

# Microwave data link **ALxxF MP400/360/165**

License exempt frequency bands 17 and 24 GHz

---

## Installation and operation manual



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## 1. INTRODUCTION

The radio relay link ALxxF 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 ALxxF 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 ALxxF MP400/360/165. Please pay increased attention to the safety instructions that are marked like this in the text:



### WARNING

Violating of this marked safety instructions can cause serious injury to personnel.



### CAUTION

Violating of this 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

- The link is protected by expiration
- License exempt frequency band **17 GHz** (17.100 – 17.300 GHz) and **24 GHz** (24.000 – 24.250 GHz)
- The ALCOMA ALxxF MP400/360/165 link is designed as unattended
- The data transmission capacity is up to
  - 900 Mbps for AL24F MP400 link
  - 660 Mbps for AL17F MP400 link
  - 384 Mbps for MP360 link
  - 165 Mbps for MP165 link
- Channel bandwidth
  - 3.5 MHz to 112 MHz for AL24F MP400 link
  - 3.5 MHz to 80 MHz for AL17F 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
- **Dual polarization** (vertical and horizontal transmitted polarizations at the same time)
- Interfaces: 2 Ethernet 10/100/1000Base-T(X) channels marked as User line 2 and User line 3
- Optional possibility of 1 x 1000Base-T/LX/SX – marked as user line 4
- The spectral analyzer shows the spectra of received signal of the local and remote stations along the whole spectrum
- The link consists of the outdoor ODU unit, protected terminal box ALS1-GEth (RP) or ALS1-2GEth (RP) 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.com](http://www.alcoma.com)
- It is possible to insert several relay stations in a signal path if needed due to the path character
- The radio relay link ALxxF MP400/360/165 enables using of the antenna types ALCOMA UNI, MP
- 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 ALxxF MP400/360/165 station consists of three main parts:

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 switches, 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 feeder and the pole attachment.
3. Considering placement of the data block in ODU, the station ALxxF MP400/360/165 has an indoor unit reduced to the protected terminal box **ALS1-GEth (RP)** or **ALS1-2GEth (RP)** 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 can be connected to the microwave parabolic antennas of the types ALCOMA UNI1-xxAF (Ø 0,35 m), UNI1-xxAS (Ø 0,35 m), UNI2-xxAF (Ø 0,65 m), UNI2-xxAS (Ø 0,65 m), AL3-xx/MP (Ø 0.90 m), and AL4-xx/MP (Ø 1.20 m). It is also possible to use the previous types of antennas ALCOMA (ME and AP), for more information contact your sales representative. These antennas are standard equipped by icing protection (OPN) for use in demanding climatic conditions. The simply removable ODU is integrated with the antenna system into one compact whole.

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. DESCRIPTION OF THE LINK

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 ALxxF MP400/360/165 use only with protected terminal box marked

- **ALS1-GEth Line 3** (121/516\*35)
- **ALS1-2GEth** (121/516\*30)

protected terminal box **optimized for power backup**

- **ALS1-GEth RP** (121/516\*33)
- **ALS1-2GEth RP** (121/516\*34).

Protected terminal box optimized for **separate management**

- **ALS1-GEth + Line 2 NMS** (121/516\*38)

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. 200 m long for the 10 Mbps 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. 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 to bring the connection cable with ODU to the front, or back 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 + mgmt) in the outdoor unit (ODU).

The high frequency block of the ALxxF 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.

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 10) 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.

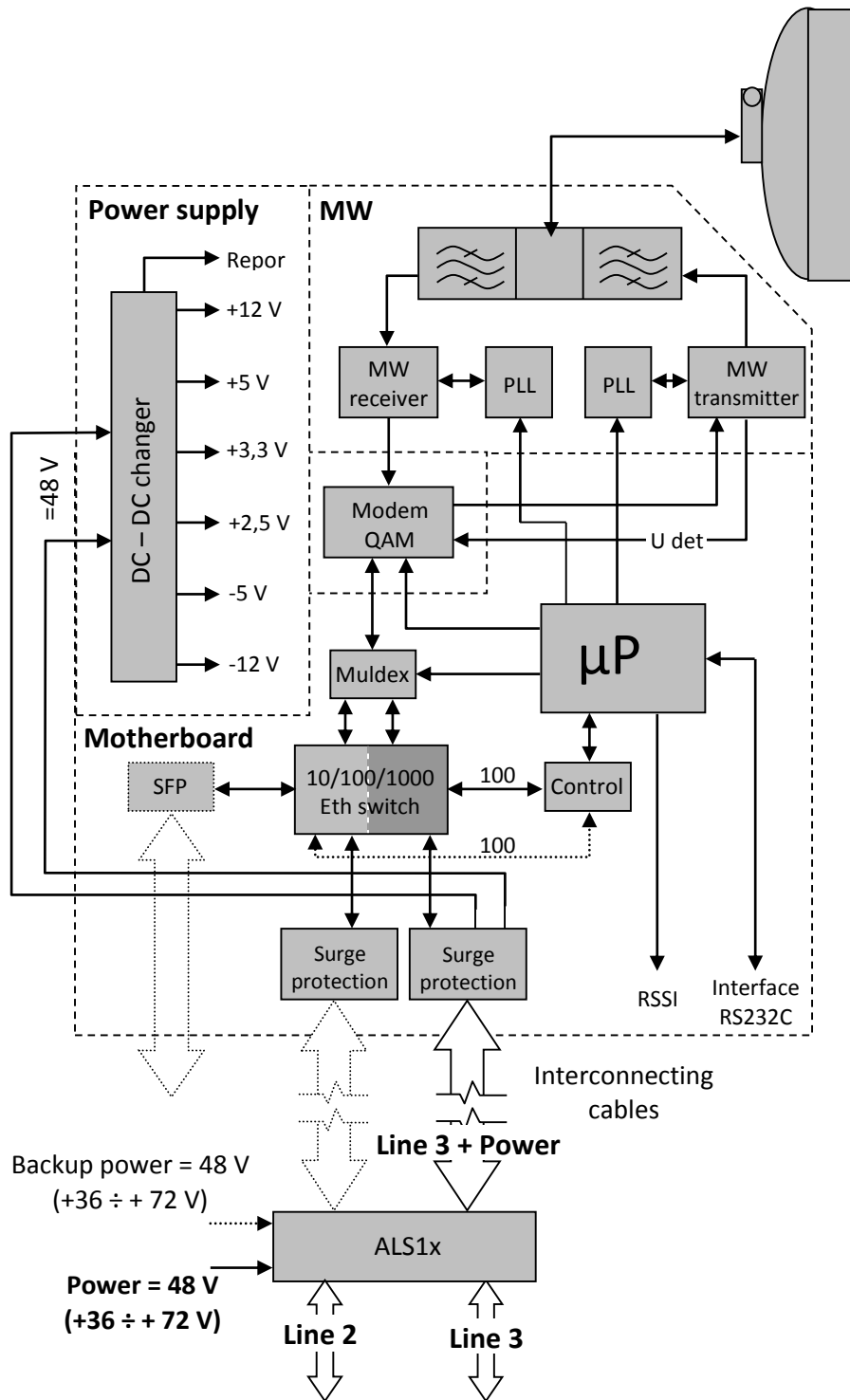


Figure 1 The block schematic of the ALxF MP400/360/165 link

## 2.1 TX POWER REGULATION

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

## 2.2 PROTECTED TERMINAL BOX

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 ALxF MP400/360/165 (see plate at ODU). The numbers in the terminal nameplate is ALS1-GEth Line 3 121/516\*35 (ALS1-2GEth 121/516\*30).

Protected terminal box **ALS1x RP** is designed for **power backup**. The numbers in the terminal box nameplate is **ALS1-GEth RP** (121/516\*33) or **ALS1-2GEth RP** (121/516\*34). These terminal boxes are designed for use with MP400/360/165 data links.

Protected terminal box **ALS1-GEth + Line 2 NMS** (121/516\*38) is designed for separate management. User data and management data are transmitted separate.

Protected terminal ALS1-GEth or ALS1-2GEth 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.)

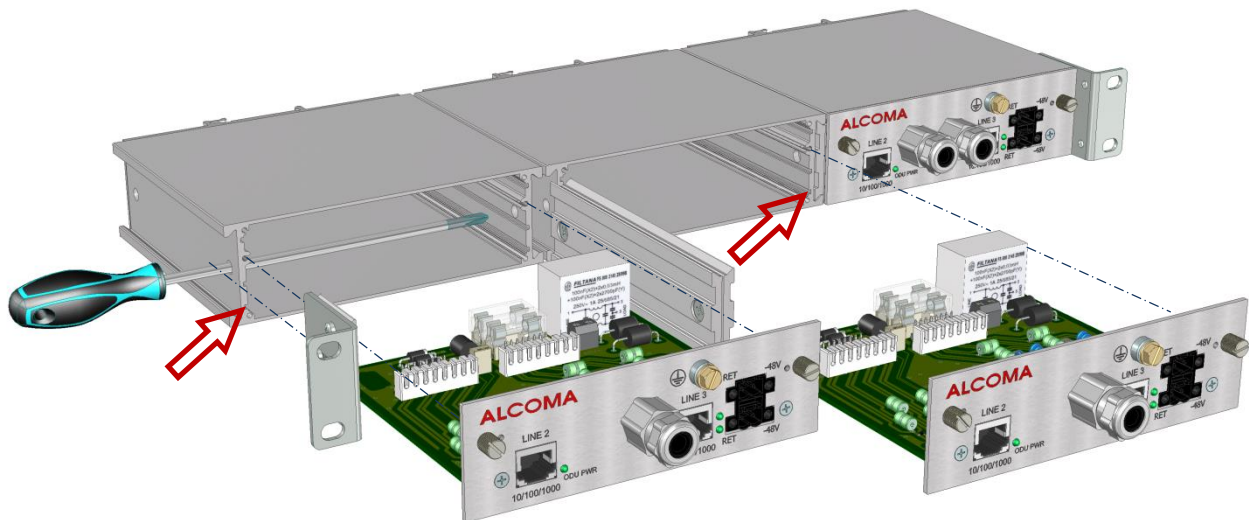


Figure 2 Assembling the three ALS1-GEth or ALS1-2GEth to 19" 1U unit



Figure 3 Protected terminal box ALS1-GEth Line 3



Figure 4 Protected terminal box ALS1-2GEth



Figure 5 Protected terminal box ALS1-GEth RP



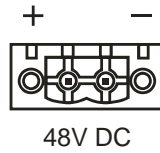
Figure 6 Protected terminal box ALS1-2GEth RP



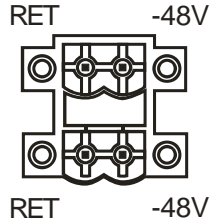
Figure 7 Protected terminal box ALS1-GEth + Line 2 NMS

### 2.2.1 Input Connectors

#### Power supply connector on the front panel ALS1x



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-TX**

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 Line 2 and Line 3**



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

### 2.2.2 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		white
	2	gr	green
	3		white
	4	or	orange
	5	bl	blue
	6		white
	7		white
	8	br	brown

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

#### Cutting box "Krone" for the Line 2 (separate management)



**Attention!**

Line 2 does not include power supply.

**Thin pairs of six-pair cable** are connected according to the following table.

Recommended cable: **ALCOMA UV SFTP 4+2**, product number: **893/814\*101-611**

in case you are using a cable with a different color markings of Cat5 conductors, follow these instructions

- first thin pair of conductors connects the green pins between ALS1 and ODU (1-8, 2-7)
- second thin pair of conductors connects the orange pins between ALS1 and ODU (3-6, 4-5)

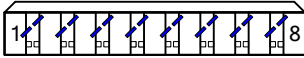








Wiring	Pins	Description	The marking of cable conductors S-STP Cat7
	1		brown
	2	gr	blue
	3		green
	4	or	orange
	5	bl	–
	6		–
	7		–
	8	br	–

Table 3 The protected terminal box - cutting box "KRONE" for the Line 2 (separate management)

**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	Power
	1		white	-
	2		green	-
	3		white	+
	4		orange	-
	5		blue	-
	6		white	+
	7		white	-
	8		brown	+

**Table 4 The protected terminal box - cutting box “KRONE” for the Line 3 + Power**



The cable S-STP Cat.7 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.

### 2.2.3 Indication

Board: Protected terminal box		
LED	Abbreviation	Meaning
	POWER	Power ON – indication of the station power supply being switched on

### 2.2.4 Jumpers - without function for the S-STP Cat7 cable

ALS1-GEth

ALS1-2GEth

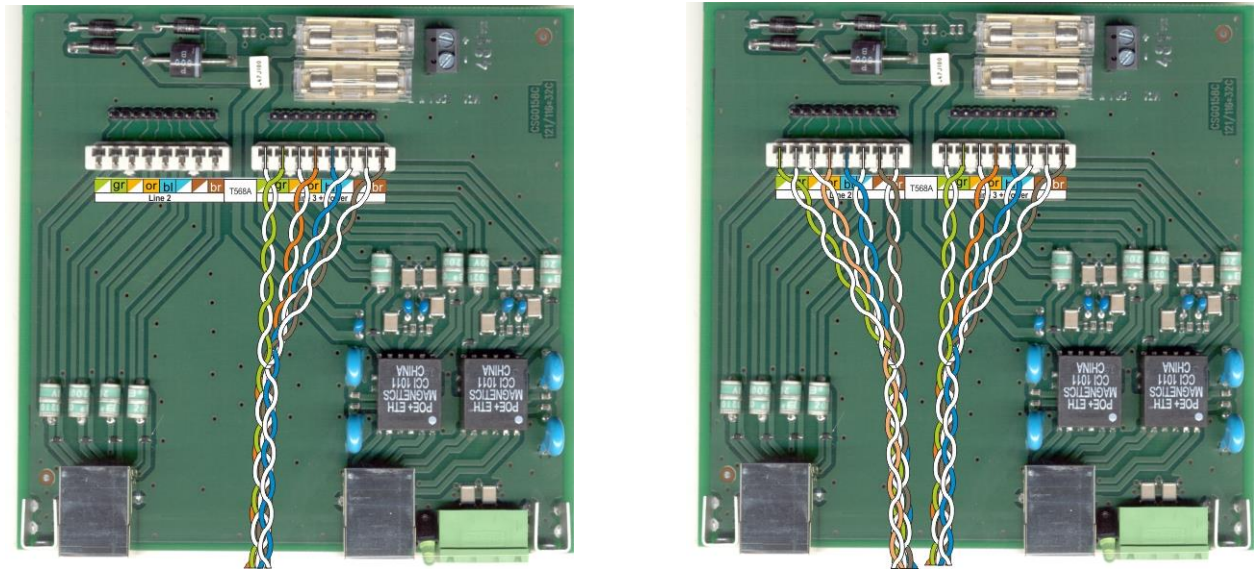


Figure 8 Wiring in the terminal box ALS1-GEth, ALS1-2GEth

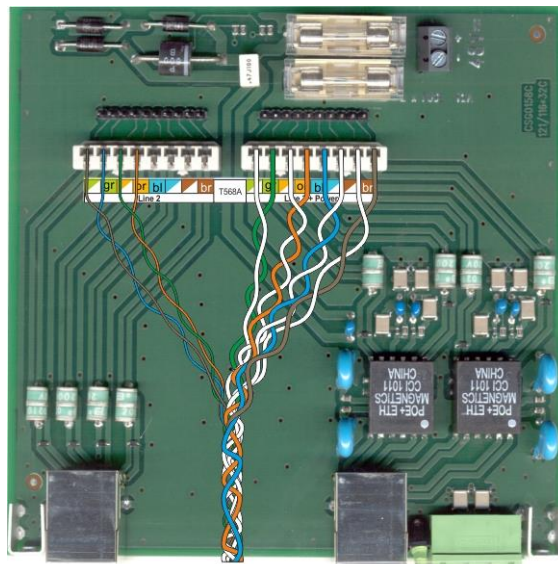


Figure 9 Separate management - wiring in the terminal box ALS1-GEth + Line 2 NMS

### 2.3 THE ODU OUTDOOR UNIT

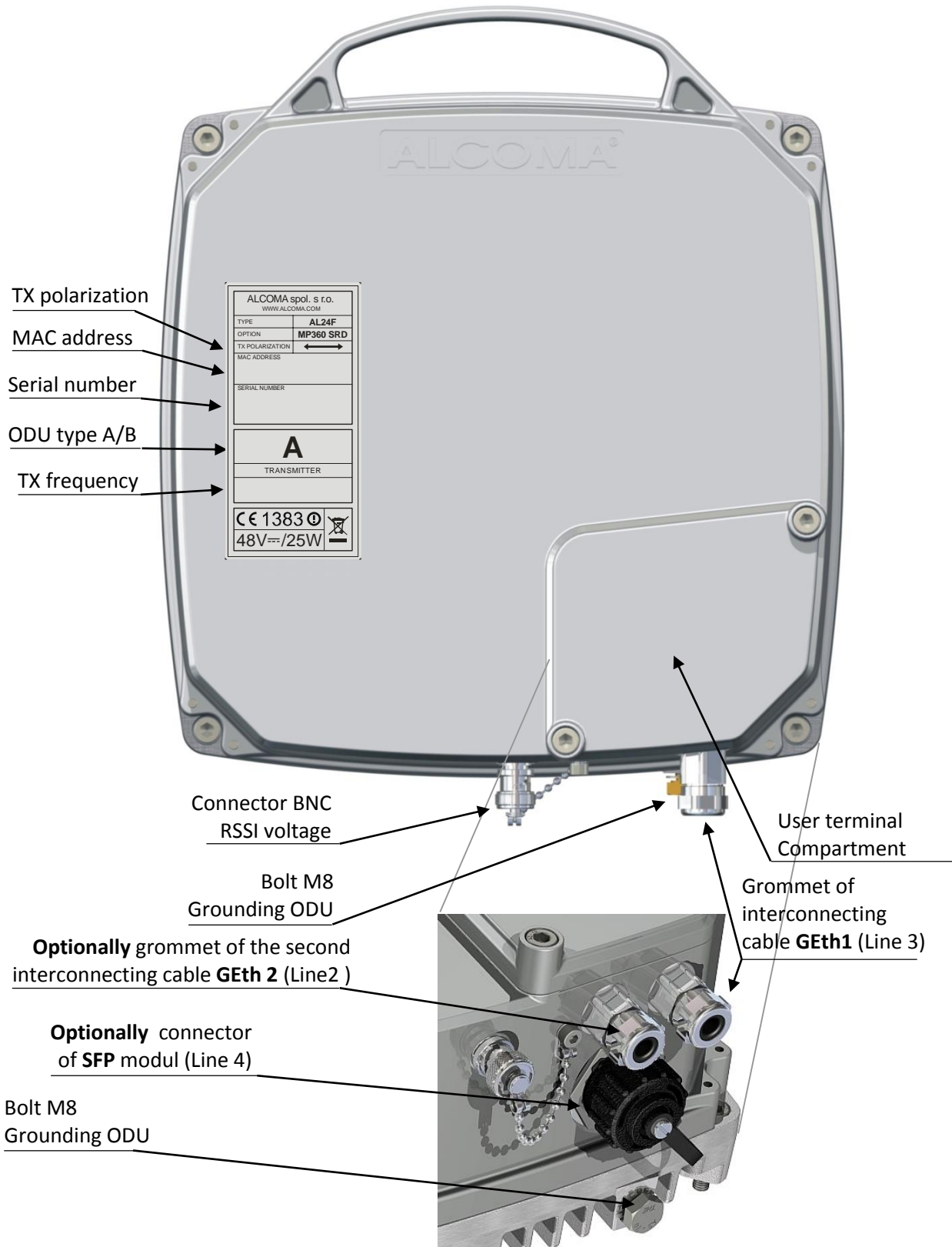


Figure 10 The ODU connection places

The standard station has a right side design, where the ODU and the antenna (while looking into the antenna) are on the right hand side of the support pipe. Left hand versions can be supplied if requested by a customer. Attachment of ODU depends on the used parabolic antenna. represent the right hand side

installation of individual types of compact antennas and their main construction dimensions (the figure scales are not identical).

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.

### 2.3.1 Input Connectors

#### Cutting box “Krone” for the Line 2

Wiring	Plns	Description	The marking cable conductors S-STP Cat7
	1		brown
	2		white
	3		white
	4		blue
	5		orange
	6		white
	7		green
	8		white

Table 5 The outdoor unit - cutting box “KRONE” for the Line 2

#### Cutting box “Krone” for the Line 2 (separate management)

**Attention!**

Thin pairs of six-pair cable are connected according to the following table.

Recommended cable: **ALCOMA UV SFTP 4+2**, product number: **893/814\*101-611**



in case you are using a cable with a different color markings of Cat5 conductors, follow these instructions

- first thin pair of conductors connects the green pins between ODU and ALS1 (8-1, 7-2)
- second thin pair of conductors connects the orange pins between ODU and ALS1 (6-3, 5-4)

Wiring	Plns	Description	The marking cable conductors S-STP Cat7
	1		–
	2		–
	3		–
	4		–
	5		orange
	6		green
	7		blue
	8		brown

Table 6 Separate management - the outdoor unit - cutting box “KRONE” for the Line 2

Cutting box “Krone” for the Line 3 + Power

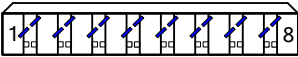

Wiring	Pins	Description	The marking of cable conductors S-STP Cat7	Power supply
	1	br	brown	+
	2	[diagonal brown/white]	white	-
	3	[diagonal blue/white]	white	+
	4	bl	blue	-
	5	or	orange	+
	6	[diagonal orange/white]	white	-
	7	gr	green	-
	8	[diagonal green/white]	white	

Table 7 The outdoor unit - cutting box “KRONE” for the Line 3 + power

**Connector for direct connection of power supply**

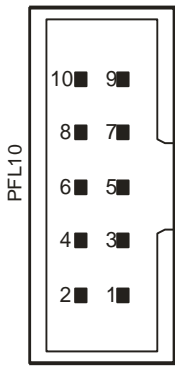
This connector can be used to power ODU see examples on chapter 3.10, page 31. Description of the pins is shown on the label in the ODU user space. Power supply cord is connected to the terminal block in the user space ODU unused grommet for S-STP cable.

Wiring	Pins	Color
	+	red
	-	blue

**Table 8 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 9 Connector PFL10 for direct connection of PC**

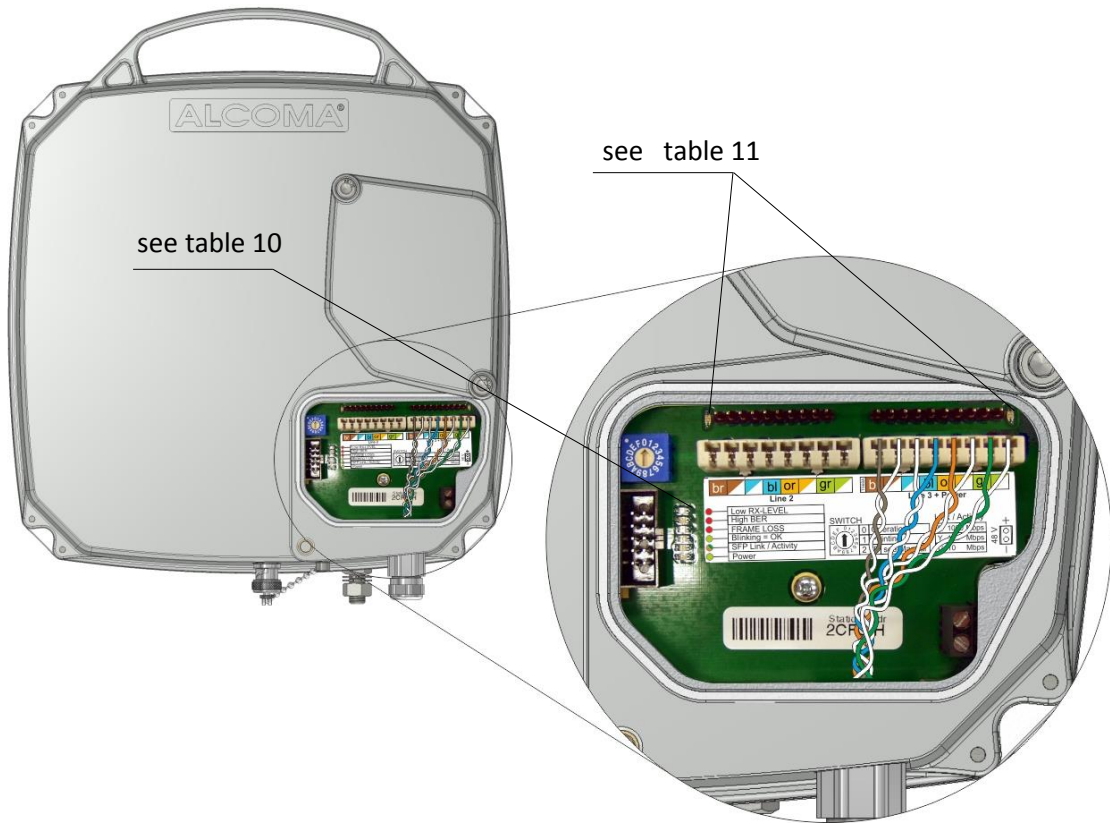


Figure 11 The ODU user space 1xGEth

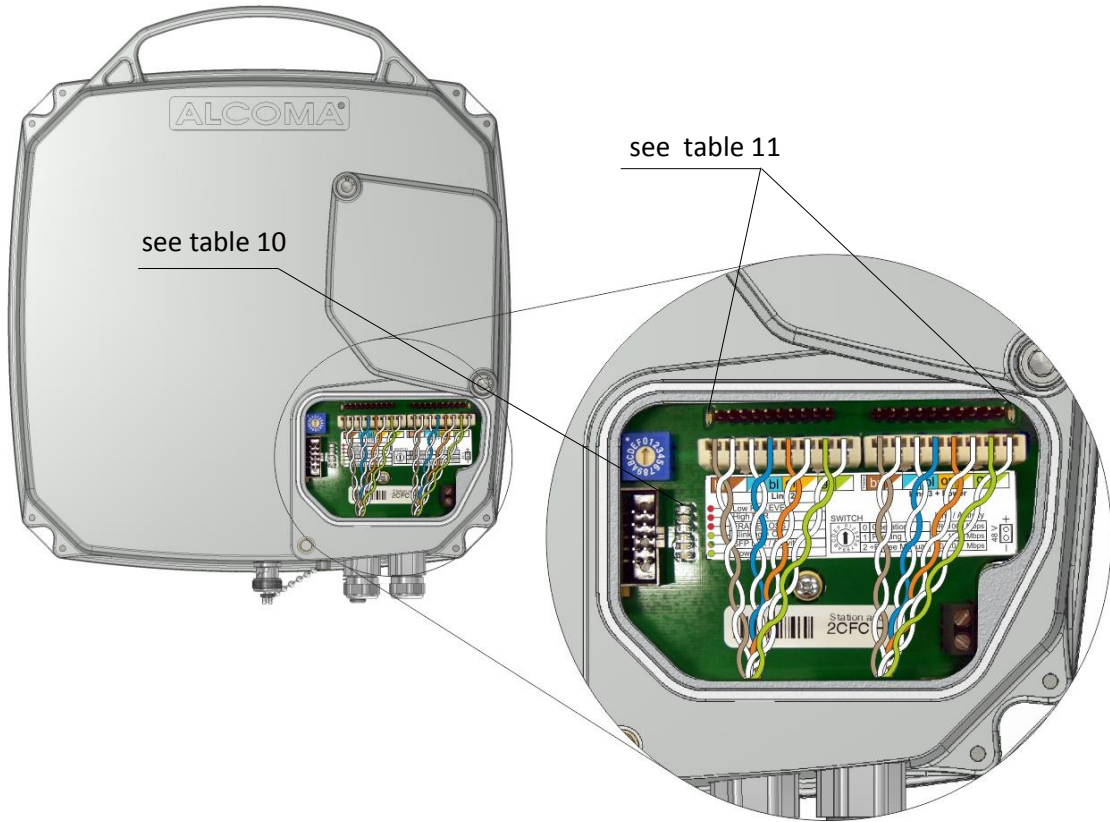


Figure 12 The ODU user space 2xGEth

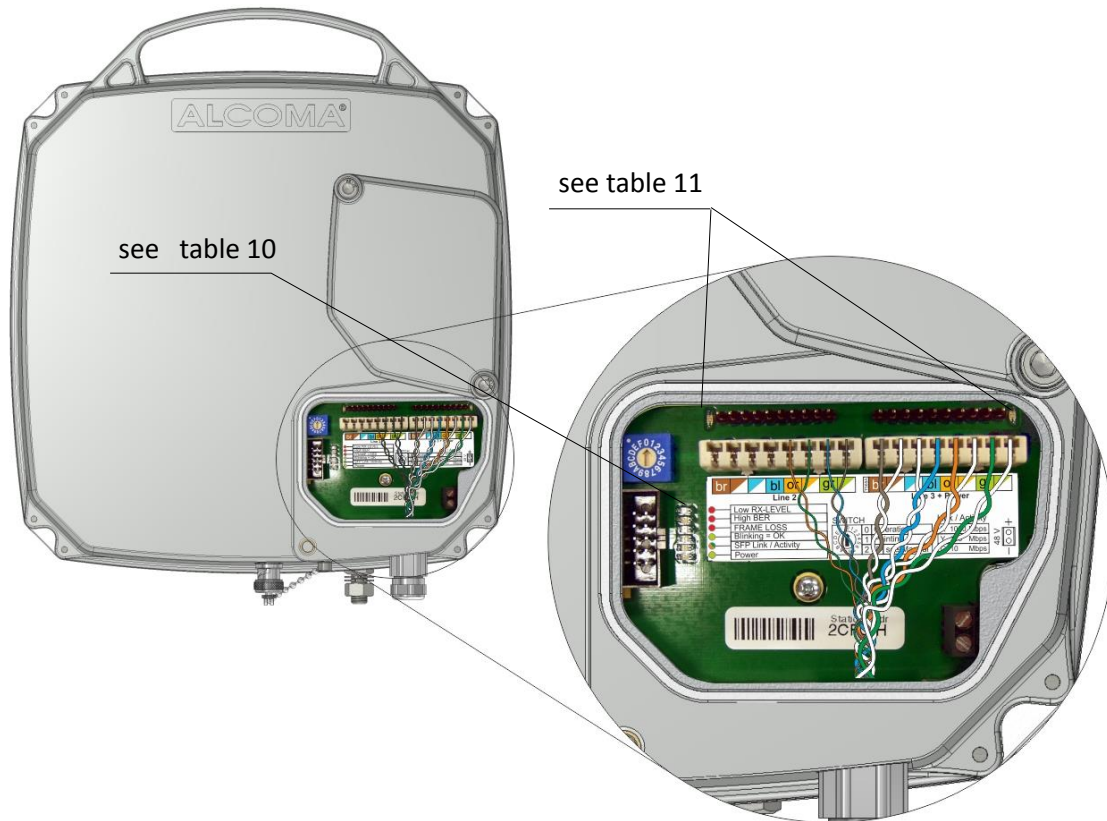


Figure 13 Separate management - the ODU user space 1xGEth

2.3.2 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 10 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 11 Meaning of LEDs next the cutting box “KRONE” in the ODU user space

2.3.3 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 12 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 ALxxF 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.

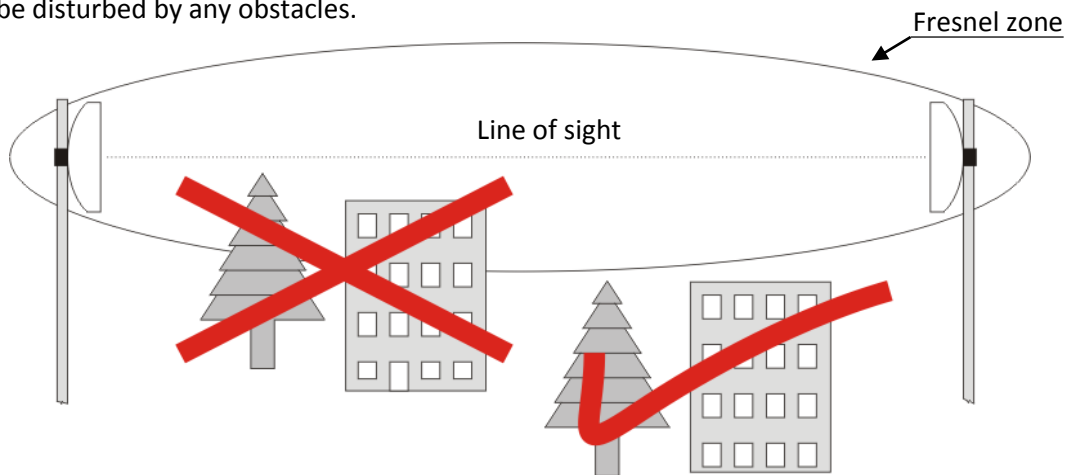
### 3. INSTALLATION INSTRUCTIONS

#### 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 ALS1-GEth or ALS1-2GEth
- Path to lay the ODU – ALS1-GEth or ALS1-2GEth 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 14 The Fresnel zone**

Figure 14 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.

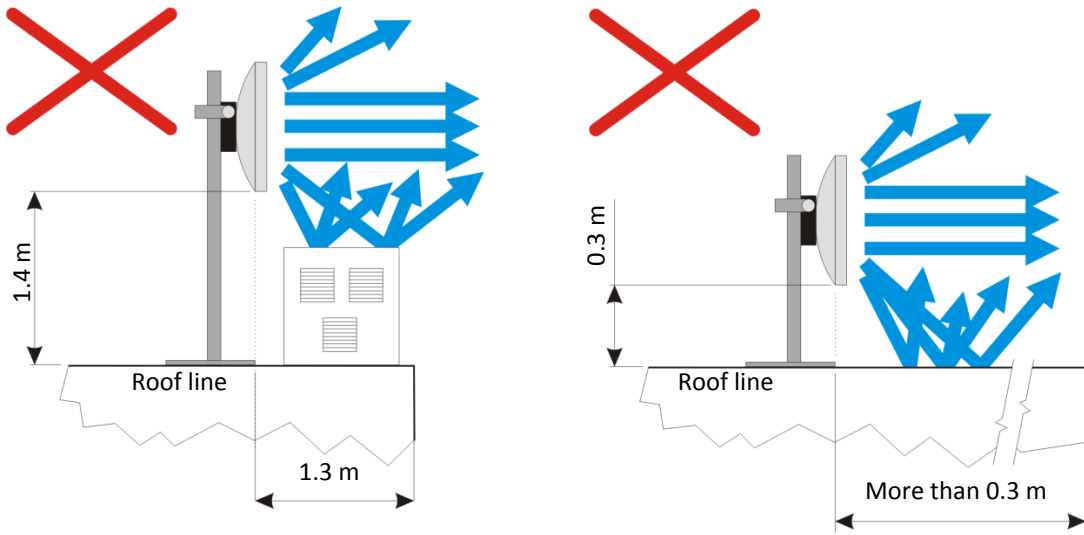


Figure 15 Improper placement of antenna on mounting pipe

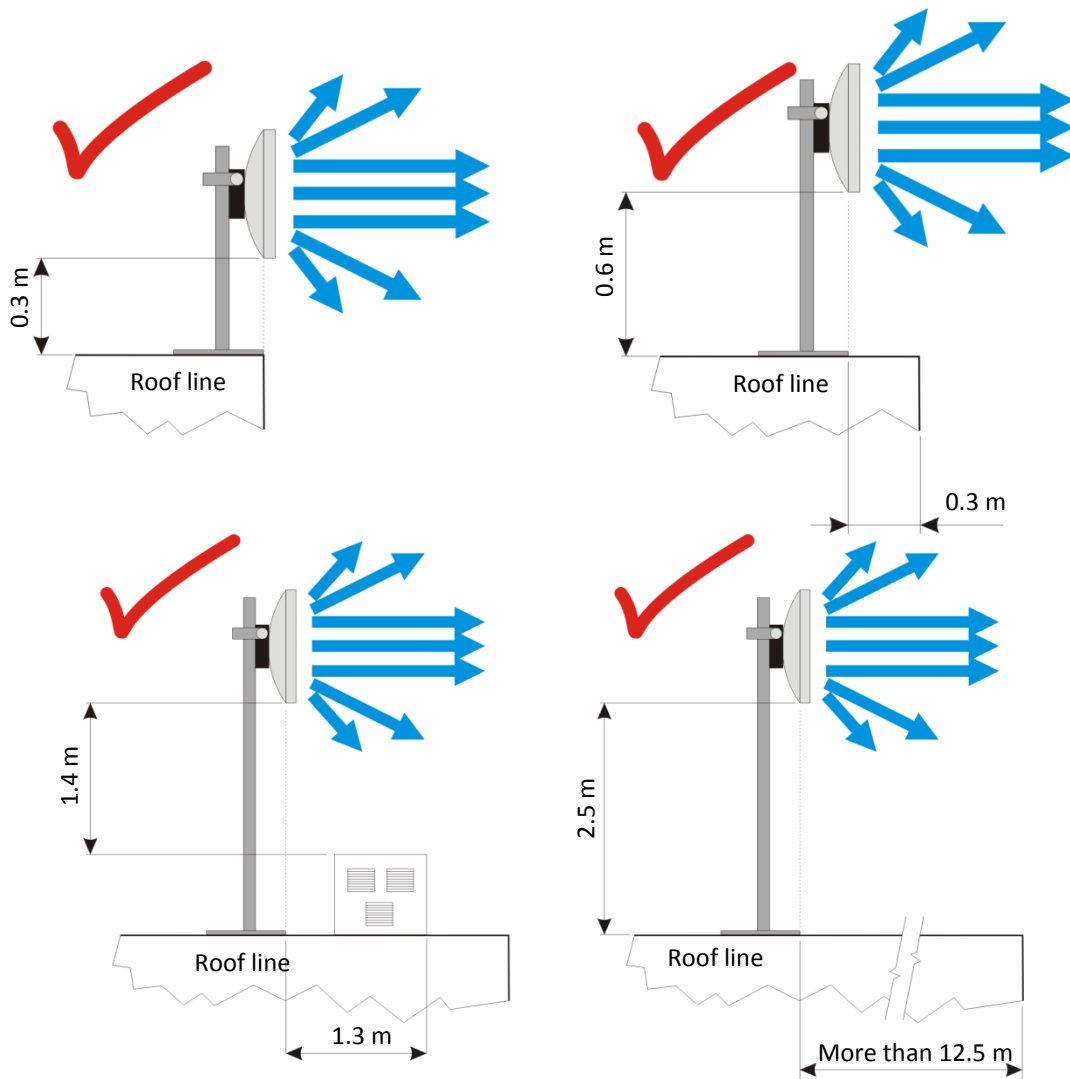


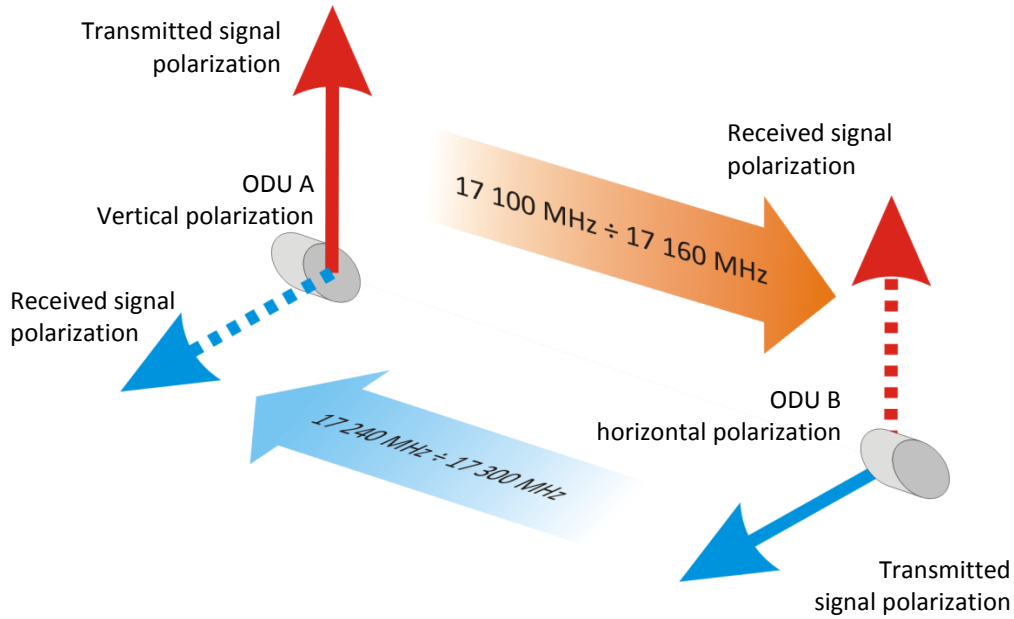
Figure 16 Proper placement of antenna on mounting pipe

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 13 Recommended antenna placements considering a distance from an obstacle<sup>1</sup>**

### 3.3 DUAL POLARIZATION OF RADIO LINK

The ALxxF MP400/360/165 radio link for unlicensed 17 GHz and 24 GHz band uses horizontal and vertical polarization. The microwave coupler of transmitted and received signal in ODU consists of the polarization switch and band filters. Figure 17 is shown for easier understanding of the polarization beam splitter of transmitted and received signals.



**Figure 17 The dual polarization of the radio link ALxxF MP400/360/165**

<sup>1</sup> 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 LOCAL FREQUENCY COORDINATION

If there is more 17 GHz or 24 GHz frequency band radio links in one location, polarization, or possibly link channel numbers must be selected to eliminate undesirable interference. The following figure 18 shows possible polarization combinations. Separation by channels is also possible – however, this possibility means using narrower transmitting band (lower transmission rate).

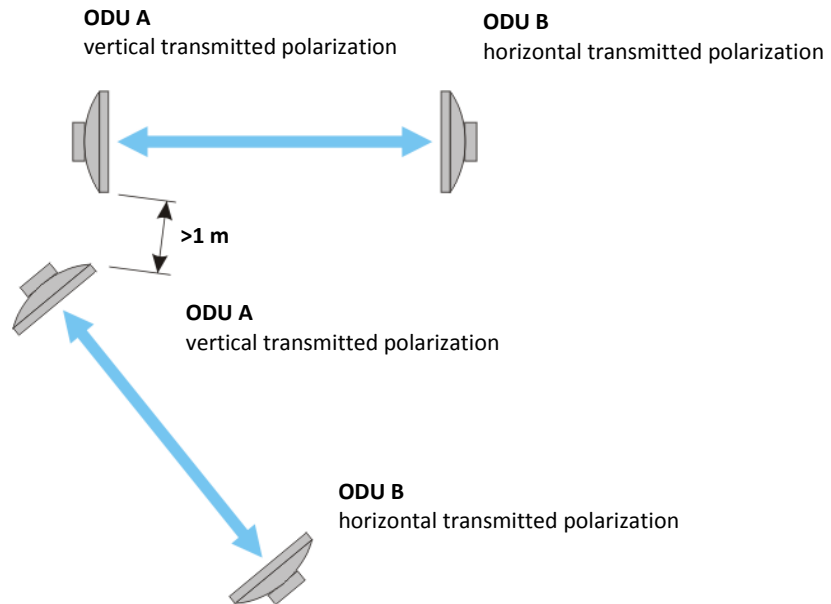


Figure 18 The examples of channel and polarization usage in case of more links in one location

### 3.5 FEEDER INSTALLATION

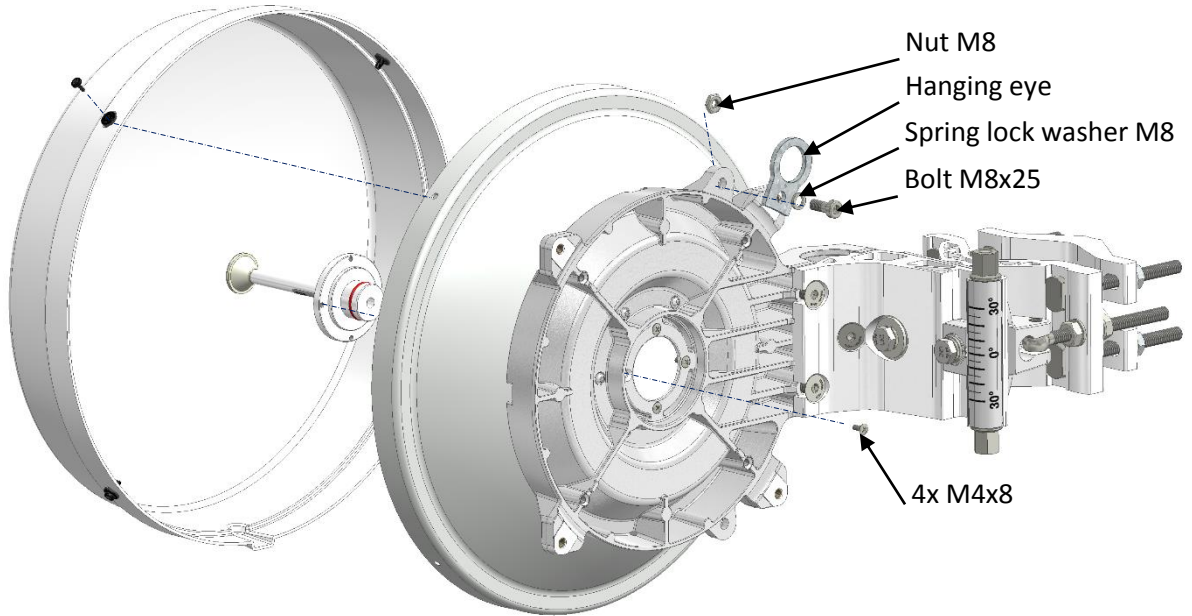
The antenna feeder and the ODU box are one compact whole. If the feeder element is delivered separately it needs to be attached to ODU before the ODU is installed to the antenna unit supports. A waveguide transformer is attached to the ODU box at the manufacturer, and the feeder is attached to the transformer using two M4 bolts (figure 19). On the AL3-xx/MP and AL4-xx/MP antennas the feeder is firmly attached to the parabola, see figure 20.

- The waveguide cover is removed from both the antenna feeder, and the waveguide transformer.
- The antenna feeder is installed and M4 bolts are tightened. (It does not matter which way the feeder is turned.)
- With the AL3-xx/MP and AL4-xx/MP antennas the ODU position, according to the pictograms on the feeder flange, needs to be kept.

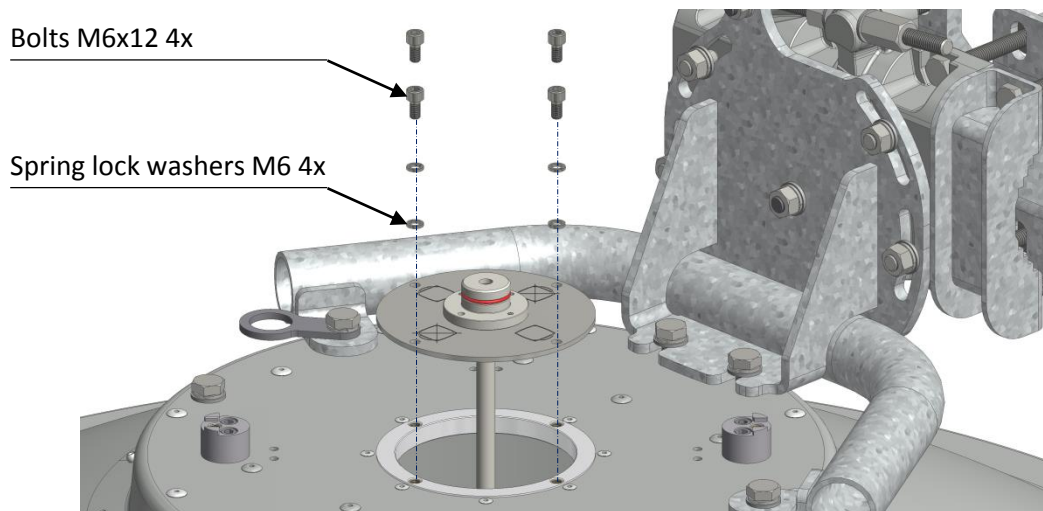


#### CAUTION

The antenna feeder can be damaged during installation or disassembly of ODU if done by non-professionals. The antenna feeder is a precise component that needs to be handled with utmost care. Any damage to the feeder can cause improper function of the whole antenna system.



**Figure 19 Attaching of the feeder to the antenna (antenna types UNI)**



**Figure 20 Attaching of the feeder to the antenna (antenna types MP)**

**WARNING**



The radio relay link ALxF MP400/360/165 is not intended to be used by non-specialist personnel. The equipment must be operated at least by personnel familiar with it (Paragraph 3, of the Public Notice No. 50/1978). Installation, adjusting and maintenance must be performed by the manufacturer instructed personnel with electrotechnical qualifications (Paragraph 5, Public Notice No. 50/1978). Therefore the following chapters do not contain work procedures split into individual steps.

### 3.6 INSTALLATION OF THE ANTENNA SYSTEM

Station antenna systems are attached to a vertical steel pipe that is a part of a girder mast structure, or to other steel constructions firmly connected to the building, on which the station is being installed. Diameters of supporting pipes are set by the table 23 and table 35.

The antenna unit may not be installed on building equipment that have not been set or modified for this purpose.

Allowed installation torques:

Bolt and nut	Torque
M10	35 Nm
M8	17 Nm
M6	11 Nm
M5	5 Nm
M4	3 Nm

We recommend that all bolts and nuts are greased before installation.

The antenna is normally delivered as the right hand side one, where, in front view into the antenna, the antenna holder and ODU are on the right side of the support pipe. For the change to the left hand side attachment the parabolic antenna must be unscrewed from the antenna holder and the holder needs to be turned by 180°. Then the antenna needs to be screwed back, so the condensed water drain holes in the antenna OPN are facing down. The bottom part of parabolic antenna is marked with the sticker "This side always down".

The change to the left side installation is always done without ODU installed, and on a horizontal support (table) of appropriate dimensions if possible.

Antenna bracket nuts are always tightened by the no. 17 wrench.

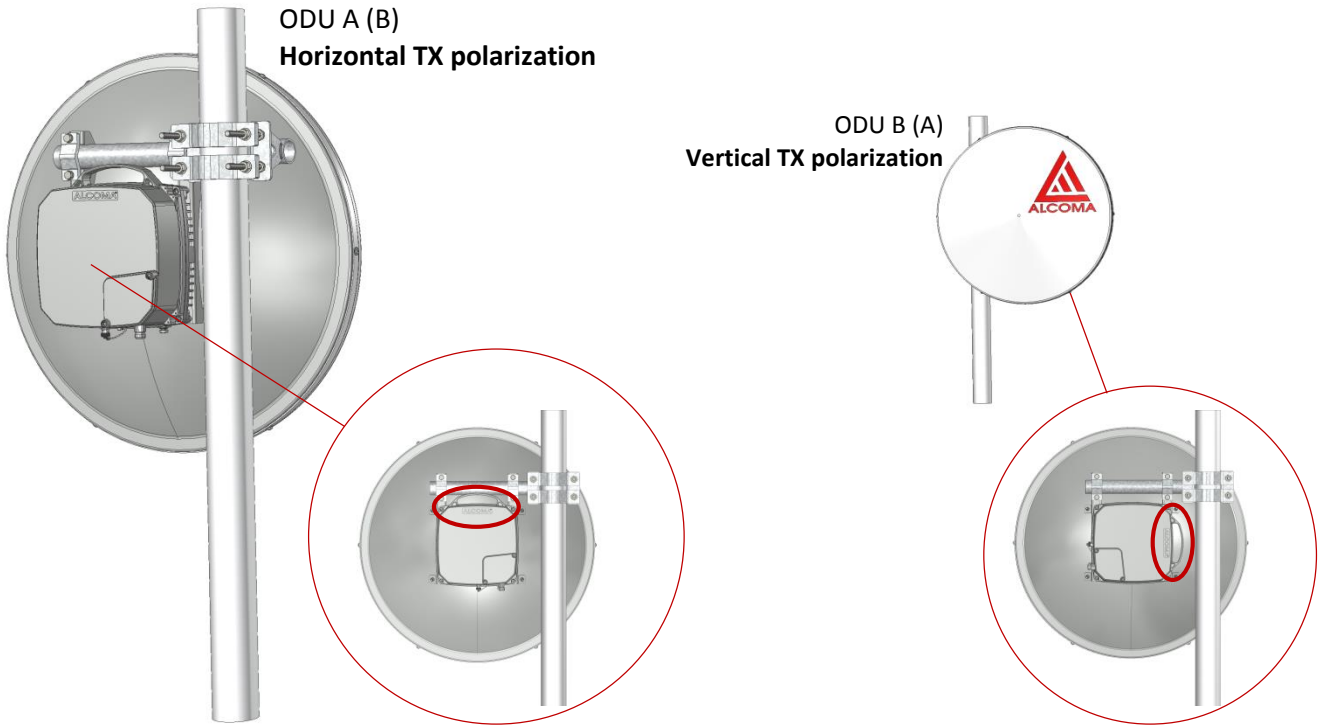
### 3.7 RADIO LINK INSTALLATION



**THE RADIO RELAY link ALxxF MP400/360/165 USES CROSS POLARIZATION**

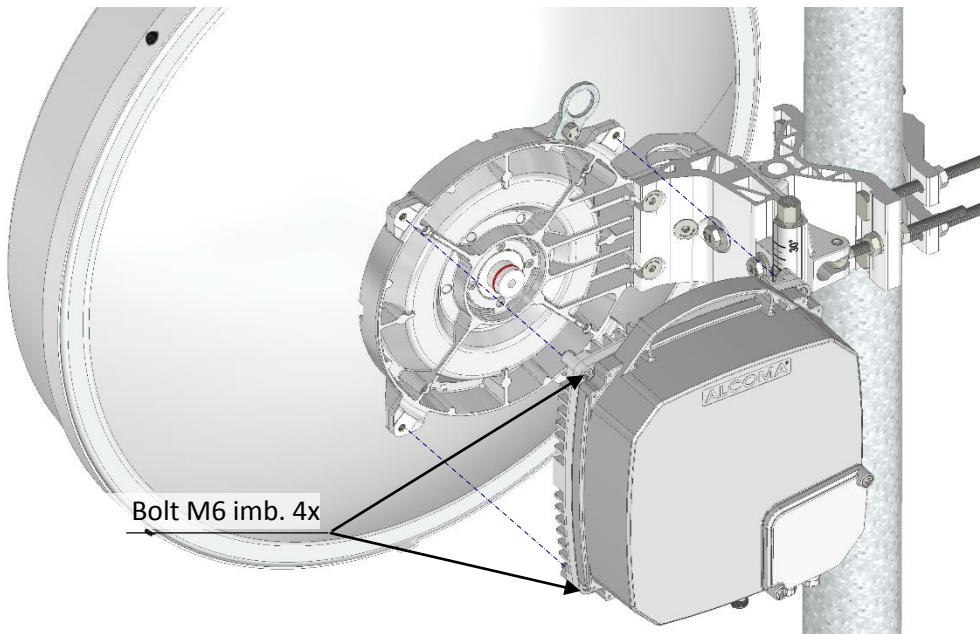
**ODU A is set with the opposite polarization than ODU B**

- (e.g.: ODU A horizontal – ODU B vertical polarization, or
- ODU A vertical – ODU B horizontal polarization)



**Figure 21 Radio link installation – dual polarization**

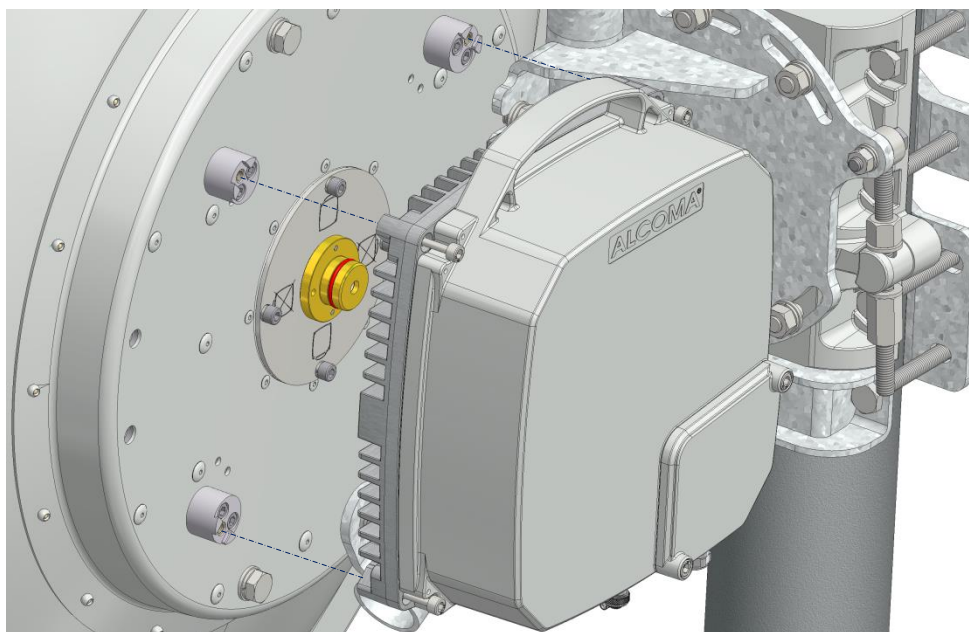
### 3.7.1 The UNI2-xxAx antenna type (also for the UNI1-xxAx)



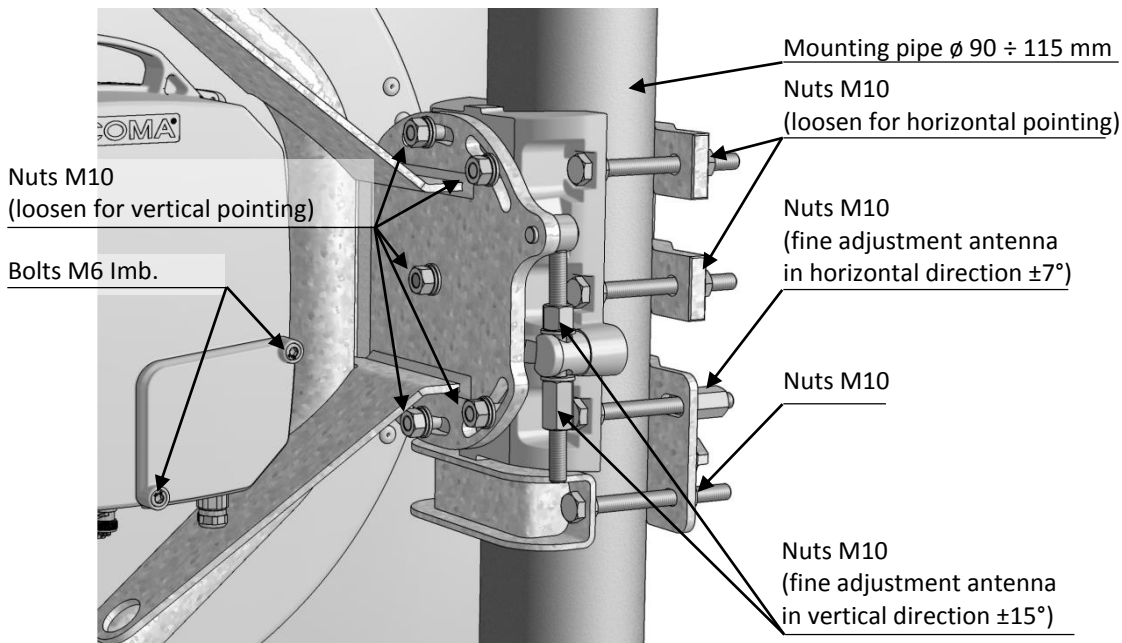
**Figure 22 The ODU to the antenna UNI2-xxAx connection (also for UNI1-xxAx)**

- The antenna feeder element is attached to the antenna
- Remove protective cap before connection antenna and ODU
- ODU is fastened to Antenna 4 bolts M6

### 3.7.2 The AL3-xx/MP antenna type (also for the AL4-xx/MP)



**Figure 23 The ODU to the AL3-xx/MP antenna connection (also for the AL4-xx/MP)**



**Figure 24 The attachment of the AL3-xx/MP antenna holder (also for the AL4-xx/MP antenna)**

The attachment of ODU with antenna must be sufficiently rigid to withstand wind acting on the ODU without making the link to point in a wrong direction. These forces are primarily caused by the front wind resistance of the microwave antenna.

The ODU box is installed with the outlet of connection cable **pointing down with the horizontal polarization** or to the **side with the vertical one**. It is never installed with the outlet pointing up. Possible disassembly can be performed without affecting the connection pointing direction.

The parabolic antennas UNI1-xx, UNI2-xx and AL3-xx/MP and AL4-xx/MP are equipped by a lifting eye for this purpose.

Please note that, according to the Safety Office Public Notice no. 324/90 Coll. About safety of work and technical equipment during construction, workers must be equipped by PPE, especially a hard hat, during work on masts and in their proximity.

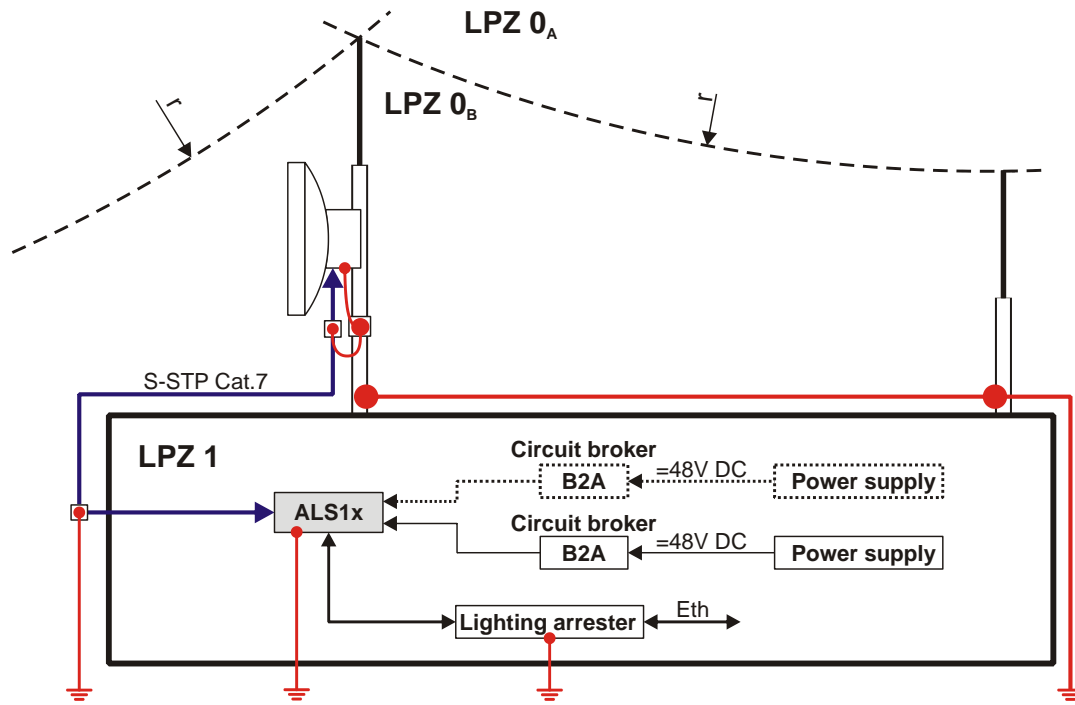
**Firm tightening of all connections of an antenna system must be checked after installation.** We especially note the tightening of the antenna unit brackets to the antenna support pipe and of the bolts that secure the vertical setting.

### 3.8 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.



**Figure 25 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  $50 \text{ mm}^2$ . Also the ODU box and the antenna system must be grounded, best by a copper rope with the cross section of at least  $14 \text{ mm}^2$  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.

The antenna system grounding points for the UNI1-xx and UNI2-xx antennas are common with ODU. The grounding points of the AL3-xx/MP and AL4-xx/MP antennas are at the bolts for attaching the equipment to the parabolic mirror.

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 ALS1-GEth or ALS1-2GEth - ODU just before entering a building must be made by a copper rope with the same cross section of at least  $14 \text{ mm}^2$ .

The protected terminal box ALS1x in a building is grounded by a copper rope with the cross section of at least  $5 \text{ mm}^2$  with cable eyelets. This cable should be connected to the marked M4 pin on the front side of ALS1x.

### 3.9 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 an Allen 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.

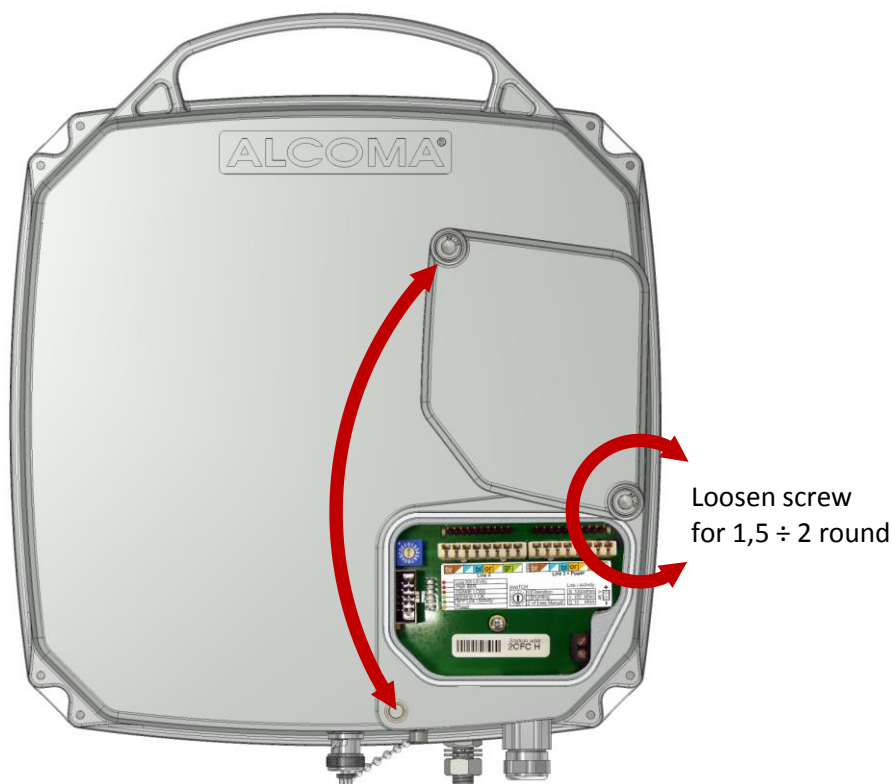


Figure 26 Manipulation with the user space cover



#### 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**.

### 3.10 TYPICAL ODU WIRING

The following pictures show typical connection diagram for use ALxxF 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 KRONE line3 + POWER.

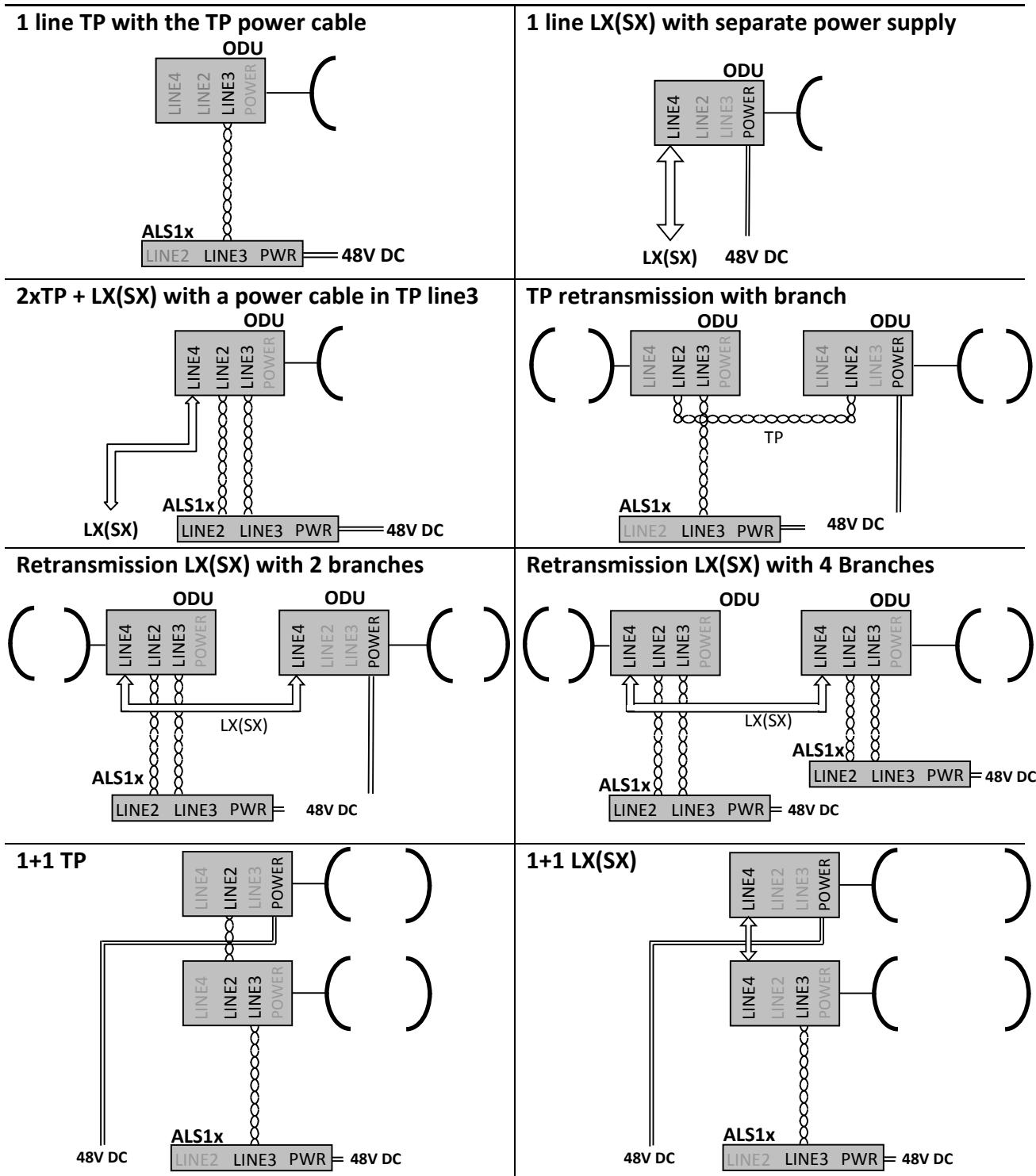


Figure 27 Typical ODU wiring

### 3.11 INSTALLATION OF INTERCONNECT CABLE

We recommend using the **shielded cable for outside use** type **Cat 7 S-STP** with four pairs of conductors for the connection of the terminal box ALS1x and the station ALxxF 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. Additional outside insulation of the cable increases its climate resistance and also resistance against the sun UV radiation.

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

(Identical for the protected terminal box and ODU)

- The front panel with PCB is removed using a screwdriver (figure 2) or the cover of the terminal box space in ODU is opened using an Allen wrench no. 5 (figure 26).
- 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 28). 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  $\Omega$  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.

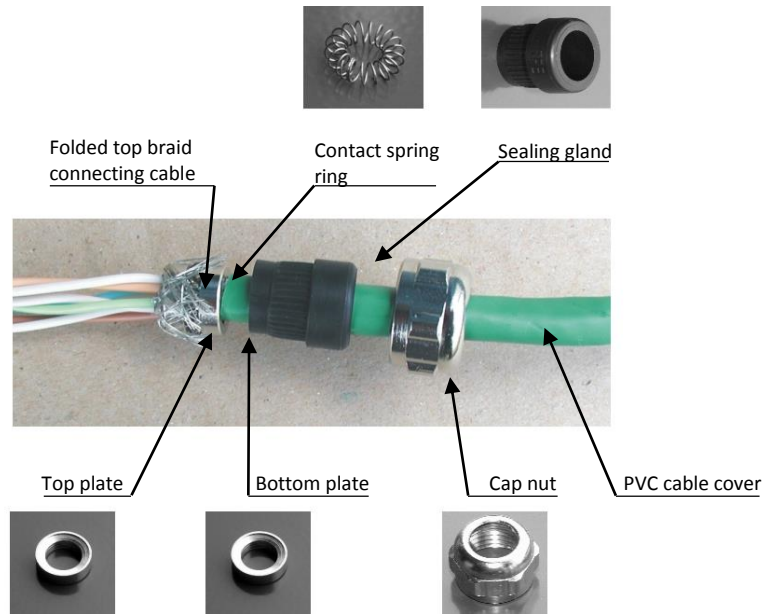


Figure 28 The grommet installation

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.

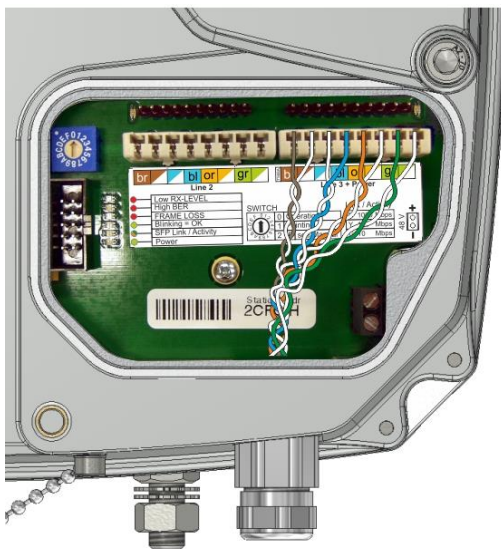
Corresponding after installation tightness of the grommet must be ensured for these customer selected cables too.

**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.

ODU ALxxF MP400/360/165



Protected terminal box ALS1-GEth

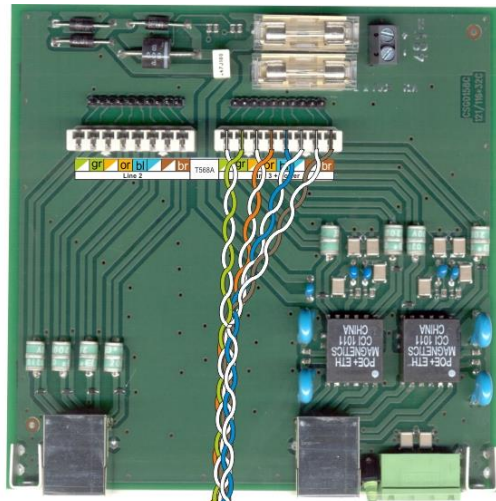


Figure 29 Finished assembly of the connection cable Cat7 S-STP

### 3.12 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)



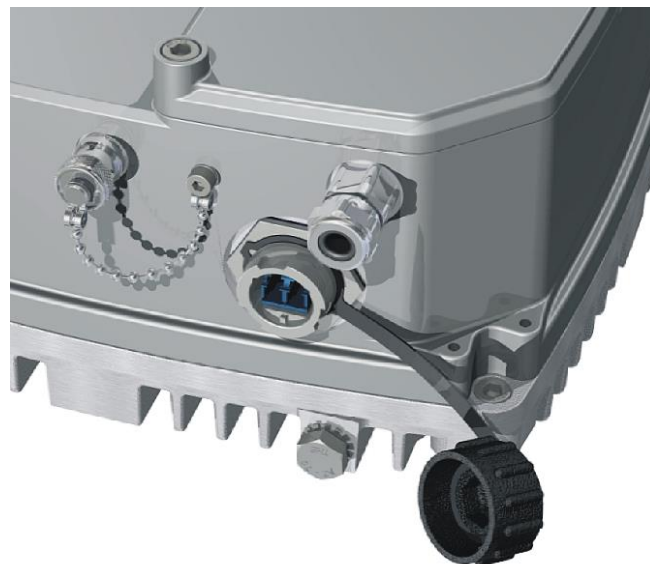
1000Base-BX  
WDM Singlemode (TX 1310 nm – RX 1550 nm)



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

**Figure 30** 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 31** 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.

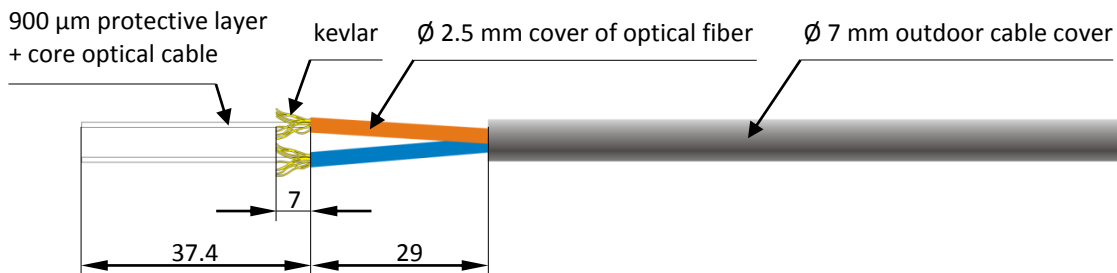
### 3.13 INSTALLING AN OPTICAL CONNECTOR MOLEX 106059

#### 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)

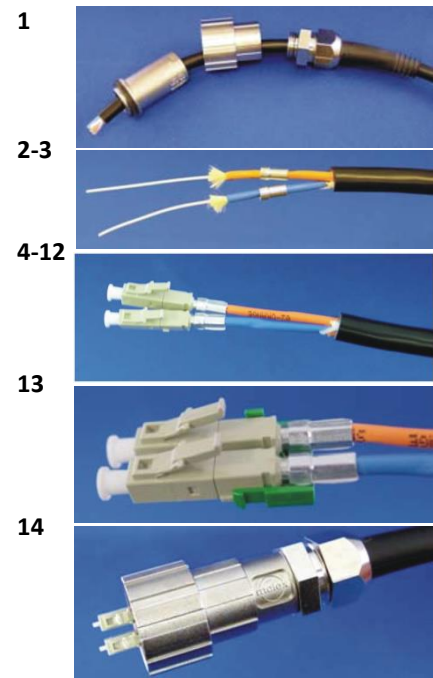


#### Preparation of optical cable



#### 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. Injected into the body tube connector the adhesive<sup>2</sup>.
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.

<sup>2</sup> We recommend using the adhesive LOCTITE 638 + activator 7649.

### 3.14 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.

### 3.15 ACCESSORIES

Based on customer wishes we can deliver all accessories necessary for installation and service of the radio relay links ALxxF 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

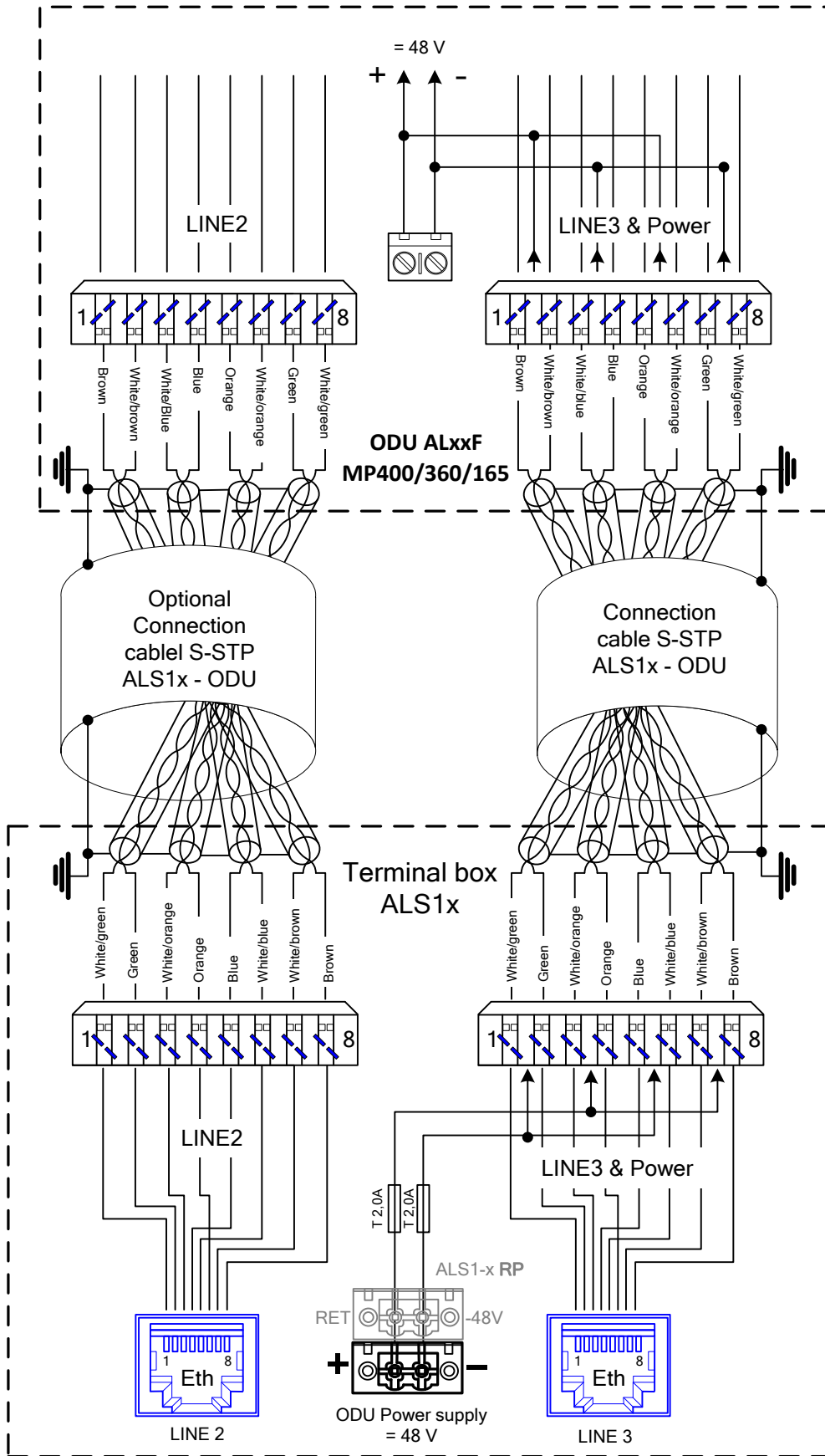


Figure 32 Connection of the connecting cable

## 4. SETTING OF THE RADIO LINK AND ITS COMMISSIONING

Installation and commissioning of the radio relay ALxxF 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 ALS1-GEth or ALS1-2GEth 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 11, figure 12).

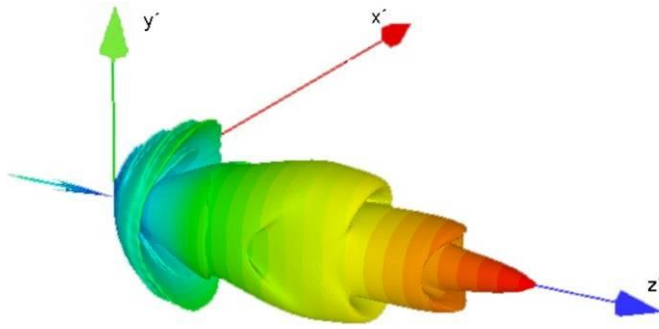


Figure 33 Radiation characteristics

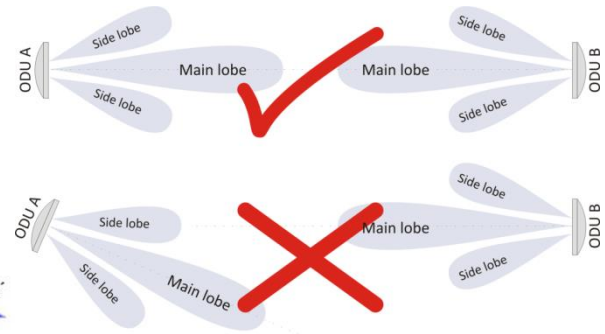


Figure 34 Pointing

#### 4.1.1 Pointing Procedure:

- Loosen all M10 bracket nuts of the antenna support by no. 16/17 mm and 13 mm wrench.
- Using an Allen wrench no. 5 loosen and flip up the cover on the ODU box (see the chapter 3.9 on the page 30).
- After removing the BNC connector cover at the bottom part of the ODU box connect DC voltmeter set to the min. range of 5 V to it. It is more advantageous to use an analog voltmeter for easier reading while searching for a maximum value. (In a pinch you can connect a DC ampere meter with the min. range of 5 mA).
- The rotary switch needs to be moved to the pointing position. Base tone of acoustic signalization sounds, which by its pitch (not intensity) corresponds to the strength of received signal. A deep (base) tone sounds when the unit does not receive any signal, or the signal is very weak. The tone (voltage on  $U_{RSSI}$ ) increases in jumps, since it is digitally linearized.

After switching the rotary switch, it is good to wait with reading of  $U_{RSSI}$  about 5 s for the ATPC system to stabilize (if switched on).



#### 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.

#### 4.1.2 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.

### 4.1.3 The pointing of radio link with the UNI2-xx (also for UNI1-xx)

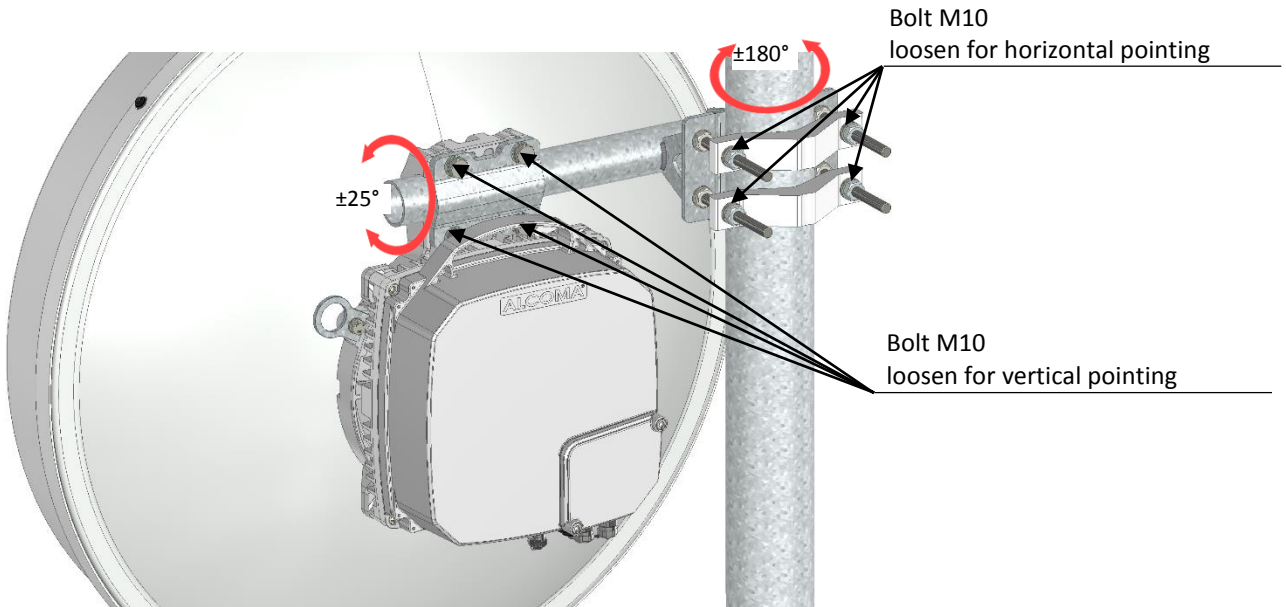


Figure 35 The UNI2-xxAS antenna pointing (also for the UNI1-xxAS antenna)

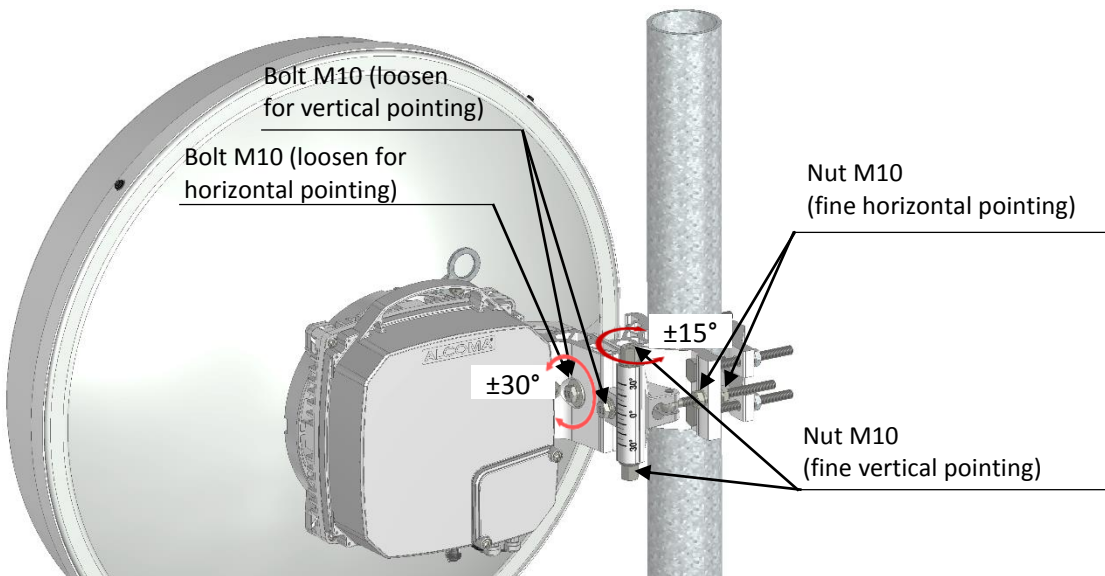
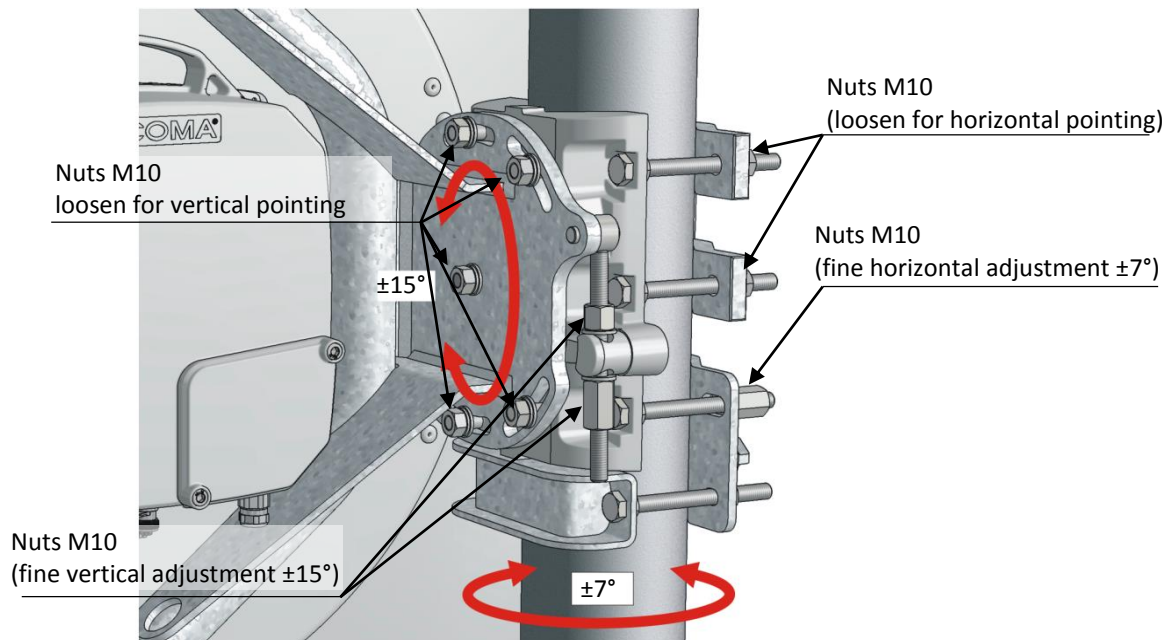


Figure 36 The UNI2-xxAF antenna pointing (also for the UNI1-xxAF antenna)

#### 4.1.4 The pointing of radio link with the AL3-xx/MP antenna (also for the AL4-xx/MP antenna)



**Figure 37 The AL3-xx/MP antenna pointing (also for the AL4-xx/MP antenna)**

In order to reach the direction stability and resistance against outside loads the antennas AL3-xx/MP, and AL4-xx/MP use a different way of attachment in comparison with smaller antennas. There is a support bracket that prevents sliding of the antenna down along a pipe at the bottom part. There is a special set of brackets above this one for a fine setting in the horizontal and vertical directions (figure 37).

##### Fine horizontal pointing

- Loosen all M10 antenna support bracket nuts using no. 16/17 wrench. It is better to loosen the nuts without unnecessary play that would later cause a loss of exact direction after tightening. With the MP antenna type it is better to use an auxiliary bracket that prevents the antenna sliding along the support pipe.
- Turning of the parabolic antenna by  $\pm 15^\circ$  you can find the main lobe on the connected DC voltmeter and in the beginning of measurement also both side lobes of the antenna radiation characteristic.
- Setting of the maximum level on the **main lobe**.
- After you set the maximum level on the main lobe, fix the antenna in the found direction by tightening the antenna support M10 bracket nuts.

##### Vertical Pointing

- Loosen the fixation M10 bolts without unnecessary play that would cause loss of the proper direction after tightening.
- By turning of the parabolic antenna you can find the main lobe on the connected DC voltmeter and in the beginning of measurement also both side lobes of the antenna radiation characteristic.
- Set the maximum level on the main lobe.
- After you set the maximum level on the main lobe, tighten fixation bolts/ nuts at found positions.

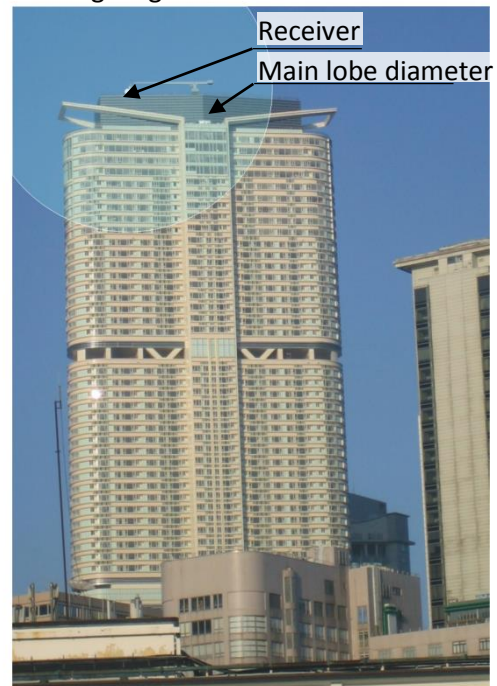
### The pointing of radio link with the AL4-xx/MP antenna ( $\varnothing$ 1.20 m)

- The vertical setting bolts are loosened for the vertical pointing. For horizontal pointing then the support bracket bolts.
- During pointing of an antenna in the horizontal direction position of the antenna is roughly set and the M10 bolt on the main bracket are tightened. The antenna position for the maximum signal is set by the M10 nuts on the rotating bracket.
- All M10 bolts on the horizontal pointing brackets are tightened.
- During pointing of the antenna in vertical direction the vertical pointing bolts are loosened. The antenna is set to the highest signal level by a connecting rod with M10 nuts.
- All M10 bolts are tightened to secure the antenna vertical position.

Main lobe diameter: 14 m  
Hop length: 1 Km  
Antenna: AL4-xx/MP  
Building height: cca 140 m



Main lobe diameter: 74 m  
Hop length: 5 Km  
Antenna: AL4-xx/MP  
Building height: cca 140 m



**Figure 38 Main lobe diameter with different hop lengths**

#### 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 was 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.

## 4.2 CHANGE OF POLARIZATION

The polarization change can be performed without losing the link direction just by turning ODU by 90° that is done as follows:

### 4.2.1 UNI type antennas

- Unscrew 4 M6 Allen screws that hold ODU to the supporting ODU profiles for attachment of the antenna and ODU.
- Turn the ODU by 90°. Turning direction is not important. However, for **horizontal polarization** the connecting cable output must point **down** and for **vertical polarization to the side**.
- Using the center guide ring insert the ODU into the antenna.
- The ODU profile attachment bolts are screwed in.

### 4.2.2 MP type antennas

- Unscrew 4 M6 Allen screws that hold ODU to the supporting ODU profiles for attachment of the antenna and ODU.
- Unscrew 4 M5 bolts that hold the feeder flange in the parabola, the feeder is turned and then attached to the parabola again.
- ODU is turned by 90°. Turning direction is not important. However, for **horizontal polarization** the connecting cable output must point **down** and for **vertical polarization to the side**. The **ODU position** must be maintained, in order to **agree with the pictograms** on the feeder flange (figure 20 on the page 24).
- ODU inserted on the feeder flange and placed into the parabola spacers.
- The ODU attachment bolts are screwed into the spacers.

The used polarization for left hand or right hand ODU installation can be determined according to the position of the connection cable outlet. If the outlet **points down**, the used **polarization is horizontal, if to the side**, then **it is vertical**.

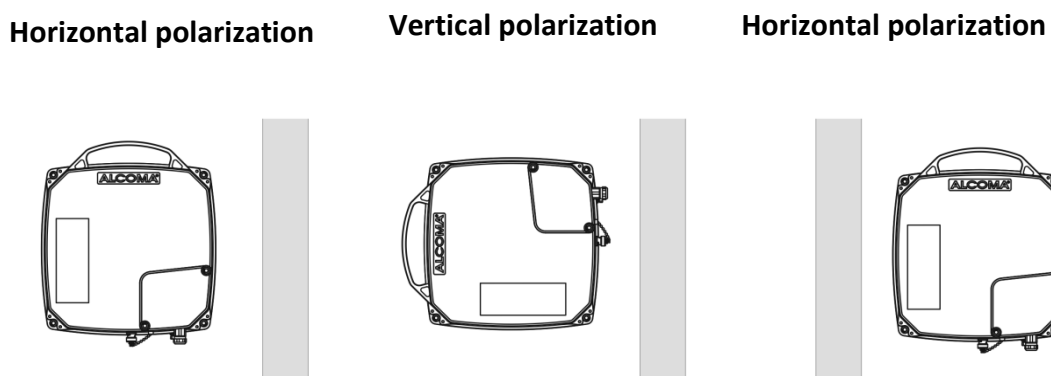


Figure 39 The setting of polarization for the ALxxF MP400/360/165 station

## 4.3 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  $\pm 3$  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.

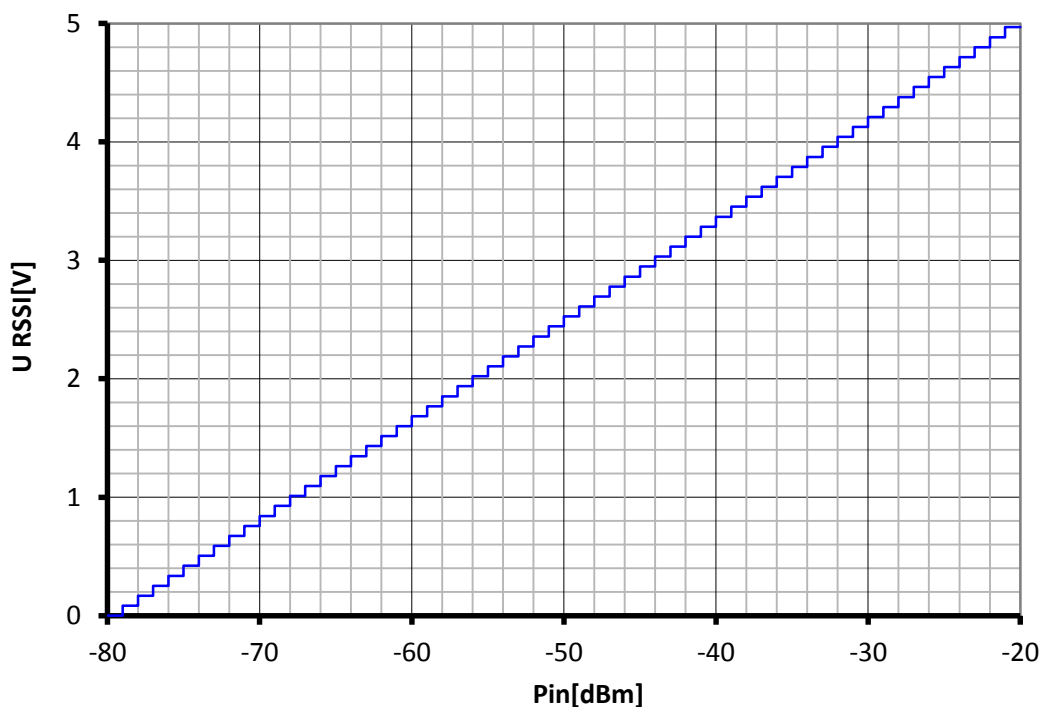


Figure 40 The RSSI calibration graph

## 4.4 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:

$$P_{in}[\text{dBm}] = P_{out}[\text{dBm}] + G_{at}[\text{dB}] + G_{ar}[\text{dB}] - A_0[\text{dB}]$$

where:

$P_{out}[\text{dBm}]$	is the transmitted output of the opposite station
$G_{at}[\text{dB}]$	is the transmitting antenna gain
$G_{ar}[\text{dB}]$	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:

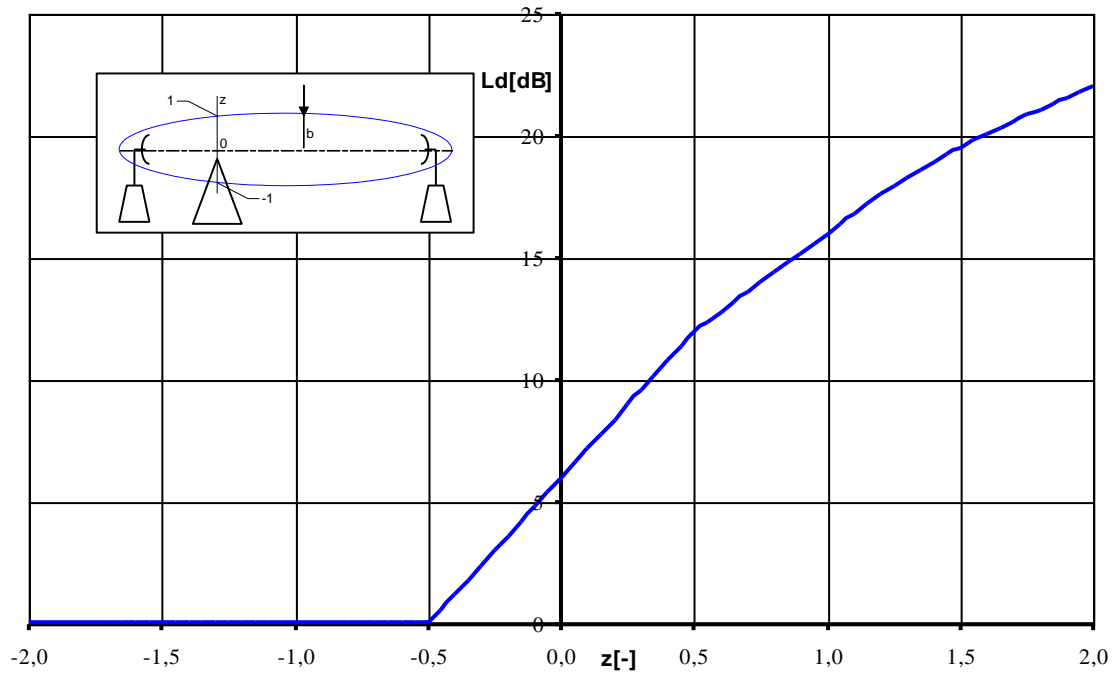
$d[\text{km}]$	distance between antennas
$f[\text{GHz}]$	used frequency.

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 41). 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 Pečač 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**

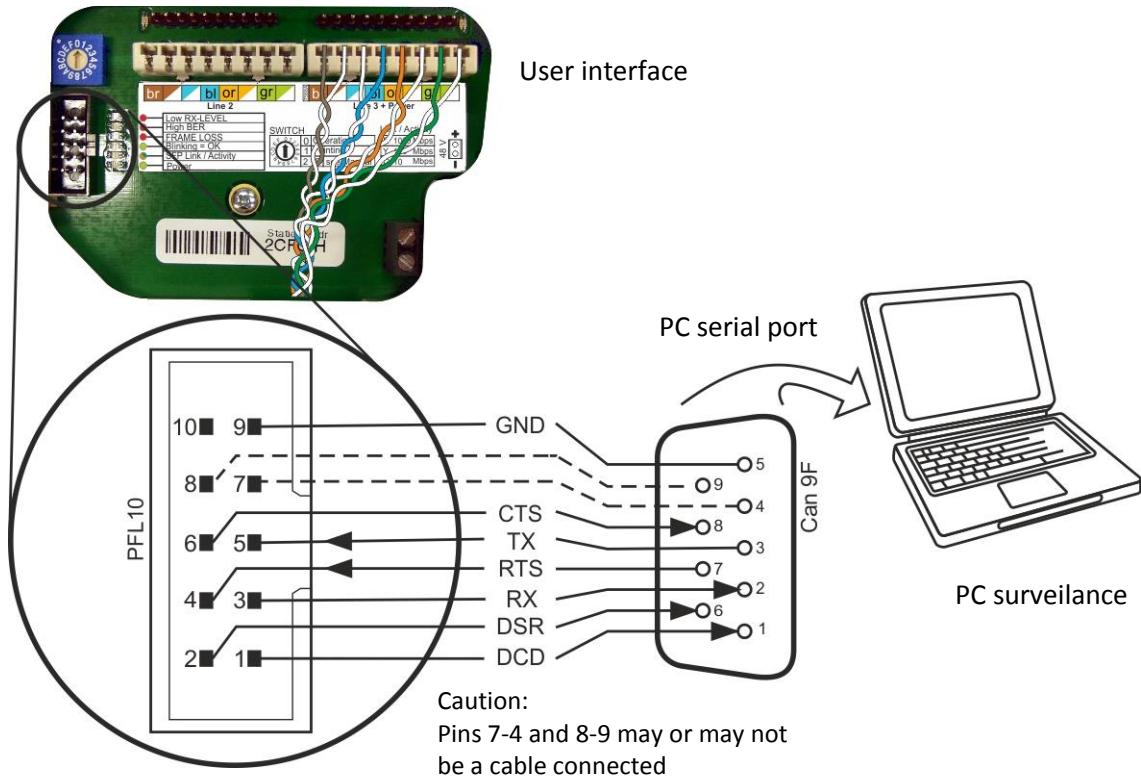


**Figure 41 The approximation of additional attenuation behind an obstacle**

**4.5 DIRECT CONNECTION OF A MONITORING PC**

Normally the communication of the monitoring PC with the ALxF 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 42 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 ALxF MP400/360/165 does not require any service or maintenance during operation.

The radio relay link ALxF 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.

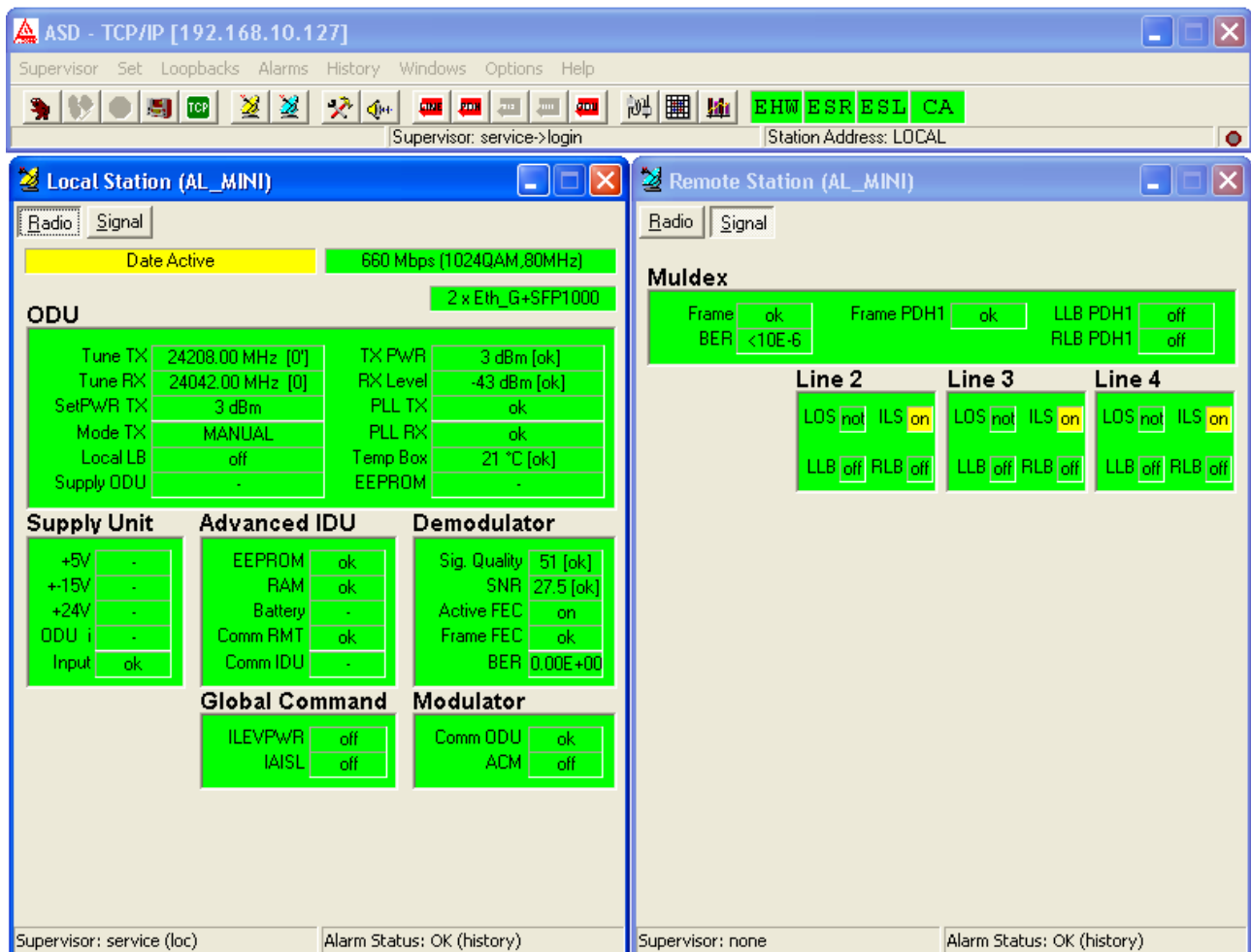


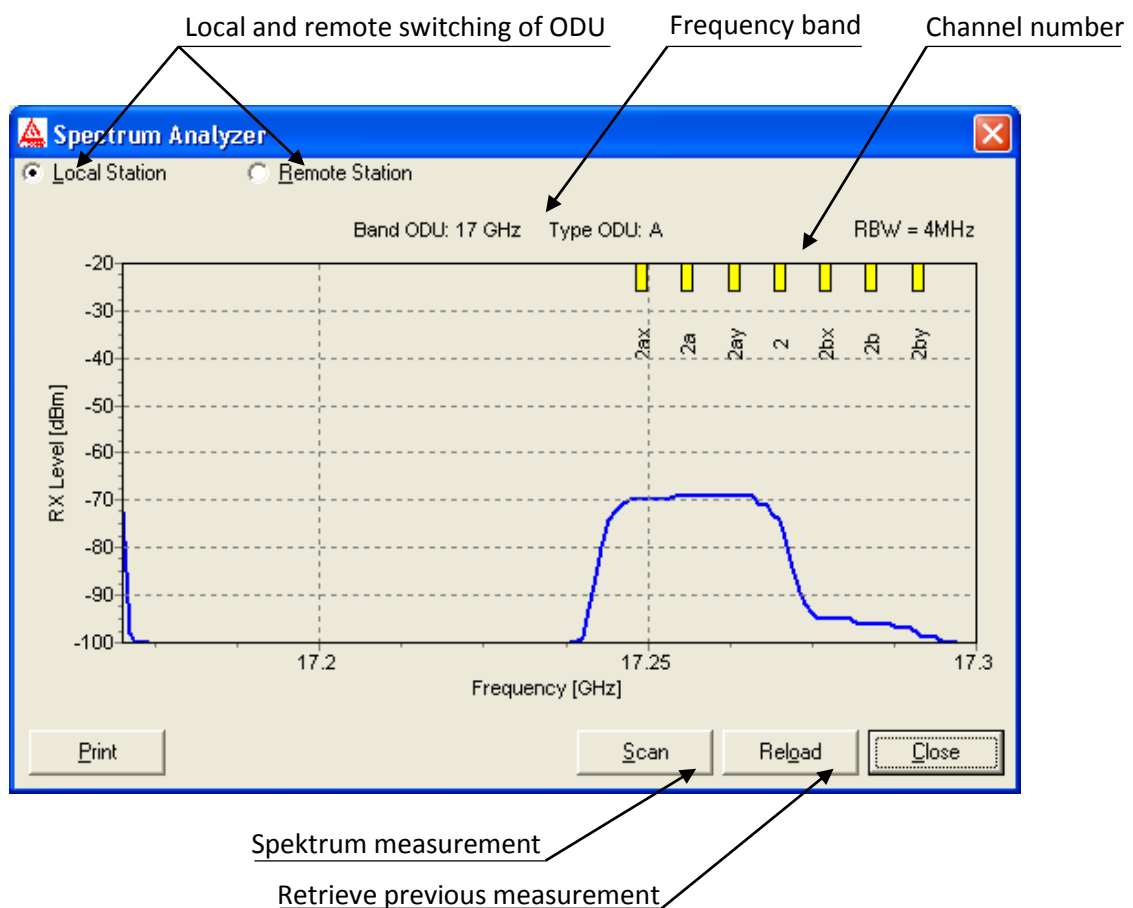
Figure 43 Main windows of the ASD program

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 SPECTRAL ANALYZER

The following figure 44 shows the function of the spectral analyzer.

- To show channel numbers and a relayed range it is necessary to read in the corresponding frequency table in the ASD monitoring program (Option / Channel Table).
- Representation of the received spectrum for local and remote ODUs.
- **Print** will print a graph of the received signal spectrum in the whole frequency range.
- **Scan** will start measurement of the received signal spectrum (temporary interruption of data transmission). The measured values will be written into memory, from where it can be recalled anytime.
- **Reload** is a display of last measurement of the received signal spectrum values.
- **Close** will close the spectral analyzer window.



**Figure 44 The spectral analyzer**



### CAUTION

There will be a temporary interruption of data transmission during the start of measuring of received signal spectrum (Scan). (The connection is scanned for receiving frequencies of the frequency range.) Spectral data from the previous measurement will be overwritten.

### 5.3 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.

### 5.4 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 ALxxF 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 ALxxF 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.

### 5.5 END 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 ALxxF 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 ALxxF 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 17 GHz

### 7.1 FREQUENCY PLAN

The radio relay link ALCOMA AL17F MP400/360/165 works in the frequency range of 17 100 to 17 300 MHz. Radio relay link operation in the Czech Republic is allowed based on the general authorization no. VO-R/12/09.2010-12. Microwave links can be operated by physical and legal entities for their own use without any further fees or evidence according to these licenses.

In the specified frequency range the microwave units are tuned according to the frequency plan as it is specified in table 14. The table frequencies are in MHz.

A – band lower half		B – band upper half	
Channel number	Transmitter frequency [MHz]	Channel number	Transmitter frequency [MHz]
8	17 105.50	8´	17 245.50
9	17 112.50	9´	17 252.50
10	17 119.50	10´	17 259.50
11	17 126.50	11´	17 266.50
12	17 133.50	12´	17 273.50
13	17 140.50	13´	17 280.50
14	17 147.50	14´	17 287.50
15	17 154.50	15´	17 294.50
7 MHz channel width, duplex spacing 140 MHz			
A – band lower half		B – band upper half	
Channel number	Transmitter frequency [MHz]	Channel number	Transmitter frequency [MHz]
4	17 109	4´	17 249
5	17 123	5´	17 263
6	17 137	6´	17 277
7	17 151	7´	17 291
14 MHz channel width, duplex spacing 140 MHz			

**Table 14** Channel table for AL17F MP400/360/165 link

A – band lower half		B – band upper half	
Channel number	Transmitter frequency [MHz]	Channel number	Transmitter frequency [MHz]
2	17 116	2'	17 256
3	17 144	3'	17 284
28 MHz channel width, duplex spacing 140 MHz			

A – band lower half		B – band upper half	
Channel number	Transmitter frequency [MHz]	Channel number	Transmitter frequency [MHz]
1	17 130	1'	17 270
56 MHz channel width, duplex spacing 140 MHz			

**Table 14 Channel table for AL17F MP400/360/165 link**

A – band lower half		B – band upper half	
Channel number	Transmitter frequency [MHz]	Channel number	Transmitter frequency [MHz]
2w	17 125	2w'	17 235
3w	17 165	3w'	17 275
40 MHz channel width, duplex spacing 110 MHz			

**Table 15 Channel table 40 MHz for AL17F MP400 link**

A – band lower half		B – band upper half	
Channel number	Transmitter frequency [MHz]	Channel number	Transmitter frequency [MHz]
1w	17 145	1w'	17 225
80 MHz channel width, duplex spacing 110 MHz			

**Table 16 Channel table 80 MHz for AL17F MP400 link**

The channel tables are related to the data transmission speed. The frequency range for the transmitters **A** and **B** is divided as follows:

ODU type	Transmitter frequency range		Duplex spacing [MHz]
	Min. frequency [MHz]	Max. frequency [MHz]	
AL17F MP360/165 / A	17 100	17 160	140
AL17F MP360/165 / B	17 240	17 300	140

**Table 17** The transmitter frequency range for AL17F MP360/165

ODU type	Transmitter frequency range		Duplex spacing [MHz]
	Min. frequency [MHz]	Max. frequency [MHz]	
AL17F MP400 / A	17 100	17 195	110 / 140
AL17F MP400 / B	17 205	17 300	110 / 140

**Table 18** The transmitter frequency range for AL17F MP400

Stations with the frequency range in the sub range A can cooperate with all sub range B frequencies. This setting requires a proprietary frequency table. Further info is in the ASD monitoring program manual. The pair tuning according to channels is usually selected that always shows on one line of table 14.

## 7.2 MODULATION, THRESHOLD SENSITIVITY AND TRANSFER CAPACITY AL17F MP360/165

The AL17F MP360/165 link can be set to various transmission capacities according to used modulation and channel bandwidth. The individual transmission capacities are related to different threshold sensitivities as shown in table 19.

The highest internal transmission speed, including service communication, of the link is 384 Mbps.

User data capacity [Mbps]	Modulation	MP165 Typical Threshold sensitivity for BER = $10^{-6}$ [dBm]	MP360 Typical Threshold sensitivity for BER = $10^{-6}$ [dBm]	TX power [dB]	Channel width [MHz]
10	QPSK	-96.0	-93.5	-24 — 8	7
19	16 QAM	-87.0	-87.5	-24 — 8	
25	32 QAM	-83.0	-83.0	-24 — 8	
30	64 QAM	—	-89.0	-24 — 5	
35	128 QAM	—	-75.0	-24 — 5	
17	QPSK	-93.0	-90.5	-24 — 8	14
39	16 QAM	-86.0	-84.0	-24 — 8	
50	32 QAM	-82.0	-81.0	-24 — 8	
61	64 QAM	-79.0	-76.0	-24 — 5	
72	128 QAM	—	-73.0	-24 — 5	
34	QPSK	-90.0	-88.0	-24 — 8	28
77	16 QAM	-83.0	-81.0	-24 — 8	
100	32 QAM	-79.0	-78.0	-24 — 8	
123	64 QAM	-76.0	-74.0	-24 — 5	
165	128 QAM	-71.0	-70.0	-24 — 5	
186	256 QAM	—	-66.0	-24 — 5	56
89	QPSK	—	-83.5	-24 — 8	
179	16 QAM	—	-76.5	-24 — 8	
230	32 QAM	—	-73.5	-24 — 8	
282	64 QAM	—	-69.5	-24 — 5	
333	128 QAM	—	-66.0	-24 — 5	384
384	256 QAM	—	-61.5	-24 — 5	

**Table 19 Radio link transmission speeds and Treshold sensitivity for Interleaving 16 (High)**



### 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.

### 7.3 MODULATION, THRESHOLD SENSITIVITY AND TRANSFER CAPACITY AL17F MP400

The AL17F MP400 link can be set to various transmission capacities according to used modulation and channel bandwidth. The individual transmission capacities are related to different threshold sensitivities as shown in table 19. The highest internal transmission speed, including service communication, of the link is 660 Mbps.

User data capacity [Mbps]	Modulation	TX power [dB]	MP400 Typical Threshold sensitivity for BER=10 <sup>-6</sup> [dBm]	Channel width [MHz]
5	QPSK	-24 — 12	-95.0	3.5
8	8QAM	-24 — 12	-92.0	
11	16QAM	-24 — 12	-89.0	
14	32QAM	-24 — 12	-85.0	
17	64QAM	-24 — 5	-82.0	
20	128QAM	-24 — 5	-79.0	
22	256QAM	-24 — 5	-76.0	
25	512QAM	-24 — 5	-72.0	
27	1024QAM	-24 — 5	-69.0	
11	QPSK	-24 — 12	-92.0	
16	8QAM	-24 — 12	-89.0	
22	16QAM	-24 — 12	-86.0	
28	32QAM	-24 — 12	-83.0	
33	64QAM	-24 — 5	-80.0	
40	128QAM	-24 — 5	-77.0	
44	256QAM	-24 — 5	-74.0	
50	512QAM	-24 — 5	-71.0	
55	1024QAM	-24 — 5	-66.0	
25	QPSK	-24 — 12	-89.0	14
35	8QAM	-24 — 12	-86.0	
46	16QAM	-24 — 12	-83.0	
58	32QAM	-24 — 12	-80.0	
69	64QAM	-24 — 5	-77.0	
81	128QAM	-24 — 5	-74.0	
92	256QAM	-24 — 5	-71.0	
104	512QAM	-24 — 5	-68.0	
115	1024QAM	-24 — 5	-64.0	

User data capacity [Mbps]	Modulation	TX power [dB]	MP400 Typical Threshold sensitivity for BER=10 <sup>-6</sup> [dBm]	Channel width [MHz]
50	QPSK	-24 — 12	-86.0	28
69	8QAM	-24 — 12	-82.0	
92	16QAM	-24 — 12	-79.0	
116	32QAM	-24 — 12	-76.0	
139	64QAM	-24 — 5	-73.0	
162	128QAM	-24 — 5	-70.0	
185	256QAM	-24 — 5	-68.0	
208	512QAM	-24 — 5	-65.0	
230	1024QAM	-24 — 5	-61.0	
66	QPSK	-24 — 12	-85.0	
100	8QAM	-24 — 12	-81.0	
132	16QAM	-24 — 12	-78.0	
165	32QAM	-24 — 12	-75.0	
200	64QAM	-24 — 5	-72.0	
232	128QAM	-24 — 5	-69.0	
265	256QAM	-24 — 5	-66.0	
300	512QAM	-24 — 5	-63.0	
330	1024QAM	-24 — 5	-59.0	
100	QPSK	-24 — 12	-84.0	56
139	8QAM	-24 — 12	-80.0	
185	16QAM	-24 — 12	-79.0	
232	32QAM	-24 — 12	-74.0	
278	64QAM	-24 — 5	-70.0	
324	128QAM	-24 — 5	-68.0	
370	256QAM	-24 — 5	-65.0	
417	512QAM	-24 — 5	-61.0	
459	1024QAM	-24 — 5	-58.0	

User data capacity [Mbps]	Modulation	TX power [dB]	MP400 Typical Threshold sensitivity for BER=10 <sup>-6</sup> [dBm]	Channel width [MHz]
132	QPSK	-24 — 12	-82.0	80
200	8QAM	-24 — 12	-78.0	
265	16QAM	-24 — 12	-76.0	
330	32QAM	-24 — 12	-72.0	
400	64QAM	-24 — 5	-69.0	
463	128QAM	-24 — 5	-66.0	
530	256QAM	-24 — 5	-63.0	
600	512QAM	-24 — 5	-59.0	
660	1024QAM	-24 — 5	-55.0	

**Table 20 AL17F MP400 radio link transmission speeds and Treshold sensitivity for Interleaving 16 (High)**

## 7.4 TECHNICAL PARAMETERS

Parameter	AL17F MP400/360/165	
Transmitter frequency MP400	- lower band section (/A)	17 100 ÷ 17 195 MHz
	- upper band section (/B)	17 205 ÷ 17 300 MHz
Transmitter frequency MP360/165	- lower band section (/A)	17 100 ÷ 17 160 MHz
	- upper band section (/B)	17 240 ÷ 17 300 MHz
Minimum channeling tuning step	200 kHz	
Channel spacing	See table 14	
Frequency stability better than	$\pm 1 \times 10^{-6}$	
Transmitted output of basic version	see table 19 ATPC <sup>3</sup>	
Transmitter spectrum mask	ETSI 302 217-2-2	
Typical threshold sensitivity during BER = $10^{-6}$ (max. values are by +3 dB higher than typical values)	See table 19	
Maximum RF Input Operating Level BER = $10^{-6}$	-19 dBm / -22 dBm <sup>4</sup>	
Maximum RF Non Destructive Input Level	-3 dBm	
Ethernet user interface	10/100/1000Base-T(X)	
Optional user interface 1xSFP Line 4	10/100/1000Base-LX/SX 1000Base-T	
Input connectors for Ethernet user lines	RJ-45	
Interconnect cable between protected terminal box - ODU (recommended type S-STP Cat.7 ACOME)	4 pairs, shielded imp. 100 $\Omega$	
Maximum length of interconnect cable <sup>5</sup>	for 10Base-T	250 m
	for 100Base-TX	100 m
	for 1000Base-T	90m
DC supply voltage on the protected terminal box	+36 V ÷ +72 V	
Supply input for U = +48 V and 100 m connection cable	< 25 W	

**Table 21 Radio 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 feeder and antenna) (w x h x d)	255 x 301 x 133 mm
ODU weight (without antenna and antenna feeder)	5.1 kg
ALS1x weight	0.5 kg

**Table 22 Technical parameters**

<sup>3</sup> The transmitter output power is set during manufacturing, so the transmitted output EIRP (i.e., including parabolic antenna gain) would in the Czech Republic be in agreement with VO-R/12/09.2010-12, max. 20 dBm.

<sup>4</sup> Links MP360/165: -19 dBm for modulation QPSK – 32 QAM, -22 dBm for modulation 64 QAM – 256QAM.  
Links MP400: -19dBm for modulation QPSK – 1024 QAM.

<sup>5</sup> Including the cable that brings data to the protected terminal strip.

## 7.5 ANTENNA SYSTEMS

Parabolic antennas for fixed connection to ODU were developed for the 17 GHz band. The ALCOMA parabolic antennas can be used for horizontal and vertical polarization and left or right hand installation without modifications. All antennas are standard equipped by protection against icing (OPN). The change of polarization is performed by turning ODU by 90°, see the chapter 4.2, page 43.

Compact microwave antennas	Type					
	UNI1-17AS	UNI1-17AF	UNI2-17AS	UNI2-17AF	AL3-17/MP	AL4-17/MP
Parabola diameter	Ø 0.35 m	Ø 0.35 m	Ø 0.65 m	Ø 0.65 m	Ø 0.90 m	Ø 1.20 m
Antenna gain $G_{ant}$	32.5 dBi	32.5 dBi	37.9 dBi	37.9 dBi	42 dBi	44 dBi
Main lobe 3 dB	3.3°	3.3°	2.1°	2.1°	1.3°	1.0°
Horizontal antenna setting	± 180°					
Fine horizontal antenna setting	–	±15°	–	±15°	±7°	±7°
Vertical antenna setting	±20°	–	±20°	–	±15°	±15°
Fine vertical antenna setting	–	±30°	–	±30°	±15°	±15°
Weight of compact antennas	6.7 kg	6.5 kg	9.0 kg	8.9 kg	26 kg	36 kg
Diameter of installation stand min.	Ø 42 mm	Ø 42 mm	Ø 42 mm <sup>6</sup>	Ø 42 mm <sup>6</sup>	Ø 73 mm	Ø 101 mm
max.	Ø 115 mm					

**Table 23** Antenna parameters for 17 GHz band

<sup>6</sup> Diameter 42 – 48 mm can be used when the wind speed does not exceed 50 m/s (180 km/h)

## 8. RADIO RELAY LINK PARAMETERS 24 GHz

### 8.1 FREQUENCY PLAN

The radio relay link ALCOMA AL24F MP400/360/165 SRD works in the frequency range of 24 000 to 24 250 MHz. Radio relay link operation in the Czech Republic is allowed based on the general authorization no. VO-R/10/04.2012-7. Microwave links can be operated by physical and legal entities for their own use without any further fees or evidence according to these licenses.

In the specified frequency range the microwave units are tuned according to the frequency plan as it is specified in table 24. The table frequencies are in MHz.

A – band lower half		B – band upper half	
Channel number	Transmitter frequency [MHz]	Channel number	Transmitter frequency [MHz]
8	24 005.5	8'	24 195.5
9	24 012.5	9'	24 202.5
10	24 019.5	10'	24 209.5
11	24 026.5	11'	24 216.5
12	24 033.5	12'	24 223.5
13	24 040.5	13'	24 230.5
14	24 047.5	14'	24 237.5
15	24 054.5	15'	24 244.5
7 MHz channel width, duplex spacing 190 MHz			
A – band lower half		B – band upper half	
Channel number	Transmitter frequency [MHz]	Channel number	Transmitter frequency [MHz]
4	24 009	4'	24 199
5	24 023	5'	24 213
6	24 037	6'	24 227
7	24 051	7'	24 241
14 MHz channel width, duplex spacing 190 MHz			

**Table 24 Channel table for AL24F MP400/360/165 SRD**

A – band lower half		B – band upper half	
Channel number	Transmitter frequency [MHz]	Channel number	Transmitter frequency [MHz]
2	24 016	2'	24 206
3	24 044	3'	24 234
28 MHz channel width, duplex spacing 190 MHz			

A – band lower half		B – band upper half	
Channel number	Transmitter frequency [MHz]	Channel number	Transmitter frequency [MHz]
1	24 030	1'	24 220
56 MHz channel width, duplex spacing 190 MHz			

**Table 24 Channel table for AL24F MP400/360/165 SRD**

A – band lower half		B – band upper half	
Channel number	Transmitter frequency [MHz]	Channel number	Transmitter frequency [MHz]
5w	24 022	5w'	24 188
6w	24 062	6w'	24 228
40 MHz channel width, duplex spacing 166 MHz			

**Table 25 Channel table 40 MHz for AL24F MP400 SRD**

A – band lower half		B – band upper half	
Channel number	Transmitter frequency [MHz]	Channel number	Transmitter frequency [MHz]
3w	24 030	3w'	24 164
4w	24 086	4w'	24 220
56 MHz channel width, duplex spacing 134 MHz			

**Table 26 Channel table 56 MHz for AL24F MP400 SRD**

A – band lower half		B – band upper half	
Channel number	Transmitter frequency [MHz]	Channel number	Transmitter frequency [MHz]
2w	24 042	2w'	24 208
80 MHz channel width, duplex spacing 166 MHz			

**Table 27 Channel table 80 MHz for AL24F MP400 SRD**

A – band lower half		B – band upper half	
Channel number	Transmitter frequency [MHz]	Channel number	Transmitter frequency [MHz]
1w	24 058	1w'	24 192
112 MHz channel width, duplex spacing 134 MHz			

**Table 28 Channel table 112 MHz for AL24F MP400 SRD**

The channel tables are related to the data transmission speed. The frequency range for the transmitters **A** and **B** is divided as follows:

ODU type	Transmitter frequency range		Duplex spacing [MHz]
	Min. frequency [MHz]	Max. frequency [MHz]	
AL24F MP360 / A	24 000	24 060	190
AL24F MP360 / B	24 190	24 250	190

**Table 29** The transmitter frequency range for AL24F MP400/360/165 SRD

ODU type	Transmitter frequency range		Duplex spacing [MHz]
	Min. frequency [MHz]	Max. frequency [MHz]	
AL24F MP400 / A	24 000	24 122	134 / 166 / 190
AL24F MP400 / B	24 128	24 250	134 / 166 / 190

**Table 30** The transmitter frequency range for AL24F MP400 SRD

Stations with the frequency range in the sub range A can cooperate with all sub range B frequencies. This setting requires a proprietary frequency table. Further info is in the ASD monitoring program manual. The pair tuning according to channels is usually selected that always shows on one line of table 24.

## 8.2 MODULATION, THRESHOLD SENSITIVITY AND TRANSFER CAPACITY OF THE AL24F MP360/165 SRD

The AL24F MP360/165 SRD can be set to various transmission capacities according to used modulation and channel bandwidth. The individual transmission capacities are related to different threshold sensitivities as shown in table 19.

The highest internal transmission speed, including service communication, of the SRD is 384 Mbps.

User data capacity [Mbps]	Modulation	MP165 Typical Threshold sensitivity for BER = $10^{-6}$ [dBm]	MP360 Typical Threshold sensitivity for BER = $10^{-6}$ [dBm]	TX power [dB]	Channel width [MHz]
10	QPSK	-92.0	-92.0	-27 — 5	7
19	16 QAM	-87.0	-84.0	-27 — 5	
25	32 QAM	-83.0	-81.0	-27 — 5	
30	64 QAM	—	-78.0	-27 — 5	
35	128 QAM	—	-74.0	-27 — 5	
17	QPSK	-88.0	-88.0	-27 — 5	14
39	16 QAM	-84.0	-82.0	-27 — 5	
50	32 QAM	-80.0	-79.0	-27 — 5	
61	64 QAM	-77.0	-76.0	-27 — 5	
72	128 QAM	—	-72.0	-27 — 5	
34	QPSK	-87.0	-85.0	-27 — 5	28
77	16 QAM	-80.0	-79.0	-27 — 5	
100	32 QAM	-77.0	-77.0	-27 — 5	
123	64 QAM	-75.0	-73.0	-27 — 5	
165	128 QAM	-70.0	-69.0	-27 — 5	
186	256 QAM	—	-65.0	-27 — 5	56
89	QPSK	—	-82.0	-27 — 5	
179	16 QAM	—	-75.0	-27 — 5	
230	32 QAM	—	-72.0	-27 — 5	
282	64 QAM	—	-69.0	-27 — 5	
333	128 QAM	—	-65.0	-27 — 5	
384	256 QAM	—	-60.0	-27 — 5	

**Table 31 AL24F MP360/165SRD transmission speeds and Treshold sensitivity for Interleaving 16 (High)**



### 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.

### 8.3 MODULATION, THRESHOLD SENSITIVITY AND TRANSFER CAPACITY OF THE AL24F MP400 SRD

The AL24F MP400 SRD can be set to various transmission capacities according to used modulation and channel bandwidth. The individual transmission capacities are related to different threshold sensitivities as shown in table 19.

The highest internal transmission speed, including service communication, of the SRD is 900 Mbps.

User data capacity [Mbps]	Modulation	TX power [dB]	MP400 Typical Threshold sensitivity for BER=10 <sup>-6</sup> [dBm]	Channel width [MHz]
5	QPSK	-27 — 5	-93.0	3.5
8	8QAM	-27 — 5	-89.0	
11	16QAM	-27 — 5	-86.0	
14	32QAM	-27 — 5	-82.0	
17	64QAM	-27 — 5	-79.0	
20	128QAM	-27 — 5	-76.0	
22	256QAM	-27 — 5	-73.0	
11	QPSK	-27 — 5	-91.0	7
16	8QAM	-27 — 5	-88.0	
22	16QAM	-27 — 5	-85.0	
28	32QAM	-27 — 5	-82.0	
33	64QAM	-27 — 5	-79.0	
40	128QAM	-27 — 5	-76.0	
44	256QAM	-27 — 5	-73.0	
50	512QAM	-27 — 5	-70.0	
25	QPSK	-27 — 5	-85.0	14
35	8QAM	-27 — 5	-82.0	
46	16QAM	-27 — 5	-79.0	
58	32QAM	-27 — 5	-76.0	
69	64QAM	-27 — 5	-73.0	
81	128QAM	-27 — 5	-70.0	
92	256QAM	-27 — 5	-67.0	
104	512QAM	-27 — 5	-64.0	
115	1024QAM	-27 — 5	-61.0	

User data capacity [Mbps]	Modulation	TX power [dB]	MP400 Typical Threshold sensitivity for BER=10 <sup>-6</sup> [dBm]	Channel width [MHz]
50	QPSK	-27 — 5	-82.0	28
69	8QAM	-27 — 5	-79.0	
92	16QAM	-27 — 5	-76.0	
116	32QAM	-27 — 5	-73.0	
139	64QAM	-27 — 5	-70.0	
162	128QAM	-27 — 5	-68.0	
185	256QAM	-27 — 5	-64.0	
208	512QAM	-27 — 5	-61.0	
230	1024QAM	-27 — 5	-58.0	
66	QPSK	-27 — 5	-81.0	40
100	8QAM	-27 — 5	-77.0	
132	16QAM	-27 — 5	-74.0	
165	32QAM	-27 — 5	-71.0	
200	64QAM	-27 — 5	-68.0	
232	128QAM	-27 — 5	-65.0	
265	256QAM	-27 — 5	-62.0	
300	512QAM	-27 — 5	-59.0	
330	1024QAM	-27 — 5	-56.0	
100	QPSK	-27 — 5	-79.0	56
139	8QAM	-27 — 5	-76.0	
185	16QAM	-27 — 5	-73.0	
232	32QAM	-27 — 5	-70.0	
278	64QAM	-27 — 5	-67.0	
324	128QAM	-27 — 5	-64.0	
370	256QAM	-27 — 5	-61.0	
417	512QAM	-27 — 5	-58.0	
459	1024QAM	-27 — 5	-55.0	
132	QPSK	-27 — 5	-78.0	80
200	8QAM	-27 — 5	-74.0	
265	16QAM	-27 — 5	-74.0	
330	32QAM	-27 — 5	-68.0	
400	64QAM	-27 — 5	-65.0	
463	128QAM	-27 — 5	-62.0	
530	256QAM	-27 — 5	-59.0	
600	512QAM	-27 — 5	-55.0	
660	1024QAM	-27 — 5	-53.0	

User data capacity [Mbps]	Modulation	TX power [dB]	MP400 Typical Threshold sensitivity for BER=10 <sup>-6</sup> [dBm]	Channel width [MHz]
184	QPSK	-27 — 5	-76.0	112
277	8QAM	-27 — 5	-71.0	
369	16QAM	-27 — 5	-69.0	
461	32QAM	-27 — 5	-68.0	
553	64QAM	-27 — 5	-63.0	
646	128QAM	-27 — 5	-59.0	
738	256QAM	-27 — 5	-56.0	
830	512QAM	-27 — 5	-53.0	
900	1024QAM	-27 — 5	-50.0	

**Table 32 AL24F MP400 SRD transmission speeds and Treshold sensitivity for Interleaving 16 (High)**



#### 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.

## 8.4 TECHNICAL PARAMETERS

Parameter	AL24F MP400/360/165 SRD
Transmitter frequency MP400	- lower band section (/A) 24 000 ÷ 24 122 MHz - upper band section (/B) 24 128 ÷ 24 250 MHz
Transmitter frequency MP360/165	- lower band section (/A) 24 000 ÷ 24 060 MHz - upper band section (/B) 24 190 ÷ 24 250 MHz
Minimum channeling tuning step	50 kHz
Channel spacing	See table 24
Frequency stability better than	$\pm 1 \times 10^{-6}$
Transmitted output of basic version	see table 31, ATPC <sup>7</sup>
Transmitter spectrum mask	ETSI 302 217-2-2
Typical threshold sensitivity during BER = 10 <sup>-6</sup> (max. values are by +3 dB higher than typical values)	See table 31
Maximum RF Input Operating Level BER = 10 <sup>-6</sup>	-24 dBm / -27 dBm <sup>8</sup>
Maximum RF Non Destructive Input Level	-4 dBm
Ethernet user interface	10/100/1000Base-T(X)
Optional user interface 1xSFP Line 4	10/100/1000Base-LX/SX 1000Base-T
Input connectors for Ethernet user lines	RJ-45
Interconnect cable between protected terminal box - ODU (recommended type S-STP Cat.7 ACOME)	4 pairs, shielded imp. 100 Ω
Maximum length of interconnect cable <sup>9</sup>	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	< 25 W

**Table 33 Radio 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 feeder and antenna) (w x h x d)	255 x 301 x 133 mm
ODU weight (without antenna and antenna feeder)	5.1 kg
ALS1x weight	0.5 kg

**Table 34 Technical parameters**

<sup>7</sup>The transmitter output power is set during manufacturing, so the transmitted output EIRP (i.e., including parabolic antenna gain) would in the Czech Republic be in agreement with VO-R/10/04.2012-7, max. 20 dBm.

<sup>8</sup> Links MP360/165: -24 dBm for modulation QPSK – 32 QAM, -27 dBm for modulation 64 QAM – 256 QAM  
Links MP400: -20 dBm for modulation QPSK – 1024 QAM.

<sup>9</sup> Including the cable that brings data to the protected terminal strip.

## 8.5 ANTENNA SYSTEMS

Parabolic antennas for fixed connection to ODU were developed for the 24 GHz band. The ALCOMA parabolic antennas can be used for horizontal and vertical polarization and left or right hand installation without modifications. All antennas are standard equipped by protection against icing (OPN). The change of polarization is performed by turning ODU by 90°, see the chapter 4.2, page 43.

Compact microwave antennas	Type					
	UNI1-24AS	UNI1-24AF	UNI2-24AS	UNI2-24AF	AL3-24/MP	AL4-24/MP
Parabola diameter	Ø 0.35 m	Ø 0.35 m	Ø 0.65 m	Ø 0.65 m	Ø 0.90 m	Ø 1.20 m
Antenna gain $G_{ant}$	35.5 dBi	35.5 dBi	40.8 dBi	40.8 dBi	45 dBi	47 dBi
Main lobe 3 dB	2.6°	2.6°	1.6°	1.6°	±0.5°	±0.4°
Horizontal antenna setting	± 180°					
Fine horizontal antenna setting	–	±15°	–	±15°	±7°	±7°
Vertical antenna setting	±20°	–	±20°	–	±15°	±15°
Fine vertical antenna setting	–	±30°	–	±30°	±15°	±15°
Weight of compact antennas	6.7 kg	6.5 kg	9.0 kg	8.9 kg	26 kg	36 kg
Diameter of installation stand min.	Ø 42 mm	Ø 42 mm	Ø 42 mm <sup>10</sup>	Ø 42 mm	Ø 73 mm	Ø 101 mm
max.	Ø 115 mm					

**Table 35 Antenna parameters for 24 GHz band**

<sup>10</sup> Diameter 42-48 mm can be used when the wind speed does not exceed 50 m/s (180 km/h)

## 9. ENVIRONMENT

### 9.1.1 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	from -25 °C to +55 °C
	ODU	from -35 °C to +55 °C
Guaranteed parameters	ALS1x	from -25 °C to +55 °C
	ODU	from -33 °C to +50 °C
Storage ability	ALS1x and ODU	from -25 °C to +55 °C

**Table 36 Operational 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.

ALS1x 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 ALS1x 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.

ALS1x can be stacked into a cabinet without forced cooling air flow with the minimum spacing of 15 mm. Moving of ODU and ALS1x 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.

### 9.1.2 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  $-25 \div +55$  °C, with the relative humidity max. 85 %.

## 10. MAIN EQUIPMENT DIMENSIONS

### 10.1 ODU – OUTDOOR UNIT

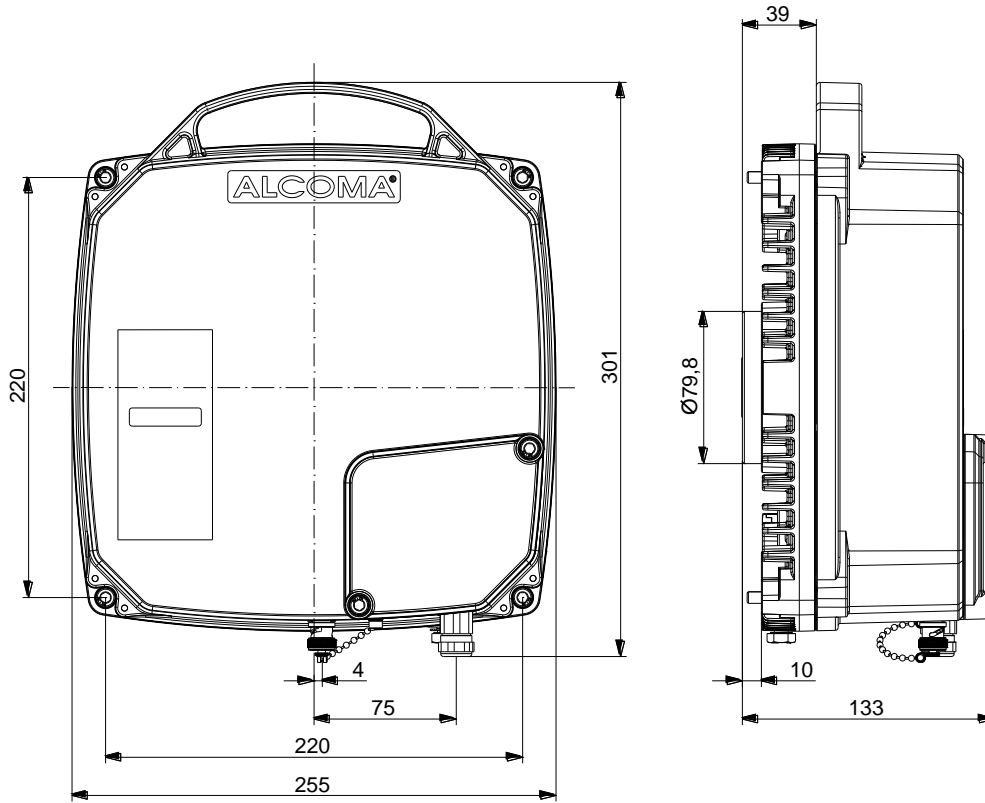


Figure 45 The ODU main dimensions

## 10.2 PROTECTED TERMINAL BOX

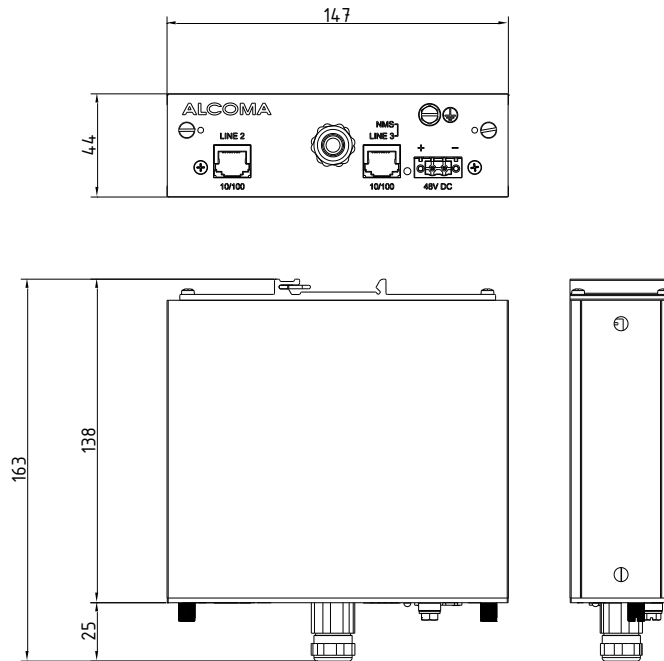


Figure 46 Protected terminal box ALS1x

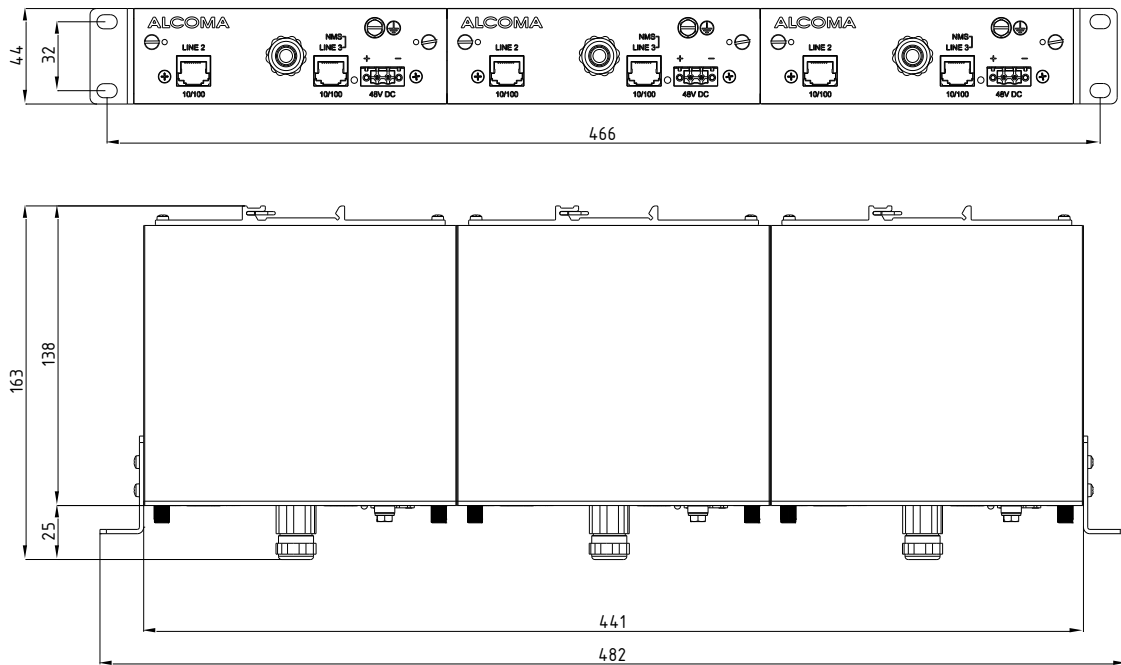


Figure 47 Assembled 3 terminal box ALS1x

### 10.3 ANTENNAS WITH ODU

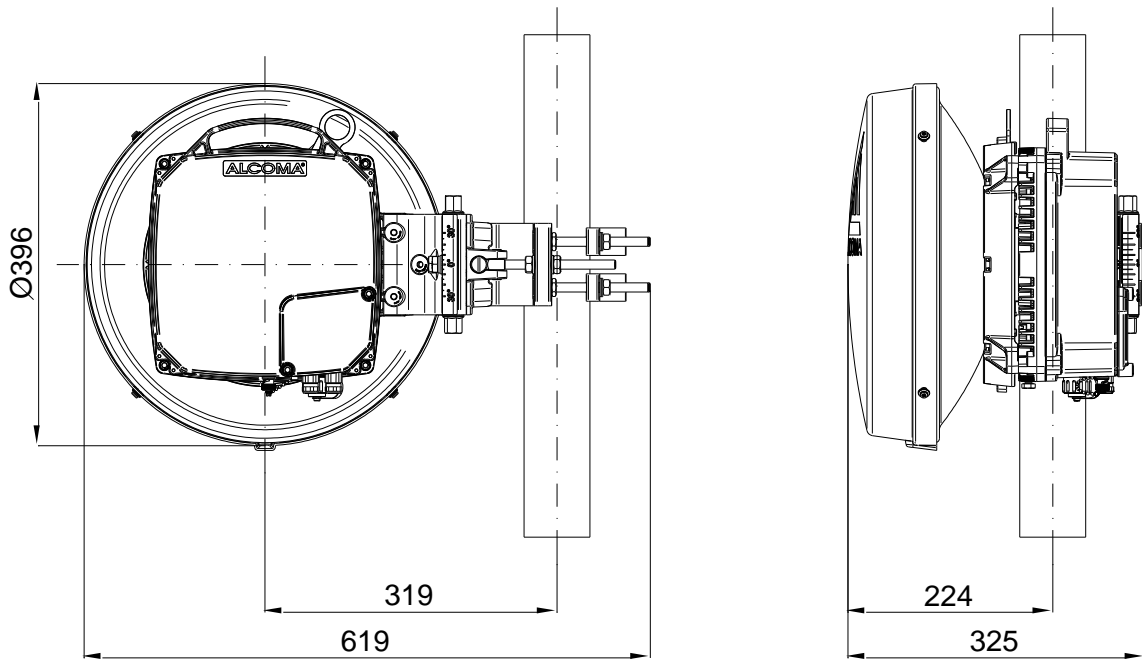


Figure 48 Antenna UNI1-xxAF

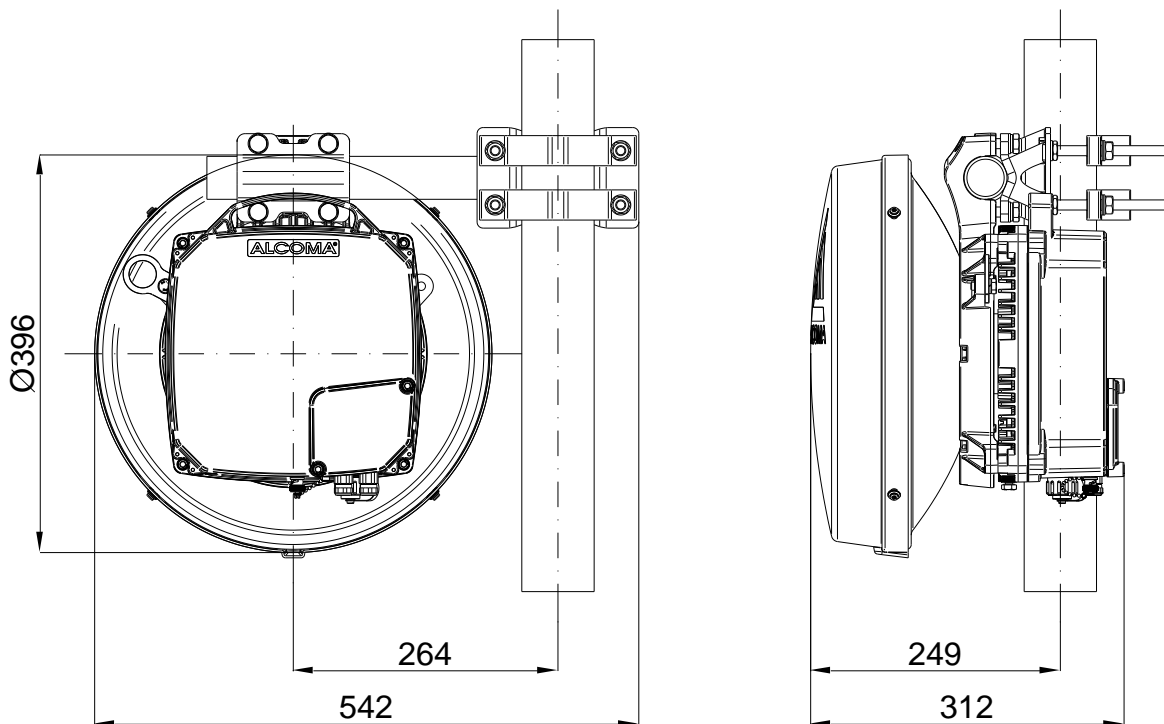


Figure 49 Antenna UNI1-xxAS

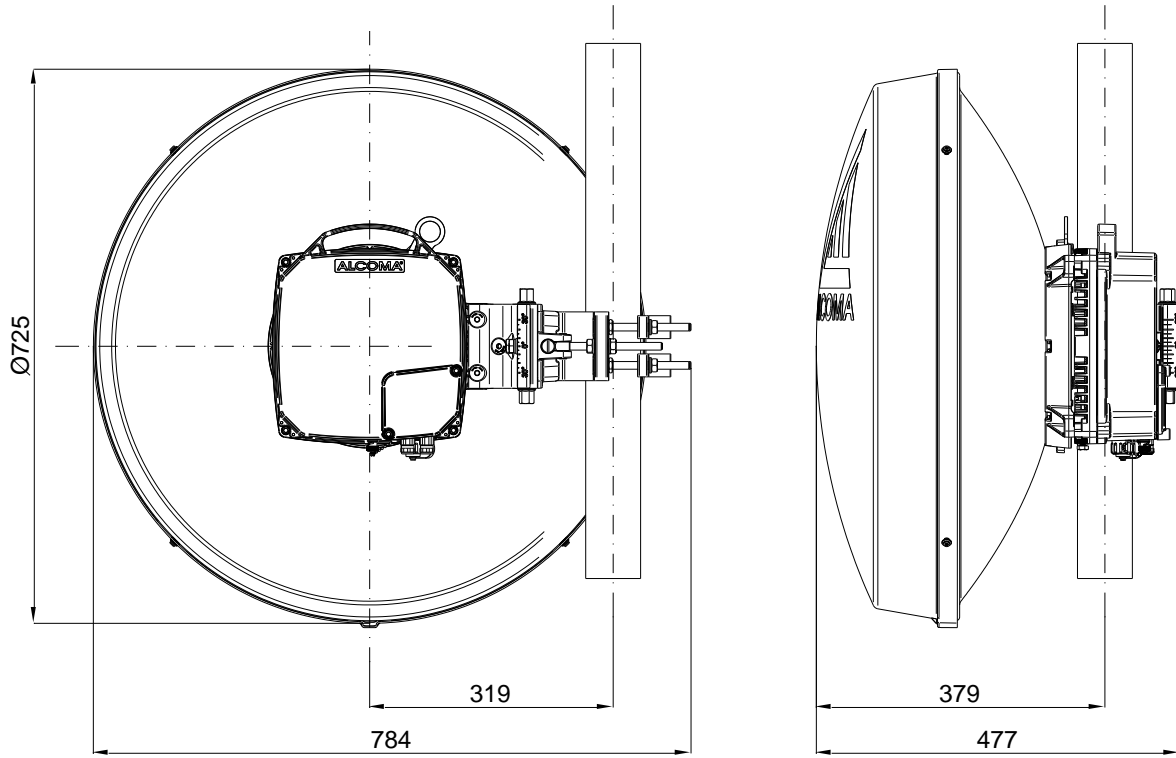


Figure 50 Antenna UNI2-xxAF

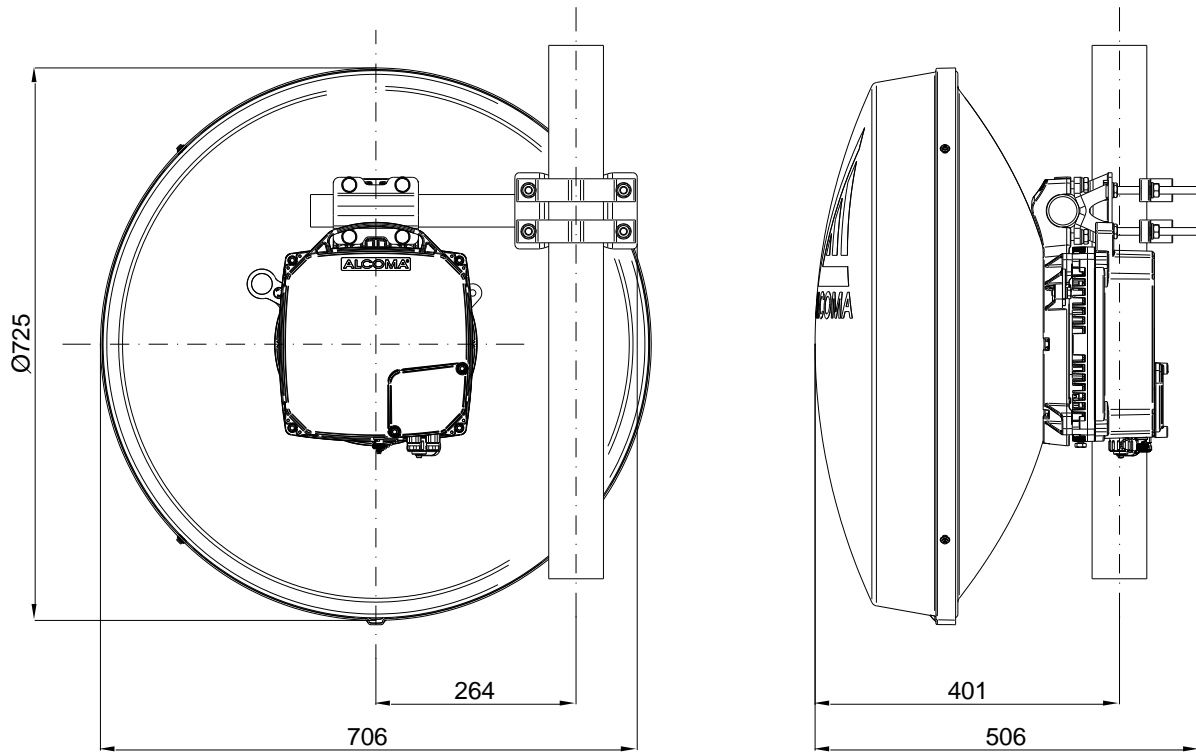


Figure 51 Antenna UNI2-xxAS

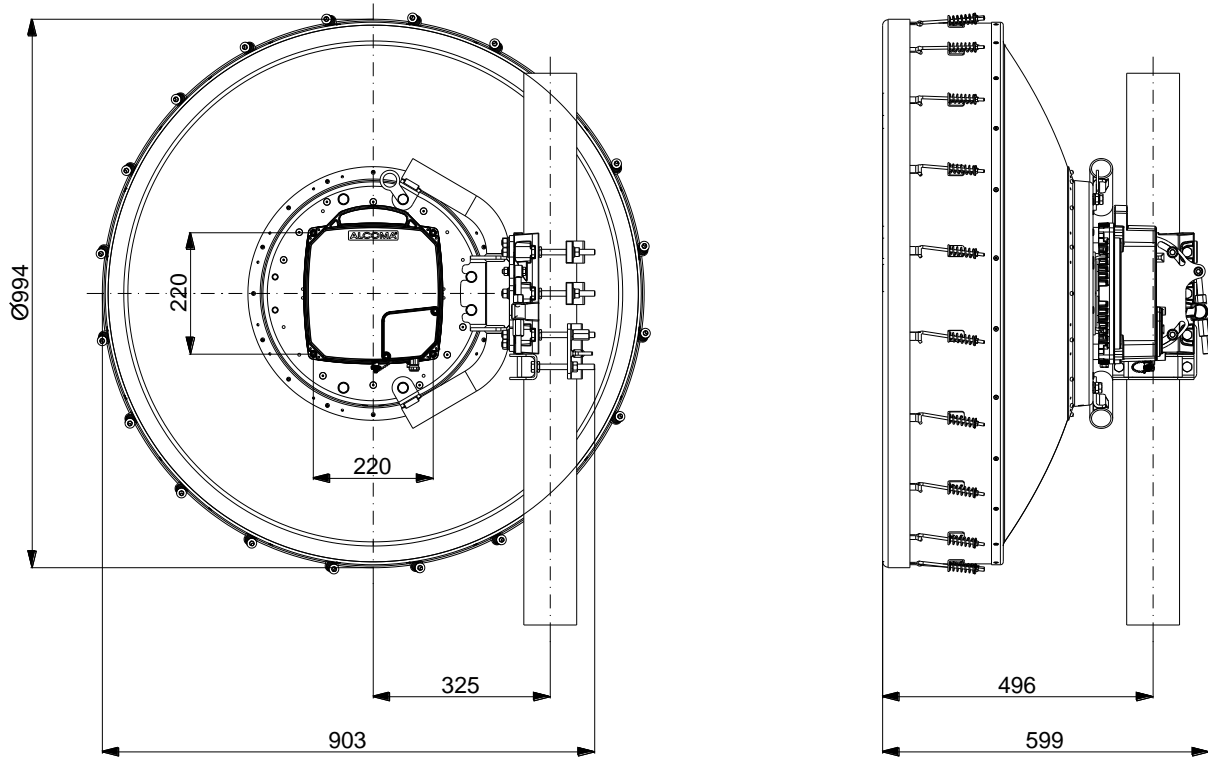


Figure 52 Antenna AL3-xx/MP

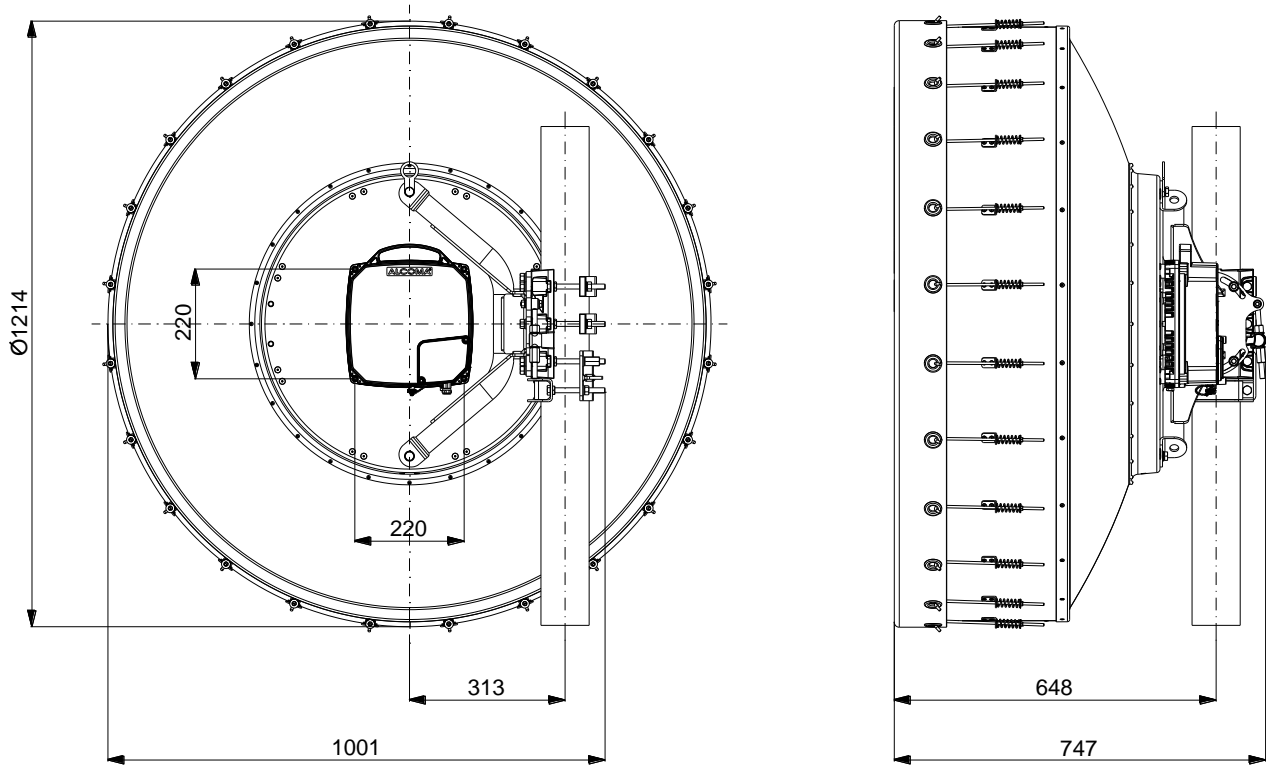


Figure 53 Antenna AL4-xx/MP

# 11. APPENDIX

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