Industriefunkuhren

hopf Elektronik GmbH

Technical Manual

Remote Control System

System 7001RC

ENGLISH

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Valid for Control Board 7020RC with FIRMWARE Version: **05.xx**

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Version number (Firmware / Description)

THE FIRST TWO DIGITS OF THE VERSION NUMBER OF THE TECHNICAL DESCRIPTION AND THE FIRST TWO DIGITS OF THE FIRMWARE VERSION MUST **COMPLY WITH EACH OTHER**.

SEE:

- ***Chapter 3.3 Display after System Start / Reset (Firmware)***
- ***Chapter 4.1.3.5 System Information (Firmware, Serial Number)***
- *hopf* 7001RC Remote software (Remote Software Technical Specification)

THE DIGITS AFTER THE POINT IN THE VERSION NUMBER INDICATE CORRECTIONS IN THE FIRMWARE / DESCRIPTION THAT ARE OF NO SIGNIFICANCE FOR THE FUNCTION.

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Symbols and Characters

Operational Reliability

Disregard may cause damages to persons or material.

Functionality

Disregard may impact function of system/device.

Information

Notes and Information.

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Safety regulations

The safety regulations and observance of the technical data serve to ensure trouble-free operation of the device and protection of persons and material. It is therefore of utmost importance to observe and compliance with these regulations.

If these are not complied with, then no claims may be made under the terms of the warranty and no liability will be assumed for any ensuing damage.

Safety of the device

This device has been manufactured in accordance with the latest technological standards and approved safety regulations

The device should only be put into operation by trained and qualified staff. Care must be taken that all cable connections are laid and fixed in position correctly. The device should only be operated with the voltage supply indicated on the identification label.

The device should only be operated by qualified staff or employees who have received specific instruction.

If a device must be opened for repair, this should only be carried out by employees with appropriate qualifications or by *hopf* Elektronik GmbH.

Before a device is opened or a fuse is changed all power supplies must be disconnected.

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.

CE-Conformity

CE

This device fulfils the requirements of the EU directive 89/336/EWG "Electromagnetic compatibility" and 73/23/EWG "Low voltage equipment".

Therefore the device bears the CE identification marking (CE=Communauté Européenne)

CE = Communautes Europeénnes = European communities

The CE indicates to the controlling bodies that the product complies with the requirements of the EU directive - especially with regard to protection of health and safety for the operator and the user - and may be released for sale within the common markets.

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1 7001RC System Description

The *hopf* system 7001RC was developed as a central clock system to undertake complex time distribution tasks. It can provide interfaces for industrial computers, process control systems and control devices, synchronize networks, control slave clocks and much more. All 'RC-Function Boards' of the system 7001RC (with the exception of the control board 7020RC) are hot-plug-compatible and as such can be disconnected from and reconnected to any point on the operating system at any time, without affecting the operation of other 'RC-Function Boards'.

The system's 7020RC control board communicates, via the internal system bus, with the 'RC-Function Boards' that are integrated into the system, and simultaneously monitors these boards for faults.

Due to its modular structure the system can be configured individually for each application and is easy to upgrade or modify if the application conditions change.

hopf 'Function Boards' for 19" systems can also be integrated into the system alongside the 'RC-Function Boards'.

In addition to the standard quartz generator, the 7020RC control board can also be equipped with an oven-stabilized OCXO quartz generator, which increases the accuracy of the system when operating in independent mode. See ***Chapter 8 Technical Data System 7001RC*** .

Some base functions of the system 7001RC

- Operation via remote software
- Hot-plug compatibility
- Display blanking to increase the lifetime of the display
- Sync-OFF timer (reception failure) for operation without error messages, even in difficult reception conditions
- Redundant, multiple verification of the synchronization signal for error-free and leap-free signal evaluation
- Maintenance-free, buffered back-up clock for three days
- Error monitoring of the integrated 'RC-Function Boards'
- System 5000 (Switch-Box) control for redundant systems
- True Time Server functionality – also upgradeable in the future

Extension options

- Evaluation of several synchronization sources (multi-source system)
- 7020RC control board can be extended with OCXO as quartz base to provide very high accuracy in independent operation
- Redundant power supply for the system 7001RC via 2 power supply units and a coupling card for interconnecting 2 power supply units
- Additional power supply for internal line voltage for the 'RC-Function Board' 7406RC.
- Extension of the 1/1 19" rack by an additional 3U (height units) to 6U.
- Customer-specific system adaptations for bespoke project solutions.

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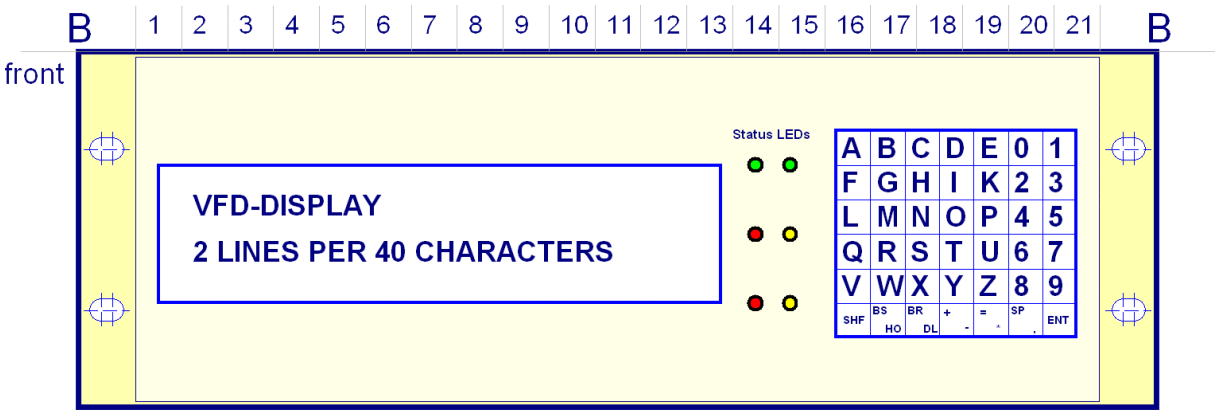
1.1 7001RC System Structure

Due to its modular structure, the system can be configured individually for each application and can be easily upgraded or modified in the event of a change in the conditions of the application.

1.1.1 19" Rack

The base system consists of:

- 1/1 19" 3U/84HP rack
- Power supply unit with 120/240V AC / 30VA (50-60Hz)
  Other input voltages possible
- Power supply feed with power supply unit and mains filter
- System front panel with VFD display (2x40) and keypad (6x7)



(here with option **"BG7008/6LED"** – front panel for system 7001RC including 6x status LED)

- 7020RC control board for:
  - Synchronization signal reception and evaluation
  - Keypad control
  - Display control
  - System bus control
  - Time distribution in the system
  - *hopf* Switch-Box control via 9-pin SUB-D connector
- DCF77 antenna simulation (77.5 kHz) via BNC socket
- System bus with prepared extension slots

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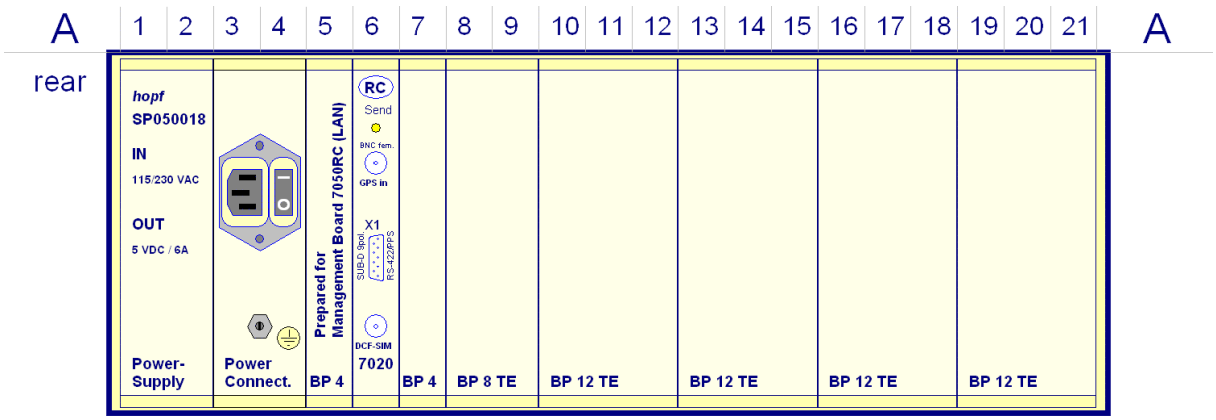
System example: rear/connection side:



- Up to 14 slots (including management board (LAN) 7050RC for system 7001RC) are available on a 3U rack for 'Function Boards' / 'RC-Function Boards' with 4HP faceplate width. Where 'Function Boards' or 'RC-Function Boards' with 8, 12 or 16HP width are used, the number of slots is reduced accordingly.

1.1.2 Display

The display consists of a two-line VFD display (Vacuum Fluorescent Display) with 2x40 characters.

For technical reasons the VFD display has a limited lifetime. Luminosity is reduced over the time of operation. In order to extend lifetime (luminosity) the display can be switched to blank.
See ***Chapter 4.1.1.6.1 Bit 7/6, Display Control***.

For a description of the display functions see ***Chapter 3.3 Display after System Start / Reset (Firmware)***.

1.1.3 Keypad

The alphanumeric keypad with 6x7 layout provides menu-driven operation of the clock system.

The keypad is a membrane keypad and must not be operated with sharp or pointed objects (fingernails, pens etc.).

For keypad operation see ***Chapter 3.6 Keypad Functions***.

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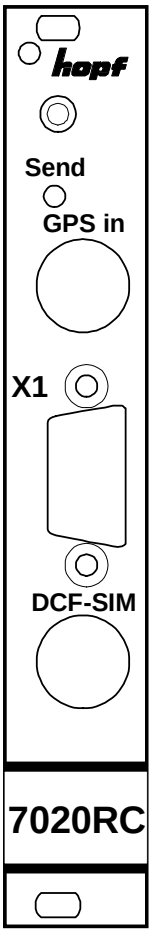
1.1.4 Control Board 7020RC - Hardware

The hardware components of the control board 7020RC and the standard hardware configuration are described below.

1.1.4.1 Front Panel Components



Bus LED

GPS antenna input (BNC socket)

9-pin SUB-D male connector with

- Serial interface for **remote** and **Flash update** function
- **PPS output** or **Switch-Box control** see ***Chapter 4.1.1.6.3 Bit 4, PPS/Switch-Box Control Output via X1 of the 7020RC***

DCF77 simulation output (BNC socket)

Identification of the **board type** on the handle of the 7020RC control board

1.1.4.2 9-pin SUB-D Connector X1 Assignment

Pin	Signal
1	DCF77 pulse, low active (TTL level)
2	RxD (RS232)
3	TxD (RS232)
4	PPS pulse or error message output (TTL level)
5	GND
6	–TXD (RS422) - low active
7	+TXD (RS422) - high active
8	–RXD (RS422) - low active
9	+RXD (RS422) - high active

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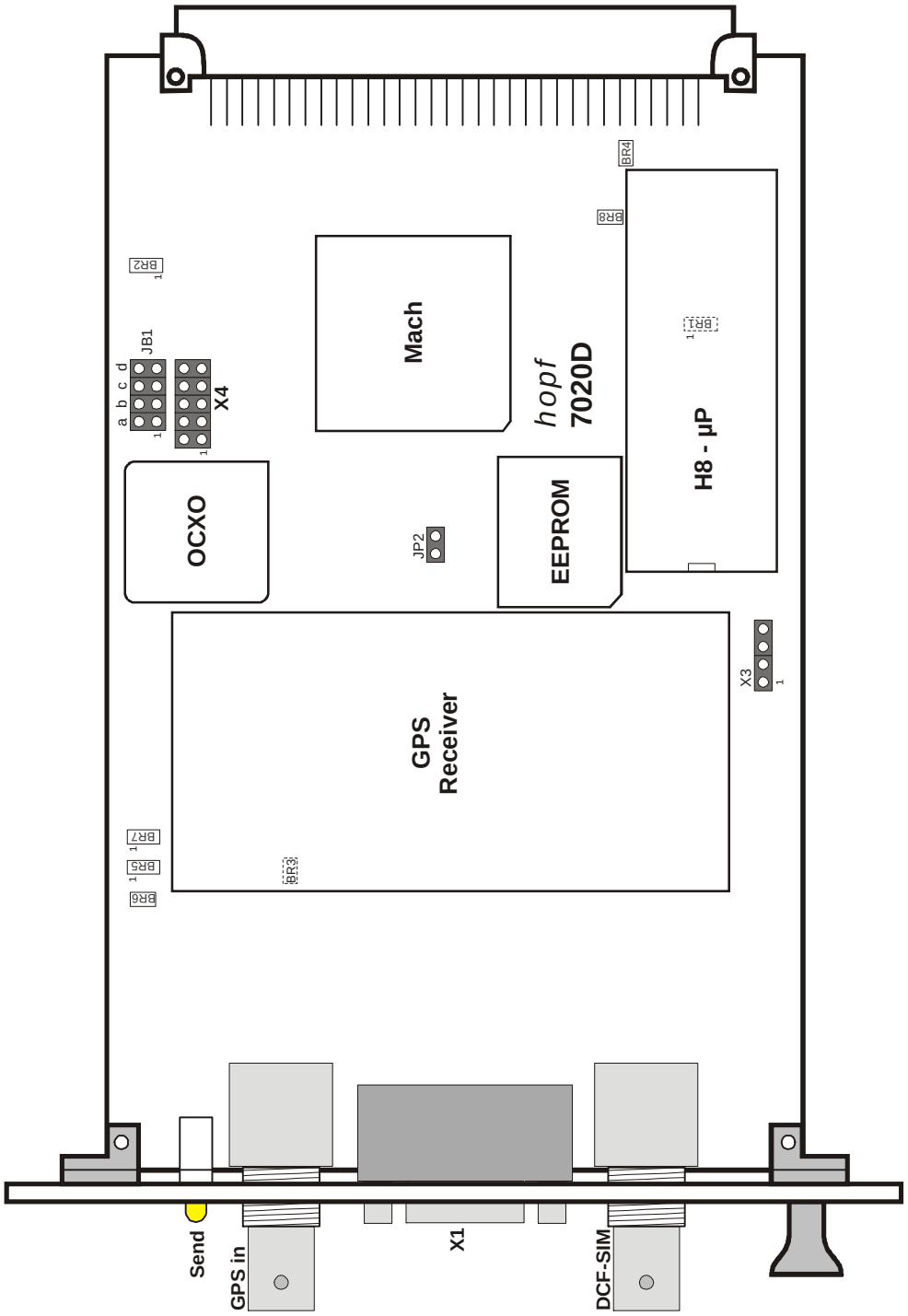
1.1.4.3 Layout Drawing



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Jumper bank JB1	**A**	**free (frei)**		
	closed (geschlossen)		☐	☐
	opened (offen)		☒	☐
	B	**free (frei)**		
	closed (geschlossen)		☐	☐
	opened (offen)		☒	☐
	C	**7020RC with standard quartz / OCXO**		
	closed (geschlossen)	7020RC with OCXO	☐	☐
	opened (offen)	7020RC with standard quartz	☒	☐
	D			
	closed (geschlossen)	only for factory use (nur für werksinterne Einstellungen)	☐	☐
	opened (offen)	only for factory use (nur für werksinterne Einstellungen)	☒	☐

JP2	closed (zu)	only for factory use (nur für werksinterne Einstellungen)	☒	☐
	opened (offen)	only for factory use (nur für werksinterne Einstellungen)	☐	☐

			def.	user
BR1	1-2 opened (offen), 2-3 closed (zu)	only for factory use (nur für werksinterne Einstellungen)	☒	☐
	1-2 closed (zu), 2-3 opened (offen)	only for factory use (nur für werksinterne Einstellungen)	☐	☐
BR2	1-2 opened (offen), 2-3 closed (zu)	only for factory use (nur für werksinterne Einstellungen)	☒	☐
	1-2 closed (zu), 2-3 opened (offen)	only for factory use (nur für werksinterne Einstellungen)	☐	☐
BR3	closed (zu)	only for factory use (nur für werksinterne Einstellungen)	☒	☐
	opened (offen)	only for factory use (nur für werksinterne Einstellungen)	☐	☐
BR4	closed (zu)	only for factory use (nur für werksinterne Einstellungen)	☒	☐
	opened (offen)	only for factory use (nur für werksinterne Einstellungen)	☐	☐
BR5	1-2 opened (offen), 2-3 closed (zu)	only for factory use (nur für werksinterne Einstellungen)	☒	☐
	1-2 closed (zu), 2-3 opened (offen)	only for factory use (nur für werksinterne Einstellungen)	☐	☐
BR6	closed (zu)	only for factory use (nur für werksinterne Einstellungen)	☐	☐
	opened (offen)	only for factory use (nur für werksinterne Einstellungen)	☒	☐
BR7	1-2 opened (offen), 2-3 closed (zu)	only for factory use (nur für werksinterne Einstellungen)	☒	☐
	1-2 closed (zu), 2-3 opened (offen)	only for factory use (nur für werksinterne Einstellungen)	☐	☐
BR8	closed (zu)	only for factory use (nur für werksinterne Einstellungen)	☒	☐
	opened (offen)	only for factory use (nur für werksinterne Einstellungen)	☐	☐

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1.1.4.4 VG-Ledge 96-pin (DIN 41612)

Assignment of the VG-ledge for the 7020RC control board

Pin Nr.	ROW A		ROW B		ROW C	
	Signal	Con-nection	Signal	Con-nection	Signal	Con-nection
1			VCC			
2			VCC			
3			VCC			
4			GND			
5			GND			
6			GND			
7			GND			
8						
9						
10						
11						
12						
13						
14	Master Slave Conf String					
15	Master Slave Sync String					
16						
17	PPSX		Error message TTL			
18	Tx+ (RS422)		Error message OK1 Collector		Rx- (RS422)	
19	Tx- (RS422)		Error message OK1 Emitter		Rx+ (RS422)	
20	GND				FDCF	
21					RESB	
22	DCFT in				DCFT	
23	SCLK				SERI	
24	SECB				KHZB	
25						
26						
27						
28						
29						
30						
31	GND				GND	
32	VCC				VCC	

Tx+ / Rx+: high active

1.1.5 7001RC Bus

The system bus is located inside the system 7001RC. This consists of a bus board with VG-ledges via which the 'Function Boards' or 'RC-Function Boards' are connected to the 7020RC control board.

The system bus provides:

- communication between the 7020RC control board and the 'RC-Function Boards'
- transmission of the regulated second pulse (PPS) for synchronization of the data output of implemented 'RC-Function Boards'
- distribution of the regulated DCF77 pulse generated by the 7020RC control board
- power supply for the installed boards

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1.1.6 Differentiation between 'Function Boards' and 'RC-Function Boards'

'Function boards' are mostly simple output boards that do not possess their own “intelligence”. Generally, the information to be output is supplied from any desired signal source. It is not mandatory for these boards to have a system bus. However, most of these 'Function Boards' can pick up the information available on the system bus (PPS pulses, DCF77 pulse) and output them in a board-specific hardware format. Any parameterization that is possible is carried out directly on the 'Function Boards'.

The term 'RC-Function Board' is used to describe boards that can be clearly identified in the system due to their “intelligence“ and which receive their parameterization via the system bus. All parameters that are specific to 'RC-Function Boards' are stored in the system.

Board type	Explanation
'Function Board'	• Can not be integrated into the system 7001RC via the system menu. • Board numbers are not allocated. • Functions immediately after installation in the system 7001RC, provided that any necessary additional wiring to its slot is in place. • Can not be configured via the BOARD menu. • 'Function board' settings take place directly on the boards via jumpers and/or DIP switches. • Since 'Function Boards' are not monitored by the system 7001RC, they are also unable to trigger an error message.
'RC-Function Board'	• Function boards are: o integrated/deleted o parameterized o read o monitored via the system menu. • Clearly identifiable via 'RC-Function Board' type and board number set. • With the exception of the board number, no further settings are made directly on the 'RC-Function Boards'. All settings are made exclusively via the system keypad or the remote software. • Triggers an error message in the system 7001RC when a fault occurs on the board. • Have no function until they have been completely integrated into the system 7001RC via the menus.

Only 'RC-Function Boards' (recognizable via the identification 'RC' on the handle) can be implemented in the system 7001RC.

Exceptions: passive 'Function Boards', which do not communicate with the system bus.

If other board types (e.g. from the 7001DCF77/GPS system) are installed in the system 7001RC, this can cause damage to the board and the system 7001RC.

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1.1.7 'Function Boards' / 'RC-Function Boards' Slots

Up to 14 further 'Function Boards' / 'RC-Function Boards' with 4HP front panel width can be installed in the system 7001RC alongside the 7020RC control board, depending on the space requirement of individual system components such as, for example, a second power supply unit or wider front panel(s).

The first bus slot next to the power supply feed is reserved exclusively for the 7020RC control board because of the wiring to the display/keypad.

In principle the slot for each 'Function Boards' / 'RC-Function Boards' is freely selectable.

A free slot is required for the installation of a new 'Function Boards' / 'RC-Function Board'. This must meet the following conditions:

- The slot width must be at least the same as the front panel width (e.g. 4TE, 8TE ...).
- A VG ledge with board guide bars must be installed in the system bus and be available at this point.

If not all slots are provided with VG ledges and board guide bars but these are required for a system extension, they can usually be retrofitted. Please make contact with *hopf* Elektronik GmbH for this purpose.

Limitations to free slot selection:

It should be noted that in certain circumstances 'Function Boards' / 'RC-Function Boards' require special wiring to their slot, e.g. additional power supply or signal wiring. Due to this additional wiring, these 'Function Boards' / 'RC-Function Boards' are tied to the correspondingly prepared slot.

Slots with additional wiring can be seen on the respective system drawing.

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1.2 Hot-plug Compatibility of the System 7001RC

Hot-plug describes the connection and removal of system components whilst the system is operating, without the need to pause or switch off the complete system. This guarantees interruption-free operation of the system.

The hot-plug compatibility of the system 7001RC is limited exclusively to the following components:

'Function boards' / 'RC-Function Boards'

The 'Function Boards' / 'RC-Function Boards' available for the system 7001RC are hot-plug compatible.

Exception:

The **7020RC** control board is not hot-plug compatible due to its system control function.

In order to prevent faults on connected systems it is recommended to disconnect the cables of the 'Function Boards' / 'RC-Function Boards' **during** removal or installation of the board.

Power supply unit on systems with redundant power supply units (option):

Power supply units on systems with redundant power supply units, which are connected via a coupling card, are hot-plug compatible. In this configuration, one of the power supply units can be changed whilst the system is running without restricting the functionality of the system, provided that the remaining power supply unit is functioning correctly. This ready-to-go power supply unit takes over the power supply without interrupting the system voltage.

1.3 System Operation via Remote Software

All system parameterization for the 7020RC control board and 'RC-Function boards' can be carried out from a PC, connected via a serial interface, using remote software.

Keypad operation is blocked whilst the system is being operated via remote software. Equally, it is not possible to build a connection from the remote software to the system 7001RC whilst the system is being operated via the keypad.

For further information see ***Chapter 3.7 Operating with Remote Software***.

1.4 Clock Variants in the System 7001RC

The following describes the clock variants that are possible in the 7001RC.

1.4.1 Radio-Controlled Clocks

When operating as a radio-controlled clock, the system 7001RC is synchronized by means of a connected antenna device. The data received is used to calculate the current time/date and to control the internal quartz base.

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1.4.2 Quartz-Controlled Clocks

Quartz-controlled clocks are independent clocks, whose internal quartz base is not controlled by an external synchronization signal. The accuracy of these clocks depends directly on the quality of the installed quartz and the precise setting of a quartz control value. The accuracy of the quartz clock can be increased by the optional installation of an oven-stabilized quartz (OCXO).

The quartz control value relevant for the accuracy of the system can be set manually. See ***Chapter 4.1.2.2 Quartz Control***.

Identifier on standard display	Synchronization source
QUARZ	Quartz-controlled clock. Synchronization from the quartz generator on the 7020RC control board only.
QUARZ+	Not implemented

1.4.3 Master Systems

Master clock systems may be defined as clock systems that are able to synchronize other, subordinate clock systems.

1.4.4 Slave Systems

Slave systems may be defined as systems, which are synchronized by one or more master systems. The accuracy of a slave system is directly dependent on the accuracy of the master system.

1.4.5 Single Source Systems

Single source systems are synchronized and controlled from a single synchronization source.

Identifier on standard display	Synchronization source
GPS_M	Synchronization via a GPS receiver
DCF_T	Synchronization via a DCF77 pulse
MA_SL	Synchronization via a serial Master/Slave-String from another *hopf* system
DCF_A	Not implemented

1.4.5.1 Sync-Signal: GPS

Operating mode: **GPS_M**

GPS radio-controlled clock systems are synchronized via the time signal transmitted by the GPS satellite. For this reason it is necessary to install suitable GPS antenna equipment. Details about the GPS operating method are described in ***Chapter 9.1 GPS (Global Positioning System)***.

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1.4.5.2 Sync-Signal: DCF77

Operating mode: **DCF_A**

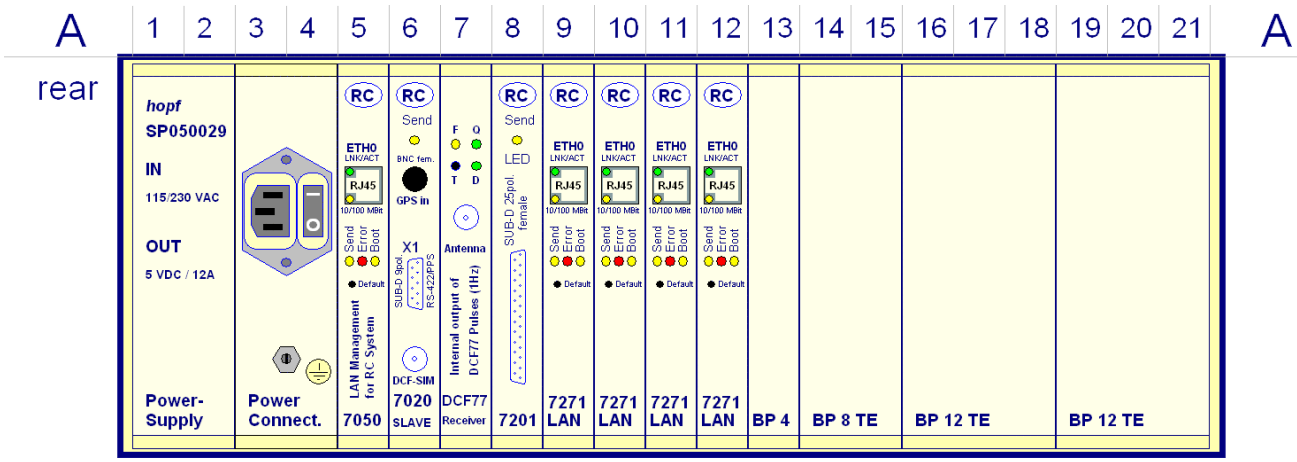
This operating mode is not implemented.

Synchronization via a DCF77 signal is carried out using a different function (see ***Chapter 1.4.7 Sync. Signal via Converter***).

1.4.5.3 Sync-Signal: DCF77 Pulse

Operating mode: **DCF_T**

The DCF77 pulse is a digital pulse based on the DCF77 signal, which can be transmitted in various signal forms (such as TTL, RS232, RS422, LWL...). The time information is transmitted via the DCF77 pulse. This pulse can also be used to control the internal quartz base of the receiver. For further information see ***Chapter 9.2.2.2 DCF77 Pulse (1 Hz)***.



Sample Configuration:

Synchronisation of the **System 7010RC-Slave with DCF77 reception** via an antenna System.

The additionally implemented DCF77 receiver board (slot A7) is synchronized via the DCF77 antenna System and transfers an exact DCF77 pulse to board 7020RC-Slave being successfully synchronized. Hereupon board 7020RC-Slave synchronizes and provides the entire System with this time information.

1.4.5.4 Sync-Signal: Master/Slave-String

Operating mode: **MA_SL**

The Master/Slave-String is a serial *hopf* data string, which can be supplied to the system via converter cards in various signal forms (such as TTL, RS232, RS422, LWL...).

The time information is transmitted via the Master/Slave-String. The Master/Slave-String can also be used to control the internal quartz base of the receiver. For further information see ***Chapter 9.3 Master/Slave-String***.

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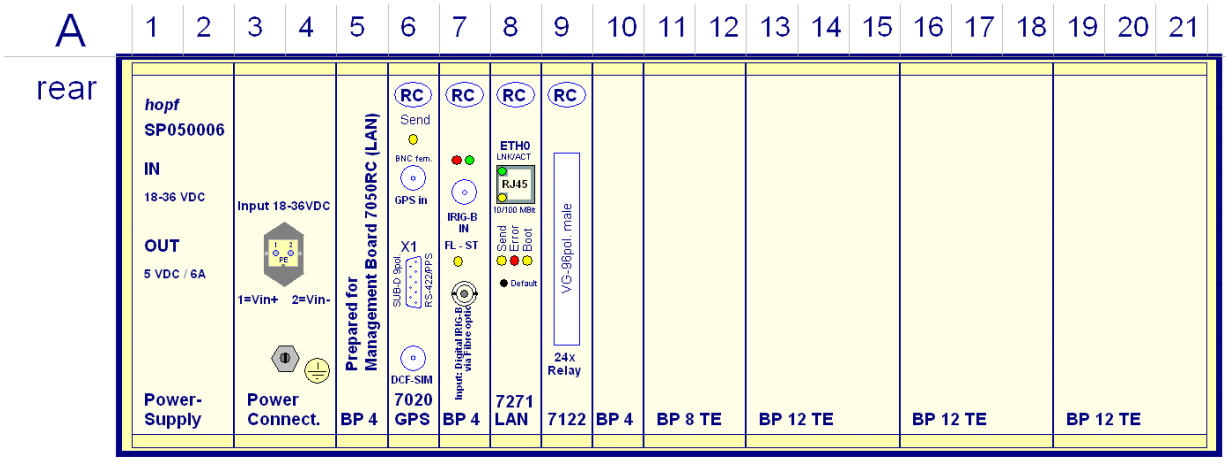

Sample Configuration:

Synchronisation of the **System 7010RC-Slave by an IRIG-B signal**.

The additionally implemented IRIG-B evaluation board (slot A7) supplies an exact Master/Slave String to board 7020RC-Slave being successfully synchronized with an analogue or digital IRIG-B signal. Hereupon board 7020RC-Slave synchronizes and provides the entire System with this time information.

1.4.6 Multi-Source Systems

In contrast to single source systems, two or more synchronization signals are required in order to synchronize multi-source systems. It is important to differentiate between safety systems and multi-source systems.

1.4.6.1 Safety Systems (Optional)

Safety systems can be identified by the fact that they require at least two, independent, radio-synchronous synchronization sources for synchronization.

The time information is mutually checked for plausibility. The information must be in agreement both in respect of time and status information, such as time zone, ST/WT changeover announcements etc., since otherwise no synchronization of the internal clock system takes place. In this way it is possible to monitor the occurrence of time deviations.

Identifier on standard display	Synchronization source
GPS_M+	Synchronization via a GPS receiver and via a serial Master/Slave-String from another *hopf* system
DCF_T+	Synchronization via a DCF77 pulse and via a serial Master/Slave-String from another *hopf* system
DCF_A+	Not implemented

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1.4.6.2 Multi-Source Systems (option)

A multi-source system makes it possible to create a clock system that can select between various synchronization sources (sync. sources), independent of their respective status. For this purpose, all available sync. sources are evaluated and monitored.

Different priorities are assigned by the user to the various sync. sources (primary, secondary etc.). These priorities define the synchronization source that will be preferred when sources have the same status.

The system will be synchronized and controlled by the primary source for as long as this source has the status "Sync". In the event that the primary source reverts to "Quartz" or "Invalid" status, the system automatically switches for synchronization to the secondary source – provided that this source has the synchronization status "Sync".

More information about Multi-Source Systems can be found in the technical manual ***'7001 MultiSourceSystem - version 02.01'***.

1.4.6.3 Multi-Source with GPS and Master/Slave-String (option)

A multi-source mode with both GPS and Master/Slave-String channels can be selected with the system 7001RC as well as the allocation of primary and secondary sources.

Identifier on standard display	Synchronization source
Display alternately **>GPS**_ and **SER**_	**Primary source (>)**: GPS **Secondary source ( )**: Master/Slave-String
Display alternately **>SER**_ and **GPS**_	**Primary source (>)**: Master/Slave-String **Secondary source ( )**: GPS (option)

1.4.6.4 Multi-Source with DCF77 Pulse and Master/Slave-String (option)

A multi-source mode with both DCF77 pulse and Master/Slave-String channels can be selected with the system 7001RC. Primary and secondary sources can also be allocated.

Identifier on standard display	Synchronization source
Display alternately **>DCF**_ and **SER**_	**Primary source (>)**: DCF77 pulse **Secondary source**: Master/Slave-String
Display alternately **>SER**_ and **DCF**_	**Primary source (>)**: Master/Slave-String **Secondary source ( )**: DCF77 pulse

1.4.7 Sync. Signal via Converter

Various converters are available for the system 7001RC. These serve to adjust signals, data and levels to the 7001RC signal inputs. In this way inputs to the 7020RC control board can be adjusted individually. The system 7001RC can then be synchronized, e.g. via IRIG-B.

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2 Installation

The installation of the system hardware is described below.

2.1 19" Rack Installation

When installing the system 7001RC in a control panel, care must be taken to ensure that there is sufficient convection, in order to maintain the system operating temperature within the prescribed limits. See ***Chapter 8 Technical Data System 7001RC*** . Non-observance can cause damage to the system 7001RC.

The following steps are to be carried out:

- Place the rack in position in the control cabinet and screw it tight with 4 screws in the retaining brackets on the front side of the rack.

Refrain from exerting pressure on the green display in order to prevent damage.

- Make sure that there is sufficient space between the side of the rack where the connections are made and the control cabinet in order to be able to connect cables to the system.

2.2 Power supply

The system can be equipped with power supply units for various power supply voltages.

2.2.1 Fuse Protection

When connecting the system 7001RC care must be taken to ensure suitable fuse protection of the power supply.

The capacity data on the nameplate on the side of the housing should be consulted for this purpose. At present the system 7001RC is equipped with a 30 VA power supply unit as standard. The power input can be increased dependent on the system.

2.2.2 Connection

When connecting the power supply take care to ensure the correct:

- voltage type (AC or DC)
- voltage level
- polarity

The system can be damaged if incorrect voltage is supplied to the system 7001RC.

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The following steps are to be carried out dependent on the type of power supply:

Make sure that the external voltage source is switched off. When connecting the lead make sure that the polarity is correct and that the earth wire is connected correctly.

- Alternating current (AC):
  - Check that the mains switch is in position "0" (= off).
  - Plug the power cable into the mains power input of the system.
  - Connect the power cable to the mains power supply.
- Direct current (DC):
  - Connect the power supply cable to the 3-pin socket on the system 7001RC:
    - V_{in}+: Positive pole
    - V_{in}-: Negative pole
    - PE: Earth

2.3 Earth Protection

The system 7001RC is usually earthed via the protective earth line of the power cable.

For additional protection, an earth line can be mounted on the housing with the aid of a screw, since the housing is fully conductive of electricity.

2.4 Connection of Synchronization Sources

If the system 7001RC is to be synchronized by GPS it is necessary to install a suitable antenna.

GPS Master System:

The GPS antenna is plugged into the BNC socket identified by "GPS in" on the control board 7020RC. Further specifications regarding the installation, such as cable lengths or cable types, can be found in the GPS appendix.

Quartz system:

Quartz systems do not have external synchronization sources or antenna devices and therefore corresponding connections are not available.

All other systems:

Information about the connection of the synchronization source can be found in the system documentation.

2.5 Connection of 'Function Boards' / 'RC-Function Boards'

The steps necessary for the connection of the installed 'Function Boards' / 'RC-Function Boards' can be found in the respective technical specifications.

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3 Commissioning

3.1 General Procedure

Commissioning is structured as follows:

- Check the cabling:
  - Earth
  - Power supply
  - Sync. signal
  - Function boards / 'RC-Function Boards'
- Disconnect all connections to the 'Function Boards' / 'RC-Function Boards' (recommended)
- Sync. signal connection remains in place
- Switch system 7001RC on
- Power supply unit LED(s) light up / start screen appears on the display (for approx. 3 seconds)
- Execution of all parameterization via the INITIAL menu (menu 1)
- Check for successful synchronization of the system 7001RC
- Commission the 'RC-Function Boards':
  - Parameterize the 'RC-Function Boards'
  - Rebuild connections
  - Check the connected devices for time data transfer

3.2 Switch on Operating Voltage

AC power supply:

Put mains switch to position "1" (= on).

The system 7001RC starts up with a message on the display giving details of the firmware version and the programming date (see ***Chapter 3.3 Display after System Start / Reset (Firmware)***).

DC power supply:

Switch on external voltage source.

The system 7001RC starts up with a message on the display giving details of the firmware version and the programming date (see ***Chapter 3.3 Display after System Start / Reset (Firmware)***).

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3.3 Display after System Start / Reset (Firmware)

After switch on the following screen appears on the 2x40 position VFD display for approx. 3 seconds:

```
     HOPF-ELEKTRONIK      VERS:  01.01
   MASTER-CLOCK 7001RC    14/JUL/2004
```

Display:

- **HOPF-ELEKTRONIK** ⇨ *hopf* Elektronik GmbH
- **MASTER –CLOCK 7001RC** ⇨ system 7001RC
- **VERS: 01.01** ⇨ firmware of control board 7020RC
- **14/JUL/2004** ⇨ programming date of control board 7020RC

3.4 Standard Display without Valid Time

The following screen appears on the display upon **first commissioning** or after a minimum of **3 days without power** (example of a GPS Master System):

```
LT:  00:00:05  --  00/---/2000  S--  GPS_M  E
UT:  23:00:05  --  00/---/2000  -  9.9  e-07  -
```

After a power failure of less than 3 days the display starts with the internal emergency clock information, provided that time data was present at the time of the power failure.

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3.5 Standard Display with Valid Time

Example of screen with synchronized GPS Master System:

```
LT:  08:45:48  MO  12/JUL/2004  D--  GPS_M   E
UT:  06:45:48  MO  12/JUL/2004  R  5.3  e-07  K
```

The meaning of the individual items is as follows:

LT : 08:45:48	The **local time** is displayed in these fields.
UT : 06:45:48	**UTC time** is displayed in these fields.
MO - TU - WE - TH - FR - SA - SU	**Day-of-week** display in abbreviated form: (corresponds to **MONDAY – SUNDAY**)
12/JUL/2004	Date display: **Day / Month (abbr.) / Year**

Status display:

Position 1: X- -	**"D"** **"S"**	For summer time (Daylight saving time) For winter time (Standard time)
Position 2: -X-	**"A"** **"–"**	Announcement of the ST/WT changeover (summer time/winter time changeover) to a different time zone. This announcement takes place approx. 1 hour before the time zone change.
Position 3: - -X	**"A"** **"–"**	Announcement of the leap second. This announcement takes place approx. 1 hour before the second is inserted.

GPS_M	System specification. **GPS Master System** in this example. A system identifier is displayed according to the setting. The system identifiers are listed in ***Chapter 4.1.1.5.4 Bits 3-0, Synchronization Source Selection***.

Display of the clock system synchronization status:

"–"	Invalid time.
"C"	The clock system is running in quartz mode (C = Crystal).
"r"	The clock system is running synchronous to the synchronization source, but without controlling the internal quartz base.
"R"	The clock system is running synchronous to the synchronization source and is controlling the internal quartz base.
"5.3"	This item displays the accuracy of the internal quartz base.
"E"	When an error message is activated, "E" (error) is displayed in this position.
"K"	After the key-word has been entered, "K" is displayed in this position.

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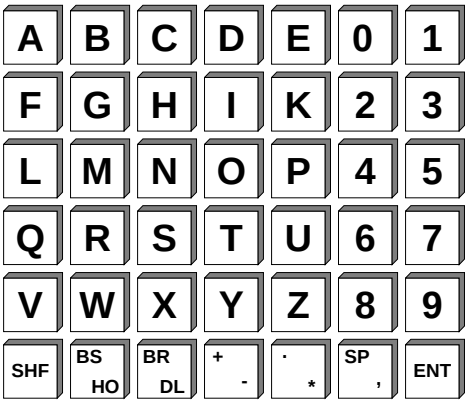
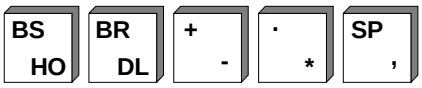
3.6 Keypad Functions

The layout and operation of the keypad are described below.

3.6.1 Keypad Layout



3.6.2 Key Allocation

Key	Function
A ... Z	Input of the alphabet in capital letters (without "J").
0 ... 9	Input of numbers.
SHF	Shift function for the keys: 
HO	HO = Home, not used at present.
DL	DL = Delete, not used at present.
+-	Input of the operational sign for number values.
. *	Input of "dot" and "star".
SP	Input of a free display space.
,	Input "comma".
ENT	Main menu call-up. Each new complete input must be confirmed with **ENT**. If no new input is made but **ENT** is pressed the old value is taken. After pressing **ENT** the cursor switches to the next input item and only returns to the sub-function request when the last item has been entered.
Y	Select the sub-function of the menu group.
N	Sub-function of the menu group is refused and the next sub-menu is displayed.
BS	Deletion of the last entered character (Backspace).
BR	BR = BREAK, terminates all keypad control. Quits the input menu at any time and at any point. All inputs since the last activation of the **ENT** key are discarded.

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3.6.3 Keypad Inputs / Main Menu Activation

The main menu is activated by pressing the **ENT** key.

The display switches from the standard or blank[1] screen to the main menu:

```
LT: 07:45:48 TU 23/FEB/2003 S--GPS_M  E
UT: 06:45:48 TU 23/FEB/2003 R 5.3 e-07 K
```

Main menu:

```
 INITIAL-SETUP:1 CLOCK-CONTROL:2 SHOW:3
   BOARD-SETUP:4 SPECIAL-BOARD-TIME:5
```

- By entering the corresponding number the required menu heading is executed.
- The cursor on the screen indicates the point at which the next input can take place.
- The input of an incorrect character is either refused immediately or is checked for plausibility after the **ENT** key is pressed. An **"ERROR: INPUT"** message is generated. The display then switches back to the sub-function request.
- All sub-function requests are not always needed or served. The specification indicates, at the beginning of each sub-function, the system executions in which the sub-function requests are active. In the event that such a function is called up by mistake then this should be exited by pressing the **BR** key.

[1] In order to increase the life of the VFD display, the display can be switched automatically to blank (see ***Chapter 4.1.1.6.1 Bit 7/6, Display Control***).

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3.7 Operating with Remote Software

The following components are required to parameterize and monitor the system 7001RC via the serial interface of the control board 7020RC:

- PC with a free RS232 interface
  see technical specification "*hopf* 7001RC Remote Software"
- Remote software supplied by *hopf* Elektronik GmbH
- *hopf* KA6870 data cable

First, the serial *hopf* cable KA6870 is used to build a connection between the 7020RC control board connector X1 and a free serial port on a PC.

As an alternative, a serial cable may be used with the following pin assignment:

For PCs with 9-pin SUB-D connector:

PC (cable-side: 9-pin female SUB-D socket)	7020RC (connector X1) (cable-side: 9-pin female SUB-D socket)
2	3
3	2
5	5

For PCs with 25-pin SUB-D connector:

PC (cable-side: 25-pin female SUB-D socket)	7020RC (connector X1) (cable-side: 9-pin female SUB-D socket)
2	2
3	3
7	5

To ensure problem-free data transmission the serial interface of the system 7001RC should be set to 9600 baud, 8 data bits, no parity and 1 stop bit (standard setting). See ***Chapter 4.1.1.9 Serial Interface Parameters of the 7020RC***.

The connection to the system 7001RC can then be made via the remote software. Further details concerning the operation of the system 7001RC via remote software are explained in the “7001RC Remote Software” technical specification.

3.8 Initialization

In order to initialize the system 7001RC all the settings described in ***Chapter 4.1.1 INITIAL-SETUP:1 - System 7001RC Basic Settings*** must be carried out. In so doing, attention should be paid to system and location-specific requirements, such as time base, synchronization source or synchronization parameters.

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4 System Parameterization

The following describes the menu structure and the menus. In addition, the installation and removal of 'RC-Function Boards' and the structure of error evaluation in the system 7001RC are explained.

4.1 Menu Structure

The main menu is called up by pressing the **ENT** key. This is divided into 5 different menu headings. The menu headings are called up by entering the respective number (1-5). In this way the corresponding sub-menus become available. The menu structure is constructed as follows:

Main menu	Menu heading selection by entering the corresponding number	Sub-menus
Main menu level	Menu heading 1: '**INITIAL SETUP**' **Input of basic values** e.g. • Time • Time offset • ST/WT changeover times • Synchronization source selection	**'TIME/DATE'**
		'TIME OFFSET LOCAL-TIME TO UTC'
		'CHANGE-OVER DATES'
		'DELAY-TIME FOR SYNC.STATUS "R" (RECEPTION)'
		'SYNCHRONISATION SETTINGS'
		'FUNCTION CONTROL'
		'POSITION'
		'ERROR-PRIORITY'
		'SERIAL PARAMETER FOR BOARD 7020'
		'DCF77-SIMULATION SETTINGS FOR BOARD 7020 AND DCF-PULSE SYSTEM BUS'
	Menu heading 2: '**CLOCK-CONTROL**' Trigger system control as per clock reset and manage key-words	**'RESET'**
		'QUARTZ-CONTROL'
		'SET KEY-WORD'
		'DUMPTERM'
	Menu heading 3: '**SHOW**' Display of system settings and error messages	**'ERROR MONITORING'**
		'SHOW SATELLITES'
		'SHOW CHANGE-OVER DATES'
		'SHOW POSITION'
	Menu heading 4: '**BOARD-SETUP**' Management of the installed 'RC-Function Boards', e.g. integrate, parameterize	**'SET SYSTEM-BOARDS PARAMETER'**
		'SET SYSTEM BOARDS TO ACTIVATE THE MONITORING –MODE OR IDLE-MODE'
		'REMOVE SYSTEM-BOARD'
		'ADD SYSTEM-BOARD'
		'SHOW ALL ADDED SYSTEM-BOARDS'
		'SHOW SYSTEM-BOARDS INFORMATION'
	Menu heading 5: '**SPECIAL-BOARD-TIME**' Control of slave-line and mains frequency analysis boards.	**'B. 7406'** (7406 slave-line board)
		'B. 7515' (7515 mains frequency analysis board)

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4.1.1 INITIAL-SETUP:1 - System 7001RC Basic Settings

Entering or viewing the basic set functions such as time/date, position, time offset etc.

All sub-menus contained in the **'INITIAL-SETUP'** should be configured at the time of the first commissioning.

4.1.1.1 Time/Date Input

Required for: All operating modes

The local time is set with this input function. The data is input on the second line between the arrows >...< and must be complete. Single figure values must be preceded by a zero.

Selection screen:

```
 TIME/DATE Y/N
```

Input screen:

```
 LOCAL-TIME  hh.mm.ss   DD.MM.YYYY
          >23.15.55<  >23.02.2003<
```

The meaning of the individual items is as follows:

Identifier on display	Description	Input range
hh	Hour	00 - 23
mm	Minute	00 - 59
ss	Second	00 - 59
DD	Day	01 - 31
MM	Month	01 - 12
YYYY	Year	2000 – 2099

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4.1.1.2 Inputting the Time Offset: Local Time - UTC (Time Zone)

Valid for: All operating modes except Master/Slave mode

This function sets the time offset between the local standard time and world time (UTC time).

The time offset always relates to **Standard** (winter) time and is therefore always constant. This means that the same time offset applies to summer time and winter time; the additional hour is inserted via the summer time offset.

It is not necessary to input the time offset in Master/Slave mode, since this information is contained in the synchronizing Master/Slave-String.

Selection screen:

```
 TIME OFFSET LOCAL-TIME TO UTC   Y/N
```

Input screen:

```
 TIME OFFSET   OLD:  >+01:00<   WEST=-
             NEW:  >~~~:~~<     EAST=+
```

The operational sign indicates the direction in which local time deviates from world time:

- **'+'** signifies east of the zero meridian
- **'-'** signifies west of the zero meridian (Greenwitch)

The current time offset is shown on the top line.

The time offset should be input in hours and minutes.

Example for Germany:

UTC	Local time	Time difference to be set:	Comment
13:00:00	14:00:00 **(winter time)**	+01:00	
13:00:00	15:00:00 **(summer time)**	+01:00	The time offset of 2 hours is made up of: +01:00h time offset und +01:00h for the summer time offset.

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4.1.1.3 Inputting the ST/WT Changeover Times

Valid for systems with internally activated ST/WT changeover times

This input is used to define the points of time during the course of the year at which the changeover is made to summer time or winter time. The hour, day-of-week, week and month information are input, at which the ST/WT changeover (summer time/winter time changeover) is due to take place. The exact points of time are calculated automatically from the date of the current year.

In GPS and QUARTZ modes ST/WT changeover takes place exclusively via the ST/WT changeover times activated in the system 7001RC.

By contrast, in all other operating modes ST/WT changeover is controlled via the external synchronization source.

Exception: The internal ST/WT changeover times are activated in the **'SYNCHRONISATION SETTINGS'** menu (see ***Chapter 4.1.1.5.2 Bit 6/5, ST/WT Changeover System Internal or External***). In this case, ST/WT changeover takes place in accordance with the settings activated in the system.

Selection screen:

```
 CHANGE-OVER DATES   Y/N
 STD->STANDARD       DST->DAYLIGHT SAVING
```

Input screen:

```
 STD->DST>hh.d.w.MM<  DST->STD>hh.d.w.MM<
          >~~.~.~.~~<         >~~.~.~.~~<
```

STD ⇨ DST The entered ST/WT changeover is valid for:
STD (Standard time or winter time) to **DST** (Daylight Saving Time or summer time)

DST ⇨ STD The entered ST/WT changeover is valid for:
DST (summer time) to **STD** (winter time)

The two ST/WT changeover times are entered between the arrows. After the ST/WT changeover times have been entered the system 7001RC calculates the exact ST/WT changeover date to the next minute change and acquires these new values.

If no ST/WT changeover is required to be activated then all values should be set to 0. The system 7001RC then only operates in standard time (winter time).

The meaning of the inputs is as follows:

Identifier on display	ST/WT changeover point of time	Input
hh	Hour	00 ... 23 hours
d	Day-of-week	1 - 7 = Monday - Sunday
w	Week in month	1 – 4 week in month 5 = last week
MM	Month	01 - 12 = January - December

Input example for Germany:

STD -> DST by 2 o'clock on the last Sunday in March. Input: 02.7.5.03

DST -> STD by 3 o'clock on the last Sunday in October. Input: 03.7.5.10

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4.1.1.4 Inputting the "Radio" Status Delay

Valid for all operating modes

The on/off switch delay of the system's radio status is controlled with this function.

Selection screen

Input screen

The current values are displayed on the top line. The new values are entered on the second line.

This setting affects **all** outputs that depend on radio status (e.g. status displays, serial string, LAN, DCF77 pulse, DCF77 simulation etc.).

4.1.1.4.1 Switch On Delay of the "Radio" System Status

Setting: **'After Sync. ok'**

The value can be set from 000 to 255 minutes. This value indicates the length of time for which synchronization must be available through the source in order for 'Radio' system status to be set. The display indicates this when the status changes from **(C)**rystal to **(R)**eception. This status is also output on the bus, such that in the same way a serial 'Function Board' / 'RC-Function Board' emits delayed output of this status in its data string, for example.

If the system 7001RC is required to synchronize further systems with high accuracy, without their being affected by fluctuations of the system pulse caused by adjustment behaviour, the **'After Sync. ok'** timer should be activated. In general 10 - 15 minutes are sufficient for the system 7001RC to be well adjusted.

4.1.1.4.2 Switch Off Delay of the "Radio" System Status

Setting: **'After Sync. Fail'**

This value serves to bridge short-term failures in reception from the synchronization source and is designed to prevent the system from losing synchronization at once. During the period of reception failure the system runs via the internal, high-precision controlled quartz base.

The value can be set from 002 to 255 minutes. This setting depends primarily on the accuracy required for independent operation.

Calculation example for independent operation accuracy

To calculate the maximum value to be set for **'After Sync. Fail'** the value for the independent operation accuracy of the quartz is multiplied by the required minimum accuracy of the system. For example, an accuracy of 1x10E-6 under independent operation and a required minimum system accuracy of 5ms give the following equation:

0.005s / 1x10E-6 = 5000s = **83Minutes 20Seconds**

⇨ The set value for **'After Sync. Fail'** may be a maximum of 83 minutes.

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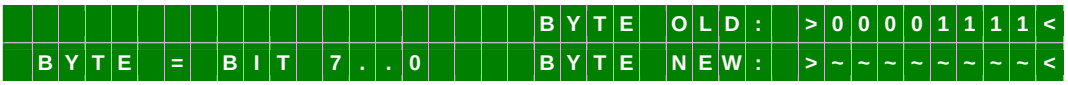
4.1.1.5 Overview of Synchronization Settings

Valid for: All systems

The synchronization source and behaviour of the system 7001RC are selected with the **SYNCHRONISATION SETTINGS**:

Selection screen:

Input screen:



The meaning of the individual bits is as follows:

B7		GPS Evaluation 3D/Position-fix
0		Position-fix evaluation
1		3D evaluation
Bit 6	**Bit 5**	**ST/WT changeover via source / internal system**
0	0	ST/WT changeover times are only carried out by the external source. The internal ST/WT changeover times of the 7001RC are ignored. (GPS always requires the internal ST/WT changeover)
1	0	ST/WT changeover is carried out either via the external source **or** via the system-internal ST/WT changeover times, dependent on the status of the external source system: • ST/WT changeover times are carried out by the external source, provided that this is delivering valid time information. (GPS always requires the internal ST/WT changeover) • ST/WT changeover times are carried out by the 7001RC when the external source is not available.
x	1	ST/WT changeover times are only carried out in accordance with the times set in the 7001RC. ST/WT changeover times transmitted via the synchronization sources are ignored.
B4		**Synchronization procedure**
0		**Standard synchronization procedure**
1		**Special synchronization procedure** / the time clock status is set to “invalid” if the time difference between the internal clock and the synchronization source is greater than one second.

B3 … B0	Configuration of operating mode and Synchronisation source
0 0 0 0 (h'0) … 1 1 0 0 (h'C)	Configuration of operating mode (single / multi source) as well as the different synchronisation sources (GPS, DCF77 pulse, Master/Slave-String) and/or combinations of them.

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4.1.1.5.1 Bit 7, 3D / Position-fix (GPS Mode)

Valid for: GPS systems

Selection can be made between 3D or Position-fix evaluation with Bit 7:

- Bit 7 = 0 Position-fix evaluation
- Bit 7 = 1 3D evaluation

The accuracy of the time evaluation is defined by the exact calculation of the installation position. In order to carry out this calculation (3D evaluation) it is necessary to receive information from at least 4 satellites. The signal runtime to several satellites is determined from the calculated position and the precise second mark is produced from their mean value.

In many cases for stationary installations a less precise evaluation of the second mark suffices; for example, this can be inaccurate by up to several milliseconds. In Position-fix mode the accuracy fundamentally depends on the exact input of the installation position. The second mark is then calculated from the data from one received satellite and the input position. When the position input is precise, the same accuracy can be achieved as in 3D mode.

The advantage of the Position-fix mode is that the clock can be synchronized using the data from only one received satellite. So the antenna can also be installed in locations where less than ¼ of the sky is visible.

In many cases the antenna can be mounted internally at the window (short cable, no lightning protection). If 4 satellites are available in this mode then the evaluation switches automatically into 3D mode and calculates the exact position. In this case, the accuracy with one satellite increases to the same accuracy as in 3D mode.

Position-fix Evaluation Features	3D Evaluation Features
• Clock can synchronize with just one received satellite. • Accuracy depends on the exact input of the installation position. • If 4 satellites are received in this mode then the evaluation switches automatically into 3D mode and calculates the exact position. Bit 7 remains 0. • The antenna can also be installed in locations where less than ¼ of the sky is visible. • In many cases the antenna can be mounted internally at the window (short cable, no lightning protection).	• Position is calculated automatically. • The accuracy of the synchronization is increased by exact calculation of the position. • Antenna generally requires more than ¼ free visibility of the sky. • When less than 4 satellites are received there is no synchronization of the system.

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4.1.1.5.2 Bit 6/5, ST/WT Changeover System Internal or External

Valid for Master/Slave operation, DCF77 pulse

Bit 6 selects, dependent on the status of the synchronization source, whether the ST/WT changeover announcement is activated by the synchronization source or by the internally set ST/WT changeover times in the system 7001RC.

Bit 5 selects **in principle** whether only the ST/WT changeover times from the sync. source are used, or only the internally set ST/WT changeover times in the 7001RC board. The status of the synchronization source is not considered in this instance.

The combinations of **Bit 5 and Bit 6** therefore give the following **system behaviour**:

Bit 6	Bit 5	System behaviour
0	0	ST/WT changeover times are only carried out via the external sync. source. The internal ST/WT changeover times on the 7001RC are ignored.
1	0	ST/WT changeover times are carried out either via the external sync. source **or** via the internal ST/WT changeover times, depending on the status of the external sync. source: • ST/WT changeover times are carried out via the external sync. source, provided that this is delivering valid time information. • ST/WT changeover times are carried out via the internally set times in the system 7001RC when the external source is not available.
x	1	ST/WT changeover times are only carried out via the internally set times in the system 7001RC. The ST/WT changeover times sent via the sync. sources are ignored.

GPS always uses the internal ST/WT changeover.

An incorrect hour leap can result if the local sync. source does not execute the same ST/WT changeover times as those activated internally in the system 7001RC.
In order to avoid this hour leap the ST/WT changeover times of the sync. source must be in agreement with the times set in the internal system.

Example: System behaviour with different ST/WT changeover times

Synchronization source transmits in local time **without** ST/WT changeover			**System 7001RC** **with** internal ST/WT changeover		
Local time	**UTC**	**Comment**	**Local time**	**UTC**	**Comment**
01:59:00	00:59:00	No ST/WT changeover set	01:59:00	00:59:00	1 minute before ST/WT changeover
01:59:59 -> 02:00:00	00:59:59 -> 01:00:00	Winter time continues	01:59:59 -> 03:00:00	00:59:59 -> 01:00:00	ST/WT changeover from winter to summer time
02:01:00	01:01:00		03:01:00	01:01:00	1h difference to the source
02:02:00	01:02:00		02:02:00	00:02:00	New time transfer - therefore incorrect UTC time ⇨ hour leap

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4.1.1.5.3 Bit 4, Recognition of Time Leaps on Synchronization

Valid for all operating modes

The status of the system during synchronization is controlled via **Bit 4**.

Bit 4 = 0:

Standard synchronization procedure – no time leap recognition. The system 7001RC synchronizes with the sync. source "with possible time leaps".

Bit 4 = 1:

Special synchronization procedure – time leap recognition.

The system accuracy depends on the internal quartz base, controlled by the sync. source. In the event of a lengthy period of reception failure from the sync. source, the internally controlled quartz base of the system 7001RC may distort the system to such an extent that on renewed synchronization a leap of more than one second is possible.

Such a time leap can be detected with the aid of this function. In the event that, on renewed synchronization, the difference is greater than one second, the internal clock is indeed overwritten with the new time information, however the clock status is set to Invalid ('**-**' in the display).

With the aid of this information connected systems can refuse synchronization. In this way a time leap can be avoided.

For greater security, the special synchronization procedure should only be carried out with two synchronization sources.

It is recommended to use the special synchronization procedure with only a safety system (**DCF_T+, GPS_M+;** see ***Chapter 4.1.1.5.4 Bits 3-0, Synchronization Source***), since it is only in this case that the corresponding error status is set.
In all other modes the synchronization status is merely set to 'Invalid'.

4.1.1.5.4 Bits 3-0, Synchronization Source Selection

The synchronization source for the system 7001RC is selected with the aid of **Bits 3, 2, 1 and 0**. The corresponding system identifier appears in the display (see ***Chapter 4.1.1.5.5 Single-Source Mode*** and ***Chapter 4.1.1.5.6 Multi-Source Mode, Safety System***).

All further settings of Bits 3-0 generate an **ERROR** message on the display, instead of the operating mode. These settings should be avoided due to undefined system behaviour.

After the synchronization source has been set with Bit 3-0 a master reset (system reset) is carried out automatically.

During configuration of the synchronization / source mode the setting of the **function control byte bit 0** must be checked (operation mode **R_SIM**, see ***chapter 4.1.1.6.7***).

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4.1.1.5.5 Single-Source Mode

B3	B2	B1	B0	Identifier on standard display	Synchronization source
0	0	0	0	**QUARZ**	Quartz clock. Synchronization only by quartz generator on the control board 7020RC.
0	0	1	0	**DCF_T**	Synchronization via a DCF77-pulse
0	0	1	1	**DCF_A**	No sync. mode implemented.
0	1	0	0	**MA_SL**	Synchronization via a serial Master/Slave-String of another *hopf* system.
0	1	0	1	**GPS_M**	Synchronization via a GPS receiver.

4.1.1.5.6 Multi-Source Mode, Safety System

B3	B2	B1	B0	Identifier on standard display	Safety system
0	0	0	1	**QUARZ+**	Not implemented.
0	1	1	0	**DCF_T+**	Synchronization via a DCF77 pulse + synchronization via a serial Master/Slave-String of another *hopf* system.
0	1	1	1	**DCF_A+**	No sync. mode implemented.
1	0	0	0	**GPS_M+**	Synchronization via a GPS receiver + synchronization via a serial Master/Slave-String of another *hopf* system.

4.1.1.5.7 Multi-Source Mode, Multi-Source (optional)

B3	B2	B1	B0	Identifier on standard display	Multi-source (option) GPS + Master/Slave-String
1	0	0	1	Display alternately **>GPS_** and **SER_**	**Primary source (>)**: GPS **Secondary source ( )**: Master/Slave-String
1	0	1	0	Display alternately **>SER_** and **GPS_**	**Primary source (>)**: Master/Slave-String **Secondary source ( )**: GPS(Option)
B3	**B2**	**B1**	**B0**	**Identifier on standard display**	**Multi-source (option) DCF77 pulse + Master/Slave-String**
1	0	1	1	Display alternately **>DCF_** and **SER_**	**Primary source (>)**: DCF77 pulse **Secondary source**: Master/Slave-String
1	1	0	0	Display alternately **>SER_** and **DCF_**	**Primary source (>)**: Master/Slave-String **Secondary source ( )**: DCF77 pulse

4.1.1.5.8 Unassigned Sync. Modes

B3	B2	B1	B0	Identifier on standard display	Synchronization source
1	1	0	1	**ERROR**	No sync. mode implemented.
1	1	1	0		
1	1	1	1		

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4.1.1.6 Function Control Overview

Valid for all operating modes

Various system functions can be switched on and off with **Function Control**.

Selection screen:

```
  FUNCTION CONTROL  Y/N
```

Input screen:

```
                    BYTE OLD:  >00000000<
  BYTE = BIT 7..0   BYTE NEW:  >~~~~~~~~<
```

The meaning of the individual bits is as follows:

B7	B6	Display control
0	0	The display is permanently on.
0	1	The brightness of the display is reduced to approx. 1/4 of normal intensity.
1	0	The display is switched off. Only a moving dot is visible on the display.
1	1	The display is switched off. Only a moving dot is visible on the display. In addition, the brightness of the dot is reduced to 1/4 of normal intensity.

B5	Static/dynamic error message
0	Static error message
1	Dynamic error message

B4	PPS or Switch-Box control output on Sub-D connector X1
0	**PPS** on Sub-D connector X1, pin 4 of control board 7020RC **Error message** (output on VG ledge of control board 7020RC)
1	**Error message** on Sub-D connector X1, pin 4 of control board 7020RC **Error message** (output on VG ledge of control board 7020RC)

B3	**Changeover between primary and secondary source** (for optional multi-source)
0	Automatic changeover between primary and secondary source
1	Manual changeover only between primary and secondary source by entering the synchronization setting byte

B2	B1	Time base in the Master/Slave-String
x	0	Standard evaluation with all string information
		only for synchronization with sync module
0	1	The time base in the Master/Slave-String is local time (standard setting)
1	1	The time base in the Master/Slave-String is UTC

B0	Radio status - simulation
0	Radio status is only set via the synchronization source
1	Activating the operating mode **R_SIM** with simulation of the synchronization status "**radio**".

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Valid for all synchronisation modes

When the **Function Control Byte Bit 0** is set to **1** the control board 7020RC simulates the synchronisation status '**R**'. This function is helpful in particular in testing configurations with no antenna or synchronisation source available when connected systems require a synchronisation status “Radio” for correct function.

The setting influences the following functions and components of the System 7001RC:

- Indication of the operation mode **R_SIM**
- Indication of the synchronisation status “**R**”
- Data output which depends on or contains the synchronisation status
- ERROR – message concerning the synchronisation status

Overview system behaviour:

Activating the **simulation of the synchronisation status "Radio"** (operation mode **R_SIM**)

Operation Mode	Time Status	System Behaviour
QUARZ	Invalid	• Operation mode **R_SIM** will not be activated. • The setting **Control Byte Bit 0** remains stored failsafe. That means after a system reset or similar the activation persists. • Operation mode **R_SIM** is activated only after setting a valid system time.
	Valid	• Operation mode **R_SIM** will be activated immediately and stored failsafe. • Operation mode **R_SIM** can only be deactivated with the setting **Control Byte Bit 0 = 0**.
DCF_T **MA_SL** **GPS_M** **DCF_T+** **GPS_M+**	Invalid	• Operation mode **R_SIM** will not be activated.. • The setting **Control Byte Bit 0** remains stored failsafe. That means after a system reset or similar the activation persists. • Operation mode **R_SIM** is activated only after setting a valid system time.
	Valid	• Operation mode **R_SIM** will be activated immediately. • Operation mode **R_SIM** will be automatically deactivated after 4 hours or after a system reset or similar.

While the synchronisation status is “**R**” time leaps may occur when the operation mode **R_SIM** is active:

- When the system time is set manually. The synchronisation status will not be reset in this case.
- At synchronisation via the connected synchronisation source (GPS_M, DCF_T, MA_SL etc.), when the system time deviates from the time of the synchronisation source.

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4.1.1.6.1 Bit 7/6, Display Control

Valid for all operating modes

For technical reasons the VFD display has a limited lifetime. Luminosity is reduced over the time of operation. In order to extend lifetime (luminosity) the display can be switched to blank.

The blanking of the display is controlled with **Bit 7** and **Bit 6**.

If a key is pressed when the screen is switched to blank the display is re-initialized with standard output and normal brightness. This condition remains in place for approx. 4 minutes from the last keystroke.

Four different operating modes are possible for the display control:

- The display is permanently on
- The brightness of the display is reduced to approx. 1/4 of normal intensity
- The display is switched off. Only a moving dot is visible on the display
- The display is switched off. Only a moving dot is visible on the display. In addition, the brightness of the dot is reduced to 1/4 of normal intensity

4.1.1.6.2 Bit 5, Static/Dynamic Error Message

Valid for all operating modes

Bit 5 is used to differentiate between two different types of error message. In the case of a static error message the output merely confirms whether or not an error exists. A dynamic error message can, in addition, differentiate between a major error (high weighting) and a minor error (low weighting). The selection between major and minor errors as well as which error messages should be masked takes place in the '**INITIAL SETUP**' -> '**ERROR_PRIORITY**' menu.

Bit 5	**Error message outputs of control board 7020RC**	**TTL signal** • VG ledge pin 17b • Sub-D connector X1 pin 4 (see ***Chapter Error message on Sub-D connector X1 Bit 4***)	**Optical Coupler on VG ledge** • Collector: Pin 18b • Emitter: Pin 19b
B5 = 1 **dynamic**	No error approx. 980/20 ms	HIGH/ LOW level	High-impedance / low-impedance
	Minor error approx. 20/980 ms	HIGH/ LOW level	High-impedance / low-impedance
	Major error	LOW level	Low impedance
B5 = 0 **static**	No error	LOW level	Low impedance
	Error	HIGH level	High impedance

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4.1.1.6.3 Bit 4, PPS/Switch-Box Control Output via X1 of the 7020RC

Valid for all operating modes

Bit 4 can be used to select between the PPS (Pulse Per Second) output and the output of the error message on Sub-D connector X1 pin 4 on the front panel of control board 7020RC. In this way the error message is available to external devices.

This output is used especially to control the *hopf* Switch-Box. The Switch-Box is a modular system for error-dependent signal changeover between a master and its redundant system.

In order to control the *hopf* Switch-Box, **Bit 4** should be set to "1". See ***Chapter 6.4 Static and Dynamic Error Output*** for the selection between static and dynamic error evaluation.

Bit 4	Output on SUB-D connector X1 of control board 7020RC
0	PPS pulse output
1	Error message output (*hopf* Switch-Box control)

4.1.1.6.4 Bit 3, Changeover Between Primary and Secondary Source

Valid for: Multi-source systems only (option)

Bit 3 is used to select between automatic (standard setting) and manual changeover between primary and secondary sources.

This setting is only valid for the optional multi-source systems (see "Multi-source Systems" technical specification).

4.1.1.6.5 Bit 2, Master/Slave-String Time Base

Valid for: Slave systems only

Bit 2 sets whether UTC time or local time is transmitted in the received Master/Slave-String. This setting is only effective if the '**Special evaluation for application with sync module**' function in the **FUNCTION CONTROL BYTE** (see ***Chapter 4.1.1.6.6 Bit 1, Master/Slave-String Evaluation***) is set to the special evaluation of the Master/Slave-String.

If Bit 2 is set incorrectly (e.g. UTC time is received but local time is selected), then the system 7001RC calculates both local time and UTC time incorrectly.

In the example given the UTC time would be interpreted as local time and the UTC time would be calculated incorrectly as a result.

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Bit 2 = 0, The time base in the Master/Slave-String is local time (standard setting):

If the Master/Slave-String contains the local time **Bit 2** is set to "0", so that the 7001 system interprets the time information in the Master/Slave-String as local time and calculates the UTC time correctly by means of the internally set time offset and the ST/WT changeover times, provided that these are activated. (See ***Chapter 4.1.1.5.2 Bit 6/5, ST/WT Changeover System Internal or External***).

⇨ **Local time is received; UTC time is calculated.**

Bit 2 = 1, the time base in the Master/Slave-String is UTC

If the Master/Slave-String contains the UTC time, **Bit 2** is set to “1”. In this case the time in the Master/Slave-String is interpreted as UTC time and the local time is calculated from this time information having regard to the internally set time offset and the ST/WT changeover times, provided that these are activated. (See ***Chapter 4.1.1.5.2 Bit 6/5, ST/WT Changeover System Internal or External***).

⇨ **UTC time is received; local time is calculated.**

4.1.1.6.6 Bit 1, Master/Slave-String Evaluation

Valid for Master/Slave-String system

Bit 1 = 0, Standard evaluation with all string information:

This setting should be selected when the system 7001RC is to be synchronized with the standard, un-manipulated (with all status information) Master/Slave-String as transmitted. This contains all status information, including time offset between local time and UTC, ST/WT announcement, leap second announcement, etc.

The ST/WT changeover and time offset is set by the Master/Slave-String in the system. In addition the evaluation of the source status must be activated (see ***Chapter 4.1.1.5.2 Bit 6/5, ST/WT Changeover System Internal or External***).

Bit 1 = 1, Special evaluation for application with sync module:

If the system 7001RC is synchronized with IRIG-B via sync module, then this module converts the time information received via IRIG-B into a Master/Slave-String, which is sent to the control board 7020RC system internally. Since IRIG-B does not contain status information such as ST/WT announcements or time offset, these settings should be made in the system 7001RC. For this purpose Bit 1 should be set to 1, so that the internal information for time calculation may be called upon.

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4.1.1.6.7 Bit 0, Simulation of 'Radio' System Status

Valid for all operating modes

The control board 7020RC simulates radio-synchronicity with **Bit 0 = 1**. This function is useful for test structures where an antenna or synchronization source is not yet available but connected systems require radio-synchronous status in order to function correctly.

This setting affects the following system functions and components:

- Display of the system 7001RC operating mode (**R_SIM**)
- Display of the synchronization status '**R**'
- Data output that is dependent on the system status
- ERROR messages about the system status

- 4 hours after activation of the 'Radio' system status simulation, or after a reset, the system 7001RC reverts back to the originally selected operating mode (e.g. GPS_M).
- Systems in QUARZ operating mode remain permanently in 'Radio' system status, even after the 4 hours have lapsed. This condition is retained until a reset is triggered.

4.1.1.7 Position Input

Valid for: GPS systems

Selection screen:

```
 POSITION  Y/N
```

The geographical position of the system is entered with this function. This function is helpful on first commissioning, since it shortens the re-initialization of the GPS receiver.

An exact degree setting is not necessary. This is calculated automatically later when there is radio reception from at least 4 satellites – independent of whether the 3D or Position-fix evaluation is set. See ***Chapter 4.1.1.5.1 Bit 7, 3D / Position-fix (GPS Mode)***.

Input screen:

```
 LATITUDE:  N/S  >~<  >~~<  DEGR.  >~~<  MIN.
LONGITUDE:  W/E  >~<  >~~~<  DEGR.  >~~<  MIN.
```

The latitude and longitude of the position is entered in degrees and minutes.

The operational signs for the degrees of latitude are:

N	Northern hemisphere (north)
S	Southern hemisphere (south)

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and for the degrees of longitude:

E	East of the zero meridian (Greenwich)
W	West of the zero meridian (Greenwich)

The latitude position is entered first under **P GG.MM**. The meanings of the operational signs are as follows:

P	N or S, North or South	
GG	Degrees of latitude	00 - 89
MM	Minutes of latitude	00 - 59

The longitude position is entered next under **p GGG.MM**. The meanings of the operational signs are as follows:

p	E or W, East or West	
GGG	Degrees of longitude	000 - 179
MM	Minutes of longitude	00 - 59

4.1.1.8 Error Priority, Major and Minor Errors

Valid for all operating modes

The system 7001RC can set various individual error messages, which can be grouped into a common error message (see also ***Chapter 6 Error Evaluation in the System 7001RC***).

Error priority serves to select which individual errors should trigger a common error message. Three different priority levels can be assigned to an individual error: a high ('**H**'igh) level, also known as a major error, a low ('**L**'ow) level, also known as a minor error, or the error can be masked. If dynamic error output is switched on (see ***Chapter 4.1.1.6.2 Bit 5, Static/Dynamic Error Message***), the three error levels can be identified in the output. This differentiation can not take place under static error output; the output only indicates whether an error has occurred or not. If an error has occurred and is being monitored this is indicated by an 'E' at the end of the top line.

Selection screen:

```
ERROR-PRIORITY  Y/N
>H<IGH-  >L<OW-  >-<NO-PRIORITY
```

Input screen:

```
ERROR-NO:  1-8>HLH-L-H-<  9-16>L-LHH--L<
     NEW:  1-8>~~~~~~~~<  9-16>~~~~~~~~<
```

The error priorities can now be set as a new entry:

- **'H'** sets the high ('**H**'igh) priority level (major error)
- **'L'** sets the low ('**L**'ow) priority level (minor error)
- By entering **'-'** the error is removed from the common message

The input is sub-divided into 2 groups of errors: 1-8 and 9-16. If no change is required to one group the previous selection is acquired by pressing **ENT**.

The meanings of the individual error messages are described in ***Chapter 6.5 Error Messages - Meanings***.

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4.1.1.9 Serial Interface Parameters of the 7020RC

Valid for all operating modes

The parameters that are set with this menu apply to all serial interfaces of the control board 7020RC. They are accessible via the front panel (RS232, RS422) and the VG ledge (RS422 or TTL).

Selection screen:

```
 SERIAL PARAMETER FOR BOARD 7020  Y/N
```

Input screen:

```
 BYTE=     OLD  1:>10000110<  2:>00000000<
 BIT 7..0  NEW  1:>~~~~~~~~<  2:>~~~~~~~~<
```

Overview of Serial Parameter Byte 1:

Byte 2 is not assigned at present and should be set to '00000000'

B7	Master/Slave-String output (only via VG ledge)
1	Master/Slave-String output activated
0	No Master/Slave-String output
B6	**Data bits**
1	7 data bits
0	8 data bits

B5	B4	Parity
0	0	No parity
0	1	-
1	0	Even parity
1	1	Odd parity

B3	Stop bit
1	2 stop bits
0	1 stop bit

B2	B1	B0	Baud rate
0	0	0	-
0	0	1	-
0	1	0	-
0	1	1	-
1	0	0	2400
1	0	1	4800
1	1	0	9600
1	1	1	19200

Standard serial interface setting:
9600 baud, 1 stop bit, 8 data bits, no parity, with Master/Slave-String output
⇨ **BYTE1: >10000110< 2: >00000000<**

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4.1.1.10 DCF77 Simulation and DCF77 Pulse of the Control Board 7020RC

Valid for all operating modes

The system 7001RC simulates the DCF77 antenna (DCF77 simulation) and DCF77 pulse signal for the synchronization of other *hopf* systems or systems from other suppliers.

This sub-function controls this signal output.

Selection screen:

```
 DCF77-SIMULATION SETTINGS  Y/N
 FOR BOARD 7020 AND DCF-PULSE SYSTEM-BUS
```

Input screen:

```
>200/100<H/L  >050<T-OUT  >00001111<STAT
>~~~/~~~<MSEC >~~~<MIN    >~~~~~~~~<BYTE
```

The time information is completely transferred within one minute at one bit/sec. The information is BCD-coded. A logic "0" is represented by a 100 ms and a logic "1" by a 200 ms amplitude reduction or pulse width (see ***Chapter 9.2.2 DCF77 Generation by hopf Clocks***).

4.1.1.10.1 Adjustment of the DCF77 Sim. Signal Pulse Length

The antennas of some radio-controlled clocks from other manufacturers falsify the duration of the reduction and the receiver connected downstream is adjusted to different pulse lengths for this reason.

The pulse length for such receivers can be selected under **H/L**.

For the **H** pulse from 140 - 240 ms, **standard is 200 ms**
For the **L** pulse from 070 - 130 ms, **standard is 100 ms**

4.1.1.10.2 T-OUT – Time-Out of the DCF77 Sim. Signal

'Radio' status is not contained in the DCF77 sim. signal. When radio synchronicity of the system 7001RC is lost the status of connected clock systems can not be recognized if the simulated DCF77 sim. signal emitted continues to run continuously. For this reason the DCF77 sim. signal is no longer output or is modulated with a 2Hz pulse if the system 7001RC is no longer radio-synchronous.

In order to bridge reception failures of the system 7001RC, however, or if the system 7001RC is running without any synchronization, under test operation for example, a time-out (T-OUT) value can be used to set the length of time for which the simulated DCF77 sim. signal continues to be output. The delay time can be set from 4-255 minutes.

The delay time to be set depends on the required accuracy of the connected clock system, see ***Chapter 4.1.1.10.3 Calculation Example for DCF77 Sim. Signal***. For systems synchronized by DCF77 sim. signal the delay time should be set to approx. 55 minutes; for systems synchronized via GPS the delay time may be set to 255 minutes.

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4.1.1.10.3 Calculation Example for DCF77 Sim. Signal Accuracy

- In this example the accuracy of the internal quartz base is taken as ± 1 *10E-6.
- Minimum accuracy required: **5ms**
- **5ms / (1 x 10E-6) = 5000s = 83 minutes 20 seconds**

⇨ The value to be set for **'T-Out'** may be a **maximum of 83 minutes**

4.1.1.10.4 STATUSBYTE – DCF77 Simulation Status Byte

The following settings may be made with the status byte:

Bit	Description
B7-B2	**Not assigned at present**
0	To be set to 0 for compatibility reasons (default setting)
B1	**Description**
0	DCF77 simulation output is dependent on the set Time-OUT value and the synchronization status (see ***Chapter 4.1.1.4 Inputting the "Radio" Status Delay***)
1	DCF77 simulation output is permanent
B0	**Description**
0	No reception and T-OUT has lapsed: no amplitude reduction or pulse output takes place
1	No reception and T-OUT has lapsed: the amplitude is modulated on the DCF sim. BNC plug and the DCF77 pulse is modulated with approx. 2 Hz.

4.1.1.10.5 Bits 7-2, Unassigned Bits

Bits 7 to 2 are not yet assigned.
For compatibility reasons they should be set to 0 (default setting)

4.1.1.10.6 Bit 1, DCF77 Simulation Output

The DCF77 simulation can be output independently of **T-OUT** and the synchronization status of the system 7001RC using Bit 1.

Bit 1 = 0 DCF77 simulation is output dependently of **T-OUT** and system 7001RC synchronization.

Bit 1 = 1 DCF77 simulation is output permanently, independent of whether the system 7001RC is radio-synchronous or not, or whether a **T-OUT** of less than 255 was set.

4.1.1.10.7 Bit 0, DCF77 Signal Type on Radio Failure

The fault behaviour of the DCF77 sim. signal on loss of 'radio' system status can be set with Bit 0.

Bit 0 = 0 If the system 7001RC is not radio-synchronous, **T-OUT** has lapsed and **Bit 1 of the STATBYTE = 0**, no amplitude reduction takes place and there is no pulse output.

Bit 0 = 1 If the system 7001RC is not radio-synchronous, **T-OUT** has lapsed and **Bit 1 of the STATBYTE = 0**, the amplitude is modulated on the DCF sim. BNC plug and the pulse is modulated with approx. 2 Hz. In this way line breaks can be monitored in connected devices.

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4.1.2 CLOCK-CONTROL:2 - General System Functions

Special system functions such as ‘trigger system reset’ and ‘set key-word’ are found under this menu heading.

4.1.2.1 Programme Reset and System Reset

Valid for all operating modes

This function triggers a re-start of the system 7001RC. The function does not change the previous settings. A system reset is recommended after a complete system initialization, to speed up the first synchronization in GPS operating mode.

Selection screen:

```
 RESET  Y/N
```

Input screen:

```
 MASTER RESET - SYSTEM 7001RC   => M
  PROG. RESET - BOARD 7020 ONLY => R >~<
```

By pressing **R** followed by **ENT** a **Programme Reset** is executed on the control board 7020RC only. All other 'Function Boards' / 'RC-Function Boards' in the system continue to operate.

By pressing **M** followed by **ENT** a **System Reset** (Master Reset) of the complete system 7001RC is triggered. All 'RC-Function Boards' available in the system 7001RC are reset and re-started.

4.1.2.2 Quartz Control

Valid for: systems that run in quartz mode only

The quartz control value is pre-set by *hopf* Elektronik. In radio-controlled operation the quartz control value readjusts automatically and can not be controlled. The quartz control value serves to correct the ageing and temperature drift of the quartz. This function is only required by QUARTZ mode and can also only be controlled in this mode.

The quartz control value can shift the quartz frequency by ±15ppm.

- -15ppm ⇨ quartz control value 000
- +15ppm ⇨ quartz control value 999
- Mean value = 500 quartz control value

Selection screen:

```
 QUARTZ-CONTROL  Y/N
 ADJUSTMENT ONLY IN QUARTZ MODE
```

Input screen:

```
 QUARTZ-CONTROL-VALUE    OLD:->569<
 (000 - 999)             NEW:->---<
```


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4.1.2.3 Key-Word for Keypad

Valid for: all systems

The system 7001RC can be protected against unauthorized data changes by the use of a key-word.

A key-word set via this menu only secures access via the system keypad. Access and changes to the system 7001RC continue to be available via the remote software. Should it be required to block access via the remote software, a further key-word is to be set in the remote software. (***See Remote software manual***)

4.1.2.3.1 Activate Key-Word

Valid for all operating modes

The key-word consists of a set of six numbers. Numbers are to be allocated to six positions. The key-word ‘000000’ has a special function; this deletes an existing key-word and can therefore not be used itself as a key-word.

- Permissible numbers: all numbers from 0 to 9.
- A set key-word is indicated on the display with a **"K"** at the end of the bottom line.

In order to avoid delays during commissioning, the key-word should only be set after commissioning has been fully completed. The key-word should be stored in a secure place, protected against unauthorized access.

Selection screen:

```
 SET KEY-WORD  Y/N
```

Input screen:

```
 SET/CHANGE  KEY-WORD = >~~~~~~<
        DELETE = >000000<
```


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4.1.2.3.2 Key-Word Request

Valid for all operating modes

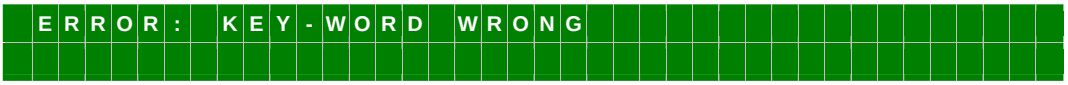
If a key-word has been set then this is requested each time before entering the main menu.

The following screen appears on the display:

The 6-position number can now be entered. For each input the display registers a star **"*"**.

If the entry is correct the display switches to the main menu. Key-word protection is now deactivated for the next 255 seconds. If a menu entry takes place within these 255 seconds access clearance is extended by a further 255 seconds; otherwise the key-word protection is re-activated.

In the event of an incorrect entry the following error message appears for 3 seconds:



before a further entry can be made:

If an incorrect key-word is also entered at the second attempt the error message reappears together with the advice that only one more attempt is possible:

3 attempts can be made at entering the correct input. After the 3rd incorrect entry the keypad is locked for approx. 4 hours. The lockout time period only lapses if the equipment remains in operation.

The following information appears on the display:

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4.1.2.3.3 Delete Key-Word

Valid for all operating modes

This function only enables the deletion of the key-word set via the system keypad. Any key-word set via the remote software remains unaffected.

In order to delete the key-word it is necessary to input this first. The display then switches into the main menu. The sub-heading **'Set Key-Word Y/N'** is then selected via the **'CLOCK-CONTROL'** menu and the new key-word **000000** is entered and confirmed with the **ENT** key.

In order to **deactivate the key-word** it is necessary to carry out a Master Reset after the key-word has been entered (see ***Chapter 4.1.2.1 Programme Reset and System Reset***).

4.1.2.3.4 Key Word Forgotten – Unlock Key-Word

Valid for all operating modes

This function only enables the deletion of the key-word set via the system keypad. Any key-word set via the remote software remains unaffected.

If the key-word has been forgotten an **"UNLOCK"** password can be requested in writing from *hopf* Elektronik GmbH (see footnote for e-mail address). It is essential to provide the date on which the key-word is to be deleted, since the **"UNLOCK"** password changes daily.

In order to enter the password it is necessary to carry out a completely invalid key-word input sequence (3x incorrect key-word). When the start menu is selected again the following screen appears on the display:

```
ENTER HOPF UNLOCK-CODE ->~~~~~~<-
(SEE MANUAL)
```

After the *hopf* **UNLOCK-CODE** has been entered correctly the key-word is deleted. The following information is displayed:

```
KEY-WORD DELETED
```

The key-word has now been completely deleted.

If entered incorrectly the following is displayed:

```
ERROR: INPUT
```

After 3 seconds the display reverts back to the UNLOCK input screen.

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4.1.2.4 Monitor

Valid for all operating modes

This menu heading provides a service function for *hopf* Elektronik GmbH technicians. Use of this function by the user can cause the system to function incorrectly.

4.1.3 SHOW:3 – Display System Settings

Valid for all operating modes

The SHOW menu serves to display various system functions. They are only displayed here and can not be configured.

The individual display functions of the system 7001RC are explained below.

The Show menu can be exited at any time by pressing the **BR** key.

All sub-functions are not always needed or used, e.g. the satellite display in DCF_T mode. For this reason the operating mode(s) for which the sub-function is valid is given at the beginning of each Chapter. If a function that is not required is called up by mistake this should be exited by pressing the **BR** key.

The sub-functions of the Show menu are output to the display. The menu is controlled as follows:

- By entering **N** the next sub-function is displayed.
- By entering **Y** the corresponding sub-function is loaded.
- By pressing **ENT** the display returns to the sub-function request screen.

4.1.3.1 Error Monitoring

Valid for all operating modes

Individual messages, which can be grouped into a common error message with the aid of the ERROR-PRIORITY menu, are available on the control board 7020RC.

When an error occurs this is first checked to see if it is a sporadic error before the error message is output to the display. This can take up to 4 minutes. This does not mean, however, that a sporadic error is masked for 4 minutes in the same way in respect of signal processing in the internal system.

The error output is sub-divided into two groups, the meaning of which may be consulted in the table in ***Chapter 6.5 Error Messages - Meanings***.

A logic **'1'** indicates that an error is present.

The priority allocated to the individual errors, and how they are entered into the common error message, are shown underneath the error message:

- **'H'**: (high) **Major error** High priority level
- **'L':** (low) **Minor error** Low priority level
- **'-':** (non) **masked** The error is not included in the common error message

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When an error message with 'H' or 'L' priority arises this is indicated with an 'E' at the end of the top line of the standard display.

Selection screen:

```
 ERROR MONITORING  Y/N
```

Display screen:

```
 ERROR NO 1-8 >00001000< 9-16 >00000011<
 PRIORITY 1-8 >HHH-LLLL< 9-16 >-LLLL-HH<
```

4.1.3.2 Satellite Values (GPS)

Valid for: GPS Systems

This sub-function displays the number of satellites that are theoretically within sighting range, which satellites are being received and a relative measurement of reception performance. This sub-function is particularly helpful for the installation of the equipment.

Selection screen:

```
 SHOW SATELLITES  Y/N
```

Display screen:

```
 V  T SA/SN 01/102 ~~/~~~ ~~/~~~ ~~/~~~ ~~/~~~
10 01       ~~/~~~ ~~/~~~ ~~/~~~ ~~/~~~ ~~/~~~
```

The number of satellites that are theoretically visible from this location assuming an optimum antenna position is shown under **V** (visible). The value "00" is shown for (V) during the first reception process or after lengthy power failure.

The number of satellites that are actually being received by the GPS receiver at the time is shown under **T (T**racked).

The satellite number and the relative signal/noise ratio with which the satellite is being received by the GPS receiver are shown after **SA/SN** (Satellite/Signal Noise).

Description	Display
No satellite received	**~~/~~~**
For poor signal/noise conditions the values are:	**010 - 030**
For satisfactory signal/noise conditions the values are:	**031 - 050**
For good signal/noise conditions the values are:	**> 050**

In order to synchronize the GPS Master Clock System with UTC it is necessary to have 4 satellites in sighting range of the antenna, if the system is set to 3D synchronization. In optimum conditions 9-10 satellites will be within the sighting range of the antenna, of which 8 may be received in parallel. At least 1 satellite is required in Position-fix mode.

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4.1.3.2.1 Error Analysis for GPS Reception Problems

Valid for: GPS-Systems

System reception errors can be identified from the satellite display screen.

Example 1:

Effect: No satellite appears on the display after the first installation, even after several hours. 0 is displayed under 'T'.

Possible errors:

- The antenna cable is too long.
- An incorrect type of lead is installed for the cable length.
- The antenna cable is faulty.
- The antenna cable is not connected.
- The antenna is faulty.
- The lightning protection is faulty.

Example 2:

Effect: There are 7 satellites in the sighting range (**V=7**); a maximum of 2 appear on the display screen (**T=2**). However, the value of these satellites is 70 or higher.

Possible error:

- The visibility range of the antenna to the sky is restricted.

Example 3:

Effect: There are 9 satellites in the sighting range (**V=9**); 6 satellites appear on the display screen (**T=6**). The signal/noise ratio is 10-30 in all cases. The equipment does not synchronize.

Possible errors:

- The cable is too long.
- The wrong type of lead is fitted for the cable length.
- The BNC-connectors are not fitted correctly.
- The cable is crimped or broken.
- The cable has an incorrect impedance value.
- Reception conditions are extremely poor (e.g. thick, wet snow).

Example 4:

Effect: The equipment was working well previously but there has been no reception for several days. There are 7 satellites in sighting range (**V=7**). However, no satellite is picked up (**T=0**).

Possible errors:

- The cable is damaged.
- There was a lightning strike and the lightning protection is damaged.
- The antenna is faulty.
- The receiver is faulty.
- The power supply is faulty.

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4.1.3.3 View ST/WT Changeover Times

Valid for systems with internally activated ST/WT changeover times

The ST/WT changeover times calculated for the current year can be viewed with this function. After a year change the ST/WT changeover times are automatically re-calculated.

Selection screen:

```
SHOW CHANGE-OVER DATES  Y/N
STD->STANDARD   DST->DAYLIGHT SAVING
```

The ST/WT changeover times are shown for central Europe in the year 2003 as an example.

Display screen:

```
STD->DST TIME: 02:00 DATE: 30/MAR/2003
DST->STD       03:00       26/OCT/2003
```

If no ST/WT changeover times are activated the following message appears:

```
CHANGE-OVER DATES NOT ACTIV
```

4.1.3.4 Position

Valid for: GPS Systems

This sub-function displays the antenna position as input or the antenna position as updated by GPS. In contrast to the input of the position, the position display is extended by 4 decimal places after the position minute. The positional data is updated by GPS every second.

Selection screen:

```
SHOW POSITION  Y/N
```

Display screen:

```
LATITUDE:  N  51 DEGR.  12,6950 MIN.
LONGITUDE: E 007 DEGR.  39,7859 MIN.
```

The position of *hopf* Elektronik GmbH is given in the above example.

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4.1.3.5 System Information (Firmware, Serial Number)

Valid for all operating modes

This sub-function displays system information. This includes:

- (S-NO.:) The serial number of the control board 7020RC
- (VERS:) The firmware and programming date of the control board 7020RC
- (KN:) The commission number of the system 7001RC
- Eight pieces of coded system information

Selection screen:

```
 SHOW SYSTEM INFORMATION  Y/N
```

Display screen:

```
 S-NO.:123456  VERS:00.64  15/MAY/2003
 KN:123456789  FF 00 55 AA FF FF FF FF
```

4.1.3.6 Contact Address of *hopf* Elektronik GmbH

Valid for all operating modes

This sub-function displays the address of *hopf* Elektronik GmbH.

Selection screen:

```
 SHOW HOPF ELEKTRONIK GMBH ADDRESS  Y/N
```

Display screen:

```
 D-58511 LUEDENSCHEID / GERMANY
 NOTTEBOHMSTRASSE 41          >N<EXT
```

```
 TEL.:++49(0)2351/9386-86 FAX.:-93
 HTTP://WWW.HOPF.COM
```


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4.1.4 BOARD-SETUP:4 – Control of 'RC-Function Boards'

'RC-Function Boards' can be integrated, deleted, parameterized and integrated into the error monitoring system via the '**BOARD-SETUP'** menu.

4.1.4.1 Integration of 'RC-Function Boards'

Valid for all operating modes

All 'RC-Function Boards' are parameterized individually from the system 7001RC. This requires clear identification. For this reason all 'RC-Function Boards' must be integrated into the system under the '**ADD SYSTEM-BOARD'** menu heading.

```
ADD SYSTEM-BOARDS   Y/N
```

The 'RC-Function Board' does not require to be connected in order to implement it in the system 7001RC. This can be done later when the system 7001RC is running.

```
NEW BOARD: 7270  Y/N>Y    NO.:01-31  >25
BOARDNAME: >LANBOARD<              >ENT<
```

NEW BOARD: defines the board type of the new 'RC-Function Board'. All 'RC-Function Boards' recognized by the system 7001RC are scrolled with the **N** key. When the corresponding 'RC-Function Board' has been found, this is selected with the **Y** key.

Under **NO:** The two digit (01-31) board number defined via the DIP switch on the 'RC-Function Board' is recorded here. The coding is described in the technical manual of the respective 'RC-Function Board'.

BOARDNAME: An 8-digit name can be assigned to the 'RC-Function Board' here. The field must be filled out completely. If a name is not required this can be skipped by pressing the **ENT** key.

Valid range of values: All numbers and letters; free positions have to be filled by pressing the **SP** (Space) key. It is possible to enter special characters and lower and upper case letters via the remote software.

The 'RC-Function Board' is implemented in the system after all entries have been completed and the menu has been closed by pressing the **ENT** key. The yellow **SEND-LED** of the 'RC-Function Board' only begins to flash ('RC-Function Board' operating) when it has been switched into a monitoring mode. See ***Chapter 4.1.4.3 MONITORING or IDLE Mode - Monitoring 'RC-Function Boards'***.

If the input is incorrect the following error screen is displayed and the input can be re-entered.

```
ERROR: INPUT
```

If an 'RC-Function Board' of the same type and with the same name is already installed in the system the following error message is displayed:

```
ERROR: SYSTEM-BOARD ALREADY EXIST
```


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If two 'RC-Function Boards' with the same number are installed in the system 7001RC, the SEND-LED's of the two 'RC-Function Boards' in question flash simultaneously. The SEND-LED's of all monitored 'RC-Function Boards' are usually controlled in sequence.

Two or more **'RC-Function Boards' of the same type and with the same board number** must not be connected to the system 7001RC, since this will cause a conflict. This condition has to be changed immediately by assigning a different board number to one of the two 'RC-Function Boards'.
The determination of the already allocated board numbers is described in ***Chapter 5.3 Installing an additional 'RC-Function Board'***.

4.1.4.2 'RC-Function Board' Parameterization

The 'RC-Function Board' settings are made under this menu heading. All parameters are stored in the 7020RC control board and sent to the respective 'RC-Function Board' via the system bus.

```
 SET SYSTEM-BOARDS PARAMETER Y/N
```

The [Y] key calls up the following menu:

```
 PARAMETER BOARD 01/18:  7201 NO.:31
STATUS:M/E  BOARDNAME: SERIAL   SET>Y/N
```

Example of the above menu:

PARAMETER BOARD 01/18:	Board 01 of a total of 18 integrated 'RC-Function Boards'
7201:	'RC-Function Board' type to be parameterized
NO.: 31:	Board number of the 'RC-Function Board' to be parameterized
STATUS:	Indicates the monitoring mode and the error status of the 'RC-Function Board'
BOARDNAME: SERIAL	The board name assigned to the 'RC-Function Board' by the customer

Pressing the [N] key selects and displays the next integrated 'RC-Function Board'.

Pressing the [BR] key stops the function without adjusting an RC board.

Pressing the [Y] key takes the user into the parameter menu of the selected 'RC-Function Board'.

The parameter menu settings can be taken from the technical manual of the respective 'RC-Function Board' type.

4.1.4.3 MONITORING or IDLE Mode - Monitoring 'RC-Function Boards'

The system 7001RC offers the facility to monitor 'RC-Function Boards'. This means that the control board 7020RC will set an error message in the ERROR-MONITORING Byte if an RC board is faulty or not available in the system (see ***Chapter 4.1.3.1 Error Monitoring***).

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A newly implemented 'RC-Function Board' only begins to operate after it has been set to monitoring (Monitoring or Idle mode).

The **MONITORING** and **IDLE** monitoring modes facilitate differentiation between 'Function Boards' whose status is important for the user (Monitoring), or less important (Idle). For more information about Monitoring and Idle modes see ***Chapter 6.2 Monitoring and Idle, Monitoring Modes for 'RC-Function Boards'***.

This ability to differentiate becomes meaningful when, for example, a faulty 'RC-Function Board' is to be removed from the system, but

- the 'RC-Function Board' parameters are not to be deleted and
- a common error message is not to be triggered

Output can be prevented to the common error message by masking the error message allocated to Idle mode.

The Monitoring and Idle modes are operated as follows:

Call up the '**SET SYSTEM-BOARD TO MONITORING-MODE OR IDLE-MODE'** menu:

```
SET SYSTEM-BOARDS TO
MONITORING-MODE OR IDLE-MODE Y/N
```

Call up the displayed menu under '**BOARD-SETUP'** by pressing the **Y** key.

```
MON.BOARD 15/31: 7201 NO.:31 STATUS:M/E
NAME SERIAL M:MONITORING I:IDLE N:NEXT
```

PARAMETER BOARD 15/31:	Board 15 of 31 integrated 'RC-Function Boards'
7201:	'RC-Function Board' type to be monitored
NO.: 31:	Board number of the board type to be monitored
STATUS:	Indicates the 'RC-Function Board' monitoring mode and error status
NAME: SERIAL	Assigned name of the 'RC-Function Board'

Pressing the **M** key the displayed 'RC-Function Board' is set to Monitoring mode and the following menu screen appears:

```
BOARD IS SET TO MONITORING-MODE
```

Pressing the **I** key the displayed 'RC-Function Board' is set to Idle mode and the following menu screen appears:

```
BOARD IS SET TO IDLE-MODE
```

Key **N** selects the next 'RC-Function Board'.

Key **BR** exits the menu without setting any parameters.

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4.1.4.4 Deletion of 'RC-Function Boards'

Every integrated 'RC-Function Board' can be deleted from the system 7001RC at any time. The board does not need to be physically removed from the system for this purpose. Uninstalling the board stops it from functioning. The yellow **SEND-LED** on the board panel stops flashing.

Deleted 'RC-Function Boards' lose their parameter settings. To physically remove an 'RC-Function Board' from the system 7001RC it is not necessary to uninstall it first; it may be unplugged whilst the system 7001RC is operating and reconnected at any desired point. The parameter settings will not be lost.

'RC-Function Boards' are deleted from the system under the **'REMOVE SYSTEM-BOARD'** menu heading.

```
 REMOVE SYSTEM-BOARDS  Y/N
```

The displayed menu is called up under **'BOARD-SETUP'** by pressing the **Y** key.

```
 DEL.BOARD 02/31: 7530 NO.:31 STATUS:S/E
 BOARDNAME: FREQUNZ0  REMOVE:Y NEXT:N>_
```

DEL.BOARD 02/31:	Board 02 of 31 integrated 'RC-Function Boards'
7530:	Selected 'RC-Function Board' type to be deleted
NO.: 31:	Board number assigned to the 'RC-Function Board' type to be deleted
STATUS:	Indicates the monitoring level and error status of the 'RC-Function Board' to be deleted
BOARDNAME: FREQUENZ0:	Board name assigned to the 'RC-Function Board' type to be deleted

Pressing the **Y** key removes the selected 'RC-Function Board' from the system.

Pressing the **N** key selects and displays the next integrated 'RC-Function Board'.

Pressing the **BR** key exits the menu without removing the 'RC-Function Board'.

After deletion the following message appears for 3 seconds:

```
 SYSTEM-BOARD IS REMOVED
```

The following message appears if no 'RC-Function Board' is integrated in the system:

```
 ALL SYSTEM-BOARDS ARE REMOVED
```


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4.1.4.5 Display Implemented 'RC-Function Boards'

The **'SHOW ALL ADDED SYSTEMBOARDS'** menu heading is purely a display function via which neither 'RC-Function Boards' nor system values can be controlled.

Whilst the display function is being operated the output of ALL implemented 'RC-Function Boards' may be restricted.

Only the SEND-LED of the selected 'RC-Function Board' flashes throughout the entire period that the display function is operating. In this way the 'RC-Function Board' that is being addressed can be clearly identified.

If two 'RC-Function Boards' with the same number are installed in the system 7001RC, the SEND-LED's of the two 'RC-Function Boards' in question flash simultaneously. The SEND-LED's of all monitored 'RC-Function Boards' are usually controlled in sequence.

Two or more **'RC-Function Boards' of the same type and with the same board number** must not be connected to the system 7001RC, since this will cause a conflict. This condition has to be changed immediately by assigning a different board number to one of the two 'RC-Function Boards'.

Selection menu:

```
 SHOW ALL ADDED SYSTEM-BOARDS  Y/N
```

Call up the displayed menu with the **Y** key:

```
 SHOW BOARD 05/17: 7201 NO.:06
 STATUS: I/-  BORDNAME: SERI 01  NEXT:N
```

BOARD 05 OF 17	⇨ Board **05** of **17** implemented
7201 NR.: 06	⇨ Board type **7201RC** with board number **06**
STATUS: M/-	⇨ **M** = monitoring / **-** = operating without error
I/E	**I** = no monitoring / **E** = board error
BOARDNAME: "SERI 01_"	⇨ **SERI 01** Board name freely selectable by customer

Pressing the **N** key selects and displays the next installed 'RC-Function Board'.

Pressing the **BR** key exits the menu.

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4.1.4.6 Display of 'RC-Function Board' Information

The **'SHOW BOARD INFORMATION'** menu heading is purely a display function via which neither 'RC-Function Boards' nor system values can be controlled.

Selection menu:

The [Y] key calls up the displayed menu:

BOARD 05 OF 17	⇨	Board **05** of **17** implemented **7201RC** boards: 'RC-Function Board' type displayed
7201 NR.: 06	⇨	Board type **7201RC** with board number **06**
VERS: 01.01:	⇨	Programme version 01.01 of the displayed 'RC-Function Board'
DAT:	⇨	Firmware programming date of the selected 'RC-Function Board'
B:	⇨	Special service information

Pressing the [N] key selects and displays the next installed 'RC-Function Board'.

Pressing the [BR] key exits the function.

4.1.5 SPECIAL-BOARD-TIME:5 - Setting Functions for 'RC-Function Boards' 7406RC / 7515RC

SPECIAL BOARD TIME is an additional setting function for the slave-line board 7406RC and the mains frequency analysis board 7515RC.

These functions are explained in the respective technical manual of the 'RC-Function Boards' referred to.

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5 Inserting and Removing 'Function Boards' / 'RC-Function Boards'

Valid for: All operating modes

It is essential to observe the following points when handling 'Function Boards'.

5.1 Important Information

Two or more **'RC-Function Boards' of the same type and with the same board number** must not be connected to the system 7001RC at the same time, since this will cause a conflict. Board names may, however, be identical.
The determination of the already allocated board numbers is described in ***Chapter 5.3 Installing an additional 'RC-Function Board'***.

Only 'RC-Function Boards' (recognizable by the identification 'RC' on the handle) may be implemented in the system 7001RC.

Exceptions: passive 'Function Boards', which do not communicate with the system bus.

If other board types (e.g. from the 7001DCF77/GPS system) are installed in the system 7001RC, this can cause errors and damage to the board and the system 7001RC.

- In principle, every 'Function Board' / 'RC-Function Board' can be connected at any desired point on the system 7001RC.

  Exceptions:

  - Control board 7020RC, due to the wiring to keypad and display
  - Slave-line boards 7406RC with any internal line voltage wiring
  - Mains frequency analysis boards 7515RC, due to internal network voltage wiring
  - Passive output boards with any system-internal wiring

Slots equipped with wiring at the time of delivery should be taken from the system drawing.

- All 'Function Boards' / 'RC-Function Boards' can be connected to or disconnected from the system 7001RC at any time whilst the system is in operation, without interrupting the functionality of the system 7001RC.
- System slots can be kept free in between 'Function Boards' / 'RC-Function Boards'.
- Each 'RC-Function Board' is uniquely identified by the system 7001RC via the 'RC-Function Board' type (e.g. 7270RC) and the allocated board number (01-31).
- A board name given to an 'RC-Function Board' can not be changed at a later date. The 'RC-Function Board' must therefore be deleted and re-integrated via the menu. The parameterization of the 'RC-Function Board' is lost in the process.

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- If an 'RC-Function Board' is unplugged from the system 7001RC, without being deleted via the menu, the settings of the 'RC-Function Board' are retained.
- If an 'RC-Function Board' is deleted via the menu, the settings of this 'RC-Function Board' are deleted.
- 'RC-Function Boards' can be integrated and parameterized via the menu, without the need for them to be physically present. If the 'RC-Function Boards' are then connected to the system 7001RC at a later time, they then take up their function immediately.
- Function of the SEND-LED's on the panel of the 'RC-Function Boards':
    - The SEND-LED's only begin to operate from the time that the 'RC-Function Board' is set to the Idle or Monitor supervisory modes.
    - All SEND-LED's are controlled consecutively in short sequence. This means that, in a correctly parameterized system 7001RC, the SEND-LEDs of two or more 'RC-Function Boards' are never on simultaneously. If this situation should arise, however, this means that the 'RC-Function Boards' in question are of the same type and have been given the same board number. This mistake should be corrected immediately, since the board functions will be disturbed in an unpredictable manner. The determination of the already allocated board numbers is described in ***Chapter 5.3 Installing an additional 'RC-Function Board'***.

5.2 Exchanging a 'RC-Function Board'

The following steps are required to exchange a 'RC-Function Board' for an identical model of board whilst retaining all of the previous functions:

- Remove all connections from the board to be exchanged.
- Unscrew the 'RC-Function Board' and unplug it from the 7001RC (hot-plug capability).
- Transfer the board number of the old 'RC-Function Board' to the new board.
- Insert the new 'RC-Function Board' into the system 7001RC and screw tightly into place.

Make sure that the earth clamp is in the correct position. The fastening screw of the 'RC-Function Board' should pass through the hole in the earth clamp in order to guarantee a safe contact.

- The new 'RC-Function Board' takes over all the software settings of the exchanged 'RC-Function Board'.
- Remake all connections.

5.3 Installing an additional 'RC-Function Board'

Up to 14 slots are available in a 3U rack for 'Function Boards' / 'RC-Function Boards' with 4HP panel width. If 'Function Boards' / 'RC-Function Boards' with a width of 8, 12 or 16HP are installed the number of slots is reduced accordingly.

Valid for: All operating modes

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The following steps are required to retrofit an additional 'RC-Function Board' to the system 7001RC:

- Remove the slot cover(s) from the connection side of the system 7001RC in accordance with the panel width of the new 'RC-Function Board' to be installed.
- Check that the slot behind is equipped with board guide bars and a VG ledge that is connected to the system bus.
- If additional wiring is required on the bus slots, e.g. to connect to other 'Function Boards', details should be taken from the user information enclosed with the new 'Function Board'.
- Set the desired board number on the 'RC-Function Board' to be installed, in accordance with the technical specification. When doing so make sure that there is **no** 'RC-Function Board' of the same type already installed in the system 7001RC with the same board number.

Two or more **'RC-Function Boards' of the same type and with the same board number** must not be connected to the system 7001RC at the same time, since this will cause a conflict. Board names may, however, be identical.

- The board numbers allocated previously can be displayed via the **SHOW ALL ADDED SYSTEM-BOARDS** menu. The board numbers that are not listed for this board type are available for the new board.
- Boards that are present but not yet activated via the system menu are **not** listed in the **SHOW ALL ADDED SYSTEM-BOARDS** menu. (The "SEND" LED of these boards does not flash when the system is operating.) In order to ascertain the board number set for these boards they must be taken out of the system in order to determine the set board number from the DIP switch settings.
- Insert the 'Function Board' / 'RC-Function Board' into the system 7001RC. The SEND-LED of the newly installed 'RC-Function Board' remains unlit, until the 'RC-Function Board' is integrated via the system menu/remote software (see ***Chapter 5.4 Integrate the 'RC-Function Board' into the System 7001RC (Software)***).

Make sure that the earth clamp is in the correct position. The fastening screw of the 'RC-Function Board' should pass through the hole in the earth clamp in order to guarantee a safe contact.

5.4 Integrate the 'RC-Function Board' into the System 7001RC (Software)

In order to put a non-implemented 'RC-Function Board' into operation in the system 7001RC the steps presented in the following Chapters should be carried out:

- ***Chapter 4.1.4.1 Integration of 'RC-Function Boards'***
- ***Chapter 4.1.4.2 'RC-Function Board' Parameterization***
- ***Chapter 4.1.4.3 MONITORING or IDLE Mode - Monitoring 'RC-Function Boards'***

After the steps described in the above-mentioned Chapters have been carried out the previously set board parameters become valid and the 'RC-Function Board' begins to work.

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5.5 Permanent Removal of an 'RC-Function Board'

The following steps should be carried out to remove an 'RC-Function Board' from the system 7001RC permanently:

- Remove all connections on the 'RC-Function Board' in question.
- Unscrew the 'RC-Function Board' and unplug it from the system 7001RC (hot-plug capability).
- Delete the 'RC-Function Board' in the system 7001RC. See ***Chapter 4.1.4.4 Deletion of 'RC-Function Boards'***.

5.6 Installation and Removal of 'Function Boards'

'Function boards' are not integrated in the system 7001RC. Therefore:

- they can neither be integrated nor deleted via the system 7001RC.
- they can not be parameterized via the system. 'Function board' settings are made via jumpers and/or DIP switches on the boards themselves.

Installation

Up to 14 slots are available in a 3U rack for 'Function Boards' with 4HP panel width. If 'Function Boards' with a width of 8, 12 or 16HP are installed the number of slots is reduced accordingly.

The following steps are required to retrofit an additional 'Function Board' to the system 7001RC:

- Remove the slot cover(s) from the connection side of the system 7001RC in accordance with the panel width of the new 'Function Board' to be installed.
- Check that the slot behind is equipped with board guide bars and a VG ledge that is connected to the system bus.
- If additional wiring is required on the bus slots, e.g. to connect to other 'Function Boards', details should be taken from the user information enclosed with the new 'Function Board'.
- Insert the new 'Function Board' into the system 7001RC and fasten the screws tightly.

Make sure that the earth clamp is in the correct position. The fastening screw of the 'Function Board' should pass through the hole in the earth clamp in order to guarantee a safe contact.

- The 'Function Boards' start to operate as soon as they are inserted into the system 7001RC.

Removal

- Remove all connections form the 'Function Board' to be exchanged.
- Unscrew the 'Function Board' and unplug it from the 7001RC (hot-plug capability).

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6 Error Evaluation in the System 7001RC

The error monitoring and evaluation facilities of the system 7001RC are described in the following sections.

6.1 Basic Principle

The system 7001RC monitors itself and the installed 'RC-Function Boards' for errors. These may be, for example, reception failure, 'RC-Function Board' error or line fault on a 7406RC slave-line board. The 7001RC can differentiate between different types of error message (see ***Chapter 6.5 Error Messages - Meanings***).

- Error messages can be triggered by system errors and 'RC-Function Board' errors.
- Differentiation can be made between important and less important 'RC-Function Board' errors by means of two different 'RC-Function Board' monitoring modes (Idle and Monitoring).
- Each error type is assigned to one error message
- All error messages are grouped to one error byte.
- A rating can be allocated to every error message via a filter function:
    - Mask error (and thereby ignore)
    - Minor error: Low Priority
    - Major error: High Priority
- An error output occurs as soon as an error message with low or high priority has been triggered.
- An 'E' appears on the top right of the system 7001RC display, independent of the error message rating (see ***Chapter 3.3 Display after System Start / Reset (Firmware)***)
    - In the event of an error a TTL output and an optocoupler output are set on the system–internal VG ledge of the control board 7020RC.
    - A TTL error output can also be switched on the control board 7020RC Sub-D connector via the system menu.
- The error output can take two different forms: static and dynamic.
    - The static error output can only differentiate between two conditions: ‘No error’ or 'Error'. The error rating (major error or minor error) is not considered in this case.
    - The dynamic error output differentiates additionally between major und minor errors. In combination with the *hopf* Switch-Box and dependent of the error rating, two systems 7001RC can be switched over in order to provide a redundant time source (see ***Chapter 4.1.1.6.3 Bit 4, PPS/Switch-Box Control Output via X1 of the 7020RC***).

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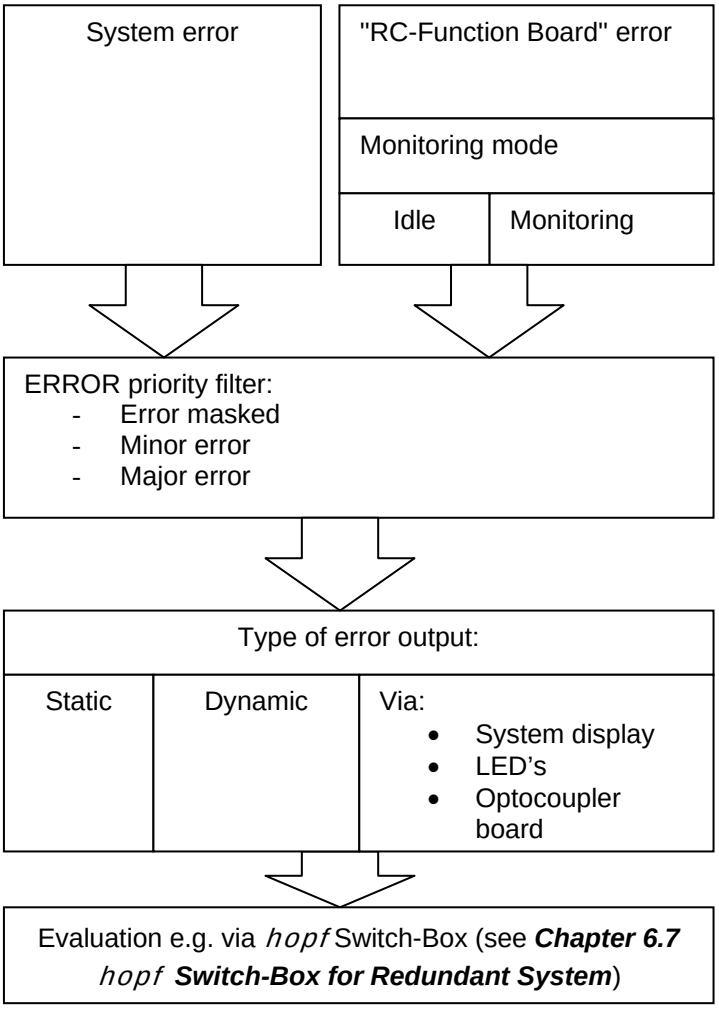
The following diagram clarifies the structure of the error handling system:



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6.2 Monitoring and Idle, Monitoring Modes for 'RC-Function Boards'

The system 7001RC has the ability to monitor 'RC-Function Boards'. This means that if one or more 'RC-Function Boards' is:

- faulty
- not available in the system
- or reports another error

then the control board 7020RC sets corresponding error messages in the ERROR-MONITORING Byte. There are two different error monitoring modes: **IDLE** and **MONITORING**:

Monitoring mode	Monitored errors	Error messages set in the ERRORBYTE
MONITORING	An integrated 'RC-Function Board' is not recognized by the system 7515RC board: No mains frequency 7406RC board: Line monitoring error	Error messages **12** and **13** are set
IDLE	An integrated 'RC-Function Board' is not recognized by the system	Error message **13** is set
	Errors on a 'RC-Function Board' itself (e.g. 7406RC line errors or mains frequency errors on board 7515RC) are not monitored	**No** error message is set

In this way the user can differentiate between 'RC-Function Boards' whose error status is important or less important. In combination with the '**H**'igh and '**L**'ow priority settings in the **'ERROR PRIORITY'** sub-menu of the **'INITIAL-SETUP'** menu and a dynamic error output (see ***Chapter 4.1.1.6.2 Bit 5, Static/Dynamic Error Message***) it is then possible to:

- output a minor error ('**L**'ow priority error) when an 'RC-Function Board' monitored under 'Idle' mode does not reply;
- output a major error ('**H**'igh priority error) as soon as an 'RC-Function Board' monitored under 'Monitor' mode triggers an error.

6.3 Error Priority, Major and Minor Errors

Individual error messages are available in the system 7001RC (see Error Bytes), which are grouped into a common error message. Error priority is used to decide which individual errors will trigger a common error message, and with what priority. The individual errors can be masked or 2 different priority levels can be allocated:

- Major error = high ('**H**'igh) priority
- Minor error = low ('**L**'ow) priority
- or the error is completely masked

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As soon as a major or minor error occurs, an ‘E’ appears on the top right of the system 7001RC display. This message can not be used, however, to ascertain the error priority.

It is only possible to ascertain the error priority when the dynamic error output is switched on and the error output is monitored. In addition the current error status can be consulted in the **'SHOW'** menu.

6.4 Static and Dynamic Error Output

In the case of dynamic error output, major and minor errors can be differentiated via the signal output on the VG ledge of the control board 7020RC and, dependent on the setting, also on the 9-pin SUB-D connector X1 in the 7020RC board panel. This differentiation can not be made with the static error message, both levels being considered to be high priority errors. See ***Chapter 4.1.1.6.2 Bit 5, Static/Dynamic Error Message*** for more information about signal outputs.

6.5 Error Messages - Meanings

The current status of the individual error messages can be consulted in the system 7001RC at any time (see ***Chapter 4.1.3.1 Error Monitoring***). The listing does not take into account whether errors are static or dynamic.

Bit	Function
0	No error
1	Error

ERROR-1	**GPS reception**
0 / 1	Bit 1 changes from logic **"0"** to logic **"1"** if the system has no GPS reception in “**GPS_M"** mode.
ERROR-2	**DCF77 pulse**
0 / 1	Bit 2 changes from logic **"0"** to logic **"1"** if, in **"DCF_T"** mode, the system does not receive pulses from the DCF77 pulse, or if these are faulty.
ERROR-3	**DCF77 analogue**
0/1	Not implemented.
ERROR-4	**Master/Slave-String**
0 / 1	Bit 4 changes from logic **"0"** to logic **"1"** if the serial Master/Slave-String was read incorrectly or is not available.
ERROR-5	**Master/Slave-String**
0 / 1	Bit 5 changes from logic **"0"** to logic **"1"** if the serial Master/Slave-String reports quartz operation from a 2nd synchronization source.
ERROR-6	**Synchronization source comparison error in GPS_M+ mode**
0 / 1	Bit 6 changes from logic **"0"** to logic **"1"** if a synchronization source comparison error is present in **GPS_M+** mode. In this setting synchronization takes place via the GPS receiver and via a serial Master/Slave-String. An error message is generated if there is a difference in the time information.
ERROR-7	**Synchronization source comparison error in DCF_T+ mode**
0 / 1	Bit 7 changes from logic **"0"** to logic **"1"** if a synchronization source comparison error is present in **DCF_T+** mode. In this setting synchronization takes place via the DCF77 pulse input and via a serial Master/Slave-String. An error message is generated if there is a difference in the time information.
ERROR-8	**Synchronization source comparison error in DCF_A+ mode**
0 / 1	Not implemented.

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ERROR-9	Radio synchronicity
0 / 1	Bit 9 changes from logic **"0"** to logic **"1"** when the system status is not 'Radio'.
ERROR-10	**Internal quartz control - lower limit**
0 / 1	Bit 10 changes from logic **"0"** to logic **"1"** when the quartz control lower limit is reached and in this way no further downward frequency control steps can take place.
ERROR-11	**Internal quartz control - upper limit**
0 / 1	Bit 11 changes from logic **"0"** to logic **"1"** when the quartz control upper limit is reached and in this way no further upward frequency control steps can take place.
ERROR-12	**Monitoring error**
0 / 1	Bit 12 changes from logic **"0"** to logic **"1"** when a 'RC-Function Board' that is in **Monitoring mode** triggers an error. This means that only faulty 'RC-Function Boards' that are in this monitoring mode are reported (see the following table).
ERROR-13	**Monitoring/Idle error**
0 / 1	Bit 13 changes from logic **"0"** to logic **"1"** when a 'RC-Function Board' that is in **Idle-Monitoring mode** does not reply or when a 'RC-Function Board' that is in **Monitoring mode** triggers an error.
ERROR-14	**Monitoring error**
0 / 1	Bit 14 changes from logic **"0"** to logic **"1"** when a Board 7406RC in the system reports a line error.
ERROR-15	**Monitoring/Idle error**
0 / 1	Bit 15 changes from logic **"0"** to logic **"1"** when a Board 7515RC in the system reports a mains frequency error.
ERROR-16	Not currently assigned

6.6 Configuration Example for Error Monitoring

A system 7001RC is configured as follows and is equipped with the following 'RC-Function Boards':

Control board 7020RC synchronized via GPS antenna (GPS_M mode).

The following 'RC-Function Boards' are implemented:

- 7201RC - serial output board
- 7270RC - LAN board
- 7406RC - slave-line board
- 7515RC - mains frequency board

Any of the following errors that arise are considered to be **critical** and should therefore trigger a **major error** on the Sub-D connector X1 in the front panel of the 7020RC control board:

System 7001RC not operating

System 7001RC no longer synchronous

LAN board 7270RC no longer recognized by the system 7001RC

Board 7515RC does not recognize any mains frequency

Any of the following errors that arise are considered to be **non-critical** and should therefore trigger a **low priority error**:

'RC-Function Board' 7201RC failure

'RC-Function Board' 7406RC failure - errors in the slave-line controller should not be reported.

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The following settings are necessary in this case:

- **'BOARD-SETUP'** menu, sub-menu **'SET SYSTEM-BOARDS TO MONITOR-MODE OR IDLE MODE'**:
- Set the monitoring mode for the 7515RC 'RC-Function Board' to MONITOR (errors arising set error reports 12 and 13)
- Set monitoring mode for 'RC-Function Board' 7270RC to MONITOR
- Set monitoring mode for 'RC-Function Board' 7201RC to IDLE (errors arising set error report 13 only)
- Set monitoring mode for 'RC-Function Board' 7406RC to IDLE
- **'INITIAL SETUP'** menu, sub-menu **'ERROR PRIORITY Y/N'**:

Error Bit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Value	H	-	-	-	-	-	-	-	H	-	-	H	L	-	-	-

Explanation:

- Bit 1 reports ‘No GPS reception’ ⇨ High error priority
- Bit 9 reports ‘Clock not radio-synchronous' ⇨ High error priority
- Bit 12 is triggered exclusively via a monitored 'RC-Function Board'; in this case the 7270RC board (error is triggered when the 'RC-Function Board' can no longer be addressed) and the 7515RC board (error is triggered when the 'RC-Function Board' does not recognize mains frequency or when the 7515RC 'RC-Function Board' can no longer be addressed).
- In addition to the monitored 'RC-Function Boards', 'RC-Function Boards' monitored in Idle mode also set Bit 13 when there is a fault. In this way, the 7201RC and 7406 'RC-Function Boards' are monitored and in the case of a fault a low priority error message is reported.

'INITIAL SETUP' menu, sub-menu 'FUNCTION CONTROL':

Set Bit 5 and Bit 4 to '1'. By so doing dynamic error output is enabled on pin 4 of the SUB-D connector X1.

The following TTL signals are now output on pin 4 of the SUB-D connector X1 and on pin 17b of the internal 7020RC VG ledge:

- No error approx. 980/20 ms HIGH/ LOW level
- Minor error approx. 20/980 ms HIGH/ LOW level
- Major error LOW level

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6.7 *hopf* Switch-Box for Redundant Systems

The *hopf* Switch-Box for redundant systems is a modular system for error-dependent signal switchover between a master system and its redundant system (hot-standby).

System characteristics

- A safety system developed for the *hopf* 7001 / system 7001RC
  - also suitable for other suppliers' systems due to variable status evaluation
- Also applicable to the 6000 system, however with limited status evaluation
- The Switch-Box monitors master and redundant systems for the following conditions:
  - o System O.K.
  - o MINOR alarm
  - o MAJOR alarm
  - o Total failure
- Intelligent changeover dependent on the operating conditions of the master and redundant systems
- Individually configurable
  - free allocation of error priority in the *hopf* 7001 / system 7001RC
- Status LED's in the system front panel
- Switch-Box faults and status report for switchover readiness via relay contact and LED
- System 5000 is provided with a corresponding switch-board for each output signal to be switched over
- Switchover mode of every switch-board adjustable via a switch on the board panel (output fixed on redundant system / output fixed on master system / output controlled by Switch-Box)
- Complete electrical isolation between the output signals
- Electrical isolation between the systems available as an option. Only the housing earth wires are joined together by the connection lead
- Simple retrofitting of individual systems with a redundancy-switchover - all switch-board output pins and connectors are compatible with the *hopf* 7001 / system 7001RC
- Base system in 1/1 19" rack (84HP/3U) including control board 5100 and power supply unit
- Power supply 115/230V AC – other voltages on enquiry
- Housing extensions with additional switch-board slots available for larger systems

A Switch-Box is not required for the 7270 LAN board, since the redundancy of the two LAN boards can be carried out directly in the network via different IP addresses.

To connect the *hopf* Switch-Box see ***Chapter 4.1.1.6.3 Bit 4, PPS/Switch-Box***)

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7 Care and Maintenance

The system 7001RC is generally maintenance-free. It can be cleaned whilst operating.

When the system 7001RC requires cleaning the following steps should be taken.

7.1 General Guidelines for Cleaning

The following must **not** be used to clean the system 7001RC:

- Fluids
- Cleaning agents containing solvents
- Cleaning agents containing acids
- Abrasive media

The use of such cleansing agents or media could damage the system 7001RC.

Do not use a wet cloth to clean the system 7001RC.
There is the danger of an electric shock.

To clean the system 7001RC use a cloth that is:

- antistatic
- soft
- non-fabric
- damp

7.2 Cleaning the Housing

Whilst cleaning the housing of an active system make sure that connections or cables are not loosened. There is a risk that the system could become damaged and lose functionality.

7.3 Cleaning the Display and Keypad

Minimum pressure should be exerted when cleaning the display and keypad. Excessive pressure may cause mechanical damage.

When cleaning active systems 7001RC make sure that system functions are not altered by accidentally pressing a key.

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8 Technical Data System 7001RC

General Data	
Housing:	Aluminium, closed
Housing dimensions:	19" System, 3U/84HP (132,5mm / 482,6mm), depth 230mm
Housing protection class:	IP20
Protection class:	I
Cooling:	passive cooling ⇨ attend convection: above and below system a minimum of 1 U to the next device.
Display: Optional:	VFD-Display: 2x40-digit (colour: green) Character height: 5mm; Display type: alphanumeric Status / Error LEDs
Keypad:	42 keys
Operation:	Via keypad and VFD-Display
MTBF (Basis Board 7020):	> 290.000 hours
Weight (Basis System):	Approx. 5kg (depends on system configuration level)

Environmental Conditions		
Temperature:	Operating:	0°C to +55°C
	Storage:	-20°C to +75°C
Humidity:		Max. 95%, not condensed

Operating Voltage	
Standard:	120/230V AC +10% -15% / 30VA
Option:	48V DC (36V - 72V) / 30VA 24V DC (18V - 36V) / 30VA Other power supplies on request
Power Consumption:	Depends on power supply and configuration level of system (see type plate)

CE compliant in accordance with EMC Directive 89/336/EEC and Low Voltage Directive 73/23/EEC	
Safety / Low Voltage Directive:	DIN EN 60950-1:2001 + A11 + Corrigendum
EMC (Electromagnetic Compatibility) / Interference Resistance:	EN 610000-4-2 /-3 /-4 /-5 /-6 /-11 EN 61000-3-2 /-3, EN 61000-6-2 /-4
Interference voltage:	EN 55022 Class B

Backup Clock	
Accuracy:	± 25ppm at +10°C to +50°C
Buffering (maintenance-free):	3 days

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Internal System Accuracy (1)

Synchronisation Source	Standard Quartz	OCXO
GPS		
Accuracy (2) (absolute)	< ± 100ns	< ± 100ns
Jitter / Stability (2) (averaged)	< ± 1 * 10^{-8} (τ = 1sec) < ± 5 * 10^{-9} (τ = 100sec)	< ± 6 * 10^{-9} (τ = 1sec) < ± 2 * 10^{-9} (τ = 100sec)
Freewheel Stability (2)	< ± 2 * 10^{-8} (at 1.day) (< ± 2ms / 1.day)	< ± 3 * 10^{-9} (at 1.day) (3) (< ± 0,3ms / 1.day)
DCF77 Pulse		
DCF77 pulse signal accuracy: < **± 300nsec**		
Accuracy (2) (absolute)	< ± 150ns	< ± 150ns
Jitter / Stability (2) (averaged)	< ± 1 * 10^{-8} (τ = 1sec) < ± 5 * 10^{-9} (τ = 100sec)	< ± 6 * 10^{-9} (τ = 1sec) < ± 4 * 10^{-9} (τ = 100sec)
Freewheel Stability (2)	< ± 2 * 10^{-8} (at 1.day) (< ± 2ms / 1.day)	< ± 5 * 10^{-9} (at 1.day) (3) (< ± 0,3ms / 1.day)
DCF77 pulse signal accuracy: approx. **± 1,2msec**		
Accuracy (2) (absolute) (to averaged input signal)	< ± 150µsec	< ± 150µsec
Jitter / Stability (2) (averaged)	< ± 1 * 10^{-5} (τ = 1sec) < ± 3 * 10^{-6} (τ = 100sec)	< ± 1 * 10^{-5} (τ = 1sec) < ± 2 * 10^{-6} (τ = 100sec)
Freewheel Stability (2)	< ± 1 * 10^{-7} (at 1.day)	< ± 5 * 10^{-8} (at 1.day) (3)
***hopf* Master/Slave String** (4)		
Accuracy (2) (absolute) (to averaged input signal)	< ± 150µsec	< ± 150µsec
Jitter / Stability (2) (averaged)	< ± 5 * 10^{-6} (τ = 1sec) < ± 3 * 10^{-6} (τ = 100sec)	< ± 5 * 10^{-6} (τ = 1sec) < ± 3 * 10^{-6} (τ = 100sec)
Freewheel Stability (2)	< ± 1 * 10^{-7} (at 1.day)	< ± 5 * 10^{-8} (at 1.day) (3)
General Settings		
Aging	< ± 5 *10^{-6} / year	< ± 3 * 10^{-9} / day < ± 2 * 10^{-7} (in 1.year)

Comments:

(1) The system quartz frequency is the leading value to generate PPS pulses and 1kHz (msec). It is determining for the system accuracy.

(2) After a minimum of 4 hours continuously synchronisation at constant temperature.

(3) After a minimum of 15 days continuously operating at constant temperature.

(4) Master/Slave String accuracy **ETX** at second change by 9600Baud:
Offset: approx. +330µsec (to GPS-PPS), Jitter: ± 60µsec

τ: Capture time / Averaging time

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Signal Outputs	
Serial full duplex interface (without Handshake):	Via 9-pole SUB-D male connector X1 • RS232 und RS422
PPS Pulse	Via 9-pole SUB-D male connector X1 • Signal level TTL (5V) • Pulse duration: 50ms / ± 5ms • Accuracy: same as **internal system accuracy**
DCF77 Pulse	Via 9-pole SUB-D male connector X1 • Signal level TTL (5V) • Pulse duration: 100ms or 200ms / ± 5ms • Accuracy: same as **internal system accuracy**
DCF77 Antenna Simulation (77,5kHz):	Via BNC female connector • Signal level: V_{pp} = 10mV / RL = 50Ω • Carrier frequency: 77,5kHz ± 25ppm • Accuracy (**to DCF77 pulse**): Offset: +13µs / Jitter: ± 7µsec

GPS Data	
Receiver Type:	12-channel phase-tracking receiver, C/A-Code
Analysis:	L1 frequency (1.575,42MHz)
Synchronisation Time:	• Cold start: 5min. - 30min. (First commissioning without input of position) • Warm start: < 1min. (Voltage failure < 3 days)
Antenna connection:	• Via BNC bush • For active antennas, U_b = 5V DC • Antenna supply via BNC bush of board 7001RC

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9 Appendix

9.1 GPS (Global Positioning System)

Satellites circumnavigate the earth about twice per day at an altitude of approximately 20,000 km, on 6 different courses and at different angles.

The GPS system was developed based on 18 satellites with 3 replacement satellites. In order to prevent short-term gaps in coverage the number was increased during development to 21 satellites with 3 replacement satellites. Above any point on the skyline, therefore, there are always between 6 and 11 satellites visible. Highly precise atomic clocks are on board every satellite (accuracy min. $1*10^{-12}$).

A base frequency of 10.23 MHz is taken from the atomic clocks. The two carrier frequencies used, L1 and L2, are produced from this base frequency.

- Transmission frequency L1 = 154 * Base frequency = 1575.42 MHz
- Transmission frequency L2 = 120 * Base frequency = 1227.60 MHz

Each satellite sends all important navigation and system data by modulation on these two carrier frequencies. In the public domain, data transmitted on L1 frequency may be evaluated. The precise time can be calculated from this data by defining the position via the antenna.

The GPS antenna receives the signals of all satellites that are within sighting range above the skyline and forwards them to the GPS receiver via a coaxial cable. 4 satellites are required for continuous time evaluation.

hopf GPS radio-controlled clocks have a **Position-fix function** for difficult antenna positions that do not permit continuous reception from 4 satellites (where satellite signals may be screened by surrounding buildings or in mountain valleys, for example). This function also permits synchronization with only one satellite.

Time calculation

The GPS receiver calculates world time UTC (Coordinated Universal Time) from GPS world time (GPS-UTC) radiated by the satellite, by subtracting the leap seconds; at present (status: January 1999) world time is running 13 seconds behind GPS-UTC time. The difference is not constant and changes with the insertion of leap seconds.

The current standard time for the respective time zone is calculated by the addition of a time offset to the UTC time. This time offset, between UTC time and the time zone in which the clock is situated, is set in the clock by the user during commissioning of the clock.

Any ST/WT changeover that is due in the time zone is carried out via a switching function that is to be configured in the clock.

Advantages/Disadvantages:

+ High accuracy
+ High security against interference
+ Worldwide application possible
+ High security against failure (terrestrial transmitters are often switched off when bad weather conditions prevail at the transmission location)
+ High independent clock accuracy
– Outdoor antenna required
– Limited antenna cable lengths

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9.2 DCF77 (German Long-Wave Transmitter Frankfurt 77.5 kHz)

DCF77[1] is a time signal that is radiated via a terrestrial long-wave transmitter in Frankfurt, Germany, with a carrier frequency of 77.5 kHz.

9.2.1 DCF77 General

The DCF77 signal transmits central European time (CET) or central European summer time (CEST). This time is calculated from UTC plus one hour (CET) or two hours (CEST).

The DCF77 signal contains complete time information: minute, hour, day-of-week and date. The following information is transmitted:

- Local time
- Current time zone (ST or WT)
- Announcement bit for ST/WT changeover
- Announcement bit for the leap second

If UTC is to be calculated from the local time transmitted by DCF77 then the receiver must know the time offset (local time to UTC). In the CET zone this is +1 hour in an easterly direction. The system 7001RC calculates the correct UTC time from the local time, via the internally set time offset.

9.2.1.1 DCF77 Signal Structure

Specific time information is transmitted every second of every minute, with the exception of the 59th second. The missing signal in this second gives notice of an impending minute change in the next second.

The amplitude of the 77.5 kHz carrier frequency is reduced from 100% to 25% at the beginning of every second for a duration of 100 or 200 ms (amplitude modulation). The beginning of each reduction marks the precise second change.

The duration of reductions of 100 and 200 ms (binary 0 and 1) is converted into a BCD code and in this way decodes the transmitted time telegram.

The time telegram is sub-divided into three different groups, each followed by a parity check:

- P1 = number of minutes
- P2 = number of hours
- P3 = current day-of-year, day-of-week, month and year

The binary ‘1’s’ of a group are calculated and supplemented with the parity bit to form an even number.

When valid time information is transferred from CEST, the 17th second mark has a duration of 200 ms. One hour before changeover from CEST to CET, or vice-versa, the 16th second mark has a duration of 200 ms.

[1] DCF77: **D** = Deutscher (German), **C** = Long-wave transmitter, **F** = Frankfurt, **77** = frequency

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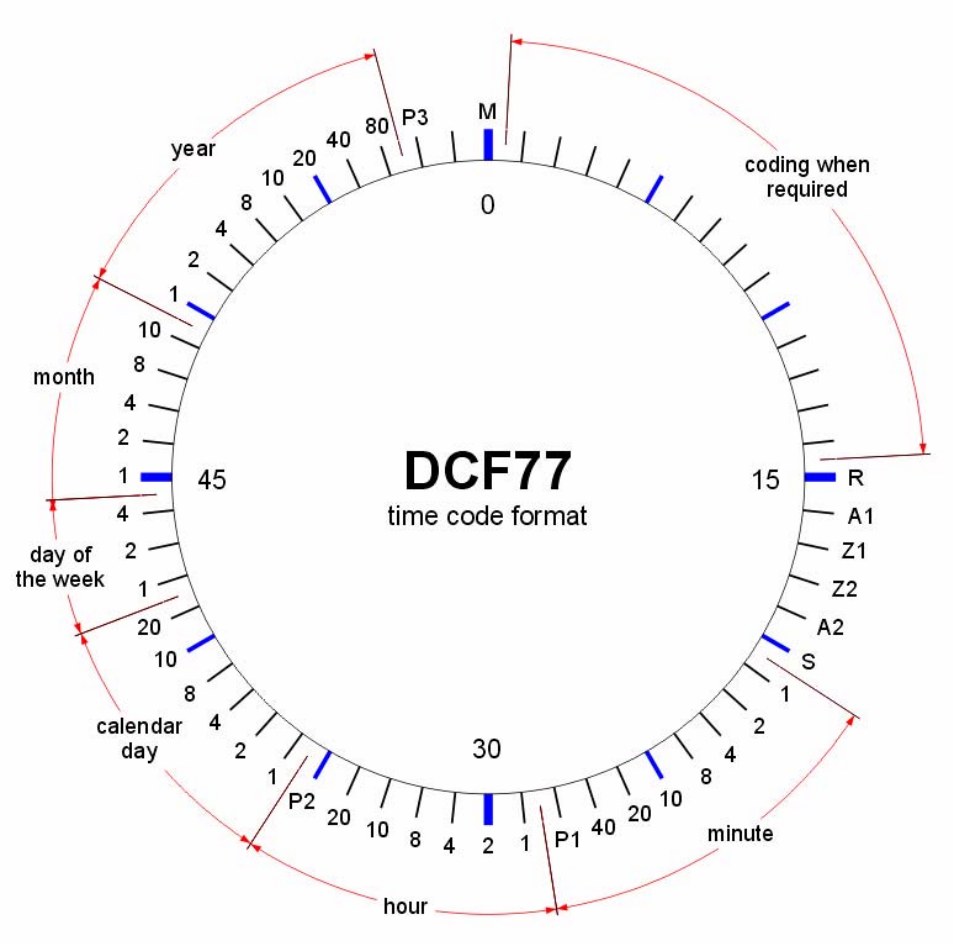
The coding is shown in the following illustration:



M	Minute mark (0.1 s)
R	The second mark no. 15 has a duration of 0.2 sec. when radiation takes place via the standby antenna.
A1	Announcement of an imminent change from CET to CEST or vice-versa.
Z1, Z2	Time zone bits
A2	Announcement of a leap second
S	Start bit of the coded time information
P1, P2, P3	Test bits

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9.2.1.2 Advantages and Disadvantages

+ DCF77 receivers are generally less expensive than GPS receivers
+ Reception of the legal time in Germany
+ The antenna can be installed inside a building
  (no lightning protection or expensive laying of antenna cable is necessary)

– Sensitive to interference signals
  (atmospheric interference or radiation from electric motors, monitors or other switched, inductive loads)
– Installation limited to within approx. 1500 km of Frankfurt, Germany
– Transmitter may be switched off when there is bad weather at the transmission location
– Lower short-term accuracy when compared with GPS

9.2.2 DCF77 Generation by *hopf* Clocks

hopf clocks can simulate DCF77 for other clocks in order to operate DCF77 clocks in locations where there is no DCF77 signal.

This can realized as DCF77 antenna simulation (77,5 kHz) and also as DCF77 pulse (1 Hz).

9.2.2.1 DCF77 Signal Simulation

An analogue, amplitude-modulated carrier signal is generated by the clock system. A connected, standard DCF77 radio-controlled clock is unable to differentiate this signal from an "original" DCF77 signal received via an antenna. It is also possible to use time bases other than only CET/CEST to simulate the signal.

The term **DCF77 simulation** or, in short, **DCF77-sim** is commonly used in *hopf* literature to describe this term.

9.2.2.2 DCF77 Pulse (1 Hz)

The DCF77 pulse uses the same coding procedure as that used by the DCF77 signal radiated by the transmitter. The difference lies in the fact that an amplitude-modulated carrier signal is not used for transmission. The 100 and 200 msec long reductions are represented by logical signal levels.

In this digital form, the signal can then also be transmitted via a fibre optic cable, for example.

9.2.2.3 Fault Mode when Clock Status in the System 7001RC is not 'Radio'

The DCF77 telegram is not output if the 7001RC does not have a plausible time or if it is not radio-synchronous because the radio status information is not contained in the DCF77 telegram. In this way, connected systems are able to recognize a reception failure in the master system.

This means that for the simulation of the DCF77 signal the 77.5 kHz carrier frequency is either modulated with a 2 Hz signal or is not modulated at all.

In the case of the DCF77 pulse the 1 Hz signal pulse is either replaced by a 2 Hz fault signal or switched off.

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9.3 Master/Slave-String

Slave systems can be synchronized highly accurately with the time data of the master system, with the aid of the Master/Slave-String.

The Master/Slave-String is only available on the 96-pin VG ledge of the control board 7020RC.

In order to transmit the Master/Slave-String it is necessary to activate the string output. See ***Chapter 4.1.1.9 Serial Interface Parameters of the 7020RC***

9.3.1 Local Time as Time Base in the Master/Slave-String (Standard)

As standard the system 7001RC is synchronized with the local time information via the Master/Slave-String. This is set as described in ***Chapter 4.1.1.6.5 Bit 2, Master/Slave-String Time Base***.

The system UTC time is calculated from the local time and the time offset between UTC and local time as set in the internal system, as well as the summer time/winter time status information.

9.3.2 UTC as Time Base in the Master/Slave-String

If UTC time is to be transmitted via the Master/Slave-String then this is to be set up in the system in accordance with ***Chapter 4.1.1.6.5 Bit 2, Master/Slave-String Time Base***.

The system local time is calculated from UTC and the time offset between UTC and local time as set in the internal system, as well as the summer time/winter time status information.

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9.3.3 String Structure

The Master/Slave-String transmits:

- Complete time (hour, minute, second)
- Date (day, month, year ([2 position])
- Time offset between local time and UTC (hour, minute)
- Day-of-week
- Status information (ST/WT changeover announcement, leap second announcement and Master/Slave-String source reception status).

The time offset in hours and minutes is transmitted after the year. Transmission takes place in BCD. The time offset can be max. ± 11.59 hours.

The operational sign is shown as the highest bit in tens of hours.

Logic **1** = Local time in advance of UTC

Logic **0** = Local time behind UTC

Example:

Data string	10's time offset nibble	Time offset
(STX)831234560301960300(LF)(CR)(ETX)	**0000**	- 03:00h
(STX)831234560301961100(LF)(CR)(ETX)	**0001**	- 11:00h
(STX)831234560301968230(LF)(CR)(ETX)	**1000**	+ 02:30h
(STX)831234560301969100(LF)(CR)(ETX)	**1001**	+ 11:00h

Character number	Meaning	Hex-value
1	STX (start of text)	$02
2	status	$30-39, $41-46
3	day of the week	$31-37
4	tens hour	$30-32
5	unit hour	$30-39
6	tens minute	$30-35
7	unit minute	$30-39
8	tens second	$30-36
9	unit second	$30-39
10	tens day	$30-33
11	unit day	$30-39
12	tens month	$30-31
13	unit month	$30-39
14	tens year	$30-39
15	unit year	$30-39
16	difference time tens hour / operational sign	$30-31, $38-39
17	difference time unit hour	$30-39
18	difference time tens minute	$30-35
19	difference time unit minute	$30-39
20	LF (line feed)	$0A
21	CR (carriage return)	$0D
22	ETX (end of text)	$03

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9.3.4 Status and Day-of-Week in the Master/Slave-String

Nibble	b3	b2	b1	b0	Meaning
Status	x	x	x	0	No announcement of ST/WT changeover
	x	x	x	1	Announcement of ST/WT changeover
	x	x	0	x	Winter time (WT)
	x	x	1	x	Summer time (ST)
	x	0	x	x	No announcement of leap second
	x	1	x	x	Announcement of leap second
	0	x	x	x	Quartz operation
	1	x	x	x	Radio operation
Nibble	b3	b2	b1	b0	Meaning
Day-of-week	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

9.3.5 Example of a Master/Slave-String

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

- Radio operation
- No announcement
- Winter time
- It is Wednesday 03 Jan. 1996 - 12:34:56
- The time offset to UTC is + 2.30 hours

9.3.6 Settings

For the synchronization of the *hopf* slave system the following parameters are fixed:

- Output every minute
- Output with second forerun
- ETX on second change; selectable: string at beginning or end of the (59^{th}) second
- Local time
- 9600 baud, 8 bits, 1 stop bit, no parity

These settings provide optimum control of the time base in slave systems.

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10 Abbreviations

Abbreviation	Meaning
ST/WT changeover	Summer Time/Winter Time changeover
UTC	Universal Time Coordinated
IRIG B	
GPS	Global Positioning System
DCF77	German Long-wave Transmitter Frankfurt on 77.5kHz
U	Height units
HP	Units of parts
PPS	Pulse Per Second
CET	Central European (winter) Time
CEST	Central European Summer Time
M/S string	Master/Slave-String
RC	Remote Control

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