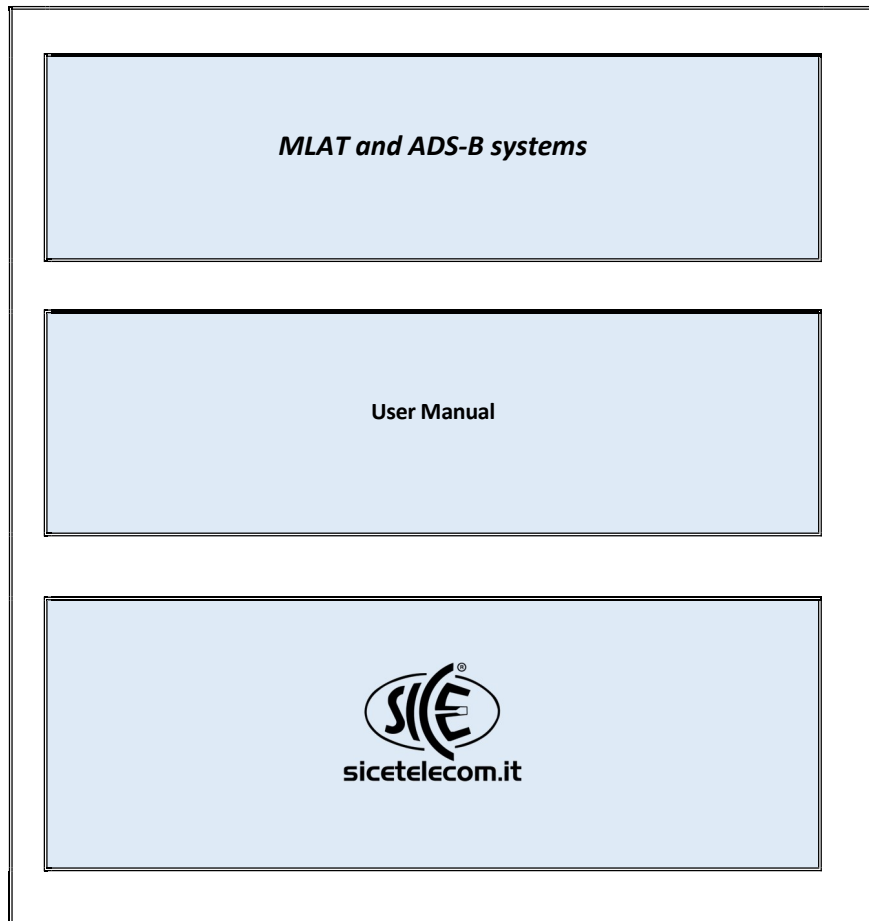


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Document information		
Wrote by	Francesco Vigolo	Data: 18/04/2025

Version n.	Data	Description
00	18/04/2024	First release

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1 ACRONYM LIST

- ADS-B Automatic Dependent Surveillance – Broadcast
- CPF Central Processing Facility
- CRC Cyclic redundancy check
- e.g. exempli gratia, “for example”
- dB decibel
- dBm decibel referenced to power input @ 10^{-3} Watts
- HPA High Power Amplifier
- Hz Hertz
- ID Identification
- LAN Local Area Network
- LED Light emitting diode
- LNA Low Noise Amplifier
- MHz 10^6 Hz
- MLAT MultiLATERation
- MTBF Mean time between failures
- N.A. Not Applicable
- PC Personal Computer
- pn part number
- RTX Receiver and Transmitter
- RX Receiver
- SYNCHRO Synchronizer
- TOA Time Of Arrival

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2 INTRODUCTION

This document defines the operative and maintenance activities used in MLAT and ADS-B systems.

Main instructions for safety are marked by a special symbol in order to remind operators usual or special recommendations and warnings to use, configure and handle MLAT/ADS-B equipment.



Figure 1 – Recommendation symbol



Operators have to read carefully the whole information on this manual. Not conformity operations might cause damages to things, equipment or people.



Operators have to be properly trained before install, switch on, manage, configure, etc equipment.



Devices are usually included in special shelters or restricted areas, so avoid unintended people come in contact with equipment.

This manual is intended to describe the operative and maintenance activities only if devices are whole and not tampered.



Remember not to tamper with equipment.

3 APPLICABILITY

The operation and maintenance manual is evaluated for MLAT/ADS-B devices and configurations below

ATRGML0022 RTX	ATRGMS0022 RTX-SGU	AR0GML0022 RX
---------------------------	-------------------------------	--------------------------

AT0GML0033 RTX	AT0GMS0033 RTX-SGU	AR0GML0033 RX	AT0GMH0022 HIGH POWER TX	AS06012651 BOX LNA
---------------------------	-------------------------------	--------------------------	-------------------------------------	-------------------------------

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4 IDENTIFICATION

In this chapter we identify the products and the configurations requested to be assessed, as described in the previous chapter.

4.1 MLAT and ADS-B techniques

See below a generale description of MLAT and ADS-B techniques.

4.1.1 MLAT

MLAT is a navigation and surveillance technique that allows to calculate with extreme precision the position of a collaborative target. The technique is based on the measurement of the times of arrival (TOAs) of radio signals: airborne (or terrestrial vehicle on airports) transmits to multiple receiving synchronized stations, that receive and trigger the time of arrival of the signal from the target. Receiving stations send on a LAN info collected to a special CPU that processes data and determine the position of the target. CPU is provided with a special software CPF that calculates the precise position of the target based on the times of arrival of radio collaborative target.

4.1.2 ADS-B

ADS-B is a surveillance technique that allows to show the position of an aircraft declared by the target itself. Each avionic transponder sends a periodical broadcasts message concerning its position composed by satellite GPS position received by the aircraft. The message is received by an air traffic control system that is able to track the target. ADS-B is "automatic" because the signal is periodically transmitted by the aircraft without any pilot management, and it is "dependent" because the position is depending from the satellite GPS navigation system.

4.2 MLAT/ADS-B models, frequency bands and power limits

MLAT/ADS-B techniques are focused on two different frequency bands that regulate the communications airborne/Ground Stations:

- uplink from Ground Station to airborne, so MLAT/ADS-B transmits @ 1030MHz;
- downlink from airborne to Ground Station, so MLAT/ADS-B receives @ 1090MHz.

Other special devices called "SGU/SYNCHRO" are able to synchronize Ground Stations, so they transmit and receive @ 1090MHz both.

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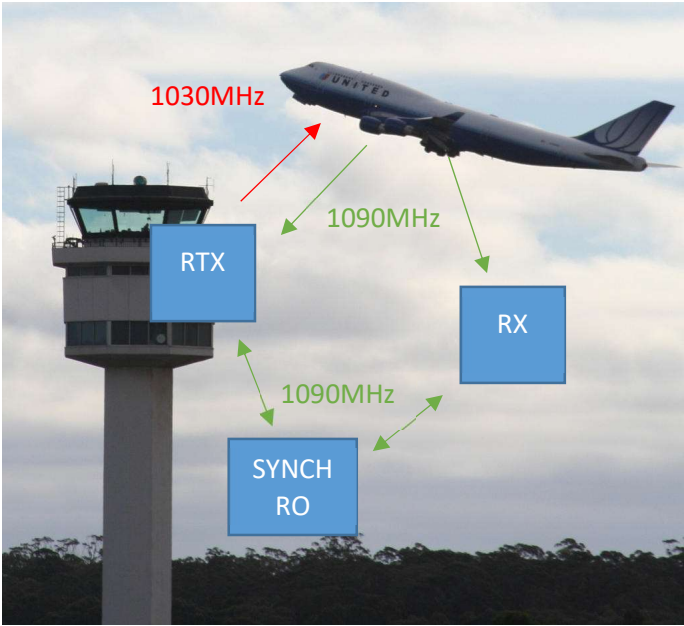
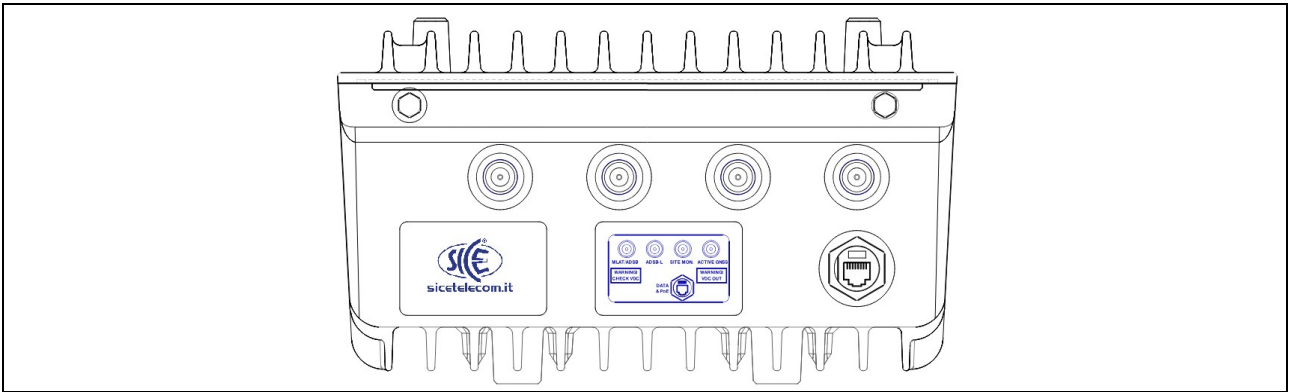


Figure 2 - MLAT/ADS-B frequency bands

4.2.1 outdoor

ATRGML0022 RTX	ATRGMS0022 RTX-SGU	AR0GML0022 RX
---------------------------	-------------------------------	--------------------------

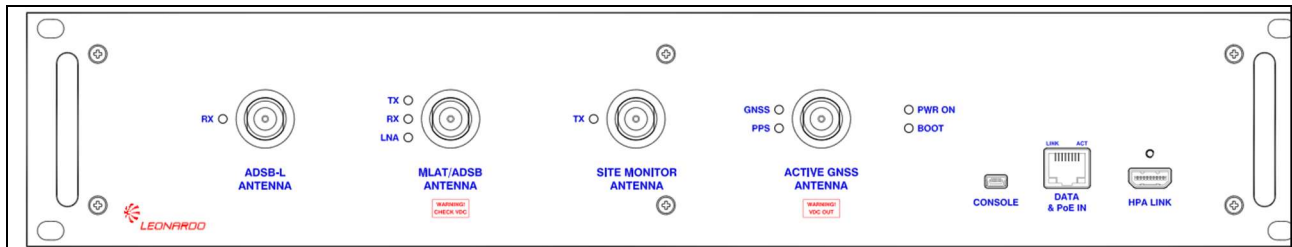


4.2.2 Indoor

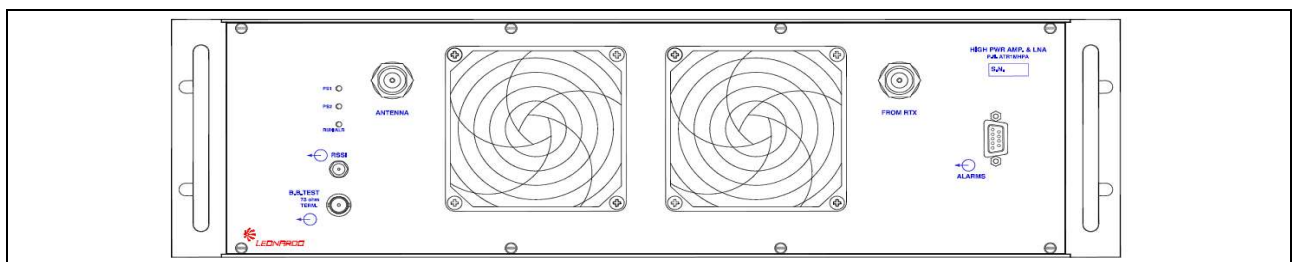
AT0GML0033 RTX	AT0GMS0033 RTX-SGU	AR0GML0033 RX	AT0GMH0022 HIGH POWER TX	AS06012651 BOX LNA
---------------------------	-------------------------------	--------------------------	-------------------------------------	-------------------------------



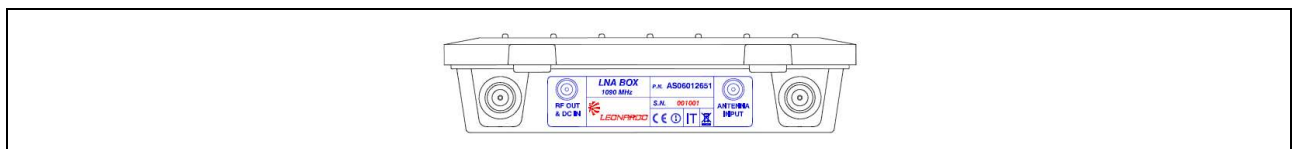
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4.2.2.1 HPA



4.2.2.2 LNA



See below the indications on frequency bands of each equipment, depending on combination of internal boards:

- *ATRGM0022-SM-FL: RX board + Tx board 1030 MHz + site monitor + flarm in full outdoor enclosure*
- *ATRGM0022-SM: RX board + Tx board 1030 MHz + site monitor in full outdoor enclosure*
- *ATRGM0022-FL: RX board + Tx board 1030 MHz + flarm in full outdoor enclosure*
- *ATRGM0022: RX board + Tx board 1030 MHz in full outdoor enclosure*
- *ATRGM0022-SM-FL: RX board + Tx board 1090 MHz + site monitor + flarm in full outdoor enclosure*
- *ATRGM0022-SM: RX board + Tx board 1090 MHz + site monitor in full outdoor enclosure*
- *ATRGM0022-FL: RX board + Tx board 1090 MHz + flarm in full outdoor enclosure*

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- *ATRGMS0022: RX board + Tx board 1090 MHz in full outdoor enclosure*

- *AROGML0022-SM-FL: RX board + site monitor + flarm in full outdoor enclosure*
- *AROGML0022-SM: RX board + site monitor in full outdoor enclosure*
- *AROGML0022-FL: RX board + flarm in full outdoor enclosure*
- *AROGML0022: RX board in full outdoor enclosure*

- *ATOGML0033-SM-FL: RX board + Tx board 1030 MHz + site monitor + flarm in 2U 19" rack enclosure*
- *ATOGML0033-SM: RX board + Tx board 1030 MHz + site monitor in 2U 19" rack enclosure*
- *ATOGML0033-FL: RX board + Tx board 1030 MHz + flarm in 2U 19" rack enclosure*
- *ATOGML0033: RX board + Tx board 1030 MHz in 2U 19" rack enclosure*

- *ATOGMS0033-SM-FL: RX board + Tx board 1090 MHz + site monitor + flarm in 2U 19" rack enclosure*
- *ATOGMS0033-SM: RX board + Tx board 1090 MHz + site monitor in 2U 19" rack enclosure*
- *ATOGMS0033-FL: RX board + Tx board 1090 MHz + flarm in 2U 19" rack enclosure*
- *ATOGMS0033: RX board + Tx board 1090 MHz in 2U 19" rack enclosure*

- *AROGML0033-SM-FL: RX board + site monitor + flarm in 2U 19" rack enclosure*
- *AROGML0033-SM: RX board + site monitor in 2U 19" rack enclosure*
- *AROGML0033-FL: RX board + flarm in 2U 19" rack enclosure*
- *AROGML0033: RX board in 2U 19" rack enclosure*

- *ATOGMH0033: High power amplifier in 3U 19" rack enclosure (stand-alone module, it operates together with a RX module in 2U 19" rack enclosure AROGML0033-xx-xx)*

RTX model, can transmit on 1030 MHz (TX, Interrogator) or 1090 MHz(SGU/SYNCHRO)

- @ 1090MHz is intended to emits a signal @ 1090MHz +/- 3MHz;
- @ 1030MHz is intended to emits a signal @ 1030MHz +/- 0.2MHz.

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The transmission power level of each TX equipment is listed in the table below:

Equipment	TX frequency band [MHz]	TX power level [W / dBm]
MLAT/ADS-B RTX	1030	250 W / 54 dBm
MLAT/ADS-B RTX + HPA	1030	2500 W / 64 dBm
MLAT/ADS-B RTX SGU	1090	250 W / 54 dBm

Table 1 – MLAT/ADS-B power levels

4.3 MLAT/ADS-B equipment

SICE designed special equipment to implement a complete system:

- MLAT/ADS-B sensors are RX or RTX devices included in indoor rack 19" or Full Outdoor case;
- MLAT/ADS-B amplification devices are in indoor rack 19" (HPA) or outdoor unit LNA).

4.3.1 MLAT/ADS-B amplification devices

MLAT/ADS-B amplification devices are equipment connected with MLAT/ADS-B sensors:

- HPA&LNA: bidirectional RTX amplification device that allows to amplify up to 3kW the 1030MHz TX signal and amplify the RX signal. This equipment is intended for indoor use deployed inside a 19" rack.
- LNA outdoor: unidirectional RX amplification device. Its case allows the installation of LNA in outdoor environment e.g. very close to the external antennas.

4.4 MLAT/ADS-B configurations and compositions

See below the schemes of typical configuration performed with detailed composition tables.

4.4.1 MLAT/ADS-B RTX [Indoor]

See below the typical configuration of a MLAT/ADS-B RX/RTX SGU/SYNCHRO/RTX:

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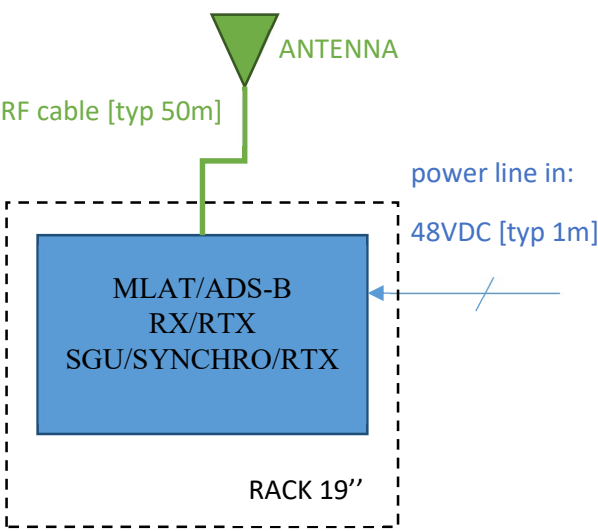


Figure 3 - MLAT/ADS-B RX/RTX SGU/SYNCHRO/RTX [indoor] typical configuration

Power in outlets MLAT/ADS-B RX/RTX SGU/SYNCHRO/RTX:

HPA	DC screw connectors	
MLAT	DC screw connectors	
	AC	External Power Supply

See below the frontal view of MLAT/ADS-B RX/RTX SGU/SYNCHRO/RTX:

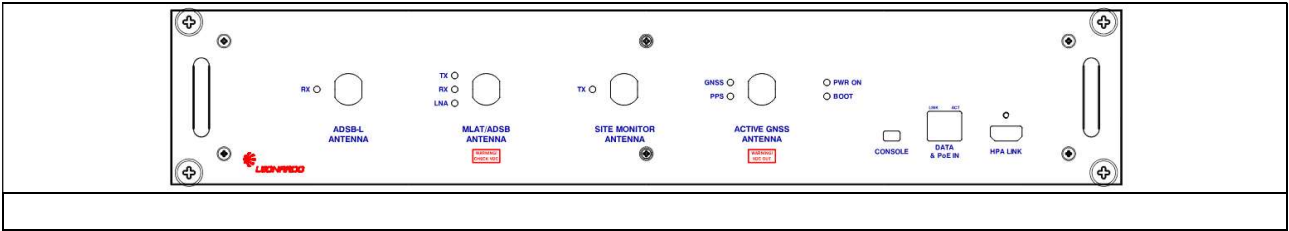


Figure 4 - MLAT/ADS-B RX/RTX SGU/RTX frontal view

4.4.2 MLAT/ADS-B RTX HPA&LNA

See below the typical configuration of a MLAT/ADS-B RTX + HPA&LNA:

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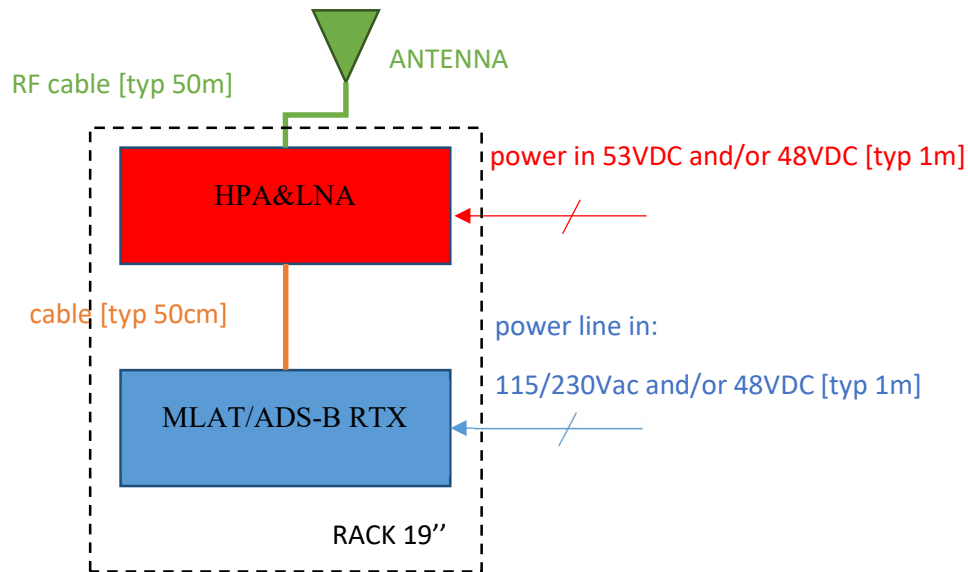


Figure 5 - MLAT/ADS-B RTX + HPA&LNA [indoor] typical configuration

Power in outlets MLAT/ADS-B RTX + HPA&LNA:

HPA	DC screw connectors	
MLAT	DC screw connectors	
	AC	External Power Supply

See below the frontal view of MLAT/ADS-B RTX and HPA&LNA:

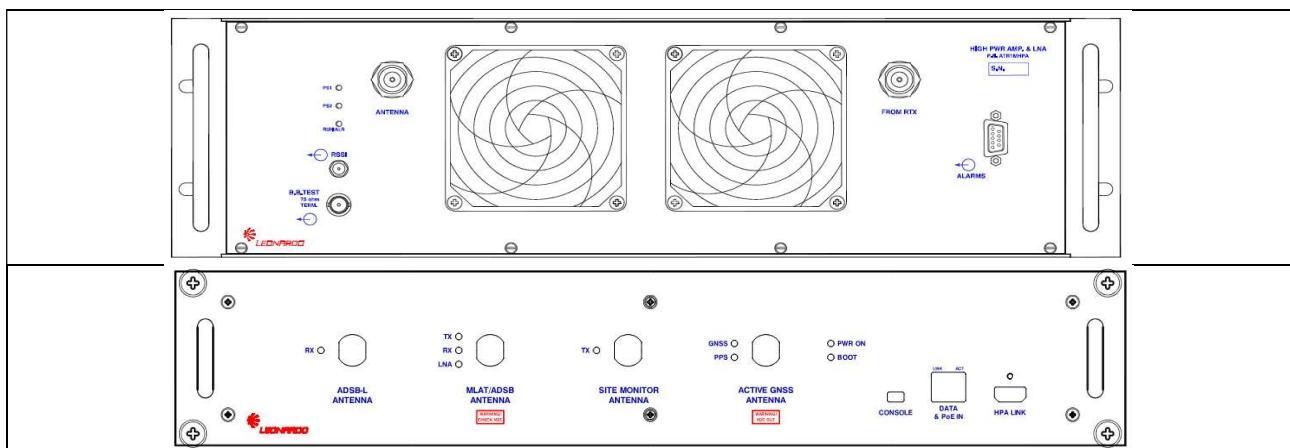


Figure 6 - MLAT/ADS-B RTX + HPA&LNA frontal view

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4.4.3 MLAT/ADS-B RX + LNA OUTDOOR

See below the typical configuration of a MLAT/ADS-B RX + LNA OUTDOOR:

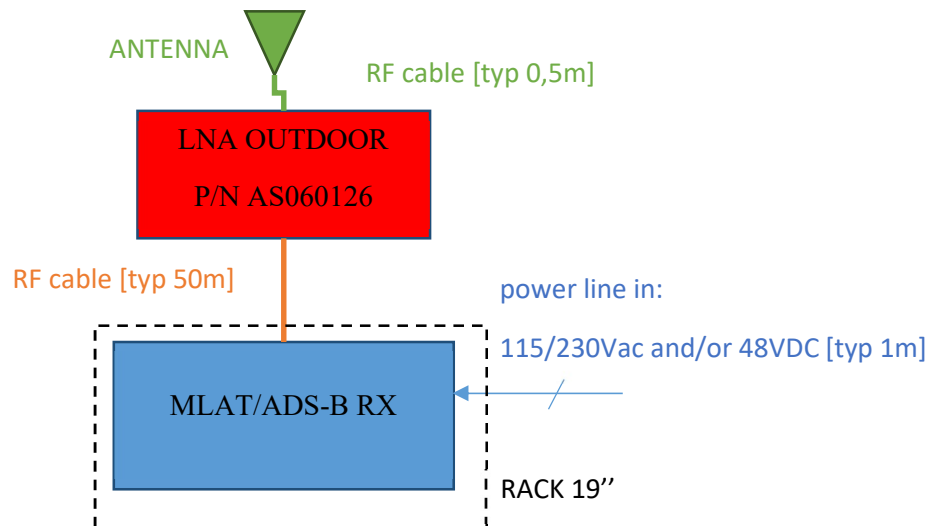


Figure 7 - MLAT/ADS-B RX [indoor] + LNA OUTDOOR typical configuration

Power in outlets MLAT/ADS-B RX [indoor] + LNA OUTDOOR:

HPA	DC screw connectors	
MLAT	DC screw connectors	
	AC	External Power Supply

See below the frontal view of MLAT/ADS-B RX [indoor] + LNA OUTDOOR:

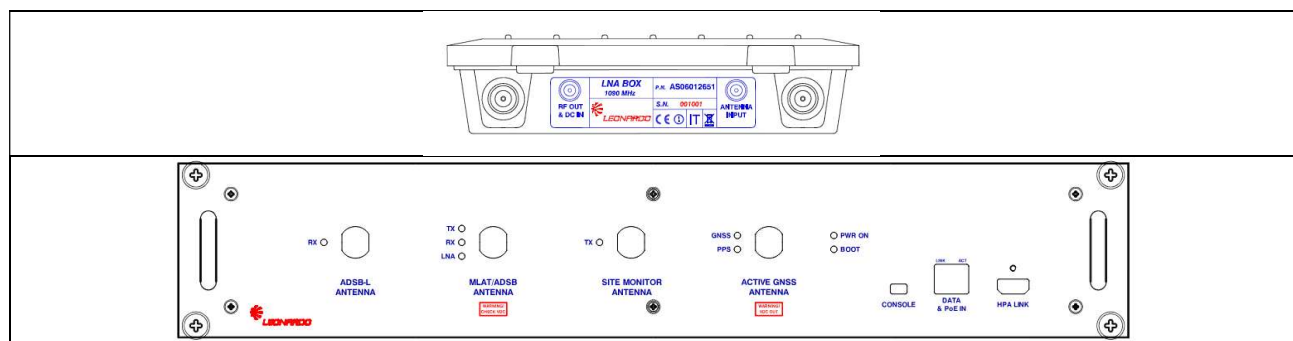


Figure 8 - MLAT/ADS-B RX + LNA OUTDOOR frontal view

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4.4.4 MLAT/ADS-B RTX [Full Outdoor]

See below the typical configuration of a MLAT/ADS-B RX/RTX SGU/SYNCHRO/RTX:

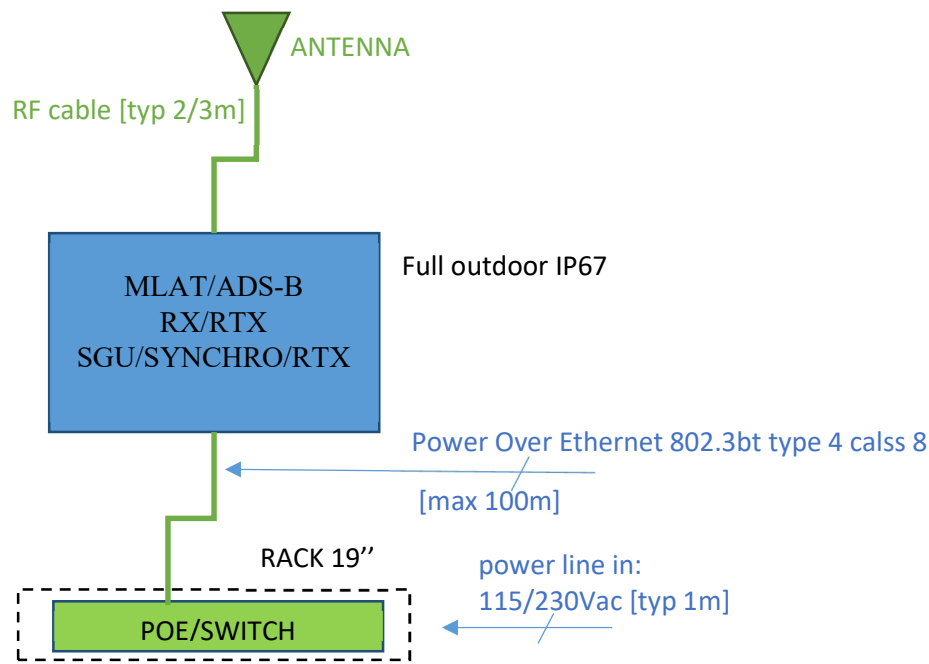


Figure 9 - MLAT/ADS-B RX/RTX SGU/SYNCHRO/RTX [full outdoor] typical configuration

Power in outlets MLAT/ADS-B RX/RTX SGU/SYNCHRO/RTX [full outdoor]:

MLAT	RJ45 poe IN 802.3bt	
	AC	External POE Power Supply
POE/SWITCH	DC screw connectors	
	AC	External POE Power Supply

See below the frontal view of MLAT/ADS-B RX/RTX SGU/SYNCHRO/RTX:

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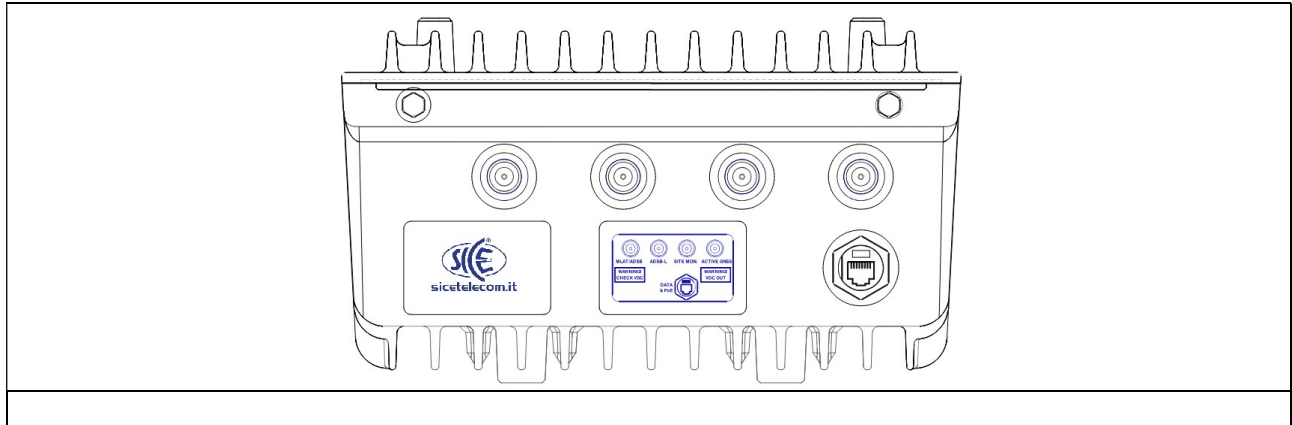


Figure 10 - MLAT/ADS-B RX/RTX SGU/RTX Full Outdoor frontal view

5 SAFETY

See below main safety instructions to manage MLAT/ADS-B equipment.

5.1 Mechanical safety

MLAT/ADS-B equipment are designed with mechanical protection in order to prevent accidental contacts with moving parts and avoid damages.



Avoid removing the mechanical protections.



If it's necessary to remove them, never remove the mechanical protections while devices are on.



When removing protections, be sure that all the measures for preventing accidental contact with a mechanical moving part (e.g. gears, fans, etc.) are taken (for example: cut off power supply, sending away unnecessary personnel, etc.).



Once that operations have been completed, place the barrier to its original position.



Do not insert object in equipment's holes.

5.2 Moving devices

During the installation phase and maintenance phase, operators may need to move equipment. The weight of devices may be high.



Operators have to move them carefully and with attention to safety procedures about moving high weights.

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Operators have to wear gloves and all individual protections needed in order to reduce exclude injuries.

5.3 Lightning

MLAT/ADS-B equipment are usually connected with external antennas and other devices by long RF cables, so they are exposed to lightning bolt that can discharge the voltage to the equipment.



Operators, during “Installation phase” have to deploy special lightning arresters that discharge the great voltage of the lightning bolt to earth connection.

5.4 Earthing

Indoor devices have to be correctly grounded and operators have to check each time they manage the equipment.

Outdoor devices, like LNA, have to be correctly grounded with the mast or pole by the dedicated grounding screw on the case of the amplifier.

In both cases, technicians must check and measure the grounding system, accordingly with security plan, in order to avoid electric shock for operators and leakage currents.



Operators have to check devices, rack and pole earthing connections before using.

5.5 Units extraction

Sometimes during maintenance phase, operators have to extract units from modules to check or to substitute faulty units in order to restore the proper service.



Never extract sub-units while devices are on.

5.6 Outdoor devices deployments

Some devices have pole mounting installation.



Operators need to wear and use properly a climbing kit during outdoor installation activities.



Operators have to follow strictly the procedure to install outdoor equipment.

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6 INSTALLATION

See below main installation instructions.

6.1 Installation of an equipment in a rack

Installation of the device rack in a cabinet must be carried out verifying that the cabinet is equipped with proper air flow.

Ventilation for the devices is obtained thanks to

- the natural tendency of air to rise upwards
- fan units in the rack.

In order to help ventilation, operators must place openings on both the upper and lower surfaces of the modules by special panels (airing) inside the cabinet. Airing avoid obstructions of the air flow.

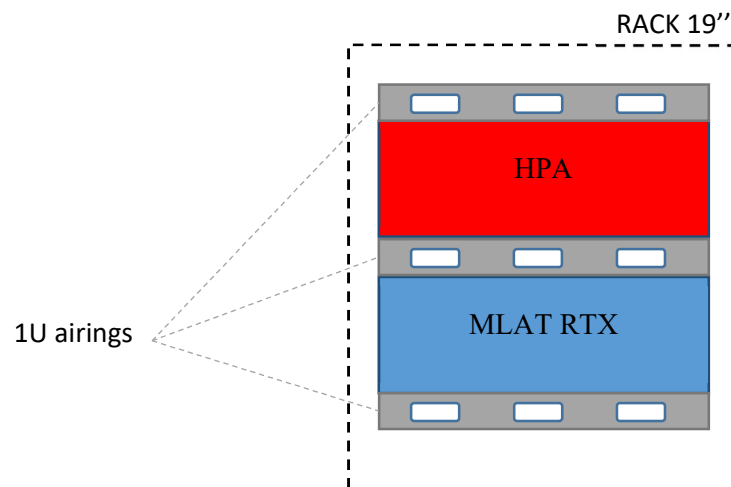


Figure 11 – Airing disposition

AC and DC power cable lengths are intended to be less than 3 meters. The typical installation cable inside the rack is 1 meter.



Don't power the equipment by more than 3 meters AC/DC power cables. In case of POE, don't use cables, more than 100 meters length, and power supply different than 802.3bt standard.

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6.2 Installation place of the rack [INDOOR VERSION]

Operators must take care to place the rack in the best position in order to avoid problems.



Operators have to pay attention to place the rack indoor (IP20) in dry areas: no water drop from ceiling or windows near the rack, no wet infiltration from the floor or from walls in contact with rack. If needed, provide a special rack IP55 or more.



Operators have to place racks checking the cooling systems are free and not obstructed by walls, other racks or other systems that may limit the cooling system action. Consider each cooling system has an “air input port” and a “air output port”: both ports needs free space for the intake and/or outlet port. Leave a minimum clearance of 50cm near the cooling system.

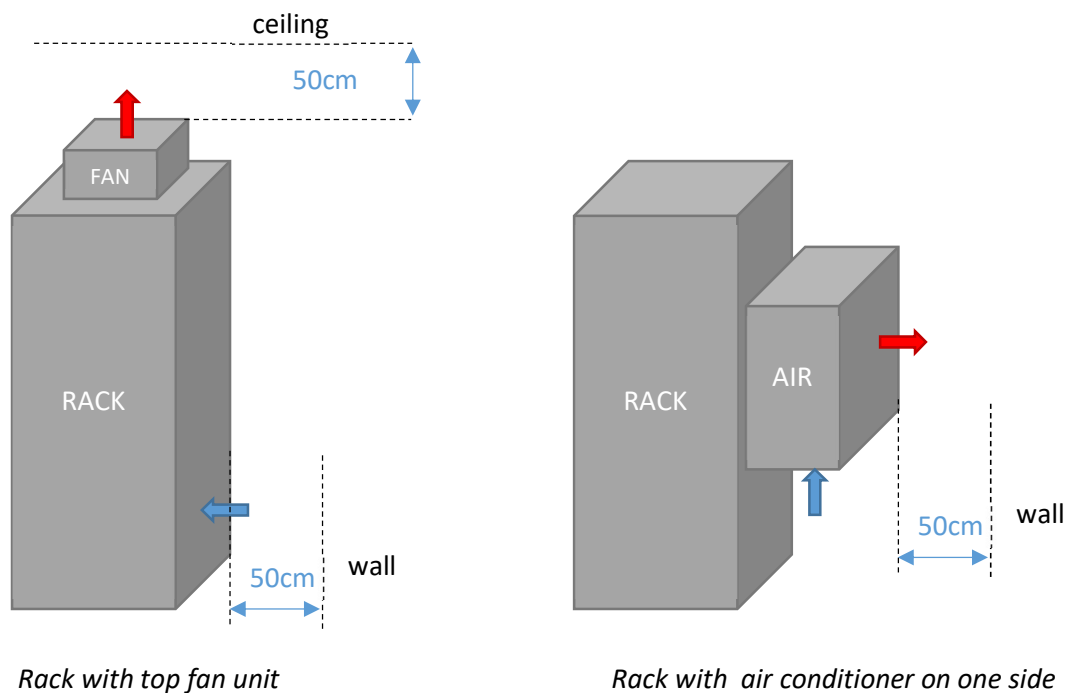


Figure 12 – Air input port (blue arrow) and air output port (red arrow)



Operators have to check periodically that the cooling systems work properly and air filters are in good conditions.

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 Operators, during Installation phase have to deploy special lightning arresters that discharge the great voltage of the lightning bolt to earth connection.

 Operators have to move devices carefully and with attention to safety procedures about moving high weights.

 Operators have to wear gloves and all individual protections needed in order to reduce exclude injuries.

 Operators have to take care the operating temperature is around 25°C in order to maintain performances and MTBF of equipment.

 Operators have to check devices, rack and pole earthing connections before using.

6.3 Installation of outdoor equipment

Some MLAT/ADS-B devices like LNA are outdoor equipment and they need to be deployed on the pole near the external antenna by its installation kit provided with the LNA.

 Operators have to check devices, rack and pole earthing connections before using.

 Operators have to wear gloves and all individual protections needed in order to reduce exclude injuries.

 Operators, during Installation phase have to deploy special lightning arresters that discharge the great voltage of the lightning bolt to earth connection.

6.4 Power up the rack

Once rack with MLAT/ADS-B is properly deployed, it has to be started up.

 Operators have to check devices and pole earthing connection before using.

 Operators have to place always antennas or adequate loads on RF outputs.

The MLAT/ADS-B has to be powered up:

- by AC voltage [only indoor]: The operator has to provide 115/230 VAC to the main power supply (115/230 to 48VDC)
- by DC voltage [only indoor]: operators can apply 56 VDC directly to DC connector. Pay attention to connect a right voltage source to VDC connector:
 - DC undervoltage: if a lower VDC is connected to DC input, voltage is not sufficient to feed the input stage, so equipment doesn't start and there is any relevant injury to the operator.

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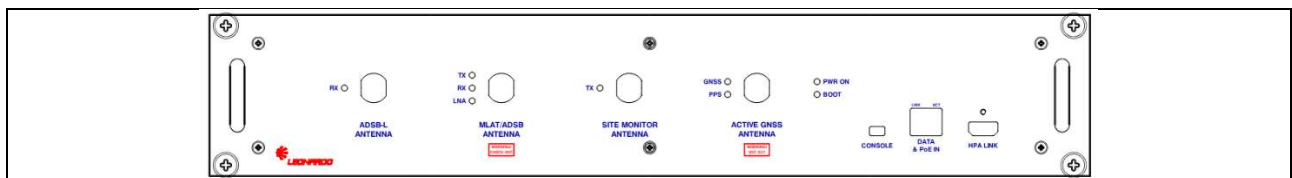
- DC overvoltage: if a higher VDC is connected to DC input (e.g. more than 60VDC), DC protections are able to section the damage to the single DC input area (fuse) and there is any relevant injury to the operator.
- AC instead of DC: DC protections are able to section the damage to the single DC input area (fuse) and there isn't any relevant injury to the operator.
- by DC voltage POE 802.3bt [indoor RTX and outdoor RTX]: Pay attention to connect a right POE standard to Ethernet POE in connector:
 - DC undervoltage: if a lower VDC is connected to DC input or lower standard that 802.3bt, voltage is not sufficient to feed the input stage, so equipment doesn't start and there is any relevant injury to the operator.

After connecting the power supply source verify that the LEDs on for each power supply module are on.

6.5 Activation of the system

After powering the system, the system will boot. After a few seconds, the sensor will be ready and started-up.

- Ensure that the LAN LED on the front panel of the sensor is green and flashing when powered on and connected to a compatible switch
- Ensure that the BOOT LED is flashing blue only during boot and is off after boot
- Ensure that the GPS and GNSS are blinking green (one second duty cycle) after GPS is correctly acquired



Now connect a PC by a common ethernet cable RJ45 connector in front of the MLAT/ADS-B panel and, if it's necessary, modify the configuration of the MLAT/ADS-B equipment by configuration software.

- Ensure there are no sensor IP address conflicts on the LAN;
- Ensure there are no PC IP address conflicts on the LAN;
- Ensure PCFA and/or PCFB are set and are correct and there are no PCFA/B IP address conflicts on the LAN.

Now operators may connect the MLAT/ADS-B equipment to LAN.

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7 MLAT/ADS-B SENSOR CONFIGURATION

The sensor configuration and management can also be performed remotely by using the built-in sensor web interface.

8 Sensors Overview

Two type of sensors are provided: the RTX-SGU transmitting at 1090 MHz and the RTX transmitting at 1030 MHz. Both sensors are able to receive at 1090 Mhz. Both sensors need to be powered by the provided managed POE Switch.

9 Connections and switch on

The output peak power of the RTX and RTX-SGU transmitter is 54 dBm (50 Ohm impedance). Please be sure to use appropriate attenuators or loads before switching on equipments. The RTX SGU may start transmitting just after booting and without issuing any command.

In order to switch on the sensor do the following steps:

- Connect the Sensor to Port 1 of the POE Switch using an RJ45 cable
- Connect the POE Switch to a Lab Power Supply (50 V, 2 A) using the provided red and black cable
- Connect the antenna port of the sensor to a suitable load to protect power amplifier
- Connect a free port of the POE Switch to a LAN
- Connect the provided notebook to the same LAN. Network addresses are:

Sensor IP address: 192.168.178.76
Netmask 255.255.255.0
Notebook IP address: 192.168.178.1

- Switch on the Lab Power Supply
- Wait until the POE Switch completes its boot
- After a while, a steady yellow led on the Port 1 of the Power Switch confirms that the Sensor has started to boot
- Wait about a minute to let the Sensor complete the boot

10 Transmission at 1030 MHz (RTX)

The output peak power of the transmitter is 54 dBm (50 Ohm impedance). Please connect appropriate attenuators or loads to the antenna port before starting transmitter tests.

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The output peak power of the transmitter is 54 dBm (50 Ohm impedance). Please be sure to use appropriate attenuators or loads before starting transmitter tests. The RTX SGU starts transmitting just after the boot and without any command, so pay attention to connect appropriate load.

The maximum transmission rate of the RTX-SGU sensor is 2 pulses per second.

11 Reception at 1090 MHz (RTX and RTX-SGU)

Please be sure to switch off the Transmitter section of the RTX or RTX SGU before doing the receiver tests. To do so, wait until the RTX SGU has completed the boot and and double check for example by connecting a Peak Power meter to the Antenna connector that the RTX-SGU is not transmitting before connecting the test transmitter or signal generator.

Figure 13 – Dynamic Range Page

12 PERIODICAL MAINTENANCE

Periodical maintenance is based on planned checks of all devices, scheduled on MTBF of systems. See below the main checks operators have to perform periodically on the equipment by IP address on a LAN network.

12.1 Reachability of equipment

Verify the MLAT/ADS-B equipment is reachable on the LAN by setting the command “ping” to the IP sensor address by a shell.

If the MLAT/ADS-B is unreachable by the “ping” command, check your PC LAN connection.

If your PC LAN connections is OK, contact the Networking Manager of the LAN.

12.2 Remote alarms

Run CPF software and check the alarm status.

If any alarm is red, operators may need to move physically to the equipment or contact the manufacturer assistance center to check if the alarm is blocking.

12.3 MLAT/ADS-B RX TEST

Check the sensor are receiving targets.

13 TROUBLESHOOTING

See below main checks to evaluate the status of equipment.

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13.1 Physical checks

See below the main checks that operators have to perform physically on the equipment.



Avoid removing the mechanical protections.



Operators have to check devices and rack earthing connection before using.



Operators have to wear gloves and all individual protections needed in order to reduce exclude injuries.



Operators have to check devices and rack earthing connection before using.

13.1.1 LAN connection

Verify the LAN LEDs are green and flashing. If LAN LEDs are flashing but they are yellow/red or off, check:

- RJ45 plug is connected with MLAT/ADS-B
- RJ45 plug is connected with the LAN
- RJ45 cable is proper

If all checks are OK and the LEDs are not green, contact the assistance center.

13.1.2 Alarm LED

If this LED is red or off, contact the manufacturer assistance center.

13.1.3 Antenna connection

Verify the antenna cable is properly connected with the N connector of the MLAT/ADS-B equipment.

If the antenna is not connected, plug the cable or contact the manufacturer assistance center.

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14 INSTALLATION

Full Outdoor systems installation: the sensor and the GPS antenna shall be mounted on a pole or trellis as indicated into the next figure.

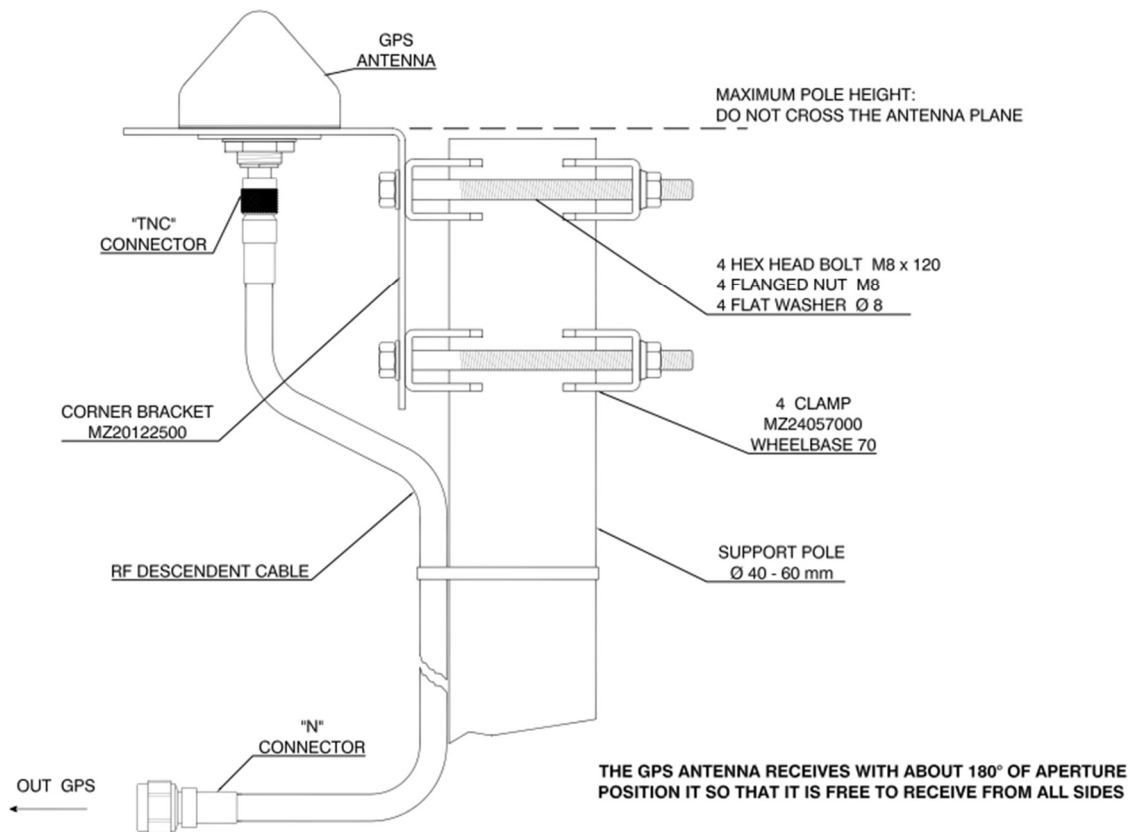


Figure 14 – GPS antenna installation

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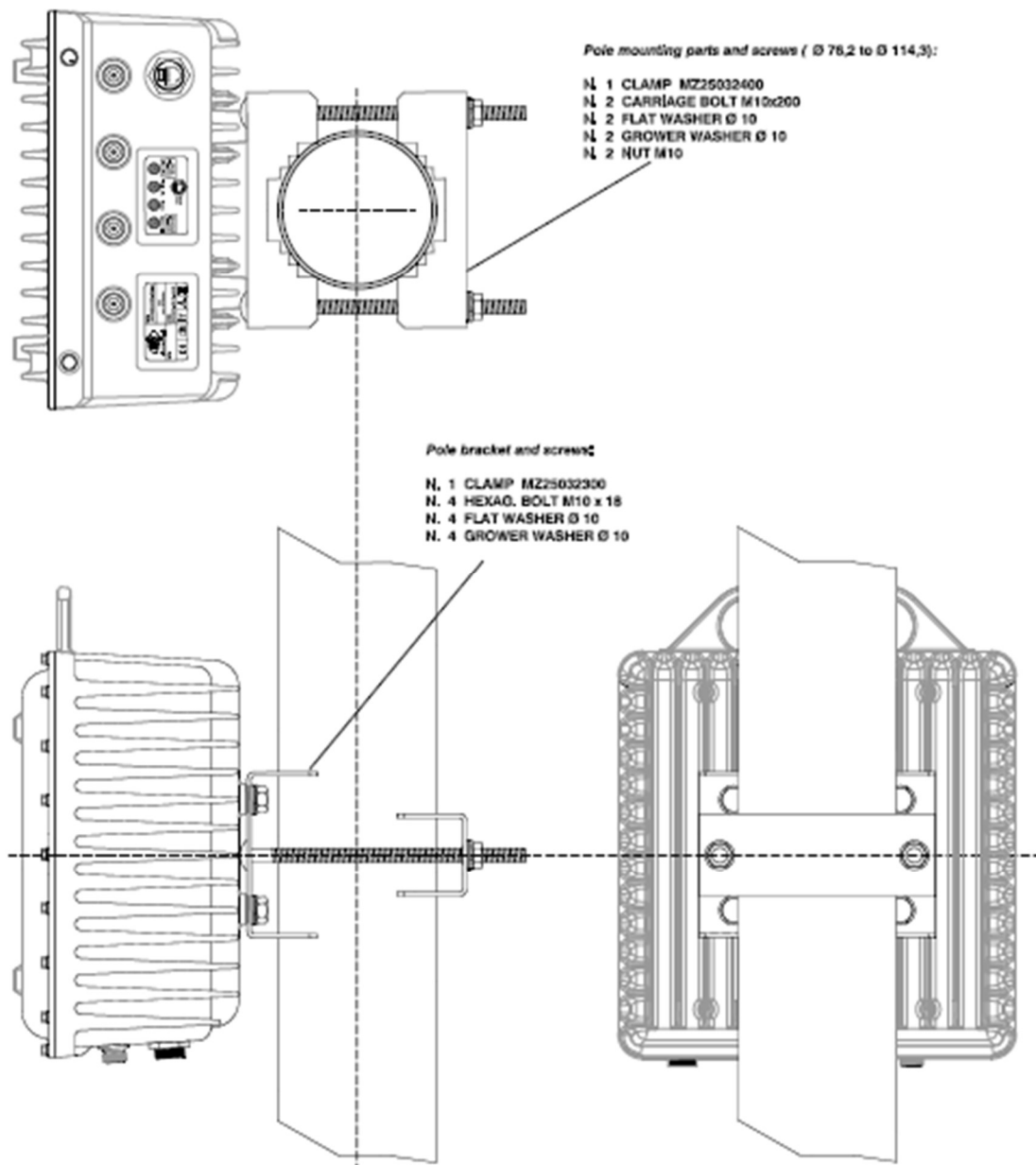


Figure 15 – Full outdoor sensor installation

Cabinet installation consists in standard 19" rack mounting.