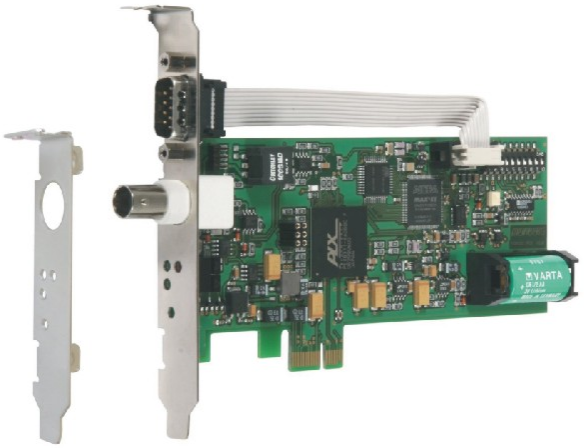

MANUAL

TCR511PEX

IRIG Time Code Receiver
for Computers (PCI Express)

13th July 2015

Meinberg Radio Clocks GmbH & Co. KG

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1 Imprint

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2 Introduction: Abstract of Time Code

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

Except these "IRIG Time Codes" other formats, like NASA36, XR3 or 2137, are still in use. The board &PRODUCT 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.

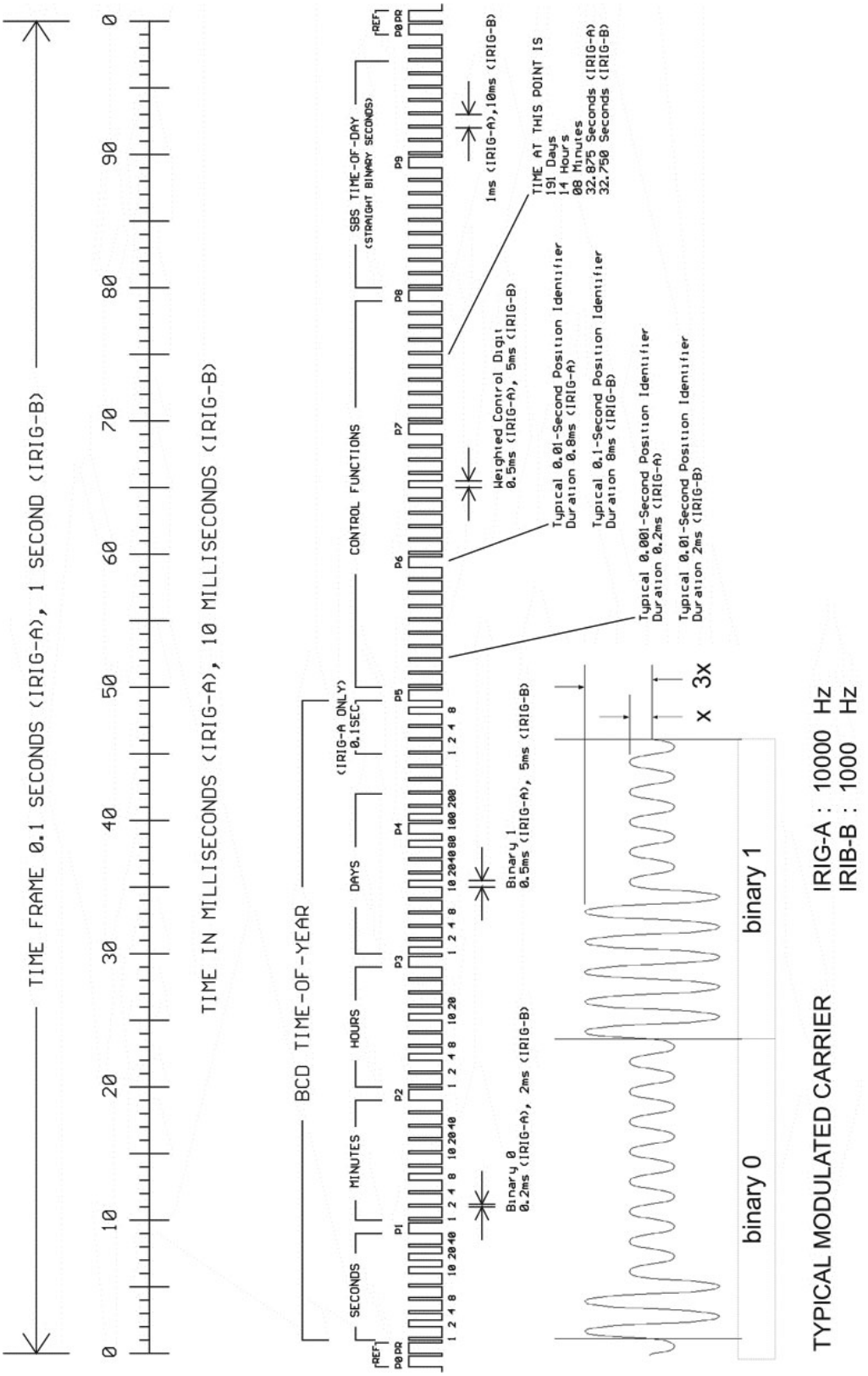
3 Description of IRIG-Codes

The specification of individual IRIG time code formats is defined in IRIG Standard 200-04. 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):

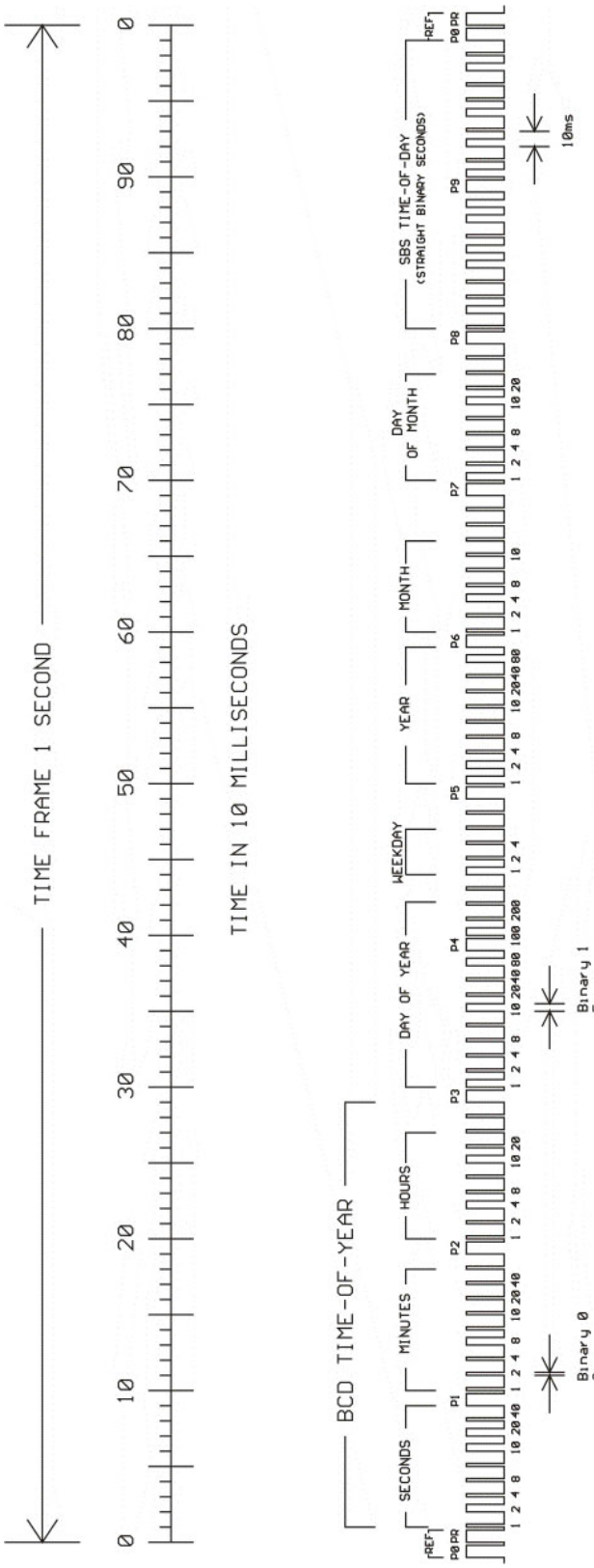
character	bit rate designation	A	1000 pps
		B	100 pps
1st digit	form designation	0	DC Level Shift pulse width modulated
		1	sine wave carrier amplitude modulated
2nd digit	carrier resolution	0	no carrier (DC Level Shift)
		1	100 Hz, 10 msec resolution
		2	1 kHz, 1 msec resolution
		3	10 kHz, 100 μsec resolution
3rd digit	coded expressions	0	$BCD_{(TOY)}$, CF, SBS
		1	$BCD_{(TOY)}$, CF
		2	$BCD_{(TOY)}$
		3	$BCD_{(TOY)}$, SBS
		4	$BCD_{(TOY)}$, $BCD_{(YEAR)}$, CF, SBS
		5	$BCD_{(TOY)}$, $BCD_{(YEAR)}$, SBS
		6	$BCD_{(TOY)}$, $BCD_{(YEAR)}$
		7	$BCD_{(TOY)}$, $BCD_{(YEAR)}$, SBS

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

4 IRIG Standard Format



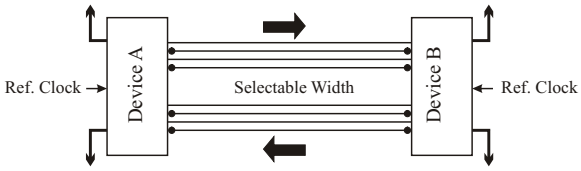
5 AFNOR Standard Format



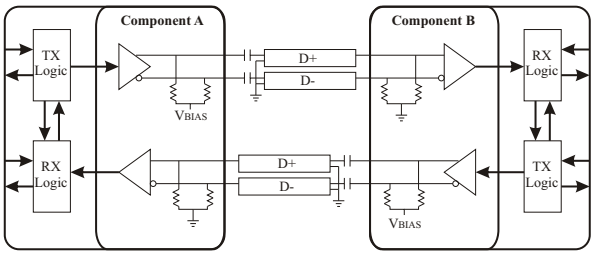
6 PCI Express (PCIe)

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.

7 Features TCR511PEX

The board TCR511PEX is designed as a „low profile“ board for computers with PCI Express interface. The data transfer to the computer is done by using a single PCI Express Lane (x1 board).

The IRIG receiver is equipped with a standard height bracket. For installation in a „low profile“ computer, an adequate bracket can be mounted that is included in delivery. The I/O signals provided by a D-Sub connector are only available when using an additional bracket (not included) in this case.

TCR511PEX serves to receive and decode 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.

Automatic gain control within the receive circuit for unmodulated codes allows decoding of IRIG signals with a carrier amplitude of 600 mVpp to 8 Vpp. The input stage is elecctically insulated and has an impedance of 50 0, it is accessible via the BNCconnector in the bracket of TCR511PEX.

Unmodulated time codes must be connected to the D-Sub-plug of the module. An onboard photocoupler insulates the internal receive circuit. In delivery state of TCR511PEX 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.

The board TCR511PEX provides a configurable serial interface (RS-232), a pulse per second (PPS) with TTL or RS-232 level and a pulse per minute (PPM) with TTL level. Like the photocoupler, these signals are only connected to the D-Sub-plug after setting DIP-switches into the ‘ON’ position.

Software running on the computer can read out information regarding date, time and status of the IRIG receiver. Access to the board is made via writing to/reading from I/O ports. It is possible but not necessary to let the board generate periodic hardware interrupts on the computer bus.

7.1 Functional description

After the received IRIG code has passed a consistency check, the software clock and the battery backed realtime clock of TCR511PEX 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. Drifting of the internal time base and the generated pulses (PPS/PPM) is limited to 1μsec/sec by regulating the onboard quartz of TCR511PEX. IRIG code includes day of year information only. The complete date is kept in the battery backed realtime clock and the software clock therefore. The received day of year is compared to this complete date once per minute. If the board detects a difference between received and stored date information, TCR511PEX switches to holdover mode but still synchronizes the internal time base to the received IRIG code.

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-Express bus.

The internal system clock is always set to the received IRIG time, which might have a local offset to UTC. Only if TCR511PEX is configured with this offset, Meinberg driver software is able to set the system time of the computer correctly. The serial interface COM0 can send the Standard Meinberg Timestring with UTC or local (IRIG) time.

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 free-wheeling mode in case of such event, and resynchronize afterwards.

The board TCR511PEX decodes the following formats:

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
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
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
B007:	100 pps, DCLS Signal, no carrier, BCD time-of-year, Year, SBS time-of-day
B006:	100 pps, DCLS Signal, no carrier, BCD time-of-year, 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
B127:	100 pps, AM sine wave signal, 1 kHz carrier frequency, BCD time-of-year, Year, SBS time-of-day
B126:	100 pps, AM sine wave signal, 1 kHz carrier frequency, BCD time-of-year, Year

C37.118:	Like IEEE1344 - with turned sign bit for UTC-Offset
IEEE1344:	100pps, AM sine wave signal, 1kHz carrier, BCD time of year, SBS time of day, IEEE1344 expansion for date, time zone, daylight saving and leap second in Control Funktions Segment
AFNOR NFS 87-500:	100pps, amplitude modulated sine wave signal, 1 kHz carrier frequency BCD time of year, complete date, SBS time of day

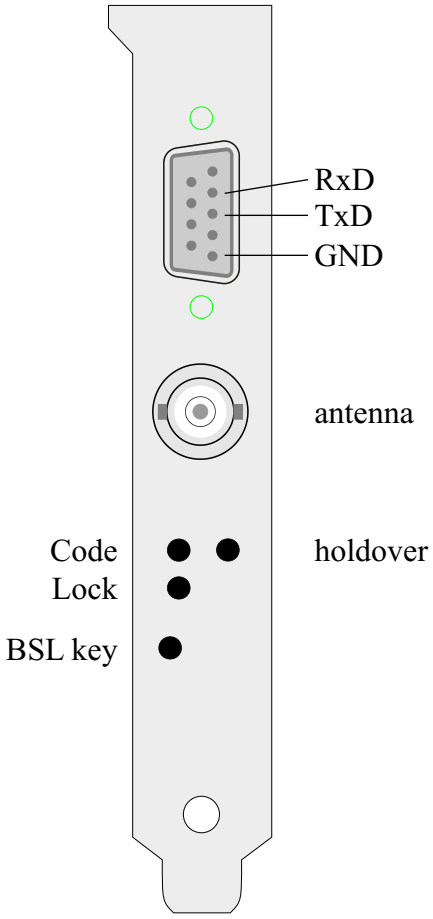
7.2 Pulse outputs

The module TCR511PEX generates pulses at change of second (PPS) and change of minute (PPM). The PPS signal is available with TTL (0/+5V) or RS-232 (-3..12V/ +3..12V) level, the PPM signal with TTL level only. If required, DIP-switches can be set up to direct the pulses to a corresponding pin of the D-Sub-connector in the bracket.

7.3 Asynchronous serial port

TCR511PEX provides an asynchronous serial interface (RS-232) called COM0. The serial port sends a Standard Meinberg Time string either once per second, once per minute or on request with ASCII '?' only. The format of this telegram is described in the 'Technical Specifications'. The transmission speed and the framing can be set via the PCI-Express bus by using the shipped monitor software. Furthermore, the serial interface COM0 is used for a potential firmware update.

7.4 Connectors and LEDs in the bracket



The bracket of the board includes the BNCconnector for the amplitude modulated time codes, three 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 upper, red LED is switched on whenever the internal timing of TCR511PEX 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.The central, green LED is switched on if the IRIG receiver detects a correct telegram at its input. If the below, green LED (Lock) is switched on, the internal timing of TCR511PEX is synchronized to the received IRIG code by a PLL (Phase Locked Loop).

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.

7.5 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.

Only one of the switches 5 or 4 may be put in the 'ON' position to connect the pulse per second with TTL level or with RS-232 level to pin 8 of the plug. 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	3
2	RxD in (RS232)	-
3	TxD out (RS232)	-
4	PPM out (TTL)	6
5	GND	-
6	+ DCLS in	1
7	- DCLS in	2
8	PPS out (TTL/RS232)	5/4
9	(reserved)	8

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.

8 Putting into operation

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

8.1 Installing the TCR511PEX 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 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.

The computer has to be turned off and its case must be opened. The board 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 before restarting the computer.

8.2 Power supply

All power supplies needed by TCR511PEX are delivered by the PCI-(Express) bus.

8.3 Input signals

Amplitude modulated IRIG-A/B or AFNOR codes must be connected to the BNC-jack in the bracket of TCR511PEX. A shielded or twistet 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.

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

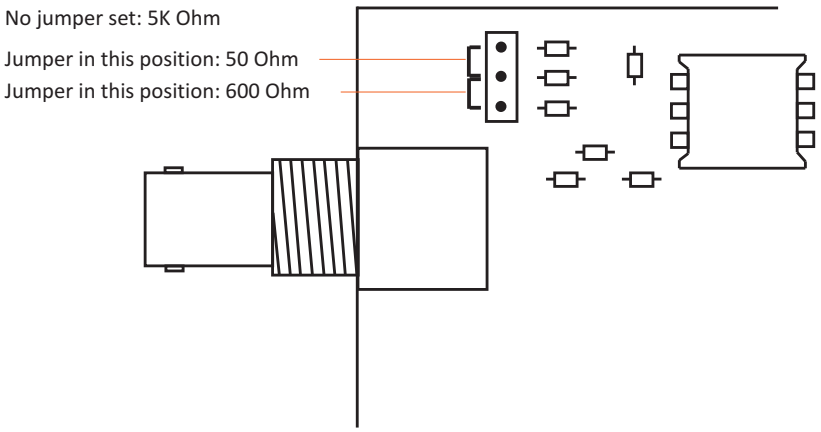
The board TCR511PEX can't be used to decode amplitude modulated and DC Level Shift signals simultaneously. Depending on the selected code, only the signal at the BNC-jack or the D-Sub connector is decoded.

8.4 Input impedance

The IRIG-specification does not 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 TCR511PEX provides a jumper to select the impedance (500 Ω, 600 Ω or 5 kΩ) of the input for modulated codes 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 TCR511PEX, the input impedance has to be set to 50 Ω accordingly (default on delivery).

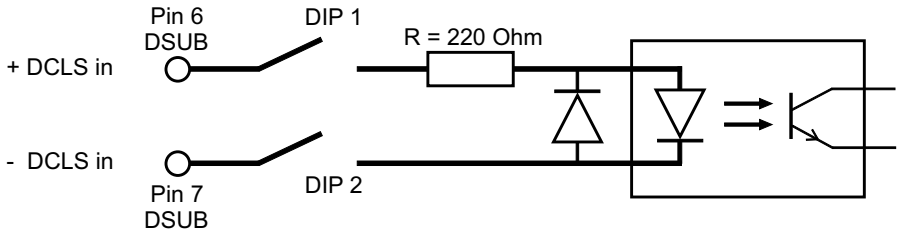
In addition to the telegram, the AFNOR-code defines the input/output impedances also. If TCR511PEX is synchronized by this code, an input impedance 600 Ω of must be set.

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. The following detail of the placeplan of TCR511PEX shows the possible jumper setting with the related input impedance:



8.5 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 imput 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.

8.6 Configuration of TCR511PEX

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 PCIExpress 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 TCR511PEX, 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.

9 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.

10 Technical specification TCR511PEX

RECEIVER INPUT:	AM-input (BNC-connector): insulated by a transformer impedance settable 50 Ω, 600 Ω, 5 kΩ input signal: 600 mVpp to 8 Vpp (Mark) other ranges on request DC Level Shift input (D-Sub-connector): insulated by photocoupler internal series resistance: 220 Ω maximum forward current: 50 mA diode vorward voltage: 1.0 V...1.3 V
DECODING:	decoding of the following telegrams possible: IRIG-A003/A002/A133/A132 IRIG-B003/B002/B007/B006/B123/B122/B127/B126 IEEE1344/C37.118/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 1E-6 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
RELIABILITY OF OPERATION:	microprocessor supervisory circuit provides watch dog timer, power supply monitoring and backupbattery 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 bus
OUTPUTS:	pulse per second (PPS): TTL- and RS-232 level positive pulse, pulse duration 200 msec pulse per minute (PPM): TTL level positive pulse, pulse duration 200 msec
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 Telegram
POWER REQUIREMENT:	+3.3 V: +12 V :	150 mA 45 mA
	power supplies provided by PCI Express interface	
PHYSICAL DIMENSION:	low profile expansion board	
AMBIENT TEMPERATURE:	0 ... 50°C	
HUMIDITY:	max. 85 %	

11 Format of the Meinberg Standard Time String

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

<STX>D:*dd.mm.yy;T:w;U:hh.mm.ss;uvxy*<ETX>

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

<STX>	Start-Of-Text, ASCII Code 02h		
	sending with one bit accuracy at change of second		
dd.mm.yy	the current date:		
	dd	day of month	(01..31)
	mm	month	(01..12)
	yy	year of	
	the century	(00..99)	
w	the day of		
	the week		(1..7, 1 = Monday)
hh.mm.ss	the current time:		
	hh	hours	(00..23)
	mm	minutes	(00..59)
	ss	seconds	(00..59, or 60 while leap second)

uv clock status characters (depending on clock type):

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

x time zone indicator:

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

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

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

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

Konformitätserklärung

Declaration of Conformity

Doc ID: TCR511PEX-05032013

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 **TCR511PEX**
Product Designation

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

EN55022:2010, Class B	Limits and methods of measurement of radio interference characteristics of information technology equipment
EN55024:2010	Limits and methods of measurement of Immunity characteristics of information technology equipment
EN 50581:2012	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

gemäß den Richtlinien 2004/108/EG (Elektromagnetische Verträglichkeit), 2006/95/EG (Niederspannungsrichtlinie), 2011/65/EU (Beschränkung der Verwendung bestimmter gefährlicher Stoffe) 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), 2011/65/EU (restriction of the use of certain hazardous substances) and 93/68/EEC (CE marking) and its amendments.

Bad Pyrmont, den 05.03.2013

Günter Meinberg
Managing Director