








- ▶ Network of **indoor 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
- ▶ 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 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	
Relative Humidity	1	1	1	1	
Illuminance		5 directions	5 directions		
Dig. Temp. Ext.				2 inputs	
Atmo. Pressure	1	1	1	1	
UVA			1		
VOC					1
PM (1,2,5,4,10)					1
CO ₂					1
Battery	Not Rech.	Not Rech.	Not Rech.	Not Rech	Rech.+micro-USB
Sphere diameter	45 mm	45 mm	45 mm	45 mm	80 mm

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

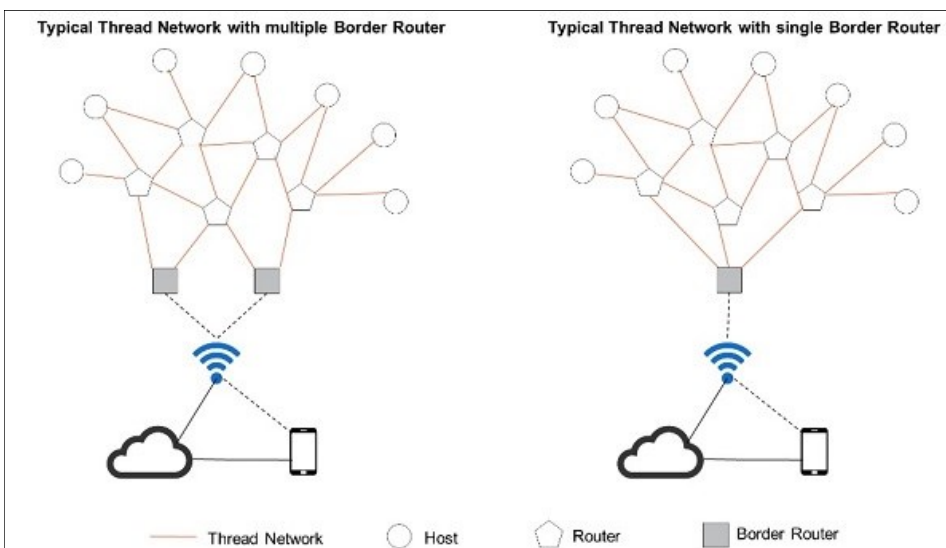
The primary function of the Sphensor Gateway is to decode and route the radio messages arriving from the sensors via the Thread protocol to the MQTT broker reachable via the Ethernet connection and, vice versa, to send the messages coming from the same MQTT broker to the sensors of the net.

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



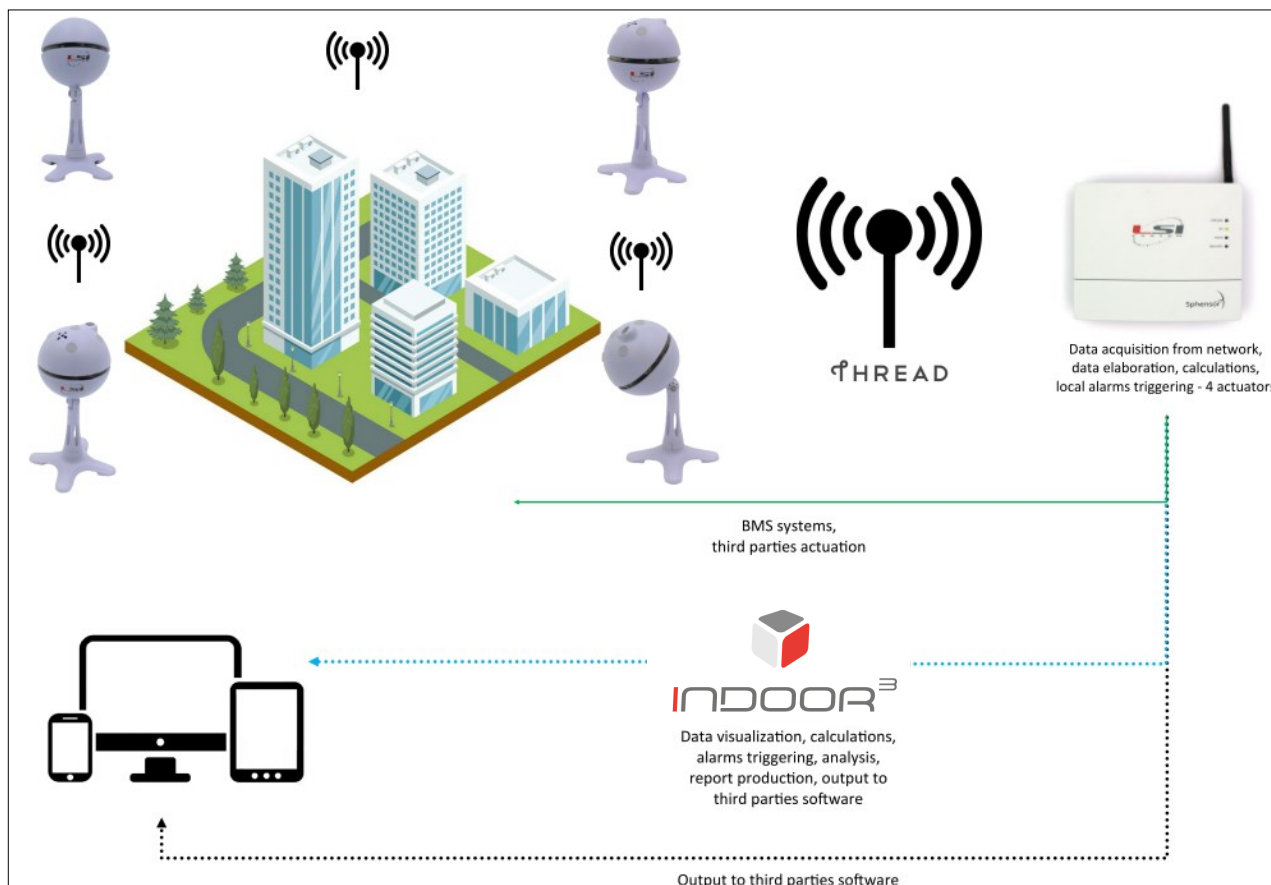
▶ The **Thread protocol** allows the connection and communication of the Sphensor™ sensor network to one or more Sphensor Gateways.

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™** 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** (see Table "Additional sensors integration").

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**.

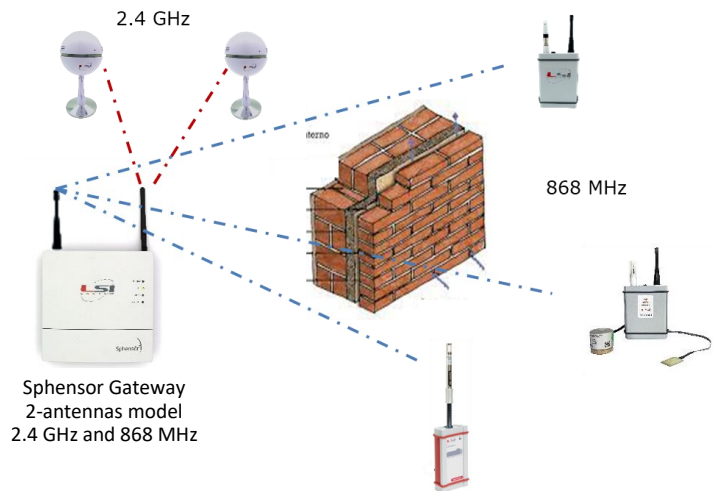
Additional sensors integration

The **Sphensor Gateway** can communicate via radio with additional sensors for both meteorological and indoor applications, such as the hot-wire anemometer (with internal radio communication), heat flow, temperature and humidity, global solar radiation and dust sensors (with external radio communication accessory).

Kit P/N	Quantities	Products' P/N	Reference
EXP125	Air velocity	EXP125	MW9001-ENG-08-Air-speed
EXP240	Thermal flow	EXP821+DPE240.1/DPE240	MW9001-ENG-11-Thermal-flow
EXP901	Temperature/Relative Humidity	EXP820+DMA875/DMA867	MW9000-ENG-05-Air-temperature-and-relative-humidity
EXP902	Global solar radiation	EXP820+DPA855/DPA863DPA952	MW9000-ENG-11-Solar-radiation-global-irradiance
EXP903	T/RH + global radiation	EXP820+DMA875/DMA867+DPA855/DPA863DPA952	MW9000-ENG-05 MW9000-ENG-11
EXP904	T/RH + PM2.5 + PM10	EXP820+DMA875/DMA867+PRMPA1002	MW9000-ENG-05 MW9000-ENG-28-Dust-PM 2.5-10

EXP81* multi-parameter radio sensors can be introduced into the Sphensor network in the presence of the dual-antenna Sphensor Gateway TXRGB1101.

The sensors communicate with **868 MHz** frequency and can **overcome communication problems in the presence of thick walls**.

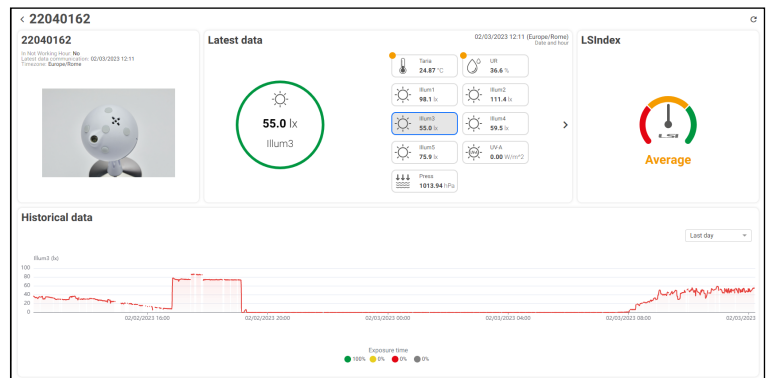


The INDOOR CUBE cloud platform

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

- **Dynamic 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
- **Monitoring project design**

(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 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 is the **accuracy** at the highest market standards, combined with the **modern design**, which allows the introduction of the sensors 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.

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	<ul style="list-style-type: none"> ±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	<ul style="list-style-type: none"> ±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	<ul style="list-style-type: none"> Lithium battery: non-recharg. 2/3 A, 2,1 Ah, replac. Micro-USB socket for additional external power supply.

Sphensor™ Technical Specifications

Lux (PRMPB0402-3)	Principle	Ambient Light Photodiode Sensor
	Measure direction	<ul style="list-style-type: none"> 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 µW/cm ²
	Accuracy	±5% VL
	Resolution	0.05 µW/cm ²

VOC (PRMPA0423)	Principle	Nanotechnological metal oxide sensor materials with multi-pixel gas measurement system
	Range (TVOC)	0...60000 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/m ³
	Precision	PM1 and PM2.5: <ul style="list-style-type: none"> 0...100 µg/m³ ±10 µg/m³ 100...1000 µg/m³ ±10 % of measured value
		PM4 and PM10: <ul style="list-style-type: none"> 0...100 µg/m³ ±25 µg/m³ 100...1000 µg/m³ ±25 % of measured value
	Temperature drift	<ul style="list-style-type: none"> 0...100 µg/m³ ±1.25 µg/m³/year 100...1000 µg/m³ ±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
CO₂ (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

	Non-Rechargeable Battery Life			
Sampling Rate	PRMPB0401	PRMPB0402	PRMPB0403	PRMPB0404
30"	2 years and 6 months			
1'	4 years			
2'	5 years			
5'	6 years			
10'	7 years			

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 rechargeable, 3,7 V/11,6 Ah
	Power consumption	<ul style="list-style-type: none"> During the battery recharge: max 1 A With full battery: max 400 mA
	Autonomy	1 day
	Charging time	15 h
Diagnostic	Green led <i>USB pwr</i>	Presence of 5 Vdc power supply from USB-C cable, full back-up battery
	Orange led <i>USB pwr</i>	Presence of 5 Vdc power supply from USB-C cable, backup battery on charge
	Green led <i>On</i>	Power on state
	Blue led <i>Active</i>	Activity state
	Red led <i>Alarm/Err</i>	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 to a **BASE** (metallic base with stem is included in each Sphensor)

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



- ▶ Fixing system to **WALL**

Removing the base, Sphensor stem can be easily fixed to a wall through the use of M4 dowel.



- ▶ Fixing system to **PLATE**

Removing the base, Sphensor stem can be fixed to a plate, using a M4 nut placed on the back side of the plate.



- ▶ **SUSPENSION** fixing system (**MAGFA2006**)




Removing the base plus stem, Sphensor can be suspended from a ceiling using a wire, in this case the stem is replaced by the MAGFA2006 fixing system.



- ▶ Fixing system to a **TRIPOD** (**MC8113**)

Removing the base plus stem, Sphensor can be fixed to a tripod using the MC8113 stem with W 1/4" nut.

Accessories

	MC8113	Stem containing nut for thread W 1/4 " tripods
	MAGFA2006	Suspension fixing system
	PRTHA0701	Thermo-hygrometric cell for PRMPB04xx spare part
	PRTEA0922	Contact temperature sensor for PRMPB0404. Flat cable L=5 m
	PRTEA4922.1	Globe temperature sensor for PRMPB0404. Cable L=2 m
	TXMRB1110	Sphensor Repeater— directly connected to power socket. Maximum consumption 1 W.