

# Installation Guide for the GBInSAR LISAMOBILE system

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## Glossary

<b>Azimuth</b>	Calculated distance of the back scattered electromagnetic signal from a point of the target area. It is the projection of the position of the point along the system's linear positioner longitudinal direction.
<b>Back scattering</b>	Signal reflected by an object hit by a radar impulse.
<b>Displacement/deformation</b>	
<b>maps</b>	Large scale and detailed extended areal graphical representations of the movements and/or displacements of the target.
<b>Frequency</b>	The number of times in which a periodical phenomenon happens in the unit of time.
<b>Interferogram</b>	Complex image resulting from the complex conjugated product of two radar images. Represented in phase, provide information related to the movements happened during the time interval between two acquisitions.
<b>JRC</b>	Joint Research Centre. European Commission research centre.
<b>Line of sight</b>	Line or direction joining two points. It joins the point in which is located the system to a specific point under observation located in the target area.
<b>LiSA</b>	Linear Synthetic Aperture radar. The system is able to measure the behavior and the damage of structures, such as ground displacement typical of landslide activity. Such a system uses a ground based interferometric sensor (GBInSAR) based on the technique of synthetic radar aperture, completed and integrated by specific software packages, developed for this purpose, to purchase, process and analyze data collected from the sensor.
<b>LiSALab (technology)</b>	Derivative technology developed by Ellegi srl on the basis of the original LiSA and of the GBInSAR LiSALab sensor. This technology belongs exclusively to Ellegi srl.
<b>Microwaves</b>	Electromagnetic waves with a wave length between 25mm and 600mm.

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<b>Power or Phase images</b>	Each pixels of a complex image representing a part (or cell) of the region in which the raw data are focalized. It can be associated to information related to the reflected signals from everything contained in the cell; therefore there are available two ways to represent the same image, in power and in phase. The first one provide an indication on the intensity level of the back scattered signals, the second one on its phase.
<b>Radiometric amplitude</b>	Intensity level of irradiated energy.
<b>Range</b>	Distance calculated by means of the signal "time of flight" and assuming that the electromagnetic waves have a speed equal to the light ( $3 \times 10^8$ m/s). It gives the distance of a point of the target area perpendicular to the system's linear positioner longitudinal direction.
<b>SAR</b>	Synthetic Aperture Radar. Radar antenna whose dimension is simulated to be bigger than the real one, sampling the antenna signals when it is in movement. This technique is useful to increase spatial resolution.
<b>Signal to noise ratio</b>	Shortened in 'S/N ratio'. It is the ratio between useful signal measured and the present background noise signal.
<b>Scan frequency</b>	Coherent emission and receiving of a frequency band in discrete packets.
<b>Scatterometer</b>	Scatterometer is a radar able to measure the capability of objects to reflect the electromagnetic energy that hits them.
<b>Spatial resolution</b>	In radar technology, it is the dimension of a measuring cell (pixel). Two objects of dimensions smaller than cell's ones have to belong to two different cells to be discriminated and/or measured.

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# Installation guide for the GBInSAR LISAMOBILE System

## Introduction

The GBInSAR LISAMOBILE system is a ground based interferometric synthetic aperture radar system, designed and developed for monitoring applications as for the ground displacement monitoring and for the structure deformation measurements.

This installation guide aims to describe the main components of the system, the installation procedure, the setting of the system and some recommendations for the use and maintenance.

For a detailed explanation of the GBInSAR LISAMOBILE system functioning and of the GBInSAR LiSALab technology please refer to the provided technical manual and to the software user's guide "User's Guide - Main LiSA Mobile".

### WARNINGS

- Precautions to be taken when installing or moving. Heavy equipment.
- Do not overload the linear positioner. Avoid torsional stress.
- Avoid prolonged exposure to heavy atmosphere agents.
- Avoid damage. Always use appropriate tools and follow the mounting & maintenance procedures.
- Pay attention to moving parts. Do not rest objects on the axis.
- It is forbidden the use in technical and/or logistical conditions where Ellegi srl has not guaranteed for the system correct functioning.
- Each component of the LISAMOBILE is labeled with its model number and serial number.
- It is recommended to use shock proof transport boxes in order to avoid damages to the system components during their transports.

## Warnings

This installation guide contains important informations on the product and for the operators' security, the management, the waste disposal, the recycle and the directives for the use of the LISAMOBILE system. Before using the LISAMOBILE system it is recommended to carefully read all the following security information and the instructions on its functioning.

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## Builder

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## System's data

Device: Ground Based Interferometric Synthetic Aperture Radar (GBInSAR).

Technology: LiSALab (© & ™). The LiSALab technology belongs exclusively to the Ellegi srl company. Such a technology is licenced to be used but not reselled according to the licence contract. Ellegi srl reserves itself all the rights not expressly granted.

Model: LISAMOBILE

Use: Interferometric measurements for the superficial displacements monitoring of terrain and structures. Interferometric measurements for the continuous environmental monitoring of catastrophic events in emergency situations

## Important security information

The data and the information collected by the LISAMOBILE system are designed to be used only by experienced professionals. These data can never substitute the professional knowledge of their users.

The people that will use these data and information are responsible of their supervision, management and control. This responsibility includes the choice of the appropriate uses for these data and information in order to obtain the desired results. The users of these data and information are also responsible of evaluating the appropriateness of independent procedures for the reliability and accuracy examination of their eventual interpretations and uses.

**Warning: the misobserving of these security instructions may cause a fire, electrical shock or other damages to people or things.**

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Status: Confidential, Public

## Using the LISAMOBILE system

Never drop down, dismount, open, crush, bend, deform, perforate, cut, burn down or insert any extraneous object inside the LISAMOBILE .

### Avoid water and damp environments

Even if the LISAMOBILE system is designed for outdoor use, never submerge it into water and never use it in environments with condensative humidity.

Pay attention not to spill any liquid or food inside the LISAMOBILE system or into any of its components. In case of water spilling inside the LISAMOBILE system, turn off the system and unplug all the cables before the cleaning and drying operations. The system can be switched again only when all the liquids are completely dried. Avoid the use of an external heating source (e.g. a blow dryer) for the LISAMOBILE system drying.

## Fixing the LISAMOBILE system

It is forbidden fixing or modifying the LISAMOBILE system. The LISAMOBILE system components are not fixable by the user. If the LISAMOBILE system was submerged into water, perforated or damaged, avoid its use and contact the Ellegi srl technical assistance.

The rechargeable battery of the LISAMOBILE power base can be replaced only by Ellegi srl technicians.

Carefully read all the security instructions of all its products and accessories before using the LISAMOBILE system. Ellegi is not responsible of the functioning of third-parties accessories or their compatibilities with the security standards and directives.

The power unit inside the LISAMOBILE power base can heat up while functioning.

Always leave an appropriate breathing space around the LISAMOBILE power base and always handle with care.

Unplug the LISAMOBILE power unit if:

- The power cable and/or its plugs are worn out or damaged;
- the Power Base was exposed to rainfall, liquids or excessive humidity;
- The power base protective casing is damaged.

## Avoid eye straining

Avoid eye straining watching the system display or reading textures on the power base for a prolonged time. To avoid eye straining watching the PC display for a prolonged time it is recommended to have several breaks.

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## Glass components

The external cover of the LISAMOBILE power base display is made of glass. It can break if the system is dropped down or hit hard. Avoid touching or removing it if the glass is chipped or crushed and immediately contact Ellegi srl. Never use the LISAMOBILE system until the broken parts are replaced by Ellegi srl technicians.

Warranty does not respond for broken glasses due to improper or excessive use.

## Exposition to radiofrequency energy

The LISAMOBILE system contains a radio transmitter and radio receiver. When it is switched on, the LISAMOBILE system antennas send and receive radio-frequency energy (RF).

The LISAMOBILE system is designed and built respecting the allowed limits and the directives for the RF energy exposition.

To reduce the risks deriving from the exposition to the RF energy it could be effective to reduce the use of the LISAMOBILE system because of the relation between the working time and the quantity of emitted RF energy. Moreover, being the energy levels dependant by the distance from the system, it could be useful to increase the distance between the user and the system.

The actual directive recommends not to come nearer than 0,5 m from the transmitting antenna in order not to overcome the thresholds for the population exposition, while the attention values and the quality objectives are respected at frontal distances higher than 3 meters. It is recommended that no one stops in this area for more than four hours.

### More information

For more information on the scientific research about the exposition to RF energy please consult the research database on electromagnetic fields (EMF) of the World Health Organization site: [www.who.int/emf](http://www.who.int/emf)

## Radio frequency interference

Almost every electronic device is influenced by radio frequency interference coming from external sources if not properly protected, designed or configured. The LISAMOBILE system could then generate interferences with other devices.

The following information can avoid interference problems:

### Vehicles

RF signals could interfere with the electronic systems installed or not properly protected on motor vehicles. Refer to the vehicle builder or its representative for further informations.

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## **Electronic devices**

The majority of the modern electronic devices are protected from RF interferences. However it is possibile that some electronic devices are not protected against the RF signals of the LISAMOBILE system. If there is a suspect of a possible interference, immediately turn off the LISAMOBILE system.

## **Medical devices**

In case of use of medical devices, refer to the device builder or to a doctor to determine if the device is properly protected against external RF energy.

Turn off the LISAMOBILE system inside medical structures if this is explicitly specified by security warnings. The devices used in hospitals and sanitary structures might be vulnerable to external RF energy.

## **Important information on the use and handling of the LISAMOBILE system**

**WARNING: the disregard of these instruction might cause the damage of the LISAMOBILE system or of other ownerships.**

### **Trasporting the LISAMOBILE system**

The LISAMOBILE system has delicate components. Avoid bending, dropping or crushing the LISAMOBILE system.

### **Using plugs and sockets**

Never force a plug into a socket.

Verify eventual obstructions of the socket. If the plug and the socket do not connect easily, probably they don't match. Verify that the plug matches the socket and that they are correctly aligned.

### **Keep the LISAMOBILE system into a controlled temperatures range**

The ideal temperatures range for the use of the LISAMOBILE system is between -20 °C and +55 °C.

The battery duration could temporary decrease at low temperatures.

The ideal storing temperatures range for the LISAMOBILE system is between -20° and +70° C.

It is normal that the LISAMOBILE system heats up when it is switched on and/or its battery is recharging.

Keep clean the LISAMOBILE external protective casing. For the LISAMOBILE cleaning operations, switch off the system and unplug all its cables. Use a soft and moist cloth that won't leave fibers on the system components.

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Avoid the entering of humidity into the system openings. For the LISAMOBILE cleaning avoid using glass cleaners or generic home cleaners, spray cleaners, alcohol, cleaning solvents, ammonia or abrasive products.

## Information on the waste disposal and recycling

The LISAMOBILE has to comply to the local laws and regulations about waste disposal. Because this system contains a battery and electronic equipments it should not be treated as household waste.

Always contact Ellegi srl or the local authorities for the information on the LISAMOBILE system waste and recycling disposals.

## European Community Compliance Statement

The equipment complies with the RF Exposure Requirement 1999/519/EC, Council Recommendation of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0- 300GHz).

This equipment meets the following conformance standards: EN 300 328, EN 301 894, EN 301 489-17, EN 50385

EMC Complies with European EMC directive 89/336/EEC, amended by 93/68/EEC IEC/EN 61326

Safety Complies with European Low Voltage Directive 73/23/EEC, amended by 93/68/EEC IEC/EN 61010-1:2001

Europe—EU Declaration of Conformity

Ellegi Srl declares that this system complies with the essential requirements and all the disposals concerning the 1999/5/CE directive.

## System components

The GBInSAR LISAMOBILE system consists of five main components that should be separated during the system transportation and has to be assembled on site (see pictures below, Figure 1):

1. Power cable (model number LMPC);
2. Umbilical cable (model number LMUC);
3. Power base (model number PBLM);
4. Measuring head (model number LM);
5. Linear positioner (model number PLLM).

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1 - Power cable LMK09PC;  
 2 - Umbilical cable LMK09UC;  
 3 - Power base PB LMK09;  
 4 - Measuring head LMK09;  
 5 - Linear positioner PLLMK09.

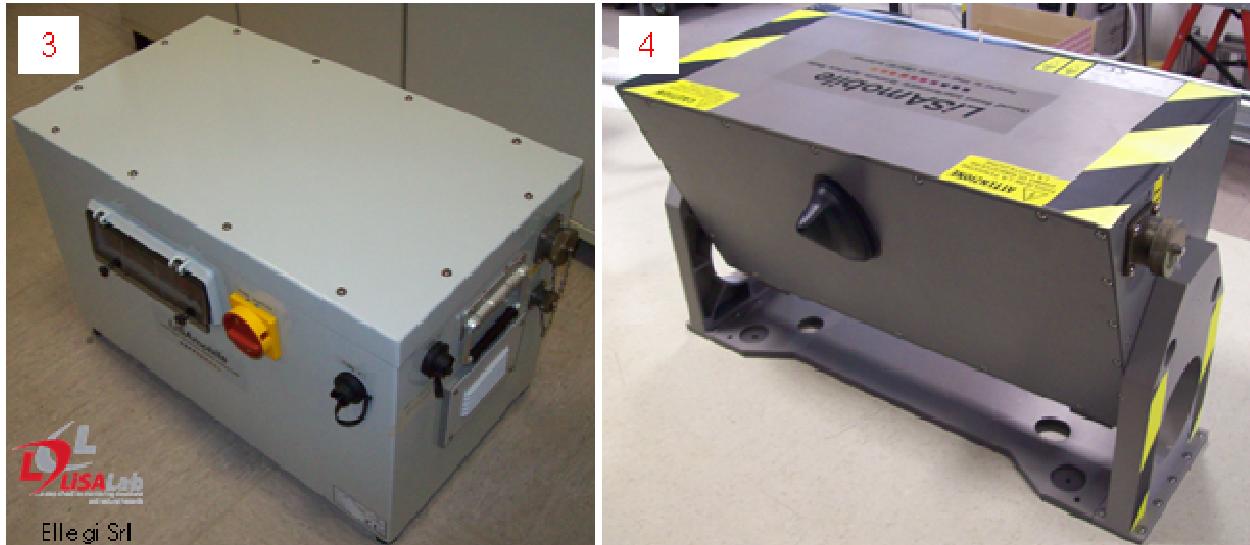


Figure 1: LISAMOBILE components.

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## System components main features

**1. Power Cable LMPC:** the power cable LMPC is used to connect the power base PBLM to a power line. One end of the power cable has a standard IEC309 16A 6AH 1PH+N plug power connector and the other end has a 3 pins standard MIL size 16 socket (Figure 2).

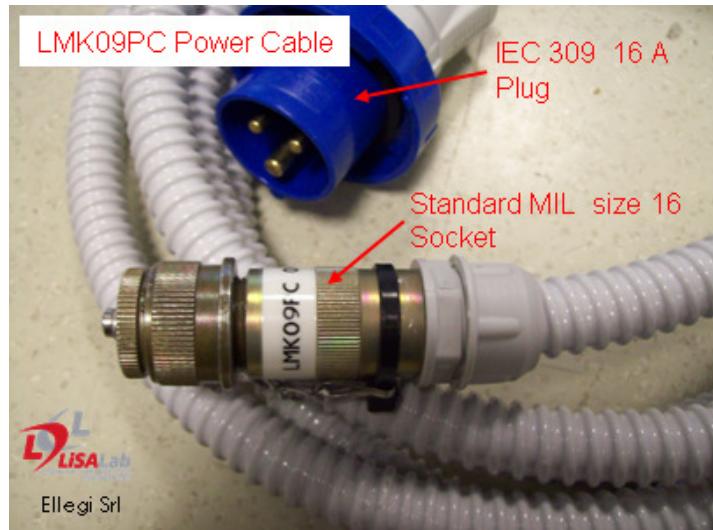


Figure 2: LISAMOBILE LMPC power cable and its connectors.

**2. Umbilical Cable LMUC:** the umbilical cable LMUC to connects the power base PBLM to the linear positioner PLLM. At each end of the umbilical cable there is a 22 pins standard MIL size 28 connector; the side of the umbilical cable that has to be connected to the power base has got a socket whilst the side that has to be connected to the linear positioner has a plug (Figure 3).

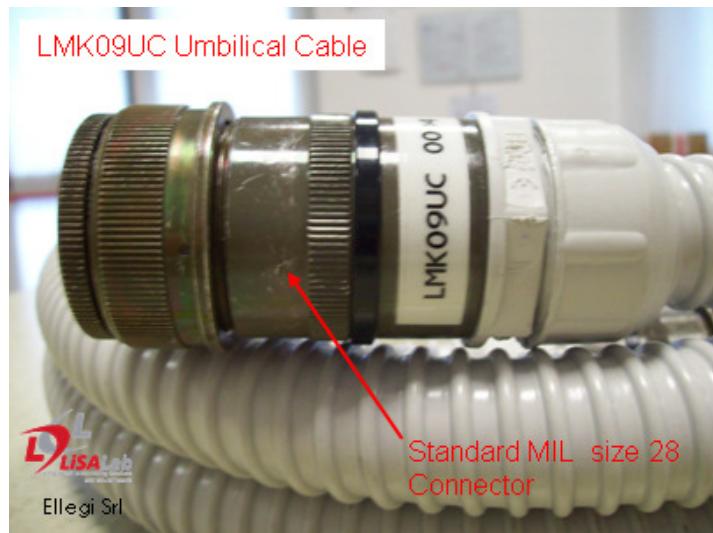


Figure 3: LISAMOBILE LMUC umbilical cable and one of its connectors.

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**3. Power base PBLM:** the power base contains the electronic devices needed in case of a power line fault and the computing and storage facilities needed for the management of the data acquired by the GBInSAR LM system. On its frontal side it features an LCD display equipped with a keypad, two switches, two status LEDs, a security switch and a LAN socket. On its lateral side it features the power line plug (3 pins standard MIL size 16 plug), the umbilical cable socket (22 pins standard MIL size 28 socket) and a second LAN socket (Figure 4).

On the sides of the power box there are two air vents that ensure the air circulation and the cooling of its electronic devices.

### WARNING

When the system is switched on, never obstruct the two air vents at the sides of the power base.

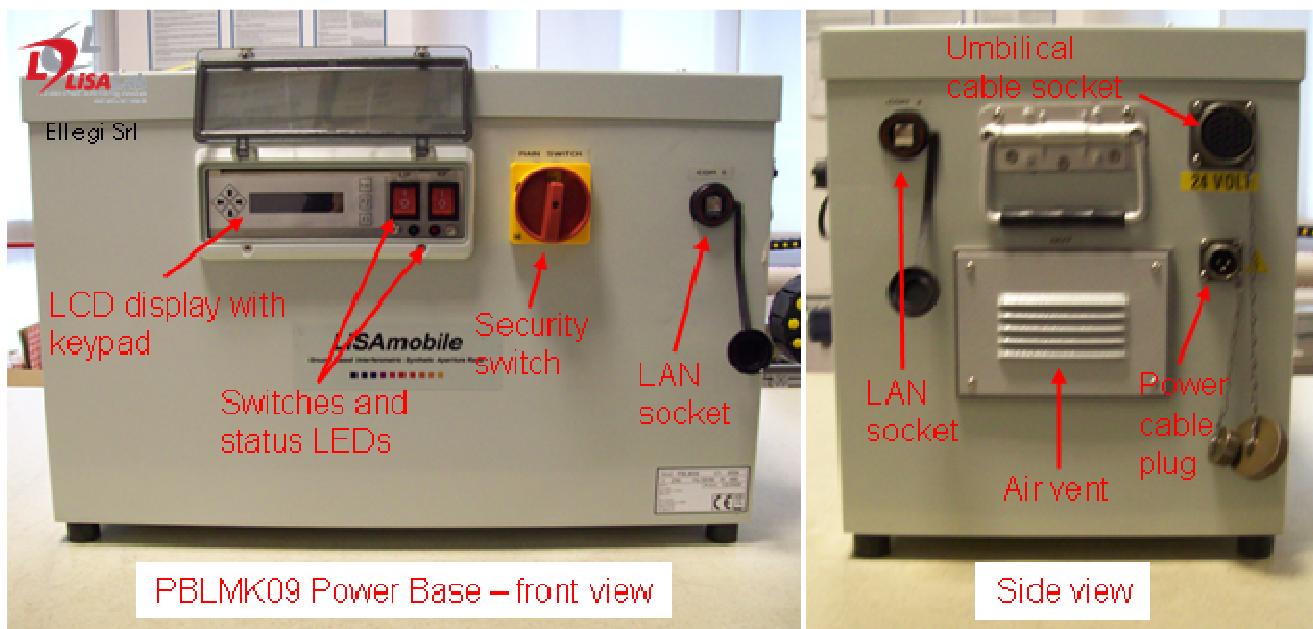


Figure 4: LISAMOBILE PBLM power base main features. Front view (left) and side view (right).

**4. Measuring head LM:** it is the core component of the LISAMOBILE system and it contains the electronic and the electromagnetic devices needed to perform the radar measurements.

The measuring head is equipped with a protractor that allows its rotation of a desired angle on a horizontal axis in order to point the radar antennas towards the target area. When the measuring head is not mounted it is recommended to point the antennas downwards (see the “transport position” in the figure below).

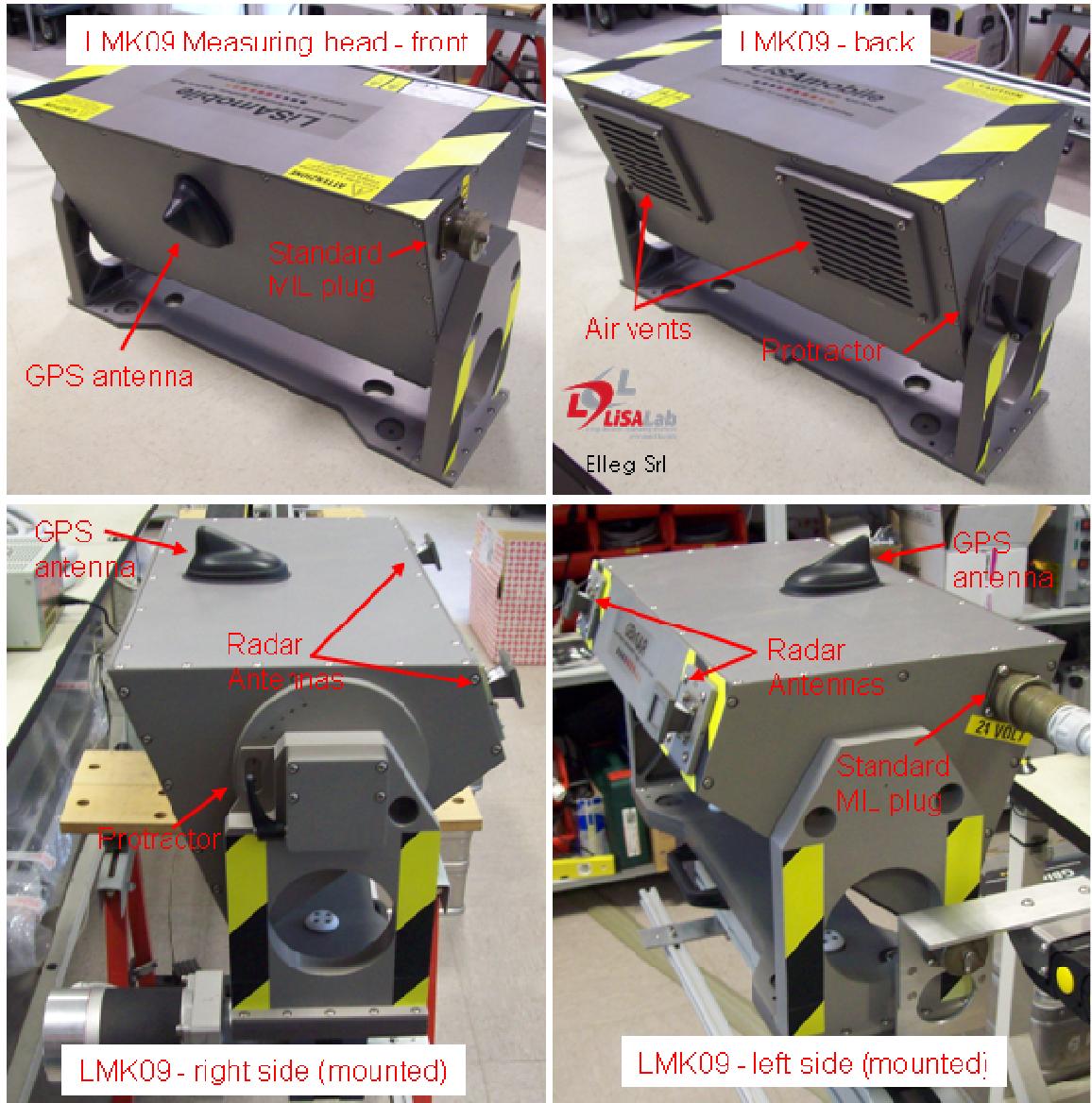
The GPS antenna is on the top of the measuring head while the air vents are located on its lower part. On the left side of the measuring head there is a 14 pins standard MIL size22 plug that is used

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to connect the measuring head with the other electronic devices of the LISAMOBILE system (Figure 5).

## WARNINGS

- When switched off, keep the measuring head in the transport position (antennas downwards).
- When the system is switched on, never obstruct the two air vents under the measuring head.
- Always make sure that the protractor is firmly ensured in the desired position.
- Always HANDLE WITH CARE the measuring head.
- Never switch on the system with the measuring head in the transport position.
- Do not cover the GPS antenna and the radar antennas.
- While measuring don't stand in front of the radar antennas. If the system is switched on but not measuring, keep at least 20 cm away from the antennas.



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Figure 5: LISAMOBILE LM measuring head main features. In clockwise direction starting at the upper left picture: transport position front view, transport position back view, measuring position left side and measuring position right side.

**5. Linear positioner PLLM:** it is the component of the LISAMOBILE system that ensures the measuring head displacement. It is composed of an aluminium linear rail with a moving sledge that can be moved forwards and back along the rail, a high performance stepper motor, three security switches, a junction box, a cable chain and two fixing plates (Figure 6).

The junction box has a plug for the umbilical cable for the connection with the power base and a 14 pins standard MIL size 22 socket for the connection with the cable in the cable chain that will link it to the measuring head. The measuring head has to be mounted on the moving sledge and connected to the rest of the LISAMOBILE system using the cable inside the cable chain. The fixing plates are needed to secure the linear position in a stable way; each one has four holes customized for bail heads 1/4 turn studs and four holes suitable for M5 screws.

### **WARNINGS**

- Always ensure that the fixing plates are secured to a stable base before mounting the head.
- Before running the system remove any possible obstacle to its moving parts.
- Pay attention to the moving parts and never touch them when the system is switched on.

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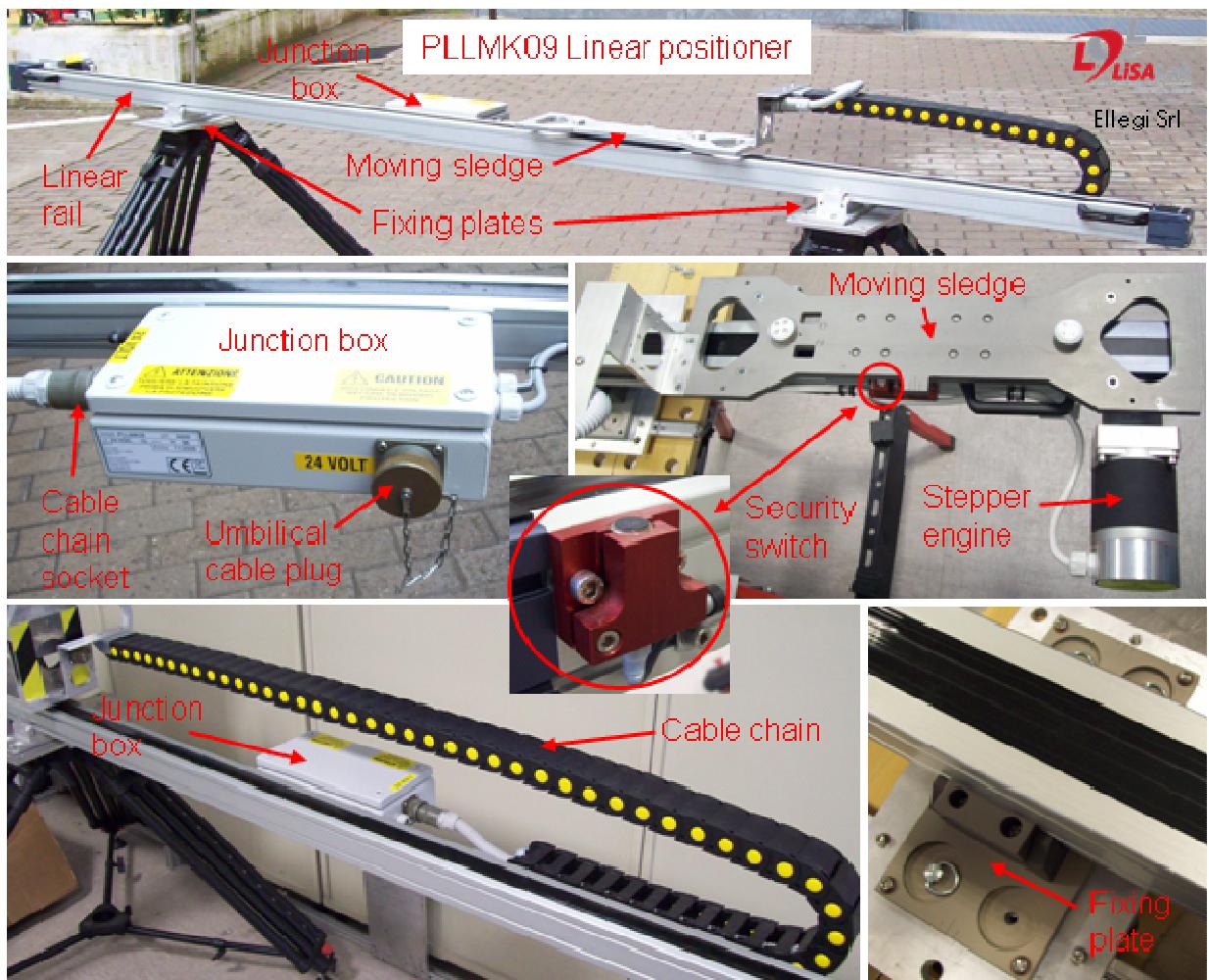


Figure 6: LISAMOBILE PLLM linear positioner main features.

## Mounting the GBInSAR LISAMOBILE system

The linear positioner plates are equipped with custom made counterplates that have to be installed and left in each monitoring site in order to allow the repositioning of the system. If no repositioning is needed, at the end of the monitoring campaign also the counterplates can eventually be disinstalled. Figure 7 shows a system counterplate with its main features. There is a central pin that will insert in the lower part of the linear positioner fixing plates. There are also four press-in receptacles with locking stops for the insertion of the bail head 1/4 turn studs that will secure the systems fixing plates to the counterplates. If needed, on the counterplates are also available four M5 screw threaded holes (e.g. for the fastening with M5 security screws).

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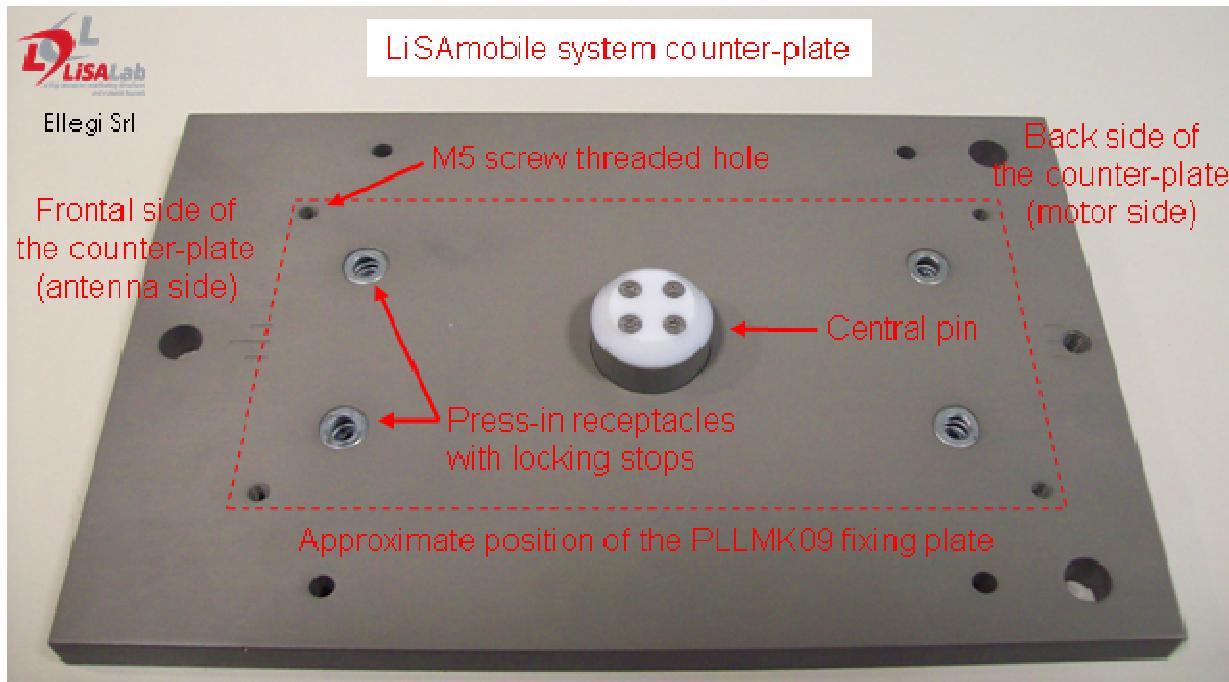


Figure 7: LiSA Mobile counter-plate.

The counterplates have to be attached to a stable basement (e.g. H-beam steel concrete structure) in order to allow the system to be safely installed. The counterplates have to be attached to the basements using suitable mechanic solutions depending on the basement's characteristics.

The LISAMOBILE system can provide reliable data only if it is mounted on a stable basement.

NOTE: in order to preserve the correct alignment it is recommended to attach the counterplates to the basement having them mounted on the linear positioner plates.

The counter plates are not symmetric, the side with only one Ø 11 mm hole must be on the frontal part of the system (towards the observed scenario).

Once the counterplates are firmly attached to a stable basement, the following general procedure aims to give a simplified guideline in the installation of the GBInSAR LISAMOBILE system. Each one of these steps has to be fully carried out before proceeding to the following one.

1. Set down the linear positioner (PLLM) with its fixing plates positioned on the counterplates that are attached to the basement. The central pin on the counterplate should insert in the lower part of the fixing plates.

NOTE: before securing the plates to the counterplates ensure that the counter-plates pins are touched on their rear and right side, i.e. once the counter-plates pins are inserted in the linear

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