SATELLINE-M3-R1
and
SATELLINE-M3-T1

Receiver and Transmitter Radio Modem Modules

User Guide

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Salo, Finland 2009

RESTRICTIONS ON USE

SATELLINE-M3-R1 and -M3-T1 radio modem modules have been designed to operate on 403...470 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-R1 and -M3-T1 radio modem modules 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.

WARNING! Users of SATELLINE-M3-R1 and -M3-T1 radio modem modules in Canada should be aware that Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

PRODUCT CONFORMITY

SATELLINE-M3-R1 and -M3-T1

SATEL Oy hereby declares that SATELLINE-M3-R1 and -M3-T1 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.

CE 0523 ! CE 1987 !

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-075
Manufacturer:	SATEL Oy
Address:	POB 142, (Meriniitynkatu 17), 24101 Salo, Finland

Products :

Type	*Model*	
SATEL-TA10	**SATELLINE-M3-R1**	Radio Modem Module
	SLR2	Radio Modem Module
SATEL-TA11	**SATELLINE-M3-T1**	Radio Modem Module
	SLR1	Radio Modem Module

Notified Body Opinion:

SATELLINE-M3-R1 / SLR2:		SATELLINE-M3-T1 / SLR1:	
according to:	Annex IV of R&TTE Directive	according to:	Annex IV of R&TTE Directive
Document No:	FI08700012/F108700013	Document No:	119239
Dated on:	11.8.2008	Dated on:	17.12.2008
Issued by:	Ficora / No: 0523	Issued by:	Nemko Oy / No 1987

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*
TL 990313	-3ASd/125	ETS 300 113	EMCEC / Espoo 29.02.2000
TL 1000461	-3ASd/250	ETS 300 113	EMCEC / Espoo 29.02.2000
200212216	-3ASd/125 and/250	IEC 60950 3rd Ed 1999	NEMKO / Oslo 22.03.2002
1031925	-3ASd/250	EN 301 489-1,-5	NEMKO / Espoo 30.10.2003
118426	SLR1	EN 300 113-2 V1.4.1	NEMKO / Espoo 4.12.2008
107121A	SLR2	EN 300 113-2 V1.4.1	NEMKO / Espoo 28.5.2008
107121B	SATELLINE-M3-R1	EN 300 113-2 V1.4.1	NEMKO / Espoo 28.5.2008

Based on the fact that the technical requirements have not changed between the standards ETS 300 113 and EN 300 113-2, we therefore declare the full conformity to the standard EN 300 113-2.

Salo on the 23th of January, 2009.

SATEL Oy

Tuomas Pitkänen
Managing Director

SATEL Oy
P.O.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:

- The 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.

TABLE OF CONTENTS

1. 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.

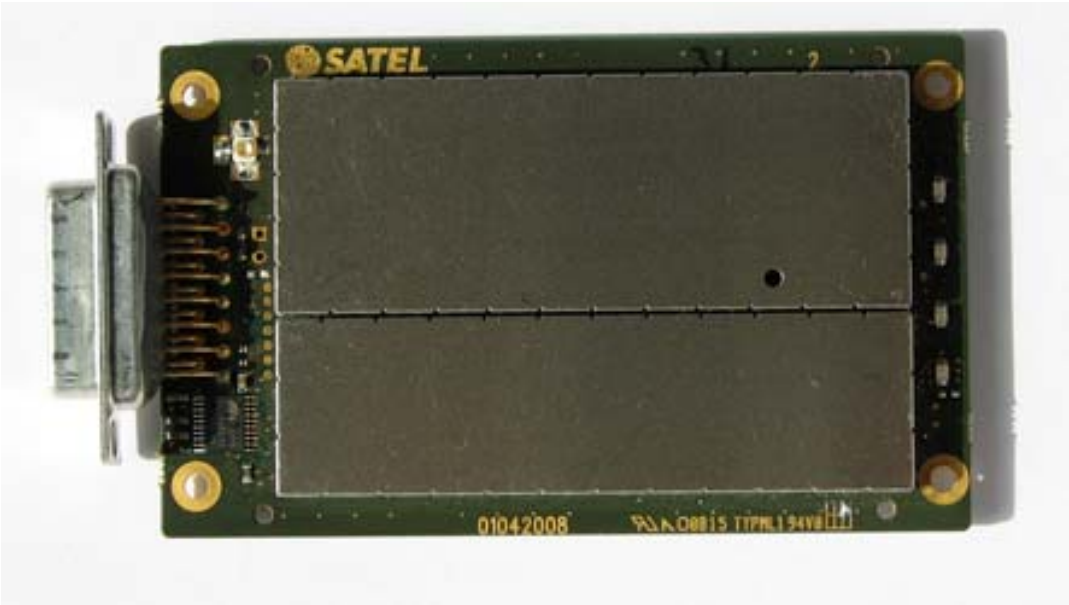
1.1 Description of the products

SATELLINE-M3-R1
is a UHF radio receiver module that is radio compatible with SATELLINE-3AS(d) radio transceivers or transmitters.

SATELLINE-M3-T1
is a UHF radio transmitter module. It provides a transparent one-way data link with SATELLINE-3AS(d) receivers or transceivers.

The modules consist of printed circuit board (PCB), sheet metal covers and connector(s).

Receiver module layout (transmitter module layout is similar).



2 TECHNICAL SPECIFICATIONS

2.1 SATELLINE-M3-R1 and -T1 Technical Specifications

SATELLINE-M3-R1 and -M3-T1 complies with the following international standards:

- EN 300 113-2
- EN 301 489 (EMC-requirements)
- EN 60950 (Safety Standard)

	RECEIVER	TRANSMITTER	Note!
Frequency Range	403...470 MHz		
Channel Spacing	12.5 kHz / 20 kHz / 25 kHz		selectable
Tuning range	67 MHz		
Spurious Radiations	< 2 nW		
Frequency error tolerance	< 3 kHz		
Sensitivity	- 113... -110 dBm (BER < 10 E-3)		FEC On
Co-channel Rejection	> 10 dB		FEC On
Adjacent Channel Selectivity	> 45 / 50 dB		FEC On
Intermodulation Attenuation	>55 dB		FEC ON
Blocking	74 dB		FEC ON
Spurious Rejection	60 dB		FEC On
Spurious Emission	-57 / -47 dBm		-100 dBm on GPS-frequencies
Power Consumption	<1.2 W	<3 W @ 0.5W output power <6 W @ 1W output power	
Power Consumption, Sleep ON	0.24 W typical		
Type of Emission		F1D	
Carrier power		100, 200, 500, 1000 m W	
Adjacent Channel Power		300 113 and CRF47 part90	
Carrier power stability		< ±1.5 dB	

	DATA MODEM	
Timing	RS-232	
Electrical Interface	RS-232 & LVTTL or RS-232 & TTL	Order options
Interface Connector	D-15 (female)	
Data speed of I/O-interface	300 – 38400 bps	
Data speed of Radio Interface	19200 bps (25 kHz channel) / 9600 bps (12.5 kHz channel)	
Data Formats	Asynchronous data	
Modulation	4FSK, GMSK	Optional:Trimtalk

	GENERAL	
Operating Voltage	+ 6.0 ... +30 Vdc	
Operating Temperature Range	-30 °C ... +65 °C (Tx) -30 °C ... +80 °C (Rx)	
Antenna Connector	50 ohm, SMA, Female	
Construction	PCB with sheet metal EMI shields	
Size L x W x T	96 mm x 56 mm x 9 mm	
Weight	150 g	

	OTHER MEASURES	
ESD-failure threshold	8 kV contact, 15 kV air discharge	

2.1.1 Power supply

The allowed operating voltage is 6V - 30 V_{DC}. The radio modem must only be connected to a power supply with an adequate current output.

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

The power cable ($+V_b$ and GND) must be connected to a power supply with a proper output voltage and with a minimum output current of 1A.

The modem withstands a live insertion or removal from the DTE-unit without switching OFF the power.

2.2 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
Operating frequency	436.500 MHz	Range: 403-407 MHz
Channel Spacing	25 kHz	Range:12.5, 20, or 25 kHz
Tx Power	1000 mW	Range: 100, 200, 500 or 1000 mW
Protocol	SATEL 3AS	SATEL 3AS, Option 1, Option 2
Addressing	RX Address OFF / TX Address OFF	
Tx-Delay	0 ms	
Signal threshold	-117 dBm	
SyncInterval	default (=21845 bytes)	
Rx-Delay	0 ms	
Pause length	3 characters	
FEC	OFF	
Error check	OFF	
Error correction	OFF	
Serial port 1 settings	Port function=DATA Data speed=9600 bps Data bits=8 Parity=None Stop bits=1 Pause length=3 bytes	
Handshaking settings	CTS=Clear to send CD=RSSI threshold RTS=Ignored	Handshaking lines apply to the DATA-port.
SL-commands	ON	

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).
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".

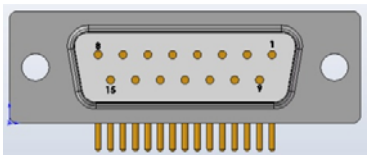
3 SERIAL INTERFACE

The radio modem 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-R1 and -M3-T1 radio modules include 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 one serial port, which is designated as **Port 1** for communication.

- *RD* = **R**eceive **D**ata. Output of the data received from the radio modem to the DTE.
- *TD* = **T**ransmit **D**ata. Input of the data to be transmitted from the DTE to the radio modem.
- *CTS* = **C**lear **T**o **S**end.
- *RTS* = **R**equest **T**o **S**end.
- *GND* = Both the negative pole of the operating voltage and the signal ground.
- V_b = Positive pole of the operating voltage.

3.1 D-15 connector



D-15 female connector in the radio modem

Pinout of the D-15

15-PIN FEMALE D CONNECTOR PINOUT o DTE is an abbreviation for Data Terminal Equipment o I/O 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.				
PIN	NAME	I/O	LEVEL	EXPLANATION
1	DTR	IN	TTL/LVTTL	Data Terminal Ready to Power Down the radio module. Open = Normal Data Transfer Mode. Ground= Power Down; low current consumption mode.
2	CTS	OUT	TTL/LVTTL	Port 2 Clear to send
3	RD	OUT	TTL/LVTTL	Port2 Receive Data to DTE from the radio modem
4	TD	IN	TTL/LVTTL	Port2 Transmit Data from DTE to the radio modem.
5	RTS	IN	TTL/LVTTL	Port2 Request To Send from DTE.
6	CTS	OUT	RS-232	Clear To Send.
7, 8	GND	-		Operating Ground and Signal Ground
9	RD	OUT	RS-232	Port1 Receive Data to DTE from the radio modem
10	N.C.			Not Connected
11	TD	IN	RS-232	Port1 Transmit Data from DTE to the radio modem.
12	$\overline{\text{MODE}}$	IN	0..30V	<2VDC or connected to ground = Programming Mode >3VDC or Not connected = Data Transfer Mode Note*)
13	RTS	IN	RS-232	Request To Send from DTE.
14, 15	V_b	-		Operating Voltage. +6...30 VDC
1. Note! Unused pins can be left unconnected. 2. Note*) Programming Mode is for changing the settings of the radio modem with a terminal program via the programming menu. Normally the MODE-line is NOT connected i.e. the radio modem is in Data Transfer Mode. 3. The default port is Port 1. Port 2 is set by special command.				

Description of pins:

1. 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<2.7V. ON>3V-30V.

2. Port 2. CTS. Clear To Send.
TTL-Signal from modem to DTE.

3. Port 2. RD. Receive data.
TTL-Signal from modem to DTE. Asynchronous serial data.

4. Port 2. TD. Transmit data.
TTL-Signal from DTE to modem. Asynchronous serial data.

5. Port 2. RTS. Request to Send.
TTL-Signal from DTE to modem.

6. Port 1. CTS. Clear To Send.
Signal from modem to DTE.

7, 8. GND. Ground
Main voltage minus. Signal and chassis ground.

9. Port. 1. RD, Receive Data.
RS-232 Signal from modem to DTE. Asynchronous serial data.

10. Not Connected.

11. Port 1. TD, Transmit Data
RS-232 Signal from DTE to modem. Asynchronous serial data.

12. MODE.
Programming pin. When connected to + Voltage the unit is in normal mode. When connected to Ground the unit is in programming mode.

13. Port 1. RTS, Request To Send
Signal from DTE to modem.

14, 15. PWR
+VDC. Main voltage input. The radio module is designed for 6-30VDC +/- 5%.

NOTE!
Port definition. 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. When the Port has been defined, it'll be activated by switching the Power OFF-ON, or switching the Program Switch switched to OFF.

4 RF INTERFACE

The SATELLINE-M3-R1 and -M3-T1 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.

4.1 Transmitter

The output power of the transmitter is adjustable between 100, 200, 500 or 1000 mW. 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.

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.

4.2 Receiver

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.

4.2.1 RSSI-signal

The RSSI-signal (Received Signal Strength Indicator) gives an indication of the strength of the received radio signal. This signal can be used to determine the approximate signal level. The RSSI–signal can be set and read using the SL-command.

4.3 Error correction

The error correction mode is called the FEC-method (Forward Error Correction). When activated, the FEC-function will cause the SATELLINE-M3-R1 and -M3-T1 to 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. The 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 %.

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

4.4 Error checking

When 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.

5 USER INTERFACE

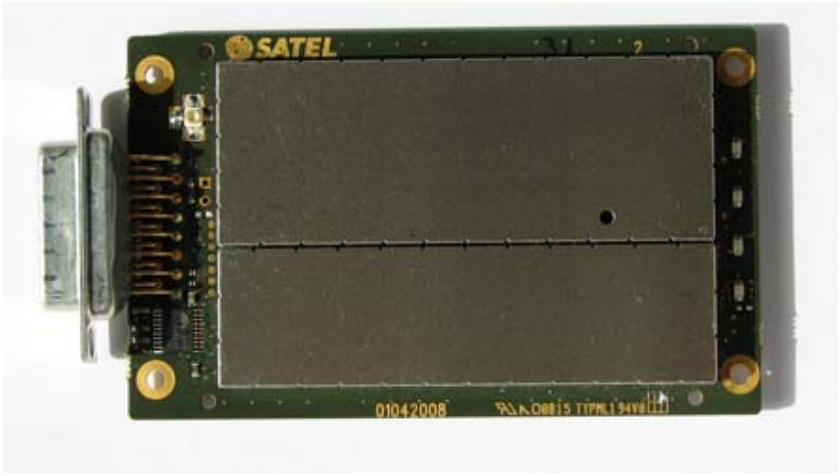
5.1 LED-indicators

There are four (4) LED-indicators on the front panel of the radio modem, and they give an indication of the status of the serial port and the radio interface:

LED	Indication	OFF	Red	Red, Flashing
Power	ON/OFF	Inactive	Active	
RSSI	Signal strength	No data	Data detected and ok	Data detected, but weak signal
RX/TX	Data indicator	No data transferred		Data transfer
Mode	Communication or programming	Data Mode	Programming mode	

Description of the LED-indicators:

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



- Power
- RSSI
- RX/TX
- MODE

6 TRANSPARENT DATA TRANSMISSION

6.1 Handshaking lines

When using the serial interface, handshaking signals can be used to control data transfer on the DATA-port. For example, the radio modem can inform the DTE that the radio channel is busy and that it is not allowed to initiate transmission.

A common way of using handshaking signals is to monitor the CTS-line and ignore the others. Usually the terminal device 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 contentions) by using poll queries, or if there is only little traffic and if there is no adverse affect from occasional data contention situations (two or more radio modems trying to transmit at the same time).

6.1.1 CTS-line

CTS (Clear To Send) is a signal from the radio modem to the DTE. It indicates when the radio modem is ready to accept more data from the DTE. The options for CTS-line controls are:

1) Clear To Send
The CTS-line is set to active when the radio modem is ready to accept data for transmission. CTS will shift into an inactive state during data reception and when a pause (packet end) is detected in transmitted data. CTS shifts back into an active state either when reception ends or the radio modem has finished data transmission. CTS will also shift into an inactive state when the serial interface data transfer speed is greater than the radio interface transfer speed and the transmit buffer is in danger of overflowing.

2) TX buffer state
The CTS-line will shift into an inactive state only when the data buffer for the data to be transmitted is in danger of overflowing.

6.1.2 RTS-line

RTS (Ready To Send) is a signal from DTE to the radio modem. DTE controls the data flow from the radio modem by using RTS. The options for RTS-line controls are:

1) Ignored
The RTS-line status is ignored.

2) Flow control

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

3) Reception control

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

6.2 Pause length

The radio modem recognises a pause on the serial line (a pause is defined as a time with no status changes in the TD-line). The pause detection is used as criteria for:
- End of radio transmission - when the transmit buffer is empty and a pause is detected, the modem stops the transmission and will change the radio to the receiving mode
- SL-command recognition - for an SL-command to be valid, a pause must be detected before the actual "SL" prefix of the SL-command.
- User address recognition - in order to detecting the message, 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) has changed this tradition by adding random pauses in the asynchronous data stream. Such systems cannot serve the hardware UART properly when performing other tasks (other applications or tasks of the operating system itself).

The pauses described above are typically up to 100 ms. When such a pause appears in the middle of a user message, the radio modem transmits the message as two separate radio transmissions. This will generate problems in at least two ways:
1) The inter-character delay will be increased by at least the time of the modem transfer delay
2) The probability of collisions on the radio path will increase. This will be especially harmful for repeater chains

The default value for the pause length is 3 bytes.

6.2.1 Data buffering in the radio data modem

A synchronisation signal is transmitted at the beginning of each radio transmission and this signal is detected by another radio modem, which then turns into receive mode. During the transmission of the synchronisation signal the radio modem buffers the data to be transmitted into its memory. Transmission ends when a pause is detected in the data flow sent by the terminal device, and after all the buffered data has been transmitted. When the data speed of the serial port is the same or slower than the speed of the radio interface, the internal transmit buffer memory can not overflow. However, when the serial interface speed exceeds the speed of the radio interface, data will eventually fill the transmit buffer memory. After the terminal device

has stopped data transmission, it will take a moment for the radio modem to transmit the buffered data and switch the transmitter off. The maximum size of the transmit buffer memory is one kilobyte (1 kb). If the terminal device does not follow the status of the CTS-line and transmits too much data to the radio modem, the buffer will be cleared and the transmission restarted.

In the receiving mode, the data coming from the radio is also buffered, thus evening out differences in data transfer speeds at the serial ports.

6.2.2 TX-delay

The radio modem can be configured to delay the beginning of a radio transmission by 1...65000 ms. During this delay data sent to the radio modem is buffered.

7 ADDRESSING

7.1 Addressing

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

The SATELLINE-M3-R1 and -M3-T1 radio modules allow the use of individual addresses either for reception or for transmission respectively.

The SATELLINE-M3-T1 radio modem module contains one transmission address and SATELLINE-M3-R1 one reception address, which are known as the primary addresses. The primary address is used whenever data from the serial interface is transmitted.

It is also possible to transfer the received address onto the serial interface.

The address is composed of two characters totalling 16 bits, resulting in over 65,000 different address combinations. The address is attached to the beginning of each data packet sent by the SATELLINE-M3-T1. When a SATELLINE-M3-R1 receives a data packet whilst using addressing mode, the receiver will check the first two characters of each received data packet to ensure that the packet in question was intended for the correct SATELLINE-M3-R1.

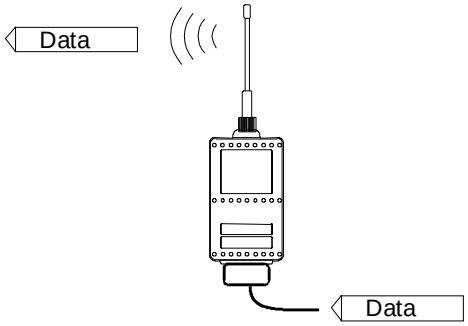
ADD H	ADD L	DATA

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

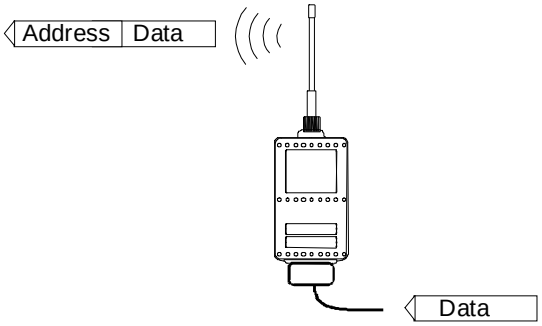
Example: address 1234h (4660 in decimal format), where 12h is ADD H and 34h is ADD L.

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

Transmission:

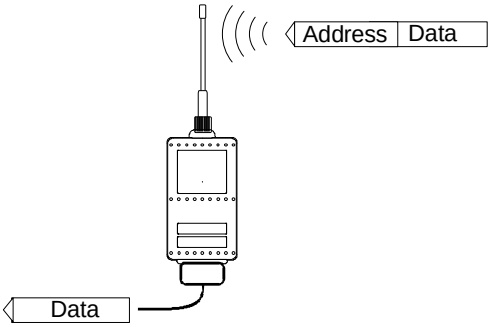


Transmission address has been set OFF. Radio modem will transmit the data packet as such.



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

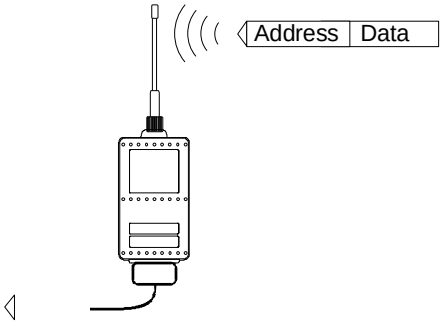
Reception:



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

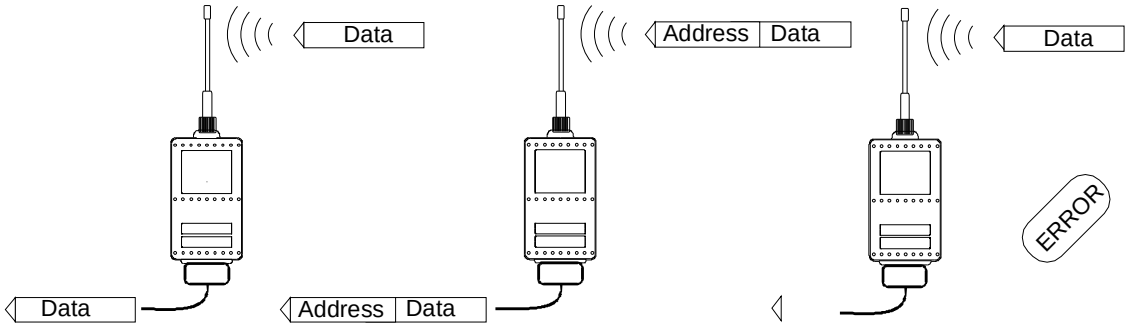
The radio modem will remove the address and send the actual data to the RS-232 interface.

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



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

Data does not appear on the RS-232 interface.



Reception addressing has been set OFF. The radio modem will transfer all received data to the RS-232 interface.	Reception addressing has been set OFF. The radio modem will consider the characters of the address as a part of the data and will send all the characters to the RS-232 interface.	Reception addressing has been set ON but there is no address in the data packet. Data will appear on the RS-232 interface ONLY if the first 2 characters of the data match either of its own RX-address. The radio modem will remove those 2 characters of data.

7.1.1 Connection between two points

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

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

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

7.1.2 System of one base station and several substations

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

For example, if the substation terminal devices are not able to check and form addresses by themselves, addressing may be achieved with the help of the addresses of the radio modems attached to these terminal devices. The base station may, in such a case, define the destination of a message by adding the address of the corresponding radio modem into the beginning of the data packet. The substation radio modem(s) will check the address and the corresponding radio modem will identify and remove the address characters.

8 SETTINGS

The configuration of SATELLINE-M3-R1 and -M3-T1 radio modules can be easily changed simply by connecting the module to the PC and using SATEL Configuration Manager or DTE. Programming is done using the serial port of the module. The serial port settings are 9600 bps, N, 8,1 (data transfer speed 9600 bps, no parity, character length 8 bits and one (1) stop bit).

8.1 SATEL Configuration Manager software

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

8.2 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.

8.2.1 SL-Command

An SL-command is a one continuous string of characters that is separated from other data by pauses that are equal or greater than the time defined by the Pause Length parameter (see chapter Pause Length) 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. An 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 returns to values defined initially or as saved using SL-commands.

The radio modem will acknowledge all SET-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. "Question" is responded to with a value (Note! A question is not answered as "OK"). The SL-commands are set ON using a relevant SL-command.

8.3 SATELLINE SL COMMANDS LIST

	Frequency related	*Effect and description of command*
1	SL&F=nnn.nnnnn	Set frequency to nnn.nnnnn MHz
2	SL&F?	Display current frequency (response 'nnn.nnnnn MHz')
3	SL&C?	Display center frequency (response 'nnn.nnnnn MHz')
4	SL&+=nn	Set frequency nn channels above center frequency Frequency = Center frequency + nn * Channel spacing, where nn=[0...Number of channels/2]
5	SL&-=nn	Set frequency nn channels below center frequency Frequency = Center frequency – nn * Channel spacing, where nn=[0…Number of channels/2]
6	SL&N?	Display current frequency deviation from center frequency as channels (Frequency – Center frequency)/Channel spacing (response '+nn' or '-nn')
7	SL&D=x	Set the operational mode of the radio. The different values of x are: "S" = Single Channel "D" = Dual Channel "R" = Reverse Dual Channel **Note!** Use this command only, if the setup of the frequency bands matches the Dual Channel operation.
8	SL&D?	Request the operational mode of the radio. The response is one of the following: "S" = Single Channel "D" = Dual Channel "R" = Reverse Dual Channel **Note!** Use this command only, if the setup of the frequency bands matches the Dual Channel operation.
9	SL!D?	Display the lower limit of frequency band 1
10	SL!U?	Display the upper limit of frequency band 1
11	SL!W?	Display the lower limit of frequency band 2
12	SL!Y?	Display the upper limit of frequency band 2
13	SL&W?	Returns the channel spacing: "25.0 kHz" "20kHz" "12.5 kHz"

	Addressing related	*Effect and description of command* *(These commands are NOT applicable in this application)*
14	SL#I=xxxx	Set all addresses (RX1, RX2, TX1, TX2) to value xxxx
15	SL#I?	Display both primary addresses (TX1, RX1) (response 'xxxx;yyyy')
16	SL#T=xxxx	Set both transmit addresses (TX1, TX2) to value xxxx
17	SL#T?	Display primary transmit address (TX1) (response 'xxxx')
18	SL#R=xxxx	Set both receive addresses (RX1, RX2) to value xxxx
19	SL#R?	Display primary receive address (RX1) (response 'xxxx')
20	SL#P=xxxx;yyyy	Set primary transmit address (TX1) to value xxxx and receive address (RX1) to value yyyy
21	SL#S=xxxx;yyyy	Set secondary transmit address (TX2) to value xxxx and receive address (RX2) to value yyyy
22	SL#P?	Display primary transmit address (TX1) and receive address (RX1) (response 'xxxx;yyyy')
23	SL#S?	Display secondary transmit address (TX2) and receive address (RX2) (response 'xxxx;yyyy')
24	*Note:* xxxx and yyyy below mean address in the hexadecimal format (0000 … FFFF)	

	Other radio related	*Effect and description of command*
25	SL@R?	Display field strength of the last received message (the value is an average of many measurements made during the same reception). Response "-xx dBm", where xx is a decimal value of the field strength and it is between –80 dBm and –118 dBm. Value available 7s after reception. SATELLINE-3AS Epic returns the stronger value of two receivers.
26	SL@P=xxxxx	Set the RF output power, where xxxxx is the decimal value of the intended power in mW. If the given value does not correspond to one of the programmed power levels, the output power is set to the nearest possible value.
27	SL@P?	Requests the RF-output power. Response "xxxxx mW", where xxxxx is a decimal value the output power of the transmitter.
28	SL@T=-xxx	Set the minimum power level of the signal to be received (="Signal Threshold level), where xxx is a decimal value of the new intended level in dBm.
29	SL@T?	Request the current "Signal Threshold Level". Response is "-xxx dBm.
30	SL@G=1	Switch to GSM-mode (Note: No response message follows the command)
31	+++SL@G=0	Switch to UHF-modem mode.
32	SL@X=1	Reset the BT-module
32.1	SL@X=9	Reset modem. Shuts down the modem. Does not retrieve "ok".
32.2	SL@S=0	Set Satel 3AS (default)
32.3	SL@S=1	Set Option 1 (PCC-4FSK)
32.4	SL@S=2	Set Option 2 (PCC-GMSK)
32.5	SL@S?	"0" if the modem is in SATEL 3AS-mode "1" if the modem is in Option 1-mode "2" if the modem is in Option 2-mode
	FC -related	*Effect and description of command*
33	SL!M?	Show the FCS-mode of the modem. The reply is 'O' if FCS is turned OFF, 'M' for a master (=transmitter) and 'S' for the slave (=receiver).
34	SL!O?	Return beacon sending disable timeout
35	SL!O=	Set the beacon sending disable timeout. Time is in seconds. If it is zero then beacon is never disabled. If timeout is less than beacon timeout, modem will not send additional beacons.
36	SL!D?	Return the lower limit for band 1
37	SL!U?	Return the upper limit for band 1
38	SL!W?	Return the lower limit for band 2
39	SL!Y?	Return the upper limit for band 2
40	SL!I?	Return the FCS Net ID
41	SL!I=	Set the FCS Net ID
42	SL!R?	Return the RX listen timeout
43	SL!R=	Set the RX listen timeout
44	SL!B?	Return the Beacon interval
45	SL!B=	Set the Beacon interval
46	SL!C?	Return the number of used channels
47	SL!C0	Clear the number of used channels
48	SL!F?nn	Return the frequency of channel nn
49	SL!F=	Add a new frequency to list

	Other SL commands	*Effect and description of command*
50	SL**>	Save current settings as permanent settings
51	SL*R>	Restore default factory settings. If successful returns "Factory defaults restored!"' If default settings don't have SL command enabled "SL+" is added to the response. Different serial port settings are ignored until user settings are stored to eprom and restarted.
52	SL!V?	Returns modem type: - "3AS " - "3AS(d) " - "M3 R1" - "3ASrm" for receiver module.
53	SL%V?	Display software revision information (response 'Vn.nn')
54	SL+P=xxxx	Get the measured signal strength from the remote modem i.e. SL "ping". *(NOT applicable in this application)*
55	SL!H?	Display radio board version (response "HW:nnnnnn")
56	SL!Z=x	Forces the TX/RX led on G = green led on, red off R = red led on, green off O = normal mode Note: This mode is not saved to eprom by SL**> command.
57	SL%C=	Set p/n if it is empty. P/n must be stored to eprom with command SL**> Save settings. Otherwise it will be lost when power is turned off.
58	SL%C?	Return the p/n
59	SL+S=1	Set the unit to SLEEP-mode and reduces STDBY-current.
60	SL%P=1	Set the unit to Programming mode

8.4 SL-commands available by using the SATEL Configuration Manager

See table below.

Details 10.1.x	Function	Supported by modem	Supported by SATEL Configuration Manager (Dealer version)	Supported by SATEL Configuration Manager (User version)	Supported by Customer's Data Terminal Equipment, DTE (=SL-command)	Comments	SL No from the list above	SL-command
1	Create channel list	no	yes	definable	no			no
2	Set channel	yes	yes	definable	yes			new: SL$F=nnnn
3	Set Default Channel	no	yes	definable	yes			new: SL$D=nnnn
4	Go to Default Channel	yes	yes	definable	yes			new: SL$A=1
5	Read Default Channel	yes	yes	definable	yes			new: SL$D?
6	Export channel table to file	no	yes	definable	no			no
7	Import channel table from file to SATEL Configuration Manager	no	yes	definable	no			no
8	Read current settings from modem	yes	yes	definable	no	DTE: Only one-by-one		
9	Read factory settings like: model, serial number, FW-version, frequency band, module-ID	yes	yes	definable	yes	DTE: Only one-by-one	52 53 36 37 38 39	model: SL!V? serial number: SL%S? sw: SL%V? b1 low: SL!D? b1 high: SL!U? b2 low: SL!W? b2 high: SL!Y? module ID: SL%H?
10	Send settings to modem	yes	yes	definable	yes	DTE: Only one-by-one or by special exe-file		
11	Channel scanning mode (only on RX)	yes	no	no	yes			new: SL$S=1 (shows RSSSI-values)
12	Search for free channel (only on RX)	yes	no	no	yes			new: SL$E=1
13	Assign frequencies to channel numbers (min 20 channels)	yes	yes	definable	no			no
14	Set channel spacing:12.5, 20 or 25 kHz	yes	yes	definable	no			SL&W=xxxx (xxxx=1250, 2000 or 2500)
15	Addressing	yes	yes	definable	no		14 15 16 17 18 19 20	SL#I=xxxx SL#I? SL#T=xxxx SL#T? SL#R=xxxx SL#R? SL#P=xxxx;yyyy

							21 22 23	SL#S=xxxx;yyyy SL#P? SL#S? SL#Q=e SL#W=e SL#Q? SL#W? SL#A=xxxx,yyyy,zzzz,wwww SL#A?
16	Configure communication port parameters	yes	yes	definable	yes			SL%B= only speed
17	SLEEP	yes	no	no	yes		59	SL+S=1
18	Set FEC	yes	yes	definable	no			no
19	Print actual settings from modem	yes	yes	definable	no			no
20	Additional settings (auto baud rate detection…)	no	yes	definable	no			no
21	Describe settings via "Help" Tool	no	yes	yes	no			no
22	Show used COM- port of PC	no	yes	yes	no			no
23	Update firmware	yes	yes	definable	no		60	SL%P=1 and SLFLOEM
24	Set protocol format: SATEL 3As, PCC TrimTalk	yes	yes	definable	no			no
25	Read SW-version	yes	yes	definable	yes		53	SL%V?
26	Read HW-version	yes	yes	definable	yes			SL%H? (new)
27	Power down	no	yes	definable	yes			no
28	Output power configurable in W and or dBm	yes	yes	definable	yes		27 26	SL@P? SL@P=nnn
29	Max. output power	yes	yes	definable	no			no
30	Configure handshaking parameters	yes	yes	definable	yes			no
31	Set programming mode	yes	yes	definable	no		60	SL%P=1
32	Read RSSI-threshold	yes	yes	definable	yes		27	SL@T?
32.1	Reset modem	yes	no	no	yes		32.1	SL@X=9
32.2	Set 3AS-mode	yes	yes	no	yes		32.2	SL@S=0
32.3	Set Option 1	yes	yes	no	yes		32.3	SL@S=1
32.4	Set Option 2	yes	yes	no	yes		32.4	SL@S=2
32.5	Read mode	yes	yes	no	yes		32.5	SL@S?
33	Set RSSI-threshold	yes	yes	definable	yes		28	SL@T=-xxx
34	Read noise level	no	no	no	yes			SL@F?
35	Read message level	no	no	no	yes			SL@R?

8.5 Command table description

1. Create channel list. SATEL Configuration Manager. No DTE

The channel list is generated by the SATEL Configuration Manager. The ready-made list is sent to the modem using by the SATEL Configuration Manager. The maximum number of channels on the list is 40. When the modem is powered ON it goes to the default channel.

2. Set channel. SATEL Configuration Manager and DTE

The operating channel can be manually set by the CM, or selected from the list by the DTE.

3. SET Default Channel. SATEL Configuration Manager and DTE

Assigns the default channel.

Note1!

1. If the Default Channel is not set the modem uses the Factory Default Frequency.
2. If the Channel List is established the Default Channel is the 1st Channel in the list.

Note2!

When the modem is switched ON

- the modem uses the Default Frequency set by the Factory, if no other settings are done, or
- the User frequency that is set by the SATEL Configuration Manager, if the Channel List has not been used before switching OFF, or
- the frequency that is set by the Channel List as 1st Channel, if the User frequency has not been used before switching OFF.

4. Go to Default Channel. DTE

Modem goes to the channel which is assigned as default channel.

5. Read Default Channel. SATEL Configuration Manager and DTE

Reads default channel from the modem.

6. Export channel table to file. SATEL Configuration Manager

Saves channel table PC.

7. Import channel table from file. SATEL Configuration Manager

Loads settings from file to SATEL Configuration Manager.

8. Read current settings from modem. SATEL Configuration Manager. DTE one-by-one

All settings can be read by the SATEL Configuration Manager. The DTE can read settings one-by-one, because there is no such an SL-command that will read all settings using only one command.

9. Read factory settings. SATEL Configuration Manager. DTE one-by-one

Model, serial number, FW-version, frequency band and module ID can be red from the modem using the SL-commands.
Read Model = SL No. 52, serial no.= SL?, FW-version = SL 53, frequency band= SL 9, 10, Module ID= SL 55.

10. Send settings to modem. SATEL Configuration Manager. DTE one-by-one

Settings to the modem can be sent by the SATEL Configuration Manager. The DTE can send settings one-by-one or by using a special exe-command.

11. Channel Scanning feature. DTE

When activated, the modem scans channels one by one and saves the RSSI-readings to memory. The respond to the DTE is: 1st RSSI, 2nd RSSI, 3rd RSSI and so on.

12. Search Free channel. DTE

When activated the modem searches for the next channel which is free from traffic. The listening time of the traffic is about 2 seconds. The response is "channel xx is free". By activating same command again, the modem shows the next free channel.

13. Assign Frequencies to channel numbers. SATEL Configuration Manager

All possible frequencies, which are available by the modem type, are listed in the SATEL Configuration Manager. The user can pick up a maximum of 40 frequencies and assign them channel numbers.

14. Set Channel Spacing. SATEL Configuration Manager

Channel spacing must be assigned to the list or every channel separately. The alternatives are 12.5 kHz, 20kHz or 25 kHz.
Note that there can be only one channel spacing alternative per channel.

15. Addressing. SATEL Configuration Manager

Defines addresses to the receiver and transmitter.

16. Configure communication port parameters. SATEL Configuration Manager and DTE

Configurable parameters are Baud Rate, Parity, Number of Data Bits, Number of Stop Bits.

17. SLEEP. DTE

Special SL-command, SL+S=1 (which shuts down power units, synthesisers, and processor to a low power sleep mode)
Waking up from SLEEP is done if by sending a character to the modem. Wake-up time is about 40ms, before the modem is ready to receive data.

18. Set FEC. SATEL Configuration Manager

Sets the Forward Error Correction ON/OFF.

19. Print actual settings from modem. SATEL Configuration Manager

Reads settings from modem and makes it possible to print settings a list.

20. Additional settings (auto baud rate detection…) Optional. SATEL Configuration Manager

When activated, the PC will start polling the modem (HW-version) with different baud rates, and other values. When recognised the PC knows modem's port settings. The response is "modem found on port" or no modem found.

21. Describe settings via "Help" Tool. SATEL Configuration Manager
SATEL Configuration Manager shows help info when the cursor is clicked on the ?-mark. It is also possible to make different languages on the help menu. The languages are made by special configuration tool. The language can be selected by the user.

22. Show used COM-port of PC. SATEL Configuration Manager
Shows the COM-port status of the PC.

23. Update Firmware. SATEL Configuration Manager
The FW can be loaded from the PC to the Modem. The modem can be programmed with or without Programming-PIN.

24. Set Protocol format. SATEL, PCC, Trim Talk. SATEL Configuration Manager
Sets modulation type 3AS /FSK, PCC and TrimTalk/GMSK.
Reads modulation type from the modem.

25. Read SW-version. SATEL Configuration Manager. DTE
Reads SW-version from the modem.

26. Read HW-version. SATEL Configuration Manager
Reads HW-version from the modem.

27. Power down. DTE. Not used in this version
Power ON/OFF can be driven by the DTR-pin. Power ON, when DTR=open or +Vb. Power OFF, when DTR= ground.

28. Output Power configurable in Watt or dBm. SATEL Configuration Manager and DTE
Shows the output power ether in Watt or dBm.

29. Max. Output Power. SATEL Configuration Manager and DTE
Sets the output power.
This command sets the maximum output limit that can be set by the DTE-unit. This limit can not be changed by the DTE-unit.

30. Configure handshaking parameters. SATEL Configuration Manager and DTE
Configures the handshaking parameters

31. Set programming mode. SATEL Configuration Manager
Sets unit to programming mode.

32. Read RSSI-threshold. SATEL Configuration Manager and DTE
Shows the RSSI-threshold level.

32.1 Reset modem.
Resets modem. This command switches OFF the modem, and does not retrieve ok.

32.2 Set Satel 3AS-mode.

32.3 Set Option1

This Option is 4FSK-mode.
When this mode is used the other values are must be:

SATEL Modem	PCC Modem
FEC: OFF	Forward Error Correction: ON
Baud Rate: 19200	Scrambling: ON
Addressing: Not available	Protocol Mode: Transparent Mode w/EOT Timeout

32.4 Set Option2

This Option is GMSK-mode
When this mode is used the other values are must be:

SATEL Modem	PCC Modem
FEC: OFF	Forward Error Correction: ON
Baud Rate: 9600	Scrambling: ON
Addressing: Not available	Protocol Mode: Transparent Mode w/EOT Timeout

32.5 Read Option

Read the current Option
The Modem retrieves:
"0" when in 3AS-mode.
"1" when in Option 1-mode.
"2" when in Option 2-mode.

33. Set RSSI-threshold. SATEL Configuration Manager

Sets the RSSI-threshold level.
The RSSI Signal Threshold setting of the receiver determines the level that the modem operates properly. The number is shown as [–dBm], so the greater the number is the weaker is the signal threshold level (-100 dBm is weaker than -90 dBm).
The modem operates only, if the received signal is stronger than the Signal Threshold level.
When set, it applies to all channels and frequencies.

If the environment is noisy and it is needed that the modem does not listen to noisy channels, it is usually recommended to use a value that is about 10 above noise level.

Example of noisy environment:

Noise level measurement, SL@F?, retrieves [-100 dBm] ==> RSSI threshold level should be set to -102...-98 dBm, so the receiver will not try to find a signal from the noise.

The recommended value under normal circumstances is about -117.
The available values are -80··· -118 dBm.

34. Read noise level. DTE

Shows the noise level of the channel/frequency.

35. Read message level. DTE.

Shows the level [– xxx dBm] of the last message if received within 7 seconds from the SL-command. If no messages received within 7 seconds from the SL-command, the modem retrieves -118dBm, which means "no reading received".

9 Programming

9.1 Flash update

The Firmware can be updated in two ways:

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

10 CHECKLIST

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

1. All operating voltages of all the equipment concerned must always be switched OFF before connecting the serial interface cable.

2. When considering the exact placement of a radio modem and/or its antenna, the following points must be taken into account to guarantee optimal results:
   - The antenna should be installed in open space as far as possible from any possible sources of interference
   - The radio modem should not be installed onto a strongly vibrating surface
   - The radio modem should be installed in such a way as to minimise exposure to direct sunlight or excessive humidity.

3. To ensure reliable operation the voltage output of the power supply used must be stable enough and the current capability of the power supply must be sufficient.

4. The antenna must be installed according to instructions.

5. The settings of the radio modem must correspond to settings of the terminal.

6. All radio modems in the same system must be configured using same settings (radio frequency, channel spacing and data field length).

11 APPENDIX A

11.1 Functional delays

Function	Delay (ms)
Time from turning power ON, until it is ready to send/receive data	<300 ms
Wake-up time from SLEEP, until it is ready to send/receive data	<95 ms
Inter character delay	max. 2-3 characters

11.2 Transmission related delays

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

DATA
Modem 1
TD-line start end

DATA
Modem 2
RD-line start end

Delay

Time