MEINBERG
FUNKUHREN

Technical Information

Operating Instructions

DCF77 UA509

Impressum

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Table of Contents

Impressum 2

General Information about DCF77 5

Features of the AM Radio Clock DCF77 UA509 6

- LF Receiver 7
- Microprocessor System 7
- Display 7
- Buffered Real Time Clock 7
- Pulse Outputs 7
- Serial Interfaces 8
  - Outputs 8
  - Inputs 8

Installation 9

- Power Supply 9
- Mounting the Antenna 9
- Powering Up the System 9

Configuration 10

- Transmission Speed 10
- Framing 11
- Time Zone 11
- Output mode 11

Setting the Clock Manually 12

Firmware Updates 13

Inquiring Serial Number and Software Revision 13

Technical Specifications 14
CE Label 15
Format of the Meinberg Standard Time String 16
Rear Connector Pin Descriptions 17
Rear Connector Pin Assignments 19
Component Layout 21

General Information about DCF77

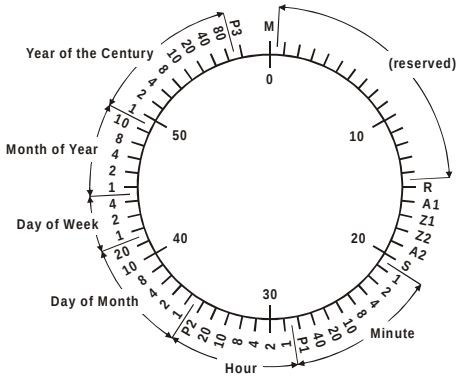
The radio remote clocks made by Meinberg receive the signal from the long wave transmitter DCF77. This long wave transmitter installed in Mainflingen near Frankfurt/Germany transmits the reference time of the Federal Republic of Germany. This time reference is either the Central European Time (Mitteleuropäische Zeit, MEZ) or the Central European Summer Time (Mitteleuropäische Sommerzeit, MESZ). The transmitter is controlled by the atomic clock plant at the Federal Physical Technical Institute (PTB) in Braunschweig/Germany and transmits the current time of day, date of month and day of week in coded second pulses. Once every minute the complete time information is available.

At the beginning of every second the amplitude of the high precision 77.5 kHz carrier frequency is lowered by 75% for a period of 0.1 or 0.2 sec. The length of these time marks represent a binary coding scheme using the short time mark for logical zeroes and the long time mark for logical ones. The information on the current date and time as well as some parity and status bits can be decoded from the time marks of the 15th up to the 58th second every minute. The absence of any time mark at the 59th second of a minute signals that a new minute will begin with the next time mark.

Our radio remote clocks decode the highly accurate information on date and time within a wide range around Germany. So some of our clocks are installed in Bilbao/ Spain as well as in the city of Umeå in northern Sweden - fully satisfying the requirements of the users. The radio remote clocks automatically switch to summertime and back. The reception of the time information is free of charge and does not need to be registered.

Generally it is important to position the antenna in an optimal way. It should be mounted at least 30 centimeters away from the clock unit and from solid steel. The antenna should be aligned at a right angle to the direction of the transmitter (Frankfurt).

Figure: Decoding Scheme

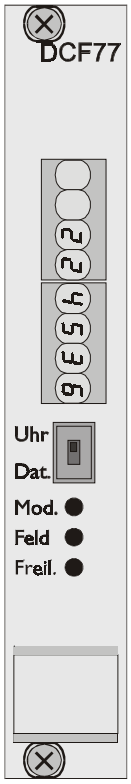


M	Start of Minute (0.1 s)
R	RF Transmission via secondary antenna
A1	Announcement of a change in daylight saving
Z1, Z2	Time zone identification
	Z1, Z2 = 0, 1: Daylight saving disabled
	Z1, Z2 = 1, 0: Daylight saving enabled
A2	Announcement of a leap second
S	Start of time code information
P1, P2, P3	Even parity bits

Features of the AM Radio Clock DCF77 UA509

The hardware of UA509 is a 100mm x 160mm microprocessor board. The 20mm wide front panel contains an 8-digit LED display, three LED indicators and a time/ date switch. The receiver is connected to the external ferrite antenna by a 50 ohm coaxial cable with length up to 100m. When using a cable with length of more than 100m an antenna amplifier should be used.

The radio remote clock UA509 has been designed for applications where two independent serial interfaces are needed. The rear connector pin assignment is compatible with the former clocks DCF77 UA31 and UA537 to replace this clocks in the future. The UA509 contains a new flash EPROM with bootstrap loader that allows to upload a new firmware via the serial interface without removal of the clock.



Frontview UA509

LF Receiver

An external ferrit antenna is used to receive the signal from DCF77 and supplies it to the on-board direct conversion quadrature receiver with automatic gain control. The demodulated time marks are fed to the clock´s microprocessor.

Microprocessor System

The time marks from the receiver circuit are filtered and decoded by the microprocessor system. Parity and consistency checks over a period of two minutes take care for detecting errors in the received time telegram. The checked and decoded time is written to the on-board real time clock and spread by the interfaces. A software watchdog lets the microprocessor recover from malfunction. A power-fail comparator resets the microprocessor if the supply voltage drops below a specified threshold. Aflash EPROM is used as program memory which can be loaded with the firmware by the serial interface COM0.

Display

An 8-digit LED display with 2.5mm character height shows the time or date of the UA509. A switch in the front panel lets the user select to view either date or time. The displayed time zone corresponds to the time zone assigned to the serial port COM0 by a DIL switch.

Buffered Real Time Clock

In case of supply voltage failure the on-board real time clock keeps the time powered by a backup capacitor for more than 150 hours. This capacitor does not need any maintenance. Alternatively, the clock can be ordered with a lithium battery which has a live time of at least 10 years guaranteed.

Pulse Outputs

The UA509 generates active high and active low pulses per second and per minute. This TTL pulses are 200ms of lenght and valid immediately after reset.

Serial Interfaces

Two independent asynchronous serial ports can be used to transmit information on date and time to other devices. Each of the ports can be set up as either RS232 port or 20mA current loop port. Baudrate, framing and mode of operation can be configured separately for both interfaces COM0 and COM1 by DIL switches. Additionally, a time zone can be assigned to each port: The drivers can be configured individually to transmit either standard time (MEZ/MESZ=CET/CEST), standard time with suppression of daylight saving (always MEZ=CET), or UTC. The format of the time string is described in the section "Technical Specifications".

Outputs

All outputs of one interface (e.g. COM0) distribute the same time string and can be connected simultaneously. When using the port in the RS232 mode no additional supply voltage is necessary. The required ±10V are generated on-board.

When using the port in the 20mA current loop mode the additional supply voltage of -15V is not essential either when using only the passive outputs or a lower interference immunity is tolerated. In the second case the negative output lines have to be connected to GND.

Inputs

Only when using the output mode "on request" the RS232 input or the 20mA current loop input has to be connected. It is not possible to connect both inputs. The jumpers JP0 and JP1 assigned to COM0 and COM1 have to be set, either to the RS232 input or to the 20mA current loop input as described on the board (RS = RS232; CL = Current Loop).

The 20mA current loop input can be driven passive or active (see Rear Connector Pin Assignment). It is possible to drive the active input without the -15V supply voltage by connecting the "-akt_in" pin to GND.

Although RTS and CTS handshake lines are provided by the RS232 interfaces, in most cases they need not to be connected. Due to pullup resistors, the serial outputs are enabled if the pins at the rear connector are left open.

Installation

Power Supply

The System requires a single supply voltage of 5V/250mA. The power supply should be longitudinal regulated. If a switched mode power supply is used the negative pole is to ground directly or via a capacitor >0,1F. The voltage feed should be applied low impedance and via the pins a1 and c1.

Mounting the Antenna

Generally it is important to position the antenna in an optimal way. The antenna should be aligned at a right angle to the direction of the transmitter (Frankfurt). It should be mounted at least 30 centimeters away from the clock unit and from solid steel. A distance of several meters is recommended to all TVs or computer monitors.

The scope of supply includes an active ferrite antenna for indoor mounting (AI01) and 5m of RG175 coaxial cable. When mounting the antenna outdoor the weather proof Antenna AW02 is to use.

Powering Up the System

After connecting the power supply and the antenna the system is ready to operate. Time or date is displayed on the 8 digit LED display (the timebase choosen for COM0 is displayed).

The brighness of the “Feld” LED in the front panel depends on the signal strength of the DCF77 carrier. In order to get the maximum signal, the antenna should be aligned in two steps. First it should be turned **slowly** until the “Feld” LED is mostly dimmed. Finally the antenna must be turned by 90° from this position to obtain maximum signal. If the antenna is installed properly and the signal from DCF77 can be received without strong distortions, the "Mod." LED starts blinking exactly once per second, corresponding to the time marks from DCF77. If this LED flashes intermediately, there is some electrical noise around which prevents the microprocessor from decoding the time message. So a better location for the antenna must be found. In case of correct reception it takes up to three minutes after power-up until the clock is synchronized and the "Freil." LED is turned off. It is turned on again to indicate the loss of or an error in reception. Without RF signal the clock runs on XTAL with an accuracy of 10^{-6} (after 24 hours of synchronous operation, otherwise: 10^{-5}). If the clock have lost reception for more than 12 hours the "Freil." LED starts blinking.

The serial outputs are enabled immediately after power up. Baudrate, framing, output mode and time zone can be configured separately by two DIL switches.

Configuration

There are two DIL switches to configure the UA509 as described below.

DIL0

DIL1

Default settings of COM0(DIL0) and COM1(DIL1):

Baudrate:	9600 Baud
Framing:	7E2
Output Mode:	once per second
Time Zone:	MEZ/MESZ (CET/CEST)

The two DIL switches SWx9 and SWx10 are reserved.

Transmission Speed

The transmission speed of each channel can be selected by the levers 1 to 3 of the DIL switches. Using RS232 mode both interfaces can be set to baudrates between 600 baud and 57600 baud. If a 20mA current loop output driver is used, the transmission speed of that channel should not exceed 9600 baud. Changes in these settings become valid after reset.

SWx-1	SWx-2	SWx-3	Baudrate
off	off	off	600
on	off	off	1200
off	on	off	2400
on	on	off	4800
off	off	on	9600
on	off	on	19200
off	on	on	38400
on	on	on	57600

Framing

Lever 4 of the DIL switches is used to select the framing of the serial ports. Changes in these settings become valid after reset. Other framings on request.

SWx-4	Framing
off	7E2
on	8N1

Time Zone

Levers 7 and 8 of the DIL switches let the user select a time zone (MEZ/MESZ, UTC, MEZ) for each channel. The front panel display always shows the time zone selected for COM0.

SWx-7	SWx-8	Time Zone
off	off	MEZ/MESZ = CET/CEST
off	on	always MEZ=CET
on	off	UTC
on	on	(reserved)

Output mode

Both of the serial ports send a time string in three different output modes.

SWx-5	SWx-6	String Mode
off	off	on request only
on	off	once per second
off	on	once per minute
on	on	(reserved)

1. on request only: output of the time string starts 2ms after sending a "**?**" (ASCII-Code 3Fh) to the clock

2. once per second: output of the time string starts whenever a new second begins

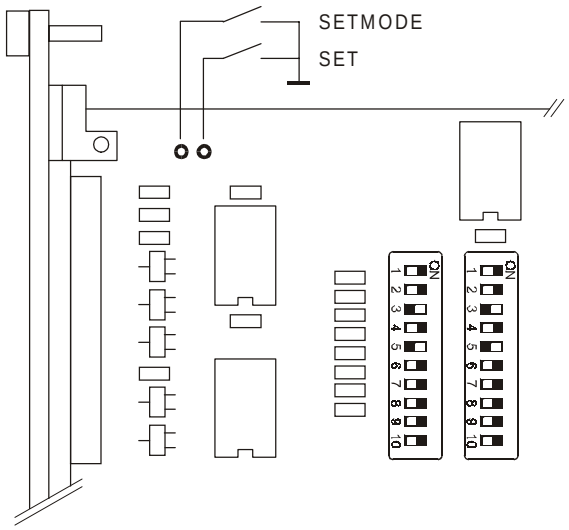
3. once per minute: output of the time string starts whenever a new minute begins

Setting the Clock Manually

To set time and date it is necessary to connect two additional push-buttons either to the circuit board (see figure below) or to the assigned pins of the rear connector (see table Rear Connector Pin Assignments). Pushing the buttons pulls the signal down to ground. The clock can be set as described below.

If the button labeled SETMODE is pressed and held, the on-board clock is stopped and one of the digits begins to blink. The blinking digit can be incremented once per second by pressing and holding the SET button. If the SET button is released and pressed again, the next digit starts to blink and increments while the SET button is being held. When the SETMODE button is finally released, the clock starts at the time that has been set up.

If the display is switched to “Date” before the SETMODE button is pressed, the date can be set in the same manner. However, if the radio clock has synchronized with DCF77, the decoded information of time and date will override the time and date that have manually been set.



Firmware Updates

Whenever the on-board software must be upgraded or modified, the new firmware can be downloaded to the internal flash memory via the serial port COM0.

If the pin "Boot" of the rear connector (see table Rear Connector Pin Assignments) is pulled down to ground while the system is powered up, a bootstrap-loader will be activated that waits for instructions from the serial port COM0. The new firmware can be sent to the UA509 from any standard PC with serial interface. A loader program will be shipped together with the file containing the image of the new firmware.

The contents of the program memory will not be modified until the loader program has sent the command to erase the flash memory. So if the "Boot" signal is grounded unintentionally while the system is powered up, the firmware will not be changed accidentially. After the next power-up, the system will be ready to operate again.

Inquiring Serial Number and Software Revision

The serial number and the revision of the loaded software can be red out by sending the three characters "**SN!**" via COM0 to the clock that starts sending the following string:

```
SN:UA509 9041260  REV:03.00/01
```

The software revision is updated automatically with every update of the firmware. The serial number is fixed in an I^2C bus EEPROM and can not be changed.

Technical Specifications

RECEIVER:	Direct conversion quadrature receiver with automatic gain control Bandwidth: approx. 20Hz
DISPLAY:	eight digit 7-segment display, 2.5mm character height shows either time or date, selectable by front-panel switch LEDs for modulation, field strenght and free running
TIMECODE CHECK:	multiple software check of the incoming timecode parity and consistency check over a period of two minutes
RUNNING ON XTAL:	RF distortions indicated by "Freil."-LED and a status character in the serial output string without RF signal the clock runs on XTAL with an accuracy of 10^{-6} (after 24 hours of synchronous operation)
BUFFERING:	In case of supply voltage failure the on-board RTC keeps the time based on XTAL for more than 150 hours (buffer capacitor) optional lithium backup battery (life time: 10 years)
RELIABILITY OF OPERATION:	A software watchdog lets the microprocessor recover from malfunction. A power-fail comparator resets the microprocessor if the supply voltage drops below a specified threshold.
MANUAL TIME SETTING:	Two optional push buttons provide manual setting of time and date.
PULSE OUTPUTS:	active high and active low TTL output lines provide pulses per second and per minute with 200ms of lenght
INTERFACES:	2 independent interfaces (COM0 and COM1) baudrate, framing, output mode and time zone are configurable for each interface
COM0:	2 active and 2 passive 20mA current loop outputs 1 active/passive 20mA current loop input 1 RS232 output, 1 RS232 input RTS and CTS handshake signals
COM1:	1 active and 1 passive 20mA current loop outputs 1 active/passive 20mA current loop input 1 RS232 output, 1 RS232 input RTS and CTS handshake signals

TRANSMISSION SPEED:	configurable by DIL switches 600 to 57600 baud
FRAMING:	configurable by DIL switches 1 start bit / 7 data bits / 1 even parity bit / 2 stop bits (7E2) 1 start bit / 8 data bits / no parity bit / one stop bit (8N1)
OUTPUT MODE :	configurable by DIL switches once per second, once per minute, only on request ("**?**")
TIME ZONE:	configurable by DIL switches MEZ/MESZ=CET/CEST, MEZ=CET, UTC
OUTPUT STRING:	refer to: "Format of the Meinberg Standard Time String"
CONNECTORS:	64 pin rear VG edge connector DIN 41612 Subminiature coaxial RF connector (SMB type)
ANTENNA:	active external ferrite antenna in a plastic case Length of the cable: up to 100m without amplifier
POWER REQUIREMENTS:	+5V, @250mA -15V only when using the aktive 20mA current loop port
PHYSICAL DIMENSIONS:	Eurocard, 100mm x 160mm, 1.5mm Epoxy
AMBIENT TEMPERATURE:	0 ... 50°C
HUMIDITY:	max. 85 %
OPTIONS:	Hardware and software modifications accordding to customer specification

CE Label

CE

This device conforms to the directive 89/336/EWG on the approximation of the laws of the Member States of the European Community relating to electromagnetc compatibility.

Format of the Meinberg Standard Time String

The Meinberg Standard Time String is a sequence of 32 ASCII characters starting with the STX (start-of-text) character and ending with the ETX (end-of-text) character. The format is:

<STX>D:*dd.mm.yy*;T:*w*;U:*hh.mm.ss*;*uvxy*<ETX>

The letters printed in *italics* are replaced by ASCII numbers whereas the other characters are part of the time string. The groups of characters as defined below:

<STX> Start-Of-Text (ASCII code 02h)

dd.mm.yy the current date:

dd	day of month	(01..31)
mm	month	(01..12)
yy	year of the century	(00..99)

w the day of the week (1..7, 1 = Monday)

hh.mm.ss the current time:

hh	hours	(00..23)
mm	minutes	(00..59)
ss	seconds	(00..59, or 60 while leap second)

uv clock status characters:

u: '#' clock has not synchronized after reset
' ' (space, 20h) clock has synchronized after reset
v: '*' DCF77 clock currently runs on XTAL
' ' (space, 20h) DCF77 clock is sync'd with transmitter

x time zone indicator:

'U'	UTC	Universal Time Coordinated, formerly GMT
' '	MEZ	European Standard Time, daylight saving disabled
'S'	MESZ	European Summertime, daylight saving enabled

y anouncement of discontinuity of time, enabled during last hour before discontinuity comes in effect:

'!' announcement of start or end of daylight saving time
'A' announcement of leap second insertion
' ' (space, 20h) nothing announced

<ETX> End-Of-Text (ASCII code 03h)

Rear Connector Pin Descriptions

Signal Name	Pin	Description
GND	32a+c	power supply ground
VCC in (+5V)	1a+c	supply voltage
P_SEC out	6c	pulse per second, TTL level, active high pulse width: 200 msec
P_MIN out	8c	pulse per minute, TTL level, active high pulse width: 200 msec
/P_SEC out	6a	like P_SEC, but active low
/P_MIN out	8a	like P_MIN, but active low
DCF_MARK	4c	time marks from DCF77, used as output line with standard version of the clock, used as input line with boards without LF receiver
SET button	2c	SET button for setting the clock manually
SET_MODE button	12c	SETMODE button for setting the clock manually
Boot	4a	Boot signal for starting bootstrap loader
SDA, SCL	3a, 3c	I²C bus interface (option)
curr_loop -15V in	13a	auxiliary supply voltage input used with current loop interface
curr_loop +5V out	15c	auxiliary supply voltage output used with current loop interface
COM0:		
-pass_in/+act_in	14a	passive 20mA current loop input (-) or active 20mA current loop input (+)
+pass_in	14c	passive 20mA current loop input (+)
-act_in	15a	active 20mA current loop input (-)
-act_out_1	17a	active 20mA current loop output (-)
+act_out_1	17c	active 20mA current loop output (+)
-act_out_2	19a	active 20mA current loop output (-)
+act_out_2	19c	active 20mA current loop output (+)
-pass_out_1	21a	passive 20mA current loop output (-)
+pass_out_1	21c	passive 20mA current loop output (+)
-pass_out_2	23a	passive 20mA current loop output (-)
+pass_out_2	23c	passive 20mA current loop output (+)

Signal Name	Pin	Description
TxD out	26c	RS232 output
RxD in	30c	RS232 input
RTS out	27c	RS232 handshake signal (Request to Send)
CTS in	31c	RS232 handshake signal (Clear to Send)
COM1:		
-pass_in/+act_in	16a	passive 20mA current loop input (-) or active 20mA current loop input (+)
+pass_in	16c	passive 20mA current loop input (+)
-act_out_1	11a	active 20mA current loop output (-)
+act_out_1	11c	active 20mA current loop output (+)
-pass_out_1	9a	passive 20mA current loop output (-)
+pass_out_1	9c	passive 20mA current loop output (+)
TxD out	24c	RS232 output
RxD in	29c	RS232 input
RTS out	25c	RS232 handshake signal (Request to Send)
CTS in	28c	RS232 handshake signal (Clear to Send)

Rear Connector Pin Assignments

	a	c
1	VCC in (+5V)	VCC in (+5V)
2		SET button
3	SDA (Option)	SCL (Option)
4	Boot	DCF_MARK
5		
6	/P_SEC out	P_SEC out
7		
8	/P_MIN out	P_MIN out
9	COM1 -pass_out_1	COM1 +pass_out_1
10		Reserve
11	COM1 -act_out_1	COM1 +act_out_1
12		SET_MODE button
13	curr_loop -15V in	
14	COM0 -pass_in/+act_in	COM0 +pass_in
15	COM0 -act_in	curr_loop +5V out
16	COM1 -pass_in/+act_in	COM1 +pass in
17	COM0 -act_out_1	COM0 +act_out_1
18		
19	COM0 -act_out_2	COM0 +act_out_2
20		
21	COM0 -pass_out_1	COM0 +pass_out_1
22		
23	COM0 -pass_out_2	COM0 +pass_out_2
24		COM1 TxD out
25		COM1 RTS out
26		COM0 TxD out
27		COM0 RTS out
28		COM1 CTS in
29		COM1 RxD in
30		COM0 RxD in
31		COM0 CTS in
32	GND	GND

Component Layout