Technical Description

DCF77 Radio Controlled Clock

6855

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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CONTENTS Page

CONTENTS Page

1 Specifications Model 6855

- fully automatic setting of the clock by reception of the time signal transmitter DCF77[1]
- synchronisation by serial data string from other ***hopf*** radio controlled clock systems
- elimination of reception errors by micro-processor controlled checking of the received time data string
- extensive tests for plausibility and parity checks
- imminent ST/DS or DS/ST changeovers are stored in a fail-safe memory, so that interruptions of the reception during the announcement hour are permissible
- bridging of transmitter failures by integrated crystal clock, which continues time and date in case of failures of the transmitter
- in case of power cut, internally continuing back-up clock (3 day buffering)
- completely maintenance free buffering of the back-up clock due to modern components and chips
- built-in watch-dog circuit (automatic restart in case of programme execution error)
- data output via 2 independent interfaces (V.24/V28) and (V.24/V.11)
- all parameter and various output strings can be set by means of the key-pad
- output of the internal clock status in the status byte of the data string
- date/time, status and parameter can be shown on LCD-display
- connection of 2 synchronous clock boards 7406

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

2 Functioning of the Synchronisation

2.1 Functioning of the DCF77-transmitters

The DCF77-time code transmitter DCF77 broadcasts a time signal and time code information on the long wave range at 77.5 kHz. The time information are set to 25% of the standard value by lowering of the carrier amplitude (amplitude modulation). The beginning of a lowering marks the beginning of a second. The lowering takes 0.1 sec for a logical "0" and 0.2 sec for a logical "1".

After the 20th second of every minute the BCD values for minutes, hours, day of the week, month and year are transmitted. As synchronisation marker the 59th second is not lowered.

During the first 20 seconds various information like announcement of a changeover, announcement of a leap second and the information of the actual time zone are transmitted as unchecked bits.

The broadcasted amplitude does not drop immediately to the 25% value. Due to the high resonant quality of the antenna this values is reached after 600 - 800 µsec.

The inaccuracy of the broadcasted carrier frequency is:

average on 1 day	$< 1 * 10^{-12}$
average over 100 days	$< 1 * 10^{-13}$

As the carrier frequency and the control of the lowering of the carrier have the same source, the above inaccuracy also applies to the beginning of the lowering of the second marker.

2.2 DCF77-Synchronisation

Description of how the synchronisation by DCF77-time signal transmitter or simulated DCF77-signal works.

There are 3 independent clocks in the basic system, a DCF77-clock, a crystal clock and a back-up clock. Once the voltage supply is connected, the back-up clock is loaded into the crystal clock, so that a complete time information is available instantly. If the circuit board was without voltage for more than 3 days the time is not taken from the back-up clock because of a deviation of several seconds. The system starts up with naughts in all digits of time and date. The status of the time information is then set to invalid.

The time signal reaches an integrated controllable amplifier via the potential free selective input circuit. The control range is at least 70 dB. The micro-processor uses pulse-width modulation to control the amplification. The pulse width is a measure for the signal field strength at the installation location. The bigger the pulse width the smaller the signal field strength.

There is a an inertialess AM/FM converter behind the signal amplifier. The basic frequency of the FM is about 500Hz when the DCF77-signal is not lowered. When the second is lowered to 25% of the amplitude the FM is also lowered by 25%.

The processor measures the pulse width of every FM frequency oscillation and stores it with the crystal clock in milliseconds. It is traced retrospectively from which oscillation point, the pulse width changed. This point is interpreted as the DCF77-second marker.

The achievable accuracy is close to one pulse width - i.e. about ± 2 msec.

The time information is calculated from the position of the different DCF77-second lowerings. At the same time the calculated DCF77-second markers are compared to the internal crystal clock second markers over the span of one minute. Tendencies are noticed, e.g. on average the calculated DCF77-second marker is earlier than in the previous minute, i.e. the clock is running slow.

Two control values are deducted from this:

- the crystal frequency of the VCO is adjusted positively.
- to make up for the difference up to max. ± 10 ppm frequency offset adjust the second marker softly.

Therefore the crystal frequency can be adjusted to ± 2 ppm inaccuracy for the free-running of the clock. It also levels out other distorting influences on the crystal e.g. ageing, temperature influence etc. so that the accuracy stays constant for the whole life span of the system.

The pulse width of the FM-frequency is also used to control the amplification. The average value of the longest and the shortest pulse width must be 25% apart within one second. If the gap between the two values is bigger than 25%, the DCF77-signal has increased, the amplification can therefore be lowered.

After every minute it is checked whether the parity bits is the last DCF77-data string were o.k., whether the data string is one minute ahead of the previous data string. If all parameter are o.k. the time information is taken over into the crystal clock and into the back-up clock. This is indicated in the status by setting the radio bit. If one parameter is not o.k. the whole minute is not decoded, indicated by taking back the radio bit in the status.

The 1st synchronisation requires 3 subsequent correct minute decodings. The 1st minute is used to synchronise the minute marker, the 2nd and 3rd minutes are used to find the difference between two subsequent DCF77-decoder data strings.

2.3 Sources of Interference

The time code is transmitted in the long-wave-range produced by amplitude modulation, it can therefore be easily disturbed and interfered. There are many different external sources of interference like e.g. corona discharges at high-voltage lines, atmospheric turbulences i.e. thunderstorms on the way to the receiver. In case of a thunderstorm near the location of the transmitter the broadcasting is stopped for the time of the thunderstorm. This may take several hours.

Internal disturbances on the location of the receiver are usually caused by engines, monitors, switching contacts, shields etc. The place for the antenna must therefore be selected with utmost care.

Apart from the correct choice of the antenna location to suppress disturbances the other possibility is the use of narrow-band receivers.

> **PLEASE NOTE :** *NARROW-BAND RECEPTION AND ACCURACY EXCLUDE EACH OTHER.*

In case of industrial use we advise avoiding internal disturbances completely by installing an outdoor antenna. This also excludes possible disturbances caused by devices which may be installed at a later date.

2.4 Accuracy of the DCF77-Decoding

Regarding the DCF77-signal we must differentiate between short-term and long-term accuracy. Where the decoded second marker is concerned the usual decoding technique may allow deviations of + 5 to + 150 msec from the absolute time marker. This depends mainly on the antenna and on the used signal filters and detection. Narrow-band antennas and very narrow-band crystal filters are used to suppress disturbances. This causes a long final oscillation time when the signal is lowered. The rectification used to create the pulse delays the accuracy even further.

The accuracy suffices completely for clocks in private homes, where the long-term accuracy is of interest. After one year the second deviation remains at + 5 to + 150 msec.

For industrial operations these deviations are often not tolerable. The antenna and also the receiver must be of wide-band design to achieve more precise second markers. Values ranging between + 5 to + 15 msec require band widths of about 4 kHz for the antenna. But this means on the other hand that the antenna sends considerably more disturbances to the electronics and the receiving electronics cannot decode a minute cycle. Comparing them with the clocks for the home use this liability to disturbances is erroneously interpreted as lack of sensitivity.

As a rule:

short-term accuracy and high disturbance immunity exclude each other in DCF77.

To achieve an acceptable accuracy from the DCF77-signal we use antenna with a band width of 4 kHz and not the usual reception technique with a straight-on receiver. We transform the amplitude modulated signal from the antenna, as described above, inertialessly into a frequency modulated signal. The achievable accuracy compared to the DCF77-signal lowering at the installation location of the antenna is here about one FM pulse width, i.e. about, ± 2 msec.

Further inaccuracy can be caused by the transmission time between sender and receiver.

In case of sole ground wave reception, if the distance is constant it is possible to calculate a constant value. The reception side is not able to influence time fluctuations in case of sky waves. Due to variation in height of the reflecting and deviating level of the ionosphere, differences in height influence directly time deviations. The same applies to the cross-over section of ground and sky waves. This section is not constant but it varies between 600 to 1200 km from the location of the transmitter during the course of the day. This may cause additional time fluctuations of about some milliseconds at permanent locations.

2.5 Data String Synchronisation

It is possible to set a DCF-slave data string in all serial data outputs in **hopf** radio controlled clocks or systems. This string serves to synchronise sub-master systems. It contains all the required data like hour, minute, second, day, year and status message of the master clock.

This string is transmitted between the control signals STX (start of text) and ETX (end of text). The baud rate is 9600 baud , i.e. about one signal per millisecond. Whereas all data, except for ETX, are transmitted with the data of the following full minute in the 59^{th} second, the ETX is transmitted exactly on the minute change.

The received data are decoded on the board 6855 and after plausibility and upward compatibility checks supplied for synchronisation. In case of the first synchronisation, once the ETX signal is received, the data are written into the crystal clock and the internal millisecond counter is set to 1 millisecond.

The millisecond counter is no longer synchronised in further synchronisation data strings, but the status of the counter is maintained. The counter must read 1 when the crystal clock runs precisely.

In case of inaccuracies 2 control values are produced for the crystal clock

- control value for the present inaccuracy and
- control value for the tendency of the inaccuracy

Pt. 1 adjusts the time softly to ± 1 msec and pt. 2 counteracts long-term errors of the crystal e.g. ageing. After 8 hours of synchronisation the crystal has reached an accuracy of ± 2 ppm at constant temperature. This accuracy is maintained by the board or system in case of a transmission failure or error.

PLEASE NOTE :	*A SYNCHRONISATION WITH THE DCF-SLAVE DATA STRING IS ONLY POSSIBLE AT COM 1. WHEN THE DCF-SLAVE SYNCHRONISATION HAS BEEN SET THE SERIAL PARAMETER FOR COM 1 ARE SET AUTOMATICALLY (ALSO SEE PT.* ***STATUS OF SYSTEM AND SERIAL PARAMETER****).*

3 Commissioning

3.1 Voltage Supply

The system is available with different voltage supplies. Therefore please take note of the right voltage and polarity when connecting the power supply.

The standard voltages available are:

for stand alone systems

- 230 V AC +10%, -15%
- 120 V AC +10%, -15%

for plug-in cassettes

- + 5V/1A DC, +/-5%
- Other voltage supplies are available on request

PLEASE NOTE :	*ONLY AUTHORISED AND TRAINED PERSONNEL MAY CARRY OUT THE COMMISSIONING*

3.2 Antenna Installation

All ***hopf*** antennas are active antennas of directional character. They should therefore be directed to maximum reception of the signal. The outdoor antenna should be fixed to the wall facing the direction Frankfurt. Also the antenna foot has to point to Frankfurt by loosening the screw underneath the antenna foot. This results in the best signal/noise ratio.

Our portable DCF77-signal analysis device can be supplied to customers to help in the search for the best location for the installation of the antenna.

If the direction Frankfurt is unknown when aligning the antenna foot, the antenna alignment programme can be called up to help.

3.3 Set-up Base System

By supplying the correct operating voltage the device is switched on.

3.3.1 Display

In case of the first set-up or after 3 days without voltage supply the following picture is displayed on the 2x16-digit LCD display:

LT: [1] **00:00:00** [2] **S - C**
[3] - - [4] - - / - - - / - - - -

The positions have the following meaning:

[1] **LT**: 00:00:00
Here the local time is displayed.

[2] Status display:

position 1 **X--** **"S"** for standard time
"D" for daylight saving time

position 2 **-X-** **"A"** announcement of changeover to a different time zone. The announcement occurs at the earliest 57 minutes before the time zone changeover.

position 3 **--X** Display of the internal status of the clock system:
"C" = the clock system runs on crystal operation
"r" = the clock system runs on radio operation
"R" = the clock system runs on radio operation. Reception at highest accuracy- soft adjustment of accuracy

[3] Display of the days of the week abbreviated:
MO - TU - WE - TH - FR - SA - SU

[4] Display of the date:
day / short form of month / year

The lighting of the display is switched on as soon as the voltage supply is connected or a key is pressed. If the keypad is not used for any entries for 4 minutes the lighting switches itself off again.

3.3.2 Standard Display

After a power cut (< 3 days), the display starts with the internally continued back-up clock information.

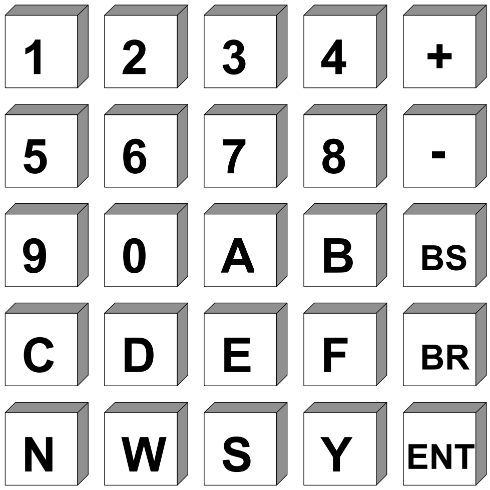
3.3.3 Status LED

On the front panel next to the **GPS/DCF IN** connector there is a yellow LED for status messages.

Depending on the structure of the system, the LED can indicate the following status:

- In systems which control synchronous clocks (board 7405) the LED indicates the data flow on the system bus.

4 Key-Pad



4.1 Key Functions

+/- = entry of sign of numbers
BS = BACKSPACE, deletes the last entry
BR = BREAK, stops all key controls
ENT = ENTER, activates the key pad and enters values

4.1.1 Key-Pad 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 key-pad or system control of start picture. Three input or control modes can be selected at present. By entering the according numbers the key entry jumps to the according mode.

Start-picture:

SET=1 SHOW=2
S.CLOCK=3 INI=4 _

The modes have the following meaning:

SET: input of set functions like time/date, interface parameter, time offset, clock status etc.
SHOW: selection of display functions like time difference, interface parameter etc.
S.CLOCK: input of set functions like start, stop and pulse of synchronous clock
INI: initialising function, reset of the radio controlled clock.

4.2 SET-Functions

When the number 1 is entered the program returns to the set-functions. The program is structured as a user guidance. All the sub-functions are shown on display and selected by

"Y" = yes or turned down by
"N" = no

any key but **"Y"** and **"BR"** is read as no.

When **"N"** is selected the next sub-function is displayed. At present the following set functions can be chosen.

4.2.1 System status

This entry is used to set various basic settings e.g. language of the user guidance or synchronisation mode.

selection picture

SET SYSTEM
STATUS Y/N

When **"Y"** is entered the following appears

selection picture

BIT 7 6 5 4 3 2 1 0

"0" and "1" on the key-pad are used to set the individual status bits and "ENT" to take them over fail-safe into the system.

The bits have the following meaning

Bit 7
0 = time displayed is the local time
1 = time displayed is UTC

Bit 6
free

Bit 5
0 = German language as user guidance
1 = English language as user guidance

Bit 4	Bit 3	Time base for the DCF77 simulation
0	0	Standard
0	1	CET
1	0	UTC
1	1	Standard

Bit2	Bit 1	Bit0	Synchronisation via
0	0	0	crystal clock
0	0	1	DCF77-antenna
0	1	0	DCF77-pulse input
0	1	1	DCF slave by serial data string **(only COM1)**
1	0	0	DCF77-antenna simulation (not **CET**)
1	0	1	DCF77-pulse input (**not CET**)
1	1	0	DCF slave by serial data string **(not CET / only COM1)**

1. **Crystal Clock**
   No evaluation of the time information. The clock has only the accuracy of the internal quartz.
2. **Synchronisation by the DCF77-antenna**
   This requires an antenna or antenna distributor to receive or distribute the original DCF77-time signal. The difference to UTC is fixed to 1 hour.
3. **Synchronisation by the DCF77-pulse input**
   In this setting a DCF77-pulse signal is applied at the VG ledge (pin 1c / GND1 pin 1a) by the optical coupler input[2]. It is automatically detected if the signal is LOW or HIGH active. By reception of the origin time code transmitter the difference time is fixed to 1 hour.
4. **Synchronisation by serial data string**
   In this setting a DCF-slave data string is transferred to the clock via the serial interface COM 1. The interface is barred from other data traffic. The UTC-time difference is fixed to 1 hour.
5. **Synchronisation by DCF77-antenna simulation (worldwide)**
   In order to synchronise the 6855 in this mode a simulation signal of up to 20 mV_{ss} is supplied to the antenna connector "DCF in". As this simulation is also possible with time zones other than CET, e.g. Asia, the time difference to UTC is freely selectable.
6. **Synchronisation by the DCF77-pulse input (worldwide)**
   In this setting a DCF77-pulse signal is applied at the VG ledge (pin 1c / GND1 pin 1a) by the optical coupler input. It is automatically detected if the signal is LOW or HIGH active. The time difference to UTC is freely selectable.
7. **Synchronisation by serial data string (worldwide)**
   In this setting a DCF-slave data string is transferred to the clock via the serial interface COM 1. The interface is barred from other data traffic. The UTC-time difference is freely selectable.

[2] The optical coupler input has it's own pull-up resistor and potential isolation, so a open collector circuit to GND1 is sufficient for the signal generation.

4.2.2 Time/Date Entry

selection picture

SET TIME Y / N _

entry picture

TIME: HH:mm:ss
d.DD/MM/YYYY.Z

This entry function can set the local time. The entry has two lines and must be complete. Leading naughts must also be entered.

The positions have the following meaning:

Input	1. step	**HH**	= hour	range	from 00 - 23
	2. step	**mm**	= minute	"	from 00 - 59
	3. step	**ss**	= seconds	"	from 00 - 59
	4. step	**d**	= day of the week	"	from 1- 7 (1 for Monday...7 for Sunday)
	5. step	**DD**	= day	range	from 01 - 31
	6. step	**MM**	= month	"	from 01 - 12
	7. step	**YYYY**	= year	"	from 1970 - 2069
	8. step	**Z**	= time zone S or D		

If the entry is plausible, the time is taken over into the system, otherwise the information **"INPUT-ERROR"** is shown for 3 seconds. The set-function is left at **"INPUT-ERROR"**, the standard picture is displayed again. To continue the entry any key but **"Y"** and **"BR"** may be pressed.

BReak leaves the set program. The standard picture reappears.

PLEASE NOTE : *IF THE ENTERED TIME ZONE (SUMMER / DAYLIGHT SAVING TIME) DIFFERS FROM THE SYSTEM VALUE SET BEFORE THE NEW ENTRY, IT TAKES 2 MINUTE CHANGES BEFORE IT IS TAKEN OVER. AFTER THE FIRST MINUTE CHANGE THE SYSTEM TIME RETURNS FOR 1 MINUTE TO THE VALUE WHICH EXISTED BEFORE THE ENTRY. THIS PHENOMENON IS DUE TO VARIOUS PLAUSIBILITY CHECKS WHICH THE SYSTEM RUNS INTERNALLY.*

4.2.3 Time Difference

selection picture

SET DIF.-TIME
Y/N _

entry picture

DIF-TIME: _

This function is used to enter the time difference between the local standard time and the world-time (UTC). The sign indicates in which direction the local time deviates from the worldtime.

In general it is:

+ means East of
– means West of the 0 meridian

Most countries in the world choose time differences in steps of full hours, the entry is also done in hour steps.

e.g. **+ 05:00** or – **11:00**

Some countries though do have smaller time steps, entries in minutes are therefore permissible.

e.g. **+ 05:30** or – **08:45**

> ***PLEASE NOTE :*** *THE TIME DIFFERENCE ALWAYS REFERS TO THE **LOCAL STANDARD TIME,** EVEN IF THE SET-UP OR THE ENTRY OF THE DIFFERENCE TIME IS DONE DURING THE POSSIBLE DAYLIGHT SAVING TIME.*

4.2.4 Time Zone Changeover

Some countries in the world have, depending on the season, two time zones - one standard time (also called wintertime) and a daylight saving time (also called summertime). The daylight saving time has a time-offset + 1 h. to the standard time. The changeovers are always carried out on the last Sunday of the month at night-time. Only the hour of the changeover and the month must be entered. Then at the turn of the year the exact point of changeover is calculated automatically. The **show** function shows the exact date for your information. If there is no time zone changeover in the country, 00 are entered for month and hour.

> ***PLEASE NOTE :*** *THIS INPUT IS ONLY ACTIVE IF THE SYSTEM IS RUNNING AS QUARTZ CLOCK. THE CHANGES ARE MADE AUTOMATICALLY BY THE DCF77 TELEGRAM IN CASE OF OTHER SET-UPS.*

Selection picture

daylight saving / standard time changeover	standard / daylight saving time changeover
SET CHANGEOVER	**SET CHANGEOVER**
TIME D → S Y/N	**TIME S → D Y/N**
(**D**ay-light-saving-time ⇨ **S**tandard-time)	(**S**tandard-time ⇨ **D**ay-light saving time)

Entry picture

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

The 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 **=** number of the day of the week in the month when the changeover is to take place (week counter)
1st ... 4th day in the month e.g. 1st ... 4th Sunday in the month
5 last day e.g. last Sunday in the month

MM = the month when the changeover is to take place

The entry is completed by ENT.

4.3 Serial Interface Parameter

For each of the two interfaces the parameters like baud rate, parity etc. and the modes can be entered separately. The following selection pictures appear.

Except for: If the synchronisation is set via the serial data string the parameter for the interface COM 1 can be selected but they are automatically reset to the setting for the reception of the DCF-slave data string.

> **PLEASE NOTE :** *THE SYNCHRONISATION WITH THE DCF-SLAVE DATA STRING IS ONLY POSSIBLE AT COM 1.*

4.3.1 Selection Picture Parameter of Serial Interface

SET COM_0 SERIAL or **SET COM_1 SERIAL**
PARAMETER Y/N_ **PARAMETER Y/N_**

see point 7: parameter of the serial transmission

4.3.2 Setting Modebyte 1, Selection of Output Features

selection picture

SET COM_0 or **SET COM_1**
MODE_1 Y/N_ **MODE_1 Y/N_**

see point 6: configuration of the data string (mode byte)

4.3.3 Setting Modebyte 2 Selection of the Output Data Strings

selection picture

SET COM_0	or	**SET COM_1**
MODE_2 Y/N_		**MODE_2 Y/N_**

see point 6: configuration of the data string (mode byte)

4.3.4 Status and Pulse Output (optional at present)

At VG-ledge (pin 8c) there is a programmable output which can be used for status or pulse messages.

The programming is done by entering one byte. The programming is called up by the following picture:

SET STATUS– OR
PULS-OUTPUT Y/N

On entering **"Y"** the following picture is shown:

BIT 7654 3210

Once the complete byte is entered it is taken over by ENT.

Now a "0" or a "1" for the individual bits can be entered in the second line, while a "1" is like a switch-on function. As there is only one output available only a "1" may be set in the byte. In case of several "1" conditions the function for the lowest bit is carried out.

The bits have the following meaning for the switching of the output to naught:

Bit 7	free	
Bit 6	free	
Bit 5	3 minute pulse	on-period 1 s
Bit 4	day pulse (24 h)	on-period 1 s
Bit 3	hour pulse	on-period 1 s
Bit 2	minute pulse	on-period 1 s
Bit 1	second marker	on-period 250 msec
Bit 0	Status radio operation	

4.3.5 Special Byte

The special byte is used to control customised and special programmes.

selection picture

SET SPECIAL
BYTE Y/N _

Entering **"Y"** calls up the following entry picture

entry picture

BIT 7 6 5 4 3 2 1 0

The keys **"0"** and **"1"** on the key-pad can now be used to set the individual bits and to take them over failsafe into the system by **"ENT"** once the complete byte has been entered.

You will find the description of the individual bits in the respective special descriptions. In the standard version this byte is not active.

4.3.6 Data Security

All the entry data of points 4.2.2 - 4.3.3 are checked for plausibility and then stored in a voltage fail-safe EEPROM. To check the values a hardware-reset is carried out so that the stored values in the EEPROM are reread into the working memory.

4.3.7 Set Difference Days

This entry is only necessary in special programmes and will be described in the according special description.

4.3.8 LAN-IP-Address (Option)

It is possible to enter the LAN-IP-address as well as an additionally control bit via the keypad if the system will be extended with one or two LAN-boards.

You will find further information in the description of the board 7270.

4.4 Checking the Entered Values

To check the entered values or those updated by the GPS receiver, the **SHOW**-function is called up.

After jumping to the key-pad- basic picture by pressing **"ENT"**, the number 2 is entered. The first **SHOW** selection picture appears.

The **SHOW**-function can be interrupted by **"BR"** = break at any time.

4.4.1 Time Difference

This function enables you to view the actual time difference between local and UTC time.

Request picture

SHOW DIF.– TIME
Y/N _

After pressing the **Y**es key the time difference is shown by :

DIF-TIME: +02:00 _

If **"N"** or any other key except **"Y"** and **"BR"** is entered, the display jumps to the next request picture.

4.4.2 Time Zone Changeover D ⇨ S

This function shows the point of changeover from daylight saving time to standard time.

selection picture

SHOW CHANGE-OVER
D ⇨ S Y/N _

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

ZEIT: 03.00.00
7.28/09/1994_ D > S

The changeover has been carried out on Sunday 28th September 1994 at 03.00h.

4.4.3 Time Zone Changeover S ⇨ D

This function shows the point of changeover from standard time to daylight saving time.

selection picture

SHOW CHANGE-OVER
S ⇨ D Y/N _

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

ZEIT: 02:00:00
7.30/03/1994 S > D

The changeover has been carried out on Sunday 30th March 94 at 2.00h

4.5 Initialising Function

After jumping into the menu picture by the key **"ENT"** the **INI**- function area is activated by the digit **"4"**. The 1. selection picture for the **INI-**function appears.

4.5.1 Delay of the Status Change "no radio control"

The display also shows in the serial data strings whether the system is synchronised by the DCF77-signal or whether it is running on internal crystal basis. In connected devices this information is often used for error messages. To avoid a short interruption of the reception being interpreted as an error, the status change from reception to crystal basis can be delayed. The delay period can be set from 2-255 minutes.

selection picture

DELAY STATUS–
CHANGE Y/N_

Entering “Y“ moves the display to the input mode. The following picture is shown

STATUS CHANGE
AFTER > xxx < MIN.

The xxx are replaced by the presently valid delay period.

The key **"+"** increases the time and **"-"** diminishes it. When you leave the programme by means of the key **"BR"** the value displayed last is stored in a non-volatile memory.

4.5.2 Setting for DCF77-Simulation

The DCF77-simulation can continue even if there is no DCF77-reception or if the signal is disturbed for a short time. This menu point is used to set the delay time between 2-254 minutes. After that time, the DCF77-signal will be disturbed. The connected devices are no longer synchronised and may release error messages.

In case of a setting of 255 minutes there is a continuous DCF77-simulation even without DCF77-reception. In the setting crystal mode (system byte, bit 0 = off), the simulated DCF77 signal is constantly put out regardless of the pre-set simulation period and without decoding of the DCF77 entry signal. This setting is therefore most suitable for testing connected systems or if the clock is to operate as crystal clock.

Selection picture

DELAY DCF_SIM
STOP Y/N_

Entering **"Y"** moves the display to the input mode. The following picture is then shown.

DCF-SIM STOP
AFTER > xxx < MIN

The presently valid delay time replaces the >xxx<. The key **"+"** increases the time and **"–"** diminishes it.

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

4.5.3 Alignment of the Antenna

This programme can be used to align the antenna. The black bar underneath the antenna foot is turned to the presumed direction Frankfurt. Then the programme 'alignment of the antenna' is started.

ANTENNA ALIGMENT
Y/N

entry **"Y"**

The control of the signal amplifier is restarted. The display is deleted. After 20 seconds the amplification of the signal required for the location is reached again and maintained. The display shows the following picture over both lines

" □□□□□□□□□□□□□
□□□□□□□□□ "

which moves backwards every second by 5-10 bars depending on the DCF77-signal dip.

Display DCF77-dip

" □□
"

When the antenna is slowly turned from its position the received field strength changes. As the amplification is blocked the signal is not adjusted. If the presumed direction is correct, the displayed pictures change.

The field strength diminishes and so does the number of bars.

from about

" □□□□□□□□□□□□□□
□□ "

to

" □
"

When the antenna is turned by exactly 90° from the direction Frankfurt, only a fraction is left of the field strength.

The display stays constant at 1 or 2 bars.

" □□
"

The antenna is turned again by 90° to the best alignment.

The alignment of the antenna should then be completed by checking the reading of the amplification.

4.5.4 Display of the Amplification

The amplification is controlled by the processor by a pulse width modulation. A relative percentage value for the control range of the amplifier is calculated from this.

SHOW DCF-SIGNAL
RESERVE Y/N _

The display shows

DCF-SIGNAL-
RESERVE: xxx %

4.5.5 Carry Out Program Reset

PROGRAMM RESET
Y/N _

Entering **"Y"** releases the **P**rogram-**R**eset. The programme jumps back to the start of the programme. Other functions are not carried out. This function sets the programme counter back to the beginning.

4.5.6 Carry Out Master Reset

The following picture guides the selection

HARDWARE RESET

Y/N _

When **"Y"** is entered it starts a **M**aster-**R**eset. The reset line on the board is set to naught for a short time. This causes all the other chips in the system to be set to naught and the programme jumps to programme start.

4.6 Summary Key Pad

- the main menu is activated by pressing the **ENT** key.
- selection of functions by **1** to **4**
- stopping an entry or switch to standard picture by **BR**eak
- finishing entries by **ENT**er
- selection of individual functions by **Y**es
- pass function by **N**o or any other key except **BR**eak and **Y**es.
- plausibility errors are indicated by **INPUT-ERROR**, new selection and entry is required.

4.6.1 Set Functions

- local time, points of changeover

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	1 - 2
YEAR	H	Y	0 - 9
YEAR	T	Y	0 - 9
YEAR	S	Y	0 - 9
.			
time zone	D or S		

4.7 Display Functions

- settings of synchronous clocks
- points of changeover
- amplification
- interfaces parameter
- interfaces modebyte
- alignment of antenna

4.8 Control of Synchronous Clocks

If the circuit board 6855 is used in a sub-system with synchronous clock lines, these lines are controlled via menu pt.3.

Up to 4 lines can be managed by the board.

After menu pt.3 is called up, the selection picture for the number of the synchronous clock appears.

SLAVE CLOCK NO.
1 - 4 >

Entering number 1-4 selects the according synchronous clock. This number is kept in all subsequent pictures.

To control the synchronous clocks the following points are available.

4.8.1 Viewing Synchronous Clock

This command shows all information about the synchronous clock.

selection picture

SLAVE CLOCK NO: x
SHOW Y/N

x = number of synchronous clock

When **"Y"** is entered the status picture of the synchronous clocks is shown.

e.g.

SC.x R: 15.43.17
3,0 s 19/01/98

or

SC.x S: 15.45.18
3,0 s 19/01/98

x	=	stands for the selected synchronous clock	
R	=	**R**un	the synchronous clock is running
S	=	**S**top	the synchronous clock has stopped
			15.43.17 and 15.45.18 is the time of the synchronous clock
			15.43.18 19/01/98 date of the synchronous clock day/month/year

Pressing any key but **"BR"** up-dates the display.

"BR" stops the display.

4.8.2 Setting the Synchronous Clock

After commissioning or after repair works to the synchronous clock it must be updated to the current time.

selection picture

SLAVE CLOCK NO.x
SET Y/N

The entry picture appears once **"Y"** is entered.

SC.-NO. x SET TIME
>

The time shown by the **synchronous clocks** is now entered in **HR : MI : SE**, ended by **ENT.** The date is added automatically. The complete data string is now transmitted to the according synchronous clock. If this clock was stopped before this entry automatically starts the clock again. A master reset of the system also releases an automatic start of the clocks.

Please note the following: If synchronous clocks with 12 or 24 hour clocks are used together the time of the 24 hour clock must be entered.

4.8.3 Start/Stop Synchronous Clock

In case of commissioning or repairing the synchronous clock we advise stopping the clock line first.

All the clocks must be set mechanically to the same time in case of commissioning. Then following pt.5.2 puts the clock into operation.

The repair of a synchronous clock e.g. exchange of a clock, requires the mechanical setting of the exchanged clock to the time of the other clocks to put the line back into operation.

selection picture

SLAVE CLOCK NO.x
RUN /STOP Y/N

Entering **"Y"** shows the selection picture

SLAVE CLOCK NO.x
RUN = + STOP = --

+ = Start of the line
– = stopping the line

Completing the entry by ENT not necessary

4.8.4 Synchronous Lines Pulse Time

The analogue synchronous clocks need a pole-alternating setting pulse varying in length depending on the size. This pulse can be set individually for every line between 0.2 s and 3.2 s.

Selection picture

SLAVE CLOCK NO.x
SET PULS Y/N

The following entry picture appears once **"Y"** is entered

S.CLOCK x PULS
IN=+/- > 3.0 < sec

At present the valid pulse is up to 3.0 seconds long. It can be increased by + or diminished by - in steps of 0.1 sec.

The pulses are stored in a fail-safe memory. Completing the entry by **ENT** is not required. The picture is left by entering **BR.**

5 Signal- and Data output

5.1 Configuration of the Serial Interfaces

The satellite radio controlled clock is equipped with two serial interfaces with handshake line which can be set independently. The data are exchanged via RS232c(V.24) or RS422 (V.11) signal level. The interfaces can be used for the transmission of time data strings to other computers.

The ***hopf*** 6021, Siemens MADAM-S and SINEC H1, IBM Sysplex and ABB T-String data strings are the supported time data strings. Customised data strings are available on request. The following settings are possible separately for serial interfaces COM 0 and COM 1.

5.1.1 Parameter of the Serial Transmission

The interface is parametered by means of the key pad. The setting for baud rate, data bit, stop bit and parity is reached by pressing the **[ENT]** key and selecting the **"SET"** function. In the selection dialogue the entry for **COM 0** or **COM 1** must be chosen. Only the interface **0** is described below. The same settings apply to the interface **1**.

- **enter** - key
- **"1"** for "SET - functions"
- select "SET COM_0 SERIAL PARAMETER Y/N"
- **"Y"**

The interface - parameter - dialogue appears on LCD-display showing:

B:_

Here the baud rate must be entered as a five digit numeric value. The following entries are possible:

- 19200 for 19.200 baud
- 09600 for 9.600 baud
- 04800 for 4.800 baud
- 02400 for 2.400 baud
- 01200 for 1.200 baud
- 00600 for 600 baud
- 00300 for 300 baud
- 00150 for 150 baud

After the entry of the last digit the following message is displayed:

W:_

Here the number of data bit for the transmission must be entered. Possible entries are:

- 8 for 8 data bit
- 7 for 7 data bit

After the entry of the digit for the number of data bits the following message is displayed:

P:_

Here the type of parity bit for the transmission must be entered. Possible entries are:

- N for no parity
- E for parity even
- 0 for parity odd

When the parity function is entered the following message is displayed:

S:_

Here the number of stop bits for the transmission must be chosen:

- 1 for 1 stop bit
- 2 for 2 stop bit

Finally the release for the handshake lines RTS and CTS appears:

HS:_

The following can be entered here

- N data transmission **without** handshake
- Y data transmission **with** handshake

After the entry of the number of stop bits the key **[ENT]** must be pressed, which causes a plausibility check of all entries. If all the entries are plausible the settings are taken over.

PLEASE NOTE : *IN CASE OF A FAULTY ENTRY YOU CAN USE THE KEY* ***[BS]*** *(BACKSPACE) TO RETURN TO THE PREVIOUS EDITING FIELD AND REWRITE IT.*

5.2 Configuration of the Data String (Modebyte)

The time information received via DCF77 can be put out via the interfaces in a data string stating the internal clock status. This enables the user to synchronise connected computers with the atom accurate time. The read out point of time, the string structure and the used control characters can be chosen by entering the according **Modebyte 1 and 2**.

You reach the set function for the **Modebyte** via the following combination of keys :

- **enter** key
- **"1"** for "SET functions"
- selection of "SET COM_0 MODE 0/1 Y/N"
- **"Y"**

The input mask for the **Modebyte** appears:

BIT 7654 3210

The LCD cursor is now under the bit position 7. Every bit is like a switch by means of which the mode of the serial interface can be set. Depending on the required mode of the serial interface either

0 = switch off
or 1 = switch on

must be entered under every bit position. The meaning of every bit position (switch) is explained in the chapters below.

5.2.1 Local or UTC Time with Modebyte 1

Bit position 7	time zone
on	local time
off	UTC time

5.2.2 Second Advance of the Serial Output with Modebyte 1

Bit position 6	second advance
off	with second advance
on	without second advance

5.2.3 Transmission with Control Characters STX/ETX with Modebyte 1

These setting are only for data string in witch control character are defined as delimiters.

Bit position 5	transmission with control chg.
off	with control characters
on	without control characters

5.2.4 Last Control Character as On-Time-Marker with Modebyte 1

When this setting has been activated and also the transmission with control characters has been selected (STX/ETX), then the last character ETX is transmitted on the next second change.

Bit position 4	Control Character on second chg. only when 'with control characters' is selected
off	with control char. on second change
on	without control char. on second chg.

5.2.5 Control Characters CR and LF with Modebyte 1

The characters CR and LF can be changed with this switch.

Bit position 3	Control Character CR and LF
off	LF/CR
on	CR/LF

5.2.6 Delayed Transmission with Modebyte 1

In case of the setting "control characters on the second change" the last character of the data string is transmitted on the second change and straight afterwards the new data string which is valid for the next second change. This causes errors in some highly loaded computers. Bit position 2 can delay the transmission of the new data string depending on the baud rate.

Example :

Baud rate 9600 baud

milliseconds	with delay	without delay
000	final character (ETX)	final character (ETX)
002	–	new data string
25	–	end of new data string
930	new data string	–
955	end of new data string	–
000	final character (ETX)	final character (ETX)

Baud rate 2400 baud

milliseconds	with delay	without delay
000	final character (ETX)	final character (ETX)
002	–	new data string
105	–	end of new data string
810	new data string	–
913	end of new data string	–
000	final character (ETX)	final character (ETX)

Bit position 2	delayed transmission
off	with delayed transmission
on	without delayed transmission

5.2.7 Synchronisation Point with Modebyte 1

Bit position 1 a. 0		Transmission Point
off	off	transmission every second
off	on	transmission on the minute change
on	off	transmission on the hour change
on	on	transmission on request only

5.2.8 Data String Selection with Modebyte 2

The output data string is set by this mode byte. Bits 3-0 are used to address the standard programs. All other bits are set to **"off"**.

Bit position 3	2	1	0	Data String Structure
off	off	off	off	standard data string 6855 (6021 compatible)
off	off	off	on	standard data string 6855 (6021) time only
off	off	on	off	DCF-Slave
off	off	on	on	Siemens SINEC H1
off	on	off	off	Siemens Madam-S
off	on	off	on	IBM Sysplex Timer
off	on	on	off	standard data string 6855 (6021) with year 2000
off	on	on	on	T-String
on	off	off	off	ABB_S_T-String
on	off	off	on	NGTS-String
on	off	on	off	Master/Slave-String
on	off	on	on	standard data string 6855 (6021) right now
on	on	off	off	data string 5500 time and date
on	on	off	on	data string 5500 time only
on	on	on	off	standard 6855 (6021) at UTC with local status
on	on	on	on	standard data string 6855 (6021) right now

5.2.9 Customised Programs

If a special customised program is integrated in the system, the program is released by bit 4.

Bit position	program select
Bit 4 = "off"	standard program addressed
Bit 4 = "on"	customised program addressed

The customised programs are described in a separate part of the description.

5.2.10 Output Standard time only

The daylight saving time change over-over can be blocked through bit 5.

The same is valid for the requests with "D" and "U".

In this mode the status of the string neither includes the information "daylight saving time" nor the announcement of the change-over.

This output should only be used with original DCF77-reception due to the fact that just one hour is added to the UTC-time and therefore only CET will be given out.

bit position	meaning
bit 5 = "off"	daylight saving time / standard time
bit 5 = "on"	standard time only

5.3 Data Format of the Serial Transmission

The data are transmitted as BCD values in ASCII and can be displayed by every terminal programme (e.g. TERMINAL.EXE under Windows). The following control characters from the ASCII set of characters are used in the data string if necessary.

- $20 = space
- $0D = CR (carriage return)
- $0A = LF (line feed)
- $01 = SOH (start of header)
- $02 = STX (start of text)
- $03 = ETX (end of text)

PLEASE NOTE : *THE STATUS VALUES MUST BE DECODED SEPARATELY (SEE DATA STRING STRUCTURE).*

5.4 Serial Request

5.4.1 Serial Requests with ASCII Characters in the standard data string 6855

The user can start a data string output using an ASCII character. These control characters are:

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

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

This is often too fast for the requesting computer. It is therefore possible to delay the answer in 10 msec steps by software in case of request. To delay the transmission of the data string the small letters "u,d,g" are transmitted to the clock by the requesting computer with a two digit multiplication factor.

The multiplication factor is interpreted by the clock as hexa decimal values.

Example:

The computer sends **ASCII u05** (Hex 75, 30, 35)
After 50 milliseconds the clock answers with the data string time only (local time).

The computer sends **ASCII gFF** (Hex 67, 46, 46)
The clock sends the data string time/date (UTC time) after 2550 milliseconds

5.4.2 Serial Requests in MADAM S

In case of MADAM-S output compatible, the output on request only can be activated by the following character sequence only

:ZSYS:
or **:WILA:**

PLEASE NOTE : *IN CASE OF OUTPUT ON REQUEST IT SHOULD BE SET IN THE MODE-BYTE 1, OTHERWISE AN ACTIVE CYCLIC OUTPUT CAN CAUSE A DELAY IN THE ANSWER.*

6 Data Strings

6.1 General Information on the Serial Data Output of the 6855

The control characters STX and ETX are transmitted only if in modebyte 1 the output "with control characters" has been set. Otherwise these control characters are missed out.

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

The output of the control characters CR and LF can be exchanged with modebyte 1 in all data strings.

The transmitted data strings are compatible with the data strings of the following ***hopf*** radio clocks:

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

6.2 Structure of the Data String 6855/6021 Time and Date

character no.	meaning	
1	STX (start of text)	
2	status (internal clock status)	; see 6.2.2
3	day of the week (1=Monday...7=Sunday) for UTC time bit 3 is set to 1 in the day of the week	; see 6.2.2
4	hour tens digit	
5	hour unit digit	
6	minute tens digit	
7	minute unit digit	
8	second tens digit	
9	second unit digit	
10	day tens digit	
11	day unit digit	
12	month tens digit	
13	month unit digit	
14	year tens digit	
15	year unit digit	
16	LF (line feed)	; see 6.1
17	CR (carriage return)	; see 6.1
18	ETX (end of text)	

6.2.1 Structure of the Data String 6855/6021 Time Only standard

character no.	meaning	
1	STX (start of text)	
2	hour tens digit	
3	hour unit digit	
4	minute tens digit	
5	minute unit digit	
6	second tens digit	
7	second unit digit	
8	LF (line feed)	; see 6.1
9	CR (carriage return)	; see 6.1
10	ETX (end of text)	

6.2.2 Status- and Day of the Week Nibble in the Data String 6855/6021

The second and the third ASCII-characters contain the status and the day of the week. The status is decoded binarily. The structure of these characters:

	b3	b2	b1	b0	meaning
status nibble:	x	x	x	0	no announcement hour
	x	x	x	1	announcement (DS-ST-DS)
	x	x	0	x	standard time (ST)
	x	x	1	x	daylight saving time (DS)
	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

The standard data string can be selected with 2 different settings in modebyte 2. The difference consists into state information when UTC will be transmitted.

	meaning
6855 standard Modebyte 2: 0000 0000	**local time:** status with local time information like announcement bit and daylight saving / standard time bit **UTC:** status announcement and daylight saving / standard time bit forever **low**, UTC-output bit **high**
6855 standard at UTC with local status Modebyte 2: 0000 1110	**local time:** status with local time information like announcement bit and daylight saving / standard time bit **UTC:** status like local time output, UTC-output bit **high**

6.2.3 Example of Data String 6855/6021

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

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

6.3 Structure of the Data String DCF-Slave

This data string is used to synchronise ***hopf*** DCF-slave systems. The only difference to the standard data string 7001/6021 is the status byte.

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

6.3.1 Status in the Data String DCF-Slave

	b3	b2	b1	b0	meaning
status nibble:	x	x	x	0	no announcement hour
	x	x	x	1	announcement (DS-ST-DS)
	x	x	0	x	standard time (ST)
	x	x	1	x	daylight saving time (DS)
	x	0	x	x	no announcement leap second
	x	1	x	x	announcement 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

6.3.2 Example of a Data String DCF-Slave

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

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

6.3.3 Setting

The synchronisation of the ***hopf*** salve system requires the following setting:

- output every minute
- output second advance
- ETX on the second change

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

PLEASE NOTE : *IN CASE OF THE SETTING OF THE DCF-SLAVE STRINGS IN MODE BYTE 2 MODE BYTE 1 IS AUTOMATICALLY SET AS DESCRIBED ABOVE. WHEN THIS SETTING IS ALTERED IN MODE BYTE 1 - AFTER MODE BYTE 2 IS ENTERED - THERE IS NO AUTOMATIC CORRECTION. THEREFORE WE ADVISE CHECKING THE CORRECT SETTING IN MODE BYTE 1 BEFORE USING THE DCF-SLAVE STRING.*

6.4 Data String SINEC H1

The control characters STX and ETX are transmitted only if the output 'with control characters' has been set at the dip-switch block 2. Otherwise these control characters are missed out. In case of the setting ETX delayed the last character (ETX) is transmitted on the second change.

The data string can be requested with **"?"**.

character no.	meaning	value (value range)	
1	STX (start of text)	$02	
2	"D" ASCII D	$44	
3	":" colon	$3A	
4	day tens digit	$30-33	
5	day unit digit	$30-39	
6	"." point	$2E	
7	month tens digit	$30-31	
8	month unit digit	$30-39	
9	"." point	$2E	
10	year tens digit	$30-39	
11	year unit digit	$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	hours tens digit	$30-32	
20	hours unit digit	$30-39	
21	"." point	$2E	
22	minutes tens digit	$30-35	
23	minutes unit digit	$30-39	
24	"." point	$2E	
25	second tens digit	$30-36	
26	seconds unit digit	$30-39	
27	";" semicolon	$3B	
28	"#" or space	$23 / $20	; see 6.4.1
29	"*" or space	$2A / $20	; see 6.4.1
30	"S" or space	$53 / $20	; see 6.4.1
31	"!" or space	$21 / $20	; see 6.4.1
32	ETX (end of text)	$03	

6.4.1 Status in the Data String SINEC H1

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

Meaning:

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 internal crystal of the clock
	Space	time from radio reception
Character no.: 30 =	"S"	daylight saving time
	Space	standard time
Character no.: 31 =	"!"	announcement of a W/S or S/W changeover
	Space	no announcement

6.4.2 Example of a Data String SINEC H1

(STX)D:03.01.96;T:1;U:12.34.56; _ _ _ _ (ETX) (_) = Space

radio operation, no announcement, standard time
It is Wednesday 03.01.96 - 12:34:56 h

6.5 The data string MADAM-S

The structure depends on the request string. When the superior computer (PROMEA-MX) requests with the string:

:ZSYS:

the clock answers with the following data string:

character no.	meaning	value (value range)	
1	STX (start of text)	$02	
2	: colon	$3A	
3	Z	ASCII Z $5A	
4	S	ASCII S $53	
5	Y	ASCII Y $59	
6	S	ASCII S $53	
7	: colon	$3A	
8	status of the changeover	$00, 01, 7F	; see 6.5.1
9	time scale identification	$30-33	
10	day of the week	$31-37	
11	tens - year	$30-39	
12	unit year	$30-39	
13	tens month	$30-31	
14	unit month	$30-39	
15	tens day	$30-33	
16	unit day	$30-39	
17	tens hour	$30-32	
18	unit hour	$30-39	
19	tens minute	$30-35	
20	unit- minute	$30-39	
21	tens second	$30-35	
22	unit second	$30-39	
23	LF (line feed)	$0A	; see 6.1
24	CR (carriage return)	$0D	; see 6.1
25	ETX (end of text)	$03	

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

:WILA:

the clock answers with the following data string

character no.	meaning	value (value range)	
1	STX (start of text)	$02	
2	: colon	$3A	
3	W ASCII W	$57	
4	I ASCII I	$49	
5	L ASCII L	$4C	
6	A ASCII A	$41	
7	: colon	$3A	
8	status	$00, 01, 7F	; see 6.5.1
9	time scale ident.	$30-33	
10	day of the week	$31-37	
11	tens year	$30-39	
12	unit year	$30-39	
13	tens month	$30-31	
14	unit month	$30-39	
15	tens day	$30-33	
16	unit day	$30-39	
17	tens hour	$30-32	
18	unit hour	$30-39	
19	tens minute	$30-35	
20	unit minute	$30-39	
21	tens second	$30-35	
22	unit second	$30-39	
23	LF (line feed)	$0A	; see 6.1
24	CR (carriage Return)	$0D	; see 6.1
25	ETX (end of text)	$03	

6.5.1 Meaning of the Status Nibble in the Data String MADAM-S

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

This byte can have the following values

Nul (Hex 00)	no announcement
SOH (Hex 01)	announcement changeover daylight saving time / standard time standard time / daylight saving time
DEL (Hex 7F)	no radio time available

time scale ident. (9. Byte of the transmission)

ASCII 0 (Hex 30)	standard time
ASCII 1 (Hex 31)	daylight saving time + announcement
ASCII 3 (Hex 33)	daylight saving time

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

6.5.2 Required Setting in Case of Output MADAM-S

The synchronisation process in case of output MADAM-S requires the following setting:

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

6.6 Data String IBM 9037 Sysplex Timer

The second protocol in the device (9037) must be selected to synchronise the IBM 9037 Sysplex Timer. The 9037expects the time at its output every second. The following settings are required: 9600 baud, 8 data bit, parity odd, 1 stop bit, transmission on request and control characters. When the Sysplex Timer is switched on it transmits the ASCII character "C" to the connected radio controlled clock, so that the protocol in the table below is put out automatically every second.

The setting UTC or local time are optional.

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

6.6.1 Status in the Data String Sysplex Timer

Character number 14 informs about the synchronisation status of the clock. Possible values and their meaning are listed below.

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

6.6.2 Example of a Transmitted Data String Sysplex Timer

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

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

6.7 Structure of Data String 6855/6021 String 2000

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

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

6.7.1 Data String 2000 Status- and Day of the Week Nibble

The second and third ASCII-characters 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 (SZ-WZ-SZ)
	x	x	0	x	standard time (WZ)
	x	x	1	x	daylight saving time (SZ)
	0	0	x	x	time/date invalid
	0	1	x	x	crystal operation
	1	0	x	x	radio operation
	1	1	x	x	radio operation (high accuracy)
day of the week nibble:	0	x	x	x	CEST/CET
	1	x	x	x	UTC - time
	x	0	0	1	Monday
	x	0	1	0	Tuesday
	x	0	1	1	Wednesday
	x	1	0	0	Thursday
	x	1	0	1	Friday
	x	1	1	0	Saturday
	x	1	1	1	Sunday

6.7.2 Example of a Transmitted Data String 2000

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

radio controlled operation (high accuracy)
daylight saving time
no announcement
It is Wednesday 03.01.1996 - 12:34:56 h.
( ) - ASCII-control characters e.g. (STX)

6.8 Data String T-String

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

The data string can be requested by "**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

6.8.1 Example of a Transmitted Data String T-String

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

It is Wednesday 03.01.96 - 12:34:56h

6.9 Data String ABB_S_T

The data string ABB_S_T corresponds with the T-string in the transmitted values. It is switched on via mode byte 2. The string can be requested by "T".

The following settings are required:

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

6.10 Data String TimeServ for the Operating System Windows NT

The synchronization of a Computer running Windows NT version 3.51 and higher is done with the same string as described under pt. **"Sysplex Timer"**. The **modebyte 2** setting must match the following items:

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

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

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

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

http://www.hopf-time.com

6.11 Data String for NTP (Network Time Protocol)

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

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

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

http://www.hopf-time.com

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

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

6.12 Data String NGTS-String

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

As a rule this string is transmitted in the 59th second with the data of the minute change. The exact synchronisation in the connected computer requires an additional minute pulse.

character no.:	meaning	value (value range)
1	"T" ASCII T	$54
3	tens year	$30-39
4	unit year	$30-39
6	tens month	$30-31
7	unit month	$30-39
9	tens day	$30-33
10	unit day	$30-39
13	unit day of the week	$31-37
15	tens hours	$30-32
16	unit hours	$30-39
18	tens minutes	$30-35
19	unit minutes	$30-39
22	Status (0, 1)	$30-31 (30 ⇨ Local Time, 31 ⇨ UTC)
23	CR (carriage return)	$0D
24	LF (line feed)	$0A

6.12.1 Example of a Transmitted Data String NGTS

T960103312340(CR)(LF)

It is Wednesday 03.01.96 - 12:34 h

6.13 Master/Slave-String

This master /slave string can be used to synchronise slave systems with the time data of the master system up to an accuracy of ± 0.5msec. It differs from the DCF-slave-string in as much as the UTC time is included in the transmission.

The difference time is transmitted in hours and minutes following the year. The transmission is done in BCD. The difference time may be up to± 11 .59 h.

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

The string can be requested by ASCII "U", "D", "G" (see pt. **Fehler! Verweisquelle konnte nicht gefunden werden.**).

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 shows the following structure:

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

6.13.1 Status in the Data String Master-Slave

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

6.13.2 Example of 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 is +2.30 hours

6.13.3 Settings

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

- output every minute
- output second advance
- ETX on the second change
- 9600 baud, 8 bit, 1 stop bit, no parity

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

6.14 Data String 5500 time and date

When the data telegram 5500 is set, time and date can be requested by the character "D" and time only with the character "U" (please see format 6.15.1).

character no.	meaning	value	
1	STX (start of text)	$02	
2	status (internal clock status)	$30-39,$41-46	; see 6.15.1
3	space	$20	
4	hour tens digit	$30-32	
5	hour unit digit	$30-39	
6	minute tens digit	$30-35	
7	minute unit digit	$30-39	
8	second tens digit	$30-36	
9	second unit digit	$30-39	
10	space	$20	
11	day tens digit	$30-33	
12	day unit digit	$30-39	
13	month tens digit	$30-31	
14	month unit digit	$30-39	
15	year tens digit	$30-39	
16	year unit digit	$30-39	
17	space	$20	
18	day of the week	$31-37	; see 6.15.1
19	LF (line feed)	$0A	; see 6.1
20	CR (carriage return)	$0D	; see 6.1
21	ETX (end of text)	$03	

6.15 Data String 5500 time only

character no.	meaning	value	
1	STX (start of text)	$02	
2	Status	$30-39,$41-46	; see 6.15.1
3	Space	$20	
4	hour tens digit	$30-32	
5	hour unit digit	$30-39	
6	minute tens digit	$30-35	
7	minute unit digit	$30-39	
8	second tens digit	$30-36	
9	second unit digit	$30-39	
10	LF (line feed)	$0A	; see 6.1
11	CR (carriage return)	$0D	; see 6.1
12	ETX (end of text)	$03	

6.15.1 Status in the data string 5500

The status and day of the week information are implemented in the second and third ASCII-character in the data string. The status is interpreted binaurally.

Structure of these characters:

	b3	b2	b1	b0	meaning
status nibble:	x	0	x	x	winter time (WZ)
	x	1	x	x	summer time (SZ)
	x	x	1	x	announcement WT-ST-WT
	x	x	0	x	no announcement WT-ST-WT
	x	x	x	1	crystal operation
	x	x	x	0	radio operation
day of the week nibble:	0	x	x	x	CET/CEST
	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

6.15.2 Example of a transmitted data string 5500

(STX)0(Space)123456(Space)090200(Space)4(LF)(CR)(ETX)

- radio operation
- winter time
- no announcement
- It is Thursday 09.02.2000 - 12:34:56
- ( ) - ASCII-control character e.g. (STX)

7 Serial Interface

7.1 Setting the Clock via Serial Interface

Time and date can also be set via serial interface. The following data string is needed.

character no.	meaning	value (value range)
1	"S" (setting the time)	$53
2	hour tens digit	$30-32
3	hour unit digit	$30-39
4	minute tens digit	$30-35
5	minute unit digit	$30-39
6	second tens digit	$30-35
7	second unit digit	$30-39
8	day tens digit	$30-33
9	day unit digit	$30-39
10	month tens digit	$30-31
11	month unit digit	$30-39
12	year tens digit	$30-39
13	year unit digit	$30-39
14	day of the week	$31-37
15	(CR) carriage return	$0D

Example of a transmission:

>S1234560708943(CR)< for Wednesday 07.08.94, 12:34:56

7.2 Pin Assignment of the serial Interfaces

7.2.1 Pin Assignment of the 9 pole SUB-D Connector COM 1

9-pole SUB-D Connector pin no.	Designation	64-pole VG-ledge pin no.
1	GND	7c
2	TxD (transmit data) RS232c	2c
3	RxD (receive data) RS232c	3c
4	/RxD (receive data) RS422	13c
5	RxD (receive data) RS422	12c
6	RTS (ready to send) RS232c	4c
7	CTS (clear to send) RS232c	5c
8	TxD (transmit data) RS422	10c
9	/TxD (transmit data) RS422	11c

7.2.2 Pin Assignment of the 25 pole SUB-D Connector COM 0

25-pole SUB-D Connector pin no.	Designation	64-pole VG-ledge pin no.
1	free	free
2	TxD (transmit data) RS232c	2a
3	RxD (receive data) RS232c	3a
4	RTS (ready to send) RS232c	4a
5	CTS (clear to send) RS232c	5a
6	free	free
7	0V GND	7a
8	free	free
9	free	free
10	free	free
11	TxD (transmit data) RS422	10a
12	/TxD (transmit data) RS422	11a
13	free	free
14	free	free
15	free	free
16	free	free
17	free	free
18	free	free
19	free	free
20	free	free
21	free	free
22	RxD (receive data) RS422	12a
23	/RxD (receive data) RS422	13a
24	free	free
25	free	free

8 Technical Data

voltage supply

circuit board	+ 5V DC / 0.7A
Voltage supply for the system:	230 V AC + 10% - 15% 120 V AC + 10% - 15%
Optional for the system:	110 V DC (60 V - 120 V) 60 V DC (38 V - 75 V) 24 V DC (18 V - 36 V)

temperature

Temperature range:	0 - 50°C for the specified data 0 - 70°C with reduced free-running characteristics

antenna input circuit

potential free:	500V DC
maximum length of cable:	500 m
type of cable:	RG 59
input impedance:	50Ω
antenna supply:	5V DC over 100Ω
input sensitivity:	< 40µV

DCF77-decoding

automatic amplifier control:	70 dB
decoding:	AM/FM-converter

accuracy

second deviation:	± 2 msec compared to the DCF77-Signal on location of antenna
VCO-control (crystal):	< ± 2 ppm
free running features:	< ± 2 ppm at constant temperature
back-up clock:	± 25 ppm at + 10 to + 50 °C
Jitter of the second marker:	< 10 µsec
second adjustment:	max. ± 10 ppm

interfaces

display:	illuminable LCD-display (2 lines, 16 alphanumeric characters each)
key-pad:	25 keys in 5x5 key matrix

DCF77-Simulation

output impedance:	50Ω
output:	potential free BNC-connector
max. length of cable:	500 m
DCF77-simulation output:	3 mV_{ss} at load

serial interfaces

V.24 / V.28 (RS232):	2
handshake:	RTS / CTS
V.24 / V.11 (RS422):	2
handshake:	RTS/ CTS

parameter (can be set by key-pad)

baud rate:	150 - 19200 Bd
parity:	no/even/odd
data bits:	7 / 8 Bit
stop bits:	1 / 2 Bit
handshake:	active/ not active
data strings:	EWSD / SEL 1000 S 12

quality characteristic

MTBF	150 000 h.
MTTR	15 min.

Based on guidelines

EN55022	limits and measuring techniques for radio interferences of information technical stations
EN50082-1	framework standards noise radiation
EN60950	safety guidelines

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