

Microwave data link
AL5F MP400/360/165
Licensed exempt frequency band 5 GHz
Installation and operation manual



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1. INTRODUCTION

The radio relay link AL5F MP400/360/165 as a whole or as parts is not intended to be used by untrained personnel. Installation, adjustments and maintenance must be performed only by a person with electrotechnical qualifications trained by the manufacturer.

The link AL5F MP400/360/165 is an information technology device, to which the ČSN EN 50 116 – Routine electrical safety testing in production standard applies. If the power supply (BKE-JS 38 – 480/DIN, BKE-JS 150 – 480/DIN) is a part of delivered merchandise, a copy of its testing protocol can be ordered from the manufacturer.

Please read this operation manual carefully before installation and operation of the duplex microwave link for data transmission ALCOMA AL5F MP400/360/165. Please pay increased attention to the safety instructions that are marked like this in the text:



WARNING

Violating of thus marked safety instructions can cause serious injury to personnel



CAUTION

Violating of thus marked instructions can cause damage to the equipment.



EXPIRATION

The link is provided expires. The expiry date is indicated on the ODU, invoice and in ASD Client program (Supervisor - Identification - Local/Remote station).

Prior to the end of expiration, please contact our sales department ALCOMA to send codes to unlock.

Beyond the expiration link only transmits management data.

1.1 BASIC DATA

- License free frequency bands 5 GHz (5.479 – 5.535, 5.665 – 5.721 GHz)
- The ALCOMA AL5F MP400/360/165 link is designed as unattended
- The data transmission capacity is up to
 - 830 Mbps for MP400 link
 - 384 Mbps for MP360 link
 - 165 Mbps for MP165 link
- channel bandwidth
 - 3.5 MHz to 112 MHz for MP400 link
 - 3.5 MHz to 56 MHz for MP360 link
 - 7 MHz to 28 MHz for MP165 link
- Digital modulations
 - QPSK to 1024 QAM for MP400 link
 - QPSK to 256 QAM for MP360 link
 - QPSK to 128 QAM for MP165 link
- Hitless ACM Adaptive Coding and Modulation for MP400 link
- ACM (Adaptive Coding and Modulation) for MP360 and MP165 link
- ATPC automatic output regulation (ATPC lowers mutual interference of links and lowers operational costs)
- Advanced FEC forward error correction
- Full duplex operation
- Point to Point type link
- Vertical or horizontal polarization
- Interfaces: 2 x 10/100/1000 Base-T(X) channels marked as User Line2 and User Line 3 + power
- Optional possibility of 1 x Eth1000BaseLX(SX, BX) – marked as user line 4
- 1 or 2 independent user Ethernet channel are transmitted, there is possibility to select transmission of diagnostic data through channel 1 or channel 2 using diagnostic software ASD
- The link consists of the outdoor ODU unit, protected terminal box ALS1-GEth or ALS1-2GEth and the appropriate cables
- The link is supervised by the ASD Client program through a web interface, hyperterminal, or SNMP protocol Ver. 1
- For the monitoring program ASD Client actual version see the following web page: www.alcoma.eu
- It is possible to insert several relay stations in a signal path if needed due to the path character
- The radio relay link AL5F MP400/360/165 enables using of third-party the antenna connected via N-connector
- ODU contains the acoustic signalization of incoming signal level RSSI

**WARNING**

The microwave link outdoor unit contains a microwave transmitter, which causes the health risk of non-ionizing radiation while in operation. It is dangerous to look directly into the antenna, or stay close in front of it, while the transmitter is in operation. The danger increases in direct proportion to the transmitted output. It is not allowed to switch on the transmitter without connected parabolic antenna. During work on and presence by the antenna, while the transmitter is in operation, the Government Directive 480/2000 About protection of health against non-ionizing radiation requirements must be met.

The radio relay link ALSF MP400/360/165 station consists of three main parts. Link is below referred to as **ALSF MP400/360/165**.

1. The outdoor microwave unit that is integral with the antenna contains:
 - The RF block that includes the microwave receiver, power amplifier, and oscillators controlled by the phase-lock loop.
 - The data block that includes GETh 1000/100/10 switch, a modem and the monitoring system supervised by a controller. The power supply block that consists of DC-DC transformers that power the whole station. This complete block has been designed on one printed circuit board (PCB) which removed a lot of circuits and thus significantly increased reliability.

(Then there is the outdoor microwave unit called **ODU** - Outdoor unit for short in the text.)

2. The antenna set with the parabolic antenna, the feed element and the pole attachment.
3. Considering placement of the data block in ODU, the station ALSF MP400/360/165 has an indoor unit reduced to the protected terminal boxes **ALS1-GETh** or **ALS1-2GETh**, that ensures transmission of customer data, powering of the station, and protection against the atmospheric origin overvoltage and overcurrent. (The protected terminal box is marked as **ALS1x** in the further text.)

ODU is attached separately to the ODU holder. RRL is designed for use with third-party antennas. Antenna and ODU are connected via coaxial cable with N connector. Cable attenuation must be less than 1 dB, impedance 50Ω.

Interconnection between the protected terminal box and ODU is done by a double shielded outside cable (S-STP Cat 7) with 4 pairs of conductors with the 100 Ω impedance. The link cable transmits customer data, powering for ODU and ODU monitoring signals.

2. LINK DESCRIPTION

User data are connected to the protected terminal box ALS1x by the standard RJ45 connectors. The two-stage terminal protection limits breakdowns caused by overvoltage originating in atmospheric electricity, or due to industrial breakdowns. The protected terminal box contains user selectable jumpers enabling its optimum grounding and adjustment.

Also ODU is powered using the protected terminal box. The power supply in the range of +36 to +72 V, with the typical value of +48 V, is protected by the tube thermal fuse T2.0 A. The presence of supply voltage is indicated by a green LED. The supply voltage is transported to ODU by all four pairs of connecting cable conductors.

CAUTION



Link ALSF MP400/360/165 use only with protected terminal box marked **ALS1-GEth** (121/516*29), or **ALS1-2GEth** (121/516*30).

It is important to keep proper link of all connecting cable conductors both in ODU and ALS1x. There is danger of equipment damage in case that the links are not connected properly.

The main line power supply of the category SELV according to the ČSN EN 60950 "Information technology - Safety of information technology equipment ..."

The power cable ALS1x is connected by the connector that is screwed on the box of the protected terminal box, and so guarantees a reliable link.

The protected terminal box is connected to ODU by a single shielded cable with 4 pairs of conductors. This cable is both on the side of the protected terminal box, and the ODU side connected by the "Krone" cutting boxes. The link cable passes through cable screw-in grommets on both sides, and so it is firmly attached to the box. The total length of the link cable and the cable that brings data into the protected terminal box can be max. 90 m long for the 1 Gbps Ethernet, for the Ethernet speed of 100 Mbps it can be max. 100 m long. These lengths are set and verified for the recommended cable S-STP Cat. 7. by ACOMA. The terminal box ALS1x is passive and the cable length must be considered from the terminal user device all the way to ODU.

Protected ALS1x terminal is adapted for mounting on DIN rail TS35. By constructing three blocks ALS1x and making the connecting pieces can create a compact unit for installation into 19" 1U building.

The mechanical design of the protected terminal box assumes installation into a 19" rack. The design allows sufficiently flexible arrangement of outputs without additional mechanical adjustments. The protected terminal box allows bringing the connection cable with ODU to the front, or backing panel. Customer data and the power supply can be brought to the front panel only. The arrangement can be modified according to customer wishes, and it is possible to deliver an arrangement that will suit the station, while it not necessary to have the outputs identically arranged in a box.

The ODU input has similar over voltage protection as the one in the protected terminal box, including a separate supply voltage. The supply voltage separated in the over voltage protection is brought to the switch-on power supply. Activity of the ODU supply is indicated by the green LED placed on the mother board in the space of the user terminal box. Monitoring data are added to the user line (Line3 or Line2) in the outdoor unit (ODU).

The high frequency block of the ALSF MP400/360/165 link consists of a microwave receiver, transmitter, microwave oscillators and other support circuits.

Microwave oscillators generate signals for mixers in the receiver and transmitter. Its frequency is controlled by the PLL loop. Accuracy and stability of the frequency adjustment is determined by a crystal oscillator.

The intermediate frequency signal at the 350 MHz frequency from the modem is mixed with the signal from a microwave oscillator, filtered, and power amplified. The signal goes through a branch, where the transmitted output detection circuit resides. From there the transmitter signal goes through a diplexer to the transmitting antenna.

A received signal from the parabolic antenna is led through the diplexer to the receiver. There it is amplified and mixed to the intermediate frequency of 140 MHz and further amplified. From there the signal goes to a modem.

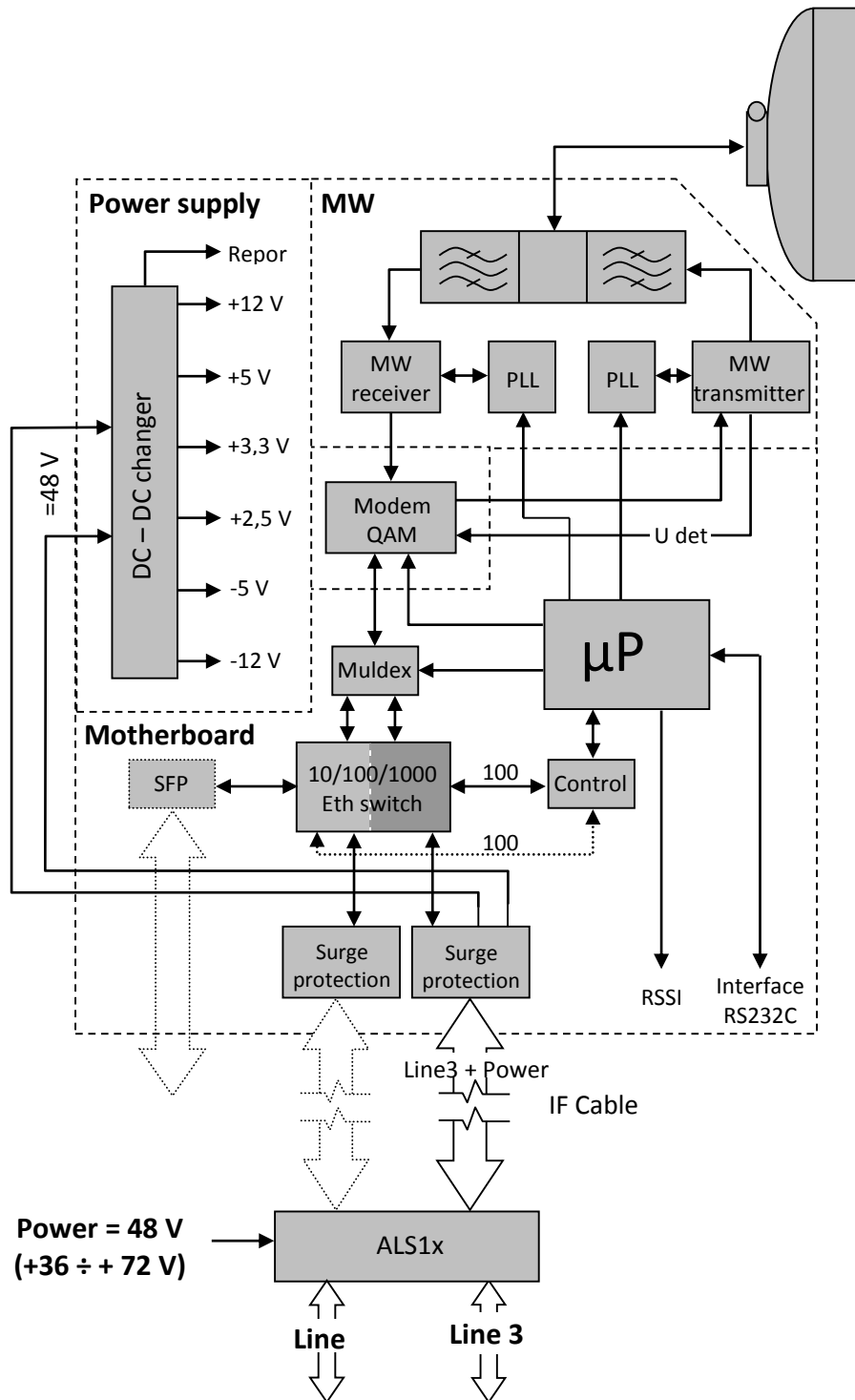


Figure 1 The block schematic of the AL5F MP400/360/165 link

**CAUTION**

Link ALSF MP400/360/165 use only with protected terminal box marked **ALS1-GEth** (121/516*29), or **ALS1-2GEth** (121/516*30). or protected terminal box **optimized for power backup ALS1-GEth RP** (121/516*33), or **ALS1-2GEth** (121/516*34).

The demodulated signal goes from the modem to a muldex, where user data (Ethernet) are separated from the monitoring data. The user data are sent to the protected terminal box again through the overvoltage protection by a connection cable with 4 pairs of conductors.

The voltage on the RSSI connector (Figure 8) is proportionate to the intensity of the signal received from the opposite station. This voltage determines the height of the tone for the acoustic transformer that serves as an indicator during pointing of the link.

TX power regulation

TX power must be regulated from diagnostic system according to local regulations.

2.1 PROTECTED TERMINAL BOX ALS1-GETH / ALS1-2GETH

Protected terminal box ALS1x is intended for simultaneous transmission of two channels of Ethernet. This terminal box protects customer data and power station overvoltage of atmospheric origin. ODU power supply divides into four pairs of cable that connects it to the ODU. The protected terminal box can be used only with the link type ALSF MP400/360/165 (see plate at ODU). The numbers in the terminal nameplate is ALS1-GEth 121/516 * 29 (ALS1-2GEth 121/516*30).

Protected terminal ALS1x is designed for mounting on DIN rail TS35. By giving the three protected terminals can be create a unit for installation in standard 19" a 1U. The connection terminals shall be protected by connecting sections. Before inserting the bearing and coupling profiles into terminal slots protected, you need to enable bolts. (Tighten the bolts will provide profiles of anti-slip.)

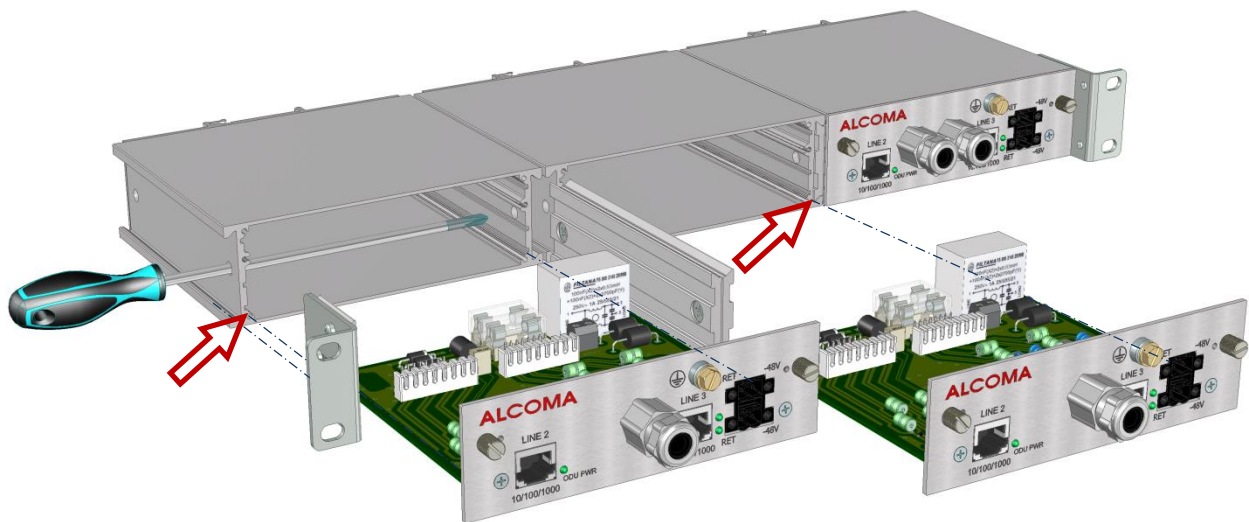


Figure 2 Assembling the three ALS1x to 19" 1U unit



Figure 3 Protected terminal box ALS1-GEth



Figure 4 Protected terminal box ALS1-2GEth



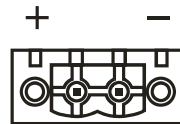
Figure 5 Protected terminal box ALS1-GEth RP



Figure 6 Protected terminal box ALS1-2GEth RP

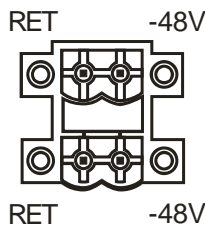
2.1.1 Input Connectors

Power supply connector on the front panel ALS1x



48V DC

The connection cable for this connector ends with fork type 1777989 Phoenix (0395340002 Molex) Type designation corresponds to the catalog Phoenix (Molex).



The connection cable for this connector (bottom position) ends with fork type 1777989 Phoenix (0395340002 Molex) and second connection cable for this connector (upper position) ends with fork type 1805301 Phoenix. Type designation corresponds to the catalog Phoenix (Molex).

RJ45 connectors for user line input

User lines 2 and 3: **1000Base-T**

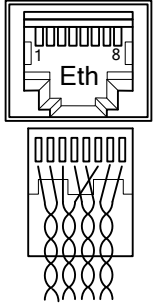
Wiring	Pins	Description
	1	A+
	2	A-
	3	B+
	4	C+
	5	C-
	6	B-
	7	D+
	8	D-

Table 1 The RJ45 connector wiring - user lines Eth2 and Eth3



The AutoMDIX function assures switching of RX and TX as needed.

2.1.2 Output Connectors

Cutting box "Krone" for the line 2



Attention!

Line 2 does not include power supply.
(The connector is plugged mirrored compared to ODU)

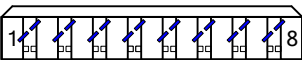
Wiring	Pins	Description	The marking of cable conductors S-STP Cat7
	1	A+	white
	2	A-	green
	3	B+	white
	4	B-	orange
	5	C+	blue
	6	C-	white
	7	D+	white
	8	D-	brown

Table 2 The protected terminal box - cutting box "KRONE" for the line 2

Cutting box "Krone" for the Line 3 + Power



Line 3 + Power
(The connector is plugged mirrored compared to ODU)

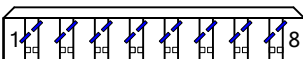
Wiring	Pins	Description	The marking of cable conductors S-STP Cat7	Powering
	1	A+	white	-
	2	A-	green	-
	3	B+	white	+
	4	B-	orange	-
	5	C+	blue	-
	6	C-	white	-
	7	D+	white	+
	8	D-	brown	-


Table 3 The protected terminal box - cutting box "KRONE" for the line 3 + Power



The cable ACOME S-STP Cat7 has its shielding connected to ground through the metal input grommet. If the cable has the shielding coming out through one conductor it can be connected to any shielding pin.

2.1.3 Indikace

Board: Protected terminal box

LED	Abbreviation	Meaning
 G	POWER	Power ON – indication of the station power supply being switched on

2.1.4 Jumpers - without function for the S-STP Cat7 cable

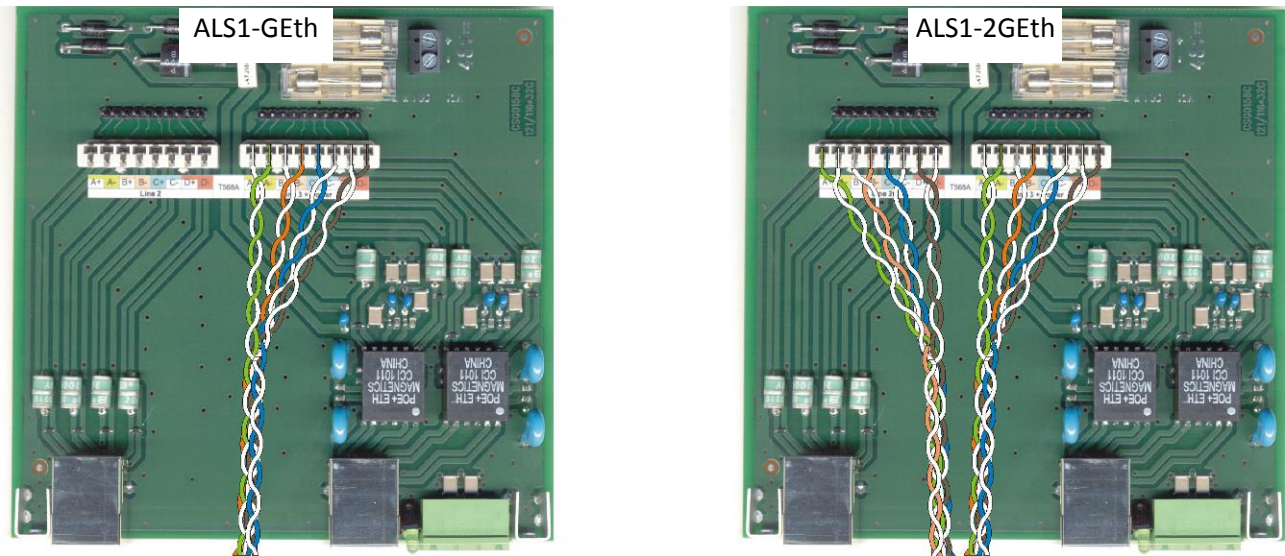


Figure 7 Wiring in the terminal box ALS1-GEth, ALS1-2GEth

2.2 THE OUTDOOR UNIT (ODU)

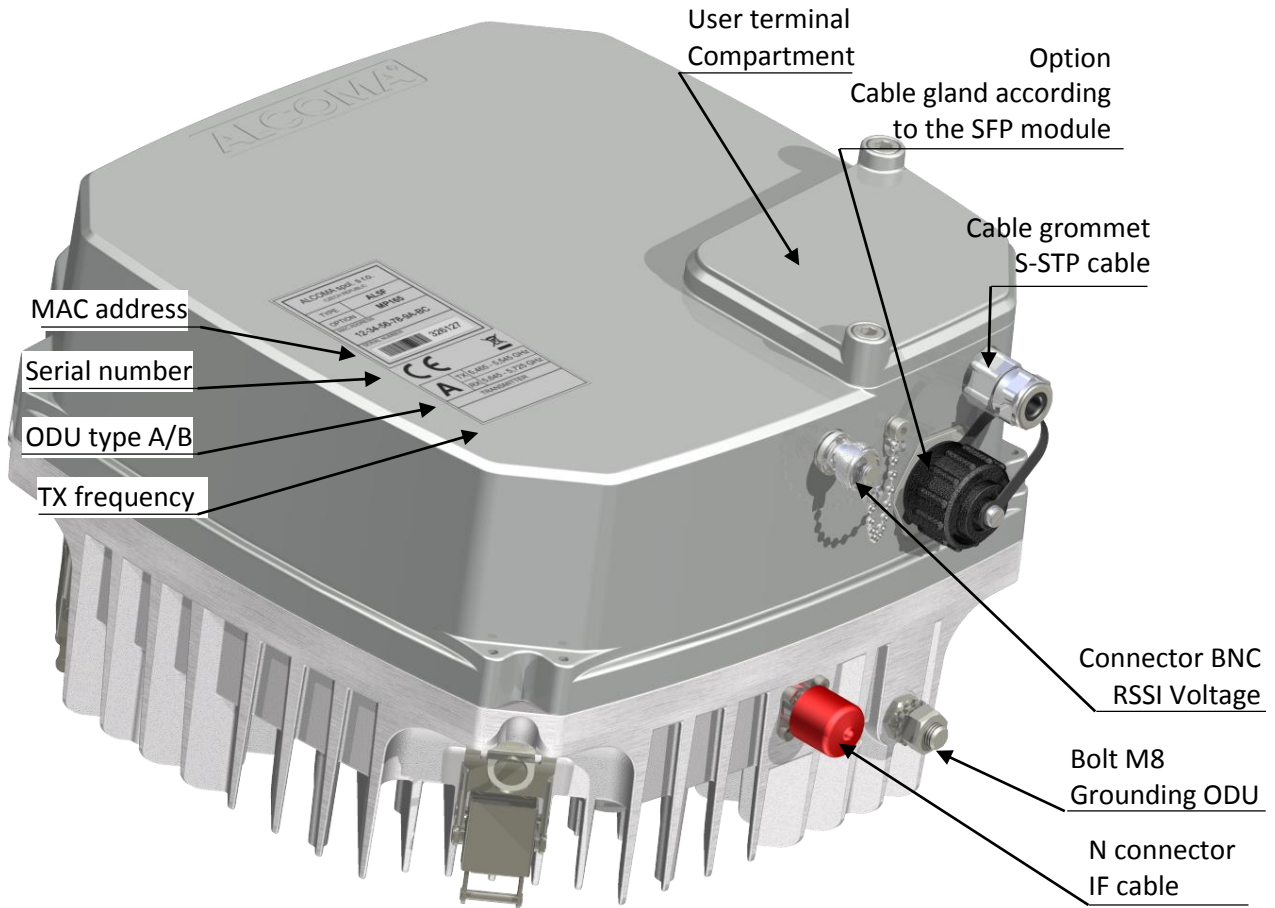


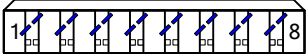
Figure 8 The ODU connection places

ODU is attached separately by 4 latches to the ODU holder. Antenna and ODU are connected via coaxial cable with N connectors. Cable attenuation must be less than 1 dB, impedance 50Ω. Recommended length of the connecting cable is 0.5 m.

The outdoor unit (ODU) is placed into a full metal box. ODU is painted light gray that protects it from extreme temperatures, but especially contributes in creating of needed temperature balance inside of the ODU.

Input Connectors

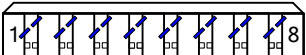
Cutting box “Krone” for the line 2

Wiring	Pins	Description	The marking cable conductors S-STP Cat7
	1	D-	brown
	2	D+	white
	3	C-	white
	4	C+	blue
	5	B-	orange
	6	B+	white
	7	A-	green
	8	A+	white

For simpler description the table does not consider the active functions AUTO MDIX.

Table 4 The outdoor unit - cutting box “KRONE” for the line 2

Cutting box “Krone” for the line 3 + Power

Wiring	Pins	Description	The marking of cable conductors S-STP Cat7	Power supply
	1	D-	brown	
	2	D+	white	+
	3	C-	white	
	4	C+	blue	-
	5	B-	orange	
	6	B+	white	+
	7	A-	green	
	8	A+	white	-

Shielding S1 ÷ S4 for the cable ACOME S-STP Cat 7 is connected to ground through the metal input grommet.

Table 5 The outdoor unit - cutting box “KRONE” for the line 3 + power

Connector for direct connection of power supply

This connector can be used to power ODU see examples on chapter 3.6, page21. Description of the pins is shown on the label in the ODU user space. Power supply cord is connected to the terminal block in the user space ODU unused grommet for S-STP cable.

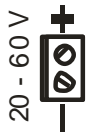
Wiring	Pins	Color
	+	red
	-	blue

Table 6 Connector for direct connection of power supply

Connector PFL10 for direct connection of PC

PC running ASD Client can be connected directly to the ODU via connector PFL10. Access to the connector PFL10 is possible after removing the cap user space. On this connector are brought RS232 signals.

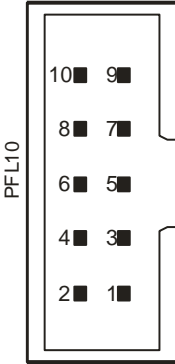
Wiring	Pins	Description
	1	DCD
	2	DSR
	3	RX
	4	RTS
	5	TX
	6	CTS
	7	-
	8	-
	9	GND
	10	-

Table 7 Connector PFL10 for direct connection of PC

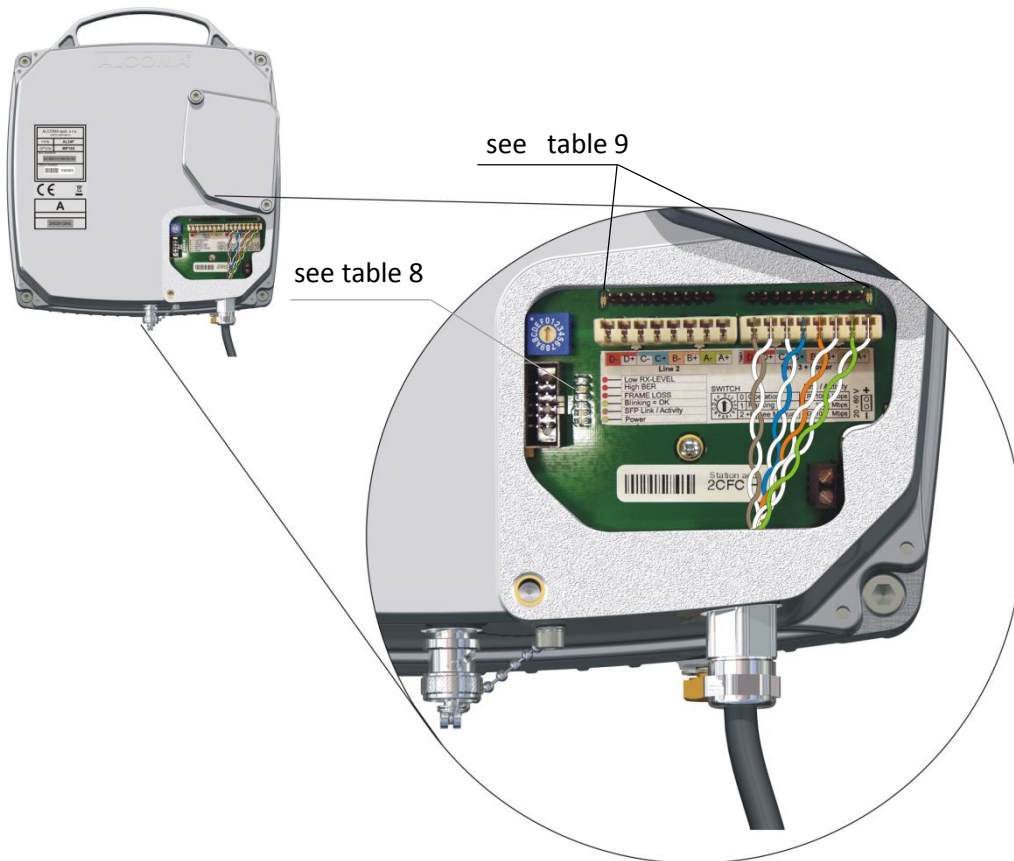


Figure 9 The ODU user space 1xEthernet

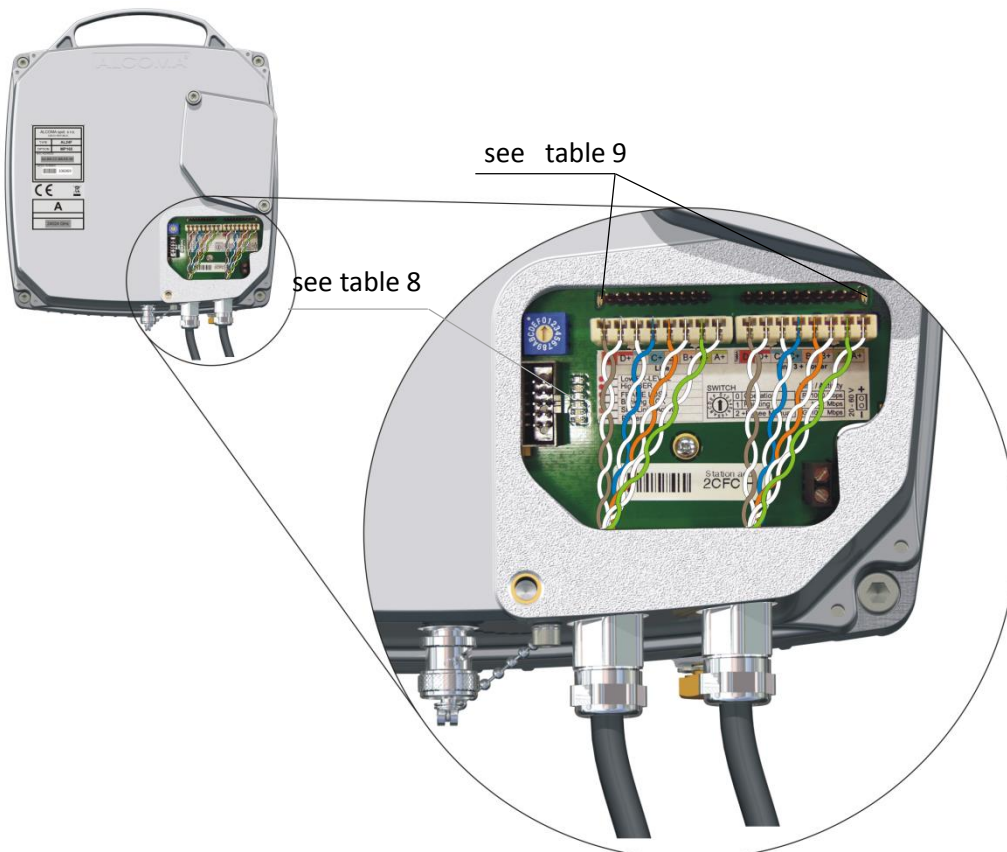


Figure 10 The ODU user space 2xEthernet

Indication







LED	Description	Meaning
 R	Low RX-LEVEL	Low level of the input microwave signal
 R	HIGH BER	Increased errors on the microwave path
 R	FRAME LOSS	Loss of frame sync
 G	Blinking = OK	Blinks = monitoring system does not register any error states at the moment. Light on / Light off = monitoring system indicates an error state
 YG	SFP Link / Activity	Orange = Link to SFP. Green = activity
 G	Power	Indication for stable output voltage of +3.3 V

Table 8 Meaning of LEDs in the ODU user space




colour of LED	Meaning
 R	Link 1000 Mbps
 RG	Link 100 Mbps
 G	Link 10 Mbps
Blinking	Traffic

Table 9 Meaning of LEDs next the cutting box "KRONE" in the ODU user space

Rotary function switch

The rotary switch is located on the mother board. It is accessible after flipping off the lid on the ODU cover. The station does not have any other elements that can be changed during normal operation.

Position	Description
0	Normal station operation
1	Pointing
2 ÷ F	Reserve - not used yet

Table 10 Description of functions of the rotary switch in the ODU user space

The rotary switch in the position Pointing (1) also switches off a transmitter of the local station. Switching off of the output also in the remote station by the rotary switch can be used to find a level of interference signals (background noise) on given channels.

The AL5F MP400/360/165 station is optimally tuned during manufacture, set and tested in accordance with guaranteed parameters and customer requirements. If there is a new requirement to retune to a different channel or for a configuration change (possible on this equipment) after installation or inspection, it is possible to do this work using the monitoring program only. Retuning to a different frequency range that requires replacement of microwave filters can be done at the manufacturer only.

3. INSTALLATION INSTRUCTIONS

3.1 EVALUATION OF SUITABLE PLACEMENT

For installation and proper operation of the radio link the following must be provided:

- Direct optical visibility
- Place for attachment of antenna with ODU
- A place for the protected terminal box ALSx
- Path to lay the ODU – ALSx connection cable

Guaranteed direct visibility is not always sufficient guarantee of a quality connection. A condition for a trouble free propagation of electromagnetic waves is a pure radio visibility. If fixed objects, like tree tops, mountains or buildings are too close to the signal route, they can distort or attenuate a radio signal. This occurs even in cases when these obstructions do not prevent direct visibility. This phenomenon can be explained by the radio beam Fresnel zone – an elliptical area that immediately surrounds the direct visibility axis (the line between link antennas). Size of this zone varies depending on the hop length and radio signal frequency. The Fresnel zone must be calculated before design of the wireless link and it must be verified that it will not be disturbed by any obstacles.

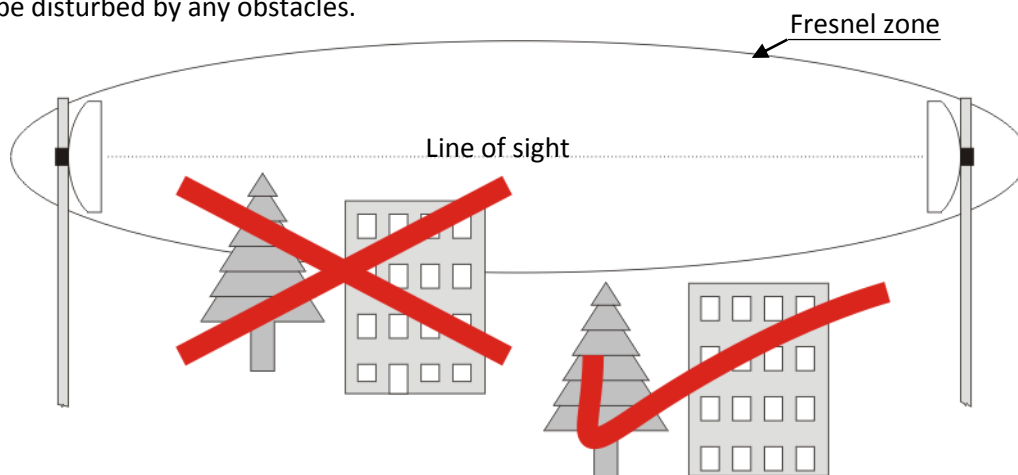


Figure 11 The Fresnel zone

Figure 11 shows situation when a solid object penetrates a Fresnel zone of signal propagation. The obstacle, just like the one on the figure, causes bending of the beam along the sharp edge. This beam then arrives at the receiver antenna little bit later than the direct beam. In other words there are two identical signals coming to the antenna, but with various phases, which strongly degrades the signal quality; and this can cause temporary break in data transmission. Trees or other “soft” objects infringing on the Fresnel zone attenuate the radio signal. In short: The fact that you can see the opposite side does not mean that you can set up a quality radio connection.

3.2 PLACEMENT OF THE ANTENNA ON A SUPPORT CONSTRUCTION

The antenna of radio link must be placed sufficiently far away from other antennas, in order to avoid undesirable perturbation of radio signal. Badly installed antenna will cause deterioration of our transmitted signal and also of the signals of neighboring links. During installation of a radio relay link we need to calculate with a distance from the roof edge or different obstacles that can be present on the roof (A/C, elevator shaft...). The following figures show incorrect and correct ways of installation of radio relay link antenna on the supporting construction.

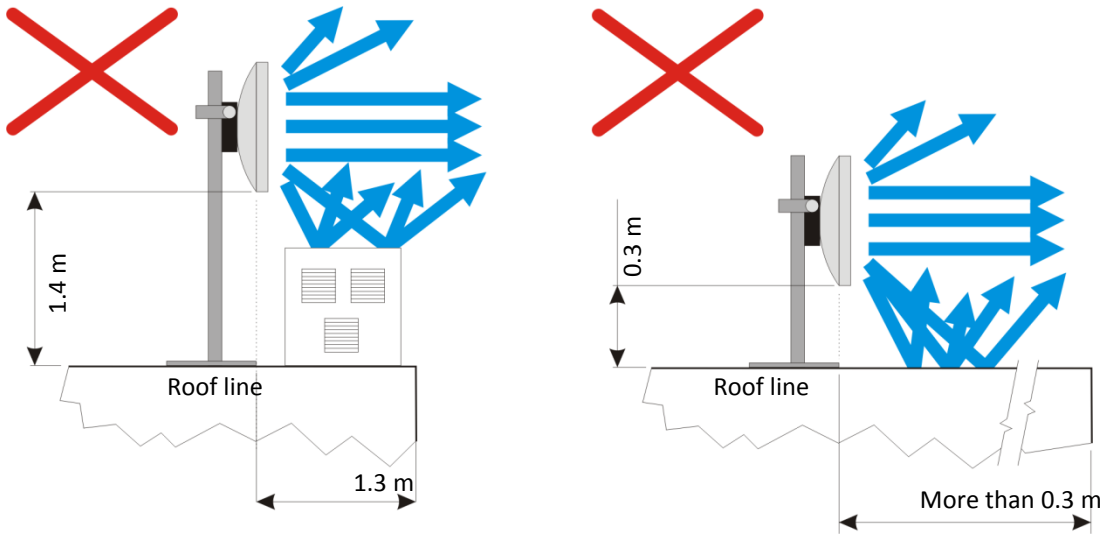


Figure 12 Improper placement of antenna on supporting construction

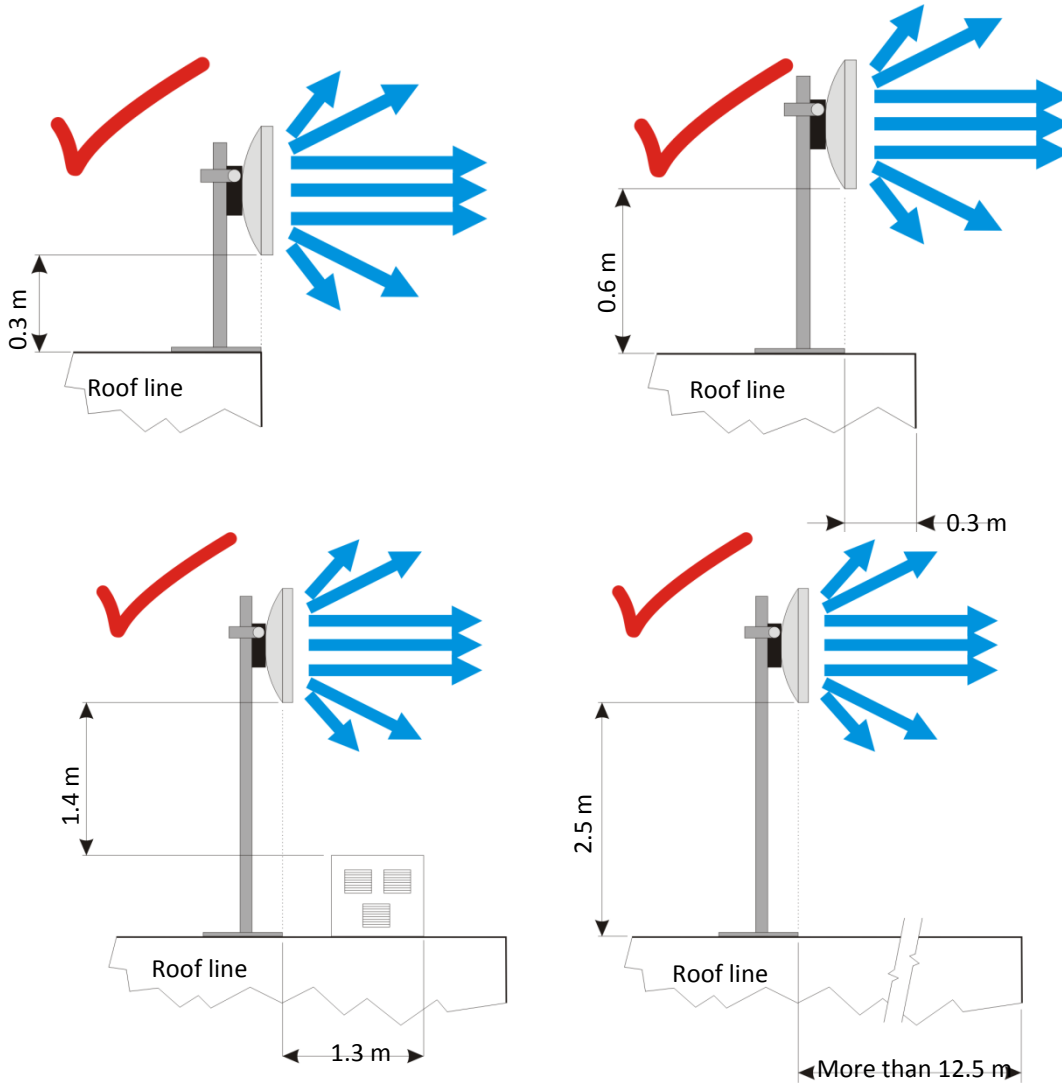


Figure 13 Proper placement of antenna on supporting construction

Obstacle distance [m]	0	0.3	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.8	3.1	6.1	9.2	12	>12.5
Height of antenna above obstacle [m]	0.3	0.6	0.9	1.2	1.3	1.4	1.4	1.4	1.4	1.5	1.5	1.8	2.1	2.3	2.5

Table 11 Recommended antenna placements considering a distance from an obstacle¹

3.3 ODU INSTALLATION

ODU is attached separately by 4 latches to the ODU holder. RRL is designed for use with third-party antennas. Antenna and ODU are connected via coaxial cable with N connectors. Cable attenuation must be less than 1 dB, impedance 50Ω. ODU installation is shown on Figure 14

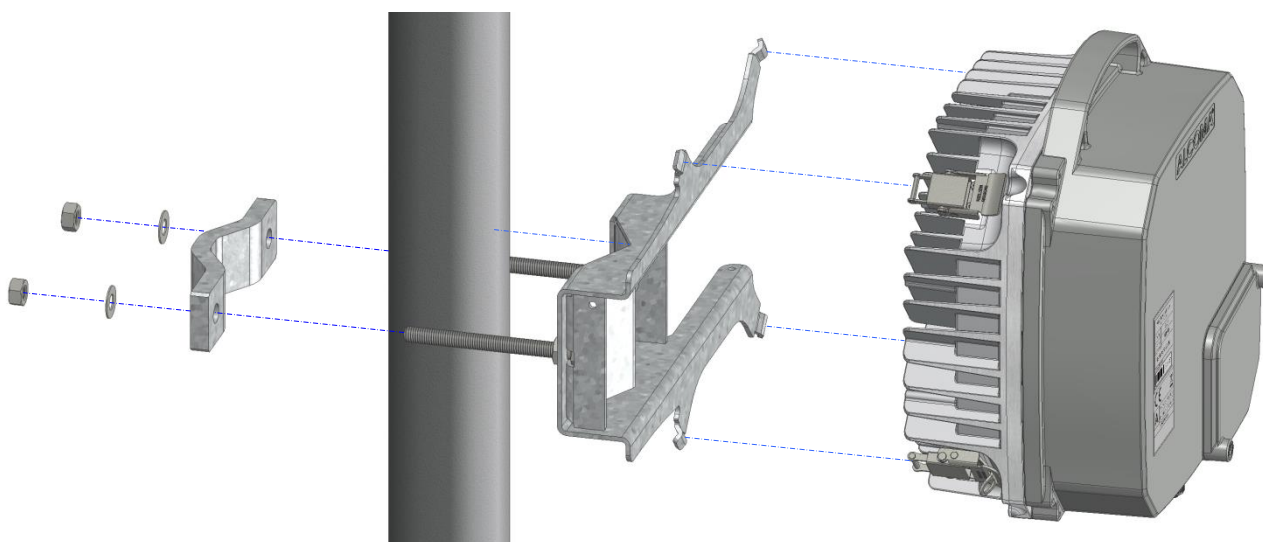


Figure 14 ODU Installation on the ODU holder

¹ Table values correspond to an average antenna size and normal climatic conditions. Parameters of the used radio link type and climatic conditions have to be always taken into account.

3.4 GROUNDING



CAUTION

The antenna support pipe, antenna system, and the ODU box must be properly connected and grounded with regard to discharges of atmospheric energy. Always refer to local valid standards. and regulations..

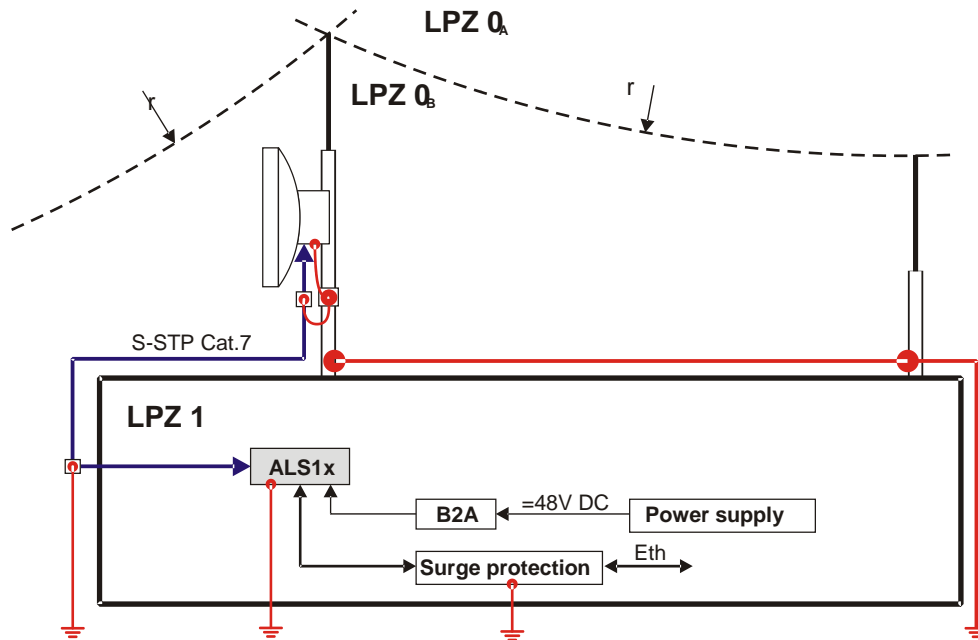


Figure 15 The terminal grounding

A support pipe in a stand or lattice mast must be grounded by a steel galvanized wire or a copper wire with a cross section of at least 50 mm^2 . Also the ODU box and the antenna system must be grounded, best by a copper rope with the cross section of at least 14 mm^2 that is ended by a cable eyelet. The brass bolt M8 with the grounding rope eyelet is screwed into the marked hole at the bottom of ODU that is placed under the connection cable grommet.

This whole equipment should be, if possible, located in the space that is protected by lightning traps against direct lightning strike. If this cannot be guaranteed even through installation of additional traps, then other corresponding modifications must be performed according to the ČSN EN 62305-4 (Protection against lightning) standard and after consultation with a professional.

Also grounding of the shielding of the connecting cable ALSx - ODU just before entering a building must be made by a copper rope with the same cross section of at least 14 mm^2 .

The protected terminal box ALSx in a building is grounded by a copper rope with the cross section of at least 5 mm^2 with cable eyelets. This cable should be connected to the marked M4 pin on the front side of ALSx.

3.5 MANIPULATION WITH THE USER SPACE COVER

The user space cover enables access to the user interfaces for connection and diagnostics of ODU only. This eliminates a possibility of undesirable interference into other ODU parts.

The cover is attached by 2 M6 bolts that can be unscrewed by a Hexagon wrench no. 5. One of the bolts can be only partially loosened, which ensures attachment to the box during manipulation with the cover. Retightening of this bolt in open position enables locking of the lid in any position.

Since the user buses are located in the inside hermetically enclosed space of the box, the lid is provided with a gasket. To protect the gasket from damage, please rigorously keep the safety notice specified below.

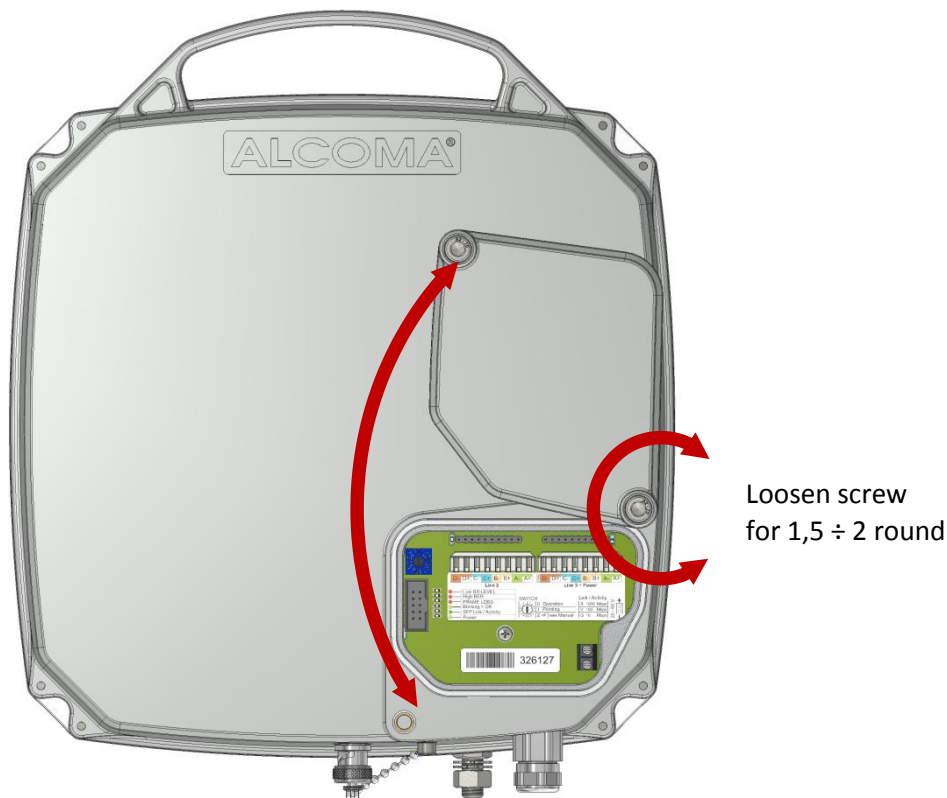


Figure 16 Manipulation with the user space cover



Warning

The bolt that ensures attachment of the cover during manipulation must be loosened at least by 1.5 to 2 turns during moving of the cover. In case that the **bolt is tightened during moving of the cover** more or completely, the gasket is sliding over the box sharp edges that **can damage the gasket seriously**.

3.6 TYPICAL INVOLMENT OF ODU

The following pictures show typical connection diagram for use ALSF MP400/360/165. It is possible to use a separate power supply and optical connector ODU in line4. Connection via an optical cable allows interconnection between the different buildings (different potential, etc.) increases the durability and safety during a lightning strike. ODU power supply from a protected block is supplied via a cable plugged into the tape zařezávacím line3 + POWER.

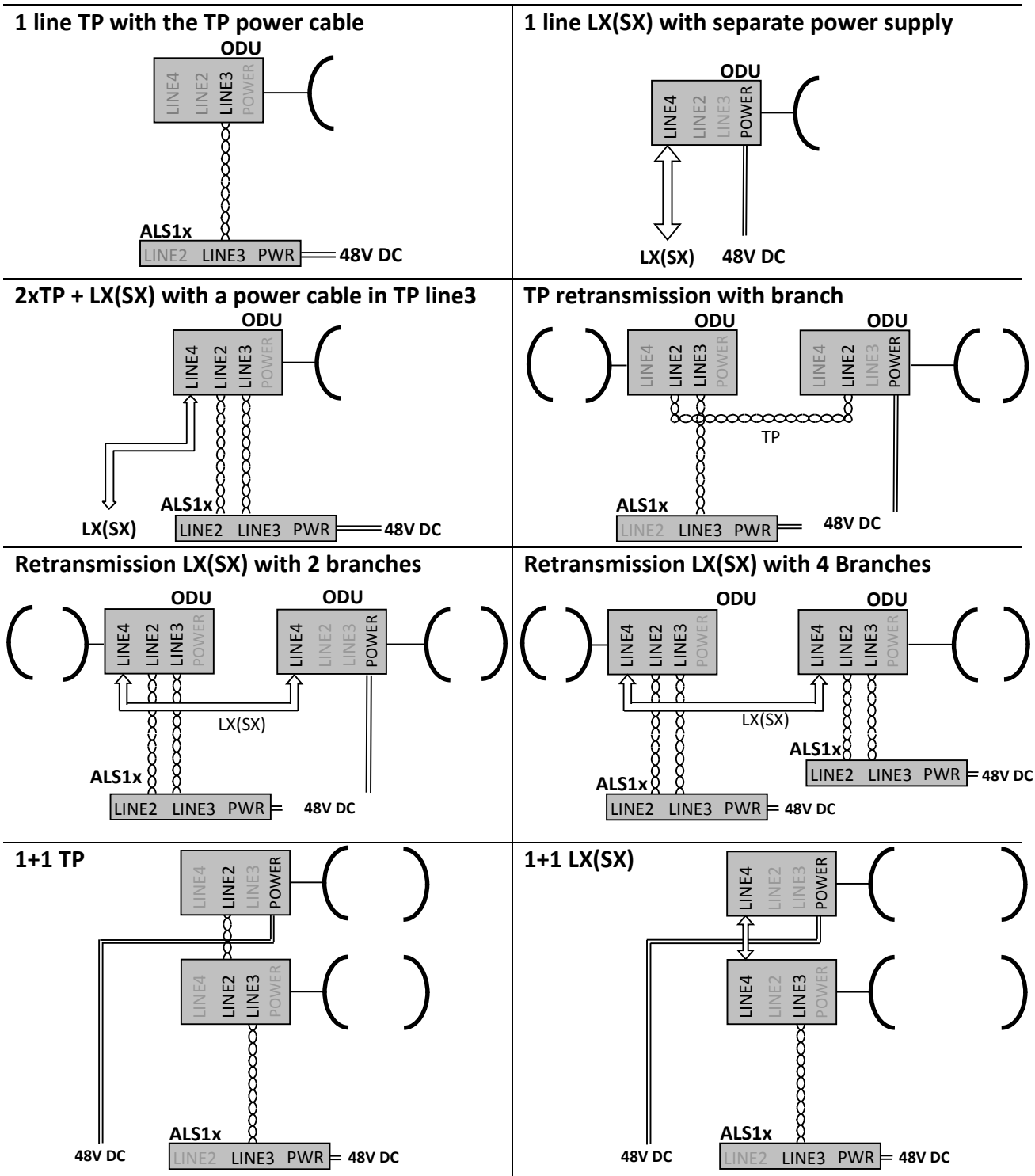


Figure 17 Typical involvement of ODU

3.7 INSTALLATION OF INTERCONNECT CABLE

We recommend using the **shielded cable for outside use** by ACOME, type **Cat 7 S-STP**, or the type Telco 100 W 4*ISTP from Belden Wire, with four pairs of conductors for the connection of the terminal box ALS1x and the station AL5F MP400/360/165. The cable is led into the link box through a sealing grommet that prevents penetration of climatic humidity from the surroundings and shows sufficient shielding necessary for keeping of electromagnetic compatibility of the whole device at the same time.

The connection cable must not be mechanically loaded. It has to be protected by a flexible electric installation pipe, especially in the outside environment, and attached so the mechanical loading is out of the question. We recommend using the electric installation pipe type HFX 16 by Dietzel Univolt.

It is necessary to keep a minimum curvature during installation and attachment of the cable. The critical spot, especially for vertical polarization, is at the outlet of the connection cable from ODU.

Alcoma completes the radio relay system deliveries by the modified cable of the type Cat 7 S-STP from ACOME. Additional outside insulation of the cable increases its climate resistance and also resistance against the sun UV radiation.

The procedure during installation of ACOME cable type Cat 7 S-STP

(Identical for the protected terminal box and ODU)

- The cover of the terminal box space in ODU is opened using an Hexagon wrench no. 5 (Figure 9).
- The pull-over nut and the sealing grommet are placed over the cable. The top 25 cm of PVC cable cover from the cable end will be removed. The silk guiding thread also needs to be cut.
- The shielding has to be compressed a little, and the conductors need to be cut by about 2 cm. Thus created overlapping shielding will be twisted together.
- The bottom washer, spring washer, and the top washer (in this order) will be pulled over the cable and pushed against the PVC cable cover.
- The twisted shield will be untwisted and released somewhat. Then it will be pulled over the washers on the cable and shortened at the bottom washer (figure 18). No wire of the shielding must go over the bottom washer, in order to tighten the sealing grommet by the pull-over nut well on the cable, and thus seal the grommet properly.
- Shielding of individual pairs will be removed all the way to the turned over top braiding.
- The cable will be inserted through the grommet, and the pulled-over nut will be completely tightened.
- The individual pairs will be divided to the internal Krone connectors that are color coded and numbered on the PCB sticker according to the color codes (for the Cat7 S-STP cable), or numbers (for the Telco 100 Ω 4*ISTP code).
- The individual conductors will be connected using the pusher knife for Krone connectors. The conductor insulation is not removed. It automatically cuts through by the knife connector contacts during installation. The conductors are automatically cut to necessary length at the same time. The cutaway ends must be removed. That is why individual conductor lengths must be sufficient in order to be able to hold the cut off ends in hand during cutting into the connector. Removing them will prevent possible defects.
- The cable installation will be finished by the reinstallation of removed cover. The attachment screws are tightened by a Phillips screwdriver or an Allen wrench.

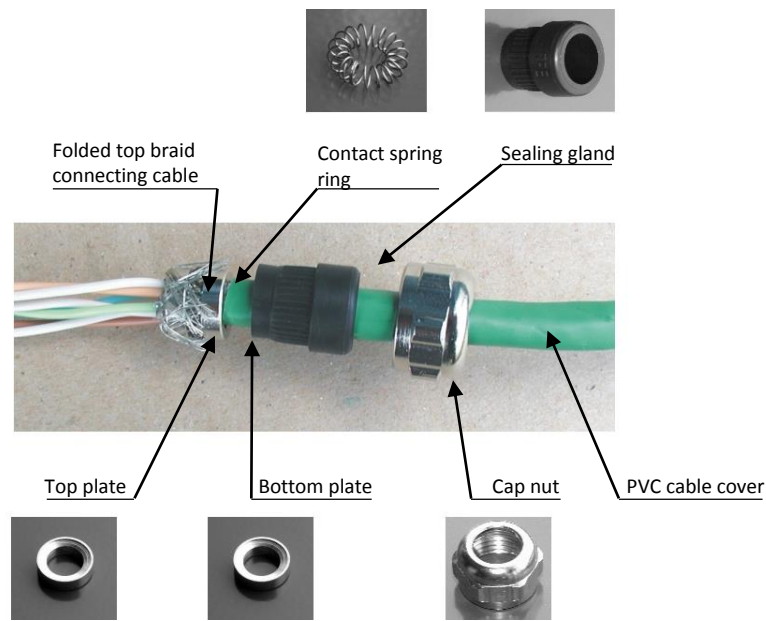


Figure 18 Grommet installation

If a customer uses a different cable than the recommended type Cat 7 S-STP by ACOME, the installation is similar. If the cable has separate shielding for each pair of conductors, then the shielding must be connected according to the marking on the Krone connectors. In cables with only one shielding cable taken out the shielding is connected to any shielding pin.

Corresponding after installation tightness of the grommet must be ensured for these customer selected cables too.

CAUTION



It is not allowed to unscrew the grommet from the ODU wall under any circumstances. This grommet is hermetically sealed and this seal would be damaged during disassembly. Caution! Do not **loose washers and a spring ring if you straighten the bent shielding** of the connection cable during disassembly of the cable.

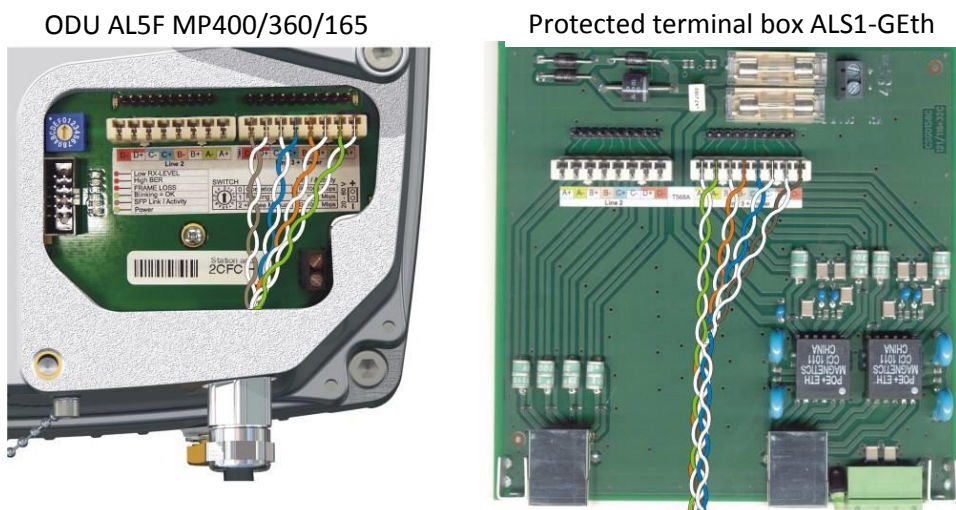


Figure 19 Finished assembly of the connection cable Cat7 S-STP

3.8 OPTIONAL SFP MODULES

The outdoor unit can be expanded with optional SFP modules. We recommend using modules from Finisar. These modules have been tested and tested their performance with this type of ODU. Replacing the SFP module is only possible in the factory ALCOMA.



1000Base-LX
Singlemode (1310 nm)



1000Base-SX
Multimode (850 nm)



1000Base-BX
WDM Singlemode (TX 1310 nm – RX 1550 nm)



1000Base-BX
WDM Singlemode (TX 1550 nm – RX 1310 nm)

Figure 20 Optional SFP modules

Modules can be installed only ODU equipped with a special connector shown below. Connector provides secure connection optical or metallic interfaces, depending on the SFP module.

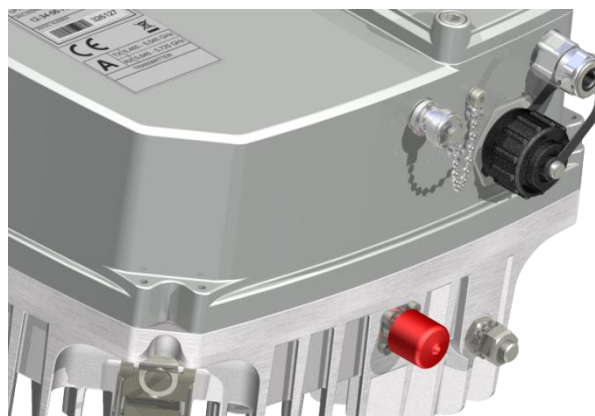


Figure 21 Cable gland fitted optical connector



Warning

When handling fiber-optic cable to follow the principles of working with optical cables, such as minimum bend radius of cable. It is necessary to keep all optical connectors. When handling fiber SFP module, use the cap against the dirt on the optical interface module.

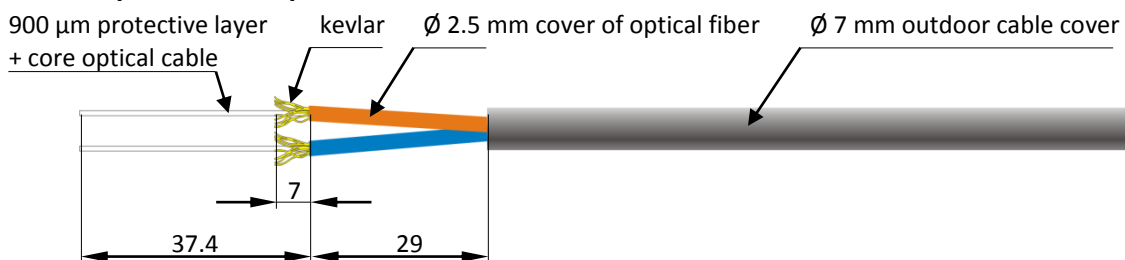
3.9 INSTALLING AN OPTICAL CONNECTOR MOLEX 106059

3.9.1 Package contents

1. Dust cover
2. Plug housing
3. Bayonet nut
4. Securing cable nuts
5. LC 3 mm connector body with a tube of the adhesive injection
6. LC Crimp ring 2x
7. Clutch duplex (upper and lower)

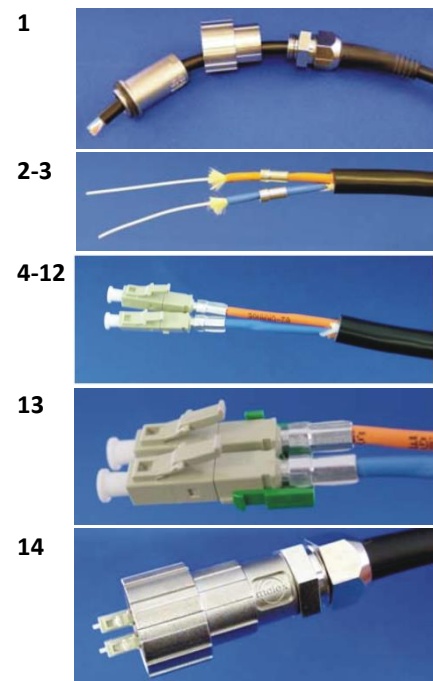


3.9.2 Preparation of optical cable



3.9.3 Connector assembly

1. Thread the cable retaining nut cable, bayonet nut and the connector housing.
2. Prepare an optical cable according to the above sketch.
3. Thread the crimp ring (1 ring, a vein)
4. Injekted into the body tube connector the adhesive².
5. Remove the tube of adhesive injection (pull out).
6. The protective layer applied activator.
7. Thread the body connector to the optical fiber package.
8. Dress crimp ring over the Kevlar and the end of the connector body
Orange is right when viewed from the rear of the connector and locks on the body facing upward.
9. Krimp the ring.
10. Upright cut beyond the end of the optical fiber, clean and polish the fiber.
11. Check the cut is clean and free of burrs and polish the orthogonality.
12. Snapped the lower and upper body coupling to LC connector.
13. Body connector assembly.



The other end of the cable must finish them so, that each fiber has always linked the optical transmitter with an optical receiver.

² We recommend using the adhesive LOCTITE 638 + activator 7649

3.10 BEFORE PUTTING THE RADIO LINK INTO OPERATION

Before putting the radio link into operation the user must verify, whether he has available documents certified by the distributor that verify that the product is in safe condition.

The manufacturer delivers “Measuring and Testing Protocol” together with the radio link, based on a special request, where basic electrical parameters measured during activation and adjusting of the connection are specified.

3.11 ACCESSORIES

Based on customer wishes we can deliver all accessories necessary for installation and service of the radio relay links AL5F MP400/360/165:

- interconnect cables
- KRONE pusher knife
- Lockable 19” standard installation cabinets
- For the attachment of antenna systems and outdoor units:
 - High and low stands \varnothing 76 mm a \varnothing 102 mm.
 - Side and outside brackets
 - Brackets for walls and poles
 - Special brackets according to customer wishes or needs

Mechanical constructions that show requested strength, rigidity, and atmospheric resistance, and that it can be used according to actual needs.

- DC Power supply with requested characteristics.
- Overvoltage protection for the power supply.
- Cables to connect monitoring PC

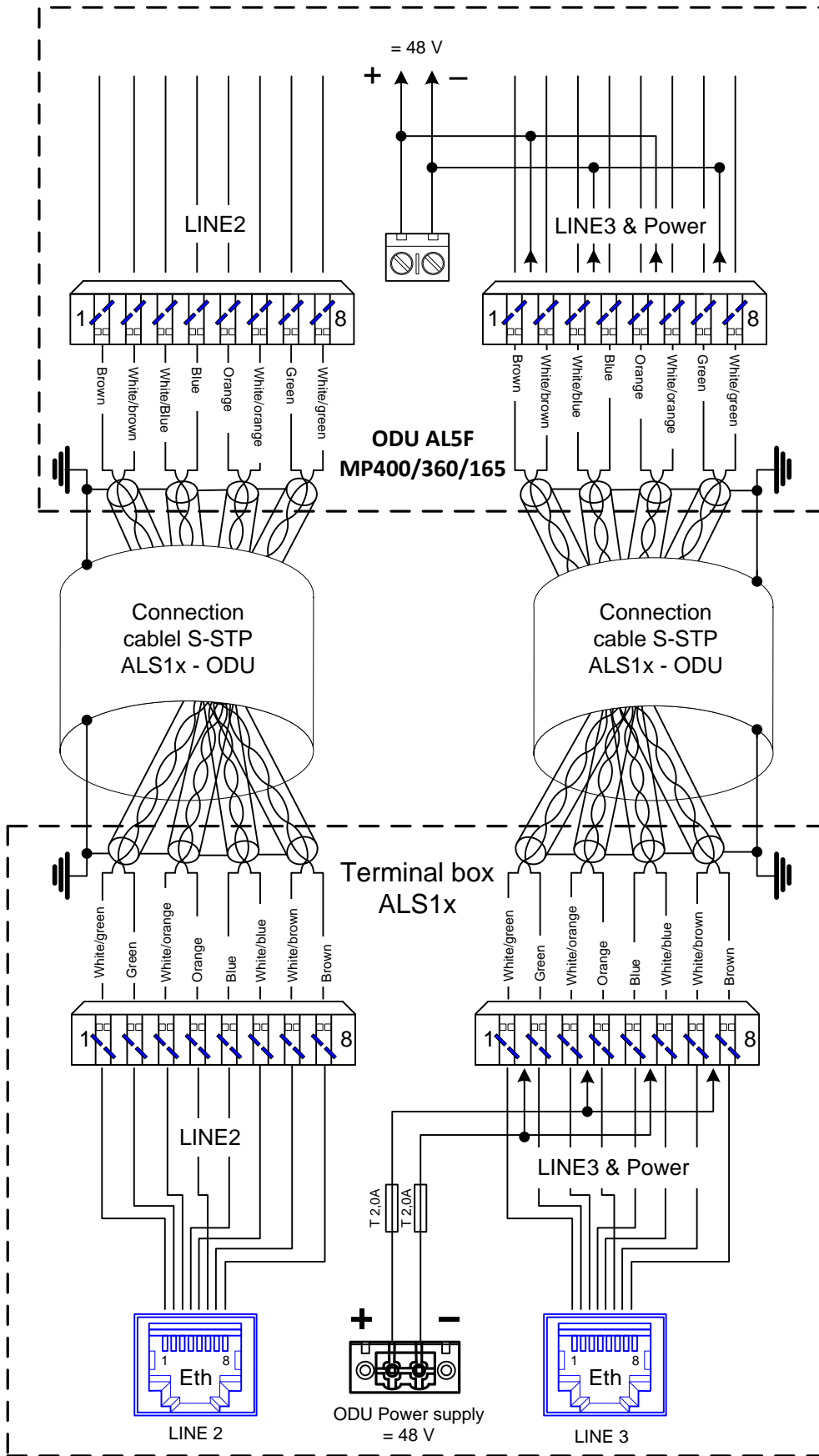


Figure 22 Connection of the connecting cable

4. SETTING OF THE RADIO LINK AND ITS COMMISSIONING

Installation and commissioning of the radio relay ALSF MP400/360/165 radio link can be performed by the manufacturer or by a company authorized by him only. The installation can be performed by connecting to a power grid, whose technical condition and manner of protection against electric current injury meets conditions of the ČSN 33 2000-4-41 standard and related regulations. The user must verify whether the ODU supply voltage agrees with the output voltage of a power supply. Electric power network, to which the product will be connected, must be initially inspected according to the ČSN 332000 2000-6-61 standard. If using of extension cables is absolutely necessary, then these cables must be routed in the way that would prevent their damage, overheating, or possible injuries to personnel (by tripping).

For reasons of achieving high operational reliability, parameter stability and long life the units (even enclosed in a cabinet) may not be placed near heat, water, dust, or vibration sources etc.

The ALCOMA ODU units do not contain any adjustment or tuning elements that would have to be modified during commissioning by customers. The units are delivered tuned and tested. Removal of possible defects and failures within the warranty period is done by the manufacturer or a company authorized by the manufacturer. Any manipulation with adjustment elements is prohibited. Any unprofessional interference with the equipment, especially manipulation with adjustment elements, voids the warranty.



CAUTION

An outdoor unit and a protected terminal box must be properly connected to a protection cable, and grounding must be performed due to atmospheric electricity charges. (ČSN 33 4010 - Communication line and equipment protection against atmospheric overvoltage and overcurrent).

Changing of jumpers in ALS1x can be done only by personnel instructed at the manufacturer.

In case of commissioning after long term storage (in order of months) the actual time needs to be checked about 10 minutes after switching on. Data are backed up by a high capacity capacitor.

4.1 ANTENNA POINTING

Pointing of radio link is done by adjusting antennas to the maximum level of received signal. The pointing of a radio link needs to be done in the horizontal and vertical directions systematically and very carefully in several steps. The pointing is done gradually at both stations. It is not possible to point both stations at the same time.

Pointing of a radio link needs to be done during stable sunny weather (dry air). If there are meteorological fluctuations along the route (rain, snow) that cause sudden changes of the level of received signal, then it is better to interrupt the pointing a wait for better weather.

At the beginning of pointing both opposite stations must already be roughly adjusted and switched on in order to pick up their signals. This is difficult with long hops where bigger gain antennas with consequently narrower radiation diagrams are used.

To make pointing easier, ODU has the built in acoustic signalization of the size of received signal level that can be switched on by a rotary switch at the user space (Figure 9).

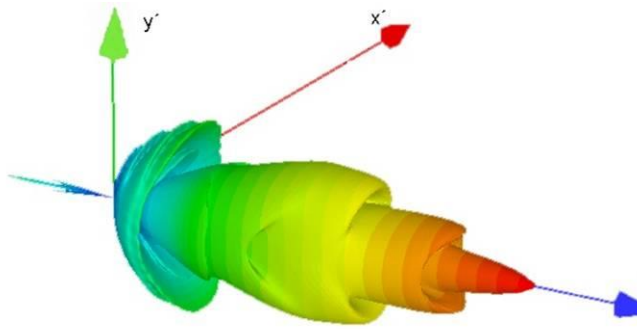


Figure 23 Radiation characteristics

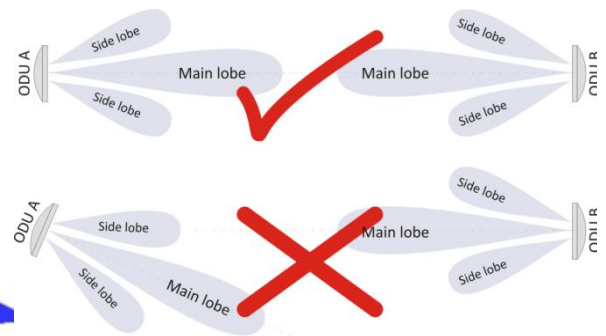


Figure 24 Pointing



CAUTION

The rotary switch in the position Pointing also switches off a transmitter of the local station. Switching off of the output also in the remote station by the rotary switch can be used to find a level of interference signals (background noise) on given channels.

Rough Adjustment

The rough adjustment can be done “by eye” using binoculars rested against the antenna. If the visibility is bad, or distance is too long, you need to determine the azimuth first using a compass.

Caution! Compass measurement accuracy is limited by steel mast construction! The rough pointing should have a variation of max. $\pm 5^\circ$ from the ideal antenna connecting line.

We are trying to attain a signal of the opposite station by horizontal turning of the antenna by $\pm 30^\circ$ from assumed direction.

The vertical setting is changed gradually, and the scanning in the direction of reception is done by horizontal turning. We do not recommend changing both directions at the same time. The maximum reception is set approximately.

Main lobe diameter: 14 m
Link length: 1 Km
Antenna: diameter 1.2 m
Building height: cca 140 m



Main lobe diameter: 74 m
Link length: 3 Km
Antenna diameter: 1.2 m
Building height: cca 140 m

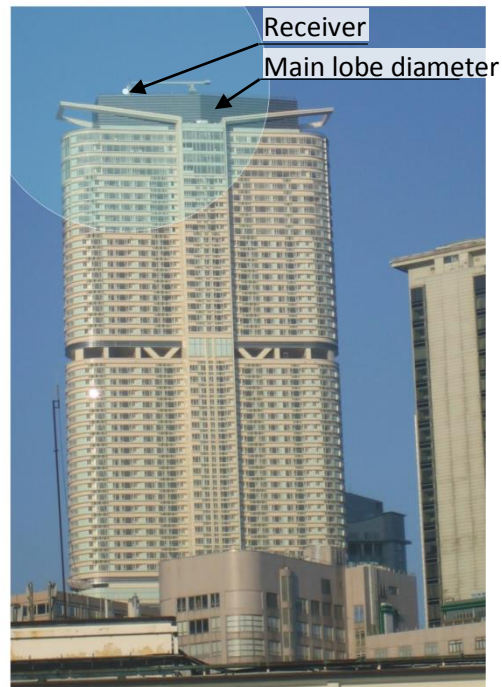


Figure 25 Main lobe diameter with different hoplengths

Remark:

The basic range for setting of the vertical direction is $\pm 15^\circ$.

The pointing procedure in both horizontal and vertical directions must be repeated several times to make sure that the best maximum of the radiation characteristic is found. The opposite station antenna needs to be final adjusted the same way. It is necessary to prevent sliding of the parabolic antenna along the support pipe during horizontal pointing.

Checking of Pointing

The value of received level can be determined by direct reading in the ASD monitoring program or by calculation using the calibration graph for RSSI. The RSSI voltage can be measured at the BNC connector without necessity to adjust the rotary switch.

To check for the proper pointing, it is good to calculate the signal level that should be measured. The maximum allowed deviation between the calculated and measured signal levels is ± 3 dB. If the negative deviation is higher the connection needs to be better pointed.

The noise level on the receiving channel needs to be checked while the opposite station is switched off. The minimum requested separation of the noise level from the received signal is 20 dB. The opposite station can be switched off remotely using the ASD monitoring program.

- Place the pointing switches to the 0 position (in both connection stations) after pointing is finished.
- Screw the user space cover back on.
- It makes sense to write down all measured values for checking later.

Frequent problem during antenna pointing is pointing to an antenna side lobe. The antenna can then show a sharp peak, however, the signal level is about 20 dB lower. Therefore it is important to turn the antenna during pointing at least $\pm 10^\circ$ in horizontal and vertical directions, and catch the main and both side lobes of the antenna radiation diagram. We need to realize that the antenna radiation diagram is three dimensional, and if we make a setting error in one direction (for example vertical one), then it is possible to receive only the side lobes in the other direction, and they do not even need to be equal due to route conditions.

The radiation characteristics of parabolic microwave antennas are shown in the measurement protocols for ALCOMA antenna type approval. ALCOMA will provide copies of these protocols upon request.

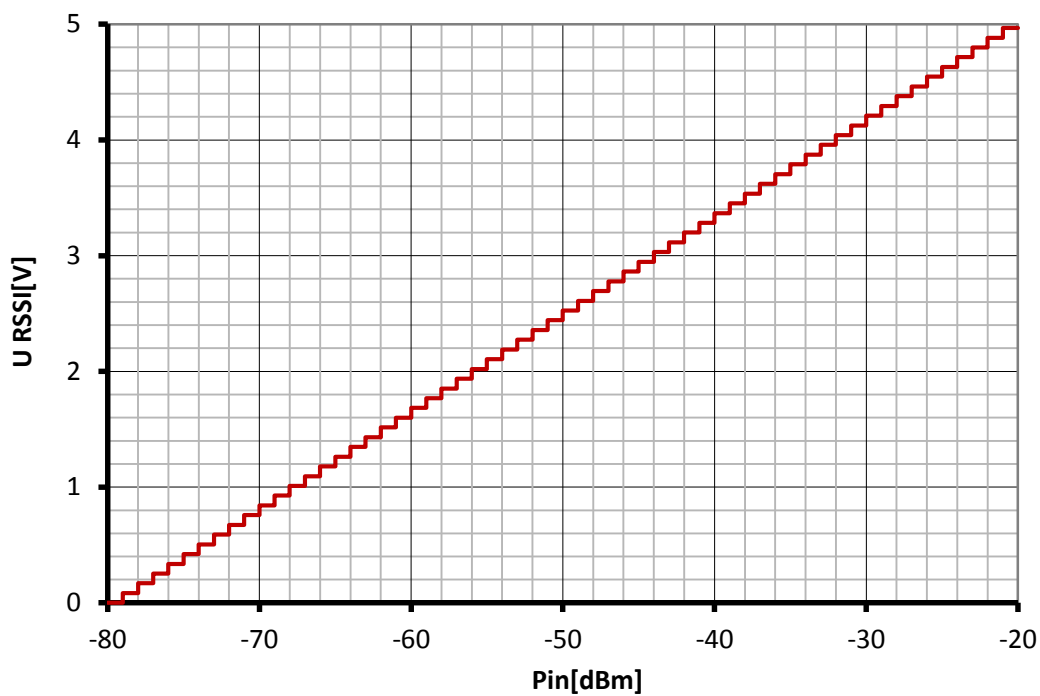


Figure 26 The RSSI calibration graph

4.2 CONTROL CALCULATION

The following relationship is valid for the calculation of a level at the output of the receiving antenna, i.e., at the input of the microwave receiver:

$$P_{in}[\text{dBm}] = P_{vys}[\text{dBm}] + G_{antV}[\text{dB}] + G_{antP}[\text{dB}] - A_0[\text{dB}]$$

where:

$P_{vys}[\text{dBm}]$	is the transmitted output of the opposite station
$G_{antV}[\text{dB}]$	is the transmitting antenna gain
$G_{antP}[\text{dB}]$	is the receiving antenna gain
$A_0[\text{dB}]$	is the free environment attenuation

The following relationship is valid for the attenuation of free environment during good climatic conditions (without rain and fog):

$$A_0[\text{dB}] = 92.44 + 20 \log(d[\text{km}] * f[\text{GHz}])$$

where:

$d[\text{km}]$	distance between antennas
$f[\text{GHz}]$	used frequency.

The calculated values P_{in} can be compared with the values measured by using the RSSI calibration graph, or by direct reading of the values given by the monitoring program.

If the constructed connection has a partially disturbed first Fresnel zone then the attenuation due to the disturbance cannot be higher than -6 dB in comparison with a free path. The optical visibility along the antenna axis has to be maintained in any case. In the opposite case retranslation would have to be used, and the critical spot would have to be circumvented.

The additional attenuation of the path given by the disturbance of the 1st Fresnel zone by a single terrain obstacle with a sharp peak is represented by the graph (figure 27). The graph shows the relative height of the obstacle z related to the ellipsoid radius of the 1st Fresnel zone. The value $z = 0$ represents the edge that touches the optical connection, i.e., covering of 50% of the ellipsoid of the 1st Fresnel zone. More details can be found in the book by Pavel Pechač and Stanislav Zvánovec: "Bases of wave propagation for planning of land radio relay links (Základy šíření vln pro plánování pozemních rádiových spojů)", published by BEN in 2007.

Additional attenuation behind an obstacle

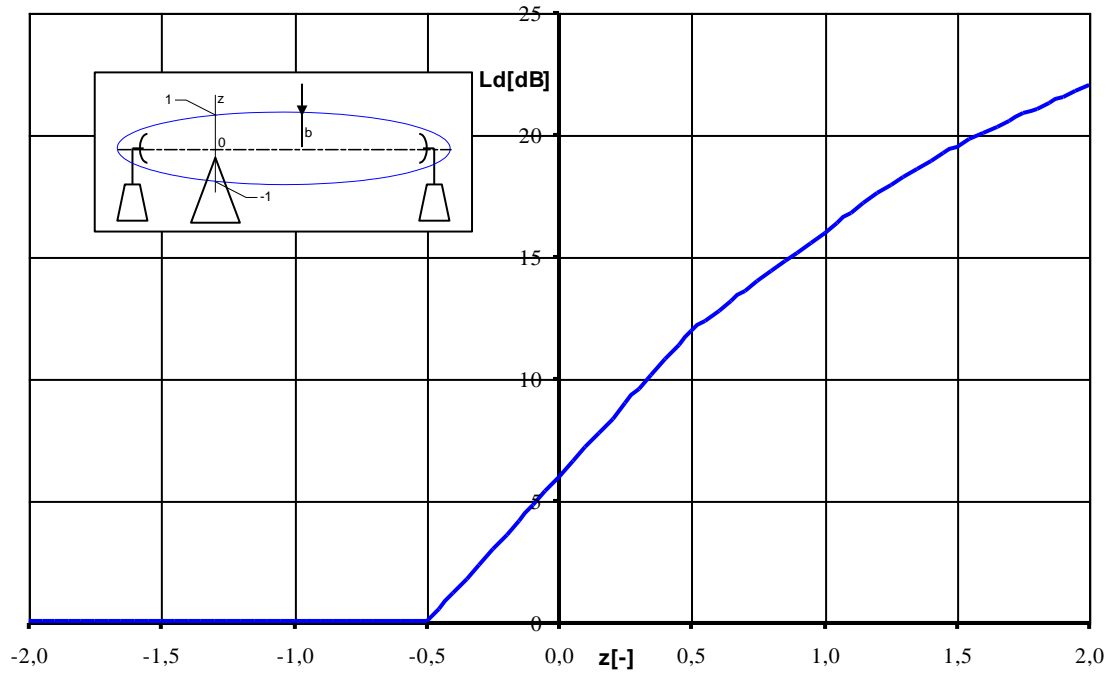


Figure 27 The approximation of additional attenuation behind an obstacle.

4.3 DIRECT CONNECTION OF A MONITORING PC

Normally the communication of the monitoring PC with the AL5F MP400/360/165 station takes place through data connection (TCP/IP protocol) over Ethernet, where both user data and the monitoring data are transmitted. If this connection is not possible the monitoring PC with installed and running, ASD program can be connected directly to ODU through an RS-232 interface. The interface connector PFL10 is located on the ODU motherboard. The connector is accessible after opening of the ODU box cover. All standard signals with the RS-232 interface signal level are brought onto this connector, while the signal ground of this interface is galvanically connected with the ODU ground.

A cable connected according to the following figure can be used for this connection:

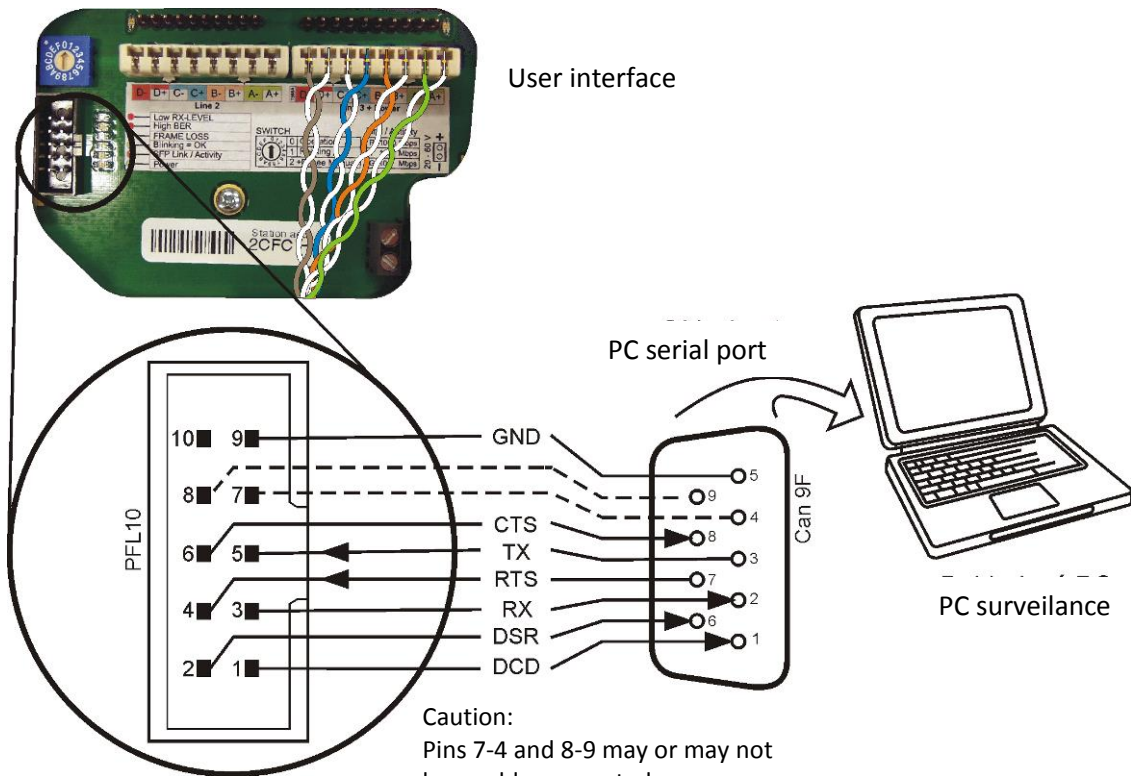


Figure 28 The direct connection of the monitoring PC

If the PC frame is galvanically connected with the power grid, the direct monitoring of the PC to ODU is not recommended. With regard to possible transfer of noise signals from the ODU unit to the power grid and the other way round this connection is only an emergency solution acceptable for a short time.

For service purposes Alcoma delivers a cable ended on one side by the Cannon 9F connector and on the other by the Cannon 9M and PFL10 connectors, which connects the DCD, RX, TX, DSR, DTR, RTS, and CTS signals. The cable is intended for a temporary connection of the monitoring PC with the monitoring processor in ODU.

The minimum 4 wire connection requires the RX, RTS, TX signals and the signal grounding, i.e., using of no. 3, 4, 5, and 9 pins.

5. OPERATION INSTRUCTIONS

5.1 OPERATION

The radio relay link AL5F MP400/360/165 does not require any service or maintenance during operation.

The radio relay link AL5F MP400/360/165 can be remotely monitored by the ASD program that is intended for the management and diagnostics of the ALCOMA radio relay links using a monitoring PC during operation. All actual states, events and instructions are shown in individual windows in the arrangement according to separate functions or meanings (local station window, alarm history, station configuration, etc.). The monitoring system enables diagnostics of the radio links and both local and remote ends of the connection. The monitoring system is not necessary for the link transfer function itself (the link can be operated even without monitoring elements). However, monitoring is giving us diagnostic possibilities that simplify checking of the proper link function, or localization of possible defects. Detailed description and use of the ASD monitoring program is in a separate manual.

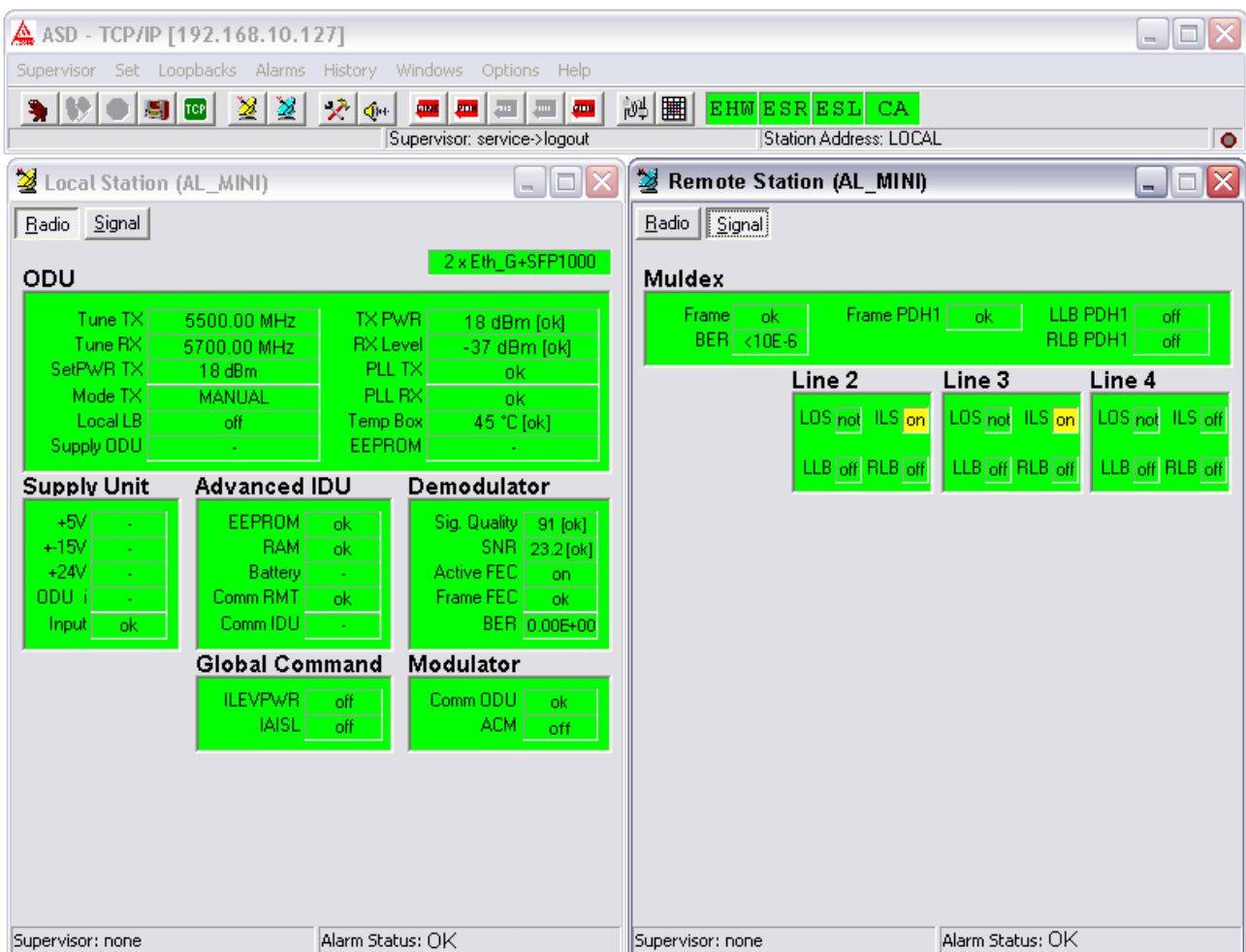


Figure 29 Main window of the ASD program

According to the ČSN 33 1500 standard regular inspections and checks of safe status during operation are recommended once every 24 months. (see the chap. 6). Inspections and checks are recommended to be performed by the supplier professional service.

5.2 EMERGENCY CONDITIONS

Emergency conditions are such states and equipment demonstrations that can cause property damage and endanger health and safety of persons. These states and demonstrations include: damage of covers, connection cables, loosening of the equipment mechanical connections, strong corrosion, excessive heating, smell, smoke, etc.



WARNING

In case that any emergency conditions are observed, the operator must immediately remove them.

5.3 REPAIRS



CAUTION

Equipment repairs can be performed only by personnel that have necessary professional qualifications and have been instructed at the manufacturer according to the microwave data link AL5F MP400/360/165 service manual. Operation personnel are prohibited from opening covers, breaking seals and unprofessionally interfering with the equipment.

After each product repair or discovery of emergency condition there must be demonstrable inspection of the safe product condition. This inspection must be recorded and signed by an authorized person. This record must be handed, together with the repaired product, to the user. The inspection may be performed by personnel qualified at least by Paragraph 5, Notice No. 50/1978 (knowledgeable worker).

Since the current version of the AL5F MP400/360/165 link does not support E1 transmission, it is not possible to perform any measurement loop for the purpose of error diagnostics using the ASD monitoring program.

5.4 ENDING OF OPERATION – ECOLOGICAL LIQUIDATION

The product is, from the ecological standpoint, classified as a hazardous electrotechnical object. After its service life it is, according to Law No. 7/2005 (Waste Law), an electronic waste, and as such it must be handed over to the appropriate enterprises that perform recycling of old electronic products. The product may not be liquidated as general community waste. The ALCOMA Company has concluded a Contract about liquidation of electronic waste with the SAFINA a.s. Company.

In agreement with the Public Notice No. 352/2005, Paragraph 8c, every serial label that is placed on each product shows a graphic symbol of stricken through waste bin that cautions about obligations related to liquidation of electronic waste.

The product transport packaging is made from common recyclable material (paper and polyethylene) marked as such by a label according to the ČSN 77 0052-2 standard.

6. SAFETY CHECK

Each AL5F MP400/360/165 radio link is verified within check-out inspection, and its parameters are measured according to the ČSN 33 1500 standard (Inspection and testing of electrical installations). According to the ČSN 33 1610 standard the ODU of the radio relay link AL5F MP400/360/165 is an electrical device of the class B (appliances used in the outside environment), supplied by SELV (Safety Extra-Low Voltage) supply and inside of the unit there is no higher voltage than SELV. The unit allows connection of dead parts by a grounding bolt to a protection circuit that serves also as a protection against overvoltage and overcurrent of atmospheric origin.

In agreement with the ČSN 33 1610 standard the ODU belongs to

- the group B according to its use – appliances used in outside areas
- the class III according to protection – protection against injury by electric current is based on the connection to a SELV supply, with the voltage no higher than SELV.

According to the ČSN 33 1500 standard regular inspections and checks of safe status during operation are recommended once every 24 months. Inspections and checks are recommended to be performed by the supplier professional service.

The following activities are recommended during regular checks and inspections:

- Check of ODU tightness.
- Condition of antenna OPN (protection against icing) cover.
- Status of interconnect cable and its grommets.
- Tightening and lubrication of all attachment bolts and nuts. No construction part can be weakened or damaged by corrosion.
- Checking of grounding connection strength at grounding points and their connection to earth.
- Finding possible damage or changes of the whole system that would require further measures and the verification of safety.
- We recommend measuring and recording the level of received signal.

7. RADIO RELAY LINK PARAMETERS

7.1 FREQUENCY PLAN 5 GHZ

The link AL5F MP400/360/165 can be operated in any subband between 4 850 – 6 000 MHz depending on diplexer tuning. Links can be operated by physical and legal entities only with individual license.

Diplexer can be tuned according to customer's specification in subbands without existing ITU channel table, it must only comply with technical possibilities of the link.

The tables below are related to the frequency range of 5,479 to 5,721 MHz according to 302 217-2-2 and EN 301 126-1.

Type	A – band	B – band
A-B	5.479 – 5.535	5.665 – 5.721

Table 12 The ALCOMA frequency tables for AL5F MP400/360/165

7.1.1 Modulation schemes, BER thresholds and capacities of the link



Interleaving Low / High

Interleaving high increase the resistance link to impulsive interference and changes its sensitivity. On the other hand, has resulted in an increase in latency.

AL5F MP400 link can be set to different capacities based on used modulation scheme and bandwidth. Highest capacity of the link is 830 Mbps.

Capacity [Mbps]	Modulation scheme [QAM]	MP400 Threshold for BER=10 ⁻⁶ [dBm]	TX power [dBm]	Channel bandwidth [MHz]
5	QPSK	-91,0	-10 – 18	3,5
8	8QAM	-88,0	-10 – 18	
11	16QAM	-85,5	-10 – 18	
14	32QAM	-82,0	-10 – 18	
17	64QAM	-78,5	-10 – 18	
20	128QAM	-75,5	-10 – 18	
22	256QAM	-73,5	-10 – 18	
25	512QAM	-70,0	-10 – 18	
27	1024QAM	-66,5	-10 – 18	
11	QPSK	-88,0	-10 – 18	7
16	8QAM	-86,0	-10 – 18	
22	16QAM	-82,0	-10 – 18	
28	32QAM	-79,0	-10 – 18	
33	64QAM	-76,5	-10 – 18	
40	128QAM	-74,0	-10 – 18	
44	256QAM	-71,0	-10 – 18	
50	512QAM	-67,5	-10 – 18	
55	1024QAM	-64,5	-10 – 18	
25	QPSK	-84,5	-10 – 18	14
35	8QAM	-82,0	-10 – 18	
46	16QAM	-79,0	-10 – 18	
58	32QAM	-76,0	-10 – 18	
69	64QAM	-74,0	-10 – 18	
81	128QAM	-71,0	-10 – 18	
92	256QAM	-68,5	-10 – 18	
104	512QAM	-65,0	-10 – 18	
115	1024QAM	-62,0	-10 – 18	

Capacity [Mbps]	Modulation scheme [QAM]	MP400 Threshold for BER=10 ⁻⁶ [dBm]	TX power [dBm]	Channel bandwidth [MHz]
50	QPSK	-81,0	-10 – 18	28
69	8QAM	-79,0	-10 – 18	
92	16QAM	-76,0	-10 – 18	
116	32QAM	-73,5	-10 – 18	
139	64QAM	-70,0	-10 – 18	
162	128QAM	-67,5	-10 – 18	
185	256QAM	-65,0	-10 – 18	
208	512QAM	-62,0	-10 – 18	
230	1024QAM	-58,0	-10 – 18	
66	QPSK	-80,5	-10 – 18	
100	8QAM	-78,0	-10 – 18	
132	16QAM	-74,5	-10 – 18	
165	32QAM	-72,0	-10 – 18	
200	64QAM	-68,5	-10 – 18	
232	128QAM	-66,5	-10 – 18	
265	256QAM	-63,0	-10 – 18	
300	512QAM	-60,0	-10 – 18	
330	1024QAM	-57,0	-10 – 18	
100	QPSK	-78,0	-10 – 18	56
139	8QAM	-76,0	-10 – 18	
185	16QAM	-73,5	-10 – 18	
232	32QAM	-71,0	-10 – 18	
278	64QAM	-68,0	-10 – 18	
324	128QAM	-65,0	-10 – 18	
370	256QAM	-61,5	-10 – 18	
417	512QAM	-58,5	-10 – 18	
459	1024QAM	-55,5	-10 – 18	
132	QPSK	-77,5	-10 – 18	
200	8QAM	-74,5	-10 – 18	
265	16QAM	-71,0	-10 – 18	
330	32QAM	-69,0	-10 – 18	
400	64QAM	-66,0	-10 – 18	
463	128QAM	-62,5	-10 – 18	
530	256QAM	-60,0	-10 – 18	
600	512QAM	-56,5	-10 – 18	
660	1024QAM	-53,5	-10 – 18	

Capacity [Mbps]	Modulation scheme [QAM]	MP400 Treshold for BER=10 ⁻⁶ [dBm]	TX power [dBm]	Channel bandwidth [MHz]
185	QPSK	-76,5	-10 – 18	112
277	8QAM	-73,5	-10 – 18	
370	16QAM	-70,0	-10 – 18	
460	32QAM	-67,5	-10 – 18	
555	64QAM	-64,5	-10 – 18	
650	128QAM	-61,0	-10 – 18	
740	256QAM	-58,0	-10 – 18	
830	512QAM	-54,5	-10 – 18	

Table 13 Capacities of AL5F MP400 link

AL5F MP360 link can be set to different capacities based on used modulation scheme and bandwidth. Highest capacity of the link is 384 Mbps.

Capacity [Mbps]	Modulation scheme [QAM]	MP360 Treshold for BER=10 ⁻⁶ [dBm]	TX power [dBm]	Channel bandwidth [MHz]
10	QPSK	-92	-10 – 18	7
19	16QAM	-87	-10 – 18	
25	32QAM	-83	-10 – 18	
30	64QAM	-80	-10 – 18	
16	QPSK	-90	-10 – 18	10
31	16QAM	-84	-10 – 18	
41	32QAM	-82	-10 – 18	
50	64QAM	-78	-10 – 18	
59	128QAM	-74	-10 – 18	14
17	QPSK	-90	-10 – 18	
39	16QAM	-84	-10 – 18	
50	32QAM	-80	-10 – 18	
61	64QAM	-77	-10 – 18	18
72	128QAM	-74	-10 – 18	
60	16QAM	-83	-10 – 18	
60	32QAM	-80	-10 – 18	
100	128QAM	-72	-10 – 18	20
32	QPSK	-87	-10 – 18	
64	16QAM	-81	-10 – 18	
83	32QAM	-79	-10 – 18	
102	64QAM	-75	-10 – 18	28
119	128QAM	-72	-10 – 18	
34	QPSK	-87	-10 – 18	
70	16QAM	-81	-10 – 18	
100	32QAM	-78	-10 – 18	40
123	64QAM	-75	-10 – 18	
158	128QAM	-71	-10 – 18	
165	128QAM	-70	-10 – 18	
168	256QAM	-68	-10 – 18	40
178	256QAM	-67	-10 – 18	
186	256QAM	-66	-10 – 18	
58	QPSK	-83	-10 – 18	
116	16QAM	-78	-10 – 18	40
149	32QAM	-76	-10 – 18	
183	64QAM	-72	-10 – 18	
216	128QAM	-69	-10 – 18	
249	256QAM	-65	-10 – 18	

Capacity [Mbps]	Modulation scheme [QAM]	MP360 Treshold for BER=10 ⁻⁶ [dBm]	TX power [dBm]	Channel bandwidth [MHz]
89	QPSK	-82	-10 – 18	56
179	16QAM	-76	-10 – 18	
230	32QAM	-73	-10 – 18	
282	64QAM	-70	-10 – 18	
300	128QAM	-68	-10 – 18	
333	128QAM	-66	-10 – 18	
355	256QAM	-64	-10 – 18	
384	256QAM	-62	-10 – 18	

Table 14 Capacities of AL5F MP360 link

AL5F MP165 link can be set to different capacities based on used modulation scheme and bandwidth. Highest capacity of the link is 165 Mbps.

Capacity [Mbit/s]	Modulation scheme	Treshold for BER = 10 ⁻⁶ [dBm]	Bandwidth [MHz]
59	128 QAM	-72	10
32	QPSK	-87	20
64	16 QAM	-81	
83	32 QAM	-78	
102	64 QAM	-74	
119	128 QAM	-71	
100	32 QAM	-77	28
165	128 QAM	-70	

Table 15 Capacities of AL5F MP165 link

7.1.2 Technical parameters

Parameter	AL5F MP400/360/165
TX frequency	- lower band section (/A) 5.479 – 5.535 GHz - upper band section (/B) 5.665 – 5.721 GHz
Minimum channeling tuning step	50 kHz
Channel spacing	software configurable
Frequency stability better than	$\pm 10 \times 10^{-6}$
Transmitted output of basic version	0-18 dBm, ATPC
Transmitter spectrum mask	ETSI 301 751
Typical threshold sensitivity during BER = 10^{-6}	see table 15
Ethernet user interface	10/ 100/ 1000Base-T(X)
Optional user interface 1xSFP Line 4	100/1000BaseLX(SX, BX)
Input connectors for Ethernet user Lines	RJ-45
Interconnect cable protected terminal box - ODU (recommended type S-STP Cat.7 fa ACOME)	4 pair shielded imp. 100 Ω
Maximum length of interconnect cable ³	for 10Base-T 250 m for 100Base-TX 100 m for 1000Base-T 90 m
DC supply voltage on the protected terminal box	+36 V ÷ +72 V
Supply input for U = +48 V and 100 m connection cable	< 35 W

Table 16 AL11F MP400/360/165 link parameters

Parameter	Value
ALS1x terminal box dimensions (w x h x d)	163 x 44 x 147 mm
Assembled 3 terminal box ALS1x (w x h x d)	163 x 44 x 482 mm
ODU dimensions (without antenna radiator and antenna) (w x h x d)	255 x 310 x 174 mm
ODU weight (without antenna and antenna radiator)	5,1 kg
ALS1x weight	0,5 kg

Table 17 Technical parameters

³ Including the cable that brings data to the protected terminal box

7.2 ENVIRONMENT

Operation

ODU is intended for stationary use in locations unprotected against climatic conditions.

The protected terminal box is intended for stationary use in locations protected against climatic conditions.

Climatic resistance	Surrounding temperature	
Operation capability	ALS1x	od -25 °C do +55 °C
	ODU	od -35 °C do +55 °C
Guaranteed parameters	ALS1x	od -25 °C do +55 °C
	ODU	od -33 °C do +50 °C
Storage ability	ALS1x i ODU	od -25 °C do +55 °C

Table 18 Operation Temperature

By operation ability we understand that the radio link can be operated within the specified temperatures, but some parameters can deviate from specified limits. There will be no irreversible or permanent change or damage to units in the specified temperature range.

ALSx and ODU units surrounding environment must not contain aggressive vapors and gases, must have a normal radiation level, and be without vibrations and shocks. All ALSx and ODU units are air-cooled by natural air circulation. They do not contain fans that would suck in dirt from surrounding areas and thus lower the reliability of the microwave link.

The radio link is resistant against effects of wind with speeds of up to 33 m/s (120 km/h) without influence to transmission quality. Reversible changes, i.e., elastic deformation occur up to the wind speed of 56 m/s (200 km/h). Permanent deformation can occur above this threshold, however, without damage to ODU itself.

ALSx can be stacked into a cabinet without forced cooling air flow with the minimum spacing of 15 mm. Moving of ODU and ALSx is possible after disconnecting of the power supply cable and other cables, in other words not while they are in operation.

If used in environment that does not meet these requirements, the user must consult the operational conditions with the supplier technical service.

Transport and Storage

The radio relay link units can be transported only in covered vehicles and the units must be protected against direct weather influence at the same time. They should be transported in suitable (best in original) packaging in order to prevent excessive loads through shaking, vibrations etc., they are not allowed to be dropped. A specific form of transport is a matter of agreement between the manufacturer and the client.

The radio relay units must be stored in dry, partially air-conditioned areas. The range of storage temperatures is -25 ÷ +55 °C, with the relative humidity max. 85 %.



Warning

Beware of condensation of air humidity.

The sudden movement of the appliance for cold to warm moist places, it can lead to condensation of atmospheric moisture to parts of the service, not intended for use in wet environments. The device must be connected to power, unless it is completely dry.

7.3 ANTENNA SYSTEMS

RRL AL5F MP400/360/165 is compatible with third-party antennas. Interconnecting cable between ODU and antenna is supplied with the link. Example of ODU and antenna installation is shown in figure 30.

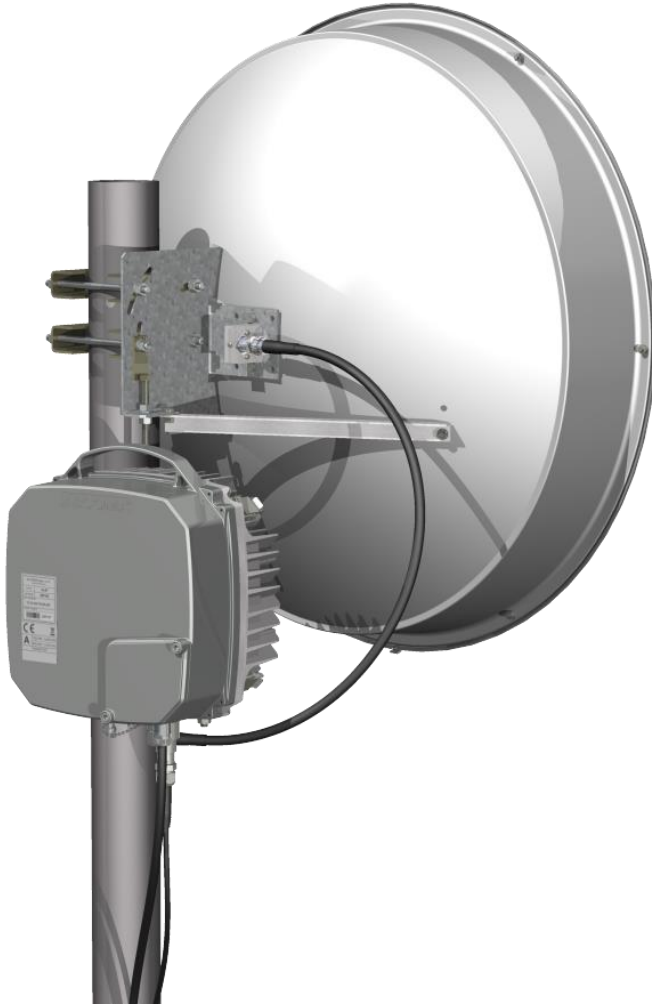


Figure 30 AL5F MP400/360/165 ODU + antenna

8. MAIN EQUIPMENT DIMENSIONS

8.1 ODU – OUTDOOR UNIT

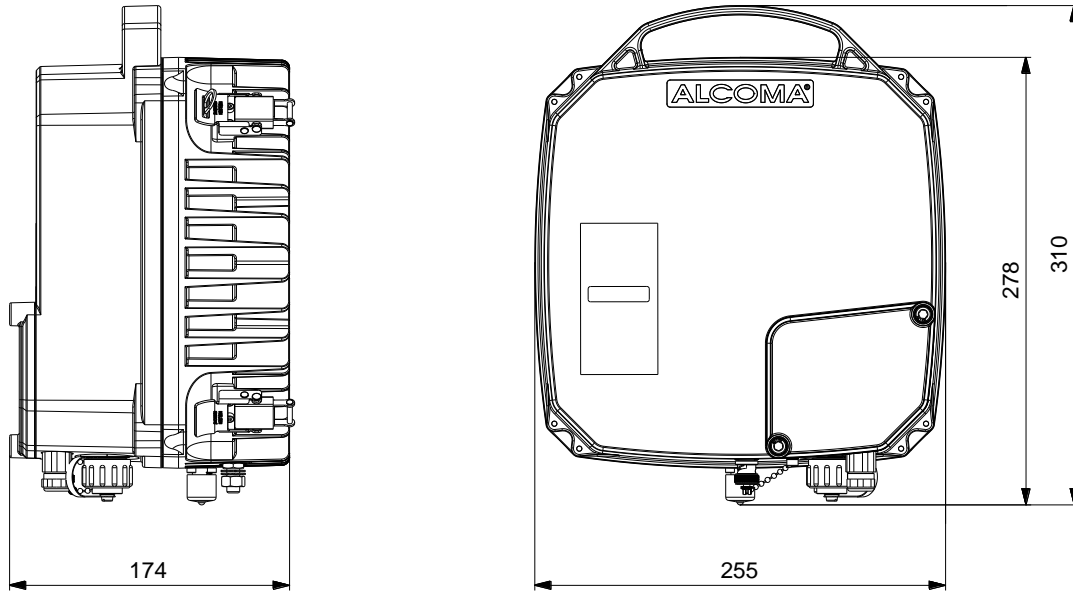


Figure 31 The ODU main dimensions

8.2 PROTECTED TERMINAL BOX

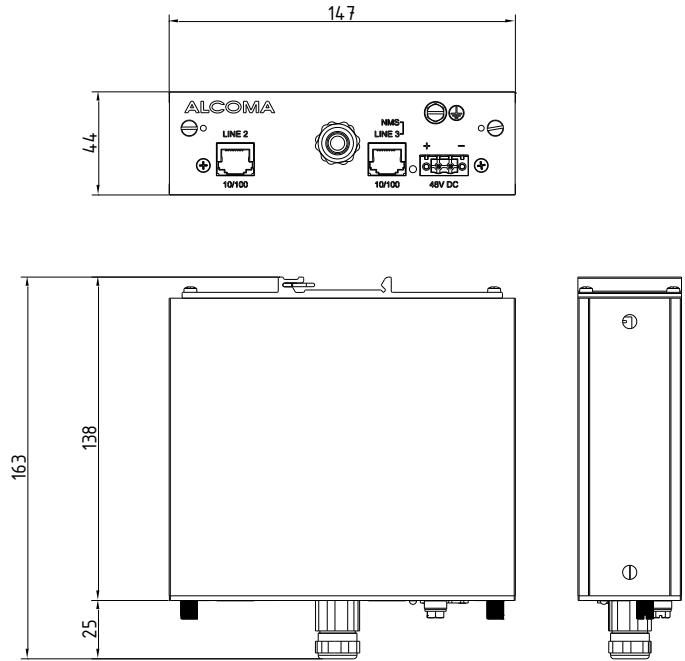


Figure 32 Protected terminal box ALS1x

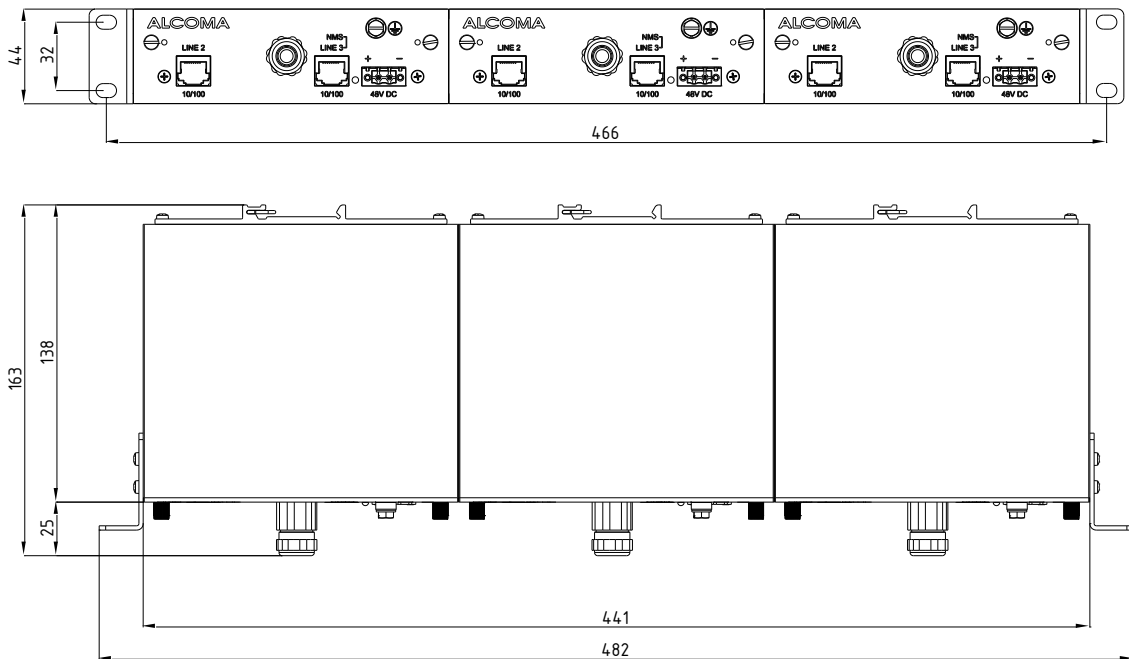


Figure 33 Assembled 3 terminal boxes ALS1x

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