ECOTEL®

VIERLING

Antenna Installation Instructions

Edition 2.0

VIERLING Communications GmbH

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1. Introduction

During design of **ECOTEL® VTM**, special attention was given to simple assembling and easy access to the operating interfaces.

Certain considerations must be observed however when installing the various interfaces.

This application sheet offers practical suggestions for the installation of antennas.

IMPORTANT NOTE:

To comply with FCC RF exposure compliance requirements, the following antenna installation and device operating configurations must be satisfied:

a) The antennas used for this transmitter are to be fixed-mounted on outdoor permanent structures.

b) The device must operate with the specific antennas described in section 3.2 of this document

c) The antennas used for this device must be installed to provide 1 meters from all persons and the antenna gain must not exceed 2 dBi.

e) The device must operate in the transmitter co-location configurations identified in section 3.5 of this document

2. Selecting a Location

The location of **ECOTEL®** should be chosen based on the following criteria (listed in the order of priority):

- Close to the antenna (10 m up to 50 m)
- Close to the PBX / switch -system (up to 200 m phone cable for ISDN (BRI/PRI))

3. Information for Antenna Installation

3.1 Attenuation Values of Antenna Cables

Antenna cables exhibit very marked differences with regard to attenuation. When assembling, care should be taken to use a short antenna cable. If space requirements do not permit, then a cable with less attenuation must be used.

Cable	Diameter	min. Radius	850 MHz	1900 MHz	Order No.
RG-178B/U			140 dB/100 m		
RG-174/U			90 dB/100 m		
RG-58C/U	5,0 mm	30 mm	50 dB/100 m	74 dB/100 m	
RG-213/U	10,3 mm	110 mm	23 dB/100 m	35 dB/100 m	
AirCell 7	7,3 mm	25 mm	21 dB/100 m	32 dB/100 m	
AirCom Plus	10,8 mm	55 mm	12 dB/100 m	25 dB/100 m	27741.193

An attenuation of 3 dB equals 50% field strength

Attenuation = 10 lg (input power/ output power) dB

Field Strength Spectrum:

-113 dB ... -95 dB insufficient field strength

-95 dB ... -70 dB sufficient field strength

-70 dB ... -51 dB optimal field strength (best voice quality)

(The power control of the GSM network tries to get a signal about –70 dBm)

Receive Field Strength (dBm/RxLev):

P_{dBm} = (RxLev *2 –113) dBm

Output Power (dBm/PwrLev)

For 900 MHz: $P_{dBm} = 33 – (PwrLev –5)*2$

For 1800 MHz: $P_{dBm} = 30 – PwrLev *2$

The translation of power values in dBm to Watt:

P_W = 0,001 W * 10 ^ (P_{dBm}/10)

Receive Field Strength (RSSI / dBm)

RSSI	dBm	RSSI	dBm
0	-113	16	-81
1	-111	17	-79
2	-109	18	-77
3	-107	19	-75
4	-105	20	-73
5	-103	21	-71
6	-101	22	-69
7	-99	23	-67
8	-97	24	-65
9	-95	25	-63
10	-93	26	-61
11	-91	27	-59
12	-89	28	-57
13	-87	29	-55
14	-85	30	-53
15	-83	31	-51

GSM and UMTS Frequencies

GSM

Band	Uplink (MHz)	Downlink (MHz)	Bandwidth
GSM450	450,4-457,6	460,4-467,6	200 kHz
GSM480	478,8-486	488,8-496	200 kHz
GSM750	777-792	747-762	200 kHz
GSM850	824-849	869-894	200kHz
GSM-R	876-880	921-925	200kHz
EGSM900	880-890	925-935	200kHz
PGSM900	890-915	935-960	200kHz
DCS1800	1710-1785	1805-1880	200kHz
PCS1900	1850-1910	1930-1990	200kHz

UMTS

Band	Uplink (MHz)	Downlink (MHz)	Duplex-Distance
I	1920- 1980	2110 – 2170	190 MHz
II	1850 - 1910	1930 – 1990	80 MHz
III	1710 - 1785	1805 – 1880	95 MHz

3.2 Antennas

For the US market only the **Kathrein 800 10147** order code **VPol Omni 824–960/1805–2170 360° 2dBi** is certificated for operation with ECOTEL®VTM pro.

3.2.1 GSM/UMTS omni directional Antenna

(Order Number 70459.112)

Technical data

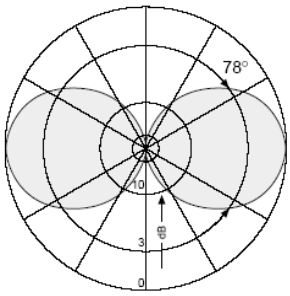
Mechanical parameter

Colour	RAL 7035 (light-grey)
Dimensions	216 x 20 mm
Weight	0,250 kg

Electrical parameter

Frequency I	824 –960 MHz
Frequency II	1805 -2170 MHz
Gain	2 dBi (max 6,5 dBi)
Impedance	50 Ohm
Match/VSWR	<2:1
Max. power	50 W
Polarisation	vertical
Connector	N female

Antenna Diagram



Vertical Pattern

NOTE:

The antenna is a 850/1900 MHz antenna. To get the best reception, the antenna must be mounted vertical!

ATTENTION:

This antenna does not support GSM1800

3.3 Antenna Installation ECOTEL®VTM pro

ECOTEL®VTM pro should be mounted as close to the antenna system as possible (maximum antenna length: 50 m). The antenna at the serving GSM-cell should be visible from the mounting position.

ECOTEL®VTM pro provides an individual RF connector for each antenna.

For a distance of up to 30 m a RG 58 antenna cable is sufficient. Longer distances could only be obtained with a AirCel/AirCom cable. Adapters for SMA to N or SMA to FME are necessary to link the different cable diameters.

To simplify the antenna installation a antenna installation package is available. (Order Number 70466.401).

The antenna installation set comprises:

GSM850/1900/UMTS	Order Number 70459.112
Adapter FME-SMA :	Order Number 47560.915
Adapter N-female/SMA-female:	Order Number 47560.020
N-male for AirCom Plus:	Order Number 47560.018
N-female for AirCom Plus:	Order Number 47560.019

The maximum length of antenna cable has to be calculated before installation! (see section 3.4)

Mounting Position

The installation of the antennas should be done as close as possible to the GSM-gateway. The RF-cable length should be not longer than 50 m.

distance between antennas > 0,2 m;
distance to bottom (roof) > 1 m;
distance to lightning protectors > 5 m;
distance to the base station > 20 m

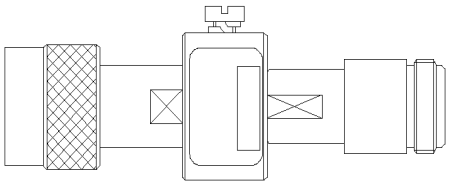
3.3.1 Antenna Mast

The antennas could be mounted on one antenna mast. If it is not possible or allowed to install the antenna mast direct on the roof of the building, small foundations out of cement could be used to fix the antenna mast on the roof. In this case the mast should be not higher than 2 m to avoid problems with wind. The mast must be grounded.

3.3.2 Surge Protection

The antenna system could be hit by lightning. Therefore the antenna must be protected against over voltage. A surge protector limits the risk of over voltage for most cases. For a complete protection an insurance which covers the possible financial loss could be arranged.

Surge Protector (N-femal/male connector)

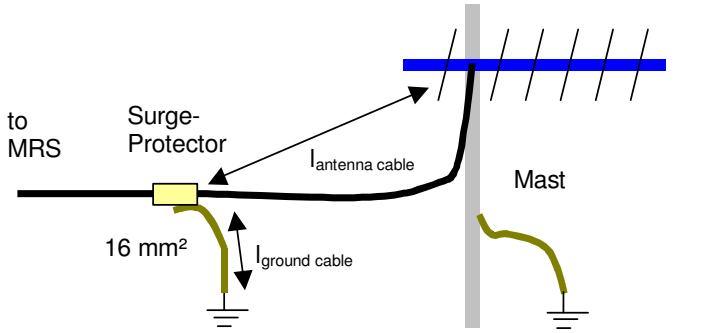


frequency range:	DC to 2500 MHz
return loss:	≥ 20dB
insertion loss:	≤ 0,2dB
impedance:	50 Ohm

surface:	sucoplate
temperature range:	-40°C to +100°C
I_{max}:	20 kA
U_{max}	800 V

Mounting Conditions

The surge arrestor should not be mounted in cable ducts or rooms with inflammable objects. The cable from the antenna to the arrestor must be > 5 m. The arrestor must be grounded by a 16 mm² wire with at maximum half the length of the antenna cable length. The ground must have a low resistance to earth. The ground must not be connected to the lightning protector of the roof! (regulation: EN 50083)



$I_{antenna\ cable} > 2 \times I_{ground\ cable}$

ATTENTION:

Protection earth and the lightning protector must be individual, none coupled grounds. The diameter of protection earth must be >= 16 mm².

Supplier:

VIERLING Communications GmbH

Surge Protector

Surge Protector 20kA Order Number 47560.939

Available Adapter Cables for Antennas

Cable SMA-male - FME-female (60 cm):	Order Number 47560.914
Cable SMA-male - FME-female (300 cm):	Order Number 47560.920
Adapter SMA-male - FME-male:	Order Number 47560.915
Cable SMA-male - SMA-male (20 cm):	Order Number 47560.916
Cable SMA-male - N-male (30 cm):	Order Number 47560.919
Adapter N-female - SMA-female:	Order Number 47560.020
Connector N-male:	Order Number 47560.018
Connector N-female:	Order Number 47560.019

3.4 Calculating the Cable Attenuation

A sufficient field GSM field strength with adequate reserve, requires a receptive field strength of > -80 dBm. In most cases, this requirement can be met in locations where the GSM transmitting mast is visible. (As a rule, with the transmission mast direct visibility, field strength is between –60 dBm and –50 dB). The attenuation of the entire receiving system in this case must be < 20 dBm (80 dBm – 60 dBm = 20 dBm), (a < -20 dB).

These values should serve as a guide. In any case, prior to installation of a GSM antenna system, the actual field strength must be determined using a measuring device or an **ECOTEL®**-desk-top device.

Example:

GSM Antenna +2 dB

50 m distance between antenna and **ECOTEL®**

-20 dB < -2 dB + a_{cable}
(Total Attenuation = Antenna Gain – Attenuation of Splitter + Attenuation of Cable)

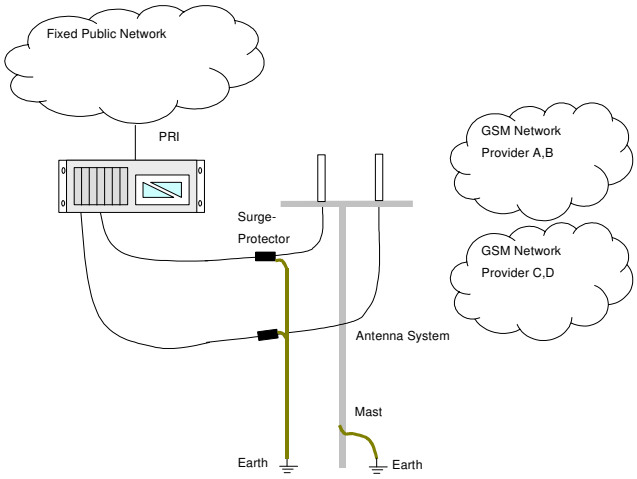
a_{cable} > -18 dB

$a_{AirCell\ 7}$	= -32 dB / 100 m	= -16,0 dB / 50 m
$a_{AirCom\ Plus}$	= -25 dB / 100 m	= -12,5 dB / 50 m

-> AirCel7 and AirCom cable can be used for the installation!

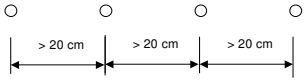
(RG58CU cable should not be used for this location: a_{RG58CU} = -37 dB it is not less than –18 dB !!)

3.5 Antenna Installation VT-Multi Channel

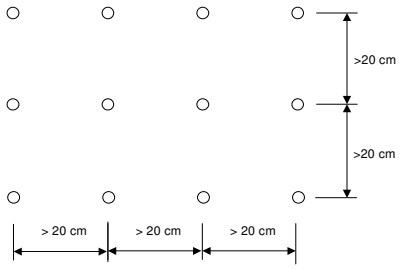


If more than one antenna is installed, the antennas can be installed in a line or as an antenna array. In both cases the distance between the single antenna must be >20 cm.

Antenna in line installation



Antenna as array installation



3.6 Installing the Antenna Cable

Assembling the antenna cable with N-male/N-female-connectors is shown at Assembling antenna cable on page 19.

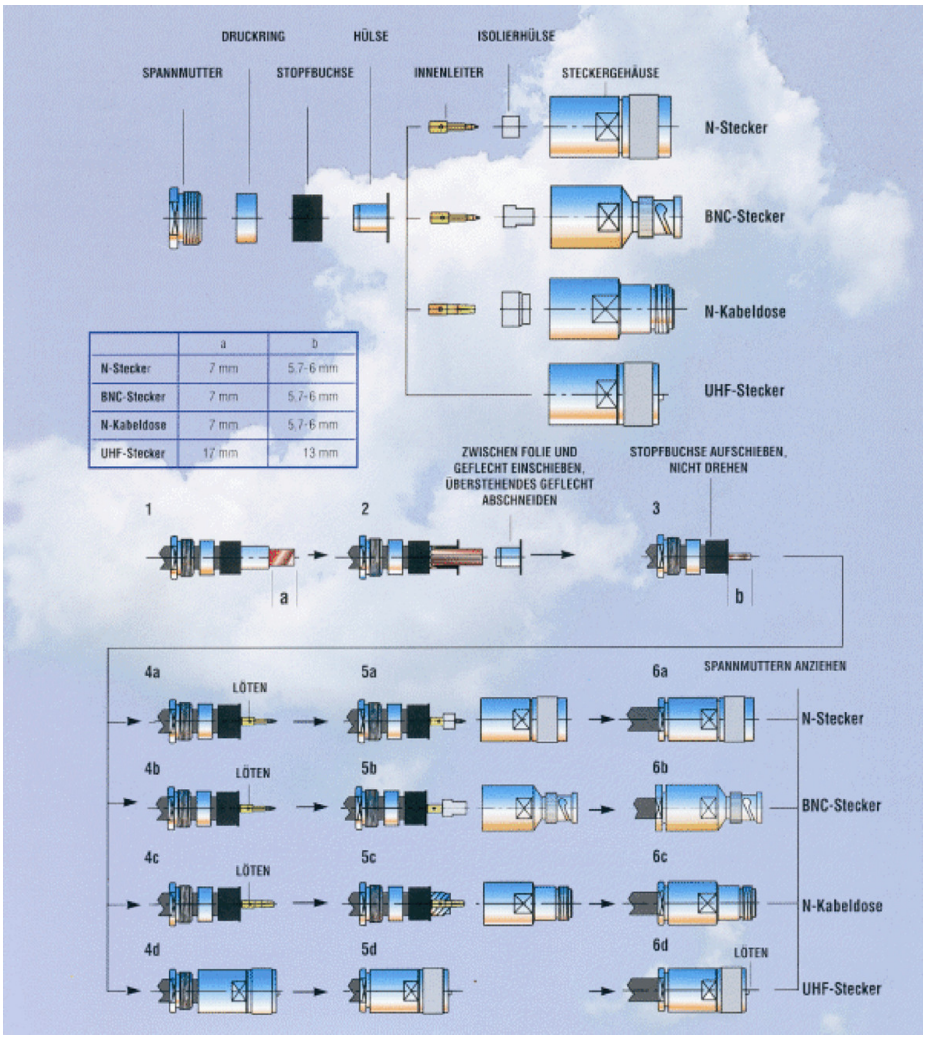
Directions for assembling the N-male/N-female connectors:

The N-male/N-female connector must be assembled in compliance with the mounting instructions. Special attention should be given to inserting the sleeve; for this, a tip:

After stripping the isolation, the copper mesh must be bent back completely. The visible copper foil should be smoothed all around in order to facilitate placing the sleeve over it. The somewhat smaller inside diameter of the sleeve was intentionally designed in order to ensure an HF-conform connection between sleeve and copper foil. Screwing the sleeve on works satisfactorily; and screwing the nut onto the threads works in a similar fashion.

The sleeve is parenthesized up to the limit. The copper foil hanging over from the sleeve should now be scarified with a sharp knife and then removed. The copper mesh must be bent back all around onto the sleeve soil; the overhanging mesh must then be carefully cut off. Because of the one-sided plastic-coated copper foil, the sleeve must be shoved over this foil. Should the sleeve be shoved under the foil, then galvanic contact is not possible!

Tightening the tightening-nut should be very carefully done using the 2 thin spanners (17 and 18 mm). Tightening the nut by force up to the limit results in completely crushing the cable sleeve and the cable itself.



Assembling antenna cable

4. ICNIRP/MPE Compliance

ICNIRP (**I**nternational **C**ommission on **N**on-Ionising **R**adiation **P**rotection) released limits for non ionising radiation. ECOTEL VTM gateway systems full fill all requirements, if the access of pedestrians is restricted in an area of **3.3 m** around the antenna (the restriction can be implemented by a information plate, by fence, …).

4.1 ICNIRP/MPE Limits

Freq		**ICNIRP**	**ICNIRP**	**MPE**	**MPE 5%**	**MPE**
MHz	W	General Public	Occupational	General Public	General Public	Occupational
		400-2000 MHz 1,375 $f^{1/2}$	400-2000 MHz 3 $f^{1/2}$	300-1500 MHz 1,585 $f^{1/2}$	300-1500 MHz 0,354 $f^{1/2}$	300-1500 MHz 3,545 $f^{1/2}$
850	2	40,08 V/m	87 V/m	46,2 V/m	10,32 V/m	103 V/m
900	2	41,25 V/m	90 V/m	47,55 V/m	10,62 V/m	106 V/m
		400-2000 MHz 1,375 $f^{1/2}$	400-2000 MHz 3 $f^{1/2}$	300-1500 MHz 61,4 V/m	300-1500 MHz 13,69 V/m	1500-100000 MHz 137 V/m
1800	1	58,33 V/m	127 V/m	61,4 V/m	13,69 V/m	137 V/m
1900	1	59,93 V/m	130 V/m	61,4 V/m	13,69 V/m	137 V/m

MPE (maximum permissible exposure, defined by FCC):

If the RF emission of the device is lower than 5% of the MPE limit (in mW/cm^2), the device can be installed without extra on site measurement.

For calculation 10 V/m for the 850/900 MHz band is taken (worst case).

-> GSM band with the highest emissions and the lowest limit.

4.2 Absolute Maximum Power Output of VTM32

GSM850/900:

Number of channels:	32
Peek Power per channel:	2 W
Effective Power Factor for GSM (Time Division Multiplex):	1/8

P_{max} = 32 * 2 W * 1/8 = **8 W**;

GSM1800/1900:

Number of channels:	32
Peek Power per channel:	1 W
Effective Power Factor for GSM (Time Division Multiplex):	1/8

P_{max} = 32 * 2 W * 1/8 = **4 W**;

UMTS:

Number of channels:	32
Peek Power per channel:	0,125 W
Effective Power Factor for UMTS:	1

P_{max} = 32 * 0,125 W = **4 W**;

4.3 Maximum Power Output of VTM32 (US Version)

4.3.1 System under operational conditions

GSM850/900:

Number of channels:	32
Peek Power per channel:	2 W
Effective Power Factor (Time Division Multiplex):	1/8
Effective Power Factor (Splitter/Combiner):	1

: $P_{operational}$ = 32 * 2 W * 1/8 = **8 W**

4.3.2 System under worst case conditions

GSM850/900:

Number of channels:	32
Peek Power per channel:	2 W
Effective Power Factor (Time Division Multiplex):	1/8
Effective Power Factor (Splitter/Combiner):	1

: $P_{worst\ case}$ = 32 * 2 W * 1/8 = **8 W**

4.4 Safety Distance

4.4.1 Calculation

In the GSM850/900 band the highest energy is transmitted, so the safety distance is calculated for the GSM850/900 band only;

P_{max} = 8 W (EIRP: maximal average sending power)

P_{EIRP} = 8 W * 6 dBi = 8 W * 10 (6,5/10) = 35 W

E_{limit} = 10 V/m

r = sqr(30V/A * P_{EIRP}) / E
= sqr(30V/A * 35 W) / 10 V/m = 3.3 m

Conditions:

Typical isotrope antenna gain	=	2 dBi
Worst case isotrope antenna gain	<=	6,5 dBi

As far as the cable loss is higher than the antenna gain (is full filled for standard installations) the calculated 3.3 m safety distance also apply for this installations.

4.4.2 FCC compliance

To fulfil FCC compliance measures for one meter distance have been completed. The result did under-run the 100% MPE limit clear. In a conservative consideration therefore the distance of **1m** must be fulfilled for FCC compliance. In the follow the distance for 5% MPE is **4,5m**.

The operator of the gateway has to guarantee, that there is no person within this safety area. The area has to be restricted to any persons by means of a fence or must be marked as hazard area by black/yellow bars painted on the ground. If the access to the area is already restricted by the location of installation (e.g. the antenna is mounted on a roof), an information plate can give a warning to the people which enter this restricted area.

4.5 Country Specific Regulations

The local authorities claim several other regulative handling from the operator of a antenna system. In Germany each antenna system has to be registered at the local office of the telecom regulation authority. Please contact your local telecom authorities for details.