LSI LASTEM
Environmental Monitoring Solutions

Sphensor™

- Network of **indoor datalogger sensors** that communicate via **radio**
- **Measurement quality** at the highest market standards
- An entire family of multi-parameter sensors with an **innovative design** for the best location in the environment
- Integration of different measures within a single **small body**
- Thread protocol, allows the creation of an **interconnected sensors network** with high extension and flexibility of geometry
- Extension of the radio range through the use of signal **repeaters**
- **Installation flexibility** thanks to a wide variety of supports
- Data sent to **LSI LASTEM** INDOOR CUBE **cloud software** or **server**
- **Local diagnostics** through multicolored led crown
- **High autonomy** of battery operation. Additional power supply via standard micro USB socket
- Three levels of **data storage**: sensor (for lack of communication), Sphensor Gateway and server with the "store and forward" function
- Availability of **additional inputs** for connection to external sensors
- Automatic calculation of **derived quantities** on LSI LASTEM cloud platform

LSI LASTEM has been designing a new kind of indoor monitoring sensors. **Sphensor™** are spherical multiparametric radio data logger sensors, they can be built up to form a **network** and can be easily integrated with the **LSI LASTEM INDOOR CUBE cloud-based application platform**. Sphensor™ have been designed with a pleasant visual impact, to be **harmoniously integrated into their surroundings**. The sensors are white spheres that act like black boxes, measuring several **physical and chemical quantities**, sending data through a robust mesh radio network to a border router (Sphensor Gateway) to be finally transferred to the LSI LASTEM **INDOOR CUBE** cloud platform.

SPHENSOR™ MODELS					
PN	**PRMPB0401**	**PRMPB0402**	**PRMPB0403**	**PRMPB0404**	**PRMPA0423**
Temperature	1	1	1	1	Of the cell
Relative Humidity	1	1	1	1	
Illuminance		5 directions	5 directions		
Dig. Temp. Ext.				2 inputs	
Atmo. Pressure	1	1	1	1	Of the cell
UVA			1		
VOC					1
PM (1,2.5,4,10)					1
CO$_2$					1
Battery R/NR	NR	NR	NR	NR	R+micro-USB

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Sphensor Gateway

▶ Possibility of **connection** via Ethernet LAN and, via accessory, 3G/4G or Wi-Fi modem

▶ Possibility of **local and autonomous generation of alarms** based on measured values, with 4 independent outputs that can be activated

▶ **Power supply** via standard mini USB socket and integrated back-up battery

▶ **Function programming** via PC software

▶ **Open architecture** for easy integration into third-party systems, through data transmission in standard market format and protocols (MQTT, JSON)

▶ Possibility of installing additional Sphensor Gateways with **back-up** functions

▶ Two models: with **single 2.4 GHz antenna** or with **dual antenna 2.4GHz and 868MHz** for integration of non-Sphensor sensors
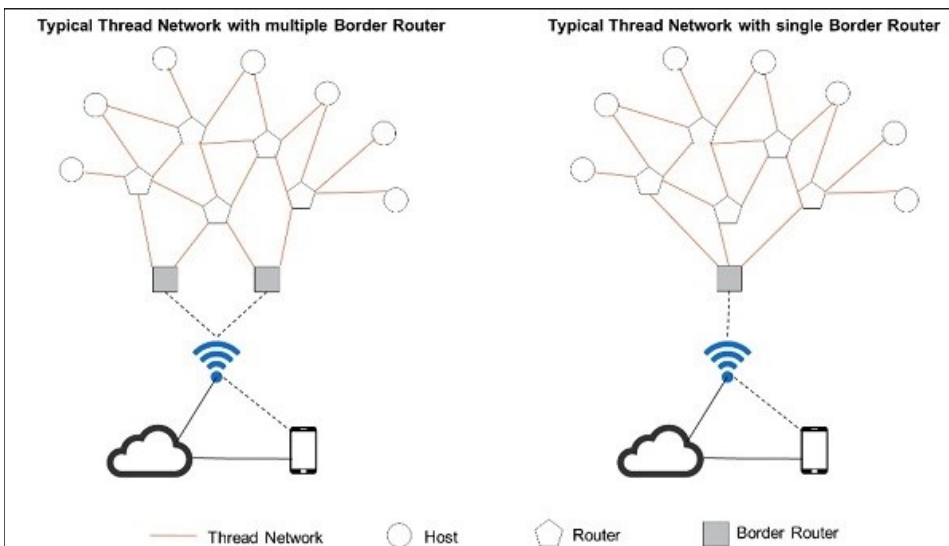
The primary function of the Sphensor Gateway is to decode and route the radio messages arriving from the sensors via the Thread protocol to the MQTT broker reachable via the Ethernet connection and, vice versa, to send the messages coming from the same MQTT broker to the sensors of the net.

The Sphensor Gateway also collects diagnostic information from the sensors in case the broker is not reachable due to unavailability of the network connection or the broker itself. The size of this memory space is determined by an editable configuration parameter.

The Sphensor Gateway also defines the system time by obtaining it from a suitably configured NTP server.

There is also an alternative internal MQTT broker or that can be used as an integration to the one present on an external server.

The Thread protocol

Typical Thread Network with multiple Border Router — Typical Thread Network with single Border Router

Thread Network — Host — Router — Border Router

▶ The **Thread protocol** allows the connection and communication of the Sphensor[TM] data logger sensor network to one or more Sphensor Gateways.

The **Sphensor Gateway** communicates via the internet with external devices and with the network management software cloud.

The **cloud software** is accessible from any point connected to the internet via PC, Tablet, mobile phone.

To enlarge the signal coverage of the Thread network it is possible to add **repeaters.**

Sphensor™ network architecture
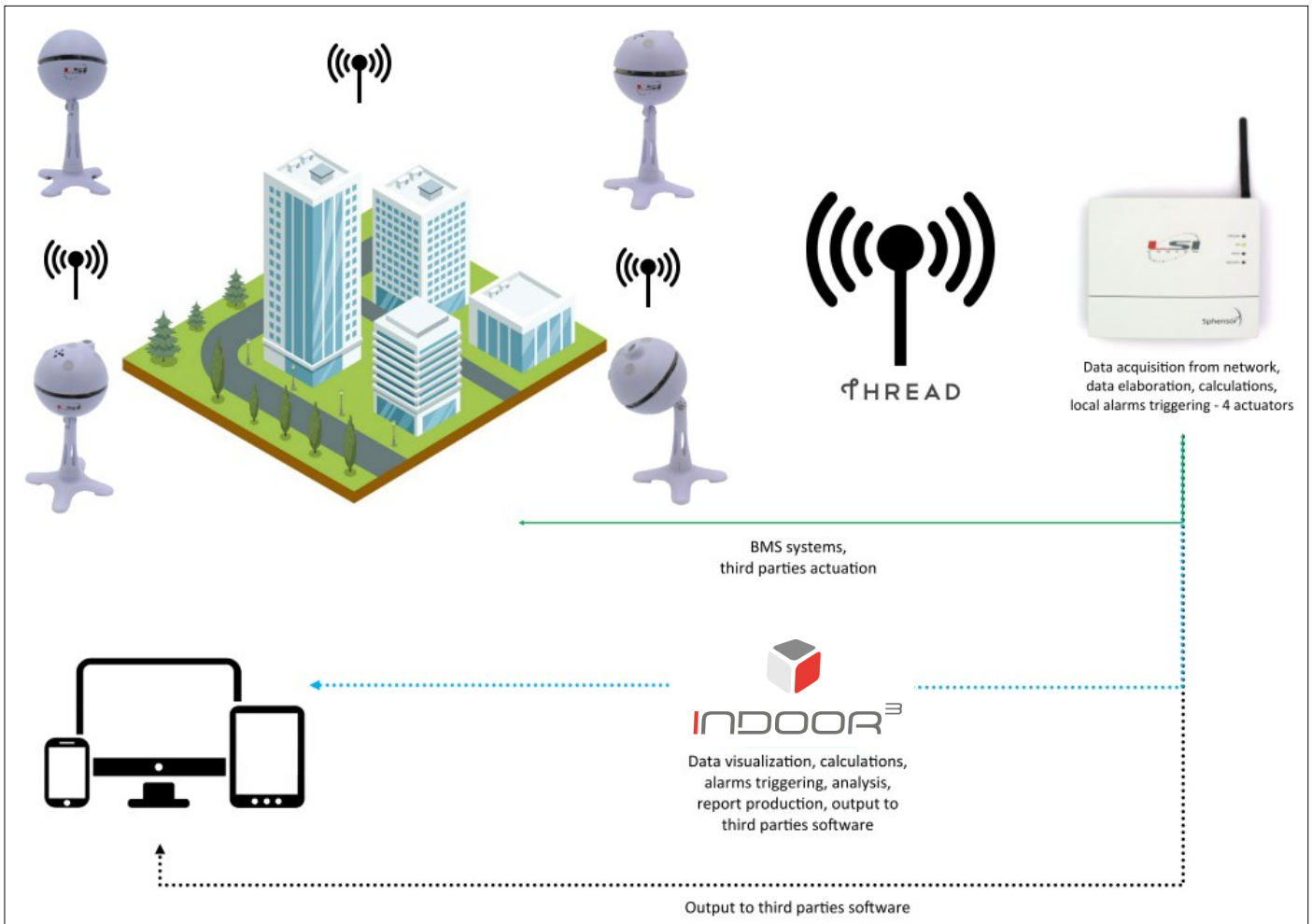
► The **Sphensor™** *data logger sensors form an indoor sensor network and communicate with each other and with the Sphensor Gateway via **2.4 GHz radio, Thread protocol**. The Sphensor Gateway (TXRGB1101) with **dual antenna** can receive signals from sensors that communicate on the **868 MHz frequency**.*

*The **Sphensor Gateway** acquires data from the network and processes them locally, allows local data storage, the execution of calculations and the implementation of alarms via 4 implemented outputs. The Sphensor Gateway can also act directly on third-party **BMS systems** (Building Management Systems) to regulate the environmental conditions of buildings.*

*The data are sent from the Sphensor Gateway via the internet to the **LSI LASTEM INDOOR CUBEcloud software** for managing and saving data. The data can also be automatically exported directly from the Sphensor Gateway or by passing through the cloud software to **specialized third-party software**.*

The INDOOR CUBE cloud platform

Sphensor™ sensors are managed by the **INDOOR CUBE** cloud platform**,** with desktop and mobile version. The features are:

- **Dinamic dashboard visualization** with last data
- **LSIndex** visualization, the synthetic index for indoor environmental quality
- **Calculate quantities** configuration
- **Historical data** visualization and download, **comparisons**
- **Alarm** setting
- **Report** download

(*see catalogue MW9006-ENG-15-LSI-INDOOR-CUBE*)

Sphensor™ Applications

Sphensor™ sensors are designed for **long-term monitoring** of physico-chemical quantities of indoor environments.
The goal of this line of multi-parametric wireless data logger sensors is to monitor the **healthiness** of indoor environments, or the **IEQ** (Indoor Environmental Quality) Monitoring, which includes **IAQ** (Indoor Air Quality).

Among the strengths of the system is the ability to monitor the **state of the environment in real time**, continuously and simultaneously monitoring all the main variables for the definition of healthiness. Another key feature of the range of sensors is the **accuracy** of the measurements at the highest market standards, combined with the **modern and attractive design**, which allows the introduction of the monitoring network even in a central position with respect to the area to be monitored.

The possibility of data transmission to customer servers, to those of **system integrators** or to the **LSI LASTEM cloud platform** allows **remote control** of the quantities of interest, even in the case of complex monitoring projects. The platform allows the execution of **analyzes** and **comparisons** of data even from different environments, as well as the management of **alarms**.

All these features make **Sphensor™** the most suitable solution for monitoring:

- Museums
- Buildings (residential and public)
- Offices and Workplaces
- Schools / Universities
- Hospitals
- Shopping centers
- Close Control Laboratories and Productions

Sphensor™ Common Technical Specifications

Temperature	Principle	RTD Pt100 1/3 DIN B (Class AA EN60751)
	Measure range	-30...60°C
	Accuracy	• ±0.1 °C; Max ±0.3 °C (@20...60 °C) • ±0.2 °C; Max ±0.3 °C (@-40 ...20 °C; 60...80 °C)
	Resolution	0,015°C
	Response time (T63)	> 2 sec
	Long term stability	<0.03 °C/yr
Relative Humidity	Principle	Capacitive
	Measure range	0...100%
	Accuracy	• ±1.5 %; Max ±2 % (@25 °C; 0...80 %) • ±2 %; Max ±3 % (@25 °C; 80...100 %)
	Resolution	0.01%
	Response time (T63)	8 sec
	Long term stability	<0.25 %RH/yr
Atmospheric Pressure	Principle	Piezoresistive
	Measure range	600...1100 hPa
	Accuracy	0.18 hPa (@ 25 °C); ±0.6 hPa (@ -40...85 °C)
	Resolution	0.1 hPa
General Information	Protection grade	IP30
	Operative temperature	-30...60°C
	Sampling rate	Programmable from 1 to 600 s
	Power supply	• Lithium battery: non-recharg. 3.6 V 1.2 Ah, ½ AA, replac. • Micro-USB socket for additional external power supply.

Sphensor™ Technical Specifications

Lux (PRMPB0402-3)	Principle	Ambient Light Photodiode Sensor
	Measure direction	• 0°, 90°, 180°, 270° elevation 45° respect the sensor plane • 1 measure on the normal of the sensor plane
	Measure Range	0.1...90 klx
	Accuracy	±5% MV ± 5 lx
	Resolution	1 lx
	Sensitivity	3 lx
	Cosine response	2% (for incidence angle < 50°)
UV-A (PRMPB0403)	Principle	Indium Gallium Nitride Photodiode
	Measure direction	On the normal of the sensor plane
	Measure Range	0...200 $\mu W/cm^2$
	Accuracy	±5% VL
	Resolution	0.05 $\mu W/cm^2$

VOC (PRMPA0423)	Principle	Nanotechnological metal oxide sensor materials with multi-pixel gas measurement system
	Range (ethanol, H_2)	0...1000 ppb
	Accuracy	Ethanol: 15% of measured value
		H_2: 10% of measured value
	Resolution (ethanol, H_2)	0.2% of measured value
	Thermal drift (ethanol, H_2)	1.3% of measured value
	Operative temperature	-10...60 °C
PM (1, 2.5, 4, 10) (PRMPA0423)	Range	0...1000 µg/m3
	Precision	PM1 and PM2.5: • 0...100 $\mu g/m^3$ ±10 $\mu g/m^3$ • 100...1000 $\mu g/m^3$ ±10 % of measured value
		PM4 and PM10: • 0...100 $\mu g/m^3$ ±25 $\mu g/m^3$ • 100...1000 $\mu g/m^3$ ±25 % of measured value
	Temperature drift	• 0...100 $\mu g/m^3$ ±1.25 $\mu g/m^3$/year • 100...1000 $\mu g/m^3$ ±1.25 % of measured value/year
	Life time	24h/g > 10 years
	Acoustic emission level	25 dB
	Noise emission level drift	+0.5 dB
	Operative temperature	-10...60 °C
CO_2 (PRMPA0423)	Principle	Dual wavelength NDIR (Non Dispersive InfraRed)
	Range	0...5000 ppm
	Accuracy	<± (50 ppm + 3% of measured value)
	Response time (T63)	140 s (with measured average), 75 s (without average)
	Automatic calibration	Present: it does not require positioning of the sensor outdoors for recalibration.
	Periodic calibration	5 years
	Temperature influence	± (1+CO_2[ppm]/1000) ppm/°C (-20±45°C)
Internal Temperature (PRMPA0423)	Range	-40±60 °C
	Accuracy	±0.5 °C @ 25 °C
Internal Pressure (PRMPA0423)	Range	700...1100 mbar
	Accuracy	±2 mbar @ 20±80% RH @ 25 °C

Sampling Rate	Non-Rechargeable Battery Life			
	PRMPB0401	PRMPB0402	PRMPB0403	PRMPB0404
30"	1 year e 3 months	1 year e 1 month		
1'	2 years e 1 month	1 year e 10 months		
2'	2 years e 9 months	2 years e 5 months		
5'	4 years e 2 months	3 years e 9 months		
10'	5 years	4 years e 6 months		

Border Router Technical Specifications (TXRGB1001, TXRGB1101)

Power Supply	Connector	USB-C
	Max voltage USB-C	5,4 V
	Max current USB-C	5 A
	Switch	External switch
	Backup batteries	Lithium recheargeable, 3,7 V/11,6 Ah
	Power consumption	• During the battery rechearge: max 1 A • With full battery: max 400 mA
	Autonomy	1 day
	Charging time	15 h
Diagnostic	Green led *USB pwr*	Presence of 5 Vdc power supply from USB-C cable, full back-up battery
	Orange led *USB pwr*	Presence of 5 Vdc power supply from USB-C cable, backup battery on charge
	Green led *On*	Power on state
	Blue led *Active*	Activity state
	Red led *Alarm/Err*	Alarm status according to pre-set or error logics
Thread Radio (TXRGB1001 and TXRGB1101)	Module	Minew
	Antenna connector	SMA tilt
	Antenna	External
	Gain	2,4 GHz - 2 dBi
868 MHz (TXRGB1101)	Module	ERE
	Antenna connector	SMA tilt
	Antenna	External
	Gain	868 MHz - 2 dBi
Network connection	Connection 1	Ethernet RJ45
	Connection 2	USB key for external modem connection/key. Max current: 1A with self-resettable protection fuse
Actuators	Relays number	4
	Type	SPDT (Normal Open e Normal Close). Imax= 2,8 A—Vmax= 260 Vac
General information	Protection grade	IP20
	Operative temperature	-20...+60 °C
	Weight—Dimensions (antenna included)	500 g— 285 x 180 x 94 mm

Fixing systems

▶ *Fixing system with **BASE***

System suitable for the temporary positioning of sensors on a flat surface for easy repositioning. The system also allows the inclination of the sensor towards the horizontal up to a maximum inclination of 45°.

▶ *Fixing system with **PRIGIONIERO***

This system is very practical and allows the sphere to rotate in any direction by acting on the joint that connects it to the sphere in case of fixing on a pre-drilled rod or indoor support (see Accessories).

▶ *Fixing system to **WALL***

Directly derived from the previous method, the sensor can be easily fixed to a wall through the use of a plug (see Accessories).

▶ *Fixing system to **PLATE***

A similar method to fixing to the wall with a plug, but with greater control over the position, axis and direction of the sensor is fixing with a plate (see Accessories).

▶ ***SUSPENSION** fixing system*

Should the Sphensor be suspended from a ceiling, the stem can be replaced by a hook.
The fixing to the ball takes place in the same way as the stem, but the presence of a hole allows the passage of the wire (Accessory included).

Fixing systems

▶ *Fixing system with **MINI TRIPODE***

Possibility of anchoring the stem with nut to a mini photographic tripod for a fast and stable positioning of the sensor on a flat, inclined or uneven surface.

▶ *Fixing system with **PLIER***

▶ *Fixing system with **ARTICULATED ARM***

Accessories

	MC8113	Shank containing nut for thread W 1/4 "
	PRTHA0701	Thermo-hygrometric cell for PRMPB04xx spare part
	PRTEA0922	Contact temperature sensor for PRMPB0404. Flat cable L=5 m
	TXMRB1100	Sphensor Repeater