

Microwave data link
ALxxF MP400/360
Licensed frequency bands 6, 7, 8 GHz
Installation and operation manual



Contents

page.

1. INTRODUCTION	1
1.1 BASIC DATA.....	2
2. LINK DESCRIPTION	4
2.1 TX POWER REGULATION	7
2.2 PROTECTED TERMINAL BOX	7
2.2.1 <i>Input Connectors</i>	9
2.2.2 <i>Output Connectors</i>	10
2.2.3 <i>Indication</i>	11
2.2.4 <i>Jumpers - without function for the S-STP Cat7 cable</i>	11
2.3 THE OUTDOOR UNIT (ODU).....	13
2.3.1 <i>Input Connectors</i>	14
2.3.2 <i>Indication</i>	18
2.3.3 <i>Rotary function switch</i>	18
3. INSTALLATION INSTRUCTIONS	19
3.1 EVALUATION OF SUITABLE PLACEMENT	19
3.2 PLACEMENT OF THE ANTENNA ON A SUPPORT CONSTRUCTION.....	19
3.3 INSTALLATION OF THE ANTENNA SYSTEM	21
3.4 INSTALLATION OF THE ANTENNA FEEDER	22
3.4.1 <i>UNI antennas</i>	22
3.4.2 <i>MPR antennas</i>	23
3.5 RADIO LINK INSTALLATION	24
3.5.1 <i>The UNI2-xx antenna type</i>	24
3.5.2 <i>The AL4-xx/MPR antenna type (also for the AL3-xx/MPR)</i>	25
3.6 LOCAL FREQUENCY COORDINATION.....	27
3.7 GROUNDING	28
3.8 MANIPULATION WITH THE USER SPACE COVER	29
3.9 TYPICAL ODU WIRING.....	30
3.10 INSTALLATION OF INTERCONNECT CABLE	31
3.10.1 <i>The procedure during installation of cable type Cat 7 S-STP</i>	31
3.11 OPTIONAL SFP MODULES	33
3.12 INSTALLING AN OPTICAL CONNECTOR MOLEX 106059	34
3.13 BEFORE PUTTING THE RADIO LINK INTO OPERATION.....	35
3.14 ACCESSORIES.....	35
4. SETTING OF THE RADIO LINK AND ITS COMMISSIONING	37
4.1 ANTENNA POINTING.....	37
4.1.1 <i>Pointing Procedure:</i>	38
4.1.2 <i>Rough Adjustment</i>	38
4.1.3 <i>The pointing of radio link with the UNI2-xxRS</i>	39
4.1.4 <i>The pointing of radio link with the UNI2-xxRF antenna</i>	40
4.1.5 <i>The pointing of radio link with the AL4-xx/MPR antenna (also for the AL3-xx/MPR)</i>	41
4.2 CHANGE OF POLARIZATION	43
4.3 CHECKING OF POINTING	43
4.4 CONTROL CALCULATION	45
4.5 DIRECT CONNECTION OF A MONITORING PC	46
5. OPERATION INSTRUCTIONS	48
5.1 OPERATION.....	48
5.2 EMERGENCY CONDITIONS	49
5.3 REPAIRS	49
5.4 ENDING OF OPERATION – ECOLOGICAL LIQUIDATION.....	49

6.	SAFETY CHECK	50
7.	RADIO RELAY LINK PARAMETERS 6 GHz	51
7.1	FREQUENCY PLAN	51
7.2	MODULATION SCHEMES, BER TRESHOLDS, TX POWER AND CAPACITIES OF THE LINK	53
7.3	TECHNICAL PARAMETERS	56
7.4	ANTENNA SYSTEMS.....	57
8.	RADIO RELAY LINK PARAMETERS 7 GHz	58
8.1	FREQUENCY PLAN	58
8.2	MODULATION SCHEMES, BER TRESHOLDS, TX POWER AND CAPACITIES OF THE LINK	59
8.3	TECHNICAL PARAMETERS	62
8.4	ANTENNA SYSTEMS.....	63
9.	RADIO RELAY LINK PARAMETERS 8 GHz	64
9.1	FREQUENCY PLAN	64
9.2	MODULATION SCHEMES, BER TRESHOLDS, TX POWER AND CAPACITIES OF THE LINK	65
9.3	TECHNICAL PARAMETERS	68
9.4	ANTENNA SYSTEMS.....	69
10.	ENVIRONMENT	70
10.1.1	<i>Operation.....</i>	70
10.1.2	<i>Transport and Storage.....</i>	70
11.	MAIN EQUIPMENT DIMENSIONS.....	71
11.1	ODU – OUTDOOR UNIT.....	71
11.2	PROTECTED TERMINAL BOX	71
11.3	ANTENNAS WITH ODU.....	73
12.	APPENDIX	75
12.1	LIST OF FIGURES	75
12.2	LIST OF TABLES.....	76

1. INTRODUCTION

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



WARNING

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



CAUTION

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



EXPIRATION

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

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

Beyond the expiration link only transmits management data.

1.1 BASIC DATA

- Licensed frequency bands 6 GHz (5.925 – 7.125 GHz), 7 GHz (7.110 – 7.900 GHz) and 8 GHz (7.725 – 8.500 GHz)
- The ALCOMA ALxxF MP400/360 link is designed as unattended
- The data transmission capacity is up
 - 900 Mbps for MP400 link
 - 384 Mbps for MP360 link
- channel bandwidth
 - 3.5 MHz to 112 MHz for MP400 link
 - 3.5 MHz to 56 MHz for MP360 link
- Digital modulations
 - QPSK to 1024 QAM for MP400 link
 - QPSK to 256 QAM for MP360 link
- ATPC automatic output regulation (ATPC lowers mutual interference of links and lowers operational costs)
- Advanced FEC forward error correction
- Hitless ACM Adaptive Coding and Modulation for MP400 link
- ACM Adaptive Coding and Modulation for MP360 link
- Full duplex operation
- Point to Point type link
- Vertical or horizontal polarization
- Interfaces: 2 x 10/100/1000Base-T(X) channels marked as User Line2 and User Line 3 + power
- Optional possibility of 1 x 1000Base-T/LX/SX/BX – marked as user line 4
- 1 or 2 independent user Ethernet channel are transmitted, there is possibility to select transmission of diagnostic data through channel 1 or channel 2 using diagnostic software ASD
- The link consists of the outdoor ODU unit, protected terminal box ALS1-GEth or ALS1-2GEth and the appropriate cables
- The link is supervised by the ASD Client program, through a web interface, hyperterminal, or SNMP protocol Ver. 1
- For the monitoring program ASD Client actual version see the following web page:
www.alcoma.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 enables using of the antenna types ALCOMA UNI and MPR
- 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 station consists of three main parts. Link is below referred to as **ALxxF MP400/360**.

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

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

2. The antenna set with the parabolic antenna, the feeder and the pole attachment.
3. Considering placement of the data block in ODU, the station ALxxF MP400/360 has an indoor unit reduced to the protected terminal boxes **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 ALCOMA UNI2-xx (Ø 0.65 m), AL3-xx/MPR (Ø 0.90 m) and AL4-xx/ MPR (Ø 1.20 m). Antennas are standard equipped by frost 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. LINK DESCRIPTION

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

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



CAUTION

Link ALxxF MP400/360 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 Mb/s Ethernet, for the Ethernet speed of 100 Mb/s 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 bringing the connection cable with ODU to the front, or backing panel. Customer data and the power supply can be brought to the front panel only. The arrangement can be modified according to customer wishes, and it is possible to deliver an arrangement that will suit the station, while it not necessary to have the outputs identically arranged in a box.

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

The high frequency block of the ALxxF MP400/360 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.

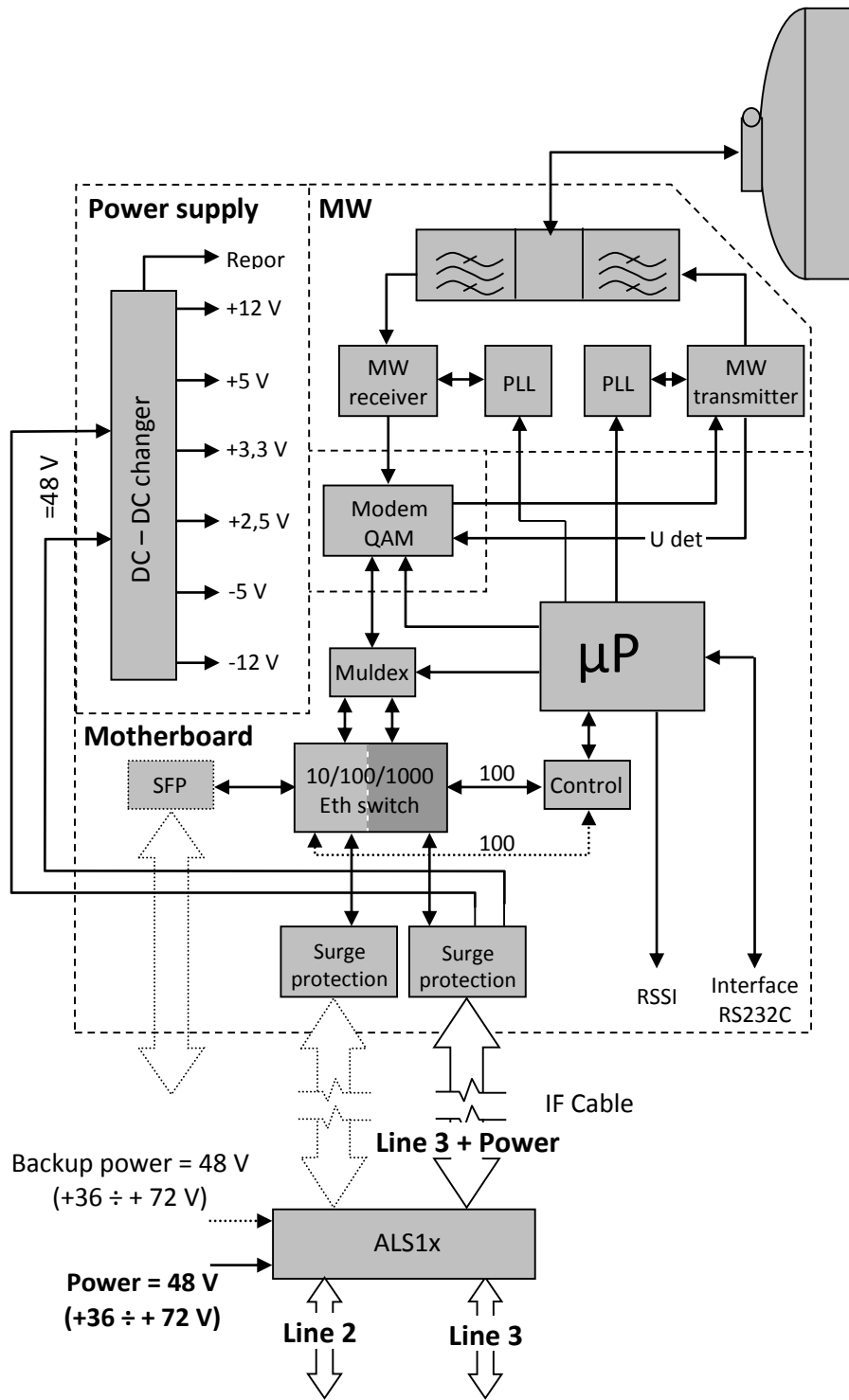


Figure 1 The block schematic of the ALxF MP400/360 link

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 ALxxF MP400/360 (see plate at ODU). The numbers in the terminal nameplate is **ALS1-GEth Line3** 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 data links.

Protected terminal box ALS1-GEth + Line2 NMS is designed for separated management. The numbers in the terminal box nameplate is **ALS1-GEth + Line2 NMS** (121/516*38).

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



Figure 2 Protected terminal box ALS1-GEth Line3



Figure 3 Protected terminal box ALS1-2GEth



Figure 4 Protected terminal box ALS1-GEth RP



Figure 5 Protected terminal box ALS1-2GEth RP



Figure 6 Protected terminal box ALS1-GEth + Line2 NMS

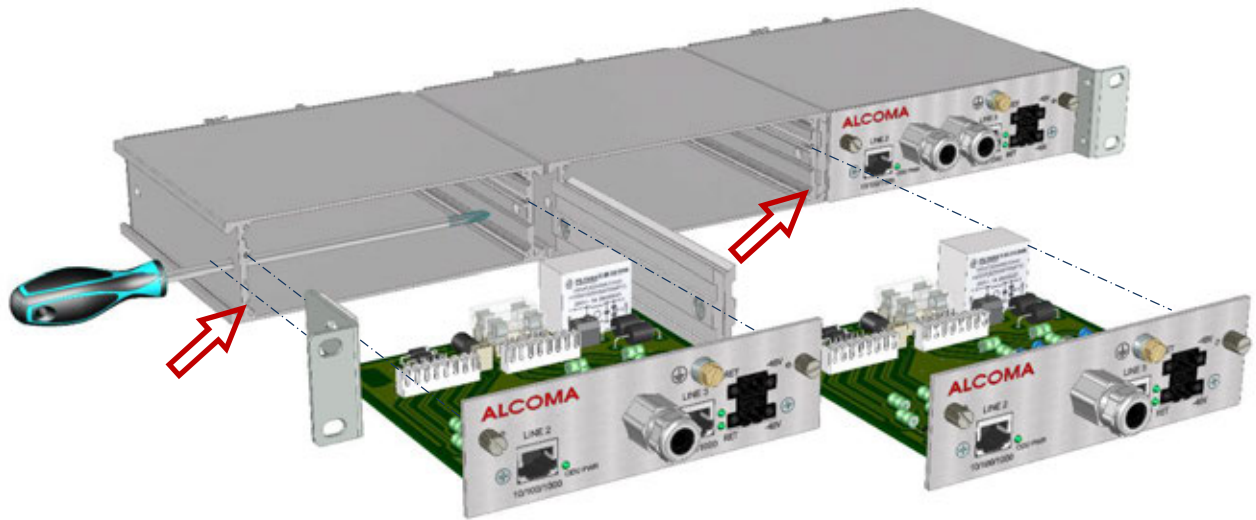
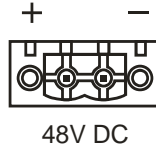


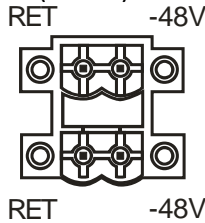
Figure 7 Assembling the three ALS1x to 19" 1U unit

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: **100Base-TX**

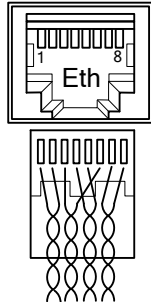
Wiring	Pins	Description
	1	A+
	2	A-
	3	B+
	4	C+
	5	C-
	6	B-
	7	D+
	8	D-

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



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)

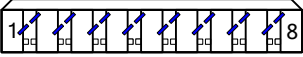
Wiring	Pins	Description	The marking of cable conductors S-STP Cat7
	1	A+	white
	2	A-	green
	3	B+	white
	4	B-	orange
	5	C+	blue
	6	C-	white
	7	D+	white
	8	D-	brown

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

6 pair cable wiring for separate management



Thin pairs of 6 pair cable are connected to cutting box „Krone“ for the line 2 according the table 3.

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

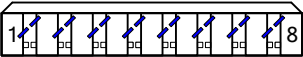
Wiring	Pins	Description	The marking of cable conductors S-STP Cat7
	1	A+	brown
	2	A-	blue
	3	B+	green
	4	B-	orange
	5	C+	–
	6	C-	–
	7	D+	–
	8	D-	–

Table 3 Separate management – The protected terminal box – cutting box "KRONE" for the line 2

Cutting box “Krone” for the Line 3 + Power



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

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

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



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

2.2.3 Indication

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

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

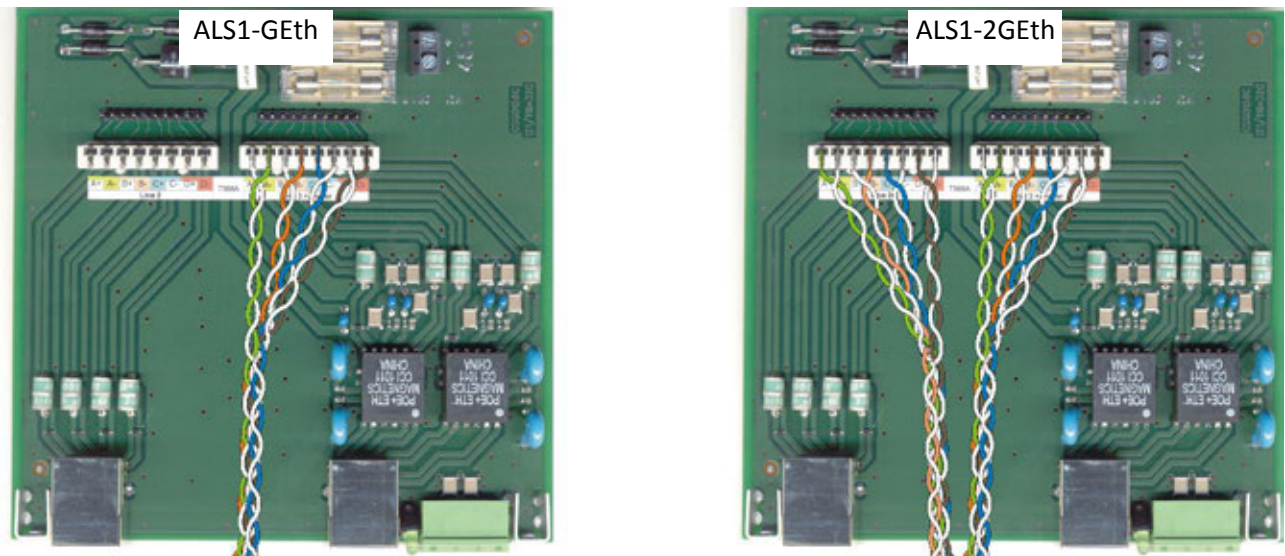


Figure 8 Wiring in the terminal box ALS1-GEth, ALS1-2GEth

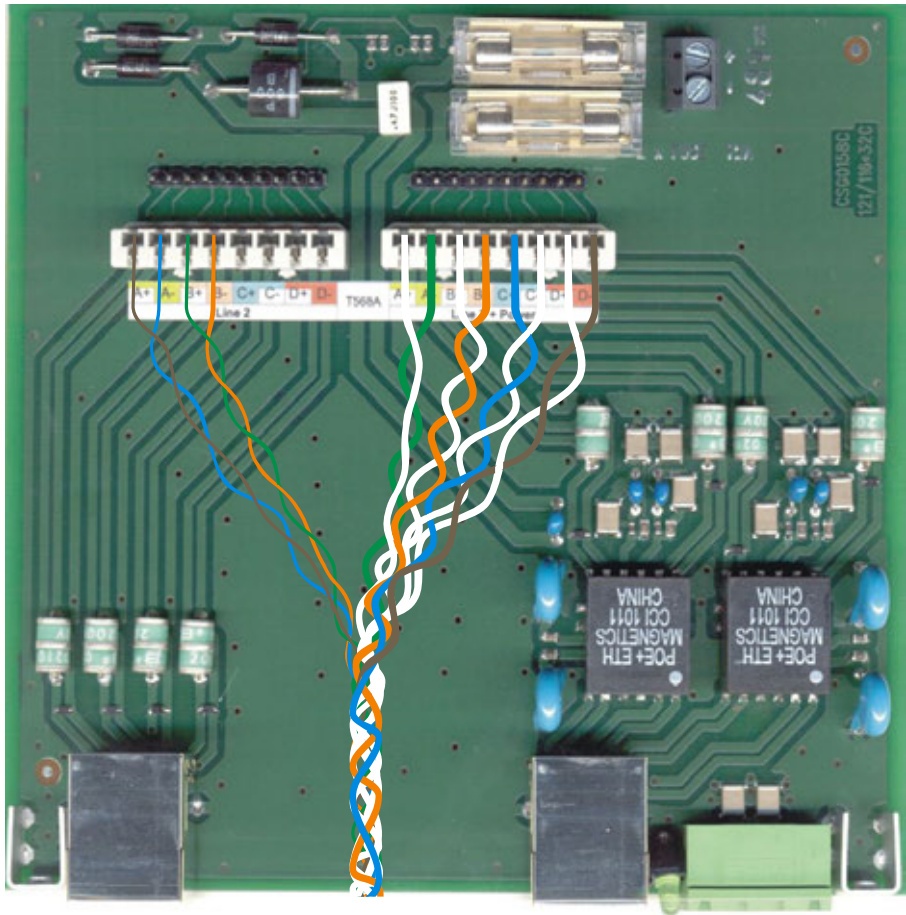


Figure 9 Separate management - wiring in the terminal box



Thin pairs of 6 pair cable are connected to cutting box „Krone“ for the line 2 according the table 3.

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

2.3 THE OUTDOOR UNIT (ODU)

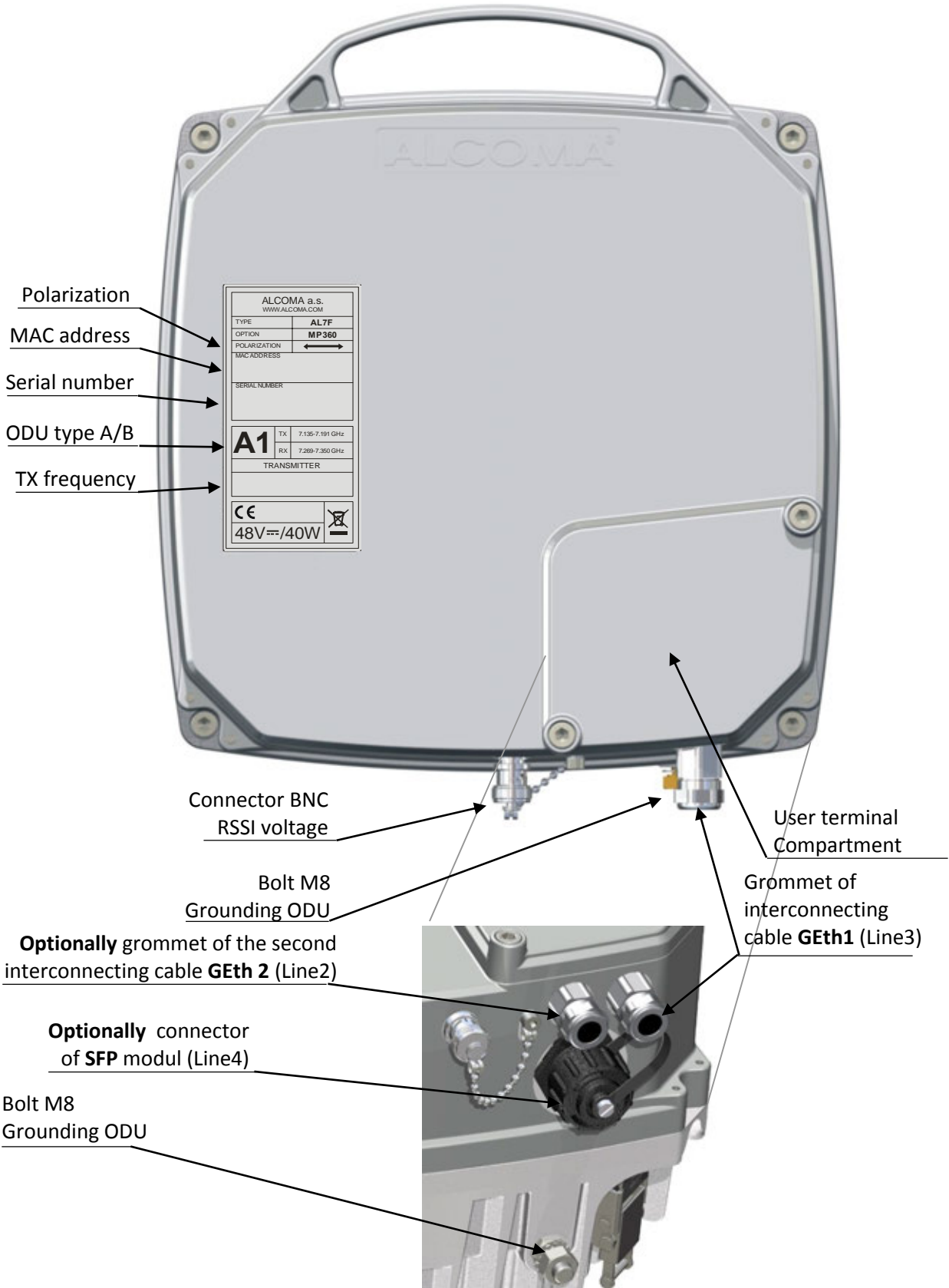


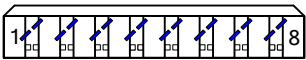
Figure 10 The ODU connection places

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

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

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

6 pair cable wiring for separate management



Thin pairs of 6 pair cable are connected to cutting box „Krone“ for the line 2 according the table 3.

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

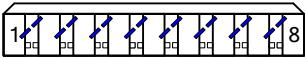
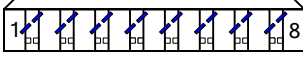
Wiring	Pins	Description	The marking of cable conductors S-STP Cat7
	1	D-	–
	2	D+	–
	3	C-	–
	4	C+	–
	5	B-	orange
	6	B+	green
	7	A-	blue
	8	A+	brown

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	D-	brown	+
	2	D+	white	
	3	C-	white	-
	4	C+	blue	
	5	B-	orange	+
	6	B+	white	
	7	A-	green	-
	8	A+	white	

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

Table 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 3.9, page 30. 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.

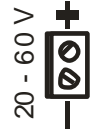
Wiring	Pins	Color
	+	red
	-	blue

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

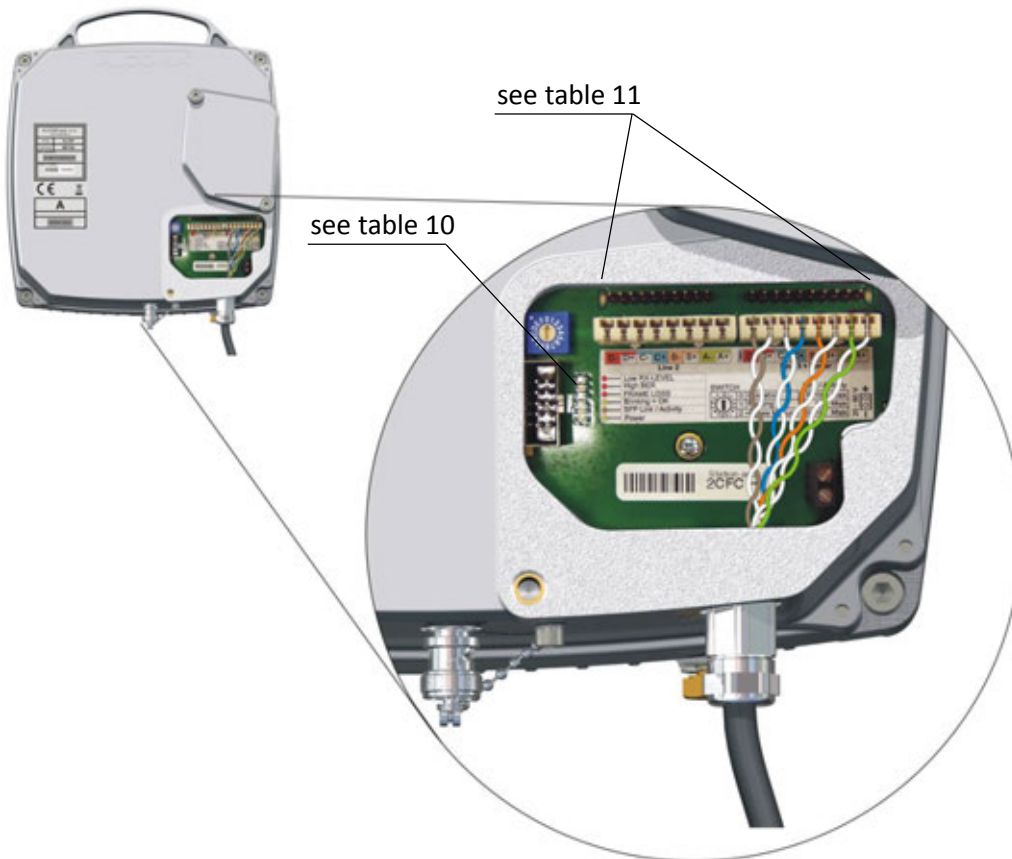


Figure 11 The ODU user space 1xGEth

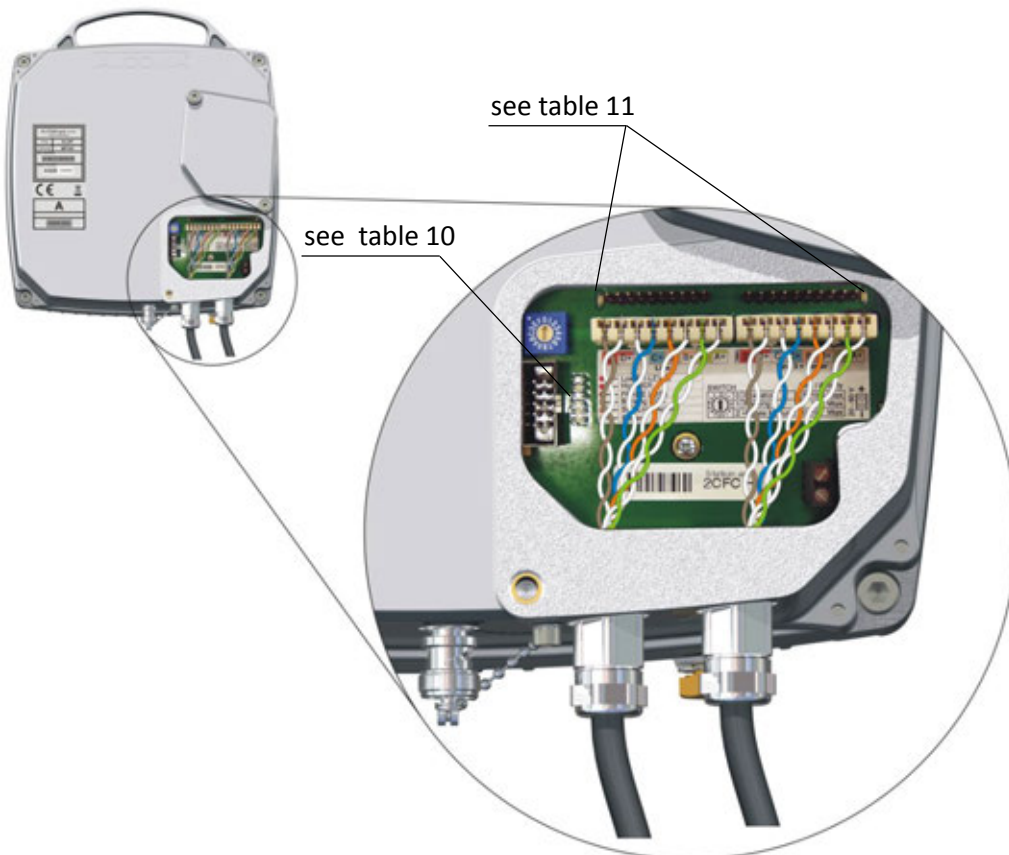


Figure 12 The ODU user space 2xGEth

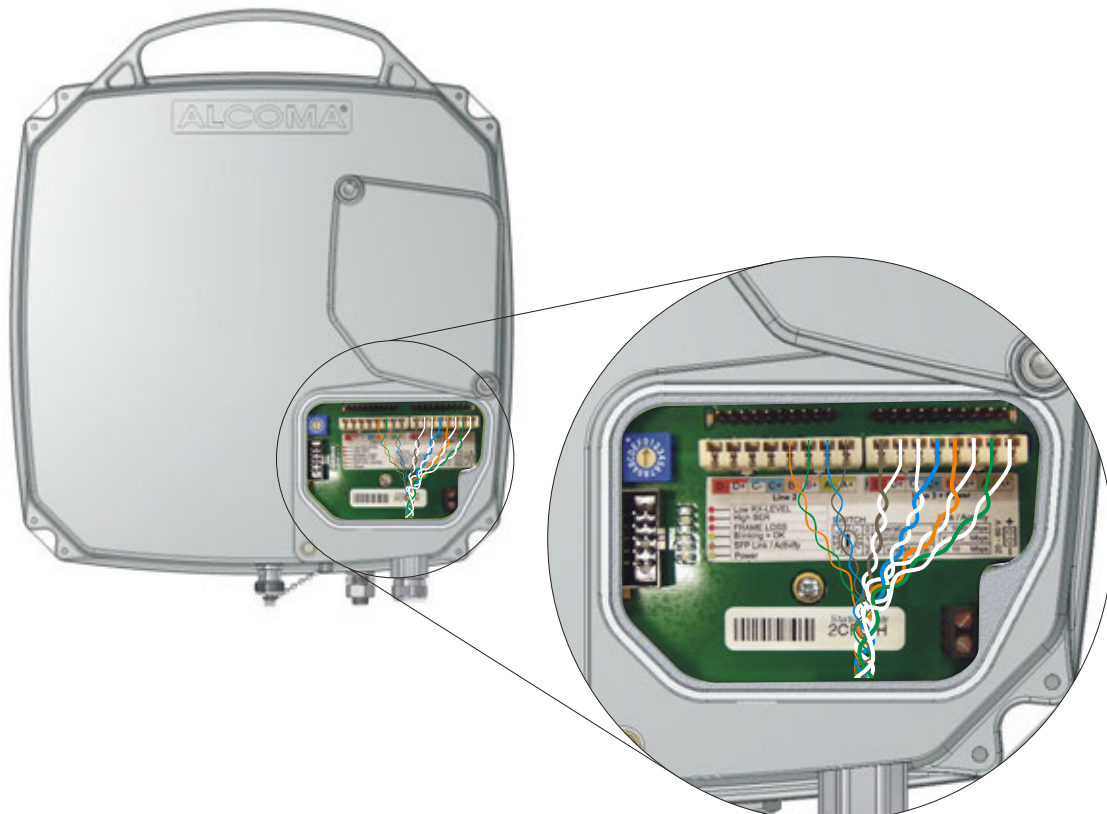


Figure 13 The ODU user space 1xGEth separated management

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

3. INSTALLATION INSTRUCTIONS

3.1 EVALUATION OF SUITABLE PLACEMENT

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

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

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

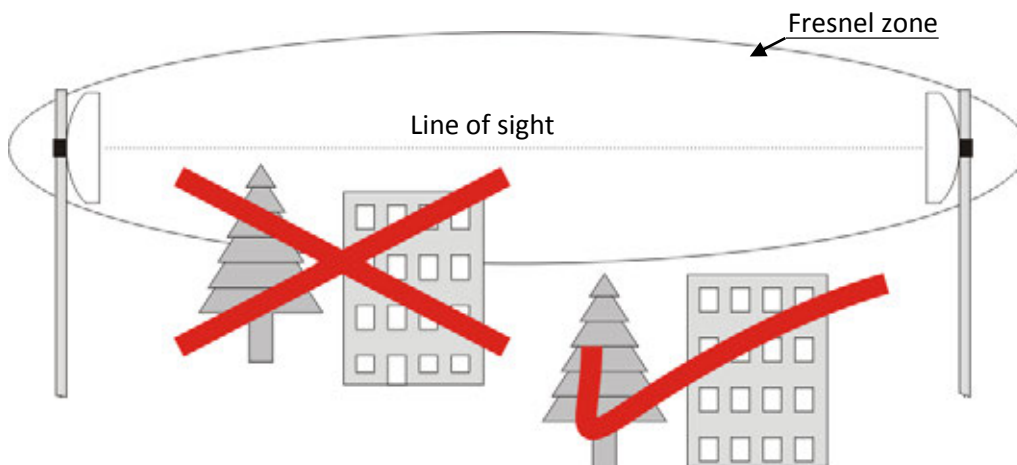


Figure 14 The Fresnel zone

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.

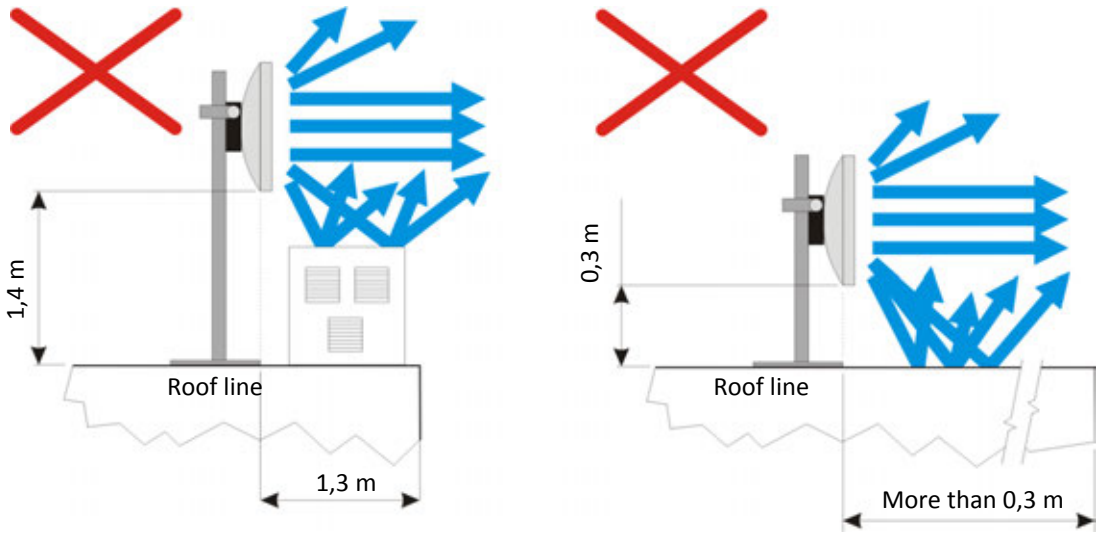


Figure 15 Improper placement of antenna on supporting construction

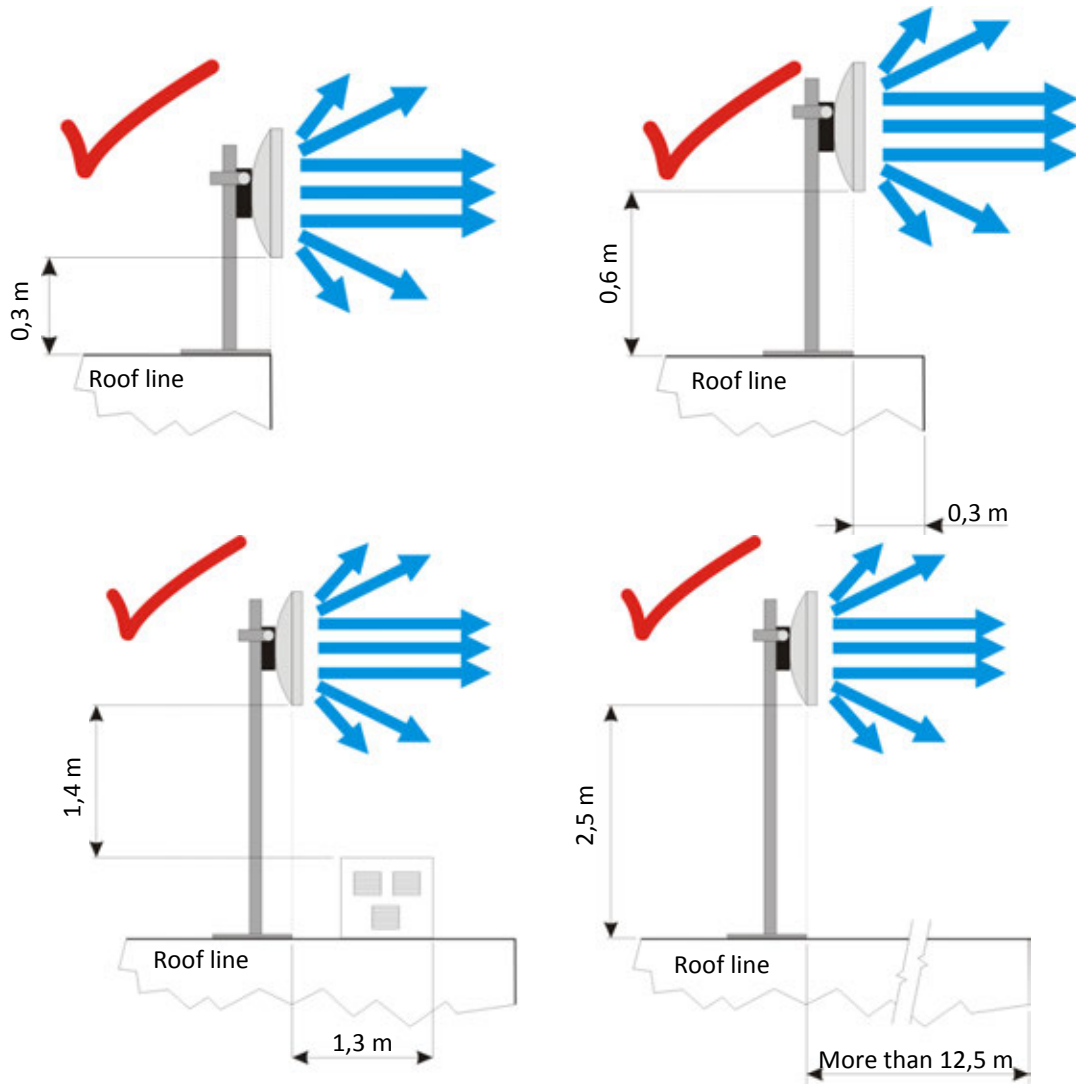


Figure 16 Proper placement of antenna on supporting construction

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

Table 13 Recommended antenna placements considering a distance from an obstacle¹

3.3 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 table 21 (table 28) the on the page 57 (63).

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.

WARNING



The radio relay link ALxxF MP400/360 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.

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

3.4 INSTALLATION OF THE ANTENNA FEEDER



CAUTION

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

3.4.1 UNI antennas

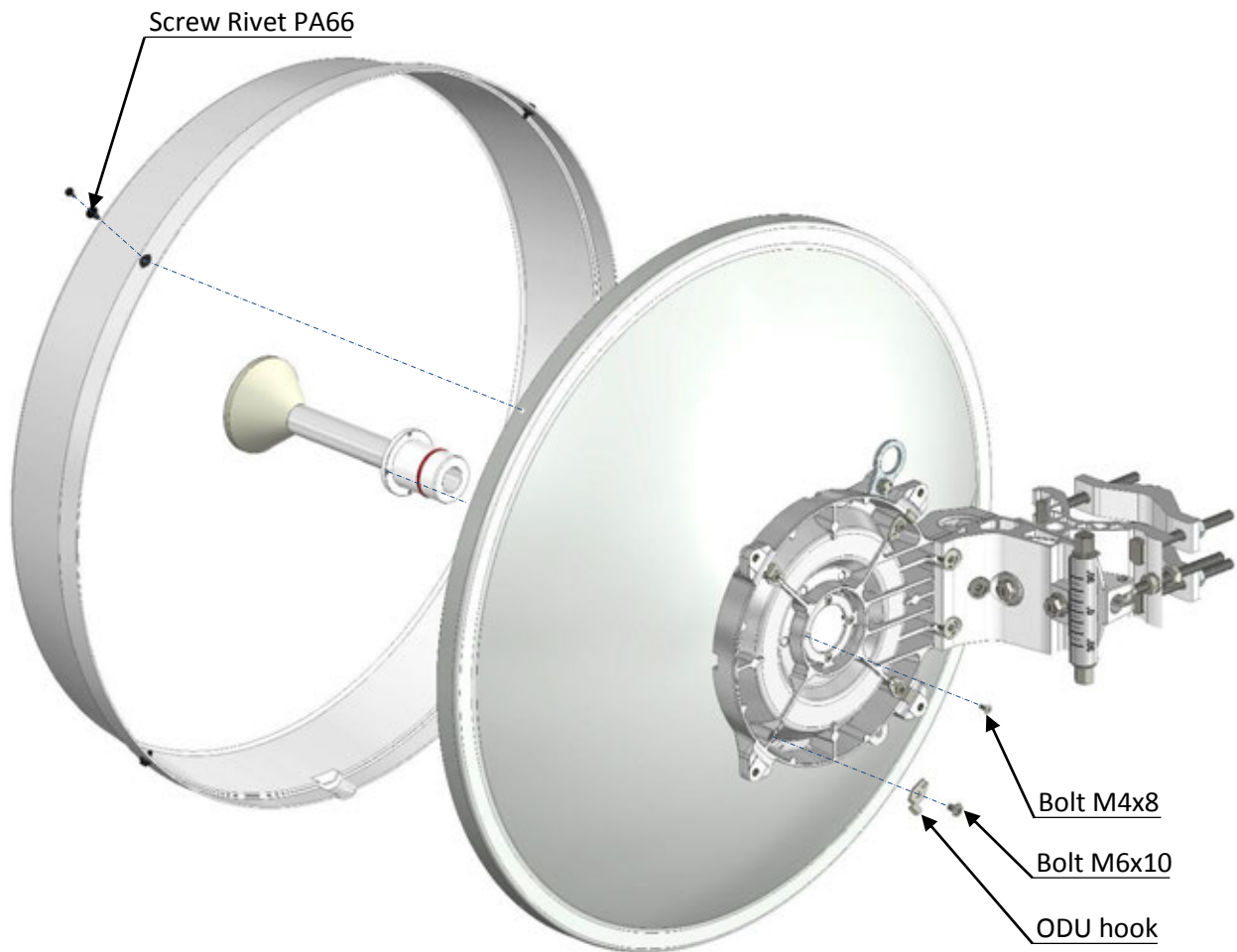


Figure 17 Attaching of the feeder to the Antenna UNI2-xx

The antenna feeder and the antenna are one compact whole. If the feeder is delivered separately it needs to be attached to antenna before the ODU is installed to the antenna unit supports. The feeder is attached to the antenna using four M4 bolts (Figure 17).

- 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.)

3.4.2 MPR antennas

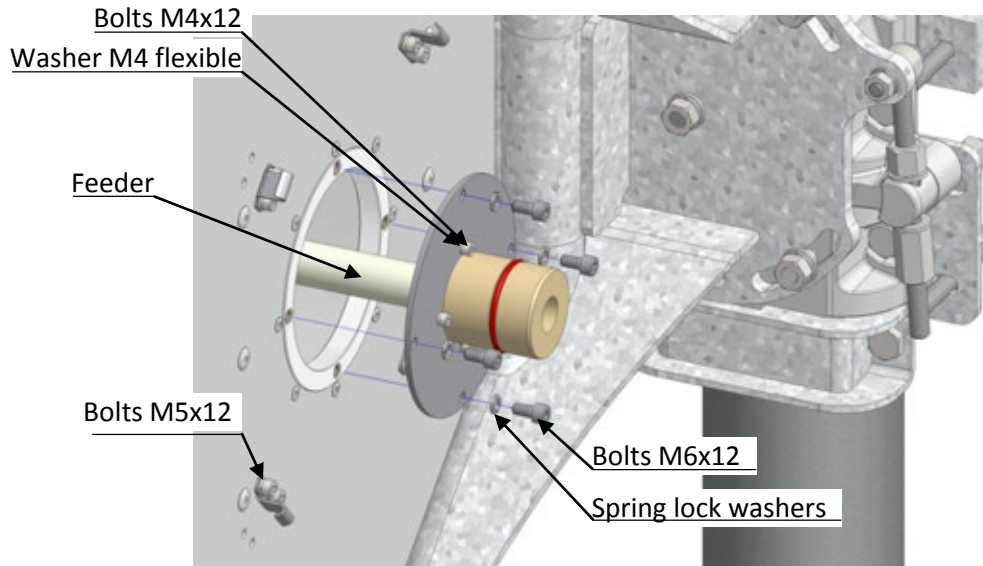


Figure 18 Attaching of the feeder to the antenna (antenna types MPR)

The antenna feeder and the antenna are one compact whole. If the feeder is delivered separately it needs to be attached to antenna before the ODU is installed to the antenna unit supports. The feeder is attached to the antenna using four M6 bolts (Figure 18).

- The waveguide cover is removed from both the antenna feeder, and the waveguide transformer
- The antenna feeder is installed and M6 bolts are tightened. (It does not matter which way the feeder is turned.)

3.5 RADIO LINK INSTALLATION

3.5.1 The UNI2-xx antenna type

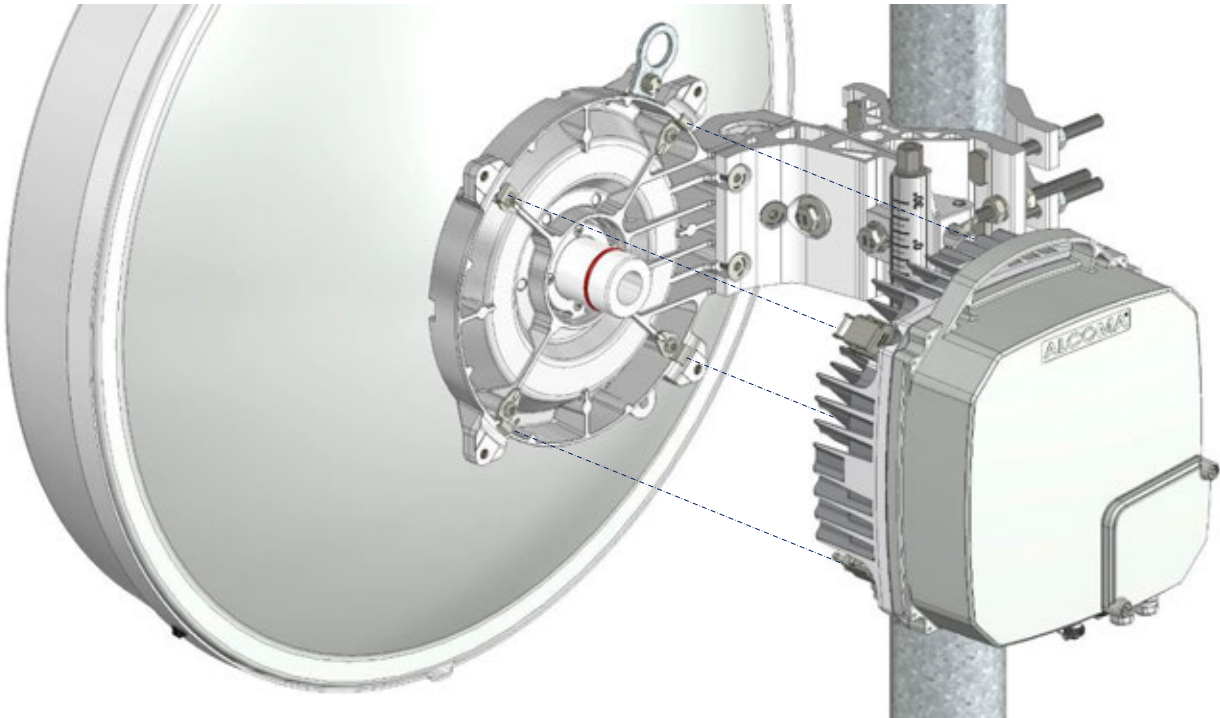


Figure 19 Attaching of the ODU to the antenna UNI2-xx

- The antenna feeder is attached to the antenna
- The antenna feeder is inserted into the ODU using the center guide ring.
- ODU is attached 4 clips to the ODU holderby. The rotation of ODU depends on the used polarization. ODU may not be turned down with its handle!

3.5.2 The AL4-xx/MPR antenna type (also for the AL3-xx/MPR)

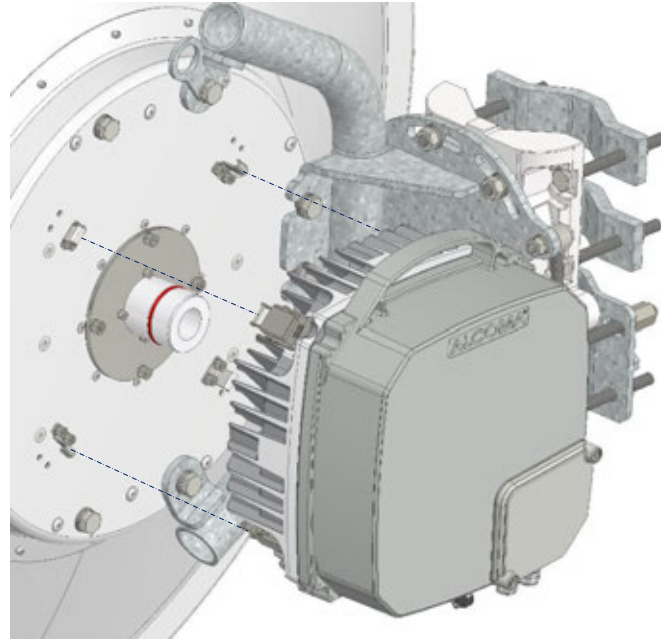


Figure 20 The ODU to AL3-xx/MPR antenna connection (also for AL4-xx/MPR)

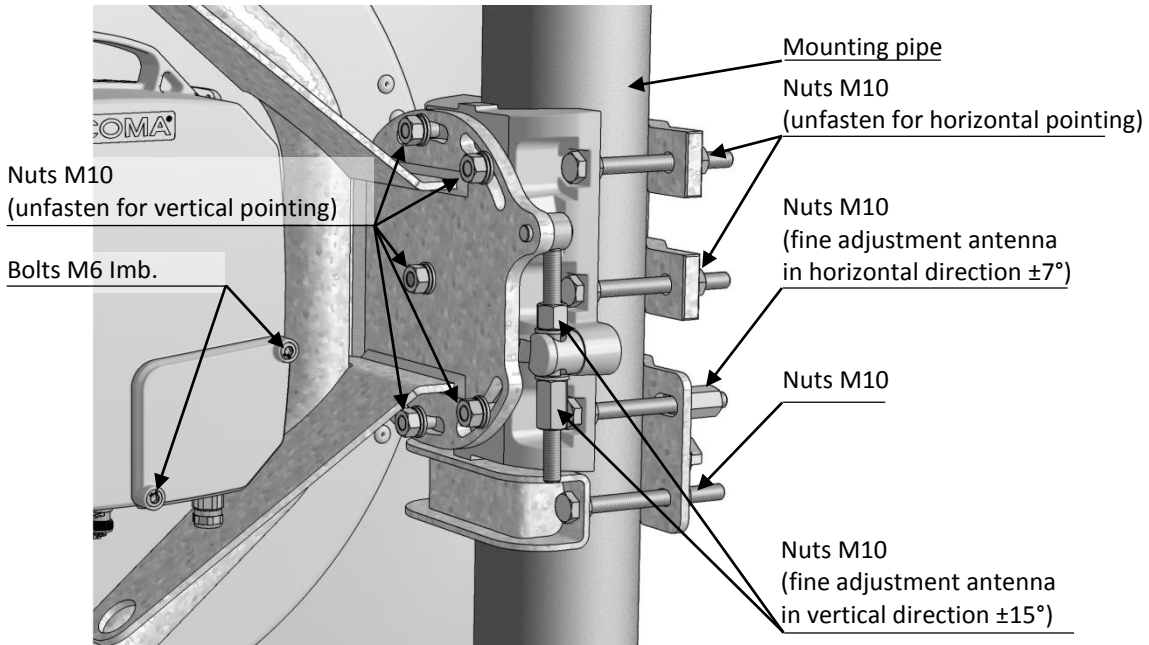


Figure 21 The attachment of the AL4-xx/MPR antenna holder (also for the AL3-xx/MPR antenna)

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.

For easy pulling up of ODU with the antenna to a mast, the parabolic antennas 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.

3.6 LOCAL FREQUENCY COORDINATION

If there is more 6 GHz, 7 GHz or 8 GHz frequency band radio links in one location, polarization, or possibly link channel numbers must be selected to eliminate undesirable interference. The following figure 22 shows possible polarization combinations. Separation by channels is also possible – however, this possibility means using narrower transmitting band (lower transmission rate).

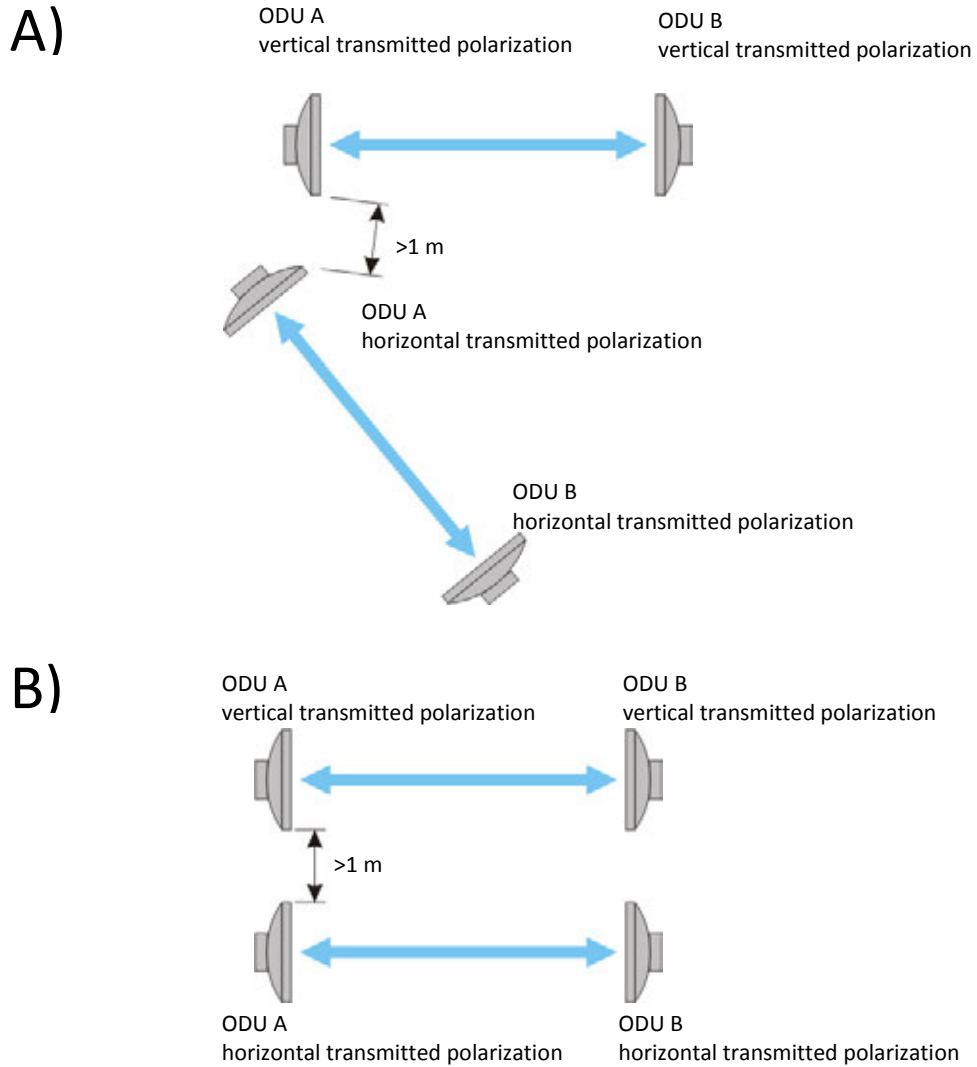


Figure 22 The examples of channel and polarization usage in case of more connections in one location

3.7 GROUNDING



CAUTION

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

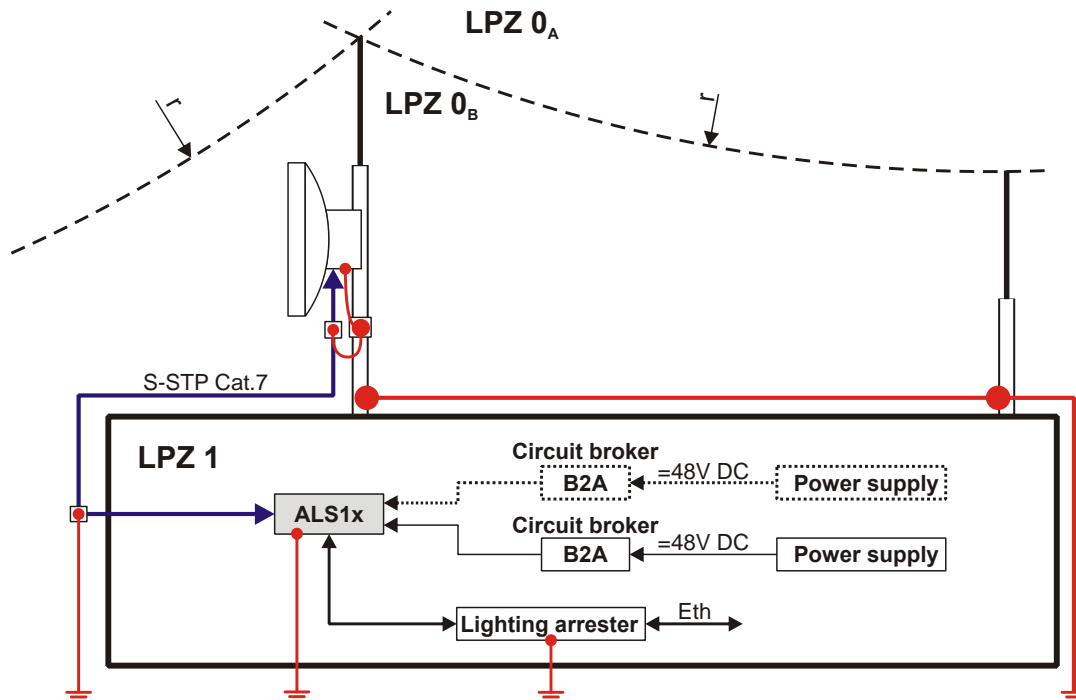


Figure 23 The terminal grounding

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

The antenna system grounding points for the UNI2-xx antennas are common with ODU. The grounding points of the AL3-xx/MPR and AL4-xx/MPR 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 ALSx - ODU just before entering a building must be made by a copper rope with the same cross section of at least 14 mm^2 .

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

3.8 MANIPULATION WITH THE USER SPACE COVER

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

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

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

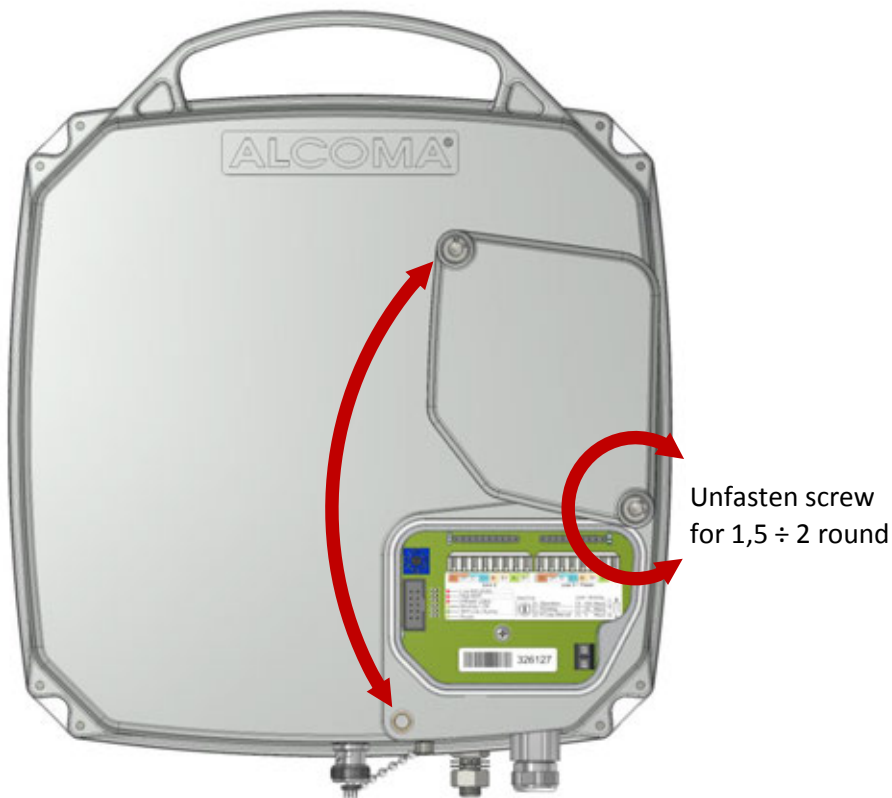


Figure 24 Manipulation with the user space cover



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**.

3.9 TYPICAL ODU WIRING

The following pictures show typical connection diagram for use ALxxF MP400/360. 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.

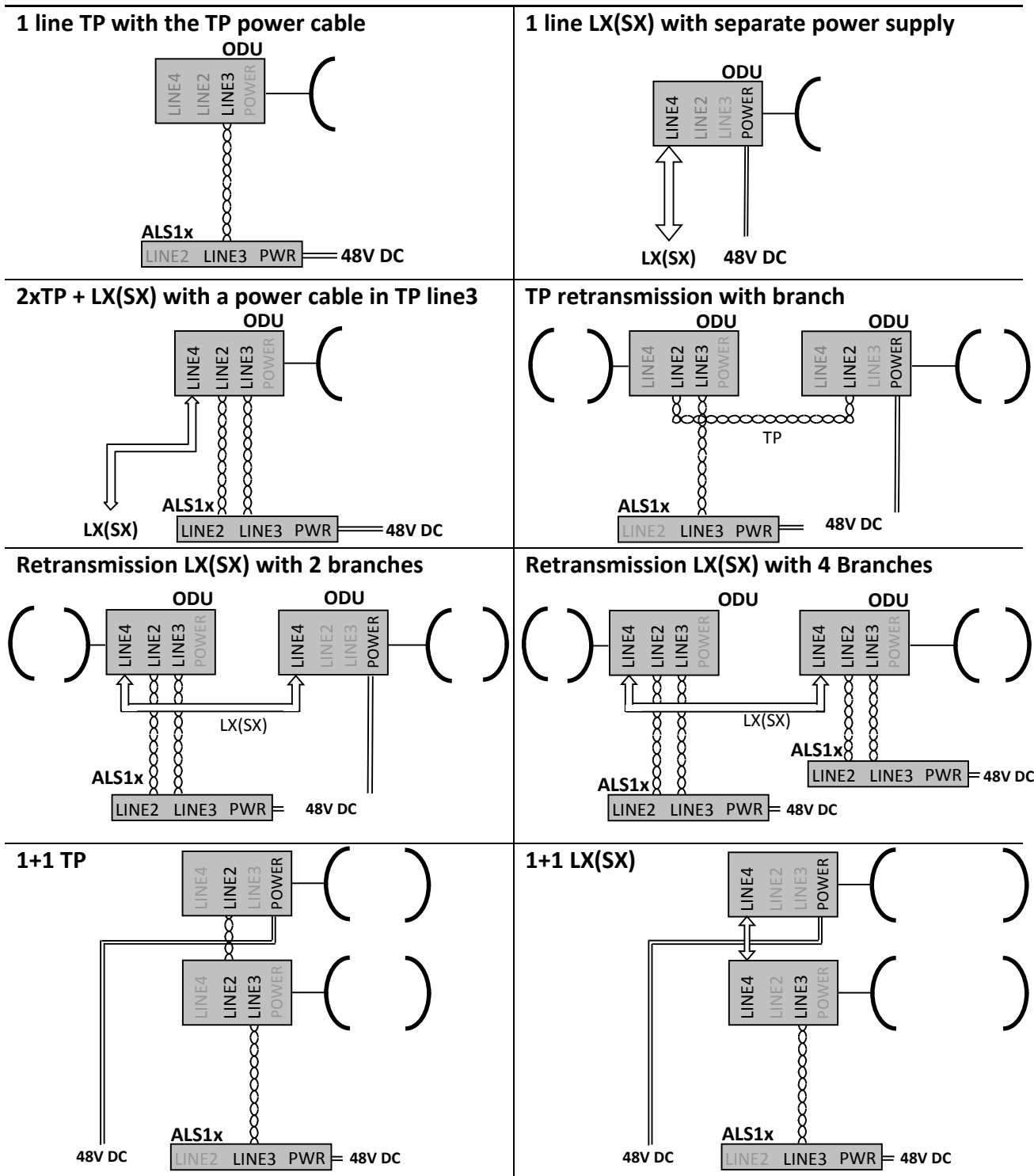


Figure 25 Typical ODU wiring

3.10 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. 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.

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

(Identical for the protected terminal box and ODU)

- The cover of the terminal box space in ODU is opened using an Hexagon wrench no. 5 (figure 11).
- 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 26). No wire of the shielding must go over the bottom washer, in order to tighten the sealing grommet by the pull-over nut well on the cable, and thus seal the grommet properly.
- Shielding of individual pairs will be removed all the way to the turned over top braiding.
- The cable will be inserted through the grommet, and the pulled-over nut will be completely tightened.
- The individual pairs will be divided to the internal Krone connectors that are color coded and numbered on the PCB sticker according to the color codes (for the Cat7 S-STP cable), or numbers (for the Telco 100 Ω 4*ISTP code).
- The individual conductors will be connected using the pusher knife for Krone connectors. The conductor insulation is not removed. It automatically cuts through by the knife connector contacts during installation. The conductors are automatically cut to necessary length at the same time. The cutaway ends must be removed. That is why individual conductor lengths must be sufficient in order to be able to hold the cut off ends in hand during cutting into the connector. Removing them will prevent possible defects.
- The cable installation will be finished by the reinstallation of removed cover. The attachment screws are tightened by a Phillips screwdriver or an Allen wrench.

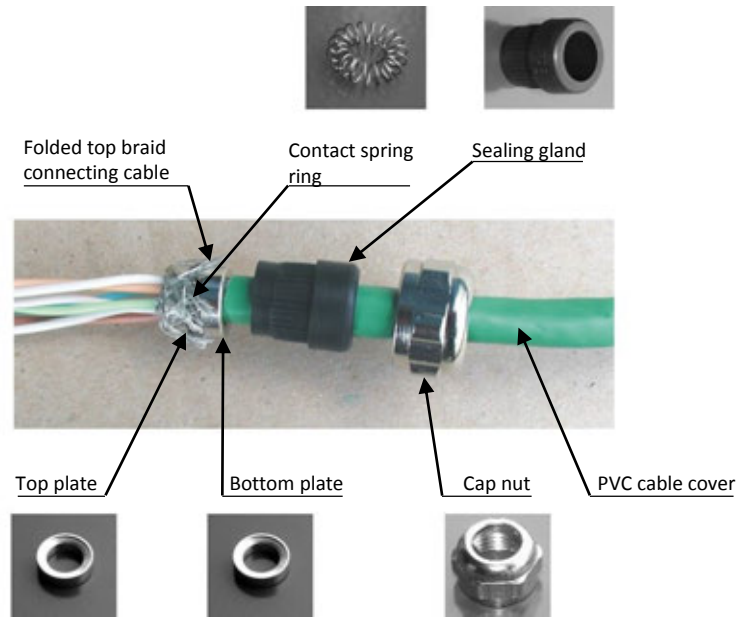


Figure 26 The grommet installation

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

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

CAUTION



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

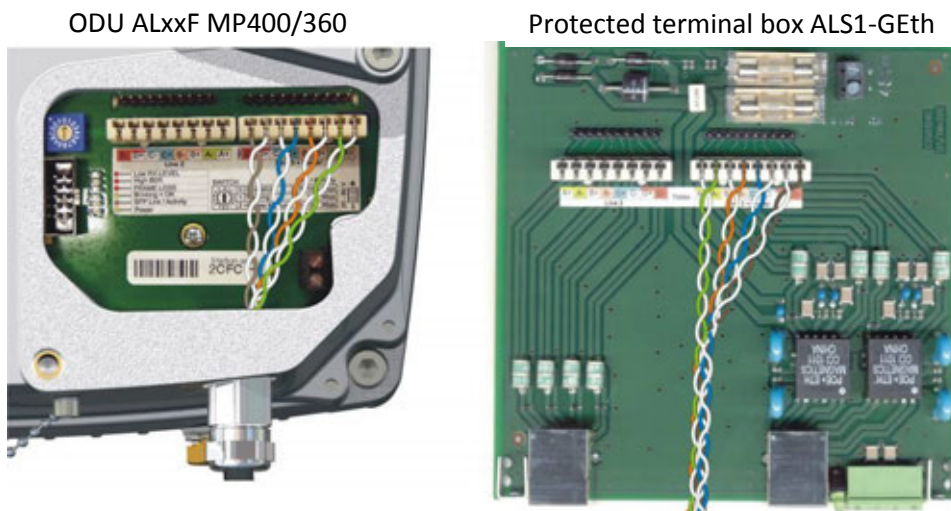


Figure 27 Finished assembly of the connection cable Cat7 S-STP

3.11 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 28 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 29 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.

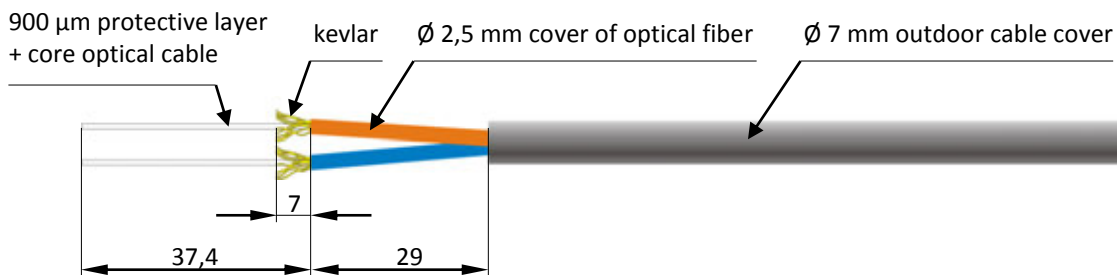
3.12 INSTALLING AN OPTICAL CONNECTOR MOLEX 106059

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)

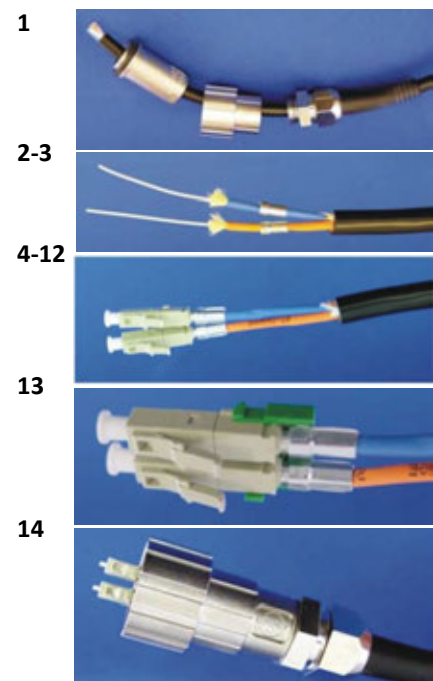


Preparation of optical cable



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



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

² We recommend using the adhesive LOCTITE 638 + activator 7649.

3.13 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.

3.14 ACCESSORIES

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

- 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

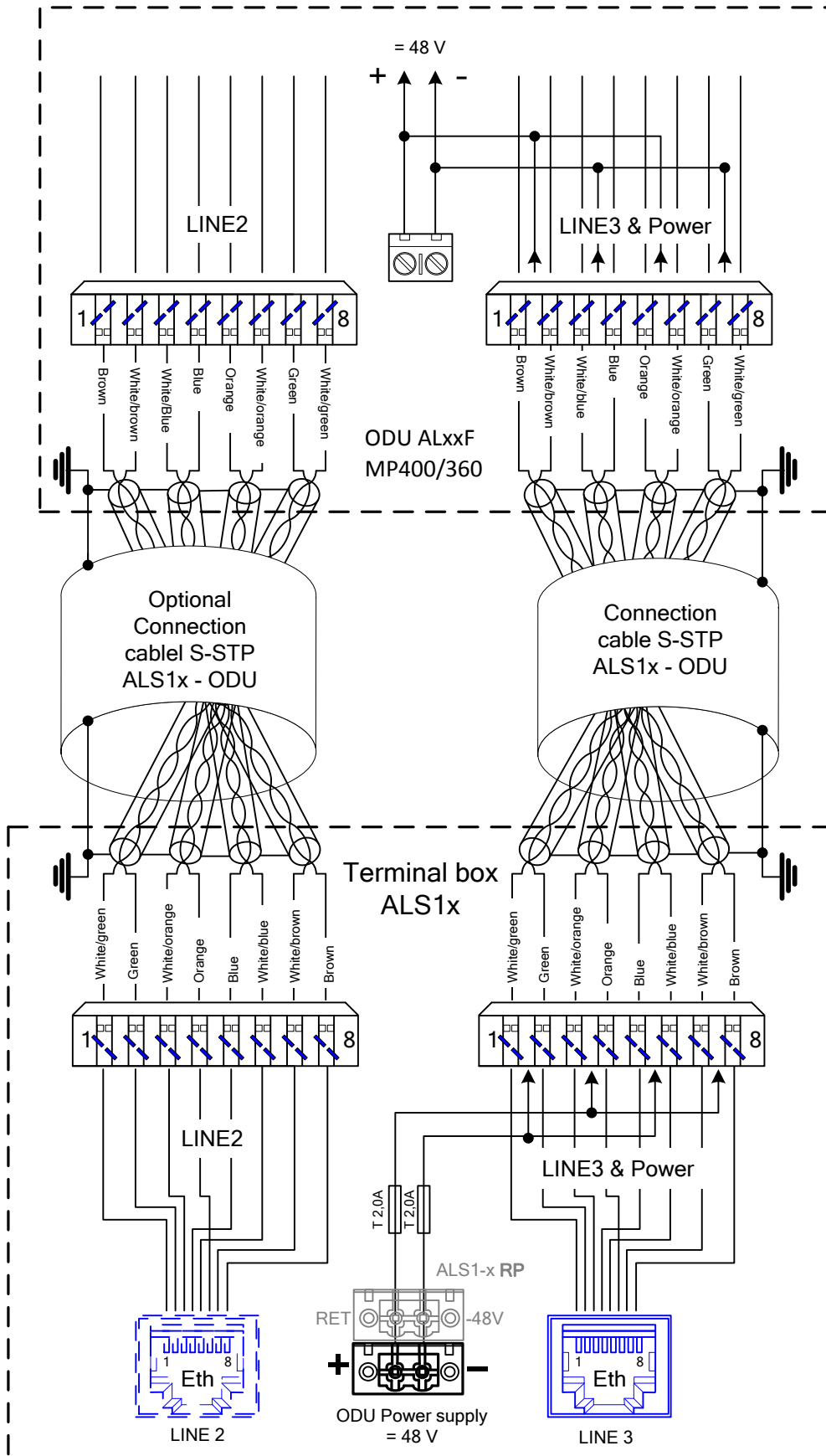


Figure 30 Connection of the connecting cable

4. SETTING OF THE RADIO LINK AND ITS COMMISSIONING

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

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

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

CAUTION



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

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

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

4.1 ANTENNA POINTING

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

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

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

To make pointing easier, ODU has the built in acoustic signalization of the size of received signal level that can be switched on by a rotary switch at the user space (figure 11).

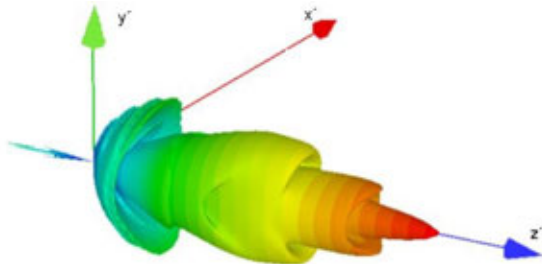


Figure 31 Radiation characteristics

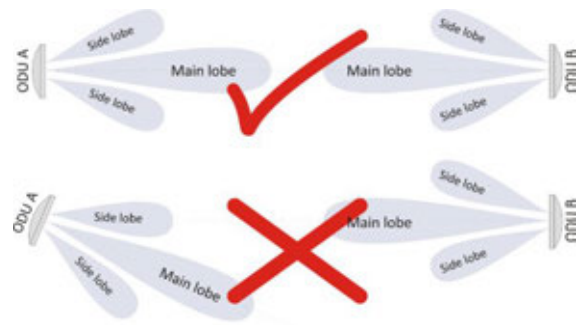


Figure 32 Pointing

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 3.8 on the page 29).
- 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-xxRS

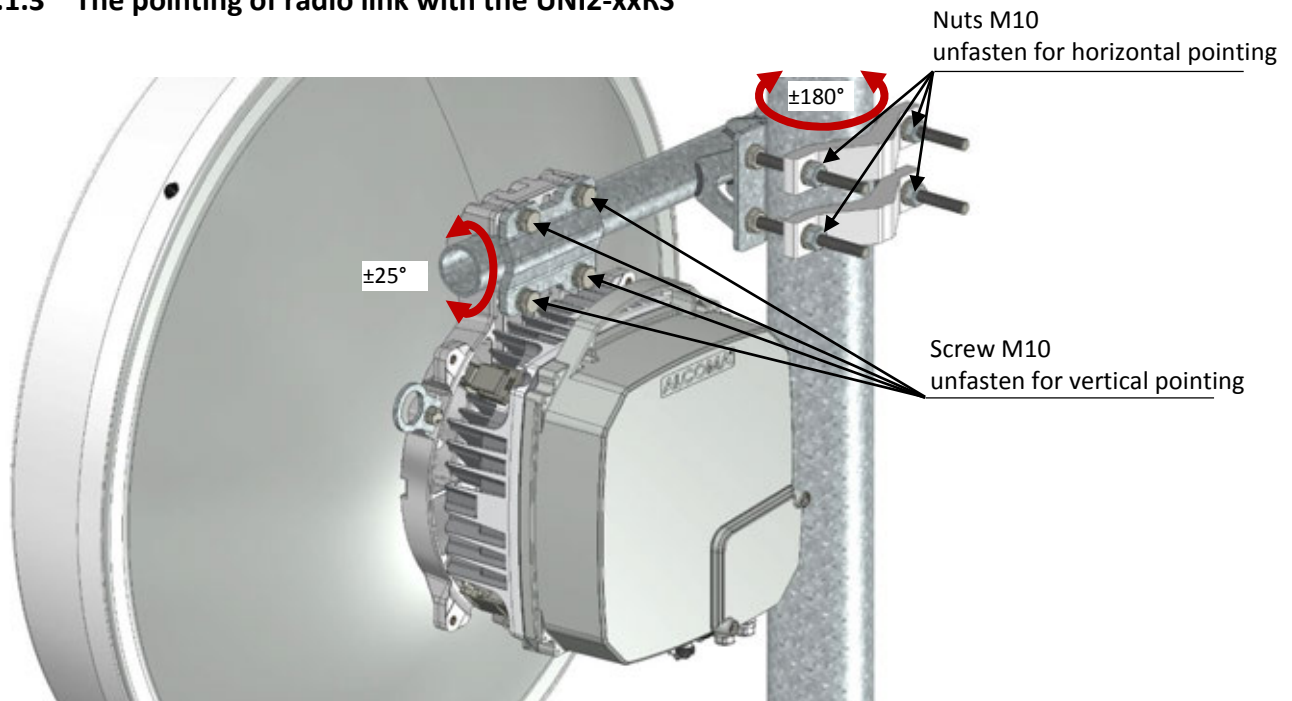


Figure 33 Antenna UNI2-xxRS pointing

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.
- 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 M8 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 MER type antennas by tightening of fixation bolt nuts, and ME type antennas by tightening bolts at found positions.

4.1.4 The pointing of radio link with the UNI2-xxRF antenna

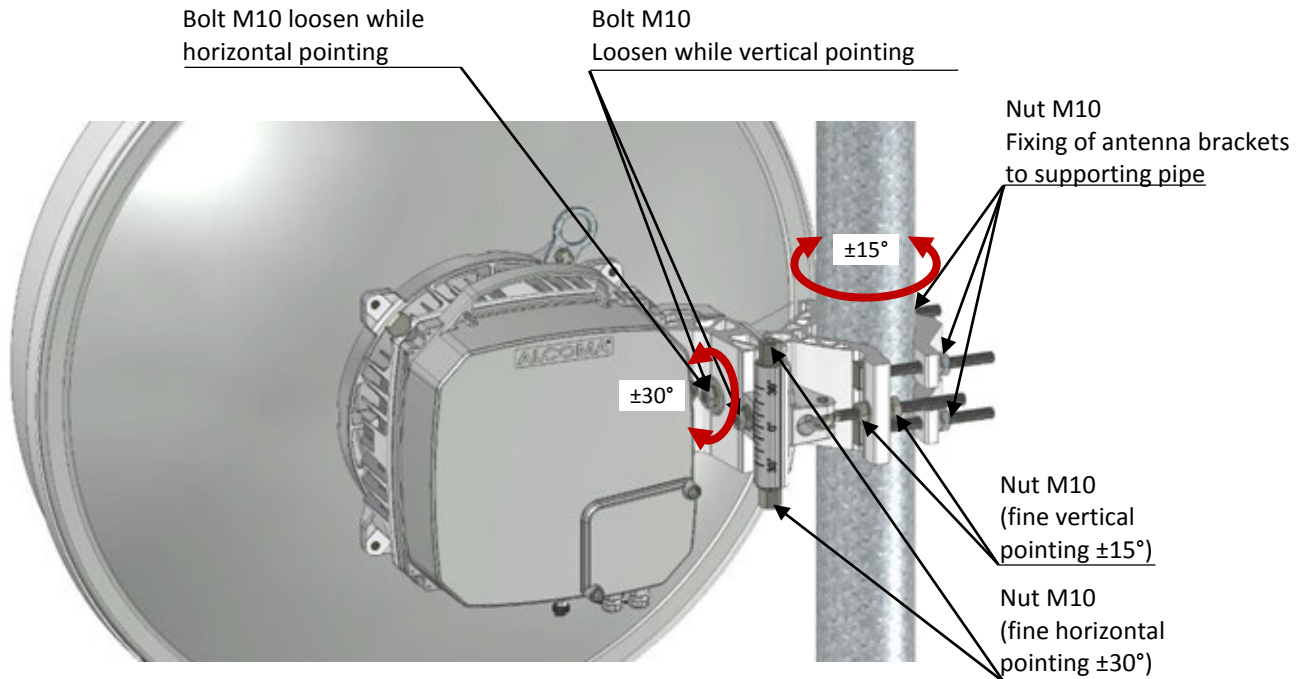


Figure 34 Antenna UNI2-xxRS pointing

Fine horizontal pointing

- Loosen M10 bolt and nut using wrench no. 17. It is better to loosen the nuts without unnecessary play that would later cause a loss of exact direction after tightening.
- While turning fine horizontal pointing nuts of 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 bolts and nuts.
-

Fine vertical pointing

- Loosen M10 bolts. It is better to loosen the nuts without unnecessary play that would later cause a loss of exact direction after tightening.
- While turning fine vertical pointing bolt of 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
- 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 M10 bolts.

4.1.5 The pointing of radio link with the AL4-xx/MPR antenna (also for the AL3-xx/MPR)

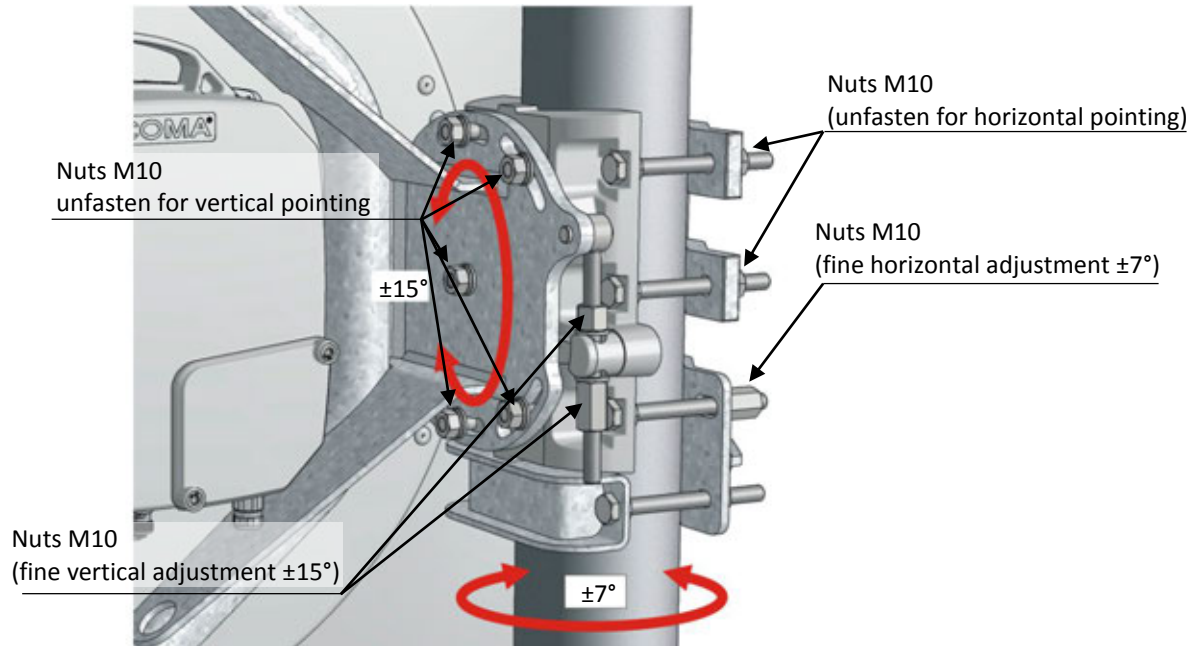


Figure 35 The AL3-xx/MPR antenna pointing (also for the AL4-xx/MPR antenna)

In order to reach the direction stability and resistance against outside loads the antennas AL3-xx/MPR, AL4-xx/MPR 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 35).

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

- 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
Connection length: 1 Km
Antenna: AL4-7/MPR
Building height: cca 140 m



Main lobe diameter: 74 m
Connection length: 5 Km
Antenna: AL4-7/MPR
Building height: cca 140 m

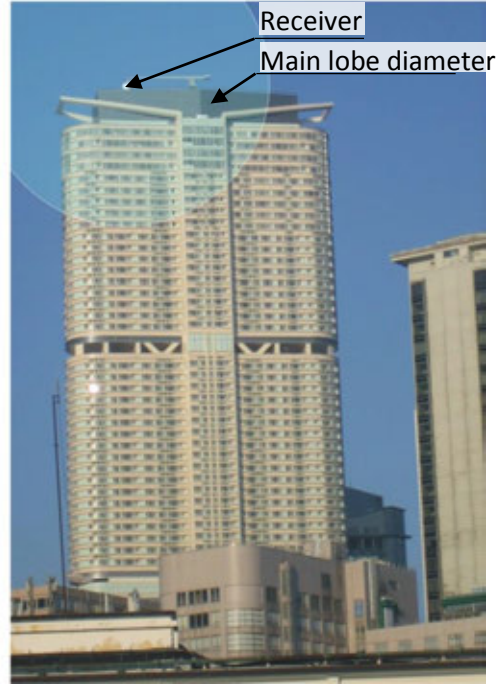


Figure 36 Main lobe diameter with different hoplengths

Remark:

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

The pointing procedure in both horizontal and vertical directions must be repeated several times to make sure that the best maximum of the radiation characteristic 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:

- Unfasten 4 clips that hold ODU to the ODU holder.
- 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.
- 4 clips are fastened.

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**.

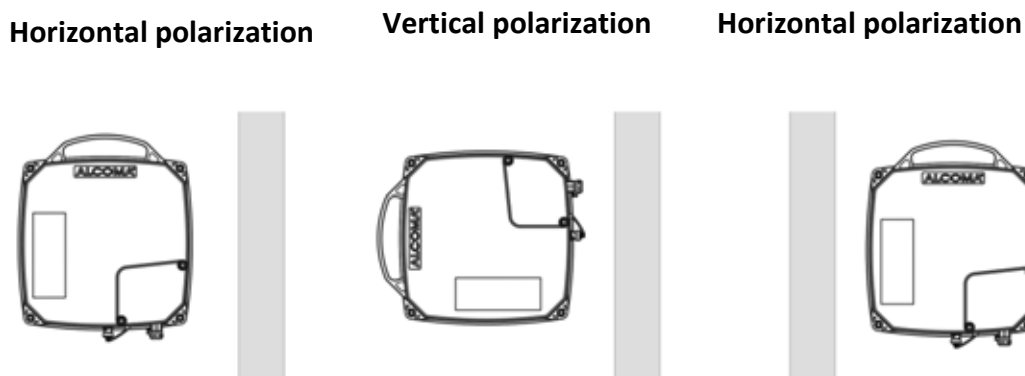


Figure 37 The setting of polarization for the ALxxF MP400/360 station

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 ± 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.

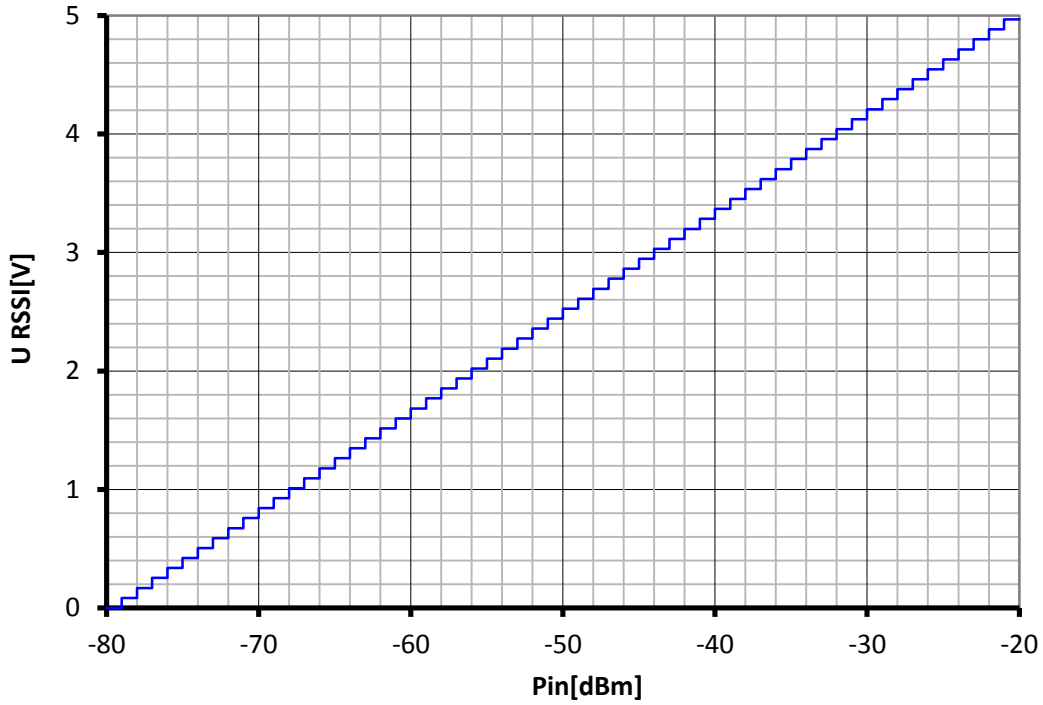


Figure 38 The RSSI calibration graph

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:

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

where:

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

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

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

where:

$d[km]$	distance between antennas
$f[GHz]$	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 39). 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

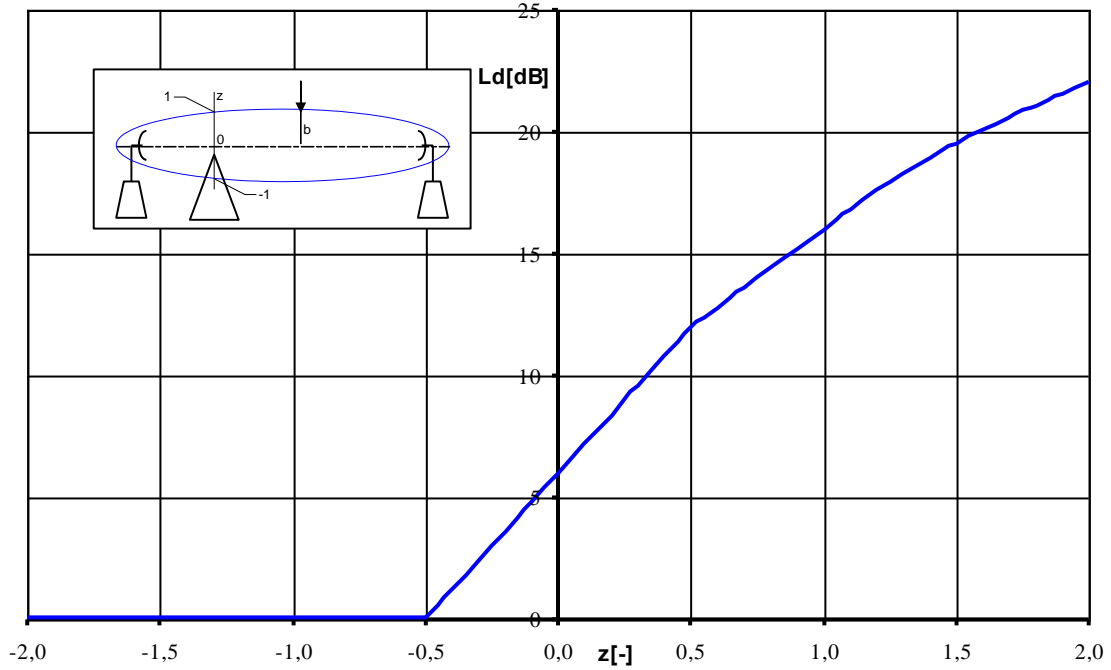


Figure 39 The approximation of additional attenuation behind an obstacle

4.5 DIRECT CONNECTION OF A MONITORING PC

Normally the communication of the monitoring PC with the ALxxF MP400/360 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:

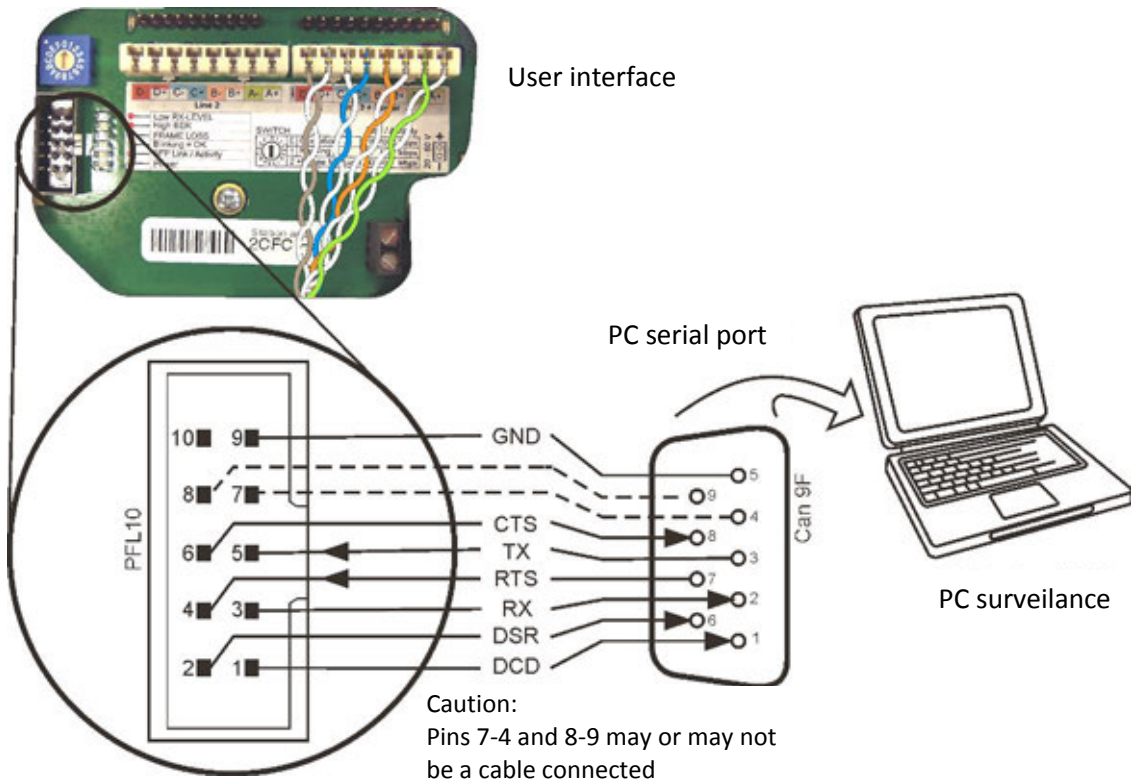


Figure 40 The direct connection of the monitoring PC

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 ALxxF MP400/360 does not require any service or maintenance during operation.

The radio relay link ALxxF MP400/360 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.

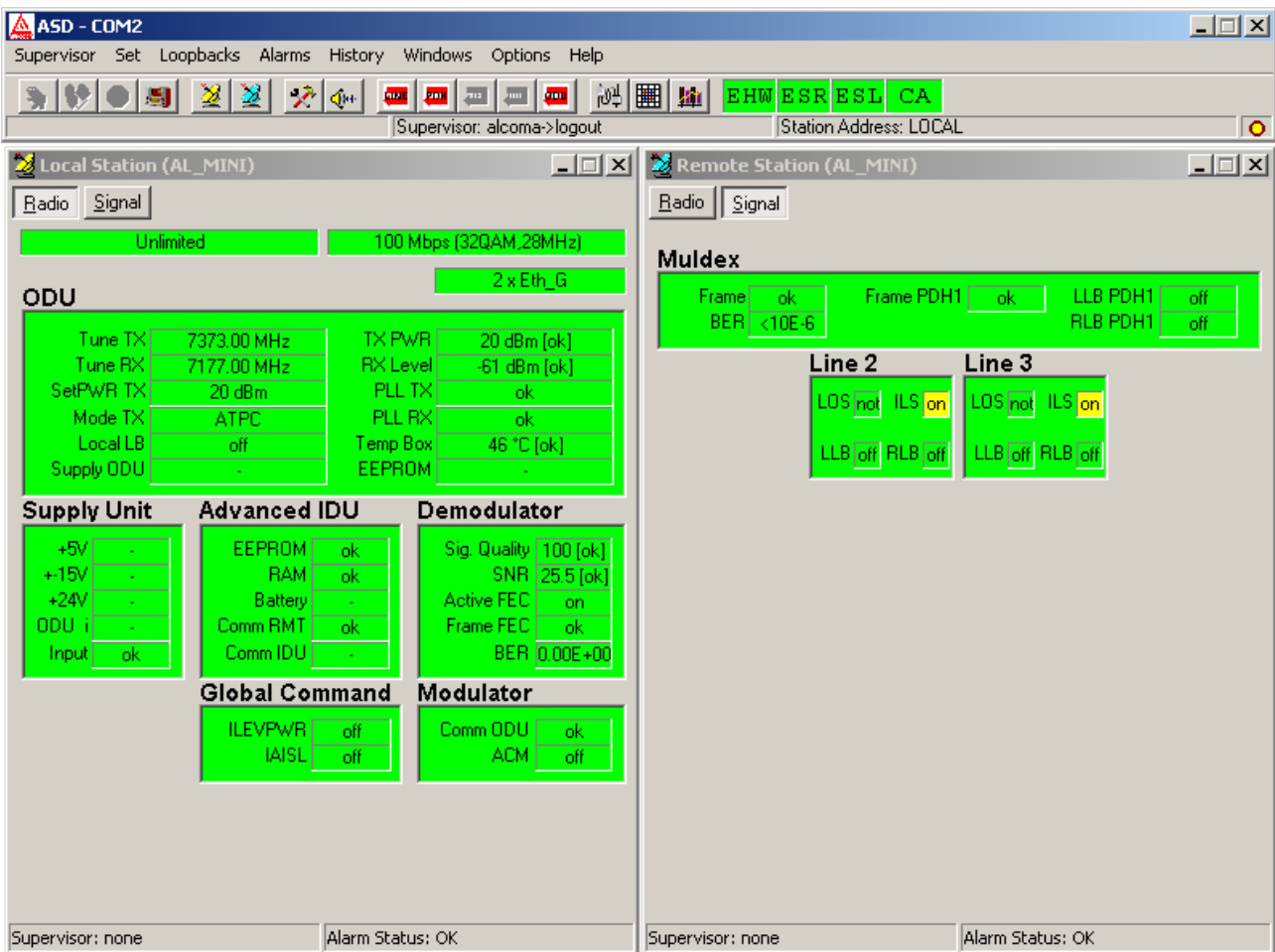


Figure 41 Main window of the ASD program

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

5.2 EMERGENCY CONDITIONS

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



WARNING

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

5.3 REPAIRS



CAUTION

Equipment repairs can be performed only by personnel that have necessary professional qualifications and have been instructed at the manufacturer according to the microwave data link ALxxF MP400/360 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 link does not support E1 transmission, it is not possible to perform any measurement loop for the purpose of error diagnostics using the ASD monitoring program.

5.4 ENDING OF OPERATION – ECOLOGICAL LIQUIDATION

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

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

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

6. SAFETY CHECK

Each ALxxF MP400/360 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 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 6 GHz

7.1 FREQUENCY PLAN

The radio relay link ALCOMA AL6F MP400/360 works in the frequency range of 5.925 to 7.125 GHz. according to 302 217-2-2 a EN 301 126-1. Microwave links can be operated by physical and legal entities only with individual license.

In the specified frequency range the microwave units are tuned according to the local frequency plan.

A - band lower half		B - band lower half		Filter						
Channel number	Transmitter frequency [MHz]	Channel number	Transmitter frequency [MHz]	A1	A2	A3		B1	B2	B3
1	5945,20	1'	6197,24							
2	5974,85	2'	6226,89							
3	6004,50	3'	6256,54							
4	6034,15	4'	6286,19							
5	6063,80	5'	6315,84							
6	6093,45	6'	6345,49							
7	6123,10	7'	6375,14							
8	6152,75	8'	6404,79							
29,65 MHz channel width, duplex spacing 252,04 MHz										

Table 14 Frequency plan lower 6 GHz according to ITU-R F.383

A - band lower half		B - band lower half		Filter						
Channel number	Transmitter frequency [MHz]	Channel number	Transmitter frequency [MHz]	A1	A2	A3		B1	B2	B3
1	6440,00	1'	6780							
2	6460,00	2'	6800							
3	6480,00	3'	6820							
4	6500,00	4'	6840							
5	6520,00	5'	6860							
6	6540,00	6'	6880							
7	6560,00	7'	6900							
8	6580,00	8'	6920							
9	6600,00	9'	6940							
10	6620,00	10'	6960							
11	6640,00	11'	6980							
12	6660,00	12'	7000							
13	6680,00	13'	7020							
14	6700,00	14'	7040							
15	6720,00	15'	7060							
16	6740,00	16'	7080							
20 MHz channel width, duplex spacing 340 MHz										

Table 15 Frequency plan upper 6 GHz according to ITU-R F.384

A - band lower half		B - band lower half		Filter						
Channel number	Transmitter frequency [MHz]	Channel number	Transmitter frequency [MHz]	A1	A2	A3		B1	B2	B3
1	6460,00	1'	6800							
2	6500,00	2'	6840							
3	6540,00	3'	6880							
4	6580,00	4'	6920							
5	6620,00	5'	6960							
6	6660,00	6'	7000							
7	6700,00	7'	7040							
8	6740,00	8'	7080							
40 MHz channel width, duplex spacing 340 MHz										

Table 16 Frequency plan upper 6 GHz according to ITU-R F.384

7.2 MODULATION SCHEMES, BER TRESHOLDS, TX POWER AND CAPACITIES OF THE LINK

AL6F MP360 link can be set to different capacities based on used modulation scheme and bandwidth. Highest capacity of the link including service channels is 384 Mbps.

Capacity [Mbps]	Modulation scheme [QAM]	Treshold for BER=10 ⁻⁶ [dBm]	TX power [dBm]	Channel bandwidth [MHz]
10	4	-94	-7 – 23	7
19	16	-88,5	-7 – 23	
25	32	-85	-7 – 23	
30	64	-81	-7 – 20	
35	128	-78	-7 – 20	
17	4	-92	-7 – 23	14
39	16	-86	-7 – 23	
50	32	-82	-7 – 23	
61	64	-79	-7 – 20	
72	128	-75	-7 – 20	
34	4	-89	-7 – 23	28
77	16	-83	-7 – 23	
100	32	-79,5	-7 – 23	
123	64	-76	-7 – 20	
158	128	-72	-7 – 20	
165	128	-72	-7 – 20	40
168	256	-71	-7 – 20	
178	256	-70	-7 – 20	
186	256	-70	-7 – 20	
58	4	-86	-7 – 23	
116	16	-80,5	-7 – 23	56
149	32	-78	-7 – 23	
183	64	-75	-7 – 20	
216	128	-70,5	-7 – 20	
249	256	-67	-7 – 20	
89	4	-84	-7 – 23	56
179	16	-79	-7 – 23	
230	32	-76	-7 – 23	
282	64	-72	-7 – 20	
300	128	-70	-7 – 20	
333	128	-68	-7 – 20	56
355	256	-65	-7 – 20	
384	256	-63	-7 – 20	

Table 17 Capacities of AL6F MP360 link

AL6F MP400 link can be set to different capacities based on used modulation scheme and bandwidth. Highest capacity of the link including service channels is 900 Mbps.

Capacity [Mbps]	Modulation scheme [QAM]	Threshold for BER=10 ⁻⁶ [dBm]	TX power [dBm]	Channel bandwidth [MHz]
5	4	-94,0	-7 – 22	3,5
8	8	-90,0	-7 – 22	
11	16	-86,0	-7 – 22	
14	32	-83,0	-7 – 22	
17	64	-80,0	-7 – 20	
20	128	-77,0	-7 – 20	
22	256	-74,0	-7 – 20	
25	512	-71,0	-7 – 20	
27	1024	-66,0	-7 – 20	
11	4	-90,0	-7 – 22	7
16	8	-88,0	-7 – 22	
22	16	-84,0	-7 – 22	
28	32	-81,0	-7 – 22	
33	64	-78,0	-7 – 20	
40	128	-75,0	-7 – 20	
44	256	-72,0	-7 – 20	
50	512	-69,0	-7 – 20	
55	1024	-65,0	-7 – 20	
25	4	-85,0	-7 – 22	14
35	8	-83,0	-7 – 22	
46	16	-81,0	-7 – 22	
58	32	-77,0	-7 – 22	
69	64	-75,0	-7 – 20	
81	128	-72,0	-7 – 20	
92	256	-69,0	-7 – 20	
104	512	-66,0	-7 – 20	
115	1024	-63,0	-7 – 20	
50	4	-82,0	-7 – 22	28
69	8	-81,0	-7 – 22	
92	16	-77,0	-7 – 22	
116	32	-73,0	-7 – 22	
139	64	-72,0	-7 – 20	
162	128	-69,0	-7 – 20	
185	256	-66,0	-7 – 20	
208	512	-64,0	-7 – 20	
230	1024	-61,0	-7 – 20	

Capacity [Mbps]	Modulation scheme [QAM]	Treshold for BER=10 ⁻⁶ [dBm]	TX power [dBm]	Channel bandwidth [MHz]
66	4	-82,0	-7 – 22	40
100	8	-80,0	-7 – 22	
132	16	-76,0	-7 – 22	
165	32	-74,0	-7 – 22	
200	64	-71,0	-7 – 20	
232	128	-68,0	-7 – 20	
265	256	-65,0	-7 – 20	
300	512	-62,0	-7 – 20	
330	1024	-59,0	-7 – 20	
100	4	-80,0	-7 – 22	56
139	8	-78,0	-7 – 22	
185	16	-75,0	-7 – 22	
232	32	-72,0	-7 – 22	
278	64	-69,0	-7 – 20	
324	128	-67,0	-7 – 20	
370	256	-64,0	-7 – 20	
417	512	-60,0	-7 – 20	
459	1024	-58,0	-7 – 20	
132	4	-80,0	-7 – 22	80
200	8	-76,0	-7 – 22	
265	16	-74,0	-7 – 22	
330	32	-70,0	-7 – 22	
400	64	-68,0	-7 – 20	
463	128	-64,0	-7 – 20	
530	256	-61,0	-7 – 20	
600	512	-59,0	-7 – 20	
660	1024	-55,0	-7 – 20	
185	4	-77,0	-7 – 22	112
277	8	-75,0	-7 – 22	
370	16	-72,0	-7 – 22	
460	32	-69,0	-7 – 22	
555	64	-66,0	-7 – 20	
650	128	-62,0	-7 – 20	
740	256	-60,0	-7 – 20	
830	512	-55,0	-7 – 20	
900	1024	-52,0	-7 – 20	

Table 18 Capacities of AL6F MP400 link

7.3 TECHNICAL PARAMETERS

Parameter	AL6F MP400/360
Frequency	5.925 ÷ 7.125 GHz
Minimum channeling tuning step	50 kHz
Duplex spacing	SW configurable
Frequency stability better than	$\pm 10 \times 10^{-6}$
Transmitted output power	see table 17 and table 18, ATPC ³
Transmitter spectrum mask	ETSI 302 217-2-2
Typical threshold sensitivity during BER = 10^{-6}	see table 17 and table 18
Maximum RF Input Operating Level BER = 10^{-6}	23 dBm / 20 dBm ⁴
Maximum RF Non Destructive Input Level	-2 dBm
Ethernet user interface	10/100/1000Base-T(X)
Optional user interface 1xSFP Line 4	1000Base-T/LX/SX/BX
Input connectors for Ethernet user Lines	RJ-45
Interconnect cable protected terminal box - ODU (recommended type S-STP Cat.7 fa ACOME)	4 pair shielded imp. 100 Ω
Maximum length of interconnect cable ⁵	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	< 40 W

Table 19 AL6F MP400/360 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 310 x 174 mm
ODU weight (without antenna and antenna feeder)	6.7 kg
ALS1x weight	0.5 kg

Table 20 Technical parameters

³ ATPC minimal output power -20 dBm.

⁴ 23 dBm for modulation QPSK – 32 QAM, 20 dBm for modulation 64 QAM – 256 QAM links MP360, 23 dBm for modulation QPSK – 1024 QAM links MP400.

⁵ Including the cable that brings data to the protected terminal box.

7.4 ANTENNA SYSTEMS

Parabolic antennas for fixed connection to ODU were developed for the 6 GHz bands. 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 frost (OPN). The change of polarization is performed by turning ODU by 90° see the chapter 4.2, page 43.

Compact microwave antennas	Type			
	UNI2-6RS	UNI2-6RF	AL3-6/MPR	AL4-6/MPR
Parabola diameter	Ø 0.65 m	Ø 0.65 m	Ø 0.90 m	Ø 1,20 m
Antenna gain G_{ant}	29.5 dBi	29.5 dBi	33.1 dBi	35.6 dBi
Main lobe 3 dB	5.7°	5.7°	3.3°	2.5°
Horizontal antenna setting			±180°	
Fine horizontal antenna setting	–	± 15°	± 7°	± 7°
Vertical antenna setting			±25°	
Fine vertical antenna setting	–	± 30°	±15°	±15°
Weight of compact	9.3 kg	9.1 kg	26 kg	36 kg
Diameter of installation stand ⁶ min.	Ø 42 mm	Ø 42 mm	Ø 73 mm	Ø 101 mm
max.			Ø 115 mm	

Table 21 Antenna parameters for 6 GHz band

⁶ Supporting pipe lengths must guarantee sufficient rigidity considering climatic influence of surrounding environment, and Ø 38 ÷ 60 mm pipes can be used as lattice antenna mast parts only.

8. RADIO RELAY LINK PARAMETERS 7 GHz

8.1 FREQUENCY PLAN

The radio relay link ALCOMA AL7F MP400/360 works in the frequency range of 7.110 to 7.900 MHz. according to 302 217-2-2 a EN 301 126-1. Microwave links can be operated by physical and legal entities only with individual license.

In the specified frequency range the microwave units are tuned according to the local frequency plan.

A - band lower half		B - band lower half		Filter				
Channel number	Transmitter frequency [MHz]	Channel number	Transmitter frequency [MHz]	A1	A2		B1	B2
1	7121,00	1'	7317					
2	7149,00	2'	7345					
3	7177,00	3'	7373					
4	7205,00	4'	7401					
5	7233,00	5'	7429					
28 MHz channel width, duplex spacing 196 MHz								

Table 22 Frequency plan lower 7 GHz according to ITU-R F.385

A - band lower half		B - band lower half		Filter				
Channel number	Transmitter frequency [MHz]	Channel number	Transmitter frequency [MHz]	A1	A2		B1	B2
1	7457,00	1'	7625					
2	7485,00	2'	7653					
3	7513,00	3'	7681					
4	7541,00	4'	7709					
5	7569,00	5'	7737					
28 MHz channel width, duplex spacing 168 MHz								

Table 23 Frequency plan upper 7 GHz according to ITU-R F.385

8.2 MODULATION SCHEMES, BER TRESHOLDS, TX POWER AND CAPACITIES OF THE LINK

AL7F MP360 link can be set to different capacities based on used modulation scheme and bandwidth. Highest capacity of the link including service channels is 384 Mbps.

Capacity [Mbps]	Modulation scheme [QAM]	Treshold for BER=10 ⁻⁶ [dBm]	TX power [dBm]	Channel bandwidth [MHz]
10	4	-94	-7 – 22	7
19	16	-89	-7 – 22	
25	32	-86	-7 – 20	
30	64	-81	-7 – 18	
35	128	-78	-7 – 18	
17	4	-92	-7 – 22	14
39	16	-86	-7 – 22	
50	32	-83	-7 – 20	
61	64	-79	-7 – 18	
72	128	-75	-7 – 18	
34	4	-90	-7 – 22	28
77	16	-83	-7 – 22	
100	32	-80	-7 – 20	
123	64	-77	-7 – 18	
158	128	-72	-7 – 18	
165	128	-72	-7 – 18	56
168	256	-70	-7 – 18	
178	256	-70	-7 – 18	
186	256	-67	-7 – 18	
89	4	-85	-7 – 22	
179	16	-79	-7 – 22	56
230	32	-77	-7 – 20	
282	64	-73	-7 – 18	
300	128	-70	-7 – 18	
333	128	-68	-7 – 18	
355	256	-65,5	-7 – 18	
384	256	-63	-7 – 18	

Table 24 Capacities of AL7F MP360 link

AL7F MP400 link can be set to different capacities based on used modulation scheme and bandwidth. Highest capacity of the link including service channels is 900 Mbps.

Capacity [Mbps]	Modulation scheme [QAM]	Threshold for BER=10 ⁻⁶ [dBm]	TX power [dBm]	Channel bandwidth [MHz]
5	4	-94,0	-7 – 22	3,5
8	8	-90,0	-7 – 22	
11	16	-86,0	-7 – 22	
14	32	-83,0	-7 – 22	
17	64	-80,0	-7 – 20	
20	128	-77,0	-7 – 20	
22	256	-74,0	-7 – 20	
25	512	-71,0	-7 – 20	
27	1024	-66,0	-7 – 20	
11	4	-90,0	-7 – 22	7
16	8	-88,0	-7 – 22	
22	16	-84,0	-7 – 22	
28	32	-81,0	-7 – 22	
33	64	-78,0	-7 – 20	
40	128	-75,0	-7 – 20	
44	256	-72,0	-7 – 20	
50	512	-69,0	-7 – 20	
55	1024	-65,0	-7 – 20	
25	4	-85,0	-7 – 22	14
35	8	-83,0	-7 – 22	
46	16	-81,0	-7 – 22	
58	32	-77,0	-7 – 22	
69	64	-75,0	-7 – 20	
81	128	-72,0	-7 – 20	
92	256	-69,0	-7 – 20	
104	512	-66,0	-7 – 20	
115	1024	-63,0	-7 – 20	
50	4	-82,0	-7 – 22	28
69	8	-81,0	-7 – 22	
92	16	-77,0	-7 – 22	
116	32	-73,0	-7 – 22	
139	64	-72,0	-7 – 20	
162	128	-69,0	-7 – 20	
185	256	-66,0	-7 – 20	
208	512	-64,0	-7 – 20	
230	1024	-61,0	-7 – 20	

Capacity [Mbps]	Modulation scheme [QAM]	Treshold for BER=10 ⁻⁶ [dBm]	TX power [dBm]	Channel bandwidth [MHz]
66	4	-82,0	-7 – 22	40
100	8	-80,0	-7 – 22	
132	16	-76,0	-7 – 22	
165	32	-74,0	-7 – 22	
200	64	-71,0	-7 – 20	
232	128	-68,0	-7 – 20	
265	256	-65,0	-7 – 20	
300	512	-62,0	-7 – 20	
330	1024	-59,0	-7 – 20	
100	4	-80,0	-7 – 22	56
139	8	-78,0	-7 – 22	
185	16	-75,0	-7 – 22	
232	32	-72,0	-7 – 22	
278	64	-69,0	-7 – 20	
324	128	-67,0	-7 – 20	
370	256	-64,0	-7 – 20	
417	512	-60,0	-7 – 20	
459	1024	-58,0	-7 – 20	
132	4	-80,0	-7 – 22	80
200	8	-76,0	-7 – 22	
265	16	-74,0	-7 – 22	
330	32	-70,0	-7 – 22	
400	64	-68,0	-7 – 20	
463	128	-64,0	-7 – 20	
530	256	-61,0	-7 – 20	
600	512	-59,0	-7 – 20	
660	1024	-55,0	-7 – 20	
185	4	-77,0	-7 – 22	112
277	8	-75,0	-7 – 22	
370	16	-72,0	-7 – 22	
460	32	-69,0	-7 – 22	
555	64	-66,0	-7 – 20	
650	128	-62,0	-7 – 20	
740	256	-60,0	-7 – 20	
830	512	-55,0	-7 – 20	
900	1024	-52,0	-7 – 20	

Table 25 Capacities of AL7F MP400 link

8.3 TECHNICAL PARAMETERS

Parameter	AL7F MP400/360
Frequency	7.110 ÷ 7.900 GHz
Minimum channeling tuning step	50 kHz
Duplex spacing	SW configurable
Frequency stability better than	$\pm 10 \times 10^{-6}$
Transmitted output power	See Table 24 and Table 25, ATPC ⁷
Transmitter spectrum mask	ETSI 302 217-2-2
Typical threshold sensitivity during BER = 10^{-6}	see Table 24 and Table 25
Maximum RF Input Operating Level BER = 10^{-6}	23 dBm / 20 dBm ⁸
Maximum RF Non Destructive Input Level	-2 dBm
Ethernet user interface	10/100/1000Base-T(X)
Optional interface 1xSFP Line4	1000Base-T/LX/SX/BX
Input connectors for Ethernet user lines	RJ-45
Interconnect cable protected terminal box - ODU (recommended types S-STP Cat.7 fa ACOME)	4 pair shielding imp. 100 Ω
Maximum length of interconnect cable ⁹	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	< 40 W

Table 26 AL7F MP400/360 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 310 x 174 mm
ODU weight (without antenna and antenna feeder)	6.7 kg
ALS1x weight	0.5 kg

Table 27 Technical parameters

⁷ ATPC minimal output power -20 dBm

⁸ 23 dBm for modulation QPSK – 32 QAM, 20 dBm for modulation 64 QAM – 256 QAM links MP360, 23 dBm for modulation QPSK – 1024 QAM links MP400.

⁹ Including the cable that brings data to the protected terminal box.

8.4 ANTENNA SYSTEMS

Parabolic antennas for fixed connection to ODU were developed for the 7 GHz bands. 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 frost (OPN). The change of polarization is performed by turning ODU by 90° see the chapter 4.2, page 43.

Compact microwave antennas	Typ			
	UNI2-7RS	UNI2-8RF	AL3-7/MPR	AL4-7/MPR
Parabola diameter	Ø 0.65 m	Ø 0.65 m	Ø 0.90 m	Ø 1.20 m
Antenna gain G_{ant}	31.1 dBi	31.1 dBi	34.4 dBi	36.9 dBi
Main lobe 3 dB	4.8°	4.8°	2.8°	2.1°
Horizontal antenna setting	±180°			
Fine horizontal antenna setting	–	± 15°	± 7°	± 7°
Vertical antenna setting	±25°			
Fine vertical antenna setting	–	± 30°	±15°	±15°
Weight of compact	9.3 kg	9.1 kg	26 kg	36 kg
Diameter of installation stand min.	Ø 42 mm	Ø 42 mm	Ø 73 mm	Ø 101 mm
max.	Ø 115 mm			

Table 28 Antenna parameters for 7 GHz band

9. RADIO RELAY LINK PARAMETERS 8 GHz

9.1 FREQUENCY PLAN

The radio relay link ALCOMA AL8F MP400/360 works in the frequency range of 7.725 to 8.500 MHz. according to 302 217-2-2 a EN 301 126-1. Microwave links can be operated by physical and legal entities only with individual license.

In the specified frequency range the microwave units are tuned according to the local frequency plan.

A - band lower half		B - band lower half		Filter						
Channel number	Transmitter frequency [MHz]	Channel number	Transmitter frequency [MHz]	A1	A2	A3		B1	B2	B3
1	7747,70	1'	8059,02							
2	7777,35	2'	8088,67							
3	7807,00	3'	8118,32							
4	7836,65	4'	8147,97							
5	7866,30	5'	8177,62							
6	7895,95	6'	8207,27							
7	7925,60	7'	8236,92							
8	7955,25	8'	8266,57							
29,65 MHz channel width, duplex spacing 311,32 MHz										

Table 29 Frequency plan lower 8 GHz according to ITU-R F.386

9.2 MODULATION SCHEMES, BER TRESHOLDS, TX POWER AND CAPACITIES OF THE LINK

AL8F MP360 link can be set to different capacities based on used modulation scheme and bandwidth. Highest capacity of the link including service channels is 384 Mbps.

Capacity [Mbps]	Modulation scheme [QAM]	Treshold for BER=10 ⁻⁶ [dBm]	TX power [dBm]	Channel bandwidth [MHz]
10	4	-94	-7 – 22	7
19	16	-89	-7 – 22	
25	32	-86	-7 – 20	
30	64	-81	-7 – 18	
35	128	-78	-7 – 18	
17	4	-92	-7 – 22	14
39	16	-86	-7 – 22	
50	32	-83	-7 – 20	
61	64	-79	-7 – 18	
72	128	-75	-7 – 18	
34	4	-90	-7 – 22	28
77	16	-83	-7 – 22	
100	32	-80	-7 – 20	
123	64	-77	-7 – 18	
158	128	-72	-7 – 18	
165	128	-72	-7 – 18	56
168	256	-70	-7 – 18	
178	256	-70	-7 – 18	
186	256	-67	-7 – 18	
89	4	-85	-7 – 22	
179	16	-79	-7 – 22	56
230	32	-77	-7 – 20	
282	64	-73	-7 – 18	
300	128	-70	-7 – 18	
333	128	-68	-7 – 18	
355	256	-65,5	-7 – 18	
384	256	-63	-7 – 18	

Table 30 Capacities of AL8F MP360 link

AL8F MP400 link can be set to different capacities based on used modulation scheme and bandwidth. Highest capacity of the link including service channels is 900 Mbps.

Capacity [Mbps]	Modulation scheme [QAM]	Threshold for BER=10 ⁻⁶ [dBm]	TX power [dBm]	Channel bandwidth [MHz]
5	4	-94,0	-7 – 22	3,5
8	8	-90,0	-7 – 22	
11	16	-86,0	-7 – 22	
14	32	-83,0	-7 – 22	
17	64	-80,0	-7 – 20	
20	128	-77,0	-7 – 20	
22	256	-74,0	-7 – 20	
25	512	-71,0	-7 – 20	
27	1024	-66,0	-7 – 20	
11	4	-90,0	-7 – 22	7
16	8	-88,0	-7 – 22	
22	16	-84,0	-7 – 22	
28	32	-81,0	-7 – 22	
33	64	-78,0	-7 – 20	
40	128	-75,0	-7 – 20	
44	256	-72,0	-7 – 20	
50	512	-69,0	-7 – 20	
55	1024	-65,0	-7 – 20	
25	4	-85,0	-7 – 22	14
35	8	-83,0	-7 – 22	
46	16	-81,0	-7 – 22	
58	32	-77,0	-7 – 22	
69	64	-75,0	-7 – 20	
81	128	-72,0	-7 – 20	
92	256	-69,0	-7 – 20	
104	512	-66,0	-7 – 20	
115	1024	-63,0	-7 – 20	
50	4	-82,0	-7 – 22	28
69	8	-81,0	-7 – 22	
92	16	-77,0	-7 – 22	
116	32	-73,0	-7 – 22	
139	64	-72,0	-7 – 20	
162	128	-69,0	-7 – 20	
185	256	-66,0	-7 – 20	
208	512	-64,0	-7 – 20	
230	1024	-61,0	-7 – 20	

Capacity [Mbps]	Modulation scheme [QAM]	Treshold for BER=10 ⁻⁶ [dBm]	TX power [dBm]	Channel bandwidth [MHz]
66	4	-82,0	-7 – 22	40
100	8	-80,0	-7 – 22	
132	16	-76,0	-7 – 22	
165	32	-74,0	-7 – 22	
200	64	-71,0	-7 – 20	
232	128	-68,0	-7 – 20	
265	256	-65,0	-7 – 20	
300	512	-62,0	-7 – 20	
330	1024	-59,0	-7 – 20	
100	4	-80,0	-7 – 22	56
139	8	-78,0	-7 – 22	
185	16	-75,0	-7 – 22	
232	32	-72,0	-7 – 22	
278	64	-69,0	-7 – 20	
324	128	-67,0	-7 – 20	
370	256	-64,0	-7 – 20	
417	512	-60,0	-7 – 20	
459	1024	-58,0	-7 – 20	
132	4	-80,0	-7 – 22	80
200	8	-76,0	-7 – 22	
265	16	-74,0	-7 – 22	
330	32	-70,0	-7 – 22	
400	64	-68,0	-7 – 20	
463	128	-64,0	-7 – 20	
530	256	-61,0	-7 – 20	
600	512	-59,0	-7 – 20	
660	1024	-55,0	-7 – 20	
185	4	-77,0	-7 – 22	112
277	8	-75,0	-7 – 22	
370	16	-72,0	-7 – 22	
460	32	-69,0	-7 – 22	
555	64	-66,0	-7 – 20	
650	128	-62,0	-7 – 20	
740	256	-60,0	-7 – 20	
830	512	-55,0	-7 – 20	
900	1024	-52,0	-7 – 20	

Table 31 Capacities of AL8F MP400 link

9.3 TECHNICAL PARAMETERS

Parameter	AL8F MP400/360
Frequency	7.725 ÷ 8.500 GHz
Minimum channeling tuning step	50 kHz
Duplex spacing	SW configurable
Frequency stability better than	$\pm 10 \times 10^{-6}$
Transmitted output power	See Table 30 and Table 31, ATPC ¹⁰
Transmitter spectrum mask	ETSI 302 217-2-2
Typical threshold sensitivity during BER = 10^{-6}	See Table 30 and Table 31
Maximum RF Input Operating Level BER = 10^{-6}	23 dBm / 20 dBm ¹¹
Maximum RF Non Destructive Input Level	-2 dBm
Ethernet user interface	10/100/1000Base-T(X)
Optional interface 1xSFP Line4	1000Base-T/LX/SX/BX
Input connectors for Ethernet user lines	RJ-45
Interconnect cable protected terminal box - ODU (recommended types S-STP Cat.7 fa ACOME)	4 pair shielding imp. 100 Ω
Maximum length of interconnect cable ¹²	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	< 40 W

Table 32 AL8F MP400/360 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 310 x 174 mm
ODU weight (without antenna and antenna feeder)	6.7 kg
ALS1x weight	0.5 kg

Table 33 Technical parameters

¹⁰ ATPC minimal output power -20 dBm

¹¹ 23 dBm for modulation QPSK – 32 QAM, 20 dBm for modulation 64 QAM – 256 QAM links MP360, 23 dBm for modulation QPSK – 1024 QAM links MP400.

¹² Including the cable that brings data to the protected terminal box.

9.4 ANTENNA SYSTEMS

Parabolic antennas for fixed connection to ODU were developed for the 8 GHz bands. 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 frost (OPN). The change of polarization is performed by turning ODU by 90° see the chapter 4.2, page 43.

Compact microwave antennas	Typ			
	UNI2-8RS	UNI2-8RF	AL3-8/ME	AL4-8/ME
Parabola diameter	Ø 0,65 m	Ø 0,65 m	Ø 0,90 m	Ø 1,20 m
Antenna gain G_{ant}	31.1 dBi	31.1 dBi	34.4 dBi	36.9 dBi
Main lobe 3 dB	4.8°	4.8°	2.8°	2.1°
Horizontal antenna setting	±180°			
Fine horizontal antenna setting	–	±15°	±7°	±15°
Vertical antenna setting	±25°			
Fine vertical antenna setting	–	±30°	±15°	±15°
Weight of compact	9,3 kg	9,1 kg	26 kg	36 kg
Diameter of installation stand min.	Ø 42 mm	Ø 42 mm	Ø 73 mm	Ø 101 mm
max.	Ø 115 mm			

Table 34 Antenna parameters for 8 GHz band

10. ENVIRONMENT

10.1.1 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 caability	ALS1x	od -25 °C do +55 °C
	ODU	od -35 °C do +55 °C
Guaranteed parameters	ALS1x	od -25 °C do +55 °C
	ODU	od -33 °C do +50 °C
Storage ability	ALS1x i ODU	od -25 °C do +55 °C

Table 35 Operation Temperature

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

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

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

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

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

10.1.2 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 ÷ +55 °C, with the relative humidity max. 85 %.

Warning



Beware of condensation of air humidity.

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

11. MAIN EQUIPMENT DIMENSIONS

11.1 ODU – OUTDOOR UNIT

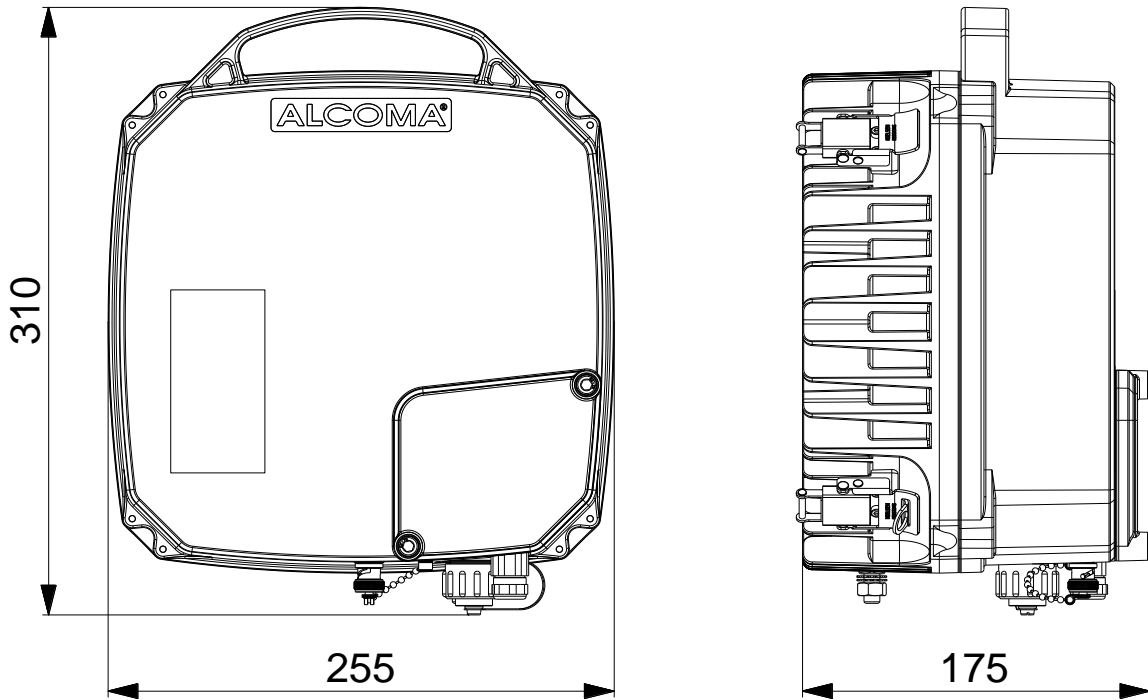


Figure 42 The ODU main dimensions

11.2 PROTECTED TERMINAL BOX

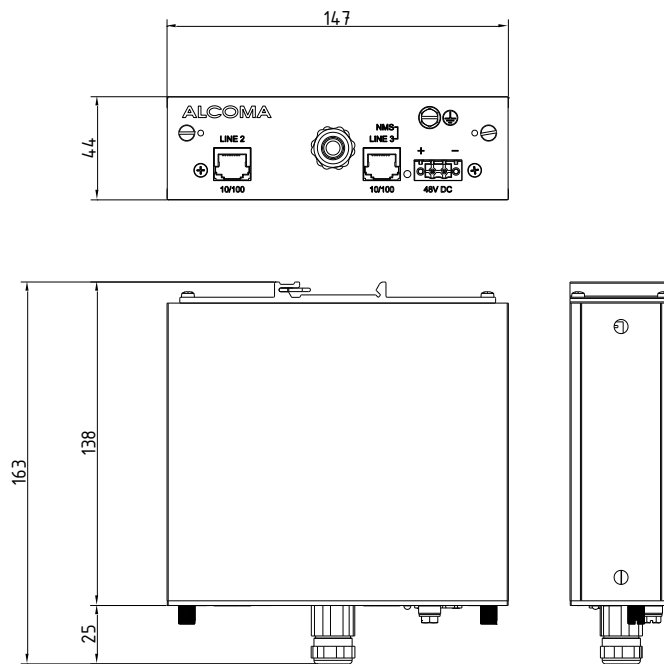


Figure 43 Protected terminal box ALS1x

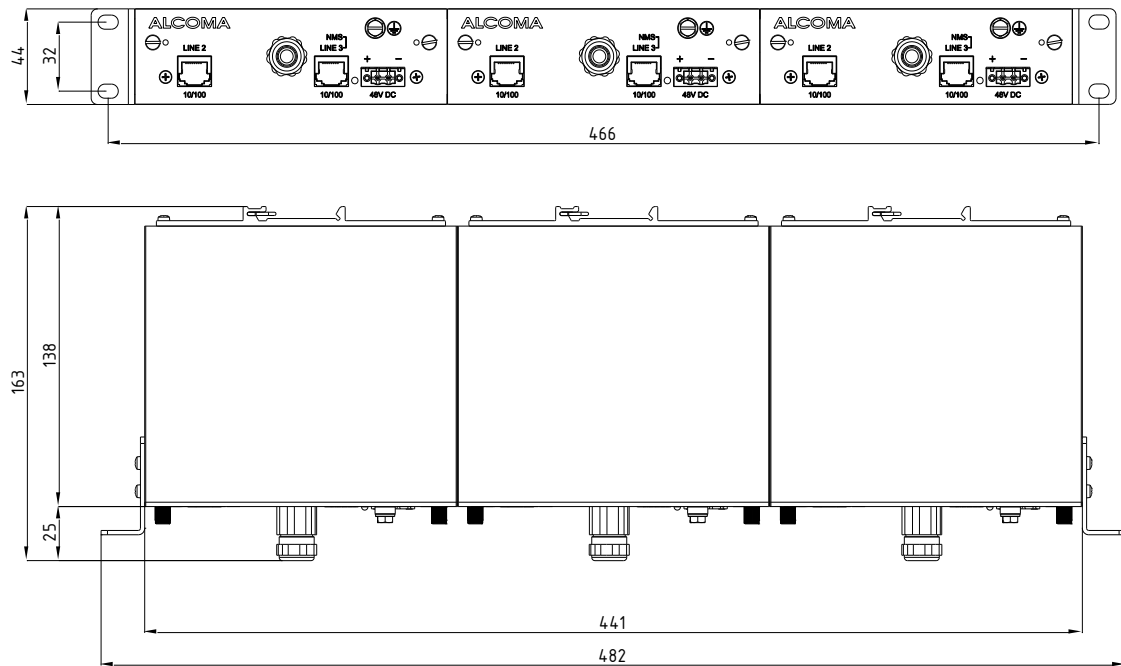


Figure 44 Assembled 3 terminal boxes ALS1x

11.3 ANTENNAS WITH ODU

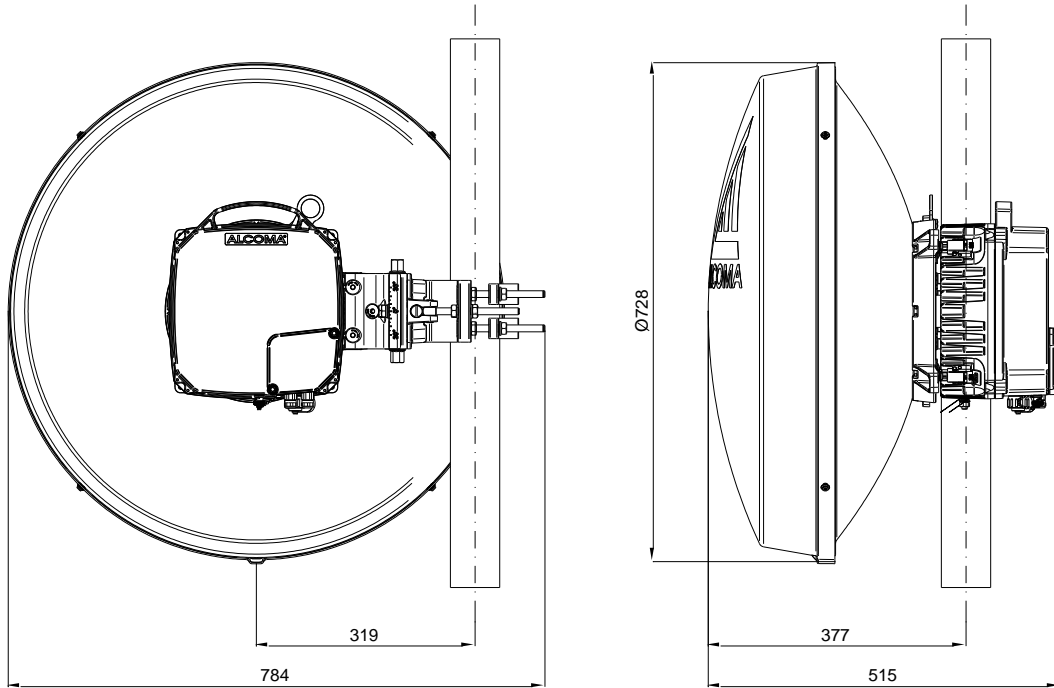


Figure 45 Antenna UNI2-xxRF

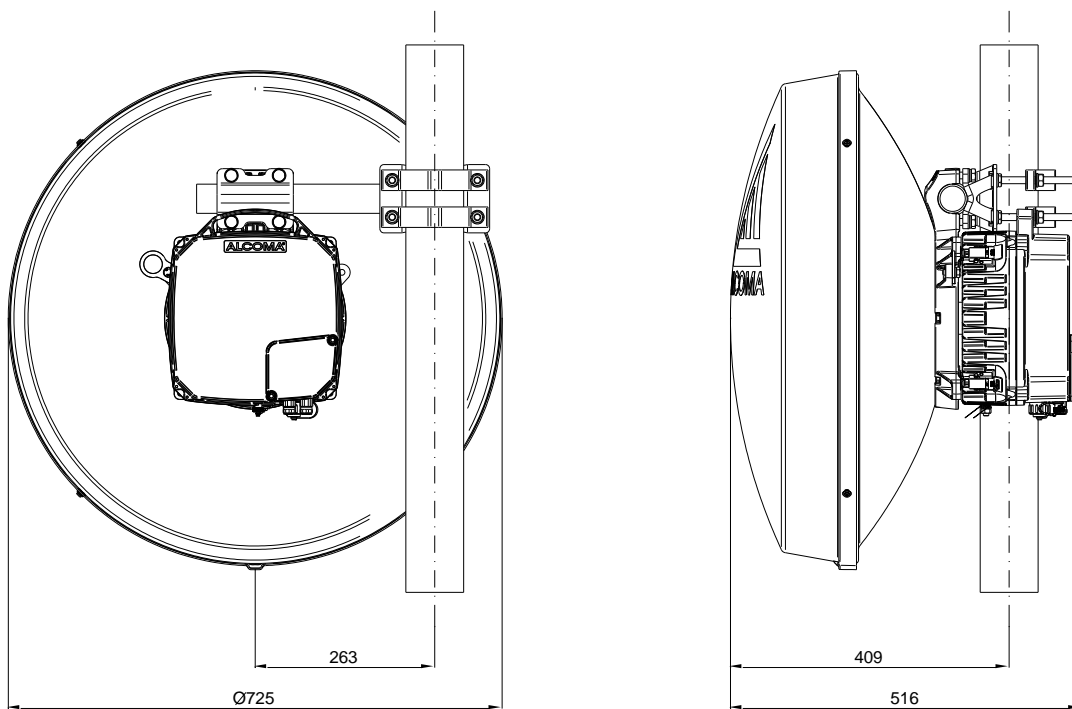


Figure 46 Antenna UNI2-xxRS

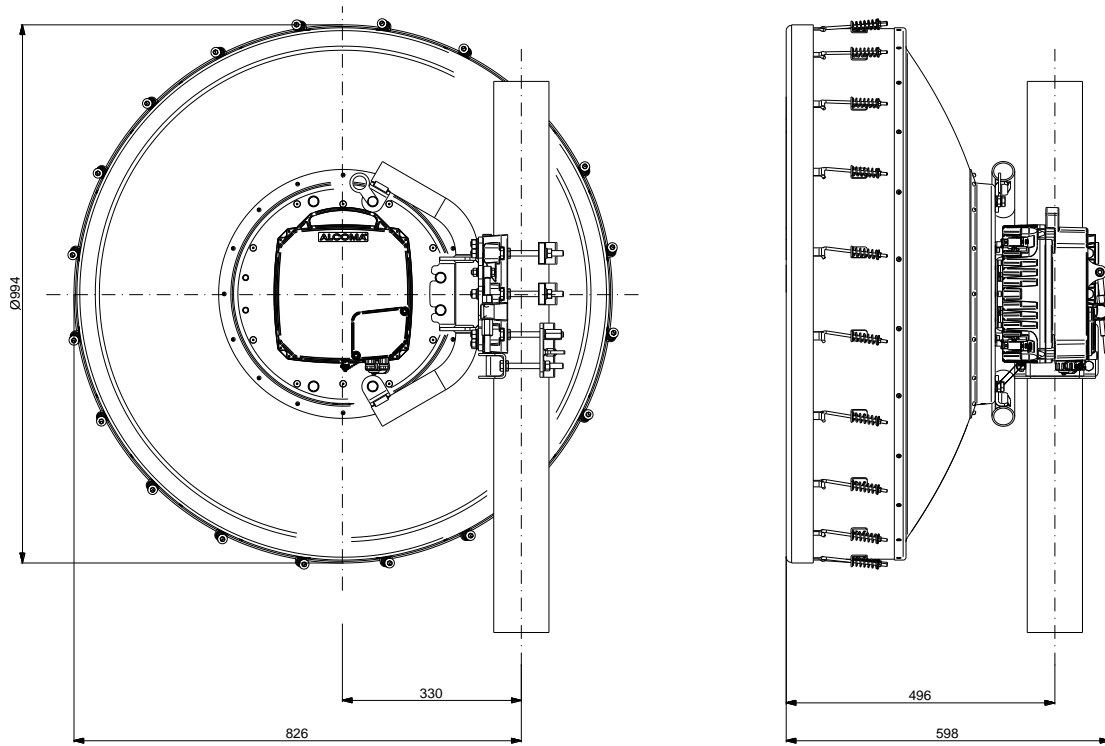


Figure 47 Antenna AL3-xx/MPR

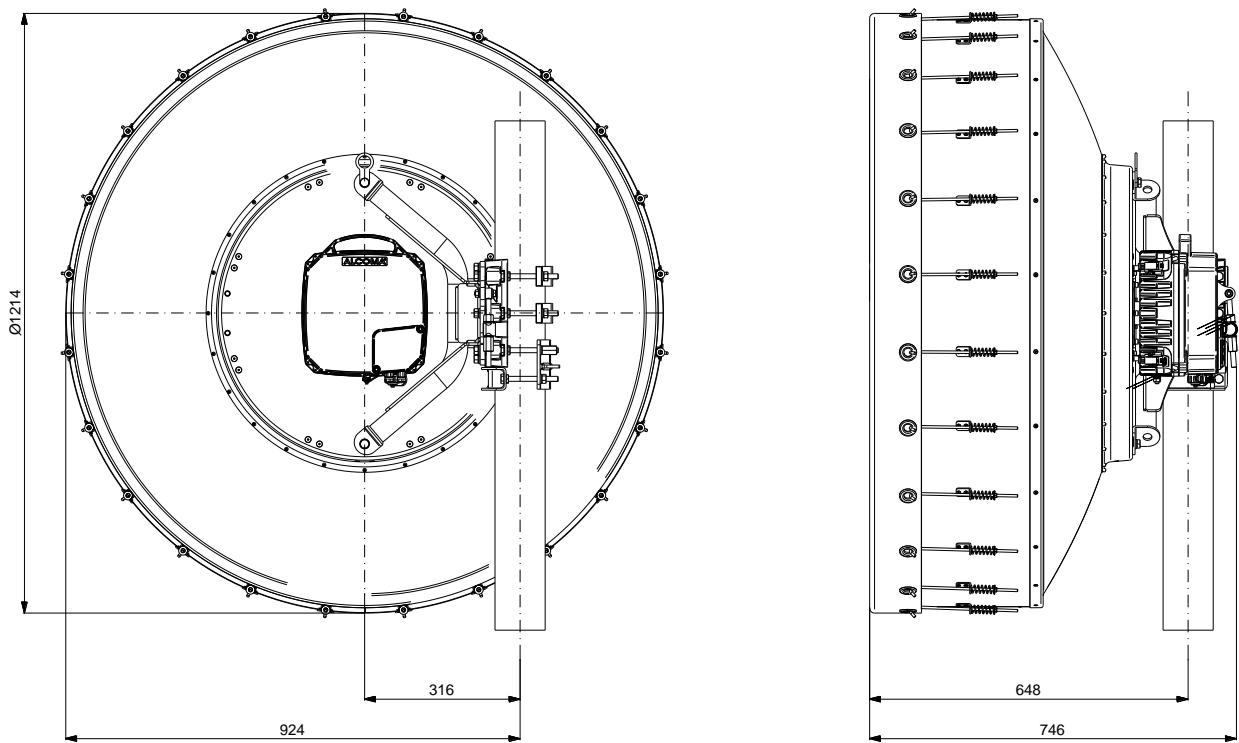


Figure 48 Antenna AL4-xx/MPR

12. APPENDIX

12.1 LIST OF FIGURES

The block schematic of the ALxxF MP400/360 link	6
Protected terminal box ALS1-GEth Line3.....	7
Protected terminal box ALS1-2GEth	7
Protected terminal box ALS1-GEth RP	7
Protected terminal box ALS1-2GEth RP	7
Protected terminal box ALS1-GEth + Line2 NMS	7
Assembling the three ALS1x to 19" 1U unit.....	8
Wiring in the terminal box ALS1-GEth, ALS1-2GEth	11
Separate management - wiring in the terminal box.....	12
The ODU connection places.....	13
The ODU user space 1xGEth	16
The ODU user space 2xGEth	17
The ODU user space 1xGEth separated management.....	17
The Fresnel zone	19
Improper placement of antenna on supporting construction	20
Proper placement of antenna on supporting construction	20
Attaching of the feeder to the Antenna UNI2-xx.....	22
Attaching of the feeder to the antenna (antenna types MPR)	23
Attaching of the ODU to the antenna UNI2-xx.....	24
The ODU to AL3-xx/MPR antenna connection (also for AL4-xx/MPR)	25
The attachment of the AL4-xx/MPR antenna holder (also for the AL3-xx/MPR antenna)	25
The examples of channel and polarization usage in case of more connections in one location	27
The terminal grounding	28
Manipulation with the user space cover	29
Typical ODU wiring.....	30
The grommet installation	32
Finished assembly of the connection cable Cat7 S-STP	32
Optional SFP modules.....	33
Cable gland fitted optical connector	33
Connection of the connecting cable	36
Radiation characteristics.....	38
Pointing.....	38
Antenna UNI2-xxRS pointing	39
Antenna UNI2-xxRS pointing	40
The AL3-xx/MPR antenna pointing (also for the AL4-xx/MPR antenna)	41
Main lobe diameter with different hoplengths	42
The setting of polarization for the ALxxF MP400/360 station	43
The RSSI calibration graph	44
The approximation of additional attenuation behind an obstacle	46
The direct connection of the monitoring PC.....	47
Main window of the ASD program	48
The ODU main dimensions	71
Protected terminal box ALS1x	71
Assembled 3 terminal boxes ALS1x	72
Antenna UNI2-xxRF.....	73
Antenna UNI2-xxRS.....	73
Antenna AL3-xx/MPR.....	74
Antenna AL4-xx/MPR.....	74

12.2 LIST OF TABLES

The RJ45 connector wiring - user lines Eth2 and Eth3.....	9
The protected terminal box - cutting box "KRONE" for the line 2.....	10
Separate management – The protected terminal box – cutting box "KRONE" for the line 2	10
The protected terminal box - cutting box "KRONE" for the line 3 + Power.....	11
The outdoor unit - cutting box "KRONE" for the line 2	14
Separate management – The outdoor unit – cutting box "KRONE" for the line 2	14
The outdoor unit - cutting box "KRONE" for the line 3 + power	15
Connector for direct connection of power supply.....	15
Connector PFL10 for direct connection of PC.....	16
Meaning of LEDs in the ODU user space	18
Meaning of LEDs next the cutting box "KRONE" in the ODU user space.....	18
Description of functions of the rotary switch in the ODU user space	18
Recommended antenna placements considering a distance from an obstacle	21
Frequency plan lower 6 GHz according to ITU-R F.383	51
Frequency plan upper 6 GHz according to ITU-R F.384	52
Frequency plan upper 6 GHz according to ITU-R F.384	52
Capacities of AL6F MP360 link.....	53
Capacities of AL6F MP400 link.....	55
AL6F MP400/360 link parameters	56
Technical parameters	56
Antenna parameters for 6 GHz band.....	57
Frequency plan lower 7 GHz according to ITU-R F.385	58
Frequency plan upper 7 GHz according to ITU-R F.385	58
Capacities of AL7F MP360 link.....	59
Capacities of AL7F MP400 link.....	61
AL7F MP400/360 link parameters	62
Technical parameters	62
Antenna parameters for 7 GHz band.....	63
Frequency plan lower 8 GHz according to ITU-R F.386	64
Capacities of AL8F MP360 link.....	65
Capacities of AL8F MP400 link.....	67
AL8F MP400/360 link parameters	68
Technical parameters	68
Antenna parameters for 8 GHz band.....	69
Operation Temperature.....	70

ALCOMA a.s. | Vinšova 11 | 106 00 Praha 10 | Czech Republic
Phone: +420 267 211 111
E-mail: alcoma@alcoma.cz
www.alcoma.com