

Technical Description

GPS Satellite Clock
6870



Safety information

The safety regulations and technical data are important for the smooth running of the devices and the protection of people and equipment. Strict compliance with these regulations is required. In case of non-compliance with these regulations the guarantee and warranty claims for the device expire. There is no liability for possible consequential damages.

Safety of the Devices

The production of this device follows the latest technological standards and safety regulations.

The device must not be assembled by anyone but trained personnel. Please make sure that all the connected cables are laid and fixed properly. The device is to be run with the supply voltage stated on the identification plate only.

Only trained personnel or specialists may operate the device.

Repair on opened devices must not be carried out by anyone but specially trained staff or by the **hopf** Elektronik GmbH company.

If the maintenance work requires the opening of a device or if a fuse needs changing the device must be separated from all voltage supplies.

If there are reasons to believe that the operational safety can no longer be guaranteed the device must be taken out of service and labelled accordingly. The safety may be impaired when the device does not operate properly or if it is obviously damaged.

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1 Brief Information Model 6870 and Delivered Extras

The radio controlled clock 6870 is an all-purpose GPS¹ reception module - ideal to synchronise industrial processes. The snap-in module can be supplied with various combinations of interfaces.

Up to 16 different protocols can be put out via the interfaces, to synchronise devices by different producers (Siemens, ABB, IBM, H+B).

Three built-in optical couplers can be used to synchronize computers, control systems or measuring processes, with freely programmable pulses. Every optical coupler can carry out one of 5 output programmes, whereby either cyclic pulses are generated or status information is about at the outputs.

A simulated antenna signal is available to DCF77² systems. Further features are:

- potential free antenna circuit,
- all settings can be parametered via serial interface,
- all outputs potential free,
- two independent serial interfaces RS232/RS422, other combinations e.g. RS232/TTY (passive) or RS232/RS232 are available on request.

We supply the snap-in module with:

- PC interface cable and
- configuration software on CD-Rom.

¹ GPS = global positioning system

² DCF77 = (D) german - (C) long wave signal (F) Frankfurt a.M. (77) frequency

2 Introduction

The **hopf** radio controlled and crystal clock systems, well proved since 1975, have been extended by GPS reception unit 6870. This guarantees a world-wide use at highest precision. The time basis is synchronised by GPS, a globally installed satellite system.

At a height of about 10.900 miles satellites circle around the earth twice a day on different orbits and angles (see picture in the appendix). On board every satellite there is an atomic clock (accuracy at least 1×10^{-12}). The GPS reception units receive the orbit position and a GPS world-time from as many satellites as possible. The position of the receiver is calculated from these values first. Once the position is known, it is possible to calculate the delay time of the received GPS world-time. The accuracy of the time therefore depends mainly on how well the position is defined.

The world-time UTC³ is calculated by subtracting the leap seconds from the GPS-world-time (GPS-UTC), at present (1994) the world-time lags 8 seconds behind GPS-UTC. The difference is not constant, it changes with every insertion of a leap second. For every place on earth it is possible to enter the difference to UTC time and the local changeover points for summer/ wintertime by means of the key-pad of the system. Thus the local time is available at high precision for further use.

The following interfaces are available as a standard:

- serial RS232 interface
- serial RS422 interface
- DCF77 simulated antenna output
- 3 optical coupler outputs

Other interface combinations like RS232/TTY or RS232/RS232 are available optionally.

³ UTC = universal time coordinated

3 Commissioning

3.1 Voltage Supply

The system is supplied with a voltage of 18-60V DC. When connecting the voltage make sure that the voltage and polarity are correct. As the snap-in module is completely potential free inside, it must be set to the necessary potential by means of the earthing screw on the rear.

Please Note: REVERSED POLARITY OF THE OPERATING VOLTAGE DOES NOT DESTROY THE PACKAGE. THERE IS A BRIEF CURRENT OF 1 A. AFTER A REVERSED POLARITY THE DEVICE MUST BE DISCONNECTED FROM THE VOLTAGE SUPPLY FOR 20 SEC. NOBODY BUT SPECIALISED PERSONNEL MUST CARRY OUT THE COMMISSIONING.

3.2 Antenna Installation

The connection to the antenna system is made by the female connector marked "GPS-In".

The correct installation of the antenna system can be found in the **Appendix GPS** (General System Information GPS).

3.3 Default Button in the Front Panel

Pressing the "DEF" button on the front puts the clock in the delivery status. It must be pressed for about 10sec. until the LED "CLK" stops flashing. Release the button and the clock is put into the following standard setting.

Only the parameter of the first interface (COM 0) will be set!

Delivery status:

- baud rate 9600 Baud
- 8 data bit
- 1 stop bit
- no parity
- transmission data string (6021)
- with control characters (STX/ETX)
- without second advance
- transmission every second

3.4 LED "CLK"

The green status LED indicates the synchronisation status of the clock. Flashing at 2 Hz pulse means that the clock is running in crystal operation. This status is shown after switching the clock on or when the time-out time for the radio-bit has been exceeded (see pt. DCF77 simulation and radio-bit) when the reception is disturbed. Flashing at 1Hz pulse means that the clock is running in radio operation.

3.5 Control LED C1-C3

The LED C1-C3 indicate the switching status of the three optical couplers. A lit LED indicates that the corresponding optical coupler is switched active.

3.6 Set-up via Remote Software

All the settings on the device can be carried out with the supplied software (**GPS_6870.EXE**) via one of the both serial interfaces.

At the same time only **one** service software might have access to the device by **one** of the serial interfaces.

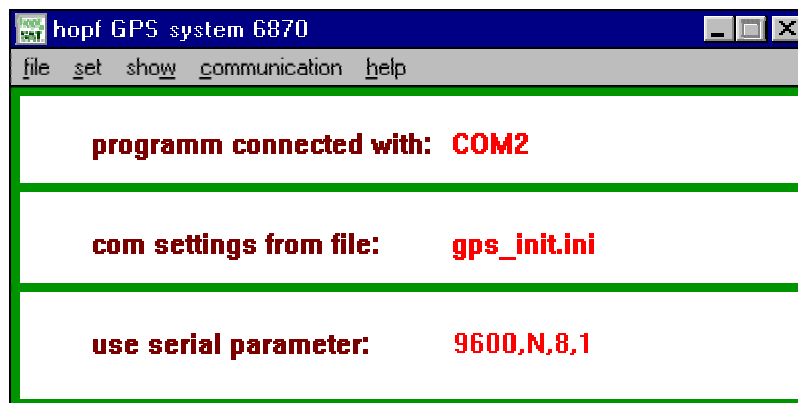
3.6.1 Pre-conditions of the System for the Remote Software

The program requires a PC/Notebook with a free serial interface and the operating system Microsoft Windows from 3.x, 95, or NT. A free serial interface (COM 1 ... COM 8) is needed for the data traffic with the clock. Before the beginning of a data transmission, the software checks the existence of a free COM-port.

3.6.2 Hints for the Installation of the Remote Software

The software is supplied on a 3.5 inch disc and should be copied into its own directory in the remote computer (PC) (e.g. **C:\HOPF6870**). The supplied serial interface cable must be connected between the computer and the GPS system. Then the software is ready for operation. When the voltage supply and the antenna are connected the program can be started.

The software automatically finds the **first** free COM-port (1-8) and shows the connection in the main window of the application "**programm connected with**". This process may be ignored (see pt. What you should know). Here you will find the actual parameter settings for the serial communication and possibly the file used for the serial parameter. If a different port should be used the program has to be started again till the right port is connected. This port can be set-up in the file **GPS_INIT.INI** (see 3.6.3).



In the main window of the application you will find all the Windows user elements like pull-down menu, switches etc. You can operate the software either by mouse or by the key-pad of your computer.

We advise Windows beginners to become acquainted with the Windows operations using the Windows teaching program. Start the teaching program in the program manager or explorer under the menu item **Help**. You can find further instructions on how to use Window applications in your Microsoft Windows manual.

3.6.3 What You Should Know

During the first installation **GPS_6870.EXE** (the file **GPS_INIT.INI** must be missing!) sets the transmission parameter in the PC for the communication with the GPS device to the following values.

- baud rate 9600 baud
- data bit 8
- stop bit 1
- parity bit no

These values must also be activated in the clock (status as delivered). The delivery status can also be produced by pressing the default button (only COM 0 / see pt. "Default Button in the Front Panel").

The changing of the parameter in the clock require also changing the setting of the COM-port of your computer. Therefore changed parameters are stored in a text file, so that they are available after a new call-up of the program. The file will be built automatically when the standard parameter have changed.

The file is in the same directory as the program **GPS_6870** and it is called:

GPS_INIT.INI

If necessary this file can also be edited manually. But the settings must correspond with the values of the particular serial interface of the clock.

Structure of the file **GPS_INIT.INI**:

```
[serial parameter]
string=9600,N,8,1
```

Only the part of the parameter **String** = may be altered

example:

```
old  9600,N,8,1
new  19200,E,7,2
```

The program works with these settings when the file is stored and **GPS_6870.EXE** restarted.

Please Note: IN CASE OF DOUBT YOU CAN DELETE THE FILE **GPS_INIT.INI**. THE PROGRAM THEN STARTS WITH THE ABOVE STANDARD SETTINGS.

From version 4.02 of the remote software upwards, the following entry in the file **GPS_INIT.INI** presets a serial port of the computer.

```
[serial Parameter]
Port=COM1
```

If the above line exists in the file **GPS_INIT.INI**, a window indicates after the start of the programme that this port is used.

You can save and load individual parameter settings under the menu item "**communication**" item "**load/save serial parameter**". The program stores these initialisation files for individual user configurations with the extension *.CST. These files can be edited manually corresponding with the above described ini-file. After loading a CST file the program automatically takes over the new settings and displays them in the main window.

3.6.4 Possible Errors in the Transmission with GPS-6870.EXE

- Check if the connection cable PC-clock has a defect. There must be a connection between the signals.

Please Note: DEPENDING ON THE INTERFACE VERSION THERE ARE FURTHER SIGNALS ON THE 9 POLE SUB-D PLUG **X2**. THEREFORE **ONLY** THE FOLLOWING CONNECTIONS ARE VALID FOR THE COMMUNICATON WITH THE REMOTE SOFTWARE.

PC	Pin	Clock	Pin
TxD	3	RxD	2
RxD	2	TxD	3
GND	5	GND	5

- Check whether the connection cable is connected to the interface named by GPS_6870.EXE.
If a transmission to the 6870 is not possible despite the correct connection there is an error in the parameter setting for the interface of the PC and the snap-in module. In this case key "**DEF**" must be pressed for 10 seconds to put the interface of 6870 into the standard setting. Then the program GPS_6870.EXE must be closed and the file GPS_INIT.INI must be deleted on the PC. The program GPS_6870.EXE must be executed again.
- System 6870 not ready for operation (e.g. no operating voltage).

4 Range of Functions of the Remote Software

The main menu of the software is divided into five functional groups:

(FILE) :	here you will find the commands to save, load, print, view and configure by means of set-up . There is also a function to control the put out data string.
(SET):	Initialising the GPS-receiver and configuring the outputs of the optical couplers
(SHOW):	Supervising the setting of the system and alignment of the antenna.
(COMMUNICATION):	Setting up the interfaces for the serial data transmission
(HELP):	Help and information about the programme version

4.1 The File Setup Menu

All the settings under the menus "**SET**" and "**COMMUNICATION**" can be written into an external file to configure other clocks with it. The setup file can be edited manually. For further information please refer to pt. "**Structure of the setup file**" and the programming manual of the clock.

4.1.1 Saving the Current Setup in a File

This function serves to save all those settings which have been transferred to the clock up to that point together in one file. It therefore requires one operation only to configure further clocks with the same settings at a later date.

First all the information required for the configuration must be transferred to the clock. After that the current settings can be saved in a file with the affix **".stp"** by calling up the menu item "**save actual setup to file**".

4.1.2 Saving the Stored Clock Data

With the menu point "**load setup from device**" the stored data in the clock can be transmitted to the PC. After this the complete data can be saved in a file by using the point "**save actual setup to file**".

4.1.3 Viewing the Current Setup

All data which have either been transferred to the clock or loaded from a file can be checked in a window by calling up the menu item "**show actual setup**". The assumption is made in four groups.

1. System information (date of changeover, difference time, reception mode, DCF77 simulation, synchronisation bit, system byte and position)
2. configuration of interfaces COM 0 (parameter byte, mode byte 1, mode byte 2)
3. configuration of interfaces COM 1 (parameter byte, mode byte 1, mode byte 2)
4. setting of the optical coupler (OK 1 to 3)

4.1.4 Transmission of the Current Setup to the Clock

The currently loaded or intended settings are transferred to the clock in one operation by the command "**send setup to device**". When the menu item has been activated a status window pops up demanding "**start**" or "**exit**". Using the "**start**" switch transfers the current settings to the clock. Use the "**exit**" switch to leave the programme.

During the transmission the settings currently being transferred to the clock are listed in the status window. Only those settings which have an entry are transmitted to the clock. If the operation is successfully completed it is indicated by **"system settings successfully stored!"**.

In case of a fault in the transmission the command **"GPS-system did not accept parameters"** will be shown. For this case see 3.6.4 (possible errors).

4.1.5 Structure of the Setup File

The setup files can be altered manually, but the following things must be considered:

1. There are small and capital letters.
2. There must not be a space between equals signs (=).
3. If an entry is to stay empty the part on the left of the equals sign and the sign itself must remain.
4. A semicolon turns the rest of the line into a comment.
5. The clock must be able to interpret the settings, faulty entries may cause errors in the clock. For more detailed descriptions of the individual entries please refer to the programming manual of the clock.

```
[COM_0] ; range interface COM 0
String=PAR:09600,N,8,1 ; parameter of the serial transmission
Mode1=MOD:1,1,0,1,1,0,0,0 ; modebyte 1
Mode2=MO1:0,0,0,0,0,0,0,0 ; modebyte 2

[COM_1] ; range interface COM 1
String=PA1:02400,N,8,11 ; parameter of the serial transmission
Mode1=MO2:1,1,1,1,1,0,0,1 ; modebyte 1
Mode2=MO3:0,0,0,0,1,0,0,0 ; modebyte 2

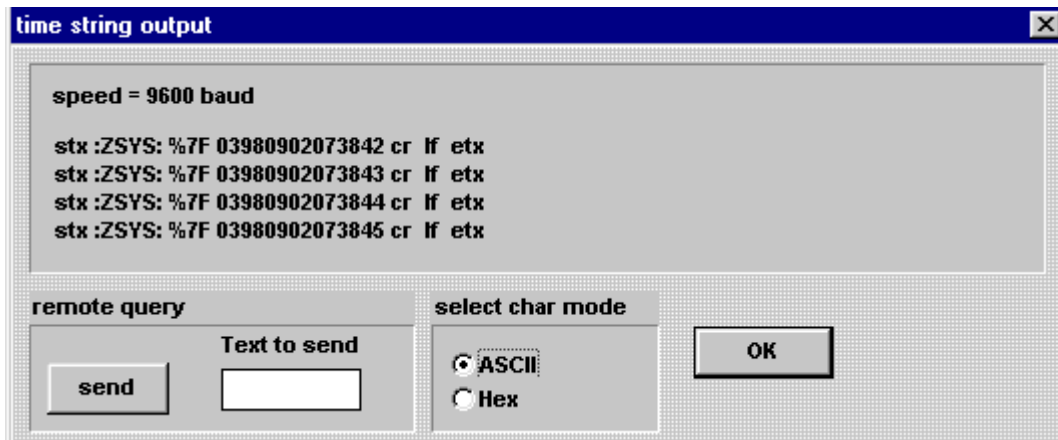
[System] ; range system settings
ChangeOver=COS:4A,02,03,52,03,10 ; times of changeover summer/winter
Difference=DIF:+01,00 ; difference time UTC/local
Reception=SAT:0 ; reception mode 3D/position fixed
Simulation=DCF:02,C8,64,02 ; DCF77 simulation and radio bit
SysByte=SYB:0,1,0,1,0,1,0,1 ; System byte settings
Position=POS:E:007,39,81,N:51,12,69 ; position data

[Pulses] ; range optical coupler
ok1=IMP:1,02,00,00,00,00,00,00 ; setting for optical coupler 1
ok2=IMP:2,02,00,00,00,00,00,00 ; setting for optical coupler 2
ok3=IMP:3,02,00,00,00,00,00,00 ; setting for optical coupler 3
```

Please Note: THE ENTRIES TO THE RIGHT OF THE EQUALS SIGN CORRESPOND WITH THE TRANSMITTED CONFIGURATION DATA STRING (WITHOUT CONTROL CHARACTERS) TO THE CLOCK AS DESCRIBED IN THE PROGRAMMING MANUAL.

4.1.6 Supervision of the Output Data String

The serial output data strings can be supervised by means of the menu item "test serial output".



The presently set baud rate is shown in the line "speed = 9600 baud".

The data output can be change from ASCII to HEX by "select char mode". In the picture above the output mode "ASCII" has been selected.

The individual characters are interpreted and put out as ASCII characters. The control characters stx, soh, etx, cr and lf are displayed as a string. The other control characters are put out hexadecimally with a percent sign in front (example %7F). When the last character shows up delayed and with three points in front it means that the mechanism "last control character on the second change" is activated.

In the operating mode "Hex" all characters are put out as hexadecimal values. A transmitted ASCII "1" would be displayed as "31".

A request string can be entered in the editing field "Text to send" which is transferred to the clock by means of the "send" switch. Leave the dialogue by using the "ok" switch.

Please Note: IF YOU HAVE SET A BAUD RATE WITH WHICH THE TRANSMISSION OF THE COMPLETE STRING TAKES MORE THAN A SECOND, IT MAY CAUSE ERRORS IN THE OUTPUT PROCESS. THE SAME APPLIES TO THE SET PROCESS "OUTPUT LAST CONTROL CHARACTER ON THE SECOND CHANGE" IF THE REQUEST COMES SHORTLY BEFORE THE SECOND CHANGE VIA THE "SEND" SWITCH.

4.1.7 Printing the Setup Settings

This menu item can be used to have the current set-up settings printed out by a connected printer. The output is made analogue to the "file-menu" entry "show actual setup".

4.2 Initialising the GPS - Receiver

Setting start values in the GPS system increases the synchronisation speed of the clock. Start values need not be entered, but the first radio reception may take up to 4 hours without initialisation.

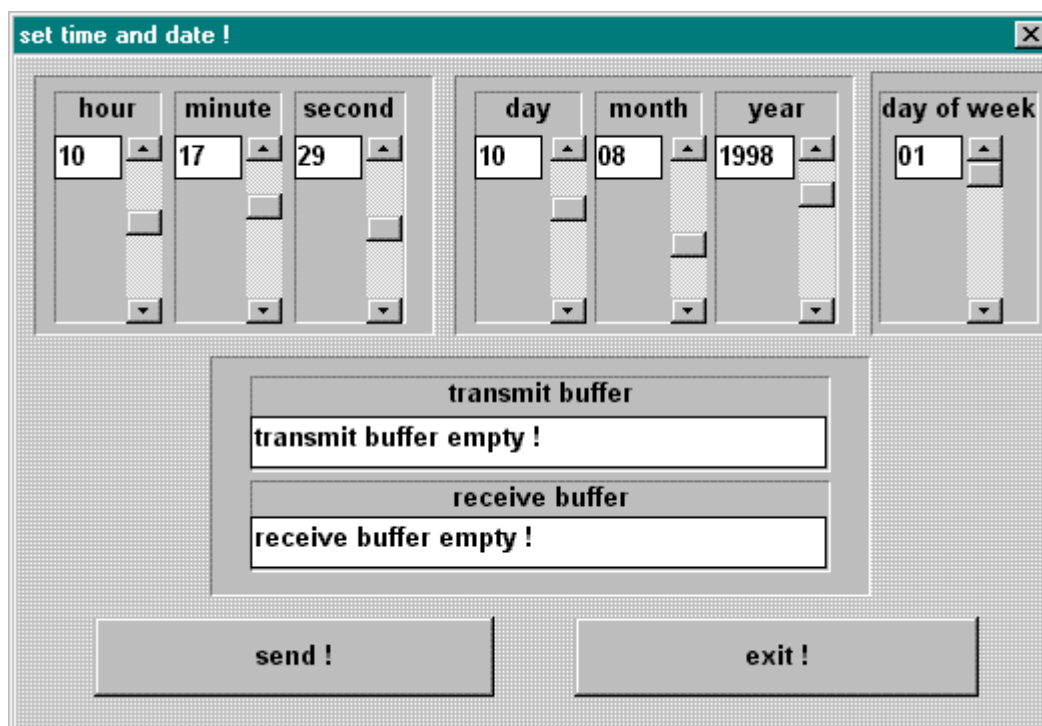
Keep the following sequence when setting start values in the system.

- input of the actual local time
- input of the position data
- input of the difference time UTC-local
- input of the change over date
- release a reset of the clock (after the next minute change)

Below the individual menu items of the program are explained.

4.2.1 Setting Time and Date

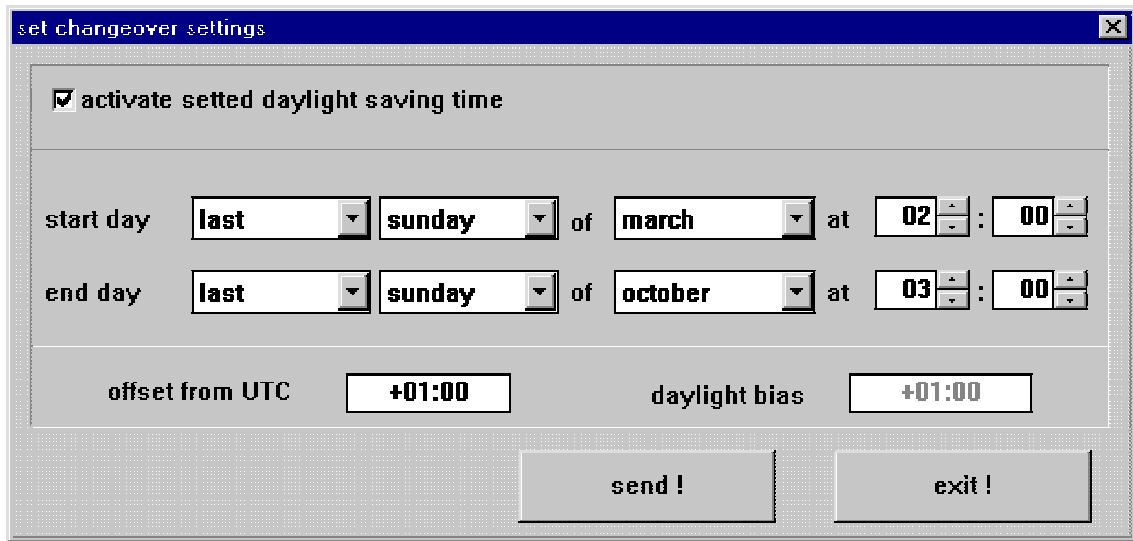
You will find the set-time-function under the menu item **"set"** and the entry **"time/date"**. Then the **"set time and date"** dialog appears. The program automatically takes over the time set in the computer into the editing field of the dialog.



You can change the time by moving the scroll bar next to the displays. After setting the correct time, start the transmission to the clock with the **"send"** switch. In the status field **"transmit buffer"** the data string which was transmitted to the clock appears. When the transmission is successful the same data string is shown in the **"receive buffer"**.

4.2.2 Entering the Points of Changeover

You'll find the function 'set points of changeover' in the menu under "set" and the entry "changeover date". The "changeover settings" dialogue appears.



Before activating the dialogue the current settings are read from the clock and displayed in the editing field. Here the points of time are entered when during the course of a year the time is to changeover to either daylight saving time or standard time on location.

The line **start day** states when the daylight saving time is to start. The line **end day** states the point when the daylight saving time ends. Changeovers can take place either on the first, second, third, fourth or last day of the month. Additionally a time in hours and minutes is required.

Change over dates can only be set, when the checkbox **automatically set daylight saving time** is activated. The change over will only be carried out, if the checkbox **automatically set daylight saving time** has been clicked. The fields **offset from UTC** and **daylight bias** have only informative value.

Once the data are entered please start the transmission to the clock by means of the "send" switch. A pop-up menu appears telling you that the information has been taken over by the clock.

Please Note: IF YOU DON'T WANT CHANGE OVER DATES, DEACTIVATE THE CHECKBOX "AUTOMATICALLY SET DAYLIGHT SAVING TIME" AND PUSH THE "SEND" SWITCH.

After the entry of the data use the "send" switch to start the transmission to the clock. The pop-up window tells us that the information has been taken over by the clock.

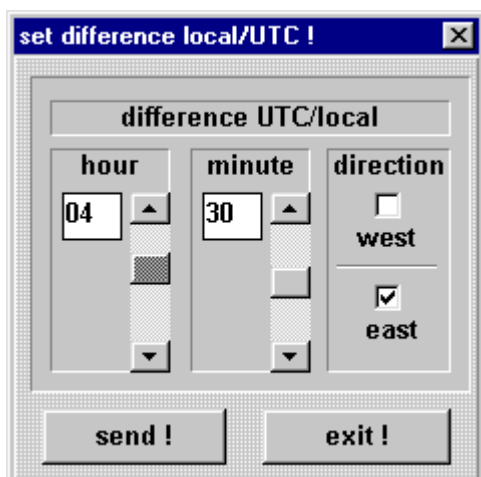
4.2.3 Setting the Difference UTC/Local

This function serves to enter the time difference between the local time and the world-time (UTC time).

The difference time is entered in hours and minutes, extended by the information whether the location lies to the east or west of the 0 longitude (Greenwich).

e.g. **West 08:00** for the USA and Canada (Pacific Time)

e.g. **East 09:30** for Adelaide Australia



You find the set-difference time-function under the menu item **"set"** and the entry **"difference local/UTC"**. The **"set difference local/UTC"** dialog appears.

Enter the actual data into the fields for hour and minute by moving the scroll bar. Click at the correct field for the direction (West/East).

After entering the data use the **"send"** switch to start the transmission to the clock.

The new time bias is calculated at the next minute change.

4.2.4 Setting the Day Offset

This function is only available in connection with special software FG687083.

4.2.5 Setting the Position Data

This function serves to enter the geographical position of the device. This function helps during the first installation but it is not necessary, it shortens the new initialisation of the GPS-receiver.

Degrees, minutes and 1/100 minutes are used for the entry of latitudes and longitudes.

Additionally the following information must be given for the latitude.

North = northern hemisphere

South = southern hemisphere

example: **North 51°12,36 51**

The entry of the longitude requires the following information.

East = east of the 0 meridian

West = west of the 0 meridian

example: **East 007°37,8426**

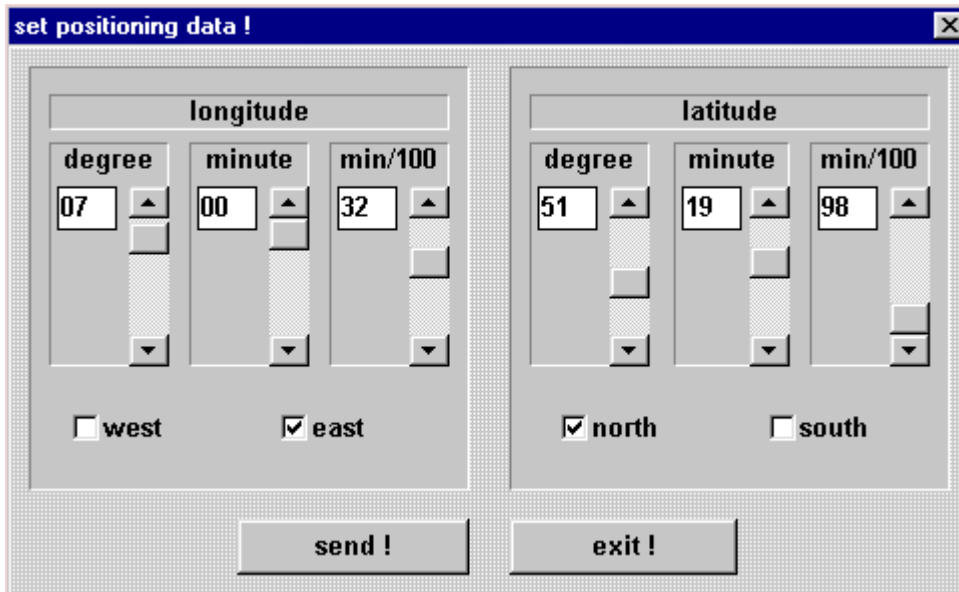
The GPS-receiver needs, for a faster synchronisation, only the entry of the rough position. For the exact position in the above example the following entry would suffice:

North 50°00,0000

East 007°00,0000

You can find the set-position-function under the menu item **"set"** and the entry **"position"**. The **"set positioning data"** dialog appears. Enter the actual data into the fields for latitude and longitude in degrees and 1/100 minutes by using the scroll bar.

Click the correct fields for latitude (north / south) and longitude (west/ east).



After entering the data use the **"send"** switch to start the transmission to the clock. If the transmission was successful a pop-up window appears with the message **"new values are stored in clock device"**.

4.2.6 Time Decoding 3D / Position fix

The accuracy of the time decoding depends on how accurately the position of the operational location is calculated. At least the reception of 4 satellites is required (3D-decoding). From the calculated position the transit time of the signal to several satellites is found and the second marker is produced from the average transit times. The 3D-decoding mode allows the second marker to have an accuracy of $\pm 1 \mu\text{sec}$.

In case of a fixed position quite often a less substantial decoding of the second marker suffices e.g. up to some milliseconds. In the position-fix mode the accuracy depends mainly on the precise entry of the position of the location of the installation. The calculation of the second marker starts with one satellite and the entered position already. An entry of the position to ± 1 minute degree achieves an accuracy of the second marker better than $\pm 20 \mu\text{sec}$. An entry even more precise can achieve the value $\pm 1 \mu\text{sec}$.

The position-fix mode has the advantage that the clock synchronises with only one satellite. The antenna may be installed somewhere where less than $\frac{1}{4}$ of the sky is visible.

Often it is possible to install the antenna indoors at the window (short cable, no lightning protection). If 4 satellites are visible in this mode, the decoding jumps automatically into the 3D-mode and calculates the exact position improving the accuracy to $\pm 5 \mu\text{sec}$. for one satellite.

Under the menu item **"set"** you will find the entry **"mode of reception"**. After selecting one of these modes, the dialog **"quality of reception"** appears. The list box **"quality of reception"** shows you the actual settings.

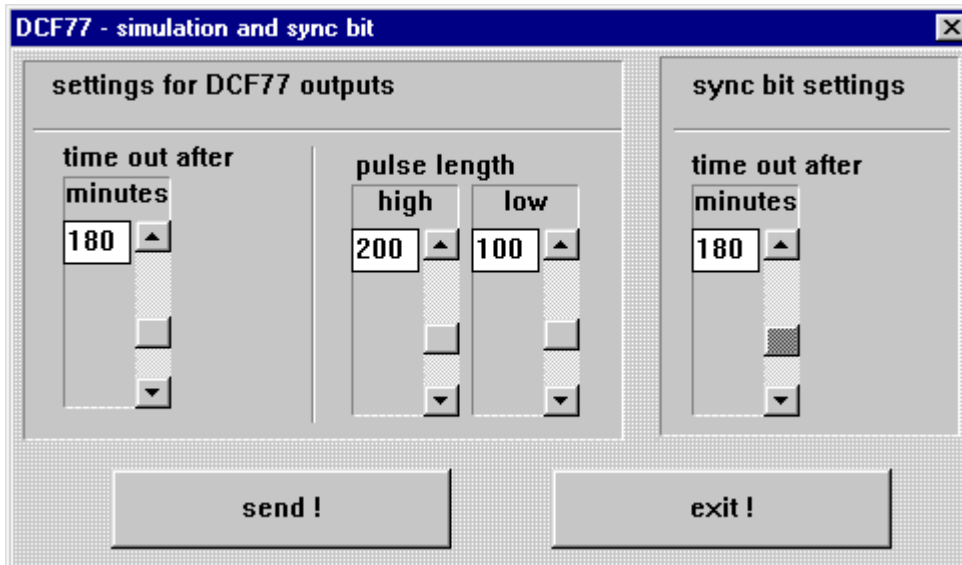
4.2.7 DCF77-Simulation and Radio-Bit

The output of the DCF77-simulation and of the radio-bit (see pt. "pulse output mode 2" and "status information in the serial data strings") are configured under this menu item.

The transmitter DCF77 broadcasts a data string, which transmits the time information with one bit per second. Lowering the amplitude of the DCF77-Signal for 100 or 200 msec codes the digital information (0/1). The narrow-band antennas of some radio controlled clocks falsify the duration of the dip and therefore the following receiver is adjusted to different pulse durations.

The base time for the DCF77-simulation can be changed with the system byte (see pt. 4.6.4).

The width of the low-high pulses for the DCF77-simulation can be adjusted to the operation with such alien products. You find the **"DCF77-simulation and sync. bit"** dialog under the **"set"** menu. After the selection the shown dialog box is displayed.



The lengths for low- and high pulse times of the DCF77-simulation are selected in the group window **"pulse length"**. The scroll bar **"time out after xx minutes"** can be used to switch off the output of the simulation when changing into crystal operation after the set time (2-254 minutes). If the value is set to 255 the simulation is not switched off. These settings have an effect on the DCF77 antenna simulation via the BNC connector on the front panel and on a possibly set DCF77-simulation to the optical coupler and on the status LED on the front.

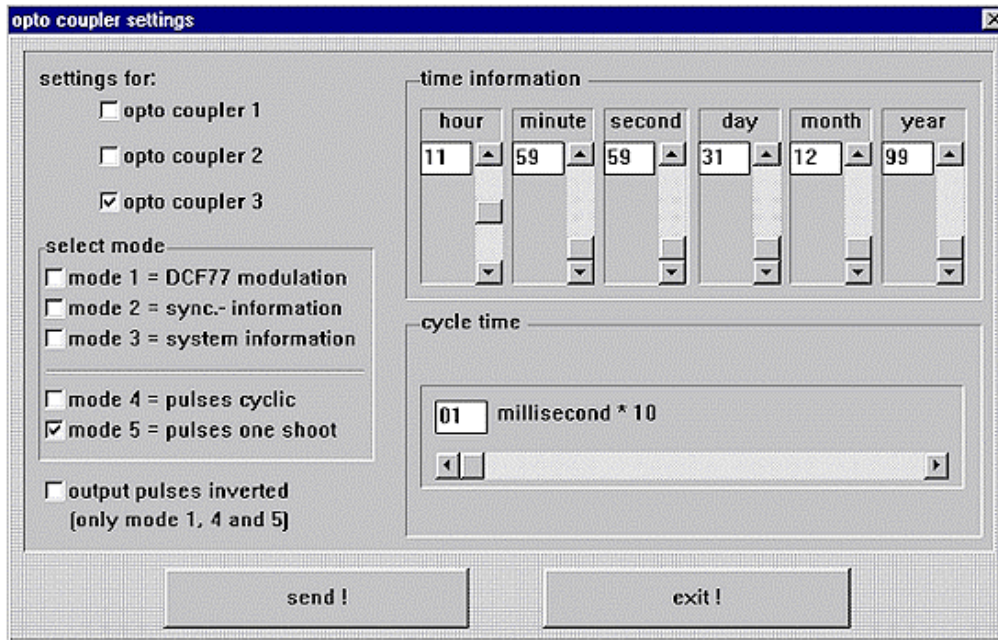
The scroll bar in the group **"sync bit settings"** can be used to delay the transfer of information **"radio"** (changeover from radio to crystal operation) by 2-254 minutes. When the value is 255 minutes the information **"radio"** is always transmitted. The clock have to be synchronous once. This method has an effect on the transmission of the synchronisation status in the put out data strings of the serial interface and on a possibly set "radio bit" at the optical couplers.

The possibility to delay the switch-off of the DCF77-simulation and radio bit serves to bridge small reception gaps, where the clock module 6870 does not fall short of the required accuracy due to its internal control. Therefore the clock must be radio synchronised (see pt. 4.2.9 System Byte settings).

Example: If an accuracy of more than 1 msec is required, the second pulse produced at the output must not deviate from the absolute time mark by more than ± 1 msec. In case of a maximum crystal drift (0.1 ppm) in free-running situation, this value would be reached after $1000 / 0,1 = 10.000$ seconds. A signalling of the crystal operation would be necessary after 166 minutes.

4.2.8 Setting the Optical Coupler Outputs

The clock module has three optical coupler outputs which can take over different functions. You find the "**opto coupler settings**" dialog under the "**set**" menu. Once selected the dialog box below is shown. The actual setting for the respective output appears when the checkbox for optical couplers 1-3 in the top left corner of the dialog is clicked.



The different functions are called modes and selected in the group window "**select mode**". Only one setting each can be selected. Depending on the selected function (mode), either the time information in the group window "**time information**" or the value for the pulse width can be set in the window "**cycle time**". If no time settings are possible for the selected mode, "**xxx**" appears in involved editing fields. The pulses can be put out inverted in the modes 1, 4 and 5 by activating the checkbox "**output pulses inverted**". This function does not make sense in the modes 2 and 3 because the voltage failure causes an error message at the outputs. A detailed description of the modes is given in the following paragraphs. The settings for each optical coupler must be send separately.

Please Note: IF THE VALUE FOR THE DAY AND MONTH IN MODE 5 IS SET TO "00", EVERY DAY A PULSE IS SENT AT THE ENTERED TIME.

4.2.8.1 DCF77-Simulation (Mode 1)

The local time information is put out as DCF77 simulation in a data string at the according optical coupler. This setting serves the synchronisation of further DCF77 radio controlled clocks with 1 Hz pulse input e.g. **hopf** 6036, 4980. The signal can also be put out invertedly. The settings for time information and cycle time are deactivated.

4.2.8.2 Information about the Synchronisation (Mode 2)

In this setting the internal clock status (radio bit) is shown at the output. If the optical coupler is switched active the clock module receives radio signals. A drop of the signal means crystal operation.

Please pay attention to the best setting of a delayed changeover of radio- to crystal operation in the dialog "**DCF77-Simulation and radio bit**" in chapter 4.2.7.

4.2.8.3 Alarm Message (Mode 3)

In this mode the output is switched through when the voltage is supplied. In case of errors or failures the signal drops, signalling an alarm.

4.2.8.4 Cyclic Pulses within 24 hours (Mode 4)

In this mode cyclic pulses with changeable pulse band are produced at the output. The following pulse intervals are possible.

every 1, 2, 3, 4, 6, 8, 12, 24 hours

every 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30 minutes

every 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30 seconds

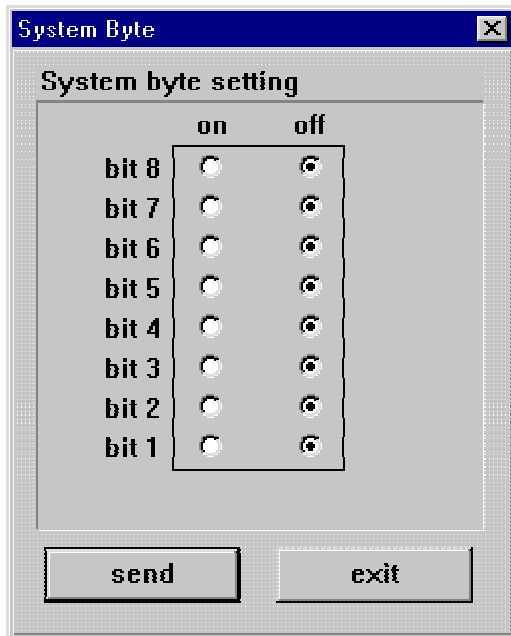
The setting 24 hour pulse interval requires the entry of naughts in all data positions in the group **time information**". The fields "**day**", "**month**" and "**year**" are deactivated. The pulse duration is selectable within the range of 10-2550 msec. in steps of 10 msec. The pulse duration should not be more than the cycle time, because in that case the output stays permanently switched active. The signal output can be inverted.

4.2.8.5 Single Pulse per Day or Date (Mode 5)

This mode produces either a single pulse per day or a single pulse per date at the output. The output time of the pulse can be set by the scroll bars of the group **time information**". If you select another value than **"00"** in the **"day"** field, the channel will switch active at the adjusted date otherwise the channel will switch daily at the selected time. A given date will be checked on validity.

The pulse duration is selectable within the range of 10-2550 msec. in steps of 10 msec. The signal output can be inverted.

4.2.9 System Byte settings



This function serves to switch on/off different internal program functions. Only bit 1-5 have a function at present. You find the **"system byte"** dialog under the **"set"** menu. After the selection the shown dialog box is displayed with the actual settings.

After entering the data use the **"send"** switch to start the transmission to the clock. (the picture shows the standard settings).

Bit no.:	switched on	switched off
8	–	–
7	radio bit always set without antenna	radio bit set with GPS reception
6	IRIG-B binary seconds per day switched off	IRIG-B binary seconds per day switched on
5	time base	
4	local time / standard time / UTC-time	
3	NGTS-pulse	IRIG-B output
2	UTC IRIG-B string	local time IRIG-B string
1	DCF77-simulation	pps (second pulse)

4.2.9.1 Adjustment by bit 1

The interface-variant 4 can be used for pulse output.

The output is able to drive a second pulse or the DCF77-simulation depending on the switch setting of bit 1.

4.2.9.2 Adjustment by bit 2

Bit 2 defines the basis time in the IRIG-B data string. It can be chosen between the local time and UTC.

4.2.9.3 Adjustment by bit 3

With bit 3 the output of IRIG-B data or the output of NGTS-pulse will be controlled in the program flow.

For IRIG-B is additionally the interface-variant 5 and for the NGTS-pulse the interface-variant 6 necessary.

4.2.9.4 Adjustment by bit 4 and 5

Bit 4 and 5 are used to chose different time basis for the DCF77-simulation.

Bit 5	Bit 4	
off	off	in the simulated DCF77-data string local time is used as time basis. The time zone bits change according to the standard or daylight-saving time. The time zone changeover is announced 1 hour before.
off	on	in the simulated DCF77-data string the local standard time is used as the time basis, the standard time is continuously transmitted in the time zone bits. There is no information of a changeover.
on	off	in the simulated DCF77-data string UTC is transmitted as time basis. The time zone bits should normally contain the UTC information. As many DCF77 decoding programmes interpret this as an error the time zone bit is transmitted as standard time if UTC is set.

4.2.9.5 Adjustment by bit 6

With these bit you can switch on or off the running seconds per day in the IRIG-B string.

4.2.9.6 4.2.9.6. Settings Bit 7

Some computers accept a data string only under the condition that the radio bit is set in the status word. That means that tests with these computers cannot be run before the antenna is installed. By means of bit 7 a permanent GPS-reception is simulated.

Bit 7 off the radio bit is set only if there is GPS-reception. If the period of no GPS-reception exceeds the set supervision time it is reset.

Bit 7 on the radio bit is always set even if there is no antenna connected.

Please Note: BIT 7 STAYS SET EVEN AFTER A VOLTAGE FAILURE. PLEASE TAKE THIS INTO CONSIDERATION WHEN YOUR TESTS ARE COMPLETED. IF THE BIT IS SWITCHED FROM "OFF" TO "ON" THE STATUS BYTE IN THE RESPECTIVE DATA STRING IS IMMEDIATELY SET TO "RADIO". BUT IF IT IS SWITCHED FROM "ON" TO "OFF" A RESET MUST BE CARRIED OUT SO THAT THE INFORMATION "CRYSTAL" IS SET IN THE PUTOUT DATA STRING.

4.2.10 Reset Function

This function is used to release a reset of the clock system. The function does not change the parameter and mode byte settings of the serial interfaces. We recommend a reset after the complete entry of all the data needed for the speeded up first synchronisation (time, difference time, and position).

You activate the reset with the menu item **"set"** and the entry **"reset clock"**. The **"Reset"** dialog appears. Press the **"send"** switch to release a clock reset. This action is confirmed in the **"receive buffer"** with the message **"reset activated"**.

4.3 Supervision of the GPS- Receiver

Use this function to display the internal clock data.

4.3.1 Time and Date

The function to display the time is activated by the menu item **"show"** and the entry **"time and date"**. The menu is divided into **"local"** and **"UTC"** time. Depending on your choice the **"time and date"** dialog appears with the according information. The time is requested in 200 msec. intervals.

4.3.2 Points of Changeover

The function to show the points of changeover is activated by the menu item **"show"** and the entry **"change over date"**. The **"show change over date"** dialog appears with the according information.

4.3.3 Difference Local-UTC

The function to show the difference time is activated by the menu item **"show"** and the entry **"difference UTC/Local"**. The **"difference UTC/Local"** dialog appears with the according information.

The data are requested only once and then displayed.

4.3.4 Position

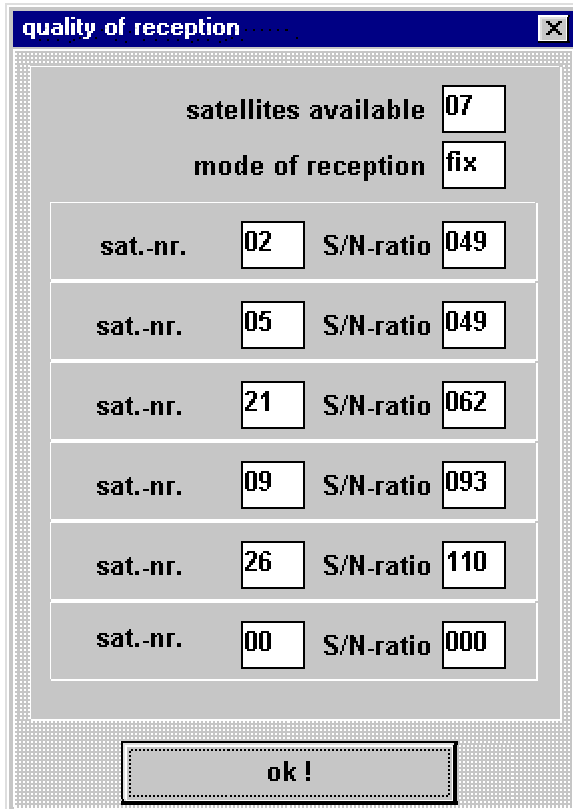
This function serves to show the entered or the by GPS updated position. Two digits after the decimal point of the position minutes are shown.

The function to show the position is activated by **"show"** and the entry **"position"**. The **"position"** dialog appears with the according information. The position data are requested once and then displayed.

4.3.5 Reception Quality

For satellites within the reception of 4 satellites necessary to synchronise the clock. At best 9-10 satellites move within the range of the antenna, of which 6 can be received simultaneously by the antenna.

Use the menu item **"quality of reception"** in the **"show"** menu to display the number of satellites in the visible range, and which satellites are received and also a relative measure for the reception quality. This function is particularly helpful during the installation of the system. When the menu item is selected the following picture is shown:



quality of reception	
satellites available	07
mode of reception	fix
sat.-nr.	02 S/N-ratio 049
sat.-nr.	05 S/N-ratio 049
sat.-nr.	21 S/N-ratio 062
sat.-nr.	09 S/N-ratio 093
sat.-nr.	26 S/N-ratio 110
sat.-nr.	00 S/N-ratio 000
ok !	

"Satellites available" lists the number of satellites visible in this antenna position in this location. The field **"mode of reception"** shows the actual selected mode.

Six satellites can be received and displayed. The figure in the fields **"sat.-no."** is the Satellite-Pseudo-Random-Number. The satellites are not numbered 1, 2, 3 etc. but named after their Pseudo-Random-Number under which the satellite broadcasts its information. In case of a satellite failure a spare satellite can be activated under the same number.

The figures in the fields **"S/N-Ratio"** state the signal/ noise ratio as a relative quantity. It may vary between 0-255.

After the first installation it may take up to 1 hour before anything is written into the display. It depends on the start information, received by the system (see programming time, position data) and the antenna position e.g. only half the sky within the view range.

- 10 - 30 represent a bad signal / noise ratio
- 30 - 70 represent a sufficient signal/ noise ratio
- 70 - 140 represent a good signal/ noise ratio

4.3.5.1 Interpretation of Errors in the Reception

Faults and errors of the reception system can be found by means of the satellite display.

Example 1

Even after several hours no satellite appears on display after the first installation.

Possible errors:

- the antenna cable is broken
- the antenna cable is not connected
- the antenna is broken
- the lightning protection does not work

Example 2

7 satellites are within the possible range of view but no more than two are displayed.

Error

- the range of view to the sky is too small

Example 3

9 satellites are within the view range , 6 are covered but the system does not synchronise because the signal/ noise ratio all vary between 10-25.

Possible errors:

- the cable is too long
- the BNC connector is badly assembled
- the cable is crimped or bent
- the cable has the wrong impedance

Example 4

The system has been working perfectly so far. 7 satellites appear in the view range- none is covered - the system has not had any reception for several days.

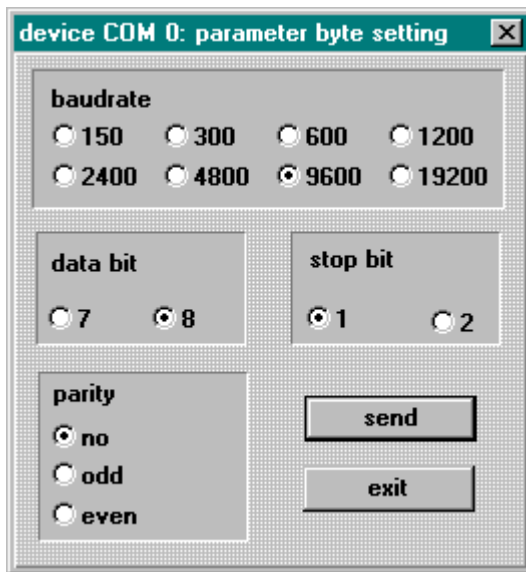
Possible errors:

- the cable is damaged
- lightning has struck and the lightning protection is broken
- the antenna is broken
- the receiver is broken
- the voltage supply has a defect

4.3.6 Firmware Revision

The firmware version and the date of the connected device can be read from this menu point of the "**show**" menu.

5.2.1 Configuration of the serial parameter



You find the setting for baud rate, data bit, stop bit and parity by selecting the menu **"communication"** and **"serial parameter"**. The parameter dialog for the selected device appears.

Confirm your entry by pressing the **[send]** key. The new parameters are taken over into the clock. When the data are taken over the following information is shown in the dialog window,

serial parameter

change from: PAR: 09600,8,N,1
to: PAR: 19200,7,N,2

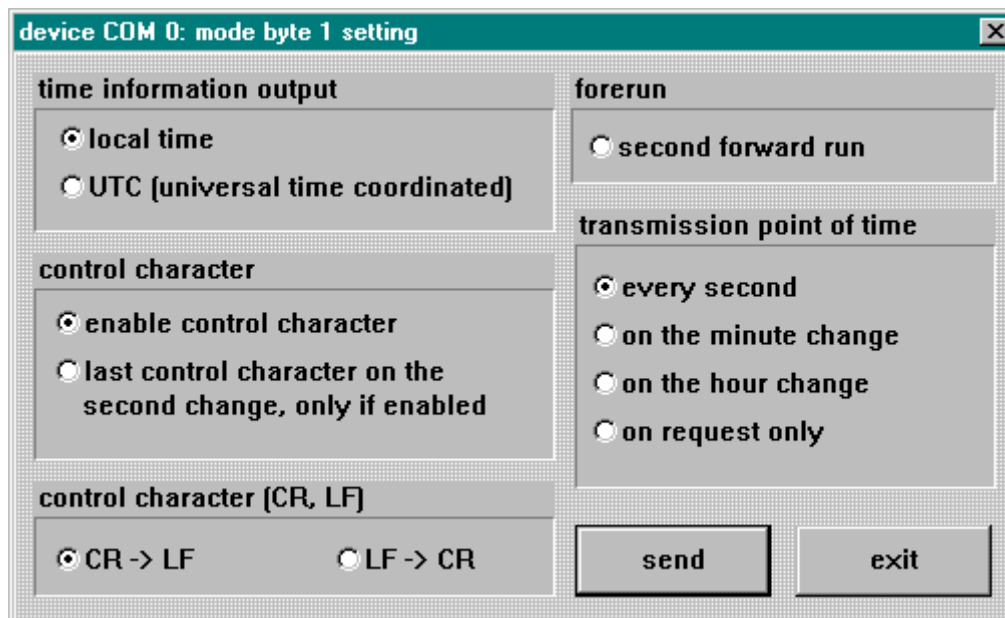
Therefore the settings are completed. In case of a successful transfer of data the new parameters are also set in the remote computer. In case of problems with the transfer the following information appears in the dialog window after 15 seconds:

GPS-System did not accept serial parameter

Please refer to pt: 3.6.4 (possible errors) for help.

5.3 Configuration of the Data String (Mode byte 1)

The time information received from satellite can be put out via the interfaces in different "data strings" including the internal status of the clock. This enables the user to synchronise connected computer systems with the atom-precise time. It is possible to choose the point of output, the time information and the used control characters by click in the **mode byte 1 dialog**.



You find the set-function for the **mode byte 1** by selecting the menu "**communication**" and "**mode byte 1**". The mode byte 1 dialog for the selected device appears which shows the actual settings of the clock. You can configure the output system to your specifications. Start the transmission with the "**send**" button. When the data have been accepted a dialog window appears with the following information

```

mode byte 1 configuration
change   from:  MOD:1,0,1,1,0,0,0,0
         to:    MOD:1,1,1,1,1,0,0,0

```

completing the setting. If problems occur with the transmission a dialog window appears after 15 seconds with this information:

GPS-System did not accept serial parameter

In this case refer to pt 6.7 possible errors for help.

Below possible settings are described.

5.3.1 Time information output

The time basis used in the output data string is chosen in the group "**time information output**". If you select "**local time**" the time information (UTC ± difference time) including a possibly existing summertime offset is put out. If you chose "**UTC**" the output data string is set to **UTC (universal time co-ordinated)** world-time.

5.3.2 Control Characters

If the checkbox "**enable control character**" is activated in the group "**control character**", the char **STX (0x02)** at the beginning and **ETX (0x03)** is added at the end. When the setting "**last control character on the second change**" was activated, the final character ETX is transmitted exactly on the next second change. This mechanism serves to calculate precisely the time in the computer which is to be synchronised.

Example :

The setting **8 bit, no parity, 1 stop bit** means that 10 bits are sent for the transmission of one character. At **9600 baud** a character therefore needs about 1 msec for the transfer. The computer must therefore add this value plus the delay time for the received character to establish the internal time.

Attention:

Some data strings does not contain the control characters **STX** and **ETX** by default. In this cases the last control character is send as **On-Time Marker** if both checkboxes are enabled. (by example **T-String** last character = **LF**).

5.3.3 Control Characters (CR, LF)

The output of the control characters **CR** (carriage return) and **LF** (line feed) can be exchanged in the group "**control character CR/LF**".

5.3.4 Forerun

If you activate the setting in the group "**forerun**" the data string is put out with a second advance. This setting is helpful in connection with the transmission of the final character "**ETX on the second change**" because the data string becomes valid when the ETX arrives.

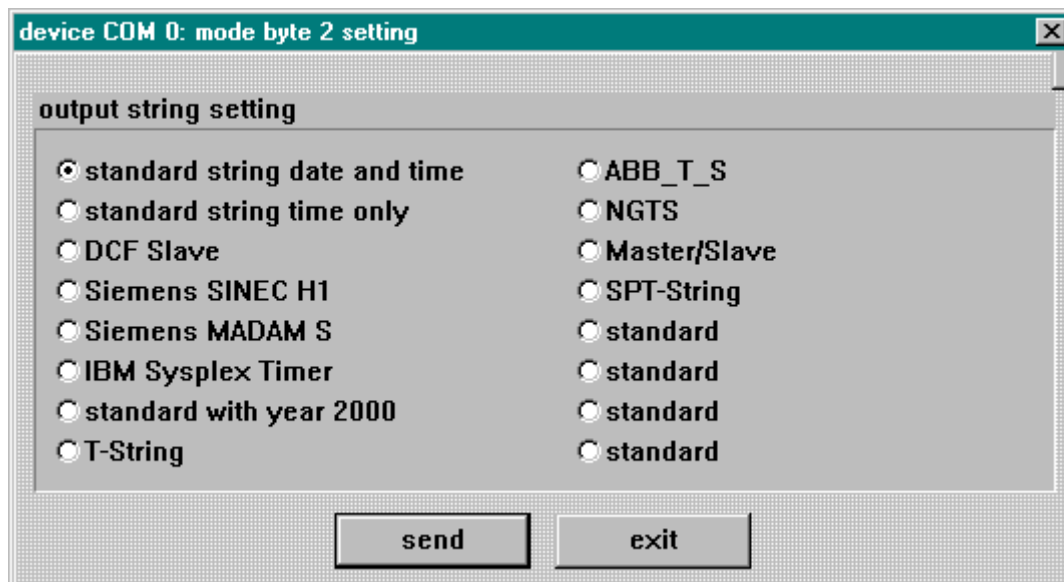
5.3.5 Transmission Point of Time

In the group "**transmission point of time**" select the output point of time for the data string. The following settings are possible:

- every second** (on the second change)
- on the minute change**
- on the hour change**
- on request only**

5.3.6 Selection of Data String with Mode byte 2

You find the set-function for the **mode byte 2** by selecting the menu "**communication**" and "**mode byte 2**". The mode byte 2 dialog for the selected device appears with the actual setting of the clock.



Click at the according checkbox for the data string you want and start the transmission to the clock with the **[send]** switch. When the data has been accepted a dialog window appears with the information:

mode byte 2 configuration

old: MO1:1,0,1,1,0,0,0,0

new: MO1:1,1,1,1,1,0,0,0

completing the setting. In cases of strings which needs to have a special setting for parameter or mode byte 1 configuration the following message lines maybe appended in the dialog box:

parameter settings changed (parameter has been changed)

mode byte 1 settings changed (configuration has been changed)

If there were any problems with the transmission a dialog window appears after about 15 sec. stating:

GPS-System did not accept serial parameter

In this case refer to pt. 3.6.4 (possible errors).

In the following chapters the structures of the individual data strings are described.

5.4 Data Format of the Serial Transmission

The data are sent in ASCII as BCD values and can be shown by any terminal program. (example TERMINAL.EXE under Windows). The following control characters from the ASCII range are used in the structure of the data string:

- \$20 = Space
- \$0D = CR (carriage return)
- \$0A = LF (line feed)
- \$02 = STX (start of text)
- \$03 = ETX (end of text)

Please Note: THE STATUS VALUES ARE TO BE DECODED SEPARATELY (SEE STRING STRUCTURE).

5.5 Serial Request

The serial data output on request with ASCII control characters' does not work when the data output "every second" has been activated.

5.5.1 Serial Request in the Standard String 6021

When the data string 6021 and year 2000 is set the data output can be started by a request from the external computer. The following characters start a transmission:

ASCII "U" – for time (local time)
 ASCII "D" – for time / date (local time)
 ASCII "G" – for time / date (UTC-time)

The system answers with the according data string within 1 msec.

As this is often too fast for the requesting computer, it is possible to delay the answer in steps of 10 msec. when requesting via software. The small letters "u, d, g" together with a two-digit multiplication factor are transmitted by the requesting computer to the clock to delay the transmission of the data string.

The multiplication factor is interpreted as hexadecimal value by the clock.

Example :

The computer transmits **ASCII u05** (Hex 75, 30, 35)

After 50 milliseconds the clock answers with the data string time only (local time).

The computer transmits **ASCII gFF** (Hex 67, 46, 46)

After 2550 milliseconds the clock answers with the data string time / date (UTC time).

5.5.2 Serial Request in MADAM S

When the output MADAM S is set, the output on request can be activated only with the character sequence:

:ZSYS:
 or :WILA:

Please Note: OUTPUT ON REQUEST SHOULD BE SET IN THE MODE BYTE 1, OTHERWISE A RUNNING CYCLIC OUTPUT MAY CAUSE A DELAYED ANSWER.

5.5.3 Serial Request in T-String, ABB S T and NGTS

Transmitting the ASCII character "T" releases an output in these data strings.

5.5.4 Serial Request in SINEC H1

Transmitting the ASCII character "?" releases an output in this data string.

Please Note: IN CASE OF OUTPUT ON REQUEST IT SHOULD BE SET IN MODE BYTE 1, OTHERWISE RUNNING CYCLIC OUTPUTS MAY CAUSE DELAYS IN THE ANSWER.

6 Data Strings

6.1 General Information on the Data Output of 6870

The control characters STX and ETX are transmitted only if the output "**with control character**" was set in the **mode byte 1**. Otherwise there are no control characters.

In case of the setting ETX on the second change there is, depending on the baud rate, a gap in transmission of up to 970 msec. Please take this into consideration when programming a time-out on the reception side.

The output of the control characters CR and LF can be interchanged in all data strings by **mode byte 1**.

The transmitted data strings are compatible with the data strings of the following **hopf** radio controlled clock boards:

- board 6020/6021 standard with control characters
- board 6025/6027 standard with control characters (string 6021 only)
- board 7200/7201 standard with control characters
- board 7220/7221 standard with control characters
- board 7240/7245 standard with control characters
- board 6840/6841 standard with control characters
- board 4465 standard with control characters

6.2 Data String 6870/6021 Time and Date

<u>character no.</u>	<u>meaning</u>	
1	STX (Start of Text)	
2	Status (internal status of the clock)	; see 6.2.2
3	day of the week (1= Monday...7=Sunday)	; see 6.2.2
	In case of 'UTC-time' bit 3 in the day of the week is set to 1	
4	tens - hours	
5	unit - hours	
6	tens - minutes	
7	unit - minutes	
8	tens - seconds	
9	unit - seconds	
10	tens - day	
11	unit - day	
12	tens - month	
13	unit - month	
14	tens - year	
15	unit - year	
16	LF (Line Feed)	; see 6.1
17	CR (Carriage Return)	; see 6.1
18	ETX (End of Text)	

6.2.1 Data String 6870/6021 Time Only

<u>character no.</u>	<u>meaning</u>	
1	STX (Start of Text)	
2	tens - hours	
3	unit - hours	
4	tens - minutes	
5	unit - minutes	
6	tens - seconds	
7	unit - seconds	
8	LF (Line Feed)	; see 6.1
9	CR (Carriage Return)	; see 6.1
10	ETX (End of Text)	

6.2.2 Status and Day of the Week Nibble in the Data String 6870/6021 Standard

The second and the third ASCII character in the data string contain the status and the day of the week. The status is decoded binarily. Structure of these characters:

	b3	b2	b1	b0	meaning
status nibble:	x	x	x	0	no announcement hour
	x	x	x	1	announcement (ST-WT-ST)
	x	x	0	x	wintertime (WT)
	x	x	1	x	summertime (ST)
	0	0	x	x	time/date invalid
	0	1	x	x	crystal operation
	1	0	x	x	radio operation
	1	1	x	x	radio operation (high accuracy)
day of the week nibble:	0	x	x	x	CEST/CET
	1	x	x	x	UTC - time
	x	0	0	1	Monday
	x	0	1	0	Tuesday
	x	0	1	1	Wednesday
	x	1	0	0	Thursday
	x	1	0	1	Friday
	x	1	1	0	Saturday
	x	1	1	1	Sunday

6.2.3 Example of a Transmitted Data String 6870/6021 (Standard)

(STX)E3123456170496(LF)(CR)(ETX)

Radio operation (high accuracy)

summertime

no announcement

It is Wednesday 17.04.96 - 12:34:56 h

() - ASCII-control characters e.g.(STX)

6.3 Data String DCF-Slave

The following data string is used to synchronise **hopf** DCF-slave systems. The only difference to the standard data string 6870 / 6021 is the status byte.

character no.	meaning	value (value range)
1	STX (start of text)	\$02
2	status	\$30-39,\$41-46 ; see 6.3.1
3	day of the week	\$31-37 ; see 6.3.1
4	tens - hour	\$30-32
5	unit - hour	\$30-39
6	tens- minute	\$30-35
7	unit - minute	\$30-39
8	tens - second	\$30-36
9	unit - second	\$30-39
10	tens - day	\$30-33
11	unit - day	\$30-39
12	tens - month	\$30-31
13	unit - month	\$30-39
14	tens - year	\$30-39
15	unit - year	\$30-39
16	LF (line feed)	\$0A ; see 6.1
17	CR (carriage Return)	\$0D ; see 6.1
18	ETX (end of text)	\$03

6.3.1 Status in the Data String DCF-Slave

	b3	b2	b1	b0	meaning
status nibble:	x	x	x	0	no announcement hour
	x	x	x	1	announcement (ST-WT-ST)
	x	x	0	x	wintertime (WT)
	x	x	1	x	summertime(ST)
	x	0	x	x	no announcement leap second
	x	1	x	x	announcement leap second
	0	x	x	x	radio operation
	1	x	x	x	radio operation (high accuracy)
day of the week nibble	0	0	0	1	Monday
	0	0	1	0	Tuesday
	0	0	1	1	Wednesday
	0	1	0	0	Thursday
	0	1	0	1	Friday
	0	1	1	0	Saturday
	0	1	1	1	Sunday

6.3.2 Example of a Transmitted Data String DCF-Slave

(STX)83123456030196(LF)(CR)(ETX)

Radio operation, no announcement, wintertime
It is Wednesday 03.01.96 - 12:34:56 h

6.3.3 Setting

The following setting is required for the synchronisation of the **hopf** slave systems:

- output every minute
- output second advance
- output with control character
- ETX on the second change
- 9600 baud, 8 bit, 1 stop bit, no parity
- LF, CR

This setting guarantees the best adjustment of the time basis in the slave systems.

6.4 Data String SINEC H1

The control characters STX and ETX are transmitted only if the output is set "with control characters". Otherwise there are no control characters. In case of the setting 'ETX delayed' the last character (ETX) is transmitted exactly on the next second change.

The data string can be requested with the character "?".

<u>character no.:</u>	<u>meaning</u>	<u>value (value range)</u>	
1	STX (start of text)	\$02	
2	"D" ASCII D	\$44	
3	":" colon	\$3A	
4	tens - day	\$30-33	
5	unit - day	\$30-39	
6	"." point	\$2E	
7	tens - month	\$30-31	
8	unit - month	\$30-39	
9	"." point	\$2E	
10	tens - year	\$30-39	
11	unit - year	\$30-39	
12	":" semicolon	\$3B	
13	"T" ASCII T	\$54	
14	":" colon	\$3A	
15	day of the week	\$31-37	
16	":" semicolon	\$3B	
17	"U" ASCII U	\$55	
18	":" colon	\$3A	
19	tens - hours	\$30-32	
20	unit - hours	\$30-39	
21	"." point	\$2E	
22	tens - minute	\$30-35	
23	unit - minute	\$30-39	
24	"." point	\$2E	
25	tens - seconds	\$30-36	
26	unit - seconds	\$30-39	
27	":" semicolon	\$3B	
28	"#" or space	\$23 / \$20	; see 6.4.1
29	"*" or space	\$2A / \$20	; see 6.4.1
30	"S" or space	\$53 / \$20	; see 6.4.1
31	!" or space	\$21 / \$20	; see 6.4.1
32	ETX (end of text)	\$03	

6.4.1 Status in the Data String SINEC H1

The characters 28-31 in the data string SINEC H1 give information about the synchronisation status of the clock.

meaning of the following:

character no.: 28 = "#"	no radio synchronisation after reset, time invalid
space	radio synchronisation after reset, clock at least in crystal operation
character no.: 29 = "*" space	time from the internal crystal of the clock time from radio reception
character no.: 30 = "S" space	summertime wintertime
character no.: 31 = "!" space	announcement of a W/S or S/W changeover no announcement

6.4.2 Example of a Transmitted Data String SINEC H1

(STX)D:03.01.96;T:3;U:12.34.56; _ _ _ _ (ETX) (_) = Space

radio operation, no announcement, wintertime

It is Wednesday 03.01.96 - 12:34:56 h

6.5 Data String MADAM-S

The structure of the data string depends on the request string. If the superior computer (PROMEA-MX) requests with the following string

:ZSYS:

the clock answers with the following data string:

<u>character no.</u>	<u>meaning</u>	<u>value(value range)</u>
1	STX (start of text)	\$02
2	: colon	\$3A
3	Z ASCII Z	\$5A
4	S ASCII S	\$53
5	Y ASCII Y	\$59
6	S ASCII S	\$53
7	: colon	\$3A
8	status of the changeover	\$00, 01, 7F ; see 6.5.2
9	time scale ident.	\$30-33
10	day of the week	\$31-37
11	tens - year	\$30-39
12	unit - year	\$30-39
13	tens - month	\$30-31
14	unit - month	\$30-39
15	tens - day	\$30-33
16	unit - day	\$30-39
17	tens - hour	\$30-32
18	unit - hour	\$30-39
19	tens - minute	\$30-35
20	unit - minute	\$30-39
21	tens - second	\$30-35
22	unit - second	\$30-39
23	LF (line feed)	\$0A ; see 6.1
24	CR (carriage return)	\$0D ; see 6.1
25	ETX (end of text)	\$03

If the superior computer (PROMEA-MX) requests using the string

:WILA:

the clock answers with the following data string:

character no.	meaning	value (value range)
1	STX (start of text)	\$02
2	: colon	\$3A
3	W ASCII W	\$57
4	I ASCII I	\$49
5	L ASCII L	\$4C
6	A ASCII A	\$41
7	: colon	\$3A
8	status	\$00, 01, 7F ; see 6.5.2
9	time scale ident.	\$30-33
10	day of the week	\$31-37
11	tens - year	\$30-39
12	unit - year	\$30-39
13	tens - month	\$30-31
14	unit - month	\$30-39
15	tens - day	\$30-33
16	unit - day	\$30-39
17	tens - hour	\$30-32
18	unit - hour	\$30-39
19	tens- minute	\$30-35
20	unit - minute	\$30-39
21	tens - second	\$30-35
22	unit - second	\$30-39
23	LF (line feed)	\$0A ; see 6.1
24	CR (carriage return)	\$0D ; see 6.1
25	ETX (end of text)	\$03

6.5.1 Required Setting for Output MADAM-S

The synchronisation mechanism for the out put MADAM-S requires the following setting :

- output on the minute change
- output with second advance
- output ETX on the second change
- output with control characters
- output CR/LF

6.5.2 Status Nibble in the Data String MADAM-S

Announcement of a changeover (8. Byte of the transmission)

This byte can have the following values :

Nul (Hex 00)	no announcement
SOH (Hex 01)	announcement changeover summer-/wintertime winter-/summertime
DEL (Hex 7F)	no radio controlled time available

time scale identification (9.byte of the transmission)

ASCII 0 (Hex 30)	wintertime
ASCII 1 (Hex 31)	summertime + announcement
ASCII 3 (Hex 33)	summertime

The day of the week nibble can take the value ASCII 1 (Hex 31 ⇔ MO) to ASCII 7 (Hex 37 ⇔ SU). In case of an invalid time the byte is transmitted with ASCII 0 (Hex 30).

6.6 Data String IBM 9037 / Sysplex Timer

This protocol is used for the synchronization of an IBM 9037 / Sysplex Timer. The IBM 9037 / Sysplex Timer expects the time at its input every second. The following settings are required: 9600 baud, 8 data bit, parity odd, 1 stop bit, sending on request without advance and without control characters. The clock starts sending the protocol automatically every second after a request by ASCII "C" of the IBM 9037 / Sysplex Timer.

The setting UTC or local time is optional.

character-no.:	meaning	value (value range)
1	SOH (start of header)	\$02
2	hundreds - cur. day of year	\$30-33
3	tens - current day of the year	\$30-39
4	unit - current day of the year	\$30-39
5	" : " colon	\$3A
6	tens - hour	\$30-32
7	unit - hour	\$30-39
8	" : " colon	\$3A
9	tens - minute	\$30-35
10	unit - minute	\$30-39
11	" : " colon	\$3A
12	tens - second	\$30-35
13	unit - second	\$30-39
14	Quality Identifier	\$20, 41, 42, 43, 58
15	CR (carriage return)	\$0D ; see 6.1
16	LF (line feed)	\$0A ; see 6.1

6.6.1 Status in the Data String IBM 9037 / Sysplex Timer

The 14th character informs about the synchronisation status of the clock. Possible values and their meaning are listed below.

"?"	=	question mark	=	no radio controlled time
" "	=	space	=	radio controlled time at hand
"A"	=	Hex 41	=	crystal operation for more than 20 minutes
"B"	=	Hex 42	=	crystal operation for more than 41 minutes
"C"	=	Hex 43	=	crystal operation for more than 416 minutes
"X"	=	Hex 58	=	crystal operation for more than 4160 minutes

6.6.2 Example of a transmitted Data String IBM 9037 / Sysplex Timer

(SOH)050:12:34:56 _ (CR) (LF) (_) = Space

radio operation, 12:34:56 h, 50th day of the year

6.7 Data String 6870/6021 String 2000

The structure of the data string is the same as the standard string 6870/6021 and differs only in the data positions century tens and unit.

<u>character no</u>	<u>meaning</u>
1	STX (start of text)
2	Status (internal status of the clock) ; see 6.7.1
3	day of the week (1=Monday ... 7=Sunday) ; see 6.7.1 In case of UTC time bit 3 is set to 1 in the day of the week
4	tens hour
5	unit hour
6	tens minutes
7	unit minutes
8	tens seconds
9	unit seconds
10	tens day
11	unit day
12	tens month
13	unit month
14	tens century
15	unit century
16	tens year
17	unit year
18	LF (line feed) ; see 6.1
19	CR (carriage return) ; see 6.1
20	ETX (end of text)

6.7.1 Status in the Data String 2000

The second and the third ASCII character in the data string contain the status and the day of the week. The status is decoded binarily. Structure of these characters:

	b3	b2	b1	b0	meaning
status nibble:	x	x	x	0	no announcement hour
	x	x	x	1	announcement (ST-WT-ST)
	x	x	0	x	wintertime (WT)
	x	x	1	x	summertime (ST)
	0	0	x	x	time/date invalid
	0	1	x	x	crystal operation
	1	0	x	x	radio operation
	1	1	x	x	radio operation (high accuracy)
day of the week nibble:	0	x	x	x	CEST/CET
	1	x	x	x	UTC - time
	x	0	0	1	Monday
	x	0	1	0	Tuesday
	x	0	1	1	Wednesday
	x	1	0	0	Thursday
	x	1	0	1	Friday
	x	1	1	0	Saturday
	x	1	1	1	Sunday

6.7.2 Example of a Transmitted Data String 2000

(STX)E312345603011996(LF)(CR)(ETX)

Radio operation (high accuracy)

summertime

no announcement

It is Wednesday 03.01.1996 - 12:34:56 Uhr.

() - ASCII-Steuerzeichen z.B. (STX)

6.8 Data String T-String

The T-string can be transmitted with all modes (e.g. **forerun** or "**last control character on the second change**").

The data string can be requested with the character "**T**".

character no.:	meaning	value (value range)	
1	"T" ASCII T	\$54	
2	":" colon	\$3A	
3	tens year	\$30-39	
4	unit year	\$30-39	
5	":" colon	\$3A	
6	tens month	\$30-31	
7	unit month	\$30-39	
8	":" colon	\$3A	
9	tens day	\$30-33	
10	unit day	\$30-39	
11	":" colon	\$3A	
12	tens day of the week	\$30	
13	unit day of the week	\$31-37	
14	":" colon	\$3A	
15	tens hour	\$30-32	
16	unit hour	\$30-39	
17	":" colon	\$3A	
18	tens minute	\$30-35	
19	unit minute	\$30-39	
20	":" colon	\$3A	
21	tens seconds	\$30-36	
22	unit seconds	\$30-39	
23	CR (carriage return)	\$0D	; see 6.1
24	LF (line feed)	\$0A	; see 6.1

6.8.1 Example of a Transmitted Data String T-String

T:96:01:03:03:12:34:56(CR)(LF)

It is Wednesday 03.01.96 - 12:34:56h

6.9 Data String ABB T S

The structure of the data string ABB_T_S is the same as those under the T-String (see 6.8 Data String T-String). It is switched on by the mode byte 2

Selecting the string also fixes the transmission parameter to the following values:

- baud rate: 4800
- word length: 7 bit
- parity: odd
- stop bits: 2 bit
- output point of time: every minute

6.10 Data String TimeServ for the Operating System Windows NT

The synchronization of a Computer running Windows NT version 3.51 and higher is done with the same string as described under pt. "**Sysplex Timer**". The **mode byte 1** setting must match the following items:

- telegram Sysplex Timer
- transmission every second
- 9600 baud
- 8 data bit
- no Parity
- 1 stop bit
- without second advance
- transmission without control characters
- output UTC

To install TimeServ on the WinNT-computer you need the program files which can be found on the Microsoft Windows NT Recource Kit CD. The newest version of the program is although available free of charge on the Microsoft Internet site:

<ftp://ftp.microsoft.com/bussys/winnt/winnt-public/reskit/nt40>

A short description how to setup TimeServ for a **hopf** radio clock is available on the **hopf** internet site:

<http://www.hopf.com>

6.11 Data String for NTP (Network Time Protocol)

NTP or also xNTP is a batch of programmes to synchronise different computers and operating systems with network support. It is the standard for the Internet Protokoll TCP/IP (RFC-1305). Source code and documentation are available as freeware in the internet under the following address:

<http://www.eecis.udel.edu/~ntp/index.html>

Binary files for the IBM operating system AIX are available on the following internet page:

<http://www.hopf.com>

NTP supports the **hopf** standard protocol as described under pt.. "**Datentelegramm (data string) 6870/6021**". The following settings in the clock are required:

transmission parameter:	9600 baud 8 databit parity no 1 stop bit
transmission mode:	data string 6870/6021 UTC as time basis with second advance with control characters (STX...ETX) LF..CR with ETX on the second change (On Time Marker) output time and date transmission every second

6.12 Data String NGTS-String

The NGTS string can be transmitted with all modes (e.g.. **forerun** or **"last control character on the second change"**).

In the standard mode this string is transmitted every minute in the 59th second with the data of the next minute change. A minute pulse must be used for the precise synchronisation in the connected computer.

The pulse width is 10 msec. The falling roll-off is synchronized on the second mark. The output is carried out at the second serial interface. The pulse will be turned on with bit 3 in the system byte. As interface variant, version 6 is necessary.

<u>character no.:</u>	<u>meaning</u>	<u>value (value range)</u>	
1	"T" ASCII T	\$54	
3	tens year	\$30-39	
4	unit year	\$30-39	
6	tens month	\$30-31	
7	unit month	\$30-39	
9	tens day	\$30-33	
10	unit day	\$30-39	
13	unit day of the week	\$31-37	
15	tens hours	\$30-32	
16	unit hours	\$30-39	
18	tens minutes	\$30-35	
19	unit minutes	\$30-39	
22	status (0⇒local, 1⇒UTC)	\$30-31	
23	CR (carriage return)	\$0D	; see 6.1
24	LF (line feed)	\$0A	; see 6.1

6.12.1 example of a transmitted data string NGTS

T960103312340(CR)(LF)

It is Wednesday 03.01.96 - 12:34 h

6.13 Master/Slave-String

The master/slave string serves to synchronise slave systems with the time data of the master system up to an accuracy of $\pm 0.5\text{msec}$. The difference to the DCF-slave string is that the difference time to UTC is included.

The difference time is transmitted in hours and minutes after the year. The transmission is done in BCD. The difference time may be up to $\pm 11.59\text{ h}$.

The sign is shown as the highest bit in the hours.

logic "1" = local time before UTC

logic "0" = local time after UTC

The complete data string is structured as follows:

character no.:	meaning	value (value range)	
1	STX (start of text)	\$02	
2	Status	\$30-39, \$41-46	; see 6.13.1
3	day of the week	\$31-37	; see 6.13.1
4	tens hour	\$30-32	
5	unit hour	\$30-39	
6	tens minute	\$30-35	
7	unit minute	\$30-39	
8	tens second	\$30-36	
9	unit second	\$30-39	
10	tens day	\$30-33	
11	unit day	\$30-39	
12	tens month	\$30-31	
13	unit month	\$30-39	
14	tens year	\$30-39	
15	unit year	\$30-39	
16	tens diff.-time + sign. h.	\$30,\$31,\$38,\$39	
17	unit diff.-time hours	\$30-39	
18	tens diff. time minutes	\$30-35	
19	unit diff. time minutes	\$30-39	
20	LF (line feed)	\$0A	; see 6.1
21	CR (carriage return)	\$0D	; see 6.1
22	ETX (end of text)	\$03	

6.13.1 Status in the Data String Master-Slave

	b3	b2	b1	b0	meaning
status nibble:	x	x	x	0	no announcement hour
	x	x	x	1	announcement (ST-WT-ST)
	x	x	0	x	standard time (WT)
	x	x	1	x	daylight saving time (ST)
	x	0	x	x	no announcement of leap second
	x	1	x	x	announcement of leap second
	0	x	x	x	crystal operation
	1	x	x	x	radio operation
day of the week nibble:	0	0	0	1	Monday
	0	0	1	0	Tuesday
	0	0	1	1	Wednesday
	0	1	0	0	Thursday
	0	1	0	1	Friday
	0	1	1	0	Saturday
	0	1	1	1	Sunday

6.13.2 Example of Transmitted Data String Master/Slave

(STX)831234560301968230(LF)(CR)(ETX)

radio operation, no announcement, standard time

It is Wednesday 03.01.96 - 12:34:56 h

The difference time to UTC is + 2.30 h.

6.13.3 Setting

The following setting is required for the synchronisation of **hopf** slave systems:

- output every minute
- output second advance
- output with control characters
- ETX on the second change
- 9600 baud, 8 bit, 1 stop bit, no parity
- LF, CR

This setting guarantees the best control of the time basis in the slave systems of more than ± 1 msec and the adjustment of the crystal for the free running operation to ± 1 ppm.

6.14 SPT-String

The SPT-string is a data string which is transmitted every minute. The time of the transmission is selected so that the middle of the first stop bit of the synchronisation signal falls exactly on the 2nd second of every minute.

The data string must be transmitted with the following parameter.

- baud rate : 1200
- data bit : 8
- parity : even
- stop bit : 2

structure of data string.

Only binary values are transmitted

<u>character no.:</u>	<u>meaning</u>	<u>value (value range)</u>
1	header	\$FF
2	header	\$01
3	status	\$08-17
4	start	\$02
5	day of the week	\$01-07
6	day	\$01-31
7	month	\$01-12
8	year	\$00-99
9	hour	\$00-23
10	minute	\$00-59
11	second	\$02
12	end	\$03
13	synchronisation character	\$16

The bits have the following meaning in the transmitted status:

Bit 0	Leap Second
0	no leap second
1	leap second inserted

Bit 1	Reception time
0	reception not disturbed for more than 8h
1	reception disturbed for more than 8h

Bit 2	Reception
0	reception
1	reception disturbed

Bit 4	Bit 3	Time
0	0	UTC-time
0	1	standard time
1	0	daylight saving time
1	1	invalid

Bit 5	bank holiday (not used at present)
0	
1	

Bit 6	not used
0	
1	

Bit 7	not used
0	
1	

7 Serial Interface and Screw Terminals

7.1 Pin Allocation of the 9-pole SUB-D Connector

The allocation of the interface is available in 5 different versions. The type of interface is identifies on the name plate under pt. "interface ver."

The serial interface signals are put out via a potential separation to the 9-pole SUB-D connector.

7.1.1 Version 1 - RS232 and RS422 (Standard)

9-pole SUB-D connector pin no.	Name of signal			
1	GND			
2	RxD	(receive data)	RS232	COM 0
3	TxD	(transmit data)	RS232	COM 0
4	GND			
5	GND			
6	+TxD ¹	(transmit data)	RS422	COM 1
7	-TxD ²	(transmit data)	RS422	COM 1
8	+RxD ¹	(receive data)	RS422	COM 1
9	-RxD ²	(receive data)	RS422	COM 1

7.1.2 Version 2 - RS232 / RS232

9-pole SUB-D connector pin no.	Name of signal			
1	GND			
2	RxD	(receive data)	RS232	COM 0
3	TxD	(transmit data)	RS232	COM 0
4	GND			
5	GND			
6	TxD	(transmit data)	RS232	COM 1
7	GND			
8	RxD	(receive data)	RS232	COM 1
9	GND			

7.1.3 Version 3 - RS232 / TTY

9-pole SUB-D connector pin no.	Name of signal			
1	GND			
2	RxD	(receive data)	RS232	COM 0
3	TxD	(transmit data)	RS232	COM 0
4	GND			
5	GND			
6	TTY out +			COM 1
7	TTY out -			COM 1
8	TTY in +			COM 1
9	TTY in -			COM 1

¹ high active

² low active

7.1.4 Version 4 - RS232 / pulse (PPS / DCF77)

9-pole SUB-D connector pin no.	Name of signal	
1	GND	
2	RxD (receive data) RS232	COM 0
3	TxD (transmit data) RS232	COM 0
4		
5	GND	
6	PPS pulse or DCF77 pulse (s. 4.2.9 System Byte settings bit 1)	
7	/PPS pulse or /DCF77 pulse (s. 4.2.9 System Byte settings bit 1)	
8		
9		

7.1.5 Version 5 - IRIG-B with RS232 and RS422

9-pole SUB-D connector pin no.	Name of signal	
1	GND	
2	RxD (receive data) RS232	COM 0
3	TxD (transmit data) RS232	COM 0
4	IRIG-B pulse	
5	GND	
6	+TxD ¹ (transmit data) RS422	COM 1
7	-TxD ² (transmit data) RS422	COM 1
8	+RxD ¹ (receive data) RS422	COM 1
9	-RxD ² (receive data) RS422	COM 1

7.1.6 Version 6 - RS232 and NGTS-pulse

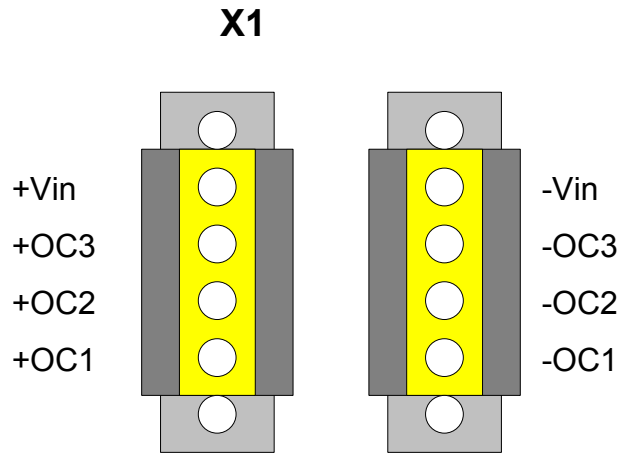
9-pole SUB-D connector pin no.	Name of signal	
1	GND	
2	RxD (receive data) RS232	COM 0
3	TxD (transmit data) RS232	COM 0
4		
5		
6	NGTS-pulse (s. 4.2.9 bit 3, 5.3, 5.3.6)	
7		
8		
9		

Please Note: THE VERSIONS 7-10 ARE NOT AVAILABLE AT PRESENT.

¹ high active

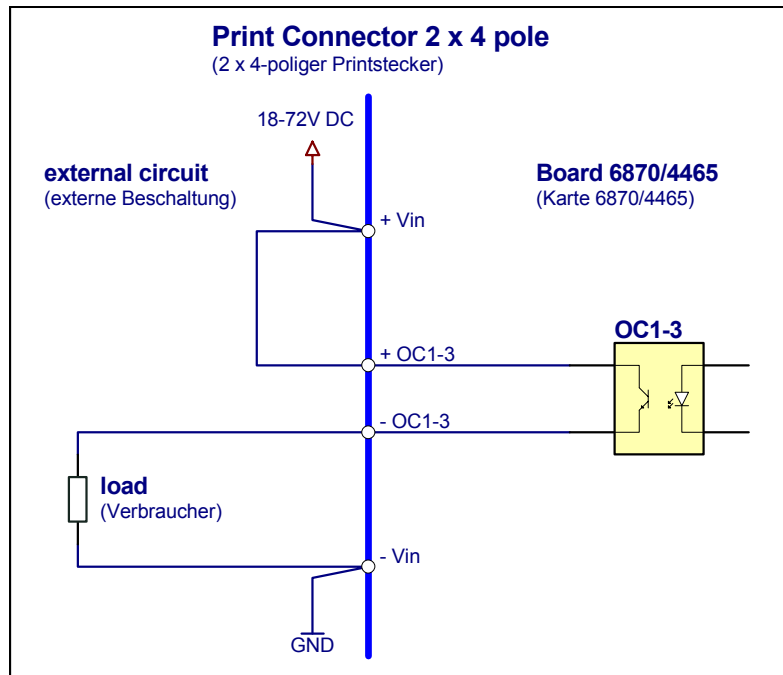
² low active

7.2 Allocation of the Screw Terminals

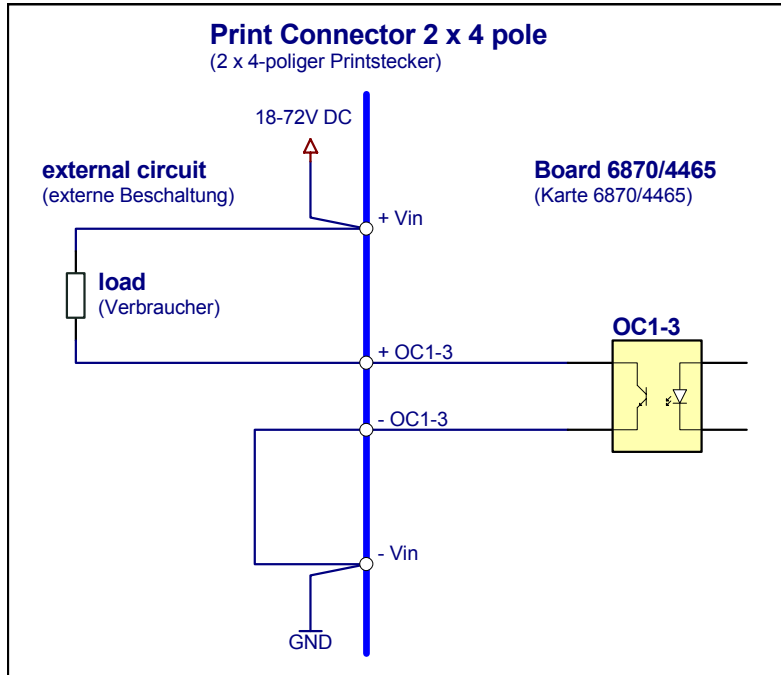


7.2.1 Examples for assignment

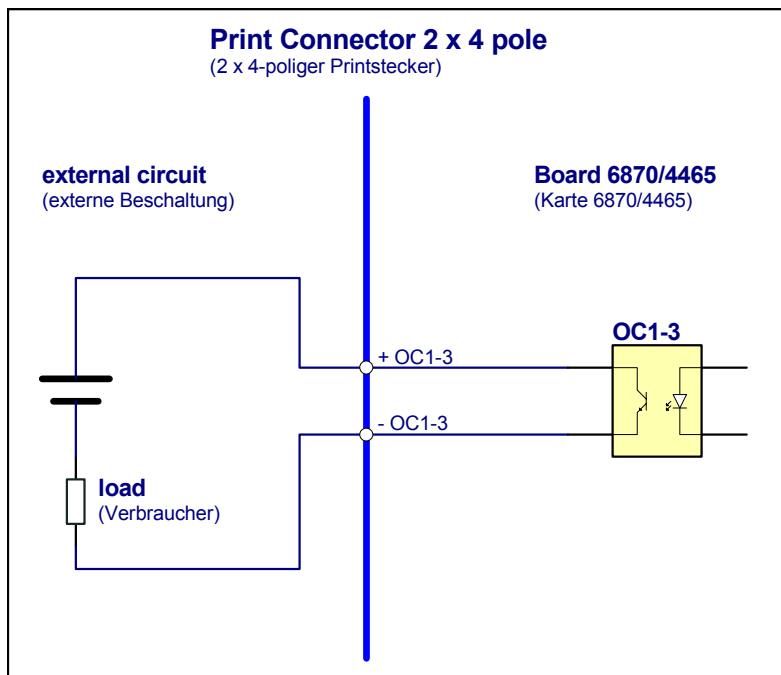
Active, positive pulse



Active, negative pulse



Passive, positive pulse



8 Technical Data Base System

operating voltage:	18 - 60V DC
consumption:	6 VA
crystal accuracy:	± 0.1 ppm after GPS-control and constant temperature
back-up clock accuracy:	± 25 ppm at 25° C
maintenance free back-up clock buffering:	3 days
MTBF:	appr. 150,000 h

DCF77 simulated output / optional IRIG-B

signal voltage at DCF77:	3 mV _{pp} at 50 Ohm
signal voltage at IRIG-B (interface version 5):	2.8 V _{pp} at 50 Ohm

Optical coupler

switching capacity, load ohm:	60V DC, 200 mA
switch on / off delay:	100 / 150 msec. at 20 mA
signal delay at I = 20 mA, 1m length of cable, 90% / 10% Signal amplitude	

8.1 Technical Data GPS-Receiver

type of receiver:	8 channel phase -tracking-receiver
decoding:	L1 frequency 1.575,42 MHz, C/A-Code
sensitivity:	- 143 dB
synchronisation time:	cold start: 30 min - 4 h (first installation without position statement) warm start: ca. 1 min. (voltage failure < 3 days)
accuracy of internal PPS-pulse:	± 300 nsec.
temperature range :	0 ... 60° C

tailor-made products:

Hard-and software alterations according to customer specifications and standards are available.

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