

## **IMPORTANT NOTICE**

All rights to this manual are owned solely by SATEL OY (later called also SATEL). All rights reserved. The copying of this manual without the written permission from the owner of the rights by printing, copying, recording or by any other means or the full or partial translation of the manual to any other language including all programming languages using any electrical, mechanical, magnetic, optical, manual or other methods or devices is forbidden.

SATEL reserves the right to change the technical specifications or functions of its products or to discontinue the manufacture of any of its products or to discontinue the support of any of its products without any written announcement and urges its customers to ensure, that the information at their disposal is valid.

SATEL software and programs are delivered "as is". The manufacturer does not grant any kind of warranty including guarantees on saleability and guarantees pertaining to applicability to a certain application. Under no circumstances is the manufacturer or the developer of a program responsible for any possible damages caused by the use of a program. The names of the programs as well as all copyrights relating to the programs are the sole property of SATEL. Any transfer, licensing to a third party, leasing, renting, transportation, copying, editing, translating, modifying into another programming language or reverse engineering for any intent is forbidden without the written consent of SATEL.

**SATEL PRODUCTS HAVE NOT BEEN DESIGNED, INTENDED NOR INSPECTED TO BE USED IN ANY LIFE SUPPORT RELATED DEVICE OR SYSTEM RELATED FUNCTION NOR AS A PART OF ANY OTHER CRITICAL SYSTEM AND ARE GRANTED NO FUNCTIONAL WARRANTY IF THEY ARE USED IN ANY OF THE APPLICATIONS MENTIONED.**

Salo, FINLAND 2000

## RESTRICTIONS ON USE

SATELLINE-3AS (d) radio modems have been designed to operate on frequency ranges, the exact use of which differs from one region and/or country to another. The user of a radio modem must take care that the said device is not operated without the permission of the local authorities on frequencies other than those specifically reserved and intended for use without a specific permit. For this reason, the notice mark has been attached to the radio modem.



The model SATELLINE-3AS(d) 869 MHz is designed to operate on the licence free frequency band of 869.400 – 869.650 MHz according to recommendation CEPT/ERC/REC 70-03. This recommendation has been drawn up by the European Radiocommunications Committee (ERC) under CEPT. The transmit/receive duty cycle of the individual unit is limited to 10% on this band, and a single transmission period must not exceed 36 s. In addition, the maximum allowed radiated output power is 500 mW<sub>ERP</sub>.

**WARNING!** Users of SATELLINE-3AS (d) radio modem in North America should be aware, that due to the allocation of the frequency band 406.0 – 406.1 MHz for government use only, the use of radio modem on this frequency band without a proper permit is strictly forbidden.

## **WARRANTY AND SAFETY INSTRUCTIONS**

Read these safety instructions carefully before using the product:

- Warranty will be void, if the product is used in any way, which is in contradiction with the instructions given in this manual, or if the housing of the radio modem has been opened or tampered with.
- The radio modem is to be used only on frequencies allocated by local authorities and without exceeding the given maximum allowed output power ratings. SATEL is not responsible, if any products manufactured by it are used in unlawful ways.
- The devices mentioned in this manual are to be used only according to the instructions described in this manual. Faultless and safe operation of the devices can be guaranteed only if the transport, storage, operation and handling of the devices is appropriate. This also applies to the maintenance of the products.
- To prevent damage both the radio modem and any terminal devices must always be switched OFF before connecting or disconnecting the serial connection cable. It should be ascertained that different devices used have the same ground potential. Before connecting any power cables the output voltage of the power supply should be checked.

**TABLE OF CONTENTS**

**IMPORTANT NOTICE..... 1**

**RESTRICTIONS ON USE..... 2**

**WARRANTY AND SAFETY INSTRUCTIONS ..... 3**

**TABLE OF CONTENTS..... 4**

**INTRODUCTION ..... 8**

**1 SATELLINE-3AS AND SATELLINE-3ASD RADIO DATA MODEMS..... 10**

**1.1 SATELLINE-3AS Technical specifications (380...470 MHz)..... 10**

**1.2 SATELLINE-3AS Technical specifications (869 MHz) ..... 11**

**1.3 SATELLINE-3ASd EPIC Technical specifications (400...470 Mhz) ..... 12**

**1.4 Basic configuration and installation ..... 13**

1.4.1 Basic configuration ..... 13

**2 CONNECTIONS..... 15**

**2.1 D15-connector functions..... 15**

2.1.1 Pin configuration ..... 16

2.1.2 RS-232 -Interface ..... 17

2.1.3 RS-422 -Interface ..... 18

2.1.4 RS-485 -Interface ..... 19

2.1.5 Termination..... 19

**2.2 RF Interface ..... 19**

2.2.1 Transmitter ..... 20

2.2.2 Receiver ..... 21

2.2.3 RSSI-signal ..... 21

2.2.4 Error correction ..... 22

2.2.5 Error checking ..... 22

**3 USER INTERFACE..... 23**

**3.1 LED-indicators ..... 23**

**3.2 Configuration mode..... 23**

3.2.1 Changing the settings ..... 24

3.2.2 Restoring factory settings..... 25

<b>3.3</b>	<b>Display and push buttons (SATELLINE-3ASd)</b> .....	<b>25</b>
<b>4</b>	<b>TRANSPARENT DATA TRANSMISSION</b> .....	<b>27</b>
<b>4.1</b>	<b>RS-Interface, data format</b> .....	<b>27</b>
<b>4.2</b>	<b>Handshake lines</b> .....	<b>28</b>
4.2.1	CTS-line.....	28
4.2.2	CD-line.....	28
4.2.3	RTS-line .....	29
<b>4.3</b>	<b>Timing and delays during data transmission</b> .....	<b>29</b>
4.3.1	Data buffering in the radio data modem.....	29
4.3.2	Optional start delay in transmit mode.....	30
<b>4.4</b>	<b>Tests</b> .....	<b>30</b>
<b>5</b>	<b>REPEATER MODE AND ADDRESSESING</b> .....	<b>31</b>
<b>5.1</b>	<b>Repeater</b> .....	<b>31</b>
<b>5.2</b>	<b>Addressing</b> .....	<b>32</b>
5.2.1	Connection between two points.....	34
5.2.2	System of one base station and several substations .....	34
<b>5.3</b>	<b>Using repeaters and addresses in the same system</b> .....	<b>35</b>
5.3.1	System with several repeaters .....	35
5.3.2	Repeater chain using address pairs .....	36
5.3.3	Repeater chain using dual addressing .....	37
<b>6</b>	<b>MESSAGE ROUTING</b> .....	<b>38</b>
<b>6.1</b>	<b>Introduction</b> .....	<b>38</b>
6.1.1	Advantages of routing.....	38
6.1.2	SaTerm (brief description) .....	39
<b>6.2</b>	<b>Operating modes of message routing</b> .....	<b>39</b>
6.2.1	Source mode .....	40
6.2.2	Virtual mode .....	40
6.2.3	Protocol configuration .....	40
<b>6.3</b>	<b>Detailed description of routing operation</b> .....	<b>41</b>
6.3.1	Source mode .....	41
6.3.2	Virtual mode .....	42
6.3.3	Overhop function in Source mode.....	43
6.3.4	Network ID .....	44
<b>6.4</b>	<b>Example of expanding the network coverage by using message routing</b> .....	<b>45</b>

6.4.1	Designing the network using SaTerm .....	45
6.4.2	Adding a mobile station.....	47
6.4.3	Transferring the settings to radio data modems .....	47
<b>7</b>	<b>DIVERSITY RECEIVER (ONLY SATELLINE-3AS EPIC) .....</b>	<b>48</b>
<b>7.1</b>	<b>Multipath fading.....</b>	<b>48</b>
<b>7.2</b>	<b>Antenna installation.....</b>	<b>49</b>
<b>8</b>	<b>SETTINGS .....</b>	<b>50</b>
<b>8.1</b>	<b>Changing parameters using a terminal device .....</b>	<b>50</b>
8.1.1	Changing frequency (active radio channel frequency).....	50
8.1.2	Changing radio settings (transmitter output power and receiver sensitivity).....	52
8.1.3	Changing addressing settings (primary and secondary RX- and TX-addresses).....	53
8.1.4	Changing serial port settings (Port 1 and Port 2) .....	55
8.1.5	Modification of handshaking functions .....	58
8.1.6	Special functions .....	59
8.1.7	Modification of routing .....	60
8.1.8	Activating tests.....	64
8.1.10	Saving modified settings into the permanent memory .....	64
<b>8.2</b>	<b>Changing parameters using the LCD-display .....</b>	<b>65</b>
8.2.1	Changing frequency (frequency of the active radio channel) .....	66
8.2.2	Changing radio settings (transmitter output power and receiver sensitivity).....	68
8.2.3	Changing addressing .....	69
8.2.4	Changing serial port settings (Port 1 and Port 2) .....	70
8.2.5	Modification of handshaking functions .....	71
8.2.6	Selecting special functions .....	72
8.2.7	Activating tests.....	72
8.2.8	Restoring factory settings.....	73
8.2.9	Adjusting the contrast of the LCD-display.....	73
8.2.10	Saving modified values into the internal memory.....	74
<b>8.3</b>	<b>Changing parameters using the SL-COMMANDS .....</b>	<b>74</b>
8.3.1	Frequency.....	75
8.3.2	Addressing.....	75
8.3.3	Other functions .....	76
8.3.4	SATELLINE-2ASx/2ASxE –compatible SL-commands .....	76
<b>9</b>	<b>INSTALLATION .....</b>	<b>77</b>
<b>9.1</b>	<b>Installation of a Radio Data Modem.....</b>	<b>77</b>
<b>9.2</b>	<b>Connection cables.....</b>	<b>78</b>
9.2.1	RS-232 -wiring .....	78
9.2.2	RS-422 -wiring .....	80
9.2.3	RS-485 wiring .....	81

9.2.4	Power supply .....	81
<b>9.3</b>	<b>Antenna installation.....</b>	<b>82</b>
9.3.1	Hand-held equipment.....	82
9.3.2	Mobile equipment .....	82
9.3.3	Base stations .....	82
9.3.4	General antenna installation instructions.....	83
<b>10</b>	<b>DESIGNING SYSTEMS .....</b>	<b>86</b>
<b>10.1</b>	<b>Factors affecting the quality and distance of the radio connection.....</b>	<b>86</b>
<b>10.2</b>	<b>Radio field strength.....</b>	<b>87</b>
<b>10.3</b>	<b>Remarks concerning the 869 MHz frequency band .....</b>	<b>87</b>
<b>11</b>	<b>CHECK LIST .....</b>	<b>88</b>
<b>12</b>	<b>ACCESSORIES.....</b>	<b>89</b>
<b>12.1</b>	<b>RS-232-cables and adapters .....</b>	<b>89</b>
<b>12.2</b>	<b>RS-485/422-cables and adapters.....</b>	<b>89</b>
<b>12.3</b>	<b>RF-cables.....</b>	<b>89</b>
<b>12.4</b>	<b>Antennas .....</b>	<b>90</b>
<b>12.5</b>	<b>Filters .....</b>	<b>90</b>
<b>12.6</b>	<b>Power supplies .....</b>	<b>90</b>
<b>12.7</b>	<b>Batteries.....</b>	<b>90</b>
<b>13</b>	<b>APPENDIX A .....</b>	<b>91</b>
<b>14</b>	<b>APPENDIX B .....</b>	<b>92</b>
<b>14.1</b>	<b>Functional delays.....</b>	<b>92</b>
<b>14.2</b>	<b>Transmission related delays.....</b>	<b>92</b>
14.2.1	Transmission delays when using a 12,5 kHz radio channel.....	93
14.2.2	Transmission delays using a 25 kHz radio channel.....	95

## INTRODUCTION

SATEL OY is a Finnish electronics and Telecommunications Company specialised in the design and manufacture of wireless data communication products. SATEL designs, manufactures and sells radio modems intended for use in applications ranging from data transfer to alarm relaying systems. End users of SATEL products are the industry, public organisations and private persons.

SATEL is the leading European manufacturer of radio modems. SATEL radio modems have been certified in most European countries and also in many non-European countries.

The amount of data transferred using local area networks is increasing constantly. On the other hand also the average size of a local area network is growing. SATEL has addressed these market requirements by introducing the SATELLINE-3AS radio modem family, which is the first SATEL manufactured radio modem to reach the wireless data transfer speed of 19,2 kbps. The speed of the RS-interface is selectable between 300 ... 38 400 bps.

In addition to increased data transfer speed the SATELLINE-3AS offers the user also other new features. For the first time, built-in support is included for RS-422- and RS-485 -interfaces in addition to the RS-232 -interface.

SATELLINE-3AS radio modem is also available as a model called the SATELLINE-3ASd, which includes a built-in LCD-display. The display offers the user new features, e.g. field programmability without a terminal device using a special mode (SET-UP-mode). The display may also be used as an aid in testing the radio connection between radio modems.

SATELLINE-3AS facilitates the construction of large radio networks using the built-in routing function. Routing is fully transparent to the user and can be used with most system protocols.

SATELLINE-3AS also offers the possibility to use an error correction function, which utilises the FEC-method (Forward Error Correction). FEC can be used to minimise errors caused by noisy channels.

SATELLINE-3AS radio modem has three (3) basic modes of operation: Data Transfer Mode, Configuration Mode and Test Mode. The SATELLINE-3AS configuration settings are changed using a PC as a terminal device via the RS-Interface. In the model with the built-in LCD-display (SATELLINE-3ASd) the changing and programming of configuration settings can also be performed without a PC using the built-in LCD-display and four (4) pushbuttons. In addition to allowing easy configuration of settings, the LCD-display is useful for checking the integrity of the radio connection.



- SATELLINE-3AS radio modem largest data transfer speed is 19,2 kbps, channel spacing selectable as 25 kHz or 12,5 kHz (defined at the time of ordering).
- SATELLINE-3AS radio modem is compatible with RS-232, RS-422 and RS-485 –interface standards.
- SATELLINE-3ASd radio modem has a built-in LCD-display, which facilitates the changing of settings without the need for an external terminal device (typically a PC).
- SATELLINE-3AS radio modem software includes a special routing function, which simplifies the construction of large networks.
- SATELLINE-3AS/(d) radio modem software can be updated easily directly through the RS-Interface of a PC.
- SATELLINE-3AS radio modem software contains an optional error correction routine (FEC), which improves the reliability of the radio interface under interference conditions.

## 1 SATELLINE-3AS AND SATELLINE-3ASD RADIO DATA MODEMS

### 1.1 SATELLINE-3AS Technical specifications (380...470 MHz)

SATELLINE-3AS and SATELLINE-3ASd (380...470 MHz) comply with the following international standards: ETS 300 113 and EN 300 220-1 (radio requirements) and ETS 300 279 and ETS 300 683 (EMC-requirements).

#### RADIO TRANSCEIVER

Frequency Range	380...470 MHz
Channel Spacing	12,5 kHz/25 kHz
Number of Channels	160/80
Frequency Stability	$< \pm 1,5$ kHz
Type of Emission	F1D
Communication Mode	Half-Duplex

#### RADIO TRANSMITTER

Carrier Power	10 mW...1 W / 50 $\Omega$
Carrier Power Stability	+ 2 dB / - 3 dB
Adjacent Channel Power	according to EN 300 220-1/ETS 300 113
Spurious Radiation's	according to EN 300 220-1/ETS 300 113

#### RADIO RECEIVER

Sensitivity	- 116... -110 dBm (BER < 10 E-3) *
Common Channel Rejection	> - 12 dB
Adjacent Channel Selectivity	> 60 dB @ 12,5 kHz, > 70 dB @ 25 kHz
Intermodulation Attenuation	> 65 dB
Spurious Radiation's	< 2 nW

#### MODEM

Interface	RS-232 or RS-485, RS-422
Interface Connector	D15, female
Data speed of RS-Interface	300 – 38400 bps
Data speed of Radio Interface	19200 bps (25 kHz channel) 9600 bps (12,5 kHz channel)
Data format	Asynchronous RS-232 or RS-422 or RS-485

#### GENERAL

Operating Voltage	+ 9 ... + 30 V <sub>DC</sub>
Power Consumption (average)	1.7 VA (Receive) 5.5 VA (Transmit) 0.05 VA (in STAND-BY -mode)
Operating Temperature Range	-25 °C...+55 °C
Antenna Connector	TNC, 50 $\Omega$ , female
Housing	Aluminium enclosure
Size H x W x D	137 x 67 x 29 mm
Installation Plate	130 x 63 x 1 mm
Weight	250 g

\* Depending on Receiver settings, see Chapters 2.2.2, 8.1.2 and 8.2.2.

## **1.2 SATELLINE-3AS Technical specifications (869 MHz)**

SATELLINE-3AS and SATELLINE-3ASd (869 MHz) comply with the following international standards: EN 300 220-1 (radio requirements) and ETS 300 683 (EMC-requirements).

### **RADIO TRANSCEIVER**

Frequency Range	869,400 ... 869,650 MHz
Channel Spacing	25 kHz
Number of Channels	10
Frequency Stability	< ± 2,5 kHz
Type of Emission	F1D
Communication Mode	Half-Duplex

### **RADIO TRANSMITTER**

Carrier Power	10 mW...500 mW / 50 Ω
Carrier Power Stability	+ 2 dB / - 3 dB
Adjacent Channel Power	according to EN 300 220-1
Spurious Radiation's	according to EN 300 220-1

### **RADIO RECEIVER**

Sensitivity	-113... -110 dBm (BER < 10 E-3) *
Common Channel Rejection	> - 12 dB
Adjacent Channel Selectivity	> 60 dB
Intermodulation Attenuation	> 60 dB
Spurious Radiation's	< 2 nW

### **MODEM**

Interface	RS-232 or RS-485, RS-422
Interface Connector	D15, female
Data speed of RS-Interface	300 – 38400 bps
Data speed of Radio Interface	19200 bps (25 kHz channel) 9600 bps (12,5 kHz channel)
Data format	Asynchronous RS-232 or RS-422 or RS-485

### **GENERAL**

Operating Voltage	+ 9 ... + 30 V <sub>DC</sub>
Power Consumption (average)	1.7 VA (Receive) 4.0 VA (Transmit) 0.05 VA (in STAND-BY –mode)
Operating Temperature Range	-25 °C...+55 °C
Antenna Connector	TNC, 50 Ω, female
Housing	Aluminium enclosure
Size H x W x D	137 x 67 x 29 mm
Installation Plate	130 x 63 x 1 mm
Weight	250 g

\* Depending on Receiver settings, see Chapters 2.2.2, 8.1.2 and 8.2.2.

### **1.3 SATELLINE-3ASd EPIC Technical specifications (400...470 MHz)**

SATELLINE-3ASd EPIC (400...470 MHz) complies with the following international standards: ETS 300 113 (radio requirements) and ETS 300 279 (EMC-requirements).

#### **RADIO TRANSCEIVER**

Frequency Range	400...470 MHz
Channel Spacing	12,5 kHz/25 kHz
Number of Channels	160/80
Frequency Stability	< ± 1,5 kHz
Type of Emission	F1D
Communication Mode	Half-Duplex

#### **RADIO TRANSMITTER**

Carrier Power	1W...10 W / 50 Ω
Carrier Power Stability	+ 2 dB / - 3 dB
Adjacent Channel Power	according to ETS 300 113
Spurious Radiation's	according to ETS 300 113

#### **RADIO RECEIVER**

Sensitivity	- 116... -110 dBm (BER < 10 E-3) *
Common Channel Rejection	> - 12 dB
Adjacent Channel Selectivity	> 60 dB @ 12,5 kHz, > 70 dB @ 25 kHz
Intermodulation Attenuation	> 65 dB
Spurious Radiation's	< 2 nW
Diversity	Positional diversity

#### **MODEM**

Interface	RS-232 or RS-485, RS-422
Interface Connector	D15, female
Data speed of RS-Interface	300 – 38400 bps
Data speed of Radio Interface	19200 bps (25 kHz channel) 9600 bps (12,5 kHz channel)
Data format	Asynchronous RS-232 or RS-422 or RS-485

#### **GENERAL**

Operating Voltage	+ 10...+30 V <sub>DC</sub>
Power Consumption (average)	3 VA (Receive) 25 VA (Transmit) 0.1 VA (in STAND-BY –mode)
Operating Temperature Range	-25 °C...+55 °C
Antenna Connector	TNC, 50 Ω, female
Housing	Aluminium enclosure
Size H x W x D	151 x 123 x 29 mm
Weight	550 g (without additional cooling parts)

\* Depending on Receiver settings, see Chapters 2.2.2, 8.1.2 and 8.2.2.

## **1.4 Basic configuration and installation**

### 1.4.1 Basic configuration

The radio modem is shipped with the following default settings (unless specifically ordered with settings other than those listed below):

FIXED SETTINGS DEFINED AT THE TIME OF ORDER	
Radio Frequency Range	According to Customer Order, between 380–470 MHz or 869.5 MHz (1)
Channel Spacing	12,5 kHz or 25 kHz (2)
RS-Interface Type	RS-232 or RS-422 and RS-485

ADJUSTABLE SETTINGS	
Radio Settings	500 mW (3) / -110 dBm (25 kHz) or -112 dBm (12,5 kHz)
Addressing	RX Address OFF / TX Address OFF
Serial Port 1	ON / 19200 / 8 bit data / None / 1 stop bit (4)
Serial Port 2	OFF / 19200 / 8 bit data / None / 1 stop bit (4)
Handshaking	CTS Clear to send / CD RSSI-threshold / RTS Ignored
Additional settings	Error Correction OFF / Error check OFF / Repeater OFF / SL-Commands OFF
Routing	OFF
Tests	OFF
Message Routing	OFF

- (1) Taking into account the regulations set by local authorities.
- (2) 869.5 MHz only available as 25 kHz version
- (3) SATELLINE-3AS EPIC 10W
- (4) At 12,5 kHz channel spacing the default data speed is 9600 bps.

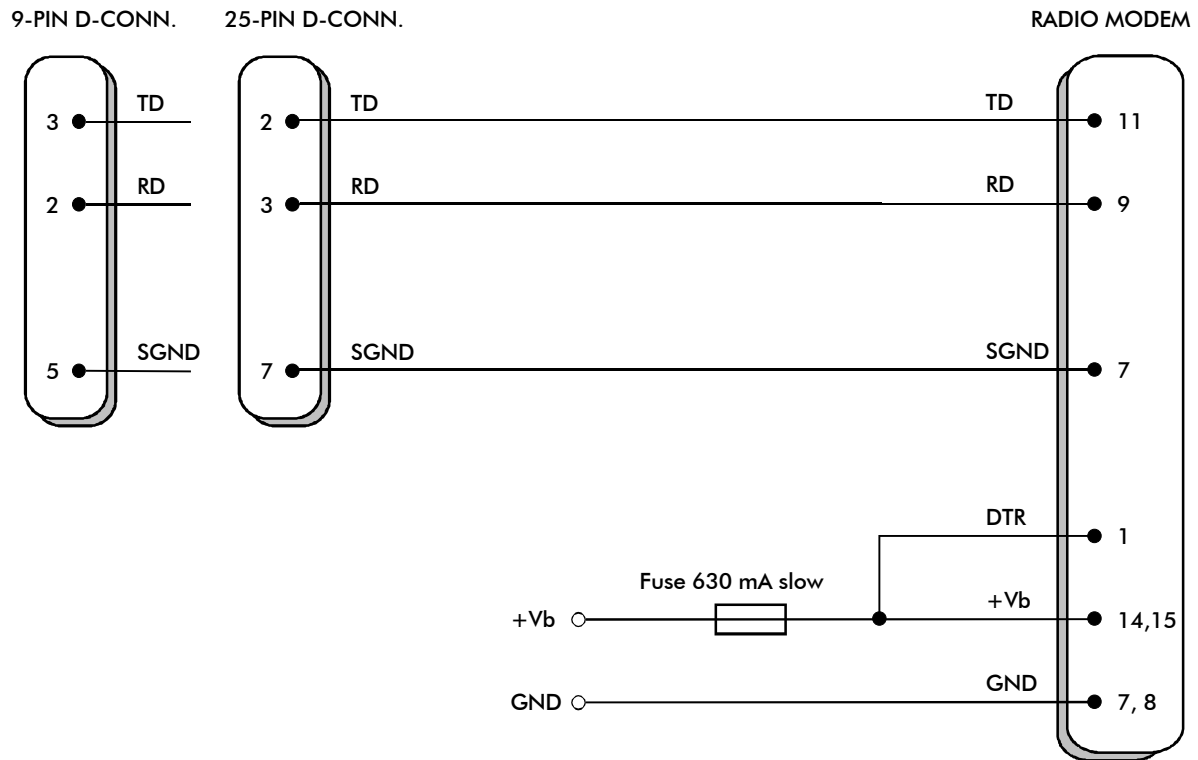
Connect the power cables (+V<sub>b</sub> and GND) to a power supply with an output voltage of 9 – 30 V<sub>DC</sub> and with a minimum output current of 1 A (in case of SATELLINE-3AS EPIC the minimum output current or the power supply is 5A). Connect also the DTR-pin of the RS-connector to a positive voltage. Detailed installation instructions can be found in Chapter 9.

If the DTR-pin is not connected, the radio modem will remain in STAND-BY mode and will therefore not send or receive any data.

When creating a test connection, you can use the SaTerm terminal program, available for free from authorised SATEL dealers or directly from SATEL Customer Support. You can also use the HyperTerminal-program, which is included in most the Windows™ based operating system packages, or almost any other terminal program. Basic settings for the serial port of the host computer when using a terminal program to communicate with SATEL radio modems are as follows: "COM1, 19200 bps, 8-bit data, none parity, 1 stop bit". If the serial port designated as COM1 in the host computer is reserved, any other free serial port in the host computer can be used (with the settings listed).

If you want to change the settings of a radio modem using the SET-UPmode of the radio modem with the help of an external terminal, the terminal data speed must be 9600 bps.

Basic connection between a radio modem and the serial port COM1 (RS-232) of a PC is depicted in the schematic below.



When using the SATELLINE-3AS EPIC model, the operating voltage must be connected to pins 14 AND 15, and the power supply ground to pins 7 AND 8, due to larger current consumption. Fuse size is 4A (slow).

## 2 CONNECTIONS

### **2.1 D15-connector functions**

The radio modem is referred to as DCE (Data Communication Equipment) whereas the PC is referred to as DTE (Data Terminal Equipment). SATELLINE-3AS radio modem includes a 15-pin 'D'-type female connector, which contains all the connections required to establish communication between the radio modem, acting as the DCE, and the PC, acting as the DTE.

All EMC-requirements set forth by authorities have been taken into account in the design of the radio modem. The user of the radio modem is thereby not required to take any special actions regarding EMC-shielding (of the radio modem).

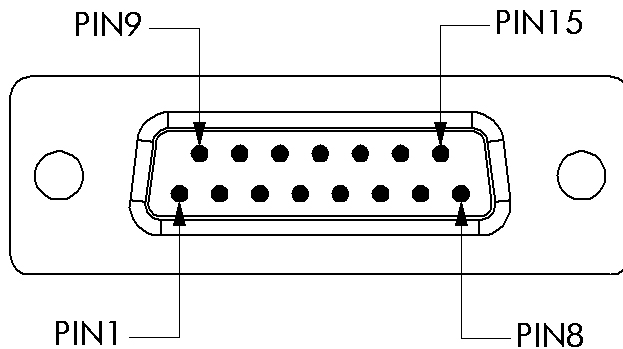
The radio modem contains two separate RS-ports, which are designated **Port 1** and **Port 2**. Only one port at a time can be used for communication.

**Port 1** complies always with the RS-232 –standard. **Port 2** can comply either with the RS-232 or RS-422 and RS-485 –standards. RS-422 and RS-485 differ only in the external connections. **Port 2** interface type (RS-232 or RS-485/422) is fixed at the factory at the time of manufacture according to the customer order. It is not possible to change the interface type of port 2 afterwards.

#### **NOTE!**

WHEN THE MODE-PIN (PIN 12 OF THE D-CONNECTOR) IS CONNECTED TO GROUND (CONFIGURATION MODE), THE RADIO MODEM IS IN THE SET-UP MODE AND **Port 1** (PINS 7,9,11) IS THEN IN USE! If you normally use **Port 2** for data transmission, the serial cable must be changed to a suitable type when switching over to the configuration mode.

### 2.1.1 Pin configuration



D-15 female connector in the radio modem

Direction IN is data from DTE (Data Terminal Equipment) to the radio modem.

Direction OUT is data from the radio modem to the DTE.

PORT AND TYPE	PIN	DIRECTION	NAME	EXPLANATION
PORT1, both models	6	OUT	CTS	*
	9	OUT	RD1	Receive data (Port1)
	11	IN	TD1	Transmit data (Port1)
	13	IN	RTS	*
PORT2 RS-232 –model	2	OUT	CD	*
	3	OUT	RD2	Receive data (Port2)
	4	IN	TD2	Transmit data (Port2)
	5	OUT	RSSI	*
PORT2 RS-422/485 – model	2	OUT	A'	Receive data positive
	3	OUT	B'	Receive data negative
	4	IN	A	Transmit data positive
	5	IN	B	Transmit data negative
COMMON PINS	1	IN	DTR	ON ( $V_b$ ) / STAND-BY (NC)
	10	OUT	DSR	
	12	IN	MODE	DATA (NC) / SETUP (GND)
	7, 8	-	GND	Power Ground
	14, 15	-	$V_b$	Operating Voltage

\*) Optional connections do not need to be connected in normal use.

\*) Handshake signal connections remain the same irrespective of the port used (Port 1 or Port 2).

NC = Not Connected.



### Description of pins:

*RD* = Receive Data. Output of the data received. Data from the radio modem to the DTE.

*TD* = Transmit Data. Input of the data to be transmitted. Data from the DTE to the radio modem.

*CTS* = Clear To Send. See Chapter 4.2.1.

*CD* = Carrier Detect. See Chapter 4.2.2.

*RTS* = Request To Send. See Chapter 4.2.3

*DTR* = Data Terminal Ready. Terminal in operation. When the DTR-line is connected to a positive voltage (e.g. to the operating voltage,  $V_b$ ), the radio modem is ON, if not, the radio modem is in the STAND-BY mode.

*DSR* = Data Set Ready. Indicates that the radio modem is switched ON.

*RSSI* = Received Signal Strength Indicator. Indicates the strength of the received signal. Can be used to approximately determine the received signal strength. See Chapter 2.2.3.

*MODE* = operating mode. When the MODE-line is connected to ground (GND), the radio modem enters the SET-UP mode (configuration mode). On the other hand, if the MODE-line is not connected, the radio modem will enter the DATA TRANSFER MODE, in which data can be transmitted and received. The configuration mode is used only when installing a radio modem when changing the operating parameters of a network. Normally the radio modem is always in the DATA TRANSFER MODE. See Chapter 3.2, 3.3 and 3.4.

*GND* = both the negative pole of the operating voltage and the signal ground.

$V_b$  = positive pole of the operating voltage.

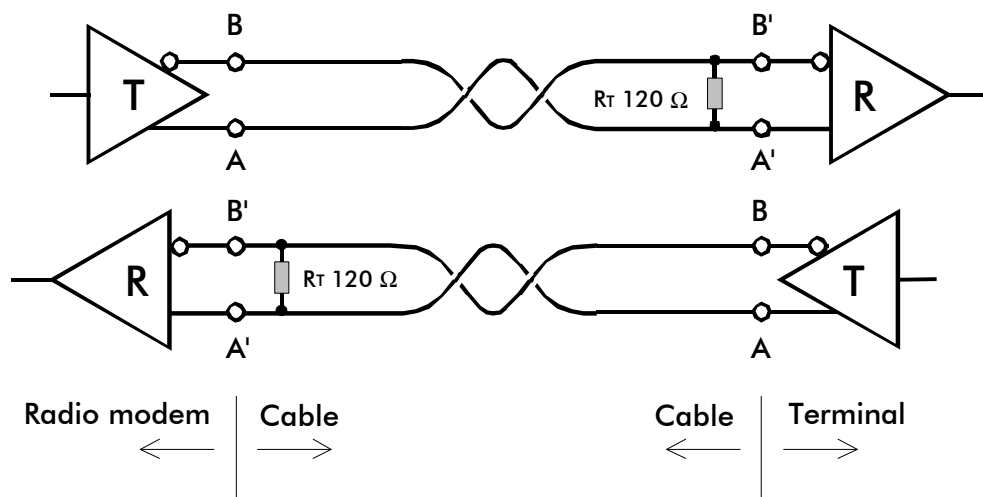
### 2.1.2 RS-232 -Interface

RS-232 –standard defines the method of serial data transfer between a computer and its peripherals. The method definition includes both the interface type and signal levels. Most computers and peripherals contain one or more RS-232 type serial ports. The RS-232 standard uses transmission lines, in which each single signal line level is referenced, to a common ground level. RS-232 has been designed to be used in serial transfer of data in cases where the distance between communicating equipment is less than 15 m. The otherwise useful RS-232 standard is unfortunately applied in a multitude of slightly differing ways (e.g. different pin configurations) and for this reason different computers and peripherals are not necessarily directly compatible with each other (see also Chapter 9.2.1 for more information on RS-232 –wiring).

### 2.1.3 RS-422 -Interface

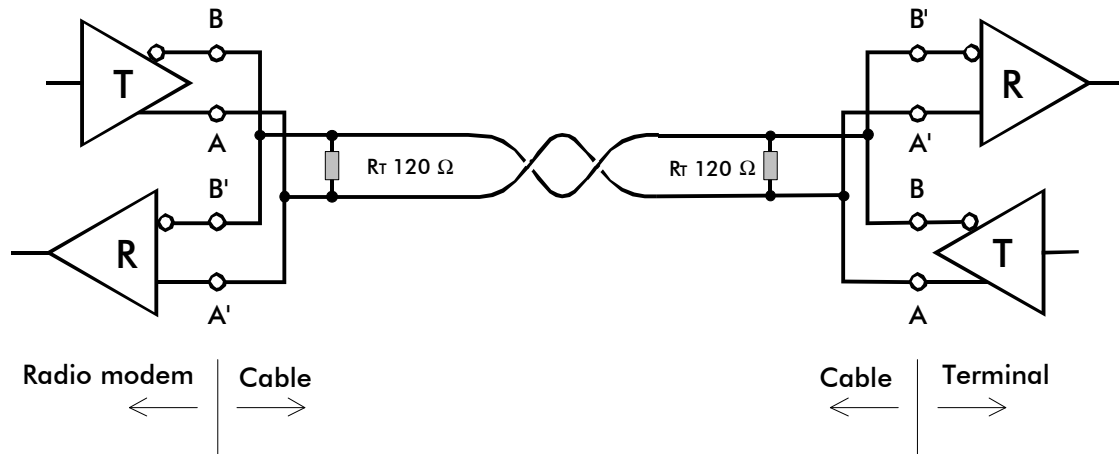
RS-422 –standard defines a serial data transfer method, which is very similar to the RS-232 standard. In RS-422 however, the signal lines are balanced (or differential) transmission lines. A balanced (or differential) transmission line is formed by using two signal wires together to convey each single signal. Because the state of the signal is defined by the mutual voltage difference (hence the name differential), any common mode disturbances induced into the lines will cancel out. The effect of different signals moving in the same cable will also be smaller than in the case of the RS-232. Transmission distance can be considerably longer than when using RS-232 type of connection, and distances of 1 km are possible. (See also Chapter 9.2.2 for more information on RS-422 –wiring).

As an example, let's examine the TX-signal: TX-signal will be transmitted using two lines (A and B). A logical "1" corresponds to a situation, where the voltage on line A is greater than the voltage on line B. Correspondingly a logical "0" corresponds to a situation, where the voltage on line A is smaller than the voltage on line B.



### 2.1.4 RS-485 -Interface

RS-485 is an extension of the RS-422 standard and enables the connection of more than two devices on to the same bus. Communication that is half-duplex, in which case the number of cable pairs is only one compared to two when using the RS-422. The RS-485 standard defines the electrical characteristics of the connections in such a way as to prevent possible data contention states as well as cable shorts etc. from harming the devices themselves. (See also Chapter 9.2.3 for more information on RS-485 -wiring).



### 2.1.5 Termination

Each differential pair of wires is a transmission line. A transmission line must be terminated properly to prevent or at least minimise harmful reflections formed between the transmitting and receiving end of the transmission line. A common method of terminating an RS-485 type of transmission line is to connect a so-called termination resistor between the wires and at both ends of the transmission line. Even when there are more than two devices on the same transmission line, the termination resistors are needed only at the ends of the transmission line. The termination resistor must be selected so that its resistance matches the characteristic impedance of the transmission line as close as possible (typical values range from 100 to 120 Ω). When using an RS-422 type of connection the termination resistor is connected only at each of the receiving ends.

Termination resistors are especially important when using long transmission lines and/or high data transfer speeds.

## 2.2 RF Interface

The antenna connector is of the TNC-type with impedance of 50 Ω. There are two antenna connectors on Satelline-3AS Epic model. Transmitter and the other receiver is connected to the left side connector, while the other receiver to the right.

When ordering the radio modem, a center frequency, to which the radio modem will be tuned to at the factory, must be defined. The user can afterwards change the frequency of the radio

modem by  $\pm 1$  MHz from the center frequency (basic tuning range, taking into consideration all local regulations set forth by the authorities).

The data speed of the radio interface depends on the chosen radio channel spacing. A channel spacing of 25 kHz enables a data speed of 19200 bps and a channel spacing of 12,5 kHz enables correspondingly a data speed of 9600 bps. The data speed of the radio interface is always fixed (19200 bps or 9600 bps) irrespective of the data speed of the RS-Interface. If the data speeds of the radio interface and the RS-Interface differ from each other, the radio modem will buffer the data in transfer temporarily, so no data loss will occur. The radio channel spacing is set at the factory and cannot be changed afterwards.

### 2.2.1 Transmitter

The output power of the transmitter is adjustable. The greatest allowable power depends on limits set by local authorities, which must not be exceeded. The output power of the transmitter should be set to the smallest possible level which still ensures error free connections under variable conditions. Large output power levels using short connection distances can in the worst case cause disturbances to the overall operation of the system.

OUTPUT POWER	dBm	3AS	3AS 869 MHz	3AS EPIC
10 mW	+10	•	•	
20 mW	+13	•	•	
50 mW	+17	•	•	
100 mW	+20	•	•	
200 mW	+23	•	•	
500 mW	+27	•	•	
1 W	+30	•		•
2 W	+33			•
5 W	+37			•
10 W	+40			•

Possible output power settings of the SATELLINE-3AS –line of radio modems.

#### NOTE!

Setting the radio data modem output power level to levels exceeding regulations set forth by local authorities is strictly forbidden. The setting and/or using of non-approved power levels may lead to prosecution. SATEL is not responsible for any illegal use of its radio equipment, and is not responsible in any way of any claims or penalties arising from the operation of its radio equipment in ways contradictory to local regulations and/or requirements and/or laws.

#### NOTE!

SATELLINE-3AS EPIC radio modem is shipped with two different cooling elements. If the transmitter of the radio modem is to be ON full power over 20 % of the operating time, additional cooling is required.

### 2.2.2 Receiver

The sensitivity of the receiver depends on the channel spacing of the radio modem (=data speed of the radio interface) and on error correction mode according to the table below:

	FEC OFF	FEC ON
25 kHz	-110 dBm	-113 dBm
12,5 kHz	-112 dBm	-115 dBm

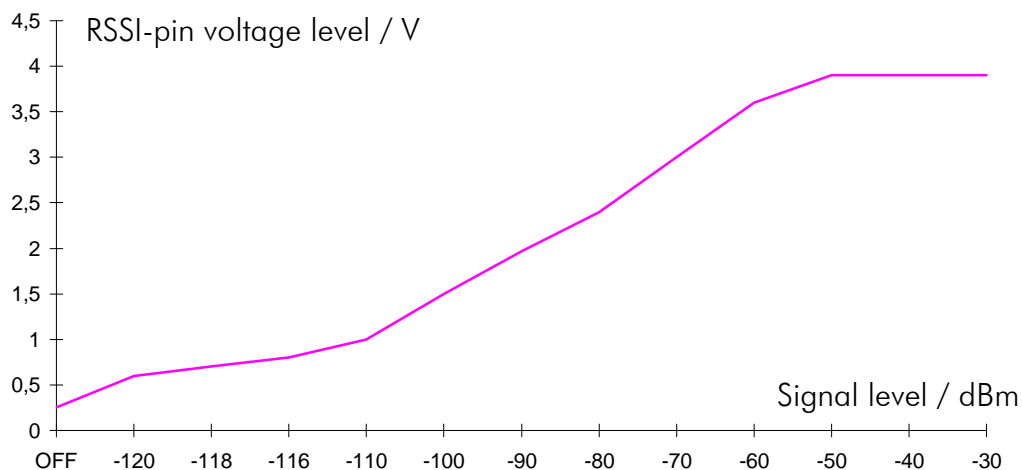
Effect of settings on the receiver sensitivity

The Signal Threshold Level setting of the receiver determines a level, above which the search for the actual data transfer signal is active. It is usually recommendable to use a value given in the table. If the Signal Threshold Level setting is set too low (the CD-LED is ON constantly), it is possible that the receiver is trying to synchronise itself with noise, in which case the actual data transmission might remain unnoticed. In the opposite case weak data transmissions will be rejected, although they would be otherwise acceptable.

SATELLINE-3AS EPIC –radio modem contains two separate receivers, and a selection is made between the signals received by these two receivers so that the stronger/better signal is used. By this way the signal fading caused by multipath propagation will be smaller than in the case of using just one antenna and receiver. The recommended distance between receiving antennas is  $\frac{3}{4}$  wavelength, which at a frequency of 450 MHz corresponds to a distance of 50 cm.

### 2.2.3 RSSI-signal

RSSI-signal (Received Signal Strength Indicator) (pin 5 of the D-type connector) gives an indication of the strength of the received radio signal. This signal can be used to determine the approximate signal level. The curve on the following page describes a typical relationship between the received signal strength and the voltage at pin 5.



#### 2.2.4 Error correction

SATELLINE-3AS includes the possibility to utilise an error correction method called the FEC-method (Forward Error Correction). FEC-function is switched ON (or OFF) by using the configuration mode (SET-UP-mode). When activated, the FEC-function will cause the SATELLINE-3AS to automatically add additional error correction information, which increases the transmitted data by 30 %. It is used by the receiving radio modem to correct erroneous bits as long as the ratio of correct and erroneous bits is reasonable.

Error correction improves the reliability of data transfer via the radio interface especially in unfavourable conditions. FEC-function should be used when link distances are long and/or if there are many disturbances in the radio channels used. The use of the FEC-function will however decrease the data transfer throughput of the actual information data correspondingly by about 30 %. For a listing of exact delays (throughput decrease) introduced by using FEC-function, see Chapters 14.1 and 14.2.

Switching the FEC-function ON in configuration mode (SET-UP-mode):

1) Error correction      ON

#### **NOTE!**

All radio modems which are to communicate with each other must have the same setting for FEC (ON or OFF). If the transmitting radio modem and the receiving radio modem have different settings, data will not be received correctly.

#### 2.2.5 Error checking

When the error checking is switched on, the radio modem will add a checksum to the transmitted data. In the receiving radio modem, the checksums are first checked before the actual data is allowed to be forwarded to the serial port. Erroneous data will be rejected.

Switching the Error checking ON in configuration mode (SET-UP-mode):

2) Error check              ON

### 3 USER INTERFACE

#### **3.1 LED-indicators**

There are five (5) LED-indicators on the front panel of the radio modem, and they give an indication of the status of the RS-port and the radio interface:

LED	Indication	OFF	Red	Orange	Green
RTS	RTS-line status	Inactive	Active		
CTS	CTS-line status	Inactive	Active		
TD	TD-line status	No data	Data		
RD	RD-line status	No data	Data		
CD	Radio status	No signal	Transmission	Noise	Reception

Description of the LED-indicators:

*RTS* indicates the status of D-connector pin 13.

*CTS* indicates the status of D-connector pin 6.

*TD* indicates that the radio modem is receiving data via RS-port.

*RD* indicates that the radio modem is sending data via RS-port.

*CD* indicates the status of the radio interface. The status of the CD-signal on the RS-interface may differ from the status of the LED-indicator.

#### **3.2 Configuration mode**

SATELLINE-3AS radio modem settings are fully configurable in configuration mode (SET-UP-mode) by using a suitable terminal program. The most recommendable set-up is ARS-1F connection cable adapter, CRS-9 cable, power supply and the SaTerm-terminal program. ARS-1F contains a switch to enable easy shifting into the configuration mode. Other suitable terminal programs and cables may also be used.

The radio modem will shift into the configuration mode (SET-UP-mode) by connecting the D-connector pin 12 to ground (GND). When using the ARS-1F this can be accomplished by moving the slide switch downwards. When using the configuration mode, the radio modem will use serial port **PORT1**, with settings 9600 bps, N, 8,1 (data transfer speed 9600 bps, no parity, length of 8 bits and 1 stopbit). For more detailed instructions for changing each setting, see Chapter 8.1 and 8.2.

### 3.2.1 Changing the settings

- Connect cables (RS-232 –cable to PC COM-port, power supply cable to power supply).
- Switch on the PC and start SaTerm program.
- Open a terminal window and select with the right mouse button a menu and choose "Prog Settings".
- Connect PROG-pin to ground (if using the ARS-1F, slide the switch downwards), and the LCD-display should look similar to the one shown in the picture below.
- Make desired changes.
- Save changes by pressing "E" in the main menu. If you don't want to save changes, press "Q".
- Disconnect PROG-pin from ground (if using the ARS-1F, slide the switch upwards), the radio modem should now return to the data transfer mode.

```
***** SATEL 3AS *****
SW Version x.yz
-----
Current settings
-----
1) Radio frequency  468.2000 MHz [ CF 468.2000 MHz, spacing 25 kHz ]
2) Radio settings   Tx power level 500 mW / Signal threshold level -110 dBm
                   TX start delay 0 ms
3) Addressing       RX address OFF / TX address OFF
4) Serial port 1    ON / 19200 bit/s / 8 bit data / None parity / 1 stop bit
5) Serial port 2    OFF / 19200 bit/s / 8 bit data / None parity / 1 stop bit (RS-485)
6) Handshaking      CTS Traditional / CD RSSI-threshold / RTS Ignored
7) Additional set-up Error Correction OFF / Repeater OFF / SL-commands OFF /
                   Diversity mode OFF / CRC check OFF
8) Routing          Source routing
9) Tests            OFF
A) Restore factory settings
E) EXIT and save settings
Q) QUIT without saving

Enter selection >
```



### 3.2.2 Restoring factory settings

Selecting menu selection "A" may restore factory settings.

```
Enter selection >A
Restore factory settings
-----
Do you want to restore factory settings? (Y/N)>
```

Factory settings are restored by selecting "Y" (YES). By pressing any other button current settings will remain active. The modem will ask this question two times to make sure that the user really wants to restore factory settings.

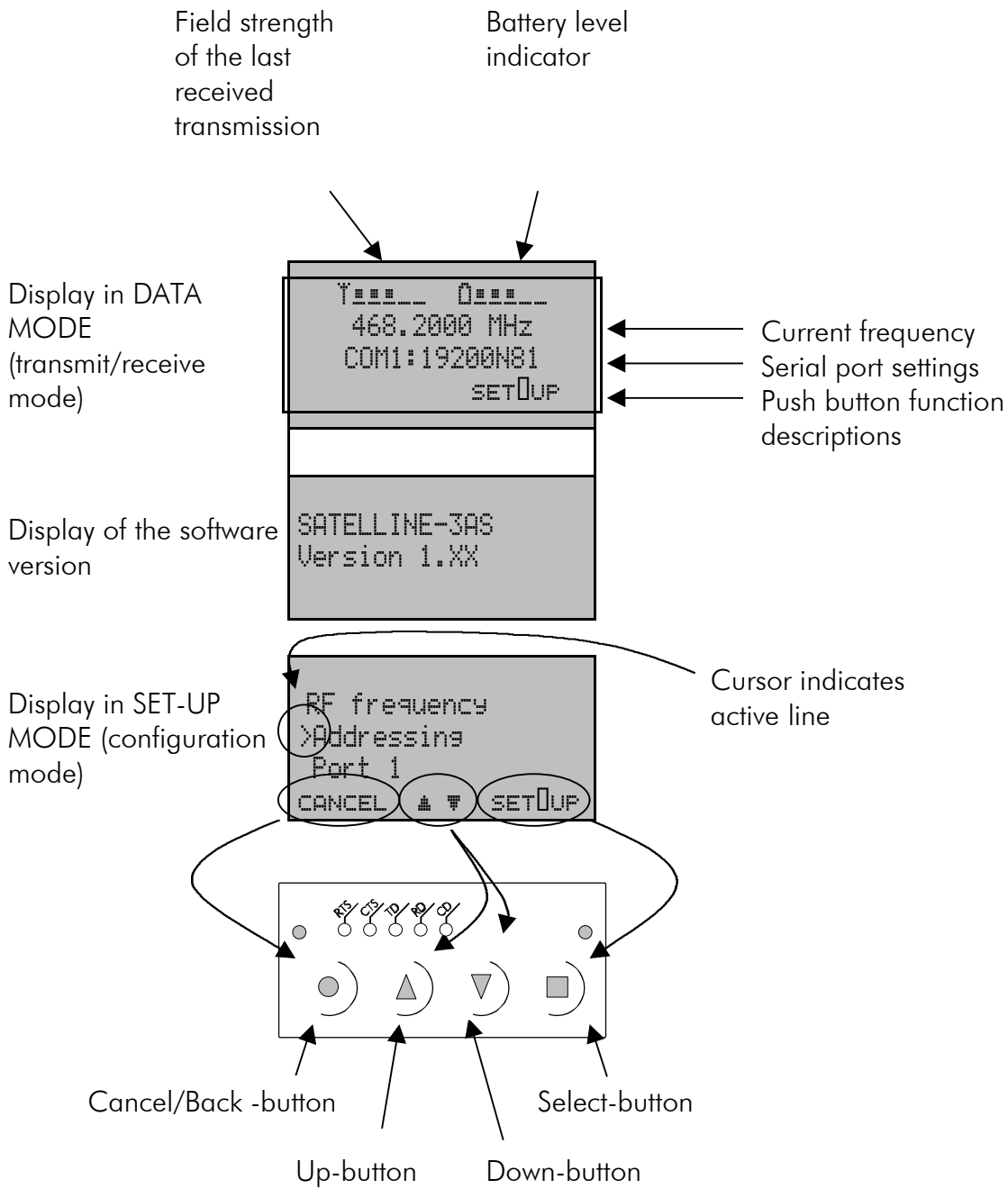
### **3.3 Display and push buttons (SATELLINE-3ASd)**

SATELLINE-3ASd radio modem includes a LCD-display (Liquid Crystal Display) with a backlight. In the data transfer mode the display will show the operating settings of the radio modem, actual radio field strength and the charge remaining in the SatelSet-battery. Using the push buttons and the LCD-display, it is possible to change most of the settings of the radio modem without the need for an external terminal. The backlight of the display activates itself automatically when pressing any of the push buttons.

The radio modem will shift into the configuration mode (SET-UP-mode) by pressing the SET-UP-push button (■). The LCD-display will then show shortly the model of the radio modem and the version number of the installed software, after which the main menu appears. The main menu is a listing of the changeable parameters.

With the help of the main menu sub-menus can be selected which in turn can be used to change the actual settings. You can always return to the previous higher level of the menu structure by pressing the CANCEL (or BACK) push button. Pressing the  $\uparrow$  or  $\downarrow$  button changes settings. Selections are confirmed by pressing the SELECT or SET button. In case of numerical values the digit to be changed is selected by pressing the NEXT button (see following page).

SATELLINE-3ASd AND EPIC LCD-DISPLAY AFTER POWER-UP



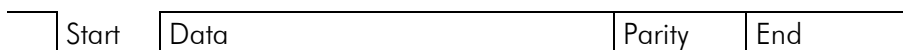
## 4 TRANSPARENT DATA TRANSMISSION

### 4.1 RS-Interface, data format

The SATELLINE-3AS radio modem serial interfaces use asynchronous data format. No external synchronising signal is needed, since necessary timing information is acquired from the start and stop bits transmitted before and after each data field bits (byte).

The data transfer speed of the serial interfaces can be set to 300, 600, 1200, 2400, 4800, 9600, 19200 or 38400 bps (bits per second). The length of the data field must be 7, 8 or 9 bits. When using a data field length of 7 or 8 bits, a parity bit may also be used.

One character to be transmitted will thus contain a start bit; the data bits (which define the actual character in question); an optional parity bit and one or two stop bits. The overall length of one character is therefore 10, 11 or 12 bits. This should be taken into account when calculating the data throughput capability of a system. In other words, also the number of start, stop and parity bits must be considered. A useful rule of thumb is that at a data transfer speed of 9600 bps, the transmission of one character will require roughly one millisecond (1 ms).



Asynchronous character data format

**Example:** With an 8-bit data character length and taking for example a decimal value of "204", which corresponds to a binary value of "11001100" and with a start bit value of "0", parity bit set to either "NO" (NONE), "0" or "1" and with a stop bit value of "1", the possible combinations are listed in the table below:

DATA FORMAT	CHARACTER	CHARACTER LENGTH
8 bit, no parity, 1 stop bit	0110011001	10 bit
8 bit, even parity, 1 stop bit	01100110001	11 bit
8 bit, odd parity, 1 stop bit	01100110011	11 bit
8 bit, no parity, 2 stop bits	01100110011	11 bit
8 bit, even parity, 2 stop bits	011001100011	12 bit
8 bit, odd parity, 2 stop bits	011001100111	12 bit

If the settings of data speed, character length, parity or the number of stop bits differ between the radio modem and the terminal, errors will be introduced into the transferred data. The serial port settings of each individual radio modem in a system can be different except for the data length setting (7, 8 or 9 bits), which must always be the same in each individual radio data modem. (7,8 or 9). In other words, the serial port used the data transfer speed, parity and number of stop bits can be different in different parts of a same system. This is especially useful in cases where one part of the system uses an RS-485 type of serial port and another part uses the RS-232 type of serial port. In other words, radio modems may also be utilised as serial port adapters in addition to the more common role of wireless data transfer.

Using the configuration mode (SET-UP-mode) can change serial port settings.

## **4.2 Handshake lines**

When using the RS-232 serial interface, handshake signals can be used to control data transfer. Handshake signals are used for example by the radio modem to inform the terminal that the radio channel is busy and that it cannot initiate transmission. Also the terminal can control the radio modem via RTS-line.

Line	Direction
CTS	To terminal
RTS	To modem
CD	To terminal

A common way of using handshake signals is to monitor the CTS-line and ignore the others. Usually the terminal is fast enough to handle the data received by the radio modem, so the use of RTS-line is not necessary.

Handshaking is not needed if the system protocol is designed to prevent collisions (data contention) by the use of polling or if there is little traffic and if there is no harm from occasional data contention situations (several radio modems try to transmit at the same time).

### 4.2.1 CTS-line

#### 1) Clear To Send

Operation is similar to SATELLINE 2ASxE. CTS is active when the radio modem is ready to accept data for transmission. CTS will shift into inactive state during data reception and when a pause (packet end) is detected in transmitted data. CTS shifts back into active state when reception ends or the radio modem has finished transmission. CTS shifts into inactive state also in cases when the serial interface data transfer speed is greater than the radio interface transfer speed and when the transmit buffer is in danger of overflowing.

#### 2) TX buffer state

CTS will shift into inactive state only if the radio modem transmit buffer is in danger of overflowing.

### 4.2.2 CD-line

#### 1) RSSI-threshold

Operation is similar to SATELLINE 2ASxE. CD is active whenever a signal with a level exceeding the level required for reception exists on the radio channel. It doesn't make any difference if the signal is an actual data transmission, a signal of a radio transmitter not belonging to the system or an interference signal caused for example by a computer or a peripheral device. CD is also active when the radio modem in question is transmitting.

## 2) Data on channel

CD will switch to active state only after recognition of a valid data transmission. CD will not react to interference signals.

## 3) Always ON

CD is always in the active state. This option can be used with terminal equipment, which use the CD-line as an indicator of an active connection (the radio modem can transmit and receive at any time).

### 4.2.3 RTS-line

#### 1) Ignored

RTS-line status is ignored.

#### 2) Flow control

The radio modem transmits data to the terminal device only when the RTS-line is active. Non-active state of the RTS-line will force the radio modem to buffer the received data. This option is used if the terminal device is too slow to handle data received from the radio modem.

#### 3) Reception control

RTS-line controls the reception process of the radio modem. Active state of RTS-line enables reception (as normal). Non-active state of the RTS-line will interrupt reception process immediately, even if the radio modem is receiving a data packet. This option is used to force the radio modem into WAIT State for an immediate channel change.

## **4.3 Timing and delays during data transmission**

When using a radio modem for data transmission, certain delays will be formed due to the use of a radio interface and from the radio modem circuitry itself. These delays exist when the radio modem switches from STAND-BY to DATA mode and during reception and transmission of data. For detailed delay values in each case see tables in Chapter 14.2.1 and 14.2.2.

### 4.3.1 Data buffering in the radio data modem

Whenever the radio modem is in Data Transfer mode it monitors both the radio channel and the RS-Interface. When the terminal device starts data transmission the radio modem switches to transmission mode. At the beginning of each transmission a synchronisation signal is transmitted and this signal is detected by the radio modem, which then switches into receive mode. During the transmission of the synchronisation signal the radio modem buffers data into its memory.

Transmission ends when a pause is detected in the data sent by the terminal device, and after all buffered data has been transmitted. When the serial interface speed is the same or slower than the speed of the radio interface, the internal transmit buffer memory cannot overflow. On the other hand, when the serial interface speed exceeds the speed of the radio interface, data will eventually fill the transmit buffer memory. In this case it will take a moment after the terminal device has stopped transmission of data for the radio modem to empty the buffer and before the transmitter switches off. The maximum size of the transmit buffer memory is one kilobyte (1 kB). If the terminal device does not follow the status of the CTS-line and transmits too much data to the radio modem, the buffer will be emptied and the transmission is restarted.

In the receive mode the buffer works principally in the above described way thus evening out differences in data transfer speeds. If the terminal device transmits data to a radio modem in receive mode, the data will go into the transmit buffer memory. Transmission will start immediately when the radio channel is available.

#### 4.3.2 Optional start delay in transmit mode

The radio modem can be configured to delay the beginning of a radio transmission by 1...65000 ms. This function can be used to prevent packet contention in a system, where all substations would otherwise answer a poll of a base-station simultaneously. During this delay data sent to the radio modem is buffered. If this function is not needed, the delay time should be set to 0 ms.

### **4.4 Tests**

The radio modem can be switched to a test mode, in which it will send a test packet on the radio channel every second. The test packet is a normal data transmission, which can be used for example when directing antennas during system installation.

When test packet transmission has been switched on from the configuration mode, the transmitting radio modem needs only a power supply and an antenna. The test mode can be configured to send either short or long packets. The length of the short packet is 52 characters whereas the length of the long packet is 988 characters.

The strength of the received signal can be monitored using the LCD-display of the receiving radio modem or by following the voltage level of pin RSSI. Error-free reception of data can be checked using a suitable terminal program. When the test mode is no longer needed it must be switched off using the configuration mode.

Example of a test transmission:

```
00 This is a testline of SATELLINE-3AS radio modem
01 This is a testline of SATELLINE-3AS radio modem
02 This is a testline of SATELLINE-3AS radio modem
```

## 5 REPEATER MODE AND ADDRESSING

Repeaters and addressing may be used to extend the coverage area of a radio modem network and to direct messages only to selected radio modems in the network. In large systems with several repeaters and thus formed repeater chains it is often practical to use routing instead of plain addresses. For more information on routing, see Chapter 6.

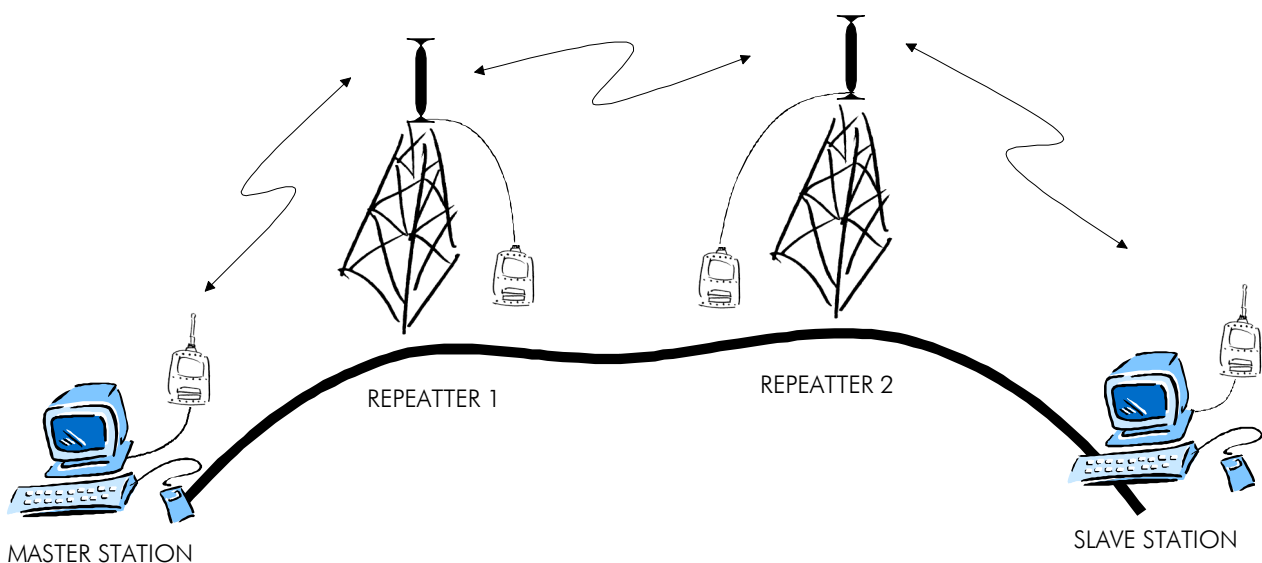
### 5.1 Repeater

In cases where it is necessary to extend the coverage area of a radio modem network, SATELLINE-3AS radio modems can be used as repeater stations.

The maximum size of a repeated data packet is 1 kB (kilobyte). The repeater function is switched on using the configuration mode (SET-UP-mode). In the repeater mode the radio modem will function as a totally independent unit, which means that only a power supply and a suitable antenna are needed. Other devices are not necessary.

A radio modem acting as a repeater can also be used to receive and transmit data. In repeater mode the radio modem will transmit the received data to the RS-Interface in a normal fashion. The difference to operation in normal operation is that the received data will be buffered into the buffer memory. After reception the radio modem will retransmit the buffered data using the same radio channel as in reception. Data received through the RS-Interface a radio modem in repeater mode will transmit as normally.

The same network may include several repeaters, which operate under the same base station. Repeaters may also be chained; in which case a message is transmitted through several repeaters. In systems with more than one serially or parallel chained repeater addressing or routing protocol must be used to prevent having a message ending up in a loop formed by repeaters and to ensure that the message finally reaches only the intended radio modem.



## **5.2 Addressing**

Addresses can be used to route a data message to the desired destination or to separate two parallel networks from each other. In networks with repeaters it is usually necessary to use addresses to prevent data messages from ending up in loops formed by repeaters.

SATELLINE-3AS radio modem facilitates the use of individual addresses both for the reception and transmission. Addresses can be switched on separately or simultaneously in both data transfer directions.

The radio modem contains two transmission and two reception addresses, which are called primary (primary address) and secondary (secondary address). Primary address is used whenever data from the RS-Interface is transmitted. At the receiving end the radio modem will receive using either of the two receive addresses.

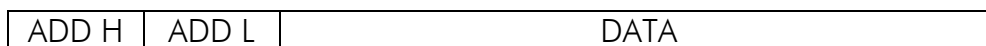
**Secondary transmit address is normally not used, and is only used in repeater applications.**

Radio modems set up to function as repeaters will repeat data messages using either the primary or secondary address depending upon which address was used during the reception of the data message.

**If only one address pair is needed in a network, both addresses must be set the same (TX1 = TX2 and RX1 = RX2).**

It is also possible to transfer the received address onto the RS-Interface.

The address is composed of two characters (totalling 16 bits), by which two characters totalling 16 bits), by which over 65 000 different address combinations can be formed can form over 65 000 different address combinations. The address consisting of two characters is attached in the beginning of each data packet sent by the radio modem. When using addressing mode in reception the radio modem will check the first two characters of each received data packet to check if the packet in question was intended for the said radio modem.



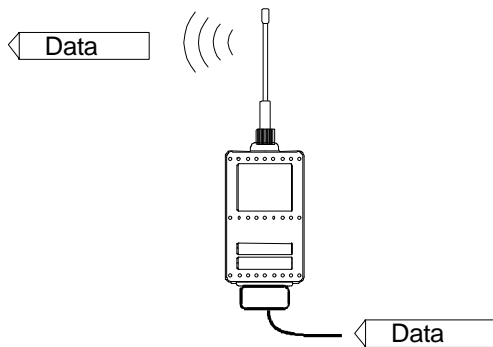
Address may be selected between 0000h...FFFFh (h = hexadecimal, corresponding decimal numbers are 0-65535).

**Example:** address 1234h (4660 in decimal format), where 12h is ADD H and 34h is ADD L.

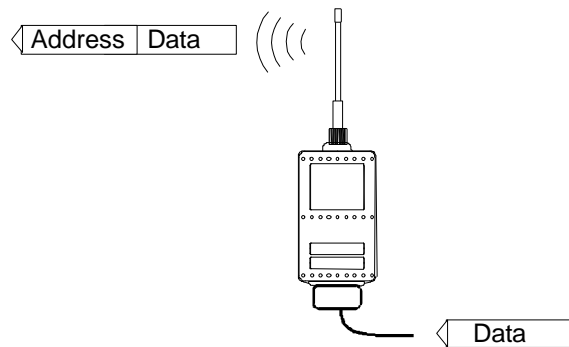
**Example:** address ABFFh (44031 in decimal format), where ABh is ADD H and FFh is ADD L.



**Transmission:**

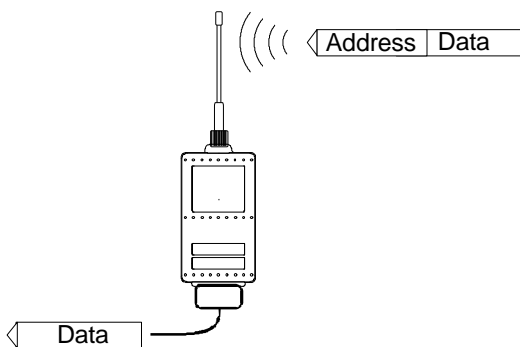


Transmission address has been set OFF. Radio modem will transmit the data packet as such.



Transmission addressing has been set ON. The radio modem will add the primary TX address to the beginning of the data packet.

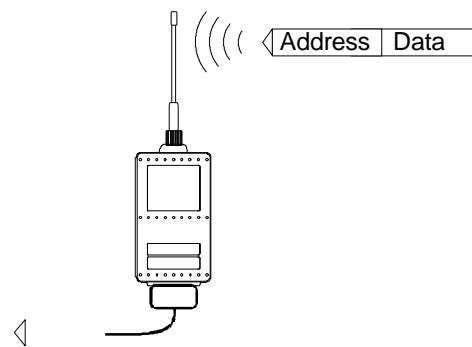
**Reception:**



Reception addressing has been set ON and either the primary or secondary RX address of the radio modem is identical to the address of the received data packet.

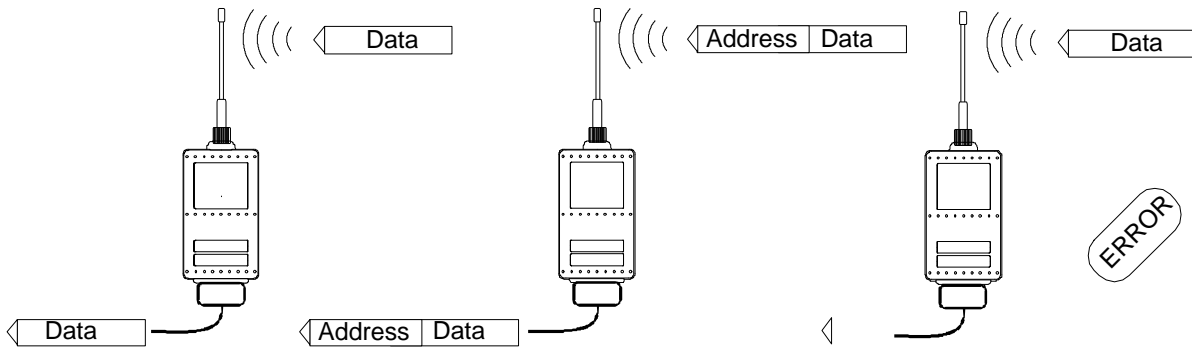
The radio modem will remove the address and send the actual data to the RS-232 interface.

However, if the "RX Address to RD-line" (configuration mode) is on, the radio modem does not remove the address.



Reception addressing has been set ON, but both the primary and secondary RX addresses of the radio modem are different from the address of the received data packet.

Data does not appear on the RS-232 - interface.



Reception addressing has been set OFF.

The radio modem will transfer all received data to the RS-232 - interface.

Reception addressing has been set OFF.

The radio modem will consider the characters of the address as a part of the data and will send all the characters to the RS-232 - interface.

Reception addressing has been set ON but there is no address in the data packet.

Data will appear on the RS-232 -interface ONLY if the first 2 characters of the data match either of its own RX address. The radio modem will remove those 2 characters of data.

### 5.2.1 Connection between two points

When forming a connection between two points it is recommendable to set both the reception addresses and transmission addresses to be identical in both radio modems. This is the easiest way to control addresses and the risk caused by interference from other systems operating in the same area is minimal.

**Example:** by setting all addresses of both radio modems to a value '1234', they will accept only those messages which contain this address, and they will use this same value when transmitting data.

If the channel is reserved to be used only by the said network or if the terminal devices are responsible for addressing, it is not necessary to use addressing in the radio modems.

### 5.2.2 System of one base station and several substations

In systems with several substations the base station must know to which substation each message must be sent and from which substation each received message originates. Usually terminal devices handle addressing completely, but it is also possible to use the addressing of the radio modems.

For example, if the substation terminal devices are not able to check and form addresses by themselves, addressing may be accomplished with the help of the addresses of the radio modems attached to these terminal devices. The base station may in such a case define the destination of a message by adding the address of the corresponding radio modem into the beginning of the data packet. The substation radio modem(s) will check the address and the corresponding radio modem will identify and remove the address characters. In a similar way, the substation will add when transmitting to the base station its address characters into the beginning of the data packet, thus defining the origin of the sent data packet. In the base station radio modem, addresses have been switched OFF, so that they are transmitted as is to the base station terminal device for further processing.

### **5.3 Using repeaters and addresses in the same system**

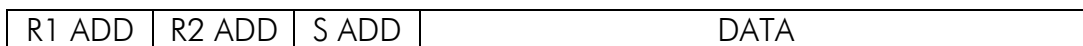
In systems with several repeaters, a substation and a base-station, addresses must be used in radio modems. It is possible to realise also a system with only one repeater without addressing. In such a case, the base station will however hear the message both from the substation and from the repeater, in other words the message is duplicated as it moves along the route.

There are at least two ways of realising such a system depending on the capabilities of the terminal devices in question and on the number of repeaters to be used and on their relative positions to each other.

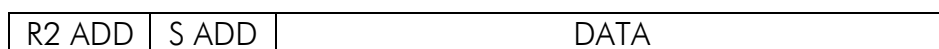
#### 5.3.1 System with several repeaters

In systems with several serially or parallel chained repeaters addressing must be used. This is to prevent messages from ending up in loops otherwise formed by repeaters and to ensure that only the desired (addressed) radio modem receives the data intended for it.

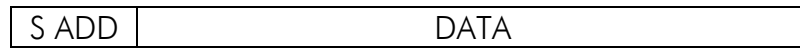
All radio modems in the network must be set to a state, in which the RX-addressing is switched ON and TX-addressing is switched OFF. Base-station and all substations add an address string in the beginning of the data to be transmitted. In the relaying of the message addressing is used in the following way:



- The above is the data received from the base station terminal device, containing repeater addresses (R1 ADD, R2 ADD) and the substation address (S ADD). Two characters define each address.



- The above is the same message after being relayed from repeater 1 to repeater 2.

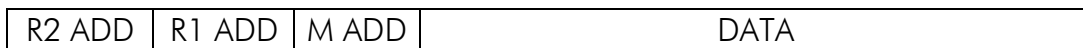


- The above is the same message after being relayed from the last repeater in the chain (repeater 2) to the substation.



- The above is the same message being relayed via the RS-Interface of the substation radio modem to the terminal device.

In a case in which the substation transmits data towards the base-station the address is formed in a similar way, but the order of the addresses is opposite:



-In the above, R2 ADD is address of repeater 2, R1 ADD is address of repeater 1 and M ADD is the address of the base-station.

### 5.3.2 Repeater chain using address pairs

In a case where the terminal devices and substations cannot form address fields but are able to recognise messages addressed to them, alternating address pairs may be used. Transmit address (TX) and receive address (RX) alternate in the order shown in the table below.

Address type	Base-station address	Repeater 1 and the addresses of the substations of the base-station	Repeater 1 substations addresses
TX-address	Address 1	Address 2	Address 1
RX-address	Address 2	Address 1	Address 2

In a network where alternating addresses are utilised, the exact route, which is used to relay a message to a certain radio modem is fixed at the time of installation and configuring the system. The order of the addresses must be the same as the order of the route, which is used to relay the message to the said radio modem. It is to be noted however that in networks where alternating addresses are used the base-station and substations will hear their own messages repeated.

### 5.3.3 Repeater chain using dual addressing

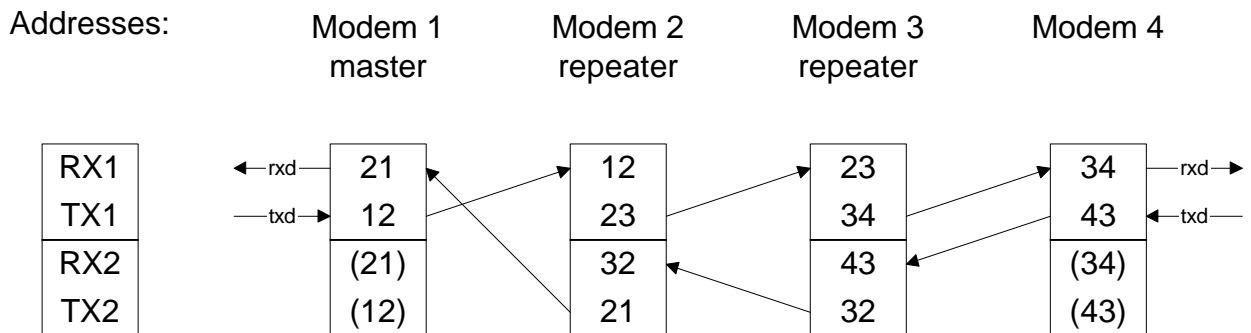
If the terminal devices cannot add address chains to the beginning of the data packets, a network with several repeaters may still be realised by using dual addressing.

In dual addressing each link (see arrow in figure) is given a unique address, which will prevent duplication of messages and endless loops in the network. The terminal devices need not add anything to the data.

Usually the primary transmit address is used in transmission (TX1). The secondary transmit address (TX2) is used only if the repeater function is used and the packet to be repeated was received using the secondary reception address (RX2).

In the following example two repeaters are used. It is to be noted how each link (arrow) may be uniquely defined with the help of radio modem numbers and data transfer directions. The repeater function should be switched ON only in the radio modems acting as repeaters to prevent the packets from remaining in endless loops in the network.

Repeaters may also act as ordinary substations. In the case of the example the master station must be connected to radio modem 4, otherwise the messages sent by terminal devices connected to radio modems 2 and 3 shall not arrive at the intended destination.

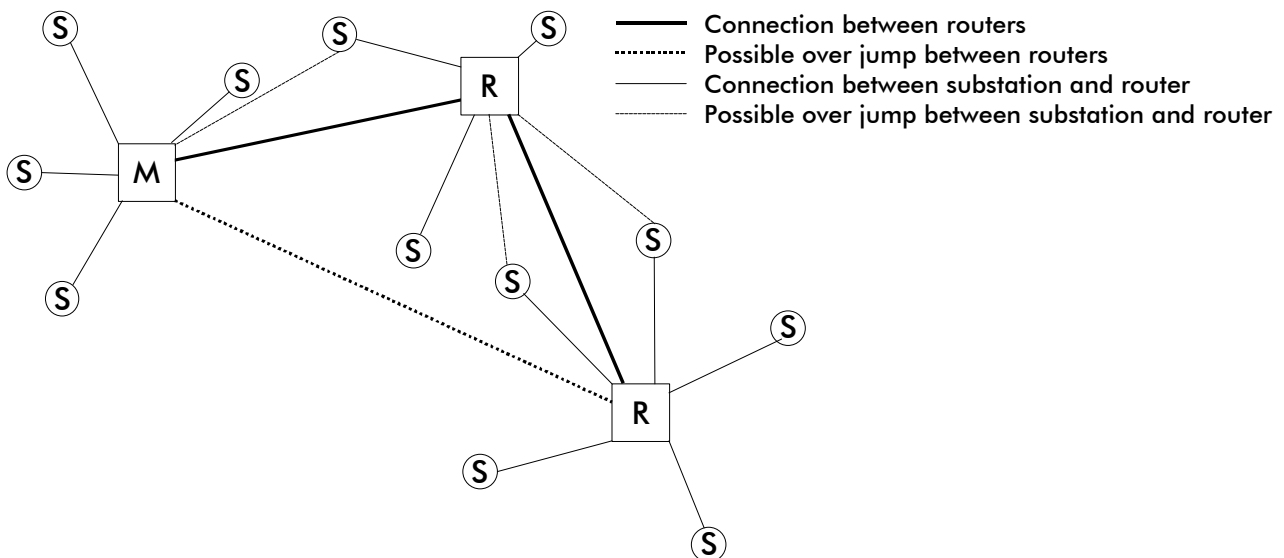


## 6 MESSAGE ROUTING

### 6.1 Introduction

Message Routing is a mode of operation in which radio modem pick a destination address from the data received via the RS-Interface and then relay the message address over the radio network to the destination device. This function facilitates the construction of a network containing several repeaters almost as easily as a network with one base-station and several substations. Any radio modem may be set to operate as a router, so that usually a separate routing network is not needed.

The design and maintenance of radio modem networks requires especially in complicated cases very precise planning. Generally the implementation process consists of planning and drawing the network with the help of SaTerm PC-program, which has a graphical user interface for easy use. All required communication settings can also be defined and the program also has functions to enable the transfer of settings to each actual radio modem. Routing will work with most network protocols assuming that the position of the address field is fixed.



#### 6.1.1 Advantages of routing

With the help of routing it is easier to design, implement and maintain radio modem networks. Also connection distances can be increased substantially by chaining repeaters. By utilising routing radio modem networks with quite large coverage areas may be realised by using just one radio channel. Also the use of mobile substations is possible. By the use of routing a fully deterministic system may be realised, in other words delays are always fully predictable. In addition the logical structure of the network may be changed from the base station. The use of routing also introduces redundancy, because a failed radio modem can in certain cases be bypassed with the help of another radio modem positioned in the same coverage area.

### 6.1.2 SaTerm (brief description)

SaTerm 3 is a PC-based program, intended to be used by network designers and constructors. With the help of SaTerm 3 it is possible to monitor serial interface traffic, send various test packets; change the settings of a radio modem, copy settings to several radio modems and also to update the internal software of a radio modem with a newer revision.

Version 3 of the program also includes the possibility to define the structure of a radio network using routing by just drawing. An advantage of using the SaTerm-program is that the planned network may be sketched very fast and easily in graphical format. When the network includes all desired elements and their relative dependencies are defined, common as well as individual settings of the radio modems in the network can be defined. Finally, each radio modem of the network can be programmed via the serial interface with just one command.

The structure of the network may also be input to the radio modems using the configuration mode. This manual method is recommended only in cases where the network structure is very simple, or when it is desirable to define such special functions, which are not possible to realise using the graphical interface of SaTerm 3. Examples of such cases are defining other than tree-structured networks, or the use of same repeaters in several overlapping networks.

## **6.2 Operating modes of message routing**

Message routing may be realised by using two different operating modes:

- Source mode
- Virtual mode

The most important differences of the two modes are shown in the table below.

	Source	Virtual
Summary	Slower, more functions	Faster, less functions
Protocol header size (bytes/jump)	6+2*number of jumps	5
Fault tolerance	Yes, if allowed by radio interface (Overhop function)	No, but can be realised at network level
Support for mobile stations	Built-in	Must be realised at network level
Addition of substations to a network	Only base station reconfigured	Repeaters reconfigured
Changing routes	Only base station reconfigured	All radio modems reconfigured
Maximum length of route	16 jumps	No limit
Max. length of repeatable packet	1 kB – size of the protocol header	1 kB – size of the protocol header
Overhop function	Yes	No
Network ID	Yes	Yes
Storing of routing information	Centralised	Dispersed
Max. number of substations	No limit	No limit

### 6.2.1 Source mode

In the Source method all routing information has been saved into the radio modem of the base station and for this reason it is easy to add substations to a Source method based network also afterwards. The changing of routes is also easy. In the Source method all routing information is included and transferred together with the packet itself and substations send a reply message to the base station using a reverse route. Operation is a little slower than when using the Virtual mode routing, but makes it possible to use the overhop function. Mobile substations can be configured to use several routers, but the transfer delay is still predictable and independent of the location of the mobile substations. The maximum number of allowed serially linked routers is 15, and the number of different routes is limited to 50-80 depending on the length of the routes.

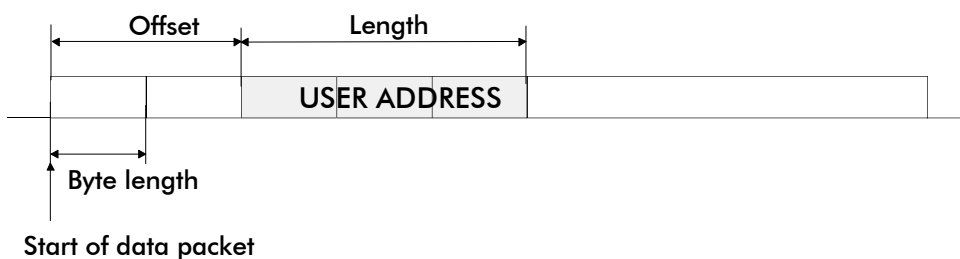
### 6.2.2 Virtual mode

The virtual mode is the fastest data transfer method (using known routes). In Virtual routing packets only one virtual link ID is added to the user data, and this is changed after each repetition. The portion of the added routing information of the total packet size is therefore smaller, but overhop function cannot be used. The routing table is dispersed among the radio modems operating as routers, which means that changing of routes necessitates also the reconfiguration of the radio modems stationed in the coverage area of the network. The number of serially linked routers is unlimited. A drawback of this method is the fact that it does not support the use of mobile substations. The maximum number of different routes is 50.

### 6.2.3 Protocol configuration

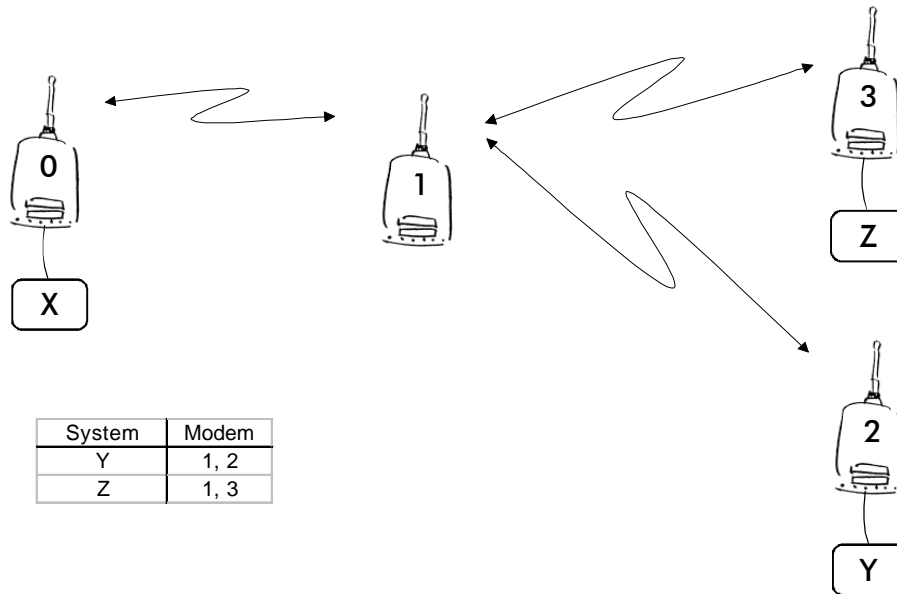
The radio modem will detect the address used by the network from the packet received via the serial interface. On the basis of this address used by the system protocol all necessary information relating to the relaying of the message is fetched from the routing table. The protocol used in each instance is not interpreted; instead, the address is searched according to its location. The beginning of the packet is located by a preceding pause. Routing can therefore be applied to most protocols.

The position and length of the address is defined with the help of Offset and Length settings. Offset defines the number of bytes (0...15) preceding the address and Length is the length of the address expressed in bytes (1...4).





### **6.3 Detailed description of routing operation**

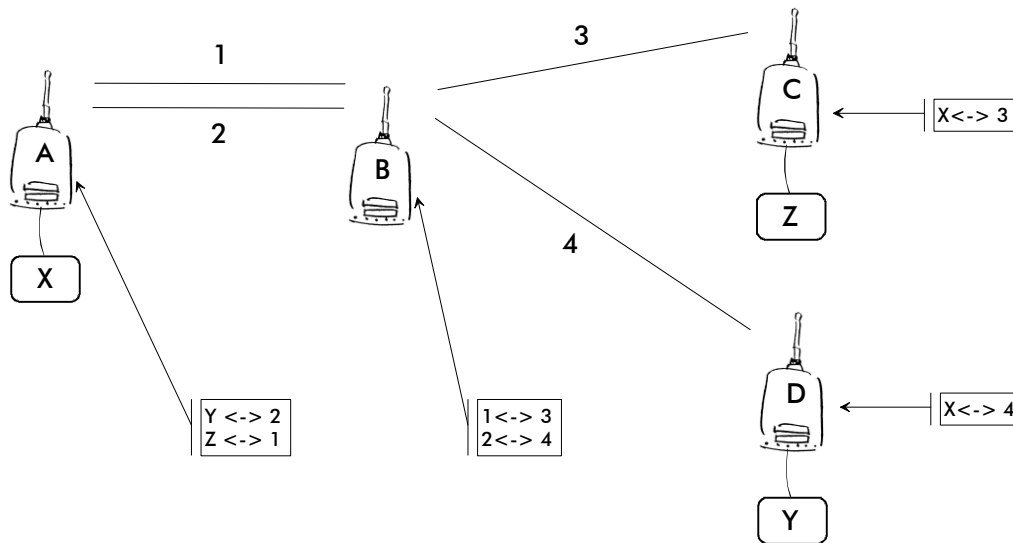


#### 6.3.1 Source mode

The above figure represents a network containing four (4) radio modems. Each radio modem is given a unique address (0...3). A terminal device has been attached to three of the four radio modems and they communicate with each other using addresses X, Y and Z, respectively. Radio modem 0 and terminal device X together constitute the base station of the network and all routing information of the network has been programmed into this base station.

When the terminal device X transmits a packet to (e.g.) terminal Y, radio modem 0 will detect the address Y from the data received through the serial port. From the routing table a route 1,2 can be found to which the radio modem also adds its own address to define the route for return data. Radio modem 1 repeats the packet and radio modem 2 removes the address information from the received data packet thereby transferring only the original data to the serial interface. The address information received together with the packet is reversed (2,1,0) and saved to be used in the transmission of subsequent reply packets.

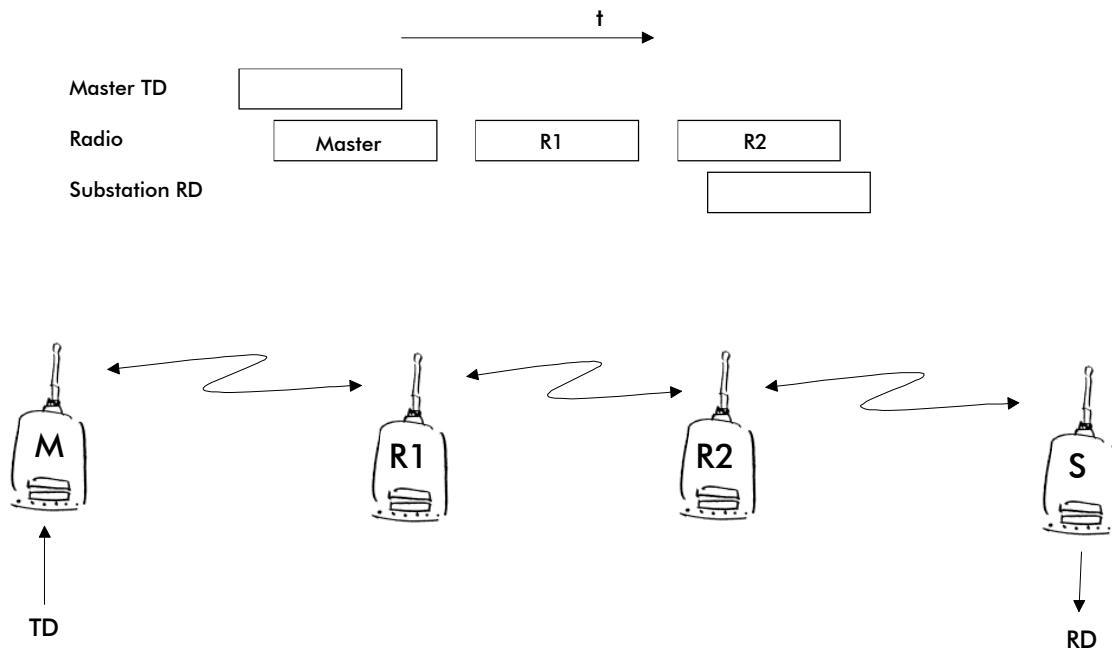
### 6.3.2 Virtual mode



The above figure represents the same network, which has now been realised using the Virtual mode. The difference is that logical links are numbered instead of radio modems. Operation is easy to understand by thinking of a telephone network realised with traditional overhead wiring.

Each radio modem contains a routing table in the internal memory, which defines all the relative dependencies of the said radio modem in relation to the links to which it forms with other radio modems in the network, as well as terminal device addresses and link depends. Terminal device X transmits a packet to terminal device Y. The routing table of radio modem contains the required route and the packet is transmitted with link ID 2 attached to it. Of the radio modems in reception mode, only the routing table of radio modem B contains a link ID 2, and because of this match will receive the packet. Re-sending (relaying) will be made with ID 4. In the case of radio modem C, routing table information defines that link 4 is connected to a serial interface, which means that radio modem C will transfer the packet to the serial interface and the terminal device attached to it after first removing the link ID added by radio modem A. All links are bi-directional, so the reply message will arrive back to the terminal device X via radio modem A in a similar way.

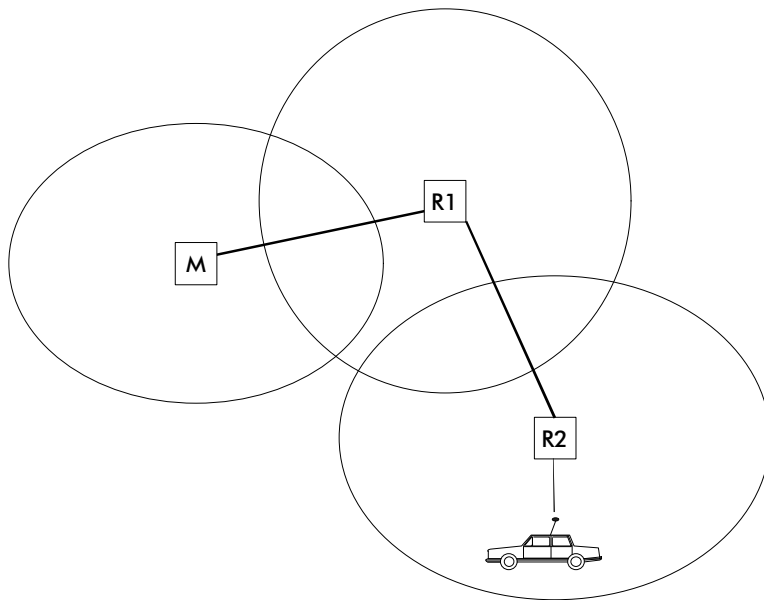
### 6.3.3 Overhop function in Source mode



When using routers the same packet is sent on a (radio) channel several times. A radio modem situated in the router chain will often hear other radio modems in addition to the immediate neighbouring radio modems. In the Source mode the complete address information sent together with the packets enables also the use of these secondary routes. Usually routers have better antennas (and/or antennas placed higher) than normal substations, which means that the distance between two routers can be much longer than the distance between a router and a substation.

Connections to other than the neighbouring stations of the router are not necessarily reliable under all possible (radio) conditions, but they can often be used to keep the network up and running at least partly in case a router somewhere in the middle of the chain fails. In addition to this, the likelihood of a transmission error decreases if it is possible to listen to more than one transmission, since in this case it is more likely that at least one of them will be received error-free. It is also possible, that the radio connection is asymmetrical due to the greater output power of a router or due to local interference, in which case data can in fact travel in opposite directions using different routes.

When a router receives a message, which contains its address but not as the first address in the address field, the packet is stored in a buffer. If the relayed message from the router, between the said router and the one having sent the message originally, is not received due for example because of radio modem failure (or if it has an erroneous checksum), the packet already buffered into the memory is resent without any change to the timing (no additional delays are introduced). Because of this, relatively short hop distances can be used, without the likelihood of errors being increased due to the added number of repeats. A possible error in one of the routers does not necessarily cause a total breakdown of traffic.



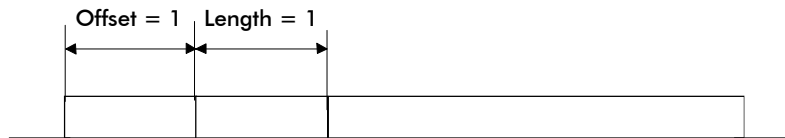
The overhop function facilitates the use of mobile substations. In the example, a mobile substation is first located in the coverage area of repeater R2. The route is defined as M, R1, R2 and vehicle. When the vehicle moves to the coverage area of repeater R1, the radio modem picks the packet already from the transmission of R1, but is then transferred to the serial port using an additional delay, so that the timing does not differ from the first case when the radio modem of the vehicle was in the coverage area of router R2. In this way a collision of the reply transmission and the transmission by repeater R2 is prevented. When the mobile station is transmitting, it is correspondingly enough that at least one radio modem defined to be a part of the route receives the transmission.

#### 6.3.4 Network ID

The Network ID is a string of characters with a maximum length of eight (8) characters. Network ID prevents reception of messages sent by radio modems, which are not part of the said network. All radio modems, which are intended to operate within the same network, must be configured to have the same Network ID. A radio modem which is configured to use routing will accept a packet only, if the Network ID included within the packet data structure matches the one configured into the memory of the receiving radio modem. Because the Network ID is never transmitted on the radio interface, it is very difficult to find out, thus adding to the security of network.

## **6.4 Example of expanding the network coverage by using message routing**

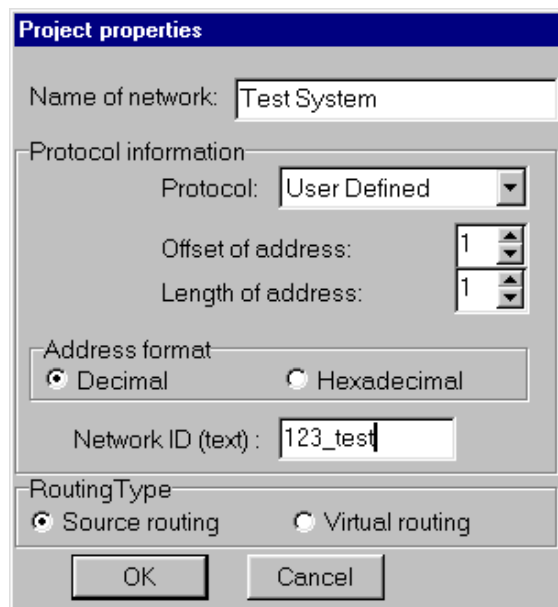
In the following example a network which utilises polling is explained. The network has originally consisted of one base station and several substations. This type of a network can usually be adapted to operate with message routing without any changes to the terminal devices.



The protocol used contains a one byte long recipient address at position 1, thus the settings of the radio modems should be Offset=1 and Length=1.

### 6.4.1 Designing the network using SaTerm

The design flow of a network using SaTerm program is initiated by starting the program and choosing from the main menu *File->Routing Set-up* and then *File->New Project*. The window, which opens now, is used to define those settings, which are common to the whole network.

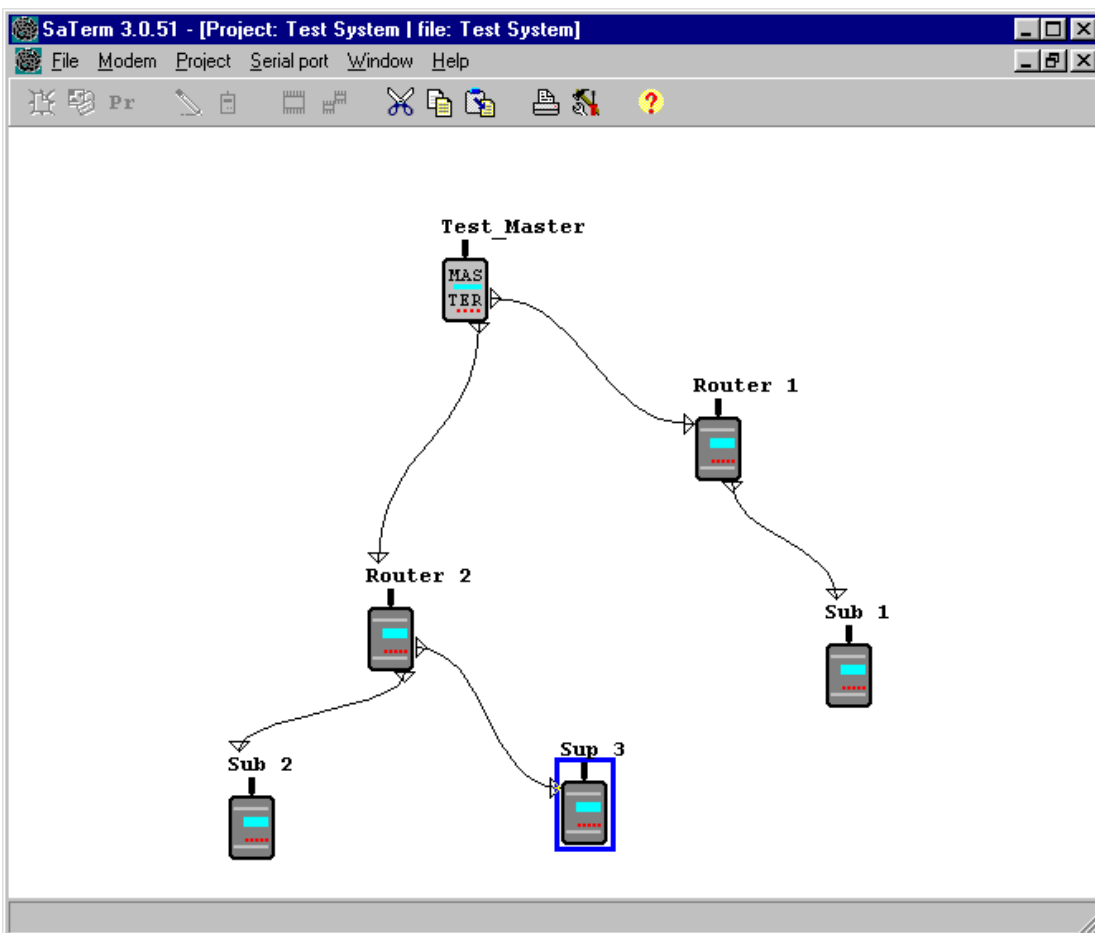


The address type is selected to be *Decimal*, which means that all addresses of the network will be given to the SaTerm program in decimal format. Also the Network ID (NetID) is defined. The routing mode is selected to be *Source*, because a mobile substation will also be defined in the example network.

A radio modem is created on the screen by choosing *Modem->New Modem->3AS* from the menu and by dropping the radio modem to the desired location. A name is given to each radio modem, which eases the identification of radio modems, and it is usually recommendable to use

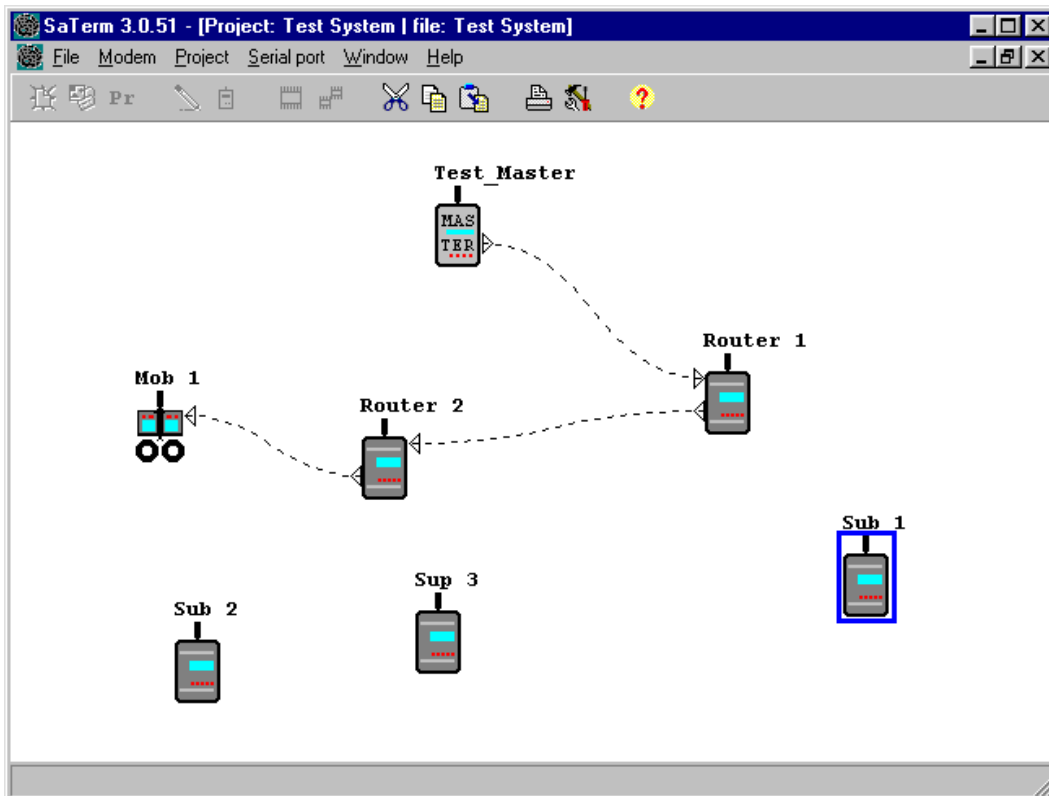
either the serial number of the radio modem or a descriptive name defining the physical location of the radio modem. Serial interface settings are configured to correspond to those of the terminal device. It is to be noted that the frequency must be configured to be the same in each radio modem of the network. The design flow continues by adding and defining the rest of the radio modems to the network.

The following step is to define all routes between all the radio modems. Clicking the right mouse button when the cursor is over the desired radio modem icon and then by choosing from the pop-up menu *Connect* does this. Before drawing any of the actual routes it is however recommended to choose and define the radio modem which will act as the base station radio modem of the network. This is done by clicking the right mouse button when the cursor is over the desired radio modem icon and then by choosing the selection *Master* from the pop-up menu. It is possible to change the *Master* setting later, but in this case all routes except those directed away from the (new) *Master* are cleared.



### 6.4.2 Adding a mobile station

Routing information of mobile substations often differs from the more common "optimal" routes. A mobile substation is added by choosing *Project->Mobile routes* from the main menu, and now all previously defined routes will disappear from the screen. A mobile substation is now added into the network by choosing *Modem->New mobile->3AS* from the main menu. The route is defined as for fixed radio modems (see Chapter 6.4.1), and the mobile substation is attached to the last router in a chain. This way the mobile substation will be able to transmit data through all routers belonging to the chain.



### 6.4.3 Transferring the settings to radio data modems

The design has now progressed to a point where the settings, definitions and configurations made according to instructions of the previous chapters can be transferred into actual radio modems with which the network will be defined. First, however, the serial port to be used must be selected from the serial port menu. Also, when transferring settings from the SaTerm program memory into the radio modems all radio modems must be set into the configuration mode during the transfer process. In other words the pin 12 of the serial port connector of the radio modem must be connected to ground (GND). (When using the ARS-1F adapter the red switch should be moved to a position away from the radio modem).

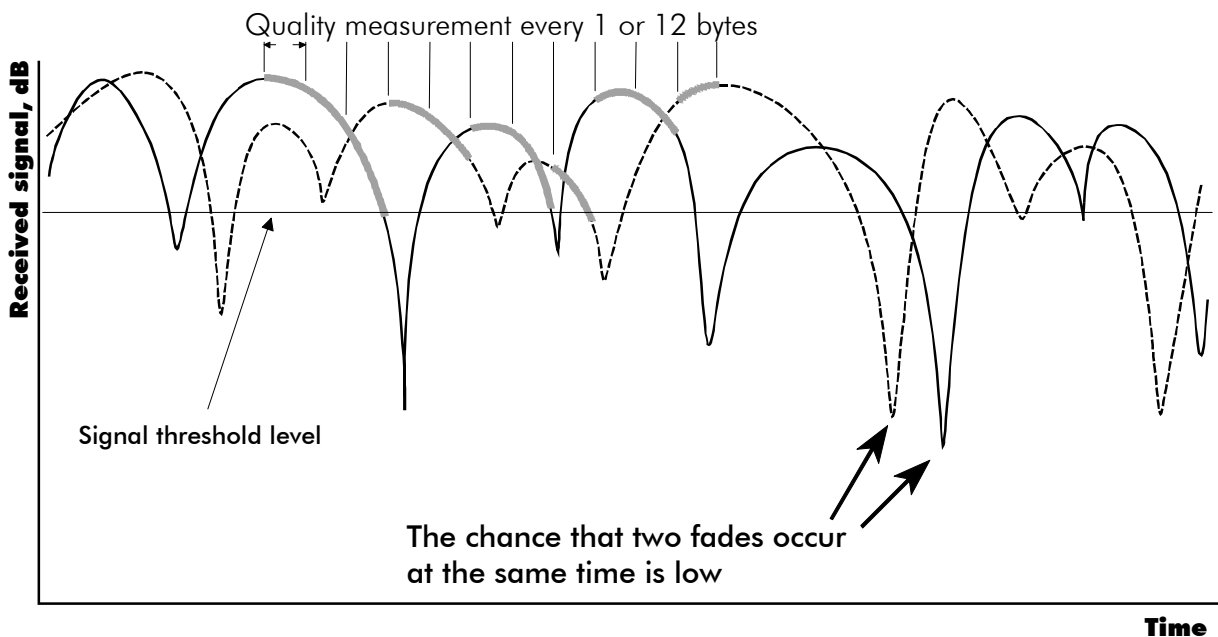
Each radio modem in turn is connected to the ARS-1F adapter and then the icon of the same radio modem is selected by moving the mouse cursor over the icon, clicking the right mouse button and by then choosing from the pop-up menu *Transmit values*. After all radio modems are programmed they are ready to be taken to the mounting sites for further installation.

## 7 Diversity receiver (only SATELLINE-3AS Epic)

SATELLINE-3AS Epic model has two antenna connectors, the other being used for reception and the other for reception and transmission. Diversity receiving means that the radio modem selects the best signal from those received by the two antennas. In this way the reliability of the connection is improved especially in those cases which are subject to a high level of reflections and multipath fading.

### 7.1 Multipath fading

In radio systems (operating at suitable frequencies) it is not necessary to have a direct line-of-sight connection between the master station and a moving substation because the radio signal propagates by reflecting from buildings and terrain contours e.g. hills. These useful reflections do however cause fading, which can occur when the radio signal experiences a number of reflections on the way to the receiving antenna. Radio signals propagate at the speed of light but if the signal is reflected from several different objects before reaching the receiving antenna the different total path lengths of these reflected signals will cause them to be detected at slightly different times. This means that these detected reflected signals are in different phases. In the worst case scenario, two equally strong signals are in exactly opposing phases thus cancelling each other out and causing the signal level to drop.

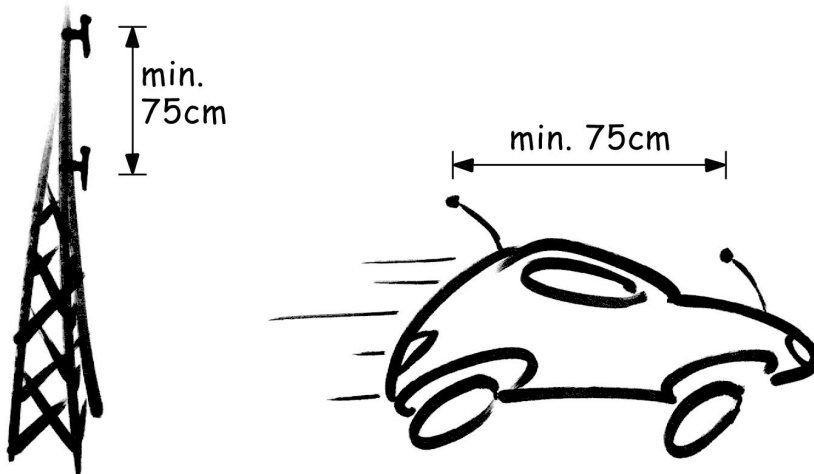


The received signals from two antennas. The selected signals are marked in grey.



## **7.2 Antenna installation**

Signal fading appears at half wave intervals. Because of this, best result is achieved by installing the two antennas of SATELLINE-3AS Epic apart from each other, so that the minimum separation distance is  $\frac{3}{4}$  x wavelength used (min. 0.75 m). It is not recommendable to use Miniflex – antennas together with the SATELLINE-3AS Epic model.



## 8 SETTINGS

The configuration of SATELLINE-3AS radio modems can be easily changed. By connecting pin 12 of the D-connector to ground (GND) the radio modem will switch over into configuration (SET-UP) mode. Serial port PORT 1 is used whenever the radio modem is in the configuration mode. The serial port settings are 9600 bps, N, 8,1 (data transfer speed 9600 bps, no parity, character length 8 bits and one (1) stop bit).

SATELLINE-3ASd model contains push buttons and a LCD-display, which can be used to modify configuration settings without the help of an external terminal device. The radio modem will switch over into configuration (SET-UP) mode by pressing the "SET-UP" button (y).

If the SL-command function has been activated active radio channel and addresses can be changed without switching the radio modem into configuration mode. Serial port settings will remain as those defined previously when the radio modem was in configuration mode.

### **8.1 Changing parameters using a terminal device**

PORT 1 of the radio modem is connected to a terminal device or a PC, which is in terminal emulation state. (This can be accomplished by using a suitable program such as the SaTerm program or the Windows™ Hyper Terminal program). Check the wiring of the serial port connection cable. Terminal device serial port settings must be set to 9600 bps, N, 8, 1 (data transfer speed 9600 bps, no parity, data length 8 bits and one (1) stop bit). Mode-pin (pin 12 of the D-connector on the radio modem) is then connected to ground (GND). Following this the radio modem will transmit the following message to the terminal (certain configuration settings might differ from the ones shown):

#### 8.1.1 Changing frequency (active radio channel frequency)

The frequency of the active radio channel can be changed by selecting main menu selection "1". In the example below the frequency is changed (465,5000 MHz ⇒ 465,5250 MHz).

```
Enter selection >1

Radio frequency set-up
-----
Active channel          465.5000 MHz
Lower limit band 1     467.2000 MHz
Upper limit band 1     469.2000 MHz
Lower limit band 2     467.2000 MHz
Upper limit band 2     469.2000 MHz
Channel spacing         25 kHz

Enter new frequency (MHz) or ESC to previous > 465.5250
```

A list of frequency values will appear on the screen updated with the new active radio channel frequency value:

```
Radio frequency set-up
-----
Active channel          465.5250 MHz
Lower limit band 1     467.2000 MHz
Upper limit band 1     469.2000 MHz
Lower limit band 2     467.2000 MHz
Upper limit band 2     469.2000 MHz
Channel spacing        25 kHz

Enter new frequency (MHz) or ESC to previous >
```

Maximum adjustment range of the active radio channel frequency is  $\pm 1$  MHz counting from the factory set center frequency. Because of possible deviations in each country and/or region concerning the authorised use of the frequency spectrum local authorities may limit this adjustment range. SATELLINE-3AS radio modem can be supplied with the adjustment range divided into two bands (**Band 1** and **Band 2**), and this feature can be utilised in case it is required to limit the arbitrary adjustment of the active radio channel accidentally to a forbidden value. The center frequency and the frequency band limiting values are factory set and the user cannot change them. The active channel is selected by entering a numerical value.

**NOTICE !**

Adjustment of the active radio channel of the radio modem to frequencies other than those allocated and/or allowed by local authorities is strictly forbidden. Use or intended use of forbidden frequencies may lead to prosecution and penalties. SATEL is not responsible for any illegal use practised with any devices manufactured and/or sold by SATEL and is not liable to pay any damages or compensation caused by such illegal use.

### 8.1.2 Changing radio settings (transmitter output power and receiver sensitivity)

Radio settings which consist of transmitter output power and receiver sensitivity can be configured by selecting main menu selection "2". In the following example both the transmitter output power (10 mW  $\Rightarrow$  20 mW) and the receiver sensitivity (-110 dBm  $\Rightarrow$  -90 dBm) are changed.

Enter selection >2	
Radio set-up ----- 1) TX power level                    10 mW 2) Signal threshold level        -110 dBm 3) TX start delay                    0 ms  Enter selection or ESC to previous menu >1	
	TX power level set-up ----- 1) 10 mW 2) 20 mW 3) 50 mW 4) 100 mW 5) 200 mW 6) 500 mW 7) 1000 mW  Enter selection or ESC to previous menu >2
Enter selection or ESC to previous menu >2	
	Signal threshold level set-up ----- Signal threshold level -110 dBm  Enter new value (80 - 118) or ESC to previous menu > -90
Enter selection or ESC to previous menu >3	
	Set TX start delay set-up ----- TX start delay 0 ms Enter new value (0 - 65535 ms) or ESC to previous menu > 100

The new values are updated in the LCD-display:

Radio set-up ----- 1) TX power level                    20 mW 2) Signal threshold level        -90 dBm 3) TX start delay                    100 ms  Enter selection or ESC to previous menu >	
---	--

The maximum useable sensitivity of the receiver is determined by the channel spacing used (=radio interface data transfer speed) and also by error correction (utilised or not). For further information see Chapter 9.3, 10.1 and 10.2.

In environments with high levels of interference and when connection distances are short it is often beneficial to use a "Signal threshold level" value which is approximately 10 – 20 dBm above the maximum sensitivity level. This will prevent unnecessary receive attempts caused by noise.

**NOTICE !**

The setting of the transmitter output power of the radio modem to levels in contradiction with transmitter power levels regulated by local or other governmental authorities is strictly forbidden. Use or intended use of forbidden transmitter power levels may lead to prosecution and penalties. SATEL is not responsible for any illegal use practised with any devices manufactured and/or sold by SATEL and is not liable to pay any damages or compensation caused by such illegal use.

### 8.1.3 Changing addressing settings (primary and secondary RX- and TX-addresses)

Addressing can be switched ON or OFF with the help of main menu selection "3". In the following example a primary RX-address (transmitter address) is switched ON and the corresponding hexadecimal address value is modified ("0000" ⇒ "0020"). The current values of the parameters are displayed and changed in toggle-type fashion by selecting the appropriate parameter selection number from the list displayed. The next menu level will then enable the modification of the values (within allowed limits). Modification of all other primary and secondary transmitter and receiver addresses is done in similar way.

```
Enter selection >3
```

```
Addressing set-up  
Toggle ON/OFF values. Current value shown.
```

- ```
-----  
1) RX address                OFF  
2) TX address                OFF  
3) RX address to RS port    OFF  
4) Change primary RX address  
5) Change primary TX address  
6) Change secondary RX address  
7) Change secondary TX address
```

```
Enter selection or ESC to previous menu >1
```

```
Addressing set-up
Toggle ON/OFF values. Current value shown.
-----
1) RX address                ON 0000/0000
2) TX address                OFF
3) RX address to RS port    OFF
4) Change primary RX address
5) Change primary TX address
6) Change secondary RX address
7) Change secondary TX address

Enter selection or ESC to previous menu >4
```

```
RX address set-up
-----
RX Address ON 0000/0000

Enter new address (HEX) or ESC to previous menu >0020
```

The new value is displayed in the LCD-display:

```
RX address set-up
-----
RX Address ON 0020/0000

Enter new address (HEX) or ESC to previous menu >
```

The address is given in hexadecimal format with four digits and the number of different addresses is thus over 65 000.

#### 8.1.4 Changing serial port settings (Port 1 and Port 2)

The settings of serial port **PORT 1** can be modified by selecting main menu selection "4" and the settings of serial port **PORT 2** by selecting choice "5". In the following example **PORT 1** will be switched to a non-active state and after this the data transfer speed is modified (19200 bit/s  $\Rightarrow$  9600 bit/s), the number of data bits is modified (8  $\Rightarrow$  7), the number of parity bits is modified (NONE  $\Rightarrow$  EVEN) and finally the number of stop bits is changed (1  $\Rightarrow$  2).

```
Enter selection >4

Serial port 1
Settings
-----
1) Port status      ON
2) Data speed      19200 bit/s
3) Data bits       8 bit data
4) Parity bits     None parity
5) Stop bits       1 stop bit

Enter selection or ESC to previous menu >1

Serial ports 1 and 2 status set-up
-----
1) Port 1 ON / Port 2 OFF
2) Port 1 OFF / Port 2 ON

Enter selection or ESC to previous menu >2

Serial port 1
Settings
-----
1) Port status      OFF
2) Data speed      19200 bit/s
3) Data bits       8 bit data
4) Parity bits     None parity
5) Stop bits       1 stop bit

Enter selection or ESC to previous menu >2

Serial port 1 data speed
-----
1) 300 bit/s
2) 600 bit/s
3) 1200 bit/s
4) 2400 bit/s
5) 4800 bit/s
6) 9600 bit/s
7) 19200 bit/s
8) 38400 bit/s

Enter selection or ESC to previous menu >6
```

Serial port 1  
Settings

- 
- 1) Port status           OFF
  - 2) Data speed           9600 bit/s
  - 3) Data bits            8 bit data
  - 4) Parity bits          None parity
  - 5) Stop bits            1 stop bit

Enter selection or ESC to previous menu >3

Serial port 1 data Bits

- 
- 1) 7 bit data
  - 2) 8 bit data
  - 3) 9 bit data

Enter selection or ESC to previous menu >1

Serial port 1  
Settings

- 
- 1) Port status           OFF
  - 2) Data speed           9600 bit/s
  - 3) Data bits            7 bit data
  - 4) Parity bits          None parity
  - 5) Stop bits            1 stop bit

Enter selection or ESC to previous menu >4

Serial port 1 parity bits

- 
- 1) None parity
  - 2) Even parity
  - 3) Odd parity

Enter selection or ESC to previous menu >3

Serial port 1  
RS-232 Settings

- 
- 1) Port status           OFF
  - 2) Data speed           9600 bit/s
  - 3) Data bits            7 bit data
  - 4) Parity bits          Odd parity
  - 5) Stop bits            1 stop bit

Enter selection or ESC to previous menu >5



```
Serial port 1 stop bits
-----
1) 1 stop bit
2) 2 stop bits

Enter selection or ESC to previous menu >2
```

Now all of the modifications of the example have been performed and the new values are displayed:

```
Serial port 1
Settings
-----
1) Port status      OFF
2) Data speed      9600 bit/s
3) Data bits       7 bit data
4) Parity bits     Odd parity
5) Stop bits       2 stop bits

Enter selection or ESC to previous menu >
```

The settings of the serial port must be modified to correspond with the settings of the terminal device that is to be connected to the radio modem. Modification of the settings of serial port **PORT 2** is done according to the principle described above and by first selecting from the main menu selection "5".

#### NOTICE!

It should be noted that switching the radio modem into configuration mode (SETUP) by connecting the MODE-pin (pin 12 of the D-connector) to ground (GND) will change the settings of serial port **PORT 1** to "9600,8,N,1" automatically irrespective of the serial port **PORT 1** DATA-mode settings.

### 8.1.5 Modification of handshaking functions

Handshaking related configuration settings can be modified by selecting selection from the main menu "6". In the following example characteristics of the CTS-line (CLEAR TO SEND ⇒ TX BUFFER STATE), CD-line (RSSI-THRESHOLD ⇒ DATA ON CHANNEL) and RTS-line (IGNORED ⇒ FLOW CONTROL) are changed.

|                                                                                                                                                                                                                        |                                                                                                                                                  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| Enter selection >6                                                                                                                                                                                                     |                                                                                                                                                  |
| Serial port 1 and 2 Handshaking<br>-----<br>1) CTS line property      Clear to send<br>2) CD line property        RSSI-threshold<br>3) RTS line property      Ignored<br>Enter selection or ESC to previous menu >1    |                                                                                                                                                  |
|                                                                                                                                                                                                                        | Select CTS line action property<br>-----<br>1) Clear to send<br>2) TX buffer state<br>Enter selection or ESC to previous menu >1                 |
| Serial port 1 and 2 Handshaking<br>-----<br>1) CTS line property      TX buffer state<br>2) CD line property        RSSI-threshold<br>3) RTS line property      Ignored<br>Enter selection or ESC to previous menu >2  |                                                                                                                                                  |
|                                                                                                                                                                                                                        | Select CD line action property<br>-----<br>1) RSSI-threshold<br>2) Data on channel<br>3) Always ON<br>Enter selection or ESC to previous menu >2 |
| Serial port 1 and 2 Handshaking<br>-----<br>1) CTS line property      TX buffer state<br>2) CD line property        Data on channel<br>3) RTS line property      Ignored<br>Enter selection or ESC to previous menu >3 |                                                                                                                                                  |

```
Select RTS line action property
-----
1) Ignored
2) Flow control
3) Reception Control

Enter selection or ESC to previous menu >2
```

```
Serial port 1 and 2 Handshaking
-----
1) CTS line property      TX buffer state
2) CD line property      Data on channel
3) RTS line property      Flow control

Enter selection or ESC to previous menu >ESC
```

Now all of the modifications of the example have been performed and the new values are displayed on the LCD-display (see above):

### 8.1.6 Special functions

Special functions are modified by selecting from the main menu selection "7". (For further information see the relevant Chapters describing the said functions). The current values of the parameters are displayed and can be modified in toggle-type fashion by selecting the appropriate parameter selection number (as described in Chapter 8.2) from the list displayed. The next menu level will then enable the modification of the values (within allowed limits).

```
Enter selection >7
```

```
Additional set-up
Toggle ON/OFF values. Current values shown.
-----
1) Error correction      OFF
2) Error check           OFF
3) Repeater             OFF
4) SL-commands          OFF

Enter selection or ESC to previous menu >
```

### 8.1.7 Modification of routing

Configuration settings defining routing can be changed by selecting main menu selection "8".

```
Enter selection >8

Routing Set-up
-----
1) Mode                Source routing
2) Protocol            Userdefined 01 01
3) Address              0009
4) Net id               testnet
5) Route list
6) Route add
7) Route delete
8) Delete all routes

Enter selection or ESC to previous menu >1

Routing mode set-up
-----
1) Disabled
2) Source routing
3) Virtual routing

Enter selection or ESC to previous menu >3

Routing Set-up
-----
1) Mode                Virtual routing
2) Protocol            Userdefined 01 01
3) Address              0009
4) Net id               testnet
5) Route list
6) Route add
7) Route delete
8) Delete all routes

Enter selection or ESC to previous menu >2

Protocol set-up
-----
1) Userdefined

Enter selection or ESC to previous menu >1

User defined address position set-up
-----
1) Start position      01
2) Length              01

Enter selection or ESC to previous menu >1
```

```
User defined address start position set-up
-----
Current value: 01

Enter new start position (0-16) >02

User defined address start position set-up
-----
Current value: 02

Enter new start position (0-16) >ESC
```

```
User defined address position set-up
-----
1) Start position      02
2) Length              01

Enter selection or ESC to previous menu >2
```

```
User defined address length set-up
-----
Current value: 01

Enter new length (1-4) >3

User defined address length set-up
-----
Current value: 03

Enter new length (1-4) >ESC
```

```
User defined address position set-up
-----
1) Start position      02
2) Length              03

Enter selection or ESC to previous menu >ESC
```

The display has now returned to the main menu of the routing settings and it can be seen that the routing mode (VIRTUAL ROUTING) as well as the protocol (USERDEFINED 02 03) have been modified.

Following this, a new address will be modified ("0009" ⇒ "0002") and a new Network ID is defined ("testnet" ⇒ "newname"):

```
Routing Set-up
-----
1) Mode           Virtual routing
2) Protocol       Userdefined 02 03
3) Address        0009
4) Net id         testnet
5) Route list
6) Route add
7) Route delete
8) Delete all routes

Enter selection or ESC to previous menu >3

Address set-up
-----
Current routing address 0009

Enter new address (HEX) or ESC to previous menu >0002

Address set-up
-----
Current routing address 0002

Enter new address (HEX) or ESC to previous menu >ESC

Routing Set-up
-----
1) Mode           Virtual routing
2) Protocol       Userdefined 01 01
3) Address        0002
4) Net id         testnet
5) Route list
6) Route add
7) Route delete
8) Delete all routes

Enter selection or ESC to previous menu >4

Net id
-----
Net id current value: testnet

Enter net id (8 char) or ESC to previous menu >newname

Net id
-----
Net id current value: newname

Enter net id (8 char) or ESC to previous menu >ESC
```

```
Routing Set-up
-----
1) Mode           Virtual routing
2) Protocol       Userdefined 01 01
3) Address        0002
4) Net id         newname
5) Route list
6) Route add
7) Route delete
8) Delete all routes

Enter selection or ESC to previous menu >
```

Selection "5" will produce a list of the routes:

```
Route list
-----
xxx
xxx
xxx

Press any key to return >
```

Selection "6" enables the addition of a route:

```
Route add
-----
Enter destination address (HEX) >
```

Selection "7" enables the removal of a route:

```
Route delete
-----
Enter destination address (HEX) >
```

Selection "8" enables erasure of ALL routing information simultaneously. The LCD-display will then display the following text:

```
Routing Set-up
-----
1) Mode           Virtual routing
2) Protocol       Userdefined 02 03
3) Address        0009
4) Net id         testnet
5) Route list
6) Route add
7) Route delete
8) Delete all routes

Enter selection or ESC to previous menu >8

Do you really want to delete all routes?

Press Y key to delete or ESC to cancel >
```

### 8.1.8 Activating tests

Tests can be activated by selecting main menu selection "9". For more information on tests, see Chapter 4.4. Tests are activated by setting the status of the desired test to "ON" and will remain active until the value of the selection in the menu is returned to the value "OFF".

```
Enter selection >9

Tests set-up
-----
1) Short block test      OFF
2) Long block test       OFF

Enter selection or ESC to previous menu >
```

### 8.1.9 Restoring factory settings

Selecting main menu selection "A" can restore factory settings.

```
Enter selection >A

Restore factory settings
-----
Do you want to restore factory settings? (Y/N)>
```

Restoring is confirmed by pressing "Y" (Y=YES) or cancelled by pressing "N" (N=NO) in the case restoring is not wanted after all. Also the pressing of "ESC" button at any point in the procedure will return the display to the previous (next higher) menu level without restoring factory settings.

### 8.1.10 Saving modified settings into the permanent memory

All modified settings must be saved into the permanent non-volatile memory of the radio modem before switching out of configuration (SET-UP) mode. Selecting the main menu selection "E" does saving:

```
Enter selection >E

Configuration saved!
Please turn off program mode switch!
```

**NOTICE!** To switch the radio modem back into DATA mode from the SET-UP mode the MODE-pin of the D-connector (D-15 pin 12) must be disconnected from ground (GND).



## **8.2 Changing parameters using the LCD-display**

SATELLINE-3ASd contains a LCD-display that facilitates the modification of the configuration settings of the radio modem without the use of an external terminal device. This is especially convenient when modifying or reinstalling radio modems in the field. The radio modem is switched into configuration mode (SET-UP) by pressing the "SET-UP-button (y). First, the LCD-display will shortly display the model of the radio modem and the software revision information after which it will automatically display the main menu, which is a list of the modifiable configuration settings.

The main menu is used to select the desired submenus and the actual modifications are performed using these submenus. It is possible to jump back at any time to the previous (higher) level in the menu hierarchy by just pressing the "CANCEL"-button (or in some cases the "BACK"-button). Pressing the  $\dot{y}$  modifies parameters with numerical values consisting of digits or  $\text{M}$ -buttons until the said digit (with the cursor blinking under it) has reached the desired value. In the case of numerical values the "NEXT-button is used to move on to the next digit in the numerical value and then the above described process is used to modify it. The process is repeated until all digits in the value have been edited. Toggle-type parameters (typically with ON/OFF choices modifications have to be confirmed by pressing the "SELECT"- or "SET"-button.

This is the display in DATA mode. Serial port **PORT 1** settings are 19200,N,8,1. Frequency is set to 468,5000 MHz. Signal strength is displayed on the upper left-hand corner and battery level respectively on the upper right corner.

```

Y...  O...
468.5000 MHz
COM1:19200N81
SETUP
    
```

After pressing the "SET-UP-button the display will shortly show the model of the radio modem and the revision of the software.

```

SATELLINE-3AS
Version 1.XX
    
```

The display will automatically then show the main menu, which is a list of modifiable parameters. Pressing the  $\dot{y}$  and  $\text{p}$  buttons can move the cursor upwards and downwards. When the cursor  $>$  is placed beside the desired selection, entry into sub-menu is done by pressing the SELECT-button.

```

>RF frequency
Radio settings
Addressing
Port 1
Port 2
Handshaking
Additional
Tests
Factory set-up
Contrast
EXIT  ▲▼ SELECT
    
```

### 8.2.1 Changing frequency (frequency of the active radio channel)

Press  $\uparrow$  or  $\downarrow$  until the cursor  $>$  points to "RF frequency" – selection and press "SELECT" to move onto the next submenu.

```
>RF frequency
Radio settings
Addressing
Port 1
Port 2
Handshaking
Additional
Tests
Factory set-up
Contrast
EXIT  ▲▼ SELECT
```

Press "CHANGE" if the frequency is to be modified.

```
Active channel
468.5000 MHz
BACK  ▼ CHANGE
```

**NOTICE:** If you want to check possible frequency band limits and the center frequency (factory set values), press  $\blacktriangledown$  and follow instructions given on page 66 (Checking the center frequency).

The cursor  $>$  will now blink under the first digit of the value indicating the center frequency (this first digit cannot be edited). To move onto the next digit, press "NEXT".

```
CF 468.5000 MHz
>468.2000 MHz
▲
CANCEL ▼ NEXT
```

```
CF 468.5000 MHz
>468.5000 MHz
▲
CANCEL ▲▼ NEXT
```

Press  $\uparrow$  or  $\downarrow$  until the said digit has reached the desired value. Press "NEXT" to move on to the next digit and repeat the above-described steps.

Previous steps are repeated four (4) times.

Press  $\uparrow$  or  $\downarrow$ , until the last changeable digit has the desired value and confirm changes by pressing "SET".

```
CF 468.5000 MHz
>468.2000 MHz
▲
CANCEL ▲▼ SET
```

The radio modem will acknowledge changes if they are within acceptable limits ( $\pm 1$  MHz from the center frequency and within optional band limits) with a similar message as shown on the right (frequency value depends on entered value) and will automatically return to display the main menu (if the entered frequency is not acceptable an error message will be displayed).

```
Ch accepted
>468.2000 MHz
```

## CHECKING THE CENTER FREQUENCY

Press ▲ or ▼ until the cursor > points to "RF frequency" selection and then press "SELECT" to move to a submenu which can be used to check (or modify) the frequency.

```
>RF frequency
Radio settings
Addressing
Port 1
Port 2
Handshaking
Additional
Tests
Factory set-up
Contrast
EXIT ▲▼ SELECT
```

The current active channel frequency setting is shown in the display. To check other related values press ▼.  
(To change the active channel frequencies press "CHANGE").

```
> Active channel
468.5000 MHz
BACK ▼ CHANGE
```

If ▼ was pressed the display will now show the lower and higher limits of frequency **Band 1** (these values cannot be changed). (To change the active channel frequency value press "CHANGE").

```
Band 1 limits
Lo 467.2000 MHz
Hi 469.2000 MHz
BACK ▲▼ CHANGE
```

By pressing ▼ again the display will show the lower and higher limits of frequency **Band 2** (these values cannot be changed). (To change the active channel frequency value press "CHANGE").

```
Band 2 limits
Lo 467.2000 MHz
Hi 469.2000 MHz
BACK ▲▼ CHANGE
```

Press ▼ again and the display will return to show the center frequency (this value cannot be changed). (To change the active channel frequency value press "CHANGE").

```
Center freq.
Cf 468.2000 MHz
BACK ▲▼ CHANGE
```

## 8.2.2 Changing radio settings (transmitter output power and receiver sensitivity)

Press  $\Delta$  or  $\nabla$  until the cursor  $>$  points to "Radio settings" selection and press "SELECT" to move on to the submenu.

```
RF frequency
>Radio settings
Addressing
Port 1
Port 2
Handshaking
Additional
Tests
Factory set-up
Contrast
EXIT  ▲▼ SELECT
```

Press  $\Delta$  or  $\nabla$  until the cursor  $>$  points to the setting to be modified and press "CHANGE".

```
>TX level
Sig. Threshold
TX start delay
BACK  ▼ CHANGE
```

### MODIFYING TRANSMITTER OUTPUT POWER:

The displayed list consists off all possible values of transmitter output power. Press  $\Delta$  or  $\nabla$  until the cursor  $>$  points to the desired value and press "SET".

**NOTICE:** The starting position of the cursor indicates the previously set value.

```
>10mW
20mW
50mW
100mW
200mW
500mW
1000mW
CANCEL ▼ SET
```

### MODIFYING RECEIVER SENSITIVITY:

The displayed list consists off all possible values of receiver sensitivity. Press  $\Delta$  or  $\nabla$  until the cursor  $>$  points to the desired value and press "SET".

**NOTICE:** The starting position of the cursor indicates the previously set value.

```
min
>-118 dBm
-117 dBm
.
.
-81 dBm
-80 dBm
max
CANCEL ▲▼ SET
```

### MODIFYING THE TRANSMIT START DELAY:

The display will show the current value of the delay. Press "SET" to modify the value.

Press  $\Delta$  or  $\nabla$  until the first digit of the value has reached the desired value and then press "NEXT" to move on to the next digit.

```
TX start delay
Current value:
0 ms
CANCEL ▲▼ SET
```

```
TX start delay
>00000
▲
CANCEL ▲▼ NEXT
```

Repeat the above described five (5) times.

⋮

Press  $\Delta$  or  $\nabla$  until the last changeable digit has the desired value and finally confirm changes by pressing "SET".

```
TX start delay
>01234
▲
CANCEL ▲▼ SET
```

### 8.2.3 Changing addressing

Press  $\blacktriangle$  or  $\blacktriangledown$  until the cursor  $>$  points to "Addressing" selection and press "SET-UP" to move on to the submenu.

```
RF frequency
Radio settings
>Addressing
Port 1
Port 2
Additional
Test
Factory set-up
Contrast
EXIT ▲▼ SETUP
```

Select the desired submenu (RX or TX address) by pressing  $\blacktriangle$  or  $\blacktriangledown$  and finally press "CHANGE".

```
>RX addr OFF
TX addr OFF
BACK ▼ CHANGE
```

Press  $\blacktriangle$  or  $\blacktriangledown$  until the first digit of the address has reached the desired value and move on to the next digit by pressing "NEXT".

```
RX address
>0000 0000 OFF
▲
CANCEL ▲▼ NEXT
```

Repeat the above described eight (8) times.

Press NEXT again to jump to the toggle field (ON/OFF) and change the status to the desired value by pressing  $\blacktriangle$  and  $\blacktriangledown$  until correct status is reached. Confirm the new address and status (ON/OFF state) by pressing "SET".

The display will return to the previous (higher) level submenu.

```
RX Address
>0123 0123 ON
▲
CANCEL ▲▼ SET
```

**NOTICE:** Both RX and TX address modifications are done in the same above described way.

## 8.2.4 Changing serial port settings (Port 1 and Port 2)

Press  $\blacktriangle$  or  $\blacktriangledown$  until the cursor > points to the desired port (in this example to **Port 1**) and move on to the submenu by pressing "SELECT".

```
RF frequency
Radio settings
Addressing
>Port 1
Port 2
Handshaking
Additional
Tests
Factory set-up
Contrast
EXIT  $\blacktriangle$  $\blacktriangledown$  SELECT
```

Press  $\blacktriangle$  or  $\blacktriangledown$  until the cursor > points to the setting to be modified and then press "CHANGE".

```
>ON
19200 bit/s
8 bit data
None parity
1 stop bit
BACK  $\blacktriangle$  $\blacktriangledown$  CHANGE
```

### MODIFICATION OF PORT STATUS:

Press  $\blacktriangle$  or  $\blacktriangledown$  until the cursor > points to the desired port status. Confirm selection by pressing "SET". The display will return to the previous (higher) level submenu.

**NOTICE:** The starting position of the cursor indicates the previously set value.

```
>P1 ON / P2 OFF
P1 OFF / P2 ON
CANCEL  $\blacktriangle$  $\blacktriangledown$  SET
```

### MODIFICATION OF DATA TRANSFER SPEED:

Press  $\blacktriangle$  or  $\blacktriangledown$  until the cursor > points to the desired data transfer speed value (X bit/s). Confirm the selection by pressing "SET". The display will return to the previous (higher) level submenu.

**NOTICE:** The starting position of the cursor indicates the previously set value.

```
300 bit/s
600 bit/s
1200 bit/s
2400 bit/s
4800 bit/s
9600 bit/s
>19200 bit/s
38400 bit/s
CANCEL  $\blacktriangle$  $\blacktriangledown$  SET
```

### MODIFICATION OF THE NUMBER OF DATA BITS:

Press  $\blacktriangle$  or  $\blacktriangledown$  until the cursor > points to the desired number of data bits (7 or 8 or 9 bit data length). Confirm the selection by pressing "SET". The display will return to the previous (higher) level submenu.

**NOTICE:** The starting position of the cursor indicates the previously set value.

```
7 bit data
>8 bit data
9 bit data
CANCEL  $\blacktriangle$  $\blacktriangledown$  SET
```

### MODIFICATION OF PARITY BITS:

Press  $\blacktriangle$  and  $\blacktriangledown$  until the cursor > points to the desired parity bit status. Confirm the selection by pressing "SET". The display will return to the previous (higher) level submenu.

**NOTICE 1:** The starting position of the cursor indicates the previously set value.

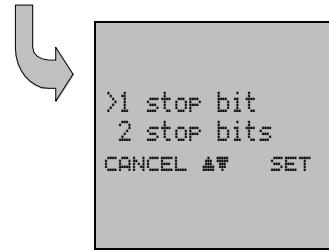
**NOTICE 2:** If the number of data bits is set to 9, the value of parity bits must be set to NONE (no parity).

```
>None parity
Even parity
Odd parity
CANCEL  $\blacktriangle$  $\blacktriangledown$  SET
```

MODIFICATION OF THE NUMBER OF STOP BITS:

Press ▲ or ▼ until the cursor > points to the desired number of STOP bits. Confirm selection by pressing "SET". The display will return to the previous (higher) level submenu.

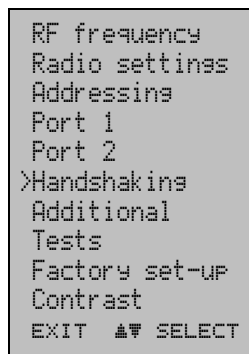
NOTICE: The starting position of the cursor indicates the previously set value.



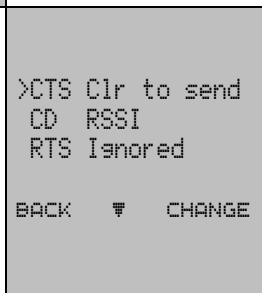
NOTICE: Port 2 settings are modified correspondingly.

8.2.5 Modification of handshaking functions

Press ▲ or ▼ until the cursor > points to "Handshaking" selection and move on to the submenu by pressing "SELECT".



There are three (3) submenus relating to handshaking parameters. Press ▲ and ▼ until the cursor > points to the desired submenu selection and press "CHANGE".



DEFINING CTS-LINE FUNCTIONS:

Press ▲ and ▼ until the desired function is indicated by the cursor > and confirm selection by pressing "SET". The display will return to the previous (higher) level submenu.



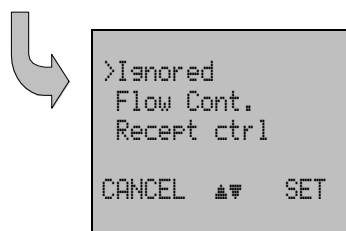
DEFINING CD-LINE FUNCTION:

Press ▲ and ▼ until the desired function is indicated by the cursor > and confirm selection by pressing "SET". The display will return to the previous (higher) level submenu.



DEFINING RTS-LINE STATUS:

Press ▲ and ▼ until the desired function is indicated by the cursor > and confirm selection by pressing "SET". The display will return to the previous (higher) level submenu.



### 8.2.6 Selecting special functions

Press  $\blacktriangle$  or  $\blacktriangledown$  until the cursor > points to "Additional" selection and press "SELECT" to move on to the submenu.

```
RF frequency
Radio settings
Addressing
Port 1
Port 2
>Additional
Test
Factory set-up
Contrast
EXIT  $\blacktriangle$  $\blacktriangledown$  SELECT
```

Press  $\blacktriangle$  or  $\blacktriangledown$  until the cursor > points to the setting to be modified. Press "CHANGE" to toggle the status of the said parameter from "ON" to "OFF" and vice versa. Press "CHANGE" until the parameter has the desired status. Repeat for all special functions to be modified and finally confirm all changes by pressing "BACK". The display will return to the previous (higher) level submenu.

```
>Error corr. OFF
Error check OFF
Repeater OFF
SL-commands OFF

BACK  $\blacktriangle$  $\blacktriangledown$  CHANGE
```

### 8.2.7 Activating tests

Press  $\blacktriangle$  or  $\blacktriangledown$  until cursor > points to "Tests" selection and press "SELECT" to move on to the submenu.

```
RF frequency
Radio settings
Addressing
Port 1
Port 2
Handshaking
Additional
>Tests
Factory set-up
Contrast
EXIT  $\blacktriangle$  $\blacktriangledown$  SELECT
```

Press  $\blacktriangle$  or  $\blacktriangledown$  until cursor > points to the test that is to be initiated. Press "CHANGE" to toggle the status of the selected test from "ON" to "OFF" and vice versa. Press "CHANGE" until the parameter has the desired status. After the tests have been set to desired states confirm all changes by pressing "BACK". The display will return to the previous (higher) level submenu.

```
>Short Block OFF
Long Block OFF

BACK  $\blacktriangle$  $\blacktriangledown$  CHANGE
```



### 8.2.8 Restoring factory settings

Press  $\blacktriangle$  or  $\blacktriangledown$  to move cursor  $>$  to point to "Factory set-up" selection and press "SELECT" to move on to the submenu.

```
RF frequency
Radio settings
Addressing
Port 1
Port 2
Additional
Test
>Factory set-up
Contrast
CANCEL  $\blacktriangle$  $\blacktriangledown$  SELECT
```

Press "YES" and all radio modem configuration settings will return to factory settings.  
**NOTICE:** The display will show the question two (2) times to make sure that restoring factory settings is actually intended.

```
Do you want to
restore factory
settings?
NO      YES
```

### 8.2.9 Adjusting the contrast of the LCD-display

Press  $\blacktriangle$  or  $\blacktriangledown$  to move the cursor  $>$  to point to "Contrast" selection and press "SELECT" to move on to the submenu.

```
RF frequency
Radio settings
Addressing
Port 1
Port 2
Additional
Test
Factory set-up
>Contrast
CANCEL  $\blacktriangle$  $\blacktriangledown$  SELECT
```

The display will show the current value of contrast. To modify contrast setting press "CHANGE".

```
Display contr.
3
BACK    CHANGE
```

Press  $\blacktriangle$  or  $\blacktriangledown$  until the cursor  $>$  points to the desired contrast level value. Confirm selection by pressing "SET". The display will return to the previous (higher) level submenu.

**NOTICE:** The modified contrast value will actually take effect only after the radio modem is switched out from the configuration mode back into data mode.  
**NOTICE:** The starting position of the cursor indicates the previously set value.

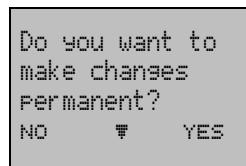
```
1
2
>3
4
5
CANCEL  $\blacktriangle$  $\blacktriangledown$  SET
```

### 8.2.10 Saving modified values into the internal memory

After all desired modifications have been performed they have to be saved in order to make them permanent (until next modification). This is accomplished by choosing selection "EXIT" from the main menu. The display will then show a message (see below) asking a confirmation of the performed modifications.

By choosing "YES" all modifications are saved into the non-volatile memory inside the radio modem. By choosing "NO" all modification performed are cancelled and previous settings remaining in the non-volatile memory.

Press "YES" to save all modifications into the non-volatile memory and "NO", if modifications are to be cancelled.



```
Do you want to
make changes
permanent?
NO      F      YES
```

## **8.3 Changing parameters using the SL-COMMANDS**

The terminal device controlling it can change the configuration settings of a radio modem. This is accomplished with the help of SL-commands, which can be used during data transfer. SL-commands can be used to change e.g. the frequency or addresses. It is also possible to interrogate a radio modem in order to gain information concerning current settings that are in use. The terminal device is either a PC or a programmable logic (PLC) together with suitable (terminal) program. SL-commands must be enabled using configuration mode before they can be used.

SL-commands are given using a continuous programming packet, which is separated from other data by pauses that are at least three (3) characters long. No extra characters are allowed at the end of such a programming packet. Serial interface settings are the same as in data transfer and pin 12 of the serial connector MUST NOT be connected to ground (GND). SL-commands themselves always end with ASCII character number 13 (CR, Carriage Return, 0x0d)\*.

When the power of a radio modem is switched off the configuration settings of a radio modem always return to values defined initially using the configuration mode, thus resetting any settings changed using SL-commands during power on. It is however possible to save settings changed by using SL-commands and to make them the new configuration settings.

The radio modem will acknowledge all commands by returning an OK (command carried out or accepted) message or an ERROR (command not carried out or interpreted as erroneous) message.

---

\* SATELLINE-2ASx –type SL-commands are provided for compatibility reasons.

### 8.3.1 Frequency

| Command       | Effect and description of command                                                                                                            |
|---------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| SL&F=nnn.nnnn | Set frequency to nnn.nnnn MHz                                                                                                                |
| SL&F?         | Display current frequency (response 'nnn.nnnn MHz')                                                                                          |
| SL&C?         | Display center frequency (response 'nnn.nnnn MHz')                                                                                           |
| SL&+=nn       | Set frequency nn channels above center frequency<br>Frequency = Center frequency + nn * Channel spacing, where nn=[0...Number of channels/2] |
| SL&-=nn       | Set frequency nn channels below center frequency<br>Frequency = Center frequency - nn * Channel spacing, where nn=[0...Number of channels/2] |
| SL&N?         | Display current frequency deviation from center frequency as channels<br>(Frequency - Center frequency)/Channel spacing                      |

### 8.3.2 Addressing

| Command   | Effect and description of command                                |
|-----------|------------------------------------------------------------------|
| SL#I=xxxx | Set all addresses (RX1, RX2, TX1, TX2) to value xxxx             |
| SL#I?     | Display both primary addresses (TX1, RX1) (response 'xxxx;xxxx') |
| SL#T=xxxx | Set both transmit addresses (TX1, TX2) to value xxxx             |
| SL#T?     | Display primary transmit address (TX1)                           |
| SL#R=xxxx | Set both receive addresses (RX1, RX2) to value xxxx              |
| SL#R?     | Display primary receive address (RX1)                            |

xxxx = address in hexadecimal format (0000 ... FFFF)

### 8.3.3 Radio parameters

| Command   | Effect and description of command                                                                                                                                                                                                                                                             |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SL@R?     | Display field strength of the last received message (the value is an average of many measurements made during the same reception).<br>Response "-xx dBm;-xx dBm", where xx is a decimal value of the field strength. Two values returned only if there is a diversity receiver in the device. |
| SL@P=xxxx | Set the RF output power, where xxxx is the decimal value of the intended power in milliwatts. If the given value does not correspond to one of the programmed power levels, the output power is set to the nearest possible value.                                                            |
| SL@P?     | Requests the RF output power.<br>Response "xxxx mW", where xxxx is a decimal value the output power of the transmitter.                                                                                                                                                                       |
| SL@T=-xxx | Set the minimum power level of the signal to be received (= "Signal Treshold level), where xxx is a decimal value of the new intended level in dBm.                                                                                                                                           |
| SL@T?     | Request of the current "Signal Treshold Level". Response is "-xxx dBm.                                                                                                                                                                                                                        |

### 8.3.4 Other functions

| Command | Effect and description of command                        |
|---------|----------------------------------------------------------|
| SL**>   | Save current settings as permanent settings              |
| SL%V?   | Display software revision information (response 'Vn.nn') |

### 8.3.5 SATELLINE-2ASx/2ASxE –compatible SL-commands

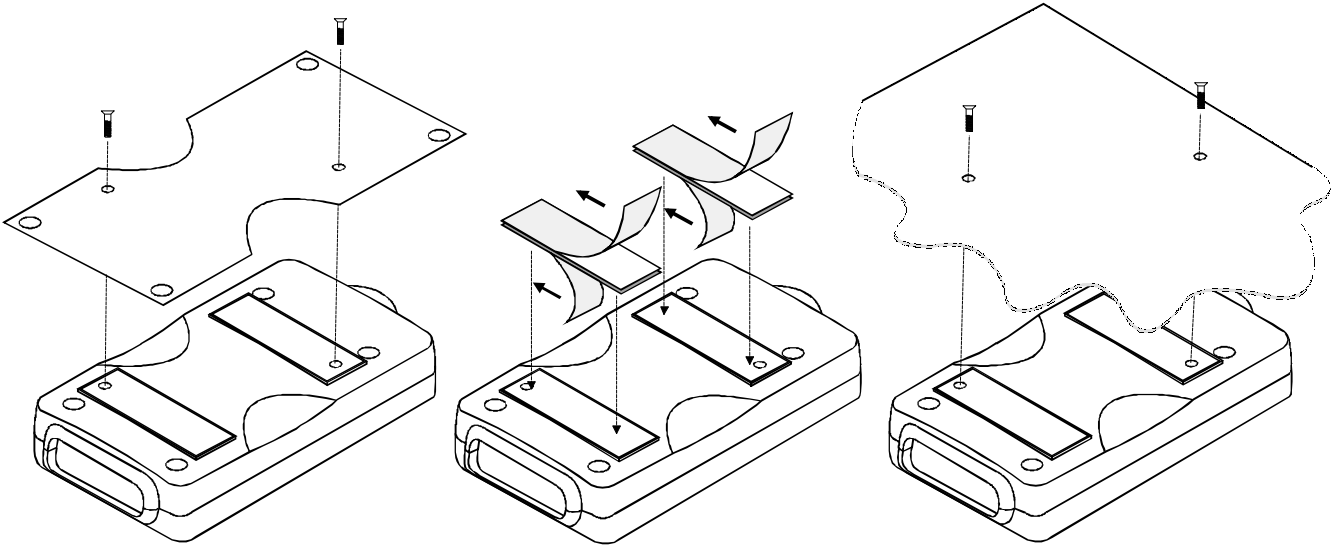
The commands listed in the table below are included only to ensure compatibility and their use is not recommended in new networks. The commands do not need a CR-character (carriage return) at the end of the command string.

| Command | Effect and description of command                                                                                          |
|---------|----------------------------------------------------------------------------------------------------------------------------|
| SLHxx   | Set frequency xx channels above center frequency.<br>Frequency = Center frequency + xx*Channel spacing, where xx=[00...99] |
| SLLxx   | Set frequency xx channels below center frequency.<br>Frequency = Center frequency - xx*Channel spacing, where xx=[00...99] |
| SLAxx   | Set all addresses (RX1, RX2, TX1, TX2) to value xx, where xx=[00h...FFh]                                                   |
| SLTxx   | Set both transmit addresses (TX1, TX2) to value xx, where xx=[00h...FFh]                                                   |
| SLRxx   | Set both receive addresses (RX1, RX2) to value xx, where xx=[00h...FFh]                                                    |
| SLSOS   | Save current settings as permanent settings                                                                                |

## 9 INSTALLATION

### 9.1 Installation of a Radio Data Modem

The radio modem should be installed with the installation accessories supplied with the radio modem. There is also an installation part for mounting the radio modem to DIN rail available.



1. Installation with the installation plate supplied with the radio modem. The installation plate is fastened to the backside of the radio modem.

The installation plate can be mounted using the holes provided on the plate.

2. Installation using the Velcro-tape provided with the radio modem.

3. Installation can also be made directly to customer equipment.

#### NOTE!

When selecting a suitable location for the radio modem it must be ensured that no water can get into the radio modem under any conditions. Direct sunlight is also to be avoided. It is not recommendable to install the radio modem on a strongly vibrating surface. Suitable dampening and/or isolation materials should be used in cases where the installation surface

## 9.2 Connection cables

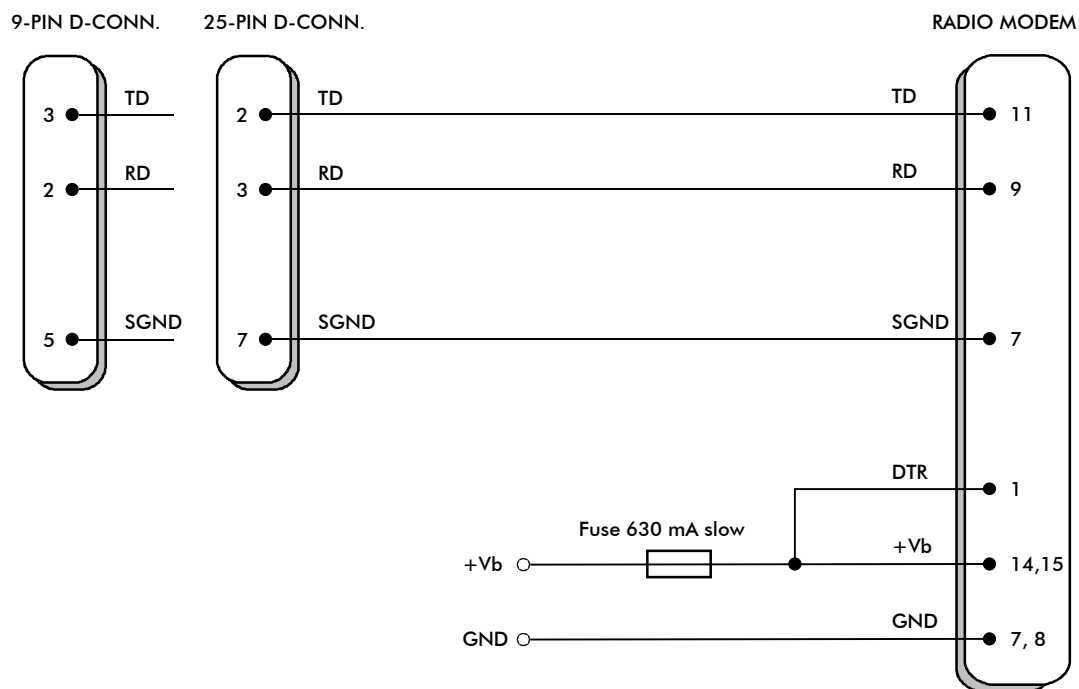
### NOTE!

When installing RS-Interface cables operating voltage of all devices must be off (POWER OFF condition).

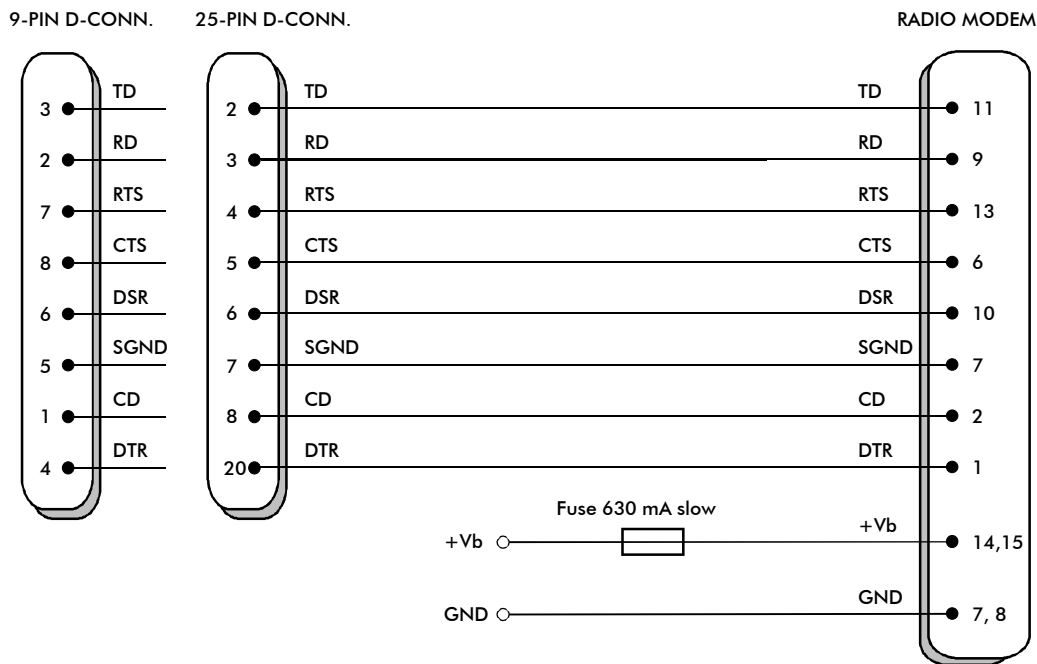
Due to the greater current consumption of SATELLINE-3AS EPIC operating voltage must be connected to pins 14 AND 15, and ground to pins 7 AND 8. Correct fuse rating is in this case 4 A (SLOW FUSE).

### 9.2.1 RS-232 -wiring

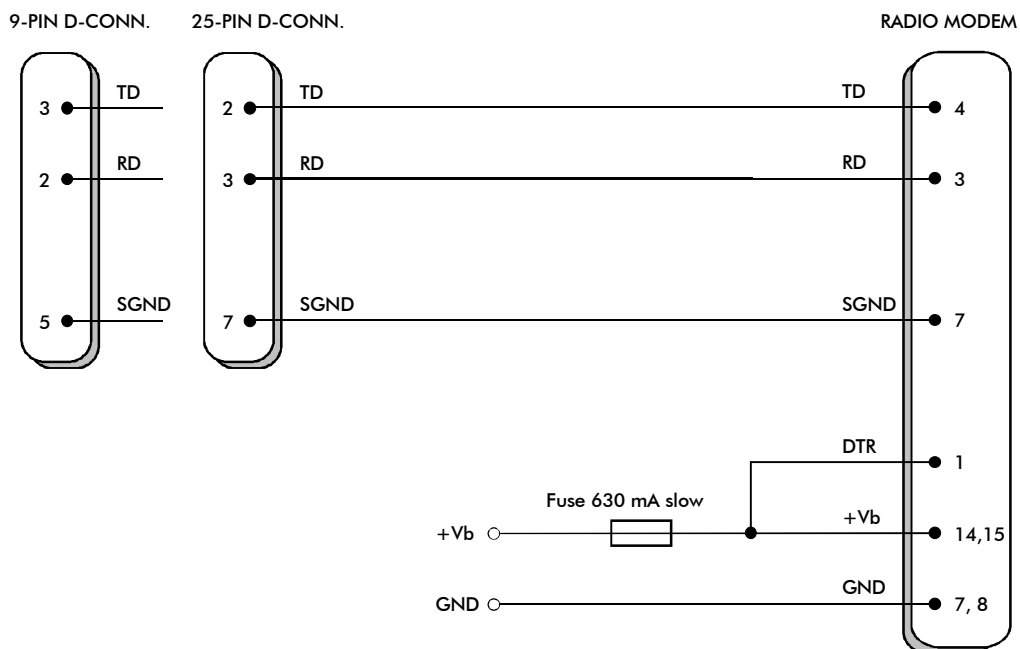
Basic RS-232 connection between the radio modem (PORT1) and a typical PC (COM-port):



Basic RS-232 connection between the radio modem (PORT1) and a typical PC (COM-port) using handshaking:

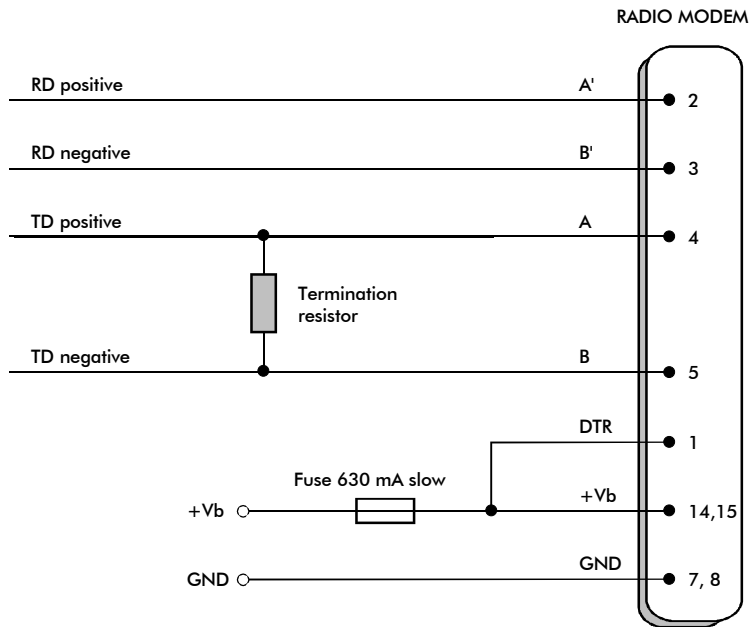


RS-232 connection between a radio modem (PORT2 in RS-232 mode) and a typical PC (COM-port):



9.2.2 RS-422 -wiring

PORT2 RS-422 connection:



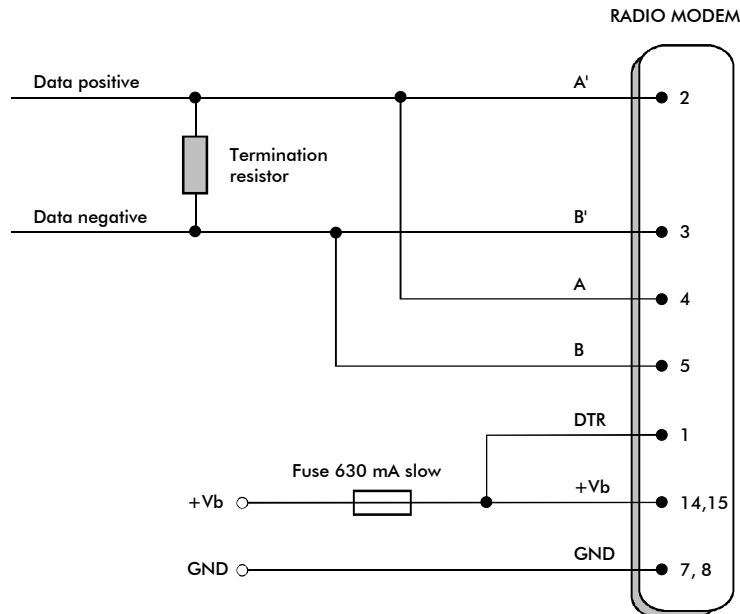
If the transmission lines are long the receiving end of the lines must be terminated using a separate termination resistor (typical values range from 100 -120  $\Omega$  depending on the characteristic impedance of the transmission line).



### 9.2.3 RS-485 wiring

#### PORT2 RS-485 connection:

Both ends of the transmission line must be terminated by connecting a separate terminating resistor (typical value range from 100 – 120  $\Omega$  depending on the characteristic impedance of the line) between the positive and negative signal wire.



### 9.2.4 Power supply

The allowed operating voltage is 9 - 30 V<sub>DC</sub>. Power supply cables must be connected only to a power supply with adequate current output (power rating minimum is 10W, with the EPIC-model 50W). The pin 15 of the D-connector is connected to the positive power supply line. Negative power supply line (ground) is connected to pin 8 of the D-connector. The DTR-line of the radio modem which is connected to pin 1 can be used as an ON/STAND-BY –switch, by which the radio modem can be switched either ON (operational state) or OFF (stand by). The logical state "1" (+5...+30 V) of the DTR-line corresponds to ON-state and a logical state "0" (0 V... -12 V) corresponds to a STAND-BY –state.

Especially in applications, where the radio modem is used as a portable device (meaning battery operation), the DTR-line (pin 1) should be connected to a logical state "0" always when it is possible to conserve battery power and prolong operational time between battery charging.

## **9.3 Antenna installation**

### **NOTICE!**

Because of the great transmission power of SATELLINE-3AS EPIC radio modem, only an external antenna is allowed. A whip-antenna directly connected to the antenna connector must not be used.

### 9.3.1 Hand-held equipment

- $\frac{1}{4}$ -wave antenna (wavelength at frequency of 450 MHz is approximately 70 cm)
- Helix-antenna

Antennas are installed directly to the TNC-type antenna connector at the upper part of the radio modem.

### 9.3.2 Mobile equipment

- $\frac{1}{4}$ -wave antenna
- $\frac{1}{2}$ -wave antenna

The ideal installation position is vertical and there should be at least 0.5 m of free space around the antenna. In small systems a  $\frac{1}{4}$ -wave antenna is sufficient. A separate ground plane should be placed under the antenna (vehicle rooftop or the engine hood or trunk door are usually suitable). In problematic cases the most suitable type is a  $\frac{1}{2}$ -wave antenna. It can be installed directly at the top of a pipe with the added benefit of gaining as much as free space around the antenna as possible. In cases which the antenna cannot be directly connected to the TNC-connector of the radio modem, a coaxial cable with 50  $\Omega$  impedance must be used between the antenna and the TNC-connector.

### 9.3.3 Base stations

- omnidirectional antennas (  $\frac{1}{4}$ - ,  $\frac{1}{2}$ - or  $\frac{5}{8}$ -wave antenna)
- directional antennas (yagi/multielement antenna or corner antenna)

The antenna should be installed in a vertical position. The exact location of the antenna depends on several factors, such as the size of the overall system and the coverage area terrain contours. A rule of thumb is that the base station antenna should be located at the highest point of the coverage area and as close to the center of the coverage area as possible. The base station antenna can also be located inside a building, if the walls of the building do not contain metal.

#### 9.3.4 General antenna installation instructions

In cases where connection distances are long or in otherwise unfavourable cases the reliability of the radio connection depends on the antennas and the way they are installed. Antenna and cable connectors should also have gold-plated pins and sockets. Use of low quality connectors usually leads to eventual oxidation of the connector surfaces that will degrade the contact and cause additional attenuation. Only first class tools and materials must be used when installing radio modems, antennas and cables. One factor to consider is also the weather tolerance of the materials used. Installed materials must withstand all foreseeable weather conditions (frost, excess sun, direct UV-radiation, seawater etc.). Also possible environmental pollution must be considered (acids, ozone etc.).

Antennas must be installed far enough from metallic objects. In the case of small antennas this distance should be at least  $\frac{1}{2}$  m. With large antennas the distance should be  $>5$  m and in case of repeater antenna combinations  $>10$  m.

If the system contains a large number of radio modems, the best location for an antenna is the highest point of a building and possibly an additional antenna mast. If a separate antenna mast is used, the antenna can, if necessary, be installed sideways about 2...3 m from the mast itself.

When installing an antenna possible interference sources must be considered. Such interference sources are, for example:

- mobile telephone network base station antennas
- public telephone network base station antennas
- television broadcast antennas
- radio relay antennas
- other radio modem systems
- PC-related devices (approximately 5 m radius from antenna)

When ordering antennas we request you to note that antennas are always tuned to a specific frequency range. Simple antennas and antennas, which have been constructed of stacked yagi-antennas, are typically rather broadband. As the number of yagi-elements increases the frequency range becomes narrower.

When designing and installing a system it is advisable to prepare to test the system and also to consider serviceability of the system. Especially cabling should be planned to allow easy access to different parts and to allow changing of parts. It is usually practical to use rather long antenna cables, so that the radio modem can be installed far enough from the antenna itself to a location that is easily accessible.

The type of the antenna cable is dependent on the length of the antenna cable, and the following table can be used to select a suitable type:

| Length  | Type                 | Attenuation 10m/450MHz |
|---------|----------------------|------------------------|
| <5m     | RG58                 | 3.0dB                  |
| 0...20m | RG213                | 1.5dB                  |
| >20m    | NK Cable RFF 1/2"-50 | 0.7dB                  |
| >20m    | AirCom+              | 0.8dB*                 |

\*) AirCom+ cable is partially air insulated, so the use of this cable requires that the connection between the cable and the connectors are fully airtight.

If there is a line-of-sight path between the antennas a 6 dB power marginal is usually adequate. Instead, if the connection is built on the reflection and/or the knife-edge diffraction the path loss can vary even 20 dB depending on the weather conditions. In this case a short test can give a too positive result of the quality of the connection. Thus the height of the antennas and topographical obstacles must be surveyed with great care. From time to time a marginal connection can be used if the data transmission protocol is well prepared for this and the data transmission that occasionally slows down does not cause any problems to the system.

Vertical polarised antennas (antenna elements are in vertical position) are often used in radio systems. In a system between a base station and substations the vertical polarisation is generally recommendable. The antenna of the radio modem can not be mounted on the same level with the other substation antennas in the same building. The best way to distinguish from the other antennas situated in the neighbourhood is to mount the antennas as far as possible from each other on the altitude level. The best result is generally obtained when all the antennas are in the same mast. With an extra ground plane between the antennas more distinction can be obtained between the antennas in the mast.

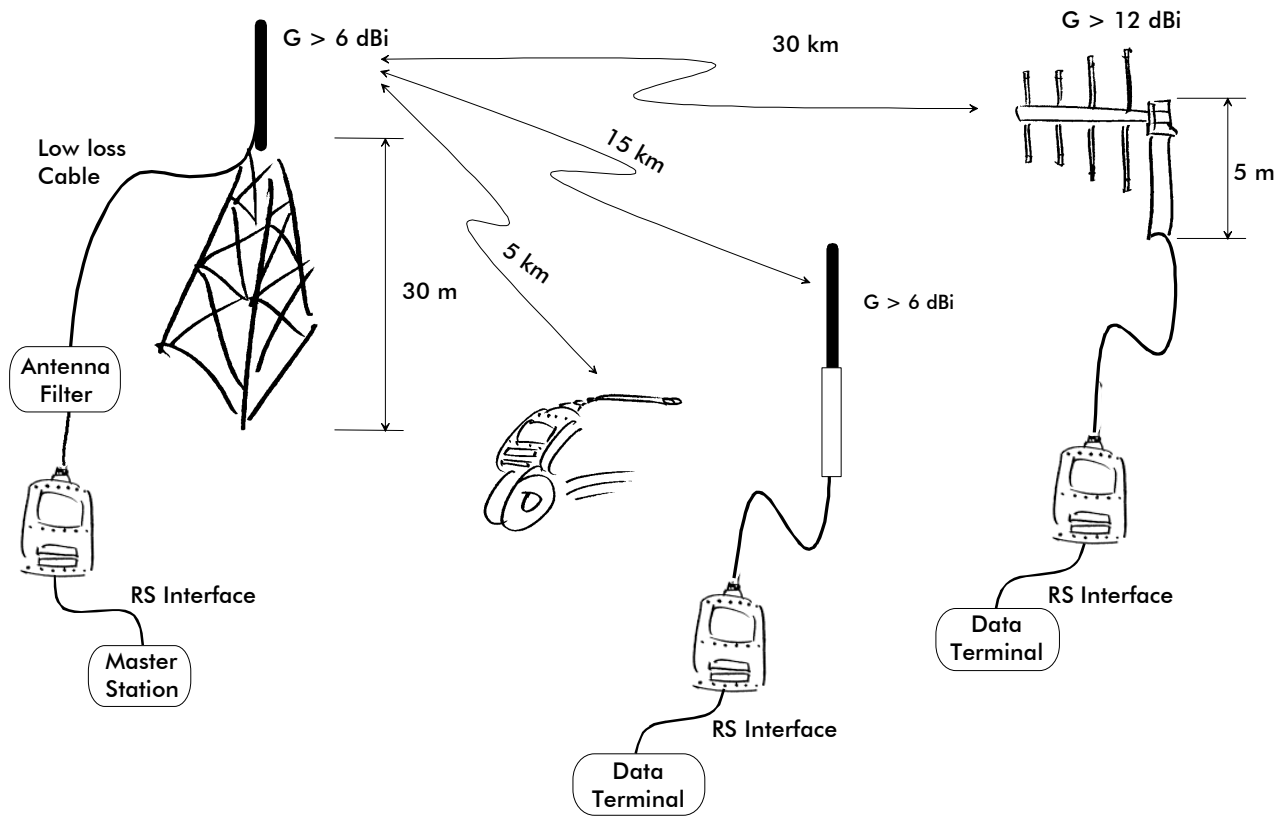
Horizontal polarisation can be used in data transmission between two points. With the polarisation attenuation more distinction is obtained to vertical polarised systems. The influence of the directional patterns of the antennas must, however, be taken into consideration. If a distinction to another interfering antenna is wanted with the horizontal polarised antennas there must be a good attenuation of the back lobe. In addition to this the interfering radiator should be situated behind the antenna.

When a system does not demand the use of an omnidirectional antenna it is recommendable to use directional antennas e.g. two-element yagis in firm external installations. As the antenna amplification increases the setting of the direction of the antenna demands for a greater care.

The base stations in high places should be supplied with 4...6 degree band-pass filters. Please note that the higher the antenna the larger the coverage area. The disadvantages of a too high antenna installation at the base station are that interference from a larger area affects the base station and that the base station occupies the channel for a too large area.

SATEL recommends the use of a bandpass filter with a large Q in the antenna cable of the base station.

Example of an antenna installation: by using amplifying antennas ( $G$ =Gain) and by installing the antenna high, long connection distances can be realised using the SATELLINE-3AS radio modem.



## 10 DESIGNING SYSTEMS

### **10.1 Factors affecting the quality and distance of the radio connection**

- power of the radio transmitter
- sensitivity of the radio receiver
- tolerance of spurious radiation's of the radio modulating signal
- amplification of transmitting and receiving antennas
- antenna cable attenuation
- antenna height
- natural obstacles
- interference caused by other electrical equipment

The transmitter power of the base model of SATELLINE-3AS is 1 W (maximum) and the sensitivity of the receiver better than -115 dBm. Thus in a flat area and in free space with a 1/4 wave antenna (antenna amplification 1dBi) and antenna height of 1 m communication distances of 3 to 4 km can be achieved. Distances may be considerably shorter in situations where there are metallic walls or other material inhibiting the propagation of radio waves.

Over long distances, increasing the height of antennas can often solve problems caused by natural obstacles. A ten-fold increase in distance can be achieved with the use of amplifying antennas. Frequent topographical variations over long distances may require that at least one of the antennas be raised to a height of 10 to 20 m.

If the antenna cable is more than 10 meters long it is necessary to use a low loss cable ( $< 0.7$  dB /10 m) in order not to waste the antenna amplification. Adding a repeater station can also solve problematical radio connections. In systems with many base stations the RSSI-signal can be used to assist in choosing the base station with the best signal. A communications network can also be built with a combination of cables and radio data modems.

The SATELLINE-3AS radio data modem operates in the 450 MHz band, where man made interference is insignificant. Long distance interference need not to be taken into account even in special weather conditions.

The SATELLINE-3AS tolerates normal levels of interference that occur. However, exceptionally high levels of interference can break through the safeguards and thus cause errors in data transfer. In mobile vehicle applications the range of operation can be increased by dividing the transmitted data into e.g. 50...500 byte long blocks and by re-transmitting the defected blocks.

A sufficient safety margin can be obtained by testing the communication path using extra 6 dB attenuation at the antenna connection and with slightly less effective antennas than those to be used in the final system.

## **10.2 Radio field strength**

Radio signal strength must be good enough for successful data transfer. Where field strength is above a certain level the operational results are very good. Below this level, a few dB marginal areas occur in which errors begin to be generated by noise and interference that will eventually lead to loss of connection.

The field strength is at its optimum level in open space, although increasing distance will still reduce it. It must also be remembered that one open space has different environmental and external factors to another, and that the effects on transmission quality must be taken into account when planning the system.

Ground, ground contours and buildings cause attenuation (loss of energy through absorption) and reflection of radio waves. Buildings reflect radio waves and therefore the affects of attenuation are not as acute when transmission is over a short distance.

However, the reflected waves will often be a bit delayed, and when they combine with the direct radio waves they interact in either a weakening or a strengthening way. This causes the fading effect in mobile systems. In reality very sharp signal drops spaced about 35 cm apart may occur. The attenuation may even reach 40 dB, normally less.

## **10.3 Remarks concerning the 869 MHz frequency band**

According to a recommendation of ETSI, the frequencies range 869.4...869.65 MHz is reserved for use of license free radio appliances. The application of this recommendation varies in each country, and for this reason local regulations concerning this frequency range must always be checked.

In frequency range 869.4...869.65 MHz, the maximum allowed radiated power of an antenna is 500 mW erp (+27dBm). When calculating the power antenna cable attenuation and antenna gain must be taken into account. For example, if the gain of the antenna is 10 dBd and the attenuation of the antenna cable used is -3dB, the maximum allowed transmission power is 100 mW (+20 dBm). It should be noted that by increasing the gain of the antennas, connection distance could be increased. This is due to the fact that the output power of the transmission remains constant, but the added antenna gain of the receiving end will enable reception of weaker signals than otherwise possible.

System designers must also take into account that at the frequency range of 869.4...869.65 MHz the transmitter is allowed to be ON only 10% of the time. Whether this limit is exceeded or not, depends on the protocol used. At a frequency range of 869 MHz there are in addition to the frequency channel 869.4...869.65 MHz also other ranges, but at these ranges the maximum allowed radiated power is 25 mW and the transmitter is allowed to be ON only 1 % or 0.1 % of the time.

## 11 CHECK LIST

The following points must be taken into account when installing and configuring a radio modem:

1. All operating voltages of all the equipment concerned must always be switched OFF before connecting the RS-interface cable.
2. When considering the exact placement of a radio modem and/or its antenna, the following points must be taken into account to guarantee optimal results:
  - The antenna should be installed in open space as far as possible from any possible sources of interference
  - The radio modem should not be installed onto a strongly vibrating surface
  - The radio modem should be installed in such a way as to minimise exposure to direct sunlight or excessive humidity.
3. To ensure reliable operation the voltage output of the power supply used must be stable enough and the current capability of the power supply must be sufficient.
4. The antenna must be installed according to instructions.
5. Settings of the radio modem must correspond to settings of the terminal.
6. All radio modems in the same system must be configured using same settings (radio frequency, channel spacing and data field length). See Chapter 4.1.



## 12 ACCESSORIES

### 12.1 RS-232-cables and adapters

| Type   | Description                          | Length | Note                                                       |
|--------|--------------------------------------|--------|------------------------------------------------------------|
| ARS-1F | Interface cable adapter D15 m / D9 f | -      | including 2 m power supply cables a and programming switch |
| CRS-9  | Interface cable D9 m / D9 f          | 2 m    | -                                                          |
| CRS-1M | Interface cable D15 m / D25 m        | 2 m    | including power supply cables                              |
| CRS-1F | Interface cable D15 m / D25 f        | 2 m    | including power supply cables                              |
| CRS-2M | Interface cable D15 m / D9 m         | 2 m    | including power supply cables                              |
| CRS-2F | Interface cable D15 m / D9 f         | 2 m    | including power supply cables                              |

Note! In the description, m=male, f=female connector type.

### 12.2 RS-485/422-cables and adapters

| Type  | Description                                     | Length | Note                                            |
|-------|-------------------------------------------------|--------|-------------------------------------------------|
| ARS-2 | Interface cable adapter D15 m / screw terminals | -      | Screw terminals for RS-485/422 and power supply |

### 12.3 RF-cables

| Type    | Description                                      | Length | Note             |
|---------|--------------------------------------------------|--------|------------------|
| CRF-1   | Cable with TNC m/TNC f-connectors                | 1 m    | RG58 (3 dB/10 m) |
| CRF-5F  | Cable with TNC m/TNC f-connectors                | 5 m    | RG58 (3 dB/10 m) |
| CRF-5M  | Cable with TNC m/TNC m-connectors                | 5 m    | RG58 (3 dB/10 m) |
| CRF-20  | Cable for connecting a booster and a radio modem | 20 cm  |                  |
| RG213   | Low loss cable                                   | X      | 1,5 dB/10 m      |
| AIRCOM+ | Low loss cable                                   | X      | 0,7 dB/10 m      |

Note! In the description, m=male, f=female connector type.

## **12.4 Antennas**

| Type             | Description                                     |
|------------------|-------------------------------------------------|
| GAINFLEX 400-430 | Half-wave antenna                               |
| GAINFLEX 430-470 | Half-wave antenna                               |
| CA420Q           | Sleeve fed quarter wave whip, 2dBi, 405–440 MHz |
| CA450Q           | Sleeve fed quarter wave whip, 2dBi, 440-475 MHz |
| MINIFLEX 400-430 | Helix antenna                                   |
| MINIFLEX 430-470 | Helix antenna                                   |

SATEL antenna selection includes also directional and/or omnidirectional antenna. These can be supplied separately on request. Antennas are also available for the 869 MHz frequency range.

## **12.5 Filters and lightning protectors**

If a radio modem system is installed in an environment that contains high-power transmitters or sources of radio frequency interference, it is highly recommendable to insert suitable filters between each radio modem and its antenna. If a station is installed to a location exposed to lightning, it is recommended to insert a lightning protector to the feed-line outside the protected zone. SATEL Customer Support can give guidance in the selection of suitable filters or protectors.

## **12.6 Power supplies**

| Type  | Description       |
|-------|-------------------|
| MAS-2 | 220 Vac/12 Vdc/1A |
| MAS-4 | 220 Vac/12 Vdc/5A |

## **12.7 Batteries**

| Type        | Description                         |
|-------------|-------------------------------------|
| SATELSET-60 | Battery Pack with a 60 mm Belt Clip |
| SATELSET-90 | Battery Pack with a 90 mm Belt Clip |
| SET-BC      | Battery Cassette, 1800 mAh capacity |
| SET-C       | Charger                             |
| SET-IC      | Installation Cradle                 |

## **12.8 Installation and enclosures**

| Type  | Description                                                             |
|-------|-------------------------------------------------------------------------|
| I-DIN | Installation plate for DIN rail mounting                                |
| H-WP  | Weather proof housing IP54                                              |
| H-EX  | Housing for potentially explosive environment, EEx d IIC T6 (also IP67) |

**13 APPENDIX A**

| ASCII CHARACTER TABLE |    |    |    |    |   |     |    |   |     |    |   |     |    |   |
|-----------------------|----|----|----|----|---|-----|----|---|-----|----|---|-----|----|---|
| D                     | H  | A  | D  | H  | A | D   | H  | A | D   | H  | A | D   | H  | A |
| 0                     | 0  |    | 43 | 2B | + | 86  | 56 | V | 129 | 81 |   | 172 | AC |   |
| 1                     | 1  |    | 44 | 2C | , | 87  | 57 | W | 130 | 82 |   | 173 | AD |   |
| 2                     | 2  |    | 45 | 2D | - | 88  | 58 | X | 131 | 83 |   | 174 | AE |   |
| 3                     | 3  |    | 46 | 2E | . | 89  | 59 | Y | 132 | 84 |   | 175 | AF |   |
| 4                     | 4  |    | 47 | 2F | / | 90  | 5A | Z | 133 | 85 |   | 176 | B0 |   |
| 5                     | 5  |    | 48 | 30 | 0 | 91  | 5B | [ | 134 | 86 |   | 177 | B1 |   |
| 6                     | 6  |    | 49 | 31 | 1 | 92  | 5C | \ | 135 | 87 |   | 178 | B2 |   |
| 7                     | 7  |    | 50 | 32 | 2 | 93  | 5D | ] | 136 | 88 |   | 179 | B3 |   |
| 8                     | 8  |    | 51 | 33 | 3 | 94  | 5E | ^ | 137 | 89 |   | 180 | B4 |   |
| 9                     | 9  |    | 52 | 34 | 4 | 95  | 5F | ~ | 138 | 8A |   | 181 | B5 |   |
| 10                    | A  |    | 53 | 35 | 5 | 96  | 60 | ` | 139 | 8B |   | 182 | B6 |   |
| 11                    | B  |    | 54 | 36 | 6 | 97  | 61 | a | 140 | 8C |   | 183 | B7 |   |
| 12                    | C  |    | 55 | 37 | 7 | 98  | 62 | b | 141 | 8D |   | 184 | B8 |   |
| 13                    | D  |    | 56 | 38 | 8 | 99  | 63 | c | 142 | 8E |   | 185 | B9 |   |
| 14                    | E  |    | 57 | 39 | 9 | 100 | 64 | d | 143 | 8F |   | 186 | BA |   |
| 15                    | F  |    | 58 | 3A | : | 101 | 65 | e | 144 | 90 |   | 187 | BB |   |
| 16                    | 10 |    | 59 | 3B | ; | 102 | 66 | f | 145 | 91 |   | 188 | BC |   |
| 17                    | 11 |    | 60 | 3C | < | 103 | 67 | g | 146 | 92 |   | 189 | BD |   |
| 18                    | 12 |    | 61 | 3D | = | 104 | 68 | h | 147 | 93 |   | 190 | BE |   |
| 19                    | 13 |    | 62 | 3E | > | 105 | 69 | i | 148 | 94 |   | 191 | BF |   |
| 20                    | 14 |    | 63 | 3F | ? | 106 | 6A | j | 149 | 95 |   | 192 | C0 |   |
| 21                    | 15 |    | 64 | 40 | @ | 107 | 6B | k | 150 | 96 |   | 193 | C1 |   |
| 22                    | 16 |    | 65 | 41 | A | 108 | 6C | l | 151 | 97 |   | 194 | C2 |   |
| 23                    | 17 |    | 66 | 42 | B | 109 | 6D | m | 152 | 98 |   | 195 | C3 |   |
| 24                    | 18 |    | 67 | 43 | C | 110 | 6E | n | 153 | 99 |   | 196 | C4 |   |
| 25                    | 19 |    | 68 | 44 | D | 111 | 6F | o | 154 | 9A |   | 197 | C5 |   |
| 26                    | 1A |    | 69 | 45 | E | 112 | 70 | p | 155 | 9B |   | 198 | C6 |   |
| 27                    | 1B |    | 70 | 46 | F | 113 | 71 | q | 156 | 9C |   | 199 | C7 |   |
| 28                    | 1C |    | 71 | 47 | G | 114 | 72 | r | 157 | 9D |   | 200 | C8 |   |
| 29                    | 1D |    | 72 | 48 | H | 115 | 73 | s | 158 | 9E |   | 201 | C9 |   |
| 30                    | 1E |    | 73 | 49 | I | 116 | 74 | t | 159 | 9F |   | 202 | CA |   |
| 31                    | 1F |    | 74 | 4A | J | 117 | 75 | u | 160 | A0 |   | 203 | CB |   |
| 32                    | 20 |    | 75 | 4B | K | 118 | 76 | v | 161 | A1 |   | 204 | CC |   |
| 33                    | 21 | !  | 76 | 4C | L | 119 | 77 | w | 162 | A2 |   | 205 | CD |   |
| 34                    | 22 | "  | 77 | 4D | M | 120 | 78 | x | 163 | A3 |   | 206 | CE |   |
| 35                    | 23 | #  | 78 | 4E | N | 121 | 79 | y | 164 | A4 |   | 207 | CF |   |
| 36                    | 24 | \$ | 79 | 4F | O | 122 | 7A | z | 165 | A5 |   | 208 | D0 |   |
| 37                    | 25 | %  | 80 | 50 | P | 123 | 7B | { | 166 | A6 |   | 209 | D1 |   |
| 38                    | 26 | &  | 81 | 51 | Q | 124 | 7C |   | 167 | A7 |   | 210 | D2 |   |
| 39                    | 27 | '  | 82 | 52 | R | 125 | 7D | } | 168 | A8 |   | 211 | D3 |   |
| 40                    | 28 | (  | 83 | 53 | S | 126 | 7E | ~ | 169 | A9 |   | 212 | D4 |   |
| 41                    | 29 | )  | 84 | 54 | T | 127 | 7F |   | 170 | AA |   | 213 | D5 |   |
| 42                    | 2A | *  | 85 | 55 | U | 128 | 80 |   | 171 | AB |   | 214 | D6 |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 215 | D7 |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 216 | D8 |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 217 | D9 |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 218 | DA |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 219 | DB |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 220 | DC |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 221 | DD |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 222 | DE |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 223 | DF |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 224 | E0 |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 225 | E1 |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 226 | E2 |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 227 | E3 |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 228 | E4 |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 229 | E5 |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 230 | E6 |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 231 | E7 |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 232 | E8 |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 233 | E9 |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 234 | EA |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 235 | EB |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 236 | EC |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 237 | ED |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 238 | EE |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 239 | EF |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 240 | F0 |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 241 | F1 |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 242 | F2 |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 243 | F3 |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 244 | F4 |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 245 | F5 |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 246 | F6 |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 247 | F7 |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 248 | F8 |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 249 | F9 |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 250 | FA |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 251 | FB |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 252 | FC |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 253 | FD |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 254 | FE |   |
|                       |    |    |    |    |   |     |    |   |     |    |   | 255 | FF |   |

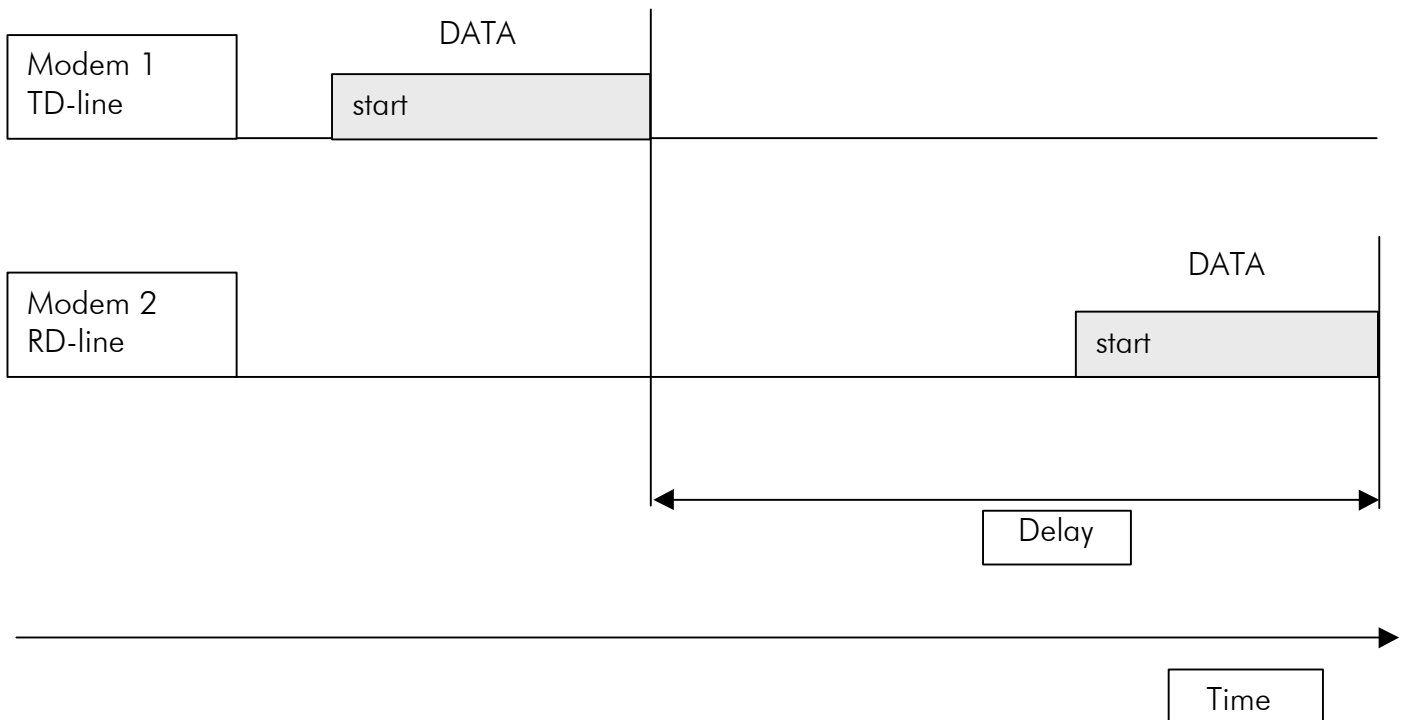
## 14 APPENDIX B

### 14.1 Functional delays

| Function                            | Delay (ms)          |
|-------------------------------------|---------------------|
| Wakeup time DTR STAND-BY/ON         | 500                 |
| RS interface turnaround time RS-232 | 0                   |
| RS interface turnaround time RS-485 | <1                  |
| Intercharacter delay                | max. 2-3 characters |

### 14.2 Transmission related delays

Delay from the end of transmission to the end of reception on the RS-interface:



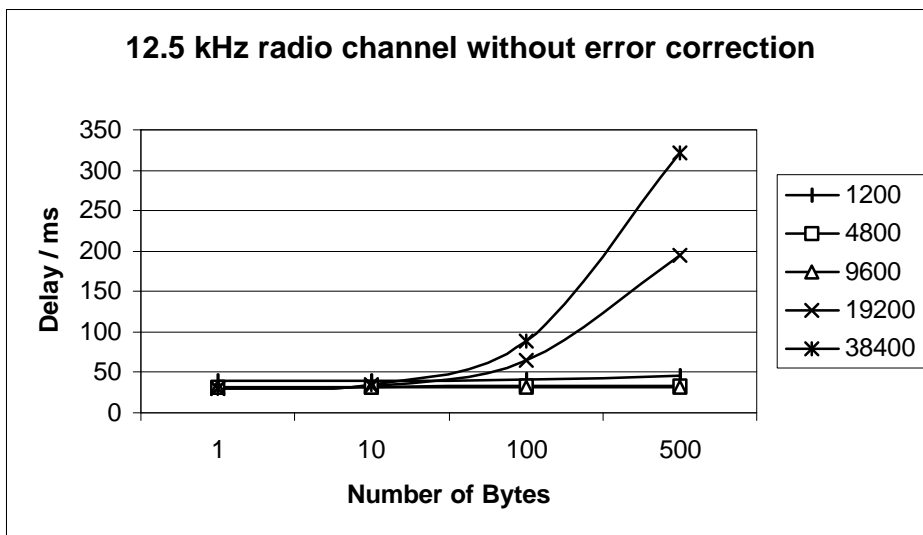
14.2.1 Transmission delays when using a 12,5 kHz radio channel

Transmission delays without FEC-function (Forward Error Correction).

Number of bytes sent

| Bps   | 1  | 10 | 100 | 500 |
|-------|----|----|-----|-----|
| 1200  | 40 | 40 | 41  | 46  |
| 4800  | 32 | 32 | 33  | 34  |
| 9600  | 31 | 31 | 31  | 31  |
| 19200 | 30 | 34 | 65  | 195 |
| 38400 | 30 | 35 | 88  | 322 |

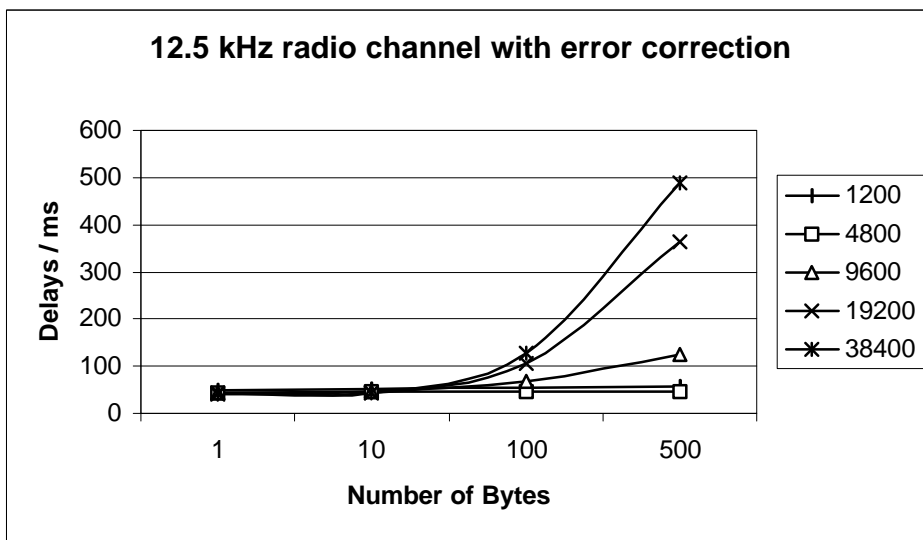
Delays are in milliseconds and with a 10% margin.



Transmission delays with FEC-function (Forward Error Correction).

|       |    | Number of bytes sent |     |     |  |
|-------|----|----------------------|-----|-----|--|
| Bps   | 1  | 10                   | 100 | 500 |  |
| 1200  | 50 | 51                   | 53  | 58  |  |
| 4800  | 44 | 45                   | 45  | 46  |  |
| 9600  | 43 | 45                   | 67  | 126 |  |
| 19200 | 43 | 43                   | 105 | 364 |  |
| 38400 | 42 | 43                   | 128 | 490 |  |

Delays are in milliseconds and with a 10% margin.



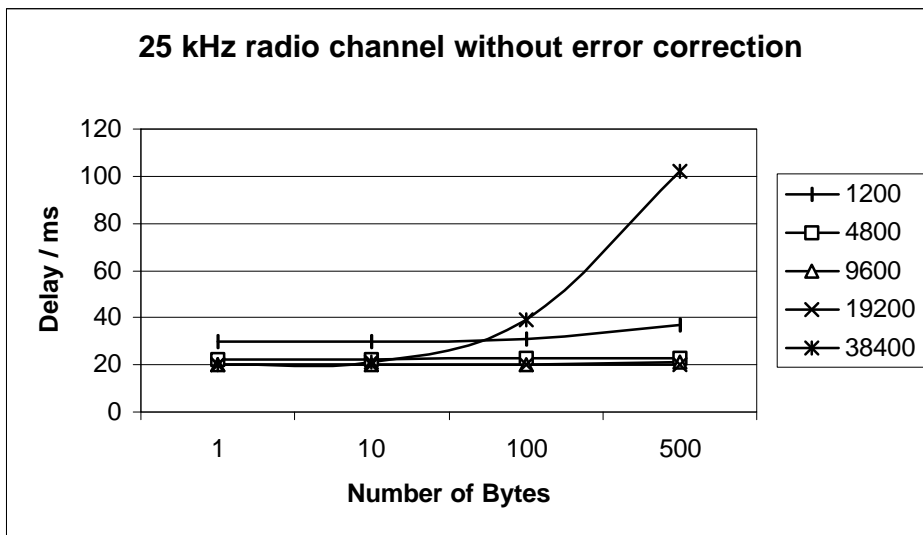
14.2.2 Transmission delays using a 25 kHz radio channel

Transmission delays without FEC-function (Forward Error Correction).

Number of bytes sent

| Bps   | 1  | 10 | 100 | 500 |
|-------|----|----|-----|-----|
| 1200  | 30 | 30 | 31  | 37  |
| 4800  | 22 | 22 | 23  | 23  |
| 9600  | 20 | 20 | 20  | 21  |
| 19200 | 20 | 20 | 20  | 20  |
| 38400 | 20 | 21 | 39  | 102 |

Delays are in milliseconds and with a 10% marginal.



Transmission delays with FEC-function (Forward Error Correction).

Number of bytes sent

| Bps   | 1  | 10 | 100 | 500 |
|-------|----|----|-----|-----|
| 1200  | 35 | 35 | 36  | 41  |
| 4800  | 28 | 29 | 30  | 32  |
| 9600  | 28 | 27 | 28  | 28  |
| 19200 | 27 | 27 | 36  | 65  |
| 38400 | 26 | 27 | 57  | 186 |

Delays are in milliseconds and with a 10% margin.

