

Press  **MODIFY** button.

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

Clear all data	73	74 Clear	Clear	Clear	Clear	Clear
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- 1) **Statistics for** – time during which statistics have been gathered;
- 2) **Ingress Pkts.** – Packets that ingress on the port;
- 3) **Ingress Bytes** – Bytes that ingress on the port;
- 4) **Egress Pkts.** – Packets that egress on the port;
- 5) **Egress Bytes** – Bytes that egress on the port;
- 6) **Total Multicast Pkts.** – The total number of good packets received that were directed to a multicast address. Note that this number does not include packets directed to the broadcast address;
- 7) **Total Broadcast Pkts.** – The total number of good packets received that were directed to the broadcast address. Note that this does not include multicast packets;
- 8) **Total Pkts. 64 Octets** – The total number of packets (including bad packets) that were 64 octets in length (excluding framing bits but including FCS octets);
- 9) **Total Pkts. 65 to 127 Octets** – The total number of packets (including bad packets) that were between 65 and 127 octets in length inclusive (excluding framing bits but including FCS octets);
- 10) **Total Pkts. 128 to 255 Octets** – The total number of packets (including bad packets) that were between 128 and 255 octets in length inclusive (excluding framing bits but including FCS octets);
- 11) **Total Pkts. 256 to 511 Octets** – The total number of packets (including bad packets) that were between 256 and 511 octets in length inclusive (excluding framing bits but including FCS octets);
- 12) **Total Pkts. 512 to 1023 Octets** – The total number of packets (including bad packets) that were between 512 and 1023 octets in length inclusive (excluding framing bits but including FCS octets);
- 13) **Total Pkts. 1024 to 1518 Octets** – The total number of packets (including bad packets) that were between 1024 and 1518 octets in length inclusive (excluding framing bits but including FCS octets);
- 14) **Total Oversize Pkts.** – The total number of packets that were longer than 1522 octets (excluding framing bits but including FCS octets) and were otherwise well formed;
- 15) **Rx Oversize Pkts.** – The total number of packets received that were longer than 1522 octets (excluding framing bits but including FCS octets) and were otherwise well formed;
- 16) **Tx Oversize Pkts.** – The total number of packets transmitted that were longer than 1522 octets (excluding framing bits but including FCS octets) and were otherwise well formed;
- 17) **Total Octets** – The total number of octets of data (including those in bad packets) received on the network (excluding framing bits but including FCS octets);
- 18) **Total Pkts.** – The total number of packets (including bad packets, broadcast packets, and multicast packets) received and transmitted;
- 19) **Tx No Errors** – The number of frames that have been transmitted by this port from its segment excluding fragmented and FCS error frames;
- 20) **Rx No Errors** – The number of frames that have been received by this port from its segment excluding fragmented and FCS error frames;

- 21) **Total Pkts. 1519 to 1522 Octets** – The total number of packets (including bad packets) that were between 1519 and 1522 octets in length inclusive (excluding framing bits but including FCS octets);
- 22) **In. Octets** – The total number of octets received on the interface, including framing characters;
- 23) **Out. Octets** – The total number of octets transmitted out of the interface, including framing characters;
- 24) **Dot1 Port In Frames** – The number of frames that have been received by this port from its segment. Note that a frame received on the interface corresponding to this port is only counted by this object if and only if it is for a protocol being processed by the local bridging function, including bridge management frames;
- 25) **Dot1 Port Out Frames** – The number of frames that have been transmitted by this port to its segment. Note that a frame transmitted on the interface corresponding to this port is only counted by this object if and only if it is for a protocol being processed by the local bridging function, including bridge management frames.;
- 26) **Received Pkts. 64 Octets** – The total number of packets (including bad packets) received that were 64 octets in length (excluding framing bits but including FCS octets);
- 27) **Transmitted Pkts. 64 Octets** – The total number of packets (including bad packets) transmitted that were 64 octets in length (excluding framing bits but including FCS octets);
- 28) **Received Pkts. 65 to 127 Octets** – The total number of packets (including bad packets) received that were between 65 and 127 octets in length inclusive (excluding framing bits but including FCS octets);
- 29) **Transmitted Pkts. 65 to 127 Octets** – The total number of packets (including bad packets) transmitted that were between 65 and 127 octets in length inclusive (excluding framing bits but including FCS octets);
- 30) **Received Pkts. 128 to 255 Octets** – The total number of packets (including bad packets) received that were between 128 and 255 octets in length inclusive (excluding framing bits but including FCS octets);
- 31) **Transmitted Pkts. 128 to 255 Octets** – The total number of packets (including bad packets) transmitted that were between 128 and 255 octets in length inclusive (excluding framing bits but including FCS octets);
- 32) **Received Pkts. 256 to 511 Octets** – The total number of packets (including bad packets) received that were between 256 and 511 octets in length inclusive (excluding framing bits but including FCS octets);
- 33) **Transmitted Pkts. 256 to 511 Octets** – The total number of packets (including bad packets) transmitted that were between 256 and 511 octets in length inclusive (excluding framing bits but including FCS octets);
- 34) **Received Pkts. 512 to 1023 Octets** – The total number of packets (including bad packets) received that were between 512 and 1023 octets in length inclusive (excluding framing bits but including FCS octets);
- 35) **Transmitted Pkts. 512 to 1023 Octets** – The total number of packets (including bad packets) transmitted that were between 512 and 1023 octets in length inclusive (excluding framing bits but including FCS octets);
- 36) **Received Pkts. 1024 to 1518 Octets** – The total number of packets (including bad packets) received that were between 1024 and 1518 octets in length inclusive (excluding framing bits but including FCS octets);

- 37) **Transmitted Pkts. 1024 to 1518 Octets** – The total number of packets (including bad packets) transmitted that were between 1024 and 1518 octets in length inclusive (excluding framing bits but including FCS octets);
- 38) **In. Broadcast Pkts.** – The number of packets, delivered by this sub-layer to a higher (sub-)layer, which were addressed to a broadcast address at this sub-layer;
- 39) **Out. Broadcast Pkts.** – The total number of packets that higher-level protocols requested to be transmitted, and which were addressed to a broadcast address at this sub-layer, including those that were discarded or not sent;
- 40) **In. Multicast Pkts.** – The number of packets, delivered by this sub-layer to a higher (sub-)layer, which were addressed to a multicast address at this sub-layer. For a MAC layer protocol, this includes both Group and Functional addresses;
- 41) **Out. Multicast Pkts.** – The total number of packets that higher-level protocols requested be transmitted, and which were addressed to a multicast address at this sub-layer, including those that were discarded or not sent. For a MAC layer protocol, this includes both Group and Functional addresses;
- 42) **Dot3 In. Pause Frames** – A count of MAC Control frames received on this interface with an opcode indicating the PAUSE operation. This counter does not increment when the interface is operating in half-duplex mode. Discontinuities in the value of this counter can occur at re-initialization of the management system, and at other times as indicated by the value of ifCounterDiscontinuityTime.;
- 43) **Dot3 Out. Pause Frames** – A count of MAC Control frames transmitted on this interface with an opcode indicating the PAUSE operation. This counter does not increment when the interface is operating in half-duplex mode. Discontinuities in the value of this counter can occur at re-initialization of the management system, and at other times as indicated by the value of ifCounterDiscontinuityTime;
- 44) **EtherStatsUndersize Pkts.** – The total number of packets received that were less than 64 octets long (excluding framing bits, but including FCS octets) and were otherwise well formed;
- 45) **Fragments** – The total number of packets received that were less than 64 octets in length (excluding framing bits but including FCS octets) and had either a bad Frame Check Sequence (FCS) with an integral number of octets (FCS Error) or a bad FCS with a non-integral number of octets (Alignment Error).
Note that it is entirely normal for etherStatsFragments to increment. This is because it counts both runts (which are normal occurrences due to collisions) and noise hits;
- 46) **CRC Align. Errors** – The total number of packets received that had a length (excluding framing bits but including FCS octets) of between 64 and 1518 octets, inclusive, but had either a bad Frame Check Sequence (FCS) with an integral number of octets (FCS Error) or a bad FCS with a non-integral number of octets (Alignment Error);
- 47) **Jabbers** – The total number of packets received that were longer than 1518 octets (excluding framing bits but including FCS octets), and had either a bad Frame Check Sequence (FCS) with an integral number of octets (FCS Error) or a bad FCS with a non-integral number of octets (Alignment Error).
Note that this definition of jabber is different than the definition in IEEE-802.3 section 8.2.1.5 (10BASE5) and section 10.3.1.4 (10BASE2). These documents define jabber as the condition where any packet exceeds 20 ms. The allowed range to detect jabber is between 20 ms and 150 ms;
- 48) **Ingress BPS** – Indicates byte per second rate on the input of the port;
- 49) **Ingress PPS** – Indicates packet per second rate on the input of the port;
- 50) **Egress BPS** – Indicates byte per second rate on the exit of the port;
- 51) **Egress PPS** – Indicates packet per second rate on the exit of the port;

73) **Clear all statistic** – Clears statistics on all switch ports;

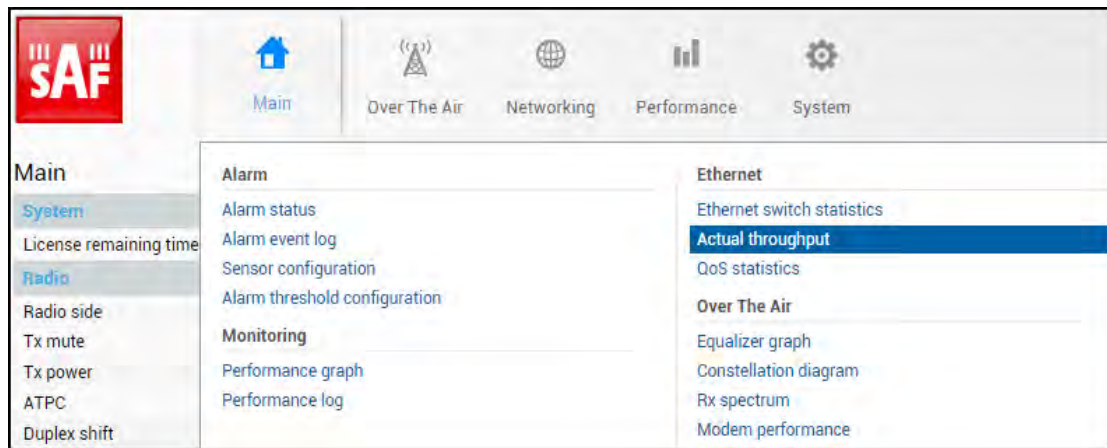
74) **Clear** – Clears statistics on a particular port.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

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

Performance → Ethernet → Actual throughput

Shows ingress and egress traffic statistics on all available switch ports.



Port		LAN1	LAN2	LAN3	WAN	MNG
Ingress Mbps	1	0.014	N/A	N/A	0.102	0.102
Ingress pps	2	4	N/A	N/A	11	10
Egress Mbps	3	0.068	N/A	N/A	0.053	0.054
Egress pps	4	10	N/A	N/A	6	6

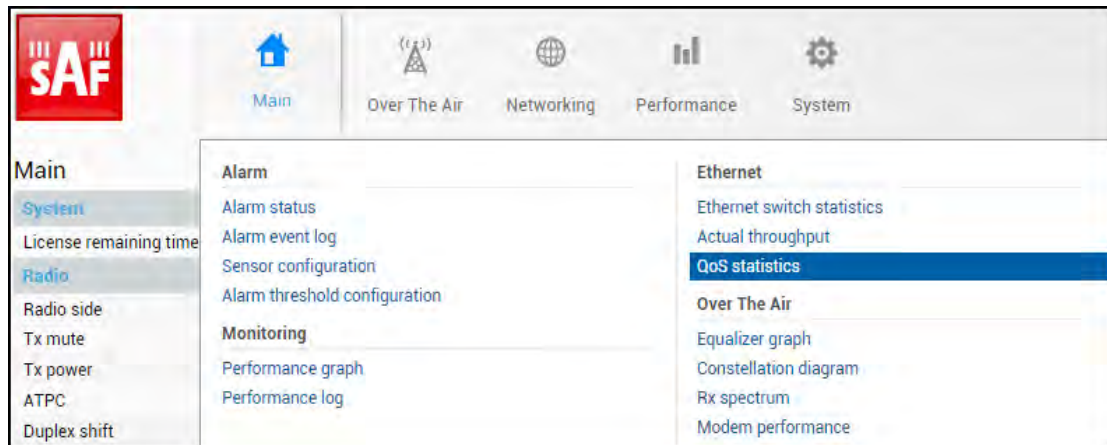
MODIFY button is deactivated on this page.

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

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

network port show throughput	Use to show current throughput on all ports.
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Performance → Ethernet → QoS statistics



Status mode

Performance / QoS statistics

Queue		Port				
		LAN1	LAN2	LAN3	WAN	MNG
Statistics for	1	1d 08:50:17	1d 08:50:17	1d 08:50:17	1d 08:50:17	1d 08:50:18
		Bytes / packets	Bytes / packets	Bytes / packets	Bytes / packets	Bytes / packets
0	Passed	113.06 M / 231572	0 / 0	0 / 0	2.99 M / 38220	2.99 M / 38221
	Dropped	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
1	Passed	0 / 0	0 / 0	0 / 0	276.40 k / 1874	276.40 k / 1874
	Dropped	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
2	Passed	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
	Dropped	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
3	Passed	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
	Dropped	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
4	Passed	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
	Dropped	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
5	Passed	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
	Dropped	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
6	Passed	0 / 0	0 / 0	0 / 0	68 / 1	68 / 1
	Dropped	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
7	Passed	0 / 0	0 / 0	0 / 0	614.29 M / 1150579	644.19 M / 1375404
	Dropped	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0

Press MODIFY button.

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



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

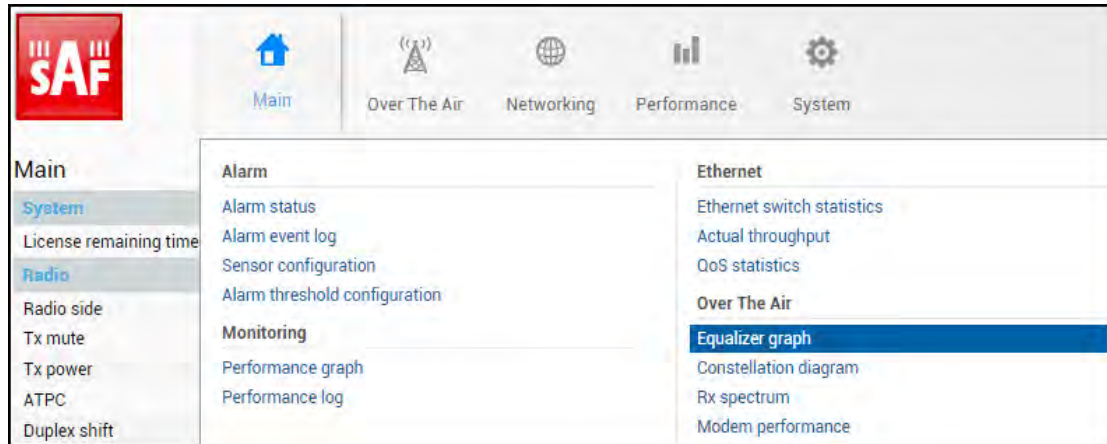
CLI commands (Chapter 4: COMMAND LINE INTERFACE)

network qos show statistics {all LAN1 LAN2 LAN3 WAN}	Use to check QoS statistics on all available ports.
network qos reset statistics {all LAN1 LAN2 LAN3 WAN}	Use to clear QoS statistics on a specific switch port or all ports simultaneously.

Performance → Over The Air → Equalizer graph

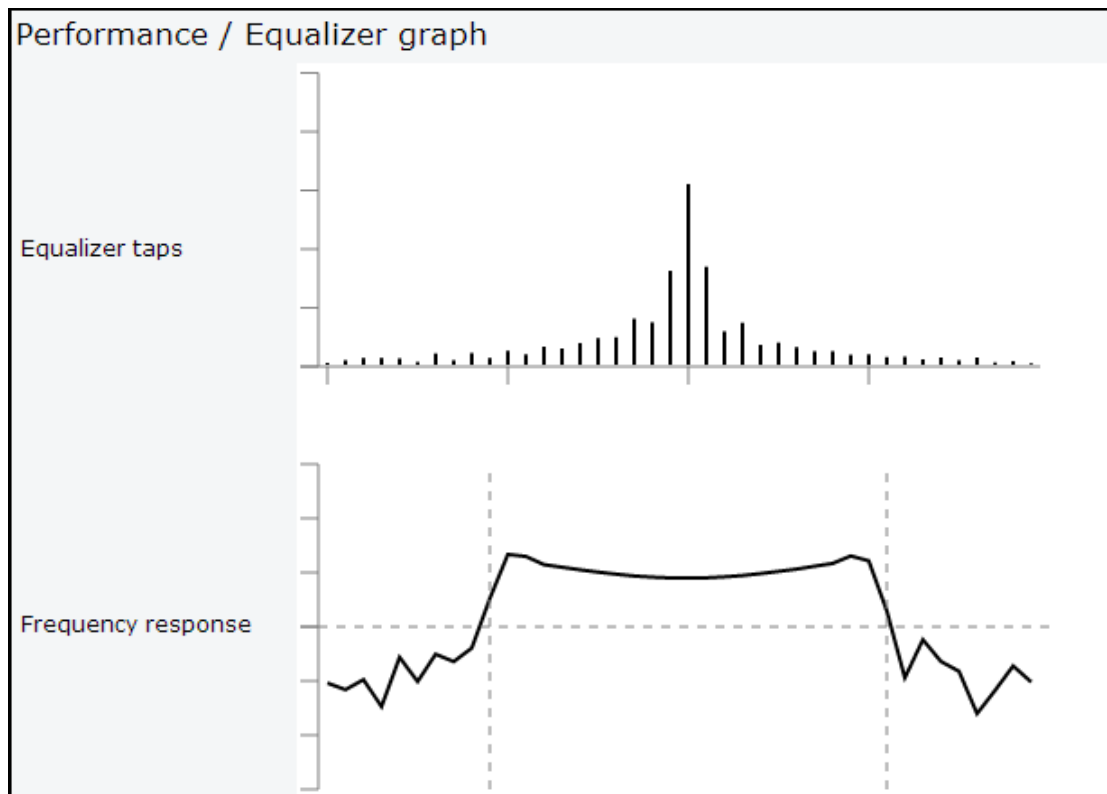
The Equalizer graph window shows adaptive equalizer taps' coefficients, which at a set time moment minimize the multipath fading effect in the channel.

For more details see [Adaptive Equalizer](#) section in Chapter 6: **FUNCTIONAL DESCRIPTION**.



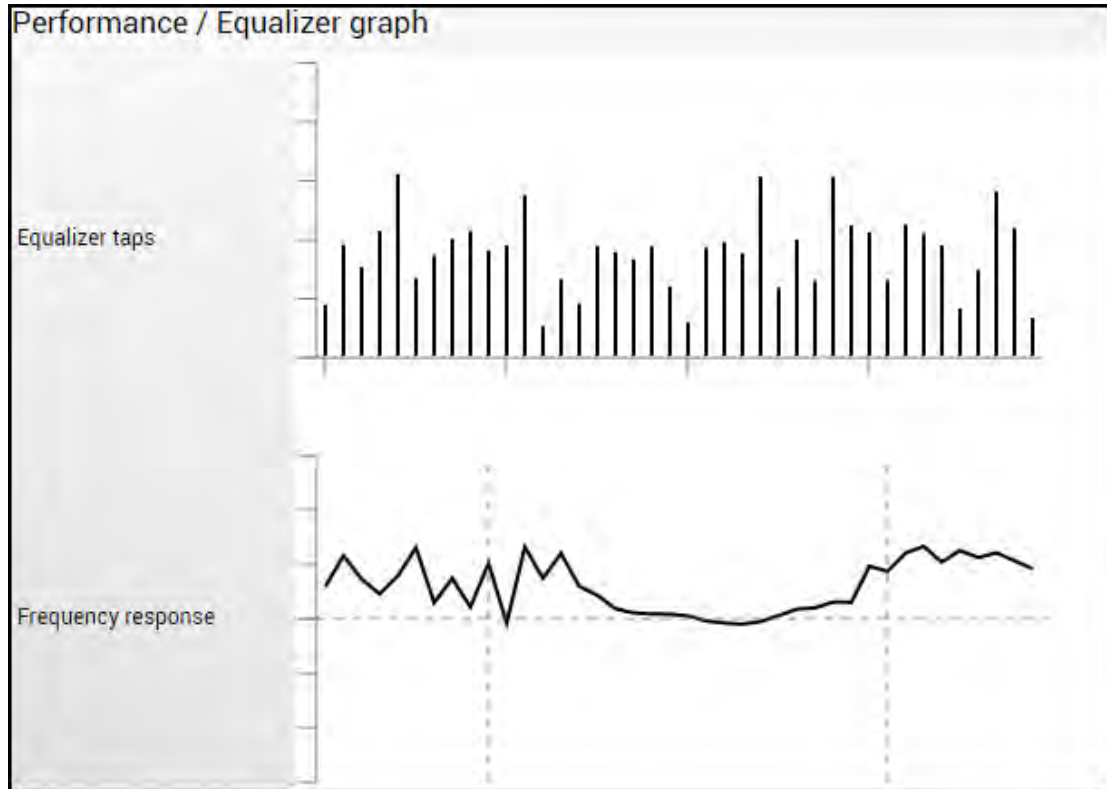
MODIFY button is deactivated on Equalizer graph page.

An example of equalizer taps' coefficients and its frequency response in case of normal operation is shown below:



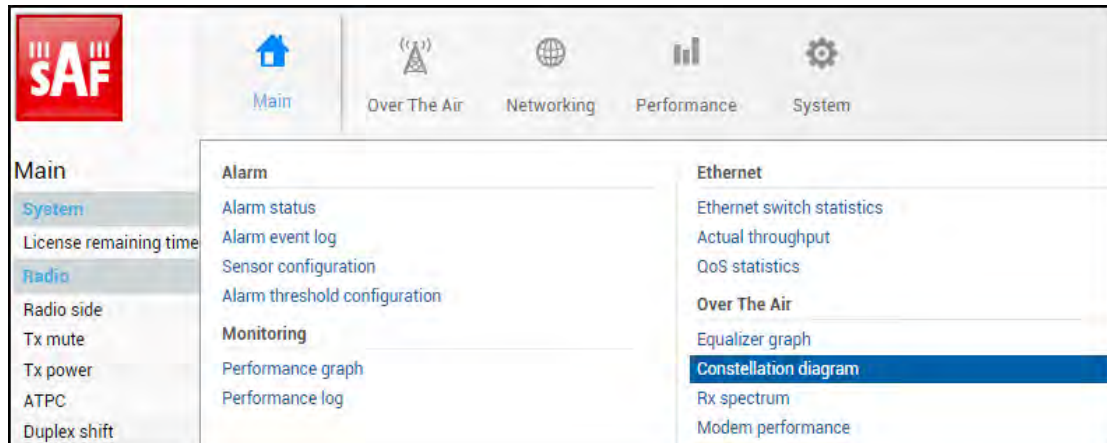
During normal operation, the frequency response curve is smooth at the center and the central equalizer tap is higher, while side towers evenly decrease. If equalizer taps and frequency response curve significantly differ from the one above, it may be an indication of multipath issues, which must be inspected with the use of precise and accurate path profiling. Higher taps mainly on the right side indicate a weaker reflected signal compared to the main signal, while higher taps mainly on the left side – a stronger reflected signal.

Below is an example of Equalizer graph in a link aligned to the reflected signal:




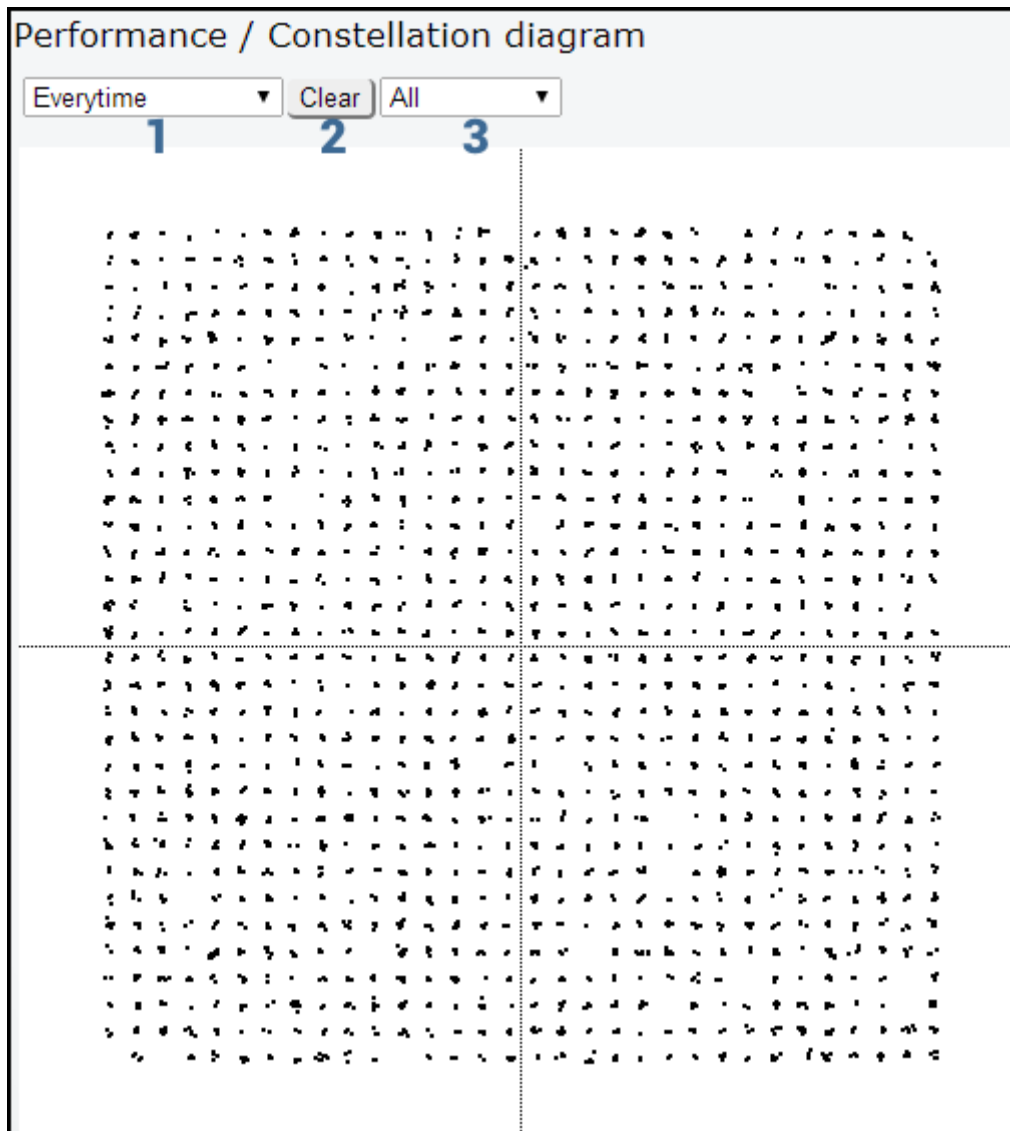
Performance → Over The Air → Constellation diagram

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



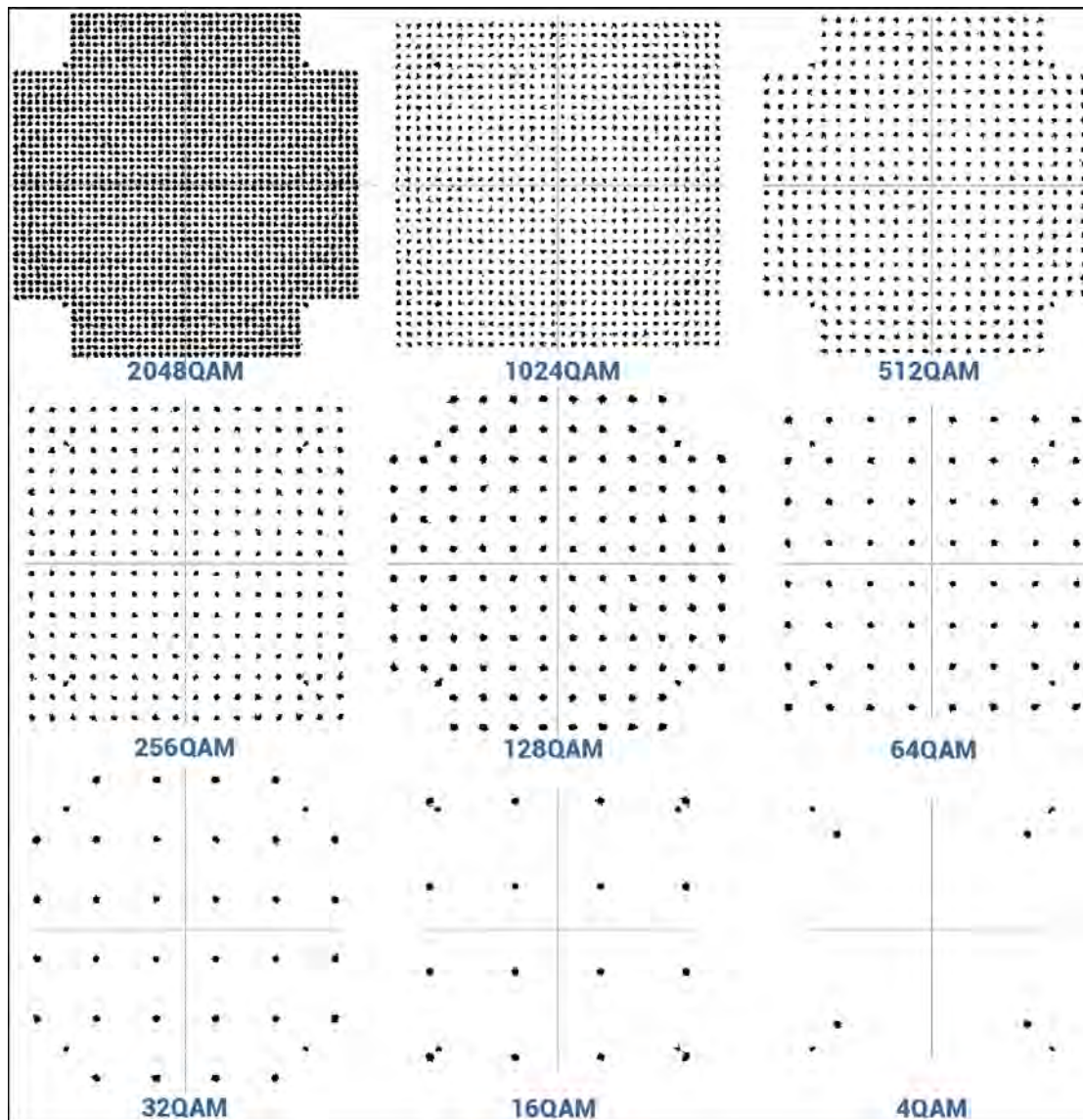
MODIFY button is deactivated on the Constellation diagram page.

 Only a single user can see Constellation at a time.



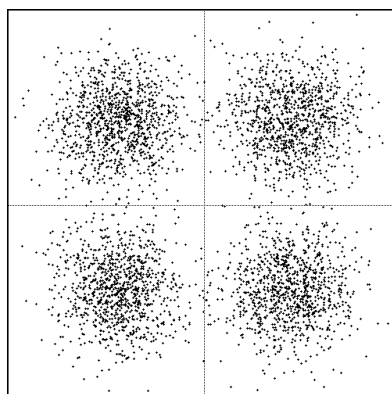
- 1) Allows choosing how often is constellation automatically cleared;
- 2) Manually clear current constellation;
- 3) Allows zooming to one of 4 constellation quadrants.

Examples of Integra/Integra-S/Integra-G/Integra-GS constellation diagrams under ideal conditions are shown below:

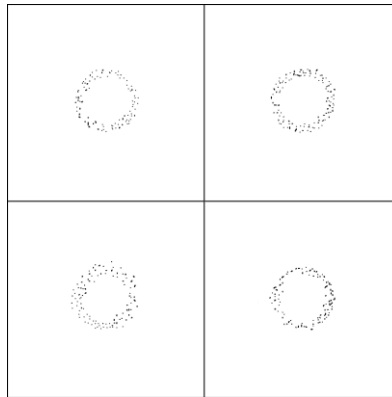


To analyze the received signal quality, some types of distortion and degradation may be evident in the constellation diagram. For example:

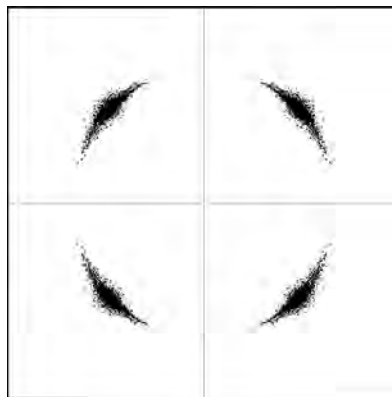
- 1) Gaussian noise is displayed as fuzzy constellation points:



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

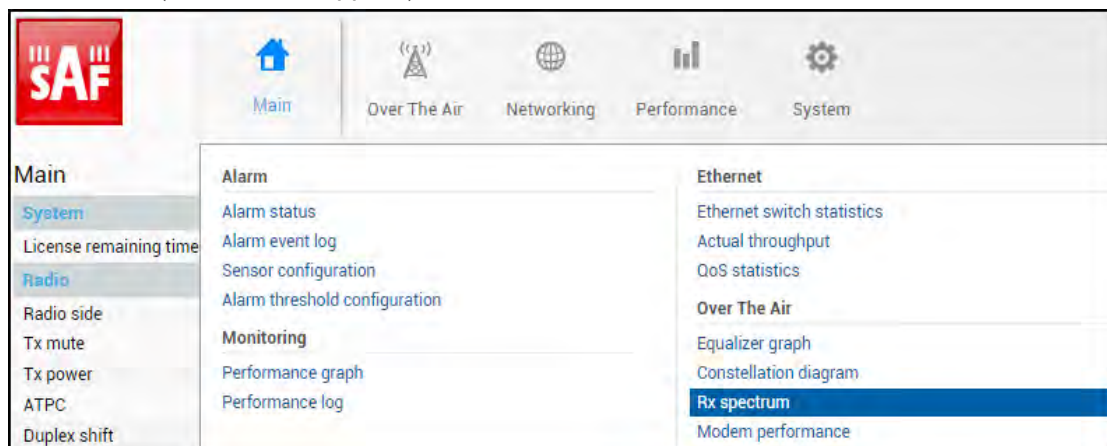


- 3) Phase noise is displayed as rotationally spreading constellation points:




Performance → Over The Air → Rx spectrum

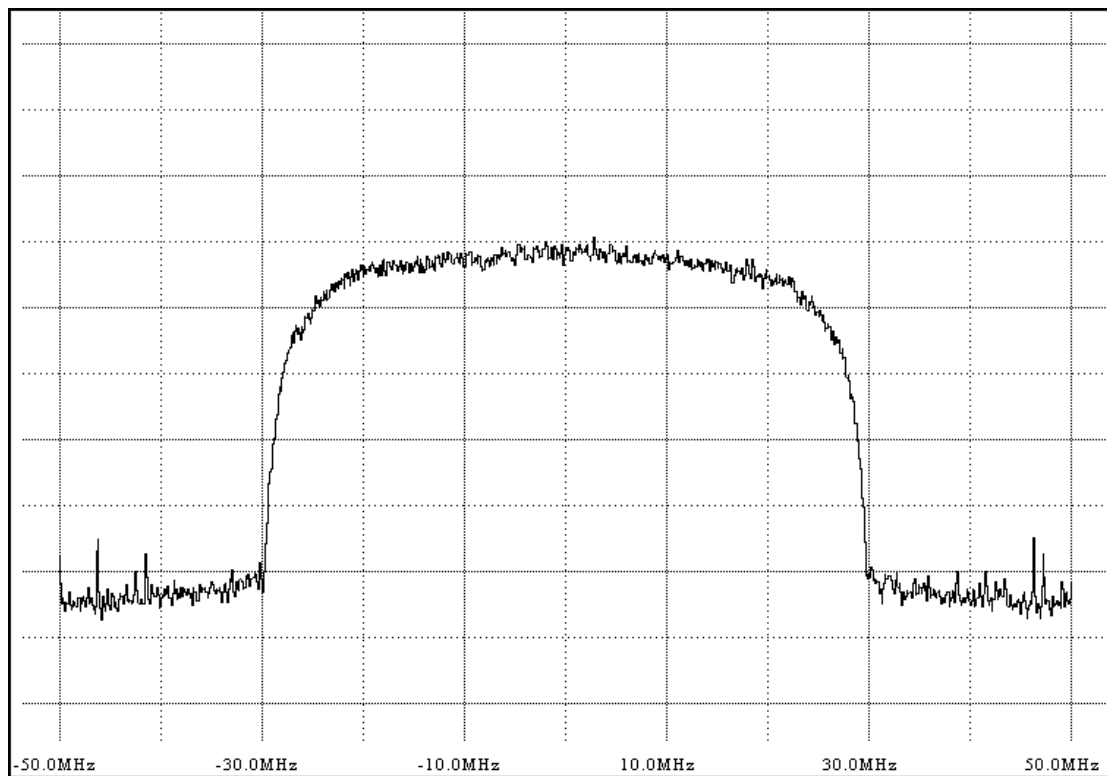
A spectrum curve is a representation of the received signal on the input of the modem. For this reason, spectrum signal levels will not correspond to the actual radio receiver’s signal level. The signal appearance will depend on configured channel bandwidth. A measured spectrum curve can be used to recognize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



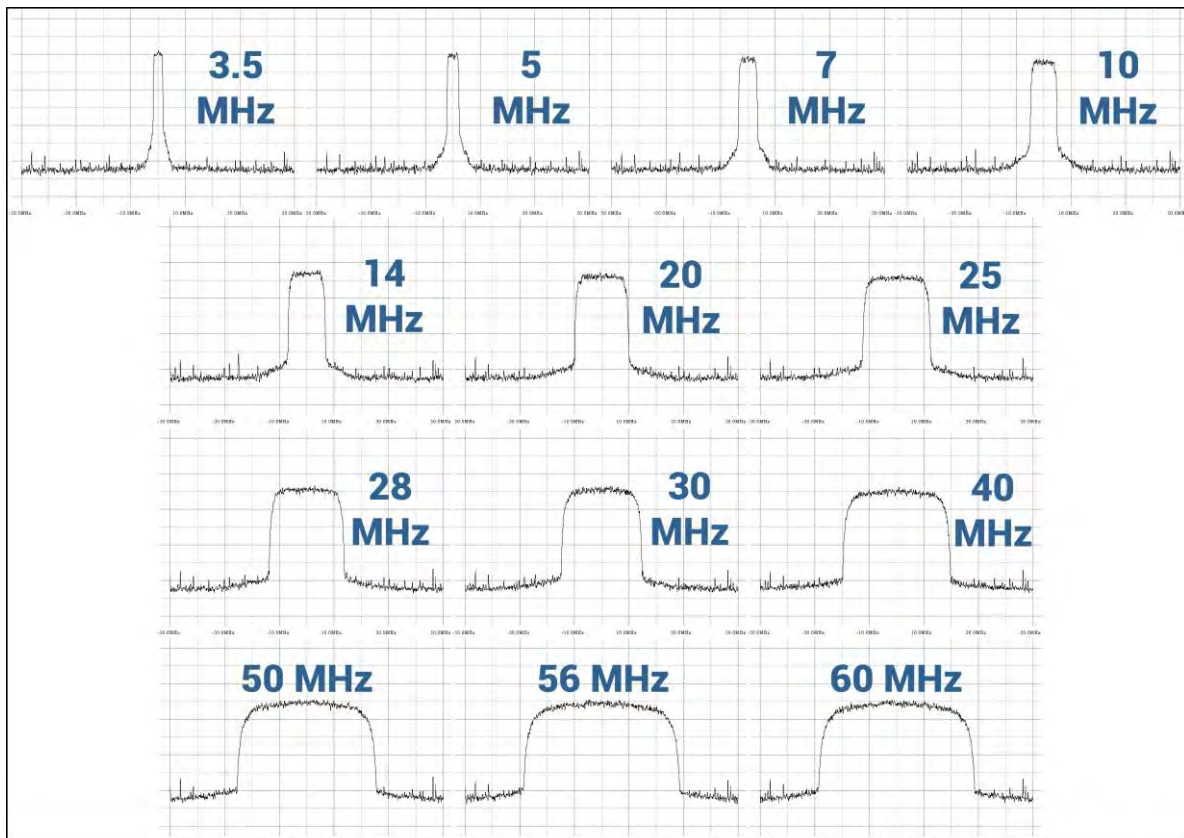
MODIFY button is deactivated on the Rx spectrum page.

 Only a single user can see Rx Spectrum at a time.

Spectrum (60MHz):

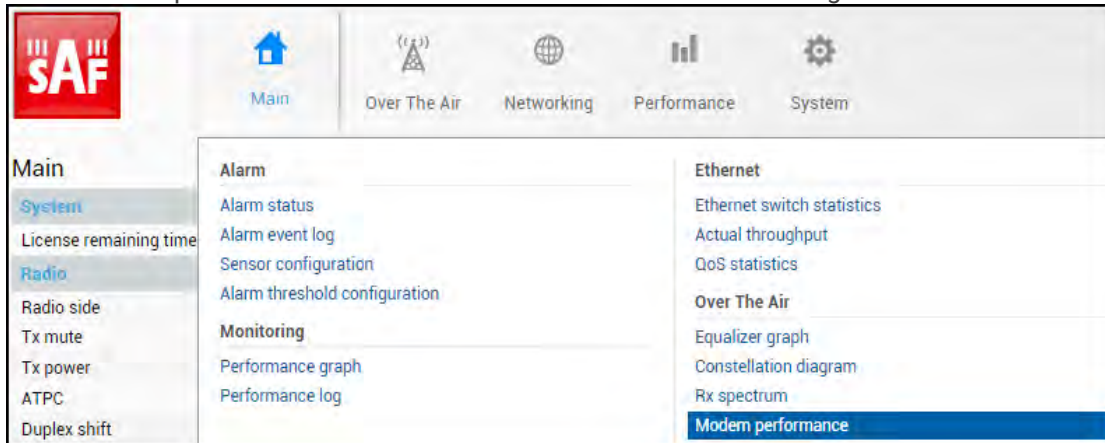


Examples of Integra/Integra-S/Integra-G/Integra-GS spectrum curves in various channel bandwidths:



Performance → Over The Air → Modem performance

The Modem performance section shows modem statistics according to ITU-T G.826.



Status mode

Performance / Modem performance		
Count Time	1	21:22:24
Errored Block	2	0
Errored Second	3	0
Severely Errored Second	4	0
Background Block Error	5	0
Total Block Number	6	2104787618
Errored Second Ratio	7	0.0e+00
Severely Errored Second Ratio	8	0.0e+00
Background Block Error Ratio	9	0.0e+00
Uptime	10	21:22:24
Unavailtime	11	00:00:00

Press MODIFY button.

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



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

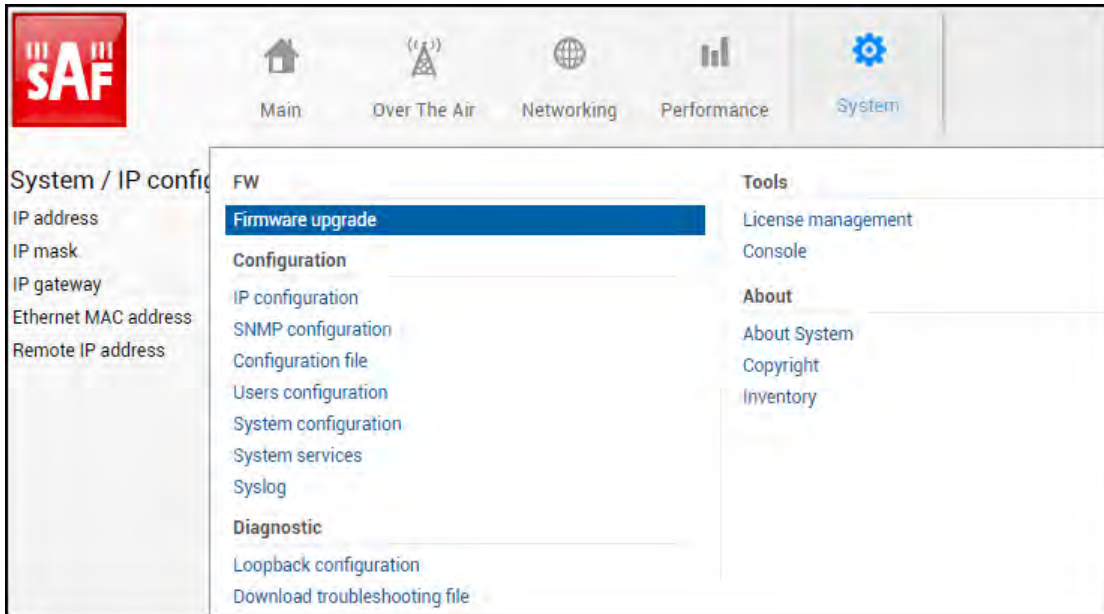
CLI commands (Chapter 4: COMMAND LINE INTERFACE)

modem performance	Use to check modem statistics according to ITU-T G.826. See the detailed description above.
modem performance clear	Use to clear modem statistics.

System

System → FW → Firmware upgrade

Upload the .bin firmware file and upgrade the firmware version on the “Firmware upgrade” page.



Status mode



Press  **MODIFY** button.

Modify mode



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



If the existing Integra/Integra-S/Integra-G/Integra-GS firmware version is older than V2.5.13, firmware must be upgraded to V2.5.13 ([link](#)) before the upgrade to the latest firmware version.



The latest Integra/Integra-S/Integra-G/Integra-GS firmware can be downloaded at <https://saftehnika.com/en/downloads> in “Firmwares” section. Registration and login are required.

- 3) **Reboot** – Reboots Integra/Integra-S/Integra-G/Integra-GS (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 Integra/Integra-S/Integra-G/Integra-GS.



A maximum of 3 firmware files can be stored. You can delete unnecessary firmware files using “Delete” button

Integra series firmware upgrade via Web GUI

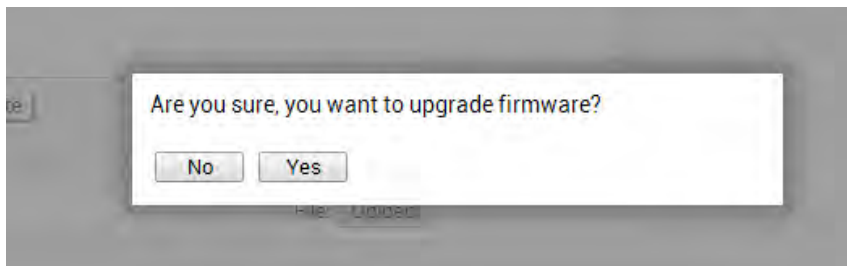
The firmware update package contains a firmware file (.bin extension), release notes, and firmware upgrade instructions.



If the existing Integra/Integra-S/Integra-G/Integra-GS firmware version is older than V2.5.13, firmware must be upgraded to V2.5.13 ([link](#)) before the upgrade to the latest firmware version.

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 the 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 the firmware list and press “Upgrade firmware” button;
- 6) Confirm the upgrade and reboot of the system.



The remote side must be upgraded first.

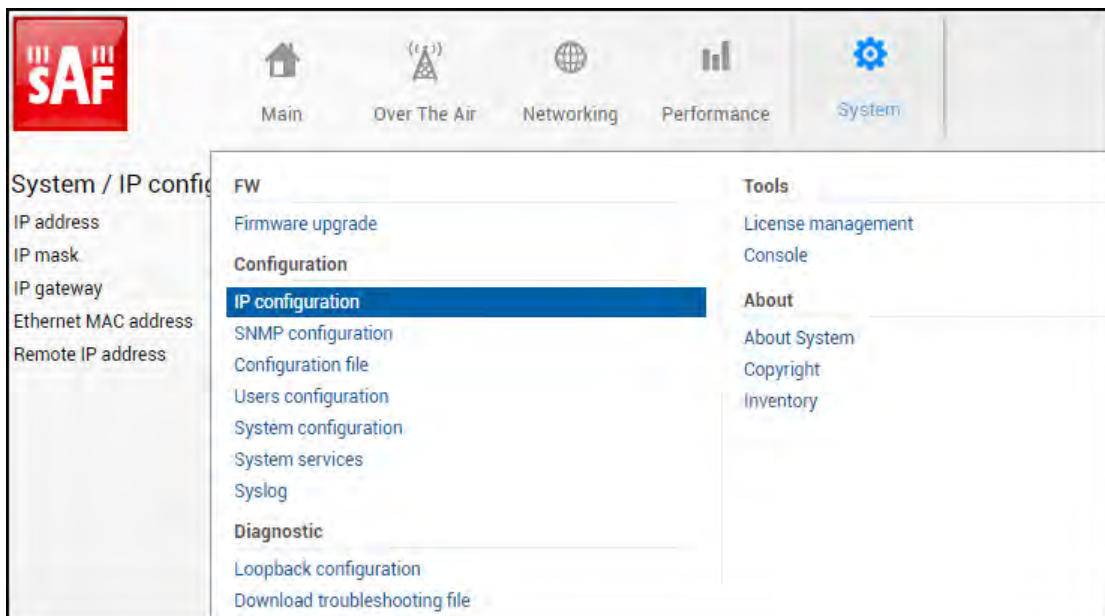
Please do not unplug power until the firmware upgrade procedure is finished - Web GUI will automatically reconnect and the login page will appear.

CLI commands ([Chapter 4: COMMAND LINE INTERFACE](#))

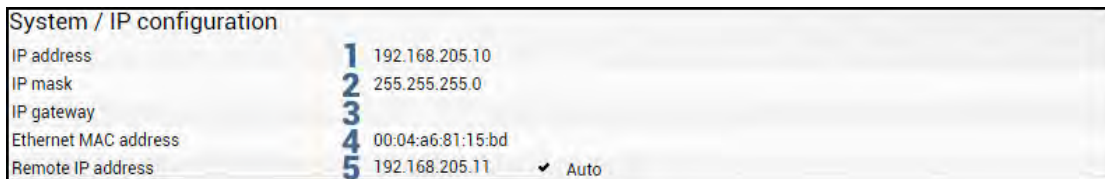
firmware info [<version>]	Use to show detailed information on current or specific Integra/Integra-S/Integra-G/Integra-GS firmware.
firmware install <version>	Use to install the firmware version uploaded. Note that the exact version needs to be entered. Check available firmware versions using the command “firmware list”.
firmware list	Use to list uploaded firmware versions.
firmware remove <version>	Use to remove the firmware version uploaded. Note that the exact version needs to be entered. Check available

	firmware versions using the command "firmware list".
firmware remove.list	Use to remove all uploaded firmware versions.
firmware switch	Use to check the running firmware bank and bank that will be used at the next boot.
firmware upload <file>	Use to upload firmware files from the FTP directory.
firmware switch {fs fw1 fw2 toggle}	Use to define the bank that will be used at the next boot. "fw1" and "fw2" subcommands set appropriate bank, "toggle" forces to set another bank than the running one, "fs" is the factory-defined emergency bank, which is used if both "fw1" and "fw2" fail.
system reboot	Use to perform a cold reboot of the radio unit.

System → Configuration → IP configuration

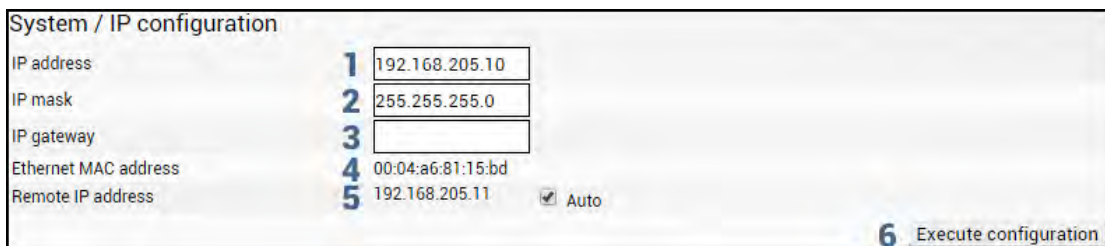


Status mode



Press MODIFY button.

Modify mode



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



Integra/Integra-S/Integra-G/Integra-GS IP addresses need to be on the same subnet.

- 2) **IP Mask** – Indicates the IP mask of the Integra/Integra-S/Integra-G/Integra-GS you are currently logged in (status mode); allows specifying the IP mask of the Integra/Integra-S/Integra-G/Integra-GS you are currently logged in to (modify mode). The default IP mask is 255.255.255.0.
- 3) **IP gateway** – Indicates the gateway address of the Integra/Integra-S/Integra-G/Integra-GS you are currently logged in to (status mode); allows specifying the gateway address of the Integra/Integra-S/Integra-G/Integra-GS you are currently logged in (modify mode). By default, the gateway is not specified (blank).
- 4) **Ethernet MAC address** – shows the MAC address of the Integra/Integra-S/Integra-G/Integra-GS you are currently connected to.
- 5) **Remote IP address** – shows the IP address of the remote (far-end) Integra/Integra-S/Integra-G/Integra-GS. By default, the remote IP address is being retrieved automatically and therefore the “Auto” checkbox is selected. In modify mode you can unselect the “Auto” option and enter the remote IP address manually.
- 6) By pressing „Execute configuration”, changes made to the corresponding section apply only to the local side Integra/Integra-S/Integra-G/Integra-GS.

CLI commands ([Chapter 4: COMMAND LINE INTERFACE](#))

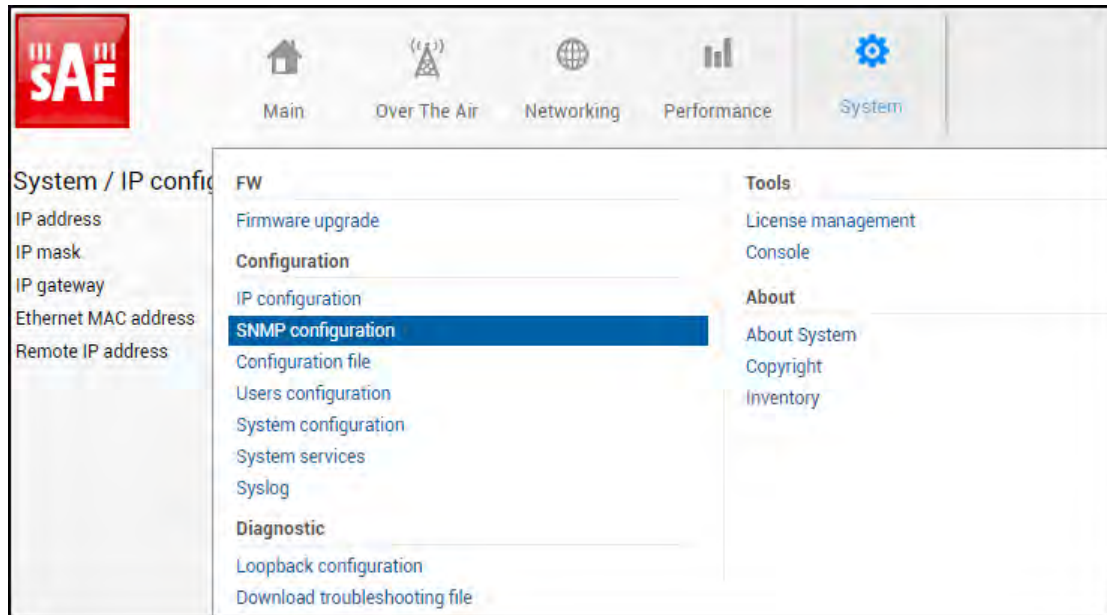
system ip addr [<IP>]	Use to show/set the IP address of the management CPU.
system ip gw [{<IP> clear}]	Use to show/manage the IP address of the gateway.
system ip mask [<mask>]	Use to show/set subnet mask.
system ip mac	Use to show the MAC address of the management CPU.
system ip cfg {<ip address> 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

System → Configuration → SNMP configuration

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

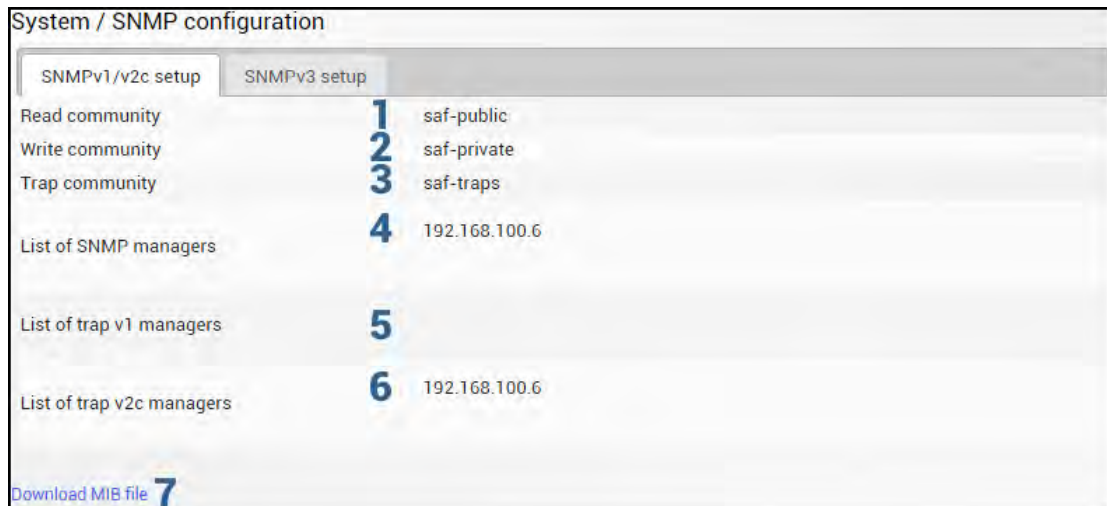


Relevant MIB files can be downloaded directly from Integra/Integra-S/Integra-G/Integra-GS Web GUI. See (7) below.



SNMPv1/v2c setup

Status mode



Press  MODIFY button.

Modify mode

System / SNMP configuration

SNMPv1/v2c setup SNMPv3 setup

Read community **1** saf-public

Write community **2** saf-private

Trap community **3** saf-traps

192.168.100.6

List of SNMP managers **4**

Add Delete

List of trap v1 managers **5**

Add Delete

192.168.100.6

List of trap v2c managers **6**

Add Delete

Download MIB file **7** **8** Execute configuration

- 1) **Read community** – Indicates currently specified read community for SNMPv1/v2c (status mode); allows specifying read community for SNMPv1/v2c of the agent to enable parameters to be read (modify mode). The default read community name is “saf-public”.
- 2) **Write community** – Indicates currently specified write community for SNMPv1/v2c (status mode); allows specifying write community for SNMPv1/v2c of the agent to enable parameters to be written (modify mode). The default write community name is “saf-private”.
- 3) **Trap community** – Indicates currently specified trap community for SNMPv1/v2c (status mode); allows specifying trap community for SNMPv1/v2c for trap authentication in monitoring applications (modify mode). The default trap community name is “saf-traps”.
- 4) **List of SNMP managers** – Shows the list of configured SNMPv1/v2c host IP addresses (status mode); allows adding/deleting SNMPv1/v2c host IP addresses (modify mode). Specified IP addresses have access to read and modify configuration parameters using the appropriate read-and-write community names.
- 5) **List of trap v1 managers** – Shows a list of configured SNMPv1 trap IP addresses (status mode); allows adding/deleting SNMPv1 trap IP addresses (modify mode). The Integra/Integra-S/Integra-G/Integra-GS management controller sends SNMPv1 traps to the Trap Manager with the IP address specified here;
- 6) **List of trap v2c managers** – Shows a list of configured SNMPv2c trap IP addresses (status mode); allows adding/deleting SNMPv2c trap IP addresses (modify mode).

The Integra/Integra-S/Integra-G/Integra-GS management controller sends SNMPv2c traps to the Trap Manager with the IP address specified here.

- 7) **Download MIB file** – Click to download Integra/Integra-S MIB files.
- 8) By pressing „Execute configuration”, changes made to the corresponding section apply only to the local side Integra/Integra-S/Integra-G/Integra-GS.

SNMPv3 setup

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

Status mode

System / SNMP configuration

SNMPv1/v2c setup | **SNMPv3 setup**

SNMPv3 users

User name	Authentication password	Privacy password	Access
safuser	write

SNMPv3 security settings

Security level: authPriv
 User authentication protocol: SHA
 Data encryption protocol: AES

Download MIB file

Press MODIFY button.

Modify mode

System / SNMP configuration

SNMPv1/v2c setup | **SNMPv3 setup**

SNMPv3 users

User name	Authentication password	Privacy password	Access
safuser	read

User name (<= 31 characters) [input field]
 Authentication password (8..31 characters) [input field]
 Privacy password (8..31 characters) [input field]
 Access: Read Write
 [Add] [Delete]

Hide password(-s) [checkbox]

Execute configuration

SNMPv3 security settings

Security level: authPriv
 User authentication protocol: SHA
 Data encryption protocol: AES

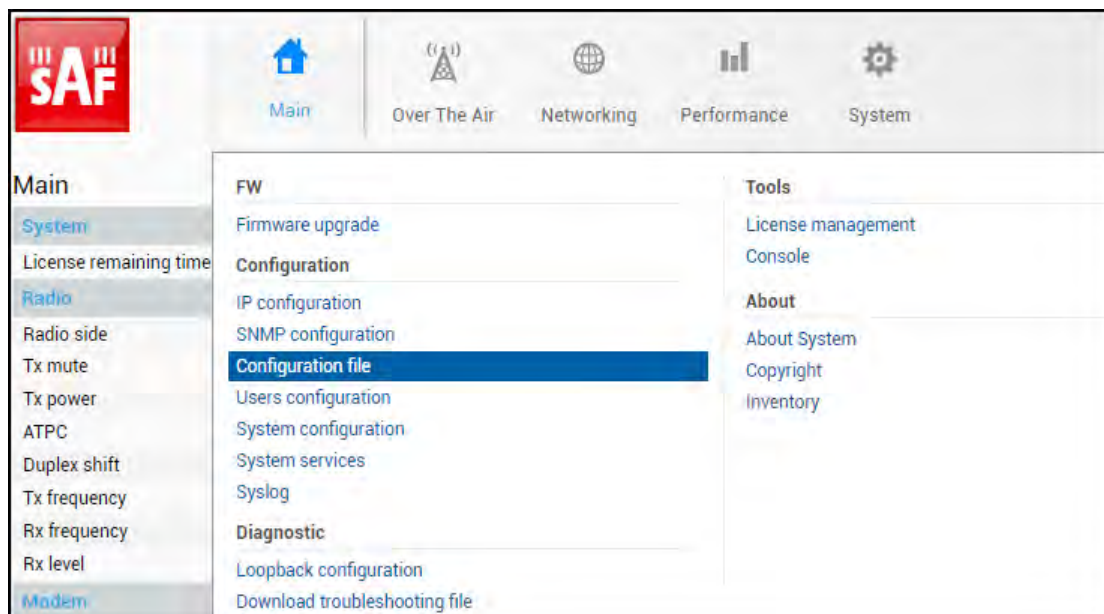
Download MIB file

- 1) **SNMP users** – Shows the list of configured SNMPv3 users;
- 2) **User name (<=31 characters)** – Enter SNMPv3 authentication user name. Length can be up to 31 symbols;
- 3) **Authentication password (8..31 characters)** – Enter SNMPv3 authentication password. Length can be between 8 and 31 symbols;

- 4) **Privacy password (8..31 characters)** – Enter SNMPv3 data encryption password (AES protocol is used on the SNMP agent's side). Length can be between 8 and 31 symbols;
- 5) **Access** – Select "Read" for read-only access or "Write" for read-write access;
- 6) **Add/Delete** – Use to add or delete selected user name. To delete user names from the list, click on the required user name in the list above;
- 7) **Hide passwords(-s)** – Uncheck to display passwords for selected SNMPv3 user;
- 8) By pressing „Execute configuration“, changes made to the corresponding section apply only to the local side Integra/Integra-S/Integra-G/Integra-GS;
- 9) **SNMPv3 security settings** – Shows SNMPv3 security settings used;
- 10) **Download MIB file** – Click to download Integra/Integra-S/Integra-G/Integra-GS MIB files.

System → Configuration → Configuration file

Shows saved and running configurations, highlighting differences between both (unsaved changes).



Status mode

System / Configuration file

Advanced cfg file features

Download saved configuration file

Restore configuration from file

Restore configuration from saved configuration file

Restore factory configuration file

Compare saved / running configurations

Saved configuration 7	8 Running configuration
<pre>{ evlogd: {}, snmpd: {}, perfd: {}, i2cd: {}, sysd: {}, aggregation: {}, modem: { version: "2", name: "factory", }, modulations: ["4QAM"], }, network: {}, sync_e: {}, radio: {}, stpd: {} }</pre>	<pre>{ evlogd: {}, snmpd: {}, perfd: {}, i2cd: {}, sysd: {}, aggregation: {}, modem: { version: "2", name: "60S_MHz", }, modulations: ["1024QAM_W"], }, network: {}, sync_e: {}, radio: {}, stpd: {} }</pre>

Press  MODIFY button.

Modify mode

System / Configuration file

Advanced cfg file features

Download saved configuration file **1** Download

Restore configuration from file **2** from **3** Choose File No file chosen **4** Cfg import

Restore configuration from saved configuration file All VLAN **5** Cfg restore

Restore factory configuration file **6** Cfg factory

Compare saved / running configurations

Saved configuration 7	8 Running configuration
<pre>{ evlogd: {}, snmpd: {}, perfd: {}, i2cd: {}, sysd: {}, aggregation: {}, modem: {}, network: {}, sync_e: {}, radio: {}, stpd: {} }</pre>	<pre>{ evlogd: {}, snmpd: {}, perfd: {}, i2cd: {}, sysd: {}, aggregation: {}, modem: {}, network: {}, sync_e: {}, radio: {}, stpd: {} }</pre>

- 1) **Download** – Press to download the system configuration txt file and save it on your hard drive.
- 2) **All/VLAN** – Select *All* to restore the complete configuration or *VLAN* to restore only VLAN configuration.
- 3) **Choose File** – Press to browse for a saved configuration file on your hard disk drive.
- 4) **Cfg import** – Press to upload a configuration file to the Integra/Integra-S/Integra-G/Integra-GS.



Uploaded configuration overwrites the saved configuration.

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



Restoring configuration overwrites running configuration with the saved configuration.

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



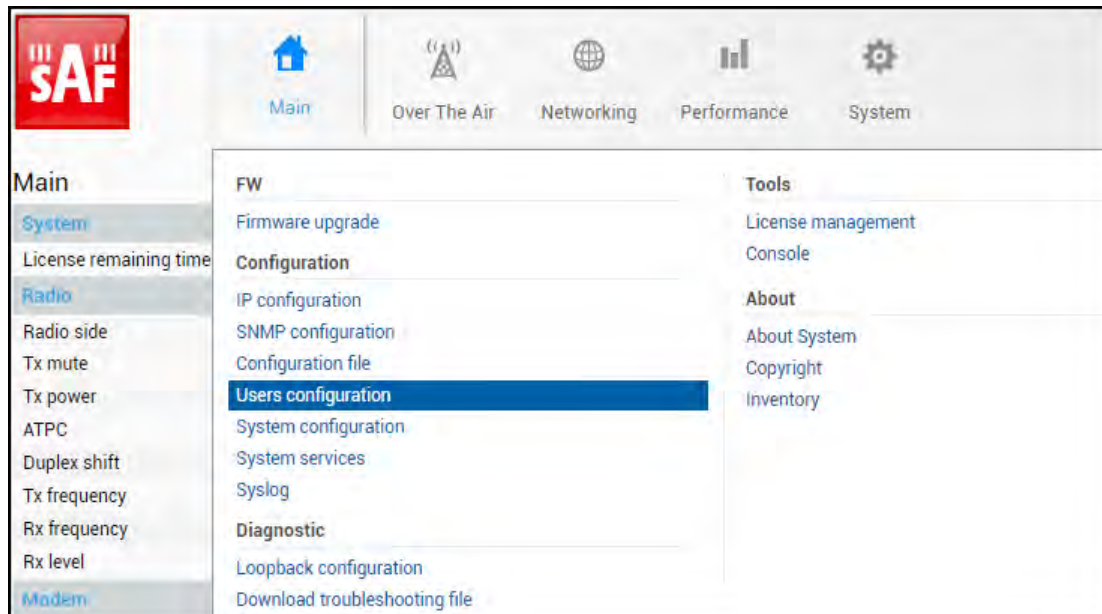
Distinct sections in saved and running configurations are highlighted in color. To examine particular differences expand highlighted sections of configuration by clicking on the down arrow of the appropriate configuration section.

CLI commands (Chapter 4: [COMMAND LINE INTERFACE](#))

configuration factory	Use to reset system configuration to factory defaults.
configuration factory aggr	Use to reset aggregation configuration to factory defaults.
configuration factory modem	Use to reset modem configuration to factory defaults.
configuration factory sysd	Use to reset the whole system configuration to factory defaults.
configuration factory sync_e	Use to reset SyncE configuration to factory defaults.
configuration factory netsys {mac-table port-state qos rate vlan}	Use to reset whole Ethernet configuration to factory defaults or particular sections using subcommands – “mac-table” for MAC table; “port-state” for port state configuration; “qos” for QoS configuration; “rate” for rate limit configuration; “vlan” for VLAN configuration.
configuration load	Use to restore saved system configuration, i.e. unsaved changes will be discarded!
configuration status	Use to check whether the running configuration is saved.
configuration store	Use to save the running configuration.
configuration download	Use to create a copy of the saved configuration file as a txt file in the FTP directory.
configuration import {all VLAN} <filename>	Use to restore the configuration from a txt file stored in the FTP directory.

System → Configuration → Users configuration

Integra/Integra-S/Integra-G/Integra-GS features 2 default user accounts – *admin* (full control) and *guest* (read-only).



Status mode

System / Users configuration

Username	Full name	Permission	Enabled
admin	1	Read/Write	Yes
guest		Read only	Yes


Press  **MODIFY** button.

Modify mode

- 1) **Users** – Shows the list of available users (Username), full name (if specified), permissions, and whether the user is active (enabled).
- 2) Press “New” to create a new user or click on a user from the list and choose to modify (Change) or delete the user (Delete).

New user / Selected user

- 3) **Name (2..32 characters)** – Enter a user name. The length is between 2 and 32 characters;
- 4) **Full name (4..32 characters)** – Enter the full name of the user (New user) or modify the existing user’s name. The length is between 4 and 32 characters;
- 5) **Permission** – Select read-only or read/write permissions. A user with “read/write” permissions can change the configuration, while a user with read-only permissions can monitor link status only;
- 6) **Enable** – Enable or disable the user;
- 7) **Enter new password (4..32 characters)** – Enter a new password. The length is between 4 and 32 characters;
- 8) **Confirm new password (4..32 characters)** – Confirm new password. The length is between 4 and 32 characters;
- 9) **Hide password** – Uncheck to display the entered password in plaintext.
- 10) By pressing „Execute configuration”, changes made to the corresponding section apply only to the local side Integra/Integra-S/Integra-G/Integra-GS.

 By default, the password for the “admin” account is ‘changeme’, while no password is defined for the “guest” account (user disabled).

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

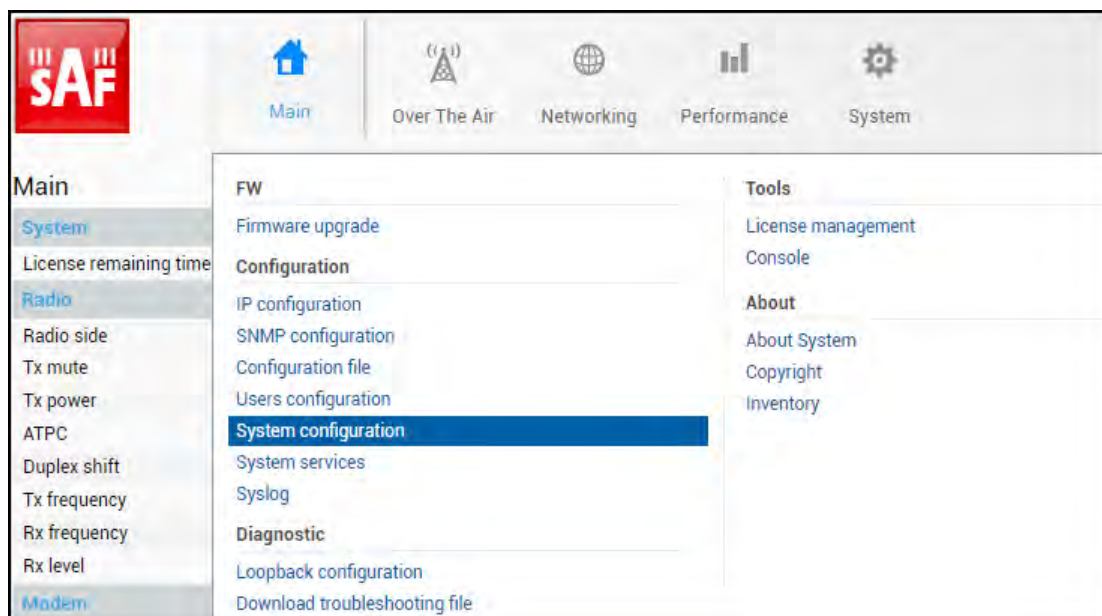
system user info	Use to show information on the current user.
system user mgmt <username> access {r w}	Use to set read (“r”) or write (“w”) access right for particular <username>.
system user mgmt <username> delete	Use to delete particular <username>. “admin” user cannot be deleted.
system user mgmt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

{enable disable}	
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

Specify DNS servers, time settings, and system/location names.

DNS servers have to be added before adding domain names to the NTP list.



Status mode

System / System configuration

System configuration

System name (<= 16 characters)	1	IntG STUDIO
Location name (<= 16 characters)	2	Riga 1
Timezone	3	UTC+03:00
Time (YY-MM-DD hh:mm:ss)	4	2022-01-28 14:44:44

DNS setup

List of DNS servers	6	8.8.8.8
	7	<input type="text"/>
		<input type="button" value="Resolve"/>

NTP setup

NTP client	8	Enabled
List of NTP servers	9	1.pool.ntp.org
		<input type="text"/>

Press  **MODIFY** button.

Modify mode

System / System configuration

System configuration

System name (<= 16 characters)	1	<input type="text" value="IntG STUDIO"/>
Location name (<= 16 characters)	2	<input type="text" value="Riga 1"/>
Timezone	3	UTC+03:00 <input type="button" value="v"/>
Time (YY-MM-DD hh:mm:ss)	4	<input type="text" value="2022-01-28 14:55:23"/> 5 <input type="button" value="Set local machine time"/>

DNS setup

List of DNS servers	6	8.8.8.8
		<input type="text"/>
		<input type="button" value="Add"/> <input type="button" value="Delete"/>

NTP setup

NTP client	8	<input checked="" type="checkbox"/> Enable
List of NTP servers	9	1.pool.ntp.org
		<input type="text"/>
		<input type="button" value="Add"/> <input type="button" value="Delete"/>

10

11

- System name** – Allows entering a preferable system name. The maximum length of the system name cannot exceed 16 symbols. The default name is 'SAF'.

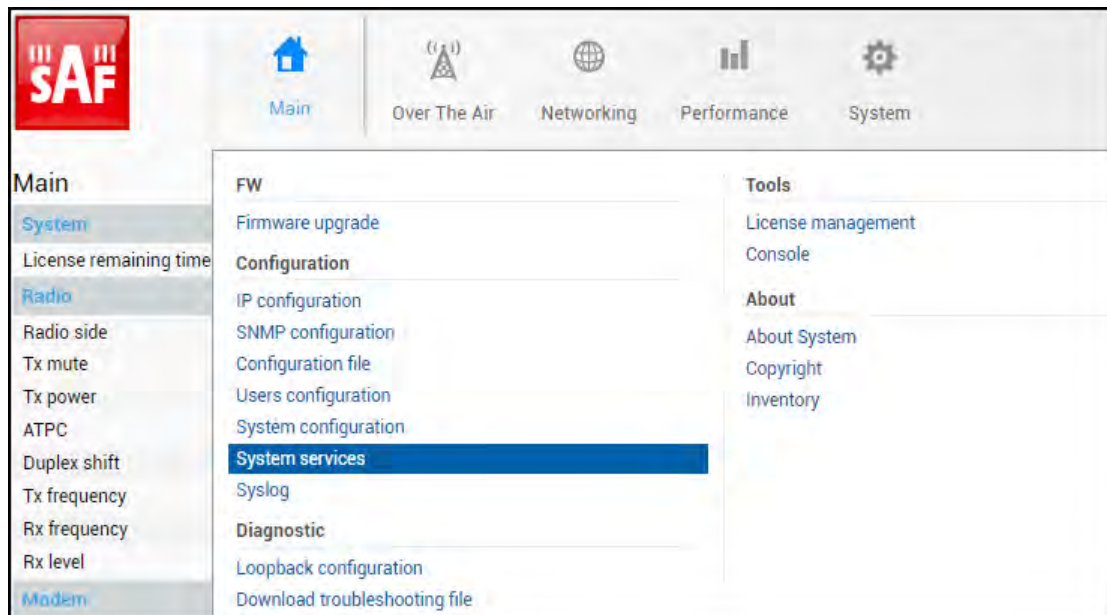
- 2) **Location name** – Allows entering preferable system location name. The maximum length of the location name cannot exceed 16 symbols. By default, the system location is not specified.
- 3) **Timezone** – Allows specifying the time zone.
- 4) **Time (YY-MM-DD hh:mm:ss)** – Allows changing system 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) **List of DNS servers** - Allows adding or deleting IP addresses of DNS servers.
- 7) Possibility to resolve domain names to check if DNS requests are working.
- 8) **NTP client** – Allows enabling or disabling the NTP (Network Time Protocol) client.
- 9) **List of NTP servers** – Allows adding or deleting IP addresses or domain names of NTP servers.
- 10) **Obtain time from NTP server** – Press to force the system to obtain the time from an NTP server.
- 11) By pressing „Execute configuration“, changes made to the corresponding section apply only to the local side Integra/Integra-S/Integra-G/Integra-GS.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

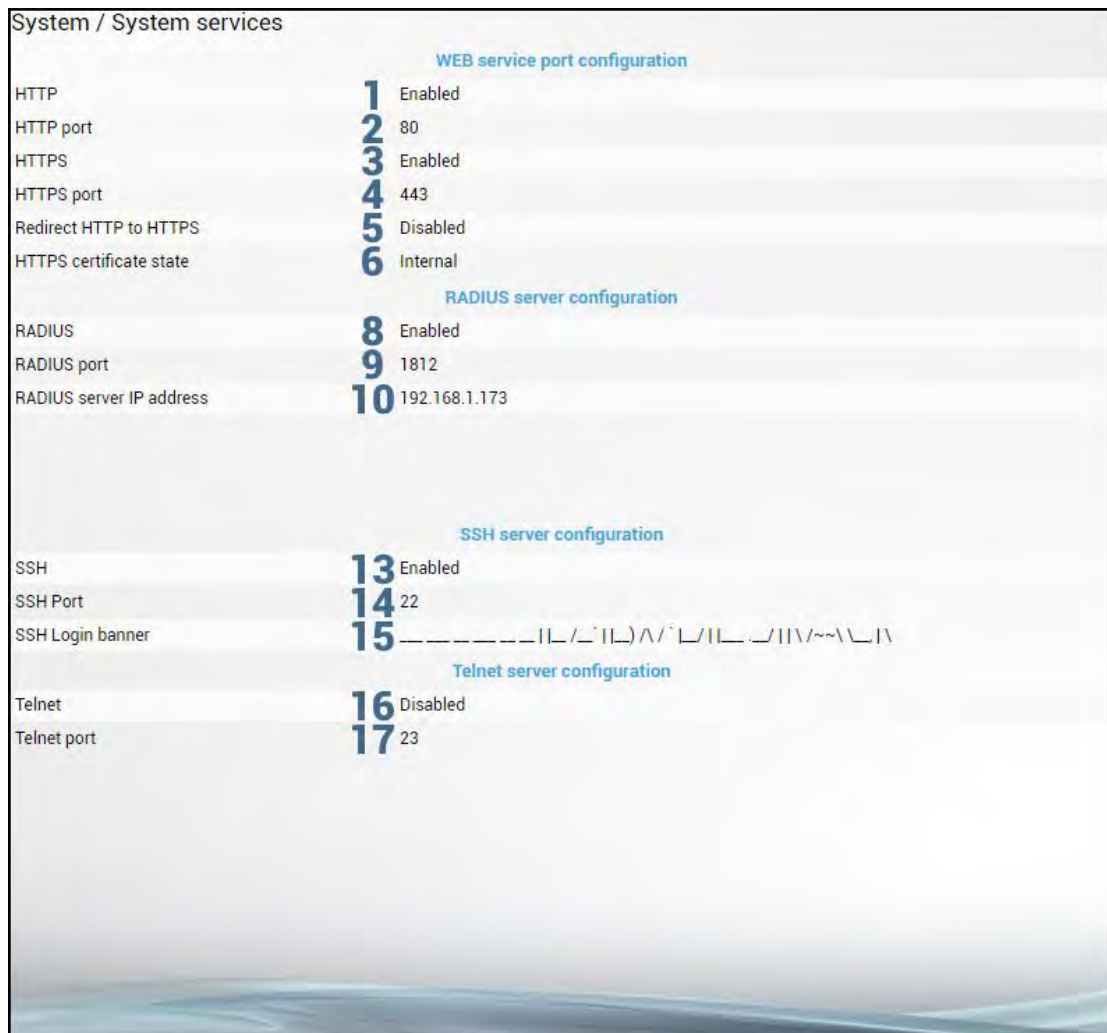
system datetime [<datetime>]	Use to show/set system time and date. Use “YYYY-MM-DD/hh:mm:ss” syntax for date/time.
system name [<name>]	Use to show/define system name.
system location [<location>]	Use to show/define system location.
system uptime	Use to show system uptime since the last system start.
system ntp status	Use to show NTP status.
system dns dig <domain_name>	Use to resolve the domain name.
system dns server add <IP_address>	Use to add an IP address of a DNS server.
system dns server remove <IP_address>	Use to remove an IP address of a DNS server.
system dns server clear	Use to clear the list of DNS servers.
system ntp {enable disable}	Use to enable or disable NTP client.
system ntp server add <IP_address domain_name>	Use to add an IP address or a domain name of an NTP server.
system ntp server remove <IP_address domain_name>	Use to remove an IP address or a domain name of an NTP server.
system ntp server clear	Use to clear the list of NTP servers.
system ntp timezone [<-12:00 ... 14:00>]	Use to show/define the UTC time zone.
system ntp sync	Use to force the system to obtain the time from an NTP server.

System → Configuration → System services

Define Web GUI connection parameters and centralized user management (RADIUS). Refer to Chapter [RADIUS authentication](#) for an example of RADIUS configuration.



Status mode



Press  MODIFY button.

Modify mode

System / System services

WEB service port configuration

1 Enable
 HTTP
 2 80
 HTTP port
 3 Enable
 HTTPS
 4 443
 HTTPS port
 5 Enable
 Redirect HTTP to HTTPS
 6 Internal
 HTTPS certificate state
 7
 HTTPS certificate (PEM)

RADIUS server configuration

8 Enable
 RADIUS
 9 1812
 RADIUS port
 10 192.168.1.173
 RADIUS server IP address
 11
 Set RADIUS secret (<33 characters)
 12
 Confirm RADIUS secret (<33 characters)
 Hide password

SSH server configuration

13 Enable
 SSH
 14 22
 SSH Port
 15
 SSH Login banner

Telnet server configuration

16 Enable
 Telnet
 17 23
 Telnet port

18 [Reboot](#) [Execute configuration](#)

NOTE: The length of RADIUS secret is constant. It has only an informative purpose!

- 1) **HTTP** – Allows disabling or enabling HTTP access to Web GUI. By default, HTTP access is enabled.
- 2) **HTTP port** – Allows specifying TCP port for Web GUI access via HTTP. By default TCP port 80 is defined.
- 3) **HTTPS** – Allows disabling or enabling HTTPS access to Web GUI. By default, HTTPS access is enabled.
- 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) **HTTPS certificate state** – Indicates whether a self-signed SAF certificate (Internal) is used or the customer's custom-defined (External).
- 7) **HTTPS certificate (PEM)** – Allows defining custom HTTPS certificate private key (PEM).
- 8) **RADIUS** - Allows enabling or disabling RADIUS (Remote Authentication Dial-In User Service). By default, RADIUS is disabled.
- 9) **RADIUS port** – Allows specifying RADIUS port. By default port 1812 is defined.
- 10) **RADIUS server IP address** – Allows specifying RADIUS server IP address.
- 11) **Set RADIUS password** – Allows specifying RADIUS password.
- 12) **Confirm RADIUS password** – Allows confirming RADIUS password.
- 13) **SSH** - Allows enabling or disabling SSH (Secure Shell). By default, SSH is enabled.
- 14) **SSH port** – Allows specifying SSH port. By default port 22 is defined.

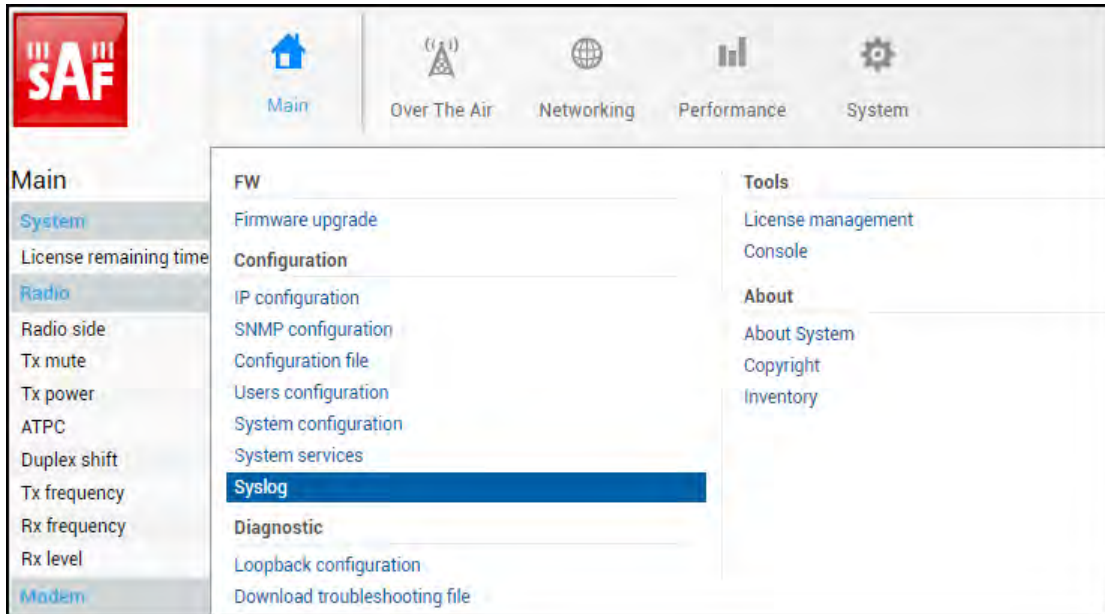
- 15) **SSH Login banner** – Allows specifying SSH Login banner displayed after successful SSH login.
- 16) **Telnet** - Allows enabling or disabling Telnet. By default, Telnet is disabled.
- 17) **Telnet port** – Allows specifying Telnet port. By default port 23 is defined.
- 18) By pressing „Execute configuration“, changes made to the corresponding section apply only to the local side Integra/Integra-S/Integra-G/Integra-GS.
- 19) **Reboot** – Reboots Integra/Integra-S/Integra-G/Integra-GS (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 the port number for HTTP service.
system service https [{enable disable}]	Use to show status or enable/disable HTTPS service.
system service https port [<port>]	Use to show/change the port number for HTTPS service.
system service 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 the 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 the 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 the port number of the TELNET service. By default port 23 is defined.

System → Configuration → Syslog

Integra/-S/-G/-GS supports the Syslog standard for system management message logging and sending to a monitoring Syslog server.



Status mode

System / Syslog		
Syslog service	1	Disabled
Facility code	2	17 (local1)
Server severity	3	7 (debug)
Syslog label	4	LOW Integra-GS
Syslog server IP	5	192.168.1.31
Syslog server port	6	514

Press MODIFY button.

Modify mode

System / Syslog		
Syslog service	1	<input checked="" type="checkbox"/> Enable
Facility code	2	17 (local1) ▼
Server severity	3	7 (debug) ▼
Syslog label	4	LOW Integra-GS
Syslog server IP	5	192.168.1.31
Syslog server port	6	514
		7 Execute configuration

- 1) **Syslog service** – allows enabling or disabling Syslog service on the device;
- 2) **Facility code** – allows selecting facility code for the Syslog messages from the device. Messages with different facility codes may be handled differently on the Syslog server. The following facility codes are possible:
 - a. 16 (local0);
 - b. 17 (local1);
 - c. 18 (local2);
 - d. 19 (local3);
 - e. 20 (local4);
 - f. 21 (local5);
 - g. 22 (local6);
 - h. 23 (local7);
- 3) **Server severity** – allows selecting maximal severity (priority) level for sensor log event messages that will be sent from the device to the Syslog server. Each sensor has 4 log event types that trigger Syslog message sending:

- a. **set** – indicates the time when the current sensor value comes out of the normal value range or the current sensor value is not valid at all;
- b. **reset** – indicates the time when the current sensor value comes back to normal value range from the previous set event state;
- c. **down** – indicates the time when the sensor stops receiving data about the parameter it monitors, for example, due to some hardware fault;
- d. **up** – indicates the time when the sensor recovers data reception about the parameter it monitors from the previous down event state;

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

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

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

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

Log event severity can be changed with the CLI command **log sensor mgmt <sensor> message <event> <severity>**.

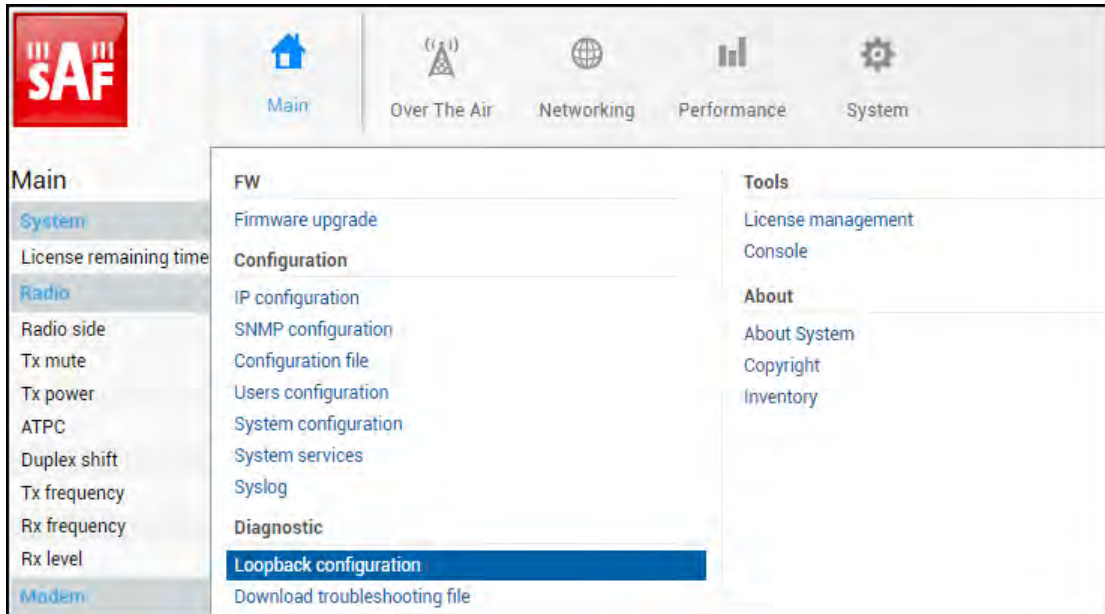
- 4) **Syslog label** – allows selecting additionally textual labeling/tagging for Syslog messages;
- 5) **Syslog server IP** – allows configuring an IP address for the Syslog server where the device should send Syslog messages;
- 6) **Syslog server port** – allows configuring port that the device should use for Syslog message sending.
- 7) By pressing „Execute configuration”, changes made to the corresponding section apply only to the local side Integra/Integra-S/Integra-G/Integra-GS.

CLI commands ([Chapter 4: COMMAND LINE INTERFACE](#))

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

System → Diagnostic → Loopback configuration

Loopback configuration allows verifying system operation.



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 the local end after the modem and Integra/Integra-S/Integra-G/Integra-GS should be able to synchronize to itself. Both MSE and FEC load should not generate an alarm (values should not be colored in red). When loopback is activated, “Loopback duration time” countdown timer will appear.
- 2) By pressing „Execute configuration”, changes made to the corresponding section apply only to the local side Integra/Integra-S/Integra-G/Integra-GS.



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	Unlimited		⚠ N/D
Radio	Local		Remote
Radio side	Low		⚠ N/D
Tx mute	Disabled		⚠ N/D
Tx power	⚠ 0 dBm		⚠ N/D
ATPC	Enabled		⚠ N/D
Duplex shift	728 MHz		⚠ N/D
Tx frequency	14529 MHz		⚠ N/D
Rx frequency	15257 MHz		⚠ N/D
Rx level	-45 dBm		⚠ N/D
Modem	Local		Remote
Bandwidth	56 MHz ETSI Variable Tx power		⚠ N/D
Modem profile	1024QAM WeakFEC ACM		⚠ N/D
Modem loopback	Enabled, digital		⚠ N/D
ACM engine	Enabled		⚠ N/D
Acquire status	Locked		⚠ N/D
MSE	-50.2 dB		⚠ N/D
FEC load	0.0e+00		⚠ N/D
Current Rx modulation	1024QAM WeakFEC		⚠ N/D
Current Tx modulation	1024QAM WeakFEC		⚠ N/D
Current Rx Ethernet capacity	456.8 Mbps		⚠ N/D
Current Tx Ethernet capacity	456.8 Mbps		⚠ N/D
Ethernet	LAN1 (RJ-45)		LAN2 (SFP)
Port	LAN1 (RJ-45)		LAN2 (SFP)
State	Enabled		Disabled
Status	Up		Down

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

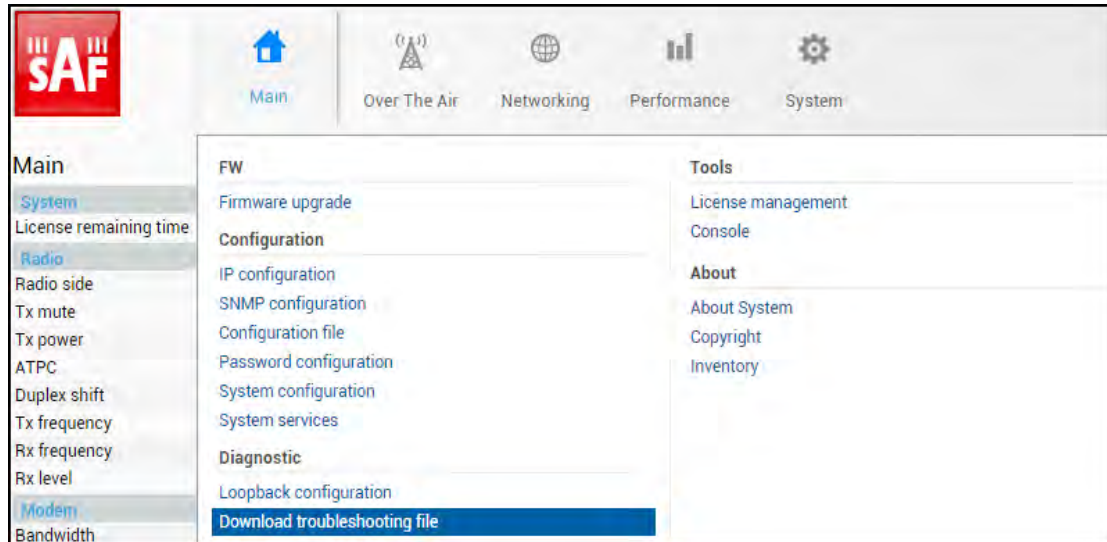
modem loopback	Use to show modem loopback status.
modem loopback digital <10..1000000>	Use to enable modem loopback for a specified time in seconds.
modem loopback digital none	Use to disable modem loopback.

System → Diagnostic → Download troubleshooting file

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



When contacting SAF technical support team (techsupport@saftehnika.com) regarding troubleshooting issues, please provide the troubleshooting file.



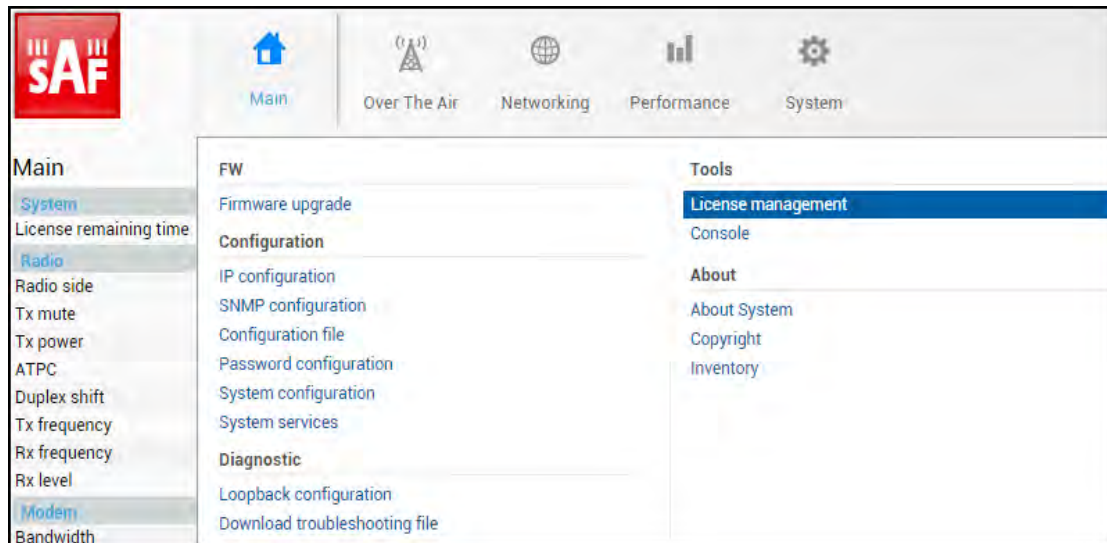
Clicking on the link will download the troubleshooting file archive package to your hard disk drive (“Downloads” folder of your browser).

Contents:

conf	Subfolder with last configuration files.
config.txt	Saved system configuration file
constell.bmp	Snapshot of modem constellation graph.
devel.tar.gz	For debugging only
eventlog.txt	Alarm-event log file
Perflog.xml	Performance log with maximum 1440 entries for 1, 15, and 60-minute intervals
spectrum.bmp	Snapshot of modem Rx spectrum graph.
troubleshoot.html	Information on currently running firmware and stored firmware files; system configuration including Web services, RADIUS, IP address, user, NTP configuration, and inventory info; SNMP v1/v2c/v3 configuration; alarm status, alarm threshold, and sensor configurations; radio status, configuration, and counters; currently active license and added license files; modem including modem status and configuration, counters, list of allowed modem profiles, header compression; Ethernet configuration and counters of LAN, WAN and MNG ports.

System → Tools → License management

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



Status mode

System / License management

Available licenses 1

License	License remaining time	Version
U0JJS5P.lic	Unlimited	1
BJG5YKFB.lic	Unlimited	1
4LEUQN5V.lic	Unlimited	1
APCV654K.lic	Unlimited	2

Selected license 5

License	4LEUQN5V.lic
Version	1
Time	Unlimited
License remaining time	Unlimited

Modem 6

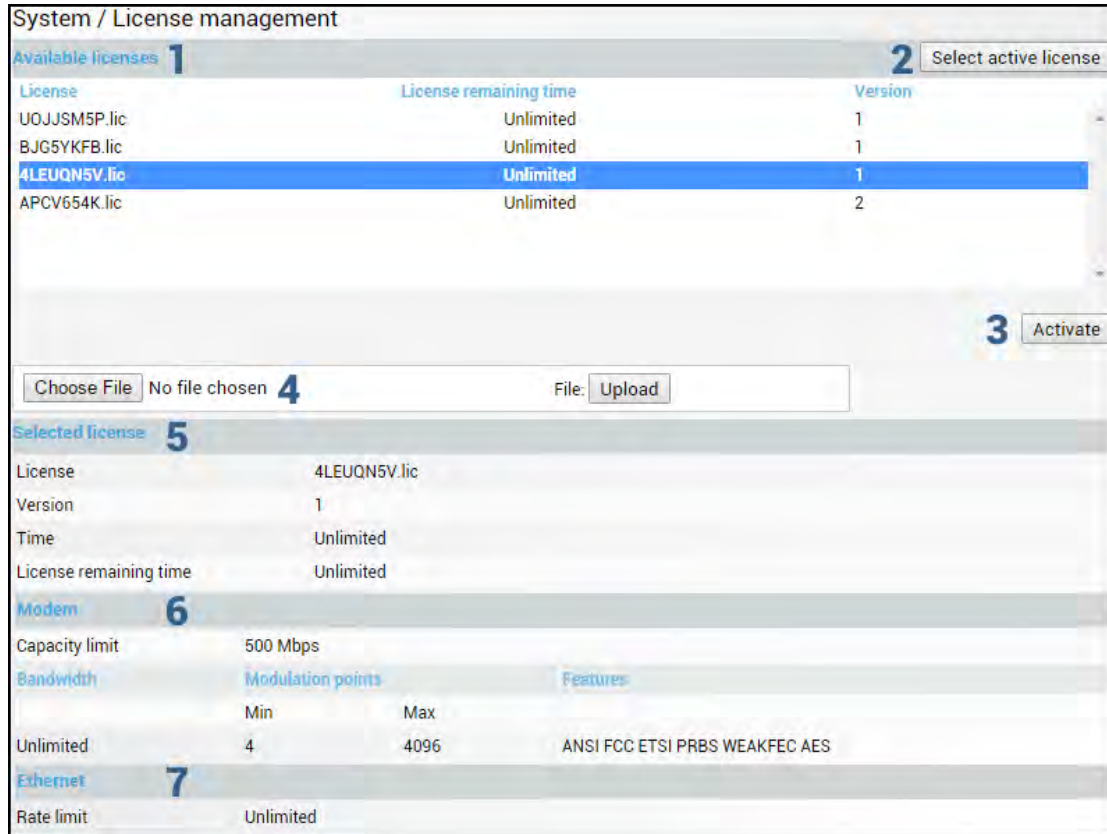
Capacity limit	500 Mbps
Bandwidth	Modulation points Features
	Min Max
Unlimited	4 4096 ANSI FCC ETSI PRBS WEAKFEC AES

Ethernet 7

Rate limit	Unlimited
------------	-----------

Press  **MODIFY** button.

Modify mode



- 1) **Available licenses** – shows a list of available licenses, remaining time, and version;
- 2) **Select active license** – automatically selects the currently active license from the list;
- 3) **Activate** – Select a license from the list and press “Activate” to switch to the preferable license;
- 4) **Choose file&Upload** – Press to browse for a license file (*.lic) on your hard disk drive. Press “Upload” to upload a license file (*.lic) to the Integra/Integra-S/Integra-G/Integra-GS;
- 5) **Selected** – shows version and time of currently selected license;
- 6) **Modem** – shows modem settings of the currently selected license;
- 7) **Ethernet** – shows the Ethernet rate limitation of the currently selected license.

CLI commands (Chapter 4: COMMAND LINE INTERFACE)

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

System → Tools → License management, steps on adding and activating a new license




For activating a license please follow these steps:

- 1) Open the License management page in Web GUI „System/Tools/License management”

- 2) Press „MODIFY” button.
- 3) Press “Choose File” or “Browse” (depending on the browser used), navigate to the license file (*.lic), select it, and press “Upload”
- 4) Choose the uploaded license from the list and press “Activate” button.

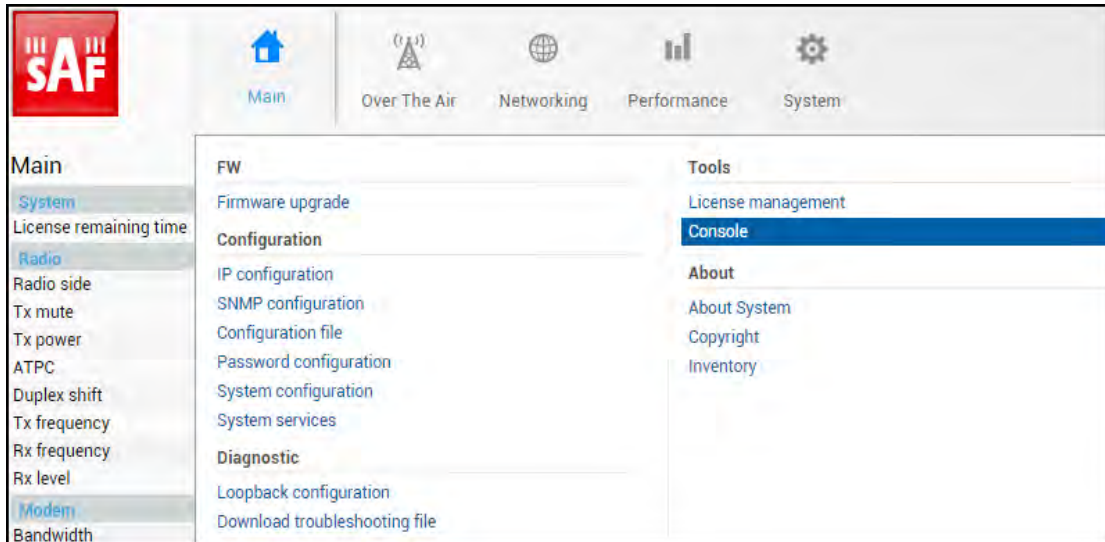
If a new license supports the current modem configuration, no configuration changes will be applied and link synchronization will not be disrupted.

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

-  When the license expires, the modulation will drop to “4QAM FEC Limited” and the link capacity will drop to 256Kbps.
-  When the license expires, the next license in the list needs to be activated manually.
-  Version 1 licenses always have an “Unlimited” Ethernet rate limit.

System → Tools → Console

Provides CLI functionality in Web GUI.



```

System / Console

SAF>
aggr          - Link aggregation commands
configuration - User configuration commands
firmware      - Firmware update and information
help         - CLI usage
license       - License commands
log          - Event / Performance log control and configuration
modem        - Modem commands
network      - Network functionality
product      - Product toolbox
radio        - Radio commands
snmp         - SNMP configuration commands
stp          - Spanning tree commands
system       - System configuration
    
```

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

Use ↵ ENTER key to execute entered command.

A 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 on how to connect to other CLI interfaces (serial, SSH, Telnet).

System → About → About System

Provides a short description of Integra/Integra-S/Integra-G/Integra-GS series products.

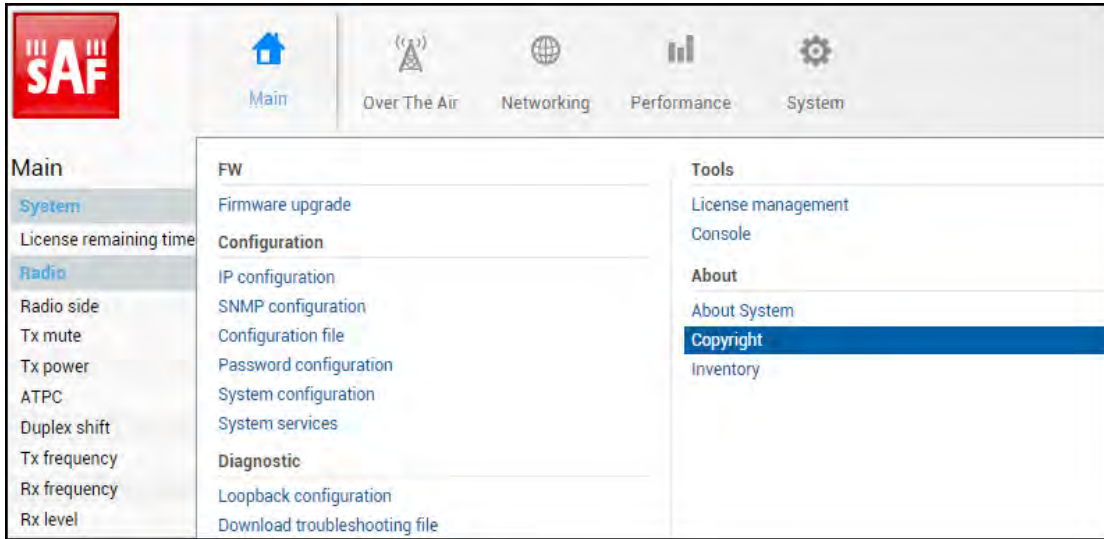
System / About System

Next generation all-outdoor microwave radio product

Integra is an unbelievably light, energy efficient carrier-grade system that exemplifies an outstanding return on smart engineering - the synergy of high competence in radio electronics and materials science. Integration of next generation microwave radio with high performance antennas into a single unit translates into a lower total cost of ownership, as well as less time spent on the installation site, and better reliability of the link even in densely served areas.

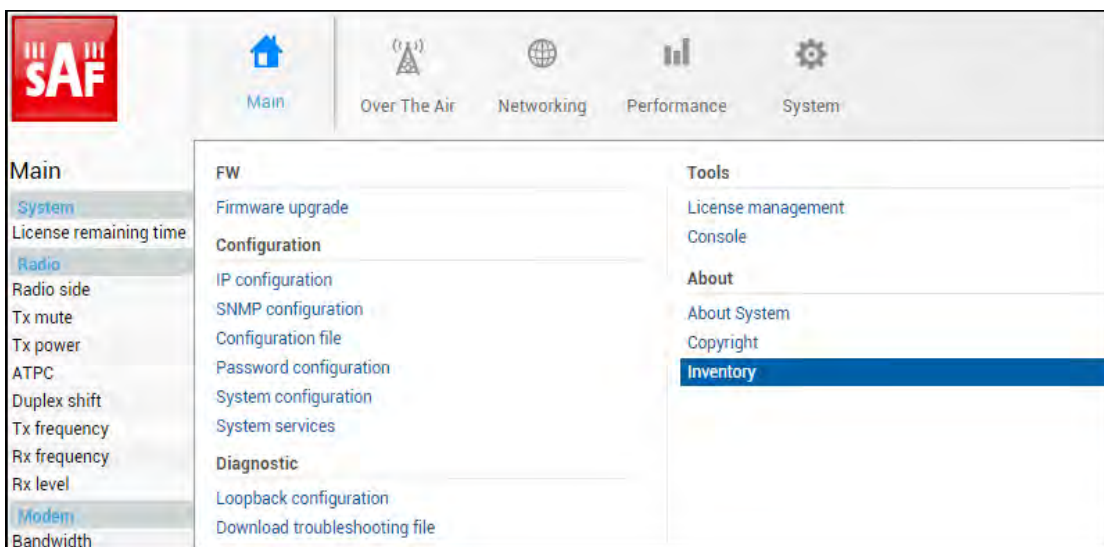
System → About → Copyright

Displays copyright information.



System → About → Inventory

Displays hardware-related information.



System / Inventory	
MB ID	0
MB Sub ID	0
MB revision	3
MAC	000.004.166.129.073.240 - 00.04.A6.81.49.F0
Model	Integra-G
System Contact	techsupport@saftehnika.com
Device Name	SAF
Description	SAF microwave radio
Copyright	Copyright (c) 2013 SAF Tehnika JSC. All rights reserved.
Product Code	D15G2R02L
Product Serial Number	347040100173
Enterprise ID	7571

CLI commands ([Chapter 4: COMMAND LINE INTERFACE](#))

product info	Use to show detailed information on the Integra/Integra-S/Integra-G/Integra-GS FODU.
system number	Use to show the Integra/Integra-S/Integra-G/Integra-GS serial number.

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 each corresponding Web GUI page section 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 on the *Console* page in Web GUI ([System](#) → [Tools](#) → [Console](#)) those shortcuts will not work.

Connecting to serial RS232 interface

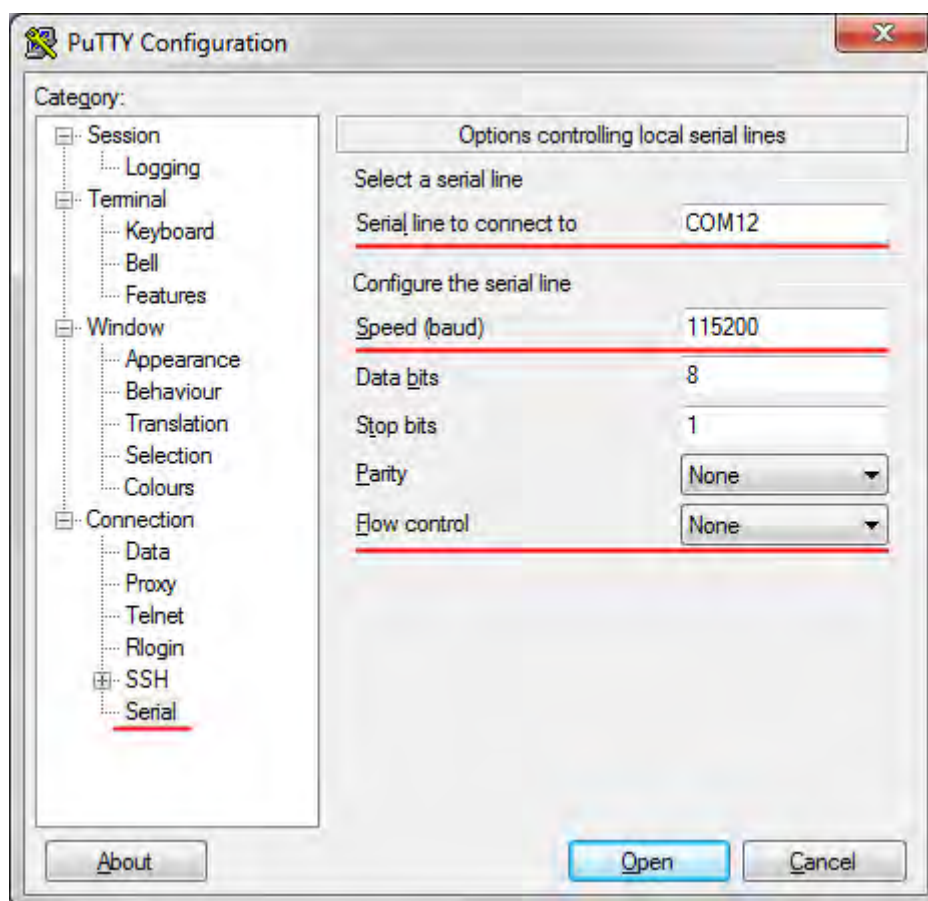
To connect to an Integra/Integra-S/Integra-G/Integra-GS serial terminal, you will require a USB cable with a USB Type B connector. Please refer to [Chapter USB port](#) for pinouts.

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

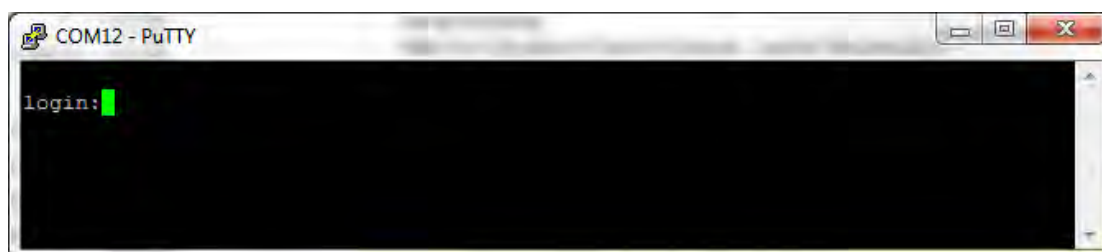
- Baud rate: 115200
- Data bits: 8
- Parity: None
- Stop bits: 1
- Data flow control: None

Below are connection steps with [PuTTY](#) - Windows freeware software.

1. Open [PuTTY](#) and go to “Serial” category. Specify the COM port number you will be using, and 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 the system name is not the default one):



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



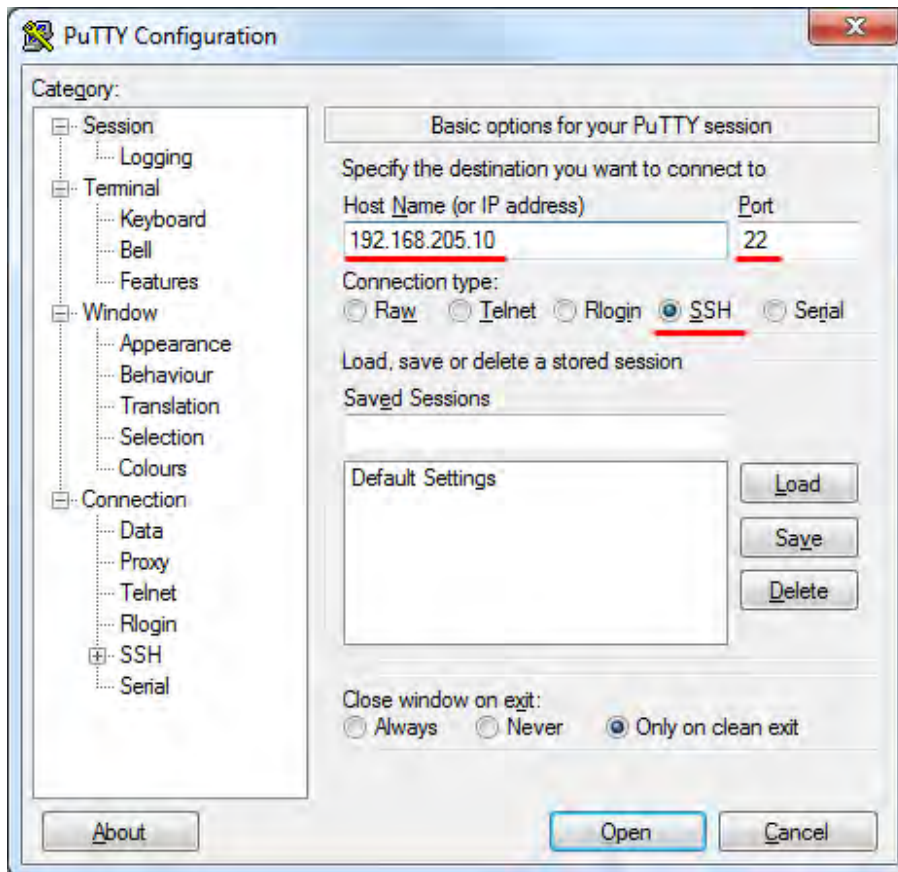
Closing the [PuTTY](#) window does not log off from the current serial terminal session.

Connecting to SSH

The SSH connection to the Integra/Integra-S/Integra-G/Integra-GS FODU is carried out using an Ethernet management connection. Please refer to the chapter [Ethernet management connection configuration](#) for Ethernet management port connection details.

You can use any SSH client. Below are connection steps with [PuTTY](#) - Windows freeware software.

1. Open *PuTTY*, choose "Connection Type": "SSH", enter the IP address, and make sure that the correct port number is used ("22" by default):



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

```
login:█
```

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 the system name is not the default one):

```
login:admin
password:
Login success
SAF>█
```

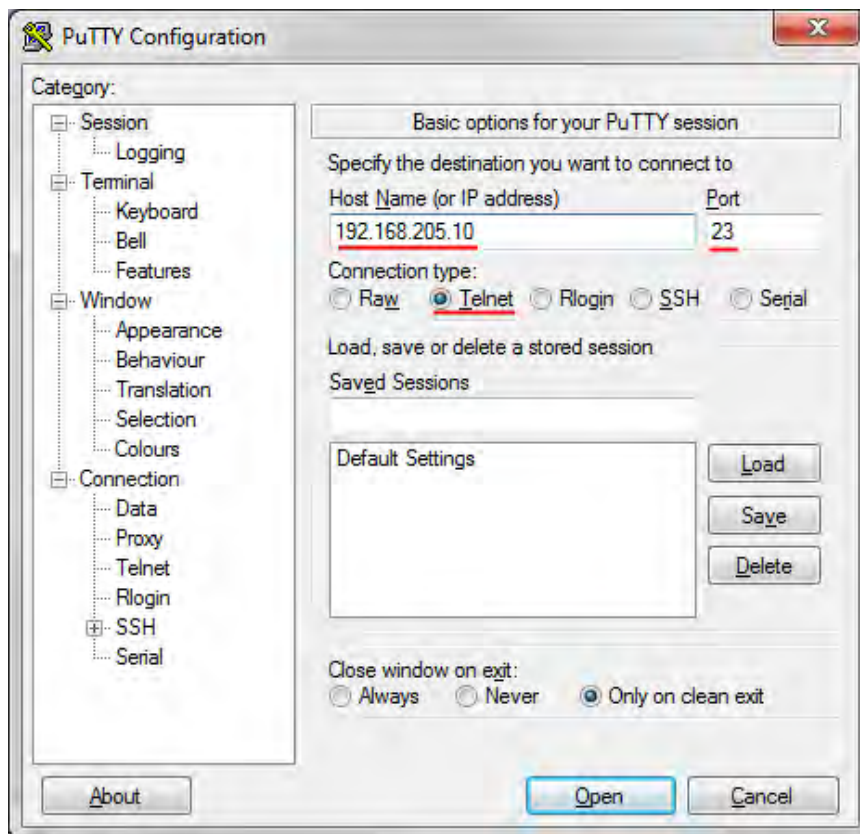
Connecting to Telnet

A Telnet connection to the Integra/Integra-S/Integra-G/Integra-GS FODU is carried out using the Ethernet management connection. Please refer to Chapter [Ethernet management connection configuration](#) for Ethernet management port connection details.

By default Telnet service is disabled. See the chapter [System → Configuration → System services](#) on how to manage system services.

You can use any Telnet client. Below are connection steps with [PuTTY](#) - Windows freeware software.

1. Open [PuTTY](#), choose “Connection Type”: “Telnet”, enter the IP address, and make sure that the correct port number is used (“23” by default).



2. Press “Open” to connect. After a 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 the system name is not the default one):



Chapter 5: 17/24GHz

Polarization Considerations

Polarizations at both ends of the link must be opposite for the 17/24 GHz Integra/Integra-S/Integra-G/Integra-GS FODUs.

For example:

If High side radio is installed in Horizontal polarization,

then Low side radio must be installed in Vertical polarization:



Changing the radio side

1) Access the Web GUI of the remote side radio first. Check its current radio side value on the Main page:

Radio	Local	Remote
Radio side	Low	High

2) Go to “System -> Console” and execute the command “**radio side high**” to change the radio side to High (in this particular example) or “**radio side low**” to change the radio side to Low. You will lose the connection to your remote side now.

3) Access the Web GUI of the local side radio. Check its current radio side value on the Main page:

Radio	Local	Remote
Radio side	High	Low

4) Go to “System -> Console” for the local side unit and execute the command “**radio side low**” to change the radio side to Low (in this particular example) or “**radio side high**” to change the radio side to High. The connection to your remote side now will be restored.

5) Save the configuration on both radios.

Radio configuration – extra fields

This chapter describes **only the differences** in the configuration for the 17/24 GHz Integra/Integra-S/Integra-G/Integra-GS FODUs. For the configuration in general, refer to the chapter [Over The Air → Radio → Configuration](#).

Status mode

Over The Air / Radio configuration	
Tx power (-26 .. -16 dBm for 4QAM)	-16 dBm
Duplex shift (140.00 .. 140.00 MHz)	1 140 MHz
Tx frequency (24220.00 .. 24220.00 MHz)	24220 MHz
Antenna (cm)	2 30
Country	3 LV

Press  **MODIFY** button.

Modify mode

Over The Air / Radio configuration	
Tx power (-26 .. -16 dBm for 4QAM)	<input type="text" value="-16"/> dBm
Duplex shift (80.00 .. 140.00 MHz)	1 <input type="text" value="140.00"/> MHz
Tx frequency (24191.75 .. 24248.25 MHz)	<input type="text" value="24220.00"/> MHz
Antenna (cm)	2 <input type="text" value="30"/>
Country	3 <input type="text" value="LV"/>

- 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 the 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 existing values.

Setting bandwidth to 60MHz

This chapter describes only the differences in setting 60 MHz bandwidth for the 17/24 GHz Integra/Integra-S/Integra-G/Integra-GS FODUs. For the configuration in general, refer to the chapter [Over The Air → Radio → Configuration](#).

1) Access the Web GUI. Configure the Tx frequency to 17130MHz (17GHz) or 24080MHz (24GHz) if it is low side unit. If it is a high side unit, configure the Tx frequency to 17270MHz (17GHz) or 24220MHz (24GHz).

2) Configure the Duplex shift to 140 MHz.

3) Configure the Bandwidth profile by selecting the needed 60 MHz profile (ETSI/FCC, with/without AES, "G-series"/Legacy).

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

5) Save the configuration on both radios.

Over The Air / Radio configuration

Tx power (-26 .. -16 dBm for 1024QAM) dBm

Duplex shift (140.00 .. 140.00 MHz) **2** MHz

Tx frequency (24220.00 .. 24220.00 MHz) **1** MHz

Antenna (cm)

Country

Tx mute [>= 10 sec] Tx mute sec

RSSI Audio Enable

RSSI LED Enable

RSSI LED mode

ATPC Enable

ATPC update period (1 .. 5 sec) sec

Rx (remote) level range (-75 .. -40 dBm) dBm dBm

Difference between Rx min and Rx max must be at least 3 dBm

Profile filter options

All All G series

FCC Without AES Legacy

ETSI With AES

Bandwidth profile

3

Modem profile

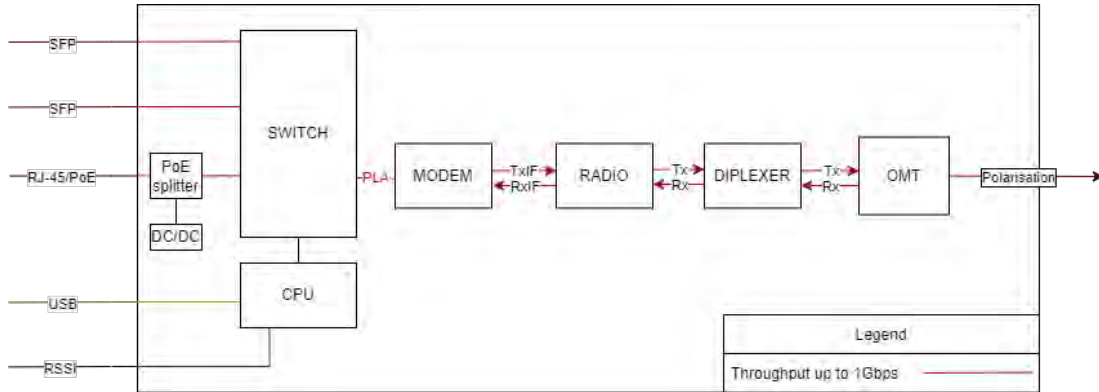
4

Rollback on

Chapter 6: FUNCTIONAL DESCRIPTION

Integra-G block diagram

The general internal block diagram of Integra-G is shown below. It has a built-in Gigabit Ethernet Network Processor that has three LAN ports: LAN1 - 1Gbps PoE-in port that you need to use for powering Integra-G, please refer to [Powering Integra/Integra-S/Integra-G/Integra-GS FODU and connecting to PC](#) for more information, **Error! Reference source not found.** LAN2, and LAN3 SFP ports, please refer to [SFP ports](#) to see the SFP compatibility. To get more information about other interfaces, please refer to [Chapter 8: INTERFACES](#) section.



ACM (Adaptive Coding and Modulation)

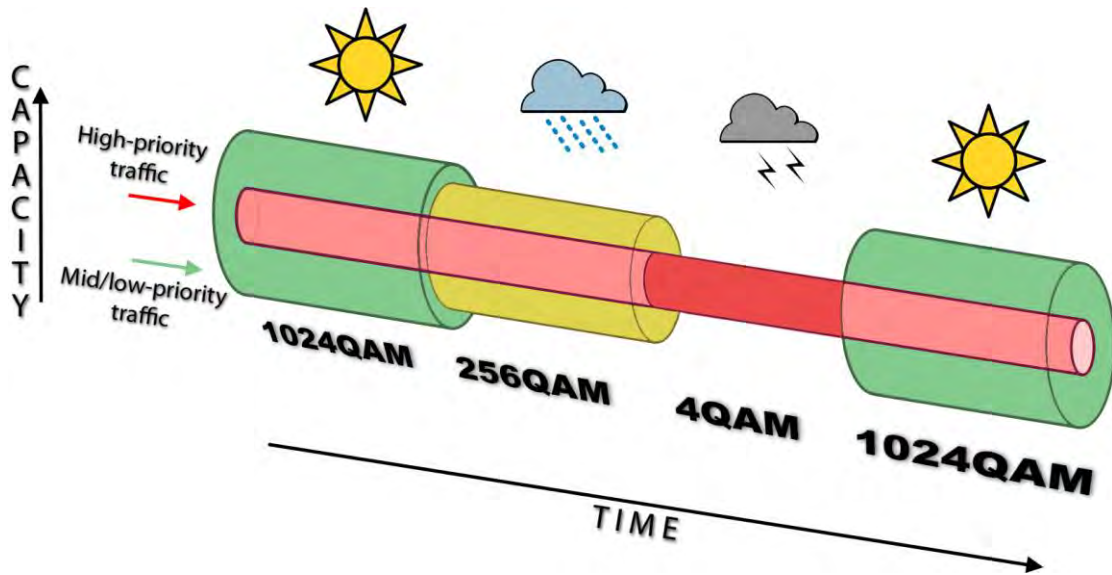
ACM technology allows operators to achieve high-capacity data transmission over microwave links and improve link utilization. This reduces both operational and capital expenditures for maintaining high-capacity links. ACM can maintain the highest link spectral efficiency possible at any given time in 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 MSE (Mean Square Error), which is the inverse of SNR (Signal to Noise Ratio). The MSE 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 and FEC mode.

FEC mode can be Weak or Strong depending on FEC overhead size – smaller or weaker respectively. As a result, Weak FEC mode provides higher throughput (5...10%) sacrificing 2-4dB of sensitivity, and vice versa for StrongFEC.

To maintain linearity, Tx power decreases for higher modulations. Tx power difference between 4QAM and 1024QAM is 8dB.

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

Once the MSE exceeds the threshold of the current ACM profile, an ACM switching process will be initiated. In the 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.

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

MSE for ACM (fixed / variable power, dB)

	3.5 MHz	5 MHz
16QAM SF→4QAM SF	-17.9 / -19.9	-18.0 / -19.7
4QAM SF→16QAM SF	-19.9 / -22.3	-19.4 / -20.9
32QAM SF→16QAM SF	-22.1 / -23.7	-22.2 / -23.3
16QAM SF→32QAM SF	-24.0 / -24.3	-23.6 / -25.5
64QAM SF→32QAM SF	-24.6 / -25.7	-24.3 / -25.3
32QAM SF→64QAM SF	-26.1 / -27.4	-26.0 / -27.5
128QAM SF→64QAM SF	-28.3 / -28.6	-27.5 / -28.7

64QAM SF→128QAM SF	-29.7 / -30.5	-29.1 / -30.9
128QAM WF→128QAM SF	-31.5 / -30.5	-31.4 / -30.9
128QAM SF→128QAM WF	-32.3 / -32.0	-32.7 / -32.0

	7 MHz	10 MHz
16QAM SF→4QAM SF	-18.0 / -18.9	-18.0 / -18.5
4QAM SF→16QAM SF	-19.5 / -20.5	-19.1 / -20.4
32QAM SF→16QAM SF	-21.5 / -22.9	-21.8 / -22.2
16QAM SF→32QAM SF	-23.2 / -25.0	-23.2 / -24.4
64QAM SF→32QAM SF	-24.3 / -24.4	-23.8 / -23.4
32QAM SF→64QAM SF	-25.9 / -26.5	-25.5 / -26.3
128QAM SF→64QAM SF	-26.9 / -27.5	-27.5 / -27.4
64QAM SF→128QAM SF	-28.5 / -29.7	-28.9 / -29.7
256QAM SF→128QAM SF	-30.3 / -31.6	-30.4 / -31.1
128QAM SF→256QAM SF	-32.0 / -35.2	-31.9 / -34.1
256QAM WF→256QAM SF	-32.9 / -34.1	-33.3 / -33.6
256QAM SF→256QAM WF	-34.3 / -35.5	-34.9 / -34.9

	14 MHz
16QAM SF→4QAM SF	-18.2 / -18.3
4QAM SF→16QAM SF	-19.6 / -20.3
32QAM SF→16QAM SF	-21.7 / -21.3
16QAM SF→32QAM SF	-23.4 / -23.5
64QAM SF→32QAM SF	-23.7 / -23.8
32QAM SF→64QAM SF	-25.5 / -26.2
128QAM SF→64QAM SF	-27.1 / -27.3
64QAM SF→128QAM SF	-28.7 / -29.9
256QAM SF→128QAM SF	-30.1 / -31.2
128QAM SF→256QAM SF	-31.8 / -34.7
512QAM SF→256QAM SF	-33.3 / -34.3
256QAM SF→512QAM SF	-34.7 / -36.5
512QAM WF→512QAM SF	-36.5 / -37.3
512QAM SF→512QAM WF	-38.1 / -39.1

	20 MHz FCC	20 MHz ETSI	25 MHz
16QAM SF→4QAM SF	-16.7 / -17.9	-16.7 / -18.2	-16.2 / -17.5
4QAM SF→16QAM SF	-18.4 / -20.2	-18.3 / -19.9	-18.8 / -20.3
32QAM SF→16QAM SF	-20.5 / -20.8	-20.6 / -21.6	-20.9 / -21.2
16QAM SF→32QAM SF	-22.3 / -23.4	-22.7 / -23.5	-22.5 / -23.6
64QAM SF→32QAM SF	-23.5 / -23.9	-23.2 / -24.2	-23.2 / -23.8
32QAM SF→64QAM SF	-25.2 / -26.5	-25.2 / -26.5	-25.2 / -25.8
128QAM SF→64QAM SF	-26.3 / -27.0	-26.5 / -27.1	-26.2 / -26.9
64QAM SF→128QAM SF	-28.2 / -29.4	-28.2 / -29.2	-27.7 / -28.5
256QAM SF→128QAM SF	-24.8 / -30.5	-29.8 / -30.5	-29.4 / -30.1
128QAM SF→256QAM SF	-31.6 / -33.5	-31.3 / -34.1	-31.3 / -32.9
512QAM SF→256QAM SF	-32.6 / -33.6	-32.9 / -33.7	-32.8 / -33.1
256QAM SF→512QAM SF	-34.3 / -36.0	-34.5 / -35.9	-34.3 / -34.8
1024QAM SF→512QAM SF	-36.1 / -36.8	-36.4 / -37.0	-36.4 / -36.4
512QAM SF→1024QAM SF	-37.5 / -39.0	-37.8 / -39.0	-37.5 / -38.2
1024QAM WF→1024QAM SF	-38.6 / -38.8	-38.3 / -38.8	-38.0 / -37.7
1024QAM SF→1024QAM WF	-39.9 / -39.9	-39.6 / -40.2	-39.6 / -39.0

	28 MHz	30 MHz	40 MHz FCC	40 MHz ETSI
16QAM→4QAM	-17.0 / -17.5	-17.2 / -17.5	-16.9 / -17.9	-17.1 / -17.4
4QAM→16QAM	-18.6 / -19.9	-18.8 / -19.6	-18.7 / -19.7	-18.8 / -19.5
32QAM→16QAM	-20.2 / -20.9	-21.2 / -20.7	-20.8 / -21.7	-20.9 / -20.9
16QAM→32QAM	-22.6 / -23.2	-22.5 / -23.0	-22.5 / -23.6	-22.4 / -23.0
64QAM→32QAM	-22.9 / -23.6	-24.1 / -23.6	-23.6 / -23.7	-23.7 / -23.4
32QAM→64QAM	-24.7 / -25.3	-25.5 / -25.6	-24.9 / -25.4	-24.8 / -25.3
128QAM→64QAM	-26.5 / -26.7	-27.0 / -26.9	-26.9 / -26.6	-26.9 / -26.6
64QAM→128QAM	-27.9 / -28.6	-28.0 / -28.6	-28.2 / -28.8	-28.0 / -28.8
256QAM→128QAM	-29.6 / -30.1	-29.9 / -30.1	-30.0 / -30.3	-30.0 / -30.5
128QAM→256QAM	-31.3 / -33.1	-31.4 / -33.1	-31.3 / -32.4	-31.6 / -32.5
512QAM→256QAM	-32.8 / -33.1	-33.2 / -32.8	-32.9 / -33.1	-32.7 / -33.1
256QAM→512QAM	-34.5 / -35.2	-34.5 / -35.0	-34.3 / -34.6	-34.2 / -34.8
1024QAM→512QAM	-36.3 / -36.1	-36.2 / -36.4	-36.2 / -36.0	-36.1 / -36.1
512QAM→1024QAM	-36.5 / -37.9	-37.4 / -38.1	-37.1 / -37.6	-37.1 / -37.5
2048QAM→1024QAM	-38.1 / -38.4	-39.3 / -38.1	-39.4 / -37.5	-39.4 / -37.5
1024QAM→2048QAM	-39.4 / -39.0	-40.5 / -39.0	-40.0 / -38.4	-39.9 / -38.6

	50 MHz	56 MHz	60 MHz FCC	60 MHz ETSI
16QAM→4QAM	-17.3 / -17.8	-17.3 / -17.1	-17.2 / -18.1	-17.6 / -18.0
4QAM→16QAM	-18.7 / -19.7	-18.5 / -19.5	-18.5 / -19.1	-18.0 / -18.4
32QAM→16QAM	-20.8 / -20.8	-20.8 / -20.6	-20.8 / -20.9	-21.0 / -21.0
16QAM→32QAM	-22.3 / -23.1	-22.2 / -22.8	-21.9 / -22.6	-22.1 / -22.0
64QAM→32QAM	-23.4 / -23.9	-23.8 / -23.2	-23.7 / -23.7	-23.6 / -23.9
32QAM→64QAM	-24.2 / -25.6	-24.7 / -25.1	-24.8 / -25.1	-24.9 / -24.4
128QAM→64QAM	-26.7 / -26.8	-26.6 / -27.2	-27.1 / -27.1	-26.6 / -27.1
64QAM→128QAM	-27.9 / -28.7	-27.7 / -28.2	-27.9 / -27.8	-27.8 / -28.1
256QAM→128QAM	-29.8 / -30.1	-29.7 / -29.5	-29.7 / -29.5	-29.8 / -31.0
128QAM→256QAM	-30.9 / -32.6	-30.8 / -32.1	-30.9 / -31.8	-30.9 / -30.4
512QAM→256QAM	-32.7 / -33.1	-33.0 / -32.5	-32.6 / -32.8	-33.0 / -32.9
256QAM→512QAM	-33.9 / -34.8	-33.9 / -34.4	-34.0 / -34.6	-33.8 / -34.3
1024QAM→512QAM	-36.0 / -36.1	-35.9 / -35.6	-36.1 / -35.9	-36.3 / -35.5
512QAM→1024QAM	-36.8 / -37.5	-36.8 / -37.1	-36.7 / -37.1	-36.7 / -36.5
2048QAM→1024QAM	-39.1 / -37.5	-38.7 / -37.1	-38.9 / -37.2	-38.9 / -37.0
1024QAM→2048QAM	-39.7 / -38.6	-39.3 / -38.0	-39.3 / -38.1	-39.3 / -38.2

For example, the link is configured to 2048QAM modulation in 60MHz FCC bandwidth. To operate with the highest modulation (and maximum capacity), MSE should be <-38.9dB in fixed ACM mode or <-37.2dB in variable ACM mode. If MSE exceeds this threshold, ACM will downshift to 1024QAM StrongFEC. Degrading further below -36.1/-35.9dB will downshift to 512QAM modulation. The last ACM downshift will happen after exceeding -17.2/-18.1dB and the link will lose synchronization when MSE reaches -6.8dB.

When MSE improves, upshift thresholds will be used. ACM will upshift back to 2048QAM modulation when MSE exceeds -39.3/-38.1dB in fixed ACM and variable ACM modes respectively.

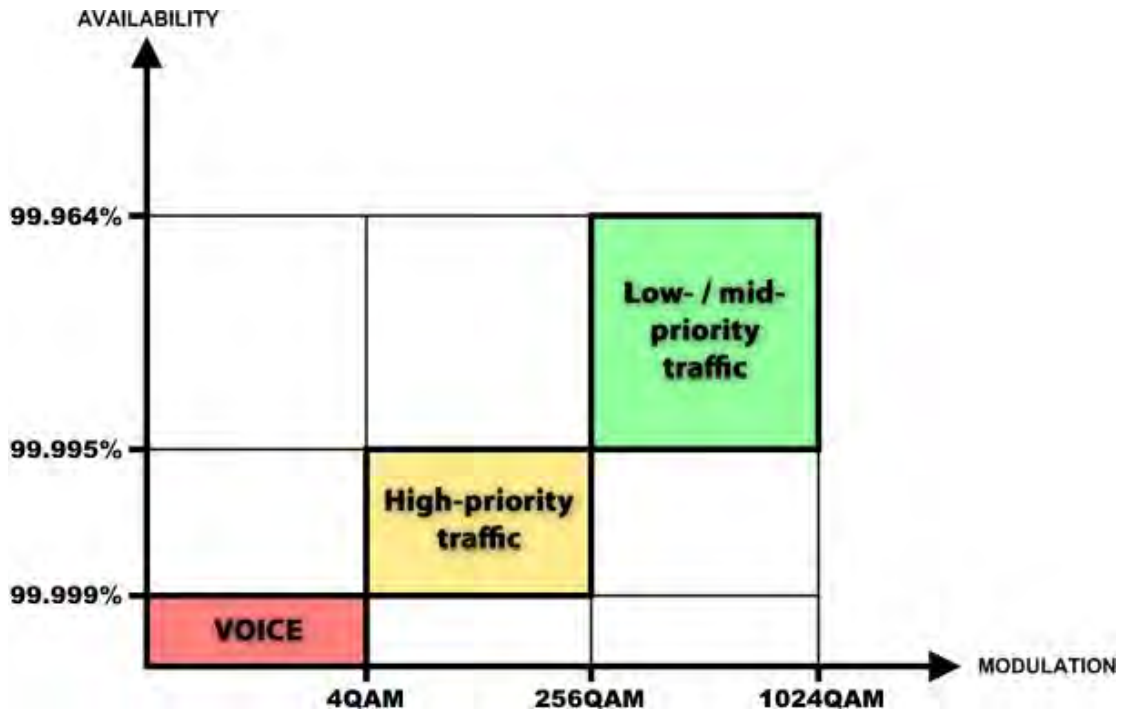
Alternatively, ACM can also be used to increase the link distance, resulting in added link spectral efficiency. The same concept is implemented as previously, with the margins that were kept for 99.995-percent bandwidth availability now used to increase the link distance.

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 Integra/Integra-S/Integra-G/Integra-GS link operating at 23 GHz with 60 MHz channel spacing and an integrated antenna with 40.5 dBi (60cm/2ft) gain. The link is operating in a moderate rain zone G (30mm/h) at a distance of 11.3 kilometers (7 miles).

The system operation is set to a minimal payload of 74Mbps (4QAM) Ethernet for 99.999% annual availability.

Most of the time system would operate at a full capacity of 474Mbps (1024QAM) instead of 74 Mbps (4QAM). The system automatically monitors MSE and changes the capacity without interrupting the data transmission and losing any frames (hitless).



In comparison, a 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.

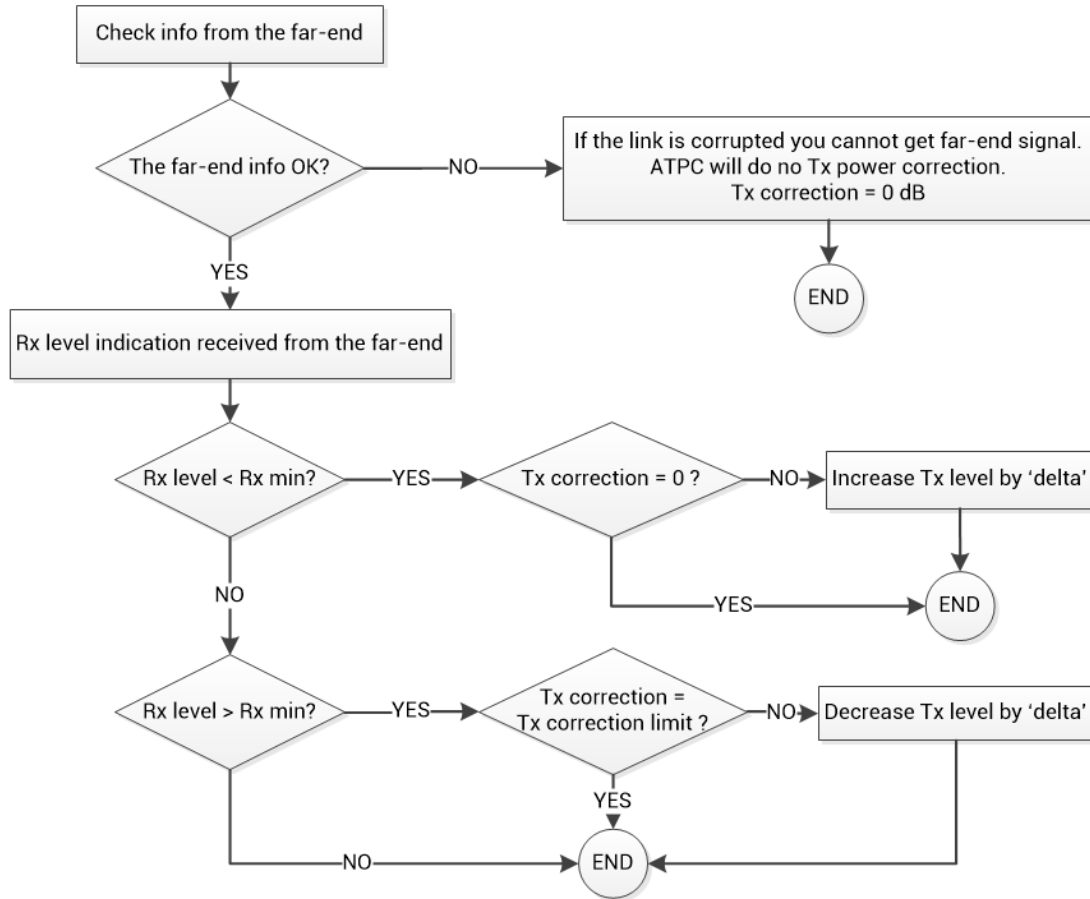
ATPC (Automatic Transmit Power Control)

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

will be 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.

Integra receives information about the Rx level from the far-end Integra through the service channel. Depending on the received Rx level parameter, the local Integra adjusts the transmitter power per the algorithm shown below.



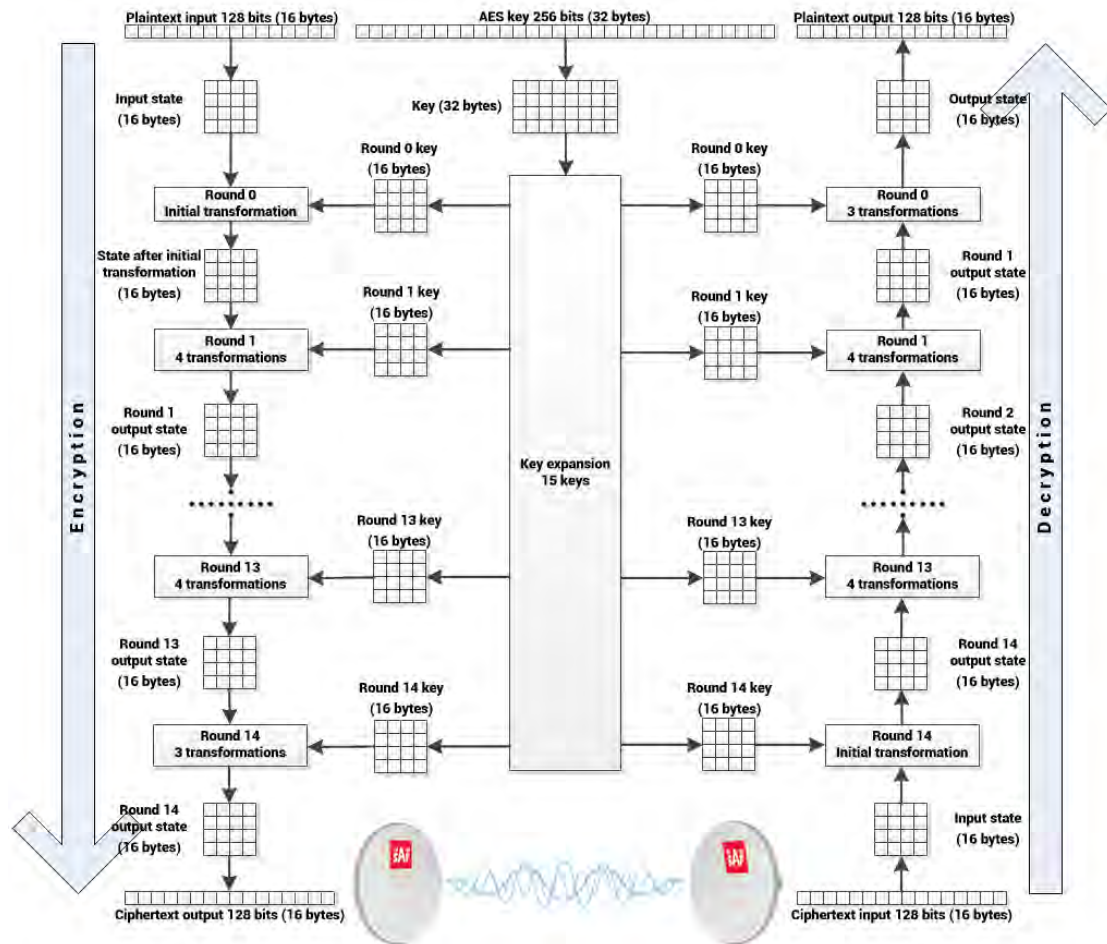
- Rx level – the Rx level value received from the far-end site
- Rx max – maximum permissible Rx level at the far-end site
- Rx min – minimum permissible Rx level at the far-end site
- Tx correction – value by what ATPC has decreased Tx power
- Tx correction limit – defined maximum of Tx correction
-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

AES - Advanced Encryption Standard

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

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

SAF's AES-256 encryption fully complies with [Federal Information Processing Standards Publication 197 \(2001\)](#).



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

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

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

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

Header compression

In many applications such as Voice over IP (VoIP), interactive gaming, or messaging, the size of the header is significant compared to the size of the payload data. Over the end-to-end connection comprised of multiple hops, these headers are significant, but they can be omitted over a single link. It is beneficial to compress those headers to provide high-capacity packet saving, achieve better bandwidth utilization, and efficiently use expensive resources. Reduction in packet loss and improved interactive response time are additional important benefits gained by header compression.

Header compression is accomplished by identifying packets with a recurring pattern of their header fields. Such header fields with recurring values are omitted and replaced with a much shorter tag (2 to 4 bytes). The tag that replaces the mask is known as a compression tag.

Packet Header Compression Header compression engine enables the compression of the following protocols over the radio link:

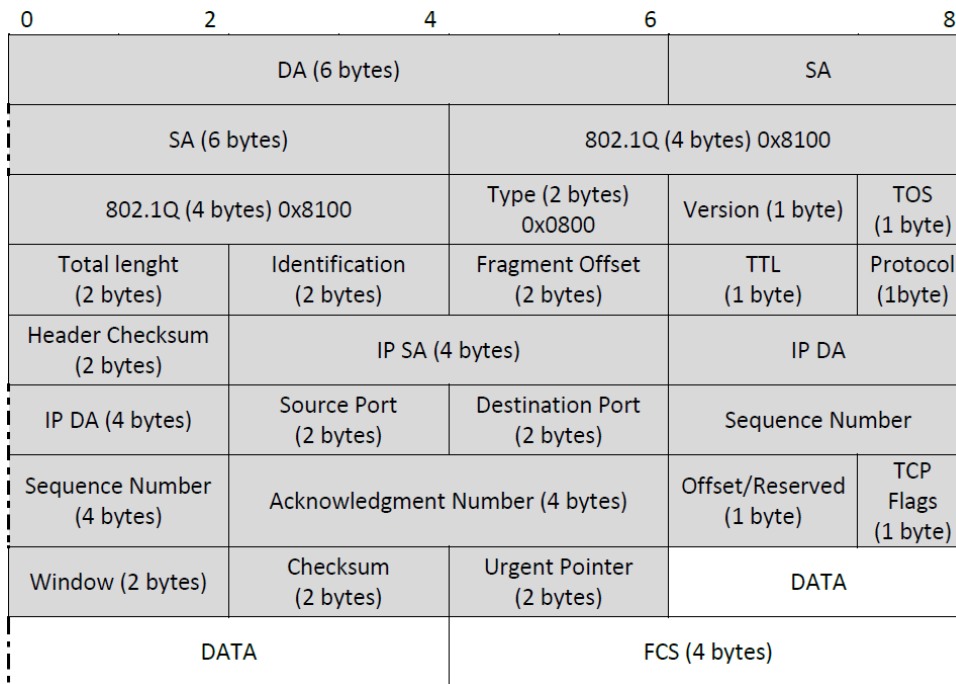
- VLAN
- IPv4
- IPv6
- UDP
- TCP

Header compression creates a compression gain which is the ratio between the original packet capacity and the compressed packet capacity. The compression gain achieved depends on the header and packet size, and the recurrence of the various packet types. For example, compressing Layer 2 and Layer 3 headers of a 128-byte long Ethernet frames yields more than 37% compression gain (this includes IFG, Preamble and FCS removal, and GFP-added encapsulation), e.g. instead of 460 Mbps without Header compression, tests show 633 Mbps with Header Compression.

In this example packets had Layer2+VLAN(0x8100)+VLAN(0x8100)+IPv4+TCP headers. See the picture below (header fields in white are not subject to compression).

Besides, the removal of Layer1 Preamble (7 bytes), start frame delimiter (1 byte), FCS (4 bytes), and Interframe Gap (12 bytes) takes place.

A handshake mechanism between the transmitter and the receiver ensures that header compression is synchronized on both sides of the link. The receiving side is removing the compression headers and reconstructing the original header fields.



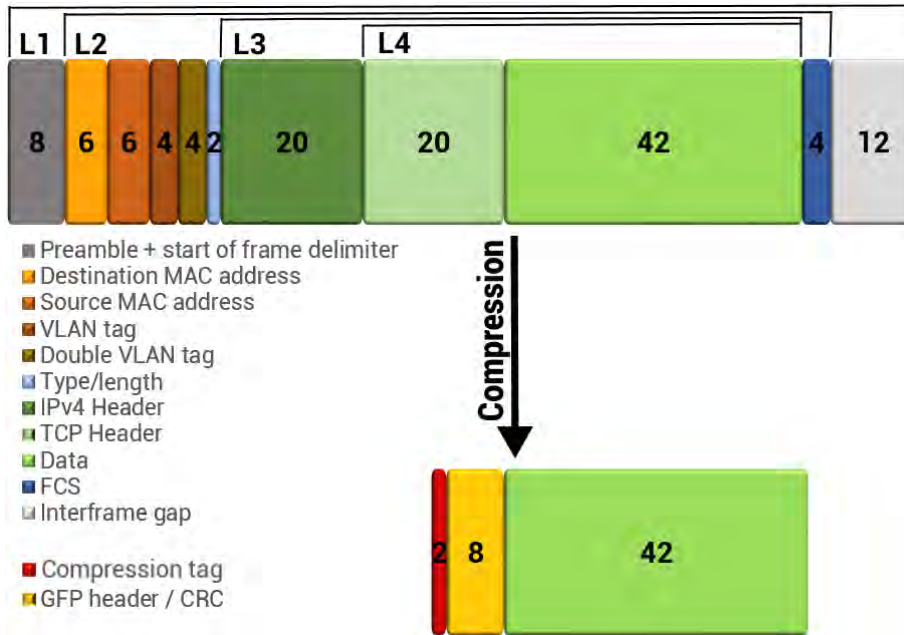
Header Replacement

At the transmitter, the header is removed and replaced by the compression tag.

One of the bits in the GFP header indicates to the receiver if the packet is compressed.

The receiver uses compression tags to search the database for the original header fields. It then replaces the compressed tags with the original header fields. In case the original packet CRC was removed, a new CRC is recalculated at the MAC.

Example with the same as above (2x802.1Q VLAN + IPv4 + TCP) 128-bytes frame:



Header Compression Statistics

The average compression gain is calculated by reading the byte counters in a resolution period of 1s.

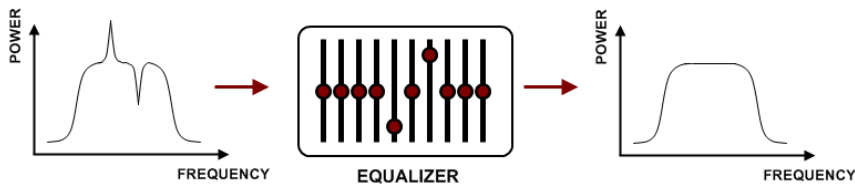
The compression measure the net compression gain and the gross compression gain:

- Net compression gain represents the compression ratio in the percentage of the outgoing bytes of the header compression block to the incoming bytes.
- Gross compression represents the compression ratio in percentage between incoming bytes and outgoing bytes including the PLA and the GFP overheads.

Adaptive equalizer

The Integra/Integra-S/Integra-G/Integra-GS features an adaptive equalizer, which is a filter that automatically adapts to the time-varying properties of a communication channel with selective fading, having a target to compensate the inequalities in frequency response, mitigating the effects of multipath propagation. In wireless telecommunications, using QAM modulation this filter equalizes not only a separate quadrature channel, but provides cancellation of cross-interference between them.

In Integra/Integra-S/Integra-G/Integra-GS, the adaptive equalizer is realized as a complex-arithmetic 40-taps digital FIR (Finite Impulse Response) filter. In other words, the equalizer is a selective frequency amplifier and attenuator, a device, which in application to IF (Intermediate Frequency) band-limited signal is schematically shown in the picture below:



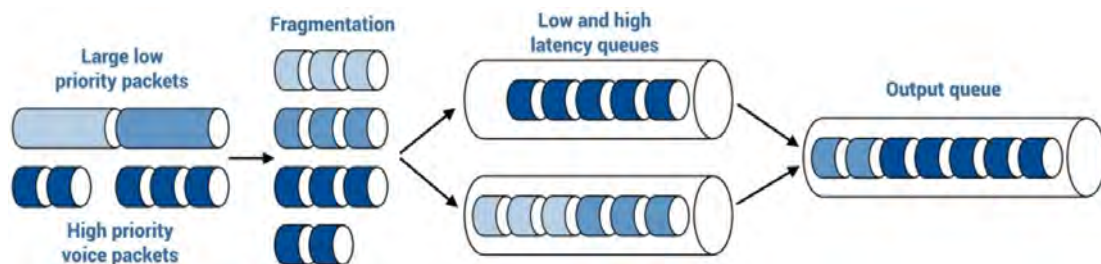
Fragmentation and interleaving

When transmitting delay or jitter-sensitive traffic, like, for example, Voice over IP, it must be transmitted across the network within a specific amount of time to ensure high quality.

The problem is that a high-priority packet needs to be transmitted across the link at the same time the link is committed to transmitting some large packet. Without fragmentation and interleaving active, the high-priority packet will wait behind this large packet until it is sent completely and this could introduce a delay that will make the VoIP packet unusable for an active VoIP conversation.

Packet fragmentation and interleaving allow for reducing delays and jitters by splitting packets into fragments and interrupting the transmission of low-priority fragments. To achieve the best results packet fragmentation and interleaving should be enabled on lower-priority queues. As result, packets and packet fragments are arranged and transmitted according to the priorities. The fragmented datagrams are reassembled at the receiving side.

The figure below illustrates the process of fragmentation and interleaving. When large low-priority packets and small high-priority (like voice) packets arrive at the same time, the large packets are fragmented into small fragments, which are then added to the queues along with the high-priority packets.



The “price” for using fragmentation and interleaving is that it creates an extra overhead. Depending on the size of fragments produced overhead is approx. 1-3%. The resulting latency decrease might reach up to 1.5%.

FTP directory

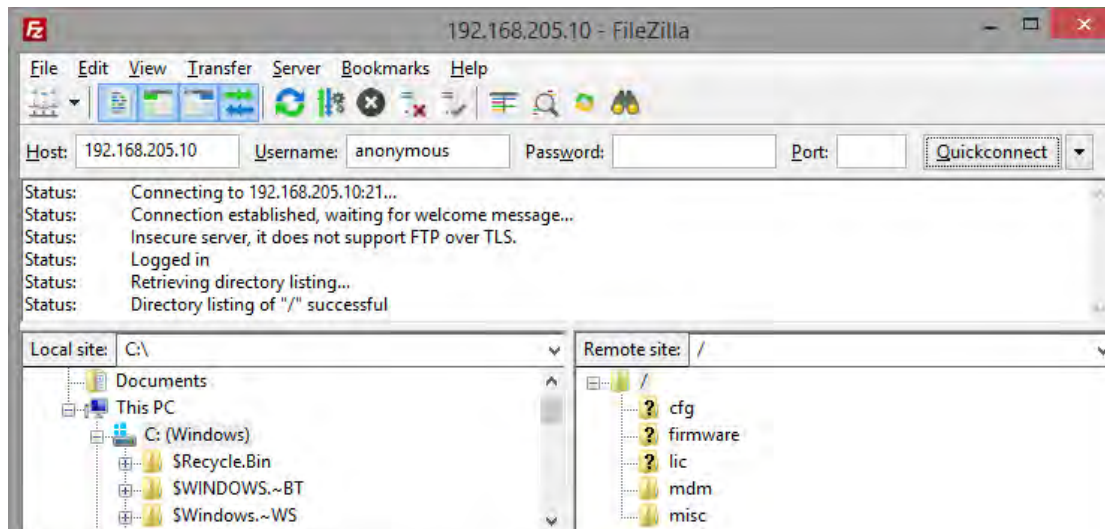
The FTP directory of Integra/Integra-S/Integra-G/Integra-GS can be used in combination with CLI commands to backup/restore system configuration, upload another FW version, and upload a new license file.

The FTP directory is a separate area of internal memory in Integra/Integra-S/Integra-G/Integra-GS.

The FTP directory function is deactivated by every restart of Integra/Integra-S/Integra-G/Integra-GS and all files from this special area are wiped out.

- 1) Use CLI command **system service ftp enable** to activate the FTP directory function.
- 2) After *system service ftp* is enabled it is possible to connect to Integra/Integra-S/Integra-G/Integra-GS by using your favorite FTP client. The username is **anonymous** and the password is empty.

Here is an example of an FTP connection to Integra/Integra-S/Integra-G/Integra-GS using FileZilla:



FTP area has several sub-directories separating every sub-function:

cfg	For managing system configuration backup/restore files. More information in Chapter System → Configuration → Configuration file .
firmware	For uploading firmware files. For more information see Chapter System → FW → Firmware upgrade and CLI commands of Chapter Over The Air → Radio → Configuration .
lic	For uploading license files. For more information see Chapter System → Tools → License management
mdm	For service use only.
misc	For service use only.

After finishing your work with the FTP directory, deactivate it by CLI command **system service ftp disable**.

Firmware upgrade management with SNMP

The firmware upgrade procedure can be performed using a set of SNMP read/write variables. This allows optimizing the process for a large number of radio units in a network.

The following steps describe the whole process.

- 1) Enable the FTP server by setting (SNMP SET command) **integraBsystemServicesFtpSwitch** variable to "2".
- 2) Check if the FTP server is enabled by reading (SNMP GET command) the following variable: **integraBsystemServicesFtpSwitch**.
- 3) Transfer the required firmware file ("bin" file inside the FW package archive) to the "firmware" folder in the FTP directory (for more information, refer to Chapter [FTP directory](#)). Use the following FTP address: ftp://anonymous@DEVICE_IP:/firmware/ (where *DEVICE_IP* should be substituted with the IP address of Integra/Integra-S/Integra-G/Integra-GS).
- 4) Initiate the upload of the transferred firmware file by setting **integraBsystemServicesFwUpload** variable to "1". Only a single firmware file is allowed to be present in the "firmware" folder during the upload. Please note that the command execution usually takes up to 30 seconds, and SNMP read/write requests will return the timeout error during this time. In about 30 seconds, the newly uploaded firmware should be seen in **integraBsystemServicesFwAvailView** list (see the next step) and available for installation.

- 5) View information about the firmware versions already available for installation by reading **integraBsystemServicesFwAvailView** variable: you will get a string containing index numbers and names of all firmware versions available for installation (n1: candfw1; n2: candfw2; etc.).
- 6) As the memory allocated for the firmware files is limited, the upload can fail if there are several firmware versions already uploaded (a maximum of 5 files are permitted). The unnecessary items can be removed with **integraBsystemServicesFwRemove** variable (setting to "n", where "n" is the index number of selected firmware file from **integraBsystemServicesFwAvailView** list). All items can be removed by setting **integraBsystemServicesFwRemoveAll** variable to "1".
- 7) Install the required candidate firmware by setting **integraBsystemServicesFwInst** variable to "n", where "n" is the index number of the selected firmware file from **integraBsystemServicesFwAvailView** list. Please note that the installation execution usually takes up to 30 seconds, and SNMP read/write requests will return the timeout error during this time.
- 8) In about 30 seconds, initiate system reboot by setting **integraBsystemServicesReboot** to "1".
- 9) After the system reboots, check the current FW version by reading **integraBsystemServicesFwCurrInfo** variable.
- 10) As additional functionality, a user can switch between two firmware banks (fw1 and fw2) using **integraBsystemServicesFwSwitchNext** variable (setting to "1/2" for fw1/fw2 bank accordingly). This will change the firmware bank that will be used during the next startup. The currently used firmware bank can be viewed by reading **integraBsystemServicesFwSwitchRunning** variable. The firmware bank selected for the next startup can be checked by reading **integraBsystemServicesFwSwitchNext** variable. Please note that when the firmware is installed it is assigned to a vacant bank (not occupied by the previously running firmware); this bank will be selected for the next startup automatically.

The description of the relevant OIDs is given in the table below:

integraBsystemServicesReboot (.1.3.6.1.4.1.7571.100.1.1.7.1.4.14.1)	WRITE	Set "1" to initiate a system reboot.
integraBsystemServicesFtpSwitch (.1.3.6.1.4.1.7571.100.1.1.7.1.4.14.2)	READ-WRITE	Status and on/off switch for the FTP server (set "1/2" to disable/enable).
integraBsystemServicesFwCurrInfo (.1.3.6.1.4.1.7571.100.1.1.7.1.4.14.3)	READ-ONLY	Currently running FW information.
integraBsystemServicesFwAvailView (.1.3.6.1.4.1.7571.100.1.1.7.1.4.14.4)	READ-ONLY	List of the uploaded FW files available for installation.
integraBsystemServicesFwRemove (.1.3.6.1.4.1.7571.100.1.1.7.1.4.14.5)	WRITE	Set "n" to remove the n-th FW file from the uploaded FW list.
integraBsystemServicesFwRemoveAll (.1.3.6.1.4.1.7571.100.1.1.7.1.4.14.6)	WRITE	Set "1" to remove all FW files from the uploaded FW list.
integraBsystemServicesFwUpload (.1.3.6.1.4.1.7571.100.1.1.7.1.4.14.7)	WRITE	Set "1" to start the upload and make the FW available for installation.
integraBsystemServicesFwInst (.1.3.6.1.4.1.7571.100.1.1.7.1.4.14.8)	WRITE	Set "n" to install the n-th FW file from the uploaded FW list.
integraBsystemServicesFwSwitchRunning (.1.3.6.1.4.1.7571.100.1.1.7.1.4.14.9)	READ-ONLY	Currently running FW bank.
integraBsystemServicesFwSwitchNext (.1.3.6.1.4.1.7571.100.1.1.7.1.4.14.10)	READ-WRITE	The next startup FW bank (set "1/2" to change the FW bank for the next startup)

RADIUS authentication

Configuration of the RADIUS server authentication

Always check your RADIUS server documentation before modifying the RADIUS configuration.

RADIUS vendor ID for Integra equipment is **7571**.

The configuration of the FreeRADIUS software based on the Linux system (Ubuntu) is given below as an example. Keep in mind that there could be differences in command syntax and file locations between FreeRADIUS software versions, always check the FreeRADIUS documentation.

- 1) Add new user data to the users` configuration file: `/etc/freeradius/users`. Add the following line to the users` list:

```
user_1 Cleartext-Password := "pass_1"
```

where `user_1` is a user name and `pass_1` is a password.

```
# This is a complete entry for "steve". Note that there is no Fall-Through
# entry so that no DEFAULT entry will be used, and the user will NOT
# get any attributes in addition to the ones listed here.

user_1 Cleartext-Password := "pass_1"
#
#steve Cleartext-Password := "testing"
```

- 2) Add client (Integra) data by editing the clients` configuration file: `/etc/freeradius/clients.conf`. Add the following lines specifying Integra IP address and the RADIUS secret:

```
client 192.168.205.10 {
    secret = radiuspass_1
}
```

where `192.168.205.10` is the IP address of Integra, `radiuspass_1` is the RADIUS secret word.

```
# the "ipaddr" or "ipv6addr" fields. For compatibility, the 1.x
# format is still accepted.
#
client 192.168.205.10 {
    secret = radiuspass_1
}
```

- 3) Restart FreeRADIUS.
- 4) Set up the RADIUS configuration in Integra Web GUI:
 - a. Open the RADIUS server configuration page ([System](#) → [Configuration](#) → [System services](#)).
 - b. Configure the RADIUS port, RADIUS server IP address, and RADIUS secret parameters according to your setup.



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

- 5) Execute a configuration, save the configuration changes and reboot Integra.
- 6) Log in to Integra using the secure HTTPS connection.
- 7) Proceed to assigning administrative rights to a user if needed, see next chapter [Assigning administrator rights to a RADIUS user](#).

You can log in with users defined both locally and on the RADIUS server.

Assigning administrator rights to a RADIUS user

- 1) Add the corresponding attribute to the main FreeRADIUS dictionary file. Open the file: `/etc/freeradius/dictionary` and add the following line under the "Miscellaneous attributes...":

```

ATTRIBUTE      SAF-User-Level      52      string
#
#      If you want to add entries to the dictionary file,
#      which are NOT going to be placed in a RADIUS packet,
#      add them here.  The numbers you pick should be between
#      3000 and 4000.
#
ATTRIBUTE      SAF-User-Level      52      string
#ATTRIBUTE      My-Local-String      3000      string
#ATTRIBUTE      My-Local-IPAddr      3001      ipaddr
#ATTRIBUTE      My-Local-Integer      3002      integer

```

- 2) For providing the specified attribute to the user that must be granted administrator rights open the users` configuration file: `/etc/freeradius/users` and insert the following line below the definition of the user name and password:

```
SAF-User-Level = admin
```

For example:

```
user_1  Cleartext-Password := "pass_1"
        SAF-User-Level = admin
```

```

# This is a complete entry for "steve". Note that there is no Fall-Through
# entry so that no DEFAULT entry will be used, and the user will NOT
# get any attributes in addition to the ones listed here.

user_1  Cleartext-Password := "pass_1"
        SAF-User-Level = admin

#
#steve  Cleartext-Password := "testing"

```

- 3) Restart FreeRADIUS.
- 4) Log in to Integra using the secure HTTPS connection.

Chapter 7: TOOLS

Link Layer Discovery tool

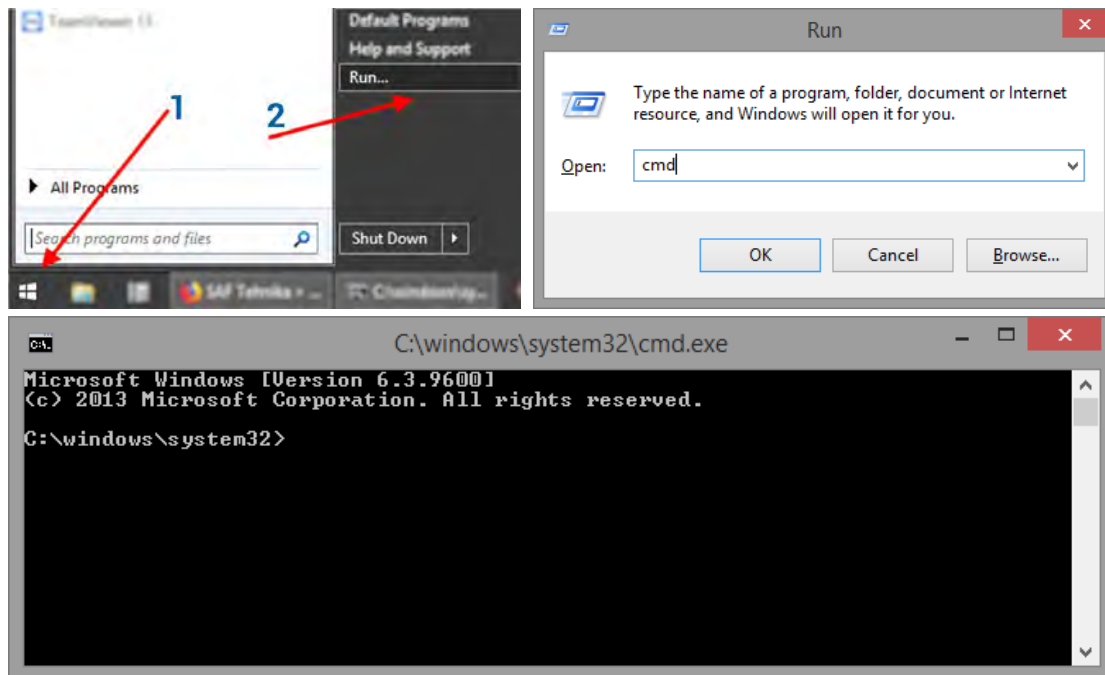
The Link Layer Discovery Tool is a command-line application for MS Windows. It sends requests to the LLD server application which runs on all Integra series devices. The tool is used to discover Integra/Integra-S/Integra-G/Integra-GS/ Integra-W/Integra-WS devices and reset their passwords or settings.

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 the Integra series can be downloaded at <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). The 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 pressing ENTER.

```

C:\windows\system32\cmd.exe
c:\SAF\LLD>lld
Usage:
  lld <if> - get surroundings
  lld <if> reset <mac> <reset list> - perform sub 3 min reset
  lld <if> safrst <mac> <rk2> <reset list> - perform saf support reset

Reset command list:
  acc          - Reset all users/passwords
  factory      - Factory reset(auto-store, no reset)
  mgmt         - Reset management ip addresses
  network      - Reset QoS and ULAN
  reboot       - Perform HW reboot
  store        - Store configuration

Network adapter list:
  1. 74:DA:38:49:FC:2F \DEVICE\NPF_{A67EA6B7-1686-4E98-BA19-2A7E5B205DCF}
     ip : 192.168.205.3
  2. 44:8A:5B:A4:27:3E \DEVICE\NPF_{6B1B97EF-B3CA-4740-9274-A857491C3BAD}
     ip : 192.168.1.150
  3. 00:50:56:C0:00:01 \DEVICE\NPF_{11FDD17E-488C-46AC-B4F0-4D1648F86190}
     ip : 192.168.144.1
  4. 00:50:56:C0:00:08 \DEVICE\NPF_{2BD231A3-5201-4264-AF5D-2022B2E378CF}
     ip : 192.168.140.1

c:\SAF\LLD>_
    
```

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

lld <network interface>

For example:

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

To copy the interface address from the network adapter list, click the right mouse button over the console and select "Mark":

```

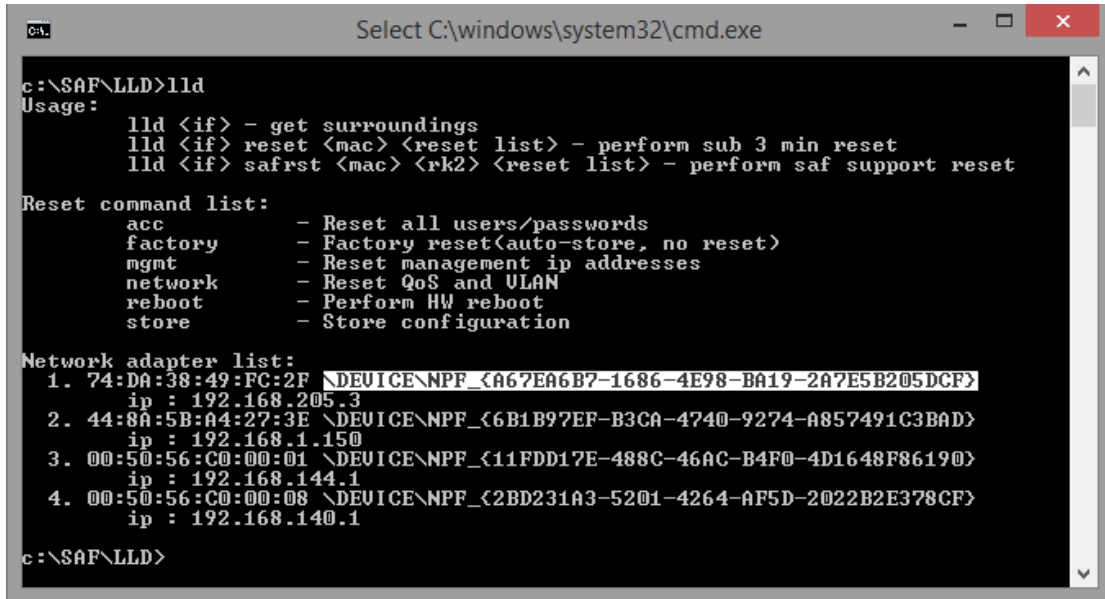
C:\windows\system32\cmd.exe
c:\SAF\LLD>lld
Usage:
  lld <if> - get surroundings
  lld <if> reset <mac> <reset list> - perform sub 3 min reset
  lld <if> safrst <mac> <rk2> <reset list> - perform saf support reset

Reset command list:
  acc          - Reset all u
  factory      - Factory res
  mgmt         - Reset manag
  network      - Reset QoS a
  reboot       - Perform HW
  store        - Store confi

Network adapter list:
  1. 74:DA:38:49:FC:2F \DEVICE\NPF_{A67EA6B7-1686-4E98-BA19-2A7E5B205DCF}
     ip : 192.168.205.3
  2. 44:8A:5B:A4:27:3E \DEVICE\NPF_{6B1B97EF-B3CA-4740-9274-A857491C3BAD}
     ip : 192.168.1.150
  3. 00:50:56:C0:00:01 \DEVICE\NPF_{11FDD17E-488C-46AC-B4F0-4D1648F86190}
     ip : 192.168.144.1
  4. 00:50:56:C0:00:08 \DEVICE\NPF_{2BD231A3-5201-4264-AF5D-2022B2E378CF}
     ip : 192.168.140.1

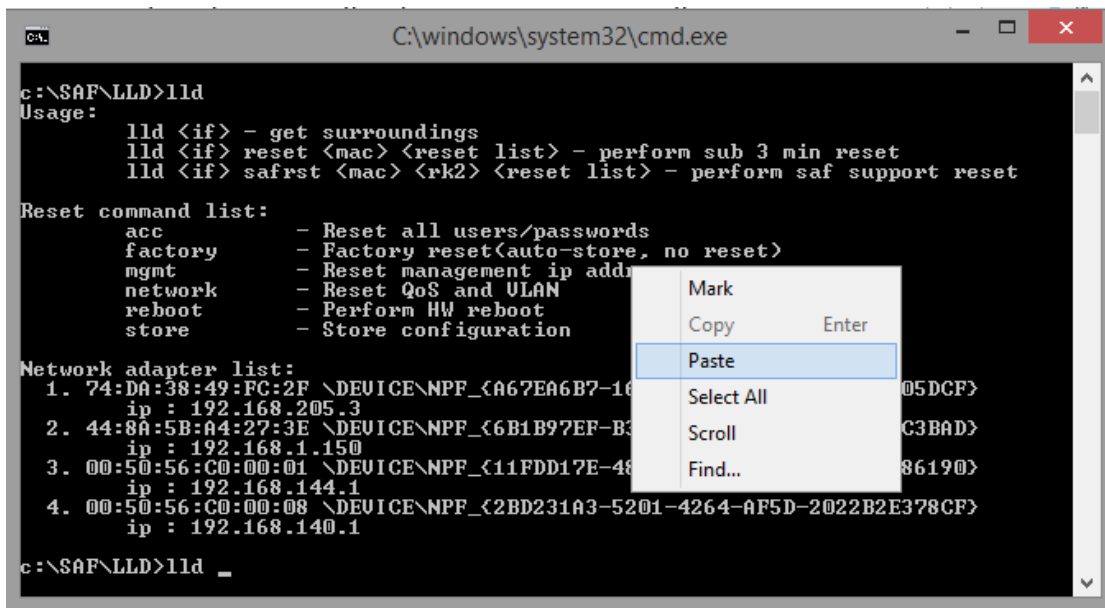
c:\SAF\LLD>_
    
```

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 shown in the image below:

```

C:\windows\system32\cmd.exe

c:\SAF\LLD>lld
Usage:
  lld <if> - get surroundings
  lld <if> reset <mac> <reset list> - perform sub 3 min reset
  lld <if> safrst <mac> <rk2> <reset list> - perform saf support reset

Reset command list:
  acc          - Reset all users/passwords
  factory      - Factory reset(auto-store, no reset)
  mgmt         - Reset management ip addresses
  network      - Reset QoS and ULAM
  reboot       - Perform HW reboot
  store        - Store configuration

Network adapter list:
  1. 74:DA:38:49:FC:2F \DEVICE\NPF_{A67EA6B7-1686-4E98-BA19-2A7E5B205DCF}
     ip : 192.168.205.3
  2. 44:8A:5B:A4:27:3E \DEVICE\NPF_{6B1B97EF-B3CA-4740-9274-A857491C3BAD}
     ip : 192.168.1.150
  3. 00:50:56:C0:00:01 \DEVICE\NPF_{11FDD17E-488C-46AC-B4F0-4D1648F86190}
     ip : 192.168.144.1
  4. 00:50:56:C0:00:08 \DEVICE\NPF_{2BD231A3-5201-4264-AF5D-2022B2E378CF}
     ip : 192.168.140.1

c:\SAF\LLD>lld \DEVICE\NPF_{A67EA6B7-1686-4E98-BA19-2A7E5B205DCF}

```

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

```

C:\windows\system32\cmd.exe

c:\SAF\LLD>lld \DEVICE\NPF_{A67EA6B7-1686-4E98-BA19-2A7E5B205DCF}
Collecting surrounding data...
Dev #0
Dev #1
      RK1 : C92EDA814D68F97AD507628F17BE194F08ABA11F
      RK1 fresh : false
      device name : SAF
      model : Integra-S
      product number : D17BSR01H
      sw version : fw1 / 3.7.6
      MAC : 0004A6813773
      ip address : 192.168.205.111
      ip mask : 255.255.255.0

c:\SAF\LLD>

```

- 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.

```

C:\windows\system32\cmd.exe

c:\SAF\LLD>lld \DEVICE\NPF_{A67EA6B7-1686-4E98-BA19-2A7E5B205DCF}
Collecting surrounding data...
Dev #0
Dev #1
      RK1 : C92EDA814D68F97AD507628F17BE194F08ABA11F
      RK1 fresh : false
      device name : SAF
      model : Integra-S
      product number : D17BSR01H
      sw version : fw1 / 3.7.6
      MAC : 0004A6813773
      ip address : 192.168.205.111
      ip mask : 255.255.255.0

c:\SAF\LLD>

```

- 8) The device is reset by using the required reset command with the recovery tool:

```
lld <interface> reset <MAC> <reset command>
```

where <interface> – network interface from the network adapter list

<MAC> – required Integra device address

<reset command> – reset options

Different reset options are available depending on the reset requirement. Reboot and store options are also available. The store option saves the device's current configuration so it will be restored after the 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 Integra device #1, use:

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

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

```
C:\windows\system32\cmd.exe
c:\SAF\LLD>lld \DEVICE\NPF_{A67EA6B7-1686-4E98-BA19-2A7E5B205DCF}
Collecting surrounding data...
Dev #0
Dev #1
      RK1 : 50FCBE12D26ED9A0C52E47FF97245A86117E11CA
      RK1 fresh : false
      device name : SAF
      model : Integra-S
      product number : D17BSR01H
      sw version : fw1 / 3.7.6
      MAC : 0004A6813773
      ip address : 192.168.205.111
      ip mask : 255.255.255.0
c:\SAF\LLD>lld \DEVICE\NPF_{A67EA6B7-1686-4E98-BA19-2A7E5B205DCF} reset 0004A6813773 acc
Collecting surrounding data...
RK1 is not fresh, try to reboot device
Collecting surrounding data...
RK1 is not fresh, try to reboot device
Collecting surrounding data...
RK1 is not fresh, try to reboot device
Collecting surrounding data...
```

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

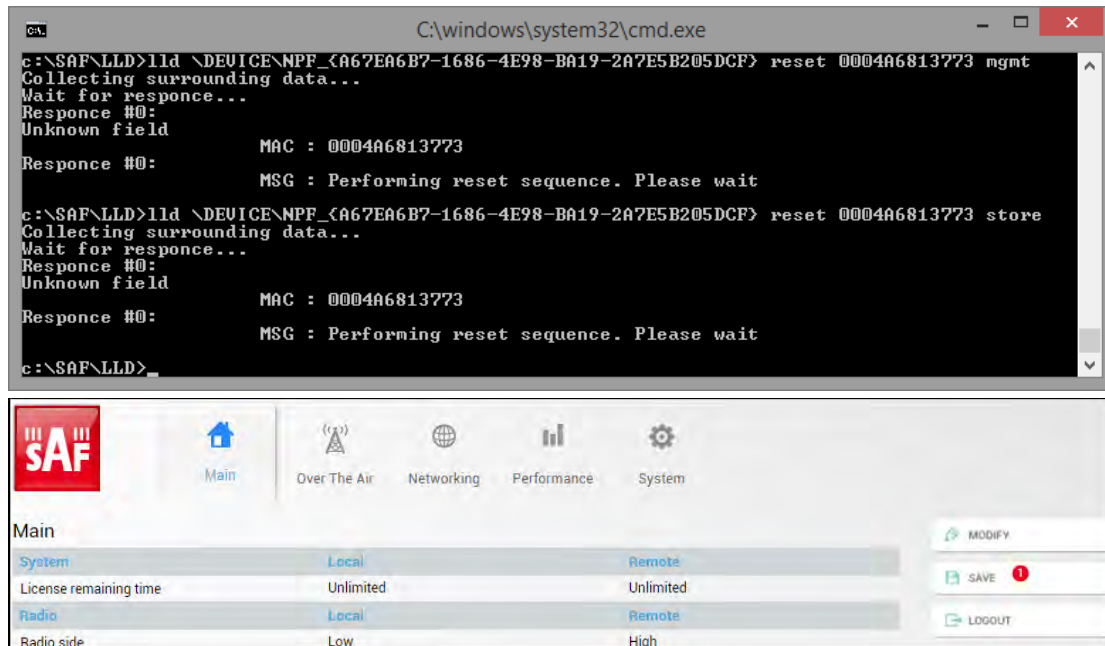
```
C:\windows\system32\cmd.exe
c:\SAF\LLD>lld \DEVICE\NPF_{A67EA6B7-1686-4E98-BA19-2A7E5B205DCF}
Collecting surrounding data...
Dev #0
Dev #1
      RK1 : 51490AFE26A5324317421721BD6659735B0ACEDD
      RK1 fresh : true
      device name : SAF
      model : Integra-S
      product number : D17BSR01H
      sw version : fw1 / 3.7.6
      MAC : 0004A6813773
      ip address : 192.168.205.111
      ip mask : 255.255.255.0
c:\SAF\LLD>lld \DEVICE\NPF_{A67EA6B7-1686-4E98-BA19-2A7E5B205DCF} reset 0004A6813773 acc
Collecting surrounding data...
Wait for response...
Response #0:
Unknown field
Response #0:
      MAC : 0004A6813773
      MSG : Performing reset sequence. Please wait
c:\SAF\LLD>
```

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 Integra device is powered off) "SAVE" button.

For example,

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



The screenshot shows a Windows command prompt window with the following text:

```
C:\windows\system32\cmd.exe
c:\SAF\LLD>lld \DEVICE\NPF_{A67EA6B7-1686-4E98-BA19-2A7E5B205DCF} reset 0004A6813773 mgmt
Collecting surrounding data...
Wait for response...
Response #0:
Unknown field
Response #0:          MAC : 0004A6813773
Response #0:          MSG : Performing reset sequence. Please wait
c:\SAF\LLD>lld \DEVICE\NPF_{A67EA6B7-1686-4E98-BA19-2A7E5B205DCF} reset 0004A6813773 store
Collecting surrounding data...
Wait for response...
Response #0:
Unknown field
Response #0:          MAC : 0004A6813773
Response #0:          MSG : Performing reset sequence. Please wait
c:\SAF\LLD>_
```

Below the command prompt is the SAF web GUI. The 'Main' page is displayed, showing a table of configuration options:

Main			MODIFY
System	Local	Remote	SAVE 1
License remaining time	Unlimited	Unlimited	
Radio	Local	Remote	LOGOUT
Radio side	Low	High	

MIB files



Relevant MIB files can be downloaded directly from the Integra/Integra-S/Integra-G/Integra-GS Web GUI. See Chapter [System](#) → [Configuration](#) → [SNMP configuration](#) for further details.

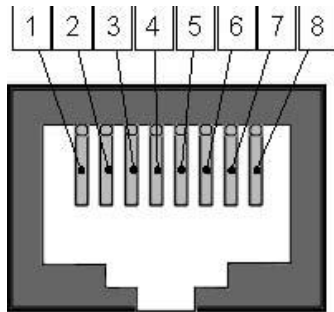
Chapter 8: INTERFACES

RJ-45 port

The RJ-45 port complies with IEEE 802.3-2005 1000Base-T, 100Base-T, and 10Base-T Ethernet and LTPoE++ Power over Ethernet standards.



The pinouts of that socket 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-



PoE power polarity can be reversed.

In case an Ethernet cable is used for power & data (with PoE injector), the combined Ethernet cable length from the PoE injector to Integra/Integra-S/Integra-G/Integra-GS FODU and from PoE injector to CPE is limited to 100m / 328ft.

In case SFP interfaces on LAN2 / LAN3 ports are used as the data interface, it is possible to use the LAN1 port solely for the power supply. Two options are possible:

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

AWG	Lmax @ 75W	Lmax @ 55W	Lmax @ 35W
26	129m / 423ft	176m / 577ft	277m / 907ft
24	205m / 673ft	280m / 918ft	440m / 1442ft
22	326m / 1071ft	445m / 1460ft	699m / 2294ft

- 2) 2-wire power cable together with a DC power adapter cable for the Integra/Integra-S/Integra-G/Integra-GS (P/N D0ACPW01).
Please refer to the tables below for maximum power cable length based on AWG wire size or cross-section area and Integra/Integra-S/Integra-G/Integra-GS FODU power consumption.

AWG	Lmax @ 75W	Lmax @ 55W	Lmax @ 35W
24	51m / 168ft	70m / 229ft	110m / 361ft

22	82m / 268ft	111m / 365ft	175m / 574ft
20	132m / 423ft	180m / 589ft	282m / 926ft
18	206m / 675ft	281m / 920ft	441m / 1446ft
16	329m / 1080ft	449m / 1473ft	705m / 2314ft
14	527m / 1728ft	718m / 2356ft	1129m / 3703ft
Cross-section area	Lmax @ 75W	Lmax @ 55W	Lmax @ 35W
0.25mm ²	64m / 211ft	88m / 288ft	138m / 452ft
0.5mm ²	129m / 422ft	175m / 575ft	276m / 904ft
0.75mm ²	193m / 633ft	263m / 863ft	413m / 1356ft
1.0mm ²	251m / 824ft	342m / 1124ft	538m / 1766ft
1.5mm ²	376m / 1232ft	512m / 1681ft	805m / 2641ft

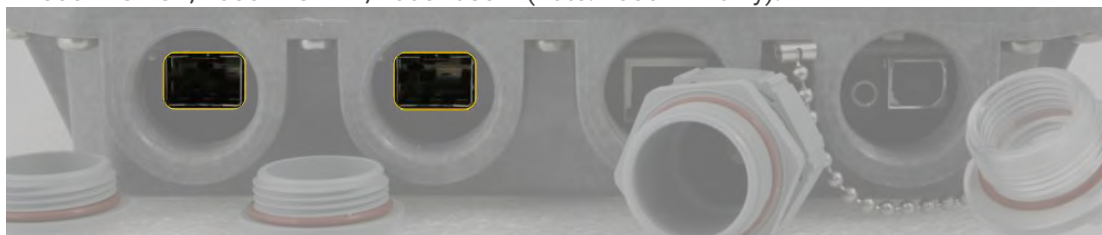


The maximum cable length calculation is done using copper resistance.

SFP ports

SFP ports provide SFP transceiver connectivity.

Both SFP ports comply with the following Gigabit Ethernet standards:
1000BASE-SX, 1000BASE-LX, 1000Base-T (note: 1000FDX only).



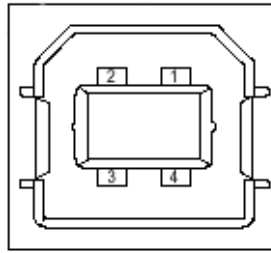
Inquire SAF representative about compatible SFP modules.

In the case of third-party modules, inquire SAF representative about the testing possibility.

USB port

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



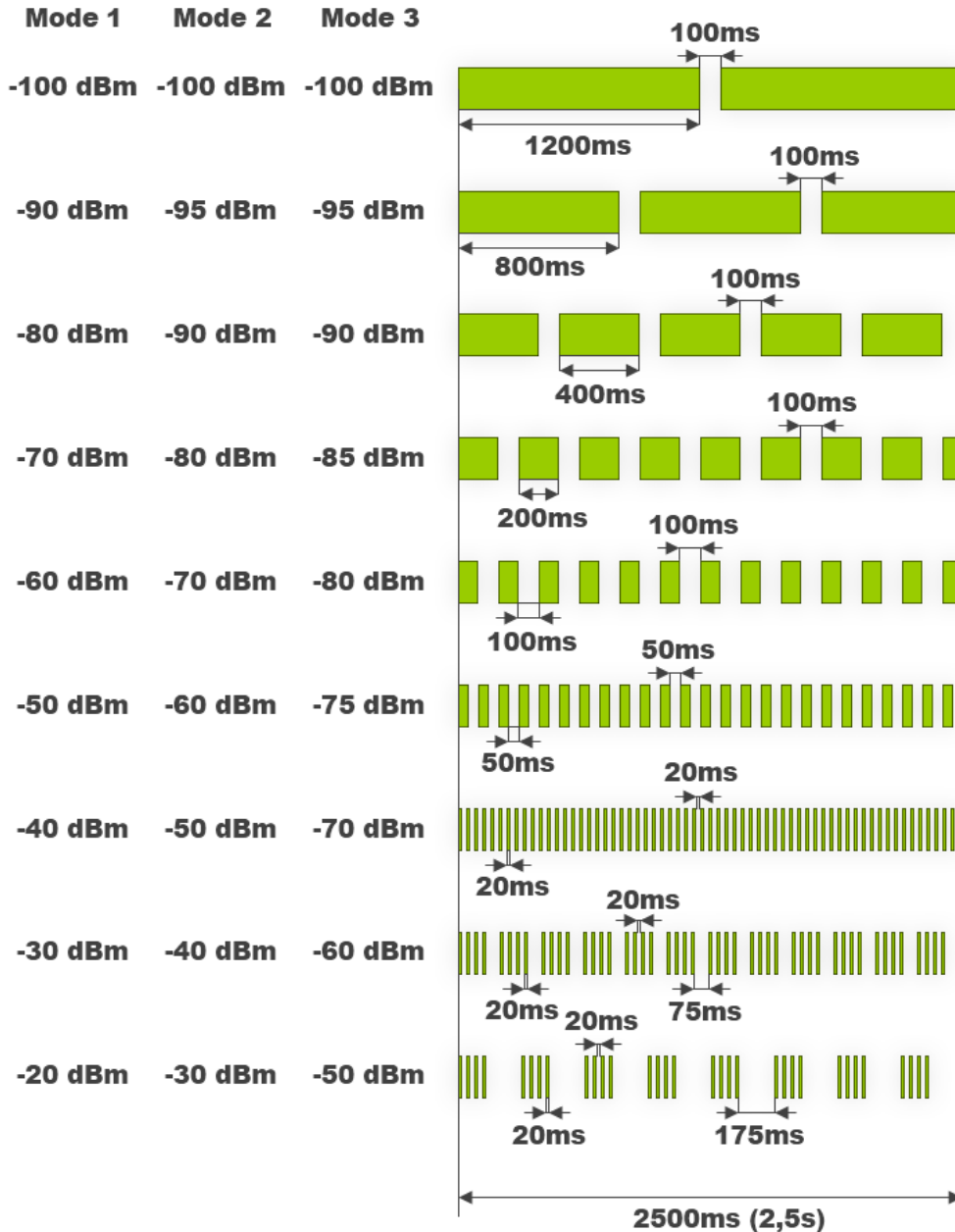
USB Type B Socket**1=Vbus (5V)****2=D-****3=D+****4=GND**

RSSI LED

The RSSI LED can be activated in three operational modes – Mode 1, Mode 2, and Mode 3. By default, RSSI LED is enabled in Mode 1. For further details please refer to the chapter [Over The Air](#) → [Radio](#) → [Configuration](#).



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



Integra-S/Integra-GS RSSI LED description

The 15-42 GHz Integra-S/Integra-GS FODUs have a dual-color RSSI LED. The RSSI LED can blink either in green or 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:

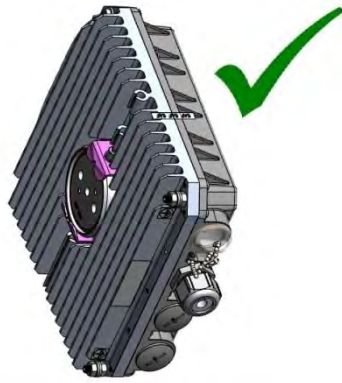
- 1) If the polarization offset from the vertical polarization axis (zero-degree level) is more than 3 degrees to both sides.



- 2) If the polarization offset from the horizontal polarization axis (zero-degree level) is more than 3 degrees to both sides.
- 3) If the elevation angle of the Integra-S/Integra-GS FODU will differ for more than ± 20 degrees from the zero-degree elevation angle



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

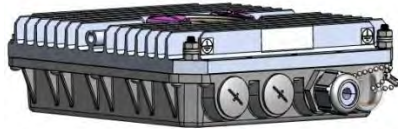


Interfaces faced down
RSSI LED: blinking green



Interfaces faced up
RSSI LED: blinking red

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



Horizontal position
RSSI LED: blinking red



Note that 17&24 GHz Integra-S/Integra-GS FODUs must be installed in opposite polarizations

RSSI/audio port

The 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 a digital multimeter or headphones connected to the RSSI port. The RSSI port is a 3.5mm socket. The output of the RSSI port is DC voltage and an audio frequency and varies depending on the received signal level. Both are linear curves.



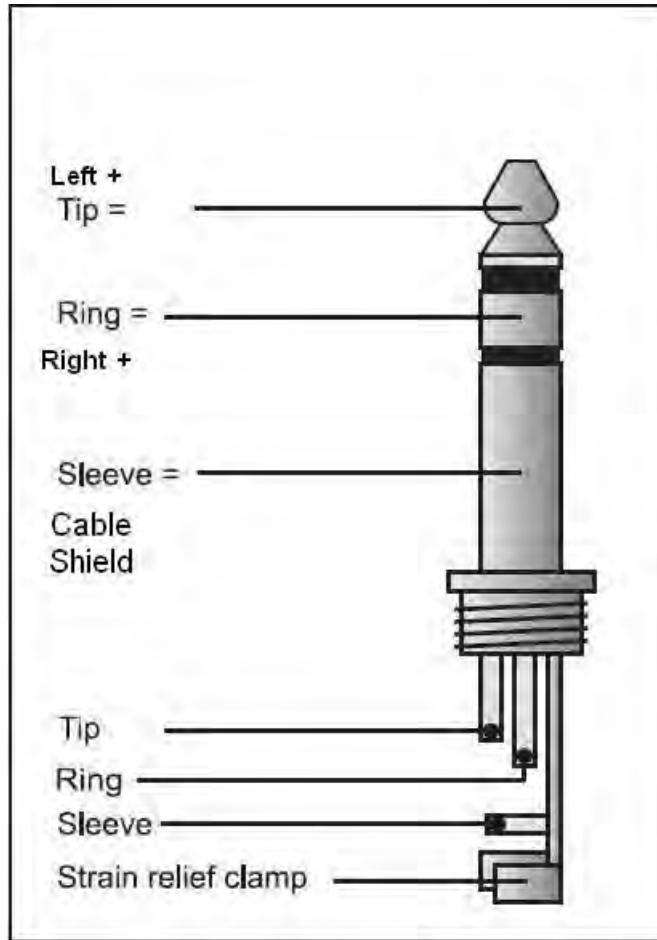
Note that in the case of Integra-S/-GS 6-13GHz RSSI/audio port is separated from the USB port and is located in the last fifth socket:



To connect a voltmeter you will require the appropriate RSSI cable (P/N D0ACRS01):

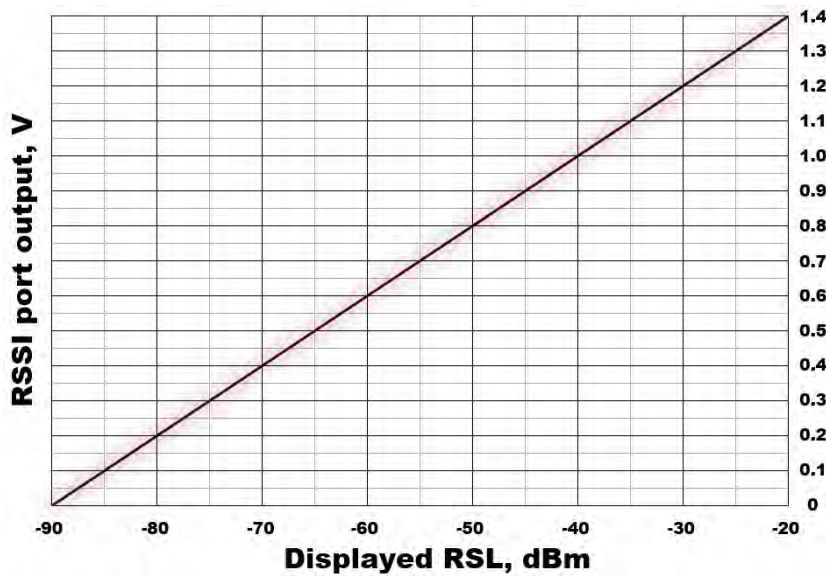


RSSI cable has a 3.5mm RSSI/audio jack with the pinout shown below:

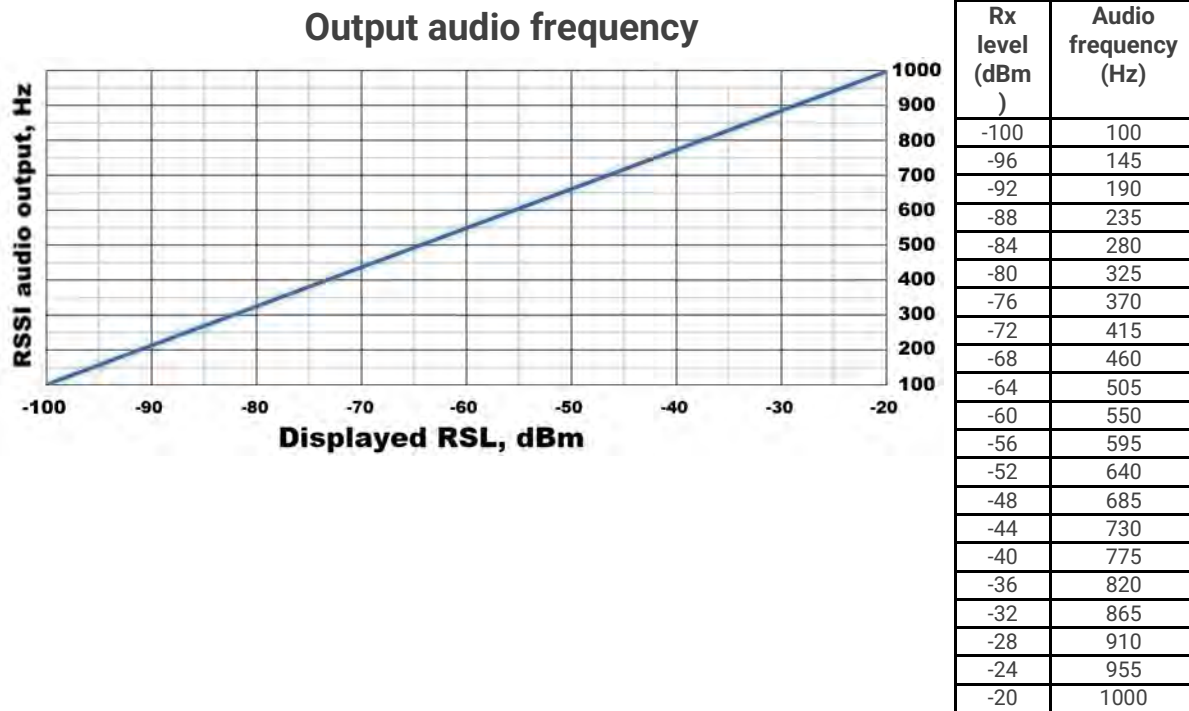


The following charts and tables show the typical relationship of the received signal level (Rx level) displayed by the Integra/Integra-S/Integra-G/Integra-GS vs. the RSSI port output voltage (RSSI – Received Signal Strength Indicator) and audio frequency. The RSSI port is located on the FODU. The evaluated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



Grounding connection

Always provide a good connection from the FODU grounding screw to the tower/mast/building grounding circuit or body. You must choose one, the most convenient, of 2 screws for grounding connection.



Appendix A: TECHNICAL SPECIFICATION

General		Integra-G	
Concept / form factor		FODU (Full-outdoor unit), directly mounted to the antenna	
Frequency bands		6GHz, 7GHz, 8GHz, 11GHz, 13GHz, 15GHz, 17GHz UL, 18GHz, 23GHz, 24GHz UL, 25GHz, 26GHz, 28GHz, 38GHz, and more*	
Radio standards		EN 302 217-2 v3.1.1, EN 300 t+40-2 v1.4.1, FCC CFR 47 Part 101, Industry Canada RSS-GEN and relevant SRSP Specifications	
Frequency stability		± 10 ppm	
Capacity		Up to 1Gbps* with HC at 1+0 or 2+0	
		474 Mbps at 60 MHz 1024QAM (legacy v.)	491 Mbps at 60 MHz 2048QAM
Max modulation		1024QAM (legacy)	2048QAM
Configurations		1+0, 2+0 link bonding, 1+1 HSB	
ACM and ATPC		Yes	
Channel bandwidth		ETSI: from 1.75* MHz, up to 56 MHz FCC: from 5 MHz, up to 60 MHz	
Ports			
Gigabit Ethernet		1x RJ-45	Electrical with built-in PoE splitter and surge arrestor
		2x SFP	Fiber Optics
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		GbE Network Processor built-in	
MAC Table size		32K entries	
VLAN		802.1Q 4096 VLANs, QinQ	
Quality of Service		8 level 802.1p, 64 level DSCP, CoS, MPLS-TP exp bit	
Spanning Tree Prot.		802.1d-2004 RSTP	
Synchronization		SyncE	
Carrier Ethernet		MEF9&14, HC, Packet Fragmentation	
Jumbo frames		Yes, 9600 bytes	
Encryption		AES 256-bit**, licensed feature	
Management		SNMP v1/2c/3, SSH, Telnet, HTTPS, Serial, RADIUS, Network Time Protocol	
		In-band MNG over the same ETH port	
Perf. monitoring		Performance graphs, constellation diagram, alarms, detailed counters	
Electrical			
Power consumption		28...74 W depending on model and frequency band. See the table below.	
Voltage range	Integra	36...57 V DC	
	PoE Injector ¹	36...60 V DC all Integra models; 22...60 V DC models with ≤50 W consumption	

* Inquire SAF representative for more information

** Integra-G is FIPS 197 (Federal Information Processing Standards) validated and placed on the validated product list, Validation No.: AES 5899: <https://csrc.nist.gov/Projects/Cryptographic-Algorithm-Validation-Program/Validation/Validation-List/AES>

¹ Voltage range using I0ATPI24 / I0ATPI44 Power over Ethernet Injector

Mechanical & environmental specification

Integra Model	Integra-G		
Antenna type	External antenna (default)	0.3m / 1ft, integrated	0.6m / 2ft, integrated
Antenna interface	SAF2R 6...13 GHz SAF2 15...38 GHz	Integrated antenna, factory assembled with radio (discontinued solution, no more available)	
Stationary use	Conforms to ETSI EN 300 019 Class 4.1, NEMA 4X		
IP class	IP66: Integra-G 6...13 GHz models and Integra-W. IP67: Integra-G 15...38 GHz		
Relative Humidity	15 to 90-100% @ 30°C		
Temperature range	-33...+55 °C / -28...+130 °F		
Size, 15GHz and higher, w/o mount	235 x 250 x 72 mm / 9.26" x 9.85" x 2.84"	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"
Size, Integra -W 17/24 GHz UL	235 x 250 x 111 mm / 9.26" x 9.85" x 4.37"	N/A	N/A
Size, 6...13 GHz	280 x 437 x 100 mm / 11.02" x 17.2" x 3.9"	N/A	N/A
Weight, w/o mount	2.9 kg / 6.4 lbs	5 kg / 11 lbs	5 kg / 11 lbs
Weight, Integra -W 17/24 GHz UL	4.9 kg / 10.8 lbs	N/A	N/A
Weight, 6...13 GHz	6.5 kg / 14.3 lbs	N/A	N/A
Mount	Mount size	292 x 176 x 250 mm / 11.5" x 7" x 10" max	
	Pole size	Mount on antenna Ø 40 – 120 mm / Ø 1.6" – 4.7"	
	Weight	2.55 kg / 5.6 lbs	

* Inquire SAF representative for more information

Power consumption and rated current at 36 – 57 V DC²

Model	L6 GH z	U6, 7,8 GHz	11, 13 GHz	15 GHz	17 GHz	18 GHz	23 GHz	24 GHz	25, 26, 28 GHz	38 GHz	
Integra-G	Power [W] @ 36–57V DC	74	69	65	40	35	45 ³	41	38	45	47
	Current [A] @ 36 V DC	2.1	1.9	1.8	1.1	1.0	1.3	1.1	1.1	1.3	1.3
	Current [A] @ 48 V DC	1.5	1.4	1.4	0.8	0.7	1.0	0.9	0.8	0.9	1.0
	Current [A] @ 57 V DC	1.3	1.2	1.1	0.7	0.6	0.8	0.7	0.7	0.8	0.8

² Power consumption of Integra radio shown only. For power consumption of the complete system add up to 8% (at 48V DC input) for PoE in DC/DC mode, around 4W for 100m cable (depending on cable), and approx. 1W for SFP transceiver, if used.

³ Both Standard and HP product versions

Exterior design of Integra-G models

 <p>Solution with integrated antenna, 15 GHz and higher, outdated design</p>	 <p>General design, 15GHz and higher</p>	 <p>6GHz ...13GHz models</p>
--	---	--

Maximum Tx Power [dBm] for Integra-G

1) For all ETSI channels, and FCC 60 MHz channels in fixed and variable Tx power modes:

“Fix” – Fixed Tx power mode for all channels mentioned above, and Variable Tx power mode for ETSI ≤14 MHz channels.

“Var” - Variable Tx power mode for all ETSI channels, except 1.75, 3.5, 7, and 14 MHz, and for the FCC 60 MHz channel.

Modulation	L6, U6, 7, 8 GHz		11 GHz 13 GHz		15 GHz, 18 GHz HP ⁴		18, 23, 26, 28 GHz		17 GHz ⁵ , 24 GHz ⁵		38 GHz		
	Fix	Var	Fix	Var	Fix	Var	Fix	Var	Fix	Var	Fixed	Variable ≤14 MHz	Var
4 QAM	+31		+26		+23		+20		-22 ... +5		+15	+15	+15
16 QAM	+30		+25		+22		+19		-22 ... +5		+14	+14	+14
32 QAM	+29		+24		+21		+18		-22 ... +5		+14	+13	+13
64 QAM	+28		+23		+20		+17		-22 ... +5		+13	+12	+12
128 QAM	+28	+27	+23	+22	+20	+19	+17	+16	-22 ... +5		+13	+12	+11
256 QAM	+27	+25	+22	+20	+19	+17	+16	+14	-22 ... +5		+12	+11	+9
512 QAM	+26	+24	+21	+19	+18	+16	+15	+13	-22 ... +5		+11	+10	+8
1024 QAM	+23		+18		+15		+12		-22 ... +5		+10	-	+7
2048 QAM ⁶	+22		+17		+14		+11		-22 ... +5		+9	-	+6

2) For FCC 5 to 50 MHz channels in fixed Tx power mode:

Frequency band	L6, U6, 7, 8 GHz			11 GHz			13 GHz			15 GHz, 18 GHz HP ⁴			18, 23, 25, 26, 28 GHz			17 GHz ⁵ , 24 GHz ⁵		38 GHz	
	BW, MHz	50	25	10	50	25	10	50	25	10	50	25	10	50	25	10	5	5 ... 60	5 ... 60
Modulation	30	20	5	30	20	5	30	20	5	30	20	5	30	20	5	30			
4 QAM	+30	+29	+27	+25	+24	+22	+25	+24	+22	+22	+21	+19	+19	+18	+16	-22 ... +5		+15	
16 QAM	+30	+29	+27	+25	+24	+22	+25	+24	+22	+22	+21	+19	+19	+18	+16	-22 ... +5		+14	
32 QAM	+29	+29	+27	+24	+24	+22	+24	+24	+22	+21	+21	+19	+18	+18	+16	-22 ... +5		+14	
64 QAM	+28	+28	+27	+23	+23	+22	+23	+23	+22	+20	+20	+19	+17	+17	+16	-22 ... +5		+13	
128 QAM	+28	+28	+27	+23	+23	+22	+23	+23	+22	+20	+20	+19	+17	+17	+16	-22 ... +5		+13	
256 QAM	+27	+27	+27	+22	+22	+22	+22	+22	+22	+19	+19	+19	+16	+16	+16	-22 ... +5		+12	
512 QAM	+26	+26	-	+21	+21	-	+21	+21	-	+18	+18	-	+15	+15	-	-22 ... +5		+11	
1024 QAM	+23	+23	-	+18	+18	-	+18	+18	-	+15	+15	-	+12	+12	-	-22 ... +5		+10	
2048 QAM ⁶	+22	-	-	+17	-	-	+17	-	-	+14	-	-	+11	-	-	-22 ... +5		+9	

3) For FCC 5 to 60 MHz channels in variable Tx power mode:

Frequency band	L6, U6, 7, 8 GHz	11 GHz	13 GHz	15 GHz, 18 GHz HP ⁴	18, 23, 25, 26, 28 GHz	38 GHz
BW, MHz	50 60 40 25 10 20 5	50 60 40 25 10 20 5	50 60 40 25 10 20 5	50 60 40 25 10 20 5	50 60 40 25 10 20 5	50 60 40 25 10 20 5
Modulation	30	30	30	30	30	30
4 QAM	+31 +30 +29 +27	+26 +25 +24 +22	+26 +25 +24 +22	+23 +22 +21 +19	+20 +19 +18 +16	+15 +14 +13 +11
16 QAM	+30 +30 +29 +27	+25 +25 +24 +22	+25 +25 +24 +22	+22 +22 +21 +19	+19 +19 +18 +16	+14 +14 +13 +11
32 QAM	+29 +29 +29 +27	+24 +24 +24 +22	+24 +24 +24 +22	+21 +21 +21 +19	+18 +18 +18 +16	+13 +13 +13 +11
64 QAM	+28 +28 +28 +27	+23 +23 +23 +22	+23 +23 +23 +22	+20 +20 +20 +19	+17 +17 +17 +16	+12 +12 +12 +11
128 QAM	+27 +27 +27 +27	+22 +22 +22 +22	+22 +22 +22 +22	+19 +19 +19 +19	+16 +16 +16 +16	+11 +11 +11 +11
256 QAM	+25 +25 +25 +27	+20 +20 +20 +22	+20 +20 +20 +22	+17 +17 +17 +19	+14 +14 +14 +16	+9 +9 +9 +11
512 QAM	+24 +24 +24 -	+19 +19 +19 -	+19 +19 +19 -	+16 +16 +16 -	+13 +13 +13 -	+8 +8 +8 -
1024 QAM	+23 +23 +23 -	+18 +18 +18 -	+18 +18 +18 -	+15 +15 +15 -	+12 +12 +12 -	+7 +7 +7 -
2048 QAM ⁶	+22 +22 - -	+17 +17 - -	+17 +17 - -	+14 +14 - -	+11 +11 - -	+6 +6 - -

⁴ Integra-G 18 GHz HP version has 3dB higher Tx power than standard version

⁵ Max Tx power settings depend on EIRP allowed by national regulatory and antenna size.

⁶ 2048QAM modulation is available only for Integra-G, not supported by legacy models

Integra-G RSL Thresholds at BER 10⁻⁶ and Total Payload Capacity (Mbps) for ETSI channels ^{6, 7, 8}

Bandwidth, MHz	Modulation	6GHz	7GHz	8GHz	11GHz	13GHz	15GHz	17GHz	18GHz	23GHz	24GHz	26GHz	28GHz	38 GHz	Capacity, Mbps	
		Guaranteed RSL Threshold, dBm														-G modes
1.75 ⁸	4QAM StrongFEC	-100	-99	-100	-99	-99.5	-98.5	-97	-99	-99	-99.5	-98.5	-98	-95	1.9	
	16QAM StrongFEC	-93	-93.5	-93.5	-92	-93	-91.5	-90.5	-92.5	-92	-92.5	-92.5	-92	-89	3.9	
	32QAM StrongFEC	-89	-89.5	-89.5	-88	-89	-87	-86	-88.5	-87.5	-88.5	-87.5	-87	-85	4.9	
	64QAM StrongFEC	-86	-86.5	-86.5	-85.5	-86	-84.5	-83.5	-85.5	-84.5	-86	-85	-85	-82	6.6	
	128QAM StrongFEC	-84	-83.5	-83.5	-82	-83	-80.5	-79.5	-81.5	-80	-82.5	-81.5	-82	-79	7.9	
	128QAM WeakFEC	-82	-81	-79.5	-79	-81	-76.5	-78	-79.5	-78	-80.5	-79.5	-79	-77	8.6	
3.5	4QAM StrongFEC	-97	-96	-97	-96	-96.5	-95.5	-94	-96	-96	-96.5	-95.5	-95	-92	4	
	16QAM StrongFEC	-90	-90.5	-90.5	-89	-90	-88.5	-87.5	-89.5	-89	-89.5	-89.5	-89	-86	8	
	32QAM StrongFEC	-86	-86.5	-86.5	-85	-86	-84	-83	-85.5	-84.5	-85.5	-84.5	-84	-82	10	
	64QAM StrongFEC	-83.5	-83.5	-83.5	-82.5	-83	-81.5	-80.5	-82.5	-81.5	-83	-82	-82	-79	13	
	128QAM StrongFEC	-80	-80.5	-80.5	-79	-80	-77.5	-76.5	-78.5	-77	-79.5	-78.5	-79	-76	16	
	128QAM WeakFEC	-77.5	-78	-76.5	-76	-78	-73.5	-75	-76.5	-75	-77.5	-76.5	-76	-74	17	
7	4QAM StrongFEC	-94	-94.5	-94	-93	-94	-93	-91	-94	-93	-93.5	-92.5	-93	-90.5	8	
	16QAM StrongFEC	-87	-87.5	-88.5	-86.5	-88	-86	-84.5	-87.5	-86	-87	-86	-86	-84	16	
	32QAM StrongFEC	-84	-84.5	-84.5	-83.5	-84	-82.5	-80.5	-83.5	-82	-83.5	-82.5	-83	-80	20	
	64QAM StrongFEC	-80.5	-81.5	-81.5	-80.5	-81	-80	-78	-80.5	-80	-80.5	-79	-80	-77.5	27	
	128QAM StrongFEC	-77	-78	-78.5	-76.5	-77	-76	-75	-77.5	-77	-77.5	-76	-76.5	-74	33	
	256QAM StrongFEC	-74	-74.5	-75	-73.5	-74.5	-73	-71	-74.5	-72	-73.5	-72.5	-73	-71	39	
14	256QAM WeakFEC	-72	-73	-67.5	-71.5	-72	-70	-69	-72.5	-71	-71.5	-69	-71	-69	41	
	4QAM StrongFEC	-91	-91	-92	-90.5	-91	-90	-88	-91	-87.5	-91	-90	-90	-87	17	
	16QAM StrongFEC	-85	-85	-85.5	-84	-85	-83.5	-81.5	-84.5	-82	-84	-83.5	-84	-81	33	
	32QAM StrongFEC	-80	-81	-81.5	-80	-80.5	-79	-77	-80.5	-78	-80	-79	-79	-77	44	
	64QAM StrongFEC	-78	-78.5	-78.5	-77	-78.5	-77	-75	-78.5	-76	-78	-77	-77	-74	56	
	128QAM StrongFEC	-75	-75.5	-74.5	-74	-71	-74	-72	-75.5	-73	-74.5	-73.5	-74	-71	67	
20	256QAM StrongFEC	-71.5	-72	-72.5	-71	-67	-71	-68.5	-71.5	-69.5	-71	-70.5	-70.5	-69	79	
	512QAM StrongFEC	-68.5	-68	-69.5	-67	-63	-67	-65	-68.5	-67	-67.5	-67.5	-67	-65	90	
	512QAM WeakFEC	-65.5	-66	-66.5	-64.5	-61	-64	-61.5	-65.5	-63	-65	-64	-64	-62	97	
	4QAM StrongFEC	-89	-90	-91	-88.5	-88.5	-88.5	-87	-89.5	-86	-89	-89.5	-89	-86	25	

Bandwidth, MHz	Modulation	6GHz	7GHz	8GHz	11GHz	13GHz	15GHz	17GHz	18GHz	23GHz	24GHz	26GHz	28GHz	38 GHz	Capacity, Mbps	
		Guaranteed RSL Threshold, dBm													-G modes	Legacy modes
	16QAM StrongFEC	-83	-84	-84.5	-83	-81	-82.5	-80	-83.5	-81	-83	-82.5	-82.5	-79.5		51
	32QAM StrongFEC	-80	-80	-80.5	-79	-78	-78	-76.5	-79.5	-77	-79	-78.5	-79	-75.5		64
	64QAM StrongFEC	-77	-77	-77.5	-76.5	-74.5	-76	-74	-77	-75	-77	-75.5	-76	-73		85
	128QAM StrongFEC	-74	-74	-74.5	-73	-71.5	-73	-70.5	-74	-72	-73	-72.5	-73	-70		102
	256QAM StrongFEC	-70.5	-71	-71.5	-69.5	-67.5	-69.5	-68	-70.5	-68.5	-70	-70.5	-71	-67		119
	512QAM StrongFEC	-67.5	-68	-67.5	-67	-65	-66	-64.5	-67.5	-65.5	-67	-66	-66	-63.5		136
	1024QAM StrongFEC	-64	-64	-64.5	-62.5	-61	-63	-60.5	-64.5	-62	-63	-62.5	-62	-60		153
	1024QAM WeakFEC	-62	-62	-60.5	-61	-58	-60	-58	-62.5	-59.5	-61	-60.5	-60	-58		163
28	4QAM StrongFEC	-88	-89	-89	-88	-87	-87	-85	-88	-84	-88	-86.5	-87	-85	34	35
	16QAM StrongFEC	-82	-83	-83	-81.5	-79.5	-81	-79	-82.5	-79.5	-82	-81.5	-81	-78	69	69
	32QAM StrongFEC	-79	-79	-80	-77.5	-77	-77	-75	-78.5	-75.5	-78	-77.5	-77	-74	87	88
	64QAM StrongFEC	-76	-76	-76.5	-75.5	-74	-75	-72	-75.5	-73.5	-75	-74.5	-74.5	-72	114	115
	128QAM StrongFEC	-73	-73	-73.5	-71.5	-70.5	-72	-69	-72.5	-70.5	-72	-71.5	-71	-69	137	138
	256QAM StrongFEC	-70	-70	-70	-68.5	-66.5	-68	-66	-69.5	-67.5	-69	-68	-68	-65	160	161
	512QAM StrongFEC	-66.5	-66	-67	-65	-63.5	-65	-62.5	-66.5	-64	-65	-64.5	-64	-62	183	184
	1024QAM StrongFEC	-63	-63	-62.5	-62	-59.5	-61.5	-59	-63.5	-61	-62	-61.5	-61	-58	206	207
1024QAM WeakFEC	-61			-59.5		-59	-57	-60.5	-59.5	-60	-58.5	-59	-56		220	
2048QAM StrongFEC	-59	-60	-60.5	-58	-56	-58	-54.5	-59	-57	-59	-58	-57	-54	226		
40	4QAM StrongFEC	-86.5	-87	-87	-85	-86	-85.5	-83	-86.5	-83	-85.5	-85	-85.5	-83	50	50
	16QAM StrongFEC	-81	-81	-82	-79.5	-78.5	-79.5	-77	-81	-78.5	-80	-79.5	-79	-76.5	98	98
	32QAM StrongFEC	-77	-77	-78	-76.5	-75.5	-75.5	-73	-77	-74.5	-76	-75.5	-75.5	-73	125	125
	64QAM StrongFEC	-74	-74	-75	-73.5	-71	-73	-71	-74	-72	-73	-73.5	-73.5	-70.5	165	165
	128QAM StrongFEC	-71	-71	-72	-70.5	-70	-70.5	-67	-71	-69	-70	-69.5	-70	-67	198	198
	256QAM StrongFEC	-68	-68	-68	-67	-65	-66.5	-64	-68	-66	-67	-66.5	-65	-63.5	231	231
	512QAM StrongFEC	-65	-65	-65.5	-64	-62	-63.5	-61	-65	-63	-63.5	-63.5	-63	-60.5	264	264
	1024QAM StrongFEC	-61	-61	-61.5	-60.5	-59	-60	-57	-61.5	-59.5	-60.5	-59.5	-59	-56.5	298	298
1024QAM WeakFEC	-59			-59		-57	-55	-59	-57.5	-58.5	-58	-57.5	-55		314	
2048QAM StrongFEC	-58	-58	-58.5	-56.5	-54	-56	-54	-57.5	-55.5	-56.5	-56	-56	-52.5	327		
56	4QAM StrongFEC	-85	-85	-86	-84	-84.5	-84	-81	-85	-82	-84	-83.5	-84	-81	71	72
	16QAM StrongFEC	-79	-79.5	-80	-78.5	-78	-78	-75	-79	-77	-78.5	-78	-78	-75	144	145
	32QAM StrongFEC	-75	-75.5	-76	-74.5	-74	-74	-71.5	-75	-73	-74.5	-73.5	-74	-72	183	183
	64QAM StrongFEC	-72	-73	-74	-72	-71	-71	-69	-72	-70	-72.5	-71	-71	-69	238	241
	128QAM StrongFEC	-70	-69.5	-70	-68.5	-68	-69	-66	-69	-67.5	-69.5	-68	-68	-65	286	289
	256QAM StrongFEC	-67	-66	-67	-65.5	-64	-65	-62	-66	-64.5	-65.5	-64.5	-65	-62	334	337
	512QAM StrongFEC	-63	-63.5	-64	-62	-61	-62	-59	-63	-61.5	-62.5	-61	-62	-59	382	385
	1024QAM StrongFEC	-60	-60	-60	-58.5	-58	-58	-56	-59	-57.5	-59.5	-57.5	-58	-55	430	433
1024QAM WeakFEC	-58			-57		-55	-54	-57.5	-55.5	-55.5	-55.5	-55.5	-54		456	
2048QAM StrongFEC	-56	-57	-57	-54.5	-55	-54	-52.5	-55	-53.5	-55.5	-54	-54.5	-52	472		

⁶ 2048QAM modulation is available only for Integra-G, not supported by legacy models.

⁷ 1024QAM modulation with Weak FEC setting is available for legacy models or in legacy modes only.

⁸ 1.75 MHz bandwidth is available on all Integra-G models but tested upon request on customized product only. Please ask SAF representative for more information.

Integra-G RSL Thresholds at BER 10⁻⁶ and Total Payload Capacity (Mbps) for FCC channels ^{6,7}

BW, MHz	Modulation	6GHz	7GHz	8GHz	11GHz	13GHz	15GHz	17GHz	18GHz	23GHz	24GHz	26GHz	28GHz	38 GHz	Capacity, Mbps	
		Guaranteed RSL Threshold, dBm														-G modes
5	4QAM StrongFEC	-96	-96	-96.5	-95	-95.5	-94	-92.5	-95	-94	-95.5	-94.5	-95	-91		5
	16QAM StrongFEC	-89	-89.5	-86.5	-88	-89	-87	-86.5	-88.5	-88	-89	-87.5	-88	-85		10
	32QAM StrongFEC	-85	-85.5	-85.5	-84	-85	-83.5	-82.5	-84.5	-84	-85	-83.5	-84	-81		12
	64QAM StrongFEC	-82.5	-82.5	-80.5	-81.5	-82	-80.5	-79.5	-81.5	-81	-82	-81	-81	-79		17
	128QAM StrongFEC	-79	-79.5	-79.5	-78.5	-79	-77.5	-76.5	-78.5	-77.5	-79	-78	-78	-75		20
	128QAM WeakFEC	-77	-77	-77	-76.5	-77	-74	-73.5	-76.5	-75.5	-76.5	-75.5	-75.5	-73		22
10	4QAM StrongFEC	-92	-92.5	-94	-91	-92.5	-91	-89	-92	-90	-92	-91.5	-91.5	-89		12
	16QAM StrongFEC	-86	-86.5	-86.5	-85	-86	-84.5	-82.5	-85.5	-84	-85.5	-84.5	-85	-82		24
	32QAM StrongFEC	-82	-82.5	-82.5	-81.5	-82	-81	-79	-82.5	-80	-82	-81	-81	-78		30
	64QAM StrongFEC	-79.5	-80	-80	-79	-79.5	-78	-76	-79.5	-78	-79	-78	-78	-76		40
	128QAM StrongFEC	-76	-76.5	-76.5	-75.5	-76	-75	-73	-76.5	-75	-76	-75	-75	-73		48
	256QAM StrongFEC	-73	-73.5	-73.5	-72	-73	-72	-69	-72.5	-71	-72.5	-71.5	-71	-70		56
256QAM WeakFEC	-70	-70.5	-70.5	-69	-70	-69	-66.5	-70.5	-68	-69.5	-68.5	-68.5	-66		60	
20	4QAM StrongFEC	-89	-90	-91	-88.5	-88.5	-88.5	-86	-89	-86.5	-89	-88.5	-88	-86		24
	16QAM StrongFEC	-83	-84	-84.5	-83	-81	-83	-80	-83.5	-81	-83	-82.5	-82.5	-80		49
	32QAM StrongFEC	-80	-80	-80.5	-79	-78	-79	-76.5	-79.5	-77	-79	-78.5	-79	-77		62
	64QAM StrongFEC	-77	-77	-77.5	-76.5	-74.5	-76	-74	-76.5	-74.5	-77	-75.5	-76	-73		82
	128QAM StrongFEC	-74	-74	-74.5	-73	-71.5	-73	-70.5	-73.5	-71.5	-73	-72.5	-73	-71		99
	256QAM StrongFEC	-70.5	-71	-71.5	-69.5	-67.5	-70	-67	-70.5	-68.5	-70	-69.5	-70	-67.5		115
	512QAM StrongFEC	-67.5	-68	-67.5	-67	-65	-66	-64.5	-67.5	-65.5	-67	-66	-66	-64		132
	1024QAM StrongFEC	-64	-64	-64.5	-62.5	-61	-63	-60.5	-64.5	-62.5	-63	-62.5	-62	-61		148
1024QAM WeakFEC	-62	-62	-60.5	-61	-58	-60	-58	-62.5	-59.5	-61	-60.5	-60	-58		157	
25	4QAM StrongFEC	-88	-88.5	-89.5	-88	-88	-88	-85	-88	-85	-88	-87.5	-87	-85		31
	16QAM StrongFEC	-82	-83	-83.5	-82.5	-81	-82	-79	-82.5	-80	-82	-81.5	-81.5	-79		62
	32QAM StrongFEC	-79	-79	-79.5	-78.5	-76.5	-78	-75.5	-78.5	-77	-78.5	-77.5	-78	-75		78
	64QAM StrongFEC	-76	-76	-76.5	-75.5	-74	-75	-73	-76.5	-73.5	-75.5	-74.5	-75	-72		104
	128QAM StrongFEC	-73	-73	-73.5	-72.5	-70.5	-72	-70	-72.5	-70.5	-72.5	-71.5	-72	-69		124
	256QAM StrongFEC	-70	-70	-69.5	-69.5	-65.5	-69	-66	-69.5	-68	-69	-68.5	-68	-66		145
	512QAM StrongFEC	-66.5	-67	-66.5	-65.5	-63	-66	-63	-66.5	-65	-66	-65.5	-64.5	-63		166
	1024QAM StrongFEC	-63	-63	-63.5	-61.5	-59	-62	-59	-63.5	-61.5	-62.5	-61.5	-61	-60		187
	1024QAM WeakFEC	-61	-61	-61.5	-59.5	-58	-58	-57	-60.5	-59.5	-60	-59.5	-59	-57		198
30	4QAM StrongFEC	-88	-88	-89	-87	-87	-87	-85	-88	-84.5	-87	-86.5	-86.5	-84		37
	16QAM StrongFEC	-82	-82	-83	-81.5	-79.5	-81	-78.5	-81.5	-79	-81.5	-80.5	-81	-78		73
	32QAM StrongFEC	-78	-79	-79	-77.5	-76.5	-77	-75	-78.5	-75	-77.5	-76.5	-77	-74		93
	64QAM StrongFEC	-76	-76	-76.5	-74.5	-74	-74	-72	-75.5	-73	-75	-74.5	-74	-71.5		123
	128QAM StrongFEC	-72	-73	-73	-71.5	-70	-71	-69	-72.5	-70	-71.5	-71.5	-71	-69		148
	256QAM StrongFEC	-69	-69	-69.5	-68.5	-67	-68	-66	-69	-67.5	-68.5	-67.5	-68	-65		173
	512QAM StrongFEC	-66	-66	-66.5	-65.5	-62.5	-65	-62	-66.5	-64.5	-65	-64.5	-64	-62		197
	1024QAM StrongFEC	-63	-62	-62.5	-61.5	-60	-61	-59	-62.5	-61.5	-61.5	-61	-60	-58		222
	1024QAM WeakFEC	-61			-60		-58	-57	-60.5	-59.5	-60.5	-59	-58.5	-56		235
	2048QAM StrongFEC	-59	-60	-60.5	-58	-56.5	-56	-54.5	-58	-57	-58.5	-57	-57.5	-54	244	
40	4QAM StrongFEC	-86.5	-87	-87	-85	-86	-85.5	-83	-86	-83	-85.5	-85	-85.5	-82		51
	16QAM StrongFEC	-81	-81	-82	-79.5	-78.5	-79	-77	-80.5	-78	-80	-79.5	-79	-77		101
	32QAM StrongFEC	-77	-77	-78	-76.5	-75.5	-76	-73	-77	-74	-76	-75.5	-75.5	-73		129
	64QAM StrongFEC	-74	-74	-75	-73.5	-71	-73	-70	-74	-72	-73	-72.5	-72.5	-70		170
	128QAM StrongFEC	-71	-71	-72	-70.5	-70	-70	-67	-71	-69	-70	-69.5	-70	-67		204
	256QAM StrongFEC	-68	-68	-68	-67	-65	-66.5	-64.5	-67	-66	-67	-66.5	-65.5	-64		238
	512QAM StrongFEC	-65	-65	-65.5	-64	-62	-64	-61	-64.5	-63	-63.5	-63.5	-63	-61		272
	1024QAM StrongFEC	-61	-61	-61.5	-60.5	-59	-58	-57.5	-61.5	-59	-60.5	-59.5	-59.5	-56.5		306
	1024QAM WeakFEC	-60			-59		-55	-55	-59.5	-57.5	-58.5	-58	-57.5	-55.5		323
	2048QAM StrongFEC	-58	-58	-58.5	-57	-54	-53	-54	-57.5	-55	-56.5	-55.5	-56	-53	336	
50	4QAM StrongFEC	-85	-86	-86	-84.5	-85.5	-85	-82	-85	-82.5	-85.5	-84	-84	-81.5	63	63
	16QAM StrongFEC	-80	-80	-80	-78.5	-78	-78	-76	-79.5	-77	-79.5	-78	-78	-76	128	130

BW, MHz	Modulation	6GHz	7GHz	8GHz	11GHz	13GHz	15GHz	17GHz	18GHz	23GHz	24GHz	26GHz	28GHz	38 GHz	Capacity, Mbps	
		Guaranteed RSL Threshold, dBm													-G modes	Legacy modes
60	32QAM StrongFEC	-76	-76	-76	-74.5	-74.5	-75	-72	-75.5	-73	-75.5	-74.5	-74.5	-72.5	163	163
	64QAM StrongFEC	-73	-73.5	-74	-72.5	-71	-72	-69	-72	-71	-72.5	-71.5	-72	-69.5	212	216
	128QAM StrongFEC	-70	-70	-71	-69	-68	-69	-66	-70	-68	-69.5	-68	-69	-66.5	254	258
	256QAM StrongFEC	-67	-67	-67	-65.5	-64	-66	-63	-66	-64.5	-66.5	-65	-65	-63	297	301
	512QAM StrongFEC	-64	-63.5	-64	-63	-61	-63	-59	-63.5	-62	-63	-62	-62	-60	339	344
	1024QAM StrongFEC	-61	-61	-60	-60	-57	-58	-56	-60	-58.5	-59.5	-58.5	-58	-56	382	385
	1024QAM WeakFEC	-59			-57		-55	-54	-57.5	-55.5	-57.5	-56	-56	-54		410
	2048QAM StrongFEC	-57	-57	-57.5	-56	-55	-53	-52.5	-56	-54	-56.5	-55.5	-55	-52	420	
	4QAM StrongFEC	-84	-85	-85.5	-83.5	-84.5	-84	-81	-85	-82	-84	-83.5	-83.5	-81	74	74
	16QAM StrongFEC	-79	-79.5	-80	-78	-77	-78	-75	-78.5	-76	-78.5	-77	-77.5	-75	149	151
	32QAM StrongFEC	-75	-75.5	-76	-74.5	-73	-74	-71	-75	-73	-74.5	-73.5	-74	-71	190	190
	64QAM StrongFEC	-72	-73	-73	-71.5	-71	-71	-69	-72	-70	-71.5	-71	-71	-69	247	251
	128QAM StrongFEC	-70	-69.5	-70	-68.5	-68	-68	-66	-69	-67	-69	-67.5	-68	-65	297	301
	256QAM StrongFEC	-66	-66	-67	-65	-64	-65	-62	-66	-64.5	-65.5	-64.5	-65	-62	347	351
	512QAM StrongFEC	-63	-63	-63	-62.5	-61	-62	-59	-62.5	-61.5	-62.5	-61	-61	-59	397	401
	1024QAM StrongFEC	-60	-59	-60	-58.5	-58	-58	-55	-59	-57.5	-58.5	-57.5	-57	-54.5	447	451
	1024QAM WeakFEC	-58			-57		-55	-53	-57	-55.5	-56.5	-55.5	-55.5	-53		474
	2048QAM StrongFEC	-56	-56	-57	-54	-54	-54	-52	-55	-53	-55.5	-54.5	-54	-51.5	491	

⁶ 2048QAM modulation is available only for Integra-G, not supported by legacy models

⁷ 1024QAM modulation with Weak FEC setting is available for legacy models or in legacy modes only

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



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