

MANUAL

GPS170PCI

Satellite controlled Radio Clock

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Meinberg Radio Clocks GmbH & Co. KG

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1 Impressum

Meinberg Radio Clocks GmbH & Co. KG
Lange Wand 9, 31812 Bad Pyrmont - Germany

Phone: + 49 (0) 52 81 / 93 09 - 0
Fax: + 49 (0) 52 81 / 93 09 - 30

Internet: <http://www.meinberg.de>
Mail: info@meinberg.de

Date: 2009-06-24

2 Content of the USB stick

The included USB stick contains a driver program that keeps the computer's system time synchronous to the received IRIG-time. If the delivered stick doesn't include a driver program for the operating system used, it can be downloaded from:

<http://www.meinberg.de/german/sw/>



On the USB stick there is a file called "readme.txt", which helps installing the driver correctly.

3 General information

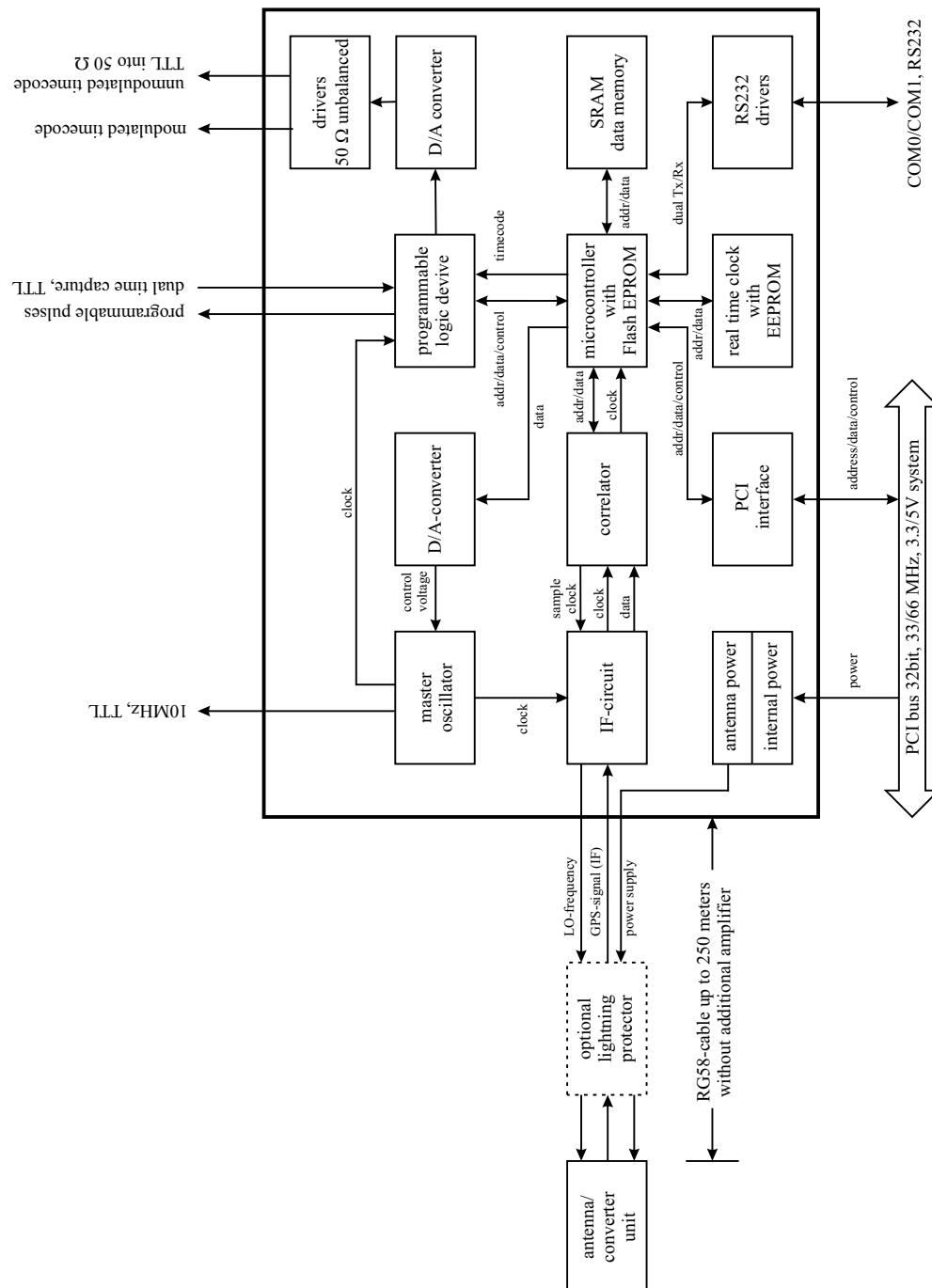
The satellite clocks made by Meinberg have been designed to provide extremely precise time to their users. The clocks have been developed for applications where conventional radio clocks can't meet the growing requirements in precision. High precision available 24 hours a day around the whole world is 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 Department 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 some active spares in six orbital planes 20,000 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 Block Diagram GPS170PCI



5 GPS170PCI features

The satellite controlled clock GPS170PCI is a plug-in board designed for computers with 3.3V or 5V PCI bus running with clock frequencies of 33MHz or 66MHz. The rear slot cover intergrates the antenna connector, the modulated timecode, two status LEDs, and a 9 pin Sub-D male connector.

The antenna/converter unit is connected to the receiver by a 50 Ω coaxial cable with length up to 300m (when using RG58 cable). Power is supplied to the unit DC insulated across the antenna cable. Optionally, an over voltage protection and an antenna distributor are available. The antenna distributor can be used to operate up to 4 Meinberg GPS receivers using a single antenna/converter unit.

The navigation message coming in from the satellites is decoded by satellite clock's microprocessor in order to track the GPS system time with an accuracy of better than 250nsec. Compensation of the RF signal's propagation delay is done by automatic determination of the receiver's position on the globe. A correction value computed from the satellites' navigation messages increases the accuracy of the board's temperature compensated master oscillator (TCXO) to $\pm 5(10^{-9})$ and automatically compensates the TCXO's aging. The last recent value is restored from the nonvolatile memory at power-up. Optionally, the clock is also available with a higher precision time base.

Monitoring software shipped with the board can be use to check the cloick's status and configure some operational parameters

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 after GPS has been initiated in 1980. The current number of leap seconds is part of the navigation message supplied by the satellites, so the satellite clock'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. For Germany, the local time zone is UTC + 3600 sec for standard time and UTC + 7200 sec if daylight saving is in effect.

The clock's microprocessor determines the times for start and end of daylight saving time by a simple algorithm e. g. for Germany:

Start of DST is on the first Sunday after March, 25th, at 2 o'clock standard time.

End of DST is on the first Sunday after October, 25th, at 3 o'clock daylight time.

The monitoring software shipped with the board can be used to configure the time zone and daylight savings parameters easily. Switching to daylight saving time is inhibited if for both start and end of daylight saving the parameters are exactly the same.

The timecode (IRIG, AFNOR, IEEE) generated by GPS170PEX is available with these settings or with UTC as reference. This can be set by the monitor program.

5.2 Asynchronous serial ports

Two asynchronous serial interfaces (RS232) called COM0 and COM1 are available to the user. Only COM0 is available at the rear panel slot cover, COM1 must use another submin-D connector which can optionally be connected to the 5 pin jumper block on the board. The monitoring program can be used to configure the outputs. In the default mode of operation, the serial outputs are disabled until the receiver has synchronized after power-up. However, they can be configured to be enabled immediately after power-up.

Transmission speed, framing and mode of operation can be configured individually for each port. Both of the ports can be configured to transmit either time strings (once per second, once per minute, or on request with ASCII '?' only), or to transmit capture strings (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.

5.3 Time capture inputs

The board provides two time capture inputs called User Capture 0 and 1 (CAP0 and CAP1) which can be mapped to pins at the 9 pin connector at the rear panel. These inputs can be used 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, an ASCII string per capture event can be transmitted via COM1 or displayed using the monitoring program. 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 COM1 can be measured. The format of the output string is described in the technical specifications at the end of this document. 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 via COM1.

5.4 Pulse and frequency outputs

The pulse generator of the satellite controlled clock GPS170 contains three independent channels (PPO0, PPO1, PPO2). These TTL outputs can be mapped to pins at the 9-pin connector at the rear slot cover by using a DIL switch. The pulse generator is able to provide a multitude of different pulses, which are configured with the monitor program. The active state of each channel is invertible, the pulse duration settable between 10 msec and 10 sec in steps of 10 msec. In the default mode of operation the 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.

The following modes can be configured for each channel independently:

Timer mode:	Three on- and off-times per day per channel programmable
Cyclic mode:	Generation of periodically repeated pulses. A cycle time of two seconds would generate a pulse at 0:00:00, 0:00:02, 0:00:04 etc.
DCF77-Simulation mode:	The corresponding output simulates the DCF77 time telegram. The time marks are representing the local time as configured by the user.
Single Shot Mode:	A single pulse of programmable length is generated once a day at a programmable point of time
Per Sec. Per Min. Per Hr. modes:	Pulses each second, minute or hour
Status:	One of three status messages can be emitted: 'position OK': The output is switched on if the receiver was able to compute its position 'time sync': The output is switched on if the internal timing is synchronous to the GPS-system 'all sync': Logical AND of the above status messages. The output is active if position is calculated AND the timing is synchronized
Idle-mode:	The output is inactive

The default configuration for the pulse outputs is:

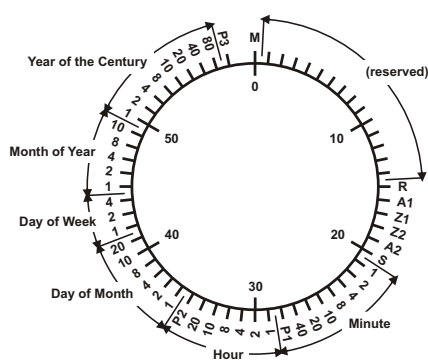
PPO0:	Pulse each second (PPS), active HIGH, pulse duration 200 msec
--------------	---

PP01: Pulse each minute (PPM), active HIGH, pulse duration 200 msec
PP02: DCF77 Simulation

A TTL level master frequency of 10 MHz is derived from the TCXO. By default, this frequency is available only at the 5 pin contact strip of the board.

5.5 DCF77 Emulation

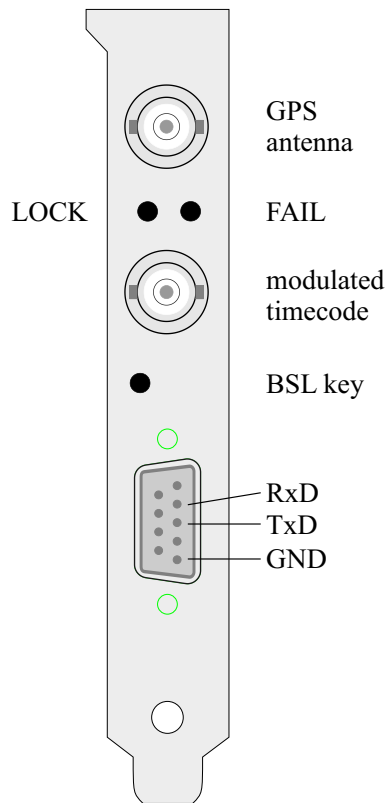
The GPS170PCI satellite controlled clock generates TTL level time marks (active HIGH) which are compatible with the time marks spread by the German long wave transmitter DCF77. This long wave transmitter installed in Mainflingen near Frankfurt/Germany transmits the reference time of the Federal Republic 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, GPS170PCI 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 scheme 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.

6 Connectors and LEDs in the rear slot cover



The coaxial antenna connector, two status LEDs and a 9 pin sub D connector can be found in the rear slot cover. (see figure). The upper, green LED (LOCK) 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.

The lower, red LED (FAIL) is turned on after power-up until the receiver has synchronized or if a severe error occurs during operation.

The 9 pin sub D connector is wired to the GPS170PEX's serial port COM0. Pin assignment can be seen from the figure beside. This port can not be used as serial port for the computer. Instead, it can be used to send out Meinberg's standard time string to an external device.



A DIL switch on the board can be used to wire some TTL inputs or outputs (0..5V) to some connector pins. In this case, absolute care must be taken if another device is connected to the port, because voltage levels of -12V through +12V (as commonly used with RS-232 ports) at TTL inputs or outputs may damage the radio clock.

Behind the little hole in the slot cover there is a push button (BSL) which is needed if the clock's firmware shall be updated. See the chapter about firmware updates for details.

7 Installing the radio clock

Every PCI board is a plug&play board. After power-up, the computer's BIOS assigns resources like I/O ports and interrupt lines to the board, the user does not need to take care of the assignments. The programs shipped with the board retrieve the settings from the BIOS.

7.1 Configuring the 9 pin connector

By default only the signals needed for the serial port COM0 are mapped to the pins of the connector. Whenever one of the additional signals shall be used, the signal must be mapped to a pin by putting the appropriate lever of the DIL switch in the ON position. The table below shows the pin assignments for the connector and the DIL switch lever assigned to each of the signals. Care must be taken when mapping a signal to Pin 1, Pin 4 or Pin 7 of the connector, because one of two different signals can be mapped to these Pins. Only one switch may be put in the ON position in this case:

Pin 1: DIL 1 or DIL 8 ON

Pin 4: DIL 5 or DIL 10 ON

Pin 7: DIL 3 or DIL 7 ON

Those signals which do not have a lever of the DIL switch assigned are always available at the connector:

D-SUB-Pin	Signal	Signal level	DIL-switch
1	VCC out	+5V	1
1	PPO0 (PPS) out	RS232	8
2	RxD in	RS232	-
3	TxD out	RS232	-
4	PPO1 (PPM) out	TTL	5
4	10MHz out	TTL	10
5	GND	-	-
6	CAP0 in	TTL	2
7	CAP1 in	TTL	3
7	IRIG DC out	TTL into 50 Ω	7
8	PPO0 (PPS) out	TTL	4
9	PPO2 (DCF) out	TTL	9

7.2 Installing the GPS170PEX in your computer

The computer has to be turned off and its case must be opened. The radio clock can be installed in any PCI Express slot not used yet. The rear plane must be removed before the board can be plugged in carefully. The computer's case should be closed again and the antenna can be connected to the coaxial plug at the clock's rear slot cover. After the computer has been restarted, the monitor software can be run in order to check the clock's configuration. The computer's case should be closed again and the antenna must be connected to the appropriate connector.

7.3 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 unit can be mounted using a pole with a diameter up to 60 mm. A standard coaxial cable with 50 Ω impedance (e.g. RG58C) should be used to connect the antenna/converter unit to the receiver. Cable thinner than RG58 should be avoided due to its higher DC resistance and RF attenuation. When using the optional antenna diplexer the total length of one antenna line between antenna, diplexer and receiver must not be longer than 300 m. If a cable with less attenuation is used its length may be increased accordingly (e.g. 700 m with RG213).

Up to four GPS170 receivers can be run with one antenna/downconverter unit by using an optional antenna splitter. The total length of one antenna line between antenna, splitter and receiver must not be longer than the max. length shown in the table above. The position of the splitter in the antenna line does not matter.

High voltage protectors must be installed directly after reaching the indoors. The optional delivered protection kit is not for outdoor usage.

7.3.1 Example:

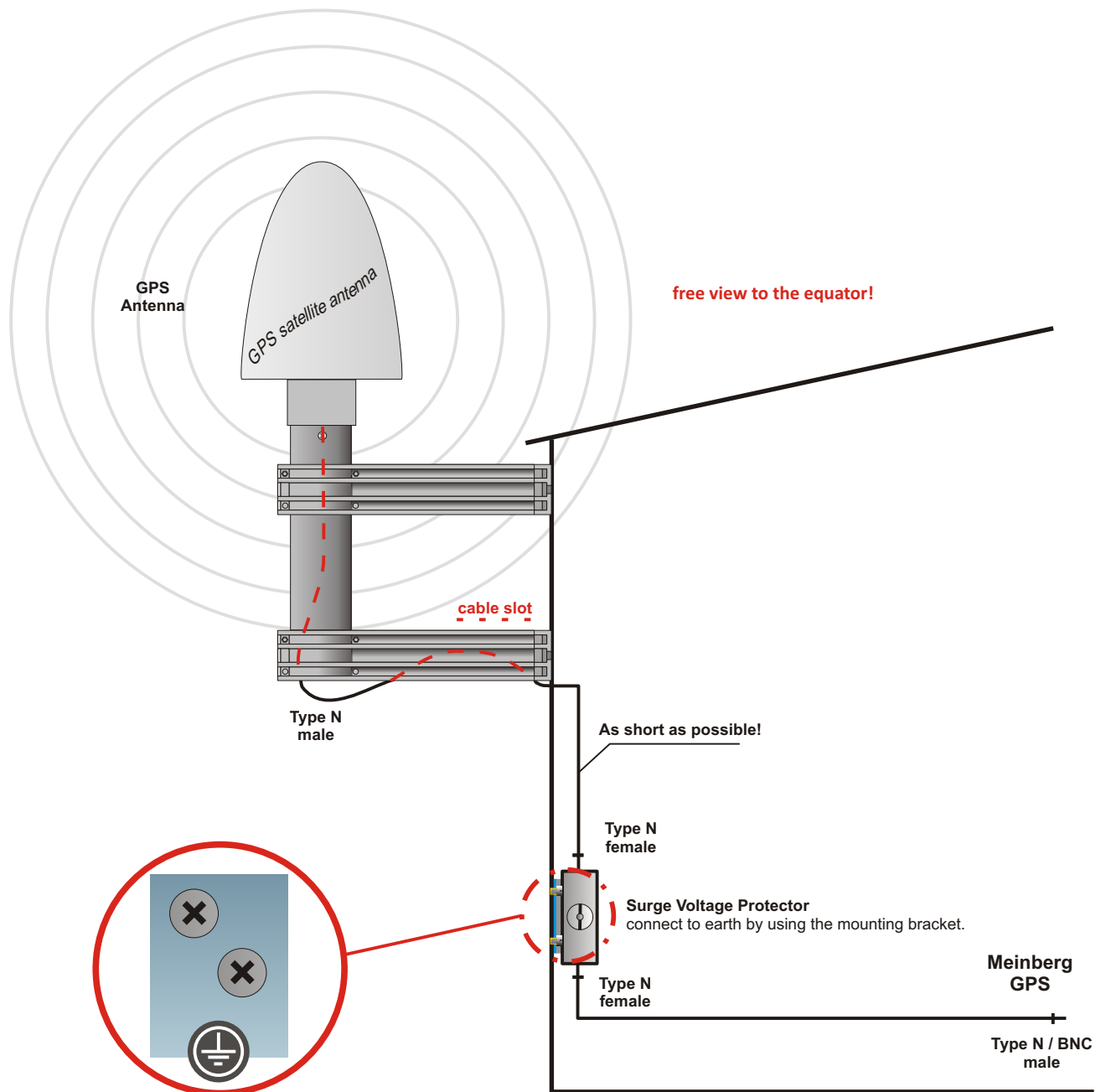
Type of cable	diameter \varnothing [mm]	Attenuation at 100MHz [dB]/100m	max lenght. [m]
RG58/CU	5mm	17	300 ⁽¹⁾
RG213	10.5mm	7	700 ⁽¹⁾

(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

7.3.2 Antenna Short-Circuit 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. Standard you connect the antenna converter directly with the antenna cable to the system.



7.4 Powering up the system

After the board has been mounted and the antenna has been connected, the system is ready to operate. About 10 seconds after power-up the receiver's TCXO 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 at least one minute after power-up. After 20 minutes of operation the TCXO has achieved its final accuracy 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 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 TCXO's output frequency has been adjusted. Up to that time accuracy of frequency drops to 10^{-8} reducing the accuracy of pulses to $\pm 2\mu\text{s}$.

8 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 radio clock's serial port COM0. There is no need to open the computer case and insert a new EPROM.

If the button behind a hole in the rear slot cover is pressed for approximately 2 seconds, a bootstrap loader is activated and waits for instructions from the serial port COM0. A loader program shipped together with the file containing the image of the new firmware sends the new firmware from one of the computer's serial ports to the clock's serial port COM0. The bootstrap loader does not depend on the contents of the flash memory, so if the update procedure is interrupted, it can easily be repeated.

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 button has been pressed accidentally, the system will be ready to operate again after the computer has been turned off and then on again.

9 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!

There is a Danger of explosion if the lithium battery is replaced incorrectly. Only identical batteries or batteries recommended by the manufacturer must be used for replacement.

The waste battery has to be disposed as proposed by the manufacturer of the battery.



10 Time codes

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 GPS170PEX 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. If desired other formats are available.

10.1 The time code generator

The board GPS170PEX generates modulated and un-modulated timecodes. Modulated signals are transmitting the information by varying the amplitude of a sine wave carrier, un-modulated timecodes are transmitted by pulse duration modulation of a DC-signal (TTL in case of GPS170PEX), see chapter „IRIG standard format“ for details.

The sine wave carrier needed for modulated signals is generated in a digital way by a programmable logic device on the board. The frequency of this signal is derived from the main oscillator of GPS170PEX, which is disciplined by the GPS-system.

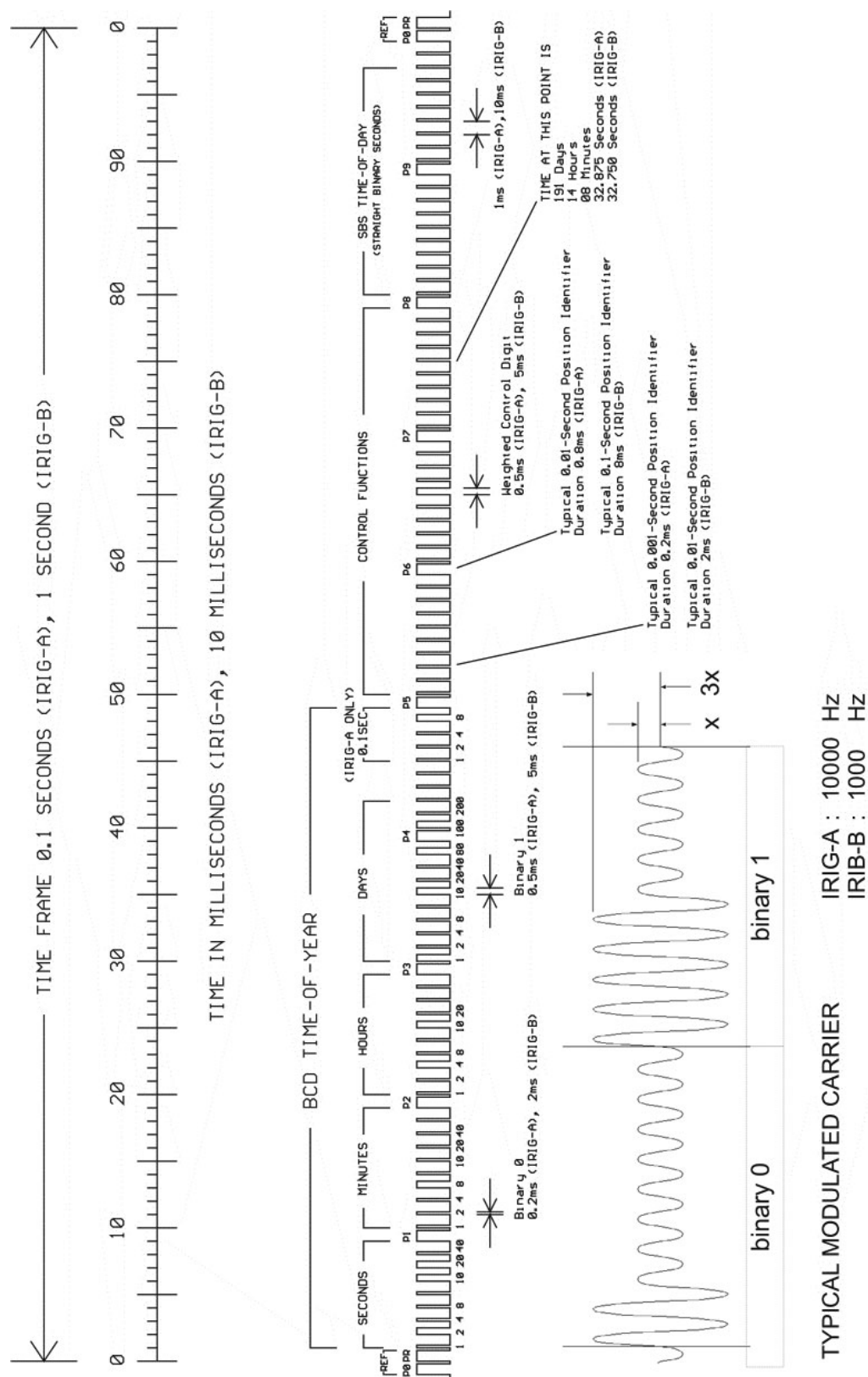
This leads to a sine wave carrier with high accuracy. Transmission of date is synchronized by the PPS (pulse per second) derived from the GPS-system. The modulated time code has an amplitude of 3Vpp (MARK) and 1Vpp (SPACE) into 50 Ω. The number of MARK-amplitudes within ten periods of the carrier defines the coding:

- 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

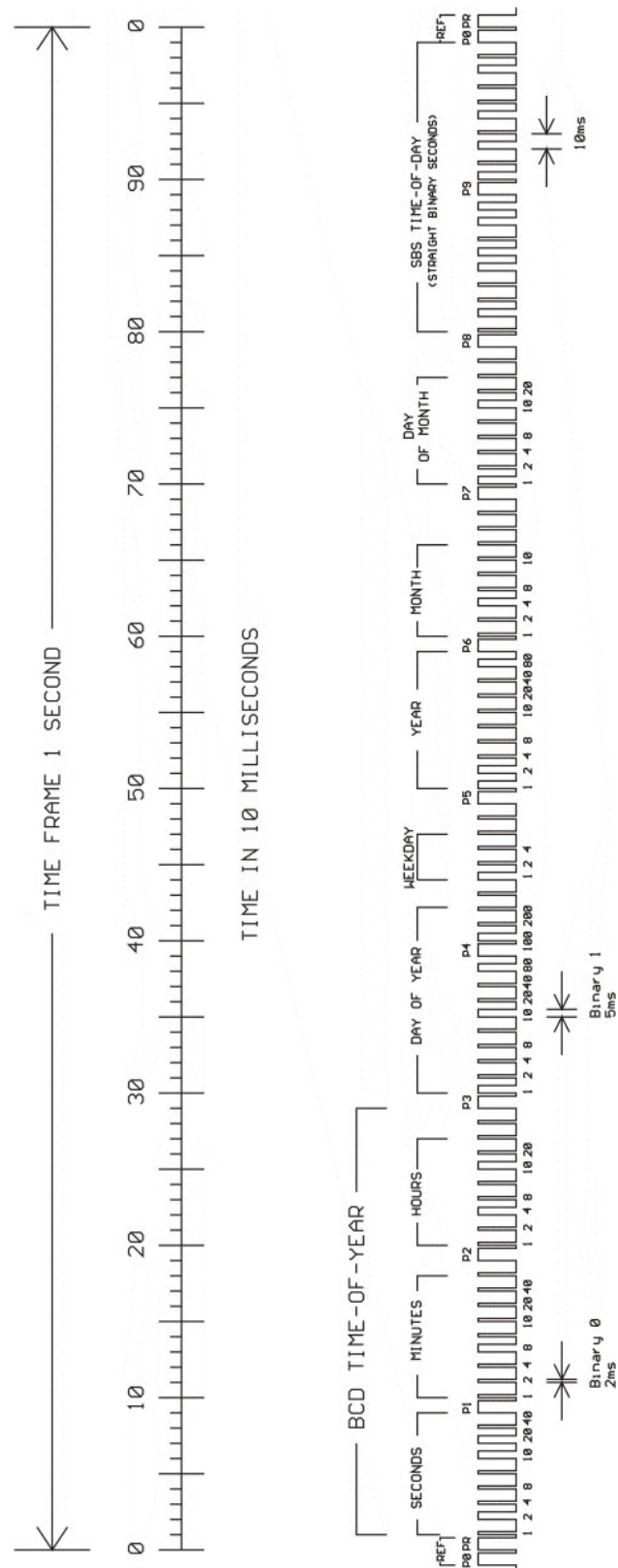
The DC-signal has the following pulse durations accordingly:

- a) binary „0“ : 2 msec
- b) binary „1“ : 5 msec
- c) position-identifier : 8 msec

10.2 IRIG Standard Format



10.3 AFNOR Standard Format



10.4 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

10.5 Generated Time Codes

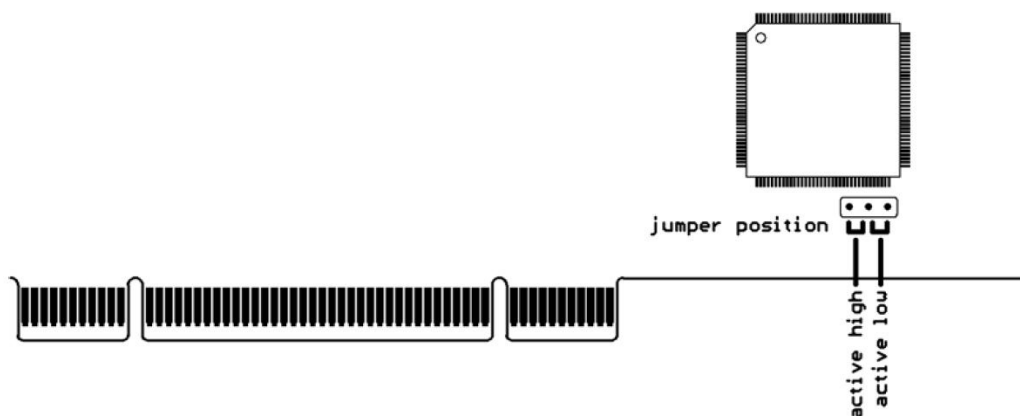
Besides the amplitude modulated sine wave signal, the board also provides unmodulated DC-Level Shift TTL output in parallel. Thus six time codes are available.

- 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) 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
- f) 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')

10.6 Selection of time code

The selection of timecode is done by the monitor software.

The un-modulated time code can be delivered as an active-high (default) or active-low signal by setting a jumper on the board GPS170PEX into the appropriate position:



11 Technical Specifications GPS170PCI

RECEIVER:	Six 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"
ANTENNA INPUT:	Antenna circuit dc-insulated; dielectric strength: 1000V Length of cable: refer to chapter "Mounting the Antenna"
TIME TO SYNCHRONIZATION:	one minute with known receiver position and valid almanac 12 minutes if invalid battery buffered memory
PULSE OUTPUTS:	three programmable outputs, TTL level Default settings: active only ,if sync' PPO0: change of second (PPS) pulse duration 200 msec valid on rising edge PPO1: change of minute (PPM) pulse duration 200 msec valid on rising edge PPO2: DCF77 simulation
ACCURACY OF PULSES:	better than ± 250 nsec after synchronization and 20 minutes of operation better than ± 2 μ sec during the first 20 minutes of operation
TIME CAPTURE INPUTS:	triggered on falling TTL slope Interval of events: 1.5msec min. Resolution: 100ns
FREQUENCY OUTPUTS:	10 MHz (TTL level)
SYSTEM BUS INTERFACE:	universal board for 3.3V and 5V systems 32 bit, 33MHz or 66MHz PCI bus compatible to PCI and PCI-X specifications
DATA FORMAT:	Binary, byte serial
SERIAL PORTS:	2 asynchronous serial ports (RS-232) Baud Rate: 300 up to 19200 Framing: 7N2, 7E1, 7E2, 8N1, 8N2, 8E1 default setting: COM0: 19200, 8N1 Meinberg Standard time string, per second COM1: 9600, 8N1

Capture string, automatically

IRIG-OUTPUTS:	Unbalanced modulated sine wave signal: 3Vpp (MARK), 1Vpp (SPACE) into 50 Ω DCLS-signal: TTL into 50 Ω , active-high or -low, selected by jumper optionally optical output (instead of modulated sine wave): optical power: typ. 15 μ W optical connector: ST-connector for GI 50/125 μ m or GI 62,5/125 μ m gradient fiber
POWER REQUIREMENT:	+5V \pm 5%, @250mA +12V \pm 5%, @190mA -12V \pm 5%, @10mA delivered by PCI bus
PHYSICAL DIMENSION:	standard height expansion board
RF CONNECTOR:	female coaxial BNC-connectors for antenna and modulated time code
AMBIENT TEMPERATURE:	0 ... 50°C
HUMIDITY:	85% max.

ACCURACY OF FREQUENCY AND PULSE OUTPUTS:

Oscillator Option	TCXO (standard)	OCXO LQ (option)
short term stability ($\tau = 1$ sec)	$2 * 10^{-9}$	$1 * 10^{-9}$
accuracy of PPS (pulse per second)	$< \pm 250$ nsec	$< \pm 250$ nsec
phase noise	1 Hz -60 dBc/Hz 10 Hz -90 dBc/Hz 100 Hz -120 dBc/Hz 1 kHz -130 dBc/Hz	1 Hz -60 dBc/Hz 10 Hz -90 dBc/Hz 100 Hz -120 dBc/Hz 1 kHz -130 dBc/Hz
accuracy free run, one day	$\pm 1 * 10^{-7}$ ± 1 Hz (Note 1)	$\pm 2 * 10^{-8}$ $\pm 0,2$ Hz (Note 1)
accuracy free run, one year	$\pm 1 * 10^{-6}$ ± 10 Hz (Note 1)	$\pm 4 * 10^{-7}$ ± 4 Hz (Note 1)
accuracy GPS-synchronous averaged 24 h	$\pm 1 * 10^{-11}$	$\pm 1 * 10^{-11}$
accuracy of time free run, one day	$\pm 8,6$ msec	$\pm 1,8$ msec
accuracy of time free run, one year	± 32 sec	± 13 sec
temperature dependant drift, free run	$\pm 1 * 10^{-6}$ (-20...70°C)	$\pm 2 * 10^{-7}$ (0...60°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 $\pm 1 * 10^{-7} * 10 \text{ MHz} = \pm 1 \text{ Hz}$ 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 24h of GPS-synchronicity is required before free run starts.		

11.1 Assignment of the 5 pin contact strip

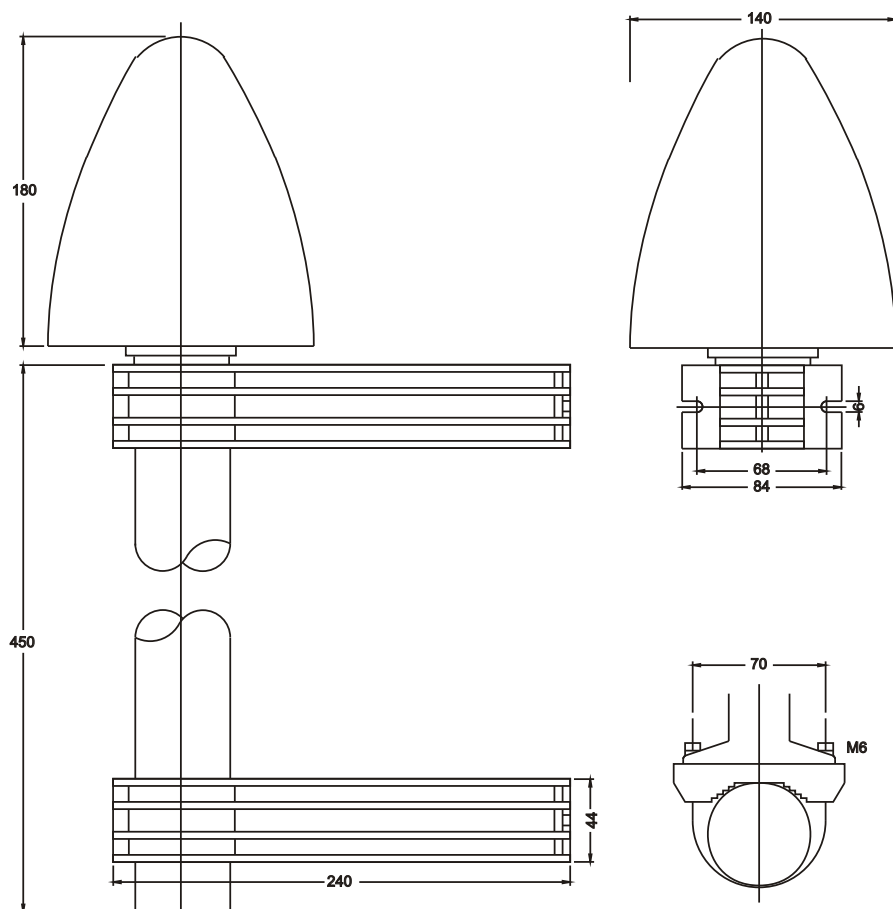
The contact strip can be used to access the 10 MHz frequency output and the serial port COM1. Pin 5 is located near the board's bus connector:

Pin	Signal
1	10 MHz out
2	GND
3	RxD1 in
4	TxD1 out
5	GND

11.2 Technical Specifications GPS Antenna

ANTENNA:	dielectrical patch antenna, 25 x 25 mm 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 (IP66)

Physical Dimension:



11.3 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 synchronized 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	announcement of discontinuity of time, enabled during last hour before discontinuity comes in effect:		
	'I'	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		

11.4 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.ffffff***<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.ffffff the capture time:

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

<CR> Carriage Return, ASCII Code 0Dh

<LF> Line Feed, ASCII Code 0Ah

11.5 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:ssxxxuv* <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	
	'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	announcement 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		

11.6 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,llll.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 occurance 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
llll.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

11.7 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.lllle 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 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)	
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	announcement 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	announcement 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
III.IIII	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	

11.8 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 CE-Label

Low-Voltage guideline **EN 60950-1**

Safety of Information Technology Equipment,
including Electrical Business Equipment

Electromagnetic
compatibility

EN50081-1

Electromagnetic compatibility (EMC).
Generic emission standard. Part 1: Residential, commercial and light industry

EN50082-2

Electromagnetic compatibility (EMC).
Generic immunity standard. Part 2: Industrial environment



Konformitätserklärung

Declaration of Conformity

Hersteller
Manufacturer

Meinberg Funkuhren GmbH & Co. KG
Lange Wand 9
D-31812 Bad Pyrmont

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

Produktbezeichnung
Product Name

Satellitenfunkuhr

Modell / Typ
Model Designation

GPS170PCI

auf das sich diese Erklärung bezieht, mit den folgenden Normen übereinstimmt
to which this declaration relates is in conformity with the following standards

EN55022:1998, Class B
(+A1:2000 +A2:2003)

Grenzwerte und Meßverfahren für Funkstörungen von
informationstechnischen Einrichtungen

Limits and methods of measurement of radio interference characteristics of
information technology equipment

EN55024:1998
(+A1:2001 +A2:2003)

Grenzwerte und Meßverfahren für Störfestigkeit von
informationstechnischen Einrichtungen

Limits and methods of measurement of Immunity characteristics of
information technology equipment

gemäß den Richtlinien 2004/108/EG (Elektromagnetische Verträglichkeit), 2006/95/EG (Nieder-
spannungsrichtlinie) und 93/68/EWG (CE Kennzeichnung) sowie deren Ergänzungen.

following the provisions of the directives 2004/108/EC (electromagnetic compatibility), 2006/95/EC (low voltage directive) and
93/68/EEC (CE marking) and its amendments.

Bad Pyrmont, den 08.07.2009


Günter Meinberg
Managing Director