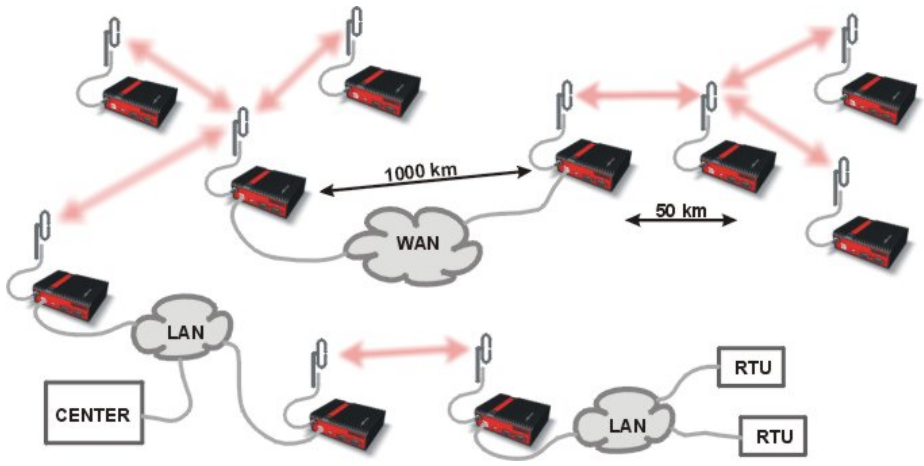
RACOM
RADIO DATA NETWORKS

Application notes



RipEX - Auto-speed

version 1.2
2022-03-10

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1. Autospeed

Normally all radio modems in a network have to transmit with the same data rate on the same radio channel. The Autospeed feature of RipEX enables different speeds to be used simultaneously in a radio modem network.

The following picture gives an example of a network layout. Let us assume, that all signals are strong enough to ensure almost perfect operation:

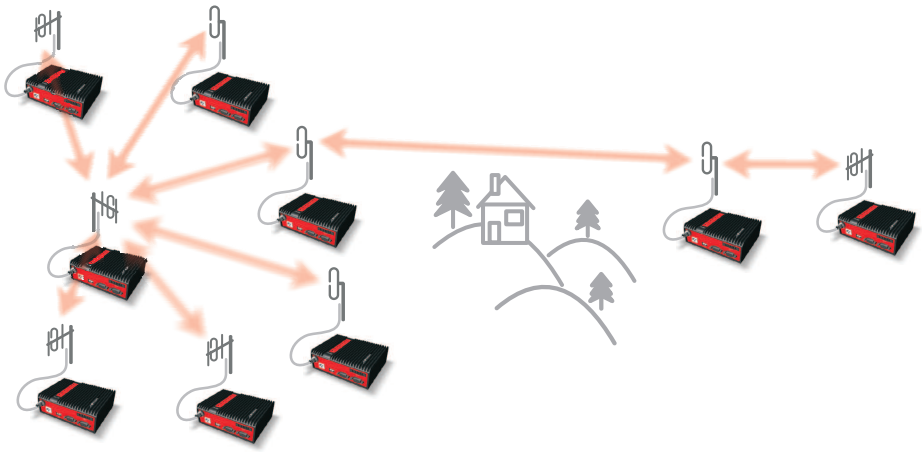

Fig. 1.1: Autospeed - initial situation

After some time situation changes and path loss on one of these links significantly increases, rendering the communication unreliable:

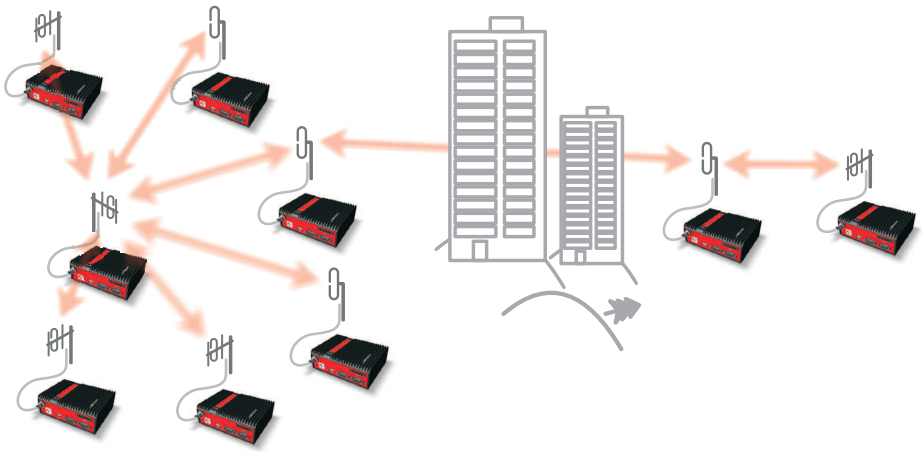

Fig. 1.2: Autospeed - problem

What can we do:

- Change antennas on one or both sides of the link
- Use higher masts on one or both sides of the link
- Build additional repeater(s)
- Lower the data rate significantly to increase the system gain

The first three possibilities require time and money, i.e. additional investment. The fourth possibility (when applied to whole network, as it normally is the case) would slow down the response time (two

to four times) of the whole network, quite probably making it unusable for the application. RipEX Autospeed feature allows to change the transmission data rate at the affected radios only, the rest of the network may continue in full speed. Consequently the overall performance of network is maintained practically at the same level while no additional investment is required. More over, the whole fix can be done in minutes from behind a web-browser screen while sitting in your office.

Of course a similar scenario can be used right from the moment of planning a new network. The investment cost can be reduced by purposefully configuring the few „difficult“ radio links to a lower data rate.

The above scenarios are made possible by the unique capability of RipEX to automatically adjust its receiver to the data rate of the incoming frame. Note that when an ACK frame is sent by the receiving RipEX, it always uses the same data rate as the frame it acknowledges. The only limitation of this feature is that all the frames have to have the same symbol rate and the same principle of modulation (i.e. CPFSK or linear).

Modulation types which can be combined within one approval type (FCC or CE):

2CPFSK & 4CPFSK with or without FEC
or
D2PSK & π/4DQPSK & D8PSK &16DEQAM with or without FEC

The improvement in system gain value using this technique may be more than 15 dB. Increasing gain of antenna system by that value would be impractical, often impossible – the „difficult“ hops are designed to use high-gain directional antennas from the beginning. Hence the Autospeed may make a radio modem network the optimum choice in situations where it could not be economically feasible before.

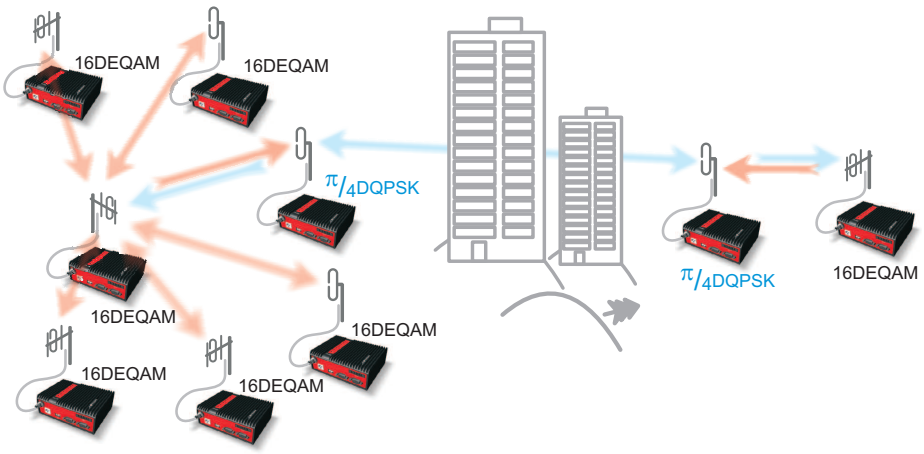

Fig. 1.3: Autospeed - solution

2. Individual Link Options

Since the firmware 1.6.2.0, RipEX radio improved the “Autospeed” function and added individual link options. RipEX radios can communicate with neighbouring RipEX units via different modulation rates, e.g. a central RipEX radio communicates with 10 remote radios and for each of those remote radios, it can configure individual modulation rate, FEC and ACK.

The only limitation of this feature is that all the frames have to have the same symbol rate and the same principle of modulation (i.e. CPFSK or linear).

Modulation types which can be combined within one approval type (FCC, CE or Narrow):

2CPFSK & 4CPFSK with or without FEC
or
D2PSK & π/4DQPSK & D8PSK &16DEQAM with or without FEC

Important

We really recommend using the most robust modulation as the "basic" one and using higher modulations for individual link options. See the respective chapters for details.

The following picture gives an example of a network layout.

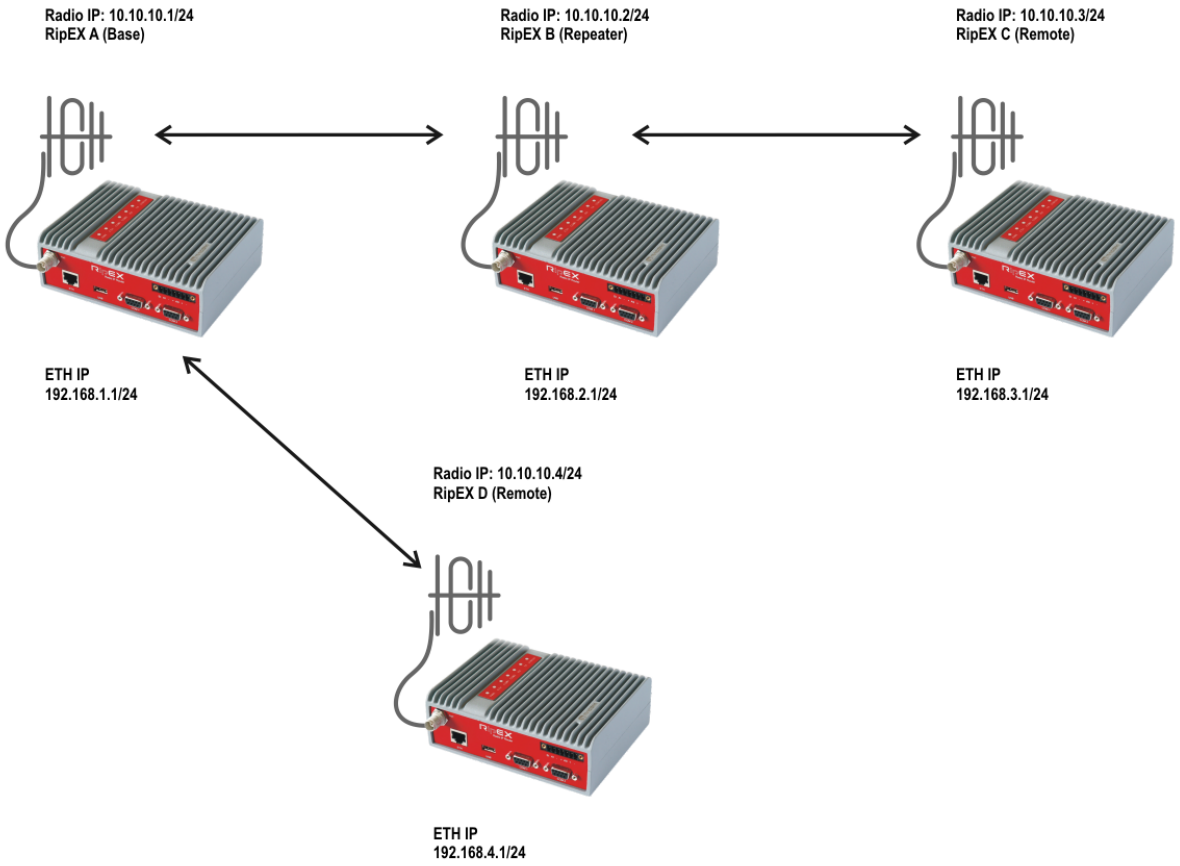

Fig. 2.1: Topology

In the following sections, all RipEX units will be configured and Flexible/BDP differences will be explained.

2.1. Flexible Protocol

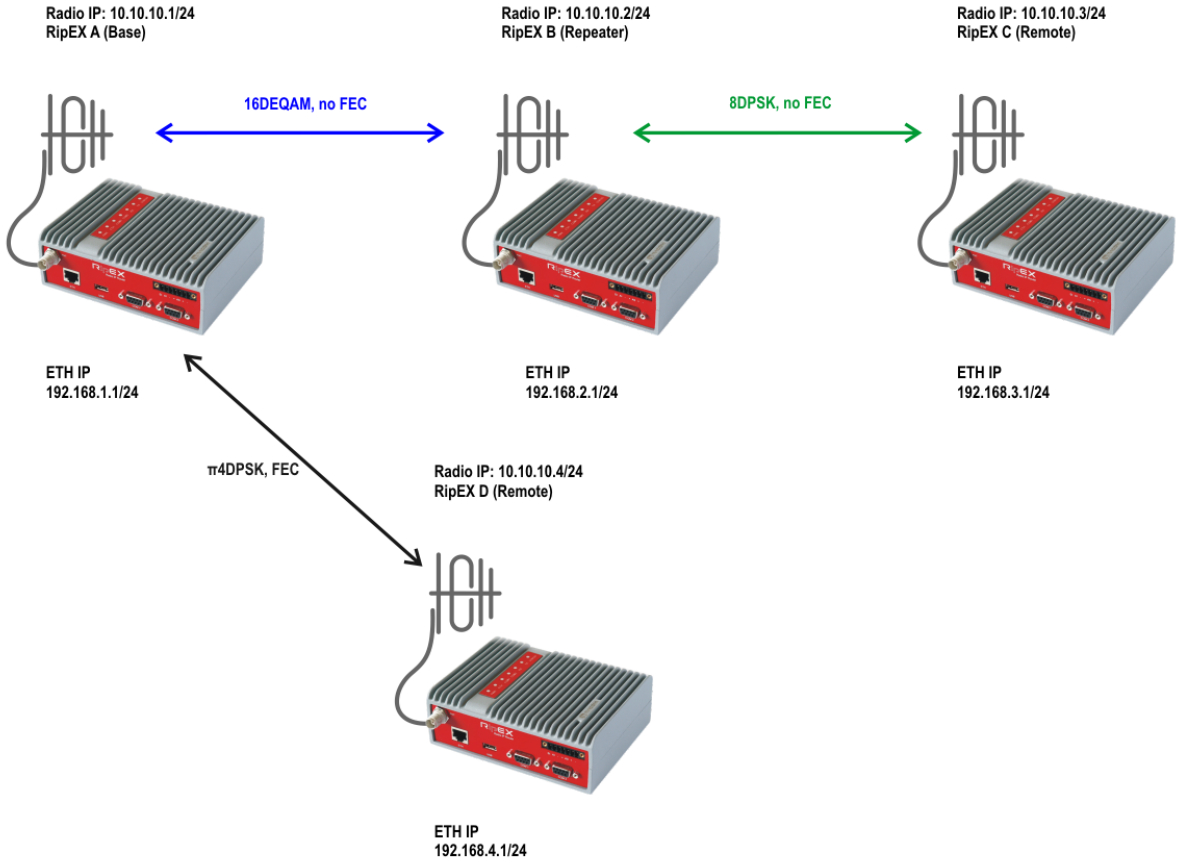

Fig. 2.2: Flexible protocol individual link options

In Flexible protocol, each individual radio link can be configured with different settings (modulation rate, FEC, ACK). In the Figure 2.2 three radio links are configured, each with different settings.

Note

Please see *Section 2.2, "Base Driven Protocol"* for differences.

Important

As already mentioned in chapter 1, using the most robust modulation for the "basic" modulation is recommended. In a Flexible protocol the main reason is that broadcast data are sent on this modulation (no matter of individual link options). If RipEX would use e.g. 16DEQAM modulation on a link which requires π/4DQPSK (or lower), broadcast data might not be sent and received successfully causing a badly working link (e.g. ARP data are also broadcast).

2.1.1. RipEX A Configuration

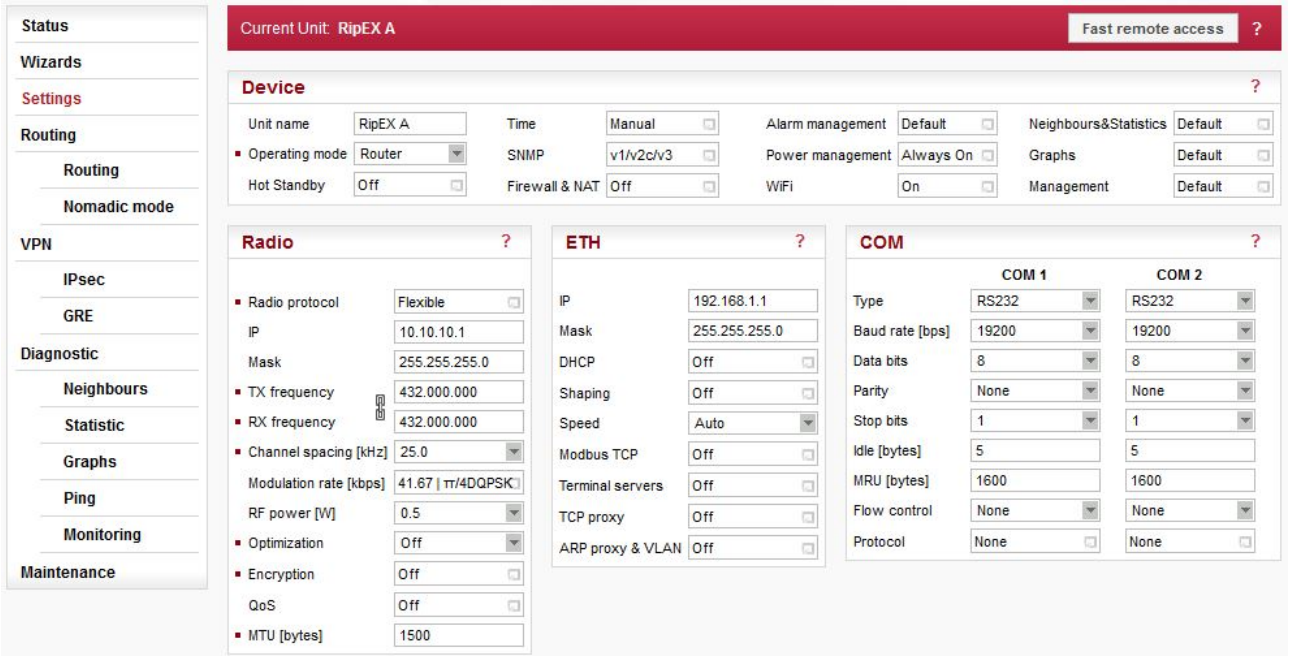

Fig. 2.3: RipEX A Settings

The basic configuration is simple. Just edit the following parameters:

- Unit name: RipEX A
- Operating mode: Router
- Radio IP: 10.10.10.1
- Radio Mask: 255.255.255.0
- TX/RX Frequency: 432.000.000 (used within this example)
- Ethernet IP: 192.168.1.1
- Ethernet Mask: 255.255.255.0

And after these changes, open Radio protocol details – e.g. click on the “Radio protocol” button. A new pop-up menu appears:

Fig. 2.4: RipEX A (Base) Radio protocol details

- Radio protocol: Flexible
- Mode: CE
- Modulation type: QAM
- Modulation rate: π/4DQPSK
- FEC: On
- ACK: On
- Retries: 3

Open the Advanced parameters “Individual link options” section and “Add” a new line.

- Counterpart Radio IP: 10.10.10.2
- Modulation rate: 16DEQAM
- FEC: Off
- ACK: On
- Retries: 3
- Note: RipEX B

This configuration makes π/4DQPSK the default modulation (used for all radio links by default). FEC is enabled by default. The “Individual link options” line forces RipEX A to use 16DEQAM modulation with disabled FEC for the radio link to RipEX B (10.10.10.2).

Note

In Flexible protocol, modulation rate must be configured in all RipEX units. In BDP, modulation rates are controlled by the Base station configuration (remote units must comply with Modulation type only).

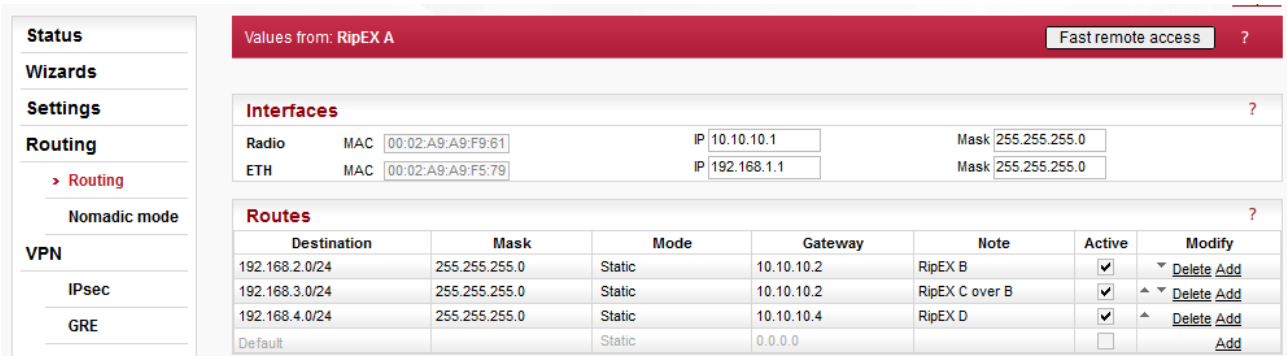

Fig. 2.5: RipEX A Routing

Three routes are added – accessibility of all remote Ethernet subnets.

- 192.168.2.0/24 via 10.10.10.2 (direct link)
- 192.168.3.0/24 via 10.10.10.2 (RipEX B is used as a repeater)
- 192.168.4.0/24 via 10.10.10.4 (direct link)

2.1.2. RipEX B Configuration

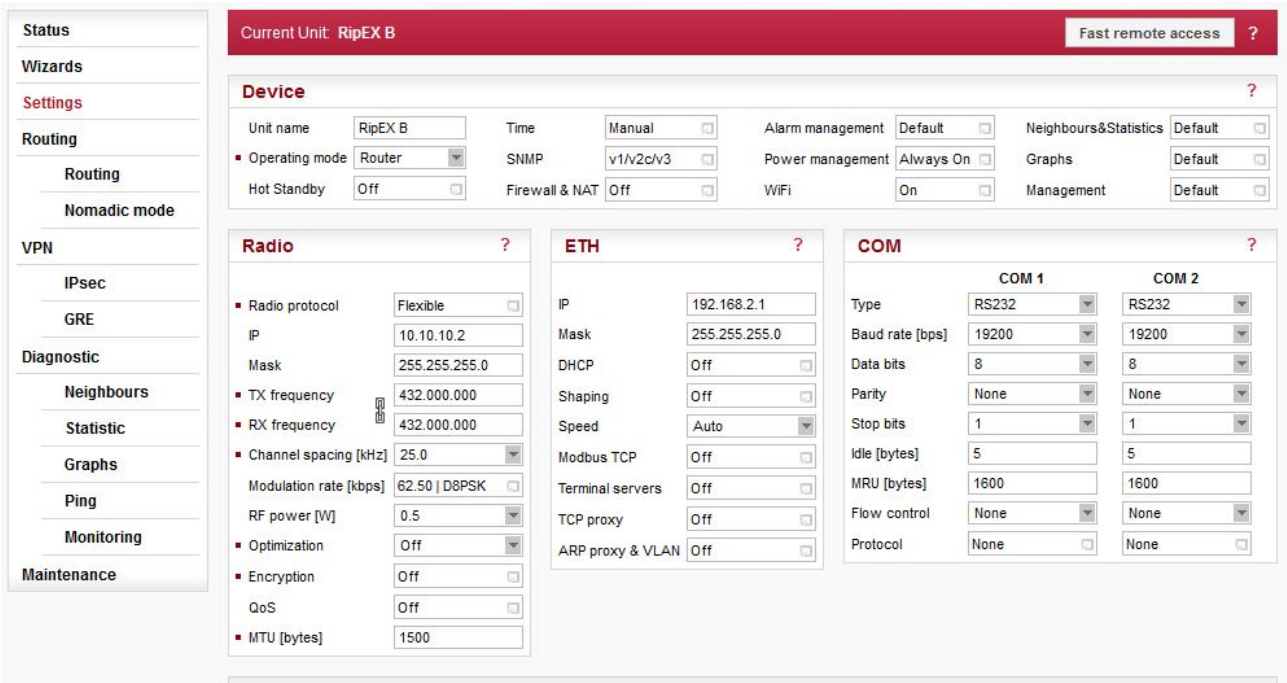

Fig. 2.6: RipEX B Settings

Parameters different from RipEX A:

- Unit name: RipEX B
- Radio IP: 10.10.10.2
- Ethernet IP: 192.168.2.1

Open the Radio protocol details:

Fig. 2.7: RipEX B Radio protocol details

- Radio protocol: Flexible
- Mode: CE
- Modulation type: QAM
- Modulation rate: D8PSK
- FEC: Off
- ACK: On
- Retries: 3

Default modulation rate is D8PSK (without FEC). Open the Advanced parameters “Individual link options” section and “Add” a new line.

- Counterpart Radio IP: 10.10.10.1
- Modulation rate: 16DEQAM
- FEC: Off
- ACK: On
- Retries: 3
- Note: RipEX A

RipEX B will always use D8PSK modulation rate (without FEC) when communicating with RipEX C (10.10.10.3) and for all broadcast data thanks to default/basic modulation. Modulation back to RipEX A is set to the higher 16DEQAM modulation.

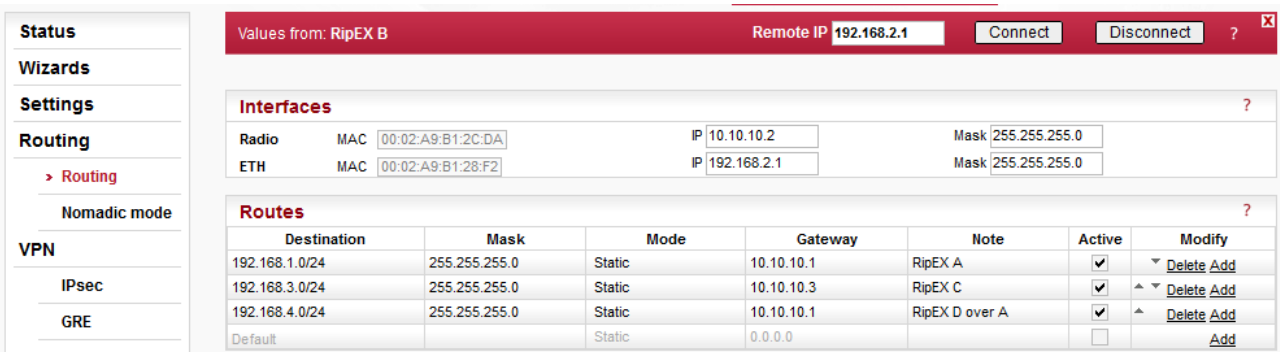

Fig. 2.8: RipEX B Routing

Routing rules:

- 192.168.1.0/24 via 10.10.10.1 (direct link)
- 192.168.3.0/24 via 10.10.10.3 (direct link)
- 192.168.4.0/24 via 10.10.10.1 (RipEX A is used as a repeater)

2.1.3. RipEX C Configuration

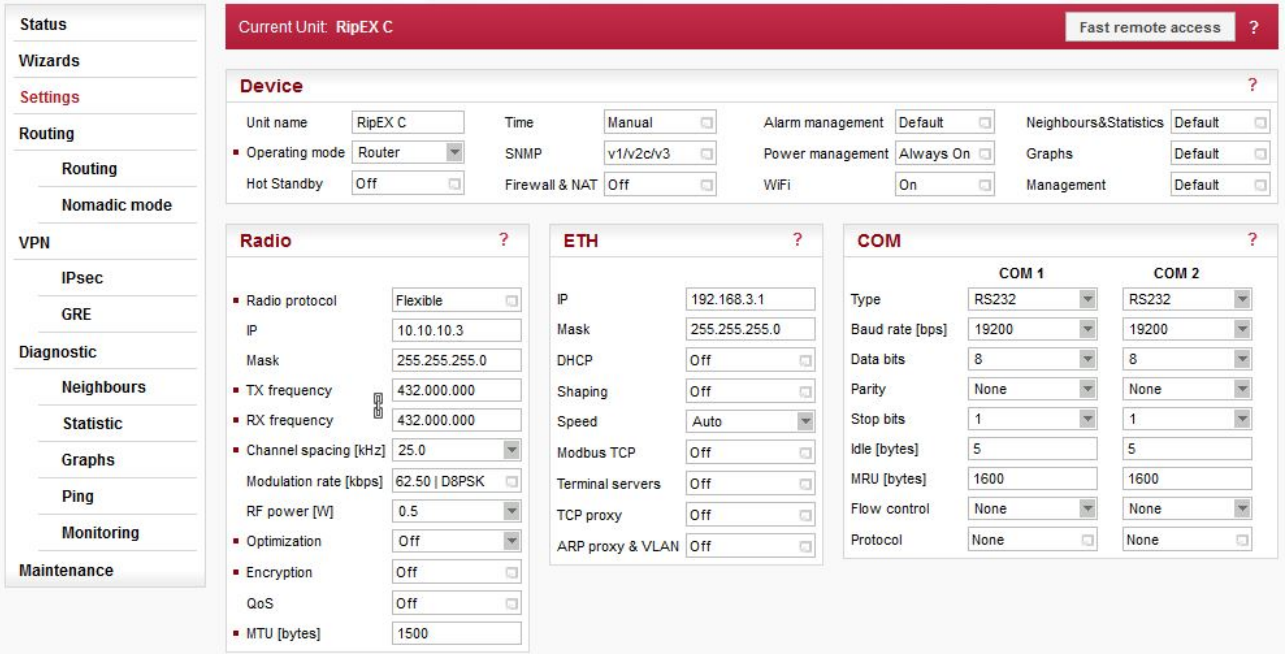

Fig. 2.9: RipEX C Settings

Parameters different from RipEX A:

- Unit name: RipEX C
- Radio IP: 10.10.10.3
- Ethernet IP: 192.168.3.1

Open the Radio protocol details:

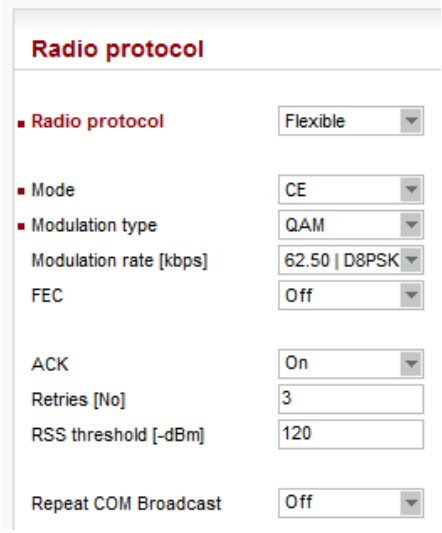

Fig. 2.10: RipEX C Radio protocol details

- Radio protocol: Flexible
- Mode: CE
- Modulation type: QAM
- Modulation rate: D8PSK
- FEC: Off
- ACK: On
- Retries: 3

Default modulation rate is D8PSK (without FEC) and there is no special individual link option configured.

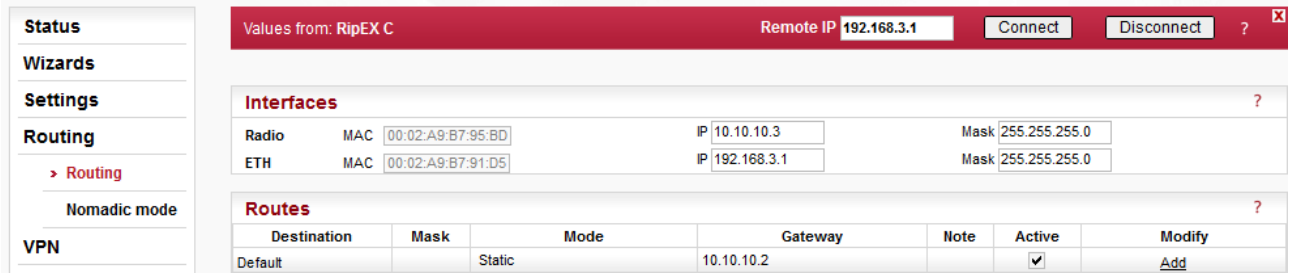

Fig. 2.11: RipEX C Routing

RipEX C only configures a default route via RipEX B (10.10.10.2).

2.1.4. RipEX D Configuration

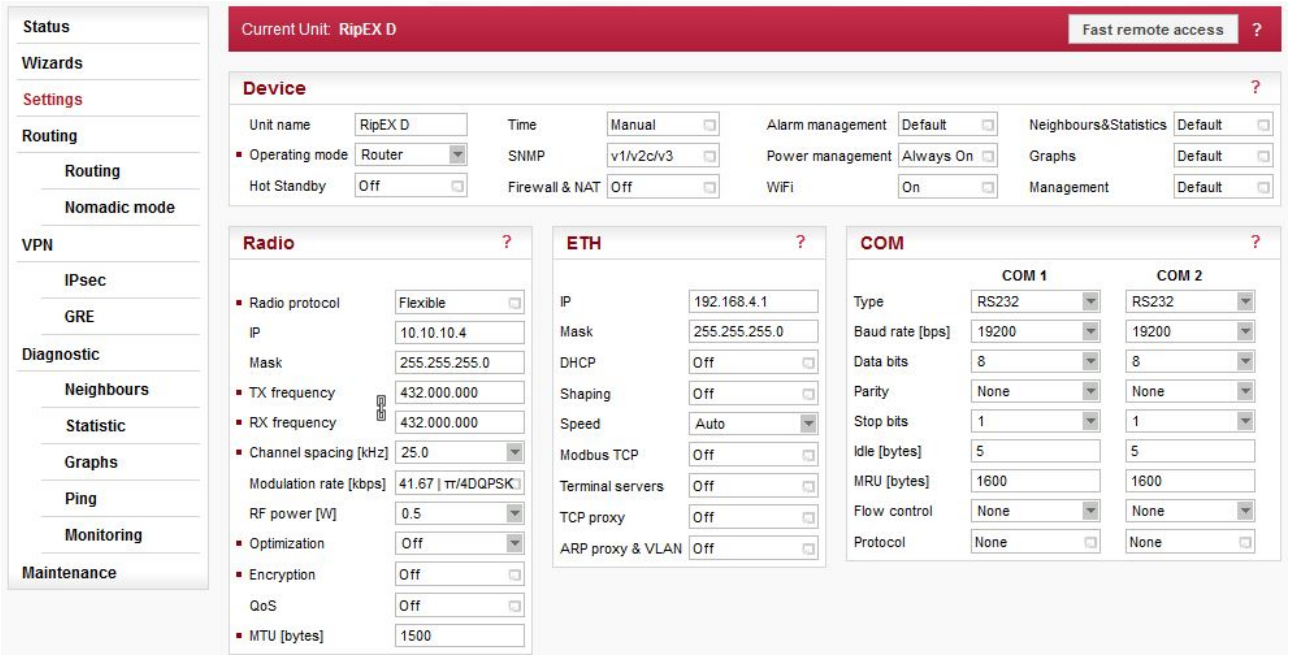

Fig. 2.12: RipEX D Settings

Parameters different from RipEX A:

- Unit name: RipEX D
- Radio IP: 10.10.10.4
- Ethernet IP: 192.168.4.1

Open the Radio protocol details:

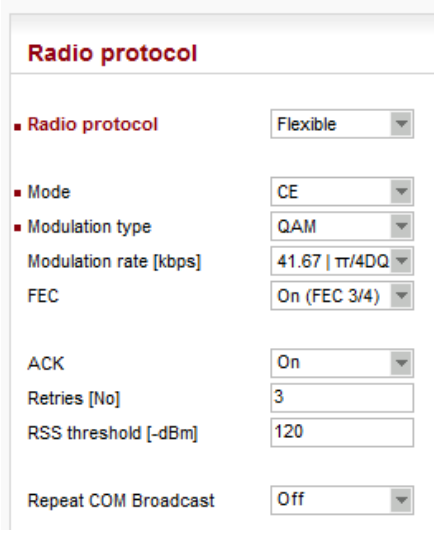

Fig. 2.13: RipEX D Radio protocol details

- Radio protocol: Flexible
- Mode: CE
- Modulation type: QAM
- Modulation rate: π/4DQPSK
- FEC: On
- ACK: On
- Retries: 3

Default modulation rate is π/4DQPSK (with FEC) and there is no special individual link option configured.

Fig. 2.14: RipEX D Routing

RipEX D configures only a default route via RipEX A (10.10.10.3).

2.1.5. Testing the Modulation Rate

One RSS ping can display all required information. Issue the RSS Ping from RipEX D (10.10.10.4) to RipEX C (10.10.10.3).

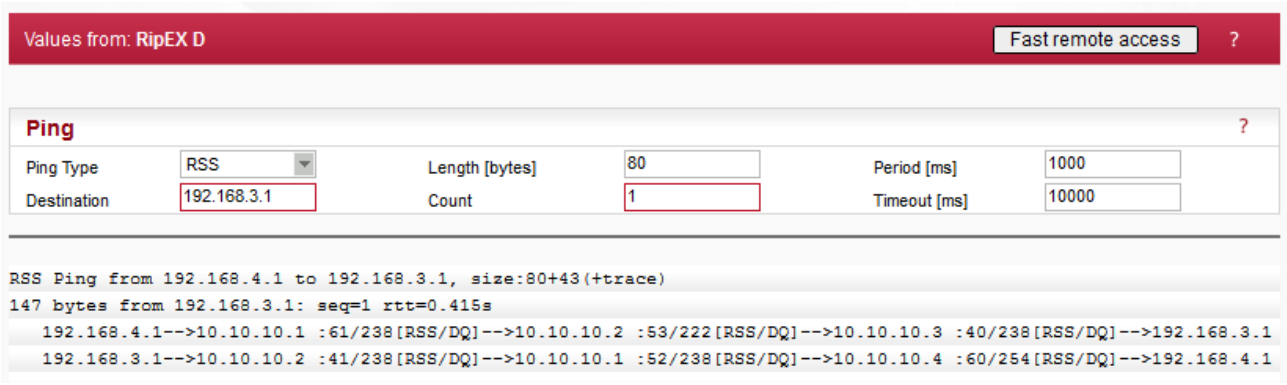

Fig. 2.15: RSS ping from RipEX D to RipEX C

The RSS ping output shows 3 radio hops in each direction, in total 6 radio hops. But the modulation rate is not visible here. Configure the Monitoring with correct parameters and Start it.

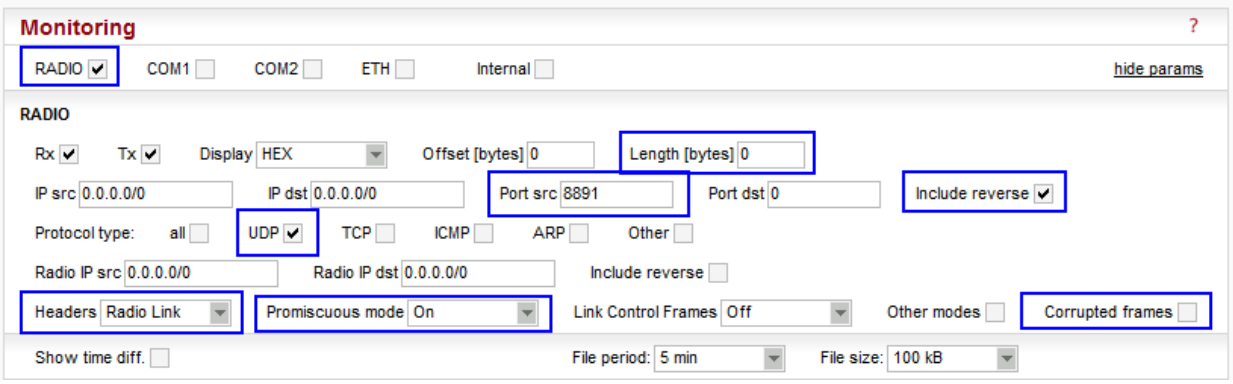

Fig. 2.16: Monitoring Configuration

Parameters:

- Interface: Radio
- Length: 0 Bytes
- Port src: 8891, Include reverse checked
- Protocol type: UDP
- Headers: Radio Link
- Promiscuous mode: On
- Corrupted frames: unchecked

This configuration will monitor the Radio interface, displaying the required headers but no data (the payload is not important for this test). The RSS ping operates via UDP port 8891 and it's not desired to display any corrupted packets. The promiscuous mode must be enabled so the monitoring displays all data within radio coverage; not only data destined to this radio (e.g. traffic from RipEX A to RipEX B).

Run the Monitoring by pressing the "Start" button and afterwards, re-run the RSS ping.

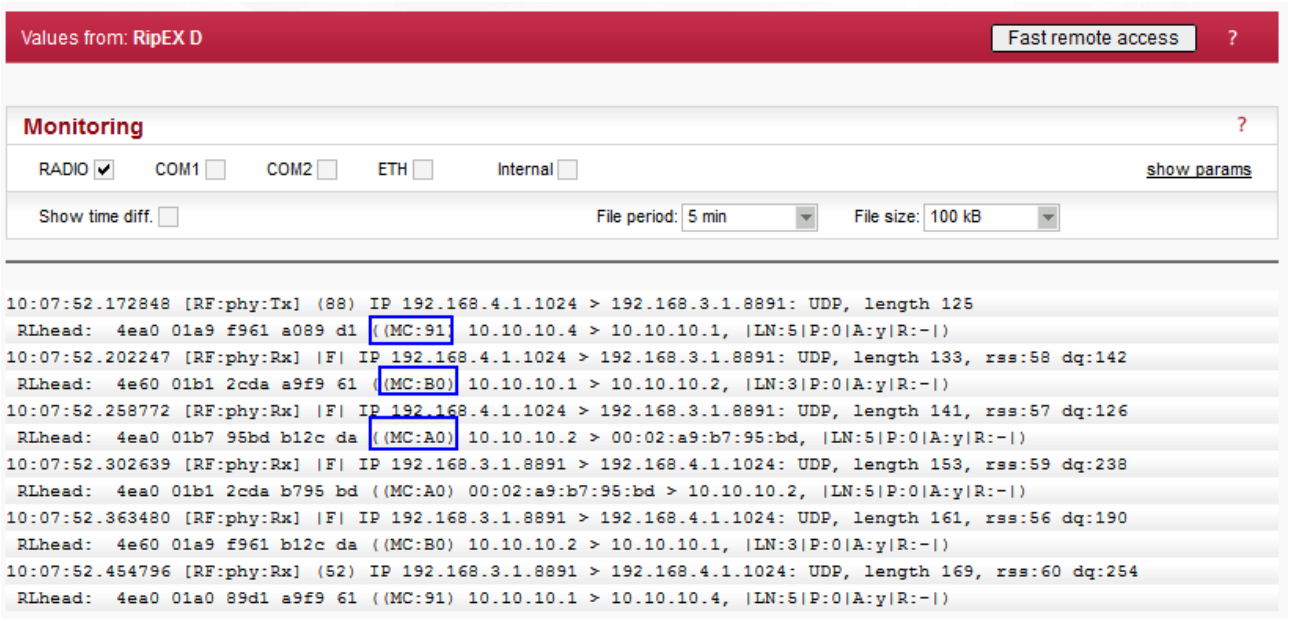

Fig. 2.17: RSS Ping Monitoring output

For each displayed packet, there is information about Modulation rate and FEC. See the highlighted values “MC:XY”.

TX Modulation and Coding ((MC:00)) explanation:

- [7..4] Modulation Select Nibble
  0x0 = 2-CPFSK (default)
  0x1 = 4-CPFSK
  0x8 = DPSK
  0x9 = π/4DQPSK
  0xA = D8PSK
  0xB = 16-DEQAM
- [3..0] Coding Select Nibble
  0x0 = FEC Off (default)
  0x1 = FEC On

In our example, there are three values:

- MC:91 - π/4DQPSK & FEC On, used for the Radio link between RipEX D and RipEX A
- MC:B0 - 16-DEQAM & FEC Off, used for the Radio link between RipEX A and RipEX B
- MC:A0 - D8PSK & FEC Off, used for the Radio link between RipEX B and RipEX C

The direction back is the same in our example. In Flexible mode, it is even possible to define different settings for different directions of one radio link. This is not possible in BDP.

Run RSS ping from another RipEX to any other and verify the behaviour in the Monitoring menu. You can check the same using any traffic, of course – e.g. run your application over the testing network.

2.2. Base Driven Protocol

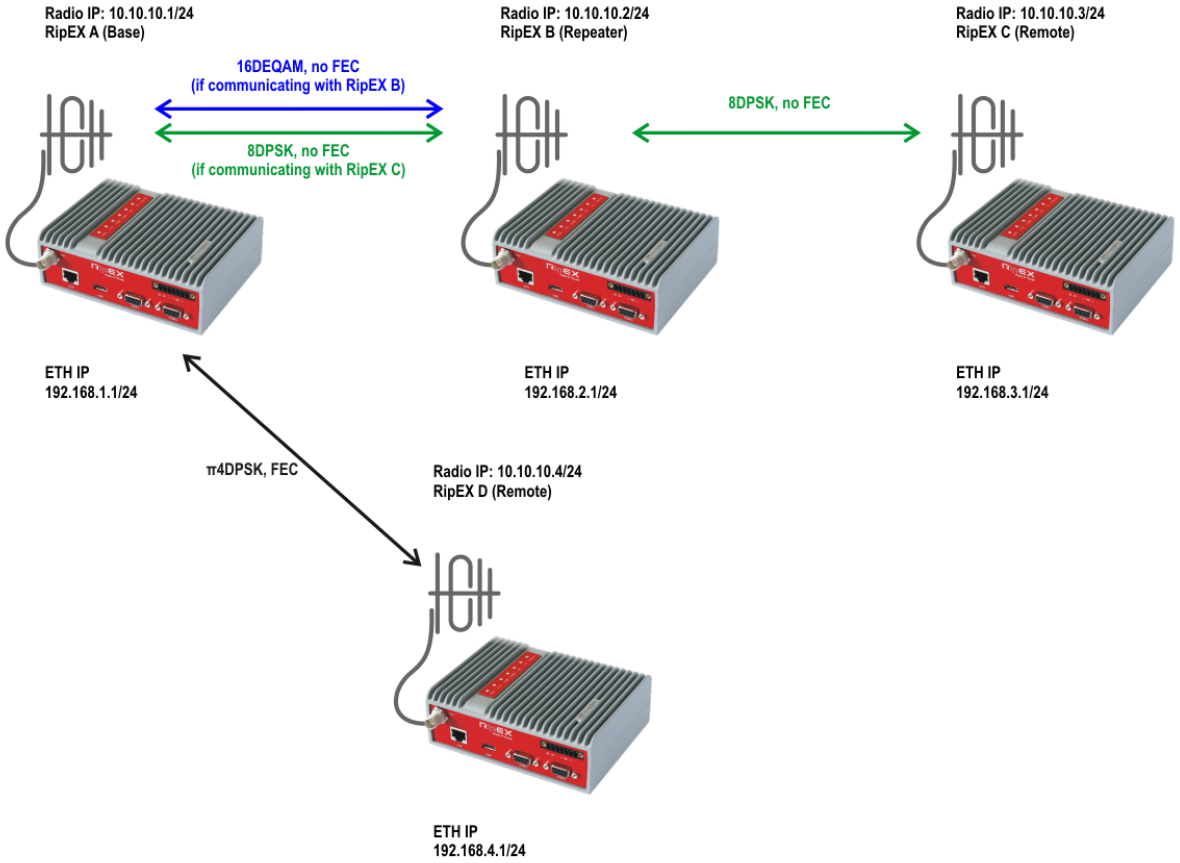

Fig. 2.18: Base Driven protocol – Individual link options

Base Driven protocol is slightly different in the way it handles individual link options. In BDP, all communication is strictly controlled by the Base station and this Base station configures all modulation rates within the whole network. Individual remote units must comply with the Modulation type; ACK can be configured at each remote unit separately.

In Figure 2.18 you can see two Modulation rates for one Radio link between RipEX A and RipEX B. This is due to BDP behaviour. If the Base station is communicating with RipEX B, it uses 16DEQAM modulation rate. But if it communicates with RipEX C, it uses D8PSK for the whole path (i.e. for those two Radio hops and the way back as well). It is NOT possible to configure it as in the Flexible mode.

Note

If there was another RipEX behind RipEX B (repeater), we could configure the communication via another Modulation rate, e.g. π/4DQPSK. And when communicating with this unit, the Radio hop between RipEX A and RipEX B will operate using this π/4DQPSK Modulation rate.

Another difference is that all the communication goes over the Base station. Even if we had a direct Radio link between RipEX D and RipEX C, the communication must go over the Base station (RipEX A).

See the following configuration example of how to configure the same network as in *Chapter 2.1.*, but using BDP.

Important

Always set the basic/default modulation to the most robust option (i.e. the lowest modulation required in one BDP network). This modulation is used for all BDP overhead data so all the units within the network must receive such data correctly. User data traffic is sent based on "Remotes" table rules explained on the following pages.

2.2.1. RipEX A Configuration

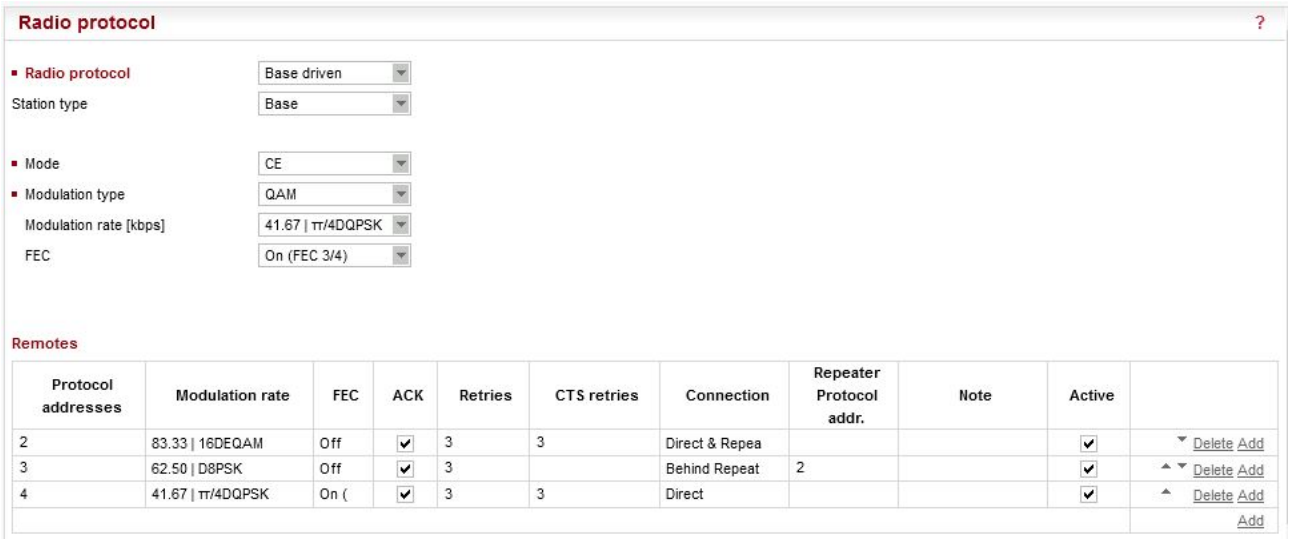

Fig. 2.19: RipEX A Radio Protocol details

Open the Radio protocol details of RipEX A (Base) and change the configuration:

- Radio protocol: Base driven
- Station type: Base

The Individual link options submenu disappeared, but a very important submenu “Remotes” has appeared and can be configured. All remote units must be configured in this table, otherwise they will not be accessible. Configure all three remote units:

- Protocol address: 2
  Modulation rate: 16DEQAM
  FEC: Off
  ACK/CTS: Enabled (3, 3)
  Connection: Direct & Repeater
- Protocol address: 3
  Modulation rate: D8PSK
  FEC: Off
  ACK: Enabled (3)
  Connection: Behind Repeater (2)
- Protocol address: 4
  Modulation rate: π/4DQPSK
  FEC: On
  ACK/CTS: Enabled (3, 3)
  Connection: Direct

Note

Please see the details in *BDP application notes*[1].

Important

Configured modulation will be used for all the user data traffic between particular units. The overhead data are sent on the basic modulation (π/4DQPSK in our case).

Different modulation rates are used for each remote station. If the Base communicates with Remote 3 (RipEX C, 10.10.10.3), it uses D8PSK for all radio links on its path (even for the link Base <-> RipEX2).

Important change must be done in the Routing menu as well.

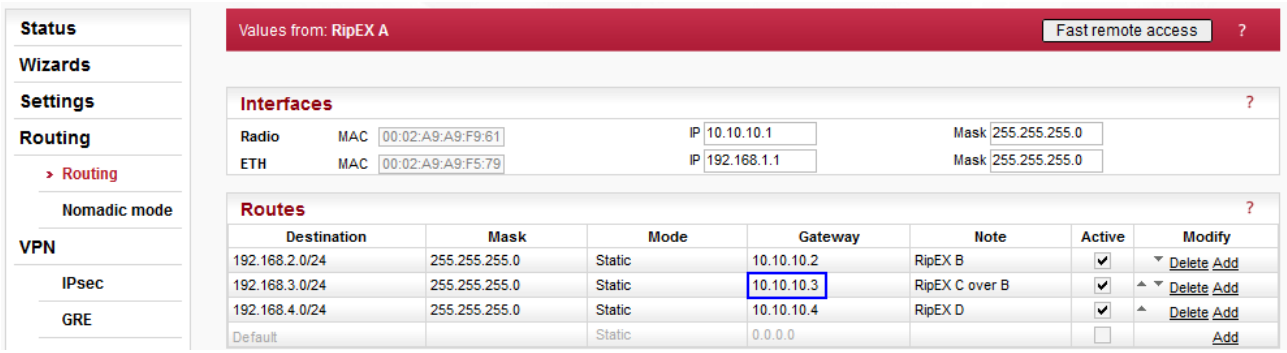

Fig. 2.20: RipEX A Routing

2.2.2. RipEX B, C and D Configurations

All the remote RipEX units have the same configuration. Change the Radio protocol to BDP and the station type to “remote”.

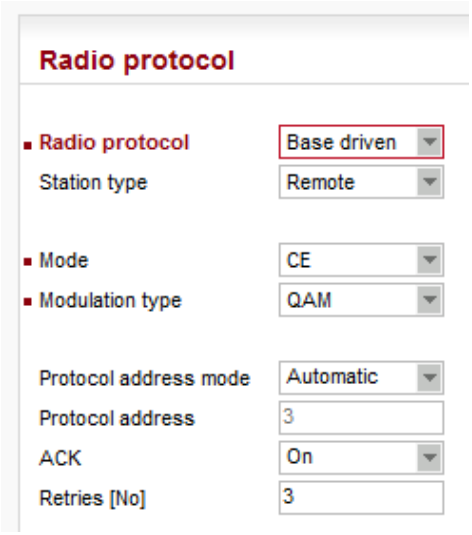

Fig. 2.21: Remote RipEX Radio protocol details

[1] https://www.racom.eu/eng/products/m/ripex/app/bdp/index.html

In the Routing menu, configure only the default route to 10.10.10.1, because all the communication is routed over the Base station.

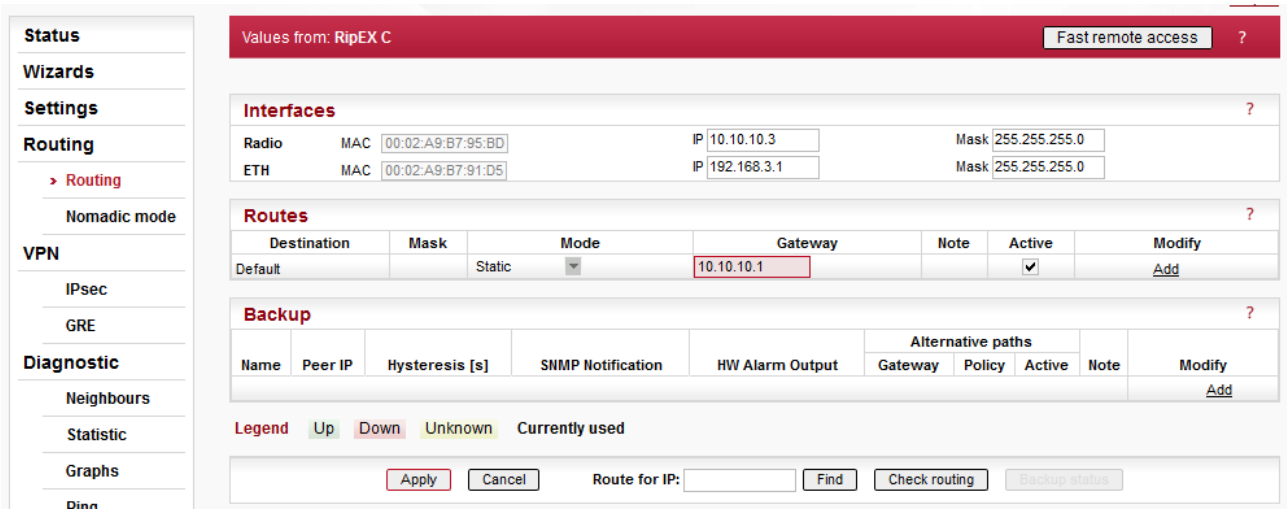

Fig. 2.22: Remote RipEX Routing

2.2.3. Testing the Modulation Rate

The test will be the same – RSS ping from RipEX D to RipEX C.

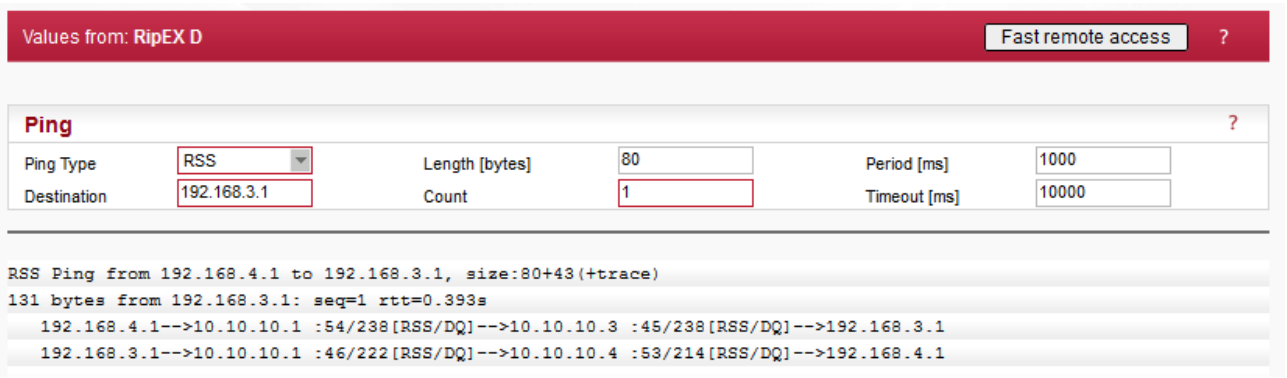

Fig. 2.23: RSS ping from RipEX D to RipEX C

In BDP, only the last hop is displayed in path to/from the Base unit. I.e. there are only two hops displayed for each direction, instead of three.

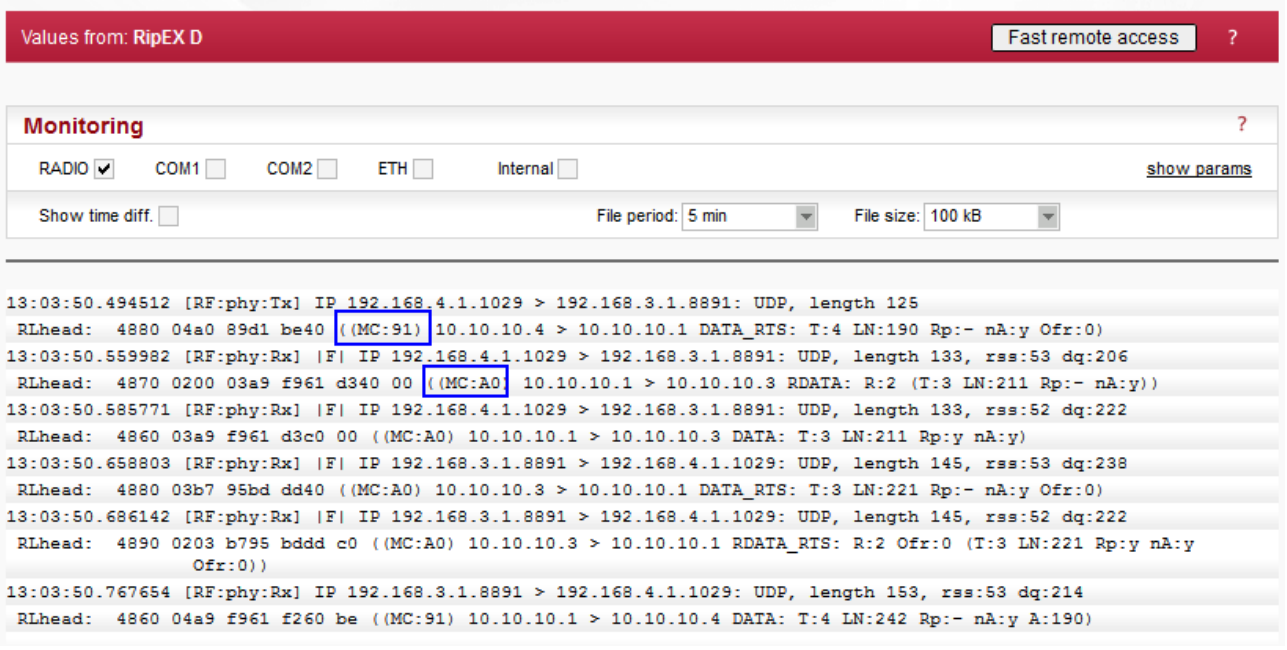

Fig. 2.24: RSS Ping Monitoring output

The first transmitted packet has the MC value 91 = π/4DQPSK with enabled FEC. The second displayed packet is from the Base station to RipEX B (repeater) and D8PSK modulation rate without FEC is used. A retransmitted packet from this repeater is also displayed using the same rate.

The RSS ping reply and a retransmitted packet both have the D8PSK rate as configured and the last hop uses π/4DQPSK again.

Note

Please see the details in *BDP application notes*[2].

[2] https://www.racom.eu/eng/products/m/ripex/app/bdp/index.html

Revision History

Revision 1.0 2017-11-27
First issue

Revision 1.1 2018-03-26
Individual Link Options

Revision 1.2 2022-03-10
Practical important notes added