User Manual
AC9400 Intelligent optical node

59300654, Rev. 002

TELESTE

Contents

Introduction

AC9400 is an intelligent 4 output 1.2 GHz DOCSIS 3.1 compatible optical node, engineered to provide reliable performance and easy alignment.

The downstream receivers can be fed with separate signals allowing the node to act as two independent nodes, or configured for a backup operation. Upstream signals are connected to up to 4 optical transmitters via a software configurable signal routing matrix allowing various routing and backup options.

AC9400 can be equipped with an RPD lid. The connection to the RPD lid is via separate AC6430 RPD interface modules installed in return path transmitter slots 2 and 4. Analog transmitters and receivers can be used simultaneously with the RPD, either as an analog overlay or in dual node mode.

The amplifier stages are based on the latest GaN HEMT technology to ensure optimised power consumption and performance.

True plug-and-play

An intelligent automatic alignment system with a wide level control range ensures optimum operation of the AC9400 node. It replaces conventional mechanical plug-in module adjustments and laborious control of parameters.

Local configuration of AC9400 is done via its USB interface using a Windows PC or tablet equipped with CATVisor Commander software or Android mobile device equipped with Teleste Commander software. A wireless Bluetooth connection can be established with AC6901 USB to Bluetooth adapter.

AC6983 and AC6992 transponder units

AC9400 can be equipped with an optional plug-in transponder unit. The features with different transponder units are described in Table 1. See the transponder spec sheet for details.

AC9400 feature map vs transponders	None	AC6983	AC6992
Intelligent continuous adjustments	●	●	●
Local control through USB connection	●	●	●
CATVisor/HMS monitoring and control	-	-	●
DOCSIS remote monitoring and control	-	●	-
ALC with fully user programmable pilots	-	●	●
Intelligent backup functionality in both forward and return path	●	●	●
Intelligent forward path alignment	●	●	●
Intelligent return path alignment	●	●	●
Automatic forward path pilot based alignment[1)]	-	●	●
Full single button automatic alignment[1)]	-	●	●
Forward path spectrum analyser[1)]	-	●	●
Return path ingress analyser with automatic ingress control[1)]	-	●	●
Return path pilot generator[1)]	-	-	●

1) These features need to be enabled with a Product Key.

Table 1. AC9400 feature map

Installation

Housing

The AC9400 can be installed either into a street cabinet or to the outdoor environment. The fibre node should be installed vertically so that the external cable connectors and ventilation hole are underneath, securing the housing with three mounting brackets. When positioning the fibre node in its final location, make certain that it has adequate ventilation on all sides. In particular, it is necessary to provide at least 150 mm of room above the fibre node for air circulation. Figure 1 depicts for the positions of mounting brackets as well as other installation dimensions.

AC9400 is equipped with an easy removable lid. The lid opens with the hinges to the left. The open cover can be removed by first opening the lid into a 90 degrees angle and then lifting it off the hinges. Before closing the lid it should be checked that:

- nothing is trapped between the lid and the case
- all case gaskets are intact and in their correct positions
- lid seats evenly on the rubber gasket

Using a 4 mm Allen key, the lid retaining bolts are fastened in a diagonal sequence with a tightening torque of 3 Nm. The class of enclosure is IP54 when correctly installed and tightened.

NOTICE: IP54 type enclosure - This enclosure provides protection from airborne dust and light sprays or splashing water from all directions.

Node housing should be grounded using a copper conductor of least 4 mm^2 cross section area from proper earth to the housing ground lug. Proper grounding will improve protection from the effects of interference and thus increase the overall reliability of the system.

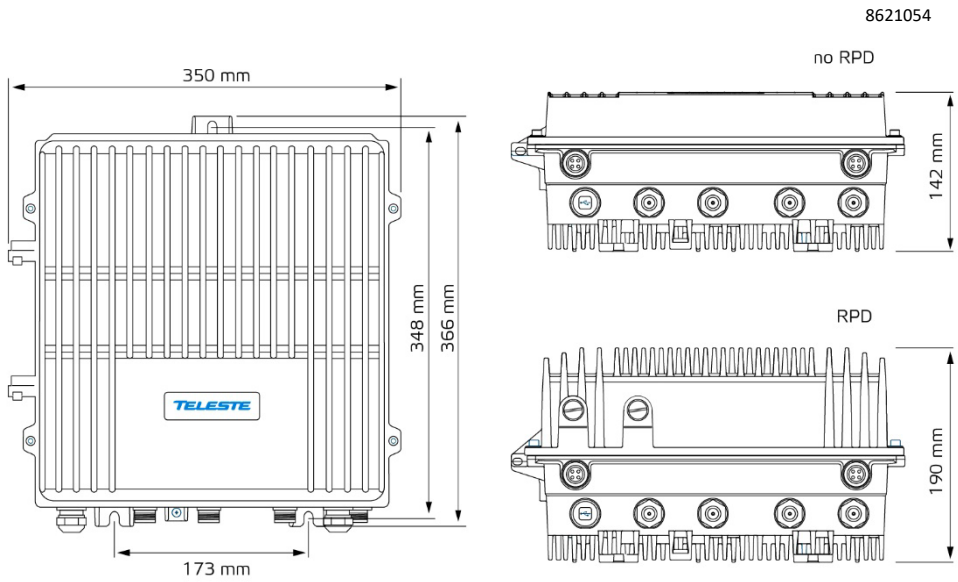

Figure 1. AC9400 housing dimensions – top and side view

Interfaces

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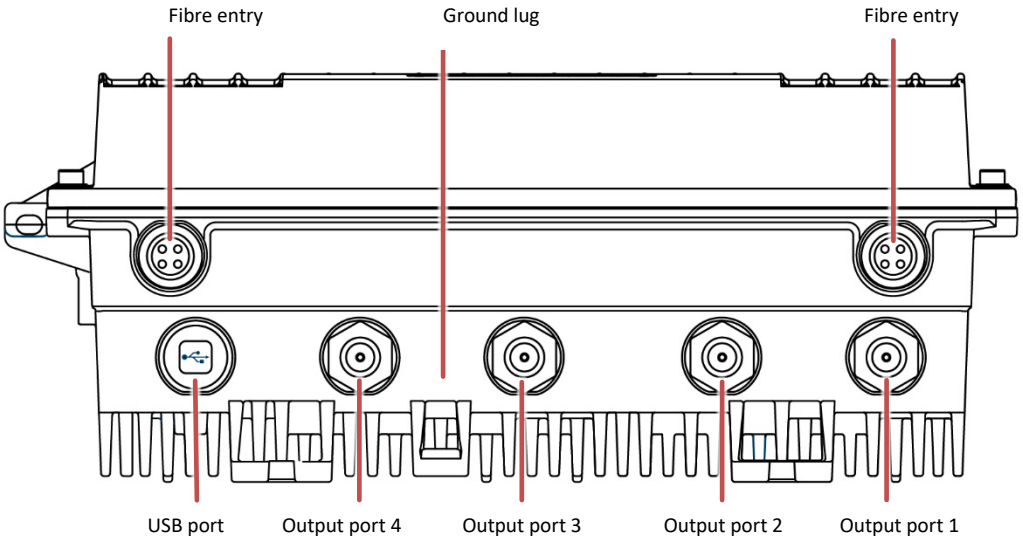

Figure 2. Port locations

The AC9400 node has six dedicated cable connection points: two inputs for fibre entries and four coaxial RF outputs. In addition, there is a port for the USB management interface.

Unused RF ports should have their AC voltage fuses removed and terminated with appropriate 75-ohm termination resistor for correct operation

All coaxial outputs have a standard PG11 thread and they accept any KDC type adapter or connector. A suitable length for the centre conductor pin is approximately 20 mm (Figure 3). Screw the KDC connector/adapter body into the port. Tighten the centre conductor seizure screw and torque to 0.7 Nm. Do not overtighten.

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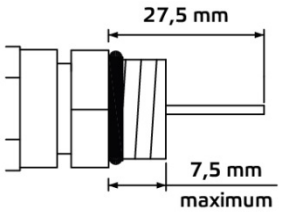

Figure 3. Centre conductor length

Transponder

Transponder units can be used for remote management and monitoring purposes. AC9400 is compatible with two transponders; AC6983 DOCSIS transponder and AC6992 CATVisor / HMS transponder. The transponder modules are illustrated below (front panel).

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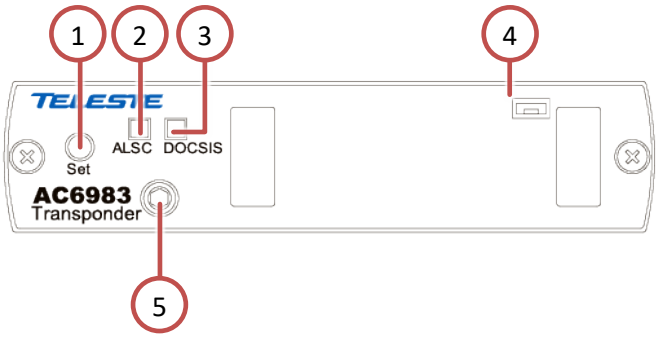

Figure 4. AC6983 DOCSIS transponder unit, 1) "Set" -button, 2) Indicator for ALSC status, 3) Indicator for DOCSIS status, 4) Ambient light sensor, 5) Fastening bolt

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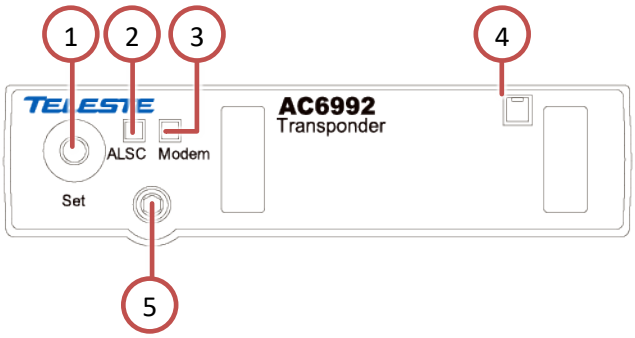

Figure 5. AC6992 transponder unit, 1) "Set" -button, 2) Indicator for ALSC status, 3) Indicator for modem status, 4) Ambient light sensor, 5) Fastening bolt

To install a transponder unit, first locate the correct installation position. Snap off the segments of the shrouds break-away type slot cover and remove the slot cover. Insert the unit by pressing it gently into place. The unit will fit only in one orientation. Finally tightly fasten the mounting bolt with a tightening torque of 1.2 Nm to ensure proper grounding and cooling, using 3 mm Allen key. There is no need to switch off the supply voltage during module installation.

AC6983 transponder receives its forward path DOCSIS signal via RF output 3. Port 3 disabling does not affect DOCSIS transponder communication, as output 1 signals are then automatically used for communication.

Fibre connections

The node accepts up to eight fibre cables. These fibres carry forward path and return path optical signals. When feeding the optical cable into the node a PG11 threaded feed-through adapter type KDO900 is available.

KDO900 adapter and fibre fitting

Remove the outer ring of the cable gland, thread the installation fibre filaments with connectors through the outer ring (Figure 6 pos. 3), through the sealing insert (Figure 6 pos. 2) and finally through the cable gland (Figure 6 pos. 1).

Mount the cable gland on the housing. The fibre filament length inside the fibre organiser is adjusted to sufficient measurement before tightening the outer ring.

Use the synthetic locking pins (supplied) to seal up unused holes in the sealing insert.

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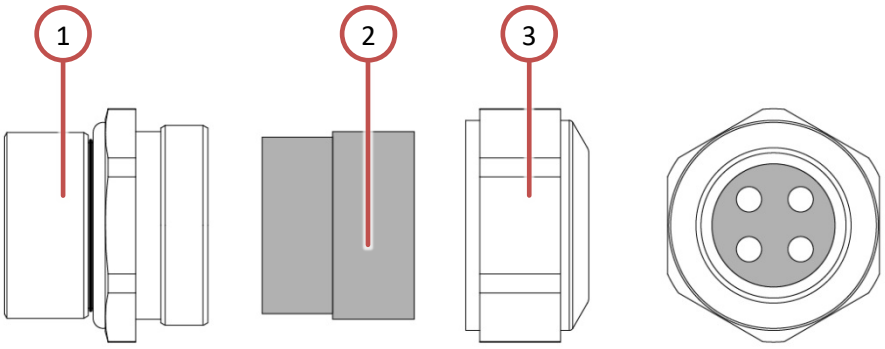

Figure 6. KDO900 adapter components

Remote PHY Device (optional)

AC6440 is a replacement lid for AC9400 node with a built-in Remote PHY Device (RPD) module. The AC6440 RPD module lid provides DOCSIS© remote PHY functionality to Teleste AC9400 node. New AC9400 devices can be equipped with a AC6440 RPD module lid as a factory installed product option, or it can be installed later on as an upgrade to existing AC9400 nodes.

AC6440 RPD module lid includes:

- A management tray and track
- AC6430 RPD connection modules (connect control bus, downstream and upstream signals between RPD module and motherboard)
- RPD module (AC6440 RPD module has one downstream signal segment and, depending on configuration, either one or two upstream signal segments)
- Power supplies (single or dual power supplies for the RPD, configuration varies)

The RPD module is designed to meet the CableLabs Remote PHY specifications. This enables interoperability between different CCAP vendors core solutions without requiring specialized development or back office upgrades. The AC6440 supports full DOCSIS 3.1 spectrum in downstream and upstream directions allowing maximum of 6 OFDM- and 2 OFDMA-channels per RF-port. Depending on configuration, AC6440 includes single or dual power supplies for the RPD.

AC6440 RPD module lid block diagram

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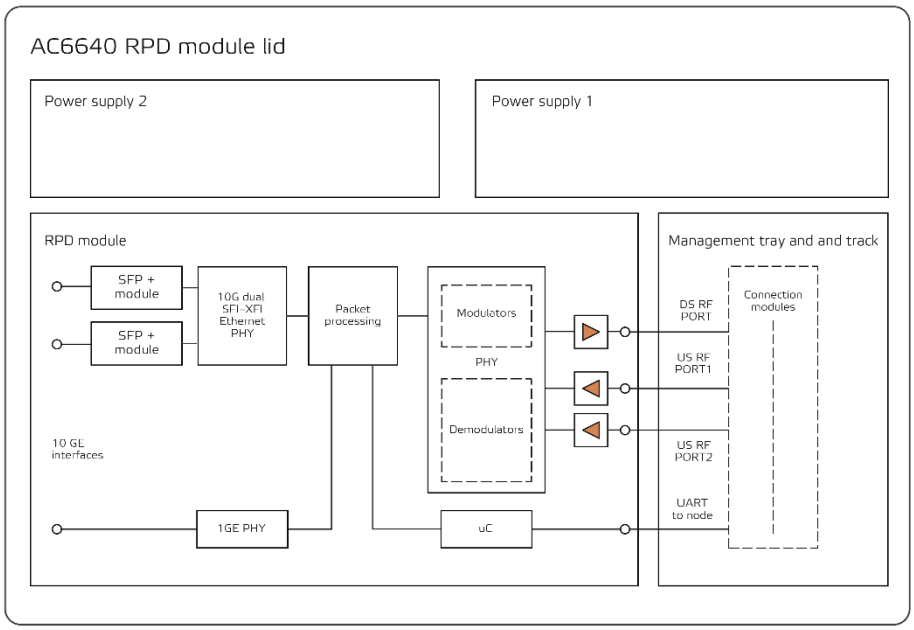

Figure 7. AC6440 RPD module lid block diagram

RPD module

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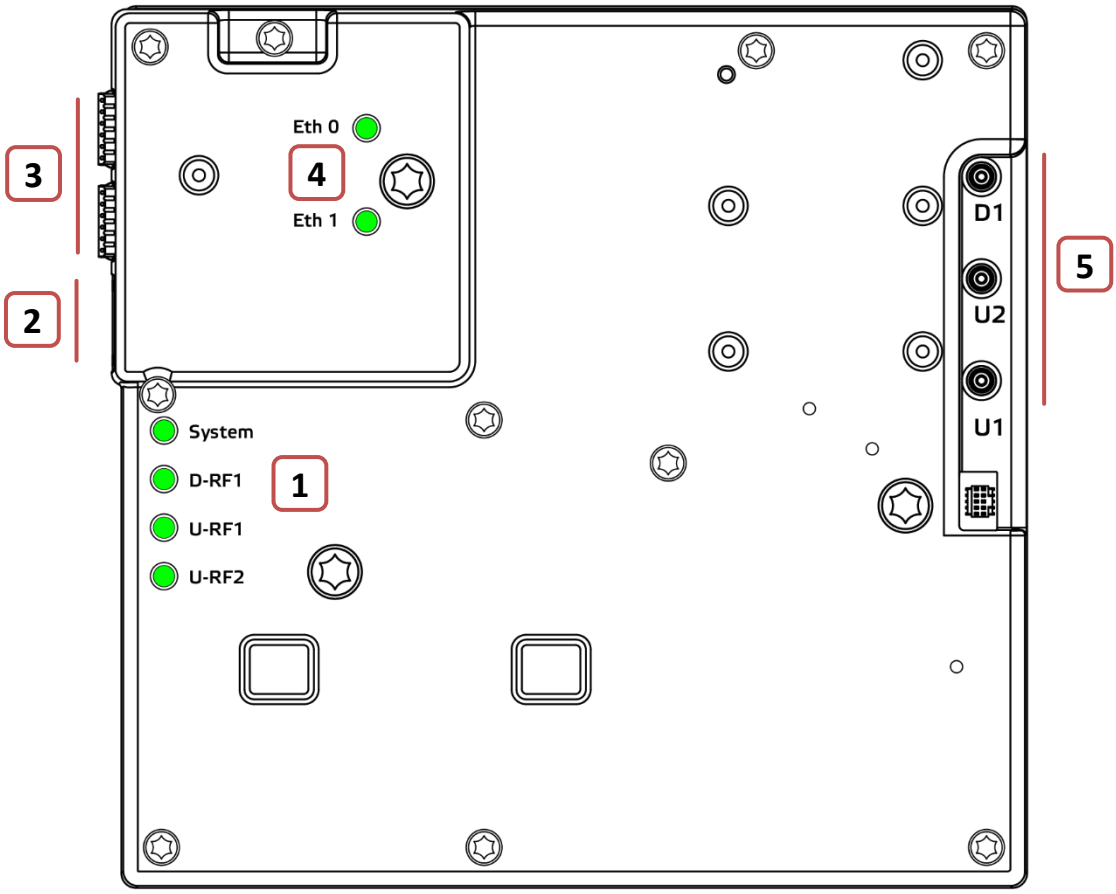

Figure 8. RPD module,
1) RPD status LEDs, 2) 1GE local management port, 3) 10GE SFP+modules,
4) 10GE Status LEDs, 4) Downstream & Upstream RF connectors

The RPD module has two 10G Ethernet ports labelled as Eth0 and Eth1. These ports support SFP+ modules for fibre connection. The Eth0 port is used to connect fibre from RPD to CCAP Core. The Eth1 port is be used for daisy chain or redundancy features.

Additionally, the RPD module has a local 1GE port for monitoring and troubleshooting purposes if remote connection to the RPD fails or if the field-technician needs to connect directly at the installation site. The local management port is disabled by default, but can be enabled via software.

NOTE: Refer to the separate **RPD user manual** for a setup guide and **RPD product specifications** for more technical details.

SFP+ modules

The optical Ethernet link connectivity is based on enhanced small form-factor pluggable (SFP+) 10 GE transceivers. The enhanced small form-factor pluggable (SFP+) 10 GE transceiver is a hot-swappable input/output device that can be plugged into the SFP receptacle on the RPD module.

Note that the SFP+ modules are not compatible with the regular SFP modules. Ensure that you are using SFP+ modules at each end.

The RPD module ICON6440 has two 10 GbE SFP+ ports to provide backhaul connectivity to the CCAP Core; the second slot is reserved for future SW and can be used for path redundancy or daisy chaining.

Installing SFP+ modules

Unmated fibre optic connector end faces must be protected from contamination using suitable dust caps. Contamination of fibre end faces will reduce the performance of the optical fibre or damage the end faces when mating and could ultimately cause failure of the system.

The SFP+ transceiver module has a bale-clasp latch that makes easier to install or remove the module. Protect the SFP+ module by inserting a clean dustplug into the module after you remove the fiber cable. Be sure to clean the optic surfaces of the fiber cable before you plug the cable into another module.

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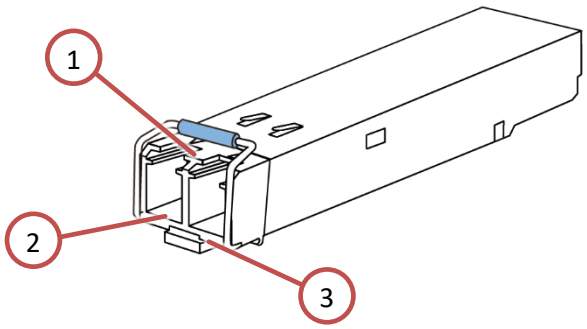

Figure 9. SFP+ module,
1) Bale clasp, 2) Transmit optical bore, 3) Receive optical bore

To unplug and plug-in the SFP+ module, follow these steps

1) Open the bale clasp on the SFP+ module by pressing the clasp downward until it is in a horizontal position.
2) Use a small flat-blade screwdriver or other long, narrow instrument to push on the hinge pin to unlock the SFP+ cage latch.
3) Grasp the SFP+ module by the bale clasp and gently pull it out of the SFP cage.

To plug-in the module:

4) Orient the transceiver with the bale clasp on the bottom, close the bale clasp by pushing it up over the transceiver, then gently insert the transceiver into the port until it clicks into place.

Cleaning the fibre adapters and connectors

Always clean and inspect fibre adapters and connectors before connection. Keeping fibre optic end-faces clean is extremely important and one of the most critical requirements for ensuring proper operation.

We recommend to use only industry approved methods, materials, and solutions for cleaning optical connectors. There are a few simple, effective products that are specifically designed for cleaning fibre adapters and connectors quickly and without the need for solvents.

Invisible or visible laser radiation may cause eye injury. Do not remove the dust plugs from the SFP+ module or dust caps from the optical fibre cables until you are ready to connect the cables.

Optical modules

The AC9400 analog optical receivers are integrated on the motherboard and accept both 1310 and 1550 nm wavelength optical inputs. Receiver 2 is enabled via software Product Key, which can be installed in the factory according to the order, or later by the user. This makes it possible to order AC9400 with only one optical receiver enabled and enable the second receiver later.

Optical return transmitters

The housing has slots for four return path transmitters, but it is possible to order the AC9400 with any number of transmitters installed. For signal routing reasons, a single transmitter should be installed into slot 1. Two transmitters go into slots 1 and 2 or 1 and 3, depending on the desired signal routing and backup functionality, see "Return path" chapter for details. Three transmitters go into slots 1, 2 and 3.

When RPD lid is installed, its two AC6430 connection modules must be installed into slots 2 and 4. If optical return transmitters are also needed, they can be installed into slots 1, 3, or both, depending on desired signal routing.

There are a variety of options for transmitter modules available for the return path applications of ACcess platform (AC67 Tx). The return path transmitters are available either in 1310 nm or 1550 nm DFB versions. In addition, the platform can be equipped with CWDM transmitters. The CWDM lasers deploy eight wavelengths in range of 1470…1610 nm. The wavelength and optical output power are marked on the product label.

CAUTION! This unit employs a laser. Due to the invisible laser radiation, all necessary safety instructions must be followed during the installation and maintenance operations. In a properly closed system, the normal operation of these components does not cause any radiation danger. The safety requirements for class 1M lasers are detailed in EN60825-1.

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Figure 10. AC67B Optical transmitter with integrated fibre organiser, 1) Retaining screw, 2) Product label

To install AC67 Tx optical unit, first locate the correct installation position. Insert the unit by pressing it gently into place. The unit will fit only in one orien-

tation. Finally, using a 3 mm Allen key, fasten the mounting bolts with a tightening torque of 1.2 Nm. There is no need to switch off the supply voltage during module installation.

NOTE that optical units shouldn't be installed or removed while the unit is powered via USB only.

Powering

NOTICE: To reduce the risk of electric shock, do not remove the shielding cover of the power supply unit if it is connected. All electrical installations must be carried out by authorised and competent technicians in accordance with the national or regional electrical regulations.

Common precautions:

- The AC9400 node is intended for installation in restricted access locations (dedicated equipment rooms, equipment closet or similar).
- Operate the device only on the specified supply voltage.
- The AC9400 must never be operated without its power supply unit shielding cover.
- The AC9400 has no separate power switch so the power plug must be easily accessible.
- Disconnect the power cord by the connector only. Never pull on the cable part of the power cord.
- Do not place or drop heavy or sharp-edged objects on the power cord.
- The power must be disconnected when installing or removing the AC9400.

Additional safety requirements for Norway and Sweden:

- Equipment connected to the protective earthing of the building installation through the mains connection or through other equipment with a connection to protective earthing and to a cable distribution system using coaxial cable, may in some circumstances create a fire hazard. Connection to a cable distribution system must be provided through a device providing electrical isolation below a certain frequency range (galvanic isolator, see EN 60728-11).

Français (French) - Mise sous tension

AVERTISSEMENT: Afin de réduire le risque de choc électrique, ne retirez pas le couvercle de protection de l'unité d'alimentation si celle-ci est branchée. Toutes les installations électriques doivent être effectuées par des techniciens agréés et compétents conformément aux réglementations nationales ou régionales en vigueur en matière d'installations électriques.

Précautions d'usage:

- L'amplificateur AC9400 est conçu pour une installation dans des emplacements d'accès restreint (locaux techniques dédiés, armoires techniques ou emplacements similaires).
- Utilisez l'appareil uniquement avec la tension d'alimentation indiquée.
- Ne faites jamais fonctionner l'AC9400 avec le couvercle de protection de l'unité d'alimentation retiré.
- L'AC9400 n'a pas d'interrupteur d'alimentation distinct. La fiche d'alimentation doit donc être facilement accessible.
- Débranchez le cordon d'alimentation par le connecteur uniquement. Ne tirez jamais sur le câble du cordon d'alimentation.
- Ne déposez pas et ne faites pas tomber d'objets lourds ou tranchants sur le cordon d'alimentation.
- L'alimentation doit être coupée lors de l'installation ou du retrait de l'AC9400.

27...65 V AC/ 35…90 V DC:

The supply voltage (27...65 V AC / 35...90 V DC) of the remote powered AC9400 is supplied via a coaxial cable by inserting a fuse to the corresponding fuse holder or directly at the external input. The external input is located on the power distribution board at the upper right corner of the node. External power can also be fed through the node into the network. Maximum feed-through current is 7 A per port (12 A total). If powering will be provided through a dedicated output port, the port must be equipped with a fuse. On delivery, RF ports are provided with fuses (MINI Auto Fuse F15A/32V, BLUE, 10.9 x 3.8 x 16.3).

The PSU can work alone, or it can be operated parallel to split the work load and create the redundancy system for internal power feeding

Cable gland at external input

The cable gland assembly provides the necessary protection against the ingress of solid objects and moisture as well as providing cable retention.

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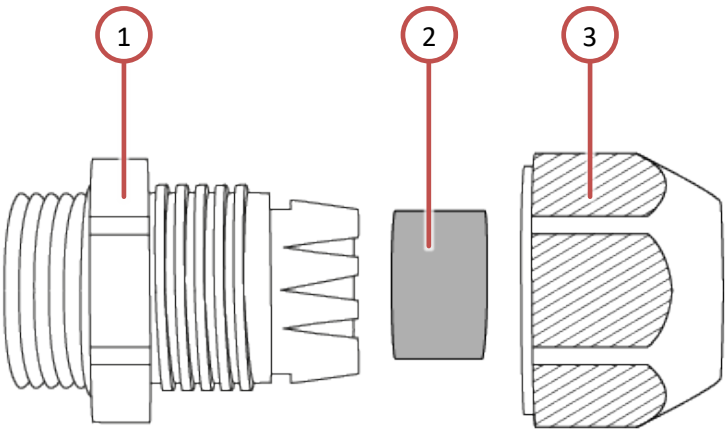

Figure 11. Cable gland components

Strip the cable sheath of the supply cord with a suitable length to suit the equipment and pass it through gland nut (3), seal (2) and plug body (1). Place appropriate conductors into plug pin housing assembly terminals and tighten screws to secure bared conductors and ensure good electrical contact. Screw the plug body tight onto the node housing to ensure that the IP rating is maintained. Position the end of the cable sheath in line with the plug body and tighten the gland nut.

Installing the PSU

Note that the electrical installation must be carried out in accordance with the current national electrical regulations by a competent person.

To gain access to PSU retaining screws, first remove the protective shroud. The primary PSU of AC9400 must be installed into the first place (closest to the hinges). Remove and retain the hexagonal spacers.

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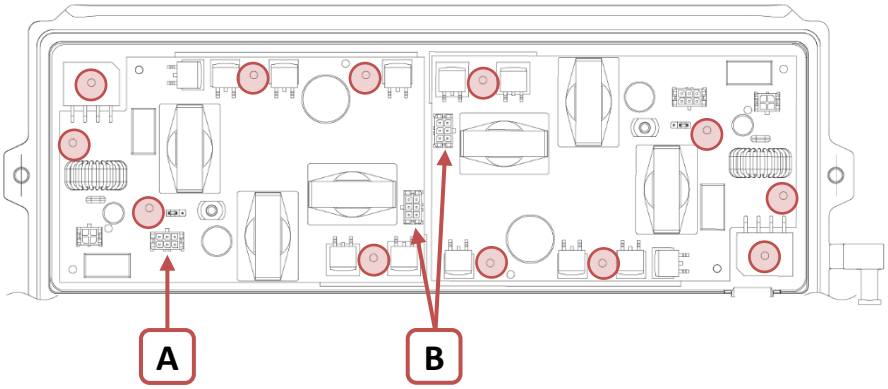

Figure 12. PSU installation - position of securing screws and wiring connections

Use the silicon elastomers (Figure 10 pos. A) between the PSU and the heat sink brackets. When the unit is in position tighten the retaining screws and hexagonal spacers to a torque of 1.2 Nm.

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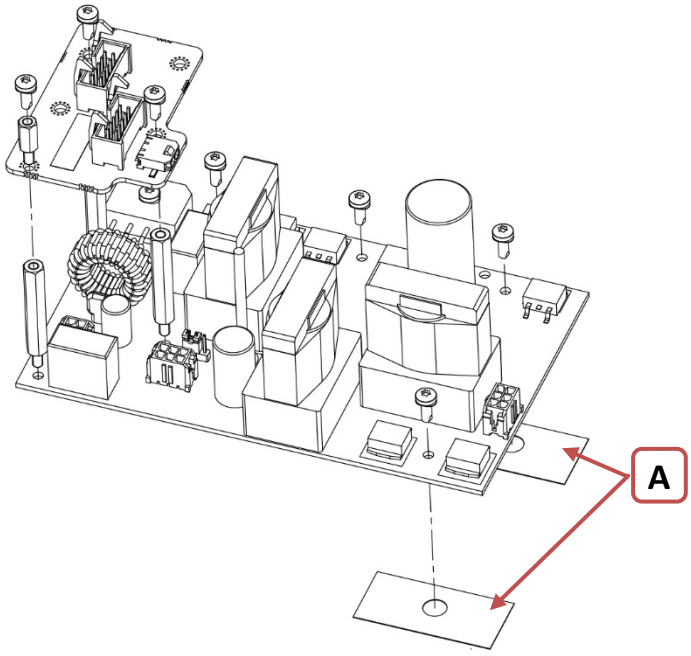

Figure 13. PSU mounting screws (A), and silicon elastomers (B)

Connect the power cable from the primary PSU to the motherboard (Figure 9 pos. A). Back-up PSU requires additional power connection from the primary power supply. Locate the 6-pin connectors and attach the supplied ribbon cable to connect the PSUs (Figure 9 pos. B).

Primary and back-up power supplies are physically identical. Their functional differences are controlled by a jumper. See (Figure 11) for locations of the jumper pins. The jumper specifies which of the PSU output voltages is shown via user interface as primary PSU1 “+24V #1” or back-up PSU2 “+24V #2”.

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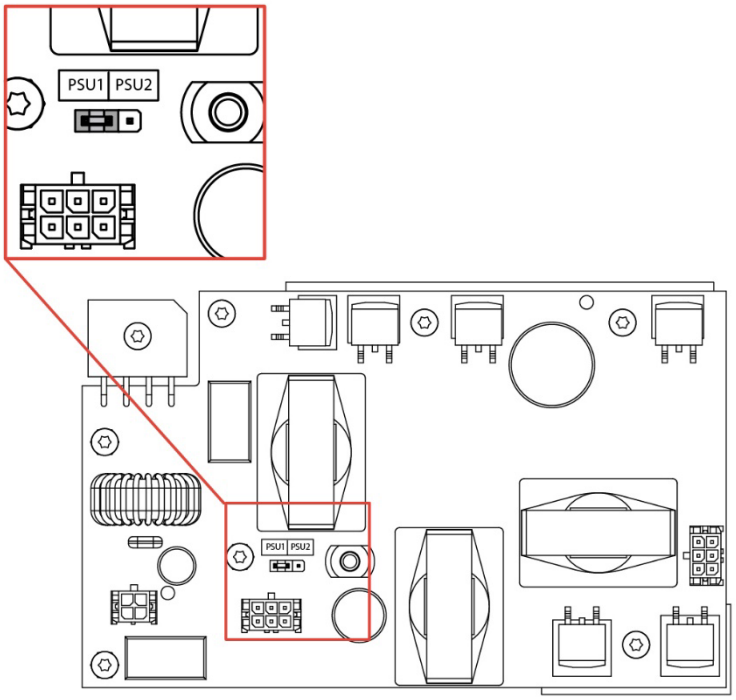

Figure 14. PSU jumper setting

After PSU installation carefully refit the shroud in the reverse order of removal. Connect the power source. The led on the PSU circuit board indicates that the unit is powered up and that the DC power supply voltage is present.

Fibre installation

Fibre installation is a critical procedure and it should be done with carefulness. Incorrect handling of the fibres can result in damage and degraded performance.

WARNING! The laser light source on this equipment (return transmitter) or the fiber cables connected to this equipment emit invisible laser radiation. Invisible or visible laser radiation may cause eye injury when viewed through magnifying optics with large apertures: never look into an open optical connector with optical instruments, such as loupes, magnifiers, microscopes! Avoid direct exposure to the laser light source. Do not apply power to this equipment if the fiber is unmated or unterminated.

Cleaning the fibre adapters and connectors

Keeping fibre optic end-faces clean is extremely important and one of the most critical requirements for ensuring proper operation.

When fibre optic connectors are unmated, the optical fibre end faces must be protected from contamination using suitable dust caps. Contamination of fibre end faces will reduce the performance of the optical fibre and could ultimately cause failure of the system. Contamination could also damage the fibre end faces when the connectors are mated. Always inspect and clean fibre adapters and connectors before connection.

Always clean and inspect fibre adapters and connectors before connection. Keeping fibre optic end-faces clean is extremely important and one of the most critical requirements for ensuring proper operation.

We recommend to use only industry approved methods, materials, and solutions for cleaning optical connectors. There are a few simple, effective products that are specifically designed for cleaning fibre adapters and connectors quickly and without the need for solvents.

Invisible or visible laser radiation may cause eye injury. Do not remove the dust plugs from the SFP+ module or dust caps from the optical fibre cables until you are ready to connect the cables

Fibre management

The fibre tray provides means for terminating outside plant cables and fibre optic terminal fibres. The fibre tray is hinged to the chassis of the node and swings outwards to provide access for connecting installation fibre filaments (external fibre optic cables) and fibre pigtails (ACcess units).

Fibre tray together with fibre organiser modules are used to provide a convenient splicing and storing location for fibre pigtails. Connectors and adapters are held in place in the fibre tray by universal type holders ensuring compatibility with a variety of existing connectors and adapters. Fibre organiser modules are stackable and are secured to each other using a latching arrangement. Referring to Figure 12 the topmost fibre organiser module can be equipped with a lid for further fibre protection.

When installing optical units positioned on the right-hand side of the node gently wind the fibre pigtails onto the left fibre organiser module and around the right fibre organiser module for optical modules installed on the left hand side of the node.

Be sure to leave sufficient slack for the pigtails to permit closing or opening the termination tray without damaging fibres. Ensure that no fibres are pinched while the tray or lid is closed.

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Figure 15. Routing fibres

Front panel

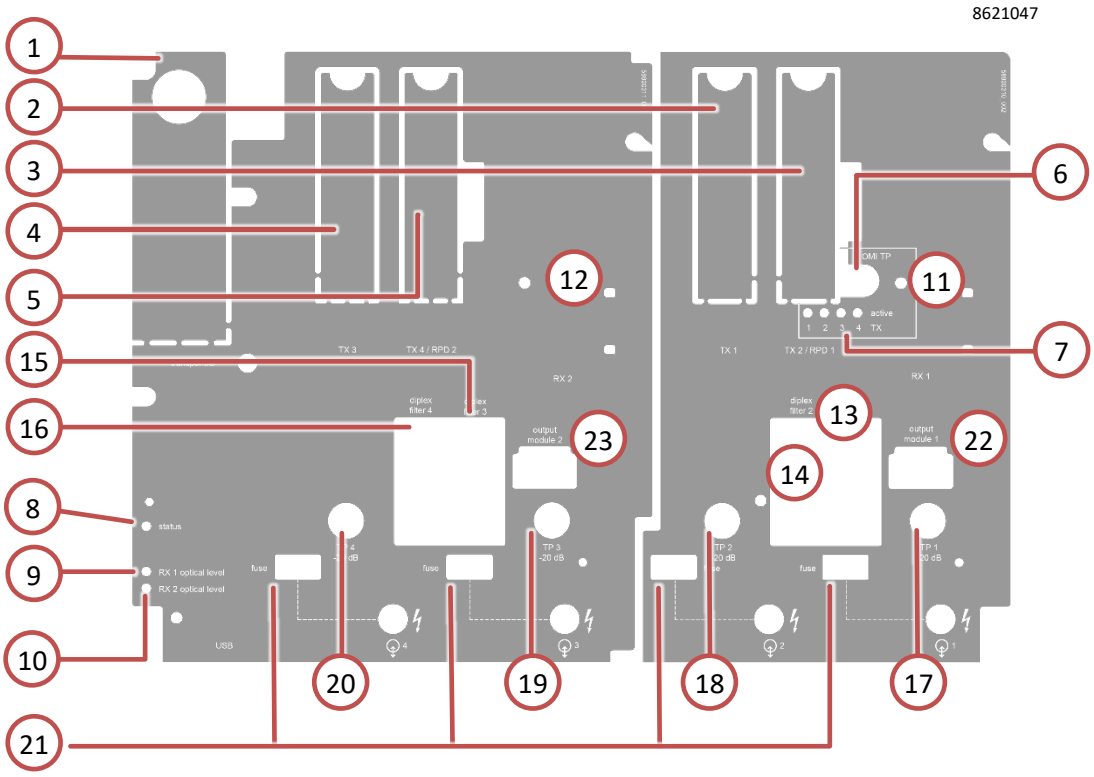

Figure 16. AC9400 front panel

1) Transponder
2) Optical transmitter 1
3) Optical transmitter 2 / RPD connection module
4) Optical transmitter 3
5) Optical transmitter 4/ RPD connection module
6) OMI test point
7) Active OMI test point indicator leds
8) Status indicator led
9) Optical receiver 1 power indicator led
10) Optical receiver 2 power indicator led
11) Fibre connector for optical receiver 1
12) Fibre connector for optical receiver 2
13) Output 1 diplex filter
14) Output 2 diplex filter
15) Output 3 diplex filter
16) Output 4 diplex filter
17) Output 1 test / injection point -20 dB directional coupler
18) Output 2 test / injection point -20 dB directional coupler
19) Output 3 test / injection point -20 dB directional coupler
20) Output 4 test / injection point -20 dB directional coupler
21) Fuses
22) Output module 1
23) Output module 2

Features

Diplex filter modules

The installed diplex filters must be new 1.2 GHz types which are automatically detected by the software. The supported diplex filter types are CXF065 (65/85 MHz), CXF085 (85/108 MHz) and CXF204 (204/258 MHz) and their high-pass versions (with "18/19" and "10" extensions). Although not required, it is a good practice to install diplex filters also in unused outputs together with output termination resistors for correct operation.

Diplex filters are automatically recognised by the software. This information is used for controlling forward path low pass filtering and return transmitter bandwidth selection, which is set according to the highest frequency detected filter for all transmitters. The "Unknown module" alarm is activated if a required diplex filter is not installed, its type cannot be detected or diplex filter types mismatch with each other.

Note that there are some special versions of the diplex filters, e.g. “CXF065 DA4” and “CXF204 UA6” which have built-in forward or return path attenuation or return path high-pass filtering. These diplex filters are detected as normal CXF065 / CXF204 respectively and the built-in attenuation is thus not taken into account in forward or return path automatic alignment. If these diplex filter types are used, their effect must be taken into account manually.

Output modules

Output module 1 controls signal splitting between outputs 1 and 2, and output module 2 controls signal splitting between outputs 3 and 4.

The output modules must be the new models which are automatically detected by the software, see Table 2. If an output module is missing or unsupported type is detected the “Unknown module” alarm is set.

When output 3 is disabled via software, also output 4 is turned off and output module 2 does not need to be installed.

Module	Functionality	Output 1/3	Output 2/4
AC6120	0 dB output module, one output in use	0 dB	not used
AC6113 *)	2/8 dB tap, 2 outputs in use	-2 dB	-8 dB
AC6114 *)	2/12 dB tap, 2 outputs in use	-2 dB	-12 dB
AC6115 *)	1/16 dB tap, 2 outputs in use	-1 dB	-16 dB
AC6117 *)	2/10 dB tap, 2 outputs in use	-2 dB	-10 dB
AC6124 *)	Two-way splitter, 2 outputs in use	-4 dB	-4 dB

Table 2. Output modules with corresponding nominal attenuation values
**) Old (pre-2020) versions of these modules are not detected correctly.*

Automatic alignment

AC9400 automatic alignment can perform several tasks during the installation or at a later stage of AC9400 lifecycle by just pressing a single button. The automatic alignment allows true plug-and-play installation and can be user configured to the finest detail already at factory.

The automatic alignment has to be enabled with a Product Key. It can run the following tasks when started with transponder "Set" button or via UI software:

- **Run forward path pilot based alignment** (default: enabled). The forward path gain and slope are aligned based on measured pilot levels and preconfigured pilot settings. ALC is enabled. Requires a transponder to be installed.
- **Run return path intelligent alignment** (default: enabled). The return path is aligned based on preconfigured OMI and input level values.
- **Set reserve pilot target level to measured value** (default: disabled). Reserve pilot measurement value is stored as target value. Requires a transponder to be installed.
- **Set interstage gain minor alarm limits** with user specified offset to current value (default: disabled, ±3 dB). Major alarms are not affected. After this the unit will alarm if the interstage gain control has been changed by ALC too much since installation, indicating a potential problem in input signal levels.
- **Set optical input power reference to measured** value (default: enabled). The unit memorises the measured optical input power during installation, which can be later used to track changes in optical input power, possibly indicating potential problems in the network.
- **Set optical input power minor alarm limits** with user specified offset to measured input power (default: enabled, ±2 dBm). Major alarms are not affected. After this the unit will alarm if the measured optical input power has changed too much since installation, indicating a potential problem in the optical link.
- **Set remote AC supply voltage minor alarm limits** with user specified offset to measured value (default: disabled, ±5 Vrms). After this the unit will alarm if the remote AC supply voltage has changed too much since installation, indicating a potential problem in remote powering.
- **Disable further automatic alignment (**default: disabled). Activated ~5 minutes after automatic alignment has completed successfully. After this the automatic alignment cannot be restarted without first activating it via UI software.

During the automatic alignment the transponder "ALSC" led will change colours fast. When the alignment has completed, the led blinks for 5 s according to the result (see below) and then returns to its normal status.

- **Red blink**: Forward path could not be adjusted properly due to e.g. missing optical power, incorrect pilot settings or missing pilot signal. No further tasks are run.
- **Yellow blink**: Forward or return path could not be adjusted properly due to missing gain / slope adjustment range. Best effort adjustment is made and the rest of the tasks are run. User should check the resulting adjustment.
- **Green blink**: Automatic adjustment completed successfully.

Detailed status information is available when the automatic alignment has been started via the UI software.

Forward path

The input and output amplifier stages are both based on high performance solutions which allow the user to set AC9400 outputs to high and low output levels. Note that AC9400 must have a proper matching at output port to ensure optimal and reliable operation.

The performance and power consumption of the RF stages can be adjusted according to the RF load and output level.

Optical receivers

Optical receivers are integrated on the motherboard. Their optical input power is measured and monitored. The optical input power low major alarm limits are used also in backup switching logic.

Optical receiver 2 is enabled via Product Key. If it is not enabled, its optical input power is still measured but not monitored, and its RF stages are shut down. The routing and backup settings should be configured accordingly, i.e. they are independent of the optical receiver 2 enabling.

Both optical receivers can be independently disabled via the user interface. Disabled optical receiver's input power is still measured but alarms are not generated. Disabling can be used e.g. when AC9400 is used as a pure RPD node.

RPD forward path signals

RPD signals are received from RPD lid via AC6430 RPD connection modules installed into optical transmitter slots 2 and 4 and combined with optical receiver 1 signals before the routing matrix. The balance between RPD signals and optical receiver signals can be adjusted with "RPF offset" and "OLC offset" parameters.

Forward path signal routing and backup

Forward path signal routing and backup modes can be configured independently of return path routing and backup configuration.

AC9400 supports three forward path signal routing modes:

- **Dual node**: Receiver 1 (and RPD, if installed) signals are routed to output 1 (and 2, depending on installed output module 1). Receiver 2 signals are routed to output 3 (and 4, depending on installed output module 2).
- **Rx 1 only**: Receiver 1 (and RPD signals are routed to all enabled outputs.
- **Rx 2 only**: Receiver 2 signal is routed to all enabled outputs.

Forward path backup can be set to three modes:

- **No backup**: The selected signal routing mode stays the same even if the optical input power is missing. This mode should be used when RPD lid is installed.
- **Automatic**: If a receiver is in use and its optical input power is below low alarm limit, and a second receiver is enabled and its optical input power is above low alarm limit + deadband, then the signal from the second receiver is routed to all outputs. When the failed receiver's optical input power is above low alarm limit + deadband, the original routing is restored.

- **Automatic with manual restore**: Identical to "Automatic" mode, except that original routing is not restored automatically. The user has to select "No backup" and then "Automatic with manual restore" again to restore the original routing.

Forward path level control

AC9400 has three gain control elements in its both forward path signal paths:

1) **Input gain** control in the optical receiver, always controlled automatically by OLC based on the measured optical input power and user-specified OMI % and "OLC offset" parameters.
2) RPD gain control in AC6430 RPD connection module, controlled manually via the "RPD offset" parameter.
3) **Interstage gain** control, controlled manually or by ALC. Adjustable in 0.1 dB steps between -15 and 0 dB.

The forward path gain control elements and thus the resulting forward path output level can be controlled with two adjustment methods:

1) **ALC off**: Interstage gain can be adjusted by the user. The software adjusts input gain based on the measured optical input power so that node performance is optimised.
2) **ALC on**, available with transponder: The software adjusts input gain based on the measured optical input power and interstage gain based on measured pilot levels.

Forward path slope control

Forward path slope is adjusted with separate controls for both signal paths, adjustable in 0.5 dB steps between 0 and 20 dB.

Slope is always in user control regardless of the selected adjustment mode.

OMI %, OLC offset and RPD offset

The "OMI %" parameter specifies the OMI % (Optical Modulation Index) used in the optical transmitter connected to AC9400's optical receiver(s). It is used by OLC in adjusting the input gain and needs to be correct for optimal RF performance.

The “OLC offset” parameter value is added to the optical receiver input gain value calculated from optical input power and can thus be used to adjust the balance between input and interstage gain controls. In hybrid RPD mode it can also be used for aligning the level of signals received via optical receiver 1 to the RPD signal levels.

OLC offset default value is 0 dB. If necessary, it can be adjusted in 0.5 steps between -15 dB and +5 dB manually, or by the pilot based automatic alignment or intelligent alignment to optimise RF performance.

Note that non-zero OLC offset values (and also OMI % values below 4 %) can cause OLC operation range to change by half of OLC offset value. For example: OLC operation range starts normally from -8 dBm, but with +2 dB OLC offset the OLC operation starts from -7 dBm.

The "RPD offset" parameter adjusts the RPD signal levels before combining with optical receiver 1 signals. Its default value is 0 dB and it is adjustable in 0.5 dB steps between -15 and +3 dB.

Both "OLC offset" and "RPD offset" parameters are adjusted by pilot based automatic alignment to achieve target levels. If they are adjusted manually, it is typically best to keep them close to 0 and avoid large positive values to prevent overloading the amplifier stages.

Power save

The RF performance and power consumption of AC9400 can be adjusted by controlling the output hybrids' current. The idea in this adjustment is that the node doesn't have to be better than the optical transmission path.

Power save is disabled as factory default. This ensures full performance and should be used if output levels are close to maximum. If output levels are more than 3 dB below maximum levels power save can be enabled without effect on RF performance. For example, with a full 1.2 GHz digital load and 8 dB sloped output without output splitting, this decision level is approximately 109 dBµV.

With the RPD it is also possible to set power save to automatic mode. In this mode AC9400 automatically adjusts the RF performance and power consumption based on the gain and slope settings and the channel loading information received from RPD lid. The automatic adjustment does not include signals received via the optical receiver.

Output 3

Output 3 can be disabled by the user. This turns off the output hybrid and saves power. Note that this also disables output 4.

When output 3 is disabled, the pilot and spectrum analyser measurements for output 3 give results that are measured from output 1. Thus it is usually a good idea to also disable pilots and spectrum analyser for output 3.

When output 3 is disabled, AC6983 DOCSIS transponder internally reroutes signal from output 1 for communication. This rerouted signal has a slightly lower level compared to normal AC6983 forward path signals and can cause remote communication loss if very low output levels are used.

Outputs 2 and 4

Outputs 2 and 4 are controlled with the plug-in output modules. See "Output modules" chapter for more information about the supported output module types.

When in use, output 2 and 4 levels follow outputs 1 and 3, respectively, with the fixed level offset determined by the installed output module type.

Pilots and ALC

Pilot measurements and ALC are supported by AC6983 and AC6992 transponders.

AC9400 uses the transponder RF level measurement unit to sequentially measure signal levels of output 1 and output 3 at user defined pilot frequencies and, if enabled, also the forward path spectrum and return path ingress frequencies. The measurement is done using narrow bandwidth (see transponder spec sheet) and then adjusted for the selected detector type and signal bandwidth.

Pilot measurements support 4 detector types:

- **Analog:** Peak detector optimised for CW or modulated analog signals.
- **EU QAM**: Averaging detector optimised for European QAM signals.
- **US QAM**: As “EU QAM” but accounts for the different channel bandwidth of American QAM signals.
- **OFDM**: As “EU QAM” but adjusts for 6 MHz measurement bandwidth. Note that measuring an OFDM signal at the PLC area containing stationary pilots typically yields +0.5…1 dB higher measurement results.

ALSC (Automatic Level and Slope Control) in AC9400 adjusts only gain, not slope, thus the term ALC (Automatic Level Control) is also used. Forward path slope is automatically adjusted only during pilot based automatic alignment. Outputs 1 and 3 are adjusted independently unless the “Output 3 follows output 1 instead of using its own pilots” feature is enabled. When enabled, AC9400 memorises output 1 and output 3 level difference, ignores output 3 pilots and adjusts output 3 according to output 1 changes, maintaining the memorised level difference.

AC9400 has a high main pilot, a low main pilot and a high reserve pilot for both signal routes. The high pilot controls interstage gain. The low pilot is not used by ALC. It is only used for slope adjustment during pilot based forward path automatic alignment. Pilot target levels for all six pilots can be independently configured by the user.

If the high main pilot is lost, i.e. its level falls below user-defined "Lost level", AC9400 uses the high reserve pilot for ALC and gives "ALC main pilot missing" alarm.

If both high main and high reserve pilots are lost, AC9400 gives "ALC all pilots missing" alarm and freezes the gain control for that output. The other output continues to adjust normally.

Setting all pilot frequencies to 0 MHz will effectively disable ALC for that output. This can be used in cases when ALC functionality is only desired at one output, leaving the other output in manual control. Setting low pilot frequency to 0 MHz will disable slope adjustment during pilot based forward path automatic alignment.

ALC keeps the output signal levels stable irrespective of input signal level variations by adjusting the interstage gain control based on the pilot measurements. Gain is adjusted slowly in small steps to guarantee stable operation in long amplifier cascades.

If either output 1 or output 3 interstage gain control is adjusted against its limit, AC9400 gives "ALC saturated" alarm but continues to adjust the other output as long as possible.

If ALC drives interstage gain control over its low/high minor/major alarm limits, a corresponding alarm is activated. This can be used for early warning for potential problems in input signal levels. The minor alarm limits can be configured to be set automatically during automatic alignment.

Forward path pilot based alignment

The forward path can be automatically aligned with a single command, provided that AC6983 or AC6992 transponder is installed and the feature is enabled with correct Product Key. Correct pilot settings need to be programmed, either at the factory or by the user.

The pilot based alignment adjusts the input gain and OLC offset, and also RPD offset if RPD lid is installed, together with interstage gain and slope so that pilot targets are reached while simultaneously optimising node performance and making sure ALC has enough adjustment range.

If the low main pilot is enabled (f > 0 MHz), it will be used for slope adjustment during pilot based alignment. If it is disabled (f = 0 MHz), slope will not be adjusted during pilot based alignment.

If the RPD lid is installed and optical receiver 1 is also enabled (hybrid RPD configuration) then the high main pilot and low pilot signals are assumed to come from RPD and the high reserve pilot is assumed to come from optical receiver 1. The high main pilot and low pilot are used for calculating the gain and slope settings, and output 1 high reserve pilot is used for calculating the OLC offset / RPD offset parameters to achieve proper combined signal levels.

The high reserve pilot is not used by pilot based automatic alignment if the RPD lid is not installed or optical receiver 1 is disabled. See Table 3 below.

Configuration	High main pilot	High reserve pilot (out 1)	Low pilot
No RPD (TxSlot2≠AC6430)	Adjusts interstage gain and OLC offset.	Not used.	Adjusts slope if f>0.
Hybrid RPD (TxSlot2=AC6430, Rx1 enabled and high reserve pilot f>0)	Adjusts interstage gain and RPD offset.	Adjusts OLC offset.	Adjusts slope if f>0. (Pilot is assumed to come from RPD.)
RPD only (TxSlot2=AC6430, Rx1 disabled or high reserve pilot f=0)	Adjusts interstage gain and RPD offset.	Not used.	Adjusts slope if f>0.

Table 3. Pilot usage in automatic alignment in different configurations.

Pilot based alignment can be included in the automatic alignment and can thus be activated with transponder front panel “Set” button. It can also be activated separately via the user interface.

Forward path pilot based alignment status is indicated by the transponder “ALSC” led as described in the "Automatic alignment" chapter.

Possible pilot based alignment error reasons and their explanations, which are displayed in the dialog box when the alignment is started via the user interface (see also Figure 16):

- **Pilot target out of range**: Pilot target levels are outside 80…120 dBµV range or high and low pilots have less than 200 MHz between them.
- **Optical input power out of range**: Measured optical input power of an active receiver is below -9 dBm.
- **Pilot not found**: Measured high main pilot level, low main pilot level, or output 1 high reserve pilot level (if RPD installed and Rx1 enabled) is below 75 dBµV. Pilot frequency may be incorrect.
- **Interstage slope out of range**: Calculated output 1 interstage slope is outside -1…20 dB range.
- **Interstage 3 slope out of range**: Calculated output 2 interstage slope is outside -1…20 dB range.
- **Gain out of range**: Calculated input gain value is outside adjustment range or calculated interstage gain value is less than 1 dB from adjustment range limit, not leaving room for ALC adjustments.

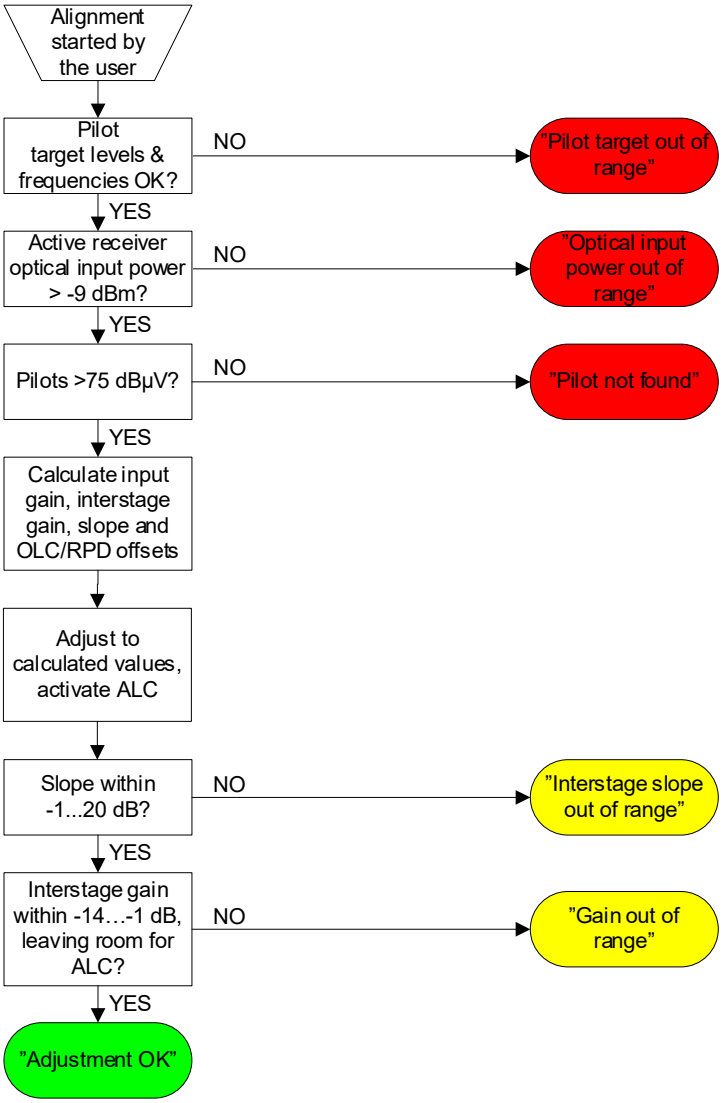

Figure 17. Simplified forward path pilot based alignment flowchart.
Red result = adjustment was aborted
Yellow result = best effort adjustment was made
Green result = targets were reached

Forward path intelligent alignment

Forward path can be also aligned based on the desired output 1 and output 3 levels and, if optical receivers are enabled, the OMI of the optical transmitter feeding forward path signal to AC9400. This feature does not need a transponder module and Product Key activation.

The intelligent alignment, formerly known as OMI based alignment, adjusts input gain (if optical receiver is enabled), OLC offset, RPD offset (if RPD is installed) and interstage gain. Slope is not adjusted, and optical receiver 1 signal level offset to RPD signal level is not changed.

Intelligent alignment accuracy is typically worse than with pilot based alignment, so when transponder is installed the pilot based alignment is recommended. It adjusts also slope and RPD offset vs OLC offset.

The intelligent alignment is started by simply typing a new output target level value(s) into UI. The transmitter OMI and OLC offset vs RPD offset difference need to be correct for successful alignment.

If the alignment completes successfully, the calculated values are taken into use. If the alignment stops due to missing optical power in an enabled optical receiver, all controls return to their original values. If the alignment cannot achieve target levels due to insufficient gain adjustment range, a best effort adjustment is made and the user is notified.

Possible intelligent alignment error reasons, which are displayed in the dialog box when the alignment is started via the user interface:

- **Optical input power out of range**: Measured optical input power of an active receiver is below -9 dBm.
- **Gain out of range**: Calculated interstage gain value is outside the adjustment range.

Spectrum analyser

Spectrum analyser is supported by AC6983 and AC6992 transponders.

AC9400 spectrum analyser can be used to measure and monitor output 1 and output 3 forward path signals, provided that transponder is installed and the spectrum analyser feature is enabled with the correct Product Key. The measurement is done using narrow bandwidth (see transponder spec sheet) and then adjusted for the selected detector type and signal bandwidth.

Spectrum measurements support 4 detector types:

- **Analog**: Peak detector optimised for CW or modulated analog signals.
- **EU QAM**: Averaging detector optimised for European QAM signals.
- **US QAM**: As “EU QAM” but accounts for the different channel bandwidth of American QAM signals.
- **OFDM**: As “EU QAM” but adjusts for 6 MHz measurement bandwidth. Note that measuring an OFDM signal at the PLC area containing stationary pilots typically yields +0.5…1 dB higher measurement results.

Up to 100 measurement frequencies with individual detector type and high/low minor/major alarm limits can be specified by the user separately for each output. The measurement frequencies, detector types, and alarm limits can be specified separately for each output port.

Each measurement frequency can have up to 4 alarm limits. The measurement result is compared against its limits. When all frequencies have been measured the number of measurements exceeding their limits is compared to the “Tolerance” parameter and the “Spectrum warning” and "Spectrum alarm" statuses are updated. The “Tolerance” parameter can be used to fine-tune alarm sensitivity; default value 0 activates the alarm even if only one measurement result exceeds its limits.

"Spectrum alarm" is set if more than "Tolerance" values are above high major alarm limit or below low major alarm limit. "Spectrum warning" is set if more than "Tolerance" values are above high minor alarm limit or below low minor alarm limit and "Spectrum alarm" is not active.

There is a fixed 1 dB hysteresis to prevent alarm toggling: once activated, the alarm only goes off when the measurement result is within (limit – 1 dB).

Return path

Optical transmitters

Optical transmitter modules have an internal pilot generator which can be controlled via user interface separately from the AC6992 transponder return path pilot generator. The optical modules' pilot generator can be disabled or set to 5.5 MHz or 6.5 MHz.

Optical transmitter module laser bias current is measured and monitored. The major alarm limits are also used in return path backup switching logic.

The bandwidth setting of the optical transmitter modules is automatically set by the software according to the highest-frequency detected diplex filter. If an unknown diplex filter is detected, the behaviour is as with CXF065.

Optical transmitter RF stages are shut down to save power for transmitters not receiving signal from the routing matrix. However if the transmitter's pilot signal generator is enabled, the RF stages are always active.

Laser operation depends on selected routing mode and backup status. When laser is turned off by the software, its bias current cannot be monitored and thus no alarms will appear. See Figure 15 for details.

AC6430 RPD interface modules

When the RPD lid is installed, AC6430 RPD interface modules must be installed into optical transmitter slots 2 and 4. The "Unknown module" alarm is given if AC6430 modules are installed in any other slots, or only one is installed. Slots 1 and 3 are available for analog transmitter use. The routing option should set accordingly, see the next chapter.

The RF input level of the RPD can be checked via the OMI testpoint.

Return path signal routing and backup

Return path signal routing and backup modes can be configured independently of forward path routing and backup configuration.

AC9400 supports 12 return path signal routing modes (see Figure 15):

Modes for analog transmitters:

- **Mode 1**: All RF ports combined to optical transmitter 1.
- **Mode 2**: RF ports 1 + 2 to Tx1, RF ports 3 + 4 to Tx3.
- **Mode 3**: RF ports 1 + 3 to Tx1, RF ports 2 + 4 to Tx2.
- **Mode 4**: RF port 1 to Tx1, RF port 2 to Tx2, RF ports 3 + 4 to Tx3.
- **Mode 5**: All RF ports to respective transmitters.
- **Mode 6**: RF ports 1 + 2 to Tx1, RF ports 3 + 4 to Tx2.
- **Mode 7**: RF ports 1 + 2 to Tx1, RF port 3 to Tx3, RF port 4 to Tx4.
- **Mode 8**: All RF ports to respective transmitters. Differs from Mode 5 only in backup switching, see Figure 15.
- **Mode 9**: All RF ports combined to optical transmitter 1. Differs from Mode 1 in that all transmitter lasers are off except the one receiving signal from routing matrix, see Figure 15
- **Mode 10**: All RF ports combined to optical transmitter 1. Differs from Mode 1 only in backup switching so that Tx2 laser is turned off if Rx2 fails and Tx1 laser is turned off if Rx1 fails, see Figure 15.

Modes for RPD (and possible analog transmitters):

- **Mode 11**: All RF ports combined to Tx2, with the option to split the signal also to Tx1.
- **Mode 12**: RF ports 1 + 2 to Tx2, with the option to split the signal also to Tx1. RF ports 3 + 4 to Tx4, with the option to split the signal also to Tx3.

Only modes 11 and 12 should be used with AC9400 equipped with RPD.

Return path backup can be set to three modes:

- **No backup**: The selected signal routing mode stays the same even if the optical receiver input power is below low major alarm limit or transmitter laser bias current is outside major alarm limits. This is the recommended setting when AC9400 is used with RPD.
- **Automatic**: The signal to a specific optical transmitter is routed to the associated backup transmitter if (see also Figure 15):
    - The transmitter fails, i.e. it is missing or its laser bias current is outside major alarm limits, or
    - The related optical receiver fails, i.e. its input power is below low major alarm limit.
- **Automatic with manual restore**: Identical to "Automatic" mode, except that the original routing is not restored automatically. The user has to select "No backup" and then "Automatic with manual restore" again to restore the original routing.

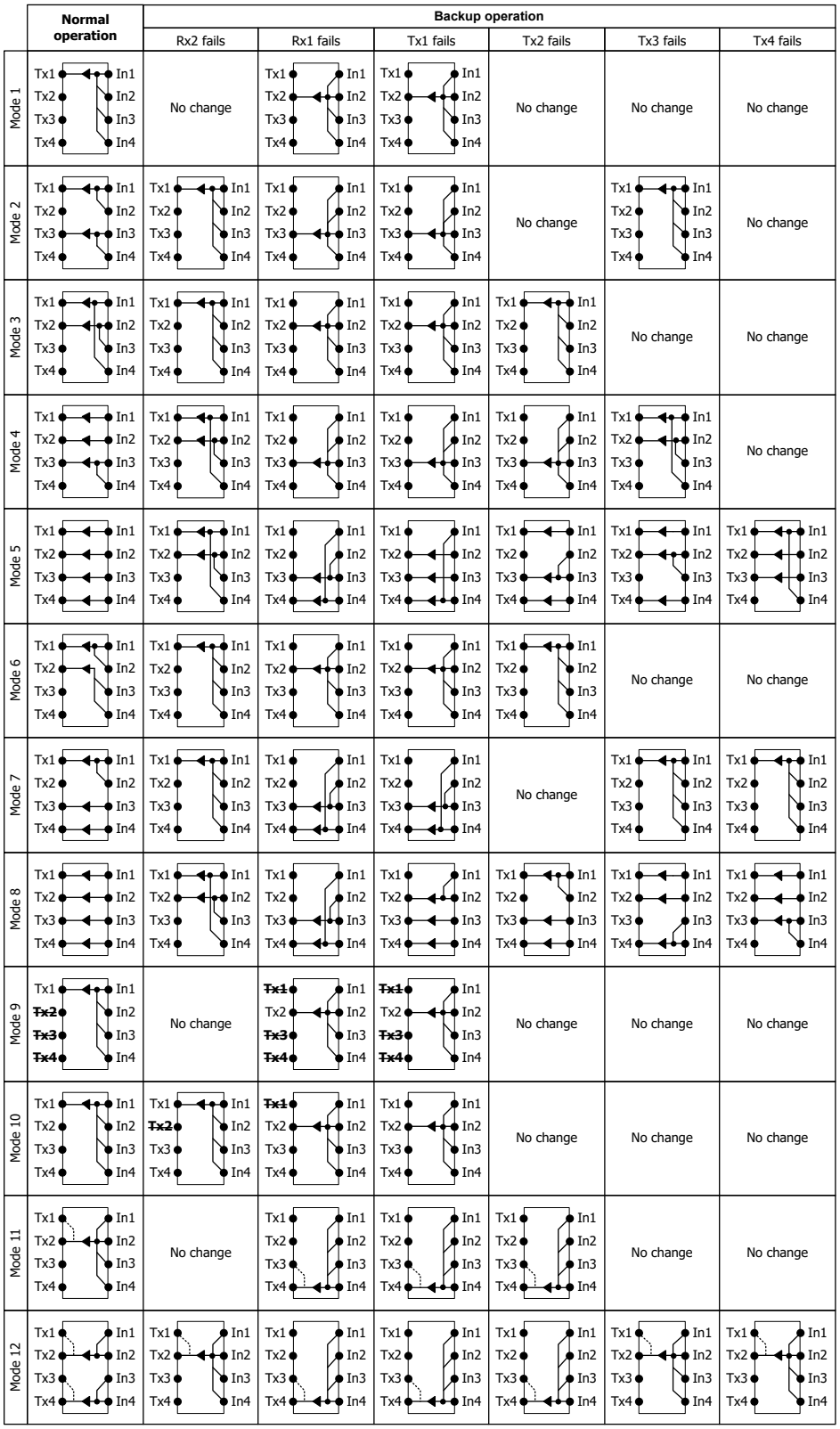

Figure 18. Return path signal routing. Backup uses first matching column, i.e. if both Rx1 and Rx2 fail, "Rx2 fails" action is taken. Laser off is marked with strikethrough (modes 9 and 10). When laser is turned off its bias current is not monitored.

OMI test point

The single OMI test point of AC9400 can be used for measuring all the optical transmitter module's OMI and RPD input signal level. Each installed module is connected to the F connector for 10 seconds, then the next one for 10 seconds, and so on. It is also possible to override this feature via the user interface and connect the F connector to a single transmitter. AC9400 reverts to OMI test point cycling after ~30 minutes.

Return path gain adjustment

Return path levels can be adjusted independently with the gain controls in 0.5 dB steps between -22 and 0 dB.

Return path intelligent alignment

The return path intelligent alignment, formerly known as OMI based alignment, can be included in the automatic alignment and can be activated with transponder front panel “Set” button. It can also be activated separately via the user interface and does not require a transponder to be installed.

Note that the return path intelligent alignment is run only once and is thus not a "return path ALC", whereas the forward path can be aligned continuously depending on the selected “Adjustment mode”.

Return path OMI based alignment adjusts gain controls independently based on the target OMI-% of the optical transmitter and the estimated RF level at return path input port. The target OMI (common for all ports) and RF input level (separately for each port) values need to be programmed either at the factory or by the user before starting the alignment.

If RPD lid is installed and there are no optical transmitters receiving return path signals, the target OMI-% parameter is ignored and the signal levels are optimiser for RPD input.

Ingress control switches

Ingress control switches are independent for all inputs and can be used to attenuate return path or to cut it off completely. Ingress measurement and modem communication are not affected by ingress switches, thus it is possible to monitor incoming ingress and communicate with the node remotely even when the return path is cut off.

The ingress switches are read-only if automatic ingress blocking is enabled.

Automatic ingress blocking

When automatic ingress blocking (AIB) is enabled, the ingress control switches are disabled from the user and the software operates them between 0 dB / attenuated / -50 dB based on the "Ingress alarm" and "Ingress warning" statuses and user-configurable delays.

AIB has 4 operation modes:

- **Disabled**: No automatic ingress blocking. Ingress switch is in user control.
- **Alarm: Att**:
  - "Ingress alarm" active for "Activation delay" time ➔ attenuate.
  - "Ingress alarm" off for "Deactivation delay" time ➔ 0 dB.
- **Alarm: -50 dB:**
  - "Ingress alarm" active for "Activation delay" time ➔ -50 dB.
  - "Ingress alarm" off for "Deactivation delay" time ➔ 0 dB.
- **Warning: Att, Alarm: -50 dB:**
  - "Ingress warning" active for "Activation delay" time ➔ attenuate.
  - "Ingress alarm" active for "Activation delay" time ➔ -50 dB.
  - Both off for "Deactivation delay" time ➔ 0 dB.

Activation and deactivation delays allow fine-tuning AIB operation and prevent unwanted switching on spurious signals. They should usually be selected so that delays are smaller deeper in the network.

The default attenuation value 6 dB can be adjusted separately for both inputs between 3 and 10 dB to fine-tune AIB.

Ingress analyser

Ingress analyser is supported by AC6983 and AC6992 transponders.

AC9400 ingress analyser can be used to measure and monitor return path signals, provided that transponder is installed and the ingress analyser feature is enabled with correct Product Key. The measurement is done using narrow bandwidth (see transponder spec sheet) and then adjusted for the selected detector type and signal bandwidth.

Ingress measurements support 2 detector types:

- **Analog**: Peak detector with 5 measurement max hold.
- **Digital**: Averaging detector, see transponder spec sheet for bandwidth.

Up to 20 measurement frequencies with individual analog / digital detector (for signals / noise, respectively) selection and high warning / high alarm limits can be specified by the user. The measurement files containing frequencies, detector types and alarm limits can be specified separately for each input port.

Each measurement frequency can have both, either or no alarm limits. Each measurement result is compared against its limits. When all frequencies have been measured the number of measurements exceeding their limits is compared to “Tolerance” parameter and “Ingress warning” and “Ingress alarm” statuses are updated. The “Tolerance” parameter can be used to fine-tune alarm sensitivity; default value 0 activates the alarm even if only one measurement result exceeds its limits.

"Ingress alarm" is set if more than "Tolerance" values are above high major alarm limit. "Ingress warning" is set if more than "Tolerance" values are above high minor alarm limit and "Ingress alarm" is not active.

There is a fixed 1 dB hysteresis to prevent alarm toggling: once activated, the alarm only goes off when the measurement result is within (limit – 1 dB).

Ingress measurement frequencies should be selected so that there are no other return path signals nearby. Selecting a measurement frequency close to other signals will affect the dynamic range of the ingress analyser. See transponder spec sheet for information on measurement bandwidth.

Ingress analyser alarm can also be used to trigger automatic ingress blocking.

Transponder return path pilot generator

AC9400 return path pilot generator can be activated when AC6992 transponder is installed and the feature is enabled with Product Key.

There can be up to 4 user programmable pilot frequencies in the frequency range of 5…65 MHz (0.1 MHz steps). The pilot generator signal (and also the RF modem transmit signal) is fed to all return transmitters configured to receive signal from transponder. Pilot levels are specified at the transponder output as with modem transmit levels, and restricted to 75…100 dBµV range. The UI displays resulting equivalent input level, i.e. the level at which a signal should be injected to return path inputs to appear at equivalent level with the generated pilot signal at return path output.

When the pilot generator is enabled, one of the pilot signals is output for user defined pilot duration, then switched to the next pilot signal and then repeated again. The duration parameter is ignored if only one pilot signal is activated.

Possible RF modem transmissions occur asynchronously, i.e. in the middle of any pilot transmission. Pilot output is switched off during modem transmission and resumes after the modem transmission has been completed. This causes typically less than 50 ms gaps in pilot transmission.

Pilot signals closer than 0.3 MHz from modem transmit frequency are not generated. Pilot signals can cause problems to modem communication if the pilot is close to modem frequency and pilot level is high compared to modem transmit level. Thus it is recommended to keep pilots at least 0.5 MHz from modem frequency.

Detection of these time domain multiplexed return path pilot signals can be accomplished at head end with e.g. a standard spectrum analyser instrument used in "Max hold" mode, or with another amplifier/node capable of return path signal measurement.

Remote communication

Remote communication via RPD

AC9400 can be accessed remotely also via the RPD module using the IP address assigned to the RPD. CATVisor TSEMP protocol and SNMP protocol traffic arriving to RPD node via its CIN interface is automatically forwarded to the node by RPD, if this forwarding functionality is enabled in the RPD configuration. For more information please refer to the RPD documentation.

The SNMP community strings must be configured in AC9400 in order to use SNMP for remote node management. If SNMP traps are to be used, also the trap receiver settings need to be configured in AC9400 via the "Properties" page "SNMP settings" button, but trap receiver addresses need to be configured in the RPD.

Remote communication via transponder

The software supports AC6983 and AC6992 transponders and CATVisor, HMS and DOCSIS communication protocols.

With AC6992 it is possible to set the communication protocol to CATVisor or HMS via the user interface. CATVisor protocol is compatible with Teleste CATVisor Commander and Argus system. HMS protocol uses SNMP for remote communication and can thus be used with Teleste CATVisor or 3rd party management software. It is possible to change between CATVisor and HMS also remotely. All modem related settings should be carefully reviewed before changing the protocol to avoid loss of remote communication.

With AC6983 the main remote communication protocol is SNMP. CATVisor protocol is also supported and thus e.g. CATVisor SmartLoader can be used.

The reported modem receive and transmit levels are measured at transponder RF input and output ports. Modem receive level is directly related to forward path output level. Modem transmit level vs. return path input level varies with return path gain as described in the technical specification.

Transponder “Modem” led is dark while the unit is scanning for communication channel and blinks when it is establishing the communication link. During normal communication the led colour is decided from modem-related alarms.

Forward path signal routing and transponder signals

Both output 1 and output 3 signals are connected to transponder slot via software controlled RF switch. The switch position is changed dynamically according to forward path signals (pilot/spectrum) to be measured.

AC6992 transponder

AC6992 transponder uses the same forward path RF signal for both signal level measurement and communication. This means that **the same management signal must be present in both ports**. In "dual node" mode is it thus necessary to inject the same management signal into both optical receivers. If this is not possible, then all pilots and spectrum measurements should be disabled from output1 or output 3 to keep the RF switch fixed to output3 or output1, respectively. In this case, the “Output 3 follows output 1 instead of using its own pilots” feature can be enabled if desired.

The software can change the RF switch position synchronously with the modem reception so that packet loss will not occur. Also, the modem receiver is able to resynchronise so fast that timing differences and/or RF level differences between ports 1 and 3 do not affect remote communication.

AC6983 transponder

With AC6983 DOCSIS transponder it is not possible to synchronise the RF switch with modem communication due to the higher data rates of DOCSIS communication. Thus for AC6983 transponder, **the management signal is taken always from output 3** via a different signal path and the RF switch signal line is used only for signal level measurements. Thus no packet loss will occur and it is enough to have the management signal in output 3. Output 3 disabling does not affect AC6983 transponder remote communication, because AC6983 then internally reroutes the measurement signal also to the modem. However in this case the signal levels seen by the modem are slightly lower, which may cause problems if very low output levels are used.

Return path signal routing and transponder signals

The transponder transmit signals (and also return path pilot generator in AC6992) are fed to all optical transmitters by default. When the same signal is transferred to the headend via different optical links with different propagation delays and then combined again before feeding to HEC / HMTS / CMTS, it can interfere with itself and cause poor performance or communication loss.

AC9400 allows selecting which return path inputs receive the modem transmit signal. This makes it possible to prevent the multi-path propagation problem. AC9400 software uses the routing matrix to determine which return transmitters the modem signal should be connected to based on the selected inputs. Thus the modem signal routing changes dynamically with return path signal routing changes during e.g. backup operation. Note that this also affects AC6992 transponder return path pilot generator signals.

CATVisor transponder functionality (AC6992)

After reset the transponder starts scanning for HEC (HeadEnd Controller, e.g. Teleste HDM100 T) carrier within the user-specified frequency range. When a communication channel is found, it waits for registration slot and sends its registration request. If the HEC accepts the registration, transponder enters normal communication mode where it is periodically polled by the HEC.

If the registration fails, or transponder is in normal communication mode but doesn't receive any packets from the HEC it starts scanning again. During registration, the HEC sends communication parameters such as transmitter frequency and transmitter level.

All communication between the transponder and CATVisor Commander, Argus or SmartLoader is done with UDP/IP packets via the HEC. This means that transponder IP address has to be unique and match HEC's subnet settings.

HMS transponder functionality (AC6992)

HMS mode is similar to CATVisor mode. The transponder scans for HMTS (Hybrid Management Termination System, e.g. Teleste HDM100 H) carrier. Transmit level is not set by the HMTS and thus has to be adjusted manually. In HMS the behaviour when forward communication is lost is controlled by the HMTS settings.

For details on HMS modem functionality, please refer to HMTS documentation and HMS standards.

DOCSIS transponder functionality (AC6983)

AC6983 transponder acts as a standard DOCSIS cable modem. There are no communication settings available for user, everything is done automatically as commanded by the CMTS (Cable Modem Termination System). Depending on the CMTS and headend LAN settings it is usually necessary to configure the transponder MAC address to DHCP server and allow SNMP (UDP ports 161 and 162) and CATVisor (UDP port 2500) traffic to transponders. The SNMP community strings and other DOCSIS related settings are configured via the DOCSIS configuration file as with other cable modems.

It is recommended to allocate dedicated DOCSIS channels for transponder communication. These channels should use more robust modulation than regular channels, for example, QAM16 in forward path and QPSK in return path. This helps in keeping the transponders online even if there is massive ingress preventing normal cable modem communication.

Establishing a connection

All the needed configurations and adjustments can be carried out locally or remotely by using the CATVisor Commander software. Detailed CATVisor Commander hardware requirements and installation instructions can be found from the User Manual supplied with Commander.

Local configuration with a PC

Commander 2.9 or later is needed for USB and Bluetooth support.

Connection to AC9400 USB port can be done with a standard USB A plug to USB mini B plug cable, or via AC6901 USB to Bluetooth adapter. The cable or adapter should be disconnected when not in use to avoid possible EMC problems caused by the cable acting as an antenna.

AC9400 will draw power from the USB connector for its microcontroller and memory if no external power supply is available. This makes it possible to configure AC9400 settings and update the software without any power supply.

Note that as only the CPU part of the unit is powered via USB, many parameters visible via the user interface may display incorrect values. Installing and removing plug-in modules while the unit is USB powered is not recommended and may lead to unexpected behaviour.

Local configuration with an Android device

Teleste Commander software for Android devices can be downloaded from Google Play. Connection to AC9400 USB port can be done via AC6901 USB to Bluetooth adapter. The adapter should be disconnected when not in use to avoid possible EMC problems caused by the adapter acting as an antenna.

Remote CATVisor connection

Remote IP connection via RPD or a HEC (e.g. Teleste HDM100 T) with AC6992 transponder. Transponder IP address has to be correctly set before remote IP communication is possible. It has to match the subnet settings of the HEC's HFC network interface and it must also be unique for each transponder.

Note that it is also possible to set the IP address remotely via the HEC, see HEC documentation for details.

Remote HMS connection

Remote SNMP connection via a HMTS (e.g. Teleste HDM100 H) with AC6992 transponder. AC9400 can be accessed remotely using an SNMP Manager application. Usually, there is no need to pre-configure any communication parameters to establish a connection with the HMTS. However, the selected installation procedure may include pre-setting e.g. the IP address, transmit level and the forward path frequency scanning limits.

Remote DOCSIS connection

Remote SNMP or CATVisor protocol connection via a CMTS with AC6983 transponder. AC9400 can be accessed remotely using an SNMP Manager application or CATVisor Commander. The CMTS system must be preconfigured to accept the transponder and the used protocols.

Alarms

The module alarms, also known as "flags", displayed in CATVisor Commander and Argus are described in the table below. Equivalent SNMP traps and alarms are also available via remote connection with HMS and DOCSIS protocols.

The affected led and factory default severity settings are presented next to each alarm in Table 2. All alarm severities (Major / Minor / Notification / Disabled) and alarm limits can be fully configured by the user. See the 'Monitoring' chapter for more details.

Note that some alarm limits (for example remote AC supply voltage) are factory configured so that alarms will only appear when hardware specifications are exceeded. The alarm limits should be reconfigured to match network parameters if more precise monitoring is needed.

Analog alarm	Description & suggested corrective action	Led	Default severity
Temperature high	Temperature is above high limit.	Status	Major & Minor
Temperature low	Temperature is below low limit.	Status	Minor
AC voltage high	AC voltage is above high limit.	Status	Minor
AC voltage low	AC voltage is below low limit. As some units are equipped with mains power supply, this alarm is disabled as factory default and should be enabled by the user if AC voltage is to be monitored.	Status	Disabled
+34V voltage high	+24V voltage is above high limit. Common for both power supplies.	Status	Major & Minor
+34V voltage low	+24V voltage is below low limit. Common for both power supplies.	Status	Major & Minor
+12V voltage high	+12V voltage is above high limit.	Status	Major & Minor
+12V voltage low	+12V voltage is below low limit.	Status	Major & Minor
Optical Rx 1/2 power high	Optical receiver input power is above high limit.	OptRx1	Major
Optical Rx 1/2 power low	Optical receiver input power is below low limit. The major alarm is used for backup switching logic, also when alarm is disabled.	OptRx1	Major
Optical Tx 1/2/3/4 laser current high	Optical transmitter laser current is above high limit.	Status	Minor
Optical Tx 1/2/3/4 laser current low	Optical transmitter laser current is below low limit.	Status	Minor
Modem receive level high	RF modem receive level is above high limit. Generated only if AC6992 transponder is installed and modem is connected.	Modem	Minor
Modem receive level low	RF modem receive level is below low limit. Generated only if AC6992 transponder is installed and modem is connected.	Modem	Minor
Interstage 1/3 gain high	Interstage gain is above high limit. Generated only if transponder is installed and ALC is enabled.	ALSC	Minor
Interstage 1/3 gain low	Interstage gain is below low limit. Generated only if transponder is installed and ALC is enabled.	ALSC	Minor
Discrete alarm	**Description & suggested corrective action**	**Led**	**Default severity**
Unknown module	Device is not able to recognise a diplex filter, output module, optical transmitter module, RPD interface module or transponder module, or diplex filter types do not match, or RPD interface modules are installed into wrong slots. If unit software is up to date and removing and reinstalling the plug-in modules to correct positions one at a time doesn't help, contact Teleste support.	Status	Major

Internal error	Device has an internal error. If resetting the unit does not help, contact Teleste support.	Status	Major
Lid open	Lid sensor light level has been above limit during last minute. Generated only if transponder is installed.	Status	Notification
Return path off	Return path is turned off, either by user or automatically due to ingress. Common for all return paths.	Status	Notification
Return path attenuated	Return path is attenuated, either by user or automatically due to ingress. Common for all return paths.	Status	Notification
Settings changed	Unit's settings have been modified by user during last minute.	Status	Notification
Application started	Unit was reset or rebooted during last minute.	Status	Notification
Application updating	Unit or plug-in module software is being updated. No changes should be made to powering, plug-in modules or settings during software update.	Status	Minor
Service terminal connected	There has been activity on local USB connector during last minute.	Status	Notification
Modem not connected	RF modem is not connected. Generated only if transponder is installed.	Modem	Notification
Modem transmit level saturated	Commanded transmit level is outside transponder's allowed range, transmit level is saturated. Generated only if AC6992 transponder is installed, modem is connected and min < max.	Modem	Notification
Tuner module error	Internal error in transponder's level measurement unit. If resetting the unit doesn't help, contact Teleste support.	Status	Major
ALC all pilots missing	Output 1 and/or output 3 all pilots are missing, ALC is frozen. Generated only if transponder is installed and ALC is enabled	ALSC	Major
ALC saturated	Output 1 and/or output 3 ALC is saturated, i.e. gain adjustment limits have been reached. Generated only if transponder is installed and ALC is enabled.	ALSC	Minor
ALC main pilot missing	Output 1 and/or output 3 main pilot is missing, ALC uses reserve pilot. Generated only if transponder is installed and ALC is enabled.	ALSC	Notification
ALC off	Transponder is installed but ALC is switched off by user. Or ALC is switched on by user but transponder is missing.	ALSC	Notification
Spectrum 1/3 warning	Spectrum analyser measurements are outside minor alarm limits, but within major alarm limits.	Status	Minor
Spectrum 1/3 alarm	Spectrum analyser measurements are outside major alarm limits.	Status	Major
Ingress 1/2/3/4 warning	Return path ingress measurements are above minor alarm limits, but within major alarm limits.	Status	Minor
Ingress 1/2/3/4 alarm	Return path ingress measurements are above major alarm limits.	Status	Major
Powered from USB	Processor powered from USB, rest of motherboard not alive.	Status	Notification
Backup activated	Forward path or return path has switched to backup mode.	Status	Notification
RPD error	RPD interface module is installed in Tx2 slot, but AC9400 has not received status data from RPD.	Status	Major
RPD remote link down	RPD reports "Remote link down" status.	Status	Major
RPD PSU 1/2 failure	RPD power supply 1/2 failure. Check RPD lid power supply cabling and connections.	Status	Major

Table 4. AC9400 alarms

Led usage

Modem related alarms are indicated with transponder "Modem" led, ALC related alarms are indicated with transponder "ALSC" led, other alarms are indicated with AC9400's “Status” led with the exception of optical alarms which are indicated with optical input power LEDs. The affected led and factory default severity settings are presented next to each alarm in Table 3. Alarms with "notification" severity do not affect LEDs.

Status led	**Description**
red	≥1 major alarm (other than modem / ALC / OptRx)
yellow	≥1 minor alarm but no major alarms
green	No alarms (other than modem / ALC / OptRx)
dark	Software / CPU / power failure

Optical receiver leds	**Description**
red	Optical power high major alarm
yellow	Optical power low major alarm
green	Optical power within major alarm limits
dark	Optical receiver disabled

ALSC led (AC6983, AC6992)	**Description**
red	ALC enabled, ≥1 major alarm
yellow	ALC enabled, ≥1 minor alarm
green	ALC enabled, no alarms
multicolour	Automatic alignment running
green blink	Automatic alignment completed successfully
yellow blink	Automatic alignment targets not fully achieved
red blink	Automatic alignment stopped due to an error
dark	ALC off

Modem led (AC6992) **DOCSIS led** (AC6983)	**Description**
red	Modem connected, ≥1 major alarm
yellow	Modem connected, ≥1 minor alarm
green	Modem connected, no alarms
green blink	Modem registering
dark	Modem not connected

Table 5. AC9400 and transponder LEDs

Product key activation of advanced features

Some AC9400 features need to be activated with the correct product key:

- Optical receiver 2
- Automatic alignment (including pilot based alignment)
- Forward path spectrum analyser and return path ingress analyser
- Return path pilot generator (AC6992 transponder)

The activation can be done when ordering the product and also later by contacting Teleste support. CATVisor Commander user manual provides more details on entering the product key.

Transferring AC9400 settings

All user-accessible settings are stored on the motherboard memory. Thus plug-in modules can be changed without losing any settings.

A “Settings Saver” DLL component for AC9400 is included in the latest DUS100 viewer packet release. It can be used with CATVisor Commander and CATVisor SmartLoader to transfer partial or complete device settings between a file and AC9400. This feature can be accessed through Commander > “Tools” > “Load/Save element configuration” when it has been activated with the correct serial number. SmartLoader supports also transferring settings from/to multiple units simultaneously.

Note that the Settings Saver component uses CATVisor protocol and cannot thus be used remotely with SNMP.

The settings are stored as *.ECML files in XML format. These files can be also edited with standard text editors, provided that the XML tags and structure are maintained. Tags can be removed to create partial settings files. This makes it easy to download e.g. new pilot target levels to multiple units simultaneously.

The settings saver ECML files can also be edited in a user-friendly format with an Excel tool. This tool can be downloaded from Teleste extranet (MyTeleste). The settings saver ECML files can also be used for specifying factory settings when ordering preconfigured AC9400 units.

AC9400 will draw power from the USB connector for its microcontroller and memory if no external power supply is available. This makes it possible to configure AC9400 settings and update the software without any power supply.

Note that as only the CPU part of the unit is powered via USB, many parameters visible via the user interface may display incorrect values. Installing and removing plug-in modules while the unit is USB powered may lead to unexpected behaviour.

Settings download and upload is possible only to installed and enabled modules. This means that e.g. it is not possible to read the pilot settings of a missing optical transmitter module or write certain transponder settings if correct transponder type is not installed.

Downloading device settings containing modem parameters over remote connection may cause loss of remote connection. Thus some settings may not be written correctly. If modem parameters need to be written remotely, it is re-

commended to put them into a separate ECML file which is transferred separately after other settings.

Software update

New software versions for AC9400 are published at Teleste extranet (My-Teleste). These may contain bug fixes, enhancements, and completely new features. For details see "AC9400 software release history" document also available in MyTeleste.

AC9400 software can be updated locally via USB using CATVisor Commander or remotely via modem connection using CATVisor Commander, SmartLoader or 3rd party download tool. AC9400 stays fully operational during the update, i.e. RF paths are not affected, ALC continues to operate etc. The "Application updating" alarm is active during the update.

The new software is taken into use after it has been completely downloaded and the device is reset. The reset takes a couple of seconds after which the device is fully functional and running the new software. If the download fails, AC9400 continues to use its previous software.

Local update

AC9400 software can be updated locally via USB using CATVisor Commander or Teleste Commander for Android devices. Local software update of AC9400 takes ~1 minute.

AC9400 will draw power from the USB connector for its microcontroller and memory if no external power supply is available. This makes it possible to configure AC9400 settings and update the software without any power supply.

Remote update – CATVisor

Remote update for CATVisor is done using CATVisor Commander or SmartLoader. It is also possible to download new software to multiple devices simultaneously without resetting them and take the new software into use later by sending a broadcast reset with CATVisor SmartLoader.

Remote update – HMS

Remote update for HMS is done using SNMP protocol with CATVisor Com-mander or other software tools supporting standard HMS-DOWNLOAD-MIB.

Remote update – DOCSIS

AC9400 software can be updated remotely with either CATVisor or HMS protocols as described above.

Transponder software update

Transponders have 2 software items: the tuner software handles the level measurements and the modem software handles remote communication. For AC6992 these both can be updated locally or remotely by using the methods above. For AC6983 the tuner software can be updated as described above, but the modem software can be updated only remotely using standard DOCSIS methods, i.e. TFTP file download initiated by DHCP server configuration.

When transponder software update has completed, it can take up to 1 minute for the software to be taken into use. Wait until the new software version appears in the user interface before removing power or the transponder.

SNMP MIBs

The parameters of a unit in HMS or DOCSIS mode can be accessed remotely using SNMP MIBs (Management Information Base). Should they be needed for e.g. integration with 3rd part management systems, the Teleste-proprietary MIBs are available for download in Teleste extranet (MyTeleste). SCTE MIBs can be downloaded from SCTE website.

Supported MIBs for AC9400:

- RFC1213-MIB
- TELESTE-ROOT-MIB
- TELESTE-ACX-MIB
- TELESTE-COMMON-MIB
- TELESTE-HMSMODEM-MIB
- TELESTE-ANALYSER-MIB
- TELESTE-PILOTGENERATOR-MIB
- TELESTE-FUNCTIONAL-COMMON-MODEM-MIB
- TELESTE-FUNCTIONAL-AUTOMATIC-ALIGNMENT-MIB
- TELESTE-ALARMS-MIB
- TELESTE-CM-CONFIG-MIB
- SCTE-ROOT
- SCTE-HMS-COMMON-MIB
- SCTE-HMS-PROPERTY-MIB
- SCTE-HMS-ALARMS-MIB
- SCTE-HMS-RFAMPLIFIER-MIB
- SCTE-HMS-FIBERNODE-MIB
- SCTE-HMS-DOWNLOAD-MIB
- Standard DOCSIS MIBs with AC6983 transponder

Viewer pages

This chapter presents AC9400 viewer pages used with local or remote CATVisor protocol connection. Some of the viewer pages used with SNMP remote connection with HMS or DOCSIS protocols slightly different in layout but contain the same parameters.

The viewer pages used to control AC9400 using CATVisor Commander or Argus are explained in this chapter. For a complete description of each feature, see the corresponding “Features” chapter.

Some features may be greyed out, indicating that they cannot be used at the moment due to e.g. missing plug-in module or product key.

AC9400 viewer pages in CATVisor Commander / Argus are:

- **Status**
- **Forward path**
- **Return path**
- **Transponder** (shown when transponder is installed, different pages for CATVisor / HMS / DOCSIS)
- **RPD** (shown when RPD is installed)
- **Spectrum** (shown when transponder is installed)
- **Ingress** (shown when transponder is installed)
- **Properties**

Some viewer pages have fields with coloured background, e.g. "Temperature" on the "Status" page. These colours indicate the alarms related to this field. Green means no alarms or notifications; red is a major alarm, yellow is minor alarm and blue is notification.

Status viewer page

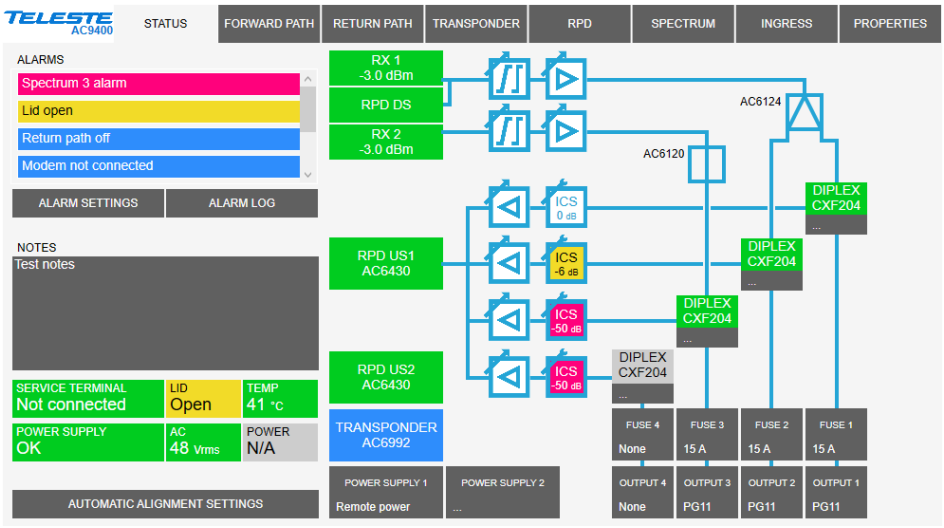

Figure 19. The Status page

The “Status” page displays the unit's alarm list together with measurement data and a graphical view of the current configuration similar to the actual station layout.

Alarm list, settings, and log

Each alarm in the alarm list on the top left corner is colour coded according to its severity. Alarm limits and severities can be configured through the "Alarm settings" dialog (see below), opened with the "Alarm settings" button. The "Alarm history" dialog (see below) can opened with the "Alarm log" button. For additional information about alarms, see table of module alarm descriptions in the "Alarms" chapter.

Notes

The “Notes” field allows storing up to 200 character message into AC9400 non-volatile memory. It can be used e.g. as a reminder for the pilot settings.

Measurements

The background colour of each field shows the parameter's alarm status.

The “Service terminal” field shows whether there has been activity on the local USB service connector during the last minute.

Lid status information is based on a light sensor in the transponder's front panel. "Lid open" is displayed if light level has been above limit during the last minute. In dark environment "Lid closed" may be displayed even if the lid is open.

AC9400's internal temperature is typically 10…25 °C above ambient temperature depending on installation.

The "Power" field displays the estimated total power consumption of the unit based on the installed modules, power supplies, supply voltage, selected operating modes, and the RPD.

The “AC voltage” field shows true RMS value (DC+AC component) of the remote supply voltage. This value is calculated using sliding average and thus reacts quite slowly to changes. The default limit values are based on AC9400's power supply specifications and are thus quite broad. They should be adjusted to match the network's AC supply voltages if accurate monitoring is needed.

The combined internal +12 V and +34 V voltage statuses are shown in the "Power supply" status field. The factory default alarm limits are based on power supply specifications and usually shouldn't be altered.

Automatic alignment settings

Transponder front panel has a “Set” button which starts automatic alignment. Clicking the "Automatic alignment settings" button on the "Status" page opens a dialog for configuring the automatic alignment behaviour. The automatic alignment can also be started with the "Start automatic alignment" button in the settings dialog. For more information see "Features / Automatic alignment" chapter.

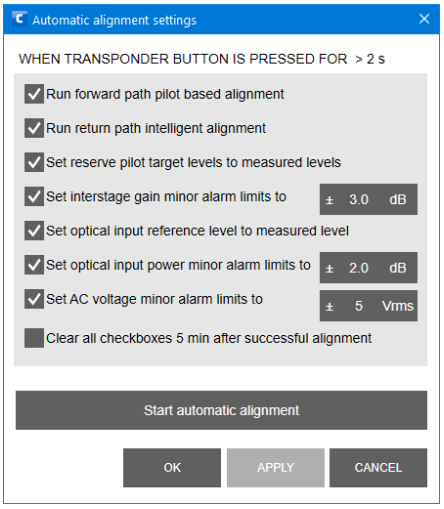

Figure 20. The Automatic alignment settings dialog

Station layout

The optical transmitter, transponder, output modules and diplex filter modules are detected automatically and represented as boxes with background colour reflecting alarm status. Some modules (fuses, connectors, special diplex filter versions, and power supplies) cannot be detected automatically. These are presented with grey boxes. Selecting a text tag representing a passive device will open a drop-down selection list in which an appropriate device according the assembly can be selected. The user can also type in the desired information (up to 12 characters, 6 characters for fuses). The information entered in these fields does not affect unit operation in any way, it's just a "checklist".

See the “Features” chapter for details on plug-in modules and configuration.

Alarm settings dialog

The "Alarm settings" button on the "Status" page opens the alarm settings dialog.

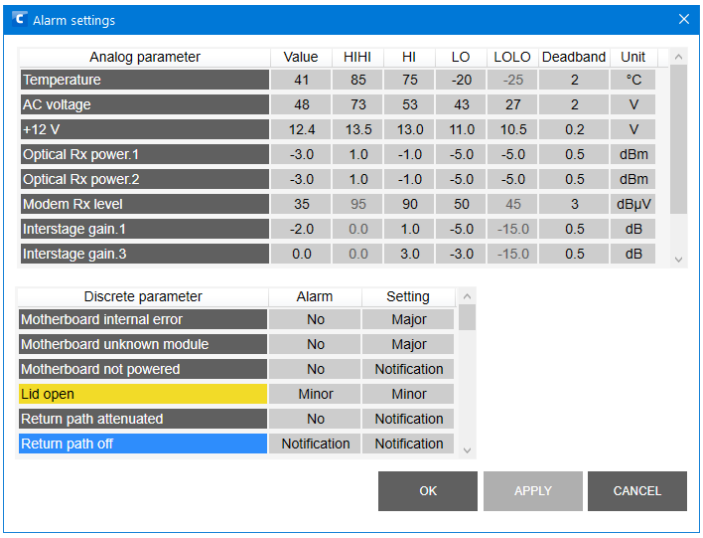

Figure 21. The Alarm settings dialog

The "Alarm settings" dialog displays all monitored parameters and their values as well as alarm limits, statuses, and severity settings.

See the "Alarms" chapter for descriptions of individual AC9400 alarms.

Analog parameters

Each monitored analog parameter of the unit is displayed in the upper half of the dialog with the following information in the list:

- **Analog parameter:** Name of the monitored parameter, with background colour indicating active alarm.
- **Value:** Current measured value**.**
- **HIHI:** High major alarm limit
- **HI:** High minor alarm limit.
- **LO:** Low minor alarm limit
- **LOLO:** Low major alarm limit.
- **Deadband:** Specifies how much the measured value has to be on the "safe" side of the alarm limit before turning off the alarm.
- **Unit:** Unit of the measured parameter.

The alarm settings can be configured by double-clicking an analog parameter name. This will open a dialog box with parameter's alarm limits and deadband.

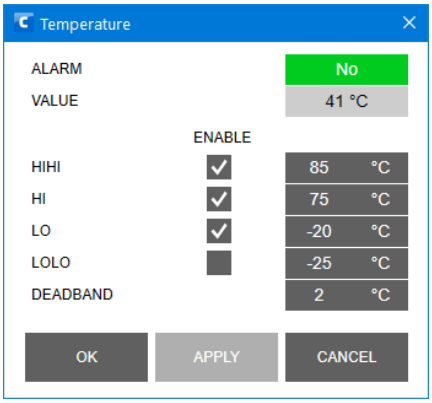

Figure 22. The analog alarm configuration dialog box

Each alarm limit can be individually enabled/disabled and configured. The alarm limits should be in decreasing order for correct alarm processing, preferably with more than "Deadband" units between each limit.

Discrete parameters

Each monitored discrete parameter of the unit is displayed in the lower half of the dialog with the following information in the list:

- **Discrete parameter**: Name of the monitored parameter, with background colour indicating active alarm.
- **Alarm**: Alarm status of the parameter: No / Notification / Minor / Major. If the alarm is disabled, but parameter is in alarming state, "Yes" is shown.
- **Setting**: Alarm severity can be configured to Major, Minor, Notification or Disabled.

The alarm severity setting is user-configurable by double-clicking a discrete parameter name. This will open a dialog box that can be edited by users with at least "Service" level user rights. For others, this is read-only information.

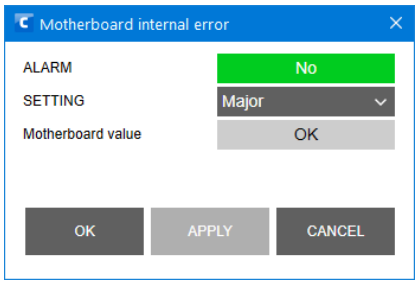

Figure 23. The discrete alarm configuration dialog box

Alarm log dialog

The "Alarm log" button on "Status" page opens the alarm log dialog.

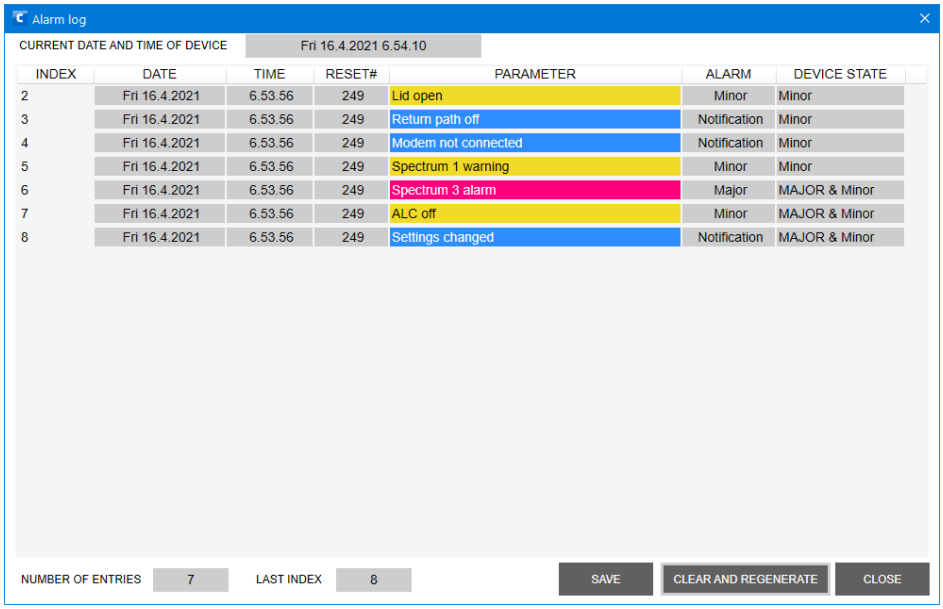

Figure 24. The Alarm log dialog

The “Alarm log” dialog box displays the alarm history for the latest 64 events. The list is stored in non-volatile memory. All entries are date and time stamped with the most current entry at the bottom. Note that date/time information may not be correct for events that occurred before latest reset.

The total number of entries in the alarm log list is shown in the “Number of entries” field. The index number of the last entry is displayed in the accompanying field. The total number of entries is limited to 64. The oldest entry is overwritten when the log becomes full.

To save the “Alarm log” page to a file, click the “Save” button.

The “Clear and regenerate” button clears log and restarts alarm detection.

Forward path viewer page

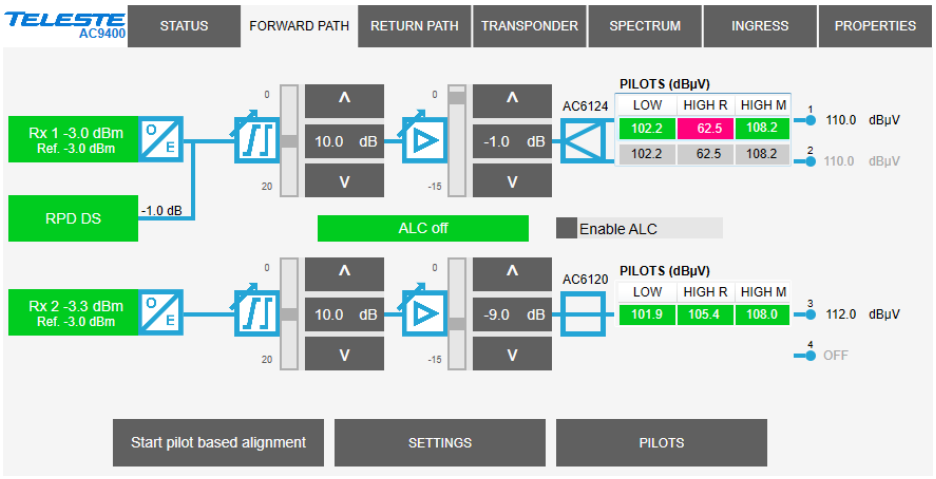

Figure 25. The Forward path page with transponder installed

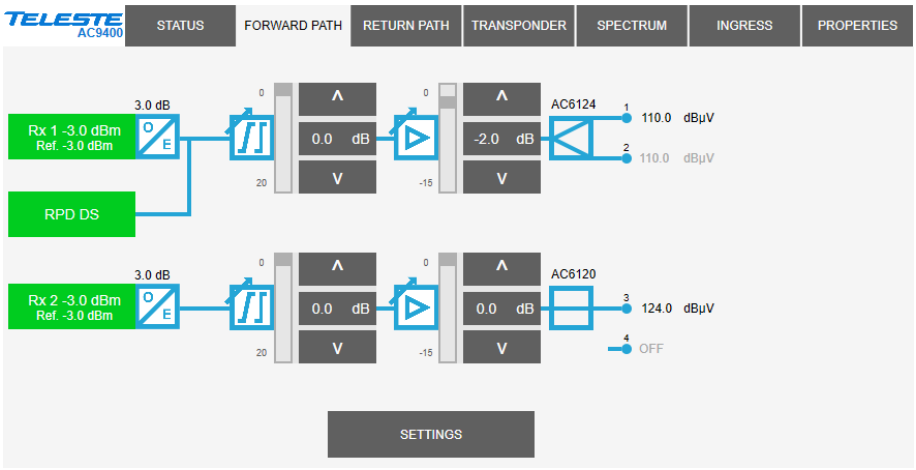

Figure 26. The Forward path page with transponder not installed

The “Forward path” page displays all forward path settings.

When transponder is not installed, the ALC status and settings as well as pilot status and settings are not visible (Figure 23).

Optical receivers and RPD

The enabled optical receivers and their measured optical input powers and reference levels are displayed on the left-hand side of the page. The background colour of the optical input power changes according to related alarms. Non-zero values of RPD offset and OLC offset parameters are shown next to the RPD module and optical receiver, respectively.

Gain and slope controls

The middle part of the "Forward path" viewer page contains the interstage gain and slope controls, which can be adjusted by clicking the up and down buttons or typing a value into the fields. The slider indicates the relative position of the control to its limits. When ALC is enabled the interstage gain is

read-only and controlled by ALC. The background colour shows interstage gain alarm status.

Adjustment mode and status

The adjustment mode (ALC on/off) can be selected with the “Enable ALC” checkbox.

The adjustment mode and possible ALC alarms are displayed in the status field in the center of the page with a background colour indicating alarm status:

- **ALC off**: OLC controls input gain, interstage gain is user-editable.
- **ALC on**: OLC controls input gain, ALC is enabled and OK and controls interstage gain.
- **ALC saturated**: ALC is enabled but saturated, i.e. interstage 1 or 3 gain is adjusted to limit. ALC continues to adjust the other output.
- **ALC main pilot missing**: ALC is enabled but main pilot is missing. ALC uses reserve pilot.
- **ALC all pilots missing**: ALC is enabled but pilots are missing. ALC is frozen, i.e. interstage gain is not adjusted.
- **No transponder**: ALC is enabled but transponder is not installed.
- **Tuner module error**: ALC is enabled but cannot adjust due to internal error in transponder tuner module.

Outputs

The right-hand side of the "Forward path" viewer page displays output module configuration and calculated 1.2 GHz output levels. The output level calculation is based on interstage gain, RPD offset and OLC offset values, and shows value for RPD signals when RPD signals are routed to that output.

When transponder is installed, the measured pilot signal levels for outputs 1 and 3, if enabled, are shown in a table after the output module. Pilot level background is red if the pilot is lost, green when the level is within ±1 dB from the target level, otherwise yellow, or "N/A" in grey if the pilot is disabled or, for output 3, if the output is disabled.

The RF routing to outputs 2 and 4 is displayed with the output module symbol. The pilot levels for outputs 2 and 4 are calculated based on the measured output 1 and 3 levels and installed plugin types. They are shown in grey with no accuracy specification.

Intelligent alignment

The intelligent output level alignment can be started by simply selecting the calculated 1.2 GHz output level value shown next to outputs 1 and 3, typing in a new target level value and clicking "Apply". The interstage gain and, if needed, also the RPD offset and OLC offset values are then adjusted to achieve the target level. If the adjustment fails due to e.g. insufficient adjustment range, an error dialog box is shown. The intelligent alignment does not adjust slope, and it also keeps the OLC offset to RPD offset difference unchanged.

When transponder is installed it is recommended to use the pilot based alignment instead of intelligent alignment due to its typically better accuracy and ability to adjust also slope and RPD offset vs OLC offset difference.

Start pilot based alignment

Clicking the “Start pilot based alignment” button starts forward path pilot based alignment, provided that transponder is installed and the automatic alignment feature is enabled with correct Product Key. The pilot settings have to be set correctly via the "Pilots" dialog before the adjustment is started. A dialog box is opened which displays the status of the alignment.

Settings

The "Settings" buttons opens a dialog box (Figure 24) for configuring forward path settings.

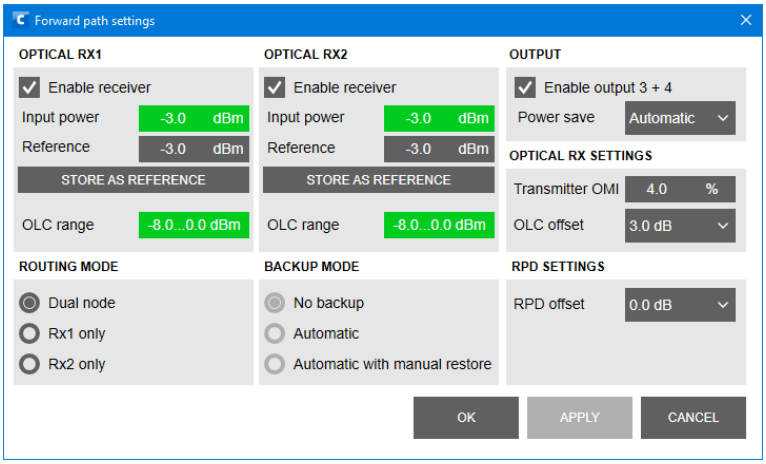

Figure 27. The Forward path settings dialog

Optical receivers

A receiver can be disabled if it is not needed. A disabled receiver's optical input power is not monitored and it disappears from the block diagrams on "Status" and "Forward path" page. Note that in order to use optical receiver 2, the receiver needs to be enabled and also a correct product key must be installed.

The "Reference" field can be edited to store the optical input power value for future reference. The "Store as reference" button opens a dialog box (Figure 25) which allows copying the current value to the reference value. In the dialog, it is also possible to enable optical input power minor alarm limits and set them according to the current value with user-specified margin, default ±2.0 dBm.

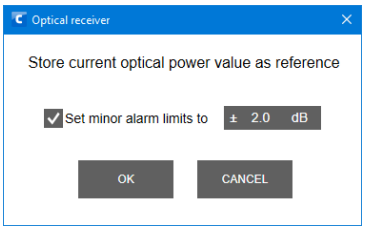

Figure 28. Forward path optical power reference dialog

Routing mode and backup mode

The RF routing and backup mode can be selected with the radio buttons. See “Features / Forward path signal routing and backup” chapter for details on backup switching logic.

If RPD is installed or optical receiver 2 is not enabled then backup mode defaults to "No backup" and routing mode should usually be set to "Rx 1 only". "Dual node" can also be used if RPD signals are needed only in outputs 1 and 2 and optical receiver 2 signals are fed to outputs 3 and 4.

Output

Output 3 can be disabled with the checkbox. It disables also output 4. See “Features / Output 3” chapter for details.

Outputs 2 and 4 are controlled with the output plug-in modules.

The power consumption of the output hybrids can be minimised by enabling power save if very high output levels are not used.

For details on output options and power save, see the "Features / Forward path" chapter.

Optical receiver settings

The "Transmitter OMI" and "OLC offset" parameters are common for both optical receivers. Transmitter OMI should be set according to the OMI of the optical signal received by AC9400. "N/A" is shown if both receivers are disabled. The OLC offset can be changed by the user or by automatic alignment from its default 0 dB value to balance signal levels with RPD signals, or to get very low output levels. See “Features / Forward path level control” chapter for details on these parameters.

RPD settings

The "RPD offset" parameter can be changed by the user or by automatic alignment from its default 0 dB value to balance signal levels with optical receiver signals, or to get very low output levels. See “Features / Forward path level control” chapter for details.

Pilots

The "Pilots" button opens a dialog box (Figure 26) for configuring the pilots.

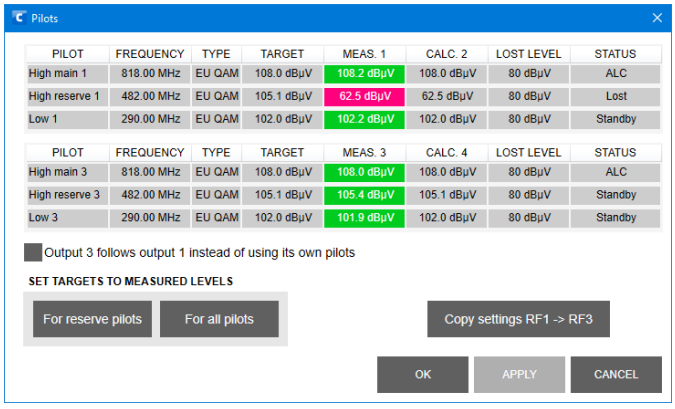

Figure 29. The Forward path pilots dialog

The pilot table consist of the following columns:

- **Pilot**: Main and reserve high pilots for both outputs, used by ALC and pilot based automatic alignment. Low pilot for both outputs, used by pilot based automatic alignment only. See the "Features / Forward path" chapter for details on pilot use.
- **Frequency**: Pilot signal frequency, adjustable in 0.25 MHz steps. If 0 MHz is entered as pilot frequency, the pilot is disabled and thus it is not used in adjustment and no alarms of missing pilot are generated.
- **Type**: Detector type. The measurement detector can be individually selected for each pilot to be either peak detect “Analog” or averaging “EU QAM”, “US QAM” or “OFDM”.
- **Target**: Pilot signal target level.
- **Meas.1/3**: Measured pilot signal level at output 1/3. The background colour is grey when pilot is disabled, red when its level is below lost level, green when its level is within ±1 dB from the target level, otherwise yellow.
- **Calc.2/4**: Calculated pilot signal level at output 2/4, based on the measured output 1/3 pilot level and installed plugin type. Shown in grey with no accuracy specification.
- **Lost level**: Limit below which the pilot is considered as lost.
- **Status**: Pilot status and usage. "Disabled": pilot disabled. "Lost": Pilot level below lost level. "ALC": Pilot OK and used for gain adjustment. "Standby": Pilot OK but not used for adjustment.

The pilot signal frequency, type, target level and lost level can be edited by double-clicking a row in pilot table.

The “Output 3 follows output 1 instead of using its own pilots” feature can be enabled with the checkbox. When enabled, AC9400 memorises output 1 and output 3 level difference, ignores output 3 pilots and adjusts output 3 according to output 1 changes.

The "Set targets to measured levels" buttons can be used to set either reserve pilots' or all pilots' target levels according to measured levels. This can be used e.g. after manual adjustment of output levels, before activating ALC.

The "Copy settings RF1 -> RF3" button can be used to quickly copy all output 1 pilot settings to output 3 pilot settings.

Return path viewer page

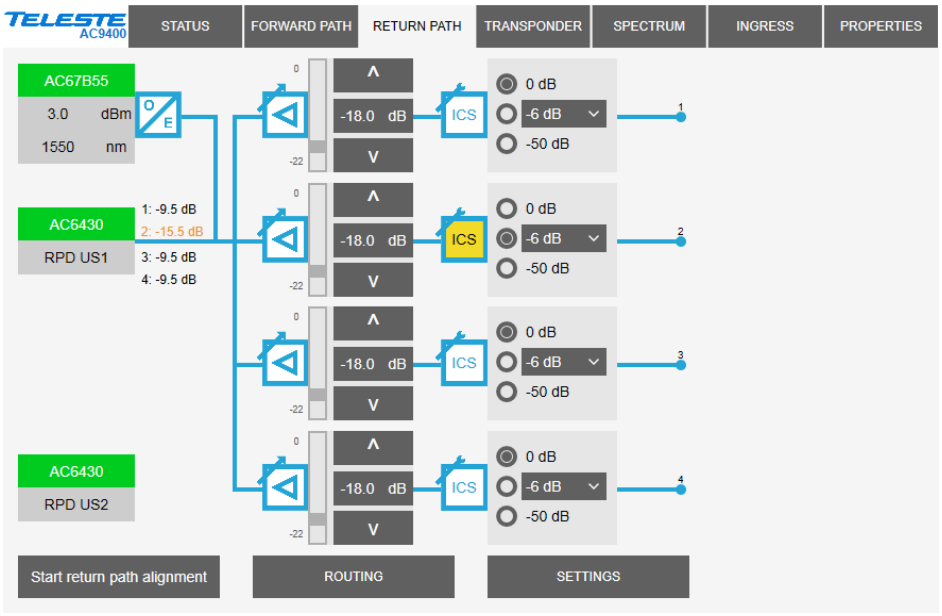

Figure 30. The Return path page

The “Return path” page displays all return path settings.

Optical transmitters and RPD interface modules

The types of installed optical transmitter modules, nominal optical output powers, and wavelengths are displayed of the left next to the "O/E" symbols. The background colour of the transmitter type changes according to laser bias current alarms.

Installed RPD interface modules are shown similarly. The calculated gain of the signal path between AC9400 return path input and RPD input is displayed next to each module separately for return path input port.

The routing status is displayed in the block diagram. Optical transmitter RF stages are shut down to save power for transmitters not receiving signal from the routing matrix. However, if the transmitter's pilot signal generator is enabled, the RF stages are always active. The laser is always on in modes 1-8 and 11-12, and depends on the routing status in modes 9 and 10, see Figure 15.

Gain control

The return path gain field and up and down buttons can be used to adjust the return path signal levels in 0.5 dB steps. The slider indicates the relative position of the control to its limits.

Ingress switches

The radio buttons are used to control the ingress switches. The “-50 dB” selection cuts off the incoming return path RF signal and thus also disconnects all transponders and modems behind this node, but the AC9400 itself can still measure return path ingress and communicate with its transponder.

The ingress switch attenuation value can be adjusted between 3…10 dB. This can be used to fine-tune the automatic ingress blocking feature.

The ingress switches are read-only if automatic ingress blocking is enabled.

Start return path alignment

Clicking the “Start return path alignment” button will start return path intelligent alignment. The adjustment parameters have to be set correctly via the "Settings" dialog before the adjustment is started. A dialog box is opened which displays the status of the alignment.

Routing

The "Routing" button opens a dialog box (Figure 28) for configuring return path routing and backup.

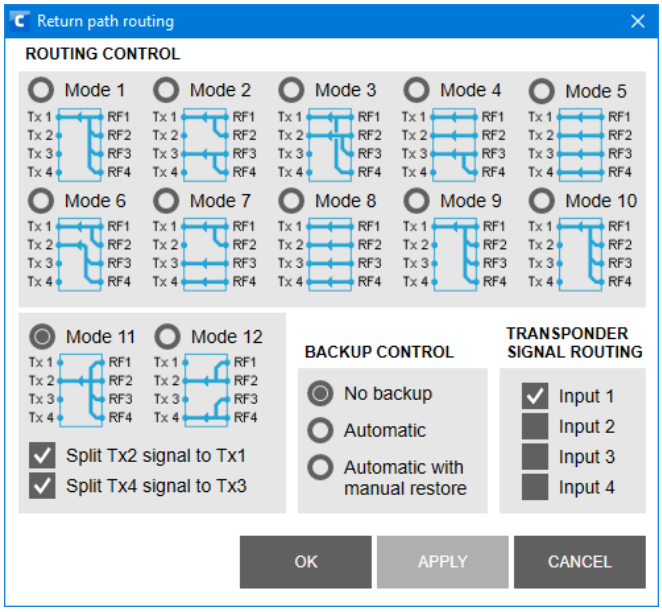

Figure 31. The Return path routing dialog

Only modes 11 and 12 should be used with AC9400 equipped with RPD. Other routing modes and backup control are disabled when RPD is installed. If analog transmitters are also installed with RPD, the return path signals can be split to both RPD and return path transmitter.

See “Features / Return path signal routing and backup” chapter for details on return path routing and backup switching logic.

The transponder transmit signal can be routed to selected return path inputs. Note that this also affects AC6992 transponder return path pilot generator signals. See "Features / Return path signal routing and backup" chapter for details.

Settings

The "Settings" button opens a dialog box (Figure 29) for configuring return path settings.

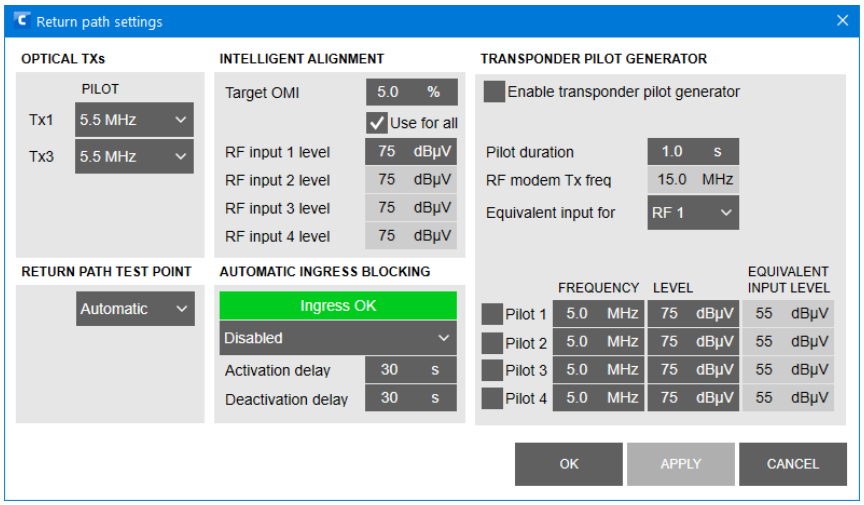

Figure 32. The Return path settings dialog

Transmitters

The pilot signal frequency (5.5 or 6.5 MHz) can be configured individually for each transmitter. The pilot signal can also be disabled. Note that this feature is independent of the transponder module's pilot generator.

Return path test point

In the default "Automatic" mode each installed transmitter / RPD interface module is connected to the OMI test point F connector for 10 seconds, then the next one and so on. The connected transmitter can also be selected from the drop-down menu. OMI testpoint cycling is restored after ~30 minutes.

Intelligent alignment

When forward path intelligent alignment is started, it uses these values for return path alignment. The target OMI is common for all transmitter. If no optical transmitters are installed the target OMI value is ignored and shown as "N/A", and signal levels are optimised for RPD input. RF input levels can be entered separately for each input, or use the same value by entering just the input 1 value and checking "Use for all".

Automatic ingress blocking

The ingress measurement status is displayed on the top of the frame:

- **Ingress OK**: Ingress measurement results are within limits.
- **Ingress alarm**: Ingress measurements are above major alarm limits.
- **Ingress warning**: Ingress measurements are above minor alarm limits, but "Ingress alarm" is not active.
- **Ingress analyser off**: Ingress analyser is disabled by the user.
- **No transponder**: No transponder module installed, AIB not possible.
- **Tuner module error**: Error in transponder tuner module.

When automatic ingress blocking (AIB) is enabled, ingress switches are controlled automatically based on ingress measurement results and activation and deactivation delays. AIB has 4 operation modes:

- **Disabled**: No automatic operation.
- **Alarm: Att**: “Ingress alarm” active for “Activation delay” time ➔ attenuate. “Ingress alarm” off for “Deactivation delay” time ➔ 0 dB.
- **Alarm: -50 dB**: “Ingress alarm” active for “Activation delay” time ➔ -50 dB. “Ingress alarm” off for “Deactivation delay” time ➔ 0 dB.
- **Warning: Att, Alarm: -50 dB**: “Ingress warning” active for “Activation delay” time ➔ attenuate. “Ingress alarm” active for “Activation delay” time ➔ -50 dB. Both off for “Deactivation delay” time ➔ 0 dB.

The activation and deactivation delays can be used to fine-tune AIB. They should usually be selected so that delays are smaller deeper in the network.

Transponder pilot generator

The pilot generator settings are visible when AC6992 transponder is installed and the pilot generator feature is enabled with correct Product Key. Note that this feature is independent of the optical transmitter module's internal pilot generator.

The “Enable pilot generator” checkbox is the master switch for return path pilot generator. When the pilot generator is enabled, the transponder outputs one of the pilot signals for a user-defined “Pilot duration”, then switches to the next pilot signal and then repeats again. The “RF modem Tx freq” field shows the modem transmit frequency as a reminder. The pilot generator signal is fed those return transmitters which are connected to RF inputs enabled in "Transponder signal routing" of "Routing" dialog (Figure 28).

Pilot frequency, level and enabling can be controlled for all four pilots separately. The equivalent input level for the selected return path RF input is shown next to each pilot. It takes into account return path losses, gain setting and ingress switch setting. When ingress switch is set to “-50 dB” the equivalent input level is shown as “N/A”.

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Transponder viewer page (CATVisor)

This page is visible with AC6992 transponder in CATVisor mode.

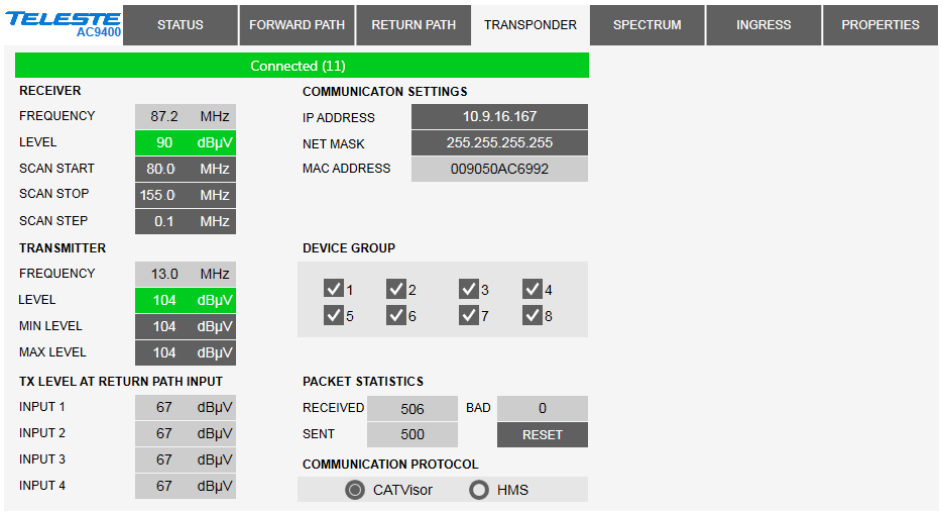

Figure 33. The Transponder (CATVisor) page

The “Transponder” page displays all the data and settings of the transponder’s RF modem and remote communication. See the “Features / Remote communication” chapter for details.

Changing any of the fields except transmitter min and max level on the "Transponder" page will reset RF modem communication.

Connection status

The communication status of the transponder is shown in the top of the page with

- **Scanning**: Searching for the HEC carrier.
- **Data carrier found**: Waiting for communication parameters.
- **Registering**: Registration in progress.
- **Connected**: Registration complete, communication OK.

The number in parenthesis is a more detailed status indicator for diagnostics purposes, ranging from 0 to 11.

Receiver

The “Frequency” data field shows the used receiver frequency.

The “Level” data field shows the measured signal level with a background colour indicating alarm status.

The “Scan start” and “Scan stop” fields determine the frequency band that the unit scans through when searching for the HEC carrier. Scanning can be disabled by setting the start and stop frequencies to the same value. Scanning speed can be improved by limiting the scanning range. The maximum range depends on the installed transponder type. The scan will start from the last known HEC carrier frequency.

The “Scan step” field sets the frequency increments of the scanning process, default and minimum value is 0.1 MHz.

Transmitter

The “Frequency” field shows the used transmitter frequency commanded by the HEC. The “Level” data field shows the transmitter signal level with a background colour indicating alarm status.

The allowed range for transmit signal level can be set in the “Min level” and “Max level” fields. The maximum range depends on the installed transponder type. If the HEC commands transponder to use transmit level outside this range, nearest allowed value is used and "Modem transmit level saturated" alarm is activated.

Tx level at return path input

These fields show the calculated equivalent input level for the transponder transmit level. This is the signal level that needs to be injected to return path input to appear at return path output at same level than transponder signal. It takes into account return path losses, gain and ingress switch settings.

Communication settings

The “IP address” field is used to define the IP address of the unit. The address has to be unique and match the HEC’s IP subnet settings to ensure proper operation and IP level communication with the HEC.

If the IP address is set incorrectly, e.g. 0.0.0.0, the transponder can still communicate with the HEC on MAC level, but IP traffic (e.g. CATVisor viewer messages) is not possible. It is possible to set the IP remotely via the HEC.

The “Net mask” field defines the corresponding IP subnet. It is only needed for broadcast software updates and has to be set according to the HFC subnet of the HEC; otherwise it can be left as 255.255.255.255.

The “MAC address” is the unit’s unique, read-only hardware address that is also printed on the transponder front panel sticker.

Device group

Manageable devices in the same HFC network can be divided into different device groups. The “Device group” check boxes can be used to group transponders under multiple HECs. For more information, see HEC manual.

Packet statistics

The “Received” field displays the total number of IP packets addressed to and received by this unit.

The “Sent” field displays the total number of IP packets sent by this unit.

The “Bad” field displays the number of all bad packets received and is a good indicator of the forward path condition.

Packet counters wrap around at 65535, so absolute values are not meaningful.

The "Reset" button will reset all packet counters to zero.

Communication protocol

It is possible to change between CATVisor and HMS on the fly. Careful planning is needed in e.g. HEC / HMTS setup for successful change, especially over remote connection. Changing the setting and clicking "Apply" will open a dialog for entering parameters specific for the selected protocol. After accepting the values the unit will reset and start communication using the new protocol.

Transponder viewer page (HMS)

This page is visible with AC6992 transponder in HMS mode.

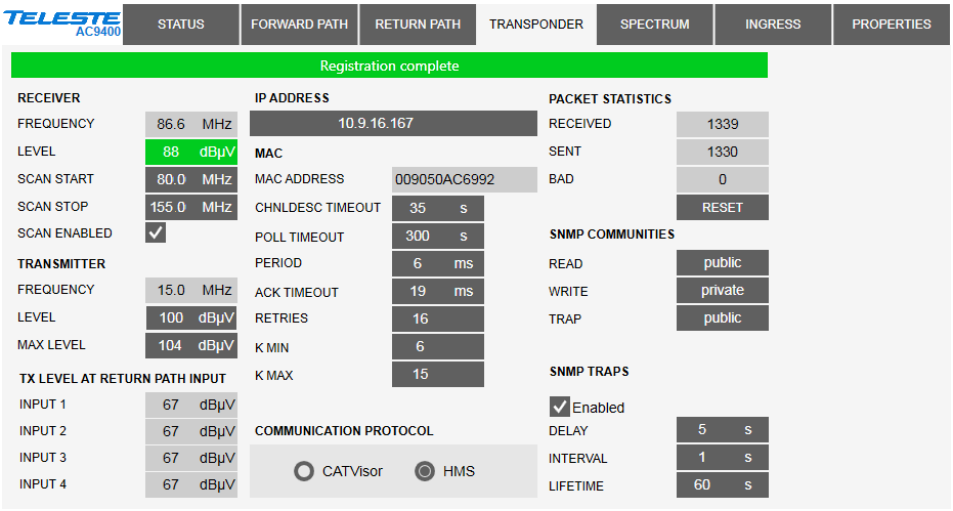

Figure 34. The Transponder (HMS) page.

The "**Connection status**", "**Receiver**", "**Transmitter**", "**Packet statistics**", "**Tx level at return path input**" and "**Communication protocol**" frames are the same as in the CATVisor version of this page and are described in the preceding chapter.

HMS standard does not support automatic transmit level alignment and therefore the transmit level is manually adjusted in the HMS version. See “Features” / “Remote communication” chapter for details.

IP address

This is the transponder’s IP address. In HMS this field is just a storage place. Depending on the used addressing method, the HMTS may or may not use this value. It may also change this value using MAC layer commands.

MAC

Unicast MAC: The transponder’s globally unique MAC layer address.

CHNLDESC timeout: HMTS broadcasts periodically the CHNLDESC packet that informs the transponders about data channel frequencies. This timeout defines how long the transponder waits for an eventual CHNLDESC packet, to define whether the carrier is an HMS channel. After the transponder is registered, it uses a timeout twice as long as the set value, to avoid the transponder from leaving the channel in case the reception of one CHNLDESC is unsuccessful.

Poll timeout: If the transponder receives no packets to its own MAC address, it will wait up to this timeout, before declaring itself as ‘forgotten’ by the HMTS. After this timeout expires, the transponder will start reregistration.

"**Period**", "**Ack timeout**", "**Retries**", "**Kmin**", "**Kmax**": These values are used by the backoff calculation algorithm, in case a collision happens in the return path transmission (two or more transponders transmitting simultaneously). These values are for experts only and should be changed only in special cases.

SNMP communities

SNMPv1 community strings. The transponder will only accept SNMP GET/GET NEXT commands containing the Read or Write community string and SET commands containing the Write community string. Traps are sent containing the Trap community string. Communities can be adjusted only locally.

SNMP traps

Enabled: Enables/disables the sending of HMS SNMP traps.

Delay: The time to wait before sending an HMS alarm trap, once an alarm is detected. This parameter can be used to control trap storms in amplifier cascades. By setting a longer delay deeper in the cascade, traps can be set to arrive on due order.

Interval: The minimum time between successive traps. This parameter applies only if several alarms are detected simultaneously.

Lifetime: The time the transponder keeps an HMS alarm trap in the transmit queue if it cannot be sent for some reason (controlled by HMTS).

All trap parameters are adjustable also remotely via TELESTE-COMMON-MIB.

Teleste MIBs are available at Teleste extranet (MyTeleste).

Transponder viewer page (DOCSIS)

This page is visible with AC6983 transponder.

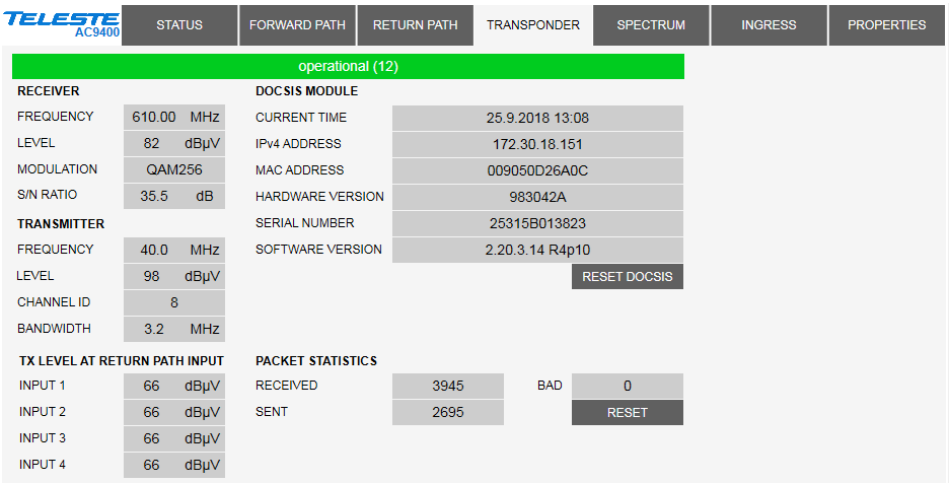

Figure 35. The Transponder (DOCSIS) page

The “Transponder” page displays read-only status information on DOCSIS communication. See the “Features / Remote communication” chapter for details.

Connection status

The communication status of the transponder is shown in top of the page. The number in parenthesis is a more detailed status indicator for diagnostics purposes, ranging from 1 to 13.

Receiver

The used forward path frequency, receive level at transponder input and modulation are shown in respective fields. "S/N ratio" is the measured signal to noise ratio at the DOCSIS receiver.

Transmitter

The return path frequency, transmit level at transponder output, channel ID and bandwidth are shown in respective fields.

Tx level at return path input

This is the signal level that needs to be injected to return path input to appear at return path output at the same level as transponder signal. The calculation takes into account return path losses, gain and ingress switch settings.

DOCSIS module

The current time and public IP address obtained from CMTS are shown in respective fields together with DOCSIS module hardware version, serial number, and software version. DOCSIS module software can be updated only remotely via CMTS using DHCP/TFTP. The MAC address is the unit’s unique, read-only hardware address that is also printed on the transponder front panel sticker.

The "Reset DOCSIS" button forces the module to re-establish the communication link.

RPD viewer page

This page is visible when RPD is installed.

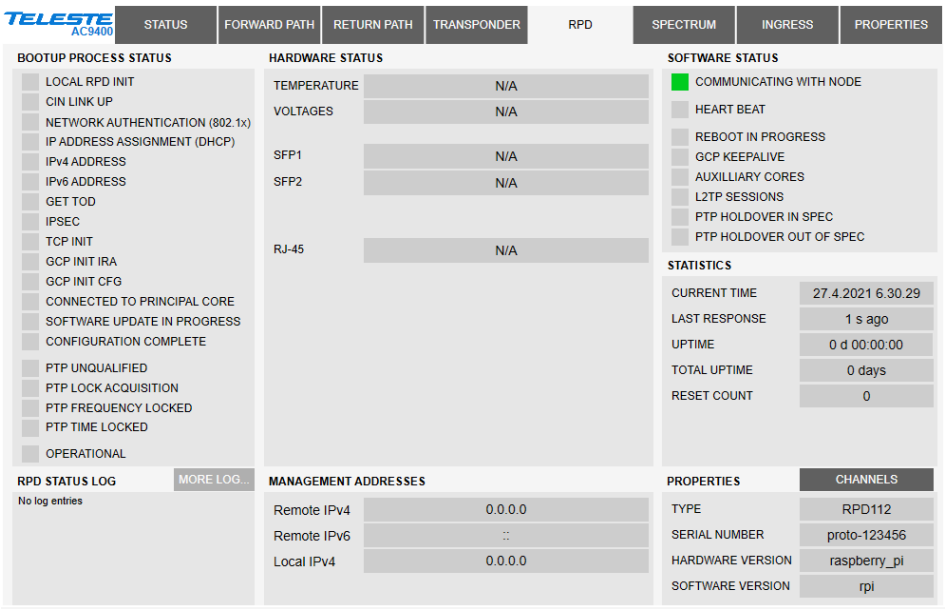

Figure 36. The RPD page

The “RPD” page displays read-only information received from the RPD module. See the RPD user manual for details.

Bootup process status and software status

RPD bootup process status and RPD software stetus is displayed with "traffic lights".

RPD status log

Detailed RPD status log messages can be seen with the "More log" button.

Hardware status

Measured temperature, voltages and detected interface modules are shown.

Management addresses

Shows the remote and local IP addresses for accessing the RPD, and AC9400 via it.

Statistics and properties

Shows similar data for RPD than the "Properties" page shows for AC9400.

The "Channels" button opens a window displaying the RPD generated channels in a spectrum analyser type view.

Spectrum viewer page

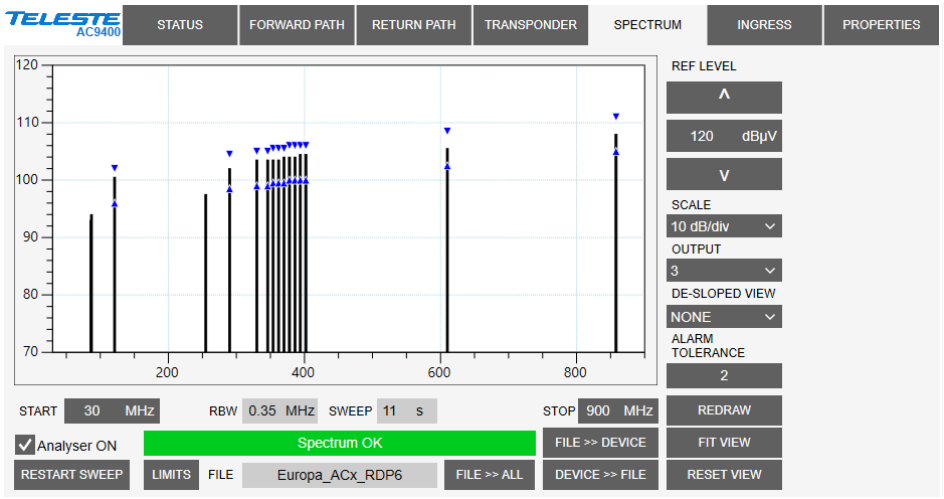

Figure 37. The Spectrum page

When the spectrum analyser feature is enabled with correct Product Key, the "Spectrum" viewer page presents forward path level measurements in a graphical “spectrum analyser” display. Up to 100 measurement frequencies with individual detector type and alarm limits can be specified with a simple text file separately for outputs 1 and 3. The measurement results can be saved back to a text file.

Display settings

When the viewer page is opened, the measurement results are retrieved from the device and displayed. The display can be zoomed or recentred by entering new values into start and stop frequency, reference level and scale dialogs and clicking “Redraw” button. The "Fit view" button scales the display so that all measurement frequencies are visible; "Reset view" button restores full-scale display.

The RBW (resolution bandwidth) is fixed by transponder hardware and depends on the installed transponder type, see transponder spec sheet.

The "Sweep" field displays the last elapsed time it took to scan through the complete set of measurement frequencies.

The “Output” drop-down box selects the displayed output. The spectrum measurement file, tolerance, and all display settings are individual for each channel, but the spectrum analyser main switch is common for both outputs.

The “De-sloped view” field can be used to simulate a view of a flat frequency response by reducing the level at the high end of the node’s response. The signal level at 1218 MHz is displayed with the attenuation specified in the "De-sloped view", signal level at 85 MHz is not affected at all and attenuation of the frequencies between these two are calculated using a standard coaxial cable model. The “De-sloped view” function acts only as a visual aid for making adjustments and does not affect device operation in any way.

If the graphical display is clicked the frequency, measured level, detector type and possible alarm limit values of the clicked measurement are displayed next to the clicked point.

Limits

The alarm limits for each measurement frequency are shown in the graph with blue triangles for minor limits and red triangles for major limits. If a measurement is over major limit it will be drawn in red; in blue if it is over minor limit; otherwise in black.

The "Tolerance" field specifies how many measurements are allowed to be outside limits before the "Spectrum warning" or "Spectrum alarm" alarm is activated. The default value 0 will generate the alarm even if only one value is outside limits. "Tolerance" allows fine-tuning the limit testing so that e.g. it doesn't react to one missing channel. The alarm is set or cleared at the end of each measurement cycle.

There is a fixed 1 dB hysteresis to prevent alarm toggling: once activated, the alarm only goes off when the measurement result is within (limit – 1 dB).

The “Limits” button opens a dialog box (Figure 34) which allows setting the alarm limits according to measured values, with user-specified offsets separately for minor and major alarm limits. The limit values are written also to the sweep file, and not to the device at all if “Save limits only to file” is checked.

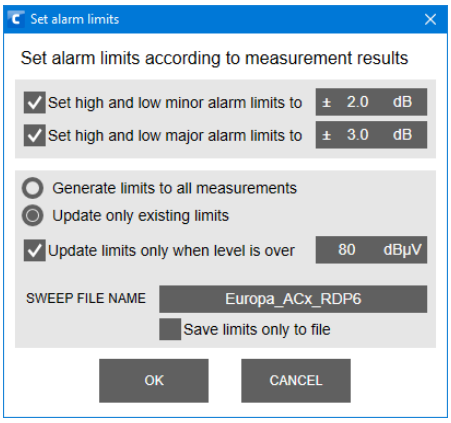

Figure 38. The Set alarm limits dialog

Analyser settings

The “Analyser on” is the master switch for spectrum analyser feature.

The data field next to the “Analyser ON” check box displays the spectrum status: Spectrum OK / Spectrum warning / Spectrum alarm / Spectrum analyser off.

The “Restart sweep” button clears the measurement results table and restarts the sweep. The “File” field displays the first 15 characters of the filename of the last sweep file downloaded to the device for selected output.

The “File >> Device” and “Device >> File” buttons open a file dialog for transferring a sweep/result file to/from the device. Files for each output are transferred separately, but can be loaded simultaneously for both outputs if “Load to all” is checked.

Sweep and result file formats

The sweep file is a simple text file than can be edited with any text editor and most spreadsheet applications. Each line in the sweep file defines one measurement frequency, preferably in ascending order. Each line has 2-6 fields separated with tab characters and dot (.) as the decimal separator:

1) The measurement frequency in multiples of 0.25 MHz.
2) The detector type:
    - **A**: analog peak detection
    - **D**: digital averaging detection (EU QAM)
    - **U**: digital averaging detection (US QAM)
    - **O**: digital averaging detection (OFDM)
3) Optional low major alarm limit in multiples of 0.5 dBµV.
4) Optional low minor high limit in multiples of 0.5 dBµV.
5) Optional high minor alarm limit in multiples of 0.5 dBµV.
6) Optional high major alarm limit in multiples of 0.5 dBµV.

Comments can be inserted at the end of the line, preceded with a tab character, or on a separate row which starts with a non-numeric character. Comments are for information only and will not be downloaded into the device and so they are lost if result table is uploaded back from the device.

An example of a valid sweep file:

```
113     D       96.0    98.0    103.5   105.5   All four limits
121.00  D       101                             Low major alarm
126.25  A                                       No limits
133.25  A                       95              High minor alarm
```

The result file format is identical to the sweep file format, except that it has a header row and an additional last column which contains the measurement results.

Ingress viewer page

Figure 39. The Ingress page

When the ingress analyser feature is enabled with correct Product Key, the "Ingress" viewer page presents return path level measurements in a graphical “spectrum analyser” display. Up to 20 measurement frequencies with individual detector type selection and alarm limits can be specified with a simple text file for each input. The measurement results can be saved back to a text file.

Display settings

When the viewer page is opened, the measurement results are retrieved from the device and displayed. If the graph is clicked the frequency, level, detector type and alarm limits of the measurement are displayed next to the clicked point. The display can be zoomed or recentred by entering new values into start and stop frequency, reference level, and scale fields and clicking the “Redraw” button. The "Fit view" button scales the display so that all measurement frequencies are visible; "Reset view" button restores full-scale display.

The “Input” drop-down box selects the displayed return path input. The ingress measurement file, tolerance, and all display settings are individual for each channel, but the ingress analyser main switch is common for all inputs.

The RBW (resolution bandwidth) is fixed by transponder hardware and depends on the installed transponder type, see transponder spec sheet. Due to the roll off of the RBW filter, a signal-free area is needed if noise levels are measured.

The "Sweep" field displays the last elapsed time it took to scan through the complete set of measurement frequencies.

The “Fast” checkbox forces the viewer to update the ingress measurement results faster but does not affect the actual measurement speed.

The “Multigraph” button displays all return path inputs simultaneously.

Limits

The alarm limits for each measurement frequency are shown in the graphical display with red triangles for alarm limit and blue triangles for warning limit. If

a measurement is over alarm limit it will be drawn in red; in blue if it is over warning limit but not over alarm limit; otherwise in black.

The "Tolerance" field specifies how many measurements are allowed to be over limits before the "Ingress warning" or "Ingress alarm" alarm is generated. The default value 0 will generate an alarm even if only one value is outside limits. The alarms are set or cleared at the end of each measurement cycle.

There is a fixed 1 dB hysteresis to prevent alarm toggling: once activated, the alarm only goes off when the measurement result is within (limit – 1 dB).

Analyser settings

The “Analyser on” is the master switch for ingress analyser feature.

The data field next to “Analyser on” check box displays the ingress status: Ingress OK / Ingress alarm / Ingress warning / Ingress analyser off.

The “Restart sweep” button clears the measurement results table and restarts the sweep. The “File” field displays the first 15 characters of the filename of the last sweep file downloaded to the device for selected input.

The “File >> Device” and “Device >> File” buttons open a file dialog for transferring a sweep/result file to/from the device. The “File >> All” button transfers the same sweep file to all return path inputs.

Sweep and result file formats

The sweep file is a simple text file than can be edited with any text editor and most spreadsheet applications. Each line in the sweep file defines one measurement frequency, preferably in ascending order. Each line has 2-4 fields separated with tab characters and dot (.) as the decimal separator:

1) The measurement frequency in multiples of 0.25 MHz.
2) The detector mode as "A"/"Analog" for peak detection or "D"/Digital" for averaging measurement.
3) Optional warning limit in multiples of 0.5 dBµV.
4) Optional alarm limit is in multiples of 0.5 dBµV.

Comments can be inserted at the end of the line, preceded with a tab character, or on a separate row which starts with a non-numeric character. Comments are for information only and will not be downloaded into the device and so they are lost if result table is uploaded back from the device.

An example of a valid sweep file:

```
Measures return path lowest frequencies
5.00    D       35.0    40.0    Comment
7.50    D       35.0    40.0    Another comment
10.00   D       35.0    40.0
12.50   D       35.0    40.0
```

The result file format is identical to the sweep file format, except that it has a header row and an additional last column which contains the measurement results.

Properties viewer page

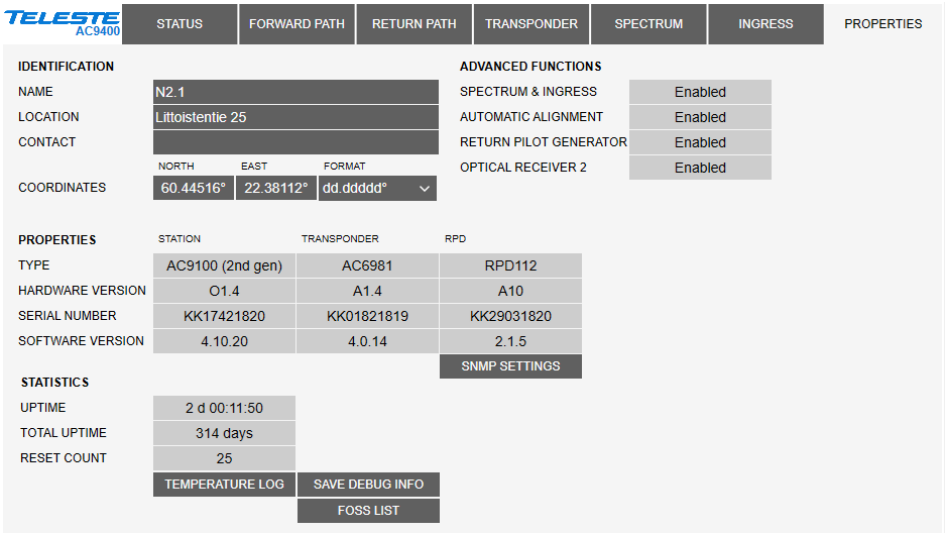

Figure 40. The Properties page

The “Properties” page displays unit identification and statistics data.

Identification

A descriptive alias name for the station can be entered into the “Name” field, site location into the “Location” field and contact information into “Contact” field. All these fields can contain up to 63 characters.

The geographical coordinates can be entered into respective latitude and longitude fields. The preferred format can be selected from the drop-down field. When entering coordinates, special characters (º/'/") can be simply omitted.

Properties

The type, hardware version, serial number, and software version are shown for the station and installed modules. The “SNMP settings” button opens a dialog box for configuring the SNMP settings for AC9400 management via RPD.

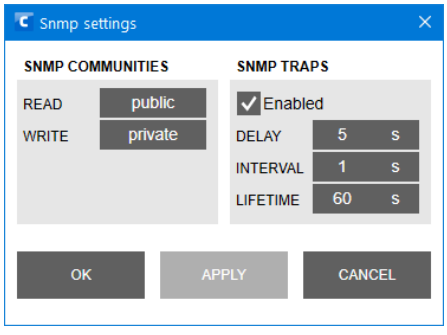

Figure 41. The SNMP settings dialog

Advanced functions

The statuses of advanced functions associated with Product Key are shown. These only indicate that the function is possible in the software, but does not display whether a correct transponder module is installed for that function.

Statistics

The “Uptime” field shows the time since the last reset or power-up. The format is days, hours, minutes and seconds, with ±5 s/day accuracy.

The "Total uptime" field shows the total number of full operating days. The "Reset count" field shows the total number of resets.

The “Temperature log” button opens a histogram chart of the unit's internal temperature history. The histogram shows the total number of operating hours of the unit in 10 °C steps between 0 (i.e. < 5) and 90 (i.e. > 85) °C.

The "Save debug info" button reads the unit's non-volatile memory contents and opens a dialog for saving it into "devicetype-serial-date.fun" and ".sad" files which can be sent to Teleste support to help troubleshooting problems.

Legal declarations

Teleste reserves the right to make changes to any of the products described in this document without notice and all specifications are subject to change without notice. Current product specifications are stated in the latest versions of detailed product specifications.

To the maximum extent permitted by applicable law, under no circumstances shall Teleste be responsible for any loss of data or income or any special, incidental, consequential or indirect damages howsoever caused.

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