Hypercable

User manual

INTEGRAL-W
INTEGRAL-WS

VER 1.9

FW 3.10.12 (MUX)
FW 3.10.12 (ESW)

Proprietary notice

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HYPERCABLE 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.

HYPERCABLE 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.

Contents

Chapter 1: OVERVIEW

Labelling

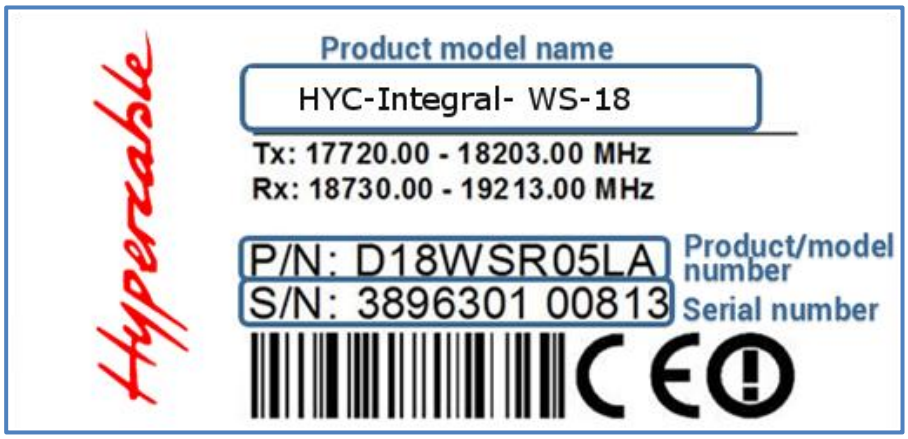
The label contains the following information (see samples in the picture below):

Product model name ("SAF INTEGRAL-WS-18"). The FODU model name example is:

- SAF INTEGRAL-W-38 for INTEGRAL-W 38GHz FODU,
- SAF INTEGRAL-WS-18 for INTEGRAL-WS 18GHz FODU, etc

Product Number / Model Number (P/N or M/N) (D18WSR05LA): product/model number contains various information about the unit. Please see translation below.

Serial Number (3896301 00813): the serial number uniquely identifies the unit.



P/N or M/N translation:

"**D**" designates INTEGRAL series product;

"**18**" designates frequency band (18 GHz) of the radio;

"**W**" designates INTEGRAL-W product type;

"**S**" split-mount, without INTEGRALted antenna;

- **"0"** - <1ft (20cm) antenna diameter and ETSI Class 3;
- **"1"** - designates 1ft antenna diameter and ETSI Class 3;
- **"2"** - 2ft antenna diameter and ETSI Class 3;
- **"3"** - 3ft antenna diameter and ETSI Class 3;
- **"4"** - 4ft antenna diameter and ETSI Class 3;
- **"5"** - <1ft (20cm) antenna diameter and ETSI Class 4;
- **"6"** - 1ft antenna diameter and ETSI Class 4;
- **"7"** - 2ft antenna diameter and ETSI Class 4;
- **"8"** - 3ft antenna diameter and ETSI Class 4;
- **"9"** - 4ft antenna diameter and ETSI Class 4.

"**R**" designates INTEGRAL with full capacity licence;

- **"N"** - 10 Mbps Basic Licence;
- **"L"** - 100 Mbps Basic Licence;
- **"K"** - 220 Mbps Basic Licence;
- **"T"** - 440 Mbps Basic Licence;

"**05**" designates the version number of the radio;

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

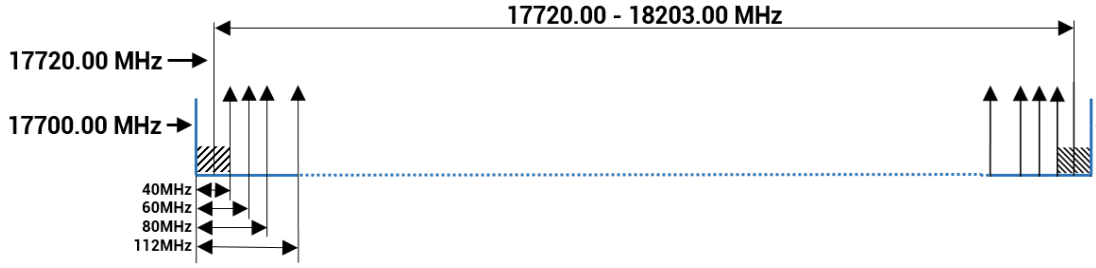
- **"H"** - high side radio

"**A**" designates A subband radio;

- **"B"** - B subband radio;
- **"C"** - C subband radio;
- **"US1"** - without subband radio with switch enabled.

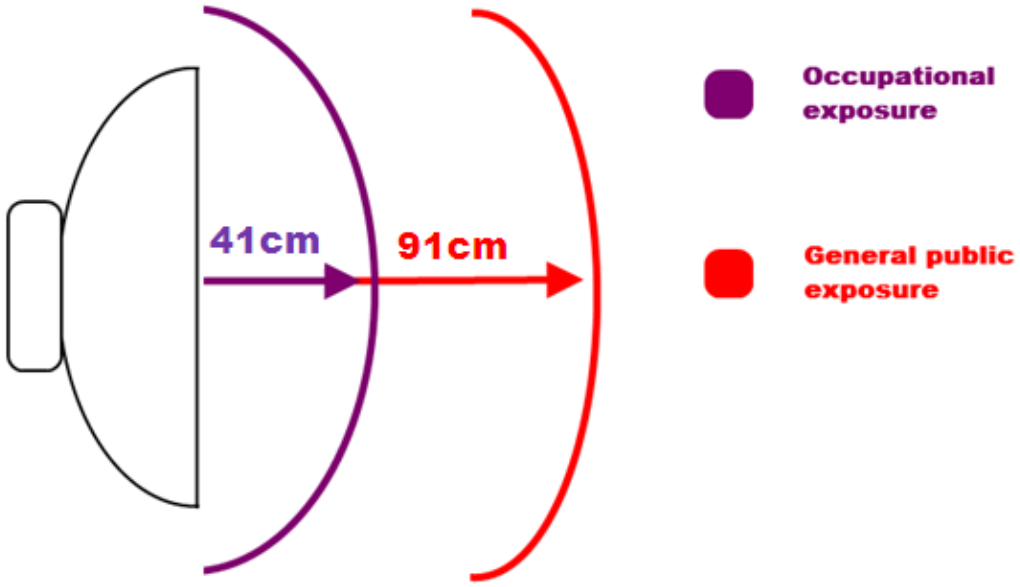
Please note that frequency range is set from the central frequency of the first 40 MHz channel to the central frequency of the last 40 MHz channel (see the diagram below).

The frequency range of subband A low side INTEGRAL-W 18 GHz FODU:



Microwave Radiation

In April 1998, ICNIRP (International Commission on Non-Ionizing Radiation Protection) published its ´Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300GHz)´. As shown in Table 2.2-1, 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.



ICNIRP Reference levels within the frequency range 24 GHz

Frequency range	Exposure characteristics	Equivalent plane wave power density Seq (W/m2)	Average time period (min)
24GHz	occupational 41cm	50	$68/f^{1.05}$ (f in GHz)
	general public 91cm	10	$68/f^{1.05}$ (f in GHz)

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 the 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 cm2 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 cm2, 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 the table below.

FCC MPE limits within the frequency range 1.5-100 GHz

Frequency range	Exposure characteristics	Equivalent plane wave power density Seq (W/m2)	Average time period (min)
24GHz	occupational 41cm	50	6
	general public 91cm	10	30

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)´

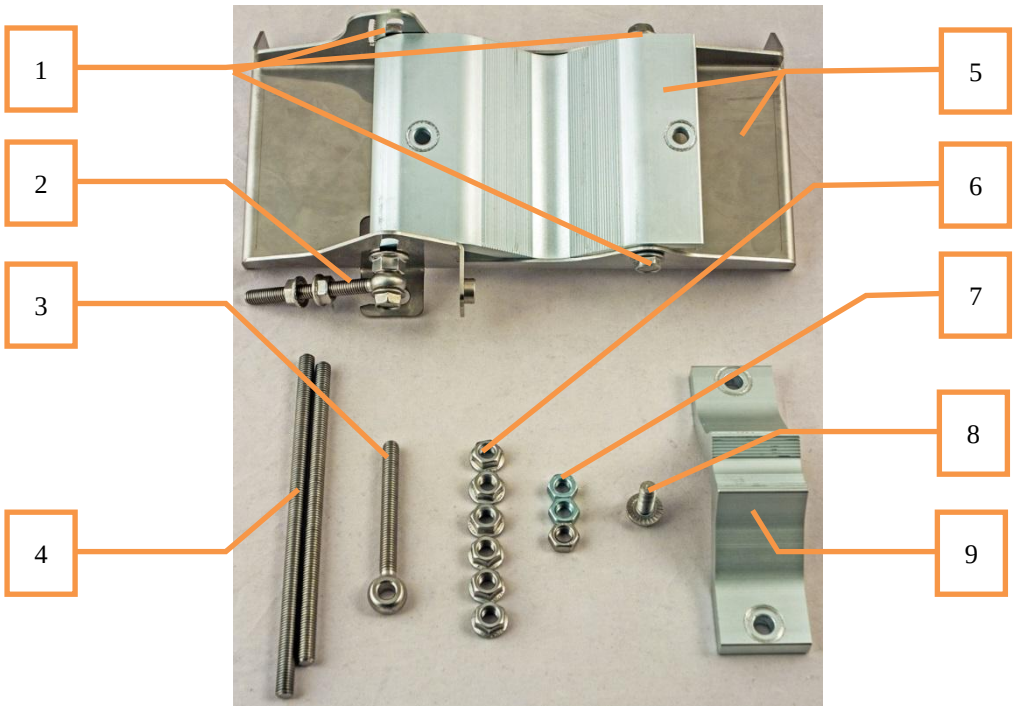
Chapter 2: INSTALLATION

Package contents

INTEGRAL-W	INTEGRAL-WS
- INTEGRAL-W FODU D**W1***** (0.3m), D**W2***** (0.6m) - Mounting bracket D0SPKR02 - Locking key for INTEGRAL-W D0ALK001 - Kit of replacement parts D0AZIP01 - RJ-45 connector 8P shield solid FOACNR02 - Installation manual D0DB2RM1	- INTEGRAL-WS FODU D**WS***** - Locking key for INTEGRAL-WS D0ALK002 - RJ-45 connector 8P shield solid FOACNR02 - Installation manual D0DBSRM1

INTEGRAL-W FODU: assembling mounting bracket and installing with antenna on a pole

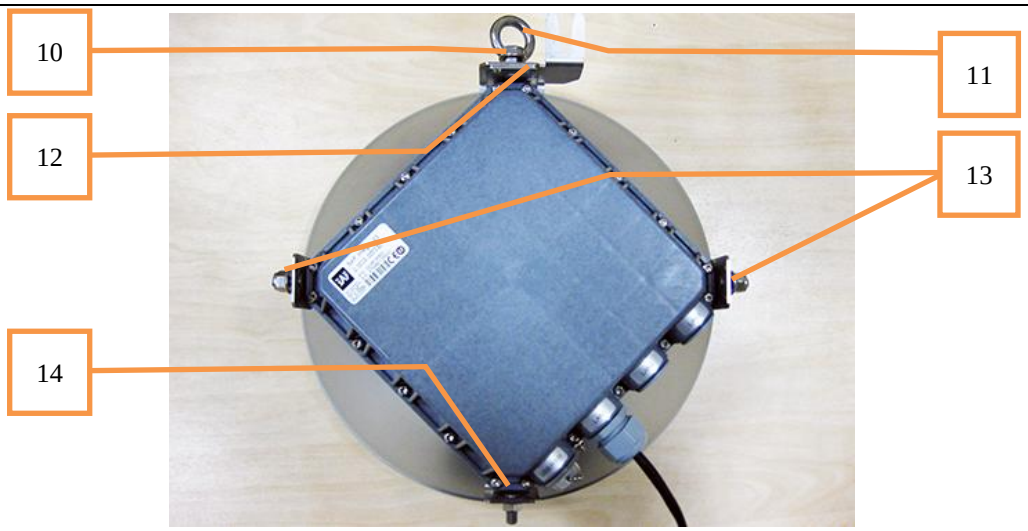
Disassembled mounting bracket and tools required for assembly



Parts of disassembled mounting bracket

#	Parts of disassembled mounting bracket
1	Three M8x1.25x16 hex flange bolts already attached to clamps for housing and pipe [5]
2	One hex flange bolt M8x1.25x30, one M10x1.5 hex flange nut and one M8x80 eye screw already attached to clamps for housing and pipe [5]
3	One M8x80 eye screw

4	M8x160 and M8x130 threaded rods
5	Clamps for housing and pipe interconnected with three M8x1.25x16 hex flange bolts [1] and an eye screw for horizontal alignment [2]
6	Six M8x1.25 hex flange nuts
7	Three M8x1.25 hex nuts
8	One hex flange bolt M8x1.25x20
9	Mounting bracket clamp



#	Parts of INTEGRAL-W FODU
10	Spacer hex flange nut
11	Lifting eye nut
12	Fixation plate
13	Side screw flange nuts
14	Grounding flange nut

Numbers of the mounting bracket and INTEGRAL-W FODU parts in next sections will be mentioned in square brackets [ ].

Changing polarization of INTEGRAL-W FODU and antenna

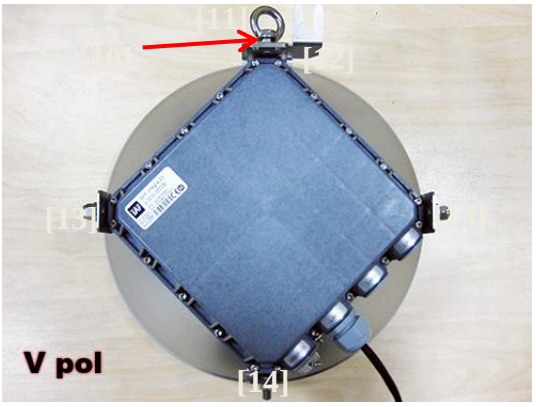
Tools required: 13mm (0.512”) wrench (comes in package)

The default polarization for licensed frequency band radios is vertical.

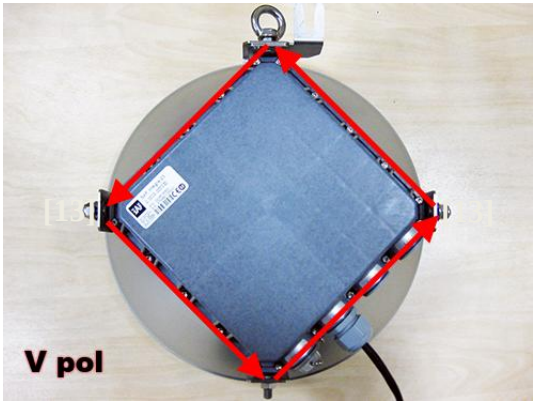
INTEGRAL series 17/24GHz FODUs should be installed in opposite polarizations.
By default INTEGRAL series 17/24GHz FODU radios are shipped with opposite polarizations pre-installed for low and high side units.

1 Remove INTEGRAL-W FODU with an antenna from mounting bracket.

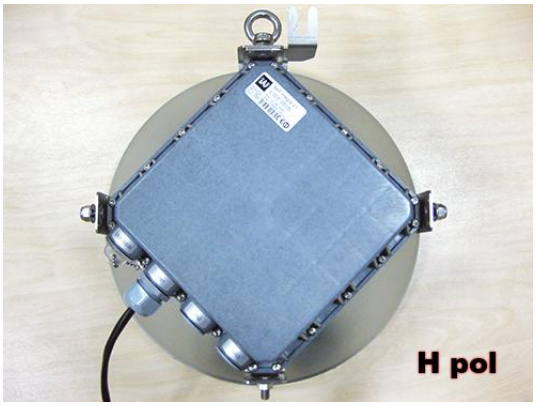
Default polarization is vertical.



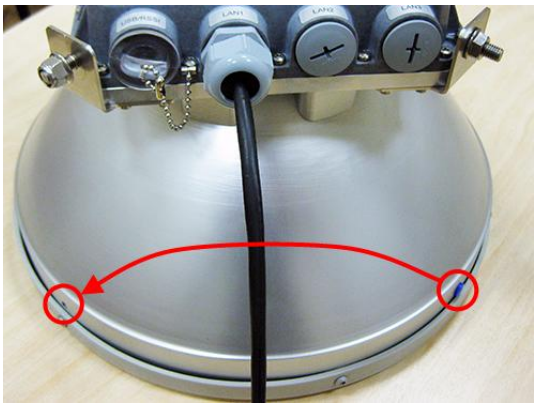
2 Using 13mm wrench remove indicated nuts and fixation plate [10, 11, 12, 13, 14].



3 Removed parts must be attached back with 90-degree offset (see above). The gap between side screw flange nuts [13] and fastening angles should be 5mm.



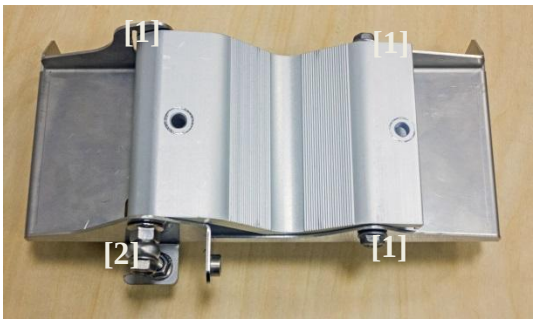
4 View of INTEGRAL-W FODU with swapped polarization.



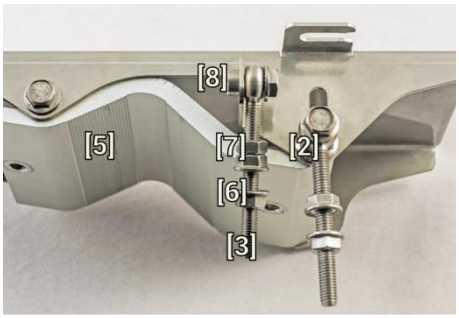
5 When polarization is changed, make sure that the drain-hole cap located at grounding flange nut is removed and inserted into the previous drain hole.

Assembly procedure

Tools required: 13mm (0.512”) wrench (comes in package)

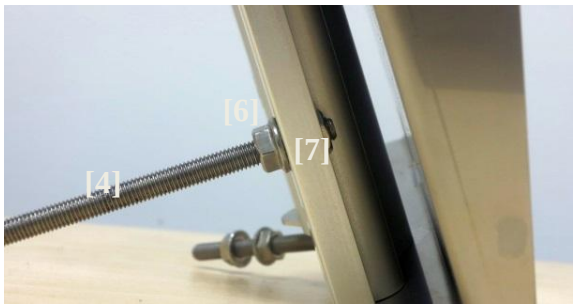


1 Using 13mm wrench slightly loosen three hex flange bolts [1] and hex flange bolt, nut and eye screw [2] interconnecting clamps for housing and pipe [5].

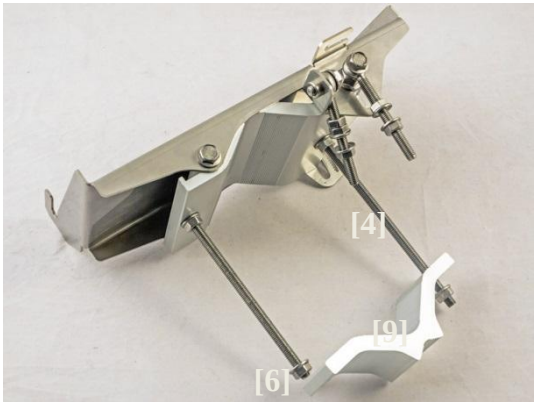


2 Attach vertical alignment eye screw [3] to clamps for housing and pipe [5] using hex flange bolt [8] and screw on one hex nut [7] and two hex flange nuts [6]. Make sure that both eye screws are positioned as shown in the image (turned to the back side of clamps). The gap between each two flange nuts on eye screws should be 15..20mm (0.6..0.8 in.). Do not tighten both hex flange bolts [8] and [2].

3 Screw on one hex flange nut [6] on each of threaded rods [4]. Note that flange nuts should be screwed on exposing approx. 20mm (0.8 in.) of threaded rods.

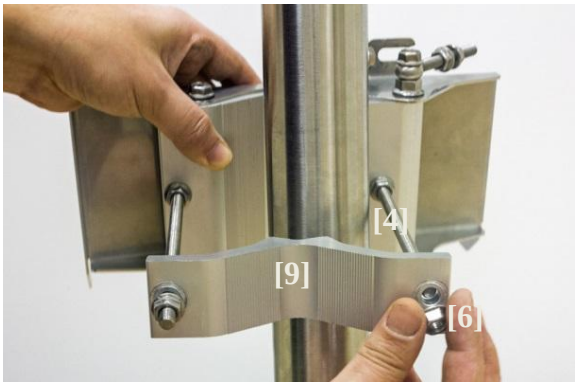


4 Insert both threaded bolts into two available holes of mounting clamp. Put hex nuts [7] on the other side of the clamp and screw on the threaded bolts until it is visible from the other side of the clamp no more than 2mm. Tighten hex flange nuts [6] with torsion 20..25 N·m.



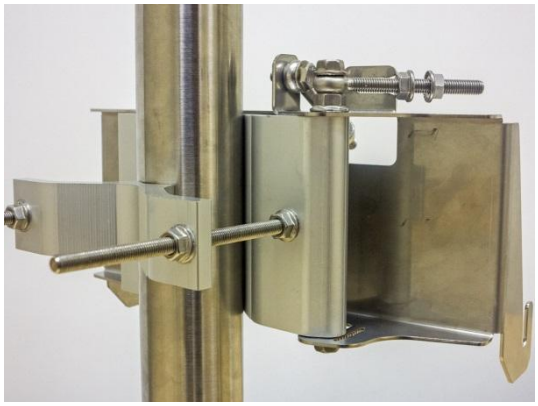
5 Attach mounting bracket clamp [9] on the longest threaded rod [4] as shown in the picture and afterwards screw on remaining two hex flange nuts [6] on both threaded rods. No parts should remain unassembled.

Bracket clamps in the following position support mast Ø 55..120mm. Reversing clamps allows support of smaller masts Ø 25..75mm.



6 Unscrew hex flange nut [6] from the shortest threaded rod [4]. Make sure that hex flange nuts on the longest threaded rod are not too far; otherwise adjust nut’s position accordingly. Put another end of mounting bracket clamp [9] on free-threaded rod and screw on hex flange nut.

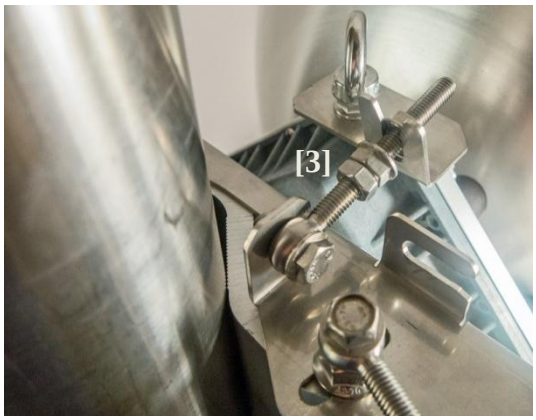
7 Hex flange nuts should be evenly aligned on threaded bolts so that mounting bracket clamp [9] is tightly attached to the pipe. Tighten hex flange nuts with torsion not exceeding 20 N·m.



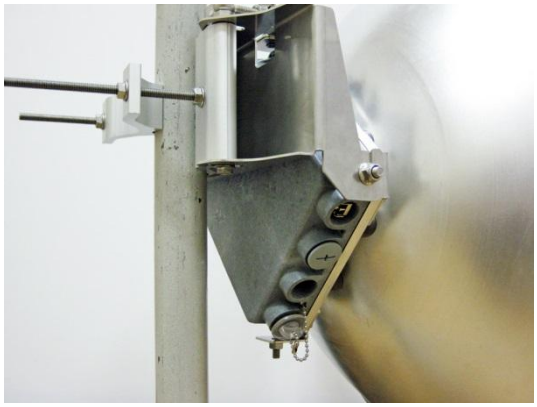
8 View of the assembled mounting bracket on the mast pole.

9 Make sure that both horizontal and vertical alignment eye screws are turned to the mast before attaching INTEGRAL-W FODU.

10 Attach INTEGRAL-W FODU with the antenna to the mounting bracket so that side screws fit into grooves of the housing clamp [5].



11 Connect vertical alignment eye screw [3] to the upper groove on INTEGRAL-W housing.



12 View of the assembled bracket on the mast pole with INTEGRAL-W FODU attached and secured.

It is recommended to protect the installed radio from direct sunlight.

Antenna alignment

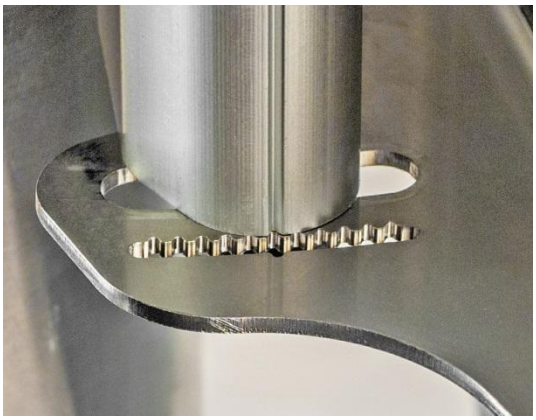
Tools required: 13mm (0.512”) wrench (comes in package)

1 Before aligning the antenna, make sure that screws marked with red dots on the right side view of the mounting bracket are loosened - hex flange nuts and bolts of azimuth and elevation eye screws, right side screw on INTEGRAL-W FODU and hex flange bolt on azimuth angle indicator.

2 Additionally loosen the following screws marked with red dots on the left side view of the mounting bracket: left side screw on INTEGRAL-W FODU and two hex flange bolts between both mounting bracket clamps for housing and pipe.

3 For initial alignment make sure that elevation is approximately at zero degrees angle by adjusting hex flange nuts [9] on vertical alignment eye screw so that INTEGRAL’s housing is parallel to the bracket.

4 Adjust azimuth angle by manually moving mounting bracket in the horizontal axis. Note that all azimuth position fixing hex flange bolts, as well as horizontal alignment eye screw with flange bolt need to be loosened ensuring free movement in the horizontal axis.



5 Each notch corresponds to one degree of azimuth angle. The half distance between notches (each lip) corresponds to 0.5 degrees.

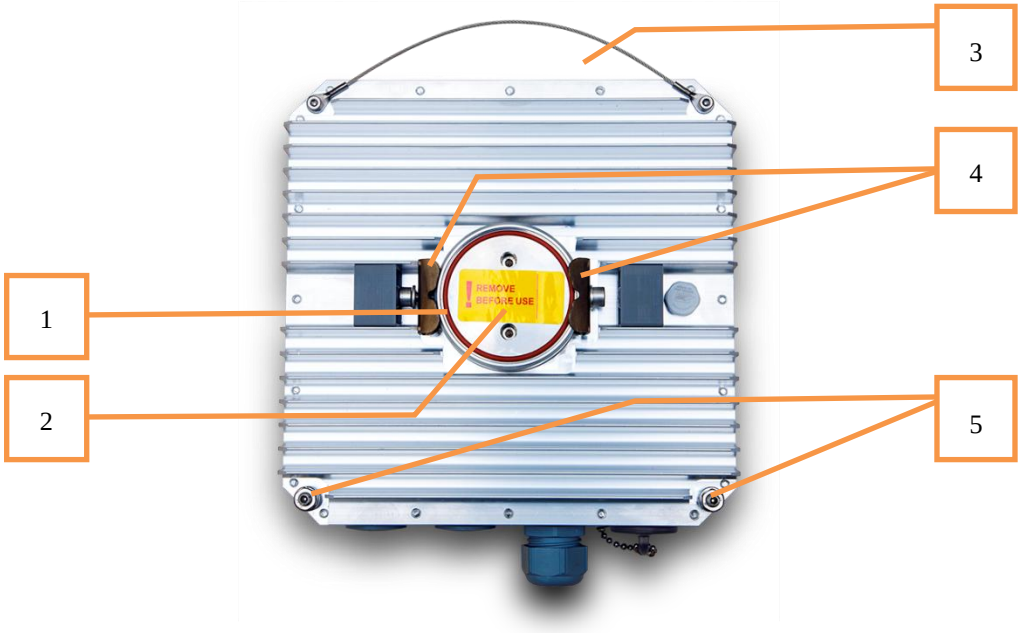
6 Fix azimuth angle on the horizontal axis by adjusting the position of flange nuts [6] on both horizontal and vertical alignment eye screws.

7 When alignment is finished tighten screws marked with red dots on the right side view of the mounting bracket: hex flange nuts and bolts of azimuth and elevation eye screws, right side screw on INTEGRAL-W FODU and hex flange bolt on azimuth angle indicator with torsion 20..25 N·m.

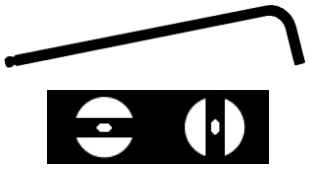
8 Additionally, tighten the following screws marked with red dots on the left side view of the mounting bracket: left side screw on INTEGRAL-W FODU and two hex flange bolts between both mounting bracket clamps for housing and pipe with torsion 20..25 N·m.

INTEGRAL-WS 15-42GHz* FODU: attaching to the antenna

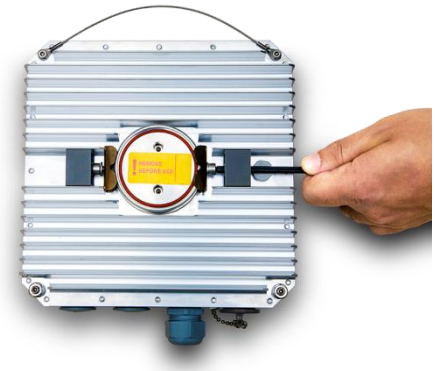
Parts of INTEGRAL-WS FODU: **1 -** O-ring; **2 -** flange protecting sticker; **3 -** wire handle; **4 -** fixation clamps; **5 -** grounding screws.



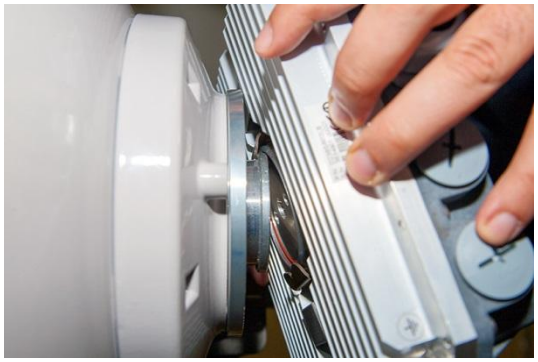
Tools required: Size 5 Allen wrench



Level (not supplied)



1 Using size 5 Allen wrench loosen one clamp completely and second clamp by a half-turn.



2 Put INTEGRAL-WS on antenna adapter flange by hooking half-turn loosened clamp at the top and leaving the completely loosened clamp at the bottom. Make sure O-ring is in place and the adapter flange fits into the INTEGRAL-WS transition flange socket.

Note! The protective sticker should be removed before attaching the INTEGRAL-WS FODU to the antenna.

3 Secure the interconnection by tightening the bottom clamp (not fully). Make sure rotation of the INTEGRAL-WS is still possible.

4 Rotate INTEGRAL-WS to match the required polarization.

5 The sticker on the back lid indicates the polarization of the INTEGRAL-WS. Adjust polarization so that the interface ports are located at the lower side of the INTEGRAL-WS.

6 Verify polarization accuracy with a level, by placing it on the top edge of the INTEGRAL-WS housing

7 Secure the position of the INTEGRAL-WS by fully tightening both fixation clamps.

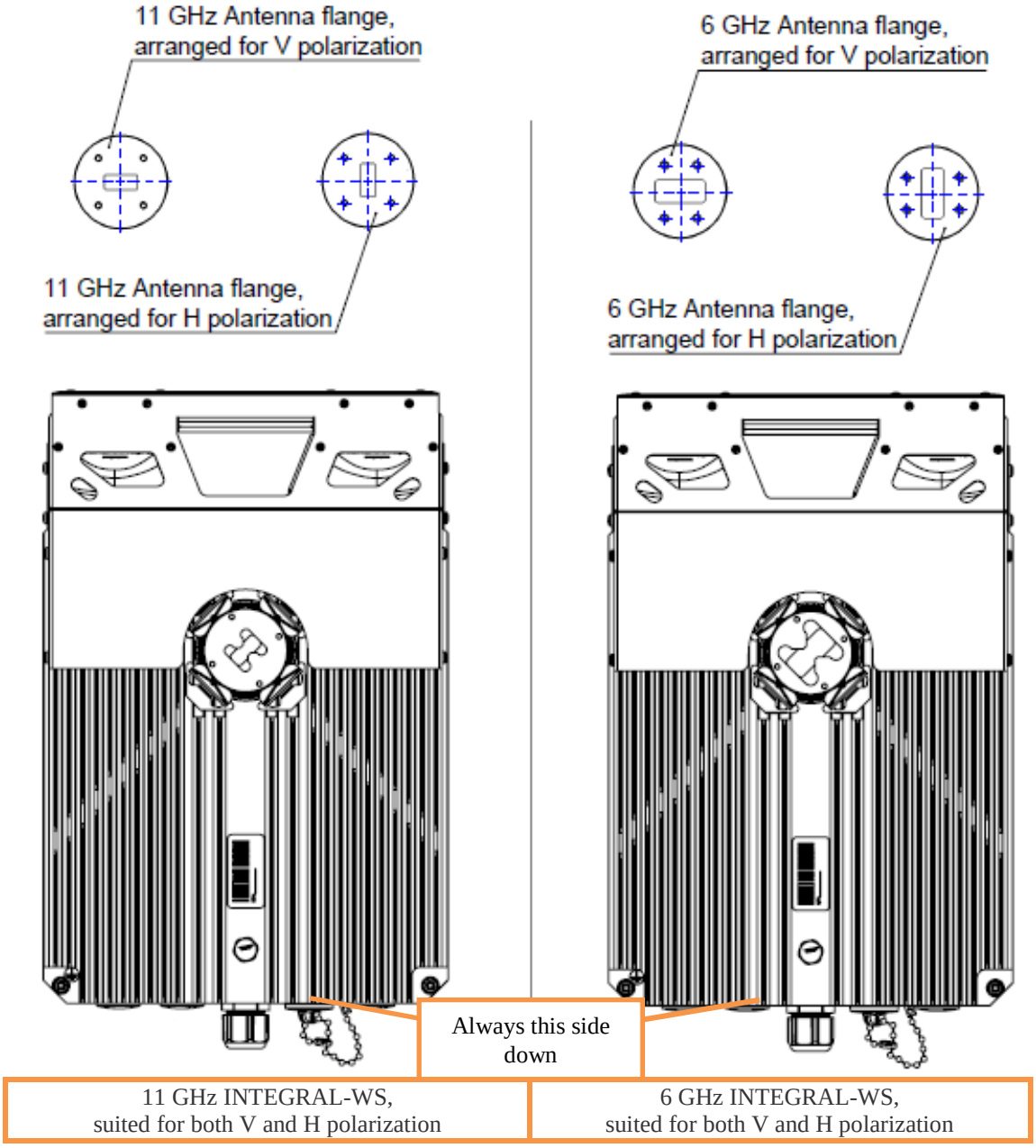
*INTEGRAL-WS 15/18/17/23/24/26/32/38/42GHz are separate FODU models

It is recommended to protect the installed radio from direct sunlight.

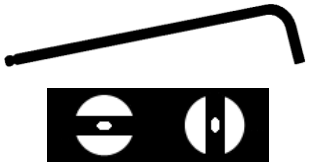
The default polarization for licensed frequency band radios is vertical.

INTEGRAL-WS 6-13GHz* FODU: attaching to the antenna

INTEGRAL-WS 6-13GHz* FODU features twisted polarization flange and resulting signal polarization is determined by Interface on antenna/OMT. To change signal polarization, please rotate only the antenna interface, as radio always remains in vertical position.



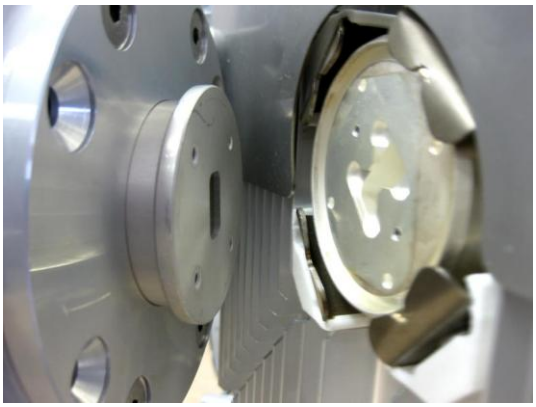
Tools required: Size 5 Allen wrench, 240mm



Level (not supplied)

1 INTEGRAL-WS 6-13GHz* FODU features twisted polarization flange and resulting signal polarization is determined by Interface on antenna/OMT. To change signal polarization, please rotate only the antenna interface, as radio always remains in vertical position.

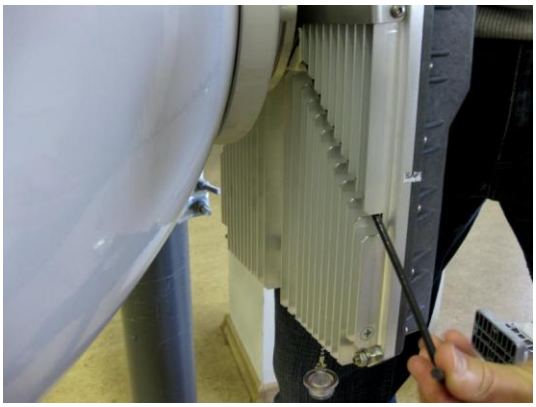
Example of vertical polarization interconnection.



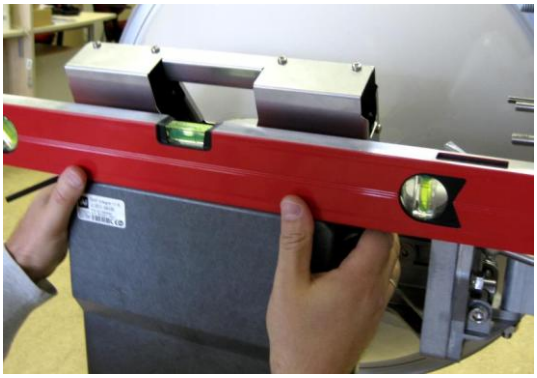
2 Example of horizontal polarization interconnection.

3 Put INTEGRAL-WS on antenna adapter flange by hooking half-turn loosened clamp at the top and leaving the completely loosened clamp at the bottom. Make sure O-ring is in place and the adapter flange fits into the INTEGRAL-WS transition flange socket.

Note! The protective sticker should be removed before attaching the INTEGRAL-WS FODU to the antenna.



4 Tighten bottom fixation clamps.



5 Use air level to verify that INTEGRAL-WS FODU is properly levelled. Tighten all four fixation clamps properly.

6 Final view of assembled INTEGRAL-WS 6-13GHz* 1+0 setup.

*INTEGRAL-WS 6U/6L/7/8/10/11/13 are separate FODU models

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

INTEGRAL-WS 6-13GHz* 2+0 & OMT interconnection

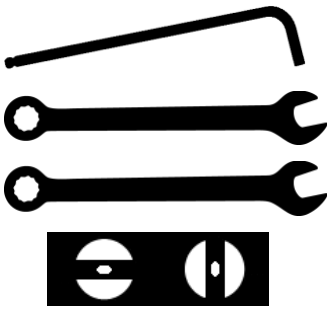
Link aggregation 2+0 for INTEGRAL-WS is available only by using external equipment (switches)!

Tools required: Size 5 Allen wrench, 240mm

10mm (0.394”) wrench (not supplied)

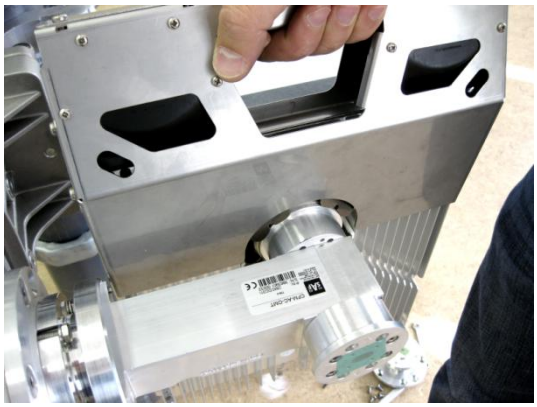
8mm (0.315”) wrench (not supplied)

Level (not supplied)

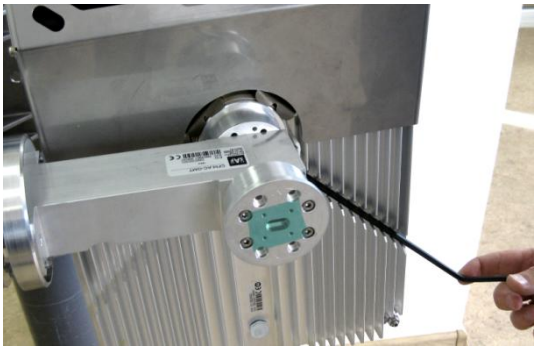


It is recommended to perform steps 1-2 on the ground.

1 Prepare INTEGRAL-WS 6-13GHz* FODU by loosening both bottom clamps (should not overlap the flange plate) and tightening both upper clamps (will be used as a hook).

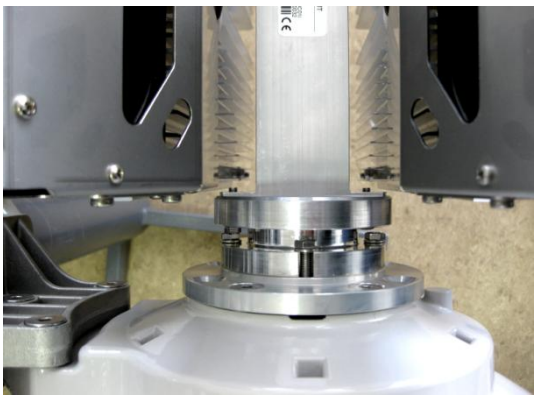


2 Attach INTEGRAL-WS 6-13GHz* FODU to the OMT using both upper clamps. INTEGRAL S 6-13GHz* FODU features twisted polarization flange and resulting signal polarization is determined by Interface on antenna/OMT. To change signal polarization, please rotate only the antenna interface, as radio always remains in vertical position



3 Slightly tighten both bottom fixation clamps to secure FODU to the OMT.

4 Use air level to verify that FODUs are properly levelled.



5 Tighten all 4 INTEGRAL fixation clamps on both FODUs. When properly attached there's a gap between FODUs, OMT and antenna.

6 Final view of assembled INTEGRAL-WS 6-13GHz* 2+0 setup.

*INTEGRAL-WS 6U/6L/7/8/10/11/13 are separate FODU models

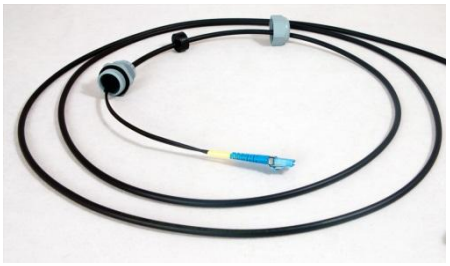
For connecting INTEGRAL-WS 15-42GHz to an OMT, please follow the instructions in Chapter INTEGRAL-WS 15-42GHz* FODU: attaching to the antenna

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

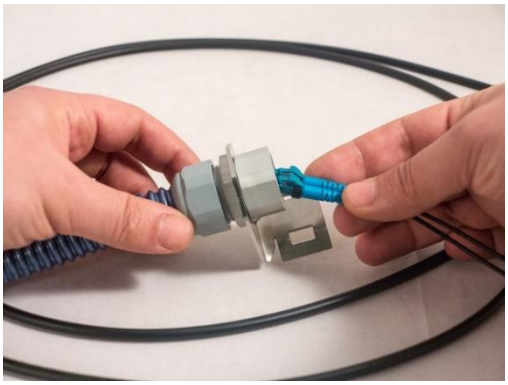
Connecting FO interface using fiber conduit kit

1 Fiber conduit kit.

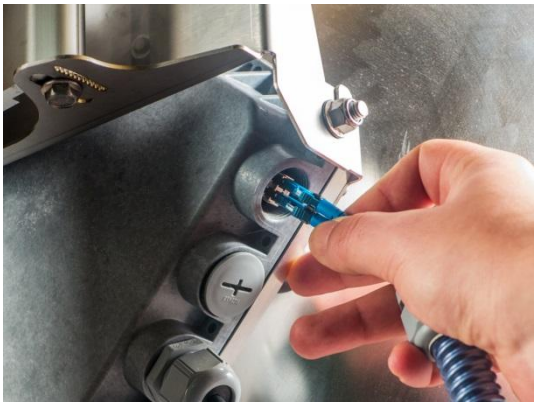
2 Unscrew the cap of the SFP port (LAN2 or LAN3) that will be used and install an SFP module.



3 Disassemble conduit kit and put its parts in the following sequence (left – INTEGRAL-W direction, right – CPE direction).



4 Push FO cable from LC connector side through the conduit.



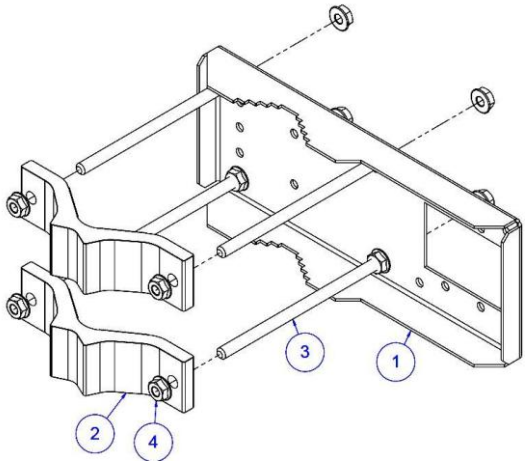
5 Connect LC connector to SFP module.

6 Tighten parts on both ends of the conduit. Fasten another end of fiber conduit to the pole using included tie-wrap. Assembled view.

INTEGRAL-WS 6-13GHz* remote mount kit assembly

Tools required: Size 5 Allen wrench

13mm (0.512”) wrench (not supplied)

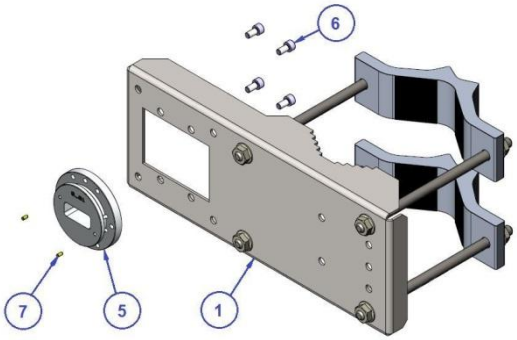


1

Assemble mounting bracket using 13mm wrench:

Screw on one hex flange nut [4] on each of four threaded rods [3]. Insert threaded rods into available holes of mounting clamp [1]. Put hex nuts [4] on the other side of the clamp and screw on the threaded rods until these are visible from another side of the clamp not more than 2mm. Tighten hex flange nuts with torsion 20..25 N·m.

Attach two mounting bracket clamps [2] on threaded rods [3] as shown in the picture and afterwards screw on remaining four hex flange nuts [4] on all threaded rods.



2

Attach waveguide transition flange to the mounting bracket using size 5 Allen wrench:

Put flat side of transition flange [5] on the flat side of mounting clamp [1] as shown on the picture and screw in four socket head screws [6] from another side of the clamp. Put in two dowel pins [7] in appropriate holes of transition flange. Pins are sitting in holes very loose; therefore, perform the last action immediately before FODU installing.

3

View of the assembled mounting bracket on thick pole mast:

Bracket clamps in following position support mast diameters 55..120 mm.

4

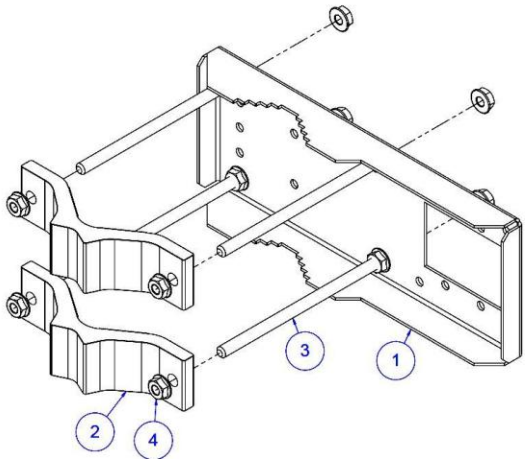
View of the assembled mounting bracket on thin pole mast: Bracket clamps in reverse position support smaller mast diameters 25...75mm.

*INTEGRAL-WS 6U/6L/7/8/10/11/13 are separate FODU models

INTEGRAL-WS 15-42GHz* remote mount kit assembly

Tools required: Size 5 Allen wrench

13mm (0.512”) wrench (not supplied)

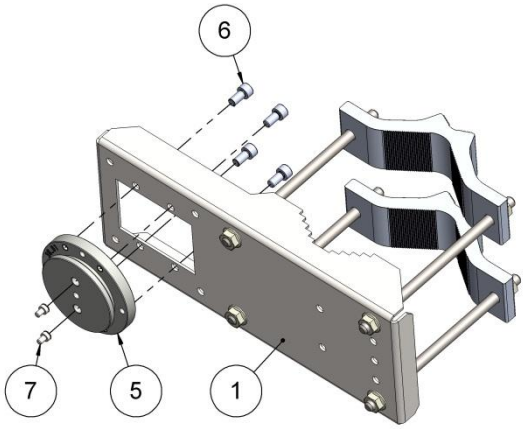


1

Assemble Mounting Bracket using 13mm wrench:

Screw on one hex flange nut [4] on each of four threaded rods [3]. Insert threaded rods into available holes of mounting clamp [1]. Put hex nuts [4] on the other side of the clamp and screw on the threaded rods until these are visible from another side of the clamp not more than 2mm. Tighten hex flange nuts with torsion 20..25 N·m.

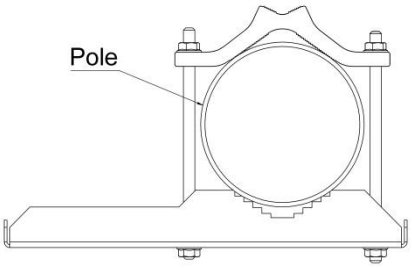
Attach two mounting bracket clamps [2] on threaded rods [3] as shown in the picture and afterwards screw on remaining four hex flange nuts [4] on all threaded rods.



2

Attach Waveguide transition flange to the mounting bracket using Size 5 Allen wrench:

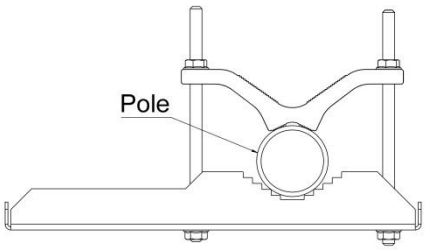
Put flat side of transition flange [5] on the flat side of mounting clamp [1] as shown on the picture and screw in four socket head screws [6] from another side of the clamp. Two screws [7] have to be screwed into antenna flange of ODU (not shown here). Screws' heads serve as guiding pins while the ODU is attached to the transition flange [5].



3

View of the assembled mounting bracket on thick pole mast:

Bracket clamps in following position support mast diameters 55..120 mm.



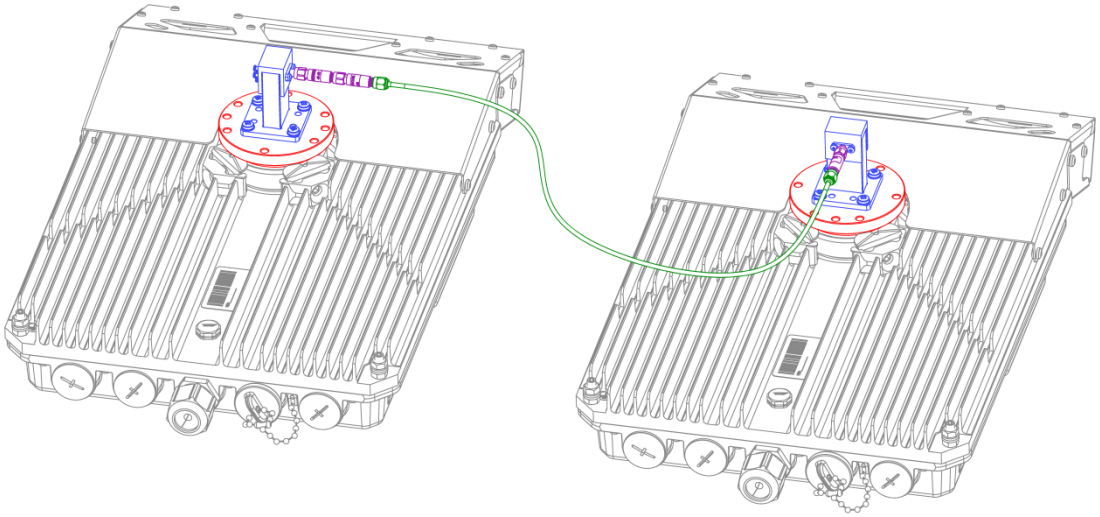
4

View of the assembled mounting bracket on thin pole mast:
Bracket clamps in reverse position support smaller mast diameters 25...75mm.

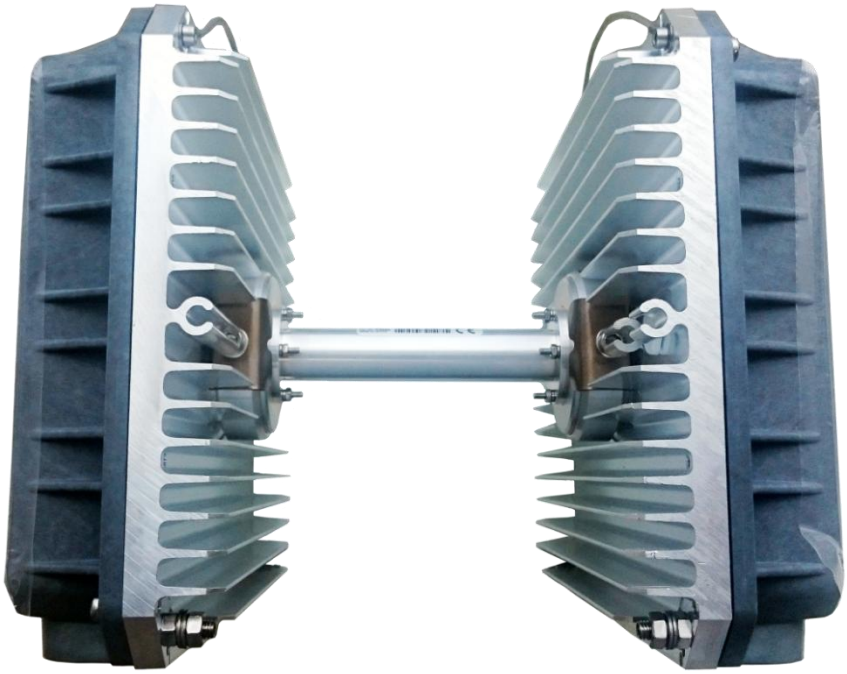
*INTEGRAL-WS 15/18/17/23/24/26/32/38/42GHz are separate FODU models

Initial setup in indoor environment

INTEGRAL-WS FODUs can be interconnected using a test kit (available for purchase as optional accessory). P/N is DxxTST01, where xx – frequency band, e.g. D11TST01 for 11GHz. The exception is 17 and 24GHz radios.



Test kit consists of adapter flange, waveguide-to-coaxial adapter, attenuators and coaxial cable.
In case of 17 and 24 GHz radios a test tube (P/N D0S17TST01 or D0S24TST01) should be used:

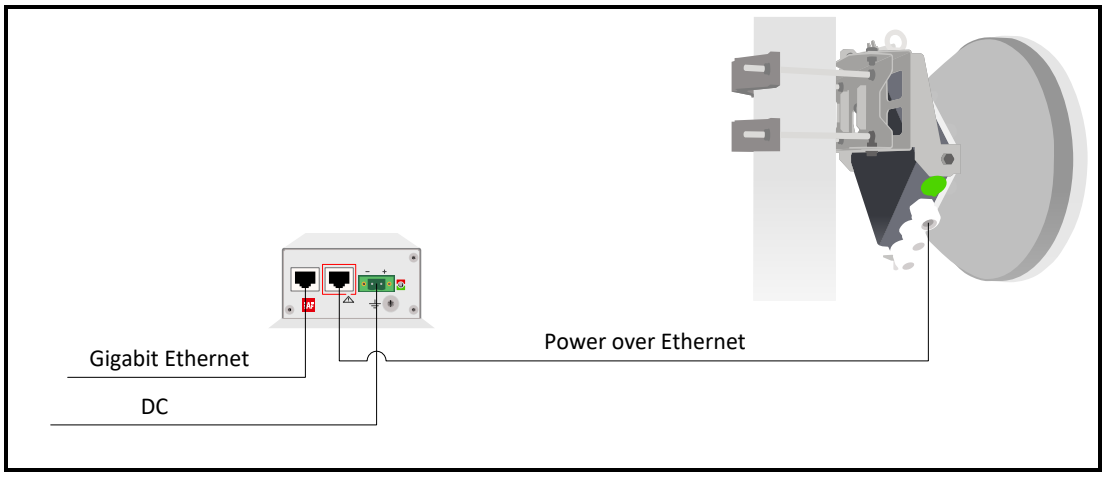


Chapter 3: WEB GUI

Initial configuration

Powering INTEGRAL-W/INTEGRAL-WS FODU and connecting to PC

Use Power over Ethernet (PoE) injector P/N I0ATPI22/24 with appropriate power supply (22…60VDC, at least 80W). Please see interconnection scheme below.



Ethernet cable from PoE injector should be connected to RJ-45 port on INTEGRAL-W/INTEGRAL-WS FODU (MM or LAN(TP)).

For some HW revisions, PoE may be available on data (LAN(TP)) port only.

The total length of Ethernet cables from CPE to PoE injector (DATA port) and from INTEGRAL-W/INTEGRAL-WS to PoE injector (DATA+PWR port) combined should not exceed 100m. It is recommended to use outdoor rated STP/FTP Ethernet cable Cat5e or better.

When powered RSSI LED will light up in solid green color for approx. 20sec. Afterwards, RSSI LED will go out for approx. 35sec. and eventually, start blinking indicating current Rx level.

Please refer to the chapter RSSI LED for further details on blinking patterns and corresponding Rx levels.

PoE injector (P/N I0ATPI22)

The injector has a built-in DC/DC converter which can be enabled with a switch at the back by switching it to “54V” position. In this mode, the 22..60VDC input voltage will be converted to the 54VDC output voltage. It is required to use this mode when the input voltage is below 48VDC or when longer Ethernet cable is used in order to ensure sufficient input voltage to INTEGRAL-W/INTEGRAL-WS FODU (36…57VDC). In “48V” mode output voltage of PoE injector is the same as the input voltage.

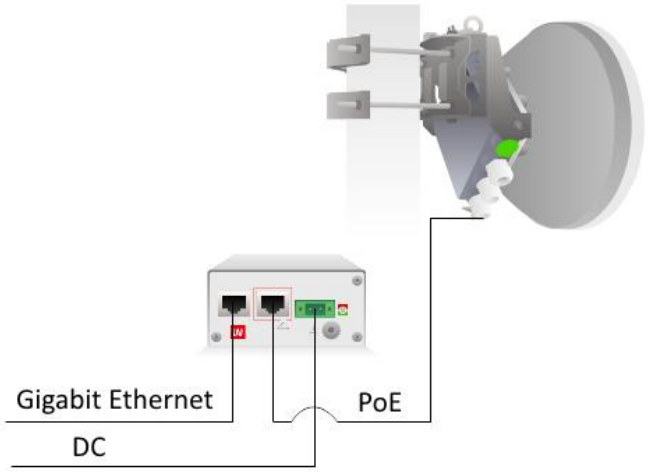
In case input voltage is between 22..36VDC, the output current is limited to 1.2A, which will not be sufficient for low-frequency band radios (6-13GHz). Use 36..60VDC input voltage instead.

Universal programmable PoE injector (P/N I0ATPI24)

The I0ATPI24 injector is designed to operate with any PoE capable product with Fast Ethernet / Gigabit Ethernet interface. Built-in protection conforms with IEC 61000-4-5 standard.

Accepted input voltage 24…60VDC. The output voltage is stabilized to 54VDC.

Interconnection scheme:



The front panel has 3 indication LEDs. LED3 indicates the position of DIP switch S1. Color indication of all LEDs must be ignored in Forced mode (DIP switch S4 in DOWN position).

Load detected and voltage fed at the output of PoE injector (POWER GOOD)		No load at the output of PoE injector (OPEN)
PoE controller detected and voltage fed at the output of PoE injector (POWER ON)		Short at the output of PoE injector (SHORT)
Classified PoE mode (PoE CLASSIFIED) (if S4 is UP; see table below).		Unclassified PoE mode (PoE MANUAL) (if S4 is UP; see table below).

The back panel has 4 switches in order to operate PoE injector in different modes.

Appropriate I_{max} selection, while unclassified PoE mode is enabled (S1 UP, S4 UP) will provide most effective surge protection for the radio. In case I_{max} exceeds set value, upper LEDs (LED1&LED2) will blink in green color.

Connecting device in Unclassified or Forced modes will introduce approx. 5-second delay of LED indication.

In case classified PoE mode is enabled (S1 position DOWN, S4 position UP) I_{max} mode (PD class) is negotiated automatically with the device connected.

The position of DIP switches should be changed only while PoE injector is turned off.

Nr.	S1	S2	S3	S4	Description
1	↓	×	×	↑	**Classified PoE mode** (PoE controller enabled). I_{max}= **auto**.
2	↑	↓	↓	↑	**Unclassified PoE mode** (PoE controller disabled). I_{max}=**750mA**.
3	↑	↓	↑	↑	**Unclassified PoE mode** (PoE controller disabled). I_{max}=**1000mA**.
4	↑	↑	↓	↑	**Unclassified PoE mode** (PoE controller disabled). I_{max}=**1250mA**.

5	↑	↑	↑	↑	**Unclassified PoE mode** (PoE controller disabled). I_{max}=**1700mA**.
6	×	×	×	↓	**Forced mode**. I_{max}=**2000mA**. **DIP switches S1, S2, S3 ignored.** LED3 color will be **blue** or **green** depending on the position of **S1**.

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

Recommended modes

Mode Nr. **1** or **5*** (Classified or Unclassified PoE mode. I_{max}= auto or I_{max}=1700mA);

* depending on HW revision

Electrical specification

Data rate	Up to 1000 Mb/s
Classified PoE mode	Green indicator LED*
Unclassified PoE mode	Blue indicator LED*
Input Voltage	22 – 65 V
Output Voltage	54 V
Max Current	1.2 A (22…36V DC), 1.6 A (36…60V DC)
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

* Color indication can be disregarded in Forced mode (DIP S4 position DOWN), will indicate only Power ON.

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 I0STPI11.01)

** 2ESDV-02P plug with screw locks included.

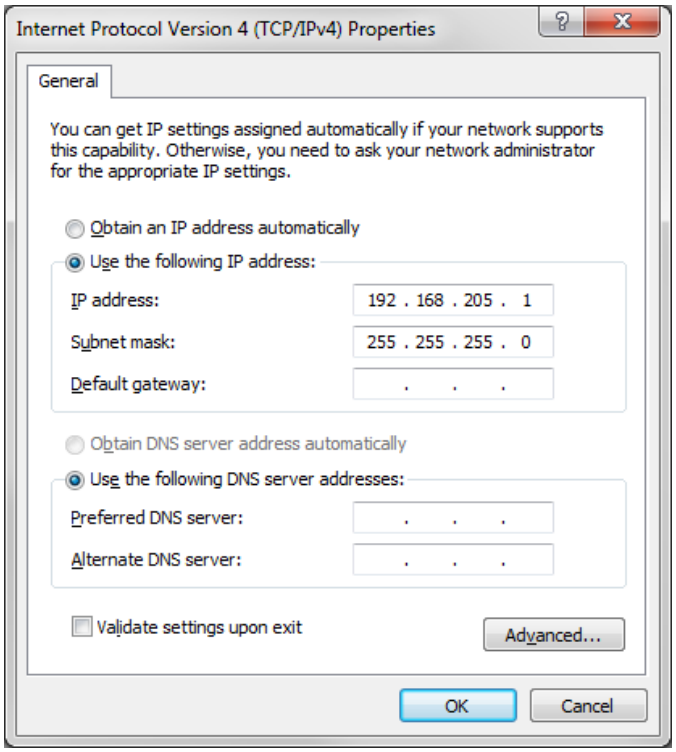
System requirements

To access INTEGRAL-W/INTEGRAL-WS Web GUI you will need a PC with the following Web browser:

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

Ethernet management connection

Before proceeding with initial link setup in Web GUI, you must adjust IPv4 settings of your LAN adapter to 192.168.205.0 subnet. IP address should be other than default low/high side IP addresses (192.168.205.10/192.168.205.11).



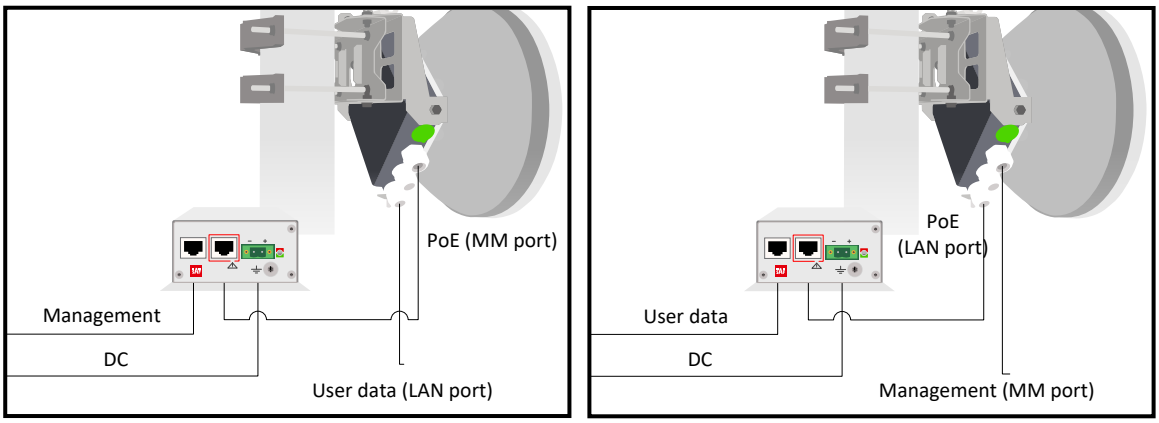
After applying these settings you are ready to connect to Web GUI or establish SSH/Telnet connection. Refer to Chapter 4: COMMAND LINE INTERFACE for details how to connect to other CLI interfaces (serial, SSH, Telnet).

Depending on the P/N INTEGRAL-W/INTEGRAL-WS may come pre-installed with in-band management or out-band management. In case of out-band management option management access will be available only on dedicated management port (labelled “MM”).

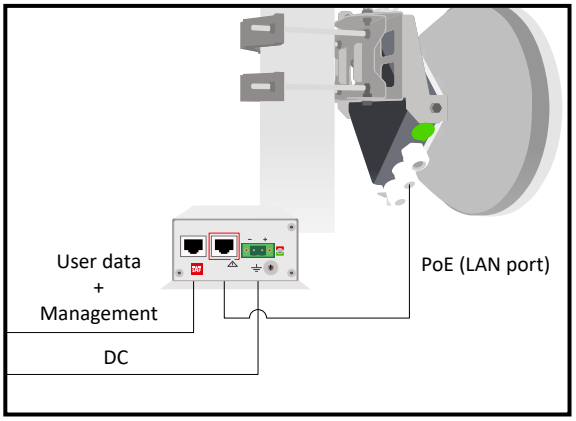
If “MM” port was used for PoE, management will be available directly on PoE injector’s port, but an additional cable will be required to be installed for user data traffic. If “LAN(TP)” port was used for PoE, user data traffic will be available directly on PoE injector’s port, but an additional cable will be required to be installed for management access.

Note that by default management is transmitted over the radio interface and you will have access to management of local and remote sides simultaneously. Back-to-back interconnection at remote side of the link will be required only if you have a chain of at least two INTEGRAL-W(S) links.

In case of in-band management access port labelled “MM” cannot be used for user data traffic, only for management access, while both LAN ports can be used for user data traffic and management access.



Traffic and management cable installation for out-band INTEGRAL-W/INTEGRAL-WS



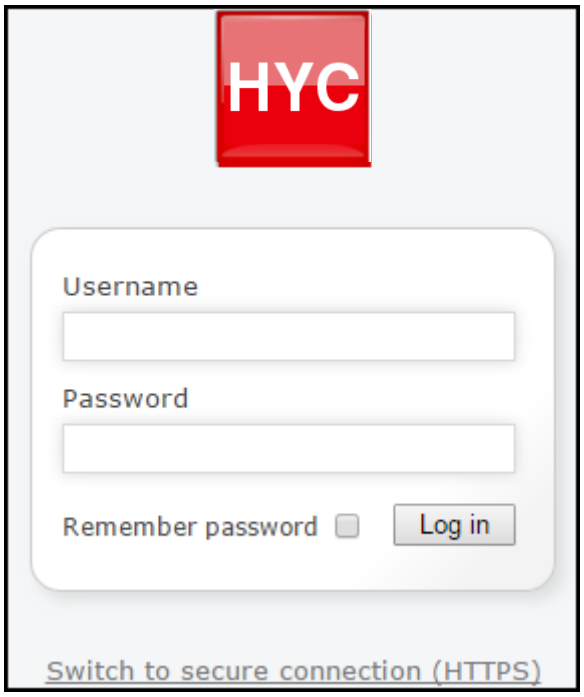
Traffic and management cable installation for in-band INTEGRAL-W/INTEGRAL-WS

Accessing Web GUI

1. Launch your browser and in address field enter INTEGRAL-W/INTEGRAL-WS FODU IP address. Default IP addresses are as follows:
   - 192.168.205.10 for low side INTEGRAL-W/INTEGRAL-WS FODU (P/N D*******L*)
   - 192.168.205.11 for high side INTEGRAL-W/INTEGRAL-WS FODU (P/N D*******H*)

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

2. Press “Enter” key.
3. The login screen will appear.
4. Enter 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.

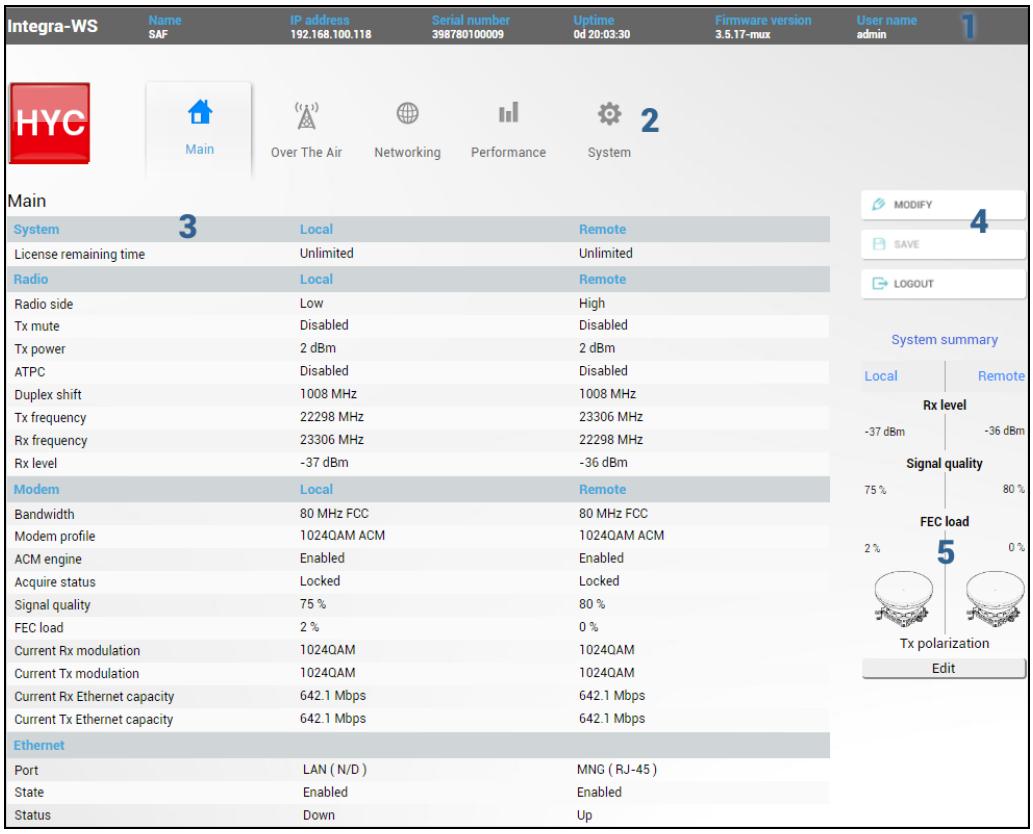
“Switch to secure connection (HTTPS)” indicates that HTTP protocol is being used. Press the link and you will be redirected to secure HTTPS URL.

Self-signed OpenSSL certificate is being used.

Minimum supported horizontal resolution is 1024px.

Main page

After login you will be automatically redirected to the Main page of Web GUI:



Web GUI is divided into 5 sections:

1 Top panel

Shows information about INTEGRAL-W/INTEGRAL-WS FODU you are connected to including:

- Model name
- System name
- IP address
- Serial number
- Uptime
- Firmware version
- User name

2 Menu panel

Allows navigating between Main page (“Main”) and subpages of 4 sections:

- Over the air (Radio/modem (NP) configuration)
- Networking (Ethernet configuration)
- Performance
- System

3 Main Web GUI window

By default Main page (“Main”) is shown. Contents will change according to menu panel selection.

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 a number of unsaved changes as well as their type (when moving the cursor over the button). LOGOUT button will logout from the current session.

5 System summary

Shows one to four (default value – three) selected parameters of local and remote systems and Tx polarization* (as read from the internal accelerometer).

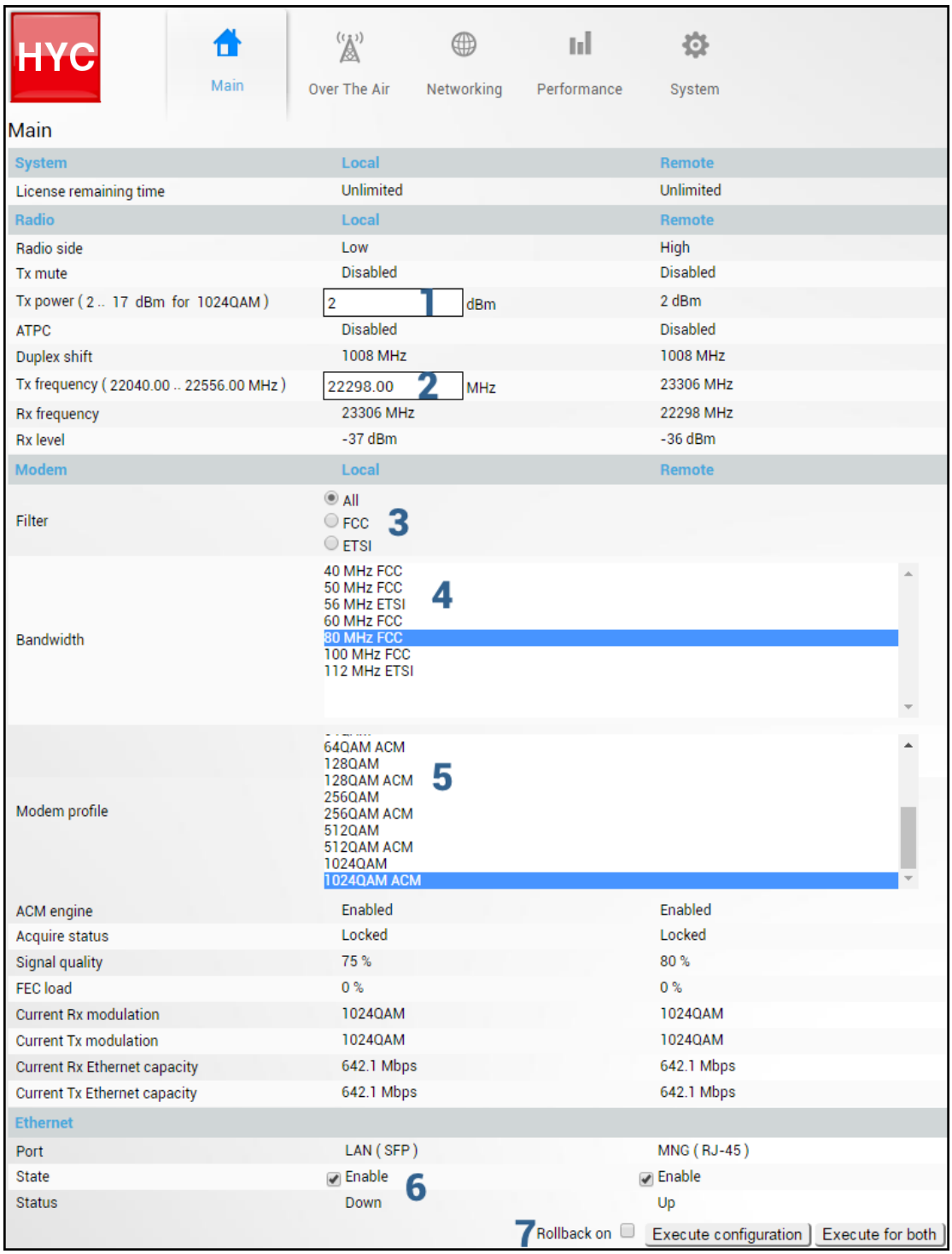
Values appear in red color in case of exceeding alarm threshold values or in case of a warning (e.g. if loopback is active).

Values appear in orange color in case alarm threshold values were exceeded during last 15 seconds.

* - Except INTEGRAL-WS 6U/6L/7/8/10/11/13 FODU models.

Modifying basic system parameters

In order to proceed with initial configuration, press MODIFY button and entry fields will appear for adjustable values:



1 Tx power

Available range depends on radio model and selected modulation. Actual range will be indicated in the brackets.

2 Tx frequency

Available range depends on the frequency band, subband, radio side and channel bandwidth selected. Actual range will be indicated in the brackets.

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

Default frequency range (indicated on the label) is defined for 14 MHz channel bandwidth.

3 Standard

Allows choosing whether only FCC, ETSI or both channel bandwidth options are visible in "Bandwidth" selection field.

4 Bandwidth

Allows choosing between available channel bandwidth, bandwidth standard (ETSI or FCC).

5 Modem profile

Allows choosing between available modulations for selected channel bandwidth.

ACM stands for Adaptive Coding and Modulation and enables adaptive modulation change according to MSE value. Modulation indicates maximum modulation, while the minimum is 4QAM.

6 State

Allows enabling/disabling each of available ports. You can switch LAN port between electrical and SFP interfaces in Networking→Ethernet→Port status and configuration.

7 Execute

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

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

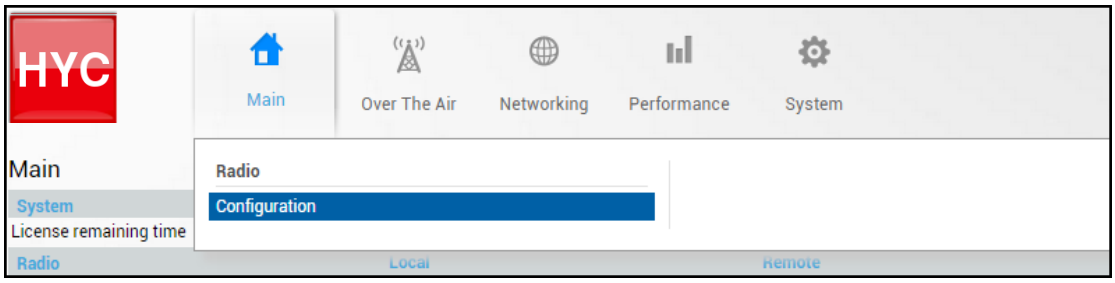
Pressing *„Execute for both"* applies changes made to the corresponding section both for local and remote side INTEGRAL-W/INTEGRAL-WS FODUs.

Over The Air

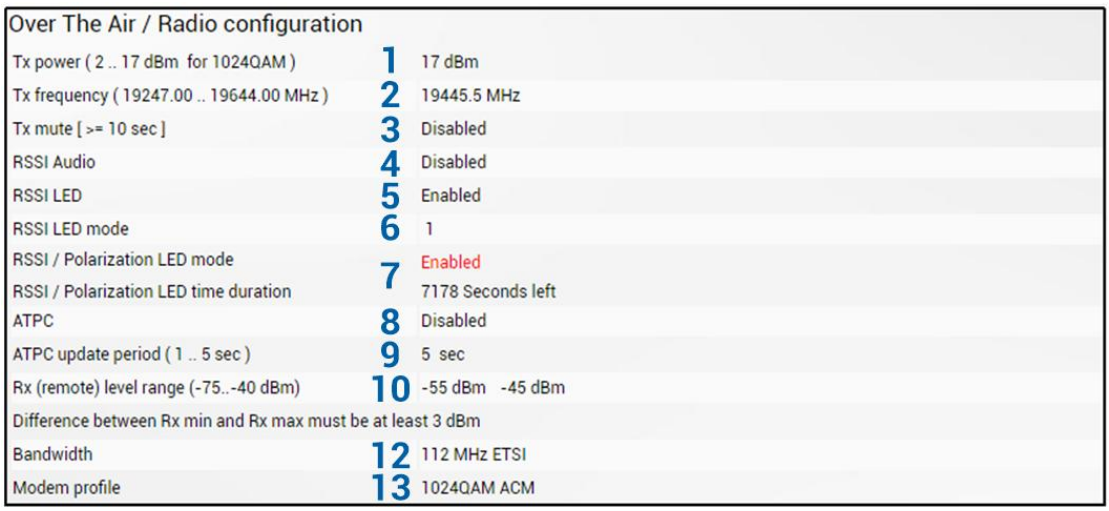
Over The Air → Radio → Configuration

The Radio configuration page is available in the menu (Over The Air → Radio → Configuration).

Refer to the chapter Radio configuration – extra fields for description of the extra fields of the 17/24 GHz INTEGRAL-W/INTEGRAL-WS FODUs.

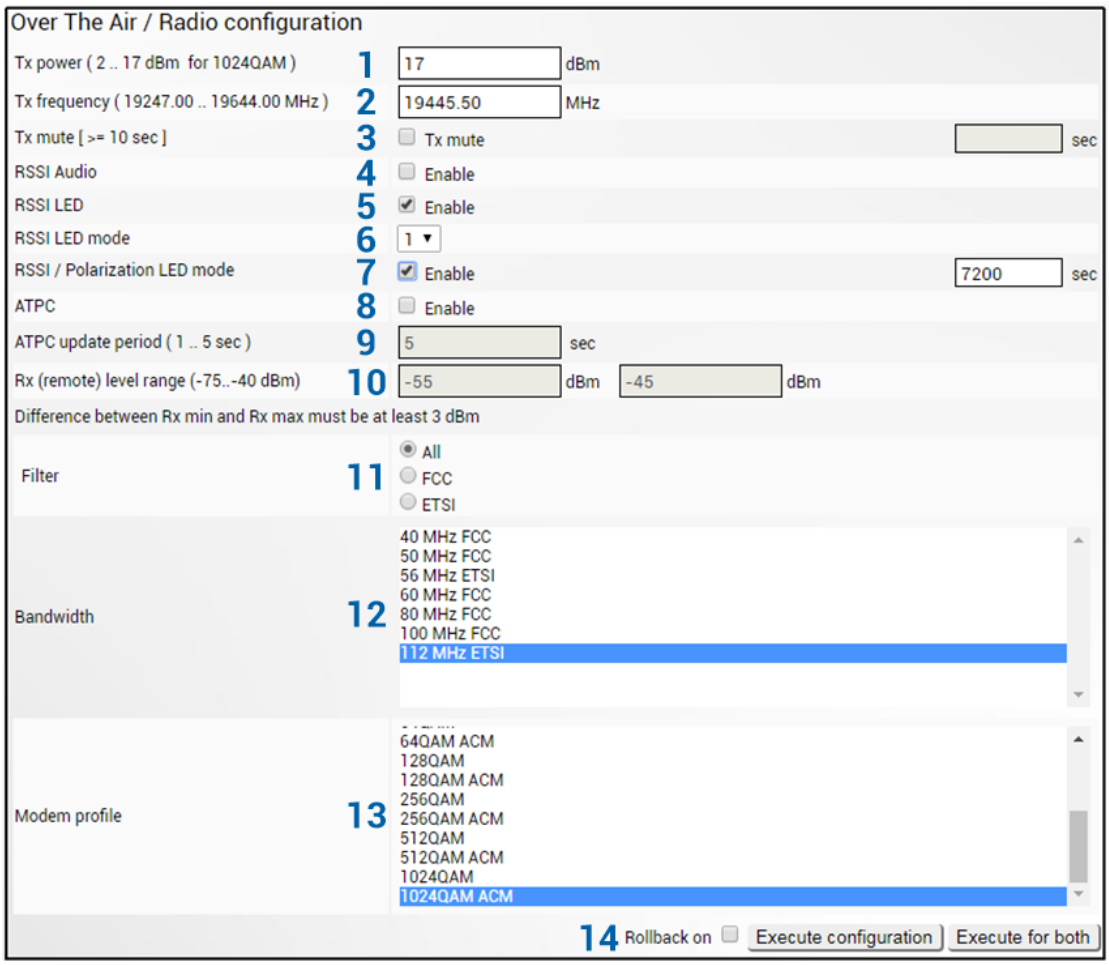


Status mode



Press MODIFY button.

Modify mode



1) ***Tx power*** – Indicates current Tx (transmit) power value (status mode); allows specifying Tx power value (modify mode). Available range depends on radio model and selected modulation. Actual range will be indicated in the brackets. ⚠ sign indicates that Tx power value was adjusted by ATPC. Move mouse over the sign for further details.
2) ***Tx frequency*** – Indicates current Tx (transmit) frequency (status mode); allows specifying Tx frequency (modify mode). Available range depends on the frequency band, subband, radio side and channel bandwidth selected. Actual range will be indicated in the brackets.
   Tx frequency range indicates the range of central frequencies for configured channel bandwidth.
   Default frequency range (indicated on the label) is defined for 40MHz channel bandwidth.
3) ***Tx mute [>=10 sec]*** – Indicates whether Tx mute is enabled or disabled (status mode); allows muting transmitter to the limited time interval in seconds (modify mode). The minimum value is 10 seconds. Note that transmitter will be muted only if the valid value in seconds is entered.
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 3.5mm jack beside USB port. By default RSSI Audio is disabled. Please refer to RSSI/audio port description for further details.
5) ***RSSI LED*** – Indicates whether RSSI LED is enabled or disabled (status mode); allows disabling or enabling RSSI LED operation (modify mode). By default RSSI LED is enabled. Please refer to RSSI LED section 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 RSSI LED section for further details.
7) ***RSSI / Polarization LED mode*** **-** Indicates if the red RSSI LED mode is enabled and reminding time (status mode); allows enable/disable the red RSSI LED operation mode for n seconds (modify mode). Its main purpose is indication of polarization alignment accuracy +/- 3deg. Functionality may not be available in older HW revisions. Please refer to RSSI LED section for further details.
8) ***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 the ATPC (Automatic Transmit Power Control) description for further details.
9) ***ATPC update period (1..5 sec)*** – Indicates 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. Please refer to the ATPC (Automatic Transmit Power Control) description for further details.
10) ***Rx (remote) level range (-75..-40 dBm)*** – Indicates minimum and maximum Rx level of remote side INTEGRAL-W/INTEGRAL-WS for ATPC operation (status mode); allows defining the minimum and maximum Rx level of remote side INTEGRAL-W/INTEGRAL-WS (modify mode). There should be at least 3dB difference between min and max values. ATPC Tx power correction will be performed only in case of exceeding these thresholds. Please refer to the ATPC (Automatic Transmit Power Control) description for further details.

Minimum Rx level threshold should be set at least 10dB above sensitivity threshold in order to avoid ACM/ATPC switching loops.

ATPC operates only when ACM is at maximum modulation (if ACM is enabled).

11) ***Filter*** – Allows choosing whether only FCC, ETSI or both channel bandwidth options are visible in "Bandwidth" selection field. Controls are available in modify mode only.
12) ***Bandwidth*** – Indicates currently configured channel bandwidth (status mode); allows choosing between available channel bandwidth options along with an indication of maximum modulation, as well as according to the standard of channel bandwidth – ETSI or FCC (modify mode).
13) ***Modem profile*** – Indicates currently configured modulation (status mode); allows choosing between available modulations for selected channel bandwidth (modify mode).
    An option with "ACM" (please refer to the chapter ACM (Adaptive Coding and Modulation) for further details) enables adaptive modulation change according to MSE value. Modulation indicates maximum modulation, while the minimum is 4QAM.
14) By pressing *„Execute configuration"* changes made to the corresponding section apply only to the local side INTEGRAL-W/INTEGRAL-WS. 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 INTEGRAL-W/INTEGRAL-WS FODUs.

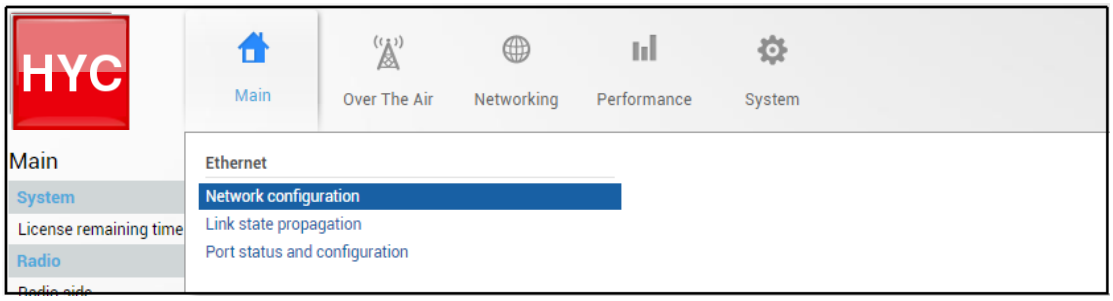
CLI commands (Chapter 4: COMMAND LINE INTERFACE)

radio [status]	Use to show radio configuration status.
radio power <Tx power>	Use to set Tx power in dBm.
radio frequency <frequency>	Use to set Tx frequency in kHz.
radio rssi-led {disable|enable [mode {1|2|3}]}	Use to enable or disable RSSI LED operation.
radio rssi-led enable mode {1|2|3} **polarization** <seconds>	Use to enable the red RSSI LED's operation for n seconds. Its main purpose is indication of polarization alignment accuracy

	+/- 3deg. Functionality may not be available in older HW revisions.
radio tx-mute {<time>|disable}	Use to mute transmitter on specific time in seconds or unmute.
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 radio firmware version. Firmware file must be located in FTP directory.
radio version	Use to check radio software version
radio atpc [status]	Use to check the status of ATPC (Automatic Transmit Power Control).
radio atpc state {enable|disable}	Use to enable/disable ATPC.
radio atpc delay <1..5>	Use to define ATPC update period.
radio atpc rx_level <-75..-40> <-72..-40>	Use to define ATPC remote Rx level min and max thresholds.
modem	Use to show modem configuration status.
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 {digital <seconds>|none}	Use to enable modem loopback for n seconds or disable it.
modem allowed	Use to check the list of available modem configurations.
modem allowed show <bandwidth> <mod>	Use to check capacity at the particular bandwidth and modulation.

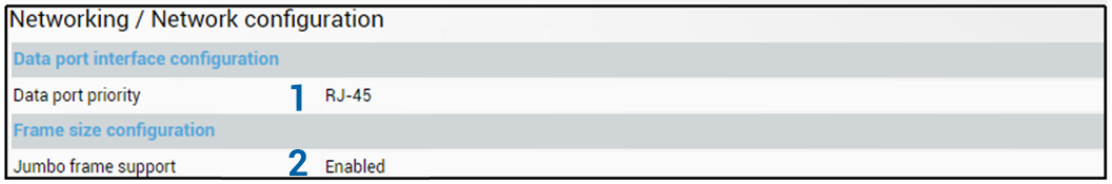
Networking

Networking → Ethernet → Network configuration



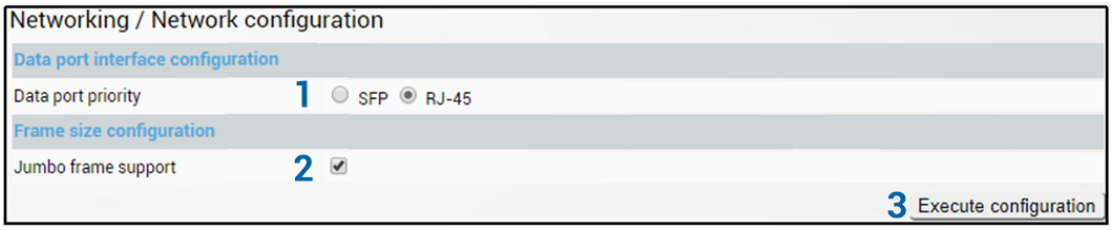
Available only in out-band firmware version (3.xx.x-mux).

Status mode



Press MODIFY button.

Modify mode



1) ***Data port priority*** – Indicates current priority interface of LAN (data) port – SFP or electrical RJ-45 (status mode); allows setting priority interface for LAN (data) port – SFP or electrical RJ-45 (modify mode). Note that only single LAN port can be active, the other one is ignored. By default, priority is set to electrical RJ-45 interface.

Priority setting means that if both interfaces are linked, only the priority interface will be used. This way redundancy can be set up – if the prioritized interface goes down, the secondary one will take over.

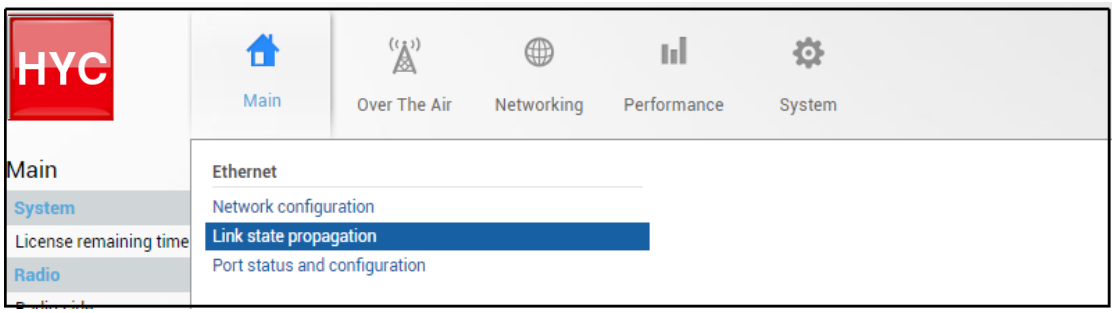
Note that the active interface is indicated in "Main status" and "Port status and configuration" pages.

2) ***Jumbo frame support*** – Indicates whether jumbo frame support is enabled (status mode); allows enabling or disabling jumbo frame support (modify mode). By default jumbo frame support (up to 9600B) is enabled. When disabled, maximum supported frame size is 1522B.
3) By pressing *„Execute configuration"* changes made to the corresponding section apply only to the local side INTEGRAL-W/INTEGRAL-WS.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

network port set LAN jumbo {enable|disable}	Use to enable or disable jumbo frame support on LAN port.
network port set LAN interf-prio [{RJ-45|sfp}]	Use to show/set active LAN port – electrical RJ-45 or SFP.

Networking → Ethernet → Link state propagation

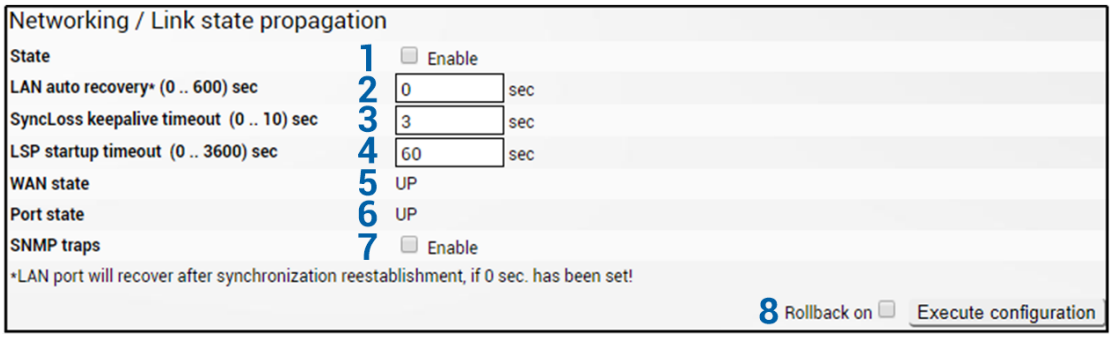


Available only in out-band firmware version (3.xx.x-mux).

Status mode

Press MODIFY button.

Modify mode

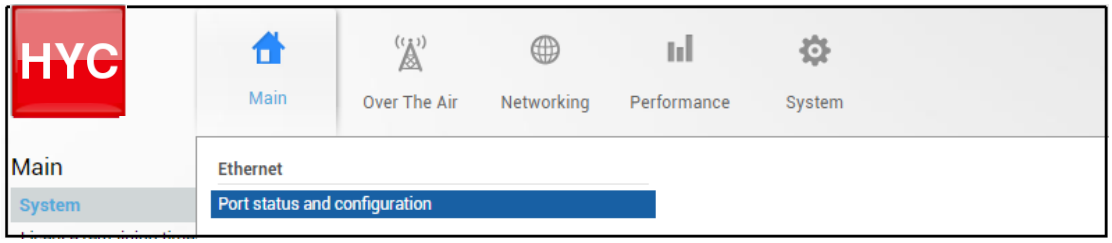


1) ***State*** – Indicates current status of Link State Propagation (status mode) and allows disabling or enabling it (modify mode).
2) ***LAN auto recovery*** – Indicates current value of LAN auto recovery (status mode) and allows specifying this value in seconds (modify mode).
3) ***SyncLoss keepalive timeout*** – Indicates current value of SyncLoss keepalive timeout (status mode) and allows specifying this value in seconds (modify mode). If value is 0, LAN port will recover after synchronization reestablishment.
4) ***LSP startup timeout*** – Indicates current value of LSP startup timeout (status mode) and allows specifying this value in seconds (modify mode).
5) ***WAN state*** – Indicates WAN port state.
6) ***Port state*** – Indicates LAN port state.
7) ***SNMP traps*** – Indicate current status of SNMP traps (status mode) and allows disabling or enabling it (modify mode).
8) By pressing *„Execute configuration”* changes made to the corresponding section apply only to the local side INTEGRAL-W/INTEGRAL-WS. If *„Rollback on”* is selected, the configuration will be reverted in case erroneous configuration changes are applied.

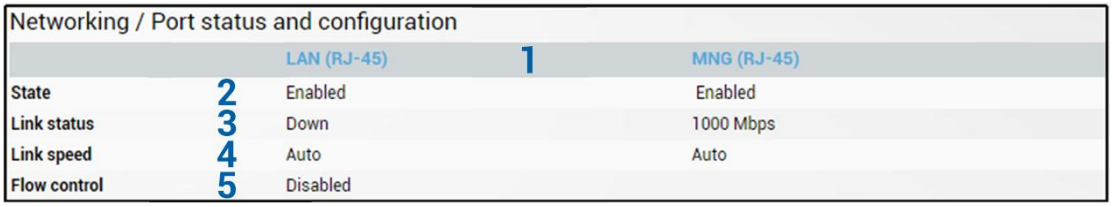
CLI commands (Chapter 4: COMMAND LINE INTERFACE)

lsp [status]	Use to show Link State Propagation status.
lsp state {enable | disable}	Use to enable/disable Link State Propagation.
lsp auto_recovery <seconds>	Use to set LAN auto recovery time in seconds.
lsp keepalive <seconds>	Use to set SyncLoss keepalive timeout in seconds.
lsp startup <seconds>	Use to set LSP startup timeout in seconds.
lsp traps {enable | disable}	Use to enable/disable SNMP traps.

Networking → Ethernet → Port status and configuration

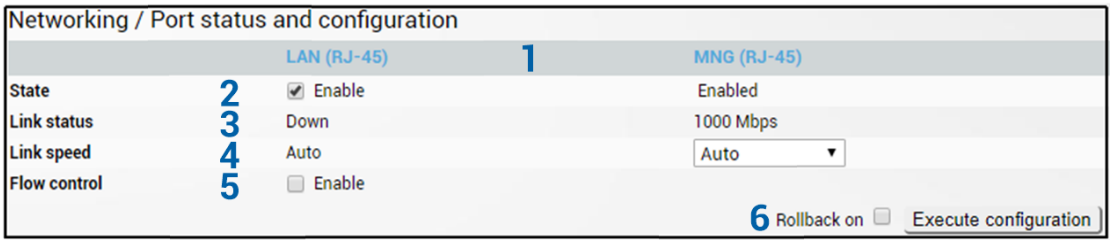


Status mode



Press MODIFY button.

Modify mode



1) ***Port*** – Indicates available switch ports. Note that in out-band firmware version (3.xx.x-mux) LAN port configuration (SFP or electrical RJ-45) should be done in the Networking → Ethernet → Network configuration page.
2) ***State*** – Indicates operation status of each LAN port (status mode); allows enabling/disabling each port (modify mode).
3) ***Link status*** – Indicates whether the link with the appropriate port is established and 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). Note that it is only possible to change the speed of MNG port (only to 100FDX).

Only MNG port can be modified to 100FDX. LAN ports support Auto Gigabit (1000FDX) only and cannot be modified.

Maximum L2 frame size supported for LAN ports is 9600B, for MNG port – 1518B.

5) ***Flow control*** – Available only in out-band firmware version (3.xx.x-mux). Indicates whether flow control is enabled or disabled on LAN port (status mode); allows enabling/disabling flow control on LAN port (modify mode). By default flow control is disabled.
6) By pressing *„Execute configuration”* changes made to the corresponding section apply only to the local side INTEGRAL-W/INTEGRAL-WS. If *„Rollback on”* is selected, the configuration will be reverted in case erroneous configuration changes are applied.

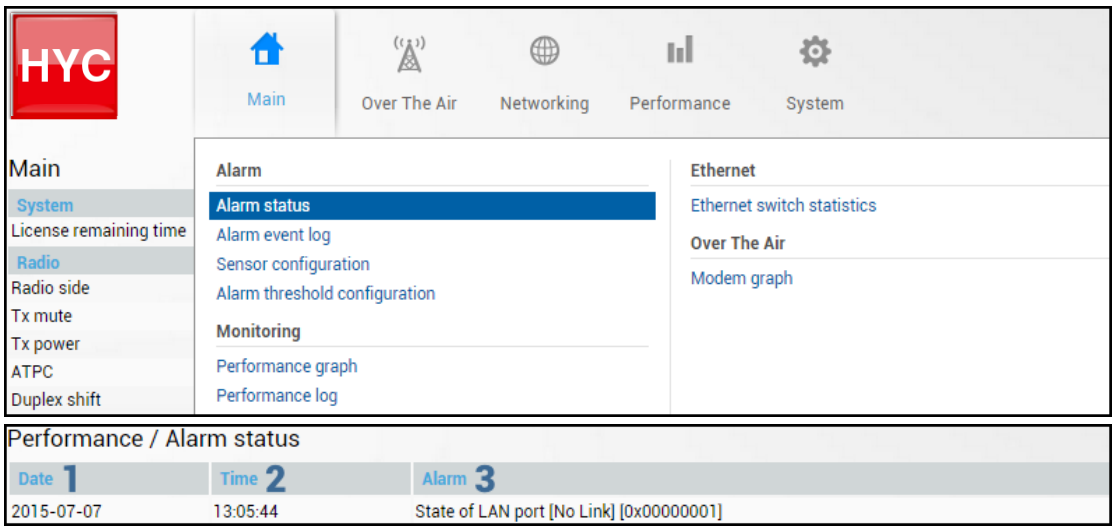
CLI commands (Chapter 4: COMMAND LINE INTERFACE)

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 particular port.
network port set MNG speed {auto|100fdx}	Use to change speed and duplex setting on MNG port. Default value is "auto" (autonegotiation).
network port set LAN **flow-control** {enable|disable}	Available only in out-band firmware version (3.xx.x-mux). Use to enable or disable flow control on LAN port.
network port set LAN **dpll** {async|master|slave}	Available only in out-band firmware version (3.xx.x-mux). Use to set DPLL operation mode on LAN port.

Performance

Performance → Alarm → Alarm status

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



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

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

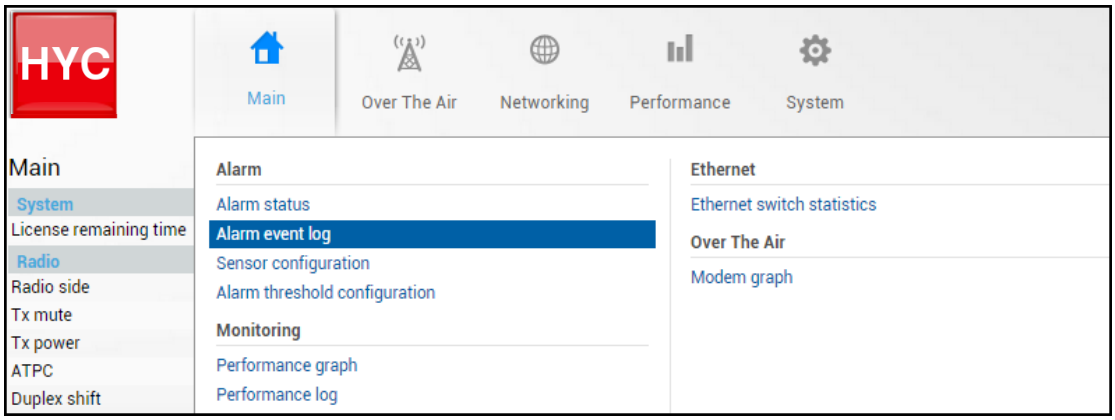
log sensor setlist	Use to show alarm status.

Performance → Alarm → Alarm event log

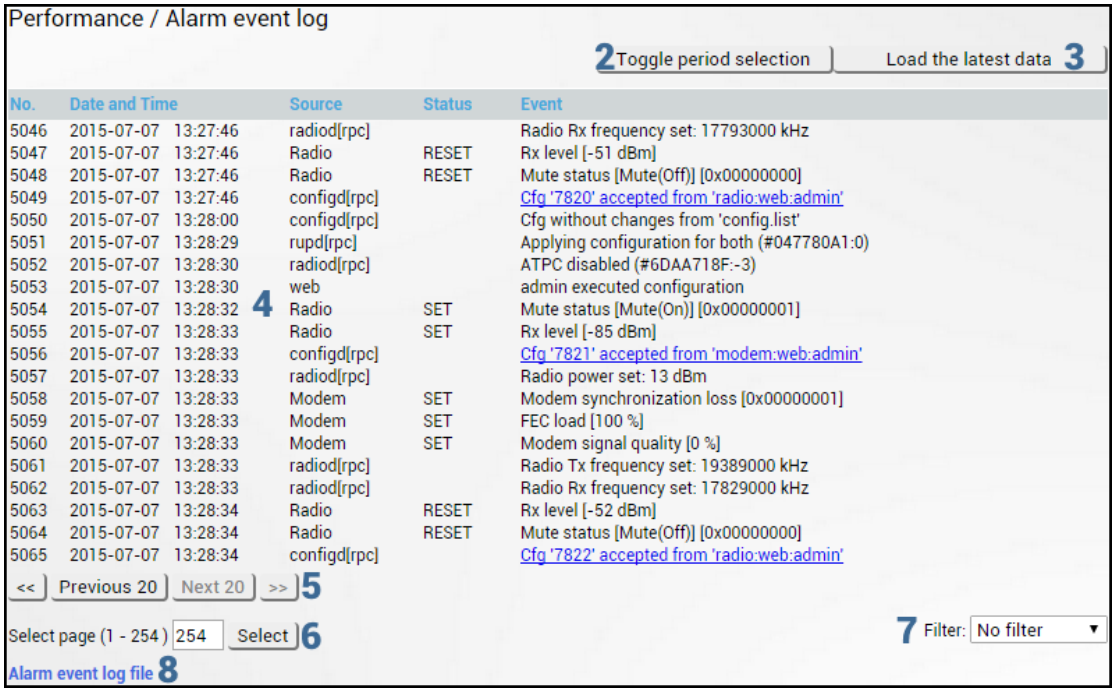
Alarm log shows 20 alarm entries per page and about 5000 alarm entries in total. Full alarm log can be downloaded by pressing on "Alarm event log file". The last page of log entries is shown by default.

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

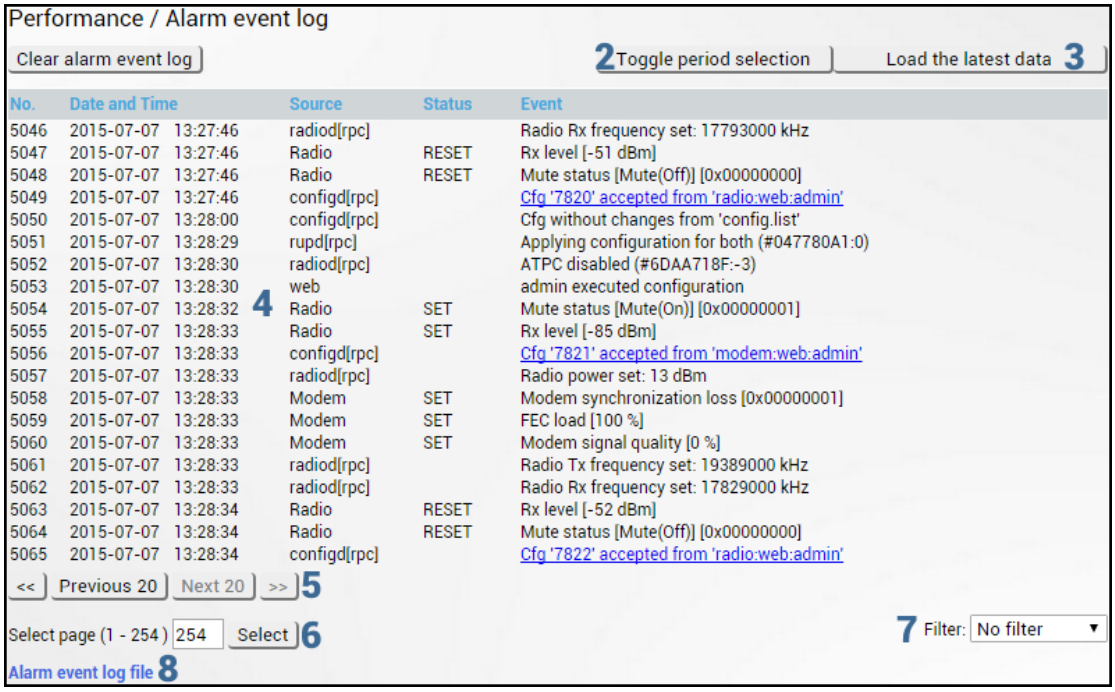


Status mode

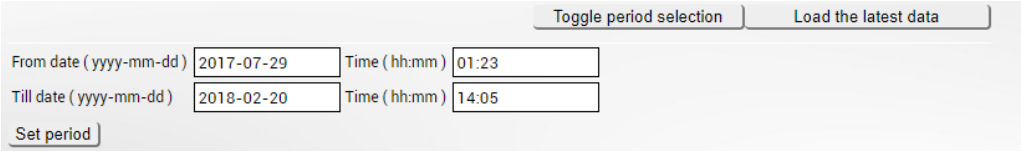


Press MODIFY button.

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. Clicking on "Cfg # accepted from <>" will redirect to Configuration file page and highlight changes made.
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, 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) ***Filter*** – press to filter alarms from certain source node (e.g. Radio);
8) ***Alarm event log file*** – press the link to download 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" refer to command above.
log event show module {alarm_only| iman| modem| ns|	Use to show entries for a specific module. Regarding

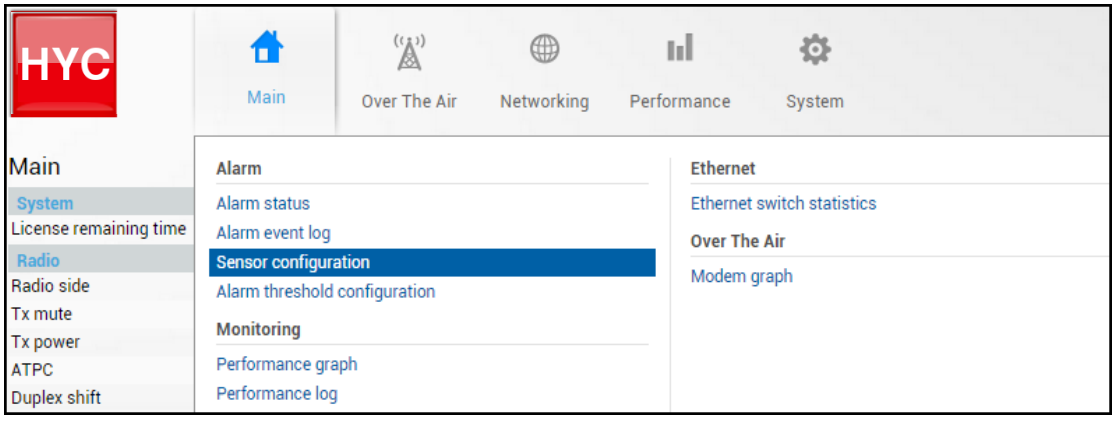
psu| radio| system} [last <#_of_entries>] [time <starttime> [<endtime]]	subcommands “last” and “time” refer to commands above.
log event clear	Use to clear alarm log
log event configure {enable| disable}	Use to enable/disable grouped repetitive alarm-event log entries.
log event configure dump <minutes>	Use to configure timer (1-60 minutes) during which repetitive log entries are counted.
log event configure pattern <1…10>	Use to specify the amount of non-repetitive entries to be counted.
log event configure status	Use to display the current configuration of grouped repetitive alarm-event log entries (filter).

Performance → Alarm → Sensor configuration

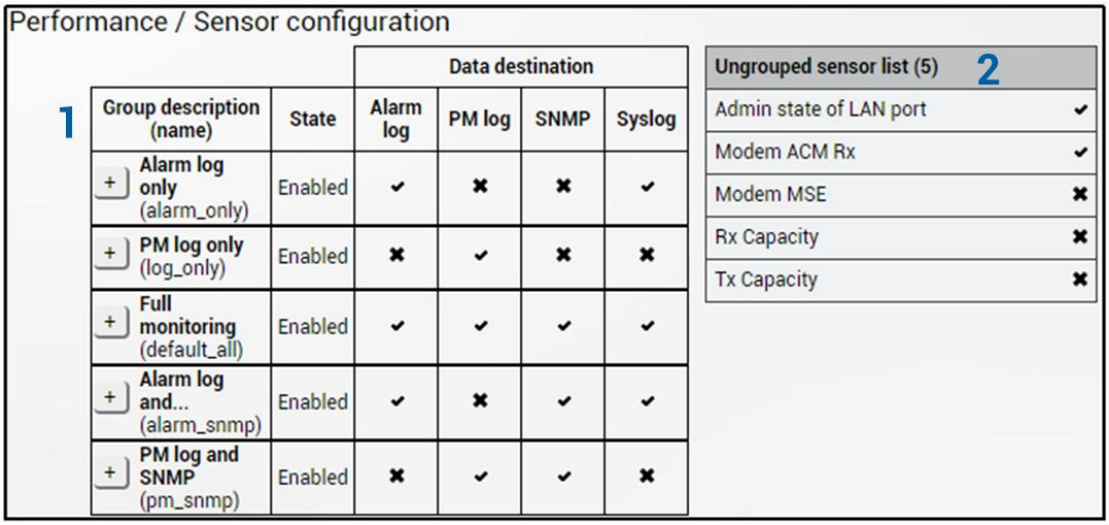
The following section allows configuring behavior of available sensor parameters.

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 log (“perf”) data destination.

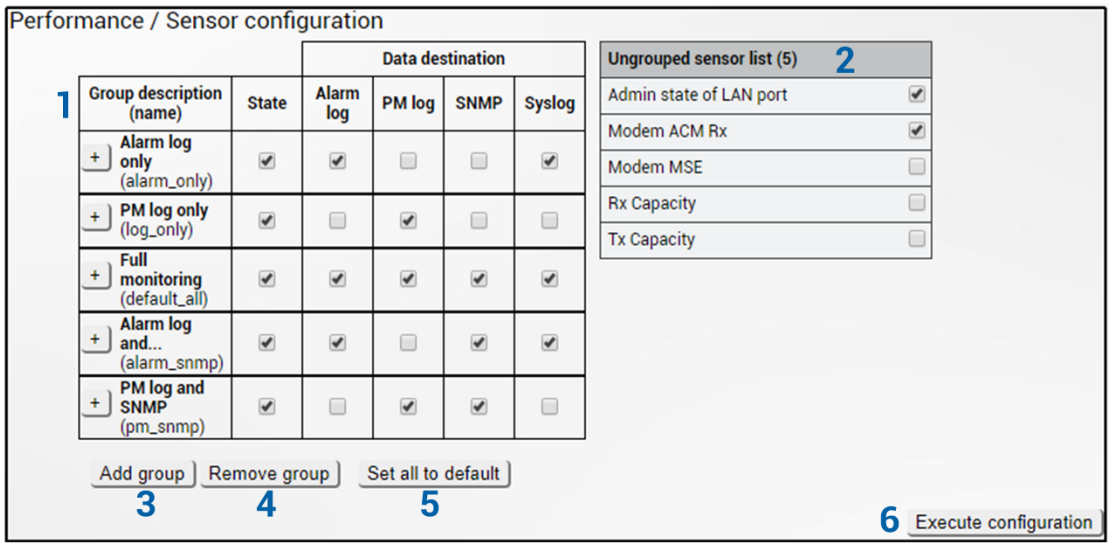


Status mode

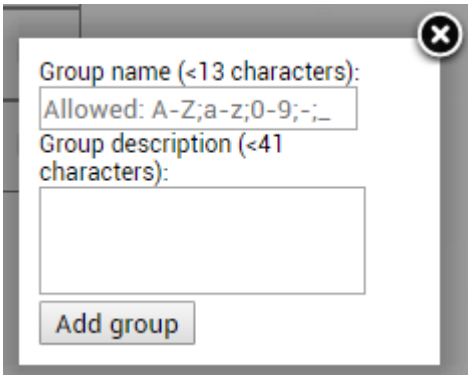


Press MODIFY button.

Modify mode

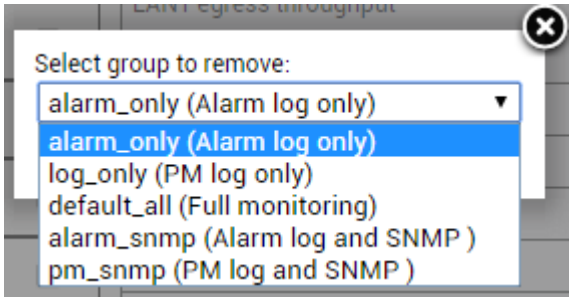


1) ***Group description (name)*** – Shows 5 groups of sensors divided by different group data destinations (event; perf; snmp), as well as indicates whether group is enabled (state);
2) ***Ungrouped sensor list*** – Shows list of sensors not added to any of existing groups (status mode); allows dragging to any of existing groups, thus specifying how the sensor will be treated. Unchecking the checkbox next to the sensor disables the sensor (modify mode).
3) ***Add group*** – Allows creating a new group with custom name and description.



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

4) ***Remove group*** – Allows deleting existing groups via a dialog window.



5) ***Set all to default*** – Restores default settings for all groups and sensors.
6) By pressing *„Execute configuration”*, changes made to the corresponding section apply only to the local side INTEGRAL-W/INTEGRAL-WS.

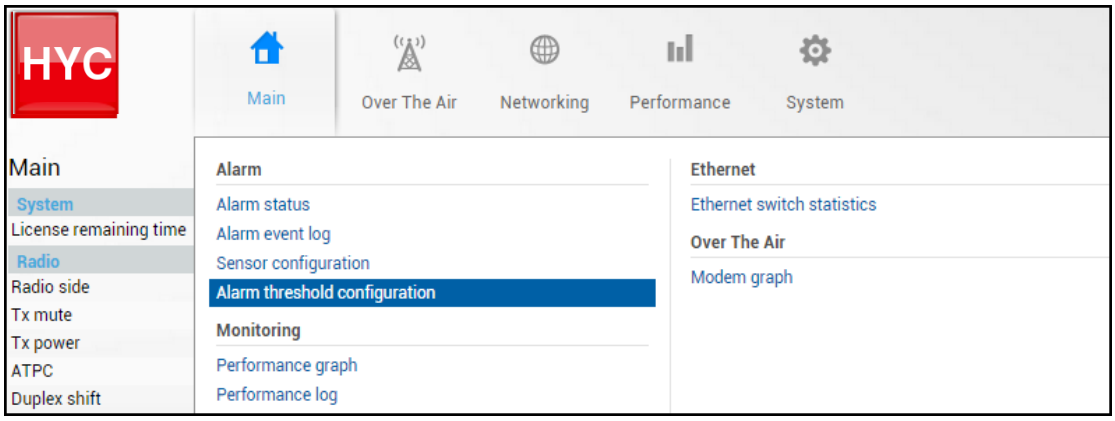
CLI commands (Chapter 4: COMMAND LINE INTERFACE)

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 list	Use to list all available sensors.

Performance → Alarm → Alarm threshold configuration

The page provides a summary of parameters' alarm thresholds. All thresholds are predefined and some change dynamically according to 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.



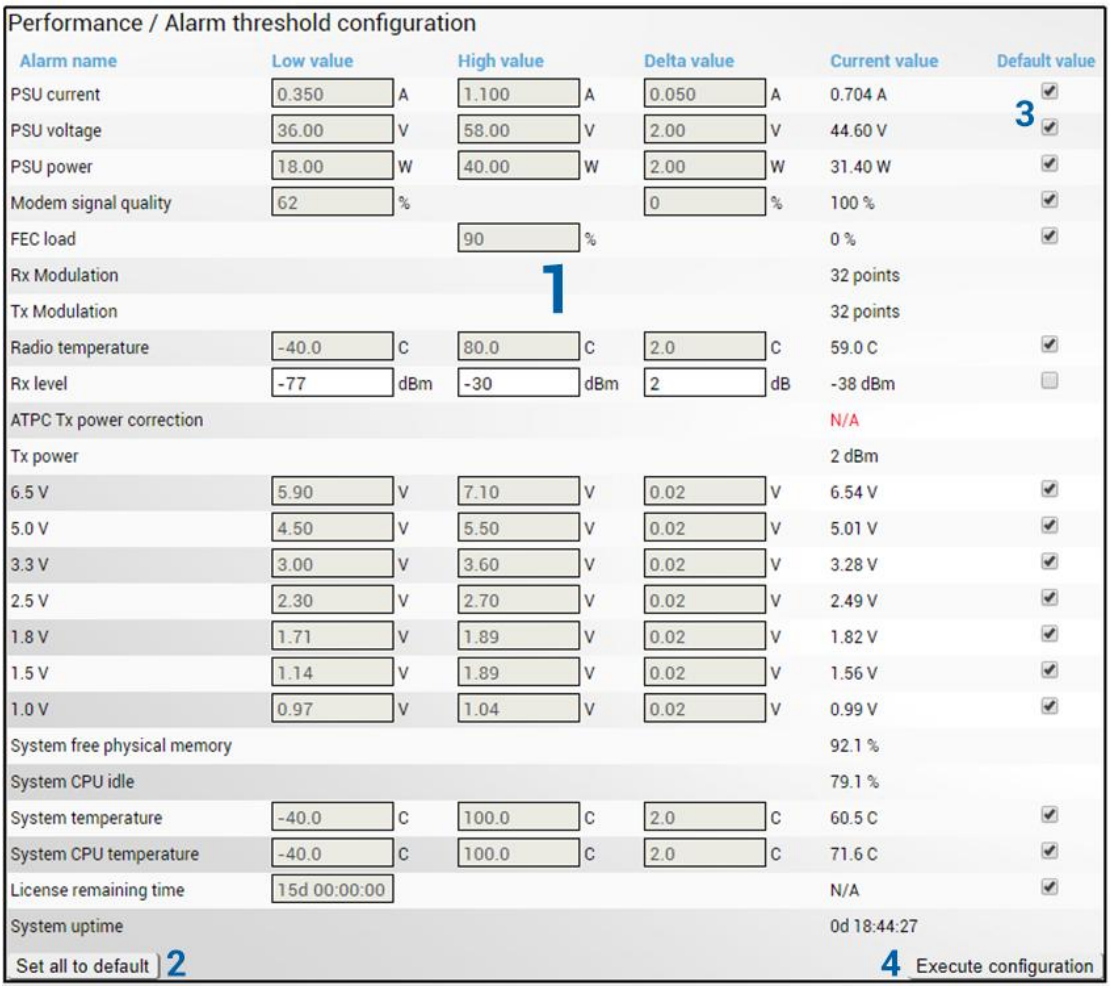
Status mode

Performance / Alarm threshold configuration

Alarm name	Low value	High value	Delta value	Current value
PSU current	0.350 A	1.100 A	0.050 A	0.704 A
PSU voltage	36.00 V	58.00 V	2.00 V	44.60 V
PSU power	18.00 W	40.00 W	2.00 W	31.40 W
Modem signal quality	62 %		0 %	100 %
FEC load		90 %		0 %
Rx Modulation				32 points
Tx Modulation				32 points
Radio temperature	-40.0 C	80.0 C	2.0 C	59.0 C
Rx level	-77 dBm	-30 dBm	2 dB	-38 dBm
ATPC Tx power correction				N/A
Tx power				2 dBm
6.5 V	5.90 V	7.10 V	0.02 V	6.54 V
5.0 V	4.50 V	5.50 V	0.02 V	5.01 V
3.3 V	3.00 V	3.60 V	0.02 V	3.28 V
2.5 V	2.30 V	2.70 V	0.02 V	2.49 V
1.8 V	1.71 V	1.89 V	0.02 V	1.82 V
1.5 V	1.14 V	1.89 V	0.02 V	1.55 V
1.0 V	0.97 V	1.04 V	0.02 V	0.99 V
System free physical memory				92.1 %
System CPU idle				91.3 %
System temperature	-40.0 C	100.0 C	2.0 C	61.0 C
System CPU temperature	-40.0 C	100.0 C	2.0 C	71.4 C
License remaining time	15d 00:00:00			N/A
System uptime				0d 18:40:26

Press MODIFY button.

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 INTEGRAL-W/INTEGRAL-WS.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

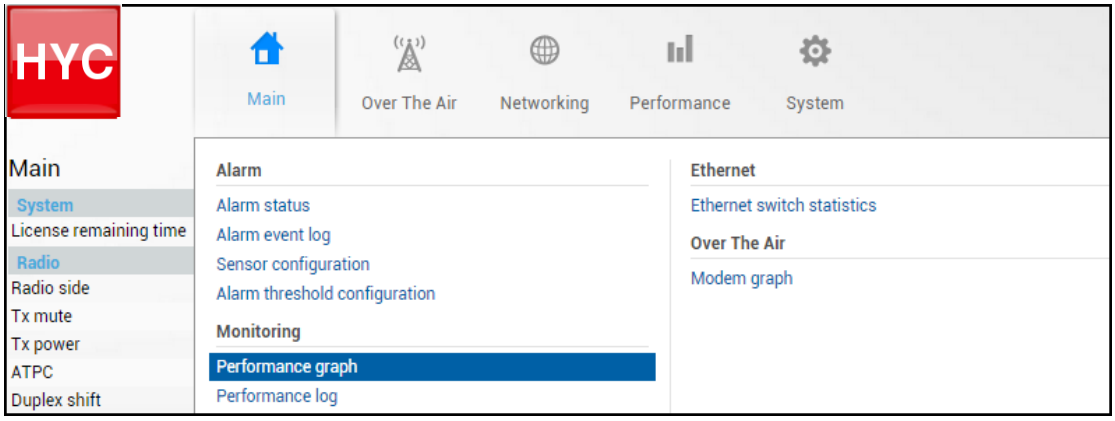
log sensor info	Use to show the configuration of sensor thresholds.
log sensor mgmt <sensor> **control {enable|disable}**	Use to enable or disable a sensor.
log sensor mgmt <sensor> **thold** <min> <max> <delta>	Use to set sensor’s min, max thresholds and delta value manually.
log sensor mgmt <sensor>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

[sensor]}	default.
log sensor list	Use to list all available sensors.

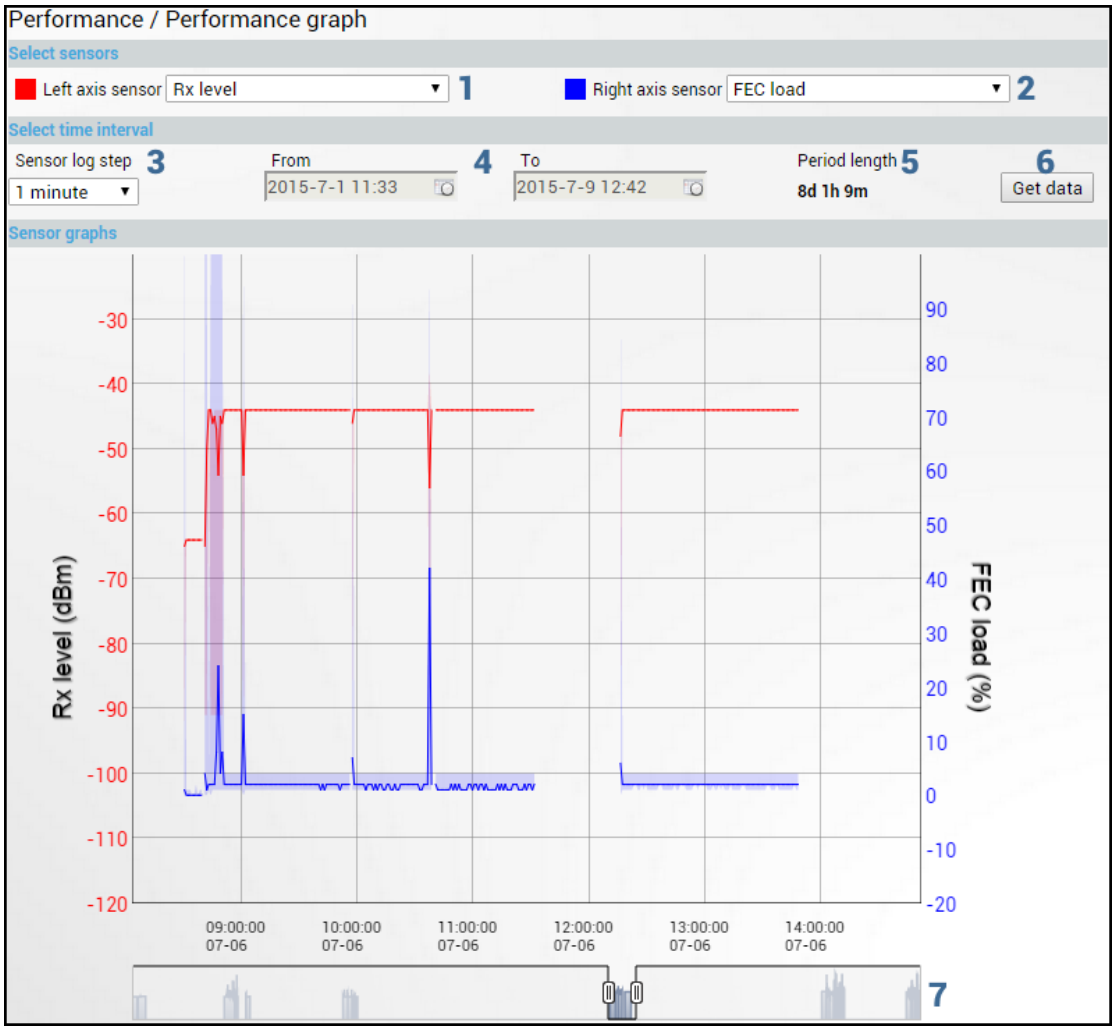
Performance → Monitoring → Performance graph

Performance graph allows visualizing various parameters over a chosen time period as 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 Radial MSE (dB) are selected.

Not all sensors available in Performance → Alarm → Sensor configuration can be displayed in the Performance graph.

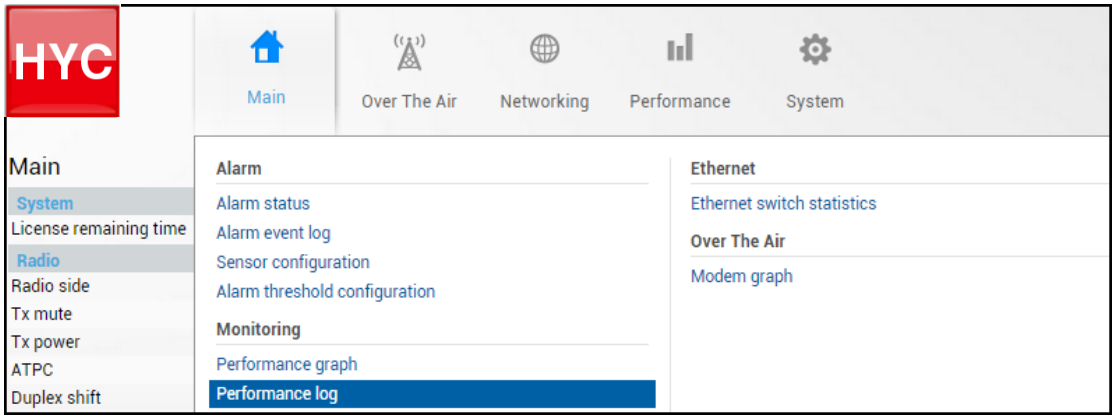


MODIFY button is deactivated in Performance graph page.

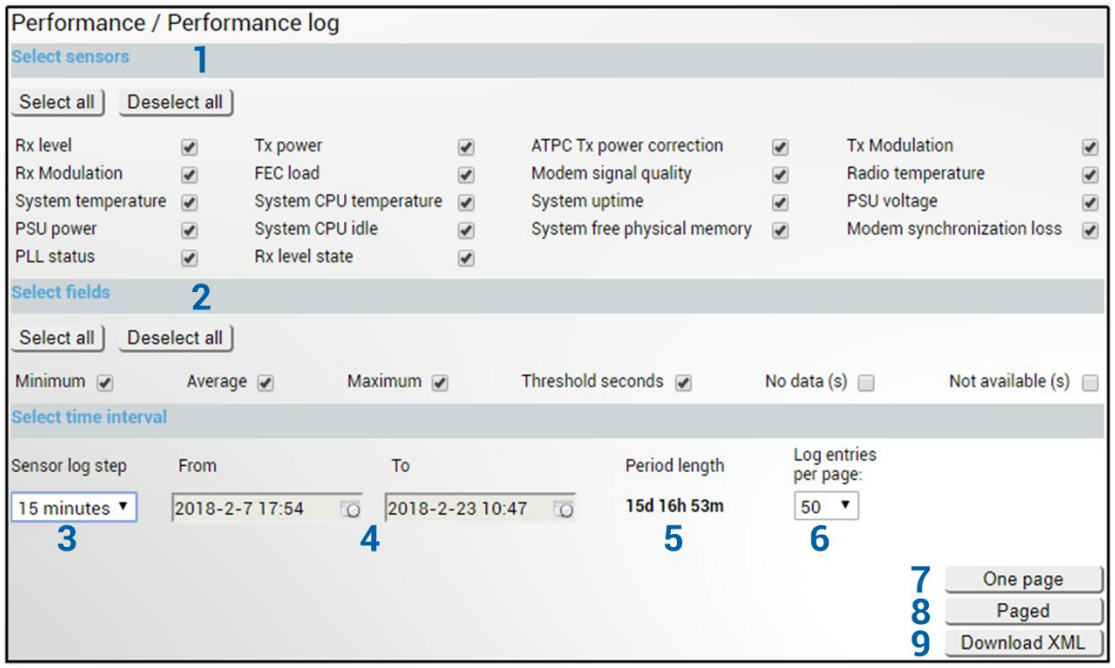


1) ***Left axis sensor*** – Allows choosing sensor parameter colored in red and displayed on the left axis.
2) ***Right axis sensor*** – Allows choosing sensor parameter colored in blue and displayed on the right axis.
3) ***Sensor log step*** – Allows choosing graph granularity – 1, 15 or 60 minutes.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

Performance → Monitoring → Performance log



MODIFY button is deactivated in Performance log page.



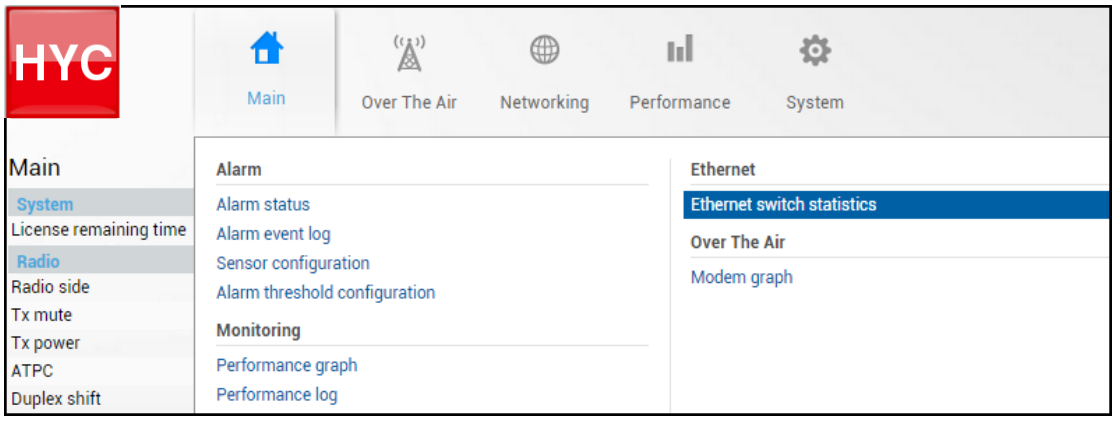
1) ***Select sensors*** – Allows choosing sensor parameters to be displayed in performance log.
2) ***Select fields*** – Allows choosing parameter fields to be displayed in performance log. "Minimum" and "Maximum" represent minimum and maximum values in specified sensor log step, while "Average" displays average value; "Threshold seconds" will show amount of seconds in chosen time interval when parameter exceeded minimum or maximum alarm thresholds; "No data (s)" and "Not available (s)" show respectively time when there was no data of according parameter and it was not available.
3) ***Sensor log step*** – Allows choosing log step – 1, 15 or 60 minutes.
4) Indicates start and end date/time of period displayed and allows selecting specific period to show.
5) ***Period length*** – Indicates 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 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 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** <starttime> <endtime> <sensor>	Use to show entries for a certain time frame. 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 perf clear	Use to clear performance log.

Performance → Ethernet → Ethernet switch statistics



Status mode (out-band management FW **version – 3.xx.x-mux**)

Performance / Ethernet switch statistics

		LAN	MNG
Statistics for	1	0d 00:05:41	0d 00:05:41
Rx Detected	2	31485464	0
Rx Dropped	3	0	0
Tx Detected	4	31485460	0
Tx Dropped	5	0	0
Rx Bytes	6	22573692664	0
Tx Bytes	7	22573688993	0
Rx 64 byte frames	8	54260	N/A
Rx 65 - 127 byte frames	9	3418064	N/A
Rx 128 - 255 byte frames	10	9743895	N/A
Rx 256 - 511 byte frames	11	2558228	N/A
Rx 512 - 1023 byte frames	12	5489062	N/A
Rx 1024 - Max byte frames	13	5489041	N/A
Rx Undersize frames	14	0	N/A
Rx Oversize frames	15	4732914	N/A
Tx 64 byte frames	16	54256	N/A
Tx 65 - 127 byte frames	17	3418054	N/A
Tx 128 - 255 byte frames	18	9743928	N/A
Tx 256 - 511 byte frames	19	2558216	N/A
Tx 512 - 1023 byte frames	20	5489088	N/A
Tx 1024 - Max byte frames	21	5488979	N/A
Tx Undersize frames	22	0	N/A
Tx Oversize frames	23	4732939	N/A
Rx Good frames	24	31485466	N/A
Rx Errors	25	N/A	0
Rx FIFO errors	26	N/A	0
Rx CRC errors	27	0	N/A
Rx Broadcast frames	28	0	N/A
Rx Multicast frames	29	0	0
Rx Control frames	30	0	N/A
Rx Length errors	31	0	N/A
Rx VLAN frames	32	0	N/A
Rx Pause frames	33	0	N/A
Rx Op errors	34	0	N/A
Rx Frame errors	35	N/A	0
Tx Good frames	36	35408758	N/A
Tx Errors	37	N/A	0
Tx FIFO err	38	N/A	0
Tx Broadcast frames	39	0	N/A
Tx Multicast frames	40	0	N/A
Tx Underrun errors	41	0	N/A
Tx Control frames	42	0	N/A
Tx VLAN frames	43	0	N/A
Tx Pause frames	44	0	N/A
Tx Single collisions	45	0	N/A
Tx Multi collisions	46	0	N/A
Tx Deferred	47	0	N/A
Tx Late collisions	48	0	N/A
Tx Excess collisions	49	0	N/A
Tx Excess deferral	50	0	N/A
Tx Alignment errors	51	0	N/A
Tx Carrier errors	52	N/A	0
Tx Collisions	53	N/A	0

Press MODIFY button.

Modify mode (buttons appear at the bottom of the page)

1) ***Statistics for*** – time during which statistics have been gathered;
2) ***Rx detected*** – The total number of packets detected on port's ingress;
3) ***Rx dropped*** – The total number of packets dropped on port's ingress;
4) ***Tx detected*** – The total number of packets detected on port's egress;
5) ***Tx dropped*** – The total number of packets dropped on port's egress;
6) ***Rx Bytes*** – Bytes on port's ingress;
7) ***Tx Bytes*** – Bytes on port's egress;
8) ***Rx 64 byte frames*** – The total number of 64-byte frames on port's ingress;
9) ***Rx 65 - 127 byte frames*** – The total number of 65…127-byte frames on port's ingress;
10) ***Rx 128 - 255 byte frames*** – The total number of 128…255-byte frames on port's ingress;
11) ***Rx 256 - 511 byte frames*** – The total number of 256…511-byte frames on port's ingress;
12) ***Rx 512 - 1023 byte frames*** – The total number of 512…1023-byte frames on port's ingress;
13) ***Rx 1024 - Max byte frames*** – The total number of 1024…1522-byte frames on port's ingress;
14) ***Rx Undersize frames*** – 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;
15) ***Rx Oversize frames*** – 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 64 byte frames*** – The total number of 64-byte frames on port's egress;
17) ***Tx 65 - 127 byte frames*** – The total number of 65…127-byte frames on port's egress;
18) ***Tx 128 - 255 byte frames*** – The total number of 128…255-byte frames on port's egress;
19) ***Tx 256 - 511 byte frames*** – The total number of 256…511-byte frames on port's egress;
20) ***Tx 512 - 1023 byte frames*** – The total number of 512…1023-byte frames on port's egress;
21) ***Tx 1024 - Max byte frames*** – The total number of 1024…1522-byte frames on port's egress;
22) ***Tx Undersize frames*** – The total number of packets sent that were less than 64 octets long (excluding framing bits but including FCS octets) and were otherwise well formed;
23) ***Tx Oversize frames*** – The total number of packets transmitted that were longer than 1522 octets (excluding framing bits but including FCS octets) and were otherwise well formed;
24) ***Rx Good frames*** – The number of frames that have been received by this port from its segment excluding fragmented and FCS error frames;
25) ***Rx Errors*** – The number of fragmented and FCS error frames;
26) ***Rx FIFO errors*** – The number of frames out of the sequence received by this port;
27) ***Rx CRC errors*** – The number of frames with the wrong CRC received by this port;
28) ***Rx Broadcast frames*** – The total number of good packets received that were directed to the broadcast address. Note that this does not include multicast packets;
29) ***Rx Multicast frames*** – 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;
30) ***Rx Control frames*** – The total number of frames received as control frames;
31) ***Rx Length errors*** – The total number of frames received with incorrect length field;
32) ***Rx VLAN frames*** – The total number of frames received containing at least one VLAN tag;
33) ***Rx Pause frames*** – The total number of frames received as control frames with valid PAUSE opcodes;
34) ***Rx Op errors*** – The total number of frames recognized as control frames but contained an Unknown Opcode;
35) ***Rx Frame errors*** – The total number of frames received with errors;
36) ***Tx Good frames*** – The number of frames that have been transmitted by this port from its segment excluding fragmented and FCS error frames;

37) ***Tx Errors*** – The number of fragmented and FCS error frames;
38) ***Tx FIFO err*** – The number of frames out of the sequence transmitted by this port;
39) ***Tx Broadcast frames*** – The total number of good packets transmitted that were directed to the broadcast address. Note that this does not include multicast packets;
40) ***Tx Multicast frames*** – The total number of good packets transmitted that were directed to a multicast address. Note that this number does not include packets directed to the broadcast address;
41) ***Tx Underrun errors*** – The number of packets transmitted that are less than the allowed 64 octets minimum length. Underrun packets occur due to jam signals generated by collisions, backpressure etc.;
42) ***Tx Control frames*** – The total number of frames transmitted as control frames;
43) ***Tx VLAN frames*** – The total number of frames transmitted containing at least one VLAN tag;
44) ***Tx Pause frames*** – The total number of frames transmitted as control frames with valid PAUSE opcodes;
45) ***Tx Single collisions*** – The total number of packets successfully transmitted by this port that experienced exactly one collision;
46) ***Tx Multi collisions*** – The total number of frames successfully transmitted by this port that experienced more than one collision;
47) ***Tx Deferred*** – The total number of frames transmitted by this port for which the first transmission attempt was delayed because the medium was busy;
48) ***Tx Late collisions*** – The total number of times that a collision was detected later than 512 bit-times into the transmission of a frame;
49) ***Tx Excess collisions*** – The total number of frames that were not transmitted from this port because 16 unsuccessful attempts were made to transmit the frame;
50) ***Tx Excess deferral*** – The total number of frames that deferred transmission for an excessive period of time;
51) ***Tx Alignment errors*** – Asserted for received frames of size 64-bytes and greater which contained an odd number of received nibbles and which also contained an invalid FCS field;
52) ***Tx Carrier errors*** – A Number of frames transmitted in which the carrier signal was lost or in which the carrier signal was not present;
53) ***Tx Collisions*** – The total number of collisions experienced by this port during packet transmissions.

Status mode **(in-band management FW version – 3.xx.x-esw)**

Performance / Ethernet switch statistics

		LAN	WAN	GFP	MNGINT	MNGCPU	MNGLAN
Statistics for	1	0d 00:18:54	0d 00:18:54	0d 00:18:54	0d 00:18:54	0d 00:18:54	0d 00:18:54
Tx Detected	2	N/D	10265	N/D	8775	10265	10190
Rx Detected	3	0	8775	N/D	10265	8773	8618
Rx CRC errors	4	0	0	0	0	N/D	N/D
Rx Length errors	5	0	0	N/D	0	N/D	N/D
Rx Bytes	6	N/D	N/D	9727554	N/D	9460246	1416304
Tx Bytes	7	N/D	N/D	9495466	N/D	9685216	7540856
Rx Good frames	8	N/D	N/D	10265	N/D	N/D	N/D
Rx Frame errors	9	N/D	N/D	0	N/D	0	0
Rx Broadcast frames	10	N/D	N/D	277	N/D	N/D	N/D
Rx Multicast frames	11	N/D	N/D	1324	N/D	0	0
Rx Control frames	12	N/D	N/D	0	N/D	N/D	N/D
Rx VLAN frames	13	N/D	N/D	0	N/D	N/D	N/D
Rx Pause frames	14	N/D	N/D	0	N/D	N/D	N/D
Tx Good frames	15	N/D	N/D	8775	N/D	N/D	N/D
Tx Broadcast frames	16	N/D	N/D	3	N/D	N/D	N/D
Tx Multicast frames	17	N/D	N/D	2	N/D	N/D	N/D
Tx Underrun errors	18	N/D	N/D	0	N/D	N/D	N/D
Tx VLAN frames	19	N/D	N/D	0	N/D	N/D	N/D
Tx Pause frames	20	N/D	N/D	2	N/D	N/D	N/D
Rx Dropped	21	N/D	N/D	N/D	N/D	0	0
Tx Dropped	22	N/D	N/D	N/D	N/D	0	0
Rx Errors	23	N/D	N/D	N/D	N/D	0	0
Rx FIFO errors	24	N/D	N/D	N/D	N/D	0	0
Tx Errors	25	N/D	N/D	N/D	N/D	0	0
Tx FIFO err	26	N/D	N/D	N/D	N/D	0	0
Tx Carrier errors	27	N/D	N/D	N/D	N/D	0	0
Tx Collisions	28	N/D	N/D	N/D	N/D	0	0

Press MODIFY button.

Modify mode (buttons appear at the bottom of the page)

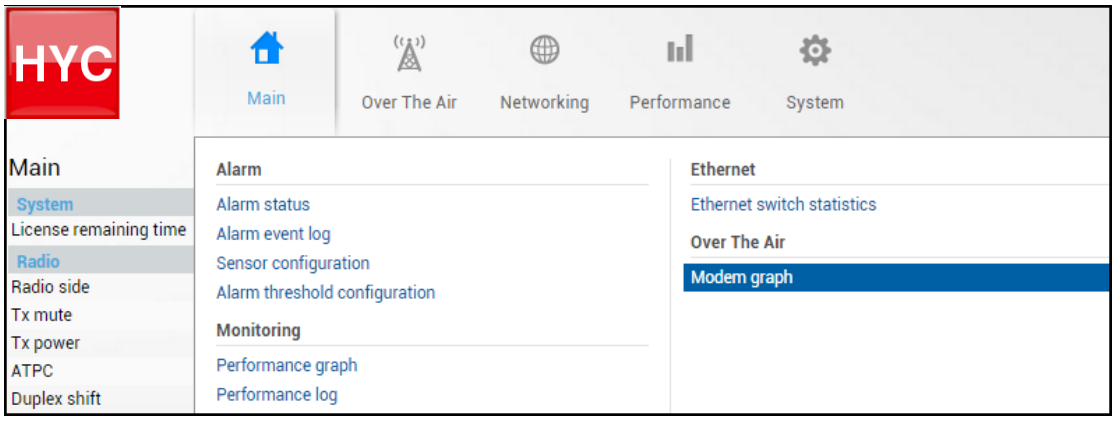
1) ***Statistics for*** – time during which statistics have been gathered;
2) ***Tx detected*** – The total number of packets detected on port's egress;
3) ***Rx detected*** – The total number of packets detected on port's ingress;
4) ***Rx CRC errors*** – The number of frames with the wrong CRC received by this port;
5) ***Rx Length errors*** – The total number of frames received with incorrect length field;
6) ***Rx Bytes*** – Bytes on port's ingress;
7) ***Tx Bytes*** – Bytes on port's egress;
8) ***Rx Good frames*** – The number of frames that have been received by this port from its segment excluding fragmented and FCS error frames;
9) ***Rx Frame errors*** – The total number of frames received with errors;
10) ***Rx Broadcast frames*** – The total number of good packets received that were directed to the broadcast address. Note that this does not include multicast packets;
11) ***Rx Multicast frames*** – 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;
12) ***Rx Control frames*** – The total number of frames received as control frames;
13) ***Rx VLAN frames*** – The total number of frames received containing at least one VLAN tag;
14) ***Rx Pause frames*** – The total number of frames received as control frames with valid PAUSE opcodes;

15) ***Tx Good frames*** – The number of frames that have been transmitted by this port from its segment excluding fragmented and FCS error frames;
16) ***Tx Broadcast frames*** – The total number of good packets transmitted that were directed to the broadcast address. Note that this does not include multicast packets;
17) ***Tx Multicast frames*** – The total number of good packets transmitted that were directed to a multicast address. Note that this number does not include packets directed to the broadcast address;
18) ***Tx Underrun errors*** – The number of packets transmitted that are less than the allowed 64 octets minimum length. Underrun packets occur due to jam signals generated by collisions, backpressure etc.;
19) ***Tx VLAN frames*** – The total number of frames transmitted containing at least one VLAN tag;
20) ***Tx Pause frames*** – The total number of frames transmitted as control frames with valid PAUSE opcodes;
21) ***Rx dropped*** – The total number of packets dropped on port's ingress;
22) ***Tx dropped*** – The total number of packets dropped on port's egress;
23) ***Rx Errors*** – The number of fragmented and FCS error frames;
24) ***Rx FIFO errors*** – The number of frames out of the sequence received by this port;
25) ***Tx Errors*** – The number of fragmented and FCS error frames;
26) ***Tx FIFO err*** – The number of frames out of the sequence transmitted by this port;
27) ***Tx Carrier errors*** – A Number of frames transmitted in which the carrier signal was lost or in which the carrier signal was not present;
28) ***Tx Collisions*** – The total number of collisions experienced by this port during packet transmissions.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

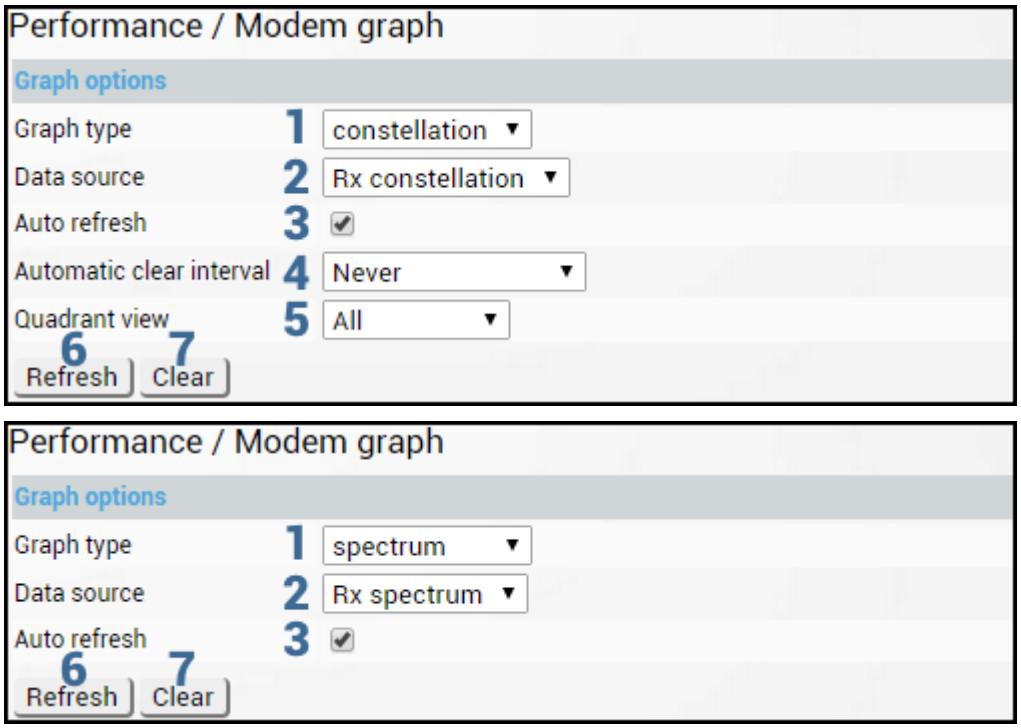
network port show statistics	Use to show Ethernet statistics on all ports.
network port reset statistics {LAN | MNG | all}	Use to reset Ethernet statistics for a particular port or all ports in out-band management FW version.
network port reset statistics {GFP | LAN | MNGCPU | MNGINT | MNGLAN | WAN | all}	Use to reset Ethernet statistics for a particular port or all ports in in-band management FW version.

Performance → Over The Air → Modem graph



MODIFY button is deactivated in the Modem graph page.

The Modem graph can be activated in two modes – "constellation diagram" and "spectrum".



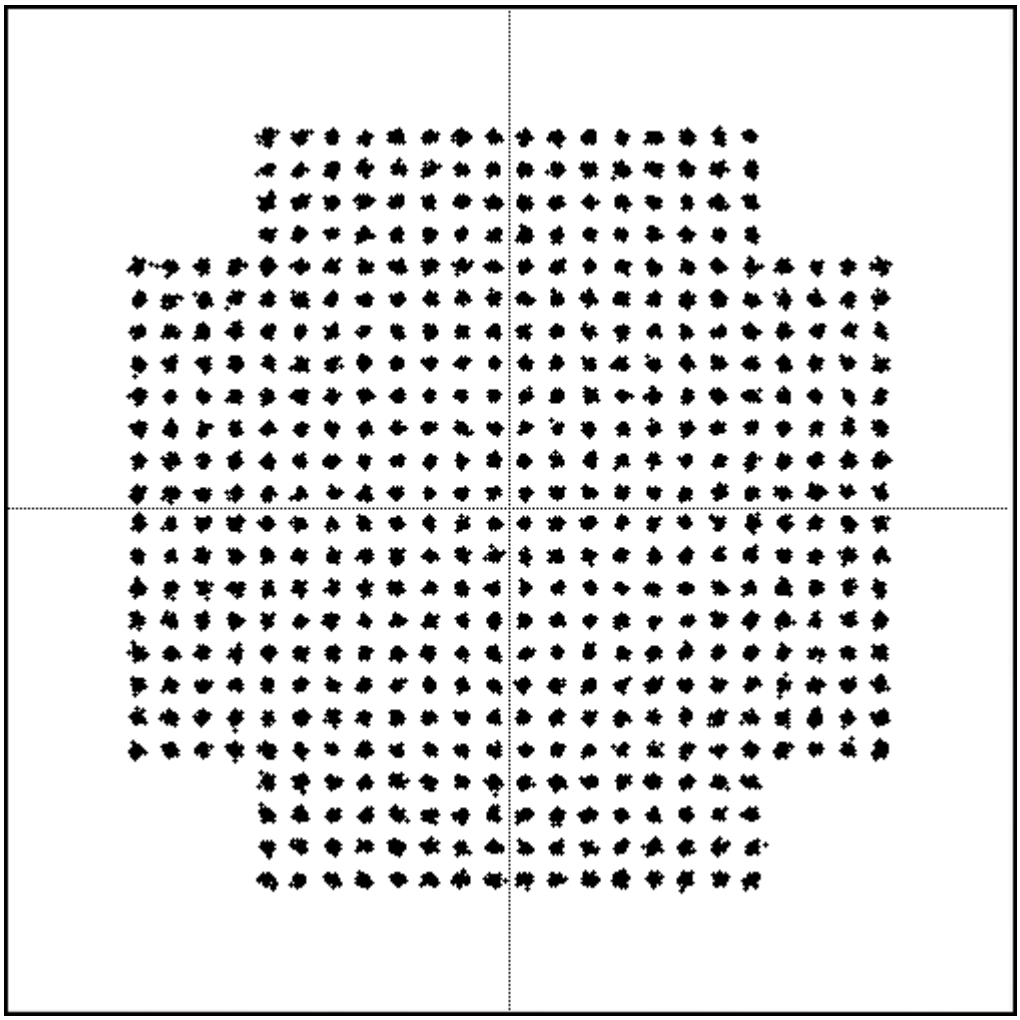
1) ***Graph type*** – Allows choosing between "constellation" and "spectrum" graph types;
2) ***Data source*** – Indicates source of the signal;
3) ***Auto refresh*** – Allows disabling auto refresh of constellation/spectrum;
4) ***Automatic clear interval*** – Allows choosing how often is constellation automatically cleared;
5) ***Quadrant view*** – Allows zooming constellation diagram to specific quadrant or part of the quadrant;
6) ***Refresh*** – Allows refreshing constellation diagram/spectrum. This button is not available if auto refresh enabled;
7) ***Clear*** – Allows clearing constellation diagram/spectrum.

Only a single user can see Constellation diagram and Spectrum curve at a time.

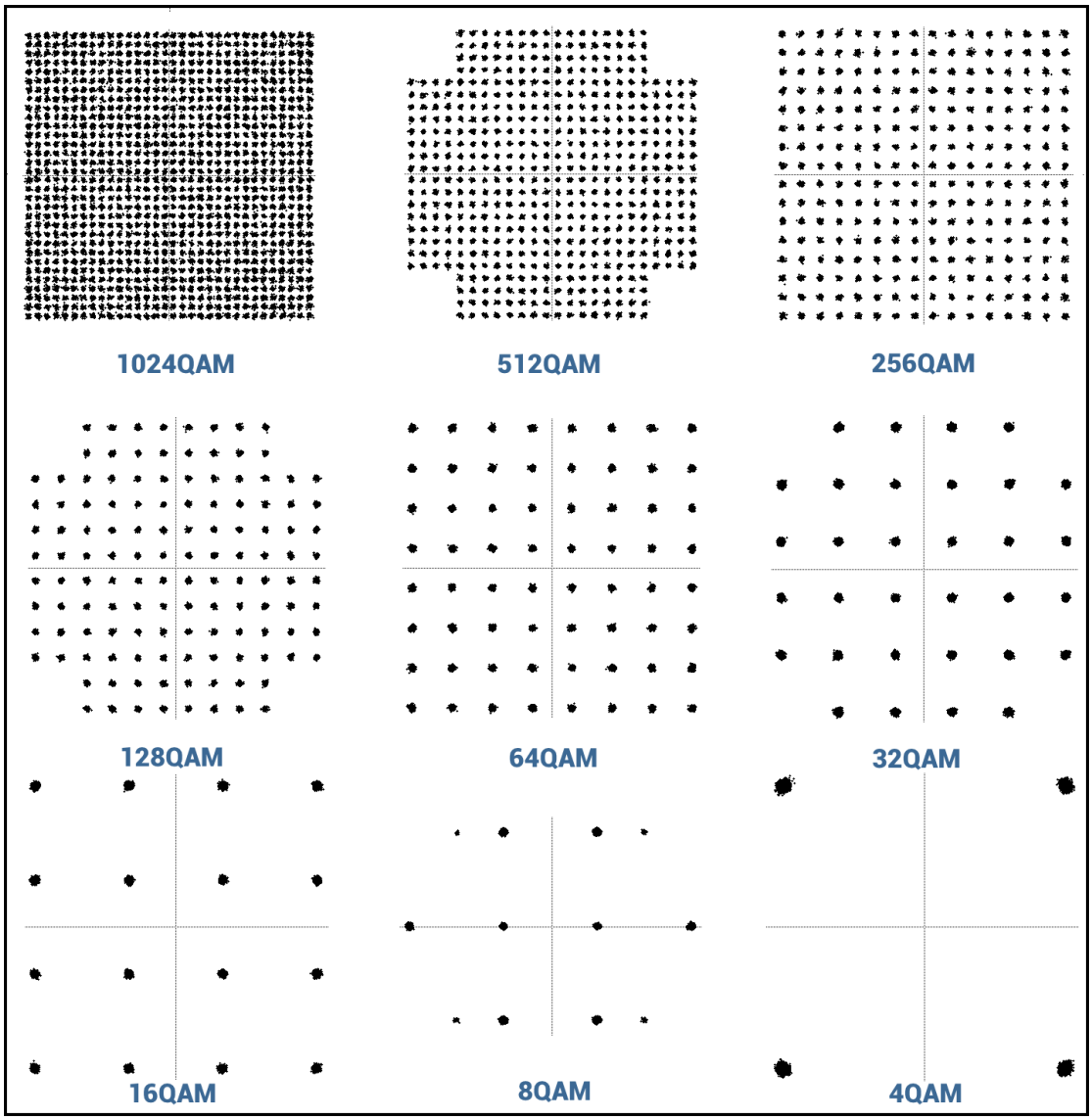
Constellation diagram

A constellation diagram is a representation of a signal modulated by the digital modulation schemes 1024QAM, 512QAM, 256QAM, 128QAM, 64QAM, 32QAM, 16QAM, 8QAM or 4QAM. It displays the signal as a two-dimensional scatter diagram in the complex plane at symbol sampling instants. Measured constellation diagram can be used to recognize the type of interference and distortion in a signal.

Constellation diagram (512QAM):

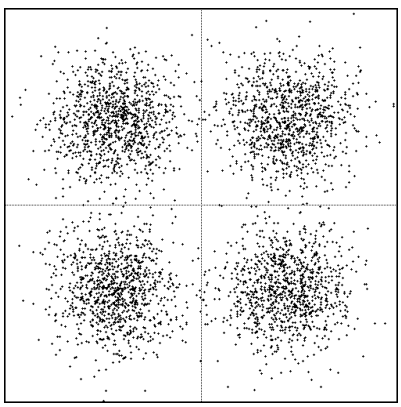


Examples of INTEGRAL-W/INTEGRAL-WS constellation diagrams under ideal conditions are shown below:

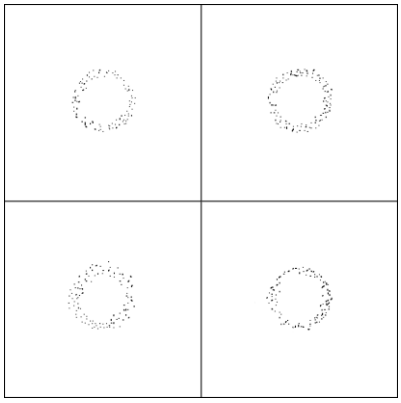


For the purpose of analyzing the received signal quality, some types of corruption are evident in the constellation diagram. For example:

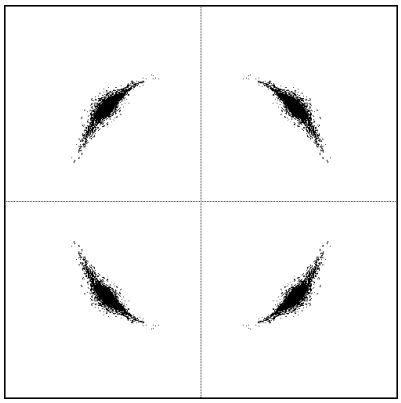
1) Gaussian noise is displayed as fuzzy constellation points:



2) Non-coherent single frequency interference is displayed as circular constellation points:



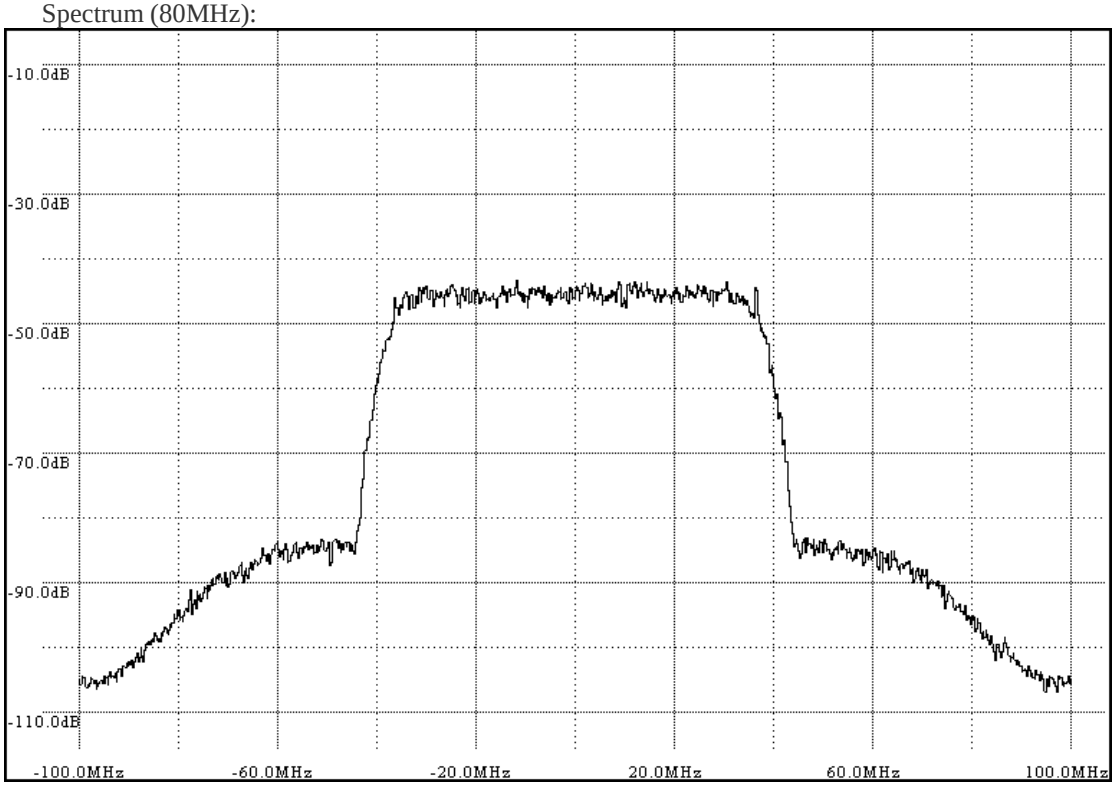
3) Phase noise is displayed as rotationally spreading constellation points:



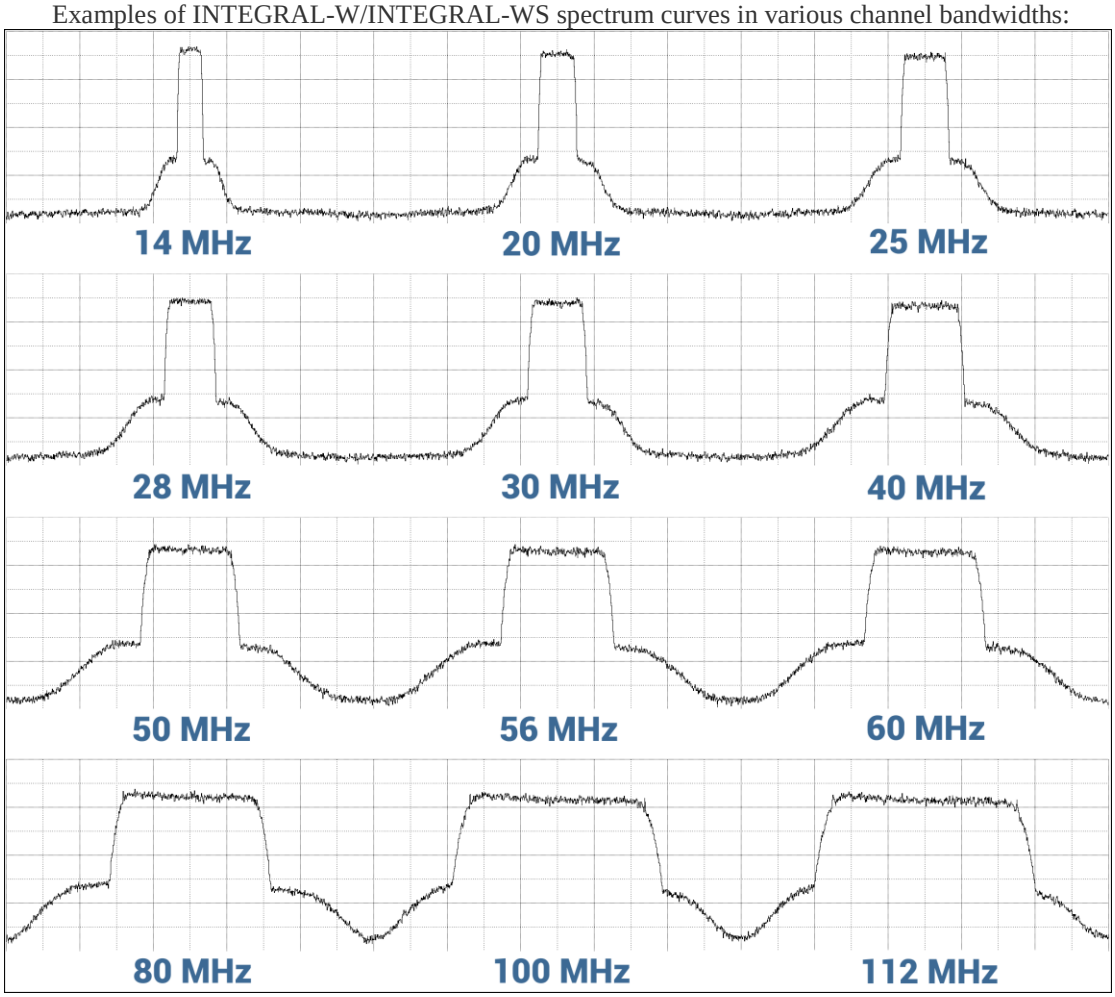
Spectrum

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

Spectrum (80MHz):

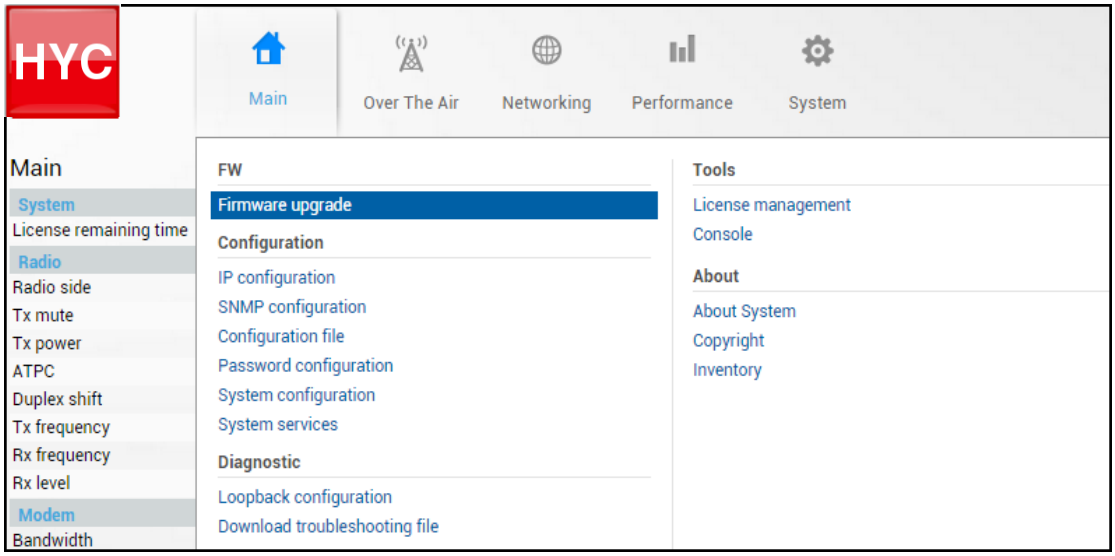


Examples of INTEGRAL-W/INTEGRAL-WS spectrum curves in various channel bandwidths:



System

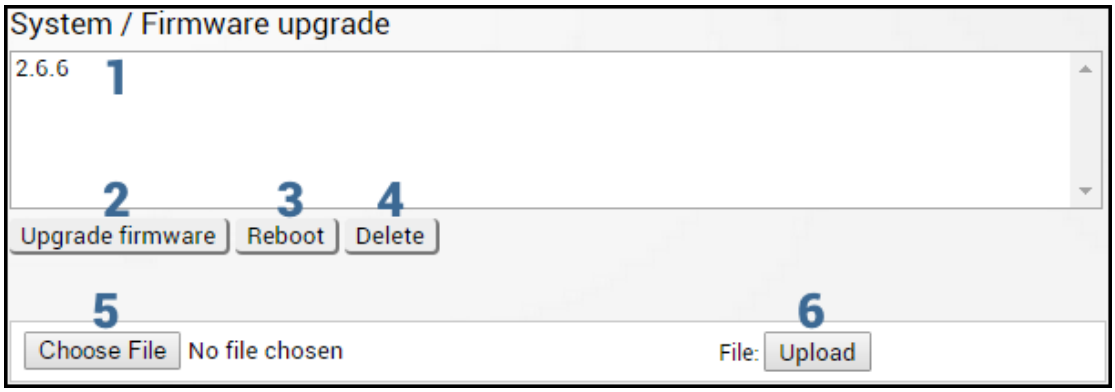
System → FW → Firmware upgrade



Status mode

Press MODIFY button.

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 firmware upgrade process.

> Latest INTEGRAL-W/INTEGRAL-WS firmware can be downloaded in https://saftehnika.com/en/downloads in "Firmwares" section. Login required.

3) ***Reboot*** – Reboots INTEGRAL-W/INTEGRAL-WS (cold restart).
4) ***Delete*** – Deletes selected firmware file from the list.
5) ***Choose File*** – Press to browse for a firmware file on your hard disk drive.
6) ***Upload*** – Press to upload a firmware file to INTEGRAL-W/INTEGRAL-WS.

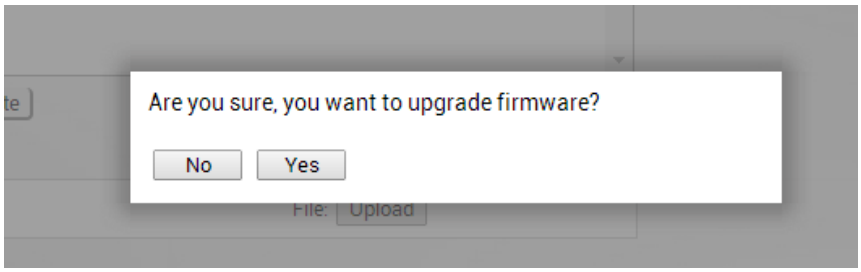
INTEGRAL series firmware upgrade via Web GUI

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

Latest INTEGRAL firmware update package can be downloaded at the following URL: https://www.saftehnika.com/en/downloads (registration required).

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

1) Go to "System → FW → Firmware upgrade";
2) Press "MODIFY" button on right side of the page;
3) Press "Choose File" button, locate *.bin firmware file on your hard disk (extracted from the firmware update package) and press "Open" button;
4) Press "Upload" button;
5) Select uploaded firmware from firmware list and press "Upgrade firmware" button;
6) Confirm the upgrade and reboot the system.



The remote side must be upgraded first.

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

Transition between out-band management and in-band management firmware versions

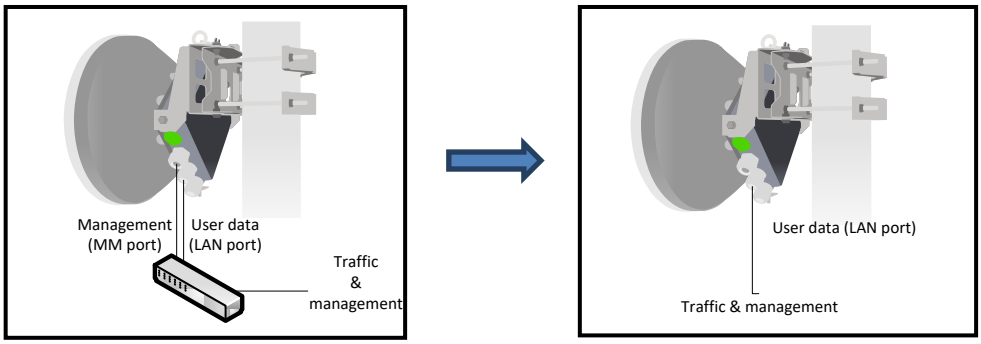
In-band management firmware version (3.xx.x-esw): management is available both on dedicated management (MM) port and on data (LAN) ports. User traffic is available only on data (LAN) ports.

Out-band management firmware version (3.xx.x-mux): management is available only on dedicated management (MM) port. User traffic is available only on one of the data (LAN) ports. By default – LAN (TP) is enabled, while LAN (SFP) is disabled.

Upgrading from out-band management (3.xx.x-mux) to in-band management (3.xx.x-esw) firmware version

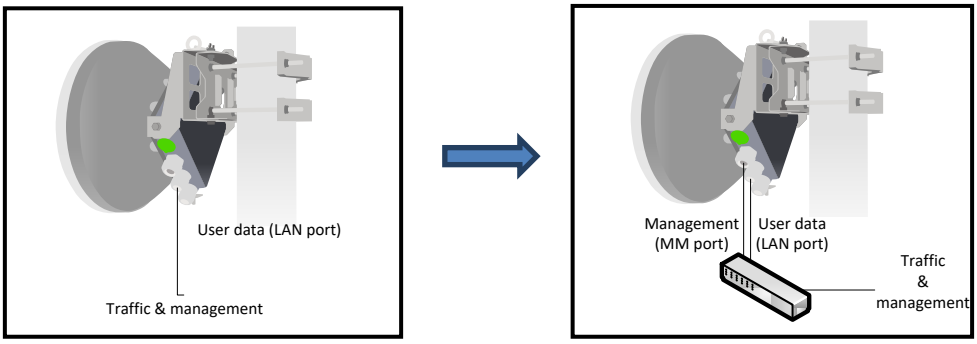
Some HW revisions (without "S1" at the end of P/N) might have issues if FW version is changed from out-band management to in-band management.

- Follow instructions in the section INTEGRAL series firmware upgrade via Web GUI.
- A single Ethernet cable should be interconnected between INTEGRAL LAN port and CPE in order to avoid Ethernet loops



Upgrading from in-band management (3.xx.x-esw) to out-band management (3.xx.x-mux) firmware version

- Follow instructions in the section INTEGRAL series firmware upgrade via Web GUI.
- Management will be available only on dedicated management (MM) port, thus in order to maintain management access after the firmware upgrade, management (MM) port should be interconnected with CPE on one side of the link if management traffic is transmitted over the link (default setting). If management traffic is not transmitted over the link, management (MM) port should be interconnected with CPE on both sides of the link.



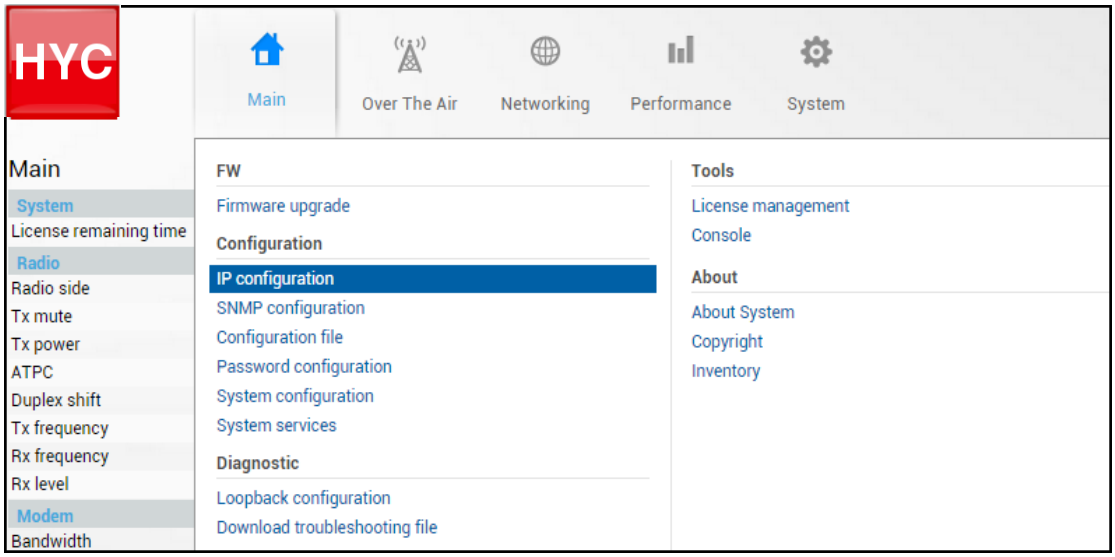
CLI commands (Chapter 4: COMMAND LINE INTERFACE)

firmware info [<version>]	Use to show detailed information on current or specific INTEGRAL-W/INTEGRAL-WS firmware.
firmware install <version>	Use to install firmware version uploaded. Note that exact version needs to be entered. Check available firmware versions using command “firmware list”. ⚠ Mind the information in the chapter Transition between out-band management and in-band management firmware versions.
firmware list	Use to list uploaded firmware versions.
firmware remove <version>	Use to remove firmware version uploaded. Note that exact version needs to be entered. Check available firmware versions using 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 switch {fs|fw1|fw2|toggle}	Use to define 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

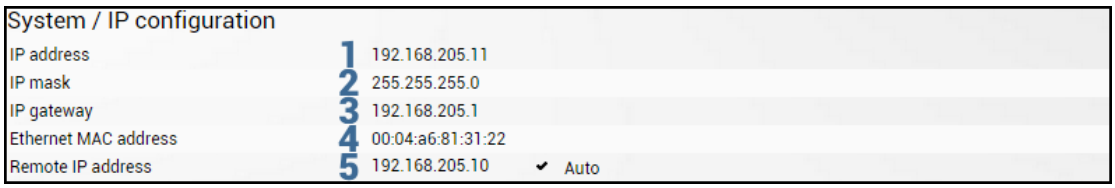
	emergency bank, which is used if both “fw1” and “fw2” fail.
firmware upload <filename>	Use to upload firmware from the FTP directory.

System → Configuration → IP configuration

The IP address configuration page is available in the menu (System → Configuration → IP configuration).

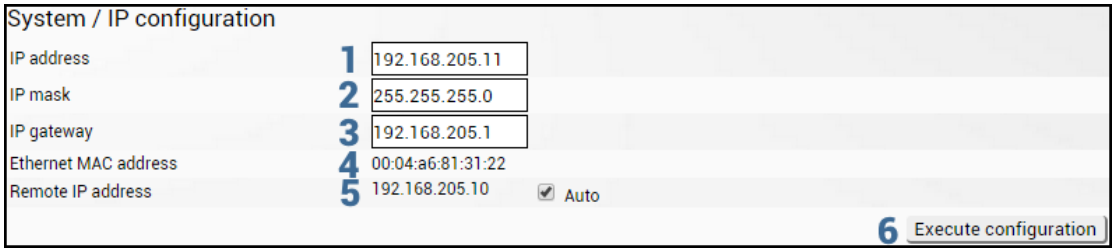


Status mode



Press MODIFY button.

Modify mode



1) ***IP address*** – Indicates IP address of INTEGRAL-W/INTEGRAL-WS you are currently logged in (status mode); allows specifying IP address of INTEGRAL-W/INTEGRAL-WS you are currently logged in (modify mode). Default IP address is 192.168.205.10 or 192.168.205.11 – depending on which side the specific INTEGRAL-W/INTEGRAL-WS is – low side has 192.168.205.10 IP address and high side – 192.168.205.11.

INTEGRAL-W/INTEGRAL-WS IP addresses need to be on the same subnet.

2) ***IP Mask*** – Indicates IP mask of INTEGRAL-W/INTEGRAL-WS you are currently logged in (status mode); allows specifying IP mask of INTEGRAL-W/INTEGRAL-WS you are currently logged in (modify mode). Default IP mask is 255.255.255.0.

3) ***IP gateway*** – Indicates gateway address of INTEGRAL-W/INTEGRAL-WS you are currently logged in (status mode); allows specifying gateway address of INTEGRAL-W/INTEGRAL-WS you are currently logged in (modify mode). By default gateway is not specified (blank).
4) ***Ethernet MAC address*** – shows the MAC address of INTEGRAL-W/INTEGRAL-WS you are currently connected to.
5) ***Remote IP address*** – shows IP address of remote (far-end) INTEGRAL-W/INTEGRAL-WS. By default, remote IP address is being retrieved automatically and therefore "Auto" checkbox is selected. In modify mode you can unselect "auto" option and enter remote IP address manually.
6) By pressing *„Execute configuration"* changes made to the corresponding section apply only to the local side INTEGRAL-W/INTEGRAL-WS.

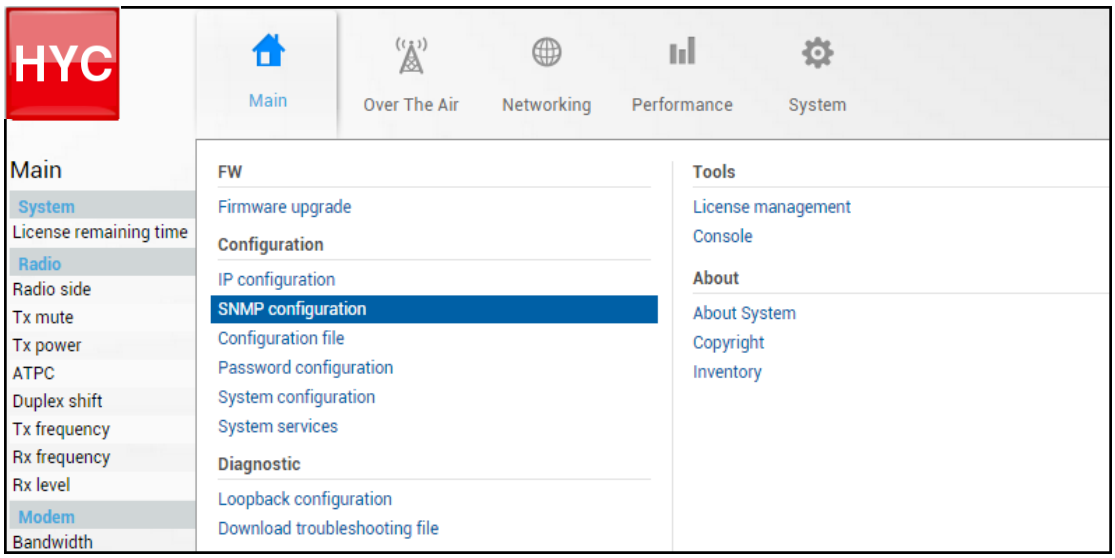
CLI commands (Chapter 4: COMMAND LINE INTERFACE)

system ip addr [<IP>]	Use to show/set IP address of management CPU.
system ip gw [{<IP>|clear}]	Use to show/manage IP address of the gateway.
system ip mask [<mask>]	Use to show/set subnet mask.
System ip mac	Use to show MAC address of management CPU.
System ip cfg {<ip address> <mask> | <ip address> <mask> <gateway> | <ip address/CIDR> | <ip address/CIDR> <gateway>}	Use to set IP address and subnet or optionally IP address, subnet mask and gateway simultaneously.
system remoteip show	Use to show remote IP address.
system remoteip auto	Use to set automatic retrieving of remote IP address.
system remoteip set <IP>	Use to define remote IP address (deactivates automatic retrieving of remote IP address).
system diag ping <IP_address>	Use to ping an IP address.

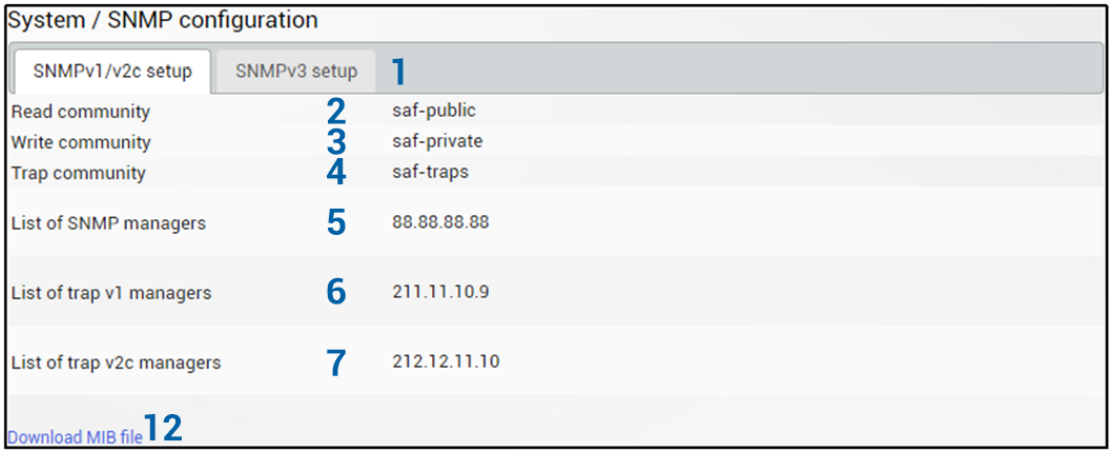
System → Configuration → SNMP configuration

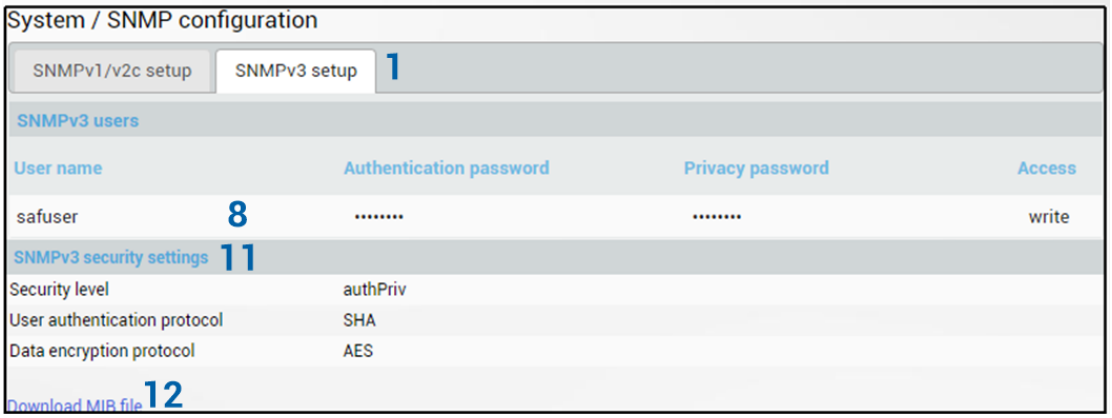
The SNMP configuration pages provide configuration of SNMP communities, host and trap addresses. SAF NMS system will work only when SNMP is properly configured.

Relevant MIB files can be downloaded directly from Web GUI. See (12) below.



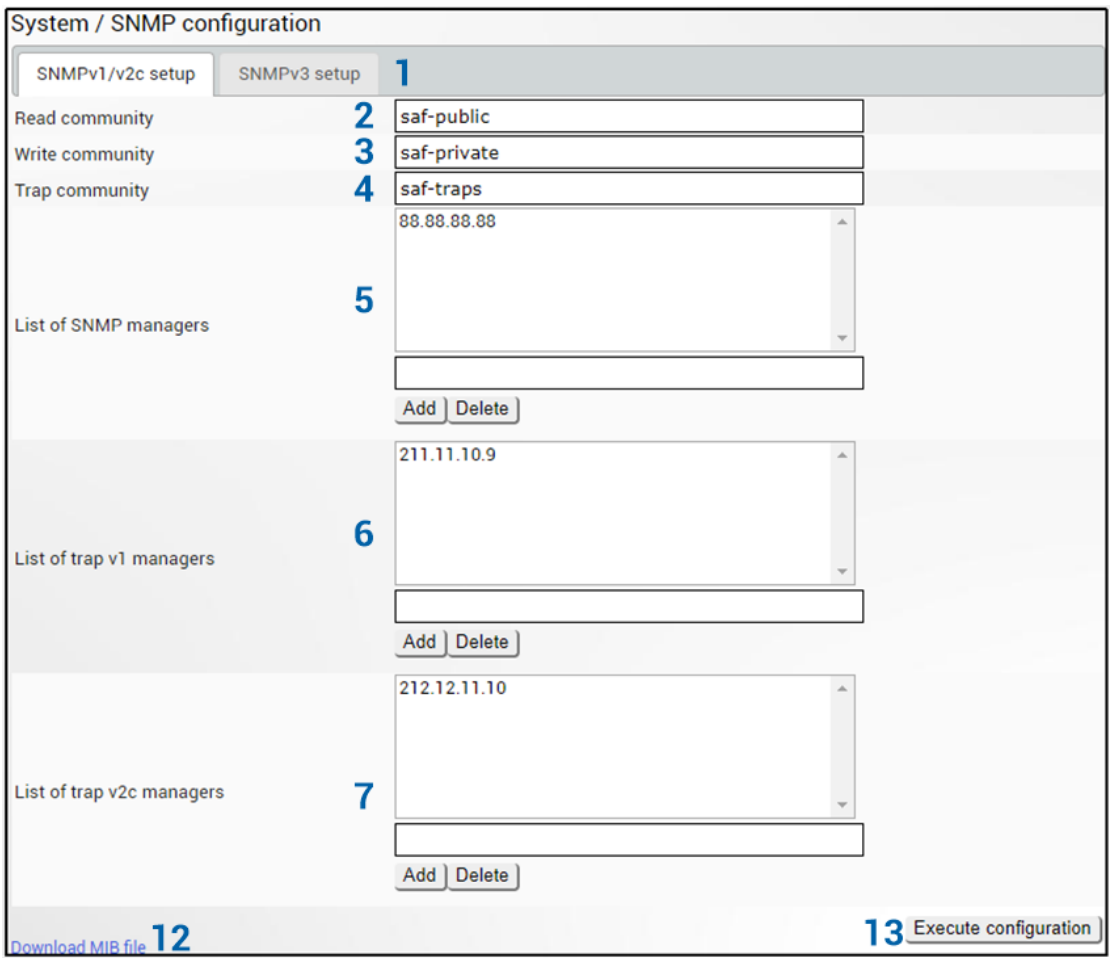
Status mode

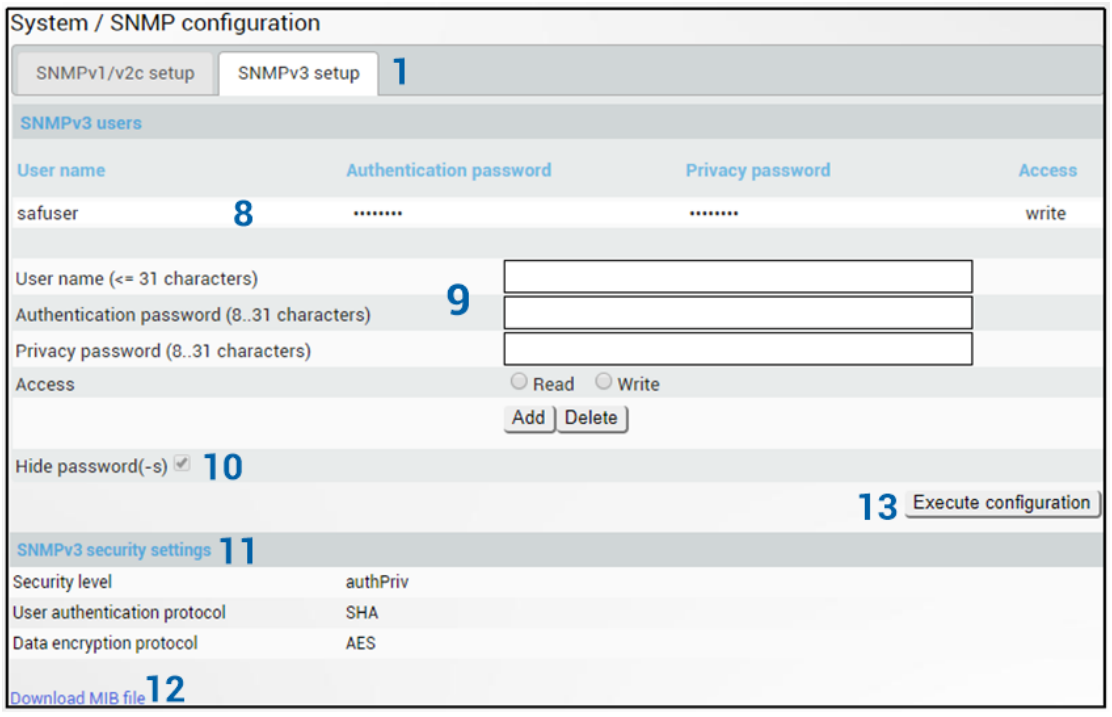




Press MODIFY button.

Modify mode





Note that changes are not applied to an actual configuration before "Execute configuration" (13) button is pressed.

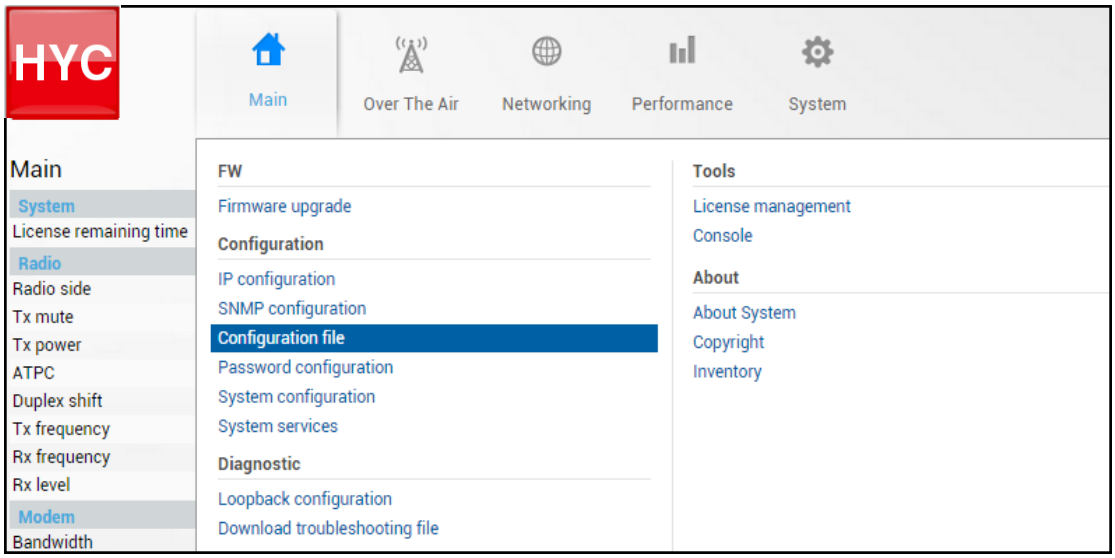
1) ***SNMP v1/v2c setup / SNMP v3 setup*** – Allows switching between status and configuration of SNMP v1, v2c or v3.
2) ***Read community*** – Indicates currently specified read community for SNMP v1 or v2c (status mode); allows specifying read community for SNMP v1 or v2c of the agent to enable parameters to be read (modify mode). Default read community name is "saf-public".
3) ***Write community*** – Indicates currently specified write community for SNMP v1 or v2c (status mode); allows specifying write community for SNMP v1 or v2c of the agent to enable parameters to be written (modify mode). Default write community name is "saf-private".
4) ***Trap community*** – Indicates currently specified trap community for SNMP v1 or v2c (status mode); allows specifying trap community for SNMP v1 or v2c for trap authentication in monitoring applications (modify mode). Default trap community name is "saf-traps".
5) ***List of SNMP managers*** – Shows list of configured SNMP host IP addresses (status mode); allows adding/deleting SNMP host IP addresses (modify mode). Specified IP addresses have access to read and modify configuration parameters using appropriate read and write community names.
6) ***List of trap v1 managers*** – Shows list of configured SNMP trap IP addresses (status mode); allows adding/deleting SNMP trap IP addresses (modify mode). The INTEGRAL-W/INTEGRAL-WS management controller sends SNMP traps to the Trap Manager with IP address specified here.
7) ***List of trap v2c managers*** – Shows list of configured SNMP trap IP addresses (status mode); allows adding/deleting SNMP trap IP addresses (modify mode). The INTEGRAL-W/INTEGRAL-WS management controller sends SNMP traps to the Trap Manager with IP address specified here.
8) ***SNMPv3 user*** – Shows list of configured SNMPv3 users with corresponding passwords and access levels.
9) Fields to define/modify SNMPv3 user's **username, authentication and privacy passwords, access level**.
10) **Hide passwords(-s)** – uncheck to display passwords for selected SNMPv3 user.
11) **SNMPv3 security settings** – Shows list of SNMPv3 security settings used.
12) ***Download MIB file*** – Click to download INTEGRAL-W/INTEGRAL-WS MIB files.
13) By pressing *„Execute configuration"* changes made to the corresponding section apply only to the local side INTEGRAL-W/INTEGRAL-WS.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

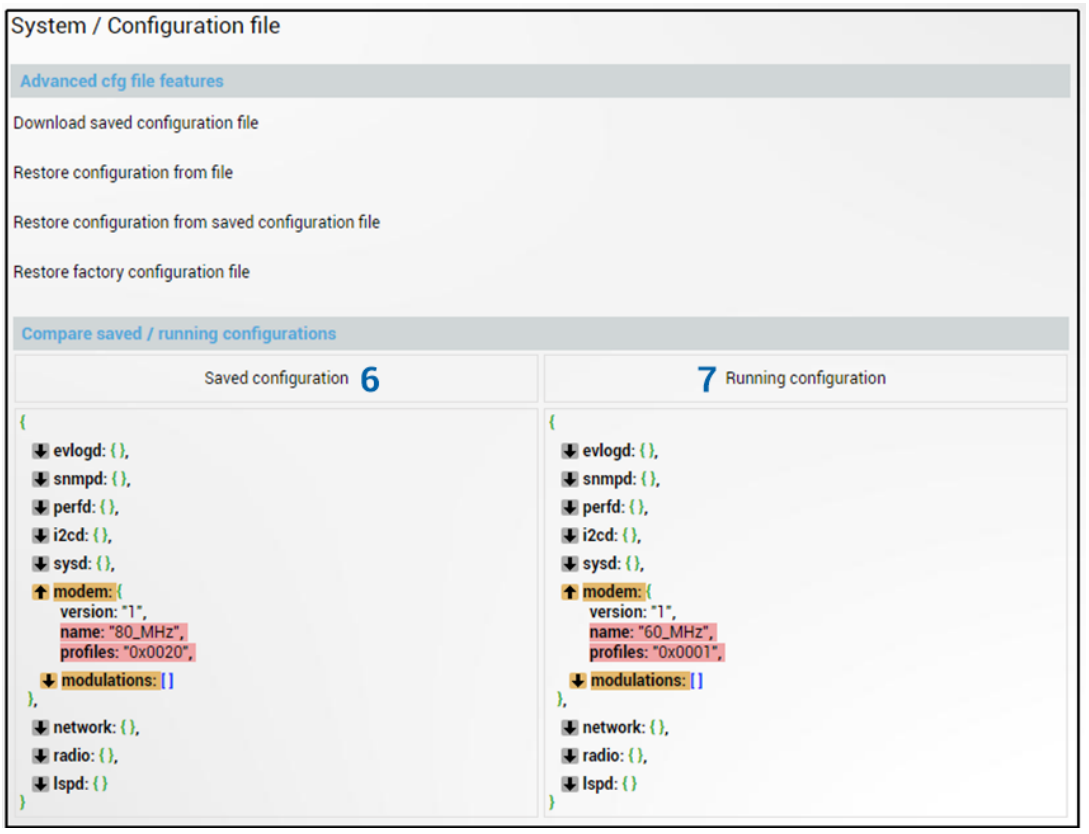
snmp manager [{add|del} <IP>]	Use to check, add or delete IP addresses of SNMP v1/v2c managers.
snmp manager read-community [{set|del} <name>]	Use to check, set or delete name of SNMP v1/v2c read community.
snmp manager write-community [{set|del} <name>]	Use to check, set or delete name of SNMP v1/v2c write community.
snmp traps trap-community [{set|del} <name>]	Use to check, set or delete name of SNMP v1/v2c trap community.
snmp traps trapv1manager [{add|del} <IP>]	Use to check, set or delete IP addresses of SNMP v1 trap managers.
snmp traps trapv2manager [{add|del} <IP>]	Use to check, set or delete IP addresses of SNMP v2c trap managers.
snmp v3 user [{add <username> <authpass> <privpass> {r|w} | del <username>}]	Use to check, set or delete users of SNMP v3.

snmp showconfig active	Use to check currently active SNMP configuration.
snmp showconfig stored	Use to check saved SNMP configuration.

System → Configuration → Configuration file

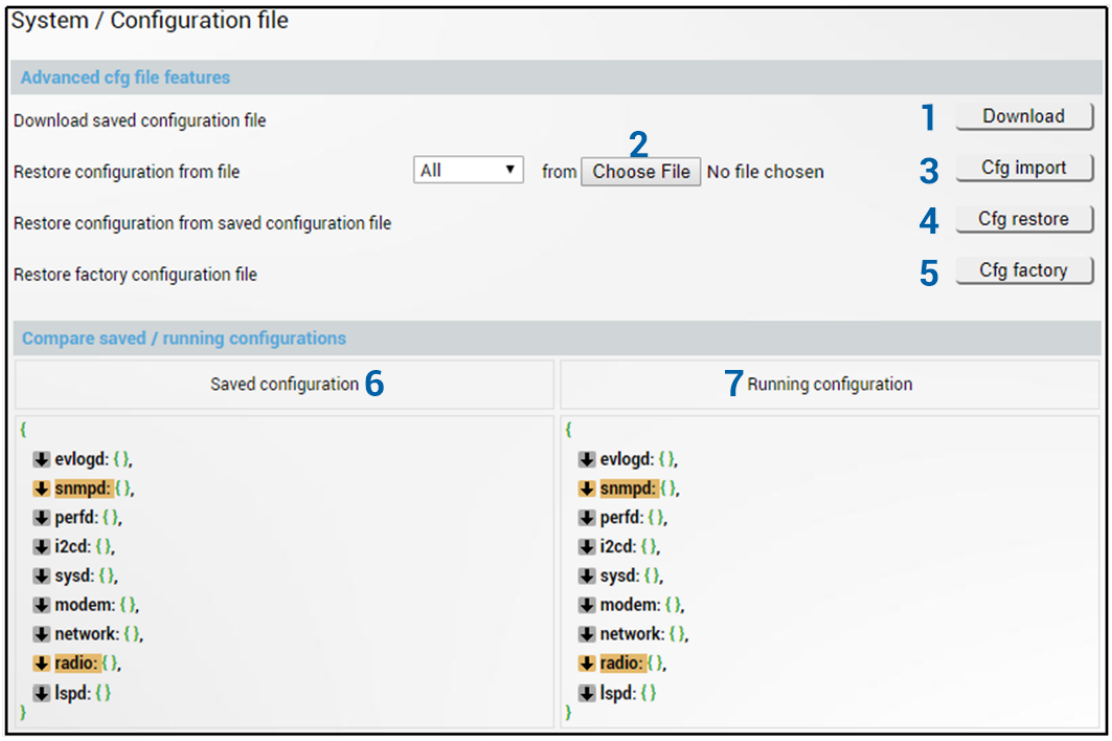


Status mode



Press MODIFY button.

Modify mode



1) ***Download*** – Press to download **saved** system configuration txt file and store it on your hard drive.
2) ***Choose File*** – Press to browse for a previously saved configuration file on your hard disk drive.
3) ***Cfg import*** – Press to upload a configuration file to INTEGRAL-W/INTEGRAL-WS.

⚠ Uploaded configuration overwrites the saved configuration.

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

⚠ Restoring configuration overwrites running configuration with the saved configuration.

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

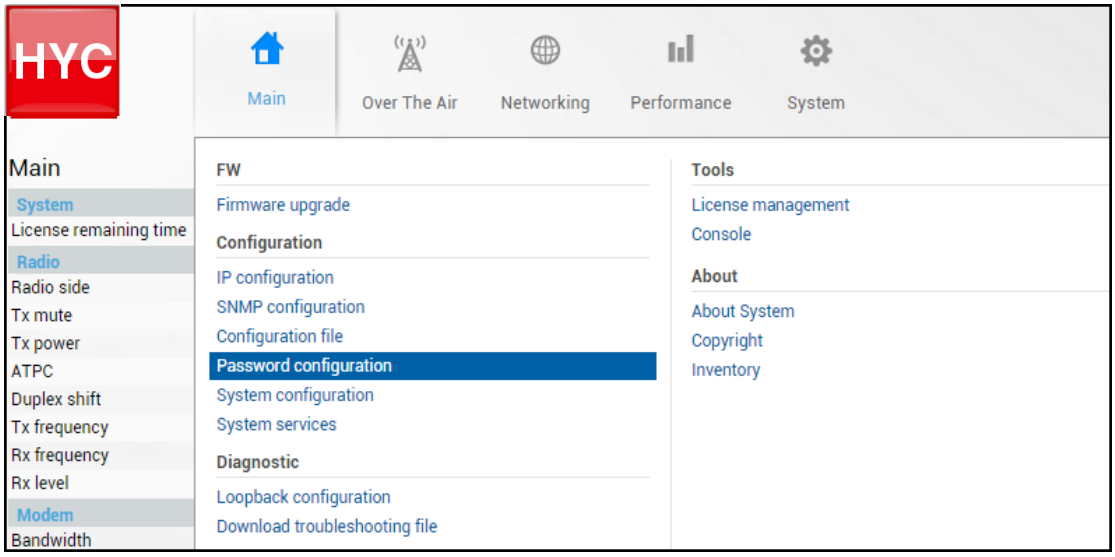
⚠ Distinct sections in saved and running configurations are highlighted with color. In order to examine particular differences expand highlighted sections of configuration by clicking on down arrow of the appropriate configuration section.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

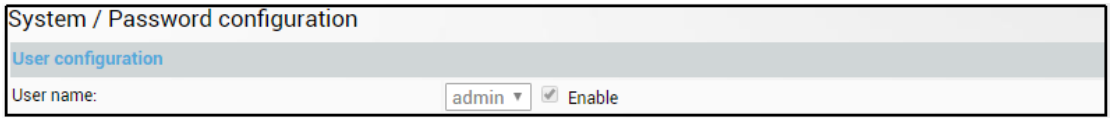
configuration factory	Use to reset system configuration to factory defaults.
configuration factory modem	Use to reset modem configuration to factory defaults.
configuration factory netsys {mac-table | port-state}	Use to reset whole Ethernet configuration to factory defaults or particular sections using subcommands – "mac-table" for MAC table; "port-state" for port state configuration.
configuration factory sysd	Use to reset whole system configuration to factory defaults.
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 running configuration.
configuration download	Use to create a copy of saved configuration file as txt file in the

	FTP directory.
configuration import all <filename>	Use to restore configuration from a txt file stored in FTP directory.

System → Configuration → Password configuration

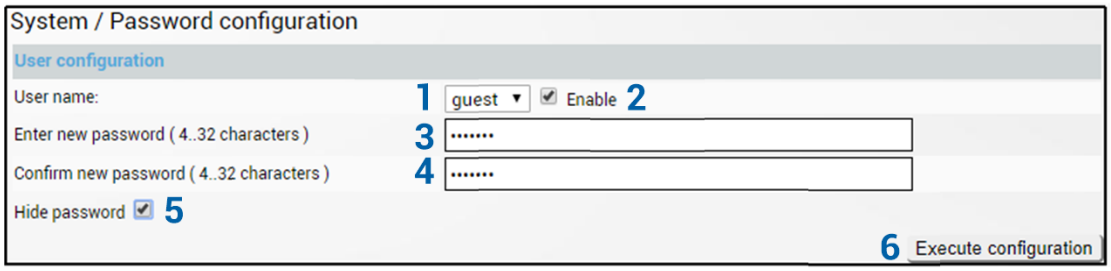


Status mode



Press MODIFY button.

Modify mode



1) ***User name*** – Choose between user accounts. "guest" user has monitoring privileges and cannot apply configuration changes.

> By default password for "admin" account is '*changeme*', while no password is defined for "guest" account (user disabled).

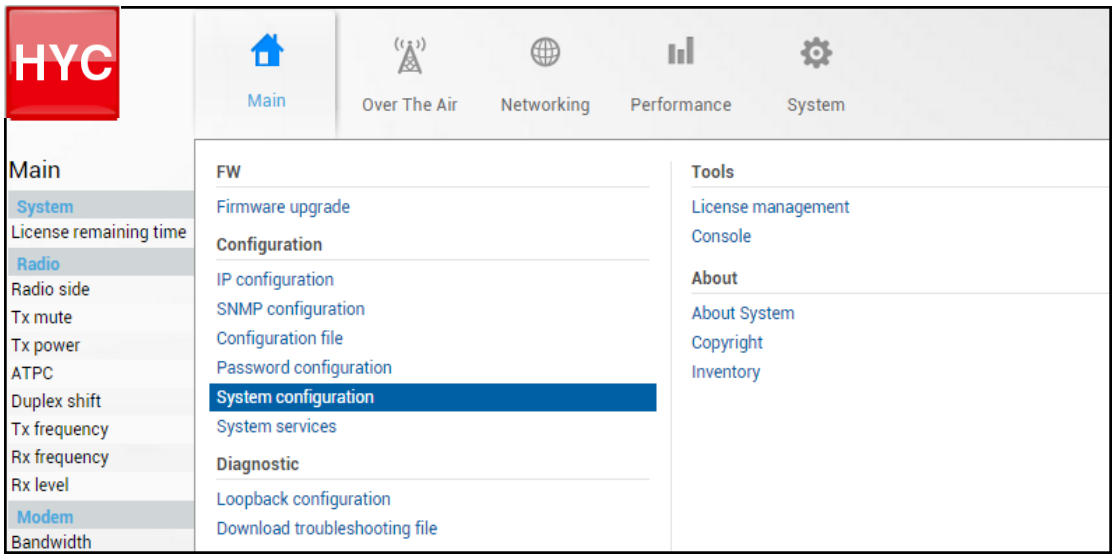
2) ***Enable*** – Check/uncheck to enable/disable user account. "admin" account can not be disabled.
3) ***Enter new password*** – Enter new password. The length between 4 and 32 characters;
4) ***Confirm new password*** – Confirm new password. The length between 4 and 32 characters;
5) ***Hide password*** – Uncheck to display entered password in plaintext.
6) By pressing *„Execute configuration"* changes made to the corresponding section apply only to the local side INTEGRAL-W/INTEGRAL-WS.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

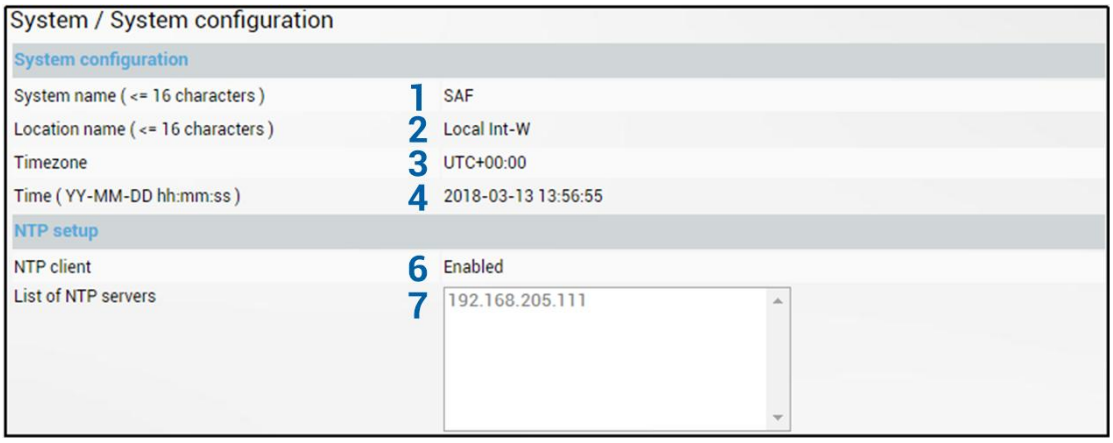
system user info	Use to show information on the current user.

system user mgmt <username> **access** {r|w}	Use to set read (“r”) or write (“w”) access right for particular <username>.
system user mgmt <username> **delete**	Use to delete particular <username>. “admin” user cannot be deleted.
system user mgmt <username> {enable|disable}	Use to enable or disable particular <username>.
system user mgmt <username> **info**	Use to show information on particular <username>.
system user mgmt <username> **password** <password>	Use to set password for particular <username>.
system user new <username> <password> {r|w} <fullname>	Use to create new user with 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

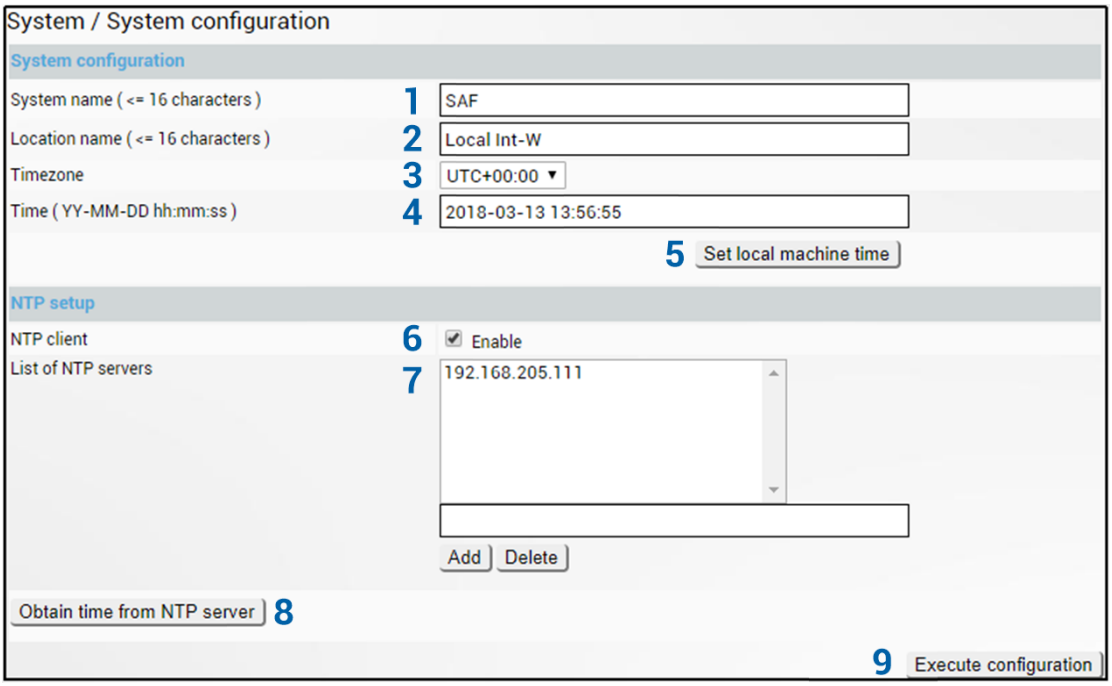


Status mode



Press MODIFY button.

Modify mode



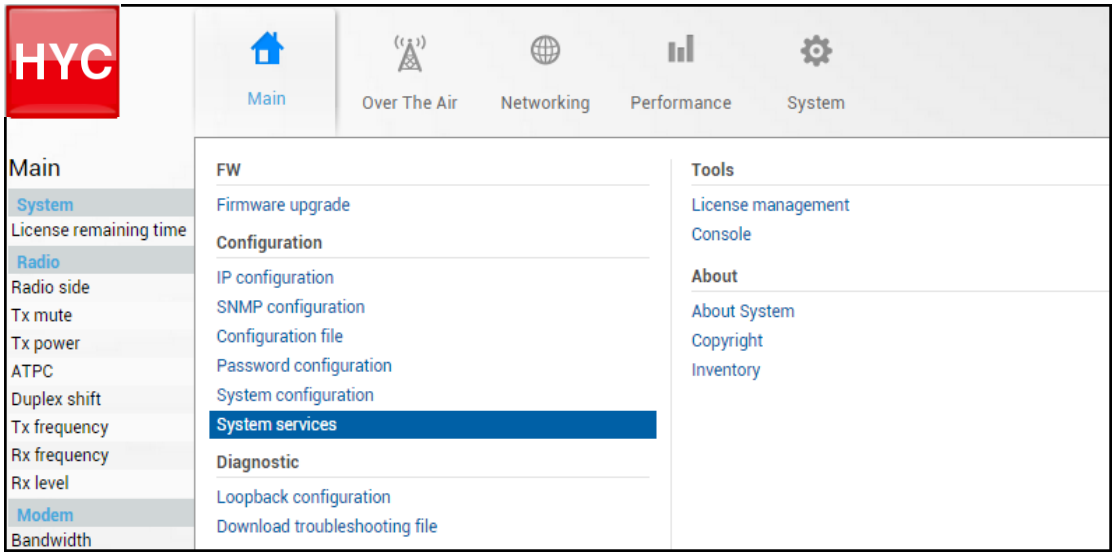
1) ***System name*** – Allows entering a preferable system name. The maximum length of the system name cannot exceed 16 symbols. The default name is 'SAF'.
2) ***Location name*** – Allows entering preferable system location name. The maximum length of the location name cannot exceed 16 symbols. By default system location is not specified.
3) ***Timezone*** – Allows specifying time zone.
4) ***Time (YY-MM-DD hh:mm:ss)*** – Allows changing system date and time manually by entering 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) ***NTP client*** – Allows enabling or disabling NTP (Network Time Protocol) client.
7) ***List of NTP servers*** – Allows adding or deleting IP addresses of NTP servers.
8) ***Obtain time from NTP server*** – Press to force the system to obtain the time from an NTP server.
9) By pressing *„Execute configuration"* changes made to the corresponding section apply only to the local side INTEGRAL-W/INTEGRAL-WS.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

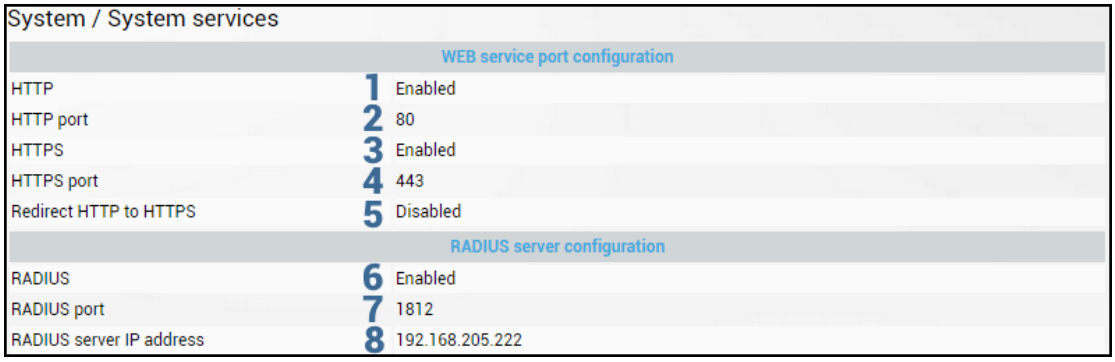
system datetime [<datetime>]	Use to show/set system time and date. Use "YYYY-MM-DD/hh:mm:ss" syntax for date/time.
system name [<name>]	Use to show/define system name.
system location [<location>]	Use to show/define system location.
system uptime	Use to show system uptime since last system start.
system ntp status	Use to show NTP status.
system ntp {enable|disable}	Use to enable or disable NTP client.
system ntp server add <IP_address>	Use to add an IP address of an NTP server.
system ntp server remove <IP_address>	Use to remove an IP address of an NTP server.
system ntp server clear	Use to clear list of NTP servers.
system ntp timezone [<-12:00 ... 14:00>]	Use to show/define UTC timezone.

system ntp sync	User to force the system to obtain the time from an NTP server.

System → Configuration → System services

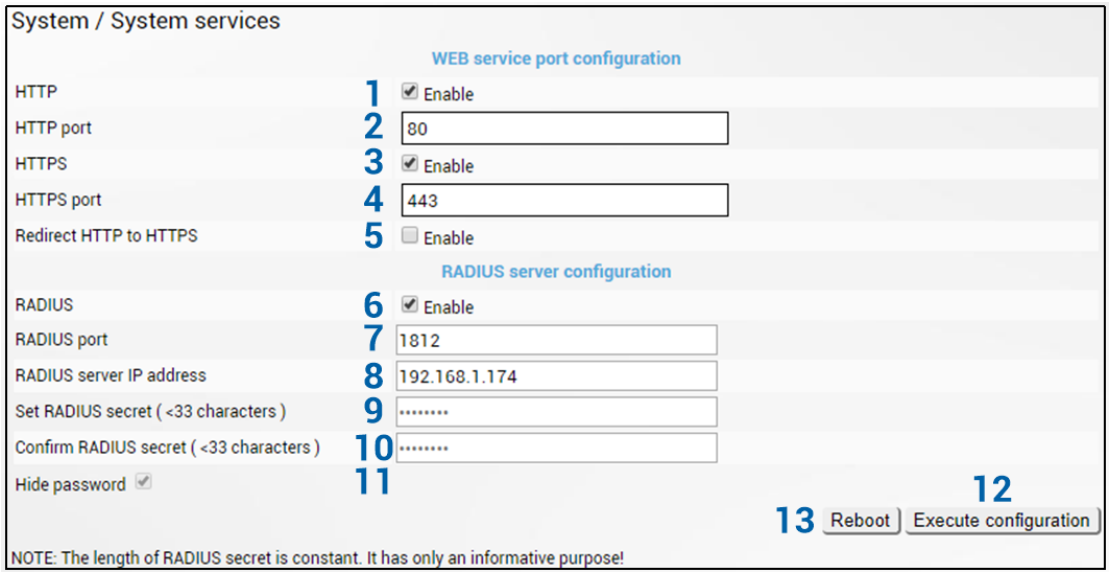


Status mode



Press MODIFY button.

Modify mode



1) ***HTTP*** – Allows disabling or enabling HTTP access to Web GUI. By default, HTTP access is enabled.

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

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.
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 enabling automatic redirect from HTTP to HTTPS.
6) ***RADIUS*** – Allows enabling or disabling RADIUS (Remote Authentication Dial In User Service). By default RADIUS is disabled.

For configuration instructions refer to the chapter RADIUS authentication.

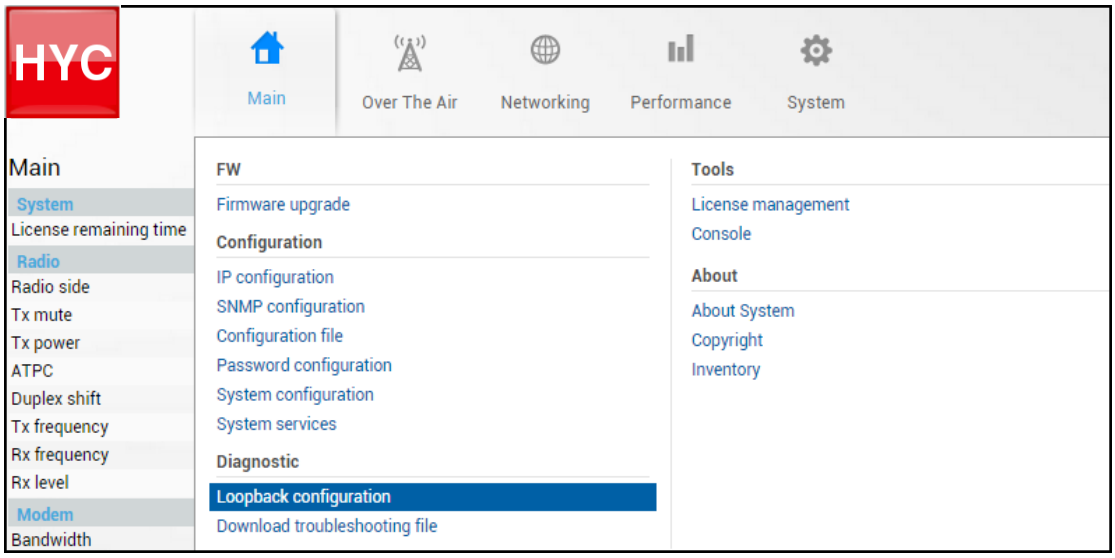
7) ***RADIUS port*** – Allows specifying RADIUS port. By default port 1812 is defined.
8) ***RADIUS server IP address*** – Allows specifying RADIUS server IP address.
9) ***Set RADIUS password*** – Allows specifying RADIUS password.
10) ***Confirm RADIUS password*** – Allows confirming RADIUS password.
11) ***Hide password*** – Uncheck to display entered the password in plaintext.
12) By pressing *„Execute configuration”* changes made to the corresponding section apply only to the local side INTEGRAL-W/INTEGRAL-WS.
13) ***Reboot*** – Reboots INTEGRAL-W/INTEGRAL-WS (cold restart).

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 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 port number for HTTPS service.
system service redirect [{enable|disable}]	Use to show status or enable/disable HTTP redirection to HTTPS.
system radius status	Use to show RADIUS configuration status.
system radius {enable|disable}	Use to enable or disable RADIUS configuration.
system radius addr <IP_address>	Use to define RADIUS server IP address.
system radius port <port>	Use to define a port number of a RADIUS server. By

	default port 1812 is defined.
system radius secret <psw>	Use to define RADIUS server password.
system service ftp [{enable|disable}]	Use to show status or enable/disable FTP service.
system service ssh status	Use to show status of SSH service.
system service ssh [{enable|disable}]	Use to enable/disable SSH service.
system service ssh port {set <port>|reset}	Use to define/reset a port number of SSH service. By default port 22 is defined.
system service telnet status	Use to show status of TELNET service.
system service telnet [{enable|disable}]	Use to enable/disable TELNET service.
system service telnet port {set <port>|reset}	Use to define/reset a port number of TELNET service. By default port 23 is defined.

System → Diagnostic → Loopback configuration



Status mode

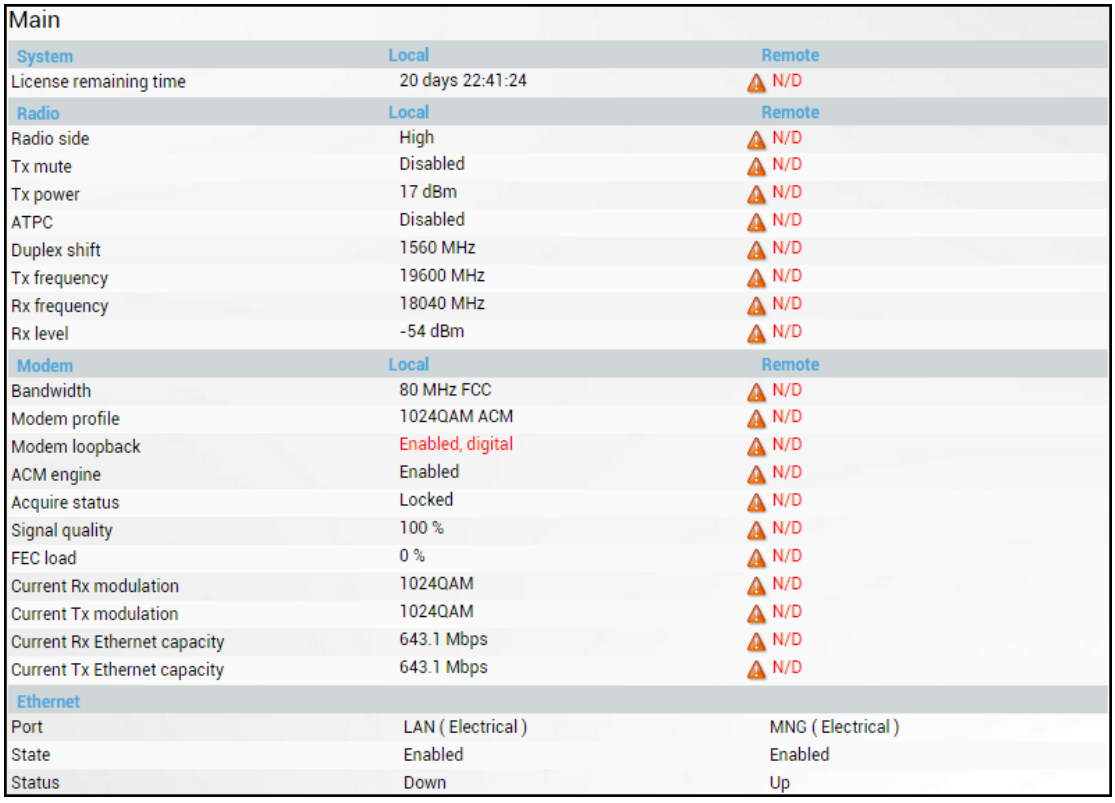
Press MODIFY button.

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 local end after the modem and INTEGRAL-W/INTEGRAL-WS should be able to synchronize to itself. Both Radial 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 INTEGRAL-W/INTEGRAL-WS.

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

Below is an example of the Main status page during modem loopback:



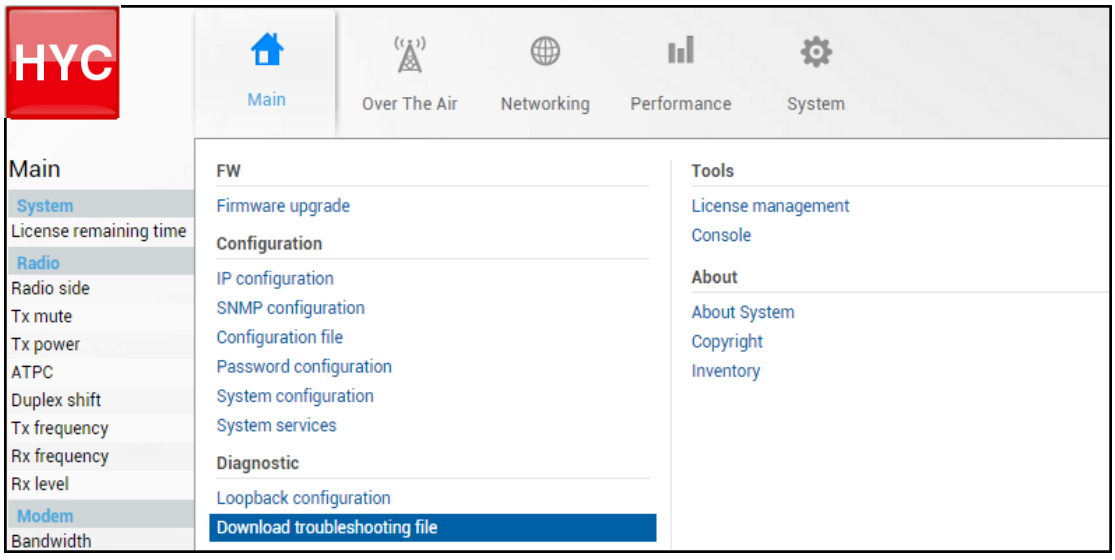
Main

System	Local	Remote
License remaining time	20 days 22:41:24	N/D
Radio	**Local**	**Remote**
Radio side	High	N/D
Tx mute	Disabled	N/D
Tx power	17 dBm	N/D
ATPC	Disabled	N/D
Duplex shift	1560 MHz	N/D
Tx frequency	19600 MHz	N/D
Rx frequency	18040 MHz	N/D
Rx level	-54 dBm	N/D
Modem	**Local**	**Remote**
Bandwidth	80 MHz FCC	N/D
Modem profile	1024QAM ACM	N/D
Modem loopback	Enabled, digital	N/D
ACM engine	Enabled	N/D
Acquire status	Locked	N/D
Signal quality	100 %	N/D
FEC load	0 %	N/D
Current Rx modulation	1024QAM	N/D
Current Tx modulation	1024QAM	N/D
Current Rx Ethernet capacity	643.1 Mbps	N/D
Current Tx Ethernet capacity	643.1 Mbps	N/D
Ethernet		
Port	LAN (Electrical)	MNG (Electrical)
State	Enabled	Enabled
Status	Down	Up

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 none	Use to disable modem loopback.

System → Diagnostic → Download troubleshooting file



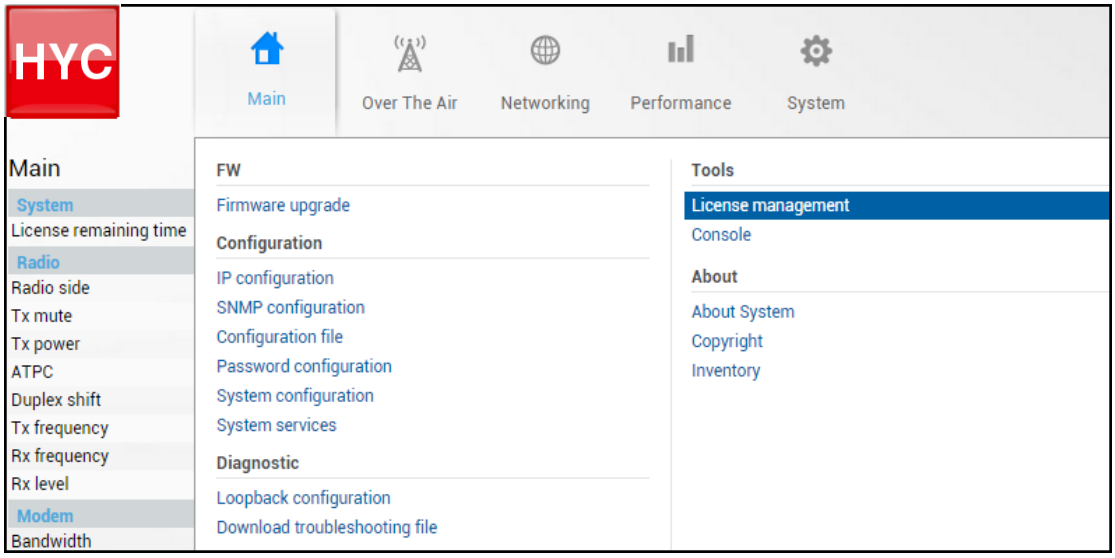
Clicking on the link will download troubleshooting file archive package to your hard disk drive ("Downloads" folder of your browser).

Contents:

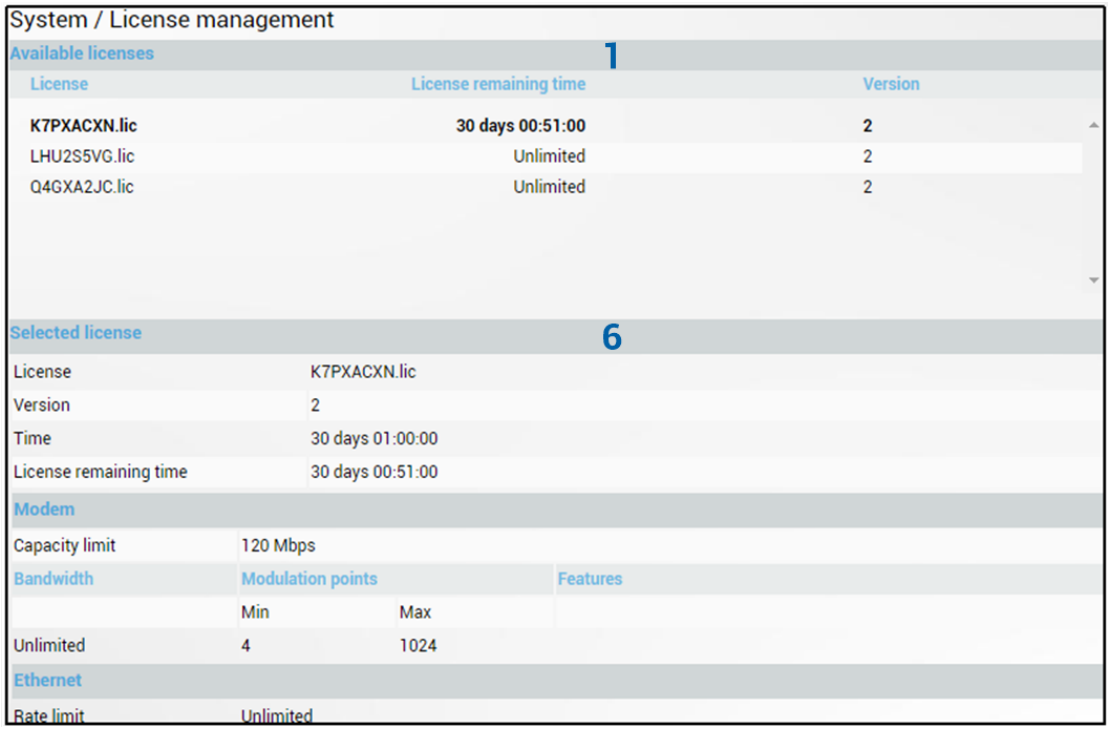
config.txt	Saved system configuration file
conf	Subfolder with last configuration files.
devel.tar.gz	For debugging only
eventlog.txt	Alarm-event log file
Perflog.xml	Performance log with maximum 1440 entries for 1, 15 and 60-minute intervals
troubleshoot.html	Information on currently running firmware 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.
constell.bmp	Snapshot of modem constellation graph.
spectrum.bmp	Snapshot of modem Rx spectrum graph.

System → Tools → License management

Provides a list of available licenses, time left for each license and license upload controls.

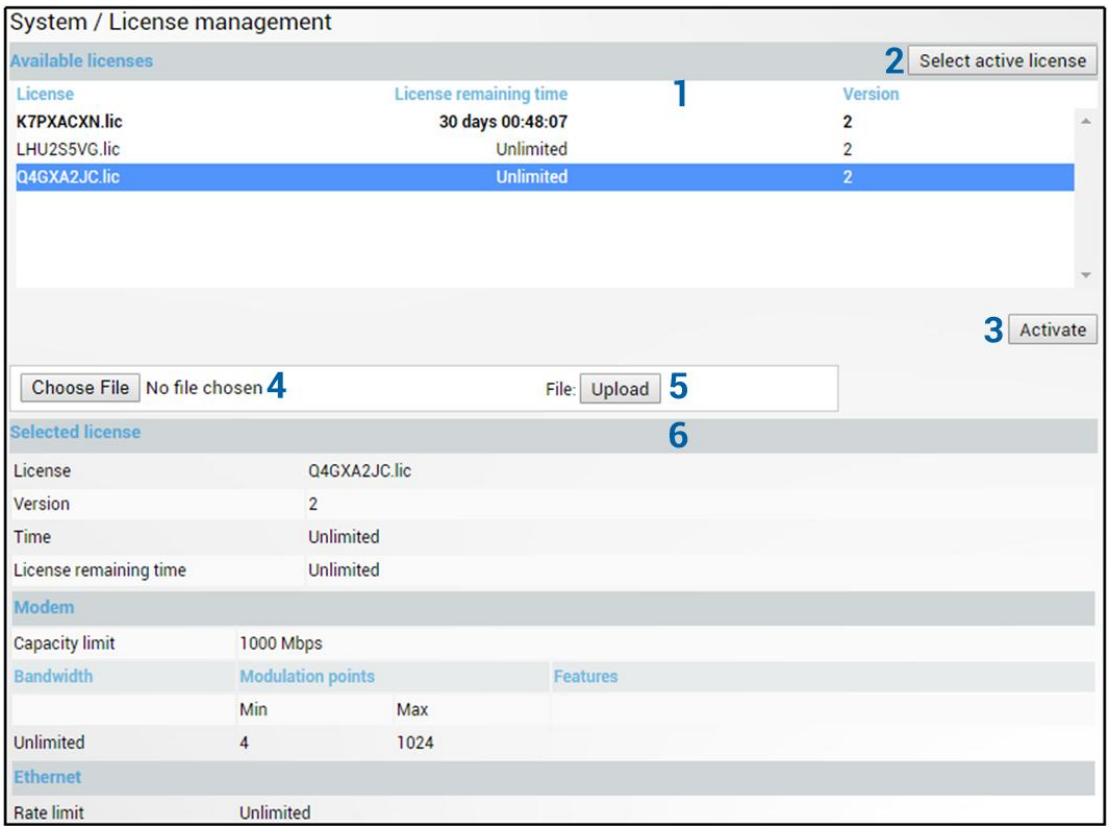


Status mode



Press MODIFY button.

Modify mode



1) Shows list of available licenses and remaining time. The active license is in bold.
2) ***Select active license –*** Press to highlight in the list the active license.
3) ***Activate*** – Select license from the list and press "Activate" to switch to preferable license.
4) ***Choose file*** – Press to browse for a license file (*.lic) on your hard disk drive.
5) ***Upload*** – Press to upload a license file (*.lic) to INTEGRAL-W/INTEGRAL-WS.
6) Details of the selected license.

If new license supports previously running modem configuration, no changes will be applied.

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

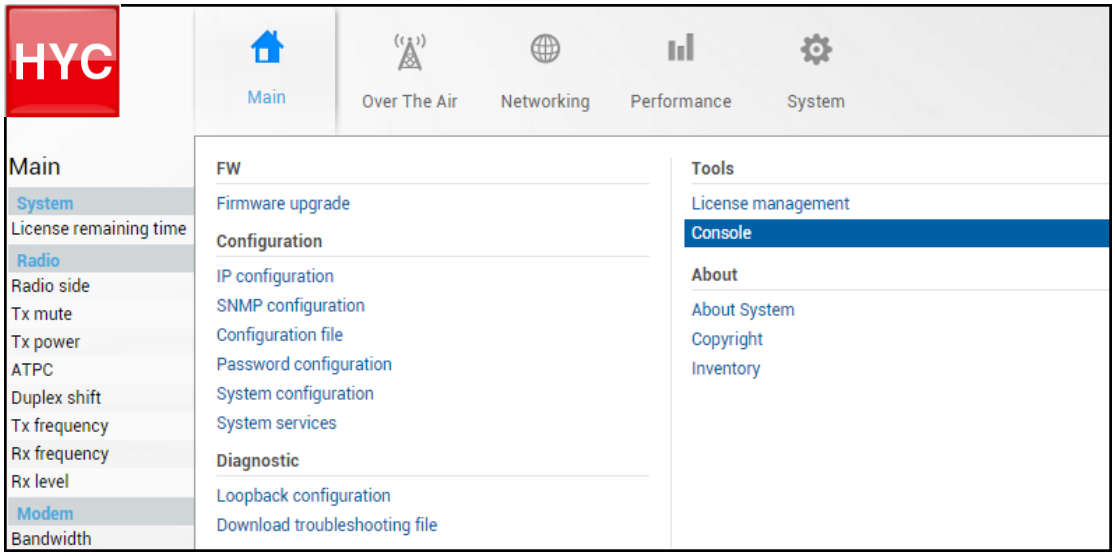
When the license expires modulation will drop to "4QAM Limited" and link capacity will drop to 256Kbps.

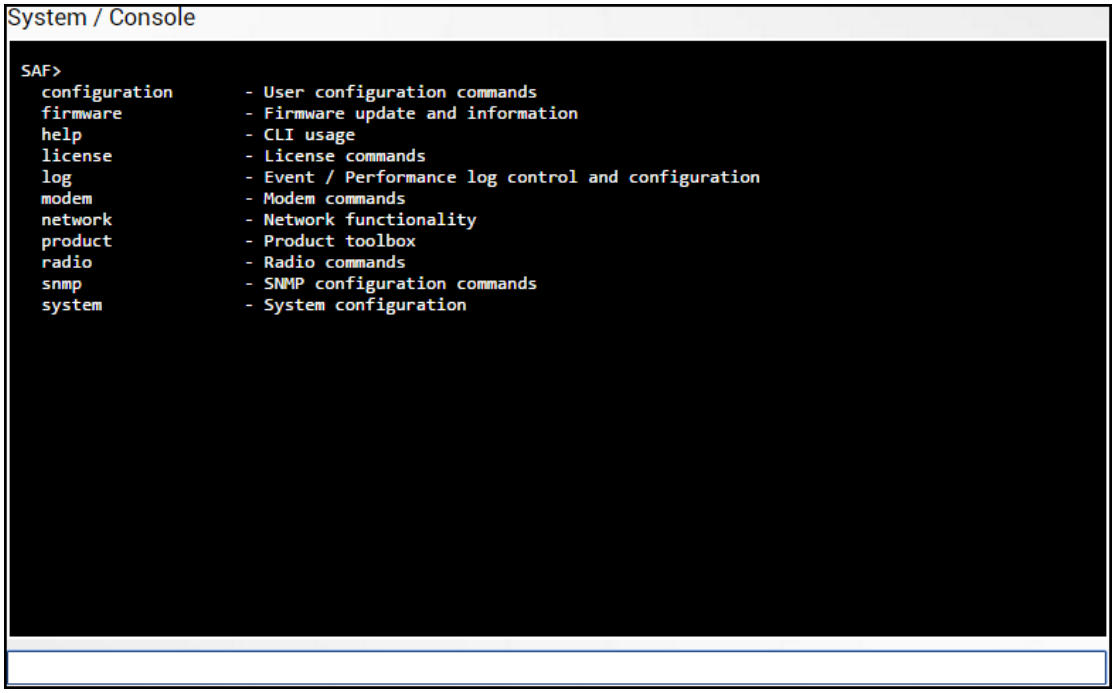
When the license expires next license in the list needs to be activated manually.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

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

System → Tools → Console





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

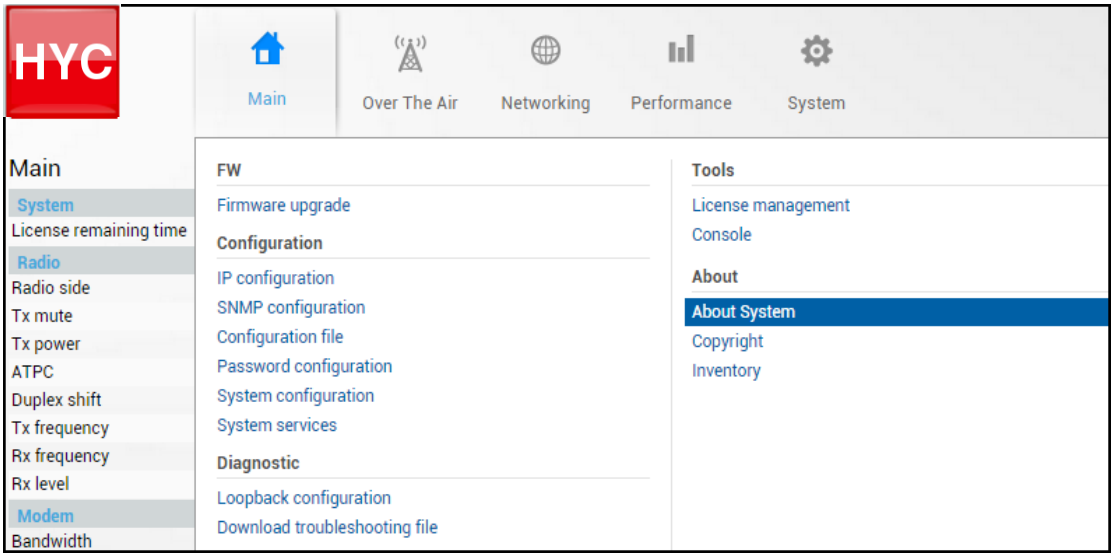
Use ↵ ENTER key to execute entered command.

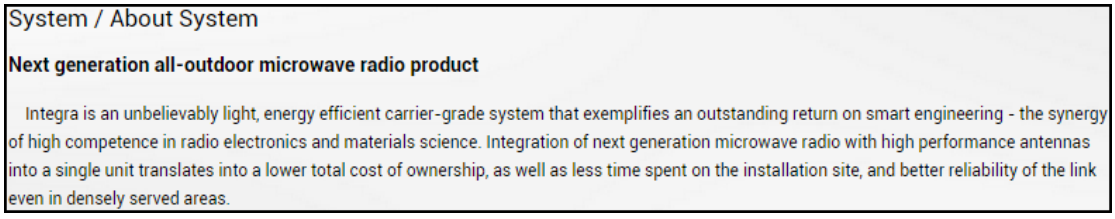
List of valid CLI commands can be found at the end of each Web GUI page description.

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

System → About → About System

Provides a short description of INTEGRAL-W/INTEGRAL-WS series products.



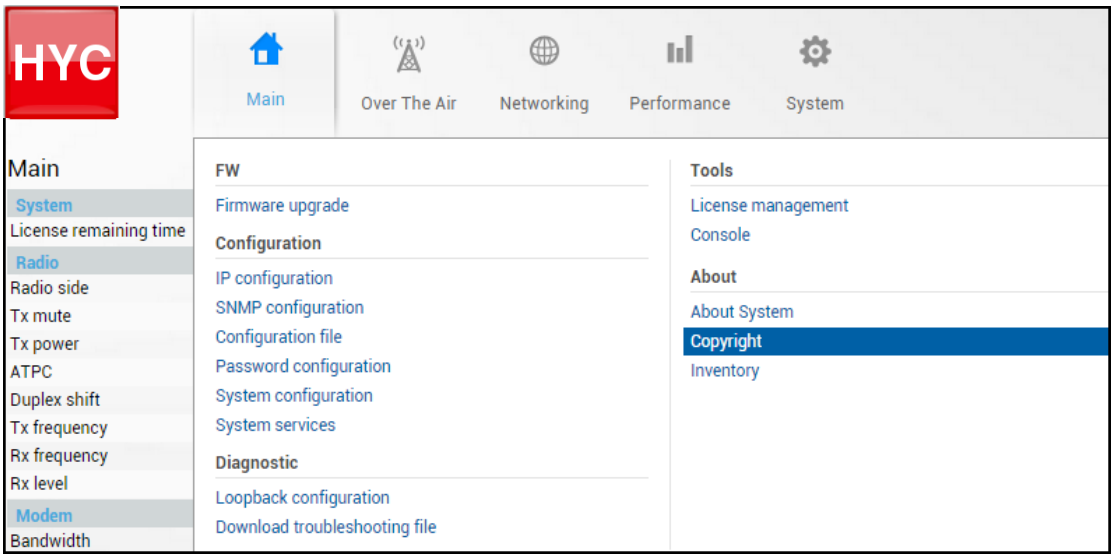


CLI commands (Chapter 4: COMMAND LINE INTERFACE)

product info	Use to show detailed information on INTEGRAL-W / INTEGRAL-WS FODU.
system number	Use to show INTEGRAL-W / INTEGRAL-WS serial number.

System → About → Copyright

Displays copyright information.



System / Copyright

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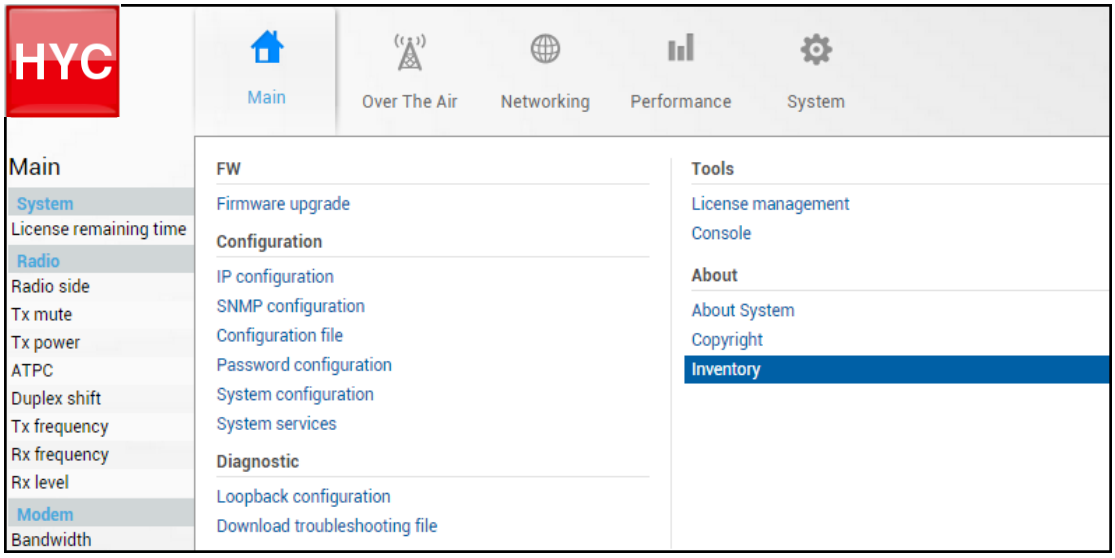
System → About → Inventory

Displays inventory information.



System / Inventory

MB ID	1
MB Sub ID	0
MB revision	3
MAC	000.004.166.129.067.166 - 00.04.A6.81.43.A6
Model	Integra-WS
System Contact	techsupport@saftehnika.com
Device Name	SAF
Description	SAF microwave radio
Copyright	Copyright (c) 2013 SAF Tehnika JSC. All rights reserved.
Product Code	D23WSR01L
Product Serial Number	398780100009
Enterprise ID	7571

Chapter 4: COMMAND LINE INTERFACE

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

- Secure Shell (SSH);
- Telnet;
- Serial terminal;
- Web GUI (System → Tools → Console, partial functionality)

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

For SSH, Telnet or serial connection you can use any client supporting 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
```

Note that in Web GUI (System → Tools → Console) those shortcuts will not work.

Connecting to serial RS232 interface

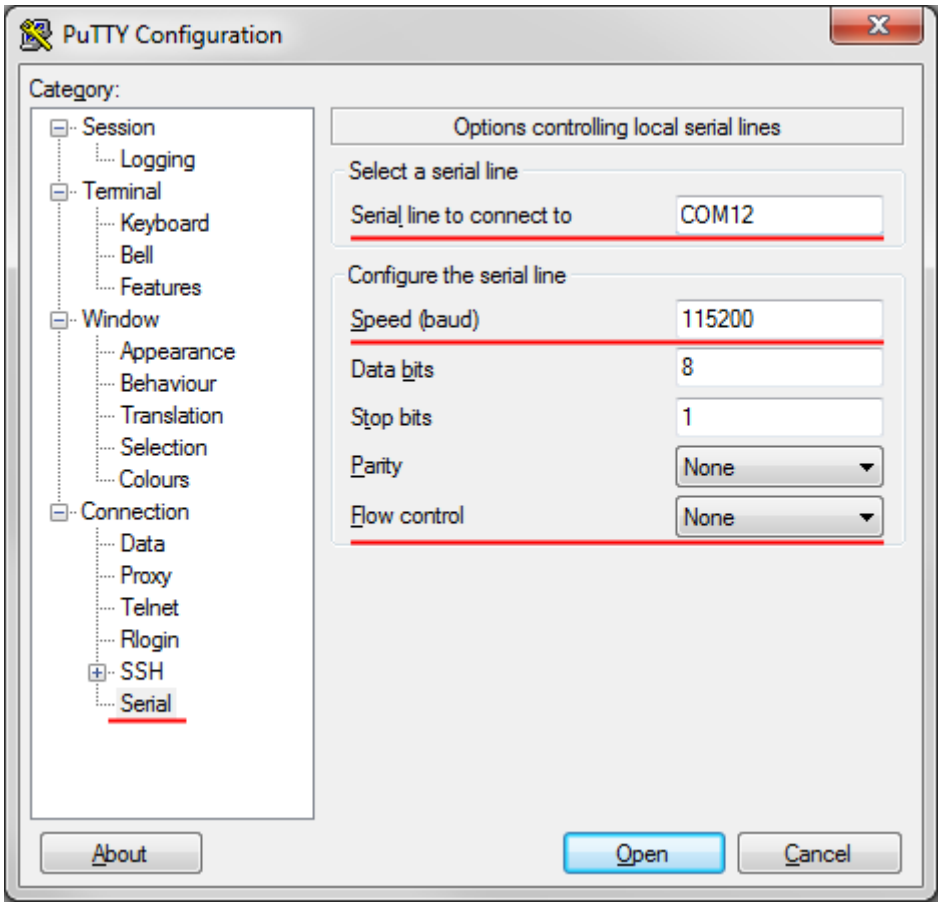
In order to connect to INTEGRAL-W/INTEGRAL-WS serial terminal, you will require USB cable with USB Type B connector. Please refer to Chapter USB port for pinouts.

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

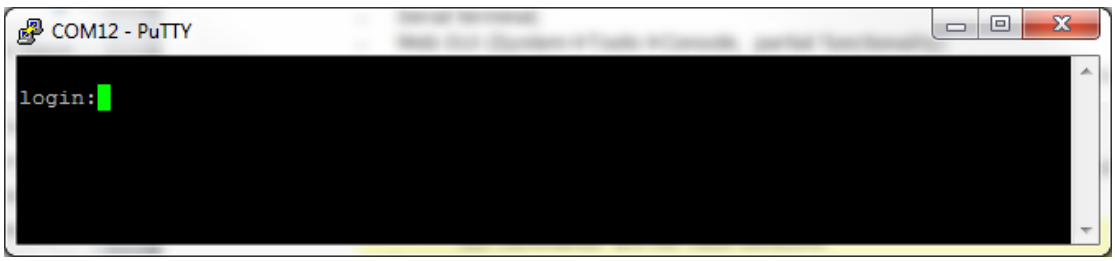
- Baud rate: 115200
- Data bits: 8
- Parity: None
- Stop bits: 1
- Data flow control: None

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

1. Open *PuTTY* and go to "Serial" category. Specify your COM port number you will be using, change "Speed (baud)" to "115200" and "Flow control" to "None":



2. Press "Open" and after pressing "Enter" key following login dialog should appear:



3. Enter 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):

5. Press “Ctrl+C” to log off from the current session.

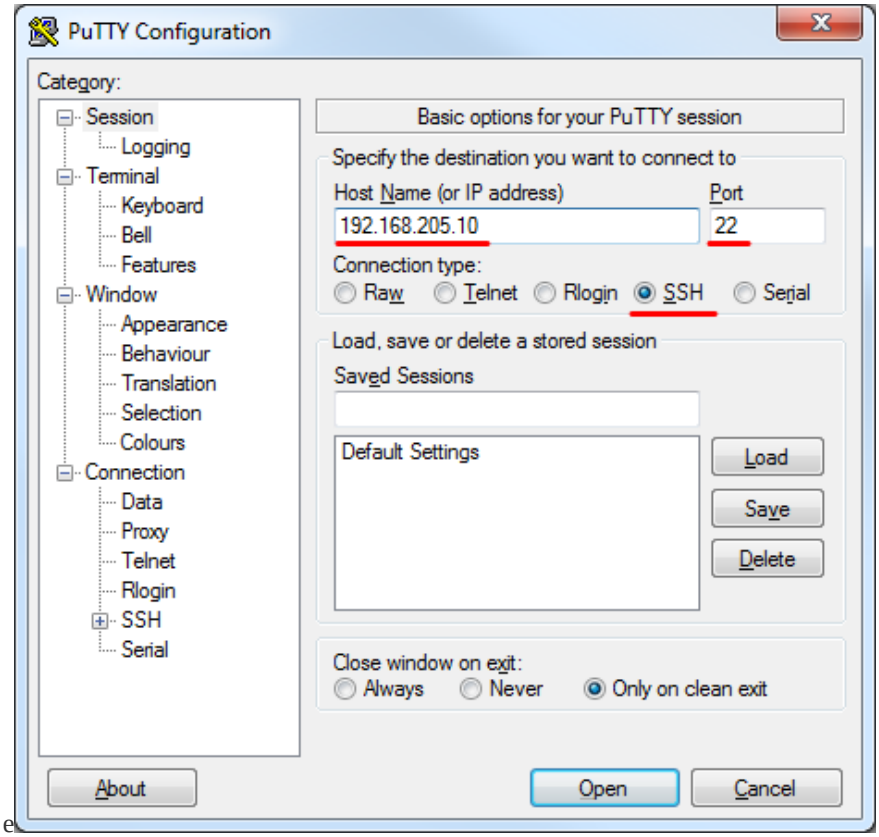
Closing *PuTTY* window without “Ctrl+C” does not log off from the current serial terminal session.

Connecting to SSH

SSH connection to INTEGRAL-W/INTEGRAL-WS FODU is carried out using Ethernet management connection. Please refer to Chapter "Ethernet management connection" 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 IP address and make sure that correct port number is used ("22" by default):



2. Press "Open", enter login credentials (default user name is *admin* and password - *changeme*). After successful login following prompt should appear:

3. Enter 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):

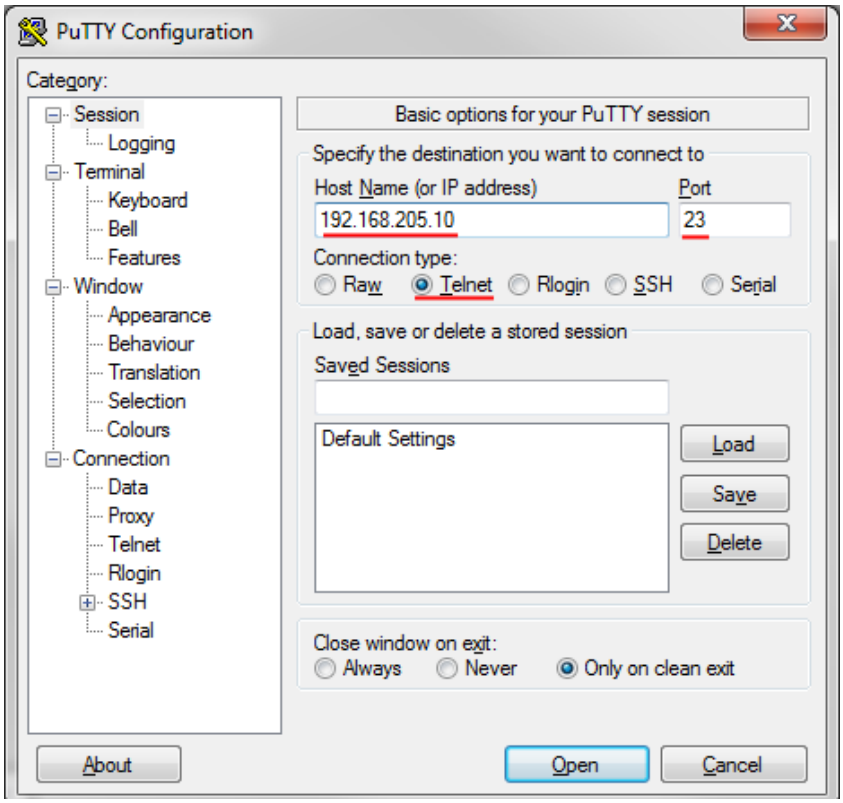
Connecting to Telnet

A telnet connection to INTEGRAL-W/INTEGRAL-WS FODU is carried out using Ethernet management connection. Please refer to Chapter "Ethernet management connection" for Ethernet management port connection details.

By default Telnet service is disabled. See Chapter System → Configuration → System services for 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 IP address and make sure that correct port number is used ("23" by default):



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

3. Enter 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):

Chapter 5: 17/24GHz

Polarization Considerations

Polarizations at both ends of the link must be opposite for 17/24 GHz INTEGRAL-W/INTEGRAL-WS FODUs.

For example:

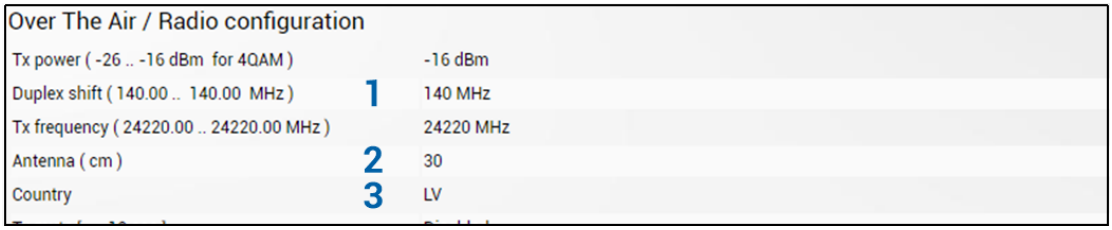
*If **High side** radio is installed in **Vertical polarization**,*

*then **Low side** radio must be installed in **Horizontal polarization**:*

Radio configuration – extra fields

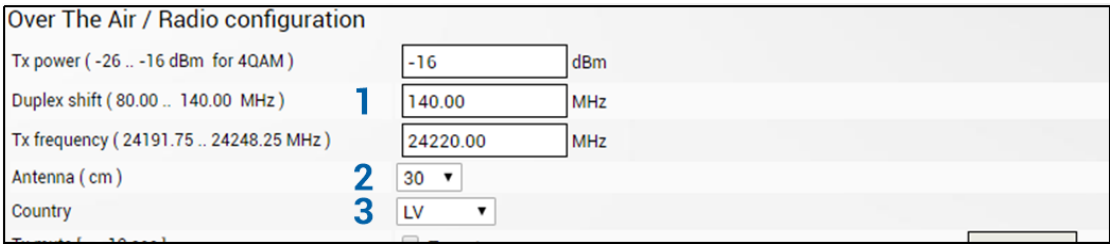
This chapter describes **only differences** of the configuration for the 17/24 GHz INTEGRAL-W/INTEGRAL-WS FODUs. For configuration in general, refer to the chapter Over The Air → Radio → Configuration.

Status mode



Press MODIFY button.

Modify mode



1) ***Duplex shift*** – Indicates the value between the transmitter frequency and receiver frequency (status mode); allows specifying the value of duplex shift in MHz (modify mode)
2) ***Antenna*** – Indicates the set size of the installed antenna (status mode); allows specifying the diameter of the installed antenna in cm (modify mode). Max Tx power settings depend on

national regulatory EIRP allowance and antenna size. Available values - 20, 30, 60, 99, 120 cm.

3) ***Country*** – Indicates the set country code (status mode); allows specifying the country code (modify mode). Max Tx power settings depend on national regulatory EIRP allowance and antenna size. Available values - AU, AT, BE, BG, CA, CY, CZ, DK, EE, FI, FR, DE, GR, HU, IE, IR, IT, LV, LT, LU, MT, NL, PL, PT, RO, SK, SI, ES, SE, UK, US, Custom.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

radio duplex-shift [<value>]	Use to show/define the value of duplex shift in kHz.
radio eirp set <antenna> <country>	Use to define antenna size in cm and country code.
radio [status]	Use to show radio status and the existing values.

Setting bandwidth to 80MHz

This chapter describes only differences of setting 80 MHz bandwidth for the 17/24 GHz INTEGRAL-W/-WS FODUs. For configuration in general, refer to the chapter Over The Air → Radio → Configuration.

Unavailable channel bandwidths (100 and 112MHz) will not be selectable due to "Disabled by duplex shift", maximum allowed channel bandwidth for INTEGRAL-W/-WS 17/24GHz radio units – 80MHz.

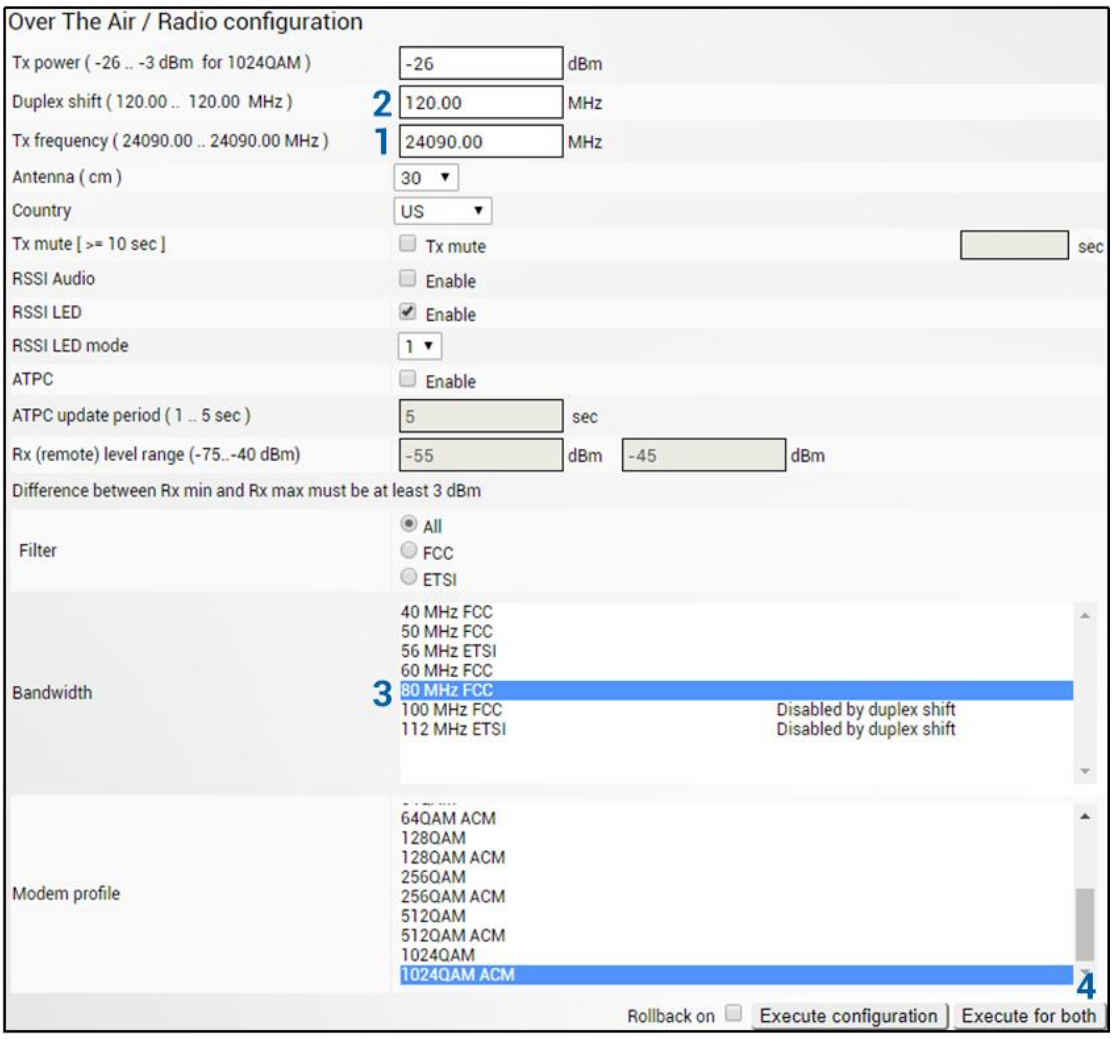
1) Access the Web GUI. Configure the Tx frequency to 17140MHz (17GHz) or 24090MHz (24GHz) if it is low side unit or to 17260MHz (17GHz) or 24210MHz (24GHz) if it is high side unit.

2) Configure the Duplex shift to 120 MHz.

3) Configure Bandwidth profile by selecting 80 MHz profile.

4) Configure Modem profile and press "Execute for both".

5) Save the configuration on both radios.



Chapter 6: FUNCTIONAL DESCRIPTION

ACM (Adaptive Coding and Modulation)

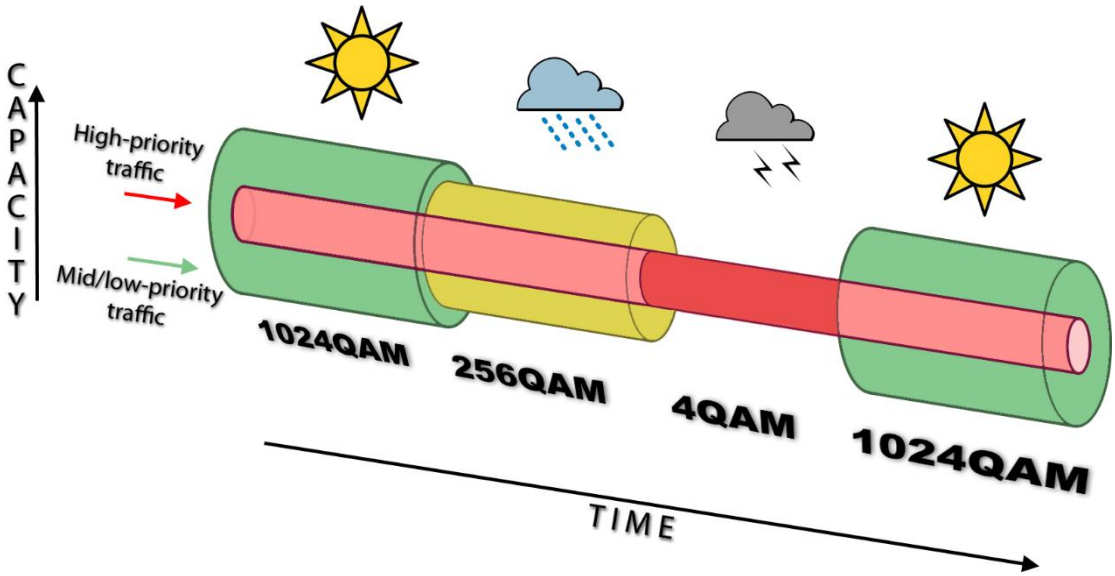
ACM technology allows operators to achieve high-capacity data transmission over microwave links and improve the link utilization. This reduces both operational and capital expenditures for maintaining high-capacity links. ACM can maintain the highest link spectral efficiency possible at any given time 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. With the use of QoS prioritizing ACM can allocate the required availability based on the priority. As a result, high-priority services such as voice enjoy 99.995% availability, while low-priority services like video streaming are allocated lower priorities.

Use of QoS prioritizing defines which services should be transmitted under any link condition and which services should be adapted whenever the link condition is degraded and the link payload is decreased.

For example, when bad weather has decreased the channel capacity of a link, ACM maintains high-priority services – such as voice data – with full bandwidth capacity while adapting the bandwidth capacity of low- and mid-priority services such as Internet browsing.



Traffic can be mapped into different priorities, which define the level of service for each application. The figure below illustrates how different services – such as rich voice and video – are mapped into different classes of availability (CoA) such as 99.995% or 99.687%.

The implementation of multiple priorities increases the available capacity up to 10 times that of standard links. 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 – predefined high-availability services such as voice are not affected. However, the capacity of low-priority services is adapted dynamically to the changing link conditions. This is done by provisioning bandwidth according to the link conditions and traffic priority.

An ACM profile defines the link parameters (modulation) for a given range of the *signal quality* value, which is an estimation of SNR expressed as a percentage. The *signal quality* range of each profile defines the threshold for switching from one ACM profile to another. Each ACM profile has a different spectral efficiency, derived from its modulation.

In order to maintain linearity, Tx power decreases for higher modulations. Tx power difference between 4QAM and 1024QAM is 5dB.

The receiver continuously monitors the link condition based on *signal quality* value.

Once the *signal quality* value exceeds the threshold of the current ACM profile, an ACM switching process will be initiated. In case of degradation in the link performance, the new ACM profile will include lower modulation, decreasing the link bitrate. The ACM switching rate is hitless, meaning that no data will be lost during a change of ACM profiles.

Signal quality values for ACM downshift and upshift can be found in the table below:

	14MHz	**20MHz**	**25 MHz**	**28 MHz**	**30 MHz**	**40 MHz**
8QAM-->4QAM	74.6	74.6	74.6	74.6	73.0	74.6
4QAM-->8QAM	95.7	95.7	96.1	95.3	95.3	95.7
16QAM-->8QAM	68.8	68.8	68.8	68.0	68.8	68.8
8QAM-->16QAM	91.8	91.8	91.8	91.8	91.8	91.8
32QAM-->16QAM	66.8	66.8	68.4	69.5	68.4	68.4
16QAM-->32QAM	92.2	91.8	92.2	91.4	91.4	91.4
64QAM-->32QAM	66.0	66.0	66.0	67.2	66.0	67.2
32QAM-->64QAM	92.2	91.8	92.2	92.2	92.2	92.2
128QAM-->64QAM	65.2	64.1	64.1	68.8	65.2	64.5
64QAM-->128QAM	91.4	90.6	90.6	91.8	90.6	89.8
256QAM-->128QAM	66.8	59.8	57.0	62.5	60.2	64.8
128QAM-->256QAM	91.0	89.8	87.9	90.2	89.5	91.4
512QAM-->256QAM	66.0	62.1	61.7	59.0	62.9	62.9
256QAM-->512QAM	91.4	90.2	89.8	87.9	88.7	88.7
1024QAM-->512QAM				53.1	58.2	60.2
512QAM-->1024QAM				87.9	89.5	88.7

	50 MHz	**56 MHz**	**60 MHz**	**80 MHz**	**100 MHz**	**112 MHz**
8QAM-->4QAM	74.6	74.6	74.6	74.6	70.7	70.7
4QAM-->8QAM	95.7	95.7	95.7	95.3	95.3	95.3
16QAM-->8QAM	68.8	73.0	69.5	68.0	69.9	68.0
8QAM-->16QAM	91.0	91.4	91.4	91.4	91.8	90.2
32QAM-->16QAM	68.4	68.4	68.4	69.1	69.5	69.5
16QAM-->32QAM	91.4	91.4	91.4	91.4	91.4	91.4
64QAM-->32QAM	67.2	69.5	68.0	64.8	64.8	64.8
32QAM-->64QAM	92.2	92.2	92.2	91.0	91.8	91.0
128QAM-->64QAM	65.2	66.8	66.8	62.9	64.1	62.9
64QAM-->128QAM	89.8	90.2	90.2	89.1	89.1	89.1
256QAM-->128QAM	63.3	65.2	65.2	59.8	60.5	59.8
128QAM-->256QAM	90.6	90.2	90.2	89.1	88.7	87.9
512QAM-->256QAM	62.1	62.5	59.0	58.2	57.8	56.3
256QAM-->512QAM	88.7	87.9	86.7	86.7	86.3	84.8
1024QAM-->512QAM	60.9	59.4	56.3	52.0	50.0	47.3
512QAM-->1024QAM	89.1	87.1	85.9	84.0	82.4	81.3

For example, the link is configured to 1024QAM modulation in 112MHz bandwidth. In order to operate with the highest modulation (and maximum capacity), *signal quality* should be >47.3%. If *signal quality* exceeds this threshold, ACM will downshift to 512QAM. Degrading below 56.3% at 512QAM will downshift to 256QAM. The last ACM downshift will happen after exceeding 70.7% and the link will lose synchronization when *signal quality* reaches 54.3%.

When *signal quality* improves, upshift thresholds will be used. ACM will upshift back to 1024QAM when *signal quality* exceeds 81.3% at 512QAM modulation.

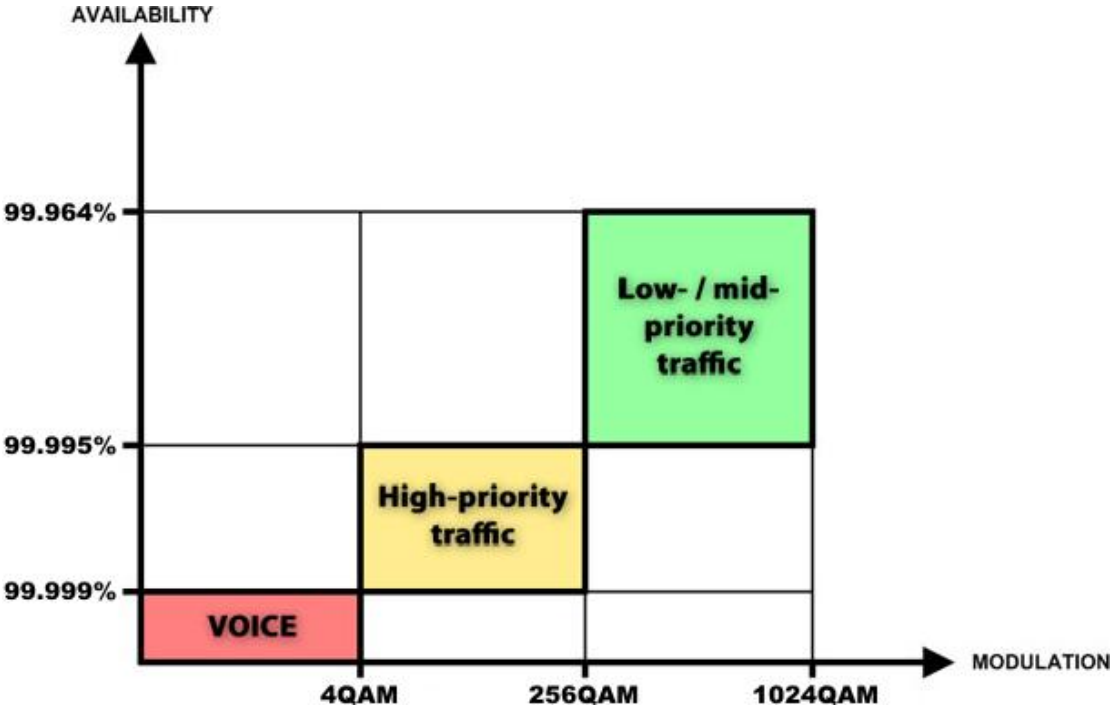
Signal quality value depends on the current Rx modulation. It is not possible to translate what would the current *signal quality* be at different Rx modulation.

Alternatively, ACM 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 ACM profile with lower spectral efficiency to maintain link synchronization.

The following real-world example illustrates the benefits of ACM. Consider an INTEGRAL-W/INTEGRAL-WS link operating at 23 GHz with 60 MHz channel spacing an INTEGRALted antenna with 40.5 dBi (60cm/2ft) gain. The link is operating in a moderate rain zone G (30mm/h) a distance of 11.3 kilometers (7 miles).

The system operation is set to a minimal payload of 75Mbps (4QAM) Ethernet for 99.999% annual availability.

Most of the time system would operate at full capacity of 883Mbps (1024QAM) instead of 75 Mbps (4QAM). The system automatically monitors *signal quality* and changes the capacity without interrupting the data transmission and losing any frames (hitless).



In comparison system using 1024QAM without ACM and providing similar capacity would offer only 99.964% of availability. You would have to decrease the distance, decrease modulation or increase antenna sizes to achieve 99.999% availability for the given link.

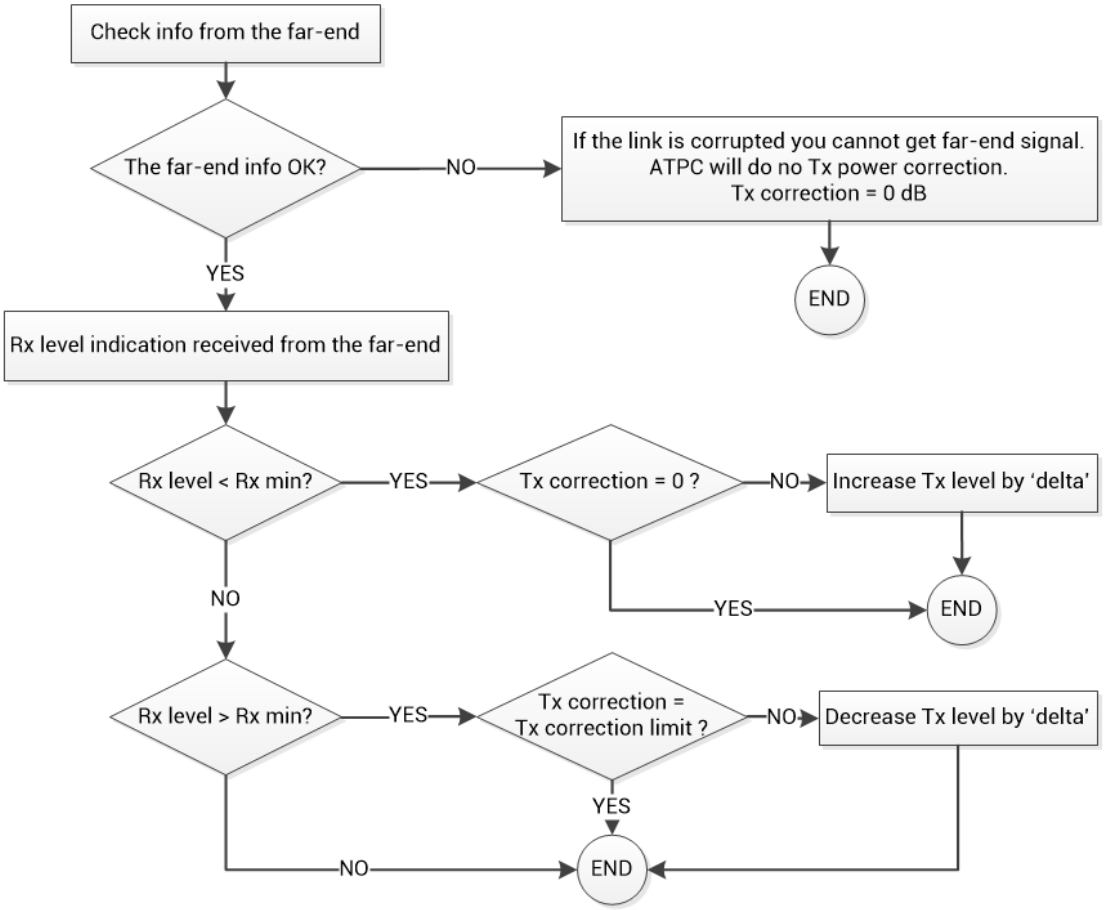
This example demonstrates how the new technology, based on an ACM mechanism, can play a key role in the development of cost-effective next-generation wireless access networks, by taking advantage of traffic evolution from synchronous TDM traffic to packet IP-based traffic.

ATPC (Automatic Transmit Power Control)

ACM can be implemented together with **automatic transmit power control (ATPC)**. ATPC reduces the average transmitted power as well as co-channel interference (CCI), and adjacent-channel interference (ACI), which is caused by extraneous power from a signal in an adjacent channel. It also enables a more efficient and cost-effective network frequency plan and deployment, as well as eliminating some of the receivers' "upfade" problems by changing the transmitted power according to the link momentary conditions. The lower average Tx power also extends the equipment's mean time between failures.

ATPC can be used together with ACM to control the transmitted power in any given ACM 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 efficacy by trying to reach the highest ACM 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 ACM profile and any link condition.

The local INTEGRAL receives information about Rx level from the far-end INTEGRAL through the service channel. Depending on the received Rx level parameter, the local INTEGRAL adjusts the transmitter power in accordance with the algorithm shown below.



Rx level – the Rx level value received from the far-end site
Rx max – maximum permissible Rx level at the far-end site
Rx min – minimum permissible Rx level at the far-end site
Tx correction – value by what ATPC has decreased Tx power
Tx correction limit – defined maximum of Tx correction
Delta – the value by which Tx power is changed according to the far-end Rx level indication (1dB by default)

FTP directory

FTP directory of INTEGRAL-W/INTEGRAL-WS can be used in combination with CLI commands to backup/restore system configuration, upload another FW version, upload new license file.

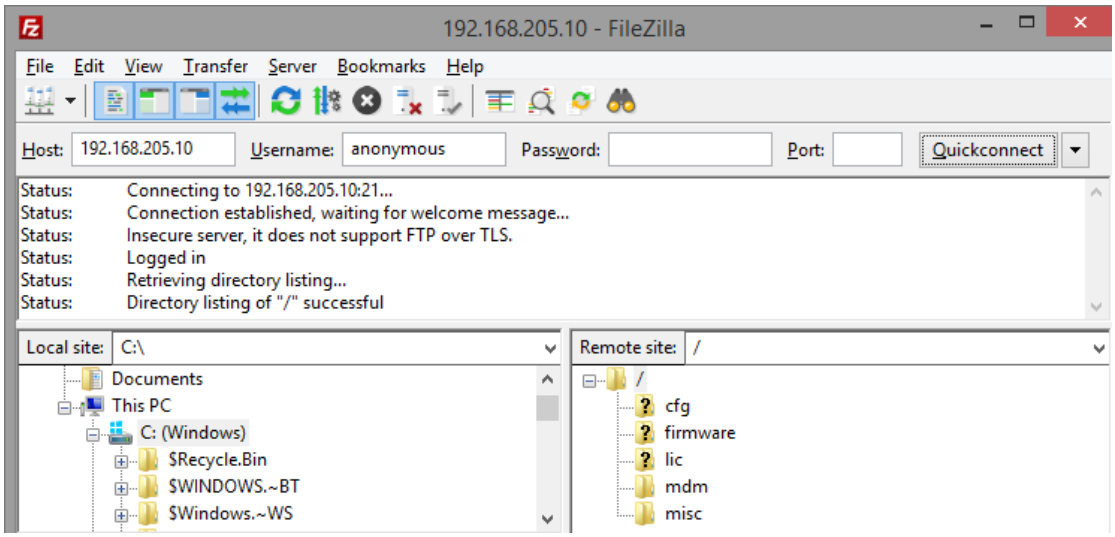
FTP directory is separated area of internal memory in INTEGRAL-W/INTEGRAL-WS.

FTP directory function is deactivated by every restart of INTEGRAL-W/INTEGRAL-WS and all files from this special area are wiped out.

Use CLI command **system service ftp enable** to activate FTP directory function.

After system service ftp is enabled it is possible to connect to INTEGRAL-W/INTEGRAL-WS by using your favorite FTP client. Username is **anonymous** and password is empty.

Here is an example of FTP connection to INTEGRAL-W/INTEGRAL-WS using FileZilla:



FTP area has a number of sub-directories separating every sub-function:

cfg	For managing system configuration backup/restore files. More information in the the chapter System → Configuration → Configuration file
firmware	For uploading a firmware files. For more information see the chapter System → FW → Firmware upgrade and CLI commands of the chapter Over The Air → Radio → Configuration
lic	For uploading a license files. For more information see the 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 CLI command: **system service ftp disable** .

RADIUS authentication

Configuration of the Radius server authentication

The configuration of the FreeRADIUS software based in Linux system (Ubuntu) is given as an example.

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"
```

2. Add client (INTEGRAL) data editing the clients configuration file: */etc/freeradius/clients.conf*

   Add the following lines specifying INTEGRAL IP address and the RADIUS secret:

   client 192.168.205.10 {

   secret = radiuspass_1

   }

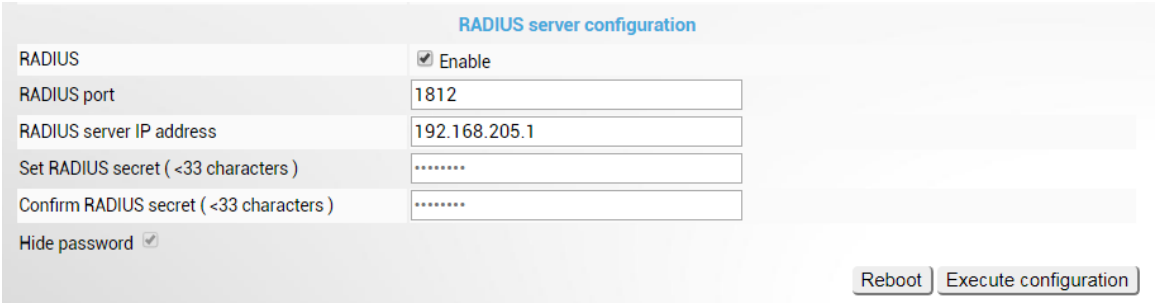
   where *192.168.205.10* is the IP address of INTEGRAL, *radiuspass_1* is the RADIUS secret word.

```
#  the "ipaddr" or "ipv6addr" fields.  For compatibility, the 1.x
#  format is still accepted.
#


client 192.168.205.10 {
secret = radiuspass_1
}
```

3. Restart FreeRADIUS.
4. Set up the RADIUS configuration in INTEGRAL Web GUI:
   4.1. Open the RADIUS server configuration page ("System→Configuration→System services").
   4.2. Configure RADIUS port, RADIUS server IP address and RADIUS secret parameters according to your setup.

RADIUS server should belong to the same subnet as INTEGRAL and should have the same secret word as INTEGRAL.



5. Execute a configuration, save the configuration changes and reboot INTEGRAL.
6. Log in to INTEGRAL using the secure HTTPS connection.
7. Proceed to assigning the administrative rights for a user if needed.

Assigning administrator rights to RADIUS user

1. Add the following Attribute to the main FreeRADIUS dictionary file. Open the file: */etc/freeradius/dictionary*

   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
~
```

2. Provide the specified attribute to the user that must be granted administrator rights. Open the users configuration file: */etc/freeradius/users*

   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"
```

3. Restart FreeRADIUS.
4. Log in to INTEGRAL using the secure HTTPS connection.

Chapter 7: TOOLS

Link Layer Discovery tool

The Link Layer Discovery Tool is a command line application for MS Windows. It sends requests to LLD server application which runs on all INTEGRAL series devices.

The tool is used to discover INTEGRAL/INTEGRAL-S/INTEGRAL-G/INTEGRAL-GS/ INTEGRAL-W/INTEGRAL-WS devices and reset their passwords or settings.

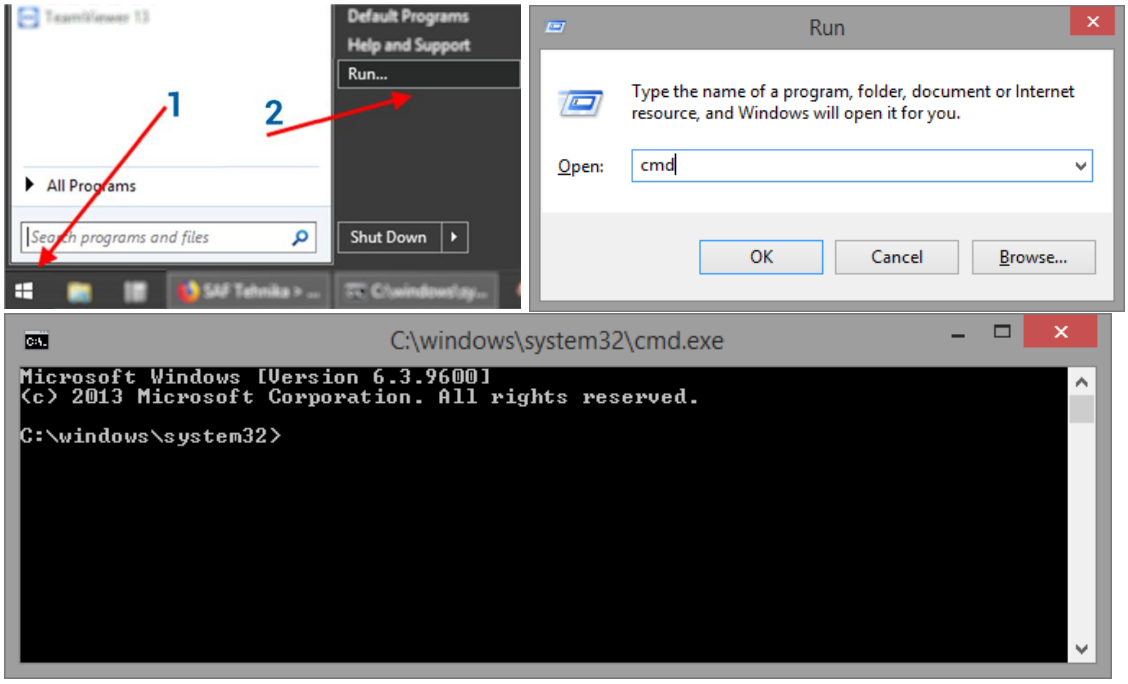
The application runs on the following version of Windows: Windows Vista, Windows 7, Windows 8, and Windows 10.

WinPCAP must be installed to use the Link Layer Discovery Tool.

The Link Layer Discovery Tool for INTEGRAL series can be downloaded in https://saftehnika.com/en/downloads in "Tools" section. Login required.

1) Unzip the LLD.zip file you downloaded to a directory of your choice, for example, C:\SAF\LLD\ .

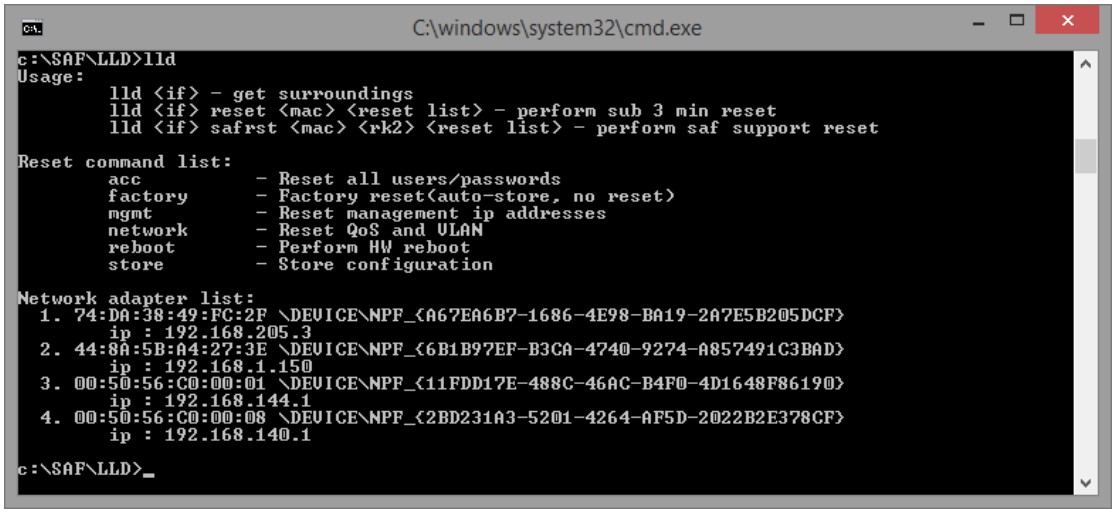
2) The application is started via the command prompt (Start menu→Run→type "cmd"→press ENTER). Command line console window should appear.



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.



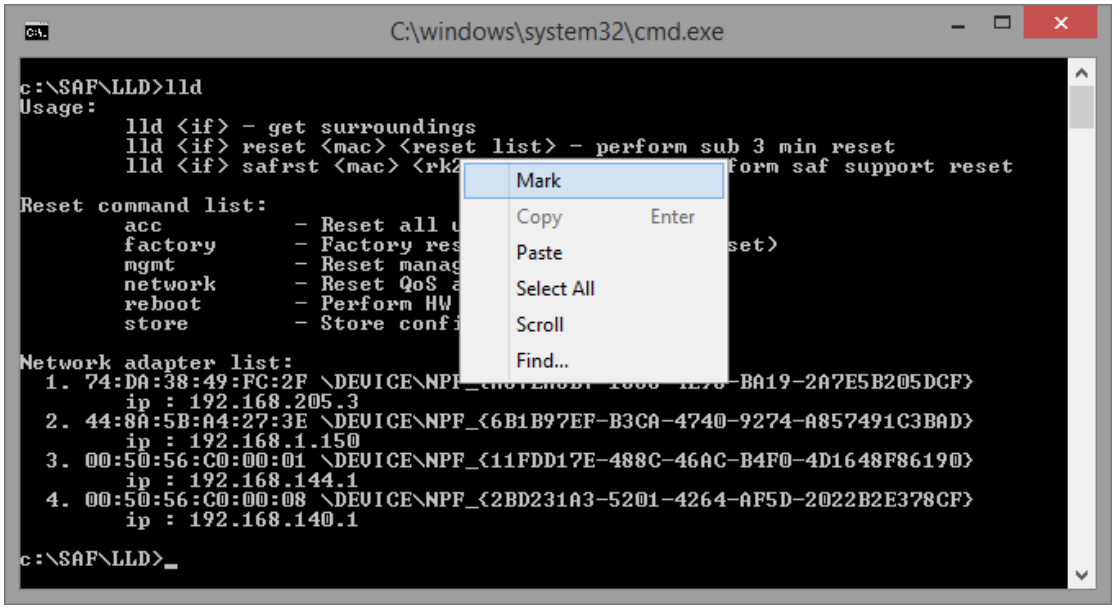
5) Available commands and network adapter list should be shown. To scan for INTEGRAL devices, the command should be run as follows:

```
lld <network interface>
```

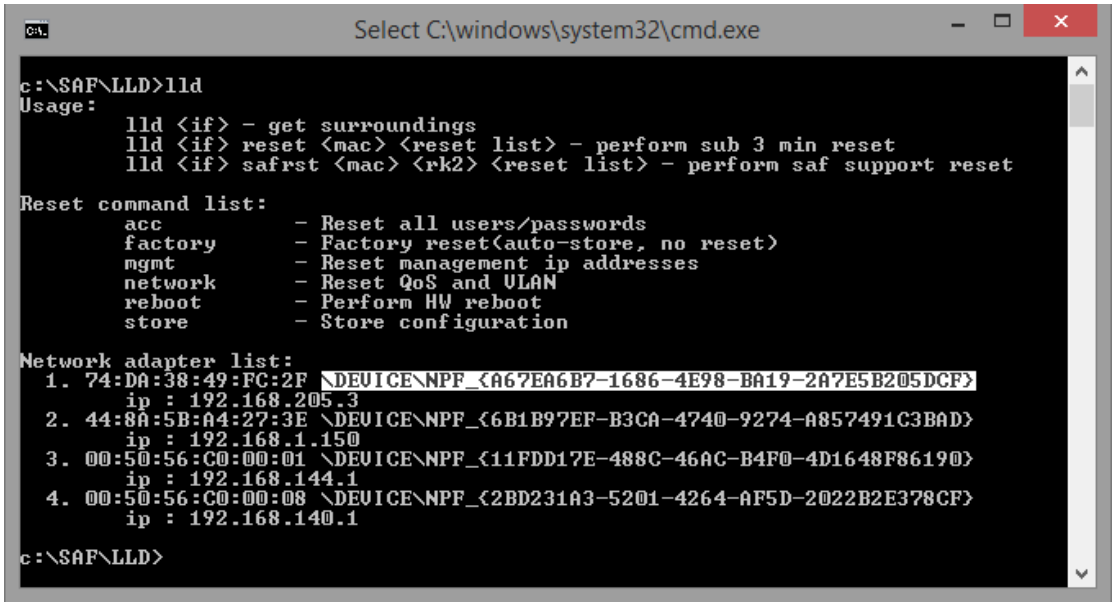
For example:

```
lld \DEVICE\NPF_{A67EA6B7-1686-4E98-BA19-2A7E5B205DCF}
```

In order to copy the interface address from network adapter list, click the right mouse button over the console and select “Mark”:

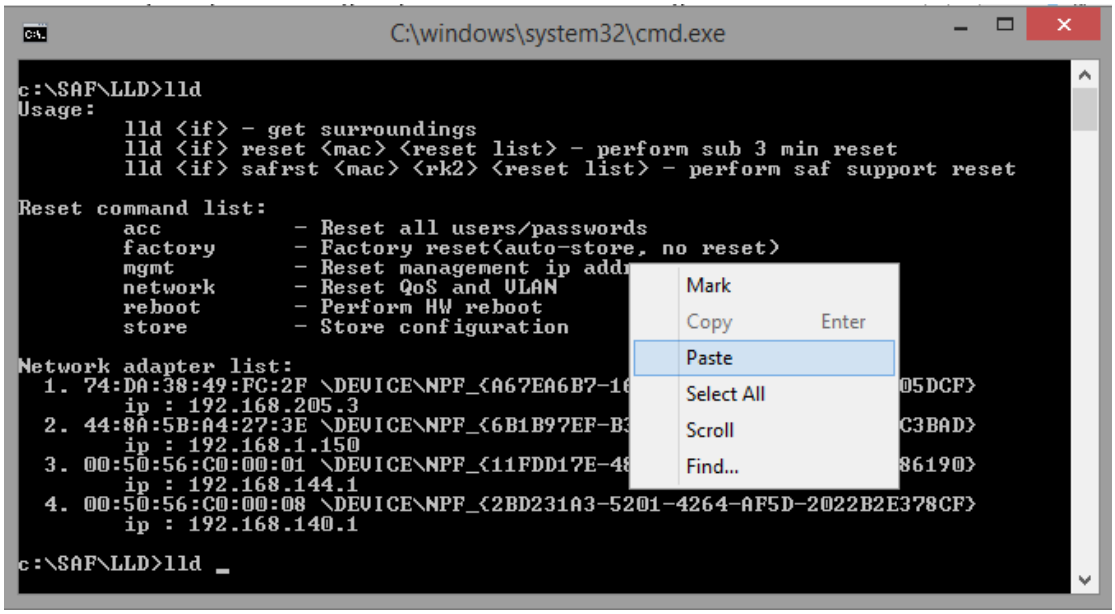


Then by holding the left button select the interface address:

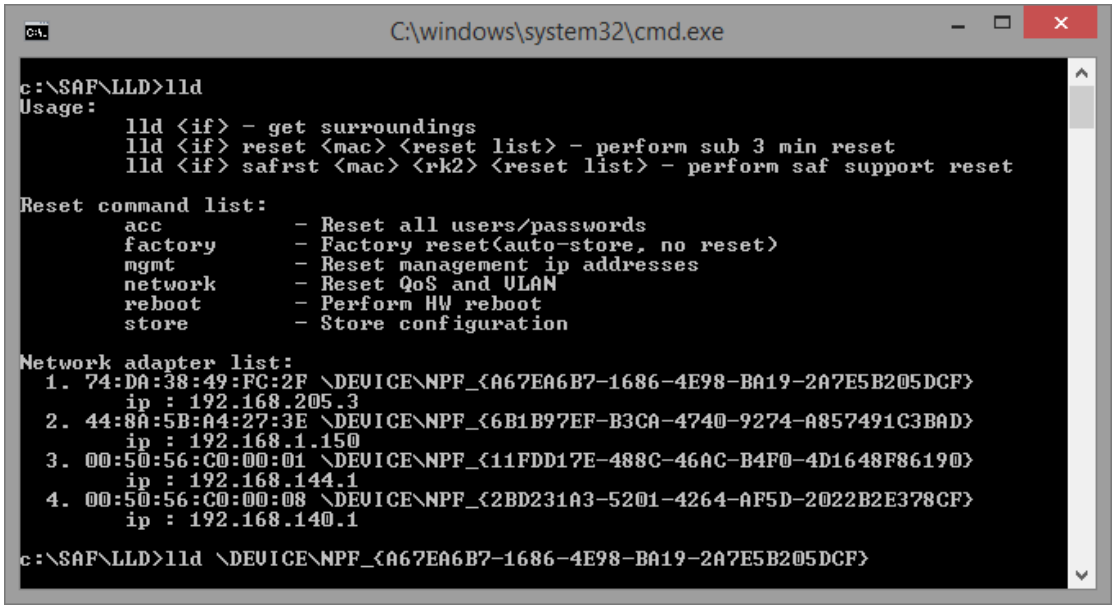


After selecting, release the left button and click the mouse right button anywhere on the console. The address should be copied.

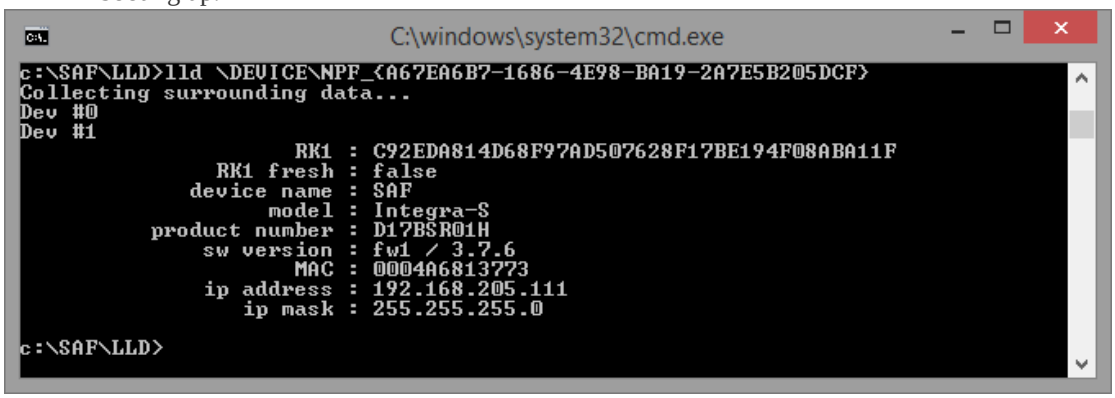
Type "`lld` " and paste the address by clicking the right button anywhere on the console:



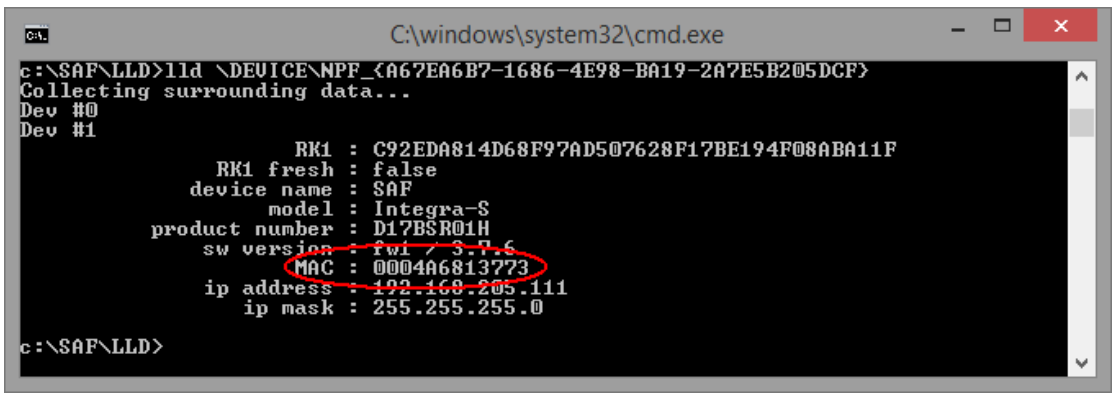
The result should be similar as in the image below:



6) Press ENTER and the recovery tool will now scan for INTEGRAL devices. Available devices and their information will appear in the console. Make sure that the device has finished booting up.



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.



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 INTEGRAL device address
<*reset command*> − reset options

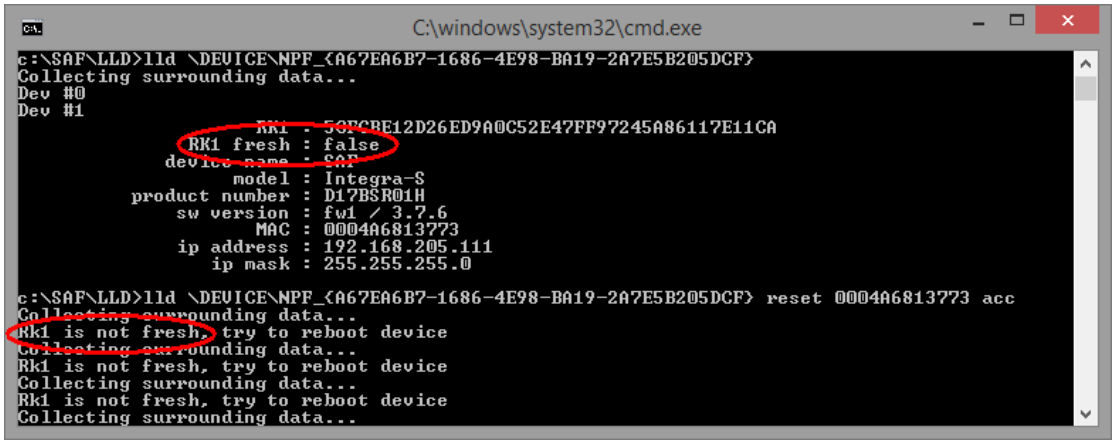
Different reset options are available depending on the reset requirement. Reboot and store options are also available. Store option saves the device current configuration so it will be restored after system reboot. The commands are available in the reset command list. Use the command after the MAC address 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
```

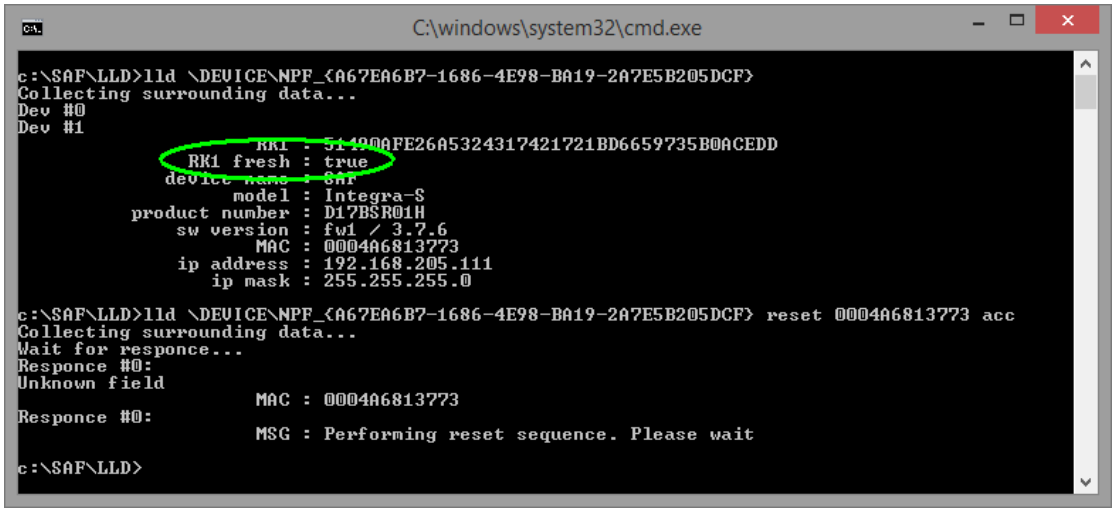
For example, to reset users and passwords on INTEGRAL device #1, use:

```
lld \DEVICE\NPF_{A67EA6B7-1686-4E98-BA19-2A7E5B205DCF} reset 0004A6813773 acc
```

Make sure the command is run within 3 minutes after INTEGRAL reboot ("*RK1 fresh*" must be "*true*" in the console), otherwise error shown in the screenshot below error will occur. The recovery tool will continue to retry the command.



Power down the INTEGRAL device and power it up again, the reset should be completed soon.

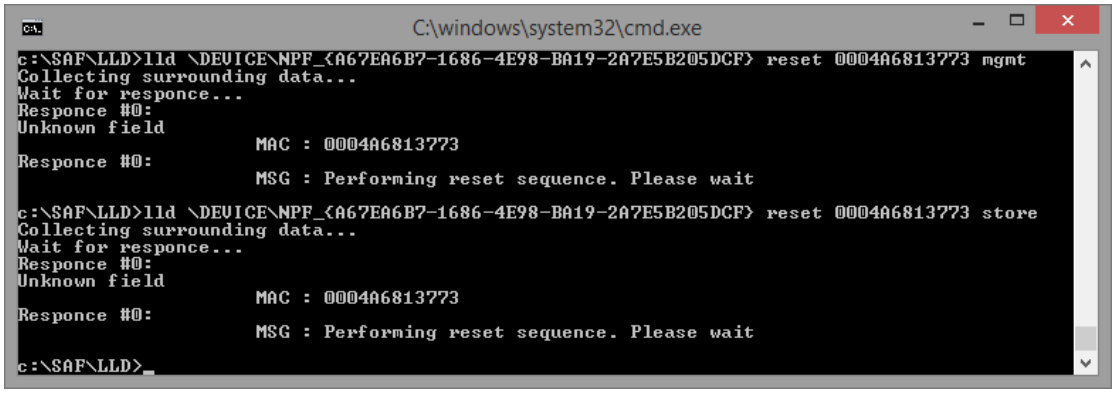


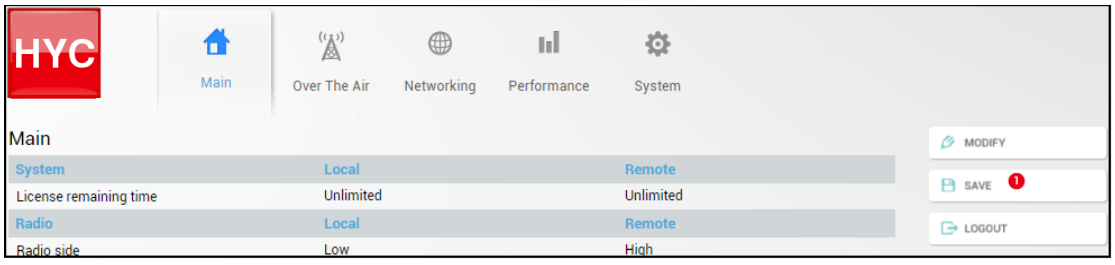
If the reset cannot be completed, redo step 8).

9) Store changes by command (must be done within the time frame of 3 minutes after boot) or by using WEB GUI (any time before the INTEGRAL device is powered off) “SAVE” button.

For example:

```
lld \DEVICE\NPF_{A67EA6B7-1686-4E98-BA19-2A7E5B205DCF} reset 0004A6813773 store
```





MIB files

Relevant MIB files can be downloaded directly from INTEGRAL-W/INTEGRAL-WS Web GUI. See Chapter “System → Configuration → SNMP configuration” for further details.

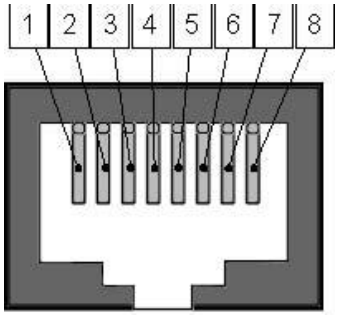
Chapter 8: INTERFACES

RJ-45 ports (MNG & LAN)

RJ-45 ports (MNG & LAN) comply with IEEE 802.3-2005 1000Base-T Ethernet and IEEE 802.3at, LTPoE++ Power over Ethernet standards. MNG port additionally complies with 100Base-T Ethernet standard.

For some HW revisions, PoE may be available on data (LAN(TP)) port only.

The pinouts are as follows:



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-

In case Ethernet cable is used for power & data (with PoE injector), combined Ethernet cable length from PoE injector to INTEGRAL-W/INTEGRAL-WS FODU and from PoE injector to CPE is limited to 100m / 328ft.

In case SFP interface (LAN) is configured for data traffic, it is possible to use RJ-45 port solely for power supply. Two options are possible:

1) Ethernet cable with PoE injector.
   Please refer to the table below for maximum Ethernet cable length from PoE injector to INTEGRAL-W/INTEGRAL-WS FODU based on AWG wire size and INTEGRAL-W/INTEGRAL-WS FODU power consumption.

AWG	Lmax @ 45W	Lmax @ 40W	Lmax @ 35W
26	202m / 662ft	227m / 745ft	259m / 851ft
24	321m / 1053ft	361m / 1184ft	413m / 1353ft
22	510m / 1674ft	574m / 1884ft	656m / 2153ft

2) 2-wire power cable together with DC power adapter cable for INTEGRAL-W/INTEGRAL-WS (P/N D0ACPW01).
   Please refer to the tables below for maximum power cable length based on AWG wire size or cross-section and INTEGRAL-W/INTEGRAL-WS FODU power consumption.

AWG	Lmax @ 45W	Lmax @ 40W	Lmax @ 35W
24	80m / 263ft	90m / 296ft	103m / 338ft
22	127m / 419ft	143m / 471ft	164m / 538ft
20	203m / 666ft	228m / 749ft	260m / 856ft
18	322m / 1058ft	362m / 1190ft	414m / 1360ft
16	512m / 1682ft	576m / 1892ft	659m / 2163ft
14	815m / 2675ft	917m / 3010ft	1048m / 3440ft

Cross-section area	Lmax @ 45W	Lmax @ 40W	Lmax @ 35W
0.25mm^2	101m / 331ft	113m / 370ft	129m / 423ft
0.5mm^2	201m / 659ft	226m / 741ft	259m / 849ft
0.75mm^2	302m / 990ft	339m / 1112ft	388m / 1273ft
1.0mm^2	402m / 1318ft	452m / 1482ft	517m / 1696ft
1.5mm^2	603m / 1978ft	679m / 2227ft	776m / 2545ft

Maximum cable length calculation is done using copper resistance.

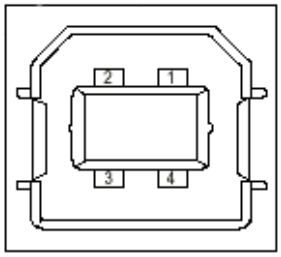
SFP port (LAN)

SFP port provides SFP transceiver connectivity.
SFP port complies with the following Gigabit Ethernet standards:
1000BASE-SX, 1000BASE-LX, 1000Base-T (note: 1000FDX only).

USB port

USB port provides serial terminal access to CLI. The socket is B type.

USB Type B Socket

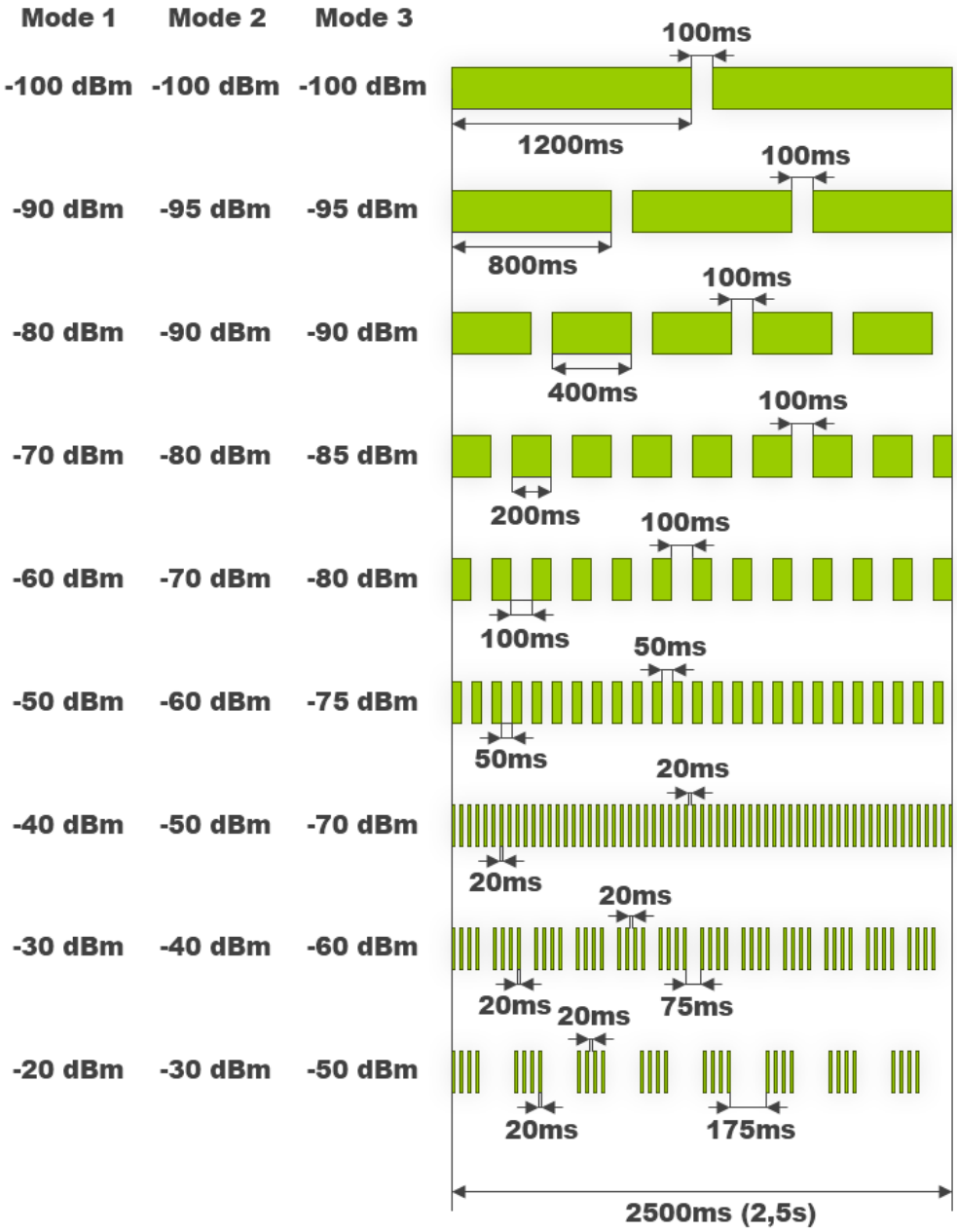


1=Vbus (5V)
2=D–
3=D+
4=GND

RSSI LED

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 Over The Air → Radio → Configuration page.

Corresponding Rx signal levels and LED blinking pattern for each mode is represented in the figure below:

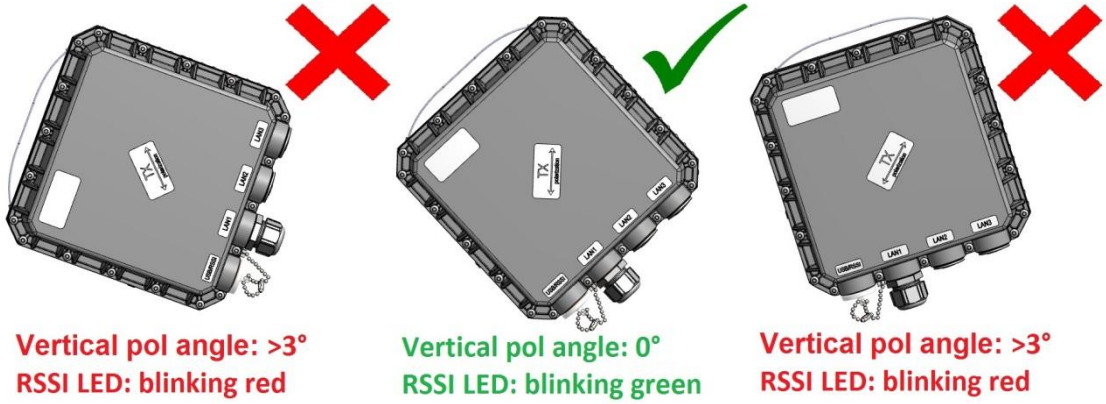


INTEGRAL-WS RSSI LED description

The 15-42 GHz INTEGRAL-WS FODUs have a dual color RSSI LED. The RSSI LED can blink either in green or in red color. The blinking pattern is as given in the figure above and is the same for both colors. (Functionality may not be available in older HW revisions.)

A red RSSI LED warns about mistakes in the FODU installation. It turns red in the following circumstances:

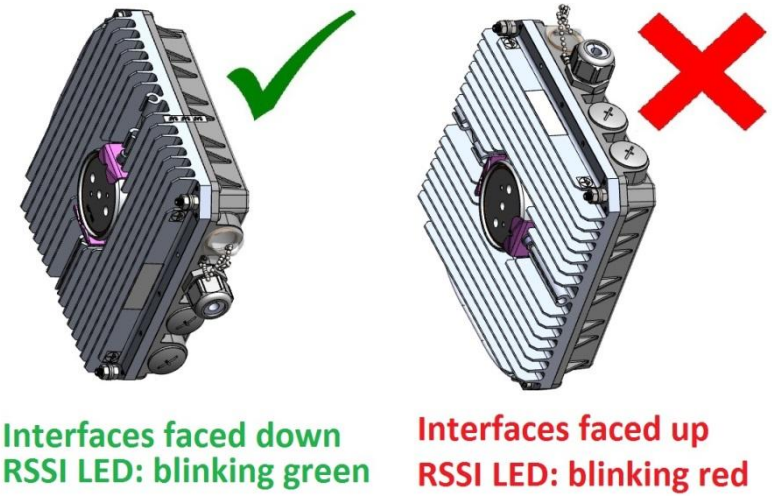
1) If the polarization offset from Vertical polarization axis (zero degrees level) is more than 3 degrees to both sides.



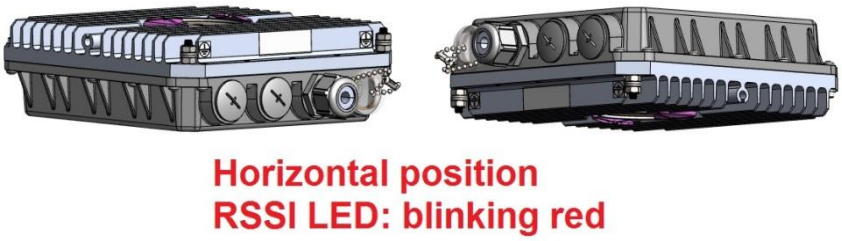
2) If the polarization offset from Horizontal polarization axis (zero degrees level) is more than 3 degrees to both sides.

3) If the elevation angle of the INTEGRAL-WS FODU will differ for more than +/-20 degrees from zero degrees elevation angle

4) If the FODU will be installed with its interfaces upwards.



5) If the FODU will be placed on any surface horizontally.



Note that 17&24 GHz INTEGRAL-WS FODUs must be installed in opposite polarizations

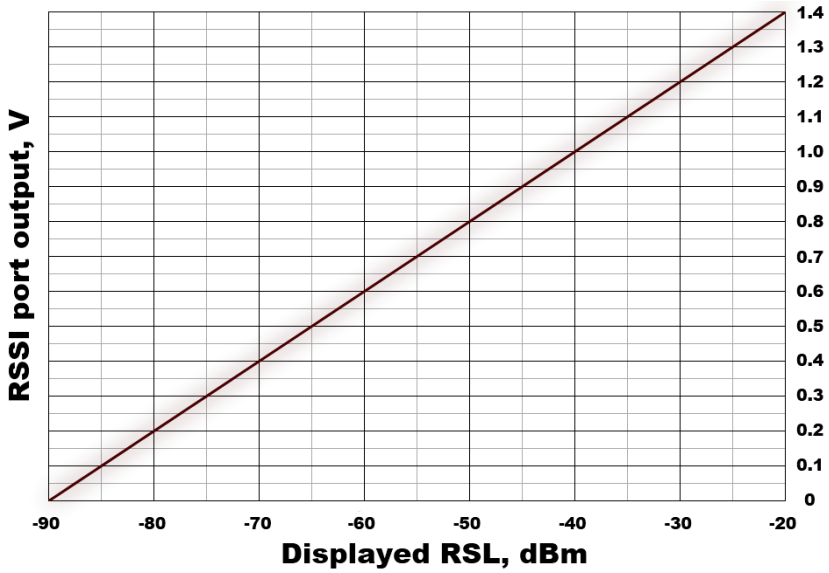
RSSI/audio port

RSSI (Received Signal Strength Indicator) port is used to adjust the alignment of the antenna for best performance (for both rough and fine adjustment); this can be done using digital multimeter or headphones connected to the RSSI port. The RSSI port is 3.5mm socket. The output of the RSSI port is DC voltage and audio frequency and varies depending on received signal level. Both are linear curves.

In order to connect a voltmeter you will require appropriate RSSI cable (P/N D0ACRS01):

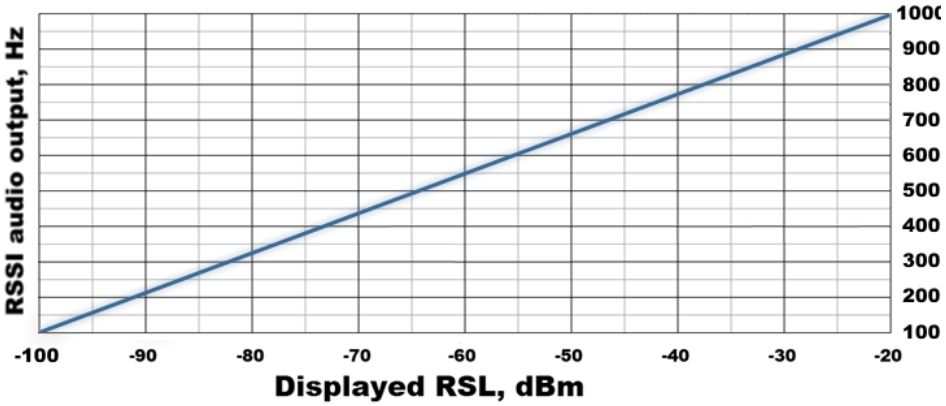
The following charts and tables show the typical relationship of the received signal level (Rx level) displayed by INTEGRAL-W/INTEGRAL-WS vs. RSSI port output voltage (RSSI – Received Signal Strength Indicator) and audio frequency. The RSSI port is located on FODU. The evaluated Rx level has the error +/-2 dB.

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	1.0
-35	1.1
-30	1.2
-25	1.3
-20	1.4

Output audio frequency



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

Appendix A: TECHNICAL SPECIFICATION

		INTEGRAL-W		INTEGRAL-WS
General				
Concept / form factor		FODU with antenna INTEGRALtion		FODU slip-fit
Capacity		883 Mbps at 112 MHz 1024 QAM 643 Mbps at 80 MHz 1024 QAM (for INTEGRAL-WS 17GHz and 24GHz)		
Frequency bands		*6GHz, 7GHz, 11GHz, 13GHz*, 15GHz, 17GHz UL, 18GHz, 23GHz, 24GHz UL, 25GHz, 26GHz, 28GHz, 38GHz, and more**		
Modulation		From 4QAM up to 1024QAM with hitless ACM		
Configurations		1+0		
ATPC		*Yes*		
Channel bandwidth		ETSI: from 56 MHz up to 112 MHz FCC: from 40 MHz up to 80 MHz		
Frequency stability		± 10 ppm		
Ports				
Gigabit Ethernet	2x RJ-45	Electrical with built-in PoE splitter and surge arrestor		
	1x SFP	Alternative to 1xRJ-45		
Service ports	3.5mm	Audible alignment and RSSI		
	USB B	RS232 serial over USB B-Type		
	LED	Power On, Link Synchronization, RSL, Polarization accuracy*		
Ethernet				
Ethernet		Unmanaged Gigabit Ethernet with only one simultaneous traffic port		
Gigabit Switch functionality		Transparent		
Management		SNMP v1/2c/3, SSH, Telnet, HTTPS, Serial, RADIUS, Network Time Protocol		
Performance monitoring		Performance graphs, constellation diagram, alarms, detailed counters		
Management		Both In-band and Out-of-band MNG		
Carrier Ethernet functionality		Transparent		
Jumbo frames		Yes, 9600 bytes		
Antenna				
Sizes		0.3m / 1ft	0.6m / 2ft	External antenna
Antenna		High Performance and *Super High Performance**		
Electrical				
Power consumption		31...74 W depending on model and frequency band. See table below.		
Power range	INTEGRAL	36 … 57 V DC		
	PoE Injector[1]	36 … 60 V DC all INTEGRAL models; 22...60 V DC models with ≤50 W consumption		
Temperature range		-33 ... +55 °C / -28 … +130 °F		

[1] *Voltage range using I0ATPI24 Power over Ethernet Injector*

** Inquire SAF representative for more information*

Mechanical specification

		INTEGRAL-W		INTEGRAL-WS
Antenna		**0.3m / 1ft**	**0.6m / 2ft**	**External antenna**
Mechanical & Environmental				
Antenna performance		High Performance and *Super High Performance*[2]		
Stationary use		Conforms to ETSI EN 300 019 Class 4.1, IP66, NEMA 4X		
Size, w/o mount		378 x 378 x 227 mm / 14.9” x 14.9” x 9”	669 x 669 x 289 mm / 26.3” x 26.3” x 11.4”	235 x 250 x 72 mm / 9.26” x 9.85” x 2.84”
Size, INTEGRAL -WS 17/24 GHz UL		N/A[3]	N/A[3]	235 x 250 x 111 mm / 9.26” x 9.85” x 4.37”
Size, 6..13[2] GHz		N/A	N/A	280 x 437 x 100 mm / 11.02” x 17.2” x 3.9”
Weight, w/o mount		5 kg / 11 lbs	5 kg / 11 lbs	2.9 kg / 6.4 lbs
Weight, INTEGRAL -WS 17/24 GHz UL		N/A[3]	N/A[3]	4.9 kg / 10.8 lbs
Weight, 6..13[2] GHz		N/A	N/A	6.5 kg / 14.3 lbs
Mount	Mount size	292 x 176 x 250 mm / 11.5” x 7” x 10” max		Mount on antenna
	Pole size	Ø 40 – 120 mm / Ø 1.6” – 4.7”		
	Weight	2.55 kg / 5.6 lbs		

[2] *Inquire SAF representative for more information*

[3] *Among INTEGRAL-W family, only INTEGRAL-WS model with external antenna is currently available for 17/24 GHz unlicensed bands.*

Power consumption at 48V DC[4]

L6 GHz	U6, 7 GHz	11, 13 GHz	15 GHz	17 GHz	18 GHz	23 GHz	24 GHz	25, 26, 28 GHz	38 GHz
70W	64W	51W	31W	28W	35W	35W	30W	36W	38W

[4] *Power consumption for INTEGRAL radio shown only. For power consumption of complete system add up to 8% (at 48V DC input) for PoE in DC/DC mode, around 4W for 100m cable (depends on cable) and approx. 1W for SFP transceiver, if used.*

INTEGRAL-W preliminary RSL Threshold (dBm) and Link Capacity (Mbps)

		6L GHz	6U GHz	11 GHz	15 GHz	17 GHz	18 GHz	23 GHz	24 GHz	26 GHz	28 GHz	38 GHz	
BW, MHz	Modulation, Strong FEC	Guaranteed RSL Threshold, dBm											Capacity, Mbps
	4QAM	-82.5	-82.5	-82.5	-82	-79	-83.5	-80.5	-80	-82	-82.5	-79	63
	8QAM	-79	-79	-78	-77.5	-76	-80.5	-76.5	-75.5	-78	-78.5	-75	94
	16QAM	-76	-76	-75.5	-75	-73	-76.5	-74.5	-72.5	-75	-74.5	-72.5	126
40	32QAM	-73	-73	-73	-72.5	-70	-74	-71.5	-70	-72	-72	-69.5	157
	64QAM	-70	-70	-70	-69.5	-67.5	-71.5	-69.5	-66.5	-69	-69	-66.5	189
FCC	128QAM	-67	-67	-67	-66.5	-64.5	-68	-65.5	-64	-66	-66.5	-63.5	220
	256QAM	-64	-64	-64	-63.5	-61	-63.5	-62.5	-60.5	-63	-61.5	-60.5	252
	512QAM	-61	-61	-60	-59.5	-58	-59.5	-59.5	-57.5	-60	-59.5	-57.5	284
	1024QAM	-57	-57	-56.5	-56	-55	-55.5	-57	-54	-56	-55.5	-53	315
	4QAM	-82	-82	-82	-81.5	-79	-82.5	-79.5	-79	-81	-81	-78.5	78
	8QAM	-78	-78	-77	-76.5	-75	-79	-75.5	-75	-77	-77	-74.5	118
	16QAM	-75	-75	-75	-74.5	-72	-76.5	-74.5	-72	-74	-74	-72	157
50	32QAM	-72	-72	-72	-71.5	-69.5	-73.5	-71.5	-69	-71	-71	-69	197
	64QAM	-69	-69	-69	-68.5	-66.5	-70.5	-68.5	-66	-68	-68.5	-66	236
FCC	128QAM	-66	-66	-66	-65.5	-63.5	-65.5	-65.5	-62.5	-65.5	-66.5	-64	276
	256QAM	-63	-63	-63	-62.5	-60	-62.5	-61.5	-60	-62	-62	-60	315
	512QAM	-60	-60	-60	-59.5	-57.5	-58.5	-58.5	-57	-59	-59	-57	355
	1024QAM	-56	-56	-56	-55.5	-54	-55.5	-55.5	-53	-55	-54.5	-52.5	394
	4QAM	-81.5	-81.5	-81	-80.5	-78.5	-82.5	-80	-78	-80	-80.5	-77.5	89
	8QAM	-77	-77	-76	-75.5	-74.5	-78	-75.5	-73	-76	-76.5	-73.5	134
	16QAM	-74.5	-74.5	-74	-73.5	-72	-75.5	-74	-71	-74	-74	-71	178
56	32QAM	-71.5	-71.5	-71	-70.5	-69	-72.5	-70.5	-68.5	-71	-71.5	-69.5	224
	64QAM	-68.5	-68.5	-68.5	-68	-66	-68.5	-67.5	-65	-68	-68	-66	269
ETSI	128QAM	-65	-65	-65	-64.5	-63	-65.5	-65	-62	-65	-65	-62	314
	256QAM	-62.5	-62.5	-62.5	-62	-60	-61.5	-61.5	-59	-62	-62.5	-59.5	359
	512QAM	-59.5	-59.5	-59	-58.5	-57	-58.5	-58.5	-56	-58	-59	-56	404
	1024QAM	-55	-55	-55.5	-55	-53	-54.5	-55	-52.5	-55	-55.5	-52.5	449
	4QAM	-81	-81	-81	-80.5	-78.5	-81.5	-80.5	-78	-80	-80	-77.5	96
	8QAM	-76.5	-76.5	-76	-75.5	-74	-78	-75.5	-74	-76	-76	-73.5	144
	16QAM	-74.5	-74.5	-74	-73.5	-71.5	-75.5	-73.5	-71	-74	-74.5	-72	192
60	32QAM	-71.5	-71.5	-71	-70.5	-68.5	-72.5	-70.5	-68	-71	-71.5	-68.5	240
	64QAM	-68.5	-68.5	-67.5	-67	-64.5	-67.5	-67.5	-65	-67	-67	-65	288
FCC	128QAM	-65	-65	-65	-64.5	-62.5	-65.5	-64.5	-62	-65	-65.5	-62.5	336
	256QAM	-62.5	-62.5	-62	-61.5	-59.5	-61.5	-61.5	-59	-61	-61.5	-58.5	385
	512QAM	-59	-59	-58	-57.5	-56.5	-58.5	-58.5	-55.5	-58	-58	-56	433
	1024QAM	-55	-55	-55	-54.5	-53	-54.5	-55	-52	-55	-54.5	-52	481
	4QAM	-79.5	-79.5	-79.5	-79	-77.5	-81	-78.5	-76	-79	-79	-76.5	128
	8QAM	-75.5	-75.5	-74	-73.5	-72.5	-77	-75	-73	-75	-75	-72.5	192
80	16QAM	-72.5	-72.5	-72	-71.5	-70	-74.5	-71.5	-70	-72	-72	-69.5	257
	32QAM	-69.5	-69.5	-69	-68.5	-67.5	-71.5	-68.5	-67	-69	-69	-66.5	321
FCC	64QAM	-66.5	-66.5	-66.5	-66	-64.5	-67.5	-65.5	-64	-66	-66	-63.5	385
	128QAM	-63.5	-63.5	-63.5	-63	-61	-64	-62.5	-61	-63	-63	-60.5	450
	256QAM	-60.5	-60.5	-60.5	-60	-58	-60.5	-59.5	-58	-60	-60	-57.5	514

		6L GHz	6U GHz	11 GHz	15 GHz	17 GHz	18 GHz	23 GHz	24 GHz	26 GHz	28 GHz	38 GHz	
BW, MHz	Modulation, Strong FEC	Guaranteed RSL Threshold, dBm											Capacity, Mbps
	512QAM	-57.5	-57.5	-57	-56.5	-55	-57	-56.5	-54	-56.5	-56.5	-54	578
	1024QAM	-53.5	-53.5	-53.5	-53	-51.5	-53.5	-53	-51	-53.5	-53.5	-51	643
	4QAM	-78.5	-78.5	-79	-78.5	-	-80	-77.5	-	-78.5	-78.5	-76	168
	8QAM	-74.5	-74.5	-74	-73.5	-	-76	-73.5	-	-73.5	-73.5	-71	252
	16QAM	-71.5	-71.5	-71	-70.5	-	-73	-70.5	-	-71.5	-71.5	-69	336
100[5]	32QAM	-68.5	-68.5	-69	-68.5	-	-70	-67.5	-	-68.5	-68.5	-66	420
	64QAM	-65.5	-65.5	-65.5	-65	-	-66	-64.5	-	-65.5	-65.5	-63	504
FCC	128QAM	-63	-63	-63	-62.5	-	-63	-61.5	-	-62.5	-62.5	-60	588
	256QAM	-59.5	-59.5	-59.5	-59	-	-60	-58.5	-	-58.5	-58.5	-56	672
	512QAM	-56	-56	-56	-55.5	-	-56	-55.5	-	-56.5	-56.5	-54	756
	1024QAM	-52	-52	-51	-50.5	-	-51.5	-52	-	-51.5	-51.5	-49	840
	4QAM	-78.5	-78.5	-77.5	-77	-	-79.5	-77.5	-	-77.5	-77.5	-75	176
	8QAM	-73.5	-73.5	-73.5	-73	-	-76	-73	-	-73	-73	-70.5	265
	16QAM	-71.5	-71.5	-71	-70.5	-	-73	-70.5	-	-70.5	-70.5	-68	359
112[5]	32QAM	-68.5	-68.5	-68	-67.5	-	-70	-67.5	-	-67.5	-67.5	-65	441
	64QAM	-65	-65	-65	-64.5	-	-66	-64.5	-	-64.5	-64.5	-62	530
ETSI	128QAM	-62.5	-62.5	-62	-61.5	-	-63	-61.5	-	-61.5	-61.5	-59	618
	256QAM	-59.5	-59.5	-59	-58.5	-	-59	-58.5	-	-58.5	-58.5	-56	707
	512QAM	-54.5	-54.5	-56	-55.5	-	-56	-54.5	-	-54.5	-54.5	-52	795
	1024QAM	-52	-52	-51.5	-51	-	-51.5	-51	-	-51.5	-51.5	-49	883

[5] 100 MHz and 112 MHz channel bandwidths are available for all INTEGRAL-W /-WS models except 17GHz and 24GHz UL.

Maximum Tx Power for INTEGRAL-W and INTEGRAL-WS

Modulation	Tx power, dBm					
	L6 GHz	U6 GHz	11 GHz	15, 18, 23, 25, 26, 28 GHz	17 GHz[6], 24 GHz[6]	38 GHz
4 QAM	+33	+31	+28	+22	-26 … +5	+17
16 QAM	+32	+30	+27	+21	-26 … +5	+16
32 QAM	+31	+29	+26	+21	-26 … +5	+16
64 QAM	+30	+28	+25	+20	-26 … +5	+15
128 QAM	+30	+28	+25	+20	-26 … +5	+15
256 QAM	+30	+28	+25	+19	-26 … +5	+14
512 QAM	+30	+28	+25	+19	-26 … +5	+14
1024 QAM	+28	+26	+23	+17	-26 … +5	+12

[6] Max Tx power settings depend on EIRP allowed by national regulatory and antenna size.

High Performance INTEGRALted antenna specification

Size	Frequency, GHz	Gain, dBi	Half power beamwidth	XPD dB	F/B ratio, dB	Compliance	
						ETSI	FCC
0.3m	**15**	32.1	4.3°	30	58	Class 3	N/A
	17	33.4	3.5°	30	60	Class 3	B2
	18	34.2	3.3°	30	61	Class 3	B2
	23	35.3	3.0°	30	62	Class 3	A
	24	36.1	2.6°	30	62	Class 3	N/A
	26	36.6	2.5°	30	63	Class 3	N/A
	38	40.1	1.6°	30	61	Class 3B	A
	42	40.8	1.5°	30	60	Class 3	A
0.6m	**15**	37.5	2.4°	30	62.5	Class 3	N/A
	17	38.2	2.3°	30	65	Class 3	A
	18	39.1	1.9°	30	64.5	Class 3	A
	23	41.4	1.6°	30	66.5	Class 3	A
	24	41.1	1.4°	30	66	Class 3	N/A
	26	41.6	1.5°	30	68	Class 3	A
	38	45.2	0.9°	30	64	Class 3B	A
	42	46	0.8°	30	65	Class 3	A

	*15-42 GHz*	*INTEGRAL-W*
	*15, 18-23, 26-42 GHz*	*INTEGRAL-WS*
	*17, 24 GHz*	
	*6-13 GHz*	

ABBREVIATIONS

ACI – Adjacent-Channel Interference
ACM – Adaptive Coding and Modulation
ATPC – Automatic Transmit Power Control
BER – Bit-Error Ratio
CCI – Co-Channel Interference
CLI – Command-Line Interface
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
MAC – Media Access Control
MSE – Mean Square Error
NMS – Network Management System
PC – Personal Computer
PLL – Phase-Locked Loop
PoE - Power over Ethernet
QAM - Quadrature amplitude modulation
QoS – Quality of Service
RSL – Received Signal Level
RSS – Radio Standards Specification
RSSI – Received Signal Strength Indicator
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