Technical Information

Operating Instructions

TCR170PEX

Impressum

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

Telefon: ++49 (0) 52 81 / 9309-0
Telefax: ++49 (0) 52 81 / 9309-30

Internet: **http://www.meinberg.de**
Email: **info@meinberg.de**

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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/english/sw/

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

Introduction

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 Instrumantation 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 TCR170PEX however only decodes IRIG-A, IRIG-B or AFNOR NFS 87-500 formats. The AFNOR code is a variant of the IRIG-B format. Within this code the complete date is transmitted instead of the ‘Control Functions’ of the IRIG-telegram.

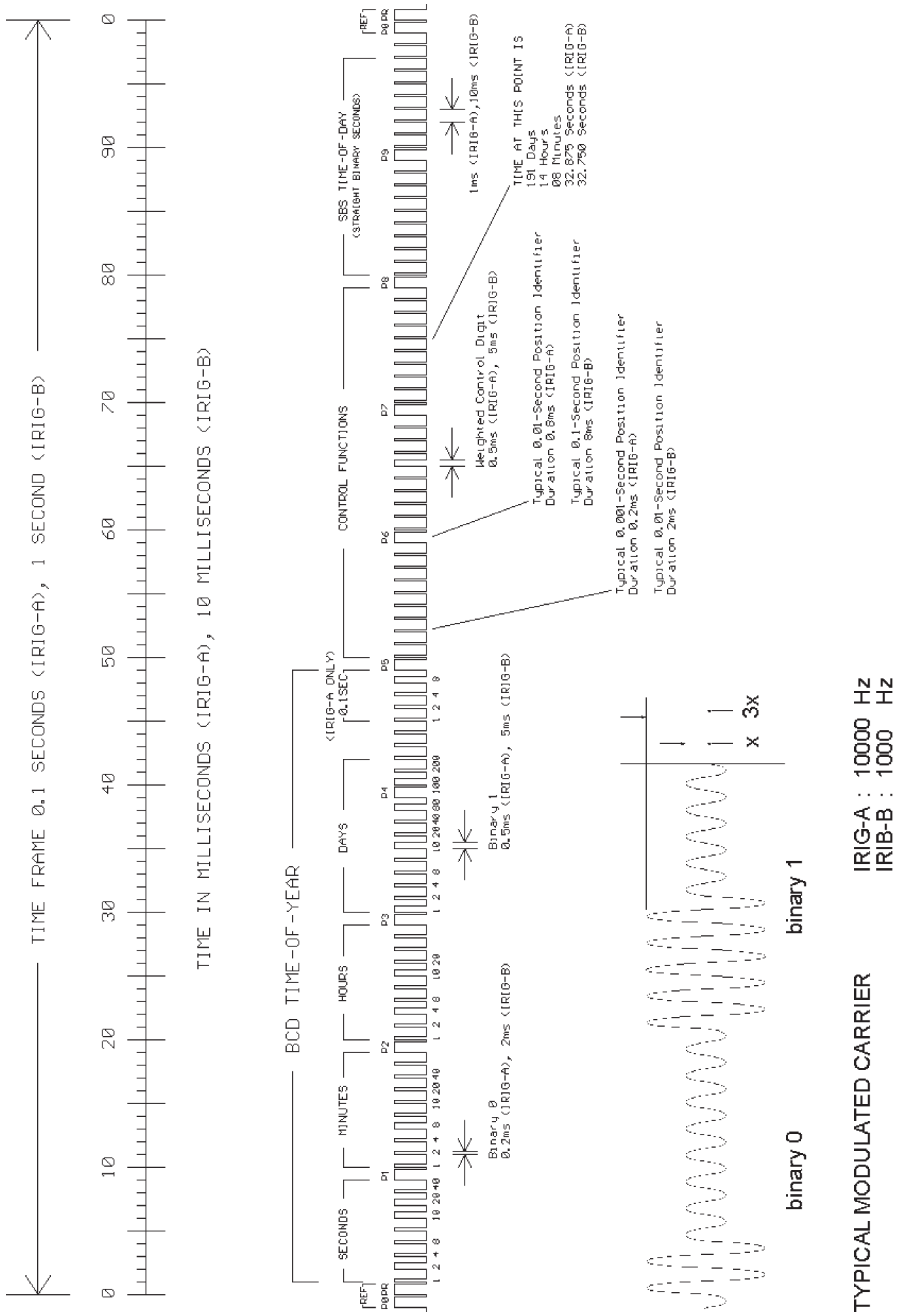
Description of IRIG-Codes

The specification of individual IRIG time code formats is defined in IRIG Standard 200-98. They are described by an alphabetical character followed by a three-digit number sequence. The following identification is taken from the IRIG Standard 200-98 (only the codes relevant to TCR170PEX are listed):

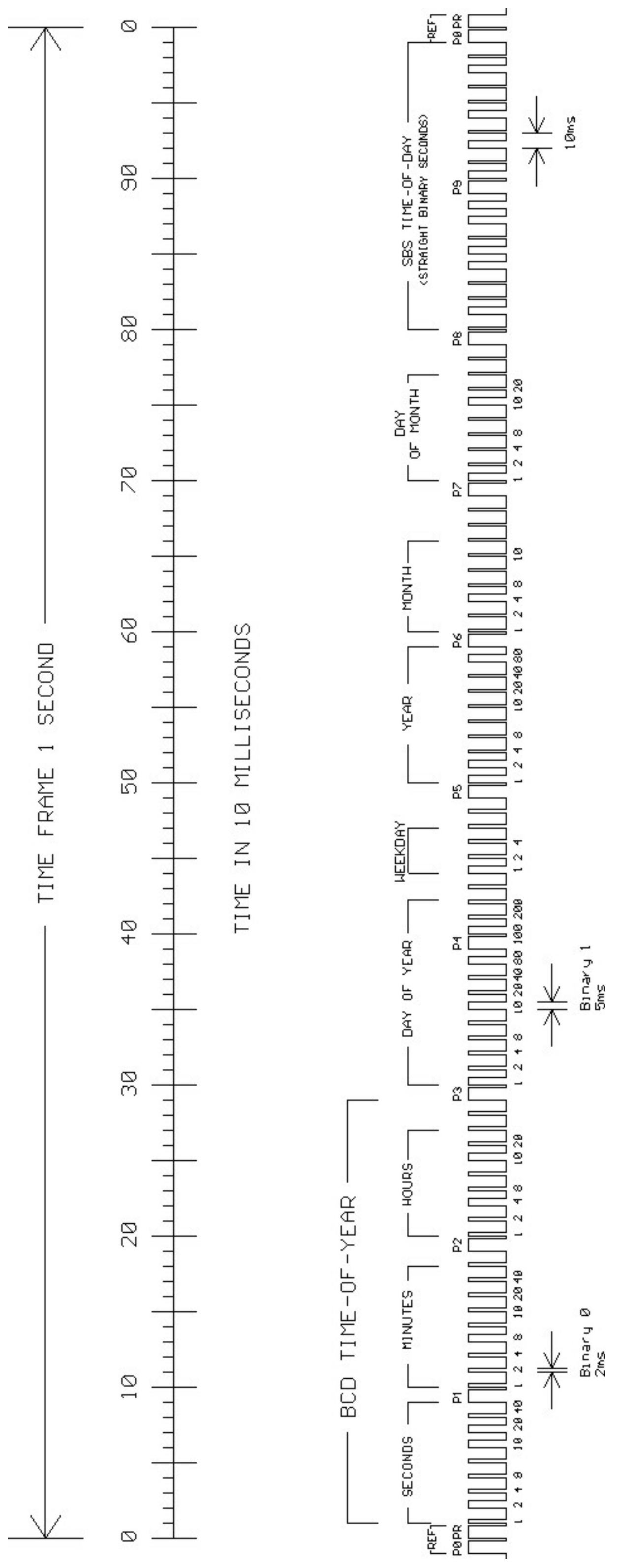
character	bit rate designation	A	1000 pps
		B	100 pps
1st digit	form designation	0	DC Level Shift width coded
		1	sine wave carrier amplitude modulated
2nd digit	carrier resolution	0	no carrier (DC Level Shift)
		1	100 Hz, 10 msec resolution
		2	1 kHz, 1 msec resolution
		3	10 kHz, 100 µsec resolution
3rd digit	coded expressions	0	BCD, CF, SBS
		1	BCD, CF
		2	BCD
		3	BCD, SBS

BCD: time of year, BCD-coded
CF: Control-Functions (user defined)
SBS: seconds of day since midnight (binary)

IRIG-Standard format



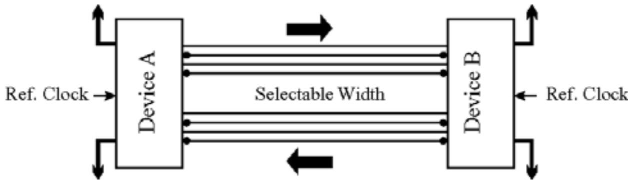
AFNOR-Standard format



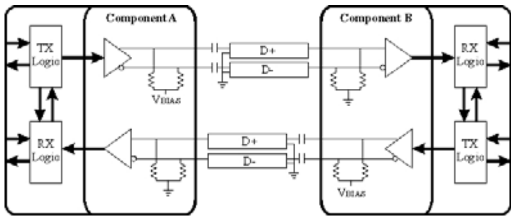
PCI Express (PCIe)

The main technical inovation of PCI Express is a serial data transmission compared to the parallel interfaces of other computer bus systems like ISA, PCI and PCI-X.

PCI Express defines a serial point-to-point connection, the so-called Link:

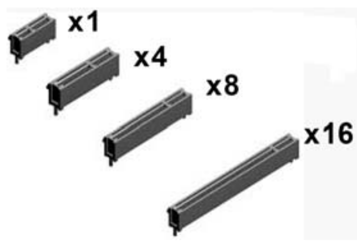


The data transfer within a Link is done via Lanes, representing one wire pair for sending and one wire pair for receiving data:



This design leads to a full duplex connection clocked with 2.5 GHz capable of transfering a data volume of 250 MB/s per lane in each direction. Higher bandwith is implemented by using multiple lanes silmutaneously. A PCI Express x16 slot for example uses sixteen lanes providing a data volume of 4 GB/s. For comparison: when using conventional PCI the maximum data transfer rate is 133 MB/s, PCI-X allows 1 GB/s but only in one direction respectively. **A PCIe expansion board (x1 like TCR170PEX for example) can always be used in slots with a higher lane width (x4, x8, x16):**

Interoperability				
Slot	x1	x4	x8	x16
Card				
x1	Yes	Yes	Yes	Yes
x4	No	Yes	Yes	Yes
x8	No	No	Yes	Yes
x16	No	No	No	Yes



One of the strong points of PCI Express is the 100% software compatibility to the well known PCI bus, leading to a fast spreading. The computer and the operating system are „seeing“ the more powerfull PCIe bus just as the convetional PCI bus without any software update.

Features TCR170PEX

The board TCR170PEX is designed as a standard height board for computers with PCI Express interface. The data transfer to the computer is done by using a single PCI Express Lane (x1 board). TCR170PEX serves to decode and generate modulated (AM) and unmodulated (DC Level Shift) IRIG and AFNOR time codes. AM-codes are transmitted by modulating the amplitude of a sine wave carrier, unmodulated codes by variation of the width of pulses.

As standard the module TCR170PEX is equipped with a TCXO (**T**emperature **C**ompensated **X**tal **O**scillator) as master oscillator to provide a high accuracy in holdover mode of +/- 1 * 10E-8. Optionally an OCXO (**O**ven **C**ontrolled **X**tal **O**scillator) is available for better accuracy.

Receiver:

Automatic gain control within the receive circuit for unmodulated codes allows decoding of IRIG or AFNOR signals with a carrier amplitude of 600 mV_{pp} to 8 V_{pp}. The input stage is electrically insulated and has an impedance of either 50 Ω, 600 Ω or 5 kΩ, selectable by a jumper. The unmodulated input is accessible via a BNC-connector in the bracket of TCR170PEX.

Unmodulated or ‘DC Level Shift’ time codes must be connected to the D-Sub-plug of the module. The receive circuit is insulated by an onboard photocoupler which can be driven by TTL or RS-422 signals for example. In delivery state of TCR170PEX the contacts of the D-Sub-plug are not connected to the photocoupler. Two DIP-switches must be set to the ‘ON’ position for making this connection.

Generator:

The generator of TCR170PEX is capable of producing time codes in IRIG-B or AFNOR format. They are available as modulated (3 V_{pp}/1 V_{pp} into 50 Ω) and unmodulated (DC Level Shift) signals (TTL into 50 Ω and RS-422). A jumper on the board allows selection of active-high or active-low time codes.

Regarding time code and its offset to UTC, the receiver and the generator can be configured independantly. Thus TCR170PEX can be used for code conversion.

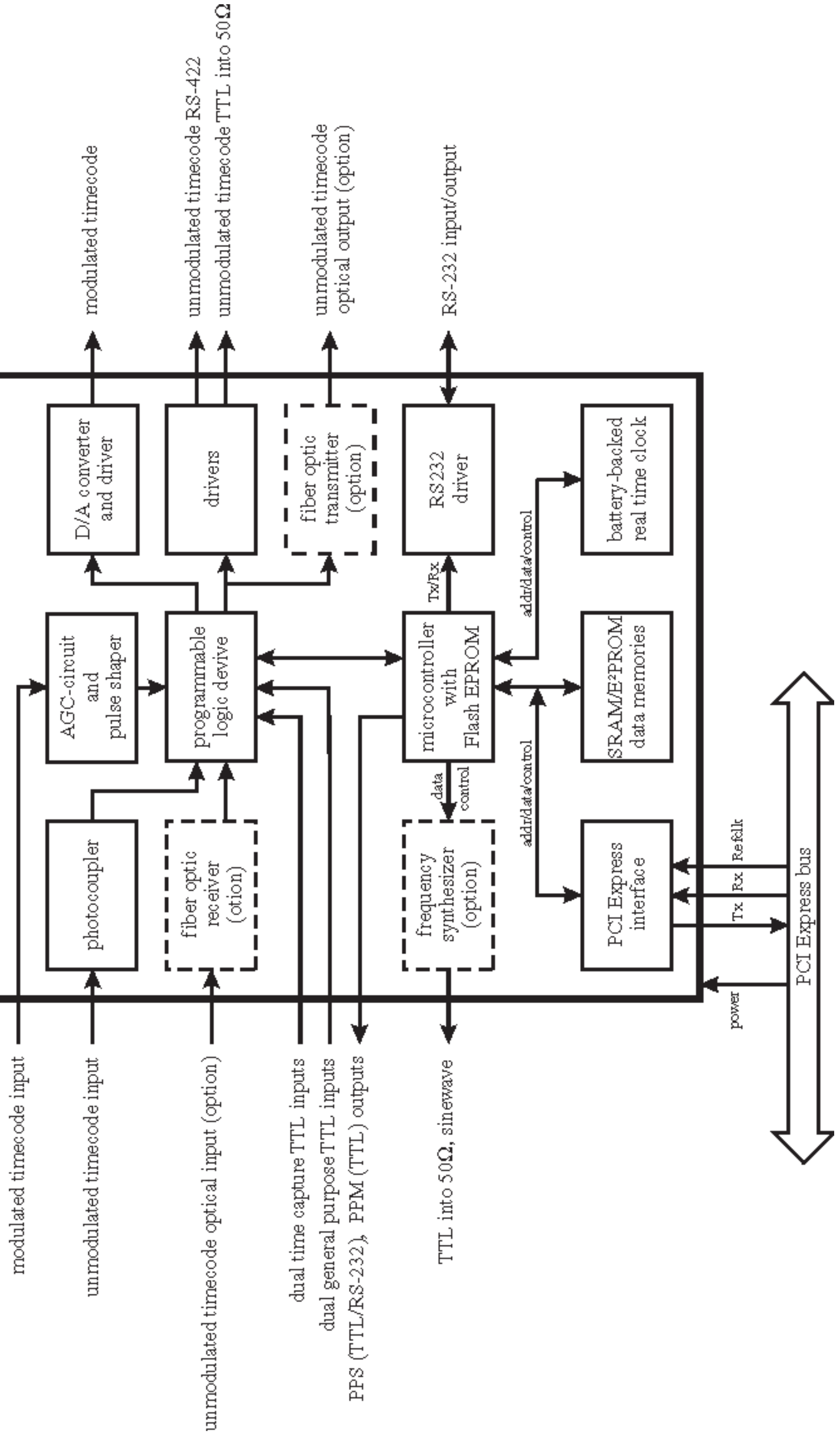
As an option the module can be delivered with optical inputs/outputs instead of the modulated signal paths.

The board TCR170PEX provides two configurable serial interfaces (RS-232). COM0 is available via the Sub-D connector, COM1 can be found at a contact strip of the board. Two programmable pulse outputs can be connected to the D-Sub-plug by setting DIP-switches into the ‘ON’ position.

A contact strip on the board provides two TTL inputs (CAP0 and CAP1) that can be used to capture asynchronous time events. These time stamps are readable via the PCI-bus or the serial interface and can be evaluated by user software.

TCR170PEX provides a synthesizer which can generate output frequencies from 1/8 Hz up to 10 MHz with TTL level into 50 Ω and as a sine signal.

Block diagram TCR170PEX



Functional description of receiver

After the received IRIG code has passed a consistency check, the software clock and the battery backed realtime clock of TCR170PEX are synchronized to the external time reference. If an error in the IRIG telegram is detected, the system clock of the board switches to holdover mode. IRIG code includes day of year information only (1...366) and no complete date. The complete date is calculated by using the IRIG day of year information and the year stored in the battery backed realtime clock. To achieve synchronization of TCR170PEX, the year stored in the realtime clock must be set correctly therefore. Date and time kept in the realtime clock can be set by sending a Meinberg Standard Time Telegram to the serial interface COM0 or via the PCI bus.

The internal system clock is always set to the received IRIG time, which might have a local offset to UTC. Only if TCR170PEX is configured with this offset, Meinberg driver software is able to set the system time of the computer correctly.

Conversion from UTC to local time including handling of daylight saving year by year can be done by the board´s microprocessor if the corresponding parameters are set up with the help of the monitor software.

The time zone is entered as offset of seconds from UTC, e.g. for Germany:
MEZ = UTC + 3600 sec, **MESZ = UTC + 7200 sec**.

The specific date of beginning and end of daylight saving can be generated automatically for several years. The receiver calculates the switching times using a simple scheme, e.g. for Germany:
Beginning of daylight saving is the first sunday after March, 25th at two o'clock => MESZ
End of daylight saving is the first sunday after October, 25th at three o'clock => MEZ

The parameters for time zone and switching to/from daylight saving can be set by using the included monitor program. If the same values for beginning and end of daylight saving are entered, no switching of time will be made.

The time code output (IRIG, AFNOR) of TCR170PEX can be generated by using these time zone settings or UTC as reference. This can be set up with by the monitor program.

IRIG telegrams don't include announcers for the change of time zone (daylight saving on/off) or for the insertion of a leap second. Hence the clock will switch into freewheeling mode in case of such event, and resynchronize afterwards.

The board TCR170PEX decodes the following formats:

A133:	1000pps, amplitude modulated sine wave signal, 10 kHz carrier frequency BCD time of year, SBS time of day
A132:	1000pps, amplitude modulated sine wave signal, 10 kHz carrier frequency BCD time of year
A003:	1000pps, DC Level Shift pulse width coded, no carrier BCD time of year, SBS time of day
A002:	1000pps, DC Level Shift pulse width coded, no carrier BCD time of year
B123:	100pps, amplitude modulated sine wave signal, 1 kHz carrier frequency BCD time of year, SBS time of day
B122:	100pps, amplitude modulated sine wave signal, 1 kHz carrier frequency BCD time of year
B003:	100pps,DC Level Shift pulse width coded, no carrier BCD time of year, SBS time of day
B002:	100pps, DC Level Shift pulse width coded, no carrier BCD time of year
AFNOR NFS 87-500:	100pps, amplitude modulated sine wave signal, 1 kHz carrier frequency BCD time of year, complete date, SBS time of day

Input signals

Amplitude modulated IRIG-A/B or AFNOR codes must be connected to the BNC-jack in the bracket of TCR170PEX. A shielded or a twisted pair cable should be used.

Pulse width modulated (DC Level Shift) signals are applied by using the D-Sub-plug. Two DIP-switches must be set to the ‘ON’ position for connecting the contacts of the D-Sub with the onboard photocoupler.

As an option, an optical input can be equipped instead of the modulated input. It is available as ST-connector for GI 50/125µm or GI 62,5/125µm gradient fiber.

The IRIG code used must be configured with the monitor software.

The board TCR170PEX can’t be used to decode amplitude modulated and DC Level Shift signals simultaneously. Depending on the selected code, only the signal at the BNC-jack, the D-Sub or the optional optical input connector is decoded.

Input impedance

The IRIG-specification doesn't define values for the output impedance of generators or the input impedance of receivers. This fact led to incompatibility of some modules, because the manufacturers could choose the impedances freely. For example: if the output impedance of the generator is high and the input impedance of the receiver low, the signal level at the receiver input might be too low for correct decoding. Therefore the board TCR170PEX contains a jumper to select the impedance (50 Ω, 600 Ω or 5 kΩ) of the input for modulated codes (BNC) to comply with the requirements of several systems.

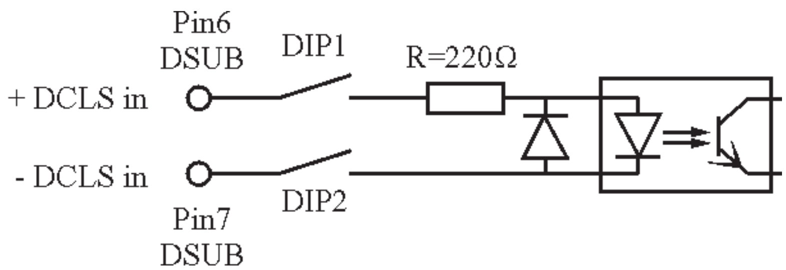
Meinberg IRIG-generators have an output impedance of **50 Ω**, to build a matched transmission system when using a coaxial cable. If such a generator is used to synchronize TCR170PEX, the input impedance has to be set to 50 Ω accordingly (default on delivery).

In addition to the telegram, the **AFNOR-code** defines the input/output impedances also. If TCR170PEX is synchronized by this code, an input impedance of **600 Ω** must be set.

The setting „5 kΩ“ may be necessary if the generator has a high output impedance (see specifications of manufacturer). The driver software shows a bar chart for evaluation of the signal level at the receiver input.

Photocoupler input

Pulse width modulated (DC Level Shift) codes are insulated by an onboard photocoupler. The connection scheme is shown below:



The internal series resistance allows direct connection of input signals with a maximum high level of +12 V (TTL or RS-422 for example). If signals with a higher amplitude are used, an additional external series resistance must be applied for not exceeding the limit of the forward current of the input diode (50 mA). The forward current should not be limited to a value of less than 10 mA to ensure save switching of the photocoupler.

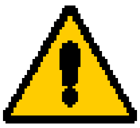
Master oscillator

As standard, TCR170PEX is equipped with a TCXO (**T**emperature **C**ompensated **X**tal **O**scillator) optionally an OCXO LQ/MQ/HQ (**O**ven **C**ontrolled **X**tal **O**scillator) as master oscillator. The internal timing of the module, basis for the software clock, the pulses and the generated time code, is derived from this oscillator. If the reciver is synchronized by an incomming time code, the oscillator is adjusted to its nominal frequency. The current correction factor is stored in a non volatile memory (EEPROM) of the system. Therefore a high accuracy in holdover mode of +/- 1 * 10E-8 is achieved, if the receiver was synchronous for at least one hour.

The 10 MHz standard frequency is available at a contact strip with TTL level into 50 Ω.

Functionality of the generator

The time code generator of TCR170PEX is based on a DDS (**D**irect **D**igital **S**ynthesis) frequency generator, which derives the sine carrier of the modulated code from the reference clock of the master oscillator. The modulation of carrier amplitude (modulated codes) or pulse duration (unmodulated, DC level shift codes) is synchronized to the pulse per second (PPS) of the system based on the software clock.



The generated time code is independant from the settings for the received code. It is possible to generated a different format and offset from UTC therefore.

Outputs

TCR170PEX provides modulated and unmodulated (DC level shift) outputs. As an option, an optical output can be equipped instead of the modulated output. It is available as ST-connector for GI 50/125µm or GI 62,5/125µm gradient fiber.

Modulated output

The amplitude-modulated sine carrier is available a BNC-coaxial-plug connector in the bracket. The carrier for IRIG-B and AFNOR signals is 1 kHz. The signal amplitude is $3V_{pp}$ (MARK) and $1V_{pp}$ (SPACE) into 50 Ω. The encoding is made by the number of MARK-amplitudes during ten carrier waves. The following agreements are valid:

binary ‘0’	:	2 MARK-amplitudes, 8 SPACE-amplitudes
binary ‘1’	:	5 MARK-amplitudes, 5 SPACE-amplitudes
position-identifier	:	8 MARK-amplitudes, 2 SPACE-amplitudes

Unmodulated outputs

The pulse width modulated DC-signals are coexistent to the modulated output and are available with TTL level into 50 Ω and as RS-422 signal. After bringing DIP-switches into the ‘ON’ position, these outputs are available at the D-Sub connector. The active state of the unmodulated outputs can be set up by a jumper on the board TCR170PEX.

Pulse outputs

The pulse generator of TCR170PEX contains three independent channels (PPO0, PPO1, PPO2). Two of these TTL outputs can be mapped to pins at the 9-pin connector at the rear slot cover by using a DIL switch, the third channel is available at a contact strip. 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
PPO1:	Pulse each minute (PPM), active HIGH, pulse duration 200 msec
PPO2:	DCF77 Simulation

Asynchronous serial port

TCR170PEX provides two asynchronous serial RS-232 interfaces. COM0 is available at the D-Sub connector, COM1 can be found at a contact strip of the module. The serial ports are sending a time string in the format 'Standard Meinberg', 'Uni Erlangen', or 'SAT' either once per second, once per minute or on request with ASCII '?' only. Furthermore they can be set up to send telegrams containing time capture events automatically or on request. The format of these telegrams is described in the 'Technical Specifications'. The transmission speed and the framing can be set via the PCI-bus by using the shipped monitor software. The serial interface COM0 is used for a potential firmware update also. The serial interfaces transmit the time zone set up in the appropriate menu. A potential offset to UTC must be set correctly.

If a serial interface sends capture events automatically, they can't be read via the PCI-bus, because they are deleted from the buffer memory after transmission.

Enabling of outputs

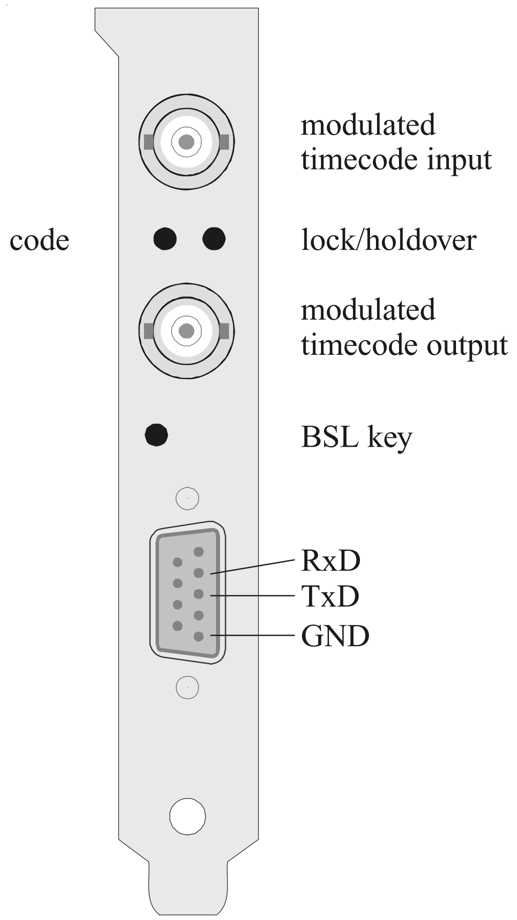
As standard, the generator, the pulse outputs, the serial interfaces and the frequency synthesizer are switched off after power up until the receiver is synchronized. By using the monitor software TCR170PEX can be set up to enable the outputs immediately after reset without synchronization. This setting can be done independant for the pulses, the serial interface and the synthesizer.

Enabling of the generator is coupled with the pulses, because generation of time codes is synchronized by the pulse per second (PPS).

Time capture inputs

Two time capture inputs (CAP0 and CAP1) are provided at a contact strip of TCR170PEX 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 the PCI-bus or the serial interface COM0. 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 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.

Connectors and LEDs in the bracket



The bracket of the board includes the BNC-connectors for the amplitude modulated time codes (input/output), two LEDs, a key for activating the Bootstrap-Loader and a 9 pin D-Sub-plug.

The LEDs signal the status of the IRIG receiver. The right, bicolor LED is switched to red whenever the internal timing of TCR170PEX is in holdover mode. This state arises after power up and if an error in the IRIG telegram is detected. This LED changes state only at change of minute. This LED is switched to green (lock) if the internal timing of TCR170PEX is synchronized to the received IRIG code by a PLL (**P**hase **L**ocked **L**oop). If the left, green LED (code) is switched on, the IRIG receiver detected a correct telegram at its input.

Pressing the hidden key BSL is required for activating the Bootstrap-Loader before updating the firmware.

The 9 pin D-Sub-connector is wired to the board's serial port. Pin assignment can be seen from the figure above. This port can **not** be used as serial port for the computer. Instead, the clock uses the port to send out Meinberg's standard time string in order to control an external display or some other external device. The string is sent out once per second, once per minute or if requested by an incoming ASCII '?'. It is also possible to change the board's board time by sending such a string towards the clock. Transmission speed, framing and mode of operation can be modified using the monitor software. The string format is described in the section 'Technical Specifications' at the end of this manual.

Pin assignments of the D-Sub connector

Only the signals of the serial interface are connected to the D-Sub-plug directly. If another signal shall be connected to a pin of the plug, a DIP-switch must be set to the 'ON' position.

Whenever an additional signal is connected to the rear panel, special care must be taken to the configuration of the cable used with the connector. If pins with TTL level and RS-232 levels are connected to each other, the circuits on the board may be damaged.

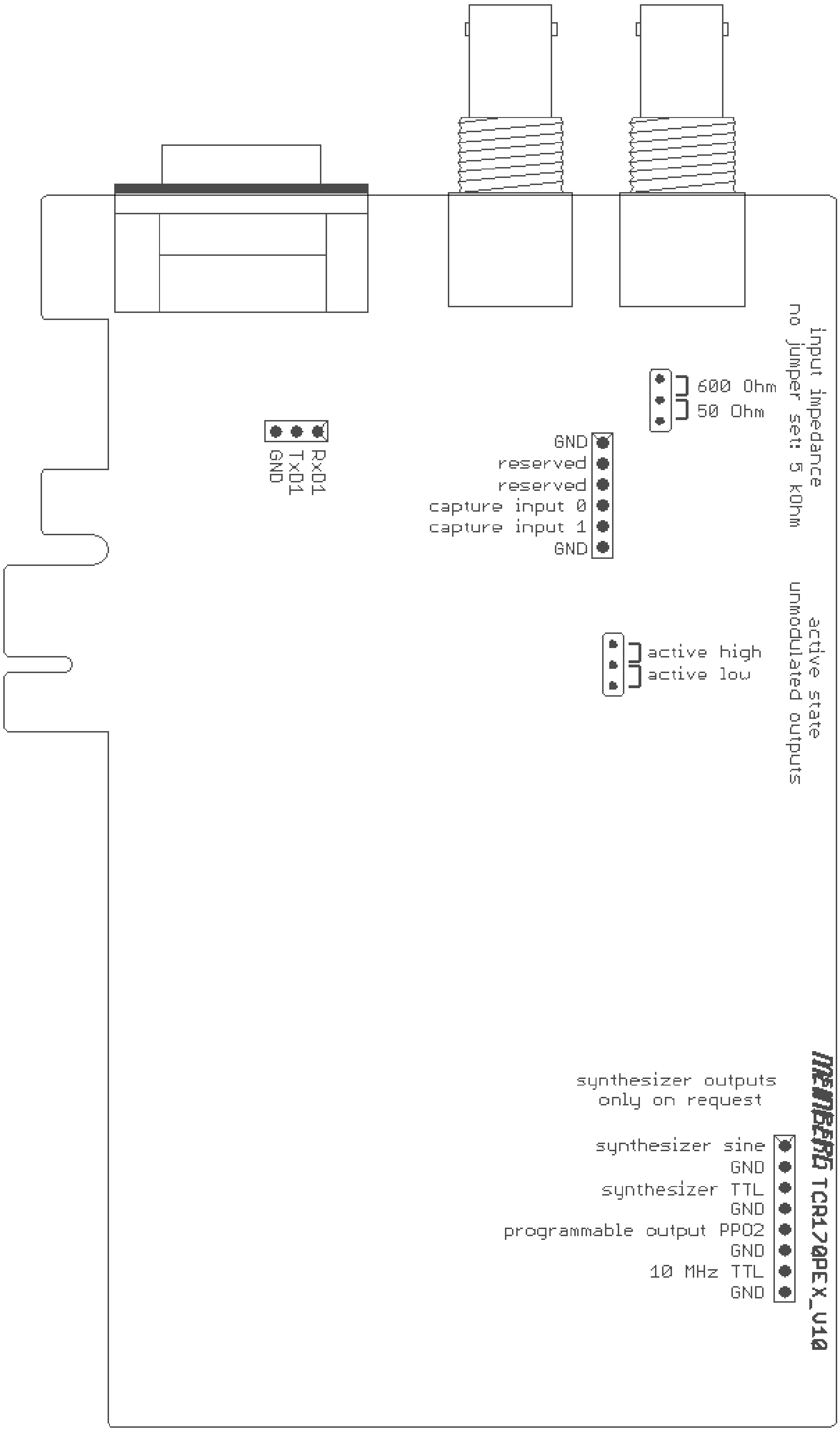
Because the pins 1/4/8 of the D-Sub connector could be used for two different signals, only one of the switches assigned to these pins might be put in the 'ON' position. The table below shows the pin assignments for the connector and the DIP-switch assigned to each of the signals:

Pin	Signal	SWITCH
1	+ 5V / PPO0 out (RS-232)	3 / 4
2	RxD in (RS-232)	-
3	TxD out (RS-232)	-
4	PPO1 out (TTL) / - DCLS out (RS-422)	6 / 10
5	GND	-
6	+ DCLS in (photocoupler)	1
7	- DCLS in (photocoupler)	2
8	PPO0 out (TTL) / +DCLS out (RS-422)	5 / 9
9	DCLS out (TTL)	8
PPO0: programmable pulse output, default: pulse per second (PPS)		
PPO1: programmable pulse output, default: pulse per minute (PPM)		
DCLS: DC level shift, unmodulated timecode		

Those signals which do not have DIP-switch assigned are always available at the connector. All DIP-switches not assigned are reserved and should remain in the 'OFF' position.

Jumper and contact strips

The following diagram shows the possible jumper settings and the assignment of the contact strips of the board TCR170PEX:



Frequency synthesizer

The frequency synthesizer is capable to generate output frequencies of 1/8 Hz up to 10 MHz as sine wave signal and with TTL level into 50 Ω. If a frequency smaller than 1 kHz has been selected, the following decimal places lead to real fractions of Hertz:

0.1:	1/8 Hz
0.3:	1/3 Hz
0.6:	1/6 Hz

If a frequency of 0 Hz is selected, the synthesizer is turned off.

The phase position of the output frequency can be set from -360° to +360° with a resolution of 0.1°. If the phase angle is increased, the signal is more delayed. If the output frequency is bigger than 10 kHz, the phase angle can’t be set.

Putting into operation

To achieve correct operation of the board, the following points must be observed.

Installing the TCR170PEX in your Computer

Every PCI Express board is a plug&play board. After power-up, the computer's BIOS assigns resources like I/O ports and interrupt numbers 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.

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 after installation.

Power supply

All power supplies needed by TCR170PEX are delivered by the PCI bus.

Configuration of TCR170PEX

The selection of the IRIG code, configuration of the serial interface and a possible offset of the received IRIG time to UTC must be set up by the monitor software via the PCI bus. In contrast to AFNOR NFS 87-500 the IRIG telegram containes only the day of year (1...366) instead of a complete date. To ensure correct function of TCR170PEX, the date stored in the realtime clock of the board must be set when using IRIG codes therefore. This setting can be done by a terminal software also.

If the time zone of the received IRIG code is not UTC, the local offset to UTC must be configured to ensure correct function of the driver software. If the local time zone is MEZ for example, the board must be set to a local offset of '+60min' (MEZ = UTC + 1 h).

The serial interface COM0 can be configured to send a time telegram with reference to UTC or to the received local IRIG time.

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 board'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 interfaces to the 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 an the on again.

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 specification TCR170PEX

RECEIVER INPUT:	<u>AM-input (BNC-connector):</u> insulated by a transformer impedance settable 50 Ω, 600 Ω, 5 kΩ input signal: 600 mV_{pp} to 8 V_{pp} (Mark) other ranges on request <u>DC Level Shift input (D-Sub-connector):</u> insulated by photocoupler internal series resistance: 220 Ω maximum forward current: 50 mA diode vorward voltage: 1.0 V...1.3 V <u>optical input(option):</u> optcal receive power: min. 3µW optical connector: ST-connector for GI 50/125µm or GI 62,5/125µm gradient fiber
DECODING:	decoding of the following telegrams possible: IRIG-A133/A132/A003/A002 IRIG-B123/B122/B003/B002 AFNOR NFS 87-500
ACCURACY OF TIME BASE:	+/-5 µsec compared to IRIG reference marker
REQUIRED ACCURACY OF TIME CODE SOURCE:	+/- 100ppm
HOLDOVER MODE:	automatic switching to crystal time base accuracy approximately +/- 1 * 10E-8 if decoder has been synchronous for more than 1h
BACKUP-BATTERY:	if the power supply fails, an onboard realtime clock keeps time and date information important system parameters are stored in the RAM of the system lifetime of the Lithium battery at least 10 years

GENERATOR OUTPUTS:	<u>modulated output:</u> unbalanced sine carrier, 1 kHz $3V_{pp}$ (MARK), $1V_{pp}$ (SPACE) into 50 Ω <u>unmodulated outputs (DCLS):</u> TTL into 50 Ω RS-422 active high or low selectable by jumper <u>optical output (option):</u> optical power: typ. 15µW optical connector: ST-connector for GI 50/125µm or GI 62,5/125µm gradient fiber
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
SERIAL PORT:	configurable RS-232 interface baudrates: 300 Bd...38400 Bd framing: 7E2, 8N1, 8N2, 8E1 mode of operation: string per second, string per minute, string on request time telegram: Meinberg Standard, Uni Erlangen, SAT, Capture Telegram
CAPTURE INPUTS:	triggered by falling TTL slope pulse repetition time: 1.5 msec min. resolution: 800 nsec output of trigger event via PCI-bus or serial interface

MASTER OSCILLATOR:	TCXO (**T**emperature **C**ompensated **X**tal **O**scillator)	
	<u>accuracy compared to IRIG-reference:</u>	
	sync. and 20 min. of operation:	$\pm 5 \cdot 10^{-9}$
	first 20 min. after sync.:	$\pm 1 \cdot 10^{-8}$
	<u>accuracy of oscillator:</u>	
	holdover, 1 day:	$\pm 1 \cdot 10^{-7}$
	holdover, 1 year:	$\pm 1 \cdot 10^{-6}$
	<u>short term stability:</u>	
	<= 10 sec, synchronized:	$\pm 2 \cdot 10^{-9}$
	<= 10 sec, holdover:	$\pm 5 \cdot 10^{-9}$
	<u>temperature dependant drift:</u>	
	holdover:	$\pm 1 \cdot 10^{-6}$
	<u>phase noise:</u>	
	1 Hz besides carrier:	-60 dB/Hz
	10 Hz besides carrier:	-90 dB/Hz
	100 Hz besides carrier:	-120 dB/Hz
	1 kHzbesides carrier:	-130 dB/Hz
	Option: OCXO LQ for higher accuracy in holdover mode (Specifications look at <u>oscillator options</u> on Meinberg homepage)	

FREQUENCY SYNTHESIZER:	output frequency:	1/8 Hz up to 10 MHz
	accuracy:	like system accuracy
	1/8 Hz to 10 kHz:	Phase synchronous to pulse per second
	10 kHz to 10 MHz:	deviation of frequency < 0.0047 Hz
	outputs:	TTL into 50 Ω sine wave 1.5 V_{rms}, output impedance 200 Ω

RELIABILITY OF OPERATION:	microprocessor supervisory circuit provides watch dog timer, power supply monitoring and backup battery switchover software watchdog monitors correct program flow and generates a reset in case of error detection
INITIALIZATION:	software and realtime clock can be set by a serial Meinberg Standard Telegram via COM0 or the PCI Express Interface
BUS INTERFACE:	Single lane (x1) PCI Express (PCIe) Interface compatible to PCI Express specifications r1.0a
DATA FORMAT:	binary, byte serial
POWER REQUIREMENTS:	+3,3V, @ 200 mA +12V, @ 120 mA
BOARD DIMENSIONS:	standard height expansion board
AMBIENT TEMPERATURE:	0 ... 70°C
HUMIDITY:	max. 85 %

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:

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

v: different for DCF77 or GPS receivers:

'*' DCF77 clock currently runs on XTAL
GPS receiver has not checked its position

' ' (space, 20h) DCF77 clock is sync'd with transmitter
GPS receiver has determined its position

x time zone indicator:
- 'U' UTC Universal Time Coordinated, formerly GMT
- ' ' (space, 20h) local IRIG time

y ' ' (space, 20h)

<ETX> End-Of-Text (ASCII code 03h)

Format of the 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 time string Uni Erlangen (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.llllе 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 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)

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)

Konformitätserklärung

Declaration of Conformity

Hersteller Manufacturer	**Meinberg Funkuhren GmbH & Co. KG** **Auf der Landwehr 22** **D-31812 Bad Pyrmont**

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

Produktbezeichnung Product Name	**Time code receiver/generator**
Modell / Typ Model Designation	**TCR170PEX**

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

EN55022, 11/01, Class B	Grenzwerte und Meßverfahren für Funkstörungen von informationstechnischen Einrichtungen Limits and methods of measurement of radio interference characteristics of information technology equipment
EN55024, 5/99	Grenzwerte und Meßverfahren für Störfestigkeit von informationstechnischen Einrichtungen Limits and methods of measurement of Immunity characteristics of information technology equipment

gemäß den Bestimmungen der Richtlinie 89/336/EWG zur Angleichung der Rechtsvorschriften der Mitgliedstaaten über die elektromagnetische Verträglichkeit.
following the provisions of Directive 89/336/EEC on the approximation of the laws of the Member States relating to electromagnetic compatibility.

Bad Pyrmont, den 04.11.2008

Authorized Signature

TCR170PEX-E-15.10.09