MANUAL

GPS180

GPS Satellite Receiver

8th November 2017

Meinberg Radio Clocks GmbH & Co. KG

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1 Imprint

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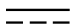
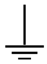
2 Safety Instructions for Building-in Equipment

This building-in equipment has been designed and tested in accordance with the requirements of Standard IEC60950-1 "Safety of Information Technology Equipment, including Electrical Business Equipment".

During installation of the building-in equipment in an end application (i.e. rack) additional requirements in accordance with Standard IEC60950-1 have to be taken into account.

- The building-in equipment is a class 1 - equipment and must be connected to an earthed outlet (TN Power System).
- The building-in equipment has been evaluated for use in office environment (pollution degree 2) and may be only used in this environment. For use in rooms with a higher pollution degree more stringent requirements are applicable.
- The building-in equipment may not be opened.
- Protection against fire must be assured in the end application.
- The ventilation opening may not be covered.
- The equipment/building-in equipment was evaluated for use in a maximum ambient temperature of 50°C (40 °C by using Rubidium).
- For safe operation the building-in equipment must be protected by max 16 A fuse in the power installation system.
- Disconnection of the equipment from mains is done by pulling the mains plug.

2.1 Used Symbols

Nr.	Symbol	Beschreibung / *Description*
1		IEC 60417-5031 Gleichstrom / *Direct current*
2		IEC 60417-5032 Wechselstrom / *Alternating current*
3		IEC 60417-5017 Erdungsanschluss / *Earth (ground) Terminal*
4		IEC 60417-5019 Schutzleiterklemme / *Protective Conductor Terminal*
5		Vorsicht, Risiko eines elektrischen Schlages / *Caution, possibility of electric shock*
6		ISO 7000-0434 Vorsicht, Risiko einer Gefahr / *Caution, Danger*
7		2002/96/EC Dieses Produkt fällt unter die B2B Kategorie. Zur Entsorgung muss es an den Hersteller übergeben werden. *This product is handled as a B2B category product. In order to secure a WEEE compliant waste disposal it has to be returned to the manufacturer.*

CE label
This device follows the provisions of the directives 93/68/EEC

3 General Information GPS

The satellite receiver clock GPS180 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.

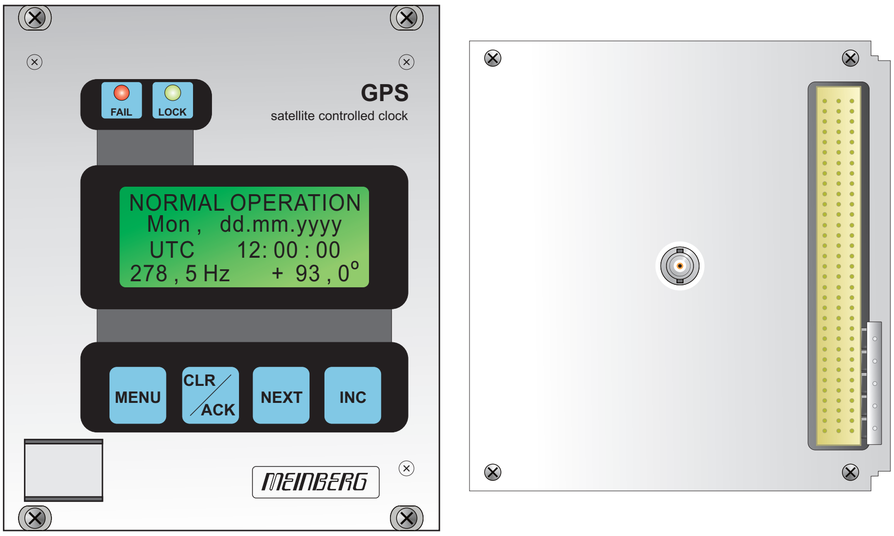
The Global Positioning System (GPS) is a satellite-based radio-positioning, navigation, and time-transfer system. It was installed by the United States Departement of Defense and provides two levels of accuracy: The Standard Positioning Service (SPS) and the Precise Positioning Service (PPS). While PPS 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.

4 The Modular System GPS180

The satellite controlled clock GPS180 is ready to operate and can be installed in a metal 19" Modular chassis. The interfaces provided by GPS180 are accessible via connectors in the rear panel of the case.



GPS180 (front/rear view basic configuration GPS180)

5 GPS180 Features

The GPS180 hardware is a 100mm x 160mm microprocessor board. The 105mm wide front panel integrates a 4 x 16 character LC display, two LED indicators and 4 push buttons. The receiver is connected to the antenna/converter unit by a 50? coaxial cable (refer to "Mounting the Antenna"). The antenna/converter unit is powered (DC insulation 1000VDC) via the antenna cable. As an option, an antenna splitter for up to four receivers connected to one antenna is available.

GPS180 is using the "Standard Positioning Service" SPS. The navigation message coming in from the satellites is decoded by GPS180´s microprocessor in order to track the GPS system time. Compensation of the RF signal´s propagation delay is done by automatical 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 oven controlled master oscillator (OCXO) and automatically compensates the OCXO´s aging. The last recent value is restored from the battery buffered memory at power-up.

The GPS180 provides different optional outputs, e.g. three progammable pulse outputs, modulated/unmodulated time code output, and up to a total of four RS232 COM ports. Additionally, you can order the GPS180 with different OCXOs (e.g. OCXO-LQ / MQ / HQ / DHQ or an external Rubidium) to match the required accuracy.

The hard- and software configuration of the clock is displayed if the NEXT key is pressed two times from the root menu (only GPS180/LCD).

5.1 Time Zone and Daylight Saving

GPS system time differs from the universal time scale (UTC) by the number of leap seconds which have been inserted into the UTC time scale since GPS was initiated in 1980. The current number of leap seconds is part of the navigation message supplied by the satellites, so the internal real time of the GPS180 is based on UTC time scale. Conversion to local time and annual daylight saving time can be done by the receiver's microprocessor if the corresponding parameters are set up by the user.

5.2 Pulse and Frequency Outputs

The pulse generator of GPS180 generates pulses once per second (P_SEC) and once per minute (P_MIN). Additionally, master frequencies of 10 MHz, 1 MHz and 100 kHz are derived from the OCXO. All the pulses are available with TTL level at the rear connector. The included synthesizer generates a frequency from 1/8 Hz up to 10 MHz synchronous to the internal timing frame. The phase of this output can be shifted from -360° to +360° for frequencies less than 10 kHz. Both frequency and phase can be setup from the front panel or using the serial port COM0. Synthesizer output is available at the rear connector as sine-wave output (F_SYNTH_SIN), with TTL level (F_SYNTH) and via an open drain output (F_SYNTH_OD). The open drain output can be used to drive an optocoupler when a low frequency is generated.

In the default mode of operation, pulse outputs and the synthesizer output are disabled until the receiver has synchronized after power-up. However, the system can be configured to enable those outputs immediately after power-up. An additional TTL output (TIME_SYN) reflects the state of synchronization. This output switches to TTL HIGH level when synchronization has been achieved and returns to TTL LOW level if not a single satellite can be received or the receiver is forced to another mode of operation by the user.

5.3 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.

5.4 Asynchronous Serial Ports (optional 4x COM)

Four asynchronous serial RS232 interfaces (COM0 ... COM3) are available to the user. In the default mode of operation, the serial outputs are disabled until the receiver has synchronized after power-up. However, the system can be configured to enable those outputs 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. A separate document with programming instructions can be requested defining a binary data format which can be used to exchange parameters with GPS180 via COM0.

5.5 Programmable pulse (optional)

At the male connector Typ VG64 there are three programmable TTL outputs (Prog Pulse 0-3), which are arbitrarily programmable.

Other technical details are described at the end of this manual.

5.6 Time Code (Option)

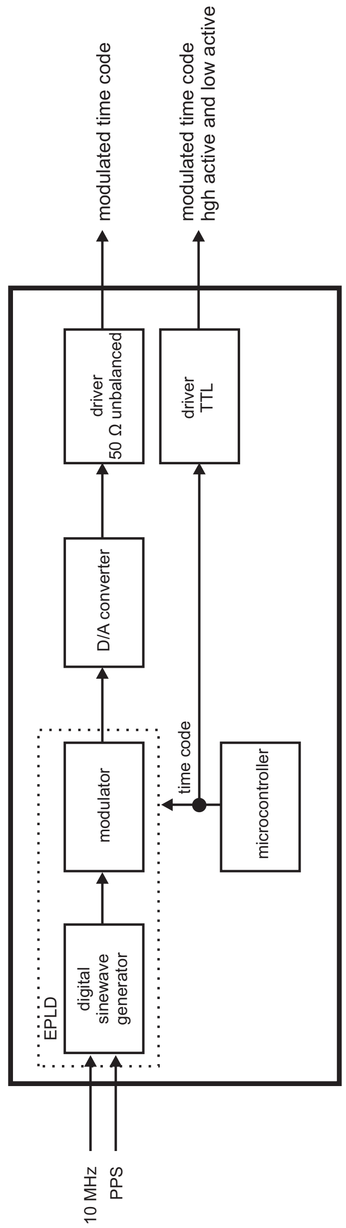
5.6.1 Abstract of Time Code

The transmission of coded timing signals began to take on widespread importance in the early 1950´s. Especially the US missile and space programs were the forces behind the development of these time codes, which were used for the correlation of data. The definition of time code formats was completely arbitrary and left to the individual ideas of each design engineer. Hundreds of different time codes were formed, some of which were standardized by the "Inter Range Instrumentation Group" (IRIG) in the early 60´s.

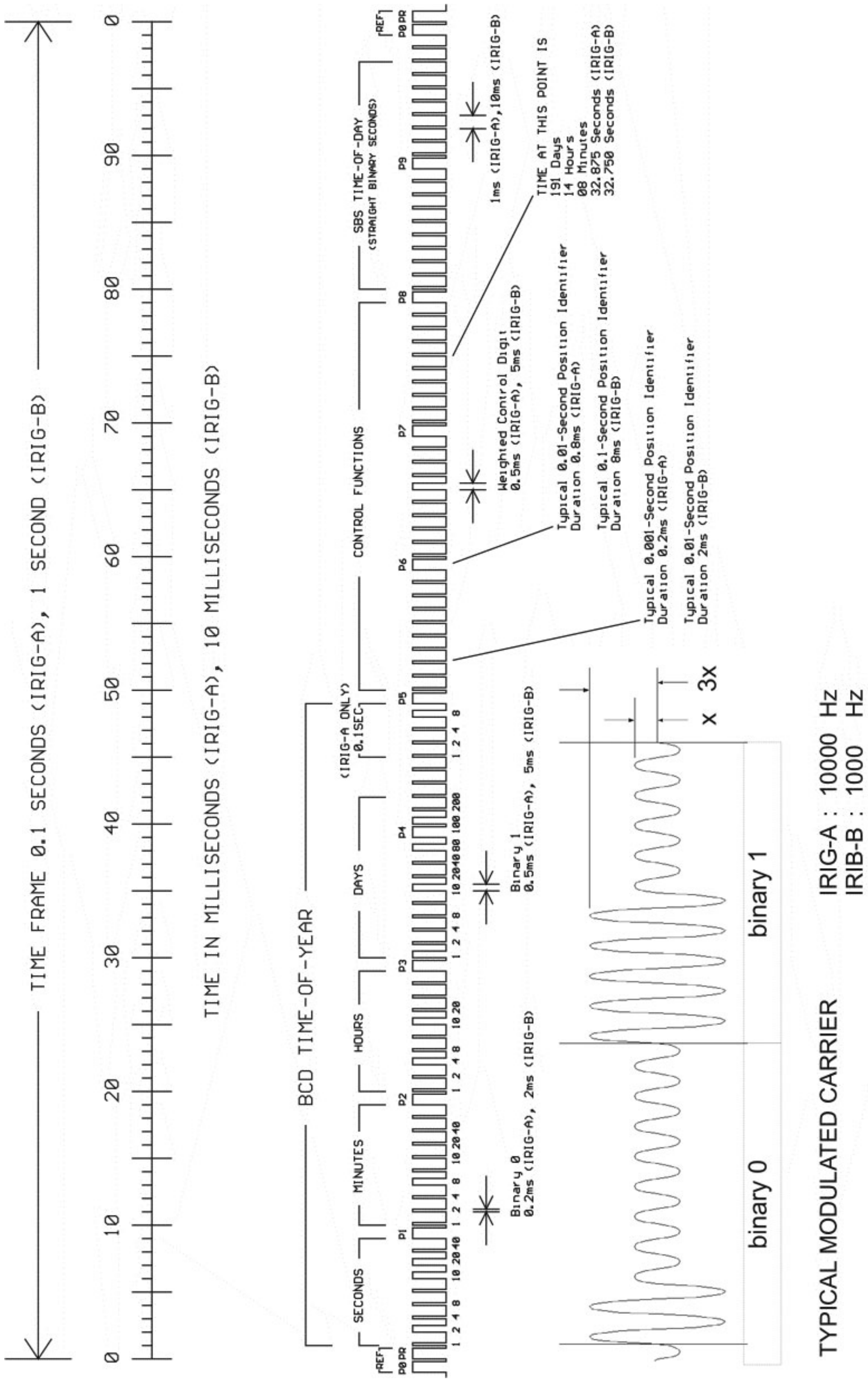
Except these "IRIG Time Codes", other formats like NASA36, XR3 or 2137 are still in use. The board GPS180 however generates the IRIG-B, AFNOR NFS 87-500 code as well as IEEE1344 code which is an IRIG-B123 coded extended by information for time zone, leap second and date. Other formats may be available on request.

A modulated IRIG-B (3 V_{pp} into 50W) and an unmodulated DC level shift IRIG-B (TTL) signal are available at the VG64 male connector of the module.

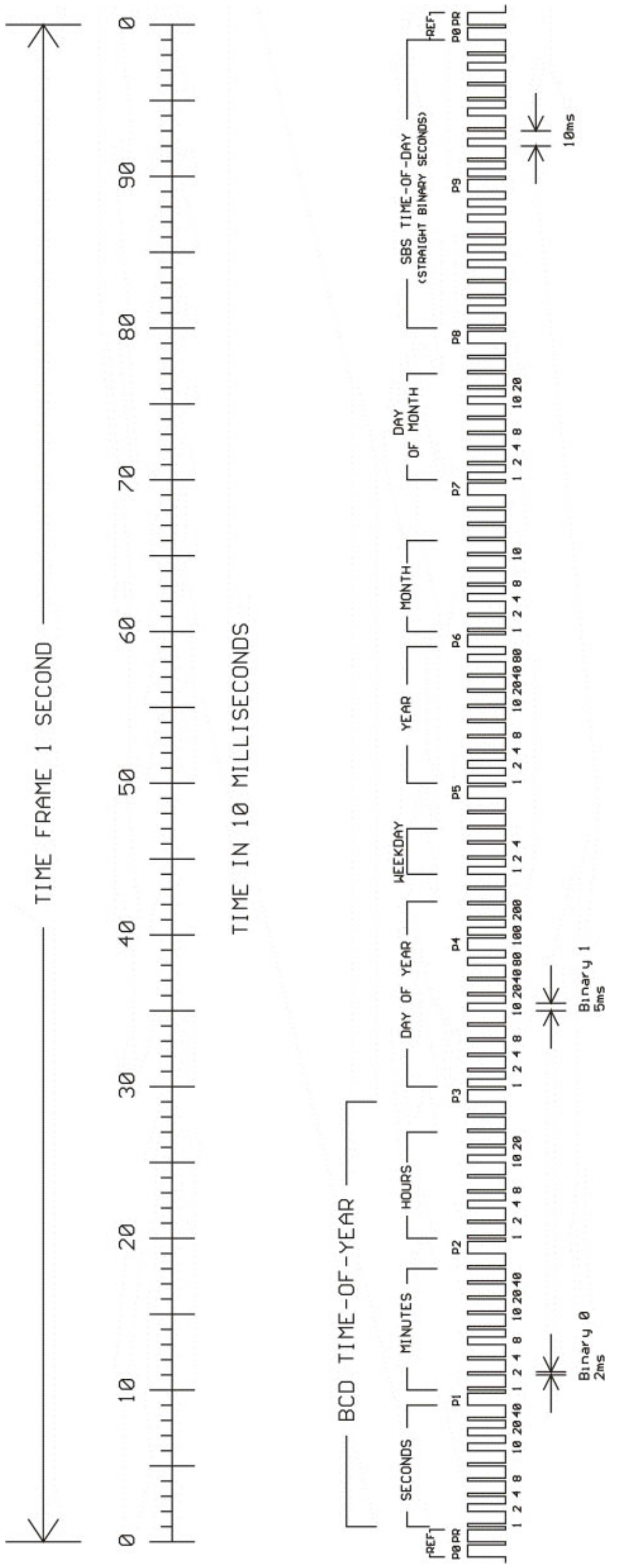
5.6.2 Block Diagram Time Code



5.6.3 IRIG Standard Format



5.6.4 AFNOR Standard Format



5.6.5 Assignment of CF Segment in IEEE1344 Code

Bit No.	Designation	Description
49	Position Identifier P5	
50	Year BCD encoded 1	
51	Year BCD encoded 2	low nibble of BCD encoded year
52	Year BCD encoded 4	
53	Year BCD encoded 8	
54	empty, always zero	
55	Year BCD encoded 10	
56	Year BCD encoded 20	high nibble of BCD encoded year
57	Year BCD encoded 40	
58	Year BCD encoded 80	
59	Position Identifier P6	
60	LSP - Leap Second Pending	set up to 59s before LS insertion
61	LS - Leap Second	0 = add leap second, 1 = delete leap second 1.)
62	DSP - Daylight Saving Pending	set up to 59s before daylight saving changeover
63	DST - Daylight Saving Time	set during daylight saving time
64	Timezone Offset Sign	sign of TZ offset 0 = '+', 1 = '-'
65	TZ Offset binary encoded 1	
66	TZ Offset binary encoded 2	Offset from IRIG time to UTC time.
67	TZ Offset binary encoded 4	Encoded IRIG time plus TZ Offset equals UTC at all times!
68	TZ Offset binary encoded 8	
69	Position Identifier P7	
70	TZ Offset 0.5 hour	set if additional half hour offset
71	TFOM Time figure of merit	
72	TFOM Time figure of merit	time figure of merit represents approximated clock error. 2.)
73	TFOM Time figure of merit	0x00 = clock locked, 0x0F = clock failed
74	TFOM Time figure of merit	
75	PARITY	parity on all preceding bits incl. IRIG-B time

1.) current firmware does not support leap deletion of leap seconds
2.) TFOM is cleared, when clock is synchronized first after power up. see chapter Selection of generated timecode

5.6.6 Generated Time Codes

Besides the amplitude modulated sine wave signal, the board also provides unmodulated DC-Level Shift TTL output in parallel. Thus six time codes are available.

a) B002: 100 pps, DCLS signal, no carrier
BCD time-of-year

b) B122: 100 pps, AM sine wave signal, 1 kHz carrier frequency
BCD time-of-year

c) B003: 100 pps, DCLS signal, no carrier
BCD time-of-year, SBS time-of-day

d) B123: 100 pps, AM sine wave signal, 1 kHz carrier frequency
BCD time-of-year, SBS time-of-day

e) B006: 100 pps, DCLS Signal, no carrier
BCD time-of-year, Year

f) B126: 100 pps, AM sine wave signal, 1 kHz carrier frequency
BCD time-of-year, Year

g) B007: 100 pps, DCLS Signal, no carrier
BCD time-of-year, Year, SBS time-of-day

h) B127: 100 pps, AM sine wave signal, 1 kHz carrier frequency
BCD time-of-year, Year, SBS time-of-day

i) AFNOR: Code according to NFS-87500, 100 pps, wave signal,
1kHz carrier frequency, BCD time-of-year, complete date,
SBS time-of-day, Signal level according to NFS-87500

j) IEEE1344: Code according to IEEE1344-1995, 100 pps, AM sine wave signal,
1kHz carrier frequency, BCD time-of-year, SBS time-of-day,
IEEE1344 extensions for date, timezone, daylight saving and
leap second in control functions (CF) segment.
(also see table 'Assignment of CF segment in IEEE1344 mode')

k) C37.118 Like IEEE1344 - with turned sign bit for UTC-Offset

5.6.7 Selection of Generated Time Code

The time code to be generated can be selected by Menu Setup IRIG-settings or the Monitorprogram GPSMON32 (except Lantime models). DC-Level Shift Codes (PWM-signal) B00x and modulated sine wave carrier B12x are always generated simultaneously. Both signals are provided at the VG64-Connector, i.e. if code B132 is selected also code B002 is available. This applies for the codes AFNOR NFS 87-500 and IEEE1344 as well.

The TFOM field in IEEE1344 code is set dependent on the 'already sync'ed' character ('#') which is sent in the serial time telegram. This character is set, whenever the preconnected clock was not able to synchronize after power up reset. The 'time figure of merit' (TFOM) field is set as follows.

Clock synchronized once after power up:	TFOM = 0000
Clock not synchronized after power up:	TFOM = 1111

For testing purposes the output of TFOM in IEEE1344 mode can be disabled. The segment is set to all zeros then.

5.6.8 Outputs

The module GPS180 provides modulated (AM) and unmodulated (DCLS) outputs. The format of the timecodes is illustrated in the diagramms "IRIG-" and "AFNOR standard-format".

5.6.8.1 AM - Sine Wave Output

The carrier frequency depends on the code and has a value of 1 kHz (IRIG-B). The signal amplitude is 3 Vpp (MARK) and 1 Vpp (SPACE) into 50 Ohm. The encoding is made by the number of MARK-amplitudes during ten carrier waves. The following agreements are valid:

a)	binary "0":	2 MARK-amplitudes, 8 SPACE-amplitudes
b)	binary "1":	5 MARK-amplitudes, 5 SPACE-amplitudes
c)	position-identifier:	8 MARK-amplitudes, 2 SPACE-amplitudes

5.6.8.2 PWM DC Output

The pulse width DCLS signals shown in the diagramms "IRIG" and "AFNOR standard format" are coexistent to the modulated output and is available at the VG connector pin 13a with TTL level.

5.6.9 Technical Data

Outputs: Unbalanced AM-sine wave-signal:
3 V_{pp} (MARK) / 1 V_{pp} (SPACE) into 50 Ohm

DCLS signal: TTL

6 Installation

6.1 Power Supply

The power supply used with a GPS180 has to provide only one output of +5V. The output voltage should be well regulated because drifting supply voltages reduce the short time accuracy of the generated frequencies and timing pulses. The power supply lines should have low resistance and must be connected using both pins a, b and c of the rear connector.

6.2 Mounting the GPS Antenna

The GPS satellites are not stationary, but circle round the globe with a period of about 12 hours. They can only be received if no building is in the line-of-sight from the antenna to the satellite, so the antenna/downconverter unit must be installed in a location that has as clear a view of the sky as possible. The best reception is achieved when the antenna has a free view of 8° angular elevation above the horizon. If this is not possible, the antenna should be installed with the clearest free view to the equator, because the satellite orbits are located between latitudes 55° North and 55° South. If this is not possible, you may experience difficulty receiving the four satellites necessary to complete the receiver's position solution.

The antenna/converter unit can be mounted on a wall, or on a pole up to 60 mm in diameter. A 50 cm plastic tube, two wall-mount brackets, and clamps for pole mounting are included. A standard RG58 coaxial cable should be used to connect the antenna/downconverter unit to the receiver. The maximum length of cable between antenna and receiver depends on the attenuation factor of the coaxial cable.

Up to four GPS180 receivers can be run with one antenna/downconverter unit by using an optional antenna splitter. The total length of an antenna line from antenna to receiver must not be longer than the max. length shown in the table below. The position of the splitter in the antenna line does not matter.

The optional delivered MBG S-PRO protection kit can also be used for outdoor installation (degree of protection: IP55).

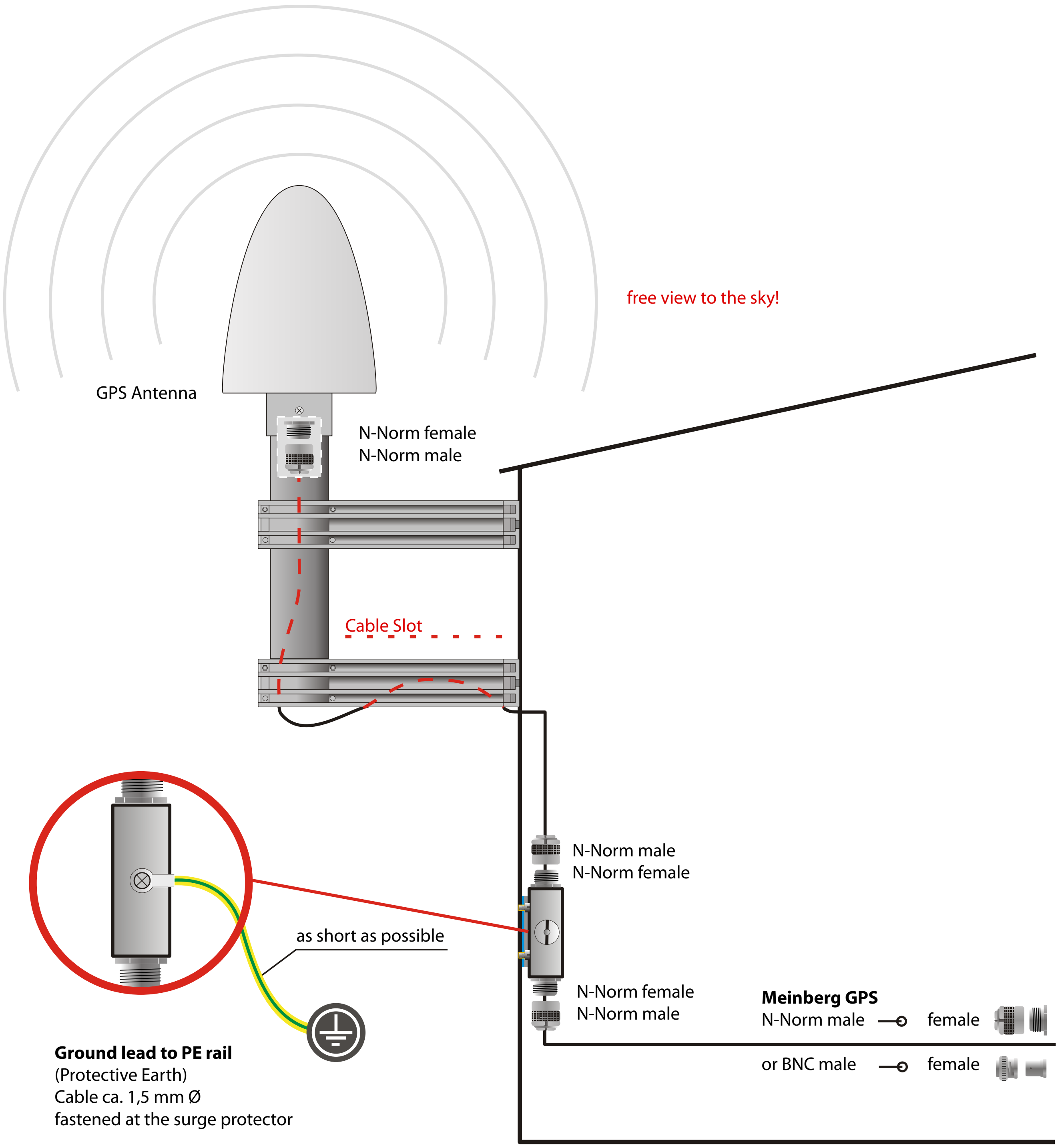
6.2.1 Example:

Type of cable	diameter Ø [mm]	Attenuation at 100MHz [dB]/100m	max lenght. [m]
RG58/CU	5mm	17	300 (1)
RG213	10.5mm	7	700 (1)

(1)This specifications are made for antenna/converter units produced after January, 2005
The values are typically ones; the exact ones are to find out from the data sheet of the used cable

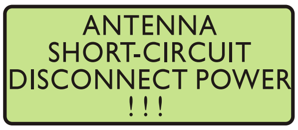
6.2.2 Antenna Assembly with Surge Voltage Protection

Optional a surge voltage protector for coaxial lines is available. The shield has to be connected to earth as short as possible by using the included mounting bracket. Normally you connect the antenna converter directly with the antenna cable to the system.



6.2.3 Antenna Short-Circuit

(systems with front display only)
In case of an antenna line short-circuit the following message appears in the display:

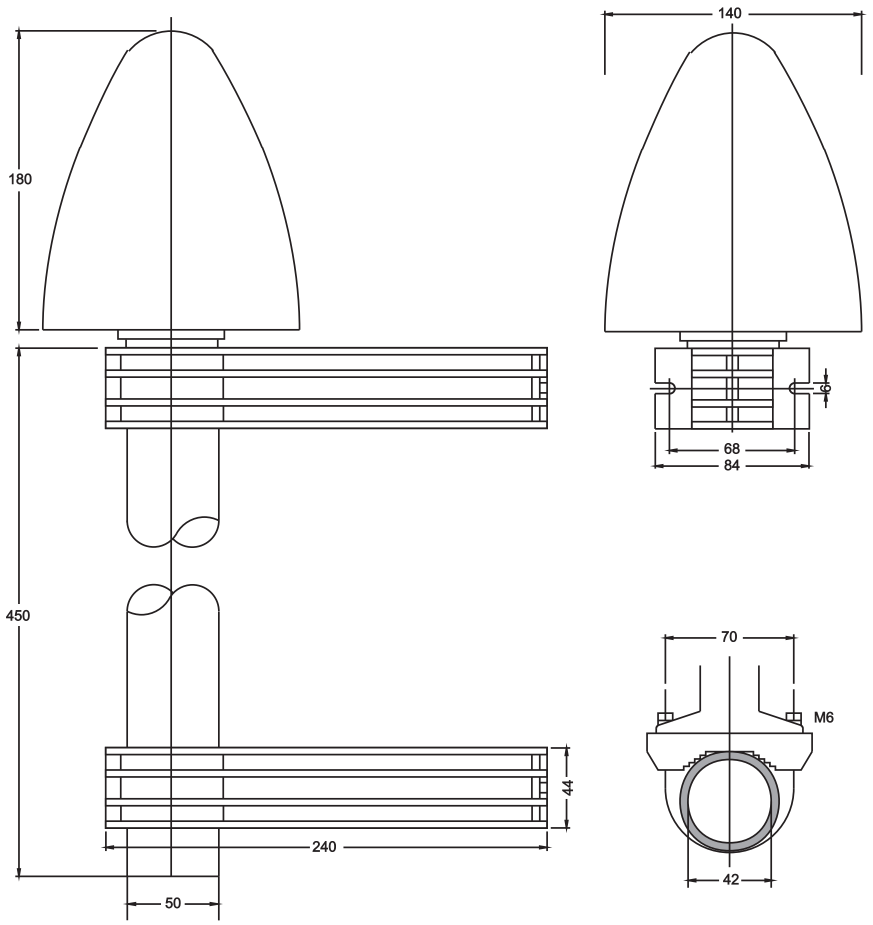


If this message appears the clock has to be disconnected from the mains and the defect eliminated. After that the clock can be powered-up again. The antenna supply voltage must be $15V_{DC}$.

6.2.4 Technical Specifications GPS Antenna

Antenna:	dielectrical patch antenna, receive frequency:	25 x 25 mm 1575.42 MHz
Bandwith:	9 MHz	
Converter:	local oscillator to converter frequency: first IF frequency:	 10 MHz 35.4 MHz
Power Requirements:	12V ... 18V, @ 100mA (provided via antenna cable)	
Connector:	N-Type, female	
Ambient Temperature:	-40 ... +65°C	
Housing:	ABS plastic case for outdoor installation (IP66)	

Physical Dimension:



6.3 Powering Up the System

If both the antenna and the power supply have been connected the system is ready to operate. About 10 seconds after power-up the receiver´s (OCXO-LQ) until 3 minutes (OCXO-MQ / HQ) 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 one minute after power-up (OCXO-LQ) until 10 minutes (OCXO-MQ / HQ) . 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.

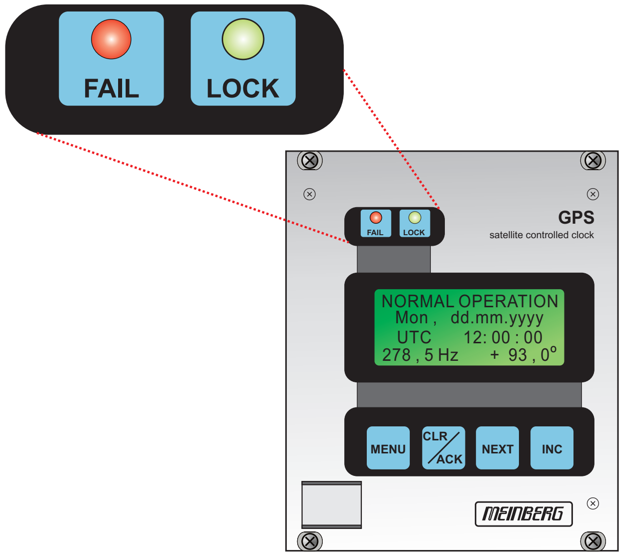
In the default mode of operation, neither pulse and synthesizer outputs nor the serial ports will be enabled after power-up until synchronization has been achieved. However, it is possible to configure some or all of those outputs to be enabled immediately after power-up. If the system starts up in a 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 +-5μs.

7 The Front Panel Layout

7.1 FAIL / LOCK LED

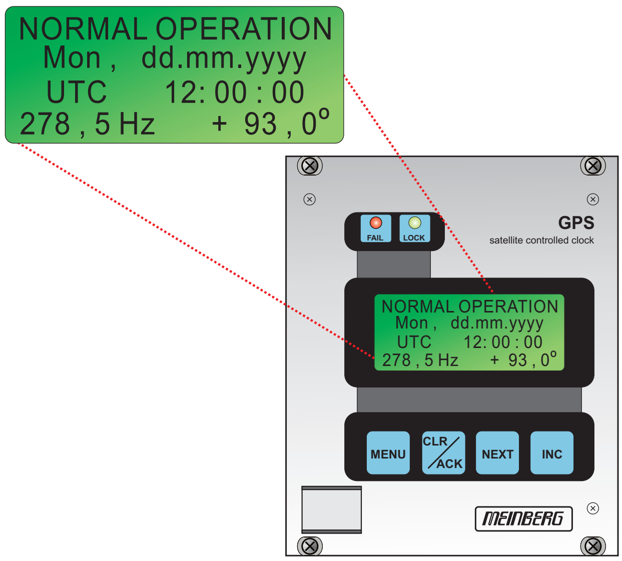
The FAIL LED is turned on whenever the TIME_SYN output is low (receiver is not synchronized).

The LOCK LED is turned on when after power-up the receiver has acquired at least four satellites and has computed its position. In normal operation the receiver position is updated continuously as long as at least four satellites can be received.



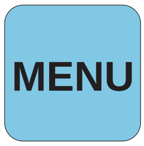
7.2 LC Display

The 4 x 16 character LC display is used to show the system's time and status and let the user edit parameters. The keys described below let the user select the desired menu. The next chapter lists all available menus in detail.



7.3 MENU Key

This key lets the user step through several display menus showing specific data.



7.4 CLR/ACK Key

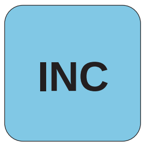
This key has to be used when parameters are to be modified. When this key is pressed the parameters that have been edited are saved in the battery buffered memory. If the menu is left without pressing CLR/ACK all changes are discarded.

7.5 NEXT Key

When editing parameters (LCD cursor is visible) this key moves the cursor to the next digit rsp. to the next parameter to be edited. If the current menu just displays data (cursor not visible) pressing this key switches to a submenu (if available).

7.6 INC Key

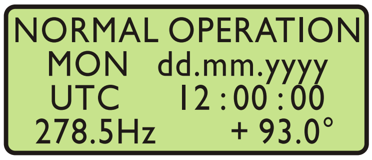
When editing parameters this key increments the digit or letter at the cursor position.



8 The Menus in Detail

8.1 Root Menu

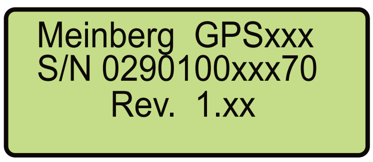
The root menu is shown when the receiver has completed initialization after power-up. The first line of the display shows the receiver´s mode of operation as described above. The text "NORMAL OPERATION" might be replaced by "COLD BOOT", "WARM BOOT", "UPDATE ALMANAC". If the antenna is disconnected or not working properly, the text "ANTENNA FAULTY" is displayed instead.



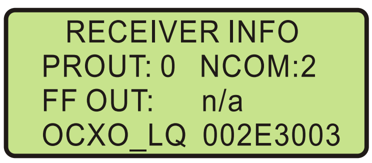
The next two lines display the current date, the name of the time zone (as defined in the setup menu) and local time. The last line shows the state of the synthesizer. It might look like following:

"Synth disabled"	Synthesizer is disabled (frequency setted on 0.000)
"F.synth inhibited"	GPS180 is not synchronized jet, but the synthesizer will be enabled after synchronisation.
"..............(free)"	The frequency is generated, but the phase is not synchronous to the pulse output P_SEC, either because the synthesizer is enabled although GPS180 has not synchronosized jet or be cause the frequency is setted to more than 10kHz.
"..............(drft)"	The frequency is generated and the phase was already synchronous to the pulse output P_SEC, but in the moment the phase can´t be controlled or adjusted because no satellite is received now.

If the NEXT key is pressed one time from the root menu a submenu is displayed showing the receiver´s software revision:



If the NEXT key is pressed for second time a submenu is displayed showing other receiver´s infos

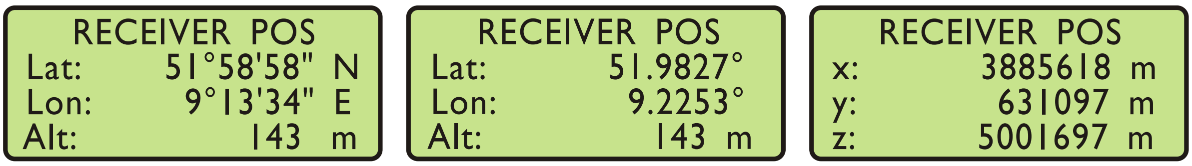


Meaning of the abbreviations and adjusted standard value:

"PROUT: 0"	programmable pulse standard: 0 (not available) optional: 3 (until three prog. pulse)
"NCOM: 2"	serial interface standard: 2 (COM0 and COM1) optional: 4 (COM0 - 3)
"FF_OUT"	frequency synthesizer for fixed frequencies standard: N/A (not available)
"OCXO_LQ"	used oscillator (see Oscillatorspecifications)
"002E3003"	EPLD Version (checksum)

8.2 Menu RECEIVER POS.

This menu shows the current receiver position. The NEXT key lets the user select one of three formats. The default format is geographic latitude, longitude and altitude with latitude and longitude displayed in degrees, minutes and seconds. The next format is geographic, too, with latitude and longitude displayed in degrees with fractions of degrees. The third format displays the receiver position in earth centered, earth fixed coordinates (ECEF coordinates). The three formats are shown below:



8.3 Menu SV CONSTELLATION

The SV constellation menu gives an overview of the current satellites (SVs) in view. The second line of the display shows the number of satellites with an elevation of 5° or more. The third line gives the number of satellites that can be used for navigation whereas the last line shows the selected set of satellites which are used to update the receiver position.

```
SV CONSTELLATION
  SVs in view:    6
  Good  SVs:      4
Sel:   1  12  13  24
```

The precision of the computed receiver position and time is affected by the geometric constellation of the four satellites beeing used. A set of values called dilutions of precision (DOP) can be computed from the geometric constellation. Those values can be displayed in a submenu of the SV constellation menu. PDOP is the position dilution of precision, TDOP is the time dilution of precision, and GDOP, computed from the others above, is the general dilution of precision. Lower DOP values mean more precision.

```
DILUTION OF PREC
   PDOP:   3.82
   TDOP:   1.12
   GDOP:   4.00
```

8.4 Menu SV POSITION

This menu gives information on the currently selected satellite (SV). The satellite´s ID number, its elevation, azimuth and distance from the receiver position reflect the satellite´s position in the sky whereas the doppler shows whether the satellite is coming up from the horizon (doppler positive) or going down to the horizon (doppler negative). All satellites in view can be monitored by using the NEXT key.

```
SV 12     INFO:
El:   6°      Az:   120°
Dist:        22073  km
Dopp:      +2.157  kHz
```

8.5 Menu USER CAPTURE

The time of the last recent capture event is displayed in this menu. The time zone depends on the parameters entered in the setup menu (see below). The NEXT key lets the display toggle between the two capture channels. If an error message ("Cap. Overrun" or "Cap. Buffer Full") is displayed in the second line it can be acknowledged pressing the CLR/ACK key.

```
USER   CAPTURE   0

MEZ         dd.mm.yyyy
12 : 00 : 00.1234567
```

```
USER   CAPTURE   1

MEZ         dd.mm.yyyy
12 : 00 : 00.1234567
```

8.6 Menu LOG EVENT

If the firmware version supports this then the device can store a number of log events in its non-volatile memory. If this feature is supported then this menu can be used to review and eventually clear the event log. When the menu is entered then the last event is displayed, e.g.:

```
LOG EVENT 12/12
WED, 30.11.2011
UTC      08:59:27
Antenna Disconn.
```

In the example above 12 events have been stored, and the 12th event is displayed. The NEXT and INC keys can be used to scroll through the list of event log entries. If the CLR/ACK key is pressed then the event log is cleared after the has once more acknowledged to continue.

```
LOG EVENT 0/0

** NO EVENTS **
```

Events which generate a log entry are e.g. power up reset, beginning and end of antenna problems, and changes in the mode of operation, e.g. cold boot, warm boot, normal operation.

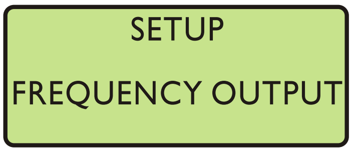
8.7 Menu SETUP

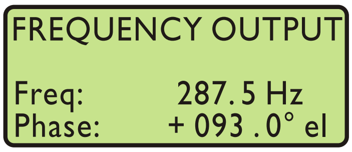
From this menu, several topics can be selected which let the user edit parameters or force special modes of operation. A specific topic can be selected using the NEXT key. Depending on the current topic, pressing the CLR/ACK key either enters edit mode with the selected set of parameters or switches to the selected mode of operation (after the user has acknowledged his decision). Once edit mode has been entered, the NEXT key lets the cursor move to the digit or letter to be edited whereas the INC key increments the digit or letter under the cursor. If changes have been made, the CLR/ACK key must be pressed in order to save those changes in the battery buffered memory, otherwise all changes are discarded when the user presses the MENU key in order to return to the SETUP display.

8.7.1 SETUP FREQUENCY OUTPUT

This setup menu lets the user edit the frequency and phase to be generated by the on-board synthesizer. Frequencies from 1/3Hz up to 10MHz can be entered using four digits and a range. The range can be selected if the INC 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), .2 (displayed as 1/4), .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 other fractions than those listed above are entered, an error message "(inval. frac.)" is displayed. In the upper ranges any fraction can be entered. If frequency is set to 0 the synthesizer is disabled.

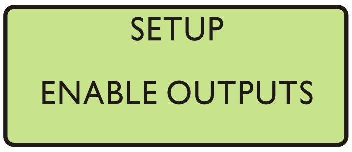
The last line of the display lets the user enter the phase of the generated frequency from -360° to +360° with a resolution of 0.1°. Increasing the phase lets the signal come out later. Phase affects frequencies less than 10.00 kHz only, if a higher frequency is selected a message "(phase ignored)" informs the user that the phase value is ignored. The synthesizer is re-initialized with the parameters on the display if the CLR/ACK key is pressed.

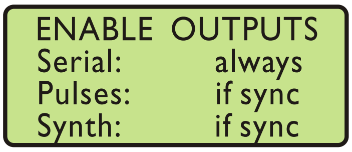




8.7.2 SETUP ENABLE OUTPUTS

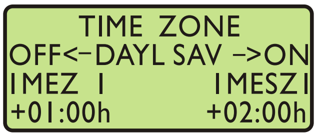
This menu lets the user configure at which time after power up the serial ports, pulse outputs, and frequency synthesizer output are to be enabled. Outputs which are shown to be enabled always will be enabled immediately after power-up. Outputs which are shown to be enabled if sync will be enabled after the receiver has decoded the signals from the satellites and has checked or corrected its on-board clock. The default setting for all outputs is if sync.





8.7.3 SETUP TIME ZONE

This menu 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. The left part of the display shows the zone and offset if daylight saving is off whereas the right part shows name and offset if daylight saving is on. These parameters are used to convert UTC to local time, e.g. MEZ = UTC + 1h and MESZ = UTC + 2h for central europe. The range of date daylight saving comes in effect can be entered using the next two topics of the setup menu.



8.7.4 SETUP IP CFG SETINGS (XPORT)

8.7.5 SETUP DAYLIGHT SAV ON/OFF

The two topics let the user enter the range of date for daylight saving to be in effect. Concerning parameter input both topics are handled identically, so they are described together in this chapter. 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 recompute the effective dates year by year. The figures below show how to enter parameters in both cases. 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 below March 25, 2000 is a Saturday, so the next Sunday is March 26, 2000.

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 (March 28, 1999 in the figures below), so the day-of-week doesn't need to be specified and therefore is displayed as wildcards.

```
SETUP
DAYLIGHT SAV ON
```

```
DAYLIGHT SAV ON
Date:      26.03.2000
Day of week:      ***
Time:         2:00:00
```

```
DAYLIGHT SAV ON
Date:      25.03.****
Day of week:      Sun
Time:         2:00:00
```

```
SETUP
DAYLIGHT SAV OFF
```

```
DAYLIGHT SAV OFF
Date:      29.10.2000
Day of week:      ***
Time:         3:00:00
```

```
DAYLIGHT SAV OFF
Date:      25.10.****
Day of week:      Sun
Time:         3:00:00
```

changeover date
for a single year

changeover the last Sunday
in March/October each year

If no changeover in daylight saving is wanted, an identical date and time must be configured in both of the submenus (see fig. below). In addition identical offsets for DAYLIGHT SAV ON/OFF should be configured in the submenu TIMEZONE.

```
SETUP
DAYLIGHT SAV ON
```

```
DAYLIGHT SAV ON
Date:      26.03.2000
Day of week:      ***
Time:         2:00:00
```

```
SETUP
DAYLIGHT SAV OFF
```

```
DAYLIGHT SAV OFF
Date:      26.03.2000
Day of week:      ***
Time:         2:00:00
```

```
SETUP
TIME ZONE
```

```
TIME ZONE
OFF<-DAYL SAV ->ON
I TIME I      I TIME I
+08:00h       +08:00h
```

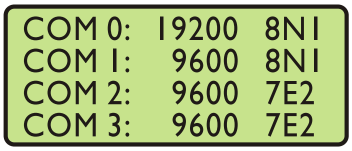
Example: For a region without daylight saving time and with a local time offset of +8 hours to UTC.

8.7.6 SETUP SERIAL PORT PARM

Using this topic the user can enter transmission speed and framing of each serial port. Default parameters are:

COM0: 19200 baud, 8N1	COM2: 9600 baud, 7E2
COM1: 9600 baud, 8N1	COM3: 9600 baud, 7E2

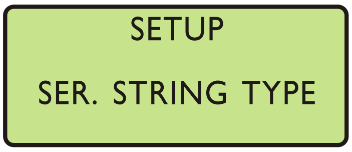
Annotation:
Even if one of the setup functions "INIT USER PARMS" is executed, the serial port parameters are reset to default values only if invalid parameters have been configured.

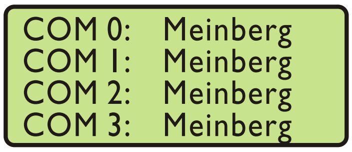


8.7.7 SETUP SERIAL STRING TYPE

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

COM0: Meinberg	COM2: Meinberg
COM1: Capture	COM3: Meinberg





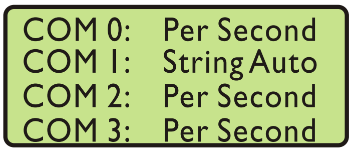
The following time strings can be selected:

- Meinberg Standard String
- Meinberg Capture String
- SAT String
- UNI-Erlangen String
- NMEA String (RMC)
- SPA String
- Computime String
- RACAL String
- SYSPLEX-1 String

Other technical details are described at the end of this manual.

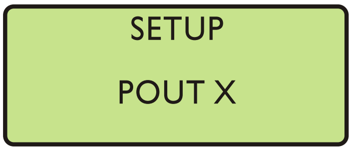
8.7.8 SETUP SERIAL STRING MODE

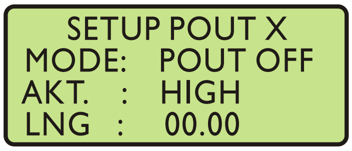
This menu lets the user select the serial ports' mode of operation. The possible modes depend on the selected output string. If a time string is selected it can be sent automatically "Per Second", "Per Minute" or only "On Request" (sending an ASCII "?" to the clock). If the capture string is selected it can be sent automatically when a trigger event occurs ("String Auto") or only "On Request" (sending an ASCII "?" to the clock). If capture message "On Request" is selected it is the user's responsibility to read out the capture buffer by sending an ASCII "?" to COMx or by the binary protocol via COM0 in order to avoid a buffer-overrun and the loss of new trigger events.



8.7.9 SETUP POUT X (optional)

This menu is used for configuration of the pulse outputs. There are three pulse outputs available (POUT 1-3).

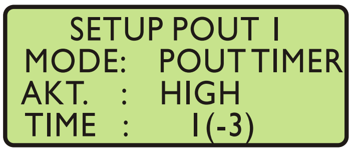


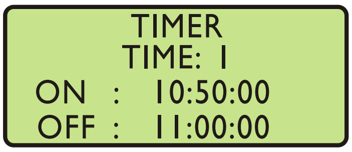


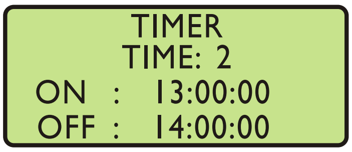
8.7.9.1 Mode

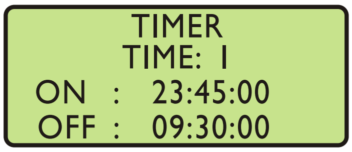
This field selects the mode of operation of an output. Possible modes are POUT OFF, POUT TIMER, SINGLE PULSE, CYCLIC PULSE, PPS, PPM and PPH.

8.7.9.2 Timer mode







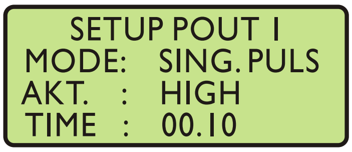


If Timer mode is selected, a window as shown above is displayed. The switching plan is assigned per day. Three turn-on and turn-off times are programmable for each output. If a switching time has to be configured, only the turn-on and turn-off time must be programmed.

Thus the example shows switching times from 10.50 to 11.00, 13.00 to 14.00 and 23.45 to 23.50. A turn-off time earlier than the turn-off time would cause the output to be enabled over midnight. For example a program 'On Time' 10.45.00, 'Off Time' 9.30.00 would cause an active ouput 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 fields 'On Time' and 'Off Time'. In this case the switch time does not affect the output.

8.7.9.3 Single Pulse

Selecting Single Pulse generates a single pulse of defined length once per day.

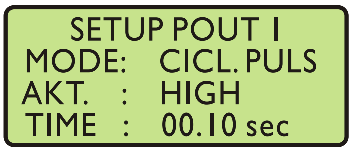


You can enter the time when the pulse is generated in the field **'Single Shot Time'**. The value in field **'Length'** determines the pulse duration. A pulse duration from 10 msec to 10 sec in steps of 10 msec can be selected.

The example shows a single pulse at 12:00 every day with a duration of 100 ms.

8.7.9.4 Cyclic mode

Cyclic mode is used for generating periodically repeated pulses.

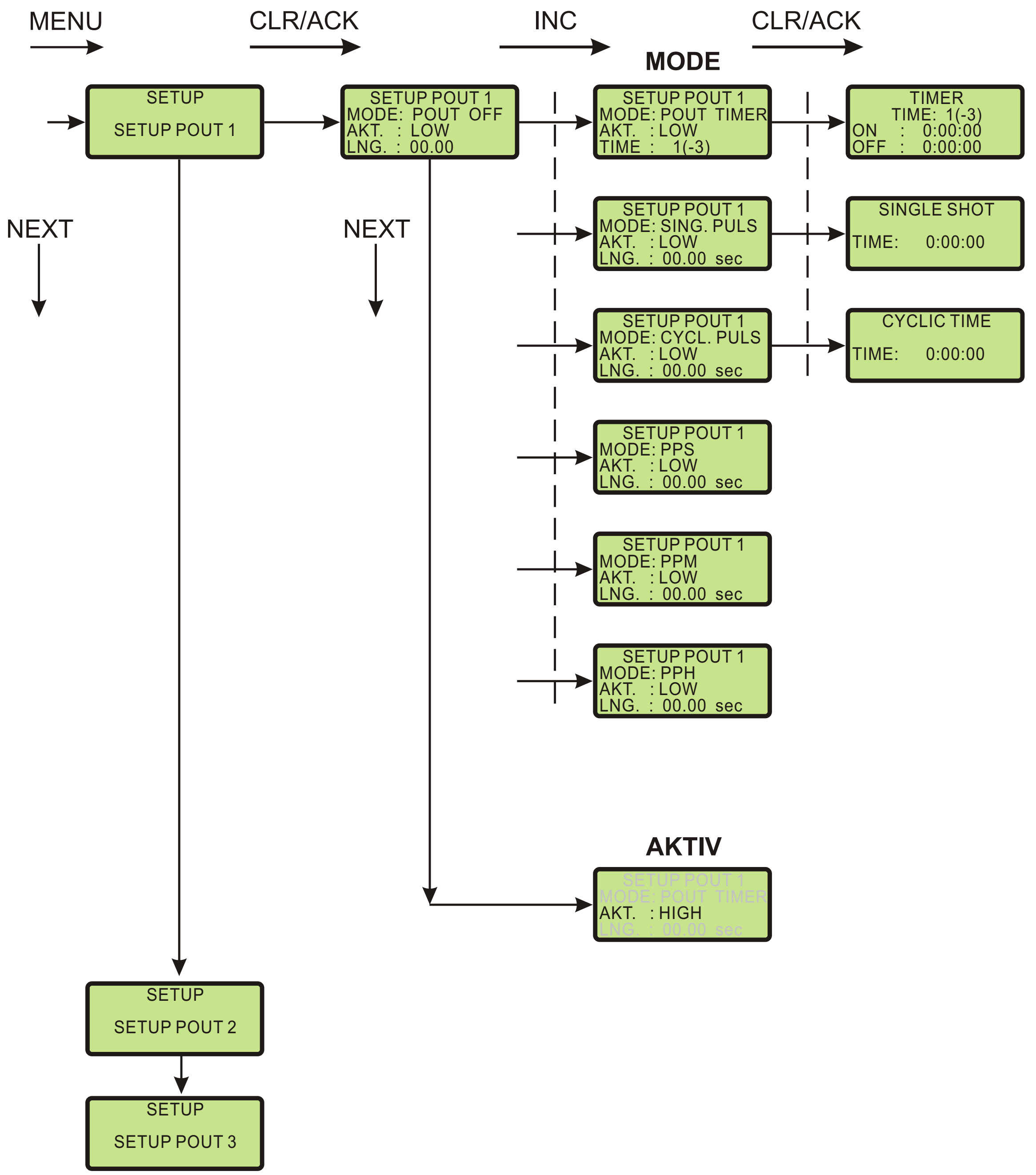


The value in field 'Cycle Time' determines the time between two consecutive pulses (2 sec in example above). This cycle time must be entered as hours, minutes and seconds. The pulse train is synchronized at 0:00 o'clock local time, so the first pulse of a day always occurs at midnight. A cycle time of 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 only a cycle times that causes a constant distance between all consecutive pulses make sense. For example a cycle time of 1 hour 45 minutes would generate a pulse every 6300 seconds (starting from 0 o'clock). The duration between the last pulse of a day and the first pulse of the next day (0:00:00 o'clock) would only be 4500 sec.

8.7.9.5 PPS, PPM, PPH Modes

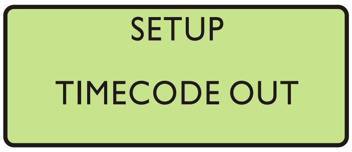
These modes generate pulses of defined length once per second, once per minute or one per hour. 'Single Shot Time' determines the pulse duration (10 msec...10 sec). The respective output remains in active state, when selecting a pulse duration longer than 990ms in pulse per sec mode.

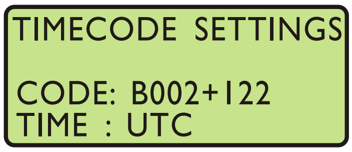
8.7.9.6 Menu Quick Reference for progr. Pulse



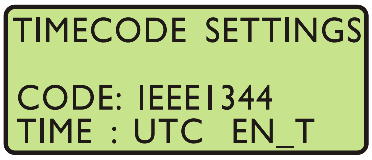
8.7.10 SETUP TIME CODE SETTINGS (optional)

This menu lets the user select the time codes to be generated by GPS180. Most IRIG codes do not carry any time zone information, hence UTC is selected for output by default. If desired, the clock's local time can be output by selecting "TIME: LOCAL".





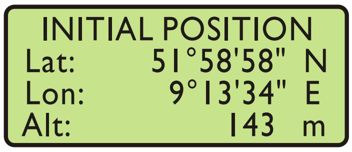
The IEEE1344 has a so called TFOM (time figure of merit) segment that carries an information on the synchronization state of the radio clock.



Whenever the selected time code carries TFOM, it can be blanked by selecting "disable TFOM", This feature can be helpful for testing when the connected IRIG reader evaluates TFOM.

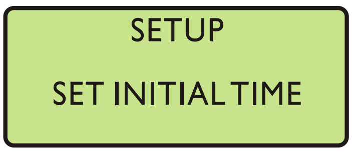
8.7.11 SETUP INITIAL POSITION

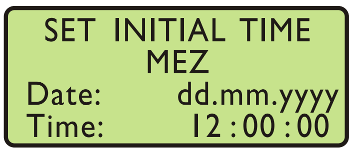
When the receiver is primarily installed at a new location far away from the last position saved in the receiver's memory the satellites in view and their dopplers will differ so much from those expected due to the wrong position that GPS180 has to scan for satellites in Warm Boot mode. Making the new approximately known position available to the receiver can avoid Warm Boot and speed up installation.



8.7.12 SETUP INITIAL TIME

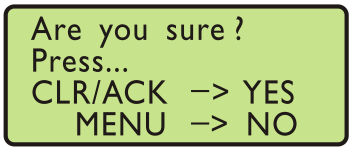
If the receiver's on-board real time clock keeps a wrong time the receiver is unable to compute the satellites' correct elevation angles and dopplers. This submenu enables the user to change the receiver's system time for initialization. After the receiver has locked, its real time clock will be adjusted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





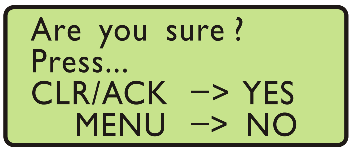
8.7.13 INIT USER PARMS

This menu lets the user set all parameters back to the default settings. The user has to acknowledge this menu again before the initialisation starts.



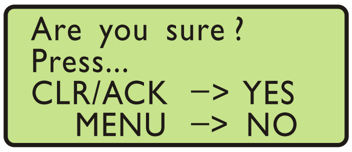
8.7.14 INIT GPS PARMS

This menu lets the user initialize all GPS datas, i.e. all saved satellite datas 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.



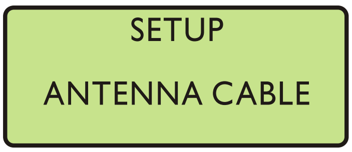
8.7.15 FORCE BOOT MODE

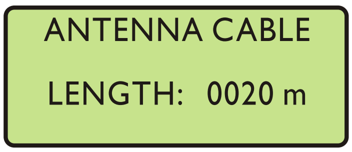
This menu lets the user force the receiver into the Boot Mode. This may be necessary when the satellite datas in the memory are too old or the receiver position has changed by some hundred kilometers since last operation. Syncronisation time may be reduced significant. If there are valid satellite datas in the memory the system starts in the WARM BOOT mode, otherwise the system changes into COLD BOOT to read new datas.



8.7.16 ANTENNA CABLE

This menu asks the user to enter the length of the antenna cable. The received time frame is delayed by approx. 5ns per meter antenna cable. The receiver is able to compensate this delay if the exact cable length is given. The default value is 20m. The maximum value that can be entered is 600m (only with low loss cable).

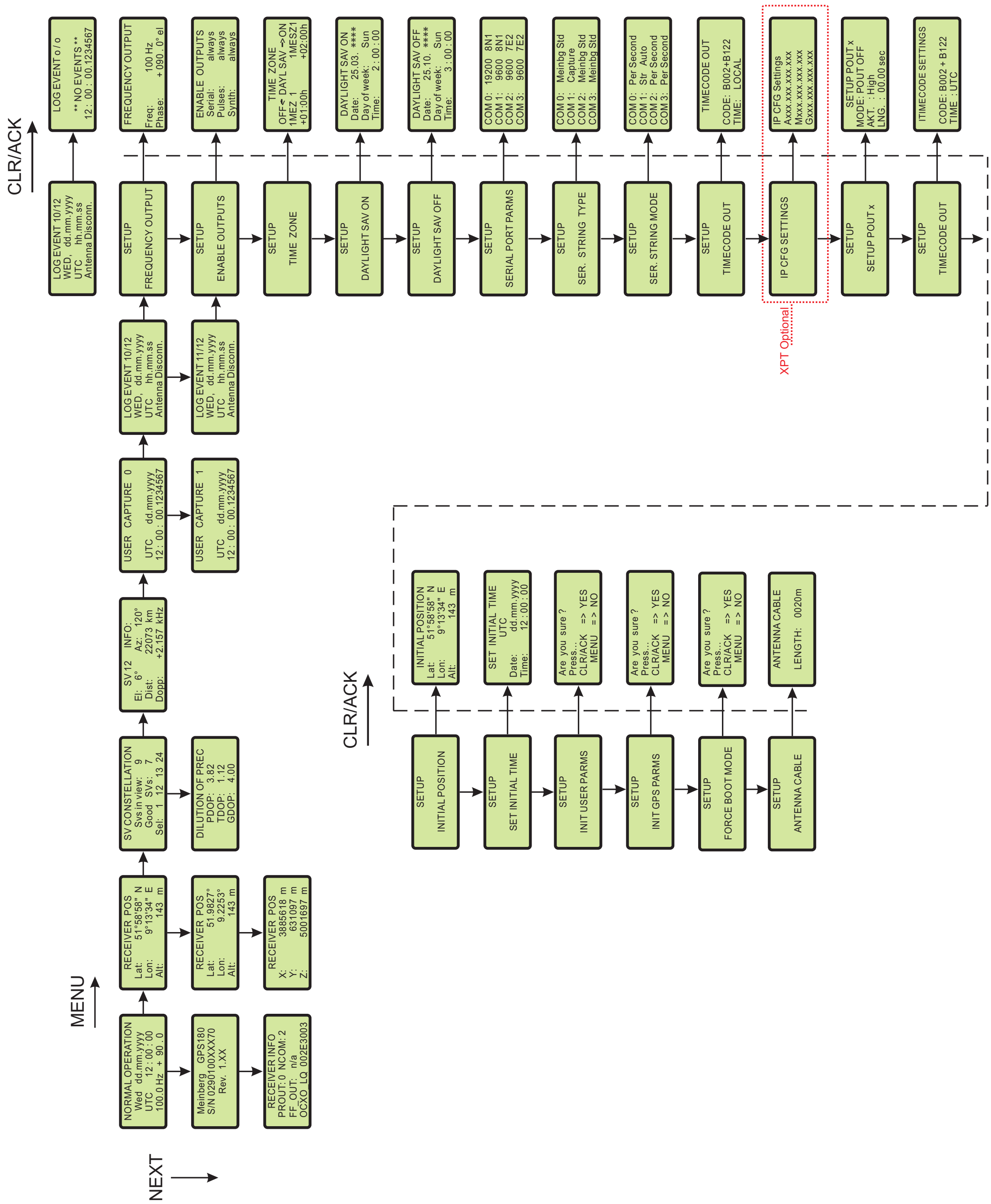




8.8 Resetting Factory Defaults

If both the NEXT key and the INC key on the front panel are pressed while the system is powered up the battery buffered memory is cleared and user definable parameters are reset to factory defaults. The key should be held until the root menu is displayed on LCD. Due to the fact that the satellites' parameters have been cleared, the system comes up in COLD BOOT mode.

9 Menu Quick GPS180 Reference



10 Firmware Updates

Whenever the on-board software must be upgraded or modified, the new firmware can be downloaded to the internal flash memory via the serial port COM0. There is no need to open the metal case and insert a new EPROM.

If the MENU key on the front panel is pressed while the system is powered up, a bootstrap-loader is actived and waits for instructions from the serial port COM0. The new firmware can be sent to GPS180 from any standard PC with serial interface. A loader program will be shipped together with the file containing the image of the new firmware.

The contents of the program memory will not be modified until the loader program has sent the command to erase the flash memory. So if the MENU key is pressed unintentionally while the system is powered up, the firmware will not be changed accidentially. After the next power-up, the system will be ready to operate again.

11 Skilled/Service-Personnel only: Replacing the Lithium Battery

The life time of the lithium battery on the board is at least 10 years. If the need arises to replace the battery, following should be noted:

ATTENTION!

Danger of explosion in case of inadequate replacement of the lithium battery. Only identical batteries or batteries recommended by the manufacturer must be used for replacement. The waste battery must be disposed as proposed by the manufacturer of the battery.

12 Technical Specifications GPS180

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 protection, automatic recovery isolation voltage 1000 V DC, provided via antenna cable
Antenna Input:	antenna circuit dc-insulated; dielectric strength: 1000V length of cable: refer to chapter "Mounting the Antenna
Time to Sychronization:	one minute with known receiver position and valid almanac 12 minutes if invalid battery buffered memory
Pulse Outputs:	change of second (P_SEC, TTL level) change of minute (P_MIN, TTL level)
Accuracy of Pulses:	after synchronization and 20 minutes of operation TCXO, OCXO LQ: better than +-100 nsec OCXO SQ/MQ/HQ: better than +-50 nsec OCXO DHQ, Rubidium: better than +-50 nsec better than +-2 μsec during the first 20 minutes of operation
Frequency Outputs:	10 MHz, TTL level into 50 Ohm 1 MHz, TTL level 100 kHz, TTL level
Frequency Synthesizer:	1/8 Hz up to 10 MHz
Accuracy of Synthesizer:	base accuracy depends on system accuracy 1/8 Hz to 10 kHz: Phase syncron with pulse output P_SEC 10 kHz to 10 MHz: frequency deviation < 0.0047 Hz
Synthesizer Outputs:	F_SYNTH: TTL level F_SYNTH_OD: open drain drain voltage: < 100 V sink current to GND: < 100 mA dissipation power at 25°C: < 360 mW F_SYNTH_SIN: sine-wave output voltage: 1.5 V eff. output impedance: 200 Ohm

Option Programmable Switch Outputs::	Up to four TTL outputs can configured independently for the following modes: - free programmable cyclic or fixed impulses - timecode - timer mode; three 'ON'- and three 'OFF'-states can be setup per day The switch states can be inverted for all three outputs, the impulse lengths are configurable in 10msec steps in a range from 10msec to 10sec. The impulse output can be configured for all channels together to 'always' or 'ifsync'.	
Time_Syn Output:	TTL HIGH level if synchronized	
Time Capture Inputs:	triggered on falling TTL slope Interval of events: 1.5msec min., Resolution: 100ns	
Serial Ports:	2 asynchronous serial ports RS-232 (optional max. 4 serial ports)	
	Baud Rate:	300, 600, 1200, 2400, 4800, 9600, 19200 Baud
	Framing:	7E1, 7E2, 7N2, 7O1, 7O2, 8E1, 8N1, 8N2, 8O1
	default setting:	
	COM0:	19200, 8N1 Meinberg Standard time string, per second
	COM1:	9600, 8N1 Capture string, automatically
Time Code Outputs:	Unbalanced modulated sine wave signal: $3V_{pp}$ (MARK), $1V_{pp}$ (SPACE) into 50 ohm DCLS-signal: TTL into 50 ohm, active-high or -low	
Power Requirements:	+5 V +-5%	
Current Consumption:	max. 1,2 A	(TCXO, OCXO-LQ)
	max. 1,4 A	(OCXO-MQ, OCXO-HQ)
	max. 2,4 A	(OCXO-DHQ)
Ambient Temp.:	0 ... 50°C	
Humidity:	85% max.	

ACCURACY OF FREQUENCY AND PULSE OUTPUTS:

Oscillators available for Meinberg GPS Receivers / Time Servers:
OCXO, TCXO, Rubidium

	TCXO	OCXO LQ	OCXO SQ	OCXO MQ	OCXO HQ	OCXO DHQ	Rubidium (only available for 3U models)
short term stability (τ = 1 sec)	$2\cdot10^{-9}$	$1\cdot10^{-9}$	$5\cdot10^{-10}$	$2\cdot10^{-10}$	$5\cdot10^{-12}$	$2\cdot10^{-12}$	$2\cdot10^{-11}$
accuracy of PPS (pulse per sec)	< ±100 ns	< ±100 ns	< ±50 ns	< ±50 ns	< ±50 ns	< ±50 ns	< ±50 ns
phase noise	1Hz -60dBc/Hz 10Hz -90dBc/Hz 100Hz -120dBc/Hz 1kHz -130dBc/Hz	1Hz -60dBc/Hz 10Hz -90dBc/Hz 100Hz -120dBc/Hz 1kHz -130dBc/Hz	1Hz -70dBc/Hz 10Hz -105dBc/Hz 100Hz -125dBc/Hz 1kHz -140dBc/Hz	1Hz -75dBc/Hz 10Hz -110dBc/Hz 100Hz -130dBc/Hz 1kHz -140dBc/Hz	1Hz < -85dBc/Hz 10Hz < -115dBc/Hz 100Hz < -130dBc/Hz 1kHz < -140dBc/Hz	1Hz < -80dBc/Hz 10Hz < -110dBc/Hz 100Hz < -125dBc/Hz 1kHz < -135dBc/Hz	1Hz -75dBc/Hz 10Hz -89dBc/Hz 100Hz -128dBc/Hz 1kHz -140dBc/Hz
accuracy free run, one day	$\pm1\cdot10^{-7}$ ±1Hz (Note1)	$\pm2\cdot10^{-8}$ ±0.2Hz (Note1)	$\pm5\cdot10^{-9}$ ±50mHz (Note1)	$\pm1.5\cdot10^{-9}$ ±15mHz (Note1)	$\pm5\cdot10^{-10}$ ±5mHz (Note1)	$\pm1\cdot10^{-10}$ ±1mHz (Note1)	$\pm2\cdot10^{-11}$ ±0.2mHz (Note1)
accuracy, free run, 1 year	$\pm1\cdot10^{-6}$ ±10Hz (Note1)	$\pm4\cdot10^{-7}$ ±4Hz (Note1)	$\pm2\cdot10^{-7}$ ±2Hz (Note1)	$\pm1\cdot10^{-7}$ ±1Hz (Note1)	$\pm5\cdot10^{-8}$ ±0.5Hz (Note1)	$\pm1\cdot10^{-8}$ ±0.1Hz (Note1)	$\pm5\cdot10^{-10}$ ±5mHz (Note1)
accuracy GPS-synchronous, average 24h	$\pm1\cdot10^{-11}$	$\pm1\cdot10^{-11}$	$\pm1\cdot10^{-11}$	$\pm5\cdot10^{-12}$	$\pm1\cdot10^{-12}$	$\pm1\cdot10^{-12}$	$\pm1\cdot10^{-12}$
accuracy of time free run, 1 day	± 4.3 ms	± 865 µs	± 220 µs	± 65 µs	± 22 µs	± 4.5 µs	± 1.1 µs
accuracy of time free run, 1 year	± 16 s	± 6.3 s	± 4.7 s	± 1.6 s	± 788 ms	± 158 ms	± 8 ms
temperature dependant drift free run	$\pm1\cdot10^{-6}$ (-20...70°C)	$\pm2\cdot10^{-7}$ (0...60°C)	$\pm1\cdot10^{-7}$ (-10...70°C)	$\pm5\cdot10^{-8}$ (-20...70°C)	$\pm1\cdot10^{-8}$ (5...70°C)	$\pm2\cdot10^{-10}$ (5...70°C)	$\pm6\cdot10^{-10}$ (-25...70°C)

Note 1: The accuracy in Hertz is based on the standard frequency of 10 MHz.

For example: Accuracy of TCXO (free run one day) is $\pm1\cdot10^{-7}\cdot10$MHz = ± 1 HZ

The given values for the accuracy of frequency and time (not short term accuracy) are only valid for a constant ambient temperature!
A minimum time of 24 hours of GPS-syncronicity is required before free run starts.

Steckerbelegung / Pin Assignment GPS180

	a	b (IMS)	c
1	VCC in (+5V)	VCC in (+5V)	VCC in (+5V)
2	VCC in (+12V)	VCC in (+12V)	VCC in (+12V)
3	VDD in (TCXO/OCXO)		VDD in (TCXO/OCXO)
4	(reserved, FreqAdjust out)	PPS out	ProgPulse3 out
5	FIXED FREQUENCY out	GND	10MHz in
6	PPS in	PPS in	PPS out
7	TIME CODE DC in	GND	PPS2 in
8	(reserved, 10 MHz_OSC in)	TC_DCLS in	PPM out
9	10 MHz SINE out	TC_AM in	
10	100 kHz out	Reserve 0	ProgPulse0 out
11	1 MHz out	GND	ProgPulse1 out
12	10 MHz out	-4.096MHz in	ProgPulse2 out
13	TIME CODE DC out	+4.096MHz in	SCL
14	TIME CODE AM out	GND	COM4 RxD in
15	COM2 RxD in	Board_ID0	SDA
16	COM2 TxD out	Board_ID1	(reserved, P7.5)
17	COM3 RxD in	Board_ID2	DCF_MARK out
18	COM3 TxD out	Board_ID3	(reserved, Vref/TxD2 TTL)
19	GND	Time Sync in	TIME_SYN out
20	GND	GND	(reserved, P7.6)
21	GND	10MHz in	F_SYNTH out
22	GND	GND	F_SYNTH_OD out
23	GND	Reserve 1	F_SYNTH_SIN out
24	GND	RxD in	COM1 TxD out
25	GND	Slot_ID0	COM4 TxD out
26	GND	Slot_ID1	COM0 TxD out
27	GND	Slot_ID2	CAP1 in
28	GND	Slot_ID3	CAP0 in
29	GND	+USB	COM1 RxD in
30	GND	-USB	COM0 RxD in
31	GND	GND	GND
32	GND	GND	GND
(yellow)	**IMS** Signale / Signals		
(green)	Hier verwendete Signale / used Signals		

Stecker: 96-polige VG-Leiste DIN 41612 a+b+c
Connector: 96-pin VG-male DIN 41612 a+b+c

IdentNr.: GPS180_V140_CON

12.1 Time Strings

12.1.1 Format of the Meinberg Standard Time String

The Meinberg Standard Time String is a sequence of 32 ASCII characters starting with the STX (start-of-text) character and ending with the ETX (end-of-text) character. The format is:

<STX>D:***dd.mm.yy;T:w;U:hh.mm.ss;uvxy***<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 sending with one bit accuracy at change of second		
dd.mm.yy	the current date:		
	dd	day of 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 current time:		
	hh	hours	(00..23)
	mm	minutes	(00..59)
	ss	seconds	(00..59, or 60 while leap second)

uv clock status characters (depending on clock type):

u:	'#'	GPS: clock is running free (without exact synchr.) PZF: time frame not synchronized DCF77: clock has not synchronized after reset
	' '	(space, 20h) GPS: clock is synchronous (base accuracy is reached) PZF: time frame is synchronized DCF77: clock has synchronized after reset
v:	'*'	GPS: receiver has not checked its position PZF/DCF77: clock currently runs on XTAL
	' '	(space, 20h) GPS: receiver has determined its position PZF/DCF77: clock is syncronized with transmitter

x time zone indicator:

'U'	UTC	Universal Time Coordinated, formerly GMT
' '	CET	European Standard Time, daylight saving disabled
	'S'	(CEST) European Summertime, daylight saving enabled

y anouncement of discontinuity of time, enabled during last hour before discontinuity comes in 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 Format of the Meinberg GPS Time String

The Meinberg Standard 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. Contrary to the Meinberg Standard Telegram the Meinberg GPS Timestring carries no local timezone or UTC but the direct GPS time without conversion into UTC. The format is:

<STX>D:*tt.mm.jj*;T:*w*;U:*hh.mm.ss*;*uv*G*y*;*lll*<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)
tt.mm.jj	the current date: *tt* day of month (01..31) *mm* month (01..12) *jj* year of the 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 while leap second)
uv	clock status characters: *u*: '#' clock is running free (without exact synchr.) ' ' (space, 20h) clock is synchronous (base accuracy is reached) *v*: '*' receiver has not checked its position ' ' (space, 20h) receiver has determined its position
G	time zone indicator 'GPS-Time'
y	anouncement of discontinuity of time, enabled during last hour before discontinuity comes in effect: 'A' announcement of leap second insertion ' ' (space, 20h) nothing announced
lll	number of leap seconds between UTC and GPS-Time (UTC = GPS-Time + number of leap seconds)
<ETX>	End-Of-Text, (ASCII Code 03h)

12.1.3 Format of the Meinberg Capture String

The Meinberg Capture String is a sequence of 31 ASCII characters terminated by a CR/LF (Carriage Return/-Line Feed) combination. The format is:

CH*x_tt.mm.jj_hh:mm:ss.fffffff*<CR><LF>

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:

x	0 or 1 corresponding on the number of the capture input
_	ASCII space 20h

dd.mm.yy the capture date:

dd	day of month	(01..31)
mm	month	(01..12)
yy	year of the century	(00..99)

hh:mm:ss.fffffff the capture time:

hh	hours	(00..23)
mm	minutes	(00..59)
ss	seconds	(00..59, or 60 while leap second)
fffffff	fractions of second, 7 digits	

<CR> Carriage Return, ASCII Code 0Dh

<LF> Line Feed, ASCII Code 0Ah

12.1.4 Format of the SAT Time String

The SAT Time String is a sequence of 29 ASCII characters starting with the STX (start-of-text) character and ending with the ETX (end-of-text) character. The format is:

<STX>*dd.mm.yy/w/hh:mm:ssxxxxuv*<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
sending with one bit accuracy at change of second

dd.mm.yy the current date:

dd	day of 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 current time:

hh	hours	(00..23)
mm	minutes	(00..59)
ss	seconds	(00..59, or 60 while leap second)

xxxx time zone indicator:

'UTC'	Universal Time Coordinated, formerly GMT
'CET'	European Standard Time, daylight saving disabled
'CEST'	European Summertime, daylight saving enabled

u clock status characters:

'#'	clock has not synchronized after reset
' '	(space, 20h) clock has synchronized after reset

v anouncement of discontinuity of time, enabled during last hour before discontinuity comes in effect:

'!'	announcement of start or end of daylight saving time
' '	(space, 20h) nothing announced

<CR> Carriage Return, ASCII Code 0Dh

<LF> Line Feed, ASCII Code 0Ah

<ETX> End-Of-Text, ASCII Code 03h

12.1.5 Format of the Uni Erlangen String (NTP)

The time string Uni Erlangen (NTP) of a GPS clock is a sequence of 66 ASCII characters starting with the STX (start-of-text) character and ending with the ETX (end-of-text) character. The format is:

<STX>***tt.mm.jj; w; hh:mm:ss; voo:oo; acdfg i;bbb.bbbbn lll.llll e hhhhm***<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 sending with one bit occuracy at change of second		
dd.mm.yy	the current date:		
	dd	day of 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 current time:		
	hh	hours	(00..23)
	mm	minutes	(00..59)
	ss	seconds	(00..59, or 60 while leap second)
v	sign of the offset of local timezone related to UTC		
oo:oo	offset of local timezone related to UTC in hours and minutes		
ac	clock status characters:		
	a:	'#'	clock has not synchronized after reset
		' '	(space, 20h) clock has synchronized after reset
	c:	'*'	GPS receiver has not checked its position
		' '	(space, 20h) GPS receiver has determined its position
d	time zone indicator:		
	'S'	CEST	European Summertime, daylight saving enabled
	' '	CET	European Standard Time, daylight saving disabled
f	anouncement of discontinuity of time, enabled during last hour before discontinuity comes in effect:		
	'!'	announcement of start or end of daylight saving time	
	' '	(space, 20h) nothing announced	
g	anouncement of discontinuity of time, enabled during last hour before discontinuity comes in effect:		
	'A'	announcement of leap second insertion	
	' '	(space, 20h) nothing announced	
i	leap second insertion		
	'L'	leap second is actually inserted (active only in 60th sec.)	
	' '	(space, 20h) no leap second is inserted	
bbb.bbbb	latitude of receiver position in degrees leading signs are replaced by a space character (20h)		
n	latitude, the following characters are possible:		
	'N'	north of equator	

	‘S’	south d. equator
lll.llll	longitude of receiver position in degrees leading signs are replaced by a space character (20h)	
e	longitude, the following characters are possible:	
	‘E’	east of Greenwich
	‘W’	west of Greenwich
hhhh	altitude above WGS84 ellipsoid in meters leading signs are replaced by a space character (20h)	
<ETX>	End-Of-Text, ASCII Code 03h	

12.1.6 Format of the NMEA 0183 String (RMC)

The NMEA String is a sequence of 65 ASCII characters starting with the '$GPRMC' character and ending with the characters CR (carriage return) and LF (line-feed). The format is:

$GPRMC,*hhmmss.ss,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 numbers or letters where as the other characters are part of the time string. The groups of characters as defined below:

$	Start character, ASCII Code 24h sending with one bit accuracy at change of second		
hhmmss.ss	the current time:		
	hh	hours	(00..23)
	mm	minutes	(00..59)
	ss	seconds	(00..59, or 60 while leap second)
	ss	fractions of seconds	(1/10 ; 1/100)
A	Status	(A = time data valid) (V = time data not valid)	
bbbb.bb	latitude of receiver position in degrees leading signs are replaced by a space character (20h)		
n	latitude, the following characters are possible:		
	'N'	north of equator	
	'S'	south d. equator	
lllll.ll	longitude of receiver position in degrees leading signs are replaced by a space character (20h)		
e	longitude, the following characters are possible:		
	'E'	east of Greenwich	
	'W'	west of Greenwich	
ddmmyy	the current date:		
	dd	day of month	(01..31)
	mm	month	(01..12)
	yy	year of the century	(00..99)
a	magnetic variation		
hh	checksum (EXOR over all characters except '$' and '*')		
<CR>	Carriage Return, ASCII Code 0Dh		
<LF>	Line Feed, ASCII Code 0Ah		

12.1.7 Format of the NMEA 0183 String (GGA)

The NMEA (GGA) String is a sequence of characters starting with the '$GPRMC' character and ending with the characters CR (carriage return) and LF (line-feed). The format is:

$GPGGA,*hhmmss.ss,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 numbers or letters where as the other characters are part of the time string. The groups of characters as defined below:

$	Start character, ASCII Code 24h sending with one bit accuracy at change of second		
hhmmss.ss	the current time:		
	hh	hours	(00..23)
	mm	minutes	(00..59)
	ss	seconds	(00..59, or 60 while leap second)
	ss	fractions of seconds	 (1/10 ; 1/100)
A	Status	(A = time data valid) (V = time data not valid)	
bbbb.bbbbb	latitude of receiver position in degrees leading signs are replaced by a space character (20h)		
n	latitude, the following characters are possible:		
	'N'	north of equator	
	'S'	south d. equator	
lllll.lllll	longitude of receiver position in degrees leading signs are replaced by a space character (20h)		
e	longitude, the following characters are possible:		
	'E'	east of Greenwich	
	'W'	west of Greenwich	
A	Position fix (1 = yes, 0 = no)		
vv	Satellites used (0..12)		
hhh.h	HDOP (Horizontal Dilution of Precision)		
aaa.h	Mean Sea Level altitude (MSL = altitude of WGS84 - Geoid Separation)		
M	Units, meters (fixed value)		
ggg.g	Geoid Separation (altitude of WGS84 - MSL)		
M	Units, meters (fixed value)		
cs	checksum (EXOR over all characters except '$' and '*')		
<CR>	Carriage Return, ASCII Code 0Dh		
<LF>	Line Feed, ASCII Code 0Ah		

12.1.8 Format of the NMEA 0183 String (ZDA)

The NMEA String is a sequence of 38 ASCII characters starting with the **'$GPZDA'** character 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 timezone.

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

$	Start character, ASCII Code 24h sending with one bit accuracy at change of second		
hhmmss.ss	the current UTC time:		
	hh	hours	(00..23)
	mm	minutes	(00..59)
	ss	seconds	(00..59 or 60 while leap second)
HH,II	the local timezone (offset to UTC):		
	HH	hours	(00..+-13)
	II	minutes	(00..59)
dd,mm,yy	the current date:		
	dd	day of month	(01..31)
	mm	month	(01..12)
	yyyy	year	(0000..9999)
cs	checksum (EXOR over all characters except '$' and '*')		
<CR>	Carriage Return, ASCII Code 0Dh		
<LF>	Line Feed, ASCII Code 0Ah		

12.1.9 Format of the ABB SPA Time String

The ABB SPA Time String is a sequence of 32 ASCII characters starting with the characters "**>900WD**" and ending with the **<CR>** (Carriage Return) character. The format is:

>900WD:*yy-mm-tt_hh.mm;ss.fff:cc*<CR>

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:

yy-mm-tt	the current date:		
	yy	year of the century	(00..99)
	mm	month	(01..12)
	dd	day of month	(01..31)
	_	Space (ASCII code 20h)	
hh.mm;ss.fff	the current time:		
	hh	hours	(00..23)
	mm	minutes	(00..59)
	ss	seconds	(00..59, or 60 while leap second)
	fff	milliseconds	(000..999)
cc	Check sum. EXCLUSIVE-OR result of the previous characters, displayed as a HEX byte (2 ASCII characters 0..9 or A..F)		
<CR>	Carriage Return, ASCII Code 0Dh		

12.1.10 Format of the Computime Time String

The Computime time string is a sequence of 24 ASCII characters starting with the T character and ending with the LF (line feed, ASCII Code 0Ah) character. The format is:

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 part of the time string. The groups of characters as defined below:

T	Start character sending with one bit accuracy at change of second		
yy:mm:dd	the current date:		
	yy	year of the century	(00..99)
	mm	month	(01..12)
	dd	day of month	(01..31)
	ww	the 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 while leap second)
<CR>	Carriage Return, ASCII Code 0Dh		
<LF>	Line Feed, ASCII Code 0Ah		

12.1.11 Format of the RACAL standard Time String

The RACAL standard Time String is a sequence of 16 ASCII characters terminated by a X (58h) character and ending with the CR (Carriage Return, ASCII Code 0Dh) character. The format is:

<X><G><U>*yymmddhhmmss*<CR>

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:

<X>	Control character sending with one bit accuracy at change of second		code 58h
<G>	Control character		code 47h
<U>	Control character		code 55h
yymmdd	the current date:		
	yy	year of the century	(00..99)
	mm	month	(01..12)
	dd	day of month	(01..31)
hh:mm:ss	the current time:		
	hh	hours	(00..23)
	mm	minutes	(00..59)
	ss	seconds	(00..59, or 60 while leap second)
<CR>	Carriage Return, ASCII code 0Dh		
Interface parameters:	7 Databits, 1 Stopbit, odd. Parity, 9600 Bd		

12.1.12 Format of the SYSPLEX-1 Time String

The SYSPLEX1 time string is a sequence of 16 ASCII characters starting with the SOH (Start of Header) ASCII controll character and ending with the LF (line feed, ASCII Code 0Ah) character.

Please note:
To receive the Timestring on a selected terminal correctly you have to send a " **C** " (once, without quotation marks).

The format is:

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

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:

<SOH>	Start of Header (ASCII control character) sending with one bit accuracy at change of second		
ddd	day of year		(001..366)
hh:mm:ss	the current time:		
	hh	hours	(00..23)
	mm	minutes	(00..59)
	ss	seconds	(00..59, or 60 while leap second)
	q	Quality indicator	(space) Time Sync (GPS lock) (?) no Time Sync (GPS fail)
<CR>	Carriage-return (ASCII code 0Dh)		
<LF>	Line-Feed (ASCII code 0Ah)		

12.1.13 Format of the ION Time String

The ION time string is a sequence of 16 ASCII characters starting with the SOH (Start of Header) ASCII controll character and ending with the LF (line feed, ASCII Code 0Ah) character. The format is:

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

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:

<SOH>	Start of Header (ASCII control character) sending with one bit accuracy at change of second		
ddd	day of year		(001..366)
hh:mm:ss	the current time:		
	hh	hours	(00..23)
	mm	minutes	(00..59)
	ss	seconds	(00..59, or 60 while leap second)
	q	Quality indicator	(space) Time Sync (GPS lock) (?) no Time Sync (GPS fail)
<CR>	Carriage-return (ASCII code 0Dh)		
<LF>	Line-Feed (ASCII code 0Ah)		