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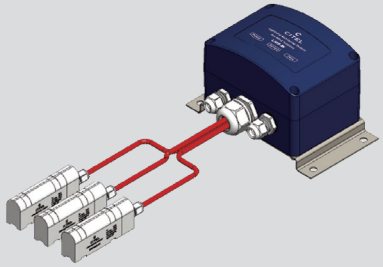

LMS-W Series

User Manual

Lightning Monitoring System for Wind Turbines

N211002b-EN

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SAFETY INSTRUCTIONS

-Installation must be performed only by electrically skilled operator;
-National electrical installation rules must be followed;
-According to the document, this product is only used for lightning current monitoring.

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1 - Introduction

1-1 Overview LMS-W Series

Lightning strike events are very frequent on the blade of wind turbine, due to the combined action of the impact mechanical energy and electrical thermal energy formed by the lightning current, it is easy to cause faults such as partial carbonization of the blade, trailing edge cracking or even breakdown, which will cause the wind turbine to stop running. Not only the power generation efficiency of the wind turbine is reduced, but also the maintenance cost is very high.

From the perspective of maintenance, engineers need to investigate the lightning strike time, lightning strike blade position, and lightning current amplitude in order to accurately judge whether there is a risk of lightning strike failure on site. Obviously, maintenance engineers cannot continuously monitor the lightning information on-site, and the card record reading method requires more time and work, but the use of wind turbine intelligent lightning monitoring system (LMS-W) can meet the application requirements.

▪ **LMS-W mainly has the following functions:**

Wide range lightning current monitoring (10/350μs) : max.250 kA lightning current amplitude, the occurrence time of lightning stroke and the position of lightning blade; it can provide the calculated value under the typical waveform (10/350μs) of the first return lightning strike current. According to the different monitoring requirements of lightning current levels, there are two levels available for selection: LMS-W(standard version) and LMS-W-HL (high level version).

▪ Store the lightning monitoring information and transmit the data to the upper computer in real time through RS485 communication, and then the lightning current can be monitored through SCADA system to assess the safety risk of blade lightning damage.

▪ Three sensors monitor independently

The lightning current information of the three blades is monitored independently. The sensor passively collects the lightning strike signal and transmits it to the monitoring unit through the optical fiber channel without electromagnetic radiation interference. The signal photoelectric conversion ensures the reliability of the lightning current monitoring data.

▪ High precision measurement

Based on the excellent inversion algorithm, good built-in circuit design and fiber anti-jamming design, LMS-W can achieve high accuracy and high immunity level in low frequency electromagnetic interference environment.

▪ High EMC immunity level

The LMS-W has passed the stringent EMC and EMI tests, and meets the requirements of IEC 61000 and CISPR standards. The LMS-W has passed the EMC test conducted in the laboratory. Please refer to the test report for the qualified test.

▪ Built-in alarm output port

The customer can customize the lightning current alarm threshold according to factors such as blade characteristics, thunderstorm conditions. When the lightning current of the monitoring channel reaches the alarm threshold, the state of the alarm output switch signal is switched.

▪ Wide operating voltage range

The power supply design based on the rectifier bridge can support AC and DC power input, allowing misoperation of wiring when power < 3W. DC Power: 24Vdc/ac Nominal: DC: 9Vdc min~36Vdc max; AC: 6Vac min~30Vac max.

▪ Strict lightning test verification

LMS-W has been tested by Shanghai Lightning Protection Center and CITEL professional LCS laboratory. The test conditions are completely based on the lightning current characteristics under the condition that the wind turbine blade is subjected to the first return stroke. The test results fully meet the expected accuracy requirements.

1-2 Main Technical Parameters

CITEL Module(Full product)	LMS-W (Standard Version)	LMS-W-HL (High Level)
Product description	1unit LMS-W0+3 unit LMS-W1	1unit LMS-W0+3 unit LMS-W2
Monitoring parameter	Monitor lightning current amplitude, Located lightning strike blade passage and occurrence time, Calculate the typical charge and specific energy under the 10/350μs waveform etc.	
Lightning current range(10/350μs)	10kA ~ 200kA	20kA ~ 250kA
Measurement error	50kA~200kA:5%; 10kA~50kA: ±3kA	30kA-250kA,10%; 20kA-30kA,±3kA
Insulation withstand Voltage	20kV	
Lightning acquisition duration	2s(monitoring the lightning current amplitude during the first return strike)	
Storage capacity	A single blade can store 1200 lightning strike records, a total of 3600 records	
Communication mode	RS485	
Communication protocol	Modbus RTU (see instructions)	
Power supply	Wideoperating voltage range of monitoring unit : 24Vdc/ac; prevent reverse connection, sensor: passive	
Mechnical characteristics	**LMS-W0 (Monitoring unit)**	**LMS-W1 / LMS-W2 (Sensor)**
Standard assembly quantity(ste)	1	3
dimensions	150*110*98mm	94*35*22mm
Weight	1200g	80g
Wiring cable	Power input: two-core shielded wire or three-core wire (standard configuration),φ6.5~10mm Data output: six-core shielded cable (tandard configuration),φ6.5~10mm	Sensor: optical fiber, φ 2.2mm, 10m (default)
Protection rating	IP67(enclosure sealed)	IP67(epoxy filled)
Operating temperature	-40 ℃~ +70 ℃	-40 ℃~+70 ℃
Mounting	M8 screws fixed to panel, stainless steel screw (50mm)	FRB binding (reinforced fiber plastic)
Housing material	Metal shell	Thermoplastic UL 94-V0
Vibration environment	comply with EN60068-2	

Part number			
LMS-W (Complete Set=1pcs*LMS-W0+3pcs*LMS-W1)	790623	LMS-W-HL (Complete Set=1pcs*LMS-W0+3pcs*LMS-W2)	
LMS-W0 (Monitoring Unit)	--		
LMS-W1 (Standard Sensor)	7906231	LMS-W2(High Level Sensor)	--

1-3 *Working Principle*

The lightning current in the ground wire of the blade is monitored by the coil in the sensor. The current induced by the coil is converted into a constant optical signal through the conversion of the circuit. The optical signal is transmitted to the main equipment monitoring unit through the optical fiber, and then converted into an electrical signal through photoelectric conversion. The electrical signal is input to the CPU through some conversion circuits. The CPU inversely calculates and restores the lightning strike information by monitoring the signal, and then stores it in the built-in memory. Users can query the lightning strike data through RS485 communication.

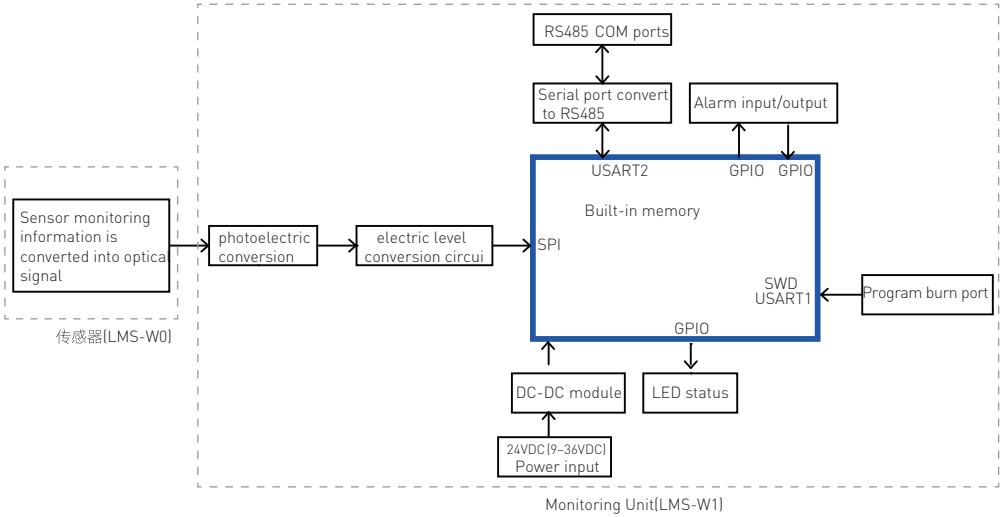
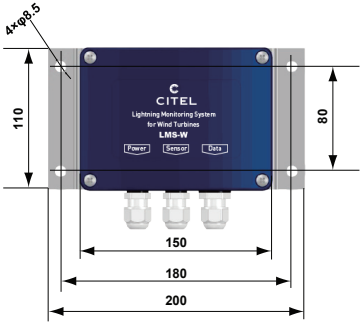


Figure 1. LMS-W(-HL) system schematic

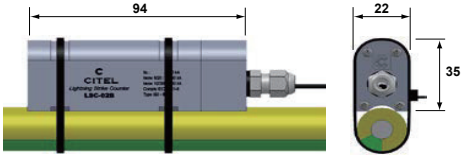
2- Installation

2-1 Mechanical Schemes



LMS-W0 (front view)

LMS-W0 (side view)



LMS-W1 (LMS-W2) (Installation diagram)

Pic 2. LMS-W Series Dimensions

2-2 Interface Introduction

2-2-1 Power supply

The norminal DC range is 24Vdc/ac, It can prevent reverse connection, applicable voltage for power supply please refer to 1-1.

For installation, the two power connections must be connected to the internal power terminals through the "POWER" port.

2-2-2 RS485 ports

RS485 ports is designed for communicating with remote computer to transmit the detecting data and monitoring instructions, this system uses half-duplex communication by the way of Modbus transmission protocol, and with standard six-core shielded cable.

The two connection lines RS485-A/B signals need to be connected to the internal data terminal through the "DATA" port.

2-2-3 PE shield connection

The communication line shield should be connected to the ground port through the "DATA" port to reduce the interference signal during RS485 communication and improve the immunity level of the system.

2-2-4 Sensor

The device is equipped with three sensor for monitring surge lightning, the sensor need to installed around the discharge conductor with FRB, and the sensor connecte to the terminal of monitoring unit by optic fiber(default 10m). At present, there are two versions of the sensor, namely LMS-W1 (standard version) and LMS-W2 (advanced version). Meet different application requirements.

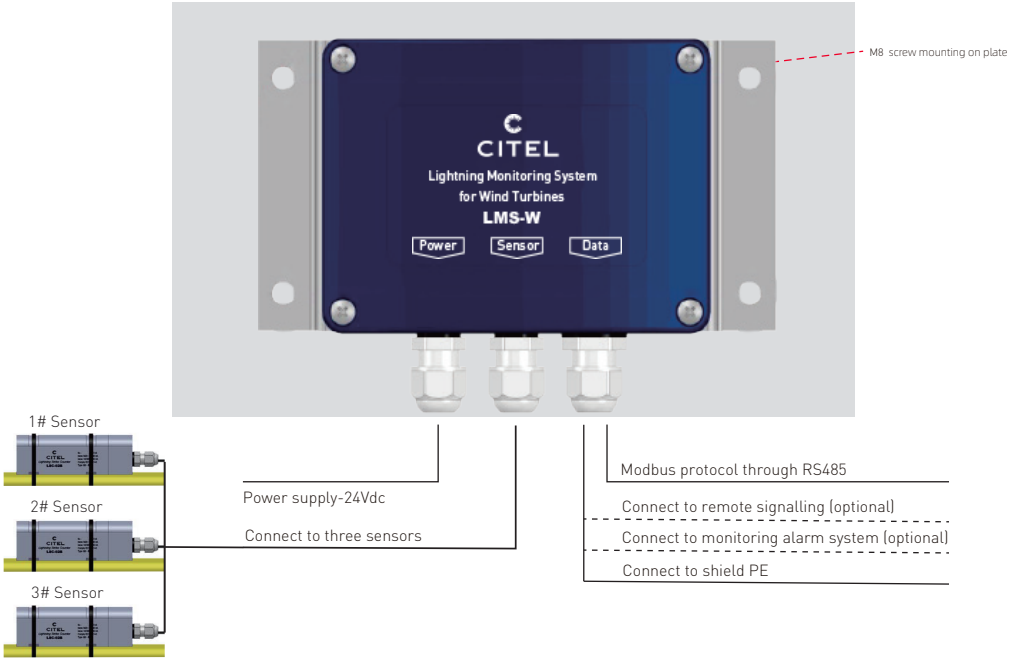
2-2-5 Switching status input

The monitoring module is equipped with two input ports for monitoring the switching input signal from remot signal and disconnectors, the receiving switch state information can queried by RS485 communication after the internal processor processed.

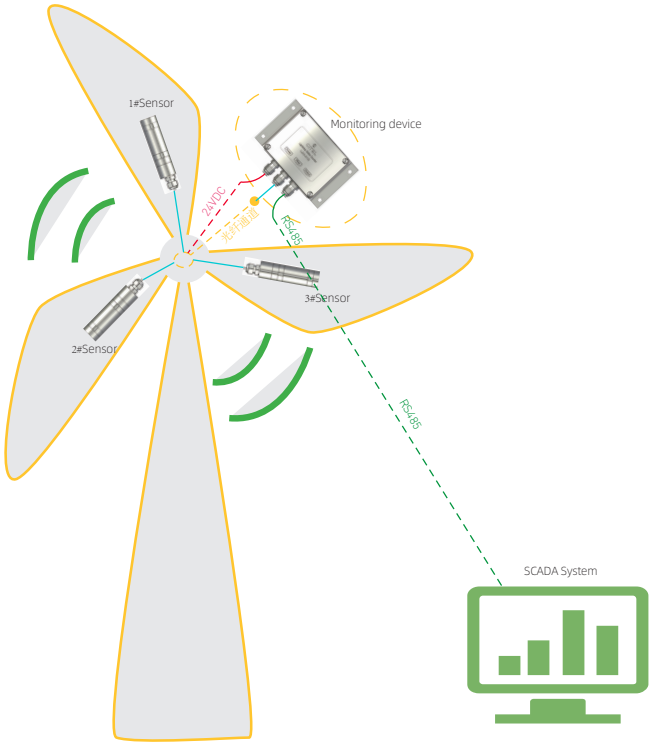
2-2-6 Lightning alarm output

Users can set the alarm mechanism through Modbus protocol, if the monitored lightning current reaches the trigger threshold, the "alarm" process will be triggered by switching the output switch signal state.

The output port is used as a feedback port for the input port, the output signal switching depends on the amplitude of the monitored lightning current, which can be defined by the user.



Pic 3. LMS-W Terminal Introduction



Pic. Sample for LMS-W wiring diagram

2-3 LMS-W Wiring Diagram

- Panel screw mounting
- Operating temperature： -40/+70 °C
- Protection rating： IP67
- Weight： 1200g(monitoring unit)； 80g(sensor/lines)
- 1.2m dual-core shielded power cable with Factory default standard , 1.2m data communication six-core shielded cable, 10m fiber optic line cable.

*Note： 1) When installing the wiring, the monitoring module is first in the off state, and then turned on after connecting the wires. Avoid false triggering due to signal interference and other factors.

2) All ports of the monitoring module should be wired as short as possible, using shielded cables to resist interference The interference performance is stronger.

3- MODBUS Protocol

3-1 Introduction

3-1-1 About Modbus protocol

Modbus is a very commonly used communication protocol and communication convention in industry. Modbus protocol includes RTU, ASCII and TCP type, and Modbus-RTU is the most commonly used, relatively simple, and can be easily implemented on single chip microcomputer.

Through Modbus protocol, controllers can communicate with each other through network, such as Ethernet, and with other devices. Modbus has become a universal industry standard and with it, control equipment produced by different manufac-turers can be connected into an industrial network for central-ized monitoring. Controller communication uses master-slave technology, that is, only one device (master device) can initiate the transport (query). Other devices (slave devices) respond accord-ingly to the data provided by the master device query. The master device can communicate with the slave device alone or broadcast with all slave devices.

3-1-2 How to realize Modbus protocol

Master device communicate with LMS-W through Modbus-RTU by RS485, the transmission medium use shielded twisted pair. Modbus RTU messages are a simple 16-bit structure with a CRC (Cyclic-Redundant Check-sum). This protocol primarily uses an RS-232 or RS485 serial interfaces for communications and is supported by almost every commercial SCADA, HMI, OPC Server and data acquisition software program in the marketplace. This makes it very easy to integrate Modbus compatible equipment into new or existing monitoring and control applications.

When configuring each controller, all devices on a Modbus network must select the same transmission mode and serial port parameters. The Modbus protocol establishes the format of the master device query: device address, functional code, all data to be sent, and an error detection field. The response message from LMS-W also consists of the Modbus protocol, including the domain to confirm the action, any data to return, and an error detection domain. If an error occurs during message receiving, or if the slave device is unable to execute its command, the slave device creates an error message and sends it back.

Device Adress	Function code	Data field	Data 1	.....	Data n	CRC check high byte	CRC check low byte

▪ **Device address**

RTU mode address field of a message frame contains eight bits. The possible address from the device is 0...247 (decimal), and the address range of a single device is 1...247. When a response message is sent from a device, it puts its address into the address field of the response so that the master device knows which device is responding.

▪ **Function code**

RTU mode functional code field in the message frame contains 8 bits. The possible code range is decimal 1...255. When a message is sent from the master device to the slave device, the functional code field tells the slave device what behavior it needs to perform. For example, to read the switching state of the input, to read the data content of a set of registers, to read the diagnostic status of the slave device, to allow the input, record, verify the program in the slave device, etc.

▪ **Data field**

Data field is composed of two sets of hexadecimal numbers, with a range of 00...FF. A pair of an RTU character sent from the master to the slave devices contain additional information: the slave devices must be used to perform what is defined by the functional code. This includes things like discontinuous register addresses, the number of items to process, and the actual number of bytes of data in the field.

▪ **CRC check**

The RTU mode is selected as the character frame, and the error detection field contains a 16 bits value (implemented with two 8-bit characters).The content of the error detection domain is obtained by looping verbose detection of the message content. The CRC is appended to the end of the message and is added first in low bytes and then in high bytes, therefore, the high byte of CRC is the last byte to send a message.

3-2 Modbus Protocol

MODBUS Protocol pls download from CITEL official website or contact with our technical engineers.

4- Lightning surge and EMC Test

Fig 5. Lightning surge tests for LMS-W in Shanghai lightning protection center.

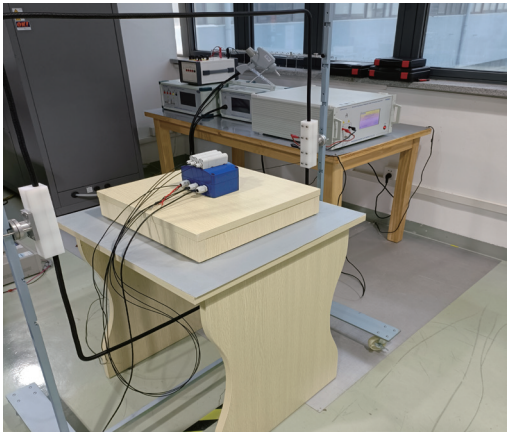


Fig 6.EMC tests for LMS-W in CITEL lab.

- Further information pls contact with our technical engineers.