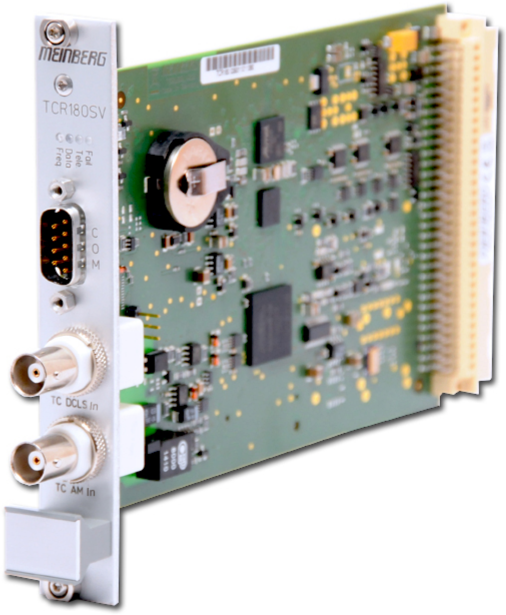

MANUAL

TCR180

IRIG Code controlled Radio Clock

4th June 2021

Meinberg Funkuhren GmbH & Co. KG

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1 Imprint

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2 Safety instructions for building-in equipment

2.1 Important Safety Instructions and Protective Measures

The following safety instructions must be respected in all operating and installation phases of the device. Non-observance of safety instructions, or rather special warnings and operating instructions in product manuals, violates safety standards, manufacturer instructions and proper usage of the device. Meinberg Funkuhren shall not be responsible for any damage arising due to non-observance of these regulations.

Depending on your device or the installed options
some information is not valid for your device.

The device satisfies the requirements of the following EU regulations: EMC-Directive,
Low Voltage Directive, RoHS Directive and - if applicable - the Radio Equipment Directive.

If a procedure is marked with the following signal words, you may only continue, if you have understood and fulfilled all requirements. In this documentation dangers and indications are classified and illustrated as follows:

DANGER!
The signal word indicates an imminently hazardous situation with a high risk level . This notice draws attention to an operating procedure or similar proceedings, of which a non-observance may result in serious personal injury or death .

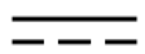
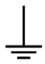
WARNING!
The signal word indicates a hazard with a medium risk gradient . This notice draws attention to an operating procedure, a procedure or the like which, if not followed, can lead to serious injuries , possibly resulting in death .

CAUTION!
The signal word indicates a hazard with a low risk gradient . This notice draws attention to an operating procedure, a procedure or the like which, if not followed, can lead to minor injuries .

ATTENTION!
This notice draws attention to an operating procedure, a procedure or the like which, if not followed, can cause damage to the product or loss of important data .

2.2 Used Symbols

The following symbols and pictograms are used in this manual. To illustrate the source of danger, pictograms are used, which can occur in all hazard classes.

Symbol	Beschreibung / Description
	IEC 60417-5031 Gleichstrom / *Direct current*
	IEC 60417-5032 Wechselstrom / *Alternating current*
	IEC 60417-5017 Erdungsanschluss / *Earth (ground) terminal*
	IEC 60417-5019 Schutzleiteranschluss / *Protective earth (ground) terminal*
	ISO 7000-0434A Vorsicht / *Caution*
	IEC 60417-6042 Vorsicht, Risiko eines elektrischen Schlages / *Caution, risk of electric shock*
	IEC 60417-5041 Vorsicht, heiße Oberfläche / *Caution, hot surface*
	IEC 60417-6056 Vorsicht, Gefährlich sich bewegende Teile / *Caution, moving fan blades*
	IEC 60417-6172 Trennen Sie alle Netzstecker / *Disconnection, all power plugs*
	IEC 60417-5134 Elektrostatisch gefährdete Bauteile / *Electrostatic Sensitive Devices*
	IEC 60417-6222 Information generell / *Information general*
	2012/19/EU Dieses Produkt fällt unter die B2B Kategorie. Zur Entsorgung muss es an den Hersteller übergeben werden. *This product is handled as a B2B category product. In order to secure a WEEE compliant waste disposal it has to be returned to the manufacturer.*

The product manuals are stored on a USB stick, which is delivered with the system. The manuals can also be downloaded from the Meinberg website https://www.meinbergglobal.com. Enter the respective system name into the search box at the top of the page.

This manual contains important safety instructions for the installation and operation of the device. Please read this manual completely before using the unit.

This device may only be used for the purpose described in this manual. In particular, the given limits of the device must be observed. The safety of the installation in which the unit is integrated is the responsibility of the installer!

Non-observance of these instructions can lead to a reduction in the safety of this device!

Please keep this manual in a safe place.

This manual is intended exclusively for electricians or persons trained by an electrician who are familiar with the applicable national standards and safety rules. Installation, commissioning and operation of this device may only be carried out by qualified personnel.

2.3 Safety Hints TCR180

This building-in equipment has been designed and tested in accordance with the requirements of Standard DIN EN 62368-1 "Audio/video, information and communication technology equipment - Part 1: Safety requirements).

During installation of the building-in equipment in an end application (i.e. PC) additional requirements in accordance with Standard DIN EN 62368-1 have to be taken into account.

General Safety instructions

- The building-in equipment has been evaluated for use in office environment (pollution degree 2) and may be only used in this environment. For use in rooms with a higher pollution degree more stringent requirements are applicable.
- The equipment/building-in equipment was evaluated for use in a maximum ambient temperature of 50°C.
- Protection against fire must be assured in the end application.

2.4 Prevention of ESD Damage

ATTENTION!

The designation ESD (Electrostatic Sensitive Devices) refers to measures which are used to protect electrostatically endangered components from electrostatic discharge and thus to prevent destruction. Systems and assemblies with electrostatically endangered components usually have the following characteristics:

Indicator for assemblies with electrostatic endangered components
The following measures protect electrostatically endangered components from destruction:

Prepare removal and installation of assemblies
Unload yourself (for example, by touching a grounded object) before touching assemblies.

Ensure that you wear a grounding strap on the wrist when working with such assemblies, which you attach to an unpainted, non-conductive metal part of the system.

Use only tools and devices that are free from static electricity.

Transporting Assemblies
Assemblies may only be touched at the edge. Do not touch any pins or conductors on assemblies.

Installing and Removing Assemblies
Do not touch persons who are not grounded while removing or installing components. This could result in a loss of grounding protection from your electrostatic discharge.

Storing Assemblies
Always keep assemblies in ESD protective covers. These protective covers must be undamaged. ESD protective covers, which are extremely wrinkled or even have holes, no longer protect against electrostatic discharge.

ESD protective covers must not be low-resistance and metallically conductive if a lithium battery is installed on the assembly.

2.5 Cabling

WARNING!
Danger to life through electric shock! Never work with voltage applied! When working on the plugs and terminals of connected cables, always disconnect both sides of the cables from the respective devices!

2.6 Replacing the Lithium Battery

Skilled/Service-Personnel only: Replacing the Lithium Battery
The life time of the lithium battery on the receiver boards is at least 10 years. If the need arises to replace the battery, the following should be noted:

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.

3 TCR180 Features

The TCR180 card decodes and generates modulated (AM) and unmodulated (DC Level Shift, DCLS) IRIG-A/B/G, AFNOR NF S87-500, IEEE C37.118, or IEEE 1344 time codes. AM codes are transmitted by modulating the amplitude of a sine wave carrier, unmodulated codes by variation of the width of pulses.

The TCR180 is equipped with a high quality oscillator which is disciplined as log as an input signal is available, and provides accurate time in holdover mode if the input signal is disconnected.

Receiver:
Automatic gain control within the receive circuit for unmodulated codes allows decoding of IRIG-A/B/G, AFNOR NF S87-500, IEEE C37.118 or IEEE 1344 signals with a carrier amplitude of 600 mVpp to 8 Vpp. The input stage is electrically insulated and has an impedance of either 50 Ω, 600 Ω or 5 kΩ, selectable by a jumper.

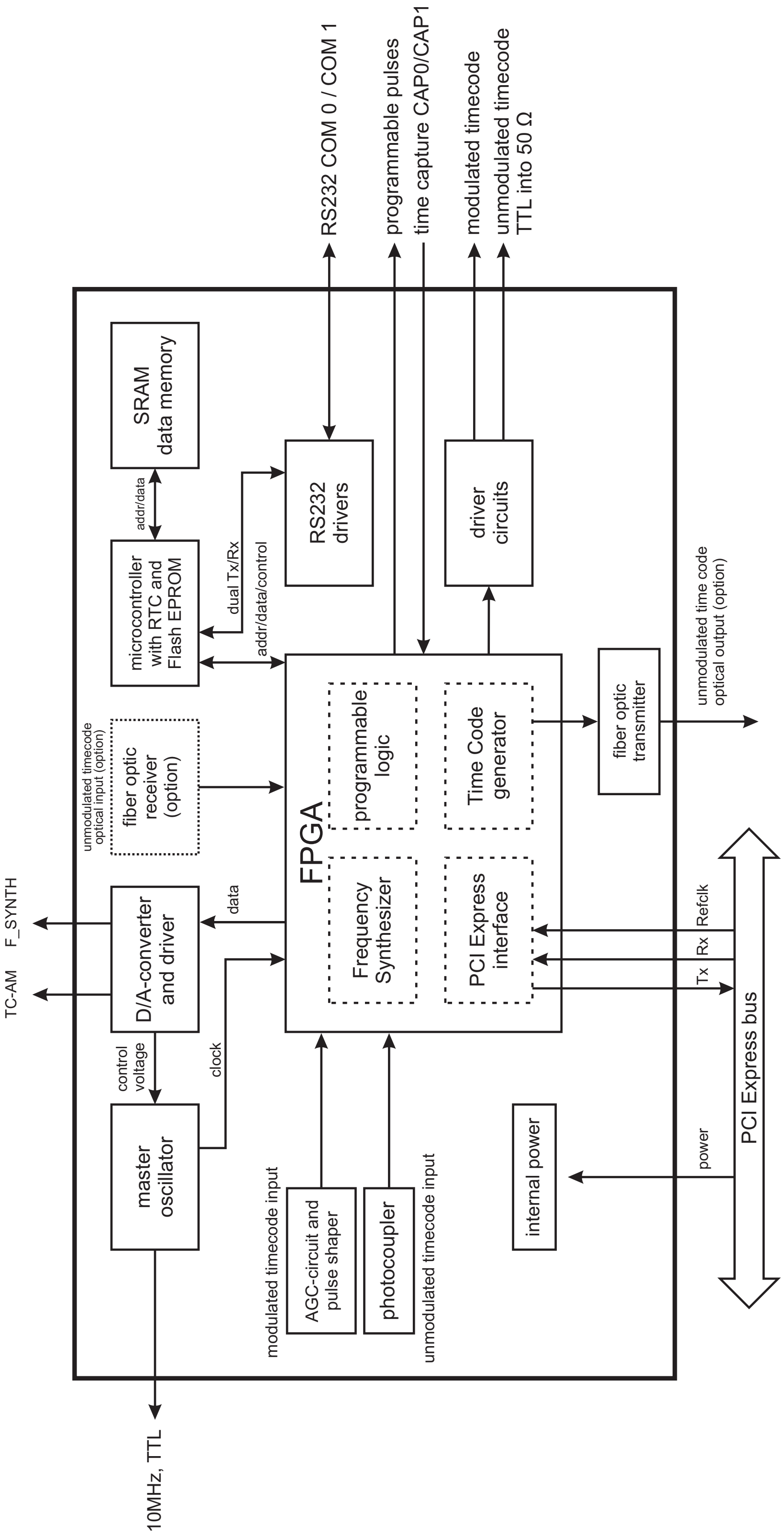
Generator:
The time code output of the TCR180 can generate time codes in IRIG-A/B/G, AFNOR NF S87-500, IEEE C37.118, or IEEE 1344 format. The output signal is available as modulated (3 Vpp / 1 Vpp into 50 Ω) and unmodulated (DC Level Shift, DCLS) signal (TTL into 50 Ω and RS-422). A jumper on the board allows selection of active-high or active-low DCLS output.

Format and UTC offset of the incoming and outgoing time codes can be configured independently, so the TCR180 is well-suited for time code conversion.

The card provides four configurable serial interfaces (RS-232) COM. COM0 is available via the Sub-D connector, COM1 is accessible via an VG connector on the board.

TCR180 provides a synthesizer which can generate output frequencies from 1/8 Hz up to 10 MHz with TTL level into 50 Ω as a sine wave signal.

4 Block diagram TCR180

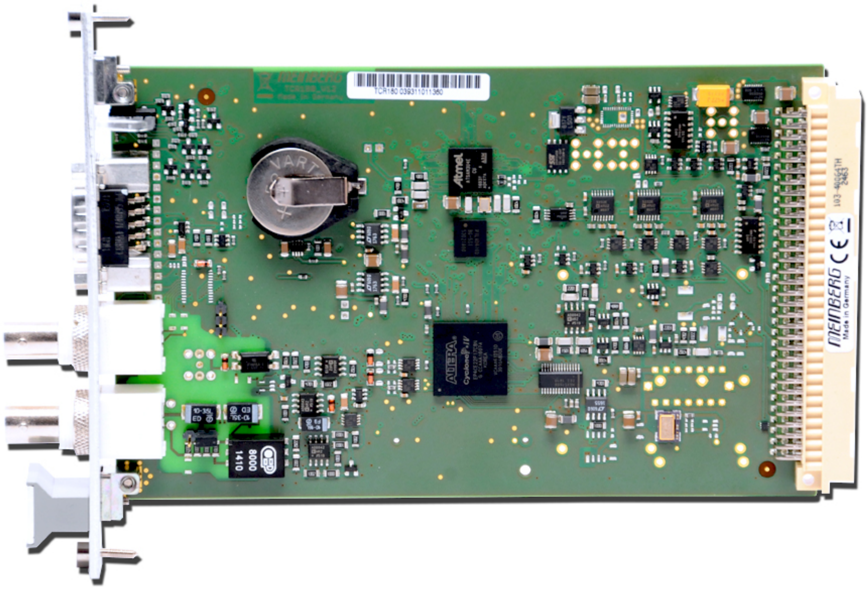


5 Master oscillator

By default the TCR180 is equipped with a TCXO (Temperature Compensated Xtal Oscillator) as master oscillator to provide a good time accuracy and frequency stability. As long as an input signal is supplied the frequency of the oscillator is adjusted from the input signal, and if the input signal is disconnected afterwards the card can still provide accurate time for a certain holdover interval. Optionally the card can be ordered with an OCXO (Oven Controlled Xtal Oscillator) which provides even better frequency stability, and thus provides more accuracy over a longer holdover interval than the TCXO.

All internal timing as well as the output signals are derived from the oscillator. The last known good oscillator adjustment value is stored in non-volatile memory, and is used as default after power-up.

The oscillator's 10 MHz output frequency is also available with TTL level via at a ribbon cable connector.



6 Functional description of receiver

After the received time code has passed a consistency check, the TCR180's on-board software clock and battery buffered real time clock are synchronized according to the external time reference. If an error or inconsistency is detected in subsequent time code frames, or the input signal is disconnected, the on-board clock switches to holdover mode, where the time is derived from the on-board high quality oscillator which has been disciplined before.

All IRIG and similar time codes provide the time-of-day, and a day-of-year number (1...365/366). When converting the day-of-year number from the incoming time code to a calendar date then the result is ambiguous unless the year number is not known: the day after February 28 can be March 1, but can also be February 29 in case the year is a leap year.

Unfortunately, most of the commonly used IRIG code formats don't include a year number, in which case the year number used for the computation of the calendar date is retrieved from the battery buffered on-board real time clock.

So care must be taken that the on-board clock has been set to the correct date. The on-board date and time can be adjusted by sending a Meinberg Standard Time string to the serial interface COM0, or via the PCI bus by using the utility programs included in the driver software package.

If the configured time code format does provide a year number (e.g. IEEE 1344, IEEE C37.118, IRIG-Bxx6/Bxx7) then the year number from the time code is used instead of the year number from the on-board real time clock, and the on-board date is set accordingly.

Most of the commonly used IRIG code formats also don't provide an indicator whether the transported time is UTC, or local time with some offset from UTC. However, the TCR180 always needs to derive UTC time from the incoming time code since the card's on-board time is expected to run on UTC.

If no UTC offset is provided by the time code then a UTC offset parameter on the card first needs to be configured, depending on the time provided by the input signal. When the TCR180 is shipped then the UTC parameter is set to "unconfigured", and as long as this is the case the card doesn't synchronize to the input signal. So the UTC offset has to be configured first when the card is put into operation. The tools that come with the driver software package given an appropriate hint if this is the case.

Only if the used time code format provides the UTC offset (e.g. IEEE 1344, IEEE C37.118) the card uses the UTC offset from the time code, and thus even synchronizes to the input signal if the card's UTC parameter is still set to "unconfigured".

Care must be taken, however, if one of the IEEE 1344 or IEEE C37.118 codes is used: The main difference between these formats is the way the UTC offset is to be applied: subtracted or added. Unfortunately there are 3rd party IRIG devices out there which claim to use a IEEE 1344 code, but in fact handle the UTC offset as specified in IEEE C37.118. This may result in a wrong UTC time derived from the time code if local time is transported. A simple fix is usually to switch the card from one of the IEEE codes to the other one.

The TCR180 can automatically convert its on-board UTC time to some local time, including automatic switching to and from DST year by year according to configurable rules. This is independent from the UTC offset of the incoming time code. The derived local time can be transmitted via the outgoing time code, the serial time strings, or can be read via the PCI interface.

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 then no switching to DST is made.

The associated settings can be changed using the configuration software shipped with the driver packages.

Most IRIG codes don't include an announcement flag for the DST change, or for the for the insertion of a leap second, so the TCR180 will switch into free wheeling mode on such event, and resynchronize a few seconds later.

The board TCR180 decodes the following formats:
Please note: all "**A**" und "**G**" **Timecodes** are only available **after** warmed up phase of the oscillator!

A002:	1000pps, DC Level Shift pulse width coded, no carrier BCD time of year
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
A133:	1000pps, amplitude modulated sine wave signal, 10 kHz carrier frequency BCD time of year, SBS time of day
B002:	100pps, DC Level Shift pulse width coded, no carrier BCD time of year
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
B123:	100pps, amplitude modulated sine wave signal, 1 kHz carrier frequency BCD time of year, SBS time of day
B006:	100 pps, DC Level Shift, no carrier BCD time-of-year, Year
B126:	100 pps, AM sine wave signal, 1 kHz carrier frequency

	BCD time-of-year, Year
B007:	100 pps, DC Level Shift, no carrier BCD time-of-year, Year, SBS time-of-day
B127:	100 pps, AM sine wave signal, 1 kHz carrier frequency BCD time-of-year, Year, SBS time-of-day
G002:	10 k pps, DC Level Shift, no carrier BCD time-of-year
G142:	10 k pps, AM sine wave signal, 100 kHz carrier frequency BCD time-of-year
G006:	10 k pps, DC Level Shift, no carrier BCD time-of-year, Year
G146:	10 k pps, AM sine wave signal, 100 kHz carrier frequency BCD time-of-year, Year
AFNOR:	Code according to NF S-87500, 100 pps, wave signal, 1kHz carrier frequency, BCD time-of-year, complete date, SBS time-of-day, Signal level according to NF S-87500
IEEE 1344:	Code according to IEEE 1344-1995, 100 pps, AM sine wave signal, 1kHz carrier frequency, BCD time-of-year, SBS time-of-day, IEEE 1344 extensions for date, timezone, daylight saving and leap second in control functions (CF) segment. (also see table 'Assignment of CF segment in IEEE 1344 mode')
IEEE C37.118:	Like IEEE 1344 - with UTC offset to be applied reversely

6.1 Input Signals

Modulated and unmodulated IRIG or AFNOR-Codes are applied via the on board BNC connector. The lead should be shielded. The IRIG-Code to be used must be set by using the deliverd Monitorprogram.

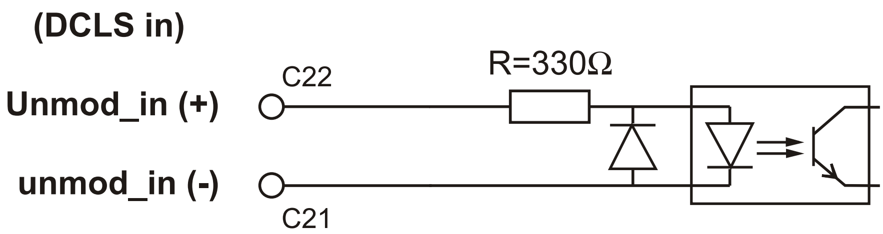
The IRIG-specification does not define values for the output impedance of generators or the input impedance of receivers. This fact led to incompatibility of some modules, because the manufacturers could choose the impedances freely. For example: if the output impedance of the generator is high and the input impedance of the receiver low, the signal level at the receiver input might be too low for correct decoding.

6.2 Input for unmodulated codes

Unmodulated IRIG-Codes, often referred to as pulse with coded or DC-Level Shift Codes (DCLS), are fed into the board via BNC connector. Insulation of this input is done by a opto coupler device.

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 (60 mA). The forward current should not be limited to a value of less than 10 mA to ensure save switching of the photocoupler.

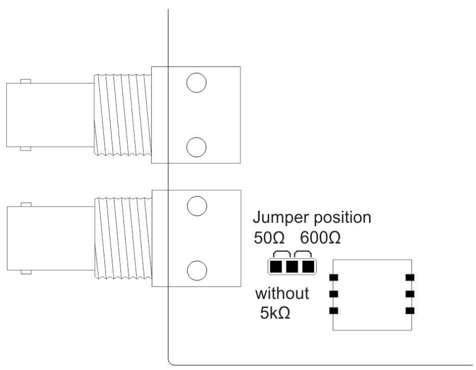
The input circuitry is shown below.



6.3 Input for modulated codes

Modulated codes must be applied by BNC Connector. An automatic gain control allows decoding of codes within an amplitude range from abt. 600 mVpp up to 8 Vpp. To allow adaption of different time code generators, the boards input impedance can be selected by an on board jumper.

Therefore the board TCR180 provides a jumper to select the impedance (50O 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 TCR180, the input impedance has to be set to 50 Ω. Default on delivery: 600 Ω.



7 Functionality of the generator

The time code generator of TCR180 is based on a DDS (Direct Digital Synthesis) 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 generated pulse-per-second (PPS) signalderived from the software clock.

The generated time code is independent from the settings for the received code. Thus it's possible to generate a output signal with a different format and UTC offset than the input signal.

7.1 Time Code Outputs

TCR180 provides modulated and unmodulated (DC level shift) outputs.

7.1.1 Modulated Outputs

The amplitude-modulated sine carrier is available by VG connector. The signal amplitude is 3Vpp (MARK) and 1Vpp (SPACE) into 50 Ohm. 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

7.1.2 Unmodulated Outputs

The pulse width modulated DC-signals are coexistent to the modulated output and are available with TTL level into 50 Ohm and as RS-422 signal.

7.2 Pulse outputs

The pulse generator of the TCR180 generates pulses for the seconds change (P_SEC) and the minute change (P_MIN). In addition, fixed output frequencies of 10 MHz, 1 MHz and 100 kHz are derived from the OCXO. All these signals are carried out with TTL level on the back-side connector (VG96).

Three programmable pulses outputs are available (PPO0, PPO1, PPO2). The generator is capable of generating various pulses, which are configured via the monitor program. The pulse position is invertible for each channel, the pulse time can be adjusted in the 10 msec grid between 10 msec and 10 sec. By default, the pulse outputs remain inactive until the receiver has synchronized. The device can also be set in such a way that the outputs are activated immediately after switching on.

The following modes can be configured independently for each channel:

Timer mode:	Three "on" and "off" time pairs per day
Cyclic mode:	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:	Outputs simulated DCF77-compüatible time marks, representing the local time configured on the device.
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 once per second, minute, or hour aligned with second boundary
Synthesizer	Frequency output 1/8 Hz up to 10 MHz
Time Codes	Generation of Time Codes as described in chapter "Time Codes"
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

Frequency Outputs (optional)
The included synthesizer generates a frequency from 1/8 Hz up to 10 MHz synchronous to the internal timing frame. The phase of this output can be shifted from -360° to +360° for frequencies less than 10 kHz. Both frequency and phase can be setup from the front panel or using the serial port COM0. Synthesizer output is available at the rear connector as sine-wave output (F_SYNTH_SIN), with TTL level (F_SYNTH) and via an open drain output (F_SYNTH_OD). The open drain output can be used to drive an optocoupler when a low frequency is generated.

The synthesizer is turned off if a frequency of 0 Hz is configured.

If the output frequency is below 10 kHz the phase of the output signal can be set from -360° to +360° with a
resolution of 0.1°.

7.2.1 Enabling of outputs

By default the time code output, the pulse outputs, the serial outputs, and the frequency synthesizer are disabled after power up until the receiver is synchronized. However, the monitor software can be used to configure each group of outputs so that they are always enabled immediately after power-up.

Please note: Enabling of the time code output and the programmable pulses are controlled by the same setting.

7.2.2 Time Capture Inputs

Two time capture inputs called User Capture 0 and 1 are provided at the rear connector (CAP0 and CAP1) to measure asynchronous time events. A falling TTL slope at one of these inputs lets the microprocessor save the current real time in its capture buffer. From the buffer, capture events are transmitted via COM0 or COM1 and displayed on LCD. The capture buffer can hold more than 500 events, so either a burst of events with intervals down to less than 1.5 msec can be recorded or a continuous stream of events at a lower rate depending on the transmission speed of COM0 or COM1 can be measured.

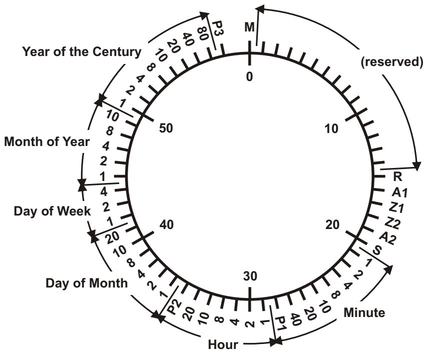
The format of the output string is ASCII, see the technical specifications at the end of this document for details. If the capture buffer is full a message "** capture buffer full" is transmitted, if the interval between two captures is too short the warning "** capture overrun" is being sent.

7.2.3 Asynchronous Serial Ports (optional 4x COM)

Four asynchronous serial RS232 interfaces (COM0 ... COM3) are available to the user. In the default mode of operation, the serial outputs are disabled until the receiver has synchronized after power-up. However, the system can be configured to enable those outputs immediately after power-up. Transmission speeds, framings and mode of operation can be configured separately using the setup menu. COM0 is compatible with other radio remote clocks made by Meinberg. It sends the time string either once per second, once per minute or on request with ASCII '?' only. Also the interfaces can be configured to transmit capture data either automatically when available or on request. The format of the output strings is ASCII, see the technical specifications at the end of this document for details.

7.2.4 DCF77 Emulation

The 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, the generates time marks representing its local time as configured by the user, including announcement of changes in daylight saving and announcement of leap seconds. The coding sheme is given below:



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

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

8 Connectors and LEDs in the frontpanel

The frontpanel of the board includes the BNC connector for the amplitude modulated time codes, four LEDs and a 9 pin D-Sub-plug.

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 below. 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 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.

LED Indicators

1.	blue:	while the receiver passes the initialization phase
	off:	Oscillator not warmed up
	green:	the internal timing of TCR180 is synchronized to the received time code (Lock)
2.	green:	correct time code detected
	red:	no correct time code detected
	yellow:	TCR180 synchronized by Multi.Ref. source
	yellow/green (flashing):	Holdover mode (Multi.Ref.), IRIG Code available
	yellow/red (flashing):	Holdover mode (Multi.Ref.), IRIG Code not available
3.	green:	telegramm consistent
	red:	telegramm inconsistent
	yellow (flashing):	Jitter too large
4.	red:	the internal timing of TCR180 is in holdover mode
	off:	the internal timing of TCR180 is synchronized to the received time code (Lock)

9 Putting into operation

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

9.1 Configuration of TCR180

The selection of the time code, configuration of the serial interface and a possible offset of the received time to UTC must be set up by the monitor software. In contrast to AFNOR NF S87-500 the IRIG telegram containes only the day of year (1...366) instead of a complete date. To ensure correct function of TCR180, 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 time 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 time.

10 Firmware Update of the TCR180.

On slot cards, with flash program memory, the firmware update is being performed using the Meinberg flash program "mbgflash" via the serial port COM0 of the slot card.

The update requires a specific firmware image that matches the the slot card type. To install the "mbgflah" program download and execute the EXE file.

Download of mgbflash program:
https://www.meinbergglobal.com/download/utils/windows/mbgflash-1.13.exe

The update process can be performed as often as needed when faults occur, since it is independent from contents of the program memory. The current content of the program memory is kept until the update process sends the command to clear the program memory. In this case, the slot card is ready for operation after the computer is switched on again.

11 Technical specification TCR180

Receiver Input:	AM-input (BNC-connector): 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 DC Level Shift input (D-Sub-connector): insulated by photocoupler internal series resistance: 220 Ω maximum forward current: 60 mA diode vorward voltage: 1.0 V...1.3 V
Decoding:	decoding of the following telegrams possible: IRIG-A002 / A132 / A003 / A133 / A006 / A136 / A007 / A137 IRIG-B002 / B122 / B003 / B123 / B006 / B126 / B007 / B127 IRIG-G002 / G142 / G006 / G146 AFNOR NF S87-500 IEEE C37.118 IEEE 1344
Accuracy of Time Base:	< 500 nsec compared to IRIG reference marker
Required Accuracy of Time Code Source:	+/- 100 ppm
Holdover Mode:	automatic switching to crystal time base accuracy approximately $1*10^{-8}$ 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:	modulated output: unbalanced sine carrier, 1 kHz $3V_{pp}$(MARK), $1V_{pp}$ (SPACE) into 50 Ω unmodulated outputs(DCLS): TTL into 50 Ω RS-422 active high or low selectable by jumper optical output (option): 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'	
	PPO_0:	change of seconds (PPS) pulse duration 200 msec valid on rising edge
	PPO_1:	change of minute (PPM) pulse duration 200 msec valid on rising edge
	PPO_2:	DCF simulation
Accuracy of Pulses:	better than +/- 1 μsec after synchronization and 20 minutes of operation	
Serial Ports:	four configurable RS-232 interface	
	baudrates:	300 Bd...115200 Bd
	framing:	7E2, 8N1, 8N2, 8E1
	7N2, 7E1, 801	
	mode of operation:	string per second string per minute string on request
	time telegram:	Meinberg Standard Uni Erlangen, SAT
	Meinberg Capture, ION Computime, SPA, RACAL	
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 (Temperature Compensated Xtal Oscillator)	
	accuracy compared to IRIG-reference: sync. and 20 min.	
	of operation:	+- 5(10 $^{-9}$)
	first 20 min. after sync.:	+- 1(10 $^{-8}$)
	accuracy of oscillator:	
	holdover, 1 day:	+- 1(10 $^{-7}$)
	holdover, 1 year:	+- 1(10 $^{-6}$)
	short term stability:	
	$\leq$ 10 sec, synchronized:	+- 2(10 $^{-9}$)
	$\leq$ 10 sec, holdover:	+- 5(10 $^{-9}$)
	temperature dependant drift:	
	holdover:	+- 1(10 $^{-6}$)

Frequency Synthesizer:	1/8 Hz up to 10 MHz	
Accuracy of Synthesizer:	base accuracy depends on system accuracy	
	1/8 Hz to 10 kHz	Phase syncron with pulse output P_SEC
	10 kHz to 10 MHz	frequency deviation < 0.0047 Hz
Synthesizer Outputs:	F_SYNTH:	TTL into 50 Ω
	F_SYNTH_SIN:	sine-wave output voltage: 1.5 V eff. output impedance: 200 Ohm
Reliability of Operation:	microprocessor supervisory circuit provides watchdog timer, power supply monitoring and backupbattery switchover software watchdog monitors correct program flow and generates a reset in case of error detection	
Initialisation:	software and realtime clock can be set by a serial Meinberg Standard Telegram via COM Port	
Data Format:	binary, byte serial	
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	
Ambient Temperature:	0 ... 50 °C	
Humidity:	max. 85 %	
Current Consumption:	450 mA	

Steckerbelegung / Pin Assignment TCR180

	a	b	c
1	**VCC in (+5 V)**	**VCC in (+5 V)**	**VCC in (+5 V)**
2	**VCC in (+12V) - do not connect**	**VCC in (+12V) - do not connect**	**VCC in (+12V) - do not connect**
3	**VDD in (TCXO/OCXO) optional, do not connect**	**VDD in (TCXO/OCXO) optional, do not connect**	**VDD in (TCXO/OCXO) optional, do not connect**
4	Reserved (FrequAdjust out)	PPS in IMS	PROG PULSE3 out
5	FIXED FREQUENCY out	GND	10 MHz IMS in
6	PPS IMS in		PPS out
7	TIME CODE DCLS IMS in	GND	PPS2 in
8	Reserved (10 MHz Osc in)		PPM out
9	10 MHz SINE out		
10	100 kHZ TTL out		PROG PULSE0 out
11	1 MHz TTL out		PROG PULSE1 out
12	10 MHz TTL out		PROG PULSE2 out
13	TIME CODE DCLS out		SCL
14	TIME CODE AM out	GND	COM4 RxD in
15	COM2 RxD in		SDA
16	COM2 TxD out		Reserved (P7.5)
17	COM3 RxD in		DCF MARK out
18	COM3 TxD out		Reserved (Vref/TxD2 TTL)
19	**GND**		TIMESYNC out
20	**GND**	GND	Reservd (P7.6)
21	**GND**		F_SYNTH TTL out
22	**GND**	GND	F_SYNTH_OD out
23	**GND**		F_SYNTH_SIN out
24	**GND**		COM1 TxD out
25	**GND**	Slot_ID0	COM4 TxD out
26	**GND**	Slot_ID1	COM0 TxD out
27	**GND**	Slot_ID2	CAP1 in
28	**GND**	Slot_ID3	CAP0 in
29	**GND**	+USB	COM1 RxD in
30	**GND**	-USB	COM0 RxD in
31	**GND**	**GND**	**GND**
32	**GND**	**GND**	**GND**

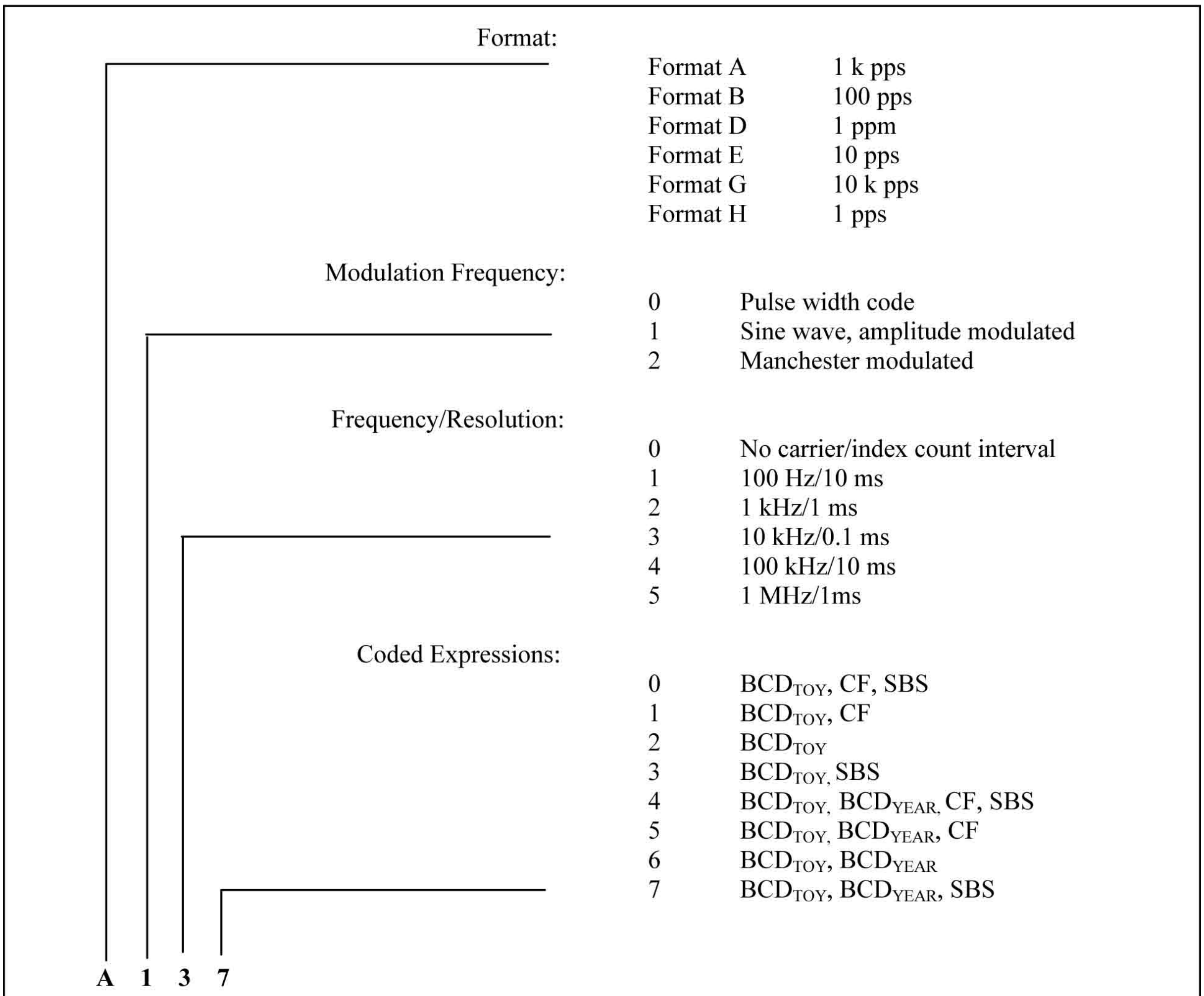
12 Technical appendix TCR180

12.1 Abstract of Time Code

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

The TCR180 supports decoding and generating of IRIG-A, IRIG-B, IRIG-G, AFNOR NF S87-500, IEEE C37.118 and IEEE 1344.

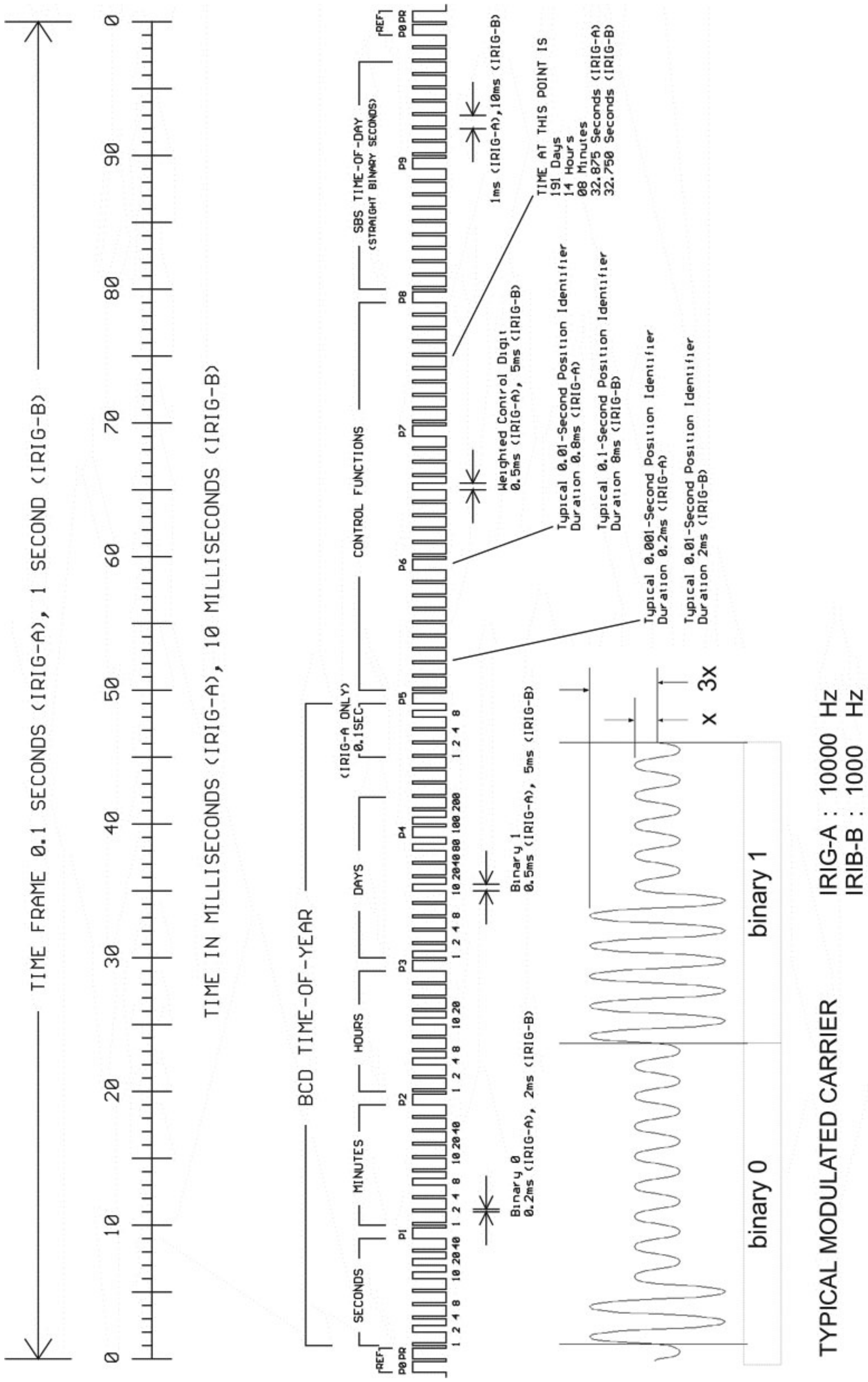
12.1.1 Description of IRIG-Codes



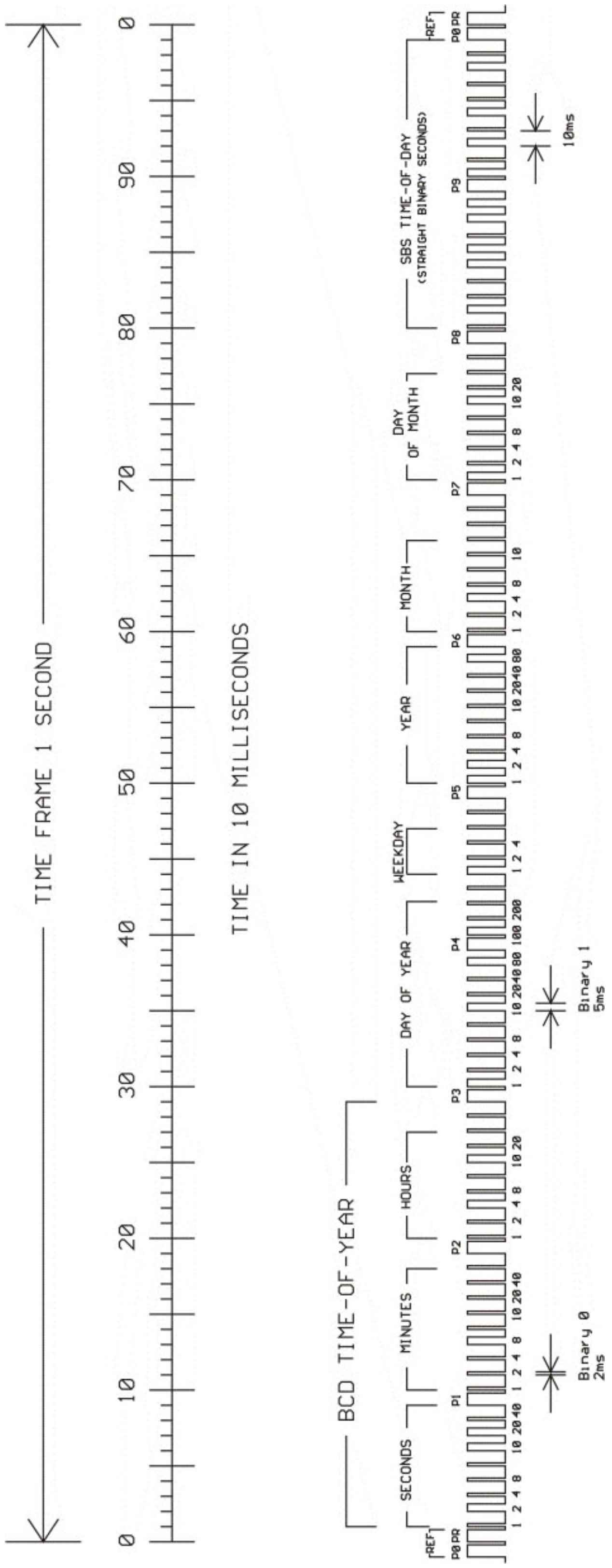
The signal designated as A137 is deciphered as follows: Format A, Sine wave (amplitude modulated), 10 kHz carrier/0.1 ms resolution, and Coded expressions BCD_{TOY}, BCD_{YEAR}, and SBS.

12.2 Time code Format

12.2.1 IRIG Standard Format



12.2.2 AFNOR Standard Format



12.3 Time Strings

12.3.1 Format of the Meinberg Standard Time String

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

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

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

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

uv clock status characters (depending on clock type):

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

x time zone indicator:

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

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

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

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

12.3.2 Format of the Meinberg Capture String

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

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

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

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

dd.mm.yy the capture date:

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

hh:mm:ss.fffffff the capture time:

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

<CR> Carriage Return, ASCII Code 0Dh

<LF> Line Feed, ASCII Code 0Ah

12.3.3 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.llllе hhhhm***<ETX>

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

<STX>	Start-Of-Text, ASCII Code 02h		
	sending with one bit occuracy at change of second		
dd.mm.yy	the current date:		
	dd	day of month	(01..31)
	mm	month	(01..12)
	yy	year of the century	(00..99)
	w	the day of the week	(1..7, 1 = Monday)
hh.mm.ss	the current time:		
	hh	hours	(00..23)
	mm	minutes	(00..59)
	ss	seconds	(00..59, or 60 while leap second)
v	sign of the offset of local timezone related to UTC		
oo:oo	offset of local timezone related to UTC in hours and minutes		
ac	clock status characters:		
	a:	'#'	clock has not synchronized after reset
		' '	(space, 20h) clock has synchronized after reset
	c:	'*'	GPS receiver has not checked its position
		' '	(space, 20h) GPS receiver has determined its position
d	time zone indicator:		
	'S'	CEST	European Summertime, daylight saving enabled
	' '	CET	European Standard Time, daylight saving disabled
f	anouncement of discontinuity of time, enabled during last hour before discontinuity comes in effect:		
	'!'	announcement of start or end of daylight saving time	
	' '	(space, 20h) nothing announced	
g	anouncement of discontinuity of time, enabled during last hour before discontinuity comes in effect:		
	'A'	announcement of leap second insertion	
	' '	(space, 20h) nothing announced	
i	leap second insertion		
	'L'	leap second is actually inserted (active only in 60th sec.)	
	' '	(space, 20h) no leap second is inserted	
bbb.bbbb	latitude of receiver position in degrees leading signs are replaced by a space character (20h)		
n	latitude, the following characters are possible:		
	'N'	north of equator	

'S' south d. equator

lll.llll longitude of receiver position in degrees
leading signs are replaced by a space character (20h)

e longitude, the following characters are possible:
'E' east of Greenwich
'W' west of Greenwich

hhhh altitude above WGS84 ellipsoid in meters
leading signs are replaced by a space character (20h)

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

12.3.4 Format of the SAT Time String

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

<STX>***dd.mm.yy/w/hh:mm:ssxxxxuv***<ETX>

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

<STX>	Start-Of-Text, ASCII Code 02h sending with one bit accuracy at change of second		
dd.mm.yy	the current date:		
	dd	day of month	(01..31)
	mm	month	(01..12)
	yy	year of the century	(00..99)
	w	the day of the week	(1..7, 1 = Monday)
hh:mm:ss	the current time:		
	hh	hours	(00..23)
	mm	minutes	(00..59)
	ss	seconds	(00..59, or 60 while leap second)
xxxx	time zone indicator:		
	'UTC'	Universal Time Coordinated, formerly GMT	
	'CET'	European Standard Time, daylight saving disabled	
	'CEST'	European Summertime, daylight saving enabled	
u	clock status characters:		
	'#'	clock has not synchronized after reset	
	' '	(space, 20h) clock has synchronized after reset	
v	anouncement of discontinuity of time, enabled during last hour before discontinuity comes in effect:		
	'!'	announcement of start or end of daylight saving time	
	' '	(space, 20h) nothing announced	
<CR>	Carriage Return, ASCII Code 0Dh		
<LF>	Line Feed, ASCII Code 0Ah		
<ETX>	End-Of-Text, ASCII Code 03h		

12.3.5 Format of the Computime Time String

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

T:*yy:mm:dd:ww:hh:mm:ss*<CR><LF>

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

T	Start character sending with one bit accuracy at change of second		
yy:mm:dd	the current date:		
	yy	year of the century	(00..99)
	mm	month	(01..12)
	dd	day of month	(01..31)
	ww	the day of the week	(01..07, 01 = monday)
hh:mm:ss	the current time:		
	hh	hours	(00..23)
	mm	minutes	(00..59)
	ss	seconds	(00..59, or 60 while leap second)
<CR>	Carriage Return, ASCII Code 0Dh		
<LF>	Line Feed, ASCII Code 0Ah		

12.3.6 Format of the 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:*jj-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:

jj-mm-tt	the current date:		
	jj	year of the century	(00..99)
	mm	month	(01..12)
	tt	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	Checksum. 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

12.3.7 Format of the RACAL standard Time String

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

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

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

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

12.3.8 Format of the ION Time String

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

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

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

<SOH> Start of Header (ASCII control character)
sending with one bit accuracy at change of second

ddd day of year (001..366)

hh:mm:ss the current time:

hh	hours	(00..23)
mm	minutes	(00..59)
ss	seconds	(00..59, or 60 while leap second)
q	Quality indicator	(space) Time Sync (GPS lock) (?) no Time Sync (GPS fail)

<CR> Carriage-return (ASCII code 0Dh)

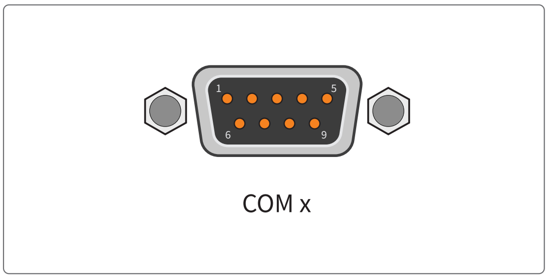
<LF> Line-Feed (ASCII code 0Ah)

12.4 RS-232 COMx

Connector: D-SUB male 9pol.

Cable: shielded data line

Assignment:
Pin 2: RxD (receive)
Pin 3: TxD (transmit)
Pin 5: GND (ground)



12.5 Time Code AM Input

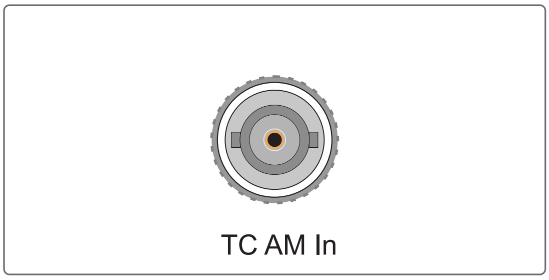
Isolation voltage: 3000 V DC

impedance (input): std. 600 Ohm,
(50 Ohm / 5 kOhm)

Signal range: ca.600 mV - 8 V
(Mark, peak-peak)

Connector: BNC female, isolated

Cable: shielded coax line

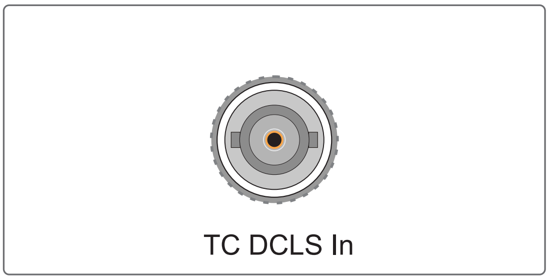


WARNING!
This equipment is operated at a hazardous voltage.

Danger to life due to electrical shock!
- Never work with open terminals and plugs while the power is on!
- When working on the connectors, always remove both sides of the cable from the respective devices!
- The device is equipped with potential-free and isolated connections. In the event of a fault in a connected device, dangerous voltages can occur at the signal lines.

12.6 Time Code DCLS Input

Isolation voltage:	3750 Vrms
internal resistance:	330 Ohm
max. current (input):	25 mA
Cable:	shielded coax line



12.7 Content of the USB stick

Besides this manual, the provided USB stick includes a setup program for the monitor software MBGMON. This utility can be used to configure Meinberg receivers via their serial ports and to display status information of the module.

If the USB storage device is lost, the installation program can be downloaded free of charge from the Internet at: https://www.meinbergglobal.com/english/sw/

13 RoHS and WEEE

Compliance with EU Directive 2011/65/EU (RoHS)

We hereby declare that this product is conform to the European Directive 2011/65/EU and its delegated directive 2015/863/EU "Restrictions of Hazardous Substances in Electrical and Electronic Equipment". We ensure that electrical and electronic products sold in the EU do not contain lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyls (PBBs), and polybrominated diphenyl ethers (PBDEs), Bis (2-ethylhexyl)phthalat (DEHP), Benzylbutylphthalat (BBP), Dibutylphthalat (DBP), Diisobutylphthalat (DIBP), above the legal threshold.

WEEE status of the product

This product is handled as a B2B (Business to Business) category product. In order to secure a WEEE compliant waste disposal it has to be returned to the manufacturer. Any transportation expenses for returning this product (at its end of life) have to be incurred by the end user, whereas Meinberg will bear the costs for the waste disposal itself.