

# SL200 USER MANUAL

Hardware V3.5 and higher



Long-range Radio Link Modem  
for Mobile Data and Live HD Video

February 2023 -V16-

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## Releases notes

V16	February 2023	Add precautions about antennas & cables VSWR
V15	January 2022	Add rules for using antennas
V14	December 2021	Update troubleshooting
V13	November 2021	Add temperature extended version, update Troubleshooting
V12	February 2021	Split in 2 manuals: hardware (this one) and software
V11	January 2021	Corrections in UART Interface configuration chapter 10.3
V10	December 2020	General update

**NOTE:** to complement this SL200 user manual, a software dedicated user manual is also available (SOFTWARE user manual)

## 1 SL200 Overview

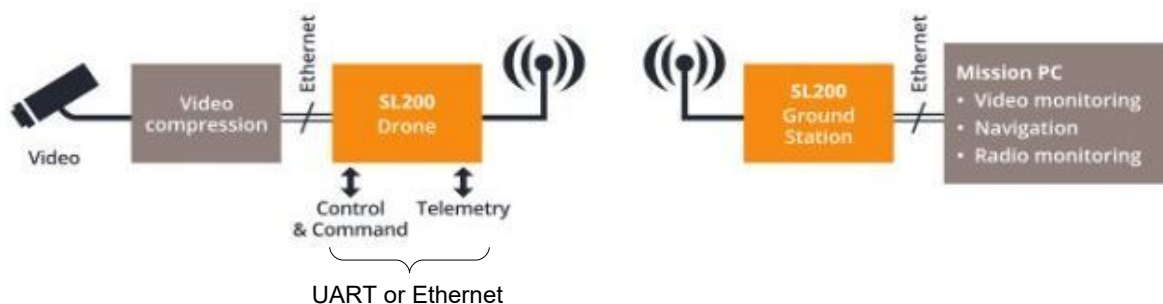
### 1.1 Main Features

The SL200 mobile data link modem is dedicated to mobile bi-directional data and video transmission for very long distance and challenging environments.

- **Very Long Transmission Range**  
Up to 80 km (HD video) or 130 km (Low res. video) in LOS with 500mW RF power at 2480 MHz, using a GRS-T200 tracking antenna.
- **Unrivalled sensitivity**  
Extending the distance range or enabling reduced transmit power
- **Excellent robustness**  
Even in Non-Line of Sight (NLOS) and mobile environments
- **Flexibility of adaptation**  
to customers' specificities and requests thanks to SDR (Software Define Radio)
- **High security**  
using proprietary waveforms in addition to AES 128/256 encryption
- **Powerful Analysis tool**  
to configure and analyze the transmission
- **Easy to integrate**  
with standard interfaces and protocols
- **Multiple logical links**  
with QoS management
- **Point-to-Multiple options**  
to connect multiple nodes (UAV/UGV or fixed stations)
- **Many frequency bands available**  
Adaptation to all Licensed/Unlicensed frequencies from 70MHz to 6GHz can be developed on demand.
- **Compact, lightweight**  
150 gr, 61 x 34 x 74 mm, OEM solution on demand

### 1.2 System integration example

The block diagram below illustrates how SL200 can be integrated in a system made of a drone and its ground station, to provide Video, Telemetry and bi-directional Control-Command through a unique radio link.



## 1.3 Radio Performance & features

Downlink (video, data, telemetry, control)	Configurable up to 4.5 Mbits/s in TDD 90-10 mode. Latency < 40ms
Uplink (control)	Configurable up to 40 kbits/s in TDD 90-10 mode, latency < 40 ms Higher data rate possible with different TDD modes
Robustness in Non-LOS and mobile channels	COFDM and Spread-Spectrum waveforms Supports high speed with multipaths
QoS in logical channels	Quality of Service management of up to 8 logical channels upstream and 8 logical channels downstream
Data Protocol	IP (Ethernet 10/100BaseT), UART/Serial bus, Mavlink
Security	Optional AES 128/256 Encryption, subject to export license Proprietary waveform to prevent radio interception
Radio Frequency	Standard version: 2390 MHz to 2490 MHz Available frequencies: see below 'Available frequency bands' Other frequency bands from 70 MHz to 6 GHz: on demand
Multi Antennas	MIMO with up to 4 antennas
Network	Features like Point-to-Multipoint or relay can be added by software upgrade. Contact us

### 1.3.1 Available frequency bands

2390 – 2490 MHz (Standard)	700 – 800 MHz	791 – 821 MHz
800 – 900 MHz	900 – 990 MHz	1805 – 1880 MHz
1900 – 2000 MHz	2000 – 2300 MHz	2300 – 2400 MHz
2490 – 2690 MHz	3400 – 3800 MHz	5150 – 5925 MHz

Other frequencies upon request

## 1.4 Bit-rate, sensitivity performances

The tables below list the **SNR** and **sensitivity** for different bitrates for 5.8 MHz occupied bandwidth. The **transmission mode** 'P\_ctrl\_rate\_m2s' and 'P\_ctrl\_rate\_s2m' are parameters that can be changed by software (see SDK Manual), in the configuration file or Advanced monitoring screen (see SOFTWARE user manual) .

Sensitivity mentioned in the tables below are typical values

Master to slave					
P_ctrl_rate_m2s	debit kbit/s	SNR single	SNR Mimo	Sensi single (dBm)	Sensi Mimo (dBm)
18	4301,4	2,7	-0,3	-100	-103
17	3166,6	1	-2	-102	-105
16	1383,4	-2,5	-5,5	-105,2	-108,2
23	691,7	-5,5	-8,5	-108	-111
22	345,8	-8,5	-11,5	-111	-114
21	172,9	-11	-14	-113,5	-116,5

Slave to Master					
P_ctrl_rate_s2m	debit kbit/s	SNR single	SNR Mimo	Sensi single (dBm)	Sensi Mimo (dBm)
23	39,2	-5,5	-8,5	-108	-111
22	19,6	-8,5	-11,5	-111	-114
21	9,8	-11	-14	-113,5	-116,5

## 2 SL200 Hardware

### 2.1 Max ratings

temperature	Max rating	Operating Range
Temperature	-50 to 100°C	0°C to +65°C (standard) -20°C to +65°C (extended)

Power supply	Max rating	Operating Range
Supply voltage	0 to 14V	5 to 14V
Input Voltage (between pins V+ and GND)	0 - 14 V	5V to 14 VDC
Power consumption		Max 11 W with Tx power 27 dBm and 12V power supply

Interfaces	Max rating	Operating Range
RF input level	-10 dBm	-10 dBm
UART input	0 to 6,5V	0 to 5V
UART output *		0 to 1,8V

\* interface boards are available (eg isolation board, RS422/RS232 board)

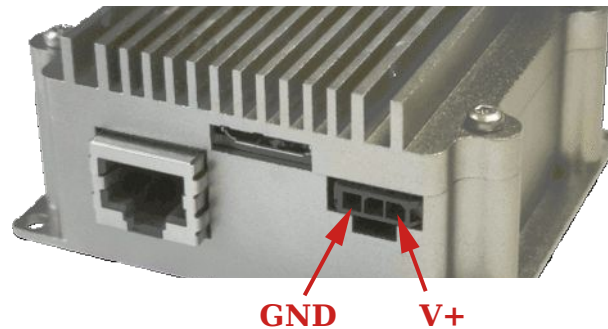
### 2.2 Interfaces

#### 2.2.1 General view

Interface Name	Connectors	Function
RF	4 female SMAs	Connection to antennas
Ethernet	RJ45 standard female connector	Input and Output for Video and all IP data
Power Supply	3 pins connector (Micro-Fit 3.0) See chapter 2.2.2 for details	Power supply See chapter 2.2.2
Extension Port	20 pins shrouded IDC header See chapter 2.2.3	Two serial bus are available to make two UART connections. See chapter 2.2.3
Software Upgrade connector	Micro USB3/ USB2 (left part)	Used to flash the modem configuration or for software upgrade

### 2.2.2 Power supply connector

Input voltage is provided on the two external pins of the Power Supply connector as described in the picture below:



The SL200 power supply connector has the following reference :  
MOLEX 43650-0303, Micro-Fit3.0, single row.

The external connectors that plug in the SL200 connector can be made of :

- MOLEX-43645-0300 - "Boîtier de connecteur, Simple rangée, Série Micro-Fit 3.0, Embase, 3 Voies, 3 mm"
- MOLEX 46235-0001 - "Contact de puissance rectangulaire, RMF™, Série Micro-Fit 3.0, Contacts plaqués or, Cuivre, Femelle"

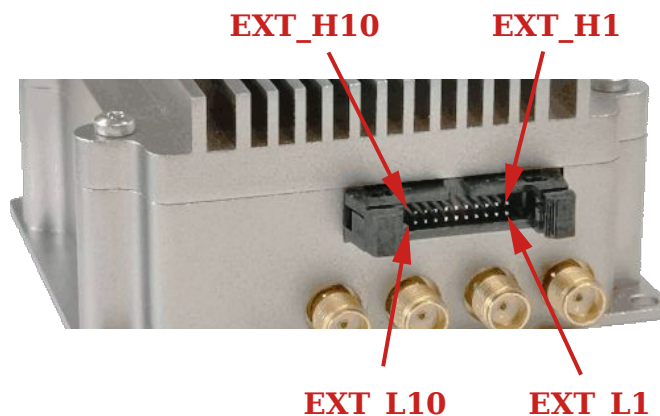
One adapter 220V-AC to 12V-DC with a direct connection to the SL200 power connector is provided with SL200.

### 2.2.3 Extension Port

The extension port is above Antenna connectors. It gives access to other data ports.

In the standard SL200 packaging, 20 pins (EXT\_Hi and EXT\_Li) are provided on a standard "Shrouded Terminal Strip" connector with reference EHF-110-01-L-D-RA from SAMTEC .

The pinout of the connector is detailed on the picture below:



## UART ports

In the standard SL200 version, two serial bus (UART/RS232) are provided by the extension port.

The position of the serial bus pins are described in table below.

Signal name	Direction (SL200 point of view)	Pin reference name
UART-RX0	Input	EXT_L3
UART-TX0	Output	EXT_H3
UART-GND0	Ground	EXT_L10
UART-RX1	Input	EXT_H7
UART-TX1	Output	EXT_L7
UART-GND1	Ground	EXT_L10

## UART port Electrical characteristics

Name	Direction	Value
<b>UART-RXi</b> max rating Low level voltage ViL High level voltage ViH	Input	0 - 6,5 V $0\text{ V} < V_{iL} < 0,63\text{ V}$ $1,17\text{ V} < V_{iH} < 5,5\text{ V}$
<b>UART-TXi</b>	Output	0 V for low level 1,8 V for high level
<b>UART-GNDi</b>	Input	Same as GND of power supply

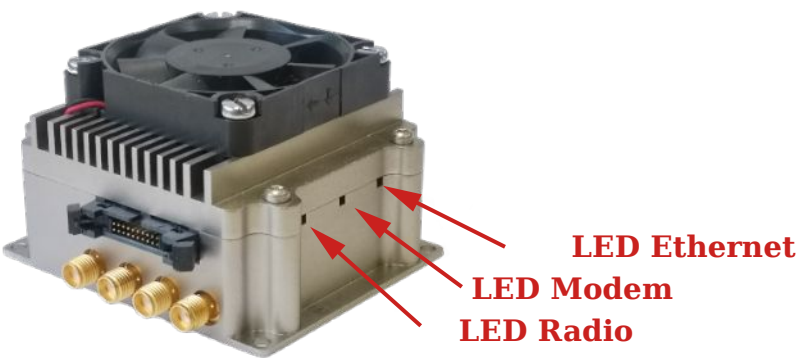
## Extension port cable

The SL200 can be provided with a “Flat ribbon cable” with a 20 pins connectors compatible with the extension port.





2.3 LEDS description

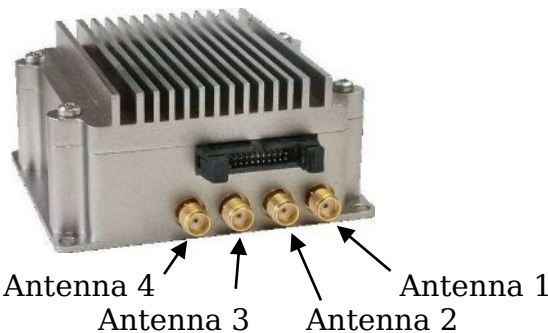


There are three LEDS on the SL200 standard box to check the modem status. When the modem boots, the LEDs first light in orange and red, then at the end, blink in green. After 30 second, the boot is complete and the LEDs will show the following states :

LED Radio	Radio status (Left side LED)	Color
	Searching synchronization	Off
	Synchronization established, bad reception	Orange
	Rx data received with good quality	Green
LED Modem	Modem status (Middle LED)	Color
	Slave	Blinking Green
	Master	Blinking Orange
	Configuration issue	Red
LED Ethernet	Ethernet status (Right side LED)	Color & Blinking
	No Ethernet	Red
	RJ45 connected	Orange
	Modem receives Ethernet data	Blinking Green
	Modem sends Ethernet data	Blinking Orange
	Ethernet packets in both direction	Blinking Green/Orange

2.4 Antenna inputs/outputs

2.4.1 Description

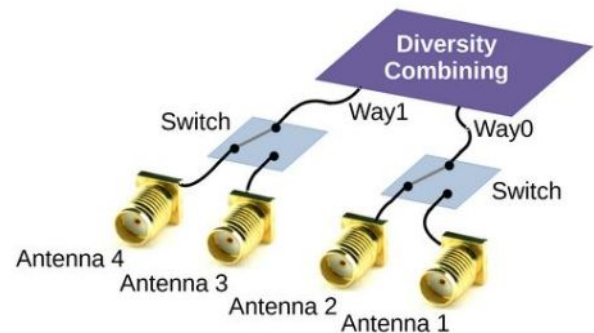


## 2.4.2 Rules for using antennas

### 2.4.2.1 For reception

The reception process is using diversity combining called Maximal Ratio Combining (MRC) on 2 signal inputs Way0 and Way1. To achieve the best performance with MRC, the 2 corresponding antennas must be enough distant to receive different and uncorrelated signals.

Note also that the SL200 RF output stage is including 2 switches to provide 4 antenna inputs.



**If you use only 2 antennas**, ensure you are using antennas leading through the switches to the 2 diversity combining inputs Way0 and Way1.

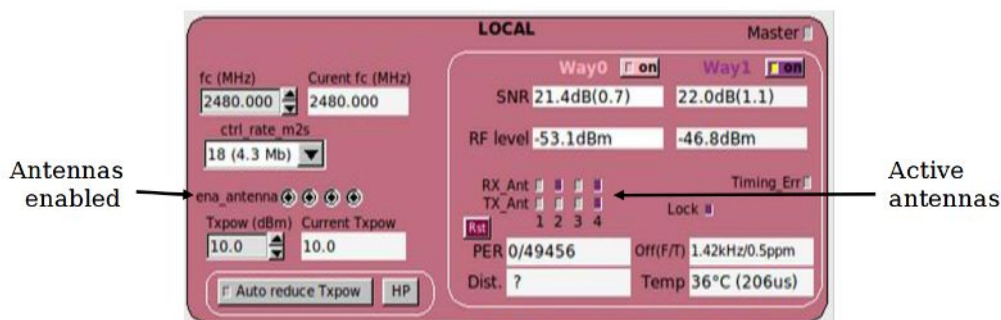
=> use antennas 1 and 3, or 1 and 4, or 2 and 3, or 2 and 4

Note: you can prevent the system to switch accidentally on unused antennas by selecting the used antennas on the configuration software.

**If you use 4 antennas**, ensure you always have at the same time 2 antennas leading to the 2 diversity inputs Way0 and Way1 receiving signal from the transmitter.

That also means ensure you cannot have antennas 1 and 2, or antenna 3 and 4 masked at the same time from the transmitter, in that case Way0 or Way1 would not get signal.

The same antenna numbering is used in the software GUI to monitor activity in transmission (Tx) and reception (Rx), or to enable/disable the antennas (see Software user manual)



### 2.4.2.2 For transmission

The transmission is using only one antenna which is automatically selected by taking into account the antenna which received the best signal during the precedent reception time slot. So, no specific rule to apply for this case.

#### **!!WARNING!!**

**Ensure each 4 RF connectors are always connected to an antenna or to a 50 ohms termination.**

**Do not connect two SL200 modems antenna-to-antenna with a coaxial cable. It could destroy the RF components due to a too high RF power coming from one modem to the other.**

## 2.5 Mechanical characteristics of SL200 with housing

All dimensions can be found on the STEP files provided on demand.  
The main dimensions of SL200 with fan are summarized on the picture below.

The SL200 housing size and weight are given in the table below.



Name	Value
Dimensions of housing with fan	73 x 60 x 45 mm
Dimensions of housing without fan	73 x 60 x 34 mm
Weight with fan	151 g

### Mounting

SL200 housing can be mounted using the 4 holes on its basis (STEP files provided on demand).

## 2.6 Operating conditions

- Temperature : 0-65°C ambient temperature (extended version: -20°C to +65°C)
- Maximum acceleration : 12G
- External protection against humidity is needed

### WARNING :

**If the modem internal temperature exceed 84° Celsius, the modem will reboot in order to preserve itself from damage or malfunction.**

## 3 Getting started with SL200

We propose in this section basic test procedures to test the bi-directional IP link between two SL200.

### 3.1 Test setup

#### **SIMPULSE equipments :**

The required equipments for this test are:

- 1 SL200 configured in Master mode also called "SL200-Master". "Master" means that it provides the time basis reference for the other modem. In typical camera video application, the Master is on the camera side.
- 1 SL200 configured in Slave mode also called "SL200-Slave" (it can be integrated in a GRS-x200 radio station).
- 2 electrical adapters (220 - 12V) with a cable for direct connection to SL200 "Power Supply Connector"

#### **Modems configuration :**

We assume SL200s have been pre-configured by Sempulse with the following parameters:

- One SL200 in Master mode, the other one in Slave mode.
- Modem IP address is **192.168.0.201 for Master** and **192.168.0.200 for Slave**.
- Data mode : Ethernet Bridge Mode. (See Software User Manual).
- Frequency : 2480 MHz.
- Tx power : 10 dBm.

#### **Other equipments :**

The following other equipments are needed:

- 1 PC (ie Laptop Windows) to be connected on SL200-Slave through Ethernet.
- 2 Antennas (on each SL200) connected on connectors 1 and 4. Connectors 2 & 3 of each modem must be equipped with 50 Ohms terminations

Examples of references for omni-directional antennas are listed here:




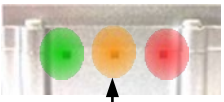
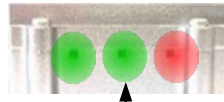
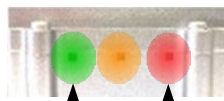
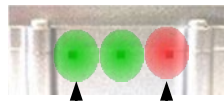

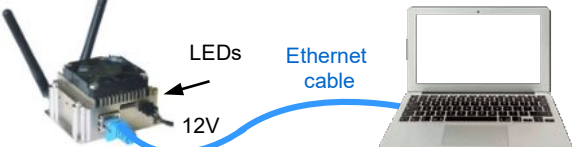


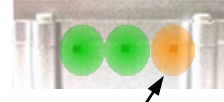
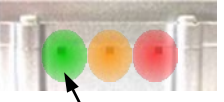
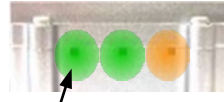
- RFSolution +3dBi whip antenna (ref: ANT-2WHIP3-SMA)
- Siretta 5dBi Delta6B (ref: Delta 6b)
- GTTWireless 2.4 dBi (ref: OA-DB-04-0206-C5R)
- Linx dipole antenna 3 dBi (ref: ANT-2.4-CW-HW-T)
- Chelton omni antenna 2 dBi (ref: SVD2-2.3V/1588)

#### **!!WARNING!!**

**The default modem configuration limits RF power to 10 dbm.**

**Before increase RF power up to 27 dbm, ensure antenna adaptations are correct: VSWR of antennas & cables at modem RF connectors must be less than 3, meaning reflected power (S11) must be less than 25 % or -6 dB.**

### 3.2 Step by Step procedures :

Step	Description	MASTER	SLAVE	PC
<b>Basic test in standalone mode</b>				
1	Setup	 <p><b>SL200 Master (UAV)</b></p> <ul style="list-style-type: none"> <li>- SL200 powered on 12V</li> <li>- Antennas on connectors 1 &amp; 4</li> <li>- 50 Ohm terminations on 2 &amp; 3</li> </ul>	 <p><b>SL200 Slave (Ground station)</b></p> <ul style="list-style-type: none"> <li>- SL200 powered on 12V</li> <li>- Antennas on connectors 1 &amp; 4</li> <li>- 50 Ohm terminations on 2 &amp; 3</li> </ul>	 <p><b>Laptop (Windows)</b> not connected</p>
2	Checking LED's : Identify <b>MASTER</b> and <b>SLAVE</b> by checking the <b>LED Modem</b> (middle). This LED should <b>blink</b>	 <p>YELLOW= MASTER If the middle LED is RED, see next chapter 'troubleshooting'</p>	 <p>GREEN= SLAVE</p>	
3	Checking LED's : Check <b>RF link &amp; Ethernet</b> input with <b>left and right</b> LEDs  If <b>left</b> LED's (LED Radio) are not green, see 'Troubleshooting'	 <p>RED= No Ethernet GREEN= RF link between the 2 modems is operational If the left LED are not green, see next chapter 'troubleshooting'</p>	 <p>RED= No Ethernet</p>	
<b>Basic test with a Laptop</b>				
4	Setup	 <p><b>SL200 Master (UAV)</b></p> <ul style="list-style-type: none"> <li>- SL200 powered on 12V</li> <li>- Antennas on connectors 1 &amp; 4</li> <li>- 50 Ohm terminations on 2 &amp; 3</li> </ul>	 <p><b>SL200 Slave (Ground station)</b></p> <ul style="list-style-type: none"> <li>- SL200 powered on 12V</li> <li>- Antennas on connectors 1 &amp; 4</li> <li>- 50 Ohm terminations on 2 &amp; 3</li> </ul>	 <p><b>Laptop (Windows)</b></p> <ul style="list-style-type: none"> <li>- Connected by Ethernet to the SLAVE modem</li> <li>- ensure <b>its IP address is in the same subnet as SL200</b></li> </ul>
5	Ping the <b>SLAVE</b> modem to check its <b>IP address</b>  If the ping fail, see next chapter 'Troubleshooting'		 <p>The Ethernet LED is turning <b>YELLOW</b> when the Ethernet cable is connected</p>	<ul style="list-style-type: none"> <li>- Open a command window (type <b>cmd</b> in search bar)</li> <li>- Check the IP address of SLAVE modem set to 192.168.0.200 in the default config file : type <b>ping 192.168.0.200</b></li> <li>- you should get a positive answer mentioning the response time</li> </ul>
6	Ping the <b>MASTER</b> modem to check its <b>IP address</b> and the <b>IP link</b>  If the ping fail, see next chapter 'Troubleshooting'	 <p>The LED Radio must be GREEN, means RF link is OK</p> <p>The ping command launched from the SLAVE side need this RF link to reach the MASTER modem.</p> <p><b>If you can ping the SL200 MASTER from the SL200 SLAVE, it means the bi-directional IP link is fully operational .</b></p>		<ul style="list-style-type: none"> <li>- Open a command window (type <b>cmd</b> in search bar)</li> <li>- Check the IP address of MASTER modem set to 192.168.0.201 in the default config file.: type <b>ping 192.168.0.201</b></li> <li>- you should get a positive answer mentioning the response time.</li> <li>- <b>Bi-directional IP link is OK</b></li> </ul>

### 3.3 Troubleshooting

Basic tests TROUBLESHOOTING	
The <b>Middle LED</b> (LED Modem) lights up <b>RED</b>	<p>Diagnostic : There is a <b>configuration issue</b>.</p> <p>What to do : - update the modem with the configuration file again, an error may have occurred during the previous update process. (See the chapter 7 in the following paragraphs)</p> <ul style="list-style-type: none"> <li>- it the configuration file used is not the default one provided by Simpulse, check your configuration file to identify the problem, correct it and update the modem</li> </ul>
The <b>Middle LED</b> (LED Modem) <b>is not blinking</b> (only for software from V 4.15)	<p>Diagnostic : The <b>software is not running anymore</b>.</p> <p>What to do : - It may be accidental, like an electrostatic discharge. The modem will reboot automatically.</p> <ul style="list-style-type: none"> <li>- If the problem remain, contact Simpulse.</li> <li>- Reading the log file with the 'GUI Flash' can give a clue about the cause.</li> </ul>
The <b>left LEDs</b> (LED Radio) of both modems are <b>OFF</b>	<p>Diagnostic : The <b>RF link is not established</b></p> <p>What to do : - ensure you switched-on the second modem to establish the RF link.</p> <ul style="list-style-type: none"> <li>- ensure antennas are connected on both modems,</li> <li>- ensure you are not too close to a powerful WiFi working on the same frequency</li> <li>- If the configuration file is not correct (ie RF power too low, different frequencies for MASTER and SLAVE ..) correct it and update the modem.</li> </ul>
The <b>Left LED</b> (LED Radio) is <b>YELLOW</b>	<p>Diagnostic : The link is established, but <b>reception is bad on this modem</b></p> <p>What to do : - ensure the transmission power of the other modem is high enough.</p> <ul style="list-style-type: none"> <li>- ensure no powerful interference (ie WiFi) is close to the modem</li> </ul>
The <b>Left LED</b> (LED Radio) on one modem is <b>OFF</b>	<p>Diagnostic : The link is not established because there is <b>no reception on this modem</b></p> <p>What to do : - ensure the transmission power of the other modem is high enough.</p> <ul style="list-style-type: none"> <li>- The modem may have a problem – Contact Simpulse -</li> </ul>
The <b>Right LED</b> (Ethernet) is blinking <b>YELLOW / GREEN</b>	<p>Diagnostic : Data are transmitted by Ethernet</p> <p>What to do : Nothing, it is normal</p>
The <b>3 LED's are OFF</b> and ping failed	<p>Diagnostic : Assuming the modem is correctly powered, there is a <b>major hardware or software issue</b></p> <p>What to do : - <b>Try first to restore the modem with the last version of software and configuration file through USB</b>. (See SOFTWARE User Manual)</p> <ul style="list-style-type: none"> <li>- If you fail to restore the modem, or after restore the LED's are still OFF, please contact Simpulse</li> </ul>
<b>Ping failed</b>	<p>Diagnostic 1 : <b>The laptop is not in the same subnet</b> as the SL200 connected by Ethernet.</p> <p>What to do : Change manually the IP address of the Laptop Ethernet adapter :</p> <p>In the Windows control panel' =&gt; '<i>network and Internet</i>' =&gt; '<i>network connections</i>' , open the '<i>Ethernet adapter</i>', select '<i>Internet Protocol Version 4 (IPv4)</i>' and open '<i>properties</i>' check 'use the following IP address' and set the IP address of your laptop Ethernet adapter to an IP address in the same subnet as the SL200.</p> <p>For example, if you used the default Simpulse config file, set the laptop Ethernet IP address to 192.168.0.10 (for example) and the subnet mask to 255.255.255.0.</p> <p>Press 'OK' to close all the configuration windows for this change to be applied.</p> <p>Diagnostic 2 : The <b>IP address used for ping process is not assigned</b> (or wrong)</p> <p>What to do : - Check the configuration file used, and ping with the correct IP address mentioned in the config file (with Simpulse default config file, MASTER is 192.168.0.201 and</p>

	<p>SLAVE is 192.168.0.200)</p> <ul style="list-style-type: none"> <li>- If you don't know the SL200 IP address, but you know you are on the same subnet, you can run a utility software like '<i>Advanced IP scanner</i>' for Windows to find all assigned IP address in this subnet. The Simpulse products can be identified as their MAC Address start with : 70:B3:D5:DE:D:--</li> <li>- If you don't know the IP address at all, the only way to update the modem with a configuration file having a known IP address, is to connect the SL200 through USB (see (See the chapter 8 in the following paragraphs)</li> </ul> <p>Diagnostic 3 : The <b>firewall</b> is preventing the ping command to be executed What to do : Check and correct the firewall permissions of your laptop</p> <p>Diagnostic 4 : If the ping fail only when you try to <b>ping the MASTER through the SLAVE</b>, the RF link may not be operational, or the MASTER IP address is wrong What to do : . Try to ping directly the SL200 MASTER with its IP address and the Ethernet cable connected directly on the MASTER.</p> <ul style="list-style-type: none"> <li>- If direct ping is OK, the RF link may not be operational. See the previous case: the left LEDS (RF) are OFF'</li> <li>- If direct ping fails, SL200 MASTER could have an IP address problem, see Diagnostic 1 and Diagnostic 2</li> </ul>
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