The Synchronization Experts.

SETUP GUIDE

IMS-GXL183

Serial Input/Output Model

Installation and Configuration

Meinberg Funkuhren GmbH & Co. KG

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1 About This Manual

1.1 Imprint and Legal Information

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1.3 Copyright and Liability Exclusion

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You may also write to **techsupport@meinberg.de** to request an updated version at any time or provide feedback on errors or suggested improvements, which we are grateful to receive.

Meinberg reserves the right to make changes of any type to this document at any time as is necessary for the purpose of improving its products and services and ensuring compliance with applicable standards, laws & regulations.

1.4 Applicability of Content in this Manual

This manual provides all of the guidance required for the initial installation, connection, and configuration of your IMS-GXL183.

Please note that this version of the manual has been prepared based on the following LANTIME configuration:

- LANTIME M3000
- IMS-GXL183 with Firmware Version 1.20
- LTOS v7.08

Meinberg products are subject to ongoing development even after their market release, with new features and enhancements added on a regular basis via firmware and software updates. Meinberg also revises its product manuals to account for these feature updates.

Accordingly, when using a different LANTIME system, a different LTOS version, or a different module firmware version, there may be noticeable differences, for example in the presentation and availability of options in the Web Interface as shown in → **Chapter 8, "Initial Configuration"**.

New versions of the manual are published on the Meinberg Customer Portal at **https://www.meinberg.support**.

1.5 Presentation Conventions in this Manual

1.5.1 Conventions for the Presentation of Critical Safety Warnings

Warnings are indicated with the following warning boxes, using the following signal words, colors, and symbols:

Caution!

This signal word indicates a hazard with a **low risk level**. Such a notice refers to a procedure or other action that may result in **minor injury** if not observed or if improperly performed.

Warning!

This signal word indicates a hazard with a **medium risk level**. Such a notice refers to a procedure or other action that may result in **serious injury** or even **death** if not observed or if improperly performed.

Danger!

This signal word indicates a hazard with a **high risk level**. Such a notice refers to a procedure or other action that will very likely result in **serious injury** or even **death** if not observed or if improperly performed.

1.5.2 Secondary Symbols Used in Safety Warnings

Some warning boxes may feature a secondary symbol that emphasizes the defining nature of a hazard or risk.

The presence of an “electrical hazard” symbol is indicative of a risk of electric shock or lightning strike.

The presence of a “fall hazard” symbol is indicative of a risk of falling when performing work at height.

This “laser hazard” symbol is indicative of a risk relating to laser radiation.

1.5.3 Conventions for the Presentation of Other Important Information

Beyond the above safety-related warning boxes, the following warning and information boxes are also used to indicate risks of product damage, data loss, and information security breaches, and also to provide general information for the sake of clarity, convenience, and optimum operation:

Important!

Warnings of risks of product damage, data loss, and also information security risks are indicated with this type of warning box.

Information:

Additional information that may be relevant for improving efficiency or avoiding confusion or misunderstandings is provided in this form.

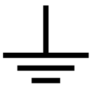
1.5.4 Generally Applicable Symbols

The following symbols and pictograms are also used in a broader context in this manual and on the product.

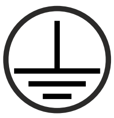
The presence of the “ESD” symbol is indicative of a risk of product damage caused by electrostatic discharge.

Direct Current (DC) *(symbol definition IEC 60417-5031)*

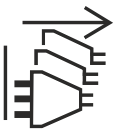
Alternating Current (AC) *(symbol definition IEC 60417-5032)*



Grounding Terminal *(symbol definition IEC 60417-5017)*



Protective Earth Connection *(symbol definition IEC 60417-5019)*



Disconnect All Power Connectors *(symbol definition IEC 60417-6172)*

1.6 Your Feedback is Valuable: A Message from Meinberg's Technical Documentation Team

We in the Meinberg Technical Documentation Team prepare our manuals with a view to providing you with the most comprehensive yet relevant source of information needed to prepare, install, set up, use, and manage your Meinberg product. Our technical writers actively engage with Meinberg's development and support engineers in the preparation of this manual, and we regularly review our documentation to keep it up to date with the latest features and to accommodate feedback.

Of course, no feedback is more valuable than that which we receive from the end users of Meinberg products, as your experiences primarily inform the direction that we take in the preparation of our documentation. We truly hope that this manual meets your requirements and expectations, but if you feel that anything is unclear or missing, please feel free to drop us a line and let us know. We are grateful for your feedback and ideas, and we of course handle them with the respect and seriousness they deserve.

Meinberg Technical Support

Phone: +49 (0) 5281 – 9309-888

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Meinberg Technical Documentation

Phone: +49 (0) 5281 – 9309-0

Email: marketing@meinberg.de

2 Important Safety Information

The safety information provided in this chapter as well as specific safety warnings provided at relevant points in this manual must be observed during every installation and operation procedure of the device, as well as its removal from service.

Any safety information affixed to the product itself must also be observed.

Any failure to observe this safety information, these safety warnings, and other safety-critical operating instructions in the product documentation, or any other improper usage of the product may result in unpredictable behavior from the product, and may result in injury or death.

Depending on your specific device configuration and installed options, some safety information may not be applicable to your device.

Meinberg accepts no responsibility for injury or death arising from a failure to observe the safety information, warnings, and safety-critical instructions provided in the product documentation.

It is the responsibility of the operator to ensure that the product is safely and properly used.

Should you require additional assistance or advice on safety-related matters for your product, Meinberg's Technical Support team will be happy to assist you at any time. Simply send a mail to techsupport@meinberg.de.

2.1 Appropriate Usage

The device must only be used appropriately in accordance with the specifications of the product documentation! Appropriate usage is defined exclusively by this manual as well as any other relevant documentation provided directly by Meinberg.

Appropriate usage includes in particular compliance with specified limits! The device's operating parameters must never exceed or fall below these limits!

2.2 Product Documentation

The information in this manual is intended for readers with an appropriate degree of safety awareness.

The following are deemed to possess such an appropriate degree of safety awareness:

- **skilled personnel** with a familiarity with relevant national safety standards and regulations,
- **instructed personnel** having received suitable instruction from skilled personnel on relevant national safety standards and regulations.

Read the product manual carefully and completely before you set the product up for use.

If any of the safety information in the product documentation is unclear for you, do **not** continue with the set-up or operation of the device!

Safety standards and regulations change on a regular basis and Meinberg updates the corresponding safety information and warnings to reflect these changes. It is therefore recommended to regularly visit the Meinberg website at https://www.meinbergglobal.com or the Meinberg Customer Portal at https://meinberg.support to download up-to-date manuals.

Please keep all product documentation, including this manual, in a safe place in a digital or printed format to ensure that it is always easily accessible.

Meinberg's Technical Support team is also always available at techsupport@meinberg.de if you require additional assistance or advice on safety aspects of your Meinberg product.

2.3 Safety During Installation

This rack-mounted device has been designed and tested in accordance with the requirements of the standard IEC 62368-1 (*Audio/Video, Information and Communication Technology Equipment—Part 1: Safety Requirements*). Where the rack-mounted device is to be installed in a larger unit (such as an electrical enclosure), additional requirements in the IEC 62368-1 standard may apply that must be observed and complied with. General requirements regarding the safety of electrical equipment (such as IEC, VDE, DIN, ANSI) and applicable national standards must be observed in particular.

The device has been developed for use in industrial or commercial environments and may only be used in such environments. In environments at risk of high environmental conductivity ("high pollution degree" according to IEC 60664-1), additional measures such as installation of the device in an air-conditioned electrical enclosure may be necessary.

If the appliance has been brought into the usage area from a cold environment, moisture may develop as a result of condensation; in this case, wait until the appliance has adjusted to the temperature and is completely dry before setting it up.

When unpacking & setting up the equipment, and before operating it, be sure to read the information on installing the hardware and the specifications of the device. These include in particular dimensions, electrical characteristics, and necessary environmental conditions.

Fire safety standards must be upheld with the device in its installed state—never block or obstruct ventilation openings and/or the intakes or openings of active cooling solutions.

The device with the highest mass should be installed at the lowest position in the rack in order to position the center of gravity of the rack as a whole as low as possible and minimize the risk of the rack tipping over. Further devices should be installed from the bottom, working your way up.

The device must be protected against mechanical & physical stresses such as vibration or shock.

Never drill holes into the device to mount it! If you are experiencing difficulties with rack installation, contact Meinberg's Technical Support team for assistance!

Inspect the device housing before installation. The device housing must be free of any damage when it is installed.

2.4 Battery Safety

The integrated CR2032 lithium battery has a service life of at least ten years.

Should it be necessary to replace the battery, please note the following:

- The battery may only be replaced by the same type or a comparable type recommended by the manufacturer.
- The battery may only be replaced by the manufacturer or authorized personnel.
- The battery must not be exposed to air pressure levels outside of the limits specified by the manufacturer.

Improper handling of the battery may result in the battery exploding or in leakages of flammable or corrosive liquids or gases.

- **Never** short-circuit the battery!
- **Never** attempt to recharge the battery!
- **Never** throw the battery in a fire or dispose of it in an oven!
- **Never** dispose of the battery in a mechanical shredder!

3 Important Product Information

3.1 Ensuring the Optimum Operation of Your Device

- Ensure that ventilation slots are not obscured or blocked by dust, or else heat may build up inside the device. While the system is designed to shut down safely and automatically in the event of temperature limits being exceeded, the risk of malfunctions and product damage following overheating cannot be entirely eliminated.
- The device is only deemed to be appropriately used and EMC limits (electromagnetic compatibility) are only deemed to be complied with while the device housing is fully assembled in order to ensure that requirements pertaining to cooling, fire safety, electrical shielding and (electro)magnetic shielding are upheld.

4 Introduction to Your IMS-GXL183

The IMS-GXL183 is an IMS module card designed for use with Meinberg's range of modular IMS time server systems. As a clock module, the IMS-GXL183 provides the primary timing reference for your IMS system, hosting both the signal receiver and the on-board oscillator that governs the accuracy of the time signal output.

With an integrated 448-channel satellite receiver developed from the ground up specifically for time and frequency synchronization purposes, the IMS-GXL183 provides a high-accuracy time and frequency reference for your Meinberg IMS system with four advanced GNSS security and accuracy features:

- support for a wide range of GNSS navigation civil signals broadcast by all four of the main GNSS constellations (GPS, Galileo, BeiDou, and GLONASS), providing a greater bandwidth of reception frequencies,
- support for multiple GNSS augmentation systems for authentication and enhanced position accuracy,
- integrated spoofing detection functionality,
- support for the Fugro AtomiChron® Navigation Authentication Message service for assurance of the veracity of inbound GNSS data.

This manual provides all the information you need to help you to install and set up your IMS-GXL183 for use as quickly and easily as possible, encompassing three key steps: → "Preparation", → "Installation" of the antenna and module, and → "Initial Configuration" via the LTOS Web Interface.

For applications that require more fine-grained control over the IMS-GXL183, this manual also includes a comprehensive → "Technical Reference" that provides both a → "Hardware Reference" containing technical specifications of all of the module connectors and LEDs and a comprehensive → "Configuration Reference" with a description of all options in the LTOS Web Interface relating to the IMS-GXL183.

Of course, if you need any additional assistance with setting up your IMS-GXL183 at any point, please do not hesitate to contact Meinberg's Technical Support Team, who will be happy to help:

Phone: +49 (0) 5281 – 9309-888

Email: techsupport@meinberg.de

5 General Information

5.1 IMS System Compatibility

The IMS-GXL183 is an IMS module that is compatible with **all current systems** in the IMS family:

IMS System	M500	M1000	M1000S	M2000S	M3000	M3000S	M4000
Compatible	✓	✓	✓	✓	✓	✓	✓

The module can only be used in a **Reference Clock** slot **(CLK)** of your IMS system:

IMS Slot	PWR	CLK	CPU	MRI	ESI	I/O
Compatible	✗	✓	✗	✗	✗	✗

To eliminate any risk of compatibility problems, your IMS system should have at least **LTOS Version 7.08** installed.

5.2 Antenna Compatibility

The IMS-GXL183 is designed for operation with the **Meinberg GNMANTv2 Antenna**.

Please refer to → Chapter 12.1.2, "Technical Specifications: GNMANTv2 Antenna" for more information on the antenna.

Antenna	Meinberg GPSANT	Meinberg GPSANTv2	PCTEL Multi-GNSS Antenna*	Meinberg Multi-Band Antenna	Meinberg GNMANTv2
Compatible	⊗	⊗	ⓘ	ⓘ	✓

Operation with the **GNMANTv2** antenna is required in order to provide the full functionality of your product, including the Fugro AtomiChron® service, access to the full range of GNSS frequencies supported by the IMS-GXL183, and full IEC 61000-4-5 surge protection; this manual assumes that you will be using this antenna.

The legacy **GNSS Multi-Band Antenna** also supports the full range of GNSS and the Fugro AtomiChron® service and access to the full range of GNSS frequencies supported by the IMS-GXL183, but may be limited in its support of additional features introduced in future versions of LTOS.

The IMS-GXL183 offers *limited* compatibility with the **PCTEL Multi-GNSS Antenna** also offered by Meinberg for use with IMS-GNS clock modules. When using the PCTEL Multi-GNSS Antenna, with the IMS-GXL183 (for example as a redundant backup), support is limited to the GPS L1, Galileo E1 (including future OSNMA support), BeiDou B1, and GLONASS G1 bands. The PCTEL Multi-GNSS Antenna does not allow reception of the GPS L2, Galileo E5b, BeiDou B2/B3, or GLONASS G2 bands or the services provided over those frequencies, and does not permit use of the Fugro AtomiChron® service.

The IMS-GXL183 is *not* compatible with the **Meinberg GPSANT** or **GPSANTv2 antenna**.

For more information on the reception requirements of the antenna, please refer to → Chapter 10.1.3, "Antenna Input: GXL Multi-Band Receiver".

For more information on the installation of the GNMANTv2 antenna, please refer to → Chapter 7.1, "Installation of the Antenna".

6 Preparation

6.1 Prevention of ESD Damage

An **ESDS device** (electrostatic discharge-sensitive device) is any device at risk of damage or malfunction due to electrostatic discharge (**ESD**) and thus requires special measures to prevent such damage or malfunction. Systems and modules with ESDS components usually bear this symbol.

Precautionary measures should be taken to protect ESDS components from damage and malfunction.

- Before removing or installing a module, ground your body first (for example, by touching a grounded object) before touching ESDS components.
- Ensure that you wear a grounding strap on your wrist when handling such ESDS components. This strap must in turn be attached to an uncoated, non-conductive metal part of the system.
- Use only tools and equipment that are free of static electricity.
- Ensure that your clothing is suitable for the handling of ESDS components. In particular, do not wear garments that are susceptible to electrostatic discharges (wool, polyester). Ensure that your shoes enable a low-resistance path for electrostatic charges to dissipate to the ground.
- Only touch or hold ESDS components by the edges. Never touch any pins or conductors on the ESDS components.
- When removing or installing ESDS components, avoid coming into contact with persons who are not grounded. Such contact may compromise your connection with the grounding conductor and thus also compromise the ESDS component's protection from any static charges you may be carrying.
- Always store ESDS components in ESD-proof 'antistatic' bags. These bags must not be damaged in any way. Antistatic bags that are crumpled or have holes cannot provide effective protection against electrostatic discharges. Antistatic bags must have a sufficient electrical resistance and must not be made of conductive metals if the ESDS component has a lithium battery fitted on it.

6.2 Unpacking Your IMS-GXL183

Unpack the IMS-GXL183 and all accessories carefully, taking all ESD-related precautions necessary as described in → Chapter 6.1, "Prevention of ESD Damage". Meinberg recommends retaining the original packaging materials, in case the product needs to be placed into storage, shipped, or transported again at a later date.

Check the contents of the delivery against the enclosed packing list to ensure that nothing is missing. If any of the listed items are missing, please contact Meinberg's Sales Department at ✉ sales@meinberg.de or your Authorized Meinberg Distributor.

Check that the product has not been damaged in transit. If the product is damaged or fails to operate upon installation, please contact Meinberg's Sales Department at ✉ sales@meinberg.de or your Authorized Meinberg Distributor immediately. Please note that in many cases, forwarders will only accept claims or complaints filed by the recipient for damage caused in transit.

7 Installation

7.1 Installation of the Antenna

7.1.1 The Importance of Good Antenna Positioning

This chapter aims to provide some basic technical background as to the factors that influence good GNSS antenna positioning.

Basics of GNSS Reception for Time Servers

A GNSS antenna captures signals from satellites visible in the sky (referred to as *live-sky signals*). These signals are transmitted by constellations of satellites (also known as *space vehicles* or SVs) in a medium Earth orbit of generally between 20,000 and 30,000 km above sea level.

GNSS antennas used by Meinberg time servers are directional antennas designed to be installed vertically in order to receive live-sky signals within their *signal cone*, which is a reception field spreading out from the antenna up to the sky.

In the case of the GNSS Multi-Band Antenna, this signal cone is approximately 120° relative to the zenith (straight up) to ensure that the antenna can capture a strong a signal as possible even at the horizontal extremes (90° from the zenith). This signal cone can be disrupted by solid objects or other radio signals in its path.

There is a certain margin of error involved in calculating a position based on the distance between an antenna and the satellites visible within the signal cone. Because of this margin of error (known as *dilution of precision*), the position calculated between two measurements can vary even though the antenna and receiver are physically in exactly the same place. Dilution of precision can be influenced by factors outside of the influence of the receiver, such as ionospheric interference, but some factors can be affected by well-considered antenna positioning that maximizes the visible sky while minimizing potential sources of interference.

Impact of GNSS Lock Count on Clock Accuracy

An antenna used for a Meinberg time server requires a lock on the live-sky signals from at least four satellites within the antenna's (ideally undisrupted) signal cone for the receiver to properly, accurately, and consistently determine its position, which it does by generating a *navigation solution*. The more satellites that are visible, the more options the receiver has to generate a *strong solution*, in which the satellites are far apart and the dilution of precision is lower, resulting in a more accurate position fix. This improves the stablility of the position that is measured from solution to solution.

The specified accuracy of synchronized Meinberg time servers assume clear-sky conditions for GNSS receivers, such that any obstructions antithetical to clear-sky conditions may reduce clock accuracy accordingly.

It is therefore important for an antenna to have as much direct exposure to the sky as possible, as this increases the chances of more live-sky signals being correctly detected and improves the quality of the position detection. Obstructions such as buildings or trees reduce or eliminate the chance of live-sky signals being correctly received from that direction, limit the strength of the navigation solution, and can also produce *multipath interference* (see below).

In locations between the 55th parallels, a clear view to the northern and/or southern horizons is especially important in increasing the number of GNSS satellites visible at any given time, because the *ground tracks* of the GPS and Galileo satellite orbits converge with greater frequency around the 55th parallels and the equator of the Earth.

In locations **north** of the **55th north parallel** (e.g., much of Canada, Scandinavia, Greenland, Alaska) GNSS reception is less reliable, as the further north the receiver is located, the less likely GNSS reception at the zenith becomes. As such, a clear view to the north is *less* beneficial and a clear, unobstructed view to the south becomes *more* important.

Conversely, in locations **south** of the **55th south parallel** (principally Antarctica, but also small parts of Brazil, Chile, and Argentina), GNSS reception at the zenith becomes more problematic the further south the receiver is located. As such, a clear view to the **south** is *less* beneficial here, while a clear, unobstructed view to the **north** becomes *more* important.

Radio-Frequency Interference

GNSS signals are conventionally very weak—typically as low as –120 to –130 dBm at ground level. For a common point of reference, the signal strength of a 2.4 GHz wi-fi router at the extremes of its range must be –80 dBm to maintain a stable connection.

With this in mind, radio-frequency interference plays a significant role in GNSS signal reception and must therefore factor into your choice of installation location. Even minor electromagnetic and other radio-frequency interference from other antennas, overhead power lines, and electrical equipment such as HVAC units and cameras can introduce errors, as can a general proximity to metallic surfaces.

Further information on RF emissions from other devices may be obtainable from the documentation of those devices, but as a general rule, a distance of 50 cm from other GNSS antennas, at least 10 m from camera systems (regardless of radio or cable transmission) or HVAC units, and at least 30 m from transmission antennas should be maintained.

Multipath Interference

To enable GNSS antennas to receive sky signals reliably even at horizon level, the signal cone of an antenna typically encompasses the ground to a certain degree. This can be problematic in that GNSS signals can be 'reflected' from terrestrial surfaces such as the ground (as well as other buildings or other vertical surfaces) and are essentially an 'echo' of an otherwise directly received GNSS signal. These signals are referred to as 'multipath interference' and can significantly disrupt a Meinberg time server's ability not only to determine its position but also acquire the time from the GNSS signal.

The mitigation of multipath interference relies first and foremost on the directional antenna being mounted vertically, so that the center of the signal cone is directed towards the zenith and is perpendicular to the horizon to ensure that as little of the signal cone is facing the ground as possible. Maximizing the elevation of the antenna above any vertical faces of surrounding architecture and landscape features also plays a significant role in mitigating the impact of multipath interference.

Reception of Fugro AtomiChron® Signal

The Inmarsat-4 satellites via which the Fugro AtomiChron® service data is transmitted follow a geostationary orbit whose ground positions are, by definition, on or very close to the equator.

This means that, at medium-to-high-latitude locations in the Northern and Southern Hemispheres, the satellites are typically only visible at very low elevation angles and are particularly dependent on a clear view of the equatorial horizon (i.e., a clear view to the southern horizon in the Northern Hemisphere, or to the northern horizon in the Southern Hemisphere).

7.1.2 Planning the Installation of the Antenna

The following conditions should be met as closely as possible when selecting the best place to install your antenna:

- a clear 360° view around the antenna (to maximize exposure to the live sky), prioritizing in particular a clear view to the northern horizon (if antenna located in the southern hemisphere) or the southern horizon (if antenna is located in the northern hemisphere) to maximize the number of GNSS satellites visible at any given time;
- the highest elevation possible (to limit exposure to reflections from the ground and from other buildings);
- at least 10 m (~ 30 ft) distance to any electrical equipment prone to emitting significant electrical interference, such as HVAC units and cameras;
- at least 50 cm (~ 2 ft) distance to other GNSS antennas;
- at least 10 m – 30 m (~ 30 ft – 100 ft) distance to other transmission antennas, depending on transmission power;
- sufficient distance from other metallic objects, which can reflect radio signals capable of interfering with GNSS signals; the necessary distance will depend on the size, orientation, and relative position of the objects.

For more information on the background to the above requirements and recommendations, please refer to → Chapter 12.2.1, "The Importance of Good Antenna Positioning".

Important Information when connecting a IMS-GXL183-Module to the GNMANTv2 Antenna

Important!

- The specified accuracy levels for your IMS-GXL183 are specified for clear-sky conditions and can only be guaranteed if the above conditions for the installation of the antenna are met fully.
- When using the Fugro AtomiChron® functionality of your IMS-GXL183, a clear view of the equatorial horizon (the southern horizon when in the Northern Hemisphere, or the northern horizon when in the Southern Hemisphere) is especially important for reception of the Inmarsat-4 satellite via which the Fugro AtomiChron® signal is transmitted.

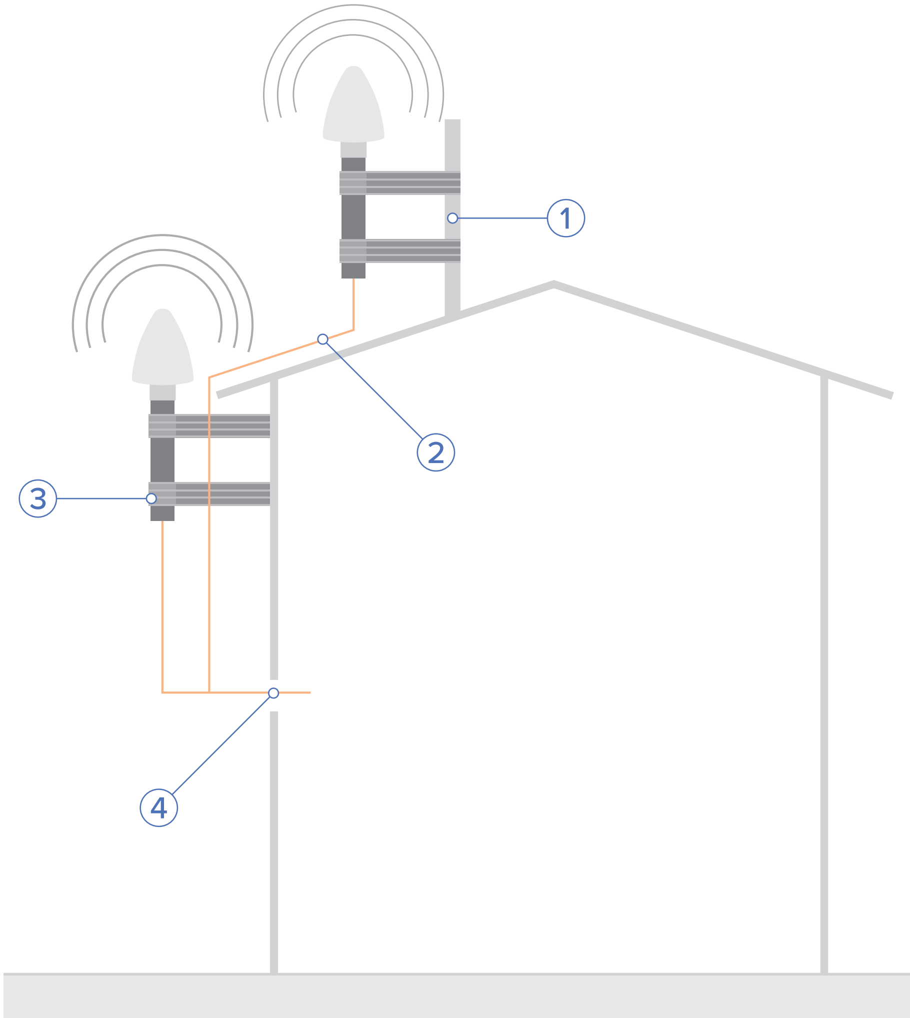


Figure 7.1: Effective Positioning of a GNSS Antenna

1. Mast Mounting
2. Antenna Cable
3. Wall Mounting
4. House Entry

Typically, these conditions can be met by installing the antenna on top of a roof as shown by the antenna on the **right** in Fig. 7.1.

However, if you do not have access to a roof to install the antenna, or if your roof conditions are such that significant radio interference is to be expected, you may consider mounting the antenna on a wall as high as possible, ensuring that a 360° view is observed with a view above the edge of the roof, as shown by the antenna on the **left** in Fig. 7.1. Mounting accessories are provided with your antenna for this purpose.

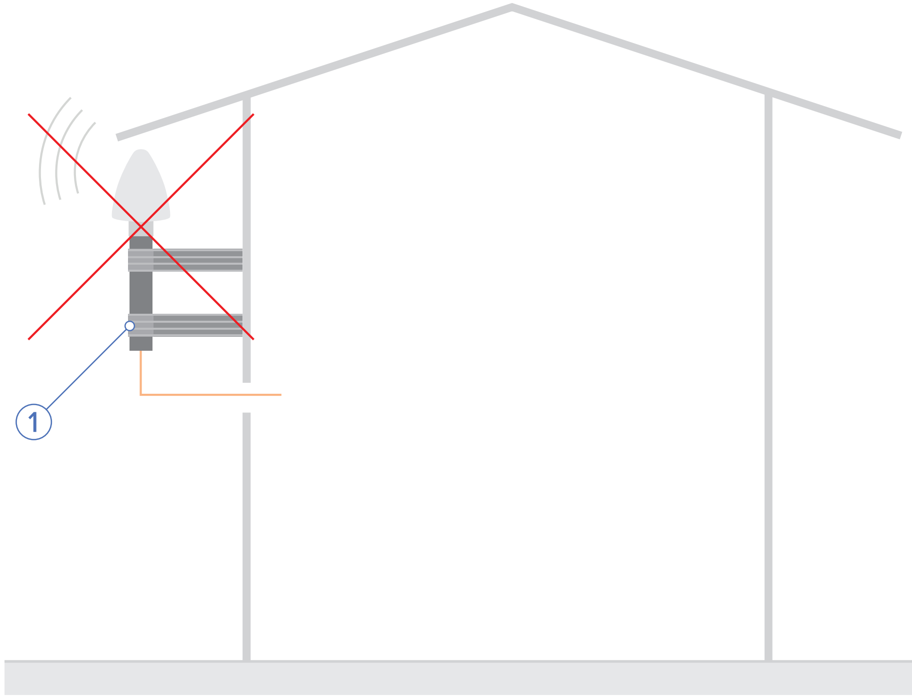


Figure 7.2: Poor Positioning of a GNSS Antenna

Please avoid mounting your antenna on a wall in such a way that the wall obscures the antenna's signal cone, as shown by the **upper antenna** in Fig. 7.2. This not only essentially halves the antenna's exposure to live-sky signals by halving the signal cone, but also exposes the antenna to signal reflections from the wall that the antenna is mounted on.

Under no circumstances should you install the antenna in a horizontal position! Doing so not only essentially halves the antenna's live-sky exposure in the same way as shown by the **lower antenna** in Fig. 7.2, but also maximizes the antenna's exposure to signals reflected from the ground and to other spurious transmissions from ground level.

7.1.3 Assembly and Fixture of the Antenna

Item	Description	QTY
1	Antenna	1
2	M8 grounding stud	1
3	safety washer	1
4	M8 hex nut	1
5	Antenna pole	1
6	M4 hex nut	8
7	M4 x 12 phillips-head screw	8
8	threaded U-bolt (pole diameter max. 60 mm)	2
9	M6 spacer	4
10	M6 hex nut	4
11	pole clamp halves	4
12	pole bracket	2

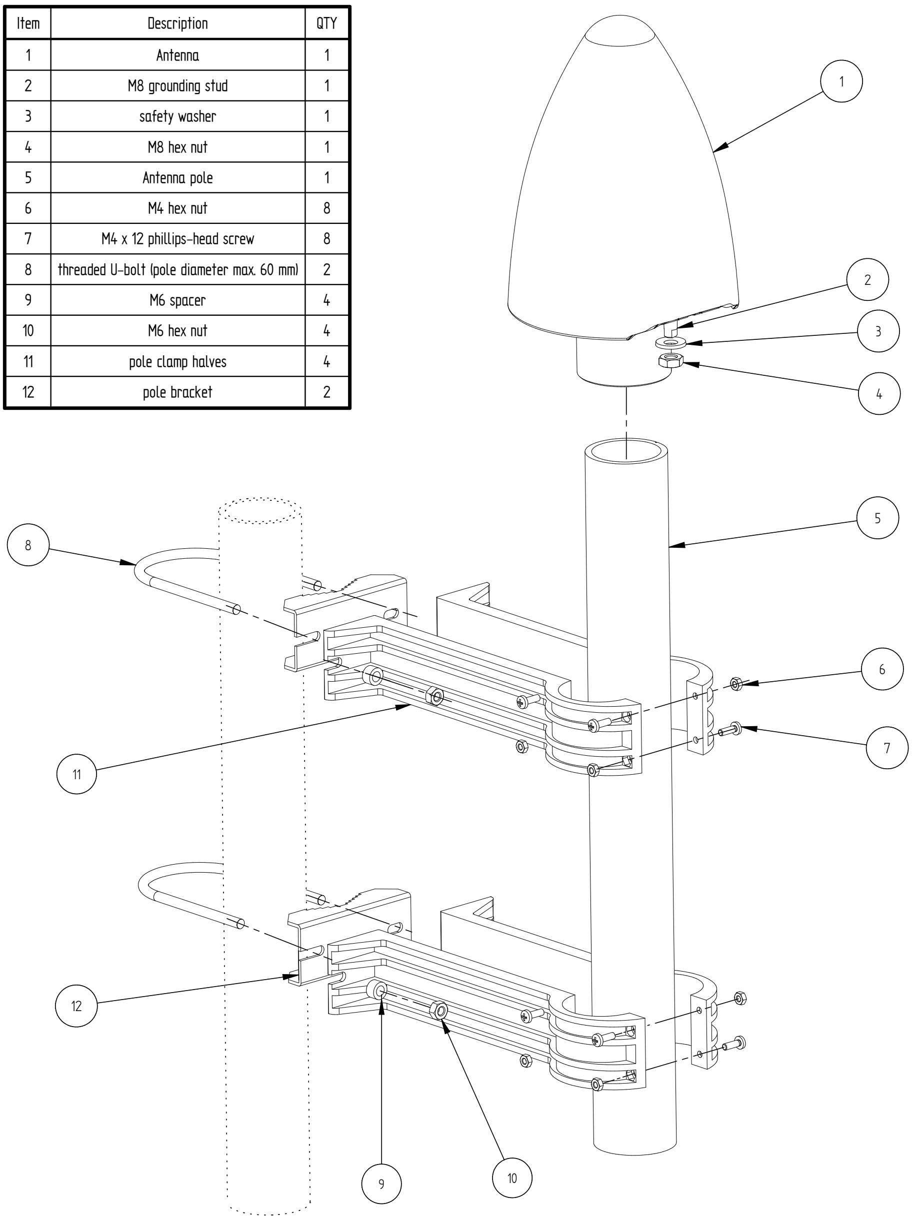


Figure 7.3: Mounting a GNMANTv2 Antenna onto a Mast

Fig. 7.3 illustrates how to assemble and mount a Meinberg GNMANTv2 Antenna on a mast by way of example.

The antenna may be mounted onto an existing mast (maximum pole diameter 60 cm / 2.3 inches) or directly onto a wall, provided that the installation conditions specified in → Chapter 7.1.2, "Planning the Installation of the Antenna" and → Chapter 12.2.1, "The Importance of Good Antenna Positioning" are met, in particular those regarding the maintenance of distances from sources of electromagnetic interference, signal reflections, and signal obstructions.

Danger!

Do not mount the antenna without an effective fall arrester!

Danger of death from falling!

- Ensure that you work safely when installing antennas!
- Never work at height without a suitable and effective fall arrester!

Danger!

Do not work on the antenna system during thunderstorms!

Danger of death from electric shock!

- Do not carry out any work on the antenna installation or the antenna cable if there is a risk of lightning strike.
- Do not perform any work on the antenna installation if it is not possible to maintain the prescribed safety distance from exposed power lines or electrical substations.

Mounting the Antenna onto a Wall

1. Assemble the two pairs of pole clamp halves (Item 8 in Fig. 7.3) with the mounting tube (Item 2 in Fig. 7.3) in the clamps. Secure the tube inside each of the two clamps using four M4x12 Phillips screws and corresponding M4 hex nuts (Items 3 and 4 in Fig. 7.3). To ensure that the clamp is secure as possible, the top and bottom screws of each clamp should be inserted from opposing directions as shown in Fig. 7.3.

2. Drill four holes for M6x45 screws in the underlying wall to match the two screw slits on each of the clamps. Insert two wallplugs into these holes.

3. Use four spacers and four M6x45 screws to mount the clamps onto the wall using the slits on each of the clamps.

4. Once you have verified that the clamps are securely mounted to the wall and the tube is securely held by the clamps, you may insert the antenna into the tube.

Mounting the Antenna onto a Mast

1. Assemble the two pairs of pole clamp halves (Item 8 in Fig. 7.3) with the mounting tube (Item 2 in Fig. 7.3) in the clamps. Secure the tube inside each of the two clamps using four M4x12 Phillips screws and corresponding M4 hex nuts (Items 3 and 4 in Fig. 7.3). To ensure that the clamp is secure as possible, the top and bottom screws of each clamp should be inserted from opposing directions as shown in Fig. 7.3.

2. Place the threaded bolts (Item 5 in Fig. 7.3) around the designated mast pole and feed the two prongs into the holes of the pole bracket (Item 9 in Fig. 7.3). Secure each of the clamps to each of the pole brackets using two spacers and two M6 hex nuts (Item 7 in Fig. 7.3) and tighten until the pole bracket and U-bolt are secure.

3. Once you have verified that the clamps are securely mounted to the mast, that they exhibit no movement without significant force, and that the tube is securely held by the clamps, you may insert the antenna into the top of the mounting tube.

7.1.4 Laying the Antenna Cable

Your IMS-GXL183 is typically shipped with a suitable antenna cable. However, if it is not, or if you must procure a replacement for an old or damaged cable, please consult → Chapter 12.4, "Antenna Cable" for information on the required specifications.

When laying the antenna cable, ensure that the specified maximum cable length is not exceeded. This length will depend on the selected cable type and its attenuation factor. If the specified maximum length is exceeded, correct transmission of the synchronization data and thus proper synchronization of the reference clock can no longer be guaranteed.

Important!

Please avoid using a mixture of different cable types for your antenna installation. This should be taken into consideration in particular when purchasing additional cable, for example in order to extend an existing cable installation.

Like any other metallic object in the antenna installation (antenna and master), the antenna cable must be integrated into the grounding infrastructure of the building and also connected to the other metallic objects. Refer to → Chapter 7.1.5, "Grounding the Antenna" for more information.

Meinberg also strongly recommends implementing in-line surge protection using the MBG S-PRO surge protector, which should be mounted as closely to the point of entry into the building itself. Refer to → Chapter 7.1.6, "In-Line Surge Protection" for more information.

Caution!

When laying the antenna cable, ensure that sufficient distance is maintained from live cables (such as high-voltage power lines), as these can cause severe interference and compromise the quality of the antenna signal significantly. Surges in power lines (caused, for example, by lightning strike) can generate induced voltages in a nearby antenna cable and damage your system.

Any kinking, crushing, or other damage to the external insulation must be avoided. In particular, the bend radius of the cable, which is the radius at which a cable can be bent without sustaining damage such as kinks, must be considered when laying the cable around corners or turns.

The coaxial connectors must be protected from damage and from exposure to water jets or corrosive substances.

7.1.5 Grounding the Antenna

Danger!

Surge protection and lightning protection systems may only be installed by persons with suitable electrical installation expertise.

Risk of fire and danger of death from electric shock!

- **Do not** attempt to implement surge protection or lightning protection systems if you do not have suitable professional electrical qualifications.

If the antenna is not properly grounded, exposure to high induced voltages from indirect lightning strikes can generate significant surge voltages in the coaxial cable, potentially causing significant damage to or even destroying both your antenna and any connected receivers or signal distributors.

Accordingly, antennas and antenna cables must always be professionally integrated into a building's equipotential bonding infrastructure as part of an effective lightning protection strategy to ensure that voltages induced by lightning strikes directly on or indirectly near the antenna are redirected safely to ground.

Meinberg antennas feature integrated surge protection in accordance with IEC 61000-4-5 Level 4 to reliably shield the antenna against surge voltages. The antenna also has a grounding terminal to allow it to be connected as directly as possible to a bonding conductor using a grounding cable. Please refer to the standards regarding antenna installations (e.g., DIN EN 60728-11) for more information.

In order to enhance the safety of the building and the protection of your Meinberg system, Meinberg also recommends the additional use of the MBG S-PRO surge protector, which is addressed in → Chapter 7.1.6, "In-Line Surge Protection".

VDE 0185-305 (IEC 62305) (relating to buildings with lightning protection systems) and VDE 0855-1 (IEC 60728-11) (addressing bonding strategies and the grounding of antenna installations in buildings with no external lightning protection system) are the lightning protection standards applicable to antenna installations on a building. Antennas must generally be integrated into a building's lightning protection system or bonding infrastructure.

If the antenna represents the highest point of a building or pole, the lightning protection strategy should incorporate a safe zone (e.g., formed by a lightning rod) positioned above the antenna. This increases the likelihood of lightning being 'caught' by the lightning rod, allowing surge currents to be safely passed from the lightning rod along a grounding conductor to ground.

Electrical bonding is the connection of all metallic, electrically conductive elements of the antenna installation in order to limit the risk of dangerous voltages for people and connected devices.

To this end, the following elements should be connected and integrated into a bonding system:

- the antenna cable shielding using cable shield bonding connectors*
- the core conductor of the antenna cable using surge protection devices
- antennas, antenna poles
- ground electrodes (e.g., foundation electrode)

** Minimum IP rating IP X4 when using bonding connectors outdoors.*

Connecting the Grounding Terminal of the Antenna

As mentioned previously, the antenna must be connected to a grounding busbar using a grounding cable (not included). A grounding cable must be assembled for this purpose; the recommended conductor thickness is 4 mm^2 – 6 mm^2 and a ring terminal fitting the M8 (0.315 inch) grounding bolt must be used.

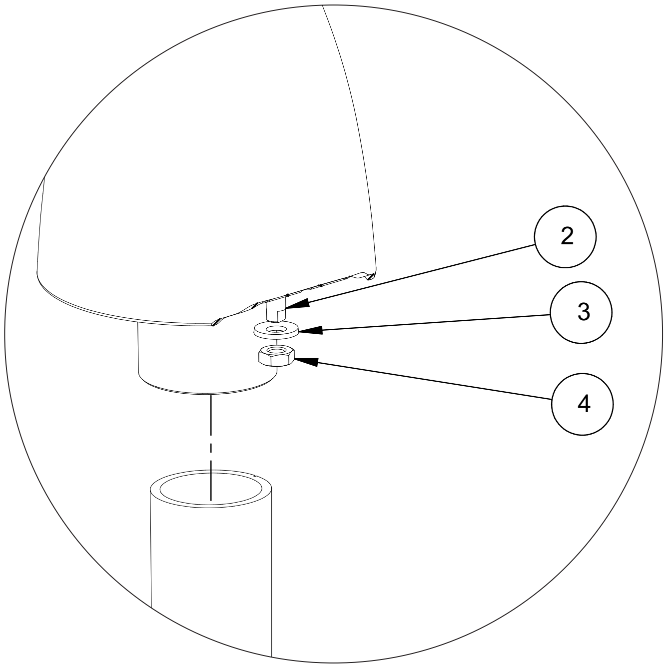


Figure 7.4: Grounding Terminal Assembly

Grounding Cable Installation Procedure

1. Remove the nut (Item 4 in Fig. 7.4) and the safety washer (Item 3 in Fig. 7.4).

2. Place the ring terminal onto the grounding bolt (Item 2 in Fig. 7.4).

3. First place the safety washer (Item 3 in Fig. 7.4) onto the grounding bolt (Item 2 in Fig. 7.4), then screw the M8 nut (Item 4 in Fig. 7.4) onto the thread of the grounding bolt.

4. Tighten the nut (Item 4 in Fig. 7.4) with a max. torque of **6 Nm**.

Once the antenna has been correctly installed with the grounding cable, connect the grounding cable to the bonding bar (see Fig. 7.5 and Fig. 7.6).

Antenna Installation without Insulated Lightning Rod System

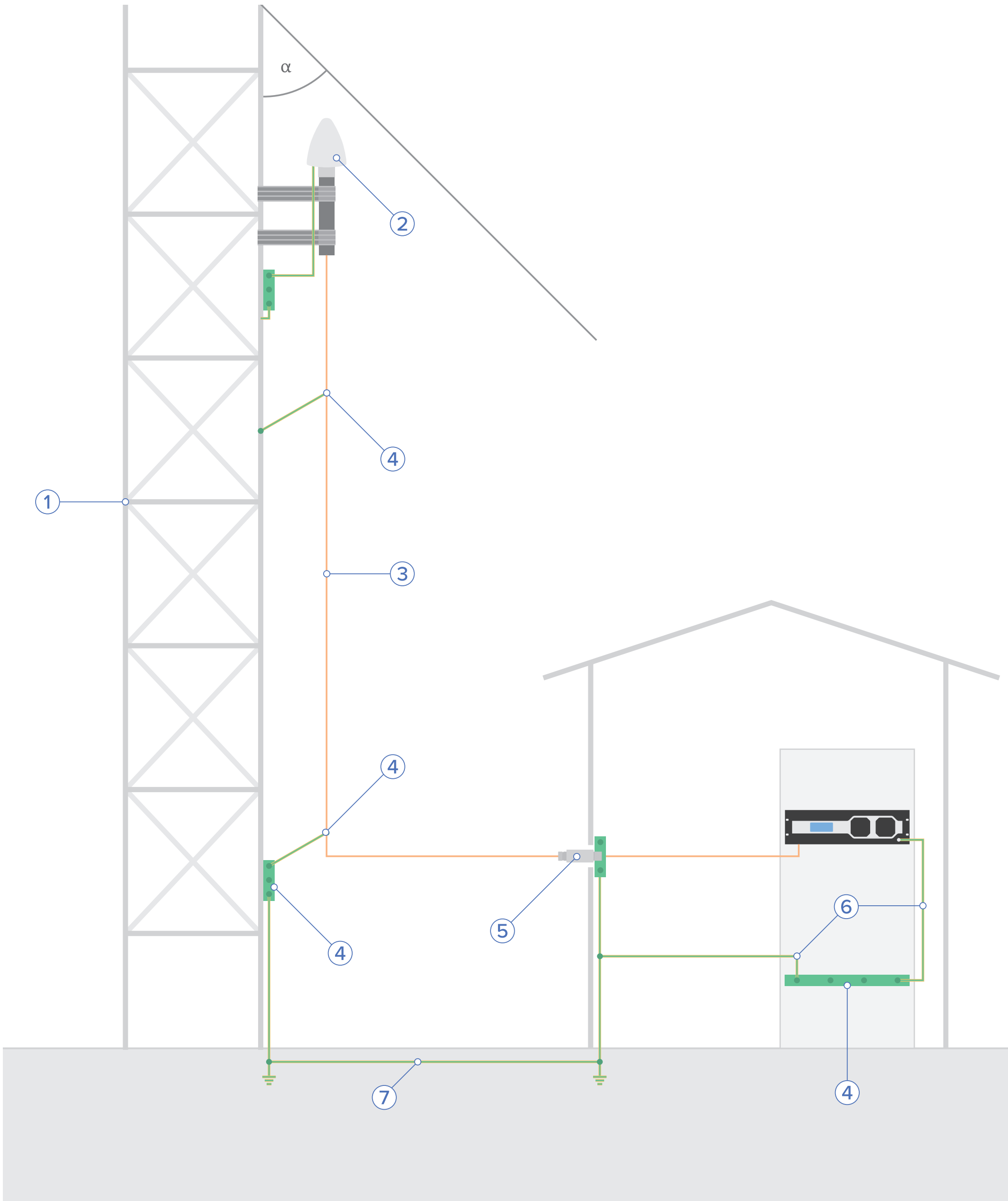


Figure 7.5: Grounding of a Mast-Mounted Antenna

1	Antenna Pole
2	Antenna
3	Antenna Cable
4	Bonding Bar
5	Bonding Conductor
6	Foundation Electrode
α	Safety Zone

Antenna Installation with Insulated Lightning Rod System

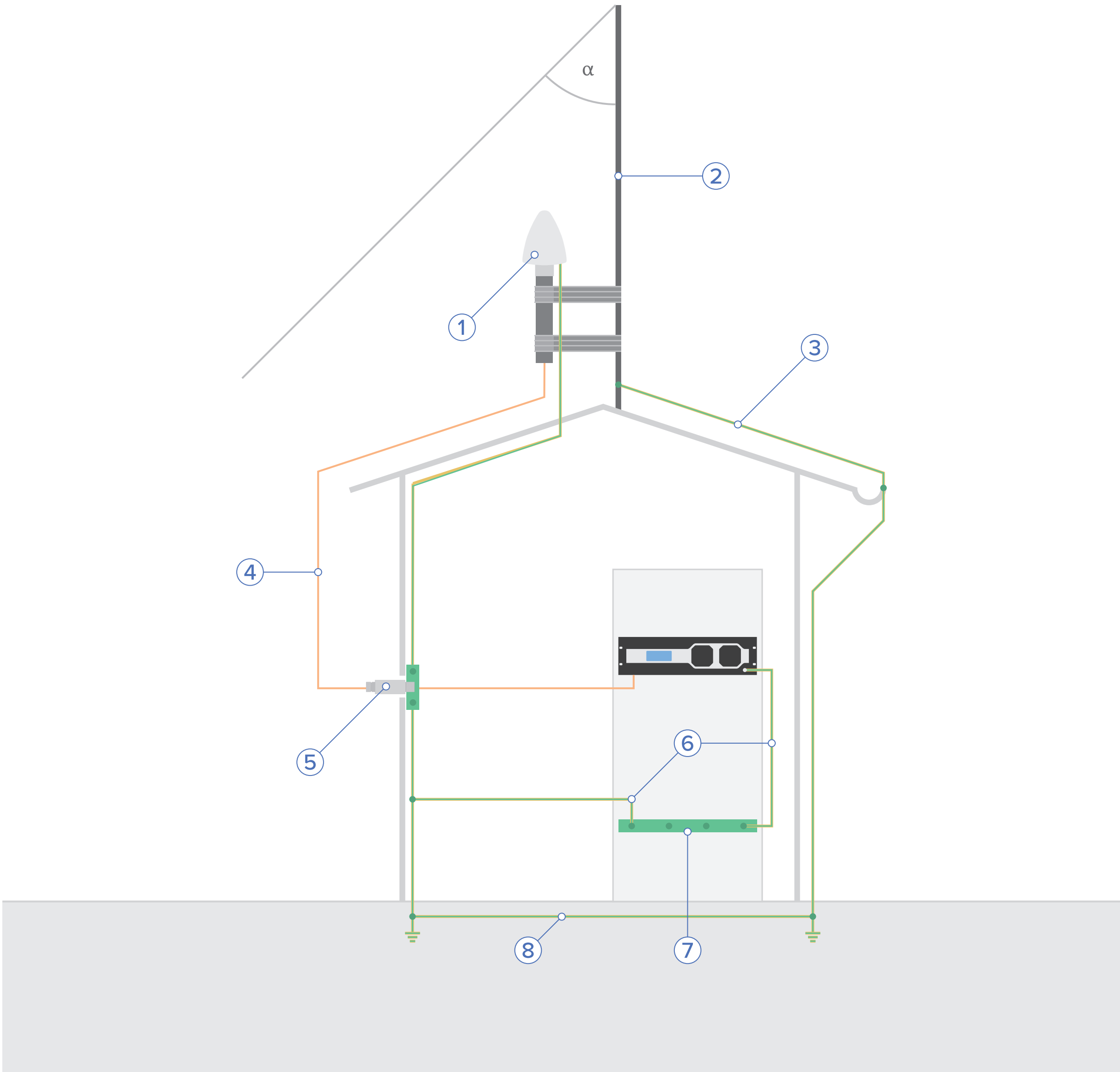


Figure 7.6: Grounding of a Roof or Wall-Mounted Antenna

1	Antenna
2	Lightning Rod
3	Lightning Rod Conductor
4	Antenna Cable
5	Surge Protector
6	Bonding Conductor
7	Bonding Bar
8	Foundation Electrode
α	Safety Zone

7.1.6 In-Line Surge Protection

Information:

The MBG S-PRO surge protector and suitable coaxial cable are not included as standard with a Meinberg antenna, but can be ordered as an optional accessory.

The MBG S-PRO is a surge protector manufactured by Phoenix Contact (Type Designation CN-UB-280DC-BB) that is designed to protect devices connected via coaxial cable. Its use is optional but strongly recommended by Meinberg.

The MBG S-PRO is patched directly into the antenna line and consists of a replaceable gas discharge tube that redirects the energy from the cable shielding to the ground potential when ignited, protecting the building from a risk of fire and connected devices from possible surge voltages and likely damage or destruction. The surge protector is installed at the point of entry of the antenna cable into the building.

The MBG S-PRO must be shielded against water spray and water jets, either by means of a suitable enclosure (IP65) or a protected location.

Installation and Connection

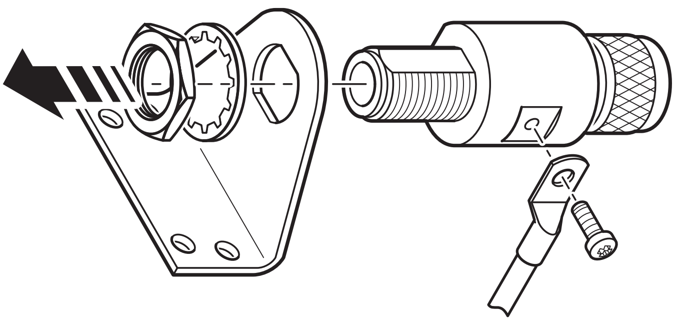


Figure 7.7: Assembly of the MBG S-PRO surge protector

1. Select a location for the installation of the MBG S-PRO. This location must be as close as possible to the point of entry into the building in order to limit the length of unprotected cable exposed to lightning strikes. The route from the ground terminal on the MBG S-PRO to the building's grounding busbar must also be as short as possible.

2. Mount the supplied mounting bracket as shown in Fig. 7.7, then fit the MBG S-PRO to the bracket.

3. Connect the MBG S-PRO to a grounding busbar using a ground conductor cable that is as short as possible. It is also important for the ground terminal of the surge protector to be connected to the same bonding bar as the connected Meinberg system in order to prevent destructive potential differences.

4. Connect the coaxial cable from the antenna to one of the surge protector connectors, then connect the other surge protector connector to the coaxial cable leading to the Meinberg reference clock.

Caution!

For safety reasons, the antenna cable must not exceed a certain length if there are no other devices such as a power distributor between the surge protector and the downstream electronic device with integrated surge protection at the mains connector level.

Please refer to the document "Technical Specifications: MBG S-PRO Surge Protector" in the appendix detailed technical specifications and a link to the data sheet.

7.2 Installation of the IMS-GXL183 Module

7.2.1 Removal of an Existing IMS Module

Important!

Take note of the safety information provided in → Chapter 2, "Important Safety Information" and the ESD-related information in → Chapter 6.1, "Prevention of ESD Damage"!

This step is only relevant if you are replacing a module that is already installed in the slot. If you are installing a module in an unused slot, you may skip this step and proceed with
→ Chapter 7.2.2, "Installation of the IMS-GXL183 Module".

A Torx screwdriver is required (T8 x 60) to remove IMS modules.

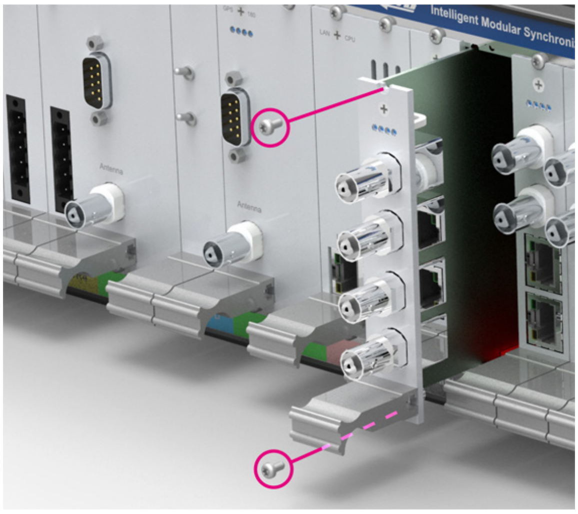


Figure 7.8: Locations of fixture screws in a 3U IMS LANTIME system

Figure 7.9: Locations of fixture screws in a 1U IMS LANTIME system

1. Remove the two marked Torx screws from the module faceplate.

2. Pull the module **carefully** out of the guide rail. Note that the module will be securely seated in the connector block inside the chassis—a certain amount of force must be applied to release the module. Once the module has been detached from the connector block on the system backplane, the module can be easily pulled out.

You may now proceed with the installation of your IMS-GXL183 module.

7.2.2 Installation of the IMS-GXL183 Module

Important!

Take note of the safety information provided in → Chapter 2, “Important Safety Information” and the ESD-related information in → Chapter 6.1, “Prevention of ESD Damage”!

A Torx screwdriver is required (T8 x 60) to install the IMS-GXL183 module.

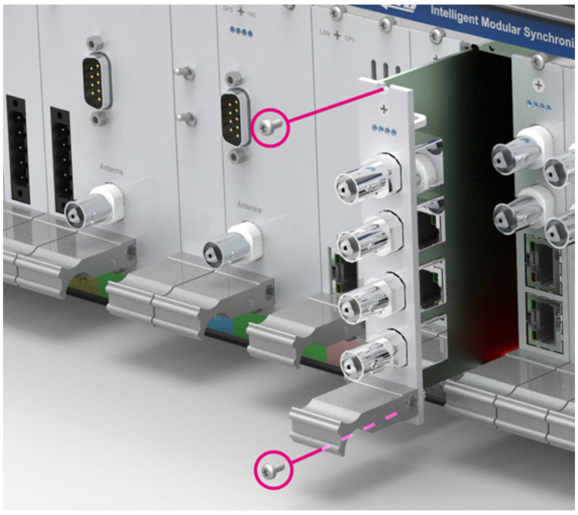


Figure 7.10: Locations of fixture screws in a 3U IMS LANTIME system

Figure 7.11: Locations of fixture screws in a 1U IMS LANTIME system

1. If you are replacing a module, remove the existing module in accordance with
   → Chapter 7.2.1, "Removal of an Existing IMS Module". Otherwise, remove the two Torx screws from the cover plate of the unused slot. We recommend keeping the cover plate in a safe place for later use.

2. Insert the IMS-GXL183 module correctly into the two guide rails of the system chassis in a slot in accordance with → Chapter 5.1, "IMS System Compatibility". If it cannot be inserted with reasonably minimal effort, it is possible that the module is not properly seated in the guide rails. In this case, you should pull the module out and try again. **Do not use excessive force when pushing the module in!** Failure to heed this instruction may result in damage to the module and/or chassis.

3. Once the module has reached the connector block of the system backplane, a little more effort will be required to insert the IMS-GXL183 module into the connector block. Ensure that the module is locked securely into place and that the faceplate of the module is flush with that of the adjacent modules or cover plates.

4. Insert and tighten the two Torx screws with a **max. torque of 0.6 Nm**.

The IMS-GXL183 is now installed and ready for set-up.

The **Init** LED should initially be blue when the module is inserted, before switching off after around five seconds to indicate that the module has completed initialization.

7.2.3 Use of Redundant Reference Clock Modules

LANTIME M2000S, M3000(S) and M4000 systems as well as special M1000(S) systems with reference clock redundancy feature an "**SCU**" mechanism (Signal Changeover Unit) that handles the transmission of pulse, frequency, and serial string outputs from the reference clock (or redundant reference clocks) to the respective output modules. This SCU mechanism may either take the form of a slot in which a suitable SCU module is installed or of an integrated clock redundancy mechanism.

Important!

If you are reliant on any of the anti-spoofing mechanisms of a IMS-GXL183 in an IMS system with redundant clocks, it is important to consider that the reference source selection mechanism will first prioritize the redundant clock. This means that if the IMS-GXL183 detects that a signal has been spoofed, it will fall back to the redundant reference clock. If that reference clock is a GNSS clock without spoofing detection (e.g., an IMS-GPS183) and the signal is genuinely being spoofed, the redundant clock will use the spoofed signal regardless of its detection by the IMS-GXL183.

Accordingly, Meinberg strongly recommends using a second IMS-GXL183 reference clock for redundancy if reliant on navigation message authentication or the integrated spoofing detection functionality to ensure signal integrity.

LANTIME M3000(S) and LANTIME M4000

LANTIME M3000(S) or LANTIME M4000 systems feature an SCU slot in which either an "**SPT**" module (Signal Passthrough) or "**RSC**" (Redundant Switch Controller) module must be installed.

If only one reference clock is installed, it is sufficient to have the standard "**SPT**" module installed; this module provides a simple passthrough route for the signals.

However, when operating LANTIME M3000(S) or LANTIME M4000 systems with redundant reference clocks, an "**RSC**" module (Redundant Signal Controller) must be installed that controls the reference clock switchover mechanism based on an automated logic.

An IMS system can still be operated with just one reference clock even if an RSC module is installed.

If you are upgrading a redundancy-capable IMS system with a second reference clock but only have an **SPT** module available, please contact Meinberg's Sales Team at ✉ **sales@meinberg.de** or your Authorized Meinberg Distributor for further assistance.

LANTIME M1000(S) with Clock Redundancy and M2000S

LANTIME M1000(S) systems with reference clock redundancy and LANTIME M2000S systems feature an integrated RSC module and support reference clock redundancy without further modification.

LANTIME M500 and Standard LANTIME M1000(S) Models

The LANTIME M500 and the **standard** models of the LANTIME M1000(S) do not support reference clock redundancy.

If you wish to have your LANTIME M1000(S) system modified to support clock redundancy, please contact Meinberg's Sales Team at ✉ **sales@meinberg.de** or your Authorized Meinberg Distributor for further assistance.

7.3 Connecting Data and Signal Cables

Connect all required data and signal cables to the module's interfaces as specified below and in the specifications provided in ➝ Chapter 10.1, "Hardware Reference".

7.3.1 Antenna Input

The IMS-GXL183 module has an SMA connector that is used to input the antenna signal via a suitable coaxial cable laid in accordance with ➝ Chapter 7.1.4, "Laying the Antenna Cable".

Please ensure that the specifications of the cable and connector are compliant with the specifications as described in ➝ Chapter 10.1.3, "Antenna Input: GXL Multi-Band Receiver" and ➝ Chapter 12.4, "Antenna Cable".

7.3.2 9-Pin D-Sub RS-232 & PPS Input Interface

Information:

This information only applies to IMS-GXL183 Models with an D-Sub 9 time string port. For more information on the various models of the IMS-GXL183, please refer to ➝ Chapter 10.1, "Hardware Reference".

Time String Output

For the purposes of outputting time strings, the pin layout of the serial COM interface is compliant with the RS-232 standard, and thus it is generally possible to use any standard pre-fabricated RS-232 cable of suitable quality (for example, D-Sub 9 to D-Sub 9, D-Sub 9 to D-Sub 25) with a female connector, as long as the receiving device possesses a corresponding RS-232-compliant interface.

Refer to ➝ Chapter 10.1.2, "COMx Time String I/O and Pulse-Per-Second Input" for more information on the pin layout.

Time String Input

For the purposes of using an external time string and pulse-per-second source as a time-of-day and phase reference respectively, the pin layout of the serial COM interface deviates from the RS-232 standard slightly by requiring a PPS signal to be transmitted over Pin 1 of the 9-pin D-Sub connector. This will generally require a bespoke cable to be manufactured or an existing RS-232 cable to be modified.

General Cable Requirement

Please note that the pin layout of the device receiving the time string output or sending the time string input will dictate whether you require a "straight-through" or a null-modem cable to connect your IMS-GXL183 module to a time string receiver. A null-modem cable has Pins 2 and 3 'crossed over', so that Pin 2 at one end leads to Pin 3 at the other, and vice versa.

If Pins 2 and 3 have identical assignments on both devices, you will require a null-modem cable. If they are opposite to one another, you will require a "straight-through" cable. Either way, it is important that the transmitter pin (TxD) of each device is connected to the receiver pin (RxD) of the other device.

For serial communication with receivers using different connector types but supporting RS-232 signaling norms, it may be necessary to purchase or assemble a suitable cable with a female 9-pin D-Sub connector on one end (ideally with shielded housing; refer to → Chapter 10.1.2, "COMx Time String I/O and Pulse-Per-Second Input" for pin layout), and the corresponding connector for the end device on the other end. The cable shielding should ideally be connected to the metallic D-Sub connector housing.

An RS-232-to-USB adapter or RS-232-to-USB cable with an integrated adapter can also be used.

8 Initial Configuration

Your IMS-GXL183 is configured via the LTOS Web Interface of your LANTIME system.

The IMS-GXL183 can be set up to be synchronized to a GNSS reference or various other reference signals. You are not limited to a single reference source; if multiple reference sources are available that your IMS-GXL183 supports, all of them can be set up, configured, and prioritized accordingly.

This chapter only describes the most basic steps for setting up your IMS-GXL183 for use for the first time. Please refer to ➜ Chapter 10.2, "Configuration Reference" or the **LTOS Configuration & Reference Manual** for a more detailed description of all configuration and monitoring options available for your module.

8.1 Initialization of the IMS-GXL183

The IMS-GXL183 will typically be detected automatically by LTOS if the LANTIME system has been powered up, power cycled, or rebooted after installation.

You can verify whether the clock has been detected by opening the "**Clock**" tab in the LTOS Web Interface. If the clock module is shown under the corresponding clock slot under "**State & Configuration**" or "**Information**", then the module has been successfully detected.

If not, it is likely that you will need to perform a scan of the installed reference clocks:

1. Open the "**System**" tab of the LTOS Web Interface.
2. Scroll down to and expand the "**Services and Functions**" panel.
3. Select the "**Rescan Refclocks**" option.

   You will be prompted to confirm whether you wish to really do this, as a rescan of the reference clocks will result in the system losing synchronization for a brief moment. Please ensure that any time-critical applications dependent on uninterrupted synchronization are prepared accordingly before a rescan of the reference clocks is performed.

After a few seconds, a message will be display confirming that the redetection of the reference clocks has been successfully completed.

You can now proceed with configuring the IMS-GXL183 to synchronize to one or more reference signals:

- For synchronization to a GNSS signal, please refer to ➜ Chapter 8.2, "Synchronization with GNSS".
- For synchronization to another external reference signal introduced via another IMS input module, please refer to ➜ Chapter 8.4, "Synchronization via Another IMS Input Module".

8.2 Synchronization with GNSS

This chapter describes how to quickly set up the IMS-GXL183 reference clock for synchronization to GNSS services.

Step 1: Connection of the IMS-GXL183 with the GNMANTv2 Antenna

Ensure that the IMS-GXL183 is connected to a correctly installed GNMANTv2 Antenna as described in → Chapter 10.1.3, "Antenna Input: GXL Multi-Band Receiver" and → Chapter 7.1, "Installation of the Antenna".

Step 2: Selecting the Satellite Constellations

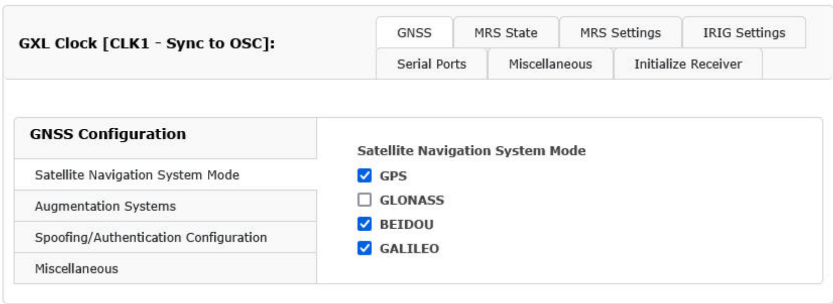


Figure 8.1: Specifying the constellations to be used

The IMS-GXL183 is capable of receiving signals from the GPS, Galileo, BeiDou, and GLONASS satellite constellations simultaneously. The concurrent use of multiple constellations can help to enhance geopositioning accuracy (and by extension, timing accuracy) and also provide additional protection against jamming and spoofing by expanding the breadth of frequencies and signal types processed by the IMS-GXL183.

Important!

The IMS-GXL183 does not support the exclusive use of the GLONASS constellation as a GNSS reference. The use of GLONASS is only supported in conjunction with at least one other constellation.

You may specify which constellations should be used and which should be excluded by logging into the Web Interface of your LANTIME system and proceeding as follows:

1. Open the menu "**Clock**" → "**State & Configuration**".
2. Select the corresponding clock module.
3. Click on the "**GNSS**" tab.
4. Select the constellations using the checkboxes under "**Satellite Navigation System Mode**".

Step 3: Enabling Support for Regional Augmentation Systems

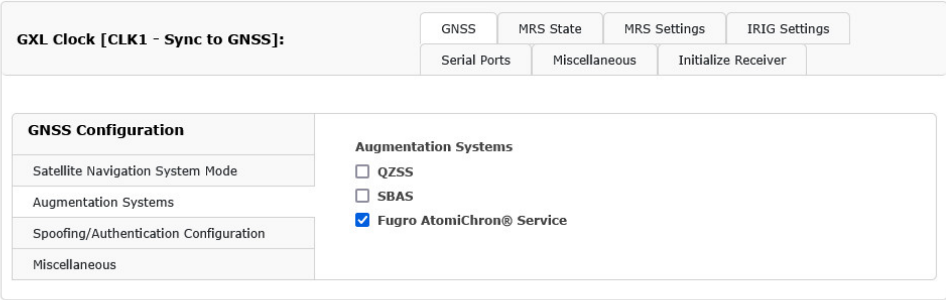


Figure 8.2: Support options for regional and commercial augmentation systems

If desired, enable support for regional augmentation systems under "**Augmentation Systems**".

The IMS-GXL183 supports the Japanese QZSS constellation and a number of national satellite-based augmentation systems (SBAS).

The supplemental use of QZSS and other augmentation systems can also help to enhance geopositioning accuracy (and by extension, timing accuracy) and also provide additional protection against jamming and spoofing by expanding the breadth of frequencies and signal types processed by the IMS-GXL183, as long as the antenna's location is covered by one of the supported geostationary satellite constellations.

The following augmentation systems are supported:

- European Geostationary Navigation Overlay Service (EGNOS) – Europe
- Wide Area Augmentation System (WAAS) – United States, Canada, Mexico
- GPS Aided Geo Augmented Navigation (GAGAN) – India
- Multi-functional Satellite Augmentation System (MSAS) – Japan
- System for Differential Corrections and Monitoring (SDCM) – Russia

If you intend to use the Fugro AtomiChron® Navigation Message Authentication service and/or have requested the transmission of the activation signal for your IMS-GXL183 module, please ensure that "**Fugro AtomiChron® Service**" is also enabled here.

Step 4: Configuring Navigation Message Authentication Support

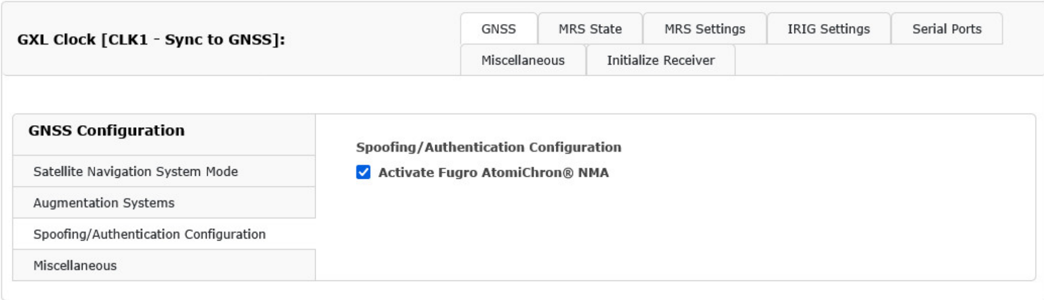


Figure 8.3: Configuring Navigation Message Authentication (spoofing detection)

The activation of the "**Fugro AtomiChron® Service**" in Step 3 above ensures that your IMS-GXL183 will authenticate all incoming navigation messages against the Fugro AtomiChron® Service, provided that you have a valid and paid-up subscription.

The IMS-GXL183 supports two operating modes: **Loose** and **Strict**.

In **Strict Mode**, your IMS-GXL183 will only accept navigation messages if they have been authenticated by the Fugro AtomiChron® Service. This means that, if your IMS-GXL183 is unable to receive the Fugro AtomiChron® Service for any reason or detects that navigation messages are very likely to have been spoofed, it will switch to the next reference source or fall back to holdover mode, depending on your MRS configuration.

In **Loose Mode**, your IMS-GXL183 will attempt to authenticate incoming navigation messages but will not react automatically to any message authentication failures. It is possible to monitor the authentication state for each SV of each enabled constellation manually.

For more information on the differences between Strict and Loose Mode and how authentication states can be monitored in Loose Mode, consult → Chapter 8.2.2, "AtomiChron®Modes".

1. Open the tab "**Spoofing/Authentication Configuration**".
2. If you intend to use the Fugro AtomiChron® spoofing detection mechanism in **Strict Mode**, check the box "**Activate Fugro AtomiChron® NMA**" and ensure that "**Fugro AtomiChron® Service**" is enabled as described in Step 3 above.

   If you intend to use the Fugro AtomiChron® spoofing detection mechanism in **Loose Mode**, leave the checkbox "**Activate Fugro AtomiChron® NMA**" *disabled* but ensure that "**Fugro AtomiChron® Service**" remains *enabled* as described in Step 3 above.

Important!

The Fugro AtomiChron® service requires an active subscription. For more information on managing a Fugro AtomiChron® subscription, refer to → Chapter 8.2.1, "Enabling the AtomiChron®Service".

Step 5: Configuring the Signal Propagation Time

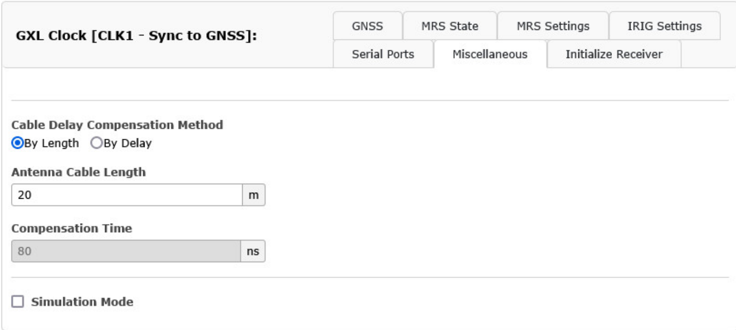


Figure 8.4: Configuring the propagation delay

The propagation of the signal from the antenna to the receiver of the reference clock can incur a certain delay. To enable the connected reference clock to compensate for the cable-induced propagation delay of the signal, the appropriate offset time must be specified. This can be entered in terms of an absolute offset in **whole** nanoseconds or estimated automatically based on the cable length.

The simplest method of achieving this adjustment is entering the length of the antenna cable in meters (from antenna to Meinberg system) in order to have the system calculate a plausible estimate of the delay. In the case of the IMS-GXL183, the system will assume that 4 nanoseconds of propagation delay is incurred per meter of antenna cable and assumes that you are the coaxial cable supplied with your IMS-GXL183.

However, while this method is generally adequate for millisecond or microsecond-level accuracy, it can induce timing errors when seeking to achieve timing accuracies in the low nanosecond range. Please refer to → Chapter 12.2.3, "Accurate Propagation Delay Measurement" for more information on ideal methods of propagation delay measurement or calculation.

You can enter the measured or calculated propagation delay or the length of your cable as follows:

1. From the same page as Step 1 above (**Clock** –> **State and Configuration**), ensure that the "**Miscellaneous**" tab under the corresponding clock module is selected.
2. Under "**Cable Delay Compensation Method**" select "**By Delay**" or "**By Length**" and enter the appropriate value.

Information:

While LTOS supports the entry of a theoretical maximum offset of 2000 m or 10000 ns respectively, the maximum lengths specified for supported cable types in → Chapter 12.4, "Antenna Cable" should not be exceeded.

Step 6: Position Lock Behavior Configuration

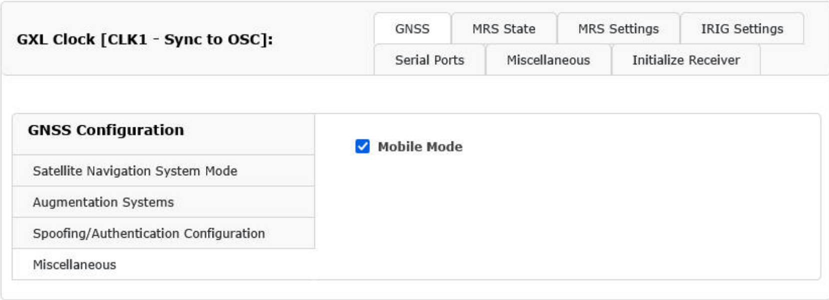


Figure 8.5: Enabling Mobile Mode

If your IMS-GXL183 is intended to be operated in a mobile capacity (i.e., aboard a moving vehicle), you should enable "**Mobile Mode**" under "**Miscellaneous**". Mobile mode allows the position of the receiver to remain dynamic.

If your IMS-GXL183 will be used in a fixed location, ensure that this option is *disabled*.

If "Mobile Mode" is incorrectly set, there is a risk that the timing accuracy may be diminished or the receiver will not be able to gain any lock at all.

Step 7: MRS Configuration

If you only wish to configure GNSS reception, proceed with the MRS configuration process described in → Chapter 8.5, "MRS Configuration".

Otherwise, proceed with the configuration of other reference sources.

Start-Up

Once the antenna and power supply have been connected, the reference clock is ready for operation.

At first boot (or if the device is being switched on for the first time after a long period, or if the device has been moved to a substantially different location), the GNSS reference clock will launch in "Cold Boot" mode, in which the receiver searches for enough satellites to establish a first fix. This process will typically take 1–2 minutes but can be as much as twenty minutes, depending on the signal quality, antenna position, visibility of satellites, and the selected constellations. A Galileo-only configuration, for example, typically takes between 6 and 12 minutes to achieve a position fix from Cold Boot.

Once the receiver has established a position fix, the reference clock will synchronize with the GNSS reference signal by adjusting the phase of the integrated oscillator. Again, depending on the amount of constellations selected and the quality of the reference signal, as well as the prior state of the oscillator, this process can take anything between a few minutes and 24 hours.

Once the **GNSS Receiver** entry under → "MRS Configuration" shows the three states *Warmed Up* (oscillator is at operating temperature), *Is Locked* (oscillator is phase-locked), and *Is Accurate* (minimum required accuracy of oscillator has been reached), the reference clock is fully synchronized with the GNSS reference.

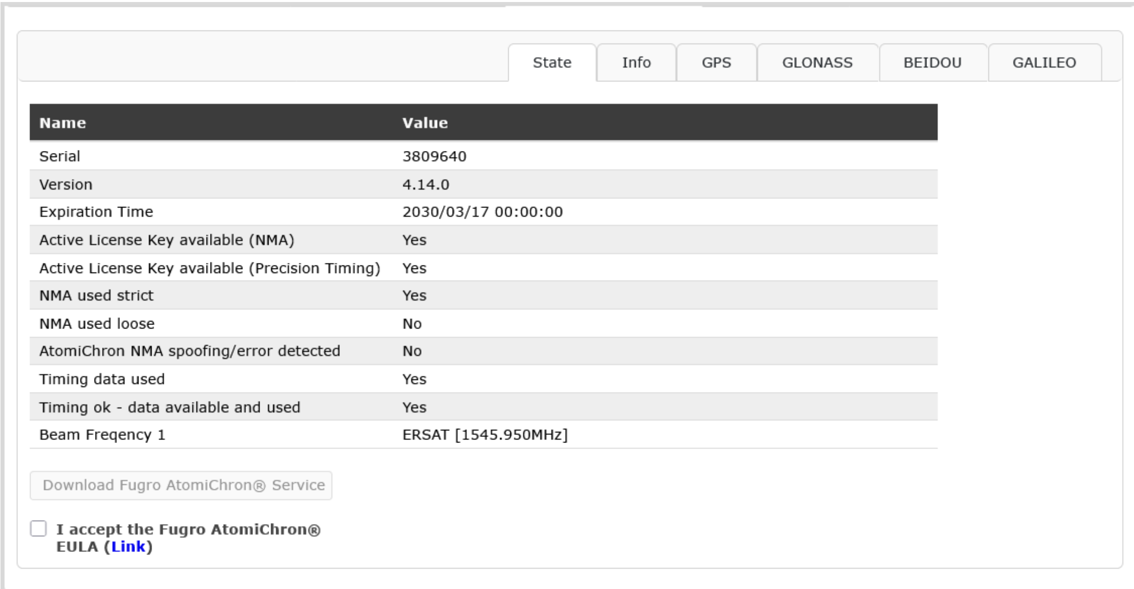
8.2.1 Enabling the AtomiChron®Service

The IMS-GXL183 supports the Fugro AtomiChron® service to allow the integrity and authenticity of incoming GNSS messages from all of the main GNSS constellations to be verified. The data required to authenticate your GNSS signals is transmitted over a separate L-band satellite frequency transmitted by the Inmarsat constellation that your IMS-GXL183 also receives in addition to the actual GNSS signals.

Fugro AtomiChron® is a paid subscriber service and the license for it must therefore be activated and occasionally renewed thereafter. The regularity of license renewal will depend on the length of your service agreement.

Because the LANTIME system in which your IMS-GXL183 is installed is expected to be isolated from the public internet for reasons of practicality or operational security, the signal required to activate or renew an AtomiChron® license will be transmitted over the same L-band satellite signal that it receives the authentication data on. Once a subscription contract is concluded and paid up (or a free subscription entitlement is claimed), the activation signal is transmitted over a specified satellite beam.

To this end, your LANTIME system must have the IMS-GXL183 installed, enabled, and connected to a functioning and operational Meinberg GNMANTv2 antenna or a Meinberg GNSS Multi-Band Antenna ("GNMANTv1").



Name	Value
Serial	3809640
Version	4.14.0
Expiration Time	2030/03/17 00:00:00
Active License Key available (NMA)	Yes
Active License Key available (Precision Timing)	Yes
NMA used strict	Yes
NMA used loose	No
AtomiChron NMA spoofing/error detected	No
Timing data used	Yes
Timing ok - data available and used	Yes
Beam Freqency 1	ERSAT [1545.950MHz]

Figure 8.6: Displaying Fugro AtomiChron®-related information in the LTOS Web Interface

Certain information is required by Meinberg and Fugro to allow your IMS-GXL183 clock module to receive the appropriate activation data. This information can be conveniently downloaded as follows:

1. From your LANTIME system's Web Interface, open the "**Clock**" tab, click on the "**Information**" panel under the corresponding GXL clock, and select the "**Fugro AtomiChron®**" tab.
2. Review the Fugro AtomiChron® EULA, accept it by enabling the checkbox, then click on the button "**Download Fugro AtomiChron® File**".
3. This will launch a download of a JSON file containing all the information needed by Meinberg and Fugro. This file should then be sent as an attachment to Meinberg at ✉ atomichron@meinberg.de when prompted by Meinberg to do so (i.e., when payment for your subscription has been received or when claiming an entitlement to a free subscription).

4. Once you have sent the Fugro AtomiChron® Service File to Meinberg, it is essential to leave your LANTIME system operational and connected to a correctly positioned and functioning GNSS Multi-Band Antenna until the activation data is received. This activation data should be transmitted over the frequencies provided in the Fugro Service File within three working days, once Meinberg has received and processed this file.

You can verify whether the AtomiChron® service has been correctly activated by opening the "**Clock → Information → GXL Clock → Fugro AtomiChron® → State**" tab as described above; if activated, the line "**Active License Key available (NMA)**" will read *Yes*, while the *Expiration Time* line will show the date & time of expiration of your current AtomiChron® license.

Important!

Please note that the activation data is normally only transmitted once and will normally not be transmitted on weekends or Dutch public holidays.

Once activation has been requested, your IMS-GXL183 must remain continuously reception-capable without any interruptions until the activation signal has been received by the module. As such, during the activation period, you should not perform any power cycles or resets of your LANTIME system, you should not perform any work on the antenna or cable infrastructure, and you should not modify the configuration of your IMS-GXL183.

If your IMS-GXL183 clock module still does not show that the activation has occurred within three working days of the Fugro Service File being sent, it is possible that the activation signal has been missed.

In this case, please verify that the **GNSS Multi-Band Antenna** is correctly installed, connected, and receiving. This can be done in the Web Interface by reviewing the "**Clock → Information → GXL Clock → Fugro AtomiChron® → Info**" tab. The entry "**LBAND SV Information available**" should show *Yes* to indicate that it has locked onto the Inmarsat satellites used for delivery of AtomiChron® data.

Ensure that the antenna is not installed in a location where the signal may be obstructed.

Once you are sure that the clock is capable of receiving the signal reliably, please contact Meinberg's Technical Support team at techsupport@meinberg.de in order to schedule another activation signal transmission.

Ensuring the Timely Renewal of Your AtomiChron® License

Figure 8.7: Configuration of notifications to ensure that the AtomiChron® license does not expire

An AtomiChron® subscription is not automatically renewed. A renewal must therefore be explicitly purchased from Meinberg.

Please ensure that your AtomiChron® license is renewed in good time to ensure that the service is not interrupted by expiry of the license. While Meinberg will endeavor to contact you to remind you of the upcoming expiry, we cannot guarantee that we will be able to contact the relevant person responsible.

Therefore, Meinberg recommends that you also:

- set some kind of organizational reminder (calendar software or similar) to ensure that you are reminded of the need to renew your AtomiChron® license,
- configure your LTOS notifications to alert you (via email, SNMP, etc.) when your AtomiChron® license is about to expire (in 28 days) and when it has expired.

Please refer to the **LTOS Configuration and Management Manual** for more information on how to configure notifications in LTOS.

8.2.2 AtomiChron®Modes

The IMS-GXL183's Navigation Message Authentication functionality is operable in two modes:

- **Strict Mode**, in which your IMS-GXL183 will authenticate all GNSS messages and only accept navigation data that has been authenticated by the Fugro AtomiChron® Service,
- **Loose Mode**, in which your IMS-GXL183 will authenticate all GNSS messages but continue to use this GNSS data as a reference source regardless of its authentication status.

Your choice of mode will depend on the circumstances of your location.

Strict Mode

Strict Mode is recommended for all operators who can confirm that they have reliable reception of the Inmarsat constellation transmitting the Fugro AtomiChron® signal 24 hours a day without risk of signal loss caused by radio interference, signal obstructions, or the device's geographical location.

In Strict Mode, your LANTIME's IMS-GXL183 reference clock will cease to use the GNSS signals as a reference source in the event of any of the following:

- The IMS-GXL183 has determined based on the Fugro AtomiChron® authentication data received via the Inmarsat signal that the navigation signal is very likely to have been spoofed.
- The IMS-GXL183 is unable to receive Fugro AtomiChron® authentication data via the Inmarsat signal.
- The IMS-GXL183 is unable to authenticate the GNSS navigation messages based on the Fugro AtomiChron® authentication data for any other reason.

In any of these cases, LTOS will follow the defined MRS configuration regarding the use of reference sources; it will either fall back to the next reference source in the priority list (after a defined holdover period as appropriate) or, failing that, will fall back to holdover mode.

If so configured, LTOS will also issue a notification to the appropriate effect and distribute this notification across all defined channels (e.g., SNMP traps, SMTP email).

Loose Mode

Loose Mode can be used to test the navigation message authentication functionality and reception capability of a IMS-GXL183 reference clock or if you do not want the reference clock to fall back to the next MRS reference or to holdover mode in the event of spoofing being detected or reception of the Fugro AtomiChron® Service being lost.

This may be useful, for example, if you find that your reference clock is occasionally unable to receive the Fugro AtomiChron® Service due to reasons not related to spoofing. Such reasons may include the antenna's reception being obstructed by solid structures such as buildings or temporary outages caused by inconsistent Fugro AtomiChron® coverage in certain parts of the world.

Please note that in Loose Mode, your LANTIME's IMS-GXL183 reference clock is not able to detect spoofing directly. Rather, the user can identify whether navigation data from a given satellite is successfully authenticated. This can be done as follows:

1. Open the LTOS Web Interface.
2. Select the "**Clock**" tab, open the "**Information**" panel, select the "**Fugro AtomiChron®**" tab of the IMS-GXL183 clock, and review the contents of the tabs for each of the four constellations (GPS, Galileo, BeiDou, GLONASS).

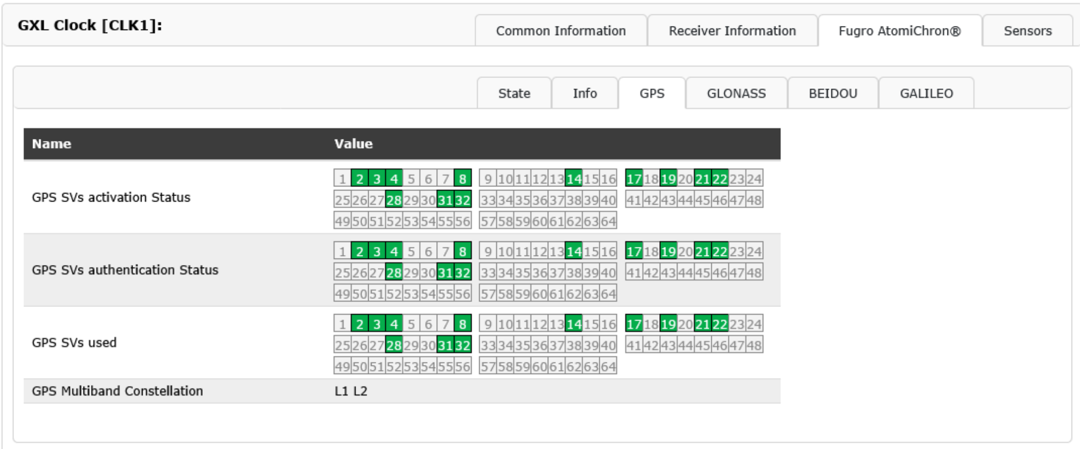


Figure 8.8: Viewing the authentication state of satellites in LTOS

The satellites (SVs or *space vehicles*) that are marked in green under "**SVs Activation Status**" are those that are being actively tracked by the IMS-GXL183. If the IMS-GXL183 has successfully authenticated the navigation data sent by each SV, the corresponding SV will also be shown in green.

Note that if an SV is **not** marked as authenticated, it is not possible to conclusively determine from this that the navigation data is spoofed, only that it could not be authenticated, which may have other reasons (e.g., signal instability).

8.3 Synchronization with Time String and PPS

This chapter describes the most important configuration processes for quickly setting up the IMS-GXL183 reference clock to synchronize to an external time string & pulse-per-second reference.

Step 1: Connection of the IMS-GXL183 with the PPS & Time String Sources

Ensure that the IMS-GXL183 is connected to **both** an external PPS phase reference and a valid time string source as described in → Chapter 10.1.2, "COMx Time String I/O and Pulse-Per-Second Input".

The time string must be received on Pin 2 (RxD) of the D-Sub 9 RS-232 connector in accordance with the RS-232 standard, and must comply with one of the following time string formats to ensure that it contains full time **and** date information:

- Meinberg Standard
- NMEA RMC
- NMEA ZDA
- Uni Erlangen

The PPS signal must be received on Pin 1; the clock expects a TTL signal with a pulse width of at least 5 μs, active high.

Step 2: Time String Configuration

Figure 8.9: Serial Port Settings of your IMS-GXL183

From the LTOS Web Interface, open the "**Clock**" page and select the "**State & Configuration**" panel. Open the tab "**Serial Ports**" under the corresponding clock.

Please note that the time string format under the "**Serial Ports**" tab relates to string *output* only; the format of the incoming time string signal will be identified automatically by the system and does not need to be manually configured here.

However, the baud rate and framing must be set here to match the incoming signal.

Important!

The external time string must be synchronized with the corresponding PPS signal such that the complete time string arrives within 500 ms of the PPS signal. Any time string that is received later will be disregarded and the clock will be unable to synchronize as a result.

Step 3: MRS Configuration

If you only wish to configure PPS & time string input, proceed with the MRS configuration process described in ➞ Chapter 8.5, "MRS Configuration".

Otherwise, proceed with the configuration of other reference sources.

Final Steps

Once the input cables and power supply have been connected, the reference clock is ready for operation.

After around two minutes of the system being switched on, the oscillator will have warmed up and thus achieved the base precision required to receive time string & PPS inputs.

8.4 Synchronization via Another IMS Input Module

Your IMS-GXL183 reference clock can also be synchronized via an expansion input module such as an IMS-MRI module (allowing AM/DCLS timecode input, 10 MHz frequency input, and standalone PPS input), an IMS-ESI module (allowing arbitrary frequency or T1/E1 clock signal inputs), or an IMS-VSI module (allowing clock signals typically used in the broadcasting industry to be used as reference signals).

Please refer to the Setup Guides for those modules for more information on how to configure your IMS-GXL183 for use with those input modules.

8.5 MRS Configuration

Once your reference sources are configured, they must be prioritized in the "**MRS Settings**" (Multi-Reference Source) tab of the clock configuration panel.

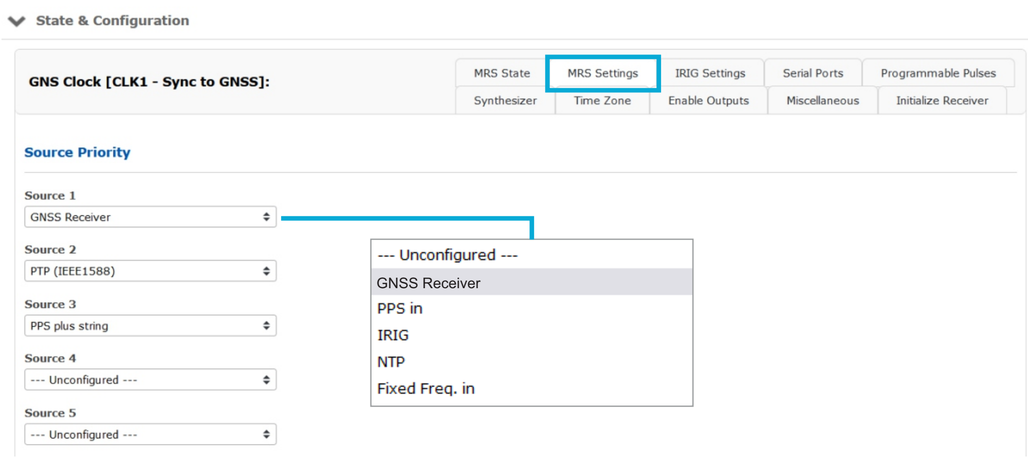


Figure 8.10: MRS Configuration – Selection and Prioritization of the Available Reference Sources

1. Open the "**Clock**" page and select the "**State & Configuration**" panel.
2. Open the tab "**MRS Settings**".
3. Select each of the references that you wish to use as sources in each of the drop-down menus. For example, if you wish to use GNSS as your primary reference and an incoming PPS & time string as a redundant backup, select "*GNSS Receiver*" as **Source 1** and "*PPS plus string*" as **Source 2**.

Information:

The Multi-Reference Source functionality of LTOS is powerful and rather complex and cannot be covered in adequate detail solely in relation to your IMS-GXL183.

For more detailed information on MRS configuration, especially regarding offsets and switching behaviors, a detailed study of → Chapter 12.8, "MRS Functionality" and the **LTOS Configuration & Management Manual** is strongly recommended.

9 Troubleshooting

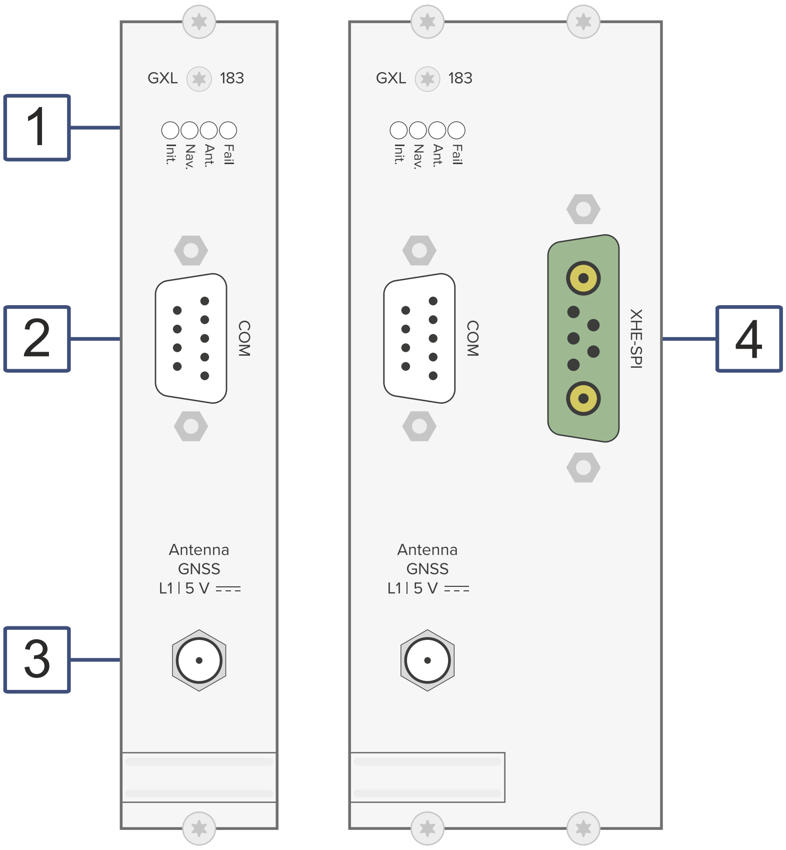
Our Technical Support team will be pleased to help you with any problems that you may be having with your Meinberg IMS-GXL183 module. However, before you contact our Technical Support team, it is advisable to read this chapter through first to see if your problem might be more quickly resolved with one of the solutions below.

Problem	**Possible Causes**	**Possible Solutions**
The IMS module is not listed and not configurable in the Web Interface of the IMS system, and it appears that the module has not been detected by the base IMS unit.	The module may not have been properly inserted into the slot.	Ensure that the module is properly aligned with the guide rails inside the IMS unit; the module must lock securely into the socket at the back. The metal plate of the module should be perfectly flush with the metal plates of the other slots and the screws should be straight.
	Detection of reference clock modules typically needs to be triggered manually.	Select "**System** → **Services and Functions** → **Rescan Refclocks**" to manually trigger a scan of the installed reference clock modules. If this does not work, perform a power cycle of the IMS system.
	The firmware of your IMS system may not be up-to-date.	Check in the menu "**System** → **Configuration & Firmware Management**" whether the latest version of LTOS is installed, and install the latest version if necessary.
The reference clock does not synchronize even after several hours (despite geolocation having successfully completed and the time being synchronized).	If the position of the antenna is poorly selected, the reference clock may be unable to detect the four satellites needed to synchronize the reference clock.	Ensure that the location of the antenna is selected in accordance with the conditions specified in ➜ Chapter 7.1.
	An improper cable installation can cause signal interference or signal loss.	Ensure that the cable infrastructure is properly laid, that there is no damage to the cables, that the specified bend radius is observed, and that the connectors are securely attached to the antenna, receiver, and any inline devices such as surge protectors.

The reference clock does not synchronize and the “Fail” LED is red.	Your LANTIME system is unable to synchronize with any of the reference sources configured under “**MRS Settings**”.	Ensure that you have the installed reference sources configured in the MRS settings.
		Verify that your reference sources are delivering a valid signal: - if synchronizing via GNSS, that your antenna is correctly connected and aligned; - if synchronizing via PPS & time string, that your source is providing a compliant PPS and time string signal.
The reference clock’s precision is poor and/or synchronization is frequently lost.	If the position of the antenna is poorly selected, the reference clock will lose track of the satellites that have been detected.	Ensure that the position of the antenna is selected in accordance with the conditions specified in → Chapter 7.1.
I have purchased a valid subscription to AtomiChron®, but the clock module has not detected the activation.	If the position of the antenna is poorly selected or it is not correctly connected, the reference clock may have missed the license data transmission.	Verify that your antenna is correctly installed, positioned, and connected, then contact Meinberg Technical Support to arrange a re-transmission of the license data.
	Transmission of the license data can take up to three days, or longer if the request is submitted over a weekend or German or Dutch public holiday.	Please allow three full working days for the license to be activated.

10 Technical Reference

10.1 Hardware Reference



Information:

The numbering in the drawing above relates to the relevant subsection in this chapter.

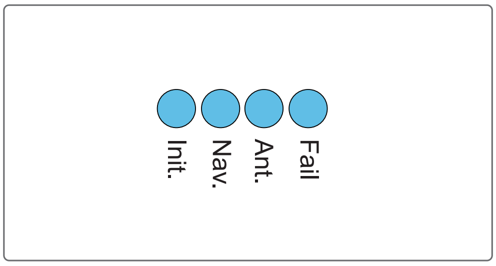
10.1.1 Status LEDs

"**In**" LED: Initialization status of reference clock

"**Nav**" LED: Navigation data (position/time) is available

"**Ant**" LED: Antenna status

"**Fail**" LED: Lack of available reference sources



LED	Colors	Description
Init	Blue	The internal firmware is initializing and a connection is being established with the LANTIME system.
	Off	The initialization of the internal firmware is complete and a connection has been established with the LANTIME system, but the oscillator is not yet locked to its phase reference.
	Green	The initialization of the clock's firmware is completed, the connection with the LANTIME system has been established, and the oscillator is locked to the phase reference.
Nav	Off	The GNSS receiver has not yet been able to determine its position.
	Green	The GNSS receiver has successfully determined its position and is receiving time data.
Ant	Green	The antenna is correctly connected, there is no fault detected in the connection, and the clock is synchronized with the GNSS reference.
	Yellow	The clock is in "**MRS Mode**"; it is synchronized to an external signal other than GNSS (e.g., PPS, IRIG).
	Red	The antenna is faulty or not correctly connected.
	Red/yellow (flashing)	The clock is in "**Holdover Mode**"; it is controlled solely via the internal oscillator and has not yet been synchronized to an external reference (e.g., GNSS, PPS, time string) since it was last initialized.
	Green/yellow (flashing)	The clock is in "**Holdover Mode**"; it is controlled solely via the internal oscillator, but has been synchronized at least once to an external reference (e.g., GNSS, PPS, time string) since it was last initialized.
Fail	Red	The clock can identify no way to successfully synchronize using one of the configured reference sources, i.e., there is no usable signal available at any of the configured inputs.

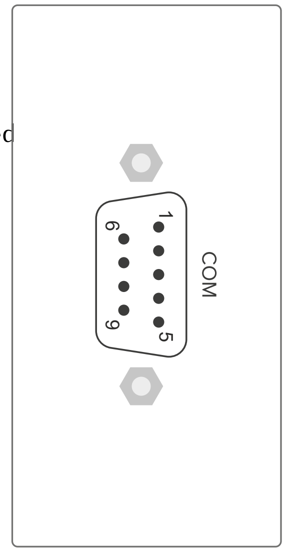
10.1.2 COMx Time String I/O and Pulse-Per-Second Input

Information:

Please note that this PPS input cannot be used as a standalone phase reference. The reference clock can only ever be synchronized via this interface in combination with an externally generated time string input to the system via the RxD (receive) pin of this interface.

Refer to → Chapter 8.3, "Synchronization with Time String and PPS" for more information on using PPS & time string inputs to synchronize your IMS-GXL183.

Connector Type: D-Sub, Male, 9-Pin
(On device)



Cable Type:
Output: Standard RS-232 Cable,
Female Connector, Shielded
Input: Modified RS-232 Cable with PPS
on Pin 1, Female Connector, Shielded

Data Transfer Mode: Serial I/O

RS-232 Baud Rates: 19200 *(Default)*, 9600, 4800, 2400, 1200, 600, 300

Framing: 7N2, 7E1, 7E2, 8N1 *(Default)*, 8N2, 8E1, 7O1, 7O2, 8O1, 8E2

Time String Formats:
(Input)
Meinberg Standard
NMEA RMC, NMEA ZDA
Uni Erlangen

Time String Formats:
(Output)
Meinberg Standard *(Default)*
Meinberg Capture
Meinberg GPS
SAT
NMEA RMC
NMEA GGA
NMEA ZDA
NMEA RMC GGA *(RMC followed by GGA)*
NMEA GGA ZDA *(GGA followed by ZDA)*
Uni Erlangen
Computime
Sysplex 1
SPA
RACAL
ION
ION Blanked
IRIG-J-1
6021
Freelance

Pin Assignment:
Pin 1: PPS In
Pin 2: RS-232 RxD *(Receive)*
Pin 3: RS-232 TxD *(Transmit)*
Pin 5: GND *(Ground)*

PPS Input Signal: TTL or RS-232, Active High, Pulse Width $\geq 5\ \mu s$

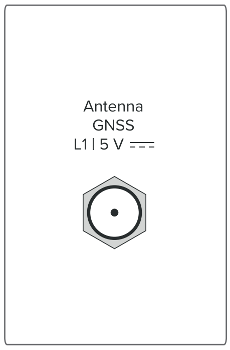
10.1.3 Antenna Input: GXL Multi-Band Receiver

Danger!

Do not work on the antenna system during thunderstorms!

Danger of death from electric shock!

- Do not carry out any work on the antenna installation or the antenna cable if there is a risk of lightning strike.
- Do not carry out any work on the antenna installation if it is not possible to maintain the prescribed safe distance to exposed lines and electrical substations.



Connector Type: (on device) SMA, Female

Cable Type: Coaxial cable, shielded

Cable Length: Max. 70 m (Belden H155, Speedfoam 240HFJ)
Max. 150 m (H2010 Ultraflex)

Receiver Type: 448-Channel Multi-GNSS Receiver

Antenna Type: GNMANTv2 (recommended), please refer to
→ Chapter 5.2, "Antenna Compatibility"

GNSS Signal Support:

GPS:	L1 C/A (1575.42 MHz) L2C and P(Y) (1227.60 MHz)
Galileo:	E1 OS B/C (1575.42 MHz) E5a (1176.45 MHz) E5b (1207.14 MHz)
BeiDou:	B1I (1561.098 MHz) B2I (1207.14 MHz) B3I (1268.52 MHz)
GLONASS*:	L1OF (1602 MHz + k*562.5 kHz) L2OF (1246 MHz + k*437.5 kHz)

Public SBAS Signal Support: EGNOS, WAAS, GAGAN, MSAS, QZSS L1 C/A (1575.42 MHz)
QZSS L2C (1227.60 MHz)

NMA Support: Fugro AtomiChron® (via Inmarsat, frequency is dependent on beam)[2]

Power Output: 5 V, max. 100 mA (power supply to antenna)

Input Impedance: 50 Ω

1 Satellites in the GLONASS constellation can only be used in conjunction with at least one other constellation. GLONASS-only operation is not supported by the IMS-GXL183.

With the L1OF and L2OF FDMA signals, *k* represents the channel number (in the range –7 to 6) within the corresponding GLONASS frequency band.

2 Visit **https://fsp.support/beams** for more information on what beam will typically be used at your location and the frequency on which the signal is broadcast.

10.2 Configuration Reference

This section of the manual provides a detailed overview of the various options available for the configuration of your IMS-GXL183. Your IMS-GXL183 is configured via the **Clock** tab of the main LTOS Web Interface.

10.2.1 GNSS Tab

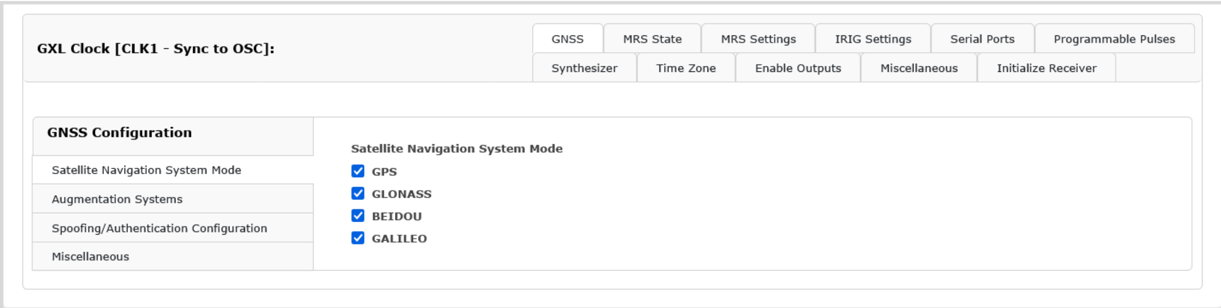


Figure 10.1: GNSS Tab

The **GNSS** tab of the IMS-GXL183 panel is used to configure the GNSS receiver of your IMS-GXL183 module.

Satellite Navigation System Mode

This section allows you to select which GNSS constellations the IMS-GXL183 should use for geopositioning: *GPS*, *GLONASS*, *BeiDou*, and *Galileo*. Please note that Galileo-only operation is not supported by the IMS-GXL183.

Augmentation Systems

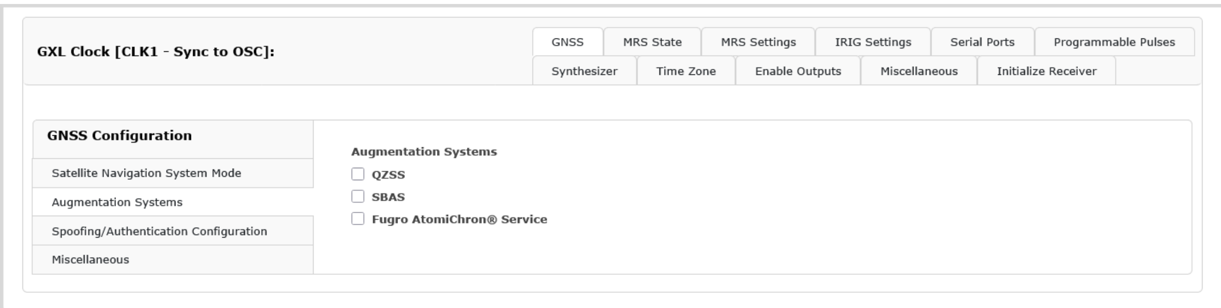


Figure 10.2: GNSS Tab: Augmentation Section

This section allows you to select which national or commercial augmentation systems should be additionally used for geopositioning and navigation message authentication:

QZSS: Enables support for the Japanese QZSS augmentation system. QZSS is officially only available in Japan, but reception may also be possible in other parts of East Asia and Oceania.

SBAS: Enables support for other civil augmentation systems, specifically EGNOS (Europe), WAAS (United States), GAGAN (India), and MSAS (Japan).

Fugro AtomiChron®: Enables support for the commercial AtomiChron® service operated by Fugro N.V. This requires a paid subscription for Navigation Message Authentication. Enabling this option with an active subscription will ensure that GNSS data is authenticated against AtomiChron data broadcast from the Inmarsat constellation. The results of this authentication process are reported in the **Information** panel under the tab **Fugro AtomiChron®**.

If this option is enabled in isolation without activation of the option **Activate Fugro AtomiChron® NMA** under **Spoofing/Authentication Configuration**, the reference clock will not react to authentication failures in its selection of reference sources. This is referred to as *Loose Mode*.

If this option is enabled in conjunction with **Activate Fugro AtomiChron® NMA** under **Spoofing/Authentication Configuration**, the reference clock will interpret any failure of authentication as a reason to fall back to the next MRS reference source or to enter a holdover state. Such an authentication failure can arise not only as a result of the module detecting potentially spoofed data, but also if the module is unable to receive the Inmarsat signal over which the AtomiChron® authentication data is received. This is referred to as *Strict Mode*.

For more information on Loose Mode and Strict Mode, please refer to
→ Chapter 8.2.2, "AtomiChron®Modes".

Spoofing/Authentication Configuration

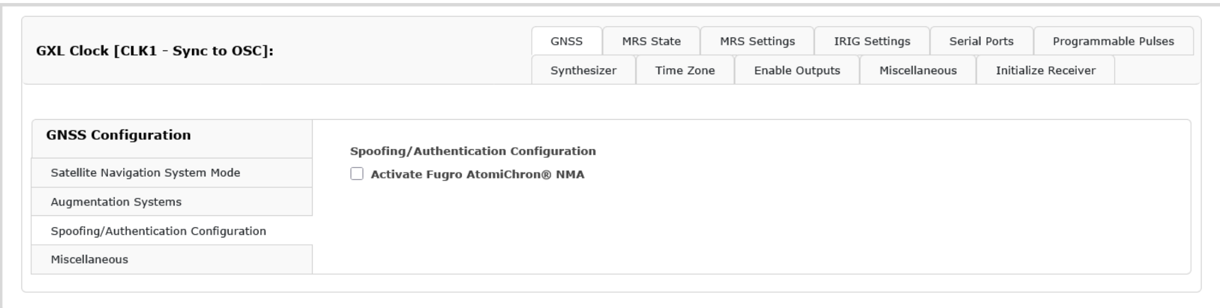


Figure 10.3: GNSS Tab: Spoofing/Authentication Section

Activate Fugro AtomiChron® NMA: If this option is enabled in conjunction with **Fugro AtomiChron®** under **Augmentation Systems**, the reference clock will interpret any failure of authentication as a reason to fall back to the next MRS reference source or to enter a holdover state. Such an authentication failure can arise not only as a result of the module detecting potentially spoofed data, but also if the module is unable to receive the Inmarsat signal over which the AtomiChron® authentication data is received. This is referred to as *Strict Mode*.

This option has no effect if the **Fugro AtomiChron®** option under **Augmentation Systems** is disabled.

Miscellaneous

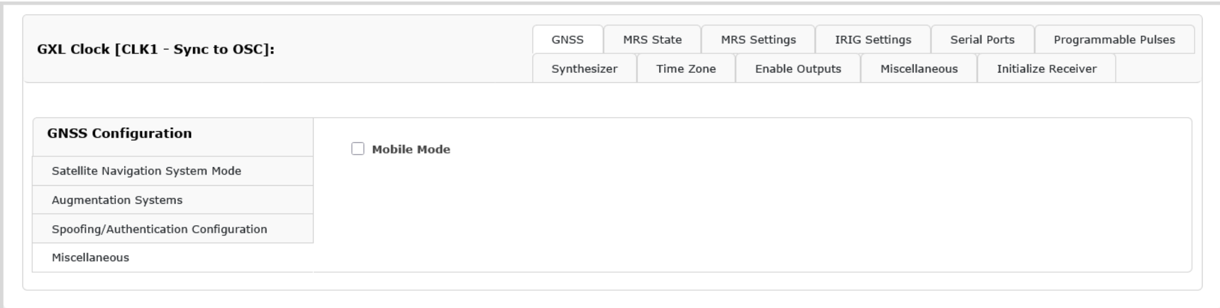
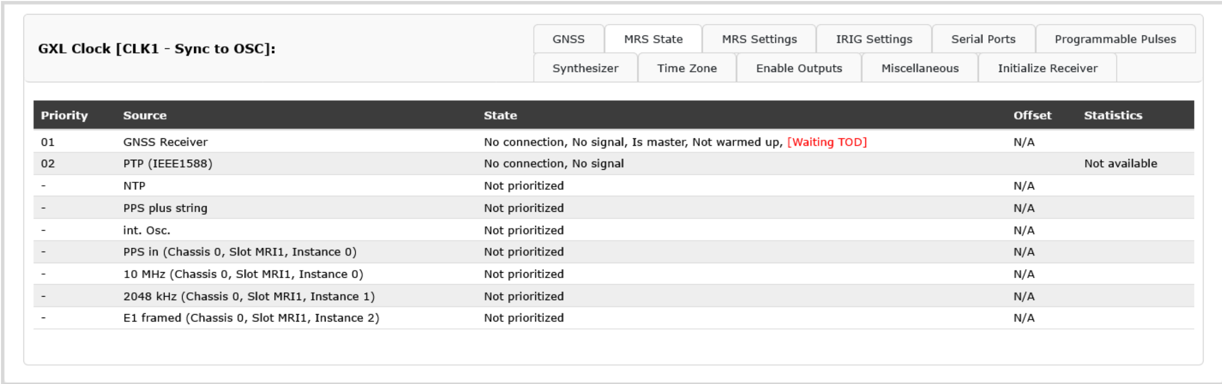


Figure 10.4: GNSS Tab: Miscellaneous Section

Mobile Mode: Enabling this allows the position of the receiver to remain dynamic. If your IMS-GXL183 will be used in a fixed location, ensure that this option is *disabled*. If "Mobile Mode" is incorrectly set, there is a risk that the timing accuracy may be diminished or the receiver will not be able to gain any lock at all.

10.2.2 MRS State Tab



Priority	Source	State	Offset	Statistics
01	GNSS Receiver	No connection, No signal, Is master, Not warmed up, [Waiting TOD]	N/A	
02	PTP (IEEE1588)	No connection, No signal		Not available
-	NTP	Not prioritized	N/A	
-	PPS plus string	Not prioritized	N/A	
-	int. Osc.	Not prioritized	N/A	
-	PPS in (Chassis 0, Slot MRI1, Instance 0)	Not prioritized	N/A	
-	10 MHz (Chassis 0, Slot MRI1, Instance 0)	Not prioritized	N/A	
-	2048 kHz (Chassis 0, Slot MRI1, Instance 1)	Not prioritized	N/A	
-	E1 framed (Chassis 0, Slot MRI1, Instance 2)	Not prioritized	N/A	

Figure 10.5: MRS State Tab

The **MRS State** tab provides information about the current list of MRS reference sources, including their current priority configuration, signal availability, phase lock state, and the current offset of the clock relative to the reference source.

10.2.3 MRS Settings Tab

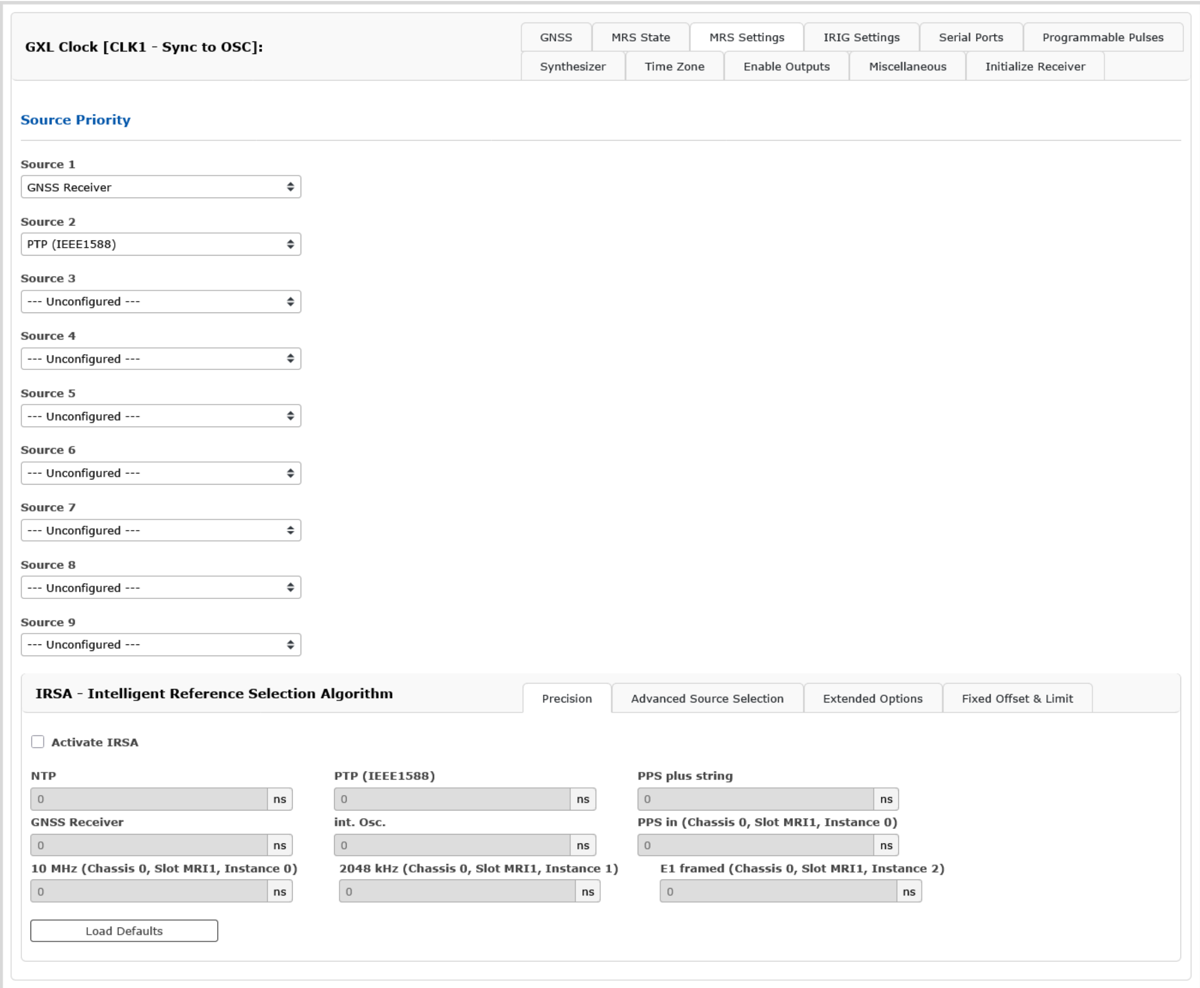


Figure 10.6: MRS Settings Tab

The **MRS Settings** tab establishes how the IMS-GXL183 prioritizes and selects its reference sources based on various criteria.

The primary order of selection is dictated by the **Source Priority** list. These reference sources are either connected directly to the IMS-GXL183 or via another IMS module:

GNSS Receiver: The GNSS antenna input of the IMS-GXL183.

PPS plus String: The time string and PPS inputs of the D-Sub 9 connector on the IMS-GXL183 module itself.

NTP: External NTP servers as configured in LTOS.

PTP (IEEE1588): External PTP masters as configured in LTOS. Requires a PTP module such as an IMS-HPS100 or an IMS-PSX210.

Ext. Osc: An external oscillator connected via the XHE-SPI connector of the IMS-GXL183 itself. This is typically an XHE^{Rb} Rubidium Unit.

Int. Osc:	A placeholder for the on-board oscillator of the IMS-GXL183. This entry specifies that the reference clock should be left in free-run/holdover mode.

IRSA (Intelligent Reference Selection Algorithm)

Precision

If enabled, the MRS mechanism will, upon loss of the current reference signal, intelligently decide whether to fall back to holdover for a certain period of time rather than switch to the next reference source based on a number of factors, including the manually defined accuracy of the reference and the quality of the reference signal. This can allow, for example, a high-grade free-running oscillator to control the time for a certain period of time before falling back to what is likely to be a less accurate time source (e.g., NTP).

If this option is disabled, the MRS mechanism will switch between reference sources directly based on availability.

For more information on IRSA, please refer to → Chapter 12.8, "MRS Functionality" and to the **LTOS Configuration & Management Manual**.

Advanced Source Selection

These options allow the MRS mechanism to be more discerning in which references are use to synchronize the reference clock's time of day and which are used for phase syntonization. It also allows the use of NTP servers to be restricted to those with NTS authentication or the use of PTP masters to be limited to a minimum clock class.

Extended Options

These are a number of advanced options that can be used to intelligently manage how reference sources are selected:

Auto Bias Master:	Enabling this for a reference source means that it is used as a baseline for the automatic determination of static time offsets for other reference sources for which the option **Auto Bias Slave** is selected.
Auto Bias Slave:	Enabling this for a reference source means that a static time offset will be calculated for this reference source based on other reference sources for which the option **Auto Bias Master** is selected.
Is Trusted Source:	Enabling this ensures that this reference source will be used as a trust baseline to identify whether another reference may potentially have been spoofed or tampered with.
Use Trusted Source:	Enabling this ensures that this reference source will be compared against a trust baseline (for which **Is Trusted Source** has been selected) and deselected if there is doubt about the integrity of the reference source.
Asymmetry Step Detection:	This enables automatic bias correction in the event that a clock jump is detected so that the clock refrains from following this clock jump and instead tries to maintain its current phase. For this purpose, the time offset of the source (bias) will be re-measured.

Measurement Only:	If selected, this reference source will only be used for the measurement of offsets relative to other reference sources and will not be used for synchronization.
Fast Lock:	If enabled, the reference clock will adjust its frequency more rapidly, which may entail some initial frequency stability. Typically, this will allow a frequency lock to be achieved within 10 to 15 minutes. Note that this option only applies to the initial adjustment of the integrated oscillator; once the oscillator has been fully adjusted, the reference clock firmware will revert to the conventional approach of gradual adjustments.

Fixed Offset & Limit

This allows fixed offsets and alert thresholds to be defined for each reference source.

A fixed offset is typically applied if a reference source has a *known* and *constant* offset for any reason.

A limit is defined if you wish to receive a notification (e.g., via syslog) in the event that the offset of that reference source exceeds a certain value.

10.2.4 IRIG Settings Tab

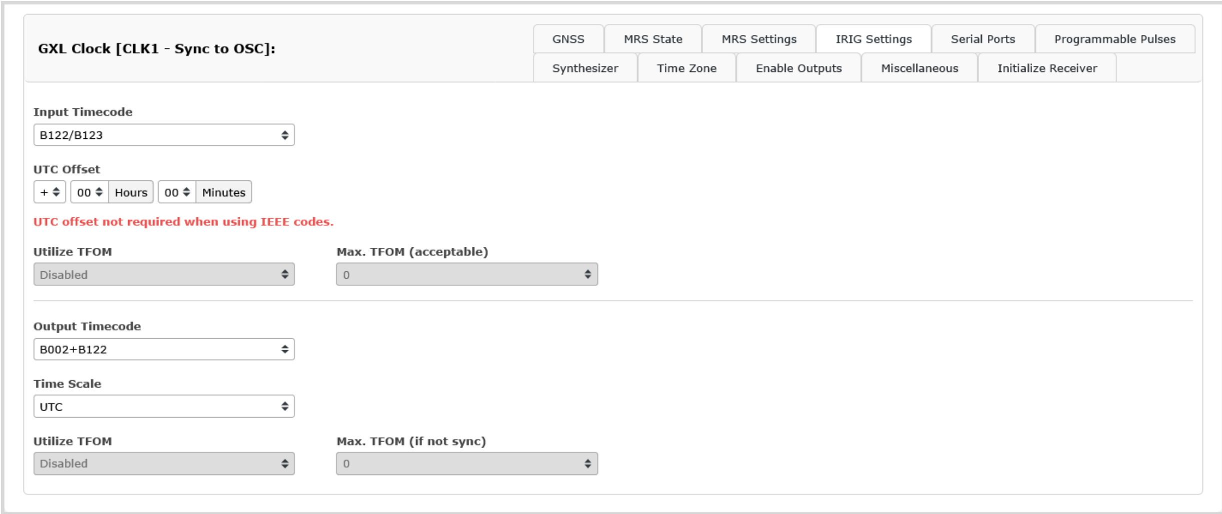


Figure 10.7: IRIG Settings Tab

Input Timecode: When synchronizing the IMS-GXL183 to a IRIG, AFNOR, or IEEE timecode reference input via another IMS module (e.g., IMS-MRI), this specifies which timecode the reference clock expects to receive.

UTC Offset: If an input timecode contains an offset relative to UTC, this can be specified here to allow the IMS-GXL183 to convert the input time of day back to UTC. This option is not necessary if the timezone is already incorporated into the timecode format (IEEE1344, C37.118).

Utilize TFOM: If enabled, the Time Figure of Merit of IEEE1344 or C37.118 timecode will be monitored and the MRS selection process will be guided by the quality of the timecode input based on this TFOM.

Max. TFOM (Acceptable): If the use of the TFOM is enabled, this is the maximum TFOM that the reference clock will accept before rejecting this timecode input as a reference and falling back to another reference source based on MRS criteria.

Information:

When operating a LANTIME M1000(S) with clock redundancy, a LANTIME M2000S, or a LANTIME M3000(S) with an RSC module, or a LANTIME M4000 with an RSC module, timecode output settings will be located in the **Switch Card** panel.

Timecode output requires installation of an additional output module.

Output Timecode: The timecode format to be output from the reference clock.

Time Scale: Specifies whether the timecode should be output as UTC or the local time of the reference clock (adjusted for configured time zone).

Utilize TFOM: If enabled, a Time Figure of Merit will be appended IEEE1344 or C37.118 timecode.

Max. TFOM (if not Sync): If TFOM output is enabled, this is the maximum TFOM that the reference clock can output and is the TFOM that is output if the clock is not synchronized.

10.2.5 Serial Ports Tab

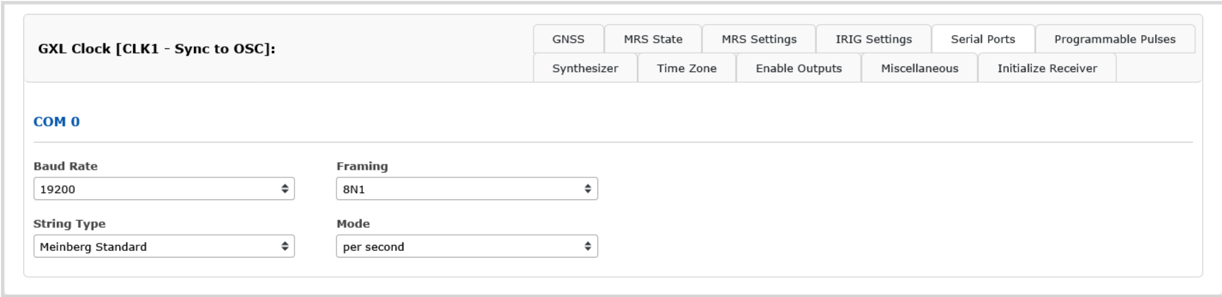


Figure 10.8: Serial Ports Tab

The **Serial Ports** tab provides options regarding the time string output via the RS-232 interface.

Baud Rate: The baud rate of the outbound transmission from the reference clock. This must match the baud rate that the receiver is expecting:

- 300, 600, 1200, 2400, 4800, 9600, 19200

Framing: The framing structure of the outbound transmission from the reference clock. This must match the framing that the receiver is expecting:

- 7N2, 7E1, 7E2, 8N1, 8N2, 8E1, 7O1, 7O2, 8O1, 8E2

String Type: The time string format to be output by the reference clock. This must match the format that the receiver is expecting:

- Meinberg Standard (Default)
- Meinberg Capture
- Meinberg GPS
- SAT
- NMEA RMC
- NMEA GGA
- NMEA ZDA
- NMEA RMC GGA (RMC followed by GGA)
- NMEA GGA ZDA (GGA followed by ZDA)
- Uni Erlangen
- Computime
- Sysplex 1
- SPA
- RACAL
- ION
- ION Blanked
- IRIG-J-1
- 6021
- Freelance

Mode: Specifies the frequency at or the conditions under which the time string is output.

per second
per minute
on request '?' only (upon receipt of ? at RxD)

10.2.6 Programmable Pulses Tab

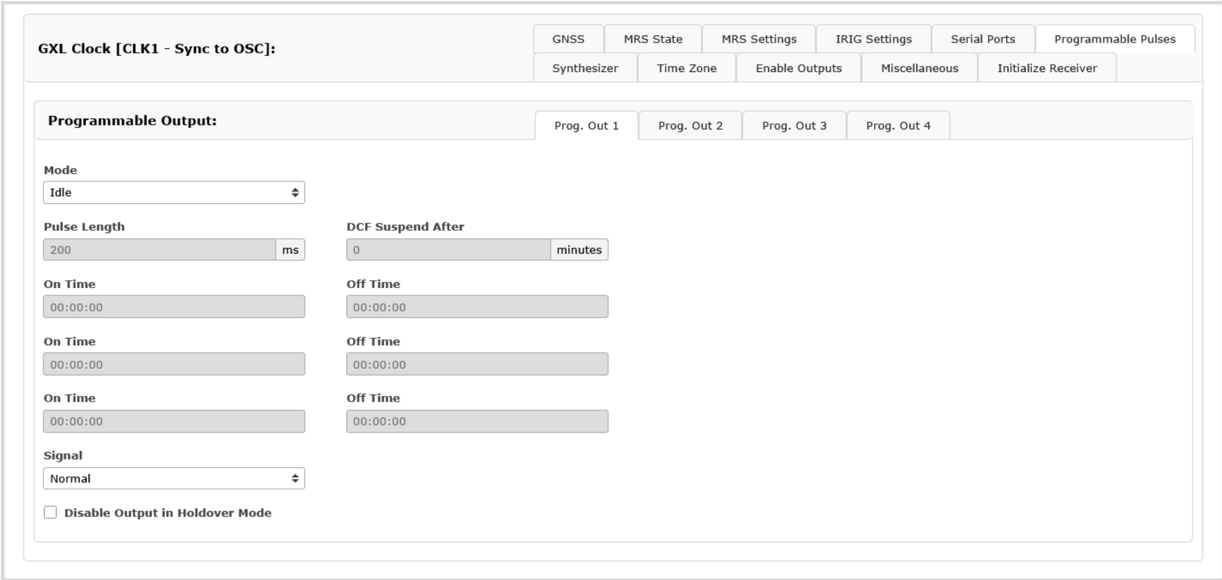


Figure 10.9: Programmable Pulses Tab

Information:

When operating a LANTIME M1000(S) with clock redundancy, a LANTIME M2000S, or a LANTIME M3000(S) with an RSC module, or a LANTIME M4000 with an RSC module, this tab will be located in the **Switch Card** panel.

Programmable signal output requires installation of an additional IMS module with Programmable Pulse output support.

Mode: The type of programmable signal to be output.

- *Idle*
- *Timer*
- *Single Shot*
- *Cyclic Pulse*
- *Pulse per Second*
- *Pulse per Min*
- *Pulse per Hour*
- *DCF77 Marks*
- *Position OK*
- *Time Sync*
- *All Sync*
- *DCLS Timecode*
- *10 MHz Frequency*
- *DCF77-like M59*
- *Synthesizer Frequency*
- *PTTI 1PPS*
- *1 MHz Frequency*
- *5 MHz Frequency*

Information:

For detailed descriptions of each of these programmable signal types, please refer to → "Overview of Programmable Signals" in the Appendix.

For more information on timecode, please refer to → "General Information about Timecode" in the Appendix.

Pulse Length:	Only applies to pulse-based signals. Specifies the length in milliseconds of each pulse.
DCF Suspend After:	Only applies to **DCF77 Marks** mode. Specifies how long DCF77-style output should continue when the clock enters free-run or holdover state.
On Time:	Only applies to **Timer** mode. Specifies the time at which the signal output should begin.
Time:	Only applies to **Single Shot** mode. Specifies the time at which the pulse of defined length should be output (rising edge).
Off Time:	Only applies to **Timer** mode. Specifies the time at which the signal output should begin.
Cycle:	Only applies to **Cyclic Pulse** mode. Specifies the frequency of the pulse (time between rising edges).
Signal:	Specifies whether the signal should be *active high* (*Normal*) or *active low* (*Inverted*).
Disable Output in Holdover Mode:	Specifies whether programmable signal output should be suspended while the reference clock is in holdover.

10.2.7 Miscellaneous Tab

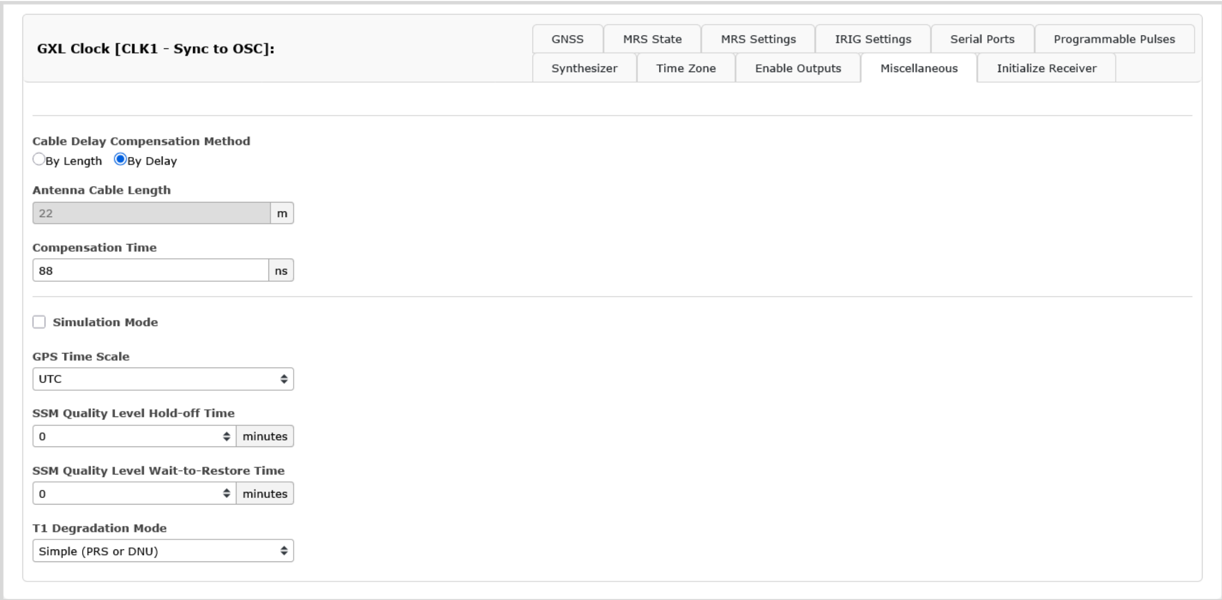


Figure 10.10: Miscellaneous Tab

Cable Delay Compensation Method: Allows the propagation delay adjustment to be calculated automatically based on the length of the antenna cable (*By Length*) or the time correction to be entered manually (*By Delay*).

Antenna Cable Length: When calculating the propagation delay adjustment based on cable length, this field is used to enter the length of the cable in *meters*.

Compensation Time: When entering the propagation delay adjustment manually, this field is used to enter the absolute adjustment in *nanoseconds*.

Simulation Mode: If enabled, the reference clock will continuously simulate a state of GNSS lock and synchronization. This is intended for setup and testing purposes only.

Information:

When operating a LANTIME M1000(S) with clock redundancy, a LANTIME M2000S, or a LANTIME M3000(S) with an RSC module, or a LANTIME M4000 with an RSC module, the following settings will be located in the **Switch Card** panel.

GPS Time Scale: Specifies the fundamental timescale employed by the reference clock.

SSM Quality Level Hold-Off Time: This specifies the amount of time in minutes that the reference clock will wait to determine if a degraded SSM Quality Level in an output E1/T1 signal is temporary.

SSM Quality Level Wait-to-Restore Time: This specifies the amount of time in minutes that the reference clock will wait to determine if a restored and superior SSM Quality Level in an output E1/T1 signal is persistent.

T1 Degradation Mode: Specifies whether the SSM Quality Level broadcast in a T1 signal alternates between two absolutes (PRS or DNU) or whether the various intermediate states are used (*Advanced*).

10.2.8 Initialize Receiver Tab

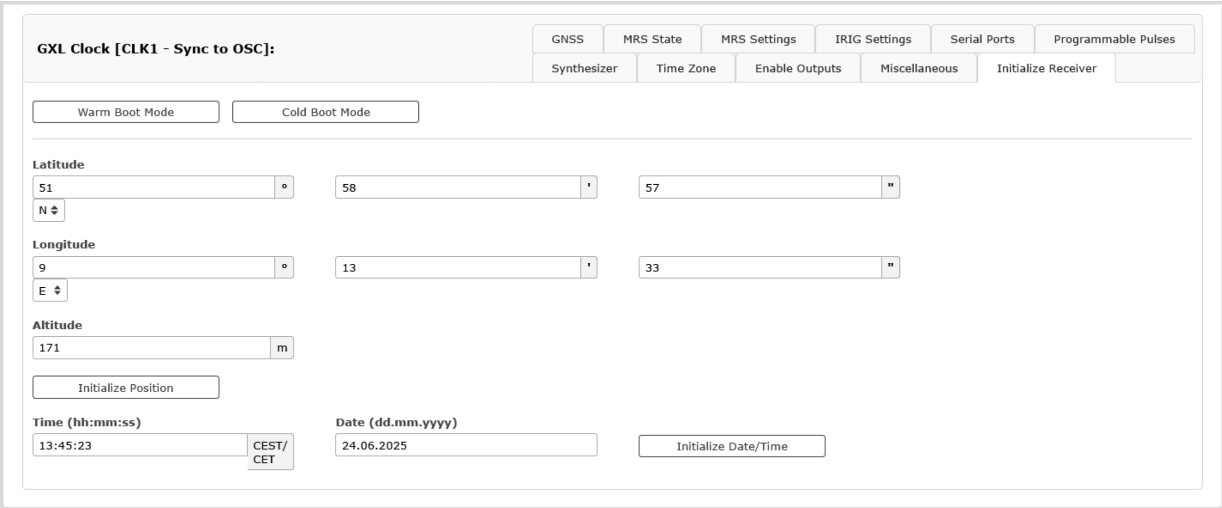


Figure 10.11: Initialize Receiver Tab

Warm Boot Mode: This option triggers a 'warm boot' of the receiver, in which the receiver uses the existing ephemeris data (the almanac) to re-acquire the satellites. This can be useful if the reference clock has been powered down for a long time, or if the antenna is located several hundred kilometers away from the location where it was last in operation.

Cold Boot Mode: This option triggers a 'cold boot' of the receiver, in which the receiver wipes its ephemeris data (the almanac) and re-acquires the satellites from scratch.

Latitude/Longitude/ Altitude: This can be used to manually force the position and altitude of the antenna; confirm the values using the **Initialize Position** button.

11 Maintenance and Modifications

Important!

Before performing any maintenance work on or authorized modification to your Meinberg system, we recommend making a backup of any stored configuration data (e.g., to a USB flash drive from the Web Interface).

11.1 Replacing the Battery

Your device's clock module is fitted with a lithium battery (type CR2032) that is used to locally storage almanac data and sustain operation of the real-time clock (RTC) in the reference clock.

This battery has a life of at least ten years. However, if the device exhibits the following unexpected behaviors, the voltage of the battery may have dropped below 3 V, and the battery will need to be replaced:

- The reference clock has the wrong date or wrong time when the system is started.
- The reference clock repeatedly starts in Cold Boot mode (i.e., upon starting, the system has no ephemeris data saved whatsoever, resulting in the synchronization process taking a very long time due to the need to rediscover all of the visible satellites).
- Some configuration options relating to the reference clock are lost every time the system is restarted.

In this case, you should not replace the battery on your own. Please contact the Meinberg Technical Support team, who will provide you with precise guidance on how to perform the replacement.

11.2 IMS-GXL183 Module Firmware Updates

While Meinberg does update the integrated firmware of its IMS modules from time to time, we generally advise against upgrading the module's firmware without specific cause to do so, as a failed module firmware update can result the module becoming inoperable, such that it must be sent to Meinberg for repair. It is very rare for issues to be traced back to a module's firmware; in most cases, bugfixes and features are introduced via LTOS firmware updates and we encourage you to always keep your LANTIME system's LTOS firmware up to date at all times.

Accordingly, Meinberg does not publish module firmware updates on its website.

If you are encountering a problem with your IMS-GXL183 despite having the latest LTOS firmware version installed on your system, please contact Meinberg's Technical Support team at ✉ techsupport@meinberg.de. If Meinberg's engineers identify a module firmware bug as the root of your problem, your Meinberg Technical Support representative will provide you with the appropriate firmware image together with instructions on how to install it correctly.

12 Appendix

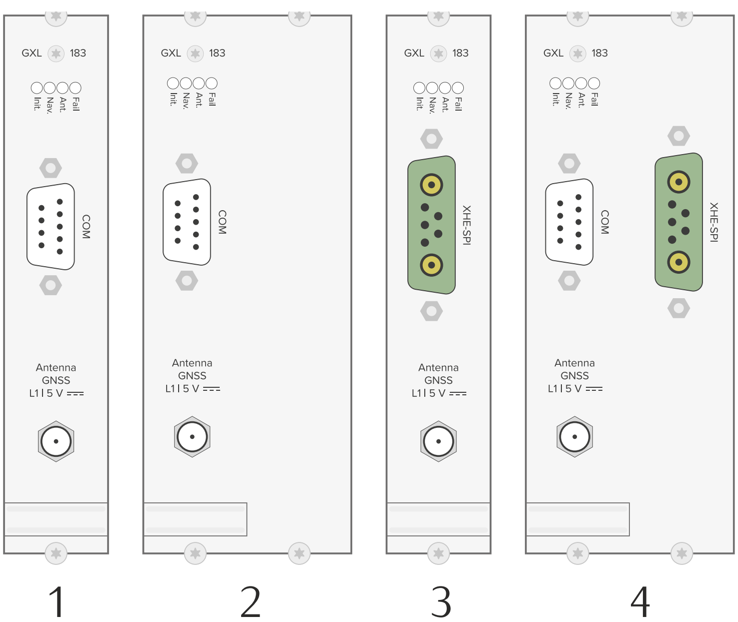
12.1 Technical Specifications

12.1.1 Technical Specifications: IMS-GXL183 Module

Electrical Connector:	96-Pin IEC 60603-2 (DIN 41612) Connector
Operating Voltage:	+5 V DC
Current Draw:	Approx. 600 mA (depending on the installed oscillator)
Temperature Range:	0 °C to 50 °C (32 °F to 122 °F)
Relative Humidity:	Max. 85 %
Surge Immunity:	IEC 61000-4-5 Level 4 Test Voltage: 4000 V Max. Peak Current Given 2 Ω Load: 2000 A
Other Surge Protection:	Integrated surge protector for protection of connected antenna

12.1.1.1 IMS-GXL183 Models

There are several models of the IMS-GXL183 that each vary in terms of the connectors and interfaces provided. The sizes relate to the widths of the faceplates and not the number of actual interface slots of your LANTIME system.



No.	Module	Size	Connectors/Interfaces	Supported Oscillators[1]
1	Standard	1 Slot	1x SMA (antenna), 1x COM	OCXO-SQ, OCXO-HQ
2	COM/DHQ	2 Slots[2]	1x SMA (antenna), 1x COM	OCXO-DHQ
3	XHE-SPI	1 Slot	1x SMA (antenna), 1x XHE-SPI[3]	OCXO-SQ, OCXO-HQ
4	COM/XHE-SPI	2 Slots[2]	1x SMA (antenna), 1x COM, 1x XHE-SPI[3]	OCXO-SQ, OCXO-HQ, OCXO-DHQ

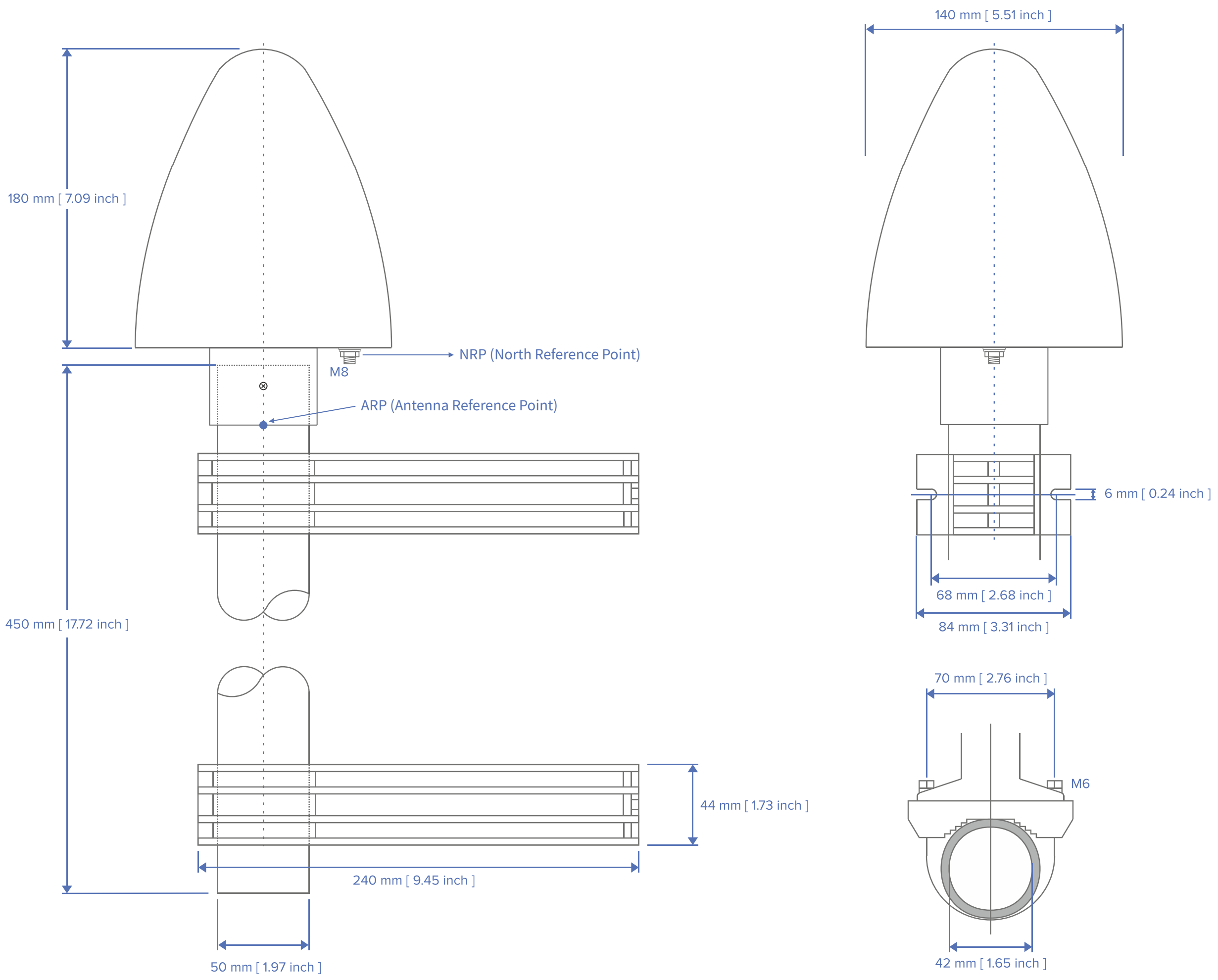
1 Refer to → Chapter 12.1.4, "Technical Specifications: Oscillators" for more information on the oscillator specifications.

2 Installing an IMS-GXL183 module with a two-slot faceplate in an M500, M1000, or M1000S IMS system will result in the adjacent slot (I/O, MRI, or Clock) being obscured and thus unavailable for another IMS module. Please note this when ordering a new IMS system or additional modules for your IMS system.

3 The XHE-SPI interface is used to connect your LANTIME system to an XHE^{Rb} system for high-accuracy holdover performance.

12.1.2 Technical Specifications: GNMANTv2 Antenna

Physical Dimensions



Physical Specifications

Housing:	ABS Plastic for outdoor installation
Weight:	1.4 kg (3.1 lbs), including mounting kit

Connection

Connector Type:	Type-N, female
Impedance (nominal)	50 Ω
Grounding:	M8 threaded bolt and hex nut for use with corresponding ring lug

Electrical Specifications

Input Voltage:	3.6 V ... 5,5 V ⎓, (via antenna cable)
Current draw (nominal)	30 mA @ 5 V
Power Consumption (typ.)	150 mW @ 25 °C

Reception and Signal Properties

Frequency Range:	1160 MHz ... 1255 MHz and 1539 MHz ... 1606 MHz
Max. Base Antenna Input Power: (continuous)	< 18 dBm @ 85°C (185 °F)
Amplification Antenna input to RF output	Lower Band: 35 dB +/- 2 dB Upper Band: 37 dB +/- 2 dB
Polarization	Right-handed, circular (RHCP)
Voltage Standing Wave Ratio (VSWR)	≤ 1.5 : 1 Maximum: 1.8:1
Noise Figure	< 2 dB
P1dB Input	-40 dBm
Antennen Pattern:	Vertical 3 dB aperture angle < 100° Max. horizontal deviation from the ideal circle max. 1 dB

Environmental Conditions

Temperature Range (Operation):	–70 °C to +85 °C (–94 °F to 185 °F)
Temperature Range (Storage):	–70 °C to +95 °C (–94 °F to 203 °F)
Supported Relative Humidity:	Max. 95 % (non-condensing) at 40 °C / 104 °F
IP Rating:	IP65

Supported Frequency Bands

GPS:	L1/L2/L5
GLONASS:	G1/G2/G3
Beidou:	B1/B2/B3
Galileo:	E1/E5a+b plus L-band/E6

Out-of-Band Rejection

Band	**Frequency Range** (in MHz)	**Out-of-Band Rejection**
Lower Band	1160 MHz – 1255 MHz	> 60 dB @ < 960 MHz > 60 dB @ > 1427 MHz
Upper Band	1539 MHz – 1606 MHz	> 60 dB @ < 1463 MHz > 70 dB @ 1710–4700 MHz > 60 dB @ 4701–6000 MHz

12.1.3 Technical Specifications: MBG S-PRO Surge Protector

The MBG S-PRO is a surge protector manufactured by Phoenix Contact (Type Designation CN-UB-280DC-BB) and designed to protect coaxial connections. It is patched directly into the antenna line and consists of a replaceable gas discharge tube that redirects the energy from the cable shielding to the ground potential when ignited. Connect the MBG S-PRO using a ground conductor cable that is as short as possible.

The MBG S-PRO has no dedicated input/output polarity and no preferred installation orientation.

Figure 12.1: MBG S-PRO Surge Protector (Phoenix CN-UB-280DC-BB)

Features

- Excellent RF Performance
- Multiple Strike Capability
- 20 kA Surge Protection
- Bidirectional Protection

Contents of Package:	Surge Protector with Mounting Bracket and Accessories
Product Type:	Surge Protector for Transmission and Receiver Devices
Construction Type:	In-Line Breaker
Connector Types:	Type-N, Female/Type-N, Female

The original product page of the supplier (see link) of the CN-UB-280DC-BB surge protector provides detailed specifications, as well as a variety of product-specific documents under the link below:

Data Sheet (Download):

https://www.meinbergglobal.com/download/docs/shortinfo/english/cn-ub-280dc-bb_pc.pdf

12.1.4 Technical Specifications: Oscillators

	OCXO-SQ	OCXO-HQ	OCXO-DHQ
Short-Term Stability (where t = 1 second)	5×10^{-10}	5×10^{-12}	2×10^{-12}
Pulse-per-Second Accuracy	< ± 50 ns	< ± 50 ns	< ± 50 ns
Phase Noise	1 Hz: -70 dBc/Hz 10 Hz: -105 dBc/Hz 100 Hz: -125 dBc/Hz 1kHz: -140 dBc/Hz	1 Hz: -85 dBc/Hz 10 Hz: -115 dBc/Hz 100 Hz: -130 dBc/Hz 1kHz: -140 dBc/Hz	1 Hz: -80 dBc/Hz 10 Hz: -110 dBc/Hz 100 Hz: -125 dBc/Hz 1kHz: -135 dBc/Hz
Frequency Accuracy in Free-Run Mode (1 Day)	$\pm 5 \times 10^{-9}$ ± 50 mHz	$\pm 5 \times 10^{-10}$ ± 5 mHz	$\pm 1 \times 10^{-10}$ ± 1 mHz
Frequency Accuracy in Free-Run Mode (1 Year)	$\pm 2 \times 10^{-7}$ ± 2 Hz	$\pm 5 \times 10^{-8}$ ± 0.5 Hz	$\pm 1 \times 10^{-8}$ ± 0.1 Hz
Frequency Accuracy with GPS Synchronization (Average over 24 Hours)	$\pm 1 \times 10^{-11}$	$\pm 1 \times 10^{-12}$	$\pm 1 \times 10^{-12}$
Time-of-Day Accuracy in Free-Run Mode (1 Day)	± 65 µs	± 10 µs	± 4.5 µs
Time-of-Day Accuracy in Free-Run Mode (7 Days)	± 9.2 ms	± 1.0 ms	± 204 µs
Time-of-Day Accuracy in Free-Run Mode (30 Days)	± 120 ms	± 16 ms	± 3.3 ms
Time-of-Day Accuracy in Free-Run Mode (1 Year)	± 4.7 s	± 788 ms	± 158 ms
Temperature-Dependent Drift in Free-Run Mode	$\pm 1 \times 10^{-7}$ (–10 °C to 70 °C)	$\pm 1 \times 10^{-8}$ (5 °C to 70 °C)	$\pm 2 \times 10^{-10}$ (5 °C to 70 °C)

12.2 Operational Optimization

12.2.1 The Importance of Good Antenna Positioning

This chapter aims to provide some basic technical background as to the factors that influence good GNSS antenna positioning.

Basics of GNSS Reception for Time Servers

A GNSS antenna captures signals from satellites visible in the sky (referred to as *live-sky signals*). These signals are transmitted by constellations of satellites (also known as *space vehicles* or SVs) in a medium Earth orbit of generally between 20,000 and 30,000 km above sea level.

GNSS antennas used by Meinberg time servers are directional antennas designed to be installed vertically in order to receive live-sky signals within their *signal cone*, which is a reception field spreading out from the antenna up to the sky.

In the case of the GNSS Multi-Band Antenna, this signal cone is approximately 120° relative to the zenith (straight up) to ensure that the antenna can capture a strong a signal as possible even at the horizontal extremes (90° from the zenith). This signal cone can be disrupted by solid objects or other radio signals in its path.

There is a certain margin of error involved in calculating a position based on the distance between an antenna and the satellites visible within the signal cone. Because of this margin of error (known as *dilution of precision*), the position calculated between two measurements can vary even though the antenna and receiver are physically in exactly the same place. Dilution of precision can be influenced by factors outside of the influence of the receiver, such as ionospheric interference, but some factors can be affected by well-considered antenna positioning that maximizes the visible sky while minimizing potential sources of interference.

Impact of GNSS Lock Count on Clock Accuracy

An antenna used for a Meinberg time server requires a lock on the live-sky signals from at least four satellites within the antenna's (ideally undisrupted) signal cone for the receiver to properly, accurately, and consistently determine its position, which it does by generating a *navigation solution*. The more satellites that are visible, the more options the receiver has to generate a *strong solution*, in which the satellites are far apart and the dilution of precision is lower, resulting in a more accurate position fix. This improves the stablility of the position that is measured from solution to solution.

The specified accuracy of synchronized Meinberg time servers assume clear-sky conditions for GNSS receivers, such that any obstructions antithetical to clear-sky conditions may reduce clock accuracy accordingly.

It is therefore important for an antenna to have as much direct exposure to the sky as possible, as this increases the chances of more live-sky signals being correctly detected and improves the quality of the position detection. Obstructions such as buildings or trees reduce or eliminate the chance of live-sky signals being correctly received from that direction, limit the strength of the navigation solution, and can also produce *multipath interference* (see below).

In locations between the 55^{th} parallels, a clear view to the northern and/or southern horizons is especially important in increasing the number of GNSS satellites visible at any given time, because the *ground tracks* of the GPS and Galileo satellite orbits converge with greater frequency around the 55^{th} parallels and the equator of the Earth.

In locations **north** of the **55^{th} north parallel** (e.g., much of Canada, Scandinavia, Greenland, Alaska) GNSS reception is less reliable, as the further north the receiver is located, the less likely GNSS reception at the zenith becomes. As such, a clear view to the north is *less* beneficial and a clear, unobstructed view to the south becomes *more* important.

Conversely, in locations **south** of the **55^{th} south parallel** (principally Antarctica, but also small parts of Brazil, Chile, and Argentina), GNSS reception at the zenith becomes more problematic the further south the receiver is located. As such, a clear view to the **south** is *less* beneficial here, while a clear, unobstructed view to the **north** becomes *more* important.

Radio-Frequency Interference

GNSS signals are conventionally very weak—typically as low as –120 to –130 dBm at ground level. For a common point of reference, the signal strength of a 2.4 GHz wi-fi router at the extremes of its range must be –80 dBm to maintain a stable connection.

With this in mind, radio-frequency interference plays a significant role in GNSS signal reception and must therefore factor into your choice of installation location. Even minor electromagnetic and other radio-frequency interference from other antennas, overhead power lines, and electrical equipment such as HVAC units and cameras can introduce errors, as can a general proximity to metallic surfaces.

Further information on RF emissions from other devices may be obtainable from the documentation of those devices, but as a general rule, a distance of 50 cm from other GNSS antennas, at least 10 m from camera systems (regardless of radio or cable transmission) or HVAC units, and at least 30 m from transmission antennas should be maintained.

Multipath Interference

To enable GNSS antennas to receive sky signals reliably even at horizon level, the signal cone of an antenna typically encompasses the ground to a certain degree. This can be problematic in that GNSS signals can be 'reflected' from terrestrial surfaces such as the ground (as well as other buildings or other vertical surfaces) and are essentially an 'echo' of an otherwise directly received GNSS signal. These signals are referred to as 'multipath interference' and can significantly disrupt a Meinberg time server's ability not only to determine its position but also acquire the time from the GNSS signal.

The mitigation of multipath interference relies first and foremost on the directional antenna being mounted vertically, so that the center of the signal cone is directed towards the zenith and is perpendicular to the horizon to ensure that as little of the signal cone is facing the ground as possible. Maximizing the elevation of the antenna above any vertical faces of surrounding architecture and landscape features also plays a significant role in mitigating the impact of multipath interference.

Reception of Fugro AtomiChron® Signal

The Inmarsat-4 satellites via which the Fugro AtomiChron® service data is transmitted follow a geostationary orbit whose ground positions are, by definition, on or very close to the equator.

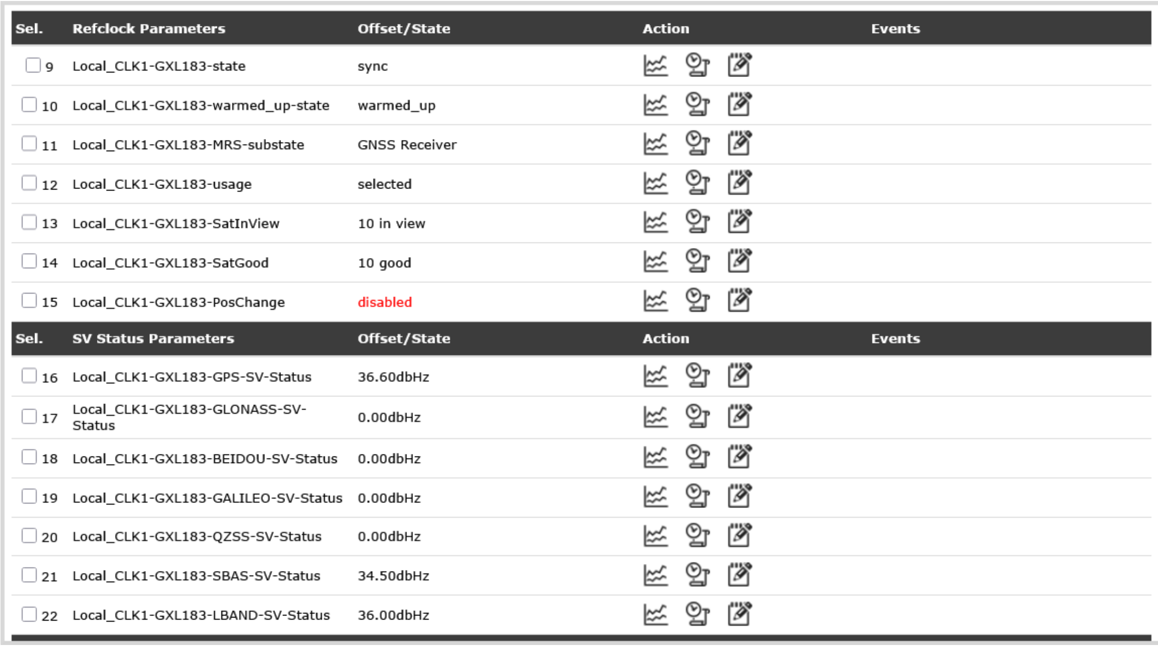
This means that, at medium-to-high-latitude locations in the Northern and Southern Hemispheres, the satellites are typically only visible at very low elevation angles and are particularly dependent on a clear view of the equatorial horizon (i.e., a clear view to the southern horizon in the Northern Hemisphere, or to the northern horizon in the Southern Hemisphere).

12.2.2 Diagnosis of GNSS Reception Issues Using SyncMon

The SyncMon application within LTOS is a versatile tool that provides much in the way of background data on not only reference sources, but also on GNSS reception itself. As such, SyncMon is a very useful tool for diagnosing and troubleshooting reception problems relating to GNSS signals and the Fugro AtomiChron® signal during the setup of your IMS-GXL183 module.

Note that this guide provides only a brief insight into the use of SyncMon for GNSS reception problem diagnosis. Please refer to the **LTOS Configuration & Management Manual** for a more in-depth guide to the use of SyncMon.

To access SyncMon, select the **SyncMon** tab from the LTOS Web Interface, then expand the **System Monitoring** panel.

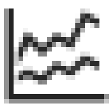


Sel.	Refclock Parameters	Offset/State	Action	Events
9	Local_CLK1-GXL183-state	sync		
10	Local_CLK1-GXL183-warmed_up-state	warmed_up		
11	Local_CLK1-GXL183-MRS-substate	GNSS Receiver		
12	Local_CLK1-GXL183-usage	selected		
13	Local_CLK1-GXL183-SatInView	10 in view		
14	Local_CLK1-GXL183-SatGood	10 good		
15	Local_CLK1-GXL183-PosChange	disabled		
Sel.	**SV Status Parameters**	**Offset/State**	**Action**	**Events**
16	Local_CLK1-GXL183-GPS-SV-Status	36.60dbHz		
17	Local_CLK1-GXL183-GLONASS-SV-Status	0.00dbHz		
18	Local_CLK1-GXL183-BEIDOU-SV-Status	0.00dbHz		
19	Local_CLK1-GXL183-GALILEO-SV-Status	0.00dbHz		
20	Local_CLK1-GXL183-QZSS-SV-Status	0.00dbHz		
21	Local_CLK1-GXL183-SBAS-SV-Status	34.50dbHz		
22	Local_CLK1-GXL183-LBAND-SV-Status	36.00dbHz		

Figure 12.2: GNSS Signal Monitoring Options in SyncMon

The **SV Status** parameters in the **System Monitoring** panel represent the reception performance of the IMS-GXL183 for each constellation. The value **State/Offset** in the **SV Status** lines represents the most recent signal strength (carrier-to-noise density ratio, C/N_0) for each constellation.

Ideally, this value should be at least *38 dB-Hz* for reliable reception. If the value for any constellation is below this, it is likely that radio interference such as external signals or multipath interference is impeding GNSS reception. If the value is zero, this typically means that either the constellation is disabled in the configuration of your IMS-GXL183, or there are line-of-sight obstructions between the antenna and any visible satellites.



Click on the **Graph** button to open a graph showing the C/N_0 and number of locked satellites over time.

If you have verified that reception of a constellation is enabled for your IMS-GXL183, the plot over time of the C/N_0 value may provide some insight as to why a constellation's signal may be lost periodically over a day.

For example, if a signal is lost entirely (C/N_0 = 0) for prolonged periods in a day, it is possible that:

- there are time-dependent interference sources (for example, HVAC technology that is switched on automatically by a timer or sensor mechanism),
- the ground tracks of the satellites follow trajectories that the antenna can only partially lock onto, with line-of-sight between the antenna and satellites obscured for parts of the ground track.

Conversely, if a signal has no reception at all over the course of a day, it is possible that:

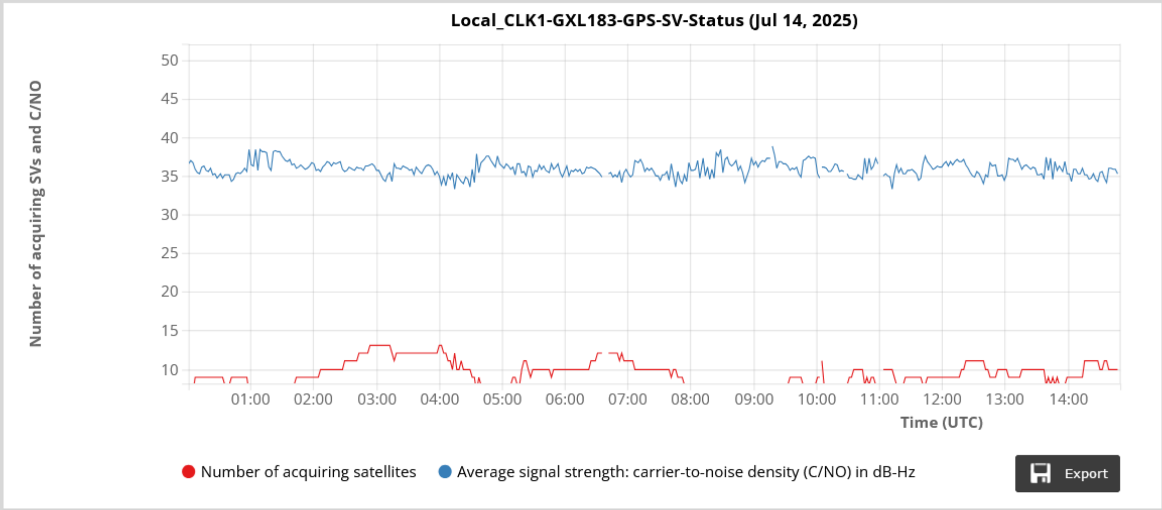


Figure 12.3: GNSS Carrier-to-Noise Density over Time in SyncMon

- there is persistent and powerful radio interference (with the possibility that frequency bands may be deliberately or inadvertently jammed, although each constellation encompasses multiple signals on different frequencies),
- the line-of-sight obstructions of the antenna are too significant for the receiver to achieve a lock on any satellite in that constellation,
- the ground tracks of the satellites follow trajectories that the antenna can only partially lock onto, with line-of-sight between the antenna and satellites obscured for parts of the ground track.

If only poor and highly inconsistent reception is displayed for a constellation throughout the day ($C/N_0 < 35$ db-Hz with variations of more than 10 dB-Hz), it is possible that:

- there is persistent radio interference,
- the line-of-sight obstructions of the antenna are too significant for the receiver to achieve a lock on any satellite in that constellation.

Special Case: Inmarsat-4

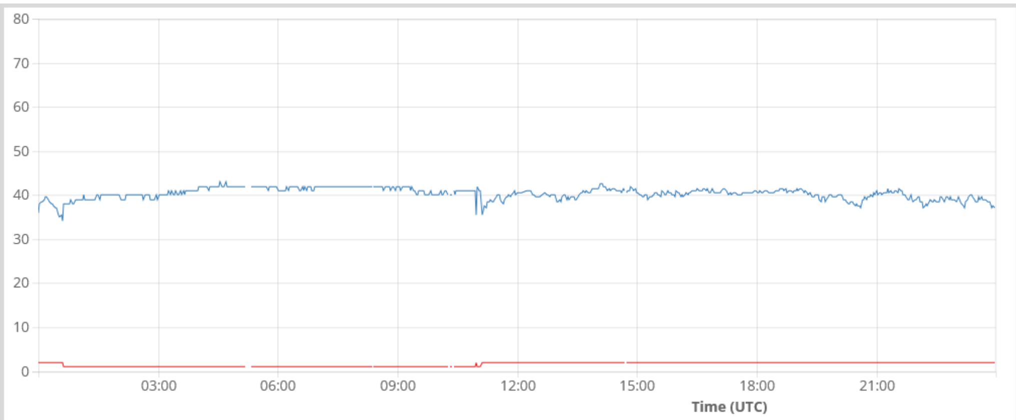


Figure 12.4: Representation of ideal Inmarsat-4 reception

Inmarsat-4 reception is shown in SyncMon as **LBAND-SV-Status** under the **SV Status Parameters**.

To use Fugro AtomiChron® in Strict Mode (see → Chapter 8.2.2, "AtomiChron®Modes") and for the reception of the activation signal, it is essential to have continuous, uninterrupted reception of the signal, such that the SyncMon graph must show a C/N_0 value of at least 35 dB-Hz continuously over the course of the day (see Fig. 12.4).

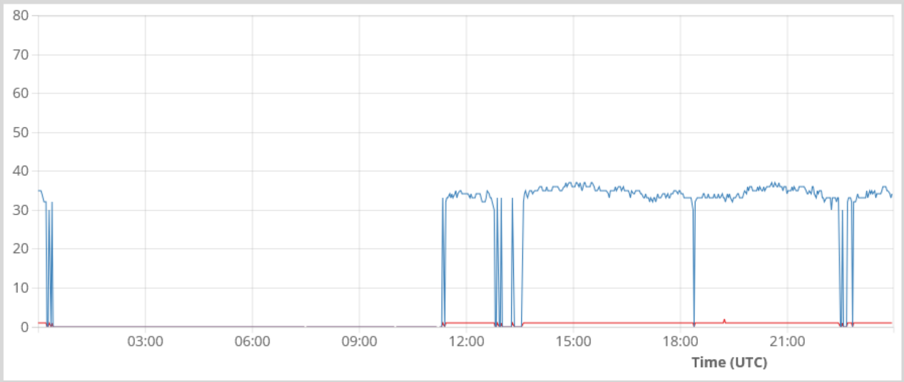


Figure 12.5: Example of poor Inmarsat-4 reception

Because Fugro AtomiChron® reception is dependent on a clear view of the equatorial horizon, problems in this respect may be shown in SyncMon in the form of intermittent or absent reception of the Inmarsat-4 signal (see Fig. 12.5), suggesting a very high likelihood that the view towards the equatorial horizon is obscured in such a way that there is no sustainable line of sight with the Inmarsat-4 satellite.

12.2.3 Accurate Propagation Delay Measurement

While Meinberg products allow the propagation delay inherent in transmission along a coaxial cable to be estimated with reasonable accuracy based on an assumed delay value per meter of specified cable, the error inherent in such an estimate can result in timing errors that increase with each additional meter of transmission.

Additionally, the following can also induce unpredictable delays:

- the use of inline amplifiers;
- coaxial cable damage;
- poor quality coaxial cable;
- minor production-related variations in coaxial cable construction, which can occur regardless of cable quality and integrity;
- outdoor cable installations in climates with very low or very high temperatures;
- cable routes along which the cable is bent frequently and/or to a significant degree.

Please note that the measurement methods described below are typically only necessary if seeking to achieve timing accuracies in the low nanosecond range. If your application requires millisecond or microsecond-level accuracy, the timing error introduced by the simplified cable length method and by the unpredictable factors described above will be negligible.

However, for applications that require timestamps with nanosecond-level accuracy or accurate frequency clocks in the megahertz range (for example), a more accurate calibration against your transmission infrastructure or at least based on the specifications of your infrastructure components (cable and amplifiers) is strongly advised.

Direct Measurement

The most accurate method of measuring propagation delay for your specific cable installation requires suitable equipment such as a time-domain reflectometer.

With such a device, a pulse is typically sent by the reflectometer along the installed cable (including all bends in the typical operating climate). It is generally worth taking multiple readings with an open circuit (i.e., the other end of the route left unconnected) and adopting a value delay based on a reasonable statistical evaluation based on multiple readings (mean value, median value, filtering of outliers, etc.)

Note that any inline amplifiers may absorb measurement pulses, which will likely impede reflectometer pulse reflections and interfere with measurements.

The delay measured by the reflectometer between pulse transmission and pulse reflection is typically twice the propagation delay of your transmission route; accordingly, half of the measured value should be entered as your adjustment value in nanoseconds.

Delay Calculation

If you do not have access to suitable equipment to directly measure the propagation delay, a reliable estimate of the propagation delay can be calculated based on the specifications provided in the data sheet of the specific cable in use and its length. While this method does not accommodate delay variations induced by the factors listed at the start of this chapter, it allows a more accurate assessment of the propagation delay per meter of your specific cable.

Most cable manufacturers will typically specify the propagation velocity v_p as a percentage of the speed of light. Given that the speed of light is 0.2998 meters per nanosecond, this allows us to calculate the signal delay in nanoseconds over a defined length of cable l_c as:

$$\frac{l_c}{0.2998 \text{ x } (v_p \ / \ 100)}$$

Example: If the cable data sheet provides a propagation velocity value of 80 % and you have 40 meters of Speedfoam 240 HFJ cable between the antenna and receiver, the above formula will result in a theoretical delay of **166.8** nanoseconds (or **4.17** nanoseconds per meter of cable). This value would be rounded up and entered as **167** nanoseconds.

12.3 Signal Specifications

12.3.1 Overview of Programmable Signals

Meinberg systems with programmable pulse outputs provide the following signal options; the actual range of available signal options will vary from system to system:

Idle

Selecting "**Idle**" allows individual programmable outputs to be disabled individually.

Timer

In "**Timer**" mode, the output simulates a timer with a fixed daily schedule. It is possible to configure three switch-on and three switch-off times for each day and each output. In order to set a timer, both the switch-on time ("**ON**") and the corresponding switch-off time ("**OFF**") must be set. If the switch-on time is later than the switch-off time, the switching scheduler will interpret this to mean that the switch-off time is on the next day, which will keep the signal enabled through midnight.

Thus, if a program was set with a switch-on time of *23:45:00* and a switch-off time of *0:30:00*, this would cause the output to be enabled on day *n* at 11:45 p.m., and then to be disabled on day *n+1* at 12:30 a.m. If any of these three programs are to be left disabled, simply enter the same times into the "**ON**" and "**OFF**" fields. The "**Signal**" selector specifies the active state for the timer periods. Selecting "*Normal*" will put the output in a low state outside of switch-on periods and in a high state during switch-on periods ("active high"). Conversely, selecting "*Inverted*" will place the output in a high state outside of switch-on periods and in a low state during switch-on periods ("active low").

Single Shot

"**Single Shot**" mode generates a single pulse of defined length once per day. The time of day when the pulse is to be generated can be set via the "**Time**" value. The value "**Length**" allows the pulse length to be set in 10 ms increments and may be any value in the range of *10 ms* to *10000 ms* (10 seconds). Entries that are not multiples of 10 ms will be rounded down.

Cyclic Pulse

"**Cyclic Pulse**" mode is used to generate cyclically repeating pulses. The time between two pulses is defined, and this value must always be provided in hours, minutes, and seconds. It is important to note that the pulse train is always synchronized with 0:00.00 local time, so that the first pulse on any given day will always be output at midnight, and is repeated at the specified cycle interval henceforth. Thus, if a cycle duration of *2 s* is specified, this will result in pulses being triggered at 0:00.00, 0:00.02, 0:00.04 and so on. While it is possible to set any cycle time between 0 and 24 hours, these repetitions are usually only useful if the time between pulses is always the same. For example, if a cycle time of *1:45.00* is set, this will output pulses at intervals of 6300 seconds. However, between the last pulse of any given day and the pulse at midnight on the following day, there will be an interval of just 4500 seconds.

Pulse-per-Second, Pulse-per-Minute, Pulse-per-Hour

These three modes generate pulses of defined length once per second, once per minute, or once per hour respectively. The configuration options for all three modes are the same. The value "**Pulse Length**" specifies the length of the pulse and can be between *10 ms* and *10000 ms* (10 seconds).

DCF77 Marks

In "**DCF77 Marks**" mode the selected output simulates the time string transmitted by the German DCF77 time code transmitter. The output pulses are the 100 ms and 200 ms pulses (logical 0/1) typical for the DCF77 code. The absence of the 59-second mark is used to signal that the next minute will begin with the following second mark.

DCF77-like M59

Sends a 500 ms pulse at the 59-second mark.

The "**Timeout**" field can be used to enter how many minutes the system should wait while in free-run mode before DCF77 simulation is suspended. Entering *0* here will disable the timeout function, so that the DCF77 simulation will continue running perpetually until manually disabled.

Position OK, Time Sync, All Sync

There are three different modes available for outputting the synchronization status of the clock. The "**Position OK**" mode outputs a signal whenever the GNSS receiver is receiving enough satellites to determine its position.

In "**Time Sync**" mode, a signal is only output as long as the clock's internal timebase is synchronized to the GNSS reference. The "**All Sync**" mode requires both of the above states to be true—for a signal to be passed through the output, there must be sufficient satellites for positioning, **and** the internal timebase must be synchronized to the reference constellation's timebase.

DCLS Timecode

DC level shift timecode. The timecode output here is configured in the "**Clock**" → "**IRIG Settings**" section of the Web Interface.

1 MHz Frequency, 5 MHz Frequency, 10 MHz Frequency

These modes are used to output a fixed frequency of 1, 5, or 10 MHz respectively, using a PPS signal as an absolute phase reference (i.e., the falling edge of the signal is synchronized with the rising edge of the PPS signal).

Synthesizer Frequency

This mode is used to output a custom frequency, which is defined using the "**Clock**" → "**Synthesizer**" section of the Web Interface.

Time Slots per Minute

This mode divides each minute up into a number of equal time slots, which can be individually enabled during those seconds of each minute. For example, if *six* time slots are selected, the user can set whether a signal should be output during the 0–10-second, 10–20 second, 20–30 second, 30–40 second, 40–50 second, and 50–60 second slots. If only the *10–20 second* slot is selected, a signal will only be output between 10 and 20 seconds of each minute and disabled outside of that.

PTTI 1PPS

This mode is used to pass a PPS signal of 20 μs pulse width through the output.

12.3.2 General Information about Timecode

The need to transmit encoded time information became a topic of some importance as early as the 1950s. The U.S. space program in particular was a key driver of advancement in this field, using timecode information to correlate different sets of measurements. However, the formats and usage of these signals were defined arbitrarily at the whims of the specific users, which resulted in the development of hundreds of different timecode formats, some of which were standardized by the "Inter Range Instrumentation Group" (IRIG) in the early 1960s. These standardized timecode formats are referred to as "IRIG Timecodes" today.

In addition to these general-purpose time signals, there are other codes in use designed for specific applications, among them NASA36, XR3, or 2137. The IMS-GXL183, however, limits itself to the output of IRIG-A, IRIG-B, AFNOR NF S87-500, and IEEE 1344 formats, as well as IEEE C37.118, the successor to IEEE 1344.

The AFNOR timecode is a variant of the IRIG-B format that uses the available "control functions" segment of the IRIG timecode to supply full date information.

Visit our website for more detailed information about IRIG and other timecodes:
https://www.meinbergglobal.com/english/info/irig.htm

12.3.2.1 Description of IRIG Timecodes

Each IRIG timecode format is denoted by an alphabetical character followed by a three-digit number sequence as specified in IRIG Standard 200-04. Each character in a timecode format designation has the following meaning:

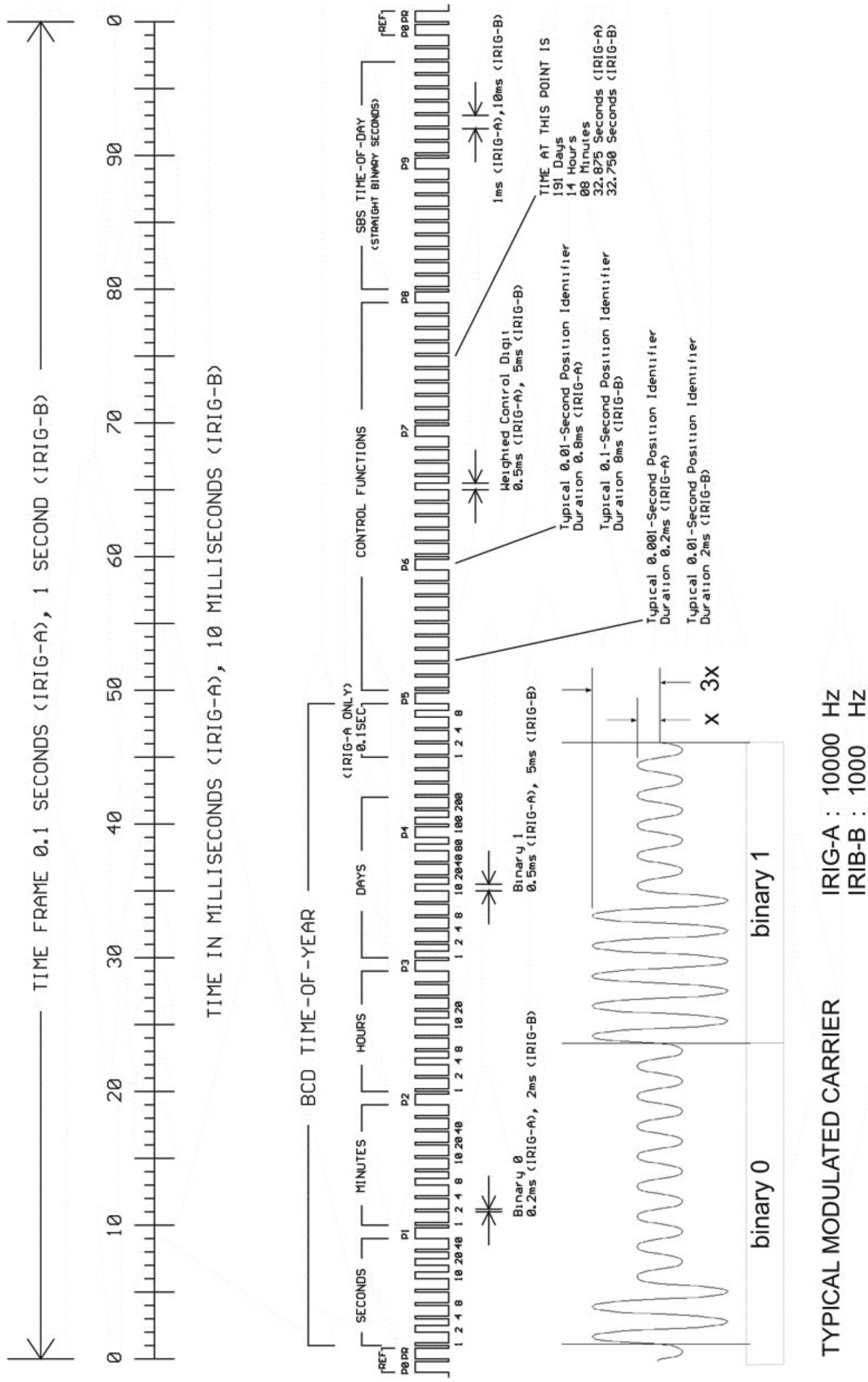
Character	Bit Rate	A	1000 pps
		B	100 pps
		E	10 pps
		G	10000 pps
1st Character	Pulse Wave	0	DC Level Shift (DCLS), pulse-width modulated
		1	Sine-wave carrier, amplitude-modulated
2nd Character	Carrier Frequency	0	No carrier (DC Level Shift)
		1	100 Hz, time resolution 10 ms
		2	1 kHz, time resolution 1 ms
		3	10 kHz, time resolution 100 μs
3rd Character	String Content	0	$BCD^{(TOY)}$, CF, SBS
		1	$BCD_{(TOY)}$, CF
		2	$BCD_{(TOY)}$
		3	$BCD_{(TOY)}$, SBS
		4	$BCD_{(TOY)}$, $BCD_{(YEAR)}$, CF, SBS
		5	$BCD_{(TOY)}$, $BCD_{(YEAR)}$, SBS
		6	$BCD_{(TOY)}$, $BCD_{(YEAR)}$
		7	$BCD_{(TOY)}$, $BCD_{(YEAR)}$, SBS

BCD: Time and day-of-year in BCD format
CF: Control Functions (for unspecified use)
SBS: Number of seconds in the day since midnight (binary)

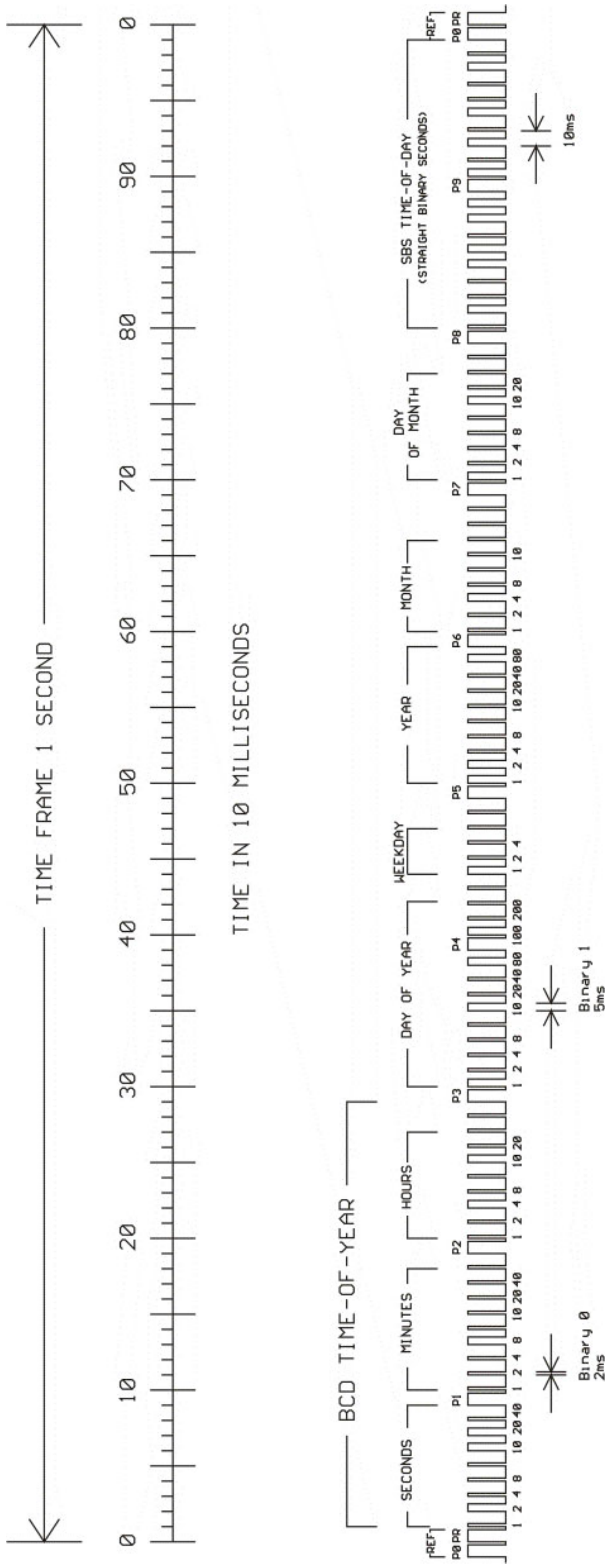
In addition to the original IRIG standards, there are other specifications issued by other bodies that define specific extensions.

AFNOR:	Code according to NF S87-500, 100 pps, AM sine-wave signal, 1 kHz carrier frequency, BCD time-of-year, complete date, SBS time-of-day, signal level specified by standard.
IEEE 1344:	Code according to IEEE 1344-1995, 100 pps, AM sine-wave signal, 1 kHz carrier frequency, BCD time-of-year, SBS time-of-day, IEEE 1344 extensions for date, time zone, Daylight Saving Time, and leap seconds in Control Functions (CF) segment. (See also table "**Structure of CF Segment in IEEE 1344 Code**")
IEEE C37.118:	Identical to IEEE 1344, but with UTC offset +/- sign bit reversed
NASA 36:	100 pps, AM sine-wave signal, 1 kHz carrier frequency, Time Resolution: 10 ms (DCLS), 1 ms (AM carrier) BCD time-of-year: 30 bits – seconds, minutes, hours, and days

12.3.2.2 Timecode Format According to IRIG Standard



12.3.2.3 Timecode Format According to AFNOR Standard



12.4 Antenna Cable

Meinberg provides suitable cable types with its antennas and these are ordered together with the antenna to match the length you need from your antenna to your Meinberg reference clock. The route to be covered for your antenna installation should be determined and the appropriate cable type selected accordingly before confirming your order.

Important!

Please avoid using a mixture of different cable types for your antenna installation. This should be taken into consideration in particular when purchasing additional cable, for example in order to extend an existing cable installation.

The cable is shipped with both ends fitted with the appropriate connectors as standard, although the cable can also be shipped without any pre-fitted connectors if so requested.

The table below shows the specifications of the supported cable types for the transmission of the GPS L1/Galileo E1 band by way of example for cables supplied by Meinberg. For cables from sources other than Meinberg, please refer to the data sheet of that cable:

Cable Type	H155	H2010 (Ultraflex)	HFJ240
Signal Propagation Time at 1575 MHz	423 ns/100 m	386 ns/100 m	401 ns/100 m
Attenuation at 1575 MHz	-40.20 dB/100 m	-17.57 dB/100 m	-33.00 dB/100 m
Core DC Resistance	3.24 Ω/100 m	1.24 Ω/100 m	1.05 Ω/100 m
Cable Diameter	5.4 mm	10.2 mm	6.1 mm
Max. Cable Length*	70 m	150 m	70 m
Min. Bend Radius (Fixed Installation)	60 mm	40 mm	61 mm

Table: Specifications of cable types supplied by Meinberg

* Relates to cable routes without inline amplifiers.

→ Chapter 7.1.5, "Grounding the Antenna" explains how to implement compliant ground protection for an antenna installation, while → Chapter 7.1.6, "In-Line Surge Protection" explains how to implement effective surge protection.

12.5 Important Information Regarding Hot-Pluggable IMS Modules

The following information should be strictly observed when replacing IMS modules during operation. Not all IMS modules are fully hot-pluggable. For example, it is naturally not possible to replace a power supply unit in a system without PSU redundancy without first having installed a second power supply unit while the system is in operation.

The following rules apply for the individual IMS slots:

PWR Slot:	"Hot-Swappable"	If you operate your system with only one power supply unit, a second power supply unit must be installed before removing or replacing it in order to keep your system operational.
I/O, ESI, and MRI Slots:	"Hot-Pluggable"	
CLK1, CLK2 Slots:	"Hot-Pluggable"	When a clock module is replaced or installed, it is important to rescan the reference clocks ("**Rescan Refclocks**") in the "**System**" menu of the Web Interface.
RSC/SPT Slots:	"Hot-Pluggable"	It will not be possible for your IMS system to switch between signal generators while the RSC/SPT is not installed.

CPU Slot:	"Not Hot-Pluggable"	Before the CPU is removed, the IMS system must be powered down. Please note that after powering on and rebooting LTOS, the configuration of some IMS modules may be reset to factory defaults!

Information:

The NTP service and access to the Web Interface will be unavailable while the CPU is not installed. Management and monitoring functions will also be disabled.

12.6 Further Reading

This Setup Guide provides the information required to quickly set up your module in your IMS system with a minimum of problems. We recommend also carefully studying the following manuals alongside this Setup Guide for the use of your IMS-GXL183:

Meinberg IMS System Manuals (all systems)	http://mbg.link/doc-en
LTOS Configuration & Management Manual	http://mbg.link/doce-fw-ltos

The IMS system manuals provide additional information on the hardware aspects of your IMS system, while the **LTOS Configuration & Management Manual** provides a detailed description of all configuration and monitoring options available for your module in conjunction with other modules. These manuals are also available to download from the Meinberg Customer Portal at https://www.meinberg.support.

12.7 How the IMS-GXL183 Works

The IMS-GXL183's receiver determines its position using at least four visible GNSS satellites. This position is used to calculate an offset for the timing data received from the GNSS satellites.

Timing data can then be validated using the premium AtomiChron® service on the basis of data provided over a separate satellite frequency.

The authenticated timing data and calculated offset adjustment can then be used as a reference for the IMS-GXL183's clock. Once the IMS-GXL183 is successfully synchronized with a suitable reference, it generates a PPS (pulse-per-second) phase reference and a 10 MHz frequency reference.

These PPS and 10 MHz references are then forwarded to the installed IMS modules to be either directly output or to serve as the basis for the generation of other output signals as required for a variety of applications.

12.8 MRS Functionality

When the system is powered up or rebooted, the oscillator will initially run solely off the internal oscillator ("free-run mode"). As soon as one of the available reference sources has been synchronized and validated, there will be an initial "hard" adjustment of the internal time (main oscillator). The oscillator from that point will then only be adjusted in very small steps.

The following reference time sources can be used, depending on the system (optional):

GNSS	GPS / GLONASS / Galileo / BeiDou satellite receivers
DCF77	DCF77 time signal transmitter (AM, PZF), DCF77 signal generator (AM only)
NTP	External NTP servers (up to seven different servers configurable)
PTP (IEEE 1588)	PTP master for clock synchronization (M500 and M900 only)
Timecode	DCLS oder AM timecode (e.g., IRIG, AFNOR)
PPS in	Pulse-per-second (PPS)
PPS plus String	PPS + serial time string
Fixed Freq. In	10 MHz frequency input

If more than one reference clock is available and synchronized, the clock with the highest priority (the "master") is used to discipline the internal oscillator.

If the master becomes unavailable, the next reference clock in the order of priority is selected. The reference clock will briefly lose synchronization during this process until it has resynchronized with the new source.

If a reference clock with a higher priority becomes synchronized, it will always be selected as the "master".

Fixed Offset

A fixed offset relative to the reference time can be defined for every reference clock, allowing for known and constant deviations of a reference clock to be accounted and compensated for. When using a GNSS reference source, it is not possible to define a fixed offset—deviations can only be accounted for here indirectly via the specification of the antenna cable length.

Precision

This parameter dictates the fundamental accuracy of this reference source. When switching between different time sources, this value and the accuracy of the oscillator is used to calculate the holdover time, which is the delay until the actual changeover. If the "precision" value is zero, the system will switch to the next reference clock in the order of priority immediately. Otherwise, the delay is calculated as:

*(precision of next reference) / (precision of current master) * constant [s]*

The parameter "constant" depends on the quality of the internal oscillator.

Example: The external pulse-per-second signal (PPS) is the current master. An IRIG timecode source is the next reference clock in the order of priority. If the master is lost, the system will switch to the IRIG input (TCR). The PPS has a configured accuracy of 100 ns, while the TCR is set as 10 μs accurate. Applying the above formula, a holdover time of 19 minutes is calculated (10000 ns / 100 ns * 11.4). The "**MRS Input Priorities**" shows the remaining and total holdover time next to the master clock. The holdover time will always be recalculated if the reference clock is lost again.

The internal NTP server does not have any direct interface with the external reference clocks and derives its time exclusively from the oscillator of the GNSS/MRS unit. The oscillator is only disciplined directly by this unit. The external NTP time servers are configured via the internal NTP server as "servers" using the "noselect" option so that time deviations relative to the external NTP time servers can be calculated. These offsets are then periodically sent to the GNSS/MRS module.

The current status of all active reference clocks can be obtained from the display, which shows the current master (marked with a "*" or in plain text) and its current status (availability). The display also shows the current time deviation relative to the internal clock:

```
  1.GPS *   20ns      2.PPS   30ns
  2.NTP   30.000us
```

M300: LC-Display 40 x 2 Characters

```
1.GPS * 20ns
2.PPS   30ns
3.NTP   30.000us
```

M400 / M900: LC-display, 4 x 16 Characters

```
        MRS Input Priorities        F1
1.GPS          is master    : -10ns
2.PPS in       is available : -20ns
3.IRIG         no signal    : n/a
4.NTP          is available : -30.000us
2.PTP(IEEE1588)is available : -300ns
```

M600: Vacuum fluorescent graphic display (VFD), 256 x 64 dots

The PTP timestamping unit is queried every 10 seconds (regardless of the broadcast interval of the PTP master). The external NTP servers are queried every 64 seconds. These values are used to calculate the time deviations. Of the maximum seven external NTP services, the one with the lowest jitter (NTP: filter error) is selected upon each calculation.

IMPORTANT: Whenever the LANTIME/MRS is powered up or restarted, the difference in the time between the internal clock and the external NTP or PTP server must not exceed 1000 seconds. If it does, the internal clock will need to be set manually or synchronized with the GNSS reference.

12.9 List of Abbreviations

B2B	Business-to-Business
BNC	Bayonet Neill–Concelman connector
CLK	Clock
CPU	Central Processing Unit
DC	Direct Current
D-Sub	D-Subminiature
EMC	Electromagnetic compatibility
ESD	Electrostatic Discharge
ESDS	Electrostatic Discharge Sensitivity/Sensitive
ESI	External Synchronization Input
FDMA	Frequency-Division Multiple Access
GND	Ground
GLONASS	Globalnaya Navigatsionnaya Sputnikovaya Sistema (or Global Navigation Satellite System)
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HP	Horizontal Pitch
IMS	Intelligent Modular Synchronization
I/O	Input/Output
IRIG	Inter-Range Instrumentation Group
LTOS	LANTIME Operating System
MRI	Multi-Reference Input
MRS	Multi-Reference Source
NTP	Network Time Protocol
OSNMA	Open Service Navigation Message Authentication
1PPS/PPS	(One) Pulse per Second
PWR	Power
RSC	Redundant Switch Control
RTC	Real-Time Clock
SMA	Subminiature Version A

SNMP Simple Network Management Protocol

SPI Serial Peripheral Interface

TTL Transistor–Transistor Logic

USB Universal Serial Bus

WEEE Waste from Electrical and Electronic Equipment (EU Directive)

13 Regulatory Information

13.1 CE Marking

This product bears the CE mark as is required to introduce the product into the EU Single Market.

The use of this mark is a declaration that the product is compliant with all requirements of the EU directives effective and applicable as at the time of manufacture of the product.

13.2 UKCA Marking

This product bears the British UKCA mark as is required to introduce the product into the United Kingdom (excluding Northern Ireland, where the CE marking remains valid).

The use of this mark is a declaration that the product is in conformity with all requirements of the UK statutory instruments applicable and effective as at the time of manufacture of the product.

13.3 Disposal

Disposal of Packaging Materials

The packaging materials that we use are fully recyclable:

Material	Use for	Disposal
Polystyrene	Packaging frame/filling material	Recycling Depot
PE-LD (Low-density polyethylene)	Accessories packaging, bubble wrap	Recycling Depot
Cardboard	Shipping packaging, accessories packaging	Paper Recycling

For information on the proper disposal of packaging materials in your specific country, please inquire with your local waste disposal company or authority.

Disposal of the Device

This product falls under the labeling obligations of the Waste Electrical and Electronic Equipment Directive 2012/19/EU ("*WEEE Directive*") and thus bears this WEEE symbol. The presence of this symbol indicates that this electronic product may only be disposed of in accordance with the following provisions.

Important!

Do not dispose of the product or batteries via the household waste. Inquire with your local waste disposal company or authority on how to best dispose of the product or battery if necessary.

This product is considered to be a "**B2B**" product for the purposes of the WEEE Directive and is also classified as "**IT and Telecommunications Equipment**" in accordance with Annex I of the Directive.

It can be returned to Meinberg for disposal. Any transportation expenses for returning this product (at end-of-life) must be covered by the end user, while Meinberg will bear the costs for the waste disposal itself. If you wish for Meinberg to handle disposal for you, please get in touch with us. Otherwise, please use the return and collection systems provided within your country to ensure that your device is disposed of in a compliant fashion to protect the environment and conserve valuable resources.

Disposal of Batteries

Please consult your local waste disposal regulations for information on the correct disposal of batteries as hazardous waste.

13.4 RoHS Conformity

Conformity with EU Directive 2011/65/EU (RoHS)

We hereby declare that this product is compliant with the European Union Directive 2011/65/EU and its delegated directive 2015/863/EU "Restrictions of Hazardous Substances in Electrical and Electronic Equipment" and that no impermissible substances are present in our products pursuant to these Directives.

We warrant that our electrical and electronic products sold in the EU do not contain lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyls (PBBs), polybrominated diphenyl ethers (PBDEs), bis(2-ethylhexyl)phthalat (DEHP), benzyl butyl phthalate (BBP), dibutyl phthalate (DBP), or diisobutyl phthalate (DIBP) above the legal limits.