

# **Technical Description**

General System Information  
Appendix DCF77



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**hopf** Elektronik

Nottebohmstr. 41    58511 Lüdenscheid  
Postfach 1847    58468 Lüdenscheid

Tel.:    ++49 (0)2351 / 938686  
Fax:    ++49 (0)2351 / 459590

Internet: <http://www.hopf-time.com>  
e-mail: [info@hopf-time.com](mailto:info@hopf-time.com)

## 1 DCF77 - General Information

The transmitter DCF77<sup>1</sup> is located in Mainflingen, about 25 kilometres south-east of Frankfurt/Main. It is run by the "Physikalisch-Technischen Bundesanstalt" (PTB) in Braunschweig.

The DCF77-signal transmits the central European time (CET) or the Central European Summertime (CEST) which is the same as UTC plus one or two hours with deviations smaller than 0,5  $\mu$ s. This station transmits continuously except for short interruptions because of technical faults or maintenance. Longer breaks may be experienced during thunderstorms on the location of the transmitter.

### Time Signals

The carrier is modulated by means of second markers with the exception of second marker 59 of each minute which signifies that the next marker will be the minute marker.

At the beginning of each second the signal amplitude is reduced to 25% for 100 ms or 200ms. The start of the decrease of the signal amplitude marks the exact beginning of the second. The second markers are phase-synchronous with the DCF77-signal.

In general: the inaccuracy of the received DCF77-timesignal is large compared to the emitted time signal.

The reception depends largely on the limited bandwidth of the time signal transmitter and other natural interferences. At a distance of

some 100 kilometres, a time signal uncertainty of less than 0.1 ms is achievable.

### Time Code

The second marker duration of 100 and 200 ms correspond to binary 0 or 1, respectively, in a BCD code used for the coded transmission of time and date.

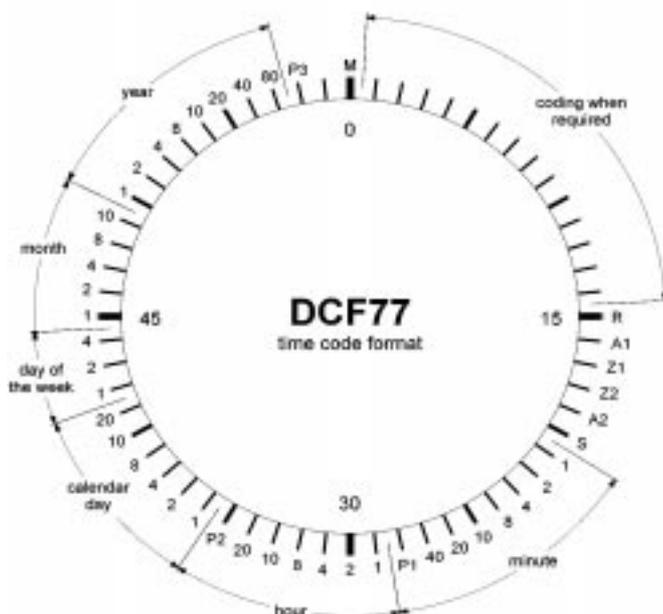
There are three groups of time information, each followed by a parity check bit P:

- P1 = number of the minutes
- P2 = number of the hours
- P3 = numbers of the calendar day, the day of the week, the month and the year

Counting the binary "ones" of the information group concerned and of the corresponding parity check bit yields an even number.

In the case of the transmission of legal time in the form of CEST, second marker 17 has a duration of 200 ms. During one hour before the change from CET to CEST or from CEST to CET, second marker 16 has a duration of 200 ms, thus announcing the approaching change.

The coding is shown in the figure:



|                   |   |
|-------------------|---|
| <b>M</b>          | minute marker (0.1 s)   |
| <b>R</b>          | second marker no. 15 has a duration of 0.2 s if the signal is sent over the spare antenna |
| <b>A1</b>         | announcement for a changeover from MEZ to MESZ or vice versa.                             |
| <b>Z1, Z2</b>     | time zone bits  |
| <b>A2</b>         | announcement for a switching second   |
| <b>S</b>          | start bit of the coding switching second  |
| <b>P1, P2, P3</b> | Parity check bits   |

<sup>1</sup> DCF77 : D = German  
C = long\_wave\_signal  
F = Frankfurt  
77 = frequency

## **2 Antennas General**

All **hopf** antennas are designed for operating with **hopf** radio controlled clocks and radio controlled clock systems. It is possible to use the antenna with strange makes if keeping to the limiting values.

### **2.1 Antenna Structure**

All **hopf** antennas are directional active antennas and of the same electrical design.

Ferrite antennas are used for the frequencies in the long-wave range to keep the antennas small. The oscillating circuit in the antenna, made of a wired ferrite rod and various capacitors, is tuned to 77.5 kHz.

The features of the oscillating circuit depend mainly on the ferrite rod. Temperature changes influence the permeability of the ferrite rod and thus the mid-frequency of the tuned oscillating circuit for the DCF77 signal. Tuning capacitors with opposing temperature coefficient compensate the deviations in a temperature range between -30°C to +80°C .

The output voltage of the oscillating circuit is fed to an amplifier with definite input resistance fixing the bandwidth of the oscillating circuit to 4 kHz. Behind the amplifier there is an adapter stage up to 50 Ω output resistance to adapt to the antenna cable.

The amplifier is supplied with voltage via the coaxial cable. The amplification and the differential output resistance 50 Ω remain constant under a voltage supply between +2,5 to +5V DC . The operating range starts from +1,7V DC.

Because of the low-ohm signal adaptation, the cable between antenna and the **hopf** radio controlled clock may be up to 500 m.

### **2.2 Types of Antennas**

The following types of antennas for the different purposes are available. They all have the same electrical data, varying in their mechanical structure only.

#### **2.2.1 Indoor Antenna FG443600**

This antenna can be used in buildings away from sources of interference for the DCF77-reception. e.g. TVs, monitors, terminals, in-house-LAN, electrical engines etc.

Also the construction of the building has to be taken into consideration. Reinforced concrete buildings and fairing plates attenuate considerably the DCF77-signal and cause a bad signal/noise ratio.

The antenna, which can be turned by 360°, is screwed to a wall bracket made of zinc-coated steel.

The standard cable is 10m long with BNC connector. It can be extended to 500m without mid-amplifier if connected to **hopf** radio controlled clocks.

### 2.2.2 Outdoor Antennas

Professional radio controlled clock systems are always run with an outdoor antenna.

Whereas the surroundings of the indoor antenna can change because of changing technical operations in the rooms, the conditions for the outdoor antenna remain nearly constant.

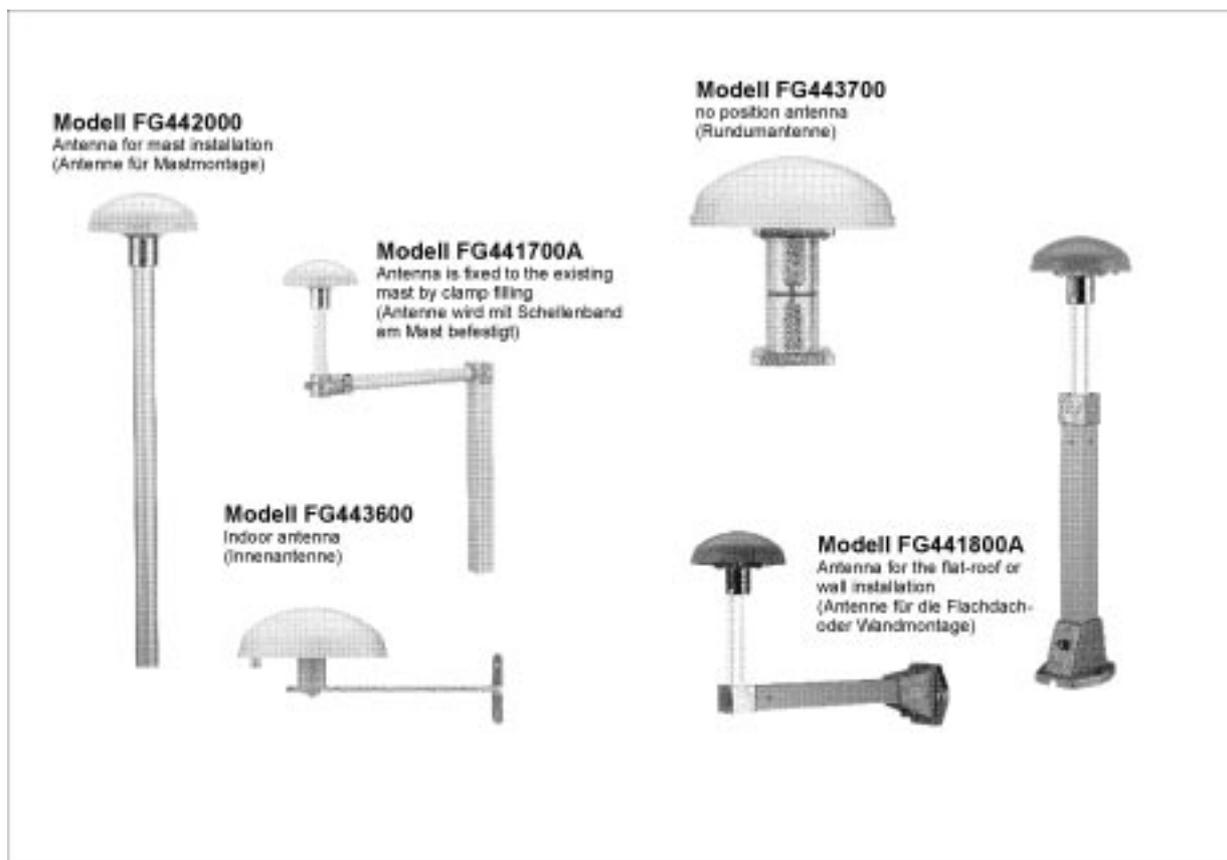
For rough weather conditions we supply a very robust outdoor antenna. It is housed in a round weatherproof plastic casing. The different antennas differ in their mechanical structure only.

The mechanical construction is made of a sturdy, anodised aluminium or die-cast aluminium designed to withstand strong wind. The antenna cable leaves the casing at the bottom.

The standard cable is 20 m long with BNC connector. It can be extended to 500 m without mid-amplifier if connected to **hopf** radio controlled clocks.

The following types are available:

- Outdoor antenna FG 441800 for the flat roof installation
- Outdoor antenna FG 441900 for the wall installation
- Outdoor antenna FG 442000 for the pole installation
- Outdoor antenna FG 443700 with non-directional reception for mobile operations



## **2.3 Place of Installation**

The time code is transmitted in the long-wave range carried out by modulation of the amplitude. It can therefore be easily disturbed. There are many external sources of interference, e.g. corona discharge at high-voltage lines, atmospheric disturbances like thunderstorms near the location of the transmitter or between transmitter and receiver.

Internal disturbances are mainly caused by engines, computer screens, monitors, cladding etc.

For the purpose of industrial use outdoor antennas should be installed to avoid internal disturbances from the start. It also avoids possible interferences caused by devices installed at a later date.

Clocks for the home use have the narrowband design to achieve noise suppression. The short-term accuracy of these devices is +5 to +150 msec. This accuracy suffices for home use where the long-term accuracy is of interest. After one year the second deviation is still only +5 to +150 msec.

For industrial purposes these deviations are often not acceptable. The antenna as well as the receiver must be of wider band design to reach more accurate second markers. Values between +5 to +15 msec. require bandwidths of about 4 kHz for the antenna. This can therefore mean that the antenna feeds a lot more noise signals to the electronics so that the receiving electronics cannot decode a minute cycle.

### **Basically we can say that:**

Short-term accuracy and high noise immunity are incompatible in DCF77-system. The location of the antenna must be chosen with utmost care.

## **2.4 Antenna Installation**

All **hopf** antennas are active, directional antennas, except for the non-directional antenna. They should therefore be directed to the maximum signal strength.

### **2.4.1 Indoor Antenna**

The **indoor antenna** is to be placed near a window facing the direction Frankfurt. The antenna rod is turned by 90° away from the direction Frankfurt.

### **2.4.2 Outdoor antenna**

The **Outdoor antenna** is fixed to the outside wall of the building facing Frankfurt. Then the antenna disc is turned (by loosening the screw) so that the arrow underneath the antenna disc also points to Frankfurt, thus reaching the optimal signal/noise ratio.

We supply our portable DCF77 signal analyser for our customers to solve difficult location problems.

All **hopf** radio controlled clocks have an integrated programme to align antennas to the direction Frankfurt.



**Please note :** Please refer to chapter "alignment of the antenna" in the individual manuals.

### **3 Lightning Protection in General**

When using outdoor antennas the antenna cables may experience high interference voltages caused by thunderstorms. This may destroy or damage not only the directly connected radio controlled clock systems but also other connected devices.

An indirect lightning protection should be connected between outdoor antenna and radio controlled clock board to avoid high cost and subsequent damages.

#### **3.1 Causes of Overvoltage**

A building can be protected by the lightning protector developed by Benjamin Franklin. But it does not protect the electronic devices inside from indirect consequences of the flash of lightning.

A flash is basically an oversized short-circuit between two lines of different potentials e.g. two layers of clouds or the clouds and the ground. A current of 1000 to 100 000 ampere circle between two clouds or between ground and cloud causing the below listed damages or destruction at open lines (antennas, antenna cables) and connected devices:

##### **3.1.1 Electrostatic Field**

The rise of this field up to 50 kV/m may be caused by a close thundercloud with potential load or by the static charging of the air. The field change happens suddenly, producing high-frequency electromagnetic micro-pulses.

##### **3.1.2 Rise of the Earth Potential**

A flash driving into the ground causes an instant rise of the earth potential which depends on the amperage and the local specific resistance of the ground. The ground reduces the overvoltage in waves which leads to high voltage potential differences in unprotected devices.

##### **3.1.3 Electromagnetic Radiation**

A flash may be compared with an antenna being a few kilometres long. The pulse currency of some kiloamperes causes the radiation of a strong electromagnetic field. The radiation induces high voltages and currents in lines close by (1 to 2 km) which again leads to overvoltages in connected devices.

### **3.2 Lightning Protection**

It is impossible to stop overvoltages caused by effects of a flash of lightning, but it is possible to protect a device from the destructive powers.

To achieve this it is necessary to short-circuit all the lines with overvoltages to reduce it as quickly as possible. Once the interference is over the device is to return to its previous specifications.

The **hopf** lightning protection consists of a combination of different components. Fast absorber diodes with < 1 nsec. time to spark-over and a discharge current of 10 kA keep the potential difference between antenna core and 0 constantly on  $\pm 12$  V . The following gas arresters, once lit, short-circuit the line to the earthing point.

It is due to this combination that the potential separation of the antenna circuit from the other electronics is guaranteed even in undisturbed situations.

If the lightning protection itself is destroyed by a flash of lightning the lines stay short-circuited. Therefore no DCF77 signal is received. We advise using the status bits in the connected devices to check.

### **3.3 Installation**

When using the **hopf** lightning protection we presume that a comprehensive lightning protection concept is in operation on location, including a direct protection of the building according to VDE and also that the voltage supply of the device is protected from lightning.

The lightning protection is usually installed directly where the cable enters the building. Therefore in-house cables running parallel to the antenna cable are disturbed as little as possible.

The antenna is connected to the BNC input-connector of the lightning protection - the extended line to the electronics is connected to the BNC-output connector.

A 10mm<sup>2</sup> copper stranded wire is run from the earthing screw to the nearest earth connection point. The earthing stranded wire should not be longer than 10m.

It is important that the earth line of the connected device has the same earth connecting point as the lightning protection, to avoid destructive potential differences. If this cannot be guaranteed, the lightning protection should be installed at a different place.

If the lightning protection is installed near the device the earth cable can be connected to the earth of the device. In this case the antenna cable between antenna and lightning protection should not run parallel to other cables.

## **4 Antenna Amplifier 4x**

If several DCF77-antennas are required in a building, the lightning protection can be supplied with a 4x potential free antenna amplifier.

The lightning protection housing contains, apart from the lightning protection, a power supply and five amplifier modules.

The antenna input is on one of the narrow sides of the housing, whereas the cable inlet for the voltage supply cable is on the other narrow side.

The DCF77 signal is fed to a pre-amplifier via the antenna input. The amplified signal is then fed to 4 potential free output steps, which carry the signal on to the insulated BNC antenna connectors on the broader sides of the housing.

If you want to connect the supply voltage just remove the lid of the housing by undoing the screws and connect the cable through the leading-in hole to the appropriate terminals.



**Please note :** Both the installation of the lightning protection as well as the lightning protection with amplifier must not be carried out by anyone but qualified personnel.

We supply 2 versions of the 4x antenna amplifier:

- 4-x antenna amplifier with lightning protection      type 4444
- 4-x antenna amplifier      type 4446

### **4.1 Antenna Amplifier FG444400**

The 4x antenna amplifier consists of 4 units.

1. mains unit
2. pre-amplifier
3. 4-x amplifier for the potential separation
4. lightning protection

#### **4.1.1 Mains Unit**

The mains unit supplies the external amplifier in the antenna and the single amplifier via the antenna cable with voltage.

A voltage supply of 230V AC  $\pm$  10% is required. The input transformer is equipped with a thermo fuse.

#### **4.1.2 Pre-Amplifier**

The pre-amplifier couples the modulated DCF77-signal from the supply voltage of the active antenna. The input resistance has an impedance of 50 Ohm. The selective amplification is about 6 dB at 77.5 kHz.

### **4.1.3 Amplifier for the Potential Separation**

The pre-amplified signal is led to 4 potential free amplifiers. These amplifiers have an output impedance of 50 Ohm. The amplification ranges between 0 to 3 dB.

### **4.1.4 Lightning Protection**

When outdoor antennas are connected to the amplifier we recommend using our version with lightning protection. The lightning protection block is connected in series with the pre-amplifier.

In case of outdoor antennas thunderstorms may cause high interference voltage pulse in the antenna cable. Not only connected radio controlled clock systems but also subsequent devices can be destroyed or damaged.

Overvoltage caused by indirect effects of the flash cannot be avoided but the device can be protected against the destructive consequences of it. To achieve this, it is necessary to "short-circuit" all the lines with overvoltage to get rid of the overvoltage as quickly as possible. When the problem is solved the device should return to its original specifications.

The lightning protection consists of a combination of different parts. Fast absorber diodes with a responding time of < 1 nsec. and a discharge current of 10 kA keep the potential differences between antenna core and naught constantly on 12V. The subsequent gas arrester short circuits, when ignited, the line to the earth terminal.

The picture shows the device **FG444400** with integrated 4x antenna distributor.



### **4.2 Antenna Amplifier FG444600**

If several DCF77-clocks are wanted in the building the 4x antenna amplifier with potential separation can be used. The device is structured like the antenna amplifier FG444400, but without lightning protection (picture above). The housing contains the mains unit and 5 amplifier modules.

The signal is fed via a pre-amplifier to 4 potential free output steps and put out via insulated BNC-connectors on the wider side of the housing.

## **5 Technical Data**

### **5.1 Antenna**

|                                   |                   |
|-----------------------------------|-------------------|
| voltage supply via antenna cable: | + 1,7 to + 5V DC  |
| differential output resistance:   | 50 Ω              |
| amplification:                    | 26 (20) dB        |
| antenna cable:                    | RG 59 compatible  |
| max. length of cable:             | 500 m             |
| temperature range 3 dB limit:     | - 30°C to + 80°C  |
| working range:                    | - 50°C to + 85° C |
| indoor antenna:                   | dust-tight        |
| outdoor antenna :                 | splash-proof      |
| plastic:                          | light proof       |
| wind stress outdoor antenna:      | max. 180 km/h     |

### **5.2 Lightning protection**

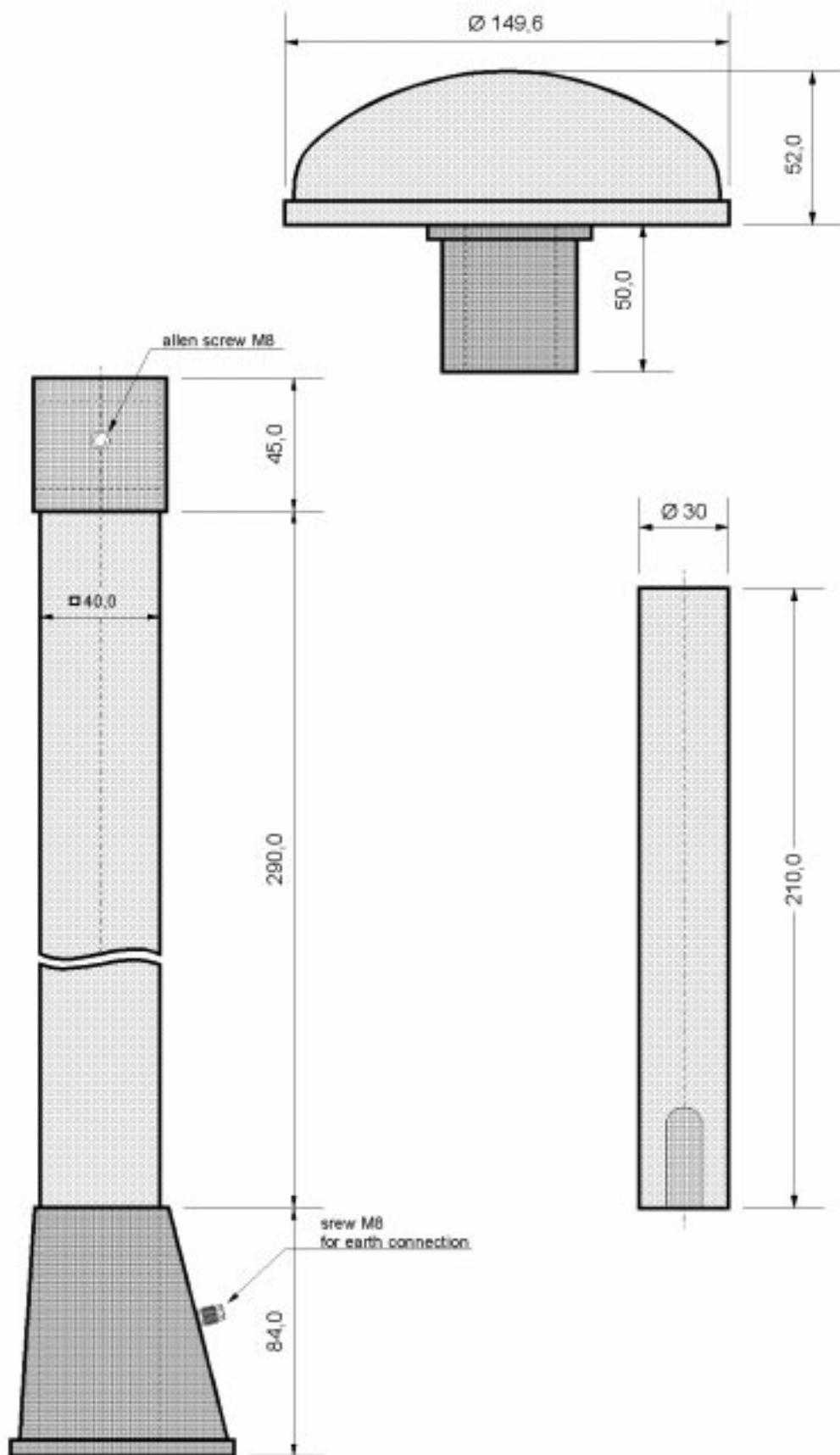
|  |                         |
|--|-------------------------|
| current stability:                                   | 10 kA (8/20 μsec. Wave) |
| speed of response:                                   | < 1ns                   |
| protection level at 6 kV 1,2/50 μsec. wave at input: | < 12V                   |
| input / output impedance:                            | 50 Ω                    |
| insertion loss:                                      | max. 3dB                |

### **5.3 4-x antenna amplifier**

|   |                      |
|---|----------------------|
| aluminium-die-cast housing (250 x 105 x 95 mm)  |                      |
| weight:   | ca. 3.5 kg           |
| input / output:                                 | BNC-connector female |
| earth connection point:                         | screw fitting M6     |
| voltage supply:                                 | 230 V AC +10%        |
| power consumption:                              | 6 VA max.            |
| fuse:   | thermal cutout       |
| input / output impedance:                       | 50 Ω                 |
| length of cable antenna - lightning protection: | max. 500 m           |
| length of cable lightning protection - clock:   | max. 500 m           |
| amplification:                                  | 0 - 3 dB             |
| temperature range:                              | -20°C to +70° C      |



**Please note :** Outdoor antenna and lightning protection can be destroyed by lightning bolts. Therefore we can give only a limited guarantee for those parts.

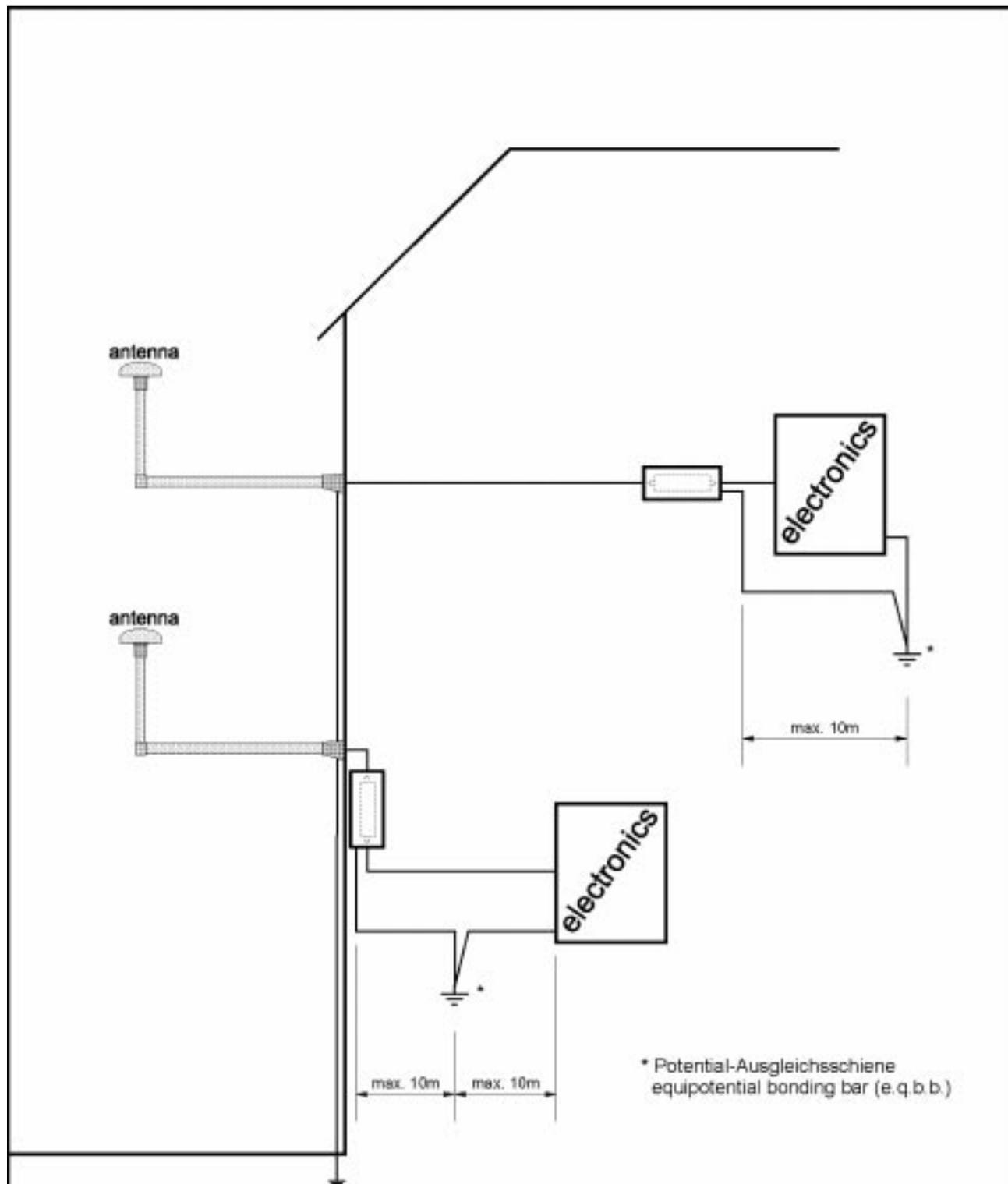


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| 02.06.98 | Vollmer | A4   | ZC98060201 | 1/1  |

**hopf** Antenna



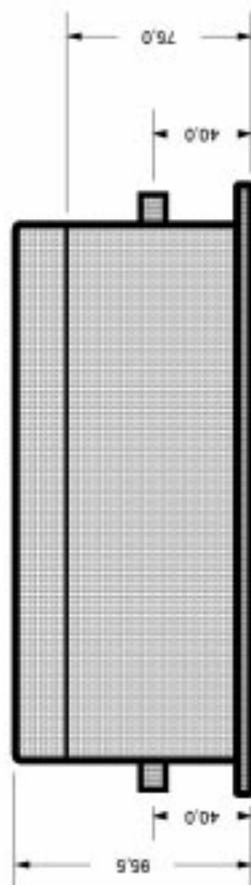
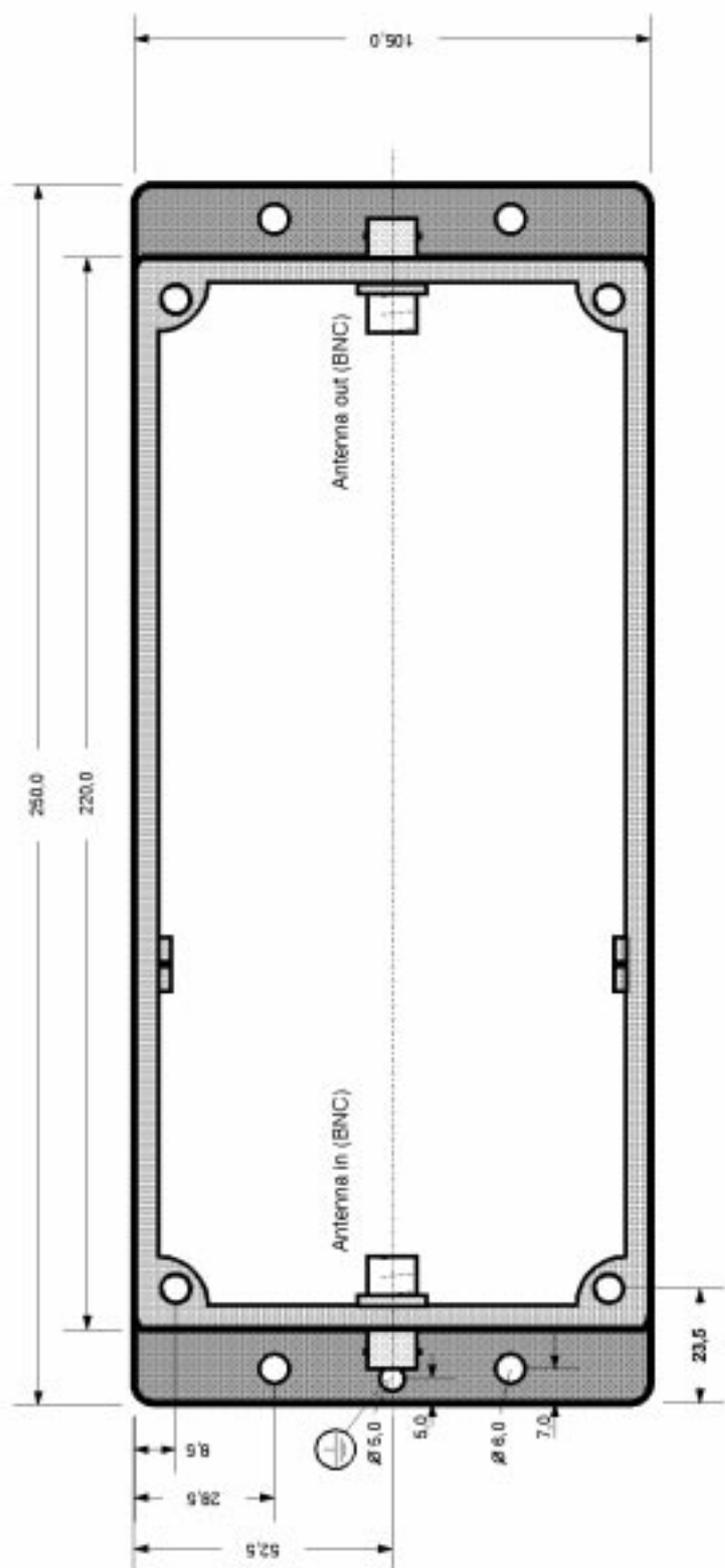
post box 1847  
D-59466 Lüdenscheid  
fon: (02351) 938835  
fax: (02351) 452590



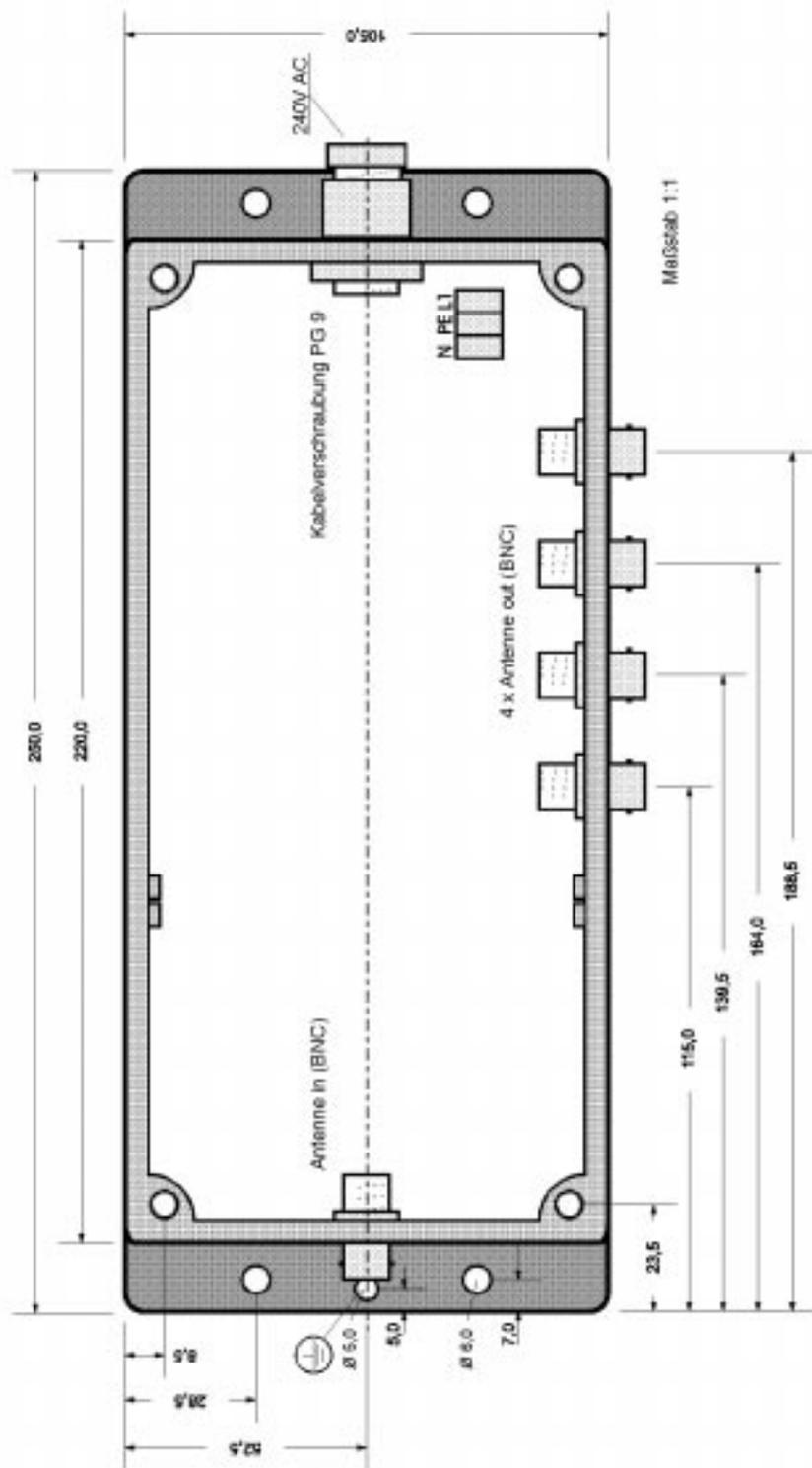
The lightning protection and the electronic must be connected on the same earth potential!  
The line between lightning protection and ground must be closer than 10m.

Der Blitzschutz und die Elektronik müssen auf dem gleichen Erdpotential liegen!  
Die Verbindung vom Blitzschutz zum Erdpotential darf eine Länge von 10m nicht überschreiten!

| date  | name    | size | no.   | page  |
|---|---------|------|---|---|
| 10.03.98  | Vollmer | A4   | ZC98031002  | 1/1   |
| indirect lightning protection<br>Indirekter Blitzschutz |         |      |  | post box 1847<br>D-59469 Lüdenscheid<br>fon: (02351) 93888-6<br>fax: (02351) 452592 |

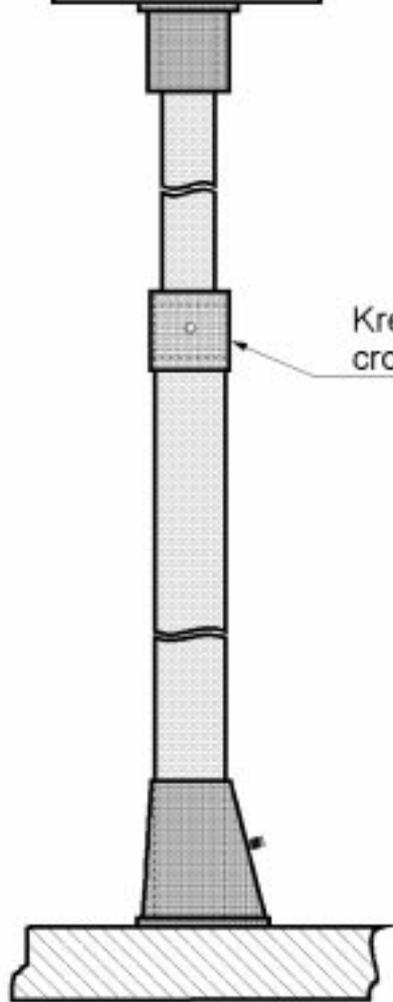


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|--|----------|--------|---------|------|----|----|------------|-------|-----|
| DATE   | 16.07.97 | AUTHOR | Vollmer | SIZE | A4 | NO | ZC97071602 | SCALE | 1/1 |
| <b>Lightning Protection</b>  |          |        |         |      |    |    |            |       |     |
|  |          |        |         |      |    |    |            |       |     |
| post box 1847<br>D-58669 Lüdenscheid<br>Tel: 1022511 338166<br>Fax: 1022511 452593 |          |        |         |      |    |    |            |       |     |



|                                |  |  |          |
|--------------------------------|--|--|----------|
| № ZCB7091903                   |  | Масштаб  | 1:1      |
| <b>Мультантенный усилитель</b> |  | Дата   | 16.09.97 |
|                                |  | Автор  | Волынов  |
|                                |  | Лист   | A3       |
|                                |  |  2000000000<br>2000000000<br>2000000000 |          |

**Model  
FG 441800A**



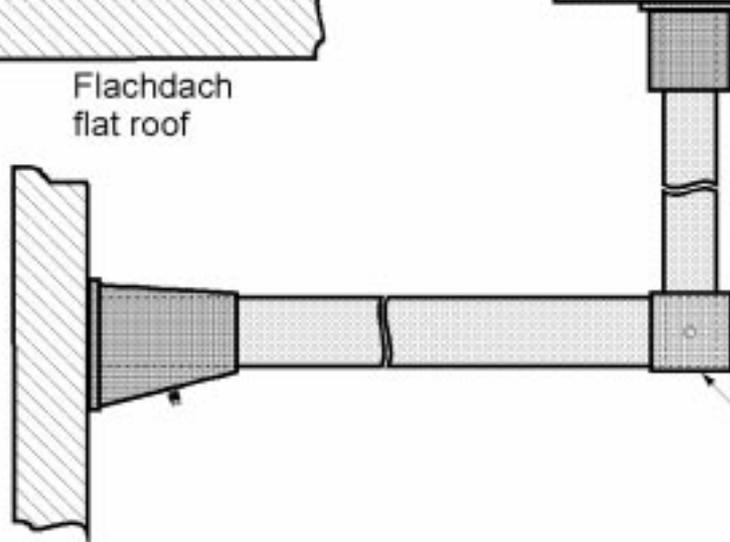
Flachdach  
flat roof

Kreuzkopf  
cross-head

Das Rohr mit dem Antennenteller wird unmontiert geliefert. Der Kreuzkopf wird je nach Montagebedarf für Hauswand oder Flachdach gesteckt.

The tube with the antenna will be supplied unmounted. The cross-head will be plugged according to mounting for wall or flat roof.

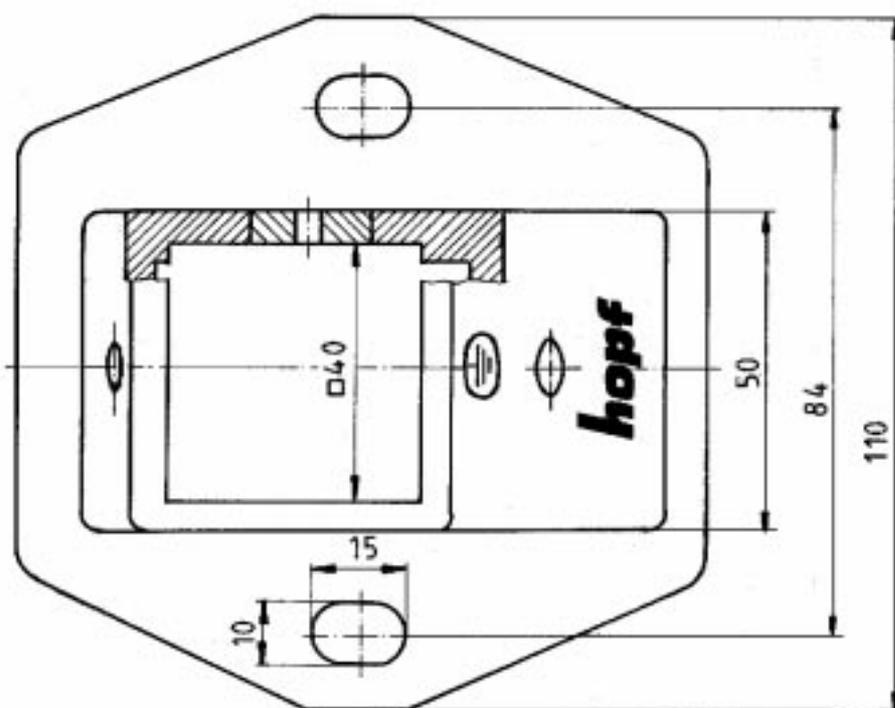
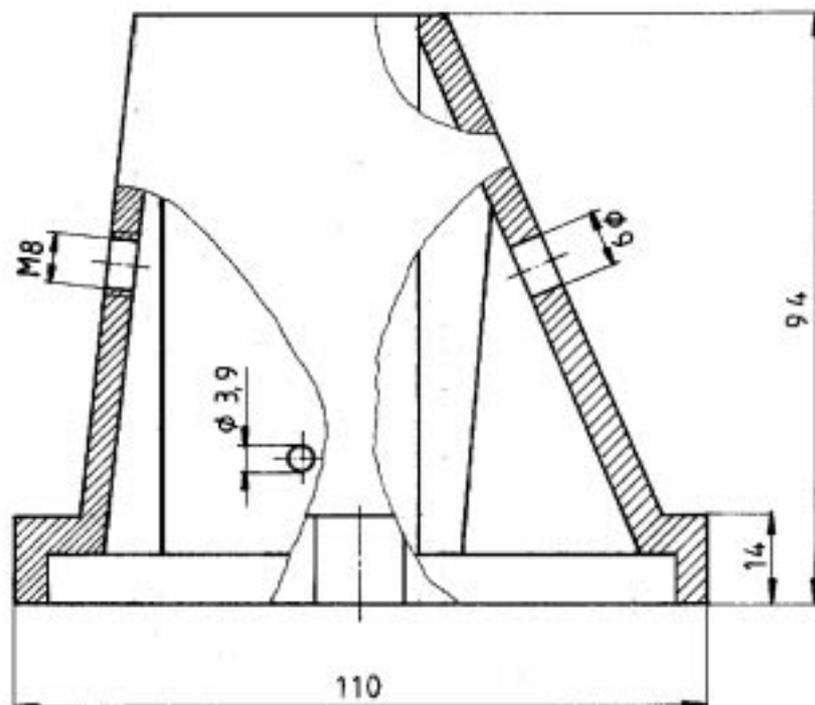
**Model  
FG 441800A**



Senkrechte Hauswand  
verticle wall

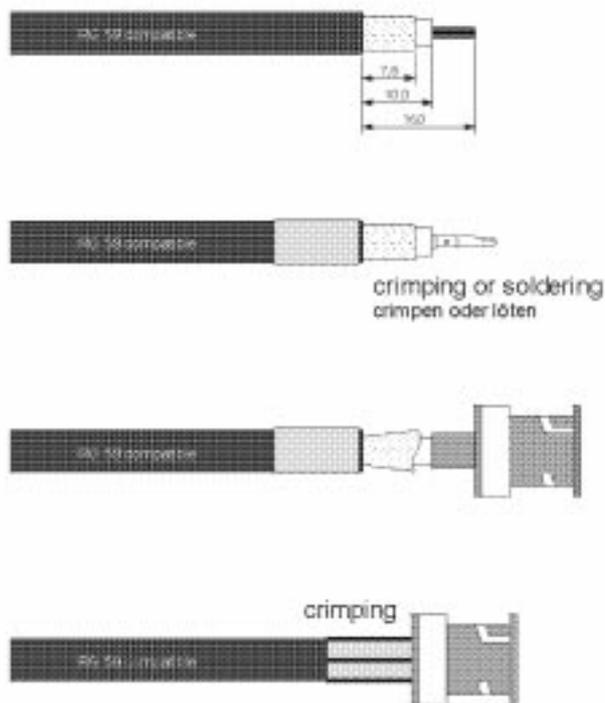
Kreuzkopf  
cross-head

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|---|---------|---|------------|---|
| 01.02.99                                | Vollmer | A4  | ZC99020102 | 1/1   |
| <b>Außenantenne<br/>Outdoor Antenna</b> |         |  |            | post box 1847<br>D-59469 Lüdenscheid<br>fax: (02351) 93888-6<br>fax: (02351) 452592 |

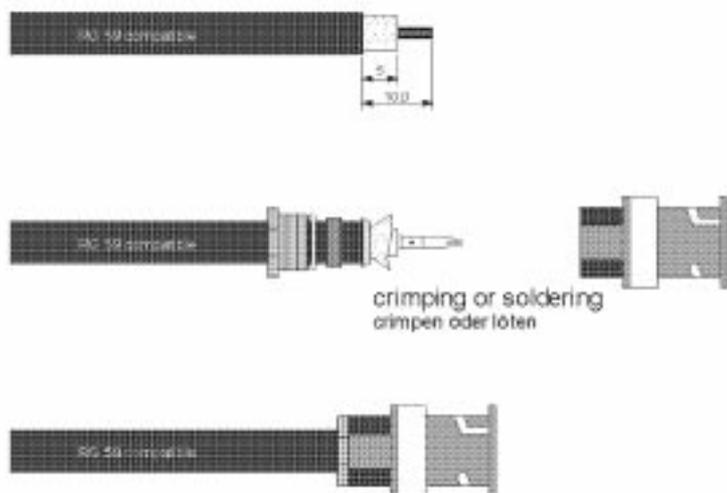


|        |   |         |  |
|--------|---|---------|--|
| no.    | ZC970-41001   | page    | 1/1  |
|        | <b>antenna mounting</b>   |         |  |
| date   | 10.04.97  | systems |  |
| author | Vollmer   |         |  |
| size   | A4  |         |  |
|        |  |         | post box 1847<br>D-58455 Lüdenscheid<br>tel: (02351) 939200<br>fax: (02351) 456690 |

Mounting the BNC-plug with crimping technique  
 Montage für BNC-Stecker mit Crimpmontage



Mounting the BNC-plug with screw technique  
 Montage für BNC-Stecker mit Schraubmontage



|         |                     |            |          |
|---------|---------------------|------------|----------|
| changes | drawing number      | Zc01010401 | page 1/1 |
|         | <b>BNC Mounting</b> |            |          |
|         | date                | 04.01.01   | System   |
|         | name                | Vollmer    |          |
|         | check               |            |          |
| date    | changes             | name       | size     |
|         |                     |            | A4       |



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 D-66488 Lutzerath e.d.  
 lev. (022351) 833688  
 fax (02351) 459500