siae microelettronica

ALFOplus 24GHz (North America)

Access Link Full Outdoor

Release 01.05.0x

User manual

MN.00395.E - 004

Our experience, your advantage. Our experience, your advantage. Our experience, your advantage. Our experie

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Section 1.
USER GUIDE

1 DECLARATION OF CONFORMITY

FCC Compliance

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

- this device may not cause harmful interference
- this device must accept any interference received, including interference that may cause undesired operation.

CAUTION: changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Failure to comply with all instructions in this user manual and specific warnings that willfully violate the standards of design, manufacture and intended user of the product are not endorsed by SIAE Microelettronica. SIAE Microelettronica assumes no liability for the end customer's failure to comply with all written instructions herein.

IC Compliance Statement in English and French

This device complies with Industry Canada license-exempt RSS standard(s). Operation in subject to The following two conditions:

- this device may not cause interference, and
- this device must accept any interference, including interference that may cause undesired operation of the device.

L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :

- l'appareil ne doit pas produire de brouillage
- l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

2 FIRST AID FOR ELECTRICAL SHOCK AND SAFETY RULES

2.1 FIRST AID FOR ELECTRICAL SHOCK

Do not touch the bare hands until the circuit has been opened. pen the circuit by switching off the line switches. If that is not possible **protect yourself with dry material** and free the patient from the conductor.

2.1.1 Artificial respiration

It is important to start mouth resuscitation at once and to call a doctor immediately. suggested procedure for mouth to mouth resuscitation method is described in the Tab.1.

2.1.2 Treatment of burns

This treatment should be used after the patient has regained consciousness. It can also be employed while artificial respiration is being applied (in this case there should be at least two persons present).

Warning

- Do not attempt to remove clothing from burnt sections
- Apply dry gauze on the burns
- Do not apply ointments or other oily substances.

Tab.1 - Artificial respiration

Step	Description	Figure
1	Lay the patient on his back with his arms parallel to the body. If the patient is laying on an inclined plane, make sure that his stomach is slightly lower than his chest. Open the patients mouth and check that there is no foreign matter in mouth (dentures, chewing gum, etc.).	
2	Kneel beside the patient level with his head. Put an hand under the patient's head and one under his neck. **Lift the patient's head and let it recline backwards as far as possible.**	
3	Shift the hand from the patient's neck to his chin and his mouth, the index along his jawbone, and keep the other fingers closed together. While performing these operations take a good supply of oxygen by taking deep breaths with your mouth open	
4	With your thumb between the patient's chin and mouth keep his lips together and blow into his nasal cavities	
5	While performing these operations observe if the patient's chest rises. If not it is possible that his nose is blocked: in that case open the patient's mouth as much as possible by pressing on his chin with your hand, place your lips around his mouth and blow into his oral cavity. Observe if the patient's chest heaves. This second method can be used instead of the first even when the patient's nose is not obstructed, provided his nose is kept closed by pressing the nostrils together using the hand you were holding his head with. The patient's head must be kept sloping backwards as much as possible.	
6	Start with ten rapid expirations, hence continue at a rate of twelve/fifteen expirations per minute. Go on like this until the patient has regained conscious–ness, or until a doctor has ascertained his death.	

2.2 SAFETY RULES

When the equipment units are provided with the plate, shown in Fig.1, it means that they contain components electrostatic charge sensitive.

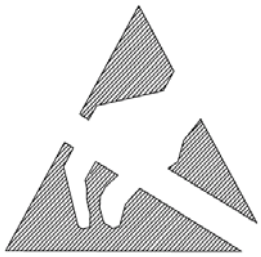


Fig.1 - Components electrostatic charge sensitive indication

In order to prevent the units from being damaged while handling, it is advisable to wear an elasticized band (Fig.2) around the wrist ground connected through coiled cord (Fig.3).

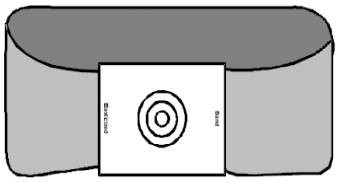


Fig.2 - Elasticized band

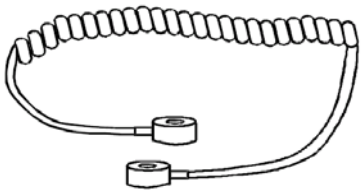


Fig.3 - Coiled cord

This device has Class I LASER modules: it is not required to have a laser warning label or other laser statement (IEC 60825-1).

2.3 INTERNAL BATTERY

Inside the equipment there is a lithium battery.

CAUTION: Risk of explosion if battery is replaced by an incorrect type. Dispose of used batteries according to law.

3 PURPOSE AND STRUCTURE OF THE MANUAL

3.1 PURPOSE OF THE MANUAL

The purpose of this manual consists in providing for the user information which permit to operate and maintain the ALFOplus radio equipment.

Warning: This manual does not include information relevant to the SCT/WebLCT management program windows and relevant application. They will provided by the program itself as help–on line.

3.2 AUDIENCE BASIC KNOWLEDGE

The following knowledge and skills are required to operate the equipment:

- a basic understanding of microwave transmission
- installation and maintenance experience on digital radio system
- a good knowledge of IP networks and routing policy.

3.3 STRUCTURE OF THE MANUAL

The manual is subdivided into sections each of them developing a specific topic entitling the section.

Each section consists of a set of chapters, enlarging the main subject master.

Section 1 – User Guide

It provides the information about the main safety rules and expounds the purpose and the structure of the manual.

Section 2 – Description and specifications

It describes a general overview of the typical applications and in particular of the whole radio equipment.

Section 3 – Installation

The mechanical installation procedures are herein set down as well as the user electrical connections.

The content of the tool kit (if supplied) is also listed.

Section 4 – Line–Up

Line–up procedures are described as well as checks to be carried out for the equipment correct operation. The list of the instruments to be used and their characteristics are also set down.

Section 5 – Maintenance

The routine maintenance actions are described as well as fault location procedures in order to identify the faulty unit and to re–establish the operation after its replacement with a spare one.

Section 6 – Programming and supervision

The ALFOplus radio is programmed and supervised using different software tools. Some of them are already available, some other will be available in the future. This section lists the tools implemented and indicates if descriptions are already available.

Each description of software tools is supplied in a separated manual.

Section 7 – Composition

Position, part numbers of the components the equipment consist of, are shown in this section.

Section 8 – RF characteristics

ALFOplus technical radio specifications, available for each frequency, are described in this section.

Section 9 – Indexes and services

Lists of figures, list of tables and assistance service are shown in this section.

3.4 MANUAL REVISION HISTORY

MN.00395.E Manual revision	Syv release	What's new?
v1	01.05.00	ALFOplus for North America
v2	01.05.01	Country recommendation update
v3	01.05.02	Update Chap. 1 Declaration of conformity; update Fig. 124 - Label attached on ODU; update Par. 14.2.2 Transmitter characteristics update Tab.39 - 24.05 ÷ 24.25 GHz band - Go-return 95 ÷ 193 MHz - Frequency carrier limits
v4	01.05.02	Update Chap. 1 Declaration of conformity; update Par. 14.1 Foreword; update Par. 14.2.2 Transmitter characteristics; update Tab.40 - RTPC attenuation range

Section 2. DESCRIPTIONS AND SPECIFICATION

4 LIST OF ACRONYMS

4.1 LIST OF ACRONYMS

What follows is a list of acronyms used in this handbook:

- ACM — Adaptive Code Modulation
- AGC — Automatic Gain Control
- ATPC — Automatic Transmitted Power Control
- BBP — Base Band Processor
- BER — Bit Error Rate
- CBS — Committed Burst Size
- CF — Coupling Flag
- CIR — Committed Information Rate
- CoS — Class of Service
- CVID — Customer VLAN Identifier
- DSCP — Differentiated Serviced Code Point
- EBS — Excess Burst Size
- EIR — Excess Information Rate
- ELP — Ethernet Line Protection
- EVC — Ethernet Virtual Connection
- FPGA — Field Programmable Gate-Array
- IP ToS — Type of Service IP
- LACP — Link Aggregation Control Protocol or Link Trunk
- LAN — Local Area Network
- LLF — Link Loss Forwarding

- LNA	Low Noise Amplifier
- MAC	Media Access Control
- MDI	Medium Dependent Interface
- MDX	Medium Dependent Interface Crossover
- MEF	Metro Ethernet Forum
- NE	Network Element
- OAM	Operation Administration and Maintenance
- ODU	Outdoor Unit
- PLL	Phase Locked Loop
- POE	Power Over Ethernet
- PToS	Priority Type of Service
- QAM	Quadrature Amplitude Modulation
- RED	Random Early Drop
- RF	Radio Frequency
- RSSI	Received Signal Strength Indicator
- RX	Direction from antenna to user
- SCT	Subnetwork Craft Terminal
- SNMP	Simple Network Management Protocol
- SVID	Service VLAN Identifier
- TX	Direction from user to antenna
- UNI	User Network Interface
- VCO	Voltage Controlled Oscillator
- VID	Virtual Lan Identifier
- VLAN	Virtual LAN
- WEBLCT	WEB Local Craft Terminal
- WRR	Weighted Round Robin

5 SYSTEM PRESENTATION

5.1 GENERAL

ALFOplus is a full-outdoor and full IP digital radio system for point-to-point applications, used for high capacity Ethernet transport (500 Mbps). The frequency range is from 6 GHz up to 42 GHz with hitless adaptive code modulation (from 4QAM up to 1024QAM).

ALFOplus radio equipment can work in two main modes:

- Fixed modulation: in this mode the system works with a fixed modulation and FEC profile, selectable by software. The modulation and the error code do not change during the time.
- Adaptive modulation: in this mode the system can dynamically change its modulation and FEC between a minimum and maximum ACM profiles that can be selected by software. The ACM profile is instantaneously decided by the equipment depending on the propagation conditions.

ALFOplus consists of a lightweight, compact, weather-proof box containing transceiver, modem, baseband unit, line interface and lightning protection.

There are two available versions for ALFOplus: Gigabit Electrical (GE) and Gigabit Optical (GO). This document provides a general overview of ALFOplus (Access Link Full Outdoor) radio equipment.

ALFOplus must be used in RAL areas (Restricted Access Location) where an equipotent bonding has been applied. The ODU unit has a supplementary specific connector for a permanent connection to grounding point intended to be installed by technical staff only.

5.2 APPLICATIONS

ALFOplus is the ideal solution in urban environments for all carrier-class applications in which the typical requirements are Ethernet connections:

- full IP radio, providing the foundation for a leading edge network
- fully integrable with 3G, 4G, LTE nodes and backhaul
- ideal for a fast and flexible evolution towards full IP network
- complementary solutions for fiber deploy
- last mile fiber extension for business customers
- ISP high capacity and performance, for LAN-to-LAN connections
- emergency wireless links
- zero footprint applications

ALFOplus doesn't need any indoor unit and the power supply can be provided directly by POE through the data cable or through a dedicated auxiliary port.

Radio link system configuration:

- 1+0 (unprotected, one ODU only)

Following two versions of ALFOplus are available:

- Electrical Gigabit Version

  - LAN1 - 1x10/100/1000BaseT traffic and/or supervision port with clock, synchronism recovery and PoE
  - LAN2 - 1x10/100/1000BaseT supervision and/or traffic port with clock and synchronism recovery
- Optical Gigabit Version
  - LAN1 - 1x100/1000BaseX traffic and/or supervision port with clock and synchronism recovery
  - LAN2 - 1x10/100/1000BaseT supervision and/or traffic port with clock, synchronism recovery and PoE

Depending on software configuration made for each port LAN1 and LAN2.

5.2.1 Functionality

ALFOplus has a Ethernet switching (L2) unit and a processing unit, both embedded in the equipment, toward the radio channel.

Ethernet ports support the “standard” subset of the functionalities provided by the embedded switch. In particular, following functionalities are available:

- MAC switching, Learning and Ageing
- Jumbo Frame up to 10 kbytes
- MEF 10.2 bandwidth profiles for Ethernet Services
- IEEE 802.1Q VLAN/IEEE VLAN stacking QinQ and VLAN rewriting
- LLF (Link Loss Forwarding) bidirectional
- IEEE 802.3x Flow control
- Flexible QoS based on VLAN (IEEE 802.1p), MPLS Exp BIT, ToS/DSCP (IPV4 or IPV6) per Port, 802.1p rewrite with MPLS
- Queue Packet with Drop Policy: Tail Drop, Queue Drop, Red, Wred/Strict, WFQ, Mixed
- Ethernet Frame Fragmentation
- Advanced multi-layer 1/2/3/4 header Ethernet compressor algorithm
- IEEE 802.1d STP (Spanning Tree Protocol)
- IEEE 802.1w RSTP (Rapid Spanning Tree Protocol)
- IEEE 802.1ag ITU-T y.1731 OAM (Operation, Administration and Maintenance)
- IEEE 802.3af PoE - Power over Ethernet [1]
- Complete Synchronisation Management G.8261, G.8262, G.8264 (SSM), IEEE 1588 v2 precision time protocol
- Advanced Statistics Monitoring Based VLAN and Priority
- Ethernet performance monitoring - RMon
- MAB (Microwave Adaptive Bandwidth) Cisco-SIAE

1 With dispensation to maximum power

5.3 PROGRAMMABILITY

ALFOplus radio system is managed by a microprocessor that makes it totally programmable via software to perform the following functions:

- radio link management
  - bandwidth and modulation
  - ACM engine configuration
  - Link ID
  - Tx frequency and power
  - ATPC (Automatic Transmission Power Control)
- main management
  - IP port configurable and supervisioning
  - routing table
  - remote element list
  - alarm severity configuration (modify alarm)
  - user manager (password, user, SNMP login)
  - SNMP V.1/V.2/V.3 compatible
  - Security Management (SSH, SFTP)
  - Secure HTTP Access (HTTPS)
- operation and maintenance
  - permanent Tx Off
  - Rx signal threshold alarm
  - performance monitoring (G.828, Rx PWR, Tx PWR, ACM) with alarm threshold
  - S/N measure
  - LAN summary, statistic basis on port, VLAN or Priority
  - backup/restore configuration
  - software update
  - report&logger maintenance (inventory, fault, commands)
  - SNTP alignment
- manual operations (depends on timeout)
  - Tx transmitter OFF
  - force switch synch
  - radio BER test
  - fade margin measure
  - baseband loop
  - Ethernet port loop
- Ethernet switch management and functionalities
- synchronisation

5.3.1 Software

Radio equipment is provided with an embedded Web Server and can be locally/remotely controlled by a HTTP browser running on PC (Internet Explorer or Firefox are recommended): this application is called WebLCT.

Optionally, it is also available software with additional features, that allows the file transfer (Backup/Restore config. and firmware update):

- WLC (WebLCT Console): it is a free software downloadable from the site www.siaemic.com after registration
- SCT (Subnetwork Craft Terminal) that can manage a subnetwork of max 100SIAE network elements and nodal configuration.

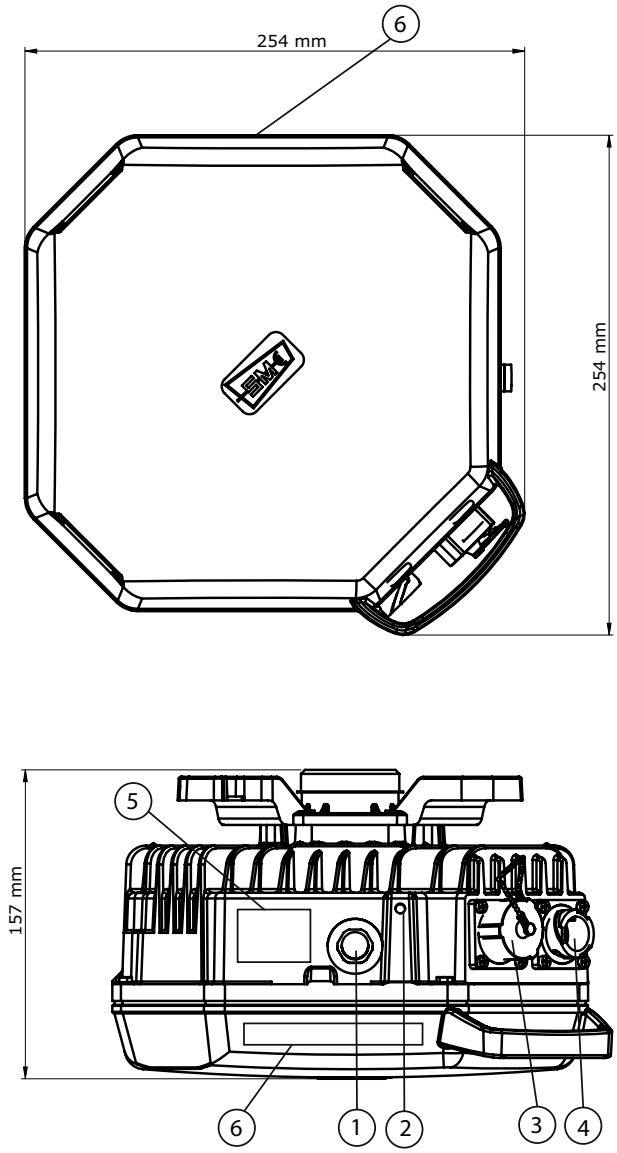
The hardware platform is based on Personal Computer with at least the following characteristics:

- HD with 200Mbyte of free space
- Windows XP/Windows 7 32bit or 64bit

The network management system (NMS5LX/UX) functionalities, SCT/WLC are widely described in the separated relevant manual.

5.4 CONNECTOR AND LABEL POSITIONS

On ALFOplus, labels shown in Fig.4 are present.



1. AUX: auxiliary connector for 48 V ⎓ power, serial console and pointing alignment (⎓ Symbol IEC 60417-5032, dc current)
2. ODU grounding point ⏚ (Symbol IEC 60417-5019)
3. 1: LAN1 10/100/1000BaseT (or 100/1000BaseX[2] depending on HW version) for data/management traffic
4. 2: LAN2 10/100/1000BaseT (or 100/1000BaseX[2] depending on HW version) for data/management traffic
5. SIAE code label (ODU kind and part number) as shown in Fig.124.
6. Hot surface label.

Fig.4 - ALFOplus front/side view

2 In case of Optional version the supported SFP modules are always optical because electrical modules are not mechanically compatible.

6 TECHNICAL SPECIFICATION

For more details, refer to Section 8. RF CHARACTERISTICS.

6.1 ADAPTIVE MODULATION

ALFOplus ODU's implement an adaptive modulation algorithm to improve the system gain when the quality of the received signal become insufficient to guarantee an error free link.

Adaptive modulation guarantees error free and hitless unidirectional downshifts with fading speed up to 30 dB/s. Ethernet frames aren't lost in case of upshift and downshift events.

The thresholds for ACM are shown in the Tab.2.

Tab.2 - ACM switching thresholds

7MHz Bandwidth	Power (Estim.)	BER 10^{-6} (Estim.)	Down-shift (Estim.)	Margin (Estim.)	Up-shift [a] (Estim.)	Margin (Estim.)	Up-shift [b] (Estim.)	Margin (Estim.)
4SQAM	0	6.4			13.2		13.2	
4QAM	0	8.2	11.2	3	17.7	5	20.2	5.0
16SQAM	-2.5	12.7	15.7	3	19.6	5	19.6	7.5
16QAM	-2.5	14.6	17.6	3	22.2	5	23.5	5.0
32QAM	-3.75	17.2	20.2	3	24.7	5	24.5	6.3
64QAM	-3.5	19.7	22.7	3	27.8	5	27.8	4.8
128QAM	-3.5	22.8	25.8	3	31	5	31.6	5.0
256QAM	-4.125	26	29	3	34.1	5	34.1	5.6
512QAM	-4.25	29.1	32.1	3	36.8	5	36.8	5.1
1KQAM	-4.25	32.3	35.3	3		4.5		4.5
10MHz Bandwidth	Power (Estim.)	BER 10^{-6} (Estim.)	Down-shift (Estim.)	Margin (Estim.)	Up-shift a. (Estim.)	Margin (Estim.)	Up-shift b. (Estim.)	Margin (Estim.)
4SQAM	0	6.4	0	0	13.2	0	13.2	0
4QAM	0	8.2	11.2	3	17.7	5	20.2	5.0
16SQAM	-2.5	12.7	15.7	3	19.6	5	19.6	7.5
16QAM	-2.5	14.6	17.6	3	22.2	5	23.45	5.0
32QAM	-3.75	17.2	20.2	3	24.7	5	24.45	6.25
64QAM	-3.5	19.7	22.7	3	27.8	5	27.8	4.75
128QAM	-3.5	22.8	25.8	3	31	5	31.625	5.0
256QAM	-4.125	26	29	3	34.1	5	34.1	5.625

512QAM	-4.25	29.1	32.1	3	36.8	5	36.8	5.125
1KQAM	-4.25	32.3	35.3	3	0	4.5	0	4.5
14MHz Bandwidth	Power (Estim.)	BER 10^{-6} (Estim.)	Down-shift (Estim.)	Margin (Estim.)	Up-shift [a.] (Estim.)	Margin (Estim.)	Up-shift [b.] (Estim.)	Margin (Estim.)
4SQAM	0	5.8			13.2		13.2	
4QAM	0	8.2	11.2	3	17.6	5.0	20.1	5.0
16SQAM	-2.5	12.6	15.6	3	19.5	5.0	19.5	7.5
16QAM	-2.5	14.5	17.5	3	22	5.0	23.3	5.0
32QAM	-3.75	17	20	3	25.7	5.0	25.5	6.3
64QAM	-3.5	19.7	23.2	3.5	27.7	6.0	27.7	5.8
128QAM	-3.5	22.7	25.7	3	30.8	5.0	31.4	5.0
256QAM	-4.125	25.8	28.8	3	33.9	5.0	33.9	5.6
512QAM	-4.25	28.9	31.9	3	36.7	5.0	36.7	5.1
1KQAM	-4.25	32.2	35.2	3		4.5		4.5
20MHz Bandwidth	Power (Estim.)	BER 10^{-6} (Estim.)	Down-shift (Estim.)	Margin (Estim.)	Up-shift [a.] (Estim.)	Margin (Estim.)	Up-shift [b.] (Estim.)	Margin (Estim.)
4SQAM	0	5.7			12.7		12.7	
4QAM	0	8.2	10.7	2.5	17.1	4.5	19.6	4.5
16SQAM	-2.5	12.6	15.1	2.5	18.9	4.5	18.9	7.0
16QAM	-2.5	14.4	16.9	2.5	21.3	4.5	22.6	4.5
32QAM	-3.75	16.8	19.3	2.5	25.6	4.5	25.4	5.8
64QAM	-3.5	19.6	23.1	3,5	27.2	6	27.2	5.8
128QAM	-3.5	22.7	25.2	2.5	30.2	4.5	30.8	4.5
256QAM	-4.125	25.7	28.2	2.5	33.3	4.5	33.3	5.1
512QAM	-4.25	28.8	31.3	2.5	36.5	4.5	36.5	4.6
1KQAM	-4.25	32	34.5	2.5		4.5		4.5
28MHz Bandwidth	Power (Estim.)	BER 10^{-6} (Estim.)	Down-shift (Estim.)	Margin (Estim.)	Up-shift [a.] (Estim.)	Margin (Estim.)	Up-shift [b.] (Estim.)	Margin (Estim.)
4SQAM	0	5.7			12.7		12.7	
4QAM	0	8.2	10.7	2.5	17.1	4.5	19.6	4.5
16SQAM	-2.5	12.6	15.1	2.5	18.9	4.5	18.9	7.0
16QAM	-2.5	14.4	16.9	2.5	21.3	4.5	22.6	4.5
32QAM	-3.75	16.8	19.3	2.5	25.6	4.5	25.4	5.8
64QAM	-3.5	19.6	23.1	3,5	27.2	6.0	27.2	5.8
128QAM	-3.5	22.7	25.2	2.5	30.2	4.5	30.8	4.5
256QAM	-4.125	25.7	28.2	2.5	33.3	4.5	33.3	5.1
512QAM	-4.25	28.8	31.3	2.5	36.5	4.5	36.5	4.6
1KQAM	-4.25	32	34.5	2.5		4.5		4.5

30MHz Bandwidth	Power (Estim.)	BER 10^{-6} (Estim.)	Down-shift (Estim.)	Margin (Estim.)	Up-shift [a.] (Estim.)	Margin (Estim.)	Up-shift [b.] (Estim.)	Margin (Estim.)
4SQAM	0	5.7			12.7		12.7	
4QAM	0	8.2	10.7	2.5	17.1	4.5	19.6	4.5
16SQAM	-2.5	12.6	15.1	2.5	18.9	4.5	18.9	7.0
16QAM	-2.5	14.4	16.9	2.5	21.3	4.5	22.6	4.5
32QAM	-3.75	16.8	19.3	2.5	25.6	4.5	25.4	5.8
64QAM	-3.5	19.6	23.1	3,5	27.2	6.0	27.2	5.8
128QAM	-3.5	22.7	25.2	2.5	30.2	4.5	30.8	4.5
256QAM	-4.125	25.7	28.2	2.5	33.3	4.5	33.3	5.1
512QAM	-4.25	28.8	31.3	2.5	36.5	4.5	36.5	4.6
1KQAM	-4.25	32	34.5	2.5		4.5		4.5
40MHz Bandwidth	Power (Estim.)	BER 10^{-6} (Estim.)	Down-shift (Estim.)	Margin (Estim.)	Up-shift [a.] (Estim.)	Margin (Estim.)	Up-shift [b.] (Estim.)	Margin (Estim.)
4SQAM	0	5.7			12.7		12.7	
4QAM	0	8.2	10.7	2.5	17.1	4.5	19.6	4.5
16SQAM	-2.5	12.6	15.1	2.5	18.9	4.5	18.9	7.0
16QAM	-2.5	14.4	16.9	2.5	21.3	4.5	22.6	4.5
32QAM	-3.75	16.8	19.3	2.5	24.6	4.5	24.4	5.8
64QAM	-3.5	19.6	22.6	3.0	27.2	5.0	27.2	4.8
128QAM	-3.5	22.7	25.2	2.5	30.2	4.5	30.8	4.5
256QAM	-4.125	25.7	28.2	2.5	33.3	4.5	33.3	5.1
512QAM	-4.25	28.8	31.3	2.5	36.5	4.5	36.5	4.6
1KQAM	-4.25	32	34.5	2.5		4.5		4.5
50MHz Bandwidth	Power (Estim.)	BER 10^{-6} (Estim.)	Down-shift (Estim.)	Margin (Estim.)	Up-shift [a.] (Estim.)	Margin (Estim.)	Up-shift [b.] (Estim.)	Margin (Estim.)
4SQAM	0	5.7			12.7		12.7	
4QAM	0	8.2	10.7	2.5	17.1	4.5	19.6	4.5
16SQAM	-2.5	12.6	15.1	2.5	18.9	4.5	18.9	7.0
16QAM	-2.5	14.4	16.9	2.5	21.3	4.5	22.6	4.5
32QAM	-3.75	16.8	19.3	2.5	24.6	4.5	24.4	5.8
64QAM	-3.5	19.6	22.6	3.0	27.2	5.0	27.2	4.8
128QAM	-3.5	22.7	25.2	2.5	30.2	4.5	30.8	4.5
256QAM	-4.125	25.7	28.2	2.5	33.3	4.5	33.3	5.1
512QAM	-4.25	28.8	31.3	2.5	36.5	4.5	36.5	4.6
1KQAM	-4.25	32	34.5	2.5		4.5		4.5
56MHz Bandwidth	Power (Estim.)	BER 10^{-6} (Estim.)	Down-shift (Estim.)	Margin (Estim.)	Up-shift [a.] (Estim.)	Margin (Estim.)	Up-shift [b.] (Estim.)	Margin (Estim.)
4SQAM	0	5.7			12.7		12.7	

4QAM	0	8.2	10.7	2.5	17.1	4.5	19.6	4.5
16SQAM	-2.5	12.6	15.1	2.5	18.9	4.5	18.9	7.0
16QAM	-2.5	14.4	16.9	2.5	21.3	4.5	22.6	4.5
32QAM	-3.75	16.8	19.3	2.5	24.6	4.5	24.4	5.8
64QAM	-3.5	19.6	22.6	3	27.2	5.0	27.2	4.8
128QAM	-3.5	22.7	25.2	2.5	30.2	4.5	30.8	4.5
256QAM	-4.125	25.7	28.2	2.5	33.3	4.5	33.3	5.1
512QAM	-4.25	28.8	31.3	2.5	36.5	4.5	36.5	4.6
1KQAM	-4.25	32	34.5	2.5		4.5		4.5

a. Upshift thresholds in case of constant output

b. Upshift thresholds in case of output power depending on current modulation

6.2 LINE INTERFACE CHARACTERISTICS

The line interfaces (LAN1, LAN2) are connected to an embedded Ethernet switch. Ethernet traffic is forwarded to the radio interface through a 1 Gbps port, baseband and modem processing blocks. Network synchronism can be acquired and provided by each Ethernet switch port (see Fig.5).

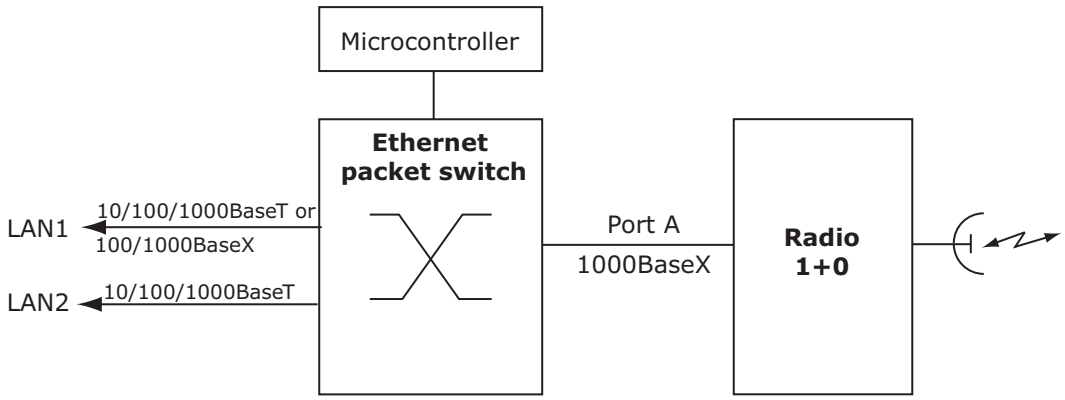


Fig.5 - ALFOplus block diagram

6.2.1 Ethernet electrical interface characteristics

All ports can be “transmitters or sources” of the synchronism through Synchronous Ethernet.

- Ethernet connectors — LAN1 IEEE 802.3 10/100/1000BaseT RJ45
LAN2 IEEE 802.3 10/100/1000BaseT RJ45
- Ethernet cable category — CAT5/CAT6
- Ethernet cable max length — 100m
- Power over Ethernet [3] — IEEE 802af PoE

3 Maximum power excluded.

- Ethernet latency see Tab.3

Tab.3 - Guaranteed Ethernet Latency (ms) for ALFOplus

One way delay (msec)	Packet size 64 bytes								
Bandwidth (MHz)	4QAM	16SQAM	16QAM	32QAM	64QAM	128QAM	256QAM	512QAM	1K QAM
7	1.100	1.083	1.069	1.064	1.060	1.056	1.054	1.051	1.049
10	0.925	0.914	0.904	0.900	0.897	0.894	0.893	0.980	0.889
14	0.649	0.641	0.634	0.632	0.629	0.627	0.626	0.625	0.624
20	0.464	0.459	0.453	0.451	0.450	0.449	0.448	0.447	0.447
28	0.329	0.325	0.321	0.320	0.319	0.318	0.318	0.317	0316
30	0.311	0.306	0.304	0.303	0.302	0.302	0.300	0.300	0.299
40	0.237	0.233	0.232	0.231	0.230	0.230	0.229	0.229	0.228
50	0.193	0.190	0.188	0.188	0.186	0.186	0.186	0.186	0.186
56	0.170	0.168	0.166	0.166	0.165	0.164	0.164	0.164	0.163

One way delay (msec)	Packet size 128 bytes								
Bandwidth (MHz)	4QAM	16SQAM	16QAM	32QAM	64QAM	128QAM	256QAM	512QAM	1K QAM
7	1.148	1.120	1.095	1.088	1.078	1.071	1.068	1.063	1.060
10	0.960	0.940	0.922	0.916	0.909	0.905	0.903	0.900	0.898
14	0.674	0.660	0.648	0.644	0.639	0.636	0.634	0.632	0.630
20	0.483	0.473	0.464	0.461	0.458	0.456	0.455	0.453	0.451
28	0.342	0.335	0.329	0.327	0.324	0.323	0.322	0.321	0.321
30	0.323	0.293	0.289	0.283	0.285	0.283	0.282	0.282	0.281
40	0.266	0.241	0.238	0.233	0.235	0.233	0.232	0.232	0.231
50	0.201	0.197	0.193	0.192	0.191	0.190	0.190	0.189	0.188
56	0.177	0.174	0.171	0.169	0.169	0.168	0.167	0.167	0.167

One way delay (msec)	Packet size 256 bytes								
Bandwidth (MHz)	4QAM	16SQAM	16QAM	32QAM	64QAM	128QAM	256QAM	512QAM	1K QAM
7	1.247	1.194	1.146	1.132	1.114	1.101	1.095	1.087	1.081
10	1.030	0.993	0.960	0.950	0.937	0.929	0.925	0.919	0.913
14	0.723	0.697	0.674	0.666	0.658	0.652	0.649	0.645	0.641
20	0.517	0.499	0.482	0.478	0.472	0.467	0.466	0.463	0.456
28	0.367	0.354	0.342	0.339	0.335	0.332	0.331	0.329	0.327
30	0.347	0.330	0.324	0.321	0.317	0.313	0.312	0.310	0.309
40	0.266	0.253	0.248	0.246	0.243	0.240	0.239	0.238	0.237
50	0.216	0.209	0.203	0.200	0.198	0.196	0.196	0.195	0.193
56	0.191	0.185	0.179	0.177	0.175	0.173	0.172	0.172	0.171

One way delay (msec)	Packet size 512 bytes								
Bandwidth (MHz)	4QAM	16SQAM	16QAM	32QAM	64QAM	128QAM	256QAM	512QAM	1K QAM
7	1.438	1.338	1.247	1.218	1.185	1.163	1.151	1.133	1.124
10	1.167	1.096	1.032	1.013	0.989	0.973	0.965	0.952	0.944
14	0.820	0.770	0.725	0.712	0.695	0.684	0.678	0.669	0.664
20	0.587	0.553	0.521	0.511	0.499	0.492	0.488	0.482	0.478
28	0.418	0.393	0.371	0.364	0.356	0.350	0.347	0.343	0.341
30	0.394	0.364	0.351	0.343	0.336	0.330	0.328	0.325	0.323
40	0.303	0.280	0.270	0.264	0.258	0.254	0.252	0.250	0.247
50	0.246	0.233	0.220	0.216	0.212	0.209	0.207	0.205	0.203
56	0.218	0.206	0.195	0.191	0.187	0.185	0.183	0.181	0.179

One way delay (msec)	Packet size 1024 bytes								
Bandwidth (MHz)	4QAM	16SQAM	16QAM	32QAM	64QAM	128QAM	256QAM	512QAM	1K QAM
7	1.824	1.628	1.450	1.395	1.329	1.284	1.261	1.228	1.208
10	1.443	1.305	1.181	1.143	1.096	1.065	1.049	1.026	1.007
14	1.014	0.917	0.830	0.803	0.770	0.748	0.737	0.721	0.711
20	0.726	0.658	0.597	0.579	0.556	0.540	0.532	0.521	0.513
28	0.519	0.470	0.426	0.414	0.397	0.386	0.380	0.372	0.368
30	0.489	0.432	0.405	0.392	0.377	0.368	0.360	0.355	0.348
40	0.376	0.332	0.311	0.301	0.290	0.283	0.277	0.273	0.269
50	0.307	0.280	0.256	0.248	0.239	0.233	0.229	0.225	0.221
56	0.272	0.248	0.227	0.220	0.212	0.206	0.203	0.200	0.197

One way delay (msec)	Packet size 1518 bytes								
Bandwidth (MHz)	4QAM	16SQAM	16QAM	32QAM	64QAM	128QAM	256QAM	512QAM	1K QAM
7	2.193	1.905	1.644	1.562	1.466	1.400	1.367	0.001	1.289
10	1.707	1.505	1.322	1.265	1.197	1.151	1.127	1.092	1.066
14	1.200	1.058	0.929	0.890	0.842	0.809	0.792	0.768	0.754
20	0.860	0.761	0.671	0.643	0.609	0.588	0.576	0.559	0.545
28	0.615	0.544	0.480	0.460	0.436	0.420	0.412	0.399	0.393
30	0.580	0.499	0.460	0.441	0.419	0.403	0.393	0.385	0.372
40	0.433	0.381	0.351	0.337	0.320	0.308	0.300	0.294	0.289
50	0.365	0.325	0.288	0.277	0.264	0.255	0.250	0.246	0.239
56	0.324	0.289	0.257	0.247	0.235	0.227	0.223	0.219	0.214

One way delay (msec)	Packet size 10000 bytes								
Bandwidth (MHz)	4QAM	16SQAM	16QAM	32QAM	64QAM	128QAM	256QAM	512QAM	1K QAM
7	8.570	6.698	5.001	4.471	3.844	3.417	3.196	2.874	2.692
10	6.271	4.959	3.769	3.399	2.958	2.659	2.505	2.280	2.101

One way delay (msec)	Packet size 10000 bytes								
14	4.418	3.493	2.655	2.394	2.084	1.873	1.764	1.606	1.516
20	3.171	2.532	1.953	1.773	1.559	1.414	1.338	1.228	1.123
28	2.284	1.824	1.407	1.277	1.123	1.018	0.964	0.885	0.840
30	2.155	1.608	1.352	1.234	1.093	0.996	0.928	0.875	0.801
40	1.670	1.246	1.048	0.956	0.847	0.772	0.719	0.678	0.646
50	1.371	1.114	0.881	0.809	0.722	0.664	0.634	0.590	0.552
56	1.227	0.997	0.789	0.724	0.646	0.594	0.567	0.528	0.505

- Guaranteed Ethernet throughput see Tab.4

Tab.4 - Guaranteed Ethernet Throughput (Mbit/s) for ALFOplus without Ethernet compression and fragmentation

Bandwidth (MHz)	Modulation	Frame size (byte)						
		64	128	256	512	1024	1518	10000
7	4QAMs	10.3	9.8	9.6	9.4	9.4	9.3	9.3
	4QAM	12.0	11.5	11.2	11.0	11.0	10.9	10.9
	16QAMs	17.9	17.2	16.7	16.5	16.4	16.3	16.2
	16QAM	23.3	22.3	21.7	21.4	21.2	21.2	21.1
	32QAM	27.1	25.9	25.2	24.9	24.7	24.6	24.5
	64QAM	33.5	32.0	31.2	30.8	30.5	30.5	30.3
	128QAM	39.9	38.2	37.2	36.7	36.4	36.3	36.1
	256QAM	46.3	44.3	43.2	42.6	42.2	42.1	41.9
	512QAM	52.8	50.5	49.2	48.5	48.1	48.0	47.8
	1024QAM	59.2	56.6	55.2	54.4	54.0	53.9	53.6
10	4QAMs	12.6	12.1	11.7	11.6	11.5	11.5	11.4
	4QAM	16.9	16.2	15.8	15.6	15.4	15.4	15.3
	16QAMs	25.3	24.2	23.6	23.2	23.1	23.0	22.9
	16QAM	32.8	31.4	30.6	30.2	29.9	29.9	29.7
	32QAM	38.2	36.5	35.5	35.0	34.8	34.7	34.5
	64QAM	47.2	45.1	44.0	43.4	43.0	42.9	42.7
	128QAM	56.3	53.8	52.4	51.7	51.3	51.2	50.9
	256QAM	65.3	62.5	60.9	60.0	59.5	59.4	59.1
	512QAM	74.4	71.1	69.3	68.3	67.8	67.6	67.3
	1024QAM	83.4	79.8	77.7	76.6	76.1	75.9	75.5

Bandwidth (MHz)	Modulation	Frame size (byte)						
		64	128	256	512	1024	1518	10000
14	4QAMs	18.1	17.3	16.9	16.6	16.5	16.5	16.4
	4QAM	24.3	23.3	22.7	22.4	22.2	22.1	22.0
	16QAMs	36.3	34.7	33.9	33.4	33.1	33.0	32.9
	16QAM	47.2	45.1	44.0	43.4	43.0	42.9	42.7
	32QAM	54.8	52.4	51.1	50.4	50.0	49.9	49.6
	64QAM	67.8	64.9	63.2	62.3	61.8	61.7	61.4
	128QAM	80.8	77.3	75.3	74.3	73.7	73.5	73.2
	256QAM	93.8	89.8	87.4	86.2	85.6	85.4	85.0
	512QAM	106.9	102.3	99.6	98.2	97.5	97.3	96.8
	1024QAM	120.0	114.7	111.8	110.2	109.4	109.1	108.6
20	4QAMs	25.7	24.6	23.9	23.6	23.4	23.4	23.3
	4QAM	34.5	33.0	32.1	31.7	31.5	31.4	31.2
	16QAMs	51.5	49.2	48.0	47.3	46.9	46.8	46.6
	16QAM	66.9	64.0	62.3	61.4	61.0	60.8	60.6
	32QAM	77.7	74.3	72.4	71.4	70.8	70.7	70.3
	64QAM	96.1	91.9	89.6	88.3	87.6	87.4	87.0
	128QAM	114.6	109.6	106.7	105.2	104.4	104.2	103.7
	256QAM	133.0	127.2	123.9	122.2	121.3	121.0	120.4
	512QAM	151.4	144.8	141.1	139.1	138.1	137.7	137.1
	1024QAM	169.9	162.5	158.3	156.0	154.9	154.5	153.8
28	4QAMs	36.4	34.8	33.9	33.5	33.2	33.1	33.0
	4QAM	48.9	46.8	45.6	45.0	44.6	44.5	44.3
	16QAMs	73.0	69.9	68.1	67.1	66.6	66.4	66.1
	16QAM	94.9	90.8	88.4	87.2	86.5	86.3	85.9
	32QAM	110.2	105.4	102.7	101.2	100.5	100.2	99.8
	64QAM	136.4	130.4	127.1	125.3	124.3	124.0	123.5
	128QAM	162.5	155.4	151.4	149.3	148.2	147.8	147.2
	256QAM	188.7	180.4	175.8	173.3	172.0	171.6	170.8
	512QAM	215.0	205.6	200.3	197.5	196.0	195.5	194.7
	1024QAM	241.2	230.7	224.7	221.5	219.9	219.3	218.4

Bandwidth (MHz)	Modulation	Frame size (byte)						
		64	128	256	512	1024	1518	10000
30	4QAMs	38.8	37.1	36.2	35.7	35.4	35.3	35.1
	4QAM	52.2	49.9	48.6	47.9	47.5	47.4	47.2
	16QAMs	77.8	74.4	72.5	71.5	71.0	70.8	70.5
	16QAM	101.1	96.7	94.2	92.9	92.2	92.0	91.6
	32QAM	117.4	112.3	109.4	107.9	107.1	106.8	106.3
	64QAM	145.3	139.0	135.4	133.5	132.5	132.2	131.6
	128QAM	173.2	165.6	161.4	159.1	157.9	157.5	156.8
	256QAM	201.0	192.3	187.3	184.7	193.3	182.8	182.0
	512QAM	228.9	218.9	213.3	210.3	208.7	208.2	207.3
	1024QAM	256.8	245.6	239.2	235.9	234.1	233.5	232.5
40	4QAMs	51.4	49.1	47.8	47.2	46.8	46.7	46.5
	4QAM	69.0	66.0	64.3	63.4	62.9	62.8	62.5
	16QAMs	103.0	98.5	95.9	94.6	93.9	93.7	93.2
	16QAM	133.8	128.0	124.7	122.9	122.0	121.7	121.1
	32QAM	155.4	148.6	144.8	142.7	141.7	141.3	140.7
	64QAM	192.2	183.9	179.1	176.6	175.3	174.8	174.1
	128QAM	229.1	219.1	213.5	210.5	208.9	208.4	207.5
	256QAM	266.0	254.4	247.8	244.3	242.5	241.9	240.8
	512QAM	302.9	289.7	282.2	278.2	276.1	275.4	274.2
	1024QAM	339.7	324.9	316.5	312.1	309.7	309.0	307.6
50	4QAMs	64.2	61.4	59.8	59.0	58.5	58.4	58.1
	4QAM	86.2	82.5	80.4	79.2	78.6	78.4	78.1
	16QAMs	128.7	123.1	119.9	118.2	117.4	117.1	116.5
	16QAM	167.2	159.9	155.8	153.6	152.5	152.1	151.4
	32QAM	194.2	185.8	181.0	178.4	177.1	176.6	175.9
	64QAM	240.3	229.8	223.9	220.7	219.1	218.6	217.6
	128QAM	286.4	273.9	266.9	263.1	261.1	260.5	259.3
	256QAM	332.5	318.0	309.8	305.4	303.1	302.4	301.1
	512QAM	378.6	362.1	352.7	347.7	345.2	344.3	342.8
	1024QAM	424.7	406.2	395.7	390.1	387.2	386.2	384.5

Bandwidth (MHz)	Modulation	Frame size (byte)						
		64	128	256	512	1024	1518	10000
56	4QAMs	72.8	69.7	67.9	66.9	66.4	66.3	66.0
	4QAM	97.6	93.6	91.2	89.9	89.2	89.0	88.6
	16QAMs	146.1	139.7	136.1	134.2	133.2	132.9	132.3
	16QAM	189.8	191.5	176.8	174.3	173.0	172.6	171.8
	32QAM	220.4	210.8	205.4	202.5	201.0	200.5	199.6
	64QAM	272.7	260.8	254.1	250.5	248.7	248.0	246.9
	128QAM	325.0	310.9	302.8	298.6	296.3	295.6	294.3
	256QAM	377.3	360.9	351.6	346.6	344.0	343.2	341.7
	512QAM	430.0	411.3	400.7	395.0	392.1	391.1	389.4
	1024QAM	482.3	461.3	449.4	443.0	439.7	438.7	436.7

6.2.2 Ethernet optical interface characteristics

The optical interface can be specialized for the different applications by insertion of the proper transceiver on the unit.

- Gigabit optical Ethernet connector: LAN1 SFP 100/1000BaseX
- Fiber max length depending on SFP module (see Tab.5)

Tab.5 - Interface characteristics

Parameter	Gigabit			100 Mbit/s	
	Single Mode	Multi Mode		Multi Mode	
	9/125 µm	50/125 µm	62.5/125 µm	50/125 µm	62.5/125 µm
Operating Distance	up to 10km	up to 550m		up to 2km	
Optical Center Wavelength	1310 nm	850 nm		1310 nm	
Optical Transmit Power	-3 ÷ -9.5 dBm	-2 ÷ -9.5 dBm		-14 ÷ -22 dBm	
Receive Sensitivity	-19 dBm	-17 dBm		-29 dBm	
Average Receive Power Max	-3 dBm	0 dBm		-14 dBm	
Link Power Budget	9.5 dB	7.5 dB		7 dB	
Compliance	1000BaseLX IEEE 802.3z	1000BaseSX IEEE 802.3z		100BaseFx IEEE 802.3z	
Transceiver Type	SFP plug-in				
Connectors Type	LC				

6.3 POWER SUPPLY AND CABLE

ALFOplus unit is compatible with standard POE IEEE 802.3af (with exceeding maximum power). Power supply can be provided at the LAN1 (ALFOplus GE) or LAN2 (ALFOplus GO).

In case of external PoE injector, verify that it has overcurrent protection. Power supply can be provided at the LAN interface or at an auxiliary separated connector at the same time. The maximum length of CAT5e cable (that carries data+PoE) is 100m.

- Operating voltage range — 48Vdc ±15%
- Power consumption [4] — see Tab.6
- Power cable operating temp. — ≤ 60°C

Tab.6 - Power consumption (W)

Power consumption (W)		
Frequency band (GHz)	Typical	Guaranteed
24	33.5	≤ 35

In any case, for other different needs, a dedicated auxiliary port (5 pin connector) provides power supply 48Volt (see Fig.50). For installation, please use rugged and waterproof cable.

6.3.1 POE units

ALFOplus 24GHz can be supplied by PoE units; in Tab.7 there is a list of suggested PoE units (all the PoE units are protected against short circuit, overvoltage, overcurrent).

Tab.7 - List of suggested PoE units

Unit code	Description
D60082	4 units PoEplus
G52005	Ethernet regenerator and PoE injector
G52008	ODU DC PoE injector
S03668	AC/DC PoE (100W)
S03666	AC/DC PoE (60W) with SPD
S03654	DC/DC PoE (60W) no SPD

PoE units different from suggested can be used but they shall guarantee short circuit, overvoltage, overcurrent protection.

4 Power consumption with negligible cable length.

6.4 WAVEGUIDE FLANGE

- Flange type — see Tab.8

Tab.8 - Flange type

Frequency band (GHz)	Flange type
24	UBR 220

6.5 MECHANICAL CHARACTERISTICS

Physical size of system components:

Tab.9 - Dimensions

	Width (mm)	Height (mm)	Depth (mm)
ALFOplus	254	254	121

Weight of system components:

- ALFOplus — < 4.25 kg

6.6 SURGE AND LIGHTNING PROTECTION

- Protection method: — gas dischargers
- Gas discharger technical characteristics
  - DC spark-over voltage — 150V +/-20%
  - Nominal impulse discharge current (wave 8/20 µs) — 20kA
  - Single impulse discharge current (wave 8/20 µs) — 25kA
  - Operation and storage temperature — -40°C ÷ +90°C
  - Performances — in accordance to EN 301 489

6.7 ENVIRONMENTAL CONDITIONS

- Operating temperature range	–33°C ÷ +55°C
- Survival temperature range (reduce MTBF)	-40°C ÷ +70°C
- Operational humidity class	weatherproof according to IP65 environmental
- Thermal resistance	thermal resistance 0.5°C/W
- Solar heat gain	not exceeding 5°C
- Wind resistance	≤ 150 km/h (in operation) ≤ 200 km/h (survival)

Solar shield on the ODU guarantees an additional protection against temperature increase.

7 EQUIPMENT DESCRIPTION

7.1 GENERAL

SIAE ALFOplus (Access Link Full Outdoor) is a microwave radio system for Ethernet full-outdoor digital link.

The Outdoor Unit can be easily installed and configured:

- reduced size
- easily orientable antenna
- wide operating temperature range
- high flexibility of line interfaces selection
- low consumption.

The first description given in the following first concerns the circuitry common to all the versions, then that of the line interfaces will follow.

7.1.1 Block diagram

The ALFOplus consists of two PCB housed in a small size aluminium cabinet:

- BBP-GE (Baseband processor Gigabit electrical)
- TRx (IF and RF transceiver)

or

- BBP-GO (Baseband processor Gigabit optical)
- TRx (IF and RF transceiver)

The description that follows (see Fig.6 and Fig.7) details the block diagrams of electrical and optical version.

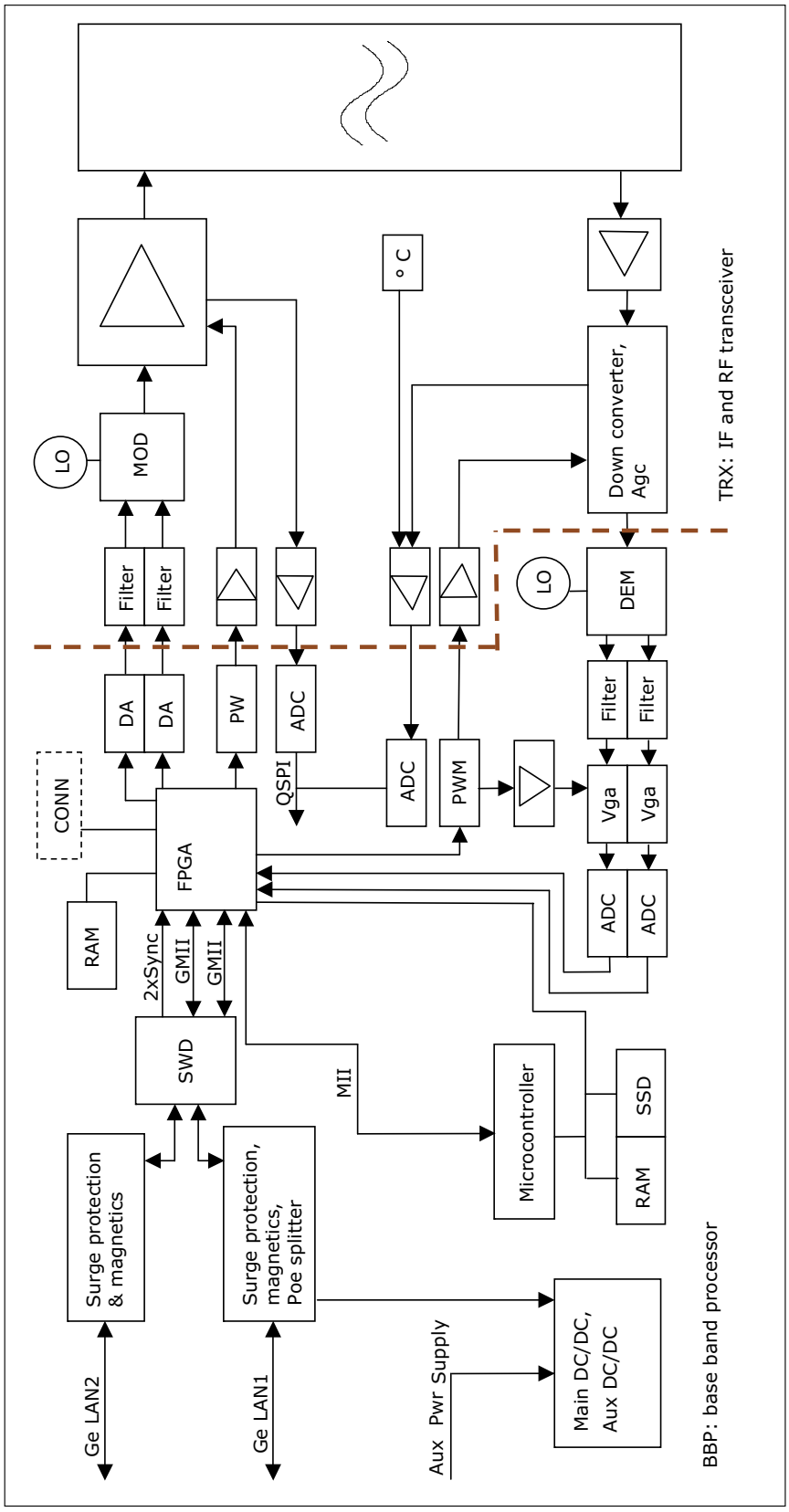


Fig.6 - ALFOplus GE

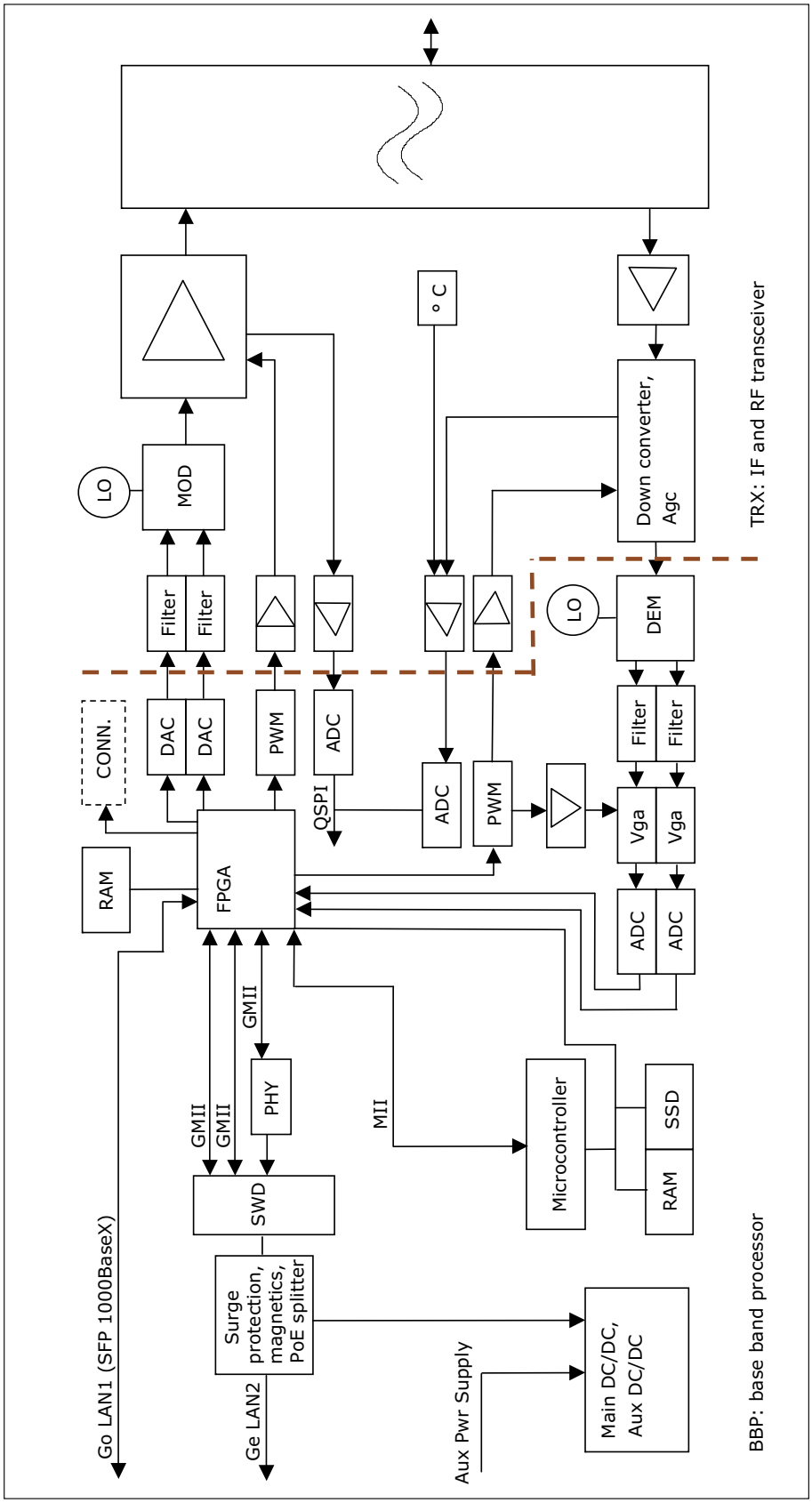


Fig.7 - ALFOplus GO

7.1.2 Baseband processor

The baseband Processor (BBP) carries out the following operations:

- primary and secondary power supply
- line interfaces and protections
- baseband circuits and packets processing
- I and Q signals generation and sampling
- I, Q demodulator
- Rx baseband filtering
- Actuators and measurement points for TRx unit
- FPGA debug connector
- FPGA
- Controller

BBP unit is different depending on the interface type (electrical or optical).

7.1.3 TRX Transceiver unit

TRX Transceiver consists of the following functional blocks:

- power supply dedicated to microwave circuits
- Tx baseband filtering
- I, Q modulator
- frequency synthesizer
- microwave transmitter and receiver
- IF devices on Rx side

7.1.4 Switch function

Ethernet frames forwarding is based on Mac address. Single or Vlan based Mac database can be selected by Web Lct - Ethernet switch (Enh) - Common Parameters.

Take account the value of Max Packet Size (byte) when “802.1Q setting” is set as DISABLE or FALLBACK the switch adds 4 Bytes for internal S_Tag. With 802.1Q setting in SECURE (that means that packet VID must be contained in Virtual LAN table list, otherwise the packet is discarded), no internal TAGs are added.

Ethernet Speed/Duplex function

With electrical interface, in **Web Lct - Baseband - Lan**, Speed/Duplex can be manually or automatically activated as half Duplex or Full Duplex 10/100/1000Base-T, while with optical interface, Speed Duplex can be set as Full Duplex 100/1000Base-X.

Link Loss Forwarding

Link Loss Forwarding (LLF) is an alarm status of Ethernet interface that propagates on data traffic.

If LLF is enabled, any linkdown alarm will generate the alarm status of Ethernet interface blocking any transmission to it. LLF can be enabled for each ports.

With LLF enabled the equipment connected (routers, switches so on) can be notified that radio link is not available and can temporarily re-route the traffic.

In same cases, the radio link failure can be unidirectional, for example when the local equipment has an Rx signal failure but the remote Rx signal is OK (i.e. unidirectional radio full due to failure of a transmitter). However, also in these cases there can be the need to shutdown the link in both directions even if there is only a unidirectional link failure.

Using the bidirectional LLF feature, in case of LLF in the local equipment, the local equipment can notify this LLF status to the remote equipment, shutting down the link on both directions.

Below it is reported an example of bidirectional LLF configuration (see Fig.8).

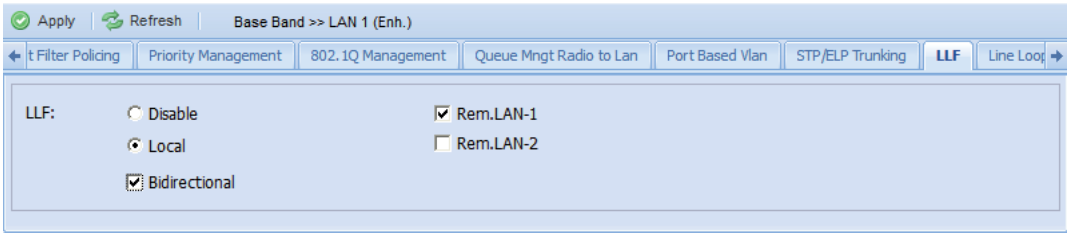


Fig.8 - Bidirectional LLF

MDI/MDIX cross-over

For each LAN interface, cross-over cable can be set in **Web Lct - Baseband - Lan - Cable Crossover** as:

- Auto - Lan recognizes automatically the connected cable type (Straight cable or Crossover cable)
- MDI (NIC) - Manual crossover wiring type T568A
- MDI-X (Switch) - Manual crossover wiring type T568B

With crossover cable it is necessary to use the same wiring format (MDI/MDI or MDI-x/MDI-x) on both ends. In case of straight cable is the opposite (MDI/MDI-X or MDI-X/MDI).

VLAN functionality

ALFOplus works with IEEE 802.1q and 802.1p tag. Tag is made up with:

- a fixed word of 2 bytes
- 3 bits for priority according with 802.1p
- 1 fixed bit
- 12 bits VLAN identifier (VLAN ID) according with 802.1q.

Switch cross-connections are based on Vlan Configuration Table where input and output ports or only output ports should be defined for any used VID. Vlan ID (VID) has a range from 1 to 4095.

Ethernet Flow Control (802.3x)

A network device asks its adjacent devices to send a pause frame because the input is faster it can process. The protocol used for this purpose is the flow control (802.3x).

Port Based VLan

Port Based VLan (or Lan Per Port) allows to share the Ethernet traffic (Ingress or Egress) in the internal SIAE switch.

7.1.5 Synchronisation unit (SETS)

Into ALFOplus a synchronisation circuit, called SETS (Synchronous Equipment Timing Source), gets the synchronisation signal from the following different sources:

- LAN1
- LAN2
- radio
- Internal source

From the synchronization sources the reference clock is chosen on the base of alarm roots (Synch Loss, Synch Drift, Holdover Freerunning), on the base of assigned priority, manual forcing and preferential switch (see Fig.9).

The selected clock drives an oscillator through a PLL circuit. The oscillator will generate the required synchronisation for the frame generation. If no input signals are available the internal oscillator source is used for the local restart.

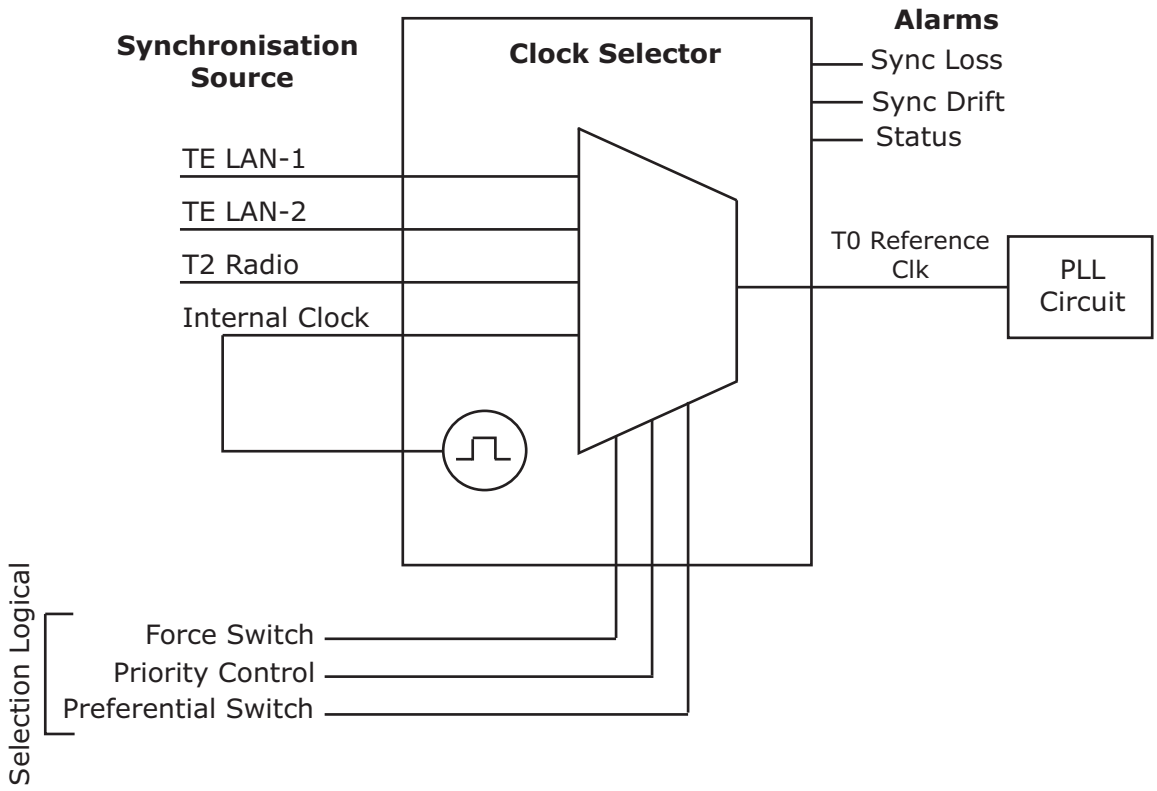


Fig.9 - Synchronisation block diagram

7.1.6 Adaptive code modulation

ACM profiles

In ALFOplus radio family uses Adaptive Code and Modulation (ACM) in order to employ the correct modulation profile depending on the Rx signal quality.

Available ACM profiles are the following:

- 4QAM strong
- 4QAM
- 16QAM strong
- 16QAM
- 32QAM
- 64QAM
- 128QAM
- 256QAM
- 512QAM
- 1024QAM.

These profiles operate in an RF channel with the following bandwidth:

- 7 MHz
- 10 MHz
- 14 MHz
- 20 MHz
- 28 MHz
- 30 MHz
- 40 MHz
- 50 MHz
- 56 MHz.

ACM switching

The criteria defining the necessity of an ACM switching, upshift or downshift, is the Rx S/N ratio.

- **Upshift** - When there is an increase of received S/N, the modulation complexity is increased in the direction from 4QAM strong to 1024QAM increasing the spectral efficiency
- **Downshift** - When there is a decrease of received S/N, the modulation is reduced in the direction from 1024QAM to 4QAM strong reducing the spectral efficiency,

In order to configure properly the radio link using ACM facility, an optimization must be found between max traffic during good propagation conditions and max availability during bad propagation conditions. To obtain this purpose the ACM in ALFOplus family can be configured via software setting the following parameters: ACM setting and Tx Power mode.

ACM setting

The ACM can vary modulation profiles between two extremes defined by the operator through software configuration: Upper Modulation and Lower Modulation.

- **Upper modulation** - When propagation into the given radio channel is in the better condition (high Rx S/N), the radio link is working at the maximum throughput defined at Upper Modulation: the highest modulation profile that ACM can employ

- **Lower modulation** - When propagation into the given radio channel is in the worst condition (low Rx S/N), the radio link is working at the minimum throughput, defined at Lower Modulation: the lowest modulation profile that ACM can employ

7.1.7 ATPC and ACM interaction

The Automatic Transmission Power Control (ATPC) regulates the RF output power of the local transmitter depending on the value of the RF level at the remote terminal. This value has to be preset from the local terminal as threshold high and low. The difference between the two thresholds must be equal or higher than 3 dB.

As soon as the received level crosses the preset threshold level low due to the increase of the hop attenuation, a microprocessor (µP), embedded in the ALFOplus, at the receiver side of the remote terminal sends back to the local terminal a control to increase the transmitted power.

A good set of the thresholds is to put the ATPC Low Level threshold higher (or even slightly higher) than the threshold of the highest modulation scheme of the ACM; this way, the ATPC start to work before the received signal is reduced and by consequence will force the system to downgrade the modulation. The behaviour of the system is to always try to increase the PTX and so the System Gain, before being forced to reduce capacity due to modulation downgrade.

Resuming, the correct setting of the thresholds is when the two windows, the ATPC one and the ACM one, are not overlapped, as per Fig.10.

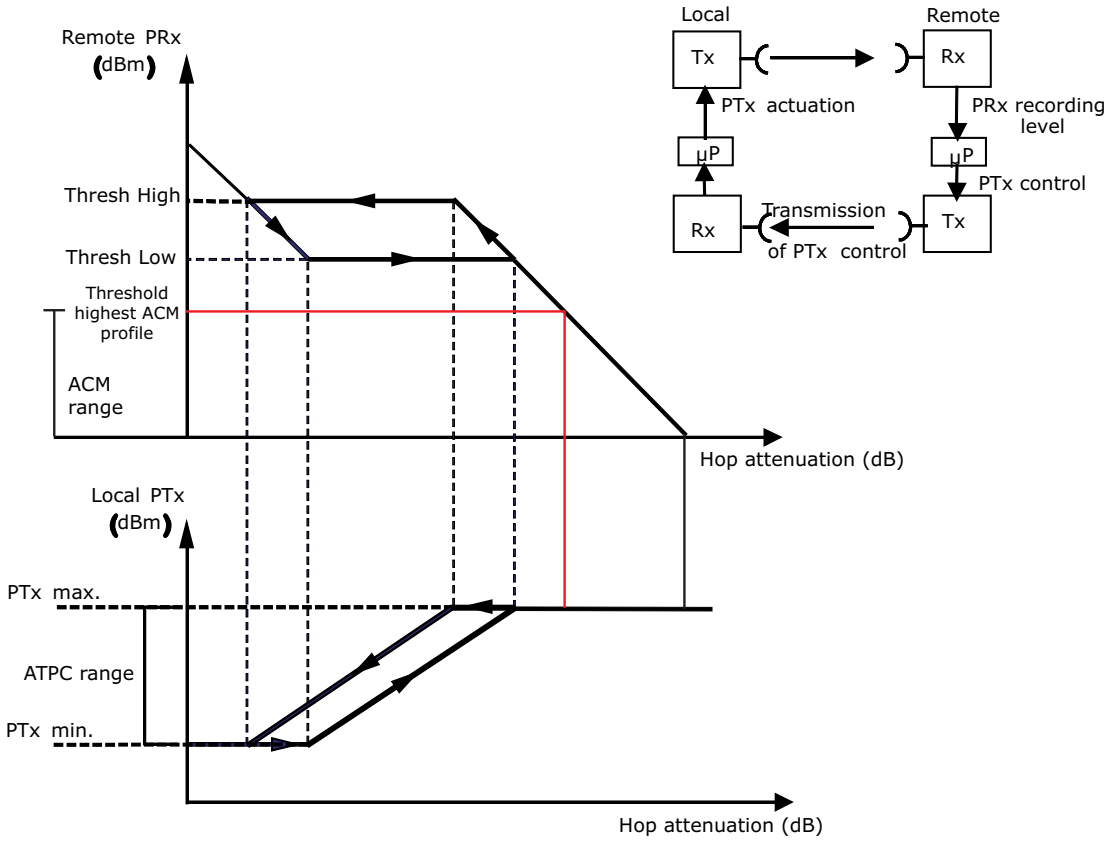


Fig.10 - ATPC diagram

7.2 LOOPS

To control the equipment correct operation a set of local and remote loops are made available. The commands are forwarded by the WEBLCT program. The available loop facilities are:

- Line Loop (Ethernet Port Loop)
- Baseband loop

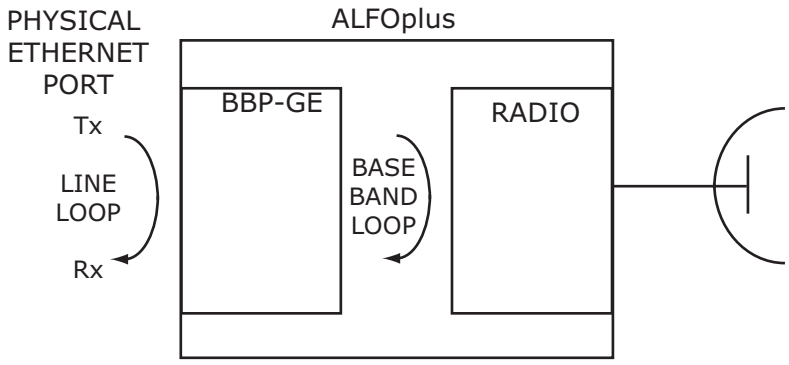


Fig.11 - Available loops

7.3 LOGICAL PROCESSING FUNCTIONS FOR ETHERNET PAYLOAD

The description of Ethernet processing in the present document is made using a set of logical blocks that represent the processing stages of a frame entering the L2 switch (it is intended to be just logical; it does not represent the structure of the physical implementation).

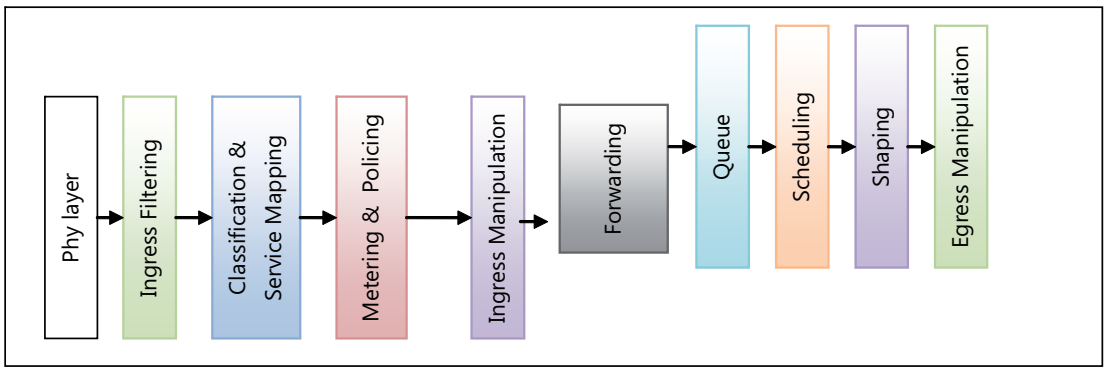


Fig.12 - Logical processing functions for Ethernet payload

From left to right the pocket processing is represented from Ingress to Egress.

Tab.10 - Logical functions

Logical function	Description of included functionalities	Examples
Physical Layer management	Management of the phy parameters and characteristics if the physical interfaces.	
Ingress Filtering	Filter/drop frames on the base of specified criteria and rules, ingress port rate limiting, storm control.	
Service Instance Mapping	Defines the association rules between an ingress frame and its VLAN/EVC	All the frames with C-VID = 10 ore mapped to the EVC-2
Classification	An Internal-Priority is assigned to the packed on the base of selected criteria.	All the packets ingressing port 1 have the highest priority
Metering & Policing	It measures the service parameters such as occupied bandwidth, rate, etc....	CIR, EIR....definition
Ingress Manipulation & Marking	Modified the packet format: add/remove/preserve tags or modify the value of same fields	
Forwarding	Determine the port/ports the packet shall egress to.	On the base of DA-MAC, or on the base of VID value.
Queue & Congestion avoidance	Before egressing each packet is assigned to a specific buffer selected in a set of N queues. Each queue has a different priority. Specific rules are used to determine if a packet can be added or can be dropped.	
Scheduling	The method adopted to empty the queues in order to fulfill the available bandwidth	Example: WFQ algorithm
Shaping	The method adopted to shape the egressing packets.	
Egress Manipulation	Nodified the packet format: add/remove/preserve tags or modify the value of some fields before egressing	

7.3.1 Rate limiting

In SIAE equipment it is possible to apply the Rate Limit, i.e. to limit the total rate passing through an interface. It is possible to apply the rate limiting from 64 kbit/s up to the maximum port speed (up to 1GE).

The values that can be inserted are pre-fixed from 64 kbit up to 10Mbit (64Kb, 128kb, 256kb, 512kb, 1Mb, 2Mb, 3Mb, 4Mb, 5Mb, 6Mb, 7Mb, 8Mb and 9Mb), In the range from 100Mbit/s up to 1Gbit/s the limiting values can be chosen by the user with a 10Mbit/s step. i.e. the minimum selectable granularity is 10Mb/s.

7.3.2 Enhanced QoS Management

The SIAE switch scheduler provides enhanced QoS management features. Based on the ingress port (and optionally also as a function of the VLAN-ID), there are four different modes that can be used to set the priority of an Ethernet frame:

- Ethernet: the priority is set based on the PCP (Priority Code Point) field of the VLAN tag (IEEE802.1p) (Native 802.1p C_Vid)
- MPLS: the priority is set based on the EXP (Experimental Bit) field of the MPLS tag (Native MPLS)

- IP: the priority is set based on the DSCP field of the either IPv4 or IPv6 (Native ToS/DSCP)
- Default: the priority is set in a static mode and its value is configurable based on the Entering LAN interface. This Default configuration is a “Port Based” Priority with default priority value of 0 (lowest priority). These priority values can be configured by the user within the range from 0 (lowest priority) up to 7 (higher priority). The Default mode is also used when all the other criteria are not applicable.

It is in addition possible to map the EXP quality of the MPLS label into the PCP field of the outer VLAN tag (802.1p Rewrite with MPLS).

7.3.3 Ingress filtering policy (CIR/EIR according to MEF 10.2)

SIAE equipment allows limiting the ingress traffic rate on the basis of:

- LAN port (Bandwidth profile per UNI): a different profile is defined for each LAN port (VLAN ID and priority are not considered in this case by the rate limiting algorithm)
- VLAN (Bandwidth profile per EVC): a different profile is defined for different VLANs (priority is not considered in this case by the rate limiting algorithm). Up to 64 VLAN can be managed with different profiles.
- VLAN + priority (Bandwidth profile per CoS): a different profile is defined for different couples VLAN+priorities (up to 64 different cases can be managed). In this case the packet priority is always considered by the rate limiting algorithm. More than one priority can be included in the same bandwidth profile.

7.3.3.1 Not registered traffic default colour

Green (MEF Compliant)/Red policy

Refer to the Fig.13.

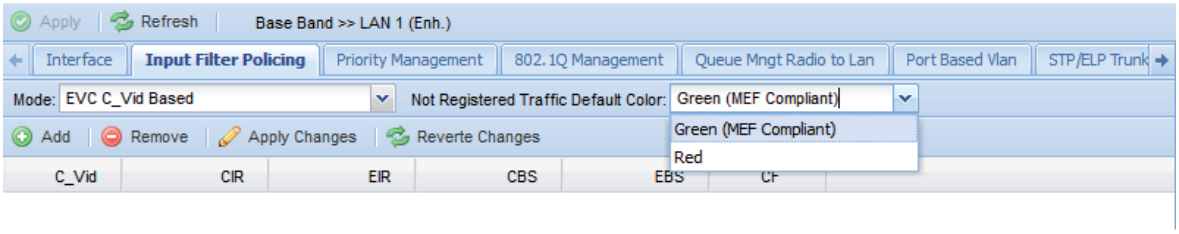


Fig.13 - Not registered traffic default colour

In case at least one CIR/EIR entry has been defined for filtering the traffic at a certain ingress port, the user is allowed to specify the colour the not registered traffic has to marked with, i.e. all not registered traffic could be marked as either “Green” or “Red” packets. In the latter case, the traffic will be immediately discarded.

7.3.3.2 CIR/EIR configuration

In general different criteria can be defined for each port/VLAN/priority. Up to 64 Ingress Filtering Policy resources can be defined and each bandwidth profile defined on the basis either of LAN port, VLAN or VLAN+priority consumes 1 of such resources.

Basing on the above policies, it is possible to assign different traffic profiles (i.e. CIR/EIR profiles) to the incoming Ethernet services.

For example, it is possible to assign specific CIR/EIR policies basing on:

- the type of service (e.g, voice, signalling, data, etc..)
- the specific operator (e.g. in case the microvawe network is shared between 2 or more operators)
- the destination terminal (e.g. each NodeB can have a specific CIR/EIR profile)

In order to define the bandwidth profile, the following parameters must be configured:

- CIR (Committed Information rate): it is the admitted ingress rate ("green" coloured), with values between 0 kbit/s and 1 Gbit/s
- CBS (Committed Burst size): it is the maximum size of the *token bucket* of the green packets, with values between 0 byte and 128 kbyte.
- EIR (Excess Information Rate): it is maximum ingress rate admitted when possible ("yellow" coloured), with values between 0kbit/s and 1Gbit/s.
- EBS (Excess Burst size): it is maximum size of the token bucket of the yellow packets, with values between 0 byte and 128 kbyte.
- CF (Coupling Flag): if enabled, the excess token (if any) charged into the green bucket are moved into the yellow packet bucket.

Red packets, i.e. the ones exceeding the CIR+EIR rate, are automatically discarded. In other words, the rate obtained with the sum of CIR+EIR is the maximum rate allowed to be transmitted.

7.3.4 Enhanced VLAN Management

The SIAE switch provides the following enhanced VLAN management features:

- VLAN rewriting
- Selective QinQ based on VLAN and IEEE 802.1p priority

VLAN rewriting

VLAN rewriting is a feature available on radio side that allows to rewrite the VID of C-TAG of the packet received (uplink side) or sent (downlink side) by the switch.

On uplink side (packets received on LAN interface by the switch and sent to the radio) the VID can be re-written on the basis of the following criteria:

- LAN port + C-VID: new values of C-VID to be written into the packet can be configured on the basis of its original C-VID and the LAN port where it has been received.
- LAN port + C-VID + priority: new values of C-VID to be written into the packet can be configured on the basis of its original C-VID + priority and the LAN port where it has been received.

On uplink side it is possible to configure for all the LAN ports up to 64 LAN port + C-VID or LAN port + C-VID + priority criteria.
On downlink side (packets received on radio side and sent by the switch on the LAN interface):

- the VID can be rewritten on the basis of the C-VID of the received packet. I.e., new values of C-VID to be written into the packet can be configured on the basis of its original C_VID. It is possible to configure up to 64 C-VID criteria in downlink, independently by the uplink configuration.
- C-VID can be removed selectively. It is possible to select the C-VID, enable the option "Removed" and select the Output interface. In other words on downlink side it is possible to select the C-VID to be remove and the correspondent Output LAN.

Selective QinQ based on VLAN and IEEE 802.1p priority

VLAN staking (also named QinQ) is a feature that allows an Ethernet frame to include more than one IEEE 802.1Q TAG. The scope of VLAN staking is to differentiate the traffic at different levels when the packets must cross networks managed by different entities.
The SIAE switch radio supports the Vlan staking. Once a packet enters into the radio it is possible to add a new IEEE 802.1Q TAG. The VID of the new TAG can be set based on different criteria:

- Ingress port of the packet
- C-VID and priority of the packet when received on the ingress port

The new TAG is added to the packet as a S-TAG. The Ethertype field of the TAG can be set either to standard values (0x88A8, 0x9100, 0x9200, 0x9300) or to any other custom values.

7.3.5 Congestion avoidance

The Congestion Avoidance is a method that permits to discard some frames before congestion occurs. When the queue is full there is a congestion situation, this means that the resources are not enough to serve all the packets and there is not enough room in the queue for more storage. In this case some packet must be dropped. The choice of the dropping policy has different effects on the network. In case of congestion, the TCP/IP protocol reduces the transmitting windows and therefore the amount of traffic transmitted. The TCP/IP protocol increases the transmitting window very slowly to allow the network to solve the congestion issues.

This means that, when congestion occurs, some selective dropping has to be done.

There are different policies of dropping that can be adopted:

- Tail: in this case the last packets that come to the full queue are dropped (default configuration)
- Queue: in this case all the queue is emptied, i.e. all the packets present in the Queue are dropped
- Red: Random Early Discard: with this policy, before the Queue is full some incoming packets are dropped randomly regardless if the frames are marked yellow or green (for more details on yellow or green frames please refer to the paragraph 7.3.3 Ingress filtering policy (CIR/EIR according to MEF 10.2))
- WRed: Weighted Random early Discard: with this policy, before the Queue is full some incoming packets are dropped randomly. First are dropped the packets coloured in yellow and then are dropped the packet coloured in green, see Fig.14.

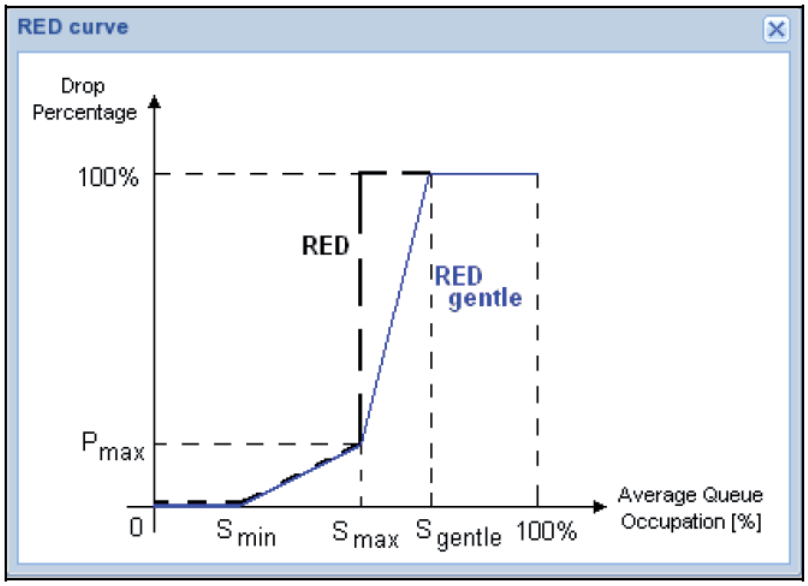


Fig.14 - Red curve

Once WRed is enabled the threshold of S_{min} S_{max} and P_{max} for the Green and Yellow frames have to be set.

The value set the points of the curve shown in Fig.14. There are some predetermined profiles to be enabled:

- Profile 1:
  - S_{min}= 30
  - S_{max}=60

- P_{max}=10

- Profile 2:
  - S_{min}= 20
  - S_{max}=40
  - P_{max}=10

These profiles can be set for the Yellow Frames (Y) and Green Frames (G) as well. These values represent:

- S_{min}: represents the threshold after which the switch starts dropping packets
- S_{man} and P_{max}: are the thresholds that makes the curve of “Drop Percentage”/”Average Queue Occupation” change. After this point the dropping packets increase rapidly.
- “Red Gentle”: after the point represented by S_{max} and P_{max}: the Drop percentage can increase to a 100% (RED) or can linearly increase. the choice of how to increase, directly or linearly to a 100% is manage by disabling or enabling the RED Gentle.

7.3.5.1 Extended buffer capability on the radio queues

The SIAE switch has been provided with an extended buffer capability on the radio queues, which allows to assign up to 128 Mbit (16MByte) to a single queue.

The following buffer configurations are available on the 8 output queues of the radio port:

- the length of each queue is configurable from 128kbit to 128Mbit
- radio port has a total available buffer of 184 Mbit (23 Mbyte), so the sum of all the queue lengths of a single radio port does not have to exceed this value.

7.3.6 Scheduling methods

Once the priority is assigned, the traffic in the queues is then emptied by menas of either Strict Priority or Weighted Fair Queue algorithms. With the Strict Priority the highest priority takes always precedence. With WFQ the available bandwidth is shared between the different priorities with configurable weights. It is in addition possible to configure at the same time some queues as Strict Priority and the remaining as WFQ.

Going into details:

- Strict Priority: first, all the packets from the highest priority queue are transmitted, then all the packets from the second queue, and so on.
- Weighted Fair Queueing (W.F.Q.): the packets are sent on the radio following a rule based on the weight assigned to each Queue.

  Each queue “i” with WFQ is given a weight (importance) Wi.

  WFQ guarantees a minimum service rate to queue “i”

  Ri = R*Wi/(W1+W2+....+Wn) [Rate of the queue i]

  Where:

  R = rate of the servant (capacity available on the MW link)

  W i= weight of the Queue taken in consideration

  Wn = weight of the last Queue with WFQ enabled

  This means that the rate of the queue is a fraction of the total bandwidth that depends on the weight assigned to the Queue.

For example if the weights are set as Fig.15.

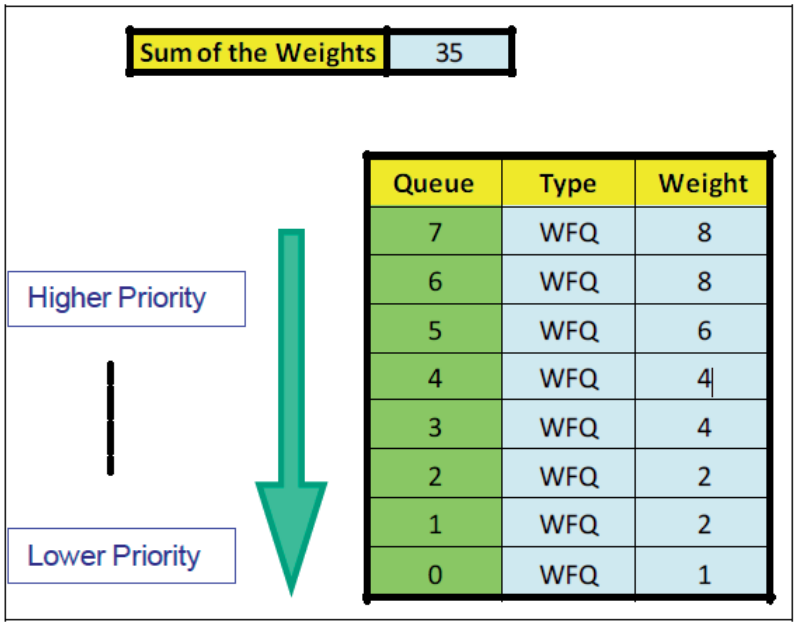


Fig.15 -

Means that the Serving Priority of the frames present in the queues will be:

- the packets present in the Queue 7 will be transmitted with a Race 8/35
- the packets present in the Queue 6 will be transmitted with a race 8/35
- .....
- the packets present in the Queue 0 will be transmitted with a rate 1/35.

7.4 ETHERNET FRAME FRAGMENTATION

QoS preserve High priority traffic, by giving it precedence during traffic congestions. However, in case of real time traffic also latency and jitter are important factors. Latency is strictly related to the line speed and usually can be managed by designing the network topology in a proper way (e.g. by limiting the maximum number of hops in link chains). Jitter is instead a more sensitive parameter because it depends on the traffic conditions.

In fact, when a High priority packet has to be sent over the radio link it is scheduled on a High Priority queue. However, before to be sent over the radio link it has to wait that the packet currently in transmission (even a Best Effort packet) will be entirely sent. This waiting time can considerably change depending on the best effort packet size (from 64bytes to 1518 bytes of even more in case of jumbo frames). One technique used to mitigate this phenomenon is packet fragmentation, i.e. longer frames are subdivided in smaller fragments at Tx side. A label is added to the packet in order to number these subframes. At Rx side the original frame is rebuilt after all the fragments are received. In this way, the maximum waiting time for a High Priority packet is reduced to the sub-frame size (some hundreds of bytes), providing sensitive benefits to the packet jitter.

The SIAE switch allows to fragment Ethernet frames with two options: 256 or 512 Bytes.

For example: in case the radio is serving a 1024Byte frame in the lowest (queue 0) and there is an incoming frame (256 bytes) in the highest priority queue (queue 7). The packet in the highest priority should be served first, but since the servant is busy processing the packet in the lower queues, the 256Byte frame has to wait until the radio has processed the 1024 Byte frame, see Fig.16.

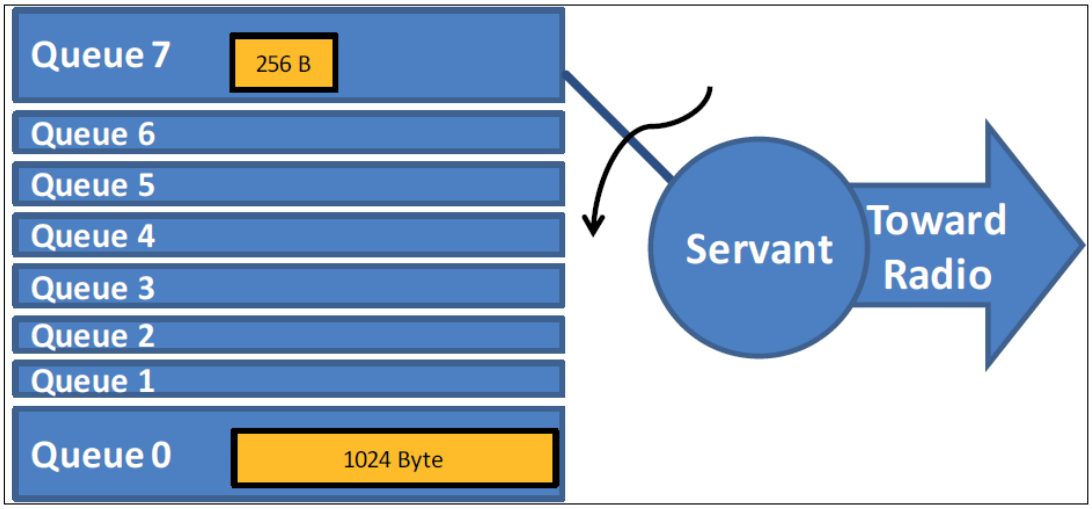


Fig.16 - Ethernet frame fragmentation disabled

With the fragmentation enabled the time that the packet in higher queues have to wait is smaller. With fragmentation enabled the radio divides the 1024 byte packet into 4 packets of 256 Bytes and the servant can transmit the first frame of 256 Byte in the lower queue and then transmit the high priority traffic, reducing the jitter in the network, see Fig.17.

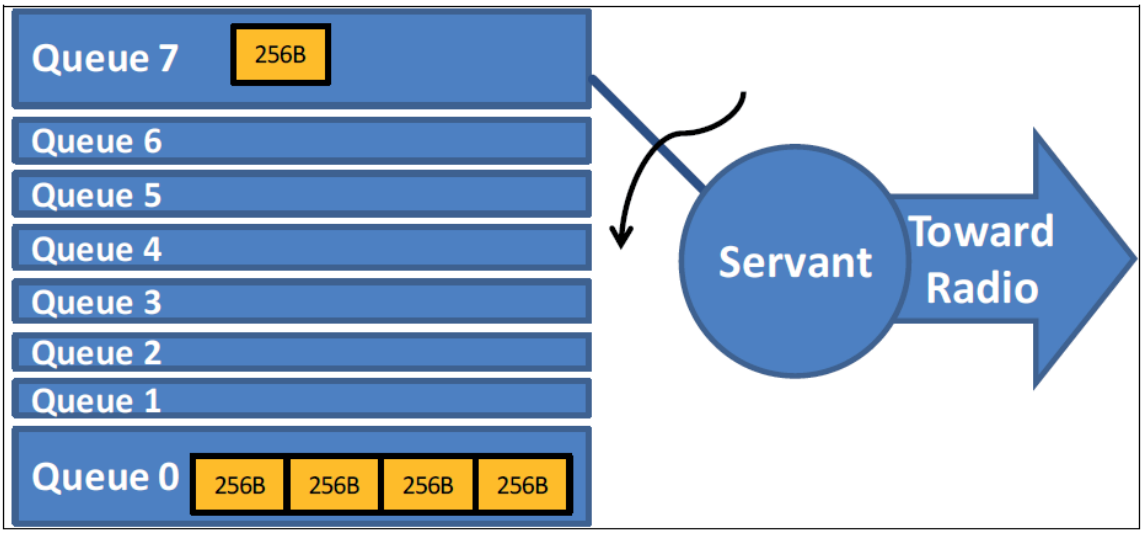


Fig.17 - Ethernet frame fragmentation enabled

7.5 HEADER PACKET COMPRESSION

The SIAE switch provides header packet compression. This feature allows to compress the packet header by transmitting over the radio link proprietary labels in place of long and repetitive header field.

Multi-layer Header Packet Compression supports the following protocols: Ethernet, MPLS, IPv4/IPv6, UDP and RTP and LTE S1 interface tunnelling. This latter cover the case of LTE eNodeB backhauling on S1 interface, where the eUE traffic (either IPv4 or IPv6) is enveloped into a GTP-U tunnel. The Header compressed in this case includes (IPv4+UDP+GTP-U of the S1 interface)+(IPv4/IPv6+UDP+RTP of the eUE traffic inserted into the tunnel).

When enabled, the user can select which header have to be compressed considering the following maximum limits:

- the total header field size cannot exceed 124 bytes
- the total header field size after internal coding cannot exceed 118 bytes. the internal coding is required by SIAE switch in order to perform the compression task.

In Fig.18 are detailed the different header fields that can be selected with their weight in terms of header field size and header field size after internal coding.

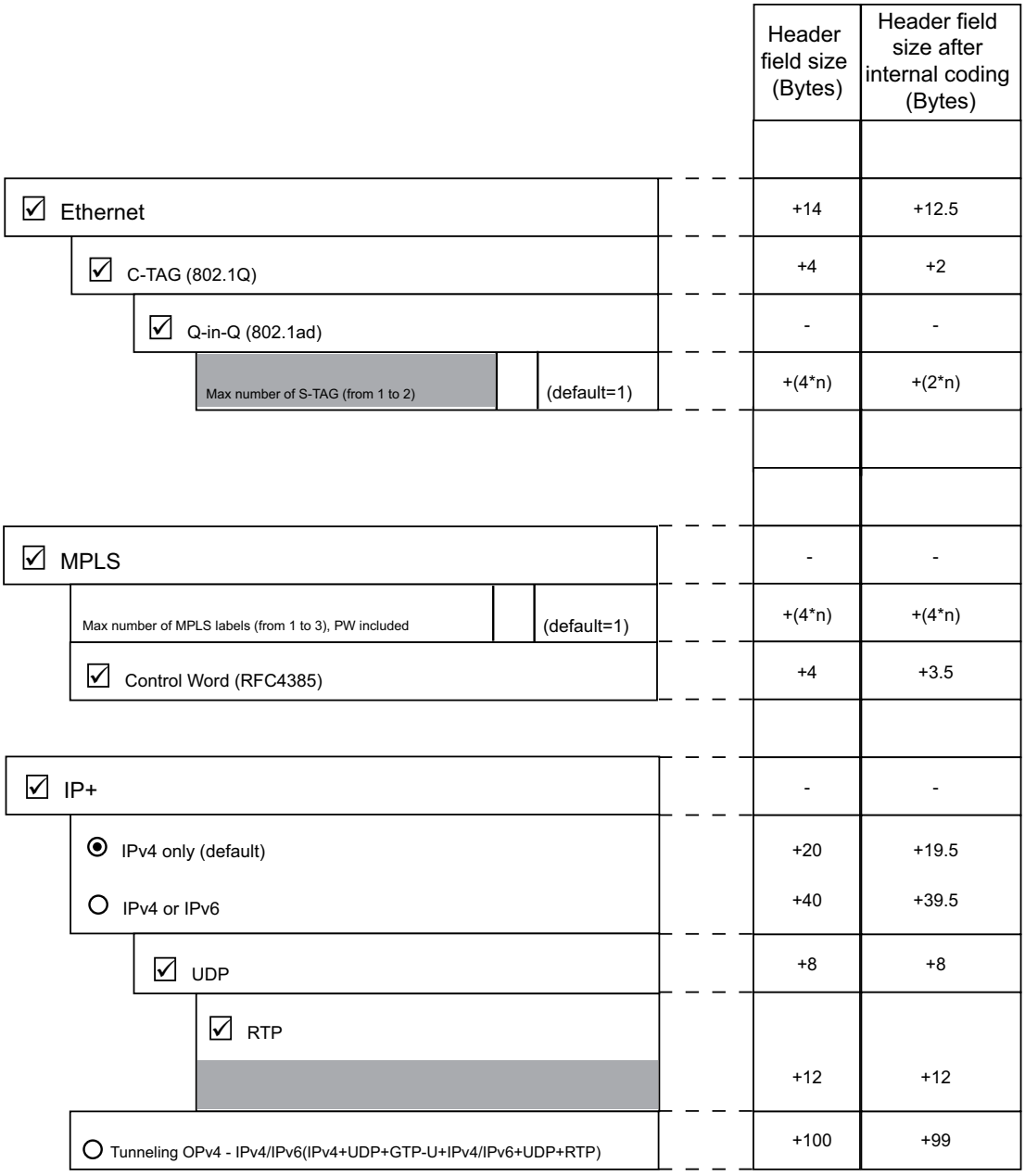


Fig.18 - Header compression

7.6 ETHERNET OAM (OPERATION ADMINISTRATION AND MAINTENANCE)

This protocol can be used in any point-to-point Ethernet link. The aim of this protocol is to check and monitor the functionality of the service that the provider guarantees on the network.

7.6.1 Service layer OAM

The Service Layer OAM fully monitors a customer End-to-End Ethernet Service. Two main standards cover this topic, the IEEE 802.1ag and ITU-T Y.1731.

The IEEE 802.1ag provides CFM (Connectivity Fault Management) useful for detecting, isolating and reporting connectivity faults. The ITU-T Y.1731 Standard comprehends the CFM plus some additional features, like RDI (Remote Defect Indicator) that allows to report back to the start of the chain the Alarm message.

SIAE equipment support CFM according to both standards ITU-T Y.1731 and 802.1ag.

The IEEE 802.1ag and the ITU-T Y.1731 are End-to-End service, i.e. provide the tools to monitor the Ethernet Service regardless of the layers, Network Path and operators. Since the spectrum of application can include many applications a more hierarchical structure is needed.

The Standards define:

- Maintenance Domains (MD): these specify the Domains of operators, users and service providers. Levels from 0 to 7 are possible depending on the type of service to be monitored. Customer Domain is the higher which includes both ends of the Ethernet service (from one End user to the other End user), Standard Default values for Customer Domain are 7, 6 and 5. Service Provider Domains should have a MD lower than the Customer Domain since include the whole network except the End Users. Standard default values for Provider Domains are 3 and 4. Operator Domains are lower than Service Provider Domains since just a part of the network is included. Standard Default values for operator domains are 0, 1 and 2. Here follows a picture explaining the hierarchical structure of Maintenance Domains.
- ALFOplus: in SIAE equipment one Maintenance Domain can be specified. At each end of the Maintenance Domain two MEPs (Maintenance End Point) will be specified. The MEPs are “markers” that define the end of a domain and are in charge of originating OAM frames. In a domain also MIPs (Maintenance Intermediate Points) can be specified. The MIPs are passive check-points. The MEPs and MIPs configuration are discussed in details in the following points. The choice of the domain and the Domain Label (name) is left to the user. Particular attenuation must be paid to use the same MD label in each equipment where the MD is specified, i.e. different equipment with same value of MD domain but different MD labels belongs to different Domains.

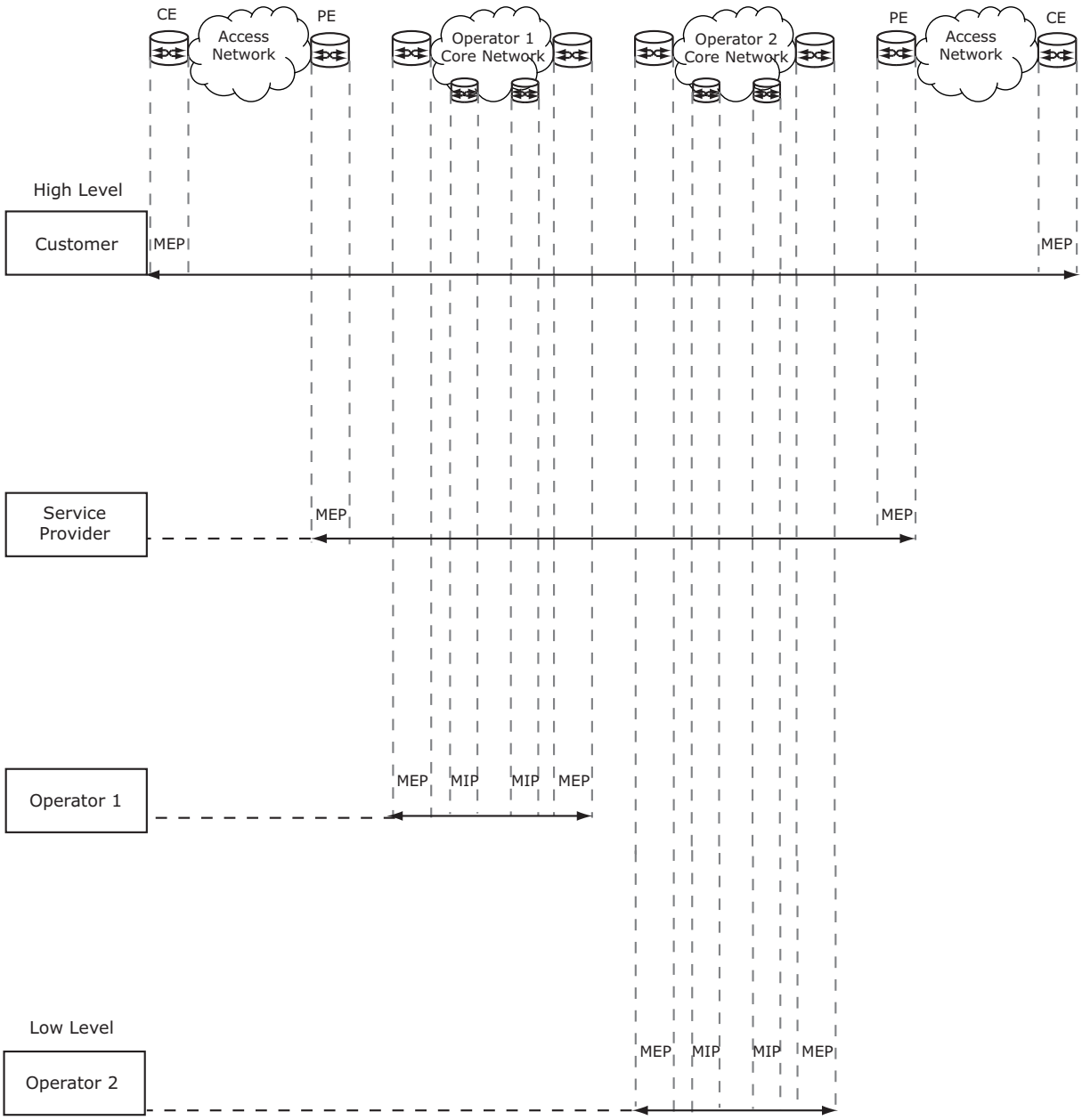


Fig.19 - Hierarchical structure of maintenance domains

- A Maintenance Association (MA) is one association which correlates the VLAN to the MD in which the MEPs and MIPs have to be defined.
- ALFOplus: when a specified traffic needs to be monitored, then it is necessary to relay the VLAN to a Domain and to the corresponding MEPs or MIPs through the MA. Before creating the Maintenance Association, the VLAN, either S-VLAN or C-VLAN, has to be specified in the VLAN Table. In each SIAE equipment it is possible to set up to 32 different MA. Particular attention must be paid to use the same MA label in each equipment where the MA is specified, i.e. different MA labels on the same VLAN correspond to different MA associations.
- At the Edge of a MD there are MEPs (Maintenance End Points) and in the middle there could be MIPs (Maintenance Intermediate Points). MEPs are the units in charge of managing the CFM to correctly monitor the status of the Ethernet service provided. MIPs are passive check-points that answer to pollings coming from MEPs. MEPs will forward OAM messages coming from higher domains and will discard OAM messages generated from lower domains.
- ALFOplus: Each interface can be configured as MEP, Port A interface (radio interface) included. Once chosen the interface, depending on the network topology, the direction of the MEP has to be spec-

ified. Two Directions are possible, MEP "▲" and MEP "▼". With MEP "▼" configured the OAM PDUs are sent from the interface in the direction outside the equipment, i.e. the OAM PDUs are sent from the interface on the cable toward next equipment. With MEP "▲" configured the OAM PDUs are sent from the interface toward the inside of the equipment and will follow the VLAN table previously configured. MEPs are distinguished from each other through a MEP ID, therefore MEPs belonging to same MA must have different MEP IDs. In order to configure a MIP the MA has to be habilitated on the equipment. Up to 32 MIPs or MEPs can be configured on each equipment.

The protocols belonging to the Connectivity Fault Management implemented in SIAE equipment are listed hereafter:

- Continuity Check Protocol: this protocol enables the sending of a periodic message (like a Heartbeat message) which enables the other MEPs deployed in the network to distinguish the status of a virtual connection. this message can only be originated by a MEP.

  ALFOplus: is adjustable with 1s, 10s, 1min, 10min. These messages do not trigger any automatic reply from the destination entity.

- LoopBack Protocol: it resembles an IP PING message; once this message is sent (e.g. MEP1 sends a Loopback Message to MEP2). MEP2 replies to MEP1 confirming therefore the status of the connection. This is done to check the status of the connection between the MEP originating the message and the MEP/MIP to which the message is addressed. This message can only be originated from one MEP and can be addressed to both MEPs or MIPs.

  ALFOplus: the number of Loopback Messages in SIAE equipment is adjustable from 1 to 5 consecutive Loopbacks. In each equipment, it is possible for each MEP to check the presence of other MEPs in the same MA. This is done through the "Remote MEP" application which allows this acknowledgement and distinguishes the other MEP through means of MEP IDs and MAC address.

- Link Trace Protocol: this protocol sends a message similar to the LoopBack protocol. Every equipment that is reached by this message will answer to the sender providing its own MAC address. In this way the sender is able to understand of which equipment the MA is composed. E.g. a MEP sends the Link Trace Message to another MEP belonging to the same Maintenance Association. the MIPs that are deployed in the middle of the path will forward this message and answer to the initiating MEP with their own MAC Address. By doing so the initiating MEP knows the OAM-devices deployed in the path and their order.

- Remote Defect Indicator: this feature allows a MEP, in presence of a fault or a defect, to send a RDI to inform the other MEPs, belonging to the same MA, of the presence of this Defect. The advantages of this procedure are to avoid multiple Alarms created by the same cause and to be able to check the status of other Remote MEPs. This RDI information is reported in the Continuity Check Message.

  ALFOplus: this feature is present in SIAE equipment and the presence of this alarm can be checked as well in the Remote MEPs screen on the equipment.

7.7 ETHERNET PERFORMANCE MONITORING - RMON

RMON (Remote Monitoring) is a standard whose function is providing a set of services of statistics count, monitoring and alarm report with reference to the activity of a LAN network.

SIAE equipment support RMONv1, first MIB, as defined in RFC2819. This MIB contains real-time LAN statistics e.g. utilization, collisions and CRC errors. These counters are managed locally into the radio equipment and are defined independently for each port of the device (both LAN and Radio interfaces). SIAE NMS systems collect periodically this data and store it into the network database. More in details, the RMON implementation in SIAE Network Elements is classified into two groups:

- RMON – Statistics: These are the counters data collected in real time by the Network Equipment. These data are stored in the network equipment itself and, the NMS Statistics viewer can visualize this data with the "Refresh" button.

- RMON - History: This is managed by the NMS through the collection of the counters data from the Network Equipment. After a periodical polling to the Network Element, the NMS collects all the data and these data are seen as the RMON History.

In other words, the “RMON Statistics” are the data that are collected and stored in the Network Equipment, while the “RMON History” is an aggregation of the data collected from each network equipment and the database is located in the NMS.

7.8 RMON COUNTERS

RMON statistics are composed by counters for each port of the device that are stored in the equipment deployed on field.

Into the equipment it can be chosen to store the values with a sampling period that can be defined between two values: 1 min, 15 min, or both. For each sampling period the counters values are stored into the equipment. After a predefined period (polling period), all the RMON data stored by the equipment are get by the NMS. The polling period can be either less than 4 hours (if the sampling period is 1 min) or 1 day (in case the sampling period is 15 min). The NMS aggregates the files received to create a bigger database with the History of the Performance Monitoring samples.

Here below are described the RMON counters available for each device interface (both LAN and radio ports):

- DropEvents: Total number of events (frames, or whole queue contents) in which packets were dropped by the interface due to lack of resources.
- Octets RX: Total number of octets of data (including those in bad packets) received by the interface.
- Pkts RX: Total number of packets (including bad packets, broadcast packets, and multicast packets) received.
- BroadcastPkts RX: Total number of good packets received that were directed to the broadcast address.
- Multicast Pkts RX: Total number of good packets received that were directed to a multicast address.
- CRC Align Errors: Total number of packets received that had a length between 64 and the Max Packet Size configured on the equipment switch (in any case not exceeding 10240 bytes) with bad Frame Check Sequence (FCS) and an integral number of octets (FCS Error) or a bad FCS with a non-integral number of octets (Alignment Error).
- Undersize Pkts: Total number of packets received that were less than 64 octets long and were otherwise well formed.
- Oversize Pkts: The number of packets received during this sampling interval that were longer than maximum allowable length (excluding framing bits but including FCS octets) but were otherwise well formed.
- Fragments: Total number of packets received that were less than 64 octets in length and had either a bad Frame Check Sequence (FCS) with an integral number of octets (FCS Error) or a bad FCS with a nonintegral number of octets (Alignment Error).
- Jabbers: Total number of packets received that were longer than n (parameter Max Packet Size, it can be set to 1522, 2048 bytes or 10240 Kbytes) octets, and had either a bad Frame Check Sequence (FCS) with an integral number of octets (FCS Error) or a bad FCS with a non-integral number of octets (Alignment Error).
- Collisions: The best estimate of the total number of collisions on this EthLannet segment.
- Utilization Rx: The best estimate of the mean physical layer network utilization on this interface during this sampling interval, in hundredths of a percent. The percentage is always referred to a 1Gbit/s port speed. So, it represents the mean RX throughput measured on the port during the sampling period and it is expressed as a percentage of a port speed.
- Octets TX: Total number of octets of data (including those in bad packets) transmitted.
- Pkts TX: Total number of packets transmitted.
- BroadcastPkts TX: Total number of good packets transmitted that were directed to the broadcast address.
- Multicast Pkts TX: Total number of good packets transmitted that were directed to a multicast address.

- Utilization TX: The best estimate of the mean physical layer network utilization on this interface during this sampling interval, in hundredths of a percent. The percentage is always referred to a 1Gbit/s port speed. So, it represents the mean TX throughput measured on the port during the sampling period and it is expressed as a percentage of a port speed.

All the counters described above are part of the RMON statistics and it is not possible to collect only a subset of them. It is however possible to select on which equipment interface activate the RMON statistics (for example, they can be enabled only on the radio interface). This allows reducing the total amount of PM data, for example avoiding data collection from unused LAN interfaces. This can be done on all Payload Interfaces (regardless if electrical or optical), the Radio interfaces are included as well.

7.9 ADVANCED STATISTIC MONITORING FOR SERVICES AND PRIORITY COUNTERS

In addition to the Ethernet Counters per Port with SIAE equipment it is possible to set on the Radio interface the RMON counters per Service (Vlan) or Priority (Queues). Differently from the previous RMON counters, the Service and Priority counters can be activated for the following variables.

- Octets TX: Total number of octets of data (including those in bad packets) transmitted.
- Pkts TX: Total number of packets transmitted.
- Octets RX: Total number of octets of data (including those in bad packets) received by the interface.
- Pkts RX: Total number of packets (including bad packets, broadcast packets, and multicast packets) received.
- DropEvents: Total number of events (frames) in which packets were dropped by the interface due to lack of resources.

The Service and Priority RMON can be activated and collected from NMS (Network Management System). The Service and Priority RMON are based on the Advanced Ethernet Counters present on the equipment and configurable on site. This means that on site it is possible to activate the Advanced Ethernet Counters but not the Service and Priority RMON.

In any case the NMS has higher priority in respect to the configuration inserted through Web LCT. This means that the local operator can enable and read the active measure, but when the configuration of these RMON is done through NMS, the local operator can only read the values of the Advanced Ethernet Counters. It is not possible to enable the RMON for Priority and, in the same equipment, the RMON per Vlan.

7.9.1 Priority RMON

The Priority RMON are based on the internal Queue of the equipment, not on the value of the Priority; this implies that:

- the maximum number of RMON (Priority) that can be enabled are limited to 8, i.e. the number of the queues available in SIAE switch.
- if traffic with different priorities are listed in the same Queue, the Priority RMON will work with one Probe on the Queue. I.e. the traffic in the same Queue is seen as “Same Priority Traffic” and the Priority RMON counts the frames belonging to the Queue

In other words, with Priority RMON there is a probe for each queue (8 queues in SIAE switch). Each probe counts the variables listed above (Octets TX, Pkts TX, Octets RX, Pkts RX and DropEvents).

These counters will be available only with the Minimum Polling Policy of 15 min.

7.9.2 Service RMON

The Service RMON counters allow the equipment to track the variables listed above depending on the Service (Vlan Tag). This type of RMON can be set only on the Radio interface.

Each equipment can be set to collect RMON up to 32 Services (Vlan Tag) and only one Customer Tag.

These counters will be available only with the Minimum Polling Policy of 15 min.

7.10 SYNCHRONISM

Network Synchronisation is a growing subject related to the network evolution from TDM to Ethernet payload.

In this chapter it will be described the different features supported by SIAE switch equipment for the synchronization transport. The decision of the correct source to enable and how to pass the synchronisation signal to customer's equipment depends on network situation which has to be evaluated case by case.

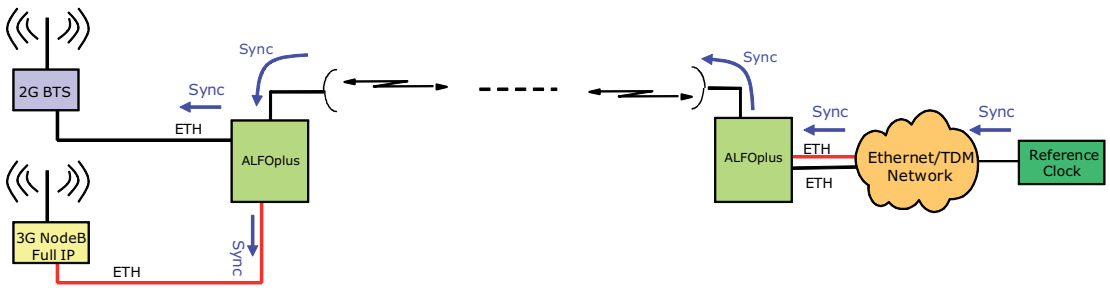


Fig.20 - NodeB and BTS synch

The main concept is to transfer the synchronization signal throughout the network deployed. This implies that SIAE equipment will take the clock signal from the concentration points (POC) and transfer it towards the tail sites and distribute the synchronization signal to the external equipment such as NodeBs and BTS (see Fig.20).

Fig.21 - SETS circuit

Going into details, this means that each SIAE equipment (represented in Fig.21) will have, at least, one "Input" and one "Output" CK.

Input (CK IN) is/are the interface/s where the SIAE equipment get the Clock signal from, these could be another SIAE equipment or external equipment.

Output (CK OUT) is/are the interface/s where the SIAE equipment provides the Clock Signal to, these could be another SIAE equipment or external equipment.

Internally to each SIAE equipment the SETS identify the input and output types of interfaces by the following codes:

- TE: This code represents an Ethernet interface (LAN) used as input CK
- T0: Output interface. This code represents the Internal Clock

The purpose of the above list is to list the different acronyms used by the SETS that may be present in the configuration screens.

There are some features to be used for maintenance or refined tuning of the clock propagation.

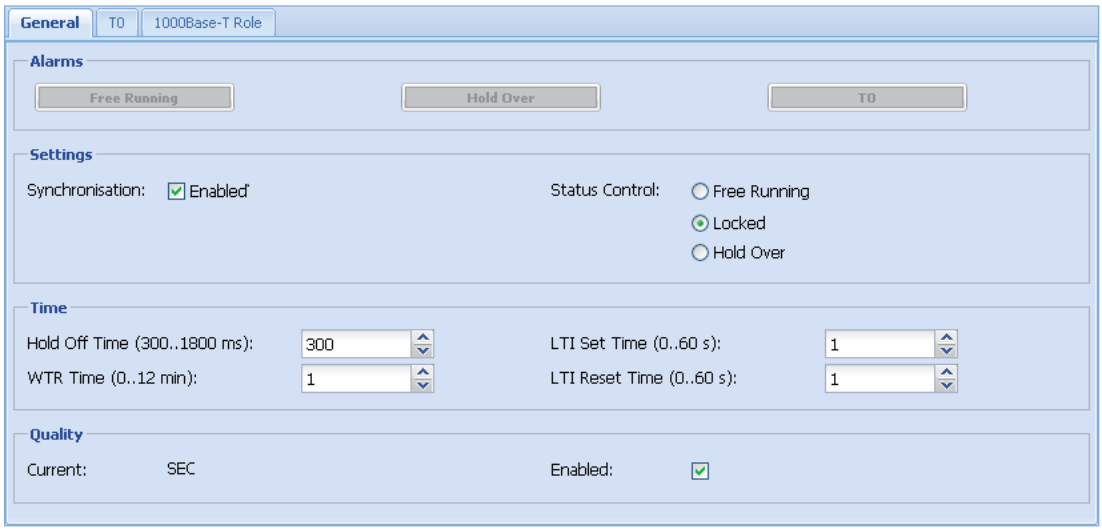


Fig.22 - Synchronisation menu

Here below are listed the different configurations to be made:

- Status Control: this is a forced status for maintenance purposes of the SETS. It can be forced in:
  - "Free Running": Independently from the synchronization signal received, the clock is locked onto the internal clock.
  - "Hold Over": The SETS is locked into the internal clock which tries to preserve the frequency received when the SETS was locked.
  - "Locked": in this case the SETS is locked to a source of synchronization.
- "Time" Settings: these are general setting for the synchronization
  - "Hold Off Time": Time (expressed in ms) during which the system keeps the evaluated frequency of a synchronism source become invalid (not present or degraded). At the end of the Hold Off time, the invalid source will be rejected and the first input source having a valid signal will be used.
  - "WTR Time": i.e. Wait-To-Restore, this is a wait time to avoid oscillations. Time (expressed in minutes) that has to pass before allowing the selected valid input source to be actually used within the process for the selection of T0 synchronism.
- "LTI Set Time" and "LTI Reset Time": are controls that avoid oscillations of Alarms. When one alarm raises up, it has to be active for at least the "LTI Set Time" and when it disappears it has to be off for at least "LTI Reset Time".
- "Enabled": Enables the SSM in the equipment

7.11 SOURCES OF SYNCHRONISM

SIAE equipment is able to select among different sources of synchronization. A priority has to be assigned to enable each source, with a value ranging from 1 to 9 included. The priority 1 corresponds to the maximum value, while the priority 9 corresponds to the minimum value. The priority shall be used to select in which order the different synch sources must be used. In case the Priority is set as “Disabled” the correspondent interface is not used as a synchronization source.

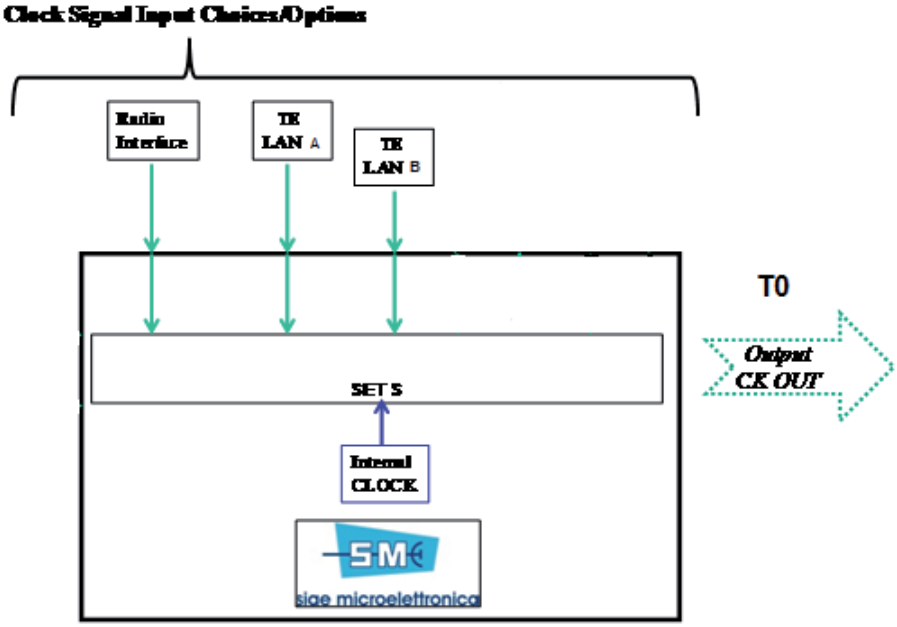


Fig.23 - Sources of synchronisation

The selectable sources of synchronisation are listed below. For each source it is also listed in square brackets the correspondent acronym used by the SETS:

- Radio Interface: it is possible to have 1 radio interfaces (1+0).
- GE Interface [TE]: to identify which LANs are the sources of synchronization they have to be chosen under “TE LAN A” and “TE LAN B”. This implies that a maximum of 2 LAN interfaces can be set as source of synchronization. In order to receive the synchronization signal (and regardless of the SSM status) the GE interface has to be set as “Slave”. The configuration choices and other details are explained in “SSM on Ethernet Interfaces”.
- Internal Clock [T0]: with the Synchronization not enabled the equipment is locked into its internal clock

In case SSM is not enabled, the equipment switches from one source of synchronization to another following the priority scale, starting from the source set to priority 1 and scaling to the sources with higher values of priority (i.e. lower priority level). The synch source switch occurs when the present source suffers one of the following events:

- The source of synchronization is not physically available
- The clock deviation is bigger than 4.6 ppm (maximum deviation that the internal clock can follow).

In other words, if the LAN1 is selected as first source (priority 1) of synchronization, and the LAN2 is selected as the second source (priority 2) of synchronization, the SIAE equipment will be synchronized on the LAN1 until the cable will be physically unplugged or the LAN1 frequency and phase will be out of their specified ranges. Once one of these events occurs, the SIAE equipment will switch the source of synchronization to the second source listed. If the second source listed is unplugged or out of maximum range then the SIAE equipment will switch to the third source and so on.
In case no other synch sources are available the SIAE equipment will go on “Internal Source”, i.e. the internal clock present in SIAE equipment. In this condition the internal clock will be kept in hold status, trying to keep the last synchronization reference received. In these conditions, the internal clock of SIAE equipment has a reliability of 0.3 ppm over 24 h. When the SIAE equipment switches to internal clock, it propagates a quality of SEC – SDH Equipment Clock.

7.12 MAB PROTOCOL (MICROWAVE ADAPTIVE BANDWIDTH)

Microwave radio transmission capacity depends on radio channel propagation conditions. In case of Ethernet ring, capacity degradation can affect one side of the ring, while the other is still working at nominal capacity. In case of congestion events, Microwave radio prioritizes the Ethernet traffic, by reducing or discarding the lower priority frames. Similar situation can be found even in other network topologies, where the microwave link bandwidth changes must be reported to an upstream Ethernet switch or router in order to adjust the relevant traffic accordingly its traffic shaping and/or forwarding rules. By knowing the capacity of the radio link, external equipment can optimize the transport on ring networks, by means of forwarding rules that choose the best direction for each traffic type, or select additional criteria for the quality management (e.g. Router/Switch shapes the traffic allowing only selected data to be transmitted through the microwave link).

The Microwave Adaptive Bandwidth (i.e. MAB) protocol has been developed by SIAE and CISCO in order to improve the behaviour of the Ethernet ring protection when using the adaptive code and modulation (ACM) on microwave links. Thus the MAB offers reliable QoS and optimized performances even in worst radio propagation conditions because it allows forwarding traffic on the Ethernet ring according to the bandwidth available for every ring branch.

For a more comprehensive scenario, the following Ethernet ring topology is assumed, where adaptive modulation microwave Radio and Ethernet switch or router are deployed.

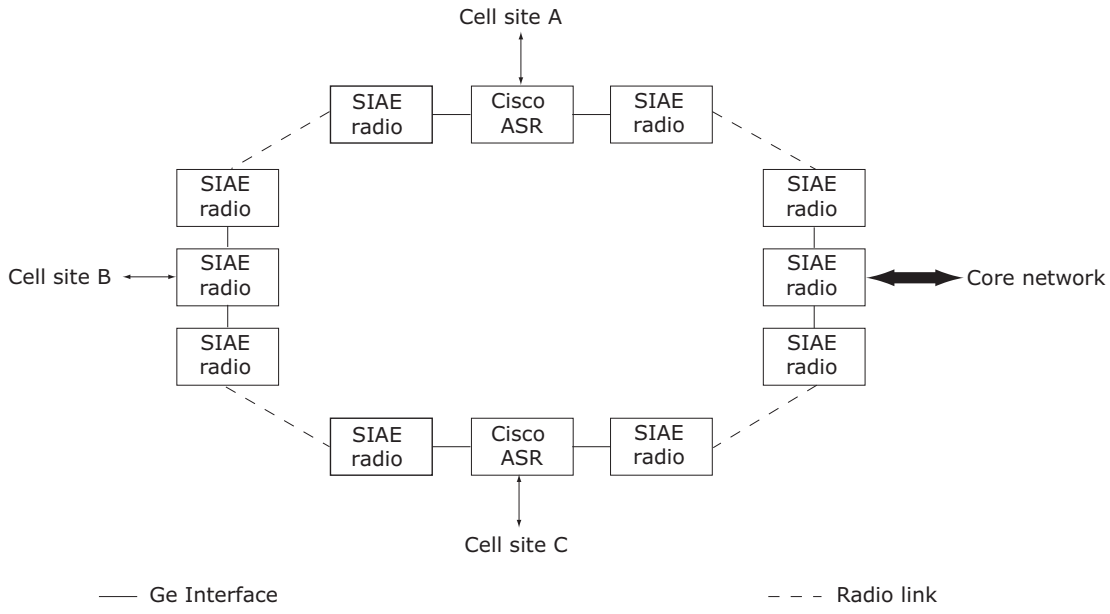


Fig.24 -

The main ring topology advantages are:

- to offer a protection path in case of equipment failure or radio link unavailability due to deep fading
- to increase Ethernet throughput (up to double) from the core towards the border of the network by distributing on the two ring branches the Ethernet traffic by means of control plane protocols (i.e.: G.8032) in order to open the Ethernet loop in a suitable segment.

The standard ring protection mechanisms are usually triggered by failures, because the control protocols stop receiving messages due to loss of connectivity among sites.

However, the traditional Ethernet ring protection mechanisms do not take into account of the degradation of radio links capacity due to ACM intervention, because the protection protocol packets (usually marked as high priority) still continue to run on the ring, and this leads to an unbalanced operation of the ring with different capacities on the two branches.

In fact, the traditional Ethernet ring protection are not sensitive to variations on the radio bandwidth occurring in presence of modulation level reduction (i.e. ACM enabled) caused by atmospheric phenomena (e.g. fading due to multipath and rain events). Therefore, in case of fading phenomena, the Ethernet ring protocol does not activate the ring protection because of lack of both Link Loss Forwarding messages com-

ing from SIAE equipment and Hello-Packets's loss (i.e. the high priority traffic is still transported while the Best Effort traffic is cut). For this reason, the ACM functioning in presence of Ethernet ring protection could generate disruptions into services because of the small amount of capacity passing across radio links affected by propagation phenomena.

A key point to consider is the duration of an event that can result in a change of modulation: it ranges from few minutes to tens of minutes. The effect of a single event lasting from milliseconds to few seconds (multipath phenomena) is already operated by the QoS management of the Microwave radio, in order to not lose the priority traffic, while the slower phenomena must be handled by traffic re-routing.

The following therefore applies only to the phenomena longer than tens of seconds. In detail, consider the following scenario:

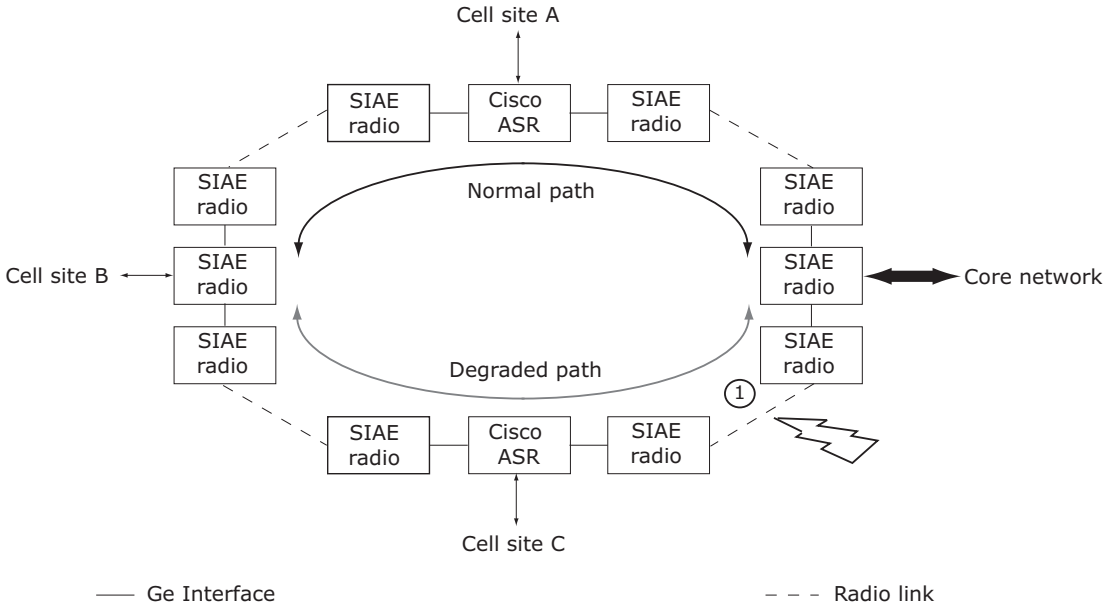


Fig.25

In the network scenario shown above:

- in each site it has been connected a CISCO router to SIAE radio through LAN ports
- each microwave link is supposed to work with the ACM enabled: it's worth to notice that the ACM feature could be useful to optimise the antenna's dimensioning by distinguishing between "High Priority Services" (i.e. the traffic to be guaranteed with an availability required by the customer) and the "Best Effort Services" (i.e. the traffic to be discarded by the equipment in case of bad propagation conditions. The capacity reserved for these services depends on the maximum modulation achievable by the equipment)

Basing on the above network scenario, on one branch, the cell sites A and B aren't affected by atmospheric phenomena and the mobile network operates at full services (from highest to lowest priority services). On the other branch, for a given time interval, the radio link between the core network and the cell site C is affected by heavy rain, resulting in capacity degradation. Since there is no balancing in the ring of traffic priorities between branches, only the "surviving" mobile services are available in the affected branch.

The solution to this behaviour is the MW Adaptive Bandwidth (MAB) feature developed by SIAE and Cisco, which allows for traffic forwarding on the Ethernet ring in accordance with the available bandwidth for each priority in the two ring branches. In other words, using dynamic traffic engineering, you can optimize the allocation of class of services in the whole ring. The feature is based on a protocol by which:

- the Microwave radio notifies the changes in link capacity to the Ethernet switch or router that it is connected to, which in turn applies the relevant forwarding rules
- the notifications take place by means of OAM (Ethernet-Operations, Administration and Maintenance) type messages which signal the changes in the band availability (BW-VSM messages)
- through the management (transmission and reception) of these messages and the proper configuration of the forwarding rules, the ring will be able to change the traffic profile to take the degraded path in consideration.

MW Adaptive Bandwidth (MAB) protocol description

The general approach to solve this problem will be through the use of a special "**Ethernet Operations, Administration and Maintenance" (E-OAM) message**, which will be able to report changes in bandwidth availability. Through a combination of the generation and reception of this message and the appropriate configuration of forwarding rules on the Cisco MWR, the ring will be able to modify the traffic profile to take account of the degraded path.

An ITU-T Y.1731 **Vendor Specific Message (VSM)** is used for the purpose of reporting the currently available bandwidth (BW) information from the Microwave radio to the Cisco MWR. This message will be referred to thereafter as the BW-VSM.

The default settings for the protocol are the followings:

- the BW-VSM is sent untagged. However, the equipment optionally supports that the BW-VSM could be transmitted with a configurable valid IEEE 802.1Q VLAN tag
- the BW-VSM is associated with Maintenance Level 0. However, the equipment optionally allows the network operator to associate the message with a valid Maintenance Level in the range 0 to 7 as per the ITU-T Y.1731 / IEEE 802.1ag-2007 standards.

Procedures on Transmitter (SIAE Microwave radio)

At steady state, and while there is no fading on the microwave link, BW-VSM messages must not be generated. Only when the radio transceiver detects degradation or subsequent improvement in the microwave link quality and changes its modulation scheme, it must advertise the change using the BW-VSM defined in the section above. The radio transceivers should handle on their own any fading event that lasts less than N seconds (N= 10 or greater, may be configurable). Such short-lived events should not be reported using BW-VSM. When the fading exceeds the N seconds threshold, the equipment must immediately generate a VSM with:

- **Nominal Tx BW**: set to the nominal link Tx BW, when there's no fading
- **Current Tx BW**: set to the current link Tx BW

Subsequent messages must be sent periodically at the set transmission period, for the duration of the fading event. In those periodic messages, the Current Tx BW field must be set to reflect the most up to date status of the link. This includes both the case where the link condition is deteriorating (i.e. decreasing BW) as well as the case where it is improving (i.e. increasing BW).

When the fading subsides, the equipment must send a final BW-VSM with the Current Tx BW field set to the nominal value. This will signal the end of the fading event.

Microwave Radio re-provisioning, equipments or cards replacement, cable re-connection must trigger a BW-VSM message transmission, with the Current Tx BW field set to the nominal value, to re-align the systems.

Procedures on Receiver (CISCO Ethernet switch or router)

The solution enables ITU-T G.8032 Ethernet Ring Protection mechanisms to be triggered in response to degradation in BW on the microwave link, i.e. **Signal Degrade (SD)** condition. **The switch will be configured a priori with the bandwidth threshold at which every Ethernet Ring Protection (ERP) instance on the ring is to be rerouted in case of a degraded link**.

As part of the network capacity planning, the operator should:

- **analyze the allocation of VLANs to ERP (G.8032) instances** according to the bandwidth profile of the EVCs associated with those VLANs
- **determine the failover thresholds based on the aggregate BW of the ERP instances** in relation to the microwave link budget at the various capacity levels associated with the adaptive modulation schemes

When a **Maintenance Endpoint (MEP)** on a Cisco MWR receives the first BW-VSM message reporting degradation, it waits for a Hold-Time of N seconds before detecting the Signal Degrade (SD) defect condition where N will be configurable in 1 sec increments from 0 to 600 seconds. The purpose of this is to introduce a dampening effect and ensure network stability in the case of link instability.

After the Hold-Time expires, the MEP detects the SD defect condition and the Cisco MWR will perform the following actions:

- Issue a Syslog message that displays the Nominal Tx BW as well as the Current Tx BW.
- Evaluate, based on the degradation in BW, which ERP instances need to be failed over and trigger the failover for these instances.

For the duration of the fading event, any subsequent VSM messages received will trigger the following actions:

- If the reported Current Tx BW is different from the value previously received, issue a Syslog message that displays the Nominal Tx BW as well as the Current Tx BW.
- If the reported Current Tx BW is the same as the one previously received, then no further action is taken.
- If the reported Current Tx BW is less than the one previously received, evaluate which additional ERP instances need to be failed over, and trigger failover for these instances.
- If the reported Current Tx BW is more than the one previously received, then no further action is taken

When the fading subsides and the MEP receives a BW-VSM indicating that the Current Tx BW is equal to the Nominal Tx BW, the switch then starts a Fading Wait-to-Restore timer M. M will be configurable in 1 sec increments from 0 to 600 seconds. If the timer expires before receiving any further BW-VSMs, then the MEP clears the SD defect condition associated with the ERP instances.

In case the BW-VSM announcing the return to nominal BW is lost, the MEP will detect that it has stopped receiving periodic BW-VSM frames. In this case, the MEP waits for 3.5 times the BW-VSM transmission interval, and then starts the Fading Wait-to-Restore timer. When the timer expires, the MEP clears the SD defect condition.

Equipment setup parameters

In order to modify the management parameters of the BW-VSM messages (MAB), the following parameters have to be set (refer to the image below):

- Enable/disable the management of the BW-VSM messages at level of single LAN port
- Define the parameters for the forwarding of the BW-VSM messages:
  - the Tag 802.1Q VLAN value in the TX VLan ID box (value between 2 and 4094). By default, the BW-VSM message is sent untagged (value 0)
  - Maintenance Level of the OAM domain in the TX OAM Maint. Level box (value between 0 and 7). The Default value is 0. This setting involves even the change of the destination MAC address of the BW-VSMmessage because this address corresponds to the CCM multicast address for the associated OAM maintenance level (the CCM multicast address depends on the CISCO equipment configuration)
  - in the Fading Hold Off (s) box, set the waiting period (in seconds) before declaring Fading and starting the transmission of BW-VSM messages (value between 10 and 60). The lesser is this value, the faster will be the reaction of the device after a fading phenomena. However, small values of the Fading Hold Off parameters can cause instability in the device in presence of fast phenomena. The default waiting period is 10 seconds
  - in the TX Period box, set the transmission period (in seconds) between one BW-VSM message and the next one (1, 10 or 60 seconds). The default waiting period is 10 seconds. The same value has to be set into CISCO equipment as well
  - in the BW Tx Type box, set the criterion used to calculate the band value available within every transmission period (Tx Period):
    - *Average*: The BW-VSM messages contain the indication of the average value of the available band within the observation period
    - *Min*: The BW-VSM messages contain the indication of the minimum value of the available band within the observation period
    - *Max*: The BW-VSM messages contain the indication of the maximum value of the available band within the observation period

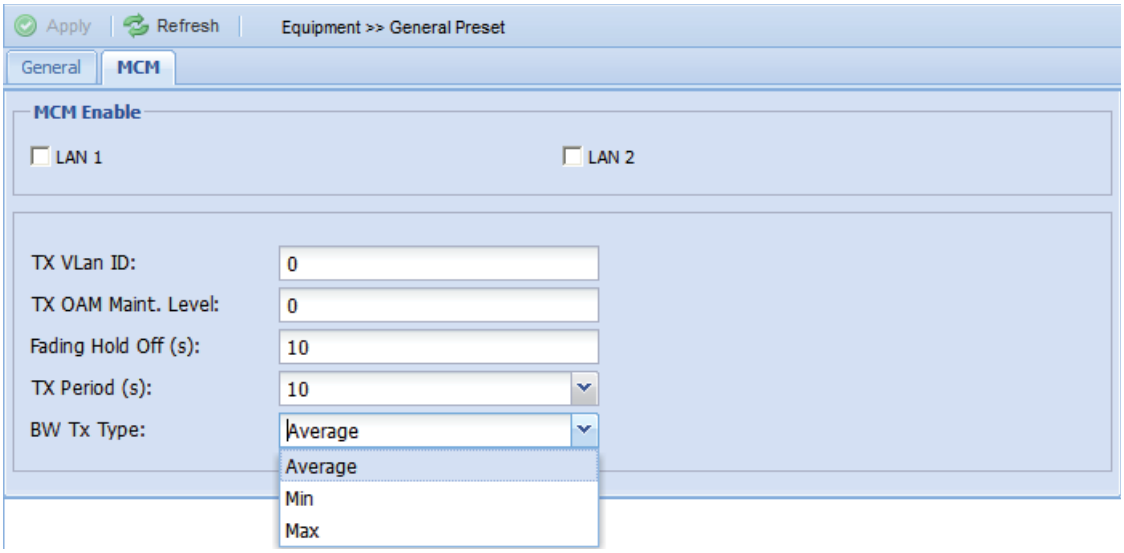


Fig.26 - Microwave adaptive bandwidth

7.13 FADE MARGIN MEASURE

In ALFOplus is available the Fade Margin Measure. The Fade Margin is the difference between the Received Power and the Threshold at a given BER. Once the link is planned, in the Link Budget is present a Fade Margin that has been calculated through mathematical formulas. The Fade Margin depends from the propagation's parameters and from the presence of interferers.

This feature is useful to compare the Fade Margin provided from the Link Budget calculation with the real Fade Margin present on field. Especially in case of interferers that have not been considered during the planning of the MW link.

In order to execute the Fade Margin measure it necessary to have:

- Theoretical Fade Margin from Link Budget calculations
- Local and Remote IP Addresses.

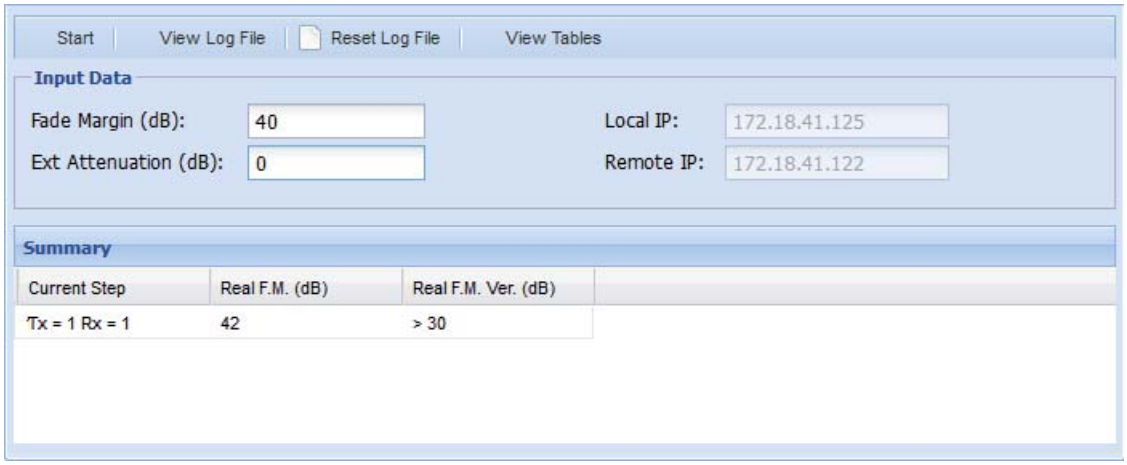


Fig.27

The maximum range of Fade Margin for ALFOplus is 30 dB. For extra attenuation is required an external attenuator.

In case the link budget presents a value of Fade Margin to be measured higher than the actual range it is necessary to apply an “External Attenuator” and insert the correspondent attenuation on input data menu.

The Fade Margin Calculation is traffic affecting.

Warning: Fade margin measure works by disabling ACM engine on local and remote equipment.

7.14 PROVIDE SYNCHRONISM TO EXTERNAL EQUIPMENT

Once the SIAE equipment is synchronized, the clock signal has to be passed toward external equipment or other SIAE equipment. SIAE equipment can give the synchronization signal through different interfaces.

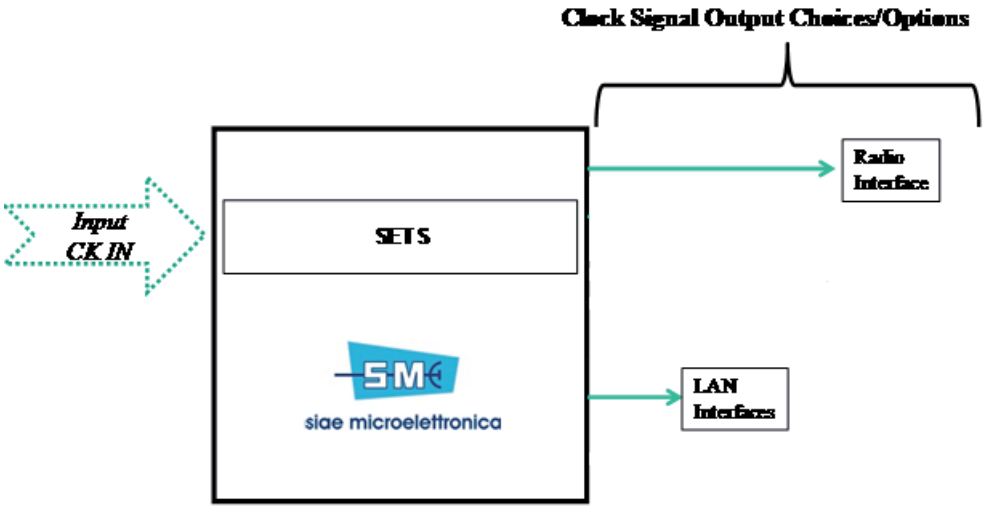


Fig.28 - Provide synchronism

The interfaces that are available to provide synchronization to other SIAE or external equipment are:

- Radio: this interface is passing the synchronism automatically to the remote equipment. No configuration is needed.
- GE Interfaces: the TX CK of the all GE lines (i.e. LAN 1 and 2) is locked to the SETS. In this way, the CK can be passed through these connections to other equipment provided that they support Synchronous Ethernet. The GE Interfaces when used in Electrical can provide the CK signal to other equipment: in this case the equipment port role must be “Master”. Once the synchronization is enabled in the SIAE equipment, automatically all the LAN interfaces are locked onto the SETS. This implies that the synchronization signal is automatically provided onto all the LAN interfaces.

The choices of the interface to pass the clock signal depend strictly on the external equipment. This means that in first place it is necessary to establish the possible sources of synchronization available on the external equipment. Depending on the availability of these sources, SIAE equipment will be configured with the correspondent interface to pass the clock signal.

7.15 G.8264 SSM – SYNCHRONISATION STATUS MESSAGE

The SSM is a protocol that transmits the quality of the synchronization message throughout the network (G.781).

In the synchronization network the transmission of the quality of the clock allows the network to be scalable and to provide redundancy. In case of failure of SIAE equipment or cable, it is helpful to provide redundancy for clock propagation in order to avoid synchronization loops.

Synchronisation loops could happen after a failure when two equipment are synchronising each other on the same physical connection. If this happens the equipment will not present any alarm on the synchronization but will generate and propagate a not reliable clock. The quality of the clocks that are propagated are:

- PRC: Primary reference Clock – Best quality clock reachable (Cesium Clock)
- SSUT: Synchronization Supply Unit Transit (Rubidium Clock)
- SSUL: Synchronization Supply Unit Local
- SEC: SDH Equipment Clock (Crystal Clock)
- DNU: Do not Use – This signal informs the receiver to do not use this clock

Here above are listed in order from the better quality clock (PRC – Primary Reference Clock) to the worse quality clock (DNU – Do Not Use). The better the quality is the more time can the SIAE equipment stay in holdover (Internal Clock) without a degradation of the payload. In other words, better is the quality, longer can remain reliable the clock in holdover cases.

The DNU quality is always propagated on the source on which the equipment is locked for synchronization. In this way the Loops of synchronization are easily avoided.

Unless the user forces the CK quality input/output, SIAE equipment reads the quality present in the input interfaces. This means that, unless there is some user's modifications, SIAE equipment propagates the quality of the clock as it is. I.e. the output quality is the same as the input quality.

E.g.: If in the input interface (POC Site) there is a quality of SSUT of the CK signal, SIAE equipment will pass throughout the network this synchronization signal with a quality message of SSUT.

In case the SIAE equipment is in Holdover (internal clock) it changes the quality of the synchronization to "SEC" quality. With SSM enabled, SIAE equipment will choose the sources of the synchronization based on the better quality received.

In general, the equipment selects the synch source with the following criteria:

- it chooses the sources with the highest quality
- if more than one source have the same quality, the one with the highest priority is selected (i.e. the ones that have the smaller priority value, from 1 up to 9)
- in any case, if a DNU quality is received on the highest priority source, this latter is discarded and the equipment selects an alternative source.

Example 1: if one SIAE equipment has the two following sources of synchronization, with the same priority:

a. LAN1 with quality SEC (Priority 1)

b. Radio with quality SSUT (Priority 1)

In case the sources have the same priority, the SIAE equipment will switch the source of synchronization to the best quality, in this case (b) the Radio with SSUT quality.

Example 2: if one SIAE equipment has the two following sources of synchronization, with the different quality and different priority:

a. LAN1 with quality SEC (Priority 1)

b. Radio with quality SSUT (Priority 2)

In case the sources have different priority and quality, the SIAE equipment will switch the source of synchronization with higher quality, in this case (b) the Radio with Priority 2 and quality SSUT. However, if a DNU quality would be received on Radio, the SIAE equipment will switch the synch source to LAN1 interface.

Example 3: if one SIAE equipment has the two following sources of synchronization, with the same quality:

a. LAN1 with quality SSUT (Priority 1)

b. Radio with quality SSUT (Priority 2)

In case the sources have equal quality, the SIAE equipment will switch the source of synchronization with higher priority, in this case (a) the LAN1 with Priority 1 and quality SSUT. However, if a DNU quality would be received on LAN1, the SIAE equipment will switch the synch source to Radio port.

The quality of the synchronism has to be enabled for each SIAE equipment and can be transported on the following interfaces:

- On the Ethernet Interfaces through a standard protocol (according to ITU-T G.8264)
- Radio interface with Local/Remote Telemetry: Depending on the MW link configuration (1+0) the SSM messages are passed to the remote SIAE equipment in different ways.
  - 1+0 Configuration: In this case there is one Local/Remote Telemetry passing the SSM messages

Within this configuration table there are also some maintenance configurations such as:

- Forced Switch: this command allows the operator to force the SETS to lock to a predetermined source. This command is above all other configurations. This means that the SETS will be locked onto this source even if the cable is unplugged
- Preferential switch: In case two sources have equal priority it is possible to set a Preferential Source. In any case the quality is the main parameter of choice, then when two sources have the same priority, the preferential source is chosen.

In relation to the SSM, it is possible to:

- Visualize the quality of the clock signal received and transmitted (Rx Quality and Tx Quality)
- Overwrite the Quality received or transmitted (Ovw Rx Qlty and Ovw Tx Quality) and the choices are:
  - PRC: Primary reference Clock – Best quality clock reachable (Cesium Clock)
  - SSUT: Synchronization Supply Unit Transit (Rubidium Clock)
  - SSUL: Synchronization Supply Unit Local
  - SEC: SDH Equipment Clock (Crystal Clock)
  - DNU: Do not Use – This signal informs the receiver to do not use this clock

The Overwrite of the Quality of the Clock is configurable by the user and simply forces in input or output the quality.

7.15.1 SSM on Ethernet Interfaces

In order to propagate the clock signal through the Ethernet 1GE Electrical interface it is necessary to set correctly the master and slave option for each interface. It is possible to assign the roles (Master or Slave) statically (as set up for source LAN) or dynamically (according to Synch direction).

This because the Master interface transmits the clock to the Slave interface and in case the direction of propagation of the clock has to be changed (line failure, insufficient quality, etc..), the master and slave assignment has to be re-negotiated with a consequent loss of traffic. This re-negotiation implies an interruption of the traffic from 2.4 to 2.6 seconds.

SIAE equipment allows to set the role of the interfaces to “According to synch direction” (dynamic), the flow of the propagation of the clock signal is automatically changed depending on the transferring direction of the CK.

If the role of the interfaces is set to “As set up for source LAN” (Static), the flow of the propagation of the clock signal is fixed (see Fig.29).

Fig.29 - LAN synchronisation method

The other configuration present in SIAE equipment that manage the role of the LAN interfaces (Master/ Slave) is present in the main configuration of each LAN interface. Regardless if each LAN interface is set manually as Master/Slave or with autonegotiation, the setting of dynamic or static in the SSM configuration is privileged. In other words if the Master/Slave are set manually in the interface configuration and in the SSM is set “According to synch direction”, if needed, the role of the LAN changes according to synch directions.

When an electrical GE interface is in Master State (despite from the fact that it comes from a “static” or “dynamic” setting) every synchronization signal that is coming from this interface has automatically the quality of DNU. This does not occur for optical GE or FE interfaces (Electrical and Optical), where the “Master” and “Slave” roles are not foreseen and so the transmitting direction for the clock can be exchanged without any port role re-negotiation.

All the Ethernet interfaces are locked on the SETS, regardless which LAN interfaces are set as sources of synchronization. Nevertheless the “Overwrite RX Quality” and “Overwrite TX Quality” can be applied only on the LAN interfaces used as sources of synchronization.

Section 3. INSTALLATION

8 INSTALLATION OF ALFOPLUS

8.1 GENERAL INFORMATION TO BE READ BEFORE THE INSTALLATION

The installation, maintenance or removal of antenna systems require qualified experienced personnel. SIAE installation instructions have been written for such a personnel. Antenna system should be inspected once a year by qualified personnel to verify proper installation, maintenance and condition of equipment.

SIAE disclaims any liability or responsibility for the results of improper or unsafe installation practices.

ALFOplus equipment is a full-outdoor IP Ethernet radio link system, for transport capacity up to 500 Mbit/s, designed to establish LAN-LAN connections. For the details related to the actual used frequency band refer to the label on the equipment.

Warning This equipment makes use of non-harmonized frequency bands.

Warning Class 2 radio equipment subject to Authorisation of use. The equipment can operate only at the frequencies authorised by the relevant National Authority.

Warning The deployment and use of this equipment shall be made in agreement with the national regulation for the Protection from Exposure to Electromagnetic Field and EIRP regulations.

8.2 GENERAL

The ALFOplus radio system is made up of an outdoor unit, protected by a metallic shield.

Compliance to electromagnetic compatibility is guaranteed through the following precautionary measures:

- during the design phase
  - use of protection circuits against lightning by means of electrical dischargers
  - use of filters on the power supply input circuits against noise propagating on the power supply wires
- during the installation phase
  - use of shielded cables
  - use of ground connections.

The installation phases of the whole system are described in the following paraghaphs and it must be done only by service person suitably trained.

Warning Remember that the whole radio link can work only if ODUs chosen for local and remote side have equal sub-band and different SSB (H and L).

8.3 ELECTRICAL WIRING

The electrical wiring must be done using appropriate cables thus assuring the equipment responds to the electromagnetic compatibility standards.

The cable terminates to flying connectors which have to be connected to the corresponding connectors on the equipment front.

Position and pin-out of the equipment connectors are available in this section.

8.4 CONNECTIONS TO THE SUPPLY MAINS

During the final installation, protect the ODU by a magneto-thermal switch (not supplied with the equipment), whose characteristics must comply with the laws in force in one's country.

The disconnection from the supply mains is made disconnecting the auxiliary connector M12 5 pin from the ODU or disconnecting the LAN PoE cable.

The typical magneto thermal switch has characteristics at least 60Vdc @6A with overcurrent relay class "C" or "K" tripping curve.

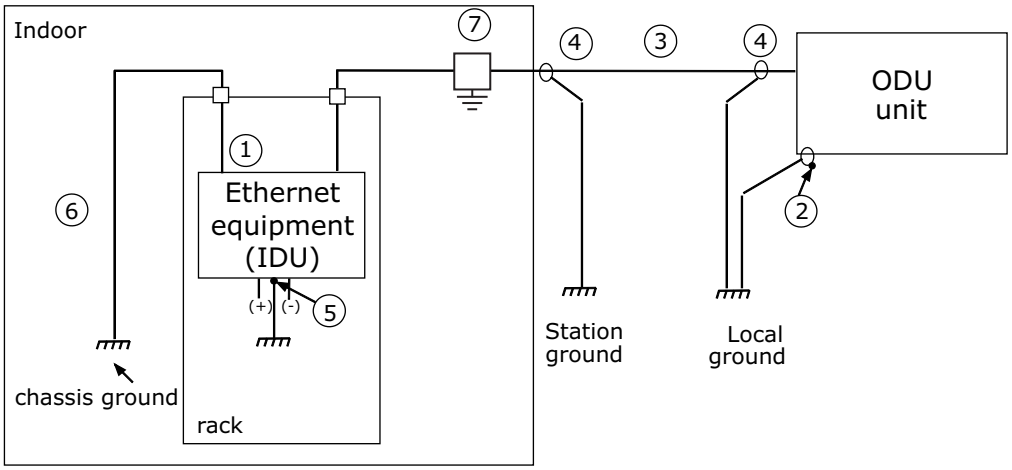
Seal the M12 connector when it isn't used, in order to avoid the removal of the cover without tools (coupling torque=4Nm).

The operating temperature of power cable must not exceed 60°C.

8.5 GROUNDING CONNECTION

Fig.30 and annexed legend show how to perform the grounding connections.

The ODU must be connected to ground with the available grounding bolt and eyelet terminal, making reference to Fig.31.



Legend

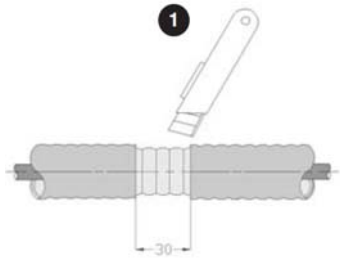
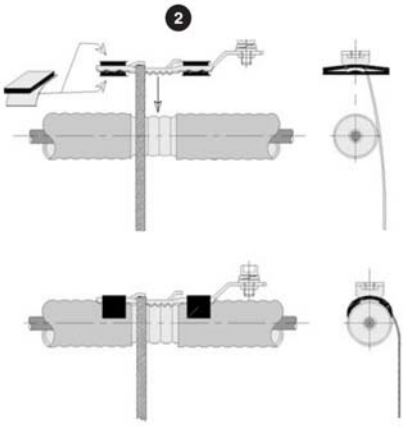
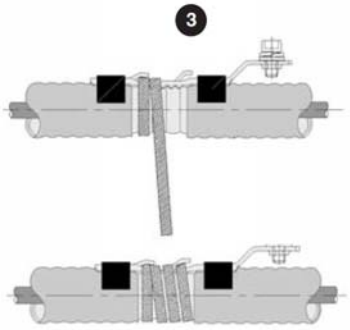
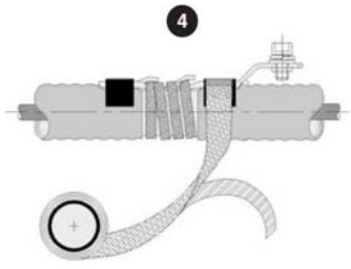
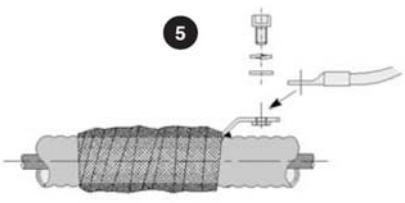
1. Ethernet equipment chassis grounding point. The cross section area of the cable used must be ≥ 4 sq. mm.
2. ODU grounding M6 bolt copper faston type. The cross section area of the cable used must be ≥ 16 sq. mm (V42025)
3. IDU–ODU interconnection cable.
4. Grounding cable kit (ICD00072F) copper cable type or copper alloy to connect the shield of interconnection cable.
5. Battery grounding point of IDU to be connected to earth by means of a cable with a section area 2.5 sq. mm. Length ≤ 10 m.
6. Grounding cords connected to a real earth internal of station. The cross section area of the cable must be ≥ 16 sq. mm
7. Surge arrester (when needed).

Fig.30 - Grounding connection

8.5.1 Mounting instructions of grounding cable kit ICD00072F (universal - no tools)

The kit IDC00072F can be used for both RG8 cable and Ethernet cable, please follow the procedure (see Tab.11).

Tab.11 - Mounting Instructions

Description	
Remove the cable jacket by 30mm width approximately. Take care not to damage the copper conductor. Clean and dry the application area.	
Remove the protective film from the butyle sealing paste. Put the contact in position on the cable, by firmly pressing on the cable jacket, checking the adherence of the butyle sealing paste. The contact is firmly positioned on the cable jacket.	
Wrap the copper mesh around the contact and outer conductor (at least 4 revolutions). Block the mesh terminal under the contact tooth. Cut the exceeding mesh length.	
Remove the self-agglomerating tape protective film. Carefully wrap tight the tape around contact and cable, following the suitable mean line. Tape adheres remaining in position and progressively self-agglomerates.	
Connect the earthing cable.	

8.6 REQUIRED TOOLS FOR MOUNTING (NOT SUPPLIED)

- N.2 13mm torque wrench
- N.1 15 mm torque wrench
- N.1 17 mm torque wrench
- N.1 3 mm Allen wrench.

8.7 INSTALLATION PROCEDURE

Installation procedure proceeds according to the following steps:

- According to antenna polarization (vertical or horizontal), assemble the antenna and support bracket.

Warning: These instructions are fully detailed in a separate manual “Antennas - Code: MN.00249.E” depending on the type of used antenna.

- Installation of the ODU
- Installation onto the pole of the supporting bracket
- ODU grounding.

8.7.1 Standard coupling kit

The standard coupling kit is mounted on ALFOplus by means of four screws.

Coupling kit assembly procedure

See Fig.31 - Put the standard coupling kit on the ODU. Align the four holes of the coupling kit with the four nut screws on the ODU. Insert and tighten the four screws.

8.8 INSTALLATION ONTO THE POLE OF THE ODU WITH INTEGRATED ANTENNA

8.8.1 ODU (Standard Lock)

Mounting kit

- Centring ring and relevant screws
- M10 bolts
- ODU with O-ring and devices for ground connection

8.8.1.1 ODU with integrated antenna

Install the antenna using the antenna installation guide (specific for each antenna) inside the antenna box provided by antenna producer. Keep attention to the polarization of the antenna feeder depending on requested polarization.

After the antenna is installed onto the pole, the ODU must be installed, see Fig.32.

- Position the three holes circular flange (1) on the antenna flange and align the three holes on the circular flange with the three relevant holes on the antenna flange
- Insert and tighten the three 3mm M4 Allen screws (2) using a 3mm Allen wrench (torque = 2 Nm).
- To maintain disassembly performances intact for a longer period add lubricant paste, e.g. MOLYKOTE P-40, on threads of four 25mm bolts (3).
  The sliding surfaces must be cleaned. The paste must then be applied with a suitable brish, rag or grease gun. It must not be mixed with grease or oils. Chemical protective gloves must be worn where repeated or prolonged contact can occur.
- Screw partially the four M10 bolts (3) on the antenna back plate: each bolt should be tightened to have the square head out of the hole of about 13-14mm (the thickness of hook, use 15mm spanner)
- It is recommended to apply seal and lubricant grease Dow Corning 4 (not supplied) to the O-ring, protecting fingers with gloves, and insert in the proper track on the ODU flange
- Position the ODU vertically near the four bolts on the antenna flange and align the ODU to match the polarization of the antenna feeder:
  - vertical polarization: the handle of the ODU is at the bottom left corner
  - horizontal polarization: the handle of the ODU is at the bottom right corner
- After the right position has been found, rotate 30° counter clockwise the ODU and approach the ODU to the antenna flange in order to have the four slots of the Standard Lock cross between the four bolts
- Rotate 30° clockwise the ODU to hook each slots on the relevant bolt
- When each slot is firmly hooked on the relevant bolt, tighten each bolt (use 15mm spanner, torque=46Nm)
- Optional: sun cover kit (AAAL00033) - Insert the sun cover and tie one of its bottom holes to the ODU handle by means of the black plastic strip included in the sun cover kit
- The ODU is ready to be connected to the grounding cable and to the LAN cable.

Warning Leave 25 cm straight Lan cable between Amphenol connector and first bending to secure waterproof IPx5.

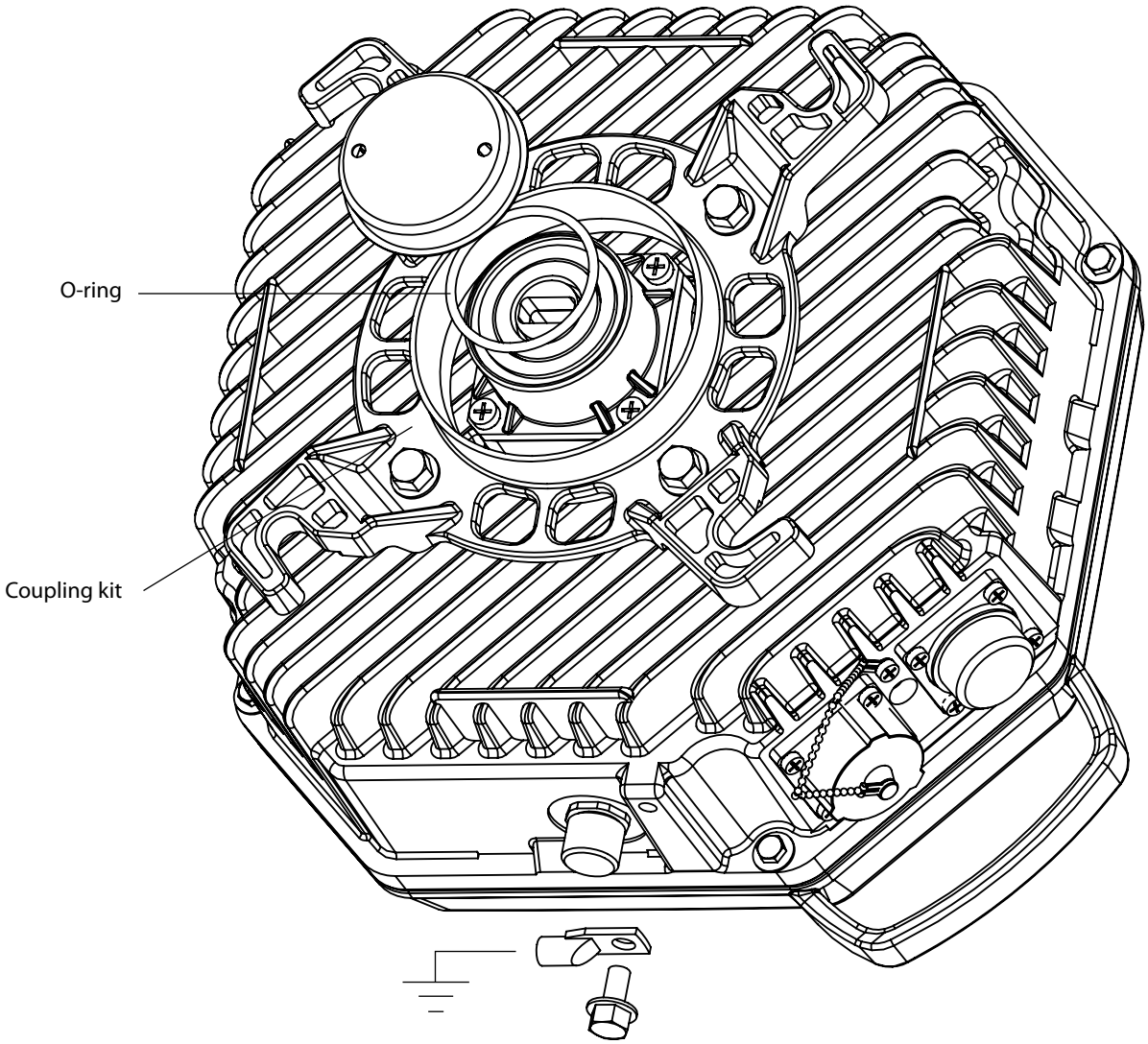


Fig.31 - ODU with standard coupling kit

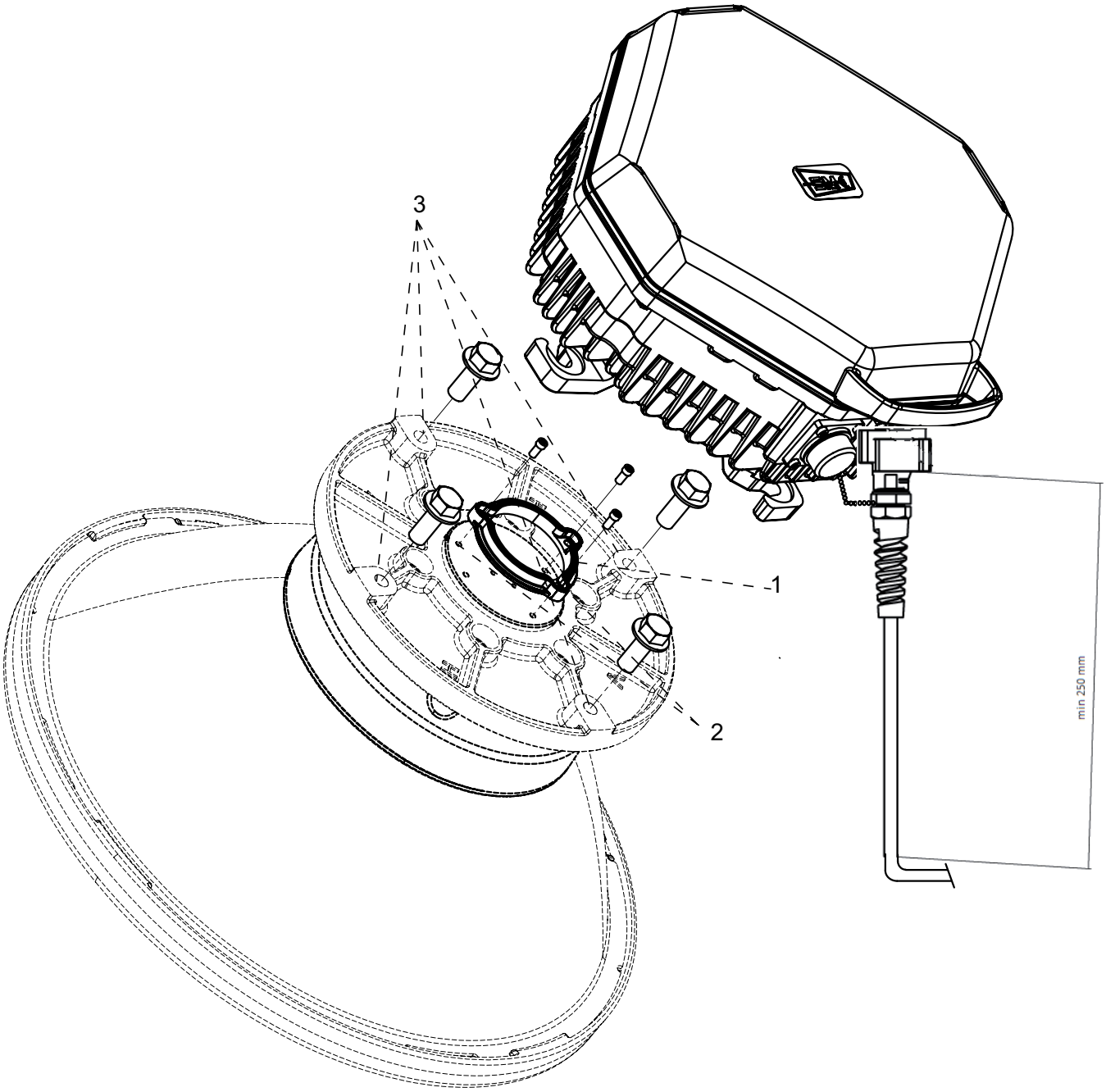


Fig.32 - ODU installation

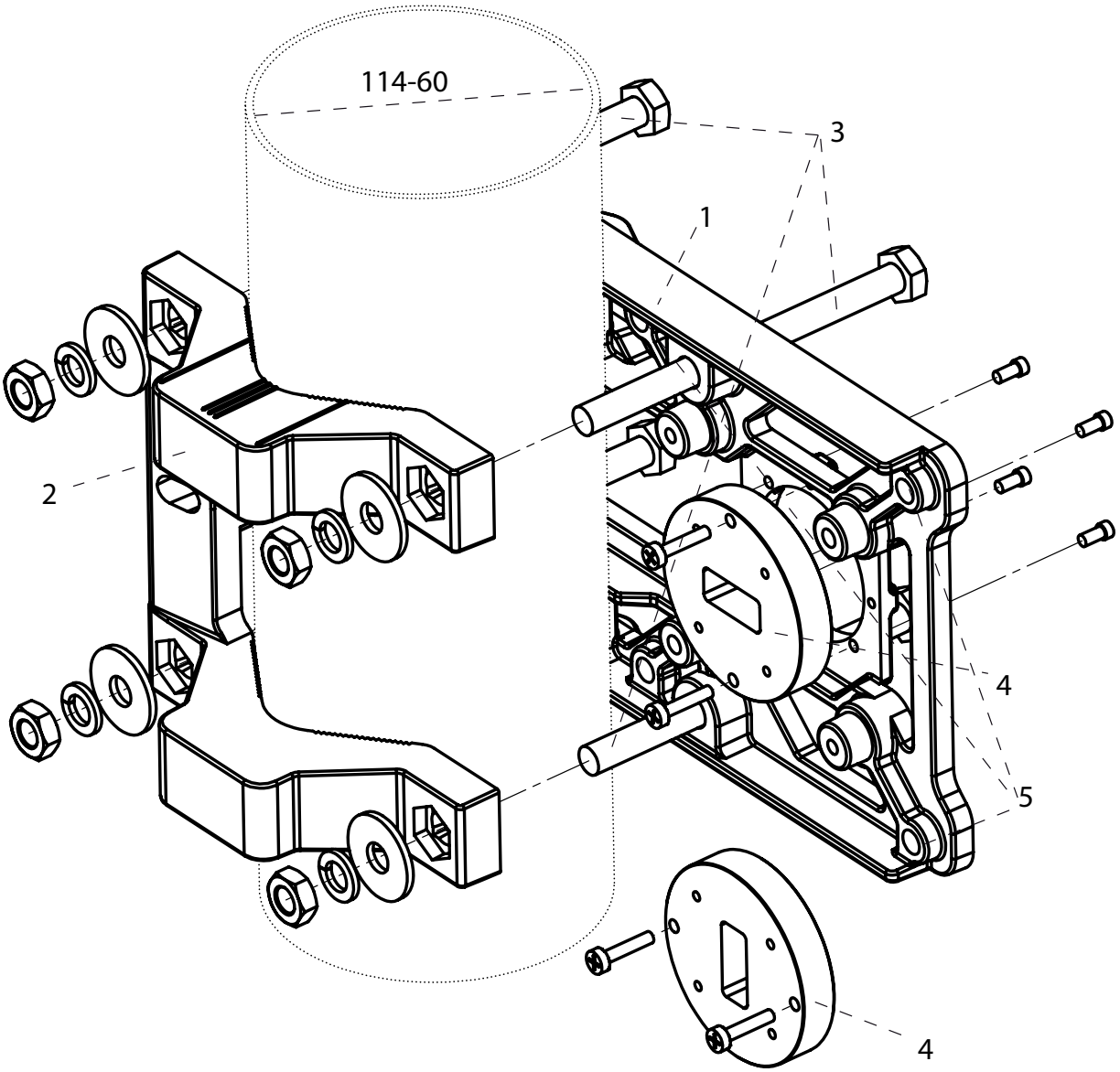


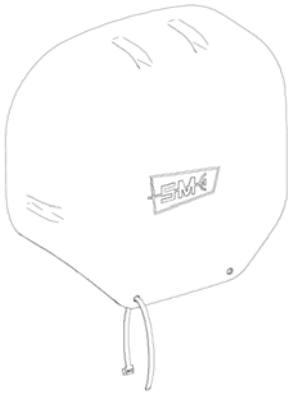
Fig.33 - Pole mounting

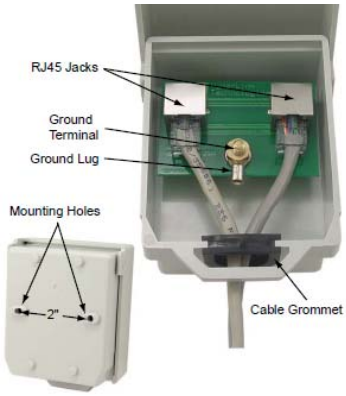
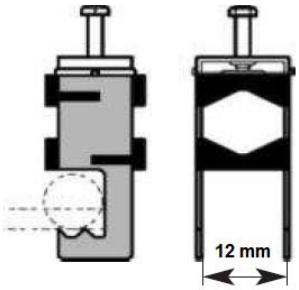
8.9 ACCESSORIES FOR INSTALLATION

In the following a list of materials to be used during installation.

Tab.12 - Accessories for installation

SIAE code	Descriptions	View
U00900[a.] [b.]	Junction box IP66, for fallen of optical cable to connect 1 ODU	
U00921[a]	Fibre optical splitter distribution box for 1 ODU	
U00922[a.] [b]	Junction box IP66, for fallen of optical cable to connect 2 ODU	
J23599	Amphenol wrench connector	
M03148	9x360 nylon ties cable	

SIAE code	Descriptions	View
ICD00072F	Universal kit cable grounding	
V60052	15...42GHz TR installation kit (Standard type)	
V42025	Grounding cable kit for ODU 1+0	
AAAL00033	ODU solar shield (optional)	
U00899 [a.]	Optical box IP67 150x250x46	

SIAE code	Descriptions	View
ICD001134 [c]	RJ45 Indoor Surge Protector	
M21565 [d]	Self locking clamp 1X	
M21564 [d.]	Self locking clamp 2X	
IFA000155	Flexible spiralled sheath self-extinguishing conduit for ODU (Φ = 32mm)	

a. Boxes don't foresee replacement seals.

b. If the second ODU connection takes place much later than the first one, it is possible that the closing of U00922 box doesn't guarantee the seal tightness.

c. This unit provides Bi-Directional protection. Input and output cables may be interchanged.

d. Hooking on Φ = 8 ÷25 round and 3-25mm Flat

8.9.1 Installation procedure of optical box

Components

Fig.34 - Components

Recommended tools (not included)

Fig.35 - Recommended tools (not included)

Installation

1. Open the cover by special key and screw off the middle plate

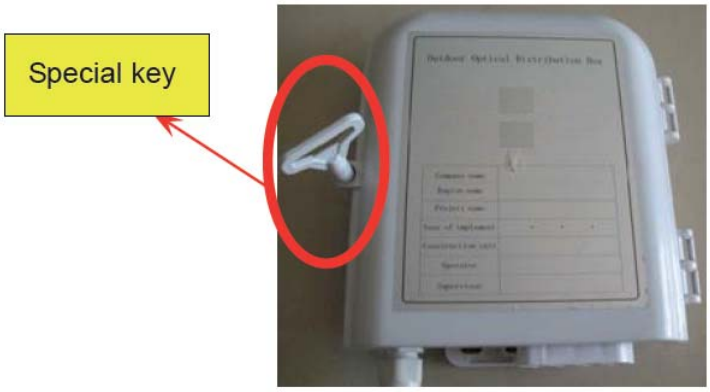


Fig.36

2. Take off the adapter panel, put it back after installing adapters

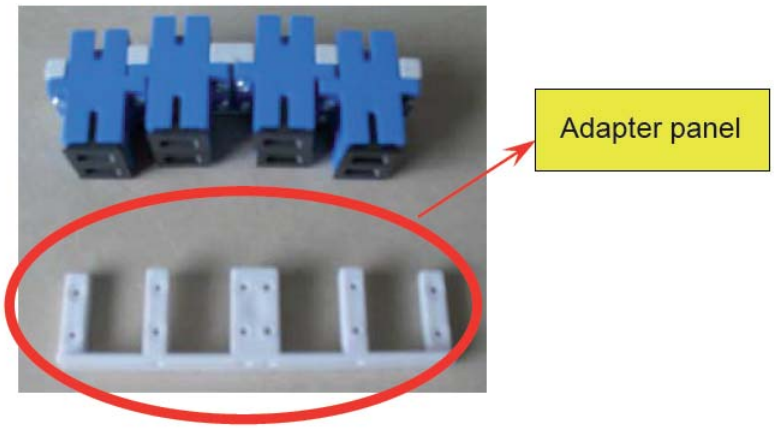


Fig.37

3. Fix PLC splitter, connect splitter ribbon fibres with output pigtails that coated loose tube, fix the arranged output pigtails with loose tube to tray. Lead output pigtail to the other side of the tray and insert adaptor.

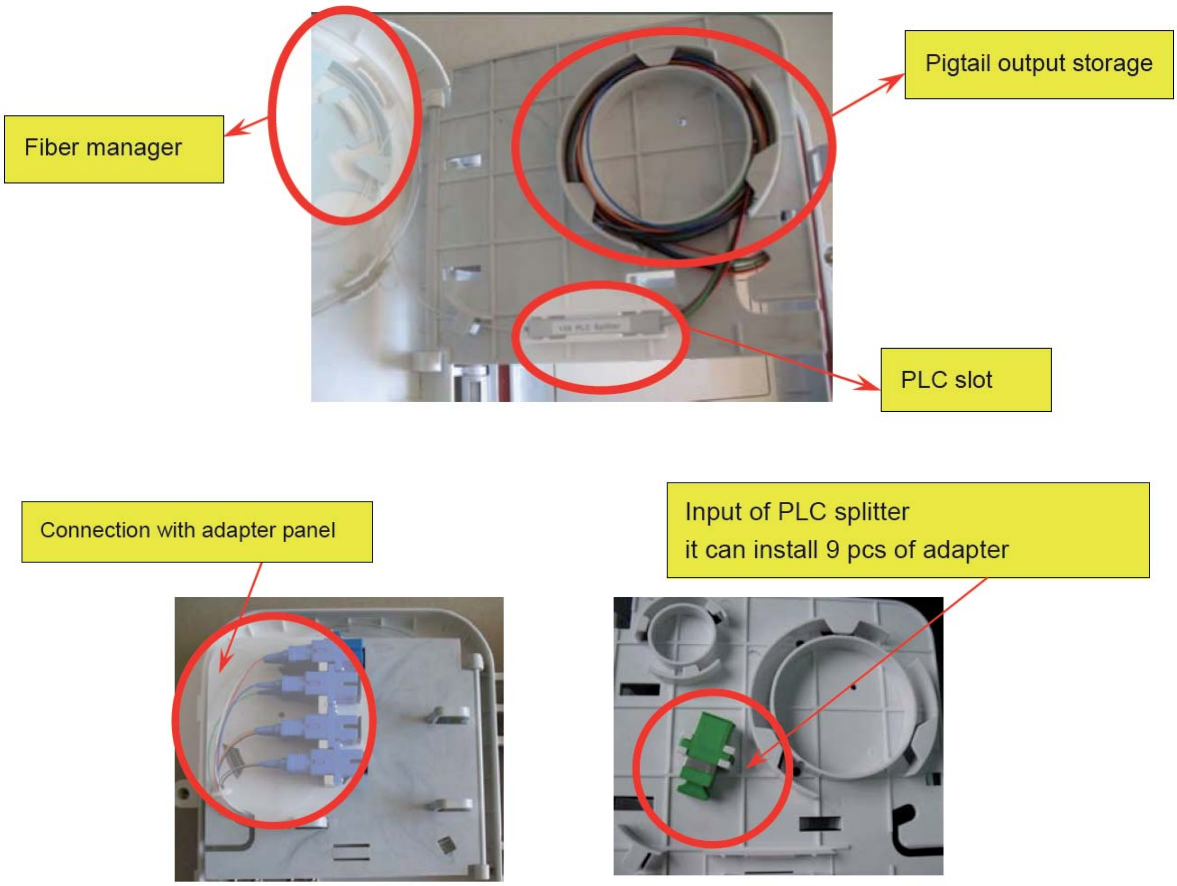


Fig.38

4. Remove the input entry holder and tension member, put stripped fibre through rubber ring and fix; then guide the fibres in sleeve to splice with input of splitter.

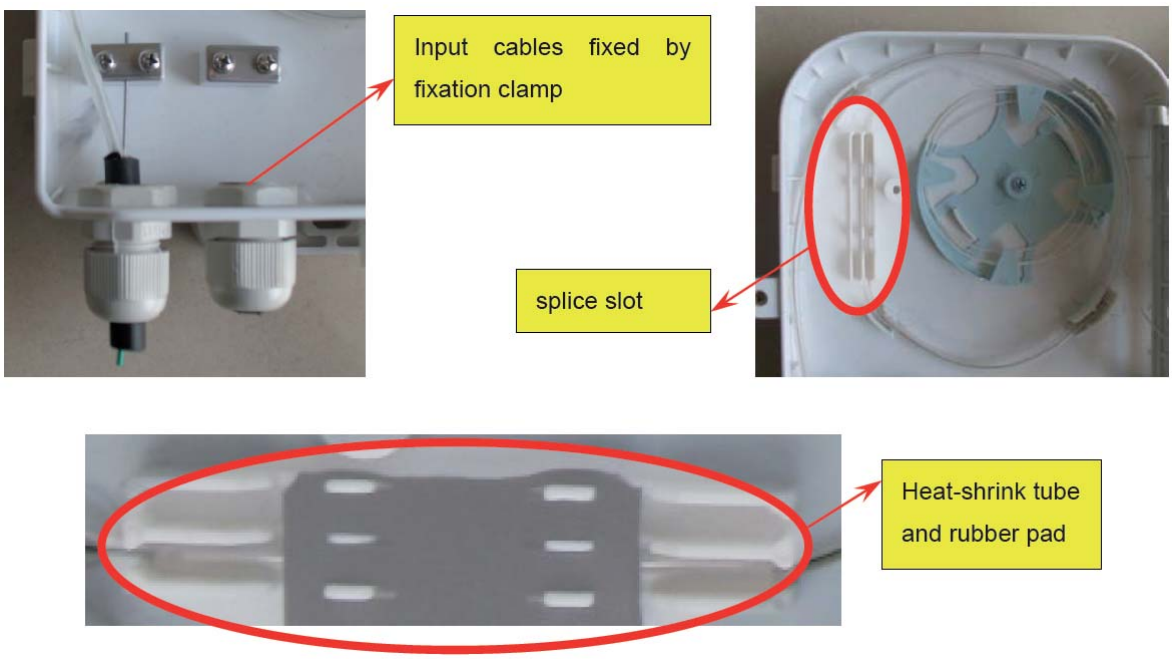


Fig.39

5. Fibre connection, coiling and storage, fixing, suitable for 2mm (or 3mm) pigtail and drop cable.

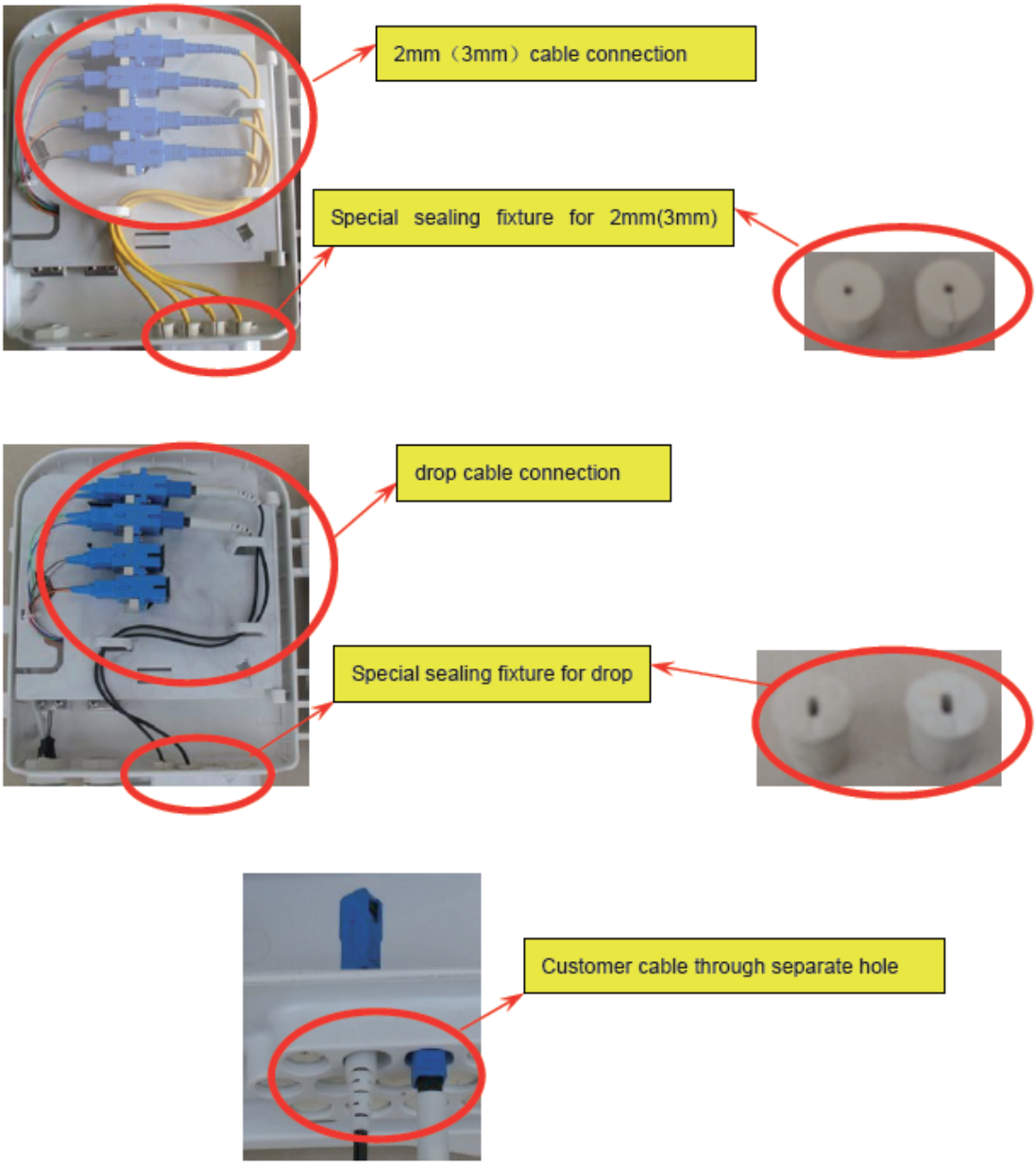


Fig.40

6. Check and lock the door

Fig.41

7. Installation:

- pole mounted, make pole band pass through bracket's hole, fix the bracket to the pole by fastening pole band's bolts
- wall mounted, mark the target point on the bracket to target point by nail or bolt.

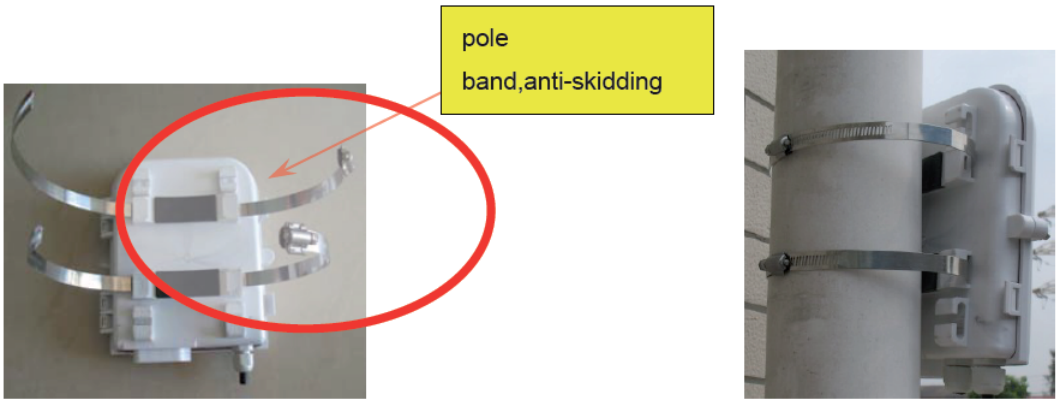


Fig.42 - On pole

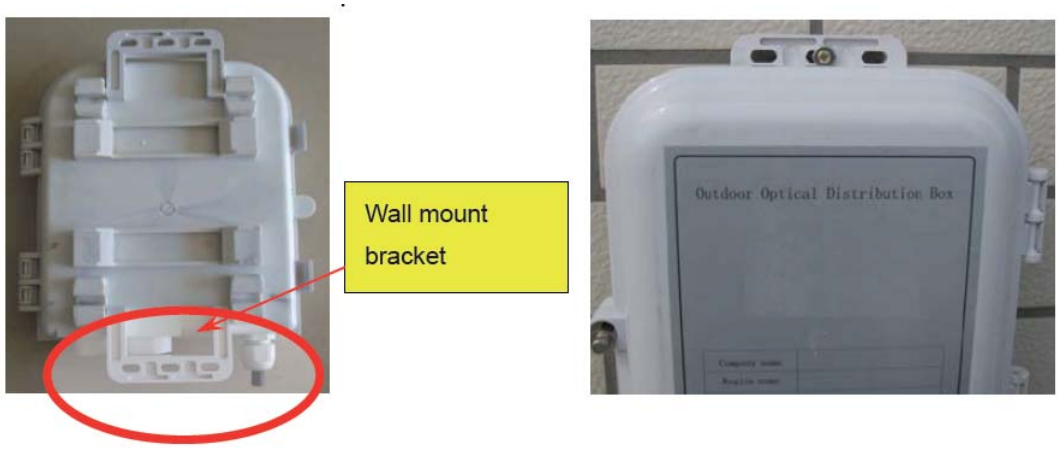


Fig.43 - Wall mounted

8.9.2 RJ45 crimping tool

The recommended RJ45 crimping tool is shown in Tab.13.

Tab.13 - Recommended RJ45 crimping tool

SIAE code	Descriptions	View
J01977	HTS2500 crimp tool for shielded plugs with strain relief, one step (L-COM Global Connectivity)	

Warning: the electrical connectivity is guaranteed only with coded connector. Please don't use other modalities (the RJ45 plug for indoor and outdoor must always be shielded).

8.9.2.1 Use standard RJ45 crimper

As shown in Fig.44, the comb of a standard crimper is inserted in the housing to fasten the indoor RJ45 shielded (P03192) connector, while in the case of an outdoor RJ45 shielded (P20051) which has a shorten dimension, the comb could destroy the connector and therefore do not ensure Ethernet Connectivity, so it is important unscrew/remove it as shown in the Fig.45.

Fig.44 - Standard RJ45 crimper used for RJ45 outdoor connector

Fig.45 - Standard RJ45 crimper (without comb) used for RJ45 shielded outdoor connector

8.10 USER CONNECTORS

ALFOplus provides an auxiliary connector (M12) and 2 Amphenol connector, which guarantee Ethernet port compatibility for both version: Gigabit electrical and optical.

Warning: to ensure waterproofing, don't forget to close the port after use, with relevant cap.

8.10.1 Auxiliary connector

The auxiliary 5 pin circulator connector has various functions and it is used when:

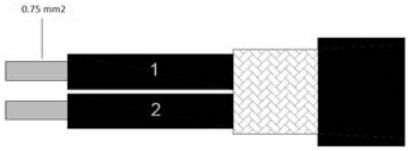
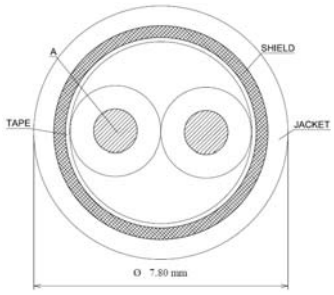
- the Power over Ethernet injector through the data Lan cable is not available or as additional power supply source
- during the alignment of antenna (remember to enable received signal strength indicator in **Equipment menu - General preset RSSI**

  It is recommended **after the alignment** to set RSSI as Disable not to overload CPU
- In case of emergency, if ALFOplus IP address is unknown, connect it with serial console (F03594), as shown in Fig.50 using hyperterminal 115200 8, N, 1 and press any button to access in the login.

The available auxiliary cables already assembled:

- F03594 cable for laboratory use only (see Fig.50)
- F03608 2xM12 5P pointing cable (remove it after commissioning pointing) (see Fig.51).

Tab.14 - Auxiliary power cable

SIAE code	Descriptions	View
P04185	Female 5 pin M12 shielded connector	
M10154	Outdoor power supply cable 2x0.75mmq for distance ≤ 100m	
M10166	Outdoor power supply cable 2x1.5mmq for distance ≤ 200m	

Assembly steps for M12 male / female connector and conductor

a= slide on parts

b= strip conductor, widen shield and lay around the shielding ring, cuf off projecting mesh. Slide cores through the housing. mount shielding ring, gasket and clamping cage. Tighten pressure screw to fix the cable. Screw down cores. Mount male/female part. Tighten pressure screw.

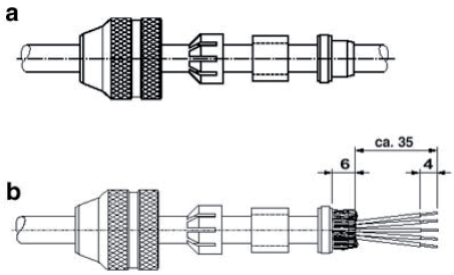


Fig.46 - Functional drawing

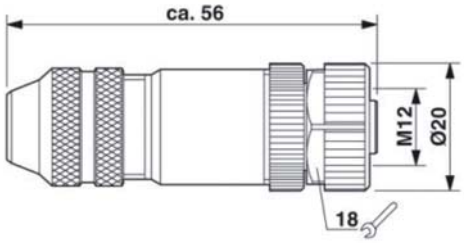


Fig.47 - Dimensioned drawing - M12 connector

Schematic diagram

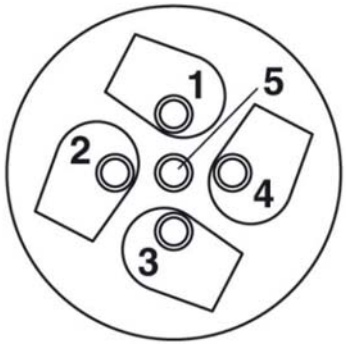


Fig.48 - Cable connection side M12 (screw connection)

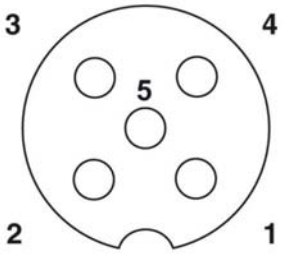
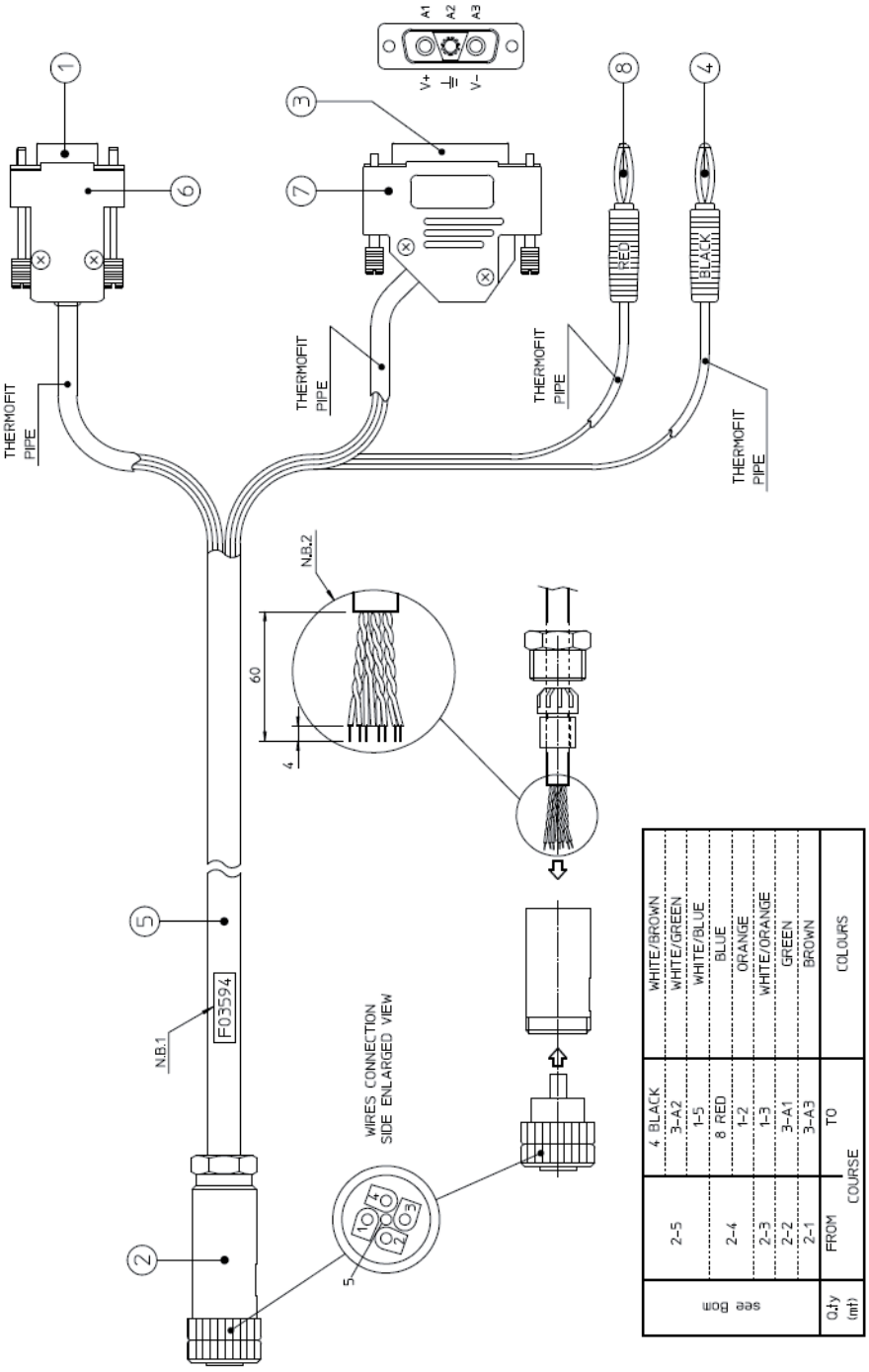


Fig.49 - Pin assignment M12 socket, 5-pos., A-coded, socket side view

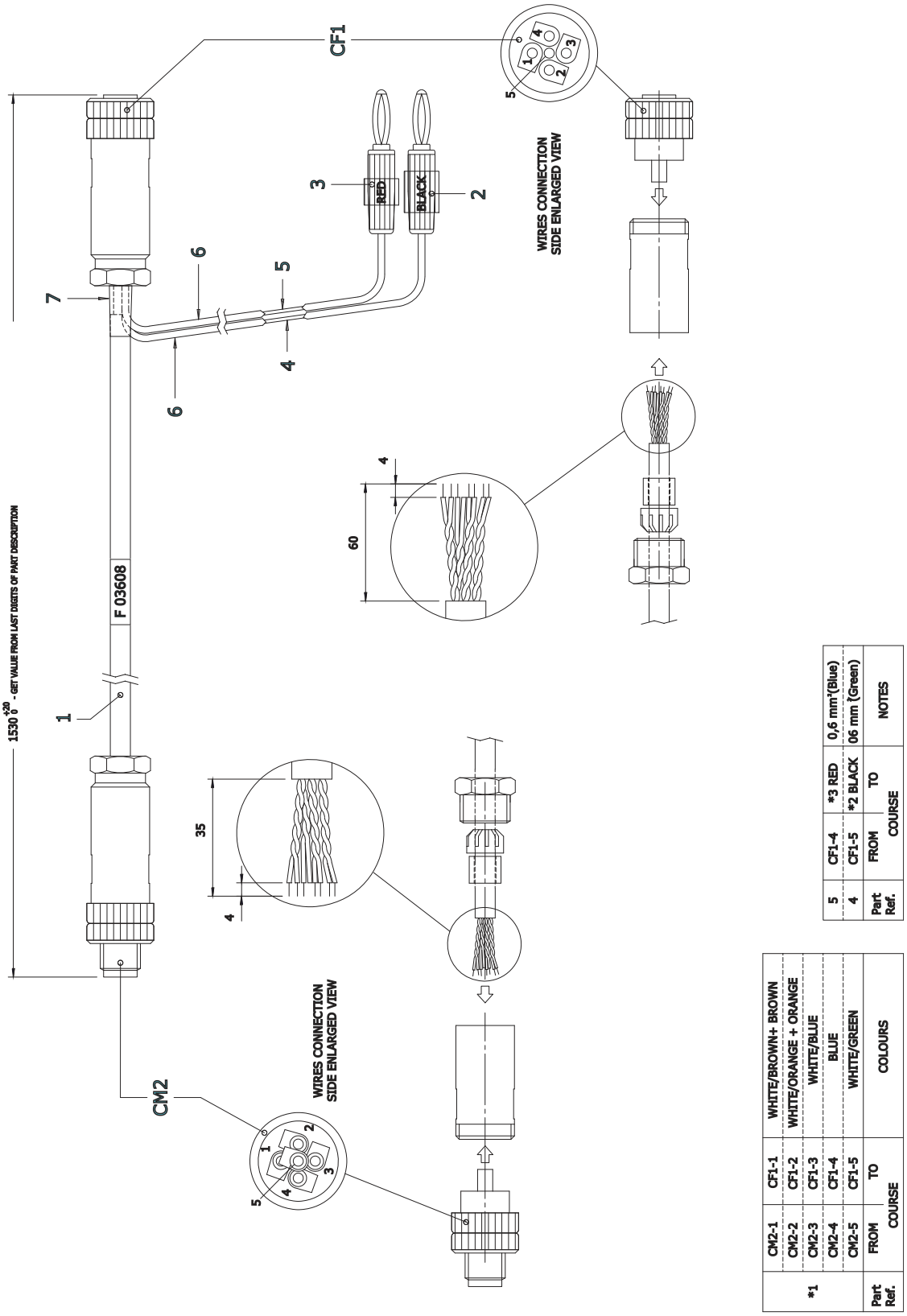
Tab.15 - Pinout M12 connector

Pinout	Description
1	Vdc (-) = -48 Volts
2	Vdc (+) = 0 Volts
3	Rx_Console
4	Tx_Console & Vpointing (+)
5	GND_Console & Vpointing (-)
Shield	Ground



In the pin table, first number is the connector and second number is the pin.

Fig.50 - F03594 cable for laboratory use only



Part Ref.	FROM	TO	COLOURS
*1	CM2-1	CF1-1	WHITE/BROWN+ BROWN
	CM2-2	CF1-2	WHITE/ORANGE + ORANGE
	CM2-3	CF1-3	WHITE/BLUE
	CM2-4	CF1-4	BLUE
	CM2-5	CF1-5	WHITE/GREEN

Part Ref.	FROM	TO	NOTES
5	CF1-4	*3 RED	0,6 mm²(Blue)
4	CF1-5	*2 BLACK	06 mm ²(Green)

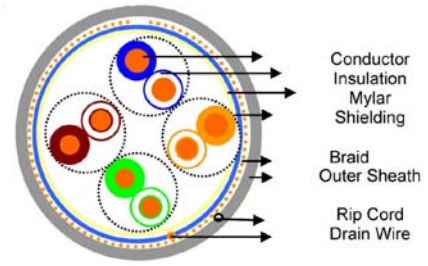
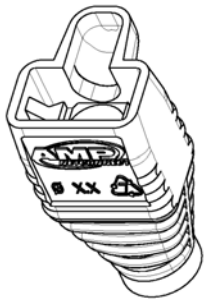
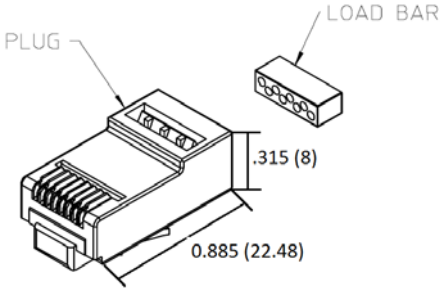
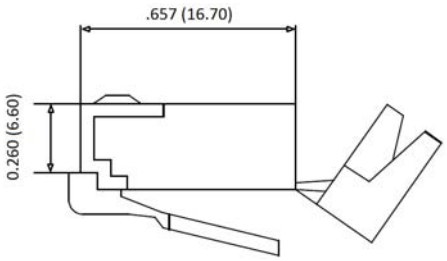
Fig.51 - F03608 cable for pointing (remove it after commission pointing)

8.10.2 RJ45 connector

The electrical RJ45 connection to ALFOplus is guaranteed only with coded connector; do not use other connectors, because the proper one is different from the RJ45 standard.

Part to be assembled (see Tab.16)

Tab.16 - Part to be assembled

SIAE code	Description	View
P20032	Amphenol kit RJ45 shielded full outdoor connector	
M02472	Data cable SF/UTP CAT5e for outdoor (AWG 24) 100 Ohm	
M05184	Indoor RJ45 boot protection black Φ=6mm	
P03192 [a]	Indoor RJ45 shielded plug	
P20051 [a.]	Outdoor RJ45 shielded	

a. Don't use different RJ45.

1000Base-T Gigabit Ethernet cables and connectors

Please be aware that modifying Ethernet cables improperly may cause loss of network connectivity. Please follow colours of wiring.

Tab.17 - Wiring 1000Base-T

Pin	Assignment 1000Base-T	T568B Colour wire
1	BI_DA+	WHT/ORG
2	BI_DA-	ORG
3	BI_DB+	WHT/GRN
4	BI_DC+	BLU
5	BI_DC-	WHT/BLU
6	BI_DB-	GRN
7	BI_DD+	WHT/BRN
8	BI_DD-	BRN

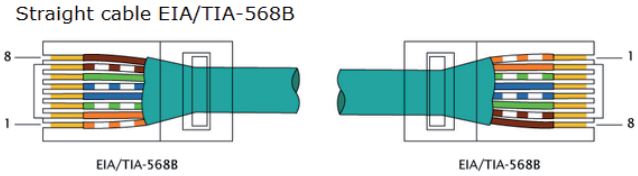


Fig.52 - Straight Ethernet cable

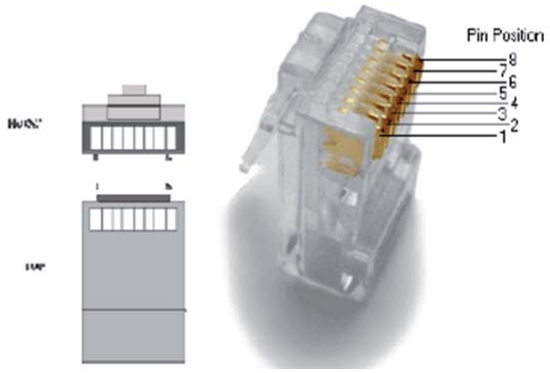


Fig.53 - RJ-45 Pinout

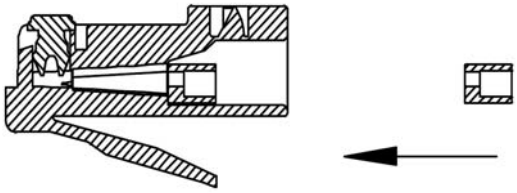


Fig.54 - Indoor RJ45 unshielded assembly

LAN Cable connector - P20032 - Assembly procedure for RJ sealed connectors

Procedure to be used for terminating and assembling of Amphenol Connector Kit

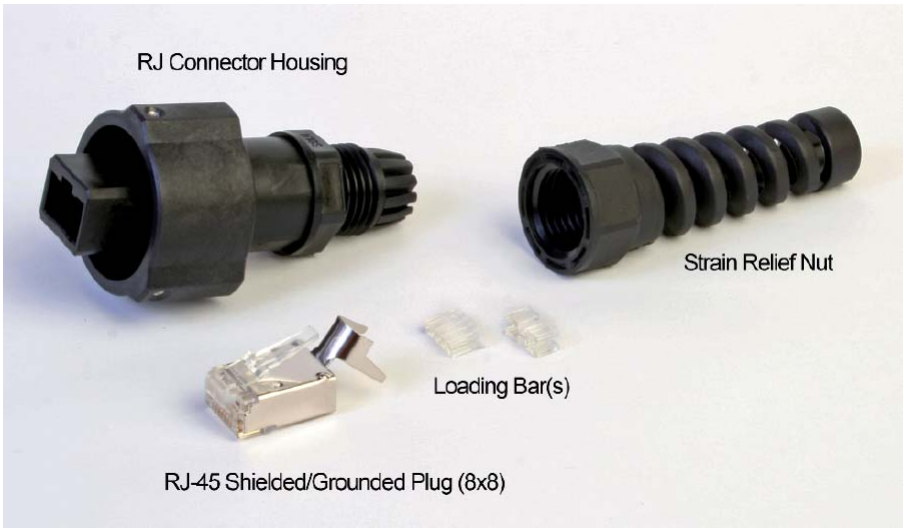


Fig.55 - P20032 kit

Step 1

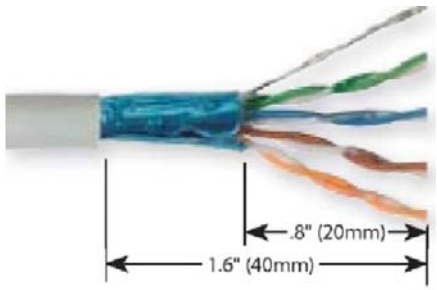
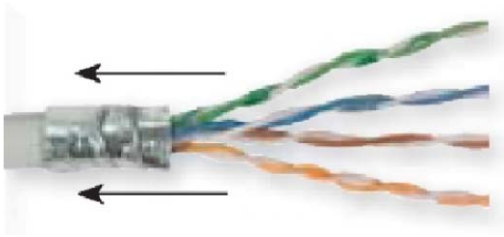
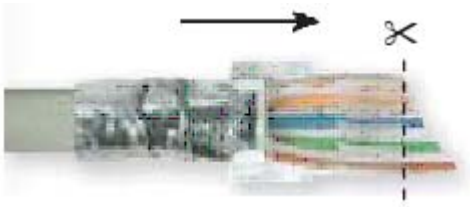
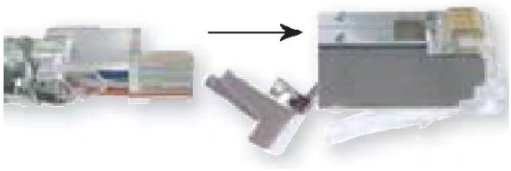
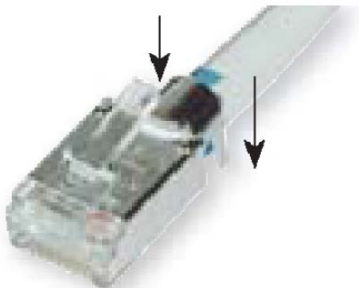
Feed CAT cable through boot and connector housing as shown below.

Warning: Care should be taken not to damage the rubber sealing gasket inside the rear of the connector housing.

Fig.56 - Boot connector

Step 2

Terminate RJ-45 connector onto CAT cable

Strip jacketing and shield as shown	
Fold shield back onto jacketing. Wrap grain wire one and a half times around the shield. Trim excess length from drain wire	
Untwist pairs and arrange to desired order. Note: it is recommended to follow TIA-568 specifications for wiring orientation Trim conductors at an angle and insert into the loading bar	
Trim excess wire from holder Insert prepared cable into RJ-45 Plug	
Bend strain relief to lay along cable	
Crimp plug and strain relief [a]	

a. Use recommended RJ45 crimping tool.

Warning It is mandatory to verify with Ethernet tester (not supplied) the proper connectivity of both ends, in order to avoid autonegotiation problems (as for example 1Gbps full duplex not reached).

Fig.57 - Assembled Amphenol

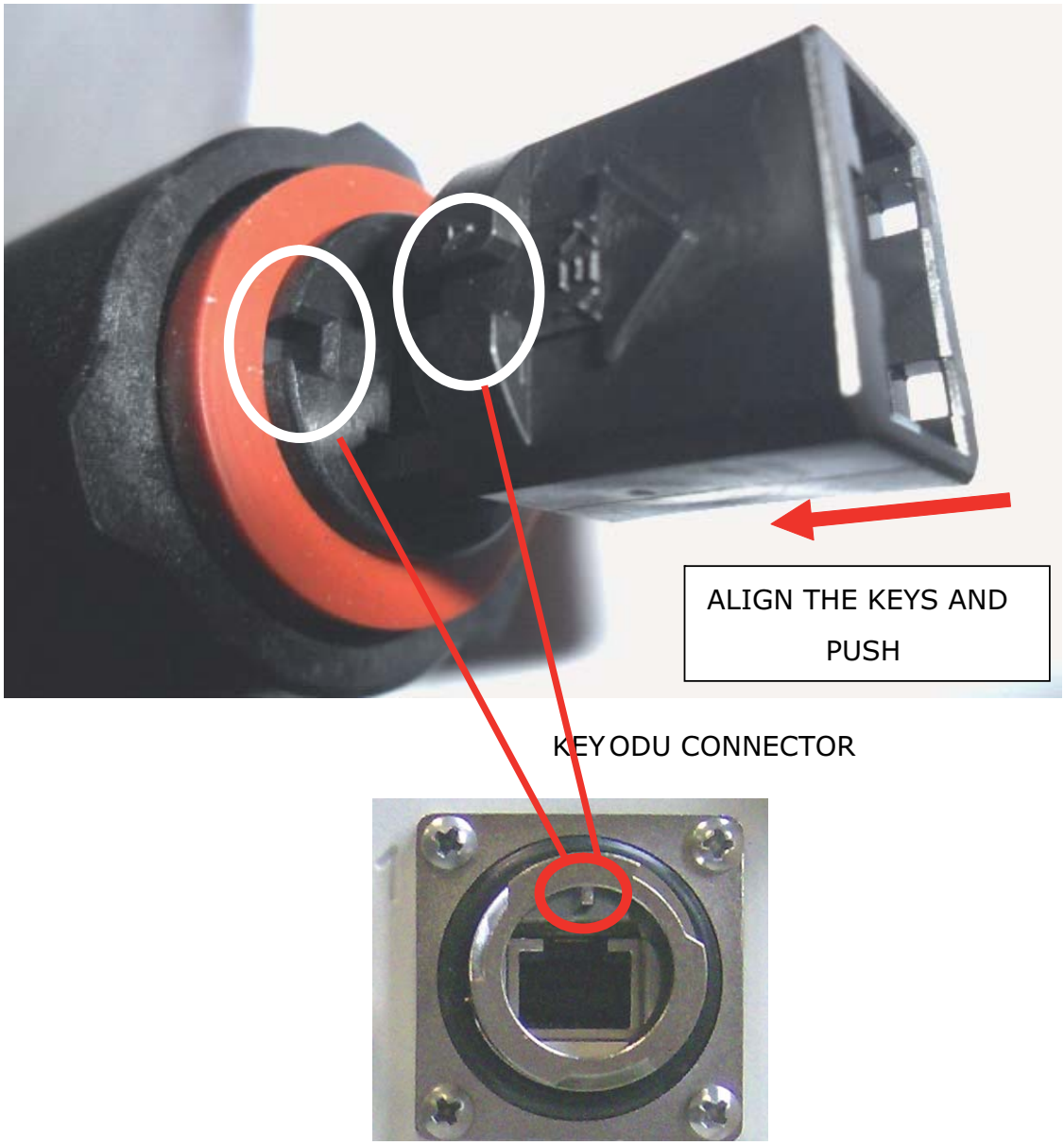


Fig.58 - Cable connector keys

Step 3

Insert terminated RJ-45 plug into connector housing.

While holding the connector body, pull cable through connector housing until RJ plus is near to the housing. Align the plug latch with the connector housing keyway.

Depress Plug latch and completely insert the RJ plug into the housing.

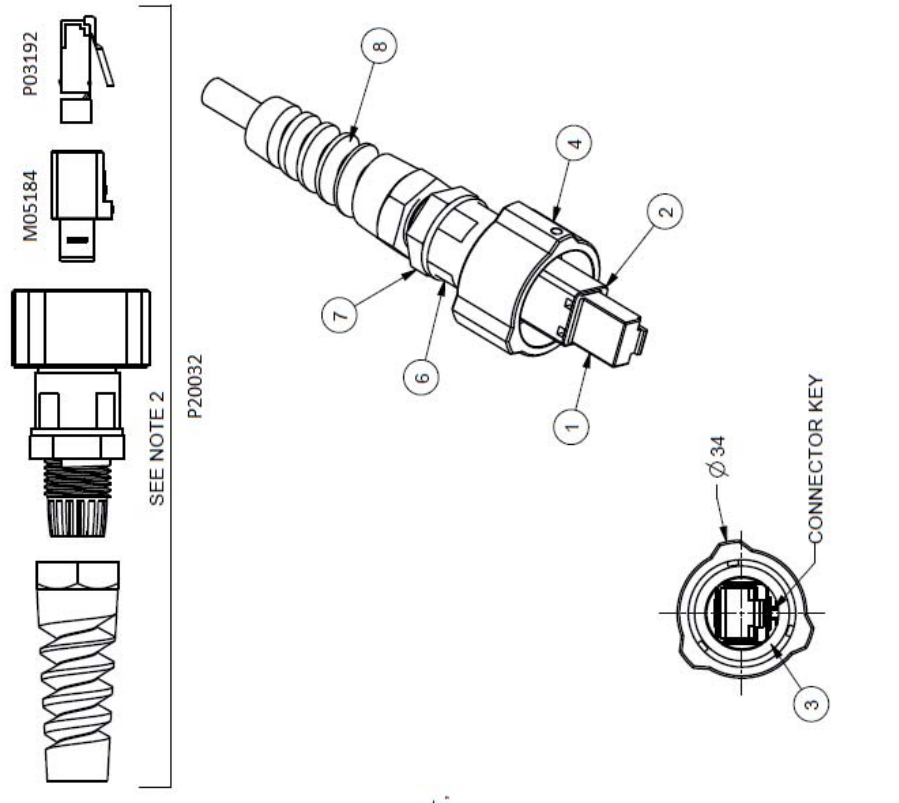
Fig.59 - Connector housing

Step 4

Attach and tighten sealing boot using a 19mm wrench.

Recommended tightening torque is 5.5 to 6.0 (in-lbs) or 0.62 to 0.68 (N-m)

Fig.60 - Connector tight



	COMPONENT	MATERIAL	QTY
1	RJ45 PLUG, 8P, SHLD	Cu W/Ni PLATED, BRASS & PC	1
2	INSERT	DERLIN	1
3	GASKET	SILICONE RUBBER	1
4	COUPLING NUT	RYTON & SS	1
5	O-RING	SILICONE RUBBER	1
6	HOUSING	RYTON	1
7	GLAND	NYLON & NBR	1
8	BOOT, SPIRAL	NYLON	1

TABLE 1

NOTES:

1. ALL DIMENSION ARE FOR REFERANCE ONLY.
2. CONNECTOR IS SUPPLIED AS AN UNTERMINATED KIT OF PARTS.
3. RJ45 SHIELDED PLUG AMPHENOL P/N 957-7105.
4. PLUG KIT MEETS IP 67 DUST AND WATER SEALING REQUIREMENT, WHEN ASSEMBLY IN IS DONE ACCORDENCE WITH AMPHENOL ASSEMBLY PROCEDURE 949-1690.
5. OPERATING TEMPERATURE RANGE -40°C TO +85°C.
6. CABLE CLAMPING RANGE FOR GLAND: 4.0 TO 7.0mm.
7. PRODUCT MUST BE RoHS COMPLIANT AND MEET AMPHENOL REGULATED MATERIAL SPECIFICATIONS 949-1604.

Fig.61 - P20032

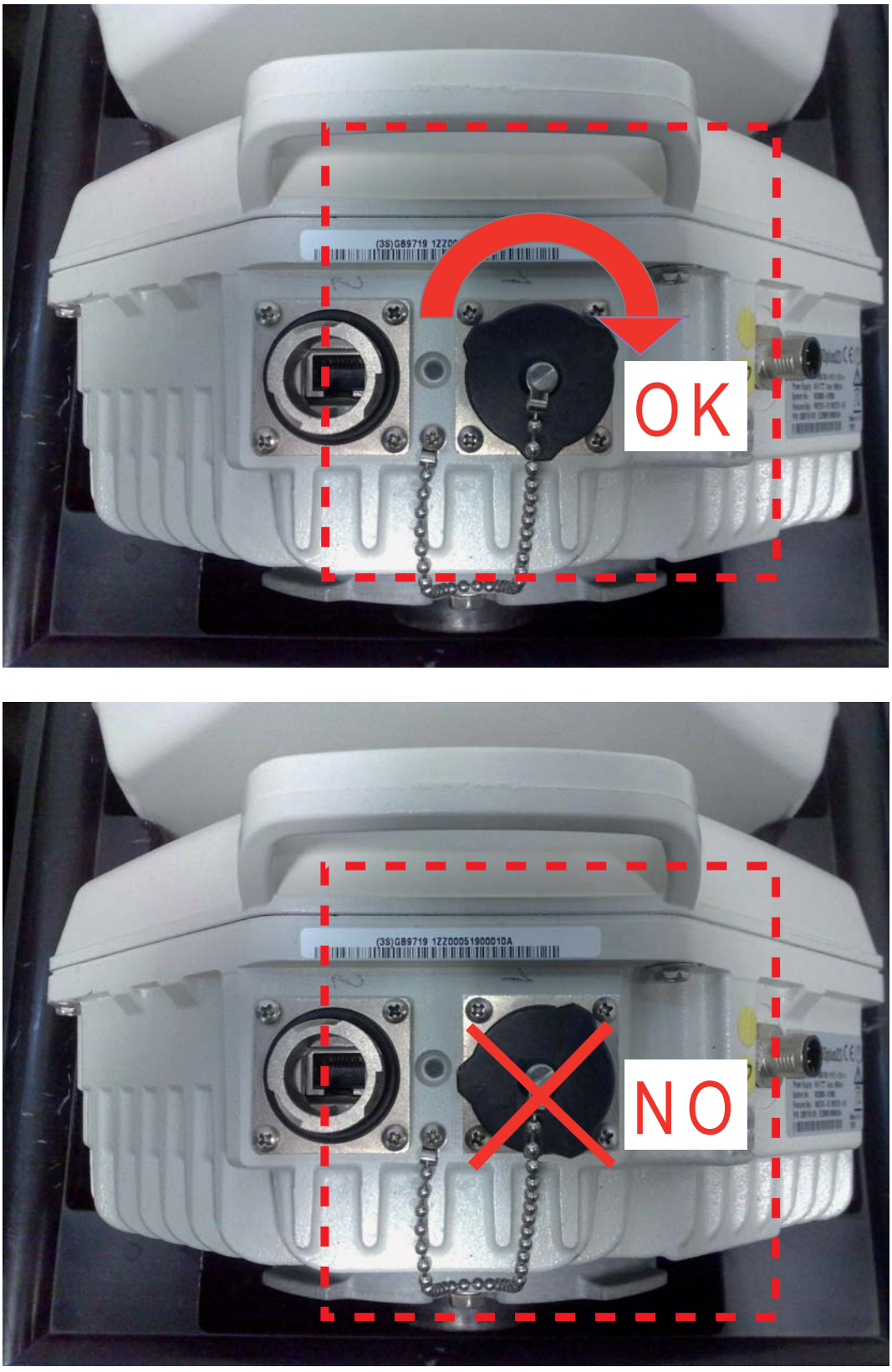


Fig.62 - Connector positions

Warning: Tighten all unused connectors with the appropriate cover using the proper wrench J23599 (see Fig.63).

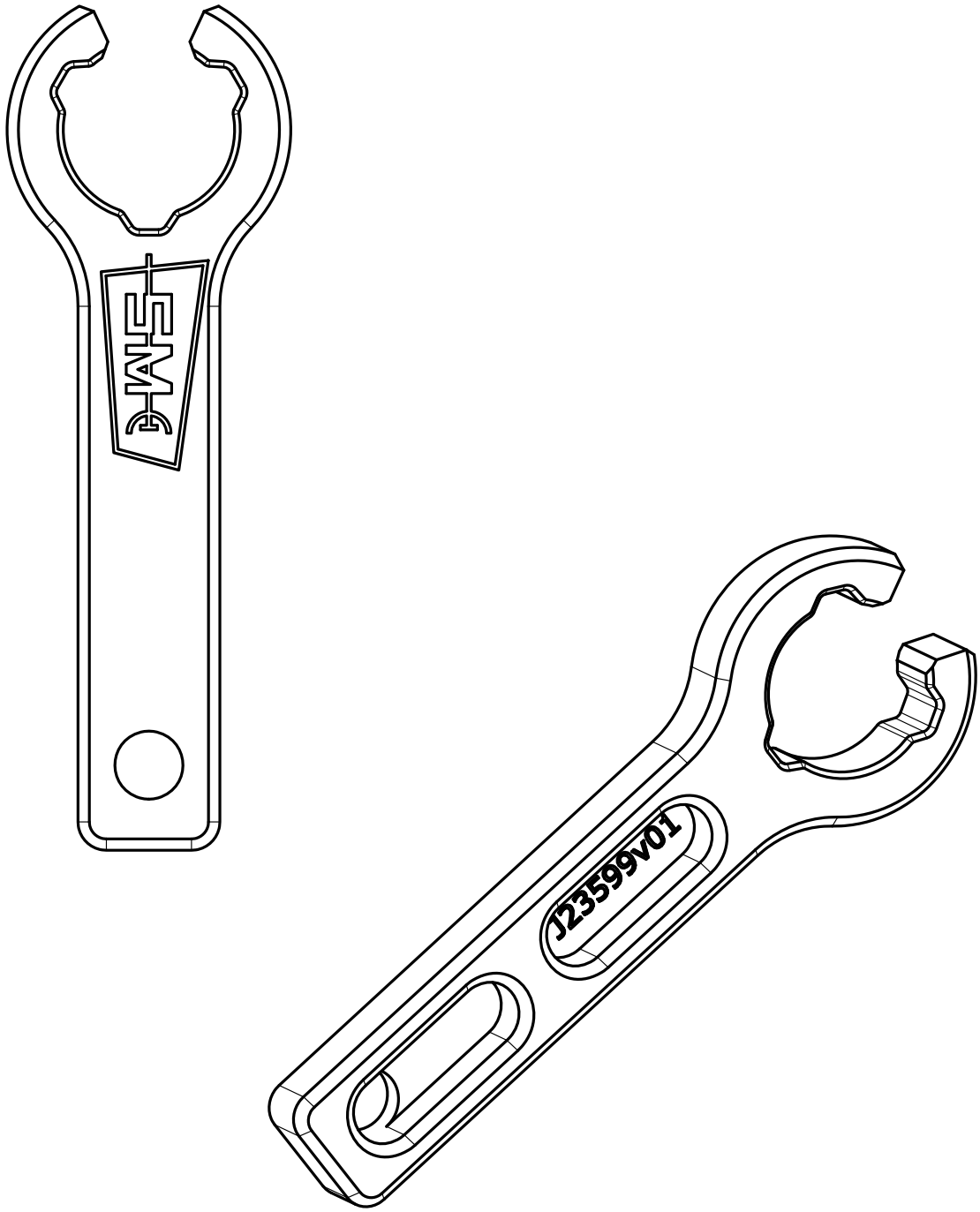


Fig.63 - Locking key for Amph. connectors - J23599

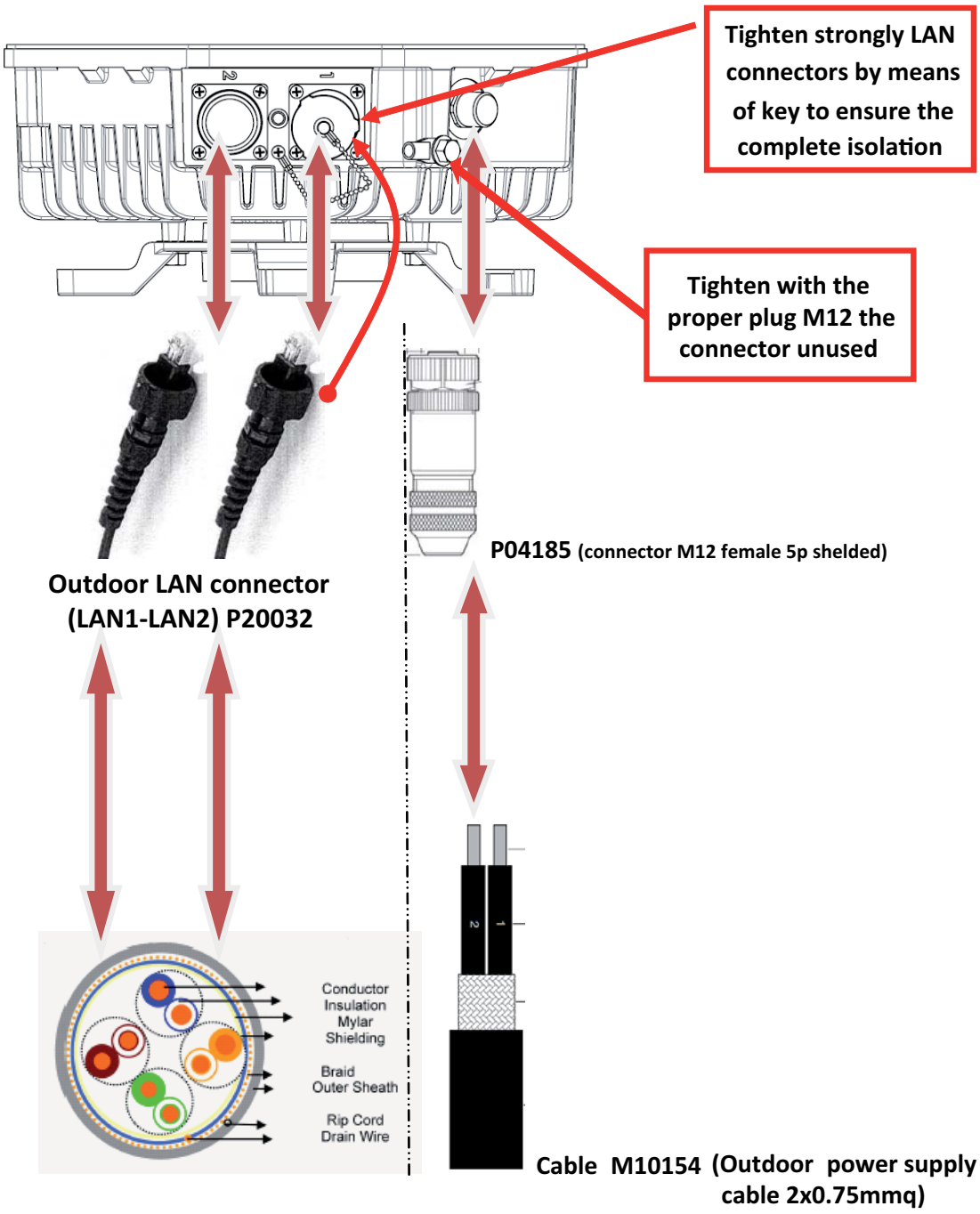


Fig.64 - Assembled connectors

8.10.3 Optical connector

- ODU optical cable — see Tab.18 and Fig.67, Fig.68, Fig.69
- Optical jumper — see Tab.19 and Fig.70
- Operating temperature range — -40° C to +85°C

- Protection class IP67
- LC optical transceivers (SFP) see Tab.20

Tab.18 - List of Amphenol optical cable

Description	SIAE Code
Jumper LC/SFP - Open end L=2.5M (MM)	P20034
Jumper LC/SFP - LC/LC L=25M (MM)	P20035
Jumper LC/SFP - LC/LC L=50M (MM)	P20036
Jumper LC/SFP - LC/LC L=100M (MM)	P20037
Jumper LC/SFP - LC/SFP L=2.5M (MM)	P20038
Jumper LC/SFP - Open end L=2.5M (SM)	P20043
Jumper LC/SFP - LC/LC L=25M (SM)	P20044
Jumper LC/SFP - LC/LC L=50M (SM)	P20045
Jumper LC/SFP - LC/LC L=100M (SM)	P20046
Jumper LC/SFP - LC/SFP L=2.5M (SM)	P20047
Jumper LC/SFP - LC/LC L=15M (MM)	P20048
Jumper LC/SFP - LC/LC L=35M (MM)	P20049
Jumper LC/SFP - LC/LC L=75M (MM)	P20050
Jumper LC/SFP - LC/LC L=2.5M (MM)	P20052
Jumper LC/SFP - LC/LC L=2.5M (SM)	P20053
Jumper LC/SFP - LC/LC L=75M (SM)	P20054
Jumper LC/SFP - LC/LC L=200M (SM)	P20055
Jumper LC/SFP - LC/LC L=15M (SM)	P20056
Jumper LC/SFP - LC/LC L=35M (SM)	P20057
Jumper LC/SFP - LC/LC L=10M (SM)	P20058
Jumper LC/SFP - LC/LC L=10M (MM)	P20059
Jumper LC/SFP - LC/LC L=150M (SM)	P20061

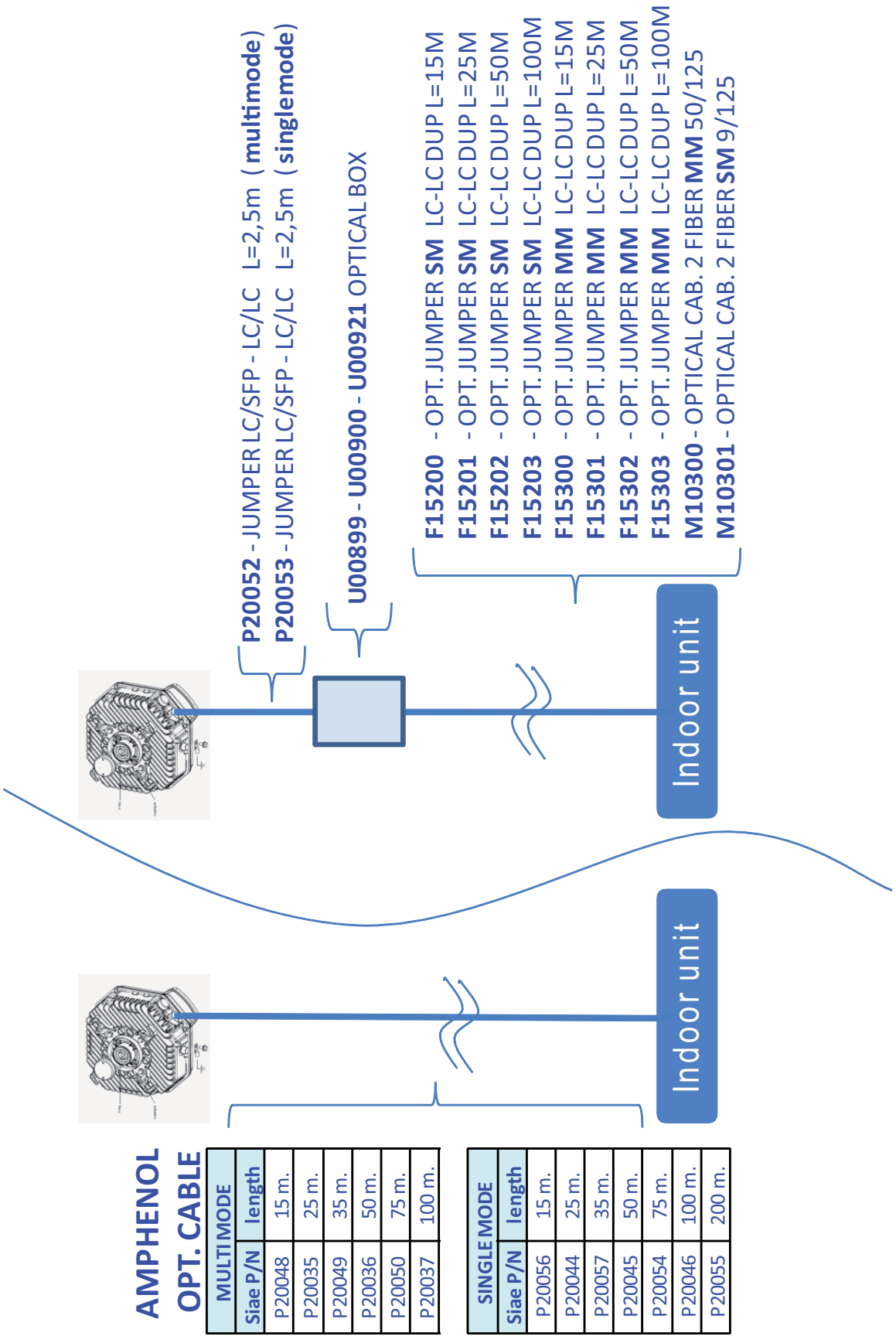
Tab.19 - List of optical jumper outdoor LC/LC

Description	SIAE Code
Opt. Jumper Outdoor SM LC/LC DUP L=15M	F15200
Opt. Jumper Outdoor SM LC/LC DUP L=25M	F15201
Opt. Jumper Outdoor SM LC/LC DUP L=50M	F15202
Opt. Jumper Outdoor SM LC/LC DUP L=100M	F15203
Opt. Jumper Outdoor SM LC/LC DUP L=75M	F15204
Opt. Jumper Outdoor SM LC/LC DUP L=40M	F15205
Opt. Jumper Outdoor SM LC/LC DUP L=60M	F15206
Opt. Jumper Outdoor SM LC/LC DUP L=90M	F15207

Description	SIAE Code
Opt. Jumper Outdoor SM LC/LC DUP L=150M	F15208
Opt. Jumper Outdoor SM 4LC-4LC L=25M	F15221
Opt. Jumper Outdoor MM LC-LC DUP L=15M	F15300
Opt. Jumper Outdoor MM LC-LC DUP L=25M	F15301
Opt. Jumper Outdoor MM LC-LC DUP L=50M	F15302
Opt. Jumper Outdoor MM LC-LC DUP L=100M	F15303
Optical cab. 2 fiber outdoor MM 50/125	M10300
Optical cab. 2 fiber outdoor SM 50/125	M10301

Tab.20 - LC optical transceiver (SFP)

Siae code	Type	Mode	Φ (μm)	Wavelength (nm)	km	Eye safety class
E01414	1000BaseLx	Singlemode	9/125	1310	10	1
E01415	1000BaseSx	Multimode	50/125	850	0.55	1
E01419	1000BaseLx	Singlemode	9/125	1310	10	1
E01428	1000BaseSx	Multimode	50/125	850	0.3	1



MULTI MODE	
Siae P/N	length
P20048	15 m.
P20035	25 m.
P20049	35 m.
P20036	50 m.
P20050	75 m.
P20037	100 m.

SINGLE MODE	
Siae P/N	length
P20056	15 m.
P20044	25 m.
P20057	35 m.
P20045	50 m.
P20054	75 m.
P20046	100 m.
P20055	200 m.

Fig.65 - IDU-ODU optical connection

8.10.4 Optical SFP mounting procedure

Follow the instructions:

- plug the SFP module into LC embedded connectors until “Click” (see Fig.71 and Fig.72)
- pull lightly the SFP and check that it is locked to the connector (see Fig.73)
- insert plugged SFP on ALFOplus optical cage (see Fig.74)
- lock the connector by turning the nut (see Fig.75).

Warning: don't insert the SFP module inside the housing of the ODU without the preliminary connection between cable and the SFP as described in this paragraph.

8.10.5 Optical SFP unmounting procedure

Follow the instructions:

- unlock the connector by untightening the nut
- eject SFP module from ALFOplus Optical cage
- to unplug thr SFP from LC connector, push the locking by keeping a finger below the SFP module (see Fig.76).

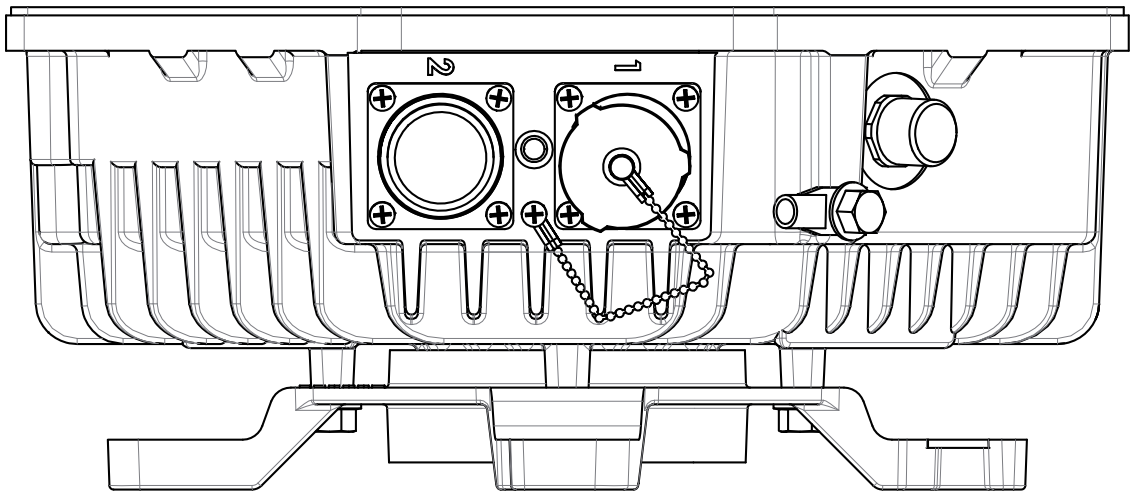


Fig.66 - ALFOplus connectors

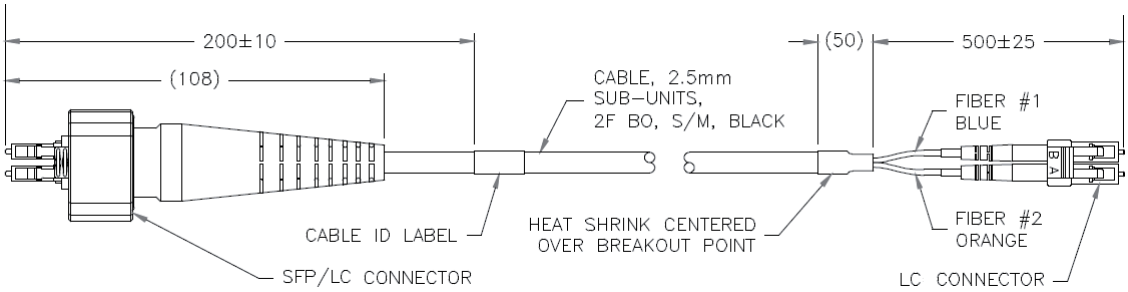


Fig.67 - Jumper LC/SFP - LC/LC

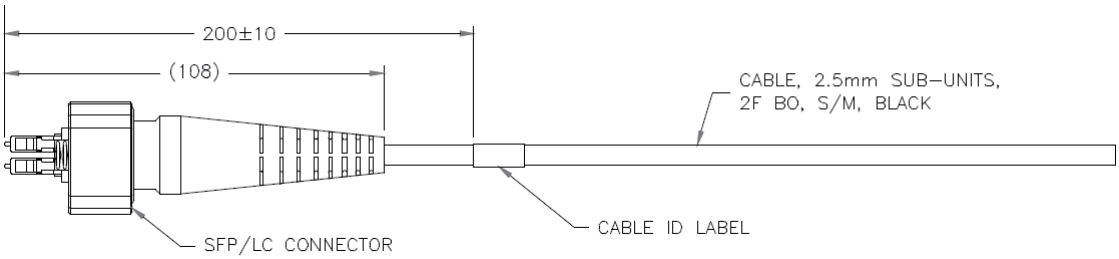


Fig.68 - Jumper LC/SFP - Open end

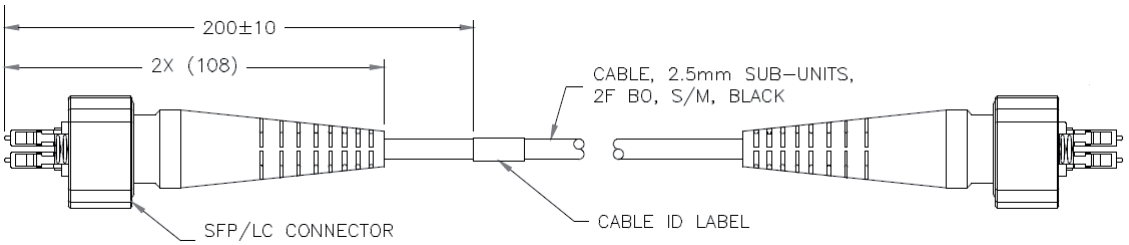


Fig.69 - Jumper LC/SFP - LC/SFP

Fig.70 - Opt. jumper outdoor LC/LC

Fig.71 - Amphenol LC connector

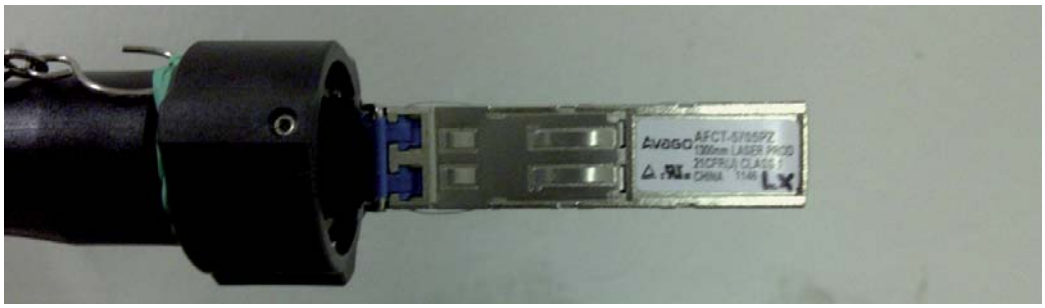


Fig.72 - Amphenol SFP/LC connector locked

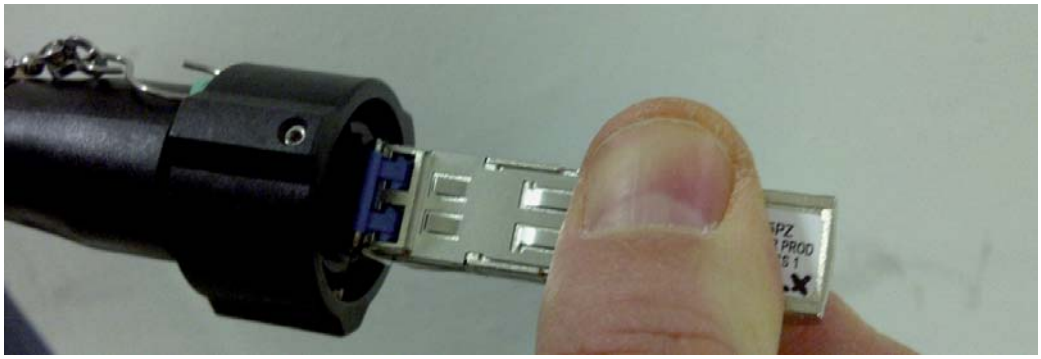


Fig.73 - Amphenol SFP/LC connector check

Fig.74 - SFP into ALFOplus

Fig.75 - Locked connection

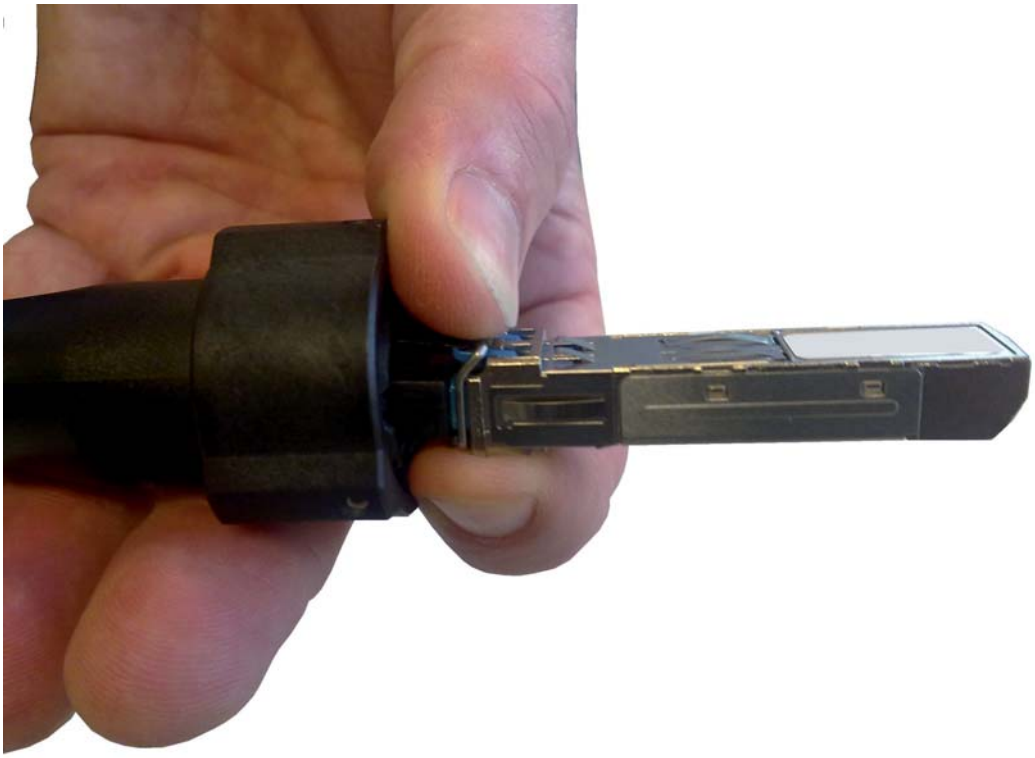


Fig.76 - Unplug SFP