MANUAL

IMS-GPS180 Setup Guide

Hot-Plug Module

31st January 2020

Meinberg Funkuhren GmbH & Co. KG
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1 Imprint

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2 Safety Instructions for hot pluggable Modules

Check before every maintenance work on the system:

- If a data backup is required?
- Is a backup required, verify the data recovery which is done by this backup.
- Make sure to avoid any static discharge while working - use a grounding cable and/or antistatic gloves during installation and removal of hot pluggable components.
- If you are replacing a hot pluggable power supply, unplug the power cable prior to removing the module from the case.
- Never open a power supply. In power supplies dangerous voltages can still remain even after disconnection from the power supply. Always send power supplies back to the manufacturer for maintenance.

Exchange of hot-swap components

- Ensure that components which will be replaced during operation, always be treated with the utmost care. Avoid contact with live components.
- Electrostatic discharge can damage electronic components. For this reason, ensure protection against electrostatic discharges by wearing anti-static shoes while working with the system.
- Take care when removing and installing the hot-plug modules. Always work with the utmost caution. Touch the modules only at the edges.
- Place the module out of the box or after removal from the system with the component side to the top on a grounded and static-free surface.
- Storage of an IMS module must be done in a dry place.
- Installation or removal from hot-swap components only by authorized personnel!
2.1 Additional Safety Hints

This manual contains important information for the installation and operation of this device as well as for your safety. Make sure to read carefully before installing and commissioning the device.

Certain operating conditions may require the observance of additional safety regulations not covered by this manual. Nonobservance of this manual will lead to a significant abatement of the security provided by this device. Security of the facility where this product is integrated lies in the responsibility of the installer.

The device must be used only for purpose named in this manual, any other use especially operation above the limits specified in this document is considered as improper use.

Keep all documents provided with the device for later reference.

This manual is exclusively for qualified electricians or by a qualified electrician trained personnel who are familiar with the applicable national standards and specifications, in particular for the construction of high voltage devices.

2.2 Supply Voltage

WARNING!
This device is powered by a dangerous voltage. Nonobservance of the safety instructions of this manual may lead to serious damage to persons and property and to danger to life! Installation, commissioning, maintenance and operation of this device are to be carried out by qualified personnel only.

The general safety instructions and standards (e.g. IEC, DIN, VDE, EN) for installation and work with high voltage equipment as well as the respective national standards and laws must be observed.

NONOBSERVANCE MAY LEAD TO SERIOUS DAMAGE TO PERSONS AND PROPERTY AND TO DANGER TO LIFE!

The device may not be opened. Repair services may only be carried out by the manufacturer.

Supply lines for this device must be equipped via an appropriate switch that must be mounted close to the device and must be marked as a mains switch for the device.

To ensure safe operation supply mains connected to this device must be equipped with a fuse and a fault-current circuit breaker according to the applicable national standards for safe operation.

The device must be connected to a protective earth with low grounding resistance according to the applicable national rules.
2.3 Cabling

WARNING!
DANGER TO LIFE BY ELECTRICAL SHOCK! NO LIVE WORKING!
Wiring or any other work done on the connectors particularly when connectors are opened may never be carried out when the installation is energized. All connectors must be covered to prevent accidental contact to live parts.

ALWAYS ENSURE A PROPER INSTALLATION!
3 Replacement or Installation of a Hot-pluggable IMS Module

If the system is supplied with an antenna and antenna cable, it is advisable to first mount the antenna in a suitable location (see chapter Antenna Mounting) and lay the antenna cable.

Please use a Torx screwdriver (T8 x 60) for removal and installation of the module.

1. Follow the safety instructions at the beginning of this manual!

1. Remove the two marked Torx screws from the module holder plate or the cover plate of the empty slot.

2. (Only for an already built-in module)
Pull the module carefully out of the holding rail. Note that the module is firmly anchored in the connector block of the housing. You need a certain amount of force to release the module from this link. Once the connection to the connector block of the system’s backplane is loosened, the module can be easily pulled out.

3. When installing the new IMS module, please ensure that the board is correctly inserted into the two guide rails of the system housing. Non-observance can cause damage to the module and the chassis. Make sure that the module is securely locked into the connector block before you fasten the two screws.

4. Now you can put the installed module into operation.

Attachment points of an 1U IMS system
3.1 Important Hints for hot-pluggable IMS Modules

The following points should be strictly observed when replacing IMS modules during operation. Not all IMS modules are fully hot-pluggable. Of course, it is not possible to replace a power supply unit of a non-redundant system without first having installed a second power source in operational mode.

The following applies to the individual IMS slots:

**PWR:** "hot swappable" If you operate your system with only one power supply, a second power supply must be installed before removing/replacing it to keep your system functioning.

**I/O, ESI and MRI Slots:** "hot swappable".

**CLK1, CLK2:** "hot swappable" After the exchange or the installation of a clock module a rescan of the reference clocks (Rescan Refclocks) must be executed in the web interface menu "System".

**CPU** not "hot swappable" The central management unit must be disconnected from mains before replacement.

**RSC/SPT** not "hot swappable" The RSC switching card must be disconnected from the mains before the replacement.
4 GPS Clock

Receiver: 12 channel GPS C/A-code receiver

Accuracy of pulse outputs:
- $< +100 \text{ ns (TCXO, OCXO LQ)}$
- $< +50 \text{ ns (OCXO-SQ, -MQ, -HQ, -DHQ)}$

Antenna Cable: shielded coax

Cable Length:
- max. 300 m to RG58
- max. 700 m to RG213

Antenna Connector: BNC female

Input GPS: Antenna circuit
- 1000 V DC insulated

Local Oscillator to Converter Frequency: 10 MHz

First IF Frequency: 35.4 MHz

1) these frequencies are transferred via the antenna cable.

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

Figure right: GPS Receiver and GPS with XHE-SPI Connector (optional)

LED Indicators

Init: blue: while the receiver passes through the initialization phase
- green: the oscillator has warmed up

Nav.: green: positioning successfully

Ant: red: antenna faulty or not connected
- yellow: the clock is synchronized by an external Signal - MRS mode (PPS, IRIG ...)

Fail: red: time has not synchronized

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Pin Assignment of the DSUB9 Connectors (male):

Pin 2: RxD
Pin 3: TxD
Pin 5: GND

Option “multiref”
Reference signal via 9-pin DSUB connector
(PPS + String Mode)

Pin 1: PPS
Pin 2: String *

* The following timestrings (time telegrams) can be used:
  NMEA RMC
  NMEA ZDA
  Meinberg Standard
  Uni Erlangen

Pin Assignment of the optional XHE-SPI Connectors:

A1: PPS In
A2: PPS Out

Pin 1: SCL_Out (SPI Clock)
Pin 2: CS (Chip Select)
Pin 3: MOSI (Master Out, Slave In)
Pin 4: MISO (Master In, Slave Out)
Pin 5: GND

Attention: Use this plug only to connect a MEINBERG IMS-XHE<sup>Rb</sup> Rubidium expansion chassis.
4.1 Configuration of IMS Modules via Web Interface

This chapter shows how to configure an IMS GNSS clock-module via the web interface and the display menu (if available).

4.1.1 Clock

On this page of the web interface, configurations can be made on the respective installed reference clocks or the changeover card.

![Menu “Clock” in case of a single receiver](image)

Depending on the design of the system, which means whether it is a single reference clock or a system with two installed remote clocks and a changeover card, the web interface builds up accordingly. This also applies to the type of reference clock and its options. In case of a redundant receiver configuration the common settings for “IRIG In/Out”, “Serial Ports”, “Time Zone”, “Enable Outputs”, “Programmable Pulses” and “Synthesizers” appears into the “Switch Card” menu.
4.1.1.1 MRS Status

Here the states of the reference inputs are shown:

**Priority:** Arrangement of the time source according to your prioritization.

**Source:** Type of reference source.

**Status:**
- No Connection, No signal → the reference source is not available.
- Signal available → the reference source is available.
- Is master → the reference source is used to synchronize the system.
- Is locked → the system synchronizes itself to the reference source.
- Is accurate → Basic accuracy of synchronization reached.

**Offset:** Time difference of the reference clock to the specified time source.

**Statistics:**
- Span → If the difference between the min / max value of the time source is over a defined statistical interval.
- Step-Compensation → Displays a hard time jump of the reference source (currently only available for PTP).
- Auto-Bias → Time offset determined for the source versus an offset-free time source.

Figure: An example of available reference signals in the priority order.
4.1.1.2 MRS Settings

The MRS stands for a Multi Reference Source clock. This is a special functionality of a receiver that can in addition to GNSS use also other input signals as a reference for synchronization.

4.1.1.3 MRS Source Priority

In the MRS Settings you can configure a priority list of input signals how the switching will follow in case that a master reference becomes unavailable. The selection of signals in the list is automatically generated by the LANTIME according to the hardware configuration. The priority list of input signals should be configured in a descending order referring to the accuracy of signals.

Here is an example how to configure a priority list in a descending order:
1. Source: GNSS / GPS
2. PPS + String
3. PTP – IEEE1588
4. external NTP Server

![Status & Configuration](image)

*Figure: Configuration example of reference signals in a descending order.*
4.1.1.4 IRSA - Intelligent Reference Selection Algorithm

IRSA stands for an Intelligent Reference Selection Algorithm. In case that a master signal fails the IRSA takes care that the switching to the next reference signal in the priority list runs automatically and smoothly. The IRSA also takes into account the highly stable holdover performance of the local oscillator. It ensures that switching from the superior reference signal to the less accurate one is delayed as long as the highly stable oscillator can provide better accuracy in holdover than the next available reference signal in the priority list.

![IRSA - Intelligent Reference Selection Algorithm](image)

*Figure: Activated IRSA mode with estimated precision values for available references.*

To ensure that IRSA is working properly, follow these steps:

1. Configure a priority list of available reference signals in descending order from the superior to inferior one in the MRS Settings menu (see chapter MRS Source Priority).
2. Activate IRSA in the IRSA menu. As per default the IRSA is deactivated.
3. Fill in the estimated precision values for the input reference signals in for this provided "Precision" column. According to the estimated precision values the holdover time between current source and the next source from the priority list will be calculated.

Here are some estimated precision values which you can load as defaults:
- GPS / GNSS as the first priority has the highest estimated precision: 100 ns
- ext. Osc. (e.g. Rubidium): 120 ns
- PTP IEEE 1588: 100 ns
- PPS plus string: 100 ns
- NTP: 100 ns
4.1.1.5 MRS Features

Advanced Source Selection
A firmware V6.24 and the following versions support a mixed combination of reference signals for synchronization. In the mixed mode you can select one source only for the ToD (Time of Day) synchronization and another source for phase and frequency. The phase and frequency can be provided by a highly stable and accurate source, for example an atomic clock, like Rubidum or Cesium.

The Time of Day (ToD) information represents a “wall clock time” – a specific time with hours, minutes, seconds and the corresponding date. The ToD information cannot be delivered by an atomic clock alone. Therefore, if you need the ToD in your system, you need to select one of the reference signal which includes the ToD information, for example GPS, NTP, PTP, PPS plus string.

If you use the mixed mode the reference clock will be steered first by a reference signal which includes the ToD. The oscillator will be roughly adjusted until it reaches the highest level of accuracy that can be achieved by this reference. After that the reference clock switches automatically to a more accurate source, for example a 1PPS coming from an external atomic clock that provides highly stable phase or a 10MHz signal to provide a stable frequency.

As per default both ToD and Phase are enabled for each available reference source. If you want to use the mixed mode, then select the ToD for one reference signal and phase for another. The reference sources you wish to use should be configured first in the Source Priority list. See MRS Settings → MRS Source Priority.

Here is one configuration example for Advanced Source Selection:

![IRSA - Intelligent Reference Selection Algorithm](image)

*Figure: An example for a mixed combination of ToD and Phase source for given reference signals.*

PTP Min. Clock Class
The MRS system should only use a PTP master to synchronize the clock if the desired clock class is given. It should be prevented that the slave remains synchronized to a bad master, although another source is available.
4.1.1.6 Extended Options

The Trusted Source (TRS) feature is a powerful tool to protect the GNSS receiver from spoofing attacks. For the moment, the Trusted Source feature is supported only in combination with a Meinberg GPS or GNSS receiver and a Meinberg XHE external Rubidium holdover unit.

To activate this feature, select "Use Trusted Source" check box for the GPS reference signal. It means that GPS reference will be checked for consistency by another reference source which is acknowledged as a Trusted Source. In our case the trusted source is a Rubidium atomic clock. It is denoted as ext.Osc. (external oscillator) in the table of Extended Options. Therefore select this check box "Is Trusted Source".

![Image: An example of a Trusted Source mode of operation with an external rubidium.](image)

The external Rubidium acts as an external oscillator that is synchronized by the GPS or GNSS Master as long as the master is available and its precision is better than the precision of the XHE. If the Master fails or for some reason uses corrupted or manipulated data the TRS will detect this as an offset limit violation. Consequently, the reference selection algorithm will discard the current master and the XHE Rubidium source will become the new master for synchronization.

Both GNSS and Rubidium reference signals need to be configured first in the Source Priority list, GPS or GNSS as "Source 1" and external Oscillator as "Source 2". All other positions should be left empty (see chapter MRS Source Priority).

Second, the IRSA Reference algorithm should be activated with corresponding precisions (see chapter IRSA - Intelligent Reference Selection Algorithm).

The precision for GPS or GNSS is at same time also the TRS limit, that the reference should comply with. If the TRS limit is violated the reference selection algorithm discards the current master and switches automatically to the Trusted Source - XHE Rubidium. For the GPS or GNSS precision value we take 250ns which is maximum time deviation allowed for the receiver.

Finally, the GPS or GNSS source should have enabled "Time of Day Source" and "Phase Source", which means that the receiver is a source for both Time of Day and Phase. At the XHE Rubidium only the Phase Source should be enabled, since the atomic clock alone does not deliver the ToD information (see chapter MRS Features).

Auto Bias Master / Auto Bias Slave

"Auto Bias" provides a technology for a situation where a constant offset which is present with a given input signal can be measured and compensated against a trusted reference automatically. The reasons for this constant offset could be a cable delay which introduces a fix offset (5ns per each m of coax cable and 3ns for fiber), a delay caused by an IRIG generator if IRIG is used as an input, or a constant offset via PTP due to a network or traffic asymmetry.

So, if you choose for example GPS as a reference signal at priority 1 while having "Auto Bias Master" ac-
tivated for GPS, then GPS will be used as a measurement reference for all other sources as long as GPS is available.

If PTP is configured as a secondary priority with "Auto Bias Slave" activated, the constant offset of the PTP input signal is measured against the current "Auto Bias Master" reference (e.g. GPS) and will be compensated automatically.

Furthermore, even if PTP becomes a reference signal in case that a Master is not available, the PTP offsets will include a compensation for the initial offset measured against the previous Master automatically. In this operating mode a smooth transition from GPS to PTP will be possible without a time step in case GPS becomes unavailable.

If PTP is then a primary sync source and an asymmetry step suddenly occurs in the network (due to path rearrangements e.g.), the occurring asymmetry step will therefore be automatically compensated as well in case "Asymmetry Step Detection" is activated.

**Asymmetry Step Detection**
When Asymmetry Step Detection is activated, the PTP slave does not follow hard time jumps. The soft synchronization is retained and the time jump is displayed as an offset in the MRS statistics.

With activated "Asymmetry Step Detection", the system measures the offset for approx. 10 minutes. After another 10 minutes, a determined value or offset is set, which is then displayed under MRS -> PTP status [Step Compensated]:

Auto-Bias: 0.000000000s
Step-Comp.: -0.000010001s
Span: 0.000000025s
4.1.1.7 Fixed Offset and Limit

The "Fixed Offsets" and "Limits" can be entered by using the corresponding fields. The "Fixed Offset" specifies a fixed offset for each reference clock to the reference time. With this value, known and constant deviations of a reference time source can be compensated. No constant offset can be set for GNSS references - this can only be done indirectly with the antenna cable compensation time.

Limit:

Here you can configure a limit value. If the reference source exceeds this limit, a notification is triggered. A configuration in the Web Interface is required on the Notification page "Notification → Notification Event → XMR Limit Exceed".

![Configuration dialog for known offsets and limits.](image-url)
4.1.8 IRIG Settings

Depending on the system configuration, the configuration of the incoming and/or outgoing time codes can be configured in this menu. There are three common time codes:

**IRIG**
- B002+B122 - IRIG-B 100pps:
  - DC Level Shift (DCLS), No carrier (DCLS),
  - Time coding (HH, MM, SS, DDD)
- Modulated, 1 kHz / 1 millisecond resolution,
- Time coding (HH, MM, SS, DDD), Control Functions
- B003+B123 as well as B002+B122, with second of day (0...86400)

**AFNOR NF S87-500**
- AFNOR NFS 87-500 is a standardized French timecode similar to the IRIG code, but with additional information such as day, day of month and year.

**IEEE1344**
- In addition to a two-digit year, the offset to the UTC time, the current daylight saving time status and announcements from the start and the end of the summer time, as well as information about an upcoming leap second are transmitted.

**Input Code:**
Configuration of the incoming IRIG / AFNOR / IEEE 1344 time code (MRS systems only).

**UTC Offset:**
If the applied timecode is impinged with a constant time offset to UTC, this time offset must be configured here, so that the clock can convert the received time to UTC.

**Output code:**
If the system has direct TC output options, you can set the parameters in this menu section.

**Time Scale:**
The output of the selected time code can be done with UTC or the local time. When "LOCAL TIME" is used, it refers to the configuration of the menu point "Time zone".
4.1.1.9 Serial Interfaces

Depending on the number and version of the system, the parameters for the serial interfaces can be configured in this menu.

**Baudrate:**
The speed with which the serial telegram is to be transmitted:
300, 600, 1200, 2400, 4800, 9600, 19200

**Framing:**
Structure of the telegram:
7E1, 7E2, 7N2, 7O1, 7O2, 8E1, 8E2, 8N1, 8N2, 8O1

**String Type:**
Meinberg Standard, SAT, NMEA RMC, Uni Erlangen, Computime, Sysplex 1, Meinberg Capture, SPA, RACAL, Meinberg GPS, NMEA GGA, NMEA RMC GGA, NMEA ZDA, ION, 6021, IRIG-J

**Mode:**
You can configure an interval (per second, per minute, on request “?” Only) for the outgoing time string. If the operating mode is set on 'Request', a connected client must send a “?” to receive the time telegram in response.

**Features:**

**MRS PPS Plus String**
If the system has the MRS “PPS plus string” option, the baudrate and framing for the incoming time string must be configured via this submenu.

**Meinberg Capture *only for specific units***
This option is for systems that have a cap input. The event is triggered by a negative edge.

Two operating modes are available for the output of the capture time stamps, "on request ? Only" and "automatically".

- **on request “?” only**
The triggered events are stored in a buffer of the reference clock. As soon as a “?” is sent to the reference clock via a serial connection, the stored events are transferred from the buffer.

- **automatically**
In this mode, the capture events are output directly on the serial interface.

4.1.1.10 Time Zone

In this menu, you can configure the time zones (offsets) for the output signals (IRIG, serial interface, programmable pulses) of the reference clock.
The data of the time zone are used from the time zone table (see chapter ?? System → Display).

4.1.1.11 Enabling the Outputs

Optionally, the outputs of the reference clock can be set to always supply a signal when the device is switched on, or only when the internal clock is running synchronously.
4.1.1.12 Programmable Pulses

If the system has programmable switching outputs, you can configure the parameters in this menu.

<table>
<thead>
<tr>
<th>Mode:</th>
<th>Output signal configuration.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulse length (ms):</td>
<td>Pulse length configuration.</td>
</tr>
<tr>
<td>Cycle:</td>
<td>For &quot;Cycle Pulse&quot; mode, an interval can be configured in hh: mm: ss.</td>
</tr>
<tr>
<td>Time:</td>
<td>In the configured mode &quot;Single Shot&quot;, the time for the pulse can be parameterized in hh:mm:ss.</td>
</tr>
<tr>
<td>DCF Suspend After (min):</td>
<td>In the &quot;DCF77 Marks&quot; mode, you can configure a shutdown time for the output port, so that in the case of an asynchrony of the reference clock, no DCF mark is available at the output.</td>
</tr>
<tr>
<td>On / Off Time:</td>
<td>For the &quot;Timer&quot; mode, it is possible to configure start and stop times in hh:mm:ss.</td>
</tr>
<tr>
<td>Signal:</td>
<td>Configuration of the output signal active in high or low.</td>
</tr>
<tr>
<td>Disable output in Holdover mode:</td>
<td>If the reference clock is asynchronous, the output signal is immediately deactivated when the checkbox is activated.</td>
</tr>
</tbody>
</table>

Note: In the clock-submenu "Enabling the Outputs" the Pulses option "if sync" must be select so that the outputs can be switched off in holdover mode.
4.1.1.13 Synthesizer

The output frequency and phase of the integrated synthesizer can be set here.

**Frequency:** Frequencies from 1/3 Hz up to 10 MHz can be set by entering four digits and a frequency range. By entering the frequency 0 Hz, the synthesizer can be switched off.

**Phase:** With phase you can enter the phase position of the set frequency in the range $-180^\circ$ to $+180^\circ$ with a resolution of 0.1. When the phase angle is increased, the delay of the output signal gets bigger. If a frequency higher than 10 kHz has been set, the phase cannot be changed.
4.1.1.14 Miscellaneous

This menu item displays specific options of the reference clock.

Antenna Cable Length (m):
The signal propagation time of the antenna cable can be compensated by this value. The received time signal is delayed by approx 5ns/m when using RG58U and 4ns/m when using H155 antenna cable. This time error is automatically compensated by entering the cable length. The default value is 20m. The maximum input value should not exceed 500m.
**GPS Simulation Mode:**
This menu allows the user to operate the time server without an antenna. Normally, the NTPD loses synchronization when the antenna or the external reference source is disconnected (red FAIL LED is turned on). By activating the simulation mode, the corresponding status information for the NTPD is permanently set to SYNC. This also makes it possible to transmit other times, which have been entered via the menu item “Initialize the receiver”, to the NTPD. In normal cases, the checkbox should remain empty. If this box is activated, the status “Simulation mode” is displayed under “Info of the receiver” in the main menu.

**GPS Time Scale:**
- **UTC**  Coordinated Universal Time (including leap seconds which are continuously updated)

If you change the timescale in the drop-down menu a warning message will appear in the browser window.

**Please Note:**
If the GPS receiver is configured to output GPS or TAI timescale instead of UTC, the distributed time via NTP isn’t based on UTC then. This is a protocol violation and this time server can’t be used to synchronize standard NTP clients which expect UTC time.

**Log Satellite Visibility (GPS Receiver):**
If this item is activated, a graphic is generated on which the constellation of the visible satellites are displayed.

**SSM Quality Level in GPS Lock Mode:**
If the system has E1 / T1 outputs, the quality level of the SSM can be configured here.

**SNS Mode - Satellite Navigation System Mode (GNS Receiver):**
If you are using a GNS receiver (GNS or GNS-UC with Up Converter), this drop-down menu allows you to select one or more satellite systems to be used simultaneously.

The following combinations can be selected and received simultaneously:

<table>
<thead>
<tr>
<th><strong>GNS Receiver</strong></th>
<th><strong>GNS-UC Receiver</strong></th>
<th><strong>GNM-Receicer</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>GPS only</td>
<td>GPS only</td>
<td>GPS</td>
</tr>
<tr>
<td>GLONASS only</td>
<td>Galileo only</td>
<td>GLONASS</td>
</tr>
<tr>
<td>Galileo only</td>
<td>GPS/Galileo</td>
<td>Galileo</td>
</tr>
<tr>
<td>BeiDou only</td>
<td></td>
<td>BeiDou</td>
</tr>
<tr>
<td>GPS/GLONASS</td>
<td></td>
<td>(All available systems can be received simultaneously)</td>
</tr>
<tr>
<td>GPS/Galileo</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GPS/BeiDou</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Galileo/GLONASS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Galileo/BeiDou</td>
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<tr>
<td>GLONASS/BeiDou</td>
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<tr>
<td>GPS/Galileo/GLONASS</td>
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<tr>
<td>GPS/Galileo/BeiDou</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Distance to the Transmitter (km) - PZF / AM Receivers only:
In the menu item “Distance to the Transmitter” you can enter the transmitter distance in km, which is used for the delay compensation of the incoming PZF-signal. The adjustment of the distance should be made as precisely as possible, because it has a direct influence on the absolute accuracy of the time raster.

PZF Simulation Mode:
This menu allows the user to operate the time server without an antenna. Normally, the NTPD loses synchronization when the antenna or the external reference source is disconnected (red FAIL LED is turned on). By activating the simulation mode, the corresponding status information for the NTPD is permanently set to SYNC. This also makes it possible to transmit other times, which have been entered via the menu item “Initialize the receiver”, to the NTPD. In normal cases, the checkbox should remain empty. If this box is activated, the status “Simulation mode” is displayed under “Info of the receiver” in the main menu.

4.1.1.15 Initialize Receiver

Warm Boot Mode only for GNSS receiver:
This menu allows the user to switch the receiver to WARMBOOT MODE. This may be necessary if the satellite data in the battery-buffered memory is too old, or if the device is operated at a location that is several hundred kilometers away from the last operating location, since the calculation of the visibility of the satellites yields incorrect results.

Cold Boot Modus only for GNSS receiver:
This menu allows the user to reinitialize all GPS system values, this means that all stored satellite data will be deleted. Please note that the receiver takes about 15 minutes to read-in the information of the satellites again, to complete the cold boot!

Coordinates (latitude, longitude, and altitude) *only GNSS receiver:
The absolute position of the GPS antenna can be entered here and can be sent to the GPS reference clock with “initialize Position”. This option is useful when the system is operated at a different location and if started with the previously battery-buffered satellite data.

Time/Date:
With this function, the reference clock can manually be set to a specific date and time.
4.1.1.16 Receiver Information

This menu item lists all the important information and options of the reference clock.

Explanation of GPS Satellite Status "Satellites in View" and "Number of Good Satellites"
Satellites of the GPS and other GNSS systems are usually not stationary, but circle around the globe on well-known tracks, so each individual satellite may be above or below the horizon at a given location and time. Satellites that are below the horizon can’t be tracked anyway, so the receiver uses its last known position and almanac data from the satellites to determine which satellites are currently expected to be above the horizon at its geographic position, and can potentially be tracked. All these satellites are called to be in view.

However, even some the satellites that are in view may be shielded by buildings, mountains, etc., so the receiver may be unable to track these satellites. Also, individual satellites may be temporarily in maintenance mode, so they must not be used even if they can be tracked. Only satellites that can be tracked and are not in maintenance mode are considered good and used to determine the current position and time.

So the number of good satellites can never exceed the number of satellites in view, but it can be significantly less if the antenna has been installed in a location with limited view to the sky. In worst case this can lead to limited accuracy, or only temporary synchronization.
4.1.1.17 Switch Card

The RSC (SCU) switch card is an automatic multiplexer for redundant systems with two Meinberg radio clocks. The card is used for the automatic switching of the pulse and frequency outputs as well as the serial interfaces of the connected clocks. The selection of the respectively active system is made, based on the state of the clock's generated TIME_SYNC signals, which show the synchronous state of the clocks.

In order to avoid unnecessary switching operations, for example during periodic free running of a system, the order of the active and the reserve system is exchanged at every change-over. For example, if the active system switches to the free running mode while the reserve system is operating synchronously, it is switched over to the synchronous reserve system. A reset to the old state occurs only if the now active system (formerly the reserve system) loses synchronization, while the reserve system (previously active system) operates synchronously. If both systems operate in the free-running mode, no changeover is made and the current state is retained.

4.1.1.18 Receiver Information Switch Card

![Switch Card: Common Information]

This menu item lists all the important information and options of the switch card.
4.1.2 Front Display - Root Menu

The root menu is shown when the receiver has completed initialization after power-up. With the four arrow buttons and the buttons „OK“, „ESC“, „F1“ and „F2“ the navigation and setting of parameters can be managed. Main menu can be reached by holding „ESC“ for a few seconds. The main menu reflect some of the main parameters of the time server. First line shows the name of the device and the status of the reference clock. The text "NORMAL MODE" might be replaced by "NOT SYNC". If an existing antenna connection is interrupted or not working properly, the text "ANTENNA FAULTY" is displayed instead.

With an integrated time code receiver it might be possible, that the message ‘NO DATA’ appears on the display – in this case the correct value can be set in the time-code parameter submenu.

Current time and date of the timeserver with the name of the time zone (NTP uses UTC time zone) will be monitored in the bottom line. If the "SIMULATION MODE" option is enabled an ‘*’ will be shown behind the time.

The multicolor LEDs will reflect the current state of the device:

„Ref. Time“
green: the reference clock produce valid time.
red: the reference clock produce no valid time (e.g. not synchronized)

„Time Service“
green: NTP has been synchronized to reference clock.
red: NTP is not synchronous to reference clock or sync to „local clock“

„Network“
green: all watched network ports has been “link up” detected
red: at least one of the watched network ports (look at „Setup Device Parameter / Check Network Linkup“) is not connected

„Alarm“
off: no error at moment
red: general error – more information will be shown on display.

If the symbol „F1“ will be shown in the upper right corner a help page can be displayed when pressing the „F1“ button. When pressing „F1“ from main menu a short description for menu navigation will be displayed:

Use ← and → to select different main menus. Use ↑ and ↓ to enter.

When pressing the „OK“ button from main menu the version of the LANTIME software, the NTP and the LINUX kernel version will be displayed.
The following main menus will be displayed when pressing the arrow buttons:
The Reference Clock menu and all its sub menus will manage all status information and parameters of the reference clock. To enter the following sub menus press the "OK" button.
4.1.3.1 Optional Menu Switch Unit

With this menu you can check all important status information about the switch card unit. The example above shows a perfect mode of operation. Both power supplies (PSU1, PSU2) are connected - the two receivers are working in "normal operation mode" (CLK1, CLK2). If the second clock is not connected or in free running mode, the display shows "CLK2:0". If there is no power connected on PSU1, you can see the status "PSU1:0" on the display of the LANTIME.

With this menu you can check all important status information about the switch card unit. The example above shows a perfect mode of operation. Both power supplies (PSU1, PSU2) are connected - the two receivers are working in "normal operation mode" (CLK1, CLK2). If the second clock is not connected or in free running mode, the display shows "CLK2:0". If there is no power connected on PSU1, you can see the status "PSU1:0" on the display of the LANTIME.

With the submenu SCU Cntl you can configure the following parameters:

**REMOTE:**
- disabled/enabled
  - disable or enable remote control of the SCU

**OUTPUTS:**
- enabled/disabled
  - disable or enable outputs of the SCU

**Selected Clk:**
- Clk:1, Clk:2
  - The reference clock can be selected with the function keys or from a connected workstation – for this the mechanical switch in front of the SCU card must be locked in position "Auto". Otherwise (position "Manual") the selected clock can only be changed by using the switch of the SCU.
4.1.3.2 Menu Option Setup MRS

The internal reference clock of the integrated clock module with the high precision oscillator (OCXO HQ) can be disciplined by different time sources. Possible time sources are GPS receiver, external Pulse Per Second (PPS), IRIG 10MHz Frequency, IRIG Time Code, external NTP server or IEEE1588 Grandmaster (M400, M600, M900). The priorities for the internal controlling can be set up in configuration. The priority will define which reference source will be used next if the highest priority reference source will be no longer available. For each reference source a bias (fixed offset) and a precision value can be defined.

With the OK and arrow buttons you can choose the current status of the MRS. All possible reference clocks will be shown with the number of priority, the name of the reference clock and the current offset to the internal reference clock (OCXO). The current master will be signed with an "*" behind the name of the reference clock.

In the next menu the user can define in which order the references will be used to control the internal oscillator. The reference clock with the highest priority will be used always if this is available.

The "Fixed Offsets" can be set up in the next sub menu, if you know the constant offset (bias) of an external reference source. By default this value is 0 ns. The bias of the internal GPS receiver can not be set up – indirectly this can be done via the antenna cable length.

This precision value will determine the hold over time when switching to the next reference clock if the current master is not available anymore. If the precision is 0 the next reference clock will be switched at once. If the precision value is greater then 0 the time for switching to the next reference (hold over time) will be calculated by the following formula:

\[
\text{precision of next reference} / \text{precision of current master} \times \text{constant [s]}
\]

The parameter „constant“ depends on the quality of the internal oscillator.
Example:
The GPS receiver with an precision of 10ns is the current master. If this master is no longer available it will switch to the next reference source of the priority order – in this case the PPS input with a precision of 100us. With the formula \((\frac{100\text{ns}}{10\text{ns}}) \times 11.4\) we get hold over time of 114 seconds/1.9 min. The online display of the MRS status will show the remaining time and the calculated time. The hold over time will be recalculated if the status of the reference clocks will change.

<table>
<thead>
<tr>
<th>Priorities</th>
<th>Fix Offsets</th>
<th>Precisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>0. GPS (30s/1m54)</td>
<td>1. NTP +6.000us</td>
<td>2. PPS n/a</td>
</tr>
<tr>
<td>3. PTP n/a</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.1.3.3 Menu Option MRS - Setup Time Code Receiver

With this menu, the parameters for the time code input signals can be displayed and adjusted.

- **MRS**
  - Set MRS & Info
  - > IRIG Receiver <

- **IRIG Receiver**
  - > Show IRIG Info <
  - Setup IRIG

- **Time Code Rec.**
  - B122/B123
  - Offs.UTC: +00:00
  - State: --------

- **IRIG Receiver**
  - Show IRIG Info
  - > Setup IRIG <

- **Set IRIG Params**
  - B122/B123
  - Offset from UTC: (+HH:MM) +00:00
4.1.3.4 Menu: Info Receiver

In this menu all relevant information about the reference clock, the internal oscillator and in case of a GNSS receiver, the visible and good satellites will be shown in the display.
### 4.1.3.5 Receiver Status and Version

**GPS / GLONASS (CLK)**

<table>
<thead>
<tr>
<th>CLK Status</th>
<th>CLK Version</th>
<th>CLK Position</th>
<th>CLK Satellites</th>
</tr>
</thead>
<tbody>
<tr>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
</tr>
</tbody>
</table>

- **CLKxxxx** 100
- **OSC warmed up:** *
- **DAC cal:** 505
- **DAC val:** -24

**Receiver Pos.**
- **LAT:** 51°58′57″N
- **LON:** 09°13′32″E
- **ALT:** 176 m

**SV CONSTELLATION**
- **SVs in view:** 10
- **Good SVs:** 10
- **Sel:** 04 10 24 13

**PZF**

<table>
<thead>
<tr>
<th>Status &amp; Version</th>
<th>Status &amp; Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>OK</td>
<td>OK</td>
</tr>
</tbody>
</table>

- **PZFxxxx** 100
- **PZFxxxx vx.XX**
- **SN:** xxxxxxxxxxxx
- **TCXO HQ**

**PZF STATE**
- **CORR.:** 18 State: row
- **FIELD:** 0
- **CORR.:** 1 State: check
- **FIELD:** 94
- **CORR.:** 97 State: fine
- **FIELD:** 94

**REF STATE:**
- **State:** SYNC
- **FIELD:** 100

**REF CLOCK**
- **REF vx.XX**
- **State:** SYNC
- **S/N:** 001510000000

**Setup:**
- **Receiver Position**
- **Trans. Distance:** 1200km

This first menu will monitor the current state ("sync" or "not sync"). The next line will reflect the firmware version, the serial number of the internal GPS and the type of the integrated oscillator.

### 4.1.3.6 Menu: IRIG Receiver State

The first line of the display shows the system state with 8 options - described in the next paragraph. The second line will display the drift in [us] of the internal oscillator and the TFOM value (Time Figure Of Merit: the quality of the IRIG-signal, only used with IEEE 1344) and the current system configuration is shown on the third line. On the fourth line the AGC (Automatic Gain Control of the input signal) value in hexadecimal will be shown.
IRIG (TCR)

IRIG Receiver State: Bit 7 ... 0
Bit 7: Invalid UTC parameter
Bit 6: TCAP exceeded, jitter out of range
Bit 5: Lock on
Bit 4: Telegramm error
Bit 3: Data available
Bit 2: Invalid sysconf
Bit 1: Pulses enabled
Bit 0: Warmed up

Invalid UTC parameter: This bit is set to one if the checksum of the ‘Offset from UTC’ parameter, which must be used if no IEEE1344 extensions are available, is invalid. User must enter new ‘Offset from UTC’ data to clear this bit. Please note that the IRIG-receiver never leaves freewheeling mode if IEEE1344 is disabled and the UTC-Parameter are invalid!

TCAP exceeded, jitter out of range: If the jitter between two consecutive IRIG-telegrams exceeds +/- 100us the receiver switches into freewheeling mode and the ‘TCAP exceeded’ Bit is set. ‘TCAP exceeded’ is cleared if the measured jitter is below +/- 100us.

Lock on: ‘Lock On’ is set whenever the receiver is in synchronous mode and the internal oscillator correction value has settled.

Telegram error: This bit is set if the consistency check of two consecutive IRIG-telegrams fails. The IRIG-receiver switches into freewheeling mode if ‘telegram error’ is set.

Data available: ‘data available’ is set if the receiver can read the timecode.

Invalid sysconf: If ‘invalid sysconf’ is set the checksum of the system configuration data is invalid. In this case the default mode ‘IEEE1344 disabled’ is selected. User must cycle the system or enter a new system configuration in the IRIG-parameter menu.

Pulses enabled: The pulse per second (PPS) signal which increases the NTP’s accuracy is turned when ‘lock on’ is set the first time. The ‘pulses enabled’ bit is set if the PPS signal is enabled.

IRIG system configuration Bit 2 ... 0
Bit 7 ... 4: reserved
Bit 3: ignore Day Of Year enabled
Bit 2: ignore TFOM
Bit 1: ignore SYNC
Bit 0: IEEE 1344 enabled
4.1.3.7 Menu: Setup Meinberg Receiver

GPS / GLONASS (CLK)

Setup MRS
Info REFCLK
->Setup REFCLK<-
Set Outputs
OK
>Antenna Length<
Simulation Mode
Init CLK

PZF

Info PZF
->Setup PZF <-
Serial Outputs
OK
> Trans.Distance <
Init Time
Ignore Lock

WWVB, MSF, JJY ...

Status
Version
->Tran. Distance<-
OK
Set up:
Receiver Position
Tran. Distance
1200km

IRIG

Info TCR
-> Setup TCR <-
OK
->UTC Offset <-
IRIG Code
Initial Time
Ignore Lock

In the Reference Time -> Setup Clock menu the receiver clock parameters can be configure. The antenna cable length of satellite based receivers must be entered here. The GPS and GLONASS reference clocks can be run in simulation mode.

Meinbergs PZF correlation receivers can be operate in simulation mode as well. In addition to that, the distance to the transmitter must be set in the setup menu.

For our long wave receivers (WWVB, MSF, JJY ...) there is only the setting for "Transmitter Distance" available - in the Submenu Reference Time -> Info Refclock. The setup for our IRIG time code receivers includes the settings for the UTC offset and the corresponding time code. The time code receiver can also operate in simulation mode with IGNORE LOCK. With Initial Time and Init Clock (GPS, GLONASS), the time and date for the simulation mode is set.
4.1.3.8 SNS Mode - Satellite Navigation System Mode

If you are using a GNS receiver (GNS or GNS-UC with Up Converter), this drop-down menu allows you to select one or more satellite systems to be used simultaneously. The following combinations are available:

```
Setup MRS
  Info GNS
  ->Setup GNS  <-
  Set Outputs
  OK

->Set GNS Param  <-
  Init GNS Rec.

->SNS Mode  <-
  Antenna Length
  Simul. Mode
  OK

Set Satellite
  Nav. System Mode
  *GPS/GALI/GLO
  GLON/BEID
  GALI/BEID
  GALI/GLON
  GPS/GALILEO
  GALILEO only
  GPS/BEIDOU
  GPS/GLONASS
  BEIDOU only
  GLONASS only
  GPS only
  GPS/GALILEO

->Set GNS Param  <-
  Init GNS Rec.
  OK

```

4.1.3.9 Initiate Cold Boot

This menu lets the user initialize all GNSS data, i.e. all saved satellite data will be cleared. The user has to acknowledge this menu again before the initialisation starts. The system starts operating in the COLD BOOT mode and seeks for a satellite to read its actual parameters.

```
Antenna Length
Simulation Mo
->Init GNSS
  OK

->GNSS Cold Boo
  GNSS Warm Boo
  Set Position
  Set GNSS Time
  OK

INITIATE
  COLD BOOT
  OF GNSS RECEIV
  Press F2!

```

4.1.3.10 Initiate Warm Boot

This menu lets the user force the receiver into the Warm Boot Mode. This may be necessary when the satellite data in the memory are too old or the receiver position has changed by some hundred kilometres since last operation. Synchronisation time may be reduced significantly. If there is valid satellite data in the memory the system starts in the Warm Boot mode, otherwise the system changes into Cold Boot to read new data.

```
Antenna Length
Simulation Mo
->Init GNSS
  OK

->GNSS Cold Boo
  GNSS Warm Boo
  Set Position
  Set GNSS Time
  OK

INITIATE
  WARM BOOT
  OF GNSS RECEIV
  Press F2!
```
### 4.1.3.11 Init Receiver Position

When the receiver is primarily installed at a new location far away from the last position saved in the receiver’s memory the satellites in view and their doppler will differ so much from those expected due to the wrong position that the GNSS receiver has to scan for satellites in Warm Boot mode. Making the new approximately known position available to the receiver can avoid Warm Boot and speed up installation.

![Diagram](image)

### 4.1.3.12 Init Receiver Time

If the receiver’s on-board real time clock keeps a wrong time the receiver is unable to compute the satellites’ correct elevation angles and Doppler. This submenu enables the user to change the receiver’s system time for initialisation. After the receiver has locked, its real time clock will be adjusted using the information from the satellites.

When the antenna is disconnected it is possible to set the system with any time. Note that the NTP will not synchronize to GNSS losing its reception or if the deviation to the system time is larger than 1024 seconds. In this case the menu *Simulation Mode* has to be active. After setting the clock manually the system time will be set and the NTP will be restarted.

![Diagram](image)
4.1.3.13 Menu: Output Options

Enable Outputs:
The submenu *Output Options* -> *Enable Outputs* lets the user configure at which time after power up the serial ports and pulse/frequency outputs are to be enabled. Outputs which are shown to be enabled ‘always’ will be enabled immediately after power-up. Outputs which are shown to be enabled ‘if Sync’ will be enabled after the receiver has decoded the incoming signals and has checked or corrected its on-board clock. The default setting for all outputs is ‘if Sync’.

Time Zone:
See Chapter “Set Time Zone of Serial Outputs”.
### 4.1.3.14 Menu: Serial Outputs

This menu lets the user configure the baud rate and the framing of the serial RS232 port to one of the following values:

- **Baudrate:** 300 to 19200
- **Dataformat:** 7E1, 7E2, 7N2, 7O1, 7O2, 8E1, 8E2, 8N1, 8N2, 8O1

COM0 provides a time string once per second, once per minute or on request. If the „on request“ is activated you have to send the character “?” to get the timestring.

#### Default Settings COM0:

<table>
<thead>
<tr>
<th>Speed</th>
<th>Framing</th>
<th>Mode</th>
<th>Signal Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>19200</td>
<td>8N1</td>
<td>per second</td>
<td>Meinberg Standard</td>
</tr>
</tbody>
</table>

This topic is used to select one of several different types of serial time strings or the capture string for each serial port.

The following time strings can be selected. All time strings are described in the appendix at the end of this documentation.

- Meinberg Standard
- SAT
- NMEA RMC (Rev. 2.2)
- Uni Erlangen
- Computime
- Sysplex 1
- Meinberg Capture
- SPA
- RACAL
- Meinberg GPS
- NMEA GGA (Rev. 2.2)
- NMEA RMC GGA (Rev. 2.2)
- NMEA ZDA (Rev. 2.2)
- ION
- 6021
- IRIG-J
4.1.3.15 Setup Output Time Zone

The time zone of the internal receiver can be set up. These parameters will affect the serial output lines and the timecode (IRIG) outputs. The internal time zone of the timeserver and the time of NTP will always be UTC. The time monitored in the main menu will be the time of the NTP.

The menu Set Timezone lets the user enter the names of the local time zone with daylight saving disabled and enabled, together with the zones time offsets from UTC. These parameters are used to convert UTC to local time, e.g. CET = UTC + 1h and CEST = UTC + 2h for central Europe. The values of daylight saving are configurable using the Time Zone setup menu.

Beginning and ending of daylight saving may either be defined by exact dates for a single year or using an algorithm which allows the receiver to re-compute the effective dates year by year. The figure show how to enter parameters for the automatic mode. If the number of the year is displayed as wildcards ‘****’, a day-of-week must be specified. Then, starting from the configured date, daylight saving changes the first day which matches the configured day-of-week. In the figure October 25th is a Saturday, so the next Sunday is October 26th.

All changeover rules for the daylight saving like “the first/the second/the second to last/the last Sunday/-Monday etc. in the x-th month,” can be described by the used format “first specified day-of-week after a defined date”.

If the number of the year is not displayed as wildcards the complete date exactly determines the day daylight saving has to change, so the day-of-week does not need to be specified.

If no changeover in daylight saving is wanted, identical dates and times must be entered in both of the submenus (DAYLIGHT SAV ON/OFF). After this a restart should be done.
4.1.3.16 Menu: Setup Time Code

The IRIG Time Code is an optional output.

This menu lets the user select the Timecodes to be generated by internal reference clock. Most IRIG-Codes do not carry any time zone information, hence UTC is selected for output by default. If desired, the clocks local time can be output by selecting "TIME: Local".

The following codes can be selected:

- IRIG B002+B122
- IRIG B006+B126
- IRIG B007+B127
- AFNOR NF S87-500
- C37.M8
- IEEE1344

Refer to chapter Timecode for details.
4.1.3.17 Option: Setup Progr. Pulses

Timer Mode
This mode simulates a programmable day assigned timer. Three turn-off and turn-on times are programmable for each output. If you want to program a switchtime, change the turn-on time "On" and the corresponding turn-off time "Off". A turn-on time later than the turn-off time would cause a switch program running over midnight. For example a program "On" 10:45.00, "Off" 9:30.00 would cause an active output from 10.45 to 9.30 (the next day!). If one or more of the three switching times are unused just enter the same time into the values "On" and "Off". In this case the switch times do not affect the output.

As already mentioned, the outputs home position is selected by "active: high or low".

Cyclic Pulse mode - generating of periodically repeated pulses
The value of "Time" determines the time between two consecutive pulses. This cycle time must be entered as hours, minutes and seconds. The pulse train is synchronized at 0:00 o'clock local time, so the first pulse of a day always occurs at midnight. A cycle time of 2 seconds for example, would cause pulses at 0:00:00, 0:00:02, 0:00:04 etc. Basically it is possible to enter any cycle time between 0 and 24 hours, however usually a cycle time that causes a constant distance between all consecutive pulses makes sense.

For example: a cycle time of 1 hour 45 minutes would cause a pulse every 6300 seconds (starting from 0 o'clock). The appearing distance between the last pulse of a day and the first pulse of the next day (0:00:00 o'clock) would be only 4500 sec. The value in entry field "Cycle" turns red, when entering a time that causes this asymmetry.

DCF77 Marks
In "DCF77 Marks" mode the selected output simulates the telegram as transmitted by german time code transmitter DCF77. The generated time code is related to the local time zone. If you want DCF simulation to be disabled when the clock is in free running mode, you can enter the delay (given in minutes) for deactivat-
ing the DCF-Simulation with the "Timeout" value. DCF Simulation is never suspended, if the delay value is zero.

**Single Shot Modus**
Selecting Single Shot generates a single pulse of defined length once per day. You can enter the time when the pulse is generated with the "Time" value. The value "Length" determines the pulse duration. The pulse duration can vary from 10 msec to 10 sec in steps of 10 msec.

**Pulses Per Second, Per Min, Per Hour Modes**
These modes generate pulses of defined length once per second, once per minute or once per hour. "Length" determines the pulse duration (10 msec...10 sec).

**Position OK, Time Sync and All Sync**
Three different modes are selectable for output of the clocks synchronization state. The Mode 'Position OK' activates the output when the receiver has sufficient satellites in view to calculate its position. In "Time Sync" mode the respective output is activated when the clocks internal timebase is synchronized to the GPS timing. The 'All Sync' Mode performs a logical AND operation of the both states previously mentioned, i.e. the output is activated if the position can be calculated AND the internal timebase is synchronized to the GPS timing.

**Idle Mode**
Selecting "Idle" deactivates the output.

**Holdover**
If "enabled" is selected the operation of the output remains. Otherwise ("disabled") the operation of the output will be switched off when synchronization is lost.
4.1.3.18 Option: Synthesizer Frequency Output

This setup menu lets the user edit the frequency and phase to be generated by the on-board synthesizer. Frequencies from 1/8 Hz up to 10 MHz can be entered using four digits and a range. The range can be selected if the „UP“ or „DOWN“ key is pressed while the cursor is positioned on the frequency’s units string. If the least significant range has been selected valid fractions of the frequency are .0, .1 (displayed as 1/8), .3 (displayed as 1/3), .5 and .6 (displayed as 2/3). Selection of 1/3 or 2/3 means real 1/3 or 2/3 Hz, not 0.33 or 0.66. If frequency is set to 0 the synthesizer is disabled.

The last line of the display lets the user enter the phase of the generated frequency from $-360^\circ$ to $+360^\circ$ with a resolution of 0.1°. Increasing the phase lets the signal come out later. Phase affects frequencies less than 10.00 kHz only, if a higher frequency is selected a message “(phase ignored)” informs the user that the phase value is ignored.
4.2 Meinberg GPS Antenna/Converter

4.2.1 Introduction

The Meinberg GPS antenna/converter unit combines a standard GPS patch antenna with a frequency converter which translates the original 1.5 GHz signal received from the GPS satellites to an intermediate frequency, so a standard coaxial cable type like RG58 can be used for antenna cable lengths up to 300 meters (1000 ft). If a low-loss cable type like RG213 is used then even 700 meters (2300 ft) between receiver and antenna are possible without requirement for an additional amplifier.

Surge protectors are optionally available and should be used in the antenna line to protect the receiver from high voltages spikes e.g. due to lightning strikes close to the antenna. The antenna/converter unit is remotely powered by the connected GPS receiver via the antenna cable, so no external power supply is required near the location of the antenna if a coaxial cable is used.

If more than a single GPS receiver are to be operated then a GPS antenna splitter can be used to distribute the GPS signal from a single antenna. The GPS antenna splitter provides 4 outputs and can be cascaded to supply even more than 4 receivers with the GPS signal.

Alternatively there is also a GPS Optical Antenna Link (GOAL) available which uses a fiber optic connection between the antenna and the receiver which allows for a length up to 2000 meters (6500 ft), and provides a high level of insulation and surge protection due to the optical transmission. Since the fiber optic connection is unable to provide the antenna with DC current, an extra power supply is required in this case at the location of the antenna.

Due to the specific requirements for remote powering and frequency conversion the Meinberg GPS equipment is not necessarily compatible with GPS equipment from 3rd party manufacturers.
4.2.2 Mounting and Installation of the GPS Antenna

Proper installation of the GPS antenna/converter unit is illustrated in the figure below:

**Figure:** GPS Antenna mounted on a pole with a free view of the sky. The optional surge protector keeps high voltage strikes through the antenna cable away from the receiver.

Mounting material (plastic pole and holders, clamps for wall or pole mounting) is shipped with all Meinberg GPS antennae for easy installation. A standard RG58 antenna cable of 20 meters length is included by default. If a different cable length is required then this can be ordered accordingly.

Surge protectors should be installed indoors, directly where the antenna cable comes in. The optionally delivered protection kit is not for outdoor usage. The ground lead should be kept as short as possible and has to be connected to building’s ground rod.

Up to four GPS receivers can be fed by a single antenna/down-converter unit by using an antenna splitter which can optionally be cascaded. The total length of an antenna cable from the antenna to each receiver must not exceed the specified maximum length according to the cable type. The position of the splitter in the antenna line does not matter.
Note:
If the antenna cable is assembled locally instead of using a cable shipped with the GPS receiver it has to be made sure that the connectors have been soldered and assembled properly, and that there is no short-circuit in the cable or in one of the connectors. Otherwise GPS reception may be degraded, or the GPS receiver can even be damaged. Mount the antenna at a distance of at least 50 cm from other antennas.

**WARNING!**
Antenna mounting without effective anti-fall protection

**Danger to life due to fall!**
- Pay attention to effective working safety when installing antennas!
- Never work without an effective anti-fall equipment!

**WARNING!**
Working on the antenna system during thunderstorms

**Danger to life due to electrical shock!**
- Do not carry out any work on the antenna system or the antenna cable if there is a risk of a lightning strike.
- Do not carry out any work on the antenna system if the safety distance to free lines and sequential circuits is exceeded.
4.3 Powering up a GNSS Receiver

If both the antenna and the power supply have been connected the system is ready to operate. Depending on the type of oscillator installed in the receiver it takes about 10 seconds (OCXO-LQ) until 3 minutes (OCXO-MQ / HQ) until the oscillator has warmed up and reached the required frequency accuracy.

If the receiver has some valid almanac data in its battery buffered memory and the receiver’s position has not changed significantly since its last operation the receiver can determine which satellites are in view. Only a single satellite needs to be received to synchronize and generate output pulses, so synchronization can be achieved at least one minute (OCXO-LQ) until 10 minutes (OCXO-MQ / HQ) after power-up. After 20 minutes of operation the OCXO is fully adjusted and the generated frequencies are within the specified tolerances.

If the receiver position has changed by some hundred kilometers since last operation, the expected satellites may not be in view after power-up. In this case the receiver switches to Warm Boot mode where it starts scanning for all possible satellites one after the other. Once the receiver can track at least 4 satellites at the same time it updates its own position and switches to Normal Operation.

If no valid data can be found in the battery buffered memory, e.g. because the battery has been disconnected or replaced, the receiver has to scan for satellites and collect the current almanac and ephemeris data first. This mode is called Cold Boot, and it takes at least 12 minutes until all required data have been collected. The reason is that the satellites send all data repeatedly once every 12 minutes. After data collection is complete the receiver switches to Warm Boot mode to scan for more satellites, and finally enters Normal Operation.

In the default configuration neither pulse and synthesizer outputs, nor the serial ports are 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 has been installed) it can take some minutes until the oscillator’s output frequency has been adjusted properly. In this case the accuracy of the output frequency and pulses is also reduced until the receiver’s control loops have settled again.

On the frontpanel (‘Reference Time → Info GPS → GPS Satellites’) as well as via the Web GUI (‘Clock → Receiver Information’) you can check the number of satellites that are in view (i.e. above the horizon) and considered good (i.e. are healthy and can be tracked).