

# **SATELLINE-M3-TR1**

## **Transceiver Radio Modem User Guide**

## **IMPORTANT NOTICE**

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Salo, FINLAND 2010

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## RESTRICTIONS ON USE

SATELLINE-M3-TR1 radio modem module has been designed to operate on 403...473 MHz, 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.

**WARNING!** Users of SATELLINE-M3-TR1 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.

SATELLINE-M3-TR1 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, BE, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IL, IT, LV, LT, NL, NO, PL, PT, RO, SE, US and SK.

## PRODUCT CONFORMITY

### SATELLINE-M3-TR1

SATEL Oy hereby declares that SATELLINE-M3-TR1 radio modem modules are 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 users that the operating frequency range of the device is not harmonised throughout the market area, and the local spectrum authority should be contacted before the usage of the radio modem is used.



### DECLARATION of CONFORMITY

In Accordance with  
1999/5/EC Directive

of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity

Doc No: SATEL-DC-RTTE-081  
Manufacturer: SATEL Oy  
Address: POB 142, (Meriniitynkatu 17), 24101 Salo, Finland

Products :	Type	Model
	<b>SATEL-TA13</b>	<b>SATELLINE-M3-TR1</b>

We, the manufacturer of the above mentioned products, hereby declare that these products conform to the essential requirements of the European Union directive 1999/5/EC. This Declaration of Conformity is based on the following documents:

Doc. No	Type of Product	Test Specification	Laboratory / Date of Issue
131691A	SATELLINE-M3-TR1	EN 300 113-2 V.1.4.1	NEMKO / Espoo 3.8.2009
131691B	SATELLINE-M3-TR1	EN 300 113-2 V.1.4.1	NEMKO / Espoo 3.8.2009
131691C	SATELLINE-M3-TR1	EN 301 489-1, -5	NEMKO / Espoo 3.8.2009
131691D	SATELLINE-M3-TR1	EN 301 489-1, -5	NEMKO / Espoo 3.8.2009
131691E	SATELLINE-M3-TR1	IEC 60950-1:2006	NEMKO / Espoo 30.9.2009

Salo on the 20<sup>th</sup> of October, 2009.

SATEL OY  
  
Pekka Aina  
CEO



SATEL OY  
PO Box 142, FI-24101 SALO, FINLAND  
Street: Meriniitynkatu 17, FI-24100 SALO, FINLAND  
Tel: +358 2 777 7800; Fax: +358 2 777 7810  
E-mail: info@satel.com, www.satel.com

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## **WARRANTY AND SAFETY INSTRUCTIONS**

Read these safety instructions carefully before using the product:

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

### **NOTE!**

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

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## **INTRODUCTION**

SATEL Oy is a Finnish electronics and Telecommunications Company specialising in the design and manufacture of wireless data communication products. SATEL designs, manufactures and sells radio modems intended for use in applications ranging from data transfer to alarm relay systems. End users of SATEL products include both public organisations and private individuals.

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

# 1 TECHNICAL SPECIFICATIONS

## 1.1 SATELLINE-M3-TR1 Technical Specifications

SATELLINE-M3-TR1 complies with the following international standards:

- EN 300 113-2
- EN 301 489 (EMC-requirements)
- EN 60950 (Safety Standard)
- FCC CFR47 section 90
- EN 61000-4-3 (2006), 10V/m Immunity test

	RECEIVER	TRANSMITTER	Note!
Frequency Range	403...473 MHz		
Channel Spacing	12.5 kHz / 20 kHz / 25 kHz		Programmable
Tuning range	70 MHz		
Spurious Radiations	< 2 nW	EN 300 113 and CRF47 part90	
Frequency error tolerance	<1 kHz		
Sensitivity (BER < 10 E-3)	-114dBm @12.5kHz -111dBm @25kHz		FEC ON See:Note 1
Co-channel Rejection	>-12 dB		FEC On
Adjacent Channel Selectivity	> 47dB @12.5kHz > 52 dB @25kHz		FEC On
Intermodulation Attenuation	>60 dB		FEC ON
Blocking	>86 dB		FEC ON
Spurious Rejection	>60 dB		FEC On
Spurious Emission	<-100dBm	< -80 dBm on 3 <sup>rd</sup> harmonics @1215 – 1240 MHz	
Power Consumption	<1.2 W	<3 W @ 0.5W output power <7 W @ 1W output power	
Power Consumption, Save Modes	Sleep: 0.24 W typical / DTR: 5 mW		
Communication Mode	Half-Duplex		
Type of Emission	F1D		
Carrier power	100, 200, 500, 1000 mW		
Adjacent Channel Power	EN 300 113 and CRF47 part90		
Carrier power stability	< ±1.5 dB		

	DATA MODEM		
Timing	RS-232		
Electrical Interface	Port1 fixed: RS-232 Port2 options: LVTTTL, TTL or RS-232 /422		Port2 RS-232/ 422 programmable
Interface Connector	D-15 (female) as standard, others by request		
Data speed of Serial interface	300 – 38400 bps		
Data speed of Radio Interface	19200 bps (25 kHz channel) 9600 bps (12.5 / 20 kHz channel)		
Data Formats	Asynchronous data		
Modulation	4FSK, GMSK (PacificCrest, TrimTalk)		

	GENERAL	
Operating voltages	Options: +3 ... +9 V or +6 ... +30 V +/-10%	
Temperature Ranges	-30 °C ... +65 °C	Functional
	-25 °C ... +55 °C	Complies with standards
	-40 °C ... +80 °C	Storage
Antenna Connector	50 ohm, U.FL	TNC, MCX, MMCX, SMA
Construction	PCB with sheet metal EMI shields	
Size H x W x D	96 mm x 56 mm x 9 mm	
Weight	50 g	

	OTHER MEASURES	
ESD-failure threshold	8 kV contact, 15 kV air discharge	
Immunity test	10V/m	

**Note 1**

Due to radio electronic design, the receiver is about 6-15dB less sensitive on the following frequencies: 403.000, 409.5875, 416.000, 429.000, 442.000, 455.000, 468.000 and 469.200 MHz.



SATELLINE-M3-TR1 module



SATELLINE-M3-TR1 in an aluminium housing

## 2 OPERATING VOLTAGE

### 2.1 Operating Voltage (PWR-module)

The SATELLINE-M3-TR1 radio modem can have two (2) operating voltage ranges. The range is set at the factory. The voltage level must be mentioned in the order. The operating voltage range is changed by replacing the PWR-module.

The operating voltage options are: +3 ... +9 V and +6 ... +30 V +/-10%.

The radio modem must only be connected to a power supply with an adequate current output. The input voltage range is marked in the label. The lower voltage PWR-module PCB is marked as SPL0006x and the higher voltage module is SPL0010x.

#### Overvoltage behaviour

+3 ... +9 V range: If the operating voltage range is exceeded the modem will automatically switch OFF. However, if the maximum value is more than 20V it may damage the module.

+6 ... +30 V range: If the voltage is less than +6 V the modem will automatically switch OFF. However, if the maximum value is more than +33 V it may damage the module.

#### 2.1.1 Fuse

A proper fuse must be connected in between the radio modem and the power supply. The correct value depends on the model (see list below). Recommended minimum value is 2A slow.

#### 2.1.2 Power supply

The radio modem must only be connected to a power supply with an adequate current output. The pins 15 and 14 of the D-connector are connected to the positive power supply line. The pins 8 and 7 of the D-connector are connected to negative power supply line (ground).

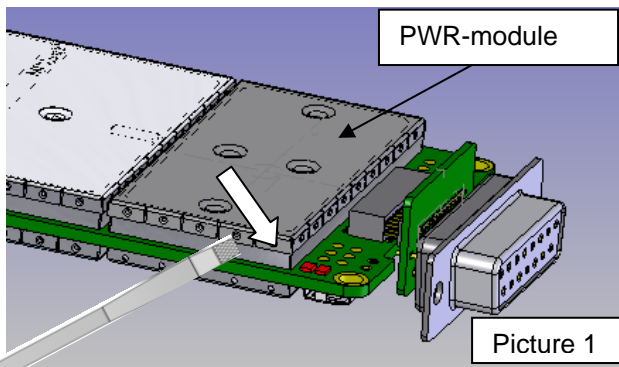
The DTR-line of the radio modem, which is connected to pin 1, can be used as an ON/STANDBY –switch, and in this way the radio modem can be switched either ON (operational state) or OFF (STANDBY). The logical state "1" (Open or more than +3.0 V, max Vdc) of the DTR-line corresponds to ON-state and a logical state "0" ( $\leq 0$  V) corresponds to a STANDBY state.

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

NOTE! There is a galvanic connection between signal ground (SGND, pin 7), ground (GND, pin 8), outer conductor of antenna connector and modem casing.

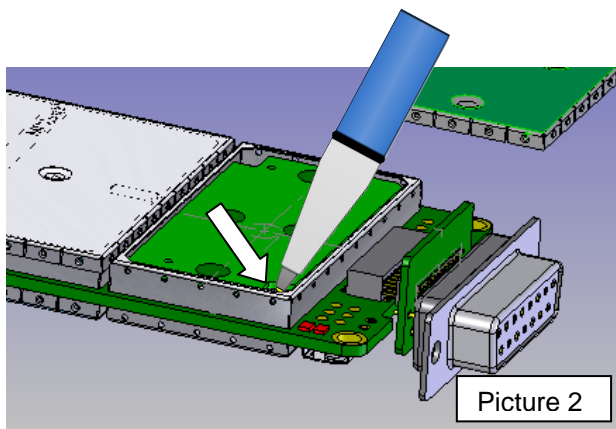
## 2.2 Instructions how to change the PWR-module

The radio module includes a removable PWR-module, which can be changed if needed.



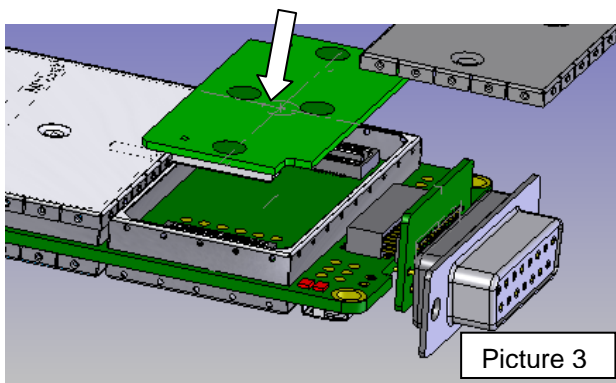
Picture 1

Use a small screwdriver and move the sheet metal nails up one-by-one until it removes.



Picture 2

Open the PWR-module by setting a pen into the whole of the corner and bend as long as the module turns out.



Picture 3

Press the new PWR-module back in reverse order.

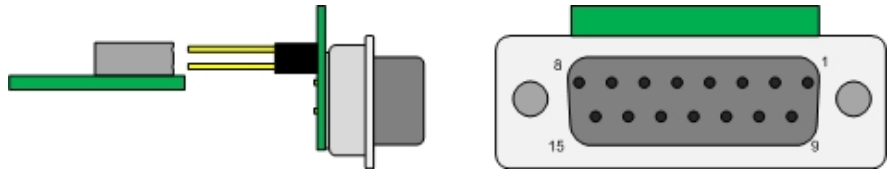
### 3 SERIAL INTERFACE

The radio modem module is referred to as DCE (Data Communication Equipment) whereas the PC or equivalent device is referred to as DTE (Data Terminal Equipment). The SATELLINE-M3-TR1 includes a 15-pin 'D'-type female connector, which contains all the connections required to establish communication between the radio modem, acting as the DCE, and the PC, acting as the DTE.

The radio modem contains two (2) serial ports, which are designated as **Port 1** or **Port 2** for communication. Only one port at a time can be used for communication. The Interface must be specified in the order. The user can set the Ports ON/OFF afterwards in the programming mode. **The Port 1** is always RS-232, but the **Port 2** has 4 alternatives:

1. RS-232 / RS-422 (programmable)
2. LVTTTL
3. TTL

#### 3.1 D-15 connector



D-15 female connector adapter of the radio modem

#### Pinout of the D-15

PORT	PIN	DIR	SIGNAL
PORT 1 RS-232	6	OUT	CTS*
	9	OUT	RD1
	11	IN	TD1
	13	IN	RTS*
PORT 2 TTL/LVTTTL	2	OUT	CTS
	3	OUT	RD
	4	IN	TD
	5	IN	RTS
PORT 2 RS-232	2	OUT	CD
	3	OUT	RD2
	4	IN	TD2
	5	-	NC
PORT 2 RS-422	2	OUT	A'
	3	OUT	B'
	4	IN	A
	5	IN	B
COMMON	1	IN	DTR
	10	OUT	DSR
	12	IN	MODE
	7,8	-	GND
	14,15	-	VB

- o DTE is an abbreviation for Data Terminal Equipment
- o DIR column below denotes the direction of the signal:  
"IN" is from DTE to the radio modem, "OUT" is from the radio modem to the DTE.

**Port 1** complies always with the RS-232 standard.

**Port 2** can comply either with the RS-232, LVTTTL, TTL or RS-422 standards. The interface type is set at the factory according to the customer order. The user can set the ports ON/OFF afterwards in the programming mode.

**NOTE!**

When the MODE-Pin (Pin 12 of the D-Connector) is connected to Ground, the modem is in the Programming Mode and **Port 1** (PINS 6, 9, 11,13) will be in use! If you normally use **Port 2** for data transmission, the serial cable must be changed to a suitable type when switching over to the configuration mode.

**NOTE!** Unused pins can be left unconnected.

\*) RTS and CTS handshaking connections remain the same irrespective of the port used (Port 1 or Port 2).

\*\*) A and B designators are opposite in Profibus standard.

### **3.2 Description of the D-15 connector**

- o DTR. Data Terminal Ready.

When open or connected to + Voltage the unit is ready for normal transfer mode.

When connected to Ground the unit goes to low current consumption mode.

OFF =  $\leq 0V$ , ON =  $\geq 3V-30V$ .

- o CTS. Clear To Send

- o RD. Receive data  
Asynchronous serial data.

- o TD. Transmit data  
Asynchronous serial data.

- o RTS. Request to Send

- o CTS. Clear To Send

- o GND. Ground  
Both the negative pole of the operating voltage and the signal ground.

- o MODE

Programming pin. When floating or connected to +VDC the unit is in normal mode. When connected to Ground the unit is in programming mode.

MODE = operational mode. When the MODE-line is connected to ground (GND), the radio modem enters the *Programming Mode* which is used to change the settings of the radio modem (i.e. configuration, set-up). If the MODE-line is not connected, the radio modem will enter the *Data Transfer Mode*, in which data can be transmitted and received. The *Programming Mode* is used only when installing a radio modem and changing the operational parameters of a network. Normally the radio modem is always in the *Data Transfer Mode*.

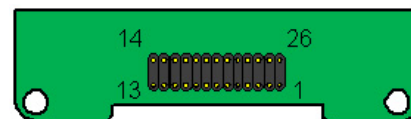
- o RTS, Request To Send
  - o PWR
- +VDC.  $V_b$  Positive pole of the operating voltage.

### NOTE!

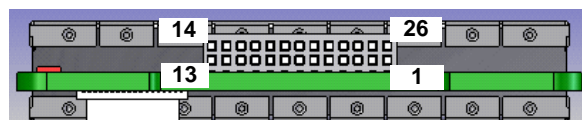
Port 1 or 2 can be defined using the Configuration Manager. When the Program switch of the adapter is switched ON (Programming-mode) the default port is always Port 1, 9600, N8,1. When the port has been defined, switching the Power OFF-ON or switching the Program Switch to OFF will activate it.

## 3.3 26-pin PCB connector

26-pin	Description	
	SATEL Name	Direction
1	Vin	IN
2	Vin	IN
3	Vin	IN
4	Vin	IN
5	RTS_RS	IN
6	MODE	IN
7	TD_RS	IN
8	DSR	OUT
9	RD1_RS	OUT
10	BOOT	IN
11	Spare_1	
12	Spare_2	
13	CD_out TTL*	OUT
14	GP	IN
15	GP	OUT
16	CD_RS**	OUT
17	DTR	IN
18	CTS_TTL/A/CD***	OUT
19	RD2TTL/B/RD2_RS	OUT
20	TD2TTL/A/TD2_RS	IN
21	RTS_TTL/B	IN
22	CTS_RS	OUT
23	GND	
24	GND	
25	GND	
26	GND	



Vertical strip, male.



Horizontal header, female

\* CD TTL in use only with TTL-module (order option: Port2=TTL)

\*\* CD Not in use. Optionally available.

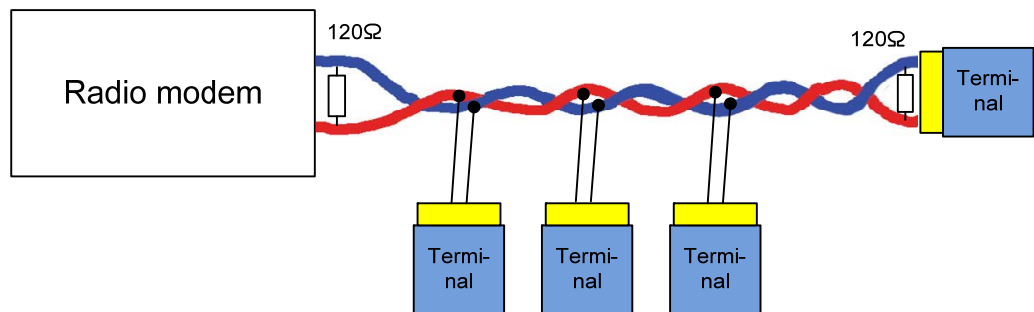
\*\*\* CD Not in use. Optionally available.

TTL-option eliminates 422-option and 422-option eliminates TTL-option.

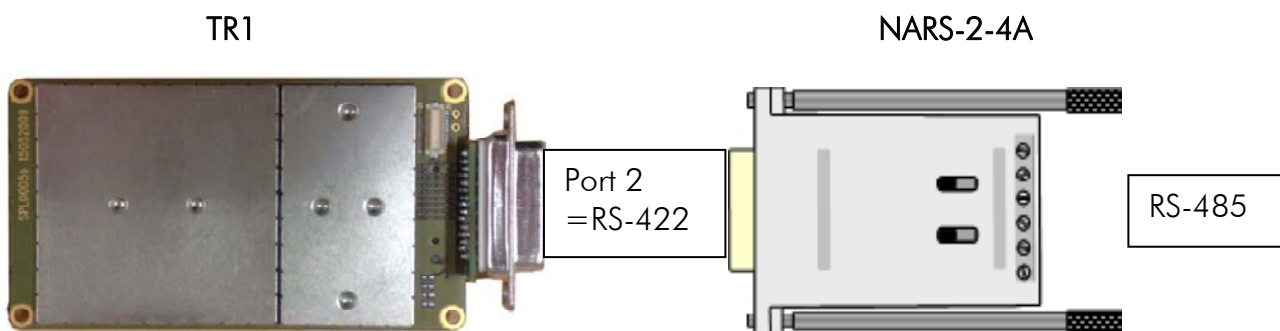
### 3.4 RS-485/RS-422 interface

#### 3.4.1 RS-485 interface

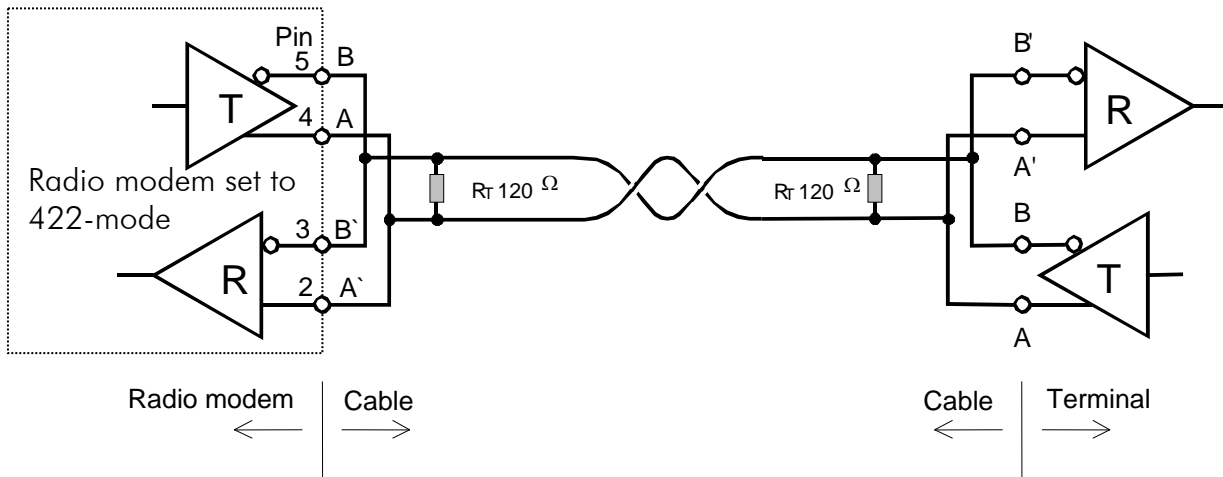
RS-485 is an extension of the RS-422 standard and enables the connection of more than two devices on to the same bus. Communication is half-duplex, so there is only one cable pair, compared to two when using the RS-422. The RS-485 standard defines the electrical characteristics of the connections in such a way as to prevent possible data contention states as well as cable shorts etc. from harming the devices themselves. To enable RS-485 function set the modem must be ordered with RS-232/RS-422 Interface. When RS-485 is used the RS-422 on Port 2 must be ON.



Typical RS-485 connection.



RS-422 to RS-485 using NARS-2-4A-adapter.



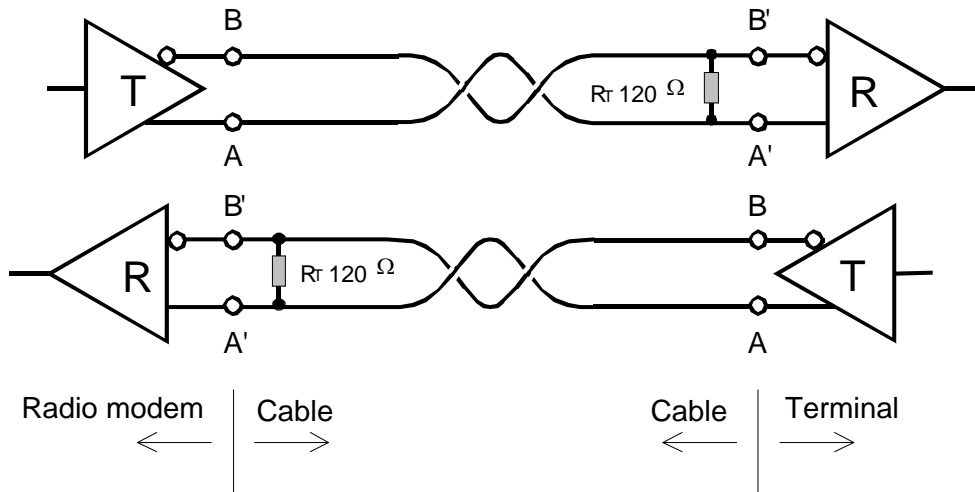
RS-422 to RS-485 using cable conversion.

### 3.4.2 RS-422 interface

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

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

To enable RS-422 function the modem must be ordered with RS-232/RS-422 Interface. When RS-422 is used RS-422 of the Port 2 must be ON.



### **3.5 Termination of RS-422/485 lines**

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

## 4 USER INTERFACE

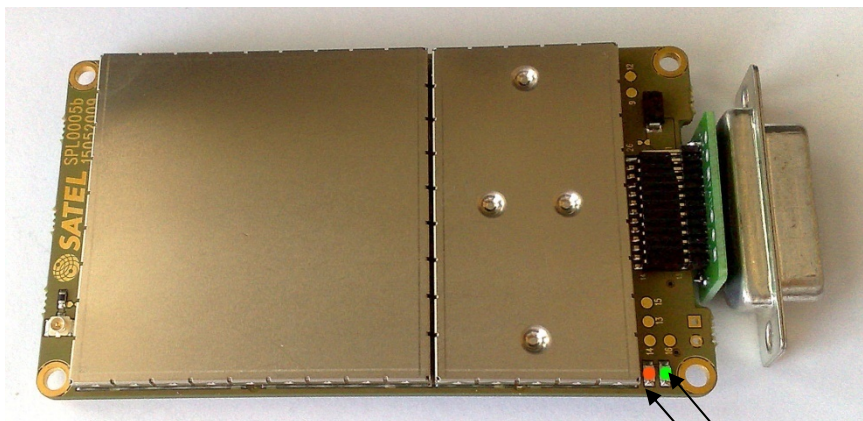
### 4.1 On-board LED-indicators

There are two (2) LED-indicators on the PCB of the radio modem, and they give an indication of the status of the serial port and the radio interface:

LED	Colour	Indication	OFF, SLEEP	ON	Red, Flashing
Power	Green	ON/OFF	Inactive	Active	
RX/TX	Red	Data indicator, Programming Mode	No data transferred	Programming mode	Data transfer

Description of the LED-indicators:

- o Power indicates the status of Power ON/OFF
- o RX/TX indicates that the radio modem is receiving or transmitting data via serial port
- o Mode indicates whether the modem on Data- or Programming mode



- o Power ON/OFF. ON=Green.
- o DATA on line (RX/TX)= Red Flashing

## 5 RF INTERFACE

The SATELLINE-M3-TR1 module has a single antenna connector with an impedance of 50 ohm.

The user can change the frequency of the radio modem afterwards within the frequency range.

The data speed of the radio interface depends on the chosen radio channel spacing. A channel spacing of 25 kHz enables a data speed of 19200 bps and a channel spacing of 12.5 kHz and 20 kHz enables, correspondingly, a data speed of 9600 bps. The data speed of the radio interface is always fixed (19200 bps or 9600 bps), irrespective of the data speed of the serial interface. If the data speeds of the radio interface and the serial interface differ from each other, the radio modem will temporarily buffer the data in transfer, so no data loss will occur.

### 5.1 Transmitter

The output power of the transmitter is adjustable between 100, 200, 500 or 1000mW. The greatest allowable power depends on limits set by local authorities, which should not be exceeded under any circumstances. The output power of the transmitter should be set to the smallest possible level, which still ensures error free connections under variable conditions. Large output power levels using short connection distances can, in the worst case, cause disturbances to the overall operation of the system.

OUTPUT POWER	dBm
100 mW	+20
200 mW	+23
500 mW	+27
1 W	+30

Transmission output power values, Watts vs. dBm

#### **NOTE!**

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

## 5.2 Receiver

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

	FEC OFF	FEC ON
25 kHz	-110 dBm	-113 dBm
20 kHz	-112 dBm	-115 dBm
12.5 kHz	-112 dBm	-115 dBm

The Signal Threshold Level setting of the receiver determines a level above which the search for the actual data transfer signal is active. If the Signal Threshold Level setting is set too low, it is possible that the receiver is trying to synchronise itself with noise, in which case, the actual data transmission might remain unnoticed. Alternatively, weak data transmissions will be rejected, even though they would be otherwise acceptable.

## 5.3 Priority RX/TX

SATELLINE-M3-TR1\_xx offers a *Priority* setting, which selects the priority between reception and transmission. The setting can be changed in *Programming Mode*. By default, transmission has higher priority than reception i.e. the default value is Priority TX.

*Priority TX* means that a terminal device attached to a radio modem decides the timing of the transmission. The transmitter is immediately switched on when the terminal device starts to output data. Should reception be in progress, the radio modem will stop it and change to a transmit state. There is no need to use any handshaking for the control of timing.

*Priority RX* means, that a radio modem tries to receive all data currently in the air. If a terminal outputs data to be transmitted (or an SL command) it will be buffered. The radio modem will wait until the reception has stopped before transmitting the buffered data. This will result in timing slacks to the system, but decreases the number of collisions on the air; this is particularly useful in systems based on multiple random accesses.

If the Repeater Function has been set on, priority setting is automatically switched to RX mode.

## 5.4 Error correction

FEC, Forward Error Correction. FEC-function is switched ON (or OFF) by using the *Programming Mode*. When activated, the FEC-function will automatically add additional error correction information, which increases the amount of transmitted data by 30 %. It is used by the receiving radio modem to correct erroneous bits - as long as the ratio of correct and erroneous bits is reasonable.

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

To switch the FEC-function ON in the *Programming Mode*, select:

7) Additional Setup =>

Error correction => set ON/OFF

**NOTE!**

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

## **5.5 Error checking**

When the error checking is switched on, the radio modem will add a checksum to the transmitted data. When the data is received, the checksums are verified before data is forwarded to the serial port. There are two different options for error checking that can be accessed in the Additional setup menu in the *Programming Mode*:

7) Additional Setup =>

Error check => set ON/OFF, Full CRC16 check => set ON/OFF

*Error check* checks data partially while data is received.

*Full CRC16 check* function adds two checksum characters at the end of the user data message. At the reception end the receiver receives first the whole package and if the checksum matches the data message is forwarded to the serial port. If *Full CRC16 check* is selected it must be set ON for all radio modems in the same network. Otherwise the checksum characters appear at the end of user message on the serial port.

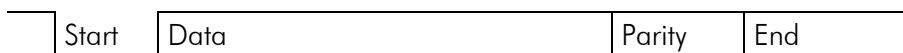
## 6 TRANSPARENT DATA TRANSMISSION

### 6.1 Serial interface, data format

The SATELLINE-M3-TR1 radio modem serial interface uses an asynchronous data format. No external synchronising signal is needed, since necessary timing information is acquired from the start and stop bits transmitted before and after each data field bits (byte).

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

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



Asynchronous character data format

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

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

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

The serial port settings can be changed in the *Programming Mode*.

## **6.2 Handshake lines**

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

Line	Direction
CTS	To terminal
RTS	To modem
CD	To terminal

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

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

### **6.2.1 CTS-line**

The options for CTS-line are:

#### **1) Clear To Send**

CTS is active when the radio modem is ready to accept data for new transmission. CTS will shift into inactive state during data reception and transmission.

#### **2) TX buffer state**

CTS will shift into inactive state only if the radio modem's TX buffer is in danger of overflowing. This typically happens when the serial interface data transfer speed is greater than the radio interface transfer speed and the size of transmitted messages is large.

### **6.2.2 CD-line**

The options for CD-line are:

#### **1) RSSI-threshold**

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

## 2) Data on channel

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

## 3) Always ON

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

### **6.2.3 RTS-line**

The options for RTS-line are:

#### 1) Ignored

RTS-line status is ignored.

#### 2) Flow control

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

#### 3) Reception control

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

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

When using a radio modem for data transmission, certain delays will be formed through the use of a radio interface and from the radio modem circuitry itself. These delays exist when the radio modem switches from *Standby Mode* to *Data Transfer Mode* and during reception and transmission of data. For detailed delay values in each case see Appendix B.

### **6.3.1 Data buffering in the radio modem**

Whenever the radio modem is in *Data Transfer Mode* it monitors both the radio channel and the serial interface. When the terminal device starts data transmission the radio modem switches to transmission mode. At the beginning of each transmission a synchronisation signal is transmitted and this signal is detected by another radio modem, which then switches into receive mode. During the transmission of the synchronisation signal the radio modem buffers data into its memory. Transmission ends when a pause is detected in the data sent by the terminal device, and after all buffered data has been transmitted. When the serial interface speed is the same or slower than the speed of the radio interface, the internal transmit buffer memory cannot overflow. However, when the serial interface speed exceeds the speed of the radio interface, data will eventually fill transmit buffer memory. In this instance, it will take a moment after the

terminal device has stopped transmission of data for the radio modem to empty the buffer and before the transmitter switches off. The maximum size of transmit buffer memory is one kilobyte (1 kB). If the terminal device does not follow the status of the CTS-line and transmits too much data to the radio modem, the buffer will be emptied and the transmission is restarted.

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

### **6.3.2 Pause length**

The modem recognises a pause on the serial line (a pause is defined as a time with no status changes on the RS-232 interface TD-line). The pause detection is used as criteria for:

- o End of radio transmission - When the transmit buffer is empty and a pause is detected, the modem stops the transmission and will then change the radio to the receive mode.
- o SL-command recognition - For a SL-command to be valid, a pause must be detected before the actual "SL..." character string.
- o User address recognition - In order for the start character to be detected, a pause must precede it in transmission.

Traditionally, in asynchronous data communication, pauses have been used to separate serial messages from each other. However, the use of non-real-time operating systems (frequently used on PC-type hardware) often adds random pauses, which may result in the user data splitting into two or more separate RF transmissions. This may cause problems especially in the systems including repeater stations.

In order to match the operation of the radio modem to the user data, the Pause length parameter can be adjusted on the programming menu. It may have any value between 3 and 255 characters. The default value is 3 characters.

Notes:

- o The absolute time of Pause length is depending on the serial port settings. For example, 1 character is  $\sim 1.04$  ms at 9600 bps / 8N1 (10 bits).
- o The maximum absolute time is always 170 ms independent from the value of the Pause length given in the set-up.
- o An increase in the Pause length increases the round trip delay of the radio link correspondingly; this is due to the fact that the radio channel is occupied for the time of the Pause length after each transmission (the time it takes to detect a pause). If this is not acceptable, the TX delay setting may also be useful in special cases.

### **6.3.3 TX delay**

The radio modem can be configured to delay the beginning of a radio transmission by 1...65000 ms. This function can be used to prevent packet contention in a system, where all substations would otherwise answer a poll of a base-station simultaneously. During this delay data sent to the radio modem is buffered. Although the priority setting is "RX" , radio modem is prevented to change over to receiving mode during the period of the TX delay. If this function is not needed, the delay time should be set to 0 ms.

## **6.4 Tests**

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

When the test packet transmission has been switched on and saved by using the *Programming Mode*, the transmitting radio modem needs only a power supply and an antenna.

If the channel spacing of the radio modems is 25 kHz, it is recommended to use 38400 bps as a serial data speed of the receiving radio modem. In the case of 12.5 / 20 kHz channel spacing the data speed of 19200 bps is recommended.

There are two *Test Modes*:

### **Short data block test**

In this test mode the radio modem sends a short test string, which is preceded by a consecutive number, and it ends to the line feed character. The short data block is repeated continuously after 1 s break.

Short data block test is suitable for running data communication tests. Error-free reception of data can be monitored using a suitable terminal program.

### **Example of a short data blocks:**

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

### **Long data block test**

Long data block consists of character strings, which are repeated without breaks 50 s time period. After 10 s break the test transmission is started again.

### **Example of a long data blocks:**

```
00 This is a long testline of SATELLINE 3AS radio modem
```

Long block data test can be used for measuring Tx output power, standing wave ratio (SWR) of the antenna system or received signal strength at Rx stations.

## 7 SETTINGS

### 7.1 Programming Mode

The settings of SATELLINE-M3-TR1 are fully configurable in *Programming Mode* by using a suitable terminal program. The most recommendable set-up (optional): NARS-1F-4A interface adapter, CRS-9 cable, a power supply and the *SaTerm* terminal program. NARS-1F-4A contains a switch to enable easy shifting into the *Programming Mode*. Other suitable terminal programs like SATEL Configuration Manager may also be used.

The radio modem will shift into the *Programming Mode* by connecting the D-connector pin 12 to ground (GND). When using the NARS-1F-4A, this can be accomplished by moving the slide switch downwards.

In the *Programming Mode*, the radio modem will use serial port **PORT1**, with settings 9600 bps, N, 8,1 (data transfer speed 9600 bps, no parity, 8 data bits and 1 stop bit). For more detailed instructions for changing each setting.

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

#### 7.1.1 Changing the settings

- o Basic settings for the serial port of the host computer, when using a terminal program to communicate with SATEL radio modems, are as follows: "COM1, 9600 bps, 8-bit data, none parity, 1 stop bit".
- o The power cable (+V<sub>b</sub> and GND) must be connected to a power supply with a proper output voltage and with a minimum output current of 2 A (for +3 ... +9 V PWR-module) and 1 A (for +6 ... +30 V PWR-module).
- o Connect cables (RS-232 cable to PC COM-port, power supply cable to power supply).
- o Switch on the PC and start *SaTerm* program (or other terminal program).
- o Open a terminal window and then choose "Pr" (in case you are using some other terminal program, set the serial port parameters of the program as follows: 9600 bits/s, 8 data bits, no parity, 1 stop bit, which is always the default in *Programming Mode*).
- o Connect PROG-pin to ground (if using the NARS-1F-4A adapter, slide the switch downwards), the radio modem shifts now into the *Programming Mode*. The screen should look similar to the one shown in the picture below.
- o Make desired changes to the settings.

- o Save changes by pressing "E" in the main menu. If you don't want to save changes, press "Q".
- o Disconnect PROG-pin from ground (if using the NARS-1F-4A adapter, slide the switch upwards), the radio modem should now return to the *Data Transfer Mode*.

When creating a test connection, you can also use the Windows-based SATEL Configuration Manager, (available for free from authorised SATEL dealers or directly from SATEL Customer Support).

```
***** SATELLINE-3AS M3-TR1 *****
SW:06.16.3.34 / HW: SPL0005B / PV: 00.00 / IM: 05 / PWR:6-30V
S/N: yywwxxxxxx
-----
Current settings
-----
1) Radio frequency 436.5000 MHz ( CF 436.5000 MHz, spacing 25 kHz )
2) Radio settings  Tx power level 1000 mW / Signal threshold -112 dBm / FCS OFF /
TX start delay 0 ms / Diversity RX OFF / EPIC PWRSave OFF /
Compatibility Satel 3AS
3) Addressing      RX address OFF / TX address OFF /
RX address to RS port OFF / TX address autoswitch OFF
4) Serial port 1   ON / 19200 bit/s / 8 bit data / None parity / 1 stop bit
5) Serial port 2   OFF / 19200 bit/s / 8 bit data / None parity / 1 stop bit (RS-232)
6) Handshaking    CTS Clear to send / CD RSSI-threshold /
RTS Ignored / Pause length 3 bytes
7) Additional setup Error correction OFF / Error check OFF / Repeater OFF /
SL-commands ON / Priority TX / Full CRC16 check OFF
8) Routing        OFF
9) Tests          OFF
A) Restore factory settings
E) EXIT and save settings
Q) QUIT without saving

Enter selection >
```

**NOTE!** To switch the radio modem back into *Data Transfer Mode* the MODE-pin must be disconnected from ground (GND).

More information at [www.satel.com](http://www.satel.com)

## **7.2 Radio Frequency**

- o Operating RX/TX frequency

Modem will always transmit the data from the terminal device in the selected TX frequency. When the transmission is finished the modem will change the operating frequency back to selected RX frequency. If the modem is programmed to operate as a repeater the modem will receive the data in RX frequency and when all data is received the modem will repeat the data and forward it in configured TX frequency. The time to change frequencies from TX to RX or RX to TX takes approximated 40ms.

- o Reference frequency

The reference frequency is used with the SL-commands (SL&+=nn /SL&-=nn) to set the modem to another channel. The reference frequency can be any frequency that is suitable for the channel space.

Note! The SATELLINE-3AS type “center frequency” is not supported by this modem type.

## **7.3 Updating Firmware**

The Firmware can be updated in two ways:

- o By using terminal program. Instructions to use this method are given by request.
- o By using Configuration Manager (CM). This requires the SATEL Configuration Manager, a cable adapter between the module and a PC with serial port.

The firmware of SATELLINE-M3-TR1 is stored in a flash memory. If needed the software is easily updated by SaTerm terminal program. Please see the user guide of SaTerm for more details.

The SATEL Configuration Manager is configuration and setup software that has been explained in a separate User Manual.

## **7.4 Basic configuration and installation**

The radio modem is shipped with the following default settings (unless otherwise specifically ordered):

DEFAULT VALUES OF THE ADJUSTABLE SETTINGS ( the user can change these settings later on )		
Setting	Default value	Notes
<b>Radio frequency</b>		
Operating TX frequency	438.000 MHz	Range: 403-473 MHz
Operating RX frequency	438.000 MHz	Range: 403-473 MHz
Reference Frequency	438.000 MHz	Range: 403-473 MHz
Channel Spacing	25 kHz	Range: 12.5 kHz, 20 kHz or 25 kHz
<b>Radio settings</b>		
Tx Power	1000 mW	Range: 100, 200, 500 or 1000 mW
Signal threshold	-115 dBm	-80 ... -118 dBm
FCS	OFF	ON/OFF

TX Start Delay	0 ms	0-65535 ms
Radio Compatibility	SATEL 3AS	SATEL 3AS, Option1=PCC 4-FSK, Option 2=PCC GMSK, 3=TrimTalk
<b>Addressing</b>		
RX Address	OFF	ON/OFF
TX Address	OFF	ON/OFF
RX addressing to RS port	OFF	ON/OFF
TX address auto switch	OFF	ON/OFF
<b>Serial port 1</b>		
Status	ON	ON/OFF
Interface	RS-232	Fixed
Data speed	9600 bps	300, 600, 1200, 2400, 4800, 9600, 19200, 38400 bps
Data bits	8	7, 8, 9.
Parity bits	None	None, Even, Odd
Stop bits	1	1, 2
<b>Serial port 2</b>		
Status	OFF	ON/OFF
Interface	LVTTTL	RS-232/422, TTL, LVTTTL
Data speed	9600 bps	300, 600, 1200, 2400, 4800, 9600, 19200, 38400 bps
Data bits	8	7, 8, 9
Parity bits	None	None, Even, Odd
Stop bits	1	1, 2
<b>Handshaking</b>		
CTS	Clear to send	Clear to send, TX buffer state
CD	RSSI threshold	RSSI- threshold, Data on channel, Always ON
RTS	Ignored	Ignored, Flow Control, Reception Control
Pause length	3 bytes	3...255
<b>Additional setup</b>		
Error correction	OFF	ON/OFF
Error check	OFF	ON/OFF
Repeater	OFF	ON/OFF
SL-commands	ON	ON/OFF
Priority	TX	RX/TX
FullCR16 Check	OFF	ON/OFF
<b>Routing</b>		
	OFF	ON/OFF
<b>Tests</b>		
	OFF	ON/OFF

When creating a test connection, you can also use the Windows-based SATEL Configuration Manager (available for free from authorised SATEL dealers or directly from SATEL Customer Support).

## **8 SW-RELATED COMMANDS AND OPTIONS**

### **8.1 Repeater mode and addressing**

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

More information at [www.satel.com](http://www.satel.com)

### **8.2 Message routing**

This feature allows messages from terminal devices to be automatically routed over the radio modem network to a specified recipient terminal.

More information at [www.satel.com](http://www.satel.com)

### **8.3 Virtual Mode Routing**

More information at [www.satel.com](http://www.satel.com)

### **8.4 SL-Commands**

An SL-command is a one continuous string of characters, which is separated from other data by pauses that are equal or greater than time defined by Pause length parameter (default=3 characters) in the set-up. No extra characters are allowed at the end of an SL-command.

Serial interface settings are the same as in data transfer and MODE pin MUST NOT be connected to ground (GND). SL-command is properly recognised also in the case when the command string is terminated in <CR> (=ASCII character no. 13, Carriage Return, 0x0d) or <CR><LF> (<LF> = ASCII char. no. 10, Line Feed, 0x0a). If multiple SL commands are sent to the radio modem the next command can be given after receiving the response ("Ok" or "Error") of the proceeding command. In addition, it is recommended to implement a timeout to the terminal software for recovering the case when no response is received from the radio modem.

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

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

#### **8.4.1 Changing parameters using the SL-commands**

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

More information at [www.satel.com](http://www.satel.com)



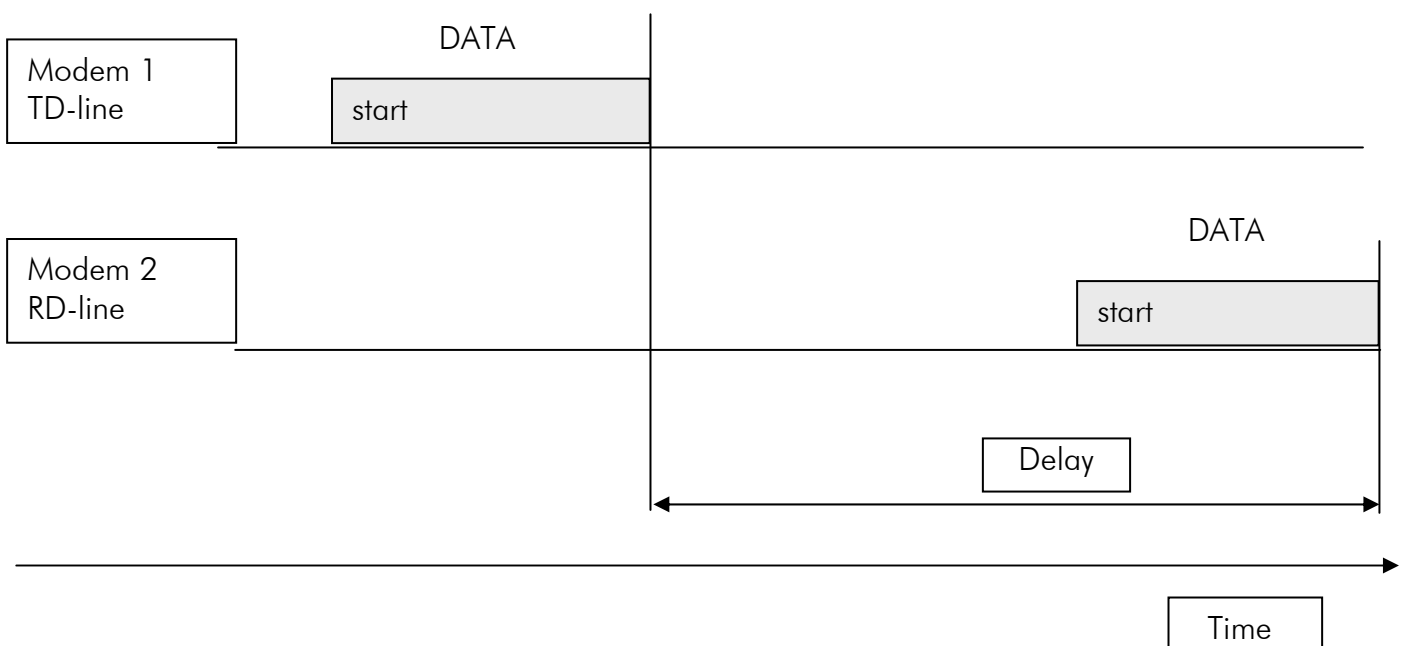
## 10 APPENDIX B

### 10.1 Functional delays

Function	Delay (ms)
Wakeup time from STAND-BY to ON (controlled by DTR line)	123 ms (CTS active)
Wakeup time from Power OFF -> Power ON (=ready to receive)	123 mstypical
Serial interface, turnaround time of RS-232	0
Serial interface, turnaround time of RS-422	<1 ms
SL-Ping response time from remote modem	222 ms

### 10.2 Transmission related delays

Delay from the end of transmission to the end of reception on the serial interface:



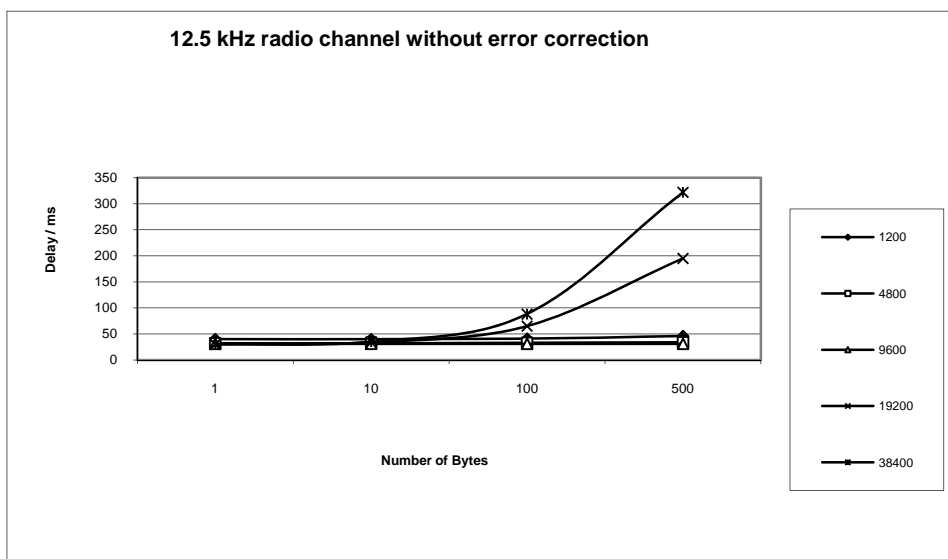
### 10.2.1 Transmission delays when using a 12.5 kHz radio channel

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

Number of bytes sent

Bps	1	10	100	500
1200	40	40	29	22
4800	34	34	31	22
9600	32	32	32	27
19200	32	35	64	193
38400	32	36	91	352

Delays are in milliseconds and with a 10% margin.

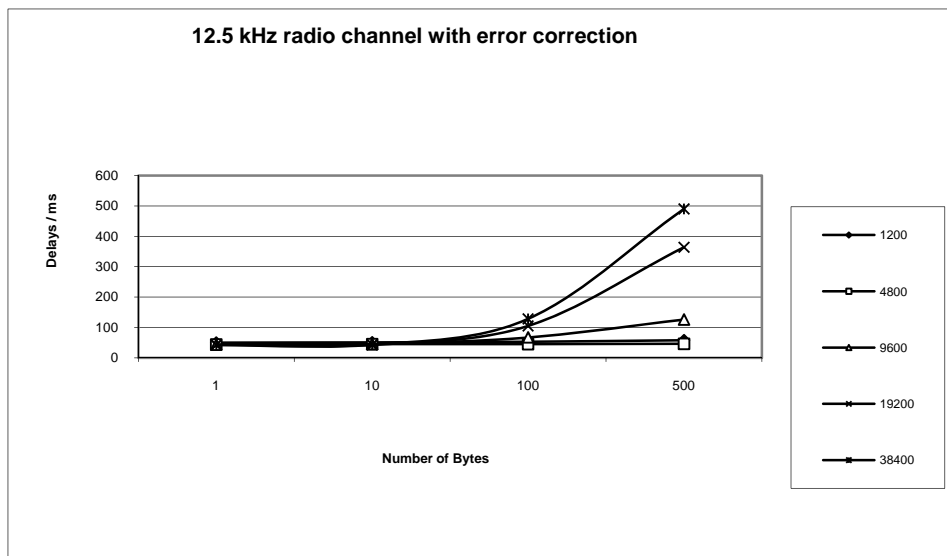


Transmission delays with FEC-function (Forward Error Correction).

Number of bytes sent

Bps	1	10	100	500
1200	52	49	48	50
4800	45	45	44	44
9600	44	44	68	121
19200	44	44	104	360
38400	48	48	132	496

Delays are in milliseconds and with a 10% margin.



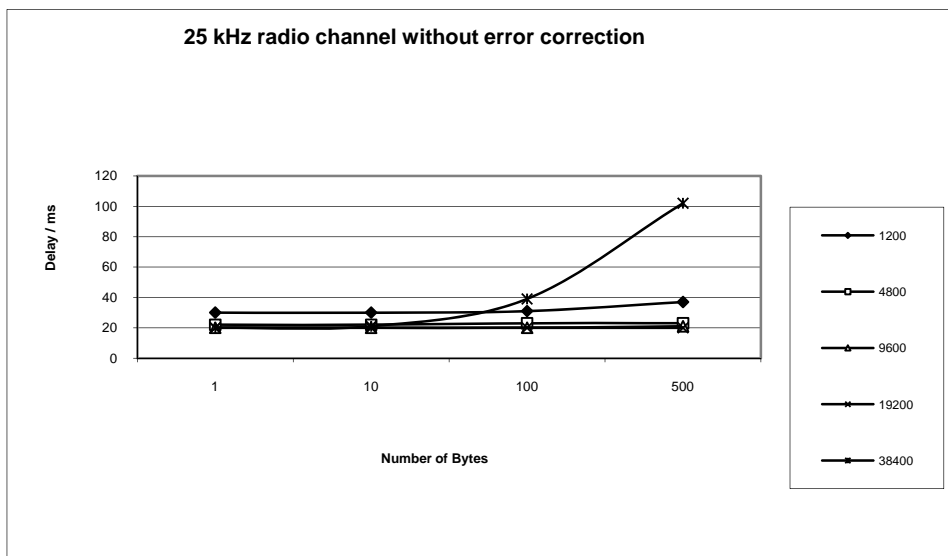
## 10.2.2 Transmission delays using a 25 kHz radio channel

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

Number of bytes sent

Bps	1	10	100	500
1200	30	30	18	16
4800	23	23	21	12
9600	23	23	21	17
19200	22	22	22	19
38400	22	22	38	102

Delays are in milliseconds and with a 10% marginal.



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

Number of bytes sent

Bps	1	10	100	500
1200	35	34	29	30
4800	28	28	27	23
9600	28	28	28	23
19200	28	28	36	64
38400	27	27	58	185

Delays are in milliseconds and with a 10% margin.

