IMPORTANT NOTICE

RESTRICTIONS ON USE

SATELLINE-2ASxE 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.

SATELLINE-2ASxE (370…470 MHz) is allowed to be used in the following countries, either on licence free channels or on channels where the operation requires a licence. More detailed information is available at the local frequency management authority.

Countries*: AT, AU, BE, CA, CZ, HR, DK, EE, FI, FR, DE, GR, HK, HU, IS, IE, IT, LV, LT, MT, MY, NL, NO, PL, PT, RO, SG, SI, ZA, ES, SE, CH, TH, TR and GB

WARNING! Users of SATELLINE-2ASxE 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.

* codes of the countries follow the ISO 3166-1-Alpha-2 standard.

PRODUCT CONFORMITY

Hereby, SATEL Oy declares that SATELLINE-2ASxE radio modem is in compliance with the essential requirements (radio performance, electromagnetic compatibility and electrical safety) and other relevant provisions of Directive 1999/5/EC. Therefore the equipment is labelled with the following CE-marking. The notification sign informs user that the operating frequency range of the device is not harmonised throughout the market area, and the local spectrum authority should be contacted in prior of use.

$C\in 0523 \textcircled{!}$

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1 SATELLINE-2ASxE Radio Data Modem

1.1 Radio data modem

```
                          ┌──────────┐    ┌──────────────┐
  ┌─────────┐  ┌────────┐ │          │    │ TRANSMITTER  │
  │         │  │ RS-232 │ │          │    ├──────────────┤   ┌────────┐
◄─┤  D-15   ├─►│ SIGNALS│ │  MODEM   │    │              │   │   RF-  │   ┌─────┐
  │         │  │        ├─┤    +     ├────┤ SYNTHESIZER  ├───┤ SIGNAL ├──►│ TNC │
  └─────────┘  │ POWER  │ │ CONTROL  │    ├──────────────┤   │        │   └─────┘
               │ SUPPLY │ │  LOGIC   │    │              │   └────────┘
               └────────┘ │          │    │  RECEIVER    │
                          └──────────┘    └──────────────┘
```

The SATELLINE-2ASxE radio data modem consists of a synthesized 450 MHz transceiver and a modem board housed in a compact aluminium enclosure. The modem has a RS-232 interface which provides the flexibility to connect it to a wide variety of data networks and terminal equipment.

The operation of SATELLINE-2ASxE is similar to a cable although data transmission is half duplex. When planning a radio data modem installation it is important to take into account the slight delays of the radio modems and possible radio interference. The most important RS-232 signals are indicated by LEDs.

Typical applications of the SATELLINE-2ASxE are:

- Replacing an RS-232-cable in situations where installation of a cable is difficult, expensive or even impossible
- Data transmission to and from mobile or portable terminals
- Wireless alarm transfer
- Telemetry
- Remote control
- Transferring text to displays
- For use with the Global Positioning System (GPS)
- etc.

With two SATELLINE-2ASxE radio data modems it is easy to establish point to point connections. The power level of the transmitter is 1 W. It is possible to reach distances of 2 to 40 km depending on topographical conditions and antenna locations. Country specific laws of radio communication must always be followed.

The radio data modem operates well in data networks where the same channel is used by several mobile terminals. In such systems the protocol can be either a polling protocol, in which the data

communication is controlled by the base station, or a multimaster protocol, in which any of the radio modems can initiate data transmission when the radio channel is free.

Due to the incorporation of unique synthesizing techniques the SATELLINE-2ASxE is also suitable for systems with several base stations using different channels. The mobile substations can easily change the frequency for communication with the different base stations. By using this method the coverage area of a system can be enlarged without incurring extra delays due to the capacity of the radio channels.

The handshaking procedure of the SATELLINE-2ASxE interface is PC compatible. Most telecommunications programs can be used with the modem in order to transmit data. This feature together with the possibility of programming the radio data modem via the RS-232 interface (see paragraph 7) makes SATELLINE-2ASxE a product with many application possibilities in wireless data communication.

1.2 RS-232 pin connections

Pin	Signal	Direction	Level	Description
1	DTR	IN	RS-232	Data Terminal Ready Operates as an ON/OFF switch
2	CD	OUT	RS-232	Carrier Detect Indicates a signal on the radio channel exceeding the sesitivity level of the modem (also interference signal)
3	-			
4	-			
5	RSSI	OUT	Analog signal	Received signal strength indicator
6	CTS	OUT	RS-232	Clear To Send Indicates that the radio modem is ready to accept data on the TD line
7 , 8	GND	-	Ground	Operating voltage negative pole and ground reference for all signals
9	RD	OUT	RS-232	Receive Data
10	DSR	OUT	RS-232	Data Set Ready Indicates the "ON" state of the modem
11	TD	IN	RS-232	Transmit Data
12	MODE	IN	open/gnd	Mode Selection *)
13	RTS	IN	RS-232	Request to Send **)
14, 15	VB	-	Voltage	Operating voltage positive pole

*) When pin 12 is open, the radio data modem is in DATA MODE and ready for receiving and transmitting data. When the line is connected to ground, the radio data modem is in PROGRAMMING MODE

**) RTS line: not used in normal data transmission, can be programmed separately for special characteristics

1.3 Technical specifications

The equipment complies with the ETS 300 113 and ETS 300 279 specifications $C\epsilon$.

TRANSCEIVER

Frequency Range	370...470 MHz
Channel Spacing	12.5 kHz/20 kHz or 25 kHz
Number of Channels	160/100 or 80
Frequency Stability	< ± 1.5 kHz
Type of Emission	F1D
Method of modulation	FSK

Transmitter

Carrier Power	1 W (+30 dBm) / 50 ohm
Carrier Power Stability	+ 2 dB / - 3 dB
Frequency Deviation	± 1.8 kHz or ± 2.5 kHz
Adjacent Channel Power	according to ETS 300 113
Spurious Radiations	according to ETS 300 113

Receiver

Sensitivity	< -115 dBm (BER < 10 E-3)
Co-channel rejection	> - 8 dB
Adjacent channel selectivity	> 60 dB / >70 dB or >70 dB
Intermodulation attenuation	> 65 dB
Spurious radiations	< 2 nW

DATA MODEM

Interface	RS-232
Interface Connector	D15 connector, female
Data speed	1200 - 4800 bps (12.5 / 20 kHz channel)
	1200 - 9600 bps (25 kHz channel)
Modulating Signal	NRZ
Data formats	Asynchronous data
	Character length: 10 or 11 bits

GENERAL

Operating voltage	+ 9 ...+ 30 Vdc
Power consumption	2.5 VA typical (Receive)
	6.6 VA typical (Transmit)
	0.05 VA typical (when DTR is "0")
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

Labelling information:

Ser.no. 98290014   Fc: 468.2000 MHz
Init. Settings: 468.2000 MHz / 25 kHz
SATEL OY
Tel: +358-2-7777800, Fax: +358-2-7777810

- Serial number
- Frequency, centre frequency, tuning range +/- 1 MHz
- Initial settings: Frequency / channel spacing
- Contact information of manufacturer or distributor

2 Transmission with the Radio Modem

2.1 Transmission

The SATELLINE-2ASxE is ready to transmit data within <u>300 ms</u> after the supply voltage is switched on and the DTR line is in the "ON" state.
There are three different methods of initiating data transmission:

1. Transmission based on CTS or CD handshaking
2. Data connected directly to the TD line
3. Using TX control of RTS line

If the connection between the radio data modems breaks in the middle of the transmission i.e. as a result of a weak signal, the radio modems can be reconnected by interrupting the transmission for a moment.

1. Transmission based on CTS or CD handshaking

Handshaking should be used when the user needs to ensure that the radio channel is free and the modem is ready to transmit data:

- CD line turns "ON" if the radio channel is occupied (i.e. the strength of another transmission or interference exceeds a preset sensitivity level)
- CTS line turns ″OFF″ if the radio modem has recognised a valid synchronization pattern or if the modem is for any reason unprepared for transmission

NOTE!
CTS does not follow the CD line. **CTS line is not affected by interference or signals from other radio equipment (= programmable data squelch).** Only real received data turns CTS "OFF". This feature makes data transmission possible also in presence of slight interference.

2. Data connected directly to the TD line

It's not necessary to use handshaking if the following conditions are met:

- The channel is completely free from other transmissions and overlapping transmissions are prevented
- Data packets are short (less than 500 bytes)
- If transmitting long data packets (more than 500 bytes) the terminal should be set to use two (2) stop bits and the radio modem in a state where the total number of bits in a character is one less than in the terminal. (Prevents the buffer from filling up.)

3. Using the RTS line to control transmission (RTS set to TX control)

RTS line activates transmission and prevents the radio modem from going into the reception mode. The radio modem sets the CTS line when it is ready to accept data for transmission.

2.2 Reception

The SATELLINE-2ASxE is ready to receive data within 300 ms after the power supply is switched on and the DTR line is in the "ON" state.

Data appears on the RD line as soon as the modem receives a valid data transmission. Start of reception can also be detected from the CTS and CD lines. (See 2.1)

In case of interference or external equipment affecting the functions of the radio modem it can be necessary to prevent the radio modem from receiving. In systems with simplex data transmission, reception can be switched off at the transmitting end. This prevents possible external interference from preventing transmission. (See 7.2.8)

In systems with several radio modems the reception of data can be stopped with the RTS line by activating the "**RD line control**" in the programming mode. (Compare with 7.2.8) When the RTS line is not active the reception of data to the RD line is disabled. Transmission is not possible as long as data transmission is present on the channel.

In systems with several radio modems the reception of data can be stopped with the RTS line by activating "**Reception Control**" in the programming mode. (Compare with 7.2.8) When the RTS line is not active reception is stopped (CTS line indicates current status) and transmission is possible.

2.2.1 RSSI signal

Received Signal Strength Indicator, RSSI, (D connector pin 5) can be used for the approximate determination of the radio signal strength on the current channel.

In the following figure is the typical RSSI voltage (V) as a function of the signal level (dBm). In practise signal level exceeds –25dBm only if the distance to a transmitting modem is less than 10 meters.
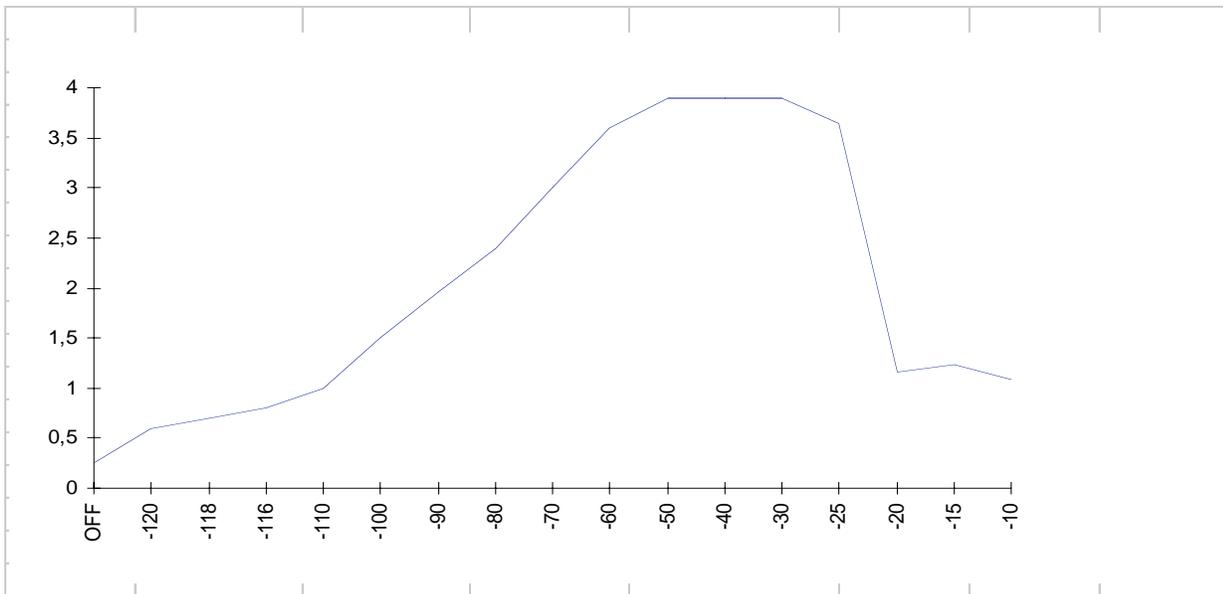
2.3 Delays during data transmission

When using a radio data modem, certain delays occur in data transmission and reception. The delays at different data speeds are:

	1200 bps	2400 bps	4800 bps	9600 bps
Wakeup time DTR OFF/ON	300 ms			
Rx/Tx turn around time on the radio interface	24 ms	12 ms	6 ms	3 ms
Rx/Tx turn around time on the RS-232 interface	0 ms			
Tx/Rx turn around time*)	40-270 ms	20-150 ms	10-90 ms	5-60 ms
Tx/Rx turn around time typical	65 ms	47 ms	30 ms	20 ms
Delay of a point-to-point connection **)	61-65 ms	47- 49 ms	30-32 ms	18-19 ms

*) depends on the length of the data packet and data speed differences between the data terminal and the radio data modem

**) TD line radio modem 1 / RD line radio modem 2 delay

2.4 Basic connection between two radio modems

In order to create a connection between two terminals transmitting and receiving data the radio modems should be programmed and wired as described below. In this case there is no external protocol in use.

Basic setup of the programming menu

```
****** SATEL OY          Salo, Finland tel: +358-2-7777800
****** SATELLINE-2ASxE   SW Version 5.01

   Center Frequency      468.0000 MHz
   Lower Freq. Limit     467.0000 MHz
   Upper Freq. Limit     469.0000 MHz

1) Current Frequency     468.2000 MHz
2) Channel Spacing       12.5 kHz
3) Data                  4800 bps 10 bits
4) Addresses             tx = 0000 / 0000 (hex) off
                         rx = 0000 / 0000 (hex) off
5) Receiver              on
6) Repeater Function     off
7) SL-commands           off
8) RTS-line              off
9) Special Functions     off
A) TX Start delay (ms)   0000 (hex)
T) Tests                 off
Q) Quit

Enter selection >
```

Two wire cable
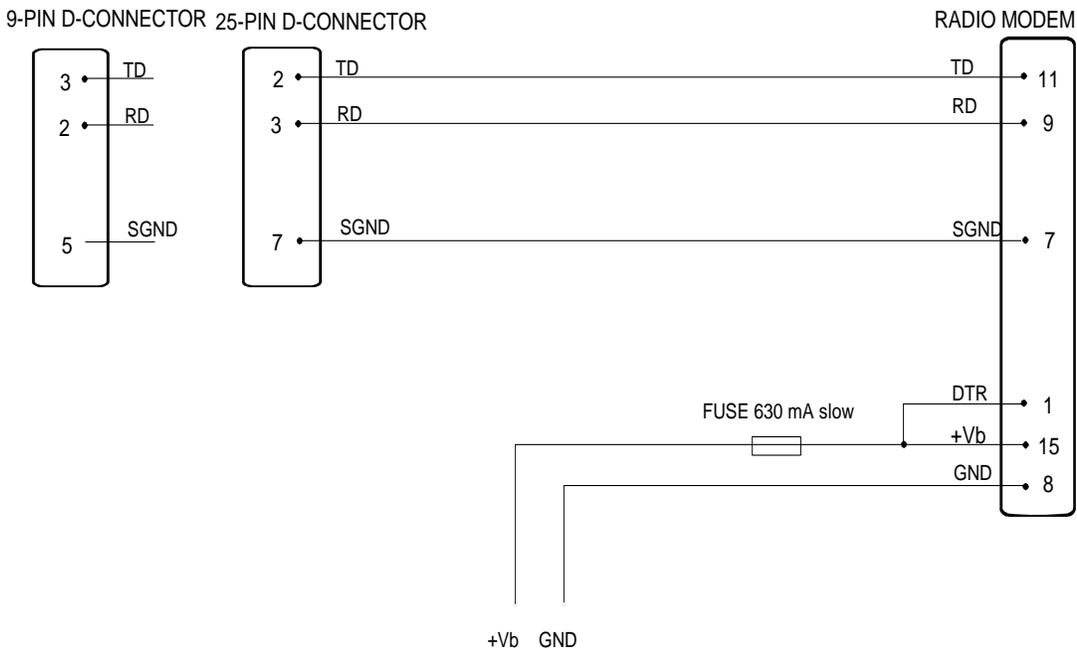
3 Asynchronous Data Transmission and Data Speed

If the character length or data speed is incorrectly set, errors will appear in transmission. At reception they appear as "error characters" or as incorrect operation of the modem.

The data settings of each station in the system should all be the same.

3.1 Asynchronous character

The asynchronous data characters are in accordance with the ANSI-standard (e.g. ASCII), and according to the length of the character are divided into two groups. **The character length is 10 or 11 bits including start, data, parity and stop bits.**

Radio data modems repeat the parity bit as such. The composition of a character is shown below (compare to 7.2.3):

10 BIT

| START | 7 DATA | PARITY | STOP | | e.g. 7,E,1 |

| START | 8 DATA | STOP | | 8,N,1 |

11 BIT

| START | 8 DATA | PARITY | STOP | | e.g. 8,E,1 |

| START | 9 DATA | STOP | | 9,N,1 |

14
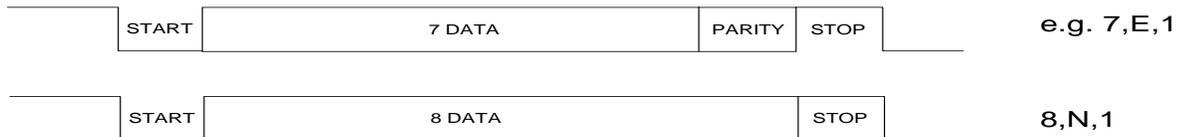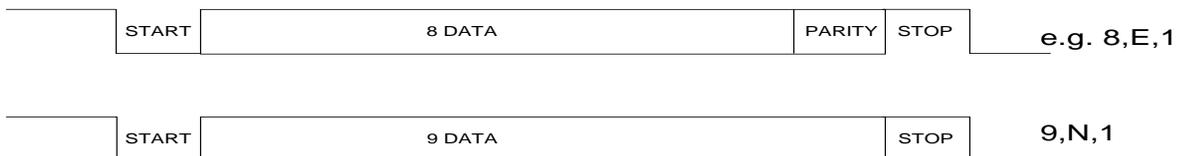
3.1.1 Special BREAK Character

A BREAK character is used in some special protocols e.g. ABB RCOM protocol. The BREAK character is the first character of the data string with 0 level. It is longer than one normal asynchronous character.

The transmitting radio modem recognises the special start element, BREAK, at the beginning of a data string. At reception side the radio modem generates a BREAK in a similar position. The exact length of the BREAK character is not transmitted.

3.2 Data speed

The data speed of the SATELLINE-2ASxE is **1200 - 9600 bit/s** with the channel spacing of 25 kHz and 1200 - 4800 bit/s with the channel spacing of 12.5 and 20 kHz respectively.

The data speed can be selected in the programming mode.

4 Repeater Station Using One Radio Modem

Short data packets of 135 B maximum can be repeated using one radio modem. The repeater function has to be set on in the programming mode. In the repeater mode the radio modem works as an independent unit. When a radio modem is only used as a repeater it only 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 receives data in the same way as usual. However, at the same time it memorizes 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 immediately transmits the received and memorized data on the same channel and with the same settings as received. When transmitting data from the RS-line the functions of the radio modem do not differ from a normal radio modem.

There can be several repeaters in the same system and under the same base station. The repeater stations can also be grouped in a chain, wherein the message goes via several repeater stations. It is necessary to use addresses of the radio modem in a system with several repeater stations.

5 Using Addresses in Data Communication

5.1 General

It is possible to use addresses in both transmission (TX) and reception (RX). An address consists of two data characters (altogether 16 bits). The addresses can either be the same in both directions or when necessary the transmission and the reception addresses can also be different.

Each modem has two pairs of addresses, the primary (1) and the secondary (2) addresses. **If only one pair is necessary both address pairs should be set equal** i.e. TX1=TX2 and RX1=RX2. **The secondary addresses are normally useful only if the radio modem is used as a repeater.**

The addresses can be selected separately for both directions. It is also possible to transfer the received address to the RS interface.

An address consists of the first two characters of a data packet that the radio modem adds to every sent packet and/or checks from every received packet. (compare to paragraph 7.3.1 SLAxy command, where ADD H corresponds to x and ADD L corresponds to y)

ADD H	ADD L	DATA
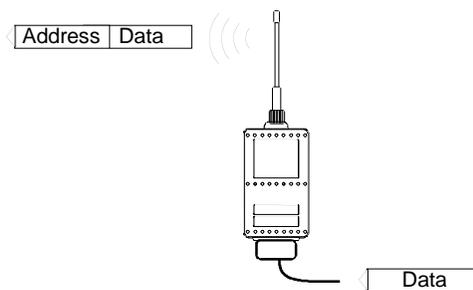
Transmission:

Fig 1 Transmission addressing has been set ON. The radio modem will add the primary TX address to the beginning of the data packet.
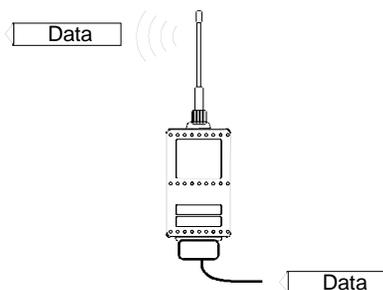
Fig 2 Transmission addresssing has been set OFF. The radio modem will transmit the data packet as such.

Reception:
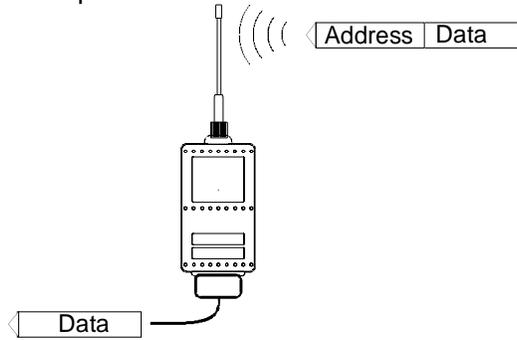
Fig 3 Reception addressing has been set ON and either the primary or secondary RX address of the radio modem is identical to the address of the received data packet.

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" (programming mode) is on, the radio modem does not remove the address.
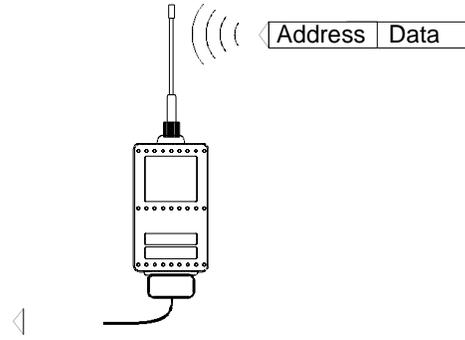
Fig 4 Reception addressing has been set ON, but both the primary and secondary RX addresses of the radio modem are different from the address of the received data packet. Data does not appear on the RS-232 interface.
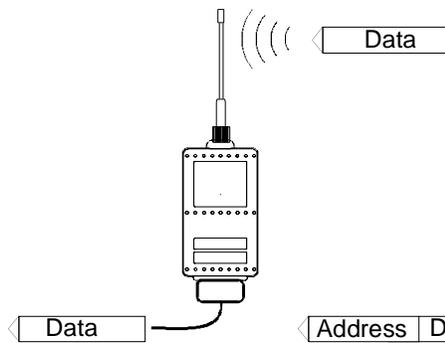
Fig 5 Reception addressing has been set OFF.

The radio modem will transfer all received data to the RS-232 interface.
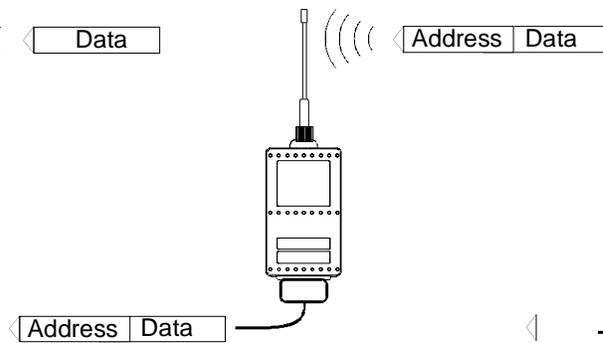
Fig 6 Reception addressing has been set OFF.

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.
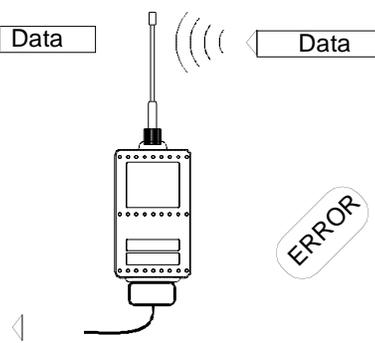
Fig 7 Reception addressing has been set ON but there is no address in the data packet.

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.

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5.2 A connection between two points

In connecting two points it is advisable to set both the receiving and the transmitting addresses equal in both radio modems. This is the easiest way to control the addresses and the risk of interference from other systems working in the same area is minimal.

It's not necessary to use addressing if a special radio channel is reserved for use in the area or if the terminal takes care of addressing.

5.3 A system with one base station and several substations

In a system with several substations it is necessary for the base station to know to which of the substations the message has to be sent and from which substation the message is received. When planning the system there are at least two different possibilities to make use of the addresses in the radio modem. It is also possible that the terminals take care of addressing and in this case the feature of the radio modem is not needed.

The address of the base station can always be changed when transmitting from one substation to another. In this case the base station can only listen to one substation at a time. In a polling system it is possible to use this arrangement because the radio modems communicate with each other in pairs.

In a system with Carrier Sense Multiple Access (CSMA) it is not possible to use addressing at the base station as it would prevent the base station from hearing all the substations. It is useful to change the address of the base station according to the substation in a polling system. It is the terminal of the base station that should take care of the addition of addresses and checking of data packets.

In these applications the radio modem at the base station is left without an address and the radio modems at the substations are set with both the transmitting and the receiving address. The software of the base station must be able to treat the addresses given by the base station and to add the addresses of the substations to the data packet.

5.4 A system with one repeater station

In systems with several repeater, sub and base stations it is necessary to use addresses in the radio modems especially if there is more than one repeater station. A system with only one repeater station can be built without addressing. However, the message will be duplicated on the communication route (the base station hears the messages from both the substation and the repeater station).

There are at least two alternative ways to use addressing depending on the programmability of the terminal equipment and the number of repeater stations and their positions to each other.

5.4.1 The alternating addresses of a pair of radio modems

When neither the terminal nor the substations are able to generate address fields, but they can recognize the message addressed to them, the addresses of the radio modems can be alternating. The transmission (TX) and reception (RX) addresses of the radio modems alternate according to the following table:

	Base station address	The address of repeater station 1 and substations of the base station	The address of the substations of the repeater station 1
TX address	address 1	address 2	address 1
RX address	address 2	address 1	address 2

In a system using alternating addresses the routing of data to a specific radio modem is set at the time of installation. The order of the addresses must be set according to the wished routing of data. Please note that in systems with alternating addresses the base station and the substations hear their own messages repeated.

5.5 A system with several repeater stations
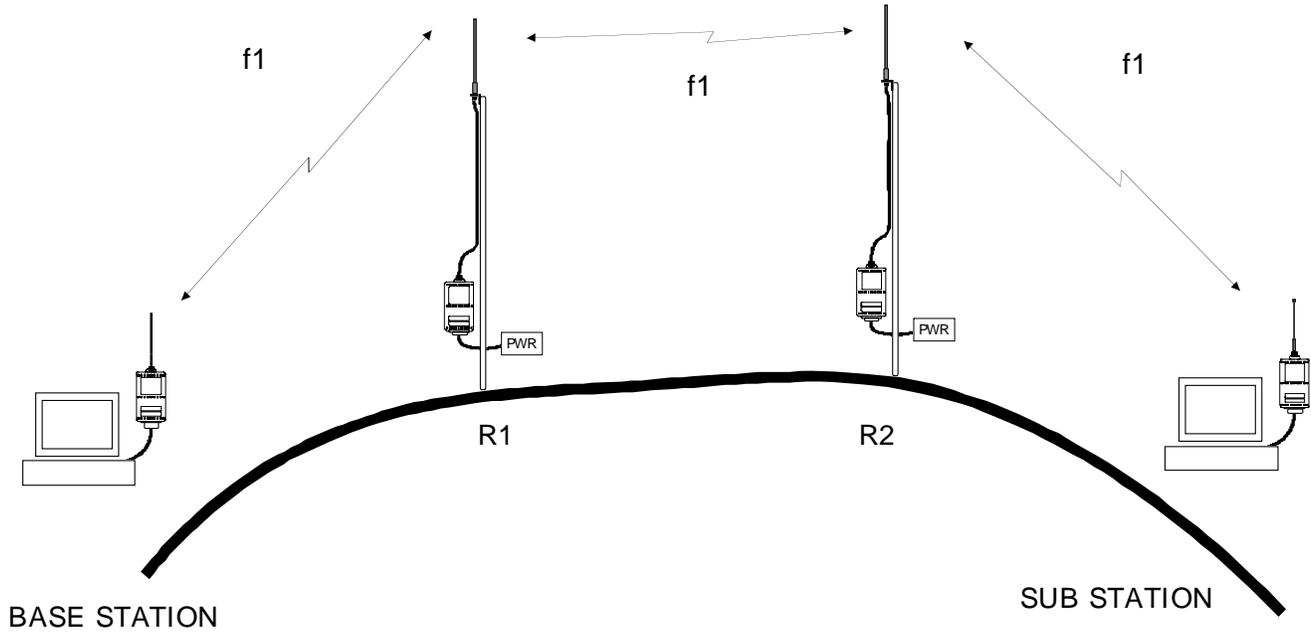
In systems with several adjacent or parallel repeater stations addresses should be used. This prevents messages from circulating around the network and ensures that only a determined radio modem receives the message.

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. Addressing is used in the following way to route a message:

R1 ADD	R2 ADD	S ADD	DATA
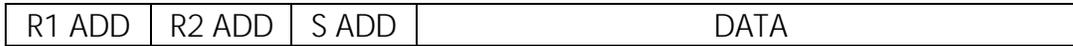
- a message from the base station terminal contains the addresses of the repeater stations and the substation (each box consists of two characters)

R2 ADD	S ADD	DATA
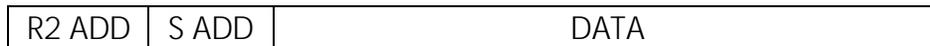
- the message from the repeater station 1 to repeater station 2

S ADD	DATA
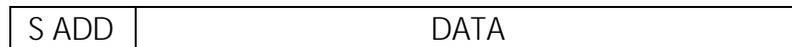
- the message from the repeater station 2 to substation 4

DATA

- the message received from the RS-232 port at the substation 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	R1 ADD	B ADD	DATA

5.6 A repeater chain using dual addressing

If the data terminal equipment is not able to generate a string of addresses to the beginning of the data packet, dual addressing can still be used to connect two points using several repeaters.

In dual addressing every single link and direction is given a unique address, which prevents duplicate and circulating messages. Data terminal equipment does not need to add anything to the data.

The idea of dual addressing is that the primary transmission address (TX1) is normally used, except when a packet with the secondary reception address (RX2) is received and the repeater mode is turned on. In this case secondary transmission address (TX2) is used instead.

In the following example two repeaters are used. Notice how unique addresses for each link (arrow) can be derived from the modem numbers. It's important that only the two repeating modems are set in the repeater mode, otherwise messages will circulate in the network. Repeaters can simultaneously function as normal substations. In this case the base station would have to be in position 4 so that routing of data from stations 2 and 3 would be correct.

Addresses:	Modem 1	Modem 2 repeater	Modem 3 repeater	Modem 4
RX1	21	12	23	34
TX1	12	23	34	43
RX2	(21)	32	43	(34)
TX2	(12)	21	32	(43)
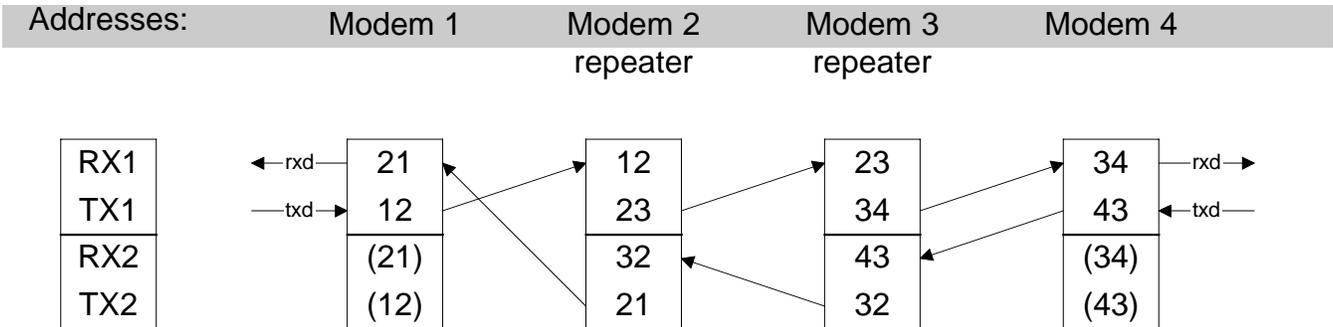
6 Test Mode

Test Mode offers a possibility to test the connection between two stations by using the internal test message beacon of a radio modem. By setting the radio modem into the Test Mode it continuously transmits either a data packet or carrier depending on the selection. By using the independent Test Mode a terminal is not required at every station when testing the connection between different stations of the system.

When a radio modem is programmed in the Test Mode, as soon as it exits the programming mode or when power is switched on, the radio modem enters the Test Mode. To exit the Test Mode put pin 12 to ground (GND) before switching the power on. In the Programming Mode the Test Mode can be disabled again. Normal data transmission is not possible in the Test Mode.

The selected settings for data transmission are the same in the Test Mode (frequency, channel spacing, address and data speed) as in the Data Transfer Mode.

6.1 TX Carrier Test

When TX Carrier Test function is selected in the programming mode the radio modem transmits a continuous carrier.

6.2 TX Data 80 B

When TX Data 80 B function is selected the radio modem transmits data packets of 80 B. There is a break of 0.25 s between the data packets.

6.3 TX Data 10 kB

When TX Data 10 kB function is selected the radio modem transmits data packets of 10 kB. There is a break of 0.25 s between the data packets.

7 Programming the SATELLINE-2ASxE

7.1 General

There are several features in SATELLINE-2ASxE radio modem that can easily be changed. The mode of the radio modem must be changed before choosing between different features. Normally SATELLINE-2ASxE is in **Data Mode**, when pin 12 of the D connector is open.

When pin 12 is connected to ground (GND), the radio data modem is turned into **Programming Mode**. In the Programming Mode the settings of the serial port are always 9600 bps, N, 8, 1. In this mode the settings of SATELLINE-2ASxE can be changed in the way described in chapter 7.2.

If the **SL-command function** is activated the radio channel and addresses can be changed without moving into the Programming Mode. Settings of the serial port are those set at the Programming Mode. With this function the features of SATELLINE-2ASxE can be changed in the way described in chapter 7.3.

7.2 Programming mode

Connect the radio data modem to a terminal or a PC running a suitable terminal program such as SaTerm. Check that the terminal settings are 9600 bps, 8N1. Connect pin 12 of the D connector to ground (GND). The radio data modem sends a screen menu to the terminal:

```
******  SATEL OY           Salo, Finland tel: +358-2-7777800
******  SATELLINE-2ASxE    SW Version 5.01

   Center Frequency        468.0000 MHz
   Lower Freq. Limit       467.0000 MHz
   Upper Freq. Limit       469.0000 MHz


1) Current Frequency       468.2000 MHz
2) Channel Spacing         12.5 kHz
3) Data                    4800 bps 10 bits
4) Addresses               tx = 0000 / 0000 (hex) off
                           rx = 0000 / 0000 (hex) off
5) Receiver                on
6) Repeater Function       off
7) SL-commands             off
8) RTS-line                off
9) Special Functions       off
A) TX Start delay (ms)     0000 (hex)
T) Tests                   off
Q) Quit

Enter selection >
```

7.2. Setting the radio frequency

The radio channel of the modem can be set in menu 1.

```
Enter a new value ? 468.2000
```

The selected frequency must be within the specified limits, normally +/- 1 MHz from the center frequency. The channel is given as a numerical value.

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

7.2.2 Setting the channel spacing

The desired channel spacing can be selected in menu 2.

```
1) Set Channel Space        20 kHz
2) Set Channel Space        12.5 kHz

Enter selection or ESC to cancel > 2
```

The channel spacing can be selected between 20 and 12,5 kHz. If the channel spacing of the unit is 25 kHz it is fixed and can not be changed.

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

7.2.3 Setting the data interface properties

The data interface settings can be set in menu 3.

```
1) Data Speed              9600 bps
2) Character Length        10 bits

Enter selection or ESC to cancel > 1
```

```
1) 1200 bps
2) 2400 bps
3) 4800 bps
4) 9600 bps

Enter selection or ESC to cancel > 3
```

```
1) Data Speed              4800 bps
2) Character Length        10 bits

Enter selection or ESC to cancel > 2
```

```
1) 10 bit
2) 11 bit

Enter selection or ESC to cancel > 2
```

In a unit with 25 kHz channel spacing the maximum data speed is 9600 bps. If the channel spacing is 12.5 or 20 kHz the maximum data speed is 4800 bps.

7.2.4 Setting the addresses

The addresses can be set in menu 4. In this example the primary transmission address is changed and activated.

```
1) Tx Address 1          0000 (hex)
2) Tx Address 2          0000 (hex)
3) Rx Address 1          0000 (hex)
4) Rx Address 2          0000 (hex)
5) Tx Addresses          off
6) Rx Addresses          off
7) Rx Address to RD-line  off

Enter selection or ESC to cancel > 1
```

```
Enter a new value ? 1234
```

```
1) Tx Address 1          1234 (hex)
2) Tx Address 2          0000 (hex)
3) Rx Address 1          0000 (hex)
4) Rx Address 2          0000 (hex)
5) Tx Addresses          off
6) Rx Addresses          off
7) Rx Address to RD-line  off

Enter selection or ESC to cancel > 5
```

```
1) Set Function ON
2) Set Function OFF

Enter selection or ESC to cancel > 1
```

The addresses are given in hexadecimal form in which case the number of different address combinations exceeds 65.000. There is a selectable address in the radio data modem which can be used both at reception and transmission. 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. In case a communication between two radio data modems is wished to be established with addresses (=they only communicate with each other), the same address must be set in both radio modems e.g. "1234".

7.2.5 Setting the receiver status

The status of the receiver can be set in menu 5.

```
1) Set Function ON
2) Set Function OFF

Enter selection or ESC to cancel > 1
```

In simplex solutions data reception can be switched off at the transmitting part of the system. This prevents possible external interference from preventing the data transmission.

7.2.6 Setting the repeater function

The status of the repeater function can be set in menu 6.

```
1) Set Function ON
2) Set Function OFF

Enter selection or ESC to cancel > 2
```

The radio modem can repeat short data packets (max. 135 B) using only one radio frequency. In the repeater function the radio modem receives data in the same way as usual, but at the same time it memorizes the received data. After finishing the reception it directly transmits the received and memorized data on the same channel and with the same settings as received. **If addressing is used, the message is retransmitted with the TX address corresponding to the RX address that matched in reception i.e. if the primary RX address matched then the primary TX address is used in the retransmission.**

7.2.7 Setting the SL-command function

The status of SL-commands can be set in menu 7.

```
1) Set Function ON
2) Set Function OFF

Enter selection or ESC to cancel > 2
```

If the SL-command function is activated the radio frequency and addresses can be selected directly from the serial port of the radio modem without connecting pin 12 to ground.

7.2.8 Setting the RTS line functions

The RTS line functions can be set in menu 8.

```
1) Set RTS-Line Functions OFF
2) TX Control
3) RD-Line Control
4) Reception Control

Enter selection or ESC to cancel > 1
```

• TX Control

The RTS line activates transmission and prevents the radio modem from entering reception. The radio modem sets the CTS line when it's ready to accept data for transmission.

• RD-line Control

When the RTS line is not active the reception of data to the RD line is disabled. Transmission is not possible as long as data transmission is present on the channel.

• Reception Control

When the RTS line goes inactive the reception of data is interrupted. The radio modem goes out of reception (the CTS line indicates current status) and the TD line is ready for use.

7.2.9 Setting the special functions

Some special functions can be set in menu 9.

```
1) Set Special Functions OFF
2) BREAK character detection
3) Slow RX turnaround

Enter selection or ESC to cancel > 1
```

• BREAK character detection

The special BREAK character is detected and transmitted.

• Slow RX turnaround

In normal operation this function should be turned off. Setting this function on in the receiving end slows down the packet end detection. If inter character delays in the transmitting end are causing data loss, setting this function on may help.

7.2.10 Setting the TX Start delay

Transmitter starting delay in milliseconds can be set in menu A.

```
Enter a new value ? 0000
```

In normal operation this parameter should be set to 0. If any other value is set, the radio modem waits for a given time between the first character to be transmitted and the beginning of the actual transmission. During this period any data to be transmitted is stored in the 135 B long data buffer.

7.2.11 Setting the Test Mode

The test mode and the separate functions can be set in menu T.

```
1) Set Test Functions OFF
2) Tx Carrier              off
3) Tx Data 80 B            off
4) Tx Data 10 kB           off

Enter selection or ESC to cancel > 1
```

7.3 SL commands

If the SL-command function is activated radio channel and addresses can be changed directly from the serial port of the radio data modem without connecting pin 12 to ground. SL commands should be sent using the data speed and bit settings which are currently in use. However, the data part of the character must be 8 bits. **The changes are made with a programming packet,** which is a separate packet and may not be included in the transmitted data packet, and may not include extra characters. The length of the programming packet should be 5 characters and the length of the pause before and after the programming packet must exceed 3 characters.

7.3.1 Setting the addresses

All the four addresses (TX1, RX1, TX2, RX2) can be set simultaneously with the command

SLAxy

where x and y are characters consisting of 8 bits.

Programming both of the receiving addresses is possible with the command

SLRxy

and both of the transmitting addresses with the command

SLTxy.

After recognizing an address programming packet the radio modem disables the CTS signal and sets the new addresses. If the setting is successfully completed the radio modem answers

OK

7.3.2 Setting the radio channel

The radio channel can be changed with the command

SLLxy

or

SLHxy

The channels below the centre frequency are set with the SLLxy command and the channels above the centre frequency with the SLHxy command (max ± 1MHz). The number of the channel is a decimal number 00-40, if the 25 kHz channel space is used, and 00-80, if the 12,5 kHz channel space is used. The desired radio channel number can be derived from the mathematical formula channel = centre frequency ± xy * channel space (eg. 25 kHz).

An example:

SLH35   =>   445 MHz + 35 * 25 kHz = 445.875 MHz

As soon as the radio modem recognizes a channel programming packet it disables the CTS signal and checks if the setting of the new channel is permitted. If the new channel was within limits the radio is set to the new channel and the modem replies

OK

If the channel is not permitted the reply is

Error

7.3.3 Saving of the current setup

Other SL-commands do not affect permanent setup values. The changes are valid only as long as the radio modem is powered. Next time when the power is switched on, the radio modem will load the permanent values from its non-volatile memory. Permanent changes can be done using the SL-command

SLSØS   (Ø = zero)

8 Forming the SL Commands

When programming the radio modem with SL commands, please note that the form of the addresses is different than in the Programming Mode. In Programming Mode an address is given in hexadecimal (values between 0000 and FFFF) e.g. 2BFAh. SL commands accept the address as two 8 bit binary characters.

SL commands must be sent as a continuous 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 continuous transmission of the command. If there is a break in the transmission, the radio modem interprets the packets as transmitted data.

The easiest way to send SL commands is to use SaTerm, as it allows any binary character to be sent using the Transmit window. See SaTerm documentation for details.

8.1 Forming a packet to change addresses

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 the 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 also 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 the numeric keypad. Use a simple DOS editor. Press ALT key, use the numeric keypad to enter the decimal value (3 numbers, e.g. 10 = 010) and release the 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.

9 Multi Modem Data Systems

9.1 Transmission sequences

The data should be transferred in continuous sequences or in sequences divided into blocks. Sequences that are too short (e.g. 1 character) should not be sent because the "overhead-information" (synchronization plus terminal address) takes a great deal of processing time in relation to the actual data and thus slows down the data transmission. The recommended length of a data packet is 50 - 500 characters.

The size of a system using one radio channel can be increased when the timeframe for transmission of one terminal is short. This must be taken into account when planning a system. The operating range of a system can be extended by increasing both the number of base stations and the number of radio channels.

It is important that only one transmitter can be active on the same channel at the same time.

9.2 Polling

The system can be configured as a "Master-Slave" network which allows one radio modem to control the others in the system. Slave units can communicate with the Master during the time allocated to a particular Slave by the Master unit.

The advantage of the polling mode is that collisions (i.e. simultaneous transmissions) do not occur. The disadvantage of this method is that the transmitter of the Master is switched on half of the time in situations when there is no data transmission from a Slave to the Master.

A polling protocol is not included in the transparent radio modem. It is a protocol of higher hierarchy and supplied by the system.

9.3 Multi Master

The system can also be configured as a "Multi-Master" network. In this situation any radio data modem can start transmission after first testing either the CTS line or the CD line to make sure that the radio channel is free.

The advantage of this system is that the transmitter is ON only during data transmission. The disadvantage is that if all the mobile stations do not "hear" each other collisions may occur.

A multi master protocol is not included in the transparent radio modem. It is a protocol of higher hierarchy and supplied by the system.

10 Planning a Radio Modem Network

10.1 Factors affecting the quality and maximum distance of a radio connection

- power of the radio transmitter
- sensitivity of the radio receiver
- tolerance of spurious radiations 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-2ASxE is 1 W 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, 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 is 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 /10m) in order not to waste the antenna amplification. Problematical radio connections can also be solved by adding a repeater station. 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-2ASxE radio data modem operates in the 450 MHz band, where man made interference is insignificant. Long distance interference needs not to be taken into account even in special weather conditions.

The SATELLINE-2ASxE 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 retransmitting 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 area occurs in which errors begin to be generated by noise and interference which will eventually lead to loss of connection.

The field strength is at its optimum level in open space, although it will still be reduced by increasing distance. 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.

11 Installation

The radio modem is to be installed with the installation accessories supplied with the radio modem:
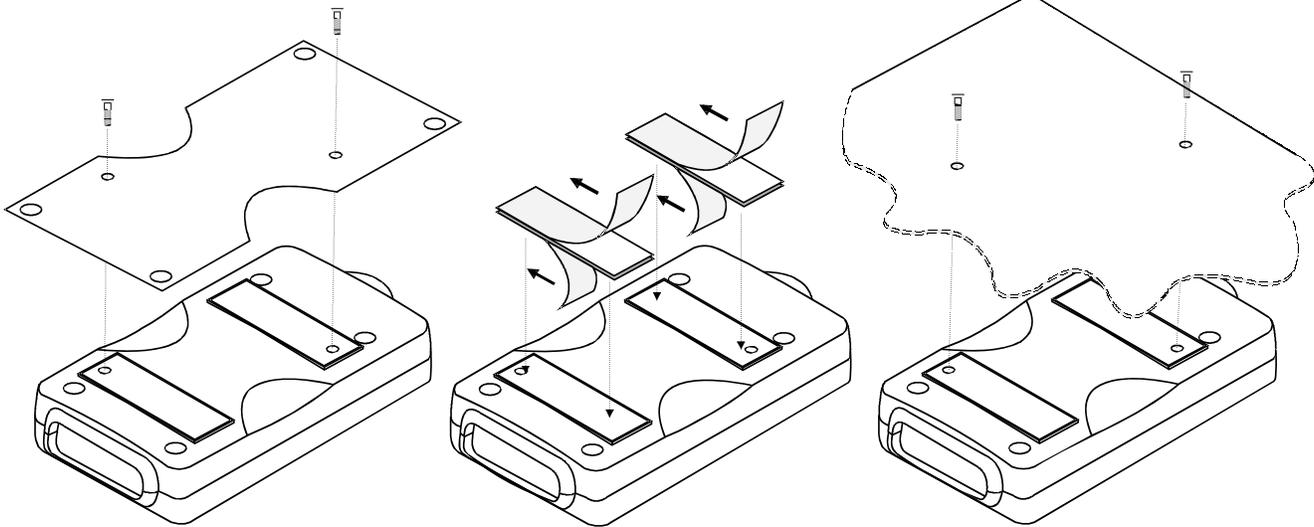
1. By using the installation plate, which should be fastened on the back side of the radio modem.
The installation plate can be mounted using the holes provided on the plate.

2. By using the velcro-type 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. It is not recommended to mount the radio modem on a powerfully vibrating foundation. The attachment should be lessened with help of a resilient material.

The radio modem fulfils the specifications according to ETS 300 113 regarding temperature range -25 °C ... +55 °C. The radio modem operates also outside this temperature range but does not necessarily fulfil all the specified specifications.

11.1 RS-232 Interface

The radio modem is connected to terminal via RS-232 interface. A typical connection where all handshaking lines are used should be made according to the figure below.
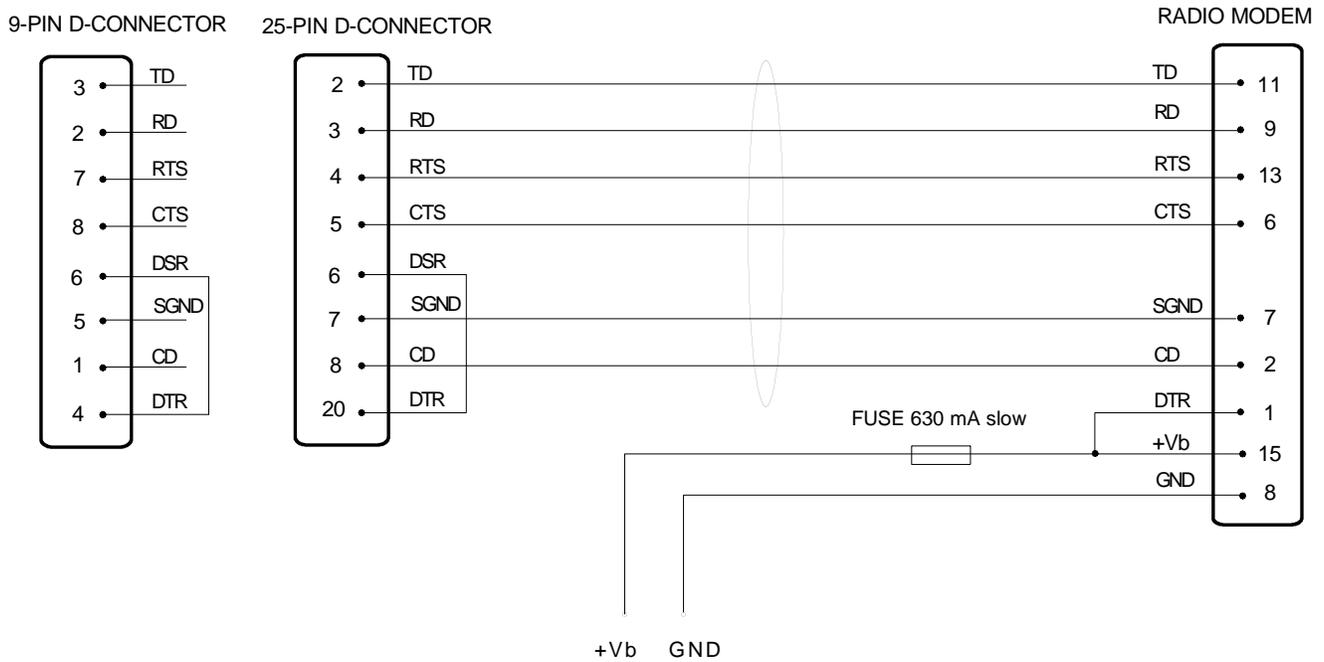
In some systems the radio modem is connected to another Data Transmission Equipment (modem). The signal lines should in this case be connected according to the picture below.
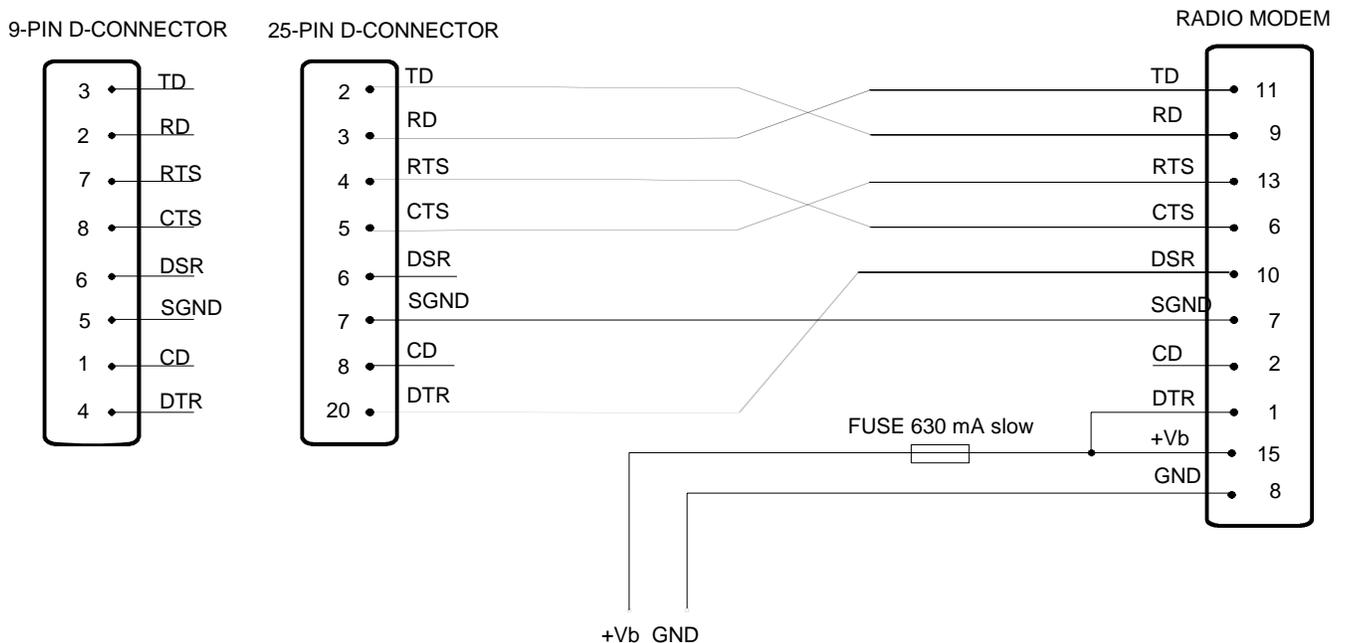
11.2 Power supply

The supply voltage range is 9 - 30 V. The <u>positive</u> pole of the power supply should be connected to D 15 connector pins <u>14 and 15</u> and the <u>negative</u> pole to pins <u>7 and   8.</u> The DTR line at pin 1 can be used as an ON/OFF switch. The logical state "1" (+5...+30 V) corresponds to ON state and "0" (0 V...-12 V) to OFF state.

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

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

11.3 Antenna installation

Over great distances or in otherwise severe conditions the operation of a radio connection is greatly dependent on antennas and their mounting. Antennas, antenna cables and terminal adaptors should always have gold plated connectors. Since connectors of poor quality oxidize and increase the attenuation in the course of time appropriate connectors and proper tools must always be used. One should also check that both the antenna and possible installation elements resist well weather 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 are to be installed the best place for the antenna is at the highest point of the building or a separate 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 are tuned to a certain frequency range. Simple antennas and those made of stacked yagis have a relatively wide bandwidth. The frequency range of an antenna becomes narrower the more elements there are in the antenna.

Keeping in mind the testing and service of a system it is generally more practical to use a long antenna cable instead of installing the radio modems into a place which is difficult to access.

The antenna cable should be chosen according to the length bearing 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.

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 polarized antennas (antenna elements are in vertical position) are often used in radio systems. In a system between a base station and substations the vertical polarization 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.

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Horizontal polarization can be used in data transmission between two points. With the polarization attenuation more distinction is obtained to vertical polarized 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 polarized 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.
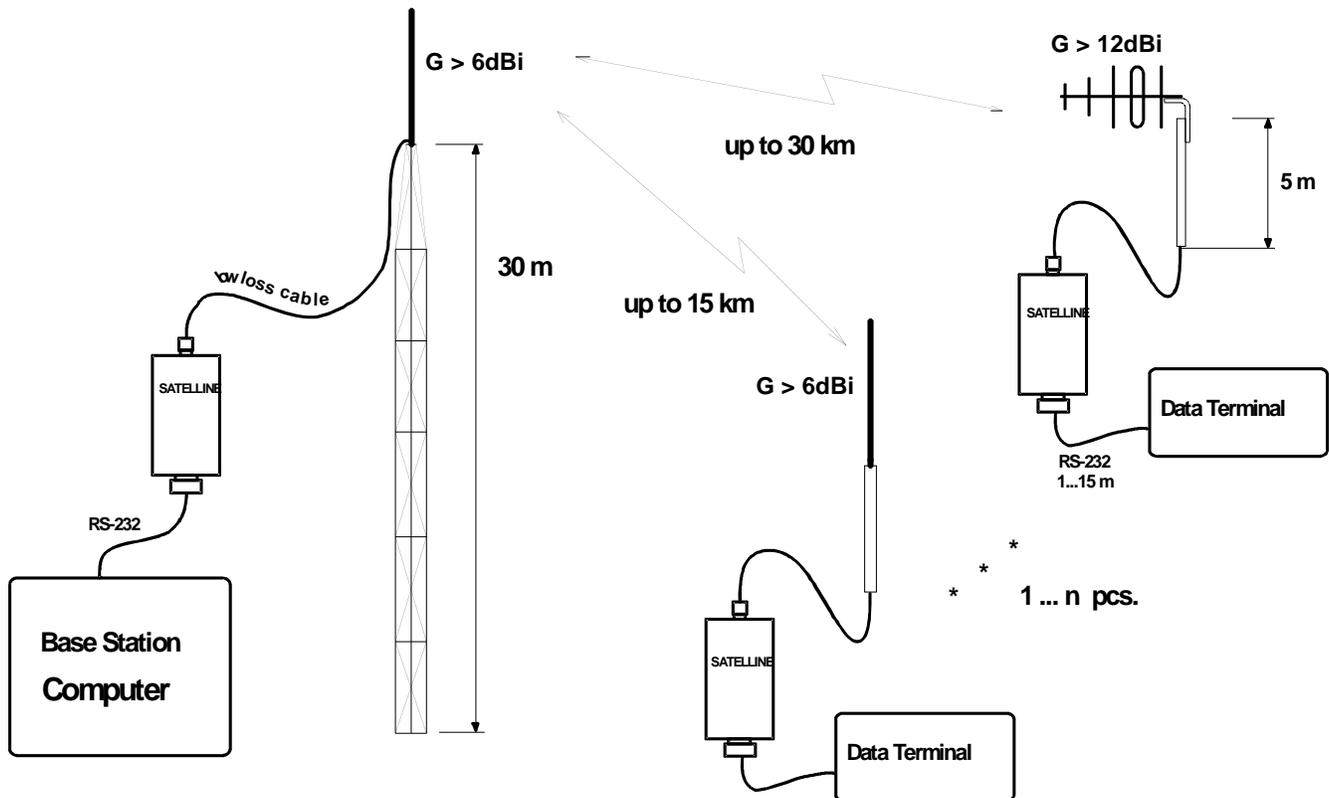
Example of an antenna installation: By using of directional (amplifying) antennas and by installing antennas on a high location, long distances can be reached with SATELLINE-2ASxE.

12 Equipment

12.1 Connecting antennas to radio modems

Recommended antenna types are as follows:

12.1.1 Hand portable equipment

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

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

12.1.2 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 <u>0.5 m</u> 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 connector a 50 ohm coaxial cable must be used to provide the link between the radio modem and the antenna.

12.1.3 Base station

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

12.2 Cables

12.2.1 RF cables

If the antenna cable is shorter than 5 m a good quality 50 ohm RF cable can be used (e.g. RG58). In case a longer cable is required, it should be a low loss RF cable. As a standard cable we supply 50 ohm RG58 cable in lengths of 1 m (CRF-1) and 5 m (CRF-5).

NOTE!
Please check, that the contact area of cable connectors is gold plated and that the connectors used are reliable. Ageing connectors of poor quality oxidize easily and cause malfunction of the system.

12.2.2 Interface cables

When planning the location of the radio modem, it must be observed that the maximum length of an RS-232 cable is 15 m. The cable must be shielded. The maximum length of the power supply cable is 2 m. As standard cables we supply cables with either a 25 pin connector CRS-1 F or CRS-1 M (F=female, M=male) or with a 9 pin connector CRS-2 F or CRS-2 M. The lengths of the cables are 2 m and they contain both interface and power supply cables.

There is also an interface adapter ARS-1F with a programming switch and power supply cables available for the SATELLINE-2ASxE radio modem. The interface adapter matches the connector of the modem and provides a 9 pin (female) D connector. In addition there is a straight cable with 9 pin connectors, CRS-9.

NOTE!
Please check, that the contact area of cable connectors is gold plated and that the connectors used are reliable. Ageing connectors of poor quality oxidize easily and cause malfunction of the system.

13 Check List

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

1. Before connecting the RS-232 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 ensured so that the current supplied to the transmitter is sufficient for creating a reliable connection.

4. The antenna is installed according to the given instructions.

5. The settings of the radio modem corresponds those of the terminal and all radio modems of the system have the same settings and are compatible to each other.

6. The radio modems are on the same channel

Appendix 1   Character Map

ASCII CHARACTER TABLE

| D	H	C	D	H	C	D	H	C	D	H	C	D	H	C	D	H	C
000	00		043	2B	+	086	56	V	129	81	ü	172	AC	¼	215	D7	î
001	01	☺	044	2C	,	087	57	W	130	82	é	173	AD	¡	216	D8	ï
002	02	☻	045	2D	–	088	58	X	131	83	â	174	AE	«	217	D9	⌐
003	03	♥	046	2E	.	089	59	Y	132	84	ä	175	AF	»	218	DA	⌐
004	04	♦	047	2F	/	090	5A	Z	133	85	à	176	B0	▒	219	DB	█
005	05	♣	048	30	0	091	5B	[	134	86	å	177	B1	▓	220	DC	▄
006	06	♠	049	31	1	092	5C	\	135	87	ç	178	B2	▓	221	DD	▌
007	07	•	050	32	2	093	5D	]	136	88	ê	179	B3	│	222	DE	▐
008	08	◘	051	33	3	094	5E	^	137	89	ë	180	B4	┤	223	DF	▀
009	09		052	34	4	095	5F	_	138	8A	è	181	B5	Á	224	E0	ó
010	0A		053	35	5	096	60	`	139	8B	ï	182	B6	Â	225	E1	ß
011	0B	♂	054	36	6	097	61	a	140	8C	î	183	B7	À	226	E2	Ô
012	0C	♀	055	37	7	098	62	b	141	8D	ì	184	B8	©	227	E3	ò
013	0D	♪	056	38	8	099	63	c	142	8E	Ä	185	B9	╣	228	E4	õ
014	0E	♫	057	39	9	100	64	d	143	8F	Å	186	BA	║	229	E5	Õ
015	0F	☼	058	3A	:	101	65	e	144	90	É	187	BB	╗	230	E6	µ
016	10	►	059	3B	;	102	66	f	145	91	æ	188	BC	╝	231	E7	Þ
017	11	◄	060	3C	<	103	67	g	146	92	Æ	189	BD	¢	232	E8	Þ
018	12	↕	061	3D	=	104	68	h	147	93	ô	190	BE	¥	233	E9	ú
019	13	‼	062	3E	>	105	69	i	148	94	ö	191	BF	┐	234	EA	Û
020	14	¶	063	3F	?	106	6A	j	149	95	ò	192	C0	└	235	EB	Ù
021	15	§	064	40	@	107	6B	k	150	96	û	193	C1	┴	236	EC	ý
022	16	▬	065	41	A	108	6C	l	151	97	ù	194	C2	┬	237	ED	Ý
023	17	↕	066	42	B	109	6D	m	152	98	ÿ	195	C3	├	238	EE	¯
024	18	↑	067	43	C	110	6E	n	153	99	ö	196	C4	─	239	EF	´
025	19	↓	068	44	D	111	6F	o	154	9A	Ü	197	C5	┼	240	F0	–
026	1A	→	069	45	E	112	70	p	155	9B	ø	198	C6	ã	241	F1	±
027	1B	←	070	46	F	113	71	q	156	9C	£	199	C7	Ã	242	F2	=
028	1C	∟	071	47	G	114	72	r	157	9D	ø	200	C8	╚	243	F3	¾
029	1D	↔	072	48	H	115	73	s	158	9E	×	201	C9	╔	244	F4	¶
030	1E	▲	073	49	I	116	74	t	159	9F	ƒ	202	CA	╩	245	F5	§
031	1F	▼	074	4A	J	117	75	u	160	A0	á	203	CB	╦	246	F6	÷
032	20		075	4B	K	118	76	v	161	A1	í	204	CC	╠	247	F7	
033	21	!	076	4C	L	119	77	w	162	A2	ó	205	CD	=	248	F8	°
034	22	"	077	4D	M	120	78	x	163	A3	ú	206	CE	╬	249	F9	¨
035	23	#	078	4E	N	121	79	y	164	A4	ñ	207	CF	¤	250	FA	·
036	24	$	079	4F	O	122	7A	z	165	A5	Ñ	208	D0	ð	251	FB	¹
037	25	%	080	50	P	123	7B	{	166	A6	ª	209	D1	Ð	252	FC	³
038	26	&	081	51	Q	124	7C	|	167	A7	º	210	D2	Ê	253	FD	²
039	27	'	082	52	R	125	7D	}	168	A8	¿	211	D3	Ë	254	FE	■
040	28	(	083	53	S	126	7E	~	169	A9	®	212	D4	è	255	FF	
041	29	)	084	54	T	127	7F	⌂	170	AA	¬	213	D5	¹			
042	2A	*	085	55	U	128	80	Ç	171	AB	½	214	D6	í			

Appendix 2   Delays and timings of the RS-232 interface with a data speed of 9600 bps

MODEM 1
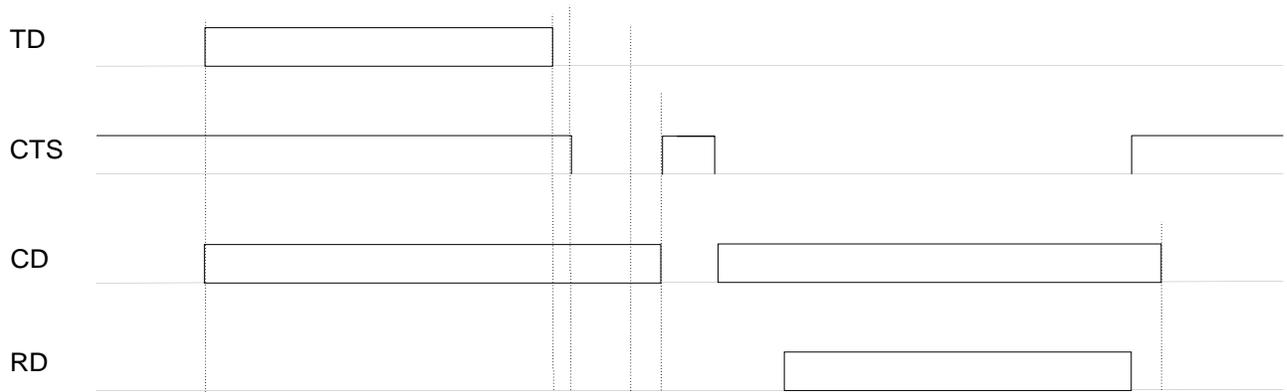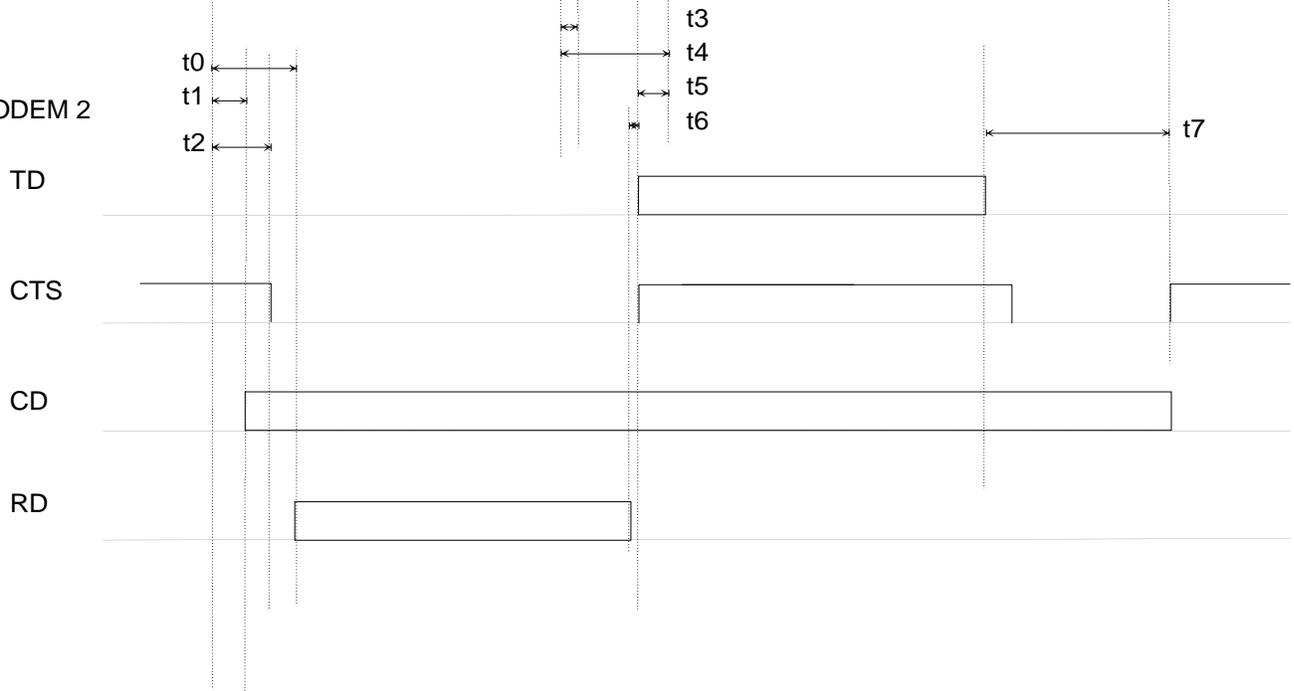
t0 = 17 - 20 ms (typ. 18 ms)   delay between TD and RD data

t1 = 1,5 - 4 ms   Tx on / Rx CD delay

t2 = 5 - 6 ms   Tx on / Rx CTS delay

t3 = 2 - 10 ms   (typ. 3 ms)   Data package end delay

t4 = 5 - 60 ms   (typ. 30 ms)   Tx buffers emptying time

t5 = 3 - 4 ms   Rx to Tx connecting time

t6 = 0 ms   Virtual Rx to Tx connecting time

t7 = t4 + (t5 - x)   Tx buffer emptying time 2 (x = TD start time before t5)