The Synchronization Experts.

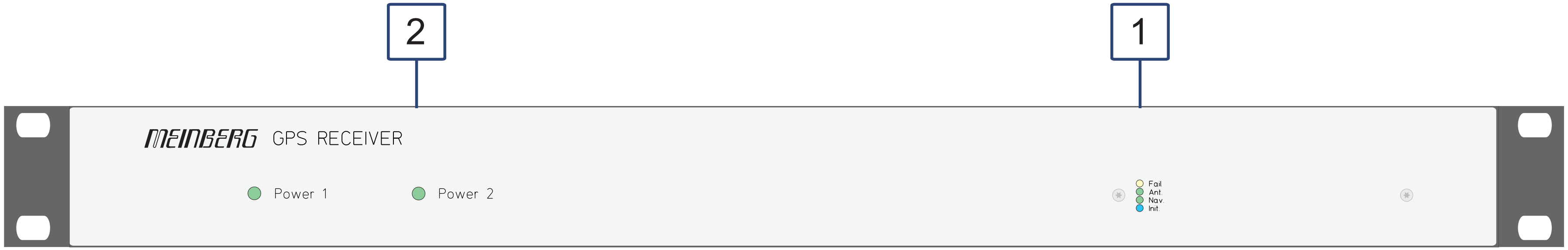
MANUAL

GPS Satellite Receiver

GPS-HQ/FT-1/PS-1/PP-4/AD10

Meinberg Funkuhren GmbH & Co. KG

Front view (Frontansicht) GPS Satellite Receiver



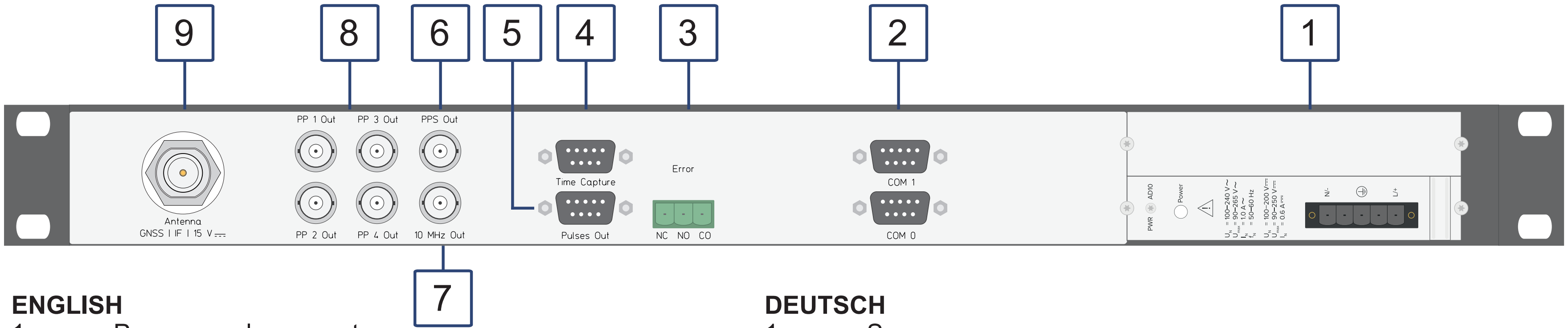
ENGLISH

1. Status LEDs: Fail, Ant, Nav, Init
1. Power LEDs / operating mode (green)

DEUTSCH

1. Status LEDs: Fail, Ant, Nav, Init
2. Power LEDs / Betriebsanzeige (grün)

Rear view (Rückansicht) GPS Satellite Receiver



ENGLISH

1. Power supply connector
2. Serial ports COM 0 / COM 1, 9pin D-SUB female
3. Error Relay
4. Time Capture, 9pin D-SUB female
5. Progr. Pulses Out, 9pin D-SUB female
6. PPS TTL Out, BNC female
7. 10 MHz TTL Out, BNC female
8. Progr. Pulses Out, TTL output, BNC female
9. GPS Antenna, N-type

DEUTSCH

1. Spannungsversorgung
2. Serielle Schnittstellen COM 0 / COM 1, D-Sub-Buchse 9-pol.
3. Error-Relais
4. Time Capture, D-Sub-Buchse 9-pol.
5. Progr. Pulsausgänge, D-Sub-Buchse 9-pol.
6. PPS Ausgang, TTL, BNC Buchse
7. 10 MHz Ausgang, TTL, BNC Buchse
8. Progr. Pulsausgänge, TTL, BNC Buchse
9. GPS Antenne, N-Norm

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1 Imprint & Legal Information

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3 Presentation Conventions in this Manual

3.1 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.

3.2 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.

3.3 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.

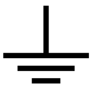
3.4 Generally Applicable Symbols

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

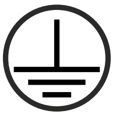
The presence of the “ESD” symbol is indicative of a risk of product damage caused by electrostatic discharge.

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

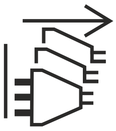
Alternating Current (AC) *(symbol definition IEC 60417-5032)*



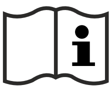
Grounding Terminal *(symbol definition IEC 60417-5017)*



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



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



Read Instruction Manual *(symbol definition ISO 7000-1641)*

4 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, set-up, and operation procedure of the device, as well as its removal from service.

Any safety warnings affixed to the device 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 device 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**.

4.1 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!

4.2 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.

4.3 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.

4.4 Grounding the Device

In order to ensure that the device can be operated safely and to meet the requirements of IEC 62368-1, the device must be correctly connected to the protective earth conductor via the protective earth terminal.

If an external grounding terminal is provided on the chassis, it must be connected to the grounding busbar for safety reasons before connecting the power supply. This ensures that any possible leakage current on the chassis is safely discharged to earth.

The screw, washer, and toothed lock washer necessary for mounting the grounding cable are provided on the grounding terminal of the chassis. A grounding cable is not included with the device.

Please ensure that your grounding cable has a thickness of 1.5 mm^2 or greater, that you use a suitable grounding terminal or lug, and that the cable is properly crimped!

4.5 Electrical Safety

This Meinberg product is operated at a hazardous voltage.

This system may only be set up and connected by skilled personnel, or by instructed personnel who have received appropriate technical & safety training from skilled personnel.

Custom cables may only be assembled by a qualified electrician.

Never work on cables carrying a live current!

Never use cables or connectors that are visibly damaged or known to be defective! Faulty, defective, or improperly connected shielding, connectors, or cables present a risk of injury or death due to electric shock and may also constitute a fire hazard!

Before operating the device, check that all cables are in good order. Ensure in particular that the cables are undamaged (for example, kinks), that they are not wound too tightly around corners, and that no objects are placed on the cables.

Cables must be laid in such a way that they do not present a tripping hazard.

The power supply should be connected using a short, low-inductance cable. Avoid the use of power strips or extension cables if possible. If the use of such a device is unavoidable, ensure that it is expressly rated for the rated currents of all connected devices.

Never connect or disconnect power, data, or signal cables during a thunderstorm! Doing so presents a risk of injury or death, as cables and connectors may conduct very high voltages in the event of a lightning strike!

Device cables must be connected or disconnected in the order specified in the user documentation for the device. Connect all cables only while the device is de-energized before you connect the power supply.

Always pull cable connectors out at **both** ends before performing work on connectors! Improperly connecting or disconnecting this Meinberg system may result in electric shock, possibly resulting in injury or death!

When pulling out a connector, **never** pull on the cable itself! Pulling on the cable may cause the plug to become detached from the connector or cause damage to the connector itself. This presents a risk of direct contact with energized components.

5-Pin MSTB Connector 3-Pin MSTB Connector

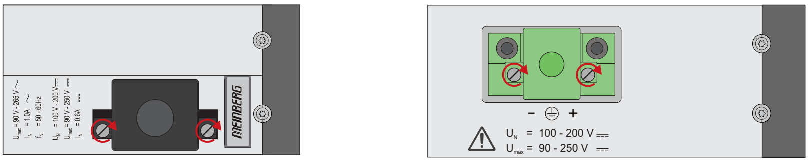


Illustration: Lock screws on an MSTB plug connector; in this case on a LANTIME M320

Ensure that all plug connections are secure. In particular, when using plug connectors with lock screws, ensure that the lock screws are securely tightened. This is especially important for power supply connectors where 3-pin or 5-pin MSTB connectors with lock screws are used (see illustration).

Before the device is connected to the power supply, the device housing must be grounded by connecting a grounding cable to the grounding terminal of the device.

When installing the device in an electrical enclosure, it must be ensured that adequate clearance is provided, minimum creepage distances to adjacent conductors are maintained, and that there is no risk of short circuits.

Protect the device from the ingress of objects or liquids!

If the device malfunctions or requires servicing (for example, due to damage to the housing, power supply cable, or the ingress of liquids or objects), the power supply may be cut off. In this case, the device must be isolated immediately and physically from all power supplies! The following procedure must be followed in order to correctly and reliably isolate the device:

- Pull the power supply plug from the power source.
- Loosen the locking screws of the MSTB power supply plug on the device and pull it out of the device.
- Contact the person responsible for your electrical infrastructure.
- If your device is connected to one or more uninterruptible power supplies (UPS), the direct power supply connection between the device and the UPS solution must be first be disconnected.

4.5.1 Special Information for Devices with AC Power Supply

This device is a Protection Class 1 device and may only be connected to a grounded outlet (TN system).

For safe operation, the installation must be protected by a fuse rated for currents not exceeding 20 A and equipped with a residual-current circuit breaker in accordance with applicable national standards.

The appliance must only ever be disconnected from the mains power supply via the mains socket and not from the appliance itself.

Make sure that the power connector on the appliance or the mains socket is readily accessible for the user so that the mains cable can be pulled out of the socket in an emergency.

Non-compliant cabling or improperly grounded sockets are an electrical hazard!

Only connect the appliance to a grounded shockproof outlet using a safety-tested mains cable designed for use in the country of operation.

4.5.2 Special Information for Devices with DC Power Supply

In accordance with IEC 62368-1, it must be possible to disconnect the appliance from the supply voltage from a point other than the appliance itself (e.g., from the primary circuit breaker).

The power supply plug may only be fitted or dismantled while the appliance is isolated from the power supply (e.g., disconnected via the primary circuit breaker).

Power supply cables must have adequate fuse protection and have an adequate wire gauge size (1 mm^2 – 2.5 mm^2 / 17 AWG – 13 AWG).

The power supply of the device must have a suitable on-demand disconnection mechanism (i.e., a switch). This disconnection mechanism must be readily accessible in the vicinity of the appliance and marked accordingly as a disconnection mechanism for the appliance.

4.6 Safety when Maintaining and Cleaning the Device

Only use a soft, dry cloth to clean the device.

Never use liquids such as detergents or solvents to clean the device! The ingress of liquids into the device housing may cause short circuits in the electronic circuitry, which in turn can cause a fire or electric shock!

Neither the device nor its individual components may be opened. The device or its components may only be repaired by the manufacturer or by authorized personnel. Improperly performed repairs can put the user at significant risk!

In particular, **never** open a power supply unit or module, as hazardous voltages may be present within the power supply device even after it is isolated from the upstream voltage. If a power supply unit or module is no longer functional (for example due to a defect), it can be returned to Meinberg for repair.

Some components of the device may become very hot during operation. Do not touch these surfaces!

If maintenance work is to be performed on the device and the device housing is still hot, switch off the device beforehand and allow it to cool.

4.7 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!

5 Important Product Information

5.1 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.

These directives are listed in the EU Declaration of Conformity, appended to this manual as → Chapter 15.

5.2 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.

These statutory instruments are listed in the UK Declaration of Conformity, appended to this manual as → Chapter 16.

5.3 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.

5.4 Maintenance and Modifications

Important!

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

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

5.4.1 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.

5.5 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.

The following 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.

5.6 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.

6 General Information GPS

The satellite receiver clock GPS has been designed to provide extremly precise time to its user. The clock has been developed for applications where conventional radio controlled clocks can´t meet the growing requirements in precision. High precision available 24 hours a day around the whole world is the main feature of this system which receives its information from the satellites of the Global Positioning System.

The Global Positioning System (GPS) is a satellite-based radio-positioning, navigation, and time-transfer system. It was installed by the United States Departement of Defense and provides two levels of accuracy: The Standard Positioning Service (SPS) and the Precise Positioning Service (PPS). While PPS is encrypted and only available for authorized (military) users, SPS has been made available to the general public.

GPS is based on accurately measuring the propagation time of signals transmitted from satellites to the user´s receiver. A nominal constellation of 24 satellites together with several active spares in six orbital planes 20000 km over ground provides a minimum of four satellites to be in view 24 hours a day at every point of the globe. Four satellites need to be received simultaneously if both receiver position (x, y, z) and receiver clock offset from GPS system time must be computed. All the satellites are monitored by control stations which determine the exact orbit parameters as well as the clock offset of the satellites´ on-board atomic clocks. These parameters are uploaded to the satellites and become part of a navigation message which is retransmitted by the satellites in order to pass that information to the user´s receiver.

The high precision orbit parameters of a satellite are called ephemeris parameters whereas a reduced precision subset of the ephemeris parameters is called a satellite´s almanac. While ephemeris parameters must be evaluated to compute the receiver´s position and clock offset, almanac parameters are used to check which satellites are in view from a given receiver position at a given time. Each satellite transmits its own set of ephemeris parameters and almanac parameters of all existing satellites.

7 GPS Features

The GPS module is a 100 mm x 160 mm microprocessor board, and is connected to the antenna/converter unit by a 50 ohm coaxial cable (refer to "Mounting the Antenna"). DC power to fed to the antenna/downconverter via the antenna cable. An optional antenna splitter is available to operate up to four receivers from a single antenna.

The navigation message coming in from the satellites is decoded by the GPS´s microprocessor in order to track the GPS system time with an accuracy of better than 500 ns (or 250 nsec OCXO). Compensation of the RF signal's propagation delay is done by automatic determination of the receiver's position on the globe. A correction value computed from the satellites´ navigation messages increases the accuracy of the board's TCXO or OCXO to 10^{-9} and automatically compensates for the oscillators aging. The last recent value is restored from the battery buffered memory at power-up.

The GPS provides different optional outputs, i.e. three programmable pulse outputs, modulated/unmodulated Time Code output, and up to a total of four RS-232 COM ports. Additionally, you can order the GPS170 with different OCXO's (e.g. OCXO-LQ / MQ / HQ / DHQ or an external Rubidium) to match the required accuracy.

7.1 Time Zones and Daylight Saving Time

GPS System Time is a linear timescale that was synchronized with the international UTC timescale (Coordinated Universal Time) when the satellite system became operational in 1980. Since it has entered service, however, several leap seconds have been introduced to the UTC timescale to adjust UTC time to irregularities in the Earth's rotation. While GPS System Time deviates from UTC time by several seconds for this very reason, satellite messages do incorporate the number of seconds by which these timescales deviate from one another, allowing GPS receivers to be synchronized internally with the international UTC timescale.

The receiver's microprocessor can identify any time zone based on UTC time and automatically apply Daylight Saving Time adjustments over several years if so configured by the user.

7.2 Time Capture Inputs

Two time capture inputs called User Capture 0 and 1 are provided at the rear connector (CAP0 and CAP1) to measure asynchronous time events. A falling TTL slope at one of these inputs lets the microprocessor save the current real time in its capture buffer. From the buffer, capture events are transmitted via COM0 or COM1 and displayed on LCD. The capture buffer can hold more than 500 events, so either a burst of events with intervals down to less than 1.5 msec can be recorded or a continuous stream of events at a lower rate depending on the transmission speed of COM0 or COM1 can be measured.

The format of the output string is ASCII, see the technical specifications at the end of this document for details. If the capture buffer is full a message "** capture buffer full" is transmitted, if the interval between two captures is too short the warning "** capture overrun" is being sent.

7.3 Asynchronous Serial Ports (optional 4x COM)

Four asynchronous serial RS-232 interfaces (COM0 ... COM3) are available to the user. By default, automatic transmission of a time string via the serial ports is disabled until the receiver has synchronized. However, it is possible to change the device configuration so that serial time strings are always transmitted immediately after power-up.

Transmission speeds, framings and mode of operation can be configured separately using the setup menu. COM0 is compatible with other radio remote clocks made by Meinberg. It sends the time string either once per second, once per minute or on request with ASCII '?' only. Also the interfaces can be configured to transmit capture data either automatically when available or on request. The format of the output strings is ASCII, see the technical specifications at the end of this document for details.

8 Installation

8.1 Installation of the GNSS Antenna

8.1.1 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 13.5, "The Importance of Good Antenna Positioning".

Important!

The specified accuracy levels for your GPS-HQ/FT-1/PS-1/PP-4/AD10 are specified for clear-sky conditions and can only be guaranteed if the above conditions for the installation of the antenna are met fully.

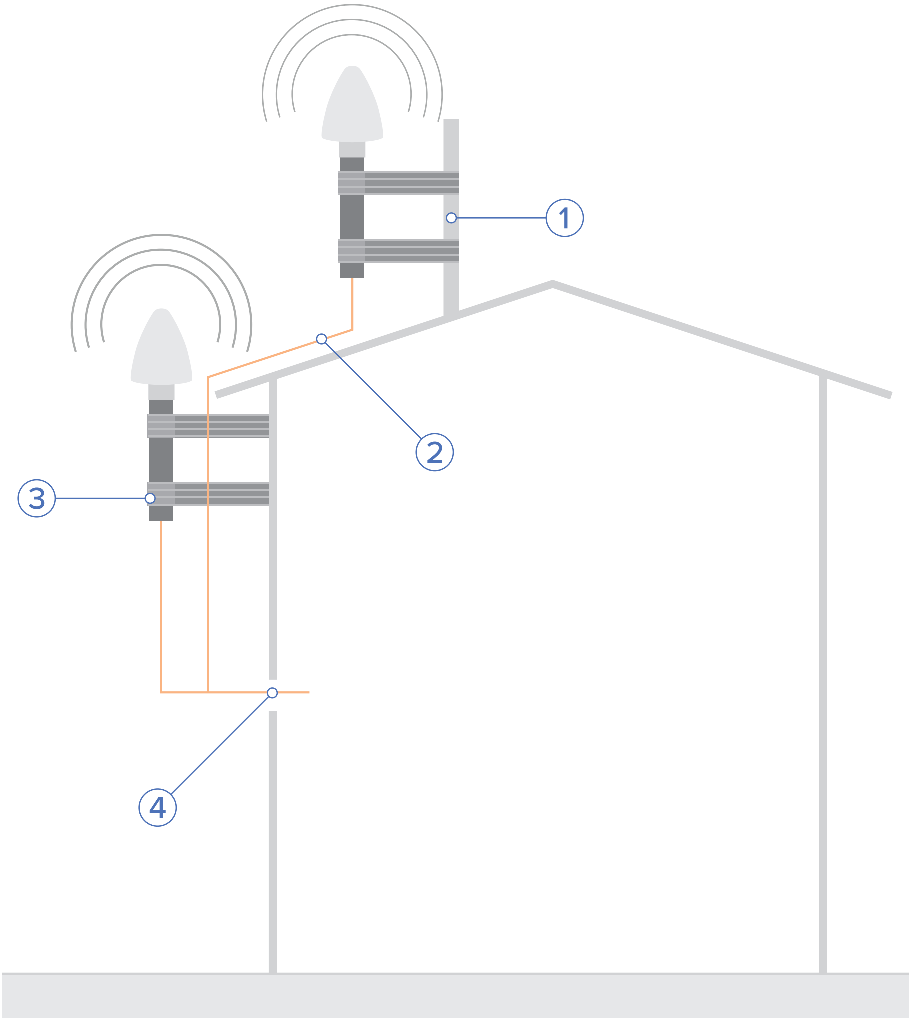


Figure 8.1: Effective Positioning of a GNSS Antenna

1. Mounted on a pole
2. Antenna cable
3. Mounted on a wall
4. Point of entry into building

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. 8.1.

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. 8.1. Mounting accessories are provided with your antenna for this purpose.

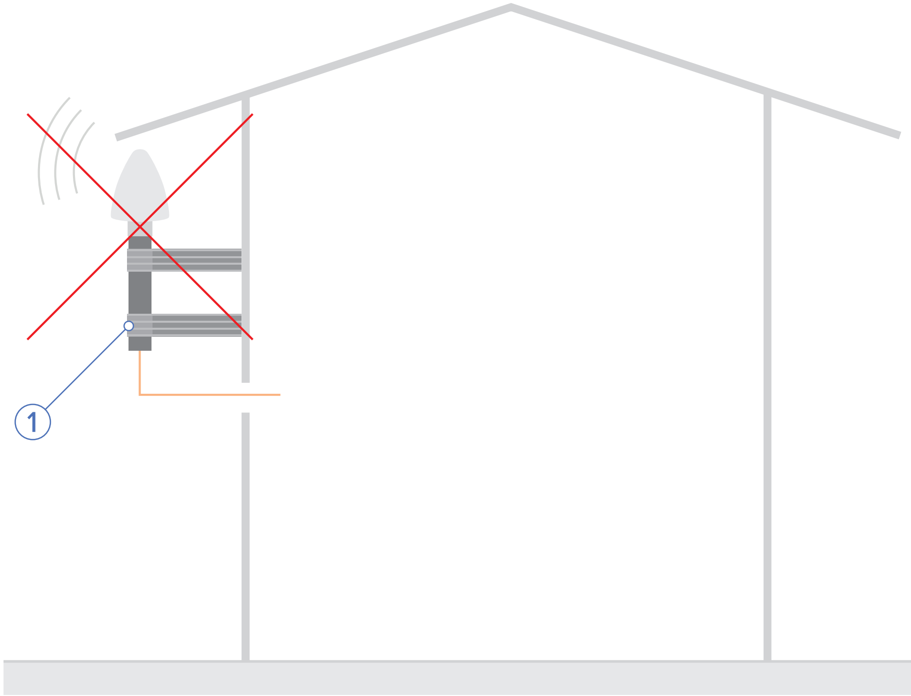


Figure 8.2: Poor Positioning of a GNSS Antenna

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 antenna in Fig. 8.2. 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, but also maximizes the antenna's exposure to signals reflected from the ground and to other spurious transmissions from ground level.

8.1.2 Laying the Antenna Cable

Your LANTIME GPS-HQ/FT-1/PS-1/PP-4/AD10 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 13.3, "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 mast), the antenna cable must be integrated into the grounding infrastructure of the building and also connected to the other metallic objects. Refer to ➜ Chapter 8.1.5, "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 8.1.3, "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.

8.1.3 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

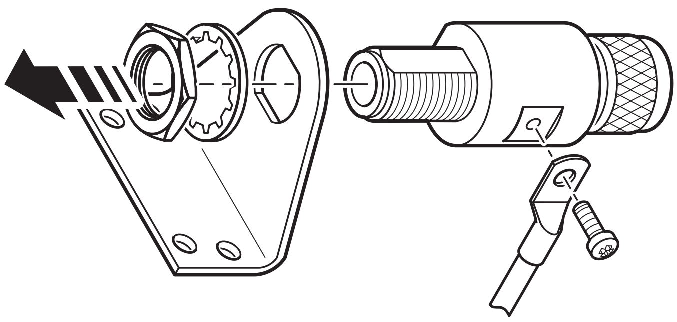


Figure 8.3: Assembly of the MBG S-PRO surge protector

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. 8.3, 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.

Detailed technical specifications and a link to the data sheet are provided in the Appendix under:

→ Chapter 13.4, "Technical Specifications: MBG S-PRO Surge Protector"

8.1.4 Mounting the Antenna

8.1.4.1 Mounting the Antenna onto a Mast

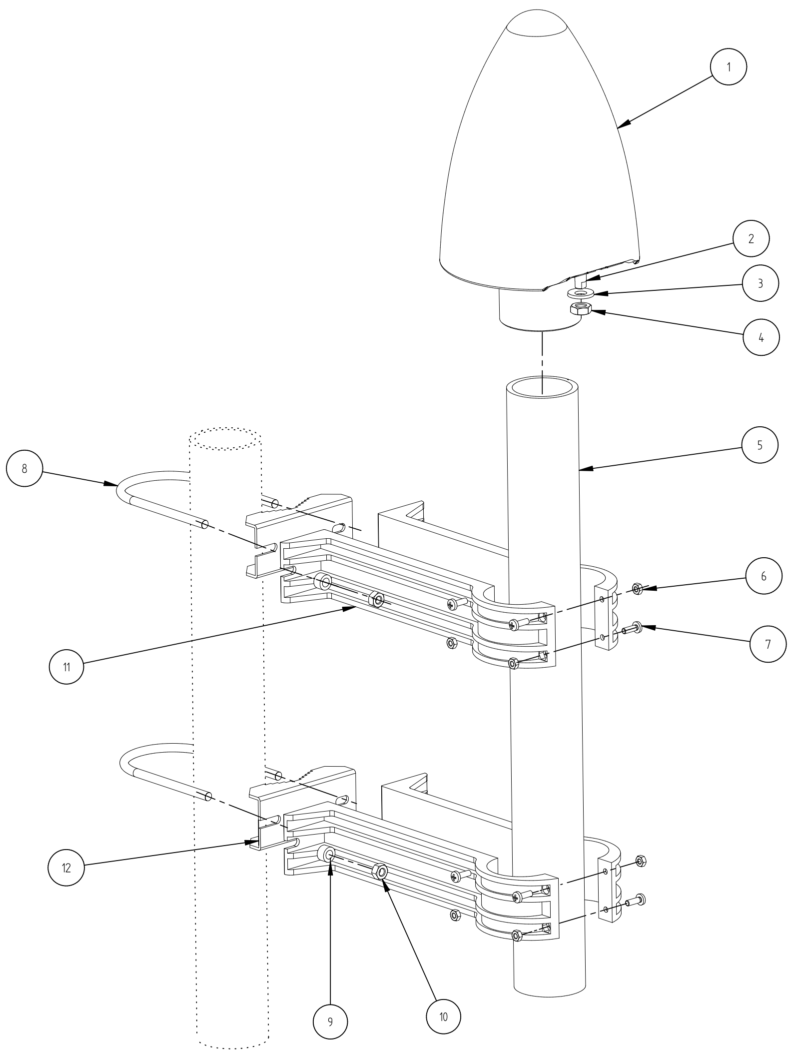


Figure 8.4: Mounting a Meinberg GNSS antenna onto a mast

No.	Description	Quantity	No.	Description	Quantity
1	Antenna	1	7	M4x12 Screw (Phillips Head)	8
2	M8 Grounding Bolt	1	8	Threaded U-Bolt	2
3	Safety Washer	1	9	M6 Spacer	4
4	M8 Hex Nut	1	10	M6 Hex Nut	4
5	Antenna Tube	1	11	Antenna Tube Clamp Half	4
6	M4 Hex Nut	8	12	Mast Bracket	2

The antenna may be mounted onto an existing mast (maximum pole diameter 60 cm / 2.3 inches) using the included accessories, provided that the installation conditions specified in → Chapter 8.1.1, "Planning the Installation of the Antenna" and → Chapter 13.5 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 installation 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 safe distance from exposed power lines or electrical substations.

Installation of the Antenna on a Mast

Fig. 8.4 illustrates the installation of a Meinberg GNSS antenna on a mast.

1. Insert the antenna tube (Item 5 in Fig. 8.4) into the designated rounded recesses of the two pairs of antenna tube clamp halves (Item 11). Secure the tube inside each of the two clamps using four M4x12 Phillips screws (Item 7) and corresponding M4 hex nuts (Item 6). To ensure that the tube (Item 5) is as secure as possible, the top and bottom M4x12 screws (Item 7) of each tube clamp should be inserted from opposing directions as shown in Fig. 8.4.

2. Place the threaded bolts (Item 8) around the designated mast pole and feed the two prongs into the holes of the mast bracket (Item 12) and tube clamp (Item 11). Secure each of the tube clamps to each of the mast brackets (Item 12) using two M6 spacers (Item 9) and two M6 hex nuts (Item 10) and tighten until the mast bracket and U-bolt are secure.

3. Verify that the tube clamps (Item 11) are securely mounted to the mast, that they exhibit no movement without significant force, and that the tube is securely held by the tube clamps.

4. Feed one end of the antenna cable (Type-N connector, male) through the antenna tube (Item 5) from below and screw it by hand onto the female Type-N connector (Item 1) of the antenna. You may then place the antenna on the top of the mounting tube and push it until it is seated. Insert the fixture screw into the base of the antenna using a suitable screwdriver (Phillips head) to secure the antenna (Item 1) onto the antenna tube (Item 5).

8.1.4.2 Mounting the Antenna onto a Wall

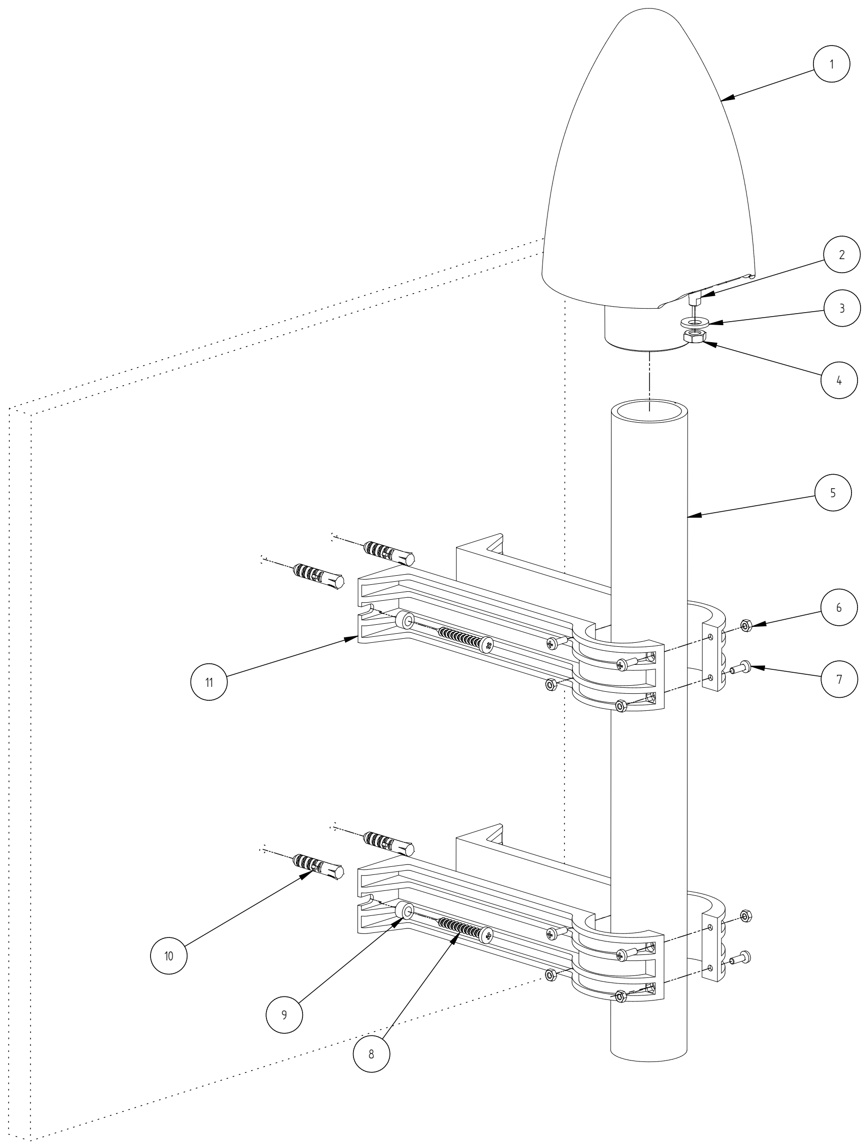


Figure 8.5: Mounting a Meinberg GNSS antenna onto a wall

No.	Description	Quantity	No.	Description	Quantity
1	Antenna	1	7	M4x12 Screw (Phillips Head)	8
2	M8 Grounding Bolt	1	8	M6x45 Screw	4
3	Safety Washer	1	9	M6 Spacer	4
4	M8 Hex Nut	1	10	8 mm Wall Plug	4
5	Antenna Tube	1	11	Antenna Tube Clamp Half	4
6	M4 Hex Nut	8			

The antenna may be mounted directly onto a wall using the included accessories, provided that the installation conditions specified in → Chapter 8.1.1, "Planning the Installation of the Antenna" and → Chapter 13.5, "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 installation 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 safe distance from exposed power lines or electrical substations.

Installation of the Antenna on a Wall

Fig. 8.5 illustrates the installation of a Meinberg GNSS antenna on a wall.

1. Insert the antenna tube (Item 5 in Fig. 8.5) into the designated rounded recesses of the two pairs of antenna tube clamp halves (Item 11). Secure the tube inside each of the two clamps (Item 11) using four M4x12 Phillips screws (Item 7) and corresponding M4 hex nuts (Item 6). To ensure that the tube (Item 5) is as secure as possible, the top and bottom M4x12 screws (Item 7) of each tube clamp should be inserted from opposing directions as shown in Fig. 8.5.

2. Drill four holes for M6x45 screws (Item 8) in the underlying wall to match the two screw slits on each of the clamps (Item 11). Insert four wallplugs (Item 10) into these holes.

3. Use four M6 spacers (Item 9) and four M6x45 screws (Item 8) to mount the tube clamps (Item 11) onto the wall using the slits on each of the clamps.

4. Verify that the tube clamps (Item 11) are securely mounted to the wall, that they exhibit no movement without significant force, and that the tube (Item 5) is securely held by the tube clamps.

5. Feed one end of the antenna cable (Type-N connector, male) through the antenna tube (Item 5) from below and screw it by hand onto the female Type-N connector (Item 1) of the antenna. You may then place the antenna on the top of the mounting tube and push it until it is seated. Insert the fixture screw into the base of the antenna using a suitable screwdriver (Phillips head) to secure the antenna (Item 1) onto the antenna tube (Item 5).

8.1.5 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 8.1.3, "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 mast, 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 hazardous 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 masts
- 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.

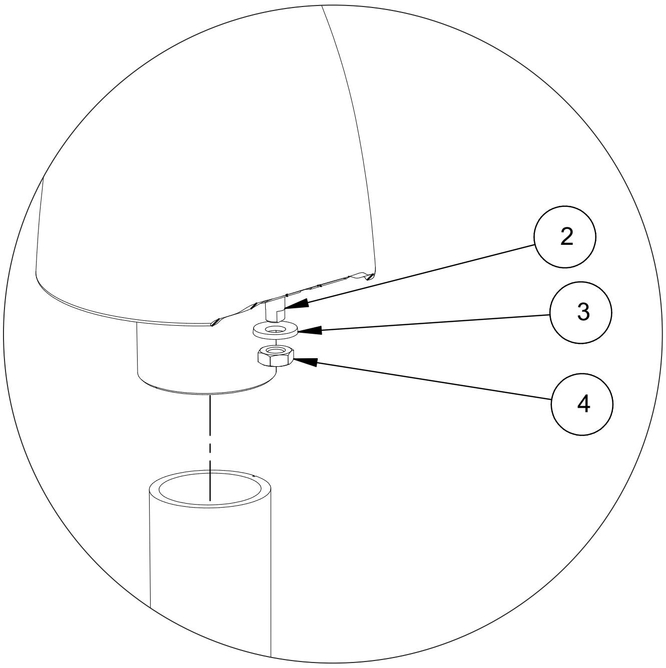


Figure 8.6: Grounding Terminal Assembly

Grounding Cable Installation Procedure

1. Remove the nut (Item 4 in Fig. 8.6) and the safety washer (Item 3).
2. Place the ring terminal onto the grounding bolt (Item 2).
3. First place the safety washer (Item 3) onto the grounding bolt (Item 2), then screw the M8 nut (Item 4) onto the thread of the grounding bolt.
4. Tighten the nut (Item 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. 8.7 and Fig. 8.8).

Antenna Installation without Insulated Lightning Rod System

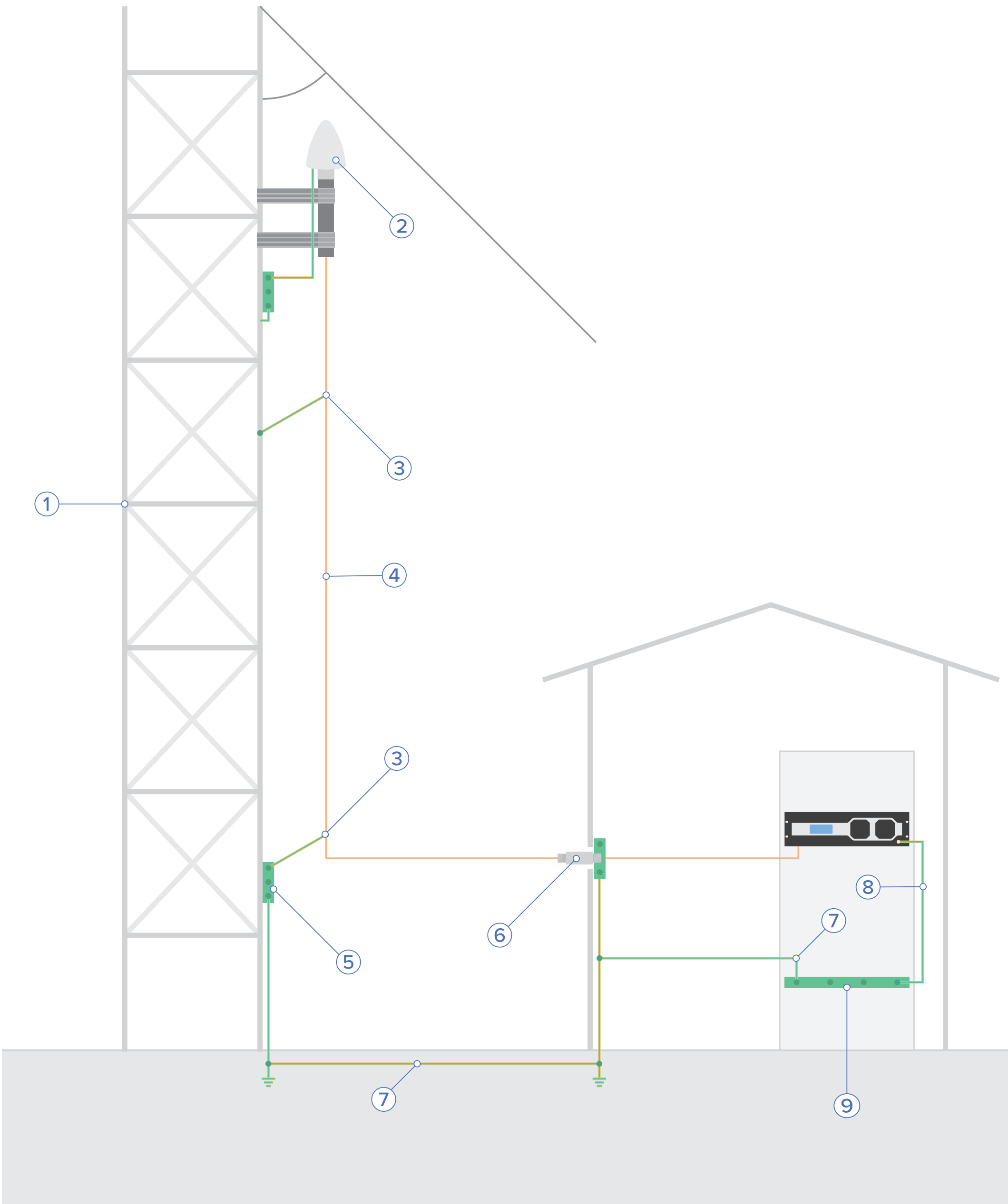


Figure 8.7: Grounding of a Mast-Mounted Antenna

1	Antenna Mast
2	Antenna
3	Shield Clamp
4	Antenna Cable
5	Bonding Bar
6	MBG S-PRO Surge Protector
7	Bonding Cable
8	Device Grounding Terminal
9	Main Ground Rail
α	Safety Zone

Antenna Installation with Insulated Lightning Rod System

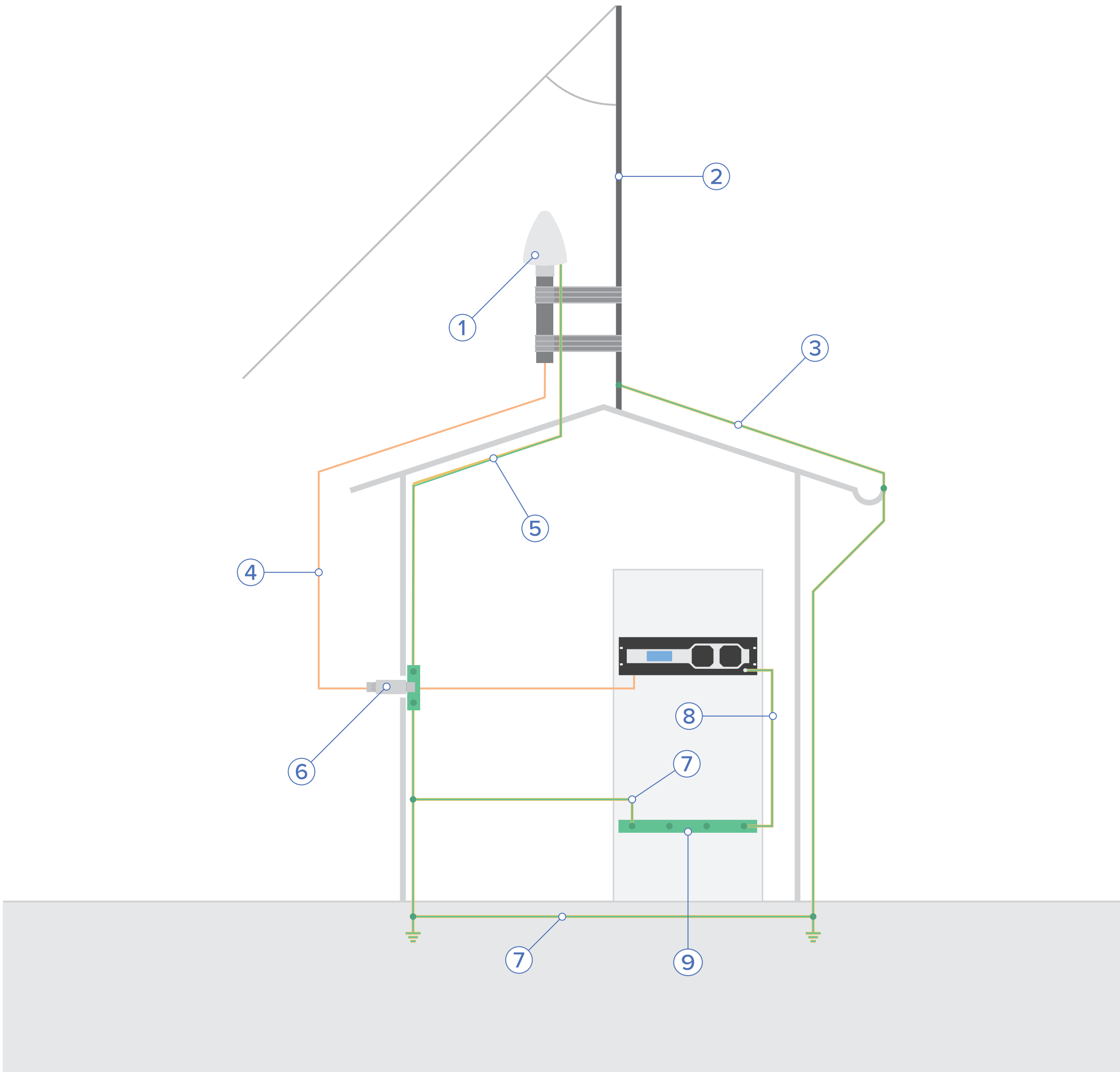


Figure 8.8: Grounding of a Roof or Wall-Mounted Antenna

1	Antenna
2	Lightning Rod
3	Lightning Rod Conductor
4	Antenna Cable
5	Antenna Grounding Terminal
6	MBG S-PRO Surge Protector
7	Bonding Cable
8	Device Grounding Terminal
9	Main Ground Rail
α	Safety Zone

8.2 Powering Up the System

If both the antenna and the power supply have been connected the system is ready to operate. About 3 minutes after power-up the receiver's oscillator has warmed up and operates with the required accuracy. If the receiver finds valid almanac and ephemeris data in its battery buffered memory and the receiver´s position has not changed significantly since its last operation the receiver can find out which satellites are in view now. Only a single satellite needs to be received to synchronize and generate output pulses, so synchronization can be achieved maximally 10 minutes after power-up (OCXO-SQ/-HQ/-DHQ) . After 20 minutes of operation the OCXO is full adjusted and the generated frequencies are within the specified tolerances.

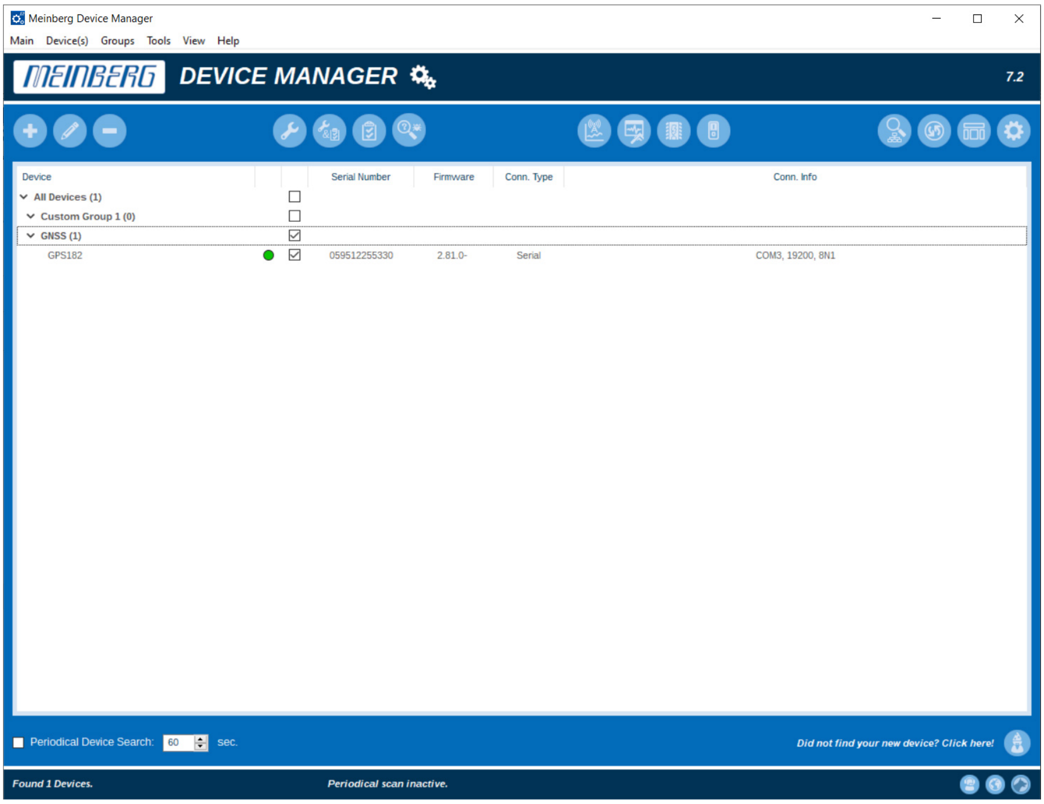
If the receiver position has changed by some hundred kilometers since last operation, the satellites´ real elevation and doppler might not match those values expected by the receiver thus forcing the receiver to start scanning for satellites. This mode is called **Warm Boot** because the receiver can obtain ID numbers of existing satellites from the valid almanac. When the receiver has found four satellites in view it can update its new position and switch to **Normal Operation**. If the almanac has been lost because the battery had been disconnected the receiver has to scan for a satellite and read in the current almanacs. This mode is called **Cold Boot**. It takes 12 minutes until the new almanac is complete and the system switches to **Warm Boot** mode scanning for other satellites.

In the default mode of operation, neither pulse and synthesizer outputs nor the serial ports will be enabled after power-up until synchronization has been achieved. However, it is possible to configure some or all of those outputs to be enabled immediately after power-up. If the system starts up in a new environment (e. g. receiver position has changed or new power supply) it can take some minutes until the OCXO´s output frequency has been adjusted. Up to that time accuracy of frequency drops to 10^{-8} reducing the accuracy of pulses to $+-5\mu$s.

8.3 Meinberg Device Manager - Quick Start Guide

After connecting the system to the power supply unit, it can be configured and monitored using the "Meinberg Device Manager" software.

The Meinberg Device Manager software for Windows and Linux together with a detailed documentation can be downloaded here:
https://www.meinbergglobal.com/english/sw/mbg-devman.htm

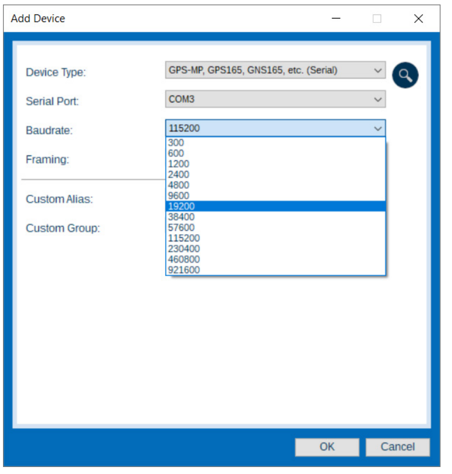


A connection between the module and the Meinberg Device Manager can be established serially. Connect the serial interface of your PC (USB with USB → serial adapter) to the COM 0 port of the GPS.

The possible configurations are described in the Meinberg Device Manager documentation.

Verbindung (Connection)

If your PC has not established an automatic connection to the reference clock, select manual connection with "Add Device". In this dialog you must now enter the port, the baud rate and the framing of the interface.



Device Type: Other

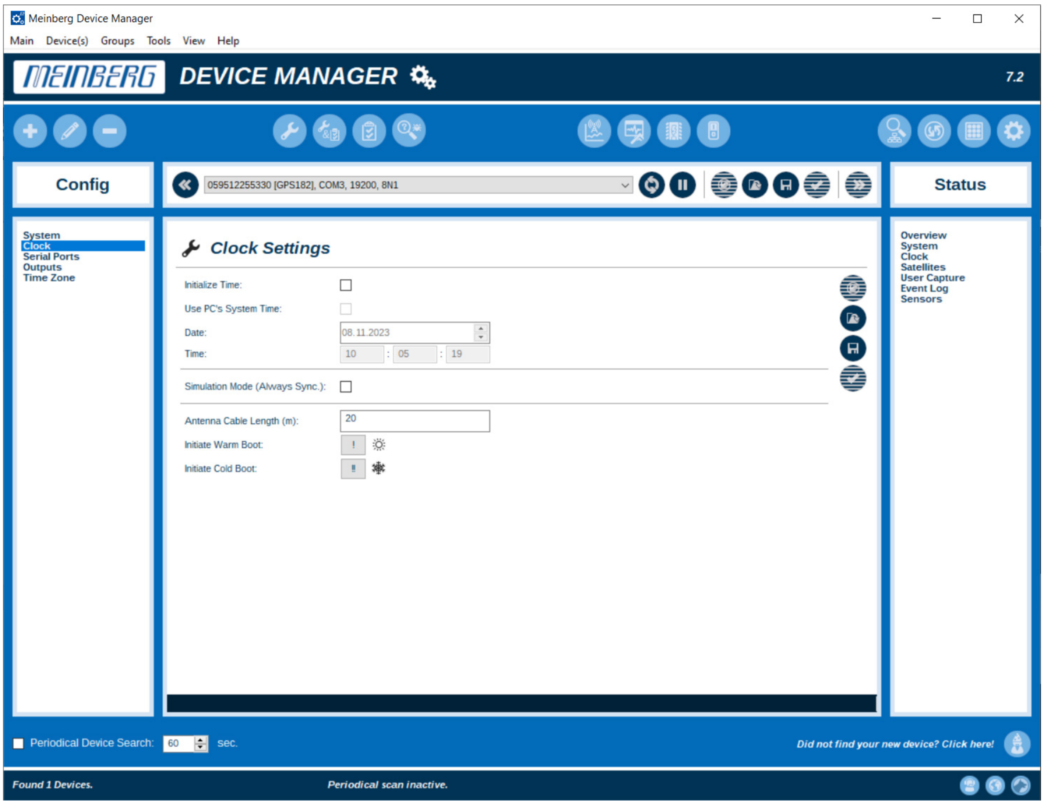
Connection Type: Serial

Serial Port: The COM port of your PC

Baudrate: 19200

Framing: 8N1

Configuration and Status



With the Meinberg Device Manager you can perform different configurations on the system and display status messages. Please note that desired changes in the settings must always be confirmed by clicking the button "Apply Configuration". The button "Restore Configuration" resets all settings to their default values. More information can be found in the Meinberg Device Manager - Manual.

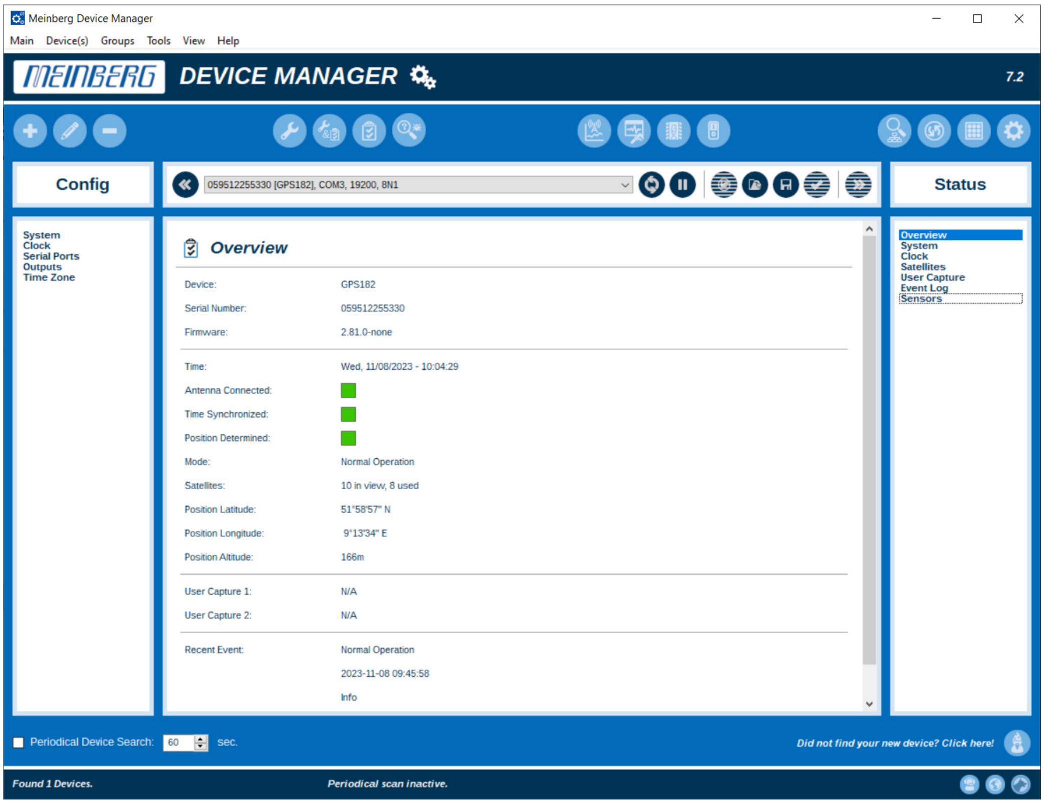


Figure: Status display of the GNSS reference clock.

8.4 Configuration and Monitoring Using GPSMON32

The program GPSMON32 was developed by Meinberg until 2017 and offered for download for programming and monitoring Meinberg products. The software was supported on Windows 7, Windows Vista, Windows 9x, Windows 2000, Windows XP, and Windows NT.

Meinberg ceased development of GPSMON32 in 2010 and ended official support in 2017. GPSMON32 was succeeded from that point by the newer "Meinberg Device Manager" software, which provides many more features and is still in active development.

Meinberg strongly recommends using the newer, more developed, and free "Meinberg Device Manager" tool to configure and monitor your GPS receiver. Even so, GPSMON32 remains available to download on the Meinberg software download page as a goodwill gesture for end users who are working with older operating systems or who may be familiar with or prefer the operating style of GPSMON32.

https://www.meinbergglobal.com/english/sw/#gpsmon

Important!

Meinberg no longer supports the use of GPSMON32 for configuring and monitoring your GPS receiver.

Before submitting a support request, please first install the free Meinberg Device Manager software to find out if that will solve your problem.

Meinberg provides no guarantee that GPSMON32 will work correctly on any specific operating system, PC configuration, or with any specific Meinberg product. This applies in particular to PC operating systems (especially Windows 8, Windows 10, and Windows 11), PC configurations, and Meinberg products that were developed after the end of support for GPSMON32.

9 The Front Panel Layout

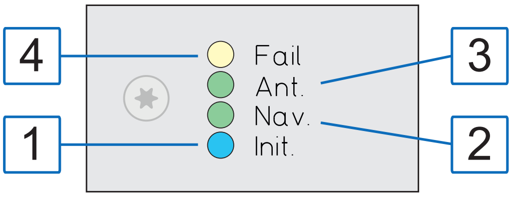
Status LEDs

1. "*Init*" LED: Initialization status of reference clock

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

3. "*Ant*" LED: Antenna status

4. "*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 system.
	Off	The initialization of the internal firmware is complete and a connection has been established with the 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 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.
	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 the external GNSS reference 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 the external GNSS reference since it was last initialized.
Fail	Red	The clock can identify no way to successfully synchronize the GNSS reference source, i.e., there is no usable signal available at any of the configured inputs.

10 Update of the System Software

If it is ever necessary to copy an updated version of the system firmware to the device, this can be done via the serial interface COM 0 without opening the housing of the device. The new firmware version can easily be loaded onto the system using the Meinberg monitoring software "Meinberg Device Manager".

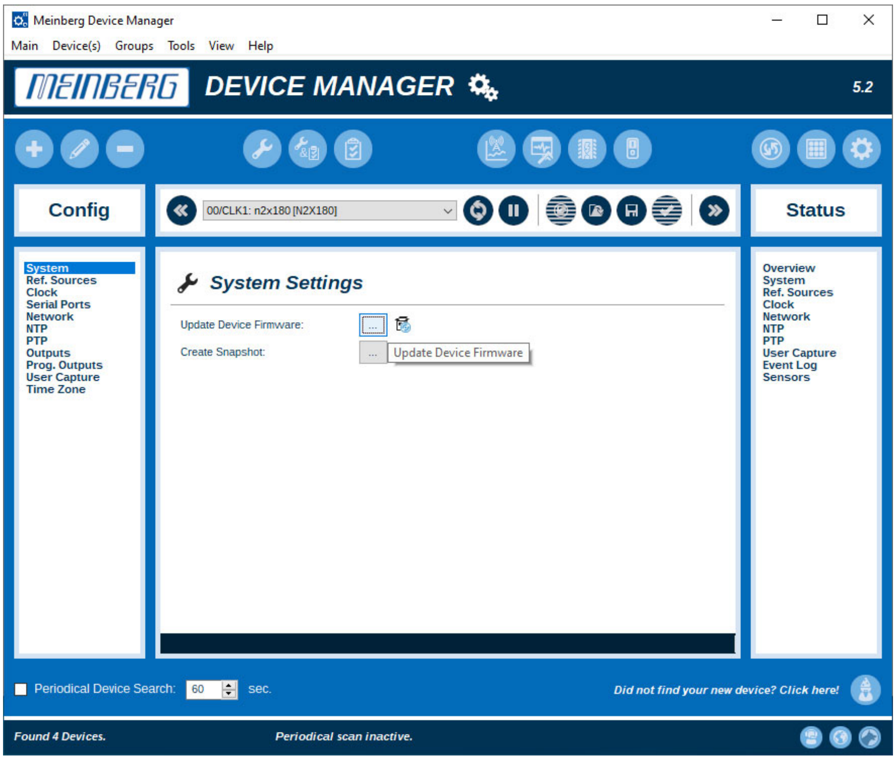
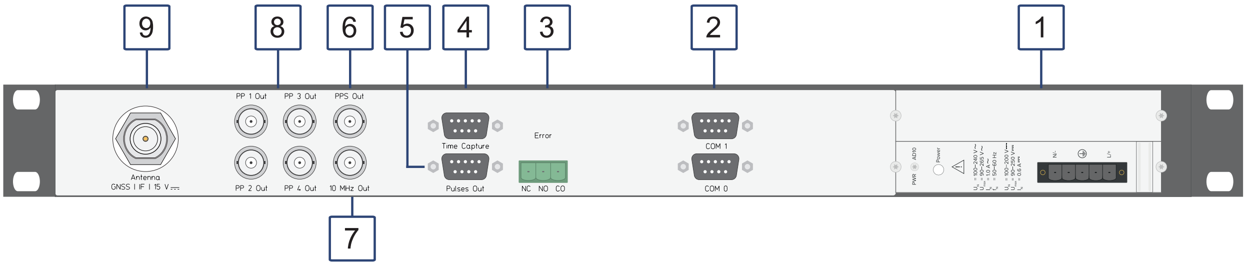


Figure: With the button **Update Device Firmware** *a current firmware version can be loaded on the GPS module.*

Create Snapshot
It is possible to save the current configuration of the GPS module as a text file (zip format). In case of operating problems you can send this file to the MEINBERG support team.

Note:
You may need a "Serial to USB Converter" to connect the system with your PC. This converter is not included in the scope of delivery.

11 GPS-HQ/FT-1/PS-1/PP-4/AD10 Connectors



Information:

The numbering above relates to the corresponding subsection in this chapter.

11.1 AC/DC Power Connector

Information:

Hot-Plugging Support

It is only possible to remove or install a power supply module (e.g., due to a fault) while maintaining operation if the system is operated with redundant power supplies.

Important!

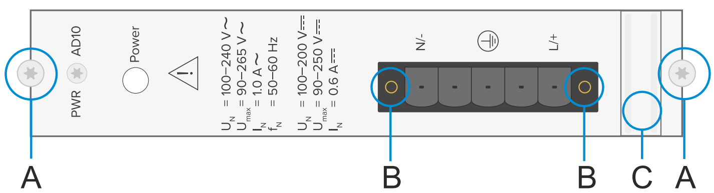
Screw Torque Value (A)

When tightening the Torx screws (A) to fix the newly installed power supply module in place, please do not exceed the specified torque of 0.6 Nm.

Tools Required

- Slotted Screwdriver: 0.4 mm Tip Thickness, 2.5 mm Tip Width
- Torx Screwdriver: TR8x60

Instructions for Hot-Pluggable Power Supplies
Replacing the Power Supply Module

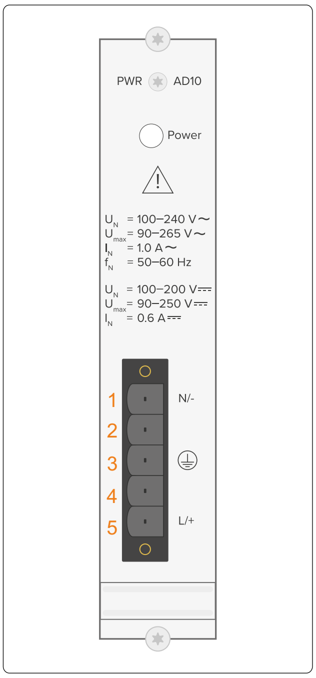


1. Cut off the power supply to the module by switching off the upstream DC power supply.
2. Remove the 5-pin MSTB plug from the power supply module after loosening the two screws (B) using the slotted screwdriver.
3. The detached power supply can now be removed by the handle (C).
4. Insert the new power supply module into the free slot and secure it using the two Torx screws (A).
5. Connect the 5-pin MSTB connector of the power cable to the power supply module and retighten the two slotted-head screws (B).
6. The power cable can now be reconnected to the power supply.
7. The status LED of the new power supply module should now light up green.

Checking the Status
The status of each power supply module can be checked using the associated LED on the front panel of the device or using the LED on the power supply module itself.

Connector Type: 5-Pin MSTB

Pin Assignment:
1: N/-
2: Not Connected
3: PE (Protective Earth)
4: Not Connected
5: L/+



Input Specifications

Nominal Voltage Range:	U_N	=	100 – 240 V ∼ 100 – 200 V ⎓
Rated Voltage:	U_{max}	=	90 – 265 V ∼ 90 – 250 V ⎓
Power Consumption:	I_N	=	1.0 A ∼ 0.6 A ⎓
Nominal Frequency Range:	f_N	=	50 – 60 Hz
Rated Frequency Range:	f_{max}	=	47 – 63 Hz

Output Specifications

Max. Power:	P_{max}	=	50 W
Max. Heat Output:	E_{therm}	=	180.00 kJ/h (170.61 BTU/h)

Danger!

This equipment is operated at a hazardous voltage.

Danger of death from electric shock!

- This device must be connected by qualified personnel (electricians) only.
- Never handle exposed terminals or plugs while the power is on.
- All connectors must provide protection against contact with live parts in the form of a suitable plug body!
- Always ensure that wiring is safe!
- The device must be grounded by means of a connection with a correctly installed protective earth conductor (PE).

11.2 Error Relay

Danger!

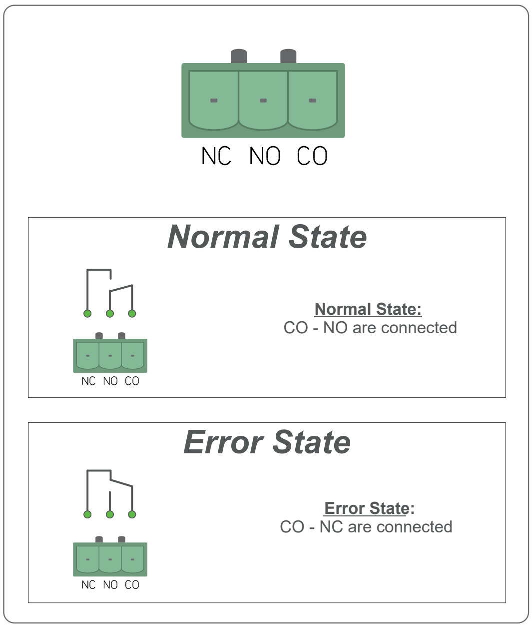
This equipment is operated at a hazardous voltage.

Danger of death from electric shock!

- **Never** handle exposed terminals or plugs while the power is on.
- When handling the connectors of the error relay cable, always disconnect **both ends** of the cable from their respective devices!
- Hazardous voltages may be passing through the terminal of the fault signal relay! **Never** handle the error relay terminal while the signal voltage is present!

The device features a 3-pin relay output labeled with "**Error**". This 0 V ("dry") relay output is connected directly to the reference clock (GPS, GNS, GNS-UC, etc.) Normally, when the reference clock has been synchronized to its source, this relay will switch to "NO" (Normally Open) mode. However, if there is a poor antenna signal or the device has been switched off, the relay will fall back to "NC" (Normally Closed) mode.

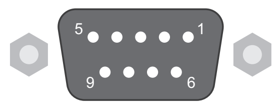
This relay can also be switched to a "NO" (normally open) state using messages, providing a variety of switch states at this output.



Technical Specifications

Connector Type: (on device)	MSTB 3-Pin, Male with lock screws	
Max. Switching Voltage:	125 V ⎓	
	140 V ∼	
Max. Switching Current:	1 A	
Max. Switching Load:	DC	30 W
	AC	60 VA
UL/CSA Switching Load:	0.46 A	140 V ∼
	0.46 A	65 V ⎓
	1 A	30 V ⎓
Response Time:	Approx. 2 ms	

11.3 COMx Time String: RS-232



Connector Type: D-Sub 9-pin, Female
(on device)

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: Meinberg Standard *(Default)*
(Output)
Meinberg Capture
Meinberg GPS

A complete list of supported time string formats is provided in
➜ Chapter 12.1, "Time String Formats".

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

Cable Type: Standard RS-232 Cable (Shielded)

Information:

Please note that the pin assignment of the device receiving the time string output will dictate whether you require a "straight-through" or a null-modem cable to connect your system 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.

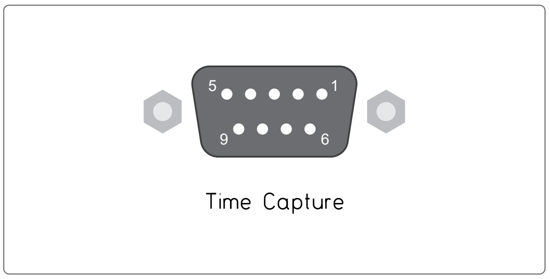
If Pins 2 and 3 have identical assignments on both devices, you will require a null-modem cable. If they are opposite to one another, you will require a "straight-through" cable. Either way, it is important that the transmitter pin (TxD) of each device is connected to the receiver pin (RxD) of the other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

11.4 Time Capture Input

Connector: D-Sub 9-pin, Female
(on device)

Pin Assignment:
Pin 2: CAP_IN0
Pin 3: CAP_IN1
Pin 5: GND *(earth)*

Cable Type: Standard data cable (shielded)

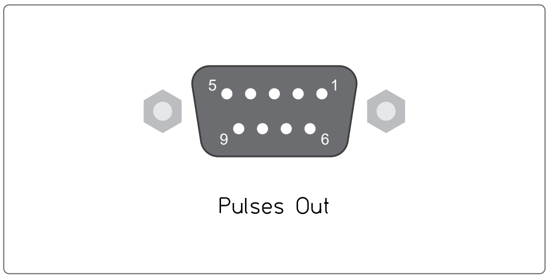


11.5 Pulses Output

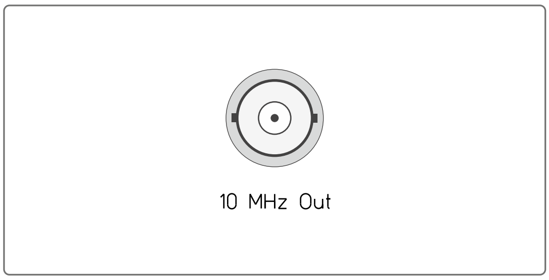
Connector: D-Sub 9-pin, Female

Assignment:
Pin 1: PPS (Pulse Per Second)
Pin 4: PPM (Pulse Per Minute)
Pin 5: GND (ground)

Cable Type: Standard data cable (shielded)



11.6 10 MHz Frequency Output



Connector Type: (on device) BNC, Female

Output Signal: 10 MHz Frequency

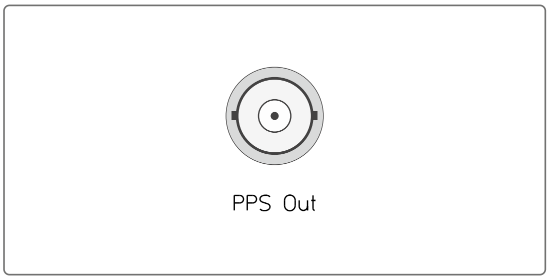
Signal Level: TTL = 5 V (no load),
2.5 V (with 50 Ω load)

Rise Time: Typically 2.6 ns

Fall Time: Typically 2.6 ns

Cable Type: Coaxial Cable, Shielded

11.7 Pulse-per-Second Output



Connector Type: (on device) BNC, Female

Output Signal: PPS (Pulse per Second)

Signal Level: TTL = 5 V (no load),
2.5 V (with 50 Ω load)

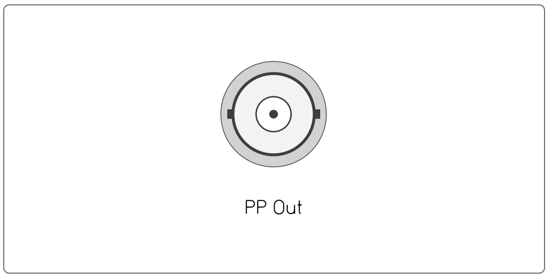
Rise Time: Typically 2.6 ns

Fall Time: Typically 2.6 ns

Pulse Width: 200 ms

Cable Type: Coaxial Cable, Shielded

11.8 Programmable Pulse Output



Output Signal: Programmable Pulses

Signal Level: TTL = 5 V (no load),
2.5 V (with 50 Ω load)

Rise Time: Typically 4 ns

Fall Time: Typically 4 ns

Connector Type: BNC, Female

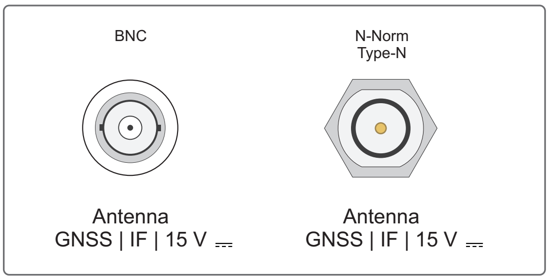
Cable Type: Coaxial Cable, Shielded

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

(For more information on programmable signals, please refer to
→ Chapter 13.7, “Overview of Programmable Signals”)

11.9 Antenna Input: GPS Reference Clock

Antenna Input



Receiver Type: GPS
12-Channel GPS C/A Code Receiver

Mixing Frequency
(Reference Clock to Antenna)
(GPS Converter): 10 MHz [1]

Intermediate Frequency
Antenna (GPS Converter)
to Reference Clock: 35.4 MHz [1]

1) These frequencies are transferred via the antenna cable

Power Supply: 15 V, 100 mA (provided via antenna cable)

Connector Type: BNC, Female/Type-N, Female

Cable Type: Coaxial Cable, Shielded

Cable Length: Max. 300 m (RG58)
Max. 700 m (RG213)

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.

12 Technical Specifications GPS Receiver

Receiver:	12 - channel C/A code receiver with external antenna/converter unit	
Antenna:	Antenna/converter unit with remote power supply refer to chapter "Technical specifications of antenna"	
Power Supply for Antenna:	15 V DC, continuous short circuit potection, automatic recovery Isolation voltage 1000 V DC, provided via antenna cable	
Antenna Input:	Antenna circuit dc-insulated; dielectric strength: 1000 V Length of cable: refer to chapter "Mounting the Antenna	
Time to Synchronization:	one minute with known receiver position and valid almanac 12 minutes if invalid battery buffered memory	
Pulse Outputs:	three programmable outputs, TTL level Default settings: active only ‚if sync'	
	PPO0:	change of second (PPS) pulse duration 200 msec valid on rising edge
	PPO1:	change of minute (PPM) pulse duration 200 msec valid on rising edge
	PPO2:	DCF77 simulation
Synthesizer:	Option:	
	1/8 Hz to 10 MHz	base accuracy according to system accuracy
	1/8 Hz to 10 kHz	phase syncron with pulse per second
	10 kHz to 10 MHz	frequency deviation < 0.0047 Hz
Accuracy of Pulses:	after synchronization and 20 minutes of operation OCXO SQ/MQ/HQ/DHQ: better than ± 50 nsec better than ± 2 μsec during the first 20 minutes of operation	
Time Capture Inputs:	triggered on falling TTL slope Interval of events: 1.5msec min., Resolution: 100ns	
Frequency Outputs:	10 MHz (TTL level)	
Data Format:	Binary, byte serial	
Serial Ports:	2 asynchronous serial ports (RS-232)	
	Baud Rate:	300 up to 19200
	Framing:	7N2, 7E1, 7E2, 8N1, 8N2, 8E1, 8O1
	default setting:	
	COM0:	19200, 8N1 Meinberg Standard time string, per second

	COM1:	9600, 8N1 Capture string, automatically
Option Time Code Outputs:	Unbalanced modulated sine wave signal: 3 V_{pp} (MARK), 1 V_{pp} (SPACE) into 50Ω	
	DCLS-signal: TTL into 50 ohm, active-high or -low, selected by jumper	
	optionally optical output(instead of modulated sine wave):	
	optical power:	typ. 15 μW
	optical connector:	ST-connector for GI 50/125 μm or GI 62.5/125 μm gradient fiber
RF Connector:	female coaxial BNC-connectors for antenna and modulated time code	
Ambient Temperature:	0 ... 50 °C	
Storage Temperature	-20 ... 70 °C	
Humidity:	85% max.	

Accuracy of Pulse and Frequency Outputs:

	TCXO	OCXO-SQ	OCXO-HQ	OCXO-DHQ
Short-Term Stability (where t = 1 second)	2×10^{-9}	5×10^{-10}	5×10^{-12}	2×10^{-12}
Pulse-per-Second Accuracy	< ± 100 ns	< ± 50 ns	< ± 50 ns	< ± 50 ns
Phase Noise	1 Hz: -60 dBc/Hz 10 Hz: -90 dBc/Hz 100 Hz: -120 dBc/Hz 1kHz: -130 dBc/Hz	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)	$\pm 1 \times 10^{-7}$ ± 1 Hz	$\pm 5 \times 10^{-9}$ ± 50 mHz	$\pm 5 \times 10^{-10}$ ± 5 mHz	$\pm 1 \times 10^{-10}$ ± 1 mHz
Frequency Accuracy in Free-Run Mode (1 Year)	$\pm 1 \times 10^{-6}$ ± 10 Hz	$\pm 2 \times 10^{-7}$ ± 2 Hz	$\pm 5 \times 10^{-8}$ ± 0.5 Hz	$\pm 1 \times 10^{-8}$ ± 0.1 Hz
Frequency Accuracy with GPS Synchronization	$\pm 1 \times 10^{-11}$	$\pm 1 \times 10^{-11}$	$\pm 1 \times 10^{-12}$	$\pm 1 \times 10^{-12}$
Time-of-Day Accuracy in Free-Run Mode (1 Day)	± 4.3 ms	± 65 µs	± 10 µs	± 4.5 µs
Time-of-Day Accuracy in Free-Run Mode (7 Days)	± 128 ms	± 9.2 ms	± 1.0 ms	± 204 µs
Time-of-Day Accuracy in Free-Run Mode (30 Days)	± 1.1 s	± 120 ms	± 16 ms	± 3.3 ms
Time-of-Day Accuracy in Free-Run Mode (1 Year)	± 16 s	± 4.7 s	± 788 ms	± 158 ms
Temperature-Dependent Drift in Free-Run Mode	$\pm 1 \times 10^{-6}$ (–20 to 70 °C)	$\pm 1 \times 10^{-7}$ (–10 to 70 °C)	$\pm 1 \times 10^{-8}$ (5 to 70 °C)	$\pm 2 \times 10^{-10}$ (5 to 70 °C)

12.1 Time String Formats

12.1.1 Meinberg Standard Time String

The Meinberg Standard time string is a sequence of 32 ASCII characters, starting with the character <STX> (Start of Text, ASCII code 02h) and terminated with the character <ETX> (End of Text, ASCII code 03h). The format is as follows:

<STX>D:*dd.mm.yy*;*T:w*;*U:hh.mm.ss*;*uvxy*<ETX>

The letters printed in italics are replaced by ASCII-formatted numbers, whereas the other characters are directly part of the time string. The groups of characters as defined below:

<STX>	Start of Text, ASCII code 02h sent with one-bit accuracy at the change of each second		
dd.mm.yy	The date:		
	dd	Day of the month	(01–31)
	mm	Month	(01–12)
	yy	Year of the Century	(00–99)
w	The day of the week		(1–7, 1 = Monday)
hh.mm.ss	The time:		
	hh	Hours	(00–23)
	mm	Minutes	(00–59)
	ss	Seconds	(00–59, or 60 during leap second)
uv	Clock status characters (depending on clock type):		
	u:	"#"	GPS: Clock is in free-run mode (no exact synchronization) PZF: Time frame not synchronized DCF77: Clock has not synchronized since last reset
	" "	(Space, 20h) GPS: Clock is synchronized (base accuracy is reached) PZF: Time pattern synchronized DCF77: Clock has synchronized since last reset	
	v:	"*" GPS: Receiver has not yet verified its position PZF/DCF77: Clock currently in free-run mode	
	" "	(Space, 20h) GPS: Receiver has determined its position PZF/DCF77: Clock is synchronized with transmitter	
x	Time zone indicator:		
	"U"	UTC	Universal Time Coordinated, formerly GMT
	" "	CET	European Standard Time, Daylight Saving Time active
	"S"	(CEST) Central European Summer Time, Daylight Saving Time inactive	
y	Announcement of clock jump during last hour before jump enters effect:		
		"!"	Announcement of start or end of Daylight Saving Time
		'A'	Announcement of leap second insertion
		" "	(Space, 20h) nothing announced
<ETX>	End of Text, ASCII code 03h		

12.1.2 Meinberg GPS Time String

The Meinberg GPS time string is a sequence of 36 ASCII characters, starting with the `<STX>` (Start of Text) character and ending with the `<ETX>` (End of Text) character. Unlike the Meinberg Standard time string, it does not contain UTC time or time adjusted to any local time zone. Instead, it contains GPS time without the UTC adjustments. The format is as follows:

`<STX>D:`*`dd.mm.yy`*`;T:`*`w`*`;U:`*`hh.mm.ss`*`;`*`uvGy`*`;`*`lll`*`<ETX>`

The letters printed in *italics* are replaced by ASCII-formatted numbers, whereas the other characters are directly part of the time string. The groups of characters as defined below:

`<STX>`	Start of Text, ASCII code 02h		
`dd.mm.yy`		The date:	
	dd	Day of the month	(01–31)
	mm	Month	(01–12)
	yy	Year of the Century	(00–99)
`w`	The day of the week		(1–7, 1 = Monday)
`hh.mm.ss`	The time:		
	hh	Hours	(00–23)
	mm	Minutes	(00–59)
	ss	Seconds	(00–59, or 60 while leap second)
`uv`	Clock status characters:		
	u:	"#"	Clock is in free-run mode (no exact synchronization)
		" "	(Space, ASCII code 20h) Clock is synchronized (base accuracy is achieved)
	v:	"*"	Receiver has not yet verified its position
		" "	(Space, ASCII code 20h) Receiver has determined its position
`G`	Time zone identifier "GPS Time"		
`y`	Announcement of clock jump during last hour before discontinuity comes into effect:		
	"A'"	Announcement of leap second insertion	
	" "	(Space, ASCII code 20h) nothing announced	
`lll`	Number of leap seconds between GPS time and UTC (UTC = GPS time + number of leap seconds)		
`<ETX>`	End of Text, ASCII code 03h		

12.1.3 Meinberg Capture Time String

The Meinberg Capture time string is a sequence of 31 ASCII characters, terminated with the sequence <CR> (Carriage Return, ASCII code 0Dh) and <LF> (Line Feed, ASCII code 0Ah). The format is as follows:

CH*x<SP>dd.mm.yy_hh:mm:ss.fffffff*<CR><LF>

The letters printed in italics are replaced by ASCII-formatted numbers, whereas the other characters are directly part of the time string. The groups of characters as defined below:

x	0 or 1, number of input		
<SP>	Space (ASCII code 20h)		
dd.mm.yy	Capture date:		
	dd	Day of the month	(01–31)
	mm	Month	(01–12)
	yy	Year without century	(00–99)
hh:mm:ss.fffffff	Capture Time:		
	hh	Hours	(00–23)
	mm	Minutes	(00–59)
	ss	Seconds	(00–59, or 60 during leap second)
	fffffff	Fractions of second, 7 digits	
<CR>	Carriage Return, ASCII code 0Dh		
<LF>	Line Feed, ASCII code 0Ah		

12.1.4 ATIS Time String

The ATIS standard Time String is a sequence of 23 ASCII characters terminated with a <CR» (Carriage Return) character. The standard interface configuration for this string type is 2400 Baud, 7E1. The format is as follows:

<GID><ABS><TSQ><CC><CS><ST>*yymmddhhmmsswcc*<GID><CR>

The letters printed in italics are replaced by ASCII-formatted numbers whereas the other characters are directly part of the time string. The groups of characters are as defined below:

<GID>	Address of the Receiver, ASCII code 7Fh	
<ABS>	Originator of Message, '0', ASCII code 30h	
<TSQ>	Telegram Number, '0', ASCII code 30h	
<CC>	Command Code 'S' (for 'SET'), ASCII code 53h	
<CS>	Command Code 'A' (for 'ALL'), ASCII code 41h	
<ST>	Time Status 'C' (for valid time), ASCII code 43h	
yymmdd	The current date:	
	yy Year of the Century	(00–99)
	mm Month	(01–12)
	dd Day of month	(01–31)
hhmmss	the current time:	
	hh hours	(00–23)
	mm minutes	(00–59)
	ss seconds	(00–59, or 60 during leap second)
w	Day of the Week	(1–7, 1 = 31h = Monday)
cc	Checksum in hexadecimal, generated from all characters including GID, ABS, TSQ, CC, ST, etc.	
<CR>	Carriage Return, ASCII code 0Dh	

12.1.5 SAT Time String

The SAT time string is a sequence of 29 ASCII characters, starting with the character `<STX>` (Start of Text, ASCII code 02h) and terminated with the character `<ETX>` (End of Text, ASCII code 03h). The format is as follows:

`<STX>`*dd.mm.yy/w/hh:mm:ssxxxxuv*`<ETX>`

The letters printed in italics are replaced by ASCII-formatted numbers, whereas the other characters are directly part of the time string. The groups of characters as defined below:

`<STX>` Start of Text, ASCII code 02h sent with one-bit accuracy at the change of each second

`dd.mm.yy` The date:

dd	Day of the month	(01–31)
mm	Month	(01–12)
yy	Year without century	(00–99)

`w` The day of the week (1–7, 1 = Monday)

`hh:mm:ss` The current time:

hh	Hours	(00–23)
mm	Minutes	(00–59)
ss	Seconds	(00–59, or 60 during leap second)

`xxxx` Time zone identifier:

"UTC"	Universal Time Coordinated, formerly GMT
"CET"	European Standard Time, daylight saving disabled
"CEST"	Central European Summer Time, Daylight Saving Time active

`u` Clock status characters:

"#"	Clock has not synchronized since last reset
" "	(Space, ASCII code 20h) Clock has synchronized since last reset

`v` Announcement for time jump during last hour before event:

"!" Announcement of start or end of Daylight Saving Time

" "(Space, ASCII code 20h) nothing announced

`<CR>` Carriage Return, ASCII code 0Dh

`<LF>` Line Feed, ASCII code 0Ah

`<ETX>` End of Text, ASCII code 03h

12.1.6 Uni Erlangen Time String (NTP)

The Uni Erlangen time string (NTP) is a sequence of 66 ASCII characters, starting with the character `<STX>` (Start of Text, ASCII code 02h) and terminated with the character `<ETX>` (End of Text, ASCII code 03h). The format is as follows:

```
<STX>dd.mm.yy; w; hh:mm:ss; voo:oo; acdfg i;bbb.bbbbn lll.lllle hhhhm<ETX>
```

The letters printed in italics are replaced by ASCII-formatted numbers, whereas the other characters are directly part of the time string. The groups of characters as defined below:

`<STX>`	Start of Text, ASCII code 02h sent with one-bit accuracy at the change of each second		
`dd.mm.yy`	The date:		
	dd	Day of the month	(01–31)
	mm	Month	(01–12)
	yy	Year (without century)	(00–99)
`w`	The day of the week		(1–7, 1 = Monday)
`hh.mm.ss`	The time:		
	hh	Hours	(00–23)
	mm	Minutes	(00–59)
	ss	Seconds	(00–59, or 60 during leap second)
`v`	Positive/negative sign for offset of local time zone relative to UTC		
`oo:oo`	Offset of local time zone relative to UTC in hours and minutes		
`ac`	Clock status:		
	a:	"#"	Clock has not synchronized since reset
		" "	(Space, ASCII code 20h) Clock has synchronized since reset
	c:	"*"	GPS receiver has not verified its position
		" "	(Space, ASCII code 20h) GPS receiver has determined its position
`d`	Time zone identifier:		
	"S"	CEST	Central European Summer Time
	" "	CET	Central European Time
`f`	Announcement of clock jump during last hour before discontinuity comes into effect:		
	"!"	Announcement of start or end of Daylight Saving Time	
	" "	(Space, ASCII code 20h) nothing announced	
`g`	Announcement of clock jump during last hour before discontinuity comes into effect:		
	"A'"	Announcement of leap second	
	" "	(Space, ASCII code 20h) nothing announced	
`i`	Leap second		
	"L"	Leap second is currently to be inserted (only active in 60th second)	
	" "	(Space, ASCII code 20h) No leap second announced	
`bbb.bbbb`	Geographical latitude of the receiver position in degrees Leading zeroes are padded with spaces (ASCII code 20h)		

`n` Geographical hemisphere, possible characters are:
"N" North of Equator
"S" South of Equator

`lll.llll` Geographical longitude of the receiver position in degrees
Leading zeroes are padded with spaces (ASCII code 20h)

`e` Prime meridian hemisphere, possible characters are:
"E" East of Greenwich Meridian
"W" West of Greenwich Meridian

`hhhh` Altitude in meters of receiver position above WGS84 ellispoid
Leading zeroes are padded with spaces (ASCII code 20h)

`<ETX>` End of Text, ASCII code 03h

12.1.7 NMEA 0183 String (RMC)

The NMEA 0183 RMC time string is a sequence of 65 ASCII characters, starting with the string "$GPRMC" and terminated with the sequence <CR> (Carriage Return, ASCII code 0Dh) und <LF> (Line Feed, ASCII code 0Ah). The format is as follows:

$GPRMC,*hhmmss.ff*,A,*bbbb.bb*,*n*,*lllll.ll*,*e*,*0.0*,*0.0*,*ddmmyy*,*0.0*,*a***hh*<CR><LF>

The letters printed in italics are replaced by ASCII-formatted numbers, whereas the other characters are directly part of the time string. The groups of characters as defined below:

$	Start character, ASCII code 24h sent with one-bit accuracy at the change of each second
GP	Device ID, in this case "GP" for GPS
RMC	Message type ID, in this case "RMC"
hhmmss.ss	The current time: hh Hours (00–23) mm Minutes (00–59) ss Seconds (00–59, or 60 during leap second) ff Fractional seconds (1/10 ; 1/100)
A	Status (A = Time data valid, V = Time data not valid)
bbbb.bb	Geographical latitude of the receiver position in degrees Leading zeroes are padded with spaces (ASCII code 20h)
n	Geographical hemisphere, possible characters are: "N" North of Equator "S" South of Equator
lllll.ll	Geographical longitude of the receiver position in degrees Leading zeroes are padded with spaces (ASCII code 20h)
e	Prime meridian hemisphere, possible characters are: "E" East of Greenwich Meridian "W" West of Greenwich Meridian
0.0,0.0	Speed over the ground in knots and track angle in degrees. With a Meinberg GPS clock, these values are always 0.0, with GNS clocks, the values are calculated by the receiver for mobile applications.
ddmmyy	Current Date: dd Day of the month (01–31) mm Month (01–12) yy Year of Century (00–99)
a	Magnetic variation E/W
hh	Checksum (XOR sum of all characters except "$" and "*")
<CR>	Carriage Return, ASCII code 0Dh
<LF>	Line Feed, ASCII code 0Ah

12.1.8 NMEA 0183 Time String (GGA)

The NMEA 0183 GGA string is a sequence of characters starting with the string "`$GPGGA`" and ending with the characters `<CR>` (Carriage Return) and `<LF>` (Line Feed). The format is as follows:

`$GPGGA,`*`hhmmss.ff`*`,`*`bbbb.bbbbb`*`,`*`n`*`,`*`lllll.ll`*`,`*`e`*`,`*`A`*`,`*`vv`*`,`*`hhh.h`*`,`*`aaa.a`*`,M,`
`ggg.g``,M,,`*`0`*`*`*`cs`*`<CR><LF>`

The letters printed in italics are replaced by ASCII-formatted numbers, whereas the other characters are directly part of the time string. The groups of characters as defined below:

`$`	Start character, ASCII code 24h sent with one-bit accuracy at the change of each second
`GP`	Device ID, in this case "GP" for GPS
`GGA`	Message type ID, in this case "GGA"
`hhmmss.ss`	The current time: *hh* Hours (00–23) *mm* Minutes (00–59) *ss* Seconds (00–59, or 60 while leap second) *ff* Fractional seconds (1/10 ; 1/100)
`bbbb.bbbbb`	Geographical latitude of receiver position in degrees Leading zeroes are padded with spaces (ASCII code 20h)
`n`	Geographical hemisphere, possible characters are: "`N`" North of Equator "`S`" South of Equator
`lllll.lllll`	Geographical longitude of the receiver position in degrees Leading zeroes are padded with spaces (ASCII code 20h)
`e`	Prime meridian hemisphere, possible characters are: "`E`" East of Greenwich Meridian "`W`" West of Greenwich Meridian
`A`	Position determined (1 = yes, 0 = no)
`vv`	Number of satellites used (0–12)
`hhh.h`	HDOP (Horizontal Dilution of Precision)
`aaa.h`	Mean Sea Level Altitude (MSL Altitude = WGS84 Altitude - Geoid Separation)
`M`	Meters (unit as fixed value)
`ggg.g`	Geoid Separation (WGS84 Altitude - MSL Altitude)
`M`	Meters (unit as fixed value)
`cs`	Checksum (XOR sum of all characters except "`$`" and "`*`")
`<CR>`	Carriage Return, ASCII code 0Dh
`<LF>`	Line Feed, ASCII code 0Ah

12.1.9 NMEA 0183 Time String (ZDA)

The NMEA 0183 ZDA time string is a sequence of 38 ASCII characters starting with the string "$GPZDA" and ending with the characters <CR> (Carriage Return) and <LF> (Line Feed). The format is:

$GPZDA,*hhmmss.ss*,*dd*,*mm*,*yyyy*,*HH*,*II***cs*<CR><LF>

ZDA - Time and Date: UTC, day, month, year, and local time zone.

The letters printed in italics are replaced by ASCII-formatted numbers, whereas the other characters are directly part of the time string. The groups of characters are as defined below:

$	Start character, ASCII code 24h sent with one-bit accuracy at change of second		
hhmmss.ss	UTC time:		
	hh	Hours	(00–23)
	mm	Minutes	(00–59)
	ss	Seconds	(00–59, or 60 during leap second)
HH,II	The local time zone (offset to UTC):		
	HH	Hours	(00–±13)
	II	Minutes	(00–59)
dd,mm,yy	The date:		
	dd	Day of Month	(01–31)
	mm	Month	(01–12)
	yyyy	Year	(0000–9999)
cs	Checksum (XOR of all characters except "$" and "*")		
<CR>	Carriage Return (ASCII code 0Dh)		
<LF>	Line Feed (ASCII code 0Ah)		

12.1.10 ABB SPA Time String

The ABB SPA string is a sequence of 32 ASCII characters, starting with the string ">900WD:" and terminated with the character <CR> (Carriage Return). The format is as follows:

>900WD:*yy-mm-dd[[lt]SP>hh.mm;ss.fff:cc*<CR>

The letters printed in italics are replaced by ASCII numbers whereas the other characters are directly part of the time string. The groups of characters as defined below:

yy-mm-dd	Current Date:		
	yy	Year without century	(00–99)
	mm	Month	(01–12)
	dd	Day of the month	(01–31)
	<SP>	Space (ASCII code 20h)	
hh.mm;ss.fff	Current Time:		
	hh	Hours	(00–23)
	mm	Minutes	(00–59)
	ss	Seconds	(00–59, or 60 during leap second)
	fff	Milliseconds	(000–999)
cc	Checksum. This is calculated as the XOR sum of the preceding characters. The resultant 8-bit value is reported as a hex value in the form of two ASCII characters (0-9 or A-F)		
<CR>	Carriage Return (ASCII code 0Dh)		

12.1.11 Computime Time String

The Computime time string is a sequence of 24 ASCII characters, starting with the character T and terminated with the character <LF> (Line Feed, ASCII code 0Ah). The format is as follows:

T:*yy:mm:dd:ww:hh:mm:ss*<CR><LF>

The letters printed in italics are replaced by ASCII numbers whereas the other characters are unalterable parts of the time string. The groups of characters as defined below:

T	Start character Sent with one-bit accuracy at the change of each second		
yy:mm:dd	The current date:		
	yy	Year without century	(00–99)
	mm	Month	(01–12)
	dd	Day of the month	(01–31)
	ww	Day of the week	(01–07, 01 = Monday)
hh:mm:ss	The current time:		
	hh	Hours	(00–23)
	mm	Minutes	(00–59)
	ss	Seconds	(00–59, or 60 during leap second)
<CR>	Carriage Return, ASCII code 0Dh		
<LF>	Line Feed, ASCII code 0Ah		

12.1.12 RACAL Time String

The RACAL time string is a sequence of 16 ASCII characters started by a X character and terminated by the <CR> (Carriage Return, ASCII code 0Dh) character. The format is as follows:

XGU*yymmddhhmmss*<CR>

The letters printed in *italics* are replaced by ASCII-formatted numbers, whereas the other characters are directly part of the time string. The groups of characters are as defined below:

X	Start character (ASCII code 58h) Sent with one-bit accuracy at the change of each second		
G	Control character (ASCII code 47h)		
U	Control character (ASCII code 55h)		
yymmdd	Current date:		
	yy	Year of Century	(00–99)
	mm	Month	(01–12)
	dd	Day of Month	(01–31)
hh:mm:ss	Current time:		
	hh	Hours	(00–23)
	mm	Minutes	(00–59)
	ss	Seconds	(00–59, or 60 during leap second)
<CR>	Carriage Return (ASCII code 0Dh)		

12.1.13 SYSPLEX-1 Time String

The SYSPLEX 1 time string is a sequence of 16 ASCII characters, starting with the character `<SOH>` (Start of Header, ASCII code 01h) and terminated with the character `<LF>` (Line Feed, ASCII code 0Ah).

Important!

To ensure that the time string can be correctly output and displayed through your terminal software of choice, a "C" must be sent (once, without quotes).

The format is as follows:

<SOH>*ddd:hh:mm:ssq*<CR><LF>

The letters printed in italics are replaced by ASCII numbers whereas the other characters are unalterable parts of the time string. The groups of characters as defined below:

<SOH>	Start of Header (ASCII code 01h) sent with one-bit accuracy at the change of each second			
ddd	Day of the Year		(001–366)	
hh:mm:ss	The current time:			
	hh	Hours	(00–23)	
	mm	Minutes	(00–59)	
	ss	Seconds	(00–59, or 60 during leap second)	
	q	Clock Status:	Space (ASCII code 20h)	Time Sync (GPS Lock)
			"?" (ASCII code 3Fh)	No Time Sync (GPS Fail)
<CR>	Carriage Return, ASCII code 0Dh			
<LF>	Line Feed, ASCII code 0Ah			

12.1.14 ION Time String

The ION time string is a sequence of 16 ASCII characters, starting with the character `<SOH>` (Start of Header, ASCII code 01h) and terminated with the character `<LF>` (Line Feed, ASCII code 0Ah). The format is as follows:

<SOH>*ddd:hh:mm:ssq*<CR><LF>

The letters printed in italics are replaced by ASCII-formatted numbers, whereas the other characters are directly part of the time string. The groups of characters as defined below:

<SOH>	Start of Header (ASCII code 01h) sent with one-bit accuracy at the change of each second			
ddd	Day of Year		(001–366)	
hh:mm:ss	Current time:			
	hh	Hours	(00–23)	
	mm	Minutes	(00–59)	
	ss	Seconds	(00–59, or 60 while leap second)	
	q	Quality Indicator	Space (ASCII code 20h)	Time Sync (GPS Lock)
			"?" (ASCII code 3Fh)	No Time Sync (GPS Fail)
<CR>	Carriage Return (ASCII code 0Dh)			
<LF>	Line Feed (ASCII code 0Ah)			

12.1.15 ION Blanked Time String

The ION time string is a sequence of 16 ASCII characters, starting with the character <SOH> (Start of Header, ASCII code 01h) and terminated with the character <LF> (Line Feed, ASCII code 0Ah). The format is as follows:

<SOH>*ttt:hh:mm:ssq*<CR><LF>

Important!

The blanking interval lasts for 2 minutes and 30 seconds and is inserted every five minutes.

The letters printed in italics are replaced by ASCII numbers whereas the other characters are unalterable parts of the time string. The groups of characters as defined below:

<SOH>	Start of Header (ASCII code 01h) sent with one-bit accuracy at the change of each second			
ddd	Day of the year		(001–366)	
hh:mm:ss	The current time:			
	hh	Hours	(00–23)	
	mm	Minutes	(00–59)	
	ss	Seconds	(00–59, or 60 during leap second)	
	q	Clock Status:	Space (ASCII code 20h)	Time Sync (GPS Lock)
			"?" (ASCII code 3Fh)	No Time Sync (GPS Fail)
<CR>	Carriage Return, ASCII code 0Dh			
<LF>	Line Feed, ASCII code 0Ah			

12.1.16 IRIG-J Timecode

The IRIG-J timecode consists of a string of ASCII characters sent in "701" format, i.e.,:

- 1 start bit
- 7 data bits
- 1 parity bit (odd)
- 1 stop bit

The start of the second is marked by the leading edge of the start bit of the string. The string is 15 characters long and is sent once a second at a baud rate of 300 or greater. The format is as follows:

`<SOH>`*`DDD:HH:MM:SS`*`<CR><LF>`

The letters printed in italics are replaced by ASCII numbers whereas the other characters are unalterable elements of the string. The groups of characters as defined below:

`<SOH>`	Start of Header (ASCII code 01h)
`DDD`	Day of the year (ordinal date, 1–366)
`HH`, `MM`, `SS`	Time of the start bit in hours (`HH`), minutes (`MM`), seconds (`SS`)
`<CR>`	Carriage Return, ASCII code 0Dh
`<LF>`	Line Feed, ASCII code 0Ah

12.1.17 6021 Time String

The 6021 time string is a sequence of 18 ASCII characters starting with the `<STX>` (Start of Text, ASCII code 02h) ASCII control character and terminated with the sequence `<LF>` (Line Feed, ASCII code 0Ah), `<CR>` (Carriage Return, ASCII code 0Dh), `<ETX>` (End of Text, ASCII code 03h).

It is broadly identical to the → **"Freelance Time String"**, but with a different order to the termination sequence.

The format is as follows:

<STX>*C9hhmmssddmmyy*<LF><CR><ETX>

The letters printed in italics are replaced by ASCII numbers whereas the other characters are part of the time string. The groups of characters as defined below:

`<STX>` Start of Text, ASCII code 02h

`C` Clock status. This is represented as an ASCII nibble*, whereby each bit in the binary sequence has the following meaning:

Bit 0 (LSB)	Leap second announced (1) / not announced (0)
Bit 1	Leap second active (1) / not active (0)
Bit 2	Real-time clock time valid (1) / invalid (0)
Bit 3 (MSB)	Clock is synchronized (1) / not synchronized (0)

Example: If the clock outputs `C` (ASCII code 0x43h) at this position, this corresponds to a binary value of *1100*, indicating that the RTC time is valid and the clock is synchronized, and that no leap second has been announced, nor is one in effect.

`9` UTC status of clock and day of the week. This is represented as an ASCII nibble*, whereby the three least significant bits represent the day of the week and may be any value between 1 and 7 (corresponding to Monday to Sunday). The most significant bit represents the UTC state and will be 1 if set to UTC and 0 if it is a local time zone. Thus, if the clock is outputting local (non-UTC) time, this will be in a range of 1–7, whereas if the clock is outputting UTC time, this value will be in a range of 9–F.

Example: If the clock outputs `9` (ASCII code 0x39h) at this position, this corresponds to a binary value of *1001*. The most significant bit of *1* here indicates that the clock is running on UTC time, while the 3-bit value represented by the least significant bits *001* indicates that the day is Monday.

`hhmmss` Current time:

`hh`	Hours	(00–23)
`mm`	Minutes	(00–59)
`ss`	Seconds	(00–59, or 60 during leap second)

`ddmmyy` Current date:

`dd`	Day	(01–31)
`mm`	Month	(01–12)
`yy`	Last two digits of year	(00–99)

`<LF>` Line Feed (ASCII code 0Ah)

`<CR>` Carriage Return (ASCII code 0Dh)

`<ETX>` End of Text (ASCII code 03h)

* With ASCII nibbles, the actual ASCII character itself (`0-9`, `A-F`, ASCII codes *0x30h–0x39h* and *0x41h–0x46h*) represents the hexadecimal equivalent of a 4-bit binary sequence. For example, if the clock outputs "`A`" at these positions, this is equivalent to a binary sequence of *0x1010b*. Please note that it is not the binary equivalent of the ASCII code (*0x41h*) itself.

12.1.18 Freelance Time String

The Freelance time string is a sequence of 18 ASCII characters starting with the <STX> (Start of Text, ASCII code 02h) ASCII control character and terminated with the sequence <CR> (Carriage Return, ASCII code 0Dh), <LF> (Line Feed, ASCII code 0Ah), <ETX> (End of Text, ASCII code 03h).

It is broadly identical to the → "6021 Time String", but with a different order to the termination sequence.

The format is as follows:

<STX>*C9hhmmssddmmyy*<CR><LF><ETX>

The letters printed in italics are replaced by ASCII numbers whereas the other characters are part of the time string. The groups of characters as defined below:

<STX> Start of Text, ASCII code 02h

C Clock status. This is represented as an ASCII nibble*, whereby each bit in the binary sequence has the following meaning:

Bit 0 (LSB)	Leap second announced (1) / not announced (0)
Bit 1	Leap second active (1) / not active (0)
Bit 2	Real-time clock time valid (1) / invalid (0)
Bit 3 (MSB)	Clock is synchronized (1) / not synchronized (0)

Example: If the clock outputs C (ASCII code 0x43h) at this position, this corresponds to a binary value of *1100*, indicating that the RTC time is valid and the clock is synchronized, and that no leap second has been announced, nor is one in effect.

9 UTC status of clock and day of the week. This is represented as an ASCII nibble*, whereby the three least significant bits represent the day of the week and may be any value between 1 and 7 (corresponding to Monday to Sunday). The most significant bit represents the UTC state and will be 1 if set to UTC and 0 if it is a local time zone. Thus, if the clock is outputting local (non-UTC) time, this will be in a range of 1–7, whereas if the clock is outputting UTC time, this value will be in a range of 9–F.

Example: If the clock outputs 9 (ASCII code 0x39h) at this position, this corresponds to a binary value of *1001*. The most significant bit of *1* here indicates that the clock is running on UTC time, while the 3-bit value represented by the least significant bits *001* indicates that the day is Monday.

hhmmss Current time:

hh	Hours	(00–23)
mm	Minutes	(00–59)
ss	Seconds	(00–59, or 60 during leap second)

ddmmyy Current date:

dd	Day	(01–31)
mm	Month	(01–12)
yy	Last two digits of year	(00–99)

<CR> Carriage Return (ASCII code 0Dh)

<LF> Line Feed (ASCII code 0Ah)

<ETX> End of Text (ASCII code 03h)

* With ASCII nibbles, the actual ASCII character itself (`0-9`, `A-F`, ASCII codes *0x30h–0x39h* and *0x41h–0x46h*) represents the hexadecimal equivalent of a 4-bit binary sequence. For example, if the clock outputs "`A`" at these positions, this is equivalent to a binary sequence of *0x1010b*. Please note that it is not the binary equivalent of the ASCII code (*0x41h*) itself.

12.1.19 ITU-G8271-Y.1366 Time-of-Day Message

The ITU-G8271-Y.1366 standard stipulates the transmission of this time message at 9600 Baud with framing of 8N1. The message data should be sent no sooner than 1 ms after the rising edge of the PPS signal and transmission must be completed within 500 ms. The message should be sent once a second and mark the rising edge of the PPS.

The ITU-G8271-Y.1366 time message itself output by Meinberg clocks is always a sequence of 21 bytes. While the standard briefly references the use of two ASCII characters for the first two characters, it should be noted that this message is not an ASCII string in the typical sense. Multi-octet values are transmitted as big-endian values, while each byte is transmitted with the least-significant bit **first**. Accordingly, while the first two characters are deemed to represent the ASCII characters "`C`" (ASCII code 0x43h, binary `00101011`) and "`M`" (ASCII code 0x4Dh, binary `01001101`) respectively, these are transmitted as `11010100` and `10110010`.

The standard byte sequence (least significant bit first in each byte) is as defined below:

Byte No.	Meaning
0–1	Always 0x43h followed by 0x4Dh. These are Sync Characters 1 & 2 respectively and are used as a delimiter between messages.
2	The message class. This will always carry a value of 0x01h.
3	The message ID. In the time-of-day messages provided by Meinberg clocks this will always be 0x01h.
4–5	The payload length, expressed as an unsigned 16-bit integer, not including the sync characters, message class, message ID, or checksum. In the time-of-day messages provided by Meinberg clocks this will always be 0x0Eh.
6–11	PTP time, or the number of seconds in the TAI timescale. This is expressed as an unsigned 48-bit integer.
12	This byte is reserved for future use and is set to 0x00h.
13	Contains a number of time status flags: **Bit 0:** Positive leap second pending **Bit 1:** Negative leap second pending **Bit 2:** UTC offset valid **Bit 3:** Reserved **Bit 4:** Time is traceable to a primary frequency standard **Bit 5:** Frequency is traceable to a primary frequency standard **Bit 6:** Reserved **Bit 7:** Reserved
14–15	Current offset between TAI and UTC in seconds, expressed as an unsigned 32-bit integer.
16–19	This byte is reserved for future use and is set to 0x00h.
20	An 8-bit cyclic redundancy check value calculated on the basis of bytes 2–19.

12.1.20 CISCO ASCII Time String

The CISCO ASCII time string is a sequence of at least 73 ASCII characters. The format is as follows:

**.A.mjdxx*,*yy/mm/dd*,*hh*:*mm*:*ss*,*+3600.0*,*12N34.567*,*123W45.678*,+1234,
EV<SP>GPS<SP>FLT

The letters printed in italics are replaced by ASCII-formatted numbers, whereas the other characters are directly part of the time string. The groups of characters as defined below:

*	Sync state of clock: *: Clock is synchronized to reference !: Clock is not synchronized
A	The format revision. With Meinberg clocks, this will always be 'A'.
mjdxx	The current date in Modified Julian Date format.
yy/mm/dd	The current date in Gregorian *yy/mm/dd* format.
hh:mm:ss	The current time in 24-hour format.
+3600	The current local time offset in seconds. If the clock is outputting UTC time, this will be 00000.0. If the clock is outputting local time, however, the first character will be the sign (– or +) and the subsequent digits up to the period character are the offset. For example, if CET is set as the time zone, this will show +3600.
0	Indicator of a pending leap second.
12N34.567	The current latitude of the GNSS receiver. If the time reference is not a GNSS receiver, this will show 00 00.000.
123W45.678	The current longitude of the GNSS receiver. If the time reference is not a GNSS receiver, this will show 000 00.000
+1234	The current altitude above sea level of the GNSS receiver. If the time reference is not a GNSS receiver, this will show +0000.
EV	Indicates the level of any current alarm state of the clock: EV: Non-error event MN: Minor error MJ: Major error CL: Critical error
GPS	Indicates the source of the current error (e.g., 'GPS' for GPS receiver).
FLT	Indicates the cause of the current error (e.g., 'FLT' for hardware fault).

12.1.21 NTP Type 4 Time String

The NTP Type 4 time string is a sequence of 24 ASCII characters. The format is as follows:

?<SP>*yy*<SP>*ddd*<SP>*hh:mm:ss.SSSL*<SP>S

The letters printed in italics are replaced by ASCII-formatted numbers, whereas the other characters are directly part of the time string. The groups of characters as defined below:

?	Sync state of clock:		
	Space:	Clock is synchronized to reference	
	'?':	Clock is not synchronized	
yy	Year of the century		(00–99)
ddd	Day of the year		(001–366)
hh:mm:ss.SSS	Current time:		
	hh	Hours	(00–23)
	mm	Minutes	(00–59)
	ss	Seconds	(00–59, or 60 while leap second)
	SSS	Milliseconds	(000–999)
L	Leap second announcement:		
	Space:	No leap second announcement	
	'L':	Leap second pending	
S	Daylight Savings Time indicator:		
	'S':	Standard Time (wintertime)	
	'D':	Daylight Savings Time (summertime)	

13 Technical Appendix

13.1 Technical Specifications GPS-HQ/FT-1/PS-1/PP-4/AD10 Chassis

Housing 19" multipac housing, 1U

Housing material sheet steel

Temperature range

Operation 0 ... 50 °C (32 ... 122 °F)

Storage -20 ... 70 °C (-4 ... 158 °F)

Relative humidity

Operation max. 85 % (non-condensing) at 30°C

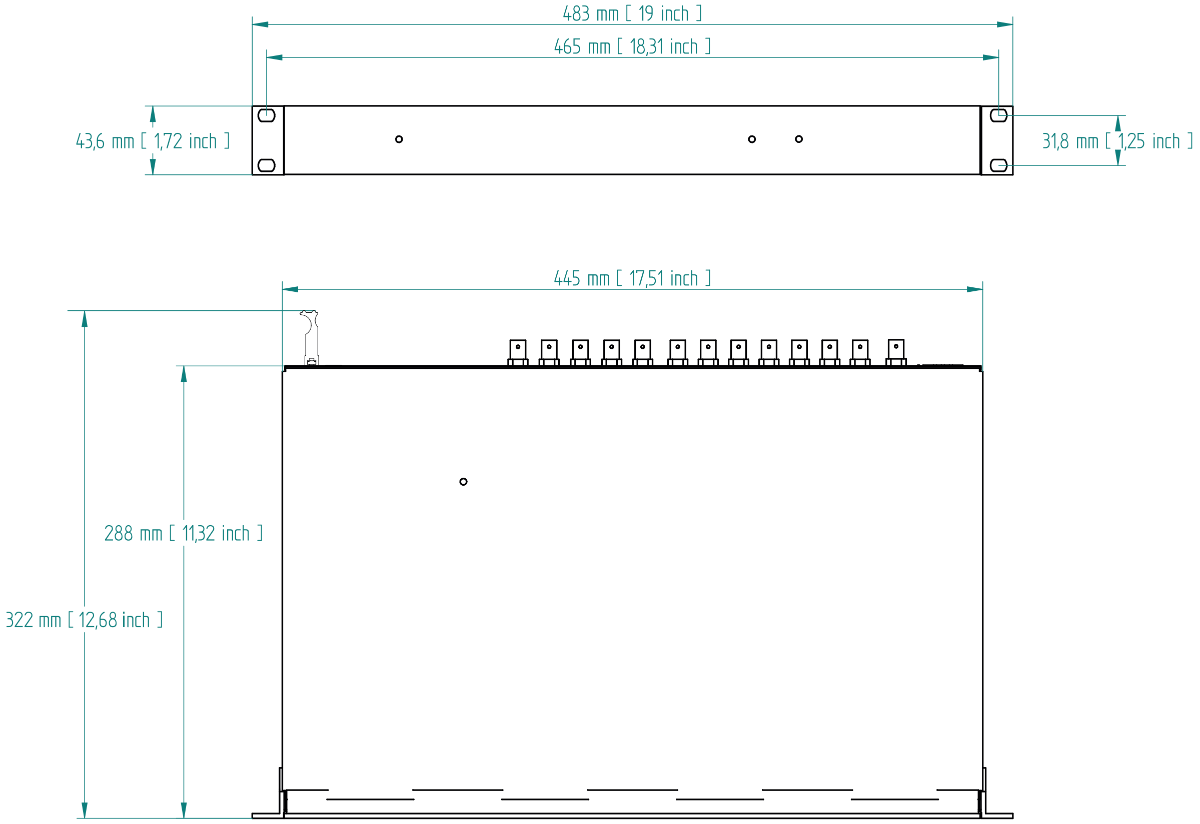
Maximum altitude

Operation max. 4000 m / 13123 ft (above sea level)

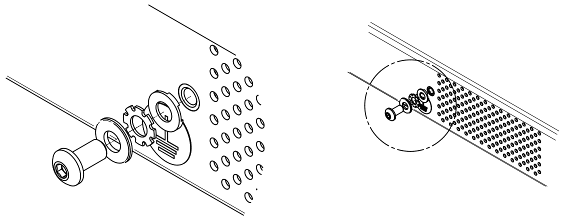
Acoustics 0 dB (A)

IP protection class IP20

Housing dimensions



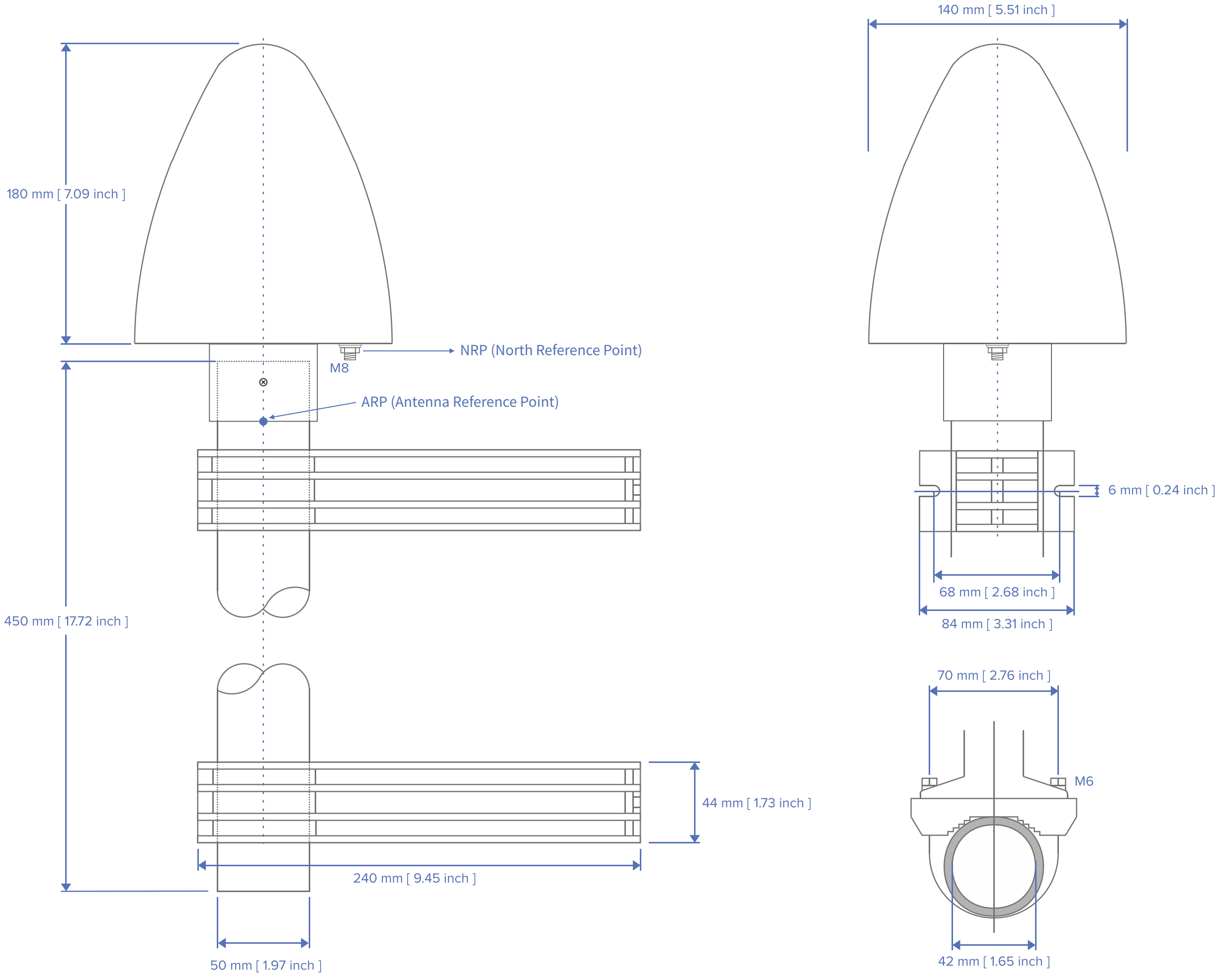
External Ground Connection on the Housing



This connector must be wired to an equipotential bonding bar (earthing bar). Connection is possible on the power supply side of the housing. The mounting parts (without cable) are included in the scope of delivery.

13.2 Technical Specifications: GPSANTv2 Antenna

Physical Dimensions



Electrical Specifications

Power Supply: (via Antenna Cable)	15 V ± 3 V
Nominal Current Draw: (via Antenna Cable)	Approx. 100 mA at 15 V, max. 115 mA

Signal Reception & Processing

Reception Frequency:	1575.42 MHz (GPS L1/Galileo E1 Band)
Axial Ratio:	≤ 3 dB at zenith
Element Gain:	Typically 5.0 dBic at zenith
Mixing Frequency:	10 MHz
Intermediate Frequency:	35.4 MHz
Out-of-Band Rejection:	≥ 70 dB @ 1555 MHz ≥ 55 dB @ 1595 MHz
Conversion Gain: Antenna Input to IF Output	59 dB ± 3 dB
Noise Figure:	Typically 1.8 dB, maximum 3 dB at +25 °C
Input Filter Survival Capacity:	Exposure to > 13 dBm for 24 h without destruction
Conversion Delay: (Patch Connector to IF Output)	Typically 152 ns ± 5 ns
Group Delay Ripple within 2.4 MHz System Bandwidth:	Max. 15 ns
Polarization:	Right-Hand Circular Polarization
ETSI-Compliant Frequency Blocking:	Blocked frequency range further extended to 6 GHz
	–40 dBm
P1dB Input:	
Antenna Pattern:	Vertical 3 dB Angle Width: 100° centered around azimuth

Connection

Connector Type:	Type-N, Female
Nominal Impedance:	50 Ω
Voltage Standing Wave Ratio (VSWR):	$\leq$ 1.5 : 1
Grounding Terminal:	M8 threaded bolt and hexagon nut for use with corresponding ring lug

Specifications for Interference Immunity

Surge Protection:	Level 4 (per IEC 61000-4-5) Test Voltage: 4000 V Max. Peak Current @ 2 Ω: 2000 A
ESD Protection:	Level 4 (per IEC 61000-4-2) Contact Discharge: 8 kV Air Discharge: 15 kV

Mechanical and Environmental Specifications

Housing Material:	ABS Plastic Case for Outdoor Installation
Specified Environment:	Outdoor Environments
IP Rating:	IP65
Temperature Range (Operation):	–60 °C to +80 °C (–76°C to +176 °F)
Temperature Range (Storage):	–20 °C to +70 °C (–4°C to +158 °F)
Relative Humidity (Operation):	5 % to 95 % (non-condensing)
Weight:	1.4 kg (3.09 lbs), including mounting kit

13.3 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 35 MHz intermediate frequency for cables supplied by Meinberg. For cables from sources other than Meinberg, please refer to the data sheet of that cable.

Cable Type	RG58C/U	RG213	H2010 (Ultraflex)
Signal Propagation Time at 35 MHz*	503 ns/100 m	509 ns/100 m	387 ns/100 m
Attenuation at 35 MHz	8.48 dB/100 m	3.46 dB/100 m	2.29 dB/100 m
DC Resistance	5.3 Ω/100 m	1.0 Ω/100 m	1.24 Ω/100 m
Cable Diameter	5 mm	10.3 mm	10.2 mm
Max. Cable Length	300 m	700 m	1100 m

Table: Specifications of cable types recommended by Meinberg

* The propagation times are specified on the basis of 100 m cable; these values can be used as a reference to calculate the propagation time of any other arbitrary length of cable. Please note that these values are based on real measurements performed by Meinberg engineers on available cable. When performing your own measurements or calculating propagation delay based on the specifications provided in the data sheet for your cable, the results may vary slightly from this table.

Compensating for Signal Propagation Time

The signal propagation time can be compensated for in Meinberg Device Manager by entering the length of the antenna cable under "**Settings**" → "**Clock**".

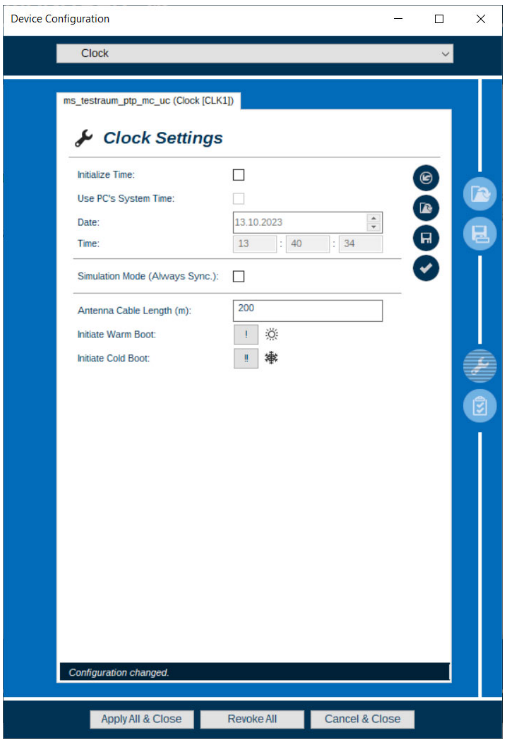


*Illustration: "**Clock**" menu in Meinberg Device Manager*

13.4 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) that is designed to protect devices connected via coaxial cable. 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 13.1: 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

13.5 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 Synchronization Applications

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 reference clock technology 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 GNMANTv2, 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 product 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 stability of the position that is measured from solution to solution.

The specified accuracy of synchronized Meinberg reference clocks 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 (2 ft) from other GNSS antennas, at least 10 m (30 ft) from camera systems (regardless of radio or cable transmission) or HVAC units, and at least 30 m (100 ft) 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 receiver'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.

13.6 How Satellite Navigation Works

The use of a receiver for location tracking and time synchronization relies on the ability to measure the satellite-to-receiver propagation delay as precisely as possible. It is necessary to have simultaneous reception from at least four satellites so that the receiver can determine its relative spatial position in three dimensions (x, y, z) and measure the deviation of its clock against the system clock. Monitoring stations around the planet track the orbital trajectory of the satellites and detect deviations between the local atomic clocks and the system time. The collected data is transmitted up to the satellites, which then send navigation data back to Earth.

The high-precision trajectory data of each satellite, known as the satellite's ephemeris, is needed by the receiver to continuously calculate the precise location of the satellites in space. A roughly defined ephemeridal schedule based on empirical data, referred to as an almanac, is used by a receiver to identify which satellites are visible above the horizon given a known approximate location and time. Each satellite transmits its own ephemeridal schedule as well as the almanacs of all existing satellites.

Satellite Systems

GPS was installed by the United States Department of Defense (US DoD) and operates at two performance levels: the Standard Positioning Service, or SPS, and the Precise Positioning Service, or PPS. The structure of the messages transmitted by the SPS has been openly published and reception is provided for public use. The timing and navigation data of the more precise PPS is encrypted and is thus only accessible to certain (usually military) users.

GLONASS was originally developed by the Russian military for real-time navigation and ballistic missile guidance systems. GLONASS satellites also send two types of signal: a Standard Precision Signal (SP) and an encrypted High Precision Signal (HP).

BeiDou is a Chinese satellite navigation system. The second-generation system, officially referred to as the BeiDou Navigation Satellite System (BDS) and also known as "COMPASS", consists of 35 satellites. BeiDou entered service in December 2011 with ten satellites and was made available to users in the Asia-Pacific region. The system was completed in June 2020 with the launch of the final satellite.

Galileo is an in-development global European satellite navigation and time reference system controlled by a civilian authority (European Union Agency for the Space Programme, EUSPA). Its purpose is the worldwide delivery of high-precision navigation data and is similarly structured to the American GPS, Russian GLONASS and Chinese BeiDou systems. The main differences in the systems lie in their approaches to frequency usage & modulation and the satellite constellation.

13.6.1 Time Zones and Daylight Saving Time

GPS System Time is a linear timescale that was synchronized with the international UTC timescale (Coordinated Universal Time) when the satellite system became operational in 1980. Since it has entered service, however, several leap seconds have been introduced to the UTC timescale to adjust UTC time to irregularities in the Earth's rotation. While GPS System Time deviates from UTC time by several seconds for this very reason, satellite messages do incorporate the number of seconds by which these timescales deviate from one another, allowing GPS receivers to be synchronized internally with the international UTC timescale.

The receiver's microprocessor can identify any time zone based on UTC time and automatically apply Daylight Saving Time adjustments over several years if so configured by the user.

13.7 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 signal 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.

14 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.

15 Declaration of Conformity for Operation in the European Union

EU-Konformitätserklärung
Doc ID: GPS-HQ/FT-1/PS-1/PP-4/AD10-2025-10-23

Hersteller *Manufacturer*	Meinberg Funkuhren GmbH & Co. KG Lange Wand 9, D-31812 Bad Pyrmont

erklärt in alleiniger Verantwortung, dass das Produkt,
declares under its sole responsibility, that the product

Produktbezeichnung *Product Designation*	**GPS-HQ/FT-1/PS-1/PP-4/AD10**

auf das sich diese Erklärung bezieht, mit den folgenden Normen und Richtlinien übereinstimmt:
to which this declaration relates is in conformity with the following standards and provisions of the directives:

RED – Richtlinie *RED Directive* 2014/53/EU	ETSI EN 303 413 V1.2.1 (2021-04)
EMV – Richtlinie *EMC Directive* 2014/30/EU	ETSI EN 301 489-1 V2.2.3 (2019-11) ETSI EN 301 489-19 V2.2.1 (2022-09) DIN EN IEC 61000-6-2:2019 DIN EN IEC 61000-6-3:2021 DIN EN 55032:2015/AC:2016/A11:2020/A1:2020 DIN EN 55035:2017/A11:2020
Niederspannungsrichtlinie *Low Voltage Directive* 2014/35/EU	DIN EN IEC 62368-1:2020/A11:2020
RoHS – Richtlinie *RoHS Directive* 2011/65/EU + 2015/863/EU	DIN EN IEC 63000:2018

Bad Pyrmont, den 2025-10-23

Aron Meinberg
Quality Management

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16 Declaration of Conformity for Operation in the United Kingdom

UK Declaration of Conformity

Doc ID: GPS-HQ/FT-1/PS-1/PP-4/AD10-2025-10-23

Manufacturer	Meinberg Funkuhren GmbH & Co. KG Lange Wand 9 31812 Bad Pyrmont Germany
declares that the product **Product Designation**	 **GPS-HQ/FT-1/PS-1/PP-4/AD10**

to which this declaration relates, is in conformity with the following standards and provisions of the following regulations under British law:

Radio Equipment Regulations 2017 (as amended) *SI 2017/1206*	ETSI EN 303 413 V1.2.1 (2021-04)
Electromagnetic Compatibility Regulations 2016 (as amended) *SI 2016/1091*	ETSI EN 301 489-1 V2.2.3 (2019-11) ETSI EN 301 489-19 V2.2.1 (2022-09) EN IEC 61000-6-2:2019 EN IEC 61000-6-3:2021 EN 55032:2015/AC:2016/A11:2020/A1:2020 EN 55035:2017/A11:2020
Electrical Equipment (Safety) Regulations 2016 (as amended) *SI 2016/1101*	EN IEC 62368-1:2020/A11:2020
The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012 (as amended) *SI 2012/3032*	EN IEC 63000:2018

Bad Pyrmont, Germany, dated 2025-10-23

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