User manual

Integra-E
Integra-E2
Integra-E3

VER 2.1

FW 3.23.16/23

Proprietary notice

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SAF Tehnika, JSC has no liability for typing errors in this document or damages of any kind that result from the use of this document.

To get up-to-date information about accessories and their availability, please contact a sales representative.

⚠ FODU does not contain serviceable parts. Warranty will not be applicable in the event FODU has been hermetically unsealed.

⚠ SAF Tehnika, JSC is not responsible for any radio or TV interference caused by unauthorized modifications to this equipment. Such modifications could void the user's authority to operate the equipment.

This device complies with part 15 of the FCC Rules. The operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

Reorient or relocate the receiving antenna.

Increase the separation between the equipment and receiver.

Connect the equipment into an outlet on a circuit different from the one connected to the receiver.

Consult the dealer or an experienced radio/TV technician for help.

This device complies with Industry Canada licence-exempt RSS standard(s). The 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.

Le présent appareil est conforme aux CNR d'Industrie Canada 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'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Copyright Notice

Contents

Chapter 1 : OVERVIEW

Labeling

The label contains the following information - see a sample below:

Figure 1-1 Integra-E label and label placement on the FODU
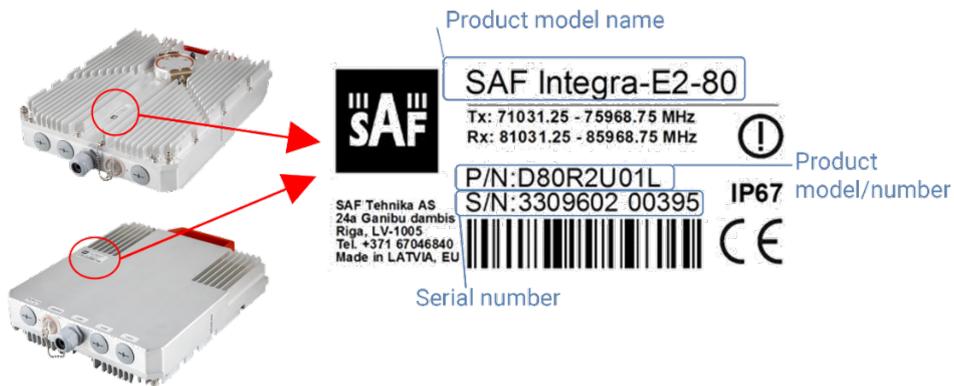
Figure 1-2 Integra-E2/E3 label and label placement on the FODU

Product model name ("SAF Integra-E-80"). The FODU model name example is shown in *Figure 1-1* and *Figure 1-2.*

Product Number / Model Number (P/N or M/N) (D80R1U01L): product/model number contains various information about the unit. Please find the translation below.

P/N or M/N translation:

"**D80R**" designates Integra-E/E2/E3 E-band product.

"**0**" Integra-E initial Hardware revision:

- "**1**" Integra-E Mark 1.5.
- "**2**" Integra-E2 Mark 2.
- "**3**" Integra-E3 Mark 3 (AES encryption supported).

"**U**" designates Integra-E/E2/E3 with full capacity license[1]:

- "**K**" - 5 Gbps Licence.
- "**L**" - 2.5 Gbps Licence.

"**01**" designates the version number of the radio.

"**L**" designates low side radio;

"**H**" - high side radio.

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[1] Contact SAF representatives for detailed license information.

| Minimal tunable frequency for 62.5MHz bandwidth is 71.03125GHz | Maximal tunable frequency for 62.5MHz bandwidth is 75.96875GHz | Minimal tunable frequency for 62.5MHz bandwidth is 81.03125GHz | Maximal tunable frequency for 62.5MHz bandwidth is 85.96875GHz |

Tunable range for 62.5MHz bandwidth   Tunable range for 62.5MHz bandwidth

| E band lower diapason start frequency 71GHz | E band lower diapason end frequency 76GHz | E band higher diapason start frequency 81GHz | E band higher diapason end frequency 86GHz |

Figure 1-3 The central frequency range for 62.5MHz channel (high side Integra-E)

An example above in *Figure 1-3* shows the tunable central frequency range for 62.5 MHz channel bandwidth. Full Tx/Rx frequency range can be found on Product Label, see *Figure 1-1* and *Figure 1-2*.

Serial Number (3933002 00003): the serial number uniquely identifies the unit.

Microwave Radiation
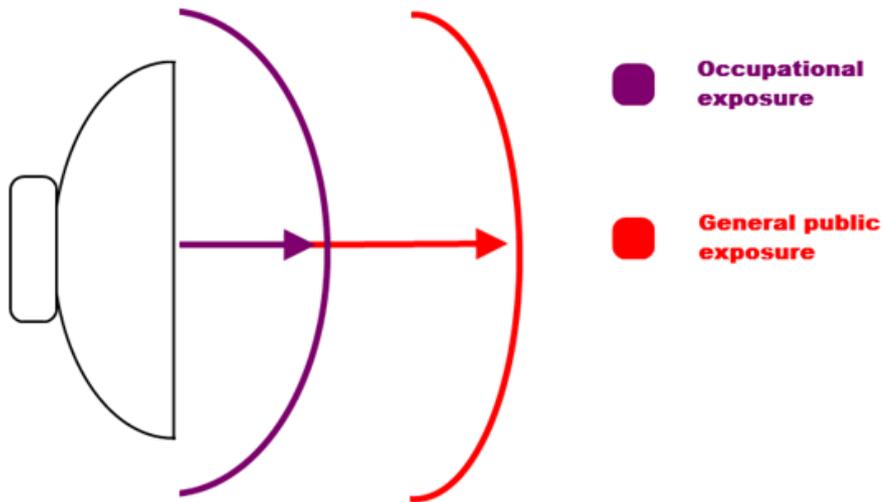
Figure 1-4 Microwave radiation exposure diagram

In April 1998, ICNIRP (International Commission on Non-Ionizing Radiation Protection) published its ´Guidelines *(https://www.icnirp.org/cms/upload/publications/ICNIRPemfgdl.pdf)*, for limiting exposure to time-varying electric magnetic and electromagnetic fields (up to 300GHz)´. The guidelines (Tables 6 and 7) specify the ´Reference levels on power density for occupational exposure and general public exposure to time-varying electric and magnetic fields (unperturbed RMS values) between 2 and 300 GHz.

Table 1-1 ICNIRP Reference levels within the frequency range 80 GHz

Frequency 80GHz			
Antenna	**Exposure characteristics**		**Equivalent plane wave power density Seq (W/m2)**
VHLP200-80-SAF2	Occupational:	1.51m	50
	Public:	3.37m	10
VHLP1-80-SAF2	Occupational:	2.04m	50
	Public:	4.54m	10
VHLP1-80A-SAF2	Occupational:	2.87m	50
	Public:	6.41m	10
VHLP2-80-SAF2	Occupational:	4.54m	50
	Public:	10.14m	10

Note: For pulsed signals, it is suggested that the peak equivalent plane wave power density, as averaged over the pulse width, does not exceed 1000 times the Seq exposure levels given in the table.

Note: Within the frequency range 10 – 300 GHz the basic restrictions are identical to the reference levels.

Remarks on the definition of basic restrictions:

1. Power densities are to be averaged over any 20 cm^2 of exposed area and any 68/f1.05 minute period (where f is in GHz) to compensate for progressively shorter penetration depth as the frequency increases.

2. Spatial maximum power densities, averaged over 1 cm^2, should not exceed 20 times the values above.

Compared to the ICNIRP restrictions, FCC CFR 47 specifies the Maximum Permissible Exposure (MPE) levels for the occupational/controlled environment and general public/uncontrolled environment, as shown in Table 1-2 FCC MPE limits within the frequency range 1.5-100 GHz

Frequency 80GHz			
Antenna	**Exposure characteristics**		**Equivalent plane wave power density Seq (W/ft2)**
VHLP200-80-SAF2	Occupational:	4.95ft	4.66
	Public:	11.06ft	0.93
VHLP1-80-SAF2	Occupational:	6.69ft	4.66
	Public:	14.90ft	0.93
VHLP1-80A-SAF2	Occupational:	9.42ft	4.66
	Public:	21.03ft	0.93
VHLP2-80-SAF2	Occupational:	14.90ft	4.66
	Public:	33.27ft	0.93

Quite a few other documents specify or refer to exposure limits comparable to those given above, e.g.:

- 1999/519/EC: Council Recommendation of July 12, 1999, on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz);

- WHO: Environmental Health Criteria 137: ´Electromagnetic Fields (300 Hz to 300 GHz);

- ANSI/IEEE C95.1, 1999:

´IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz;

- BRD, Bundesimmissionsschutzgesetz, 26. BImSchV Verordnung über elektromagnetische Felder;

- Bundesamt für Umwelt, Wald und Landwirtschaft (BUWAL), Bern/Schweiz

Schriftenreihe Umwelt Nr. 164, Luft, Mai 1992

´Messung nichtionisierender elektromagnetischer Strahlung, 1. Teil: Frequenzbereich 100 kHz bis 300 GHz;

- DIN VDE 0848-2, Entwurf, Oktober 1991:

´Sicherheit in elektrischen, magnetischen und elektromagnetischen Feldern, ´Teil 2: Schutz von Personen im Frequenzbereich von 30 kHz bis 300 GHz;

- ENV 50166-2, January 1995 (withdrew in December 1999 by CENELEC) ´Human Exposure to Electromagnetic Fields (10 kHz – 300 GHz).

Chapter 2 : INSTALLATION

Package contents

Table 2-1 Package contents

Products and accessories	Qty
1. D80R0xxxx Integra-E/E2/E3 80 GHz	1
2. XSPR_2148 RJ45 CAT5 connector 4P	1
3. D0ALK003 Locking key for Integra-E/E2/E3	1
4. XSPR_184 2-pin RIA pluggable terminal block	1

> ⚠ If any further assistance is required please contact *techsupport@saftehnika.com*

Additional information on the web on SAF Integra-E/E2/E3 configuration and installation

You can find fast references for installation and adjustment in our blog *https://blog.saftehnika.com/en/tags/10-gbps-capacity/* and our Youtube channel "SAFTehnika". There you can find video instructions on how to set up Integra-E/E2/E3 link and perform a very basic "bench test" in the office with paper packs.

Please visit our page *https://www.saftehnika.com/* for the latest firmware and manual versions, you need to have an account for full access.

Integra-E/E2/E3 FODU: attaching to the antenna

> ⚠ The antenna must be assembled according to the instructions from the antenna manufacturer, supplied with the antenna.

Figure 2-1 Tools for antenna attachment

Tools required for FODU mounting: Level (not supplied, optional), D0ALK003 Locking key for Integra-E/E2/E3 (supplied), see *Figure 2-1*.

Setting link polarization

> ⚠️ We strongly recommend checking polarization before transporting equipment to the site. In case you need to change polarization, it is much easier to do it on the ground than on the tower.
>
> Make sure the polarization change procedure is performed with caution, avoiding contamination by foreign bodies.
>
> FODU always must be installed with handle up and cables outlet down.

The antenna (SAF2) mounting flange for Integra-E/E2/E3 is shown in *Figure 2-2* below. Note that only the Integra-E/E2/E3 flange orientation determines the resulting polarization, while the antenna flange is circular and accepts both polarizations.
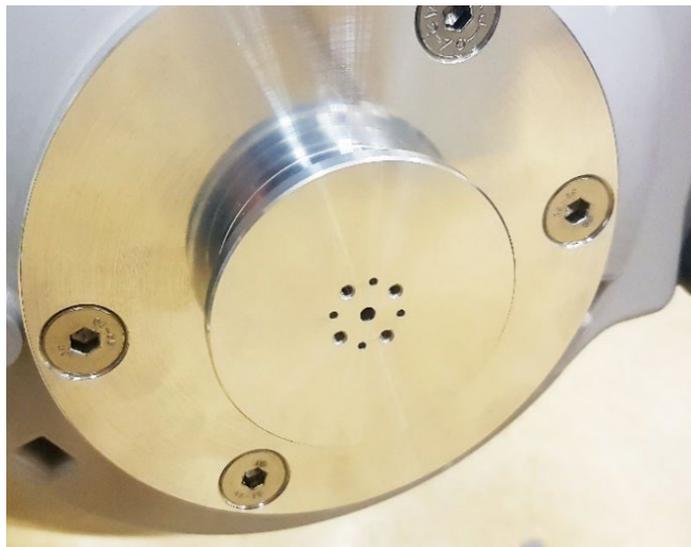
Figure 2-2 SAF2 flange

To determine the polarization, look at FODU **before** installation. Polarization is shown by the engraved arrow on the FODU flange. Please see *Figure 2-3*, which depicts the horizontal polarization set.
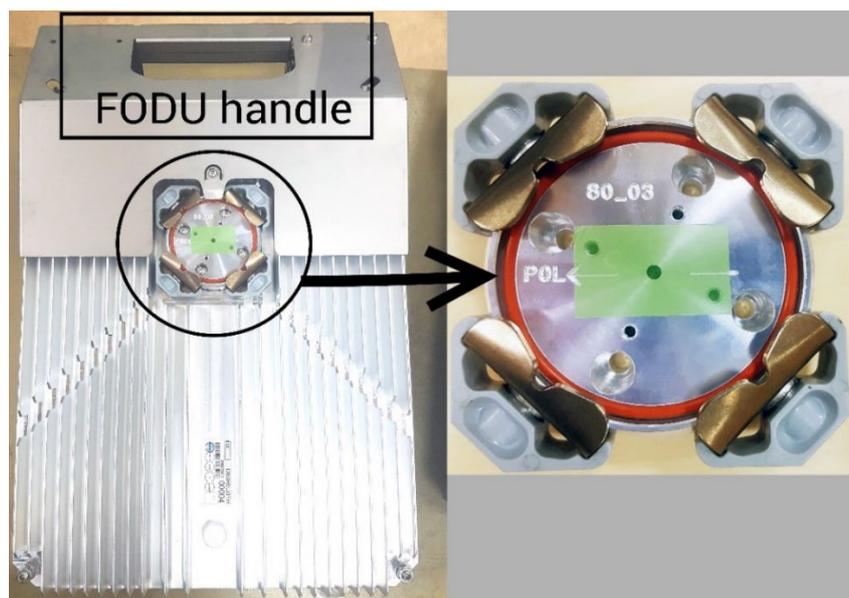
Figure 2-3 FODU with horizontal polarization

To change the polarization, it is required to use securing clamp P/N D0S80FIX01_ADG_01 please see *Figure 2-4.* For availability, please contact the SAF sales representative.

ITEM NO.	PartNo	Rev.	Description	QTY.
1	D0K80FIX01.001	DDG_01	Plate with rubber cushion	1
2	M5x45		Hexagon flat point socket screw A2 DIN 913	2
3	Nut M5		Coupling nut DIN 6334 Steel Zinc plated	2
4	Nut wrench 8		S=8 mm	1
5	Allen key 2.5		Hex 2.5 mm DIN911	1
6	Allen key 4		Hex 4mm DIN 911	1
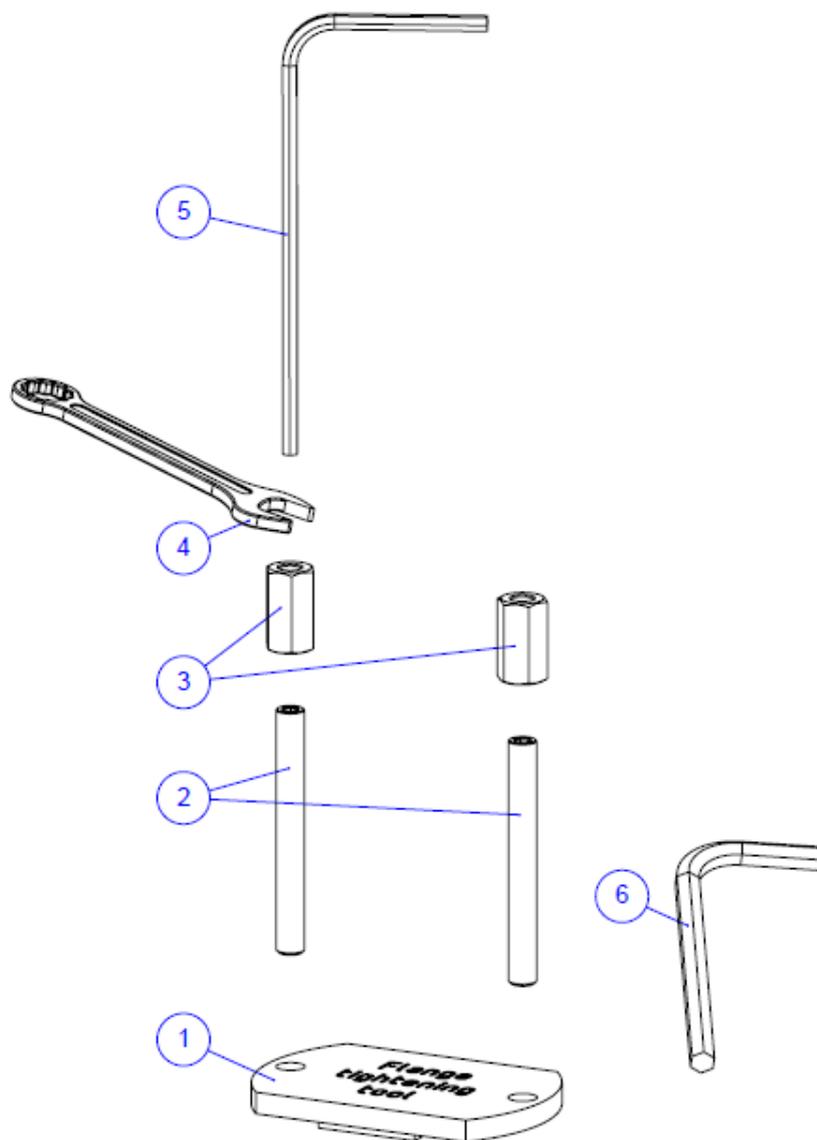
Figure 2-4 Securing plate with rubber cushion

For polarization change instructions please refer to the picture below, see *Figure 2-5*.
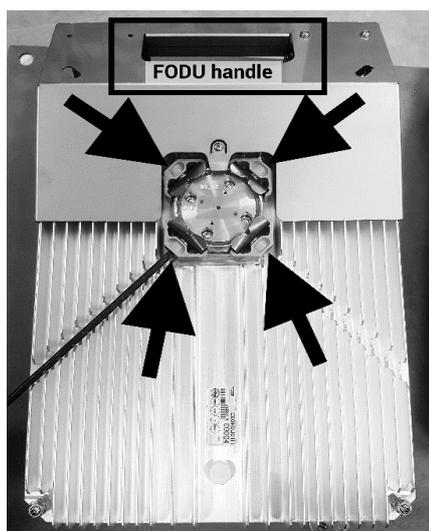
1 Screw in FODU flange clamp screws with supplied Locking key up to lock position. Do not tighten.
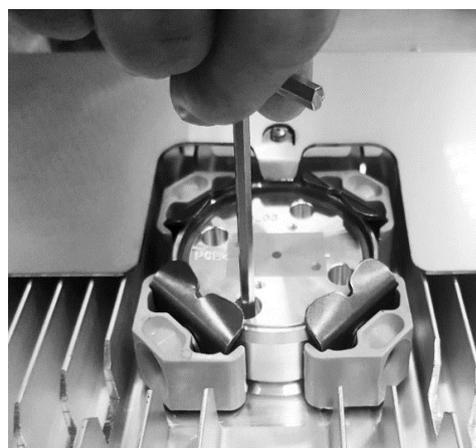
2 Unscrew 4 screws with 4mm Allen key 4 (6) holding FODU flange.

3 Take out flange by tilting up part opposite to the FODU handle.
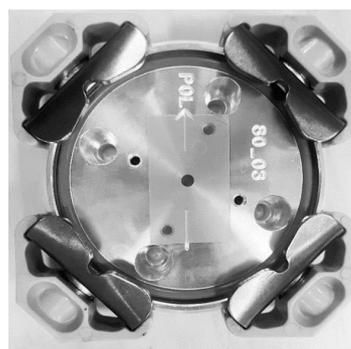
4 Turn flange by 90° to change polarization.
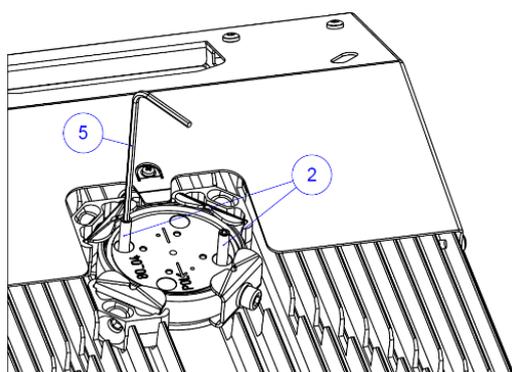
5 Using allen key (5), screw in two hexagon flat point socket screws (2). Do not tighten.
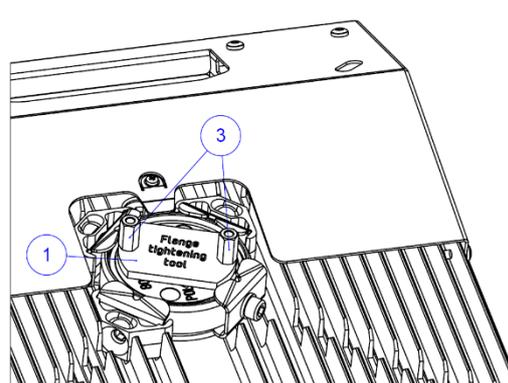
6 Place D0K80FIX01.001 plate with rubber cushion (1) - rubber cushion down - and screw on coupling nuts (3).
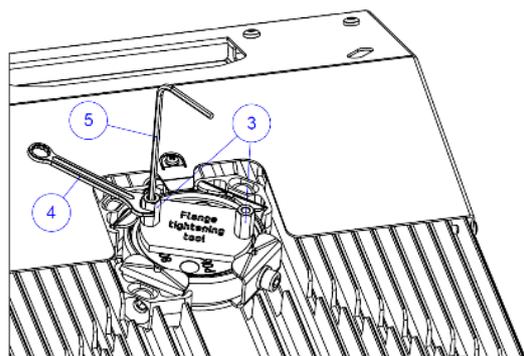
7 Fix hexagon flat point socket screws (2) using allen key (5), tighten coupling nuts (3) gradually and equally using nut wrench (4) with force not exceeding 5Nm/ 3.69 ft-lb.
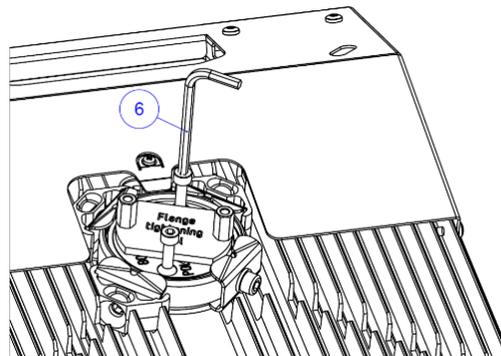
8 Screw in equally and gradually two unscrewed bolts (step 2) using allen key (6) with force not exceeding 4Nm/2.95 ft-lb.
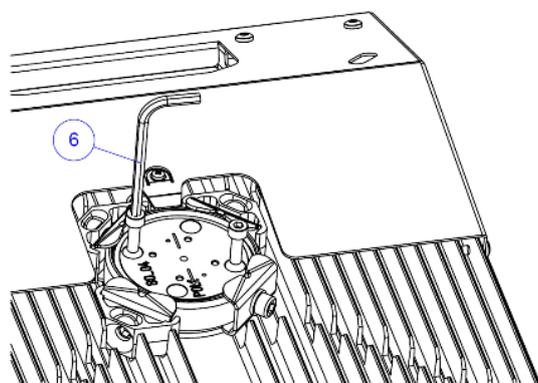
9 Remove plate with rubber cushion (1), hexagon flat point socket screws (2), and coupling nuts (3) and screw in equally and gradually remaining two unscrewed bolts (step 2) using allen key (6) with force not exceeding 4Nm/2.95 ft-lb.

Figure 2-5 Polarization change procedure

⚠ We strongly recommend putting a permanent mark of polarization on FODU back cover for easy recognition later on. You can use supplied Integra Tx polarization sticker D0KGEE01.024.

Before attaching FODU to the antenna flange, peel off the protective sticker, see *Figure 2-6*.
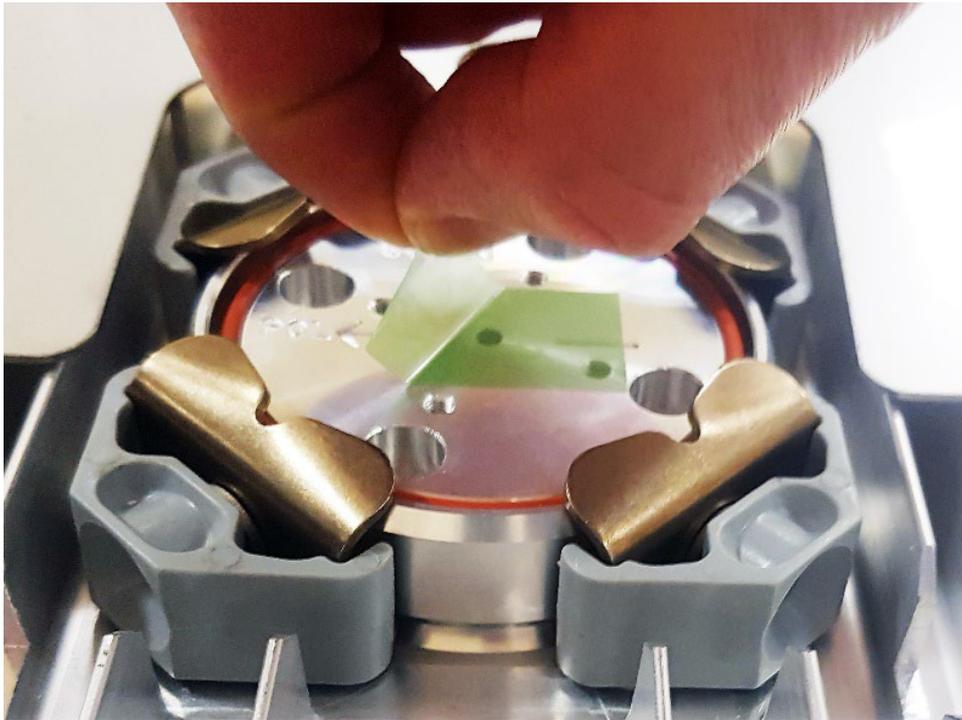
Figure 2-6 Peel off the sticker before installation

⚠️ Find antenna adjustment recommendations in the link below: *Antenna Alignment Whitepaper*. Note that 80GHz antennas have a very narrow beamwidth, hence sweeping must be done very slowly and carefully. Before alignment switch off ATPC, ACM and variable Tx power. After achieving the calculated Rx level, configure ACM, ATPC and variable Tx power according to the link requirements.

⚠️ If any further assistance is required, please contact techsupport@saftehnika.com

Attaching FODU to the antenna

Please follow the steps described in the *Figure 2-7* below:
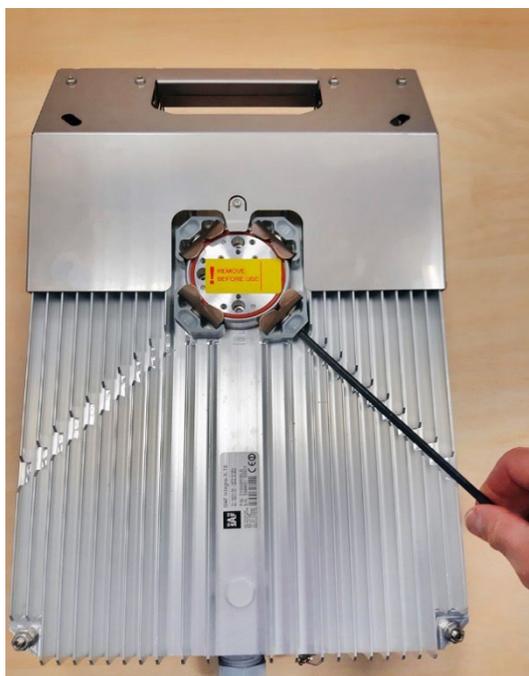
1   Use the locking key. Screw in clamp tensioner bolts but don't tighten. Loosen two upper bolts on side of the handle by 2 turns, and two bolts on the bottom side by 4 turns.

2   Remove the protective sticker from the FODU diplexer flange. Check also SAF2 flange on the antenna for a sticker. If it is not a permanent one, remove it too.
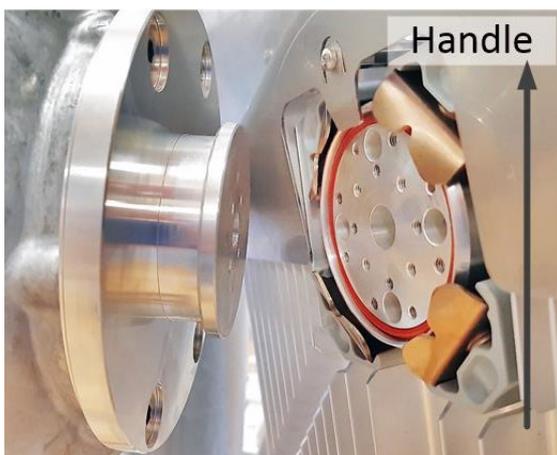
3   Make sure that O-ring is in place. Holding Integra-E/E2/E3 by handle attach it to SAF2 flange by hanging on upper tensioners.
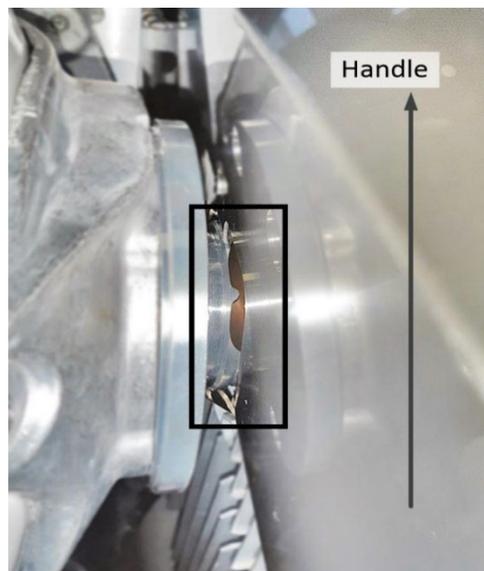
4   Hang Integra-E/E2/E3 on upper tensioners on SAF2 flange. Push lower part until lower clamps touch the flange. Make sure that all 4 clamps are in the proper position and the FODU diplexer presses to SAF2 flange.

5   Tighten all four clamp bolts with 3Nm/2.2-foot lbs force.

6   Assembled Integra-E/E2/E3 view. Cables must always be at the bottom of the Integra-E/E2/E3.

Figure 2-7 Attaching Integra-E/E2/E3 to the antenna

Grounding connection

Always provide a good connection from FODU grounding screw to tower/mast/building grounding circuit. For further details see Chapter *Grounding connection.*

For further information on surge protection and grounding of Integra FODU please refer to *Lightning Protection Guide.*

Connecting FO interface using a fiber conduit kit

1   Fiber conduit kit.

2   Unscrew the cap of the SFP port (LAN2 or LAN3) that will be used and install an SFP module.
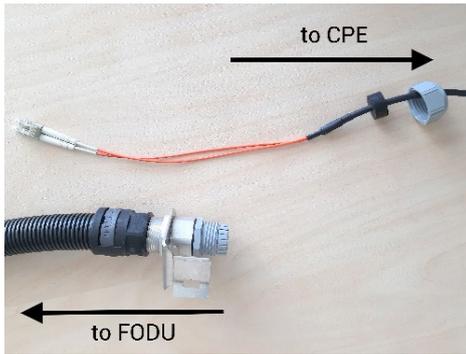
3 Disassemble conduit kit and put its parts in the correct sequence on the cable.
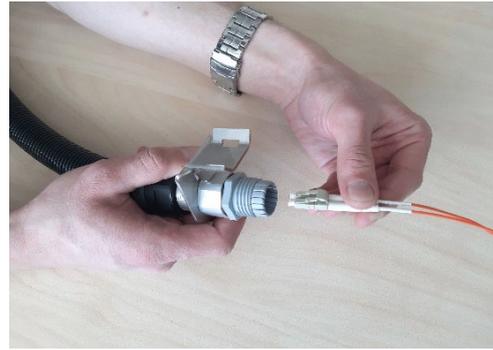
4 Push FO cable with LC connector through the conduit. Use protective covers for the LC connector optics.

5 Remove protective covers from the LC connector and connect the connector to SFP module.

6 Tighten parts on both ends of the conduit to weatherproof assembly. Do not break the cable.

7 Fasten another end of fiber conduit to the pole using included tie-wrap.

8 Assembled view of the Integra-E/E2/E3 with optical cable conduit. Cables must always be at the bottom of the Integra-E/E2/E3.

Figure 2-8 optical cable conduit assembly

⚠ If any further assistance is required, please contact *techsupport@saftehnika.com*

Chapter 3 : WEB GUI

Initial configuration

Powering Integra-E/E2/E3 FODU and connecting to PC

There are three options for powering the Integra-E/E2/E3 FODU as shown in *Figure 3-1*.

Option #1: an Ethernet cable from SAF Tehnika **I0ATPI43** PoE injector connected to the RJ-45 port (LAN1) of Integra-E/E2/E3 FODU.

The combined length of the Ethernet cable from CPE to PoE injector ("DATA" port on PoE injector) and from Integra-E/E2/E3 to PoE injector ("DATA+PWR" port on PoE injector) should not exceed 100m. It is recommended to use good quality outdoor rated STP/FTP Cat 5e or better Ethernet cable from a reputable manufacturer (for details see Chapter *RJ-45 port*).

> ⚠ Use 5-10A rated type B circuit breaker in the chain between the power supply and the PoE injector for isolating each radio powered by the same PSU in case of a surge.

When powered, the RSSI LED will light up a solid green color for approx. 20s. Afterward, RSSI LED will go out for approx. 35s and eventually start blinking indicating the current Rx level. Please refer to Chapter *RSSI LED* for further details on blinking patterns and corresponding Rx levels.

For details on SAF Tehnika PoE injectors, their connection scheme, settings, specifications, and more see: *Description of SAF produced PoE injectors* .

Option #2: a 2-wire DC power supply connected to the 2-wire DC power port of Integra-E/E2/E3 FODU using the supplied 2-pin pluggable terminal block (P/N XSPR_184). All three LAN ports are available for user traffic. Integra-E/E2/E3 can be powered using 36…57V DC, with power consumption up to 50W. See *Table 8-3* for suitable cable diameter and length.

For cable lengths, mechanical and electrical specifications for power cable and connector see Chapter *2-wire DC power port*.

Option #3: use both DC and PoE power interfaces simultaneously for power line and power supply redundancy.

For uninterrupted and hitless power supply failover operation on the Integra radio, there is only 1 possible power connection configuration: SAF Tehnika **DXATPI03** PoE injector is used as the main power source (note that it should be used only in PoE 120W mode), but DC power supply as the standby power source. For more details and best connection practices of hitless redundancy for Integra radio see: *Integra radio power connection redundancy.*

Connecting Integra radio power supply

The example below shows Integra-E/E2 power supply options.
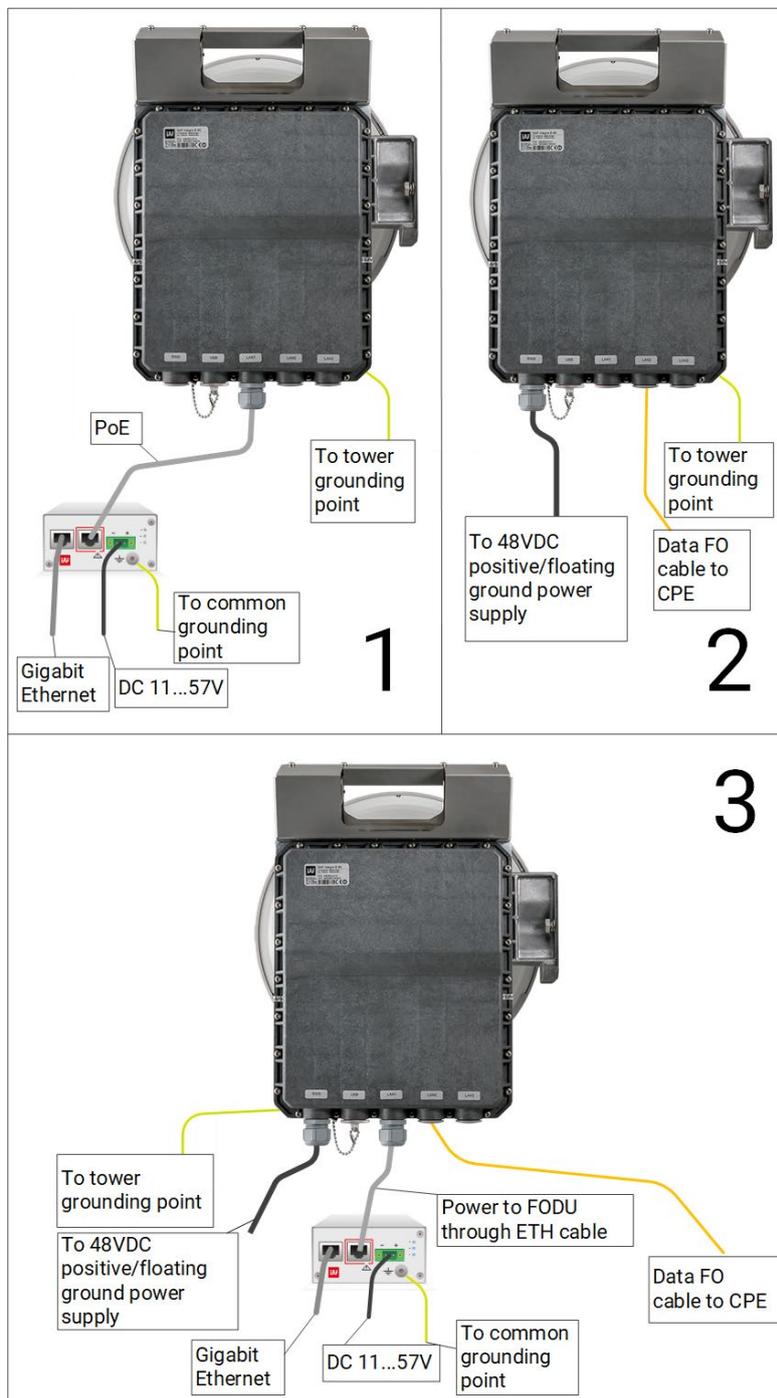
Figure 3-1 Power connection to FODU

> ⚠️ For Ethernet cables longer than 30 meters it is recommended to make grounding points each 20…30 meters.

System requirements

To access the Integra-E/E2/E3 Web GUI you will need a PC with the following Web browser:

- Google Chrome;
- Mozilla Firefox;
- Internet Explorer 8 (or above)

Ethernet management connection configuration

Before proceeding with the initial link setup in the Web GUI, you must set the IPv4 settings of your LAN adapter to 192.168.205.0/24 subnet. The IP address should differ from the default low/high side IP addresses (192.168.205.10/192.168.205.11).
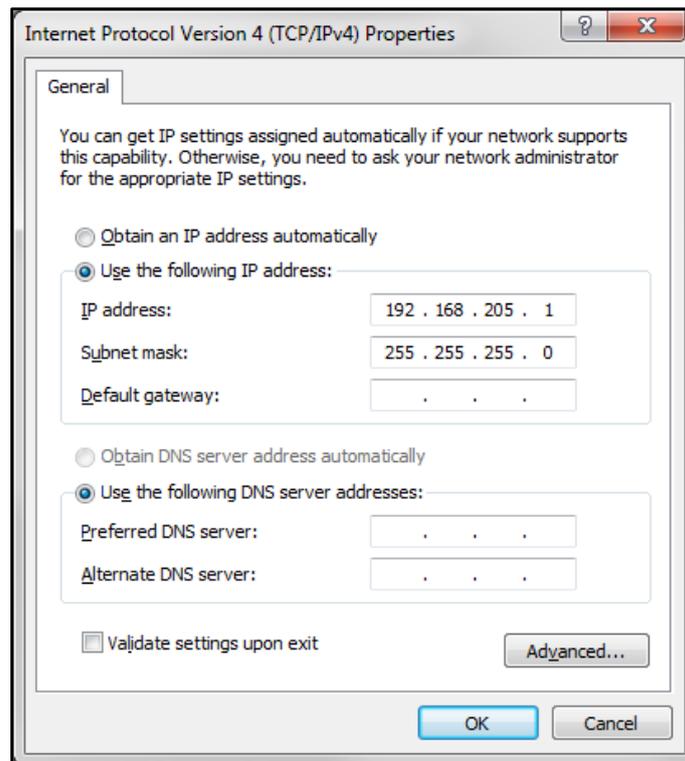
Figure 3-2 LAN adapter setup

After applying these settings you are ready to connect to the Web GUI or establish an SSH/Telnet connection, please check *Chapter 4: COMMAND LINE INTERFACE* for details on how to connect to other CLI interfaces (serial, SSH, Telnet).

Accessing Web GUI

1) Launch your browser and in the address field enter Integra-E/E2/E3 FODU IP address. Default IP addresses are as follows:
- 192.168.205.10 for low side Integra-E/E2/E3 FODU (P/N D80R∗∗∗∗L)
- 192.168.205.11 for high side Integra-E/E2/E3 FODU (P/N D80R∗∗∗∗H)

Figure 3-3 Browser's address field

⚠ For secure connection use *https://* prefix.

2) Press "Enter" key.
3) The login screen will appear:
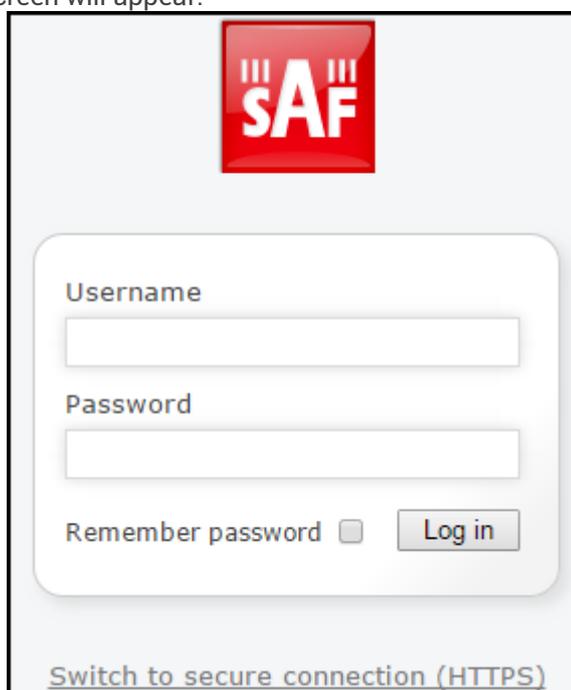
Figure 3-4 Login screen

4) Enter the username and password. Default credentials are as follows:
- Username: **admin**
- Password: **changeme**

5) Select "Remember password" if you want the browser to remember entered login credentials.
6) Press "Log in" button.

⚠ "Switch to secure connection (HTTPS)" indicates that HTTP protocol is being used. Press the link and you will be redirected to a secure HTTPS URL.
A self-signed OpenSSL certificate is being used.

Main page

After login you will be automatically redirected to the Main page of Web GUI:
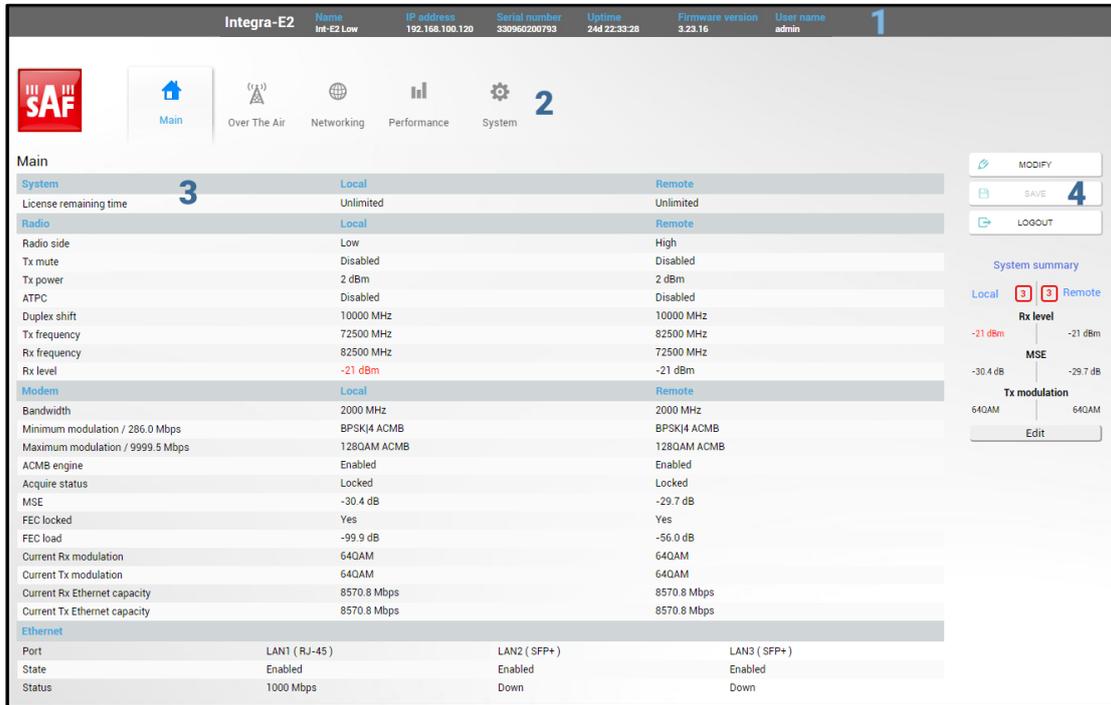
Figure 3-5 Main page

Web GUI is divided into 5 sections:

1) **Top panel** - shows information about the Integra-E/E2/E3 FODU you are connected to including:
   - Model name. Please refer to *Labeling* for more info.
   - System name
   - IP address
   - Serial number
   - Uptime
   - Firmware version
   - User name
2) **Menu panel** - allows navigating between 5 configuration sections:
   - *Main page*
   - *Over The Air* (Radio/modem configuration)
   - *Networking* (Ethernet configuration)
   - *Performance*
   - *System*
3) **Main Web GUI window** - contents will change according to the menu panel selection. By default, the main page ("Main") is shown.
4) **MODIFY / SAVE / LOGOUT** - allows modifying parameters in the main window. If none can be modified, MODIFY button appears inactive. After modification SAVE button becomes active and indicates the number of unsaved changes as well as their type (when moving the cursor over the button). LOGOUT button will logout from the current session.

⚠️ If you do not save the configuration after modification, it will be lost after FODU restart

System summary - shows one to four (default value – three) selected parameters of the local and remote systems.

> Values appear in red color in case of exceeding alarm threshold values (*Performance →
> Alarm → Alarm threshold configuration*) or in case of a warning (e.g., if loopback is active).
>
> Values appear in orange color in case alarm threshold values were exceeded during the last 15 seconds.
>
> Values with ⚠ are modified by enabled automation (e.g., ATPC, LSP, or Backup-link configuration and status). Move the mouse over the sign for further details.

The two square indicators show the number of active alarms on local and remote radios. The indicator is colored green if no alarms ("0") are present, and it is colored red if alarms are present. By pressing on the local alarm count the *Performance → Alarm → Alarm status* section is opened.
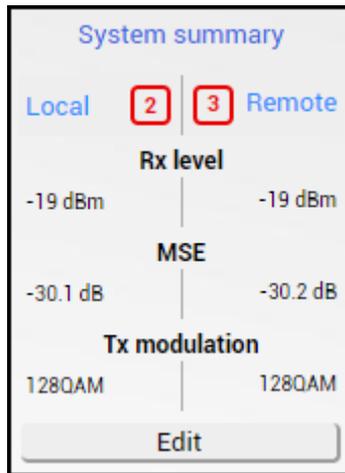
Figure 3-6 System summary

By pressing "Edit button" you can change displayed parameter count and parameters by choosing from the dropdown box.

Modifying basic system parameters

To proceed with the initial configuration, press the MODIFY button and the entry fields will appear for adjustable values:

Figure 3-7 Main page Integra-E/E2/E3 – modify mode

1) Tx power - the available range depends on the radio model, modem profile and selected modulation. The actual range will be indicated in brackets. If a Variable Tx power bandwidth profile was selected, the available range is the maximum Tx power at 4QAM modulation when ACMB downshift occurs. See: *Appendix A: Technical specifications* for further details.

2) Tx frequency - the available range depends on the frequency band, subband, radio side and channel bandwidth selected. The actual range will be indicated in brackets.

3) Tx frequency range indicates the range of central frequencies for the configured channel bandwidth.

4) The default frequency range (indicated on the label, see *Labeling*) is defined for 62.5MHz channel bandwidth.

5) Bandwidth - allows choosing between available channel bandwidth options along with the indication of Tx power mode – fixed or variable – in case ACMB profile is chosen. The options must match on both ends of one link. Bandwidths, marked with LDPC, are available for all the Integra-E2/-E3 radios and the Integra-E radios only if the modem has a firmware version starting with "110".

   The Integra-E/E2/E3 modem firmware version can be checked in CLI using the command "modem" based on the first value of "Firmware version" parameter:

   >modem
   Site A> Firmware Version   = 100.7.131 - Chip revision 0x00

where "100" designates no availability of LDPC modem profiles.
or

Site A> Firmware Version   = 110.5.5 - Chip revision 0x04

where "110" designates the availability of LDPC modem profiles.

6) Modem profile - allows choosing between "ACMB range" and "Fixed" modem profiles.
   If "ACMB range" is selected, specify minimum and maximum ACMB modulation.
   If "Fixed" is selected, specify fixed modulation from the list.
   ACMB stands for Adaptive Coding and Modulation and Bandwidth and enables the adaptive modulation change according to MSE value. If the modulation order reaches BPSK, ACMB will reduce bandwidth two-fold (/2) or four-fold (/4).
   Please refer to Chapter *ACMB (Adaptive Coding and Modulation and Bandwidth)* for further details.

7) State - allows enabling/disabling each of three available LAN ports.

8) Execute - by pressing „*Execute configuration",* changes made to the corresponding section apply only to the local side Integra-E/E2/E3. If „*Rollback on"* is selected, the configuration will be reverted in case erroneous configuration changes are applied.

> ⚠ Rollback triggers when configuration changes are applied interrupt management connectivity. For this reason, rollback will not work if the remote side of the link is not reachable.

Pressing „*Execute for both"* applies changes made to the corresponding section both for local and remote side Integra-E/E2/E3 FODUs.

Parameters on Main page

Main			
System		**Local**	**Remote**
License remaining time	1	Unlimited	Unlimited
Radio		**Local**	**Remote**
Radio side	2	Low	High
Tx mute	3	Disabled	Disabled
Tx power	4	4 dBm	4 dBm
ATPC	5	Disabled	Disabled
Duplex shift	6	10000 MHz	10000 MHz
Tx frequency	7	73500 MHz	83500 MHz
Rx frequency	8	83500 MHz	73500 MHz
Rx level	9	-18 dBm	-19 dBm
Modem		**Local**	**Remote**
Bandwidth	10	2000 MHz	2000 MHz
Minimum modulation / 9999.5 Mbps	11	128QAM	128QAM
Maximum modulation / 9999.5 Mbps	12	128QAM	128QAM
ACMB engine	13	Disabled	Disabled
Acquire status	14	Locked	Locked
MSE	15	-30.1 dB	-30.2 dB
FEC locked	16	Yes	Yes
FEC load	17	-57.2 dB	-41.9 dB
Current Rx modulation	18	128QAM	128QAM
Current Tx modulation	19	128QAM	128QAM
Current Rx Ethernet capacity	20	9999.5 Mbps	9999.5 Mbps
Current Tx Ethernet capacity	21	9999.5 Mbps	9999.5 Mbps
Ethernet			
Port	22	LAN1 (RJ-45)	LAN2 (SFP+)	LAN3 (SFP+)
State	23	Enabled	Enabled	Enabled
Status	24	1000 Mbps	Down	Down

Figure 3-8 Main page

1) ***License remaining time*** – shows the amount of time (in seconds) remaining for active time-limited license; in case of unlimited time license, "Unlimited" is shown.

> ⚠ When the license expires, the link capacity will drop to 2 Mbps, and you will see a warning.

2) ***Radio side*** – shows the radio side of the local and remote Integra-E/E2/E3.

3) ***Tx mute*** – Tx shows if the transmitter is currently muted ("Enabled") or active ("Disabled").

4) ***TX power*** – shows current transmitter power in dBm.

5) **ATPC** – shows if ATPC is enabled or disabled.
6) **Duplex shift** – shows the margin between the transmitting and receiving frequencies.
7) **Tx frequency** – shows the transmitting frequency.
8) **Rx frequency** – shows the receiving frequency.
9) **Rx level** – shows the current level of the received signal. It must not differ significantly from the previously calculated value.
10) **Bandwidth** – shows the width of currently utilized bandwidth in MHz along with additional modem profile features. "Variable Tx power" stands for ACM profile with increased Tx power when modulations are downshifted. "LDPC" stands for LDPC modem profiles (only available for modem firmware starting with "110.xx.xx").
11) **Minimum modulation** – minimum modulation for given modem profile / bitrate for minimum modulation.
12) **Maximum modulation** – maximum modulation for given modem profile / bitrate for maximum modulation.
13) **ACMB engine** – shows the status of ACMB engine.
14) **Acquire status** – indicates the acquired status of the modem. During normal operation, "Locked" will be shown.
15) **MSE** – shows Mean squared error value lower value means better signal quality.
16) **FEC locked** – shows whether Forward Error Correction algorithm is working and the number of corrected errors is significantly higher compared to uncorrected errors.
17) **FEC load** – shows the load of Forward Error Correction.
18) **Current Rx modulation** – current received signal modulation.
19) **Current Tx modulation** – current transmitted signal modulation.
20) **Current Rx Ethernet capacity** – ingress capacity of the WAN port, depends on current Rx modulation and bandwidth.
21) **Current Tx Ethernet capacity** – egress capacity of the WAN port, depends on current Tx modulation and bandwidth.
22) **Port** – Name and interface type of the Ethernet port, RJ-45 or SFP/SFP+.
23) **State** – Ethernet port state – Enabled or Disabled. An exclamation mark designates the restricted state of the port. Move the mouse pointer over the icon to see the explanation.
24) **Status** – Ethernet port status, up or down (if the port is enabled).

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

radio [status]	Use to show radio status.
radio power <Tx power>	Use to set Tx power in dBm.
radio frequency <frequency>	Use to set Tx frequency in kHz.
modem allowed show <profile name>	Use to check modem profile parameters.
modem configuration set <bandwidth> <min_mod> <max_mod>	Use to set modem configuration – bandwidth, minimum and maximum modulation.
modem configuration set factory	Use to reset modem settings to factory defaults – bandwidth and modulation will be reset to a minimum.
radio factory	Use to reset radio settings to factory defaults – Tx power will be disabled and frequencies set to factory defaults.
network port show info	Use to show the status of all ports.
network port show config	Use to show the configuration of all ports.
network port set <port> **admin-state** {enable|disable}	Use to enable or disable a particular port.

Over The Air

Over The Air → Radio → Configuration

The Radio configuration page allows to define the main radio and modem parameters such as Tx power (Tx mute) and bandwidth/modulation, as well as to enable ATPC and ACMB functionality. It also allows to configure RSSI LED indicator.
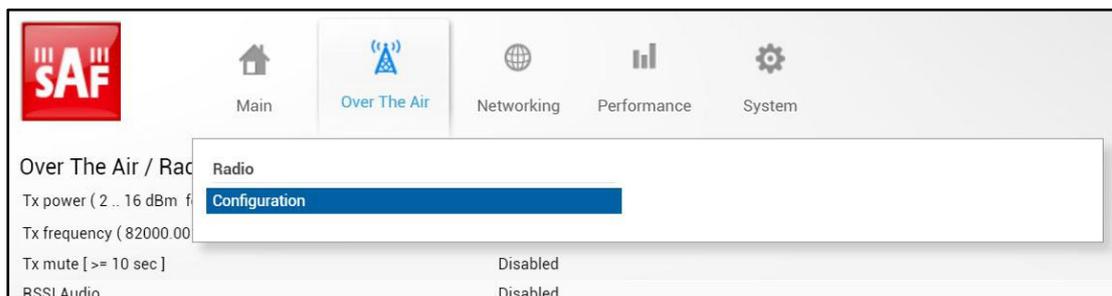
Figure 3-9 Accessing Radio configuration page

Status mode

Figure 3-10 Radio configuration - status mode

Press ✏️ **MODIFY** button.
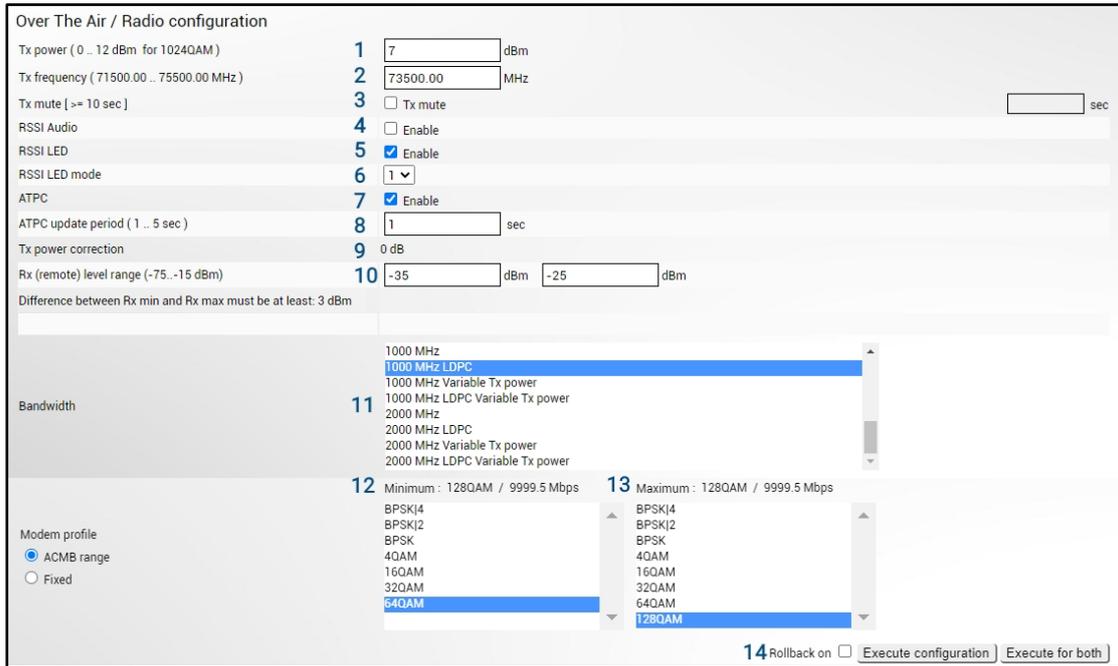
Modify mode

Figure 3-11 Radio configuration - modify mode

1) **Tx power** – Indicates current Tx (transmit) power value (status mode); allows specifying Tx power value (modify mode). The usable range is indicated in the brackets. The ⚠️ sign could indicate that momentary Tx power value on output was adjusted by ATPC. Move the mouse over the sign for further details.

2) **Tx frequency** – Indicates current configured Tx (transmit) frequency (status mode); allows specifying Tx frequency (modify mode). Available center Tx frequencies for chosen bandwidth are shown in the brackets.

3) **Tx mute [>=10 sec]** – Indicates whether Tx mute is enabled or disabled (status mode); allows muting the transmitter to the limited time interval in seconds (modify mode). The minimum value is 10 seconds. Note that the transmitter will be muted only if a valid value in seconds is entered. If enabled, the data link is interrupted.

4) **RSSI Audio** – Indicates whether RSSI audio is enabled or disabled (status mode); allows disabling or enabling RSSI audio (modify mode). RSSI audio is available using the 3.5mm jack beside the USB port. By default, RSSI Audio is disabled. Please refer to Chapter *RSSI/audio port* for further details.

5) **RSSI LED** – Indicates whether the RSSI LED is enabled or disabled (status mode); allows disabling or enabling RSSI LED operation (modify mode). By default, the RSSI LED is enabled. Please refer to Chapter *RSSI LED* for further details.

6) **RSSI LED mode** – Indicates which RSSI LED mode is active (status mode); allows selecting RSSI LED operation mode (modify mode). By default, Mode 1 is enabled. Please refer to Chapter *RSSI LED* for further details.

7) **ATPC** – Indicates whether ATPC (Automatic Transmit Power Control) is enabled (status mode); allows enabling/disabling ATPC (modify mode). By default, this feature is disabled. Please refer to Chapter *ATPC (Automatic Transmit Power Control)* for further details.

8) **ATPC update period** – Indicates the ATPC update period (status mode); allows defining the period in seconds with which ATPC parameters are being updated (modify mode). By default, the update period is 5 seconds. The range

is 1…5 seconds. The field is modifiable only when ATPC is enabled. Please refer to Chapter *ATPC (Automatic Transmit Power Control)* for further details.

9) ***Tx power correction*** - displays the amount of transmitter power in decibels ATPC has currently corrected.

10) ***Rx (remote) level range (-75..-15dBm)*** – Indicates minimum and maximum Rx level of the remote side Integra-E/E2/E3 for ATPC operation (status mode); allows defining the minimum and maximum Rx level of the remote side Integra-E/E2/E3 (modify mode). At least a 3dB difference between min and max values should be specified. ATPC Tx power correction will be performed only in case of exceeding configured thresholds. Values should be defined between -75 and -15 dBm, recommended range is -35…-25. The field is modifiable only when ATPC is enabled. Please refer to Chapter *ATPC (Automatic Transmit Power Control)* for further details.

⚠️ The minimum Rx level threshold should be set at least 10dB above the sensitivity threshold to avoid ACMB/ATPC switching loops.

11) ***Bandwidth*** – Indicates currently configured available channel bandwidth (status mode); allows choosing between available profiles according to the ETSI standard of channel bandwidth (modify mode). Please refer to Chapter *ACMB (Adaptive Coding and Modulation and Bandwidth)* for the explanation of fixed/variable Tx power modes. The options must match on both ends of one link. Bandwidths, marked with LDPC, are available for all the Integra-E2/-E3 radios and the Integra-E radios only if the modem has firmware version "110.xx.xx". The Integra-E/E2/E3 modem firmware version can be checked in CLI using command "*modem*" based on the first value of "Firmware version" parameter:

>modem

Site A> Firmware Version   = 100.7.131 - Chip revision 0x00

where "100" designates the unavailability of LDPC modem profiles;

or

Site A> Firmware Version   = 110.5.5 - Chip revision 0x04

where "110" designates the availability of LDPC modem profiles.

12) ***Minimum modulation***– currently configured minimum modulation (status mode); allows defining the minimum modulation for ACMB (modify mode). Selection is not available in case "Fixed" modulation is chosen. Please refer to Chapter *ACMB (Adaptive Coding and Modulation and Bandwidth)* for the explanation of fixed/variable Tx power modes.

13) ***Maximum modulation*** - currently configured maximum modulation (status mode); allows defining the maximum modulation for ACMB (modify mode). Selection is not available in case "Fixed" modulation is chosen. Please refer to Chapter *ACMB (Adaptive Coding and Modulation and Bandwidth)* for the explanation of fixed/variable Tx power modes.

14) By pressing „*Execute configuration",* changes made to the corresponding section apply only to the local side of Integra-E/E2/E3. If „*Rollback on"* is selected, the configuration will be reverted in case erroneous configuration changes are applied.

Pressing „*Execute for both"* applies changes made to the corresponding section both for local and remote side Integra-E/E2/E3 FODUs.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

radio [status]	Use to show radio status.
radio power <Tx power>	Use to set Tx power in dBm.
radio frequency <frequency>	Use to set Tx frequency in kHz.

radio tx-mute {<time>|disable}	Use to mute the transmitter at a specific time in seconds or unmute. If you mute Tx, the link synchronization will be lost for a given time.
radio rssi-led {disable | enable }	Use to enable or disable RSSI LED operation
radio rssi-led enable mode {1|2|3}	Use to enable or disable the RSSI LED's operation. Example: "radio rssi-led Enable Mode 2" enables LED on FODU in mode 2. Please refer to Chapter *RSSI LED* for further details.
rssi-audio {enable|disable}	Use to enable or disable rssi-audio. Please refer to Chapter *RSSI/audio port* for further details.
radio atpc state {enable|disable}	Use to enable/disable ATPC.
radio atpc status	Use to check ATPC status.
radio atpc delay <1..5>	Use to define ATPC update period.
radio atpc rx_level <-75..-43> <-72..-40>	Use to define ATPC remote Rx level min and max thresholds.
modem configuration set <bandwidth> <min_mod> <max_mod>	Use to set modem configuration – bandwidth, minimum and maximum modulation.
modem configuration set factory	Use to reset modem settings to factory defaults – bandwidth and modulation will be reset to a minimum.
modem loopback [{none | digital <time>}]	Use to check, disable, or enable modem loopback for n seconds.
modem allowed show <profile name>	Use to check modem profile parameters.
radio factory	Use to reset radio settings to factory defaults – Tx power will be disabled and frequencies set to factory defaults.
radio upgrade <firmware>	Use to upgrade the radio firmware version. The firmware file must be located in the FTP directory.
radio version	Use to check the radio software version.

Over The Air → Security → AES encryption

Enabling AES encryption provides payload data encryption over the air using Advanced Encryption Standard (AES).

For more details see *AES - Advanced Encryption Standard section* in *Chapter 5: FUNCTIONAL DESCRIPTION.*
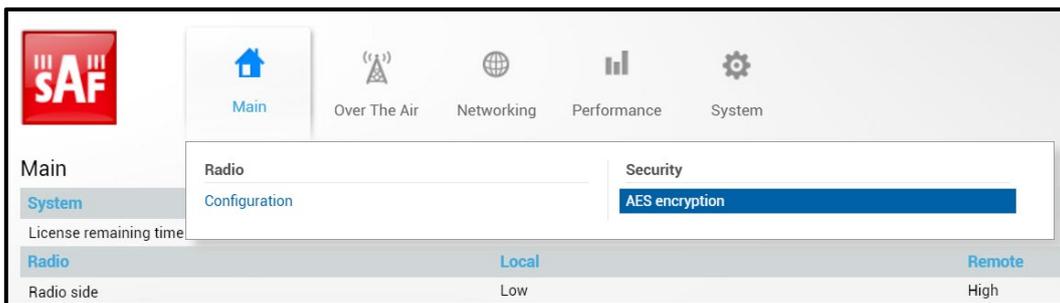
Figure 3-12 Accessing AES encryption configuration page

> ⚠ AES encryption is available only in Integra-E3 model.

Status mode

Over The Air / AES encryption
AES IS ENABLED **1**

AES 256 bit key (64 hexadecimal characters)
e7337e86f7af42d2df0599a8c0c7c5496f90640d208c0a375aba0e1f0ddfda29 **2**

Figure 3-13 AES encryption page in Status mode

Press MODIFY button.

Modify mode

Over The Air / AES encryption

☑ Enable **1**

AES 256 bit key (64 hexadecimal characters)
Generate random key | 587838efa46e67cd6b62adf0e69e55c753498611097a58637b14831eb19bb04e | **2**

3 Rollback on ☐ Execute configuration
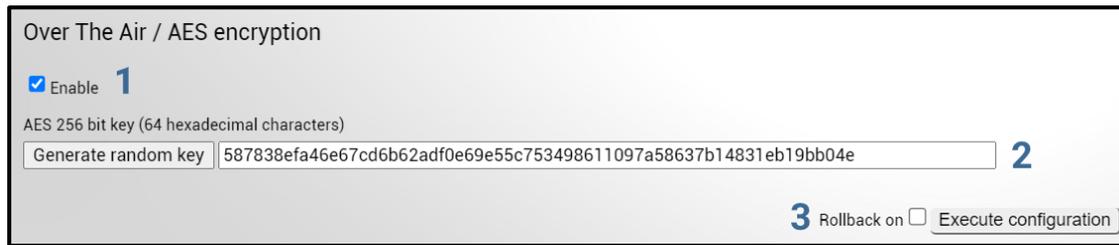
Figure 3-14 AES encryption page in Modify mode

1) Allows enabling/disabling AES encryption function.
2) **AES 256 bit key (64 hexadecimal characters)** – Indicates AES key used and allows to set or generate a random key. The key should be exactly 64 hexadecimal characters long. A dialog window will not allow more than 64 characters.
3) By pressing „*Execute configuration*", changes made to the corresponding section apply only to the local side Integra-E3. If „*Rollback on*" is selected, the configuration will be reverted in case erroneous configuration changes are applied.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

aes counters	Use to show AES counters.
aes key <64hexkey>	Use to set AES 256-bit key (64 hex characters).
aes random_key	Use to generate random AES key.
aes state {enable | disable}	Use to set AES state.
aes status	Use to show AES state, key and statistics.

Activation of AES for Integra-E3 FODU

1) Upload and activate license key enabling AES functionality:

⚠️ Skip this step if the AES license is already uploaded.

a) Go to "System→Tools→License management" on the remote side of the link.
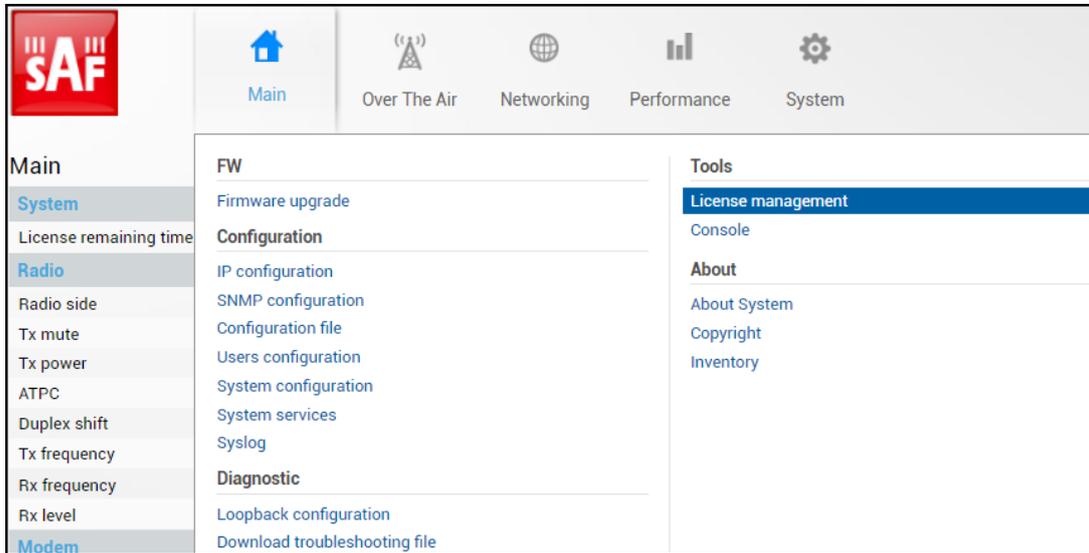
Figure 3-15 Accessing Licence management page

b) Press 🖉 MODIFY button.
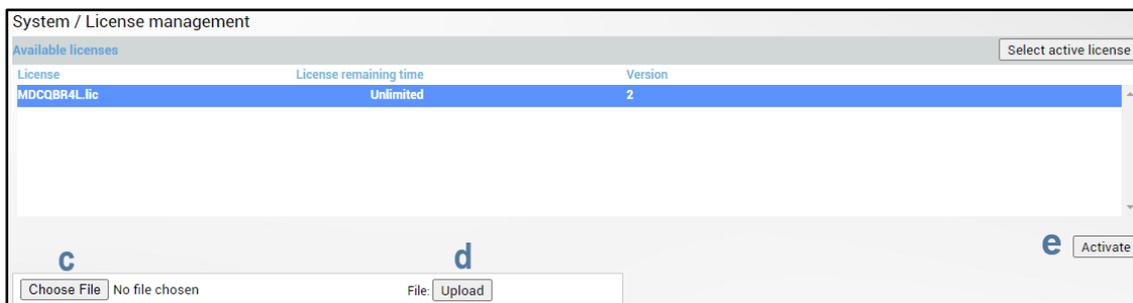
Figure 3-16 License management page in Modify mode

c) Locate *.lic license file on your hard disk drive.
d) Upload selected *.lic license file.
e) Select the uploaded *.lic license file from the list and press "Activate".
f) Repeat a)-e) for the local side of the link.

2) Apply AES 256-bit key:
a) Go to "Over The Air→Security→AES encryption" on the remote side of the link.
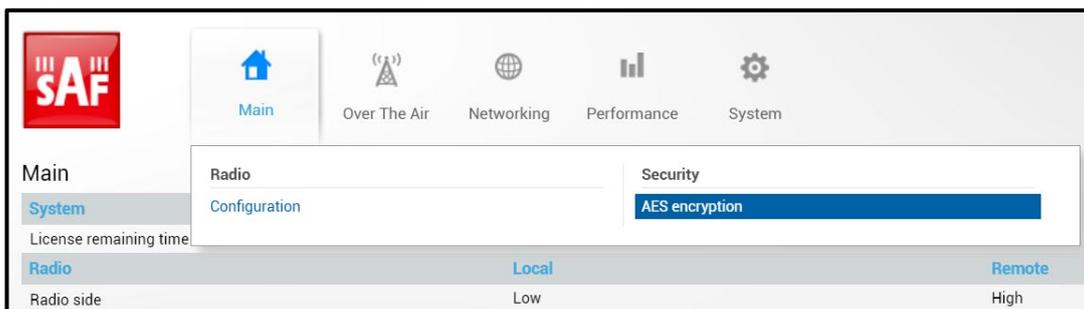
Figure 3-17 Accessing AES encryption page

b) Press ✎ MODIFY button.

Figure 3-18 AES encryption page in Modify mode

c) Select the "Enable" checkbox.
d) Enter a 64-symbol key consisting of hexadecimal values (0-9, A-F) or press "Generate random key" button.
e) Select and copy the generated key.
f) Press "*Execute configuration*" button.
g) Repeat steps a)-e) for the local side of the link using the same copied AES key.

Networking

Networking → Ethernet → VLAN
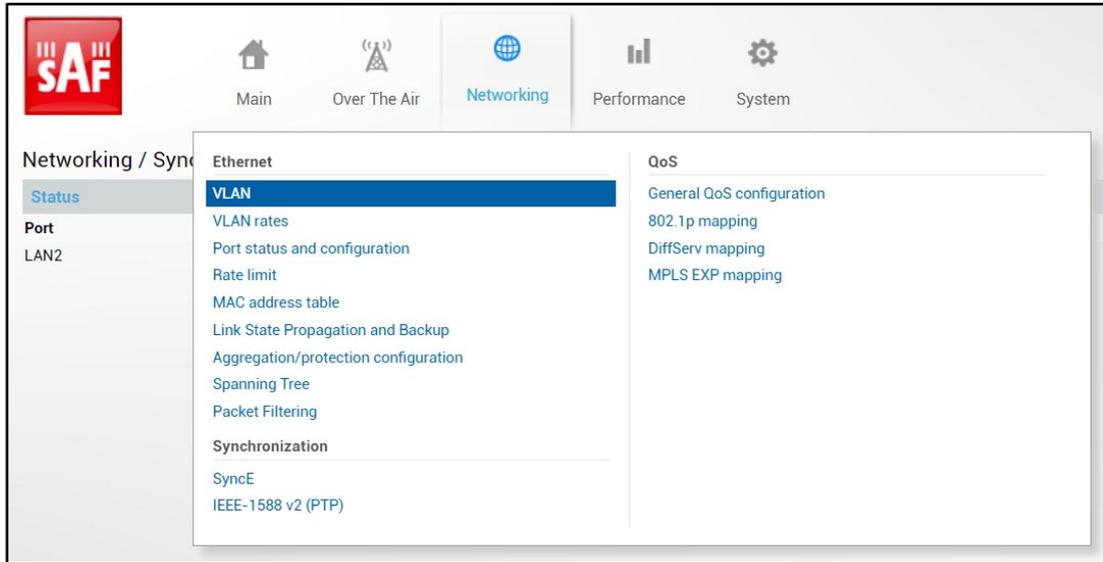
Figure 3-19 Accessing VLAN configuration page

The VLAN configuration page provides the configuration of port-based Ethernet Virtual Local Area Networks (VLANs), allowing up to 4094 different VLAN IDs. It is possible to set VLAN IDs as tagged or untagged members on each LAN port.

To add a VLAN tag to untagged packets on ingress direction, "Default VLAN" (2) should be specified. By default, the "Default VLAN" value on all ports is VLAN ID 1.

Status mode

Figure 3-20 VLAN – status mode

Press ✏️ MODIFY button.

Modify mode

Figure 3-21 VLAN – modify mode

1) **VLAN mode** – Indicates VLAN operational mode. The default is "Disable" – 802.1Q disabled. Change to "Enable" to enable 802.1Q VLAN support. Change to "QinQ" to enable 802.1ad QinQ (Double Tagging) VLAN support.

⚠️ As soon as you enable VLAN operational mode, connectivity with untagged traffic will be lost.

2) **Default VLAN** – Indicates Default VLAN IDs on LAN and WAN ports (status mode); allows specifying the default VLAN ID on each of LAN and WAN ports (modify mode). Specified VLAN ID will be added to untagged ingress packets. VLAN ID will be removed according to the tagged/untagged configuration, of that particular port. Allows configuring VLAN priority 0…7.

3) **QinQ settings** – this panel becomes visible only when QinQ VLAN mode is selected, allowing to configure QinQ settings, TPID (Etype) selection between 0x88a8, 0x9100 and 0X9200.

⚠️ Note that only the "outer" VLAN ID will be accepted by the MNG port, see **8) MNG** below.

4) **Name** – Indicates configured (if assigned) VLAN ID or VLAN ID range names (status mode); allows entering a name for each entry, i.e. individual VLAN ID or VLAN ID range (modify mode).

5) **VID (1 .. 4094)** – Indicates configured VLAN IDs and VLAN ID ranges (status mode); allows entering individual VLAN IDs or VLAN ID ranges, e.g. "100-300", "500" (modify mode).

6) **VLAN rates** – Indicates configured VLAN rate (status mode); allows to select a defined VLAN rate (modify mode). Please refer to the Chapter *Ethernet→Networking→VLAN* rates for further details.

7) **T/U/D** – Indicates whether VLAN ID entries are configured in U - untagged (access) mode, T - tagged (trunk) mode, or D - disabled (status mode); allows changing VLAN mode on LAN and WAN ports (modify mode). Changing from T to U will change the previous untagged VLAN ID on the same port to T (trunk) mode and will highlight this change in yellow color. Note that only a single U (untagged) VLAN ID can be configured on each available port. Also, U (untagged) mode is not available on WAN port.

8) **MNG** – indicates management VLAN ID (status mode); allows specifying which individual VLAN ID will be used for management access (modify mode). The management port is an access port on the Integra-E/E2/E3 switch for the Integra-E/E2/E3 management CPU.

9) **Add –** press "Add" to add a VLAN, press red cross (✖) to delete VLAN entry.

10) By pressing „*Execute configuration",* changes made to the corresponding section apply only to the local side of Integra-E/E2/E3. If „*Rollback on"* is selected, the configuration will be reverted in case erroneous configuration changes are applied.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

network vlan set mng <1…4094>	Use to set Management (MNG) VLAN ID.
network vlan set mode {disable | enable | qinq}	Use to set VLAN operation mode. "disable" – packets ingress/egress unmodified; "enable" – packets are handled according to VLAN configuration; "qinq" – QinQ functionality will be enabled.
network vlan set mode qinq inner_mng {<1 – 4095> | disable}	Use to set VLAN QinQ C-Tag for management traffic ("disable" if unused).
network vlan set mode qinq tpid {0x88a8 | 0x9100 | 0x9200}	Use to set VLAN QinQ Ethernet Type ID in hex.

network vlan set vid <1…4094> **add** {tagged|untagged} {LAN1|LAN2|LAN3|WAN}	Use to add VLAN ID as a tagged (trunk) or untagged (access) type on a specified port.
network vlan set vid <1…4094> **delete** {LAN1|LAN2|LAN3|WAN}	Use to delete VLAN ID on a specified port.
network vlan set vid <1…4094> **name** <name>	Use to name a VLAN ID. The same name can be applied for multiple VLAN IDs.
network vlan set default vid <1…4094>	Use to set default VLAN ID for untagged packets.
network vlan show summary	Use to show the general VLAN configuration summary.
network vlan show default	Use to show the configuration of untagged packets.
network vlan show mng	Use to show Management (MNG) VLAN ID.
network vlan show mode	Use to show current VLAN operational mode and custom EtherType ID.
network vlan show vids	Use to show currently configured VLAN IDs on all ports.

Networking → Ethernet → VLAN rates
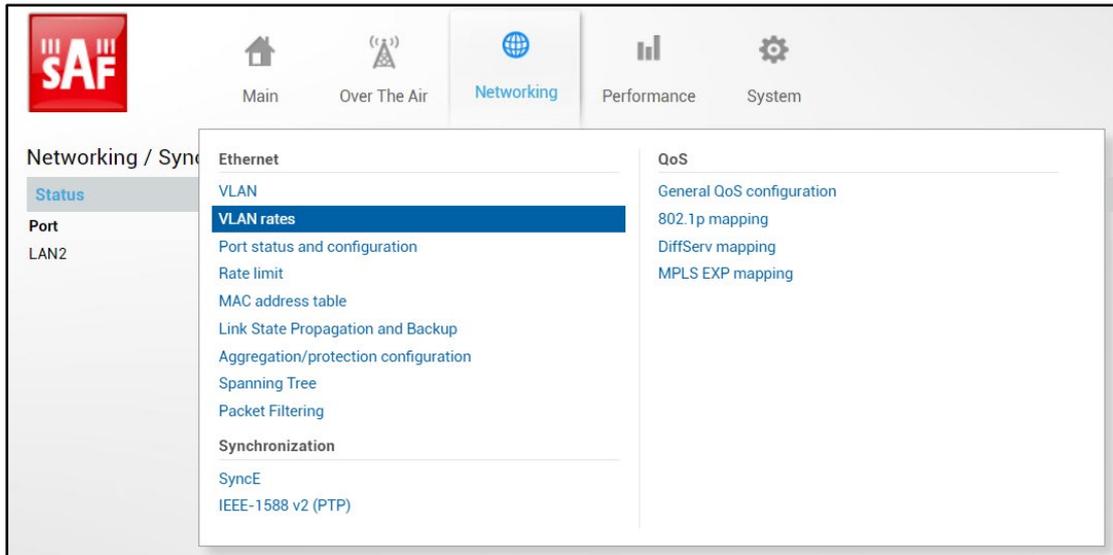
Figure 3-22 Accessing VLAN rates page

The VLAN rates page allows configuring rates for selected VLANs.

Status mode

Figure 3-23 VLAN rates – status mode

Press ✏ MODIFY button.
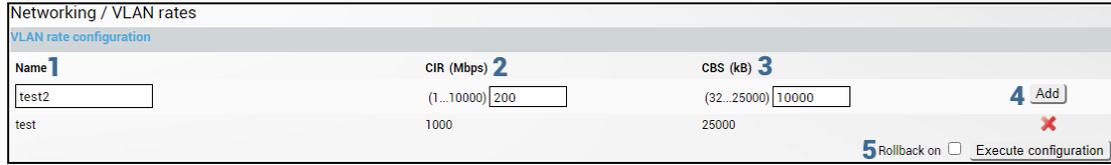
Modify mode

Figure 3-24 VLAN rates – modify mode

1) **Name** – Indicates whether the egress rate is enabled or disabled on a particular VLAN (status mode); allows enabling/disabling egress rate on a particular VLAN (modify mode).
2) **CIR (Mbps)** – Indicates configured rate CIR (Committed Information Rate) on a particular VLAN rate item in Mbps (status mode); allows setting rate CIR on a particular VLAN rate item in Mbps (modify mode).
3) **CBS (kB)** – Indicates configured rate CBS (Committed Burst Size) on a particular VLAN rate item in kB (status mode); allows setting rate CBS on a particular VLAN rate item in kB (modify mode).
4) **Add / Delete** – Press "Add" to add entered VLAN rate or press red cross (×) to delete this entry.
5) By pressing „*Execute configuration*", changes made to the corresponding section apply only to the local side Integra-E/E2/E3. If „*Rollback on*" is selected, the configuration will be reverted in case erroneous configuration changes are applied.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

network vlan show rates	Use to show created rate profiles.
network vlan set rate {add|delete} <name> **cir** <1000…1000000kbps> **cbs** <32…671kB>	Use to create new or delete existing rate configuration profiles. Please refer to Chapter *Networking → Ethernet → VLAN* to apply the created rate profile to a VLAN ID.

Networking → Ethernet → Port status and configuration
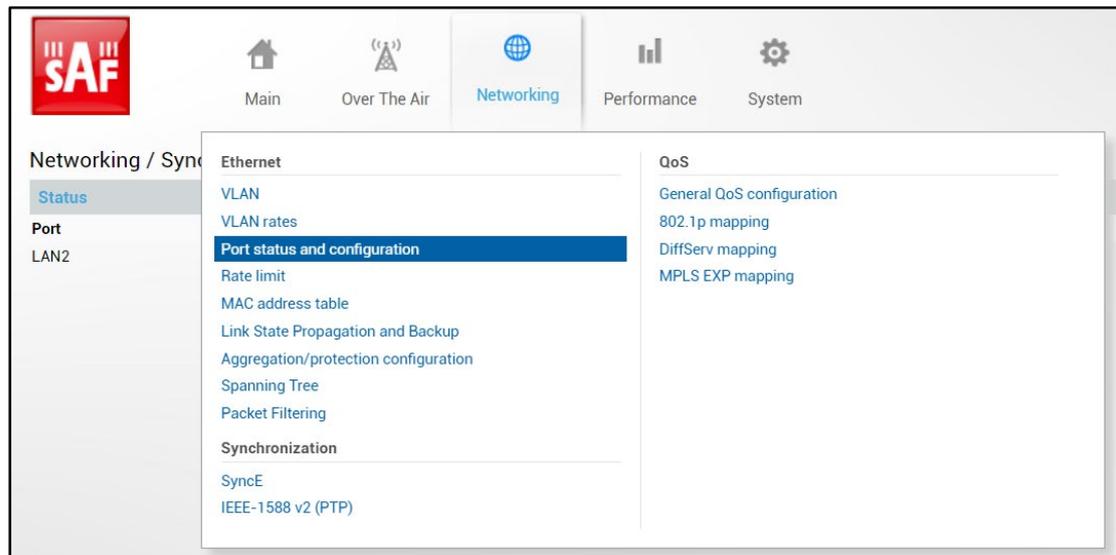
Figure 3-25 Accessing Port status and configuration page

Shows the status of Ethernet switch ports, allows enabling and disabling the ports, modifying link speed, and see SFP information if available, see (5). Please ask your SAF representative or contact us on *info@saftehnika.com* about compatible SFP/SFP+ modules.

Status mode

Figure 3-26 Port status and configuration – status mode

Press ✐ MODIFY button.

Modify mode

Figure 3-27 Port status and configuration – modify mode

1) **Port** – Indicates available switch ports.
2) **State** – Indicates operation status of each LAN port (status mode); allows enabling/disabling each LAN port (modify mode).
3) **Link status** – Indicates whether a link with the appropriate port is established as well as its link speed.
4) **Link speed** – Indicates whether link speed is configured to automatic speed setting or manual (status mode); allows changing link speed to the manual setting (modify mode). SFP ports (LAN2/LAN3) should be set to manual 1G, 2G5 or 10G setting.
5) **SFP module specification** – shows SFP module specification by pressing "+" sign if a particular SFP module is supported.
6) By pressing „*Execute configuration*", changes made to the corresponding section apply only to the local side Integra-E/E2/E3. If „Rollback on" is selected, the configuration will be reverted in case erroneous configuration changes are applied.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

network port show info	Use to show the status of all ports.
network port show config	Use to show the configuration of all ports.
network port set <port> **admin-state** {enable|disable}	Use to enable or disable a particular port.
network port set LAN1 speed {auto|100fdx|10fdx}	Use to change speed and duplex setting on LAN1 port. The default value is "auto" (auto-negotiation).
network port set LAN{2|3} **speed** {auto|10G|1G|2G5}	Use to change speed and duplex setting on LAN2 and LAN3 port. The default value is "auto" (auto-negotiation).

Networking → Ethernet → Rate limit

The rate limit page allows configuring ingress and egress rates on available Ethernet switch ports. In case a license with an Ethernet rate limitation is applied, the Ethernet limitation will be indicated as the egress rate of the WAN port.
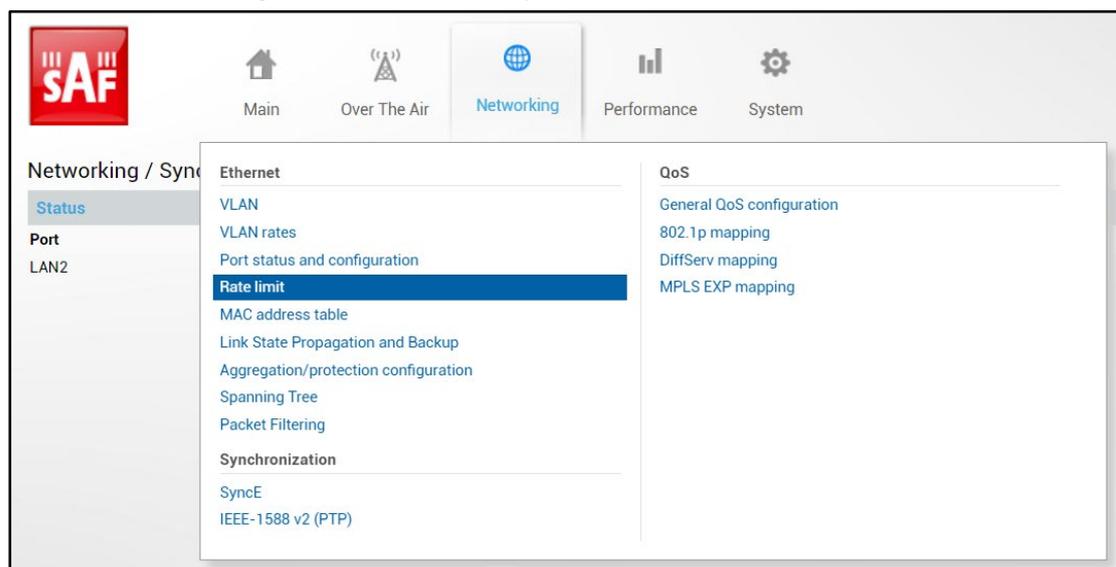
Figure 3-28 Accesing Rate limit page

Status mode

Figure 3-29 Rate limit – status mode

Press ✎ MODIFY button.

Modify mode

Figure 3-30 Rate limit – modify mode

1) **Egress rate / Status** – Indicates whether the egress rate is enabled or disabled on a particular port (status mode); allows enabling/disabling egress rate on a particular port (modify mode).
2) **Egress rate / CIR** – Indicates configured egress rate CIR (Committed Information Rate) on a particular port in Mbps (status mode); allows setting egress rate CIR on a particular port in Mbps (modify mode). The default setting is "1000".
3) **Egress rate / CBS** – Indicates configured egress rate CBS (Committed Burst Size) on a particular port in kB (status mode); allows setting egress rate CBS on a particular port in kB (modify mode). The default setting is "2000".
4) **Ingress rate / Status** – Indicates whether the ingress rate is enabled or disabled on a particular port (status mode); allows enabling/disabling ingress rate on a particular port (modify mode).
5) **Ingress rate / CIR** – Indicates configured ingress rate CIR (Committed Information Rate) on a particular port in Mbps (status mode); allows setting ingress rate CIR on a particular port in Mbps (modify mode). The default setting is "1000".
6) **Ingress rate / CBS** – Indicates configured ingress rate CBS (Committed Burst Size) on a particular port in kB (status mode); allows setting ingress rate CBS on a particular port in kB (modify mode). The default setting is "2000".
7) By pressing „*Execute configuration*", changes made to the corresponding section apply only to the local side Integra-E/E2/E3. If „Rollback on" is selected, the configuration will be reverted in case erroneous configuration changes are applied.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

network port show egress-rate <port>	Use to show egress rate limit settings and status of a particular port.
network port show ingress-rate <port>	Use to show ingress rate limit settings and status of a particular port.
network port set LAN1 egress-rate cir <96…1000000kbps> **cbs** <64…2056kB>	Use to set Committed Information Rate (CIR) and Committed Burst Size (CBS) setting for egress rate limit on LAN1 port.
network port set <LAN2|LAN3> **egress-rate cir** <96…10000000kbps> **cbs** <64…2056kB>	Use to set Committed Information Rate (CIR) and Committed Burst Size (CBS) setting for egress rate limit on LAN2 or LAN3 port.
network port set LAN1 ingress-rate cir <96…1000000> **cbs** <64…2056>	Use to set Committed Information Rate (CIR) and Committed Burst Size (CBS) setting for ingress rate limit on LAN1 port.
network port set <LAN2|LAN3> **ingress-rate cir** <96…10000000> **cbs** <64…2056>	Use to set Committed Information Rate (CIR) and Committed Burst Size (CBS) setting for ingress rate limit on LAN2 or LAN3 port.
network port set <port> **egress-rate state** {enable|disable}	Use to enable or disable egress rate limiting on a particular port.
network port set <port> **ingress-rate state** {enable|disable}	Use to enable or disable ingress rate limiting on a particular port.

In case the configured egress rate on WAN interface is below link capacity, a warning indication will be visible on the Main page. In the example shown below the rate limit is set 7000Mbps while the total link capacity is 9999.5Mbps.

Modem	Local	Remote
Bandwidth	2000 MHz	2000 MHz
Minimum modulation / 9999.5 Mbps	128QAM	128QAM
Maximum modulation / 9999.5 Mbps	128QAM	128QAM
ACMB engine	Disabled	Disabled
Acquire status	Locked	Locked
MSE	-30.1 dB	-30.1 dB
FEC locked	Yes	Yes
FEC load	-42.3 dB	-57.0 dB
Current Rx modulation	128QAM	128QAM
Current Tx modulation	12⚠ WAN port egress rate configured to 7000 Mbps due to user	128QAM
Current Rx Ethernet capacity	99	9999.5 Mbps
Current Tx Ethernet capacity	⚠ 9999.5 Mbps	9999.5 Mbps

Figure 3-31 Rate limit warning on Main page

Networking → Ethernet → MAC address table

The MAC address table displays the forwarding table of MAC addresses learned by the switch (Dynamic) and manually entered (Static).
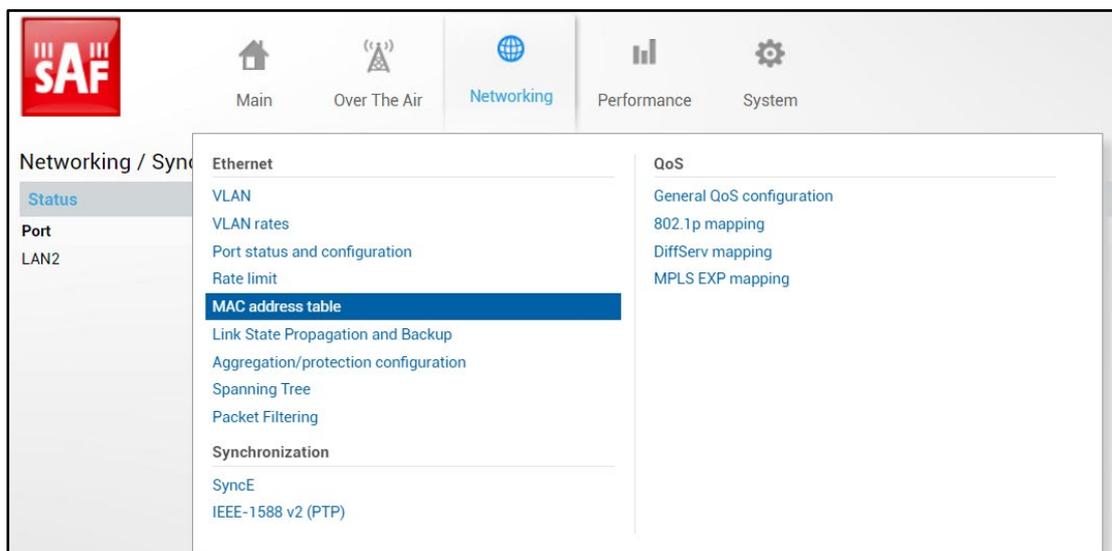
Figure 3-32 Accessing MAC address table page

Status mode

Figure 3-33 MAC address table - status mode

Press ✎ **MODIFY** button.

Modify mode

Figure 3-34 MAC address table - modify mode

1) Use to clear the dynamic MAC address table on a particular port ("Clear") or all ports simultaneously ("Clear all").
2) Shows list of MAC address entries (status mode); allows clearing specific MAC address entry (modify mode).

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

network mac table clear all	All – Clear all records from the MAC address table.
network mac table clear port <port>	Use to clear MAC table entries for a specific port.
network mac table info	Show information about MAC address table.
network mac table show	Show content of the MAC address table.

Networking → Ethernet → Link State Propagation and Backup

Link State Propagation (LSP) and Backup page provides functionality described in Chapter *Link State Propagation and Backup*.
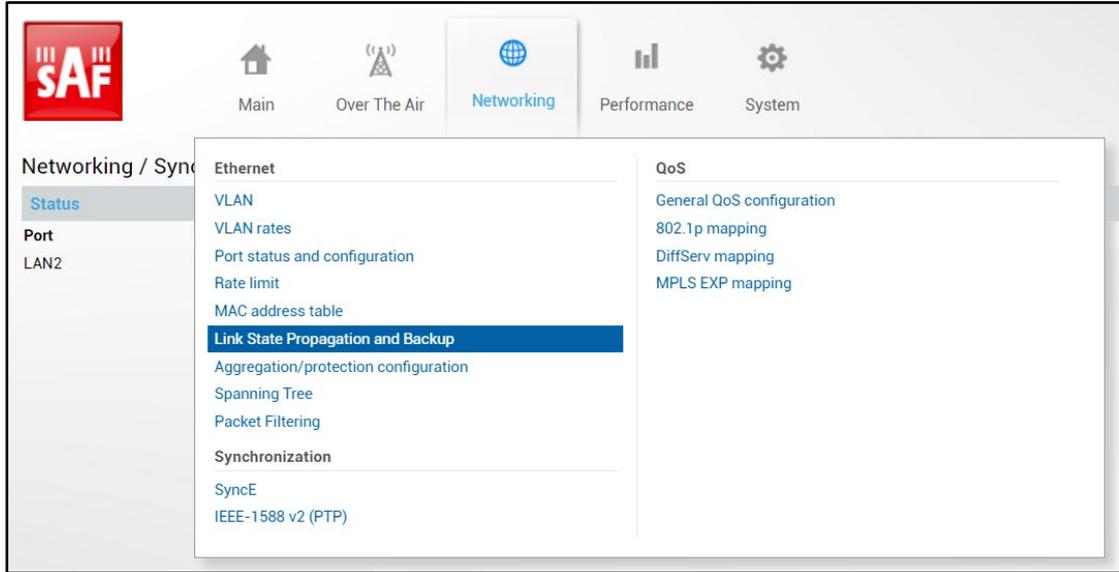
Figure 3-35 Accessing Link State Propagation and Backup page

Link State Propagation and Backup status window in LSP Enabled state

Figure 3-36 LSP – status mode

The example above shows that "Link State Propagation" is enabled, but port status change is not triggered.

Press ✎ **MODIFY** button.

Link State Propagation and Backup modify window for LSP Enabled state configuration

Figure 3-37 LSP – modify mode

1) **State**:

        Disable – LSP and backup Disabled (default state).

        Enable LSP – LSP enabled.

        Enable Backup-link – Backup-link enabled.

        Enable Inverse Backup – Inverse backup state enabled.

        LSP Advanced – Advanced LSP state enabled.

> ⚠ MAC address table is cleared when the LSP is activated or deactivated.

2) **Mode** – specify a parameter for LSP triggering - Rx or Tx or Rx/Tx capacity.
3) **LSP ports** – select port(s) for LSP triggering.

> ⚠ LSP blocks LAN port and hence management may not be accessible when LSP is active.

4) **Min. required capacity** – used to specify minimal link Ethernet (Tx, Rx, Tx, or Rx) capacity threshold exceeding which LSP is triggered and configured LSP (LAN) port is blocked. The default value is "0", meaning that LSP is triggered only in case of synchronization loss.
5) **SyncLoss keepalive timeout** – LAN port shutdown delay after capacity has dropped below "Min. required capacity" or in case of synchronization loss and after exceeding "Min. required capacity" or synchronization recovery events.
6) **Startup timeout** – LSP activity delay after management CPU start-up and configuration script execution. During this period capacity drops or synchronization events are ignored.
7) **LAN auto recovery** – capacity drop below "Min. required capacity" and synchronization loss timeout after which port is enabled even if link capacity is still below the configured threshold or synchronization is still lost, otherwise, timeout is ignored. If the parameter is set to "0", the port will not be enabled until the actual link capacity exceeds configured "Min. required capacity" value or link synchronization is recovered (if "Min. required capacity" is 0).
8) By pressing „*Execute configuration*", changes made to the corresponding section apply only to the local side Integra. If „Rollback on" is selected, the configuration will be reverted in case erroneous configuration changes are applied.

For indications during LSP activation, please see the figures below:

Figure 3-38 LSP trigger off, normal operation

Figure 3-39 LSP active, LSP port/ports down

Figure 3-40 LSP trigger is on, LSP port/ports are up after the timeout "*LAN auto recovery*" ended

9) **LSP and Backup trigger** – LSP and backup trigger status:
　　　　On – LSP is triggered and active.
　　　　Off – LSP is inactive.
10) **Status of LSP ports**:
　　　　Up – ports in normal operational mode.
　　　　Down – LSP triggered, and LAN port is blocked.
11) **Acquire status** – local modem status.
12) **Remote Acquire status** – remote modem status.
13) **Current Rx Ethernet capacity** – Current ingress Ethernet capacity on Integra-E WAN port.
14) **Current Tx Ethernet capacity** – Current egress Ethernet capacity on Integra WAN port.

CLI commands for LSP state (Chapter 4: COMMAND LINE INTERFACE)

network lsp	Show LSP/backup status
network lsp status	Show LSP/backup status
network lsp state < advanced | backup | backup_inverse | disable | enable >	Changing LSP state: disable, enable LSP, enable Backup, enable Inverse Backup, enable LSP Advanced
network lsp set auto_recovery <0 - 600>	Set auto recovery timeout in seconds

network lsp set capacity <0 - 10000000>	Set minimal required WAN capacity, "0" for sync loss, kbps
network lsp set keep_alive <0 - 10>	Set "keep alive" timeout
network lsp set mode <rx> or <rx_tx> or <tx>	Select minimal required capacity direction
network lsp set port <add> or <remove> ports {LAN1, LAN2, LAN3}	Select LSP ports, add or remove LAN1, LAN2 or LAN3
network lsp set start_up <0-3600>	Set start up timeout, seconds

Link State Propagation and Backup modify window for Enable Backup-link state configuration
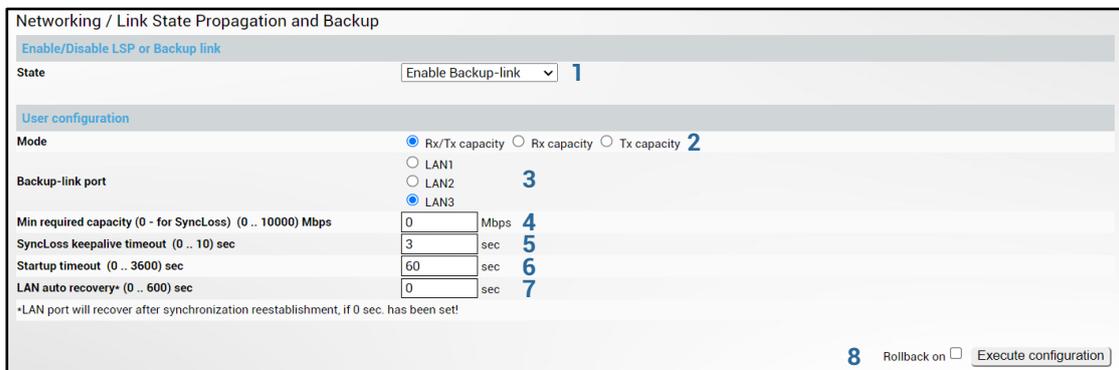
Figure 3-41 Backup-link – modify mode

1) **State**:

> **Disable** – LSP and Backup-link disabled (default state).
> **Enable LSP** – LSP enabled.
> **Enable Backup-link** – Backup-link enabled.
> **Enable Inverse Backup** – Inverse Backup state enabled.
> **LSP Advanced** – Advanced LSP state enabled.

⚠ WAN port is disabled while Backup-link is triggered and active.

⚠ MAC address table is cleared when the Backup-link is activated or deactivated.

2) **Mode** – specify a parameter for LSP triggering - Rx or Tx or Rx/Tx capacity.
3) **Backup-link port** – select a port for Backup-link.
4) **Min. required capacity** – used to specify minimal link Ethernet (Tx, Rx, Tx or Rx) capacity threshold exceeding which Backup-link is triggered and configured Backup-link (LAN) port is opened. The default value is "0", meaning that Backup-link is triggered only in case of synchronization loss.
5) **SyncLoss keepalive timeout** – Backup-link activation delay after capacity has dropped below "Min. required capacity" or in case of synchronization loss and after exceeding "Min. required capacity" or synchronization recovery events.
6) **Startup timeout** – Backup-link activity delay after management CPU start-up and configuration script execution. During this period capacity drops or synchronization events are ignored.
7) **LAN auto recovery** – after a defined time Backup-link is disabled and WAN enabled even if the link capacity is still below the configured threshold or synchronization is

still lost, otherwise, timeout is ignored. If the parameter is set to "0", the WAN port will not be enabled until capacity is exceeded, or link synchronization is recovered.

8) By pressing „*Execute configuration*", changes made to the corresponding section apply only to the local side Integra. If „Rollback on" is selected, the configuration will be reverted in case erroneous configuration changes are applied.

For indication when Backup-link is active, please see the figures below.

Figure 3-42 Backup-link trigger off

Figure 3-43 Backup-link active

Figure 3-44 Backup link status after the timeout "*LAN auto recovery*" ended

9) **LSP and Backup trigger** – LSP and backup trigger status:
       On – Backup-link is triggered and active.
       Off – Backup-link is inactive.
10) **Backup port link status**:
       Link Down – Backup-link is not active, Backup-link configured port is down.
       Active – Backup-link is triggered and active, Backup-link configured port is up and WAN port is in Discarding state.
11) **WAN Status** – WAN link status:
       Forwarding – WAN port is active, data transmission established through the WAN.
       Discarding – WAN port is not active, data switched to backup-link port.

> ⚠️ WAN port will be kept in a Forwarding state if the Backup-link configured port cannot be activated (link is down).

12) **Acquire status** – local modem status.
13) **Remote Acquire status** – remote modem status.
14) **Current Rx Ethernet capacity** – Current ingress Ethernet capacity on Integra WAN port.
15) **Current Tx Ethernet capacity** – Current egress Ethernet capacity on Integra WAN port.

CLI commands for Backup-link state (Chapter 4: COMMAND LINE INTERFACE)

network lsp	Show LSP/backup status
network lsp status	Show LSP/backup status
network lsp state < advanced | backup | backup_inverse | disable | enable >	Changing LSP state: disable, enable LSP, enable Backup, enable Inverse Backup, enable LSP Advanced

network lsp set auto_recovery <0 - 600>	Set auto recovery timeout in seconds
network lsp set backup_port <LAN1> or <LAN2> or <LAN3>	Select backup link port
network lsp set capacity <0 - 10000000>	Set minimal required WAN capacity, "0" for sync loss, kbps
network lsp set keep_alive <0 - 10>	Set "keep alive" timeout
network lsp set mode <rx> or <rx_tx> or <tx>	Select minimal required capacity direction
network lsp set start_up <0-3600>	Set start up timeout, seconds

Link State Propagation and Backup modify window for Enable Inverse Backup state configuration
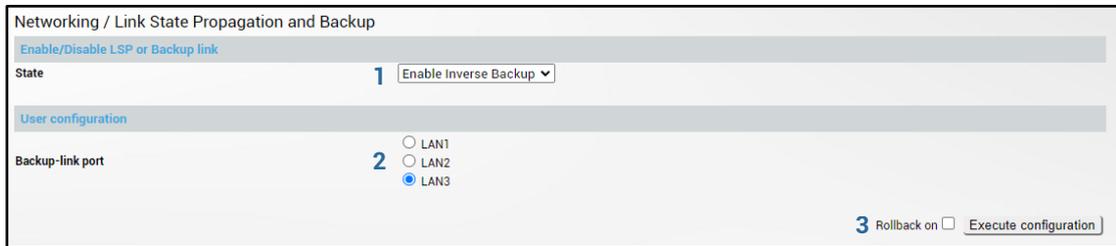
Figure 3-45 Enabling Inverse Backup

1) *State*:

> **Disable** – LSP and Backup-link disabled (default state).
> **Enable LSP** – LSP enabled.
> **Enable Backup-link** – Backup-link enabled.
> **Enable Inverse Backup** – Inverse Backup state enabled.
> **LSP Advanced** – Advanced LSP state enabled.

⚠ WAN port is disabled until Inverse Backup is triggered and active.

⚠ MAC address table is cleared when the Inverse Backup is activated or deactivated.

2) *Backup-link port* – select a port for Backup-link.
3) By pressing „*Execute configuration*", changes made to the corresponding section apply only to the local side Integra. If „Rollback on" is selected, the configuration will be reverted in case erroneous configuration changes are applied.

For indication when Inverse Backup is active, please see the figures below.

Figure 3-46 Condition trigger is off

Figure 3-47 Condition trigger is on, Local backup port is down, Backup link is active

Figure 3-48 Condition trigger is on, Remote backup port is down, Backup link is active

4) *Backup port link status*:

> *Link Down* – Main data link is not active, Backup-link configured port is down.
>
> *Inactive* – Main data link is not active, Backup-link configured port is up.
>
> *Active* – Backup-link is not triggered and not active, Backup-link configured port is up and WAN port is in Discarding state.

5) *Condition trigger (Local)*:

> *On* – Backup-link triggered and active.
>
> *Off* – Backup-link is inactive.

6) *Backup port status (Local)*:

> *Up* – Backup-link is not active, Backup-link configured port is up on local side.
>
> *Down* – Backup-link is triggered and active, Backup-link configured port is down and WAN port is in Forwarding state on local side.

7) *Acquire status* – local modem status.

8) *WAN Status* – WAN link status:

> *Forwarding* – WAN port is active, data transmission established through the WAN.
>
> *Discarding* – WAN port is not active, data switched to backup-link port.

> ⚠ WAN port will be kept in a Forwarding state if the Backup-link configured port cannot be activated (link is down).

9) *Condition trigger (Remote)*:
> *On* – Backup-link triggered and active.
> *Off* – Backup-link is inactive.

10) *Backup port status (Remote)*:

> *Up* – Backup-link is not active, Backup-link configured port is up on remote side.
>
> *Down* – Backup-link is triggered and active, Backup-link configured port is down and WAN port is in Forwarding state on remote side.

11) *Remote Acquire status* – remote modem status.

CLI commands for Inverse Backup state (Chapter 4: COMMAND LINE INTERFACE)

network lsp	Show LSP/backup status
network lsp status	Show LSP/backup status
network lsp state < advanced | backup | backup_inverse | disable | enable >	Changing LSP state: disable, enable LSP, enable Backup, enable Inverse Backup, enable LSP Advanced
network lsp set backup_port <LAN1> or <LAN2> or <LAN3>	Select backup link port

Link State Propagation and Backup modify window for LSP Advanced Enabled state configuration

Figure 3-49 Enabling LSP Advanced

1) **State**:

>> **Disable** – LSP and backup Disabled (default state).
>> **Enable LSP** – LSP enabled.
>> **Enable Backup-link** – backup link enabled.
>> **Enable Inverse Backup** – inverse backup state enabled.
>> **LSP Advanced** – advanced LSP state enabled.

⚠ MAC address table is cleared when the LSP Advanced is activated or deactivated.

2) **Startup timeout** – LSP activity delay after management CPU start-up and configuration script execution. During this period capacity drops or synchronization events are ignored.
3) **LSP Enabled** – select port(s) for LSP triggering.

⚠ LSP blocks LAN port and hence management may not be accessible when LSP is active.

4) **Capacity mode** – specify a parameter for LSP triggering - Rx or Tx or Rx/Tx capacity.
5) **WAN Trigger mode**:

>> **Normal** – trigger is active when the Ethernet (Tx, Rx, Tx, or Rx) capacity of the link is out of the configured capacity range (Capacity < *min* or Capacity > *max*).
>> **Inverse** – trigger is active when the Ethernet (Tx, Rx, Tx, or Rx) capacity of the link is within the configured capacity range (Capacity > *min* and Capacity < *max*).

6) **Capacity range** – used to specify the Ethernet (Tx, Rx, Tx, or Rx) capacity range of the link threshold, which is used to trigger the LSP and block the configured LSP (LAN) port. The value "0" means that LSP Advanced is triggered only in case of synchronization loss.
7) **Timeout on Activation** – LAN port shutdown delay after the WAN Trigger activation.
8) **Timeout on Deactivation** – LAN port recovery delay after the WAN Trigger deactivation.
9) By pressing „*Execute configuration*", changes made to the corresponding section apply only to the local side Integra. If „Rollback on" is selected, the configuration will be reverted in case erroneous configuration changes are applied.

For indications during LSP Advanced activation, please see the figures below.

Figure 3-50 Condition trigger is On for LAN1 port and Off for LAN2 and LAN3 ports

Figure 3-51 LSP Advanced status in case of SyncLoss

Figure 3-52 Timeout on Activation indication

Figure 3-53 Timeout on Deactivation indication

10) **Acquire status** – local modem status.

11) **Remote Acquire status** – remote modem status.

12) **Current Rx Ethernet capacity** – Current ingress Ethernet capacity on Integra WAN port.

13) **Current Tx Ethernet capacity** – Current egress Ethernet capacity on Integra WAN port.

14) **Condition trigger state**:
   On – LSP is triggered and active.
   Off – LSP is inactive.

15) **LSP port state:**
   Up – ports in normal operational mode.
   Down – LSP triggered, and LAN port is blocked.

The ⚠ sign will indicate that the Timeout on Activation or Timeout on Deactivation has taken the effect.

CLI commands for LSP Advanced state (Chapter 4: COMMAND LINE INTERFACE)

network lsp	Show LSP/backup status
network lsp status	Show LSP/backup status
network lsp state < advanced | backup | backup_inverse | disable | enable >	Changing LSP state: disable, enable LSP, enable Backup, enable Inverse Backup, enable LSP Advanced
network lsp set advanced <port>	Enable or disable LSP Advanced on LAN1-3

state <enable | disable>

network lsp set advanced <port> **mode** <rx> or <rx_tx> or <tx>	Select required capacity direction on LAN1-3
network lsp set advanced <port> **wan_trigger** <normal> or <inverse>	Select WAN Trigger mode: Normal or Inverse on LAN1-3
network lsp set advanced <port> **capacity_min** <0 - 10000000>	Set minimal required WAN capacity on LAN1-3, "0" for sync loss, kbps
network lsp set advanced <port> **capacity_max** <0 - 10000000>	Set maximal required WAN capacity on LAN1-3, "0" for sync loss, kbps
network lsp set advanced <port> **activation_tout** <0 - 1800>	Set WAN Trigger activation timeout on LAN1-3, seconds
network lsp set advanced <port> **deactivation_tout** <0 - 1800>	Set WAN Trigger deactivation timeout on LAN1-3, seconds
network lsp set start_up <0-3600>	Set start up timeout, seconds

Networking → Ethernet → Aggregation/protection configuration

Link aggregation/protection in 2+0 mode allows utilizing up to 10Gbps Ethernet Layer 2 and 3 throughput (128QAM @ 2000 MHz) by using an independent frequency pair for each link.

Integra-E/E2/E3 aggregation/protection requires two Integra-E/E2/E3 links – primary and secondary. The aggregation/protection setup consists of four radios: 2 x **primary** and 2 x **secondary**. Where the **primary** device is responsible for actual traffic aggregation and the **secondary** device is responsible for passing aggregated traffic via a secondary link.

Devices on the local side are named: *Local Primary* and *Local Secondary*. Thereby remote devices are named: *Remote Primary* and *Remote Secondary*.

If you select a specific device, then there is a relative naming:

- Local – unit you are referencing to.
- Alternate – local neighbour unit (over LAN).
- Remote – remote neighbour unit (over WAN).
- Remote alternate – a neighbour unit of a remote neighbour device.
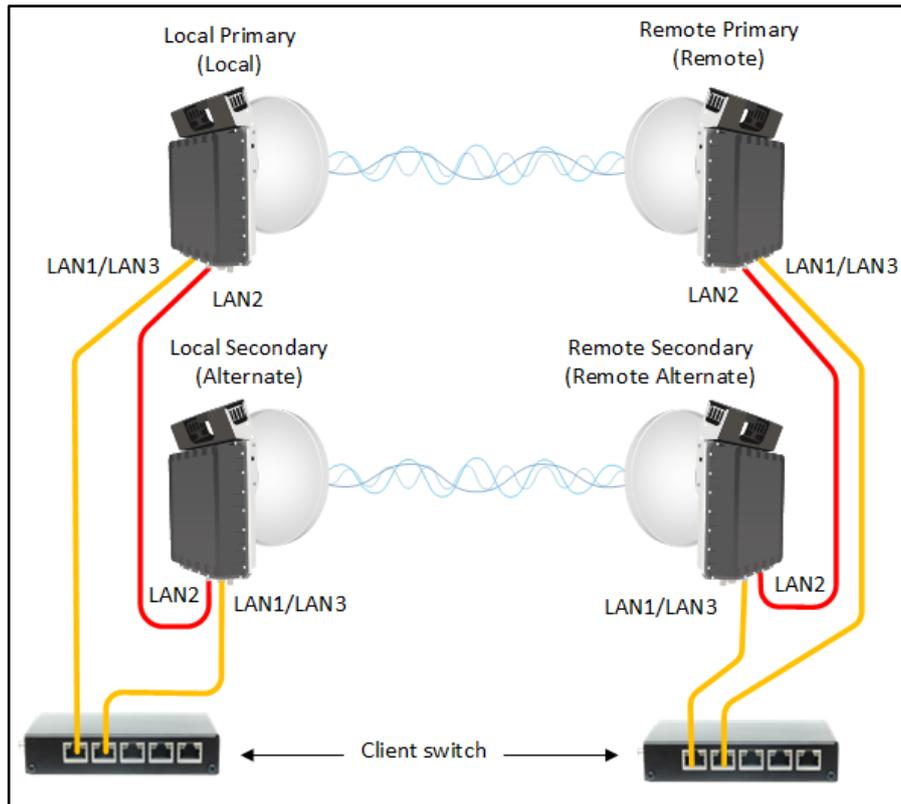
Figure 3-54 Aggregation setup schematic and naming

Please refer to *2+0 aggregation configuration* for more installation schematics.

Primary device balances traffic among two links. The aggregation engine is based on a hashing algorithm, which load balances traffic between primary and secondary links. A hash key mechanism to load balance frames is based on Layer 2 and Layer 3 fields:

- Layer 2 hash calculation is based on the following Ethernet frame L2 fields: SRC MAC, DST MAC, and VLAN.
- Layer 3 hash calculation is based on the following Ethernet frame L3 and L4 fields: IPv4, IPv6, MPLS, TCP/UDP. Traffic distribution between two links is based upon a combination of source and destination IPv4 addresses, source and destination IPv6 addresses, IPv6 flow labels, MPLS labels and/or payload, and source and destination TCP/UDP ports of network packets.

Secondary device isolates the following ports into two separate domains:

- Aggregated traffic domain – aggregation port LAN2 and WAN.
- Management traffic domain – LAN1, LAN3, MNG.

If power protection is enabled, in case of Local Primary device failure (Local Primary is down and does not aggregate traffic), the Local Secondary starts passing traffic by its own (only if setup with external switch is used). Two domains look like the following:

- Isolated domain – LAN2.
- User traffic and management domain – LAN1, LAN3, MNG, WAN.

The states in the Primary and Secondary devices are managed by Aggregation FSM (Finite State Machine). Radios exchange aggregation/protection status information of each device in the setup via SAF Mailbox Protocol (SMP). To avoid traffic aggregation via broken path (either primary or secondary), FSM in each device in the given setup monitors the state of neighbours, Ethernet links, and wireless links. In case one of the devices is down, one of the Ethernet links is down or one of the wireless links runs into Synchronization Loss, the primary devices will detect failure and will not aggregate traffic via the broken path. For, example, primary link runs into Synchronization Loss, then primary units will distribute traffic only via a secondary path (transmit over a secondary device via LAN2).

General configuration guide

1)   Do not interconnect Integra-E/E2/E3 with each other and do not plug Integra-E/E2/E3 into switches before you have finished the configuration of each node.

2)   Choose one link (low/high side radio) which will operate as the "Primary". The second link will operate as the "Secondary".

3)   Configure radio/modem parameters for each link. Channel bandwidths must be the same (e.g. 500MHz) for both links. All other parameters can differ but keep in mind that the frequencies must differ.

4)   Both links should be polarized according to ACAP (Adjacent Channel Alternate-Polarized) principle. In case the co-polarized channels are used, it is recommended to introduce a guard band equal to ¼ BW (e.g., 500MHz in the case of 2000MHz channels). CCDP (Co-Channel Dual-Polarization) operation on the same frequency channel and opposite polarizations is not allowed.

5)   Configure different IP addresses for all 4 Integra-E/E2/E3 radios.

6)   The remote IP address for all units must be entered manually. To do that, remove the selection in the "Auto" checkbox and afterwards enter the appropriate remote IP address in the menu "IP configuration" (please refer to Chapter *System → Configuration → IP configuration*).

7)   Proceed with aggregation/protection configuration.

> ⚠ The setup should be designed so that the capacity of the Primary link doesn't exceed the capacity of the Secondary link most of the time. Otherwise, packet loss will occur on the Secondary link.

> ⚠ On both sides "Primary" and "Secondary" managements must be interconnected via an external switch or directly on LAN1 or LAN3 ports (in addition to LAN2 interconnection) for aggregation/protection to work. This connection is used to interchange 2+0 aggregation/protection statuses for proper operation. Please refer to *2+0 aggregation configuration* for more installation schematics.

> ⚠ Spanning Tree should be disabled on external equipment in the ports to which Integra-E/E2/E3 is connected and on the Integra-E/E2/E3 in the Spanning Tree section (please refer to Chapter *Networking → Ethernet → Spanning Tree*).

Configuration in GUI
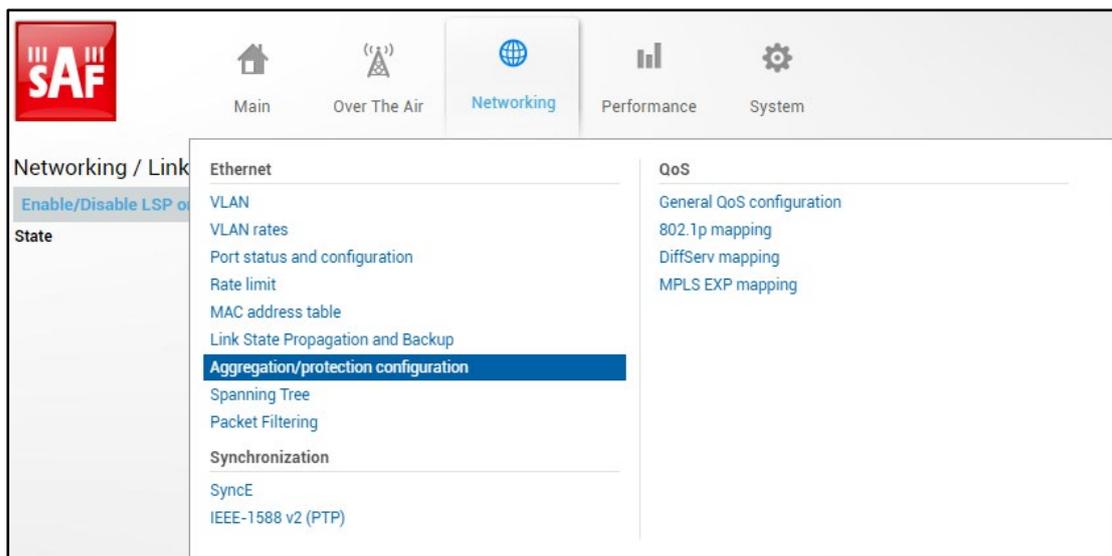
Figure 3-55 Accessing Aggregation/protection configuration page
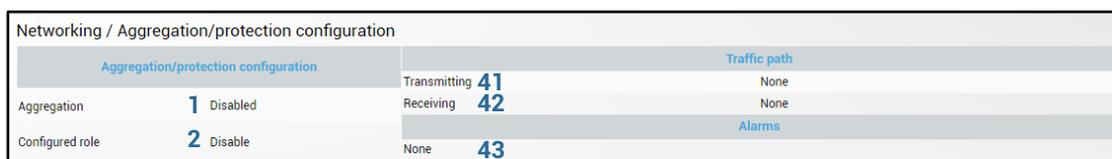
Status mode

Figure 3-56 Aggregation/protection – status mode

Press MODIFY button.
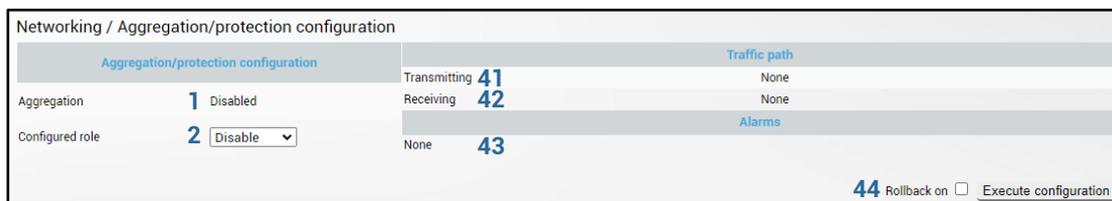
Modify mode

Figure 3-57 Aggregation/protection – modify mode

Primary status mode after enabling aggregation

Networking / Aggregation/protection configuration				

Aggregation/protection configuration

			Traffic path	
Aggregation	**1** Enabled			
Configured role	**2** Primary			
Mode	**3** 2+0	Transmitting **41**	Via Primary and Secondary links	
Hashing algorithm	**4** Layer 2			
Power protection	**5** Disabled	Receiving **42**	Both	
Current state	**6** Primary OK			
FSM state	**7** Primary Active		**Alarms**	
Instance ID	**8** 1			
Ethernet traffic port	**9** LAN3	None **43**		

Neighbour Status Data

		Local	Alternate	Remote	Remote alternate
Index	**11**	4154	59780	1040	50727
Configured role	**12**	Primary	Secondary	Primary	Secondary
Current state	**13**	Primary OK	Secondary OK	Primary OK	Secondary OK
FSM state	**14**	Primary Active	Secondary Active	Primary Active	Secondary Active
Ethernet traffic port	**15**	LAN3	LAN3	LAN3	LAN3
Ethernet alternate port	**16**	LAN2	LAN2	LAN2	LAN2
Power protection	**17**	Disabled	Disabled	Disabled	Disabled
Ethernet MAC address	**18**	00:04:a6:81:78:cb	00:04:a6:81:7d:c6	00:04:a6:81:78:ca	00:04:a6:81:7d:c7
IP address	**19**	192.168.205.10	192.168.205.20	192.168.205.11	192.168.205.21
IP mask	**20**	255.255.255.0	255.255.255.0	255.255.255.0	255.255.255.0
MB ID	**21**	7	4	7	4
Link states					
LAN1	**22**	Down	Down	Down	Down
LAN2	**23**	Up	Up	Up	Up
LAN3	**24**	Up	Up	Up	Up
WAN	**25**	Up	Up	Up	Up
Setup neighbour counters					
Timeout last	**26**	10	7	11	12
Last outage duration	**27**	2022	0	1008	1049
Timeout max	**28**	1642	52	1002	1005
Outage count	**29**	1	0	1	1
Protocol message counters					
Neigbour data updates	**30**				45
Neigbour data update discards	**31**				0
SMP Rx No Errors	**32**				1411241
SMP Rx Error[EtherType]	**33**				0
SMP Rx Error[Preamble]	**34**				0
SMP Rx Error[Instance ID]	**35**				0
SMP Rx Error[CRC]	**36**				0
SMP Rx Error[Packet Size]	**37**				0
SMP Rx Error[Other reason]	**38**				0
SMP Tx Sent	**39**				961518
SMP Tx Dropped	**40**				0

Figure 3-58 Primary aggregation/protection after enabling aggregation – status mode

Press ✏ MODIFY button.

Primary modify mode after enabling aggregation

Networking / Aggregation/protection configuration

Aggregation/protection configuration		Traffic path	
Aggregation	**1** Enabled		
Configured role	**2** Primary ▼	Transmitting **41**	Via Primary and Secondary links
Mode	**3** 2+0 ▼		
Hashing algorithm	**4** Layer 2 hashing ▼	Receiving **42**	Both
Power protection	**5** Disable ▼		
Current state	**6** Primary OK	Alarms	
FSM state	**7** Primary Active		
Instance ID (1 .. 65535)	**8** 1	None **43**	
Ethernet traffic port	**9** LAN3 ▼		

Neighbour Status Data				**10** Reset Counters
		Local	Alternate	Remote	Remote alternate
Index	**11**	13225	3320	10109	59801
Configured role	**12**	Primary	Secondary	Primary	Secondary
Current state	**13**	Primary OK	Secondary OK	Primary OK	Secondary OK
FSM state	**14**	Primary Active	Secondary Active	Primary Active	Secondary Active
Ethernet traffic port	**15**	LAN3	LAN3	LAN3	LAN3
Ethernet alternate port	**16**	LAN2	LAN2	LAN2	LAN2
Power protection	**17**	Disabled	Disabled	Disabled	Disabled
Ethernet MAC address	**18**	00:04:a6:81:78:cb	00:04:a6:81:7d:c6	00:04:a6:81:78:ca	00:04:a6:81:7d:c7
IP address	**19**	192.168.205.10	192.168.205.20	192.168.205.11	192.168.205.21
IP mask	**20**	255.255.255.0	255.255.255.0	255.255.255.0	255.255.255.0
MB ID	**21**	7	4	7	4
Link states					
LAN1	**22**	Down	Down	Down	Down
LAN2	**23**	Up	Up	Up	Up
LAN3	**24**	Up	Up	Up	Up
WAN	**25**	Up	Up	Up	Up
Setup neighbour counters					
Timeout last	**26**	6	17	7	7
Last outage duration	**27**	2022	0	1008	1049
Timeout max	**28**	1642	52	1002	1005
Outage count	**29**	1	0	1	1

Protocol message counters		
Neigbour data updates	**30**	45
Neigbour data update discards	**31**	0
SMP Rx No Errors	**32**	1437224
SMP Rx Error[EtherType]	**33**	0
SMP Rx Error[Preamble]	**34**	0
SMP Rx Error[Instance ID]	**35**	0
SMP Rx Error[CRC]	**36**	0
SMP Rx Error[Packet Size]	**37**	0
SMP Rx Error[Other reason]	**38**	0
SMP Tx Sent	**39**	978836
SMP Tx Dropped	**40**	0

44 Rollback on ☐ Execute configuration

Figure 3-59 Primary aggregation/protection after enabling aggregation – modify mode

Secondary status mode after enabling aggregation

Networking / Aggregation/protection configuration

Aggregation/protection configuration			Traffic path	
Aggregation	**1** Enabled			
Configured role	**2** Secondary		Transmitting **41**	From Alternate port to Radio
Mode	**3** 2+0			
Hashing algorithm	**4** Layer 2		Receiving **42**	Radio port
Power protection	**5** Disabled			
Current state	**6** Secondary OK		Alarms	
FSM state	**7** Secondary Active			
Instance ID	**8** 1		None **43**	
Ethernet traffic port	**9** LAN3			

Neighbour Status Data		Local	Alternate	Remote	Remote alternate
Index	**11**	805	10710	57285	7593
Configured role	**12**	Secondary	Primary	Secondary	Primary
Current state	**13**	Secondary OK	Primary OK	Secondary OK	Primary OK
FSM state	**14**	Secondary Active	Primary Active	Secondary Active	Primary Active
Ethernet traffic port	**15**	LAN3	LAN3	LAN3	LAN3
Ethernet alternate port	**16**	LAN2	LAN2	LAN2	LAN2
Power protection	**17**	Disabled	Disabled	Disabled	Disabled
Ethernet MAC address	**18**	00:04:a6:81:7d:c6	00:04:a6:81:78:cb	00:04:a6:81:7d:c7	00:04:a6:81:78:ca
IP address	**19**	192.168.205.20	192.168.205.10	192.168.205.21	192.168.205.11
IP mask	**20**	255.255.255.0	255.255.255.0	255.255.255.0	255.255.255.0
MB ID	**21**	4	7	4	7
Link states					
LAN1	**22**	Down	Down	Down	Down
LAN2	**23**	Up	Up	Up	Up
LAN3	**24**	Up	Up	Up	Up
WAN	**25**	Up	Up	Up	Up
Setup neighbour counters					
Timeout last	**26**	8	14	11	15
Last outage duration	**27**	45	2051	1031	1029
Timeout max	**28**	20	611828	182370	611828
Outage count	**29**	0	3	1	2
Protocol message counters					
Neigbour data updates	**30**				80
Neigbour data update discards	**31**				0
SMP Rx No Errors	**32**				1485886
SMP Rx Error[EtherType]	**33**				0
SMP Rx Error[Preamble]	**34**				0
SMP Rx Error[Instance ID]	**35**				0
SMP Rx Error[CRC]	**36**				0
SMP Rx Error[Packet Size]	**37**				0
SMP Rx Error[Other reason]	**38**				0
SMP Tx Sent	**39**				1051784
SMP Tx Dropped	**40**				0

Figure 3-60 Secondary aggregation/protection after enabling aggregation – status mode

Press ✎ MODIFY button.

Secondary modify mode after enabling aggregation

Figure 3-61 Secondary aggregation/protection after enabling aggregation – modify mode

Aggregation/protection configuration

1) *Aggregation* – indicates whether aggregation is enabled or disabled.
2) *Configured role* – indicates the configured role (status mode); allows specifying aggregation role (modify mode).
3) *Mode* – "2+0" for 2+0 aggregation.
4) *Hashing algorithm* – indicates the configured hashing algorithm (status mode); allows specifying hashing algorithm (modify mode).
5) *Power protection* – indicates whether power protection is enabled or disabled (status mode); allows enabling or disabling power protection (modify mode).
6) *Current state* – indicates current state. It may differ from the configured role, in case the alternate device is or was not available and reconfiguration to 1+0 configuration took place.
7) *FSM state* – indicates the current Finite State Machine's state.
    5 states are possible – Primary Active, Secondary Active, Secondary Protect, Broken Primary, Broken Secondary.
8) *Instance ID (1…65535)* – indicates configured instance ID (status mode); allows entering instance ID (modify mode).

⚠️   Instance ID should be the same on all 4 devices in a single link

⚠️   Instance ID should differ for other 2+0 links in the network.

9) **Ethernet traffic port** – indicates which LAN port is configured as the traffic/management port (status mode); allows setting LAN1 or LAN3 port as the traffic/management port (modify mode).

⚠️   The aggregated link capacity is limited to the speed of the Ethernet traffic port (i.e., 10Gbps if LAN3 port is used, or 1Gbps if LAN1 is used) or to the actual capacity of the Primary link.

Neighbour Status Data

The status of all four units is shown. Local – the unit you are currently connected to; Alternate – unit interconnected with the local unit; Remote – unit on the remote side of the link synchronized to the local unit; Remote alternate – unit interconnected with the remote unit.

The section is visible when aggregation is enabled.

If no data is available "N/D" will be displayed in red color.

10) **Clear Counters** – allows resetting neighbour refresh time data and message protocol counters. The button is available only in modify mode.
11) **Index** – aggregation data identifier. Value sequentially increments to 65535 and resets to 0.
12) **Configured role** – indicated configured role.
13) **Current state** – indicates current state. It may differ from the configured role, the alternate device is or was not available and reconfiguration to 1+0 configuration took place.
14) **FSM state** – indicates the current Finite State Machine's state.
15) **Ethernet traffic port** – indicates which LAN port is configured as the traffic/management port.
16) **Ethernet alternate port** – indicates which LAN port is used as the aggregation port (will always be a LAN2 port).
17) **Power protection** – indicates whether power protection is enabled or disabled.
18) **Ethernet MAC address** – shows the MAC address of a specific Integra-E/E2/E3.
19) **IP address** – shows the IP address of a specific Integra-E/E2/E3.
20) **IP mask** – shows the IP address mask of a specific Integra-E/E2/E3.
21) **MB ID** – indicates the main PCB ID of a specific Integra-E/E2/E3.
22) **LAN1** – indicates link status of LAN1 port – up or down.
23) **LAN2** – indicates link status of LAN2 port – up or down.
24) **LAN3** – indicates link status of LAN3 port – up or down.
25) **WAN** – indicates link status of WAN port – up or down.
26) **Timeout last** – indicates the most recent refresh time of protection data in milliseconds.
27) **Last outage duration** – indicates the duration of the last outage in milliseconds.
28) **Timeout max** – indicates the maximum refresh time of protection data in milliseconds.
29) **Outage count** – indicates the number of outages.

Protocol message counters

30) **Neighbour data updates** – indicates the number of neighbour data updates.
31) **Neighbour data update discards** – indicates the number of neighbour data update discards.
32) **SMP Rx No Errors** – indicates the number of received SMP packets with an aggregation payload without errors.
33) **SMP Rx Error [EtherType]** – indicates the number of SMP packets dropped due to an error with EtherType.
34) **SMP Rx Error [Preamble]** – indicates the number of SMP packets dropped due to an error with Preamble.

35) ***SMP Rx Error [Instance ID]*** – indicates the number of SMP packets dropped due to an error with Instance ID.

36) ***SMP Rx Error [CRC]*** – indicates the number of SMP packets dropped due to an error with CRC.

37) ***SMP Rx Error [Packet Size]*** – indicates the number of SMP packets dropped due to an error with packet size.

38) ***SMP Rx Error [Other reason]*** – indicates the number of SMP packets dropped due to an error with another reason.

39) ***SMP Tx Sent*** – indicates the number of sent SMP packets to neighbours.

40) ***SMP Tx Dropped*** – indicates the number of dropped SMP packets to be transmitted.

Traffic path

41) ***Transmitting*** – indicates whether Primary, Secondary, or both are transmitting traffic.

42) ***Receiving*** – indicates whether WAN, LAN2, or both are receiving traffic.

Alarms

43) Indicates which alarms are active. If none, "None" is shown.

> ⚠ *Aggregation port link is down* – the link status of the aggregation port (LAN2) of the local device is down.
>
> *Traffic port link is down* – the incorrect Ethernet traffic port was selected.
>
> *Power Protection configuration asymmetry* – Power protection is not enabled/disabled on all radios in the aggregation topology.

44) By pressing „*Execute configuration*", changes made to the corresponding section apply only to the local side Integra-E/E2/E3. If „*Rollback on*" is selected, the configuration will be reverted in case erroneous configuration changes are applied.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

network aggr status	Use to show full aggregation/protection statistics.
network aggr status neighbour_info	Use to show information on all device statuses in this setup.
network aggr status info	Use to show aggregation alarms and protocol statistics.
network aggr status reset_stats	Use to reset the aggregation statistics.
network aggr role disable	Use to disable aggregation functionality.
network aggr role primary	Use to specify 2+0 aggregation role to Primary.
network aggr role secondary	Use to specify 2+0 aggregation role to Secondary.
network aggr mode 2+0	Use to enable the 2+0 aggregation mode.
network aggr mode 2+0 mprot enable	Use to enable Power protection in 2+0 mode.
network aggr mode 2+0 mprot disable	Use to disable Power protection in 2+0 mode.
network aggr hash layer-2	Use to set Layer 2 hashing for aggregation.
network aggr hash layer-3	Use to set Layer 3 hashing for aggregation.
network aggr instance-id <id>	Use to specify a unique instance ID for the current setup of 4 radios.
network aggr traffic_port <port>	Use to specify the traffic port – LAN1 or LAN3.

Networking → Ethernet → Spanning Tree

The Spanning Tree page provides the configuration of Rapid Spanning Tree Protocol (RSTP) and Multiple Spanning Tree Protocol (MSTP).
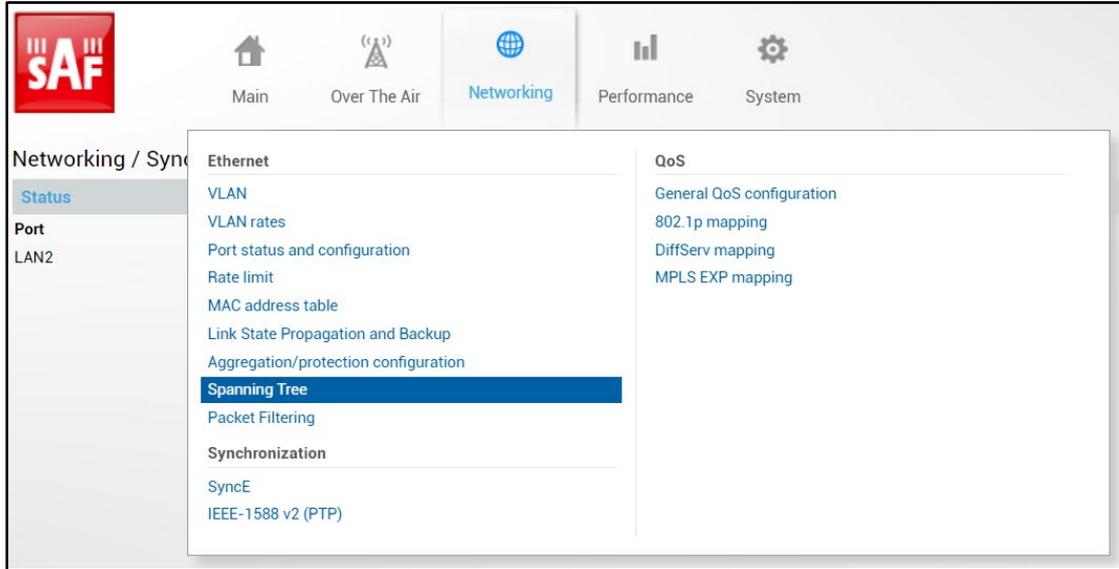
Figure 3-62 Accessing Spanning Tree page

Rapid Spanning Tree Protocol (RSTP)

Status mode

Networking / Spanning Tree

Bridge configuration			Root information		
Bridge ID	**1**	32768.00.04.A6.81.77.78	Root ID	**7**	0.00.04.A6.81.77.69
Hello time (1 .. 100 sec)	**2**	2 sec	Hello time	**8**	2
Max age (6 .. 40 sec)	**3**	20 sec	Max age	**9**	20
Forward delay (4 .. 30 sec)	**4**	15 sec	Forward delay	**10**	15
Mode	**5**	RSTP	Root port	**11**	WAN
RSTP operation	**6**	Enabled	Root path cost	**12**	13605

13 Port status and configuration

Port	RSTP state	Port state	Role	Priority	Path cost	Edge	P2P
LAN1	Enabled	Forwarding	Designated	128	20000	No	Yes
LAN2	Enabled	Forwarding	Disabled	128	14183	Yes	Yes
LAN3	Enabled	Forwarding	Disabled	128	14183	Yes	Yes
WAN	Enabled	Forwarding	Root	128	13605	No	Yes

Protocol statistics

		LAN1	LAN2	LAN3	WAN
Rx MSTP BPDUs	**14**	0	0	0	169115
Rx RSTP BPDUs	**15**	165804	0	0	351516
Rx Conf. BPDUs	**16**	0	0	0	0
Rx TCN BPDUs	**17**	0	0	0	0
Bad MSTP BPDUs	**18**	0	0	0	0
Bad RSTP BPDUs	**19**	0	0	0	0
Bad Conf. BPDUs	**20**	0	0	0	0
Bad TCN BPDUs	**21**	0	0	0	0
Tx MSTP BPDUs	**22**	296	0	0	168864
Tx RSTP BPDUs	**23**	351579	0	0	398
Tx Conf. BPDUs	**24**	0	0	0	0
Tx TCN BPDUs	**25**	0	0	0	0
Fwd Transitions	**26**	72	0	0	80
Time Since Top Chg	**27**	15:43:41	15:43:41	15:43:41	15:43:41
Top Change Count	**28**	98	98	98	98

Figure 3-63 Spanning Tree status page

Press ✏ MODIFY button.

Modify mode

Figure 3-64 Spanning Tree configuration page

1) **Bridge ID –** Indicates the configured value of Bridge ID (status mode); allows specifying the value of Bridge ID (modify mode). This parameter and MAC address determines whether a given Bridge is Root Bridge. The advantage is given to the combination of Priority and Address, which is numerically smaller.

2) **Hello Time (1 – 100 sec) –** Indicates configured time gap between which the BPDU packets are being sent (status mode); allows specifying the value of Hello Time in seconds (modify mode).

3) **Max Age (6 – 40 sec) –** Indicates configured time, during which the received BPDU packets' information is stored for a separate port (status mode); allows specifying the value of Max Age in seconds (modify mode).

4) **Forward Delay (4 – 30 sec) –** Indicates configured period that determines the time a separate port stays in Listening and Learning conditions (status mode); allows specifying the value of Forward Delay in seconds (modify mode).

5) **Mode –** Indicates chosen mode of STP configuration; allows to change the mode to RSTP or MSTP.

6) **RSTP operation –** Indicates configured status of RSTP (status mode); allows enable or disable RSTP operation (modify mode).

   Root information – displays the data only when RSTP is enabled:

7) **Root ID –** Indicates the Bridge ID of the current Root bridge.

8) **Hello Time –** Indicates the current hello time.

9) **Max Age –** Indicates the current max-age time.

10) **Forward Delay –** Indicates the current forward delay.

11) **Root Port –** Indicates elected root port is being shown.

12)   ***Root Path Cost –*** Indicates the path cost from the current bridge to the root bridge.

13)   ***Port status and configuration –*** STP parameters of every port:

-        ***RSTP state –*** Indicates RSTP state of the particular port (status mode); allows enable or disable RSTP operation for the particular port (modify mode).

-    ***Port state –*** Indicates port condition. Can be one of the following: Disabled, Blocking, Listening, Learning, or Forwarding.

-    ***Role –*** the role of the particular port. Can be one of the following: *Root, Designated, Alternate, Backup,* or *Disabled*.

-        ***Priority –*** Indicates Port Priority (status mode); allows specifying Port Priority (modify mode). A combination of Priority, Port number and Path Cost determines whether the port will be selected as the root port or will be blocked on the occasion of the loop, etc.

-    ***Path cost –*** Indicates Path cost of the particular port (status mode); allows specifying Path cost for the particular port by setting Path cost value or by selecting the *Auto* mode (modify mode). This parameter setting depends on the capacity of a separate port.

-    ***Edge –*** displays that this particular port is Edge port.

-    ***Point-to-point –*** displays whether there is a point-to-point connection from the particular port or not.

14)   ***Rx MSTP BPDUs –*** Indicates how many MSTP BPDUs packets were received.

15)   ***Rx RSTP BPDUs –*** Indicates how many RSTP BPDUs packets were received.

16)   ***RX Conf BPDUs –*** Indicates how many STP BPDUs packets were received.

17)   ***RX TCN BPDUs –*** Indicates how many topology change notification BPDUs packets were received.

18)   ***Bad MSTP BPDUs –*** Indicates how many bad MSTP BPDUs packets were received.

19)   ***Bad RSTP BPDUs –*** Indicates how many bad RSTP BPDUs packets were received.

20)   ***Bad Conf BPDUs –*** Indicates how many bad STP BPDUs packets were received.

21)   ***Bad TCN BPDUs –*** Indicates how many bad topology change notifications BPDUs packets were received.

22)   ***Tx MSTP BPDUs –*** Indicates how many MSTP BPDUs packets were sent.

23)   ***Tx RSTP BPDUs –*** Indicates how many RSTP BPDUs packets were sent.

24)   ***Tx Conf BPDUs –*** Indicates how many STP BPDUs packets were sent.

25)   ***Tx TCN BPDUs –*** Indicates how many topology change notification BPDUs packets were sent.

26)   ***Fwd Transitions –*** Indicates how many times port has been changed to forward status.

27)   ***Time Since Top Chg -*** Indicates how much time has passed since the last topology change.

28)   ***Top Change Count -*** Indicates how many times the topology has changed.

29)   By pressing „*Execute configuration",* changes made to the corresponding section apply only to the local side Integra-E/E2/E3. If „*Rollback on"* is selected, the configuration will be reverted in case erroneous configuration changes are applied.

Multiple Spanning Tree Protocol (MSTP)

Status mode

Networking / Spanning Tree

Bridge configuration						
Bridge configuration			**Root information**			
Bridge ID	**1**	32768.00.04.A6.81.77.78	Root ID	**7**	0.00.04.A6.81.77.69	
Hello time (1 .. 100 sec)	**2**	2 sec	Hello time	**8**	2	
Max age (6 .. 40 sec)	**3**	20 sec	Max age	**9**	20	
Forward delay (4 .. 30 sec)	**4**	15 sec	Forward delay	**10**	15	
Mode	**5**	MSTP	Root port	**11**	WAN	
RSTP operation	**6**	Enabled	Root path cost	**12**	13140	

13 Port status and configuration

Port	RSTP state	Port state	Role	Priority	Path cost	Edge	P2P
LAN1	Enabled	Forwarding	Designated	128	20000	No	Yes
LAN2	Enabled	Forwarding	Disabled	128	14183	Yes	Yes
LAN3	Enabled	Forwarding	Disabled	128	14183	Yes	Yes
WAN	Enabled	Forwarding	Root	128	13140	No	Yes

MSTP Config

Region	**14**	WWW
Revision	**15**	333
Digest	**16**	0x8D0D3583ABF2D8F6F4CD1141B77F53D7
Instance ID		VLAN
1	**17**	10 - 19 **18**

21 Protocol statistics

	LAN1	LAN2	LAN3	WAN
Rx MSTP BPDUs	0	0	0	0
Rx RSTP BPDUs	22	0	0	1922
Rx Conf. BPDUs	0	0	0	0
Rx TCN BPDUs	0	0	0	0
Bad MSTP BPDUs	0	0	0	0
Bad RSTP BPDUs	0	0	0	0
Bad Conf. BPDUs	0	0	0	0
Bad TCN BPDUs	0	0	0	0
Tx MSTP BPDUs	2028	26	28	157
Tx RSTP BPDUs	40	2	2	6
Tx Conf. BPDUs	0	0	0	0
Tx TCN BPDUs	0	0	0	0
Fwd Transitions	67	23	24	66
Time Since Top Chg	00:29:11	00:29:11	00:29:11	00:29:11
Top Change Count	14	14	14	14

22 Instance 1

Bridge configuration

	Bridge configuration		**Root information**	
Bridge ID	32768.00.04.A6.81.77.78	**23**	32768.00.04.A6.81.77.78	
Regional Root Port		**24**	N/A	
Reg. Root Path Cost		**25**	0	

13 Port status and configuration

Port	Port state	Role	Priority	Path cost
LAN1	Forwarding	Designated	128	20000
LAN2	Forwarding	Disabled	128	14183
LAN3	Forwarding	Disabled	128	14183
WAN	Forwarding	Master	128	13140

26 Protocol statistics

	LAN1	LAN2	LAN3	WAN
Rx BPDUs	0	0	0	0
Bad BPDUs	0	0	0	0
Tx BPDUs	1972	1	2	89
Fwd Transitions	44	1	2	43
Time Since Top Chg	00:29:40	00:29:40	00:29:40	00:29:40
Top Change Count	9	9	9	9

Figure 3-65 MSTP status page

Press ✏ **MODIFY** button.

Modify mode

Figure 3-66 MSTP configuration page

1)   ***Bridge ID –*** Indicates the configured value of Bridge ID (status mode); allows specifying the value of Bridge ID (modify mode). This parameter and MAC address determine whether a given Bridge is Root Bridge. The advantage is given to the combination of Priority and Address, which is numerically smaller.

2)   *Hello Time (1 – 100 sec) –* Indicates configured time gap between which the BPDU packets are being sent (status mode); allows specifying the value of Hello Time in seconds (modify mode).

3)   *Max Age (6 – 40 sec) –* Indicates configured period, during which the received BPDU packets' information is stored for a separate port (status mode); allows specifying the value of Max Age in seconds (modify mode).

4)   *Forward Delay (4 – 30 sec) –* Indicates configured period that determines the time a separate port stays in Listening and Learning conditions (status mode); allows specifying the value of Forward Delay in seconds (modify mode).

5)   *Mode –* Indicates chosen mode of STP configuration (status mode); allows to change the mode to RSTP or MSTP (modify mode).

6)   *RSTP operation –* Indicates configured status of RSTP (status mode); allows enable or disable RSTP operation (modify mode).

   Root information – displays the data only when RSTP is enabled:

7)   *Root ID –* Indicates the Bridge ID of the current Root bridge.

8)   *Hello Time –* Indicates the current hello time.

9)   *Max Age –* Indicates the current max-age.

10)   *Forward Delay –* Indicates the current forward delay.

11)   *Root Port –* Indicates elected root port is being shown.

12)   *Root Path Cost –* Indicates the path cost from the current bridge to the root bridge.

13)   *Port status and configuration –* STP parameters of every port:

-        *RSTP state –* Indicates RSTP state of the particular port (status mode); allows enable or disable RSTP operation for the particular port (modify mode).

-   *Port state –* Indicates port condition. Can be one of the following: Disabled, Blocking, Listening, Learning, or Forwarding.

-   *Role –* the role of the particular port. Can be one of the following: *Root, Designated, Alternate, Backup,* or *Disabled*.

-        *Priority –* Indicates Port Priority (status mode); allows specifying Port Priority (modify mode). A combination of Priority, Port number and Path Cost determines whether the port will be selected as the root port or will be blocked on the occasion of the loop, etc.

-   *Path cost –* Indicates Path cost of the particular port (status mode); allows specifying Path cost for the particular port by setting Path cost value or by selecting the *Auto* mode (modify mode). This parameter setting depends on the capacity of a separate port.

-   *Edge –* displays that this particular port is Edge port.

-   *Point-to-point –* displays whether there is a point-to-point connection from the particular port or not.

14)   *Region –* Indicates MSTP region that defines a logical domain where multiple spanning-tree instances can be administered (status mode); Allows user-defined name for the region (modify mode).

15)   *Revision –* Indicates the current revision of configuration of MSTP (status mode); Allows configuring numbered values to keep track of configuration changes (modify mode).

16)   *Digest –* Indicates digest of the VLANs-to-instance mapping table.

17)   *Instance (1-6) –* Indicates Instance ID and VLAN mapping for each instance (status mode); allows to configure up to six instances and VLAN mapping for each instance (modify mode).

18)   **VLAN (Range: 1 - 4094) –** Indicates configured VLAN IDs and/or VLAN ID ranges (status mode); allows entering individual VLAN IDs or VLAN ID ranges, e.g., "10-19", "20-29", "30-39", etc. (modify mode);

19)   **Add -** Press "Add" to add entered individual VLAN ID or VLAN ID range.

20)   **Remove -** Removes configured VLAN IDs and/or VLAN ID ranges.

21)   **Protocol statistics -** Shows combined STP statistics.

- **Rx MSTP BPDUs –** Indicates how many MSTP BPDUs packets were received.
- **Rx RSTP BPDUs –** Indicates how many RSTP BPDUs packets were received.
- **RX Conf BPDUs –** Indicates how many STP BPDUs packets were received.
- **RX TCN BPDUs –** Indicates how many topology change notification BPDUs packets were received;
- **Bad MSTP BPDUs –** Indicates how many bad MSTP BPDUs packets were received.
- **Bad RSTP BPDUs –** Indicates how many bad RSTP BPDUs packets were received.
- **Bad Conf BPDUs –** Indicates how many bad STP BPDUs packets were received.
- **Bad TCN BPDUs –** Indicates how many bad topology change notifications BPDUs packets were received;
- **Tx MSTP BPDUs –** Indicates how many MSTP BPDUs packets were sent.
- **Tx RSTP BPDUs –** Indicates how many RSTP BPDUs packets were sent.
- **Tx Conf BPDUs –** Indicates how many STP BPDUs packets were sent.
- **Tx TCN BPDUs –** Indicates how many topology change notification BPDUs packets were sent;
- **Fwd Transitions –** Indicates how many times port has been changed to forward status.
- **Time Since Top Chg –** Indicates how much time has passed since the last topology change.
- **Top Change Count –** Indicates how many times the topology has changed.

22)   **Instance ID –** Indicates each MSTP instances parameters.

23)   **Bridge ID –** Indicates the configured value of MSTP instance Bridge ID (status mode); allows specifying the value of each MSTP instance Bridge ID (modify mode). This parameter and MAC address determines whether a given Bridge is Root Bridge. The advantage is given to the combination of Priority and Address, which is numerically smaller.

24)   **Regional Root Port –** Indicates elected root port for configured MSTP region.

25)   **Reg. Root Path Cost –** Indicates root path cost of the configured MSTP region.

26)   **Protocol statistics –** Shows each MSTP instance statistics.

- **Rx MSTP BPDUs –** Indicates how many MSTP BPDUs packets were received.
- **Bad MSTP BPDUs –** Indicates how many bad MSTP BPDUs packets were received.
- **Tx MSTP BPDUs –** Indicates how many MSTP BPDUs packets were sent.
- **Fwd Transitions –** Indicates how many times port has been changed to forward status*.*
- **Time Since Top Chg –** Indicates how much time has passed since the last topology change.
- **Top Change Count –** Indicates how many times the topology has changed.

27)   By pressing „*Execute configuration",* changes made to the corresponding section apply only to the local side Integra-E/E2/E3. If „*Rollback on"* is selected, the configuration will be reverted in case erroneous configuration changes are applied.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

network stp bridgeID {0 | 4096 | 8192 | 12288 | 16384| 20480 | 24576 | 28672 | 32768 | 36864 | 40960 | 45056 | 49152 | 53248 | 57344 | 61440}	Use to set the value of Bridge ID.
network stp forwardDelay <4..30>	Use to set the time in seconds that determines how long a separate port stays in Listening and Learning conditions.
network stp helloTime <1..100>	Use to set the value of the time gap in seconds between which the BPDU packets are being sent.
network stp log {enable | disable}	Use to enable or disable STP log.
network stp maxAge <6..40>	Use to set the time in seconds, during which the received BPDU packets' information is stored for a separate port.
network stp mode {mstp | rstp}	Use to change the mode to RSTP or MSTP.
network stp mstp_bridge_id <instance ID {1..6}> {0 | 4096 | 8192 | 12288 | 16384| 20480 | 24576 | 28672 | 32768 | 36864 | 40960 | 45056 | 49152 | 53248 | 57344 | 61440}	Use to set the value of each MSTP instance Bridge ID.
network stp mstp_path_cost {LAN1 | LAN2 | LAN3 | WAN} <instance ID {1..6}> {<1 - 200000000> | auto}	Use to set MSTP path cost for the particular port and instance by setting the value or by selecting the *Auto* mode.
network stp path_cost {LAN1 | LAN2 | LAN3 | WAN} {<1 - 200000000> | auto}	Use to set RSTP path cost for the particular port by setting the value or by selecting the *Auto* mode.
network stp region	Use to set MSTP region. Allows user-defined name for the region.
network stp revision	Use to set MSTP revision. Allows to configure user-defined numbered values to keep track of configuration changes.
network stp state {enable | disable}	Use to enable or disable RSTP operation.
network stp status	Use to show STP status.
network stp vlan map <instance ID {1..6}> <vlan range {1..4096}>	Use to map VLAN or VLAN range to MSTP instances. First, you must provide the instance ID and then VLAN or VLAN range you want to map with this instance.
network stp vlan status	Use to show MSTP VLAN mapping.
network stp vlan unmap <instance ID {1..6}> <vlan range {1..4096}>	Use to unmap VLAN or VLAN range from MSTP instances. First, you must provide the instance ID and then VLAN or VLAN range you want to unmap from this instance.

Networking → Ethernet → Packet Filtering

The Packet Filtering page provides the configuration of Layer 2 Control Protocol (L2CP) for ingress and egress traffic on each radio port.
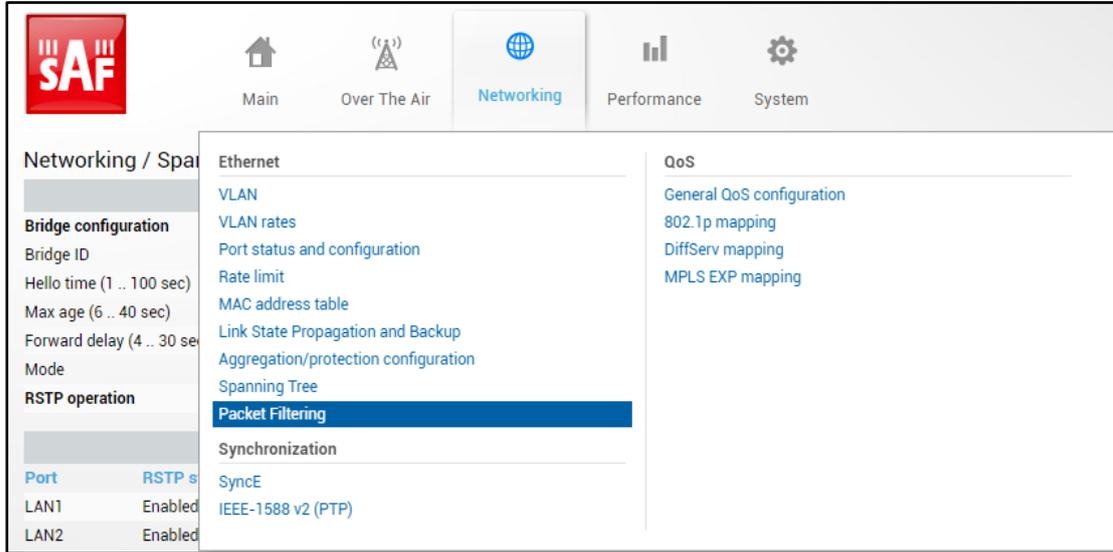
Figure 3-67 Accessing Packet Filtering page

Status mode
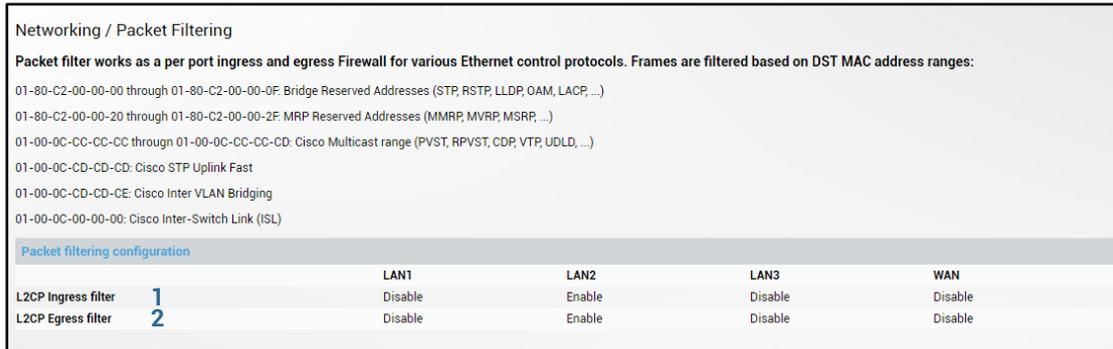
Figure 3-68 Packet Filtering – status mode

Press ✐ MODIFY button.
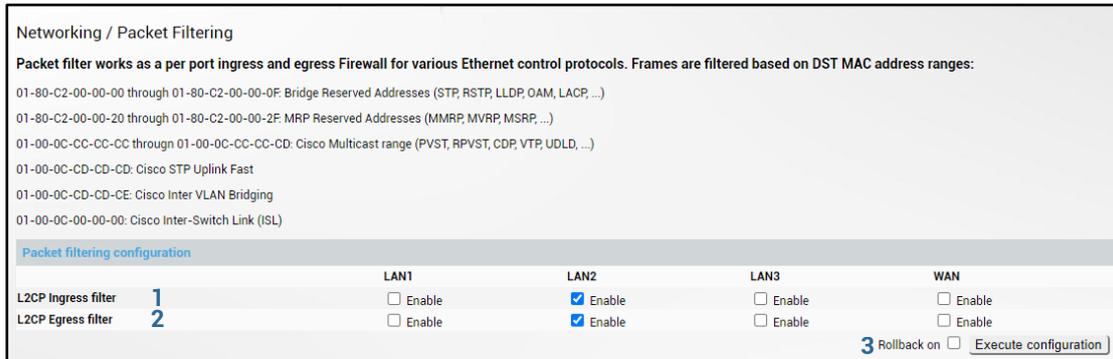
Modify mode

Figure 3-69 Packet Filtering – modify mode

1) **L2CP Ingress filter** – indicates whether L2CP packet filtering is enabled or disabled for ingress traffic on each port (status mode); allows enabling ☑ or disabling ☐ L2CP packet filtering for ingress traffic on each port (modify mode).

2) **L2CP Egress filter** – indicates whether L2CP packet filtering is enabled or disabled for egress traffic on each port (status mode); allows enabling ☑ or disabling ☐ L2CP packet filtering for egress traffic on each port (modify mode).

3) By pressing „*Execute configuration*", changes made to the corresponding section apply only to the local side Integra-E/E2/E3. If „*Rollback on*" is selected, the configuration will be reverted in case erroneous configuration changes are applied.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

network filter l2cp_egress add <port>	Use to enable L2CP packet filtering for egress traffic on the selected port.
network filter l2cp_egress remove <port>	Use to disable L2CP packet filtering for egress traffic on the selected port.
network filter l2cp_ingress add <port>	Use to enable L2CP packet filtering for ingress traffic on the selected port.
network filter l2cp_ingress remove <port>	Use to disable L2CP packet filtering for ingress traffic on the selected port.

Networking → Synchronization → SyncE

Synchronous Ethernet (SyncE) allows synchronizing the Ethernet switch clock of Integra-E/E2/E3 to an external source clock by specifying an ingress port.

⚠ Incorrect SyncE configuration may result in the loss of connectivity.

Auto-negotiation **_will not_** function properly when the clock source ports on both Integra-E/E2/E3 FODUs are pointing at each other (e.g., WAN-WAN in a link or LAN-LAN in a back-to-back connection). SyncE will work properly on LAN2 and LAN3 ports only when compatible SFP modules are used on these ports.
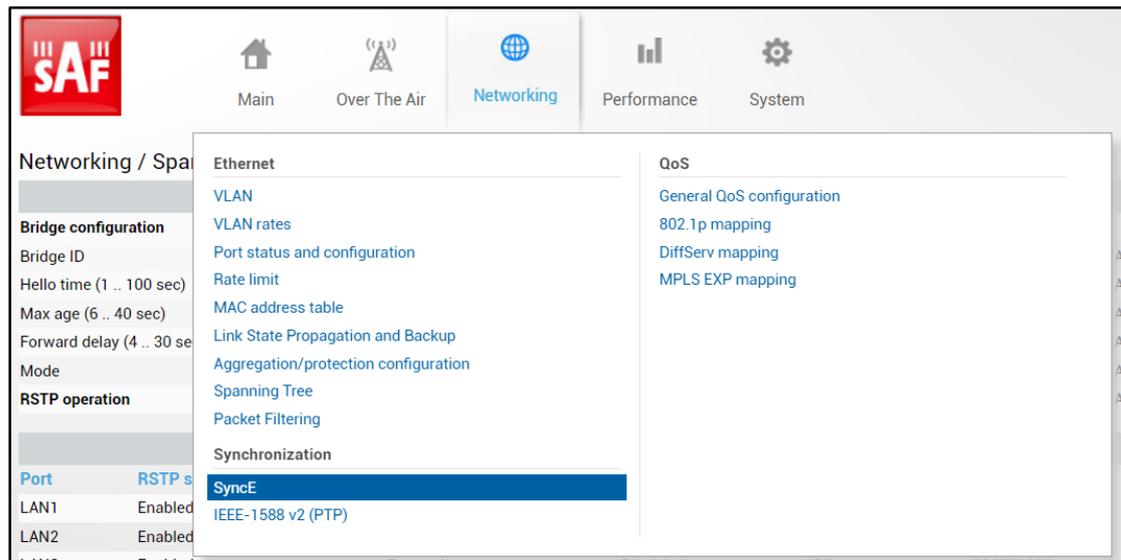
Figure 3-70 Accessing SyncE page

Status mode
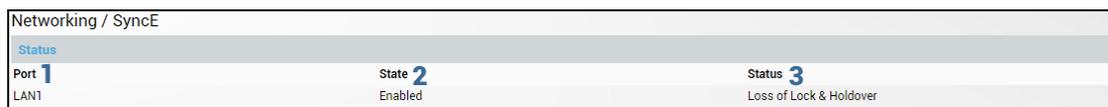
Figure 3-71 SyncE – status mode

Press ✐ MODIFY button.
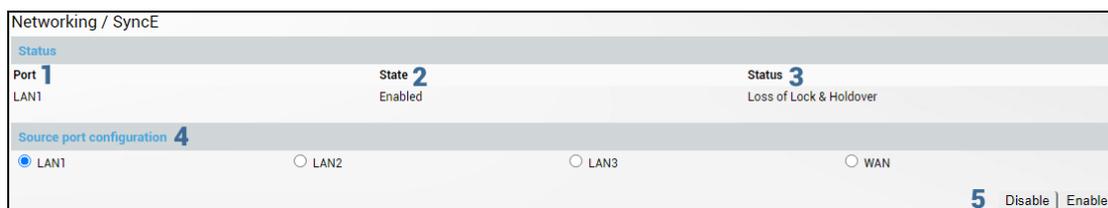
Modify mode

Figure 3-72 SyncE – modify mode

1) *Port* - Indicates SyncE source port (if enabled);
2) *State* - Indicates if SyncE is enabled. The default state is disabled.
3) *Status* - Indicates "Locked" if SyncE is operating normally.
4) *Source port configuration* - Allows specifying SyncE source port.
5) *Disable/Enable* - Allows enabling or disabling SyncE operation.

SyncE configuration examples
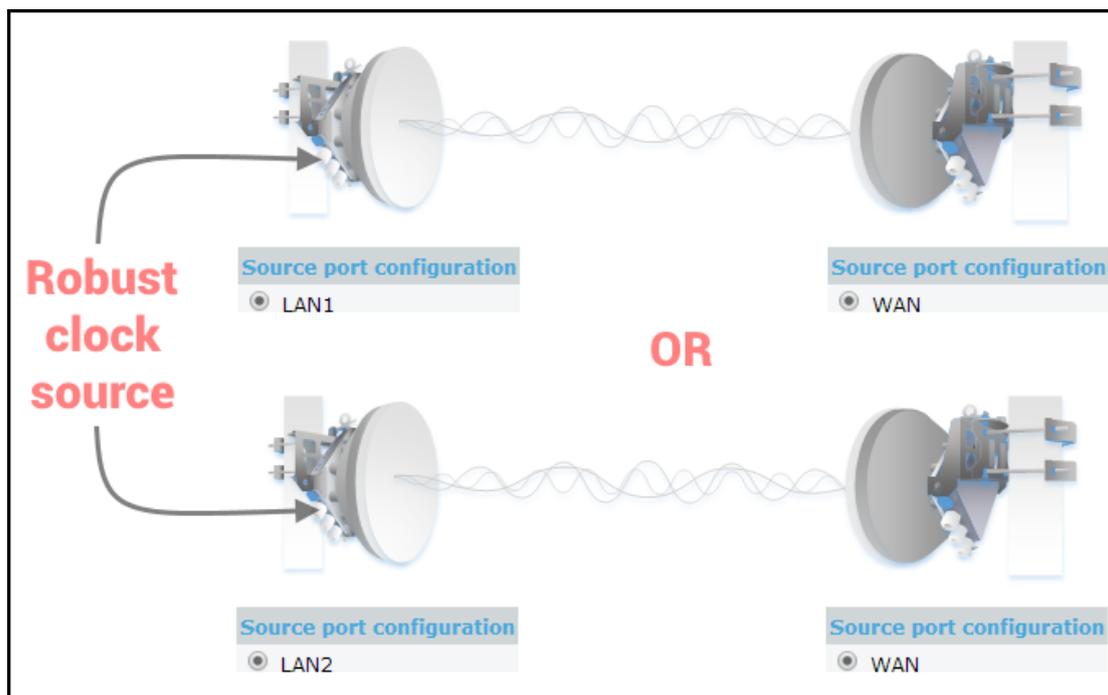
Figure 3-73 Integra-E/E2/E3 link with an external clock source
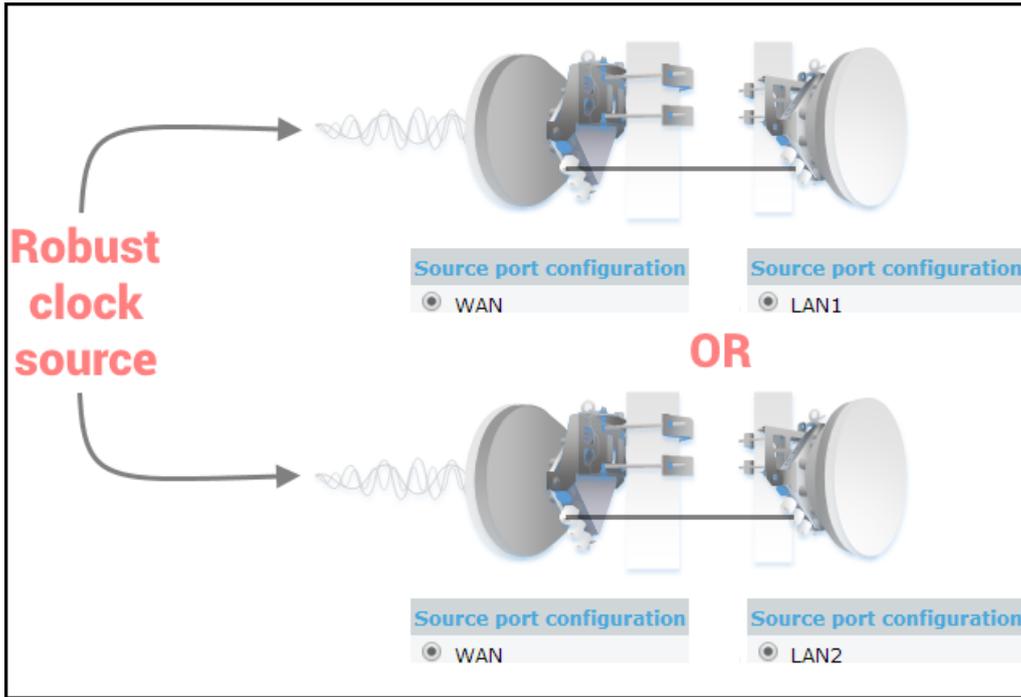
Figure 3-74 Integra-E/E2/E3 back-to-back interconnection with an external clock source
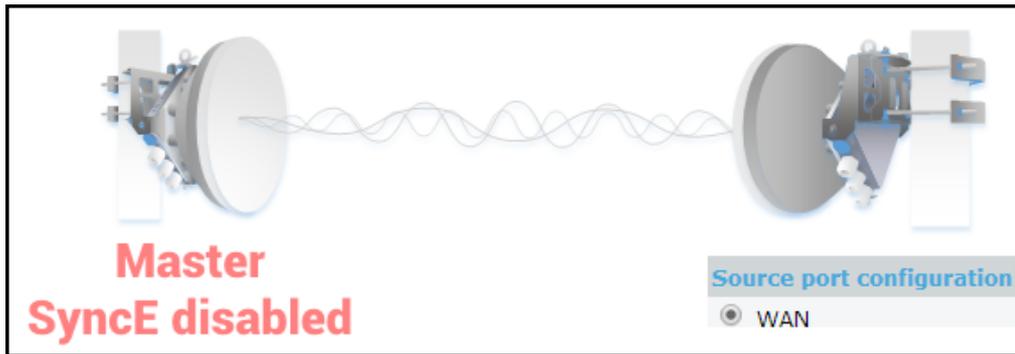
Figure 3-75 Integra-E/E2/E3 as a master clock source

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

network sync status	Use to show SyncE status and configuration.
network sync enable {LAN1|LAN2|LAN3|WAN}	Use to enable SyncE. Port with the SyncE signal ingress must be specified.
network sync disable	Use to disable SyncE on all ports.
network port show info	'SyncE_Act' and 'SyncE_Prio' field nonzero values indicate synchronous Ethernet activity.
network sync option {1|2}	Allow switching between two options for synchronous equipment clocks. The "Option 1", applies to synchronous equipment designed to interwork with networks optimized for the 2048 kbit/s hierarchy. These networks allow the worst-case synchronization reference chain as specified in Figure 8-5 of [ITU-T G.803]. The "Option 2" applies to synchronous equipment designed to interwork with networks optimized for the 1544 kbit/s hierarchy.

Networking → Synchronization → IEEE-1588 v2 (PTP)

> ⚠️ IEEE-1588 v2 (PTP) transparency mode compatibility between both sides of the link can be checked in CLI using command "modem" based on the first value of "Firmware version" parameter, for example:
>
> *>modem*
>
> *Site A> Firmware Version   = 100.7.131 - Chip revision 0x00*
>
> IEEE-1588 v2 (PTP) transparency mode compatibility will be valid if the first number value is the same on both sides of the link, i.e. it should be "100.xx.xx" or "110.xx.xx" on both sides of the link.
>
> IEEE-1588 v2 (PTP) transparency mode will not operate if the first value differs, i.e. one side of the link has "100.xx.xx" value, but the remote side – "110.xx.xx".
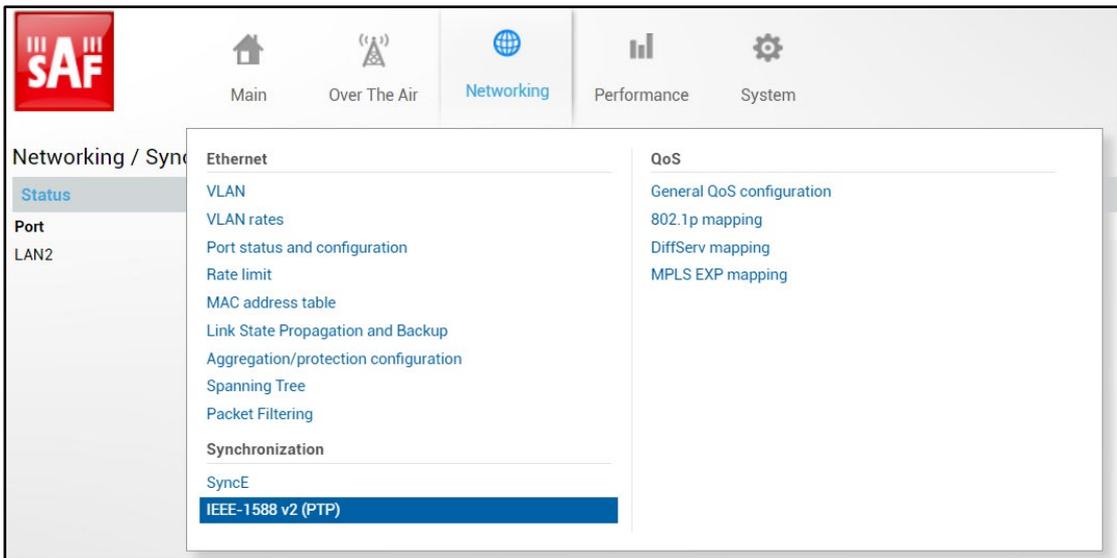
Figure 3-76 Accessing IEEE1588 configuration

Status mode

Figure 3-77 IEEE-1588 v2 (PTP) status mode

1) **RTC configured role -** Dropdown box for choosing between Disabled/Master/Slave roles.
5) **Port** - Ports with IEEE-1588 v2 (PTP) transparency.
6) **State** - IEEE-1588 v2 (PTP) transparency status on ports.

By default, IEEE1588 transparency is disabled, please refer to *Figure 3-77.*

Press ✏ MODIFY button.

IEEE-1588 v2 (PTP) Master role configuration

Configure E-band radio as "Master" on the link side where the source clock is incoming.

Figure 3-78 IEEE-1588 v2 (PTP) Master role configuration

1) **RTC configured role** - Dropdown box for choosing between Disabled/Master/Slave roles. Choose Master for master role configuration.
2) **RTC Task Enabled** - RTC task status.
3) **RTC Side** - RTC side designation.
4) **PTP transparent ports** - Enabling/disabling PTP transparency on all ports simultaneously.
5) **Port** – Port name with IEE-1588 transparency.
6) **State** - IEEE-1588 v2 (PTP) transparency status on ports.
7) By pressing „*Execute configuration",* changes made to the corresponding section apply to the local side Integra-E/E2/E3.

IEEE-1588 v2 (PTP) Slave role configuration

Configure E-band radio as "Slave" on the link side where the source clock is received over the radio link.

Figure 3-79 IEEE-1588 v2 (PTP) Slave role configuration

1) **RTC configured role** - Dropdown box for choosing between Disabled/Master/Slave roles. Chose Slave for slave role configuration.
2) **RTC Task Enabled** - RTC task status.
3) **RTC Side** - RTC side designation.
4) **RTC Lock** - RTC lock status.
5) **Link Latency** - Link Latency value in nanoseconds.
6) **Last Offset Correction** - last offset correction value in nanoseconds.
7) **RTC Status** – RTC lock status.
8) **PPF Status** - PPF lock status.
9) **PTP transparent ports** - Enabling/disabling PTP transparency on all ports simultaneously.
10) **Port** – Port name with IEE-1588 transparency.
11) **State** - IEEE-1588 transparency staus on ports.

12) By pressing „Execute configuration", changes made to the corresponding section apply to the local side Integra-E/E2/E3.

⚠	When configured correctly, "RTC Lock" status for the Slave device should be "Locked".

⚠	It is recommended to configure QoS for PTP packets to ensure PTP packets will pass through the link during excessive traffic loads.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

modem 1588v2	Use to show PTP status and configuration.
modem 1588v2 disable	Use to disable PTP transparency.
modem 1588v2 master	Use to set RTC mode master.
modem 1588v2 slave	Use to set RTC mode slave.

Networking → QoS → General QoS configuration

The General QoS configuration page allows defining QoS queueing rules.
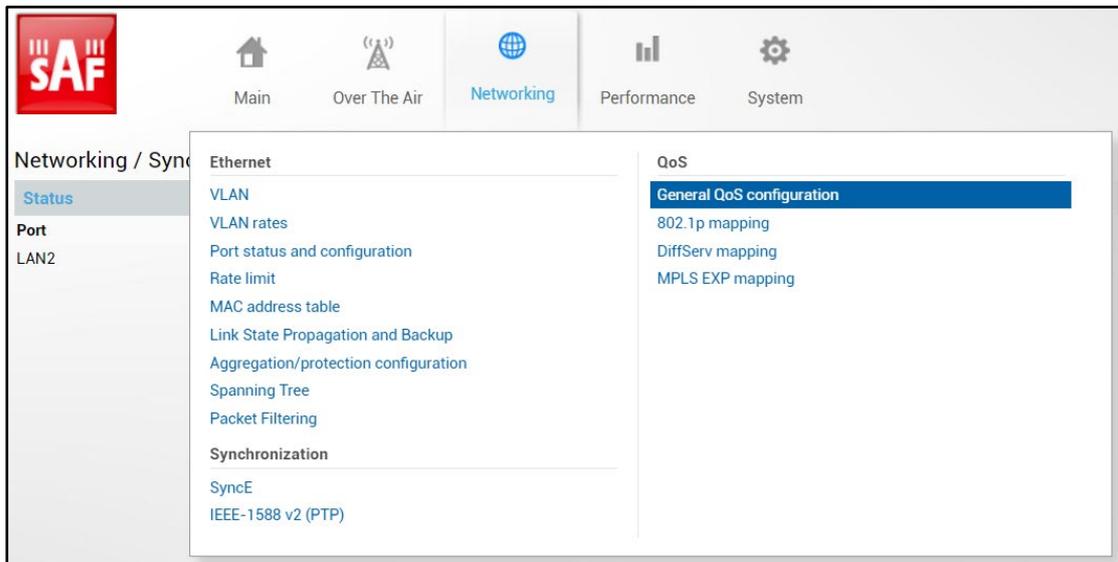
Figure 3-80 Accessing General QoS configuration page

Status mode

Figure 3-81 General QoS configuration – status mode

Press ✏ MODIFY button.

Modify mode

Figure 3-82 General QoS configuration – modify mode

1) **Egress 802.1p priority override** – Indicates whether egress 802.1p priority override is enabled on the egress direction of a particular port (status mode); allows enabling egress 802.1p priority override on available ports (modify mode).

2) **Port based priority** – Indicates whether port-based prioritization is enabled (status mode); allows enabling or disabling port-based prioritization on available ports (modify mode). If enabled, all packets on the egress of a port are put in a specified

queue. 802.1p (PCP) and DiffServ (DSCP) values are ignored. Available values are 0…7 according to eight available priority queues from the lowest to the highest.

3) ***802.1p*** – Indicates whether the 802.1p prioritization is enabled (status mode); allows enabling or disabling 802.1p prioritization on available ports (modify mode). If enabled, configured mapping (*Networking→QoS→802.1p mapping*) is taken into account. 802.1p prioritization is enabled by default on all ports.

4) ***DiffServ*** – Indicates whether DiffServ prioritization is enabled (status mode); allows enabling or disabling DiffServ prioritization on available ports (modify mode). If enabled, DSCP value is taken into account according to configured mapping (*Networking→QoS→DiffServ mapping*).

5) ***MPLS EXP*** - Indicates whether MPLS EXP prioritization is enabled (status mode); allows enabling or disabling MPLS EXP prioritization on available ports (modify mode). If enabled, DSCP value is taken into account according to configured mapping (*Networking→QoS→ MPLS EXP mapping*).

6) ***CoSQ Mode*** – Indicates selected scheduler type SP/RR/WRR/DWRR – Strict Priority/Round Robin/Weighted Round Robin/Deficit Weighted Round Robin (status mode); allows selecting scheduler type (modify mode). CoSQ configuration differs for each selected scheduler type.

- ***SP*** – scheduler drains all packets queued in the highest priority queue before continuing to service lower priority queues. Such an approach can be used for latency-sensitive traffic.
- ***RR*** – scheduler drains all queues consecutively with the same ratio (1:1:1:1:1:1:1:1). Such an approach allows utilizing droplimit buffers of all available queues.
- ***WRR*** – scheduler drains all queues consecutively according to the specified ratio (queue weights) specified in a number of frames. The default ratio is equal for all queues (1:1:1:1:1:1:1:1). Such an approach allows minimizing stacking delay for high priority traffic and at the same time retaining traffic flow at lower priority queues.
- ***DWRR*** – scheduler drains all queues consecutively according to the specified ratio (Weight) specified in kilobytes (kB). Compared to WRR excess bandwidth used in the current pass is remembered and subtracted from the allocated weight in the next pass and as a result statistically over time bandwidth used by each queue will be closer to the configured value. The default ratio is 5:5:5:10:15:15:20:25 kB.

CoSQ configuration is explained for each scheduler type below.

7) By pressing „*Execute configuration",* changes made to the corresponding section apply only to the local side Integra-E/E2/E3. If „*Rollback on"* is selected, the configuration will be reverted in case erroneous configuration changes are applied.

CoSQ configuration – SP (Strict Priority) and RR (Round Robin)
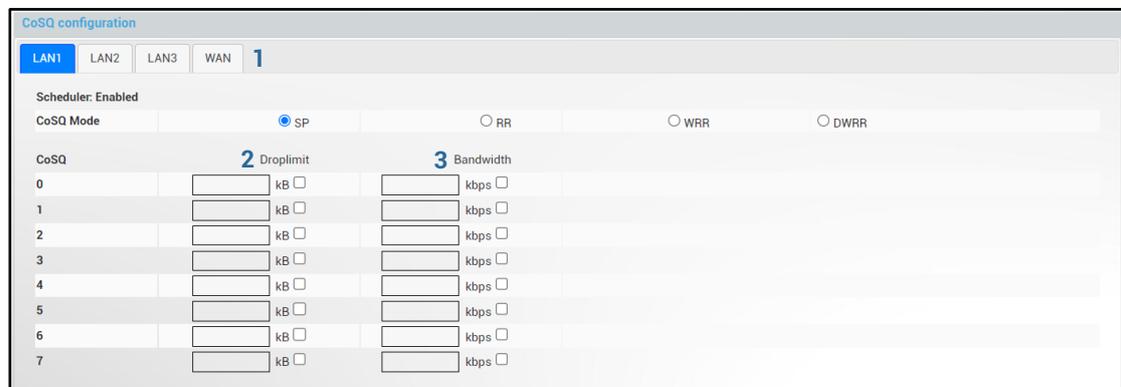
Figure 3-83 CoSQ configuration – SP & RR

1) ***LAN1/LAN2/LAN3/WAN*** – Tabs allow selecting a particular port.

2) **Droplimit** – Indicates droplimit buffer size assigned for each queue (status mode); allows modifying droplimit buffer size for each queue (modify mode).

> ⚠ Increasing buffer size increases data transmission latency.

3) **Bandwidth** - allows configuring bandwidth in kbps for each queue separately.

CoSQ configuration – WRR (Weighted Round Robin)

Figure 3-84 CoSQ configuration - WRR

1) **LAN1/LAN2/LAN3/WAN** – Tabs allow selecting a particular port.
2) **Droplimit** – Indicates droplimit buffer size assigned for each queue (status mode); allows modifying droplimit buffer size for each queue (modify mode).

> ⚠ Increasing buffer size increases data transmission latency.

3) **Weight** - allows configuring weight in frames for each queue and port separately.
4) **Bandwidth** - allows configuring bandwidth in kbps for each queue and port separately.

CoSQ configuration – DWRR (Deficit Weighted Round Robin)

Figure 3-85 CoSQ configuration - DWRR

1) **LAN1/LAN2/LAN3/WAN** – Tabs allow selecting a particular port.
2) **Droplimit** – Indicates droplimit buffer size assigned for each queue (status mode); allows modifying droplimit buffer size for each queue (modify mode).

> ⚠ Increasing buffer size increases data transmission latency.

3) **Weight** - allows configuring weight in frames for each queue and port separately.
4) **Bandwidth** - allows configuring bandwidth in kbps for each queue and port separately.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

network qos set <port> **base state** {enable|disable}	Use to configure base port priority - ingress packets processing.
network qos set <port> **base priority** {0...7}	Use to set port-based priority for all ingress packets.
network qos set <port> **cosq override-priority** {enable|disable}	Use to enable/disable override priority tag with internal priority in egress packet on a defined port.
network qos set <port> cosq scheduler mode {dwrr|rr|sp|wrr}	Use to set scheduler packet service mode.
network qos set <port> **cosq scheduler weight** {1...127}	Use to set weight for a queue in kB. Weight parameter will become configurable only when the scheduler is set to DWRR.
network qos set <port> **cosq bandwidth** {1-10000000|unlimited}	Use to set maximum bandwidth in kB allowed for a CoS queue or reset to unlimited.
network qos set <port> **cosq droplimit** {1-1564|unlimited}	Use to set droplimit (size) in kB of a CoS queue or reset to unlimited.
network qos reset statistics {LAN1|LAN2|LAN3|WAN|all}	Use to reset QoS statistics on a particular port or all ports simultaneously.
network qos reset config {LAN1|LAN2|LAN3|WAN|all}	Use to reset QoS configuration on a particular port or all ports simultaneously.
network qos show config {LAN1|LAN2|LAN3|WAN|all} ingress-map	Use to show QoS ingress priority mapping configuration.
network qos show config {LAN1|LAN2|LAN3|WAN|all} egress-map	Use to show QoS egress priority mapping configuration.
network qos show info {LAN1|LAN2|LAN3|WAN|all} ingress-cosq	Use to show the ingress priority mapping HW status.
network qos show info {LAN1|LAN2|LAN3|WAN|all} egress-cosq	Use to show the egress priority mapping HW status.
network qos show statistics {LAN1|LAN2|LAN3|WAN|all}	Use to show QoS statistics.

Networking → QoS → 802.1p mapping

The 802.1p mapping page allows customizing the mapping of IEEE 802.1p priority tags and available QoS queues.
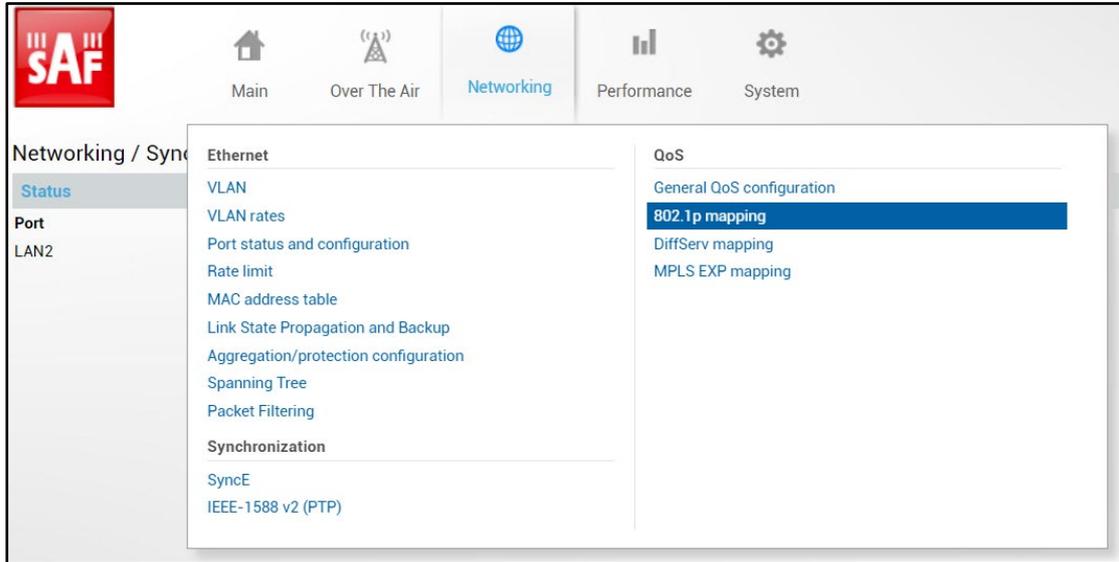
Figure 3-86 Accessing 802.1p mapping page

Status mode

Figure 3-87 802.1p mapping – status mode

Press ✎ MODIFY button.

Modify mode

Figure 3-88 802.1p mapping – modify mode

1) **State** – indicates whether 802.1p mapping is enabled or disabled on each port.
2) **VLAN priority** – Indicates PCP (Priority Code Point) values 0 – 7.

3) **LAN1** – Indicates to which egress queue packets will, according to 802.1p priority, be put in if 802.1p QoS prioritization is enabled on LAN1 port (status mode); allows modifying default mapping of priority values and queues (modify mode).

4) **LAN2** – Indicates to which egress queue packets will, according to 802.1p priority, be put in if 802.1p QoS prioritization is enabled on LAN2 port (status mode); allows modifying default mapping of priority values and queues (modify mode).

5) **LAN3** – Indicates to which egress queue packets will, according to 802.1p priority, be put in if 802.1p QoS prioritization is enabled on LAN3 port (status mode); allows modifying default mapping of priority values and queues (modify mode).

6) **WAN** – Indicates to which egress queue packets will, according to 802.1p priority, be put in if 802.1p QoS prioritization is enabled on WAN port (status mode); allows modifying default mapping of priority values and queues (modify mode).

7) By pressing „*Execute configuration"*, changes made to the corresponding section apply only to the local side Integra-E/E2/E3. If „*Rollback on"* is selected, the configuration will be reverted in case erroneous configuration changes are applied.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

network qos set <port> **vlan state** {enable|disable}	Use to enable or disable ingress 802.1p mapping on a particular port.
network qos set <port> **vlan pcp** {0...7} **priority** {0...7}	Use to set VLAN (802.1p) priority mapping.

Networking → QoS → DiffServ mapping

The DiffServ mapping page allows customizing the mapping of DSCP priority tags and available QoS queues.
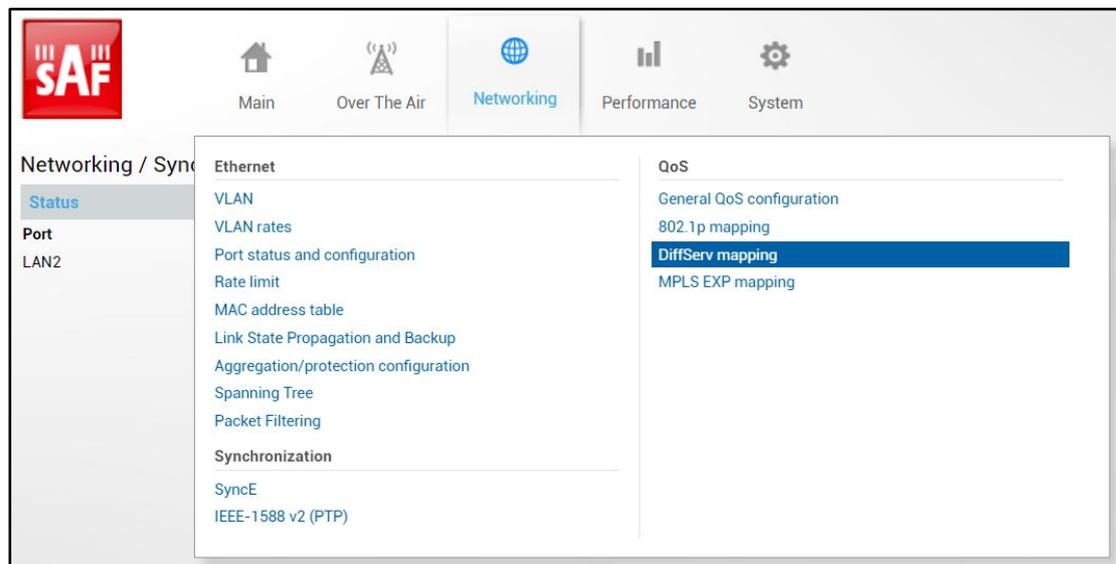
Figure 3-89 Accessing DiffServ mapping page

Status mode

Figure 3-90 DiffServ mapping – status mode

Press ✏ MODIFY button.

Modify mode

Figure 3-91 DiffServ mapping – modify mode

1) **State** – indicates whether DiffServ mapping is enabled or disabled on each port.
2) **LAN1/LAN2/LAN3/WAN** – Tabs allow selecting a particular port.
3) The table shows the mapping between DSCP values and CoS queues (status mode); allows modifying default mapping of DSCP priority values and queues (modify mode).
4) By pressing „*Execute configuration*", changes made to the corresponding section apply only to the local side Integra-E/E2/E3. If „*Rollback on*" is selected, the configuration will be reverted in case erroneous configuration changes are applied.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

network qos set <port> **diffserv state** {enable|disable}	Use to enable or disable ingress DiffServ mapping (DSCP) on a particular port.
network qos set <port> diffserv dscp {0…63} **priority** {0…7}	Use to change default DiffServ priority (DSCP) mapping.

Networking → QoS → MPLS EXP mapping

The MPLS EXP mapping page allows customizing the mapping of MPLS EXP priority bits and available QoS queues.
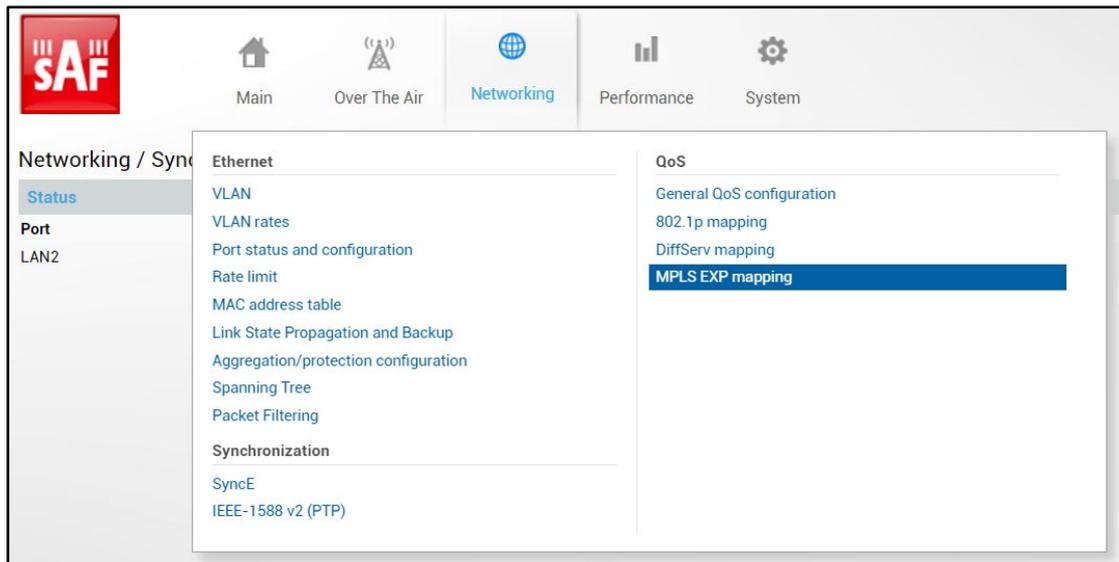
Figure 3-92 Accessing MPLS EXP mapping page

Status mode

Figure 3-93 MPLS EXP mapping – status mode

Press 🖉 MODIFY button.

Modify mode

Figure 3-94 MPLS EXP mapping – modify mode

1) **State** – indicates whether MPLS EXP mapping is enabled or disabled on each port.
2) **MPLS EXP value** – Indicates MPLS EXP values 0 – 7;
3) **Queue** – Indicates into which egress queue packets for LAN1 port with according MPLS EXP value will be place (status mode); allows modifying default mapping of MPLS EXP values for LAN1 port and queues (modify mode).
4) **Queue** – Indicates into which egress queue packets for LAN2 port with according MPLS EXP value will be placed (status mode); allows modifying default mapping of MPLS EXP values for LAN2 port and queues (modify mode).
5) **Queue** – Indicates into which egress queue packets for LAN3 port with according MPLS EXP value will be placed (status mode); allows modifying default mapping of MPLS EXP values for LAN3 port and queues (modify mode).
6) **Queue** – Indicates into which egress queue packets for WAN port with according MPLS EXP value will be place (status mode); allows modifying default mapping of MPLS EXP values for WAN port and queues (modify mode).
7) By pressing „*Execute configuration",* changes made to the corresponding section apply only to the local side Integra-E/E2/E3. If „*Rollback on"* is selected, the configuration will be reverted in case erroneous configuration changes are applied.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

network qos set <port> **mpls_exp state** {enable|disable}	Use to set MPLS EXP state.
network qos set <port> **mpls_exp exp** {0…7}	Use to set MPLS EXP mapping. Ingress packets EXP value to internal priority value.

Performance

Performance → Alarm → Alarm status
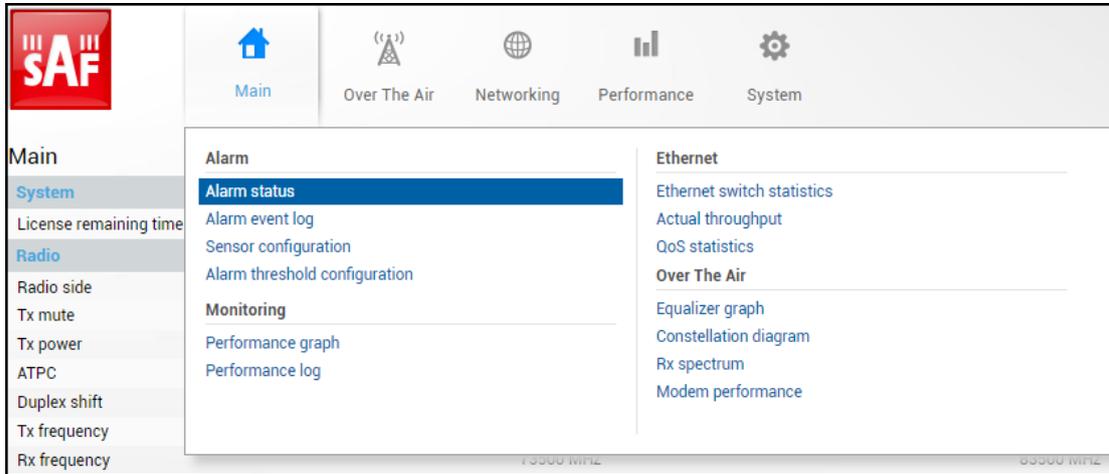
Figure 3-95 Accessing Alarm status page

Alarm status page summarizes current alarms by showing the date and time the alarm occurred and its name.

Figure 3-96 Alarm status

1) **Date** – shows the date when the alarm was initiated.
2) **Time** – shows the time when the alarm was initiated.
3) **Alarm** – shows the name of the alarm.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

log sensor setlist	Use to show alarms status.

Performance → Alarm → Alarm event log
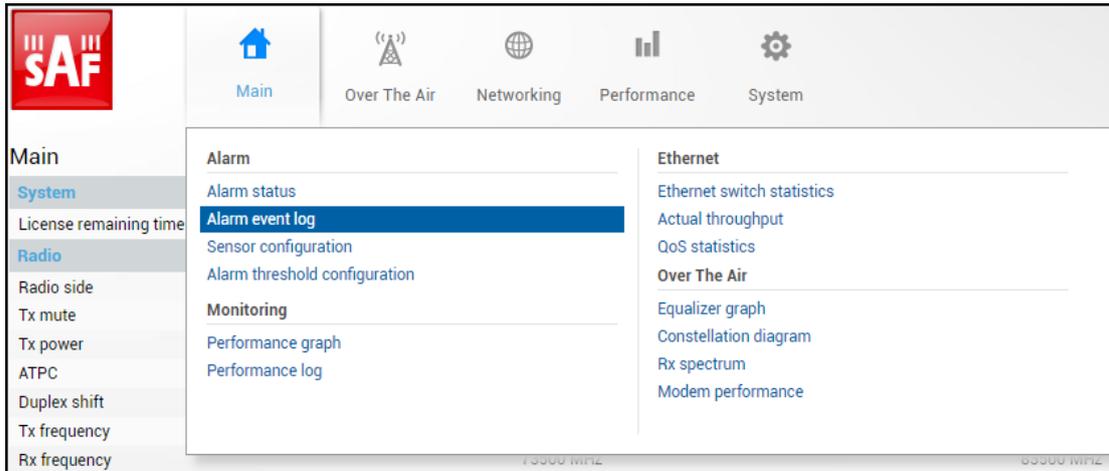
Figure 3-97 Alarm status

Alarm event log shows 20 alarm entries per page and about 5000 alarm entries in total. By default, the last page of log entries is shown. Full alarm log can be downloaded by pressing on "Alarm event log file".

Alarm entries are mostly distributed in two groups – *"Set"'* when the alarm appears and *"Reset"* when the alarm disappears.

You also have fast access to alarm filtering, where it is possible to choose which alarm groups you are willing to filter out of all log entries.

Status mode
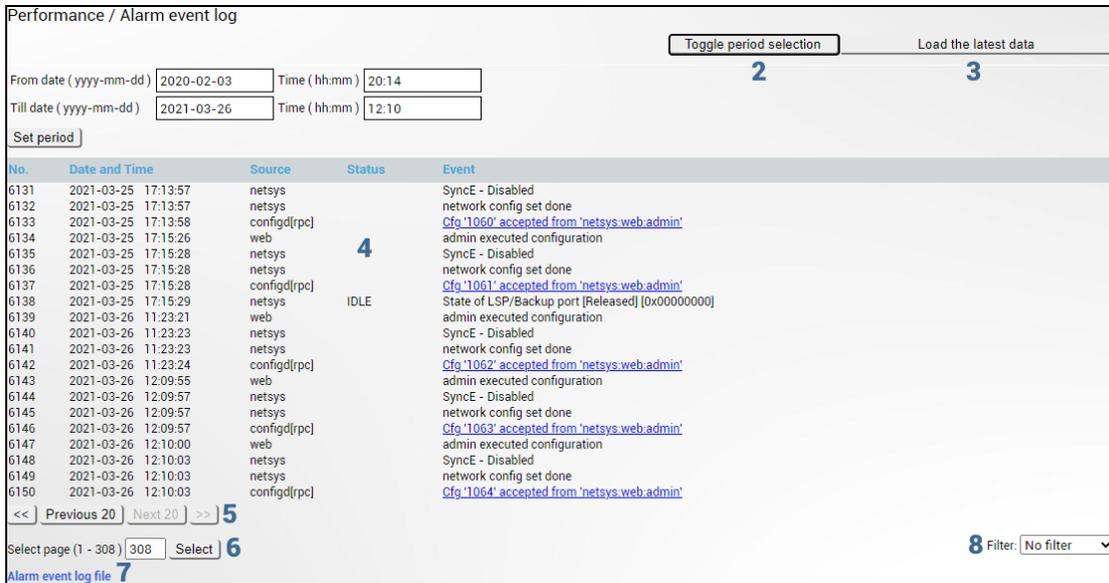
Figure 3-98 Alarm event log – status mode

Press ✏ MODIFY button.
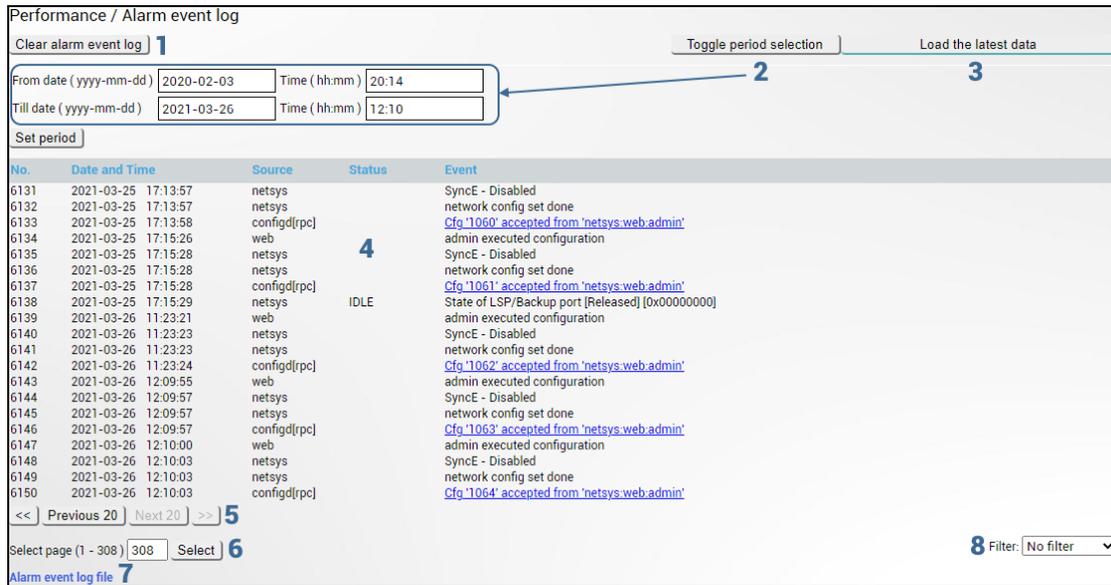
Modify mode

Figure 3-99 Alarm event log – modify mode

1) **Clear alarm log** – deletes all alarm log entries.
2) **Toggle period selection** – opens/closes period selection controls.
3) **Load the latest data** – refreshes alarm log and shows last 20 log entries.
4) **List of alarm log entries** – entry number, date and time, source node, status and event name.
5) **Navigation controls**. "<<" navigates to start of alarm log, while ">>" – to the end; "Previous 20" navigates to previous alarm log page showing 20 previous alarm log entries (if available), while "Next 20" – to next alarm log page showing 20 next alarm log entries (if available).
6) Shows the number of the currently viewed alarm log page. You can enter the specific page number to navigate to the required page.
7) **Alarm event log file** – press to filter alarms from a certain source node (e.g., Radio).
8) **Filter** – press the link to download a full alarm log text file.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

log event show last <#_of_entries>	Use to show a certain number of last alarm log entries.
log event show time <starttime> [<endtime>]	Use to show entries from a certain time point. Following formats are supported: YYYY-MM-DD/hh:mm:ss; MM-DD/hh:mm:ss; MM-DD/hh:mm; hh:mm:ss; hh:mm
log event show sensor <sensor> [last <#_of_entries>] [time <starttime> [<endtime>]]	Use to show entries for a specific sensor. Regarding subcommands "last" and "time" please refer to commands above.
log event show module {modem| psu | radio | system | alarm_only | iman} [last <#_of_entries>] [time <starttime> [<endtime>]]	Use to show entries for a specific module. Regarding subcommands "last" and "time" please refer to commands above.
log event clear	Use to clear alarm log

log event configure {enable|disable}	Use to enable or disable event log filter.
log event configure dump <1…60>	Use to configure duration in minutes during which filter is monitoring repetitions.
log event configure pattern <1…10>	Use to configure a number of log entry repetitions to be monitored.
log event configure sn_hide_sev <0…7>	Use to set alarm severity levels (up to and including) to be excluded from logging; the levels are: 0 – emergency, 1 – alert, 3 – error, 4 – warning, 5 – notice, 6 – info, 7 – debug; the default value is "4".
log event configure status	Use to display the current configuration of grouped repetitive alarm-event log entries (filter).
log event show last <#_of_entries>	Use to show a certain number of last alarm log entries.

Performance → Alarm → Sensor configuration

The section allows the specifying behavior of available sensor parameters.

⚠ After the firmware upgrade, it is required to reset sensor configuration to default using "Set all to default" button and reconfigure sensors as required.

⚠ It is not recommended to add "License remaining time" sensor parameter to performance ("perfd") type parameters.
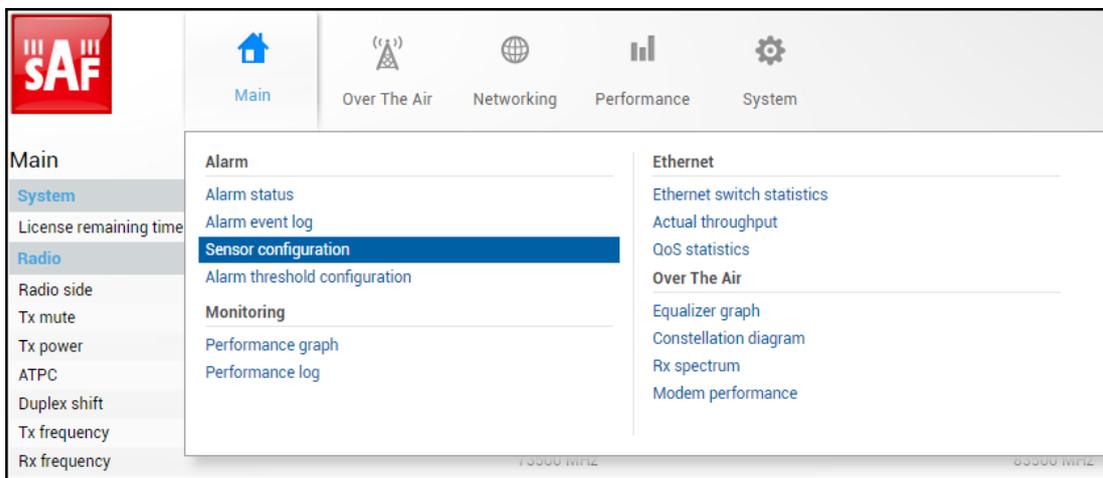
Figure 3-100 Accessing Sensor configuration page

Status mode

Figure 3-101 Sensor configuration – status mode

Press ✎ MODIFY button.

Modify mode

Figure 3-102 Sensor configuration – modify mode

1) **Group description (name)** – Shows 5 groups of sensors divided by different group data destinations (event; perf; SNMP), as well as indicates whether the group is enabled (State);

2) **Ungrouped sensor list** – Shows the list of sensors not added to any of the existing groups (status mode); allows dragging to any of the existing groups, thus specifying how the sensor will be treated. Unchecking the checkbox next to the sensor disables the sensor (modify mode).

3) **+/-** opens the dropdown box with sensors in the group. Sensors from the ungrouped sensor list or other groups can be added to the group by dragging them in. Unchecking the checkbox next to the sensor disables the sensor (modify mode).

4) **Add group** – Allows creating a new group with a custom name and description.
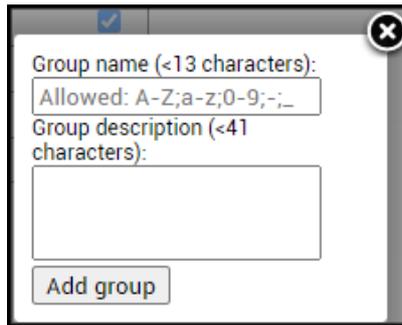
Figure 3-103 Add group

Afterward, sensors from the ungrouped sensor list or other groups can be added to the group by dragging them in.

5) **Remove group** – Allows deleting existing groups via a dialog window.
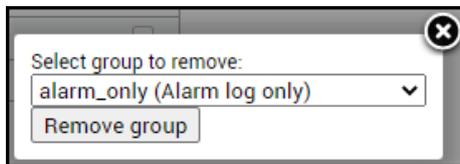
Figure 3-104 Remove group

6) **Set all to default** – Restores default settings for all groups and sensors.
7) By pressing „*Execute configuration",* changes made to the corresponding section apply only to the local side Integra-E/E2/E3.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

log group info	Use to show sensor group configuration.
log group create <name> <description>	Use to create a new group.
log group mgmt <name> **add destination** {event|perf|snmp|syslog}	Use to add a destination for a group.
log group mgmt <name> **add sensor** <sensor>	Use to add a sensor to a group.
log group mgmt <name> **config** {enable|disable}	Use to enable or disable a group.
log group mgmt <name> **delete**	Use to delete a group.
log group mgmt <name> **remove destination** {event|perf|snmp|syslog}	Use to remove a destination from a group.
log group mgmt <name> **remove sensor** <sensor>	Use to remove a sensor from a group.
log sensor info	Use to show current sensor status.
log sensor list	Use to list all available sensors.
log default {all|group|sensors [<sensor>]}	Use to set group, individual sensor, or all sensor configuration to default.

Performance → Alarm → Alarm threshold configuration

Alarm threshold page provides a summary of the parameters' alarm thresholds. All thresholds are predefined and some change dynamically according to the system configuration. Thresholds can be modified if required.

Alarm activates when current value exceeds (low-delta) or (high+delta) values. Alarm deactivates when current value exceeds (low+delta) or (high-delta) values.
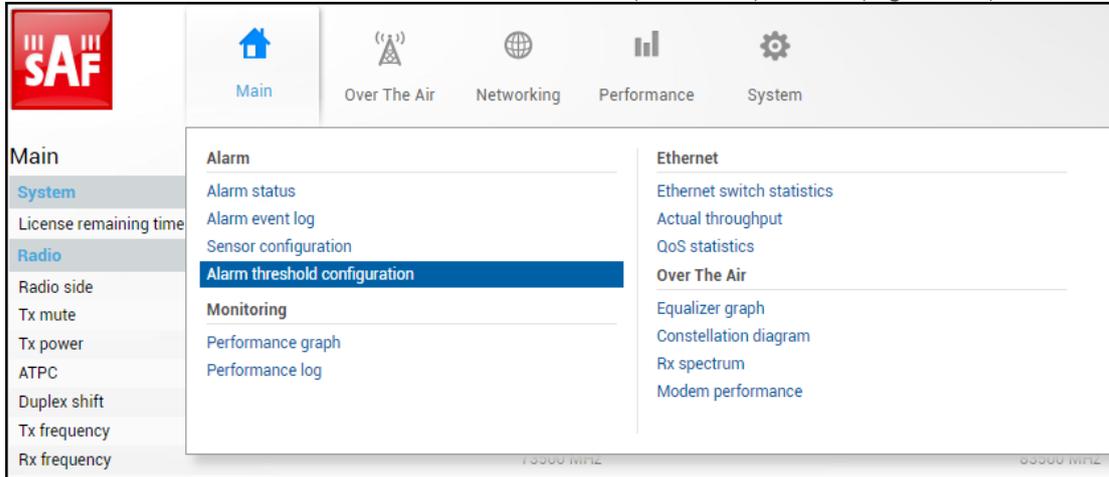
Figure 3-105 Accessing Alarm threshold configuration page

Status mode

Performance / Alarm threshold configuration

Alarm name	Low value	High value	Delta value	Current value
Rx level	-72 dBm	-20 dBm	2 dB	-25 dBm
MSE		-9.4 dB	2.0 dB	-30.3 dB
FEC load		0.0 dB	2.0 dB	-63.8 dB
Radio temperature	-40.0 C	80.0 C	2.0 C	52.0 C
System temperature	-40.0 C	100.0 C	2.0 C	59.0 C
System CPU temperature	-40.0 C	100.0 C	2.0 C	65.1 C
Modem temperature	-40.0 C	100.0 C	2.0 C	59.0 C
PSU voltage	36.00 V	58.00 V	2.00 V	53.40 V
PSU current	0.500 A	1.500 A	0.050 A	0.800 A
PSU power	30.00 W	55.00 W	2.00 W	42.72 W
System CPU idle				78.4 %
System free physical memory				89.6 %
Carrier offset	-1000.00 kHz	1000.00 kHz	10.00 kHz	-49.33 kHz
License remaining time	15d 00:00:00			N/A
1.8 V	1.71 V	1.89 V	0.02 V	1.77 V
1.5 V	1.14 V	1.89 V	0.02 V	1.50 V
1.0 V	0.97 V	1.03 V	0.02 V	0.99 V

Figure 3-106 Alarm threshold configuration – status mode

Press ✏ MODIFY button.

Modify mode

Performance / Alarm threshold configuration					
Alarm name	Low value	High value	Delta value	Current value	Default value
Rx level	-72 dBm	-20 dBm	2 dB	-25 dBm	☑ **3**
MSE		-9.4 dB	2.0 dB	-30.3 dB	☑
FEC load		0.0 dB	2.0 dB	-63.7 dB	☑
Radio temperature	-40.0 C	80.0 C	2.0 C	52.0 C	☑
System temperature	-40.0 C	100.0 C	2.0 C	59.0 C	☑
System CPU temperature	-40.0 C	100.0 C	2.0 C	65.2 C	☑
Modem temperature	-40.0 C	100.0 C	2.0 C	59.0 C	☑
PSU voltage	36.00 V	58.00 V	2.00 V	53.40 V	☑
PSU current	0.500 A	1.500 A	0.050 A	0.800 A	☑
PSU power	30.00 W	55.00 W	2.00 W	42.72 W	☑
System CPU idle				74.2 %	
System free physical memory				89.7 %	
Carrier offset	-1000.00 kHz	1000.00 kHz	10.00 kHz	-49.33 kHz	☑
License remaining time	15d 00:00:00			N/A	☑
1.8 V	1.71 V	1.89 V	0.02 V	1.77 V	☑
1.5 V	1.14 V	1.89 V	0.02 V	1.50 V	☑
1.0 V	0.97 V	1.03 V	0.02 V	0.99 V	☑

1 field marker; + button; **Set all to default** **2**; **4** Execute configuration

Figure 3-107 Alarm threshold configuration – modify mode

1) Indicates low, high and delta values of the parameters (status mode); "Low value", "High value" and "Delta value" fields for all parameters become editable when "Default value" is deselected (modify mode);
2) **Set all to default** – resets "Low value", "High value" and "Delta value" for all parameters to factory defaults;
3) **Default value** – deselect to activate manual threshold modification;
4) By pressing „*Execute configuration"*, changes made to the corresponding section apply only to the local side Integra-E/E2/E3.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

log sensor info	Use to show the configuration of sensor thresholds.
log sensor mgmt <sensor> **control {enable|disable}**	Use to enable or disable a sensor.
log sensor mgmt <sensor> **thold** <min> <max> <delta>	Use to set sensor's min, max thresholds and delta value manually.
log sensor mgmt <sensor> **time** <0…30>	Use to set sensor hysteresis time in seconds. It will be used to show value in orange color indicating that sensor value recently exceeded its thresholds.
log default {all| group| sensors [sensor]}	Use to set group, individual sensor, or all sensor configuration to default.
log sensor list	Use to list all available sensors.

Performance → Monitoring → Performance graph

The Performance graph allows visualizing various parameters over a chosen time like curves. Available parameters will depend on the *Performance → Alarm → Sensor configuration*. Any two parameters can be shown at a time. By default, Rx level (dBm) and MSE (dB) are selected.

⚠ Not all sensors available in Sensor Configuration can be displayed in the Performance graph.
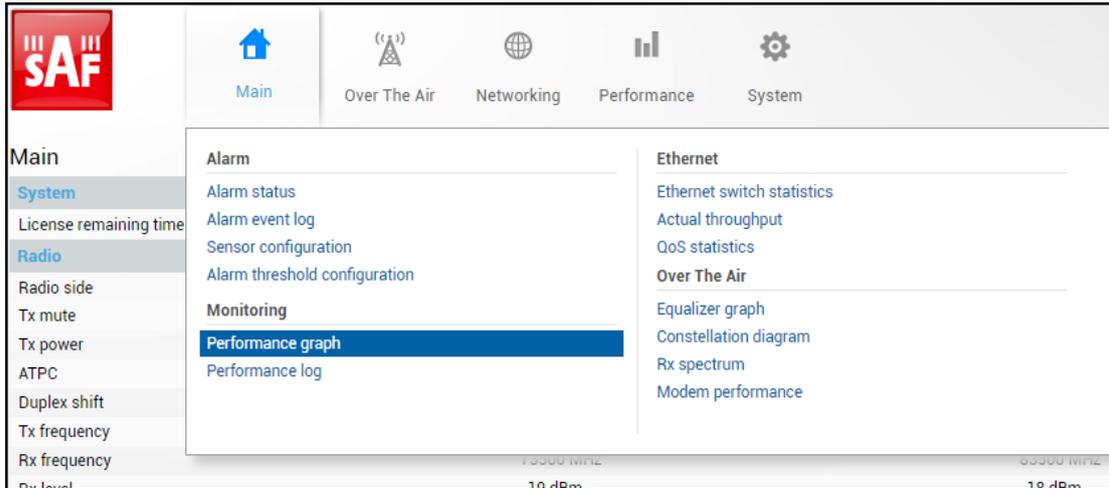
Figure 3-108 Accessing Performance graph

MODIFY button is deactivated in the Performance graph page.
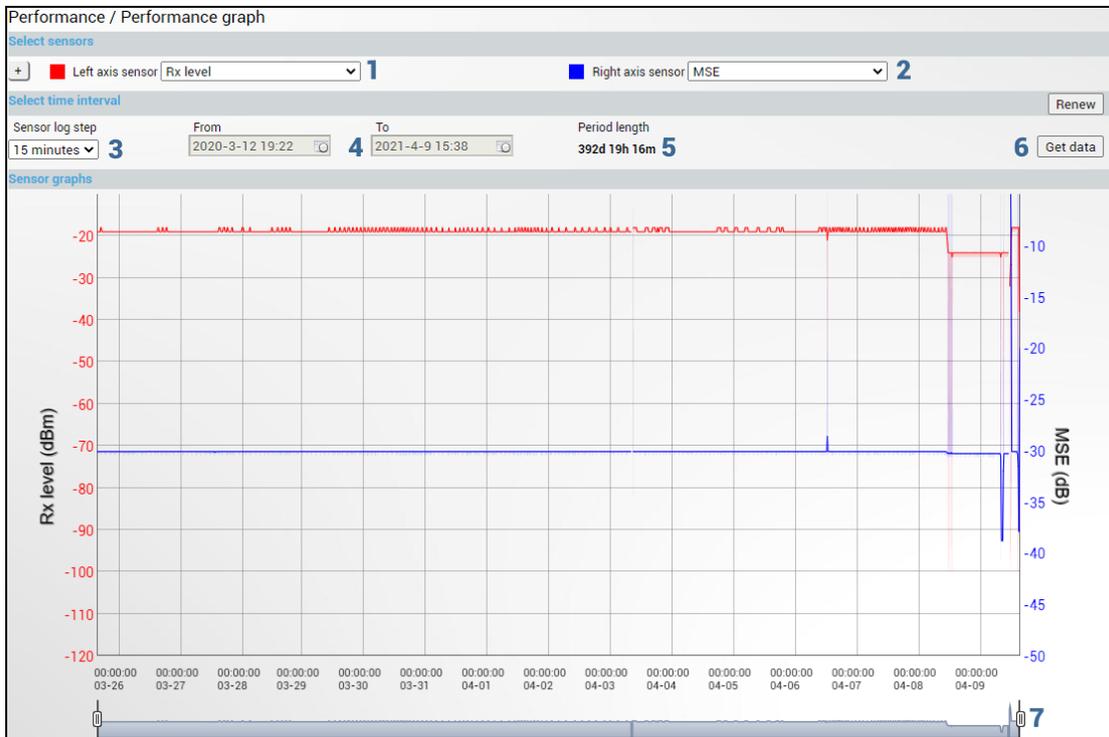
Figure 3-109 Performance graph

1) **Left axis sensor** – Allows choosing sensor parameter colored in red and displayed on the left axis.
2) **Right axis sensor** – Allows choosing sensor parameter colored in blue and displayed on the right axis.
3) **Sensor log step** – Allows choosing graph granularity – 1, 15, or 60 minutes.
4) Indicates start and end date/time of period displayed and allows selecting a specific period to show.
5) **Period length** – Indicates the length of the currently displayed period.
6) **Get data** – Press to apply selected time interval changes.
7) Left and right sliders allow to "zoom" the currently selected time.

Performance → Monitoring → Performance log

Allows viewing and downloading performance logs.
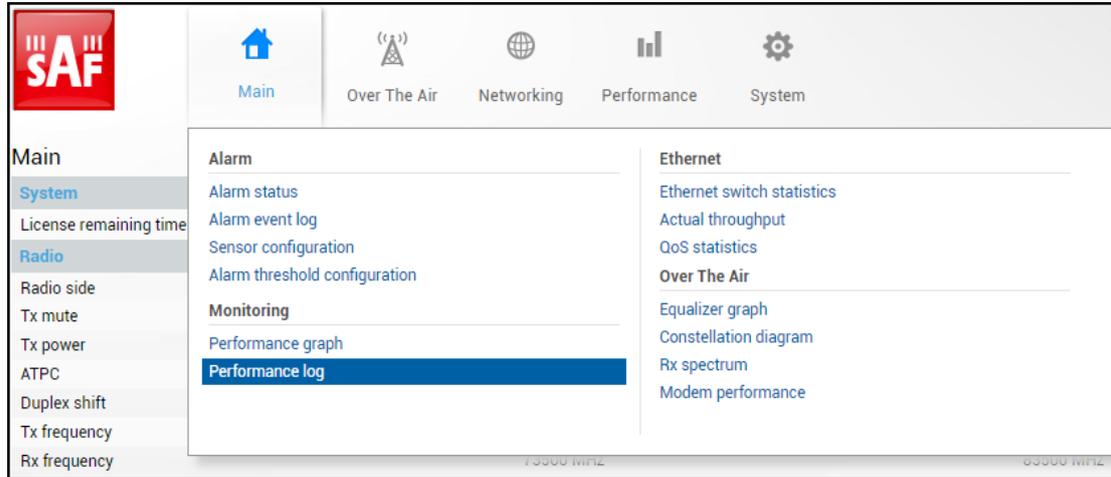
Figure 3-110 Accessing Performance log page

MODIFY button is deactivated in the Performance log page.
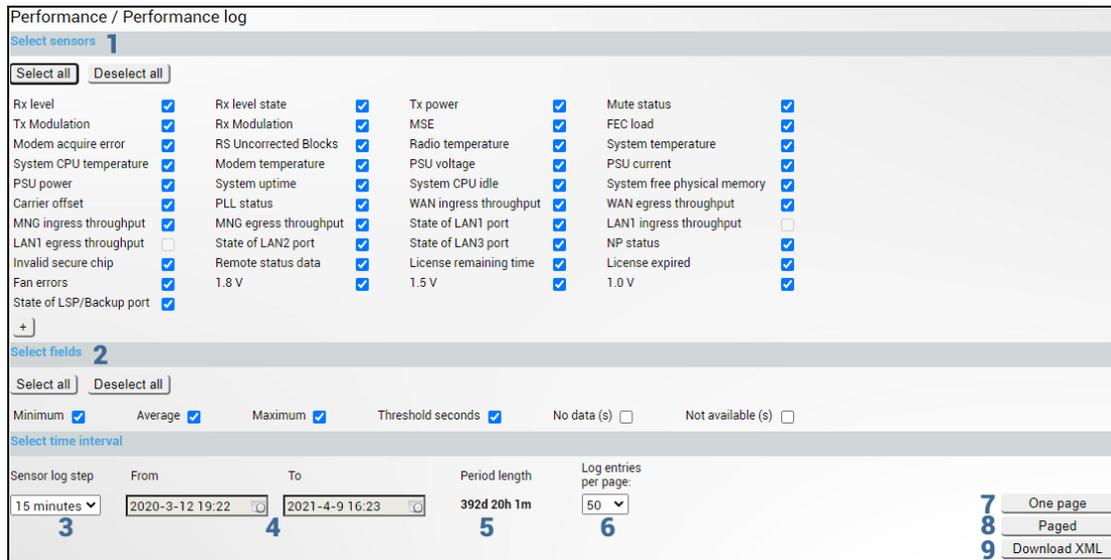
Figure 3-111 Performance log

1) **Select sensors** – Allows choosing the sensor parameters to be displayed in the performance log.
2) **Select fields** – Allows choosing the parameter fields to be displayed in the performance log. "Minimum" and "Maximum" represent the minimum and maximum values in the specified sensor log step, while "Average" displays the average value; "Threshold seconds" will show the number of seconds in a chosen time interval when the parameter exceeded minimum or maximum alarm thresholds; "No data (s)" and "Not available (s)" show respectively the time when there was no data of selected parameter and it was not available.
3) **Sensor log step** – Allows choosing log step – 1, 15, or 60 minutes.
4) Indicates the start and end date/time of period displayed and allows selecting a specific period to show.
5) **Period length** – Indicates the length of the currently displayed period.
6) **Log entries per page** – Allows choosing 20, 50, or 100 entries per page for Paged representation.

7) ***One page*** – Will display a performance log on a single page in a separate tab.
8) ***Paged*** – Will display performance log divided into pages in a separate tab.
9) ***Download XML*** – Press to download a performance log in an extensible markup language (.xml) file.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

log perf show {1M|15M|60M} **last** <1…1440> <sensor>	Use to show a specified number of last performance log entries with specified sensor log step.
log perf show {1M|15M|60M} **time** <start_time> <end_time> <sensor>	Use to show entries for a certain time frame. Follow formats are supported: YYYY-MM-DD/hh:mm:ss; MM-DD/hh:mm:ss; MM-DD/hh:mm; hh:mm:ss; hh:mm
log perf clear	Use to clear performance log.

Performance → Ethernet → Ethernet switch statistics

Shows Ethernet switch statistics on all available switch ports.
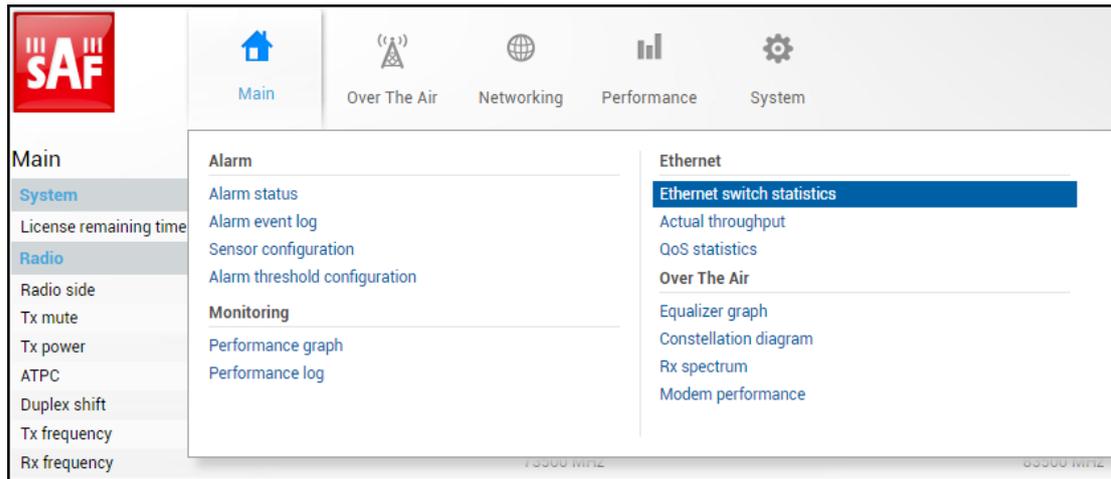
Figure 3-112 Accessing Ethernet switch statistics page

Status mode

Performance / Ethernet switch statistics					
	LAN1	**LAN2**	**LAN3**	**WAN**	**MNG**
Statistics for	0d 00:48:45	0d 00:48:45	0d 00:48:45	0d 00:48:45	0d 00:48:45
Ingress Pkts.	0	833441305	0	833521809	37661
Ingress Bytes	0	1265161553658	0	1268575935699	36013098
Egress Pkts.	0	833440969	0	833511810	48817
Egress Bytes	0	1265163432429	0	1268581467474	29767684
Total Multicast Pkts.	0	2063	0	2949	2315
Total Broadcast Pkts.	0	0	0	15653	15651
Total Pkts. 64 Octets	0	1642	0	0	25131
Total Pkts. 65 to127 Octets	0	0	0	41175	14404
Total Pkts. 128 to 255 Octets	0	226	0	595	380
Total Pkts. 256 to 511 Octets	0	195	0	1565	1357
Total Pkts. 512 to 1023 Octets	0	0	0	6625	6623
Total Pkts. 1024 to 1518 Octets	0	1666809998	0	5435	38583
Total Oversize Pkts.	0	0	0	0	0
Rx Oversize Pkts.	0	0	0	0	0
Tx Oversize Pkts.	0	0	0	0	0
Total Octets	0	2530300477977	0	2537134774077	65780782
Total Pkts.	0	1666866951	0	1667019568	86478
Tx No Errors	0	833433317	0	833504762	48817
Rx No Errors	0	833434250	0	833513966	37661
Total Pkts. 1519 to 1522 Octets	0	0	0	1666965375	0
In. Octets	0	1265152293858	0	1268566444507	36013098
Out. Octets	0	1265153890281	0	1268571644486	29767684
Dot1 Port In Frames	0	833435817	0	833516173	37661
Dot1 Port Out Frames	0	833435262	0	833505926	48817
Received Pkts. 64 Octets	0	1642	0	0	4895
Transmitted Pkts. 64 Octets	0	0	0	0	20236
Received Pkts. 65 to 127 Octets	0	0	0	28007	6635
Transmitted Pkts. 65 to 127 Octets	0	0	0	13168	7769
Received Pkts. 128 to 255 Octets	0	124	0	376	106
Transmitted Pkts. 128 to 255 Octets	0	102	0	219	274
Received Pkts. 256 to 511 Octets	0	98	0	481	972
Transmitted Pkts. 256 to 511 Octets	0	99	0	1107	392
Received Pkts. 512 to 1023 Octets	0	0	0	3065	3709
Transmitted Pkts. 512 to 1023 Octets	0	0	0	3710	3064
Received Pkts. 1024 to 1518 Octets	0	870449541	0	2644	21893
Transmitted Pkts. 1024 to 1518 Octets	0	870450665	0	3003	17544
In. Broadcast Pkts.	0	0	0	15980	0
Out. Broadcast Pkts.	0	0	0	0	15979
In. Multicast Pkts.	0	1899	0	1104	0
Out. Multicast Pkts.	0	203	0	1899	2358
Dot3 In. Pause Frames	0	0	0	0	0
Dot3 Out. Pause Frames	0	0	0	0	0
EtherStatsUndersize Pkts.	0	0	0	0	0
Fragments	0	0	0	0	0
CRC Align. Errors	0	0	0	0	0
Jabbers	0	0	0	0	0
Ingress BPS	N/A	998115281	N/A	1000930479	17240
Ingress PPS	N/A	657933	N/A	657649	17
Egress BPS	N/A	998711065	N/A	1000927549	9697
Egress PPS	N/A	657534	N/A	658045	19
All CoSQ out Pkts.	0	869865688	0	870582355	49909
All CoSQ out bytes	0	1320455857855	0	1325001924127	30442596
All CoSQ dropped Pkts.	0	0	0	0	0
All CoSQ dropped bytes	0	0	0	0	0

Figure 3-113 Ethernet switch statistics – status mode

Press ✎ MODIFY button.

Modify mode (buttons appear at the bottom of the page)
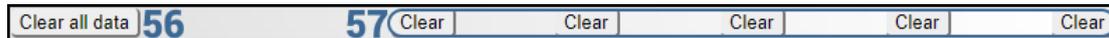
Figure 3-114 Ethernet switch statistics - modify mode

1) **Statistics for** – time during which statistics have been gathered.
2) **Ingress Pkts.** – Packets that ingress on the port.
3) **Ingress Bytes** – Bytes that ingress on the port.
4) **Egress Pkts.** – Packets that egress on the port.
5) **Egress Bytes** – Bytes that egress on the port.
6) **Total Multicast Pkts.** – The total number of good packets received that were directed to a multicast address. Note that this number does not include packets directed to the broadcast address.
7) **Total Broadcast Pkts.** – The total number of good packets received that were directed to the broadcast address. Note that this does not include multicast packets.
8) **Total Pkts. 64 Octets** – The total number of packets (including bad packets) that were 64 octets in length (excluding framing bits but including FCS octets).
9) **Total Pkts. 65 to 127 Octets** –The total number of packets (including bad packets) that were between 65 and 127 octets in length inclusive (excluding framing bits but including FCS octets).
10) **Total Pkts. 128 to 255 Octets** – The total number of packets (including bad packets) that were between 128 and 255 octets in length inclusive (excluding framing bits but including FCS octets).
11) **Total Pkts. 256 to 511 Octets** – The total number of packets (including bad packets) that were between 256 and 511 octets in length inclusive (excluding framing bits but including FCS octets).
12) **Total Pkts. 512 to 1023 Octets** – The total number of packets (including bad packets) that were between 512 and 1023 octets in length inclusive (excluding framing bits but including FCS octets).
13) **Total Pkts. 1024 to 1518 Octets** –The total number of packets (including bad packets) that were between 1024 and 1518 octets in length inclusive (excluding framing bits but including FCS octets).
14) **Total Oversize Pkts.** – The total number of packets that were longer than 1522 octets (excluding framing bits but including FCS octets) and were otherwise well formed.
15) **Rx Oversize Pkts.** – The total number of packets received that were longer than 1522 octets (excluding framing bits but including FCS octets) and were otherwise well formed.
16) **Tx Oversize Pkts.** – The total number of packets transmitted that were longer than 1522 octets (excluding framing bits but including FCS octets) and were otherwise well formed.
17) **Total Octets** – The total number of octets of data (including those in bad packets) received on the network (excluding framing bits but including FCS octets).
18) **Total Pkts.** – The total number of packets (including bad packets, broadcast packets and multicast packets) received and transmitted.
19) **Tx No Errors** – The number of frames that have been transmitted by this port from its segment excluding fragmented and FCS error frames.
20) **Rx No Errors** – The number of frames that have been received by this port from its segment excluding fragmented and FCS error frames.
21) **Total Pkts. 1519 to 1522 Octets** – The total number of packets (including bad packets) that were between 1519 and 1522 octets in length inclusive (excluding framing bits but including FCS octets).
22) **In. Octets** – The total number of octets received on the interface, including framing characters.

23) Out. Octets – The total number of octets transmitted out of the interface, including framing characters.

24) Dot1 Port In Frames – The number of frames that have been received by this port from its segment.

Note that a frame received on the interface corresponding to this port is only counted by this object if and only if it is for a protocol being processed by the local bridging function, including bridge management frames.

25) Dot1 Port Out Frames – The number of frames that have been transmitted by this port to its segment.

Note that a frame transmitted on the interface corresponding to this port is only counted by this object if and only if it is for a protocol being processed by the local bridging function, including bridge management frames.

26) Received Pkts. 64 Octets – The total number of packets (including bad packets) received that were 64 octets in length (excluding framing bits but including FCS octets).

27) Transmitted Pkts. 64 Octets – The total number of packets (including bad packets) transmitted that were 64 octets in length (excluding framing bits but including FCS octets).

28) Received Pkts. 65 to 127 Octets – The total number of packets (including bad packets) received that were between 65 and 127 octets in length inclusive (excluding framing bits but including FCS octets).

29) Transmitted Pkts. 65 to 127 Octets – The total number of packets (including bad packets) transmitted that were between 65 and 127 octets in length inclusive (excluding framing bits but including FCS octets).

30) Received Pkts. 128 to 255 Octets – The total number of packets (including bad packets) received that were between 128 and 255 octets in length inclusive (excluding framing bits but including FCS octets).

31) Transmitted Pkts. 128 to 255 Octets – The total number of packets (including bad packets) transmitted that were between 128 and 255 octets in length inclusive (excluding framing bits but including FCS octets).

32) Received Pkts. 256 to 511 Octets – The total number of packets (including bad packets) received that were between 256 and 511 octets in length inclusive (excluding framing bits but including FCS octets).

33) Transmitted Pkts. 256 to 511 Octets – The total number of packets (including bad packets) transmitted that were between 256 and 511 octets in length inclusive (excluding framing bits but including FCS octets).

34) Received Pkts. 512 to 1023 Octets – The total number of packets (including bad packets) received that were between 512 and 1023 octets in length inclusive (excluding framing bits but including FCS octets).

35) Transmitted Pkts. 512 to 1023 Octets – The total number of packets (including bad packets) transmitted that were between 512 and 1023 octets in length inclusive (excluding framing bits but including FCS octets).

36) Received Pkts. 1024 to 1518 Octets – The total number of packets (including bad packets) received that were between 1024 and 1518 octets in length inclusive (excluding framing bits but including FCS octets).

37) Transmitted Pkts. 1024 to 1518 Octets – The total number of packets (including bad packets) transmitted that were between 1024 and 1518 octets in length inclusive (excluding framing bits but including FCS octets).

38) In. Broadcast Pkts. – The number of packets delivered by this sub-layer to a higher (sub-) layer, which was addressed to a broadcast address at this sub-layer.

39) Out. Broadcast Pkts. – The total number of packets that higher-level protocols requested to be transmitted, and which were addressed to a broadcast address at this sub-layer, including those that were discarded or not sent.

40) In. Multicast Pkts. – The number of packets delivered by this sub-layer to a higher (sub-) layer, which was addressed to a multicast address at this sub-

layer. For a MAC layer protocol, this includes both Group and Functional addresses.

41) *Out. Multicast Pkts.* – The total number of packets that higher-level protocols requested to be transmitted, and which were addressed to a multicast address at this sub-layer, including those that were discarded or not sent. For a MAC layer protocol, this includes both Group and Functional addresses.

42) *Dot3 In. Pause Frames* – A count of MAC Control frames received on this interface with an opcode indicating the PAUSE operation. This counter does not increment when the interface is operating in half-duplex mode. Discontinuities in the value of this counter can occur at re-initialization of the management system, and at other times as indicated by the value of ifCounterDiscontinuityTime.

43) *Dot3 Out. Pause Frames* – A count of MAC Control frames transmitted on this interface with an opcode indicating the PAUSE operation. This counter does not increment when the interface is operating in half-duplex mode. Discontinuities in the value of this counter can occur at re-initialization of the management system, and at other times as indicated by the value of ifCounterDiscontinuityTime.

44) *EtherStatsUndersize Pkts.* – The total number of packets received that were less than 64 octets long (excluding framing bits but including FCS octets) and were otherwise well formed.

45) *Fragments* – The total number of packets received that were less than 64 octets in length (excluding framing bits but including FCS octets) and had either a bad Frame Check Sequence (FCS) with an integral number of octets (FCS Error) or a bad FCS with a non-integral number of octets (Alignment Error).

Note that it is entirely normal for etherStatsFragments to increment. This is because it counts both runts (which are normal occurrences due to collisions) and noise hits.

46) *CRC Align. Errors* – The total number of packets received that had a length (excluding framing bits but including FCS octets) of between 64 and 1518 octets, inclusive, but had either a bad Frame Check Sequence (FCS) with an integral number of octets (FCS Error) or a bad FCS with a non-integral number of octets (Alignment Error).

47) *Jabbers* – The total number of packets received that were longer than 1518 octets (excluding framing bits but including FCS octets) and had either a bad Frame Check Sequence (FCS) with an integral number of octets (FCS Error) or a bad FCS with a non-integral number of octets (Alignment Error).

Note that this definition of jabber is different than the definition in IEEE-802.3 section 8.2.1.5 (10BASE5) and section 10.3.1.4 (10BASE2). These documents define jabber as the condition where any packet exceeds 20 ms. The allowed range to detect jabber is between 20 ms and 150 ms.

48) *Ingress BPS* – Indicates byte per second rate on the input of the port.
49) *Ingress PPS* – Indicates packet per second rate on the input of the port.
50) *Egress BPS* – Indicates byte per second rate on the exit of the port.
51) *Egress PPS* – Indicates packet per second rate on the exit of the port.
52) *All CoSQ out Pkts.* - total packet count with QoS transmitted.
53) *All CoSQ out bytes* - total byte count with QoS transmitted.
54) *All CoSQ dropped Pkts*. – total packet count with QoS dropped.
55) *All CoSQ dropped bytes* - total byte count with QoS dropped.
56) *Clear all statistic* – Clears statistics on all switch ports.
57) *Clear* – Clears statistics on a particular port.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

network port show statistics	Use to show Ethernet statistics on all ports.
network port reset statistics {LAN1|LAN2|LAN3|MNG|WAN|all}	Use to reset Ethernet statistics for a particular port or all ports.

Performance → Ethernet → Actual throughput

Shows ingress and egress traffic statistics on all available switch ports.
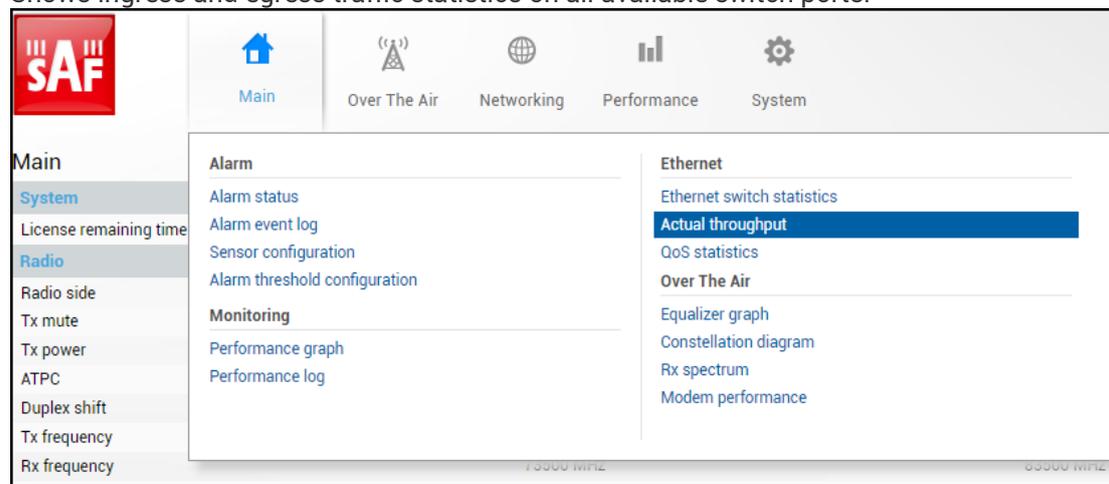
Figure 3-115 Accessing Actual throughput page

MODIFY button is deactivated on this page.

Performance / Actual throughput

Port	LAN1	LAN2	LAN3	WAN	MNG
Ingress Mbps **1**	N/A	7984.300	N/A	8010.553	0.100
Ingress pps **2**	N/A	657473	N/A	657538	11
Egress Mbps **3**	N/A	7988.737	N/A	8006.117	0.099
Egress pps **4**	N/A	657832	N/A	657901	14

Figure 3-116 Actual throughput page

1) ***Ingress Mbps*** – Indicates megabit per second rate on the input of the port.
2) ***Ingress pps*** – Indicates packet per second rate on the input of the port.
3) ***Egress Mbps*** – Indicates megabit per second rate on the exit of the port.
4) ***Egress pps*** – Indicates packet per second rate on the exit of the port.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

network port show throughput	Use to show current throughput on all ports.

Performance → Ethernet → QoS statistics

Shows QoS statistics for 8 priority queues, indicating passed and dropped packets and bytes. Elapsed time is indicated as well. Payload occupies queue 0, rest is SAF service traffic.
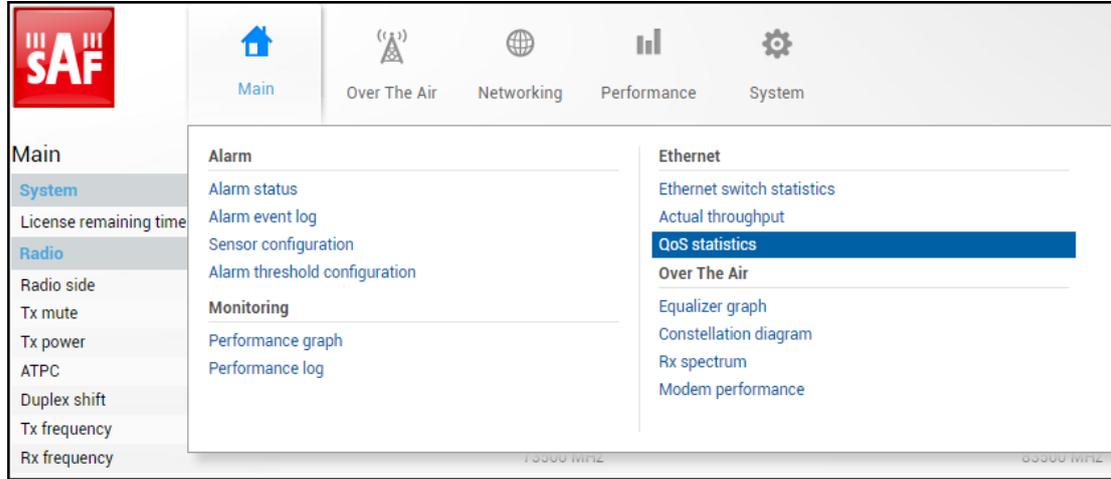
Figure 3-117 Accessing QoS statistics page

Figure 3-118 QoS statistics – status mode

Modify mode (press Modify to see buttons appear at the bottom of the page)

Figure 3-119 QoS statistics – modify mode

1) QoS statistics for all 8 available priority queues, indicating passed and dropped packets and bytes. Elapsed time is indicated as well.
2) **Clear all data** – Allows clearing QoS statistics on all switch ports.
3) **Clear** – Allows clearing QoS statistics on individual switch ports.

Performance → Over The Air → Equalizer graph

The Equalizer graph window shows adaptive equalizer 'taps' coefficients, which at a set time minimize the multipath fading effect in the channel. For more details see Chapter *Adaptive equalizer*.
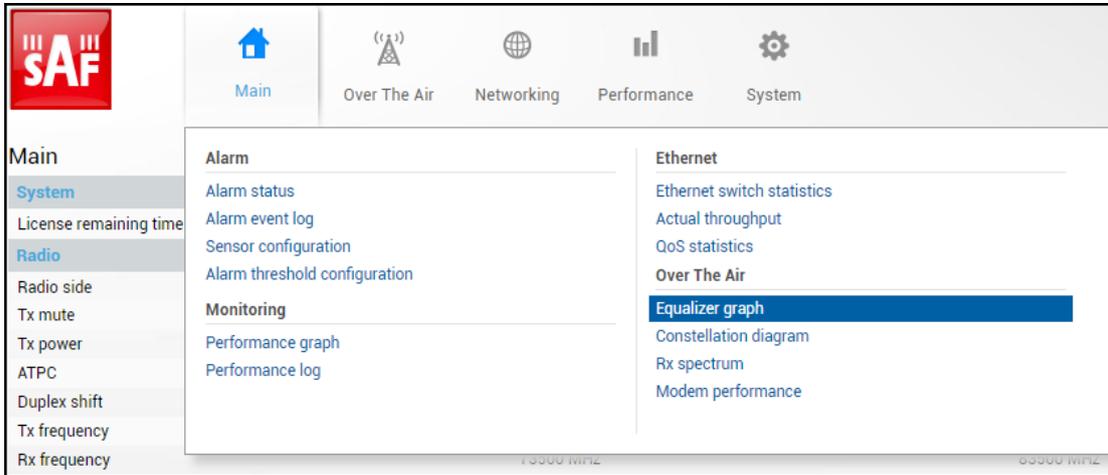
Figure 3-120 Accessing Equalizer graph page

MODIFY button is deactivated on the Equalizer graph page.

An example of equalizer 'taps' coefficients and frequency response in case of a normal operation is shown below.
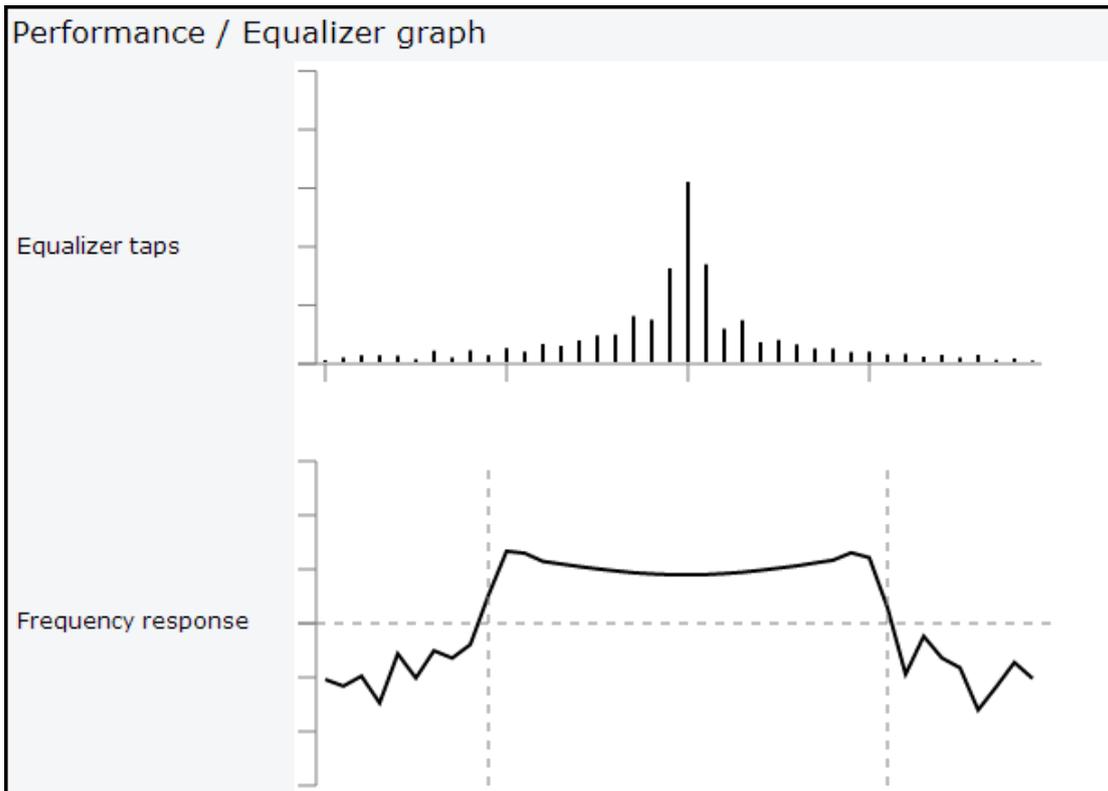
Figure 3-121 Equalizer taps and frequency response

During normal operation, the frequency response curve is smooth at the center and the central equalizer tap is higher, while side towers evenly decrease. If equalizer taps and frequency response curve significantly differ from the one above, it may be an indication of multipath issues, which must be inspected with the use of precise and accurate path

profiling. Higher taps mainly on the right side indicate a weaker reflected signal compared to the main signal, while higher taps mainly on the left side – stronger reflected signal.

Below is an example of Equalizer graph in a link aligned to the reflected signal, see figure below:
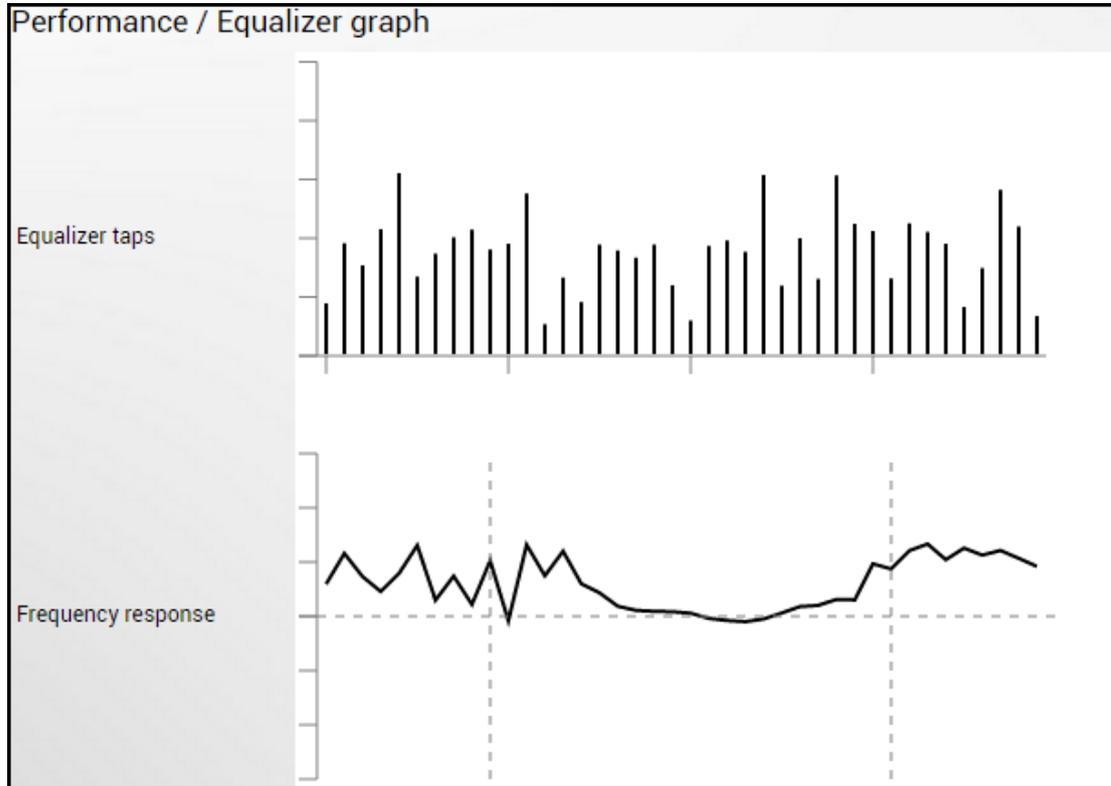
Figure 3-122 Equalizer graph for reflected signal

Performance → Over The Air → Constellation diagram

A constellation diagram is a representation of a signal modulated by the digital modulation schemes 1024QAM-BPSK. It displays the signal as a two-dimensional scatter diagram in the complex plane at symbol sampling instants. A measured constellation diagram can be used to recognize the type of interference and distortion in a signal.
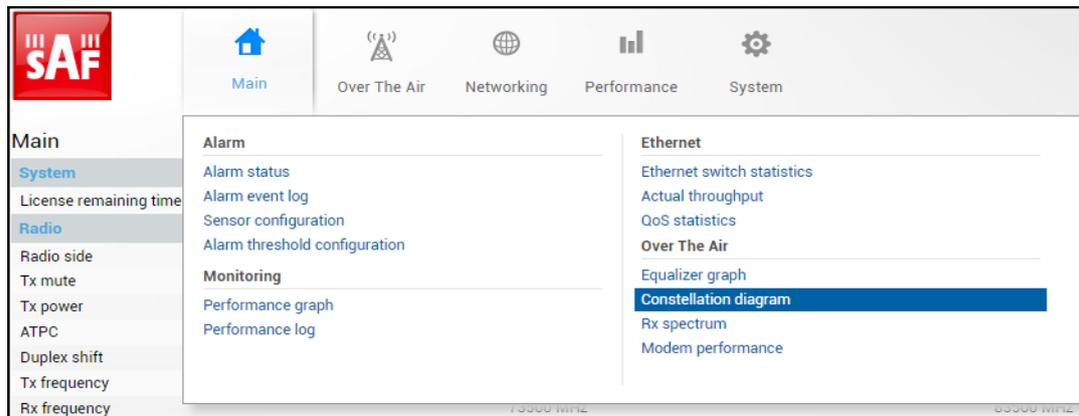
Figure 3-123 Accessing Constellation diagram page

MODIFY button is deactivated on the Constellation diagram page.

⚠ Only a single user can see the Constellation at a time.
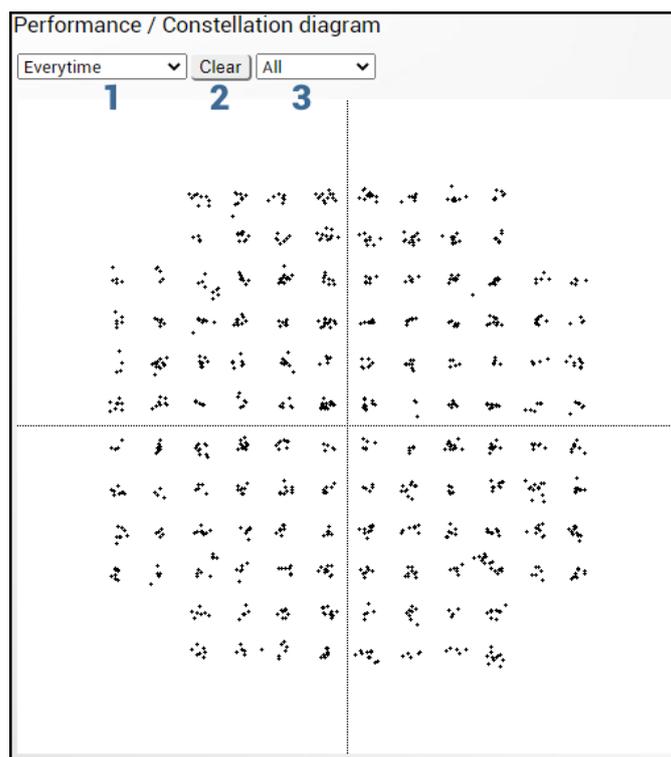
Figure 3-124 128QAM

1) Allows choosing how often is constellation automatically cleared;
2) Manually clear current constellation;
3) Allows zooming to one of 4 constellation quadrants.

To analyze the received signal quality, some types of distortion and degradation may be evident in the constellation diagram.

Gaussian noise is displayed as fuzzy constellation points, see *Figure 3-125*:
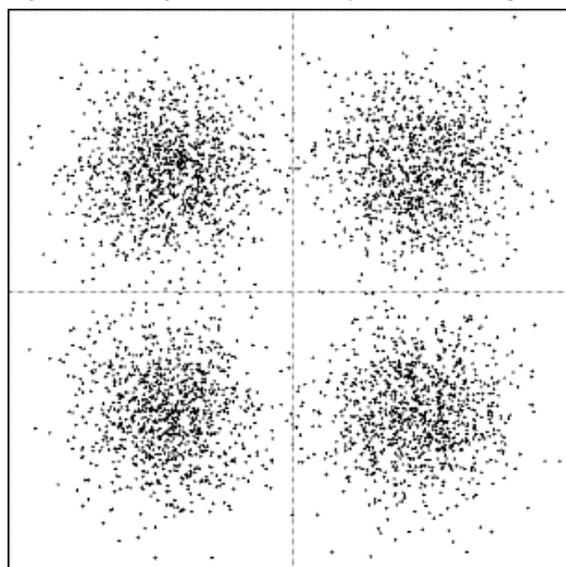
Figure 3-125 Gaussian noise

Non-coherent single frequency interference is displayed as circular constellation points, see *Figure 3-126*:
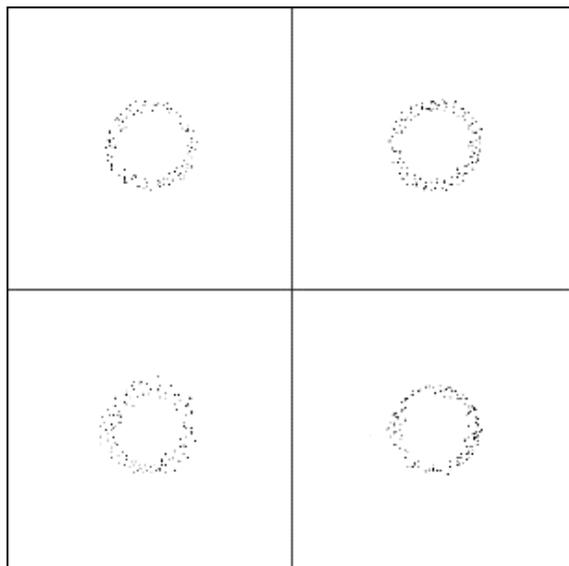
Figure 3-126 Single frequency interference

Phase noise is displayed as rotationally spreading constellation points, see *Figure 3-127*:
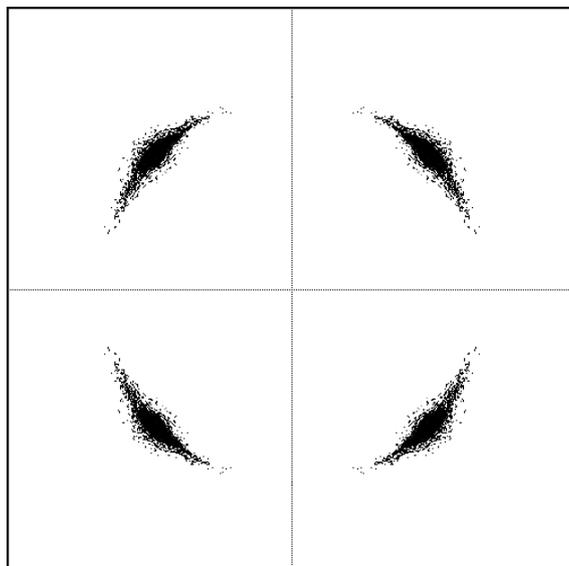
Figure 3-127 Phase noise

Performance → Over The Air → Rx spectrum

A spectrum curve is a representation of the received signal on the input of the modem. For this reason, spectrum signal levels will not correspond to the actual radio receiver's signal level. The signal appearance will depend on configured channel bandwidth. A measured spectrum curve can be used to recognize in-band interference or very powerful out-band interference (due to filters applied).
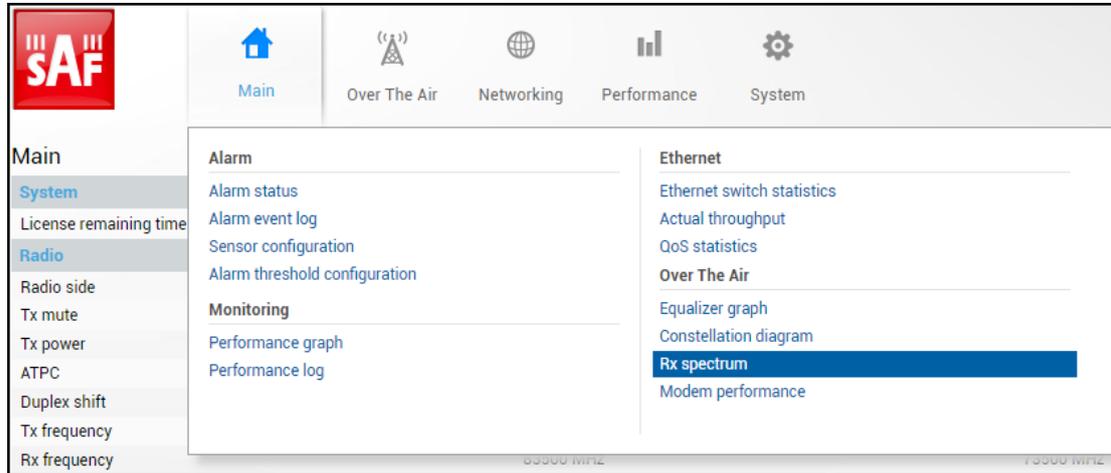
Figure 3-128 Accessing Rx spectrum page

MODIFY button is deactivated on the Rx spectrum page.

⚠ Only one single user can see the Rx Spectrum at a time.

As an example see *Figure 3-129* for 2000MHz bandwidth:
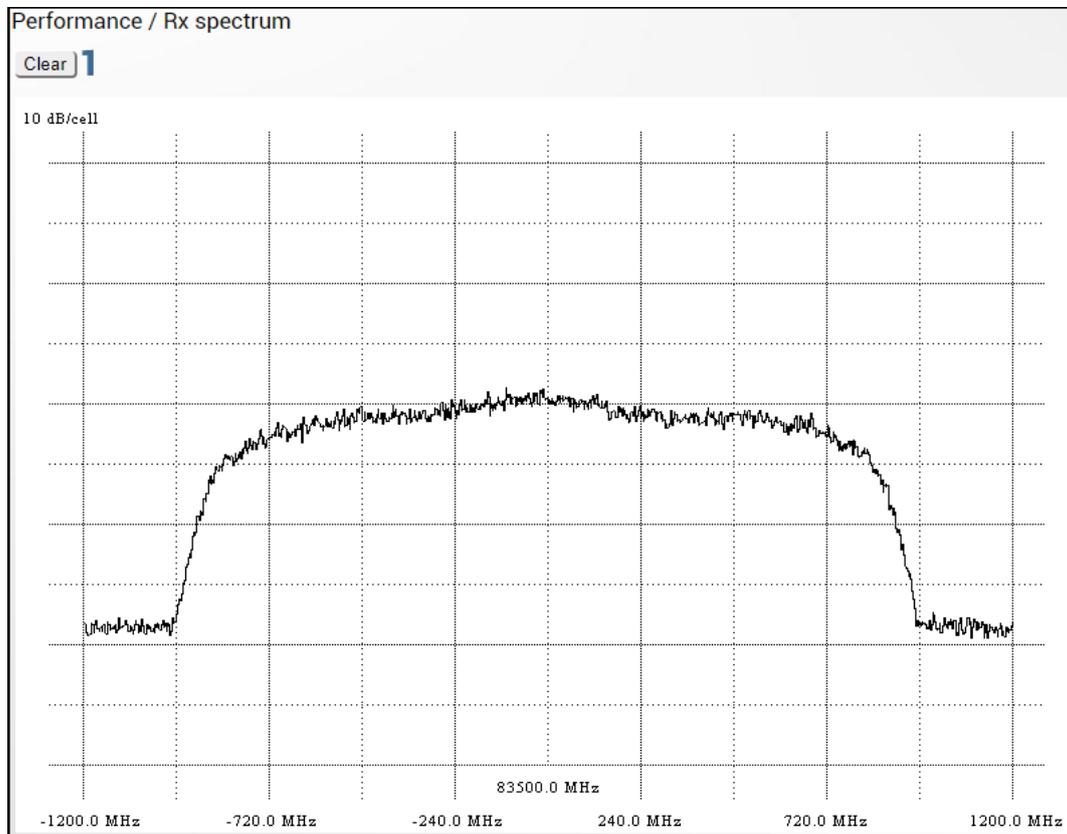
Figure 3-129 Rx spectrum for 2000MHz

1) Press "Clear" button to clean the current averaged Rx spectrum. The Rx spectrum is averaged over the period of time since "Clear" button was pressed or since the page was opened.

Performance → Over The Air → Modem performance

The Modem performance section shows modem statistics according to ITU-T G.826.
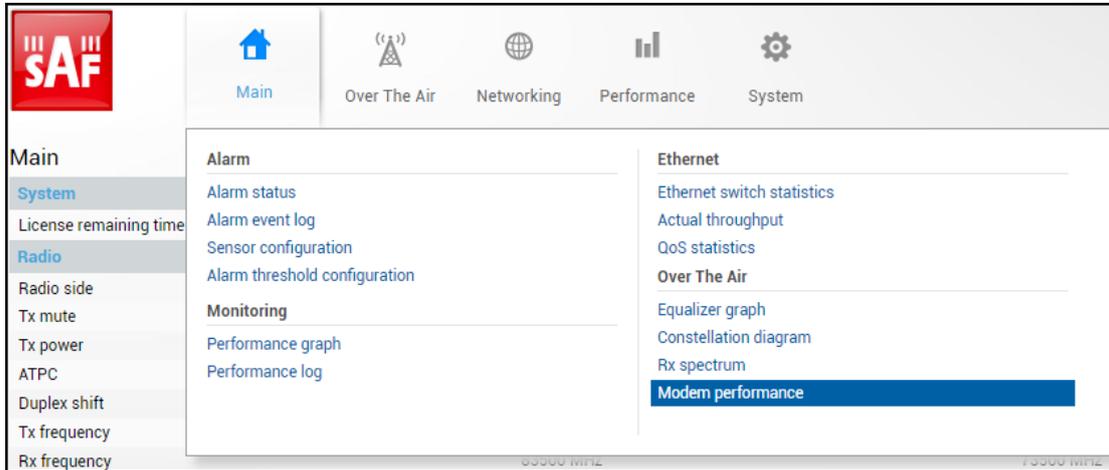
Figure 3-130 Accessing Modem performance page

Status mode

Figure 3-131 Modem performance – status mode

Modify mode (press Modify to see "Clear" button appear at the bottom of the page)

Figure 3-132 Modem performance – modify mode

1) **Count Time** – time during which statistics are gathered;
2) **Errored Block** – Number of blocks having at least one-bit error;
3) **Errored Second** – Number of seconds during which errored blocks were registered;
4) **Severely Errored Second** - Number of seconds which contain 30% errored blocks or one or more defects;
5) **Background Block Error** – Number of errored blocks that are not part of SES;
6) **Total Block number** - Number of blocks received which are not part of SES;
7) **Errored Second Ratio (ESR)** – The ratio of ES to total seconds;
8) Severely Errored Second Ratio (SESR) – The ratio of SES to total seconds;
9) **Background Block Error Ratio (BBER)** – The ratio of BBE to total seconds;
10) **Uptime** – time in seconds during which the link was synchronized;
11) **Unavailtime** – time in seconds during which the link was not synchronized;
12) **Clear** – Clears all counters.

System

System → FW → Firmware upgrade

For the upgrade process through Web GUI please refer to Chapter *Integra series firmware upgrade via Web GUI*.
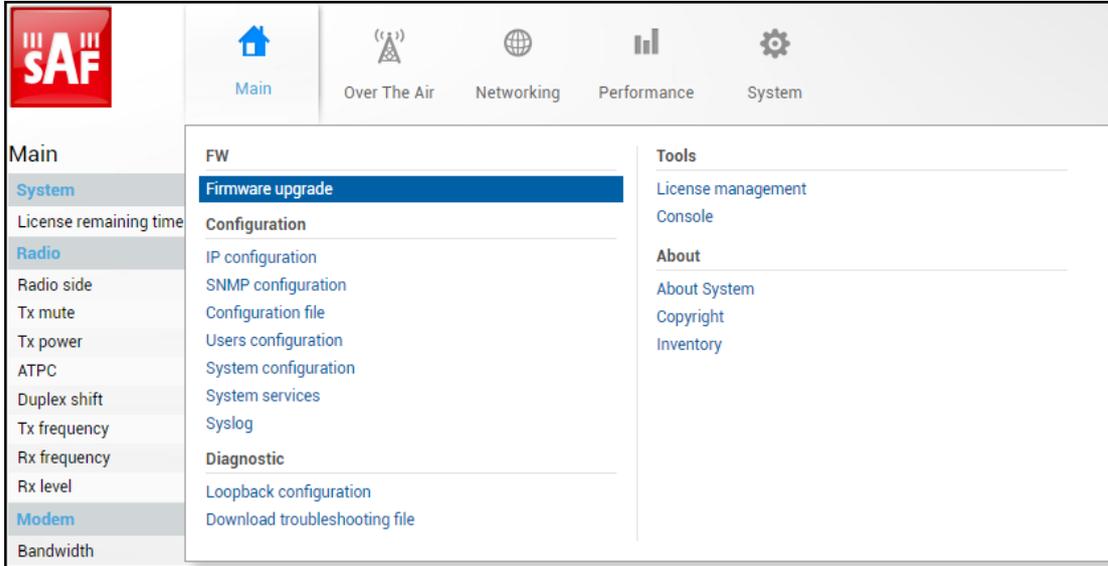
Figure 3-133 Accessing Firmware upgrade page

Status mode
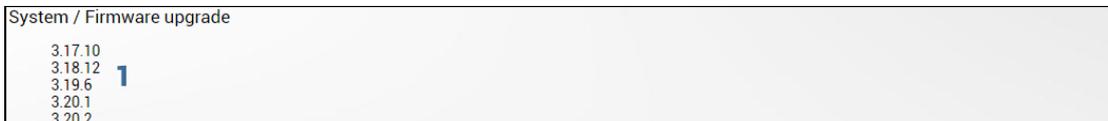
Figure 3-134 Firmware upgrade – status mode

Press ✎ MODIFY button.

Modify mode

Figure 3-135 Firmware upgrade – modify mode

1) Shows list of available firmware files.
2) **Upgrade firmware** – click on preferred firmware in the list and press "Upgrade firmware" button to initiate the firmware upgrade process.

⚠ The radio at the remote side must be upgraded first.

> ⚠ The latest Integra-E/E2/E3 firmware can be downloaded in *https://saftehnika.com/en/downloads* in "Firmwares" section. Registration and login required.

3) **Reboot** – Reboots Integra-E/E2/E3 (cold restart).
4) **Delete** – Deletes selected firmware file from the list.
5) **Browse** or **Choose File** (depending on the used web browser) – Press to browse for Integra-E/E2/E3 firmware file on your hard disk drive.
6) **Upload** – Press to upload a firmware file to the Integra-E/E2/E3.

> ⚠ A maximum of 5 firmware files can be stored. You can delete unnecessary firmware files using "Delete" button.

Integra series firmware upgrade via Web GUI

The firmware update package contains firmware file (.bin extension), release notes, and firmware upgrade instructions.

The main method for a firmware upgrade is via Web GUI, which automates the whole firmware upgrade process. To perform a firmware upgrade from Web GUI, please follow these steps:

1) Go to "System → FW → Firmware upgrade".
2) Press the "MODIFY" button on the right side of the page.
3) Press the "Browse" button, locate the *.bin firmware file on your hard disk (extracted from the firmware update package) and press the "Open" button.
4) Press the "Upload" button.
5) Select the uploaded firmware from the firmware list, press "Upgrade firmware" button and confirm the upgrade:
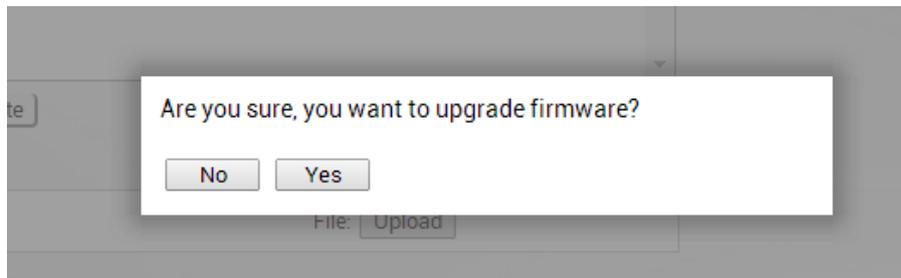
Figure 3-136 FW upgrade prompt (1)

6) After the prompt informing about successful installation appears, confirm the reboot of the system:
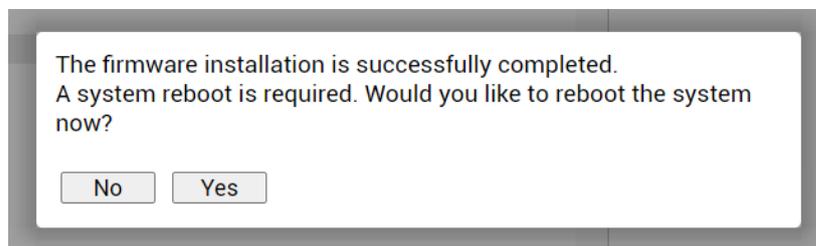
Figure 3-137 FW upgrade prompt (2)

Please do not unplug power until the firmware upgrade procedure is finished - the Web GUI will automatically reconnect, and the login page will appear.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

firmware info [<version>]	Use to show detailed information on current or specific Integra-E/E2/E3 firmware.
firmware install <version>	Use to install firmware version uploaded. Note that the exact version name needs to be entered. Check available firmware versions using the command "firmware list".
firmware list	Use to list uploaded firmware versions.
firmware remove <version>	Use to remove an uploaded firmware version. Note that the exact version name needs to be entered. Check available firmware versions using the command "firmware list".
firmware remove.list	Use to remove all uploaded firmware versions.
firmware switch	Use to check running firmware bank and bank that will be used at the next boot.
firmware upload <file>	Use to upload firmware file from the FTP directory.
firmware switch {fs|fw1|fw2|toggle}	Use to define the bank that will be used at the next boot. "fw1" and "fw2" subcommands set appropriate bank, "toggle" forces to set another bank than the running one, "fs" is factory defined emergency bank, which is used if both "fw1" and "fw2" fail.
system reboot	Use to perform cold reboot of the radio unit.

System → Configuration → IP configuration

The IP configuration page provides configuration of the management IP address, mask and gateway, as well as allows specifying the remote IP address.
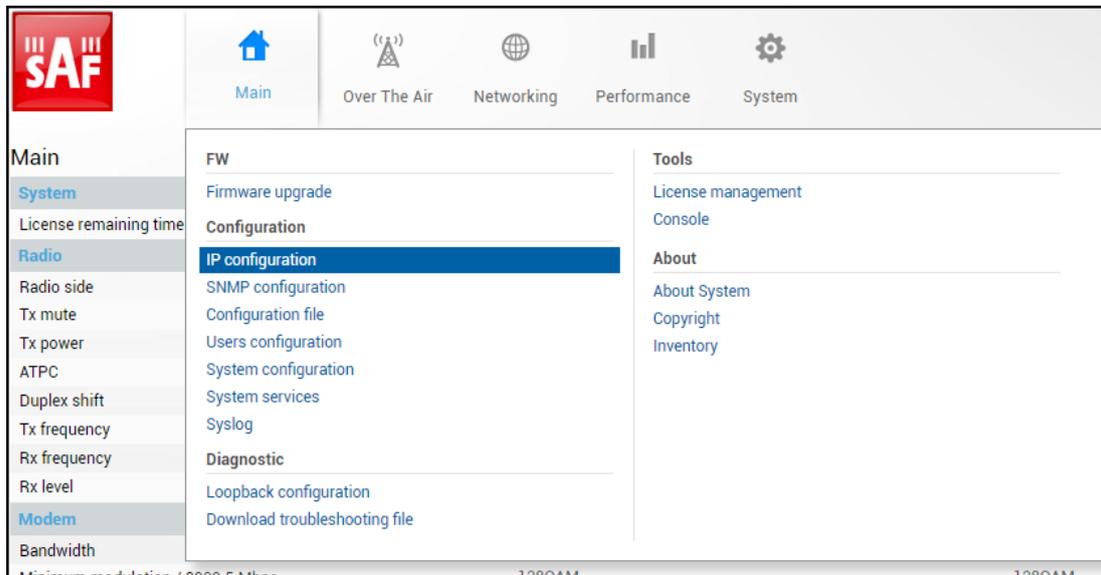
Figure 3-138 Accessing IP configuration page

Status mode

Figure 3-139 IP configuration – status mode

Press ![MODIFY] button.

Modify mode

Figure 3-140 IP configuration – modify mode

1) **IP address** – Indicates the IP address of the Integra-E/E2/E3 you are currently logged in to (status mode); allows specifying the IP address of the Integra-E/E2/E3 you are currently logged in to (modify mode). The default IP address is 192.168.205.10 or 192.168.205.11 – depending on which side the specific Integra-E/E2/E3 is – low side has 192.168.205.10 IP address and high side – 192.168.205.11.

> ⚠️ Integra-E/E2/E3 IP addresses always need to be on the same subnet.

2) **IP Mask** – Indicates the IP mask of the Integra-E/E2/E3 you are currently logged in to (status mode); allows specifying the IP mask of the Integra-E/E2/E3 you are currently logged in to (modify mode). The default IP mask is 255.255.255.0.
3) **IP gateway** – Indicates the gateway address of the Integra-E/E2/E3 you are currently logged in to (status mode); allows specifying the gateway address of the Integra-E/E2/E3 you are currently logged in to (modify mode). By default, the gateway is not specified (blank).
4) **Ethernet MAC address** – shows the MAC address of the Integra-E/E2/E3 you are currently connected to.
5) **Remote IP address** – shows the IP address of the remote (far-end) Integra-E/E2/E3. By default, the remote IP address is being retrieved automatically and therefore the "Auto" checkbox is selected. In modify mode you can unselect the "Auto" option and enter the remote IP address manually. The remote IP address manual setting is used only to establish an IP connection from the Local device to the Remote device but will not modify the real IP address on the Remote device.
6) By pressing „*Execute configuration",* changes made to the corresponding section apply only to the local side Integra-E/E2/E3.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

system ip addr [<IP>]	Use to show/set the IP address of the management CPU.
system ip gw [{<IP>|clear}]	Use to show/manage the IP address of the gateway.
system ip mask [<mask>]	Use to show/set subnet mask.
system ip mac	Use to show the MAC address of the management CPU.
system ip cfg {<ip address> <mask>	<ip address> <mask> <gateway>	<ip address/CIDR>	<ip address/CIDR> <gateway>}	Use to set an IP address and subnet or optionally IP address, subnet mask and gateway simultaneously.

system remoteip show	Use to show the remote IP address.
system remoteip auto	Use to set automatic retrieving of the remote IP address.
system remoteip set <IP>	Use to define remote the IP address (deactivates automatic retrieving of the remote IP address).
system diag ping <IP_address>	Use to ping an IP address.

System → Configuration → SNMP configuration

The SNMP configuration pages provide configuration of SNMP communities, host and trap addresses. The SAF NMS system will work only when SNMP is properly configured.

⚠️ Relevant MIB files can be downloaded directly from the Integra-E/E2/E3 Web GUI. See (7) in *Figure 3-141* below.
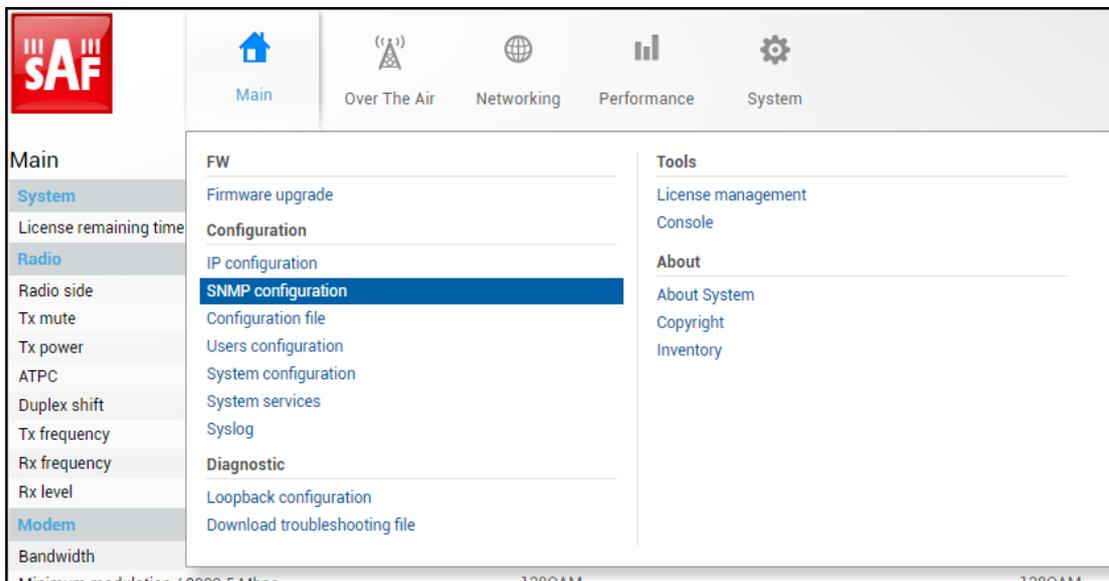
Figure 3-141 Accessing SNMP configuration page

SNMPv1/v2c setup

Status mode
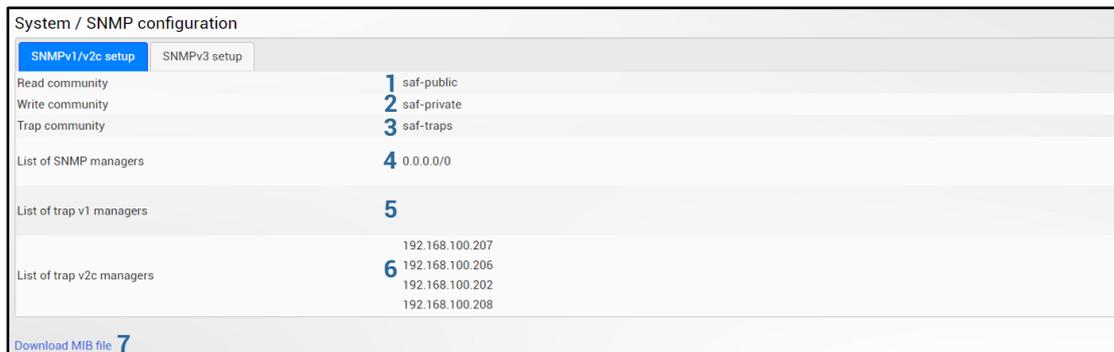
Figure 3-142 SNMP configuration – SNMPv1/v2c setup – status mode

Press ✎ MODIFY button.
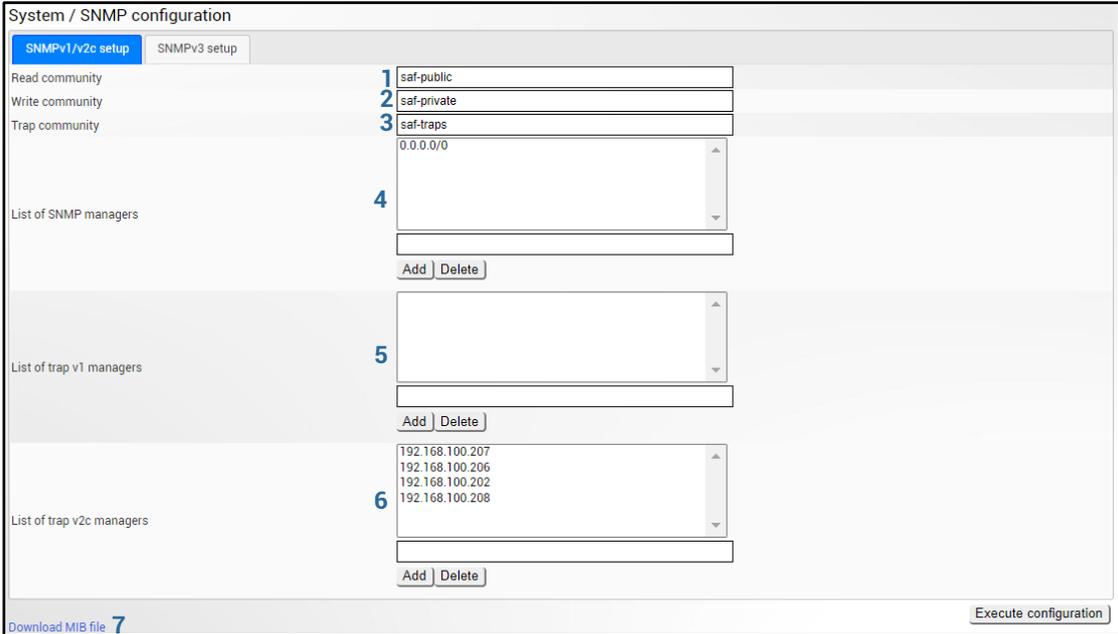
Modify mode

Figure 3-143 SNMP configuration – SNMPv1/v2c setup – modify mode

1) **Read community** – Indicates currently specified read community for SNMPv1/v2c (status mode); allows specifying the read community for SNMPv1/v2c of the agent to enable parameters to be read (modify mode). The default read community name is "saf-public".

2) **Write community** – Indicates currently specified write community for SNMPv1/v2c (status mode); allows specifying the write community for SNMPv1/v2c of the agent to enable parameters to be written (modify mode). The default write community name is "saf-private".

3) **Trap community** – Indicates currently specified trap community for SNMPv1/v2c (status mode); allows specifying the trap community for SNMPv1/v2c for trap authentication in monitoring applications (modify mode). The default trap community name is "saf-traps".

4) **List of SNMP managers** – Shows a list of configured SNMPv1/v2c host IP addresses (status mode); allows adding/deleting SNMPv1/v2c host IP addresses (modify mode). Specified IP addresses have access to read and modify configuration parameters using the appropriate read and write community names.

5) **List of trap v1 managers** – Shows a list of configured SNMPv1 trap IP addresses (status mode); allows adding/deleting SNMPv1 trap IP addresses (modify mode). The Integra-E/E2/E3 management controller sends SNMPv1 traps to the Trap Manager with the IP address specified here.

6) **List of trap v2c managers** – Shows a list of configured SNMPv2c trap IP addresses (status mode); allows adding/deleting SNMPv2c trap IP addresses (modify mode). The Integra-E/E2/E3 management controller sends SNMPv2c traps to the Trap Manager with the IP address specified here.

7) **Download MIB file** – Click to download Integra-E/E2/E3 MIB files.

8) By pressing *„Execute configuration"*, changes made to the corresponding section apply only to the local side Integra-E/E2/E3.

SNMPv3 setup

SNMPv3 primarily is improved with security settings. It does not rely on SNMP community names as it is in versions 1 and v2c.

Status mode

Figure 3-144 SNMP configuration – SNMPv3 setup – status mode

Press ✎ MODIFY button.
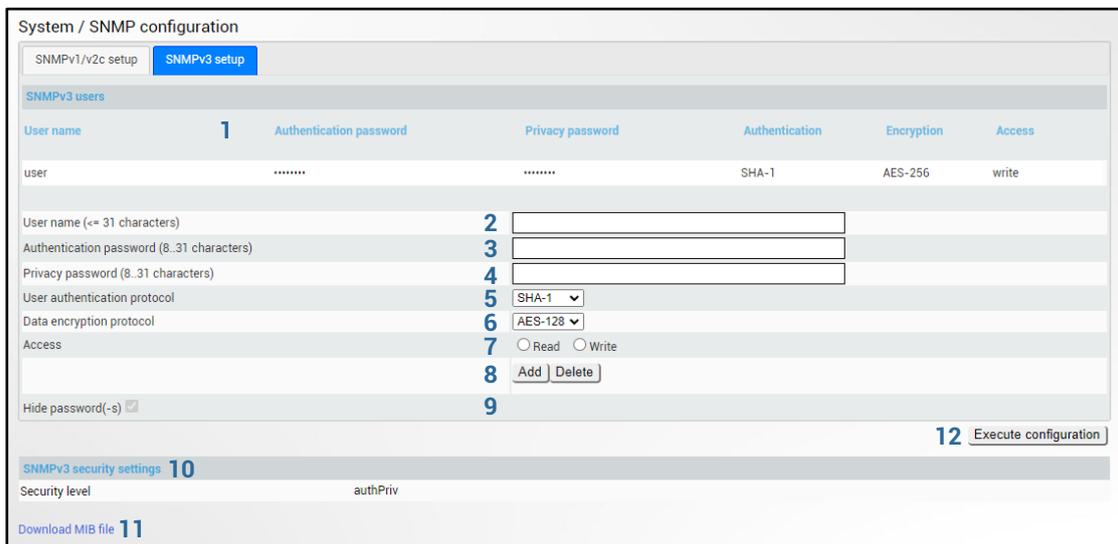
Modify mode

Figure 3-145 SNMP configuration – SNMPv3 setup – modify mode

1) ***SNMP users*** – Shows the list of configured SNMPv3 users.
2) ***User name (<=31 characters)*** – Enter SNMPv3 authentication user name. Length can be up to 31 symbols.
3) ***Authentication password (8..31 characters)*** – Enter the SNMPv3 authentication password. Length can be between 8 and 31 symbols.
4) ***Privacy password (8..31 characters)*** – Enter SNMPv3 data encryption password. Length can be between 8 and 31 symbols.
5) ***User authentication protocol*** – Use to specify user authentication protocol for selected user: *SHA-1, SHA-224, SHA-256, SHA-384* or *SHA-512*.
6) ***Data encryption protocol*** – Use to specify data encryption protocol for selected user: *DES, AES-128, AES-192* or *AES-256*.
7) ***Access*** – Select "Read" for read-only access or "Write" for read-write access.
8) ***Add/Delete*** – Use to add or delete selected user name. To delete user names from the list, click on the required user name in the list above.
9) ***Hide passwords(-s)*** – Uncheck to display passwords for selected SNMPv3 user.
10) ***SNMPv3 security settings*** – Shows SNMPv3 security settings used.

11) Download MIB file – Click to download Integra-E/E2/E3 MIB files.

12) By pressing „*Execute configuration",* changes made to the corresponding section apply only to the local side Integra-E/E2/E3.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

snmp manager {add | del} <manager>	Use to show/add/delete manager IP address
snmp manager read-community {set | del} <read-community>	Use to show/set/delete read community name
snmp manager write-community {set | del} <write-community>	Use to show/set/delete write community name
snmp showconfig {active | stored}	Use to show running or saved configuration
snmp syscontact <syscontact>	Use to show/set system contact
snmp traps trap-community {set | del} <trap-community>	Use to show/set/delete trap community name
snmp traps trapv1manager {add | del} <trapv1manager>	Use to show/add/delete v1 trap manager IP address
snmp traps trapv2manager {add | del} <trapv2manager>	Use to show/add/delete v2c trap manager IP address
snmp v3 user {add | del} <v3user> <authpass> <privpass> {r | w} {SHA-1 | SHA-224 | SHA-256 | SHA-384 | SHA-512} {DES | AES-128 | AES-192 | AES-256}	Use to show/add/delete v3 username with the corresponding authentication password, encryption password, read or write access level, authentication protocol and data encryption protocol

System → Configuration → Configuration file

Shows saved and running configurations, highlighting differences between both (unsaved changes).
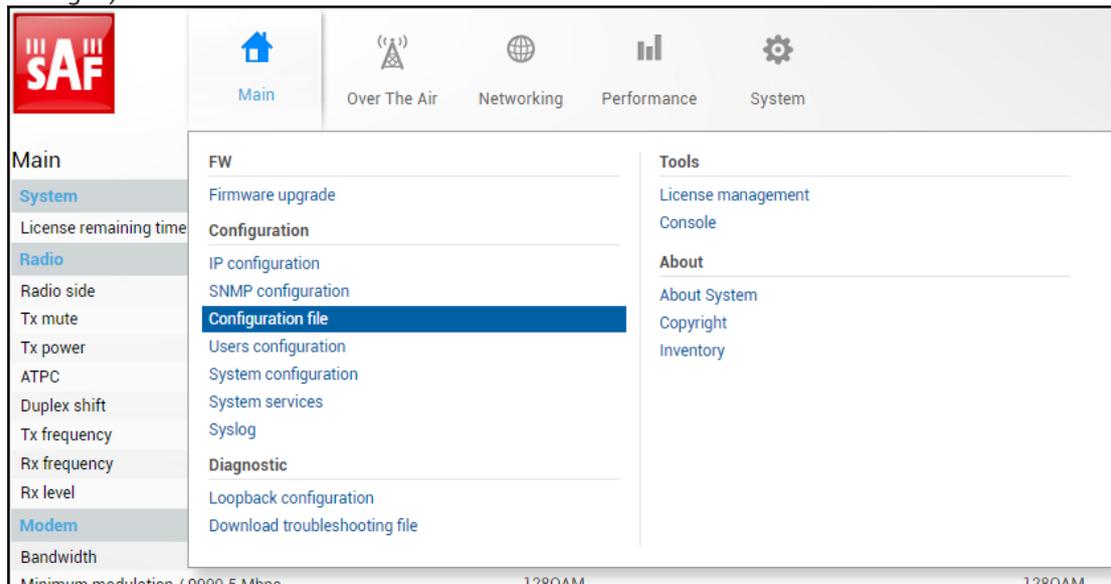
Figure 3-146 Accessing Configuration file page

Status mode
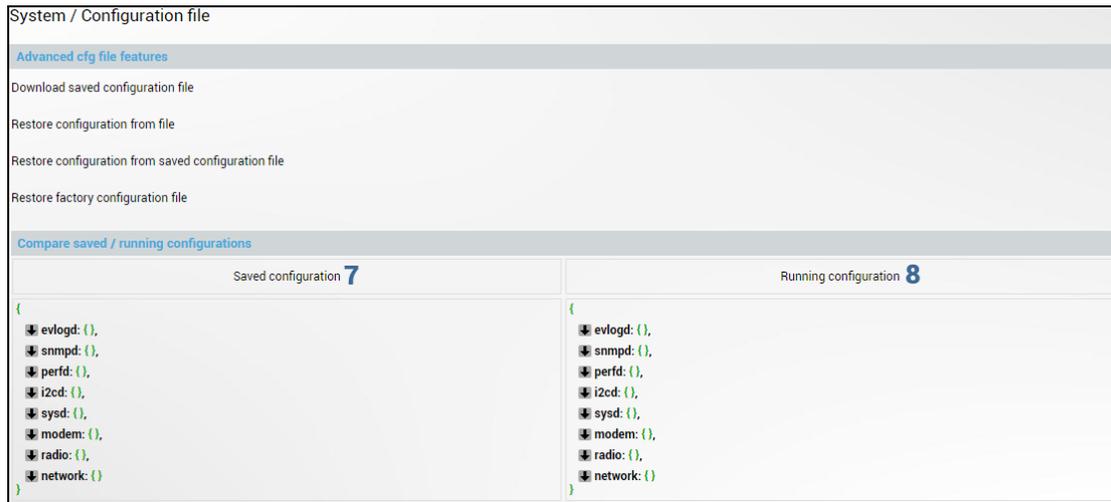
Figure 3-147 Configuration file - status mode

Press ✏ **MODIFY** button.
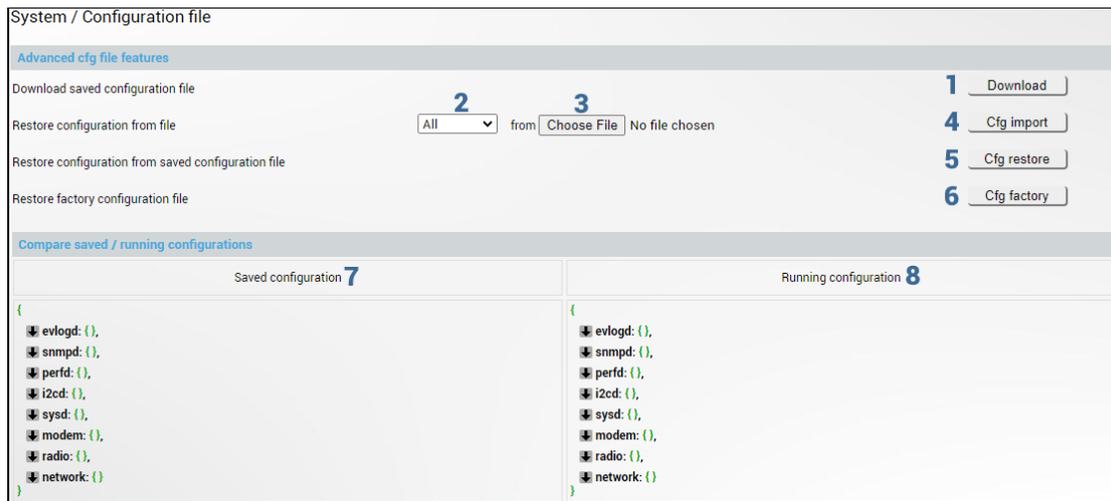
Modify mode

Figure 3-148 Configuration file – modify mode

1) **Download** – Press to download the system configuration txt file and save it on your hard drive.
2) **All** – Select *All* to restore the complete configuration.
3) **Browse** or **Choose File** (depending on the used web browser) – Press to browse for a saved configuration file on your hard disk drive.
4) **Cfg import** – Press to upload a configuration file to the Integra-E/E2/E3.

⚠ Uploaded configuration overwrites the saved configuration.

5) **Cfg restore** – Press to restore saved system configuration, i.e. unsaved changes will be discarded!

⚠ Restoring the configuration overwrites the running configuration with the saved configuration.

6) **Cfg factory** – Resets system configuration to factory defaults.
7) **Saved configuration** – Shows saved system configuration.
8) **Running configuration** – Shows currently running system configuration.

⚠️ Distinct sections in the saved and running configurations are highlighted in color. To examine particular differences, expand highlighted sections of configuration by clicking on the down arrow of the appropriate configuration section.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

configuration browse {<name> | running | saved}	Use to show one of the last 10 configurations, running or saved configuration. s
configuration download	Use to create a copy of the saved configuration file as a txt file in the FTP directory.
configuration factory	Use to reset system configuration to factory defaults.
configuration factory i2cd	Use to reset configuration of i2cd settings to factory defaults.
configuration factory modem	Use to reset modem configuration to factory defaults.
configuration factory netsys {mac-table | port-state}	Use to reset whole Ethernet configuration to factory defaults or particular sections using subcommands – "mac-table" for MAC table; "port-state" for port state configuration; "qos" for QoS configuration; "rate" for rate limit configuration; "vlan" for VLAN configuration.
configuration factory sysd	Use to reset the whole system configuration to factory defaults.
configuration import {All} <preset name>	Use to restore the configuration from a txt file stored in the FTP directory.
configuration load	Use to restore saved system configuration, i.e., unsaved changes will be discarded!
configuration status	Use to check whether the running configuration is saved.
configuration store	Use to save the running configuration.
configuration watch	Use to show entities watch status.

System → Configuration → User configuration

Integra-E/E2/E3 features 2 default user accounts – *admin* (full control) and *guest* (read-only).
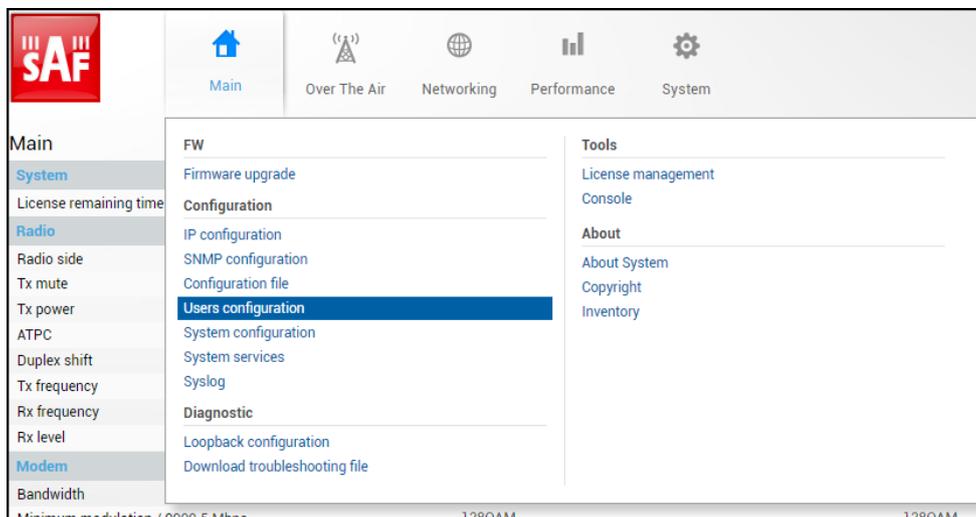
Figure 3-149 Accessing Users configuration page

Status mode

Figure 3-150 User configuration - status mode

Press ✎ MODIFY button.

Modify mode

Figure 3-151 User configuration - modify mode

1) **List of available accounts** – Default is "admin" and "guest" users. You can choose between these accounts. The "guest" user has monitoring privileges and cannot apply configuration changes.

> ⚠ By default, the password for the "admin" account is '*changeme*', while no password is defined for the "guest" account.

2) **Delete** – delete the selected user. For "admin" this button is disabled.
3) **New** – by pressing the button dialog for new user creation opens.
4) **Change** – you can change the password and enable/disable a selected existing user, the structure of "change" menu is the same as for new user creation.
5) **Name** – Enter a short name for the new user.
6) **Full name** – Enter a full name for the user.
7) **Permission** – choose permissions for the user. "Read only" or "Read/Write" available.
8) **Enable** – Check/uncheck to enable/disable a user account. "admin" account cannot be disabled.
9) **Enter new password (4..32 characters)** – Enter a new password. The length is between 4 and 32 characters.
10) **Confirm new password (4..32 characters)** – Confirm new password. The length is between 4 and 32 characters.
11) **Hide password** – Uncheck to display the entered password in plaintext.
12) By pressing „*Execute configuration",* changes made to the corresponding section apply only to the local side Integra-E/E2/E3.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

system user info	Use to show information on the current user.
system user mgmt <username> **access** {r|w}	Use to set read ("r") or write ("w") access right for a particular <username>. "admin" user cannot be modified

system user mgmt <username> **delete**	Use to delete a particular <username>. "admin" user cannot be deleted.
system user mgmt <username> {enable|disable}	Use to enable or disable a particular <username>. "admin" user cannot be disabled
system user mgmt <username> **info**	Use to show information on a particular <username>.
system user mgmt <username> **password** <password>	Use to set password for a particular <username>.
system user new <username> <password> {r|w} <fullname>	Use to create new user with a specified <username>, <password>, <fullname> and read ("r") or write ("w") permissions.
system user factory	Use to reset all users to factory defaults.
system password change <password>	Use to change the password for the current user.
system password reset	Use to reset all passwords to default.

System → Configuration → System configuration

Specify time settings and system/location names.
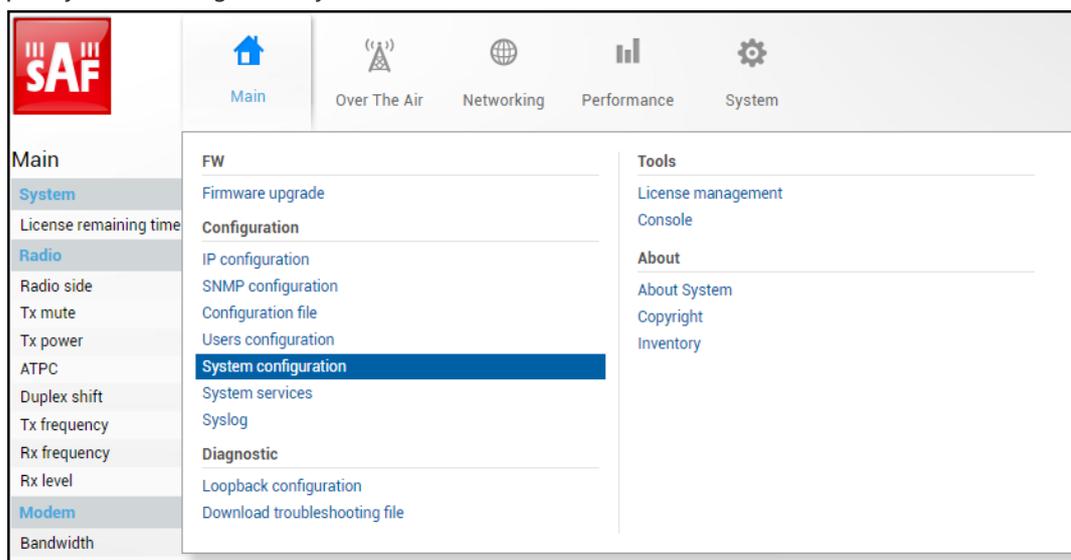
Figure 3-152 Accessing System configuration page
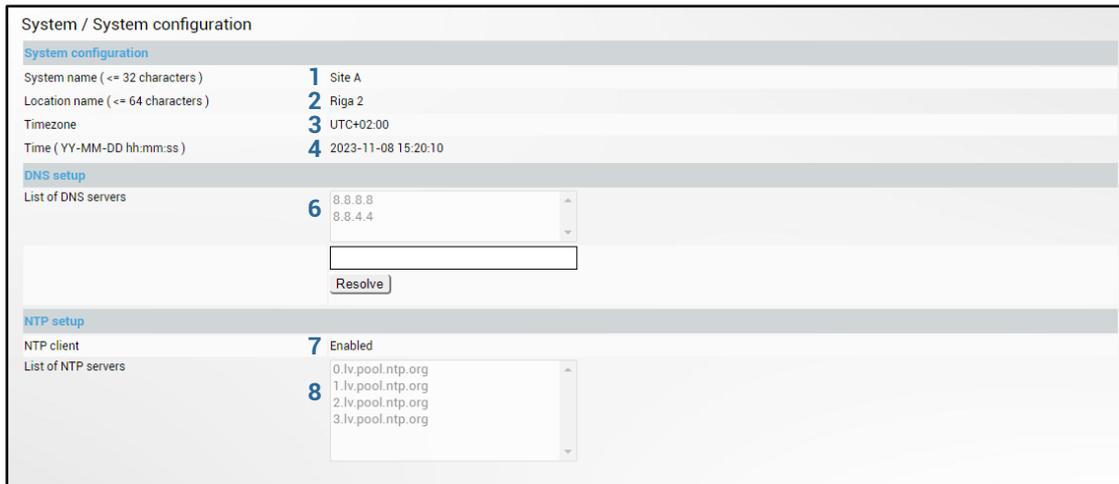
Status mode

Figure 3-153 System configuration – status mode

Modify mode

Press ![modify icon] MODIFY button.
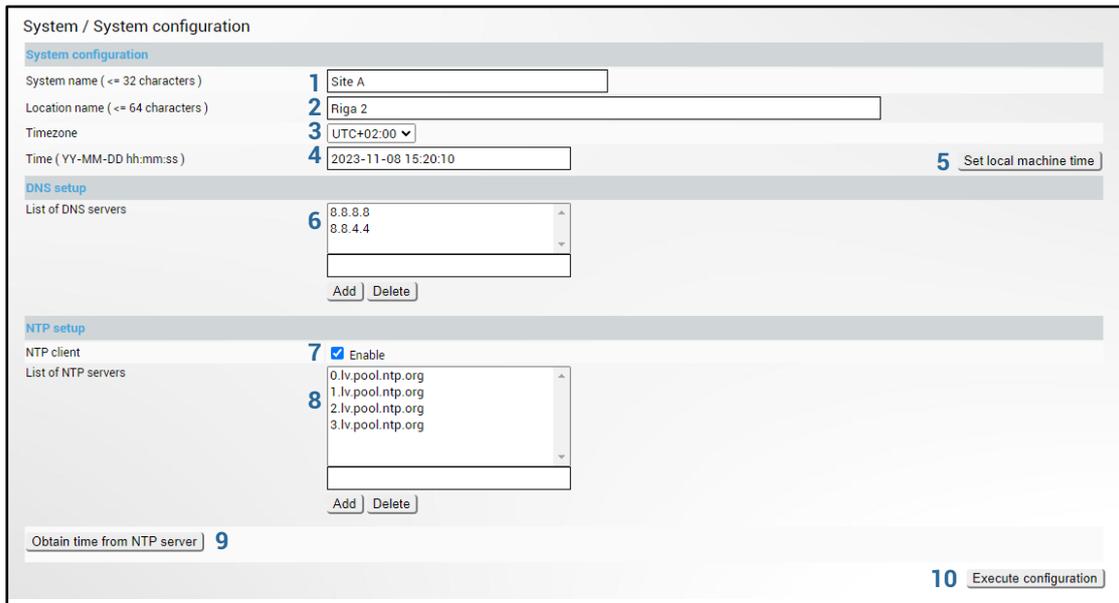
Figure 3-154 System configuration – modify mode

1) **System name** – Allows entering a preferable system name. The maximum length of the system name cannot exceed 32 symbols. The default name is 'SAF'.
2) **Location name** – Allows entering a preferable system location name. The maximum length of the location name cannot exceed 64 symbols. By default, the system location is not specified.
3) **Timezone** – Allows specifying the time zone.
4) **Time (YY-MM-DD hh:mm:ss)** – Allows changing the system date and time manually by entering the date and time in a specific syntax.
5) **Set local machine time** – Press to force the system to use the time set on your PC, from which you are connected to the Web GUI.
6) **List of DNS servers** – Allows defining DNS server for translating domain names (e.g. for NTP server).
7) **NTP client** – Allows enabling or disabling the NTP (Network Time Protocol) client.

8) **_List of NTP servers_** – Allows adding or deleting IP addresses or DNS addresses of NTP servers.
9) **_Obtain time from NTP server_** – Press to force the system to obtain the time from an NTP server.
10) By pressing „*Execute configuration",* changes made to the corresponding section apply only to the local side Integra-E/E2/E3.

⚠ Default system language selection is only allowed available in accordance with the license. Please send a request for translation and obtaining a license to *info@saftehnika.com*.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

system datetime <datetime>	Use to show/set system time and date. Use "YYYY-MM-DD/hh:mm:ss" syntax for date/time.
system discovery clear	Use to clear device surroundings
system discovery list	Use to show the list of found devices using discovery protocol
system discovery refresh	Use to refresh device surroundings
system discovery remote <dst> <bcast>	Use to perform remote discovery using specified IP address and broadcast IP address
system dns dig <domain name>	Use to resolve a domain using configured DNS servers.
system dns server {add <DNSip> | clear | remove <DNSip>}	Use to add/remove DNS server with a specified IP address or to remove all DNS servers from a list.
system dns status	Use to show configured DNS servers` list.
system location <location>	Use to show/define system location.
system name <sysname>	Use to show/define system name.
system ntp {enable | disable}	Use to enable or disable NTP client.
system ntp server {add <NTPip> | clear | remove <NTPip>}	Use to add/remove NTP server with a specified IP address/hostname or to remove all NTP servers from a list.
system ntp status	Use to show NTP status and configured NTP servers` list.
system ntp sync	Use to force the system to obtain the time from an NTP server.
system ntp timezone <-12:00 ... 14:00>	Use to show/define UTC time zone (for example '2' for UTC+2 and '-3:30' for UTC-3:30).
system uptime	Use to show system uptime since the last system start.

System → Configuration → System services

Define Web GUI connection parameters and centralized user management (RADIUS). Please refer to *RADIUS authentication* chapter for an example of RADIUS configuration.
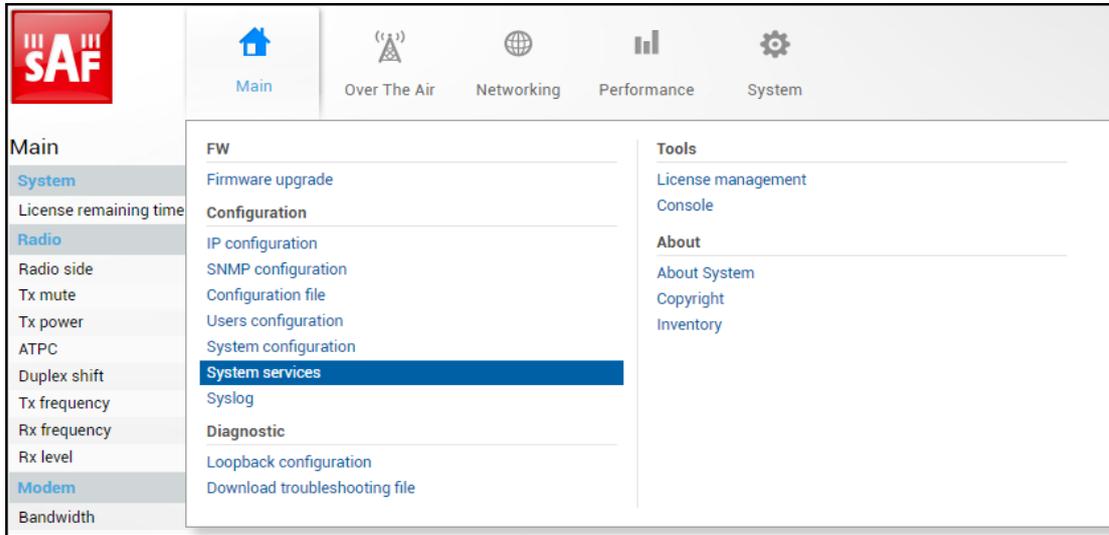
Figure 3-155 Accessing System services page

Status mode

Figure 3-156 System services – status mode

Press ✏️ **MODIFY** button.
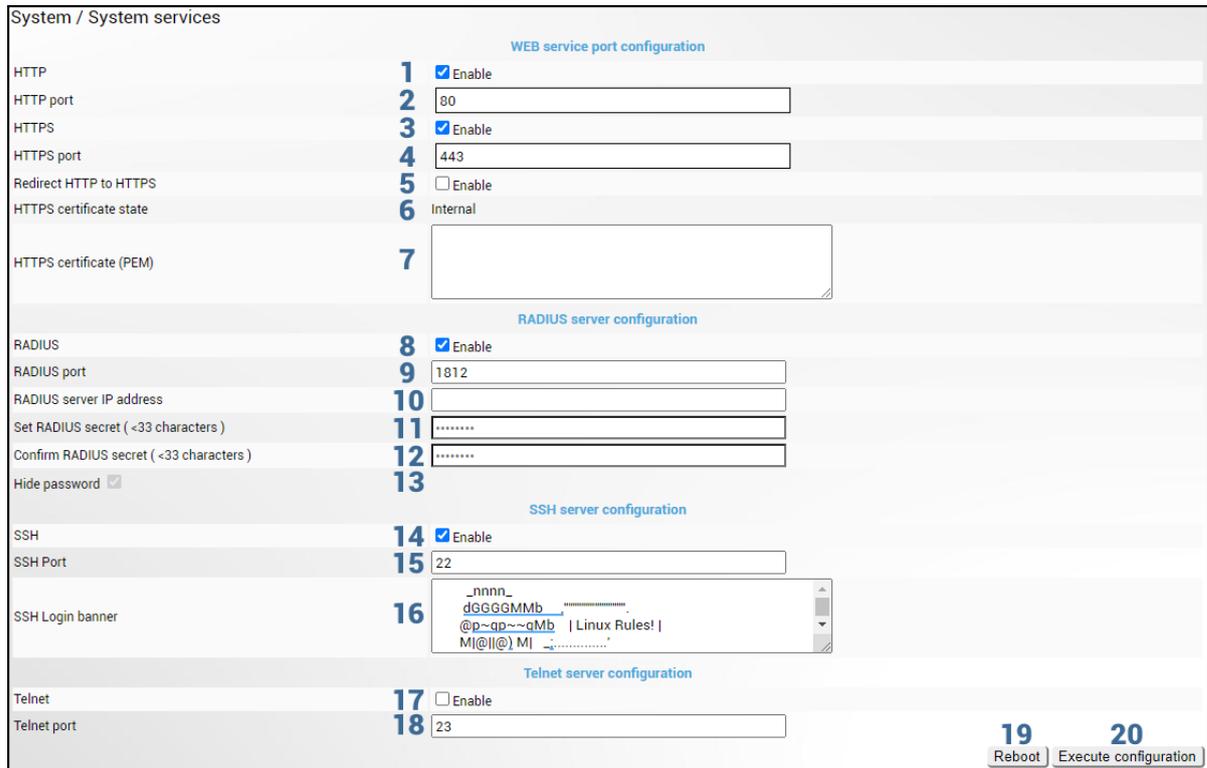
Modify mode

Figure 3-157 System services – modify mode

1) **HTTP** – Allows disabling or enabling HTTP access to Web GUI. By default, HTTP access is enabled.
2) **HTTP port** – Allows specifying TCP port for Web GUI access via HTTP. By default, TCP port 80 is defined.
3) **HTTPS** – Allows disabling or enabling HTTPS access to Web GUI. By default, HTTPS access is enabled.

> ⚠️ By disabling both HTTP and HTTPS you will lose possibility to connect to the Web GUI.

4) **HTTPS port** – Allows specifying TCP port for Web GUI access via HTTPS. By default, TCP port 443 is defined.
5) **Redirect HTTP to HTTPS** – Allows to enable automatic redirect from HTTP to HTTPS.
6) **HTTPS certificate state** – shows what type of SSL certificate is used on the device for HTTPS connections. There can be 2 types of SSL certificates:
   - *User* – user own uploaded and configured SSL certificate for HTTPS connections.
   - *Internal* – factory default firmware compiled SSL certificate for HTTPS connections. If a user's SSL certificate is uploaded and configured for HTTPS connections, then the device will first try to use this certificate. In case Integra for some reason can't use the User certificate and there are any errors in the User certificate usage process, then Integra will use the Internal certificate for HTTPS connections.
7) **HTTPS certificate (PEM)** – please paste the PEM file whole contents here.
8) **RADIUS** - Allows enabling or disabling RADIUS (Remote Authentication Dial In User Service). By default, RADIUS is disabled.
9) **RADIUS port** – Allows specifying RADIUS port. By default, port 1812 is defined.
10) **RADIUS server IP address** – Allows specifying RADIUS server IP address.

11) **Set RADIUS password** – Allows specifying RADIUS password.
12) **Confirm RADIUS password** – Allows confirming RADIUS password.
13) **Hide password** - Uncheck to display the entered password in plaintext.
14) **SSH** – Allows disabling or enabling SSH access.
15) **SSH port** – Allows defining SSH port number. By default, port number 22 is defined.
16) **SSH Login banner** – allows creating SSH Login banner.
17) **Telnet** – Allows disabling or enabling Telnet access. By default, Telnet access is disabled.
18) **Telnet port** – Allows defining Telnet port number. By default, port number 23 is defined.
19) **Reboot** – Reboots Integra-E/E2/E3 (cold restart).
20) By pressing „*Execute configuration*", changes made to the corresponding section apply only to the local side Integra device. It is not possible to apply these settings to devices on both sides at the same time and changes need to be made on each side separately.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

system service HTTP {enable | disable}	Use to show status or enable/disable HTTP service.
system service HTTP port <port>	Use to show/change the port number for HTTP service.
system service HTTPS {enable | disable}	Use to show status or enable/disable HTTPS service.
system service HTTPS port <port>	Use to show/change the port number for HTTPS service.
system service HTTPS ssl_cert import <cert>	Allows to import and configure SSL certificate in PEM format, previously uploaded to device memory via FTP, for usage on further HTTPS connections.
system service HTTPS ssl_cert reset	Allows to stop the usage of previously uploaded and imported user own SSL certificates and configures the device to use its own Internal SSL certificate.
system service ftp {enable | disable}	Use to show status or enable/disable FTP service.
system service redirect {enable | disable}	Use to show status or enable/disable HTTP redirection to HTTPS.
system service ssh banner {clear | set <banner text> | show}	Use to clear/set/show SSH login (1-255 characters long) banner.
system service ssh {enable | disable}	Use to enable/disable SSH service.
system service ssh port {set <port> | reset | show}	Use to set/reset/show a port number of SSH service. By default, port 22 is defined.
system service ssh status	Use to show the status of SSH service.
system service status	Use to show service ports configuration.
system service telnet {enable | disable}	Use to enable/disable TELNET service.
system service telnet port {reset | set <port> | show}	Use to reset/set/show a port number of TELNET service. By default, port 23 is defined.
system service telnet status	Use to show the status of the TELNET service.
system service telnet-client <IP_address>	Use to connect to a remote Integra with the specified IP address. (This command is not supported in Web Console).
system radius addr <IP_address>	Use to define RADIUS server IP address.

system radius {enable | disable}	Use to enable/disable RADIUS configuration.
system radius port <port>	Use to define a port number (0...65535) of a RADIUS server. By default, port 1812 is defined.
system radius secret <secret>	Use to define a RADIUS server password (less than 33 characters long).
system radius status	Use to show RADIUS configuration status.

System → Configuration → Syslog

Integra-E/E2/E3 supports Syslog standard for system management message logging and sending to a monitoring Syslog server.
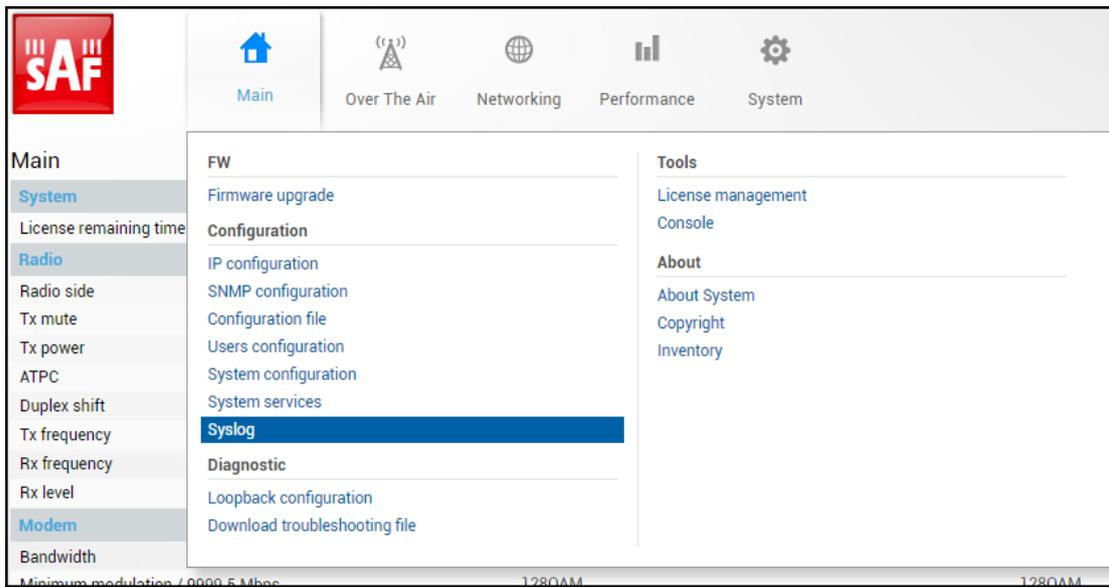
Figure 3-158 Accessing Syslog page

Status mode

Figure 3-159 Syslog – status mode

Press MODIFY button.

Modify mode

Figure 3-160 Syslog – modify mode

1) **Syslog service** – allows enabling ☑ or disabling ☐ Syslog service on the device.
2) **Facility code** – allows selecting facility code for the Syslog messages from the device. Messages with different facilities codes may be handled differently on the syslog server. The following facility codes are possible:
   a. 16 (local0);
   b. 17 (local1);
   c. 18 (local2);
   d. 19 (local3);
   e. 20 (local4);
   f. 21 (local5);
   g. 22 (local6);
   h. 23 (local7).
3) **Server severity** – allows selecting maximal severity (priority) level for sensor log event messages that will be sent from the device to the Syslog server. Each sensor has 4 log event types that trigger Syslog message sending:
   a. **set** – indicates the time when the current sensor value comes out of normal value range or current sensor value is not valid at all;
   b. **reset** – indicates the time when the current sensor value comes back to normal value range from the previous set event state;
   c. **down** – indicates the time when the sensor stops receiving data about parameter it monitors, for example, due to some hardware fault;
   d. **up** – indicates the time when the sensor recovers data reception about parameter it monitors from previous down event state.

   Additionally, each event type can have one of 8 severity levels:

   a. 0 (emerg);
   b. 1 (alert);
   c. 2 (crit);
   d. 3 (error);
   e. 4 (warn);
   f. 5 (notice);
   g. 6 (info);
   h. 7 (debug).

   By default, all sensors have the following severity levels for each of their 4 event types:

   a. set alert;
   b. reset notice;
   c. down alert;
   d. up notice.

   Log event severity can be changed with the CLI command **log sensor mgmt** *<sensor>* **message** *<event> <severity>*.
4) **Syslog label** – allows selecting additional textual labeling/tagging for Syslog messages.
5) **Syslog server IP** – allows configuring an IP address for the Syslog server where the device should send Syslog messages.
6) **Syslog server port** – allows configuring port that the device should use for Syslog message sending.
7) By pressing „*Execute configuration",* changes made to the corresponding section apply only to the local side Integra-E/E2/E3.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

log syslog cfg	Use to show current syslog configuration
log syslog disable	Use to disable syslog message sending
log syslog enable	Use to enable syslog message sending
log syslog facility <facility code>	Use to set facility code for syslog messages

log syslog ip <IP address>	Use to set an IP address for syslog server
log syslog label <syslog_label>	Use to set label/tag for syslog messages
log syslog port <syslog_port>	Use to set a port for syslog server
log syslog severity <severity>	Use to set the maximal severity level for syslog messages that will be sent from the device
log group mgmt <name> add destination {event|perf|snmp|syslog}	Use to add a destination for a group.
log group mgmt <name> remove destination {event|perf|snmp|syslog}	Use to remove a destination from a group.
log sensor mgmt <sensor> message <event> <severity>	Use to set the severity level for sensor event log messages

System → Diagnostic → Loopback configuration

Loopback configuration allows verifying system operation.
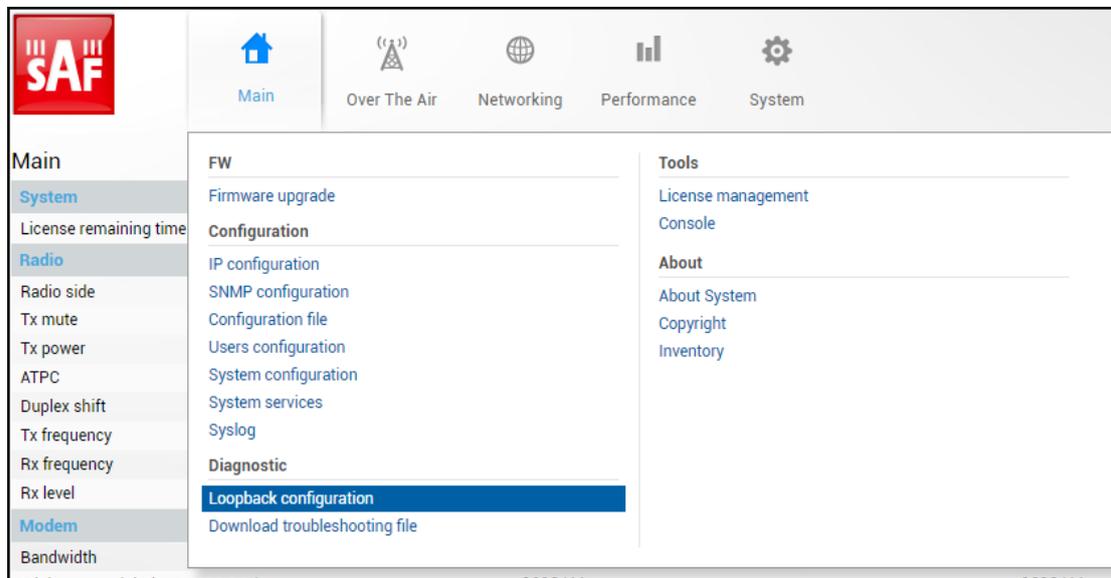
Figure 3-161 Accessing Loopback configuration page

Status mode

Figure 3-162 Loopback configuration – status mode

Press ✏ MODIFY button.

Modify mode

Figure 3-163 Loopback configuration – modify mode

> 1) **Modem loopback** – Indicates whether modem loopback is active (status mode); Allows enabling modem loopback by changing status to "On" and specifying loopback duration time (modify mode). During modem loopback,

the signal is looped back to a local end after the modem, and Integra-E/E2/E3 should be able to synchronize to itself. Both MSE and FEC load should not generate an alarm (values should not be colored in red). When loopback is activated, "Loopback duration time" countdown timer will appear.

2) By pressing „*Execute configuration",* changes made to the corresponding section apply only to the local side Integra-E/E2/E3.

⚠ While modem loopback is active "Modem loopback: Enabled, digital" indication will be shown on the Main status section.

The example of the Main status page during modem loopback is shown in *Figure 3-164.*

Figure 3-164 Main page while modem loopback is enabled

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

modem loopback	Use to show modem loopback status.
modem loopback digital <10..1000000>	Use to enable modem loopback for a specified time in seconds.
modem loopback digital none	Use to disable modem loopback.

System → Diagnostic → Download troubleshooting file

By navigating to the "Download troubleshooting file" a .tar.gz archive containing various troubleshooting data files will be automatically generated and downloaded to your PC.

> ⚠️ When contacting SAF technical support team (techsupport@saftehnika.com) regarding troubleshooting issues, please always provide the troubleshooting file.
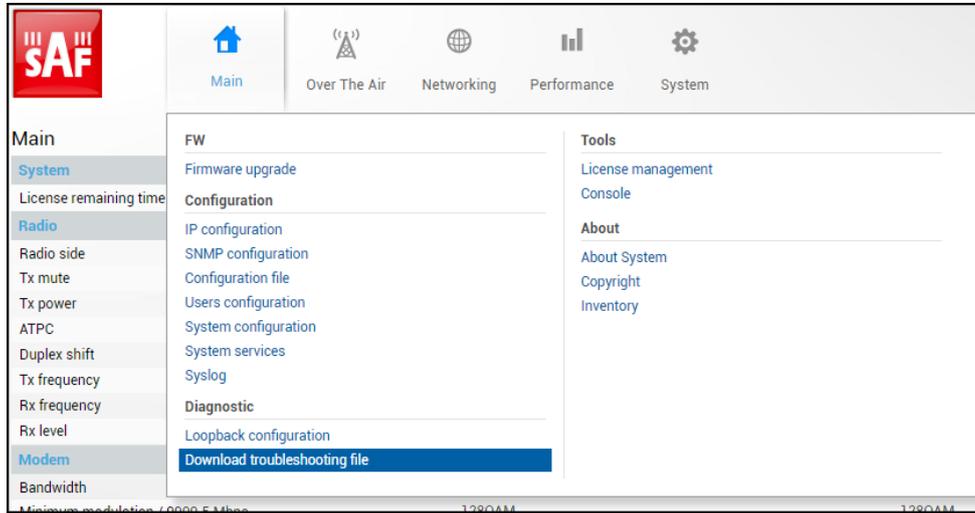
Figure 3-165 Downloading troubleshooting file

Clicking on the "Download troubleshooting file" will open a prompt window asking to confirm the troubleshooting file download process.
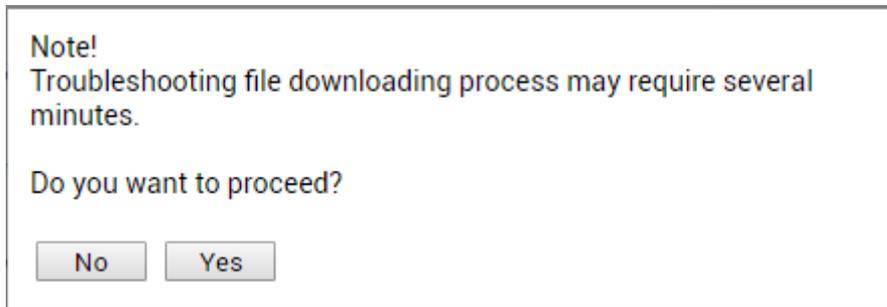
Figure 3-166 Confirmation window for troubleshooting file download

Clicking on the **Yes** button will start a process that will download the troubleshooting file archive package to your hard disk drive ("Downloads" folder of your browser).

File contents:

conf	Subfolder with last configuration files
config.txt	Saved system configuration file
constell.bmp	Snapshot of modem constellation graph
devel.tar.gz	For debugging only
equ_tap.bmp	Snapshot of the adaptive equalizer taps` coefficients
eventlog.txt	Alarm-event log file
Perflog_347040100173_D80R2U01L_2023-12-22_14-36-47.zip	Archive containing performance log files with maximum 1440 entries for 1, 15, and 60-minute intervals

spectrum.bmp	Snapshot of modem Rx spectrum graph
troubleshoot.html	Information on currently running firmware and stored firmware files; system configuration including Web services, RADIUS, IP address, user, NTP configuration, and inventory info; SNMP v1/v2c/v3 configuration; alarm status, alarm threshold, and sensor configurations; radio status, configuration, and counters; currently active license and added license files; modem including modem status and configuration, counters, list of allowed modem profiles, header compression; Ethernet configuration and counters of LAN, WAN and MNG ports

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

system troubleshoot clear	Use to clear ftp://misc/ directory
system troubleshoot diag	Use to show troubleshooting file diagnostics information
system troubleshoot export ftp	Use to export troubleshooting file to ftp://misc/ directory
system troubleshoot make	Use to generate troubleshooting file
system troubleshoot status	Use to show troubleshooting file status

System → Tools → License management

Provides a list of available licenses, time left for each license, and license upload controls.
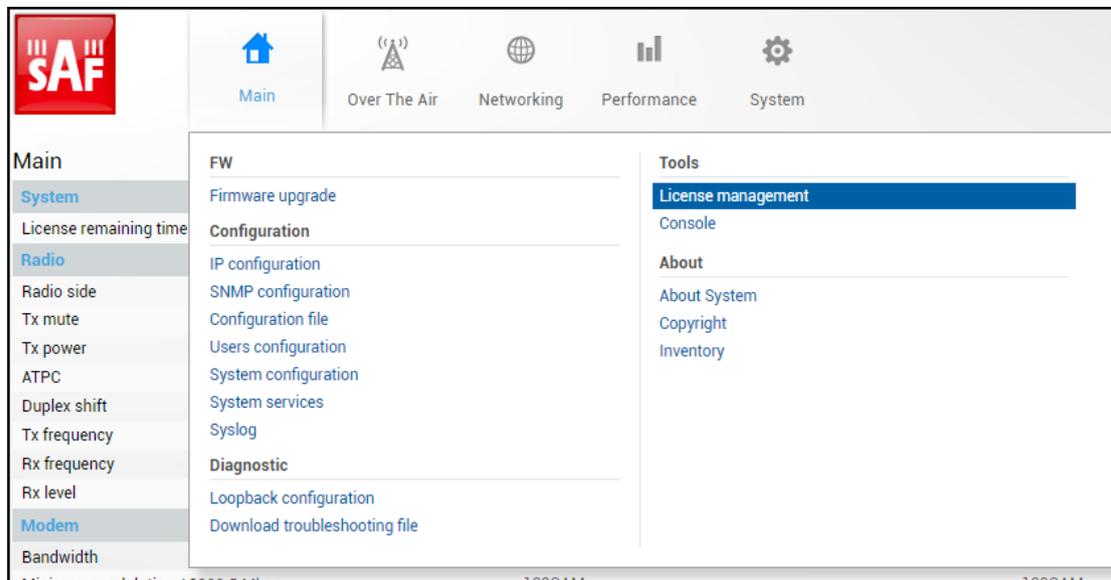
Figure 3-167 Accessing License management page

Status mode

Figure 3-168 License management – status mode

Press ✎ MODIFY button.

Modify mode

Figure 3-169 Licence management – modify mode

1) **Available licenses** – shows a list of available licenses, remaining time and version.
2) **Select active license –** automatically selects currently active license from the list.
3) **Activate** – Select a license from the list and press "Activate" to switch to the preferable license.
4) **Browse** or **Choose File** (depending on the used web browser) **& Upload** – Press to browse for a license file (∗.lic) on your hard disk drive. Press "Upload" to upload a license file (∗.lic) to Integra-E/E2/E3.
5) **Selected** – shows version and time of currently selected license.
6) **Modem** – shows modem settings of currently selected license.
7) **Ethernet** – shows Ethernet rate limitation of currently selected license.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

license list	Use to list available licenses.
license list active	Use to view settings of a currently active license.
license file list	Use to list available license files.
license file add <filename>	Use to add uploaded the license file to the license file list from the FTP directory.
license file activate <filename>	Use to activate previously added license file.
license file restriction <filename>	Use to view settings of a license file.

Adding and activating a new license

For activating a license, please follow these steps:
1) Open License management page in Web GUI „System/Tools/License management".
2) Press the „MODIFY" button.
3) Press "Browse" or "Choose File" button (depending on the used web browser), navigate to the license file (∗.lic), select it, and press "Upload".
4) Choose the uploaded license from the list and press the "Activate" button.

If a new license supports the current modem configuration, no changes will be applied.

If the modem was configured to a modem configuration that is not supported by the new license key, the modem will be reconfigured to the maximum allowed configuration in the chosen channel bandwidth.

> ⚠ When the license expires, the link capacity will drop to 2 Mbps and you will see a warning on the Main page.
>
> When the license expires, the next license in the list needs to be activated manually.
>
> Version 1 licenses always have an "Unlimited" Ethernet rate limit.

System → Tools → Console

The console provides CLI functionality in Web GUI.
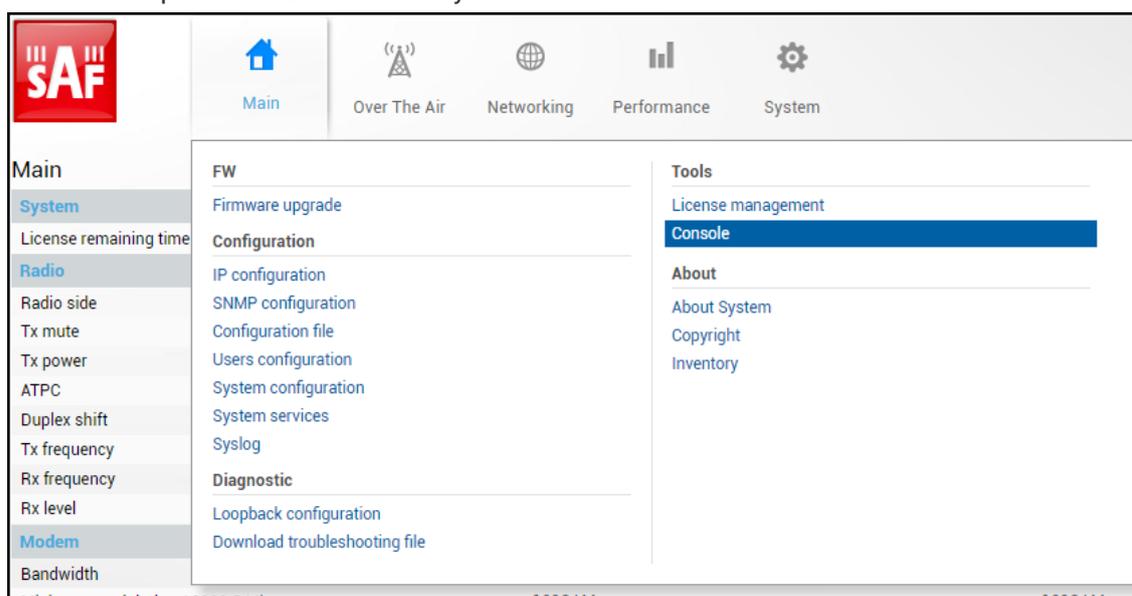
Figure 3-170 Accessing Console page
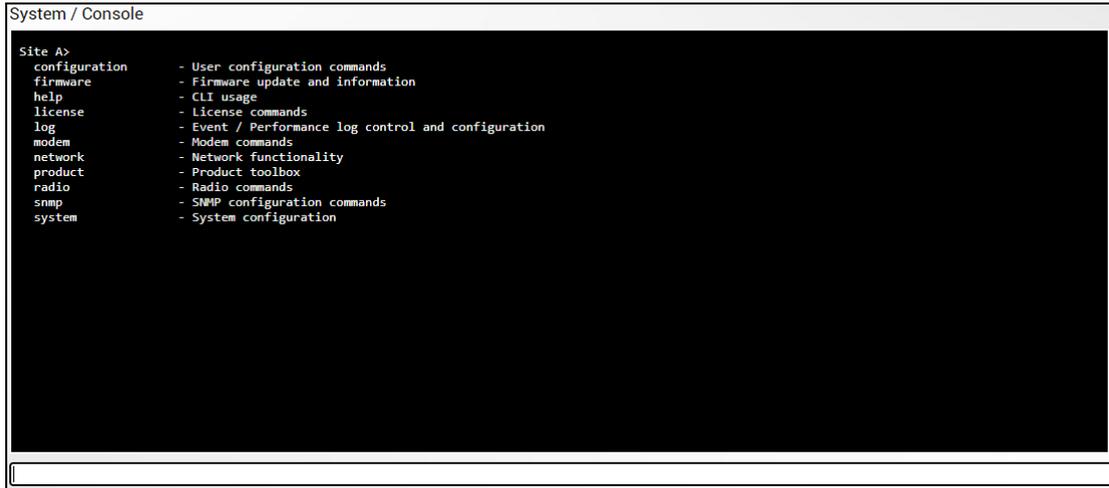
Figure 3-171 Console in WEB GUI

Use syntax "<command>?" to see information on subcommands.

The list of valid CLI commands can be found at the end of each Web GUI page description.

Please refer to *Chapter 4: COMMAND LINE INTERFACE* for details on how to connect to other CLI interfaces (serial, SSH, Telnet).

System → About → About System

Provides a short description of Integra-E/E2/E3 series products.
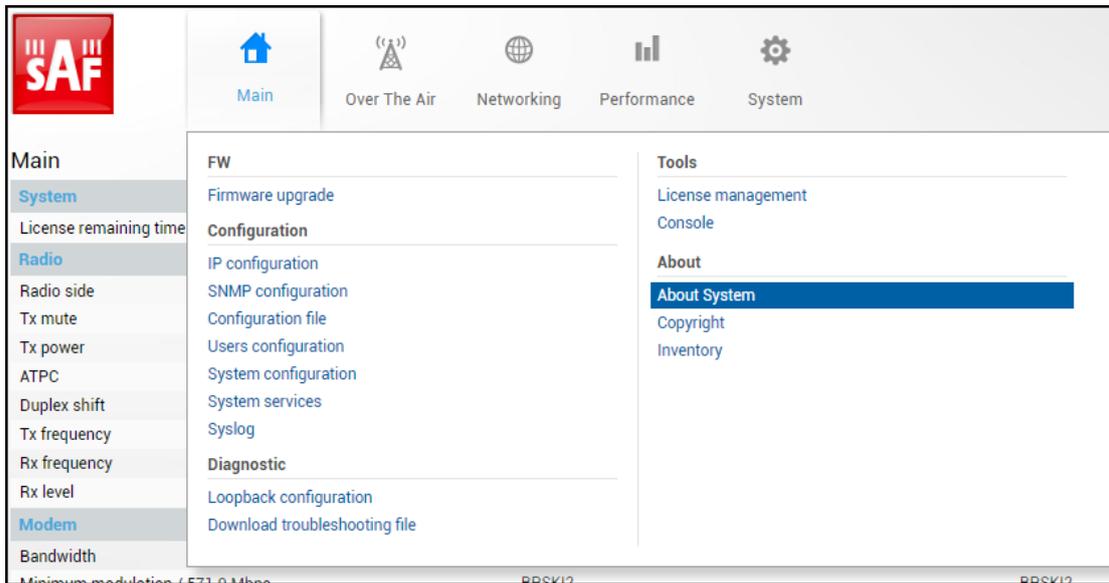
Figure 3-172 Accessing About System page
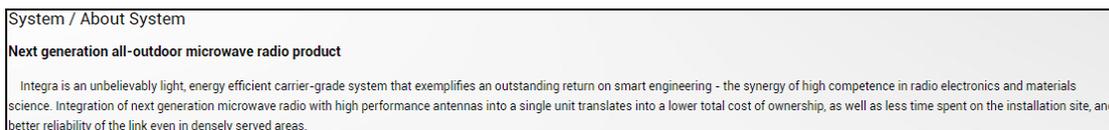
Figure 3-173 About System page

System → About → Copyright

Displays copyright information.
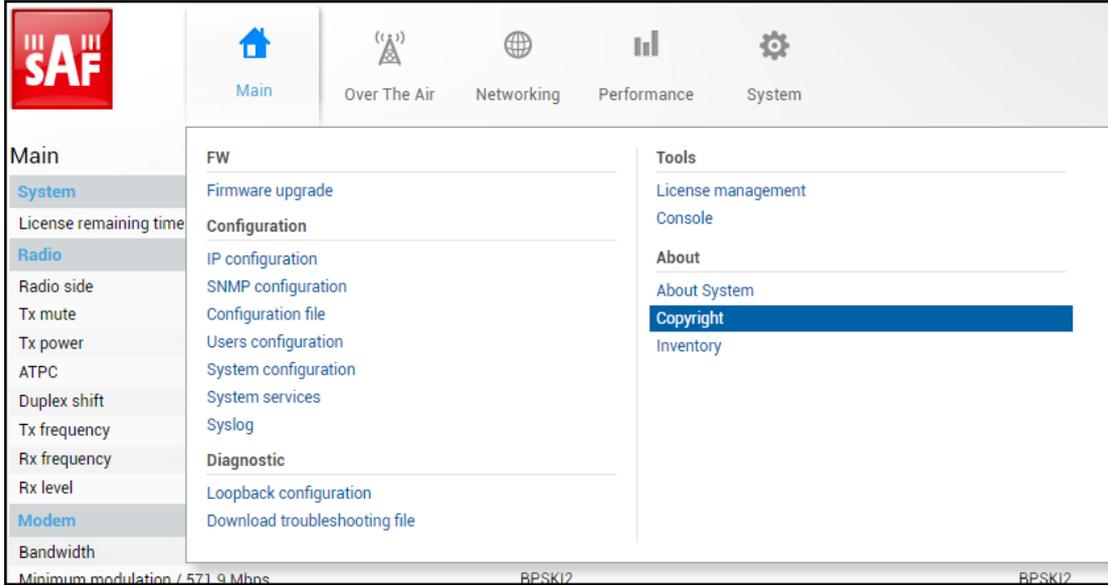
Figure 3-174 Accessing Copyright page

System / Copyright

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Figure 3-175 Copyright page

System → About → Inventory

Displays hardware related information, including such parameters as MB (Mother Board) revision, and Product Serial Number.
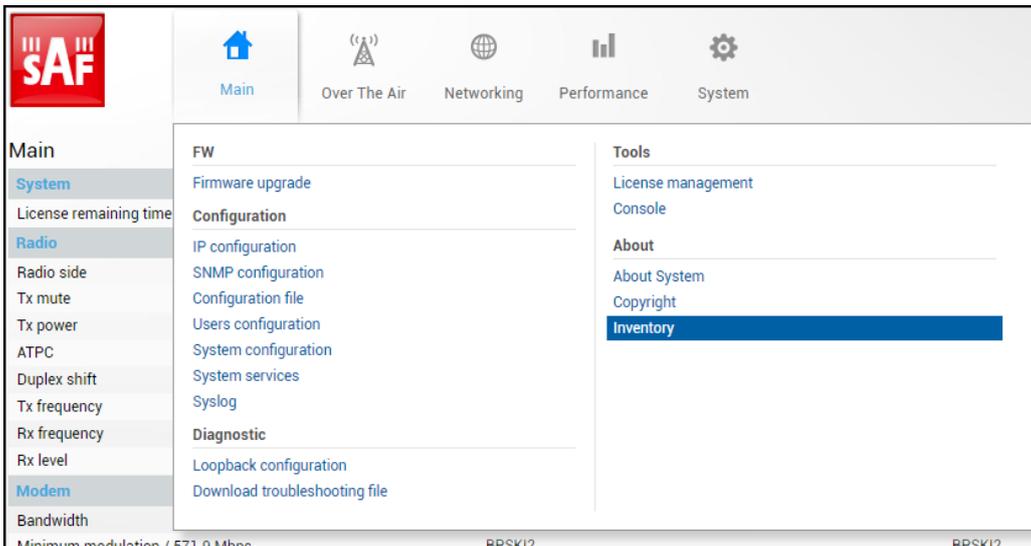
Figure 3-176 Accessing Inventory page

System / Inventory	
MB ID	4
MB Sub ID	0
MB revision	2
MAC	000.004.166.129.103.049 - 00.04.A6.81.67.31
Model	Integra-E
System Contact	techsupport@saftehnika.com
Device Name	SAF
Description	SAF microwave radio
Copyright	Copyright (c) 2013 SAF Tehnika JSC. All rights reserved.
Product Code	D80R0U01L
Product Serial Number	393300200031
Enterprise ID	7571

Figure 3-177 Integra-E/E2/E3 Inventory page

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

product info	Use to show detailed information on the Integra-E/E2/E3 FODU.
system number	Use to show the Integra-E/E2/E3 serial number.

Chapter 4 : COMMAND LINE INTERFACE

Command-line interface (CLI) is available via 4 individual interfaces:

- Secure Shell (SSH).
- Telnet (disabled by default).
- Serial terminal.
- Web GUI (System → Tools → Console, partial functionality).

The available CLI commands are found in the "CLI commands" tables in the corresponding Web GUI page sections in *Chapter 3 : WEB GUI.*

For SSH, Telnet, or serial connection you can use any client supporting the corresponding interfaces (e.g., PuTTY, Tera Term, etc.).

> ⚠ CLI commands are not case-sensitive.
>
> A User can abbreviate commands and parameters as long as they contain enough letters to be distinguished from any other currently available commands or parameters.

Useful CLI keyboard shortcuts can be printed by CLI command **help.**

```
SAF>help
  Enter              - Execute current line
  Tab                - Complete current line
  Home               - Move cursor to beginning
  End                - Move cursor to the end
  Up/Down            - History navigation
  Ctrl-k             - Delete the rest of the line
  Ctrl-w             - Delete a word
  Ctrl-c             - End session
  marked text        - Indication of erroneous user input
```

Figure 4-1 CLI keyboard shortcuts

Connecting to serial RS232 interface

To connect to an Integra-E/E2/E3 serial terminal, you will require a USB cable with a USB Type B connector. Please refer to Chapter *USB port* for pinouts.

To connect the PC to the RS232 management port, using serial terminal-emulation software (e.g. *PuTTY*), use the following parameters:

> Baud rate: 115200
>
> Data bits: 8
>
> Parity: None
>
> Stop bits: 1
>
> Data flow control: None

Below are connection steps with *PuTTY* - Windows freeware software.

1) Open *PuTTY* and go to the "Serial" category. Specify your COM port number you will be using, change "Speed (baud)" to "115200" and "Flow control" to "None":
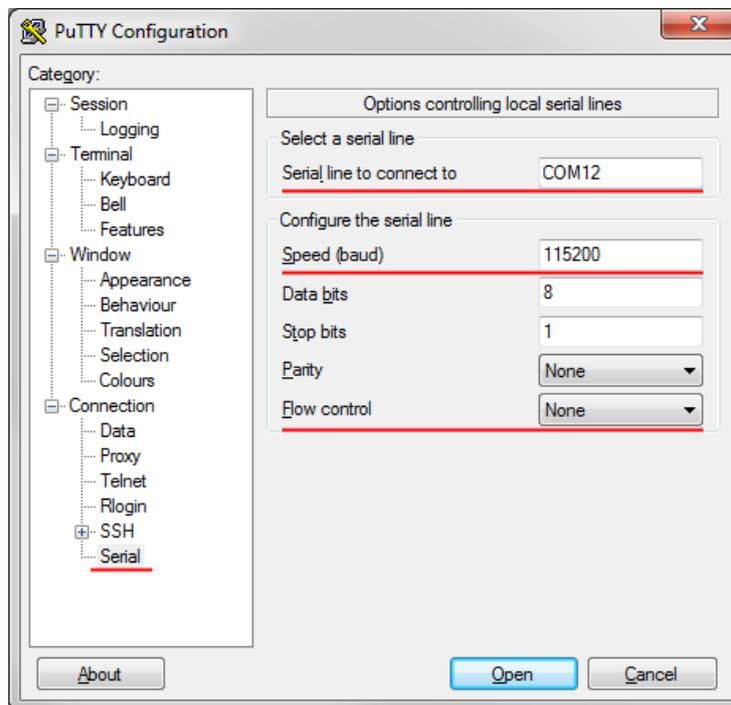
Figure 4-2 PuTTY interface for serial terminal

2) Press "Open" and after pressing "Enter" key following login dialog should appear:
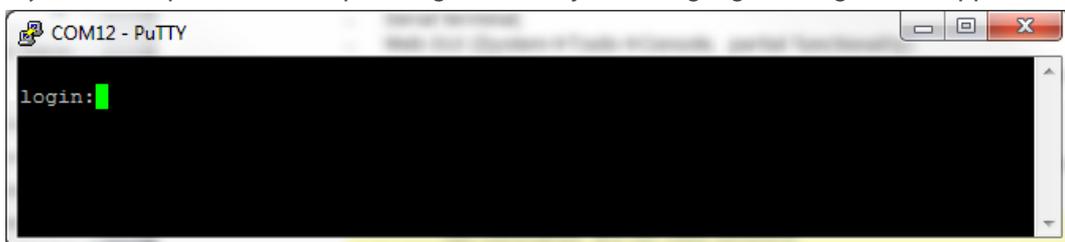
Figure 4-3 Serial terminal login prompt

3) Enter the username and password. Default credentials are as follows:
   - login: **admin**
   - password: **changeme**

4) After successful login "SAF>" prompt should appear (prompt will differ if system name is not the default one):

Figure 4-4 Serial terminal prompt

5) Press "Ctrl+C" to log off from the current session.

⚠️ Closing the *PuTTY* window does not log off from the current serial terminal session.

Connecting to SSH

The SSH connection to the Integra-E/E2/E3 FODU is carried out using an Ethernet management connection. Please refer to the Chapter *Ethernet management connection configuration* for Ethernet management port connection details.

You can use any SSH client. Below are connection steps with *PuTTY* - Windows freeware software.

1) Open *PuTTY*, choose "Connection Type": "SSH", enter the IP address and make sure that the correct port number is used ("22" by default):
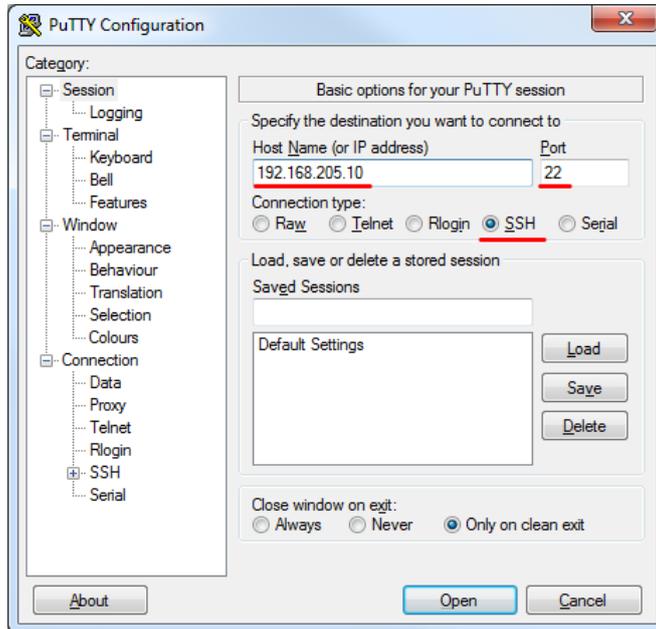
Figure 4-5 PuTTY interface for SSH connection

2) Press "Open". After a successful connection, the following prompt should appear:

Figure 4-6 SSH login prompt

3) Enter the username and password. Default credentials are as follows:
- login: **admin**
- password: **changeme**

4) After successful login "SAF>" prompt should appear (prompt will differ if system name is not the default one):

Figure 4-7 SSH prompt

Connecting to Telnet

A Telnet connection to the Integra-E/E2/E3 FODU is carried out using the Ethernet management connection. Please refer to Chapter *Ethernet management connection configuration* for Ethernet management port connection details.

By default, Telnet service is disabled. See the CLI commands in Chapter *System → Configuration → System services* on how to manage system services.

You can use any Telnet client. Below are connection steps with *PuTTY* - Windows freeware software.

1) Open *PuTTY*, choose "Connection Type": "Telnet", enter the IP address and make sure that the correct port number is used ("23" by default).
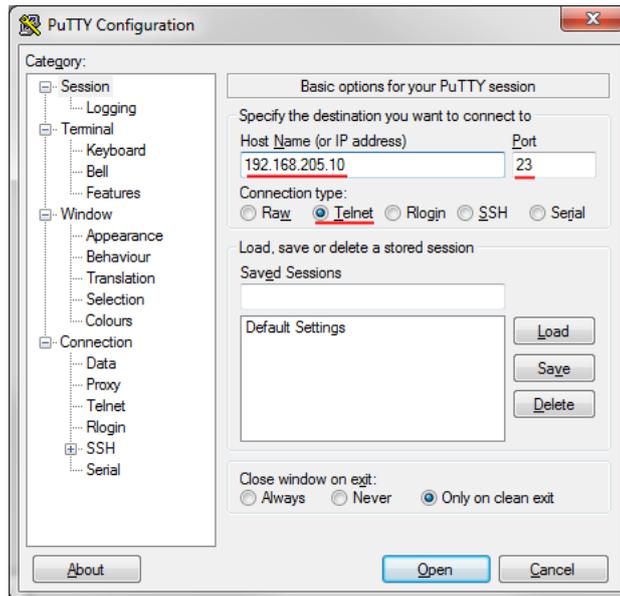
Figure 4-8 PuTTY interface for Telnet connection

2) Press "Open" to connect. After successful connection following prompt should appear:

Figure 4-9 Telnet login prompt

3) Enter the username and password. Default credentials are as follows:
- login: **admin**
- password: **changeme**

4) After successful login "SAF>" prompt should appear (prompt will differ if system name is not the default one):

Figure 4-10 Telnet prompt

Chapter 5 : FUNCTIONAL DESCRIPTION

Built-in Ethernet switch

Integra-E/E2/E3 has a built-in 10 Gbps switch with 50 Gbps switching capacity. It has three LAN ports: LAN1 - 1Gbps PoE-in port that you can use for powering Integra-E/E2/E3 (please refer to chapter *Powering Integra-E/E2/E3 FODU and connecting to PC*), LAN2 and LAN3 SFP ports that can provide up to 10Gbps speed capacity, please refer to *SFP ports* to see the SFP compatibility. In *Figure 5-1* is shown a schematic drawing of a system without VLAN configuration (Pipe mode). There is a possibility to separate different kinds of traffic using VLANs, for example, you can separate MNG traffic from user traffic using different VLANs. For more information about VLAN configuration, please refer to *Networking → Ethernet → VLAN*.

Figure 5-1 Built-in ethernet switch scheme

Description of SAF produced PoE injectors

Universal programmable PoE injector (P/N I0ATPI43)

The I0ATPI43 is an indoor Power over Ethernet injector which complies with IEEE 802.3af, LT PoE++ and Ultra PWR standards. It provides Gigabit Ethernet and DC power via a single Ethernet cable (Cat5e or better). Built-in protection conforms to the IEC 61000-4-5 standard (Class 3 up to 2kV surge).

Please check *Table 8-2* for cable considerations using PoE produced injectors only for PoE power supply of Integra.

The accepted input voltage is 10...57V DC. The output voltage is either stabilized to 57V DC or remains equal to the input voltage depending on selected operating mode.
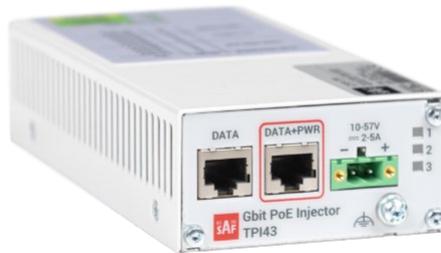
Figure 5-2 I0ATPI43 PoE injector

The front panel has 3 indication LEDs. LED3 indicates the position of DIP switch S2.

Table 5-1 PoE injector I0ATPI43 LED indication

1		PoE enabled and supplied to DATA+POWER port
2		Output voltage is equal to input voltage
3		Input voltage is within the range of 22-57V
		Input voltage is within the range of 10-22V

The injector has a built-in DC/DC converter, which can be switched on / off depending on customer setup. With the DC/DC converter switched on, the output voltage will be stabilized to 57V, regardless of whether the input voltage varies from 10 to 57V. It is designed to compensate the voltage loss in long cables or insufficient input voltage from power supply.

In turn, the mode with DC/DC converter switched off is suggested in setups with maximum output power needed in harsh, hot environments. The power consumed by the injector as well as the heat dissipated, will be the minimum in this mode. The power supply providing input voltage should be stabilized in this case and ensure voltage as close to 57V as possible.

The back panel has 2 switches to operate the PoE injector in different modes.

The PoE injector has a built-in lightning and surge protection preventing transient over-voltages from damaging radio and user's indoor equipment. Device also has an overcurrent and short circuit protection, and it is protected against reversed polarity of the input voltage.

Please be aware that proper grounding should always be used for all elements of your site setup, including the PoE injector and the powered equipment.

Table 5-2 PoE injector I0ATPI43 power mode DIP switch selection

S1	S2	Mode	P(out) max	V(out)	Description
↑	↑	A	120W	57V	DC/DC converter switched on; UltraPWR
↓	↑	B[2]	90W	57V	DC/DC converter switched on; LTPoE++
↑	↓	C	120W	=V(in)	DC/DC bypass; UltraPWR
↓	↓	D	90W	=V(in)	DC/DC bypass; LTPoE++

↓ — DIP switch position DOWN, ↑ — DIP switch position UP

⚠ The position of DIP switches must be changed only when the input voltage is disconnected and PoE injector is turned off.

Table 5-3 Electrical specifications for P/N I0ATPI43

Electrical specification	
Data rate	Up to 1000 Mb/s
DC/DC Mode	Two modes switchable: active / disabled
Input Voltage	10 – 57 V
Output Voltage	Two modes switchable: 57 V / equal to the input voltage
Max Output Current @ UIN 22…57 V DC	802.3af mode 0.375 A LTPoE++ mode 2.25 A UltraPWR mode 2.8 A
Max Output Current @ UIN 10…22 V DC	802.3af mode 0.375 A
Power Connector[3]	2ESDV-02P, centerline 5.08 mm / 0.2", with screw locks
Ethernet Connectors	Shielded RJ45 jacks
Data Lines	Pins (1, 2), (3, 6), (4, 5) and (7, 8)
Power Lines	+ (1, 2) and (4, 5); - (3, 6) and (7, 8)
Power Clamping Voltage	+/- 70 V
Surge protection according to CEI EN 61000-4-5	Class 3 up to 2kV surge
Max data cable length	100 m

Table 5-4 Mechanical specifications for P/N I0ATPI43

Mechanical specification		
Ports	-	RJ45 - Data
	-	RJ45 - Data + Power
	-	DC - 2ESDV-02P socket with screw locks
	-	Grounding screw
Dimensions (W/H/D):	-	82 mm/41 mm/154 mm
Weight	-	0.4 kg
Enclosure	-	Steel
Operating Temperature	-	-10ºC to +50ºC
Mounting	With bracket (included) 19" rack mounting shelf (P/N I0KTPI11.003) DIN-rail clip (P/N I0STPI11.001)	

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[2] Default recommended mode

[3] 2ESDV-02P plug with screw locks is included

Gigabit Ethernet High power programmable PoE injector (P/N DXATPI03)

The state-of-the-art Integra compatible SAF Tehnika PoE injector model is DXATPI03. This model can be optionally used with Integra-E/E2/E3 FODU for powering option #1 (see chapter *Powering Integra-E/E2/E3 FODU and connecting to PC*) instead of the default model P/N I0ATPI43. For availability of the injector, please inquire your SAF representative.

Figure 5-3 PoE injector DXATPI03 front and rear panel view

All SAF Tehnika injectors have a built-in and always enabled DC/DC converter. The accepted input voltage is 20…65V DC. The output voltage is stabilized to 55V DC on both PoE connection DATA+PWR and DC OUT ports. DC OUT port has a current limitation to 3A and can be used to power Integra also through a 2-wire DC power port.

In the rear panel (for details see *Figure 5-3 PoE injector DXATPI03 front and rear panel view*) injector has 4 DIP switches to configure the injector to different PoE power supply modes. For details see Table 5-5 PoE injector DXATPI03 power mode DIP switch selection.

PoE 120W mode provides the most effective surge protection for Integra. In case overload occurs and output power Pmax on the injector exceeds 120W, then the PoE injector will switch off/on until the output power decreases below 120W.

> ⚠ The position of DIP switches should be changed only when the PoE injector is turned off and no power supply is connected to the DC input port.

Table 5-5 PoE injector DXATPI03 power mode DIP switch selection

Nr.	D	C	B	A	Description
1	✘	↓	↓	↓	**PoE 120W.** Passive PoE mode provides maximal power up to 120W for the connected device.
2	✘	↓	↑	↓	**PoE++ 90W max.** LTPoE++ mode when PoE controller output power P_{max} (PD power class) is negotiated automatically with the PD connected. (P_{max} =90W)
3	✘	↑	↑	↓	**Passive 15W**. Passive PoE mode provides maximal power up to 15W for the connected device.
4	↑	✘	✘	↑	**Factory service mode. Don't use it during normal operation**

↓ — DIP switch position DOWN, ↑ — DIP switch position UP, ✘ — any position

For PoE power connection Ethernet cable from PoE injector port DATA+PWR must be connected to Integra RJ-45 port (LAN1). Interconnection schemes with Integra are shown in *Figure 5-4 SAF produced PoE injector power connection schema with Integra*.
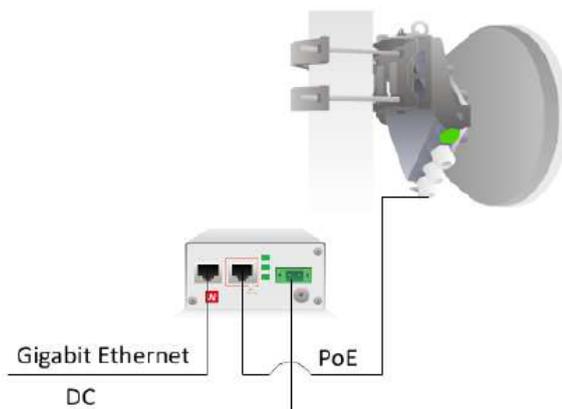
Figure 5-4 SAF produced PoE injector power connection schema with Integra

The combined length of Ethernet cables from CPE to PoE injector ("DATA" port) and from PoE injector to Integra ("DATA+PWR" port on PoE injector) should not exceed 100 m to provide Ethernet data connection from CPE to Integra. It is recommended to use outdoor type STP/FTP Ethernet cables Cat5e or better for the connection.

SAF Tehnika injectors are designed to work with any PoE-capable products which have a Fast Ethernet/Gigabit Ethernet interface and are compatible with Cat5e or Cat6 Ethernet cables. Each injector has a built-in PoE controller which complies with IEEE 802.3af, IEEE 802.3at, and LTPoE++ (proprietary PoE standard allowing auto-negotiation of up to 90 W output power delivery with connected PoE device). It also complies with IEC 61000-4-5 standard. Injectors have built-in lightning and surge protection on all connections preventing transient over-voltages from damaging Integra devices and CPE which are connected to the injectors. All injectors have also surge voltage protection from improper grounding and reversed polarity.

For PoE injector front panel LED indication description, see below *Table 5-6 PoE injector DXATPI03 LED indication*.

Table 5-6 PoE injector DXATPI03 LED indication

1	Fault on fan 1
2	Fault on fan 2
TEMP	The temperature of the injector has reached 50°C and the fan of the device starts working. The indication should be on during the normal operation of the injector.
PoE	The injector has an active PoE connection and is working normally
POWER	The injector has normal DC voltage on the input port and provides also normal 55V/3A power to output DC OUT port. Corresponds to normal working conditions

> ⚠ Note that in case of short or open circuit occurrence PoE injectors will not turn on. To establish a power connection in such a case all the connecting power cables, connectors and Integra device itself should be inspected to find and eliminate the faulty spot which causes short or open circuit occurrence.

Table 5-7 Electrical specifications for P/N DXATPI03

Electrical Specifications	
Data rate	Up to 1000 Mb/s
DC/DC Mode	Always active
Input Voltage, nominal range	20 – 60 V
Input Voltage, maximum peak value	65 V
Output Voltage, stabilized	55 V
Max Output Current in PoE++ mode	2.2 A
Switchable Current limits in PoE passive modes	0.3A(15W mode) and 2.7A(120W mode)
Power Connector	2ESDV-02P with screw locks
Ethernet Connectors	Shielded RJ45 jacks
Data Lines	Pins (1, 2), (3, 6), (4, 5) and (7, 8)
Power Lines	+ (1, 2) and (4, 5); - (3, 6) and (7, 8)
Power Clamping Voltage	+/- 70 V
Max data cable length	100 m

Table 5-8 Mechanical specifications for P/N DXATPI03

Mechanical specification	
Ports	RJ45 - Data RJ45 - Data + Power DC - 2ESDV-02P socket with screw locks[4] Grounding screw
Dimensions (W/H/D):	82 mm/41 mm/154 mm
Weight	0.45kg (DXATPI03)
Enclosure	Steel
Operating Temperature	-10ºC to +55ºC
Cooling	Temperature controlled fans built-in: 2 pcs (DXATPI03)
Stationary use	Climatic Class 3.1E compliant (ETSI ETS 300 019-1-3), IP 20; weather protected locations
Mounting	With bracket (included) 19" rack mounting shelf (p/n I0KTPI11.003) DIN-rail clip (p/n I0STPI11.01)

Integra radio power connection redundancy

For power connection redundancy Integra device can be powered also simultaneously on both power ports: 2-wire DC port and LAN1 RJ-45 port. Yet Integra will have an active power connection (main) only from one of the two power sources – the other one is in standby mode and ready to take over the power supply connection in case the main power source fails.

Note that Integra will use as the main power source the one which is connected to it first. The only exception here is when at first the device is powered from a PoE injector and then

---

[4] 2ESDV-02P plug with screw locks included

the DC power supply which has also a higher voltage level is connected – in this case, Integra will switch over to the DC power supply.

Note also that Integra will power on almost immediately and without any delay when connected to the DC power source. The only requirement here is that the DC power source should provide at least 38V as a minimum voltage level. However, it will take a couple of seconds for the device to start from SAF Tehnika PoE injectors. So, in case when the device is connected simultaneously with the PoE injector and DC power source, it will connect faster with the DC power source and select it as the main connection. When the PoE injector detection process will be finished, then it will become the standby power supply in such connection.

For uninterrupted and hitless power supply failover operation on Integra, there is only 1 possible power connection configuration: Integra has SAF Tehnika DXATPI03 PoE injector as the main power source (note that it should be used only in PoE 120W mode) and DC power supply as a standby power source. If the PoE connection fails, then the device will switch over without any service interruption to the DC power supply. For such configuration to correctly work, DC power supply voltage also should be less than from the PoE injector. So, if SAF Tehnika PoE injectors provide 55V for PoE connection, then the DC power source in such configuration should have a lower voltage level, for example, 48V. In such connection, PoE injector should be connected first. Only when Integra device is fully powered from it, then the DC power source should be connected.

In case Integra's main power source is DC power supply and SAF produced PoE injector is used in PoE 120W mode as a standby power source (for DIP switch settings on the injector see *Table 5-5* PoE injector DXATPI03 power mode DIP switch selection), if main DC power supply fails, then Integra-X will switch off, after a couple of seconds start detection process of PoE connection, establish PoE connection and start up again. The longest period here is the Integra device start-up process which can take 30 – 60 seconds – so this will also determine service interruption duration in this type of power redundancy configuration in case of main power supply breakdown. Another vulnerability of this power connection is when the main DC power supply does not fail completely and under some circumstances its voltage level just decreases under 38V, for example, even providing just 10V, then Integra will not switch over to stand-by PoE power connection and will still try using main DC power supply as the main power source with insufficient voltage level. Such incidents can cause Integra to stop working normally till the DC power supply is turned off or breaks down completely. To avoid such situations additional power monitoring and control equipment should be used with this type of redundant power connection.

Note that DXATPI03 can be used for both power connections: PoE power supply from Ethernet DATA+PWR port and DC power supply from DC OUT 55V port on the back of the injector (see *Figure 5-3 PoE injector DXATPI03 front and rear panel view*). As both injector outputs still depend on the power from the same source, then power redundancy can't be insured just by using both power outputs of just one DXATPI03 PoE injector. Each PoE injector can provide only one power connection to each Integra device and its' second power port can be used to power some other equipment, even possibly some 2nd Integra device in the same site location. As mentioned above for full hitless power redundancy configuration DXATPI03 injector can be used only connected to Integra LAN1 port from "DATA+PWR" port providing PoE connection as the main power source, but as a standby power source, some additional DC power supply with lower voltage level than 55V should be connected to 2-wire DC port of Integra.

ACMB (Adaptive Coding and Modulation and Bandwidth)

ACMB technology allows operators to achieve high-capacity data transmission over microwave links and improve link utilization. This reduces both operational and capital

expenditures for maintaining high-capacity links. ACMB can maintain the highest link spectral efficiency possible at any given time in any link condition.

In traditional voice-dominated wireless backhaul transmission networks, service availability levels of 99.995% are the norm.

However, newer services such as Internet browsing, video streaming, and video conferencing can operate at more relaxed availability levels. For example, when bad weather has decreased the channel capacity of a link, ACMB maintains the best possible capacity in given conditions. The link will stay up, synchronization is not lost, but the traffic data rate is decreased.
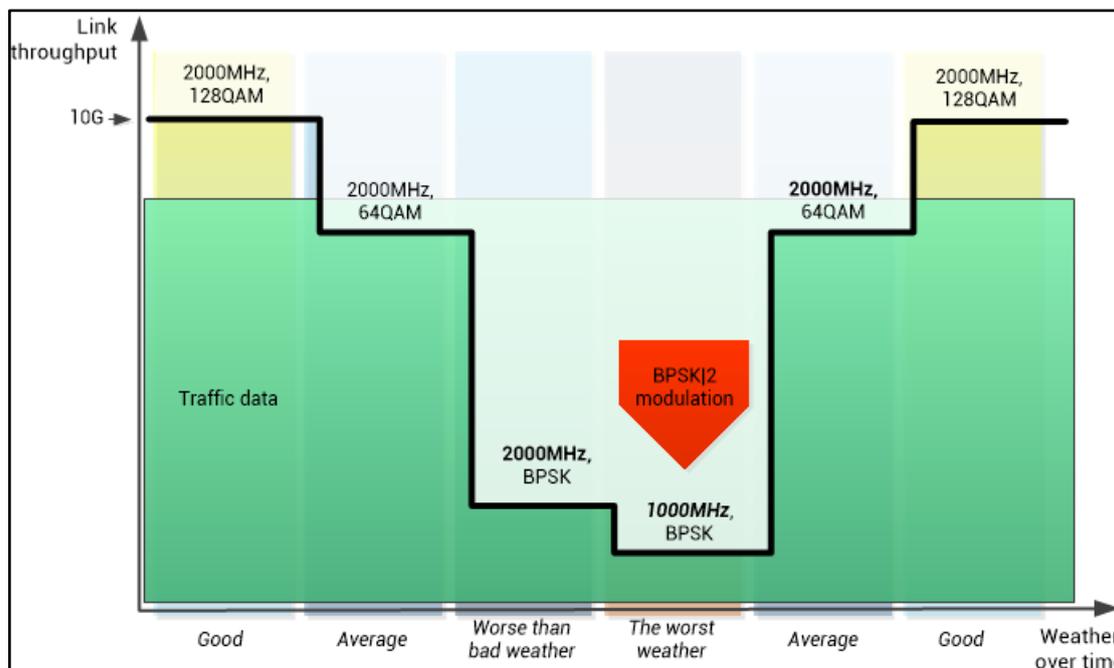
Figure 5-5 Modulation switching scheme

When conditions are clear, the wireless link operates at maximum capacity and provides all services with the full data rate. When link conditions are poor – during harsh rain, for example – services are adapted dynamically to the changing link conditions. This is done by provisioning bandwidth according to the radio conditions.

An ACMB profile defines the link parameters (modulation and bandwidth) for a given range of the MSE (Mean Square Error) alone, which is inverse of SNR (Signal to Noise Ratio). The MSE range of each profile defines the threshold for switching from one ACMB profile to another. Each ACMB profile has a different spectral efficiency, derived from its modulation and bandwidth.

To maintain linearity, Tx power decreases for higher modulations, because nonlinearity introduces an error that decreases MSE. Therefore, the Tx power difference between BPSK/4 and 256QAM is 6dB.

The ACMB switching rate is hitless, meaning that no data will be lost during a change of ACMB profiles.

The receiver continuously monitors the link condition based on MSE value.

Once the MSE exceeds the threshold of the current ACMB profile, which is higher than the threshold for BER10^{-6}, which makes sense if we take into account that switching must take place when there are no errors yet, an ACMB switching process will be initiated. In case of further radio link degradation, the new ACMB profile will include lower modulation, decreasing the link bitrate. The lowest modulation is BPSK/4, which means that the lowest modulation is BPSK, and if MSE continues to decrease, the bandwidth is decreased in half twice in sequence resulting in a better RX threshold.

MSE values for ACM downshift and upshift can be found in tables below.

Table 5-9 MSE for ACMB (dB) / indicative Rx level (dBm) for legacy Reed Solomon modem profiles in fixed Tx power mode (compatible with both Integra-E and Integra-E2/E3 radios)

	62.5MHz	125MHz	250MHz
BPSK/2-->BPSK/4		-9.4 / -77.5	-9.6 / -74
BPSK/2<--BPSK/4		-13.9 / -75.5	-13.9 / -72.5
BPSK-->BPSK/2	-9.5 / -78.5	-9.5 / -74.5	-9.8 / -71
BPSK<--BPSK/2	-14.0 / -76	-13.8 / -72.5	-14.2 / -69
4QAM-->BPSK	-14.1 / -73.5	-14.2 / -70	-14.4 / -66.5
4QAM<--BPSK	-15.8 / -71.5	-15.7 / -68	-16.0 / - 64.5
16QAM-->4QAM	-20.4 / -66.5	-20.3 / -63	-20.8 / -59.5
16QAM<--4QAM	-22.7 / -64.5	-22.8 / -61	-23.2 / -57.5
32QAM-->16QAM	-23.2 / -63.5	-23.1 / -60	-23.6 / -56.5
32QAM<--16QAM	-24.7 / -62	-25.0 / -58	-25.4 / -54.5
64QAM-->32QAM	-26.2 / -60.5	-26.2 / -57	-26.5 / -53.5
64QAM<--32QAM	-27.8 / -58.5	-28.0 / -55	-28.2 / -51.5
128QAM-->64QAM	-28.9 / -57	-28.9 / -54	-29.2 / -50.5
128QAM<--64QAM	-30.4 / -55.5	-30.5 / -52	-30.8 / -48.5
256QAM-->128QAM	-32.1 / -52.5	-31.8 / -50.5	-32.0 / -47
256QAM<--128QAM	-33.0 / -51.5	-33.1 / -48.5	-33.2 / -45.5

	500MHz	1000MHz	2000MHz
BPSK/2-->BPSK/4	-10.0 / -71.5	-10.3 / -68.5	-10.3 / -65
BPSK/2<--BPSK/4	-14.4 / -69	-14.5 / -66.5	-15.0 / -63
BPSK-->BPSK/2	-9.9 / -68	-10.1 / -65	-10.2 / -62
BPSK<--BPSK/2	-14.7 / -66	-14.7 / -63.5	-15.0 / -60
4QAM-->BPSK	-15.0 / -63.5	-15.0 / -60	-15.1 / -57
4QAM<--BPSK	-16.3 / -61	-16.5 / -58.5	-16.7 / -55
16QAM-->4QAM	-21.2 / -56.5	-21.0 / -53	-21.1 / -50
16QAM<--4QAM	-23.7 / -54	-23.7 / -51	-23.8 / -48
32QAM-->16QAM	-23.8 / -53	-23.8 / -50	-23.7 / -47
32QAM<--16QAM	-25.7 / -51	-25.7 / -48	-25.5 / -45
64QAM-->32QAM	-26.9 / -50	-27.0 / -47	-26.8 / -43.5
64QAM<--32QAM	-28.7 / -48	-28.6 / -45	-28.4 / -41
128QAM-->64QAM	-29.7 / -47	-29.9 / -43.5	-29.2 / -40
128QAM<--64QAM	-31.3 / -45	-31.1 / - 41.5	-30.5 / -37.5
256QAM-->128QAM	-32.0 / -44	-31.9 / -40.5	
256QAM<--128QAM	-33.6 / -42	-33.3 / -38.5	

Table 5-10 MSE for ACMB (dB) / indicative Rx level (dBm) for legacy Reed Solomon modem profiles in variable Tx power mode (compatible with both Integra-E and Integra-E2/E3 radios)

	62.5MHz	125MHz	250MHz
BPSK/2-->BPSK/4		-9.4 / -82.2	-9.6 / -79.4
BPSK/2<--BPSK/4		-14.0 / -79.2	-13.9 / -76.3
BPSK-->BPSK/2	-9.3 / -82.8	-11.6 / -79.3	-9.5 / -76.3
BPSK<--BPSK/2	-12.7 / -79.9	-13.8 / -76.3	-14.3 / -72.8
4QAM-->BPSK	-14.2 / -77.0	-14.3 / -73.5	-14.8 / -69.8
4QAM<--BPSK	-15.8 / -74.4	-16.0 / -70.5	-15.8 / -67.0
16QAM-->4QAM	-20.6 / -69.7	-20.9 / -66.0	-21.1 / -62.8
16QAM<--4QAM	-23.5 / -66.1	-24.0 / -62.6	-24.1 / -59.6
32QAM-->16QAM	-23.7 / -67.3	-23.6 / -63.1	-24.0 / -59.7
32QAM<--16QAM	-25.8 / -64.1	-26.0 / -60.5	-26.4 / -57.1
64QAM-->32QAM	-26.3 / -64.4	-26.7 / -60.3	-27.0 / -57.0
64QAM<--32QAM	-28.3 / -62.1	-28.8 / -58.4	-29.0 / -55.0
128QAM-->64QAM	-29 / -60.5	-29.2 / -57.3	-29.5 / -53.4
128QAM<--64QAM	-30.4 / -59.5	-30.9 / -55.9	-31.1 / -52.4
256QAM-->128QAM	-31.5 / -57.3	-32.0 / -53.8	-32.2 / -49.9
256QAM<--128QAM	-32.7 / -56.5	-33.4 / -53.0	-33.3 / -49.1

	500MHz	1000MHz	2000MHz
BPSK/2-->BPSK/4	-9.8 / -75.3	-10.0 / -72.7	-10.4 / -69.1
BPSK/2<--BPSK/4	-14.4 / -72.8	-14.8 / -70.2	-15.0 / -66.6
BPSK-->BPSK/2	-10.1 / -72.3	-9.9 / -69.1	-10.5 / -65.3
BPSK<--BPSK/2	-14.4 / -69.3	-14.8 / -66.7	-15.0 / -63.1
4QAM-->BPSK	-14.9 / -66.6	-15.1 / -63.5	-15.2 / -60.2
4QAM<--BPSK	-16.3 / -64.1	-16.6 / -61.4	-16.5 / -57.8
16QAM-->4QAM	-21.4 / -59.3	-21.3 / -56.7	-21.3 / -53.0
16QAM<--4QAM	-24.8 / -56.1	-24.9 / -53.9	-24.8 / -50.3
32QAM-->16QAM	-24.3 / -56.6	-24.3 / -53.9	-24.1 / -50.2
32QAM<--16QAM	-26.6 / -54.2	-26.7 / -51.3	-26.5 / -47.6
64QAM-->32QAM	-27.3 / -53.7	-27.3 / -50.4	-27.2 / -47.3
64QAM<--32QAM	-29.2 / -51.7	-29.5 / -48.8	-29.1 / -45.1
128QAM-->64QAM	-30.0 / -50.4	-30.0 / -47.9	-29.4 / -44.2
128QAM<--64QAM	-31.5 / -49.2	-31.6 / -46.6	-31.0 / -42.8
256QAM-->128QAM	-32.3 / -47.4	-32.1 / -44.9	
256QAM<--128QAM	-33.9 / -46.3	-33.7 / -44.0	

Table 5-11 MSE for ACMB (dB) / indicative Rx level (dBm) for LDPC modem profiles in fixed Tx power mode (compatbible only with Integra-E2/E3 radios)

	62.5MHz	125MHz	250MHz
BPSK-->BPSK/2			-10.2 / -74.0
BPSK<--BPSK/2			-12.8 / -71.7
4QAM-->BPSK	-12.1 / -71.7	-12.1 / -75.3	-12.4 / -71.5
4QAM<--BPSK	-13.8 / -69.6	-13.9 / -72.6	-14.1 / -69.3
16QAM-->4QAM	-18.5 / -66.4	-18.5 / -67.9	-18.9 / -64.7
16QAM<--4QAM	-20.1 / -64.1	-20.2 / -66.2	-20.5 / -62.7
32QAM-->16QAM	-21.1 / -64.3	-21.4 / -64.7	-21.9 / -61.3
32QAM<--16QAM	-23.3 / -61.9	-23.3 / -62.7	-23.7 / -59.3
64QAM-->32QAM	-24.0 / -62.5	-23.9 / -62.2	-24.3 / -58.6
64QAM<--32QAM	-25.9 / -59.8	-25.9 / -60.1	-26.2 / -56.5
128QAM-->64QAM	-26.9 / -60.4	-26.9 / -59.1	-27.2 / -55.6
128QAM<--64QAM	-28.6 / -57.9	-28.7 / -56.9	-29 / -53.4
256QAM-->128QAM	-29.4 / -58.3	-29.5 / -56.1	-29.8 / -52.6
256QAM<--128QAM	-31.4 / -56.2	-31.4 / -53.8	-31.8 / -50.4
512QAM-->256QAM	-32.2 / -56.3	-32.1 / -53.3	-32.5 / -49.6
512QAM<--256QAM	-33.7 / -54.2	-33.8 / -50.9	-34.1 / -47.4
1024QAM-->512QAM	-34.8 / -53.0	-34.7 / -50.1	-35.0 / -46.3
1024QAM<--512QAM	-36.2 / -51.0	-36.3 / -47.9	-36.7 / -44.2

	500MHz	1000MHz	2000MHz
BPSK/2-->BPSK/4	-10.1 / -75.3	-10.2 / -71.5	-10.4 / -68.0
BPSK/2<--BPSK/4	-13.7 / -73.3	-14.8 / -69.5	-15.1 / -65.8
BPSK-->BPSK/2	-10.1 / -71.8	-10.3 / -68.3	-10.5 / -64.2
BPSK<--BPSK/2	-14.9 / -69.7	-15.1 / -66.0	-15.3 / -62.4
4QAM-->BPSK	-12.8 / -68.9	-13.5 / -64.8	-13.8 / -60.5
4QAM<--BPSK	-14.5 / -66.7	-15.0 / -62.8	-15.6 / -58.5
16QAM-->4QAM	-19.2 / -62.1	-19.8 / -57.9	-20.5 / -53.8
16QAM<--4QAM	-21.1 / -60.3	-21.7 / -56.2	-22.3 / -51.8
32QAM-->16QAM	-22.1 / -58.4	-22.7 / -54.7	-23.2 / -50.6
32QAM<--16QAM	-24.2 / -56.2	-24.7 / -52.5	-25.0 / -48.5
64QAM-->32QAM	-24.8 / -55.6	-25.4 / -51.8	-25.8 / -47.8
64QAM<--32QAM	-26.9 / -53.5	-27.3 / -49.8	-27.6 / -45.5
128QAM-->64QAM	-27.7 / -52.6	-28.3 / -48.7	-28.6 / -44.5
128QAM<--64QAM	-29.8 / -50.3	-30.1 / -46.4	-30.0 / -42.5
256QAM-->128QAM	-30.3 / -49.4	-30.8 / -45.5	

256QAM<--128QAM	-32.4 / -47.2	-32.6 / -43.5	
512QAM-->256QAM	-33.0 / -47.3	-33.3 / -43.6	
512QAM<--256QAM	-34.6 / -44.9	-34.9 / -41.2	
1024QAM-->512QAM	-35.3 / -44.2	-35.4 / -40.1	
1024QAM<--512QAM	-36.9 / -41.6	-36.5 / -38.1	

Table 5-12 MSE for ACMB (dB) / indicative Rx level (dBm) for LDPC modem profiles in variable Tx power mode (compatbible only with Integra-E2/E3 radios)

	62.5MHz	**125MHz**	**250MHz**
BPSK-->BPSK/2			-10.8 / -74.8
BPSK<--BPSK/2			-12.6 / -72.7
4QAM-->BPSK	-12.3 / -79.7	-11.9 / -76.0	-12.2 / -72.6
4QAM<--BPSK	-13.8 / -77.6	-13.8 / -73.6	-14.0 / -70.0
16QAM-->4QAM	-18.6 / -71.9	-18.4 / -69.1	-18.5 / -65.5
16QAM<--4QAM	-21.2 / -70.2	-21.3 / -66.5	-21.3 / -63.1
32QAM-->16QAM	-21.3 / -69.5	-21.3 / -66.2	-21.3 / -62.6
32QAM<--16QAM	-24.2 / -67.2	-24.0 / -63.8	-24.2 / -60.2
64QAM-->32QAM	-24.1 / - 67.0	-23.9 / -63.4	-25.2 / -59.2
64QAM<--32QAM	-26.9 / -64.4	-26.8 / -61.0	-27.2 / -57.4
128QAM-->64QAM	-26.9 / -64.4	-26.6 / -60.7	-27.2 / -56.8
128QAM<--64QAM	-29.5 / -61.4	-29.3 / -58.3	-29.8 / -54.6
256QAM-->128QAM	-29.4 / -61.1	-29.4 / -57.6	-29.7 / -54.1
256QAM<--128QAM	-32.2 / -58.7	-32.1 / -55.1	-32.5 / -51.7
512QAM-->256QAM	-32.1 / -58.3	-31.9 / -55.0	-32.4 / -51.1
512QAM<--256QAM	-34.3 / -55.7	-34.3 / -52.5	-34.7 / -48.9
1024QAM-->512QAM	-34.9 / -54.7	-34.5 / -51.9	-34.9 / -48.2
1024QAM<--512QAM	-36.8 / -52.4	-36.9 / -49.4	-37.0 / -46.0

	500MHz	**1000MHz**	**2000MHz**
BPSK/2-->BPSK/4	-11.3 / -75.9	-10.1 / -72.9	-15.2 / -68.7
BPSK/2<--BPSK/4	-13.8 / -72.9	-14.5 / -70.4	-10.3 / -66.2
BPSK-->BPSK/2	-9.9 / -72.3	-9.9 / -69.1	-10.4 / -65.2
BPSK<--BPSK/2	-14.5 / -69.8	-15.1 / -66.6	-15.1 / -63.3
4QAM-->BPSK	-12.5 / -69.0	-13.2 / -65.6	-13.9 / -61.3
4QAM<--BPSK	-14.1 / -66.6	-14.7 / -63.7	-15.7 / -59.1
16QAM-->4QAM	-19.0 / -62.2	-19.6 / -58.7	-20.1 / -54.6
16QAM<--4QAM	-22.0 / -59.8	-22.8 / -56.4	-23.4 / -52.1
32QAM-->16QAM	-21.9 / -59.1	-22.6 / -55.6	-23.1 / -51.2

32QAM<--16QAM	-24.7 / -56.9	-25.3 / -53.4	-25.8 / -49.1
64QAM-->32QAM	-24.6 / -56.2	-25.3 / -52.7	-25.7 / -48.4
64QAM<--32QAM	-27.4 / -53.9	-27.9 / -50.7	-28.4 / -46.0
128QAM-->64QAM	-27.5 / -53.2	-28.2 / -49.6	-28.5 / -45.5
128QAM<--64QAM	-30.2 / -50.9	-30.6 / -47.6	-30.8 / -42.8
256QAM-->128QAM	-30.2 / -50.6	-30.8 / -46.7	
256QAM<--128QAM	-32.9 / -48.3	-33.2 / -44.5	
512QAM-->256QAM	-32.9 / -47.6	-33.3 / -43.7	
512QAM<--256QAM	-35.0 / -45.4	-34.9 / -41.7	
1024QAM-->512QAM	-35.1 / -44.8	-35.3 / -40.7	
1024QAM<--512QAM	-37.1 / -42.5	-36.8 / -38.4	

For example, the link is configured to 128QAM modulation in 2000MHz ETSI bandwidth. To operate with the highest modulation (and maximum capacity), MSE should be <-29.2dB. If MSE exceeds the threshold of -29.2dB, ACMB will downshift to 64QAM. Degrading further below -26.8dB will downshift to 32QAM. At MSE >-15.1dB modulation will be BPSK. Further link degradation will trigger BPSK/2 modulation, as a result, the link will be operating with BPSK modulation and bandwidth 1000MHz (2000/2). Accordingly, BPSK/4 with given parameters means BPSK and 500MHz bandwidth. This keeps the link working but with a decreased bitrate of 268Mbps until MSE reaches -6.0dB and only then link loses synchronization.

When MSE improves, upshift thresholds will be used. ACMB will upshift back to 128QAM when MSE exceeds -30.5dB.

Alternatively, ACMB can also be used to increase the link distance, resulting in added link spectral efficiency. The same concept is implemented as previously, with the margins that were kept for 99.995-percent bandwidth availability now used to increase the link distance. Whenever the link conditions are degraded, the system will switch to an ACMB profile with lower spectral efficiency to maintain link synchronization.

In comparison, a system using 128QAM/2000MHz without ACMB and providing a similar capacity would offer only 99.964% of availability. You would have to decrease the distance, decrease modulation, or increase antenna sizes to achieve 99.995% availability for the given link.

This example demonstrates how the new technology, based on an ACMB mechanism, can play a key role in the development of cost-effective next-generation wireless access networks, by taking advantage of traffic evolution from synchronous TDM traffic to packet IP-based traffic.

ATPC (Automatic Transmit Power Control)

ATPC can be used together with ACMB to control the transmitted power in any given ACMB profile. Different configurations can be implemented to achieve maximal spectral efficiency or minimal transmitted power using both features in combination. One implementation could target maximal spectral efficiency by trying to reach the highest ACMB profile, while the other is willing to compromise on some of the spectral efficiency enabling CCI and ACI reduction. In any chosen configuration, ATPC reduces the average transmitted power, benefiting each ACMB profile and any link condition.

The E-band radio waves have fast attenuation increase due to precipitation and therefore the links have high Rx levels during good weather conditions. Taking into account that short

distance of E-band links can lead to oversaturation of the Integra-E/E2/E3 receiver and MSE degradation, as a result, downshifting ACMB modulation and decreasing the throughput. ATPC tackles these limitations by reducing Tx power during favorable weather conditions and rising Tx power when link attenuation increases.

Integra-E/E2/E3 receives information about the Rx level from the far-end Integra-E/E2/E3 through the service channel. Depending on the received Rx level parameter, the local Integra-E/E2/E3 adjusts the transmitter power to keep it within the limits of the "Rx (remote) level range". Recommended Rx level range is -35dBm...-25dBm. See Chapter *Over the Air* for further details.

⚠️ Rx level >-10 dBm will result in about 1dB degradation of MSE compared to <-15 dBm Rx levels.

AES - Advanced Encryption Standard

Encryption helps to protect information by transforming the original message, called plaintext into an encoded message, called ciphertext. For example, the plaintext message "*This is text*", encoded might look like "*RtÜxø«5Ð$·hî*".

AES (Advanced Encryption Standard) is a standardized version of Rijndael cipher algorithm. The AES algorithm is capable of using cryptographic keys of 128, 192, and 256 bits to encrypt and decrypt data in blocks of 128 bits. Based on key size AES is named AES-128, AES-192, or AES-256.

⚠️ AES-256 encryption is available in Integra-E3 model.

SAF's AES-256 encryption fully complies with *Federal Information Processing Standards Publication 197 (2001)* and has been certified with *NIST (FIPS-197)* for Integra-E3.

AES 256-bit bit key is a 64 hexadecimal values (0-9, A-F) sequence. This 64-hex pre-shared key can be entered manually or generated using "Generate random key" button. In the latter case an internal software secure random number generator will be used for that purpose. The same key has to be used on both sides of the link.

The plaintext input 128-bit block is arranged in the form of a 4 x 4 square matrix of bytes. This block is copied into the state array, which is modified at each stage of encryption or decryption. After the final stage, the output state is copied to an output matrix.

Encryption/decryption starts with an initial single transformation (AddRoundKey), followed by 13 rounds each containing four distinct transformation functions: byte substitution (perform a byte-by-byte substitution of the block), ShiftRows (permutation), AddRoundKey (bitwise XOR of the current block with a portion of the round key), and MixColumns (a substitution that makes use of arithmetic over bytes). The final round contains only the first three transformations of the above.
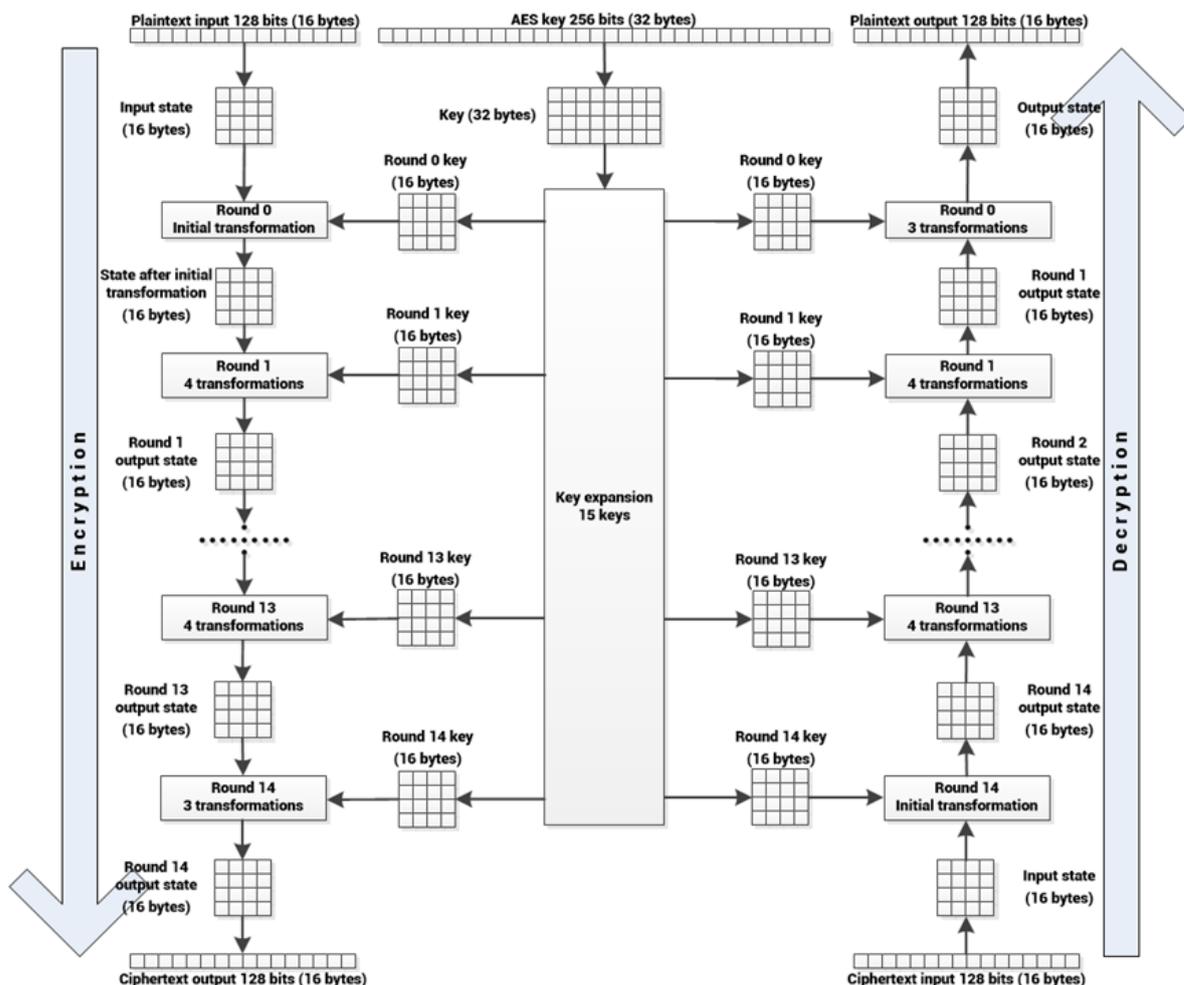
Figure 5-6 AES-256 algorithm illustration

Each transformation takes 4 x 4 matrices as input and produces a 4 x 4 matrix as output.

The key expansion function generates 15 round keys to be used at rounds. Each round key serves as one of the inputs to the AddRoundKey transformation.

The AES-256 algorithm is illustrated in *Figure 5-3*.

The Cipher Feedback (CFB) confidentiality mode (described in *NIST SP 800-38A recommendation* in chapter 6.3) is used in conjunction with AES-256 algorithm in Integra-X2 and Integra-E3 products. This 128-bit CFB mode features the feedback of successive ciphertext segments into the input blocks of the forward cipher to generate output blocks that are exclusive-OR`ed with the plaintext to produce the ciphertext, and vice versa. An unpredictable initialization vector (IV) provided by internal operating system random number generator is used for CFB implementation.

The CFB mode is illustrated in *Figure 5-4*.
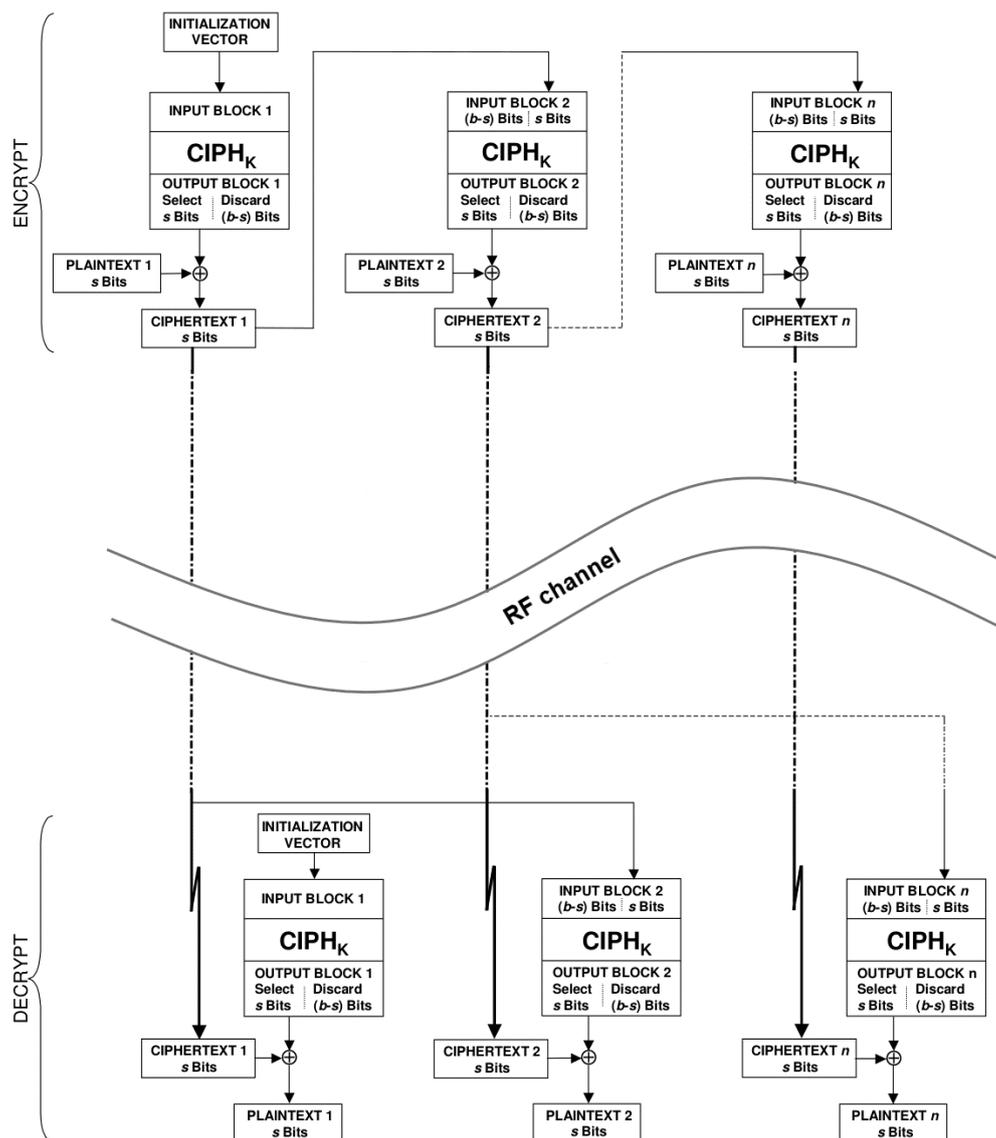
Figure 5-7 The CFB Mode

Link State Propagation and Backup

Link state propagation

Link state propagation (LSP) functionality allows shutting down specified LAN ports if synchronization loss events occur so that customer-premises equipment (CPE) can apply necessary changes promptly. LSP could be used for faster backup link activation or when link aggregation is used with external switches. There could be a situation when the radio link has errors or there is a critical drop of the bitrate, but this is not effectively detected by the connected CPE switch and data loss could occur.

For example, let's look at a time delay at LACP when detecting the fault of a LAG (Link Aggregation Group) member. Please see *Figure 5-8* below.
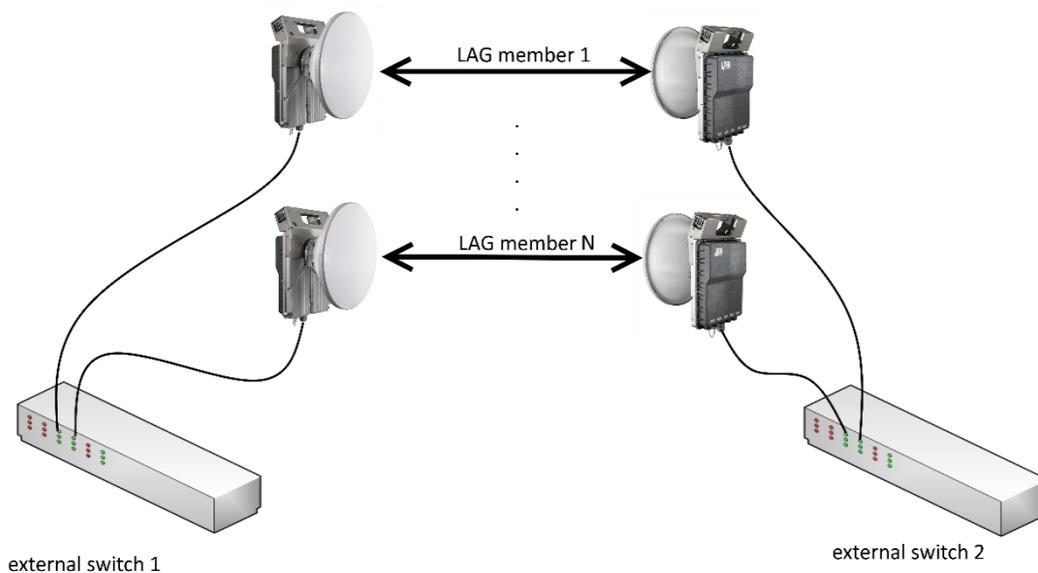
Figure 5-8 Link aggregation with LSP

During the normal operation, all LAG members have equal capacity, and external switches are passing data from all ports. If one of the LAG member links has failed or decreased link capacity below a certain level, then LACP doesn't react instantly, there usually is about a minute when data is still sent to the faulty member and lost. To avoid this, LSP steps in – you can configure certain thresholds for the Integra-E/E2/E3 (see *Networking → Ethernet → Link State Propagation and Backup* for the details on configuration) for Tx or Rx, or both Tx and Rx bitrates on the WAN port when the link is considered down, thus blocking port instantly and forcing LACP to exclude this path from the LAG or switch to backup link to avoid data loss during the fault detection time.

The main configurable parameter is "Min required capacity" – the link capacity value under which LSP is triggered, forcing the designated LSP port to switch to a disabled state. Please pay attention to the considerations below:

1) Check the management channel configuration – if the management is accessible only through the port with enabled LSP, access to the radio will be lost. To avoid this, we recommend using a different port for the management when using LSP or Backup-Link functionality. Management cables are not shown in *Figure 5-8*.

2) When traffic is asymmetric in both directions, you can choose the traffic direction which triggers LSP using "Mode" selection. It is possible to choose ingress or egress traffic and specify the appropriate threshold for it.

⚠ By default, "Min required capacity" is set to "0", meaning that LSP is triggered only when link synchronization is down.

LSP state is switched off when configured "Min required capacity" is exceeded. There is a special case when "LAN auto recovery" is not "0". In this case, the LSP state is switched "off" after the configured time and the port becomes active.

Backup link

The Backup-link has the same activation logic as LSP; however, in this case, data is not dropped, but switched to a "Backup-link port". This allows to activate a LAN port when link synchronization is down, or link capacity drops below a defined threshold while keeping the LAN port disabled during normal operation. This allows Integra-E/E2/E3 to carry traffic during normal conditions and reroute the traffic flow to a backup link when configured trigger conditions are met. See the example in *Figure 5-9*.
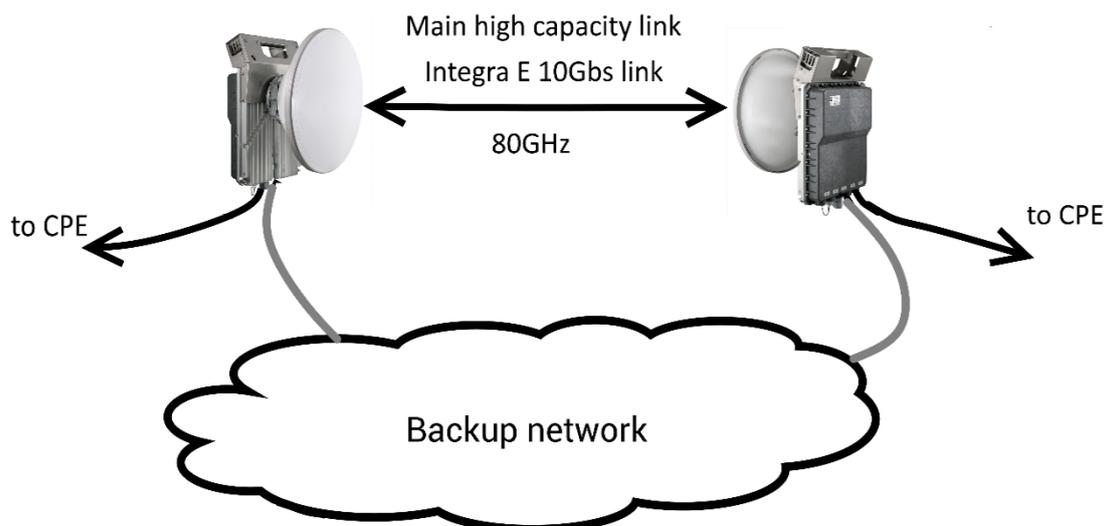
Figure 5-9 Integra-E/E2/E3 with Backup-link

In case of main link failure, traffic is switched to configured backup ports. There could be backup through the IP network or the possibility to use another radio link with a lower frequency and better resilience to attenuation caused by precipitation. Please see *Figure 5-10* where the backup is realized by an unlicensed SAF microwave, for example, Integra-GS 24GHz unlicensed link. If the main link fails, then data will be switched to the 24GHz link. When the backup link is activated, the MAC table is cleaned, and WAN discards traffic. Remote side management is available through the backup link.
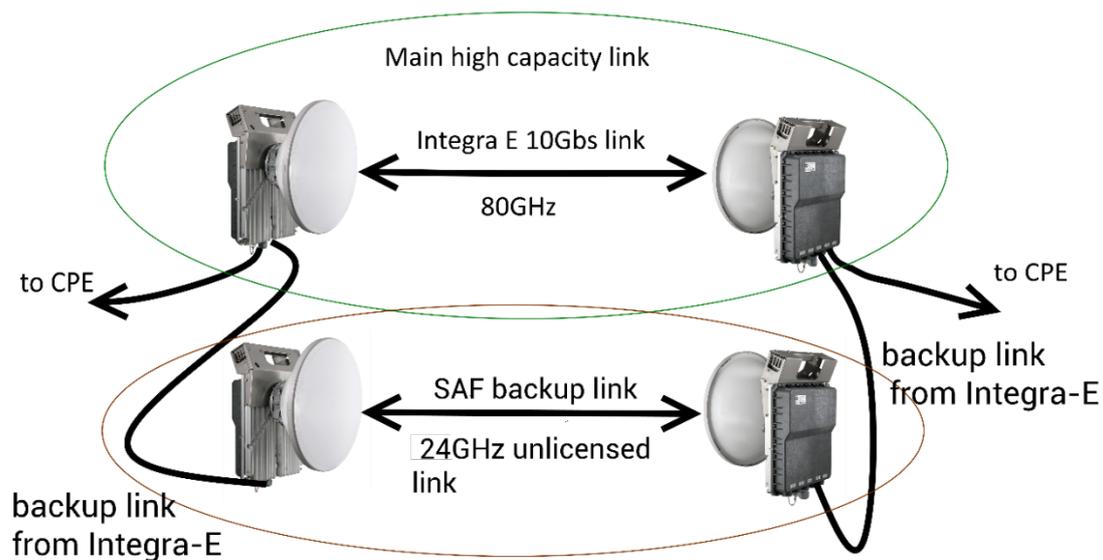
Figure 5-10 Backup through an unlicensed link

Inverse Backup

The Inverse Backup logic is very similar to Backup-link mode, but the main difference is that Main data link and Backup link are reversed. See the example below in *Figure 5-11*:
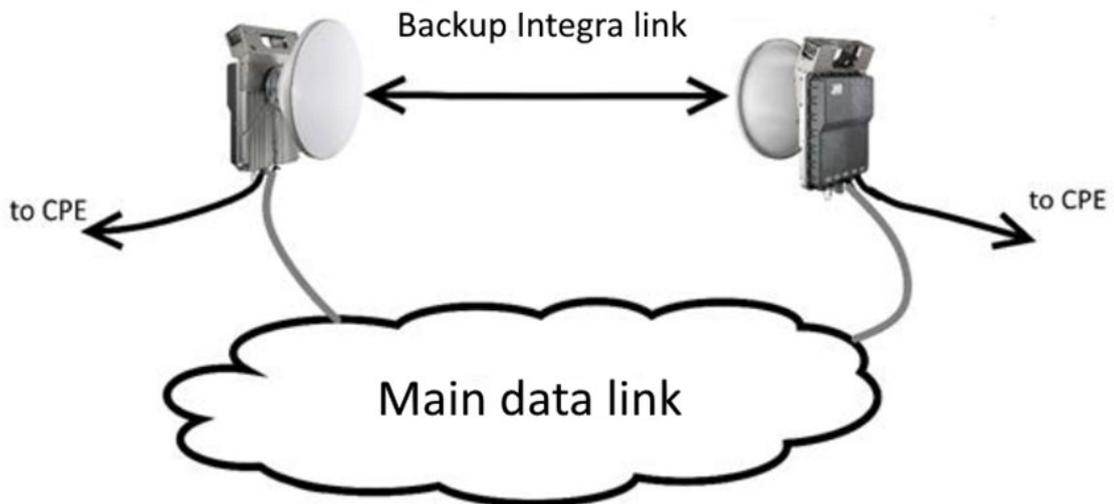
Figure 5-11 Backup Integra-E link with Main data link

> ⚠ The terminology used for the Inverse Backup state on the WEB GUI page remains the same as for the Backup-link state. Refer to *Networking → Ethernet → Link State Propagation and Backup* section for the description of the corresponding WEB GUI page.

During normal operation, traffic on the backup Integra-E/E2/E3 is switched to the configured Backup-link port, which should be connected to the Main data link, but the WAN (on the Backup Integra link) discards traffic.

During the connection failure on the configured Backup-link LAN port, traffic is switched to the Backup Integra link WAN port, and the Main data link becomes completely isolated, meaning that management access to the Main data link equipment will be unavailable via Backup-link LAN port. It is important that equipment on the Main data link is capable of disabling the LAN port connected to the backup Integra-E/E2/E3 if the Main data link fails, otherwise switchover to the Backup Integra link will not take effect.

Link state propagation Advanced

LSP Advanced functionality provides the ability to separately configure WAN status trigger conditions and timers for each LSP port. This means that ACM switching to some modulation ensuring a particular WAN speed may trigger the disabling of one LSP port and the enabling of another. Each port separately monitors WAN condition and has its own min/max Ethernet capacity thresholds.

"WAN Trigger" condition activation (True state) – triggers the corresponding port to switch off.

"WAN Trigger" condition is responsible for monitoring the status of the WAN link and provides information about whether the LSP port must be switched to "DOWN" or "UP" state. "WAN Trigger" allows to specify the WAN capacity range (0 – 10000 Mbps, the value "0" means that LSP Advanced is triggered in case of synchronization loss) within which a trigger must be enabled or disabled. The "WAN Trigger" logic has direct and inversed modes of operation: "Normal" and "Inverse", where "Normal" mode activates the trigger when the capacity is outside of the configured range, and "Inverse" activates the trigger when the capacity is within the configured range.

LSP port switching action after the "WAN Trigger" action can be delayed by using the "Timer on Activation" and "Timer on Deactivation". The "Timer on Activation" provides a time delay

after the "WAN Trigger" switches from "False" to "True" state before the LSP port switches to "DOWN" state. The "Timer on Deactivation" provides a time delay after "WAN Trigger" switches from "True" to "False" state before the LSP port switches to "UP" state. See the "WAN Trigger" and timer logic in *Figure 5-12*.
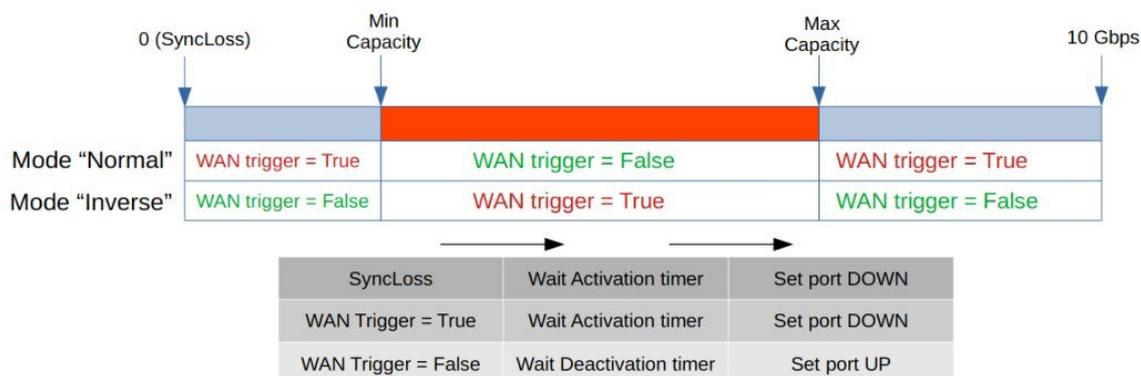
Figure 5-12 LSP Advanced "WAN Trigger" logic

Adaptive equalizer

The Integra-E/E2/E3 features an adaptive equalizer, which is a filter that automatically adapts to time-varying properties of a communication channel with selective fading, having a target to compensate the inequalities in frequency response, mitigating the effects of multipath propagation. In wireless telecommunications, using QAM modulation this filter equalizes not only a separate quadrature channel, but provides cancellation of cross-interference between them.

In the Integra-E, the adaptive equalizer is realized as a complex-arithmetic 40-taps digital FIR (Finite Impulse Response) filter. In other words, the equalizer is a selective frequency amplifier and attenuator, a device, which in application to IF (Intermediate Frequency) band-limited signal is schematically shown in the picture below:
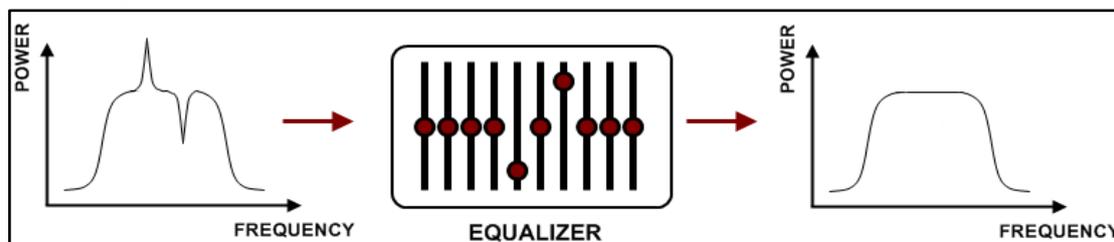
Figure 5-13 Adaptive equalizer

FTP directory

The FTP directory of the Integra-E/E2/E3 can be used in combination with CLI commands to backup/restore system configuration, upload another FW version, and upload a new license file.

The FTP directory is a separated area of internal memory in Integra-E/E2/E3.

The FTP directory function is deactivated by every restart of the Integra-E/E2/E3 and all files from this special area are wiped out.

1) Use the CLI command **system service ftp enable** to activate FTP directory function.
2) After the system service ftp is enabled, it is possible to connect to the Integra-E/E2/E3 by using your favorite FTP client. The username is **anonymous**, and the password is empty.

Here is an example of an FTP connection to an Integra-E/E2/E3 using FileZilla:
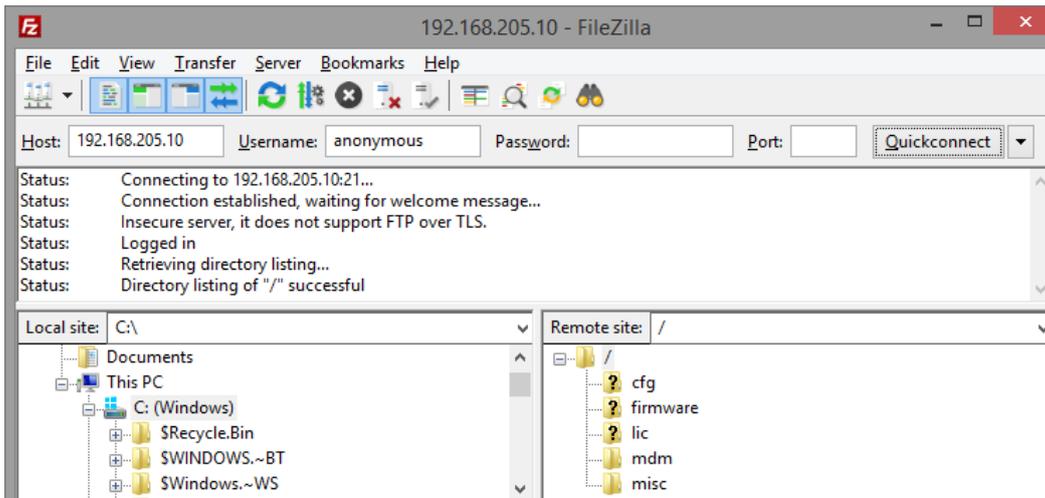
Figure 5-14 FileZilla connected to Integra-E/E2/E3 FTP

The FTP area has several sub-directories separating every sub-function:

cfg	For uploading configuration files. For more information see Chapter *System → Configuration → Configuration file*.
firmware	For uploading firmware files. For more information see Chapter *System → FW → Firmware upgrade*.
lic	For uploading license files. For more information see Chapter *System → Tools → License management*.
mdm	For service use only.
misc	For service use only.

⚠ After finishing your work with the FTP directory, deactivate it by the CLI command **system service ftp disable**.

Firmware upgrade management with SNMP

The firmware upgrade procedure can be performed using a set of SNMP read/write variables. This allows optimizing the process for a large number of radio units in a network.

The following steps describe the whole process.

1) Enable the FTP server by setting (SNMP SET command) **integraEsysServicesFtpSwitch** variable to "2".
2) Check if the FTP server is enabled by reading (SNMP GET command) the following variable: **integraEsysServicesFtpSwitch**.
3) Transfer the required firmware file ("bin" file inside the FW package archive) to the "firmware" folder in the FTP directory (for more information, refer to Chapter *FTP directory*). Use the following FTP address: *ftp://anonymous@DEVICE_IP:/firmware/* (where *DEVICE_IP* should be substituted with the IP address of Integra-E/E2/E3).
4) Initiate the upload of the transferred firmware file by setting **integraEsysServicesFwUpload** variable to "1". Only a single firmware file is allowed to be present in the "firmware" folder during the upload. Please note that the command execution usually takes up to 30 seconds, and SNMP read/write requests will return the timeout error during this time. In about 30 seconds, the newly uploaded firmware should be seen in **integraEsysServicesFwAvailView** list (see the next step) and available for installation.

5) View information about the firmware versions already available for installation by reading **integraEsysServicesFwAvailView** variable: you will get a string containing index numbers and names of all firmware versions available for installation (n1: candfw1; n2: candfw2; etc.).

6) As the memory allocated for the firmware files is limited, the upload can fail if there are several firmware versions already uploaded (a maximum of 5 files are permitted). The unnecessary items can be removed with **integraEsysServicesFwRemove** variable (setting to "n", where "n" is the index number of selected firmware file from **integraEsysServicesFwAvailView** list). All items can be removed by setting **integraEsysServicesFwRemoveAll** variable to "1".

7) Install the required candidate firmware by setting **integraEsysServicesFwInst** variable to "n", where "n" is the index number of the selected firmware file from **integraEsysServicesFwAvailView** list. Please note that the installation execution usually takes up to 30 seconds, and SNMP read/write requests will return the timeout error during this time.

8) In about 30 seconds, initiate system reboot by setting **integraEsysServicesReboot** to "1".

9) After the system reboots, check the current FW version by reading **integraEsysServicesFwCurrInfo** variable.

10) As additional functionality, a user can switch between two firmware banks (fw1 and fw2) using **integraEsysServicesFwSwitchNext** variable (setting to "1/2" for fw1/fw2 bank accordingly). This will change the firmware bank that will be used during the next startup. The currently used firmware bank can be viewed by reading **integraEsysServicesFwSwitchRunning** variable. The firmware bank selected for the next startup can be checked by reading **integraEsysServicesFwSwitchNext** variable. Please note that when the firmware is installed it is assigned to a vacant bank (not occupied by the previously running firmware); this bank will be selected for the next startup automatically.

The description of the relevant OIDs is given in the table below:

integraEsysServicesReboot (.1.3.6.1.4.1.7571.100.1.1.7.9.4.39.1)	WRITE	Set "1" to initiate a system reboot.
integraEsysServicesFtpSwitch (.1.3.6.1.4.1.7571.100.1.1.7.9.4.39.2)	READ-WRITE	Status and on/off switch for the FTP server (set "1/2" to disable/enable).
integraEsysServicesFwCurrInfo (.1.3.6.1.4.1.7571.100.1.1.7.9.4.39.3)	READ-ONLY	Currently running FW information.
integraEsysServicesFwAvailView (.1.3.6.1.4.1.7571.100.1.1.7.9.4.39.4)	READ-ONLY	List of the uploaded FW files available for installation.
integraEsysServicesFwRemove (.1.3.6.1.4.1.7571.100.1.1.7.9.4.39.5)	WRITE	Set "n" to remove the n-th FW file from the uploaded FW list.
integraEsysServicesFwRemoveAll (.1.3.6.1.4.1.7571.100.1.1.7.9.4.39.6)	WRITE	Set "1" to remove all FW files from the uploaded FW list.
integraEsysServicesFwUpload (.1.3.6.1.4.1.7571.100.1.1.7.9.4.39.7)	WRITE	Set "1" to start the upload and make the FW available for installation.
integraEsysServicesFwInst (.1.3.6.1.4.1.7571.100.1.1.7.9.4.39.8)	WRITE	Set "n" to install the n-th FW file from the uploaded FW list.
integraEsysServicesFwSwitchRunning (.1.3.6.1.4.1.7571.100.1.1.7.9.4.39.9)	READ-ONLY	Currently running FW bank.
integraEsysServicesFwSwitchNext (.1.3.6.1.4.1.7571.100.1.1.7.9.4.39.10)	READ-WRITE	The next startup FW bank (set "1/2" to change the FW bank for the next startup)

RADIUS authentication

Configuration of the RADIUS server authentication

Always check your RADIUS server documentation before modifying the RADIUS configuration.

RADIUS vendor ID for Integra equipment is **7571**.

The configuration of the FreeRADIUS software based on the Linux system (Ubuntu) is given below as an example. Keep in mind that there could be differences in command syntax and file locations between FreeRADIUS software versions, always check the FreeRADIUS documentation.

1) Add new user data to the users` configuration file: */etc/freeradius/users.* Add the following line to the users` list:

> *user_1 Cleartext-Password := "pass_1"*

where user_1 is a user name and pass_1 is a password.

```
# This is a complete entry for "steve". Note that there is no Fall-Through
# entry so that no DEFAULT entry will be used, and the user will NOT
# get any attributes in addition to the ones listed here.


user_1   Cleartext-Password := "pass_1"


#
#steve   Cleartext-Password := "testing"
```
<p align="center">Figure 5-15 Configuration example in FreeRADIUS software (1)</p>

2) Add client (Integra) data by editing the clients` configuration file: /etc/freeradius/clients.conf. Add the following lines specifying Integra IP address and the RADIUS secret:

> *client 192.168.205.10 {*
>
> *secret = radiuspass_1*
>
> *}*

where *192.168.205.10* is the IP address of Integra, *radiuspass_1* is the RADIUS secret word.

```
#   the "ipaddr" or "ipv6addr" fields.  For compatibility, the 1.x
#   format is still accepted.
#

client 192.168.205.10 {
secret = radiuspass_1
}
```
<p align="center">Figure 5-16 Configuration example in FreeRADIUS software (2)</p>

3) Restart FreeRADIUS.
4) Set up the RADIUS configuration in Integra Web GUI:
    a. Open the RADIUS server configuration page (*System → Configuration → System services*).
    b. Configure the RADIUS port, RADIUS server IP address, and RADIUS secret parameters according to your setup.

⚠ RADIUS server should belong to the same subnet as Integra and should have the same secret word as Integra.

RADIUS server configuration

RADIUS	☑ Enable
RADIUS port	1812
RADIUS server IP address	192.168.205.1
Set RADIUS secret (<33 characters)	••••••••
Confirm RADIUS secret (<33 characters)	••••••••
Hide password ☑	

Reboot   Execute configuration

Figure 5-17 RADIUS server configuration in Integra WEB GUI

5) Execute a configuration, save the configuration changes and reboot Integra.
6) Log in to Integra using the secure HTTPS connection.
7) Proceed to assigning administrative rights to a user if needed, see next chapter *Assigning administrator rights to a RADIUS user*.

You can log in with users defined both locally and on the RADIUS server.

Assigning administrator rights to a RADIUS user

1) Add the corresponding attribute to the main FreeRADIUS dictionary file. Open the file: /etc/freeradius/dictionary and add the following line under the "Miscellaneous attributes…":

ATTRIBUTE   SAF-User-Level   52   string

```
#
#        If you want to add entries to the dictionary file,
#        which are NOT going to be placed in a RADIUS packet,
#        add them here.  The numbers you pick should be between
#        3000 and 4000.
#
ATTRIBUTE        SAF-User-Level        52        string
#ATTRIBUTE        My-Local-String      3000      string
#ATTRIBUTE        My-Local-IPAddr      3001      ipaddr
#ATTRIBUTE        My-Local-Integer     3002      integer
~
```

Figure 5-18 Configuration example in FreeRADIUS software (3)

2) For providing the specified attribute to the user that must be granted administrator rights open the users` configuration file: /etc/freeradius/users and insert the following line below the definition of the user name and password:

SAF-User-Level = admin

For example:

user_1   Cleartext-Password := "pass_1"

SAF-User-Level = admin

```
# This is a complete entry for "steve". Note that there is no Fall-Through
# entry so that no DEFAULT entry will be used, and the user will NOT
# get any attributes in addition to the ones listed here.


user_1  Cleartext-Password := "pass_1"
        SAF-User-Level = admin

#
#steve  Cleartext-Password := "testing"
```

Figure 5-19 Configuration example in FreeRADIUS software (4)

3) Restart FreeRADIUS.
4) Log   in   to   Integra   using   the   secure   HTTPS   connection.

Chapter 6 : APPLICATION EXAMPLES

1+0 configuration

With a basic 1+0 configuration, it is possible to reach speeds up to 10Gbps. Please refer to *Powering Integra-E/E2/E3 FODU and connecting to PC* to see the possible powering options.
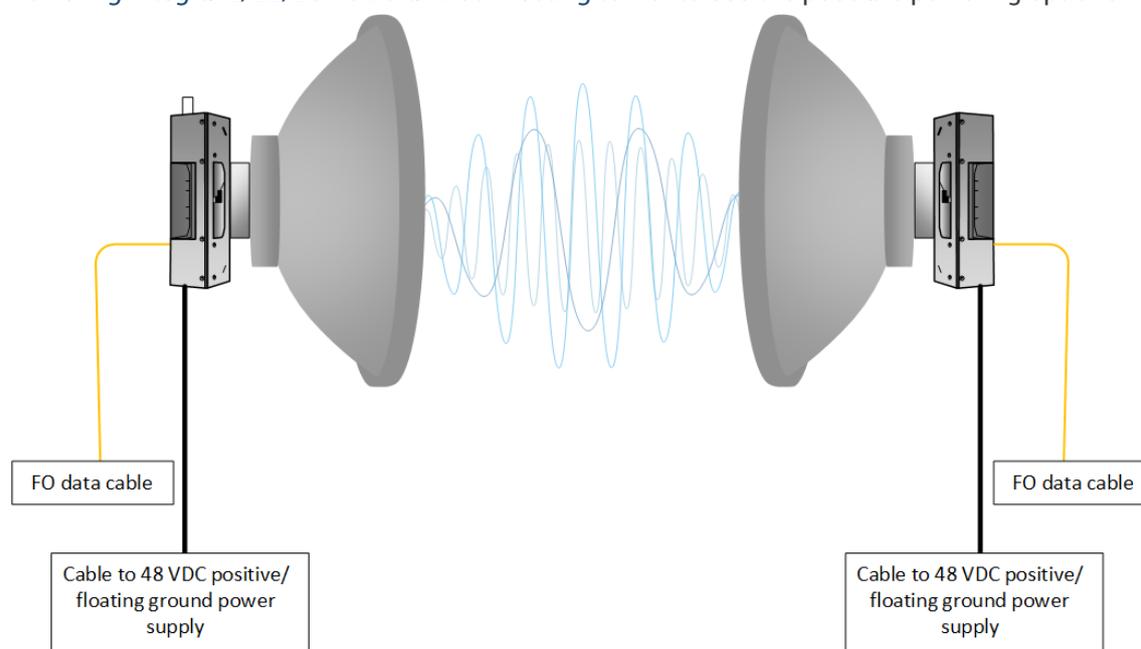
Figure 6-1 1+0 configuration using 48VDC power supply

East/West (repeater) configuration

There are two different possibilities to use Integra-E/E2/E3 as repeaters:

- Use Integra-E/E2/E3 radios with 48 VDC power supply and a FO cable interconnection to reach speeds up to 10Gbps (*Figure 6-2*).
- Use Integra-E/E2/E3 radios with PoE injectors as a power source and data interconnection between PoE injectors, but there will be a limitation to only reach speeds up to 1Gbps as electrical Ethernet interface only supports Gigabit Ethernet (*Figure 6-3*).
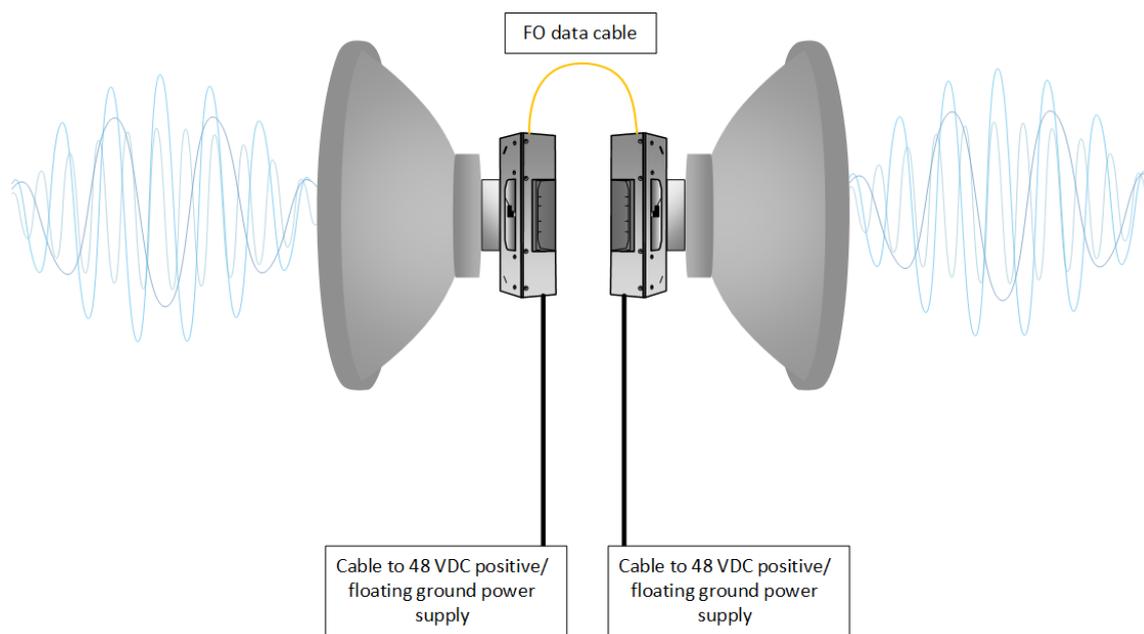
Figure 6-2 East/West (repeater) configuration using 48VDC power supply
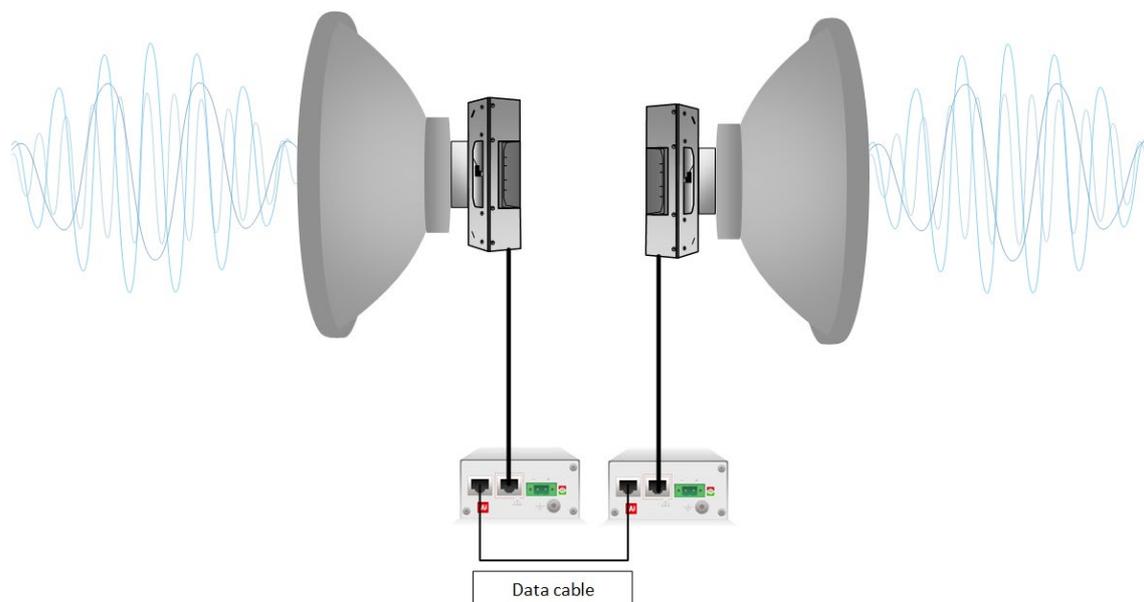
Figure 6-3 East/West (repeater) configuration using PoE injector

2+0 aggregation configuration

2+0 aggregation is possible for Integra-E/E2/E3 radio by using two interconnected links between which traffic will be distributed equally. Please refer to *Aggregation/protection configuration* for more information.

Necessary equipment

1) 4 Integra-E/E2/E3 – 2 low side, 2 high side.
2) 2 or 4 SFP modules and appropriate FO cables (multi-mode or single mode) for Integra interconnection and management/user traffic (depending on chosen interconnection scheme).
3) Electrical or optical Ethernet cables for management/user traffic (depending on chosen interconnection scheme).

2+0 aggregation without power protection configuration

There are two possible interconnection schemes:

- Scheme #1

1. Optical cable between the LAN2 (optical) ports on both units. Mandatory in all schemes.

2. Electrical Ethernet cable (1000Base-T) between PoE injector's (#1) DATA+PWR port and LAN1 (electrical) port of Secondary Integra-E/E2/E3 FODU. Both data and power are carried, therefore total length of cables #2, #3 and #4 combined should not exceed 100m.

3. Electrical Ethernet cable (1000Base-T) between PoE injector's (#2) DATA+PWR port and LAN1 (electrical) port of Primary Integra-E/E2/E3 FODU. Both data and power are carried, therefore total length of cables #2, #3 and #4 combined should not exceed 100m.

4. Electrical Ethernet cable (1000Base-T) between PoE injectors' (#1 and #2) DATA ports. Provides management access to Secondary Integra-E/E2/E3 FODU. The total length of cables #2, #3, and #4 combined should not exceed 100m.

5. Optical fiber cable between LAN3 (optical) port of Primary or Secondary Integra-E/E2/E3 FODU and CPE for both traffic and management traffic.

Figure 6-4 2+0 aggregation without power protection

The length of optical cable for traffic/management can be up to 10km.

- Scheme #2

1. Optical cable between the LAN2 (optical) ports on both units. Mandatory in all schemes.

2. Electrical Ethernet cable (1000Base-T) between LAN1 (optical) ports on both units. Provides management access to Secondary Integra-E/E2/E3 FODU. The total length of the cable should not exceed 100m.

3. Optical cable between LAN3 (optical) port on Primary Integra-E/E2/E3 FODU and CPE for data and management traffic.

Figure 6-5 2+0 aggregation without power protection

For powering both Primary and Secondary Integra-E/E2/E3 FODU use 2-wire power cable with DC power adapter (P/N D0ACPW01).

2+0 aggregation with power protection configuration

⚠️ On both sides "Primary" and "Secondary" Ethernet traffic ports must be interconnected via an external switch (in addition to LAN2 interconnection) for protection to work. This connection is used to interchange 2+0 protection statuses for proper operation.
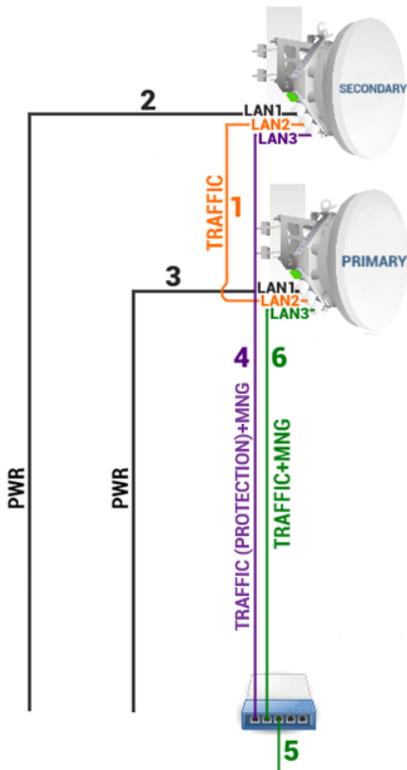
Figure 6-6 2+0 aggregation with power protection

1. Optical cable between the LAN2 (optical) ports on both units.

2. Cable for powering Secondary Integra-E/E2/E3 FODU. You can use 2-wire power cable with DC power adapter (P/N D0ACPW01) or standard Ethernet cable with PoE injector. Depending on power consumption cable length can be extended up to 700m. Refer to chapter *RJ-45 port* for details.

3. Cable for powering Primary Integra-E/E2/E3 FODU. You can use 2-wire power cable with DC power adapter (P/N D0ACPW01) or standard Ethernet cable with PoE injector. Depending on power consumption cable length can be extended up to 700m. Refer to chapter *RJ-45 port* for details.

4. Optical cable between the LAN3 (optical) port of the Secondary Integra-E/E2/E3 FODU and external switch. Provides data protection in case of failure of the Primary Integra-E/E2/E3 FODU and management access to Secondary Integra-E/E2/E3 FODU.

5. Electrical Ethernet cable (1000Base-T) between the external switch and CPE for both traffic and management traffic.

6. Optical cable between the LAN3 (optical) port of Primary Integra-E/E2/E3 FODU and external switch for both data and management traffic.

2+0 external aggregation configuration

Another option to aggregation two Integra-E/E2/E3 is by using external network equipment as shown in *Figure 6-7*. For more information please refer to page 16 of the *"Link aggregation/bonding and load balancing with SAF products"* whitepaper.
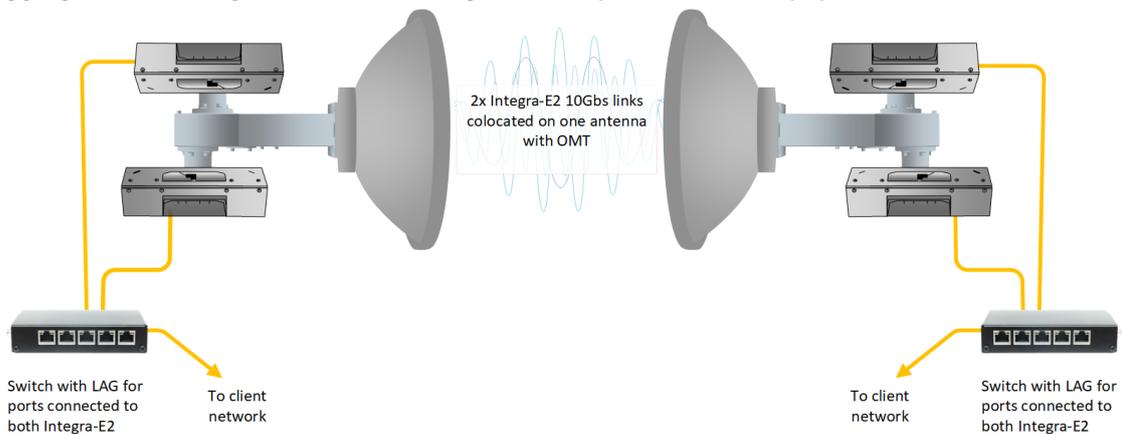
Figure 6-7 2+0 aggregation using external devices

Dual-band configuration

Two possible dual-band link configurations are possible using Integra-E/E2/E3 and lower frequency microwave radios:

- With Integra-E/E2/E3 and other microwave radio (e.g., Integra-X) links in aggregation mode supported by a 3rd party high-capacity external Ethernet switch (preferred configuration). Maximum capacity can reach up to 12.2 Gbps - *Figure 6-8*.
- Configuring Integra-E/E2/E3 as the main link and utilizing built-in LSP/Backup functionality provides MW backup redundancy. When the Integra-E/E2/E3 link capacity decreases below the pre-configured threshold, or sync loss occurs, LSP/Backup will switch traffic to the microwave radio (e.g., Integra-X) link. Maximum capacity will be limited to 10 Gbps in LSP/Backup mode and traffic will pass through one link at any time point. The external switch is not required in this configuration - *Figure 6-9*. For functional description refer to the Chapter *Backup link*.

For more detailed information about the dual-band solution please refer to our blog post - *Meet SAF's 10+ Gbps Dual Band Solution for 5G*.
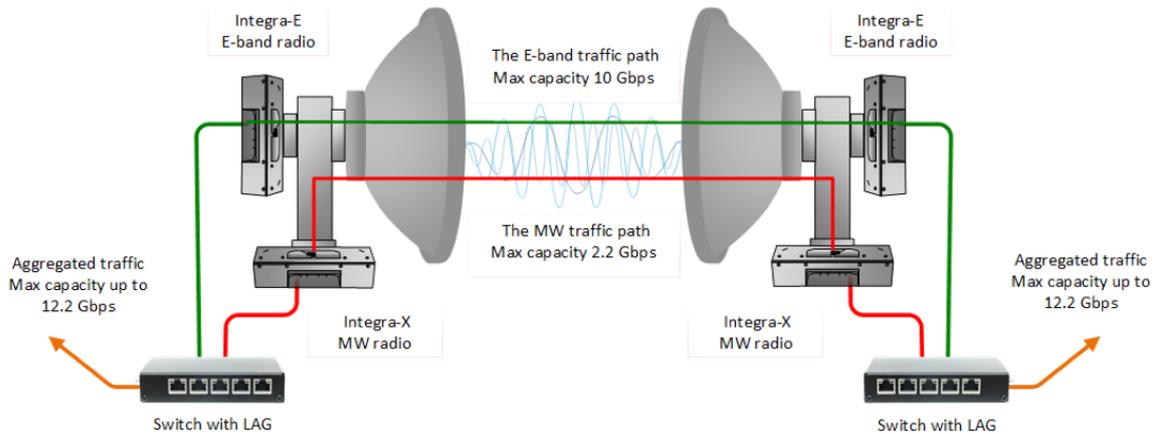
Figure 6-8 Dual-band solution in aggregation mode
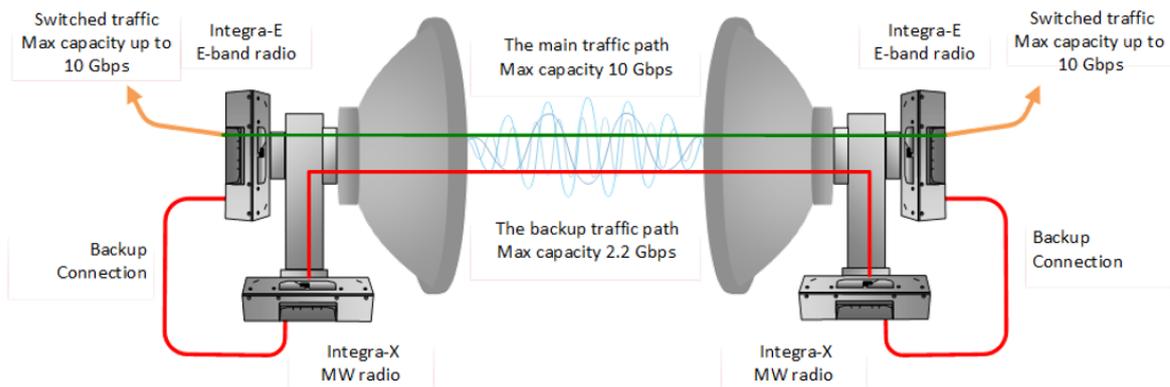
Figure 6-9 Dual-band solution in Protection (backup) mode

Chapter 7 : TOOLS

Link Layer Discovery tool

The Link Layer Discovery Tool is a command-line application for MS Windows. It sends requests to an LLD server application that runs on all Integra series devices. The tool is used to discover Integra-E/E2/E3 devices and reset their passwords or settings.

The application runs on the following versions of Windows: Windows Vista, Windows7, Windows 8 and Windows 10.

WinPCAP must be installed to use the Link Layer Discovery Tool.

The Link Layer Discovery Tool for Integra series can be downloaded from *https://saftehnika.com/en/downloads* in the "Tools" section. Login required.

1) Unzip the LLD.zip file you downloaded to a directory of your choice, for example, C:\SAF\LLD\.
2) The application is started via the command prompt (Start menu→Run→type "cmd"→press ENTER). Command line console window should appear, see *Figure 7-1*.
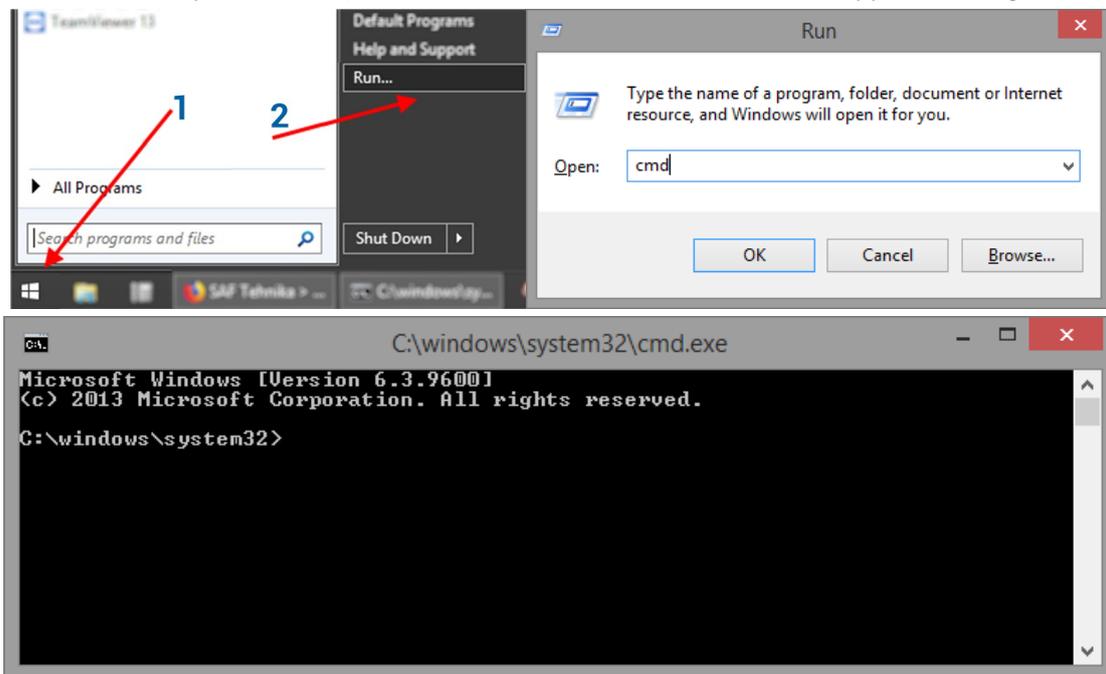
Figure 7-1 Windows CMD console

3) The default directory in the console is the current user directory. To change it, type:
cd <directory path>
For example: *cd c:\saf\lld*
4) Run the recovery tool by typing "lld" without quotes in the console prompt and press ENTER.

Figure 7-2 LLD command output

5) Available commands and network adapter list should be shown. To scan for Integra devices, the command should be run as follows:

> lld *<network interface>*

For example:

> lld *\DEVICE\NPF_{A67EA6B7-1686-4E98-BA19-2A7E5B205DCF}*

To copy the interface address from the network adapter list, click the right mouse button over the console and select "Mark":

Figure 7-3 LLD output – network adapter list

Then by holding the left button selects the interface address:
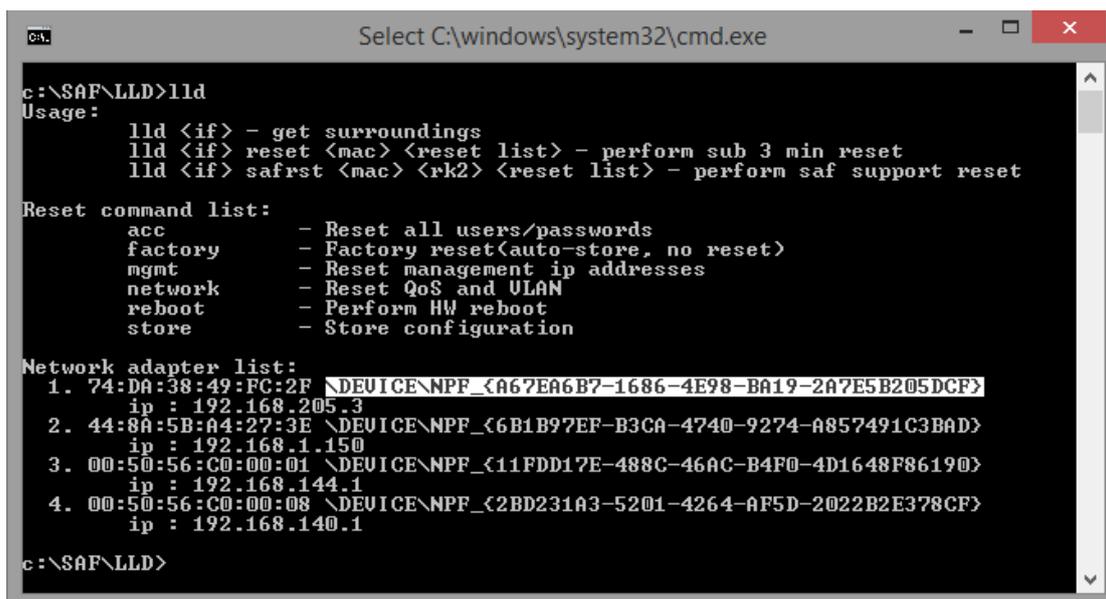
Figure 7-4 Selecting interface address

After selecting, release the left button and click the mouse right button anywhere on the console. The address should be copied.

Type "lld " and paste the address by clicking the right button anywhere on the console:
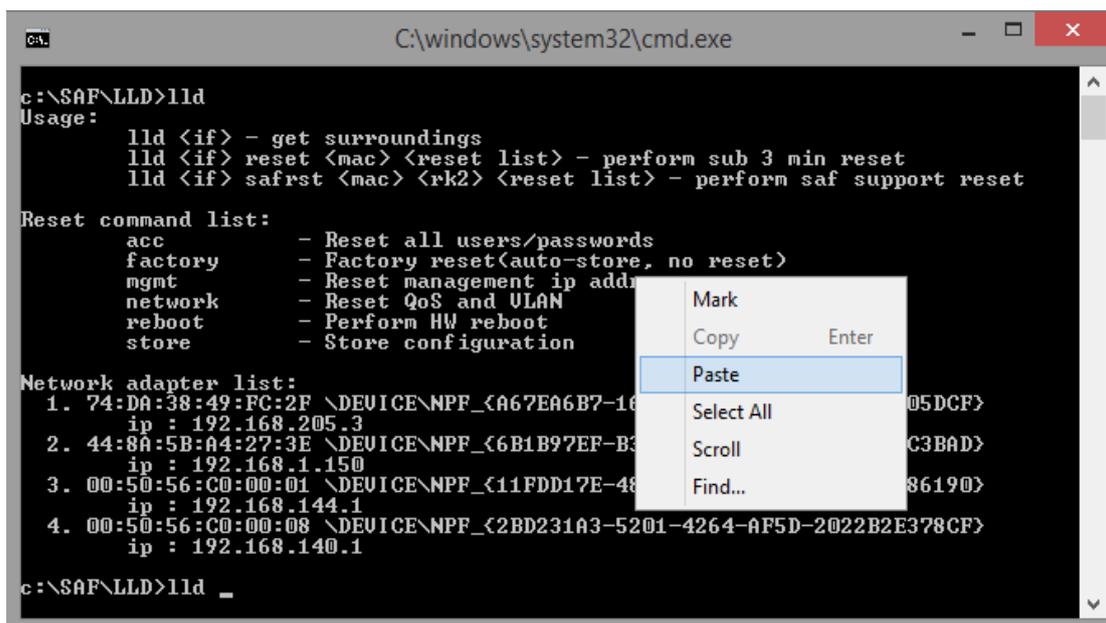
Figure 7-5 Pasting interface address

The result should be similar to the image below:

Figure 7-6 LLD command example

6) Press ENTER and the recovery tool will now scan for Integra devices. Available devices and their information will appear in the console. Make sure that the device has finished booting up.

Figure 7-7 Found Integra device

7) Use the MAC address of the device with the reset command to reset this specific device. The MAC address can be copied the same way as the interface address.

Figure 7-8 Integra device MAC address

8) The device is reset by using the required reset command with the recovery tool:

lld *<interface> reset <MAC> <reset command>*

where:

<interface> – network interface from the network adapter list;

<MAC> – required Integra device address;

<reset command> – reset options.

Different reset options are available depending on the reset requirement. Reboot and storage options are also available. Store option saves the device's current configuration so it will be restored after a system reboot. The commands are available in the reset command list. Use the command after the MAC address of the device as shown in the previous reset command example.

```
Reset command list:
        acc             - Reset all users/passwords
        factory         - Factory reset(auto-store, no reset)
        mgmt            - Reset management ip addresses
        network         - Reset QoS and VLAN
        reboot          - Perform HW reboot
        store           - Store configuration
```

Figure 7-9 Reset command list

For example, to reset users and passwords on Integra device #1, use:

lld *\DEVICE\NPF_{A67EA6B7-1686-4E98-BA19-2A7E5B205DCF} reset 0004A6813773 acc*

> ⚠ Make sure the command is run within 3 minutes after Integra reboot ("RK1 fresh" must be "true" in the console), otherwise the error shown in the screenshot below will occur. The recovery tool will continue to retry the command. In such a situation, the device needs to be rebooted to execute the reset command successfully again.
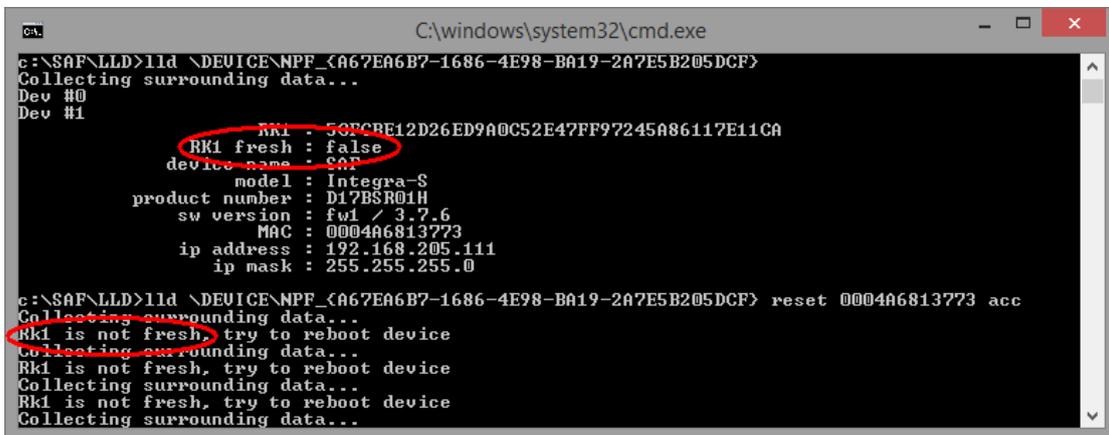
```
c:\SAF\LLD>lld \DEVICE\NPF_{A67EA6B7-1686-4E98-BA19-2A7E5B205DCF}
Collecting surrounding data...
Dev #0
Dev #1
                    RK1     5CFCBE12D26ED9A0C52E47FF97245A86117E11CA
        RK1 fresh : false
        device name : SAF
        model : Integra-S
        product number : D17BSR01H
        sw version : fw1 / 3.7.6
        MAC : 0004A6813773
        ip address : 192.168.205.111
        ip mask : 255.255.255.0
c:\SAF\LLD>lld \DEVICE\NPF_{A67EA6B7-1686-4E98-BA19-2A7E5B205DCF} reset 0004A6813773 acc
Collecting surrounding data...
Rk1 is not fresh, try to reboot device
Collecting surrounding data...
Rk1 is not fresh, try to reboot device
Collecting surrounding data...
Rk1 is not fresh, try to reboot device
Collecting surrounding data...
```

Figure 7-10 LLD command response over 3 min after Integra reboot

Power down the Integra device and power it up again, the reset should be completed soon.

Figure 7-11 LLD command response less than 3 min after Integra reboot

If the reset cannot be completed, redo step 8).

9) Store changes by the command (must be done within the time frame of 3 minutes after bootup) or by using the WEB GUI (any time before the Integra device is powered off) "SAVE" button.

For example,
lld *\DEVICE\NPF_{A67EA6B7-1686-4E98-BA19-2A7E5B205DCF} reset 0004A6813773 store*

Figure 7-12 Successful LLD command output

MIB files

⚠️ Relevant MIB files can be downloaded directly from the Integra-E/E2/E3 Web GUI. See Chapter System → *Configuration* → *SNMP configuration* for further details.

Chapter 8 : INTERFACES

RJ-45 port

The RJ-45 port, see *Figure 8-1*, complies with IEEE 802.3-2005 1000Base-T, 100Base-T, 10Base-T Ethernet, IEEE 802.3 and LTPoE++ Power over Ethernet standards.

Figure 8-1 RJ-45 port

The pinouts of the socket are displayed in *Table 8-1 RJ-45 socket pinout*:

Table 8-1 RJ-45 socket pinout
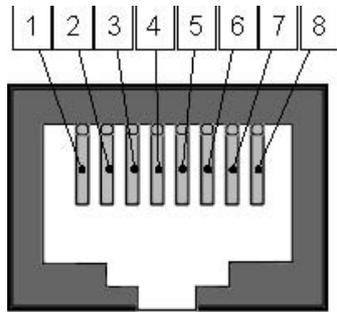
Pin	Data	PoE
1	Bi-directional A+	VB1+
2	Bi-directional A-	VB1+
3	Bi-directional B+	VB1-
4	Bi-directional C+	VB2+
5	Bi-directional C-	VB2+
6	Bi-directional B-	VB1-
7	Bi-directional D+	VB2-
8	Bi-directional D-	VB2-

If Ethernet cable is used for power & data (with PoE injector P/N I0ATPI43), the combined Ethernet cable length from the PoE injector P/N I0ATPI43 to Integra-E/E2/E3 FODU and from PoE injector P/N I0ATPI43 to a CPE is limited to 100m/328ft. It is recommended to use good quality outdoor rated STP/FTP Ethernet cable Cat 5e or better from reputable manufacturers.

Please refer to *Table 8-2* for the maximum Ethernet cable length for power only from the PoE injector P/N I0ATPI43 to the Integra-E/E2/E3 FODU based on AWG wire size and the Integra-E/E2/E3 FODU power consumption.

Table 8-2

AWG	Lmax @ 50W
26	193m / 635ft
24	307m / 1009ft
22	489m / 1605ft

⚠️ Maximum cable length calculation is done using copper resistance.

2-wire DC power port

It is possible to power up the Integra-E/E2/E3 using a screw-type terminal block, pluggable, 2-pin, centerline 5.08mm/0.2-inch port. See *Figure 8-2.*

Figure 8-2 DC power port

This port can be used together with a PoE as a redundant power solution (existing 48V source or SAF power supply) or as the only power source for the Integra-E/E2/E3 FODU.

The polarity should be obeyed as per the indication in *Figure 8-2*. Reversed polarity will result in the radio not being able to power up, but no permanent damage will be caused.

Refer to *Table 8-3* below for maximum power cable length based on AWG wire size or cross-section area and Integra-E/E2/E3 FODU power consumption. PSU voltage in calculations is 54V, copper resistance at 20°C/68°F. Please take into account that power derived from PSU is the sum of Integra-E/E2/E3 consumed power, losses on cables and PoE injector consumption.

Table 8-3

AWG	Lmax @ 50W
24	77m / 252ft
22	122m / 401ft
20	197m / 648ft
18	308m / 1013ft
16	493m / 1620ft
14	790m / 2592ft
Cross-section area	**Lmax @ 50W**
$0.25mm^2$	96m / 316ft
$0.5mm^2$	193m / 632ft
$0.75mm^2$	289m / 949ft
$1.0mm^2$	377m / 1236ft
$1.5mm^2$	563m / 1848ft

SFP ports

SFP ports provide SFP transceiver connectivity.

Both SFP ports comply with the following Gigabit Ethernet standards:

SFP: 1000BASE-SX, 1000BASE-LX, 1000BASE-EX, 1000BASE-ZX; SFP+: 10GBASE-SR, 10GBASE-LR, 10GBASE-ER, 10GBASE-ZR.

> ⚠️ Inquire SAF representative about compatible SFP modules.
> In the case of third-party modules, inquire a SAF representative about the testing possibility.

Figure 8-3 SFP ports

USB port

The USB port provides serial terminal access to the CLI. The socket is B type.

Figure 8-4 USB-B port
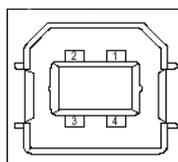
Figure 8-5 USB B socket pinout

RSSI LED

The RSSI LED can be activated in three operational modes – Mode 1, Mode 2 and Mode 3. By default, RSSI LED is enabled in Mode 1.

For further details please refer to the Chapter *Over The Air → Radio → Configuration.*

Figure 8-6 RSSI LED placement on FODU

Corresponding Rx signal levels and LED blinking pattern for each mode is represented in *Figure 8-7* below.
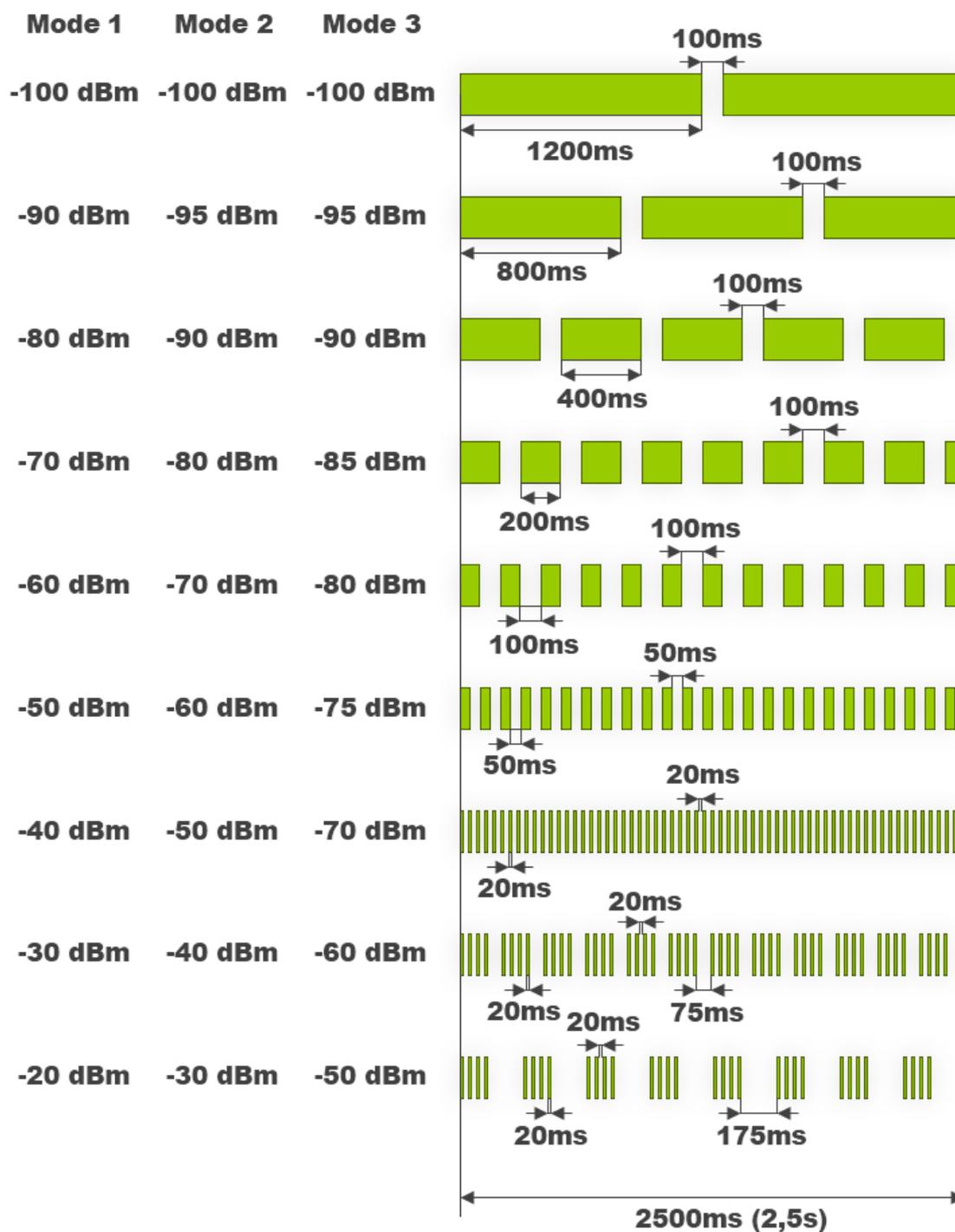
Figure 8-7 LED blinking pattern

RSSI/audio port

RSSI (Received Signal Strength Indicator) port is used during the antenna alignment for the instant reading of the Rx level. It has the best performance for both rough and fine adjustment. Measurements can be done using a digital multimeter or headphones connected to the RSSI port. The RSSI port is a 3.5mm socket (audio headphone socket). The output of the RSSI port is DC voltage or an audio frequency.

Table 8-4 RSSI output voltage shows the typical relationship of the received signal level (Rx level) displayed by the Integra-E/E2/E3 vs the RSSI port output voltage (RSSI – Received Signal Strength Indicator).

shows the typical relationship of the received signal level (Rx level) displayed by the Integra-E/E2/E3 vs the RSSI port audio frequency (RSSI – Received Signal Strength Indicator).

> ⚠   Rx level accuracy is ±2 dB.

SAF recommends using RSSI port voltage rather than audio frequency.

Figure 8-8 RSSI/audio port

To connect a voltmeter you will require the appropriate RSSI cable (P/N D0ACRS01) shown in *Figure 8-9* which has a 3.5mm RSSI/audio jack with pinout shown in *Figure 8-10:*

Figure 8-9 RSSI cable P/N D0ACRS01
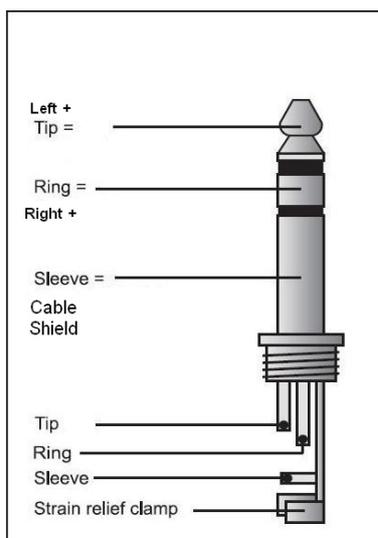
Figure 8-10 RSSI cable 3.5mm RSSI/audio jack pinout

Table 8-4 RSSI output voltage

Rx level (dBm)	RSSI voltage (V)
-90	0
-85	0.1
-80	0.2
-75	0.3
-70	0.4
-65	0.5
-60	0.6
-55	0.7
-50	0.8
-45	0.9
-40	1
-35	1.1
-30	1.2
-25	1.3
-20	1.4
-15	1.5
-10	1.6
-5	1.7
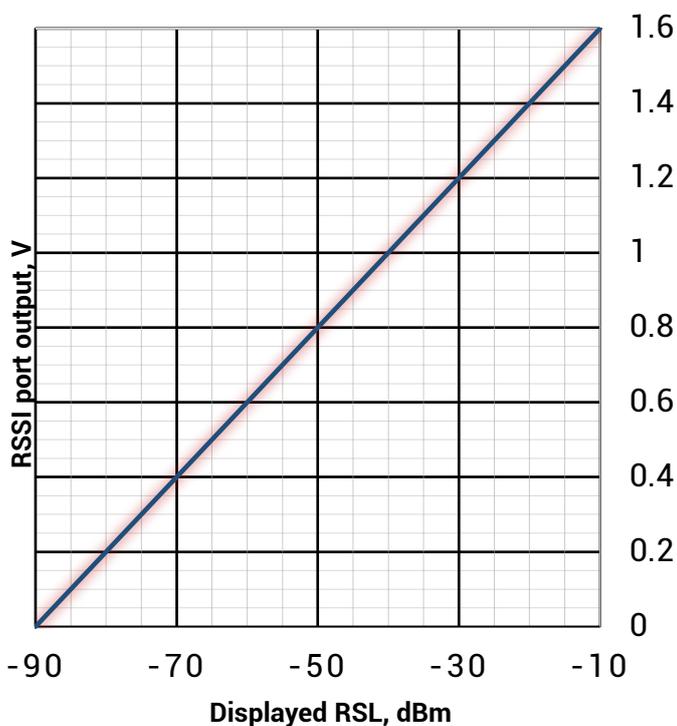
⚠ For RSL > -10dBm the RSSI curve is not linear.

Table 8-5 Audio frequency vs RSSI

Rx level (dBm)	Audio frequency (Hz)
-100	100
-96	145
-92	190
-88	235
-84	280
-80	325
-76	370
-72	415
-68	460
-64	505
-60	550
-56	595
-52	640
-48	685
-44	730
-40	775
-36	820
-32	865
-28	910
-24	955
-20	1000
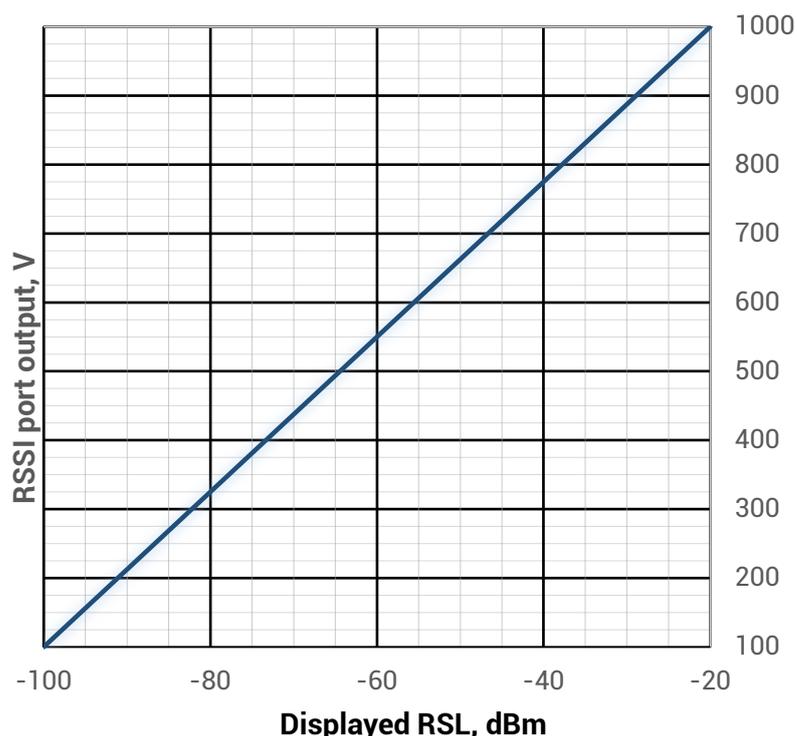
Grounding connection

Always provide a good connection from the FODU grounding screw to the tower/mast/building grounding circuit or body. You must choose one, the most convenient, of 2 screws for grounding connection. Please see *Figure 8-11*.

Figure 8-11 Grounding screws

Chapter 9 : Appendix A: Technical specifications

Integra-E/E2/E3

General	
Concept / form factor	FODU with direct-mount antenna
Frequency band	71 - 76 GHz paired with 81 - 86 GHz
Duplex spacing	10 GHz
Frequency stability	± 10 ppm
Capacity	Up to 10 Gbps at 2000 MHz 128QAM
Max modulation	256QAM/1024QAM (Integra-E/E2/E3)
Configurations	1+0
ATPC	Yes
ACMB	Adaptive Code Modulation and Bandwidth (ACMB), Hitless
Variable Tx w. ACMB	Yes
Channel bandwidth	62.5, 125, 250, 500, 1000 and 2000 MHz

Ports		
Ethernet	2 x SFP+	For Fiber Optics up to 10 Gbps (1, 2.5 and 10 Gbps speed supported)
	1 x RJ-45	Gigabit Ethernet electrical port with built-in PoE splitter and surge arrestor
Power	DC port	Screw type terminal block, pluggable, 2 pin, centerline 5.08mm / 0.2 inches
Service ports	3.5 mm	Audible alignment and RSSI
	USB B	RS232 serial over USB B-Type
	LED	Power On, RSL
Antenna	SAF2	Circular waveguide flange Ø 3.18 mm

Ethernet	
Ethernet	Built-in Carrier Ethernet 10 Gigabit Switch
VLAN	802.1Q 4096 VLANs, QinQ (Provider Bridging), VLAN Rate
Synchronization	SyncE
Quality of service	8 level 802.1p, 64 level DSCP, CoS, MPLS-TP exp bit
Spanning Tree Prot.	802.1d-2004 RSTP*
Jumbo frames	Yes, 12288 bytes
Encryption	-
Protection	LSP (Link State propagation), Backup link switching
Management	SNMP v1/2c/3, SSH, Telnet, HTTPS, Serial, RADIUS, Network Time Protocol
	In-band Management over the same ETH port. Out-band

	Management is configurable using VLANS.
Performance monitoring	Performance graphs, constellation diagram, alarms, detailed counters
Electrical	
Power consumption	Up to 50 W
Voltage range	36…57 V DC
Temperature range	-33…+55 °C / -28…+130 °F

* Inquire SAF representative for more information

Mechanical specification

Mechanical & Environmental	
Stationary use	Conforms to ETSI EN 300 019 Class 4.1, IP66, NEMA 4X
Size	280 x 437 x 100 mm / 11.02" x 17.2" x 3.9"
Weight	6.5/7.1 kg / 14.3/15.7 lbs (Integra-E/E2/E3)
Mount	Mount on antenna
Antenna	External antenna, direct-mount with SAF2 adaptation

Tx Power Ranges for Integra-E

Modulation	Tx power, dBm standard version[1]	Tx power, dBm Mk1.5 version[1]
BPSK/4	-2 … +16	0 … +19
BPSK/2	-2 … +16	0 … +19
BPSK	-2 … +16	0 … +19
4QAM	-2 … +16	0 … +19
16 QAM	-2 … +15	0 … +18
32 QAM	-2 … +14	0 … +17
64 QAM	-2 … +13	0 … +16
128 QAM	-2 … +12	0 … +15
256 QAM	-2 … +10	0 … +13

[1] please refer to *Labeling* on page *6.*

Tx Power Ranges for Integra-E2/E3

Modulation	Tx power, dBm
BPSK/4	-2 … +19
BPSK/2	-2 … +19
BPSK	-2 … +19
4QAM	-2 … +19
16 QAM	-2 … +18
32 QAM	-2 … +17
64 QAM	-2 … +16
128 QAM	-2 … +15
256 QAM	-2 … +14[2]
512 QAM	-2 … +13
1024 QAM	-2 … +12

[2] +13 dBm in backwards compatibility mode with Integra-E

RSL Thresholds and Capacity for Integra-E[3,4]

Bandwidth, MHz	Modulation	Guaranteed RSL Threshold, dBm	Capacity, Mbps
62.5	BPSK /2	-85	9
	BPSK	-82	19
	4QAM	-78	65
	16QAM	-71	131
	32QAM	-68	164
	64QAM	-65	197
	128QAM	-62	230
	256QAM	-58	263
125	BPSK /4	-85	11
	BPSK /2	-82	23
	BPSK	-80	46
	4QAM	-75	156
	16QAM	-69	313
	32QAM	-65	391
	64QAM	-62	471
	128QAM	-59	549
	256QAM	-56	628
250	BPSK /4	-83	30
	BPSK /2	-80	60
	BPSK	-77	268
	4QAM	-72	363

	16QAM	-66	727
	32QAM	-63	909
	64QAM	-60	1091
	128QAM	-57	1273
	256QAM	-53	1455
	BPSK /4	-80	67
	BPSK /2	-77	134
	BPSK	-74	268
	4QAM	-69	719
500	16QAM	-63	1440
	32QAM	-60	1800
	64QAM	-57	2160
	128QAM	-53	2520
	256QAM	-50	2881
	BPSK /4	-77	134
	BPSK /2	-74	269
	BPSK	-71	538
	4QAM	-66	1431
1000	16QAM	-60	2864
	32QAM	-57	3581
	64QAM	-54	4297
	128QAM	-50	5014
	256QAM	-47	5730
	BPSK /4	-74	286
	BPSK /2	-71	571
	BPSK	-68	1143
	4QAM	-63	2855
2000	16QAM	-56	5713
	32QAM	-53	7142
	64QAM	-50	8570
	128QAM	-47	9999

[3] All Modulation schemes use Reed-Solomon Forward Error Correction

[4] BPSK/2 means BPSK operation with half of the bandwidth, BPSK/4 means BPSK operation with a quarter of bandwidth. For further details see Chapter *Application Examples*.

Guaranteed RSL Thresholds and Capacity for Integra-E2[5,6]

Forward Error Correction		LDPC (default, recommended)		R&S (for backwards compatibility)	
Bandwidth, MHz	Modulation	RSL Threshold, dBm	Capacity, Mbps	RSL Threshold, dBm	Capacity, Mbps
62.5	BPSK /2	-	-	-90.5	9
	BPSK	-86.5	34	-87.5	19
	4QAM	-84.5	68	-81.5	65
	16QAM	-77	136	-74	131
	32QAM	-72.5	170	-71	164
	64QAM	-71	205	-68	197
	128QAM	-68	239	-64.5	230
	256QAM	-65	273	-61.5	263
	512QAM	-62	307	-	-
	1024QAM	-59	341	-	-
125	BPSK /4	-	-	-90	11
	BPSK /2	-	-	-86.5	23
	BPSK	-82.5	79	-83	46
	4QAM	-80	158	-77.5	156
	16QAM	-73	317	-70	313
	32QAM	-70	396	-67	392
	64QAM	-67	476	-64	471
	128QAM	-64.5	555	-61	549
	256QAM	-61.5	634	-58	628
	512QAM	-58.5	714	-	-
	1024QAM	-55.5	793	-	-
250	BPSK /4	-	-	-86.5	30
	BPSK /2	-84	82	-83.5	60
	BPSK	-78.5	173	-80	120
	4QAM	-76.5	364	-74	363
	16QAM	-69.5	728	-67	727
	32QAM	-66	910	-64	909
	64QAM	-63.5	1092	-61	1091
	128QAM	-60.5	1275	-57.5	1273
	256QAM	-58	1457	-54.5	1455
	512QAM	-55	1639	-	-
	1024QAM	-52	1821	-	-
500	BPSK /4	-82	105	-83	67
	BPSK /2	-79.5	169	-80	134
	BPSK	-76	337	-76	268
	4QAM	-73	720	-71	719
	16QAM	-66	1440	-64	1440
	32QAM	-63	1800	-61	1800
	64QAM	-60	2160	-57.5	2160
	128QAM	-57	2520	-54.5	2520

	256QAM	-54.5	2881	-52	2881
	512QAM	-51.5	3241	-	-
	1024QAM	-48.5	3601	-	-
1000	BPSK /4	-79.5	172	-79.5	134
	BPSK /2	-76	331	-76.5	269
	BPSK	-72.5	661	-73	538
	4QAM	-69.5	1433	-67.5	1431
	16QAM	-62.5	2867	-60.5	2864
	32QAM	-59.5	3584	-57.5	3581
	64QAM	-56.5	4300	-54	4297
	128QAM	-53.5	5017	-51.5	5014
	256QAM	-50.5	5734	-48.5	5730
	512QAM	-47.5	6451	-	-
	1024QAM	-44	7167	-	-
2000	BPSK /4	-76	325	-76	286
	BPSK /2	-72.5	649	-73	571
	BPSK	-69.5	1298	-69.5	1143
	4QAM	-65.5	2857	-64	2855
	16QAM	-58.5	5714	-57	5713
	32QAM	-55	7143	-54	7142
	64QAM	-52.5	8572	-51	8570
	128QAM	-49	10000	-48	9999

[5] The LDPC Forward Error Correction mode is the default one and recommended for all modulation schemes. Reed-Solomon Forward Error Correction is available for backwards compatibility.

[6] BPSK /2 means BPSK operation with a half of bandwidth, BPSK /4 means BPSK operation with a quarter of bandwidth.

ABBREVIATIONS

ACI – Adjacent-Channel Interference

ACMB – Adaptive Coding and Modulation, Bandwidth

ATPC – Automatic Transmit Power Control

BER – Bit-Error Ratio

CCI – Co-Channel Interference

CLI – Command-Line Interface

CPE – Customer Premises Equipment

CPU – Central Processing Unit

CRC – Cyclic Redundancy Check

DC – Direct Current

DiffServ – Differentiated Services

DSCP - Differentiated Services Code Point

ETSI – European Telecommunications Standards Institute

FCC - The Federal Communications Commission

FCS - Frame check sequence

FEC – Forward Error Correction

FO – Fiber Optics

FODU – Full Outdoor Unit

FTP – File Transfer Protocol

GUI – Graphical User Interface

IEEE - Institute of Electrical and Electronics Engineers

IF – Intermediate Frequency

ISP – Internet Service Provider

ITU-T – International Telecommunication Union – Telecommunication Standardization Sector

LAN – Local Area Network

LED – Light-Emitting Diode

MAC – Media Access Control

MSE – Mean Square Error

NMS – Network Management System

PC – Personal Computer

PLL – Phase-Locked Loop

PoE - Power over Ethernet

PPF - Pulse per frame

PTP – precision time protocol

QAM - Quadrature amplitude modulation

QoS – Quality of Service

RSL – Received Signal Level

RSS – Radio Standards Specification

RSSI – Received Signal Strength Indicator

RTC- real time clock

Rx – Receive

SNMP - Simple Network Management Protocol

SNR – Signal-to-Noise Ratio

STP – Spanning Tree Protocol

TCP/IP – Internet Protocol Suite (Transmission Control Protocol / Internet Protocol)

TDM – Time-Division Multiplexing

TFTP – Trivial File Transfer Protocol

TM – Tide Mark

TP – Twisted Pair

TS – Threshold Seconds

Tx – Transmit

USB – Universal Serial Bus

VLAN – Virtual Local Area Network

WAN – Wide Area Network

Global headquarters

SAF Tehnika JSC

VAT No. LV40003474109

OFFICE, MANUFACTURING AND LEGAL ADRESS:

24a, Ganibu Dambis

Riga, LV-1005, Latvia

E-MAIL:

info@saftehnika.com

TECHNICAL SUPPORT E-MAIL:

techsupport@saftehnika.com

PHONE: +371 670 468 40

FAX: +371 670 468 09

North America office

SAF North America LLC

OFFICE ADDRESS:

3250 Quentin Street,

Unit 128, Aurora CO 80011

E-MAIL:

salesna@saftehnika.com

TECHNICAL SUPPORT E-MAIL:

techsupport@saftehnika.com

PHONE: 720 502 0724