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Technical Information

Operating Instructions

GPS167LCD-MP

Impressum

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General Information

The satellite receiver clock GPS167 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 the new system which receives its information from the satellites of the Global Positioning System.

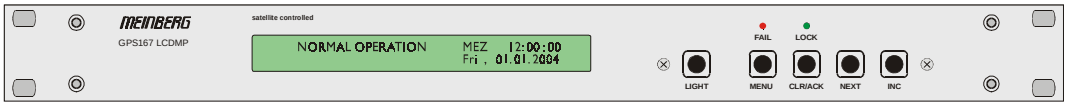
The Global Positioning System (GPS) is a satellite-based radio-positioning, navigation, and time-transfer system. It was installed by the United States Departement of Defense and provides two levels of accuracy: The Standard Positioning Service (SPS) and the Precise Positioning Service (PPS). While PPS 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 21 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.

The Modular System GPS167LCD-MP

GPS167LCD-MP GPS-Receiver is a set of equipment composed of a satellite controlled clock GPS167 (LQ-OCXO) together with a power supply unit Mean Well T-60B, both installed in a metal desktop case MULTIPAC and ready to operate. The interfaces and input/output signals provided by GPS167 are accessible via connectors in the rear and the front panel of the case. Details of the components are described below.



GPS167LCD-MP GPS-Receiver in desktop case MULTIPAC (front view)

GPS167 Features

The front panel integrates a 2 x 40 character LC display, two LED indicators and five push buttons. The receiver is connected to the antenna/converter unit by a 50 ohm coaxial cable (refer to "Mounting the Antenna"). Feeding the antenna/converter occurs DC insulated via the antenna cable. Optional an antenna splitter for up to four receivers connected to one antenna is available.

GPS167 is using the "Standard Positioning Service" SPS. The altitude with its variation of ±180m is the most inaccurate component of the position. This inaccuracy is caused by the operator (United States Departement of Defense) and not by the GPS167, but it has no influence on the accuracy of the generated time. The navigation message coming in from the satellites is decoded by GPS167´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.

Time Zone and Daylight Saving

GPS system time differs from the universal time scale UTC (**U**niversal **T**ime **C**oordinated) by the number of leap seconds which have been inserted into the UTC time scale after GPS has been initiated in 1980. The current number of leap seconds is part of the navigation message supplied by the satellites, so GPS167´s internal real time is based on UTC. Conversion to local time including handling of daylight saving year by year can be done by the receiver´s microprocessor if the corresponding parameters are set up by the user.

Pulse Outputs

The pulse generator of GPS167 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.

In the default mode of operation, pulse 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. 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.

Time Capture Inputs

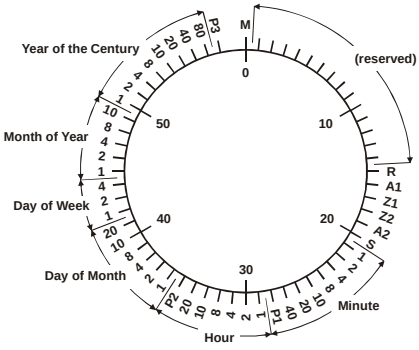
Two time capture inputs called User Capture 0 and 1 are provided at the rear connector (CAP0 and CAP1) to measure asynchronous time events. A falling TTL slope at one of these inputs lets the microprocessor save the current real time in its capture buffer. From the buffer, capture events are transmitted 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.

Asynchronous Serial Ports

Two asynchronous serial interfaces 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 Meinberg´s standard time string either once per second, once per minute or on request with ASCII ´?´ only. The interfaces can also 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 GPS167 via COM0.

DCF77 Emulation

The GPS167 satellite controlled clock generates TTL level time marks (active HIGH) which are compatible with the time marks spread by the German long wave transmitter DCF77. This long wave transmitter installed in Mainflingen near Frankfurt/ Germany transmits the reference time of the Federal Republic of Germany: time of day, date of month and day of week in BCD coded second pulses. Once every minute the complete time information is transmitted. However, GPS167 generates time marks representing its local time as configured by the user, including announcement of changes in daylight saving and announcement of leap seconds. The coding sheme is given below:



M	Start of Minute (0.1 s)
R	RF Transmission via secondary antenna
A1	Announcement of a change in daylight saving
Z1, Z2	Time zone identification
	Z1, Z2 = 0, 1: Daylight saving disabled
	Z1, Z2 = 1, 0: Daylight saving enabled
A2	Announcement of a leap second
S	Start of time code information
P1, P2, P3	Even parity bits

Time marks start at the beginning of new second. If a binary "0" is to be transmitted, the length of the corresponding time mark is 100 msec, if a binary "1" is transmitted, the time mark has a length of 200 msec. The information on the current date and time as well as some parity and status bits can be decoded from the time marks of the 15th up to the 58th second every minute. The absence of any time mark at the 59th second of a minute signals that a new minute will begin with the next time mark. The DCF emulation output is enabled immediately after power-up.

Installation

Mounting the Antenna

The GPS satellites are not stationary but circle round the globe in 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/converter unit must be installed in a location from which as much of the sky as possible can be seen. The best reception is given when the antenna has a free view of 8° angular elevation above horizon. If this is not possible the antenna should be installed with a mostly free view to the equator because of the satellite courses which are located between latitudes of 55° North and 55° South. If even this is not possible problems occure especially when at least four sattelites for positioning have to be found.

The antenna/converter unit can be mounted on a pole with a diameter up to 60 mm or at a wall. A 50cm plastic tube, two holders for wall-mounting and clamps for pole-mounting are added to every GPS167. A standard coaxial cable with 50 ohms impedance should be used to connect the antenna/converter unit to the receiver. The maximum lenght of cable between antenna and receiver depends on the attenuation factor of the used coaxial cable.

Example:

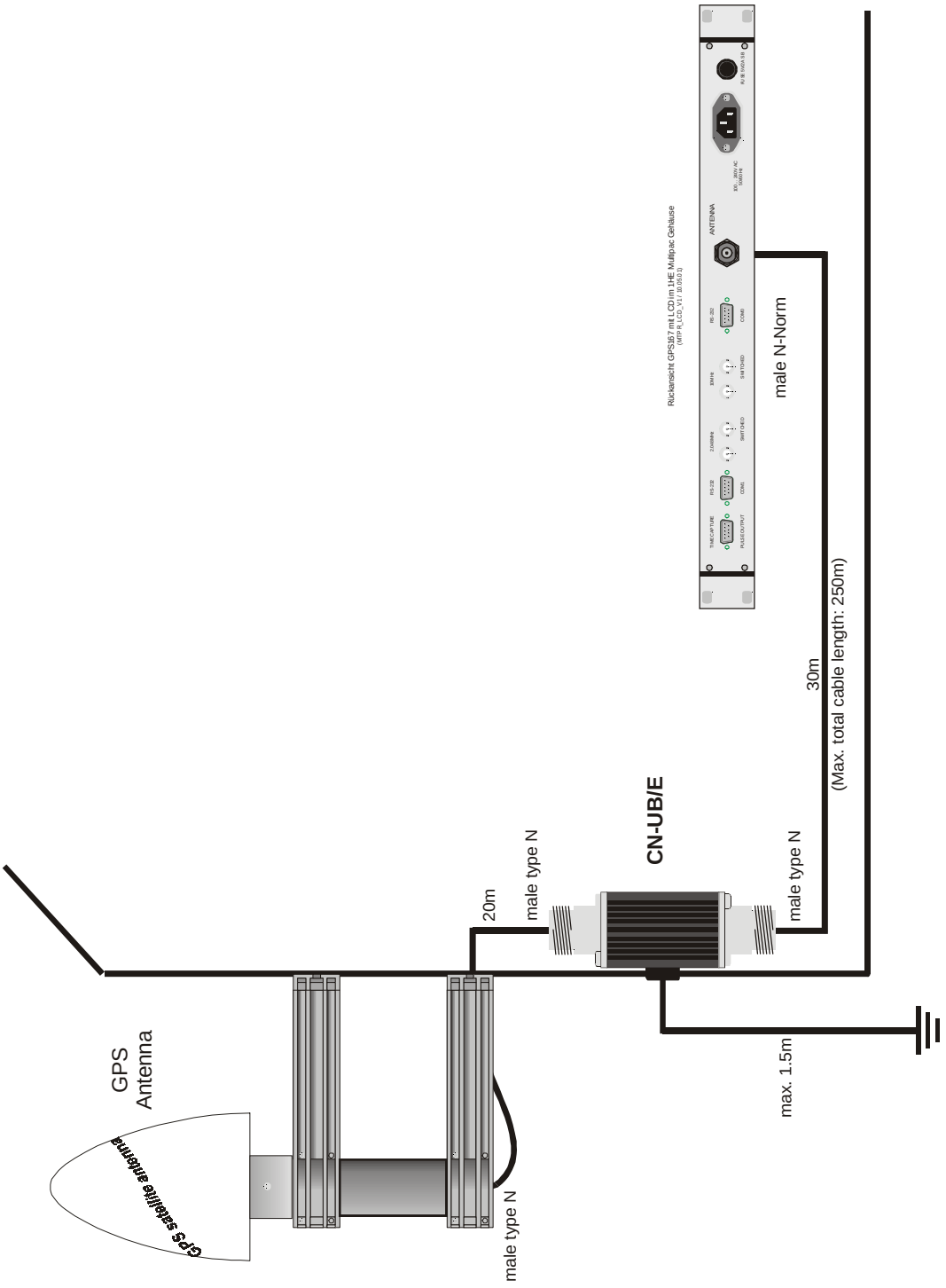
Type of cable	diameter Ø [mm]	Attenuation at 100MHz [dB]/100m	max. lenght [m]
RG58/CU	5mm	15.9	250 [1]
RG213	10.5mm	6.9	500 [1]

The values are typically ones; the exact ones are to find out from the data sheet of the used cable.

[1] This specifications are made for antenna/converter units produced after May, 1999. Older devices amount to 200m resp. 400m.

Up to four GPS167 receivers can be run with one antenna/converter unit by using the optional antenna splitter. The total length of one antenna line between antenna, splitter and receiver must not be longer than the max. lenght shown in the table above. The position of the splitter in the antenna line does not matter.

Assembly with CN-UB/E



Antenna Short-Circuit

In case of an antenna line short-circuit the following message appears in the display:

```
ANTENNA    SHORT-CIRCUIT
  DISCONNECT POWER !!!
```

If this message appears the clock has to be disconnected from the mains and the defect is to eliminate. After that the clock can be powered-up again. The antenna supply voltage must be in a range of 18.5V_{DC} (free) and 17V_{DC} (connected GPS antenna).

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 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 two minutes after power-up. After 20 minutes of operation the OCXO is full adjusted and the generated frequencies are within the spezified 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.

The Front Panel Layout

FAIL LED

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

LOCK LED

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. If the position is known, only one satellite sufficient to hold synchronisation.

LC Display

The 2 x 40 character LC display is used to show the receiver´s 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. A quick reference of the available menus and submenus can be found at the end of this document.

MENU Key

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

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.

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).

INC Key

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

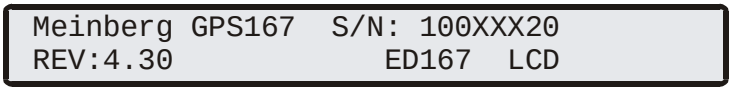
The Menus in Detail

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.

At the end of the two lines the day of the week, the current date, the name of the time zone (as defined in the setup menu) and local time is displayed.

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



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:

```
        RECEIVER POSITION
Lat:51°59’06’’N Lon: 9°13’30’’E Al:110m
```

```
        RECEIVER POSITION
Lat: 51.9851°  Lon: 9.2253°   Al: 110m
```

```
        RECEIVER POSITION
x: 3885422m   y: 631059m   z: 5001868m
```

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 (In view), the number of satellites that can be used for navigation (Good) and the selected set of satellites which are used to update the receiver position (Sel).

```
      SATELLITE CONSTELLATION
In view: 9   Good: 8   Sel:  3 19 26 13
```

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 PRECISION
PDOP:  4.33   TDOP:  2.88   GDOP:  5.20
```

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.

```
SATELITE 4 INFO:    El: 17°    AZ: 204°
Dist:   24000 km    Dopp:   -3.550 kHz
```

Menu GOOD SVS 24HOURSS MIN/MAX

This menu shows the maximum number as well as the minimum number of good satellites during the last 24 hours. Pressing CLR/ACK sets both values to the present number of good satellites.

```
      GOOD SVS 24 HOURS MIN / MAX
    MIN SVS: 4          MAX SVS: 12
```

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 CAP0
 MESZ 18.05.2001  12:00:00.1234567
```

```
USER CAP1
NA
```

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.

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**.

```
SETUP:     ENABLE OUTPUTS
```

```
Serial: if sync  Pulses:  if sync
```

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.

```
SETUP:     TIME ZONE
```

```
DAYLIGHT SAVING OFF:  !MEZ  ! +01:00h
DAYLIGHT SAVING ON :  !MESZ ! +02:00h
```

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: 25.03.****
 Day Of Week: SUN   Time:    2:00:00
```

```
SETUP:     DAYLIGHT SAV OFF
```

```
DAYLIGHT SAV OFF   Date: 25.10.****
Day Of Week: SUN   Time:    3:00:00
```

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.

```
DAYLIGHT SAV ON    Date: 26.03.2000
Day Of Week: ***   Time:    2:00:00
```

```
DAYLIGHT SAV OFF   Date: 26.03.2000
Day Of Week: ***   Time:    2:00:00
```

```
DAYLIGHT SAVING OFF:  !TIME! +08:00h
DAYLIGHT SAVING ON :  !TIME! +08:00h
```

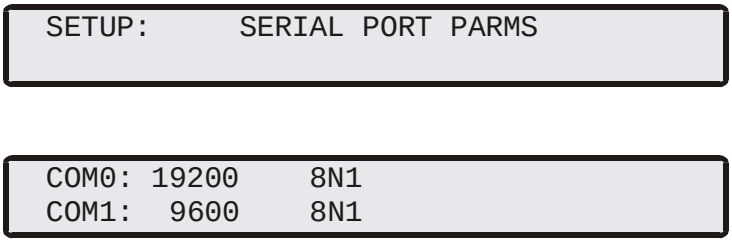
(Example for a region without daylight saving time and with a local time offset of +8 hours to UTC.)

SETUP SERIAL PORT PARM

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

COM0: 19200 baud, 8N1
COM1: 9600 baud, 8N1

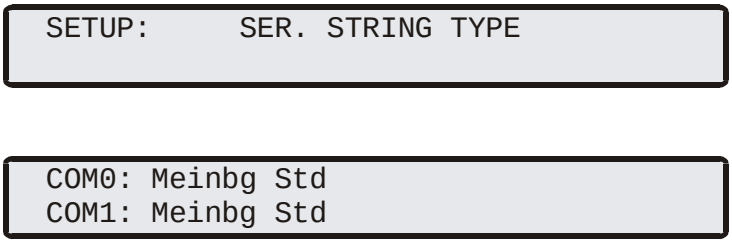
Annotation: Even if one of the setup functions “INIT USER PARMS” or “Resetting Factory Defaults” is executed, the serial port parameters are reset to default values only if invalid parameters have been configured.



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
COM1: Uni Erlangen



The following time strings can be selected:

- Meinberg Standard String
- GPS167 Capture String
- SAT String
- UNI-Erlangen String
- NMEA String (RMC)
- SPA String
- COMPUTIME String

Refer to chapter **Time Strings** for details.

SETUP SERIAL STRING MODE

This menu lets the user select the serial ports´ mode of operation. The possible modes depends on the selected output string. When a time string is selected it can be sent automatically "Per Second", "Per Minute" or only "On Request" (sending an ASCII "**?**" to the clock). When 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 COM1 or by the binary protocol via COM0 in order to avoid a buffer-overrun and the loss of new trigger events.

```
SETUP:     SER. STRING MODE
```

```
COM0: Per Second
COM1: Cap.Events
```

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 GPS167 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.

```
 SETUP:     INITIAL POSITION
```

```
           INITIAL POSITION
Lat:51°59’06’’N Lon: 9°13’30’’E Al:110m
```

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.

```
 SETUP:     INITIAL TIME
```

```
SET INITIAL TIME        MESZ
Date: 18.05.2001   Time:  12:00:00
```

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.

```
 SETUP:     INIT USER PARMS
```

```
Are you sure ?     Press ...
    INC => YES       MENU => NO
```

INIT GPS PARMS

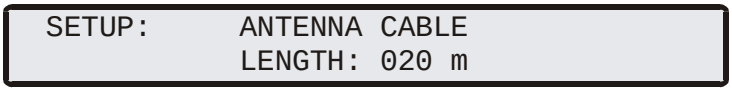
This menu lets the user initialize all GPS datas, i.e. all saved satellite datas will be cleared. The user has to acknowledge this menu again before the initialisation starts. The system starts operating in the COLD BOOT mode and seeks for a satellite to read its actual parameters.

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 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 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 500m (only with low loss cable).



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.

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 GPS167 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.

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, the 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.

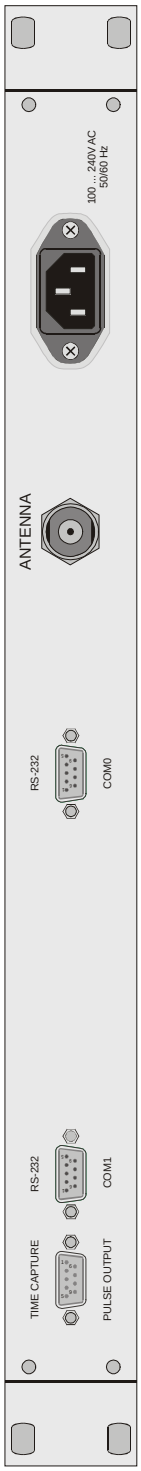
Technical Specifications GPS167LCD-MP

HOUSING:	Metal desktop case, MULTIPAC Schroff Front panel: 1 U / 84 HP (43.6 mm high / 426.4 mm wide)
PROTECTION RATING:	IP20
PHYSICAL DIMENSIONS:	482,6 mm wide x 43,7 mm high x 285 mm deep

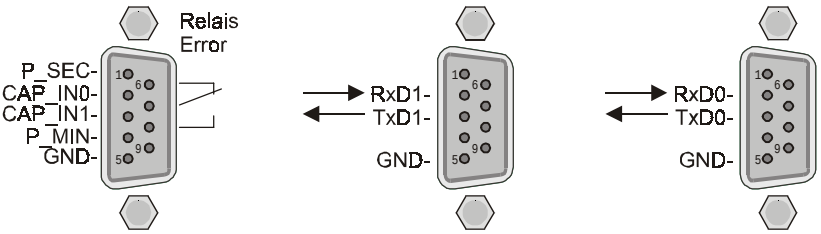
Front/Rear Panel Connectors

Name	Type	Signal	Cable
COM0	9 pin SUB-D	RS232	shielded data line
COM1	9 pin SUB-D	RS232	shielded data line
Time Capture	9 pin SUB-D	TTL input	shielded line
Error Relay	(on time capt. conn)	Relay, change over contact	
Antenna	Coax type N	35.4 MHz / 10 Mhz	shielded coaxial line
Power supply	power cord receptacle	90 ... 260V	power supply cord

Rear View GPS167LCD-MP



Pin Assignments of the SUB-D Connectors



Time Capture

RS-232 COM1

RS-232 COM0

CE Label

CE

This device conforms to the directive 89/336/EWG on the approximation of the laws of the Member States of the European Community relating to electromagnetc compatibility.

Technical Specifications GPS167 (OCXO-LQ)

RECEIVER:	6 channel C/A code receiver with external antenna/converter unit
ANTENNA:	Antenna/converter unit with remote power supply refer to chapter "Technical Specifications GPS167 Antenna"
ANTENNA INPUT:	antenna circuit dc-insulated; dielectric strength: 1000V⎓ Length of cable: refer to chapter "Mounting the Antenna"
LC DISPLAY:	2 x 40 character, menu selectable by push buttons
TIME TO SYNCHRONIZATION:	max. 2 minutes 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:	better than ±250 nsec after synchronization and 20 minutes of operation better than ±2 µsec during the first 20 minutes of operation
FREQUENCY OUTPUTS:	10 MHz, 1 MHz, 100 kHz (TTL level)

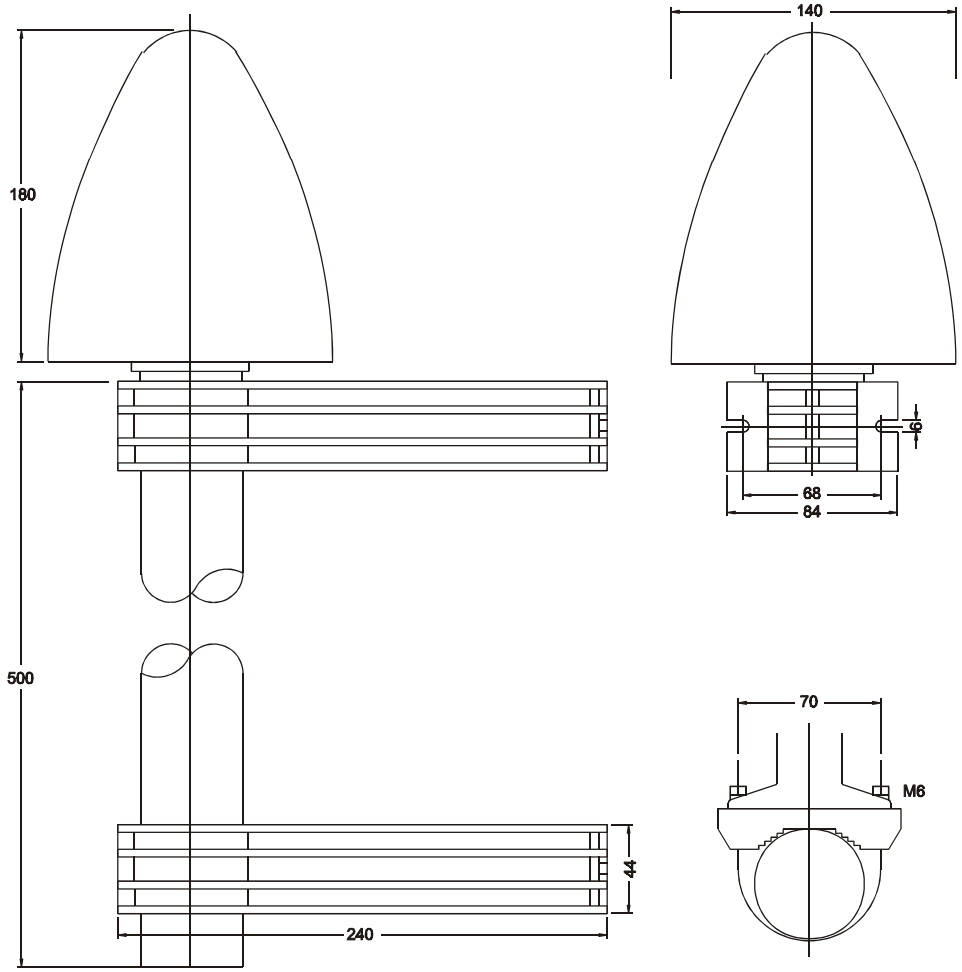
ACCURACY OF FREQUENCY:	after sync. and 20 min of operation	$\pm 1 \cdot 10^{-9}$
	during first 20 minutes of operation	$\pm 2 \cdot 10^{-8}$
	GPS synchronous, 24h averaged	$\pm 1 \cdot 10^{-11}$
ACCURACY OF FREQUENCY (QUARTZ):	one day, free-running	$\pm 2 \cdot 10^{-8}$
	one year, free-running	$\pm 5 \cdot 10^{-7}$
TIME STABILITY:	<= 10 sec, GPS controlled	$\pm 1 \cdot 10^{-9}$
	<= 10 sec, free running	$\pm 3 \cdot 10^{-9}$
TEMPERATURE DRIFT:	free running	$\pm 2 \cdot 10^{-7}$
SSB PHASE NOISE:	10 kHz beside carrier	-101 dB/Hz
	1 kHz beside carrier	-76 dB/Hz
	100 Hz beside carrier	-60 dB/Hz
TIME_SYN OUTPUT:	TTL HIGH level if synchronized	
SERIAL PORTS:	2 asynchronous serial ports (RS-232)	
	Baud Rate: 300 up to 19200	
	Framing: 7N2, 7E1, 7E2, 8N1, 8N2, 8E1	
	default setting: COM0: 19200, 8N1	
	COM1: 9600, 8N1	
TIME CAPTURE INPUTS:	triggered on falling TTL slope	
	Interval of events: 1.5msec min.	
	Resolution: 100ns	
POWER REQUIREMENTS:	5V ± 5%, @900mA	

PHYSICAL DIMENSION:	Eurocard, 100 mm x 160 mm
REAR EDGE CONNECTOR:	according to DIN 41612, type C 64, rows a+c (male)
RF CONNECTOR:	coaxial BNC
AMBIENT TEMPERATURE:	10 ... 50°C
HUMIDITY:	85% max.

Technical Specifications GPS167 Antenna

ANTENNA:	dielectrical patch antenna, 25 x 25mm	
	receive frequency:	1575.42 MHz
	bandwidth:	9 MHz
CONVERTER:	local oscillator to converter frequency:	10 MHz
	first IF frequency:	35.4 MHz
POWER REQUIREMENTS:	12V ... 18V, @ 100mA (provided via antenna cable)	
CONNECTOR:	coax type N, female	
AMBIENT TEMPERATURE:	-40 ... +65°C	
HOUSING:	ABS plastic case for outdoor installation (IP56)	

PHYSICAL DIMENSION:



Time Strings

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)

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
' '	MEZ	European Standard Time, daylight saving disabled
'S'	MESZ	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)

Format of the GPS167 Capture String

The Meinberg GPS167 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		

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:ss*xxxx*uv*<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)		
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	
	‘MEZ‘	European Standard Time, daylight saving disabled	
	‘MESZ’	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)		

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.llle hhhh*m<*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)

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’	MESZ	European Summertime, daylight saving enabled
‘ ‘	MEZ	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 sea level in meters leading signs are replaced by a space character (20h)
<ETX>	End-Of-Text (ASCII-Code 03h)

Format of the NMEA 0183 String (RMC)

The NMEA String is a sequence of 65 ASCII characters starting with the '$' 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,*ahh<*CR*><*LF*>**

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

$	start character (ASCII-Code 24h)		
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		

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)		

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		
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)		

Signal Description GPS167

Name	Pin	Function
GND	32a+c	Ground
VCC in (+5V)	1a+c	+5V supply
VCC in (+12V)	2a+c	+12V supply
VCC in (+5V)	3a+c	+5 V supply (TCXO / OCXO-MQ)
P_SEC out	6c	Pulse when second changes, TTL level, active high, length 200 msec
P_MIN out	8c	Pulse when minute changes, TTL level, active high, length 200 msec
DCF_MARK out	17c	DCF77 compatible second marks, TTL level active high, length 100/200 msec
100 kHz out	10a	100 kHz frequency output, TTL-Pegel
1 MHz out	11a	1 MHz frequency output, TTL-Pegel
10 MHz out	12a	10 MHz frequency output, TTL-Pegel
F_SYNTH	21c	Synthesizer output, TTL-Pegel
F_SYNTH_OD	22c	Synthesizer output, Open Drain, max sink current to GND: 150mA
F_SYNTH_SIN	23c	Synthesizer output, sine-wave 1.5 V eff.
TIME_SYN	19c	TTL output, HIGH level if synchronization has been achieved, LOW level after reset or in case of serious errors (e.g. antenna faulty)
CAPx	27c, 28c	Time capture inputs (TTL), capture on falling slope
COMx TxD out		COMx RS-232 transmit data output
COMx RxD in		COMx RS-232 receive data input
/RESET in/out	9c	RESET signal, Open Drain pulled up to +5V
SDA, SCL, SCL_EN		internal serial control bus, for extension boards
(reserved)		reserved, do not connect

Rear Connector Pin Assignments GPS167

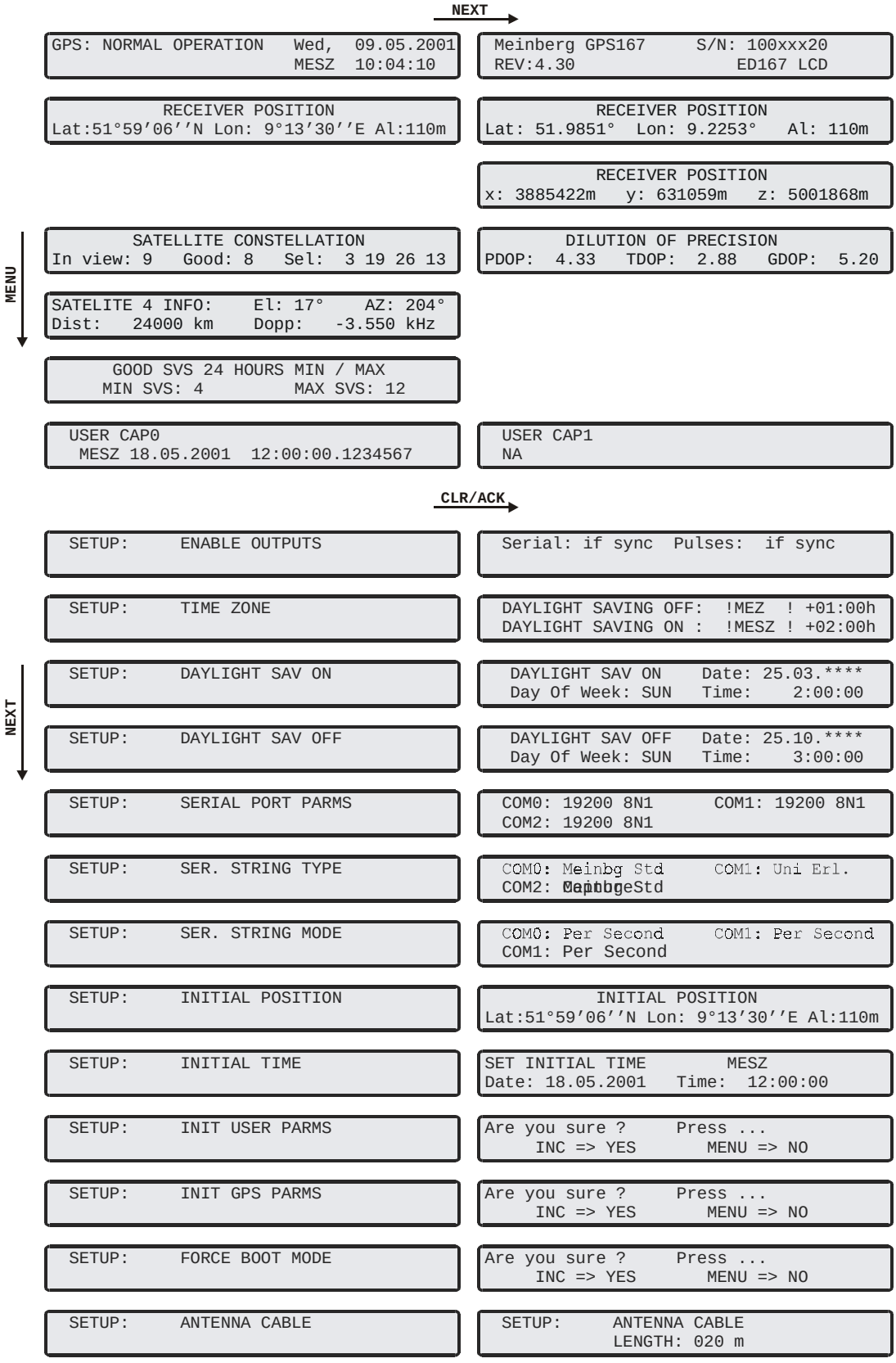
	a	c
1	VCC in (+5V)	VCC in (+5V)
2	VCC in (+12V)	VCC in (+12V)
3	VDD in (TCXO/OCXO)	VDD in (TCXO/OCXO)
4	(reserved, FreqAdjust out)	
5		
6		P_SEC out
7		
8	(reserved, 10 MHz in)	P_MIN out
9		/RESET in/out
10	100 kHz out	ProgPulse0 out
11	1 MHz out	ProgPulse1 out
12	10 MHz out	ProgPulse2 out
13		SCL
14		SCL_EN
15	COM2 RxD in	SDA
16	COM2 TxD out	(reserved, P3.2)
17	COM3 RxD in	DCF_MARK out
18	COM3 TxD out	(reserved, Vref/TxD2 TTL)
19	GND	TIME_SYN out
20	GND	(reserved, P2.3)
21	GND	F_SYNTH out
22	GND	F_SYNTH_OD out
23	GND	F_SYNTH_SIN out
24	GND	COM1 TxD out
25	GND	
26	GND	COM0 TxD out
27	GND	CAP1 in
28	GND	CAP0 in
29	GND	COM1 RxD in
30	GND	COM0 RxD in
31	GND	GND
32	GND	GND

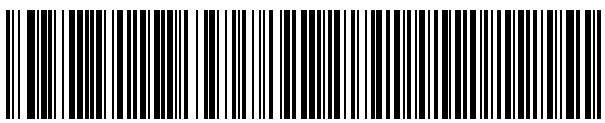
male connector according to DIN 41612, type C 64, rows a + c

Technical Specifications Power Supply T-60B

INPUT:	85 ... 264V AC, 47 ... 63Hz, 1A/230V, 2A/115V	
FUSE:	elektronic	
CURRENT LIMITING:	105 - 150% $I_{out\ nom}$	
OUTPUTS:	$V_{out}1$:	5.05V / 5A
	$V_{out}2$:	+12V / 2.5A
	$V_{out}3$:	-12V / 0.5A
TOTAL LOAD:	max. 61Watt	
CONNECTORS:	screw terminal	
HOUSING:	metal housing : 159mm x 97mm x 38mm	
AMBIENT TEMPERATURE:	-10°C ... +60°C	
HUMIDITY:	90% max.	

Menu Quick Reference GPS167LCD-MP

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