# SATEL-TR49 SnapOn

# TRANSCEIVER MODULE

# INTEGRATION GUIDE

# Version 2.1

## IMPORTANT NOTICE

Salo, FINLAND 2024

## RESTRICTIONS ON USE – SATEL-TR49 SnapOn 410-475 MHz

SATEL-TR49 SnapOn radio transceiver module has been designed to operate on 410-475 MHz and 902-928 MHz, the exact use of which differs from one region and/or country to another. The user of a radio transceiver module 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.

SATEL-TR49 SnapOn operating on 410-475 MHz band is allowed to be used in the following countries, either on license free channels or on channels where the operation requires a license. More detailed information is available at the local frequency management authority.

Countries: AT, BE, BG, CA, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MT, NL, NO, PL, PT, RU, RO, SE, SI, SK, US.

| |
|---|
| **WARNING - RF Exposure** <br> To comply with Europe, FCC and ISED RF exposure compliance requirements, maximum allowed antenna gain is 14 dBi and separation distance of at least 39 cm must be maintained between the antenna of this device and all persons. Co-location of this module with other transmitters that operate simultaneously are required to be evaluated using the FCC multi-transmitter procedures. |

This integration guide applies to the combination of Firmware/Hardware version listed in the table below. See www.satel.com for the newest firmware and Integration Guide version.

| Firmware version | Hardware version | Note! |
|---|---|---|
| 07.45.2.3.2.11 | SPL0061a | First official release |

# RESTRICTIONS ON USE — SATEL-TR49 SnapOn 902-928 MHz

SATEL-TR49 SnapOn operating on 902-928 MHz band is allowed to be used in the following countries. More detailed information is available from the local frequency management authority.

Countries: CA and US.

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WARNING - RF Exposure

To satisfy FCC and ISED RF exposure requirements for mobile transmitting devices, a separation distance of 39 cm or more should be maintained between antenna of this device and persons during device operation. To ensure compliance, operations at closer than this distance is not recommended. Co-location of this module with other transmitters that operate simultaneously are required to be evaluated using the FCC multi-transmitter procedures.

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This radio transmitter 2422A-SATELTA38 has been approved by Innovation, Science and Economic Development (ISED) Canada to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

| Antenna type | Manufacturer | Antenna model | Maximum gain (dBi) |
|---|---|---|---|
| Omnidirectional (whip) | Laird Connectivity | FG9026 | 6 |
| Directional (yagi) | PulseLarsen Antennas | YA6900W | 6 |

NOTE!
According to the requirements of the FCC, the integrator should make sure that the SATEL-TR49 SnapOn is compliant to part 15B while integrated in the host device. Output power and spurious emissions should be verified.

## PRODUCT CONFORMITY

Hereby, SATEL Oy declares that SATEL-TR49 SnapOn radio transceiver module is in compliance with the essential requirements (radio performance, electromagnetic compatibility and electrical safety) and other relevant provisions of Directive 2014/53/EU. Therefore the equipment is labeled with the following CE-marking.

$$C \in$$

For 410...475 MHz:
This device complies with part 90 of the FCC rules.

For 902-928 MHz only:

This device complies with ISED license-exempt RSS standard(s) and part 15 of the FCC Rules. 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. Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Le présent appareil est conforme aux CNR d'ISED applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

# 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

-The radio transceiver module 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 device are appropriate. This also applies to the maintenance of the products.

## HOST INTEGRATION

To ensure compliance with all non-transmitter functions the host manufacturer is responsible for ensuring compliance with the module(s) installed and fully operational. For example, if a host was previously authorized as an unintentional radiator under the Declaration of Conformity procedure without a transmitter certified module and a module is added, the host manufacturer is responsible for ensuring that after the module is installed and operational the host continues to be compliant with the Part 15B unintentional radiator requirements. This module is certified for Fixed and Mobile Applications only, for Portable applications you will require a new certification.

This device has been modularly approved. Model name, FCC and ISED identifiers of this product must appear on the outside label of the end-user equipment.

Host labelling example:

| |
|---|
| Model Name: |
| Contains         FCC ID:  MRBSATEL-TA38 |
|                 IC: 2422A-SATELTA38 |
| This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions:<br>(1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. |

## TABLE OF CONTENTS

# 1. INTRODUCTION

SATEL Oy is a Finnish electronics and Telecommunications company specializing 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 organizations and private individuals.

SATEL Oy 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.

This document is the integration guide for the SATEL-TR49 SnapOn radio transceiver module. It is intended to describe how to use the module and how to integrate it into a host device. There are many versions available of SATEL-TR49 SnapOn depending on the region of use on 900 MHz band and 400 MHz band encryption capability. They are listed in Appendix C.

## 1.1    Terms and abbreviations

| Abbreviation | Description |
|---|---|
| CTS | Clear To Send, handshaking signal used in asynchronous communication. |
| DTE | Data Terminal Equipment (typically computer, terminal…) |
| ESD | Electrostatic discharge |
| RD | Receive Data |
| TD | Transmit Data |
| RTS | Ready To Send, handshaking signal used in asynchronous communication. |
| RAM | Random Access Memory |
| LDO | Low dropout regulator |
| UHF | Ultra High Frequency |
| RF | Radio Frequency |
| CPU | Central processing unit |

## 1.2    Description of the product

The SATEL-TR49 SnapOn is a UHF radio transceiver module, which transmits and receives data on the UHF frequency band. The modules are designed to be as compact and power efficient as possible. They have been developed to be especially suitable for integration into battery powered and space constrained host applications benefiting from UHF communications.

The module transmits and receives data via the Air interface, modulates and demodulates, encodes and decodes the data and sends the received data payload to the Mini PCIe interface The Mini PCIe interface is used to provide power to the module and communicate with it.

## 2. TECHNICAL SPECIFICATIONS

### 2.1 Absolute maximum ratings

Absolute maximum ratings for voltages on different pins are listed in the following table. Exceeding these values will cause permanent damage to the module.

| Parameter | Min | Max |
|---|---|---|
| Voltage at VCC_IN | 0 V | +4 V |
| Voltage at VCC_IO | 0 V | +4 V |
| Voltage at digital inputs | 0 V | +4 V |
| Voltage at digital outputs | 0 V | +4 V |

Note. All voltages are referenced to GND.

### 2.2 DC electrical specifications

Recommended operating conditions:

| Parameter | Condition | Min | Max | Units |
|---|---|---|---|---|
| VCC_IN | | 3.3 | 3.3 | V |
| ENA_MOD, Vlow | | 0 | 0.4 | V |
| ENA_MOD, Vhigh | | 0.85 | VCC_IN | V |
| VCC_IO | | 1.8 | 3.3 | V |
| Logic input, Vlow | 1.8 V<VCC_IO<3.3V | 0 | 0.3V | V |
| Logic input, Vhigh | 1.8 V<VCC_IO<3.3V | 0.9*VCC_IO | VCCIO | V |
| Logic output, Vlow | 1.8 V<VCC_IO<3.3V | 0 | 0.5 | V |
| Logic output, Vhigh | 1.8 V<VCC_IO<3.3V | 0.6*VCC_IO | VCCIO | V |
| Logic output, max current | All logic output except STAT pin. | - | 4 | mA |
| Logic output, max current, STAT pin | | - | 12 | mA |

### 2.3 Specifications, SATEL-TR49 SnapOn (on 410-475 MHz)

Complies with the following international standards on 410-475 MHz: FCC CFR 47 Part 90
FCC CFR 47 Part 2
RSS-119 Issue 12
RSS-Gen Issue 4
ETSI EN 300 113 v2.2.1 (partially)

|  | RECEIVER | TRANSMITTER | Note! |
|---|---|---|---|
| Frequency Range | 410...475 MHz | | See Appendix A |
| Tuning range | 65 MHz | | |
| Minimum RF Frequency Step | 6.25 kHz | | |
| Channel Bandwidth | 12.5 and 25 kHz | | |
| Frequency Stability | <1 kHz | | |
| Maximum Receiver Input Power without Damage | +10 dBm | | |
| Maximum Receiver Input Power without Transmission Errors | -10 dBm | | FEC ON |
| Sensitivity [1] | typ. -120 dBm | | FEC ON |
| Blocking [1] | > 70 dB at 1-10 MHz offset | | FEC ON |
| Intermodulation Attenuation [1] | typ. > 47 dB | | FEC ON |
| CO-Channel Rejection [1] | typ. > -10 dB | | FEC ON |
| Adjacent Channel Selectivity [1] | > 50 dB | | FEC ON |
| Spurious Rejection [1] | typ. > 50 dB | | FEC ON |
| Transmitter Power | | 10, 20, 50, 100, 200, 500 and 1000 mW | |
| Communication Mode | Half-Duplex | | |
| Frequency Change Time | typ. 50 us | | Time required for switching from one RF frequency to another |
| TX to RX time RX to TX time | typ. 4 ms | | |
| Adjacent Channel Power | | acc. to EN 300 113 | TX-mode |
| Transient Adjacent Channel Power | | acc. to EN 300 113 | TX-mode |
| Carrier power stability | | < ±1.5 dB | |

|  | miniPCIe MODULE |  |
|---|---|---|
| Electrical Interface | Standard Mini PCIe interface. Used pins listed in chapter 3.1 | USB interface in use |
| Interface Connector | Mini PCIe with 0.8mm pitch and card thickness 1mm | e.g. Molex 67910002 |
| Data speed of Serial interface | 9600 – 115200 bps | |
| Data speed of Radio Air Interface | 4800 – 19200 bps | |
| Air Interface Encryption | AES128 | |
| Data Format | Asynchronous data | |
| Modulation | GMSK, 4-GFSK | |

| | GENERAL | |
|---|---|---|
| Operating voltage | 3.3 VDC | |
| Current consumption in Power Save mode | < 2 mA | W_Disable activated (Not implemented to all variants) |
| Typical Power Consumption 410…475 MHz | 400 mW | RX-mode |
| | SLEEP1: TBD mW | RX-mode |
| | 4.8 W @ 1000 mW RF out 4.5W@1000mW RF out | TX-mode, Continuous, 50 Ω |
| Inrush Current, power turned ON [3] | < 12 A, duration < 50 µs | RX-mode |
| Temperature Range | -20 °C …+55 °C | Type Approval conditions |
| Temperature Ranges | -40 °C …+70 °C | Functional |
| | -40 °C …+85 °C | Storage |
| Vibration | ≤ 25g | 100 Hz≤$f_{vibration}$≤2,0 kHz |
| ESD[4] | ± 10 kV | Antenna connector. Acc. to EN61000-4-2; 150pF/330Ω |
| | ± 8 kV | DTE connector. Acc. to EN61000-4-2; 150pF/330Ω |
| Antenna Connector | 50 Ω, HIROSE U.FL compatible | I-PEX 20279-001 -E-01 |
| Construction | PCB with billet aluminum case | |
| Size L x W x T | 51 x 30 x 4.75 mm | |
| Weight | 12 g | |

Test condition $V_{CC}$ = 3.3 V and $T_A$ = 25 °C

[1] According to EN 300 113 V2.2.1 measurement setup.

[3] Measured using Agilent 1147B current probe and TTi TSX1820P DC power supply.

[4] Measured under normal ambient conditions, $T_A$ = 25 °C. When the device is used in a different environment, the results may change significantly. It is recommended to use external ESD protection in demanding conditions.

## 2.4    Specifications, SATEL-TR49 SnapOn (on 902-928 MHz)

Complies with the following international standards:
FCC Parts 15.209 and 15.247 of Title 47
IC RSS-247, ICC RSS-Gen

| | RECEIVER | TRANSMITTER | Note! |
|---|---|---|---|
| Frequency Range | 902-928 MHz | | |
| Spreading Method | Frequency Hopping | | |
| Occupied Bandwidth | 230 kHz | | |
| Frequency Stability | <1 kHz | | |
| Maximum Receiver Input Power without Damage | +10 dBm | | |
| Maximum Receiver Input Power without Transmission Errors | -3 dBm | | |

| | | | |
|---|---|---|---|
| Sensitivity | typ. -109 dBm for BER $10^{-4}$ | | |
| Blocking | TBD | | |
| Intermodulation Attenuation | TBD | | |
| Adjacent Channel Selectivity | TBD | | |
| Transmitter Power | | 10, 20, 50, 100, 200, 500, 1000 mW | |
| Carrier power stability | | < ±1.5 dB | |
| Data Rate | 115.2 kbit/s | | |
| Modulation Method | 2-GFSK | | |
| Hopping Bands | 7, user selectable | | |
| Hopping Patterns | 15 per band, 105 total, user selectable | | |
| Hopping Channels | 50-112, user selectable | | |
| Frequency Zones | 16 Zones, 7 Channels per Zone | | |
| Temperature Ranges | -40 °C …+70 °C | Functional | |
| | -40 °C …+85 °C | Storage | |
| Operating Voltage | 3.3 VDC | | |
| Power Consumption | 400 mW (Receive mode) 4.0W (Transmit Mode 1W) | | |
| Vibration | ≤ 25g | 10 Hz≤$f_{vibration}$≤2,0 kHz | |
| ESD[1] | ± 10 kV | Antenna connector. Acc. to EN61000-4-2; 150pF/330Ω | |
| | ± 8 kV | DTE connector. Acc. to EN61000- 4-2; 150pF/330Ω | |
| Antenna Connector | 50 Ω, HIROSE U.FL compatible | I-PEX 20279-001 – E-01 | |
| Construction | PCB with billet aluminum case | | |
| Size L x W x T | 51 x 30 x 4.75 mm | | |
| Weight | 12 g | | |
| Electrical Interface | Standard mini PCIe interface. Used pins listed in chapter 4.1 | USB interface in use | |
| Interface Connector | Mini PCIe with 0.8mm pitch and card thickness 1mm | e.g. Molex 67910002 | |
| Data speed of Serial interface | 9600 – 115200 bps | | |

[1] Measured under normal ambient conditions, $T_A$= 25 °C. When the device is used in a different environment, the results may change significantly. It is recommended to use external ESD protection in demanding conditions.

# 3. ELECTRICAL INTERCONNECTION SATEL

## 3.1    Pin order of the Mini PCIe interface

| Pin No. | Mini PCI express standard description | SATEL Pin Description, I/O type | Pin State TBD |
|---|---|---|---|
| 1 | WAKE# | LED I/O output | Active low (0-0.2V) Inactive (open) |
| 2 | 3.3Vaux | Vcc IN | High |
| 3 | COEX1 | NA | - |
| 4 | GND | GND | GND |
| 5 | COEX2 | NA | - |
| 6 | +1.5V | NA | - |
| 7 | CLKREQ# | NA | - |
| 8 | UIM_PWR | NA | - |
| 9 | GND | GND | GND |
| 10 | UIM_DATA | NA | - |
| 11 | REFCLK- | NA | - |
| 12 | UIM_RESET | NA | - |
| 13 | REFCLK+ | NA | - |
| 14 | UIM_RESET | NA | - |
| 15 | GND | GND | GND |
| 16 | UIM_Vpp | NA | - |
| 17 | Reserved | NA | - |
| 18 | GND | GND | GND |
| 19 | Reserved | NA | - |
| 20 | W_DISABLE# | Shut down for the modem | Active low (0.0 – 0.2V) |
| 21 | GND | GND | GND |
| 22 | PERST# | MCU Reset | Active (GND-0.4V) Inactive (2.0-3.6V) |
| 23 | PERp0 | NA | - |
| 24 | +3.3Vaux | Vcc IN | High |
| 25 | PERp0 | NA | - |
| 26 | GND | GND | GND |
| 27 | GND | GND | GND |
| 28 | +1.5V | NA | - |
| 29 | GND | GND | GND |

| Pin No. | Mini PCI express standard description | Direction TBD | Pin State TBD |
|---|---|---|---|
| 30 | SMB_CLK | NA | - |
| 31 | PETn0 | NA | - |
| 32 | SMB_DATA | NA | - |
| 33 | PETp0 | NA | - |
| 34 | GND | GND | GND |
| 35 | GND | GND | GND |
| 36 | USB_D- | USB Data minus | High 2.0V - Vcc IN Low -0.5V - 0.8V |
| 37 | GND | GND | GND |
| 38 | USB_D+ | USB Data plus | High 2.0V - Vcc IN Low -0.5V - 0.8V |
| 39 | +3.3Vaux | Vcc IN | |
| 40 | GND | GND | GND |
| 41 | +3.3Vaux | Vcc IN | High |
| 42 | LED_WWAN# | LED I/O output | Active low (0-0.2V) Inactive (open) |
| 43 | GND | GND | GND |
| 44 | LED_WLAN# | LED I/O output | Active low (0-0.2V) Inactive (open) |
| 45 | Reserved | NA | - |
| 46 | LED_WPAN# | LED I/O output | Active low (0-0.2V) Inactive (open) |
| 47 | Reserved | NA | - |
| 48 | +1.5V | NA | - |
| 49 | Reserved | NA | - |
| 50 | GND | GND | GND |
| 51 | Reserved | NA | - |
| 52 | +3.3Vaux | Vcc IN | High |

## 3.2 LED_WWAN, LED_WLAN and LED_WPAN IO pins

These IO pins are reserved to indicate e.g. state of the module, status of the transmission etc. Signals are active in low state.

SATEL-TR49 SnapOn GPIO control for these pins (more information from document: TIL-0026_SATEL Radio Modules_GPIO interface.pdf)

| 42 | LED_WWAN# | LED I/O output | Active low (0-0.2V) Inactive (open) Control TR49 SnapOn GPIO 6 |
|---|---|---|---|
| 44 | LED_WLAN# | LED I/O output | Active low (0-0.2V) Inactive (open) Control TR49 SnapOn GPIO 7 |
| 46 | LED_WPAN# | LED I/O output | Active low (0-0.2V) Inactive (open) Control TR49 SnapOn GPIO 8 |

## 3.3 Wake

Signal is used to request that system returns from the sleep state back to service. State is active at low signal level. This signal is optional and not activated for all variants. Note: USB-based Mini Cards that implement a wakeup process are required to use the in-band wakeup protocol (across the USB_D+/USB_D- pins) as defined in the Universal Serial Bus Specification and shall not use the WAKE# signal to enable the in-band wakeup process.

## 3.4 USB_D- and USB_D+ IO pins

USB interface through the Mini PCIe connector.
Note: PCI Express receiver incorporates automatic Lane polarity inversion as part of the Link initialization and training and will correct the polarity independently on each Lane.

## 3.5 PERST#

Option for the MCU reset. Optional and not activated for all variants.

## 3.6 W_Disable

IO pin to enable/disable the modem. Disable active at low. Pull-up resistor activates the modem if the port is open (not forced down)

## 3.7 +3.3Vaux

+3.3Vaux pins to feed operating voltage of the module. Limit for this voltage (Vcc_IN) is mentioned in chapter 2.2 DC electrical specifications. User must take into consideration the surge current and current consumption issues before using these pins. User must be aware of any voltage drop on the feeding path.

## 3.8 Antenna interface

The antenna interface is a 50 Ω coaxial connector. Matching networks are not included in the module and should be placed in the host application if the antenna is not 50 Ω. The HIROSE U.FL compatible connector is located on the TOP side of the board.

NOTE! The used connector has gold plated contacts - whereas a standard HIROSE U-FL has silver plated contacts. If silver - gold joints are not allowed in your product, use gold plated cable- connector to mate to this device.

## 4. MECHANICAL CONSEDERATIONS SATEL-TR49 SnapOn

### 4.1 Dimensions and interfaces

The dimensions of the SATEL-TR49 SnapOn module are 51mm (length) x 30 mm (width) x 4.75 mm (height), weight 12 g. Figure 4.1 shows the dimensions of the module in detail.
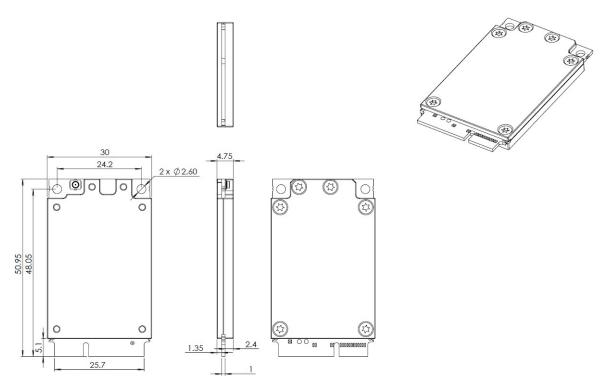


Figure 4.1 The module physical dimensions and the holes in millimeters.

### 4.2 Dimensions of the Mini PCI Express connector

The Mini PCIe module adopts a standard Mini PCI Express connector that has 52 pins and complies with the *PCI Express Mini Card Electromechanical Specification Revision 1.2*.

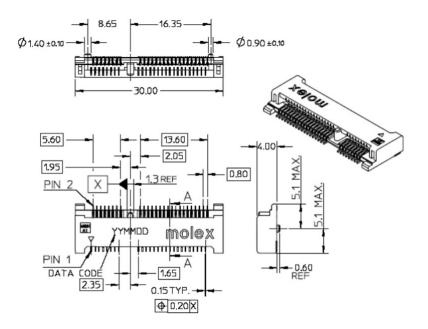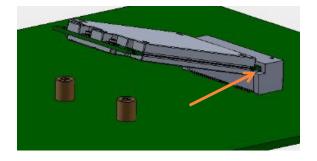Figure 4.2 shows a 52-pin Mini PCI Express connector (Molex 67910002 as an example)

Figure 4.2 Dimensions of the Mini PCI Express connector
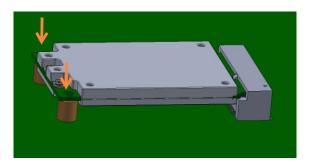
## 4.3  Installing the Mini PCIe module on the host device

To install the SATEL-TR49 SnapOn Mini PCIe module on the host device, do the following.
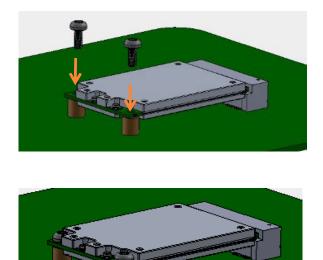
Step-1: Insert the Mini PCIe module into the Mini PCI Express connector on the host device:



Step-2: Press downwards to fix the Mini PCIe module in the module slot.

Step-3: Use a screwdriver and two screws (M2,5) to tighten Mini PCIe module on the host device.





Step-4: Insert the RF-cable connector of the UHF antenna into the antenna interface.

NOTE!
- Insert the antenna connector vertically into the antenna interface of the Mini PCIe module.
- Do not press or squeeze the antenna cable or damage connector. Otherwise, the wireless performance of the Mini PCIe module may be reduced or the Mini PCIe module cannot work normally.
- Ensure that the antenna cables are routed through the channel in the frame of the device and do not lay the cables across the raised edges of the frame.
- Check that the antenna cable cannot make any static torsion to the RF connector.

## 4.4     Thermal design guide

With the highest RF TX levels, peak power consumption can reach up to 4.5 Watt. To handle needed thermal dissipation SATEL-TR49 SnapOn has solid aluminum covers at both sides of the module. Although we have a good margin to the critical temperature levels, it is strongly recommended that the aluminum covers are not blocked by the materials with the low thermal conductivity (<150W/K*m).
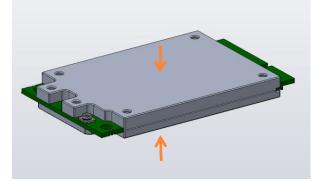
Heat sourcing area:



Figure 4.3 Heat sourcing area, both sides.

# 5. OPERATING MODES

The radio transceiver module has the following modes of operation:

| Mode | Function | Description |
|---|---|---|
| Ready to receive from RF | Search for sync | Module is searching for the start of a radio transmission from the RF signal. |
| | Receive data | The module has found a valid radio transmission and is receiving data. |
| TX | Transmit | The module transmits |
| Safe mode | | Mode is entered when a fault has been detected and the device has been Rebooted. In safe mode fault codes can be read from the module (section 6.1). |
| Sleep mode | Sleep1 | Will turn the module into a state where it will hold parts of the radio on, wakeup will take approx. 30 ms |
| Power Save mode | Power save | Automatic sleep/wake-up procedure where module sleeping time is dynamically adjusted to received data packets. Decreases the power consumption of complete receiving cycle approx. 30%. |
| Command mode | Radio in idle | Dedicated mode to configuring radio module while radio is in idle mode and cannot transmit or receive. |

## 5.1 Safe mode

When a fault has been detected by the Firmware, the module is set to Safe mode. In this mode the module sends an Error message to Mini PCIe interfaces to and reboots the device after five (5) seconds. Transmitting/Receiving is prohibited during malfunction. When connecting to the device with SATEL Configuration Manager the Error code is shown in pop up box. If the device does not recover after multiple reboots, please contact SATEL Oy.

SATEL Configuration Manager can be downloaded from website www.satel.com/downloads. The version 1.7.4 or newer is compatible with SATEL-TR49 SnapOn radio transceiver module.

## 5.2 Restart

After startup the module can be restarted by issuing an SL command, upon which the module will shut down all circuitry, and Reboot the CPU (see SL command list).

## 6. CONFIGURATION

The configuration of settings can be changed easily - the next chapters describe the details:

**SATEL SW tools**
Easy-to-use SATEL software tools suit most cases. Please see additional information in next chapters.
**SL commands**
A terminal device can command or configure the radio modem by using special commands. SL commands are applied especially in cases where radio modems are to be integrated seamlessly inside a system behind the integrator's own user interface.

The parameters changed to a device on frequency hopping 900MHz band are taken into use after either radio reboot command, electrically restarting the device or exiting from the command mode (see SL Command Mode).

### 6.1     SATEL NETCO DEVICE software

SATEL NETCO DEVICE is a software for configuring and reprogramming a SATEL device. The configuration parameters can be read and written from/to the locally connected, powered device. The device configuration can be also created/saved/explored from/to a file without device connection.

The most common use case for which the SATEL NETCO DEVICE is optimized for is editing existing parameters in a SATEL radio product using local connection, such as serial interface.

Please see additional information from SATEL WEB pages at:
https://www.satel.com/products/software/
The software is available from SATEL WEB pages at: https://www.satel.com/support-and-services/downloads/

### 6.2     SATEL Configuration Manager software

SATEL Configuration Manager is a software for configuring and reprogramming a SATEL device. The parameters can be read and written from/to the connected, powered device. The program file can be saved into a separate file to be used to other devices.

The most common use case for which the SATEL Configuration Manager is optimized for is editing existing parameters in a SATEL radio product using locally connected product over a serial interface. Minimum requirements: COM port with baud rate min. 9600 bps (alternatively with industrial level USB-RS-232 converter).

Please see additional information from SATEL WEB pages at:
https://www.satel.com/products/software/
The software is available from SATEL WEB pages at: https://www.satel.com/support-and-services/downloads/

## 6.3    Changing parameters using SL Commands

The controlling terminal device can change the configuration settings of the module. This is accomplished with the help of SL commands. SL commands can be used to change e.g. the frequency or addresses. It is also possible to ask the radio transceiver module to show current settings which are in use.

### 6.3.1  SL Commands

The controlling terminal device can change the configuration settings of a radio. 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. SL command -setting must be enabled before they can be used.

An SL command is a continuous string of characters, which is separated from other data by pauses which 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. SL command is properly recognised also in the case when the command string is terminated by <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 module, 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 module.

The transceiver module 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. SL command response time depends of the used command. Typical response time is ~100ms and upwards. Recommended safe timeout for SL command response is 500ms.

it is possible to use SL commands in Port 2 (TD2 signal in GPIO3 (Pin13) and RD2 signal in GPIO1 (Pin11)) when Port2 Function has been configured as Diagnostics. SL commands can be used even in parallel with Port1 – in that case the response appears in the same port where the SL command came from.

Port2 is configured via SL commands or SW tools (SATEL NETCO DEVICE or SATEL Configuration Manager) by selecting the Port2 Function:
- OFF (=Port 2 not in use)
- Diagnostics (=SL commands ON in this case)

CR/LF characters are added to end the response messages (unless they are already present) in order to make parsing easier. Settings can be toggled, SL Commands ON/OFF, CR/LF ON/OFF.

See Appendix B and C for SL commands. To get information of the latest and/or special SL commands please contact SATEL or local SATEL distributor: https://www.satel.com/where-to-buy/.

## 6.4 SL Command Mode

When the SL commands are enabled, there are possibilities that the user data may start with the characters "SL" which is handled as the SL command. This has caused the firmware to go to the continuous SL command search mode and any data has not been sent or even an **"ERROR"** acknowledgment has been received. To avoid this kind behavior the user can disable the SL commands.

The SL commands can be disabled or enabled by using SL commands or toggling the "*SL Command mode*" parameter via SATEL SW tools, SATEL NETCO DEVICE or SATEL Configuration Manager (maintenance access level required).

By default the *SL Command mode* is set to **ON**. If the *SL Command mode* is set to **OFF** then the SL commands can be enabled or disabled by using the below described procedure. Regardless of original SL command –setting state, changing the setting state with this procedure will affect the reception process of the radio module.

Radio can be set to *Command Mode* separately with "+++" command, regardless of the set SL command mode (ON/OFF). *Command mode* enables forcibly the SL command mode and disables the radio interface functions (Tx/Rx). By exiting from the Command Mode, user defined SL command parameter mode is restored, as well as radio interface functions.

To enable the *Command mode*:
- Send three "**+**" characters via serial port so that there is at least three bytes delay (according to Pause Length -setting) between each character. The response is **"OK"**, when successfully set.
  <**+**><*at least three bytes pause\**><**+**><*at least three bytes pause\**><**+**>

To disable the *Command mode*:
- Send three "**-**" characters via serial port so that there is at least three bytes delay (according to Pause Length -setting) between each character. The response is **"OK"**, when successfully set.
  <**-**><*at least three bytes pause\**><**-**><*at least three bytes pause\**><**-**>

*\*Pause Length -setting*

Note!
The "+ + +" and "- - -" procedures are not recommended to be used when radio is transmitting or receiving data (i.e. the application data occupies the TD or RD lines of the radio).

Note2!
900 MHz frequency band parameters set via SL commands require device restart for the new parameters to be taken into use. The device reset is performed during exiting the command mode (---).

# 7. DEFAULT DELIVERY VALUES – 410-475 MHz

| DEFAULT VALUES OF THE ADJUSTABLE SETTINGS (the user can change these settings later on) | | |
|---|---|---|
| | | |
| Setting | Default value | Range |
| Radio frequency | | |
| Operating TX and RX frequency | 438.0000 MHz | 410…475 MHz |
| Channel Width | 12.5 kHz | 12.5 kHz or 25 kHz |
| Transmitter Output Power | 1000 mW | 10, 20, 50, 100, 200, 500 and 1000 mW |
| | | |
| Radio settings | | |
| Radio Compatibility | SATEL 3AS | SATELLINE-3AS<br>PacCrest-4FSK<br>PacCrest-GMSK<br>PacCrest-FST<br>TrimTalk450s<br>RTCM SC135 1 25 kHz FEC ON<br>RTCM SC135 2 12.5 kHz FEC ON<br>RTCM SC135 3 25 kHz FEC OFF<br>RTCM SC135 4 12.5 kHz FEC OFF |
| Signal Threshold | -118 | -80 … -118 |
| Addressing | | |
| RX Address | OFF | ON/OFF |
| TX Address | OFF | ON/OFF |
| | | |
| Serial port | | |
| Data speed | 115200 bps | 9600 -115200 bps |
| Data bits | 8 | 8 |
| Parity bits | None | None, Even, Odd |
| Stop bits | 1 | 1 |
| | | |
| Handshaking | | Handshaking lines apply to the DATA-port |
| CTS | TX Buffer State | Clear to send, TX Buffer State |
| RTS | Ignored | Ignored, Flow Control |
| | | |
| Additional setup | | |
| Error Correction, FEC | OFF | ON/OFF |
| Error check | OFF | OFF, CRC8Partial, CRC8Full, CRC16Full |
| SL Command Mode | ON | ON/OFF |
| Repeater Mode | OFF | ON/OFF |
| TX Delay | 0 | 0 …. 65535 ms |
| Over-the-Air-Encryption | OFF | ON/OFF |
| Use Channel List | OFF | ON/OFF |
| Power Save Mode | OFF | ON/OFF |
| Add RSSI to Data | OFF | ON/OFF |

# 8. DEFAULT DELIVERY VALUES – 902-928 MHz

| DEFAULT VALUES OF THE ADJUSTABLE SETTINGS (the user can change these settings later on) | | |
|---|---|---|
| | | |
| Operation Mode | Default value | Note |
| Point-to-Multipoint Slave | 3 | |
| Serial Port Parameters | | |
| Baud Rate | 115200 | |
| Data Bits | 8 | |
| Parity | None | |
| Stop Bits | 1 | |
| Radio Parameters | | |
| FreqKey | 5 | |
| Hop Table Version | 0 | |
| Hop Table Size | 112 | |
| Frequency Zone | All 1s (Enabled) | |
| Max Packet Size | 8 | |
| Min Packet Size | 9 | |
| Xmit Rate | 1 | |
| RF Date Rate | 3 | |
| RF Xmit Power | 1000 | |
| Slave Security | 0 | |
| RTS to CTS | 0 | |
| Retry Timeout | 255 | |
| Call Book | Empty | |
| Call Book Entry Index | 0 | |
| Multipoint Parameters | | |
| Number of Repeaters | 1 | |
| Master Packet Repeat | 2 | |
| Max Slave Retry | 9 | |
| Retry Odds | 9 | |
| Repeater Frequency | 0 | |
| Network ID | 123 | |
| Slave/Repeater | 0 | |
| Tx Subnet | "Disabled" | |
| Rx Subnet | "Disabled" | |

# 9. CONSIDERATIONS

## 9.1     EMI interferers

The module is designed to be mounted inside a host device. The module is designed to withstand EMI even beyond type approval requirements. However, a small module which is integrated closely to modern high-speed electronics is bound to receive some interference.

To make a working integration, consider the following: EMI can enter the module in four ways:
1)  Via the antenna (radiation from enclosure enters the antenna)
2)  Radiated disturbances to the coaxial cable
3)  Radiation from other electronics / cabling directly to the module
4)  Conducting through the Mini PCIe interface (power, control and data lines).

Because the module is shielded and the Mini PCIe interface is filtered, the usually worst method of disturbance is via the antenna port, which is easily overlooked in design.  Keep in mind that the radio module has a sensitivity of approx. -107 dBm (depends on mode of operation and speed etc.). While the module has an approx. 10 dB S/N requirement, this constitutes, that any signal entering the radio antenna on receive frequency on a level of higher than -117 dBm (-107 dBm- 10 dB), causes desensitization of the radio on that particular channel.

Example:
An interferer has a level of -100 dBm at the frequency 869 MHz. The radio will have an approximate sensitivity of -90 dBm (-100 dBm + S/N requirement 10 dB) at 869 MHz.

Now consider that generic EMC requirements usually have pass/fail criteria of -57 dBm (if normalized to the surface of the device). So there is almost a 60 dB gap between generic EMC requirements and co-existence requirements between a high sensitivity narrowband radios.

To avoid problems of co-existence a good design should apply:
1)  EMI shielding in enclosure – ambient air interface
2)  Careful layout
3)  Shielding of all digital high-speed parts and cables
4)  Have a clocking plan to avoid clock frequencies causing harmonics on the UHF band of interest.

## 9.2     Electrostatic discharge

As the module is intended to be embedded in a host device, in a typical use case, the antenna port is the only port of the module directly interface with a surface or contact area subjected to Electrostatic Discharge (ESD). Thus, the antenna port is the only interface with high level ESD protection. The DTE port also features ESD protection diodes, but is not designed to withstand similar performance as expected from standalone units with enclosures.
Consequently, the module should be subject to ESD handling precautions that typically apply to ESD sensitive components. Proper ESD handling and packaging procedures must be applied throughout the processing, handling and operation of any application that incorporates this module.

## 9.3     Using the device in unmanned high reliability applications

The module features software and hardware watchdogs which are incorporated inside the CPU. While we believe that this is a reliable method of keeping the module in operational condition, there are parts of the module that cannot be monitored for proper operation to 100%. For example, the module chip has a firmware that resides in the chips RAM. The firmware can't be read back or reloaded, without interrupting reception. Hence the module cannot reload this automatically by itself without causing breaks in communication. To avoid the module from ending up in a state where for example the module chip firmware is corrupted by ionizing radiation, it is recommended that the controlling system implements some form of watchdog function for the module. This can be done for example if the system knows that data should be received every second, and no data has been received for a minute – then perform a module restart using the W-Disable pin or by issuing a restart command, or a cold boot by toggling +3,3Vaux low and high again.

## 9.4    Additional improvements for more reliable radio link

In case where one or more performance value is not met and the environment is challenging, the following mechanism can be used for improving the transmission reliability:

- Forward Error Correction, FEC, is recommended to use in challenging environment like urban areas.
- Directive antennas.
- Before building the radio link(s) it is highly recommended that the radio environment is measured to find out whether the radio environment is clean enough by using e.g. a spectrum analyzer or radio router's RSSI value.
- Co-operation with the local authority to find out the optimum free radio channel.
- If the channel is disturbed an external out-of-band filter can be used for improving the filter capacity.
- If at the adjacent channel is TDMA, Time Domain Multiple Access, transmitter can use for receiving a time slot which is not in synchronization with the TDMA radio transmission.
- In Europe it is not recommended to use channels which are located near by the TETRA or television frequencies.

# 10. APPENDIX A (SL COMMANDS, 410-475 MHz)

| Category | Command | Description | Response |
|---|---|---|---|
| Addressing | SL#A? | Show all addresses (RX1, RX2, TX1, TX2) | "xxxx,yyyy,zzzz,vvvv" |
| Addressing | SL#A=xxxx, yyyy, zzzz,vvvv | Set RX/TX addresses (RX1, RX2, TX1, TX2) | "OK" or "ERROR" |
| Addressing | SL#I? | Get primary addresses (TX1, RX1) | "xxxx;yyyy" |
| Addressing | SL#I=xxxx | Set all addresses (RX1, RX2, TX1, TX2) to value xxxx [0000.....ffff] | "OK" or "ERROR" |
| Addressing | SL#P? | Get primary transmit address (TX1) and primary receive address (RX1) | "xxxx;yyyy" |
| Addressing | SL#P=xxxx;yyyy | Set primary transmit address (TX1) to value xxxx and primary receive address (RX1) to value yyyy [0000.....ffff] | "OK" or "ERROR" |
| Addressing | SL#Q? | Get TX address mode | "0" = TX address OFF "1" = TX address ON |
| Addressing | SL#Q=x | Set TX address ON/OFF. Values of x are: "0" = TX address OFF "1" = TX address ON | "OK" or "ERROR" |
| Addressing | SL#R? | Get primary receive address (RX1) | "yyyy" |
| Addressing | SL#R=xxxx | Set receive addresses (RX1, RX2) to value xxxx [0000.....ffff] | "OK" or "ERROR" |
| Addressing | SL#S? | Get secondary transmit address (TX2) and secondary receive address (RX2) | "xxxx;yyyy" |
| Addressing | SL#S=xxxx;yyyy | Set secondary transmit address (TX2) to value xxxx and secondary receive address (RX2) to value yyyy [0000..... ffff] | "OK" or "ERROR" |
| Addressing | SL#T? | Get primary transmit address (TX1) | "xxxx" |
| Addressing | SL#T=xxxx | Set transmit addresses (TX1, TX2) to value xxxx [0000.ffff] | "OK" or "ERROR" |
| Addressing | SL#W? | Get RX address mode | "0" = RX address OFF "1" = RX address ON |
| Addressing | SL#W=x | Set RX address ON/OFF. Values of x are: "0" = RX address OFF "1" = RX address ON | "OK" or "ERROR" |
| ChannelList | SL$A=1 | Go to channel list default channel | "OK" or "ERROR" |
| ChannelList | SL$C? | Get number of channels in channel list | decimal number |
| ChannelList | SL$C=nn | Set number of channels in channel list. nn = 0...40, 0 clears the whole list | "OK" or "ERROR" |
| ChannelList | SL$D? | Get channel list default channel number | decimal number |

| Category | Command | Description | Response |
|---|---|---|---|
| ChannelList | SL$D=n | Set channel list default channel, n is channel number | "OK" or "ERROR" |
| ChannelList | SL$E=1 | Search free channel. Modem searches for next traffic-free channel. Listening time of traffic is about 2 seconds Modem shows next free channel by activating command again | "OK" followed by "channel n is free". Value of n is channel number of next free channel on channel list |
| ChannelList | SL$F? | Get active channel number | decimal number |
| ChannelList | SL$F=n | Set modem to channel number n in channel list | "OK" or "ERROR" |
| ChannelList | SL$L?nn | Get channel info. Index nn=[0...(number of channels-1)] | Channel number, Frequency, Channel width, Tx Power For example: "CH 1, 869.412500 MHz, 25.0 kHz, 500 mW" |
| ChannelList | SL$L=<info> | Set channel info. Format is SL$L=Iaa,Nbbbbbb,Fcccccccccc,Wdddddd,Peeeee<CR> or alternatively SL$L=Iaa,Nbbbbbb,FTccc.cccccc,FRccc.cccccc,Wdd.ddd,Peeeee<CR> where capital letter marks parameter field and the following decimal number presents its value. aa = Index (0...39) bbbbbb = Channel number (-32767...32767) cccccccccc = Tx/Rx Frequency in MHz (only numbers or "." allowed, "," is not allowed) F field defines a common frequency value for Tx and Rx FT field defines Tx frequency FR field defines Rx frequency dddddd = Channel spacing/width in kHz (12.5, 20 or 25), trailing decimals are tolerated e.g. "25", "25.0", "25.00" and "25.000" are all valid) eeeee = Transmitter power in mW (0...35000) (modem rounds the value to the closest applicable) Note: 0 means "don't care" value for power. <CR> = Carriage return character | "OK" or "ERROR" |
| ChannelList | SL$M? | Get status of channel list. 0 = Not in use, 1 = Channel list in use | "0" or "1" |
| ChannelList | SL$M=n | Set status of channel list. 0 = Not in use, 1 = Channel list in use | "OK" or "ERROR" |
| ChannelList | SL$R? | Get listening time (seconds) of Search free channel function | decimal number |
| ChannelList | SL$R=n | Set listening time (seconds) of Search free channel function | "OK" or "ERROR" |

| Category | Command | Description | Response |
|---|---|---|---|
| ChannelList | SL$S=<selection> | Set channel scanning mode. Selection:<br>S0 = Stop scanning (supported only by TR3/TR4/TR8)<br>S1 = Starts Scanning RSSI values of the channels in the Channel list (supported only by TR3/TR4/TR8)<br>S2 = Start searching transmission (supported only by TR3/TR4/TR8)<br>1 = Scan channels one by one and save RSSI readings to memory (supported only by TR1 based products) | "OK" followed by channel/RSSI info<br>See a separate description for more details |
| DataPort | SL%B? | Get serial data parameters | baud rate, character length, parity, number of stop bits (for example "38400, 8, N, 1") |
| DataPort | SL%B=a,b,c,d | Set serial data port parameters.<br>a= "115200", "57600", "38400", "19200", "9600", "4800", "2400" or "1200" (defines baud rate) b="8" (defines character length) c= "N", "O" or "E" (defines parity)<br>d= "1" (defines number_of_stop bits) | "OK" or "ERROR" |
| DataPort | SL%L? | Get Pause length | decimal number |
| DataPort | SL%L=n | Set Pause length | decimal number |
| Memory | SL**> | Save current settings as permanent settings | "OK" or "ERROR" |
| Memory | SL*R> | Restore settings to their factory set values | "Factory defaults restored!" or "ERROR" |
| ModemInfo | SL!H? | Get hardware info | "HW:nnnnn" |
| ModemInfo | SL!V? | Get product/variant info | Depending on variant, for example "SATELLINE-M3-TR49" |
| ModemInfo | SL%1? | Get arbitrary data stored in memory location 1 | If empty data is stored, response = "Undefined", otherwise data and carriage return |
| ModemInfo | SL%1="data" | Set arbitrary data (max 25 characters) in memory location 1 | "OK" or "ERROR" |
| ModemInfo | SL%2? | Get arbitrary data stored in memory location 2 | If empty data is stored, response = "Undefined", otherwise data and carriage return |
| ModemInfo | SL%2="data" | Set arbitrary data (max 25 characters) in memory location 2 | "OK" or "ERROR" |
| ModemInfo | SL%3? | Get arbitrary data stored in memory location 3 | If empty data is stored, response = "Undefined", otherwise data and carriage return |
| ModemInfo | SL%3="data" | Set arbitrary data (max 25 characters) in memory location 3 | "OK" or "ERROR" |

| Category | Command | Description | Response |
|---|---|---|---|
| ModemInfo | SL%4? | Get arbitrary data stored in memory location 4 | If empty data is stored, response = "Undefined", otherwise data and carriage return |
| ModemInfo | SL%4="data" | Set arbitrary data (max 25 characters) in memory location 4 | "OK" or "ERROR" |
| ModemInfo | SL%C? | Get product number (or other customer info) | Depends on setup |
| ModemInfo | SL%C="text string" | Sets p/n (or other customer info) if it is empty (command works only once). P/n must be stored to eeprom with command SL**> (Save settings). Otherwise it will be lost when power is turned off | "OK" or error message |
| ModemInfo | SL%D? | Get product type | Depends on model, for example "SATELLINE-M3-TR49" |
| ModemInfo | SL%H? | Get logic hardware version | Hardware info |
| ModemInfo | SL%I? | Get Firmware FlashID | Depends on model |
| ModemInfo | SL%R? | Get Regional Info | Region code number, Status of regional settings followed by CR character. Region code number 0=Default (=not set, or rest of the world), 1=US. Status of regional settings 0=Default(=undefined), 1=Valid, 2=Conflict Example: "1,2" means Region code US and the settings are in conflict to FCC |
| ModemInfo | SL%S? | Get Serial Number | Serial number of radio modem |
| ModemInfo | SL%V? | Get firmware revision information | For example "V07.22.2.3.0.2" |
| ModemInfo | SL+C? | Get temperature | Decimal number (degree Celcius, e.g."-31", "-2" or "7") or "No Sensor" or ERROR in case the device does not support temperature sensing. |
| OperationMode | SL+S=x | Activate sleep mode. Value of n: "1" Turn the modem into a state where it will hold parts of the radio on, wakeup will take <5ms "5" Turns ON Power Save mode (TR3/TR4 specific command) "6" Turns OFF Power Save mode (TR3/TR4 specific command) | "OK" or "ERROR" |
| RadioFreq | SL!D? | Get lower limit of frequency band 1 | "nnn.nnnnn MHz" |
| RadioFreq | SL!U? | Get upper limit of frequency band 1 | "nnn.nnnnn MHz" |
| RadioFreq | SL!W? | Get lower limit of frequency band 2 | "nnn.nnnnn MHz" |
| RadioFreq | SL!Y? | Get upper limit of frequency band 2 | "nnn.nnnnn MHz" |

| Category | Command | Description | Response |
|---|---|---|---|
| RadioFreq | SL&+=nnnn | Set active frequency nnnn channels above center frequency.<br>Frequency = Center frequency + nnnn*Channel spacing<br>Value of nnnn is [0...number of channels/2]<br>For conventional reasons, only 2 or 4 digit inputs are valid | "OK" or "ERROR" |
| RadioFreq | SL&-=nnnn | Set active frequency nnnn channels below center frequency.<br>Frequency = Center frequency – nnnn*Channel spacing<br>Value of nnnn is [0…number of channels/2]<br>For conventional reasons, only 2 or 4 digit inputs are valid | "OK" or "ERROR" |
| RadioFreq | SL&C? | Get center/reference frequency | "nnn.nnnnn MHz" |
| RadioFreq | SL&X=nnn.nnnn | Set center/reference frequency | "OK" or "ERROR" |
| RadioFreq | SL&E? | Get Enabled Channel Widths | List of supported Channel widths e.g. "12.5 kHz, 20.0 kHz, 25.0 kHz" |
| RadioFreq | SL&F? | Get active frequency | TX nnn.nnnnn MHz,<br>RX nnn.nnnnn MHz |
| RadioFreq | SL&F=nnn.nnnnn | Set active frequency to nnn.nnnnn MHz | "OK" or "ERROR" |
| RadioFreq | SL&FR? | Get Rx frequency | "nnn.nnnnn MHz" |
| RadioFreq | SL&FR=nnn.nnnnn | Set Rx frequency to nnn.nnnnn MHz | "OK" or "ERROR" |
| RadioFreq | SL&FT? | Get Tx frequency | "nnn.nnnnn MHz" |
| RadioFreq | SL&FT=nnn.nnnnn | Set Tx frequency to nnn.nnnnn MHz | "OK" or "ERROR" |
| RadioFreq | SL&N? | Get active channel calculated from center frequency ( = (active frequency – center frequency)/channel spacing ) | decimal number "+nnnn", "-nnnn", "+nn" or "-nn" |
| RadioFreq | SL&W? | Get channel spacing/channel width | "25.0 kHz" |
| RadioFreq | SL&W=xxxx | Set channel spacing. Value of xxxx is:<br>"2500" for 25 kHz<br>Command is supported only by hardware variants with adjustable channel spacing. | "OK" or "ERROR" |
| **Category** | **Command** | **Description** | **Response** |
| RadioProperty | SL%F? | Get status of Error correction (FEC) | "0" = FEC OFF , "1" = FEC ON |
| RadioProperty | SL%F=x | Set Error correction (FEC). Value of x is:<br>"1" Set FEC ON "0" Set FEC OFF | "OK" or "ERROR" |
| RadioProperty | SL%E? | Get status of Error check and Full CRC16 check modes | "0" Error check off "1" CRC8 Partial<br>"2" CRC8 Full<br>"3" CRC16 Full |

| RadioProperty | SL%E=x | Set Error check and Full CRC16 check modes. Value of x is:<br>"0" Error check off "1" CRC8 Partial<br>"2" CRC8 Full<br>"3" CRC16 Full | "OK" or "ERROR" |
|---|---|---|---|
| RadioProperty | SL%R? | Get region code setting/status | 0,0 = Default, 1,1 = US, 1,2 = US & Illegal radio setting combination (TX is disabled) |
| RadioProperty | SL@D? | Get Tx delay (ms) | For example "0 ms" or "50 ms" |
| RadioProperty | SL@D=n | Set Tx delay (ms), n is [0…65535] | "OK" or "ERROR" |
| RadioProperty | SL@E? | Get supported radio compatibility modes. | List of numbers, separated by commas, showing the supported modes. Value of x is:<br>0 = SATELLINE-3AS (Default. Original SATEL 4FSK, FEC ON or OFF)<br>1 = PacCrest-4FSK (FEC ON/ Scrambling ON)<br>2 = PacCrest-GMSK (FEC ON/ Scrambling ON)<br>3 = TrimTalk450s(P), GMSK. Rx fitted to PacCrest transmitters<br>4 = Trimtalk450s(T), GMSK. Rx fitted to Trimble transmitters<br>5 = PacCrest-FST (FEC ON)<br>6 = 2ASxE (ask availability)<br>8 = SOUTH<br>16 = Pacific Crest FEC ON 4800bps 25kHz<br>17 = Pacific Crest FEC OFF 4800bps 25kHz<br>18 = Pacific Crest FEC OFF Scrambler OFF 4800bps 25kHz<br>19 = Pacific Crest FEC ON Scrambler ON 4800bps 25kHz<br>20 = SATEL-8FSK-1 (FEC OFF)<br>21 = SATEL-8FSK-2 (FEC ON)<br>22 = SATEL-16FSK-1 (FEC ON)<br>23 = PacCrest-4FSK (FEC OFF/Scrambling ON)<br>24 = PacCrest-GMSK (FEC OFF/Scrambling ON)<br>25 = PacCrest-FST (FEC OFF)<br>26 = PacCrest-4FSK (FEC OFF/Scrambling OFF)<br>27 = PacCrest-GMSK (FEC OFF/Scrambling OFF)<br>28 = PacCrest-4FSK (FEC ON/Scrambling OFF)<br>29 = PacCrest-GMSK (FEC ON/Scrambling OFF)<br>30 = Trimtalk v1, GMSK. 8/16kbps |

| | | | 31 = Trimtalk 4800bps 25kHz |
| --- | --- | --- | --- |
| | | | 34 = RTCM SC135 1 |
| | | | 25 kHz FEC ON |
| | | | 35 = RTCM SC135 2 |
| | | | 12.5 kHz FEC ON |
| | | | 36 = RTCM SC135 3 |
| | | | 25 kHz FEC OFF |
| | | | 37 = RTCM SC135 4 |
| | | | 12.5 kHz FEC OFF |
| RadioProperty | SL@F? | Get noise level of radio channel | ”-xxx dBm" |
| RadioProperty | SL@M? | Get repeater function | "O" = Repeater OFF(character O) "R" = Repeater ON |
| RadioProperty | SL@M=x | Set repeater function. Values of x are: "O" = Repeater function OFF (character O) "R" = Repeater function ON | "OK" or "ERROR" |
| RadioProperty | SL@P? | Get transmitter output power | One of these values "10mW, "20mW", "50mW", "100mW", "200mW", "500mW" |
| RadioProperty | SL@P=nnnnn | Set RF output power (mW) Valid values for nnnnn: "10" for 10 mW TX power. "20" for 20 mW TX power. "50" for 50 mW TX power. "100" for 100 mW TX power. "200" for 200 mW TX power. "500" for 500 mW TX power. "1000" for 1000 mW TX power. | "OK" or "ERROR" |

| Category | Command | Description | Response |
| --- | --- | --- | --- |
| RadioProperty | SL@R? | Get RSSI (Received Signal Strength Indication) of last received message (dBm) | ”-nnn dBm", nnn is a decimal value of field strength between –80 dBm and –118 dBm. Value is available 7 s after reception, after that the response is "<-118 dBm". |
| RadioProperty | SL@S? | Get radio compatibility mode | Value of x, see command "SL@S=x" |
| RadioProperty | SL@S=x | Set radio compatibility mode. Value of x is: 0 = SATELLINE-3AS (Default. Original SATEL 4FSK, FEC ON or OFF) 1 = PacCrest-4FSK (FEC ON/ Scrambling ON) 2 = PacCrest-GMSK (FEC ON/ Scrambling ON) 3 = TrimTalk450s(P), GMSK. Rx fitted to PacCrest transmitters 4 = Trimtalk450s(T), GMSK. Rx fitted to Trimble transmitters 5 = PacCrest-FST (FEC ON) | "OK" or "ERROR" |

| | | 6 = 2ASxE (ask availability)<br>8 = SOUTH<br>16 = Pacific Crest FEC ON 4800bps 25kHz<br>17 = Pacific Crest FEC OFF 4800bps 25kHz<br>18 = Pacific Crest FEC OFF Scrambler OFF 4800bps 25kHz<br>19 = Pacific Crest FEC ON Scrambler ON 4800bps 25kHz<br>20 = SATEL-8FSK-1 (FEC OFF)<br>21 = SATEL-8FSK-2 (FEC ON)<br>22 = SATEL-16FSK-1 (FEC ON)<br>23 = PacCrest-4FSK (FEC OFF/Scrambling ON)<br>24 = PacCrest-GMSK (FEC OFF/Scrambling ON)<br>25 = PacCrest-FST (FEC OFF)<br>26 = PacCrest-4FSK (FEC OFF/Scrambling OFF)<br>27 = PacCrest-GMSK (FEC OFF/Scrambling OFF)<br>28 = PacCrest-4FSK (FEC ON/Scrambling OFF)<br>29 = PacCrest-GMSK (FEC ON/Scrambling OFF)<br>30 = Trimtalk v1, GMSK. 8/16kbps<br>31 = Trimtalk 4800bps 25kHz<br>34 = RTCM SC135 1 25 kHz FEC ON<br>35 = RTCM SC135 2 12.5 kHz FEC ON<br>36 = RTCM SC135 3 25 kHz FEC OFF<br>37 = RTCM SC135 4 12.5 kHz FEC OFF | |
| Reset | SL@X=n | Reset command. Values of n are:<br>"9" Reset modem | "OK" or "ERROR", then modem resets required blocks. |
| Frequency band | SL&M=x | Change frequency band. Choices are:<br>1=410-475 MHz<br>2=800 MHz (not yet supported)<br>3=902-928 MHz | "OK" or "ERROR"<br><br>Note – Frequency band change requires a save and reset commands to take place |
| Frequency band | SL&M? | Get current frequency band | "1" = 410-475 MHz<br>"2" = 800 MHz<br>"3" = 902-928 MHz |

## 11. APPENDIX B (SL COMMANDS, 902-928 MHz)

| SATEL-TR49 SnapOn Freewave protocol 902-928 MHz | | | | General format of the Freewave related SL commands is:<br><br>Set Emulation mode settings:<br>SL~E=M1,I<index>,A<Attribute1>,B<Attribute2>,C<Attribute3>,…<br>prefix M indicates the emulation mode (M1 means Freewave, M2 means something else…)<br>prefix I is the index indicating the specific setting under the emulation mode<br>prefixes A, B, C, … indicate the corresponding attributes<br><br>Get Emulation setting: SL~E?M1,I<index><br>Format of response is<br>M1,I<index>,A<Attribute1>,B<Attribute2>,C<Attribute3>,…<br><br>Get Emulation settings summary: SL~E?<br>Response is reserved for the summary of the emulation settings (to be defined later) |
|---|---|---|---|---|
| Setting name | Type | Values (Range) | Value descriptions | SL Command |
| Modem Mode | Uint8 | 0 -7 , A-B | 0: Point to Point Master<br>1: Point to Point Slave<br>2: Point to MultiPoint Master 3: Point to MultiPoint Slave<br>4: Point to Point Slave/Repeater<br>5: Point to Point Repeater<br>6: Point to Point Slave/Master Switchable<br>7: Point to Multipoint Repeater<br>A: Mirrored Bit Master<br>B: Mirrored Bit Slave | SL~E=M1,I1,A<Mode><br><Mode> = [0-7,A-B] as presented on the left |
| Call Book Entry To Call | Uint8 | 0 - A | 0 - 9: Call Book Entry Index<br>A: All | SL~E=M1,I2,A<index><br><index> = [0-9,A] as presented on the left |

| Call Book | Uint8, Uint8[3], Uint8[3], Uint8[3] | 0 - 9, 0x000000 - 0xFFFFFF, 0x000000 - 0xFFFFFF, 0x000000 - 0xFFFFFF | 0 - 9: Call Book Entry Index 0x000000 - 0xFFFFFF: Address 0x000000 - 0xFFFFFF: Repeater1 Address 0x000000 - 0xFFFFFF: Repeater2 Address | SL~E=M1,I3,A<index>,B<Address>,C<Address>,D<Address> A indicates Call Book Entry Index field <index> = [0-9] as presented on the left B indicates Address field C indicates Repeater1 Address field D indicates Repeater2 Address field <Address> = [000000-FFFFFF] |
|---|---|---|---|---|
| Frequency Key | Uint8 | 0 - E | 0 - E: Key for frequency hop table | SL~E=M1,I4,A<Frequency Key> <Frequency Key> = [0-9,A-E] |
| Frequency Zone | Uint16 | 0x0000 - 0xFFFF | Used to enable/disable frequency bands Bit 0: 902.2464 - 903.8592 MHz Bit 1: 904.0896 - 905.4720 MHz Bit 2: 905.7024 - 907.0848 MHz Bit 3: 907.3152 - 908.6976 MHz Bit 4: 908.9280 - 910.3104 MHz Bit 5: 910.5408 - 911.9232 MHz Bit 6: 912.1536 - 913.5360 MHz Bit 7: 913.7664 - 915.1488 MHz Bit 8: 915.3792 - 916.7616 MHz Bit 9: 916.9920 - 918.6048 MHz Bit 10: 918.8352 - 920.2176 MHz Bit 11: 920.4480 - 921.8304 MHz Bit 12: 922.0608 - 923.4432 MHz Bit 13: 923.6736 - 925.0560 MHz Bit 14: 925.2864 - 926.6688 MHz Bit 15: 926.8992 - 927.8208 MHz | SL~E=M1,I5,A<Frequency Zone> <Frequency Zone> = [0000...FFFF], each bit enables (1) or disables (0) the corresponding frequency band as defined on the left |

| Hop Table Version | Uint8 | 0 - 6 | 0: 902 - 928 MHz<br>1: 915 - 928 MHz<br>2: 902 - 928 MHz, 16 fewer freqs<br>3: 916 - 920 MHz<br>4: 921 - 928 MHz<br>5: 902 - 911 & 919 - 928 MHz<br>6: 902 - 915 MHz | SL~E=M1,I6,A<Hop Table Version><br><Hop Table Version> = [0-6] as presented on the left |
|---|---|---|---|---|
| Hop Table Size | Uint8 | 50 - 112 | 50 - 112: Number of different frequencies in hop table | SL~E=M1,I7,A<Number of different frequencies in hop table><br><Number of different frequencies in hop table> = [50-112] |
| Max Packet Size | Uint8 | 0 - 9 | 0 - 9: Defines maximum packet size in transmit | SL~E=M1,I8,A<Max Packet Size><br><Max Packet Size> = [0-9] |
| Min Packet Size | Uint8 | 0 - 9 | 0 - 9: Defines minimum packet size in transmit | SL~E=M1,I9,A<Max Packet Size><br><Max Packet Size> = [0-9] |
| Transmit Rate | Boolean | 0 - 1 | 0: Diagnostics<br>1: Normal | SL~E=M1,I10,A<Transmit Rate><br><Transmit Rate> = 0 (=Diagnostics) or 1 (=Normal) |
| RF Data Rate | Uint8 | 2 - 3 | 2: High<br>3: Normal | SL~E=M1,I11,A<RF Data Rate><br><RF Data Rate> = 2 (=High) or 3(=Normal) |
| Transmit Power | Uint8 | 10-1000 | 10 mW<br>20 mW<br>50 mW<br>100 mW<br>200 mW<br>500 mW<br>1000 mW | GET:<br>SL@P?<br>SET:<br>SL@P= |
| Slave Security | Boolean | 0 - 1 | 0: On<br>1: Off | SL~E=M1,I12,A<Slave Security><br><RF Data Rate> = 2 (=High) or 3(=Normal) |
| RTS To CTS | Uint8 | 0 - 2 | 0: Disabled<br>1: Enabled<br>2: ??? | SL~E=M1,I13,A<RTS To CTS><br><RTS To CTS> = 0 (=Disabled), 1 (=Enabled) or 2 (don't care?) |
| Retry Timeout | Uint8 | 8 - 255 | 8 - 255: Counter value when connection is dropped off if data is not received. | SL~E=M1,I14,A<Retry Timeout><br><Retry Timeout> = [8-255] |
| Repeaters | Boolean | | 0: Disabled<br>1: Enabled | SL~E=M1,I15,A<Repeaters><br><Repeaters> = 0 (=Disabled), 1 (=Enabled) or 2 (don't care?) |
| Master Packet Repeat | Uint8 | 0 - 9 | 0 - 9: Defines how many times master will send packets | SL~E=M1,I16,A<Master Packet Repeat><br><Master Packet Repeat> = [0-9] |
| Max Slave Retry | Uint8 | 0 - 9 | 0 - 9: Defines how many times slave try to transmit data if ack is not received | SL~E=M1,I17,A<Max Slave Retry><br><Max Slave Retry> = [0-9] |

| | | | | |
|---|---|---|---|---|
| Retry Odds | Uint8 | 0 - 9 | 0 - 9: Defines a random base when slave is trying to resend data to master if Max Slave Retry count is reached. Value 0 means that the slave's data buffer is purged after Max Slave Retry count is reached | SL~E=M1,I18,A<Retry Odds><br><Retry Odds> = [0-9] |
| Repeater Frequency | Boolean | 0 - 1 | 0: Disabled<br>1: Enabled | SL~E=M1,I19,A<Repeater Frequency><br><Repeater Frequency> = 0 (=Disabled) or 1 (=Enabled) |
| Network ID | Uint16 | 0 - 4095 | 0 - 4095: Network ID for multipoint networks.<br>Network ID 255 = Call Book Mode | SL~E=M1,I20,A<Network ID><br><Network ID> = [0-4095]<br>Note: Network ID 255 = Call Book Mode |
| Slave/Repeater | Boolean | | 0: Disabled<br>1: Enabled | SL~E=M1,I21,A<Slave/Repeater><br><Slave/Repeater> = 0 (=Disabled) or 1 (=Enabled) |
| TX Subnet | Uint8 | 0 - 9, A - F | 0: Roaming<br>1 - E: Subnet ID F: Disabled | SL~E=M1,I22,A<TX Subnet><br><TX Subnet> = [0-9, A-F] as presented on the left |
| RX Subnet | Uint8 | 0 - 9, A - F | 0: Roaming<br>1 - E: Subnet ID F: Disabled | SL~E=M1,I23,A<RX Subnet><br><RX Subnet> = [0-9, A-F] as presented on the left |
| Serial port settings | | | | GET: SL%B?<br>SET: SL%B= |

## 12. **APPENDIX C (IP traffic)**

If attached to a Linux, the module can be used to send IP traffic. Standard software called slattach, that is shipped with for example Ubuntu and other Linux distributions, can be used to create a Serial Line over IP (SLIP) interface.

To create the interface, use for example the following command:
```
slattach -p slip -s 115200 /dev/ttyUSB0 &
```

Assuming /dev/ttyUSB0 is the serial port representing the module. An IP interface called sl0 should then appear. After this, an IP address can be added with for example the following command:
```
ip a a 192.168.10.1/24
dev sl0 ip link set sl0
up
```

Now, if IP traffic is sent to an address in the subnet 192.168.10.0/24, it will be sent by the module. If another module is also configured as a SLIP interface, the IP packets will be received from that interface. If multiple modules are listening, they all will receive the same packets.

# 13. VERSION HISTORY

| Version: | Date: | Remarks: |
|---|---|---|
| 1.0 | 8.6.2018 | First version |
| 1.1 | 15.6.2018 | SATEL-TR49 SnapOn specification added |
| 1.2 | 13.8.2018 | SATEL-TR49 SnapOn Mechanical description added |
| 1.3 | 15.10.2018 | SATEL-TR49 SnapOn Specification updated |
| 1.4 | 18.10.2018 | SATEL-TR49 SnapOn technical specification updated |
| 1.5 | 16.11.2018 | SATEL-TR49 SnapOn R&D comments removed |
| 1.6 | 17.04.2019 | SATEL-TR49 SnapOn technical specification updated |
| 1.7 | 16.08.2019 | Added chapter 9.4, corrected operating voltage |
| 1.8 | 19.10.2021 | Added chapter 3.2 GPIO control (LED_WWAN, LED_WLAN and LED_WPAN IO pins), Updated Restrictions on use -chapters. |
| 1.9 | 13.03.2023 | Added information to chapter 6:<br>The parameters changed to a device on frequency hopping 900 MHz band are taken into use after either radio reboot command, electrically restarting the device or exiting from the command mode (see SL Command Mode). |
| 2.0 | 24.05.2023 | Updated Appendix A – SL command list:<br>- SL+C?<br>- SL&M? and SL&M=x<br><br>Added Command mode to Chapter 5. Operation modes<br><br>Updated description in chapter 6.2 – SL Command mode<br><br>Updated chapters 7. (400MHz) and 8. (900MHz) Default delivery values |
| 2.1 | 8.7.2024 | "RTCM SC135" radio protocol additions. Multiple additions and fixes |