INVOLI

G-1090

Swiss-made air traffic receiver

User Manual

English V1 - 20240306

www.involi.com

info@involi.com

For the latest version of this user manual or for more information, visit: http://support.involi.com

INVOLI

Version

Version	Date	Author	Amendment	Link
V1	06/03/2023	Manu Lubrano	Initial version	n/a

Table of contents

What is a G-1090 receiver?

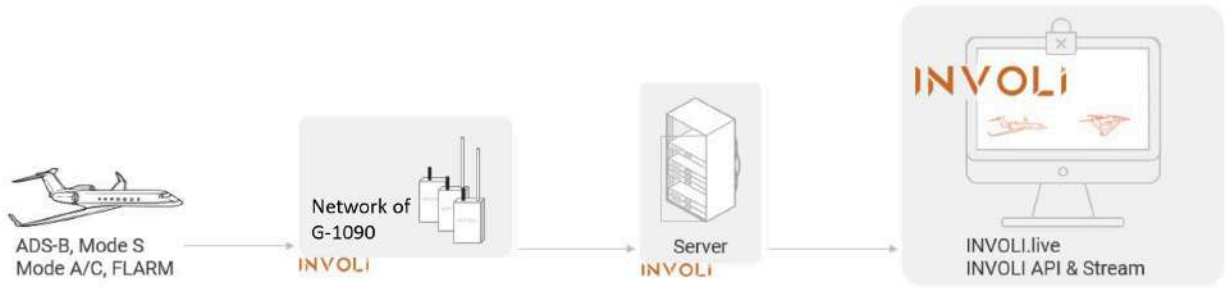
The G-1090 is a Swiss-made air traffic receiver, developed for fixed exterior mounting, with a rugged IP66 case that allows resisting any weather conditions. It can receive signals transmitted from ADS-B, Mode-S, Mode A/C, and Flarm transponders.

Once the G-1090 air traffic receiver is configured and connected to the internet, it will automatically start transmitting the air traffic messages received to the INVOLI server.

The data provided by the G-1090 is used to feed INVOLI Multilateration, transforming simple aviation signals (like Mode-S or Mode A/C messages) into useful air traffic positions. Moreover, multilateration can be used to confirm the positions received over ADS-B messages.

There are two ways to visualize the air traffic detected by the G-1090:

- By using the INVOLI.live web interface
- By using the INVOLI API to integrate a data stream of traffic information directly into your software (e.g. a UTM / U-space or a drone ground control software).



G-1090 certification

USA

INVOLI company is not responsible for any changes or modifications not expressly approved by the party responsible for compliance. Such modifications could void the user's authority to operate the equipment.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not

installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference's by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Canada

This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions:

1. This device may not cause interference.
2. This device must accept any interference, including interference that may cause undesired operation of the device.

L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

1. L'appareil ne doit pas produire de brouillage;
2. L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

G-1090 Product Line

Depending on the use case and geographical location, the basic variant of the G-1090 can be equipped with additional options. There are several types and variants of G-1090 receivers. If you are interested and want to know more, please write to us at info@involi.com.

G-1090 FLARM

This receiver has an additional module to work with FLARM transmitters, used mainly by General Aviation, balloons, or paragliders.

Equipped with an additional 868 MHz omnidirectional reception antenna, it applies mainly to Europe. The range for Flarm reception is up to 60 km due to the lower transmit power of the FLARM transponder (compared to the ADS-B big airliners' transponders).

It stands out from the ADS-B-only model, by having two antennas mounted, instead of one. FLARM antenna is 9dBi, 63cm long, fiberglass.

G-1090 UAT

This receiver is designed especially for the US market, as 978 UAT transponders are limited to use only in the United States. The receiver will also have two reception antennas: ADS-B 1090 MHz and 978 MHz omnidirectional antenna, 5.5 dBi gain, 66cm long, fiberglass.

G-1090 RemoteID

This receiver is intended to be used worldwide. It has an ADS-B standard antenna and the 2.4 GHz, omnidirectional antenna, 0 dBi, 10cm long, plastic antenna. The additional antenna is used to capture the Wi-Fi signals broadcasted by the Remote ID module from the drone. Due to the limited power of the Remote ID transmitter, the range is very limited and is up to 4 km (2Mi).

Read before deployment and use

Important tips:

- The reception quality of the G-1090 air traffic receiver is strongly dependent on the quality of the installation. Please follow carefully our recommendations to maximize the coverage of the receiver
- For Multilateration capability, a network of at least 5 properly deployed receivers is required. INVOLI can help you to plan the best location for receivers. Determination of the location of Mode S and Mode A/C aircraft is only possible via Multilateration, and the relative position of the aircraft vs receivers mesh has an impact on the multilateration precision
- INVOLI.live web access is required to visualize the air traffic
- Alternatively, INVOLI APIs can be used to receive the messages from our server and present them in any preferred interface
- If you are going to use a cellular LTE PoE router for internet connectivity, select the mobile network operator (MNO) providing sufficient data coverage in the G-1090 receiver location

WARNING:

- Aircraft equipped with ADS-B and FLARM are broadcasting their position at regular intervals (around every second). Mode S and Mode A/C aircraft broadcast their signal only when interrogated by a Secondary Radar (1030 MHz interrogations) or by a TCAS. For this reason, the detection of such aircraft is possible only in these specific areas where 1030 MHz radar interrogations are present. Alternatively, INVOLI can propose the 1030MHz interrogation transmitter if it is important for a customer.
- Aircraft not equipped with a transponder (non-cooperative air traffic), with a switched-off transponder, or with the transponder transmitting on military modes are not visible by the G-1090 air traffic receiver

G-1090 air traffic receiver quick start

Follow the steps below to start using the G-1090 air traffic receiver:

1. Install the G-1090 air traffic receiver over a pole in a place with an open sky view (e.g. a rooftop) and connect the antennas.

2. Use an Ethernet cable to connect the G-1090 to a PoE source with access to the internet (e.g. LTE PoE router), having DHCP.

3. The receiver has a status LED at the bottom, next to the Ethernet port. During normal operation, it will be constant GREEN light with short CYAN flashes.

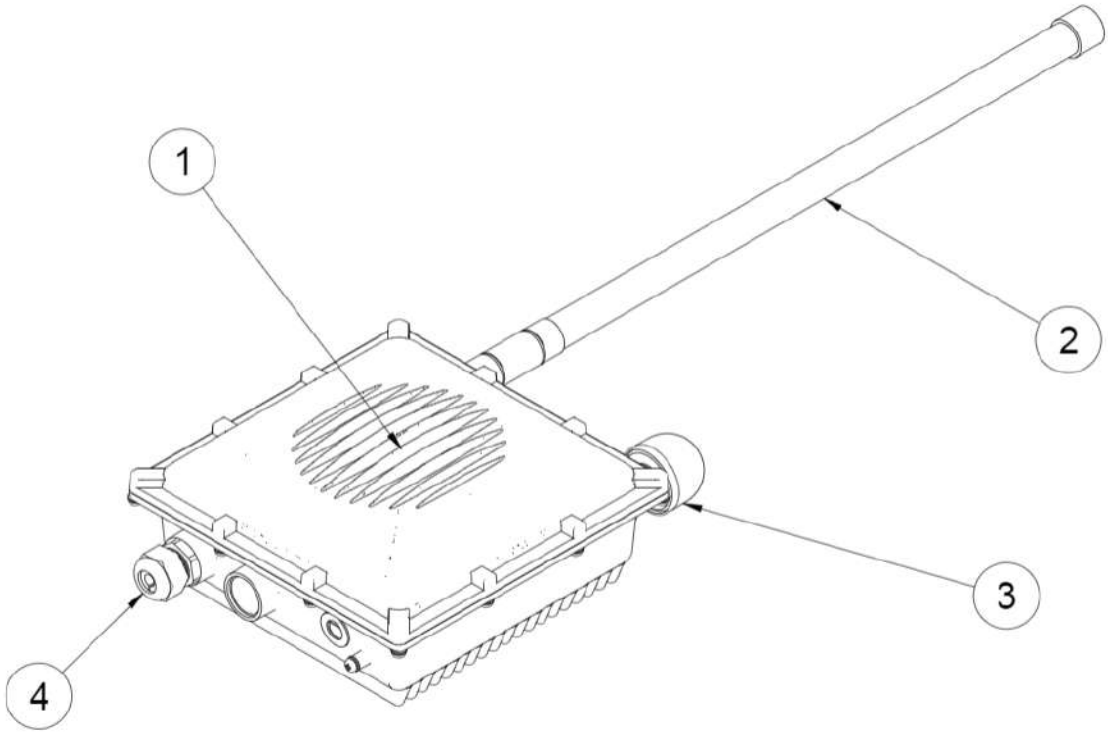
Congratulations!

Your G-1090 Air traffic receiver is ready to be used!

4. Log in to INVOLI.live to visualize the detected traffic on a map, or connect to an INVOLI stream using the INVOLI API to inject the live air traffic directly into your software.

G-1090 receiver components, features, dimensions

The picture below shows the G-1090 receiver with one antenna. Depending on the selected options (Flarm, UAT, Remote ID), the second antenna can be necessary.



Main components:

1. Receiver IP66 box
2. 1090 MHz antenna
3. GNSS antenna
4. Waterproof RJ45 Ethernet socket (communication and PoE input)

Basic features:

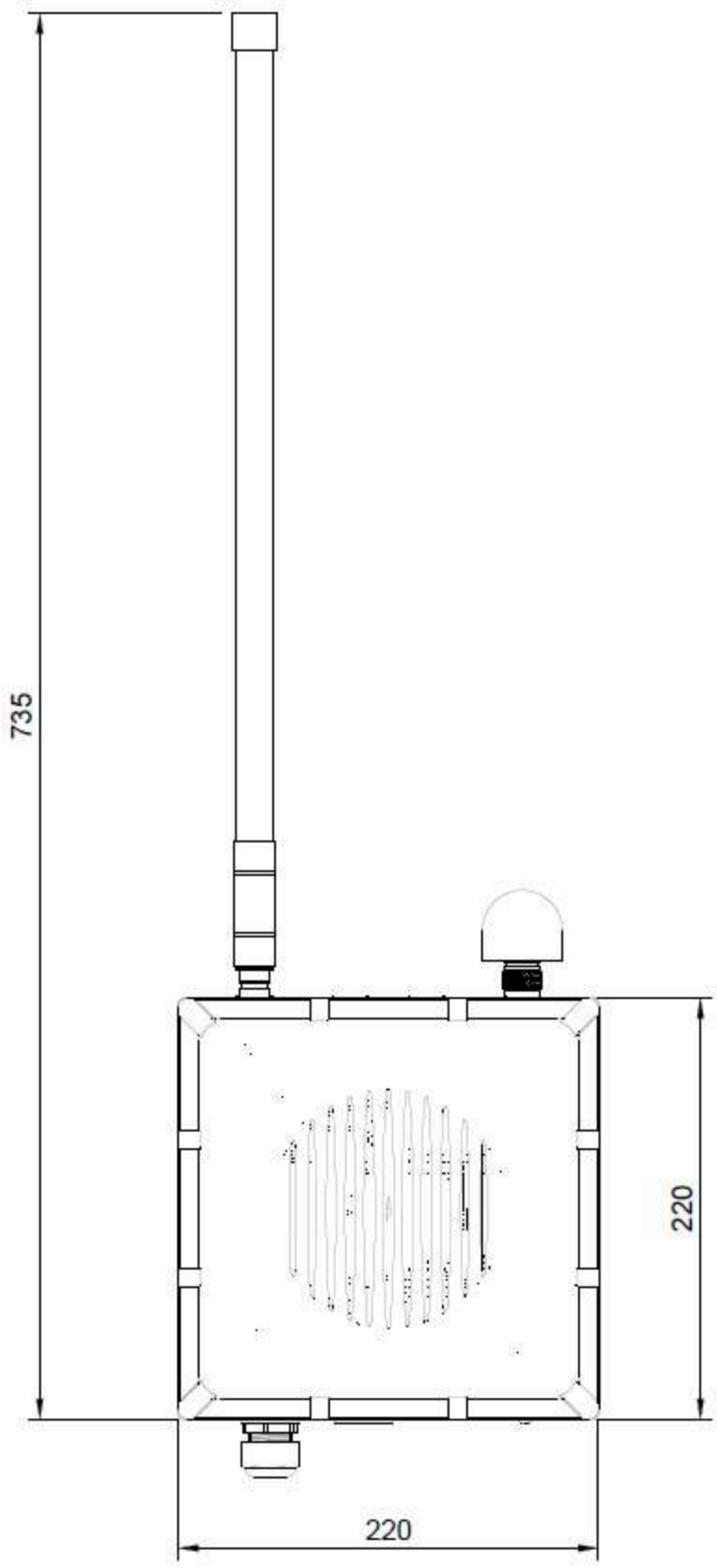
- Reception of 1090 MHz frequency aviation messages (ADS-B, Mode S, and Mode A/C)
- Measurement of local atmospheric pressure to compensate for pressure altitude
- Communication and power via Power Over Ethernet (PoE)
- Rugged box for mounting in exterior (IP66)
- Internal surge protection
- Max power consumption: 8 Watts
- Max data consumption: 1 GB /day

Options and accessories:

- Detection of FLARM signals on 868 MHz frequency (the second Flarm antenna is required)
- Detection of UAT signals on **978 MHz frequency (the second UAT antenna is required)**
- Detection of Broadcast Remote ID signals from UAV (the additional Wifi 2.4GHz antenna is required)
- Outdoor Ethernet cable pre-equipped with Waterproof RJ45 Ethernet socket
- 4G router with PoE (SIM card not provided)
- Power adapter from 110V/220V to PoE
- Lightning protection

Dimensions:

- Measures without connectors and antenna(s) (in mm): 220 x 220 x 110
- Measures without connectors and antenna(s) (in inches): 8.6" x 8.6" x 4.3"
- Measures with connectors (in mm): 220 x 270 x 110, without antenna(s)
- Measures with connectors (in inches): 8.6" x 10.63" x 4.3" without antenna(s)
- Weight: depending on the version, but with all options max 3.9kg (8.6 lb)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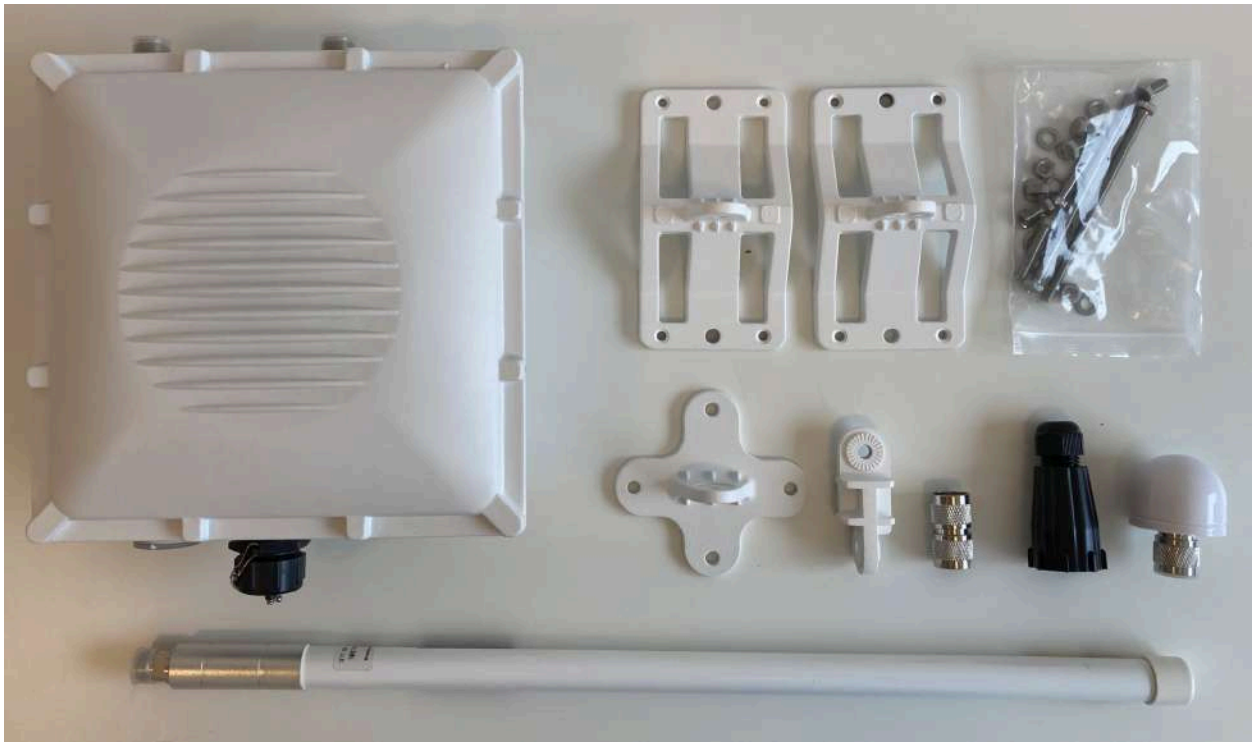
Unboxing G-1090 receiver

Thanks for purchasing a G-1090 air traffic receiver.

Items included in the box:

- A G-1090 air traffic receiver
- Components and screws for pole mounting
- A 1090 MHz antenna and a male-to-male N-type connector
- A GNSS antenna
- A waterproof RJ45 Ethernet socket cover



If a G-1090 receiver with a FLARM option was selected, a FLARM antenna (868 MHz) is also included.

If a G-1090 receiver with a UAT option was selected, a FLARM antenna (978 MHz) is also included.

The picture below shows GPS and three other possible antennas with a length comparison. The 1090 MHz antenna (second, shorter, female N connector), the FLARM antenna (third, longer, male N connector), and the UAT antenna (fourth, longer, male connector). The antennas for Flarm and UAT should have the appropriate stickers "Flarm" or "UAT".

Other important tips:

- INVOLI.live web access is required to visualize the air traffic
- Alternatively, INVOLI APIs can be used to receive the messages from our server and present them in any preferred interface
- The reception quality of the G-1090 Air traffic receiver is strongly dependent on the quality of the installation. Please follow carefully our recommendations to maximize the coverage of your receiver, the network of receivers, and Multilateration capabilities.
- If you are going to use an LTE PoE router, check the coverage for your carrier in the area you want to use the G-1090 Air traffic receiver.
- Detection of Mode S and Mode A/C aircraft is only possible via multilateration
- Multilateration is only possible when the signal emitted by the aircraft is received by multiple (at least 5) G-1090 Air traffic receivers. The configuration of these receivers and the relative position of the aircraft have an impact on the multilateration precision.

Warning

- Aircraft equipped with ADS-B and FLARM are broadcasting their position at regular intervals (around every second). On the other side, Mode S and Mode A/C aircraft broadcast their signal only when interrogated by a Secondary Radar (1030 MHz interrogations) or by a TCAS. For this reason, the detection of such aircraft is possible only in these specific areas where 1030 MHz radar interrogations are present.
- Aircraft not equipped with a transponder (non-cooperative air traffic), with a switched-off transponder, or with the transponder transmitting on military modes are not visible by the G-1090 air traffic receiver

G-1090 Status LED

The G-1090 air traffic receiver turns automatically on as soon as it gets power via the PoE.

Normal operation

The Status LED will start providing information on the status of the receiver, according to the color code below.

- **Status LED Flashing in GREEN**: Establishing a connection to the internet
- **Status LED Flashing in BLUE**: Waiting for a GPS fix
- **Status LED continuously GREEN with CYAN flashes: Receiver fully operational**

A short video about LED behavior after powering up G-1090: https://youtu.be/2uZf02nnRT4

NOTICE:

The status LED is just an indication of the device's status and connectivity. It does not provide information on its capacity to detect air traffic signals. In fact, the receiver will display a fully operational status even if no aircraft are detected. For this reason, coverage and air traffic detection should be checked online on the INVOLI.live platform.

Abnormal situation

When the Status LED is blinking in **RED**, it provides information on errors:

- **2 RED Flash/second**: The G-1090 air traffic receiver **could not establish a connection to the internet**. Action requested: Check internet connectivity and restart the receiver. If the problem persists, contact INVOLI.
- **3 RED Flash/second**: The G-1090 air traffic receiver c**ould not perform a GPS fix**. Action requested: Restart the device. Check if the top of the device has poor visibility toward the sky. In that case, the receivers should be mounted in another location. Note: The first GPS fix in a new location could take longer. If after 5 restarts the problem persists, contact INVOLI.
- **4 RED Flash/second**: **Peripheral problem**. Action requested: Restart the device. If the problem persists, contact INVOLI.

Restart the receiver by unplugging the Ethernet cable, wait for 10 seconds, and plug the cable back into the Ethernet socket.

G-1090 receiver installation

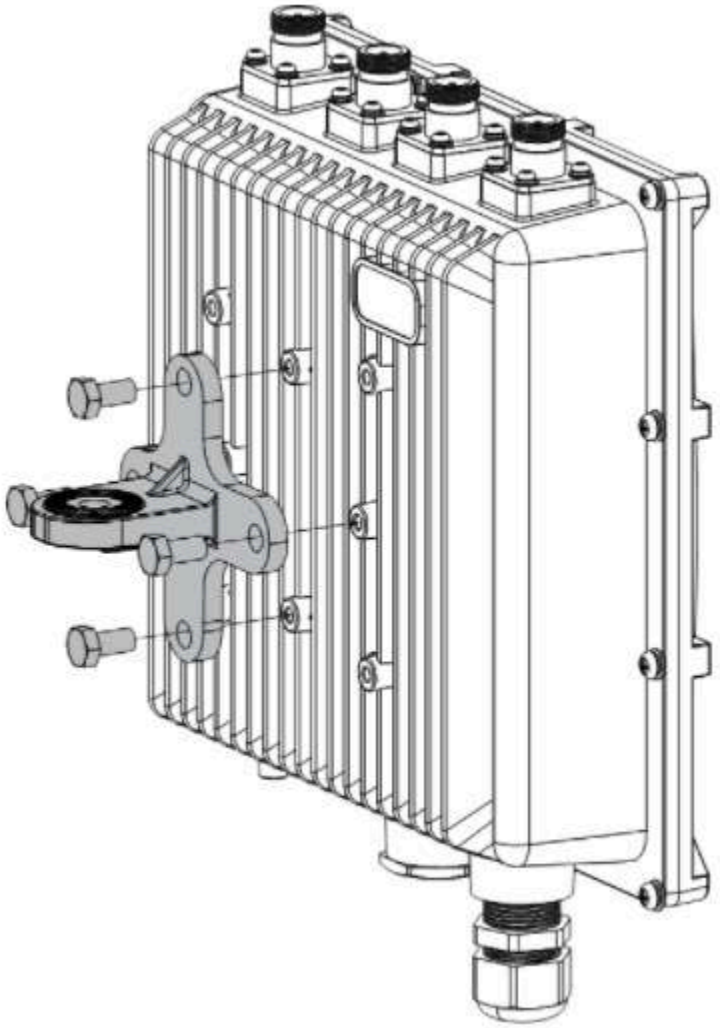
Finding the best location

The INVOLI support team can assist with the selection of the best location points for the receivers. It is particularly important if the receivers will work in the cluster for the multilateration. If the receiver is already operational, it is possible to perform an evaluation of its reception performance and decide if the installation is good enough or should be modified.

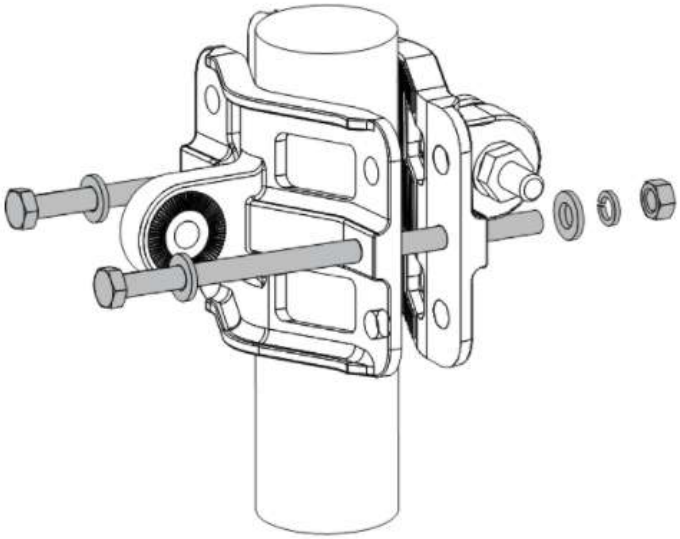
Pole mounting

Follow the instructions below to install the G-1090 Air traffic receiver over a pole:

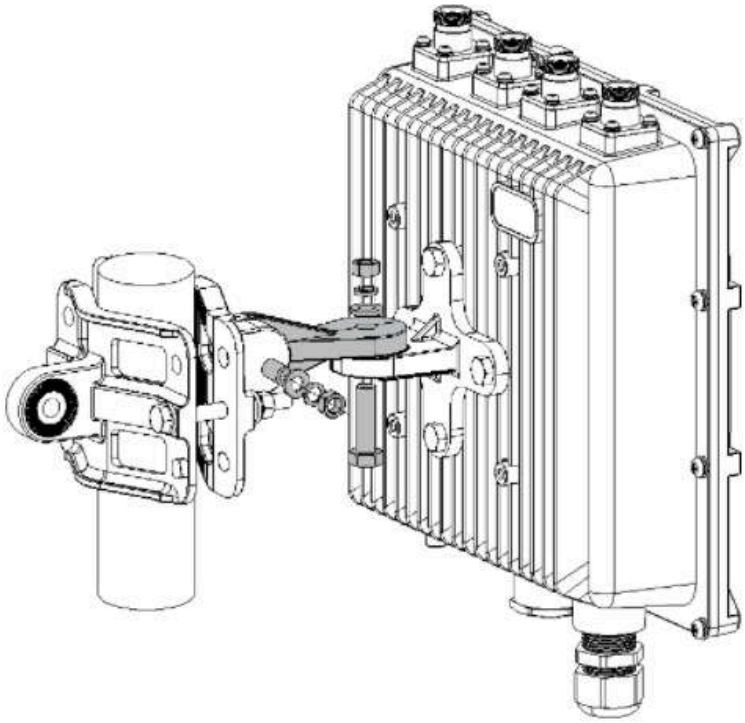
1. Fix the included cross bracket on the bottom of the enclosure with four M6x12 bolts.



2. Place two clamp pieces around the pole and tighten them with the included M6x110 bolts, washers, and nuts.



3. Connect the pole clamp and the cross bracket by securing the last piece of the mounting kit in place using M6x30 bolts, washers, and nuts.

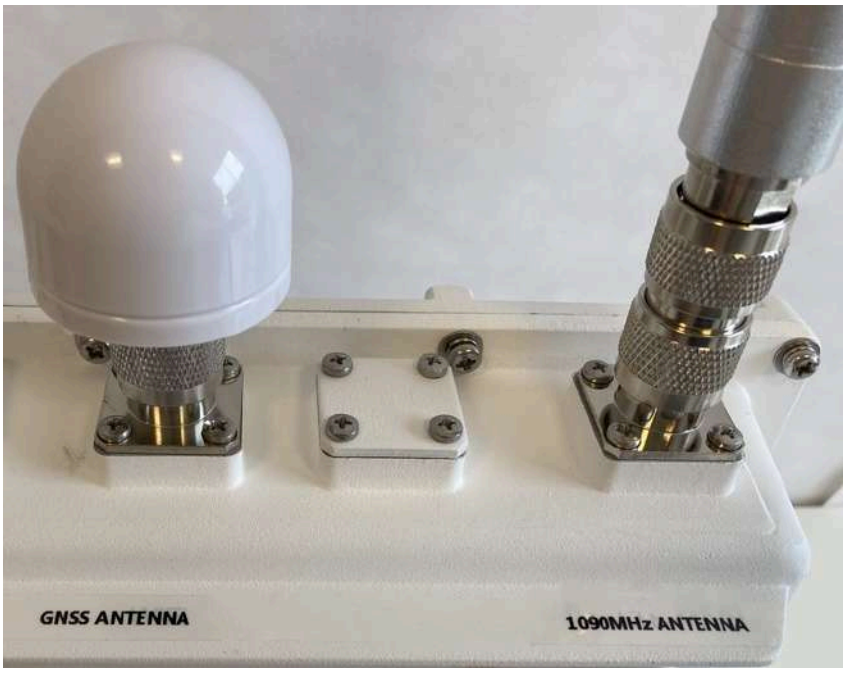


If needed, the G-1090 can be mounted on a horizontal pole without the 90° angle converter part.

Antenna mounting

The picture below shows the top of the G-1090 air traffic receiver with marked antenna ports. For the Flarm or UAT options, please see the next article, which shows the pictures with mounted Flarm and UAT antennas.

Screw the GPS antenna and the 1090 MHz antenna on their N connectors, according to indications. For a 1090 MHz antenna, use a male-to-male N-type adapter. The picture below shows properly installed antennas:



Installation documentation

It is recommended to take several photos documenting each installation from different angles. The pictures can help troubleshoot later if the installation is not performing as expected.

G-1090 Antennas Configurations

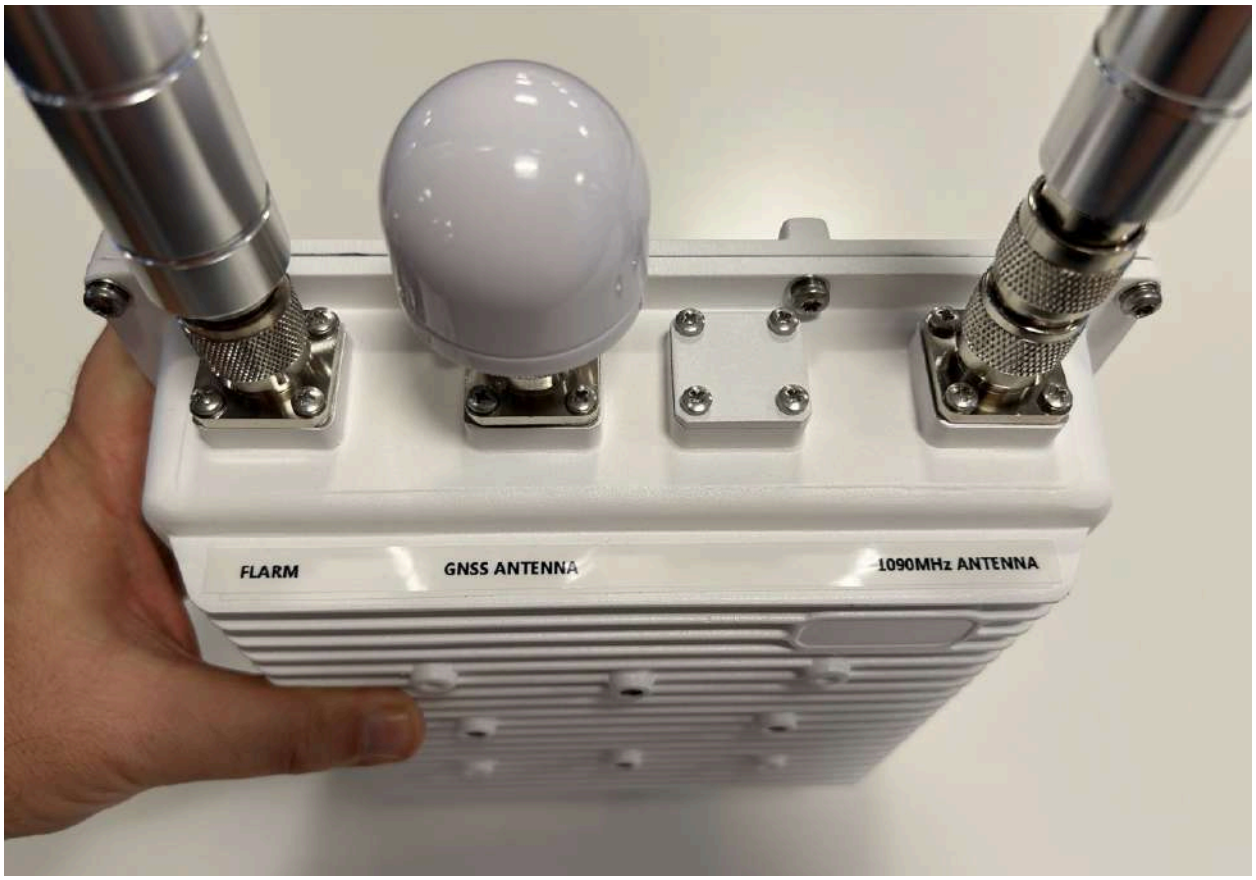
Depending on the receiver's type, there are different antennas, which should be installed on the equipment. Please see the possible cases below. Usually, receivers have stickers describing where to connect which antenna.

G-1090

This is the basic configuration, for reception of the ADS-B, Mode A/C, and Mode-S signals in the 1090MHz band. The receiver has only one antenna, which should be installed as shown in the picture below.

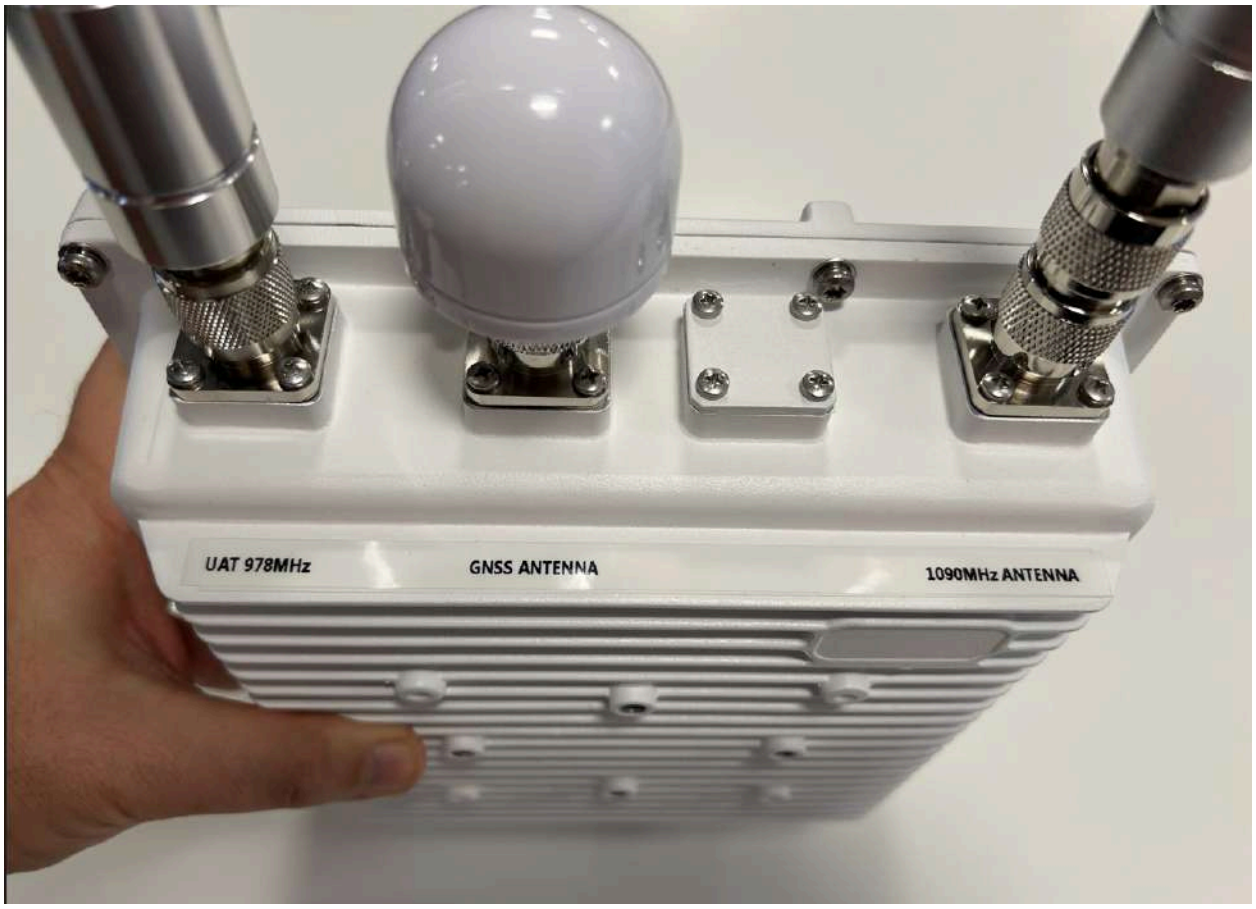
G-1090 FLARM

This receiver type can receive the FLARM transponders' signals sent in the 868 MHz band, together with ADS-B, Mode A/C, and Mode-S signals in the 1090MHz band. To receive the signals in two different frequencies, it will require two antennas, connected according to the description given on the box.



G-1090 UAT

This receiver type, designed for the US market, can receive the UAT transponders' signals sent in the 978 MHz band, together with ADS-B, Mode A/C, and Mode-S signals in the 1090MHz band. To receive the signals in two different frequencies, it will require two antennas, connected according to the description given on the box.



Antennas types

INVOLI provides the most suitable antennas for each configuration, which are tested with our equipment and should provide the best reception quality. Please contact our sales team for more information.

G-1090 installation recommendations

Aviation signals over the 1090 MHz (ADS-B, Mode S, and Mode A/C) and FLARM are detectable on the line of sight (LOS). This means that your receiver will be able to detect air traffic only in the areas that are visible from the spot where you are going to install the device. Any obstacle (mountains, buildings, trees, and others) will limit the reception along the obstacle direction.

Therefore, to optimize the coverage, we strongly recommend installing the device on top of hills or mountains, over rooftops of buildings, over light poles, or on any tall and isolated structure.

The G-1090 air traffic receiver has been developed to be installed in noisy electromagnetic environments (such as telecommunication towers), although we suggest installing the receiver as far as possible from emitting devices.

The G-1090 receiver could be installed outdoors or indoors (especially if the building or construction is in wood).

Attached to a pole

The G-1090 receiver should be installed on the top of a pole, in a way that the pole itself is not hiding the antennas (1.). If this is not possible, it is strongly recommended to place the antennas at least 35 cm of distance from the pole itself (2. and 3.), in order to avoid reflections of signals. Installing the receiver behind another device or too close to an emitting device is strongly not recommended, as it will lower the reception capability of the G-1090.

On a building

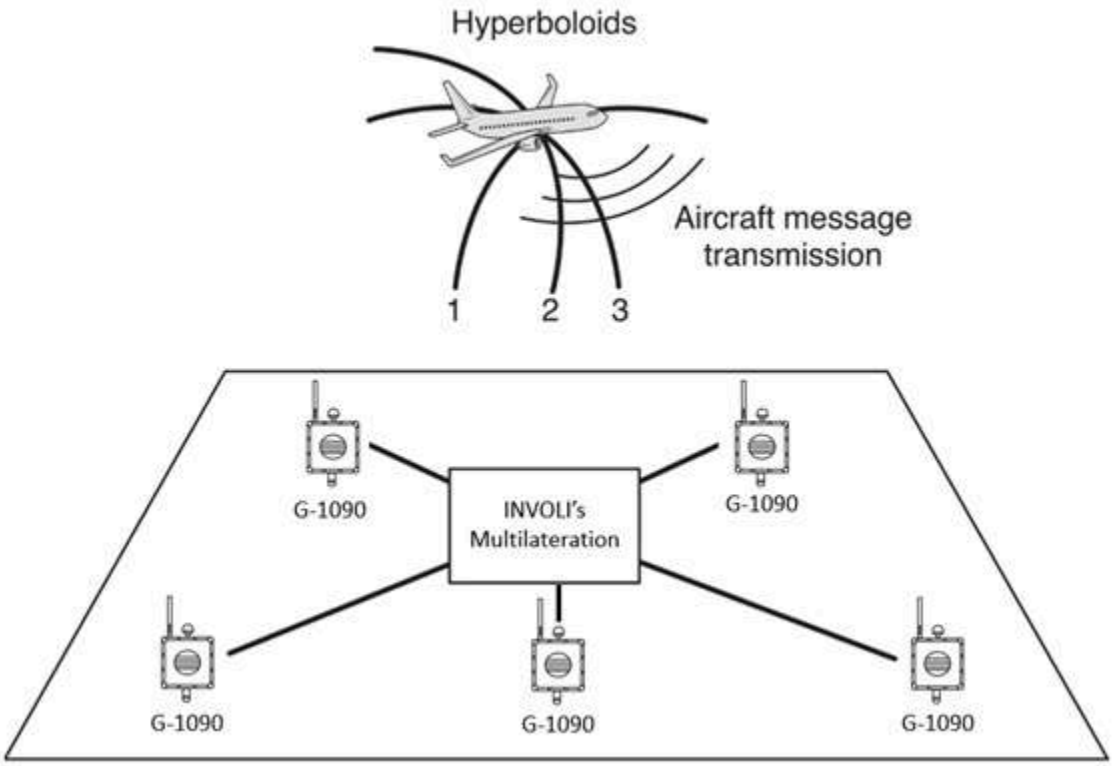
The antenna should be placed on the top of the structure (1.). If not possible, the receiver should be placed in a way that optimizes the line of sight (2.). Installation inside concrete buildings is not recommended (3.), but it is feasible to install the receiver inside wooden structures.

Multilateration

INVOLI Multilateration (or MLAT) is server-based software that unleashes the true power behind any INVOLI receiver.

When fed with data from INVOLI receivers, it calculates and validates the position of air traffic emitting signals over the 1090 MHz frequency. The Multilateration algorithm calculates the position of the aircraft by comparing the times of arrival of the same message to different receivers.

Multilateration proves itself particularly useful in calculating the position of the aircraft emitting exclusively Mode S and Mode A/C transponder messages (which do not contain information on the position).



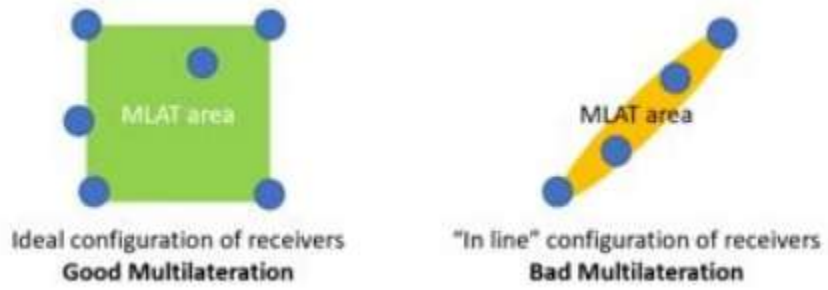
Please watch a short video about the Multilateration prepared by INVOLI: https://youtu.be/uVlfw9tGMA4

It is important to understand that Multilateration results are strongly dependent on multiple parameters, such as:

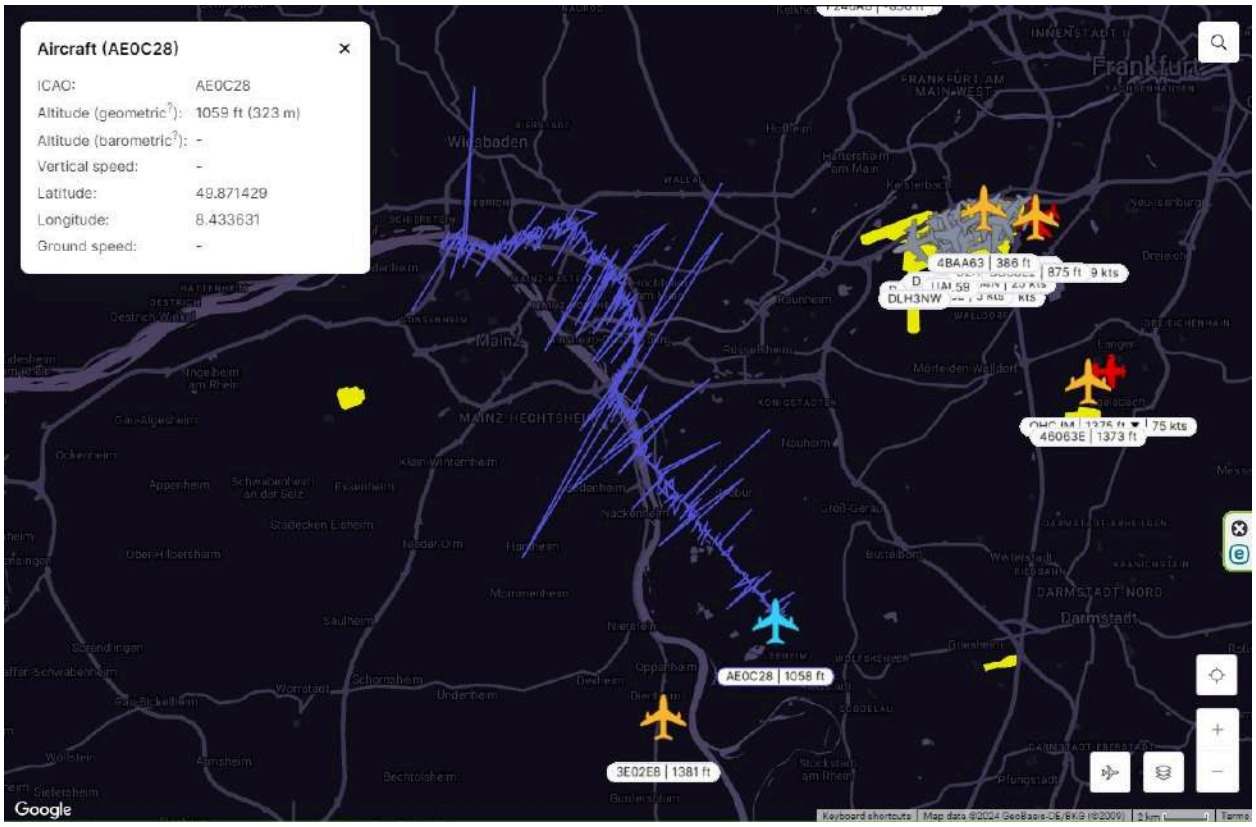
1. The **number of INVOLI receivers** that receive the same message (notice that the less powerful transponder will transmit its signal at a maximum of 10-20 km of distance, while

the most powerful one can be received up to 400 km of distance. This has to be kept in account when choosing the number of G-1090 receivers and their location)

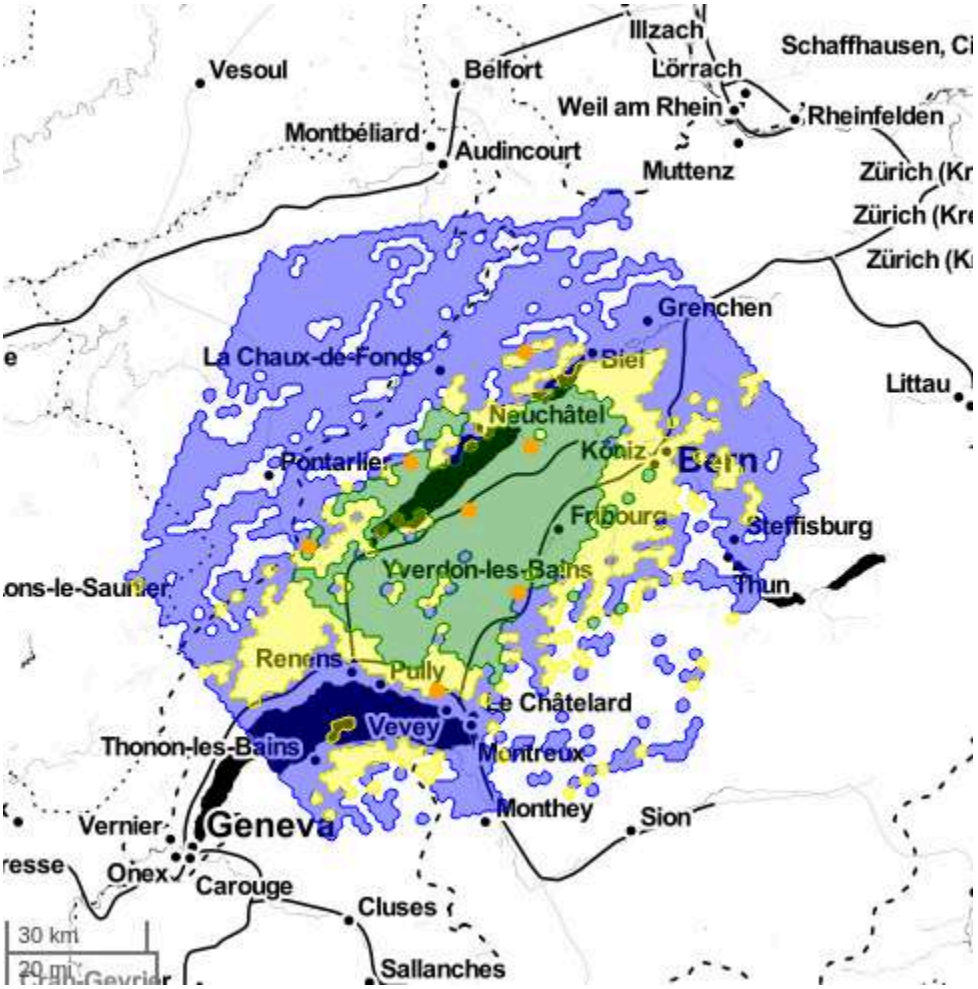
2. The **position of the aircraft relative to the G-1090** (the more the aircraft is located in the center of the G-1090 cluster, the more accurate the result)
3. The **configuration of the network of G-1090**. The G-1090 receivers should be arranged to create a “polygon”, and the area inside the polygon will be where the Multilateration converges the best. A layout along a line will not give good results in terms.



The picture below shows the real Multilateration track, where it is possible to observe the changes in the calculated position accuracy, as the object moves forward in the area, where multilateration coverage is changing from acceptable to worse and back to good.



On request, INVOLI provides the Multilateration coverage simulation of the area you are interested in covering and helps you decide which locations to pick.



Connecting the G-1090 to the Internet

Once the G-1090 air traffic receiver is physically installed in its designated location, it needs **electricity** to work correctly and **connectivity** to send data to the INVOLI.live server.

INFORMATION

To improve the durability of the installation, the Ethernet cable connecting the G-1090 air traffic receiver should be at least CAT6 and shielded.

It is very important to use its Waterproof RJ45 Ethernet socket cover (provided with the receiver), to guarantee a long connector time life. It has to be slid over the cable before mounting the RJ45 plug.

Alternatively, INVOLI provides Ethernet cables already equipped with a waterproof RJ45 Ethernet socket cover.

There are several possible ways to provide power and internet access to the G-1090 Air traffic receiver.

- Direct Ethernet (with PoE)
- PoE Router (option provided by INVOLI)
- LTE PoE Router (option provided by INVOLI)
- INVOLI Connectivity Module

Option 1 - Direct Ethernet with PoE

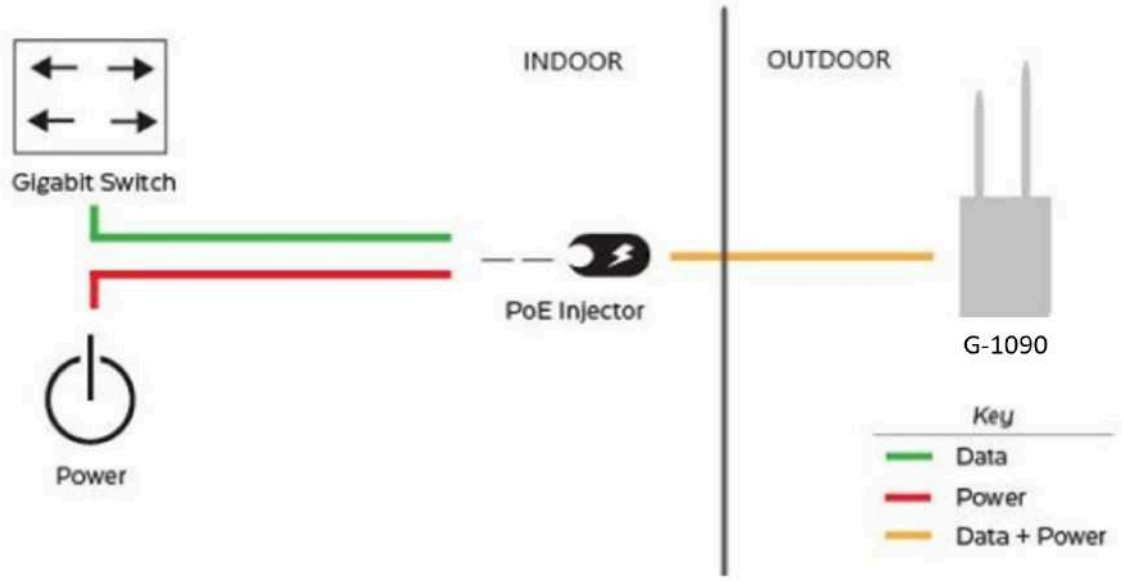
If the network you want to connect to is equipped with Power over Ethernet (PoE) and has access to the internet, simply connect the G-1090 to it by using an Ethernet cable. As soon as the connection is made, the device will turn on.

INFORMATION

The G-1090 receiver power consumption is 8W, so a 15W standard PoE power supply is sufficient (IEEE 802.3af).

Option 2 - PoE router

If internet access is not equipped with PoE, it is possible to purchase a PoE injector (available in the INVOLI catalogue of spare parts and accessories). The injector has to be connected to the Internet with an Ethernet cable and to the power supply. Then, simply connect the Ethernet cable from the G-1090 to the PoE router and the receiver should turn on.

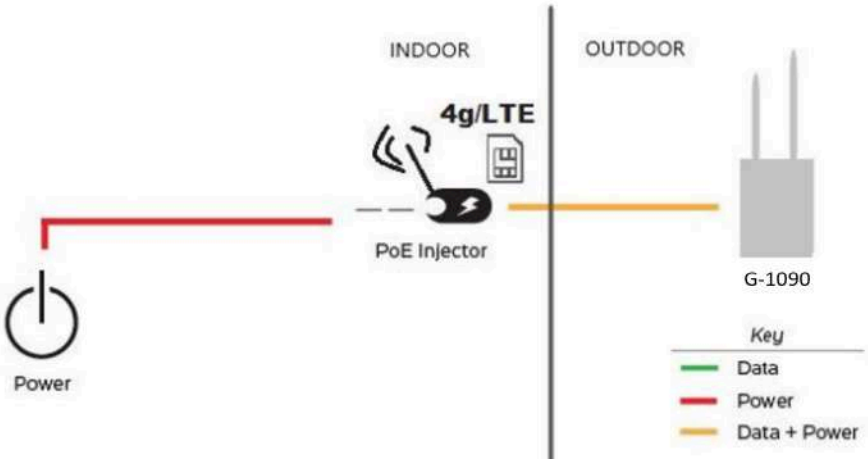


The picture below shows the typical power injector for PoE. It has a socket for a power supply and 2 Ethernet ports - a data input port to connect to the Internet (DATA-IN), and an output port with data and power (P+DATA-OUT).

- Physical dimensions: 155mm x 57mm x 33mm
- Weight: 160g
- Input: AC 100 - 240V
- Out PoE: 30W
- Temp range: -10 to 40 C
- Speed: 1Gbps
- Max Ethernet cable length with PoE: 100m

Option 3 - LTE PoE router

If you are installing a G-1090 where there is no access to the Internet, it is possible to purchase a PoE LTE router (available on the INVOLI catalog of spare parts and accessories). The installation is similar to that described above, but one SIM card is required to ensure Internet access through a 4G/LTE cellular network.



Further details on the INVOLI LTE router are available at this link:

https://involi.odoo.com/knowledge/article/66

Option 4 - INVOLI connectivity module

This connectivity solution is superior to the option described above because it is IP67 class and can be mounted outdoors, close to the G-1090 receiver, e.g. on the same pole. It provides Internet connectivity for the receiver and power through a PoE connection. Thanks to the fact, that it comes already preconfigured, it only requires to be powered to start working.

It comes with a 2.8 m power supply cable (power plug for specific countries available on request). The Ethernet cable assembly kit is provided to prepare the Ethernet cable to be IP67. Otherwise, it is possible to order a separate Ethernet cable (CO00050AA), as an accessory.

No control lights are available for the module - the actual working state can be deducted from the status lights on the G-1090 receiver.

Further details on the INVOLI connectivity module are available at this link:

https://www.involi.com/knowledge/article/83

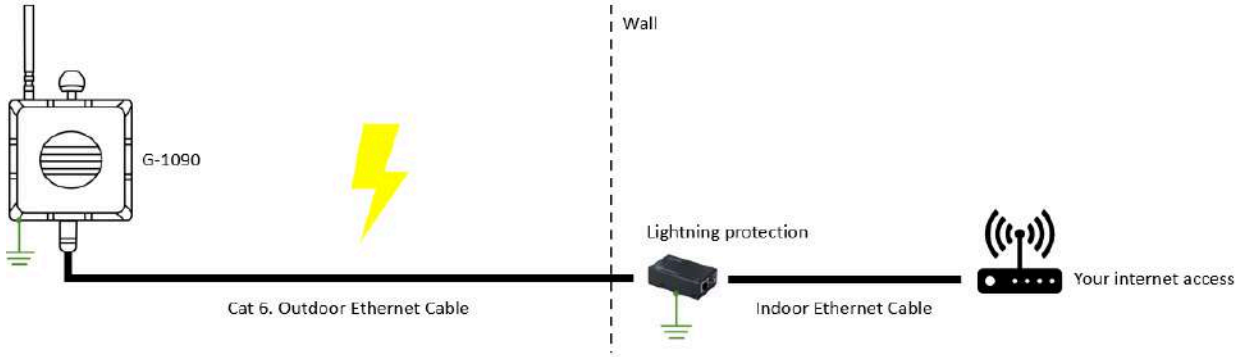
Grounding and Lightning Protection

If the Ethernet cable is connected to a device properly connected to the ground, no further grounding of the G-1090 air traffic receiver is needed. Otherwise, there is a grounding hole screw on the bottom of the receiver. Connect the grounding screw to a metallic item properly grounded.

In case of a permanent installation, appropriate lightning protection should be installed between the cable and the PoE, and between the antennas and the G-1090 Air traffic receiver.

The G-1090 receiver is protected from lightning strikes occurring at the level of the Ethernet cable. In fact, it has its own lightning protection equipment inside the receiver. This protects specifically in the case lightning creates a parasite current in the Ethernet cable between the receiver and your internet source. Note that the lightning doesn't need to specifically hit the Ethernet cable to create such a current, an inducted current could be created also if the lightning happens in the area of the cable.

In order to protect your internet source from lightning strikes, INVOLI provides lightning protection. The installation should be according to the scheme below. Both the G-1090 receiver and the lightning protection device should be properly grounded to assure effective protection. This is represented in the picture by green grounding arrows.



Troubleshooting G-1090 connectivity

If the G-1090 is not shown online in the INVOLI.live web interface, there might be an issue with the network connection. Please try the following:

- Try to ping the IP address of the G-1090. It either obtains an IP address from a DHCP server if available in the network. Otherwise, it will fallback to a default IP address (192.168.123.123)

- Verify that all relevant outgoing connections from within the network are allowed and not blocked by any firewall. The following ports need to be open for outgoing connections:
    - 23452/udp
    - 18883/tcp
    - 443/tcp
    - 80/tcp
    - 5959-5970/udp
    - 10000-40000/udp
    - 123/tcp
    - 1514/tcp

Frequently Asked Questions (FAQ)

1. What to do when the G-1090 Status LED is blinking in RED

When the Status LED is blinking in **RED**, it provides information on errors:

- **2 RED Flash/second**: The G-1090 air traffic receiver **could not establish a connection to the internet**. Action requested: Check internet connectivity and restart the receiver. If the problem persists, contact INVOLI.
- **3 RED Flash/second**: The G-1090 air traffic receiver c**ould not perform a GPS fix**. Action requested: Restart the device. Check if the top of the device has poor visibility toward the sky. In that case, the receivers should be mounted in another location. Note: The first GPS fix in a new location could take longer. If after 5 restarts the problem persists, contact INVOLI.
- **4 RED Flash/second**: **Peripheral problem**. Action requested: Restart the device. If the problem persists, contact INVOLI.

Restart the receiver by unplugging the Ethernet cable, wait for 10 seconds, and plug the cable back into the Ethernet socket.

2. What to do when the G-1090 Status LED is blinking in BLUE

If the Status LED is blinking in **BLUE** for more than 2 minutes, it means that the G-1090 air traffic receiver is experiencing issues in finding its GPS location.

- The first GPS fix in a new location can take longer than expected. If after 5 minutes the G-1090 keeps blinking in BLUE, try to restart the receiver by unplugging the Ethernet cable and plugging again after 10 seconds.
- If this does not solve the problem, there is a possibility that the G-1090 air traffic receiver is not getting a good GNSS constellation. This typically happens when there is a building or any other structure that obstructs the GNSS signal. In that case, consider installing the G-1090 in another location.