

- All data cables (upper and lower end)
- All small external housings (if used)
- All antennas on large external housings (if used)
- the radio modem designated as synchronization masters, with the additional designation "Sync master",

4.3 Installation at the Radio Tower

4.3.1 Installing the tower standoff at the radio mast

4.3.2 Installing the WIMAN hardware at the tower standoff

Attach the WIMAN hardware (external housing and antennas) to the tower standoff at the suitable positions and align. If a WIMAN is to take over the function of the synchronization-master and is not clocked from a remote location, always use the unit aligned to the north (0°) as the synchronization master.

4.3.3 Installation

Install all data cables. Connect the data cables with the Hybrid cables coming from the WIMAN radio modems.



Attention:

For correct function and error-free installation, be sure that the sync cable is installed before testing.

4.3.4 Start tests

Now test all installed components on correct function and installation. You find a specification of the tests in chapter 6 on page 58.

4.3.5 Checking the antenna adjustment

- Check to see that all antennas are facing the correct direction.
- Note the adjustments of all antennas.

4.3.6 Test all devices

- Make sure all devices on the radio tower are switched on and are connected to the synchronization cable.
- Test each WIMAN radio modem again (see chapter 6, page 58.) to make sure that there is no error caused by the synchronization cable.

4 Hardware Installation

4.3.7 **Save all configuration data of the WIMAN radio modems at the radio tower**

- Use the same name conventions used for the cables and WIMAN radio modems.
- Record the following information with a terminal program:
 - Parameter („show“-command)
 - Statistics („stat“-command)

4.4 **Grounding**

It is extremely important to ground all installed devices on the radio tower. This will reduce the amount of damage should lightning strike. The following steps will also help to reduce possible damage caused by lightning:

- Do not mount the WIMAN at the highest point of the radio tower. This is the point most likely to be struck by lightning.
- Check that the outdoor housing and the tower standoffs form a well-grounded metal-on-metal connection with the tower frame.
- Avoid using rubber washers or seals.
- Install lightning protection devices between the data cable and the hybrid-sets on both the top and bottom of the tower.
- Ground the data cable to the tower at (a minimum of) three different places. (1) to the center of the tower, (2) to the base of the tower where the cable bends (before the bridge from the tower to the shed) and (3) before the cable runs into the equipment shed. The best way to do this is to strip away the outer casing of the cable and affix a grounding clamp to the cable shielding, then connect this clamp to a second one which is fixed to the tower.
- Make sure that all equipment (Switches, Routers, etc.) at the base of the tower is properly grounded to the rack in which it is mounted. Also make sure that the rack itself is properly grounded.

4.5 Burst-Synchronisation

Burst-synchronization is the coordination process of frequency hopping tables, receipt, and points of transmitting time for several WIMAN networks within the same geographical area.

Burst-synchronization is achieved by both hardware and software items. The hardware item is a synchronization cable, which is only a wire, which connects the X.21-interfaces among themselves.

For the X.21 Interface, the synchronization cable is enclosed in the hybrid cable type 3. This is connected to further radio modems with additional cables and special T-connectors.

The software section for synchronization consists of the parameter SyncMode, which is to be entered in the basic configuration of a master or a Slave.

One master radio modem (STAR or LINE) is determined as synchronization master for all radio modems at that location. The synchronization master is adjusted as follows:

- SyncMode = Master

All further master radio modems should be adjusted as follows:

- SyncMode = Slave

4.6 Extended Point-to-Point Connections

An extended Point-to-Point connection can be structured by arranging two WIMAN LINE “back-to-back”. For this application, additional hardware is necessary. Please contact your WIMAN supplier.

For an extended point-to-point connection the parameter SyncMode has to be set to the base WIMAN LINE configuration.

The example configurations specified below refer to an extended X.21 Point-to-Point-connection. In this structure, the WIMAN LINE Slave 1 is coupled to the WIMAN LINE Master 2.

4 Hardware Installation

<i>Line Master 1</i>	<i>Line Slave 1</i>
NetId = 1	NetId = 1
NodeId = 0	NodeId = 1
Destination = 1	Destination = 0
SyncMode = (according to local Network)	SyncMode = Master

Table 1 *parameters of an extended point-to-point connection (connection 1)*

<i>Line Master 2</i>	<i>Line Slave 2</i>
NetId = 2	NetId = 2
NodeId = 0	NodeId = 1
Destination = 1	Destination = 0
SyncMode = Slave	SyncMode = (according to local Network)

Table 2 *parameter of an extended point-to-point connection (connection 2)*

5 Reception quality and transmission speeds

For the examination of the receipt quality as well as to error detection, test loops can be generated. The type of test loop can be influenced by the configuration of the parameters *LoopData*, *LoopMode* and *LoopTest*.

The parameter *LoopData* enables the setting of the Byte-values that are to be generated (see page 18). This parameter can be produced on a WIMAN ACCESS only.

The parameter *LoopTest* enables a switching to a test loop, with which the data, which can be transmitted, is produced independently by the WIMAN radio modem (see page 19).

This test loop can already be activated in the lowest authorization level and is, in combination with the statistics analysis on the wireless interface, an outstanding inspection procedure for radio communication.

The parameter *LoopMode* determines, which bit pattern will be transferred with the back loop in the loop test operation from the WIMAN radio modem (see page 18)



Attention:

If the back loop test is execute in an operating radio net, avoid all values except *normal*. Use of any other value may result in loss of performance.

5.1 Configuration of a TestLoop with Independently Generated Data Communication

1. Access the command line level of authorization level one (see chapter 2 on page 13) and change into the configuration mode. You will see an output similar to:

```
WIMAN-II (config) >
```

2. Type in the command *looptest true*.
3. Check with *show looptest* the value for the parameter *LoopTest*. This should now be switched to **true**. The following output appears:

```
WIMAN-II (config) > show looptest
LoopTest      false (      true)
```

The present and the new configuration (in parentheses) of the parameter are displayed.

5 Reception quality and transmission speeds

4. To take over the modifications into the current configuration leave the configuration mode by entering the command *exit* (see page 27).

The following output appears:

```
Configuration changed, do you want to save (y)es  
/ (n)o / (c)ancel ?
```

You now have the choice:

- To transfer the new configuration into the current configuration and to leave the configuration mode by pressing the key „y“,
- To discard the modification but to leave the configuration mode anyway by pressing the key „n“ or
- To not take over the modification into the current configuration but to stay in configuration mode by pressing the key „c“.

Press the „y“ key to activate the looptest. The modification of the parameter becomes part of the current configuration and the WIMAN starts transmitting bit samples.

5.2 Test after a Radio Tower Installation with Synchronisation

After all devices are correctly installed, a final test must be executed. This final test checks if all devices are installed correctly and whether a trouble free transmitting and receiving mode is possible.

- Switch on the first WIMAN radio modem. Always begin with the WIMAN determined as synchronization master.
- Radio test
 - If the synchronization Master is a WIMAN STAR or a WIMAN LINE Master, conduct a loop back test from a properly configured WIMAN ACCESS or LINE Slave.
 - If the synchronization Master is a LINE Slave, conduct a loop back test from its LINE Master.
- Check the X.21-interface by connecting the X.21-plug of the Hybrid cable type-2 to the Router.

5 Reception quality and transmission speeds

- For the WIMAN STAR enter the commands „stat wl“ and „stat wl<nodeID>“ to ensure proper functioning of the data exchange.
- For the WIMAN LINE enter the command „stat sync“ to check the setting of both signals (both signals have to be set to „On“).

5.2.1 Continue the Tests

- Switch on the WIMAN radio modem next to the synchronization master.
- Switch off the synchronization master.
- Perform a reception test.
- Check the X.21-interface (see chapter X.21-Test above).
- Switch the synchronization master back on.
- Perform another reception test to make sure the synchronization cable does not produce any errors (the radio statistics should not differ substantially from the preceding ones).

5.2.2 Test the Remaining Modules

- Switch on the next WIMAN.
- Switch off all WIMAN radio modems that were tested before.
- Perform a reception test.
- Check the X.21-interface (see chapter X.21-Test above).
- Switch on all WIMAN units that were tested before.
- Connect the synchronization cable to the last tested WIMAN radio modem.
- Perform another reception test to make sure the synchronization cable does not produce any errors (the radio statistics should not differ substantially from the preceding ones).

5.3 Transmission Speeds

5.3.1 FTP-Download from an FTP-Server

The maximum transmission speed of the WIMAN radio modem at optimum conditions is about 25 ... 30 Kbytes/s at 2FSK and about 55 ... 62 Kbytes/s at 4FSK (depending on the extend of utilization of the network).

6 Frame Relay

6.1 Technical Description of the Frame of Relay Features

The WIMAN STAR supports the multiplexing of Frame Relay packages. In multiplexing procedure, the packages received from the Frame Relay Switches are transferred to the WIMAN ACCESS, which is connected to a Frame Relay Router at the user's site.

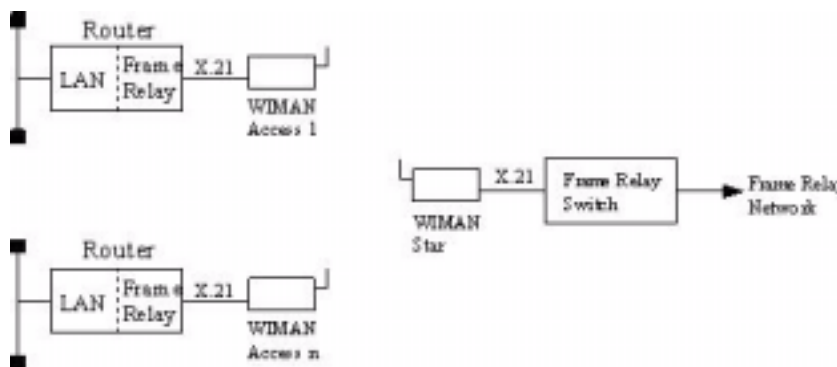


Figure 10 Frame Relay connections with the WIMAN

For addressing the WIMAN ACCESS the DLCI number (Data Link Connection Identifier) of the Frame of Relay protocol is used.

The following restrictions apply to the Frame Relay support:

- Only static connections are supported (PVC = Permanent Virtual Connection)
- DLCI numbers must be configured statically on the Frame Relay Switch and the Frame Relay Router
- 2-, 3- or 4- Byte-Frame Relay-address-arrays are supported,
- Since the WIMAN node address is embedded in the DLCI number (10-bit DLCI with implemented WIMAN node identifier), the DLCI allocation of numbers is reduced
- Up to four virtual connections are supported for each Frame Relay user
- Up to 250 Frame Relay users are supported at a WIMAN STAR (currently 9 users possible, Software Version T0.7).
- The following Frame of Relay features are not supported:

- LMI (Local Management Interface of ITU-T Q.933 or ANSI T1.617), since this procedure uses DLCI 1023 or DLCI 0,
- Establishing of connections for SVCs (uses DLCI 0),
- Multiple transmissions (uses DLCI 1019 ... 1022).

6.1.1 Frame Relay-Address array

2-Byte-Address array

Table 3 shows the structure of the 2 Byte long Address array:

8	7	6	5	4	3	2	1
DLCI 10	DLCI 9	DLCI 8	DLCI 7	DLCI 6	DLCI 5	C/R	EA
DLCI 4	DLCI 3	DLCI 2	DLCI 1	FECN	BECN	DE	EA

Table 3 Structure of the 2 Byte long address array

Explanation:

- DLCI
Data Link Connection Identifier
- C/R
Command Response Bit
- EA
Address Array Extension Bit
- FECN
Forward Explicit Congestion Notification
- BECN
Backward Explicit Congestion Notification
- DE
Discard Eligibility Indicator

The node address of the WIMAN is determined by the high order-bits (DLCI 03...DLCI 10) of the DLCI number. The low order bits (DLCI 1...DLCI 2) are used for virtual connections.

6 Frame Relay

DLCI value calculation

The LCI value for the Frame Relay Router of the user is calculated as follows:

$$DLCI_m = 512 + NodeId * 4 + m \quad m = [0 \dots 3]$$

Table 4 lists the valid DLCI numbers for appropriate node identifiers (NodeId) on use of the 2-Byte-Frame of Relay address array.

WIMAN NodeId	DLCI array	Note
0	512 – 515	reserved (<i>WIMAN STAR</i>)
1	516 – 519	
2	520 – 523	
3	524 – 527	
4	528 – 531	
5	532 – 535	
6	536 – 539	
7	540 – 543	
8	544 – 547	
9	548 – 551	
10	552 – 555	
11	556 – 559	
12	560 – 563	
13	564 – 567	
14	568 – 571	
15	572 – 575	

Table 4 NodeId with 2-Byte-Frame Relay address array

Frame Relay-support of the WIMAN Software

In the following, the implementation of the Frame of Relay Protocol within the WIMAN software is listed briefly. Exclusively the static software-Version of the WIMAN STAR supports the Frame Relay Protocol with the following characteristics:

- The maximum size of the Frame Relay information field amounts to 4096 byte.
- The WIMAN star rejects Frame Relay framework with invalid DLCI number (transmitter and receiver).

6.1.2 DLCI-areas when the 2-Byte-Address array is used (ITU Q.922)

Table 5 lists the allocation of the DLCI numbers on use of the 2-Byte-address array.

DLCI-area	Meaning
0	Signalizing in the transmission channel, if necessary
1 - 15	Reserved
16 - 511	Network option: on not-D channels, usable for the support of user information
512 - 991	logical connecting identifier for the support of user information (the use of semi permanent connections can reduce the DLCI numbers available within this area)
992 - 1007	Layer 2-Management of Frame-transport services
1008	reserved
1023	Layer 2-Management in the transmission channel if necessary (only usable without d-channel)

Table 5 *DLCI allocation in connection with 2-Byte-address array*

DLCI Range	10	9	8	7	6	5	4	3	2	1
0	0	0	0	0	0	0	0	0	0	0
1 -	0	0	0	0	0	0	0	0	0	1
15	0	0	0	0	0	0	1	1	1	1
16 -	0	0	0	0	1	0	0	0	0	0
511	0	1	1	1	1	1	1	1	1	1
512 -	1	0	0	0	0	0	0	0	0	0
911	1	1	1	1	0	1	1	1	1	1
992 -	1	1	1	1	1	0	0	0	0	0
1007	1	1	1	1	1	0	1	1	1	1
1008 -	1	1	1	1	1	1	0	0	0	0
1022	1	1	1	1	1	1	1	1	1	0
1023	1	1	1	1	1	1	1	1	1	1

Table 6 *bit sequence for different DLCI identifiers*

6 Frame Relay

6.2 Frame Relay-configuration samples

6.2.1 Sample configuration with CISCO-Routers

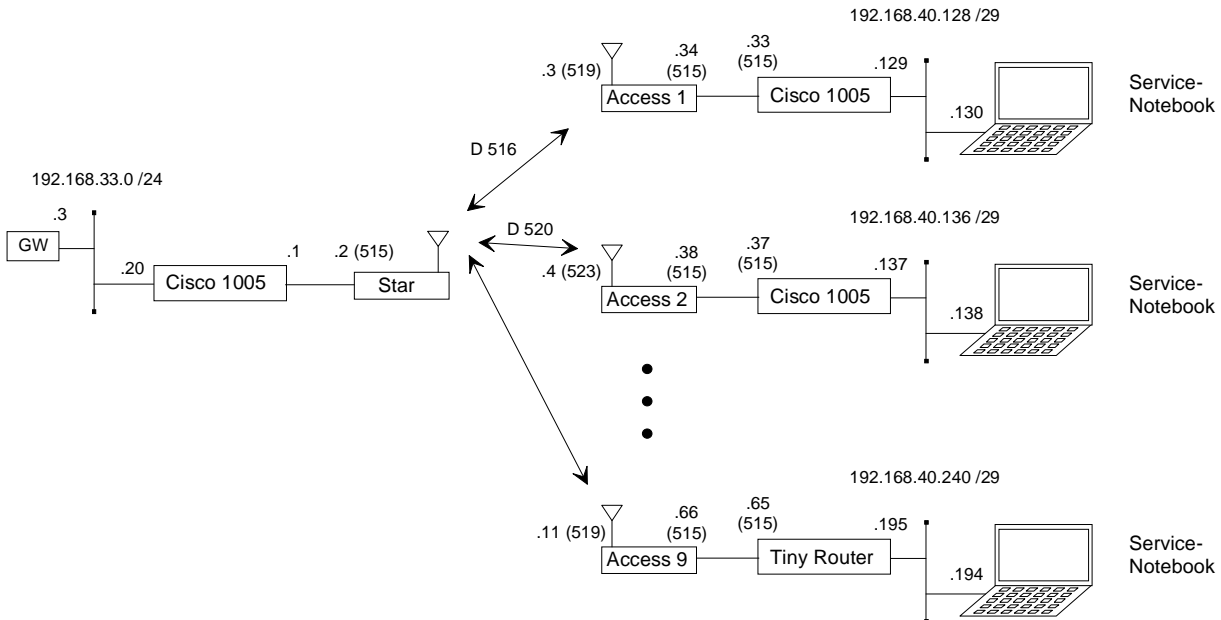


Figure 11 Simple WIMAN Network with CISCO-Router

CISCO1, connected to STAR unit:

```
! Configuration Cisco Star
!
no service password-encryption
no service udp-small-servers
no service tcp-small-servers
!
hostname Cisco_Master
!
enable password wiman
!
ip subnet-zero
!
interface Ethernet0
 ip address 192.168.33.20 255.255.255.0
!
interface Serial0
 no ip address
 encapsulation frame-relay IETF
 no keepalive
 no fair-queue
!
interface Serial0.1 multipoint
 ip address 192.168.40.1 255.255.255.224
 no arp frame-relay
 frame-relay map ip 192.168.40.2 515
 frame-relay map ip 192.168.40.3 519
 frame-relay map ip 192.168.40.4 523
 frame-relay map ip 192.168.40.5 527
```

6 Frame Relay

```
frame-relay map ip 192.168.40.6 531
frame-relay map ip 192.168.40.7 535
frame-relay map ip 192.168.40.8 539
frame-relay map ip 192.168.40.9 543
frame-relay map ip 192.168.40.10 547
frame-relay map ip 192.168.40.11 551
!
interface Serial0.2 point-to-point
 ip unnumbered Ethernet0
 no arp frame-relay
 no cdp enable
 frame-relay interface-dlci 516
!
interface Serial0.3 point-to-point
 ip unnumbered Ethernet0
 no arp frame-relay
 no cdp enable
 frame-relay interface-dlci 520
!
interface Serial0.10 point-to-point
 ip unnumbered Ethernet0
 no arp frame-relay
 no cdp enable
 frame-relay interface-dlci 548
!
ip classless
ip route 0.0.0.0 0.0.0.0 192.168.33.3
ip route 192.168.40.32 255.255.255.252 Serial0.2
ip route 192.168.40.128 255.255.255.248 Serial0.2
ip route 192.168.40.36 255.255.255.252 Serial0.3
ip route 192.168.40.136 255.255.255.248 Serial0.3
ip route 192.168.40.64 255.255.255.252 Serial0.10
ip route 192.168.40.192 255.255.255.248 Serial0.10
!
line con 0
 exec-timeout 0 0
line vty 0 4
 exec-timeout 0 0
 password wiman
 login
!
end
```

CISCO2, connected to ACCESS01:

```
! Configuration Cisco Access 01
!
no service password-encryption
no service udp-small-servers
no service tcp-small-servers
!
hostname Cisco_Access_01
!
enable secret 5 $1$9xE0$1jVP/hVttHmwhWi/b1Dzv0
!
ip subnet-zero
!
interface Ethernet0
```

6 Frame Relay

```
ip address 192.168.40.129 255.255.255.248
!
interface Serial0
no ip address
encapsulation frame-relay IETF
no keepalive
!
interface Serial0.1 point-to-point
ip address 192.168.40.33 255.255.255.252
no arp frame-relay
no cdp enable
frame-relay interface-dlci 515
!
interface Serial0.2 point-to-point
ip unnumbered Ethernet0
no arp frame-relay
no cdp enable
frame-relay interface-dlci 516
!
ip classless
ip route 0.0.0.0 0.0.0.0 Serial0.2
no cdp run
!
line con 0
exec-timeout 0 0
line vty 0 4
exec-timeout 0 0
password wiman
login
!
end
```

Configuration STAR:

```
## WIMAN II configuration file
#
# Air
Antenna                        8mn360
MaxNodeId                       1
MaxRetry                         9
NetId                           250
RadioPower                      Normal

# Serial
ConBaudrate                     9600
ConDataBit                       8
ConHandShake                    Soft
ConPageSize                     24
ConParity                       None
ConStopBit                      1
PS1                             WIMAN_Star
SerBaudrate                     2048000
SerCRC                          16
SerEncode                       NRZ

# Network
IPDefaultGW                    192.168.40.1
IPEthAddress                    0.0.0.0
IPEthMask                      255.255.255.0
```

6 Frame Relay

```
IPSerAddress      192.168.40.2
IPSerMask         255.255.255.224
IPTFTPSTServer   192.168.33.178
Location          Area_01
```

```
# Sync
SyncMode          Off
```

```
passwd enable crypt      Av/WbhGC.i1HA3E
```

Configuration ACCESS01:

```
## WIMAN II configuration file
```

```
#
# Air
Antenna           8mn360
LoopData          FF
LoopMode          Long
LoopTest          False
MaxRetry          9
NetId             250
NodeId            1
RadioPower        Normal
```

```
# Serial
ConBaudrate       9600
ConDataBit        8
ConHandShake      Soft
ConPageSize       24
ConParity         None
ConStopBit        1
SerBaudrate       2048000
SerCRC            16
SerEncode         NRZ
```

```
# Network
IPDefaultGW      192.168.40.1
IPEthAddress     0.0.0.0
IPEthMask        255.255.255.0
IPSerAddress     192.168.40.34
IPSerMask        255.255.255.252
IPTFTPSTServer   192.168.33.178
IPWLAddress      192.168.40.3
IPWLMask         255.255.255.224
Location          Area_1
```

```
# Sync
SyncMode          Master
```

```
passwd enable crypt      Av/WbhGC.i1HA3E
```

7 Troubleshooting

7.1 Techniques and Methodologies Used for Troubleshooting

7.1.1 General Problems

This section lists some common problems that may occur and cause a malfunction in the WIMAN system:

Bad RF-Link between STAR (Master) and ACCESS (Slave):

- STAR units are not synchronized → see *stat sync*
- Bad hardware on the STAR or the ACCESS
- Check RF statistics from the STAR to other ACCESS devices → see *stat wl ext*

If all other connections are functioning properly, STAR is not defective.

- If the star is working correctly consider the following questions:
 - Is the ACCESS device configured correctly (correct STAR, correct sector)?
 - Are there any obstacles between the STAR and the ACCESS?
 - Is the antenna cable attached correctly?
 - Is the antenna adjustment correctly?
 - Is the ACCESS device itself defective (defective transmitting or receiving part)? → If so, exchange the device.
 - Are two ACCESS devices within a network configured with the same NodeID? Check the ACCESS configuration, the network configuration and the documentation of the other ACCESS radio modems within in the same network.

No data communication from the STAR to the ACCESS:

- Check the radio connection between the ACCESS and the STAR.
- Check the wiring of the STAR and ACCESS
- Check the other radio modems attached to this STAR

If data can be transmitted to the other ACCESS devices then the wiring at the STAR is OK.

If you are still uncertain whether there is a problem with the wiring of the STAR, proceed as follows:

Check the statistics with the commands *stat serial ext* and *stat wl<NodeID>*. If you transmit a Ping, the Rx and Tx-counter should be increased.

Check whether the data cable is wired according to the specifications shown in chapter 10, page 85.

Check all modules for correct wiring.

Check the hybrid cables.

Check the interface converters.

Check the cross over cables.

- Check the wiring on the ACCESS:

Check the statistics with the commands *stat serial ext* (see page 49) at the ACCESS-side. If you transmit a Ping, the Rx and Tx-counters should increase.

Check whether the data cable is wired according to the specifications shown in chapter 10 on page 85.

Check the wiring of all modules.

Check the hybrid cables.

Check the routing tables.

- With the instruction *stat hw* compare the serial number entered in the device table (peer-table) with the actual serial number of the device. If the serial number does not match, all data packages will be discarded. Enter the following to delete an existing entry in the device table:

```
PEER <NodeID> <ENTER>
```

Afterwards reset the device.

- Check whether the looptest at the ACCESS radio modem is still active (*show looptest*). The Parameter „LoopTest“ must be set to „false“.
- Defective Router at the customer side:
 - Check the configuration
 - Check the Hardware
- PVC
 - PVC was built on the wrong port
 - PVC was built with wrong DLCI (according to the appropriate NodeID of the ACCESS)
- Routing tables

7 Troubleshooting

- Bad port on the switch
- Check other customers who are attached to the same STAR
- In case no further customers are attached to the same STAR, try attaching the device to another port.

WIMAN Baud rate parameters are not adjusted correctly:

If the WIMAN radio modem does not interface with the terminal program, the Baud rate may be set incorrectly on the WIMAN and/or the terminal program.

Frequency table adjusted incorrectly

If the WIMAN Slave cannot construct synchronized connections and you are using generated frequency tables, check that the parameter "*FtabMode*" is adjusted to "*user*". Make sure that all parameters are configured correctly.

Parameter *destination* not adjusted correctly (LINE only)

This situation cannot occur after a loop test. If the Socket program cannot structure a connection, check the network and ensure that all parameters "*destination*" are set to the correct value.

Baud rate in the Socket program not set correctly

If the Socket program cannot construct a connection, it could be that the Baud rate is set incorrectly on the Socket program and/or the WIMAN.

Parameter *NodeID* not set correctly

If an ACCESS radio modem receives synchronization impulses, but no data can be transmitted, it could be that the parameter *NodeID* is adjusted incorrectly. The double assignment of a node number in the same network leads to malfunctioning.

Serial number does not correspond with the device table (Peertable)

If the WIMAN STAR is adjusted to a serial number that differs from the one used in the Peertable, malfunction may occur.

IP-Parameter in the Socket-program not set properly

If the Socket program over the ACCESS radio modem cannot construct a connection, check whether all IP parameters are adjusted correctly.

Damaged or defective antenna cable

Damaged or defective synchronization cable

Any of these problems may lead to poor or no radio communication. Check the antenna cables for damages. If there are no damages, check the synchronization connection. If the problem persists, the WIMAN may need to be replaced.

7.1.2 Troubleshooting with Radio Tower Installations

- If the WIMAN radio modem can not be accessed over the RS-232-interface, the problem may be caused by:
 - A non-corresponding Baud rate of the terminal program and the WIMAN (usually the Baud rate is adjusted to 9600 Baud)
 - Incorrectly attached cables
 - Faulty Hybrid-2 or Hybrid-3-cables. Exchange the Hybrid-2-cable first and then the Hybrid-3-cable (if necessary).
 - Faulty contacts inside the data cable plug. Check the configuration and transmission with an extra 25pin data cable.
- In case the ACCESS can get no RF-synchronization signal (indicated by the Status-LED at the front side of the unit) or if the synchronization signal reception is periodically interrupted, the problem may be caused by:
 - Incorrect configuration of the ACCESS or STAR. Check whether all parameters are correct.
 - The operating voltage at the star radio modem is too low. If the operating voltage at the WIMAN radio modem drops below the given threshold value, a restart is performed automatically. It is advisable to constantly apply a voltage at the radio modem by at least 12V.
 - Defective or unattached antenna cable,
 - A Faulty Hybrid-2 or Hybrid-3-cable. Replace the Hybrid-2-cable first and then the Hybrid-3-cable (if necessary).
 - Defective RF filters.
 - Defective WIMAN STAR or ACCESS.
 - Faulty contacts inside the data cable plug. Check for perfect configuration and transmission with an additional 25pin data cable.
 - Defective synchronization cable (short-circuit in the plug) of and to the testing device.
 - Defective T-connector (short-circuit)

8 Appendix A: WIMAN Hardware

!!!!!!!!!!Still being revised!!!!!!!!!!!!!!

8.1 Technical description

Below you will find pictures of the WIMAN units:



Figure 12 front side of the WIMAN radio modem



Figure 13 rear side of the WIMAN radio modem