

Technical Description

PC satellite clock
6039 GPS



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 and possible consequential damage expire.

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** 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 In general

1.1.1 Brief Description Model 6039 GPS

The board is synchronised by the satellite navigation system GPS and therefore achieves an internal accuracy of $< 1 \mu\text{sec}$.

1.1.1.1 Communication Channels

- 32-Bit-PCI-Bus interface for computer communication
- RS232 interface to synchronise external computers
- 3 freely programmable pulse outputs
- IRIG-B output (option)

1.1.1.2 Features

- potential free antenna circuit
- no cable loss due to inserted indirect lightning protection
- for antenna cable up to 150m use **hopf** special cable and looping in an amplifier (without own voltage supply) into the antenna cable
- back-up clock with maintenance free memory
- GPS reception analysis
- synchronisation with one or several satellites possible

1.1.1.3 Supplied Software

- service programme for setting all parameter in the clock board
- Windows NT/2000 driver
- Windows 95/98 driver
- SYNCUPDT.EXE: Service programme for setting parameters in SYNCPROC.EXE
- SYNCPROC.EXE: Synchronisation programme for Windows 95/98

1.1.1.4 Available Options

- NTP (Network Time Protocol)
- Linux driver (under construction)

1.1.1.5 Function of the GPS Transmitter

The board is synchronised by the satellite navigation system GPS. At a height of about 20.000 km satellites circle on different orbits and angles around the earth twice a day (see picture in the appendix). There is an extremely precise atom clock (precision at least 1×10^{-12}) on board of every satellite. Orbit position and a GPS world time of as many satellites as possible is received by the GPS reception unit. First the position of the receiver is calculated from these values. Once the position is known the running time of the received GPS world time can be deducted from it. The accuracy of the time therefore mainly depends on the accuracy of the calculation of the position.

The world time UTC is calculated from the GPS world time (GPS-UTC) by subtracting the leap second. The difference is not constant because leap seconds are inserted. The key-pad of the system can be used to enter the difference time to UTC time for any place on earth and also the local points of changeover for summer/ daylight saving time. Therefore the highly precise local time is available for further use. A DCF77 simulation is integrated in the local or UTC time, so that all **hopf** DCF77-radio controlled clocks with DCF77 pulse input can be synchronised from there.

2 Hardware installation

2.1.1 Installation of the Radio Controlled Clock

Before the radio controlled clock is installed the computer and all connected devices must be switched off. If the computer is an ATX pc the power switch of the power supply must be turned to off! After opening the housing of the computer the clock is pushed into a free extension slot (32-Bit-PCI Slot). It is ready for operation once the antenna is connected.

When pushing in the board please make sure that it does not touch another board in the PC after installation.

After the start the PCI-BIOS of the computer automatically gives a memory address to the radio controlled clock. An interrupt line is not required. The user does not have to carry out further settings because the supplied programmes automatically recognise the set address.

2.1.1.1 Installation of the antenna

The antenna should have the best possible free view to the whole horizon to guarantee a constant GPS reception. The antenna is sized so that it covers all satellites from 10° above the horizon. View to 4 satellites is required for the calculation of position and time in 3D reception mode. In position fixed mode there is only one satellite required. If the view to the sky is partially blocked by buildings, the GPS receiver cannot decode the precise time. It will wait for 4 satellites to move into sight. Under unfavourable constellation of the satellites this may take up to 4 hours. The antenna should therefore be placed on the highest roof position.

The supplied coaxial cable connects the antenna with the base unit. In the antenna disc a coaxial coupling connects the cable to the antenna. This coupling can be opened to lay the cable. To do so the allen-screw at the antenna disc must be released and the antenna lifted.

Do not run the cable near other HF-, control- or power cables. The leakage from these cables could, because of the extremely low reception power, interfere with the GPS reception (see GPS appendix for further information).

At the computer the cable is connected to the lower BNC connector of the clock module. The standard cable is up to 25m long (**hopf** special cable up to 70m). The GPS line amplifier must be cascaded into the antenna cable for lengths up to 150m.

Laying the antenna cable requires utmost care.

Reception frequencies

The satellites broadcast two frequencies:

- L1 at 1.575,42 MHz
- L2 at 1.227,60 MHz

The frequency L1 is released for civil purposes.

The received power is about -160dB. The antenna contains a pre-amplifier, which boosts the received satellite frequencies by +20dB. Hopf antennas are active antennas. The voltage is supplied by the board 6039.

Indirect Lightning Protection

We advise using an indirect lightning protection to avoid overvoltages caused by lightning.

- FG4495G0 indirect lightning protection

Coaxial Cable Installation

The supplied coaxial cable connects the antenna to the clock.

Do not lay the antenna cable next to other HF-, control or power cables.

The following guidelines must be strictly observed:

- the bend radius of the coaxial cable must never be less than 10cm
- the sheath of the cable must not be damaged in any way
- the cable must not be crimped

3 Software installation

3.1.1 Windows 95/98 Drivers

Windows 95 Service Release 1, 2 and 2.5, Windows 98

After inserting the board into the computer and starting Windows a new PCI device has been found for which drivers are needed.

Hardware

The needed driver can be found on the CD (6039 driver disk) in the directory "**PRODUCTS\6039\DRIVER_9X**". There you must install the INF-file to integrate the board into the system. You can cancel the following dialogue to restart the system because you also have to install the software.

The installation can be checked in the system control under device manager. There must be an entry **hclk6039** with the sub-directory **hopf Elektronik Clock Device**.

Two memories should be listed under resources. The clock does not need IRQ-, DMA-line or I/O-Port addresses.

Software

To install the software the file SETUP6039.EXE must be executed. After starting the program you can first choose the installation language and then the type of model.

This only effects the installed documentation. The program itself recognizes the type of model.

Please follow the installation instructions. Normally, the service software "hopf6039" will be installed in the directory "programs" onto the hard-disk of the pc. Hereunder the directory "hopf PCI board 6039 GPS" with the particular sub-directories will be created.

The system must be restarted at the end of installation in order to take effect on all changes.

You have access to all necessary programs and documentation by selecting "run/programs/hopf PCI board 6039 GPS".

The clock is now ready for operation and can be set and checked by means of the service program **HOPF6039.EXE**. For automatic synchronisation of the pc the program **SYNCPROG.EXE** has been added to the autostart group. This program can be configured by the **SYNCUPD.EXE**.

3.1.2 Windows NT/2000 Drivers

Windows NT from version 3.51, 4.0 with Service Release 1-6:

The new board won't be automatically recognized under Windows NT. The perfect operation of the board is guaranteed by the correct installation of the software.

You can check the correct installation by finding the following entry in the registry:

HKEY_LOCAL_MACHINE/SYSTEM/CurrentControlSet/Services/hclk6039

Once the clock board is installed successfully the following entry is written in the list of devices of the system control:

"hopf radio clock hardware started".

Windows 2000:

After the board has been plugged into the PC and starting Windows, the system finds a new PCI-Device and asks for the appropriate drivers.

Hardware

The driver for the new board is on the CD (6039 driver disk) in the directory **"PRODUCTS\6039\DRIVER_9X"**. There the INF-file has to be selected so that the board can be integrated into the system. The subsequent demand to restart the system can be ignored due to the fact that the software for the board has not been installed yet.

The installation can be checked in the device manager, in which an entry **Time Synchronization Devices GPS/DCF77** with the sub-directory **ATLSOFT Driver for hopf 6039 PCIClock** must exist.

Software

The installation of the software is realized analog to Windows 95/98. Under Windows NT/2000 the service **"hopfserv"** is installed additionally.

Once the installation is finished, the system must be restarted in order to guarantee the acceptance of all amendments.

The clock is ready for operation and can be set and checked by the service program **HOPF6039.EXE**. The computer is synchronised by the service **HOPFSERV.EXE**.

3.1.3 Uninstalling the Software

The software can be uninstalled via the point software under system control. Alternatively you can execute the **UNWISE.EXE** from the installation directory.

4 Service Programm

4.1.1 Administration of the Clock Board

The program **HOPF6039.EXE** serves to set up and control the clock board. You can carry out the following tasks:

- setting time and date
- monitor the reception of satellites, setting reception modes
- setting the time zones
- entering position data
- programming the changeover process for daylight saving time
- programming the pulse outputs
- setting the IRIG-B outputs
- setting the RS232 outputs
- DCF77 simulation and sync.-bit
- version, system byte
- reset

The respective data can be set and controlled in all the following fields of the service software.

The displayed values correspond with the current settings of the board 6039.

When different values have been entered the send-key must always be pressed to transfer the data to the clock.

The new values are taken over partly after the next minute change.

When the settings on the board have been altered a reset must be carried out after the next minute change.

4.1.2 Setting time and date

The dialogue "Select new Time and Date" is used to enter the local time information. The calculation of UTC depends on the entered difference time. A possibly approaching daylight saving time is indicated on the next minute change. The date is marked by clicking at the respective data in the calendar and transferred - together with the set time information - to the clock after using the send-key.

A fly-out menu for selecting the month appears by clicking the left mouse button onto the month field. The year can be selected by clicking the left mouse button onto the year field. By clicking the right mouse button onto the calendar field the actual date can be entered.

On the next minute change the entered data are taken over into the back-up clock. They are read from there after every reset or voltage failure. When the voltage failure takes more than 3 days the values of the back-up clock are ignored.

4.1.2.1 Radio clock information

The internal time information (Local and UTC) is shown here.

Local time = UTC + (difference with the correct sign) + possibly daylight saving time offset.

4.1.2.2 Display system Status Byte

radio	crystal	synchronisation bits
off	off	time invalid
off	on	clock in crystal operation
on	off	radio controlled operation basic accuracy
on	on	radio controlled operation high accuracy
announce		announcement bit leap second
standard		standard time active
daylight		daylight saving time active
announce		announcement bit daylight saving time / standard time
n.a.		not used at present
done		changeover done (internal only)

4.1.3 Setting reception mode

The clock can operate in two different reception modes. In this dialogue you have the choice of **Position 3D** or **Position Fixed**. Select either mode and use the field **[send to clock]**.

The accuracy of the time decoding depends on the exact calculation of the position of the location. This calculation requires the reception of at least 4 satellites for the 3D-decoding. Based on the calculated position the signal travel times to several satellites are determined and the exact second marker is produced from the average travel time. In the 3D-decoding mode the second marker has an accuracy of $\pm 1 \mu\text{sec}$.

In many cases a worse decoding of the second marker e.g. up to some milliseconds suffices for a fixed installation. In the position-fix-mode the accuracy depends mainly on the precise entry of the position of the location. The second marker is then calculated by means of no more than one satellite plus the entered position. When the position is entered down to ± 1 minute degree the accuracy of the second marker is better than $\pm 20 \mu\text{sec}$. If the entry is even more accurate a value of $\pm 1 \mu\text{sec}$ can be reached.

The position-fix mode is favourable because the clock synchronises with only one received satellite. The antenna can be placed where less than $\frac{1}{4}$ of the sky is visible.

In many cases the antenna can be fixed indoors next to the window (short cable, no lightning protection). If 4 satellites can be received in this mode, the decoding switches automatically over to the 3D-mode and calculates the exact position, thus increasing the accuracy to $\pm 1 \mu\text{sec}$ for one satellite.

This dialogue also informs you about the number of "visible" satellites and the quality of the received signal. The satellites are not numbered 1, 2, 3, etc. but they are given a pseudo-random number under which the satellite broadcasts its information. In case of a satellite failure a substitute satellite can be activated under the same number.

After the first installation it may take up to 4 hours for satellite data to be at hand. This depends on the initial information given to the system (see programming time and position) and on the position of the antenna e.g. only half of the sky is visible.

- in case of a bad signal/noise ration the values are in the grey area
- in case of a sufficient signal/noise ration the values are in the green area
- in case of a good signal/noise ration the values are in the blue area

The field "visible" shows the number of satellites which can be received from the current position at the current time. If the field "visible" shows "0" it means that the initial reception process needs some time (up to 4 hours) to make a "visible" entry by correlating the reception data.

If there is an entry the reception of satellites is established after some minutes under the condition that the position data and date/time information are correct.

The "visible" entry remains for up to 3 days after a voltage failure.

4.1.4 Timezone (Set Difference Time UTC/local)

The clock can operate in various time zones. The local time is found by means of the offset stated in this dialogue (see also system byte).

The difference to **UTC** (Universal Time Co-ordinated) is entered in hours and minutes. The entry **[east]** or **[west]** determines the direction of the time offset.

Example:

Moscow **Local Time** differs by 02.00h east

Lissabon **Local Time** differs by 00.00h west

The difference between **UTC** and **Local Time** remains constant. When the daylight saving time is activated the clock adds one hour offset to the **Local Time**.

When the entry is completed the UTC time is calculated anew by finding the difference to the entered local time. As the clock status is set to naught, you must enter time and date again after the difference time is set, or wait for a new synchronisation of the clock.

The top half of the window shows the current settings of the computer and also the set time-zone.

4.1.5 Daylight Saving Time

For setting these values activate the field "Automatically set Daylight Saving Time".

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.

When the values are entered the "Send to Clock" key must be used.

The exact date of the changeover is calculated from the entered values on the next minute change.

These values are automatically calculated for the following years and shown in the field "change over date".

If a changeover is not wanted deactivate the field "Automatically set Daylight Saving Time".

4.1.6 Position (Setting of Position Data)

The geographical position is entered by this function, which is helpful for starting operation the first time, although not necessary. It shortens the re-initialisation of the GPS receiver.

The GPS receiver requires for a quicker synchronisation just the approximate position. Position of latitude and longitude are entered in degrees, minutes and seconds. The data are transferred to the clock by the switch [send to clock] and taken over by the next minute change.

The position saved in the board is shown in the field "actual Position". The fail-safe storage of the position data always takes place at the hour.

The input for the longitude and latitude is made in degrees and minutes. The specification "degree" must respectively done with a sign:

Latitude:	+ for northern hemisphere	Longitude:	+ for eastern from 0°
	- for southern hemisphere		- for western from 0°

4.1.7 Parametering interface RS232

The clock is equipped with a serial interface RS232c (V.24). The interface can be used to transmit time data strings to other computers.

The received time information can be put out via interfaces in various data strings which include the internal status of the clock. This enables the user to synchronise connected computer systems with the atom precise time. The required outputs, the time information and the control characters and the data strings can be selected by means of this dialogue.

This menu offers the possibility to view and alter the configuration of the serial interface and of the **data string**.

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

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

After the entry the **[send to clock]** key must be used, which transfers the new parameter into the clock. When the parameter have successfully been transferred the data with the current setting appear in the dialogue field after some seconds.

Now the setting is completed.

At present the filed "Serial out 2" is without any function.

4.1.8 Pulse Outputs

The clock module has three pulse outputs and optional one IRIG-B output (see pin connections in the appendix).

The pulse outputs are freely programmable.

Functions of the pulse outputs:

- DCF77- simulation
- DCF77- simulation inverted

The local time information is put out in a data string as DCF77 simulation at the respective pulse output. This setting is used to synchronise other radio controlled clocks with 1 Hz pulse input like e.g. **hopf** 6036, 4980. The signal can also be put out invertedly. The settings for time information and cycle time have been deactivated.

- Cyclic pulses within 24 hours
- Cyclic pulses within 24 hours inverted

In this mode cyclic pulses with adjustable pulse width are produced at the output. The following pulse sequences 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 entries for day, month and year are switched off. The pulse duration can be selected in steps of 10 msec between 10-2550 msec. The pulse duration should not exceed the cycle time, because the outputs would be permanently switched active. The signal output can be inverted.

- Pulse per day or date (mode pulse one shot)
- Pulse per day or date inverted (mode pulse one shot inverted)

This mode produces either one pulse per day or one switching depending on the date at the output. The point of time for the output of the pulse is set in the fields (hour, minute, second). If "00" is selected for day and month the output is switched active at the set time every day. Otherwise it is switched through on the set date only.

The pulse duration can be set between 10 and 2550 msec in steps of 10 msec. The signal output can be inverted.

The synchronisation status can also be checked by the LED on the front panel (when the LED flashes in a cycle of 2Hz it means that the clock is in operation. If the LED flashes every second it means that the clock is in radio controlled operation).

- System information

The board is in service when the output is switched to ground. When the board is turned off the output is high-impedance.

- Synchronisation information

The radio bit is set when this output is switched to ground. In case of a reception failure or end of time out the output is high-impedance.

4.1.9 IRIG-B Output (optional)

An **IRIG-B** signal is put out at the top BNC-connector (Inter-Range Instrumentation Group standard time distribution signal **B**).

This signal, widely used in USA, is used to synchronise audio or video devices. But also some computer systems like **SUN SPARCstation** have **IRIG-B** inputs. The carrier frequency is 1 kHz. The amplitude is fixed to $2 V_{SS}$ at 600 Ohm. The keying ratio of the carrier dip is 1:3. The minimum connection resistance must not drop below 50 Ohm. At 50 Ohm the amplitude drops to approx. $1.8 V_{SS}$.

The switches "**UTC**" and "**local time**" are used to select the time basis for the IRIG-B output.

binary seconds = off (not implemented at present)

Afnor-Code (not implemented at present)

4.1.10 DCF77 Pulse / Sync.-Bit

The output of the DCF77 simulation and of the radio bit are configured under this menu item.

The transmitter DCF77 broadcasts a data string which transmits the time information at the rate of 1 bit per second. The 100 or 200 msec long pulses (lowering of the amplitude) code the digital information (0/1). The narrow-band antennas of some radio controlled clocks distort the duration of the lowering and the receiver connected on load side is therefore adjusted to different pulse lengths.

This dialogue can be used to adjust the width of the low- and high pulses for the DCF77 simulation.

When "**DCF77 time out after [minutes]**" is set the output of the DCF77 simulation change into crystal operation can be switched off after the set time (2-254 minutes).

i.e. even when the radio reception is disturbed the DCF77-simulation is put out for the length of the set period. Therefore it is possible to continue operating connected devices during short failures.

If the value is 255 the simulation is not switched off (continuous simulation). This setting has an effect on a possibly set DCF77 simulation to the optical coupler and on the status LED in the front panel.

It is possible to delay the transfer of the information "**radio**" (change from radio to crystal operation) by about 2-254 minutes by means of the scroller in the group "**Sync-Bit Time Out after [minutes]**". If 255 minutes are selected the information "**radio**" is constantly passed on. This mechanism effects the transmission of the synchronisation status in the putout data strings of the serial interface and effects also possibly set radio bit (sync. information) at the optical couplers.

4.1.11 Version, System Byte

This dialogue shows the settings of the system byte and the software version of the clock board.

This system byte serves to switch individual programmes / customized solutions. In the standard version of the GPS system these switches are not used at present.

4.1.12 Reset

This function is used to release a reset of the clock. When settings are changed and entered a reset must be carried out after the next minute change.

5 PC synchronisation

5.1.1 Synchronisation under Windows 95/98

The computer is synchronised after "**SYNCPROG.EXE**" is started in pre-set intervals of 60 seconds. After the program start a green clock symbol appears in the status line in the bottom left corner next to the system time. A double click on this symbol displays the status window of "**SYNCPROG.EXE**". Here you will see the conditions under which your computer is synchronised:

- Date/time: current time of the clock board for the synchronisation with the computer.
- Difference time: relative measure for the time error of a real-time application under Windows 95/98, and it should not exceed about ± 20 msec when the cycle time is 60 seconds. Windows 95/98 has no means to adjust the internal time, we therefore advise using the operating system Windows NT with the according clock drivers for time critical applications.
- Status information in hex is the hexadecimal clock status. You will find a more detailed description in the manual of your clock board.
- Announcement daylight saving time and leap second is the announcement of the clock board of a timezone changeover or the insertion of a leap second. The program uses this mechanism to synchronise the system instantly in case of a changeover.

You will find a menu from where you can stop the synchronisation process or fade out the status window by clicking at the clock symbol with the right mouse button or under "**adjustments**" in the menu bar of the status window.

After a restart of the program the computer is set once. It is not synchronised unless the built-in clock boards indicates at least a valid crystal time.

The accuracy of the synchronisation depends on the selected cycle time and on the operating system - under Windows 95/98 systems about ± 55 msec and under Windows NT ± 1 msec.

The radio controlled clock is synchronised with the local time. The following information are read from the clock and passed on to the operating system:

- local time
- offset UTC/local
- daylight saving time active

Important: The entry "**changeover clock automatically from daylight saving to standard time**" under timezone in the dialogue "set time" must be deactivated. These settings are taken over by **SYNCPROG.EXE**.

5.1.1.1 Changing the Setting of SYNCPROG.EXE

When first started, the synchronisation program "**SYNCPROG.EXE**" is initialised automatically with the standard values:

- synchronisation every 60 seconds
- synchronisation also in crystal operation
- program not started by Windows

Use the command **Set-up SyncProg** to alter the setting according to your requirements:

- **enable autostart** - when this option is active "**SYNCPROG.EXE**" starts automatically whenever Windows is started.
- **synchronize if radio** - when this option is active, synchronisation is done in radio operation only
- **synchronisation cycle time** - in this field you can determine the synchronisation intervals in the format STD:MIN:SEC

The checkbox "**synchronisation active**" shows if SyncProg is presently active.

5.1.2 Synchronisation under Windows NT/2000

HOPFSERV.EXE is a Windows NT and Windows 2000 Service to set the system time by means of a hopf radio controlled clock 6039. The program uses the SystemAdjust-Counter (mechanism to speed up the clock of the computer in steps of 100 nsec) for synchronisation, which avoids a hard setting of the clock time and the continuity of the internal time scale remains (important for applications which work with time stamps like e.g. SQL data base).

5.1.2.1 Configuration/settings

The service is configured by means of the file **HOPFSERV.INI**. The file can be edited by any ASCII Editor and it offers the following settings:

Synchronisation in crystal operation

- **StatusQ = TRUE** System is also synchronised in the crystal operation of the clock board
- **StatusQ = FALSE** System is not synchronised in the crystal operation of the clock board

Status messages in the event-logfile

- **Report = TRUE** messages are put out
- **Report = FALSE** no output

The following messages are always put out:

clock sync.-service start normal! start message

The following messages are put out only if (Report = TRUE):

"clock sync.-service running with crystal time greater x Min." clock has not had any reception for x minutes "settime: Date xx.xx.xxxx Time: xx:xx.xxx Sta:xx" system was synchronised hard with stated time, this message should appear only after the service is started.

The entries can be viewed by means of the Evenlog Viewer.

message of reception failure

- AlarmTime = x (at least. 1 minute, up to 65535 minutes)
- If no value is entered here message is given after 30 minutes

HOPFSERV.EXE must be updated after every alteration. Please start the batch file **HOPFSERVSTOP.BAT** to delete the service. Afterwards reinstall the service with the batch file **HOPFSERVSTART.BAT**. These batch files enable you to uninstall and to install **HOPFSERV.EXE** only. You can check the correct installation by noting the entry **HOPFSERV** in the registry under **HKEY_LOCAL_MACHINE/SYSTEM/CurrentControlSet/Services**.

After this process either the service must be activated again in the system control or the computer must be rebooted.

5.1.2.2 Synchronisation

The local time of the radio controlled clock is used for the synchronisation. The following information are taken from the clock and transferred to the operating system.

- UTC
- offset UTC/local
- daylight saving time active

IMPORTANT: In the dialogue "set time" of the computer the entry "**automatic changeover of clock to daylight saving/standard time**" under timezone must be activated. These settings are not done by **HOPFSERV.EXE**.

The clock system is synchronised by the clock board under the following circumstances:

- the clock must have a valid time
- The clock of the computer is set hard only after booting/synchronisation after that the system time is adjusted by way of SystemAdjustmentCounter in steps of 100 nsec (fuzzy control)

When the computer time is altered manually it may therefore take several minutes before the synchronisation process carries out another hard setting of the computer.

If the time is set under Windows NT 3.51 the time must be set down to the seconds.

6 RS232 interface

6.1.1 RS232 interface standard data string

Some data strings are supported as standard time data strings:

- hopf_6021
- hopf_6021 with year 2000
- Siemens SINEC H1
- T-String
- Master/Slave

Customised data strings are available on request.

At present only the data string "**hopf 6021**" is implemented.

Serial Request:

This function is not available at present.

6.1.2 Data String 6021 Time and Date

character no.	meaning
1	STX (Start of Text)
2	Status (internal status of the clock)
3	day of the week (1= Monday...7=Sunday) 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)
17	CR (Carriage Return)
18	ETX (End of Text)

6.1.3 Data String 6021 Time Only

character no.	meaning
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)
9	CR (Carriage Return)
10	ETX (End of Text)

6.1.3.1 Status and Day of the Week Nibble in the String 6021

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	standard time (WT)
	x	x	1	x	daylight saving time (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

6.1.3.2 Example of a Transmitted Data String 6021 (Standard)

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

- Radio operation (high accuracy)
- daylight saving time
- no announcement
- It is Wednesday 17.04.96 - 12:34:56 h
- () - ASCII-control characters e.g.(STX)

6.1.4 Data String 6021 String 2000

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

character no.:	meaning
1	STX (start of text)
2	Status (internal status of the clock)
3	day of the week (1=Monday ... 7=Sunday) 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)
19	CR (carriage return)
20	ETX (end of text)

6.1.4.1 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	standard time (WT)
	x	x	1	x	daylight saving time (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

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

6.1.5 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.

In this data string the transmission of the ASCII "?" releases an output.

character no.:	meaning	value (value range)
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
29	"*" or space	\$2A / \$20
30	"S" or space	\$53 / \$20
31	"!" or space	\$21 / \$20
32	ETX (end of text)	\$03

6.1.5.1 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	"*"	time from the internal crystal of the clock
	space	time from radio reception
character no.: 30	"S"	summertime
	space	wintertime
character no.: 31	"!"	announcement of a W/S or S/W changeover
	space	no announcement

6.1.5.2 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
- standard time
- It is Wednesday 03.01.96 - 12:34:56 h

6.1.6 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
24	LF (line feed)	\$0A

6.1.6.1 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

6.1.7 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

Example:

90.00 difference time + 10.00 h

01.30 difference time -01.30 h

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
3	day of the week	\$31-37
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
21	CR (carriage return)	\$0D
22	ETX (end of text)	\$03

6.1.7.1 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

6.1.7.2 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.

6.1.7.3 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.

7 Settings

7.1.1 Time Zone

The time basis is selected in the field "**Time Zone**". When "**local time**" is selected, the time information (UTC \pm difference time) including a possible summer time offset is put out. When "**UTC**" is selected the output data string is set to **UTC (universal time co-ordinated)**.

7.1.2 Transmission Point

The point of the output of the data string is selected in the group "**transmission point**". The following settings are possible:

- **every second** = on the second change
- **every minute** = on the minute change
- **every hour** = on the hour change
- **on request** = output on request only

7.1.3 Baudrate

In this dialogue field you can set-up the baud rate between 150 and 19200 baud.

7.1.4 Data Bit Length

In this dialogue field you have the choice of 7 or 8 data bits.

7.1.5 Stop Bit

In this dialogue field the number of stop bits are set.

7.1.6 Parity Bit

In this field you choose either even, odd or no parity bit.

7.1.7 Forerun

When the setting "yes" in the group "forerun" is activated the data string is put out with one second advance. This setting is favourable in particular in connection with the transmission "**as on time marker**", because at that time when this character arrives the present data string becomes valid. In that way you can exactly synchronise connected devices.

7.1.8 Control Character

Depending on the settings an **STX (0x02)** is added to the output data string at the beginning and an **ETX (0x03)** at the end. When the setting "**as on time marker**" has been activated the last character ETX is transmitted exactly on the edge of the next second change. If the setting "**as on time marker with delay**" is selected, the data string is sent with a delay depending on the baud rate. This procedure serves to calculate precisely the time in the computer which is to be synchronised.

Example:

In case of the setting **8 Bit, no Parity, 1 stop bit** the transmission of one character takes exactly 10 bit. At **9600 baud** a character takes about 1 msec for the transfer. The decoding computer must add this value as an offset to the latent time which is needed to react to the received time, to find its internal time.

Please note:

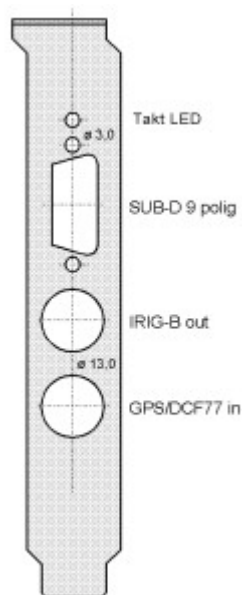
Some standard data strings do not contain ETX and STX. In these cases, if "as on time marker" is set, the last character is transmitted on the second change (e.g. T-String last character LF).

7.1.9 Control Character (CR/LF)

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

8 Front Panel

Front panel and pin-assignment of the 9-pole SUB-D connector



assignment SUB-D 9 pole

1	DCF77 pulse In
2	RS232 RxD
3	RS232 TxD
4	1 second
5	GND
6	1 kHz
7	pulse 1 (TTL)
8	pulse 2 (TTL)
9	pulse 3 (TTL)

9 Abbreviations

GPS	Global positioning system
DCF77	(D) German - (C) long wave signal - (F) Frankfurt a.M. - (77) frequency
UTC	Universal time co-ordinated
MEZ	central European time
GMT	Greenwich mean time
NTP	Network time protocol

10 Possible Errors

Error reception

After the installation even after several hours no satellite is displayed.

Possible causes

- the antenna has no sufficient "view" to the horizon
- the antenna cable has a defect
- the antenna cable is not connected
- the antenna is broken
- the lightning protection has a defect
- minimum distance line amplifier / antenna (2m) stayed below
- minimum distance power splitter / GPS-system (2m) stayed below
- minimum distance line amplifier / GPS-system stayed below (25m with standard cable, 70m with hopf special cable)

Error reception

7 satellites are within sight but no more than 2 are displayed.

Possible causes

- The view of the antenna to the horizon is too small

Error reception

9 satellites are within view, 6 are covered but the system does not synchronise, because the signal/noise ratios is in the grey area of the reception display.

Possible causes

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

Error reception

The system has worked perfectly so far. 7 satellites are within view - there is no reception, the system has not had any reception for several days.

Possible causes

- the cable is damaged
- lightning has struck or the lightning protection has a defect
- the antenna has a defect
- receiver has a defect
- voltage supply is interrupted

Error PCI-Bus

If the service programme gives the message: "**no clock board found**" despite the fact that the computer is equipped with it, or if some data points take false values please check the following:

- is the board placed correctly in the PCI-bus slot
- are the contacts of the board soiled

11 Technical Data

General

PC board for the PCI bus

Voltage supply for the board:

+ 5 V DC / 0.4 A \pm 5% via PCI bus

Temperature range:

0 - 50°C for the specified data

0 - 70°C with reduced free-running characteristics

MTBF:

appr. 150,000 h

Receiver (8 channel C / A code receiver)

Sensitivity:

-134 dBm lock-sensitivity

-143 dBm pull-out-sensitivity

Antenna cable length

- max. 25 m with standard cable RG59
- max. 70 m with special cable
- max. 100 m with standard cable RG59 and pre-amplifier
- max. 150 m with special cable and pre-amplifier

Voltage supply for the antenna:

5 V DC over the antenna cable

Accuracy

PPS pulse:

\pm 1 μ sec.

VCO control:

\pm 0.1 ppm after 0.5 hours of continuous GPS reception

Free-running properties:

\pm 0.1 ppm after VCO control at a constant temperature between + 10°C and + 50°C

Back-up clock:

\pm 25 ppm from +10°C to +50°C

Interfaces

- 1 serial interface RS232
- 1 Hz-DCF77 time in TTL pegel
- pulse output
- IRIG-B output: carrier 1kHz, 2 Vss at 50 ohm

Serial interface parameter RS232

Baud rates:

150 - 9,600 baud

Stopbit:

1 bit / 2 bit

Word length:

7 bit / 8 bit

Parity:

no, even or odd