Satelline- and Satelline-

High-Speed UHF Radio Modem with Developed Data Transfer Characteristics

SATELLINE-3AS is a half-duplex radio modem suitable for a variety of data transfer applications, in particular ones demanding high speed and precision. In addition to the maximum data speed of 19.2 kbps and channel spacings 25 kHz or 12.5 kHz, it offers a number of features and functions that are highly useful in the installation stage as well as in routine operation.

The SATELLINE-3AS software includes a selectable error correction, which improves the functioning of the radio modem under interference.

SATELLINE-3AS is compatible with the interface types RS-232, RS-422 and RS-485. The software of the radio modem can be updated through the interface from a PC, without changing the hardware.

The Model SATELLINE-3ASd is equipped with a LCD display of its own, which facilitates programming of the radio modem.

High-speed data transmission

The amount of data transferred in a local area data communications network exhibits a tendency of continuous growth. On the other hand, the average size of a communications system is increasing. Satel's response to these market tendencies is the SATELLINE-3AS, the first radio modem from Satel with a data speed of 19.2 kbps over the air. The data speed of the RS interface is selectable between 300...38 400 bps.

The SATELLINE-3AS offers several new options related to the use of the radio modem. For the first time, there is a built-in hardware compatibility with three selectable data interfaces, the RS-232, RS-422 and RS-485.

A special Model of the radio modem, the SATELLINE-3ASd, is equipped with a LCD display, which provides the user with several new, useful functions. The display can be utilised in the Setup mode for example during the implementation stage. Thanks to the display it is possible to change the setups of the radio modem in the field without using an external terminal. It can also be used for testing the quality of the radio connection between the stations.

Support from your radio modem supplier

Satel possesses not only the world's widest selection of UHF and VHF radio modems but also extensive and profound knowledge of their applications.

Starting from the specification of your problem and the configuration of a wireless data communications solution, the Satel applications experts and your local distributor will help you all the way through the project. The installation and start-up of a SATELLINE-3AS based data communications system is easy and straightforward.

Satel Oy is a Finnish electronics and telecommunications company that specialises in wireless data communications. It designs, manufactures and markets radio modems for data communications and alarm transfer systems. The main user groups include industrial companies, public organisations and private persons.

Satel is a leading supplier of radio modems in Europe. The Satel radio modems are type approved in most European countries and elsewhere.

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Salo, FINLAND 1999

2 INTRODUCTION

SATEL is a Finnish electronics and telecommunications company that specialises in wireless data communications. It designs, manufactures and markets radio modems for data communications and alarm transfer systems. The main user groups include industrial companies, public organisations and private persons.

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A special model of the radio modem, the SATELLINE-3ASd, is equipped with a liquid crystal display (LCD), which provides the user with several new, useful functions. The display can be utilised in the SETUP mode for example during the implementation stage. Thanks to the display it is possible to change the settings of the radio modem in the field without using an external terminal. It can also be used for testing the quality of the radio connection between the stations.

The SATELLINE-3AS offers the possibility to use forward error correction (FEC) over noisy radio channels. Error rate is minimised by means of advance checking and correction of the data packets. This is done transparent to the user.

The radio modem has three basic operating modes: the Data Transfer mode, Setup mode and Test mode. In the basic model SATELLINE-3AS the setting of operating parameters and selection of mode and function is performed with a PC through the RS interface. The model SATELLINE-3ASd is equipped with a LCD and four push buttons. In addition to changing the settings of the radio modem, the display is used for testing the operating condition of the radio connection.

1. SATELLINE 3AS has a maximum data speed of 19.2 kbps and channel spacings 25 kHz or 12.5 kHz.

2. SATELLINE-3AS is compatible with the interface types RS-232, RS-422 and RS-485.

3. The model SATELLINE-3ASd is equipped with a LCD of its own, which facilitates setting up of the radio modem.

4. The SATELLINE-3AS software includes a selectable error correction, which improves the functioning of the radio modem under interference.

5. The software of the radio modem can be updated through the interface from a PC, without changing the hardware.

3 WARRANTY AND SAFETY INSTRUCTIONS

Read these safety instructions carefully before using the product.
Warranty is void if the product is used against the instructions given in this manual or if the radio modem is opened by unauthorised personnel.
The radio modem should only be used with the frequencies and power levels allowed by the local authorities. SATEL is not responsible for any illegal use of its radio equipment.
The equipment described in this manual and technical description are only to be operated as instructed in this manual. Correct and safe operation of this equipment can be assured only if transportation, storage and operation are carried out correctly. This also applies to the maintenance of this equipment.
To avoid electrostatic discharge (ESD) the radio modem and the terminal should be unpowered while connecting data cables. Make sure that the different signal grounds in the devices have the same potential. The power supply voltage must be checked to ensure the correct supply voltage range is selected.

4 SATELLINE-3AS and SATELLINE-3ASd RADIO DATA MODEM

4.1 Technical Specifications

The equipment complies with the ETS 300 683 specification for EMC regulations, ETS 300 220 specification for channel spacing at 25 kHz channels, ETS 300 279 specification for EMC regulations and ETS 300 113 specification for channel spacing at 12,5 kHz channels.

RADIO TRANSCEIVER	
Frequency Range	370...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 PART	
Carrier Power	10 mW...1 W / 50 ohm
Carrier Power Stability	+ 2 dB / - 3 dB
Adjacent Channel Power	according to ETS 300 220/ETS 300 113
Spurious Radiations	according to ETS 300 220/ETS 300 113
RADIO RECEIVER PART	
Sensitivity	- 116... -110 dBm (BER < 10 E-3)
Co-channel Rejection	> - 12 dB
Adjacent Channel Selectivity	> 60 dB
Intermodulation Attenuation	> 65 dB
Spurious Radiations	< 2 nW
DATA TRANSMISSION	
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 Formats	Asynchronous RS-232, RS-422, RS-485
GENERAL	
Operating Voltage	+ 9 ...+ 30 V_{DC}
Power Consumption	2.5 VA typical (Receive) 6.6 VA typical (Transmit) 0.05 VA typical (STAND-BY mode)
Temperature Range	-25 °C...+55 °C
Antenna Connector	TNC, 50 ohm, female
Construction	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

4.2 Basic Configuration and Installation

4.2.1 Basic Configuration

The radio modem is supplied with the following settings (if not otherwise ordered):

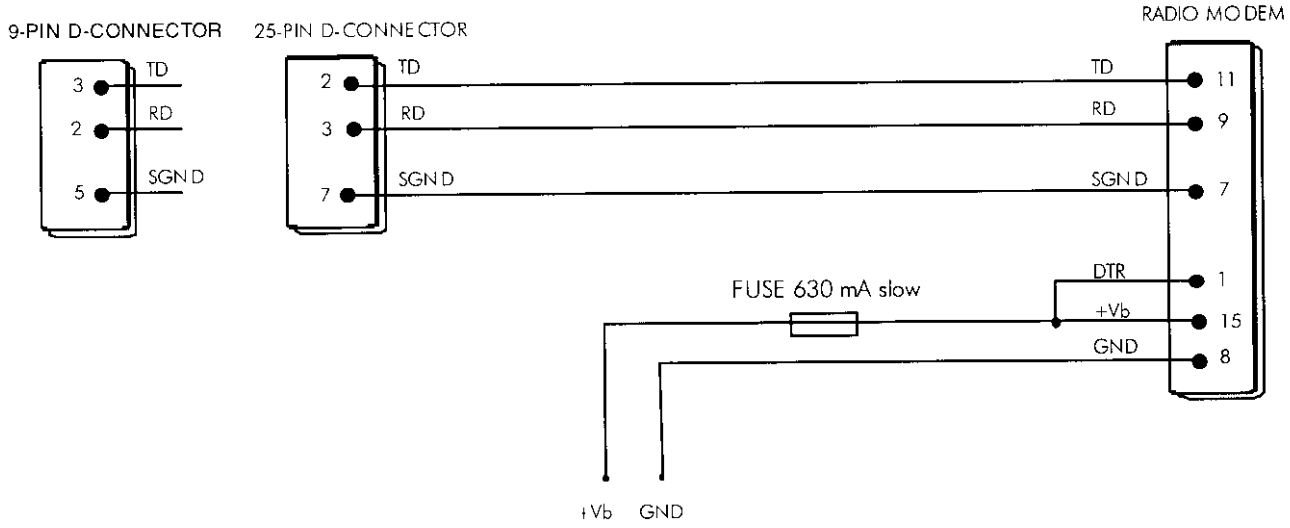
Radio frequency	Selection of the Customer
Radio settings	500 mW / -110 dBm (25 kHz) or -112 dBm (12,5 kHz)
Addressing	RX Address OFF / TX Address OFF
Serial port 1	ON / 19200 / 8 bit data / None / 1 stop bit [RS-232]
Serial port 2	OFF / 19200 / 8 bit data / None / 1 stop bit [RS-232]
Additional setup	Error Correction OFF / Repeater Function OFF / SL-commands OFF
Tests	Test Mode Inactive

Connect the power cables (+Vb and GND) to a 9 – 30 V_{DC} power supply with a power rating of at least 1 A. Also connect the DTR -pin to a positive voltage. If the DTR pin is not connected, the radio modem is in the STAND-BY mode and will not transmit or receive data.

As a terminal program you can use SaTerm which is available free from your local dealer. You can also use HyperTerminal in most of the Windows operating systems or any other terminal program. Basic settings for any terminal program are computer serial port COM1, 19200 bps, 8 bit data, none parity, 1 stop bit . If the serial port COM1 of the computer is occupied you should use another serial port.

NOTE!
When you want to program the radio modem in the SETUP mode via the terminal, the terminal speed should be set to 9600 bps.

Basic configuration for port COM1 RS-232



5 DATA COMMUNICATION

5.1 RS-Interface

5.1.1 D15 Connector

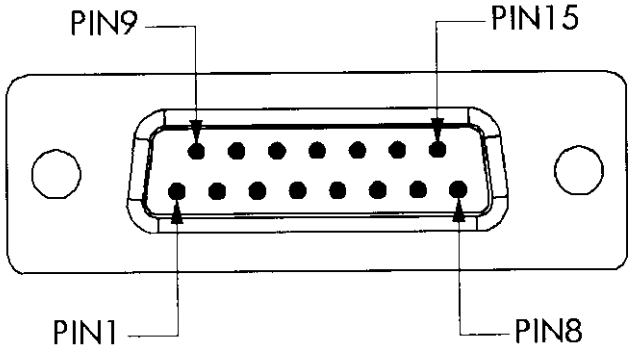
The radio modem is referred as a DCE (Data Communication Equipment) and PC's and terminals as DTE's (Data Terminal Equipment). The SATELLINE-3AS radio modem has a 15-pin 'D' type female connector for all the interface connections.

The design of the radio modem will take into account any filtering necessary on these connections to ensure compliance with spurious emissions and EMC regulations. The user should therefore not need to take any further precautions against emissions out of the radio modem.

The radio modem has two RS-ports, COM1 and COM2. Port COM1 has RS-232-level interface and port COM2 has RS-232, RS-422 and RS-485 interfaces. Only one port can be used for communication at a time. Port COM2 can be used in RS-422 or RS-485 mode only if it is physically set at the factory, the mode change is not possible afterwards by software only.

NOTICE WHEN MODE PIN (12) IS CONNECTED TO THE GROUND (SETUP MODE) THE RADIO MODEM ALWAYS USES PORT COM1 (PINS 7,9,11) ! So if you are using port COM2 for communication you have to use an appropriate cable for SETUP mode.

5.1.1.1 Pin configuration



D-15 female connector in the radio modem

Pin number is the number of the pin 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 LEVEL	PIN	DIRECTION	DATA PIN NAME	
COM1 RS-232	2	OUT	CD	Optional *
	5	OUT	RSSI	Optional *
	6	OUT	CTS	Optional *
	7	-	SGND	Signal Ground
	9	OUT	RD	Receive Data
	10	OUT	DSR	Optional *
	11	IN	TD	Transmit Data
	13	IN	RTS	Optional *
COM2 RS-232	2	OUT	CD	Optional *
	3	OUT	RD	Receive Data
	4	IN	TD	Transmit Data
	5	OUT	RSSI	Optional *
	7	-	SGND	Signal Ground
COM2 RS-422/485	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	-	DTR	ON (VB) / STAND-BY (NC)
	8	-	GND	Power ground
	12	-	MODE	DATA (NC) / SETUP (GND)
	15	-	VB	Operating voltage
	14	-	VB	Operating voltage optional *

*) Optional pins are not necessary for the normal operation, they should be used if needed.

RSSI = Received Signal Strength Indicator, can be used for monitoring the signal quality with a DTE.

CTS = Clear To Send, used in handshaking. Indicates when the radio modem is ready to accept data on the TD line.

SGND = Signal GrouND. Can be connected to GND.

RD = Receive Data. Data from the radio modem to the DTE.

DSR = Data Set Ready. Indicates "ON" state of the modem. The signal level is the same as the DTR signal level.

TD = Transmit Data. Data from the DTE to the radio modem.

RTS = Request To Send, used in handshake. The DTE usually enables RTS when it is ready to receive data. NOT IMPLEMENTED in the radio modem.

CD = Carrier Detect. Indicates a strong signal on the radio channel, can be used to avoid data collisions on the radio channel.

DTR = Data Terminal Ready, when connected to the operating voltage (VB) the radio modem is ON, when not connected (NC) the radio modem is in the STAND-BY mode

MODE = selects the DATA mode if not connected, and SETUP mode if grounded. SETUP mode is only needed when installing the radio modem, usually the radio modem is always in the DATA mode.

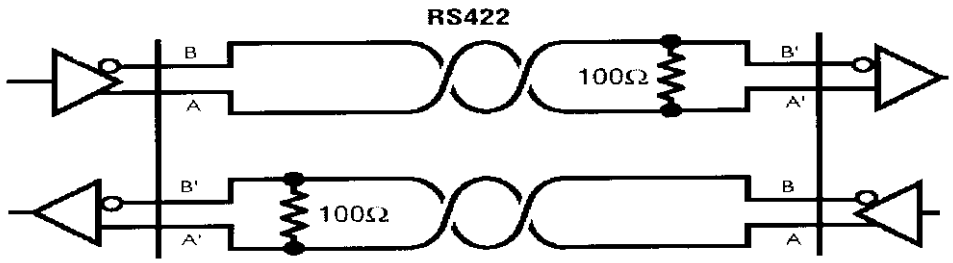
VB = Operating voltage.

5.1.1.2 RS-232 Interface

RS-232 standardises serial communication between computers and between computer terminals and modems. Most applications use the RS-232 standard for interfacing peripherals to personal computers. RS-232 uses transmission lines in which the state of each signal is represented by referencing the voltage level of a single line to ground. RS-232 was designed for serial communication cable up to distances of 15 m. RS-232 is implemented differently in different peripherals so all peripherals using RS-232 are not necessarily compatible.

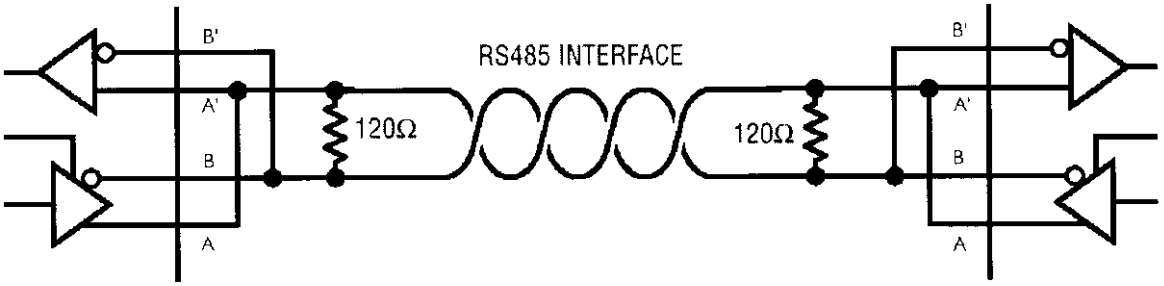
5.1.1.3 RS-422 Interface

RS-422 defines a serial interface much like RS-232. However, RS-422 uses balanced (or differential) transmission lines. Balanced transmission lines use two transmission lines for each signal. The state of each signal is represented by the relative voltage of the two lines to each other. For example, the TX signal is carried on two wires, wire A and wire B. A logical 1 is represented by the voltage on line A being greater than the voltage on line B. A logical 0 is represented by the voltage on line A being less than the voltage on line B. Differential voltage transmission creates a signal which is more immune to noise as well as voltage loss due to transmission line effects. Thus, you can use RS-422 for greater cable distances (up to 1 km) than RS-232.



5.1.1.4 RS-485 Interface

RS-485 expands on the RS-422 standard by increasing the number of devices you can use from 10 to 32 and by working with Half-duplex bus architectures. Only one pair of cables is needed compared to the two pairs needed in RS-422. Unlike the RS-422 standard, RS-485 addresses the issue of using multiple transmitters on the same line. RS-485 defines the electrical characteristics necessary to ensure adequate signal voltages under maximum load, short-circuit protection, and the ability to withstand multiple drivers driving conflicting signals at the same time.

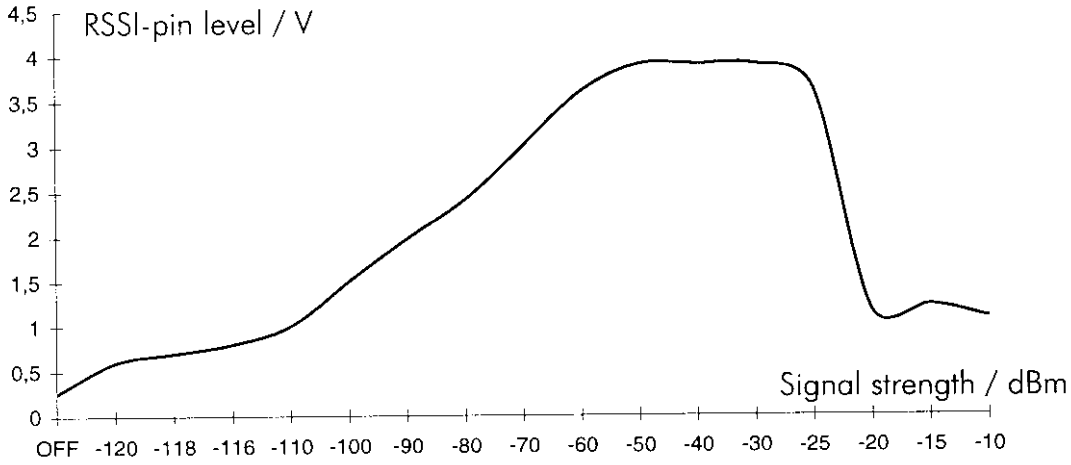


5.1.1.5 Termination

Each differential pair of wires is a transmission line. You must properly terminate the line to prevent reflections. A common method of terminating a two-wire multidrop RS-485 network is to install terminating resistors at each end of the multidrop network. If you daisy chain multiple instruments together, you need a terminating resistor only at the first and last instruments. The terminating resistor should match the characteristic impedance of the transmission line (typically 100~120 ohm).

5.1.1.6 RSSI indicator

Received Signal Strength Indicator, RSSI, (pin 5) announces the received field strength of the signal. This signal can be used for the approximate determination of the signal level. In the following figure is the typical voltage level as a function of the signal level. Notice that voltage drops with a good signal level (>-25dB). This occurs when the distance of the two modems is less than 10 meters.



5.1.2 LED indicators

The five LED's at the front of the radio modem indicate the operation of RS-interface:

LED symbol	Indication	Red	Green
RTS	Status of RTS-line on port COM1	Active	Inactive
CTS	Status of CTS-line on port COM1	Active	Inactive
TD	Data on TD-line	Data on line	No data
RD	Data on RD-line	Data on line	No data
CD	Status of radio signal carrier level	Active	Inactive

RTS indicates the state of the pin 13. The data terminal equipment (DTE) usually enables RTS when it is ready to receive data. By default the DTE enables RTS to active.

> NOTE!
> If you are using the hardware (RTS/CTS) handshake, the RTS is NOT IMPLEMENTED in the radio modem.

CTS indicates the state of the pin 6. It is active when the radio modem is ready to receive data for radio transmission.

TD indicates the radio modem is receiving data on the RS line.

RD indicates the radio modem is sending data on the RS line.

CD indicates a radio signal exceeding the sensibility level.

5.1.3 RF Interface

The antenna connectors type is TNC and the impedance is 50 ohms. The transmitter output power is between 10mW - 1W.

The bitrate in the radio channel depends on the radio channel width, with a 25 kHz channel the bitrate is 19200 bps and 9600 bps with 12,5 kHz radio channel. The radio bitrate is always the same independent of the RS line bitrate. If the RS line bitrate is slower or faster than the radio channel bitrate the radio modem buffers the data temporarily so it will not be lost.

OUTPUT POWER mW	OUTPUT POWER dBm
10	10
20	13
50	17
100	20
200	23
500	27
1000	30

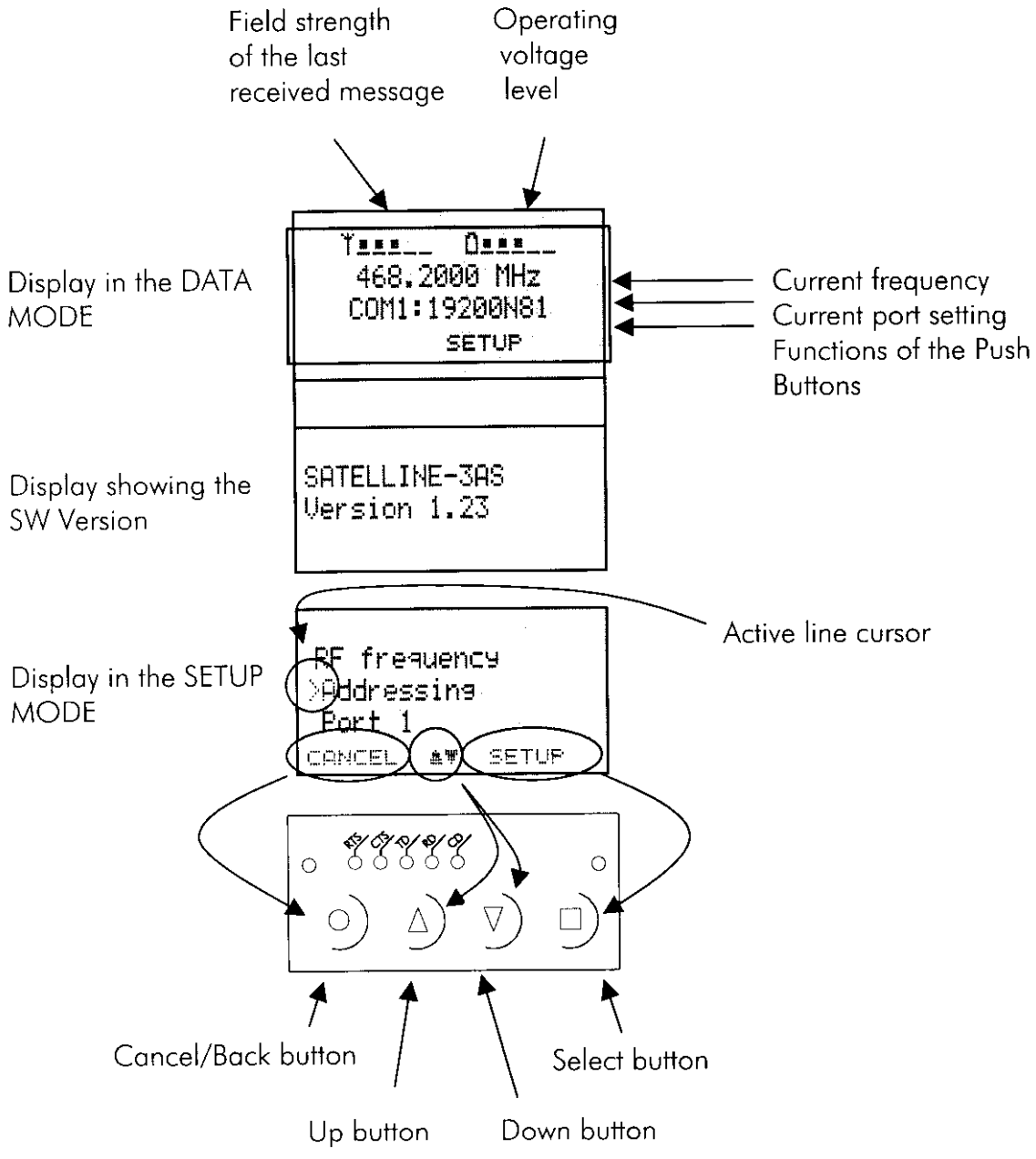
Conversion table for output power

NOTE!
Setting the radio data modem to a power level other than those specified by the local authorities is strictly forbidden. The use of non-approved power level can lead to prosecution by the local authorities. SATEL is not responsible for any illegal use of its radio equipment.

5.1.4 Display and push buttons (SATELLINE-3ASd)

The SATELLINE-3ASd radio modem contains a back-lit liquid crystal display (LCD). The display shows the settings of the radio modem, field strength and battery charge condition. Using the LCD and the push buttons it is possible to change the settings of the radio modem without using an external terminal.

The display units back light is activated by pushing any of the buttons.



5.2 Data Transmission (RS-interface)

5.2.1 Data format

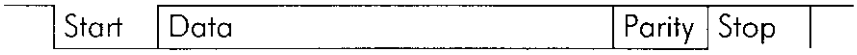
The SATELLINE-3AS radio modem uses asynchronous data format. Asynchronous transmission does not require a continuous synchronising signal from the transmitter to the receiver. The data bits of each character are preceded by a start bit and followed by one or two stop bits. They are inserted after the data bits to provide a minimum period between characters.

Standard data bit rates for SATELLINE-3AS are 300, 600, 1200, 2400, 4800, 9600, 19200 and 38400 bps (bits per second)

The length of the data field should be 7, 8 or 9 bits. If the data length is 9 bits, the selection of parity has to be *NONE*.

When a parity bit is used, its logic state depends on the specific character code and whether the agreed protocol specifies even parity or odd parity. The parity bit is simply made 1 or 0, as required, to make the total number of 1s in the data an even (even parity) or an odd (odd parity). Note that the parity bit itself is included in the count, but the stop bit or stop bits are excluded.

The whole character length includes start bit, data bits, parity bit and stop bit or bits. The character length is 10, 11 or 12 bits.



Asynchronous data format

Example:
8 bit data value is 204 (11001100 binary), start bit is 0, parity is none, 0 or 1and stop bit 1.

The possible characters are:

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

It can be seen that there are always 2, 3 or 4 extra bits per one data word, that must be taken into account when calculating the system throughput.

If the data speed, character length, parity or the number of stop bits are incorrectly set, errors will appear in transmission. At reception they appear as "error characters" or as an incorrect operation of the modem.

The data settings of each station of the system can be different except for the data length. The data length must always be same in the whole system.

The data format can be selected in the SETUP mode.

5.2.2 Handshaking

Handshaking must be used if there is a need to control the transmission between a terminal and a radio modem. For example, SATELLINE-3AS may not be ready to send because the radio channel is busy or the data buffer is full. Handshaking is used to prevent data loss.

Handshaking is not needed under the following conditions:

- radio channel is relatively free, it can be seen from the CD led
- your system can handle overlapping messages

The 3AS supports partly hardware handshaking (RTS/CTS). Hardware handshaking (or flow control) works by altering the state of the RTS (Request To Send) and CTS (Clear To Send) lines on the RS232-interface between the radio modem and the data terminal equipment (DTE). CTS is used by the radio modem on the sending end of a transmission. When the radio modem is ready to receive data, it changes the state of the CTS signal to active and the DTE starts transferring data. If the radio modem is unable to accept the data as fast as it is received from the DTE, the radio modem will change the state of the CTS to inactive to inform the DTE that the modem buffer is almost full. The DTE will then suspend data transfer. Once the radio modem has emptied its buffer by transmitting the data to the radio channel, it will change the state of the CTS back to active again. The CTS is always on in the radio modem.

RTS is changed by the DTE when receiving data. When the DTE cannot accept data at the rate at which it is sent on the RS232-interface, it will disable RTS. The DTE enables RTS again when it is ready to resume receiving data from the radio modem. THE RTS IS NOT IMPLEMENTED IN THE RADIO MODEM. IT WILL IGNORE THE RTS SIGNAL. Usually this is not a problem since most of the DTE's are fast enough to receive data from the radio modem.

5.3 Data Transmission (Radio-interface)

5.3.1 Addressing

It is possible to use addresses both in data transmission and reception on the radio channel. The address consists of two data characters (totalling 16 bits). The address consists of the first two characters of the data packet, that the radio modem adds to every sent packet and/or checks for in every received packet. (compare to SL-command SLAxy, where ADD H corresponds to x and ADD L corresponds to y)
Address range is from 0000h (h for hexadecimal) to FFFFh in hexadecimal format (0-65535 in decimal format). The maximum data length is 1 kB (kiloByte) with a repeater, in normal use it is not constrained.

ADD H	ADD L	DATA

For example, address 1234h (4660 decimal) where 12 is ADD H and 34 is ADD L.
For another example, ABFFh (44031 decimal) where AB is ADD H and FF is ADD L.

The addresses can either be the same in both directions or the transmitting and the receiving addresses can be different. It is also possible to transfer the received address to the RS interface.

You can use addressing for
- preventing unwanted messages for DTE's that might not handle it (multi-slave system)
- preventing messages circulating between repeaters

5.3.1.1 Transmission

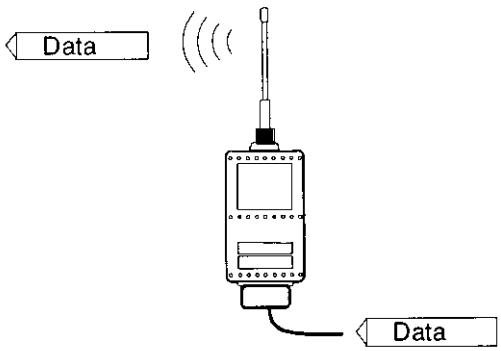


Fig 1. Address of transmission has been set OFF. Radio modem will transmit the data packet as such.

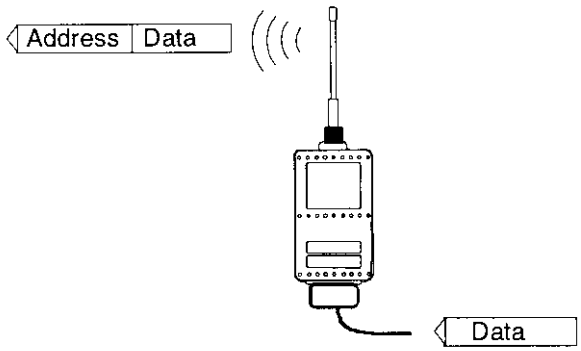


Fig 2. Address of transmission has been set ON. Radio modem will add the address to the beginning of the data packet.

5.3.1.2 Reception

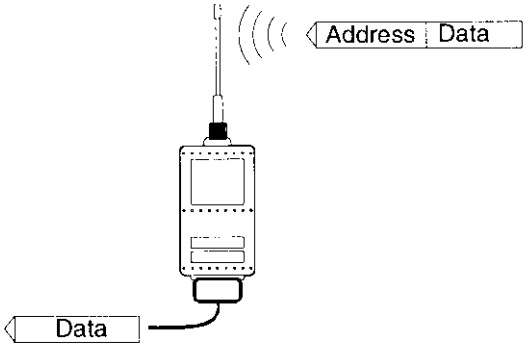


Fig 3. Address of reception has been set ON, and address of radio modem is identical to address of received data message.
Radio modem will remove the address from the beginning of data packet and will send data to the data line.

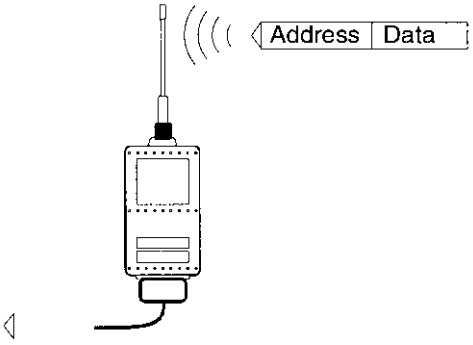


Fig 4. Address of reception has been set ON, but the address of radio modem is different from the address of the received data message. Radio modem will prevent data packet from being transferred to the data line.

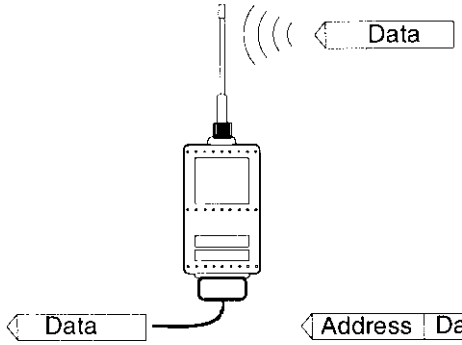


Fig 5. Address of reception has been set OFF.

Radio modem will transfer all received data to data line.

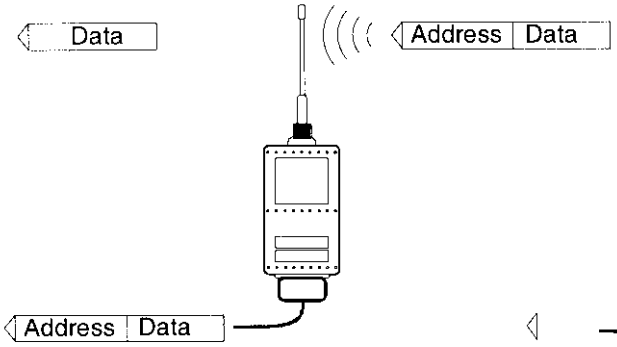


Fig 6. Address of reception has been set OFF.
Radio modem will consider characters of the address to be a part of data and will send all characters to data line.

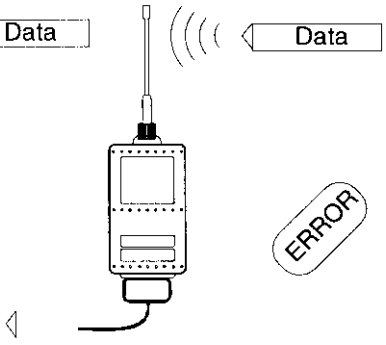


Fig 7. Address of reception has been set ON but there is no address in the data packet.
Radio modem will transfer data to data line ONLY if the address is valid.

5.3.2 Error Correction

SATELLINE-3AS offers the possibility to use Forward Error Correction (FEC), that can be set in the SETUP mode. If set, the SATELLINE-3AS adds extra FEC information to the data packets on the radio channel. The extra symbols give protection over noisy radio channels.

FEC should be used when the distances are long and if the radio channel has a lot of interference.

FEC increases transmission delay by 30 percent.

For the exact delays refer to the table in appendix A.

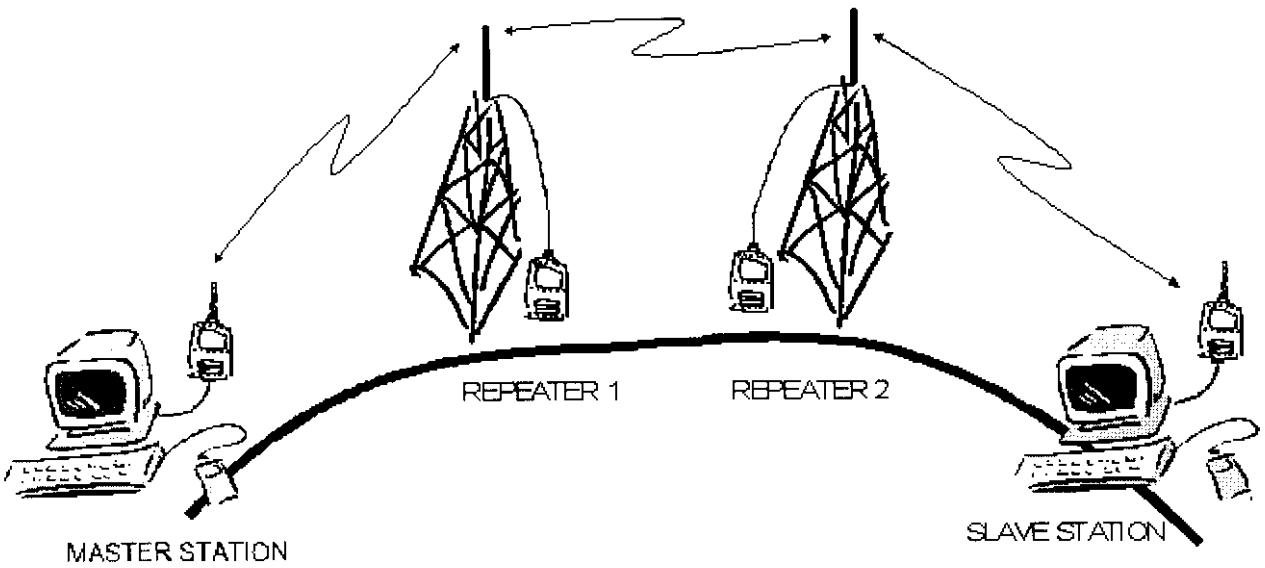
5.3.3 Repeater

In case there is a need to extend the coverage of the radio modem network, the SATELLINE-3AS can be used as a repeater station.

Data packets of maximum 1 kB (kiloByte) can be repeated. The repeater function has to be set on in the SETUP mode. In the repeater mode the radio modem works as an independent unit. When a radio modem is used only as a repeater it requires a power supply and an antenna. No other equipment is needed.

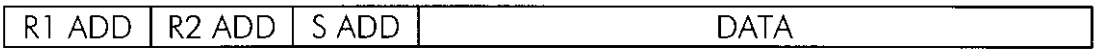
A radio modem working as a repeater can also be used for transmission and reception of data. In the repeater mode the radio modem sends the received data in the RS line the same way as usually. However at the same time it saves temporarily the received data. After finishing the reception of data the radio modem does not turn back to the state where it observes the interface lines. It directly transmits the saved data on the same channel. At the transmission of data from the RS-line the function of the radio modem is identical to a non-repeating radio modem.

There can be several repeaters in the same system and under the same master station. The repeater stations can also be grouped in a chain, wherein the message goes through several repeater stations. It is necessary to use addressing in a system with several adjacent or parallel repeater stations to avoid message from circulating between repeaters.

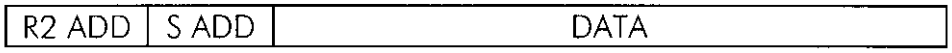


In a system with several adjacent repeater stations addresses should be used. This prevents circulation of the message and secures that only the determined radio modem receives the message.

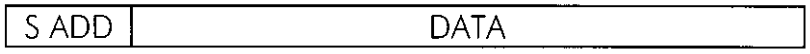
All radio modems should have RX addressing set on and TX addressing set off. The base station and substation terminals add a chain of addresses to the beginning of the data sent to radio modem on the RS-line. Addressing is used in the following way to route a message:



- the message from the master station terminal that contains the addresses of the repeater stations (R1 ADD, R2 ADD) and the substation (S ADD). Every address is two characters long



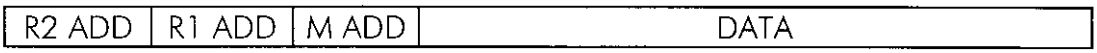
- the message from the repeater station 1 to repeater station 2



- the message from the repeater station 2 to sub-station 4

- the message received from the RS-line at the sub-station 4

The string of addresses is created in the same way when the substation replies to the base station but the routing is in the opposite way :



-R2 ADD is the address of the repeater station 1, R1 ADD is the address of the repeater station 1 and M ADD is the address of the base station

5.4 Timing and Delays During Data Transmission

When using a radio data modem, certain delays occur in wakeup, data transmission and reception.

For detailed timing information refer to the delay tables in appendix A

5.5 Tests

You can use 2 different tests for testing the radio channel quality during installation.
When you turn the test on the radio modem starts sending test messages until the test is turned off.

Short block
When this mode is turned on the radio modem transmits every second a 52 characters long message.

Long block
When this mode is turned on the radio modem transmits constantly a 988 characters long message.

6 SETTINGS

The several settings in the SATELLINE-3AS radio modem can easily be changed. When pin-12 is connected to ground (GND) radio data modem is turned into SETUP MODE. In the SETUP MODE the settings of the serial port 1 are 9600 bps, N, 8,1. In this mode the features of SATELLINE-3AS can be changed in the way described in chapter 6.1.

If the SL-command function is activated the channel and address can be changed without moving into the SETUP MODE. Settings of the serial port are those set at the SETUP MODE. In this function the features of SATELLINE-3AS can be changed in the way described in chapter 6.2.

6.1 Changing the settings using terminal

Connect the radio modem to a terminal or a PC that is in terminal mode. Check the correct wiring of the cable from the wiring diagrams. Terminals data speed should be 9600 bps and the length of the ASCII code N,8,1. Connect the mode-pin (pin-12) into ground (GND). The radio modem sends the following message to the terminal:

```
***** SATEL 3AS *****
  SW Version x.yz    HW Version 02/01
-------------------------------------------------------------------------------
Current settings
----------------
1) Radio frequency     433.0000 MHz [ CF 433.0000 MHz, Spacing 25 kHz ]
2) Radio settings      Tx Power Level 1000 mW / Rx Sensitivity Level -110 dBm
3) Addressing          RX Address OFF / TX Address OFF
4) Serial port 1       ON  / 19200 / 9 bit data / Even / 1 stop bit
5) Serial port 2       OFF / 19200 / 8 bit data / None / 1 stop bit  [ RS-232  ]
6) Additional setup    Error Correction OFF /Repeater Function OFF/ SL-commands
OFF
7) Tests               Test Mode Inactive
8) Restore factory settings
E) Exit

Enter selection >
```

6.1.1 Frequency

The radio frequency channel can be changed in position 1.

```
Enter selection >1

------------------------------------------------------------
------------
Radio frequency setup
---------------------
Active channel          433.0000 MHz
Lower limit             432.0000 MHz
Upper limit             434.0000 MHz
Channel spacing         25 kHz

Enter new frequency (MHz) or Esc to cancel > 433.5000
```

The channel can be selected within +/- 1 MHz tuning range from the factory-set center frequency. The center frequency is set at the factory and cannot be changed. The channel is given as a numerical value.

NOTE !
Setting the radio modem into frequencies other than those specified by the local authoroties is strictly forbidden. The use of non-approved frequencies can lead to prosecution by the local authorities. SATEL is not responsible for any illegal use of its radio equipment.

6.1.2 Output power and sensibility

The Tx output power level and Rx sensitivity level can be changed in position 2.

```
Enter selection >2

Radio setup
-----------
1) Tx Power Level        1000 mW
2) Rx Sensitivity Level -110 dBm

Enter selection or Esc to cancel >1

Power setup
-----------
TX Power level 1000 mW
1) Set 10 mW
2) Set 20 mW
3) Set 50 mW
4) Set 100 Mw
5) Set 200 mW
6) Set 500 Mw
7) Set 1000 Mw
Enter selection or Esc to cancel >6    OK !

Enter selection or Esc to cancel >2

Sensitivity setup
-----------------
RX Sensitivity level -110 dBm

Enter new value (80 - 118) or Esc to cancel > -115
OK !
```

NOTE !
Setting the radio data modem into power level other than those specified in the instructions is strictly forbidden. The use of non-approved power level can lead to prosecution by local authorities. SATEL is not responsible for any illegal use of its radio equipment.

6.1.3 Addressing

The address can be turned on or off and changed in position 3.

```
Enter selection >3

    Addressing setup
    ----------------
     RX Address  OFF
     TX Address  OFF

    1) Change RX address
    2) Change TX address
    3) Set RX address ON
    4) Set TX address ON

    Enter selection or Esc to cancel >1

        RX address setup
        ----------------
        RX Address            0000
        Enter new address(HEX) or Esc to cancel >1234   OK !

    Enter selection or Esc to cancel >2

        RX address setup
        ----------------
        RX Address            0000
        Enter new address(HEX) or Esc to cancel >1234   OK !

    Enter selection or Esc to cancel >3

    Enter selection or Esc to cancel >4
```

The address is given in hexadecimal form in which case the number of different addresses exceeds 65.000. In one radio data modem the address can be the same or in some special cases (e.g. in repeater) also different in transmitting and receiving.

6.1.4 Serial port settings

The settings for serial port 1 can be changed in position 4 and for port 2 in position 5.

```
Enter selection >4 (and 5)

    Serial port 1
    RS-232 Setup
    -------------
    1) Port status       ON
    2) Data speed        19200
    3) Data bits         8 bit data
    4) Parity            None  parity
    5) Stop bits         1 stop bit
    Enter selection or Esc to cancel >1

        Serial ports 1 and 2
        Status setup
        --------------------
        1) Port 1 ON  / Port 2 OFF
        2) Port 1 OFF / Port 2 ON
        Enter selection or Esc to cancel >1

    Enter selection or Esc to cancel >2

        Serial port 1
        Data speed setup
        -------------
        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 cancel >7

    Enter selection or Esc to cancel >3

        Serial port 1
        Data bits setup
        -------------
        1) 7 bit data
        2) 8 bit data
        3) 9 bit data
        Enter selection or Esc to cancel >2

    Enter selection or Esc to cancel >4
```

```
Serial port 1
Parity setup
------------
1) Even  parity
2) None  parity
3) Odd   parity
Enter selection or Esc to cancel >2
```

```
Enter selection or Esc to cancel >5
```

```
Serial port 1
Stop bits setup
------------
1) 1 stop bit
2) 2 stop bits
Enter selection or Esc to cancel >1
```

NOTE!
Remember when connecting the MODE-pin (pin-12) to the ground the radio modem enters the SETUP mode and communicates through PORT 1 with settings 9600,8,N,1 regardless of the PORT 1 settings for the DATA mode.

6.1.5 Special functions

```
Enter selection >6
```

```
Additional setup
----------------
 Error Correction  OFF
 Repeater Function OFF
 SL-commands       OFF

1) Set Error Correction ON
2) Set Repeater Function ON
3) Set SL-Commands ON

Enter selection or Esc to cancel >1
```

```
Enter selection or Esc to cancel >2
```

```
Enter selection or Esc to cancel >3
```

Refer to the corresponding chapter for more information.

6.1.6 Tests

```
Enter selection >7

Test setup
----------
 Test Mode Unactive

1) Set Short Block Test  ON
2) Set Long Block Test  ON
3) Set All Tests  OFF

Enter selection or Esc to cancel >1

Enter selection or Esc to cancel >2

Enter selection or Esc to cancel >3
```

Use tests when needed as described in corresponding chapter.

6.1.7 Restoring factory settings

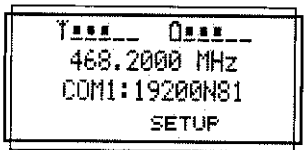
```
Enter selection >8

---------------
Restore factory settings
------------------------

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

Press Y to restore factory settings or press N to cancel.

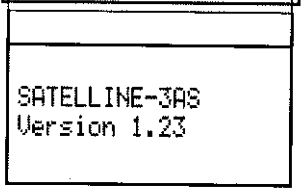
6.2 Changing the settings using the display

Using the display it is possible to change settings of the radio modem without using an external terminal. The radio modem goes into SETUP MODE, if SETUP (■) button has been pressed.

This is the DATA-mode display, PORT 1 is on with settings 19200,N,8,1

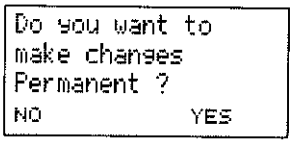


After the SETUP-button has been pressed you can see the modem type and the software version.

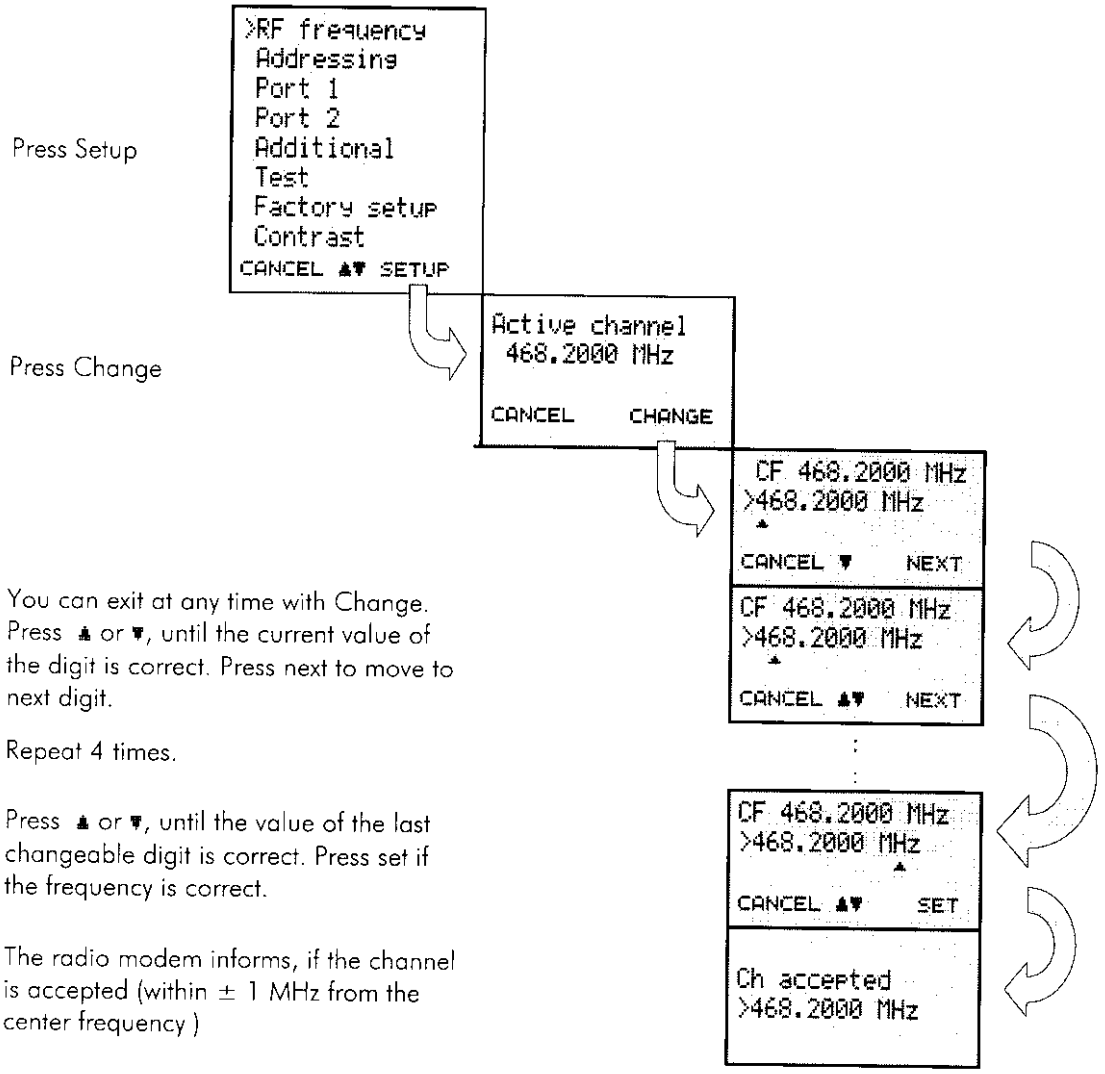


Make required changes

This will save the changes in the non-volatile memory so they are safe against power-downs



6.2.1 Frequency



You can exit at any time with Change. Press ▲ or ▼, until the current value of the digit is correct. Press next to move to next digit.

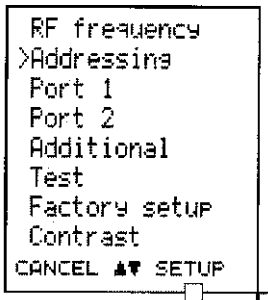
Repeat 4 times.

Press ▲ or ▼, until the value of the last changeable digit is correct. Press set if the frequency is correct.

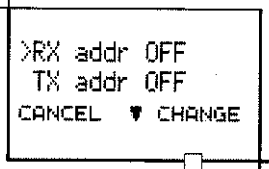
The radio modem informs, if the channel is accepted (within ± 1 MHz from the center frequency)

6.2.2 Addressing

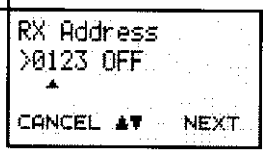
Press Setup



Select RX or TX address pressing ▲ or ▼ and then pressing Change



Press ▲ or ▼, until the value of the first digit of the address is correct. Press next to move to next digit.

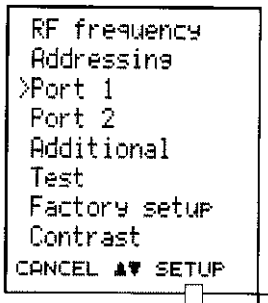


Repeat 4 times.

Press ▲ or ▼ until if the ON/OFF-status of the address is correct. Press set if the status is correct.

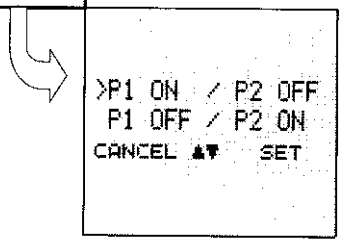
6.2.3 Serial port settings

Press ▲ or ▼ until the cursor points to the correct port (Port 1 or Port 2) and press Setup

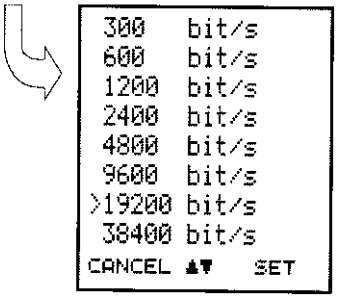


Press ▲ or ▼ until the cursor points to the parameter you wish to change and press Change

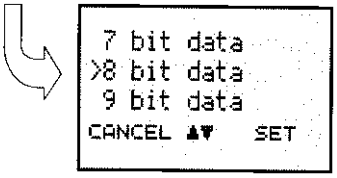
Port status selection:
Press ▲ or ▼ until the cursor points to the correct status.
To set correct port on, press set Note:
The cursor position initially indicates the current setting



Data speed selection:
Press ▲ or ▼ until the cursor points to the correct value and then press set
Note: The cursor position initially indicates the current setting



Number of data bits selection:
Press ▲ or ▼ until the cursor points to the correct value and then press set
Note: The cursor position initially indicates the current setting

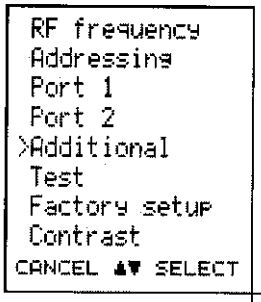


Parity selection:
Press ▲ or ▼ until the cursor points to the correct value and then press set
Note 1: The cursor position initially indicates the current setting
Note 2: If the number of data bits is 9, parity has to be none

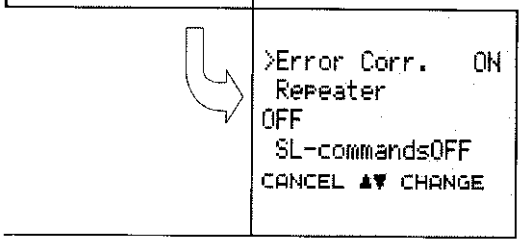
Number of stop bits selection:
Press ▲ or ▼ until the cursor points to the correct value and then press set
Note: The cursor position initially indicates the current setting

6.2.4 Special functions

Press Select

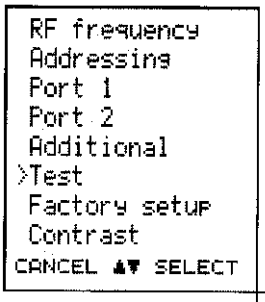


Press ▲ or ▼ until the cursor points to the parameter you wish to change and press Change to toggle the status

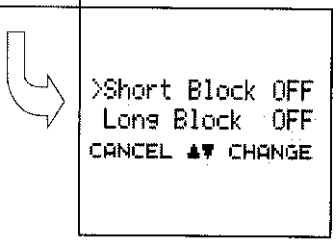


6.2.5 Tests

Press Select

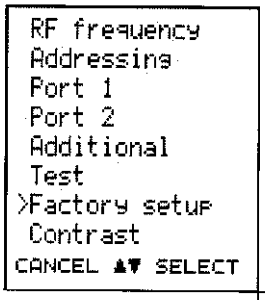


Press ▲ or ▼ until the cursor points to the parameter you wish to change and press Change to toggle the status

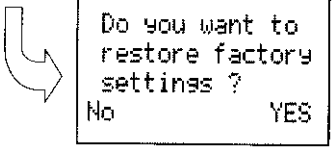


6.2.6 Restoring factory settings

Press Select

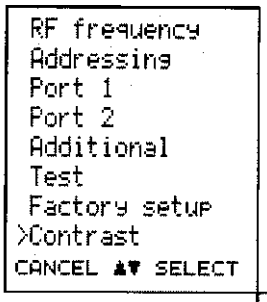


Press YES to restore factory settings for parameters

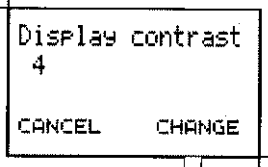


6.2.7 Contrast

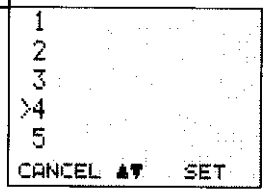
Press Select



Press Change



Contrast selection:
Press ▲ or ▼ until the cursor points to the correct value and press set
Note: The cursor position initially indicates the current setting



6.3 Changing the settings using SL-commands

All the settings can be changed with SL-commands. This makes it possible to control the modem with an intelligent data terminal equipment (DTE,e.g. a PC or a PLC) with an appropriate software. This makes it possible to use complex protocols in multi master and multi slave systems. To use the SL-commands they must first be turned on in the SETUP mode.

6.3.1 Frequency

Channel commands	Target description	
SLHxx	Write ram	Freq =CenterFreq - xx*ChanSpace, where xx=[00...99]
SLLxx	Write ram	Freq =CenterFreq - xx*ChanSpace, where xx=[00...99]
SL&N?<CR>	Show ram	(Freq-CenterFreq)/ChanSpace
SL&+=nn<CR>	Write ram	Freq =CenterFreq + nn*ChanSpace, where nn=[0...MaxNumberOfChannels/2]
SL&+>nn<CR>	Write eeprom	Freq =CenterFreq + nn*ChanSpace, where nn=[0...MaxNumberOfChannels/2]
SL&-=nn<CR>	Write ram	Freq =CenterFreq - nn*ChanSpace, where nn=[0...MaxNumberOfChannels/2]
SL&->nn<CR>	Write eeprom	Freq =CenterFreq - nn*ChanSpace, where nn=[0...MaxNumberOfChannels/2]
SL&F?<CR>	Show ram	Frequency (Response is 'nnn.nnnn MHz')
SL&F=nnn.nnnn<CR>	Write ram	Freq =nnn.nnnn MHz
SL&F=nnn.nnnn<CR>	Write eeprom	Freq =nnn.nnnn MHz
SL&C?<CR>	Show ram	CenterFrequency (Response is 'nnn.nnnn MHz')

Modem responds to all write commands with OK/ERROR

6.3.2 Addressing

Addressing commands	Target description	
SLAxx	Write ram	Id =xx, where x=[00h...FFh]
SLTxx	Write ram	TId =xx, where x=[00h...FFh]
SLRxx	Write ram	RId =xx, where x=[00h...FFh]
SL#I?<CR>	Show ram	Id
SL#I=xxxx<CR>	Write ram	Id =xxxx, where x=[0...9, A-F]
SL#I>xxxx<CR>	Write eeprom	Id =xxxx, where x=[0...9, A-F]
SL#T?<CR>	Show ram	Tid
SL#T=xxxx<CR>	Write ram	TId =xxxx, where x=[0...9, A-F]
SL#T>xxxx<CR>	Show ram	TId =xxxx, where x=[0...9, A-F]
SL#R?<CR>	Write eeprom	Rid
SL#R=xxxx<CR>	Write ram	RId =xxxx, where x=[0...9, A-F]
SL#R>xxxx<CR>	Write eeprom	RId =xxxx, where x=[0...9, A-F]

Modem responds to all write commands with OK/ERROR

6.3.3 Special functions

Satel commands	Target description	
SLSOS	Write eeprom	Save all setup info
SL%V?<CR>	Show code	Version (Response is 'Vn.nn')

Modem responds to all write commands with OK/ERROR

6.3.4 Forming of the SL Command

By programming the radio modem with the SL command, please note that the form of the address is different than in the SETUP MODE. In PROGRAMMING MODE the address is given in hexadecimal (values between 0000 and FFFF) e.g. 2BFAh. By programming the radio modem with SL command the address consists of an address of two 8 bit characters.

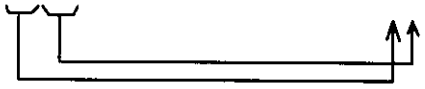
The radio modem requires the SL command as a continous packet. Either a file needs to be created for the command or the application software designed for the radio modem must take care of the continous transmission of the command. If there is a break in the transmission the radio modem interprets the packets as transmitted data.

Forming of the programming packet of the address

If you want to use e.g. address 2B5A hex start by converting the hex value to characters. This can be done by using a map of characters to convert the numbers (Appendix1). The following character map is for character set PC-8. In case you have another character set in your computer you must use a different character map or use methods given in Example 2.

Example 1

Hex. address	*characters*	*SL -packet*
2B5A	'+Z'	'SLA+Z'



Create a file needed for the SL packet and name it e.g. AD_2B5A.TXT. The first line of your file would be :

SLA+Z

You are now able to change the address of the radio modem. Copy AD_2B5A.TXT file to the serial port. Note the settings of the serial port and the radio modem (see DOS *mode* command):

copy AD_2B5A.TXT com1

The file can be sent by using ASCII file transfer in the communications software.

As some of the characters are used for controlling devices, there is no key for them in your keyboard. It is preferable to use the following method if you are not familiar with the character set you are using.

Example 2

Hex. address	*dec.values*	*Characters*
0AFF	10, 255	LF, DEL

1. You can use a hex editor to create the address
2. If you have a PC you can type some of the characters by using ALT key together with a numeric pad. Use a simple DOS editor. Press ALT key, use the numeric pad to enter the decimal value (3 numbers, e.g. 10 ® 010) and release ALT -key.

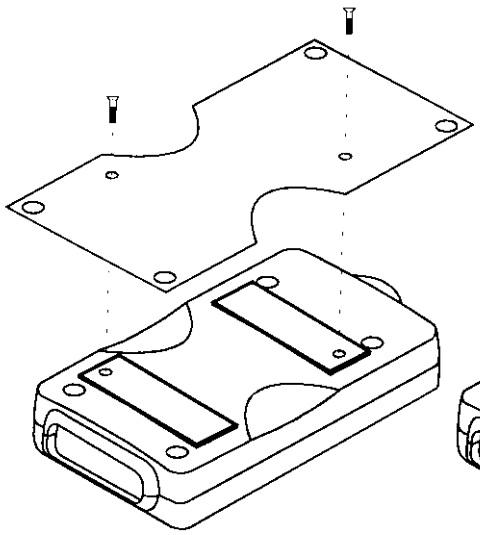
	e.g.
Hex. address	*typing of the corresponding decimal values*
0AFF	ALT (down) 0 1 0 ALT (release) ALT (down) 2 5 5 ALT (release)

NOTE !
The SL command can not be used in terminal mode. You must create a file containing the SL command and send the file to the radio modem.

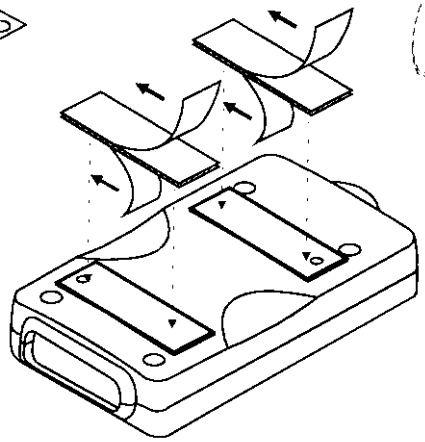
7 INSTALLATION

7.1 The installation of a radio modem

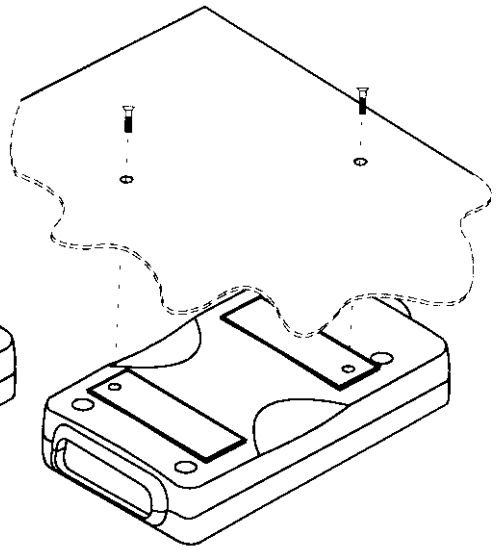
The radio modem should be installed with the installation accessories supplied with the radio modem.



1. By using the installation plate, that should be fastened on the back side of the radio modem. The installation plate can be mounted using the holes provided on installation plate.



2. By using the Velcro tape supplied with the radio modem.



3. By mounting the radio modem directly on the customer's equipment .

NOTE !
When choosing the place for mounting, please check that water can not get inside the radio modem. Avoid direct sunlight. It is not recommended to mount the radio modem on a heavily vibrating foundation. The attachment should be lessened with the help of a resilient

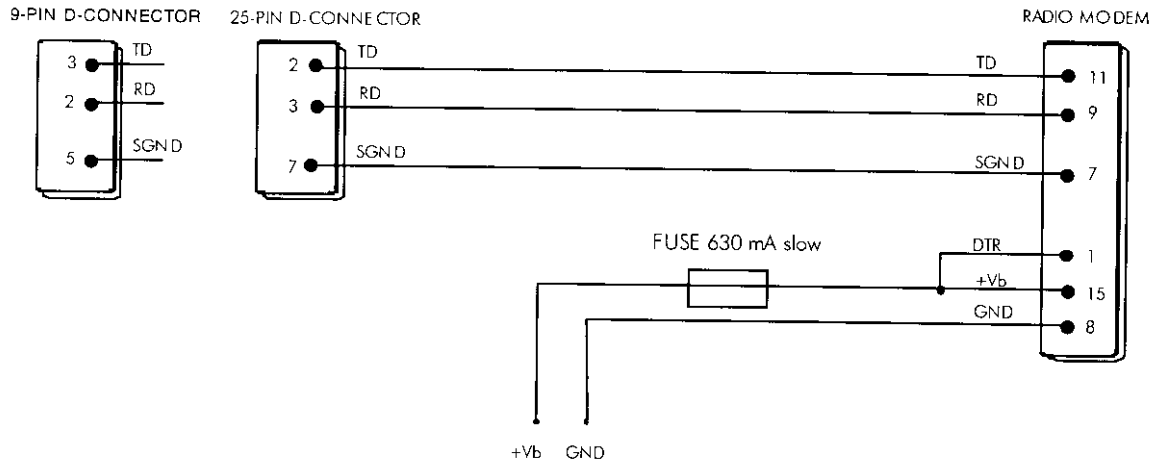
7.2 Interface Cable Connections

7.2.1 RS-232 Wiring

> NOTE!
> Whenever connecting RS-232 interface cables to equipment, the equipment MUST FIRST BE TURNED OFF.

PORT COM1

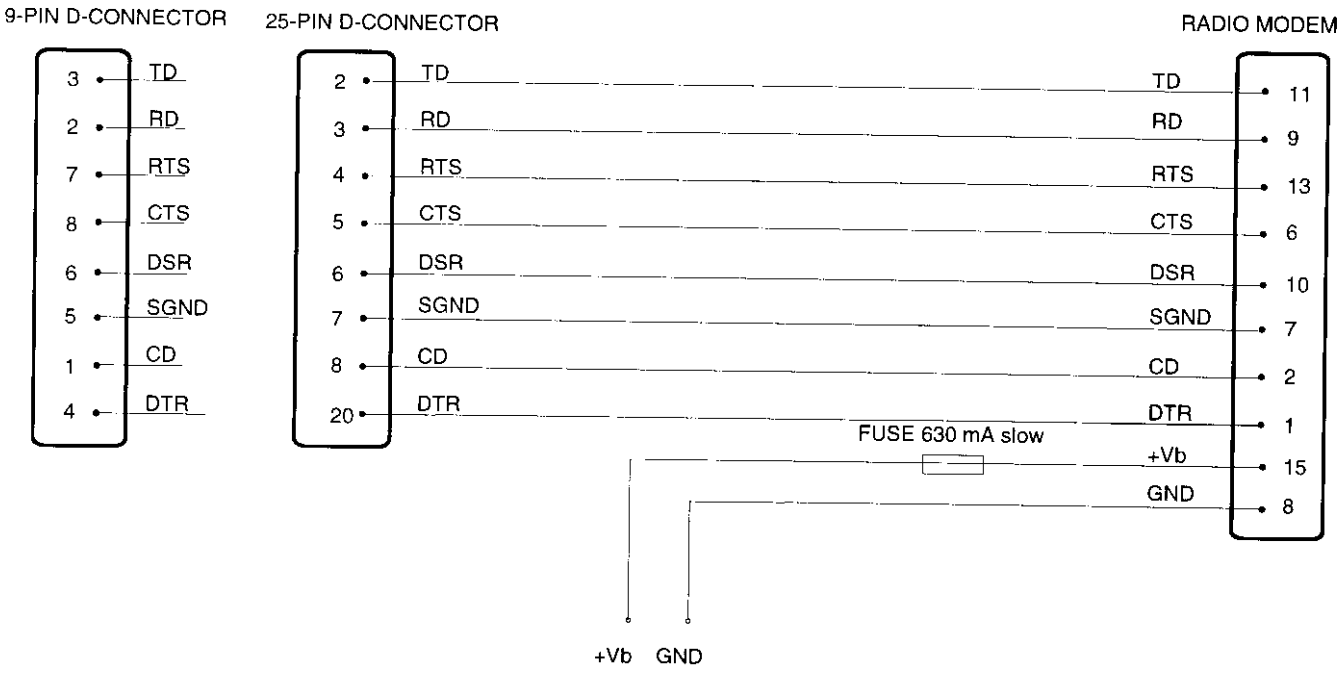
RS-232 interface basic connection:



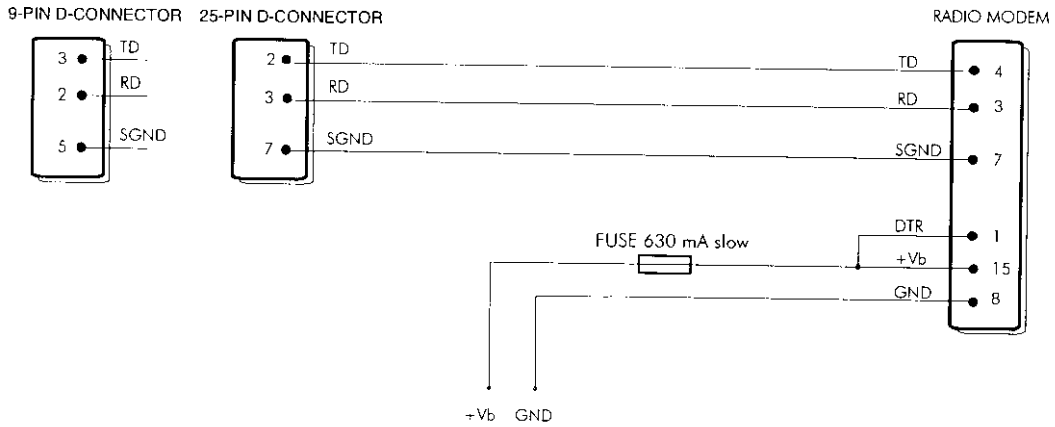
The range of voltage is 9 - 30 V. Connect the power cables to a power supply with a power rating of at least 1 A. The operating voltage of the positive pole of the D 15 connector is connected to the pin 15 of the D connector and to the negative pole 8. The DTR line in position "1" can be used as an ON/STAND-BY switch. In this case the logical state "1" (+5...+30 V) corresponds to ON and "0" (0 V...-12 V) to STAND-BY.

Especially in portable applications the DTR line (pin 1) of the radio modem should be switched to position "0" when possible to save power.

Connection with handshake lines:

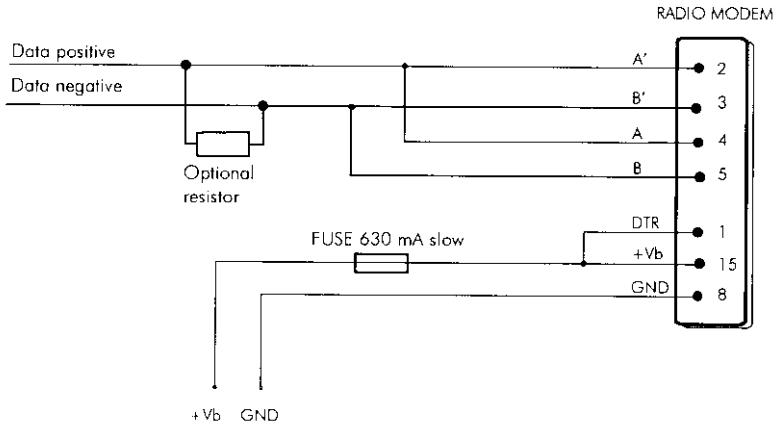


PORT COM2 RS232



7.2.2 RS-485 Wiring

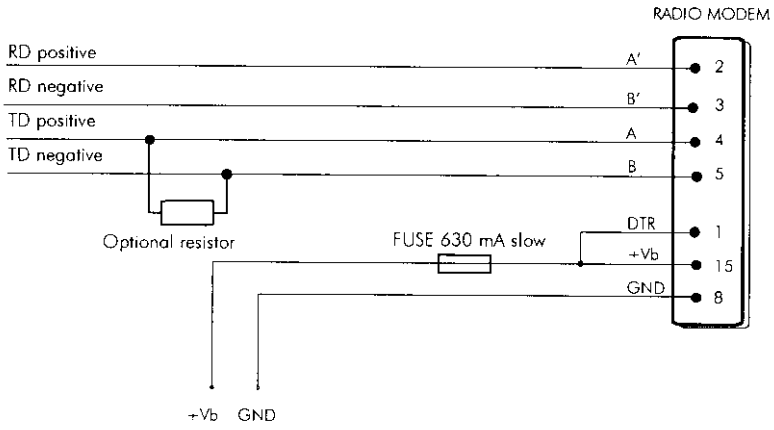
PORT COM2 RS-485



If there is only one device on each end of the line, you should terminate them with a 100-120ohm resistor between the positive and the negative data line. However this is not complimentary with short line lengths (1- 10 meters depending on the cable and the bitrate).

7.2.3 RS-422 Wiring

PORT COM2 RS-422



With a longer line lengths the positive receive and transmit lines should be terminated with a resistor (100-120ohm) on both ends.

7.2.4 Power supply

The range of voltage is 9 - 30 V. Connect the power cables to a power supply with a power rating of at least 1 A. The operating voltage of the positive pole of the D 15 connector is connected to the pin 15 of the D connector and to the negative pole 8. The DTR line in position "1" can be used as an ON/STAND-BY switch. In this case the logical state "1" (+5...+30 V) corresponds to ON and "0" (0 V...-12 V) to STAND-BY.

Especially in portable applications the DTR line (pin 1) of the radio modem should be switched to position "0" when possible to save power.

7.3 Antenna Installation

7.3.1 Hand portable equipment

- 1/4 wave antenna (wave length on 450 MHz is about 70 cm)
- Helix antenna

The antennas are mounted directly on to the antenna connector (TNC) at the top of the radio modem.

7.3.2 Equipment installed in vehicles

- 1/4-wave antenna
- 1/2 wave antenna

Ideally the antenna should be installed vertically and it should have at least 0.5 m of open space surrounding it. In a small system 1/4 wave antenna is adequate. There should be a ground plane below the antenna (truck bonnet or roof). In weak conditions a 1/2 wave antenna is the most suitable. It can be mounted at the top of a pipe, as this provides it with as much open space as possible. In places where the antenna cannot be connected directly to the TNC a 50 ohm coaxial cable must be used to provide the link between the TNC and the antenna.

7.3.3 Master station

- omnidirectional (1/4, 1/2 or 5/8 wave antenna)
- directional (yagi or corner reflecting antenna)

The antenna should be installed in an upright position. The exact location of the antenna depends on a number of factors from system size to physical ground countours. As a general rule, the antenna for a base station should be located at the highest point in the most central location of the system.
Alternatively the base station antenna can be situated inside the building, providing that the walls of the building do not contain metal.

7.3.4 General rules

In great distances or in otherwise severe conditions the operation of radio communication is dependent on antennas and their mounting. In antennas, antenna cables and terminal adaptors there should always be a gold plated connector. Since connectors of poor quality oxidate and increase the attenuation in the course of time appropriate connectors and proper tools must always be used in mounting. One should also check that both the antenna and possible fitting elements resist well under all kinds of weather conditions and environmental contamination.

The metal-free zone around small antennas should be at least 1/2 m and big antennas >5 m. The metal-free zone should be > 10 m around a repeater antenna combination. This means that if a large network of radio modems is to be installed the best place for the antenna is at the highest point of the building or even to use a radio mast. If a mast is used, the antenna can be installed using a side-installation up to 2 ...3 m away from the mast itself.

When mounting the antenna pay also attention to possible sources of interference such as:

- mobile phone network base stations
- local telephone network base stations
- television transmitters
- radio links
- other radio modem networks
- PC equipment (about a radius of 5 m from the antenna)

When ordering antennas please note that the antennas have been tuned to a certain frequency range. Simple antennas and those made of stacked yagi-antennas are relatively wide band. The frequency range of the antenna becomes narrower the more elements there are in a yagi-antenna.

Keeping in mind the possible need for testing and service of the system. It is generally useful to use, a rather long antenna cable in order to avoid the installation of radio modems near the antenna. In which case it makes it easier to place an antenna to a place, possibly difficult to access.

The antenna cable should be chosen according to the length, keeping in mind the following recommendations:

Length	Type	Attenuation
< 5 m	RG58	3.0 dB/10 m/450 MHz
5 ... 20 m	RG213	1.5 dB/10 m/450 MHz
> 20 m	Nokia RFX 1/2"-50	0.5 dB/10 m/450 MHz
> 20 m	AirCom+	0.8 dB/10 m/450 MHz *)

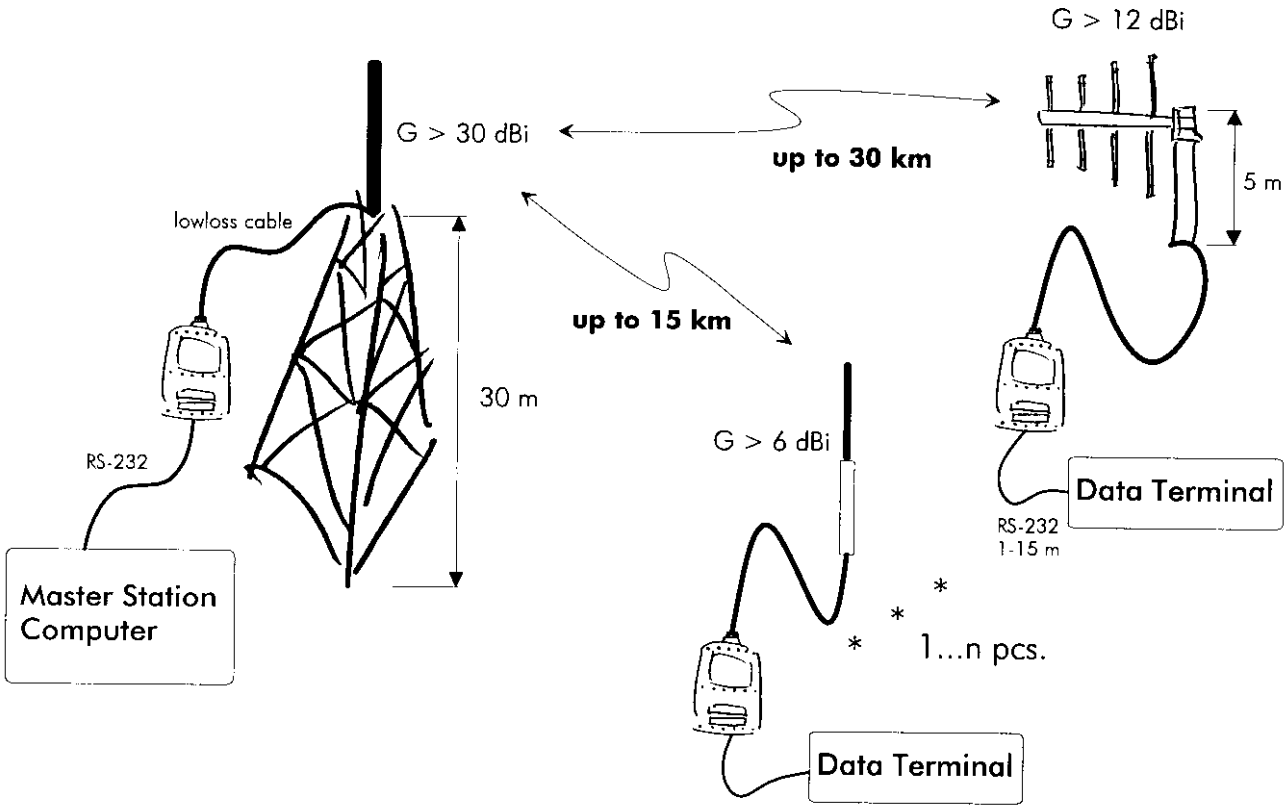
*) AirCom+ cable is partly air insulated, thus an absolutely air tight connection between the cable and the connector is required.

In great distances when the antennas are in optical positions a 6 dB power marginal is adequate. Since 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 false 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 an attenuating 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 process.

Vertical polarized systems (antenna elements are in vertical position) are often used in radio systems. In a system between a base station and sub-stations the vertical polarization is generally recommendable. The antenna of the radio modem can not be mounted on the same level with the other sub-station antennas in the same building. The best way to distinguish from the other antennas situated in the neighbourhood, is by mounting 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.

A horizontal polarization can be used in data transmission between two points. With the polarization attenuation more distinction is obtained in the vertical polarization interference. 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 polarized antennas there must be a good attenuation of the back lobe. In addtion to this the interfering radiator should be situated behind the antenna.

When the system does not demand the use of an omnidirectional antenna it is recommended 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 broadcast area. The disadvantages with a too high antenna installation at the base station are that interferences from a larger area affect the base station and that the base station occupies the channel of a too large area.
Therefore SATEL recommends the use of bandpass-filters with a high Q-value.



Example of an antenna installation: By use of amplifying antennas (G=Gain) and by installing antennas in a high location, long distances can be reached with 3AS.

8 SYSTEM DESIGN

8.1 System Configurations

8.1.1 Factors affecting quality and distance of the radio connection

- power of radio transmitter
- sensitivity of radio receiver
- tolerance of spurious radiations of the radio modulating signal
- amplification of transmitting and receiving antennas
- antenna cable rejection
- height
- natural obstacles
- interferences caused by radio frequencies

The transmitter power of the base model of SATELLINE-3AS is 1 W and sensitivity of receiver more than -115 dBm. Thus in a flat area and in free space with a 1/4 wave antenna (antenna amplification 1dBi) and an antenna height of 1 m communications from 3 km 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, problems caused by natural obstacles can often be solved by raising the height of antennas. 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 needs to be raised to a height of 10 to 20 m.

As the placement of the antenna at the base station is more than 10 m from the modem it is necessary to use a low loss cable (< 0.7 dB /10m) in order not to waste the antenna amplification. Problematical connections can also be solved by adding another intermediate station for repeater. In systems with many base stations an RSSI-signal would assist in choosing the best receiving base station. 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 interference caused by human beings is insignificant. Long distance interferences need not to be taken into account even in special weather conditions.

The SATELLINE-3AS eradicates normal levels of interference that occur. However, exceptionally high levels of interference can break through the safeguards and thus cause errors on transmssion. In mobile vehicle applications the range of operation can be increased by dividing the transmitted data into e.g. 50...500 bits blocks and by retransmitting defected blocks.

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

8.1.2 Radio field strength

A successful radio transmission depends essentially on the radio field. Where field strength is over a certain level the operational results are very good. Below this level, a few dB marginal areas may occur in which errors begin to be generated by noise and interference which will eventually lead to loss of connection.

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

Ground, ground contours and buildings cause attenuation (loss of energy through absorbtion) and reflections 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 suffer a loss in power once they travel over a certain distance, this means that they combine with the direct radio waves and interact in either weakening or strenghtening the signal respectively. In reality attenuation can even occur at 40 dB which is very sharp and the effect on the 450 MHz frequency is about 35 cm difference.

9 CHECK LIST

When installing and configuring a radio data modem following points should be considered :

1. Before connecting the RS line interface to equipment always check that the operating voltage is switched off.

2. Consider the exact location of the equipment for optimum results
   * Place the antenna in a free space as far as possible from any source of interference
   * Do not place the modem on a strongly vibrating surface
   * Do not place the modem in direct sun light or high humidity

3. The capacity and stability of the power supply must be secured so that the current required by the transmitter is sufficient for creating a reliable connection.

4. The antenna is installed according to given instructions.

5. The settings of the radio modem correspond those of the terminal.

6. All radio modems of the system have the same settings and are compatible to each other (e.g.channel frequency and width).

10 SOFTWARE UPDATE

It is possible to update the software in the 3AS. Contact your local dealer for a software update.

11 ACCESSORIES

11.1 RS Cables

Type	Description	Lenght	Notice
CRS-1M	interface cable D15 / D25 male	2 m	including power supply cables
CRS-1F	interface cable D15 / D25 female	2 m	including power supply cables
CRS-2M	interface cable D15 / D9 male	2 m	including power supply cables
CRS-2F	interface cable D15 / D9 female	2 m	including power supply cables
CRS-9	Interface cable D9 male/D9 female	2 m	
ARS-1F	interface Adapter D15 male / D9 female	-	Including 2 m power supply cable and programming switch

11.2 RF Cables

Type	Description	Lenght	Notice
CRF-1	cable TNCm/TNCf-connectors	1 m	RG58 (3 dB/10 m)
CRF-5F	cable TNCm/TNCf-connectors	5 m	RG58 (3 dB/10 m)
CRF-5M	cable TNCm/TNCm-connectors	5 m	RG58 (3 dB/10 m)
CRF-20	cable between the booster and the modem	20 cm	
RG213	Low loss cable	X	1,5 dB/10 m
AIRCOM+	low loss cable	X	0,7 dB/10 m

11.3 Antennas

Type	Description
GAINFLEX 400-430	Half wave antenna
GAINFLEX 430-470	Half wave antenna
MULTIFLEX 400-470	Quarter wave antenna
MINIFLEX 400-430	Helix antenna
MINIFLEX 430-470	Helix antenna

(We offer directional- and/or omnidirectional gain antennas separately on request.)

11.4 Power Supplies

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

11.5 Filters

11.6 Battery Pack

Type	Description
SATELSET-60	Battery Pack with 60 mm Belt Clip
SATELSET-90	Battery Pack with 90 mm Belt Clip
SET-BC	Battery Cassette
SET-C	Charger
SET-IC	Installation Cradle

11.7 Power Booster

Type	Description
SATELGAIN	10 W booster, for short data packets
SATELGAIN+	10 W booster, for continous transmission

12 APPENDIX A

ASCII CHARACTER TABLE

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

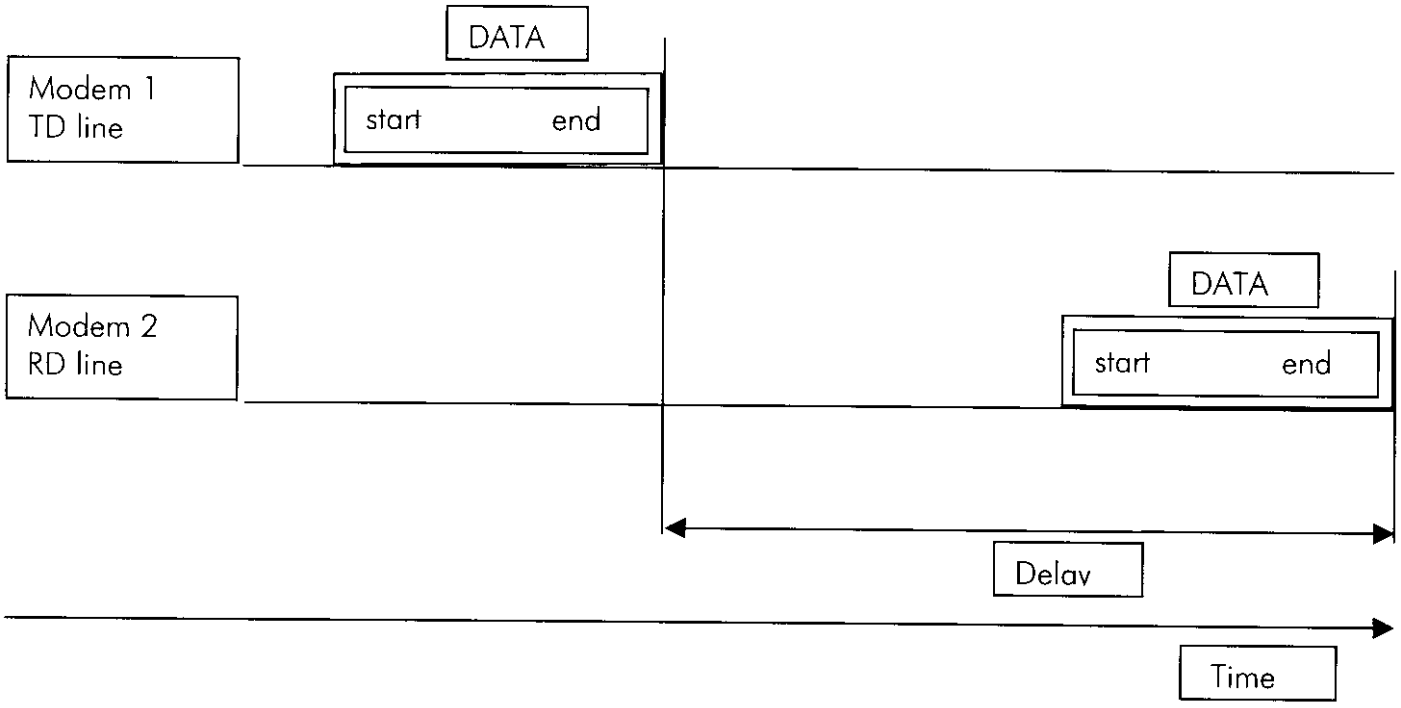
13 APPENDIX B

13.1 Functional delays

Function	Delay (ms)
Wakeup time DTR STAND-BY/ON	1500
RS interface turnaround time RS-232	0
RS interface turnaround time RS-485	<1
Intercharacter delay	max. 2-3 characters

13.2 Transmission delays

Delay from the end of the transmission on the RS-line to the end of the reception on the RS-line.



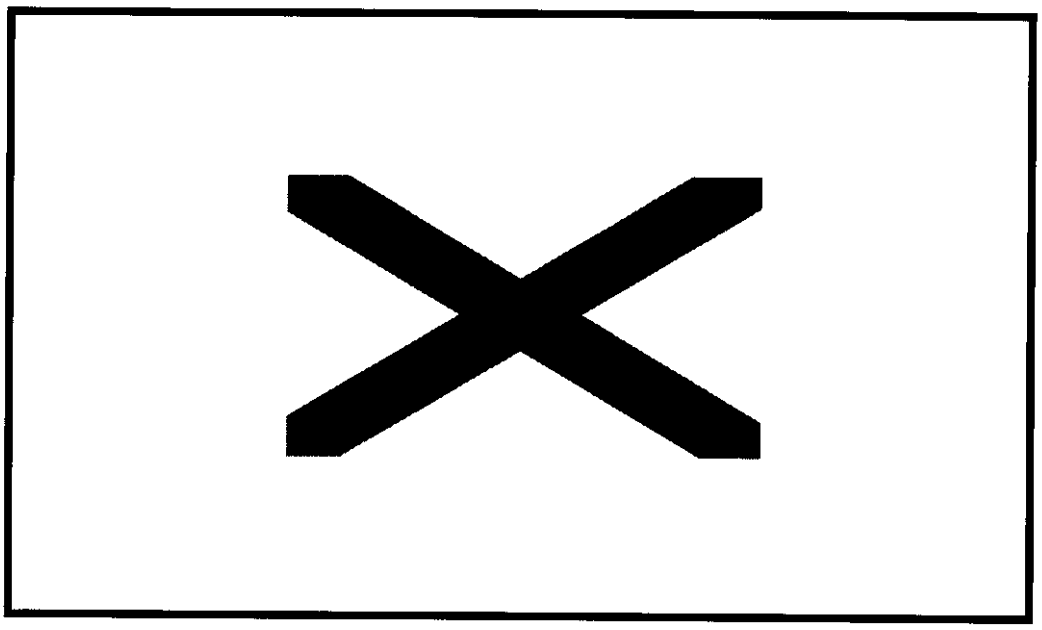
13.2.1 Transmission delays without the FEC (Forward Error Correction)

12.5 kHz radio channel

Number of Bytes sent

bps	1	10	100	500
1200	43	83	87	100
4800	32	32	35	37
9600	31	30	30	31
19200	30	33	65	196
38400	30	35	88	322

Delay in milliseconds with 10% margin

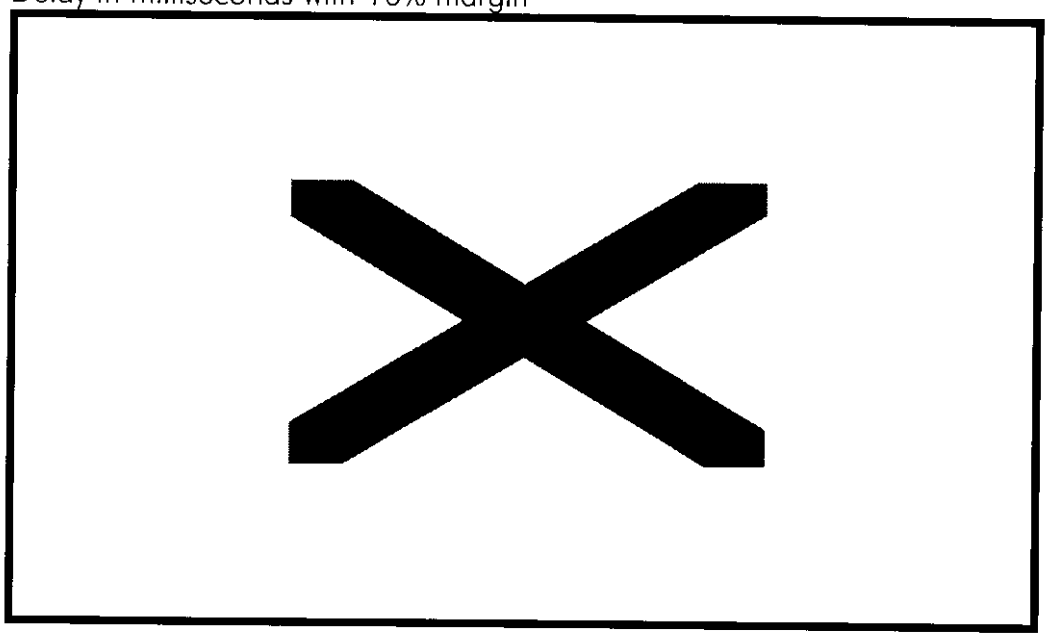


25 kHz radio channel

Number of Bytes sent

bps	1	10	100	500
1200	36	76	78	83
4800	22	26	27	28
9600	20	20	20	21
19200	20	20	20	20
38400	20	21	36	102

Delay in milliseconds with 10% margin



13.2.2 Transmission delays with the FEC (Forward Error Correction)

12.5 kHz radio channel

Number of Bytes sent

Bps	1	10	100	500
1200	63	120	120	200
4800	43	54	70	72
9600	42	42	80	140
19200	42	42	105	364
38400	42	42	128	490

Delays in milliseconds with 10% margin