Technical Description

Satellite Radio Clock

7001GPS

hopf Elektronik GmbH

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*** 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.

hopf Elektronik GmbH

Nottebohmstr. 41 58511 Lüdenscheid
Postfach 1847 58468 Lüdenscheid

Tel.: ++49 (0)2351 / 9386-86
Fax: ++49 (0)2351 / 9386-93

Internet: http://www.hopf.com
e-mail: info@hopf.com

CONTENTS Page

1 Brief Description System 7001 5
2 Introduction 7
2.1 GPS Extension 7
3 Set-up 8
3.1 Antenna Installation 8
3.1.1 Reception Process 8
3.2 Set-up of the Base-System 8
3.2.1 Display 8
4 Key-Pad 10
4.1 Design 10
4.2 Key Functions 10
4.2.1 Key-Entry / System Control 11
4.3 SET-Functions 12
4.3.1 Time / Date Entry 12
4.3.2 Time Difference 13
4.3.3 Time Zone Changeover 13
4.3.4 Position 15
4.3.5 Key-Word 16
4.3.6 Setting the System Byte 17
4.3.7 LAN board 18
4.3.8 Data Securing 18
4.4 Control of Entered Values 19
4.4.1 Satellite Display 19
4.4.2 Time Difference 21
4.4.3 Time Zone Changeover S ⇨ D 21
4.4.4 Time Zone Changeover D ⇨ S 21
4.4.5 Position 21
4.5 Ini-Functions 22
4.5.1 Crystal-Control Value 22
4.5.2 Serial Interface / Master-, Slave or Remote-Operation 22
4.5.3 Delay of the Status Change "No Radio" 23
4.5.4 Delay of the Status Change "Radio" 23
4.6 Choice of Special Functions 24
4.7 Summary Key Pad 24
4.7.1 Set Functions 25
4.7.2 Display Functions 26
4.8 Set-Up 26

CONTENTS Page

5 Service Interface of the Clock Board 7015 **27**
5.1 Interface Assignment SUB-D Connector 9-pole 27
5.2 Master/Slave-String 28
5.2.1 Status in the Data String Master/Slave 29
5.2.2 Example of a transmitted data string Master/Slave 29
5.2.3 Parameter of the Transmission 29
5.3 Remote Function of the Service Interface 30
5.3.1 The Status Byte and Data String Structure in the TIM Command 30
5.3.2 Setting the Time 33
5.3.3 Inquire Time 33
5.3.4 Setting the Points of Changeover 33
5.3.5 Inquire Points of Changeover 34
5.3.6 Time Difference Local - UTC 34
5.3.7 Position Data 35
5.3.8 GPS Reception Quality Data 36
5.3.9 Activate a Reset of the Clock System 36
6 Technical Data Base System **37**
6.1 Technical Data GPS Receiver 37

1 Brief Description System 7001

The ***hopf*** system 7001 is a multiprocessor system of modular design. Each master circuit board of this Euroboard system contains its own microprocessor; time critical tasks on the boards themselves are thus easy to execute. The modular concept allows an individual configuration of systems according to customers specifications. Furthermore, this concept ensures simplified servicing.

Board 7015

The ***hopf*** standard radio clock system 7001 can be equipped by a DCF77[1] or a GPS[2] reception unit 7015 GPS. The GPS system guarantees a time standard for a world-wide use at highest precision.

Board 7112 / 7121

By means of the optical coupler or relay board up to 24 bit can be put out potential free. 8 potential free entries are available for the output control. The optical coupler and relay boards are pin compatible.

- Board 7112 optical coupler board
- Board 7121 relay board.

Board 7201

The serial interface board 7201 sends a time data string either via a RS232c (V.24), RS422 (V.11) or a passive TTY interface. The transmission format and the output mode can be selected by DIP switches on the board.

Board 7210

This board receives the transmit data string TxD at TTL level from the 7201 or 7221 mains boards and multiplies it via 4 x RS232-, 4 x RS422- and 4 x active or passive TTY interface.

Board 7221

This serial interface contains a full duplex interface and 7 multiplied transmit data strings via RS232 and RS422 hardware.

Board 7245

This board contains a full-duplex interface and 4 multipliers for the transmission line TxD.

The interface hardware is designed for the RS232- and RS422-level. All the interfaces are set potential free to each other and to the lower logic. There are also 4 potential free minute-pulses available.

Board 7265

The board has 4 analogue dip switches with 4 inputs each. Those inputs supply the signals generated on the board itself as IRIG B 12x, IRIG B 00x and PPS pulse and an external input for the frequency boards 7530 and 7550.

The inputs are interconnected to the outputs via DIP switches. The output signals are provided at BNC female connectors.

Board 7270

On this board a 10BaseT ethernet-interface is located which can be used as time-server in local area networks. Different configurations can be adjusted by using the keypad. As well NTP as both SINEC-H1 can be used for the time protocol.

---

[1] DCF77 = (D) German - (C) longwave signal - (F) Frankfurt - (77) 77.5 kHz
[2] GPS = Global positioning system

Board 7317

This board contains 4 potential free antenna amplifiers.

Board 7405

This board contains all the units necessary for the output of two independent clock lines.

Board 7515

The circuit board 7515 is structured so that it can function at the bus of the clock system 7001 or as a separate clock in the large display 4980. The board contains an independent microprocessor system for the following tasks:

- calculation of the mains frequency
- serial interface to large displays or to superior computers
- bus interface
- calculation of the mains time
- calculation of the difference time in ms
- calculation of the difference frequency mains / GPS in mHz
- AD-converter for the power display in MW

2 Introduction

The since 1985 well proved ***hopf*** radio- crystal clock system 7000 and 7001 respectively has been extended by a GPS receiver unit.

This makes it possible to use this time basis world-wide with utmost precision.

In the standard system the time was synchronised by the local time code transmitters DCF77, MSF and WWVB which transmit the local or UTC-time[1] within the longwave range (60-90 kHz). The reception was limited to a distance of 2000 to 3000 km around transmitter.

A world-wide radio controlled use was not possible, and could only be guaranteed by oven-stabilised crystal oscillators.

2.1 GPS Extension

The GPS-reception unit makes a world-wide use of the system 7001 possible.

The time basis is synchronised by the globally installed satellite-navigation system GPS. At a height of approx. 20000 km satellites circle around the earth on different orbits and angles twice a day. On board each satellite there is a high precision atom clock (precision min. $1x10^{-12}$).

Orbit as well as GPS time is received from as many satellites as possible by the GPS-receiver unit.

From this information first the position of the receiver is calculated. Once the position is known the running time of the received GPS time can be deducted from a satellite. Therefore the precision of the time depends mainly on the quality of the position calculation.

The time UTC is calculated out of the GPS time by subtracting the leap second, at the moment (1992) the UTC-time is slower than the GPS-time by 7 seconds. The difference is not constant but changes with every insertion of leap seconds.

By means of the system's key-pad the difference to the UTC-time and the regional switch-over points for summer-/winter time can be entered for every place on earth. Thus a high precision local time is available for further use.

By integrating the GPS-receiver into the ***hopf*** system 7001 there are various well-proved communication possibilities available:

- parallel data output
- serial RS232 interfaces
- serial RS422 interfaces
- TTY interfaces
- IRIG-B code and carrier modulation

  etc.

Also a DCF77-simulation of the local time is integrated, so that all the ***hopf*** DCF77 radio clocks can be synchronised from here.

[1] UTC = Universal time co-ordinated

3 Set-up

3.1 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).

3.1.1 Reception Process

In case of an initial set-up or after a long voltage failure the first reception process may take some time (under unfavourable conditions up to several hours).

To speed up this process proceed as follows:

- enter present time and date
- enter/ check difference time
- enter / check position data

The more precise the entry the faster the GPS receiver can synchronise. If the position is unknown the values "00" should be entered.

Wrong position data and invalid date and time information delay the first synchronisation process.

In the **"Show-Menu"** the reception can be supervised under the function **"Show Satellites"**.

Before the first synchronisation or after a long voltage failure the reception menu shows the following entry:

V
00

This means that the GPS receiver must correlate the entered data and those received from the satellite to find the exact position. After that running times are used to evaluate the received time information of the satellites.

If there is an entry between 4 and 12 under V (visible) in the reception menu the GPS receiver has completed its evaluation. Example:

V
09

It now calculates for its time and position the number of the theoretically visible satellites. **V / 09** means that at that point of time 9 satellites are theoretically visible.

If there is a visible- entry future reception processes take a few minutes only (good reception assumed). This status of the GPS receiver remains even after short voltage failures.

3.2 Set-up of the Base-System

After connecting the unit to the operating voltage, the unit is switched on by means of the power switch.

3.2.1 Display

After power-up the 2x40-digit VFD-display shows the following picture :

***hopf*-Elektronik GPS MASTER-CLOCK**
VERSION 08.00 30/AUG/2000

This picture remains on the screen for about 3 seconds. In case of the first installation or a power-cut for more than 3 days the following is displayed:

GPS_M	=	GPS Master-System
GPS_S	=	GPS Slave-System

L-T:	[1]00:00:00	[2] – – / [3] – – / – – – / – – – –	[4] – –	GPS_M
UTC:	[5]00:00:00	[6] – – / [7] – – / – – – / – – – –	[8]C	[9]9.9 ppm

The positions mean as follows:

1 **L.T :**00:00:00

Here the local time is shown.

2 Display of the days of the week in English abbreviations:

MO - TU - WE - TH - FR - SA – SU

3 Display of the date:

day / abbreviation of month / year

4 status display:

Position 1 X--	**"D"**	for summertime (Daylight-Time).
	"S"	for standard or wintertime.
Position 2 -X-	**"A"**	announcement of the changeover to a different time zone. The announcement is done one hour before the changeover.
Position 3 --X	**"A"**	announcement of a leap second This information is given 1 hour before a leap second is inserted.

Description of the system

GPS_M	**GPS-Mastersystem**
GPS_S	**GPS-Slave-System**

5-7 In this position, corresponding with the display of the local time, the UTC world-time is shown.

8 Display of the internal status of the clock:

"C" = the clock system is running in crystal operation.
"r" = the system is running radio synchronously
"R" = the clock system is running with GPS-reception at highest precision and control by the crystal of the clock (R = Radio).
In slave- operation an **"R"** is shown when the master system runs radio synchronously.

9 Here you can read the accuracy the internal clock is running at, the display starts at **9,9ppm.**

The ppm display is calculated by a timer and doesn't show the accuracy level. In crystal mode 9.9ppm will be displayed after a reset although if the real accuracy is higher.

4 Key-Pad

The key-pad consists of 42 keys, 5 keys fulfil double functions. The second function on the double-function-keys is selected via the key SHF (shift) and is valid only for the next key entry.

4.1 Design

A	B	C	D	E	0	1
F	G	H	I	K	2	3
L	M	N	O	P	4	5
Q	R	S	T	U	6	7
V	W	X	Y	Z	8	9
SHF	BS HO	BR DL	+ -	. *	SP ,	ENT

4.2 Key Functions

A ... Z	entry of the alphabet in capital letters (without J)
0 ... 9	entry of the digits
SHF	shift function of the keys:

BS HO	BR DL	+ -	. *	SP ,

BS	BS = BACKSPACE, deletes the last entry.
HO	HO = home, deletes the whole line.
BR	BR = BREAK, stops all key controls.
DL	DL = delete, not used at the moment.
+	entry of the sign for the digits.
-	
.	entry full stop,
*****	asterisk , not used at the moment
SP	entry of a free display-space.
,	entry of the comma

4.2.1 Key-Entry / System Control

The key pad is activated by pressing **"ENT"**.

The display jumps from the standard picture, display of the time information, to the start picture for keypad or system control. At the moment 6 entry- or control modes are offered in this picture. Entering the according digit moves the key entry into the according mode.

start-up screen:

KEY: K SET: 1 SHOW: 2 INI: 3 MON: 4 S.-CLK: 5

LAN:6 PRG-R: R MASTER-R: M IN: 1-6 ,K, M, R

The individual modes have the following meaning:

key: If a key word has been programmed further entries can only be made via this key word.

> **Please Note:** THE KEY WORD STAYS ACTIVE FOR ONE MINUTE AFTER THE LAST KEY PAD ENTRY.

SET: entry of set functions like time/date, position, time offset etc.

SHOW: select display functions like time difference, position etc.

INI: initialising function, manufactures internal use only (Attention: use this function carefully).

MON: monitor function, manufactures internal use only.

PROG.-R: by entering the **"R"** for PROG.-R the programme on the board 7015 is set back, i.e. programme restart.

MASTER-R: Entering the **"M"** sets off a hardware-master-reset of the whole system. All the boards contained in the system are set back and restarted.

S.-CLK: select special functions

> **Please Note:** INPUTS IN THE MONITOR MENU ARE ONLY ALLOWED BY THE ***hopf*** COMPANY, BECAUSE SIGNIFICANTLY FUNCTIONS CAN BE CHANGED.

4.3 SET-Functions

Please Note: IF A KEY WORD HAS BEEN PROGRAMMED AN ENTRY CAN BE MADE ONLY VIA **"K"**, OTHERWISE THE KEY PAD IS BLOCKED.

If you enter the digit 1 the programme jumps into the field of set-functions. The programme is constructed as user menu. Every sub-function is displayed and selected by

"Y" = yes or turned down by

"N" = no.

When entering **"N"** the next sub-function is displayed, for the time being only the following set-functions can be selected.

4.3.1 Time / Date Entry

Selection picture

INPUT TIME / DATE Y / N
HH.mm.ss..d.DD.MM.YYYY.Z   Z = D or S

entry picture

LOC.-TIME HH.mm.ss..d.DD.MM.YYYY.Z
          >   **<**

This entry function can be used to set the local time. The entry is placed in the second line between the two arrows >...< and must be complete. Points and leading naughts must not be forgotten.

The positions have the following meaning:

HH	hour	range	from 00 - 23
mm	minute	— " —	from 00 - 59
ss	second	— " —	from 00 - 59
d	day of the week	— " —	from 1 - 7
	1 stands for Monday ... 7 stands for Sunday		
DD	day	range	from 01 - 31
MM	month	— " —	from 01 - 12
YY YY	years	— " —	from 1990 - 2089
Z	timezone D or S		

Many countries change their timezone during the course of the year. Here the timezone, valid for the entered time information, must be set.

The entry **"D"** stands for summer or daylight time zone.
The entry **"S"** stands for winter or standard timezone.

In countries without changeover of timezones the **"S"** for standard timezone must be entered.

All entries are taken over by pressing **"ENT"**. If the entry is plausible this time is taken over into the system, otherwise the message **"INPUT-ERROR"** is displayed for 3 seconds. The set-function is left in both cases and the display shows the standard picture again.

4.3.2 Time Difference

select screen

TIME OFFSET Y/N

input screen

TIME-OFFSET +/- HH.mm   EAST + WEST -
>   <

With this function the time difference between local and world time (UTC-time) is entered. The sign indicates in which direction the local time deviates from the world time.

In general:

+ means east
– means west of the 0-meridian

Most countries choose their time difference in one hour steps, the entry also takes place in hour steps.

e.g. + 05.00; - 11.00

Some countries move in ½ hour steps. Here the minutes are added to the entry.

e.g. + 05.30; - 08.30

Please Note: EVERY MINUTE ENTRY EXCEPT 00 IS REGARDED AS ½ HOUR STEP.

4.3.3 Time Zone Changeover

In some countries on earth there are, depending on the season, two time zones - standard time (also called wintertime) and daylight saving time. The daylight saving time has a time offset of +1 h compared to the standard time. The precise dates of changeover for the current year are calculated automatically from the entered parameter. The parameter have been chosen so that the changeover can take place at any point of time. Usually, the time change follows a logical scheme in different countries.

e.g. Europe standard- (winter) / daylight saving- (summer) time and backwards

last Sunday in March and last Sunday in October

or in some Arabian countries

First Friday in May and first Friday in October

To check the entered changeover dates, the **Show**-functions can be opened. The exact changeover date, calculated by the clock, will be shown here. If the particular country does not have time zone changeovers, naughts must be entered in all data positions.

selection picture

CHANGE-OVER DATES   S -> D   AND   D->S
S=STANDARD-TIME   D=DAYLIGHT-TIME   Y/N

That means:

- S = (**S**)tandard time (winter time), this is the normal time of the location
- D = (D)aylight saving time (summer time), this is the 1 h forward time in the summer month

After entering (**Y**)es the following picture appears:

S → D   hh.d.w.MM   **D → S   hh.d.w.MM**
>_   **<**

The two switching points of the year can be entered between the arrows. In order to read the input correctly the different parameters should be accompanied by a point or space (**SP**).

After the input of the first switching point the cursor has to be moved to the position for the input data of the next switching point by means of the space key.

All values are entered with "00" if no changeover point is wanted. The clock calculates the exact changeover date to the next minute change and the values are taken over.

All inputs become due by the key **"ENT"**. In case of an invalid input (e.g. values outside the valid range) the message **"input error"** appears. The values will not been taken over.

Provided the fact that there is no summer time at the location of the system, the input **00** for hour and month has to be made. The display shows the shortcut for the time zone **S**.

The individual entries have the following meaning

hh	=	the hour when the changeover is to take place
		00 ... 23 h
d	=	the day of the week when the changeover is to take place
		1 = Monday ... 7 = Sunday
w	**=**	the weekday in the month when the changeover is to take place
		1 ... 4 day of the week e.g. 1st ... 4th Sunday in the month
		5 last day of the week e.g. last Sunday in the month
MM	=	the month when the changeover is to take place

The entry is completed by ENT.

Please Note: AFTER ENTERING THE CHANGEOVER DATES PLEASE CHECK THE VALUES AFTER THE NEXT MINUTE CHANGE IN THE SHOW-MENU.

4.3.4 Position

select screen

Position LAT N/S LON E/W Y/N
(N)ord (S)outh (E)ast (W)est

With this function the geographical position of the equipment can be entered. This function helps with the initial set-up because it shortens the reinitialising of the GPS-receiver.

input screen

LAT/LON PGG.MM..pGGG.MM P=N/S p=E/W
> **<**

For the entry of latitude and longitude degree and minutes are used.

The sign for the latitude is:

N = northern hemisphere
S = southern hemisphere

and for the longitude:

E = east of the 0 meridian
W = west of the 0 meridian

First the latitude position is entered under **PGG.MM**, meaning

P	N or S, north or south	
GG	latitude degree from	00 - 89
MM	latitude minute from	00 - 59

After the dividing points the longitude position is entered under **pGGG.MM**, meaning:

p	E or W, east or west	
GGG	longitude degree from	000 - 179
MM	longitude minute from	00 - 59

All entries are taken over by the **"ENT"** key.

4.3.4.1 3D / Position-fixed Time Decoding

Bit 0 in the system byte (see 4.3.6) is used to choose between the 3D and the position-fixed decoding:

- Bit 0 = 0 Position-fixed decoding
- Bit 0 = 1 3D-decoding

The accuracy of the time decoding depends on how accurately the position of the operational location is calculated. At least 4 received satellites are 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 ± 1 µsec.

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 received satellite and the entered position already. An entry of the position to ± 1 minute degree achieves an accuracy of the second marker better than ± 20 µsec. An entry even more precise can achieve the value ± 1 µsec.

The position-fixed mode has the advantage that the clock synchronises with only one received satellite. The antenna may be installed somewhere where less than ¼ of the sky is visible.

Often it is possible to install the antenna indoors at the window (short cable, no lightning protection). If 4 received satellites are visible in this mode, the decoding jumps automatically into the 3D mode and calculates the exact position improving the accuracy to ± 1 µsec for one satellite.

The accuracy stated refers to the difference to the 3D-decoding:

The second marker of a system in the position-fixed mode does not change by more than ± 1µsec.

4.3.5 Key-Word

To protect the key-pad from unauthorised access you can programme a 4 letter key word.

Select screen

SET KEY-WORD Y/N

Input screen

KEY-WORD
=> <

Only one word consisting of 4 letters or digits can be entered followed by **"ENT"**.

e.g. **1A2B "ENT"**
except **0000** (see 4.3.6.1)

Please Note:	TO ACTIVATE THE KEY WORD IT IS ABSOLUTELY NECESSARY TO RUN VIA PROG.-R.,MASTER-R OR TO TURN THE SYSTEM DEAD.

Select screen

After calling up the **key-word** by **"K"** and **"ENT"** the following picture appears

KEY-WORD => <

The key word is now to be entered. The entry can neither be interrupted nor corrected. To help you keeping count, an asterisk for each entry appears between the arrows. When the entry is complete the following picture is displayed.

KEY-WORD =>**<**

Then press **"ENT"**.

If the key word is correct the display returns to the select screen.

4.3.5.1 Delete a Key Word

A key word can only be deleted by entering **"0000"** + **"ENT"**.

4.3.5.2 Error Message

Once a key word is programmed, the entry screen must be selected first then **"K"** must be entered and finally the key word. In case of an error the following picture appears:

KEY-WORD MISSING
OR KEY-WORD WRONG

After three wrong entries further entries are blocked for some hours. This blocking period cannot be shortened by a reset or by switching the system off and on again. When the correct key word is entered the menu reappears.

4.3.5.3 Key-Word Help Line

If you have forgotten your key word we can help you if you have told us the key word, the authorised persons and the hardware number beforehand.

helpline TEL. ++49 (0)2351 / 938686
FAX. ++49 (0)2351 / 459590

4.3.6 Setting the System Byte

The switching on or off of programmes or functions can be done by setting the according bit in the system byte to logic "**1**" or "**0**" The following selection picture appears for the system byte:

SET SYSTEM-BYTE Y/N

After entering (**Y**) the set picture appears showing the presently valid status byte:

SYSTEM-BYTE OLD >00000000<
SYSTEM-BYTE NEW >_ <

The bit positions can be set or deleted by entering "1" or "0" starting with bit 7.

When the complete byte (8 bit) is entered the new status byte is stored fail-safe and the menu is left.

If you just wish to view the system byte to check, do not enter any bits. The menu can be left by (**BR**)eak. The valid system byte is not altered.

The bits have the following functions

Bit 7 ⇨ not used at present
Bit 6 ⇨ not used at present
Bit 5 ⇨ not used at present
Bit 4 ⇨ not used at present
Bit 3 ⇨ setting radio bits
Bit 2 ⇨ setting radio bits
Bit 1 ⇨ DCF77 simulation switched off
Bit 0 ⇨ 1 = 3D Decoding 0 = Position-fixed Decoding (see 4.3.4.1)

Bit 3 / Bit 2

These bits can be used during commissioning or tests to manually set the radio synchrony, to test connected devices which require this information.

Please Note:	THESE BITS ARE AUTOMATICALLY SET TO ZERO AFTER POWER ON/OFF OR A RESET.

Bit 3	**Bit 2**	
0	0	Radio bits are set only by the synchronisation by GPS
0	1	No function
1	0	Radio bit is set even without synchronisation
1	1	Radio bit and high precision set even without synchronisation.

Bit 1

Bit 1 can be used to switch off the DCF77 simulation on the internal bus and on the board 7015 if there is no synchronisation. The connected boards 7317 then do not simulated antenna signal.

Bit 1 = 0 DCF77-Simulation even if there is no synchronisation

Bit 1 = 1 DCF77-Simulation only if there is synchronisation

4.3.7 LAN board

If there is a LAN board with time server function installed in the system 7001 the IP address, gateway settings and mode byte can be entered by using the keypad (see description 7270).

4.3.8 Data Securing

All entered data of point 4.3.2 - 4.3.6 are checked for plausibility and then stored in a voltage fail-safe memory EEPROM. To check the data **PROG.-R** or **M.-RESET** are carried out with the effect that the stored data in the EEPROM are read back into the working memory.

4.4 Control of Entered Values

To control entered or up-dated values by the GPS-receiver, the **SHOW**-function is called up. After jumping to the key pad basic picture by means of the key **"ENT"** the digit 2 is entered. The first **SHOW** request screen appears.

Please Note:	THE SHOW FUNCTION CAN BE INTERRUPTED AT ANY TIME BY **"BR / DL"** = BREAK. ALL POINTS OF MENU CAN BE LEAFED THROUGH ANY KEY BUT **"BR"**. ONLY AFTER VIEWING THE POINT **"SHOW SATELLITE"** YOU MUST LEAVE WITH **"BR"**.

4.4.1 Satellite Display

To synchronise the device with UTC, 4 satellites within the view range of the antenna are necessary. At best 9-10 satellites are within the view range of the antenna, out of which 6 can be received parallelly.

By means of the menu choice

SHOW SATELLITES Y/N

the number of satellites within view, the number of received satellites and the relative measure for the reception power are displayed.

This function is particularly helpful during the installation of the device. After the menu item has been selected the following picture appears on display for up to 4 minutes

V	**SAT:**	**SAT:**	**SAT:**
	SAT:	**SAT:**	**SAT:**

Under **(V)**isible the number of satellites visible for the optimal antenna position on this location is shown. In case of the first receiving procedure or after a longer voltage breakdown "00" is shown under the (V).

The satellites actually tracked by the GPS-receiver appear after **SAT:**

After the first installation it can take up to 1 hour before anything is written in the picture, depending on the start information the system receives and on the antenna position e.g. only half the sky within view.

If there are values in the system the display can look as follows:

V SAT: 05 137	**SAT:17 43**	**SAT:**
7 SAT:	**SAT:**	**SAT:**

7 satellites are in the theoretically visible range. The GPS receiver receives satellite 05 at a signal/noise ratio of 137 and satellite 17 at a signal/noise ratio of 43. This number does not suffice for a synchronisation with UTC.

In case of a bad signal/noise ratio the values range from	**10-30**
In case of a sufficient signal noise ratio the values range from	**30-70**
In case of a good signal/noise ratio the values range from	**70-140**

4.4.1.1 Error Interpretation

Errors in the reception system can be recognised by means of the display picture of the satellites.

Example 1: No satellite appears in the display even after several hours after the first installation.

Possible faults:

- the antenna cable has a defect
- the antenna cable is not connected
- the antenna has a defect
- the lightning protection has a defect

Example 2: There are 7 satellites in the view range, but only up to 2 appear on the display.

Fault

- the visible range of the antenna is too small.

Example 3: 9 satellites appear within the view range, 6 are received but the system does not synchronise because the signal/noise ratios lie between 10-30.

Possible faults:

- the cable is too long
- the BNC-connectors are badly assembled
- the cable is crimped
- the cable has the wrong impedance
- reception conditions are very bad (e.g. extreme snowfall)

Example 4: The system has run perfectly so far. 7 satellites appear in the view range, none are tracked, the system has been running without reception for several days.

Possible faults:

- the cable has been damaged
- a flash of lightning has occurred and the lightning protection has a defect
- the antenna has a defect
- the receiver has a defect
- the voltage supply has a defect

4.4.2 Time Difference

By means of this function the actual time difference between the local time and the UTC-time can be viewed.

select picture

TIME-OFFSET Y/N

After pressing the **"Y"** key the time difference appears on display as follows:

TIME-OFFSET: 02:00
EAST + WEST -

If **"N"** or any other key but **"Y"** is pressed, the display jumps to the next request picture.

4.4.3 Time Zone Changeover S ⇨ D

This function shows the point of changeover from standard time (wintertime) to daylight-time (summertime). It also tells you if the changeover is still active or has been carried out already.

selection picture

STANDARD / DAYLIGHT CHANGE-OVER Y/N

After pressing **"Y"** the following is displayed:

TIME S > D 02:00:00 30/MAR/1992

The point of changeover is on Sunday 30. March 92 at 2.00 h.

4.4.4 Time Zone Changeover D ⇨ S

This function tells you the points of changeover from daylight-time (summertime) to standard-time (wintertime)

selection picture

DAYLIGHT / STANDARD CHANGE-OVER Y/N

After pressing **"Y"** the following may be displayed:

TIME D > S 03:00:00 27/SEP/1992

The changeover takes place on (Sunday) 27th September at 3.00 h.

4.4.5 Position

This function shows the position which was either entered or updated by the GPS.

In contrast to the position entry the position display is extended by 4 points. Another 4 decimal points are displayed in the position minutes. The position is updated by GPS every minute.

Select screen

POSITION Y/N

Display

e.g. **POSITION**
N 51 12, 68 98 E 007 39, 80 50 (position of the ***hopf*** company)

4.5 Ini-Functions

Via the menu item **INI:3** various standard settings can be done. The key **"3"** changes over to a selection dialogue.

4.5.1 Crystal-Control Value

This function is designed for ***hopf*** internal use only. It should not be used during operation. It serves to deteriorate the crystal control to test the control qualities of the adjustment programme.

4.5.2 Serial Interface / Master-, Slave or Remote-Operation

This function is used to configure the RS422 interface. At present there are three different modes (see pt.5.1/ 5.2):

- Master-operation
- Slave-operation
- Remote-control

selection picture

SERVICE INTERFACE RS422 Y/N

After pressing **"Y"** - the display jumps into the input mode. The following picture is displayed. e.g.:

MASTER/SLAVE OR REMOTE CONTROL
SELECT M/S/R > <

The letters mean the following:

"M", **"S"** or **"R"** are permitted as entries.
M for master operation, synchronisation via GPS-antenna
S for slave operation, synchronisation via the Master/Slave-String by other ***hopf*** systems
R for remote-control ; see 5.3

The entry must be completed by **"ENT"**

In case of a false entry an error message is displayed.

INPUT ERROR

After about 3 seconds the display automatically returns to the standard picture. The data will not be taken over. If you want to alter data, **"ENT"** must be pressed immediately. The faulty picture is then shown without any alteration of data.

> **Please Note:** THE STANDARD SETTING OF THE INTERFACE IS 9600 BAUD, 8 BIT WORD LENGTH, 1 STOP BIT AND NO PARITY BIT.

4.5.3 Delay of the Status Change "No Radio"

Both the display and the serial data string show whether the system is synchronised by GPS or whether it is running on the internal crystal base. This information is often used for error messages in the connected devices. To avoid a short reception interruption to be interpreted as an error, the status change from reception to crystal base can be delayed. The delay time can be set from 0-255 minutes.

Select screen

TIME-OUT FOR "OFF" NO RECEIVE Y/N

After confirming by **"Y"** the display returns to the entry mode. The following picture is then displayed. e.g.

STATUS OFF AFTER >XXX< MIN. NO RECEIVE
UP INPUT U DOWN INPUT D

XXX is replaced by the delay time valid at that time.

The key **U** (up) increases the time **D** (down) diminishes it.

When leaving the programme by **"BR"** the value displayed last is stored non-volotilely.

4.5.4 Delay of the Status Change "Radio"

When the system changes from crystal operation to the radio controlled operation there is a time leap of the second marker up to about ± 20 µsec. After that the deviation is reduced to ± 3 µsec in steps smaller than 2 µsec. The remaining difference is diminished down to less than ± 0.5 µsec by the controlling system crystal. This controlling process takes about 10 minutes. This function can be used to delay the information "radio controlled operation", to keep the criterion for highest synchrony.

Select screen

TIME-OUT FOR STATUS „ON“ AFTER
GPS-RECEPTION Y/N

Pressing the **"Y"** key returns the display to the input mode. The following picture is then displayed

STATUS "ON" AFTER >XXX<MIN.NO RECEPTION
UP INPUT U DOWN INPUT D

The XXX are replaced by the delay time valid at that time.

The key **"U"** (up) increases the time and **"D"** (down) diminishes it.

When leaving the programme by means of the key break **"BR"** the value displayed last is stored in a non-volatile memory.

Normally this function is not required, it should therefore be >000< min. If this function is wanted make sure that the switch off delay is not activated (see pt. 4.5.3).

4.6 *Choice of Special* Functions

Via the menu item **S.-CLK** the extension boards integrated in the system can be addressed. Pressing **"5"** changes over to a selection dialogue.

The following special functions can be called up.

SLAVE - CLOCK MANIPULATION Y/N

Master clock function; setting, start- and stopping of analogous slave clocks.
Requires master clock board 7405/7406 in the system.
Further information in the description for the board.

IRIG-B TIME CODE MANIPULATION Y/N

Display and entry of control values for the IRIG-B time code exit.
Requires board 7230 in the system.
Further information in the description for the board.

NET-TIME MANIPULATION Y/N

Synchronisation of network times.
Requires board 7515 in the system.
Further information in the description for the board.

4.7 Summary Key Pad

- The key pad is activated by pressing the key **"ENT"**.
- Selection of functions by **"1"** to **"5"**.
- Switching to standard picture by **"BR / DL"** = BREAK.
- Completion of entry by **"ENT"**.
- Selection of functions by **"Y"**.
- Continue function by **"N"** or any other key except **"BR / DL"** =BREAK
- Plausibility errors are indicated by **INPUT-ERROR**, new selection and entry is necessary.

Please Note: IN CASE OF A HIGHER DATA FLOW RATE ON THE BUS (MANY EXTENSION BOARDS INSTALLED) IT CAN HAPPEN THAT THE KEY ENTRY IS NOT ACCEPTED IMMEDIATELY.

In this case stop the entry by pressing **"BR / DL"** and start the editing process again.

4.7.1 Set Functions

- Local Time

hour	T	H	0-2
hour	S	H	0-9
.			
minute	T	m	0-5
minute	S	m	0-9
.			
second	T	s	0-5
second	S	s	0-9
.			
.			
day of the week		d	1-7
.			
day	T	D	0-3
day	S	D	0-9
.			
month	T	M	0-1
month	S	M	0-9
.			
year	T	Y	0-9
year	S	Y	0-9
.			
time zone			D or S

- Time Offset

sign ±	+ or -
hour	0-1
hour	0-9
.	
minute	0 or 3
minute	0

- Time Zone Point of Changeover

  data string like local time

- <u>Position</u>

sign	P	N or S	
degree	T	G	0-8
degree	S	G	0-9
.			
minute	T	M	0-5
minute	S	M	0-9
.			
.			
sign	P	E or W	
degree	H	G	0-1
degree	T	G	0-9
degree	S	C	0-9
.			
minute	T	M	0-5
minute	S	M	0-9

4.7.2 Display Functions

- time offset
- standard / daylight changeover
- daylight / standard changeover
- position
- satellite display

4.8 Set-Up

- connect the antenna
- connect voltage supply
- switch on voltage
- enter local time
- enter time difference
- enter position
- enter point of changeover **S** ⇨ **D** (not absolutely necessary)
- enter point of changeover **D** ⇨ **S** (not absolutely necessary)
- cause programme reset
- view difference time
- view position
- view point of changeover **S** ⇨ **D**
- view point of changeover **D** ⇨ **S**
- cause master reset

5 Service Interface of the Clock Board 7015

The existing RS422 service interface of the clock board 7015 can be used for the following functions.

selection of mode see 4.5.2

Master-Mode

In the master mode the GPS slave data string, with which other ***hopf*** clock systems can be synchronised is putout at this interface.

Slave-Mode

In the slave mode the system can be synchronised by a GPS slave data string from other ***hopf*** clock systems.

Remote-Mode

In the remote mode time, date, position and points of changeover can be set by a different computer. This function works like the entry via key-pad.

5.1 Interface Assignment SUB-D Connector 9-pole

Pin	Signal
1	GND
2	/TxD
3	TxD
4	/RxD
5	RxD
6	DCF77-pulse low-aktiv
7	/DCF77-pulse high-aktiv
8	PPS
9	GND

5.2 Master/Slave-String

This master/slave-string serves to synchronise slave systems up to an accuracy of ± 0,5 msec with the time data of the master system via the service interface RS422. It differs from the DCF-slave string in as much as the difference time is included in the transmission.

The difference time is transmitted in hours and minutes after the year. The transmission is in BCD. The difference time may be up to an ± 11.59 hour.

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 whole 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 5.2.1
3	day of the week	$31-37	; see 5.2.1
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	
21	CR (carriage return)	$0D	
22	ETX (end of text)	$03	

5.2.1 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	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

5.2.2 Example of a 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 to UTC time is + 2.30 h.

5.2.3 Parameter of the Transmission

In case of master / slave synchronisation the data are transmitted with the following parameter:

- 9 600 baud
- 8 data bit
- 1 stop bit
- no parity

5.3 Remote Function of the Service Interface

Remote functions are required to install a clock system remote controlled via a computer.

Various data strings are transmitted to set the time, date, point of changeover (summer/winter time), position data, difference time local - UTC and decoding of the GPS reception quality.

These functions can also be handled by means of the user equipment of the system 7001.

The start of the communication connection between clock and computer is always activated by the computer. The data string is structured as follows:

STX (command) [status] [data] CR LF ETX

The body of the transmission consists of the STX (Hex 02) and, at the end of the data string, the CR (Hex 0D), LF (Hex 0A) and the ETX (Hex 03).

The command field contains four ASCII-characters, which indicate the type of function. The following commands are possible:

TIM: for time and date
DIF: for time difference local - UTC
POS: for position data
SAT: for reception quality
RES: for reset of the clock system

The fields **status** and **data** are optional and depend on the command or on the required function resp..

The **TIM** command is always transmitted with a status. The status indicates whether a time or a point of changeover is included in the data string. The other commands are transmitted without a status.

5.3.1 The Status Byte and Data String Structure in the TIM Command

The status byte consists of two ASCII nibble. The value range of individual nibbles can be Hex 30 to 39 and Hex 41 to 46 (00-FF). After the reception of both characters they are converted into binary values. Example: The two ASCII characters "4" and "2" (Hex 34 and 32) are received and change to the following bytes after ASCII correction:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	1	0	0	0	0	1	0

The status byte has the following meaning depending on whether the clock board 7015 receives or transmits a **TIM** command:

Bits in the status byte (transmitted by System 7001):

bit 7 = 1,	bit 6 = 1	clock is radio synchronous with crystal control
bit 7 = 1,	bit 6 = 0	clock is radio synchronous without crystal control
bit 7 = 0,	bit 6 = 1	clock is in crystal operation (valid time)
bit 7 = 0,	bit 6 = 0	clock has no valid time

bit 5 = 1 announcement of a leap second on the next hour change
bit 4 = 1 winter time/ local time
bit 3 = 1 summer time (only when working with changeover)
bit 4 = 0, bit 3 = 0 UTC time (Universal Time Coordinated)

bit 2 = 1 summer/winter - winter/summer changeover on the next hour change
bit 1 = 0 in case of changeover only: changeover is done
bit 0 = 1 changeover is still active

Meaning of the bits in the status byte,(received by System 7001):

bit 7	no meaning
bit 6 = 1	must always be set
bit 5 = 1	clock should fit in a leap second on the next hour change (Attention: for diagnostic purposes only)
bit 4 = 1	winter/local time
bit 3 = 1	summer time
bit 2 = 1	changeover summer/winter or winter/summer time on the next hour change (Attention: for diagnostic purposes only)
bit 1 = 1	point of changeover (summer/winter- winter/summer)
bit 1 = 0	set time and date
bit 0	no meaning

During transmission operation the data field in the **TIM** data string contains the actual setting of the clock. During reception operation the new times are entered here. If the data field is missing during reception the received status is decoded to required clock data and a transmission with the according data is caused by the clock at the next possible point of time.

The data are transmitted and received as ASCII values in BCD. The clock checks the received data for plausibility. The clock recognises invalid data like e.g. day = 32 as errors and rejects the whole data string. The day of the week nibble must always be stated 1= Monday, 7 = Sunday. For the transmission of changeover times the day of the week must always be set to 7.

Structure of the data field in the data string:

meaning	value range (Hex)
comma	$2C
hour tens	$30-32
hour unit	$30-39
comma	$2C
minute tens	$30-35
minute unit	$30-39
comma	$2C
second tens	$30-35
second unit	$30-39
comma	$2C
day tens	$30-33
day unit	$30-39
comma	$2C
month tens	$30-31
month unit	$30-39
comma	$2C
year tens	$30-39
year unit	$30-39
comma	$2C
day of the week	$31-37

5.3.2 Setting the Time

status byte (Hex)	Meaning
48	set winter time (local time)
50	set the summer time

Example data string setting the winter time 12:34:56 h, Sunday 07.08.99

STX TIM:48,12,34,56,07,08,99,7 CR LF ETX

When the data are taken over the clock answers with the new time data string:

STX TIM:48,12,34,56,07,08,99,7 CR LF ETX

5.3.3 Inquire Time

status byte (Hex)	Meaning
40	inquire UTC (world time)
48	inquire local time

Example data string inquire world time:

STX TIM: 40 CR LF ETX

The clock answers stating the actual world time at the next possible point of time.

Example answer: STX TIM: 40,10,34,56,07,08,99,7 CR LF ETX

It is 10:34:56h, Sunday the 07.08.99 world time.

5.3.4 Setting the Points of Changeover

status byte (Hex)	Meaning
4A	setting the point of winter changeover
52	setting the point of summer changeover

Example data string setting the point of winter changeover 02:00:00, Sunday 23.09.96

STX TIM: 4A,02,00,00,23,09,96,7 CR LF ETX

After the reception the clock answers with the new point of winter changeover:

STX TIM: 4B,02,00,00,23,09,96,7 CR LF ETX

bit 0 = 1 in the status byte indicates that the new point of changeover has been activated.

5.3.5 Inquire Points of Changeover

Status byte (Hex)	Meaning
52	inquire point of winter changeover
4A	inquire point of summer changeover

Example data string inquire point of winter changeover:

STX TIM: 52 CR LF ETX

The clock answers with the actual point of winter changeover at the next possible point of time.

Example answer: STX TIM: 53,02,00,00,23,09,96,7 CR LF ETX

The changeover to winter time is still active (bit 0 in the statusbyte = 1) and will take place at 02:00:00 h on Sunday 23.09.96 local time.

5.3.6 Time Difference Local - UTC

It is possible to set or inquire the difference between the local time and UTC using the DIF order. The data field for this order has the following structure:

Meaning	Value range (Hex)
direction +/-	$2B,2D
hour tens	$30-32
hour unit	$30-39
comma	$2C
minute tens	$30, 33
minute unit	$30

The time difference must not exceed ± 12 hours. The minutes can only have the value of either 0 or 30.

Example data string setting the difference between local time and UTC to -1 hour.

STX DIF:-01,00 CR LF ETX

The following data string inquires after the actual difference:

STX DIF: CR LF ETX

The clock answers with the actual setting as described under **"setting"**.

5.3.7 Position Data

The following data string sets or inquires the position data for the respective location of the clock system.

The structure of the data field is as follows:

Meaning	ASCII	Value range (Hex)
longitude West/East	W;E	$57, 45
colon	:	$3A
degree hundredth	0,1	$30,31
degree tens	0-8	$30-38
degree unit	0-9	$30-39
comma	,	$2C
minute tens	0-5	$30-35
minute unit	0-9	$30-39
comma	,	$2C
minute hundredth	0-9	$30-39
minute thousandth	0-9	$30-39
comma	,	$2C
latitude North/South	N,S	$4E,53
colon	:	$3A
degree tens	0-8	$30-38
degree unit	0-9	$30-39
comma	,	$2C
minute tens	0-5	$30-35
minute unit	0-9	$30-39
comma	,	$2C
minute hundredth	0-9	$30-39
minute thousandth	0-9	$30-39

Example data string setting the position data:

STX POS: E:007,33,34,N,:53,12,21,CR LF ETX

5.3.8 GPS Reception Quality Data

These data can only be requested. The request data string is as follows:

STX SAT: CR LF ETX

The clock answers with the number of tracked satellites and their signal/noise ratio. The data field is structured as follows:

Meaning	ASCII	Value range(Hex)
identifier tracked sat	T	$53
colon	:	$3A
number of tracked sat.	0-9	$30-39
comma	,	$2C
identifier sat	S	$53
colon	:	$3A
tens sat. no.	0-9	$30-39
unit sat. no.	0-9	$30-39
separator	/	$2F
tens SN ratio	0-9	$30-39
unit SN ratio	0-9	$30-39
comma	,	$2C

Position 5 to 12 are repeated for 6 satellites in total!

Example of a transmitted answer with satellite data:

STX SAT: T:8,S:07/43,S:12/45,S23/34,S:14/45,S:03/23,S:19/47 CR LF ETX

5.3.9 Activate a Reset of the Clock System

A master reset of the clock system is released by the following data string:

STX RES: CR LF ETX

The clock answers first with the following data string:

STX RES: CR LF ETX

to indicate that the reset-command is carried out.

6 Technical Data Base System

operating voltage:	standard:	230 V AC +10% -15%
	or	120 V AC +10% - 15%
	option:	32 - 75 V DC
		60 - 110 V DC
power consumption system fully equipped	50 VA	
display:		VFD display 2x40-digits
type of display:		alphanumerical
height of digit:		5 mm
colour:		green
crystal accuracy		
GPS master		± 0,1ppm at constant temperature (0..50°C) after continuously GPS reception for more than 30 minutes
GPS slave by serial synchronisation:		± 2ppm at constant temperature (0..50°C) after continuously reception for more than 8 hours
crystal clock (without synchronisation)		
	delivery state:	± 0,5ppm at 25°C
	aging:	± 4ppm/year, max. ±10ppm
back-up clock accuracy:		± 25 ppm
maintenance free back-up clock buffering:	3 days	
key pad:		42 keys

6.1 Technical Data GPS Receiver

potential separation:		500 V
type of receiver:		6 channel phase tracking receiver
decoding:		L1 frequency 1575.42 MHz, C/A code
sensitivity:		-143 dB
synchronisation time	cold start:	30 min. - 4 hours (first installation without position data)
	warm start:	ca. 1 min. (voltage breakdown < 3 days)
accuracy of the PPS pulse:		± 300 nsec.(95%)
temperature range:		0 - 50°C for the specified data
		0 - 70° C with reduced free-running characteristics

extras: hard- and software alterations according to customer specification are possible

Please Note: THE ***hopf*** Elektronik GmbH COMPANY WITHHOLD THE RIGHT TO HARD- AND SOFTWARE ALTERATIONS AT ANY TIME.