OPU-1

Universal
Power Line Carrier
Terminal

Instructions Manual for Universal PLC terminal type **OPU-1**
MOPUA2402Iv00

Table of Contents

Table of Contents

Chapter 1.

Introduction

1. Introduction

1.1 Product overview

The **OPU-1** Universal Power-Line Carrier (PLC) terminal is outstanding in its high level of modularity, allowing the transmission of all type of services over high-voltage lines. It can be configured to transmit **analog**, **digital** or both analog and digital channels simultaneously, including **teleprotection**.

The output power determines the mechanical characteristics of the **OPU-1** terminal.
The **OPU-1** for **20** and **40** W **PEP** requires one chassis of **6** standard units (s.u.) in height, which integrates the basic modules and the options, and one chassis of **3** s.u. in height, which integrates the power stage modules.
The **OPU-1** for **80** W **PEP**, besides the previous ones, needs an extra chassis of **3** s.u. in height, which integrates the supplementary power stage.

All the chassis are prepared for mounting in a **19**" rack.

When working with analog channels, the **OPU-1** can transmit **1** or **2** standard **4** kHz channels, in each direction. The effective band (from **300** Hz to **3850** Hz) of each channel can be used for the transmission of data, various VF telegraph channels, teleprotection signals or for a speech-plus service.

- The modulation used is single side-band **(SSB)** with suppressed carrier.

- The transmission and reception bands can be **erect** or **inverted, adjacent** or **non-adjacent.**

The **OPU-1** digital modem includes one synchronous data port (**G.703** interface), one asynchronous data port (**V.24** interface) and two **Ethernet** ports. The multiplexing of the different services can be carried out by means of an internal or external multiplexer. Both multiplexers can be used simultaneously to carry out the insertion of channels, both locally and remotely.

The **OPU-1** can support two different digital modulation schemes (**QAM** with Trellis Coding or **OFDM/OQAM**).

When using **OFDM/OQAM**, the **OPU-1** offers, in each direction, a maximum transmission rate of **324** kbit/s, **160** kbit/s, **72** kbit/s and **32** kbit/s, respectively, in a bandwidth of **32** kHz, **16** kHz, **8** kHz and **4** kHz.

When using **QAM**, the **OPU-1** offers, in each direction, a gross bit rate of **81** kbit/s (**79** kbits net bit rate) in a **16** kHz bandwidth.
Thanks to the use of a built-in **echo canceller**, the transmission and reception bands can be superimposed resulting in a total bandwidth of **16** kHz.
Operation in an **8** kHz bandwidth at **40.5** kbit/s (**39.5** kbit/s net bit rate) or in a **4** kHz bandwidth at **20.25** kbit/s (**19.75** kbit/s net bit rate) is also possible.

- In **QAM**, the transmission and reception bands can be **superimposed** or **adjacent** or **non-adjacent**.

- In **OFDM/OQAM**, the transmission and reception bands can be **adjacent** or **non-adjacent.**

The **OPU-1** includes a **web server** containing all the necessary pages for system programming and monitoring. Access to the **OPU-1** web server is carried out by typing its IP address from a browser.

The **OPU-1** terminal chronologically registers all the alarms and events produced in the terminal as well as those related to link service. In order to set the date and time when they occur, the **OPU-1** has a real time clock that can be synchronized by using an external reference.

The **OPU-1** terminal complies with the International Recommendation **IEC 62488-3** (old **IEC 495**), regarding PLC equipment.

High-Frequency Teleprotection (**HF TP**) functionality meets the security and dependability requirements specified in **IEC 60834-1** Recommendation for the three types of teleprotection command schemes: **permissive** tripping schemes, intertripping schemes (**direct** or transfer tripping) and **blocking** protection schemes.

Some of the most remarkable features of the **OPU-1** are the following:

- **Two independent line filters.**
  The **OPU-1** can incorporate an additional high-frequency line filter to use different frequency slots in the same high-voltage line or even independent lines.
  Apart from frequency congestion solution, this additional filter allows special topology applications such as Teed lines.
  In a twin-channel analog terminal also allows the transmission and reception bands of each channel to be non-adjacent.
  The additional filter is possible for an **OPU-1** of **20** and **40** W **PEP**, and implies an extra chassis of **3** s.u. in height.

- **Two digital modulation schemes.**
  The **OPU-1** offers two different modulation schemes to better suit all transmission needs in terms of the quality of service required by the applications and the transmission line characteristics.
  The **QAM** modulation focuses on robustness, being able to operate at lower S/N values and with a lower internal latency.
  The **OFDM** modulation offers a higher transmission capacity at the expense of higher S/N requirements and a higher internal latency.
  In general terms **QAM** is more suited for long lines and medium transmission rates, while **OFDM/OQAM** is more suited for higher transmission rates over short lines.

- **Automatic fall-back/increase rates.**
  A remarkable feature of the **OPU-1** when working with a digital modem is the automatic fall-back rate when there is unfavourable line noise and/or signal reflection conditions.
  In **QAM,** when the line conditions improve, the transmission rate is automatically re-established.
  In **OFDM**, the maximum transmission rate is dynamically adjusted, ensuring a correct BER in every condition.

- **Ethernet user interface with built-in bridge functionality.**
  When using the **OPU-1** for the interconnection of different line segments, the built-in Ethernet bridge selects the frames to be transmitted to the remote end, thus making a more efficient use of the communications channel.

- **Monitoring through an SNMP agent.**
  The **OPU-1** terminal includes an SNMP agent capable of transmitting unconfirmed (*trap*) or confirmed (*inform*) notifications about alarms and events of the terminal to the devices specified by the user, which makes the terminal monitoring possible from an SNMP management application.

- **Frequency range from 500 kHz to 1 MHz (bandwidth of 32 kHz).**
  This high-frequency characteristic is possible by equipping the **OPU-1** of **20** and **40** W **PEP** with specific modules.

- **Narrow-Band High-Frequency Teleprotection functionality.**
  The **OPU-1** can function as a High-Frequency teleprotection system, allowing the transmission of up to four teleprotection commands in a standard **4** kHz channel (**2** kHz being used for **Tx** and **2** kHz for **Rx**) or in a standard **2** kHz channel (**1** kHz being used for **Tx** and **1** kHz for **Rx**).
  This functionality implies a specific hardware architecture of the terminal.

- **Available options.**
  Baseband analog input/output interface (**IOPU**), Speech (**TDPU.20**), Asynchronous programmable modem (**MFPU**), VFT transit filter (**FTPU**), Digital transit filter (**FDPU**), Input/output combiner (**EYPU**), Power supply test points (**FAPX**).
  Built-in multiplexer for additional voice & data channels (**DMPU/TMPU**).
  Built-in teleprotection system (**TPPU/REPU**) by **single** or **dual** tone, in a dedicated analog band, or **integrated** into the digital operation band.

1.2 Module description

1.2.1 Modules of the OPU-1 for 20 W & 40 W

The **OPU-1** for **20** W & **40** W consists of one shelf of **3** standard units (s.u.) in height, which contains the power stage modules (**RXPU**, **HIPU**, **AMPU.00** and **AFPU**), and one shelf of **6** standard units (s.u.) in height, which contains the power supply (**FAPU**), the module for central management and signal processing (**MOPU**), the digital modem (**MQPU**) and built-in options.

Both shelves are prepared for **19**" rack mounting.

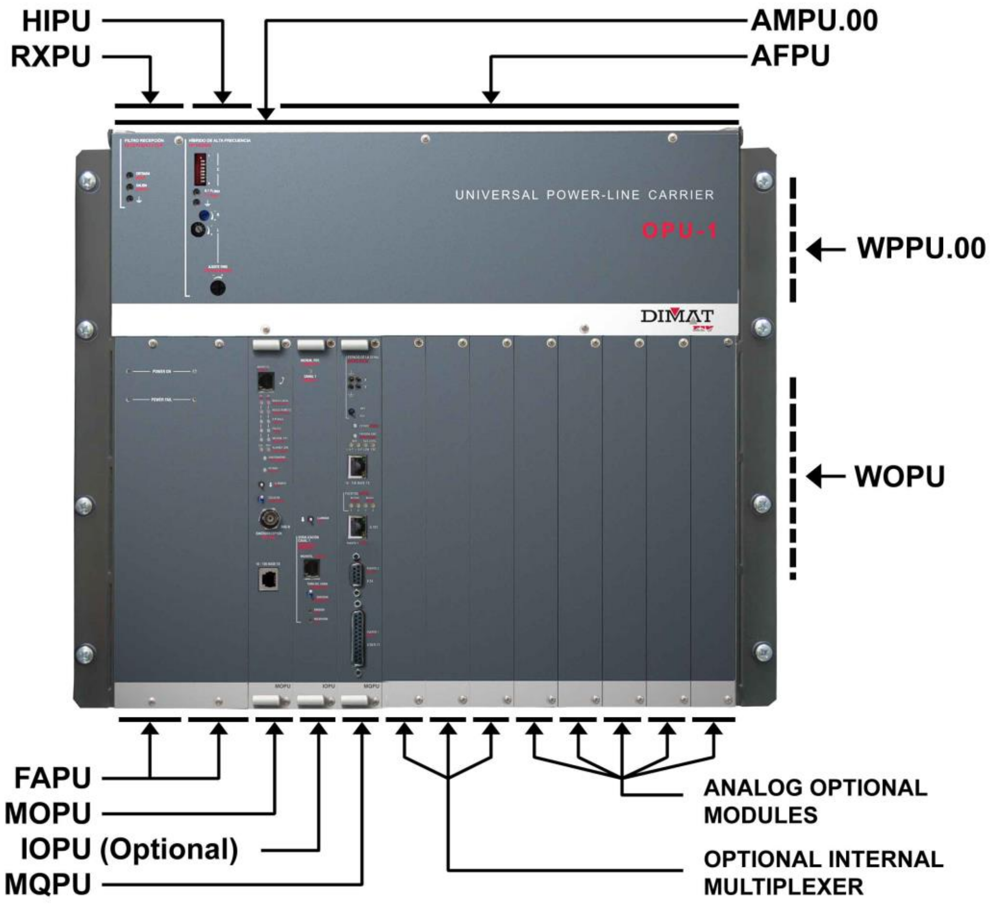


Figure 1.1 Module arrangement of the OPU-1 for 20 W & 40 W.

1.2.1.a FAPU

- **POWER SUPPLY**.
  - Contains the DC/DC converter that generates the internal power-supply voltages from the input voltage, as well as a filter at the input to suppress EMC disturbances. It also contains the power-supply alarm external signalling relay.
  - The type of module depends on the nominal input voltage:
    FAPU.02 Input voltage of **48 Vdc**
  - If a power supply of **125 Vdc** or **220 Vdc** is required, use an **external DC/DC converter** of 220 Vdc to 48 Vdc.

  If power-supply **redundancy** is required, the **OPU-1** can be equipped with two FAPU modules.

1.2.1.b MOPU

- **CENTRAL MANAGEMENT & SIGNAL PROCESSING UNIT.**
  - The central management unit is made up of: LAN interface (10/100Base-Tx), loop control, service channel, decoder capable of processing according to IRIG-B standard, web server, and SNMP agent and associated MIB.
  - The signal processing unit is made up of the circuits for: the mixing of the signals to be transmitted, modulation and demodulation, synchronization, digital signal filtering, signal-to-noise ratio measurement and automatic gain control (AGC).
  - It also contains the whole-band service-telephony circuits, which are operational only when the **IOPU** module is not installed in the equipment.
  - The type of module depends on the number of analog channels:
    MOPU.10 One analog channel
    MOPU.11 Two analog channels

1.2.1.c MQPU

- **DIGITAL MODEM.**
  - Includes two data ports, one for synchronous data with interface G.703, and the other for asynchronous data with interface V.24/V.28. It also has two Ethernet user interfaces.
  - Contains the circuits for: frequency conversion, modulation and demodulation, synchronization, automatic gain control (AGC), and control of the built-in multiplexer option.
  - For QAM, it also contains the circuits for link quality measurement according to the G.821 standard, an adaptive equalizer which minimizes the intersymbol interference, and the echo canceller which allows the transmission in superimposed bands to be carried out.
    For processing the signals from the interfaces, it generates an internal frame and carries out the 128-QAM, 16-QAM or 4-QAM modulation, and the Trellis coding.
  - For OFDM/OQAM, the bit stream is dynamically assigned to the 244 carriers which can be modulated, from a 4-QAM to a 4096-QAM, depending on the channel quality, and sharing this modulation each group of carriers.
    The turbo code rate also is dynamically assigned.
  - The type of module depends on the digital modulation scheme:
    MQPU.10 QAM
    MQPU.11 OFDM/OQAM

1.2.1.d RXPU

- **RECEPTION FILTER**.
  - Comprises the receive-channel filter for the frequency range from 40 kHz to 500 kHz.

  This module is located in the **3** s.u. shelf.

1.2.1.e HIPU

- **HF HYBRID**.
  - Contains the high-frequency hybrid.

  This module is located in the **3** s.u. shelf.

1.2.1.f AMPU.00

- **HIGH-FREQUENCY AMPLIFIER**.
  - Contains the wideband output amplifier of 20 & 40 W and the alarm circuits for overload or low transmitted-signal level.
    It has two switches for selecting the output impedance of the high-frequency amplifier.

  This module is located on the back panel of the **3** s.u. shelf.

1.2.1.g AFPU

- **LINE FILTER**.
  - Contains the line filter for the frequency range from 40 kHz to 500 kHz.
    The bandwidth of the line filter must be set up in the back panel of 3 s.u.

  This module is located in the **3** s.u. shelf.

1.2.1.h WOPU

- **BACK PANEL OF 6 STANDARD UNITS (s.u.).**
  - Contains the main power-supply switch, the fuses, the power-supply sockets, the connectors for external connections, two power-supply alarm relays, and three terminal alarm signalling relays.

  The activation conditions of the three alarm relays are configured from the Management System.

1.2.1.i WPPU.00

- **BACK PANEL OF 3 STANDARD UNITS (s.u.) FOR A BANDWIDTH OF 8/16/24 kHz.**
  - Contains the high-frequency amplifier and the following elements: line transformer, coaxial connector for making line connection, jumpers for selecting the line impedance, dummy load, a setting to connect the coaxial-cable shield to chassis or not, and a jumper for selecting the bandwidth of 8 kHz, 16 kHz or 24 kHz.

1.2.2 Modules of the OPU-1 for 500 kHz to 1 MHz

The **OPU-1** for **20** W & **40** W for frequency range from **500** kHz to **1** MHz consists of one shelf of **3** standard units (s.u.) in height, which contains the power stage modules (**RXPR**, **HIPU.01**, **AMPU.02** and **AFPR**), and one shelf of **6** standard units (s.u.) in height, which contains the power supply (**FAPU**), the module for central management and signal processing (**MOPU**), the digital modem (**MQPU**) and built-in options.

Both shelves are prepared for **19**" rack mounting.

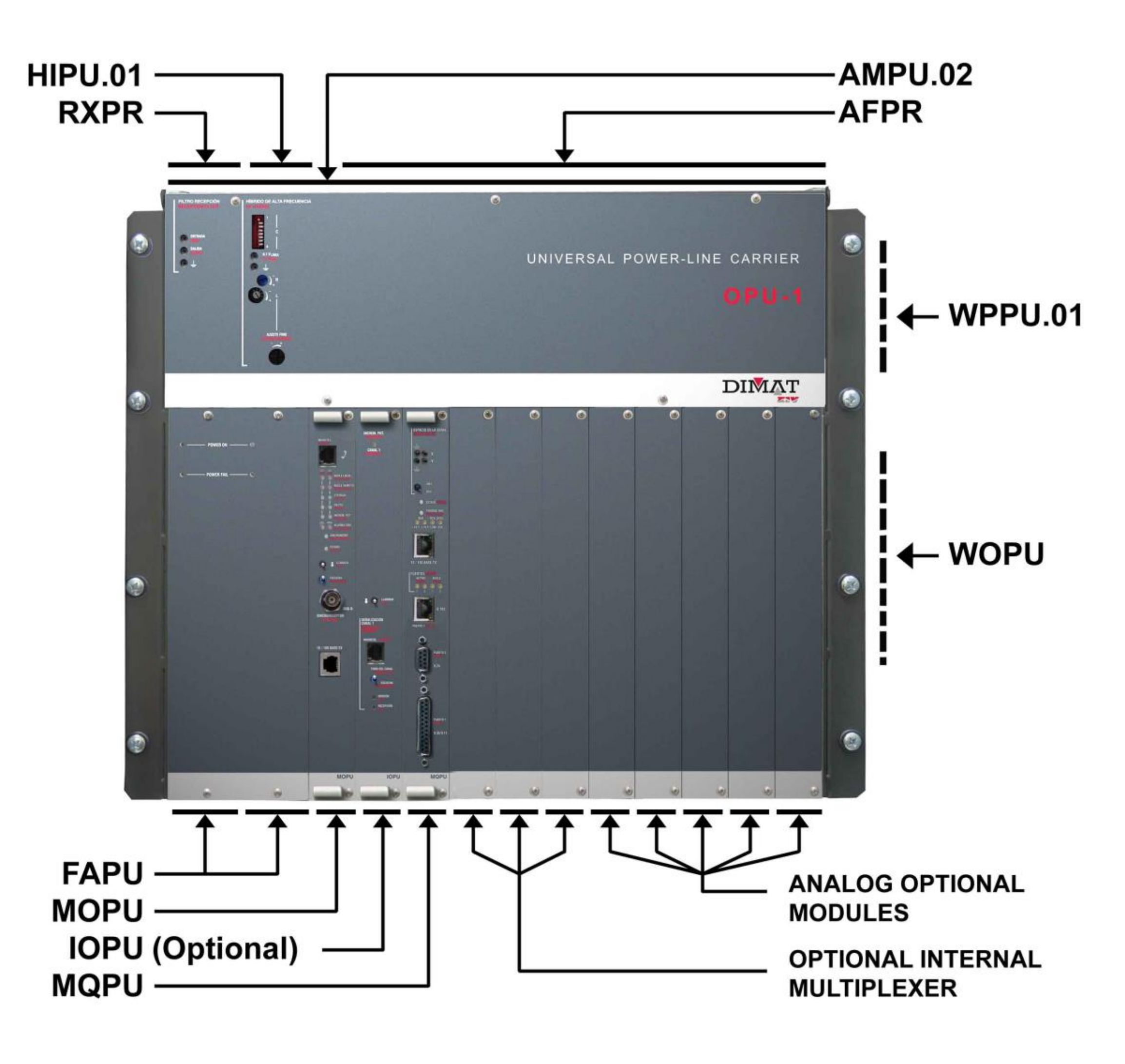


Figure 1.2 Module arrangement of the OPU-1 for 20 W & 40 W (from 500 kHz to 1 MHz).

1.2.2.a FAPU

- **POWER SUPPLY**.
  - Contains the DC/DC converter that generates the internal power-supply voltages from the input voltage, as well as a filter at the input to suppress EMC disturbances. It also contains the power-supply alarm external signalling relay.
  - The type of module depends on the nominal input voltage:
    FAPU.02 Input voltage of **48 Vdc**
  - If a power supply of **125 Vdc** or **220 Vdc** is required, use an **external DC/DC converter** of 220 Vdc to 48 Vdc.

  If power-supply **redundancy** is required, the **OPU-1** can be equipped with two FAPU modules.

1.2.2.b MOPU

- **CENTRAL MANAGEMENT & SIGNAL PROCESSING UNIT.**
  - The central management unit is made up of: LAN interface (10/100Base-Tx), loop control, service channel, decoder capable of processing according to IRIG-B standard, web server, and SNMP agent and associated MIB.
  - The signal processing unit is made up of the circuits for: the mixing of the signals to be transmitted, modulation and demodulation, synchronization, digital signal filtering, signal-to-noise ratio measurement and automatic gain control (AGC).
  - It also contains the whole-band service-telephony circuits, which are operational only when the **IOPU** module is not installed in the equipment.
  - The type of module depends on the number of analog channels:
    MOPU.10 One analog channel
    MOPU.11 Two analog channels

1.2.2.c MQPU

- **DIGITAL MODEM.**
  - Includes two data ports, one for synchronous data with interface G.703, and the other for asynchronous data with interface V.24/V.28. It also has two Ethernet user interfaces.
  - Contains the circuits for: frequency conversion, modulation and demodulation, synchronization, automatic gain control (AGC), and control of the built-in multiplexer option.
  - For QAM, it also contains the circuits for link quality measurement according to the G.821 standard, an adaptive equalizer which minimizes the intersymbol interference, and the echo canceller which allows the transmission in superimposed bands to be carried out.
    For processing the signals from the interfaces, it generates an internal frame and carries out the 128-QAM, 16-QAM or 4-QAM modulation, and the Trellis coding.
  - For OFDM/OQAM, the bit stream is dynamically assigned to the 244 carriers which can be modulated, from a 4-QAM to a 4096-QAM, depending on the channel quality, and sharing this modulation each group of carriers.
    The turbo code rate also is dynamically assigned.
  - The type of module depends on the digital modulation scheme:
    MQPU.10 QAM
    MQPU.11 OFDM/OQAM

1.2.2.d RXPR

- **RECEPTION FILTER**.
  - Comprises the receive-channel filter for the frequency range from 500 kHz to 1 MHz.

  This module is located in the **3** s.u. shelf.

1.2.2.e HIPU.01

- **HF HYBRID**.
  - Contains the high-frequency hybrid.

  This module is located in the **3** s.u. shelf.

1.2.2.f AMPU.02

- **HIGH-FREQUENCY AMPLIFIER**.
  - Contains the wideband output amplifier of 20 & 40 W and the alarm circuits for overload or low transmitted-signal level.
    It has two switches for selecting the output impedance of the high-frequency amplifier.

  This module is located on the back panel of the **3** s.u. shelf.

1.2.2.g AFPR

- **LINE FILTER**.
  - Contains the line filter for the frequency range from 500 kHz to 1 MHz.
    The bandwidth of the line filter must be set up in the back panel of 3 s.u.

  This module is located in the **3** s.u. shelf.

1.2.2.h WOPU

- **BACK PANEL OF 6 STANDARD UNITS (s.u.).**
  - Contains the main power-supply switch, the fuses, the power-supply sockets, the connectors for external connections, two power-supply alarm relays, and three terminal alarm signalling relays.

  The activation conditions of the three alarm relays are configured from the Management System.

1.2.2.i WPPU.01

- **BACK PANEL OF 3 STANDARD UNITS (s.u.) FOR A BANDWIDTH OF 8/16/32 kHz.**
  - Contains the high-frequency amplifier and the following elements: line transformer, coaxial connector for making line connection, jumpers for selecting the line impedance, dummy load, a setting to connect the coaxial-cable shield to chassis or not, and a jumper for selecting the bandwidth of 8 kHz, 16 kHz or 32 kHz.

1.2.3 Modules of the OPU-1 for 80 W

The OPU-1 for **80** W consists of three shelves.

The shelf of **6** standard units (s.u.) in height contains the two power-supply modules (**FAPU**), the central management and signal processing module (**MOPU**), the digital modem (**MQPU**) and built-in options.

The first shelf of **3** standard units (s.u.) in height contains the primary power stage modules (**RXPU**, **HIPU**, **AMPU.00** and **AFPU**).

The second additional shelf of **3** standard units (s.u.) in height contains the supplementary power stage modules (**DTPU**, second **AMPU.00** and second **AFPU**).

All the shelves are prepared for **19**" rack mounting.

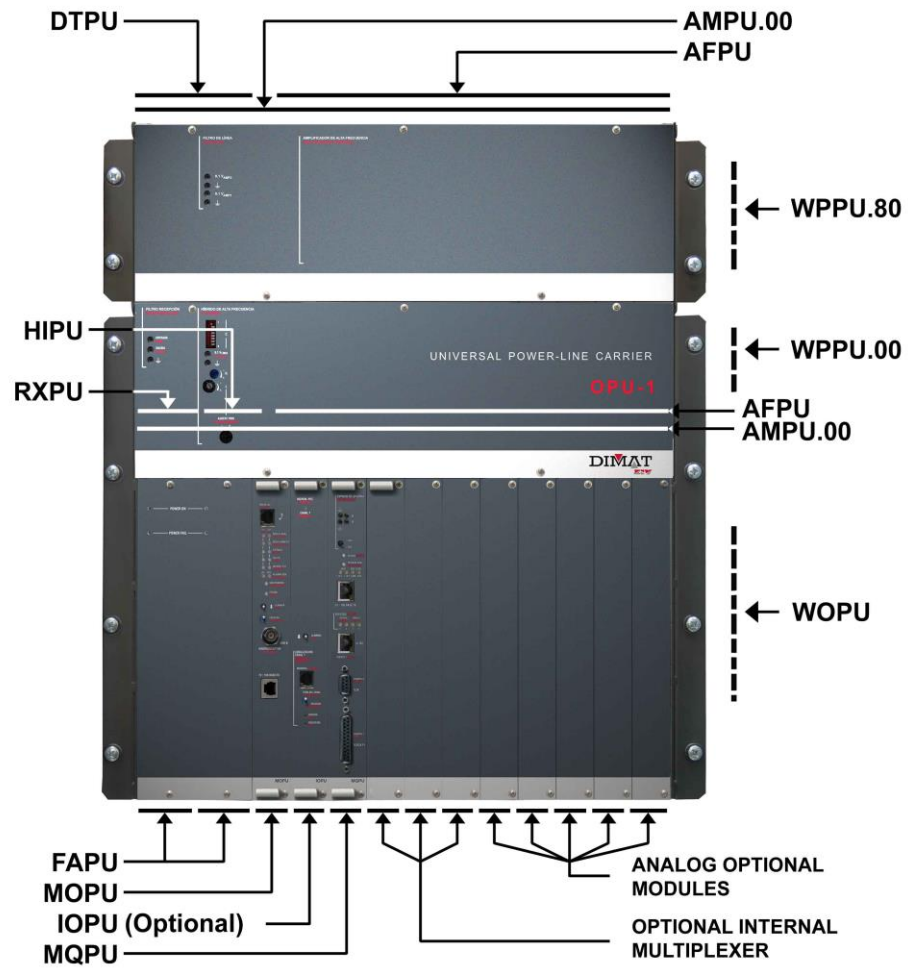


Figure 1.3 Module arrangement of the OPU-1 for 80 W.

1.2.3.a FAPU

- **POWER SUPPLY (1)**.
  - Contains the DC/DC converter that generates the internal power-supply voltages from the input voltage, as well as a filter at the input to suppress EMC disturbances. It also contains the power-supply alarm external signalling relay.
  - The type of module depends on the nominal input voltage:
    FAPU.02 Input voltage of **48 Vdc**
  - If a power supply of **125 Vdc** or **220 Vdc** is required, use an **external DC/DC converter** of 220 Vdc to 48 Vdc.

  This module is located in the **6** s.u. shelf.

1.2.3.b Second FAPU

- **POWER SUPPLY (2)**.
  - A second power-supply module is required in the **OPU-1** for **80** W
  - Contains the DC/DC converter that generates the internal power-supply voltages from the input voltage, as well as a filter at the input to suppress EMC disturbances. It also contains the power-supply alarm external signalling relay.
  - The type of module depends on the nominal input voltage:
    FAPU.02 Input voltage of **48 Vdc**
  - If a power supply of **125 Vdc** or **220 Vdc** is required, use an **external DC/DC converter** of 220 Vdc to 48 Vdc.

  This module is located next to the power-supply (1) module in the **6** s.u. shelf.

1.2.3.c MOPU

- **CENTRAL MANAGEMENT & SIGNAL PROCESSING UNIT.**
  - The central management unit is made up of: LAN interface (10/100Base-Tx), loop control, service channel, decoder capable of processing according to IRIG-B standard, web server, and SNMP agent and associated MIB.
  - The signal processing unit is made up of the circuits for: the mixing of the signals to be transmitted, modulation and demodulation, synchronization, digital signal filtering, signal-to-noise ratio measurement and automatic gain control (AGC).
  - It also contains the whole-band service-telephony circuits, which are operational only when the **IOPU** module is not installed in the equipment.
  - The type of module depends on the number of analog channels:
    MOPU.10 One analog channel
    MOPU.11 Two analog channels

  This module is located in the **6** s.u. shelf.

1.2.3.d MQPU

- **DIGITAL MODEM.**
  - Includes two data ports, one for synchronous data with interface G.703, and the other for asynchronous data with interface V.24/V.28. It also has two Ethernet user interfaces.
  - Contains the circuits for: frequency conversion, modulation and demodulation, synchronization, automatic gain control (AGC), and control of the built-in multiplexer option.

- For QAM, it also contains the circuits for link quality measurement according to the G.821 standard, an adaptive equalizer which minimizes the intersymbol interference, and the echo canceller which allows the transmission in superimposed bands to be carried out.
  For processing the signals from the interfaces, it generates an internal frame and carries out the 128-QAM, 16-QAM or 4-QAM modulation, and the Trellis coding.
- For OFDM/OQAM, the bit stream is dynamically assigned to the 244 carriers which can be modulated, from a 4-QAM to a 4096-QAM, depending on the channel quality, and sharing this modulation each group of carriers.
  The turbo code rate also is dynamically assigned.
- The type of module depends on the digital modulation scheme:
  MQPU.10 QAM
  MQPU.11 OFDM/OQAM

This module is located in the **6** s.u. shelf.

1.2.3.e RXPU

- **RECEPTION FILTER**.
  - Comprises the receive-channel filter for the frequency range from 40 kHz to 500 kHz.

  This module is located in the first **3** s.u. shelf.

1.2.3.f HIPU

- **HF HYBRID**.
  - Contains the high-frequency hybrid.

  This module is located in the first **3** s.u. shelf.

1.2.3.g First AMPU.00

- **FIRST HIGH-FREQUENCY AMPLIFIER**.
  - Contains the first 40 W wideband output amplifier and the alarm circuits for overload or low transmitted-signal level.
    It has two switches for selecting the output impedance of the high-frequency amplifier.

  This module is located on the back panel of the first **3** s.u. shelf.

1.2.3.h First AFPU

- **FIRST LINE FILTER**.
  - Contains the line filter, for the frequency range from 40 kHz to 500 kHz, associated with the first 40 W amplifier.
    The bandwidth of the line filter must be set up in the first back panel of 3 s.u.

  This module is located in the first **3** s.u. shelf.

1.2.3.i DTPU

- **DIFFERENTIAL TRANSFORMER**.
  - Contains the differential transformer to connect the first 40 W amplifier in parallel to the second 40 W amplifier to obtain the **80** W output power.

  This module is located in the second **3** s.u. shelf.

1.2.3.j Second AMPU.00

- **SECOND HIGH-FREQUENCY AMPLIFIER**.
  - Contains the second 40 W wideband output amplifier and the alarm circuits for overload or low transmitted-signal level.
    It has two switches for selecting the output impedance of the high-frequency amplifier.

  This module is located on the back panel of the second **3** s.u. shelf.

1.2.3.k Second AFPU

- **SECOND LINE FILTER**.
  - Contains the line filter, for the frequency range from 40 kHz to 500 kHz, associated with the second 40 W amplifier.
    The bandwidth of the line filter must be set up in the second back panel of 3 s.u.

  This module is located in the second **3** s.u. shelf.

1.2.3.l WOPU

- **BACK PANEL OF 6 STANDARD UNITS (s.u.).**
  - Contains the main power-supply switch, the fuses, the power-supply sockets, the connectors for external connections, two power-supply alarm relays, and three terminal alarm signalling relays.

  The activation conditions of the three alarm relays are configured from the Management System.

1.2.3.m WPPU.00

- **FIRST BACK PANEL OF 3 STANDARD UNITS (s.u.).**
  - Contains the first high-frequency amplifier and the following elements: line transformer, coaxial connector for making line connection, jumpers for selecting the line impedance, dummy load, a setting to connect the coaxial-cable shield to chassis or not, and a jumper for selecting the bandwidth of 8 kHz, 16 kHz or 24 kHz.

1.2.3.n WPPU.80

- **SECOND BACK PANEL OF 3 STANDARD UNITS (s.u.) FOR 80 W.**
  - Contains the three additional modules required for the **80** W, that is, differential transformer, second line filter, and second high-frequency amplifier. Contains a jumper for selecting the bandwidth of 8 kHz, 16 kHz or 24 kHz.

1.2.4 Modules of the OPU-1 for 20 W & 40 W with additional filter

The **OPU-1** for **20** W & **40** W with additional filter consists of three shelves.

The shelf of **6** standard units (s.u.) in height contains the two power-supply modules (**FAPU**), the central management and signal processing module (**MOPU**), the digital modem (**MQPU**) and built-in options.

The first shelf of **3** standard units (s.u.) in height contains the power stage modules (**RXPU**, **HIPU**, **AMPU.00** and **AFPU**) associated with the first channel (usually the analog channel).

The second additional shelf of **3** standard units (s.u.) in height contains the power stage modules (second **RXPU**, second **HIPU**, second **AMPU.00** and second **AFPU**) associated with the second channel (usually the digital channel).

All the shelves are prepared for **19**" rack mounting.

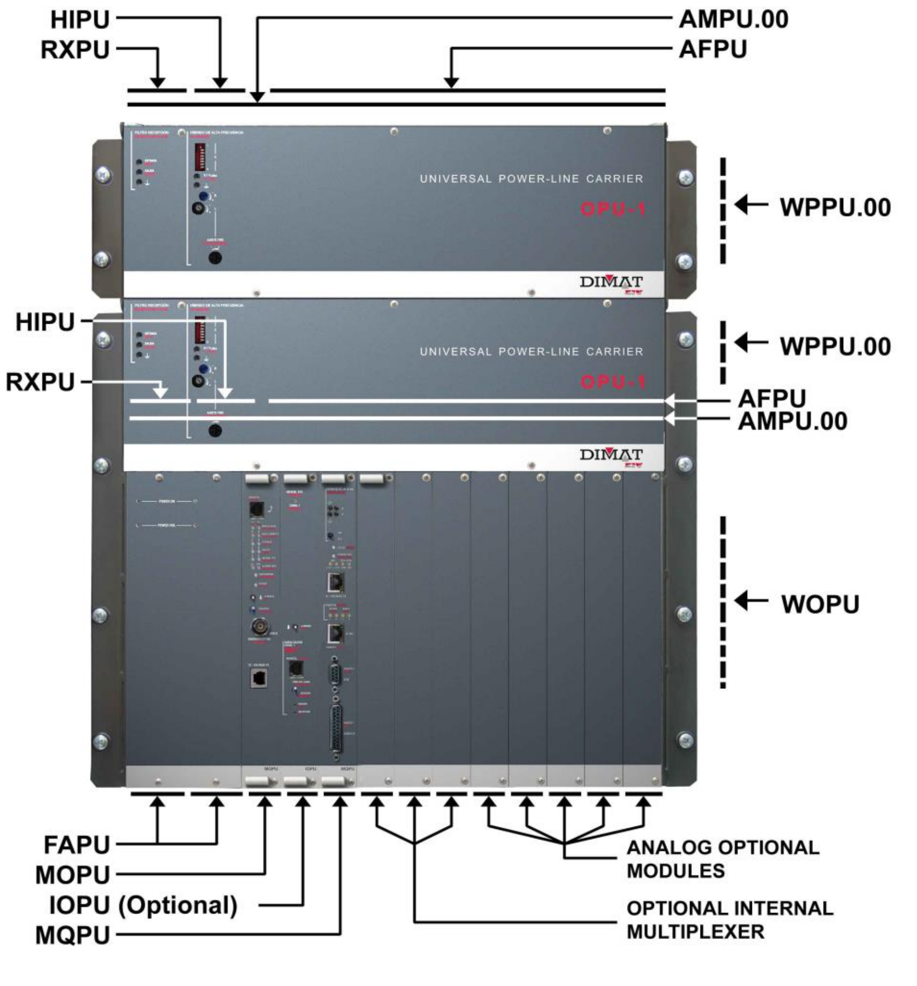


Figure 1.4 Module arrangement of the OPU-1 for 20 W & 40 W with additional filter.

1.2.4.a FAPU

- **POWER SUPPLY (1)**.
  - Contains the DC/DC converter that generates the internal power-supply voltages from the input voltage, as well as a filter at the input to suppress EMC disturbances. It also contains the power-supply alarm external signalling relay.
  - The type of module depends on the nominal input voltage:
    FAPU.02 Input voltage of **48 Vdc**
  - If a power supply of **125 Vdc** or **220 Vdc** is required, use an **external DC/DC converter** of 220 Vdc to 48 Vdc.

  This module is located in the **6** s.u. shelf.

1.2.4.b Second FAPU

- **POWER SUPPLY (2)**.
  - A second power-supply module is required in the **OPU-1** for **20** W & **40** W with additional filter.
  - Contains the DC/DC converter that generates the internal power-supply voltages from the input voltage, as well as a filter at the input to suppress EMC disturbances. It also contains the power-supply alarm external signalling relay.
  - The type of module depends on the nominal input voltage:
    FAPU.02 Input voltage of **48 Vdc**
  - If a power supply of **125 Vdc** or **220 Vdc** is required, use an **external DC/DC converter** of 220 Vdc to 48 Vdc.

  This module is located next to the power-supply (1) module in the **6** s.u. shelf.

1.2.4.c MOPU

- **CENTRAL MANAGEMENT & SIGNAL PROCESSING UNIT.**
  - The central management unit is made up of: LAN interface (10/100Base-Tx), loop control, service channel, decoder capable of processing according to IRIG-B standard, web server, and SNMP agent and associated MIB.
  - The signal processing unit is made up of the circuits for: the mixing of the signals to be transmitted, modulation and demodulation, synchronization, digital signal filtering, signal-to-noise ratio measurement and automatic gain control (AGC).
  - It also contains the whole-band service-telephony circuits, which are operational only when the **IOPU** module is not installed in the equipment.
  - The type of module depends on the number of analog channels:
    MOPU.10 One analog channel
    MOPU.11 Two analog channels

  This module is located in the **6** s.u. shelf.

1.2.4.d MQPU

- **DIGITAL MODEM.**
  - Includes two data ports, one for synchronous data with interface G.703, and the other for asynchronous data with interface V.24/V.28. It also has two Ethernet user interfaces.
  - Contains the circuits for: frequency conversion, modulation and demodulation, synchronization, automatic gain control (AGC), and control of the built-in multiplexer option.

- For QAM, it also contains the circuits for link quality measurement according to the G.821 standard, an adaptive equalizer which minimizes the intersymbol interference, and the echo canceller which allows the transmission in superimposed bands to be carried out.
  For processing the signals from the interfaces, it generates an internal frame and carries out the 128-QAM, 16-QAM or 4-QAM modulation, and the Trellis coding.
- For OFDM/OQAM, the bit stream is dynamically assigned to the 244 carriers which can be modulated, from a 4-QAM to a 4096-QAM, depending on the channel quality, and sharing this modulation each group of carriers.
  The turbo code rate also is dynamically assigned.
- The type of module depends on the digital modulation scheme:
  MQPU.10 QAM
  MQPU.11 OFDM/OQAM

This module is located in the **6** s.u. shelf.

1.2.4.e First RXPU

- **FIRST RECEPTION FILTER**.
  - Comprises the receive-channel filter, for the frequency range from 40 kHz to 500 kHz, associated with the first channel (usually the analog channel).

This module is located in the first **3** s.u. shelf.

1.2.4.f First HIPU

- **FIRST HF HYBRID**.
  - Contains the high-frequency hybrid associated with the first channel (usually the analog channel).

This module is located in the first **3** s.u. shelf.

1.2.4.g First AMPU.00

- **FIRST HIGH-FREQUENCY AMPLIFIER**.
  - Contains the wideband output amplifier of 20 W or 40 W and the alarm circuits for overload or low transmitted-signal level.
    It has two switches for selecting the output impedance of the high-frequency amplifier.

This module is located on the back panel of the first **3** s.u. shelf.

1.2.4.h First AFPU

- **FIRST LINE FILTER**.
  - Contains the line filter associated with the first channel (usually the analog channel). The bandwidth of the line filter must be set up in the first back panel of 3 s.u.

This module is located in the first **3** s.u. shelf.

1.2.4.i Second RXPU

- **SECOND RECEPTION FILTER**.
  - Comprises the receive-channel filter, for the frequency range from 40 kHz to 500 kHz, associated with the second channel (usually the digital channel).

This module is located in the second **3** s.u. shelf.

1.2.4.j Second HIPU

- **SECOND HF HYBRID**.
  - Contains the high-frequency hybrid associated with the second channel (usually the digital channel).

  This module is located in the second **3** s.u. shelf.

1.2.4.k Second AMPU.00

- **SECOND HIGH-FREQUENCY AMPLIFIER**.
  - Contains the wideband output amplifier of 20 W or 40 W and the alarm circuits for overload or low transmitted-signal level.
    It has two switches for selecting the output impedance of the high-frequency amplifier.

  This module is located on the back panel of the second **3** s.u. shelf.

1.2.4.l Second AFPU

- **SECOND LINE FILTER**.
  - Contains the line filter associated with the second channel (usually the digital channel).
    The bandwidth of the line filter must be set up in the second back panel of 3 s.u.

  This module is located in the second **3** s.u. shelf.

1.2.4.m WOPU

- **BACK PANEL OF 6 STANDARD UNITS (s.u.).**
  - Contains the main power-supply switch, the fuses, the power-supply sockets, the connectors for external connections, two power-supply alarm relays, and three terminal alarm signalling relays.

  The activation conditions of the three alarm relays are configured from the Management System.

1.2.4.n First WPPU.00

- **FIRST BACK PANEL OF 3 STANDARD UNITS (s.u.).**
  - Contains the high-frequency amplifier and the following elements: line transformer, coaxial connector for making line connection, jumpers for selecting the line impedance, dummy load, a setting to connect the coaxial-cable shield to chassis or not, and a jumper for selecting the bandwidth of 8 kHz, 16 kHz or 24 kHz.

1.2.4.o Second WPPU.00

- **SECOND BACK PANEL OF 3 STANDARD UNITS (s.u.).**
  - Contains the high-frequency amplifier and the following elements: line transformer, coaxial connector for making line connection, jumpers for selecting the line impedance, dummy load, a setting to connect the coaxial-cable shield to chassis or not, and a jumper for selecting the bandwidth of 8 kHz, 16 kHz or 24 kHz.

1.2.5 Modules of the OPU-1 for HF Teleprotection

The **OPU-1** for **Narrow-Band High-Frequency Teleprotection** functionality consists of one shelf of **3** standard units (s.u.) in height, which contains the power stage modules (**TAPU** and **WAPU**), and one shelf of **6** standard units (s.u.) in height, which contains the power supply (**FAPU**), the module for central management and signal processing (**MOPU**) and built-in teleprotection (**TPPU**).

Both shelves are prepared for **19**" rack mounting.

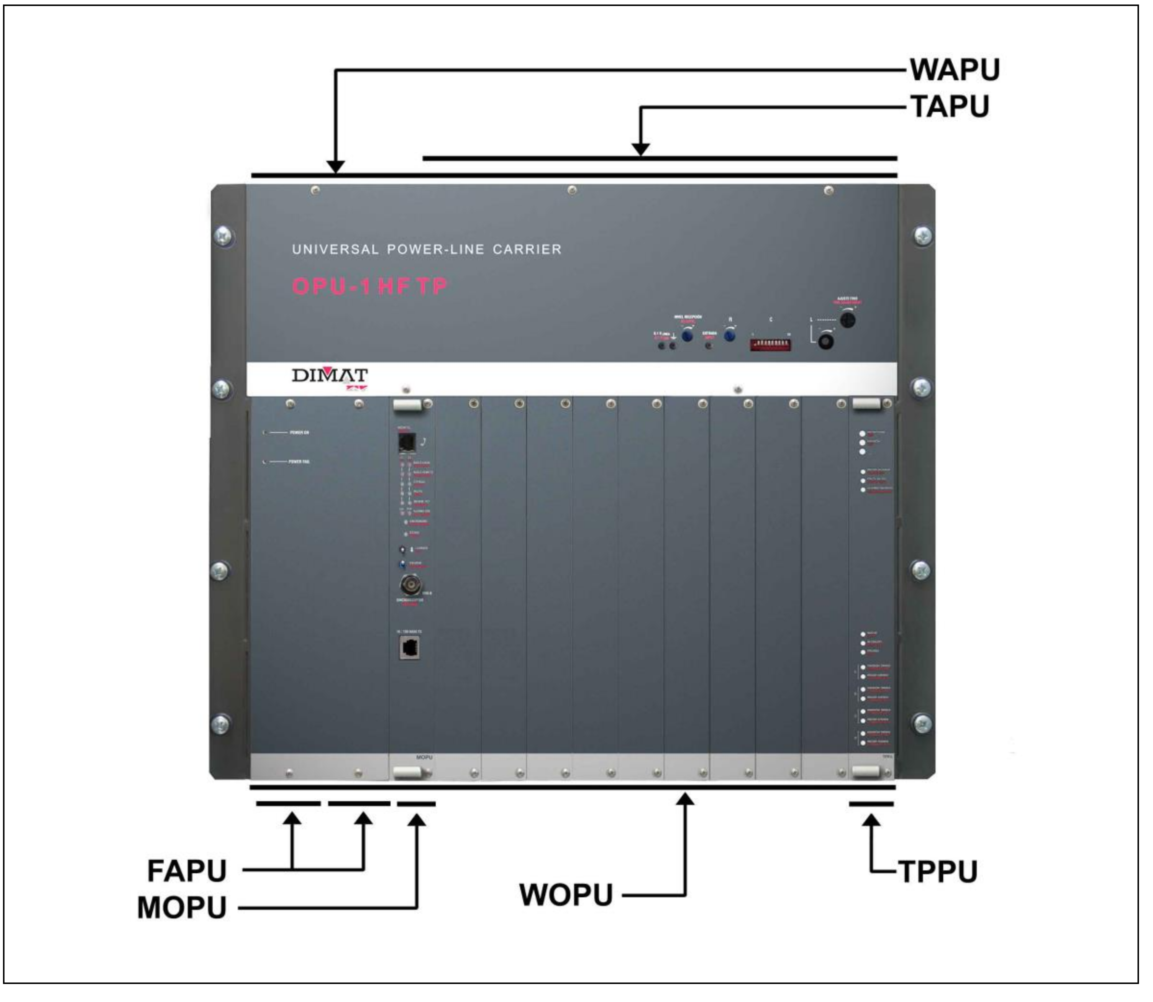


Figure 1.5 Module arrangement of the OPU-1 for HF Teleprotection.

1.2.5.a FAPU

- **POWER SUPPLY**.
  - Contains the DC/DC converter that generates the internal power-supply voltages from the input voltage, as well as a filter at the input to suppress EMC disturbances. It also contains the power-supply alarm external signalling relay.
  - The type of module depends on the nominal input voltage:
    FAPU.02 Input voltage of **48 Vdc**
  - If a power supply of **125 Vdc** or **220 Vdc** is required, use an **external DC/DC converter** of 220 Vdc to 48 Vdc.

  If power-supply **redundancy** is required, the **OPU-1** can be equipped with two FAPU modules.

1.2.5.b MOPU

- **CENTRAL MANAGEMENT & SIGNAL PROCESSING UNIT.**
  - The central management unit is made up of: LAN interface (10/100Base-Tx), loop control, service channel, decoder capable of processing according to IRIG-B standard, web server, and SNMP agent and associated MIB.
  - The signal processing unit is made up of the circuits for: the mixing of the pilot signal and the teleprotection signals to be transmitted, modulation and demodulation, synchronization, digital signal filtering, signal-to-noise ratio measurement and automatic gain control (AGC).
  - **MOPU.10** One analog channel

1.2.5.c TPPU

- **TELEPROTECTION BY DUAL TONE.**
  - This module is able to transmit and receive up to four independent commands and in any combination using a 4 kHz channel (2 kHz+2 kHz) or a 2 kHz channel (1 kHz+1 kHz).
  - It has a Digital Signal Processor (DSP) that generates the encoded signals and implements the necessary processing circuits for the reception of all the frequencies used.
  - Two configurable frequencies are assigned to each command signal, and a single frequency is assigned to the guard signal.
  - Contains four command inputs and four command outputs, and two auxiliary configurable relays for signalling and alarm.

1.2.5.d TAPU

- **LINE FILTER & HF HYBRID**.
  - Comprises the line filter (**Tx/Rx**) and the high-frequency hybrid.

  This module is located in the **3** s.u. shelf.

1.2.5.e WOPU

- **BACK PANEL OF 6 STANDARD UNITS (s.u.).**
  - Contains the main power-supply switch, the fuses, the power-supply sockets, the connectors for external connections, two power-supply alarm relays, and three terminal alarm signalling relays.

  The activation conditions of the three alarm relays are configured from the Management System.

1.2.5.f WAPU

- **BACK PANEL OF 3 STANDARD UNITS (s.u.) FOR HF TELEPROTECTION.**
  - Contains the wideband output amplifier of 20 & 40 W and the alarm circuits for overload or low transmitted-signal level.
  - It also contains the following elements: line transformer, coaxial connector for making line connection, jumpers for selecting the line impedance, dummy load, a setting to connect the coaxial-cable shield to chassis or not, and a switch for selecting the output impedance of the HF amplifier.

1.2.6 Built-in multiplexer modules

The optional built-in multiplexer of the **OPU-1** terminal consists of up to **three modules**, which can be **DMPU** or **TMPU** type, or both.

The **DMPU** module is equipped with up to a maximum of six data ports. Using only modules of **DMPU** type, the number of data ports of the **OPU-1** terminal can be extended to eighteen.

The **TMPU** module is equipped with up to two speech ports, and with a data port. Using only modules of **TMPU** type, the number of speech ports of the **OPU-1** terminal can be extended to six and that of data ports to three.

The **OPU-1** includes two basic data ports and an Ethernet bridge whose information is multiplexed together with the built-in multiplexer speech and data channels, and transmitted over the digital channel (**QAM/OFDM** signal).

1.2.6.a DMPU

- **DATA PORTS**.
  - Houses data ports whose number and their arrangement depends on the module type.
  - The connector type and interfaces supported by each port is indicated in the enclosed table.
  - The module supports point-to-multipoint topologies for polling systems.
  - There are the following module types:
    DMPU.02 Two **front** data ports, identified as **3/9/15** and **4/10/16**
    DMPU.02R Two **rear** data ports, identified as **5/11/17** and **6/12/18**
    DMPU.04 Four **front** data ports, identified as **3/9/15**, **4/10/16**, **5/11/17** and **6/12/18**
    DMPU.04R Four **rear** data ports, identified as **5/11/17**, **6/12/18**, **7/13/19** and **8/14/20**
    DMPU.06 Six **front** data ports, identified as **3/9/15**, **4/10/16**, **5/11/17**, **6/12/18**, **7/13/19** and **8/14/20**

Port identification (connector type)	Interfaces supported by the port
Port **3/9/15** (DB15 female)	V.24/V.28 (RS-232C), X.21, RS-422, RS-485 (HD/FD)
Port **4/10/16** (DB15 female)	V.24/V.28 (RS-232C), X.21, RS-422, RS-485 (HD/FD)
Port **5/11/17** (DB9 female)	V.24 asynchronous, RS-422, RS-485 (HD/FD)
Port **6/12/18** (DB9 female)	V.24 asynchronous, RS-422, RS-485 (HD/FD)
Port **7/13/19** (DB9 female)	V.24 asynchronous, RS-422, RS-485 (HD/FD)
Port **8/14/20** (DB9 female)	V.24 asynchronous, RS-422, RS-485 (HD/FD)

Table 1-1: Interfaces supported by the DMPU ports

1.2.6.b TMPU

- **SPEECH PORTS & DATA PORT.**
  - Houses one or two speech ports, and one data port.
  - Full-duplex transmission and reception at 2100 bit/s, 2450 bit/s or 2800 bit/s (RALCWI coding algorithm).
  - The Mean Opinion Score (MOS) of voice quality is about 3.5-3.6.
  - Transmission and reception by **E/M**-wire signalling, out of band, and by **DTMF**, in band.
    Factory pre-set ADASE 1200/1600 Hz tones, in band.
  - The speech port supports a 2-wire and 4-wire telephone termination.
    The 2-wire termination can be configured as an exchange-side 2-wire telephone termination (**FXO**) or as a subscriber-side 2-wire telephone termination (**FXS**).
    For the **FXO** mode, it includes ring detector and the exchange subscriber-loop management.
    For the **FXS** mode, it includes the ring current generator and pick up detection.
  - The **data** port interface (**DB15** female) complies with Recommendation **V.24/V.28** of the ITU-T (RS-232C) and Recommendation **X.21** of the ITU-T.
  - The type of module depends on the number of speech ports:
    TMPU.11 One speech port, identified on the front as **4/10/16**, plus one **front** data port, identified as **3/9/15**
    TMPU.21 Two speech ports, identified on the front as **4/10/16** and **5/11/17**, plus one **front** data port, identified as **3/9/15**

1.2.7 Built-in teleprotection modules

The teleprotection signals can be transmitted over a dedicated **analog** band or integrated into the **digital** operation band.

The operation mode using **SINGLE** tone is the most traditional.

- For **analog** band, the guard signal and each of the command signals are assigned a single frequency (**SINGLE** tone).
- For **digital** band, the system sets a fixed and specific frequency (**SINGLE** tone) for the guard signal and each of the command signals.

The operation mode using **DUAL** tone offers great channel availability when it is shared with other services.

- For **analog** band, each of the command signals is assigned two frequencies (**DUAL** tone) whose amplitude is half the amplitude of the guard signal, which is assigned a single frequency.
- For **digital** band, the command signals have two fixed and specific frequencies (**DUAL** tone) whose amplitude is half the amplitude of the guard signal, which has a fixed and specific frequency.

When the teleprotection signals are integrated into the digital band of the **OPU-1** terminal, in order to allow the transmission of the command signal (**SINGLE** tone or **DUAL** tone) using all the power available, the transmission of the **QAM/OFDM** signal is blocked for a configurable time. When the collateral **OPU-1** terminal detects the absence of the guard signal, the **QAM/OFDM** signal is also blocked for a configurable time to facilitate command signal detection.

1.2.7.a Teleprotection using SINGLE tone

TPPU

- **TELEPROTECTION BY SINGLE TONE (4 COMBINED COMMANDS IN A STANDARD 4 kHz ANALOG CHANNEL)**
  - This module is able to transmit and receive up to three independent commands in any combination or up to four commands according to a certain logic, using a standard **4** kHz analog channel in each direction.
  - It has a Digital Signal Processor (DSP) that generates the guard and command tones and implements a bank of filters for the reception of commands.
  - Contains four command inputs and four command outputs, and two auxiliary configurable relays for signalling and alarm.

  The standard **4** kHz analog channel can be shared with other services such as speech and/or data.

REPU

- **AUXILIARY OUTPUTS FOR SIGNALLING AND ALARM**
- Allows the number of auxiliary outputs for signalling and alarm to be increased to seven.

1.2.7.b Teleprotection using DUAL tone

TPPU

- **TELEPROTECTION BY DUAL TONE (4 INDEPENDENT COMMANDS IN A 1 kHz, 2 kHz or 4 kHz BANDWIDTH)**
  - This module is able to transmit and receive up to four independent commands in any combination, using a **1** kHz, **2** kHz or **4** kHz teleprotection bandwidth in each direction.
  - It has a Digital Signal Processor (DSP) that generates the encoded signals and implements the necessary processing circuits for the reception of all the frequencies used.
  - Two frequencies are assigned to each command signal, and a single frequency is assigned to the guard signal.
  - Contains four command inputs and four command outputs, and two auxiliary configurable relays for signalling and alarm.

  If a **1** kHz or **2** kHz bandwidth is used for teleprotection signals, the remaining band of the standard **4** kHz analog channel can be assigned to other services.
  If two teleprotection bands of **1** kHz or **2** kHz are used per channel in each direction, it is possible to transmit and receive up to eight independent commands. This facility requires an specific guard frequency for each of the teleprotection bands.
  If four teleprotection bands of **1** kHz are used per channel in each direction, it is possible to transmit and receive up to sixteen independent commands. This facility requires an specific guard frequency for each of the teleprotection bands.

REPU

- **AUXILIARY OUTPUTS FOR SIGNALLING AND ALARM**
- Allows the number of auxiliary outputs for signalling and alarm to be increased to seven.

1.2.7.c Teleprotection integrated in the digital band

TPPU

- **TELEPROTECTION BY SINGLE TONE (4 COMBINED COMMANDS)**
  - This module is able to transmit and receive in the digital band (**QAM/OFDM**) of the **OPU-1** terminal up to three independent commands in any combination or up to four commands according to a certain logic.
  - It has a Digital Signal Processor (DSP) that generates the fixed guard and fixed command tones and implements a bank of filters for the reception of commands.
  - Contains four command inputs and four command outputs, and two auxiliary configurable relays for signalling and alarm.

TPPU

- **TELEPROTECTION BY DUAL TONE (4 INDEPENDENT COMMANDS IN A 1 kHz BANDWIDTH)**
  - This module is able to transmit and receive in the digital band (**QAM/OFDM**) of the **OPU-1** terminal up to four independent commands in any combination, using a teleprotection band of **1** kHz.
  - It has a Digital Signal Processor (DSP) that generates the encoded signals and implements the necessary processing circuits for the reception of all the frequencies used.
  - Two frequencies are assigned to each command signal, and a fixed single frequency is assigned to the guard signal.
  - Contains four command inputs and four command outputs, and two auxiliary configurable relays for signalling and alarm.

REPU

- **AUXILIARY OUTPUTS FOR SIGNALLING AND ALARM**
- Allows the number of auxiliary outputs for signalling and alarm to be increased to seven.

1.2.8 Other optional modules

1.2.8.a IOPU

- **BASEBAND ANALOG INPUT/OUTPUT INTERFACE**.
  - Contains two **600** Ω balanced 2-wire inputs and two **600** Ω balanced 2-wire outputs per channel.
  - It is able to receive in each channel the external input for power-boosting control.
  - Contains the whole-band service-telephony circuits.
    It also receives in each channel the external input of the **M** wire (transmission call) and the signalling of the **E** wire (reception call).
  - The type of module depends on the number of analog channels:
    IOPU.01 One analog channel
    IOPU.02 Two analog channels

  The available band per analog channel is from **300** Hz to **3850** Hz.
  The **IOPU** module is always installed next to the **MOPU** module.
  The boosting and whole-band service-telephony circuits of the **IOPU** module have priority against the ones of the **MOPU** module.

1.2.8.b FAPX

- **POWER SUPPLY TEST POINTS**.
  - Contains front-plate test points for the supervision of the **OPU-1** internal power-supply levels.

  This module uses the slot of the second power-supply module and that is why it is only suitable for **OPU-1** terminals of **20** W & **40** W **PEP** without power-supply redundancy.

1.2.8.c TDPU.20

- **SPEECH**.
  - Contains the circuits necessary to carry out a 2 or 4-wire transit of the speech band coming from a **OPU-1** link. These circuits are the speech-band transmit and receive filters, the dynamic compressor/expander, a 4-wire configurable termination and a subscriber-side 2-wire telephone termination.
  - The 4-wire configurable termination can be dynamically switched between 4-wire/2-wire operation by means of an external command.
    This termination can be configured as an exchange-side 2-wire termination, carrying out the required telephone-converter tasks.
  - The subscriber-side 2-wire telephone termination comprises the telephone hybrid, the subscriber circuits and the ring-current generator.
    This termination supports up to two telephones in parallel.
  - It also contains the circuits necessary to receive the external input of the **M** wire (transmission call) and for signalling the **E** wire (reception call).
    It also contains the circuits to establish a communication in the band assigned to speech.

- All the signal inputs and outputs are **600** Ω balanced.
  The control-signal inputs are optocoupled.
  The control-signal outputs are voltage-free relay contacts.

The speech band is from **300** Hz to a programmable frequency of between **2000** Hz and **3400** Hz.

1.2.8.d MFPU

- **ASYNCHRONOUS PROGRAMMABLE MODEM.**
  - This module is an asynchronous narrowband modem with frequency-shift keying (**FSK**) modulation for the transmission of data at speeds of 50, 100, 200, 600, 1200 or 2400 Bd.
  - The central frequency covers a wide range of values including those of Recommendations R.35, R.37, R.38A and R.38B of the ITU-T.
    The modem is also compatible with standard V.23 of the ITU-T.
  - The data interface complies with specifications V.24 and V.28 of the ITU-T and RS-232C of EIA.
  - By taking into account the assignment of frequencies, up to two modems per **OPU-1** analog channel can be installed.

1.2.8.e FTPU

- **VFT TRANSIT FILTER.**
  - This module is an audio-frequency signal filter and amplifier with phase equalizer.
  - Selects a specific band of the **OPU-1** analog channel and carries out a transit to another communication channel.
  - Includes a **600** Ω balanced output with programmable level.
  - There are **3** filters available for specific bandwidth.

1.2.8.f FDPU

- **DIGITAL TRANSIT FILTER.**
  - Selects a specific band of the **OPU-1** analog channel and carries out a **two-way** transit to another communication channel.
  - Includes a **600** Ω balanced input and a **600** Ω balanced output, both with programmable level.
  - There are **5** filters available for specific bandwidth.

1.2.8.g EYPU

- **INPUT/OUTPUT COMBINER.**
  - Contains four **600** Ω balanced inputs and four **600** Ω balanced outputs.
  - It allows the combination between any one of them and it also takes into account the **OPU-1** low-frequency transmission and reception buses of each analog channel.
    In this way, it is possible to carry out any combination in the connection of:
    - six inputs (*the four **EYPU** inputs and the **OPU-1** low-frequency **RCV** buses*) and four outputs, or of
    - four inputs and six outputs (*the four **EYPU** outputs and the **OPU-1** low-frequency **XMT** buses*).

Chapter 2.

Technical characteristics

2. Technical characteristics

2.1 General characteristics

2.1.1 Transmission characteristics

2.1.1.a Operating mode

Simultaneous transmission of analog, digital or both analog and digital channels, including teleprotection

2.1.1.b Modulation

Analog channel	Single side-band (**SSB**) with suppressed carrier
Digital channel	**QAM** with Trellis Coding or **OFDM**/**OQAM**

2.1.1.c Transmission and reception bands

Analog channel	Adjacent or non-adjacent, erect or inverted
QAM digital channel	Superimposed or adjacent or non-adjacent
OFDM/**OQAM** digital channel	Adjacent or non-adjacent

2.1.1.d Basic bandwidth

Analog channel	**4** kHz per channel in each direction
QAM digital channel	**16** kHz at **81** kbit/s, in each direction or single for superimposed bands **8** kHz at **40.5** kbit/s, in each direction or single for superimposed bands **4** kHz at **20.25** kbit/s, in each direction or single for superimposed bands
OFDM/**OQAM** digital channel	**32** kHz at **324** kbit/s, in each direction **16** kHz at **160** kbit/s, in each direction **8** kHz at **72** kbit/s, in each direction **4** kHz at **32** kbit/s, in each direction

EXAMPLES OF TRANSMISSION CAPACITY

- *The transmission rate depends on the S/N ratio of the line.*
- *For simplicity, these examples do not include non-adjacent bands, and are for a frequency range from **36** kHz to **512** kHz. When equipped with specific hardware, the **OPU-1** can work with a frequency range from **500** kHz to **1** MHz.*

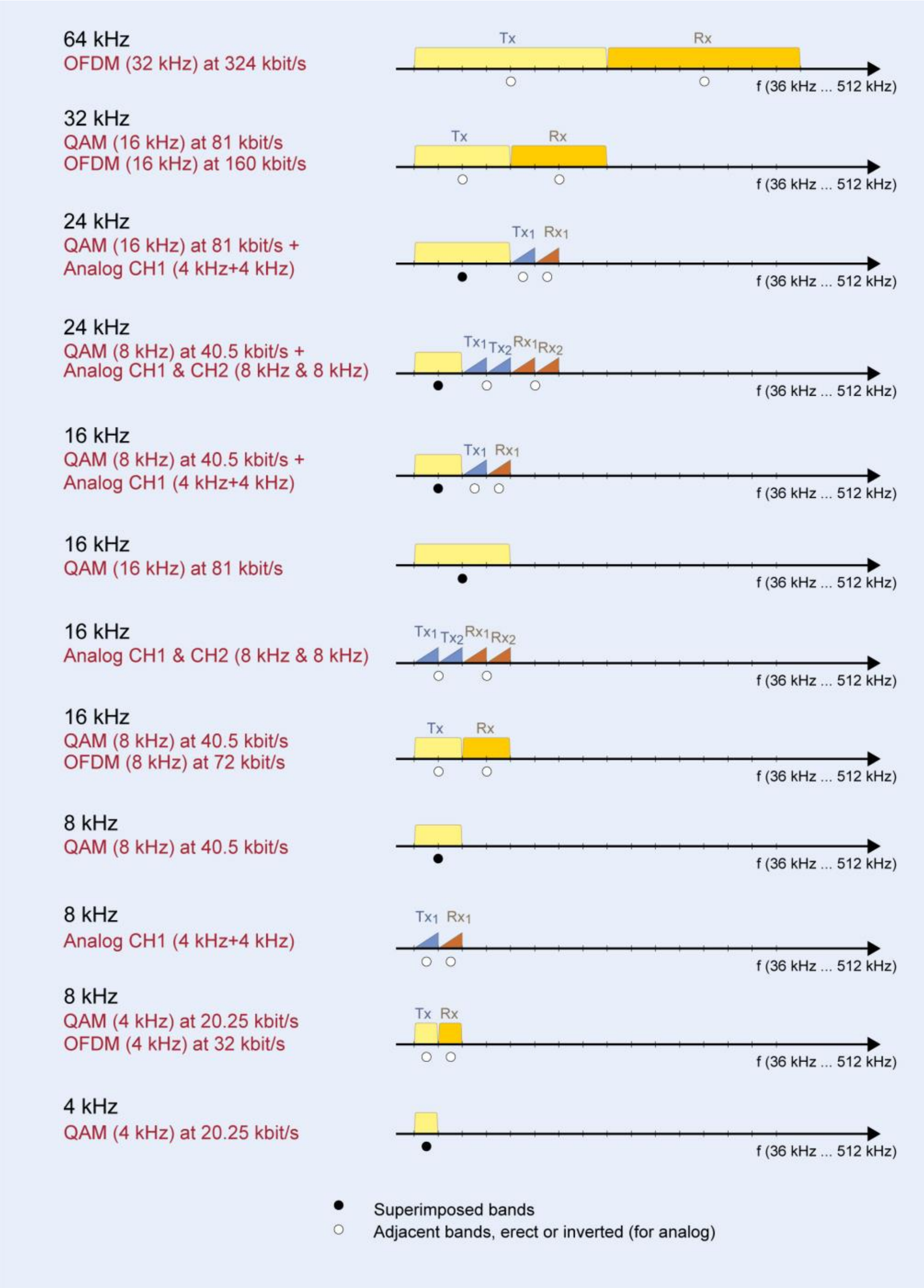


Figure 2.1 Examples of transmission capacity.

EXAMPLES OF TRANSMISSION CAPACITY WITH EXTRA FILTER

- *The possibilities can be enlarged with the use of an extra filter (additional 3 s.u. back panel), which allows different frequency slots in the same line to be used or, even, in independent lines.*
- *These examples are for the second case, that is, digital channel in one line and analog channels in other different line. The frequency range is from **36** kHz to **512** kHz. When equipped with specific hardware, the **OPU-1** can work with a frequency range from **500** kHz to **1** MHz.*

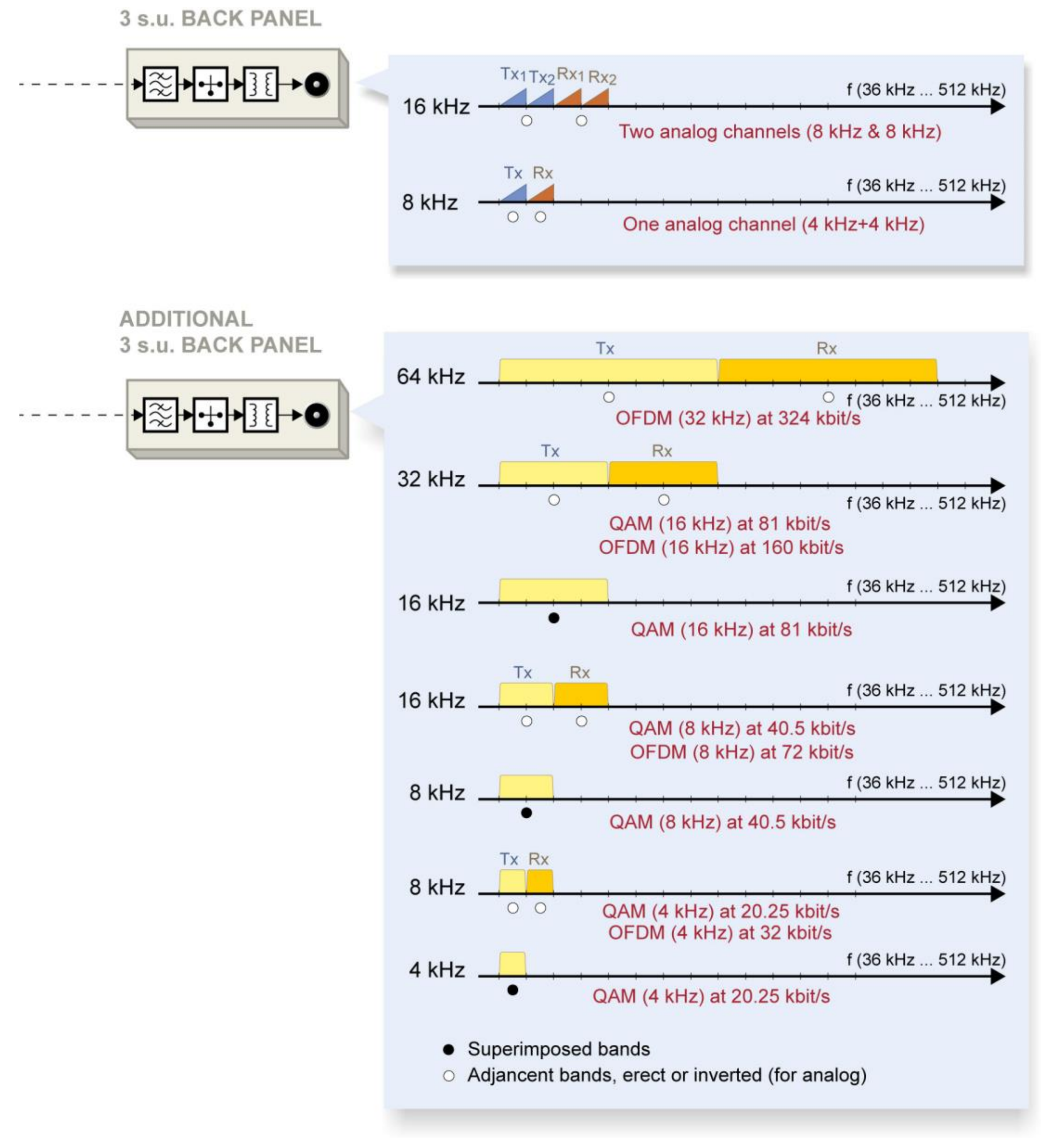


Figure 2.2 Examples of transmission capacity with extra filter.

2.1.2 Other general characteristics

2.1.2.a Pilot tone

Analog channel

Functions	Automatic Gain Control Telephone signalling Signal-to-noise ratio measurement Link synchronization Service channel (data transmission)
Central frequency	**150** Hz (virtual frequency)
Modulation	By frequency-shift keying of ±**30** Hz
Maximum rate	**50** bit/s

Digital channel

Functions	Automatic Gain Control
Situation of the pilot in the **QAM** band	f_0 ± **7950** Hz (BW= **16** kHz) f_0 ± **3975** Hz (BW= **8** kHz) f_0 ± **1987.5** Hz (BW= **4** kHz)

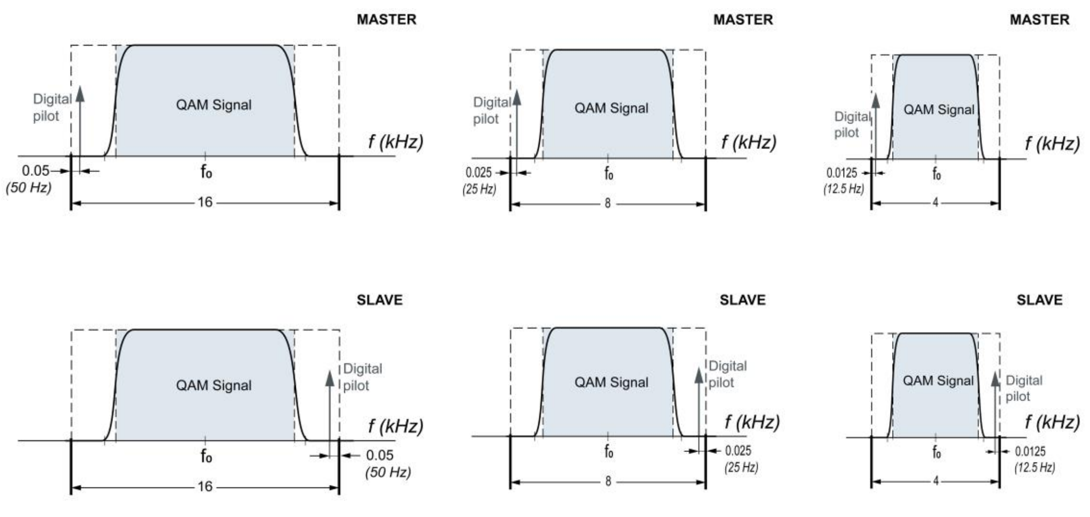


Figure 2.3 Digital pilot situation in the QAM band.

2.1.2.b Automatic Gain Control (AGC)

Analog channel	
Dynamics	≥ **55** dB with 10% pilot modulation
Efficiency	±**20** dB input level variations cause variations of less than ±**0.2** dB at the output

Digital channel	
Range	**47** dB

2.1.2.c Supervision of data link quality

According to the **G.821** standard

2.1.2.d Internal clock (master)

Frequency stability within specified temperature and voltage ranges	±**1**ppm
Ageing	<**1**ppm/year

2.1.2.e Synchronization

Analog channel	Synchronous or Plesiochronous (non-synchronism)
Digital channel (**QAM**)	Master-Slave

2.1.2.f Test devices

Analog channel	
Test elements	Possibility of carrying out HF and audio-frequency test loops

Digital channel	
Test elements	Data loop in local and remote terminals High-frequency loop (isolated terminal) Displaying of the signal space constellation

2.1.2.g Chronological register

Capacity	**1010** alarms and events (FIFO-based register) **110** logs are reserved for **Cybersecurity** related events
Resolution	**1** ms
Time synchronization	Via GPS (**IRIG-B**) or via Ethernet (**SNTP** protocol)

2.1.2.h IRIG-B input (MOPU)

Connector type	**BNC**
Standard	IRIG-B **120** to IRIG-B **123** and IRIG-B **000** to IRIG-B **003**

IRIG-B **120** to IRIG-B **123** and IRIG-B **000** to IRIG-B **003** standards do not include year information.

2.1.2.i Main digital interfaces (MQPU)

Synchronous data port with interface ITU-T **G.703** codirectional at **64** kbit/s

Asynchronous data port with interface ITU-T **V.24/V.28** at **200**, **600**, **1200**, **2400**, **3600**, **4800**, **7200**, **9600** and **14400** bit/s

Two Ethernet (**10/100Base-Tx**) ports with bridge-link functionality.
The two Ethernet interfaces (**ETH1** & **ETH2**) work as a part of a two-port hub

2.1.3 Available options

2.1.3.a Optional built-in modules

Analog options

- Baseband analog input/output interface for channel **1** (**IOPU.01** module)
- Baseband analog input/output interface for channel **1** and channel **2** (**IOPU.02** module)
- Speech (**TDPU.20** module)
- Asynchronous programmable modem (**MFPU** module)
- VFT transit filter (**FTPU** module)
- Digital transit filter (**FDPU** module)
- Input/output combiner (**EYPU** module)
- Power supply test points (**FAPX** module)

Internal multiplexer

- Additional data channels (**DMPU**)
- Additional voice channels & one data port (**TMPU**)

Teleprotection system

- Teleprotection (**TPPU** module) by single or dual tone, in a dedicated analog band, or integrated into the digital operation band.
- Auxiliary outputs for the teleprotection system (**REPU** module)

2.1.3.b Other optional hardware

OPU-1 of **20** W & **40** W for frequency range from **500** kHz to **1** MHz

- Specific **3** s.u. backpanel (**WPPU.01**)
- Specific reception filter (**RXPR**)
- Specific line filter (**AFPR**)
- Specific HF hybrid (**HIPU.01**)
- Specific HF amplifier (**AMPU.02**)

OPU-1 for **80** W **PEP**

- Specific second **3** s.u. back panel (**WPPU.80**)
- Differential transformer (**DTPU**)
- Second power supply (**FAPU**)

OPU-1 of **20** W **&** **40** W with extra filter

- Second **3** s.u. back panel (**WPPU.00**)
- Second power supply (**FAPU**)

OPU-1 of **20** W & **40** W intended for Narrow-Band **High-Frequency Teleprotection** functionality

- Specific **3** s.u. back panel (**WAPU**)
- Specific line filter (**TAPU**)
- Teleprotection module (**TPPU**) by dual tone, operating in a dedicated analog band

2.1.4 Visual indications & external signalling

2.1.4.a Visual indications

Signalling

Terminal powered (**FAPU**)

Terminal status (**MOPU** & **MQPU**)

Data port status (**MQPU**)

Local terminal in loop (**MOPU**)

Remote terminal in loop (**MOPU**)

Power-boosting command (**IOPU** or **MOPU**)

Call reception (**IOPU**)

Call transmission (**IOPU**)

Alarms

Power-supply failure (**FAPU**)

Loss of synchronism (**MOPU** & **MQPU**)

Pilot loss (**MOPU**)

Low S/N ratio (**MOPU**)

Low reception level (**MQPU**)

Excessive reception level (**MQPU**)

BER alarm (**MQPU**)

General alarm (**MOPU**)

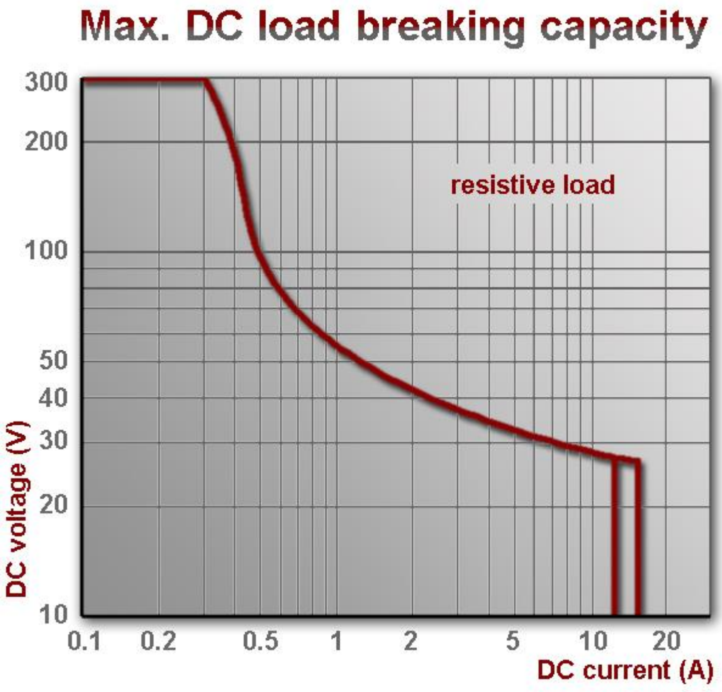
(*Power-supply failure, Amplifier overload, Low output level in amplifier, Loss of synchronism, Pilot loss, Low Signal/Noise ratio, AF limiter operation in analog channel, Temperature alarm, Terminal configuration error, Hardware failure, BER alarm in digital channel, Excessive or low reception level in digital channel*)

Remote alarm (**MOPU**)

(*Power-supply failure, Amplifier overload, Low output level in amplifier, Loss of synchronism, Pilot loss, Low Signal/Noise ratio, AF limiter operation in analog channel, Temperature alarm, Terminal configuration error, Hardware failure, BER alarm in digital channel, Excessive or low reception level in digital channel*)

2.1.4.b Power-supply alarm external signalling

Type	By relay. One per power supply. Changeover contact. Contact rating 2 A/250 **Vac** See Figure **DC voltage/DC current** for **Vdc**
Maximum operate/release times	**8/6** ms
State in normal operation	**Energized** (N.O and C contacts short-circuited)



***2** A is the maximum current in figure **DC voltage/DC current** for **Vdc**.*

Figure 2.4 DC voltage/DC current.

2.1.4.c Alarm condition external signalling

Number of relays	Three relays. Each relay is **configurable** for signalling of alarm or a combination of alarms
Type	By electromechanical relay. Changeover contact. Contact rating 2 A/250 **Vac** See Figure **DC voltage/DC current** for **Vdc**
Maximum operate/release times	**8/6** ms
State in normal operation	**Energized** (N.O and C contacts short-circuited)
Timing for relay activation	Configurable from the Management System between **0** and **60** s
Alarm programmable conditions	Power-supply failure Loss of synchronism Pilot loss Low S/N ratio Amplifier overload Low output level in amplifier AF limiter operation in analog channel Temperature alarm Terminal configuration error Hardware failure BER alarm in digital channel Low reception level in digital channel Excessive reception level in digital channel

2.1.5 Management

2.1.5.a Management interface

10/100Base-Tx LAN interface

Type of interface	**IEEE 802.3** (CSMA/CD)
Connector	8-pin **RJ-45** female
Type of cable	**UTP-5**
Transmission rate	**10** or **100** Mbit/s

Management computer

Communication	LAN module with **10/100Base-Tx** interface
Operating system	Microsoft Windows 10 or higher
Web browser	Microsoft Edge, Google Chrome and Mozilla Firefox. Access to the web server of the **OPU-1** terminal is made by typing its IP address from the browser (**http://<IP>**)

Depending on the browser version, it could happen incorrect monitoring of some **OPU-1** management pages. In this regard, correct operation is guaranteed with Mozilla Firefox (and Windows 10) from version v.90 onwards and with Google Chrome (and Windows 10) from version v.92 onwards.

2.1.5.b Management features

Programming

Network parameters, terminal identification and configuration, transmission and reception frequency bands, audio-frequency input and output levels, signal-level percentages for each service in normal operation or boosting condition, digital modulation scheme, gross bit rate of the digital modem, digital ports, fall back/increase rate, optional modules, external signalling relays, clock and synchronism and loops

Monitoring

Chronological list of alarms and events, terminal alarms, receive pilot level, S/N ratio, Quality of the link (Recommendation G.821), and status of digital ports

2.1.5.c SNMP agent

SNMP protocol

v1, v2c and v3

Functions

Transmission of unconfirmed and confirmed notifications (traps and informs) about alarms and events of the terminal. The last type is only supported for **v2c** and **v3** protocol versions

Supervision of certain terminal parameters by means of a **GET** operation:

- Network parameters (IP, subnet mask and gateway)
- Internal clock and time synchronization
- With teleprotection option: status of command transmission and reception counters and status of input and output activation counters
- Alarm monitoring (basic equipment and teleprotection option)
- Event notification
- Signal/Noise ratio (basic equipment and teleprotection option)
- Receive level

With teleprotection option: set to zero of the command transmission and reception counters and input and output activation counters, by means of a **SET** operation

Modification of the network parameters (IP, subnet mask and gateway), by means of a **SET** operation

Supervision by means of SNMP agent

Possible from an SNMP application

2.2 High-frequency characteristics

2.2.1 Frequency range

From **36** kHz to **512** kHz (upon request, from **500** kHz to **1** MHz for **OPU-1** terminals of **20** W & **40** W properly equipped)

2.2.2 Operating frequency

Programmable in **1** Hz steps

2.2.3 Nominal impedance

Selectable among **50** Ω, **75** Ω, **125** Ω and **140/150** Ω

2.2.4 Return loss

Better than **10** dB in accordance with IEC **62488-3**

2.2.5 Tapping loss

In accordance with IEC **62488-3**

2.2.6 Connecting devices in parallel

OPU-1 terminals for 20 W & 40 W PEP

Maximum number of devices to be connected in parallel	Up to **3**. For a greater number, consult with the manufacturer

OPU-1 terminals for 80 W PEP

Maximum number of devices to be connected in parallel	Up to **2**. For a greater number, consult with the manufacturer

2.2.7 Frequency separation for parallel connection on the same line (analog channel)

Between transmitter and receiver of the same equipment	≥ **0** kHz
Between transmitters of adjacent equipment	≥ **8** kHz
Between transmitter and receiver of adjacent equipment	≥ **4** kHz
Between receivers of adjacent equipment	≥ **0** kHz

2.2.8 Transmitter

Peak envelope power over resistive load	**20** W, **40** W or **80** W, shared between the analog and digital channels
Spurious emission (analog channel)	In accordance with IEC **62488-3**

2.2.9 Receiver sensitivity

-30 dBm (measured in the pilot signal)

2.2.10 Receiver selectivity

Analog channel	In accordance with IEC **62488-2**
Digital channel	In accordance with IEC **62488-3**

2.3 Digital modem characteristics

2.3.1 QAM digital modem

2.3.1.a General

Crest factor	**8** dB
Internal latency	It is about **10** ms

2.3.1.b Modulation

128 QAM	
16 kHz	**81** kbit/s (**79** kbit/s)
8 kHz	**40.5** kbit/s (**39.5** kbit/s)
4 kHz	**20.25** kbit/s (**19.75** kbit/s)

16 QAM	
16 kHz	**40.5** kbit/s (**39.5** kbit/s)
8 kHz	**20.25** kbit/s (**19.75** kbit/s)
4 kHz	**10.125** kbit/s (**9.87** kbit/s)

4 QAM	
16 kHz	**27** kbit/s (**26.3** kbit/s)
8 kHz	**13.5** kbit/s (**13.15** kbit/s)
4 kHz	**6.75** kbit/s (**6.55** kbit/s)

2.3.1.c Fall back/increase rate

Characteristics

Automatic. Can be disabled from the Management System.

The change of speed presents hysteresis, whose thresholds can be programmed from the Management System.

Factory configuration of the hysteresis thresholds

Medium-Upper step	**23** dB
Upper-Medium step	**20.5** dB
Medium-Lower step	**11.6** dB
Lower-Medium step	**14.4** dB

16 kHz QAM bandwidth

Upper	**81** kbit/s
Medium	**40.5** kbit/s
Lower	**27** kbit/s

8 kHz QAM bandwidth

Upper	**40.5** kbit/s
Medium	**20.25** kbit/s
Lower	**13.5** kbit/s

4 kHz QAM bandwidth

Upper	**20.25** kbit/s
Medium	**10.125** kbit/s
Lower	**6.75** kbit/s

The terminal permanently measures the SNR in the digital band to decide the speed increase before retraining.

2.3.2 OFDM digital modem

2.3.2.a General

Modulation	Orthogonal frequency-division multiplexing (**OFDM**/**OQAM**)
Internal latency	**150** ms - **200** ms

2.3.2.b Fall back/increase rate

Characteristics

Automatic.

The maximum transmission rate is dynamically adjusted depending on the signal-to-noise ratio to ensure a correct **BER** in every condition.

32 kHz bandwidth	**324** kbit/s (maximum)
16 kHz bandwidth	**160** kbit/s (maximum)
8 kHz bandwidth	**72** kbit/s (maximum)
4 kHz bandwidth	**32** kbit/s (maximum)

2.4 Operating conditions

2.4.1 Temperature and humidity

From **-10°C** to **+55°C** and relative humidity not greater than **95%**,
in accordance with IEC 721-3-3 class 3K5 (climatogram 3K5)

2.4.2 Power supply

Operating range	**FAPU.02** module: **48** Vdc (36÷72) -25%, +50%, protected against polarity inversion. If a power supply of **125 Vdc** or **220 Vdc** is required, use an **external DC/DC converter** of 220 Vdc to 48 Vdc
Protection against overvoltages in DC voltage	Terminals of **9** s.u. high: **5** A fuse for each power-supply module Terminals of **12** s.u. high: **6.3** / **7** A fuse for each power-supply module
Consumption at 48 Vdc (with **QAM**/**OFDM** and analog pilots at 10%)	**1.87** A (**90** W)

If power-supply redundancy is required, the **OPU-1** for **20** W & **40** W **PEP** can be equipped with two **FAPU** modules, as long as the **FAPX** option is not using the slot of the second power-supply module. Two **FAPU** modules are always required in **OPU-1** terminals of **80** W and OPU-1 terminals of **20** W & **40** W with an extra filter.

2.4.3 Storage conditions

In accordance with **IEC 721-3-1**, class 1K5.

Temperature range between **-40**°C and **+70**°C

2.4.4 Insulation, voltage withstand and electromagnetic compatibility

In accordance with **IEC 62488-2** and **IEC 62488-3:**

- IEC TS 61000-6-5:2001
- GOST R 51317.6.5:2006
- IEC 61000-4-2:2011
- IEC 61000-4-3:2008
- IEC 61000-4-4:2011
- IEC 61000-4-5:95
- IEC 61000-4-6:2008
- IEC 61000-4-8:2011
- IEC 61000-4-9:93
- IEC 61000-4-12:95
- IEC 61000-4-16:2011
- IEC 61000-4-17:2009
- IEC 61000-4-29:2000
- UNE-EN 55022:2008
- UNE-EN 60721-3-2 (2M2)
- IEC 60950-1:2009

2.5 Mechanical characteristics

2.5.1 Mechanical architecture

2.5.1.a Number of shelves

OPU-1 of **20** W & **40** W **PEP**	Two shelves: one of **6** s.u. and one of **3** s.u.
OPU-1 of **80** W **PEP**	Three shelves: one of **6** s.u. and two of **3** s.u.
OPU-1 of **20** W & **40** W with extra filter	Three shelves: one of **6** s.u. and two of **3** s.u.
OPU-1 of **20** W & **40** W intended for **HF Teleprotection** functionality	Two shelves: one of **6** s.u. and one of **3** s.u.

a) OPU-1 of 20 W & 40 W **b) OPU-1 of 80 W** **c) OPU-1 of 20 W & 40 W with extra filter** **d) OPU-1 intended for HF TP functionality**

Figure 2.5 Mechanical architecture.

2.5.1.b Dimensions

OPU-1 of **20** W & **40** W **PEP**	**483** mm (19") wide, **398** mm (9 s.u.) high, and **355** mm deep
OPU-1 of **80** W **PEP**	**483** mm (19") wide, **548** mm (9 s.u.) high, and **355** mm deep
OPU-1 of **20** W & **40** W with extra filter	**483** mm (19") wide, **548** mm (9 s.u.) high, and **355** mm deep
OPU-1 of **20** W & **40** W intended for **HF Teleprotection** functionality	**483** mm (19") wide, **398** mm (9 s.u.) high, and **355** mm deep

2.5.1.c Weight

OPU-1 of **20** W & **40** W **PEP**	~**23** kg
OPU-1 of **80** W **PEP**	~**33** kg
OPU-1 of **20** W & **40** W with extra filter	~**33** kg
OPU-1 of **20** W & **40** W intended for **HF Teleprotection** functionality	~**23** kg

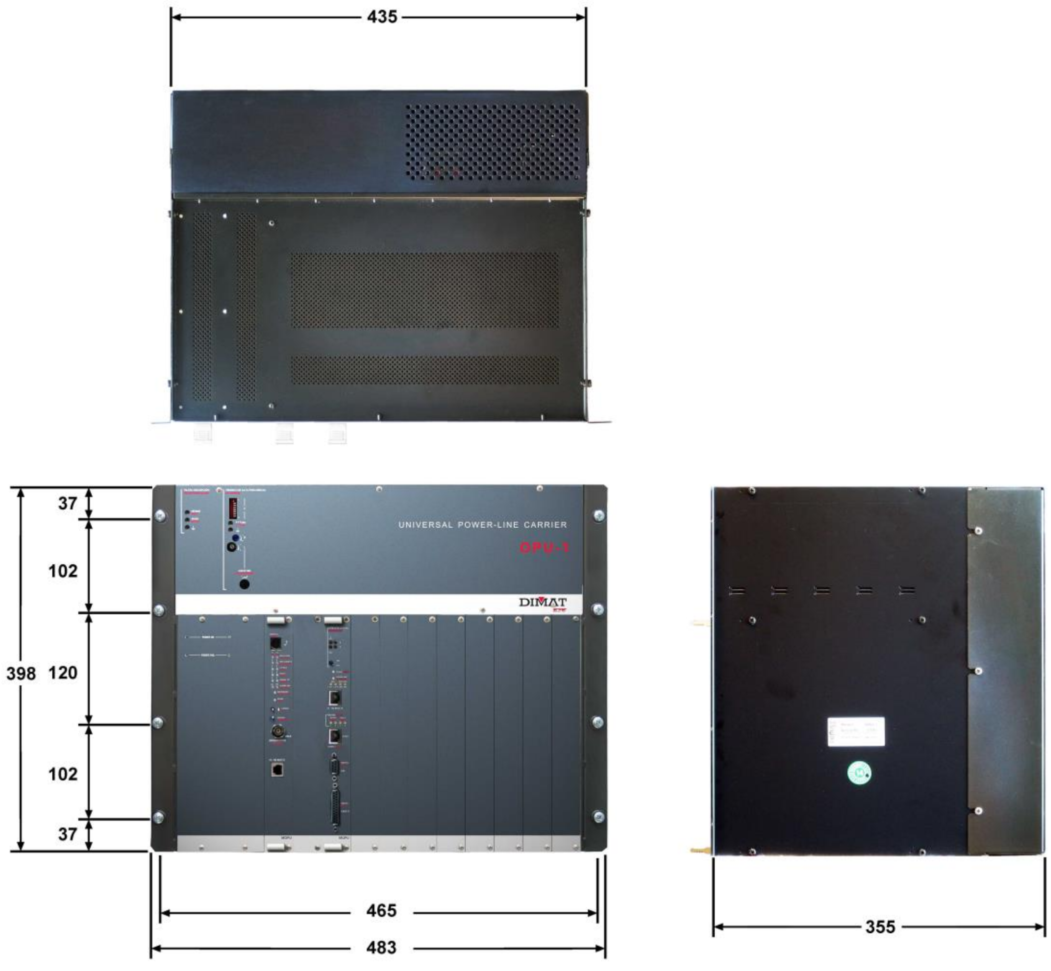


Figure 2.6 Overall dimensions in mm of the OPU-1 of 20 W & 40 W PEP.

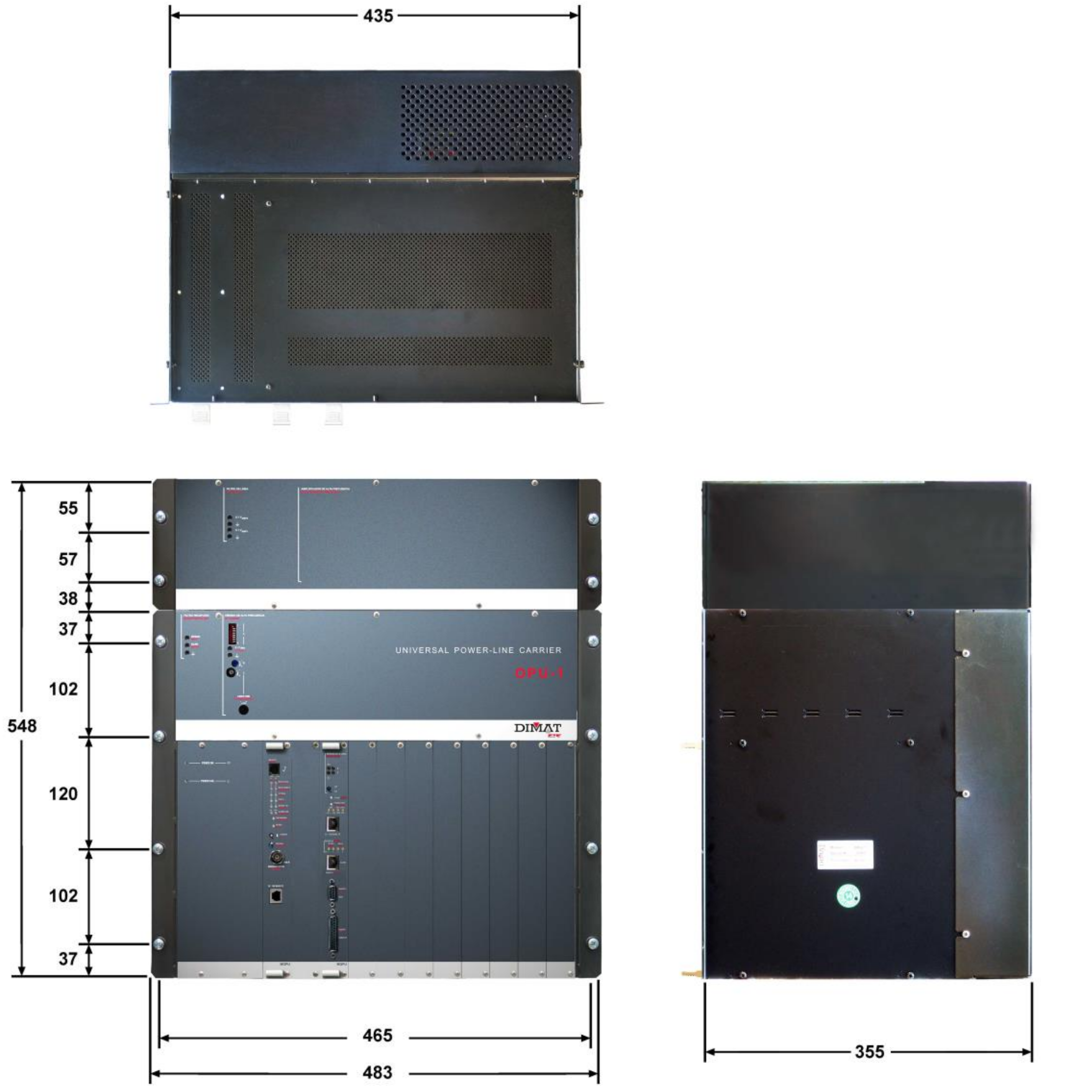


Figure 2.7 Overall dimensions in mm of the OPU-1 of 80 W PEP.

2.5.2 Arrangement of the optional modules (6 s.u. shelf)

- *The **FAPX** option uses the slot of the second power-supply module. For this reason, it is only suitable for **OPU-1** terminals of **20** W & **40** W **PEP** without power-supply redundancy.*
- *The **IOPU** option is always installed in the position of the **6** s.u. shelf that is between the **MOPU** and **MQPU** modules.*
- *The rest of the analog options must be installed in any of the last five positions of the **6** s.u. shelf.*
- *The internal multiplexer occupies any of the three positions of the **6** s.u. shelf which are starting from the position assigned to the digital modem (**MQPU**).*

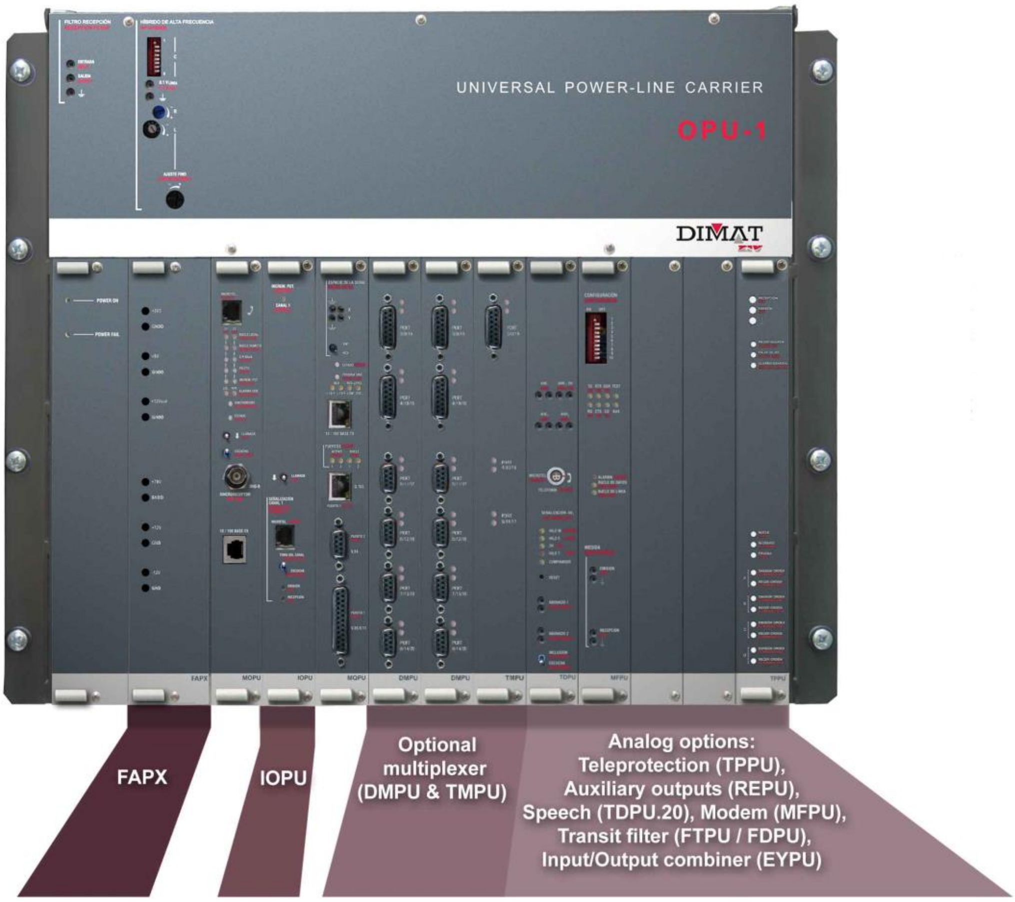


Figure 2.8 Arrangement of the optional modules in the 6 s.u. shelf.

2.5.3 External connections

2.5.3.a Equipment connections

By means of the **6** s.u. back-panel rear connectors intended for:

- Power-supply connection.
  Terminal characteristics: Non-disconnect terminals suitable for flexible conductors of up to **4** mm^2 of section or rigid conductors of up to **6** mm^2 of section
- Alarm-relay connection.
  Terminal characteristics: Non-disconnect terminals suitable for flexible conductors of up to **2.5** mm^2 of section or rigid conductors of up to **2.5** mm^2 of section
- Optional **ZIPU** plug-in terminal block associated with the baseband analog I/O interface (**IOPU** option).
  Terminal characteristics: Non-disconnect terminals suitable for **AWG 16** conductors (geometric conversion: **1.31** mm^2 ; nominal section: 1**.5** mm^2)
- Optional plug-in terminal blocks associated with the **analog** options or to the connecting hoses of optional cabinet-mounting terminal blocks
- Optional plug-in terminal blocks associated with the **multiplexer** option or to the connecting hoses of optional cabinet-mounting terminal blocks

By means of the front-plate elements and connectors intended for:

- Management interface (**MOPU** module)
- GPS time (**MOPU** module)
- G.703 interface (**MQPU** module)
- V.24/V.28 interface (**MQPU** module)
- Ethernet ports (**MQPU** module)
- Handset connector (**IOPU** option or, in its absence, **MOPU** module)
- Multiplexer data channels (**DMPU** option with front ports, and data port of **TMPU** option)

In disturbed environments it is recommended to use **screened cables** for the connections. For **safety** reasons the screen of the connection cables must be grounded, the connection to earth being made at just one end to avoid **interference**.

The plug-in terminal blocks available for options are:

- Plug-in terminal block (**ZIPU**) associated with the baseband analog I/O interface (**IOPU** option)
- Plug-in terminal block (**ZBPU**) associated with the teleprotection (**TPPU** option)
- Plug-in terminal block (**ZCPU**) associated with the teleprotection auxiliary outputs (**REPU** option)
- Plug-in terminal blocks (**ZTPU.11** & **ZTPU.21**) associated with the multiplexer speech channels (**TMPU** option)
- Plug-in terminal blocks (**ZDPU.02** & **ZDPU.04**) associated with the multiplexer data channels (**DMPU** option with rear ports)
- Plug-in terminal block (**ZAPU**) associated with the speech (**TDPU.20** option)
- Plug-in terminal block (**ZAPU**) associated with the asynchronous programmable modem (**MFPU** option)
- Plug-in terminal block (**ZAPU**) associated with the digital transit filter (**FDPU** option)
- Plug-in terminal block (**ZAPU**) associated with the VFT transit filter (**FTPU** option)

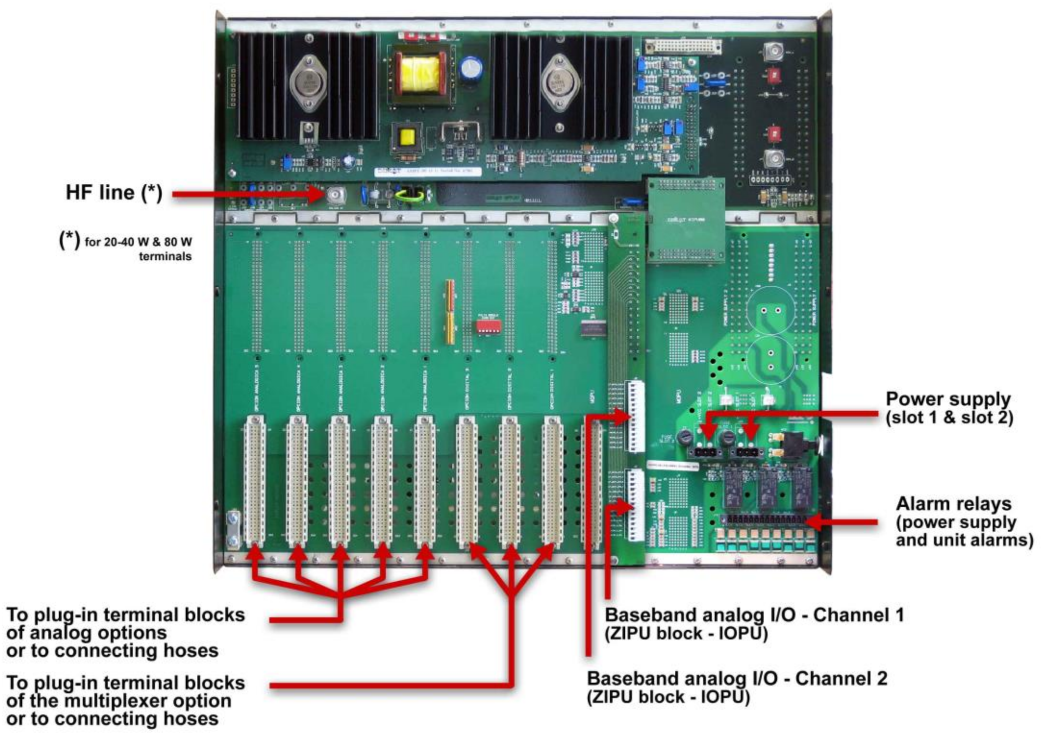


Figure 2.9 Use of the connectors located at the back of the 6 s.u. shelf.

2.5.3.b Cabinet-mounting terminal block (optional)

Upon request the connections can be carried out by means of a cabinet-mounting terminal block, which is made up of:

- Basic equipment terminal block (**ZOPU.##**).
- Terminal blocks associated with the options.

Basic terminal block (ZOPU.##)

Power-supply terminals	Non-disconnect terminals suitable for flexible conductors of up to **4** mm^2 of section or rigid conductors of up to **6** mm^2 of section
The rest of the terminals	Disconnect terminals suitable for flexible conductors of up to **2.5** mm^2 of section or rigid conductors of up to **4** mm^2 of section

Terminal blocks associated with options:

- Terminal block (**ZBBA.14**) associated with channel **2** of the baseband analog I/O interface (**IOPU.02** option).

  Terminals BB1 of* ***ZOPU.02* *terminal block are assigned to channel* ***1*** *of the* ***IOPU.02*** *option*

  Terminals BB1 of* ***ZOPU.01* *terminal block are assigned to channel* ***1*** *of the* ***IOPU.01*** *option*

- Terminal blocks (**ZBBA.16-BB1** & **ZBBA.06-BB2**) associated with the teleprotection (**TPPU** option)
- Terminal blocks (**ZTPU.10** & **ZTPU.20**) associated with the multiplexer speech channels (**TMPU** option)
- Terminal block (**ZBBA.20**) associated with the speech (**TDPU.20** option)
- Terminal block (**ZBBM.00**) associated with the asynchronous programmable modem (**MFPU** option)
- Terminal block (**ZBBA.04**) associated with the digital transit filter (**FDPU** option)
- Terminal block (**ZBBA.02**) associated with the VFT transit filter (**FTPU** option)
- Terminal block (**ZBBA.16**) associated with the Input/Output combiner (**EYPU** option)

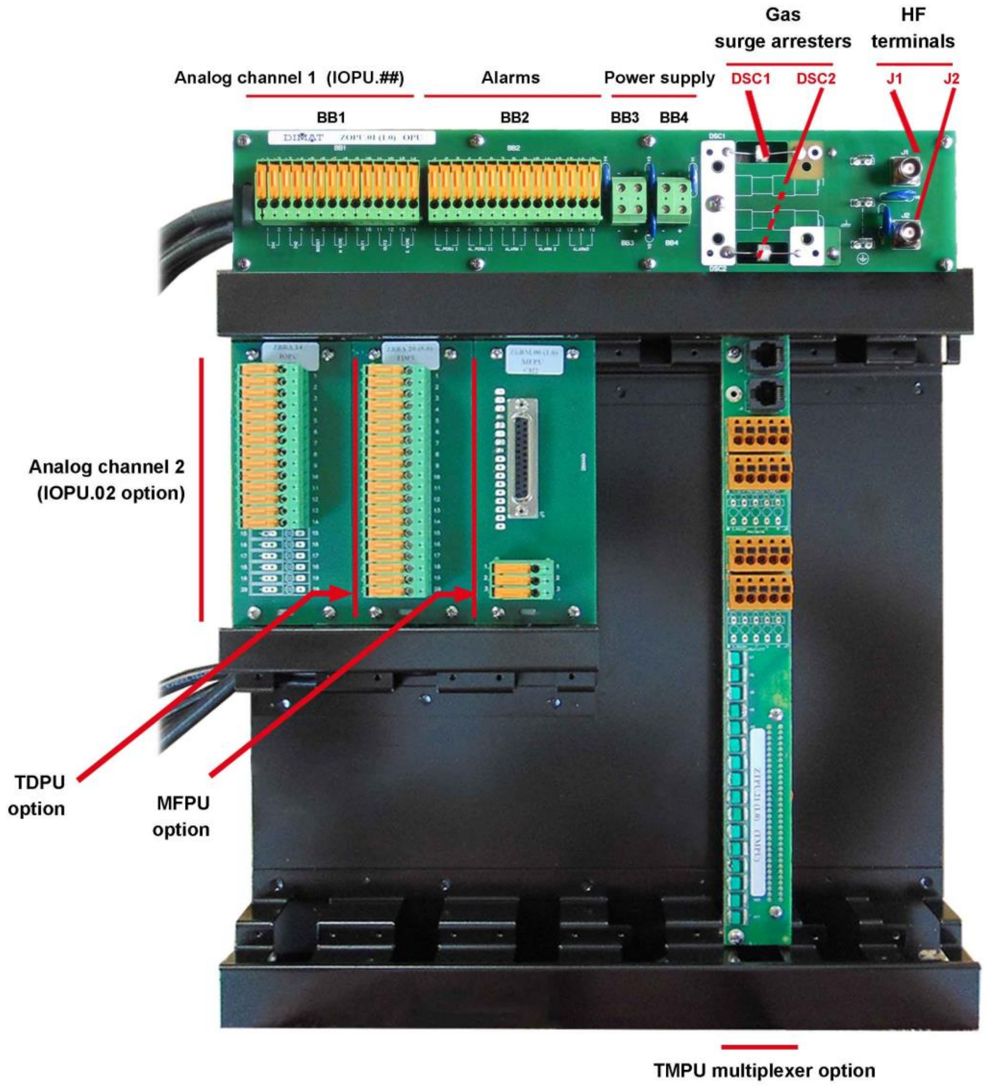


Figure 2.10 Example of arrangement of the optional OPU-1 cabinet-mounting terminal block.

2.5.4 Other mechanical characteristics

2.5.4.a IP protection level

IP2x according to IEC 60529

2.5.4.b Transport

OPU-1 terminals comply with **EN 60721-3-2** class 2M1 transport specifications regarding **vibration** and **shock** according to **IEC 62488-2** and **IEC 62488-3**

2.5.4.c Operation

OPU-1 terminals comply with **EN 60721-3-3** class 3M1 operating specifications regarding **vibration** and **shock** according to **IEC 62488-2** and **IEC 62488-3**

2.6 Built-in multiplexer characteristics

2.6.1 DMPU option

2.6.1.a Module types

DMPU.02 module	Two **front** data ports, identified as **3/9/15** and **4/10/16**
DMPU.02R module	Two **rear** data ports, identified as **5/11/17** and **6/12/18**
DMPU.04 module	Four **front** data ports, identified as **3/9/15**, **4/10/16**, **5/11/17** and **6/12/18**
DMPU.04R module	Four **rear** data ports, identified as **5/11/17**, **6/12/18**, **7/13/19** and **8/14/20**
DMPU.06 module	Six **front** data ports, identified as **3/9/15**, **4/10/16**, **5/11/17**, **6/12/18**, **7/13/19** and **8/14/20**

2.6.1.b Port interfaces

Port **3/9/15** (DB15 female)	**V.24/V.28** of the ITU-T (EIA RS-232C) **X.21** of the ITU-T **RS-422** of the ITU-T **RS-485** (HD/FD)
Port **4/10/16** (DB15 female)	**V.24/V.28** of the ITU-T (EIA RS-232C) **X.21** of the ITU-T **RS-422** of the ITU-T **RS-485** (HD/FD)
Port **5/11/17** (DB9 female)	**V.24** asynchronous **RS-422** of the ITU-T **RS-485** (HD/FD)
Port **6/12/18** (DB9 female)	**V.24** asynchronous **RS-422** of the ITU-T **RS-485** (HD/FD)

Port **7/13/19** (DB9 female)	**V.24** asynchronous **RS-422** of the ITU-T **RS-485** (HD/FD)
Port **8/14/20** (DB9 female)	**V.24** asynchronous **RS-422** of the ITU-T **RS-485** (HD/FD)

Improved implementation of V.24 in asynchronous mode, which enables communications between devices with speeds up to 10% different.

2.6.1.c Data format

Synchronous, asynchronous or anisochronous

2.6.1.d Asynchronous data format

1 Start bit

6 to **8** data bits

1 or **2** stop bits

2.6.1.e Speed

Synchronous port

600, 1200, 2400, 3600, 4800, 6400, 7200, 8000, 9600, 14400, 16000, 19200, 28800, 32000 and 38400 bit/s

up to 19200 bit/s for a speed in line of **27 kbit/s*

Asynchronous port

50, 100, 200, 300, 600, 1200, 2400, 3600, 4800, 6400, 7200, 8000, 9600, 14400, 19200 and 28800 bit/s

up to 19200 bit/s for a speed in line of **27 kbit/s*

Anisochronous port

60, 120, 240, 360, 480, 640, 720, 800, 960 and 1440 bit/s

2.6.1.f External signalling

By optical indication:

- Transmitted data (**TD**)
- Received data (**RD**)
- Port in loop
- Port blocked or non-programmed

2.6.1.g External connection

Module with **front** ports:

- Female **DB15** / **DB9** connectors on the module front

Module with **rear** ports:

- **ZDPU.02** plug-in terminal block:
  Two female **DB9** connectors (**2** data ports)
- **ZDPU.04** plug-in terminal block:
  Four female **DB9** connectors (**4** data ports)

2.6.1.h Dimensions

30 mm wide, **262** mm high, and **256** mm (with handles) depth

2.6.1.i Weight

450 g

2.6.2 TMPU option

2.6.2.a Module types

TMPU.11 module	One speech port, identified on the front as **4/10/16**, plus one **front** data port, identified as **3/9/15**
TMPU.21 module	Two speech ports, identified on the front as **4/10/16** and **5/11/17**, plus one **front** data port, identified as **3/9/15**

2.6.2.b Speech port

Transmission mode

Full-duplex at **2100** bit/s, **2450** bit/s or **2800** bit/s (RALCWI coding algorithm)

Voice quality

Mean Opinion Score (**MOS**) about 3.5-3.6

Terminations

2-wire and **4**-wire telephone termination

FXO (exchange side) mode or **FXS** (subscriber side) mode for the **2**-wire telephone termination

Signalling

E & **M** (out-of-band)

DTMF (in-band)

Factory pre-set ADASE **1200**/**1600** Hz tones (in-band)

2.6.2.c Exchange-side 4-wire telephone termination

4-wire input

Nominal impedance	**600** Ω, balanced
Return loss	≥ **20** dB
Nominal level	Configurable from -**20** dBm to +**8** dBm

4-wire output

Nominal impedance	**600** Ω, balanced
Return loss	≥ **20** dB
Nominal level	Configurable from -**20** dBm to +**8** dBm

2.6.2.d Exchange-side 2-wire telephone termination

Nominal impedance	**600** Ω, balanced
Nominal input level	Configurable from -**20** dBm to +**8** dBm
Nominal output level	Configurable from -**20** dBm to +**8** dBm
Hybrid rejection	≥ **15** dB
Loop current	**35** mA
Minimum ring voltage	**15** Vpp

The 2-wire terminals (**2W**) coincide physically with the 4-wire reception terminals (**4WR**).

2.6.2.e Subscriber-side 2-wire telephone termination

Nominal impedance	**600** Ω, balanced
Return loss	≥ **20** dB
Nominal input level	+**3** dBm
Nominal output level	-**3** dBm
Maximum loop resistance	**1800** Ω
Type of telephone set	Decadic and multifrequency
Ring voltage	**96** Vpp
Ring frequency	**25** Hz
Maximum number of telephones in parallel	**4**

2.6.2.f Control signals

2W / 4W switching (optional)	
External control	By means of optocoupler. Input voltage between **30** V and **190** V

Signalling	
M wire input	By means of optocoupler. Input voltage between **30** V and **190** V
E wire output	By means of solid-state relay. Contact rating: **100** mA / **300** V
T wire output (optional)	By means of solid-state relay. Contact rating: **100** mA / **300** V

2.6.2.g Data port interface

Port **3/9/15** (DB15 female)	**V.24/V.28** of the ITU-T (EIA RS-232C) **X.21** of the ITU-T

Improved implementation of V.24 in asynchronous mode, which enables communications between devices with speeds up to 10% different.

2.6.2.h External signalling

Speech port

By front optical indication:

- Activation of **E** & **M** wires
- Port blocked or non-programmed

Data port

By front optical indication:

- Transmitted data (**TD**)
- Received data (**RD**)
- Port in loop
- Port blocked or non-programmed

2.6.2.i External connection

Speech port

Plug-in terminal block:

- **ZTPU.11**. One speech port
- **ZTPU.21**. Two speech ports

Cabinet-mounting terminal block:

- **ZTPU.10**. One speech port
- **ZTPU.20**. Two speech ports

Data port

Female **DB15** connector on the module front

2.6.2.j Dimensions

30 mm wide, **262** mm high, and **256** mm (with handles) depth

2.6.2.k Weight

450 g

2.7 Built-in teleprotection characteristics

2.7.1 Teleprotection (TPPU) over dedicated analog band

2.7.1.a Application

Transmission of teleprotection commands over dedicated **analog** band for electrical high-frequency line protection for these schemes:

- Blocking
- Direct tripping
- Permissive tripping

2.7.1.b Security and dependability

In accordance with **IEC 60834-1** standard

2.7.1.c Operating principle

Transmission of a guard signal in quiescent conditions that is substituted by a command signal (**dual** tone or **single** tone) when a command needs to be transmitted.

When the receiver detects the absence of the guard signal and the presence of the command signal, the corresponding command-output relay is activated.

2.7.1.d Input and output levels

Configurable between **10** % and **97** %

2.7.1.e Capacity

Dual tone

Up to **4** independent commands and in any combination in a teleprotection band of BW=**1** kHz, BW=**2** kHz or BW=**4** kHz per channel in each direction.

Up to **8** independent commands in **two** teleprotection bands of BW=**1** kHz or BW=**2** kHz per channel in each direction.

Up to **16** independent commands in **four** teleprotection bands of BW=**1** kHz per channel in each direction.

ENCODED SIGNAL	F1	F2	F3	F4	F5	F6	F7
A						X	X
B					X	X	
A+B					X		X
C			X	X			
A+C	X		X				
B+C			X		X		
A+B+C	X			X			
D		X	X				
A+D	X						X
B+D		X				X	
A+B+D				X		X	
C+D		X		X			
A+C+D			X				X
B+C+D	X					X	
A+B+C+D	X				X		

Table 2-1: Logic of the encoded signals for four commands (dual tone)

Single tone

Up to **3** independent commands and in any combination, in a **4** kHz channel in each direction.

Up to **4** commands, in a **4** kHz channel in each direction, according to the following logic:

- **Mode 2+2**: simultaneous protection of two lines by means of two permissive trips and two direct trips
- **Mode 3+1**: simultaneous protection of the three phases of a line by means of three permissive trips (**A**, **B** and **C**) and one direct trip (**D**) which has priority

NOTE:

The difference between the two versions of the **Mode 2+2** is the commands associated with the permissive and direct trips.

In Mode 2+2 **(1)** direct trips are associated with commands **A** and **B** and have priority over permissive trips (**C** and **D**).

In Mode 2+2 **(2)** direct trips are associated with commands **C** and **D** and have priority over permissive trips (**A** and **B**).

NOTE:

The difference between the two versions of the **Mode 3+1** is the command tone that is transmitted for each of the different input combinations associated with the permissive trips.

INPUT COMMANDS	MODE 2+2 (1)	MODE 2+2 (2)	MODE 3+1(1)	MODE 3+1(2)
A	f(A)	f(A)	f(A)	f(A)
B	f(B)	f(B)	f(B)	f(B)
C	f(C)	f(C)	f(C)	f(C)
D	f(D)	f(D)	f(D)	f(D)
A+B	f(A+B)	f(A+B)	f(A+B)	f(D)
A+C	f(A)	f(C)	f(A+C)	f(D)
A+D	f(A+D)	f(A+D)	f(D)	f(D)
B+C	f(B+C)	f(B+C)	f(B+C)	f(D)
B+D	f(B)	f(D)	f(D)	f(D)
C+D	f(C+D)	f(C+D)	f(D)	f(D)
A+B+C	f(A+B)	f(B+C)	f(A+B+C)	f(D)
A+B+D	f(A+B)	f(A+D)	f(D)	f(D)
A+C+D	f(A+D)	f(C+D)	f(D)	f(D)
B+C+D	f(B+C)	f(C+D)	f(D)	f(D)
A+B+C+D	f(A+B)	f(C+D)	f(D)	f(D)

Table 2-2: Logic of the transmission tones for four commands (single tone)

2.7.1.f Guard and command frequencies

Single tone

The **guard** signal and each of the **command** signals are assigned a single frequency, which is configurable from among those defined in Recs. R.35, R.37 and R.38 of the ITU-T and the frequencies:

3300 Hz, 3360 Hz, 3420 Hz, 3480 Hz, 3540 Hz, 3600 Hz, 3660 Hz, 3780 Hz and 3800 Hz

Dual tone

Each of the **command** signals is assigned two frequencies whose amplitude is half the amplitude of the **guard** signal, which is assigned a single frequency.

- BW=**1** kHz

  The **guard** is at **150** Hz from the end of band. The distance between tones is **100** Hz

  NOTE 1: When working with two teleprotection bands per channel, the **guard** of *Teleprotection A* must be of **2900** Hz and that of *Teleprotection B* of **3800** Hz

  NOTE 2: When working with four teleprotection bands per channel, the **guard** of *Teleprotection A* must be of **1100** Hz, that of *Teleprotection B* of **2000** Hz, that of *Teleprotection C* of **2900** Hz and that of *Teleprotection D* of **3800** Hz

- BW=**2** kHz

  The **guard** is at **300** Hz from the end of band. The distance between tones is **200** Hz

  NOTE: When working with two teleprotection bands per channel, the **guard** of *Teleprotection A* must be of **1850** Hz and that of *Teleprotection B* of **3650** Hz

- BW=**4** kHz

  The **guard** is at **416.6** Hz from the end of band.

  The distance between tones is **277.7** Hz

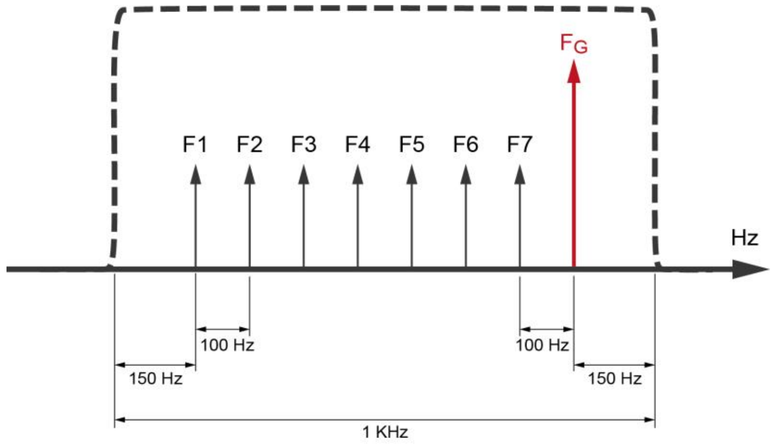


Figure 2.11 Distance between tones (BW= 1 kHz).

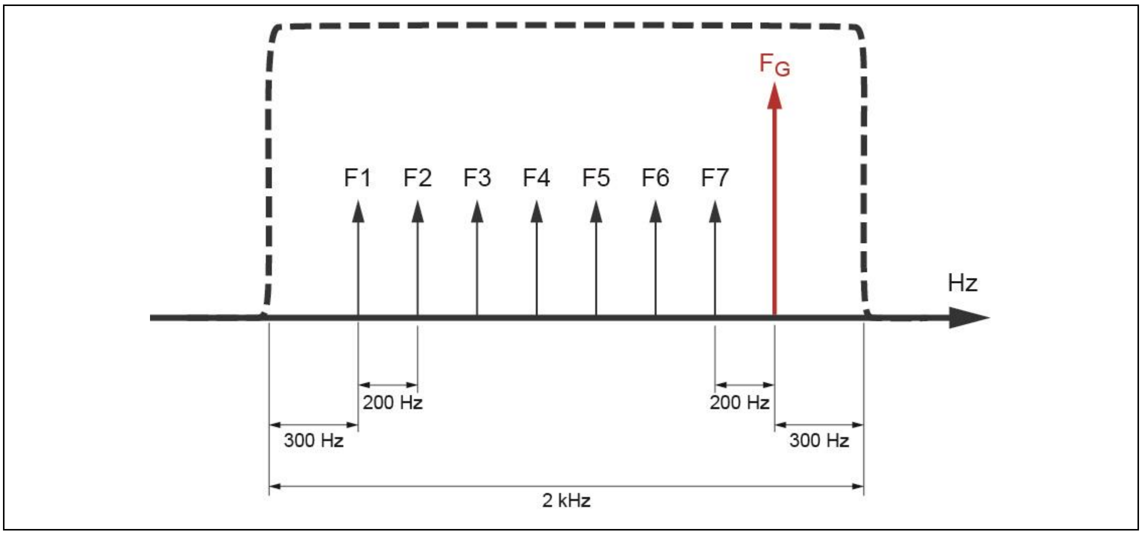


Figure 2.12 Distance between tones (BW= 2 kHz).

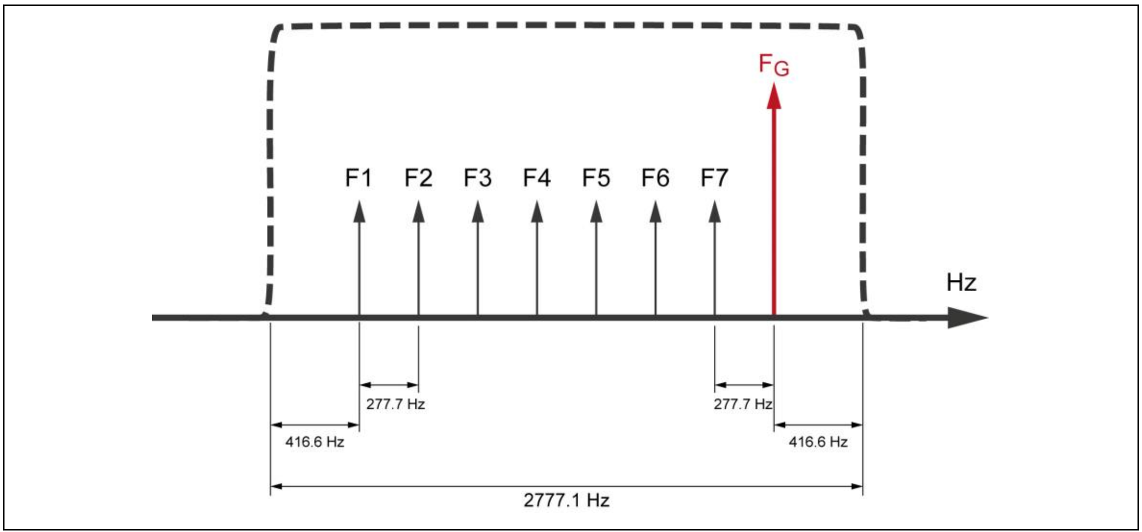


Figure 2.13 Distance between tones (BW= 4 kHz).

2.7.1.g Nominal transmission time

Dual tone

BW=**1** kHz

Configurable from the Management System:
- **12** ms (intended for **blocking**)
- **13** ms (intended for **permissive** tripping)
- **14** ms (intended for **direct** tripping)

NOTE: *the transmission time of the channel (**4** ms), which already contains the phase equalizer, must be added to these values*

BW=**2** kHz

Configurable from the Management System:
- **7** ms (intended for **blocking**)
- **8** ms (intended for **permissive** tripping)
- **9** ms (intended for **direct** tripping)

NOTE: *the transmission time of the channel (**4** ms), which already contains the phase equalizer, must be added to these values*

BW=**4** kHz

Configurable from the Management System:
- **6** ms (intended for **blocking**)
- **7** ms (intended for **permissive** tripping)
- **8** ms (intended for **direct** tripping)

NOTE: *the transmission time of the channel (**4** ms), which already contains the phase equalizer, must be added to these values*

Single tone

Configurable from the Management System:
- **7** ms (intended for **blocking**)
- **12** ms (intended for **permissive** tripping)
- **21** ms (intended for **direct** tripping)

NOTE: *the transmission time of the channel (**4** ms), which already contains the phase equalizer, must be added to these values*

2.7.1.h Command inputs

Type	Optocoupled
Number of inputs per command	Configurable (**1** to **4**)
Nominal operating voltage	**24**, **48**, **110** and **220** Vdc (configurable with internal jumpers)
(Lower) voltage that guarantees activation	-**20**% of the nominal voltage
(Higher) voltage that guarantees NO activation	-**40**% of the nominal voltage
Maximum operating voltage	+**20**% of the nominal voltage
Polarity	Indistinct
Consumption	**10** mA at the nominal voltage (in the whole range) **Upon request, **3** mA*
Activation minimum time	**700** µs
Activation logic	By presence or absence of voltage (configurable with internal jumpers)
Additional timing for command transmission	Configurable from the Management System between **1** and **30** ms with **1** ms steps
Duration of command transmission	In permanence. **Prolonged** between 20 and 2500 ms. Configurable in **10** ms steps **Limited** between 20 and 2500 ms. Configurable in **10** ms steps **Fixed duration** between 20 and 2500 ms. Configurable in **10** ms steps

2.7.1.i Command outputs

Type	Solid-state **relay** (semiconductor)
Number of outputs per command	Configurable (**1** to **4**)
Contact	Normally open. Voltage free
Maximum connection power	**900** W
Maximum current in connection	Permanent: **1.5** A **3** A for a max. of **20** s
Maximum connection voltage	**265** Vdc (**300** Vdc for a maximum current of 1 A)
Residual voltage in connection	**4** V
Leakage current	< **300** µA
Switching time	< **250** µs
Time period during which the command received must remain active	Whilst receiving command. **Prolonged** between 20 and 2500 ms. Configurable in **10** ms steps **Limited** between 20 and 2500 ms. Configurable in **10** ms steps **Fixed duration** between 20 and 2500 ms. Configurable in **10** ms steps

2.7.1.j Test devices

Command transmission (permanent or not).

Local loop (permanent or not).

Local test (it runs automatically when programming its periodicity).

2.7.1.k Counters

Command transmission and reception	Monitored through the Management System or frontal display
Input and output activation	Monitored through the Management System or frontal display

2.7.1.l Teleprotection chronological register

Capacity	**3000** alarms and events (FIFO-based register)
Resolution	**1** ms
Time synchronization	Via GPS (**IRIG-B**) or via Ethernet (**SNTP** protocol)

2.7.1.m External signalling

By front optical indication:

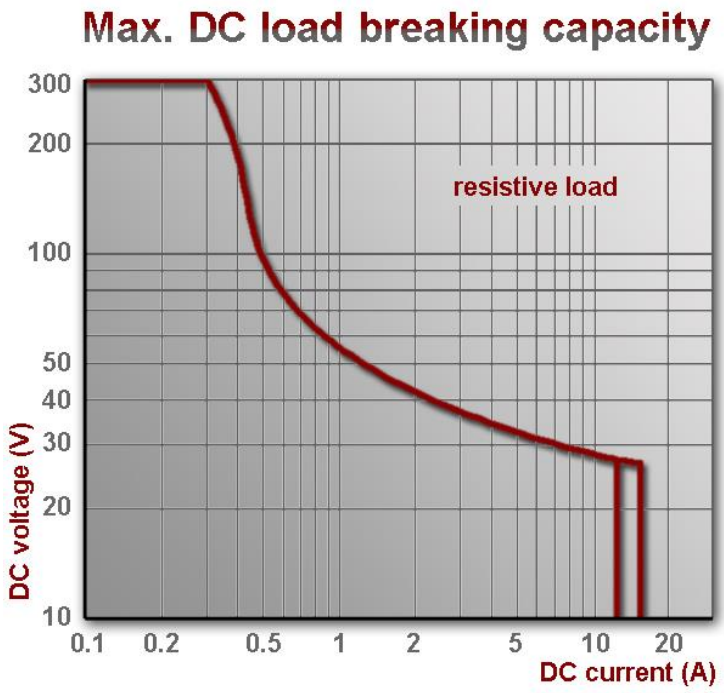
- Guard reception
- Signal loss
- Command transmission (A, B, C and D)
- Command reception (A, B, C and D)
- Output circuit blocking, protection side
- Automatic test result
- Terminal in loop
- General alarm
  (*Receiver blocking, Signal loss, Low S/N ratio, Incorrect guard-signal level, Local test failure, Device error, Manual blocking, Erroneous configuration data*)

By relay:

- Alarm or signalling (configurable conditions)

2.7.1.n Alarm/Signalling relay characteristics

Number of relays	Two relays. Each relay is **configurable** for signalling or alarm conditions
Type	Electromechanical relay. Changeover contact. Contact rating: **1** A/250 Vac See Figure **DC voltage/DC current** for **Vdc**
Maximum operate/release times	**8**/**6** ms
State in normal operation	Signalling: **non-energized** (N.C and C contacts are short-circuited) Alarm: **energized** (N.O. and C contacts short-circuited)
Timing for relay activation	Configurable from the Management System between **0** and **60** s
Signalling configurable conditions	Command transmission (A, B, C and D) Command output (1, 2, 3 and 4)
Alarm configurable conditions	Receiver blocking Signal loss Low S/N ratio Incorrect guard signal level Local test failure Device error



*2 A is the maximum current in figure **DC voltage/DC current** for **Vdc**.*

Figure 2.14 DC voltage/DC current.

2.7.1.o External connection

Plug-in terminal block	**ZBPU**
Cabinet-mounting terminal block	**ZBBA.16-BB1** & **ZBBA.06-BB2**

2.7.1.p Dimensions

30 mm wide, **262** mm high, and **256** mm (with handles) depth

2.7.1.q Weight

500 g

2.7.2 Teleprotection (TPPU) integrated into the digital band

2.7.2.a Application

Transmission of teleprotection commands integrated into the **digital** band for electrical high-frequency line protection for these schemes:

- Blocking
- Direct tripping
- Permissive tripping

2.7.2.b Security and dependability

In accordance with **IEC 60834-1** standard

2.7.2.c Operating principle

Transmission of a guard signal in quiescent conditions that is substituted by a command signal (**dual** tone or **single** tone) when a command needs to be transmitted.

When the receiver detects the absence of the guard signal and the presence of the command signal, the corresponding command-output relay is activated.

The guard signal is transmitted together with the **QAM/OFDM** signal generated in the **OPU-1** terminal. When a command needs to be transmitted, the transmission of the **QAM/OFDM** signal is interrupted for a configurable period of time (it is recommended not to exceed **500** ms).

2.7.2.d Guard signal modulation percentages

Dual tone	Fixed at **30** %
Single tone	Fixed at **20** %

2.7.2.e Situation of the guard signal in the QAM band

Dual and single tone	f_0 ± **7850** Hz (BW= **16** kHz) f_0 ± **3925** Hz (BW= **8** kHz) f_0 ± **1962.5** Hz (BW= **4** kHz)

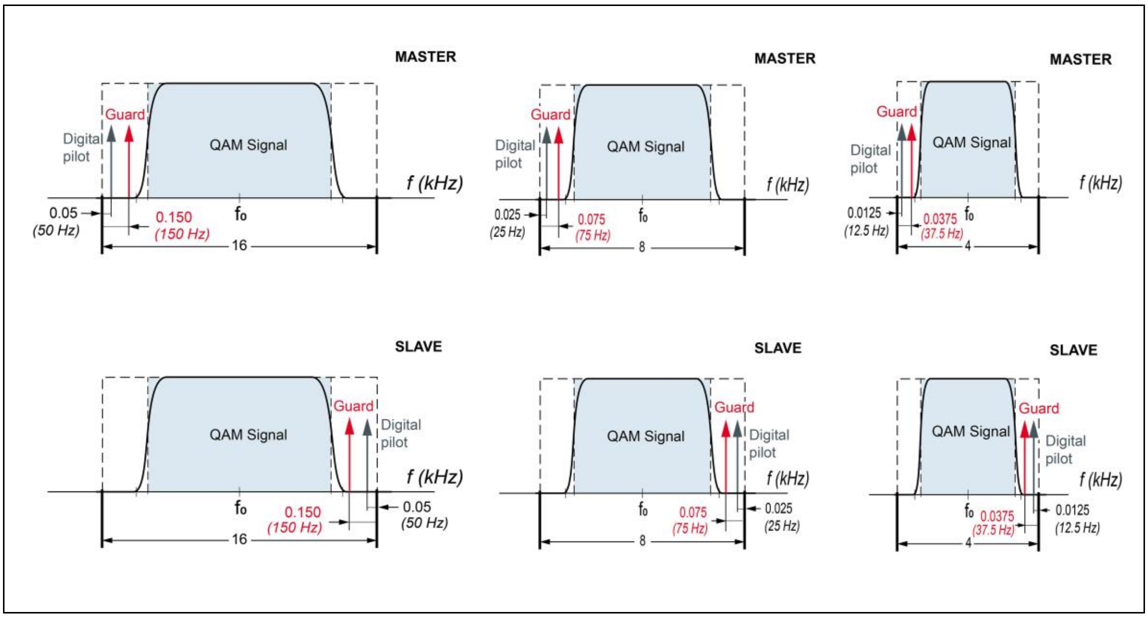


Figure 2.15 Guard signal situation in the QAM band.

2.7.2.f Capacity

Dual tone

Up to **4** independent commands and in any combination in a teleprotection band of BW=**1** kHz

ENCODED SIGNAL	F1	F2	F3	F4	F5	F6	F7
A						X	X
B					X	X	
A+B					X		X
C			X	X			
A+C	X		X				
B+C			X		X		
A+B+C	X			X			
D		X	X				
A+D	X						X
B+D		X				X	
A+B+D				X		X	
C+D		X		X			
A+C+D			X				X
B+C+D	X					X	
A+B+C+D	X				X		

Table 2-3: Logic of the encoded signals for four commands (dual tone)

Single tone

Up to **3** independent commands and in any combination.

Up to **4** commands according to the following logic:

- **Mode 2+2**: simultaneous protection of two lines by means of two permissive trips and two direct trips
- **Mode 3+1**: simultaneous protection of the three phases of a line by means of three permissive trips (**A**, **B** and **C**) and one direct trip (**D**) which has priority

NOTE:
The difference between the two versions of the **Mode 2+2** is the commands associated with the permissive and direct trips.

In Mode 2+2 **(1)** direct trips are associated with commands **A** and **B** and have priority over permissive trips (**C** and **D**).

In Mode 2+2 **(2)** direct trips are associated with commands **C** and **D** and have priority over permissive trips (**A** and **B**).

NOTE:
The difference between the two versions of the **Mode 3+1** is the command tone that is transmitted for each of the different input combinations associated with the permissive trips.

INPUT COMMANDS	MODE 2+2 (1)	MODE 2+2 (2)	MODE 3+1(1)	MODE 3+1(2)
A	f(A)	f(A)	f(A)	f(A)
B	f(B)	f(B)	f(B)	f(B)
C	f(C)	f(C)	f(C)	f(C)
D	f(D)	f(D)	f(D)	f(D)
A+B	f(A+B)	f(A+B)	f(A+B)	f(D)
A+C	f(A)	f(C)	f(A+C)	f(D)
A+D	f(A+D)	f(A+D)	f(D)	f(D)
B+C	f(B+C)	f(B+C)	f(B+C)	f(D)
B+D	f(B)	f(D)	f(D)	f(D)
C+D	f(C+D)	f(C+D)	f(D)	f(D)
A+B+C	f(A+B)	f(B+C)	f(A+B+C)	f(D)
A+B+D	f(A+B)	f(A+D)	f(D)	f(D)
A+C+D	f(A+D)	f(C+D)	f(D)	f(D)
B+C+D	f(B+C)	f(C+D)	f(D)	f(D)
A+B+C+D	f(A+B)	f(C+D)	f(D)	f(D)

Table 2-4: Logic of the transmission tones for four commands (single tone)

2.7.2.g Guard and command frequencies

Dual tone

The **command** signals have two fixed and specific frequencies whose amplitude is half the amplitude of the guard signal, which has a fixed and specific frequency.

- Guard frequency
  3800 Hz (QAM of **16** kHz and **8** kHz)

- Command frequencies
  From the guard, the distance between tones is **100** Hz

Single tone

The system sets a fixed and specific frequency for the **guard** signal and each of the **command** signals.

- Guard frequency
  3800 Hz (QAM of **16** kHz and **8** kHz)

- Command frequencies
  Fixed and according to Table 2.5

Scheme ≤3 commands	Mode 1 (2+2)	Mode 2 (3+1(1))	Mode 3 (3+1(2))
Command A: 3540 Hz Command B: 3300 Hz Command C: 2700 Hz Commands A+B: 3000 Hz Commands A+C: 2400 Hz Commands B+C: 2100 Hz Commands A+B+C: 1140 Hz	Command A: 3540 Hz Command B: 3300 Hz Command C: 2700 Hz Command D: 1860 Hz Commands A+B: 3000 Hz Commands A+D: 2400 Hz Commands B+C: 2100 Hz Commands C+D: 1140 Hz	Command A: 3540 Hz Command B: 3300 Hz Command C: 2700 Hz Command D: 1860 Hz Commands A+B: 3000 Hz Commands A+C: 2400 Hz Commands B+C: 2100 Hz Commands A+B+C:1140 Hz	Command A: 3540 Hz Command B: 3300 Hz Command C: 2700 Hz Command D: 1860 Hz

Table 2-5: Command frequencies for QAM digital band (single tone)

2.7.2.h Nominal transmission time

Dual tone

BW=**1** kHz (QAM of **16** kHz)

Configurable from the Management System:

- **12** ms (intended for **blocking**)
- **13** ms (intended for **permissive** tripping)
- **14** ms (intended for **direct** tripping)

NOTE: *the transmission time of the channel (**4** ms), which already contains the phase equalizer, must be added to these values*

BW=**1** kHz (QAM of **8** kHz)

Configurable from the Management System:

- **13** ms (intended for **blocking**)
- **14** ms (intended for **permissive** tripping)
- **15** ms (intended for **direct** tripping)

NOTE: *the transmission time of the channel (**4** ms), which already contains the phase equalizer, must be added to these values*

Single tone

Configurable from the Management System:

- **12** ms (intended for **permissive** tripping)
- **21** ms (intended for **direct** tripping)

NOTE: *the transmission time of the channel (**4** ms), which already contains the phase equalizer, must be added to these values*

2.7.2.i Command inputs

Type	Optocoupled
Number of inputs per command	Configurable (**1** to **4**)
Nominal operating voltage	**24**, **48**, **110** and **220** Vdc (configurable with internal jumpers)
(Lower) voltage that guarantees activation	-**20**% of the nominal voltage
(Higher) voltage that guarantees NO activation	-**40**% of the nominal voltage
Maximum operating voltage	+**20**% of the nominal voltage
Polarity	Indistinct
Consumption	**10** mA at the nominal voltage (in the whole range) **Upon request, **3** mA*
Activation minimum time	**700** µs
Activation logic	By presence or absence of voltage (configurable with internal jumpers)
Additional timing for command transmission	Configurable from the Management System between **1** and **30** ms with **1** ms steps
Duration of command transmission	In permanence. **Prolonged** between 20 and 2500 ms. Configurable in **10** ms steps **Limited** between 20 and 2500 ms. Configurable in **10** ms steps **Fixed duration** between 20 and 2500 ms. Configurable in **10** ms steps

2.7.2.j Command outputs

Type	Solid-state **relay** (semiconductor)
Number of outputs per command	Configurable (**1** to **4**)
Contact	Normally open. Voltage free
Maximum connection power	**900** W
Maximum current in connection	Permanent: **1.5** A **3** A for a max. of **20** s
Maximum connection voltage	**265** Vdc (**300** Vdc for a maximum current of 1 A)
Residual voltage in connection	**4** V
Leakage current	< **300** µA
Switching time	< **250** µs
Time period during which the command received must remain active	Whilst receiving command. **Prolonged** between 20 and 2500 ms. Configurable in **10** ms steps **Limited** between 20 and 2500 ms. Configurable in **10** ms steps **Fixed duration** between 20 and 2500 ms. Configurable in **10** ms steps

2.7.2.k Test devices

Command transmission (permanent or not).

Local loop (permanent or not).

Local test (it runs automatically when programming its periodicity).

2.7.2.l Counters

Command transmission and reception	Monitored through the Management System or frontal display
Input and output activation	Monitored through the Management System or frontal display

2.7.2.m Teleprotection chronological register

Capacity	**3000** alarms and events (FIFO-based register)
Resolution	**1** ms
Time synchronization	Via GPS (**IRIG-B**) or via Ethernet (**SNTP** protocol)

2.7.2.n External signalling

By front optical indication:

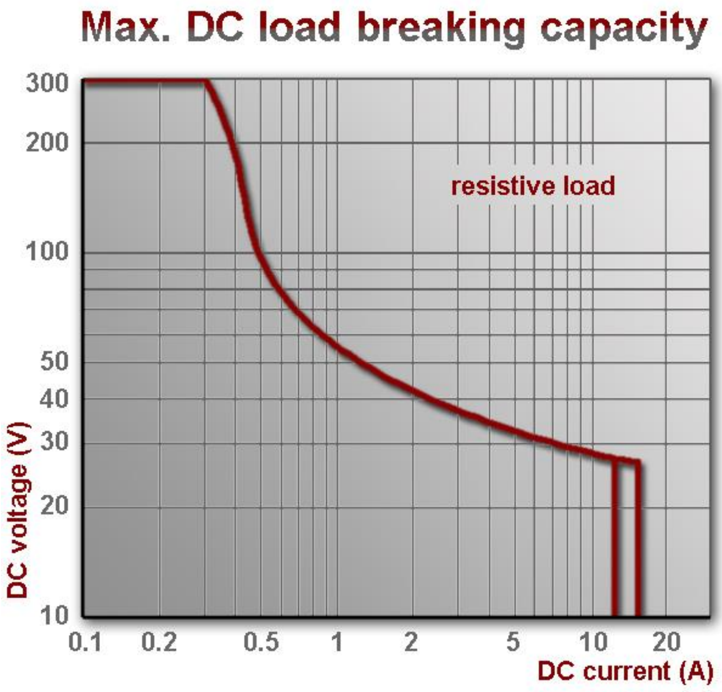
- Guard reception
- Signal loss
- Command transmission (A, B, C and D)
- Command reception (A, B, C and D)
- Output circuit blocking, protection side
- Automatic test result
- Terminal in loop
- General alarm
  (*Receiver blocking, Signal loss, Low S/N ratio, Incorrect guard-signal level, Local test failure, Device error, Manual blocking, Erroneous configuration data*)

By relay:

- Alarm or signalling (configurable conditions)

2.7.2.o Alarm/Signalling relay characteristics

Number of relays	Two relays. Each relay is **configurable** for signalling or alarm conditions
Type	Electromechanical relay. Changeover contact. Contact rating: **1** A/250 Vac See Figure **DC voltage/DC current** for **Vdc**
Maximum operate/release times	**8**/**6** ms
State in normal operation	Signalling: **non-energized** (N.C and C contacts are short-circuited) Alarm: **energized** (N.O. and C contacts short-circuited)
Timing for relay activation	Configurable from the Management System between **0** and **60** s
Signalling configurable conditions	Command transmission (A, B, C and D) Command output (1, 2, 3 and 4)
Alarm configurable conditions	Receiver blocking Signal loss Low S/N ratio Incorrect guard signal level Local test failure Device error



***2** A is the maximum current in figure **DC voltage/DC current** for **Vdc**.*

Figure 2.16 DC voltage/DC current.

2.7.2.p External connection

Plug-in terminal block	**ZBPU**
Cabinet-mounting terminal block	**ZBBA.16-BB1** & **ZBBA.06-BB2**

2.7.2.q Dimensions

30 mm wide, **262** mm high, and **256** mm (with handles) depth

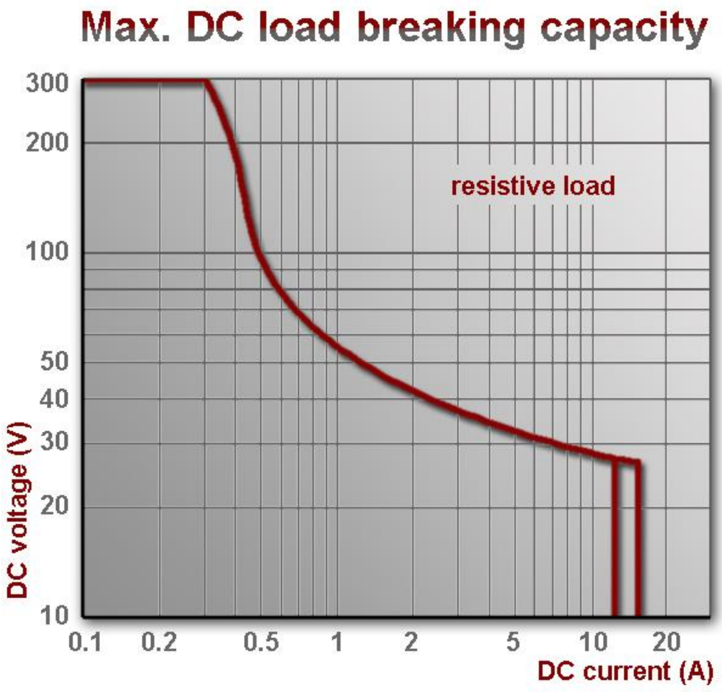
2.7.2.r Weight

500 g

2.7.3 REPU option

2.7.3.a External signalling

Number of relays	Seven relays. Each relay is **configurable** for signalling or alarm conditions
Type	Electromechanical relay. Changeover contact. Contact rating: **1** A/250 Vac See Figure **DC voltage/DC current** for **Vdc**
Maximum operate/release times	**8**/**6** ms
State in normal operation	Signalling: **non-energized** (N.C and C contacts are short-circuited) Alarm: **energized** (N.O. and C contacts short-circuited)
Timing for relay activation	Configurable from the Management System between **0** and **60** s
Signalling configurable conditions	Command transmission (A, B, C and D) Command output (1, 2, 3 and 4)
Alarm configurable conditions	Receiver blocking Signal loss Low S/N ratio Incorrect guard signal level Local test failure Device error



2 *A is the maximum current in figure* ***DC voltage/DC current*** *for* ***Vdc****.*

Figure 2.17 DC voltage/DC current.

2.7.3.b External connection

Plug-in terminal block	**ZCPU**

2.7.3.c Dimensions

30 mm wide, **262** mm high, and **256** mm (with handles) depth

2.7.3.d Weight

500 g

2.8 Other optional modules characteristics

2.8.1 IOPU option

2.8.1.a Analog interfaces

One channel

IOPU.01 module	Channel **1**: Two 2-wire audio frequency (**VFT**) inputs Two 2-wire audio frequency (**VFT**) outputs

Two channels

IOPU.02 module	Channel **1**: Two 2-wire audio frequency (**VFT**) inputs Two 2-wire audio frequency (**VFT**) outputs Channel **2**: Two 2-wire audio frequency (**VFT**) inputs Two 2-wire audio frequency (**VFT**) outputs

Audio frequency (VFT) inputs

Available band	From **300** Hz to **3850** Hz
Nominal impedance	**600** Ω, balanced
Return loss	Better than **14** dB in accordance with IEC **62488-2**
Nominal level	Configurable from -**20** dBm to +**6** dBm
Limiter action	In accordance with IEC **62488-2**

Audio frequency (VFT) outputs	
Nominal impedance	**600** Ω, balanced
Return loss	Better than **14** dB in accordance with IEC **62488-2**
Nominal level	Configurable from -**20** dBm to +**6** dBm
Blocking conditions	Pilot loss Low S/N ratio. Configurable threshold values for each output

2.8.1.b Link amplitude distortion

In accordance with IEC **62488-2**

2.8.1.c Link group-delay distortion

In accordance with IEC **62488-2**

2.8.1.d E & M signalling

Transmission	By means of optocoupler. Input voltage between **30** V and **150** V
Reception	By means of relay. Contact rating: **1** A/**250** Vac
Pulse distortion of telephone signalling	≤**10**%

2.8.1.e Boosting control

By means of optocoupler. Input voltage between **30** V and **150** V

Any audiofrequency (**VFT**) input can be used for the transmission of a command signal coming from an external teleprotection terminal, and therefore it can be programmed with a signal-level percentage of between **10**% and **100**%.

2.8.1.f External signalling

By front optical indication:

- Power-boosting command in channel **1** / **2**
- Call transmission (**M** wire activation) in channel **1** / **2**
- Call reception (**E** wire activation) in channel **1** / **2**

2.8.1.g External connection

Plug-in terminal block

ZIPU

Cabinet mounting terminal block

IOPU.01 module

Terminals **BB1** of **ZOPU.01** terminal block for channel **1**

IOPU.02 module

Terminals **BB1** of **ZOPU.02** terminal block for channel **1**

ZBBA.14 terminal block for channel **2**

2.8.1.h Dimensions

30 mm wide, **262** mm high, and **256** mm (with handles) depth

2.8.1.i Weight

350 g

2.8.2 FAPX option

2.8.2.a Voltage monitoring

Voltages that power the digital circuitry	+**3.3** V and +**5** V
Voltages that power the analog circuitry	+**12** V and -**12** V
Voltage that power the relays	+**12** Vout
Voltage that power the high-frequency amplifier	+**70** V

2.8.2.b Dimensions

30 mm wide, **262** mm high, and **256** mm (with handles) depth

2.8.2.c Weight

350 g

2.8.3 TDPU.20 option

2.8.3.a Speech band

From **300** Hz to a programmable frequency of between **2000** Hz and **3400 Hz**

2.8.3.b Dynamic compressor/expander

In accordance with Recommendation G.162 of the ITU-T

2.8.3.c Exchange-side 4-wire telephone termination

4-wire input

Nominal impedance	**600** Ω, balanced
Return loss	≥ **20** dB
Nominal level	Configurable from -**20** dBm to +**8** dBm

4-wire output

Nominal impedance	**600** Ω, balanced
Return loss	≥ **20** dB
Nominal level	Configurable from -**20** dBm to +**8** dBm

2.8.3.d Exchange-side 2-wire telephone termination

Nominal impedance	**600** Ω, balanced
Nominal input level	Configurable from -**20** dBm to +**8** dBm
Nominal output level	Configurable from -**20** dBm to +**8** dBm
Rejection of the telephone hybrid	≥ **20** dB in the specified band

The 2-wire terminals (**2W**) of this termination coincide physically with the 4-wire reception terminals (**4WR1**).

2.8.3.e Subscriber-side 2-wire telephone termination

Nominal impedance	**600** Ω, balanced
Return loss	≥ **20** dB
Nominal input level	+**3** dBm
Nominal output level	-**3** dBm
Maximum loop resistance	**1800** Ω
Maximum number of telephones in parallel	**2**
Ring voltage	**120** V_{pp}
Ring frequency	**25** Hz

2.8.3.f Control signals

Signalling	
M wire input	By means of optocoupler. Input voltage between **34** V and **190** V
E wire output	By means of solid-state relay. Contact rating: **100** mA / **300** V
T wire output	By means of solid-state relay. Contact rating: **100** mA / **300** V

2W / 4W switching	
Activation mode	From an external control **In rest conditions, it can be selected as being 4W/2W or 2W/4W, by means of internal microswitch*
External control	By means of optocoupler. Input voltage between **34** V and **190** V

Compressor/expander acting	
Activation mode	From an external control **In rest conditions, it can be selected as being included or excluded, by means of internal jumper or from the Management System*
External control	By means of optocoupler. Input voltage between **34** V and **190** V

2.8.3.g External signalling

By front optical indication:

- **M** wire activation (the user picks up the phone or telephone exchange activation is received)
- Call reception (**E** wire activation)
- Termination operating as an exchange-side 2-wire telephone termination
- Unavailable link (**T** wire activation)
- Compressor/expander included

2.8.3.h External connection

Plug-in terminal block	**ZAPU**
Cabinet-mounting terminal block	**ZBBA.20**

2.8.3.i Dimensions

30 mm wide, **262** mm high, and **256** mm (with handles) depth

2.8.3.j Weight

700 g

2.8.4 MFPU option

2.8.4.a Data format

Binary, serial.

Asynchronous and anisochronous.

2.8.4.b Modulation

Frequency-shift keying (**FSK**)

2.8.4.c Transmission speed

Selectable by means of internal microswitches or from the Management System:

- **50** Bd
- **75** Bd (Tx V.23)
- **100** Bd
- **200** Bd
- **600** Bd
- **600** Bd (Tx V.23)
- **1200** Bd
- **1200** Bd (Tx V.23)
- **2400** Bd

2.8.4.d Transmission mode

Selectable by means of internal microswitches:

- Full-duplex
- Half-duplex

2.8.4.e Central frequency

Selectable by means of internal microswitches or from the Management System.

Depending on the transmission speed the modem is working on. See Figure 2.18.

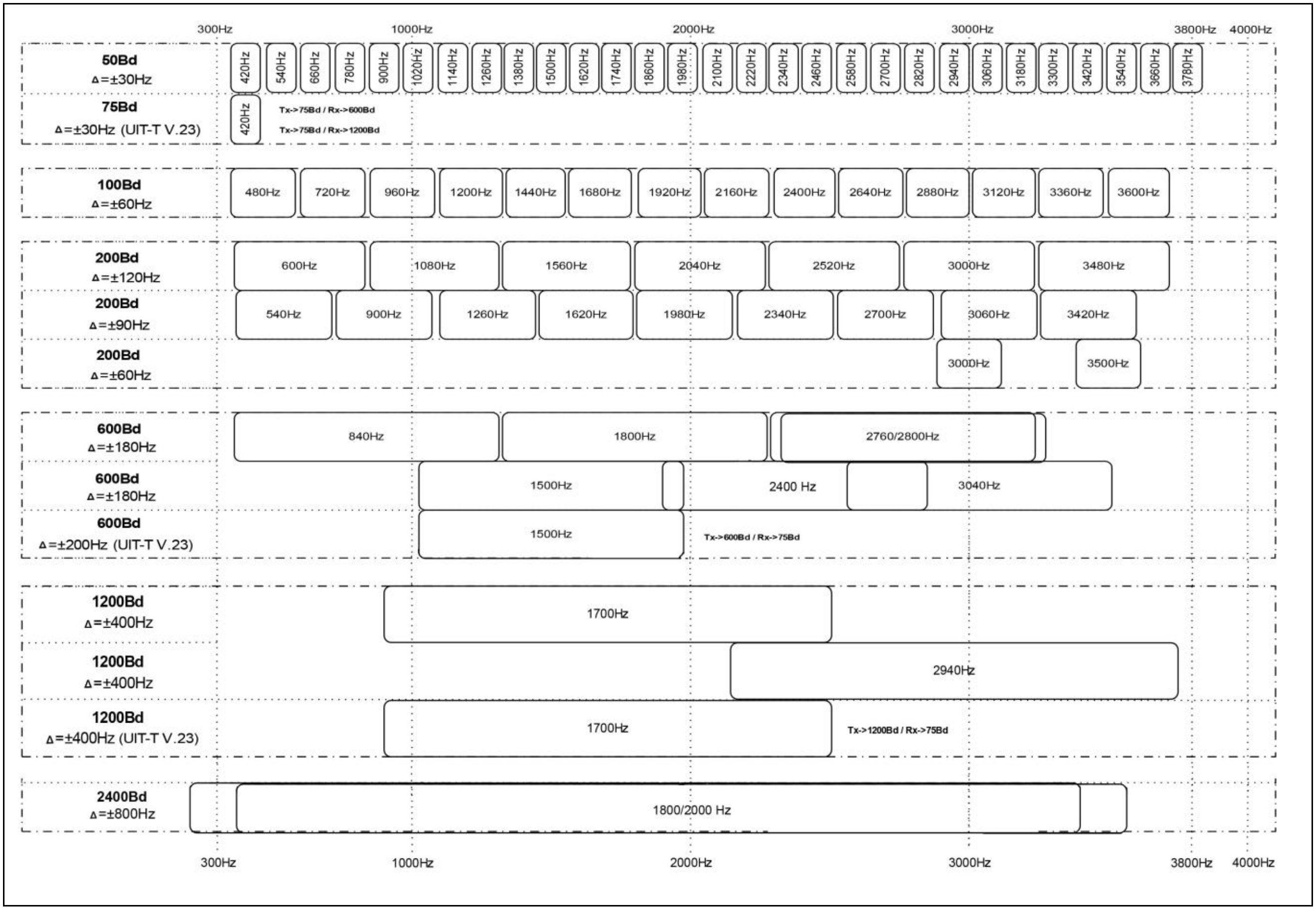


Figure 2.18 Central frequency programmable in the MFPU modem according to the transmission speed.

2.8.4.f Response curves

The following figures show response curves of the transmission and reception filters for certain speeds and central frequencies.

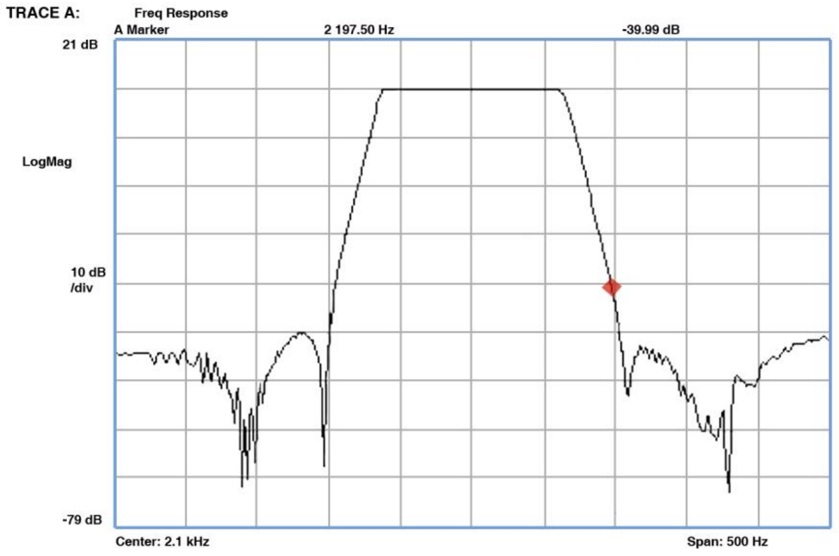


Figure 2.19 Transmission speed of 50 Bd and central frequency of 2100 Hz (reception filter).

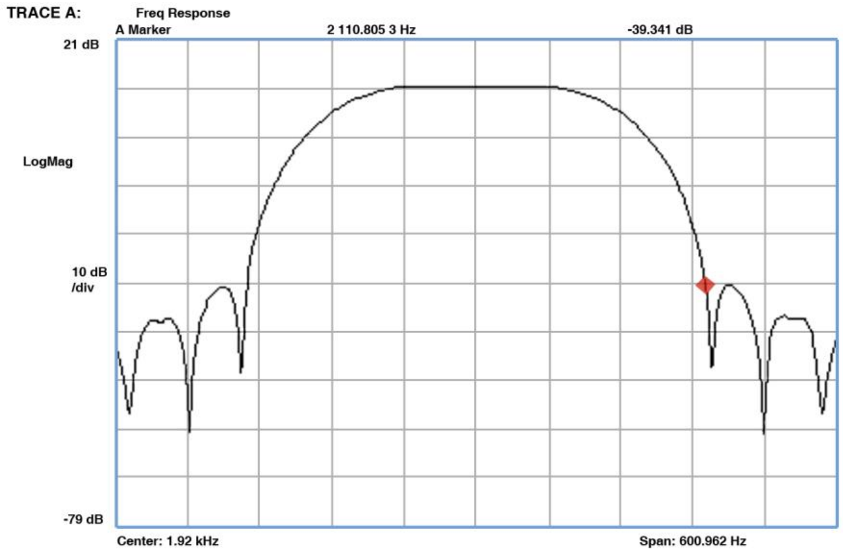


Figure 2.20 Transmission speed of 100 Bd and central frequency of 1920 Hz (transmission & reception filters).

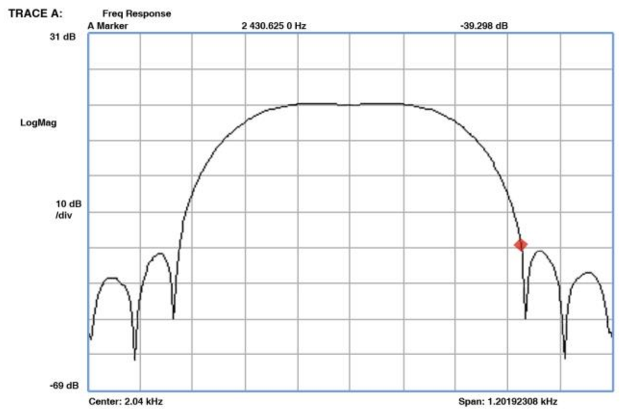


Figure 2.21 Transmission speed of 200 Bd/± 120 Hz and central frequency of 2040 Hz (transmission & reception filters).

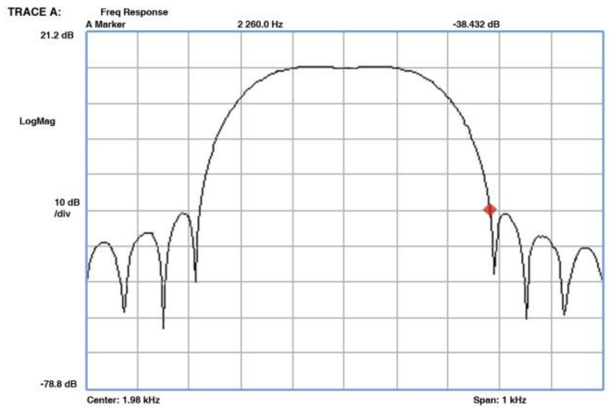


Figure 2.22 Transmission speed of 200 Bd/± 90 Hz and central frequency of 1980 Hz (transmission & reception filters).

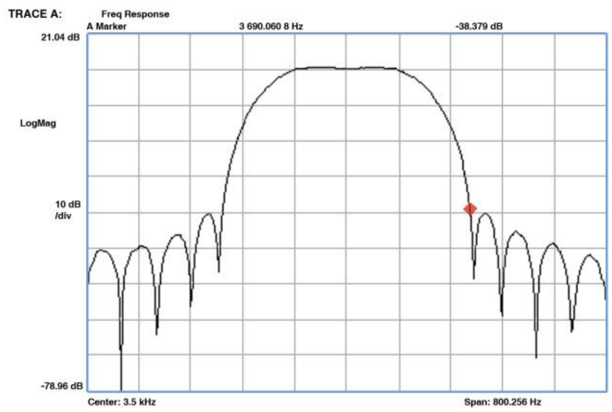


Figure 2.23 Transmission speed of 200 Bd/± 60 Hz and central frequency of 3500 Hz (transmission & reception filters).

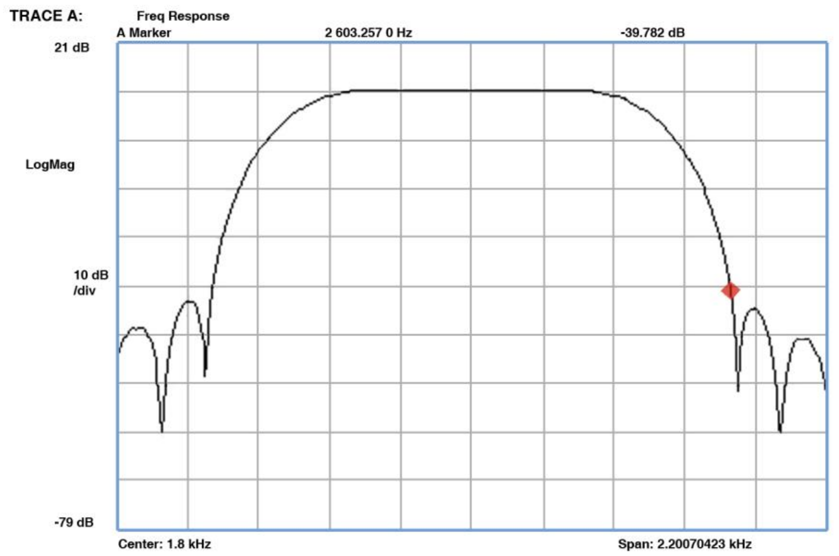


Figure 2.24 Transmission speed of 600 Bd and central frequency of 1800 Hz (transmission & reception filters).

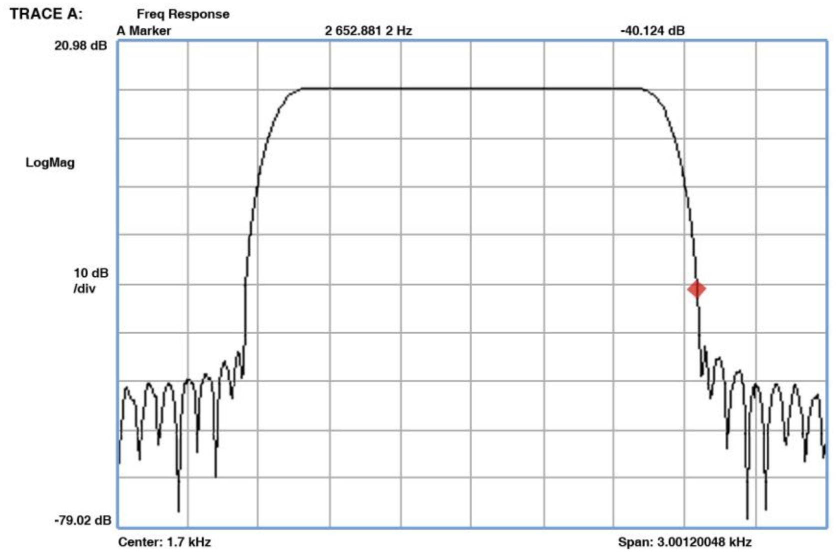


Figure 2.25 Transmission speed of 1200 Bd and central frequency of 1700 Hz (transmission and reception filters).

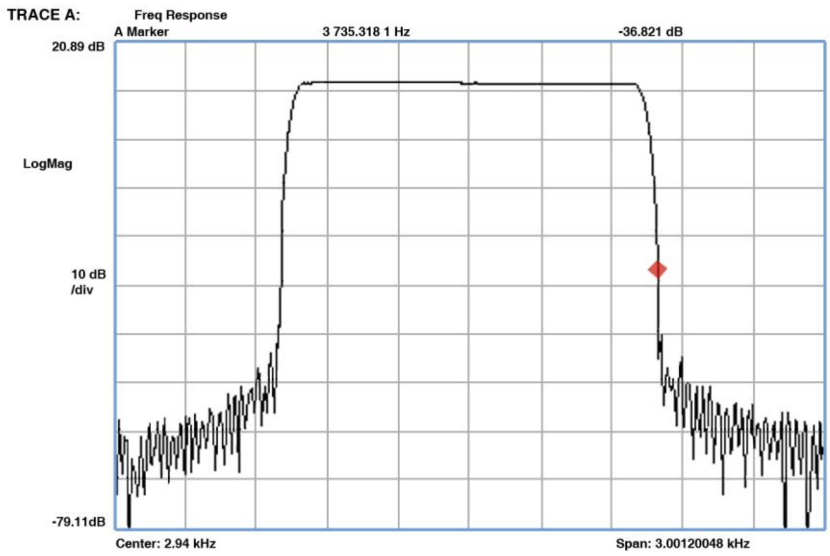


Figure 2.26 Transmission speed of 1200 Bd and central frequency of 2940 Hz (transmission & reception filters).

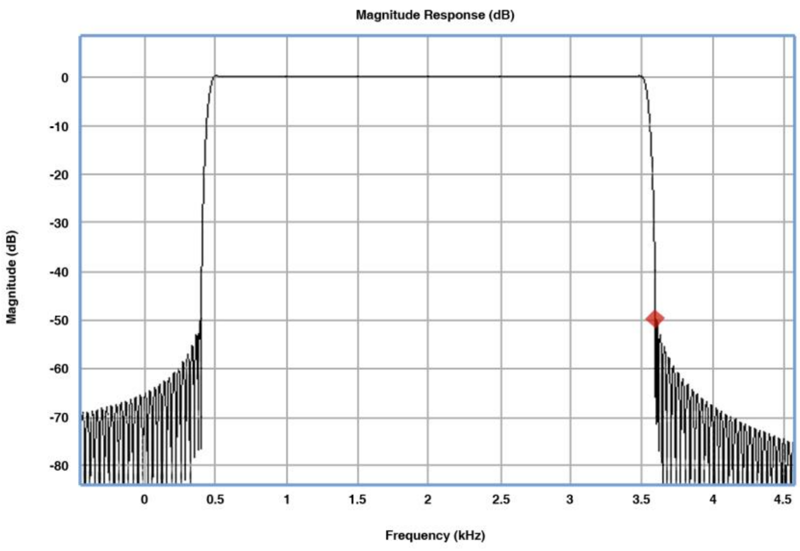


Figure 2.27 Transmission speed of 2400 Bd and central frequency of 2000 Hz (transmission and reception filters).

2.8.4.g Frequency shifting

From ±**30** Hz to ±**800** Hz, according to speed

2.8.4.h Nominal bandwidth at 0.2 dB

At **50** Bd/±**30** Hz	**121** Hz (reception filter), **140** Hz (transmission filter)
At **100** Bd/±**60** Hz	**123** Hz
At **200** Bd/±**120** Hz	**245** Hz
At **200** Bd/±**90** Hz	**185** Hz
At **200** Bd/±**60** Hz	**126** Hz
At **600** Bd/±**180** Hz	**715** Hz
At **1200** Bd/±**400** Hz	**1405** Hz or **1435** Hz, depending on whether or not the modem operates in the frequency band above speech-band
At **2400** Bd/±**800** Hz	**3016** Hz

2.8.4.i Nominal propagation delay

At **50** Bd	**23.5** ms
At **100** Bd	**23** ms
At **200** Bd	**11.5** ms to **21.5** ms, depending on the central frequency
At **600** Bd	**7** ms
At **1200** Bd	**14** ms (f_0=**1700** Hz) **32** ms (f_0=**2940** Hz)
At **2400** Bd	**32** ms

The nominal propagation delay does not take into account the **OPU-1** link delay.

2.8.4.j Nominal delay in the CD signalling at the appearance of the carrier

At **50** Bd	**10** ms
At **100** Bd	**10.5** ms
At **200** Bd	**7.9** ms to **10.6** ms, depending on the central frequency
At **600** Bd	**4.8** ms
At **1200** Bd	**8** ms (f_0=**1700** Hz) **17.3** ms (f_0=**2940** Hz)
At **2400** Bd	**17** ms

The nominal delay in the CD signalling at the appearance of the carrier does not take into account the **OPU-1** link delay.

2.8.4.k Nominal delay in the CD no-signalling at the disappearance of the carrier

At **50** Bd	**14** ms
At **100** Bd	**12.5** ms
At **200** Bd	**9.6** ms to **12.6** ms, depending on the central frequency
At **600** Bd	**5.6** ms
At **1200** Bd	**9** ms (f_0=**1700** Hz) **18.4** ms (f_0=**2940** Hz)
At **2400** Bd	**18** ms

The nominal delay in the CD no-signalling at the disappearance of the carrier does not take into account the **OPU-1** link delay.

2.8.4.l Nominal selectivity for an attenuation of 40 dB

At **50** Bd/±**30** Hz	**192** Hz
At **100** Bd/±**60** Hz	**380** Hz
At **200** Bd/±**120** Hz	**784** Hz
At **200** Bd/±**90** Hz	**560** Hz
At **200** Bd/±**60** Hz	**381** Hz
At **600** Bd/±**180** Hz	**1600** Hz
At **1200** Bd/±**400** Hz	**1472** Hz or **1902** Hz, depending on whether or not the modem operates in the frequency band above speech-band
At **2400** Bd/±**800** Hz	**3192** Hz

2.8.4.m Isochronous distortion

<**3**% for all speeds

2.8.4.n Line-frequency stability

<±**0.5** Hz accross the whole temperature range from -**5**°C to +**45**°C

2.8.4.o Modulation percentage

Transmission (**XMT**)	Programmable of between **10**% and **97**%, from the Management System
Reception (**RCV**)	Programmable of between **10**% and **97**%, from the Management System

2.8.4.p RTS-CTS delay

Selectable by front microswitch configuration

2.8.4.q Data interface

Levels and impedance	In accordance with ITU-T **V.28** Recommendation
Operation mode	In accordance with ITU-T **V.24** Recommendation. Available signals: TD, RD, RTS, CTS, RLSD-Carrier detection (CD), DSR and DTR

2.8.4.r Test devices

By front microswitch configuration:

- Data loop.
- Line loop.
- Continuous sending of a logical level "**1**"
- Continuous sending of a logical level "**0**"
- Continuous sending of alternate sequence of "**0**" and "**1**"

2.8.4.s External signalling

By front optical indication:

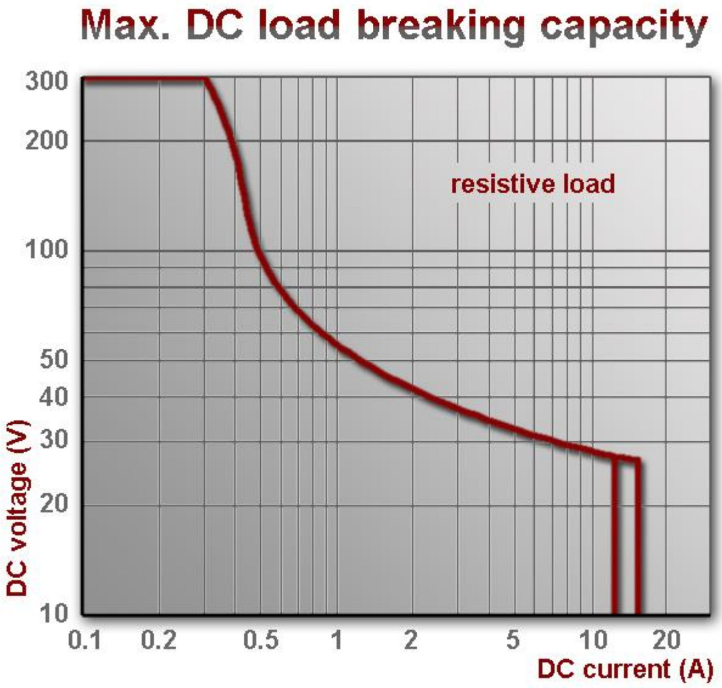
- Status of the interface logical signals
- Carrying out of some type of test (sending of signals or loop)
- Carrying out of a loop (data/line)
- Module status

By relay:

- General alarm

2.8.4.t General alarm relay characteristics

Type	Voltage-free changeover contact relay
Changeover maximum current	**3** A
Changeover maximum voltage	**250** Vac, **150** Vdc
Changeover maximum power	See Figure **DC voltage/DC current**
Insulation voltage	IEC 870-2-1 class 2. **1** kVrms / **50** Hz / **1** min



***3** A is the maximum current in figure **DC voltage/DC current**.*

Figure 2.28 DC voltage/DC current.

2.8.4.u External connection

Plug-in terminal block	**ZAPU**
Cabinet-mounting terminal block	**ZBBM.00**

2.8.4.v Dimensions

30 mm wide, **262** mm high, and **256** mm (with handles) depth

2.8.4.w Weight

350 g

2.8.5 FTPU option

2.8.5.a Band-pass filters available

FTPU.20 module	**2150** Hz to **3850** Hz
FTPU.21 module	**2150** Hz to **3360** Hz
FTPU.22 module	**2400** Hz to **3200** Hz

2.8.5.b VFT-signal output

Nominal impedance	**600** Ω, balanced
Return loss	≥ **20** dB
Nominal level	Configurable from -**20** dBm to +**6** dBm
Insulation and transient immunity	In accordance with IEC **62488-2**

2.8.5.c External connection

Plug-in terminal block	**ZAPU**
Cabinet-mounting terminal block	**ZBBA.02**

2.8.5.d Dimensions

30 mm wide, **262** mm high, and **256** mm (with handles) depth

2.8.5.e Weight

400 g

2.8.6 FDPU option

2.8.6.a Band-pass filters available

Filter 1

Pass band	**300** Hz to **3480** Hz
Attenuation band	From **0** to **180** Hz and starting at **3600** Hz
Maximum ripple in the pass band	**0.2** dB
Minimum rejection in attenuation band	**60** dB

Filter 2

Pass band	**2240** Hz to **3640** Hz
Attenuation band	From **0** to **2140** Hz and starting at **3740** Hz
Maximum ripple in the pass band	**0.1** dB
Minimum rejection in attenuation band	**50** dB

Filter 3

Pass band	**1000** Hz to **2400** Hz
Attenuation band	From **0** to **740** Hz and starting at **2660** Hz
Maximum ripple in the pass band	**0.1** dB
Minimum rejection in attenuation band	**50** dB

Filter 4

Pass band	**1000** Hz to **2400** Hz
Attenuation band	From **0** to **740** Hz and starting at **2500** Hz
Maximum ripple in the pass band	**0.1** dB
Minimum rejection in attenuation band	**50** dB

Filter **2** is intended to transit the data of an **MFPU** modem programmed at **1200** Bd and **2940** Hz (frequency band above speech-band). Filters **3** and **4** are intended to transit the data of an **MFPU** modem programmed at **1200** Bd and **1700** Hz.

Filter 5

Cutoff frequency	**3600** Hz
Attenuation band	Starting at **3720** Hz
Maximum ripple in the pass band	**0.2** dB
Minimum rejection in attenuation band	**50** dB

Filter **5** is designed so that teleprotection and multiplexer can coexist on the same analog channel.

2.8.6.b VFT-signal input and output

Nominal impedance	**600** Ω, balanced
Return loss	≥ **20** dB
Nominal level	Configurable from -**20** dBm to +**6** dBm
Insulation and transient immunity	In accordance with IEC **62488-2**

2.8.6.c External connection

Plug-in terminal block	**ZAPU**
Cabinet-mounting terminal block	**ZBBA.04**

2.8.6.d Dimensions

30 mm wide, **262** mm high, and **256** mm (with handles) depth

2.8.6.e Weight

350 g

2.8.7 EYPU option

2.8.7.a Inputs

Number	**4**
Nominal impedance	**600** Ω, balanced
Return loss	≥ **20** dB
Nominal level	Configurable from -**20** dBm to +**6** dBm

2.8.7.b Outputs

Number	**4**
Nominal impedance	**600** Ω, balanced
Return loss	≥ **20** dB
Nominal level	Configurable from -**20** dBm to +**6** dBm

2.8.7.c Modulation percentage

It must be expressed as a modulation percentage:

- The level at which the input signals are to be injected into the **OPU-1** system **AF XMT** bus.
- The level at which a service is to be extracted from the **AF RCV** bus for injection into one of the output circuits.

- *All the inputs that are connected to an output must be programmed with the same modulation percentage.*
- *The sum of the modulation percentages of all the inputs and services connected to the corresponding **AF XMT** bus must not exceed **100**%.*

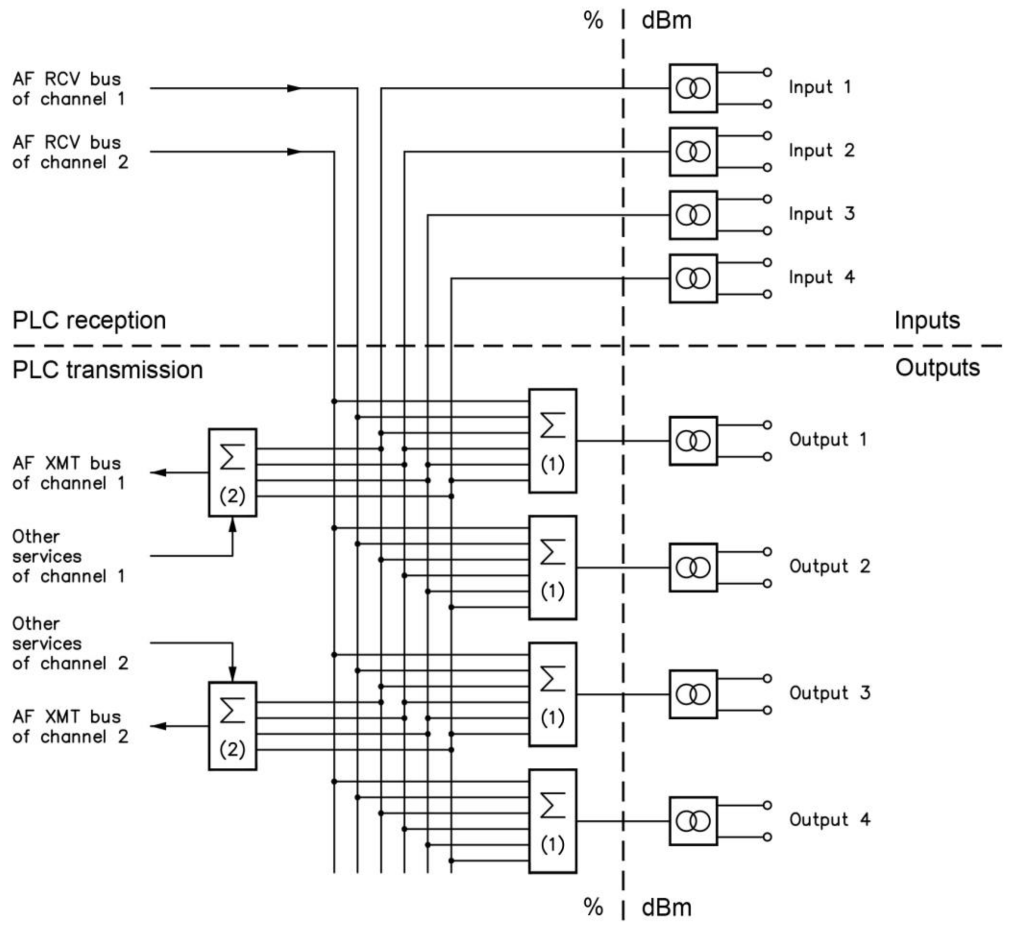


Figure 2.29 Parameters (dBm and %) related to the input and output level.

2.8.7.d Balance to ground

≥ **60** dB

2.8.7.e Insulation, voltage withstand and electromagnetic compatibility

In accordance with IEC **62488-2**

2.8.7.f External connection

Cabinet-mounting terminal block	**ZBBA.16**

2.8.7.g Dimensions

30 mm wide, **262** mm high, and **256** mm (with handles) depth

2.8.7.h Weight

450 g

2.9 High-Frequency Teleprotection functionality characteristics

2.9.1 General characteristics for HF TP functionality

2.9.1.a Operating mode

Transmission of teleprotection commands over dedicated analog band for blocking, direct and permissive tripping teleprotection schemes

2.9.1.b Modulation

Single side-band (**SSB**) with suppressed carrier

2.9.1.c Transmission and reception bands

Adjacent, Erect (*Tx*) & Inverted (*Rx*) or Inverted (*Tx*) & Erect (*Rx*)

2.9.1.d Total bandwidth

4 kHz (using **2** kHz for transmission and **2** kHz for reception).

2 kHz (using **1** kHz for transmission and **1** kHz for reception).

TRANSMISSION CAPACITY FOR HIGH-FREQUENCY TELEPROTECTION FUNCTIONALITY

- *The programming of the transmission and reception bands of both terminals of the link, local and remote, should be carried out in a coherent way in order for the link to work properly.*
- *For example, if the local terminal is configured with **erect** band in transmission and **inverted** in reception, the remote terminal must be configured with **inverted** band in transmission and **erect** in reception.*

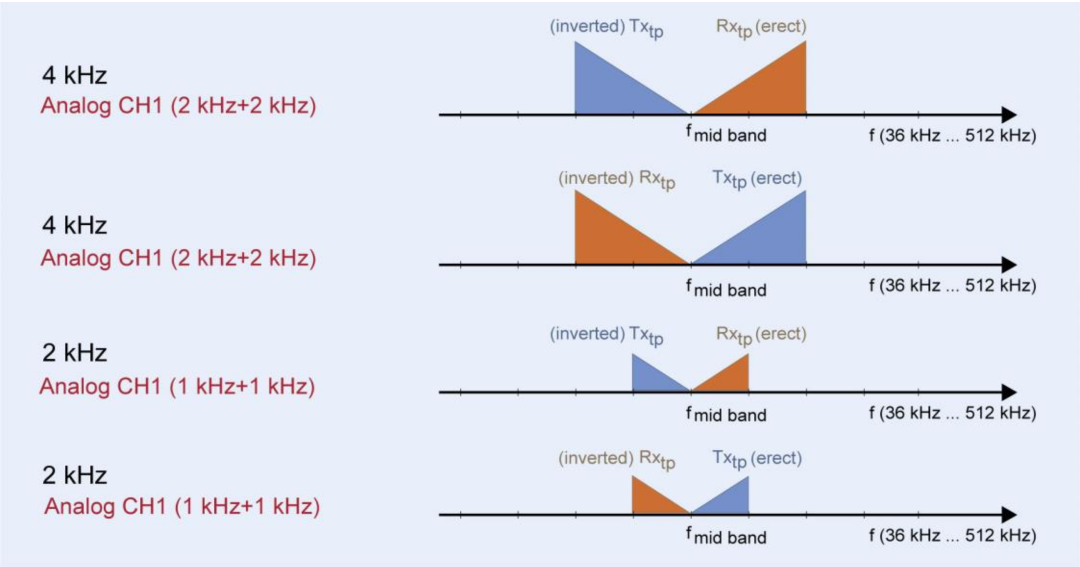


Figure 2.30 Transmission capacity for HF TP functionality.

2.9.1.e Pilot tone

Analog channel

Functions	Automatic Gain Control Signal-to-noise ratio measurement Link synchronization Service channel (data transmission)
Central frequency	**150** Hz (virtual frequency)
Modulation	By frequency-shift keying of ±**30** Hz
Maximum rate	**50** bit/s

2.9.1.f Automatic Gain Control (AGC)

Analog channel

Dynamics	≥ **55** dB with 10% pilot modulation
Efficiency	±**20** dB input level variations cause variations of less than ±**0.2** dB at the output

2.9.1.g Internal clock (master)

Frequency stability within specified temperature and voltage ranges	±**1**ppm
Ageing	<**1**ppm/year

2.9.1.h Synchronization

By master-slave operation

2.9.1.i Test devices

General	High-frequency test loop
Teleprotection operation	Audio-frequency test loop (teleprotection signal) Automatic local test Command transmission (permanent or not)

2.9.1.j Chronological register

General capacity	**1010** alarms and events (FIFO-based register) **110** logs are reserved for **Cybersecurity** related events
Teleprotection capacity	**3000** alarms and events associated with teleprotection
Resolution	**1** ms
Time synchronization	Via GPS (**IRIG-B**) or via Ethernet (**SNTP** protocol)

2.9.1.k IRIG-B input (MOPU)

Connector type	**BNC**
Standard	IRIG-B **120** to IRIG-B **123** and IRIG-B **000** to IRIG-B **003**

IRIG-B **120** to IRIG-B **123** and IRIG-B **000** to IRIG-B **003** standards do not include year information.

2.9.1.l Visual indications

General signalling

Terminal powered (**FAPU**)
Terminal status (**MOPU**)
Local terminal in loop (**MOPU**)
Remote terminal in loop (**MOPU**)

General alarms

Power-supply failure (**FAPU**)
Loss of synchronism (**MOPU**)
Pilot loss (**MOPU**)
Low S/N ratio (**MOPU**)
General alarm (**MOPU**)

(*Power-supply failure, Amplifier overload, Low output level in amplifier, Loss of synchronism, Pilot loss, Low Signal/Noise ratio, Temperature alarm, Terminal configuration error, Hardware failure*)

Remote alarm (**MOPU**)

(*Power-supply failure, Amplifier overload, Low output level in amplifier, Loss of synchronism, Pilot loss, Low Signal/Noise ratio, Temperature alarm, Terminal configuration error, Hardware failure*)

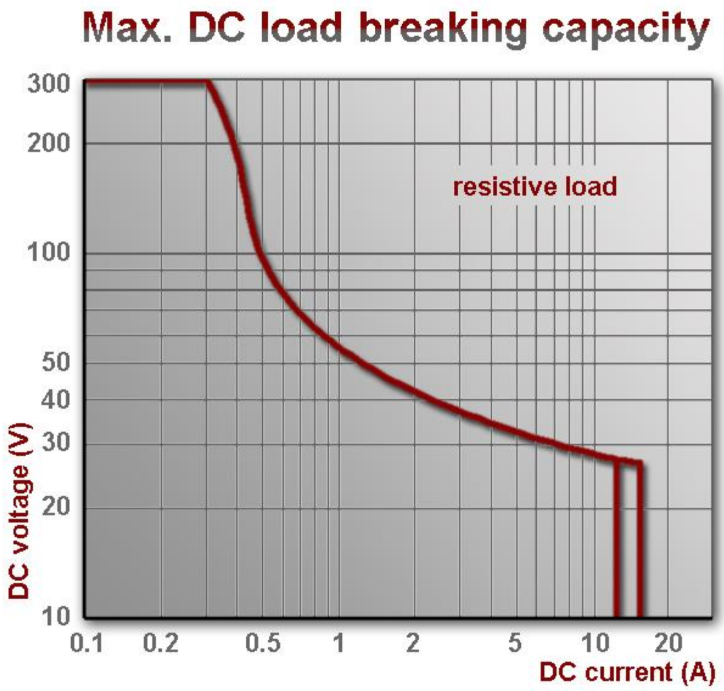
Teleprotection signalling and alarms

Guard reception (**TPPU**)
Signal loss (**TPPU**)
Command transmission (**TPPU**)
Command reception (**TPPU**)
Output circuit blocking, protection side (**TPPU**)
Automatic test result (**TPPU**)
Terminal in loop (**TPPU**)
General alarm (**TPPU**)

(*Receiver blocking, Signal loss, Low S/N ratio, Incorrect guard-signal level, Local test failure, Device error, Manual blocking, Erroneous configuration data*)

2.9.1.m Power-supply alarm external signalling

Type	By relay. One per power supply. Changeover contact. Contact rating 2 A/250 **Vac** See Figure **DC voltage/DC current** for **Vdc**
Maximum operate/release times	**8/6** ms
State in normal operation	**Energized** (N.O and C contacts short-circuited)



***2** A is the maximum current in figure **DC voltage/DC current** for **Vdc**.*

Figure 2.31 DC voltage/DC current.

2.9.1.n External signalling (General)

Number of relays	Three relays. Each relay is **configurable** for signalling of alarm or a combination of alarms
Type	By electromechanical relay. Changeover contact. Contact rating 2 A/250 **Vac** See Figure **DC voltage/DC current** for **Vdc**
Maximum operate/release times	**8/6** ms
State in normal operation	**Energized** (N.O and C contacts short-circuited)
Timing for relay activation	Configurable from the Management System between **0** and **60** s
Alarm programmable conditions	Power-supply failure Loss of synchronism Pilot loss Low S/N ratio Amplifier overload Low output level in amplifier Temperature alarm Terminal configuration error Hardware failure

2.9.1.o External signalling (Teleprotection)

Number of relays	Two relays. Each relay is **configurable** for signalling or alarm conditions
Type	Electromechanical relay. Changeover contact. Contact rating: **1** A/250 Vac See Figure **DC voltage/DC current** for **Vdc**
Maximum operate/release times	**8**/**6** ms
State in normal operation	Signalling: **non-energized** (N.C and C contacts are short-circuited) Alarm: **energized** (N.O. and C contacts short-circuited)
Timing for relay activation	Configurable from the Management System between **0** and **60** s
Signalling configurable conditions	Command transmission (A, B, C and D) Command output (1, 2, 3 and 4)
Alarm configurable conditions	Receiver blocking Signal loss Low S/N ratio Incorrect guard signal level Local test failure Device error

2.9.2 High-frequency characteristics for HF TP functionality

2.9.2.a Frequency range

From **36** kHz to **512** kHz

2.9.2.b Operating frequency

Programmable in **1** Hz steps

2.9.2.c Nominal impedance

Selectable among **50** Ω, **75** Ω, **125** Ω and **140/150** Ω

2.9.2.d Return loss

Standard **4** kHz channel	IEC 62488-2. Better than **11** dB from **40** kHz to **200** kHz Better than **12** dB from **200** kHz to **500** kHz
Standard **2** kHz channel	IEC 62488-2. Better than **11** dB

2.9.2.e Tapping loss

From **40** kHz to **200** kHz	**1.5** dB at 1.5 x BW
From **200** kHz to **500** kHz	**1.5** dB at 2 x BW

2.9.2.f Maximum number of devices to be connected in parallel

Up to **3**. For a greater number, consult with the manufacturer

2.9.2.g Frequency separation for parallel connection on the same line

4 kHz channel

Between transmitter and receiver of the same equipment	≥ **0** kHz
Between transmitters of adjacent equipment	≥ **4** kHz (from **40** kHz to **200** kHz) ≥ **6** kHz (from **200** kHz to **500** kHz)
Between transmitter and receiver of adjacent equipment	≥ **2** kHz (from **40** kHz to **200** kHz) ≥ **4** kHz (from **200** kHz to **500** kHz)
Between receivers of adjacent equipment	≥ **0** kHz

2 kHz channel

Between transmitter and receiver of the same equipment	≥ **0** kHz
Between transmitters of adjacent equipment	≥ **2** kHz (from **40** kHz to **200** kHz) ≥ **4** kHz (from **200** kHz to **500** kHz)
Between transmitter and receiver of adjacent equipment	≥ **1** kHz (from **40** kHz to **200** kHz) ≥ **2** kHz (from **200** kHz to **500** kHz)
Between receivers of adjacent equipment	≥ **0** kHz

2.9.2.h Transmitter

Peak envelope power over resistive load (**4** kHz channel)	**20** W or **40** W (from **40** kHz to **500** kHz) **60** W (from **40** kHz to **200** kHz)
Peak envelope power over resistive load (**2** kHz channel)	**20** W
Spurious emission for the guard and command tones	In accordance with IEC **62488-2**

2.9.2.i Receiver sensitivity

-30 dBm (measured in the pilot signal)

2.9.2.j Receiver selectivity

In accordance with IEC **62488-2**

2.9.3 Teleprotection characteristics for HF TP functionality

2.9.3.a Security and dependability

In accordance with **IEC 60834-1** standard

2.9.3.b Operating principle

Transmission of a guard signal in quiescent conditions that is substituted by a command signal (**dual** tone) when a command needs to be transmitted.

When the receiver detects the absence of the guard signal and the presence of the command signal, the corresponding command-output relay is activated.

2.9.3.c Input and output levels

Configurable between **10** % and **97** %

2.9.3.d Capacity

Up to **4** independent commands in any combination using a **4** kHz channel (**2** kHz for Tx and **2** kHz for Rx) or a **2** kHz channel (**1** kHz for Tx and **1** kHz for Rx)

2.9.3.e Guard and command frequencies

Each of the **command** signals is assigned two frequencies whose amplitude is half the amplitude of the **guard** signal, which is assigned a single frequency.

ENCODED SIGNAL	F1	F2	F3	F4	F5	F6	F7
A						X	X
B					X	X	
A+B					X		X
C			X	X			
A+C	X		X				
B+C			X		X		
A+B+C	X			X			
D		X	X				
A+D	X						X
B+D		X				X	
A+B+D				X		X	
C+D		X		X			
A+C+D			X				X
B+C+D	X					X	
A+B+C+D	X				X		

Table 2-6: Logic of the encoded signals for four commands (dual tone)

4 kHz channel

Teleprotection for BW= **2** kHz

- The **guard** is set at **1850** Hz
- From the guard, the distance between command signals is **200** Hz

2 kHz channel

Teleprotection for BW= **1** kHz

- The **guard** can be selected from among **1100** Hz and **1850** Hz in **50** Hz steps
- From the guard, the distance between command signals is **100** Hz

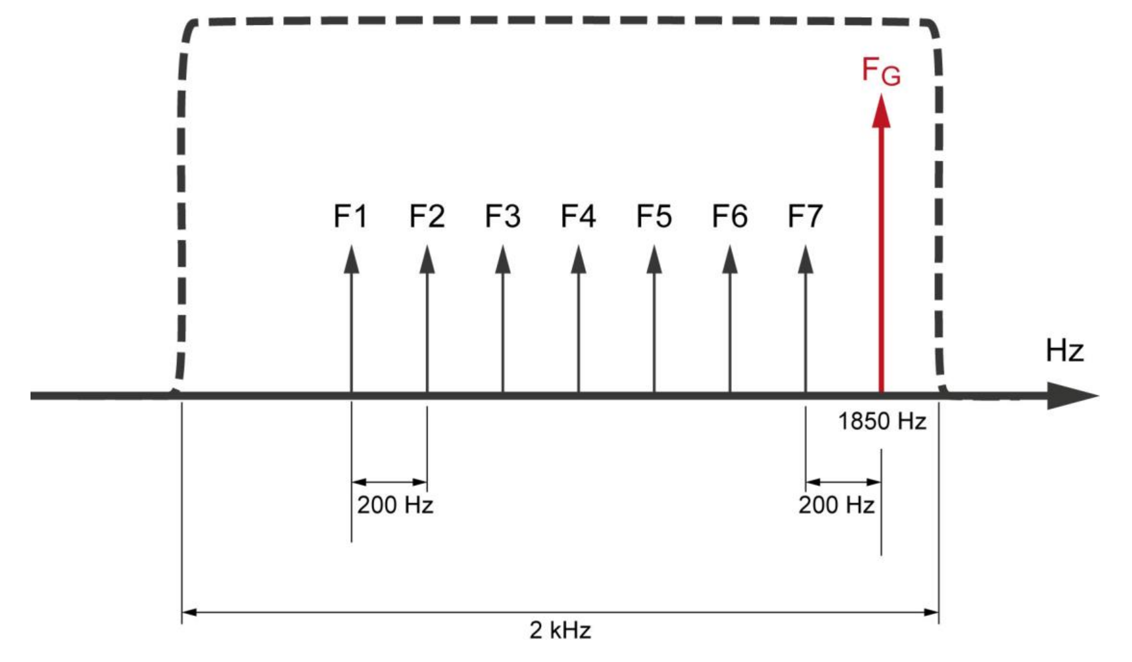


Figure 2.32 Distance between tones (Teleprotection for BW= 2 kHz).

2.9.3.f Nominal transmission time

Dual tone

Teleprotection for BW=**1** kHz	Configurable from the Management System: **16** ms (intended for **blocking**) **17** ms (intended for **permissive** tripping) **18** ms (intended for **direct** tripping)
Teleprotection for BW=**2** kHz	Configurable from the Management System: **11** ms (intended for **blocking**) **12** ms (intended for **permissive** tripping) **13** ms (intended for **direct** tripping)

2.9.3.g Command input/output assignment

Inputs

From one to three commands	Number of inputs per command can be set as desired. Configurable (**1** to **4**)
Four commands	Fixed. Inputs **I1** to **I4** to commands **A** to **D**, respectively

Outputs

From one to three commands	Number of outputs per command can be set as desired. Configurable (**1** to **4**)
Four commands	Fixed. Inputs **O1** to **O4** to commands **A** to **D**, respectively

2.9.3.h Command inputs

Type	Optocoupled
Nominal operating voltage	**24**, **48**, **110** and **220** Vdc (configurable with internal jumpers)
(Lower) voltage that guarantees activation	-**20**% of the nominal voltage
(Higher) voltage that guarantees NO activation	-**40**% of the nominal voltage
Maximum operating voltage	+**20**% of the nominal voltage
Polarity	Indistinct
Consumption	**10** mA at the nominal voltage (in the whole range) **Upon request, **3** mA*
Activation minimum time	**700** µs
Activation logic	By presence or absence of voltage (configurable with internal jumpers)
Additional timing for command transmission	Configurable from the Management System between **1** and **30** ms with **1** ms steps
Duration of command transmission	In permanence. **Prolonged** between 20 and 2500 ms. Configurable in **10** ms steps **Limited** between 20 and 2500 ms. Configurable in **10** ms steps **Fixed duration** between 20 and 2500 ms. Configurable in **10** ms steps

2.9.3.i Command outputs

Type	Solid-state **relay** (semiconductor)
Contact	Normally open. Voltage free
Maximum connection power	**900** W
Maximum current in connection	Permanent: **1.5** A **3** A for a max. of **20** s
Maximum connection voltage	**265** Vdc (**300** Vdc for a maximum current of 1 A)
Residual voltage in connection	**4** V
Leakage current	< **300** µA
Switching time	< **250** µs
Time period during which the command received must remain active	Whilst receiving command. **Prolonged** between 20 and 2500 ms. Configurable in **10** ms steps **Limited** between 20 and 2500 ms. Configurable in **10** ms steps **Fixed duration** between 20 and 2500 ms. Configurable in **10** ms steps

Chapter 3.

Applications

3. Applications

3.1 General purpose

- Transmission of data, speech and teleprotection signals.
- The analog channel is intended for teleprotection signals, and the digital channel for data and speech channels.
- For this application the **OPU-1** is equipped with a built-in teleprotection system and with the necessary built-in multiplexer modules.

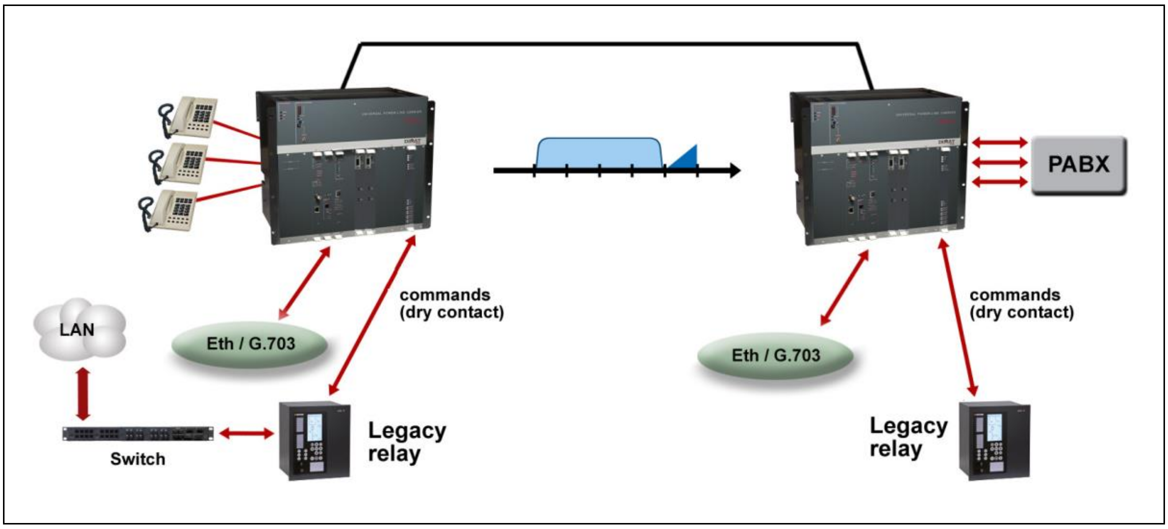


Figure 3.1: General purpose (example of use).

3.2 Data transit in OPU-1 links

- The digital transit filter (**FDPU**) module is used to select a specific band of the **OPU-1** analog channel and to carry out a transit to another communication channel.

- To transit data between **OPU-1** links, in the first link, the output of the **FDPU** module must be connected to the input of the **IOPU** module of the **OPU-1** terminal with which the transit is to be carried out.

- For transit in the other direction of the transmission, the input of the **FDPU** module must be connected to the output of the **IOPU** module of the same **OPU-1** terminal with which the transit is carried out.

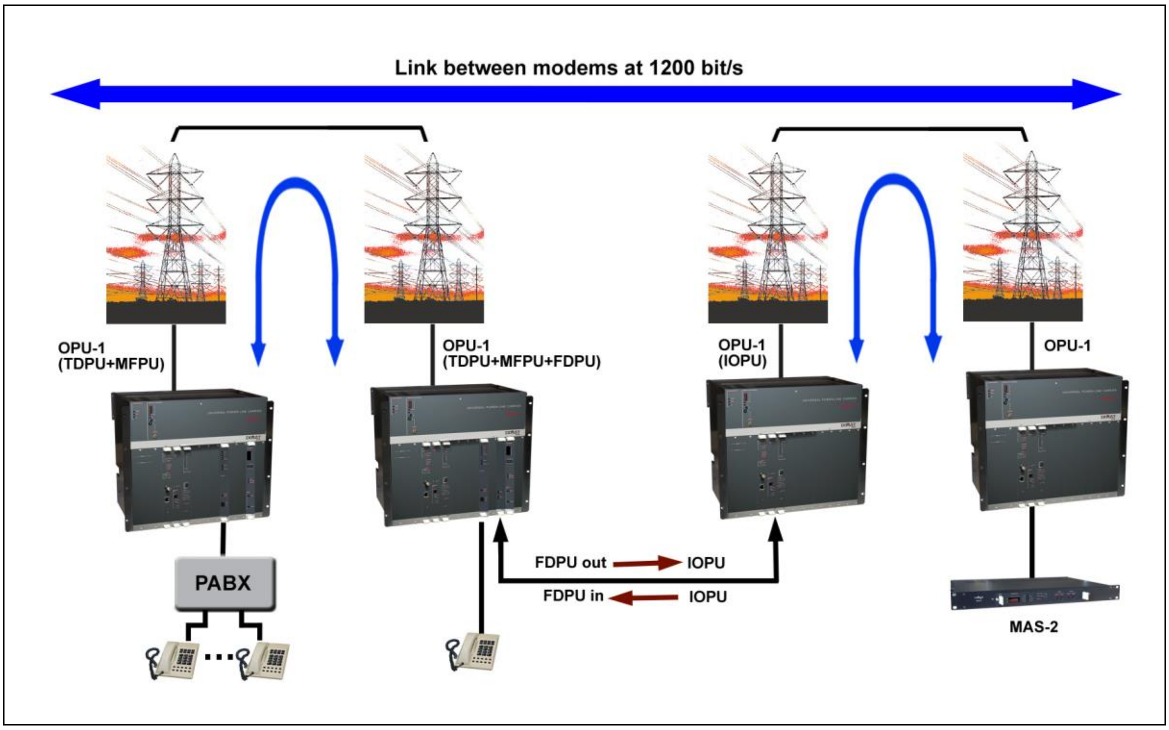


Figure 3.2: Data transit in OPU-1 links (example of use).

3.3 Frequency congestion solution

- The **OPU-1** for **20** W & **40** W can incorporate an additional high-frequency line filter to use different frequency slots in the same high-voltage line.

*In a twin-channel analog **OPU-1** terminal, the additional line filter also allows the transmission and reception bands of each channel to be non-adjacent.*

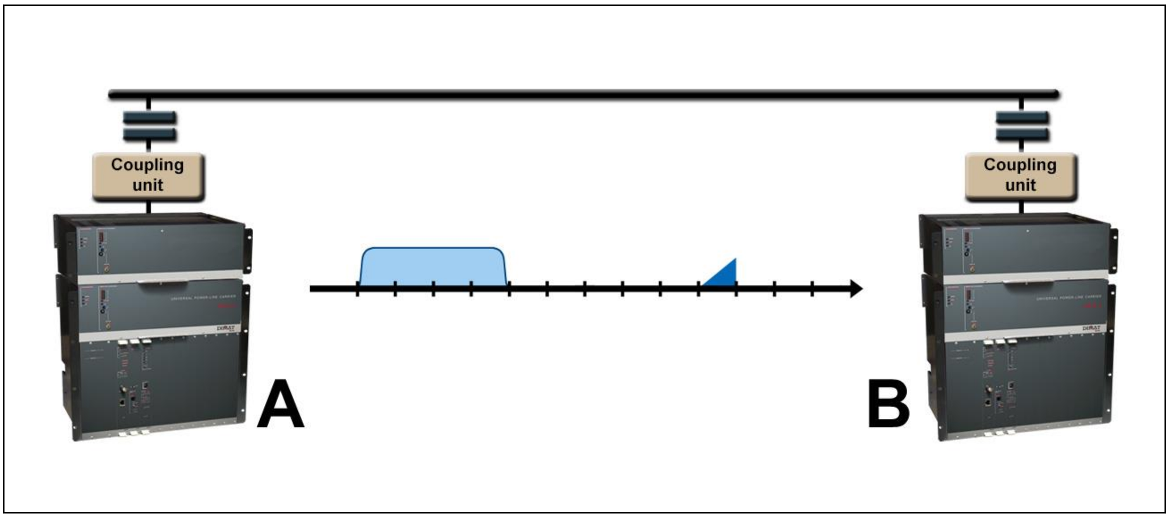


Figure 3.3: Frequency congestion solution (example of use).

3.4 Two virtual PLCs in one physical unit

- Digital channel in one direction and analog channels in the other.
- For this application, the **OPU-1** for **20** W & **40** W located at the intermediate point is equipped with an additional high-frequency line filter.

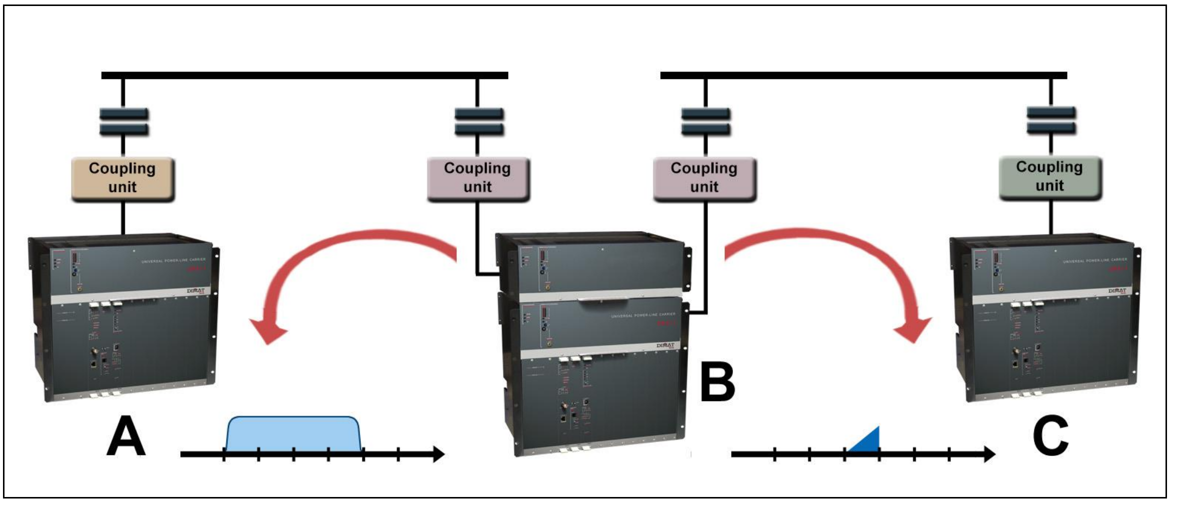


Figure 3.4: Two virtual PLCs in one physical unit (example of use).

3.5 3-site connection (Teed lines)

- The additional high-frequency line filter allows special topology applications such as Teed lines.

- This application consists in sending the same teleprotection information to two different sites using three **OPU-1** terminals.

- Each **OPU-1** for **20** W & **40** W incorporates an additional high-frequency line filter and a built-in teleprotection system.

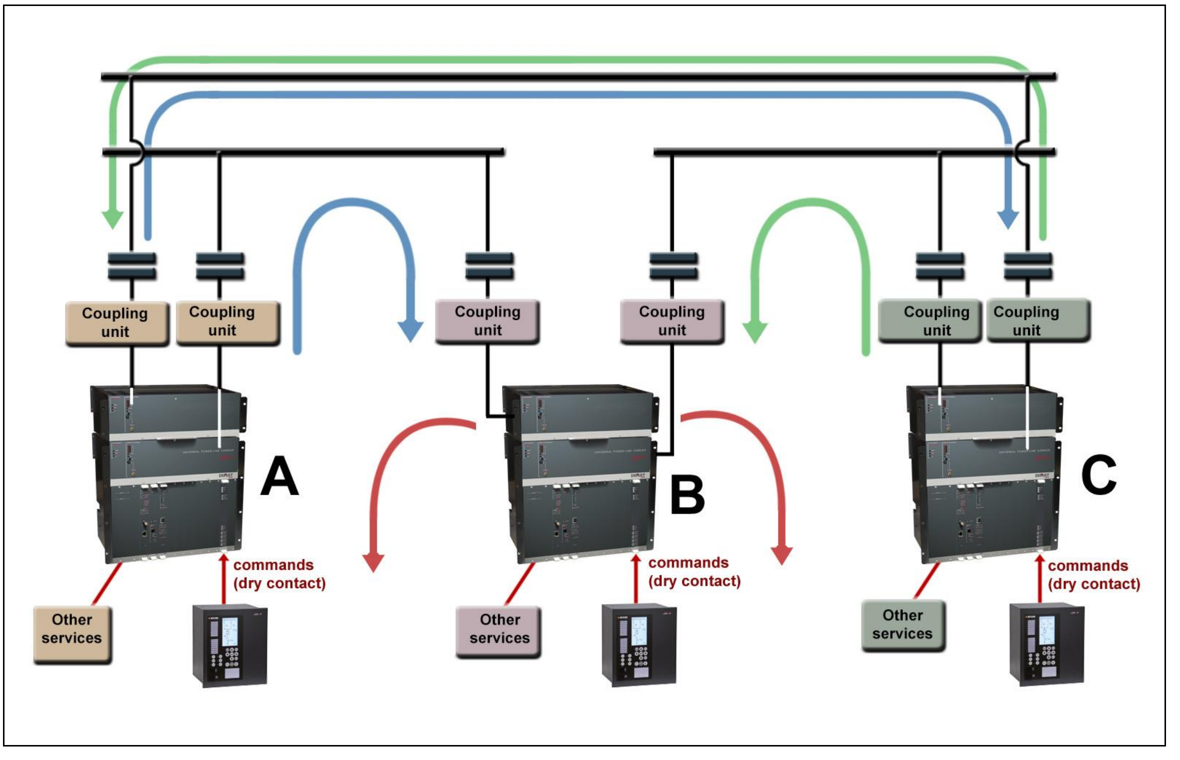


Figure 3.5: 3-site connection (example of use).

3.6 Teleprotection integrated in the digital band

- The digital operation band is used for the **QAM** signal and teleprotection signals.
- The guard signal is sent to the high-voltage line together with the **QAM** signal.
- When the receiver detects the absence of the guard signal, the **QAM** signal is blocked for a pre-set period of time to allow command signal detection.

*For this application, the **OPU-1** terminal is equipped with a specific built-in teleprotection system.*

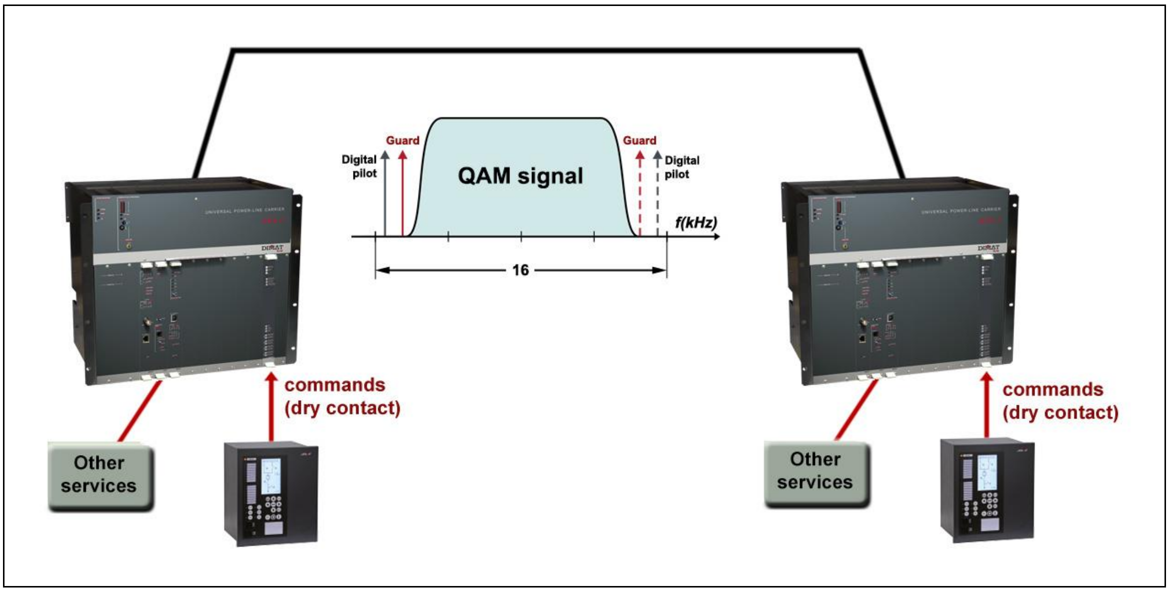


Figure 3.6: Teleprotection integrated in the digital band (example of use)

3.7 Narrow-Band High-Frequency Teleprotection

- By suitably equipped, and using a built-in teleprotection module by dual tone over dedicated analog band, the **OPU-1** permits the transmission of up to four teleprotection commands over high-voltage lines in a standard **4** kHz channel (**2** kHz for transmission and **2** kHz for reception) or in a standard **2** kHz channel (**1** kHz for transmission and **1** kHz for reception).

This application is compatible with blocking, direct tripping and permissive tripping teleprotection schemes.

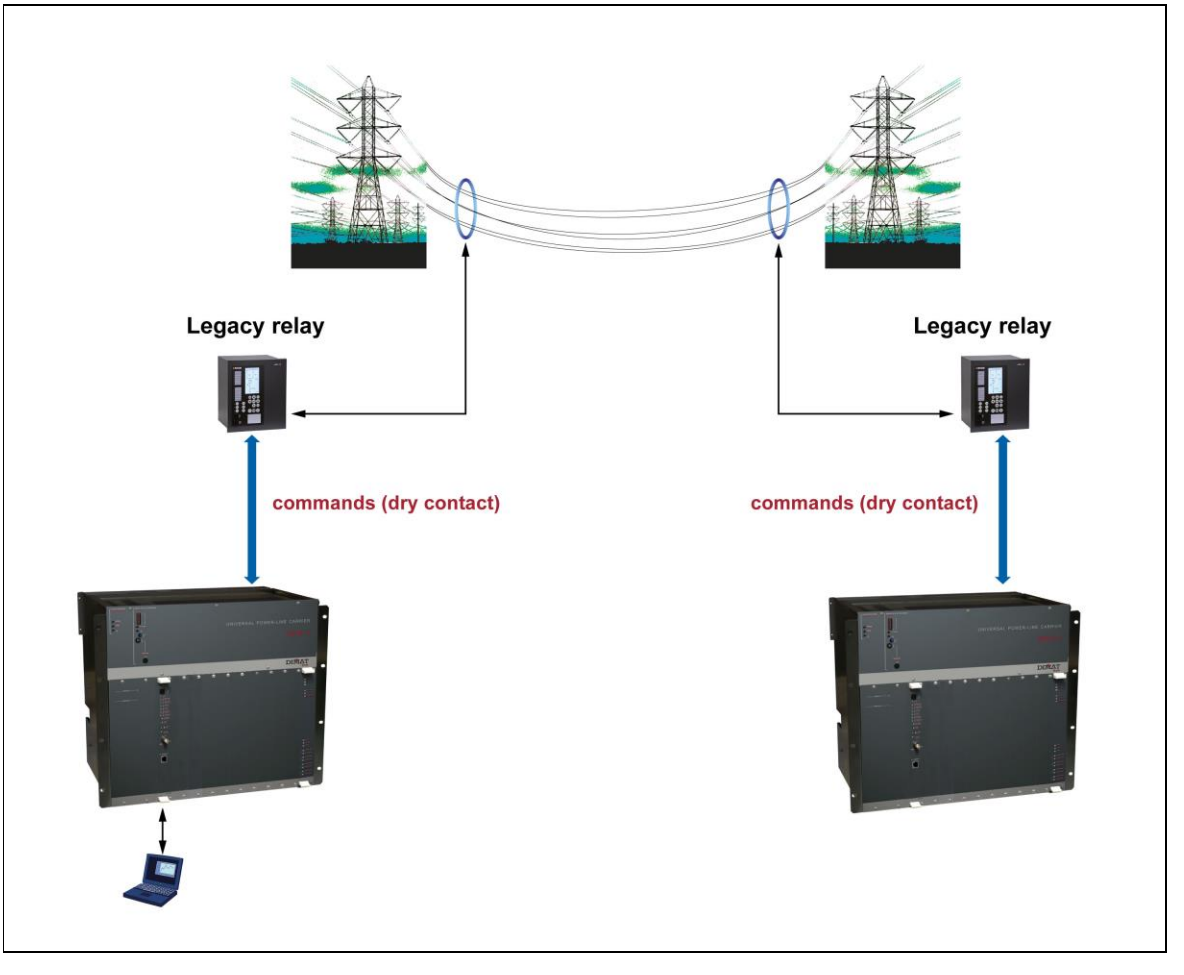


Figure 3.7: Narrow-Band High-Frequency Teleprotection (example of use).

3.8 Link between two telephone exchanges

- For this application, the **OPU-1** terminal is equipped with the speech (**TDPU.20**) module.
- The exchange-side 4-wire/2-wire telephone termination of the **TDPU.20** module is used.
- The E & M wires in the **TDPU.20** module itself are used for signalling.

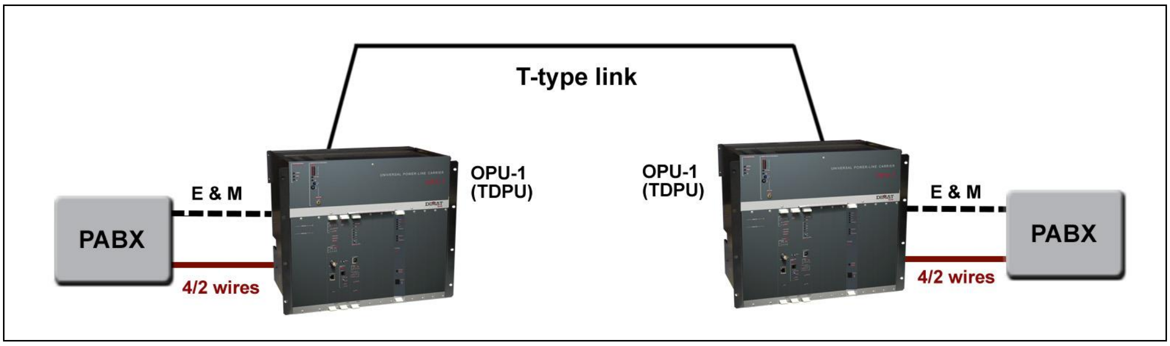


Figure 3.8: Link between two telephone exchanges (example of use).

3.9 Connection of a remote subscriber

- For this application, the **OPU-1** terminal is equipped with the speech (**TDPU.20**) module.
- The subscriber-side 2-wire telephone termination of the **TDPU.20** module is used.
- For communication with the exchange without using the E & M wires, exchange-side operation must be selected on the **TDPU.20** module by means of internal microswitches.

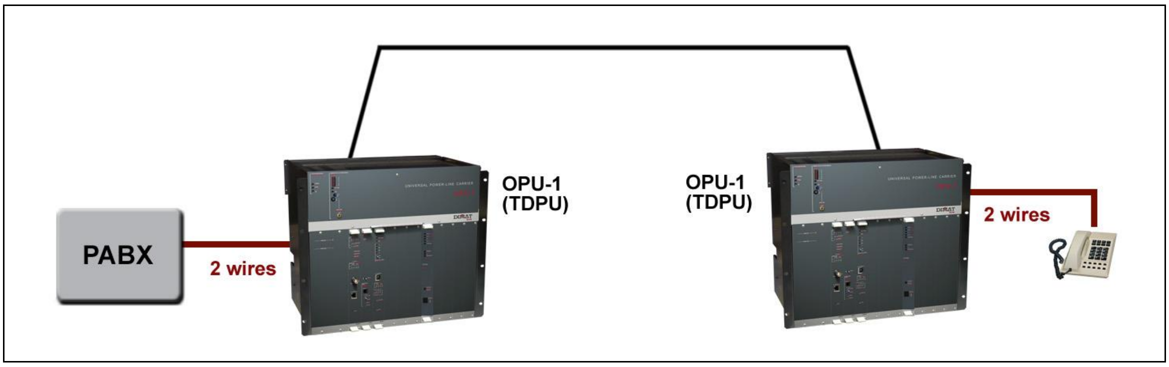


Figure 3.9: Connection of a remote subscriber (example of use).

Chapter 4.

Functional description

4. Functional description

4.1 System particularities

4.1.1 Use of the available band in an analog channel

Each **analog** channel can be used for speech-plus transmission (known as version **T**) or exclusively for data transmission (known as version **D**).

The speech-plus transmission (version **T**) is obtained by including a speech module (**TDPU.20**).

The effectively transmitted frequency band of the channel, that is, the available band extending from **300** Hz to **3850** Hz, can be used for the transmission of a:

- **D**-type channel:
  data, various VF telegraph channels and teleprotection signals.

- **T**-type channel:
  speech-plus service where the available band is shared between speech and data.

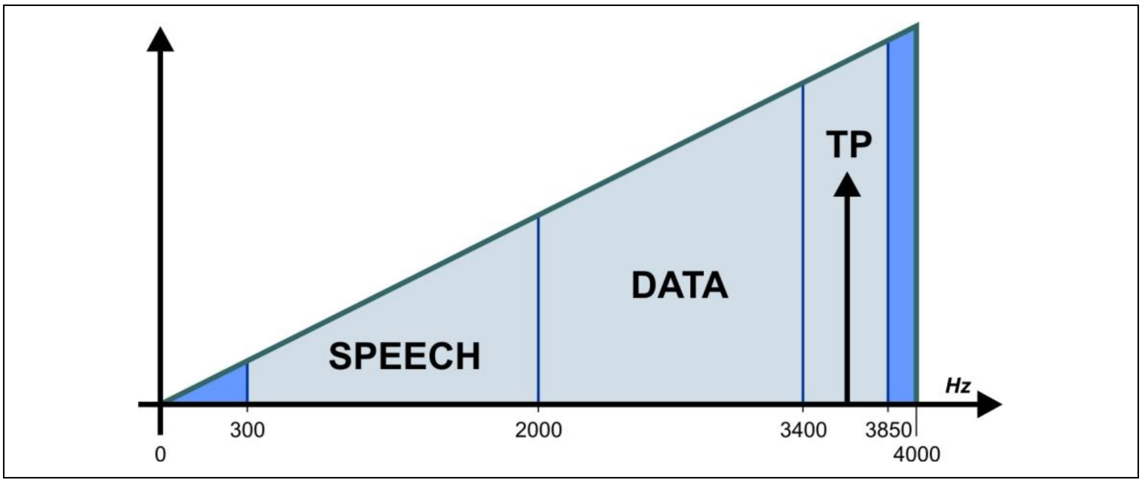


Figure 4.1 Use of the available band extending from 300 Hz to 3850 Hz.

In the **T**-type channel, the speech band is limited from **300** Hz to a frequency programmable between **2000** Hz and **3400** Hz.

The frequency band above speech-band extends between 1.06 times the cutoff frequency selected for the speech band and **3850** Hz. The maximum transmission rate that can be obtained in the frequency band above speech-band is **1200** Bd when the speech band is limited to **2000** Hz.

*In a **mixed** (analog+digital) terminal, the teleprotection guard signal is transmitted over the analog channel.*

The enclosed table indicates the maximum number of standardized channels of **50**, **100** and **200** Bd that can be situated in the **D**-type channel.

The number of higher-rate FSK channels that can be transmitted in the same band is three for a transmission rate of **600** Bd (with separation of **960** Hz) and two for a rate of **1200** Bd.

ITU-T Recommendation	R.35	R.37	R.39	R.38A	R.38B
Transmission rate (Bd)	50	100	100	200	200
Separation (Hz)	120	240	170	480	360
Number of channels	29	14	20	7	9

Table 4-1: Maximum number of channels for a D-type channel

4.1.2 Situation of pilot tone

4.1.2.a Pilot tone in analog channel

*The pilot is situated below the available band, at the virtual frequency of **150** Hz ±**30** Hz, and maximum rate of **50** bit/s.*

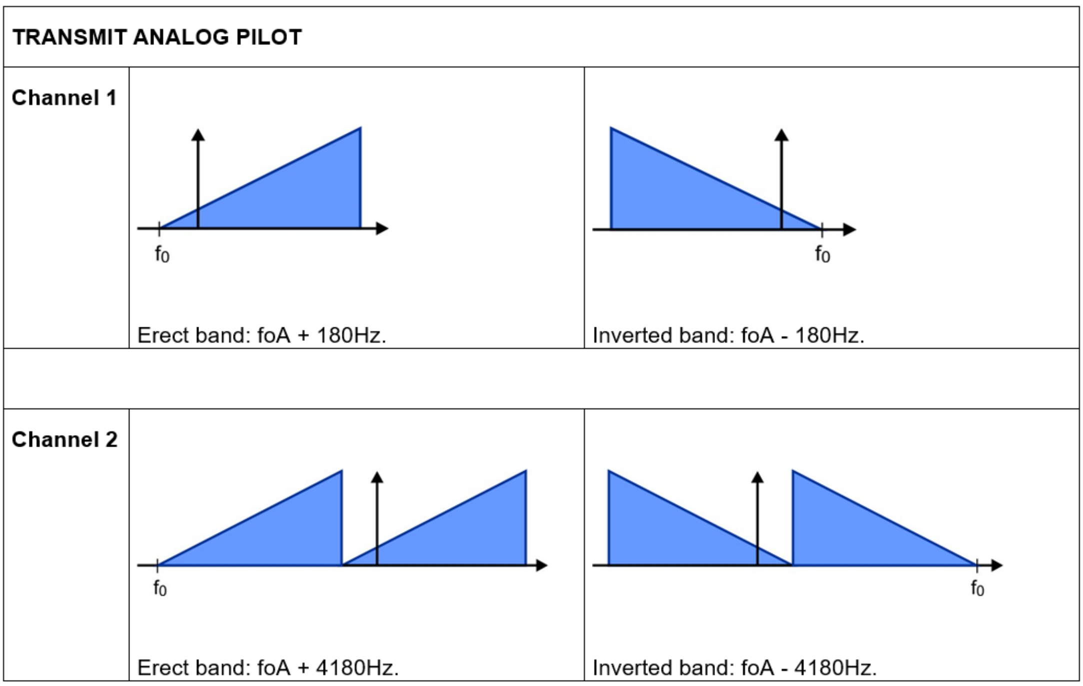


Figure 4.2 Situation of pilot tone in the analog band.

Chapter 4. Functional description

The different functions performed by the pilot channel are:

- **Automatic Gain Control (AGC).**
  The **OPU-1** supervises at all times the level of the pilot signal received in each of the analog channels.
  The amplitude of this signal, once digitized, is used to carry out the automatic gain control (AGC) of each channel.

- **Telephone signalling.**
  Modulating the pilot signal by frequency-shift keying at a maximum rate of **50** Bd, corresponding to **25** impulses per second, permits telephone signalling to be transmitted.

- **Signal-to-noise ratio measurement.**
  The system estimates the noise spectral density from the measurement of the noise power in the band of the pilot tone.
  Assuming that this density is constant in the whole **4** kHz channel, the signal-to-noise ratio is independently calculated for each of the analog channels.

- **Link synchronization.**
  It is possible to work plesiochronously, that is, each terminal works with its own master clock or in a synchronized way, that is, each terminal uses its internal oscillator as the master transmission clock and synchronizes its reception with the other terminal using the pilot received.

- **Service channel (data transmission).**
  The supervision of the system is carried out by transmitting data through the internal communication channel at a rate of **50** Bd.
  The transmission is interrupted when telephone signalling appears and is resumed when it has no transitions.
  Data transmission is periodically interrupted to carry out the link synchronization.

4.1.2.b Pilot tone in digital channel

The pilot performs the automatic gain control (AGC).

*The situation of the pilot in the **QAM** band is shown in the enclosed figures.*

*f_0 ± **7950** Hz (BW= **16** kHz)*
*f_0 ± **3975** Hz (BW= **8** kHz)*
*f_0 ± **1987.5** Hz (BW= **4** kHz)*

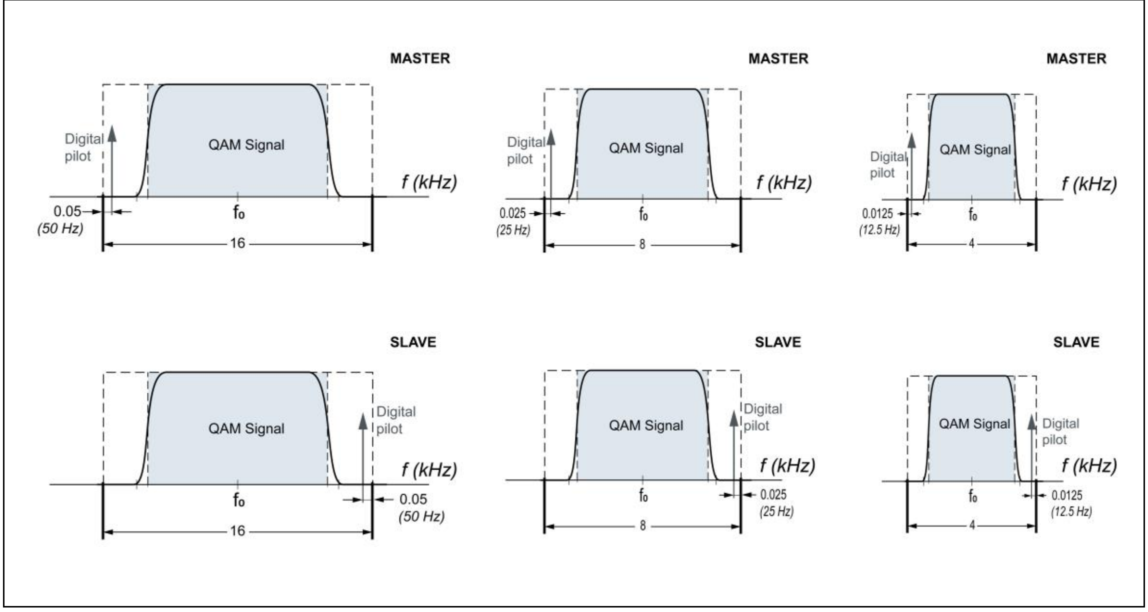


Figure 4.3 Situation of pilot tone in the QAM band.

4.1.3 Modulations and demodulations

4.1.3.a Analog channel

The transposition of a **4** kHz channel to a band of frequencies that extends from **36** to **512** kHz is carried out by means of a modulation process that is completely digital.

The type of modulation used is single side-band (**SSB**) with suppressed carrier.

The analog signal in base band is digitized and delivered to the **MOPU** module where, by means of digital signal processing, is transported to the desired channel frequency, with a resolution of **1** kHz.

The resulting digital signal is converted to analog and, before being transmitted to the high-voltage line, passes through a power stage.

In reception, the received analog signal passes through the AGC circuit.

Then it is digitized and delivered to the **MOPU** module which performs the transposition of the signal of each channel in base band and extracts the pilot.

Finally, the digital signal of each channel is converted to analog.

4.1.3.b QAM digital channel

For the **QAM**, the data stream proceeding from the digital user interface is encoded and modulated at **128** QAM, **16** QAM or **4** QAM according to whether the gross bit rate is of **81** kbit/s, **40.5** kbit/s or **27** kbit/s, respectively.

The data is subjected to the following processes: scrambling, serial to parallel conversion, differential encoding, convolutional encoding (Trellis encoding), symbol mapping, pulse shaping filtering and **QAM** modulation.

The **QAM** signal obtained in this way is transposed to the desired frequency band and, before being transmitted to the high-voltage line, passes through a power stage.

In reception, the received analog signal enters the **MQPU** module. There, it is subjected to an AGC process and converted into a digital signal. Finally, it passes through a band pass filter which gives the receiver the selectivity characteristics desired.

In the **superimposed band** operation mode, the filtered signal is applied to an echo canceller device where the transmit signal that superimposes the received signal is cancelled, by means of a signal coming from the transmitter and adequately processed. The obtained signal is demodulated and decoded and is sent to the user interface.

In the **non-adjacent band** operation mode, where the echo canceller is not used, the filtered signal is directly demodulated and decoded and is sent to the user interface.

4.1.3.c OFDM/OQAM digital channel

The input of the **OFDM/OQAM** modulator is a complex symbol stream for each of the carriers of the system.

This symbol stream is first processed by a staggering block, which outputs a complex symbol stream at twice the input rate.

This stream is then multiplexed by a carrier specific exponential weight and processed by an IFFT block, whose output is filtered by the polyphase components of the prototype pulse followed by a decimate-and-sum network.

At the receiving side, the inverse operations are carried out.

4.1.4 Service telephony

The speech-band service-telephony circuits are the button for sending the call, the handset connector, and the switch for establishing the communication.

These circuits can be found in the **MOPU** module and in the **IOPU** optional module, but the circuits of the **IOPU** module have priority against the ones of the **MOPU** module.

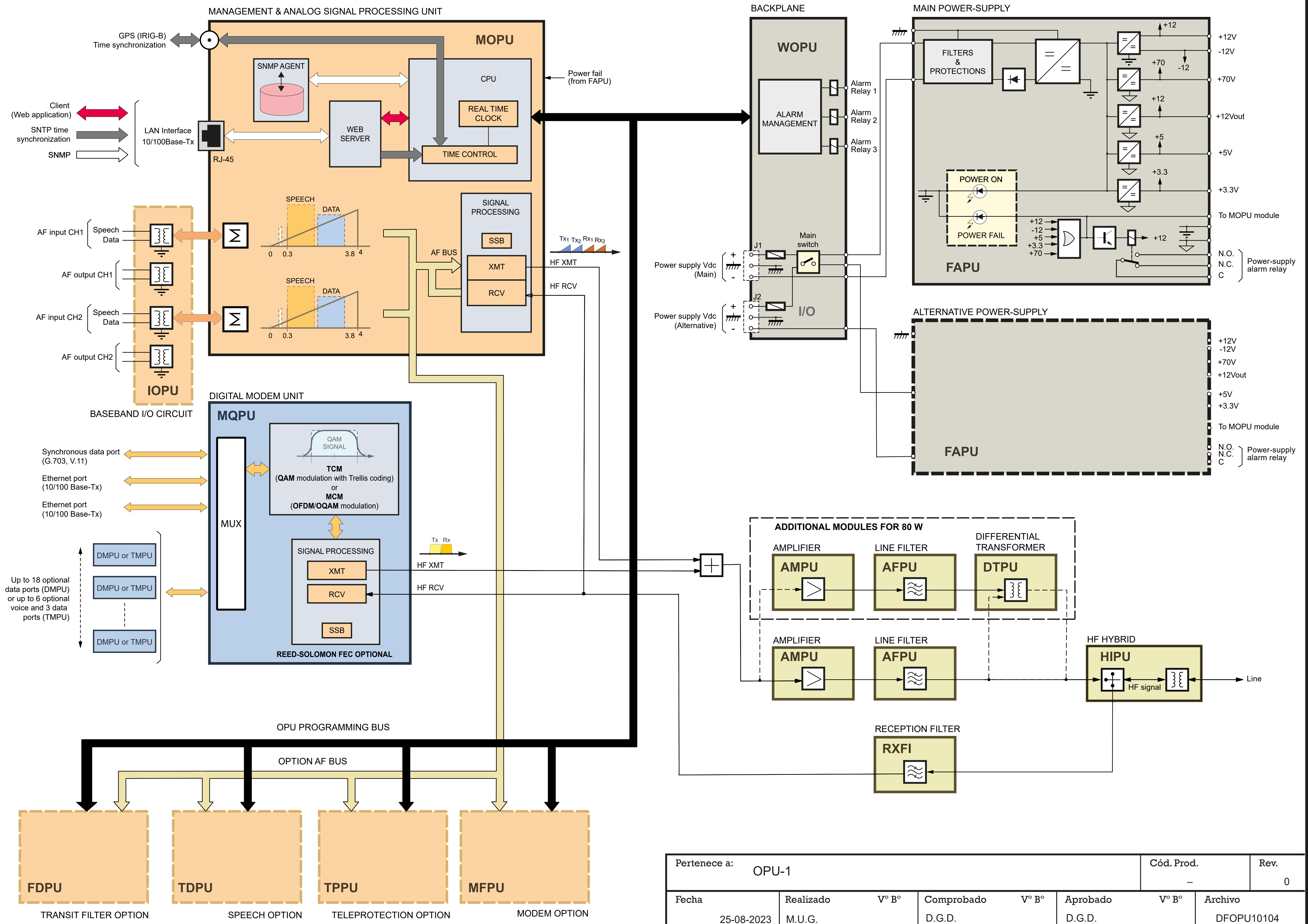
- **Sending a call.**
  When the **CALL** button is pressed, the call is transmitted to the remote terminal and the **M**-wire activates in the corresponding analog channel.
  The **M**-wire activation causes the lighting of the **XMT** LED in the **IOPU** optional module.

- **Call reception.**
  With the handset connected, the buzzer is activated when a call is received. The **RCV** LED of the **IOPU** optional module lights up.

- **Communication.**
  With the handset connected, when the switch is in the **CHANNEL SEIZURE (INCLUSION)** position, the microphone is connected to the emission circuit and communication is established.
  When the channel is seized, the terminal deactivates all the audio-frequency inputs and allocates the 4-kHz whole band for service telephony.

4.1.5 Functional block diagram

The simplified block diagram of the basic **OPU-1** terminal can be seen in the attached drawing.



Pertenece a: OPU-1						Cód. Prod. –	Rev. 0
Fecha 25-08-2023	Realizado M.U.G.	Vº Bº	Comprobado D.G.D.	Vº Bº	Aprobado D.G.D.	Vº Bº	Archivo DFOPU10104
	FUNCTIONAL BLOCK DIAGRAM					Siglas OPU-1	Hoja 1/1

4.2 High-Frequency Teleprotection particularities

4.2.1 Operating principle

In quiescent conditions, the **OPU-1** terminal with High-Frequency Teleprotection functionality continuously transmits a guard signal, which is continuously supervised by the terminal at the other end of the link. This maintains the remote terminal in quiescent conditions and indicates that the transmission channel is in good condition.

When a command needs to be transmitted, the guard signal is replaced by the corresponding command signal (**DUAL TONE**). When the remote terminal detects the absence of the guard signal and the presence of a command signal (**DUAL TONE**), the corresponding command-output relay is activated.

4.2.2 Command transmission

The **TPPU** has four independent command-input circuits, protection side, the nominal activation voltage of which is configurable by means of jumpers. The activation logic of the said circuits, by the presence or absence of voltage, is also configurable by internal jumper.

The assignment of the inputs (**I1**, **I2**, **I3** and **I4**) to the commands (**A**, **B**, **C** and **D**) is set from the Management System. The assignment depends on the number of commands configured in transmission.

From one to three commands, a logic need to be programmed:

- All the inputs active (logic **AND**)
- One of the inputs active (logic **OR**)

When working with four commands, the circuits are always assigned in the following way: inputs **I1** to **I4** to commands **A** to **D**, respectively.

The change of state of a command input starts a validation routine. If the programmed input conditions are satisfied, the command-transmission process is begun.

*The process starts with the replacement of the guard signal by the corresponding command signal (**DUAL TONE**), and the activation of the power-boosting command.*

The transmission of a command can be programmed to take place in one of the following ways:

- Continuous transmission of the corresponding command signal while the command is present at the input.

- Transmission of the command signal for a prolonged period of time after the disappearance of the command at the input.
  This period of time can be programmed to be between **20** ms and **2500** ms.

- Transmission of the command signal limited to a value programmed to be between **20** ms and **2500** ms when the duration of the command that is present at the input is greater than this value.
  If the command present at the input is present for a period of time shorter than the programmed value, the transmission of the command stops when the command is no longer present at the input.

- Transmission of the command signal for a fixed period of time, which can be programmed to be between **20** ms and **2500** ms, independently of the time during which the command is present at the input.

*In any of the previous four cases, it is possible to program that the transmission of the corresponding command signal took place only if the active input-condition persists for at least a period of time between **1** ms and **30** ms from its detection.*

The date on which and time at which the command is transmitted, together with the number of the command input circuit activated for this purpose, are stored in the chronological register of the teleprotection system.

4.2.3 Command reception

A received command is considered as valid if it exceeds a minimum pre-established duration, which depends on the type of application programmed.

When the command is considered valid, the corresponding output relay is energized.

The **TPPU** has four command-output relays (**O1**, **O2**, **O3** and **O4**). The relay assignment to the commands (**A**, **B**, **C** and **D**) is set from the Management System.

For four commands, the assignment of the relays to each one of the commands is fixed and is always: outputs **O1** to **O4** to commands **A** to **D**, respectively.

The command-output relay activation time can be programmed to be one of the following:

- The same as that of command reception.

- Prolonged to a value between **20** ms and **2500** ms after the disappearance of the received command.

- Limited to a value between **20** ms and **2500** ms.

- Fixed, with a total duration of between **20** ms and **2500** ms.

The date on which and time at which the command is received is stored in the chronological register of the teleprotection system.

4.2.4 Blocking of the receiver

Receiver blocking can be produced by one of the following causes:

- If the received guard signal is below the pre-set minimum level and no command signal has been received for more than **50** ms.
- Once the terminal is started up, the guard signal has not been received for more than **500** ms.
- The output circuits, protection-side, have been blocked from the Management System.
- The guard and command tones are received simultaneously.

When the receiver blocks, the receiver-blocking alarm is generated. The alarm remains active until the receiver is unblocked.

*Guard signal must be received for a period of time for the receiver to become unblocked. In all cases, guard must be received for at least **50** ms. However, should any of the blocking situations last for a time longer than **500** ms, the guard signal must be received for at least **2.5** s.*

4.3 Time synchronization

The **OPU-1** terminal chronologically registers all the alarms and events produced in the power-line carrier link.

To set the date and time when these alarms and events occur, the **OPU-1** has a **real time clock** that can be synchronized by using an external reference.

When the clock is synchronized by an **external reference**, the received time reference will always prevail over any time setting programming.

- **SNTP synchronization.**
  The **OPU-1** can synchronize its real time clock via the 10/100Base-Tx (MOPU) port using the **SNTP** (*Simple Network Time Protocol*) protocol, which uses UTC as a time base.
  From the Management System, it is possible to configure up to **5** possible addresses of **SNTP** servers.

- **IRIG-B synchronization.**
  The **OPU-1** can synchronize its real time clock with the time reference given by a GPS receiver that has an **IRIG-B** output.
  The **OPU-1** is capable of processing signals from the **IRIG-B 120** to **IRIG-B 123** standard, in which the signal is modulated in amplitude at 1 kHz, and signals from the **IRIG-B 000** to **IRIG-B 003** standard, in which the signal is modulated by pulses.

4.4 Test devices

To facilitate alignment and maintenance operations the **OPU-1** allows high and low-frequency loops to be carried out.

An analog channel can be checked locally by carrying a high-frequency loop. It is also possible to know the amplitude response of the link by using the low-frequency loops.

A digital channel can be checked by carrying a high-frequency loop. Basic and additional ports can also be checked by carrying out loops.

4.4.1 High-frequency loop

A high-frequency loop allows the equipment to be locally checked by checking the transmit circuits on one side and the receive circuits on the other.

Loop activation is carried out by programming the **MAKE HF LOOP** command button of the ***Basic equipment*** option of the ***Configuration*** menu.

The Management System automatically matches the receive frequency to the transmit frequency. Transmission is looped over reception at local level, making possible the verification of all transmission and reception processes.

Once the loop is disabled, the Management System restores the receive frequency to its original value.

*If the **OPU-1** terminal has an internal teleprotection unit, it is advisable to block the teleprotection receiver to prevent false commands.*

Figure 4.4 High-frequency loop.

4.4.2 Low-frequency loops (analog channel)

The response curve of the link can be obtained from one end of the link by performing two types of loops at the other end.

The first loop, which has **signal-level regeneration** at the looped end, allows the response curve of the return circuit to be obtained. This is possible thanks to the measurement of the received signal, for which it is known that the transmission level is constant.

The second loop, which **does not have signal-level regeneration**, allows the response curve of the looped circuit to be obtained and, therefore, allows the response curve of the outward circuit to be calculated.

Figure 4.5 Low-frequency loops (analog channel).

4.4.3 Loops in the basic ports and in the multiplexer (digital channel)

It is possible to carry out a loop in the data ports of the **MQPU** module and, if it is installed, those of the optional built-in multiplexer.

When a loop is carried out in a port, the port input data returns at input/output level to its original source, whilst the data received from line is sent back to the line.

A data analyzer (data interface) or tone generator (speech interface) will be required.

*The loop is ordered by means of the corresponding **PROGRAM** command button (**Multiplexer loops** option of the **Digital part** submenu of the **Alignment help** menu).*

Figure 4.6 Loops (digital channel).

4.4.4 Other facilities available

In addition of loops, the management system also offers other options for system monitoring and checking, such as:

- Real-time alarm monitoring.
- Alarms/events chronological register.
- Monitoring of received-pilot level.
- Monitoring of S/N ratio level.
- Constellation view (QAM digital link).
- G.821 statistics monitoring (QAM digital link).
- Signal spectrum monitoring (QAM digital link).
- Signal quality monitoring (OFDM digital link)

4.5 Terminal management

The **OPU-1** terminal includes a **web server** containing all the pages necessary for **programming** and **monitoring** the system, being unnecessary for any software to be supplied with the equipment.

Access to **OPU-1** embedded **web server** is done by typing its IP address (**http://<IP>**) from a browser.

The connection between the **PC** and the **OPU-1** can be done **directly** or **remotely** through an IP network. In the latter, all the computers connected to the IP network have the possibility of managing any **OPU-1** connected to it.

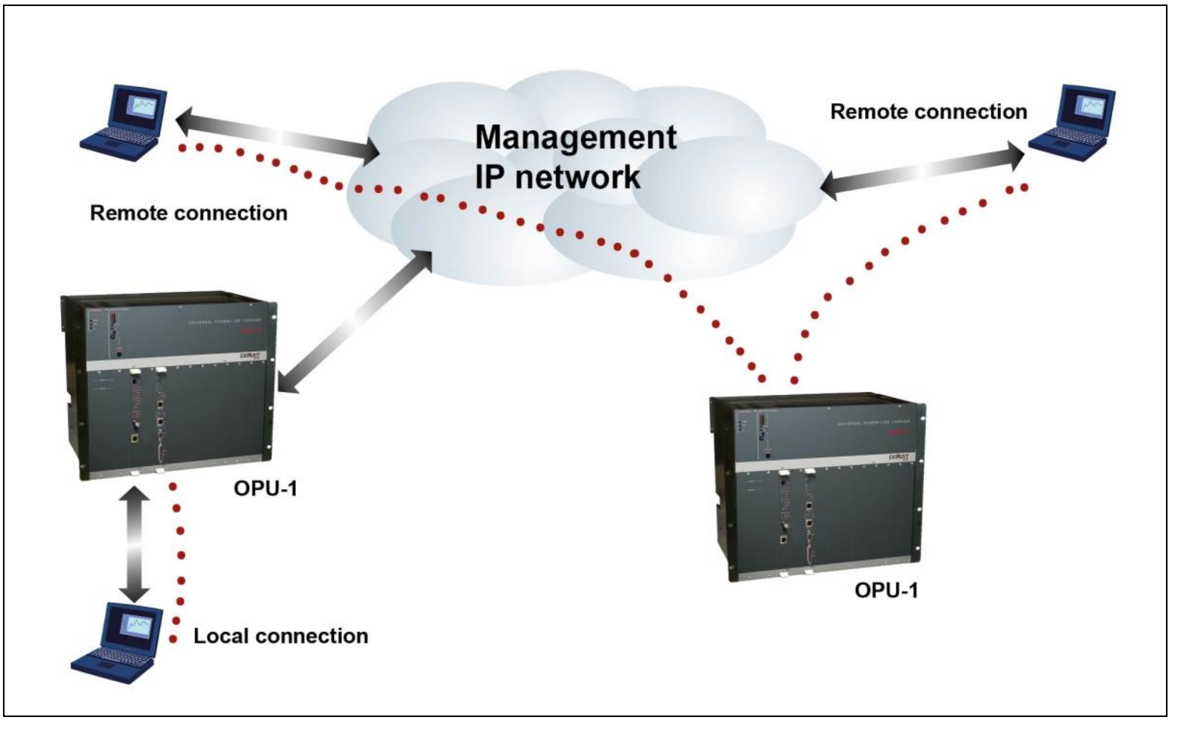


Figure 4.7 Connection possibilities between PC and OPU-1.

4.6 Main management menus

The **OPU-1** Management System consists of four main menus.

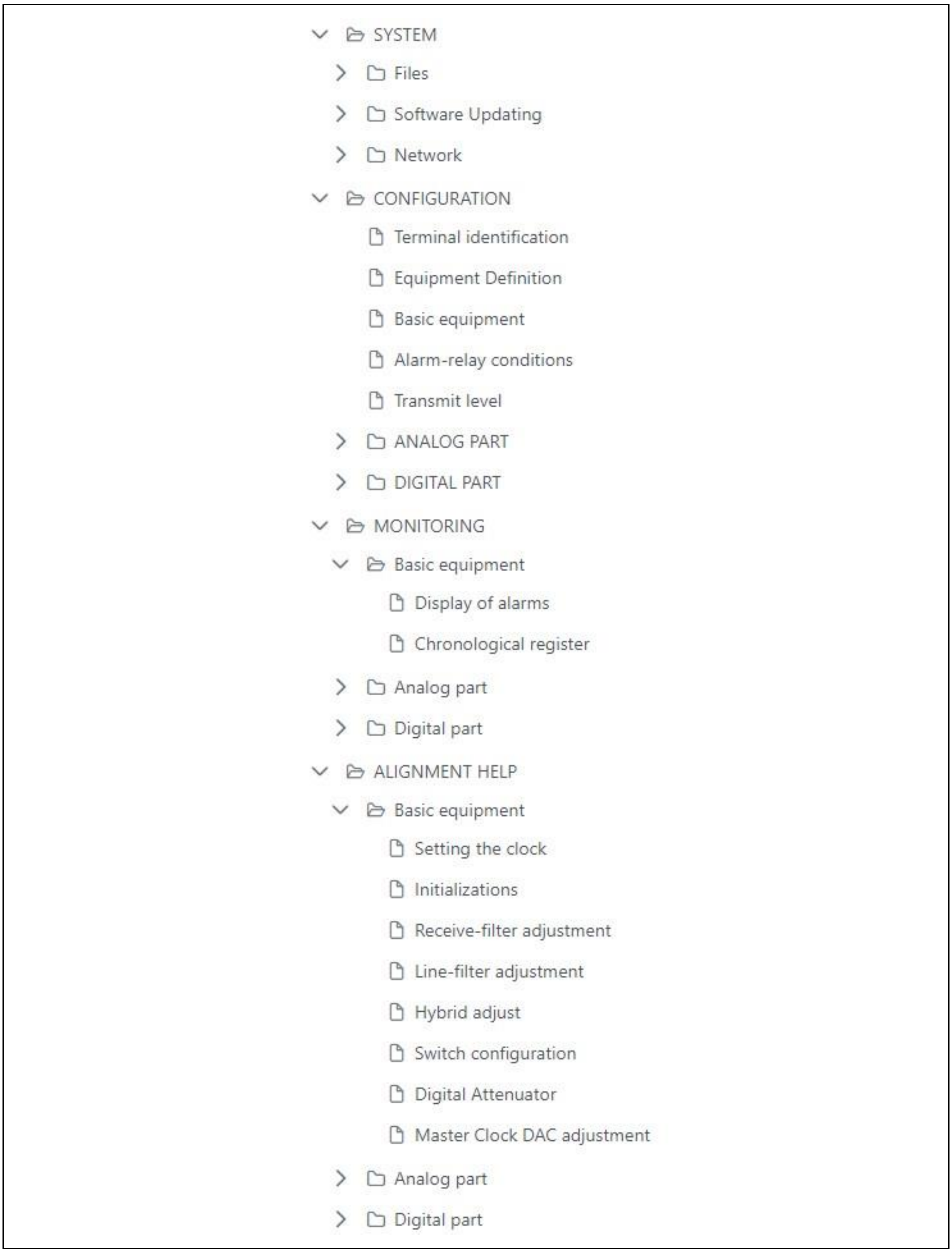


Figure 4.8 OPU-1 main management menus.

<table>
<tr><th>Menu</th><th>Description</th></tr>
<tr><td>System</td><td>Contains three main submenus:
- Files: gives access to the disk or terminal reading functions, as well as writing functions on disk or terminal.
- Software updating: displays the module software and firmware versions of the equipment, together with the checksum, and allows to update them.
- Network: configures the web server user passwords and the basic network management parameters (IP address, subnetwork mask and gateway), which must be compatible with those of the management computer. Activates the SNMP agent included in the terminal and allows its operation parameters to be configured. Displays the MAC address of the MOPU module and that of the MQPU module.</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Configuration</td><td>Configures all the operation parameters of the terminal.

Contains main options:
- Terminal identification
- Equipment definition
- Basic equipment
- Alarm-relay conditions
- Transmit level
- Modulation percentages (for HF teleprotection only)

The submenus corresponding to each type of channel, Analog part (analog channel) and Digital part (digital channel), contains specific programming facilities.

The Analog part submenu also includes the submenus related to optional analog modules.

The Digital part submenu also includes the options related to optional multiplexer.

For HF teleprotection, the Teleprotection submenu includes the specific programming facilities.</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Monitoring</td><td>Supervises system operation.

The Basic equipment submenu contains two main options:
- Display of alarms
- Chronological register

The submenus corresponding to each type of channel, Analog part (analog channel) and Digital part (digital channel), contains specific monitoring facilities.

The Analog part submenu also includes the submenus related to optional analog modules.

The Digital part submenu also includes the options related to optional multiplexer.

For HF teleprotection, the Teleprotection submenu includes the specific monitoring facilities.</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Alignment help</td><td>Provides facilities for the commissioning and maintenance of the terminal.

The Basic equipment submenu contains main options such as:
- Setting the clock
- Initializations
- Receive-filter adjustment (NOT for HF teleprotection)
- Line-filter adjustment
- Hybrid adjust
- Switch configuration
- Loop control (for HF teleprotection only)
- Receive level (for HF teleprotection only)

The submenus corresponding to each type of channel, Analog part (analog channel) and Digital part (digital channel), contains specific commissioning facilities.

The Analog part submenu also includes the submenus related to optional analog modules.

The Digital part submenu also includes the options related to optional multiplexer.

For HF teleprotection, the Teleprotection submenu includes the specific commissioning facilities.</td></tr>
</table>

Table 4-2: Description of the main menu functions

Chapter 5.

Installation & connections

5. Installation & connections

5.1 Front elements of the main equipment

5.1.1 OPU-1 of 20 W & 40 W (3 s.u. shelf)

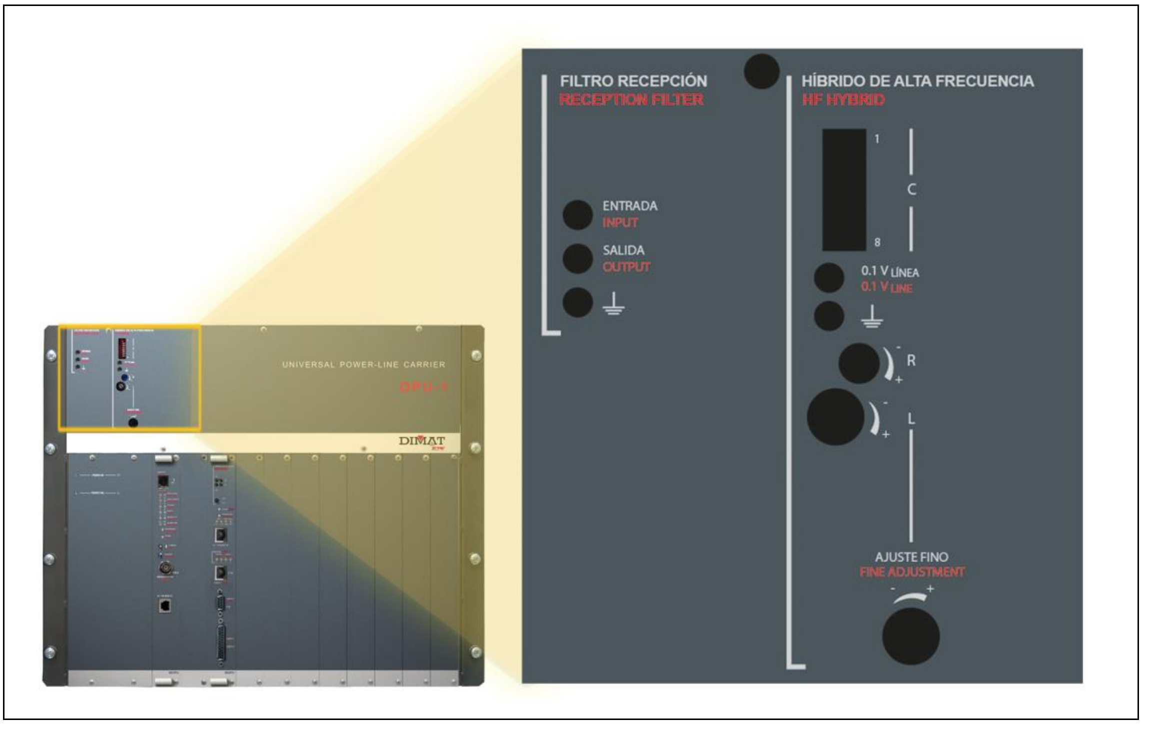


Figure 5.1 Detail of the elements accessible from the front of the 3 s.u. shelf of the OPU-1 for 20 W & 40 W.

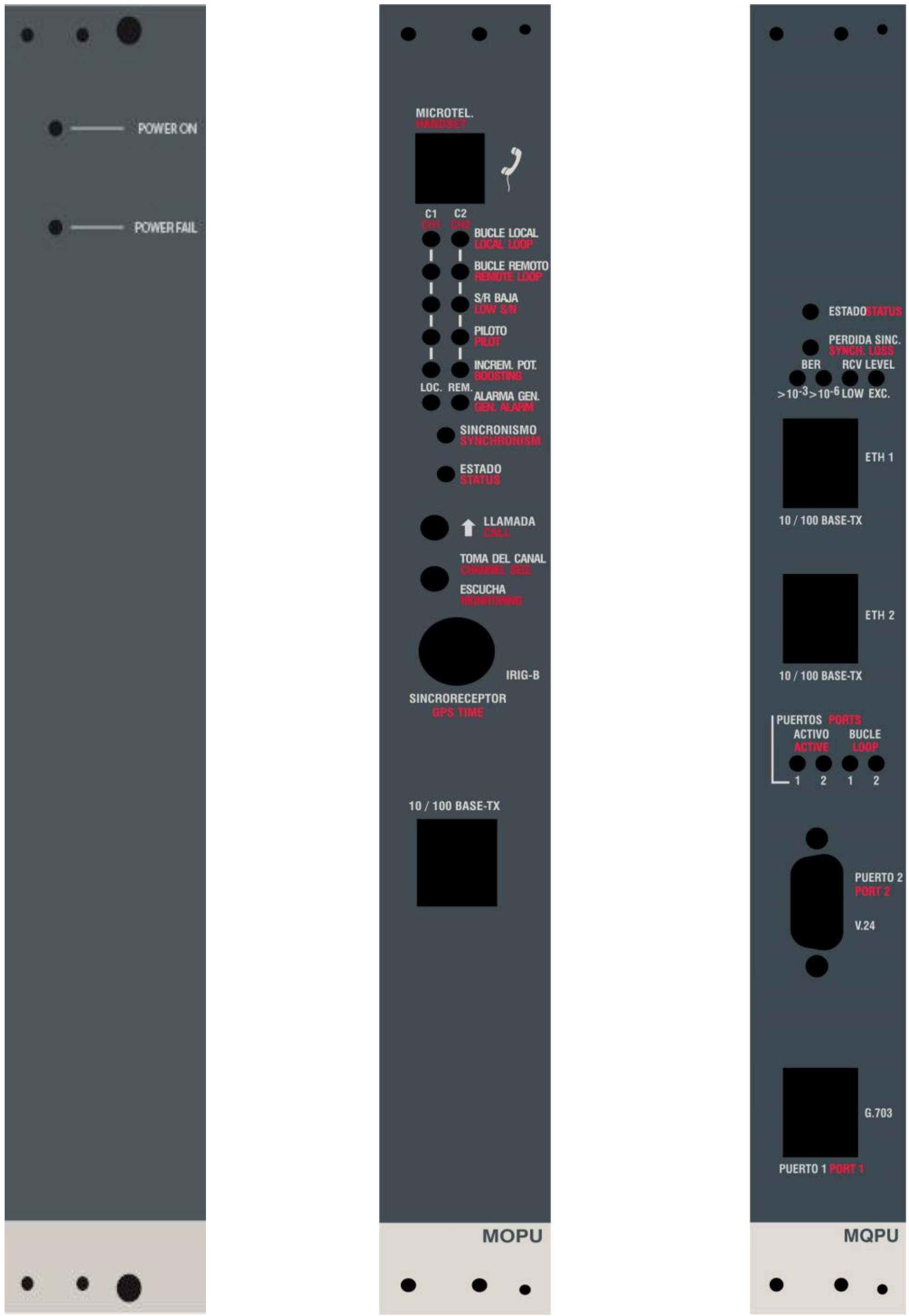
RXPU or RXPR (RECEPTION FILTER)

INPUT / ⏚	Test points to measure the **reception** level of the high-frequency signal before the reception filter.
OUTPUT / ⏚	Test points to measure the level of the high-frequency signal after the reception filter.

HIPU or HIPU.01 (HF HYBRID)

0.1 V_{LINE} / ⏚	Test points to measure the **output** level of the high-frequency signal attenuated in approximately **20** dB with respect to the line signal level.
C	Element to adjust the **capacitive** component of the high-frequency hybrid. The adjustment is made by **MI1** microswitches **1** to **8**. The position **1** corresponds to open circuit.
R	Element to adjust the **resistive** component of the high-frequency hybrid. The adjustment is made by potentiometer **P1**.
L	Elements to adjust the **inductive** component of the high-frequency hybrid. - **Thickness adjustment.** It is made by rotating microswitch **MI3** of five positions. The position **0** corresponds to open circuit. - **Fine adjustment.** It is made by inductance **TF3**. It is advised to use a flat-headed screwdriver. The inductance increases when the control is turned clockwise.

5.1.2 OPU-1 of 20 W & 40 W (6 s.u. shelf)



a) FAPU b) MOPU c) MQPU

Figure 5.2 Front view of main modules (6 s.u. shelf).

FAPU (POWER SUPPLY)

POWER ON	**Green**. This LED lights to indicate the power-supply module is operative.
POWER FAIL	**Red**. This LED lights to indicate power-supply module faulty.

MOPU (CENTRAL MANAGEMENT & SIGNAL PROCESSING UNIT)

HANDSET	**Jack** for plugging-in the handset for the whole-band service telephony, in the corresponding analog channel. When the terminal receives a call and the handset is plugged-in, the buzzer rings. It is used as long as the equipment does not have the optional **IOPU** module installed. In that case, the HANDSET of the **IOPU** module must be used.
LOCAL LOOP	**Yellow**. This LED lights to indicate that the loop has been carried out in the corresponding analog channel (**CH1** or **CH2**) of the local terminal.
REMOTE LOOP	**Yellow**. This LED lights to indicate that the loop has been carried out in the corresponding analog channel (**CH1** or **CH2**) of the remote terminal.
LOW S/N	**Red**. This LED lights to indicate, in the corresponding analog channel (**CH1** or **CH2**), that the signal/noise (S/N) ratio is less than the predetermined value.
PILOT	**Red**. This LED lights in reception to indicate a loss of receive pilot in the corresponding analog channel (**CH1** or **CH2**).
BOOSTING	**Yellow**. This LED lights to indicate that a power-boosting command is been given in the corresponding analog channel (**CH1** or **CH2**). It is used as long as the equipment does not have the optional **IOPU** module installed. In that case, the BOOSTING LED of the **IOPU** module must be used.
GENERAL ALARM	**Red**. This LED lights to indicate that an alarm is being given in the local terminal (**LOC**) or remote terminal (**REM**). The LED remains lit during the alarm situation *(Power-supply failure, Amplifier overload, Low output level in amplifier, Loss of synchronism, Pilot loss, Low Signal/Noise ratio, AF limiter operation in analog channel, Temperature alarm, Terminal configuration error, Hardware failure, BER alarm in digital channel, Excessive or low reception level in digital channel).* This LED flashes in case of alarm for *Terminal configuration error* or *Hardware failure*.
SYNCHRONISM	**Red**. This LED lights to indicate loss of synchronism in the terminal. It is only useful for operation with synchronism.
STATUS	**Three-colour**. This LED lights in **red** when the module is starting up. If the start-up is correct, this LED lights in **green**. However, if a configuration error alarm is detected, this LED remains **red**. This LED flashes in **yellow** when a data loading is being carried out.

CALL	This **button** when pressed it activates the **M** wire, in the corresponding analog channel. It is used as long as the equipment does not have the optional **IOPU** module installed. In that case, the CALL button of the **IOPU** module must be used.
CHANNEL SEIZURE / MONITORING	This **switch** permits the seizure of the analog whole-band channel for service telephony when changing from the **MONITORING** position to **CHANNEL SEIZURE**, with the handset plugged-in. When the channel is seized, the terminal deactivates all the audio-frequency inputs and allocates the whole-band for service telephony. It is used as long as the equipment does not have the optional **IOPU** module installed. In that case, the switch of the **IOPU** module must be used.
IRIG-B	**BNC** connector that allows the **OPU-1** terminal to be connected to a GPS time equipment in order to guarantee time synchronization.
10/100 BASE-TX	**RJ-45** 8-pin female connector that allows the **OPU-1** terminal to be connected to the management computer. It also admits the SNTP synchronization.

MQPU (DIGITAL MODEM)

STATUS	**Three-colour**. This LED lights in **red** when the module is starting up. If the start-up is correct, this LED lights in **green**. However, if a configuration error alarm is detected, this LED remains **red**. This LED flashes in **yellow** when a data loading is being carried out.
SYNCHRONISM LOSS	**Red**. This LED lights to indicate that the module has lost the frame synchronism, either because of excessive noise level in the channel or because broken link.
BER >10^{-3}	**Yellow**. This LED lights to indicate that the error rate evaluated by the system is higher than the maximum error rate permitted. The link could be interrupted if the error rate does not improve.
BER >10^{-6}	**Yellow**. This LED lights to indicate that the system is not working in optimum conditions. It is considered to be a preventive alarm.
LOW RCV LEVEL	**Red**. This LED lights to indicate that pilot level is lower than the threshold specified.
EXCESSIVE RCV LEVEL	**Red**. This LED lights to indicate that pilot level is higher that the threshold specified.
10/100 BASE-TX (ETH 1)	**RJ-45** 8-pin female connector that supports the Ethernet user interface. The **ETH1** & **ETH2** Ethernet interfaces work as a part of a two-port hub. The Ethernet ports have bridge-link functionality.
10/100 BASE-TX (ETH 2)	**RJ-45** 8-pin female connector that supports the Ethernet user interface. The **ETH1** & **ETH2** Ethernet interfaces work as a part of a two-port hub. The Ethernet ports have bridge-link functionality.

PORTS	Block of four **LEDs** associated with the module ports (**1** and **2**). - **ACTIVE** **Green**. This LED lights to indicate that the port is programmed and activated. When remains off it indicates that the port is blocked or non-programmed. - **LOOP** **Yellow**. This LED lights to indicate that a data loop has been programmed in the port.
V.24	**SUB-D** 9-pin female connector that supports **V.24** signals associated with port **2**.
G.703	**RJ-45** 8-pin female connector that supports **G.703** signals associated with port **1**.

5.1.3 OPU-1 of 80 W (second 3 s.u. shelf)

Figure 5.3 Detail of the elements accessible from the front of the 3 s.u. shelves of the OPU-1 for 80 W.

DTPU (DIFFERENTIAL TRANSFORMER)

0.1 V_{AMP2} / ⏚	Test points to measure the **output** level of the high-frequency signal proceeding from the **second** AMPU.00 amplifier, after the second AFPU line filter (3 s.u. shelf – 80 W). The signal is attenuated in approximately **20** dB.
0.1 V_{AMP1} / ⏚	Test points to measure the **output** level of the high-frequency signal proceeding from the **first** AMPU.00 amplifier, after the first AFPU line filter (3 s.u. shelf). The signal is attenuated in approximately **20** dB.

5.1.4 OPU-1 of 80 W (first 3 s.u. shelf)

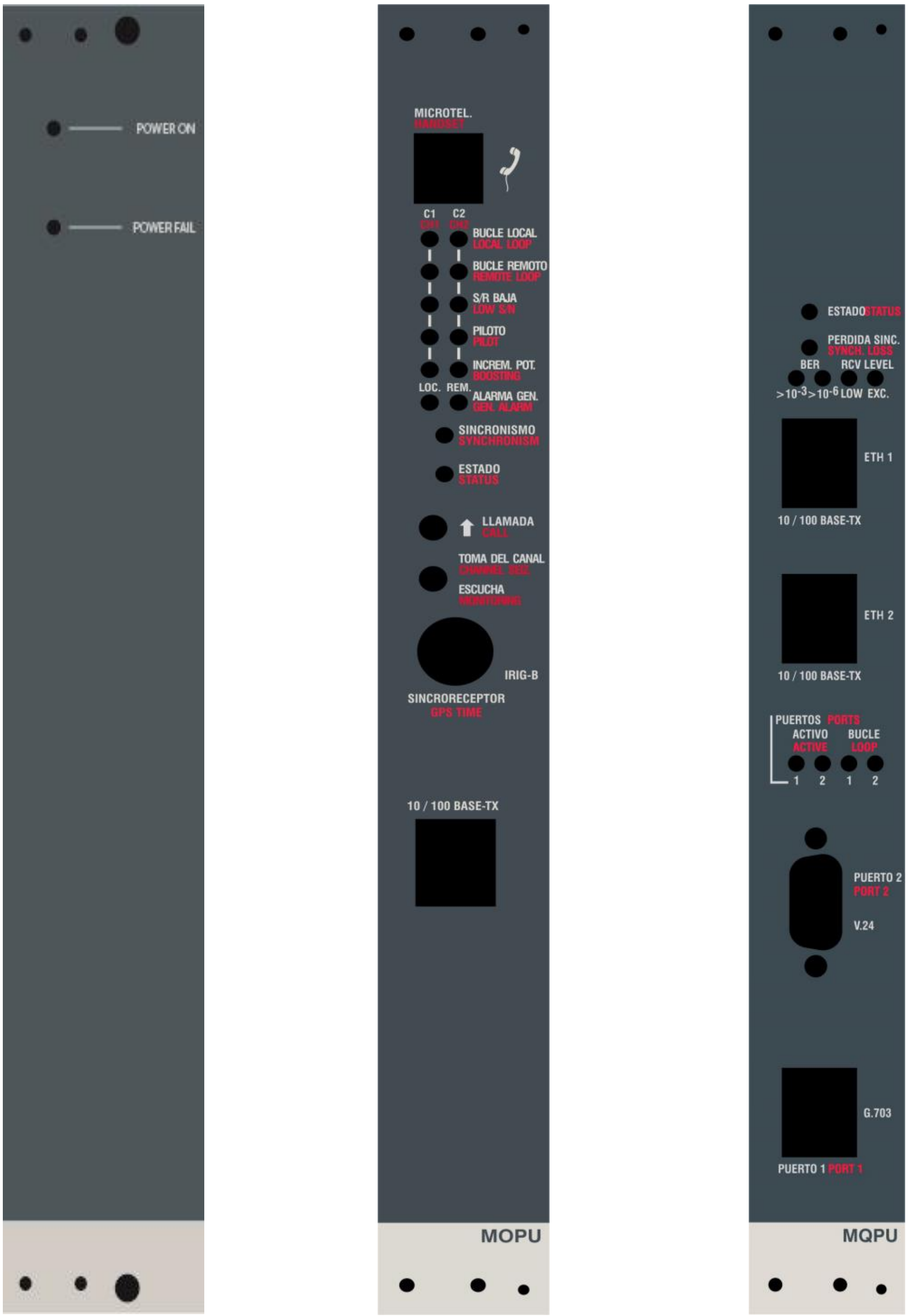
RXPU (RECEPTION FILTER)

INPUT / ⏚	Test points to measure the **reception** level of the high-frequency signal before the reception filter.
OUTPUT / ⏚	Test points to measure the level of the high-frequency signal after the reception filter.

HIPU (HF HYBRID)

0.1 V_{LINE} / ⏚	Test points to measure the **output** level of the high-frequency signal attenuated in approximately **20** dB with respect to the line signal level.
C	Element to adjust the **capacitive** component of the high-frequency hybrid. The adjustment is made by **MI1** microswitches **1** to **8**. The position **1** corresponds to open circuit.
R	Element to adjust the **resistive** component of the high-frequency hybrid. The adjustment is made by potentiometer **P1**.
L	Elements to adjust the **inductive** component of the high-frequency hybrid. - **Thickness adjustment.** It is made by rotating microswitch **MI3** of five positions. The position **0** corresponds to open circuit. - **Fine adjustment.** It is made by inductance **TF3**. It is advised to use a flat-headed screwdriver. The inductance increases when the control is turned clockwise.

5.1.5 OPU-1 of 80 W (6 s.u. shelf)



a) FAPU b) MOPU c) MQPU

Figure 5.4 **Front view of main modules (6 s.u. shelf).**

FAPU (POWER SUPPLY)

POWER ON	**Green**. This LED lights to indicate the power-supply module is operative.
POWER FAIL	**Red**. This LED lights to indicate power-supply module faulty.

MOPU (CENTRAL MANAGEMENT & SIGNAL PROCESSING UNIT)

HANDSET	**Jack** for plugging-in the handset for the whole-band service telephony, in the corresponding analog channel. When the terminal receives a call and the handset is plugged-in, the buzzer rings. It is used as long as the equipment does not have the optional **IOPU** module installed. In that case, the HANDSET of the **IOPU** module must be used.
LOCAL LOOP	**Yellow**. This LED lights to indicate that the loop has been carried out in the corresponding analog channel (**CH1** or **CH2**) of the local terminal.
REMOTE LOOP	**Yellow**. This LED lights to indicate that the loop has been carried out in the corresponding analog channel (**CH1** or **CH2**) of the remote terminal.
LOW S/N	**Red**. This LED lights to indicate, in the corresponding analog channel (**CH1** or **CH2**), that the signal/noise (S/N) ratio is less than the predetermined value.
PILOT	**Red**. This LED lights in reception to indicate a loss of receive pilot in the corresponding analog channel (**CH1** or **CH2**).
BOOSTING	**Yellow**. This LED lights to indicate that a power-boosting command is been given in the corresponding analog channel (**CH1** or **CH2**). It is used as long as the equipment does not have the optional **IOPU** module installed. In that case, the BOOSTING LED of the **IOPU** module must be used.
GENERAL ALARM	**Red**. This LED lights to indicate that an alarm is being given in the local terminal (**LOC**) or remote terminal (**REM**). The LED remains lit during the alarm situation *(Power-supply failure, Amplifier overload, Low output level in amplifier, Loss of synchronism, Pilot loss, Low Signal/Noise ratio, AF limiter operation in analog channel, Temperature alarm, Terminal configuration error, Hardware failure, BER alarm in digital channel, Excessive or low reception level in digital channel).* This LED flashes in case of alarm for *Terminal configuration error* or *Hardware failure*.
SYNCHRONISM	**Red**. This LED lights to indicate loss of synchronism in the terminal. It is only useful for operation with synchronism.
STATUS	**Three-colour**. This LED lights in **red** when the module is starting up. If the start-up is correct, this LED lights in **green**. However, if a configuration error alarm is detected, this LED remains **red**. This LED flashes in **yellow** when a data loading is being carried out.

CALL	This **button** when pressed it activates the **M** wire, in the corresponding analog channel. It is used as long as the equipment does not have the optional **IOPU** module installed. In that case, the CALL button of the **IOPU** module must be used.
CHANNEL SEIZURE / MONITORING	This **switch** permits the seizure of the analog whole-band channel for service telephony when changing from the **MONITORING** position to **CHANNEL SEIZURE**, with the handset plugged-in. When the channel is seized, the terminal deactivates all the audio-frequency inputs and allocates the whole-band for service telephony. It is used as long as the equipment does not have the optional **IOPU** module installed. In that case, the switch of the **IOPU** module must be used.
IRIG-B	**BNC** connector that allows the **OPU-1** terminal to be connected to a GPS time equipment in order to guarantee time synchronization.
10/100 BASE-TX	**RJ-45** 8-pin female connector that allows the **OPU-1** terminal to be connected to the management computer. It also admits the SNTP synchronization.

MQPU (DIGITAL MODEM)

STATUS	**Three-colour**. This LED lights in **red** when the module is starting up. If the start-up is correct, this LED lights in **green**. However, if a configuration error alarm is detected, this LED remains **red**. This LED flashes in **yellow** when a data loading is being carried out.
SYNCHRONISM LOSS	**Red**. This LED lights to indicate that the module has lost the frame synchronism, either because of excessive noise level in the channel or because broken link.
BER >10^{-3}	**Yellow**. This LED lights to indicate that the error rate evaluated by the system is higher than the maximum error rate permitted. The link could be interrupted if the error rate does not improve.
BER >10^{-6}	**Yellow**. This LED lights to indicate that the system is not working in optimum conditions. It is considered to be a preventive alarm.
LOW RCV LEVEL	**Red**. This LED lights to indicate that pilot level is lower than the threshold specified.
EXCESSIVE RCV LEVEL	**Red**. This LED lights to indicate that pilot level is higher that the threshold specified.
10/100 BASE-TX (ETH 1)	**RJ-45** 8-pin female connector that supports the Ethernet user interface. The **ETH1** & **ETH2** Ethernet interfaces work as a part of a two-port hub. The Ethernet ports have bridge-link functionality.
10/100 BASE-TX (ETH 2)	**RJ-45** 8-pin female connector that supports the Ethernet user interface. The **ETH1** & **ETH2** Ethernet interfaces work as a part of a two-port hub. The Ethernet ports have bridge-link functionality.

PORTS	Block of four **LEDs** associated with the module ports (**1** and **2**). - **ACTIVE** **Green**. This LED lights to indicate that the port is programmed and activated. When remains off it indicates that the port is blocked or non-programmed. - **LOOP** **Yellow**. This LED lights to indicate that a data loop has been programmed in the port.
V.24	**SUB-D** 9-pin female connector that supports **V.24** signals associated with port **2**.
G.703	**RJ-45** 8-pin female connector that supports **G.703** signals associated with port **1**.

5.1.6 OPU-1 with additional filter (second 3 s.u. shelf)

Figure 5.5 Detail of the elements accessible from the front of the two 3 s.u. shelves of the OPU-1 for 20 W & 40 W with additional filter.

RXPU (RECEPTION FILTER)

INPUT / ⏚	Test points to measure the **reception** level of the high-frequency signal before the reception filter of the **second** 3 s.u. shelf.
OUTPUT / ⏚	Test points to measure the level of the high-frequency signal after the reception filter of the **second** 3 s.u. shelf.

HIPU (HF HYBRID)

0.1 V_{LINE} / ⏚	Test points to measure the **output** level of the high-frequency signal of the **second** 3 s.u. shelf attenuated in approximately **20** dB with respect to the line signal level.
C	Element to adjust the **capacitive** component of the high-frequency hybrid of the **second** 3 s.u. shelf. The adjustment is made by **MI1** microswitches **1** to **8**. The position **1** corresponds to open circuit.
R	Element to adjust the **resistive** component of the high-frequency hybrid of the **second** 3 s.u. shelf. The adjustment is made by potentiometer **P1**.
L	Elements to adjust the **inductive** component of the high-frequency hybrid of the **second** 3 s.u. shelf. - **Thickness adjustment.** It is made by rotating microswitch **MI3** of five positions. The position **0** corresponds to open circuit. - **Fine adjustment.** It is made by inductance **TF3**. It is advised to use a flat-headed screwdriver. The inductance increases when the control is turned clockwise.

5.1.7 OPU-1 with additional filter (first 3 s.u. shelf)

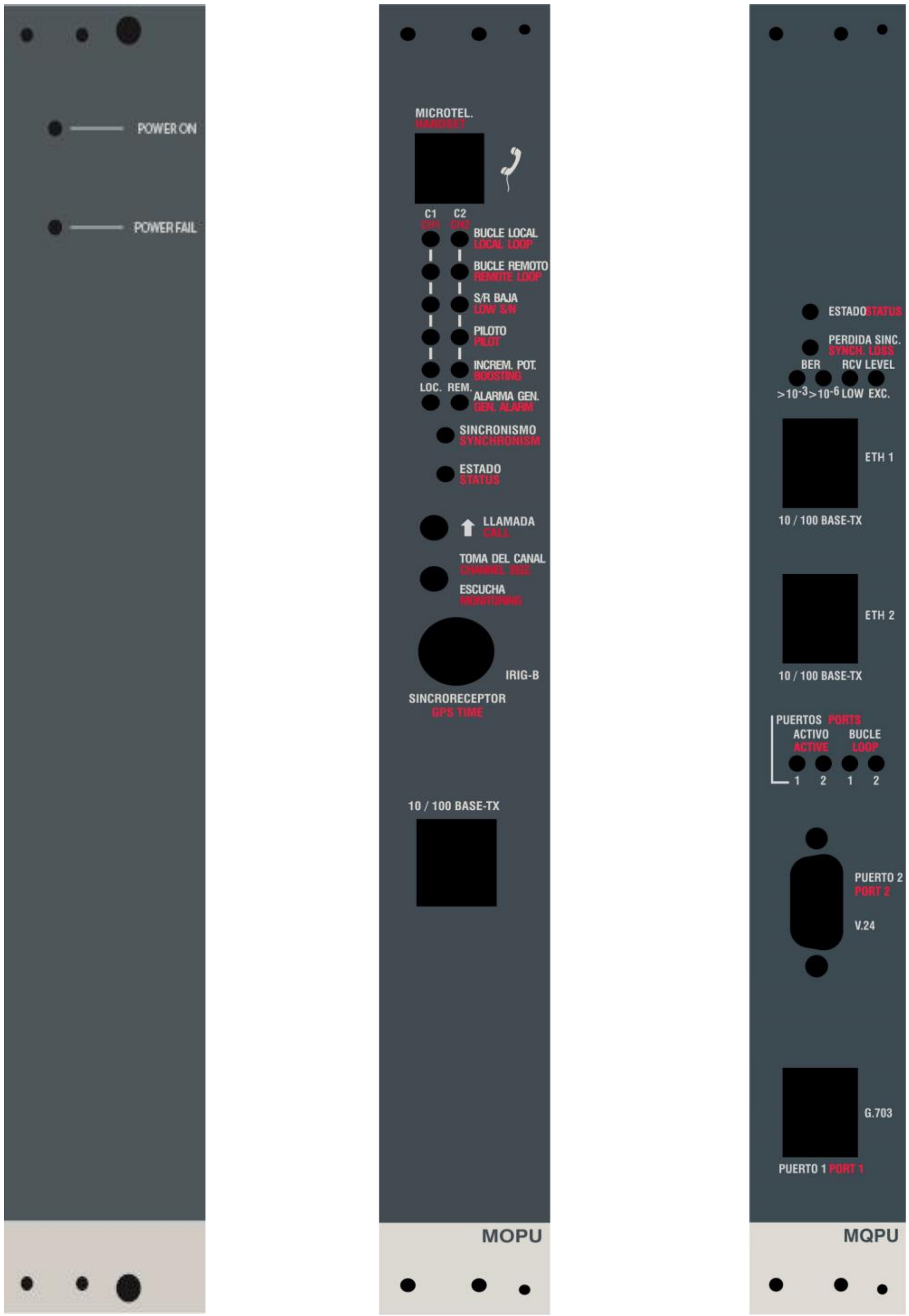
RXPU (RECEPTION FILTER)

INPUT / ⏚	Test points to measure the **reception** level of the high-frequency signal before the reception filter of the **first** 3 s.u. shelf.
OUTPUT / ⏚	Test points to measure the level of the high-frequency signal after the reception filter of the **first** 3 s.u. shelf.

HIPU (HF HYBRID)

0.1 V_{LINE} / ⏚	Test points to measure the **output** level of the high-frequency signal of the **first** 3 s.u. shelf attenuated in approximately **20** dB with respect to the line signal level.
C	Element to adjust the **capacitive** component of the high-frequency hybrid of the **first** 3 s.u. shelf. The adjustment is made by **MI1** microswitches **1** to **8**. The position **1** corresponds to open circuit.
R	Element to adjust the **resistive** component of the high-frequency hybrid of the **first** 3 s.u. shelf. The adjustment is made by potentiometer **P1**.
L	Elements to adjust the **inductive** component of the high-frequency hybrid of the **first** 3 s.u. shelf. - **Thickness adjustment.** It is made by rotating microswitch **MI3** of five positions. The position **0** corresponds to open circuit. - **Fine adjustment.** It is made by inductance **TF3**. It is advised to use a flat-headed screwdriver. The inductance increases when the control is turned clockwise.

5.1.8 OPU-1 with additional filter (6 s.u. shelf)



a) FAPU b) MOPU c) MQPU

Figure 5.6 Front view of main modules (6 s.u. shelf).

FAPU (POWER SUPPLY)

POWER ON	**Green**. This LED lights to indicate the power-supply module is operative.
POWER FAIL	**Red**. This LED lights to indicate power-supply module faulty.

MOPU (CENTRAL MANAGEMENT & SIGNAL PROCESSING UNIT)

HANDSET	**Jack** for plugging-in the handset for the whole-band service telephony, in the corresponding analog channel. When the terminal receives a call and the handset is plugged-in, the buzzer rings. It is used as long as the equipment does not have the optional **IOPU** module installed. In that case, the HANDSET of the **IOPU** module must be used.
LOCAL LOOP	**Yellow**. This LED lights to indicate that the loop has been carried out in the corresponding analog channel (**CH1** or **CH2**) of the local terminal.
REMOTE LOOP	**Yellow**. This LED lights to indicate that the loop has been carried out in the corresponding analog channel (**CH1** or **CH2**) of the remote terminal.
LOW S/N	**Red**. This LED lights to indicate, in the corresponding analog channel (**CH1** or **CH2**), that the signal/noise (S/N) ratio is less than the predetermined value.
PILOT	**Red**. This LED lights in reception to indicate a loss of receive pilot in the corresponding analog channel (**CH1** or **CH2**).
BOOSTING	**Yellow**. This LED lights to indicate that a power-boosting command is been given in the corresponding analog channel (**CH1** or **CH2**). It is used as long as the equipment does not have the optional **IOPU** module installed. In that case, the BOOSTING LED of the **IOPU** module must be used.
GENERAL ALARM	**Red**. This LED lights to indicate that an alarm is being given in the local terminal (**LOC**) or remote terminal (**REM**). The LED remains lit during the alarm situation *(Power-supply failure, Amplifier overload, Low output level in amplifier, Loss of synchronism, Pilot loss, Low Signal/Noise ratio, AF limiter operation in analog channel, Temperature alarm, Terminal configuration error, Hardware failure, BER alarm in digital channel, Excessive or low reception level in digital channel).* This LED flashes in case of alarm for *Terminal configuration error* or *Hardware failure*.
SYNCHRONISM	**Red**. This LED lights to indicate loss of synchronism in the terminal. It is only useful for operation with synchronism.
STATUS	**Three-colour**. This LED lights in **red** when the module is starting up. If the start-up is correct, this LED lights in **green**. However, if a configuration error alarm is detected, this LED remains **red**. This LED flashes in **yellow** when a data loading is being carried out.

CALL	This **button** when pressed it activates the **M** wire, in the corresponding analog channel. It is used as long as the equipment does not have the optional **IOPU** module installed. In that case, the CALL button of the **IOPU** module must be used.
CHANNEL SEIZURE / MONITORING	This **switch** permits the seizure of the analog whole-band channel for service telephony when changing from the **MONITORING** position to **CHANNEL SEIZURE**, with the handset plugged-in. When the channel is seized, the terminal deactivates all the audio-frequency inputs and allocates the whole-band for service telephony. It is used as long as the equipment does not have the optional **IOPU** module installed. In that case, the switch of the **IOPU** module must be used.
IRIG-B	**BNC** connector that allows the **OPU-1** terminal to be connected to a GPS time equipment in order to guarantee time synchronization.
10/100 BASE-TX	**RJ-45** 8-pin female connector that allows the **OPU-1** terminal to be connected to the management computer. It also admits the SNTP synchronization.

MQPU (DIGITAL MODEM)

STATUS	**Three-colour**. This LED lights in **red** when the module is starting up. If the start-up is correct, this LED lights in **green**. However, if a configuration error alarm is detected, this LED remains **red**. This LED flashes in **yellow** when a data loading is being carried out.
SYNCHRONISM LOSS	**Red**. This LED lights to indicate that the module has lost the frame synchronism, either because of excessive noise level in the channel or because broken link.
BER >10^{-3}	**Yellow**. This LED lights to indicate that the error rate evaluated by the system is higher than the maximum error rate permitted. The link could be interrupted if the error rate does not improve.
BER >10^{-6}	**Yellow**. This LED lights to indicate that the system is not working in optimum conditions. It is considered to be a preventive alarm.
LOW RCV LEVEL	**Red**. This LED lights to indicate that pilot level is lower than the threshold specified.
EXCESSIVE RCV LEVEL	**Red**. This LED lights to indicate that pilot level is higher that the threshold specified.
10/100 BASE-TX (ETH 1)	**RJ-45** 8-pin female connector that supports the Ethernet user interface. The **ETH1** & **ETH2** Ethernet interfaces work as a part of a two-port hub. The Ethernet ports have bridge-link functionality.
10/100 BASE-TX (ETH 2)	**RJ-45** 8-pin female connector that supports the Ethernet user interface. The **ETH1** & **ETH2** Ethernet interfaces work as a part of a two-port hub. The Ethernet ports have bridge-link functionality.

PORTS	Block of four **LEDs** associated with the module ports (**1** and **2**). - **ACTIVE** **Green**. This LED lights to indicate that the port is programmed and activated. When remains off it indicates that the port is blocked or non-programmed. - **LOOP** **Yellow**. This LED lights to indicate that a data loop has been programmed in the port.
V.24	**SUB-D** 9-pin female connector that supports **V.24** signals associated with port **2**.
G.703	**RJ-45** 8-pin female connector that supports **G.703** signals associated with port **1**.

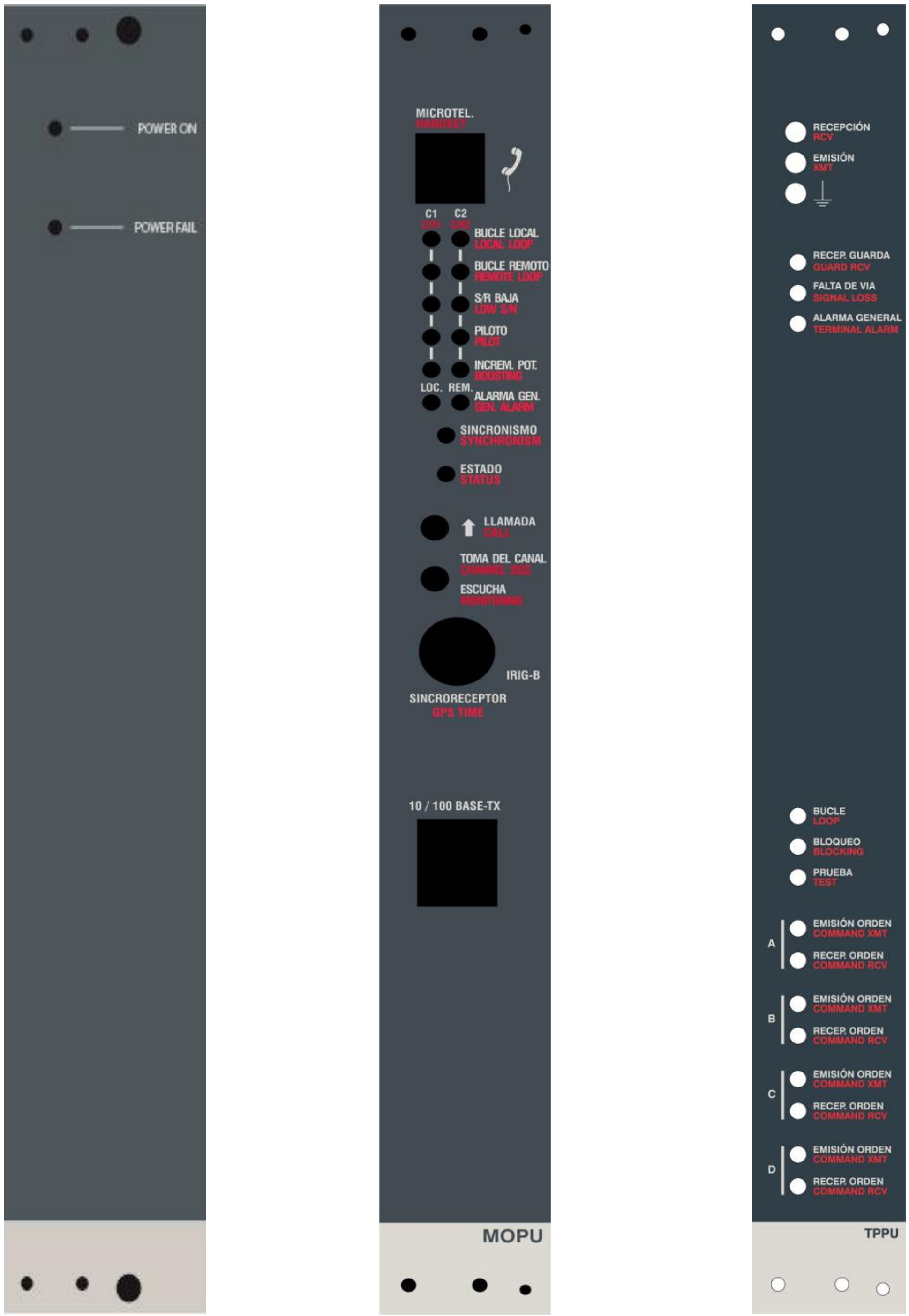
5.1.9 OPU-1 for HF Teleprotection (3 s.u. shelf)

Figure 5.7 Detail of the elements accessible from the front of the 3 s.u. shelf of the OPU-1 of 20 W & 40 W for HF Teleprotection functionality.

TAPU (LINE FILTER & HF HYBRID)

INPUT / ⏚	Test points to measure the **reception** level.
RECEIVE LEVEL	Element for **reception** adjustment. It is made by potentiometer **P3**.
0.1 V_{LINE} / ⏚	Test points to measure the **output** level of the high-frequency signal attenuated in approximately **20** dB with respect to the line signal level.
C	Element to adjust the **capacitive** component of the high-frequency hybrid. The adjustment is made by **MI2** microswitches **1** to **10**. The position **1** corresponds to open circuit.
R	Element to adjust the **resistive** component of the high-frequency hybrid. The adjustment is made by potentiometer **P1**.
L	Elements to adjust the **inductive** component of the high-frequency hybrid. - **Thickness adjustment.** It is made by rotating microswitch **CM5** of five positions. The position **0** corresponds to open circuit. - **Fine adjustment.** It is made by inductance **TF1**. It is advised to use a flat-headed screwdriver. The inductance increases when the control is turned clockwise.

5.1.10 OPU-1 for HF Teleprotection (6 s.u. shelf)



a) FAPU   b) MOPU   c) TPPU

Figure 5.8 Front view of main modules (6 s.u. shelf).

FAPU (POWER SUPPLY)

POWER ON	**Green**. This LED lights to indicate the power-supply module is operative.
POWER FAIL	**Red**. This LED lights to indicate power-supply module faulty.

MOPU (CENTRAL MANAGEMENT & SIGNAL PROCESSING UNIT)

HANDSET	Not used.
LOCAL LOOP	**Yellow**. This LED lights to indicate that the loop has been carried out in the local terminal.
REMOTE LOOP	**Yellow**. This LED lights to indicate that the loop has been carried out in the remote terminal.
LOW S/N	**Red**. This LED lights to indicate that the signal/noise (S/N) ratio in the channel is less than the predetermined value.
PILOT	**Red**. This LED lights in reception to indicate a loss of receive pilot in the channel.
BOOSTING	**Yellow**. This LED lights to indicate that a power-boosting command is been given.
GENERAL ALARM	**Red**. This LED lights to indicate that an alarm is being given in the local terminal (**LOC**) or remote terminal (**REM**). The LED remains lit during the alarm situation *(Power-supply failure, Amplifier overload, Low output level in amplifier, Loss of synchronism, Pilot loss, Low Signal/Noise ratio, Temperature alarm, Terminal configuration error, Hardware failure).* This LED flashes in case of alarm for *Terminal configuration error* or *Hardware failure*.
SYNCHRONISM	**Red**. This LED lights to indicate loss of synchronism.
STATUS	**Three-colour**. This LED lights in **red** when the module is starting up. If the start-up is correct, this LED lights in **green**. However, if a configuration error alarm is detected, this LED remains **red**. This LED flashes in **yellow** when a data loading is being carried out.
CALL	Not used.
CHANNEL SEIZURE / MONITORING	Not used.
IRIG-B	**BNC** connector that allows the **OPU-1** terminal to be connected to a GPS time equipment in order to guarantee time synchronization.
10/100 BASE-TX	**RJ-45** 8-pin female connector that allows the **OPU-1** terminal to be connected to the management computer. It also admits the SNTP synchronization.

TPPU (TELEPROTECTION BY DUAL TONE)

RCV / ⏚	Tests points to measure the **receive** signal level after being band limited. **315** mV_{rms} ±10% should be obtained for guard level at 30% modulation and command level at 90% modulation in the remote terminal.
XMT / ⏚	Tests points to measure the level of the signal **sent** to the line after level adjustment. **390** mV_{rms} ±10% should be obtained for guard level at 30% modulation and command level at 90% modulation.
GUARD RCV	**Green**. This LED remains off while the received guard-signal level is not within the pre-set nominal values. That is, when the received level exceeds the nominal level by **6** dB or when it is **5** dB below this level.
SIGNAL LOSS	**Red**. This LED lights to indicate alarm when: - in normal operating conditions, the received guard signal is below the pre-set minimum level considered as disappearance of guard signal and **50** ms have elapsed without having received a command signal. - after the powering up of the terminal, no signal is received for more than **500** ms. In both cases, the receiver is blocked.
TERMINAL ALARM	**Red**. This LED lights to indicate an alarm situation (*Blocking of the receiver, Signal loss, Low Signal/Noise ratio, Incorrect guard-signal level, Local test failure, Device error, Manual blocking, Erroneous configuration data*).
LOOP	**Yellow**. This LED lights to indicate that a loop is being carried out.
BLOCKING	**Red**. This LED lights to indicate that the receiver is blocked. This LED also lights when the output circuits are blocked from the Management System.
TEST	**Two-colour**. This LED lights in **green** when the result of the local-loop test is satisfactory, and in **red** when the test is unsatisfactory.
COMMAND XMT	**Yellow**. There are four LEDs, one for each of the four commands (**A**, **B**, **C** and **D**). The LED lights to indicate command transmission.
COMMAND RCV	**Yellow**. There are four LEDs, one for each of the four commands (**A**, **B**, **C** and **D**). The LED lights to indicate command reception.

5.2 Front elements of the 6 s.u. optional modules

5.2.1 Built-in multiplexer modules

5.2.1.a DMPU

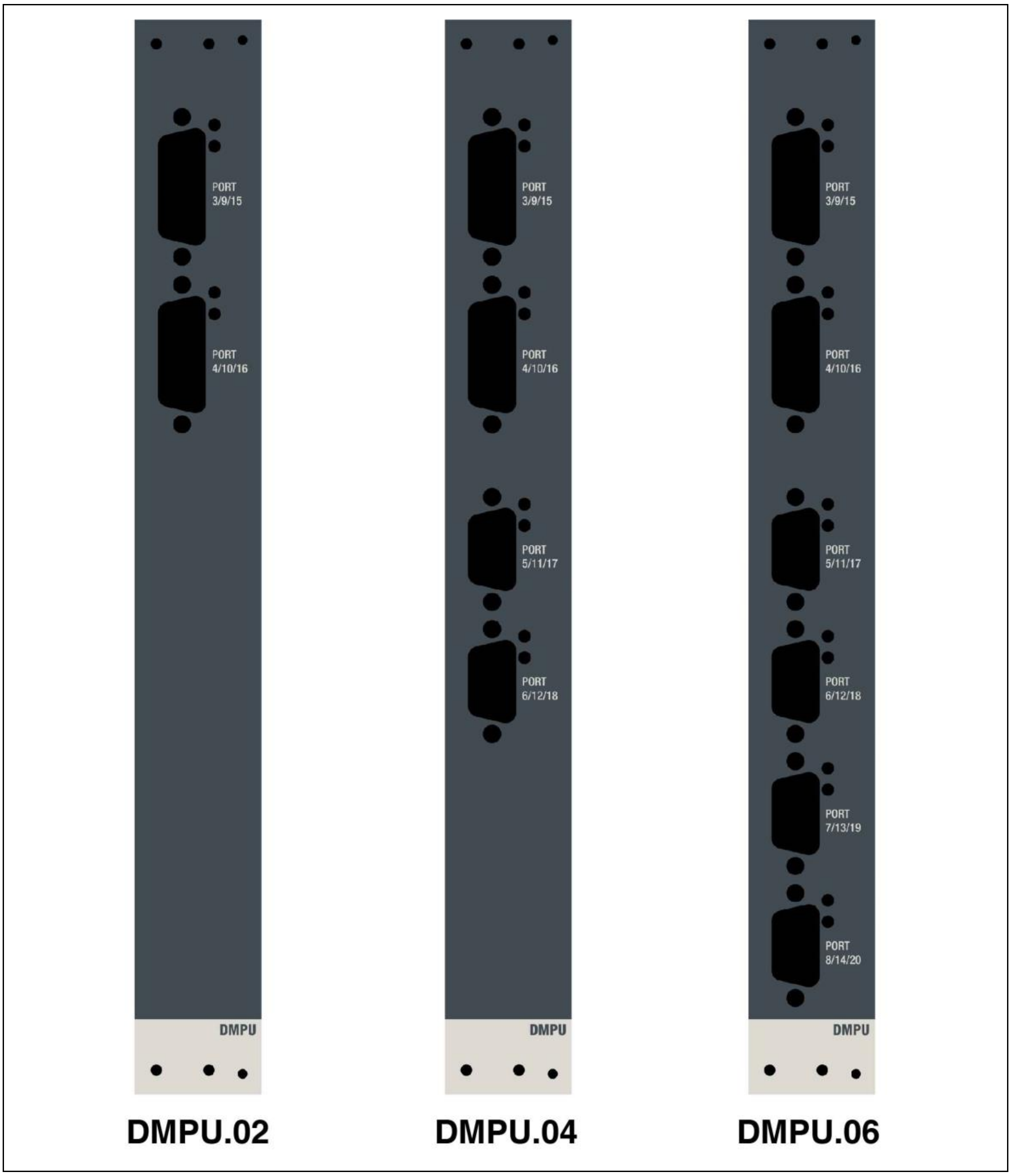


Figure 5.9 **Front views of the differents types of DMPU with connection at the front.**

DMPU (DATA PORTS WITH CONNECTION AT THE FRONT)

Each of the ports has two LEDs associated (higher & lower).

Higher LED	**Yellow**. This LED lights to indicate the transmission of a logical “0” in the **TD** line.
Lower LED	**Yellow**. This LED lights to indicate the reception of a logical “0” in the **RD** line.

The higher & lower LEDs flash ***alternatively*** *(timing of* ***0.5*** *s /* ***0.5*** *s) when a data loop is programmed in the port.*

The higher & lower LEDs light ***simultaneously*** *(timing of* ***0.2*** *s /* ***0.2*** *s) in case of port disabling or port without programming.*

5.2.1.b DMPU (rear ports)

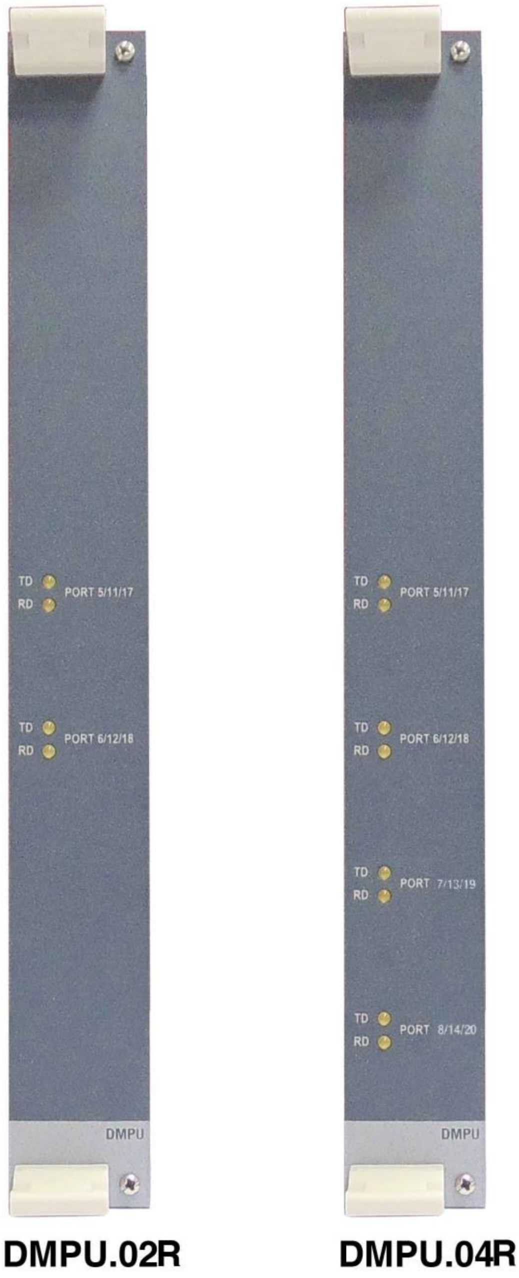


Figure 5.10 Front views of the differents types of DMPU with connection at the rear.

DMPU (DATA PORTS WITH CONNECTION AT THE REAR)

Each of the ports has two LEDs associated (TD & RD).

TD	**Yellow**. This LED lights to indicate the transmission of a logical “0” in the **TD** line.
RD	**Yellow**. This LED lights to indicate the reception of a logical “0” in the **RD** line.

*The TD & RD LEDs flash **alternatively** (timing of **0.5** s / **0.5** s) when a data loop is programmed in the port.*

*The TD & RD LEDs light **simultaneously** (timing of **0.2** s / **0.2** s) in case of port disabling or port without programming.*

5.2.1.c TMPU

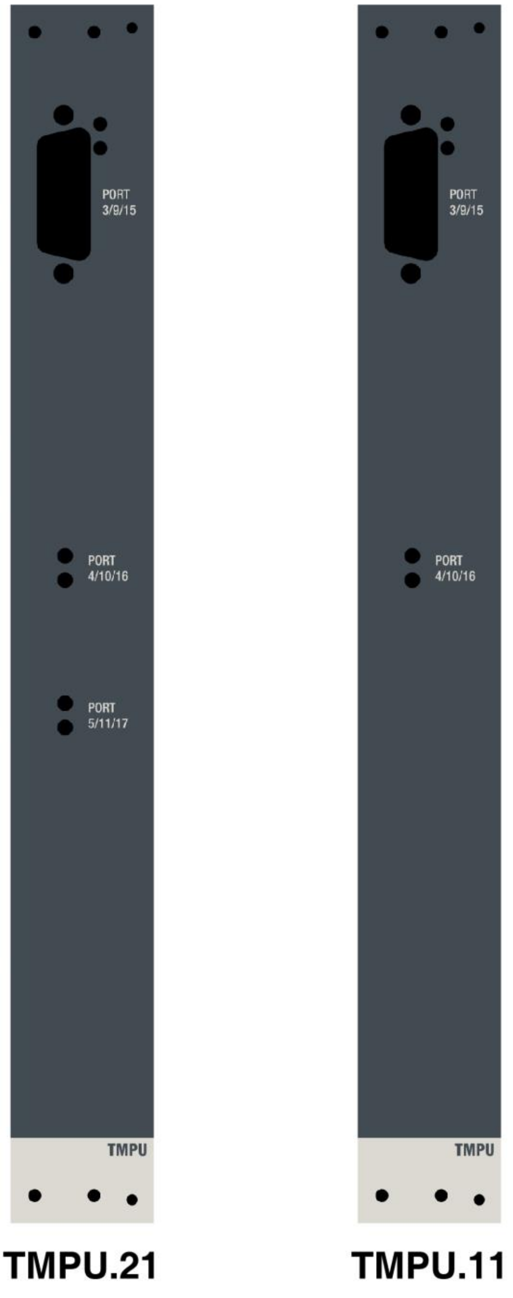


Figure 5.11 Front views of the differents types of TMPU.

TMPU (SPEECH PORTS & DATA PORT)

Each speech port has two LEDs associated (higher & lower).

There also two LEDs (higher & lower) next to the data port connector.

Higher LED (speech)	**Yellow**. This LED lights to indicate the **M**-wire activation.
Lower LED (speech)	**Yellow**. This LED lights to indicate the **E**-wire activation
Higher LED (data)	**Yellow.** This LED lights to indicate the transmission of a logical “0” in the **TD** line.
Lower LED (data)	**Yellow.** This LED lights to indicate the reception of a logical “0” in the **RD** line.

*The higher & lower LEDs flash **alternatively** (timing of **0.5** s / **0.5** s) when a data loop is programmed in the data port.*

*The higher & lower LEDs light **simultaneously** (timing of **0.2** s / **0.2** s) in case of port disabling or port without programming.*

5.2.2 Built-in teleprotection modules

5.2.2.a TPPU

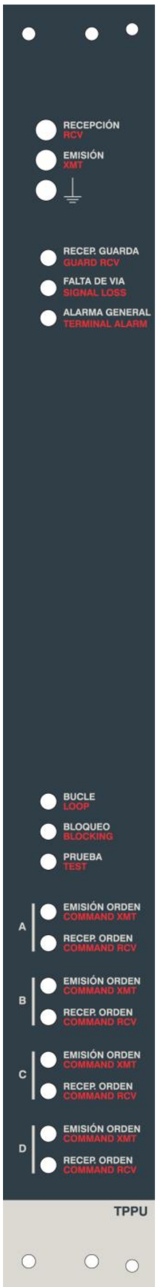


Figure 5.12 TPPU module front view.

TPPU (TELEPROTECTION BY SINGLE / DUAL TONE)

RCV / ⏚ : Test points to measure the **receive** signal level after being band limited.	
- **Single tone (analog band)**: **210** mV_{rms} ±10% should be obtained for guard level at 20% modulation and command level at 90% modulation in the remote terminal. - **Dual tone (analog band)**: **315** mV_{rms} ±10% should be obtained for guard level at 30% modulation and command level at 90% modulation in the remote terminal.	- **Single and dual tone (digital band)**: **35** mV_{rms} ±5%.

XMT / ⏚ : Test points to measure the level of the signal **sent** to the line after level adjustment.	
- **Single tone (analog band)**: **260** mV_{rms} ±10% should be obtained for guard level at 20% modulation and command level at 90% modulation. - **Dual tone (analog band)**: **390** mV_{rms} ±10% should be obtained for guard level at 30% modulation and command level at 90% modulation.	- **Single tone (digital band)**: **270** mV_{rms} ±10%.

GUARD RCV	**Green**. This LED remains off while the received guard-signal level is not within the pre-set nominal values. That is, when the received level exceeds the nominal level by **6** dB or when it is **5** dB below this level.
SIGNAL LOSS	**Red**. This LED lights to indicate alarm when: - in normal operating conditions, the received guard signal is below the pre-set minimum level considered as disappearance of guard signal and **50** ms have elapsed without having received a command signal. - after the powering up of the terminal, no signal is received for more than **500** ms. In both cases, the receiver is blocked.
TERMINAL ALARM	**Red**. This LED lights to indicate an alarm situation (*Blocking of the receiver, Signal loss, Low Signal/Noise ratio, Incorrect guard-signal level, Local test failure, Device error, Manual blocking, Erroneous configuration data*).
LOOP	**Yellow**. This LED lights to indicate that a loop is being carried out.
BLOCKING	**Red**. This LED lights to indicate that the receiver is blocked. This LED also lights when the output circuits are blocked from the Management System.

TEST	**Two-colour**. This LED lights in **green** when the result of the local-loop test is satisfactory, and in **red** when the test is unsatisfactory.
COMMAND XMT	**Yellow**. There are four LEDs, one for each of the four commands (**A**, **B**, **C** and **D**). The LED lights to indicate command transmission.
COMMAND RCV	**Yellow**. There are four LEDs, one for each of the four commands (**A**, **B**, **C** and **D**). The LED lights to indicate command reception.

5.2.2.b REPU

REPU (AUXILIARY OUTPUTS FOR SIGNALLING & ALARM)

This module does not have elements accessible from the front.

5.2.3 Other optional modules

5.2.3.a IOPU.01 (one channel)

Figure 5.13 IOPU.01 module front view.

IOPU.01 (CH1 BASEBAND ANALOG INPUT/OUTPUT INTERFACE)

BOOSTING	**Green**. This LED lights to indicate that a power-boosting command is been given in the analog channel (**CH1**). It has priority against the BOOSTING LED of the **MOPU** module.
CALL	This **button** when pressed it activates the **M** wire, in the analog channel (**CH1**). It has priority against the CALL button of the **MOPU** module.
HANDSET	**Jack** for plugging-in the handset for the whole-band service telephony, in the analog channel (**CH1**). When the terminal receives a call and the handset is plugged-in, the buzzer rings. It has priority against the HANDSET of the **MOPU** module.
CHANNEL SEIZURE / MONITORING	This **switch** permits the seizure of the analog whole-band channel (**CH1**) for service telephony when changing from the **MONITORING** position to **CHANNEL SEIZURE**, with the handset plugged-in. When the channel (**CH1**) is seized, the terminal deactivates all the audio-frequency inputs and allocates the whole-band for service telephony. It has priority against the switch of the **MOPU** module.
XMT	**Green**. This LED lights to indicate that the **M**-wire is activated in the analog channel (**CH1**). That is, when a call is being transmitted.
RCV	**Green**. This LED lights to indicate that the **E**-wire is activated in the analog channel (**CH1**). That is, when a call is being received.

5.2.3.b IOPU.02 (two channels)

Figure 5.14 IOPU.02 module front view.

IOPU.02 (CH1 & CH2 BASEBAND ANALOG INPUT/OUTPUT INTERFACE)

BOOSTING	**Green**. This LED lights to indicate that a power-boosting command is been given in the analog channel (**CH1 / CH2**). It has priority against the BOOSTING LED of the **MOPU** module.
XMT **(signalling channel 2)**	**Green**. This LED lights to indicate that the **M**-wire is activated in the analog channel (**CH2**). That is, when a call is being transmitted.
RCV **(signalling channel 2)**	**Green**. This LED lights to indicate that the **E**-wire is activated in the analog channel (**CH2**). That is, when a call is being received.
CHANNEL SEIZURE / MONITORING **(signalling channel 2)**	This **switch** permits the seizure of the analog whole-band channel (**CH2**) for service telephony when changing from the **MONITORING** position to **CHANNEL SEIZURE**, with the handset plugged-in. When the channel (**CH2**) is seized, the terminal deactivates all the audio-frequency inputs and allocates the whole-band for service telephony. It has priority against the switch of the **MOPU** module.
HANDSET **(signalling channel 2)**	**Jack** for plugging-in the handset for the whole-band service telephony, in the analog channel (**CH2**). When the terminal receives a call and the handset is plugged-in, the buzzer rings. It has priority against the HANDSET of the **MOPU** module.
CALL	This **button** when pressed it activates the **M** wire, in the corresponding analog channel (**CH1 / CH2**). It has priority against the CALL button of the **MOPU** module.
HANDSET **(signalling channel 1)**	**Jack** for plugging-in the handset for the whole-band service telephony, in the analog channel (**CH1**). When the terminal receives a call and the handset is plugged-in, the buzzer rings. It has priority against the HANDSET of the **MOPU** module.
CHANNEL SEIZURE / MONITORING **(signalling channel 1)**	This **switch** permits the seizure of the analog whole-band channel (**CH1**) for service telephony when changing from the **MONITORING** position to **CHANNEL SEIZURE**, with the handset plugged-in. When the channel (**CH1**) is seized, the terminal deactivates all the audio-frequency inputs and allocates the whole-band for service telephony. It has priority against the switch of the **MOPU** module.
XMT **(signalling channel 1)**	**Green**. This LED lights to indicate that the **M**-wire is activated in the analog channel (**CH1**). That is, when a call is being transmitted.
RCV **(signalling channel 1)**	**Green**. This LED lights to indicate that the **E**-wire is activated in the analog channel (**CH1**). That is, when a call is being received.

5.2.3.c FAPX

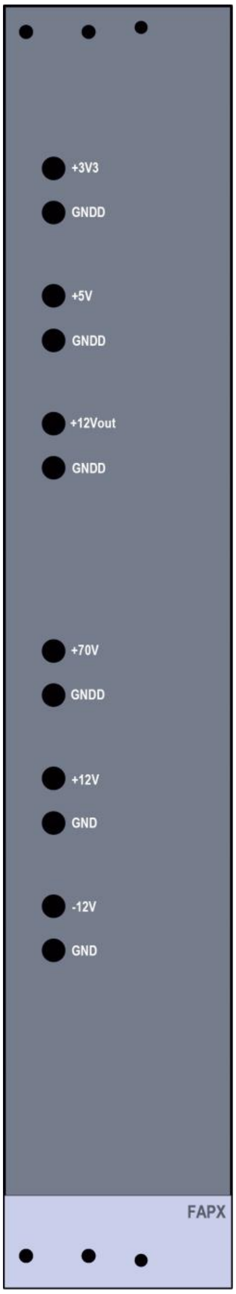


Figure 5.15 FAPX module front view.

FAPX (POWER SUPPLY TEST POINTS)

+3V3 / GNDD	Test points to measure the **+3V3** voltage given by the main **FAPU** module to power the **digital** circuitry.
+5V / GNDD	Test points to measure the **+5V** voltage given by the main **FAPU** module to power the **digital** circuitry.
+12V$_{out}$ / GNDD	Test points to measure the **+12V$_{out}$** voltage given by the main **FAPU** module to power the **relays**.
+70V / GNDD	Test points to measure the **+70V** voltage given by the main **FAPU** module to power the **high-frequency amplifier**.
+12V / GND	Test points to measure the **+12V** voltage given by the main **FAPU** module to power the **analog** circuitry.
-12V / GND	Test points to measure the **-12V** voltage given by the main **FAPU** module to power the **analog** circuitry.

5.2.3.d TDPU.20

Figure 5.16 TDPU.20 module front view.

TDPU.20 (SPEECH)

M WIRE	**Yellow**. This LED lights when the subscriber is off-hook (operation as subscriber termination) and when activation from the telephone exchange is received (operation as exchange-side 2-wire telephone termination).
E WIRE	**Yellow**. This LED lights to indicate that the **E**-wire is activated, that is, when a call is being received. With the handset connected, the buzzer is activated when a call is received.
2W	**Yellow**. This LED lights to indicate that the configurable termination is operating as exchange-side 2-wire termination.
T WIRE	**Red**. This LED lights to indicate that the link is unavailable. It is necessary to have previously defined by configuration this condition.
COMPANDOR	**Yellow**. This LED lights to indicate the inclusion of the compandor.
AF XMT / ⏚	Tests points to measure the **4**-wire transmit level of the configurable termination.
AF RCV / ⏚	Tests points to measure the **4**-wire receive level or **2**-wire signal level of the configurable termination.
INCLUSION / MONITORING	This **switch** permits to establish communication in the band assigned to speech when changing from the **MONITORING** position to **CHANNEL SEIZURE**, with the handset plugged-in. The microphone is connected to the emission circuit and communication is established.
HANDSET	**Jack** for plugging-in the handset associated with the band assigned to speech. When the handset is connected, the earpiece is connected to reception in the band assigned to speech.

5.2.3.e MFPU

Figure 5.17 MFPU module front view.

MFPU (ASYNCHRONOUS PROGRAMMABLE MODEM)

CONFIGURATION MICROSWITCH (1 to 10)
- **Microswitch 1**: Selection of the operation mode. **ON**: Full-duplex transmission. **OFF**: Half-duplex transmission. - **Microswitches 2, 3 & 4**: Selection of the delay between the **RTS** and **CTS** signals. See Table 5.1. - **Microswitch 5**: Activation of the data loop. **ON**: data loop. **OFF**: normal operation. - **Microswitch 6:** Activation of the line loop. **ON**: line loop. **OFF**: normal operation. - **Microswitch 7:** Activation mode of the **RTS** signal. **ON**: permanently. **OFF**: according to interface. - **Microswitch 8:** Selection of the reception-blocking condition. **ON**: permanent. **OFF**: by means of **CD** signal (carrier loss). - **Microswitches 9 & 10**: Selection of the test signals. See Table 5.2. The **RTS** signal is generated internally and continuously in all test conditions.

Microswitch			RTS-CTS delay (ms)	
2	**3**	**4**	**50, 100 and 200 bit/s**	**600, 1200 and 2400 bit/s**
ON	ON	ON	30	10
OFF	ON	ON	60	20
ON	OFF	ON	90	30
OFF	OFF	ON	120	40
ON	ON	OFF	150	50
OFF	ON	OFF	180	60
ON	OFF	OFF	210	70
OFF	OFF	OFF	240	80

Table 5-1: RTS-CTS delay selection

Microswitch		Description
9	**10**	
OFF	OFF	Normal operation
ON	OFF	Continuous sending of a logical level "1"
OFF	ON	Continuous sending of alternate sequence of "0" and "1"
ON	ON	Continuous sending of a logical level "0"

Table 5-2: Test-signal selection

INTERFACE SIGNALS	
- **TD /103. Yellow.** This LED lights to indicate data input. - **RD / 104. Yellow.** This LED lights to indicate data output. - **RTS / 105. Yellow.** This LED lights to indicate that the signal of request to transmit is in active state. - **CTS / 106. Yellow.** This LED lights to indicate that the signal of modem is ready to transmit is in active state. - **DSR / 107. Yellow.** This LED lights to indicate that the modem is working correctly. - **CD / 109. Yellow.** This LED lights to indicate that the level of the line signal (carrier) is above a pre-set level. If not, it remains off.	
TEST	**Yellow**. This LED lights to indicate a test (sending of signals or loops) is being carried out in the modem.
AUX	**Yellow**. This LED must always be off. If it lights, check if microswitch **1** is in the **OFF** position.
STATUS	**Three-colour**. This LED lights in **green** to indicate that there are no alarms. If there is general alarm, this LED lights permanently in **red**. That is, when the level of the received signal falls in **14** dB below the nominal level. It must be taken into account that there is an hysteresis of **3** dB. This LED flashes in **red** to indicate incorrect configuration. This LED lights in **yellow** when the firmware is being upgraded.
DATA LOOP	**Yellow.** This LED lights to indicate that a data loop is being carried out.
LINE LOOP	**Yellow.** This LED lights to indicate that a line loop is being carried out.
XMT MEASUREMENT/ ⏚	Test points to measure the signal level in transmission. **12** V_{pp} should be obtained when the modem is transmitting.
RCV MEASUREMENT/ ⏚	Test points to measure the signal level in reception. **0.5** V_{pp} should be obtained if the transmission and reception modulation percentages are coherent.

5.2.3.f FTPU

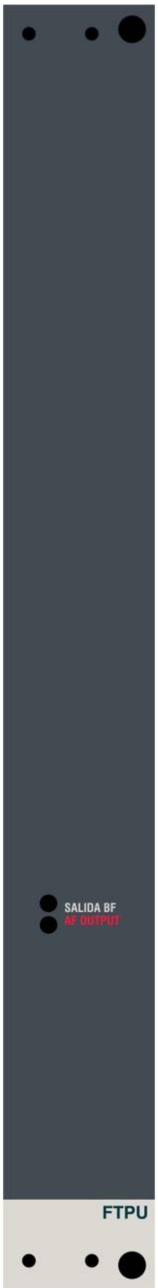


Figure 5.18 FTPU module front view.

FTPU (VFT TRANSIT FILTER)

AF OUTPUT	Test points to measure the VFT-signal output level.

5.2.3.g FDPU

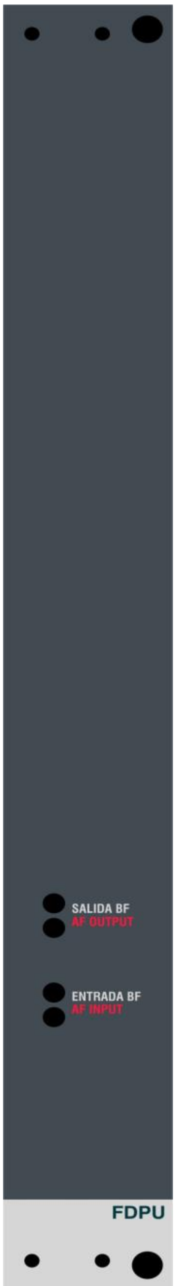


Figure 5.19 FDPU module front view.

FDPU (DIGITAL TRANSIT FILTER)

AF OUTPUT	Test points to measure the VFT-signal output level.
AF INPUT	Test points to measure the VFT-signal input level.

5.2.3.h EYPU

Figure 5.20 EYPU module front view.

EYPU (INPUT/OUTPUT COMBINER)

INPUTS	Test points to measure the signal level of each of the additional inputs (**1**, **2**, **3** and **4**). Note that inputs are balanced.
OUTPUTS	Test points to measure the signal level of each of the additional outputs (**1**, **2**, **3** and **4**). Note that outputs are balanced.

5.3 Internal settings of the main modules

5.3.1 MOPU

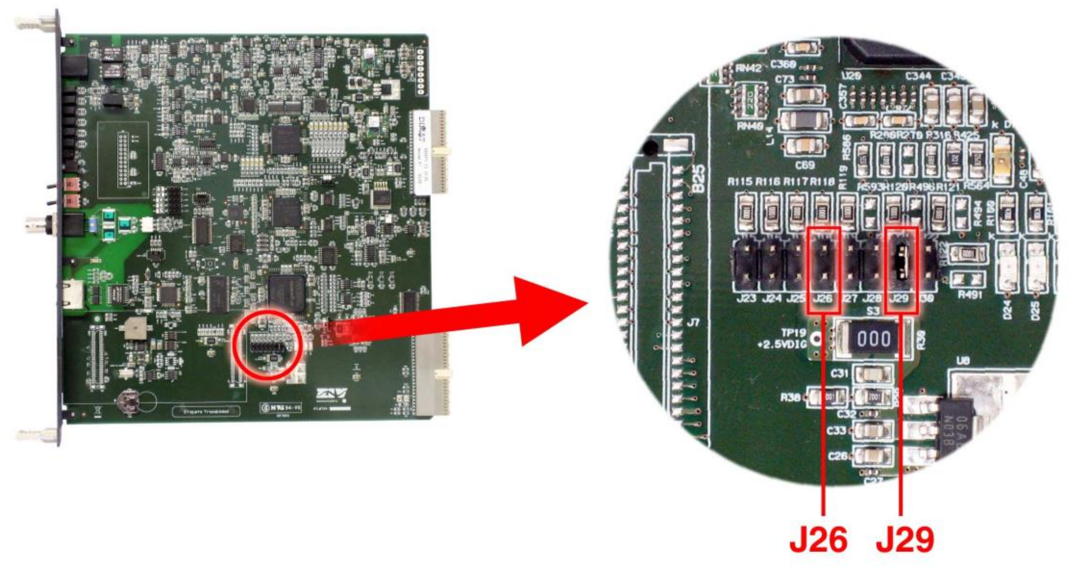


Figure 5.21 Location of the MOPU internal settings.

MOPU (CENTRAL MANAGEMENT & SIGNAL PROCESSING UNIT)

The **MOPU** module has two internal jumpers: **J29** & **J26**.

J29	**Jumper**. Configures the presence of the digital modem (**MQPU**) module into the equipment. • **Linked.** The digital modem (**MQPU**) module is installed. • **Not linked.** The digital modem **(MQPU)** module is **NOT** installed.
J26	**Jumper**. When set, the default IP address and the default user passwords are loaded on the terminal.

*The IP address programmed in factory is the **172.16.20.24** or the **172.16.20.25**.*

The default user passwords of the system are indicated in Table 5.3.

	User identification	Password
Basic User	basic	basic **or** Basic@01
Administrator User	admin	admin **or** Admin@01

Table 5-3: Default user passwords of the system

5.3.2 MQPU

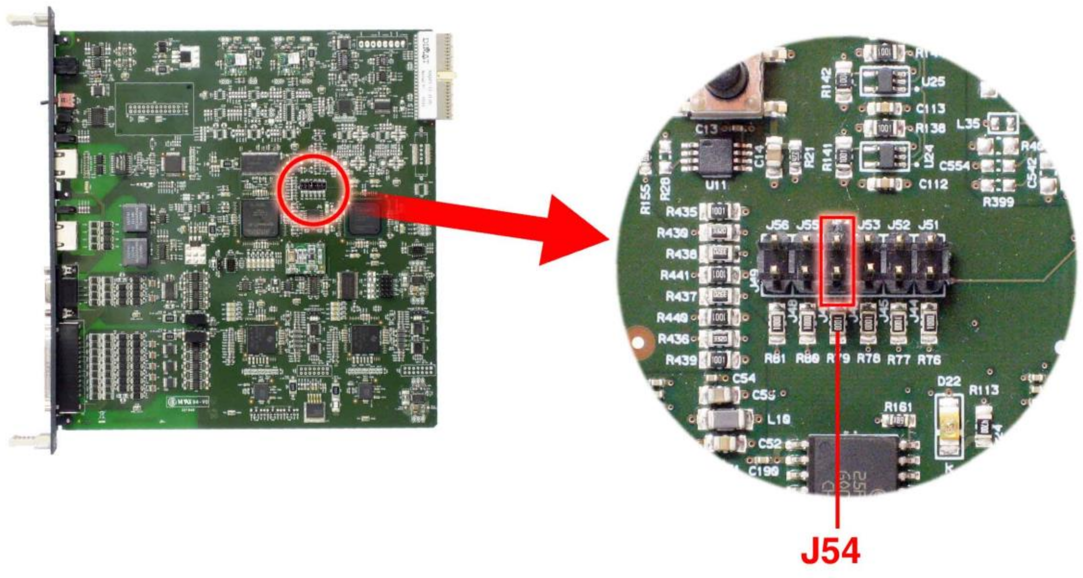


Figure 5.22 Location of the MQPU internal settings.

MQPU (DIGITAL MODEM)

The **MQPU** module has an internal jumper: **J54**.

J54	**Jumper**. Configures the digital modulation scheme which **MQPU** module works with. • **Linked.** OFDM/OQAM. • **Not linked.** QAM.

5.3.3 RXPU

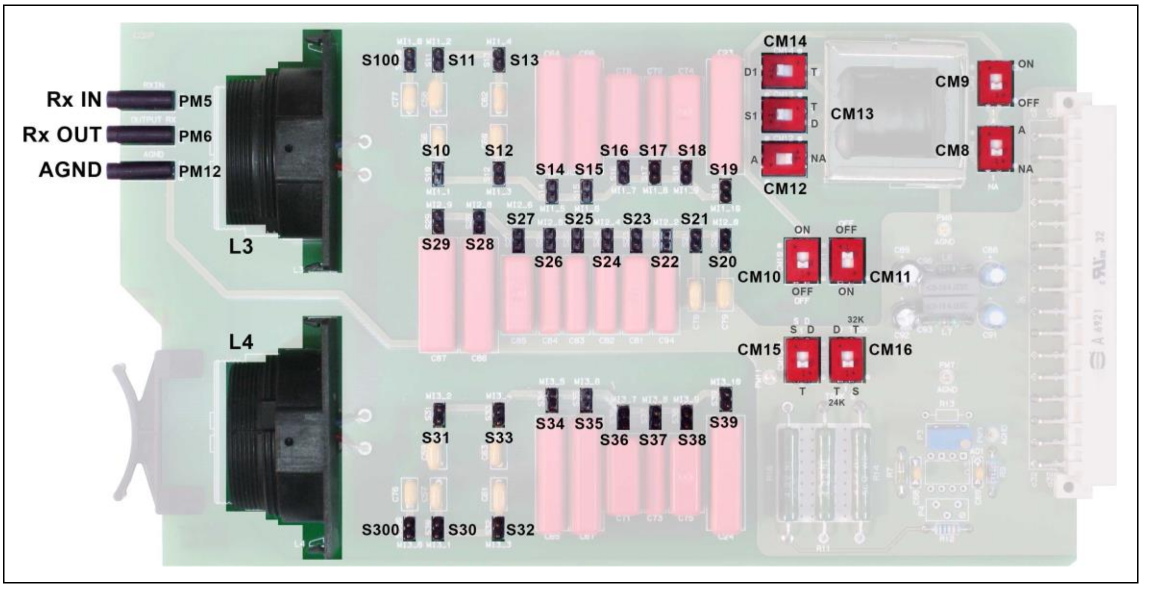


Figure 5.23 Location of the RXPU internal settings.

RXPU (RECEPTION FILTER from 40 kHz to 500 kHz)

The **RXPU** module has internal jumpers and switches: **S100**, **S300**, **S10** to **S39**, **CM8** to **CM16.**

The jumpers to carry out in the **RXPU** module according to **Rx** frequency are described in section 6.5.1.a, *Jumpers in RXPU*, of chapter 6, *Commissioning*.

S100 & **S10** to **S19** of inductance **L3**	**Jumpers.** Used to carry out the adjustment of the input resonance circuit.
S300 & **S30** to **S39** of inductance **L4**	**Jumpers.** Used to carry out the adjustment of the output resonance circuit.
S20 to **S29**	**Jumpers.** Used to select the central frequency of the line filter.

Each jumper connects a different capacitor.

CM8 & **CM12**	**Switches**. Exclusion of the HF hybrid. • **NA.** To exclude the HF hybrid. • **A.** Normal operation.
CM15 & **CM16**	**Switches**. Selection of the output impedance of the reception filter. • **S.** 8 kHz filter. • **D.** 16 kHz filter. • **T / T_{24K}.** 24 kHz filter.
CM13	**Switch**. It must always be in position **S**.
CM14	**Switch**. It must always be in position **D**.
CM9, **CM10** & **CM11**	**Switches**. Used to carry out L3/L4 adjustment and to exclude/include the reception filter.

	CM9	CM10	CM11
Receive filter included	ON	ON	ON
Receive filter excluded	OFF	ON	OFF
Adjustment of L3	ON	OFF	ON
Adjustment of L4	OFF	OFF	ON

Table 5-4: Configuration of CM9, CM10 & CM11 for L3/L4 adjustment and exclusion/inclusion of the reception filter

5.3.4 RXPR

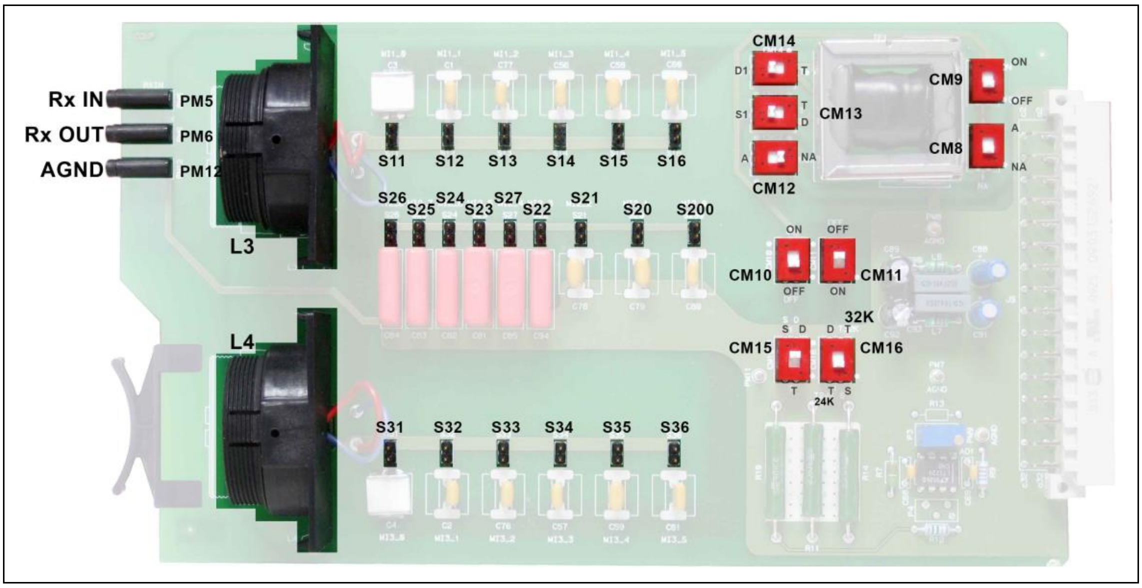


Figure 5.24 Location of the RXPR internal settings.

RXPR (RECEPTION FILTER from 500 kHz to 1 MHz)

The **RXPR** module has internal jumpers and switches: **S200**, **S11** to **S16**, **S20** to **S27**, **S31** to **S36**, **CM8** to **CM16**.

The jumpers to carry out in the **RXPR** module according to **Rx** frequency are described in section 6.5.1.b, *Jumpers in RXPR*, of chapter 6, *Commissioning*.

S11 to **S16** of inductance **L3**	**Jumpers.** Used to carry out the adjustment of the input resonance circuit.
S31 to **S36** of inductance **L4**	**Jumpers.** Used to carry out the adjustment of the output resonance circuit.
S200 & **S20** to **S27**	**Jumpers.** Used to select the central frequency of the line filter.

Each jumper connects a different capacitor.

CM8 & **CM12**	**Switches**. Exclusion of the HF hybrid. • **NA.** To exclude the HF hybrid. • **A.** Normal operation.
CM15 & **CM16**	**Switches**. Selection of the output impedance of the reception filter. • **S.** 8 kHz filter. • **D.** 16 kHz filter. • **T / T_{32K}.** 32 kHz filter.
CM13	**Switch**. It must always be in position **S**.
CM14	**Switch**. It must always be in position **D**.
CM9, **CM10** & **CM11**	**Switches**. Used to carry out L3/L4 adjustment and to exclude/include the reception filter.

	CM9	CM10	CM11
Receive filter included	ON	ON	ON
Receive filter excluded	OFF	ON	OFF
Adjustment of L3	ON	OFF	ON
Adjustment of L4	OFF	OFF	ON

Table 5-5: Configuration of CM9, CM10 & CM11 for L3/L4 adjustment and exclusion/inclusion of the reception filter

5.3.5 AFPU

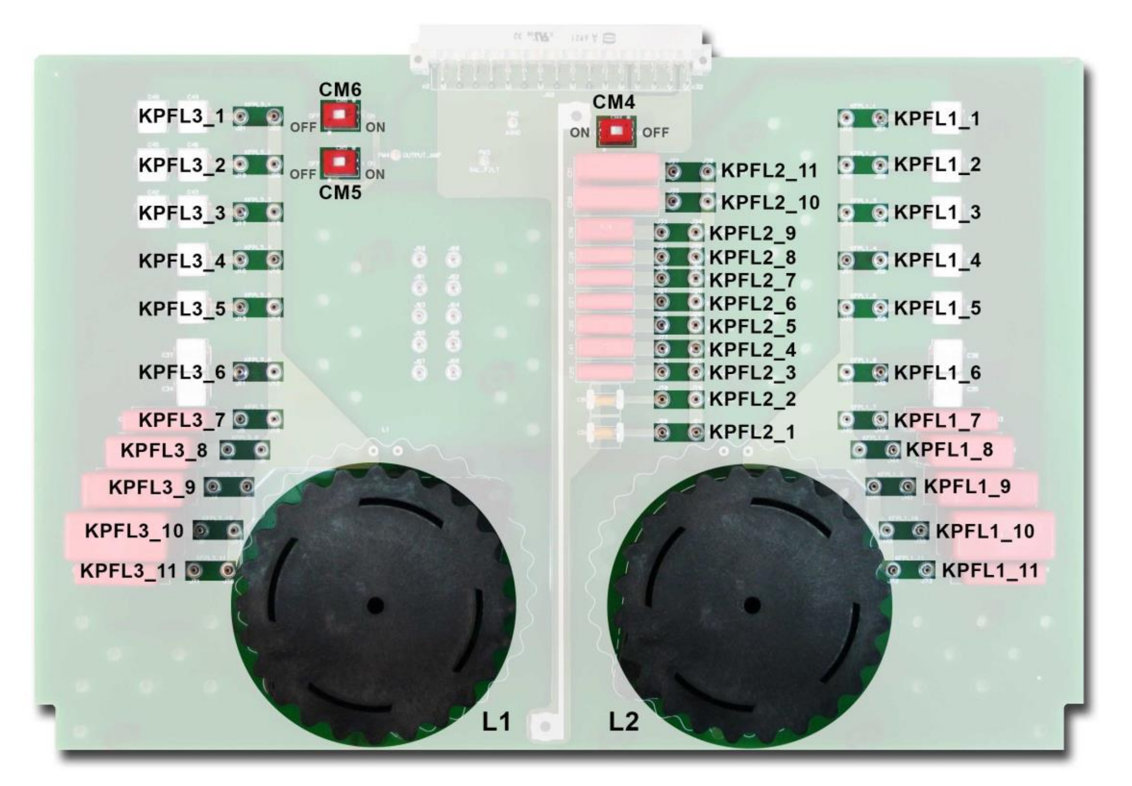


Figure 5.25 Location of the AFPU internal settings.

AFPU (LINE FILTER from 40 kHz to 500 kHz)

The **AFPU** module has internal jumpers and switches: **KPFL3_1** to **KPFL3_11, KPFL2_1** to **KPFL2_11, KPFL1_1** to **KPFL1_11, CM4** to **CM6.**

The jumpers to carry out in the **AFPU** module according to **Tx** frequency are described in section 6.5.3.a, *Jumpers in AFPU*, of chapter 6, *Commissioning*.

KPFL3_1 to **KPFL3_11** of inductance **L1**	**Jumpers.** Used to carry out the adjustment of the input resonance circuit.
KPFL1_1 to **KPFL1_11** of inductance **L2**	**Jumpers.** Used to carry out the adjustment of the output resonance circuit.
KPFL2_1 to **KPFL2_11**	**Jumpers.** Used to select the central frequency of the line filter.

Each jumper connects a different capacitor.

CM4, **CM5** & **CM6**	**Switches**. Used to carry out L1/L2 adjustment and to exclude/include the line filter.

	CM4	CM5	CM6
Line filter included	ON	ON	OFF
Line filter excluded	OFF	OFF	OFF
Adjustment of L2	ON	OFF	OFF
Adjustment of L1	OFF	ON	ON

Table 5-6: Configuration of CM4, CM5 & CM6 for L1/L2 adjustment and exclusion/inclusion of the line filter

5.3.6 AFPR

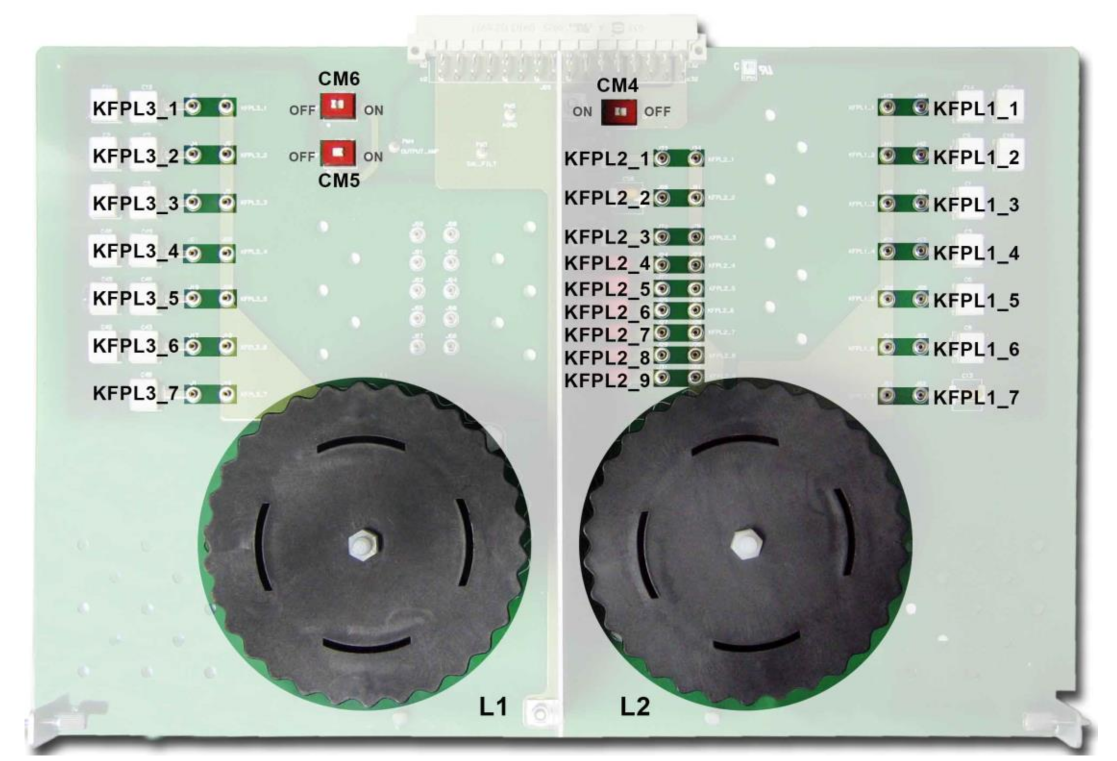


Figure 5.26 Location of the AFPR internal settings.

AFPR (LINE FILTER from 500 kHz to 1 MHz)

The **AFPR** module has internal jumpers and switches: **KPFL3_1** to **KPFL3_7, KPFL2_1** to **KPFL2_9, KPFL1_1** to **KPFL1_7, CM4** to **CM6.**

The jumpers to carry out in the **AFPR** module according to **Tx** frequency are described in section 6.5.3.b, *Jumpers in AFPR*, of chapter 6, *Commissioning*.

KPFL3_1 to **KPFL3_7** of inductance **L1**	**Jumpers.** Used to carry out the adjustment of the input resonance circuit.
KPFL1_1 to **KPFL1_7** of inductance **L2**	**Jumpers.** Used to carry out the adjustment of the output resonance circuit.
KPFL2_1 to **KPFL2_9**	**Jumpers.** Used to select the central frequency of the line filter.

Each jumper connects a different capacitor.

CM4, **CM5** & **CM6**	**Switches**. Used to carry out L1/L2 adjustment and to exclude/include the line filter.

	CM4	CM5	CM6
Line filter included	ON	ON	OFF
Line filter excluded	OFF	OFF	OFF
Adjustment of L2	ON	OFF	OFF
Adjustment of L1	OFF	ON	ON

Table 5-7: Configuration of CM4, CM5 & CM6 for L1/L2 adjustment and exclusion/inclusion of the line filter

5.3.7 HIPU

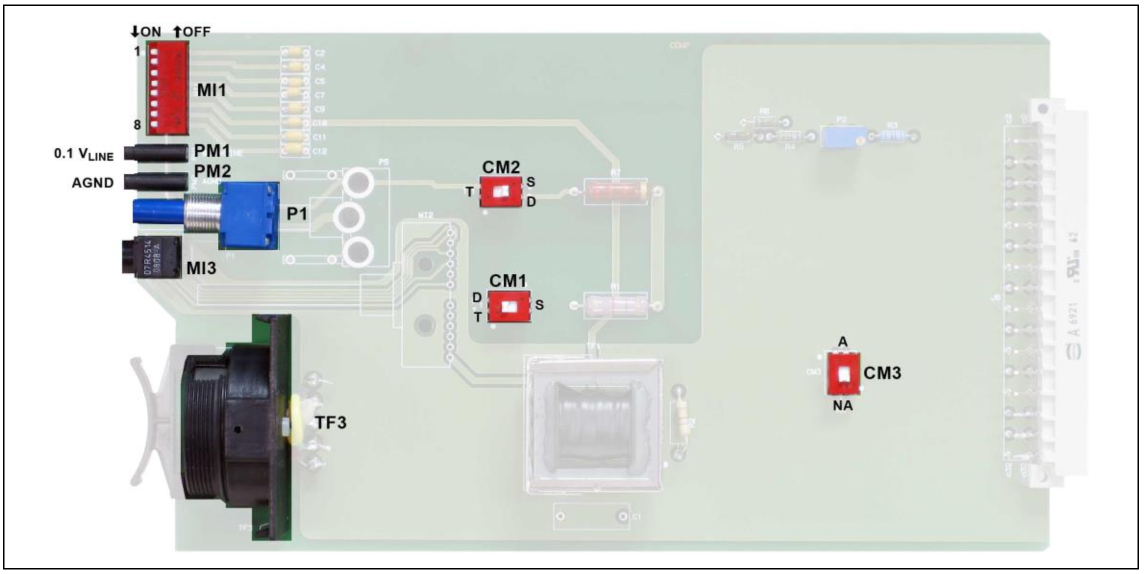


Figure 5.27 Location of the HIPU internal settings.

HIPU or HIPU.01 (HF HYBRID)

The **HIPU** module has three internal switches: **CM1**, **CM2** & **CM3**.

CM1 & **CM2**	**Switches**. Selection of the hybrid adjustment impedance. • **S.** 8 kHz filter. • **D.** 16 kHz filter. • **T.** 24 kHz filter or 32 kHz filter.
CM3	**Switch**. Exclusion of the HF hybrid. • **NA.** To exclude the HF hybrid. • **A.** Normal operation.

5.3.8 DTPU

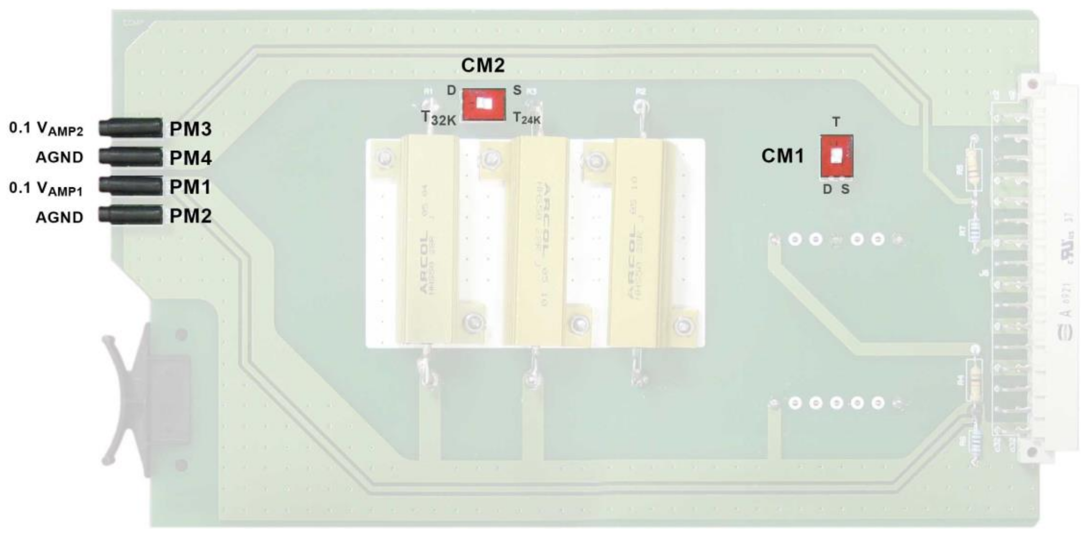


Figure 5.28 Location of the DTPU internal settings.

DTPU (DIFFERENTIAL TRANSFORMER FOR 80 W)

The **DTPU** module has two internal switches: **CM1** & **CM2**.

CM1 & **CM2**	**Switches**. Selection of the output impedance of the line filter which is included in the DTPU module. • **S.** 8 kHz filter. • **D.** 16 kHz filter. • **T / T_{24k}.** 24 kHz filter. • **T / T_{32k}.** 32 kHz filter.

5.3.9 AMPU.00

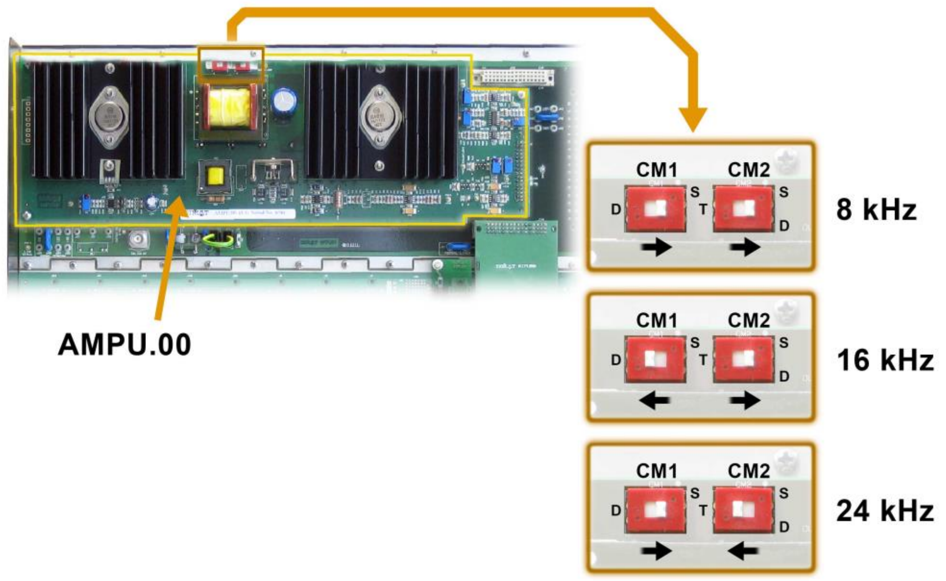


Figure 5.29 Location of the AMPU.00 internal settings.

AMPU.00 (HF AMPLIFIER from 40 kHz to 500 kHz)

The **AMPU.00** module has two internal switches: **CM1** & **CM2**.

CM1 & **CM2**	**Switches**. Selection of the output impedance of the high-frequency amplifier. • **S.** 8 kHz filter. • **D.** 16 kHz filter. • **T.** 24 kHz filter.

5.3.10 AMPU.02

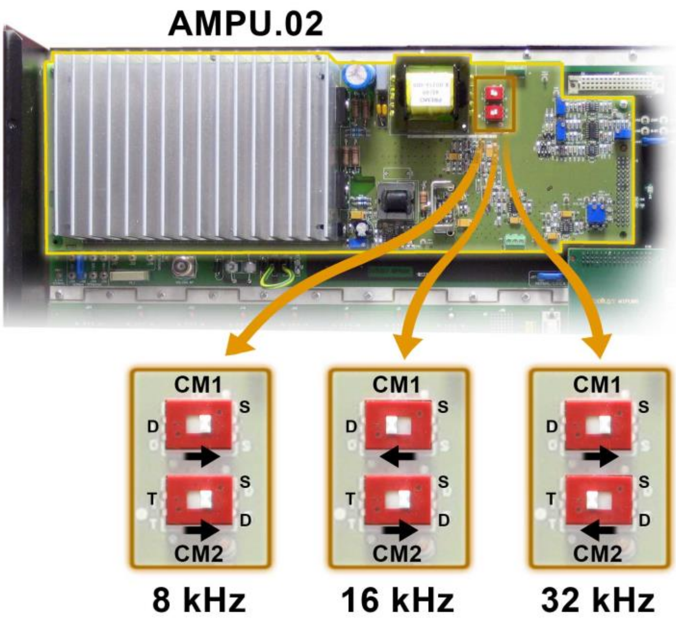


Figure 5.30 Location of the AMPU.02 internal settings.

AMPU.02 (HF AMPLIFIER from 500 kHz to 1 MHz)

The **AMPU.02** module has two internal switches: **CM1** & **CM2**.

CM1 & **CM2**	**Switches**. Selection of the output impedance of the high-frequency amplifier. • **S.** 8 kHz filter. • **D.** 16 kHz filter. • **T.** 32 kHz filter.

5.3.11 TAPU

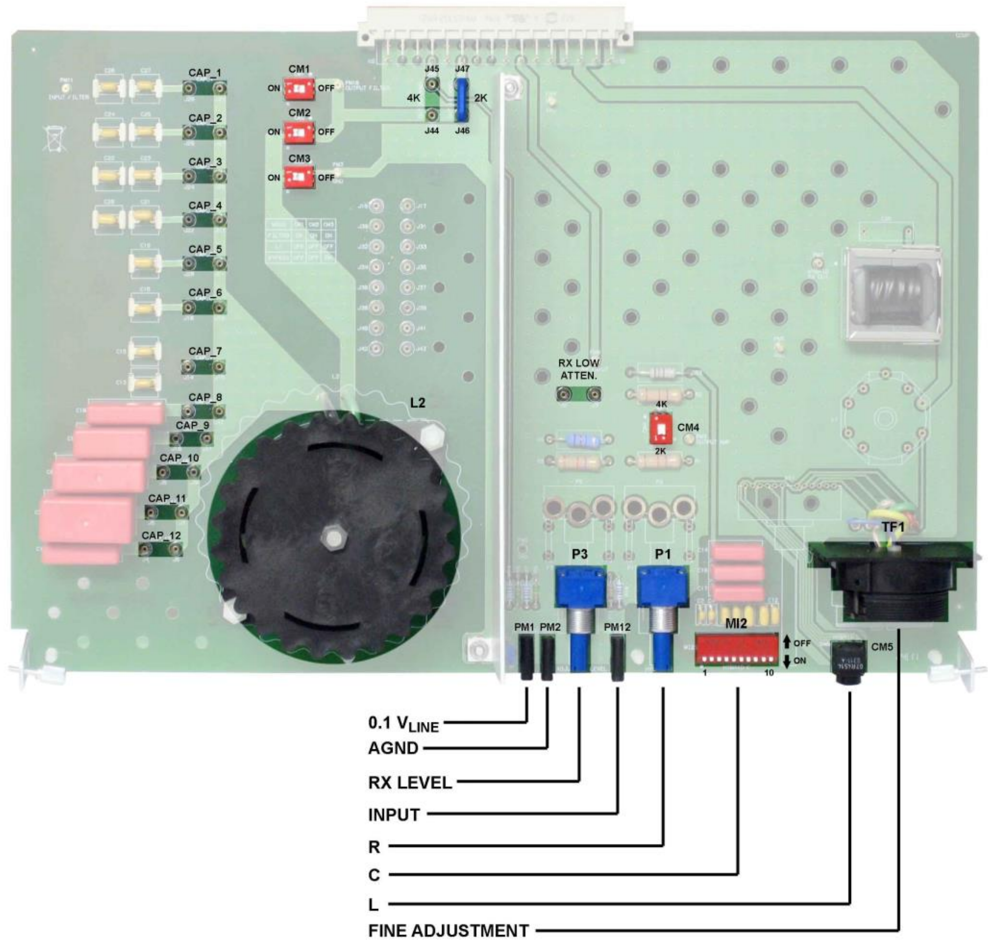


Figure 5.31 Location of the TAPU internal settings.

TAPU (LINE FILTER & HF HYBRID for HF Teleprotection functionality)

The **TAPU** module has internal jumpers and switches: **CAP_1** to **CAP_12, J44** to **J47, CM1** to **CM4**.

The jumpers to carry out in the **TAPU** module according to the **central** frequency are described in section 6.5.5.a, *Jumpers in TAPU*, of chapter 6, *Commissioning*.

CAP_1 to **CAP_12** of inductance **L2**	**Jumpers.** Used to select the central frequency of the line filter.

Each jumper connects a different capacitor.

J44 to **J47**	**Jumpers**. Selection of the output impedance of the line filter. • **J44-J45 (4K).** When set, 4 kHz filter (2 kHz + 2 kHz). • **J46-J47 (2K).** When set, 2 kHz filter (1 kHz + 1 kHz).
CM4	**Switch**. Selection of the output impedance of the line filter. • **4K.** 4 kHz filter (2 kHz + 2 kHz). • **2K.** 2 kHz filter (1 kHz + 1 kHz).
CM1, **CM2** & **CM3**	**Switches**. Used to carry out L2 adjustment and to exclude/include the line filter.

	CM1	CM2	CM3
Line filter included	ON	ON	ON
Line filter excluded	OFF	OFF	ON
Adjustment of L2	OFF	OFF	OFF

Table 5-8: Configuration of CM1, CM2 & CM3 for L2 adjustment and exclusion/inclusion of the line filter

5.3.12 TPPU

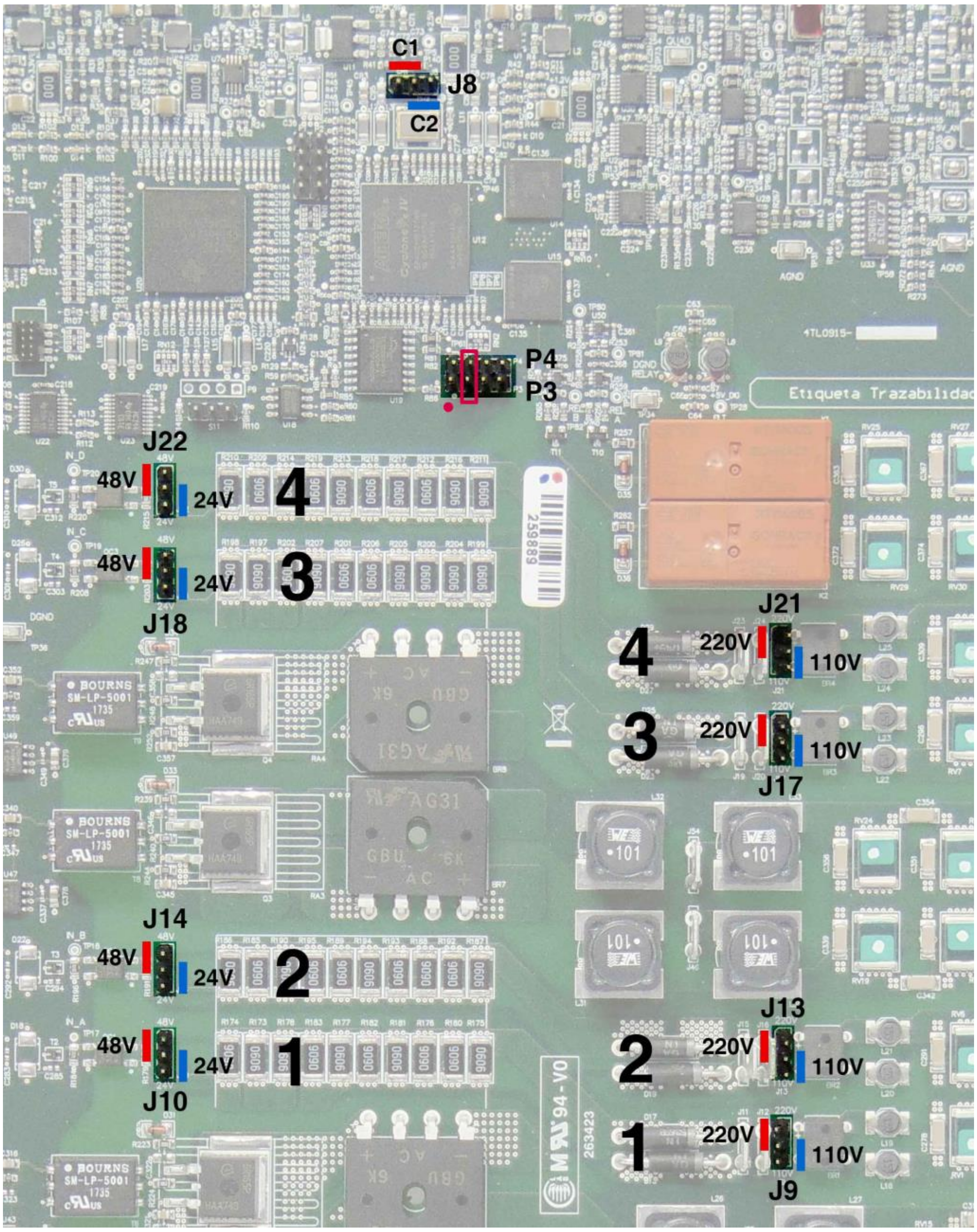


Figure 5.32 Location of the TPPU internal settings.

TPPU (TELEPROTECTION BY DUAL TONE for HF Teleprotection functionality)

The **TPPU** module has internal straps and jumpers: **J8, J9, J10, J13, J14, J17, J18, J21, J22** & **P3-P4.**

J8	**Strap**. It must always be in position **C1**.
J9 & **J10**	**Straps**. Selection of the nominal voltage to activate the command-input circuit **1**. • **J9** at **220V** position. Activation by voltage of **220** Vcc. • **J9** at **110V** position. Activation by voltage of **110** Vcc. • **J10** at **48V** position. Activation by voltage of **48** Vcc. • **J10** at **24V** position. Activation by voltage of **24** Vcc.
J13 & **J14**	**Straps**. Selection of the nominal voltage to activate the command-input circuit **2**. • **J13** at **220V** position. Activation by voltage of **220** Vcc. • **J13** at **110V** position. Activation by voltage of **110** Vcc. • **J14** at **48V** position. Activation by voltage of **48** Vcc. • **J14** at **24V** position. Activation by voltage of **24** Vcc.
J17 & **J18**	**Straps**. Selection of the nominal voltage to activate the command-input circuit **3**. • **J17** at **220V** position. Activation by voltage of **220** Vcc. • **J17** at **110V** position. Activation by voltage of **110** Vcc. • **J18** at **48V** position. Activation by voltage of **48** Vcc. • **J18** at **24V** position. Activation by voltage of **24** Vcc.
J21 & **J22**	**Straps**. Selection of the nominal voltage to activate the command-input circuit **4**. • **J21** at **220V** position. Activation by voltage of **220** Vcc. • **J21** at **110V** position. Activation by voltage of **110** Vcc. • **J22** at **48V** position. Activation by voltage of **48** Vcc. • **J22** at **24V** position. Activation by voltage of **24** Vcc.
P3 & **P4** (position **2**)	**Jumper**. Selection of the command-input activation logic. • **Both linked in position 2**. Negative logic (absence of voltage). • **NOT linked in position 2**. Positive logic (presence of voltage).

5.4 Internal settings of the 6 s.u. optional modules

5.4.1 Built-in multiplexer modules

5.4.1.a DMPU

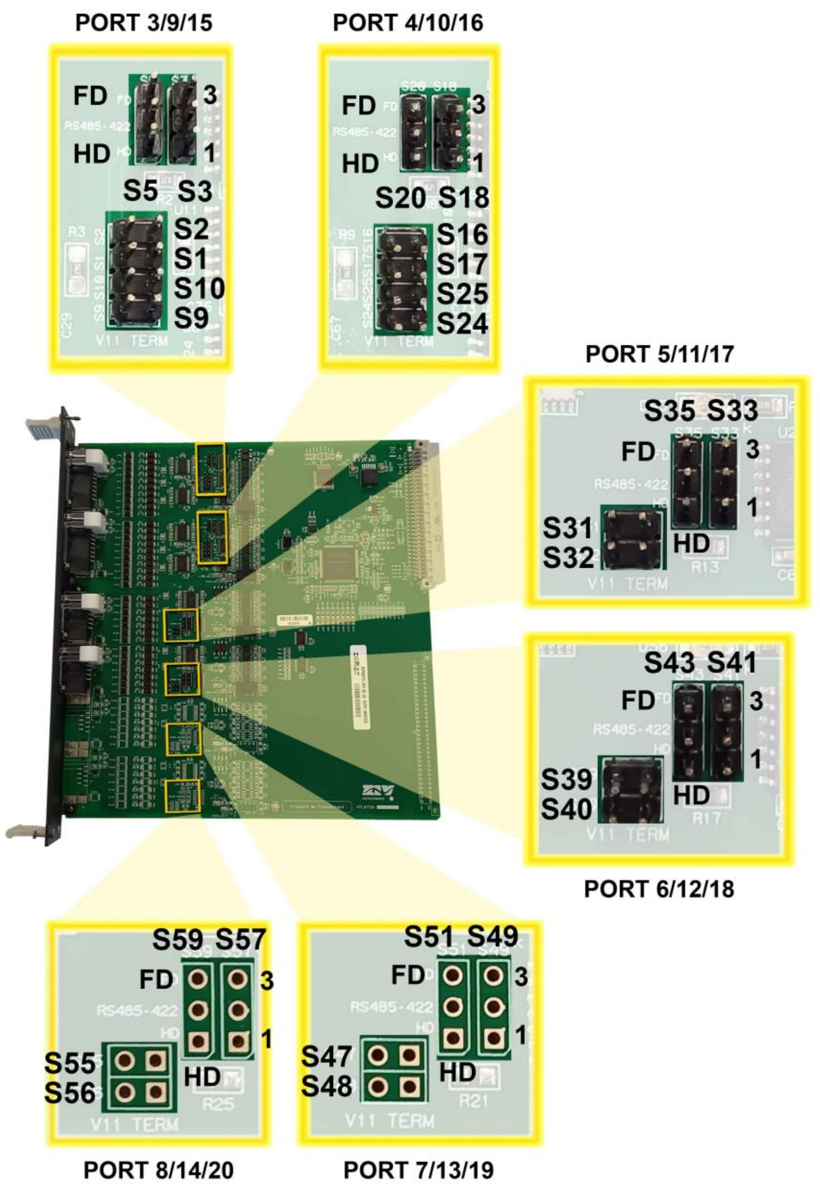


Figure 5.33 Internal configuration elements of the DMPU module with connection at the front.

DMPU (DATA PORTS WITH CONNECTION AT THE FRONT)

The **DMPU** module with connection at the **front** has internal straps and jumpers to configure the interface with which each of the possible ports will work.

PORT 3/9/15 It has associated: **S5, S3, S2, S1, S10** & **S9**
- **V.24/V.28 interface**: No jumper must be made in **S5, S3, S2, S1, S10** & **S9**. - **X.21 interface**: **S2** linked. **S1** linked. **S10** linked. **S9** linked. **S5** linked in position **2-3**. **S3** linked in position **2-3**. - **RS-422 interface**: **S2** linked. **S1** linked. **S5** linked in position **2-3**. **S3** linked in position **2-3**. - **RS-485 (HD/FD) interface** **S2** linked. **S1** linked. **S5** linked in position **2-3 FD** (Full Duplex) or **1-2 HD** (Half Duplex). **S3** linked in position **2-3 FD** (Full Duplex) or **1-2 HD** (Half Duplex).

PORT 4/10/16 It has associated: **S20, S18, S16, S17, S25** & **S24**
- **V.24/V.28 interface**: No jumper must be made in **S20, S18, S16, S17, S25** & **S24**. - **X.21 interface**: **S16** linked. **S17** linked. **S25** linked. **S24** linked. **S20** linked in position **2-3**. **S18** linked in position **2-3**. - **RS-422 interface**: **S16** linked. **S17** linked. **S20** linked in position **2-3**. **S18** linked in position **2-3**. - **RS-485 (HD/FD) interface** **S16** linked. **S17** linked. **S20** linked in position **2-3 FD** (Full Duplex) or **1-2 HD** (Half Duplex). **S18** linked in position **2-3 FD** (Full Duplex) or **1-2 HD** (Half Duplex).

PORT 5/11/17 It has associated: **S35, S33, S31** & **S32**
- **V.24 asynchronous interface**: No jumper must be made in **S35, S33, S31** & **S32**. - **RS-422 interface**: **S31** linked. **S32** linked. **S35** linked in position **2-3**. **S33** linked in position **2-3**. - **RS-485 (HD/FD) interface** **S31** linked. **S32** linked. **S35** linked in position **2-3 FD** (Full Duplex) or **1-2 HD** (Half Duplex). **S33** linked in position **2-3 FD** (Full Duplex) or **1-2 HD** (Half Duplex).

PORT 6/12/18 It has associated: **S43, S41, S39** & **S40**
- **V.24 asynchronous interface**: No jumper must be made in **S43, S41, S39** & **S40**. - **RS-422 interface**: **S39** linked. **S40** linked. **S43** linked in position **2-3**. **S41** linked in position **2-3**. - **RS-485 (HD/FD) interface** **S39** linked. **S40** linked. **S43** linked in position **2-3 FD** (Full Duplex) or **1-2 HD** (Half Duplex). **S41** linked in position **2-3 FD** (Full Duplex) or **1-2 HD** (Half Duplex).

PORT 7/13/19

It has associated: **S51, S49, S47** & **S48**

- **V.24 asynchronous interface**:
  No jumper must be made in **S51, S49, S47** & **S48**.

- **RS-422 interface**:
  S47 linked. **S48** linked.
  S51 linked in position **2-3**.
  S49 linked in position **2-3**.

- **RS-485 (HD/FD) interface**
  S47 linked. **S48** linked.
  S51 linked in position **2-3 FD** (Full Duplex) or **1-2 HD** (Half Duplex).
  S49 linked in position **2-3 FD** (Full Duplex) or **1-2 HD** (Half Duplex).

PORT 8/14/20

It has associated: **S59, S57, S55** & **S56**

- **V.24 asynchronous interface**:
  No jumper must be made in **S59, S57, S55** & **S56**.

- **RS-422 interface**:
  S55 linked. **S56** linked.
  S59 linked in position **2-3**.
  S57 linked in position **2-3**.

- **RS-485 (HD/FD) interface**
  S55 linked. **S56** linked.
  S59 linked in position **2-3 FD** (Full Duplex) or **1-2 HD** (Half Duplex).
  S57 linked in position **2-3 FD** (Full Duplex) or **1-2 HD** (Half Duplex).

5.4.1.b DMPU (rear ports)

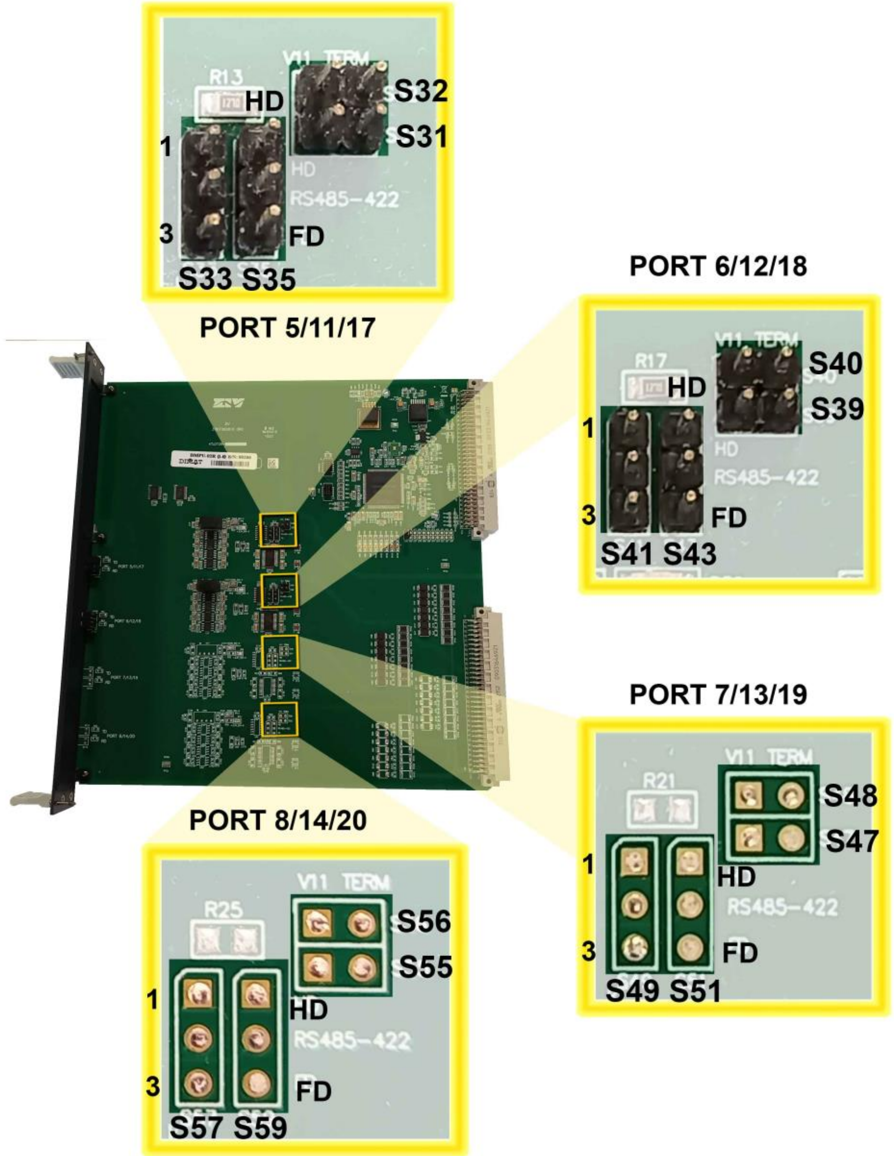


Figure 5.34 Internal configuration elements of the DMPU module with connection at the rear.

DMPU (DATA PORTS WITH CONNECTION AT THE REAR)

The **DMPU** module with connection at the **rear** has internal straps and jumpers to configure the interface with which each of the possible ports will work.

PORT 5/11/17

It has associated: **S33, S35, S32** & **S31**

- **V.24 asynchronous interface**:
  No jumper must be made in **S33, S35, S32** & **S31**.

- **RS-422 interface**:
  S32 linked. **S31** linked.
  S33 linked in position **2-3**.
  S35 linked in position **2-3**.

- **RS-485 (HD/FD) interface**
  S32 linked. **S31** linked.
  S33 linked in position **2-3 FD** (Full Duplex) or **1-2 HD** (Half Duplex).
  S35 linked in position **2-3 FD** (Full Duplex) or **1-2 HD** (Half Duplex).

PORT 6/12/18

It has associated: **S41, S43, S40** & **S39**

- **V.24 asynchronous interface**:
  No jumper must be made in **S41, S43, S40** & **S39**.

- **RS-422 interface**:
  S40 linked. **S39** linked.
  S41 linked in position **2-3**.
  S43 linked in position **2-3**.

- **RS-485 (HD/FD) interface**
  S40 linked. **S39** linked.
  S41 linked in position **2-3 FD** (Full Duplex) or **1-2 HD** (Half Duplex).
  S43 linked in position **2-3 FD** (Full Duplex) or **1-2 HD** (Half Duplex).

PORT 7/13/19

It has associated: **S49, S51, S48** & **S47**

- **V.24 asynchronous interface**:
  No jumper must be made in **S49, S51, S48** & **S47**.

- **RS-422 interface**:
  S48 linked. **S47** linked.
  S49 linked in position **2-3**.
  S51 linked in position **2-3**.

- **RS-485 (HD/FD) interface**
  S48 linked. **S47** linked.
  S49 linked in position **2-3 FD** (Full Duplex) or **1-2 HD** (Half Duplex).
  S51 linked in position **2-3 FD** (Full Duplex) or **1-2 HD** (Half Duplex).

PORT 8/14/20

It has associated: **S57, S59, S56** & **S55**

- **V.24 asynchronous interface**:
  No jumper must be made in **S57, S59, S56** & **S55**.

- **RS-422 interface**:
  S56 linked. **S55** linked.
  S57 linked in position **2-3**.
  S59 linked in position **2-3**.

- **RS-485 (HD/FD) interface**
  S56 linked. **S55** linked.
  S57 linked in position **2-3 FD** (Full Duplex) or **1-2 HD** (Half Duplex).
  S59 linked in position **2-3 FD** (Full Duplex) or **1-2 HD** (Half Duplex).

5.4.2 Built-in teleprotection modules

5.4.2.a TPPU

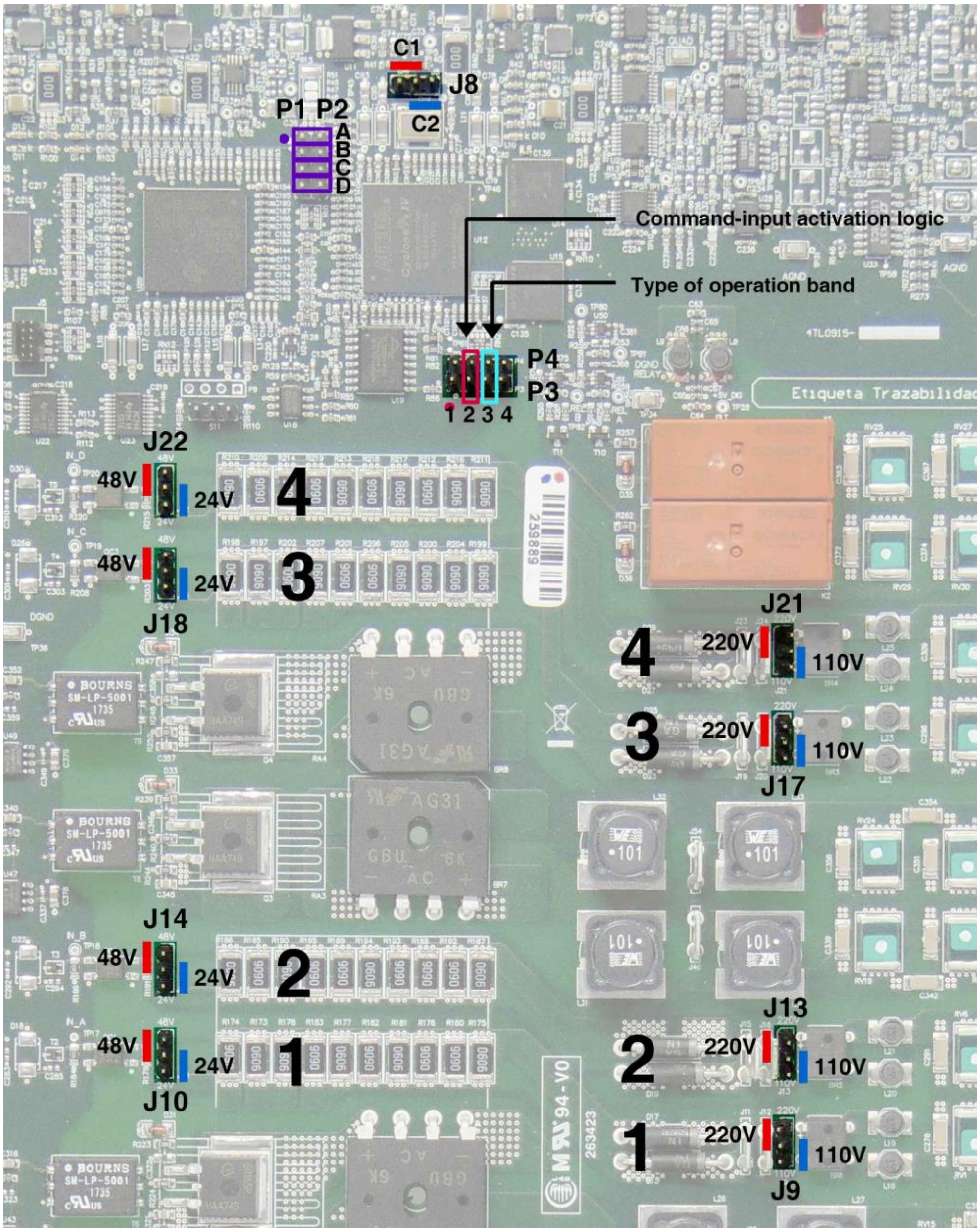


Figure 5.35 Internal configuration elements of the TPPU module.

TPPU (TELEPROTECTION BY SINGLE / DUAL TONE)

The **TPPU** module has internal straps and jumpers: **J8, J9, J10, J13, J14, J17, J18, J21, J22, P3-P4** & **P1-P2.**

J8	**Strap**. Selection of the channel associated with the module. • **C1.** Channel 1. • **C2.** Channel 2. For digital-band operation, it must always be in position **C1**.
P3 & **P4** in position **2**	**Jumper**. Selection of the command-input activation logic. • **Both linked in position 2**. Negative logic (absence of voltage). • **NOT linked in position 2**. Positive logic (presence of voltage).
P3 & **P4** in position **3**	**Jumper**. Selection of type or operation band. • **Both linked in position 3**. Digital-band operation. • **NOT linked in position 3**. Analog-band operation. For digital-band operation, it is essential that **P3** & **P4** be linked in position **3**.
P1 & **P2**	**Jumper**. For **dual tone** operating mode, used to configure the **TPPU** as **A** to **D**. • **A**. Module configured as ***Teleprotection A***. • **B**. Module configured as ***Teleprotection B***. • **C**. Module configured as ***Teleprotection C***. • **D**. Module configured as ***Teleprotection D***. A proper configuration is essential when various **TPPU** modules are used in the same analog channel.
J9 & **J10**	**Straps**. Selection of the nominal voltage to activate the command-input circuit **1**. • **J9** at **220V** position. Activation by voltage of **220** Vcc. • **J9** at **110V** position. Activation by voltage of **110** Vcc. • **J10** at **48V** position. Activation by voltage of **48** Vcc. • **J10** at **24V** position. Activation by voltage of **24** Vcc.
J13 & **J14**	**Straps**. Selection of the nominal voltage to activate the command-input circuit **2**. • **J13** at **220V** position. Activation by voltage of **220** Vcc. • **J13** at **110V** position. Activation by voltage of **110** Vcc. • **J14** at **48V** position. Activation by voltage of **48** Vcc. • **J14** at **24V** position. Activation by voltage of **24** Vcc.

J17 & **J18**	**Straps**. Selection of the nominal voltage to activate the command-input circuit **3**. • **J17** at **220V** position. Activation by voltage of **220** Vcc. • **J17** at **110V** position. Activation by voltage of **110** Vcc. • **J18** at **48V** position. Activation by voltage of **48** Vcc. • **J18** at **24V** position. Activation by voltage of **24** Vcc.
J21 & **J22**	**Straps**. Selection of the nominal voltage to activate the command-input circuit **4**. • **J21** at **220V** position. Activation by voltage of **220** Vcc. • **J21** at **110V** position. Activation by voltage of **110** Vcc. • **J22** at **48V** position. Activation by voltage of **48** Vcc. • **J22** at **24V** position. Activation by voltage of **24** Vcc.

5.4.3 Other optional modules

5.4.3.a TDPU.20

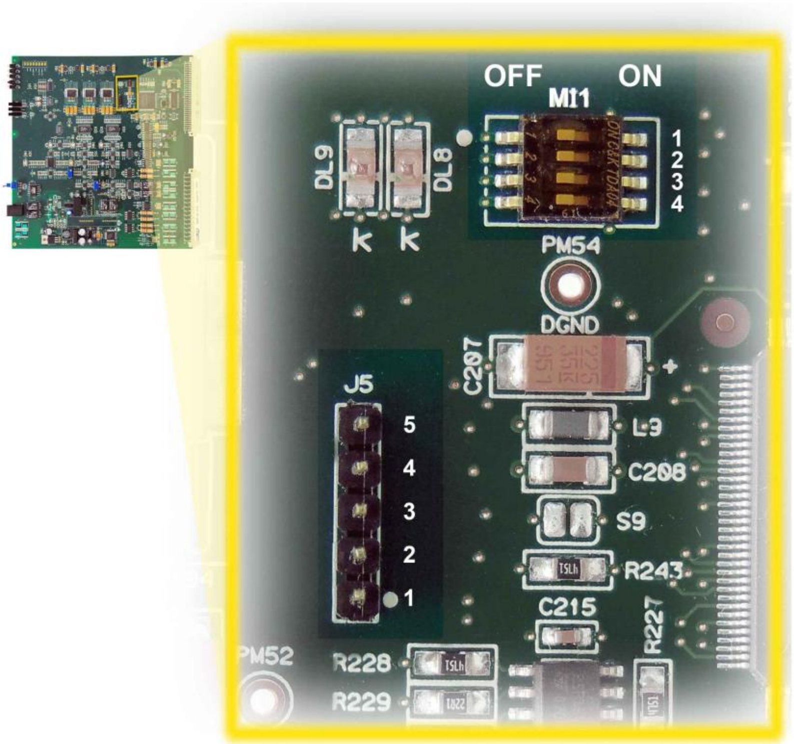


Figure 5.36 Internal configuration elements of the TDPU.20 module.

TDPU.20 (SPEECH)

The **TDPU.20** module has an internal microswitch and jumper: **MI1** & **J5.**

J5	**Jumper**. In position 1-2, configures the compandor activation or deactivation from an external command. • **OFF.** Compandor activation. • **ON.** Compandor deactivation.

MI1 MICROSWITCHES (1 to 4)

- **Microswitch 4**:
  Selection of the analog channel associated with the module.
  ON: Channel 2.
  OFF: Channel 1.

- **Microswitch 3**:
  Selection of 4W/2W or 2W/4W switching mode from an external command.
  ON: 4W/2W switching.
  OFF: 2W/4W switching.

- **Microswitches 1 & 2**:
  Selection of the **TDPU.20** operating mode. See Table 5.9.

Microswitch	1	2
Subscriber	ON	ON
Exchange-side 2-wire operation	ON	OFF
2 wire	OFF	ON
4 wire	OFF	OFF

Table 5-9: TDPU.20 operating mode selection

4-wire operating mode

By means of the 4-wire configurable termination it is possible to connect a 4-wire system that requires a power-line carrier link as its transmission medium.

If the system features E&M-wire signalling, the corresponding terminals in the speech module can be used.

For the transmission of signals by power-line carrier link, the module contains conditioning circuits such as the dynamic compressor/expander, the amplitude limiter and the filters used to limit the speech band.

From the Management System the termination must be configured with the 4-wire option.

The programming of the input and output levels is also carried out from the Management System.

The factory-programmed nominal value is 0 dBm.

The modulation percentage assigned must be the maximum that the service can occupy in any condition.

The factory-assigned modulation percentage is normally 50%.

2-wire operating mode

The 2-wire operation is analogous to that of the 4-wire operation except that the termination must be configured with the 2-wire option, from the Management System, and that the low-frequency hybrid is included.

This hybrid carries out the conversion to 2-wire/4-wire and vice versa and it is necessary for speech-signal transmission by the power-line carrier system.

This termination is programmed with a nominal level of +3 dBm in transmit and -3 dBm in receive.

When the operating mode is dynamically switched, the system detects which levels correspond to the operation in question - previously introduced - and programs them when the change-of-state command is received.

In 2-wire operation, input 4WT1 is de-activated and the 4WR1 terminals become 2W terminals.

In 2-wire operation this termination can only be used as a speech-signal transit as it does not permit the detection of subscriber-loop signalling.

Exchange-side 2-wire operating mode

For exchange-side 2-wire operation, appart from configuring microswitches 1 and 2 of MI1 respectively in the ON and OFF position, from the Management System the termination must be configured with the 2-wire option.

This operation mode allows a remote subscriber to be connected when the telephone converter necessary for subscriber-loop operation is activated. The system detects the exchange ring-current, activates the M-wire and transforms the changes of state in the E-wire into openings and closures of the subscriber loop.

Subscriber operating mode

It consists of a subscriber 2-wire balanced termination that presents an impedance of 600 Ω.

The input and output levels are not programmable; they are factory-supplied with values of +3 dBm and -3 dBm respectively.

The subscriber termination uses the E&M-wire signalling.

The E-wire activation causes the generation of the ring current in the subscriber termination, and the subscriber-loop state (on-hook/off-hook) is converted into transitions in the M-wire.

This termination supports two telephones in parallel.

5.4.3.b MFPU

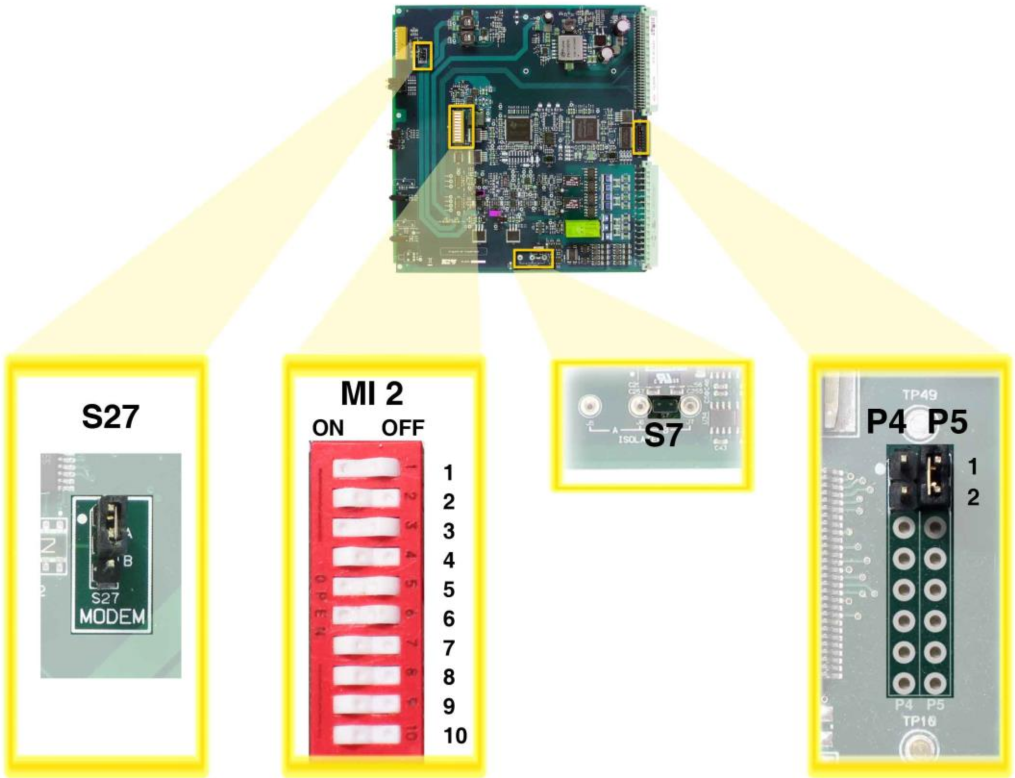


Figure 5.37 Internal configuration elements of the MFPU module.

MFPU (ASYNCHRONOUS PROGRAMMABLE MODEM)

The **MFPU** module has the following configuration elements: **MI2, S27, S7, P4** & **P5.**

S27	**Strap**. Used to configure the **MFPU** as modem **A** or modem **B**. • **A**. Module configured as ***Modem A***. • **B**. Module configured as ***Modem B***. There should be special attention when two **MFPU** modems are used in the same analog channel. In that case, one module must be configured as modem **A** and the other as modem **B**.
S7	**Jumper**. Always open (not carried out).
P4 & **P5**	**Jumpers**. When pin **1** of **P4** and pin **1** of **P5** are linked, the firmware of the **MFPU** module can be updated from a terminal emulator program.

MI2 MICROSWITCHES (1 to 10)

- **Microswitch 1**:
  It must always be in position **OFF**.

- **Microswitch 2**:
  Selection of the analog channel associated with the module.
  ON: Channel 1.
  OFF: Channel 2.

- **Microswitches 3, 4 & 5**:
  Selection of the transmission speed of the modem. See Table 5.10.

- **Microswitches 6, 7, 8, 9 & 10**:
  Selection of the desired central frequency (in Hz) according to the speed selected. See Table 5.11.

Microswitch			Transmission speed (Bd)
3	4	5	
ON	OFF	OFF	50
ON	OFF	OFF	75 (T_X V.23)
OFF	ON	OFF	100
ON	ON	OFF	200
OFF	OFF	ON	600
OFF	OFF	ON	600 (T_X V.23)
ON	OFF	ON	1200
ON	OFF	ON	1200 (T_X V.23)
OFF	ON	ON	2400

Table 5-10: MFPU transmission speed selection

Microswitch					Transmission speed (Bd)/±Δf (Hz)								V.23 T_x/R_x (Bd): f(Hz)
6	7	8	9	10	50/±30	100/±60	200/±120	200/±90	200/±60	600/±180	1200/±400	2400/±800	
OFF	OFF	OFF	OFF	OFF	420	480	600	---	---	840	1700	1800	---
ON	OFF	OFF	OFF	OFF	540	720	1080	---	---	1800	2940	2000	---
OFF	ON	OFF	OFF	OFF	660	960	1560	---	---	2760	---	---	1200/75: 1700
ON	ON	OFF	OFF	OFF	780	1200	2040	---	---	1500	---	---	---
OFF	OFF	ON	OFF	OFF	900	1440	2520	---	---	3040	---	---	---
ON	OFF	ON	OFF	OFF	1020	1680	3000	---	---	2800	---	---	---
OFF	ON	ON	OFF	OFF	1140	1920	3480	---	---	---	---	---	600/75: 1500
ON	ON	ON	OFF	OFF	1260	2160	---	540	---	2400	---	---	---
OFF	OFF	OFF	ON	OFF	1380	2400	---	900	---	---	---	---	---
ON	OFF	OFF	ON	OFF	1500	2640	---	1260	---	---	---	---	---
OFF	ON	OFF	ON	OFF	1620	2880	---	1620	---	---	---	---	---
ON	ON	OFF	ON	OFF	1740	3120	---	1980	---	---	---	---	---
OFF	OFF	ON	ON	OFF	1860	3360	---	2340	---	---	---	---	---
ON	OFF	ON	ON	OFF	1980	3600	---	2700	---	---	---	---	---
OFF	ON	ON	ON	OFF	2100	---	---	3060	---	---	---	---	---
ON	ON	ON	ON	OFF	2220	---	---	3420	---	---	---	---	---
OFF	OFF	OFF	OFF	ON	2340	---	---	---	3000	---	---	---	---
ON	OFF	OFF	OFF	ON	2460	---	---	---	3500	---	---	---	---
OFF	ON	OFF	OFF	ON	2580	---	---	---	---	---	---	---	---
ON	ON	OFF	OFF	ON	2700	---	---	---	---	---	---	---	---
OFF	OFF	ON	OFF	ON	2820	---	---	---	---	---	---	---	---
ON	OFF	ON	OFF	ON	2940	---	---	---	---	---	---	---	---
OFF	ON	ON	OFF	ON	3060	---	---	---	---	---	---	---	---
ON	ON	ON	OFF	ON	3180	---	---	---	---	---	---	---	---
OFF	OFF	OFF	ON	ON	3300	---	---	---	---	---	---	---	---
ON	OFF	OFF	ON	ON	3420	---	---	---	---	---	---	---	---
OFF	ON	OFF	ON	ON	3540	---	---	---	---	---	---	---	---
ON	ON	OFF	ON	ON	3660	---	---	---	---	---	---	---	---
OFF	OFF	ON	ON	ON	3780	---	---	---	---	---	---	---	---
ON	OFF	ON	ON	ON	---	---	---	---	---	---	---	---	75/600: 420
OFF	ON	ON	ON	ON	---	---	---	---	---	---	---	---	75/1200: 420

Table 5-11: MFPU central frequency selection

5.4.3.c FTPU

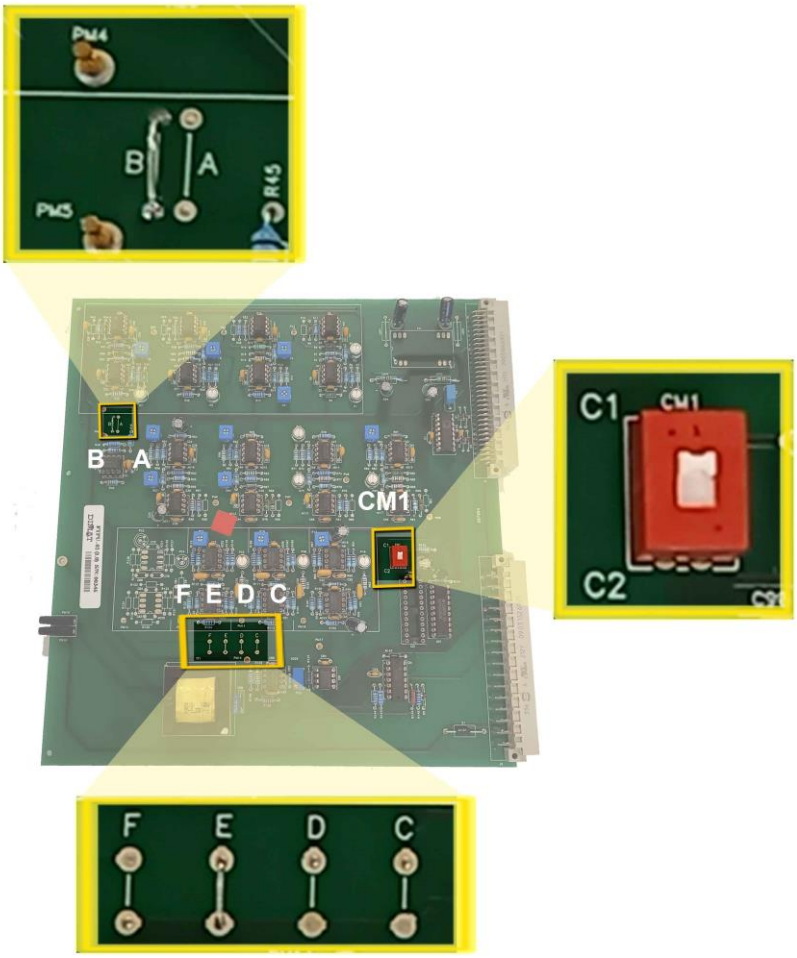


Figure 5.38 Internal configuration elements of the FTPU module.

FTPU (VFT TRANSIT FILTER)

The **FTPU** module has an internal microswitch and soldered jumpers: **CM1** & **A** to **F.**

CM1	**Microswitch**. Selection of the analog channel for the audio-frequency signal in reception. • **C1**. Channel 1. • **C2**. Channel 2.
A, B	**Soldered jumpers**. Used to include or exclude the low-pass filter in the module. • **A soldered**. Low-pass filter excluded. • **B soldered**. Module with low-pass filter.
C, D, E, F	**Soldered jumpers**. Each jumper connects to group-delay equalizer cells. • **C soldered**. One equalizer cell. • **D soldered**. Two equalizer cells. • **E soldered**. Three equalizer cells. • **F soldered**. Four equalizer cells.

*Soldered jumpers **A** to **F** are factory configured.*

5.4.3.d FDPU

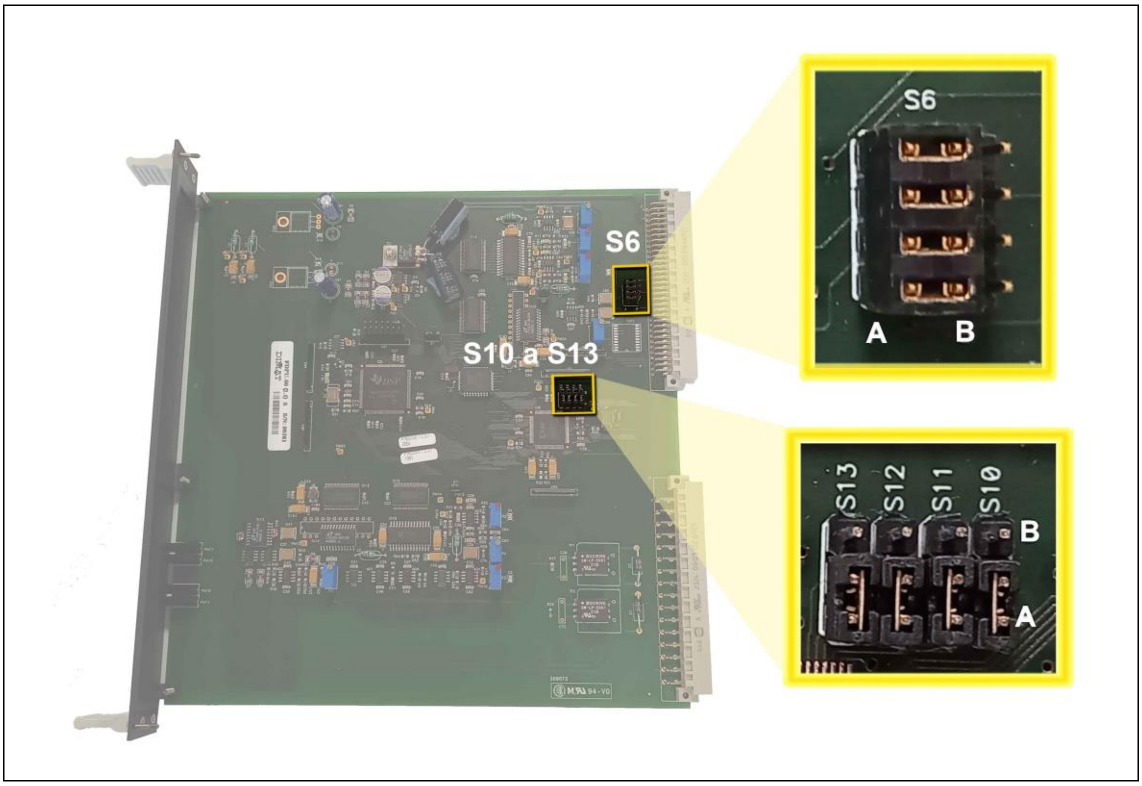


Figure 5.39 Internal configuration elements of the FDPU module.

FDPU (DIGITAL TRANSIT FILTER)

The **FDPU** module has an strap and internal jumpers: **S6** & **S10** to **S13.**

S6	**Strap**. Selection of the analog channel associated with the module. • **A**. Channel 1. • **B**. Channel 2.
S10, **S11, S12, S13**	**Jumpers**. Selection of the band-pass filter (**1** to **5**). See Table 5.12.

Filter	S13	S12	S11	S10
Filter 1: 300-3480 Hz	A	A	A	A: with mutiplexer B: without mutiplexer
Filter 2: 2240-3640 Hz	B	A	A	B
Filter 3: 1000-2400 Hz **Attenuation band: 2660 Hz**	A	B	A	B
Filter 4: 1000-2400 Hz **Attenuation band: 2500 Hz**	A	A	B	B
Filter 5: 0-3600 Hz	B	B	A	A: with mutiplexer B: without mutiplexer

Table 5-12: Jumper combination to select each particular (1 to 5) band-pass filter

5.5 Back-panel elements

5.5.1 OPU-1 for 20 W & 40 W

The elements available on the back of the **OPU-1** for **20** W & **40** W are indicated in the attached figure.

The **3** s.u. back panel (**WPPU.00**) contains the high-frequency output coaxial connector and associated configuration elements, the line test points, the dummy load, and the elements for selecting the bandwidth of the line filter and output impedance of the high-frequency amplifier.

The **6** s.u. back panel (**WOPU**) contains the main switch, the fuses and the main connectors. It also has a setting to connect chassis to earth.

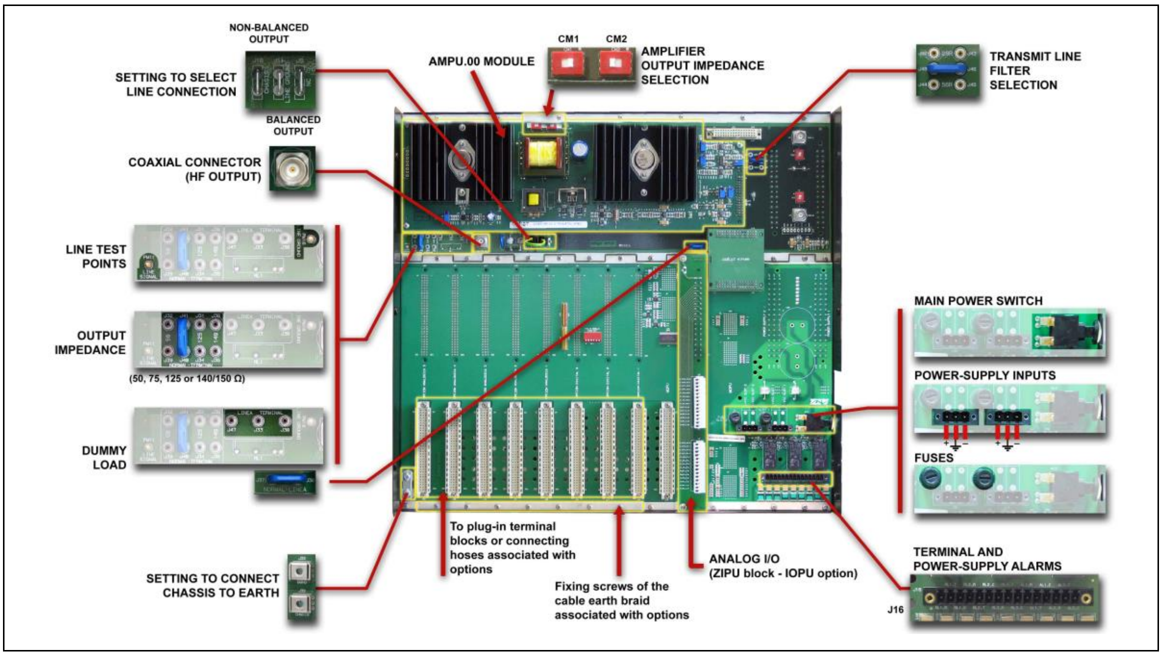


Figure 5.40 Back panel elements of the OPU-1 for 20 W & 40 W.

5.5.1.a Microswitches & jumpers of the 3 s.u. back panel (WPPU.00)

Microswitches CM1 & CM2

Selection of the output impedance of the HF amplifier.

- **S** position: **8** kHz filter.
- **D** position: **16** kHz filter.
- **T** position: **24** kHz filter.

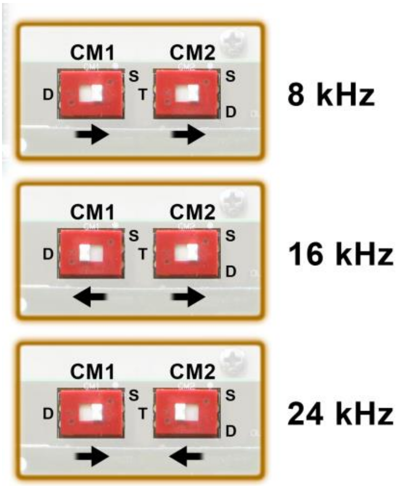


Figure 5.41 Selection of the output impedance of the HF amplifier.

Jumpers 28R (J42-J43), 56R (J44-J45), 84R (J48-J46)

Selection of the bandwidth of the line filter.

- **28R (J42-J43)** linked: **8** kHz filter.
- **56R (J44-J45)** linked: **16** kHz filter.
- **84R (J48-J46)** linked: **24** kHz filter.

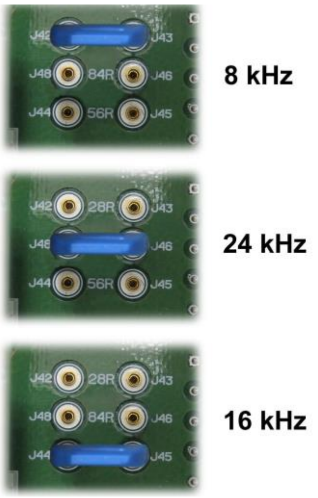


Figure 5.42 Selection of the bandwidth of the line filter.

Jumpers 50 (J32-J39), 75 (J41-J40), 125 (J31-J34), 140 (J36-J35)	**Strap J47-J33-J30 & jumper J37-J38**
Selection of the output impedance. • **50 (J32-J39)** linked: **50** Ω • **75 (J41-J40)** linked: **75** Ω • **125 (J31-J34)** linked: **125** Ω • **140 (J36-J35)** linked: **140 / 150** Ω	Selection of the dummy-load connection. • **J47-J33** linked & **J37-J38** linked: Dummy load connected **line side**. • **J33-J30** linked & **J37-J38** NOT linked: Dummy load connected **terminal side**. • **J47-J33-J30** NOT linked & **J37-J38** linked: **Normal** position.

__J37-J38__ can be __removed__ if complete isolation of the terminal with respect to the line is required.

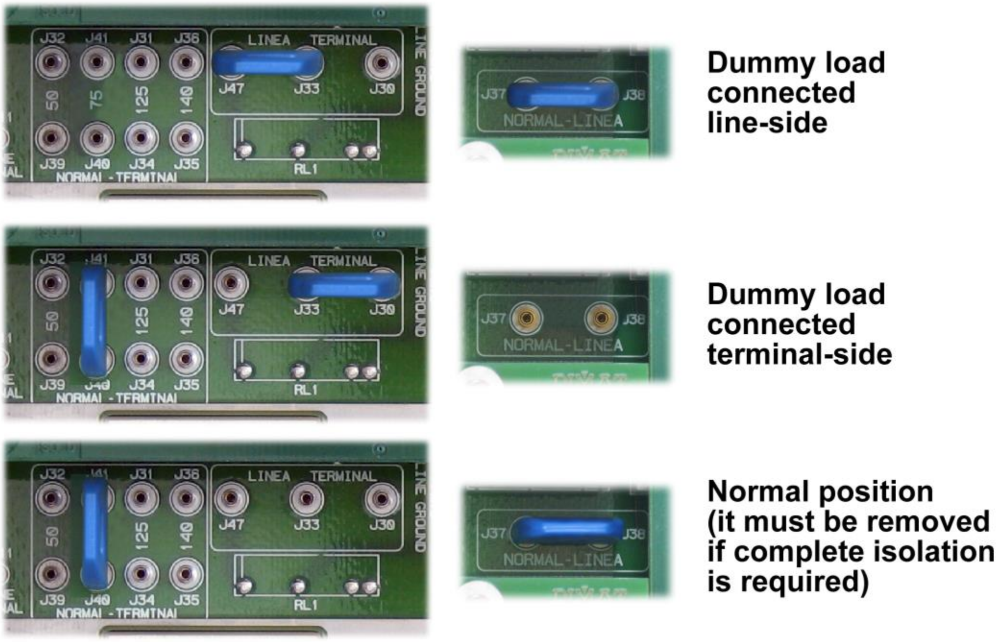
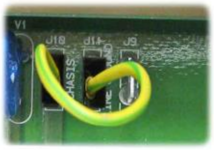


Figure 5.43 Selection of the dummy-load connection.

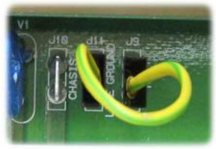
Strap J10-J11-J9

Selection of the line connection.

- **J10-J11** linked: **Non-balanced**.
- **J11-J9** linked: **Balanced** output.

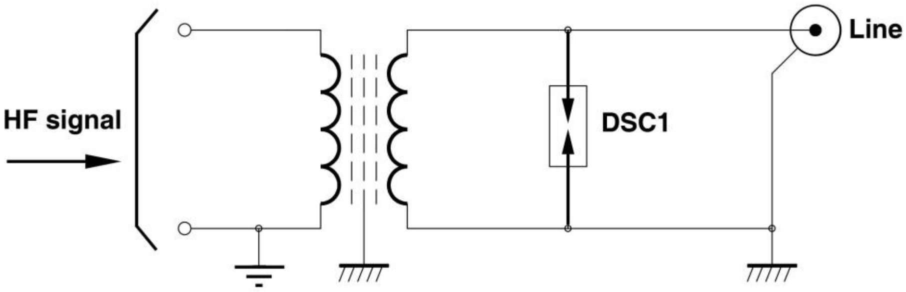


Non-balanced (Coaxial-cable shield connected to chassis)



Balanced (Coaxial-cable shield not connected to chassis)

Figure 5.44 Selection of the balanced or non-balanced line connection.



*When the shield is connected to the chassis, the **DSC2** surge arrester is short circuited.*

Figure 5.45 Non-balanced output.

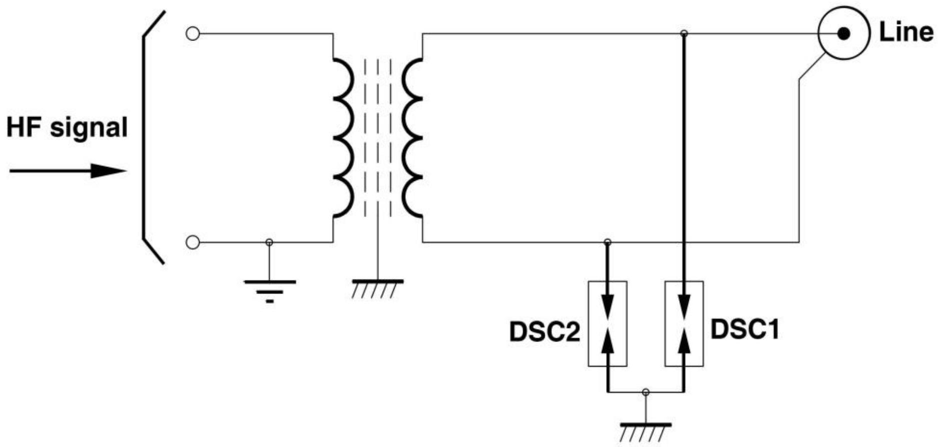


Figure 5.46 Balanced output.

5.5.1.b Use of main connectors of the 6 s.u. back panel (WOPU)

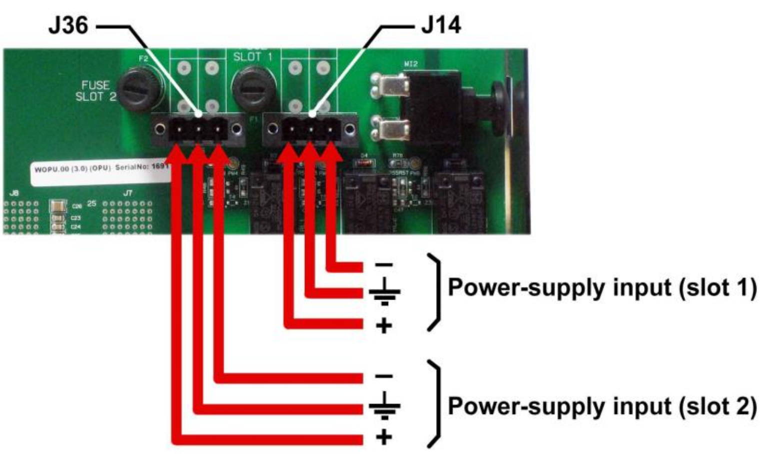
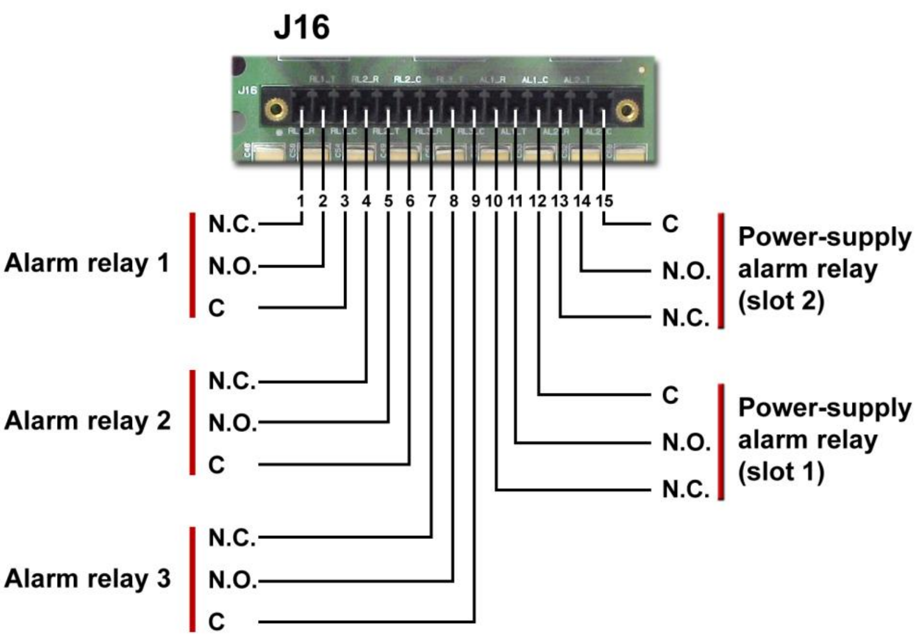


Figure 5.47 Use of the power-supply sockets.



*In **normal** operation conditions the relays are **energized**, that is, the **N.O.** and **C** contacts are short-circuited.*

Figure 5.48 Use of the alarm relay connector.

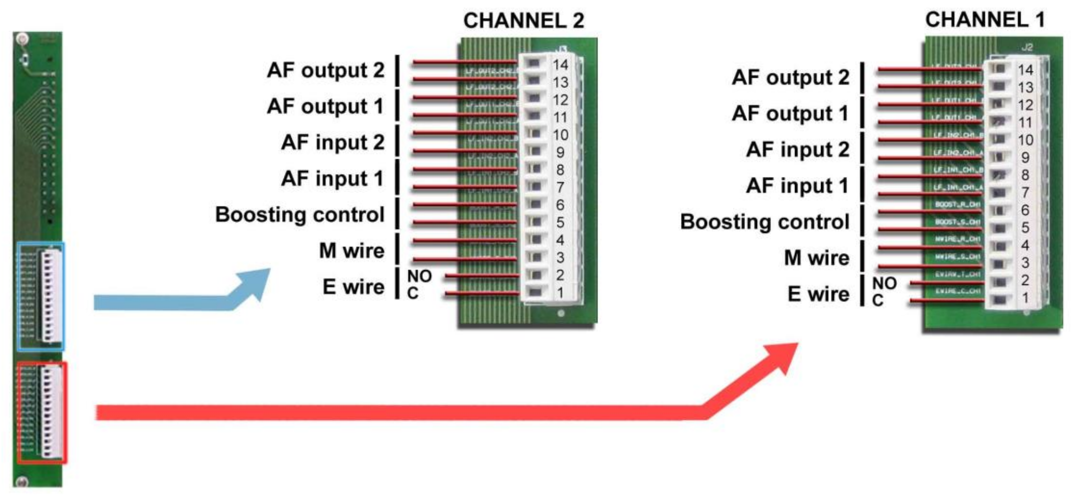
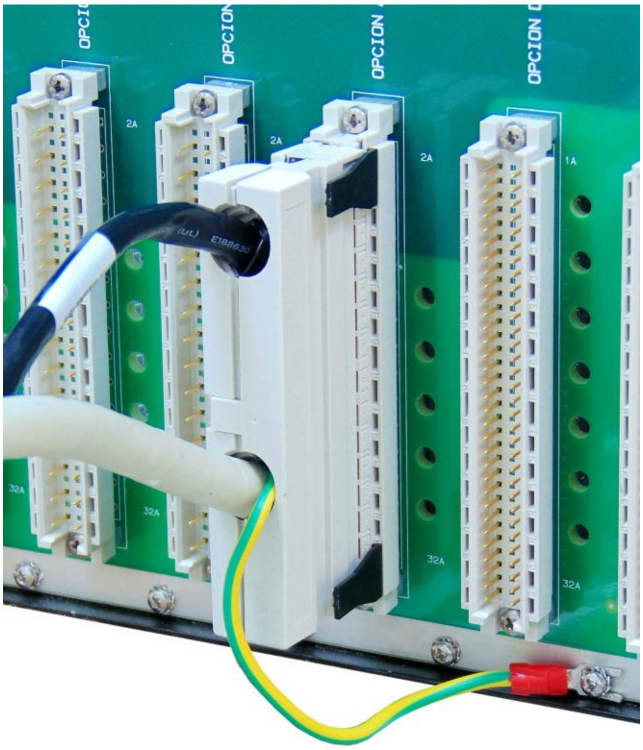


Figure 5.49 Use of the ZIPU plug-in terminal block associated with the AF input/output analog signals (IOPU option).



*When connecting a cable to the corresponding connector on the shelf associated with options, attach the earth cable to the **screw** at the bottom of the chassis.*

Figure 5.50 Detail of the earth cable fixing.

5.5.2 OPU-1 for 500 kHz to 1 MHz

The elements available on the back of the **OPU-1** for **500** kHz to **1** MHz are indicated in the attached figure.

The **3** s.u. back panel (**WPPU.01**) contains the high-frequency output coaxial connector and associated configuration elements, the line test points, the dummy load, and the elements for selecting the bandwidth of the line filter and output impedance of the high-frequency amplifier.

The **6** s.u. back panel (**WOPU**) contains the main switch, the fuses and the main connectors. It also has a setting to connect chassis to earth.

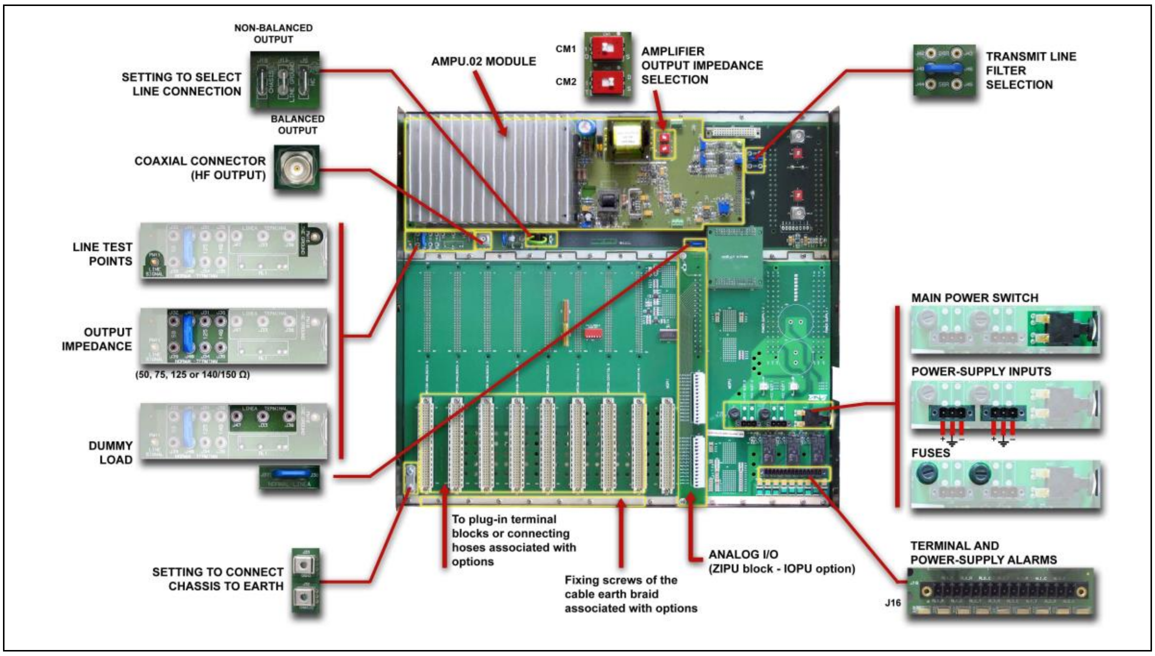


Figure 5.51 Back panel elements of the OPU-1 for 500 kHz to 1 MHz.

5.5.2.a Microswitches & jumpers of the 3 s.u. back panel (WPPU.01)

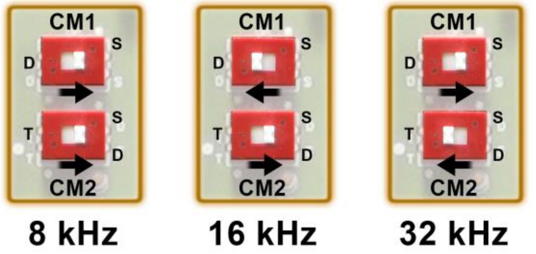
Microswitches CM1 & CM2 Selection of the output impedance of the HF amplifier. • **S** position: **8** kHz filter. • **D** position: **16** kHz filter. • **T** position: **32** kHz filter.	

Figure 5.52 Selection of the output impedance of the HF amplifier.

Jumpers 28R (J42-J43), 56R (J44-J45), 84R (J48-J46) Selection of the bandwidth of the line filter. • **28R (J42-J43)** linked: **8** kHz filter. • **56R (J44-J45)** linked: **16** kHz filter. • **84R (J48-J46)** linked: **32** kHz filter.	

Figure 5.53 Selection of the bandwidth of the line filter.

Jumpers 50 (J32-J39), 75 (J41-J40), 125 (J31-J34), 140 (J36-J35)	**Strap J47-J33-J30 & jumper J37-J38**
Selection of the output impedance. • **50 (J32-J39)** linked: **50** Ω • **75 (J41-J40)** linked: **75** Ω • **125 (J31-J34)** linked: **125** Ω • **140 (J36-J35)** linked: **140 / 150** Ω	Selection of the dummy-load connection. • **J47-J33** linked & **J37-J38** linked: Dummy load connected **line side**. • **J33-J30** linked & **J37-J38** NOT linked: Dummy load connected **terminal side**. • **J47-J33-J30** NOT linked & **J37-J38** linked: **Normal** position.

***J37-J38** can be **removed** if complete isolation of the terminal with respect to the line is required.*

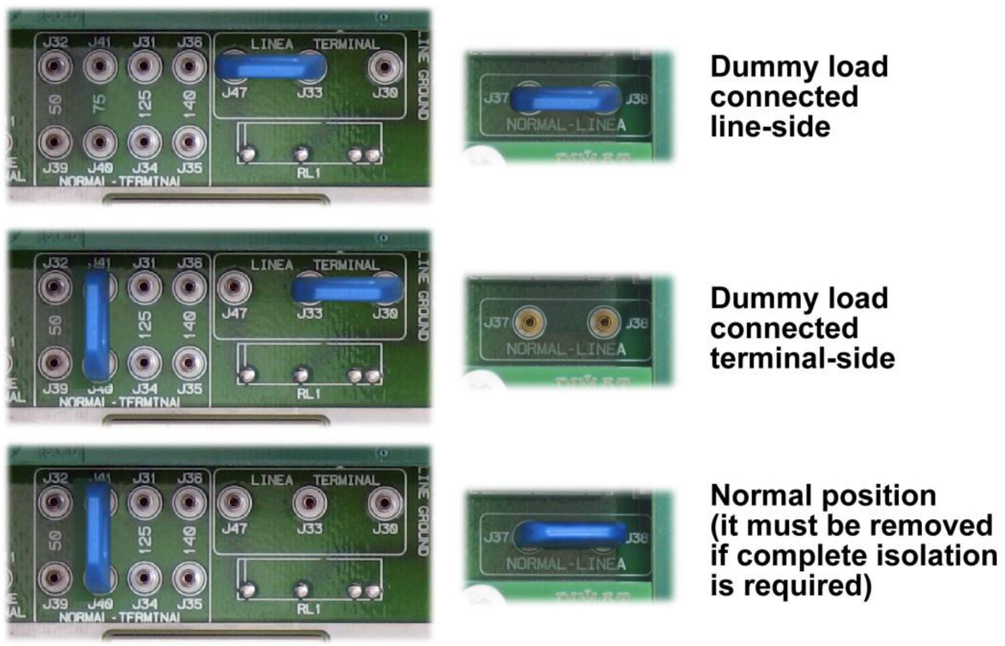
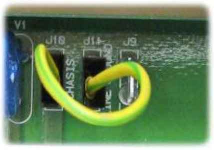


Figure 5.54 Selection of the dummy-load connection.

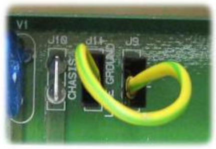
Strap J10-J11-J9

Selection of the line connection.

- **J10-J11** linked: **Non-balanced**.
- **J11-J9** linked: **Balanced** output.

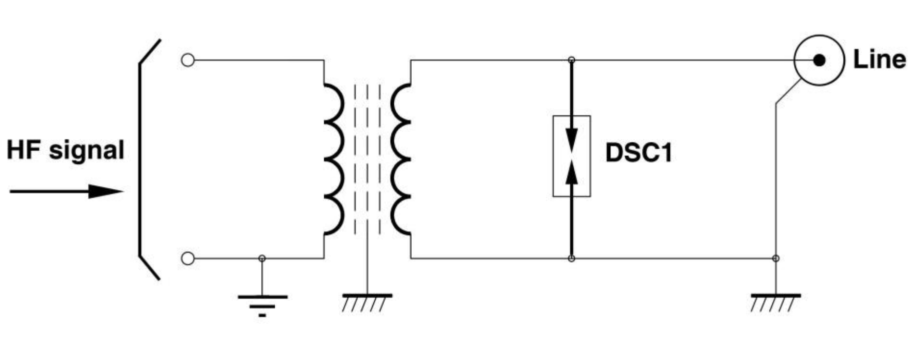


Non-balanced (Coaxial-cable shield connected to chassis)



Balanced (Coaxial-cable shield not connected to chassis)

Figure 5.55 Selection of the balanced or non-balanced line connection.



*When the shield is connected to the chassis, the **DSC2** surge arrester is short circuited.*

Figure 5.56 Non-balanced output.

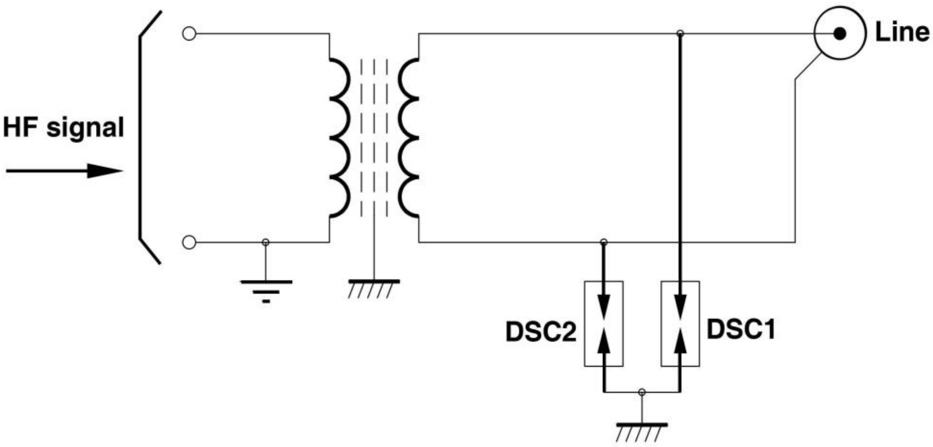


Figure 5.57 Balanced output.

5.5.2.b Use of main connectors of the 6 s.u. back panel (WOPU)

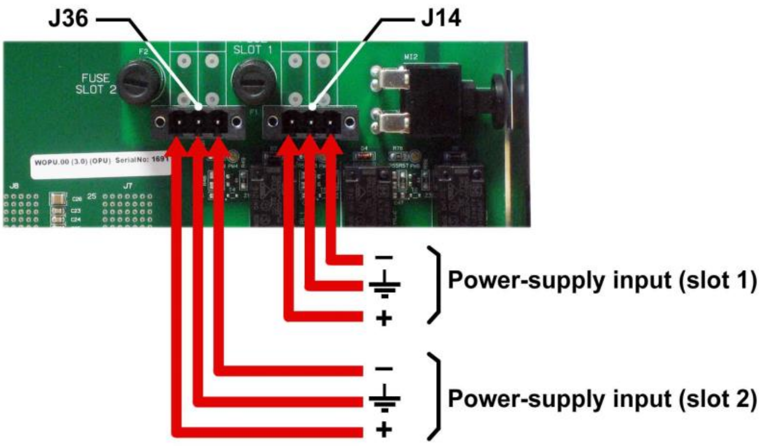
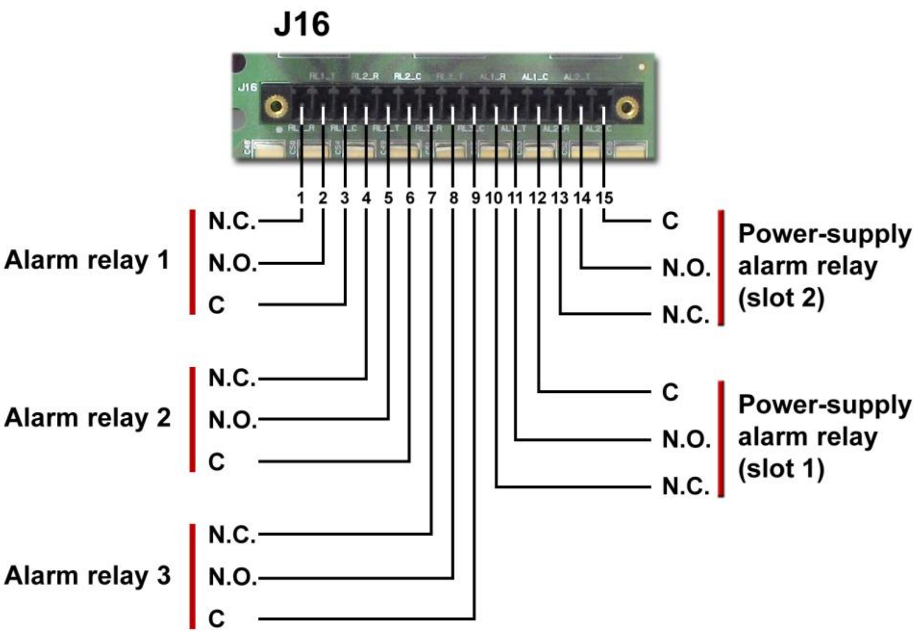


Figure 5.58 Use of the power-supply sockets.



*In **normal** operation conditions the relays are **energized**, that is, the **N.O.** and **C** contacts are short-circuited.*

Figure 5.59 Use of the alarm relay connector.

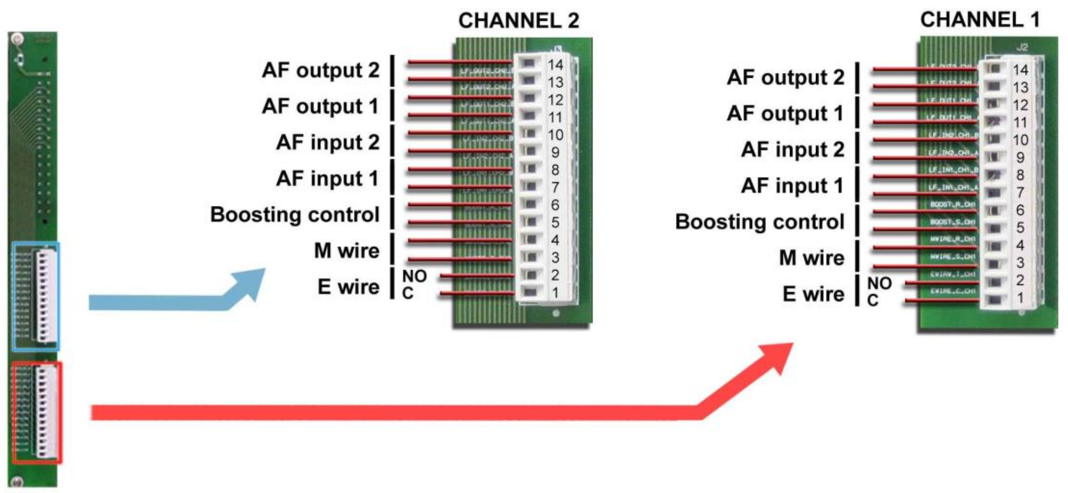
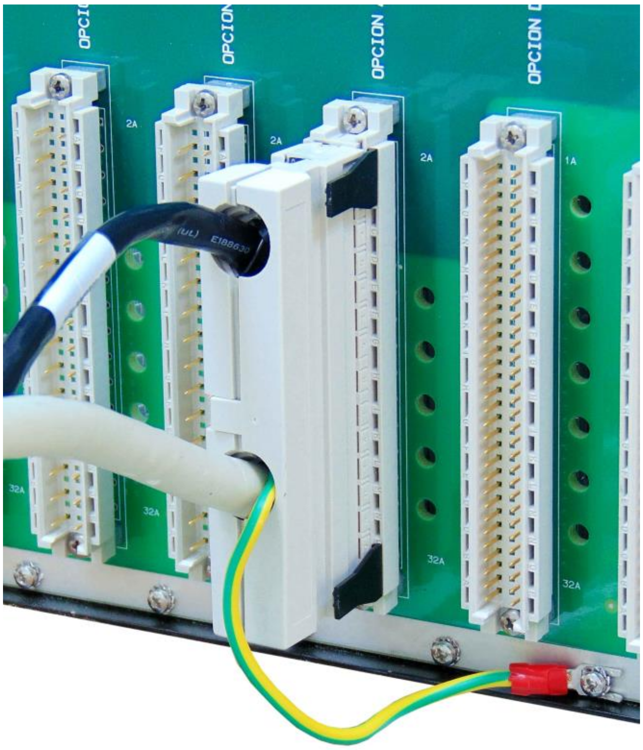


Figure 5.60 Use of the ZIPU plug-in terminal block associated with the AF input/output analog signals (IOPU option).



*When connecting a cable to the corresponding connector on the shelf associated with options, attach the earth cable to the **screw** at the bottom of the chassis.*

Figure 5.61 Detail of the earth cable fixing.

5.5.3 OPU-1 for 80 W

The elements available on the back of the **OPU-1** for **80** W are indicated in the attached figure.

The first **3** s.u. back panel (**WPPU.00**) contains the high-frequency output coaxial connector and associated configuration elements, the line test points, the dummy load, and the elements for selecting the bandwidth of the **first** line filter and output impedance of the **first** high-frequency amplifier.

The second **3** s.u. back panel (**WPPU.80**) contains the elements for selecting the bandwidth of the **second** line filter and output impedance of the **second** high-frequency amplifier.

The **6** s.u. back panel (**WOPU**) contains the main switch, the fuses and the main connectors. It also has a setting to connect chassis to earth.

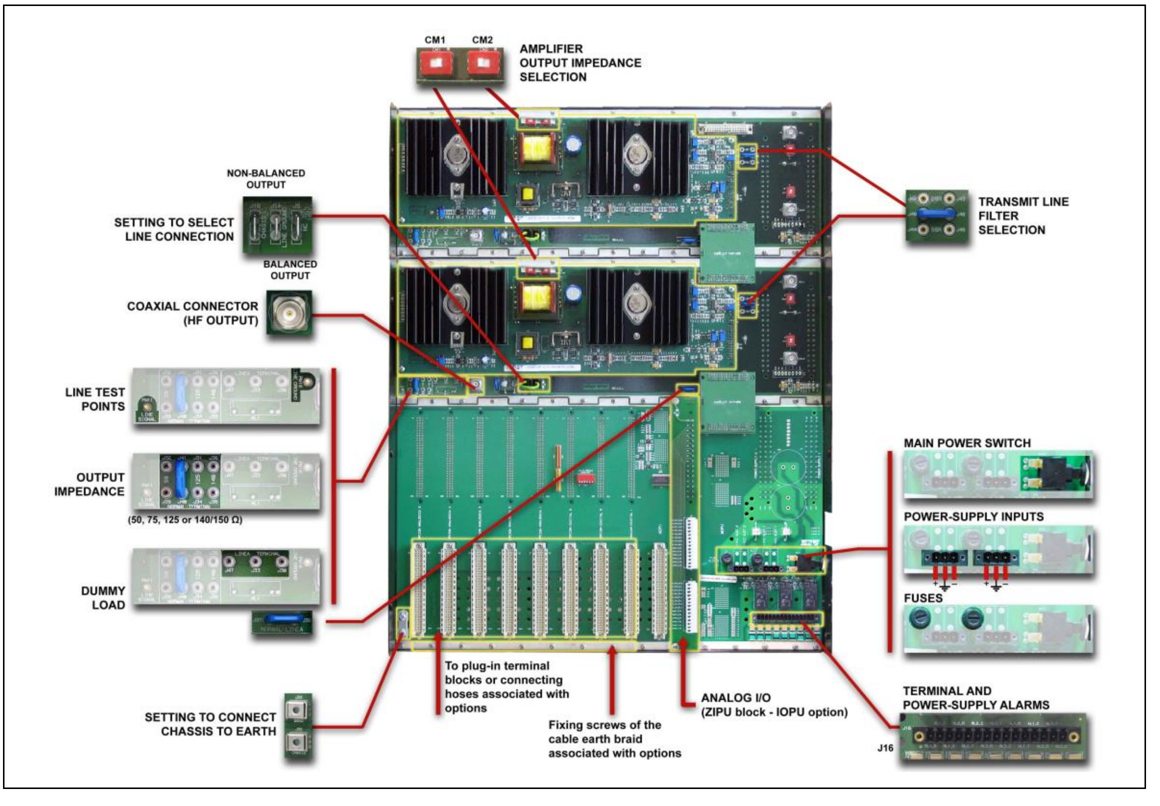


Figure 5.62 **Back panel elements of the OPU-1 for 80 W.**

5.5.3.a Microswitches & jumpers of the first 3 s.u. back panel (WPPU.00)

Microswitches CM1 & CM2

Selection of the output impedance of the **first** HF amplifier.

- **S** position: **8** kHz filter.
- **D** position: **16** kHz filter.
- **T** position: **24** kHz filter.

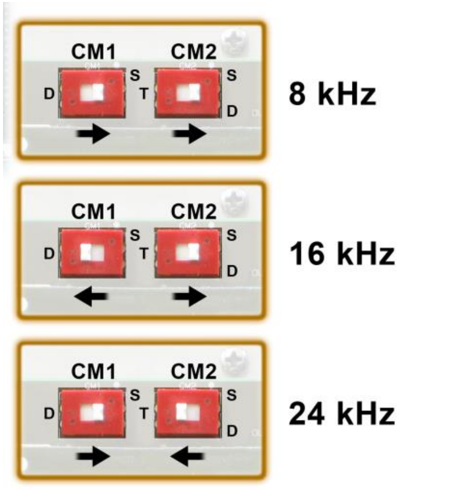


Figure 5.63 Selection of the output impedance of the first HF amplifier.

Jumpers 28R (J42-J43), 56R (J44-J45), 84R (J48-J46)

Selection of the bandwidth of the **first** line filter.

- **28R (J42-J43)** linked: **8** kHz filter.
- **56R (J44-J45)** linked: **16** kHz filter.
- **84R (J48-J46)** linked: **24** kHz filter.

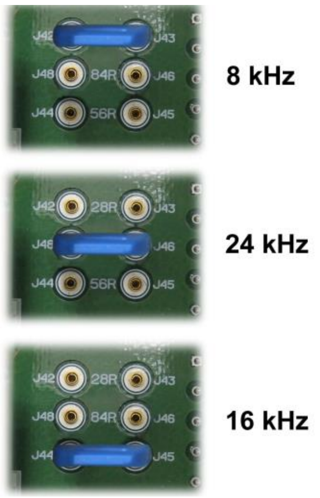


Figure 5.64 Selection of the bandwidth of the first line filter.

Jumpers 50 (J32-J39), 75 (J41-J40), 125 (J31-J34), 140 (J36-J35)	**Strap J47-J33-J30 & jumper J37-J38**
Selection of the output impedance. • **50 (J32-J39)** linked: **50** Ω • **75 (J41-J40)** linked: **75** Ω • **125 (J31-J34)** linked: **125** Ω • **140 (J36-J35)** linked: **140 / 150** Ω	Selection of the dummy-load connection. • **J47-J33** linked & **J37-J38** linked: Dummy load connected **line side**. • **J33-J30** linked & **J37-J38** NOT linked: Dummy load connected **terminal side**. • **J47-J33-J30** NOT linked & **J37-J38** linked: **Normal** position.

__J37-J38__ can be __removed__ if complete isolation of the terminal with respect to the line is required.

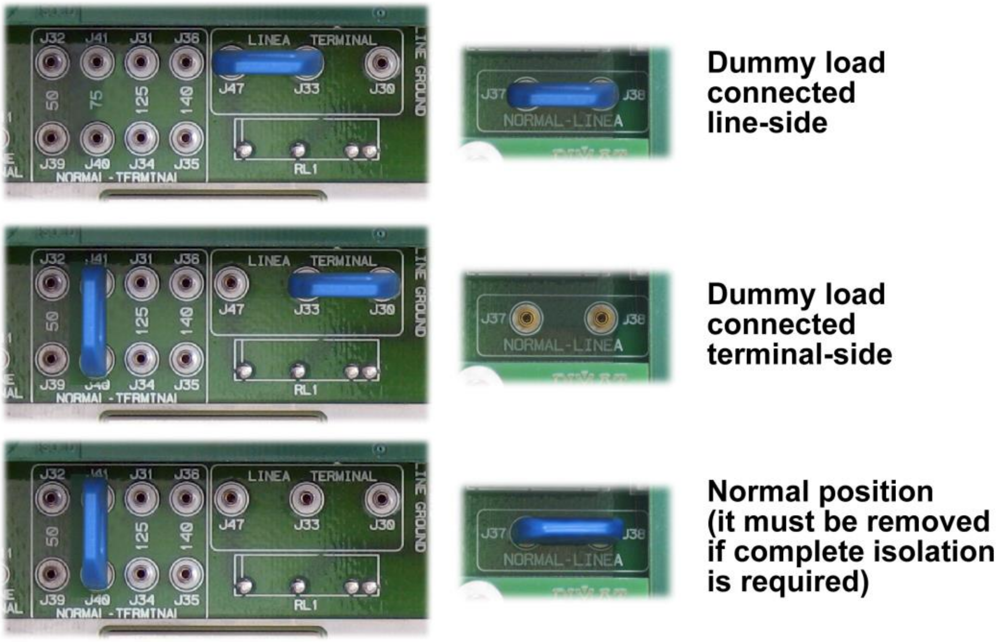
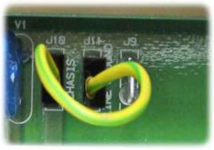


Figure 5.65 Selection of the dummy-load connection.

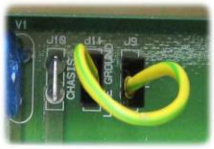
Strap J10-J11-J9

Selection of the line connection.

- **J10-J11** linked: **Non-balanced**.
- **J11-J9** linked: **Balanced** output.

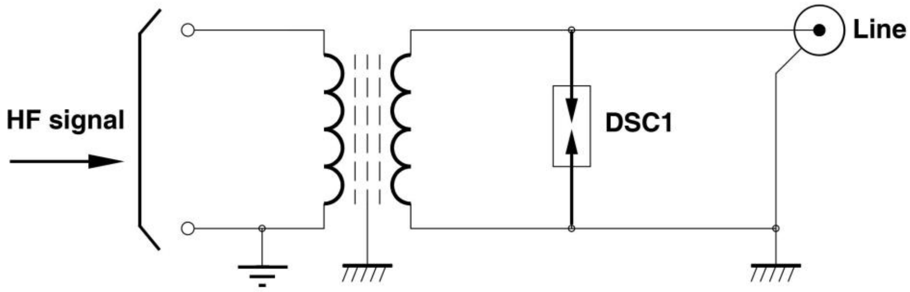


Non-balanced (Coaxial-cable shield connected to chassis)



Balanced (Coaxial-cable shield not connected to chassis)

Figure 5.66 Selection of the balanced or non-balanced line connection.



When the shield is connected to the chassis, the ***DSC2*** *surge arrester is short circuited.*

Figure 5.67 Non-balanced output.

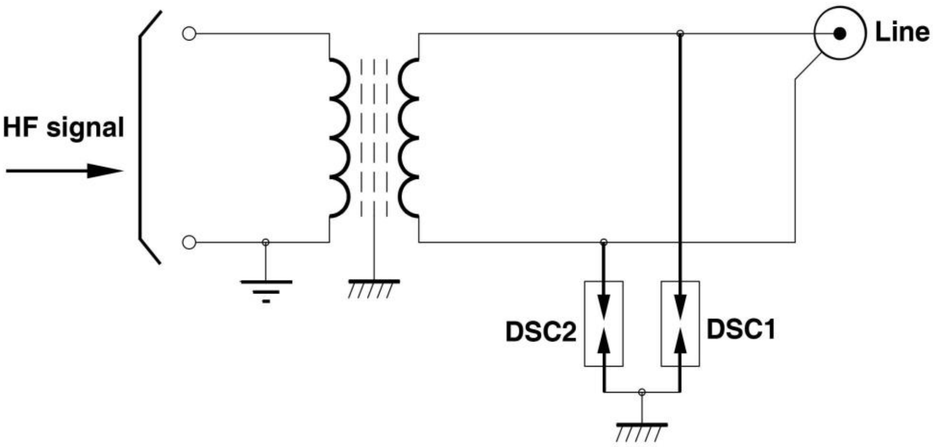


Figure 5.68 Balanced output.

5.5.3.b Microswitches & jumpers of the second 3 s.u. back panel (WPPU.80)

Microswitches CM1 & CM2

Selection of the output impedance of the **second** HF amplifier.

- **S** position: **8** kHz filter.
- **D** position: **16** kHz filter.
- **T** position: **24** kHz filter.

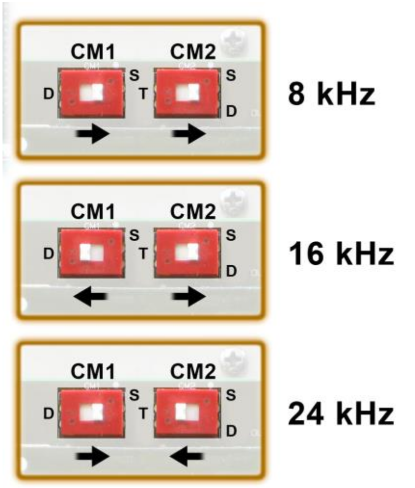


Figure 5.69 Selection of the output impedance of the second HF amplifier.

Jumpers 28R (J42-J43), 56R (J44-J45), 84R (J48-J46)

Selection of the bandwidth of the **second** line filter.

- **28R (J42-J43)** linked: **8** kHz filter.
- **56R (J44-J45)** linked: **16** kHz filter.
- **84R (J48-J46)** linked: **24** kHz filter.

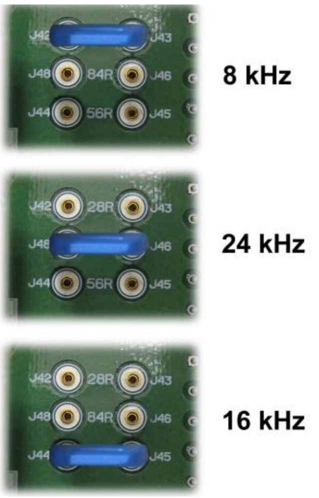


Figure 5.70 Selection of the bandwidth of the second line filter.

5.5.3.c Use of main connectors of the 6 s.u. back panel (WOPU)

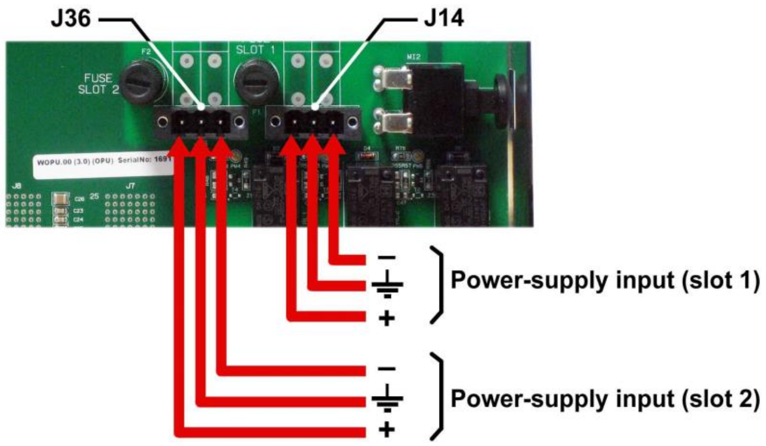
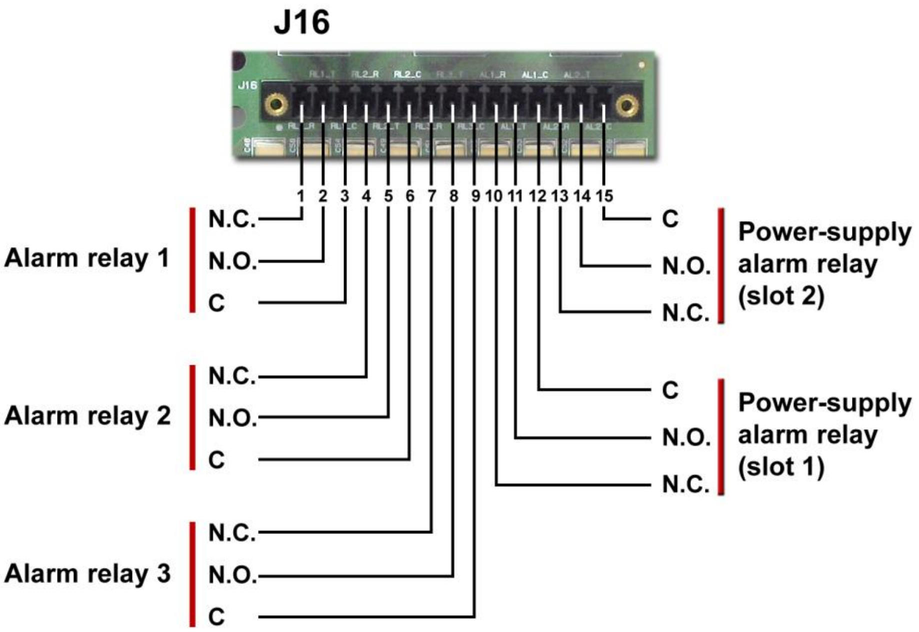


Figure 5.71 Use of the power-supply sockets.



*In **normal** operation conditions the relays are **energized**, that is, the **N.O.** and **C** contacts are short-circuited.*

Figure 5.72 Use of the alarm relay connector.

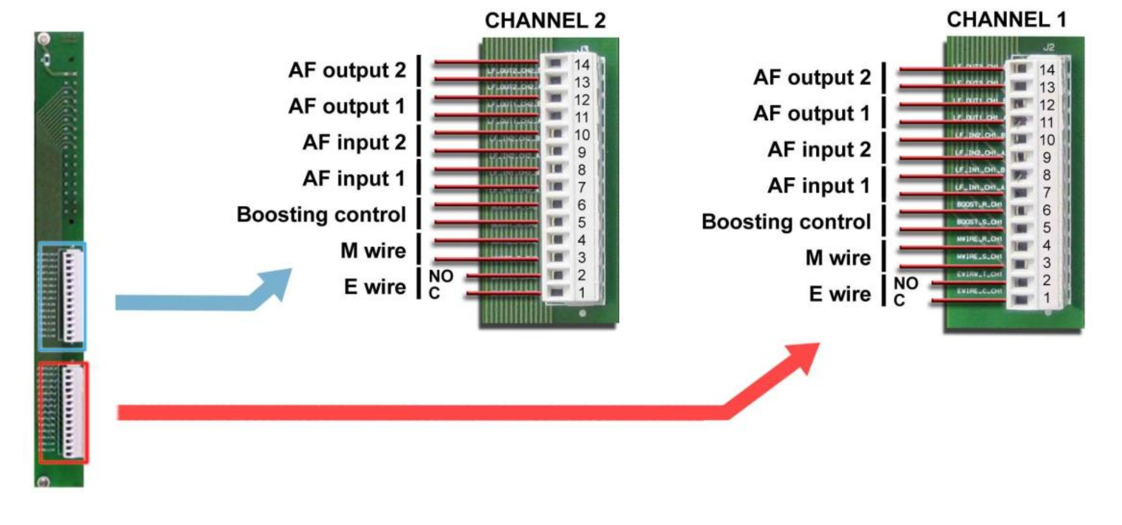
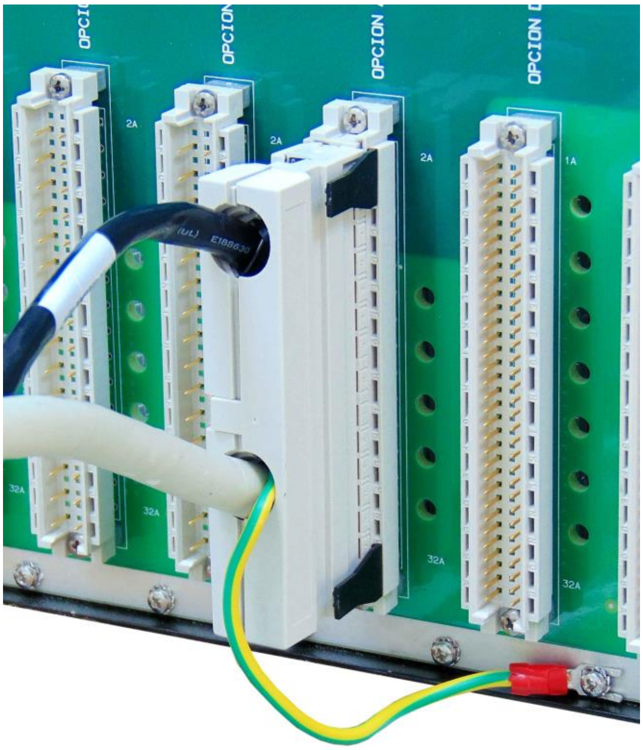


Figure 5.73 Use of the ZIPU plug-in terminal block associated with the AF input/output analog signals (IOPU option).



When connecting a cable to the corresponding connector on the shelf associated with options, attach the earth cable to the ***screw*** *at the bottom of the chassis.*

Figure 5.74 Detail of the earth cable fixing.

5.5.4 OPU-1 with additional filter

The elements available on the back of the **OPU-1** for **20** W & **40** W with additional filter are indicated in the attached figure.

The first **3** s.u. back panel (**WPPU.00**) contains the elements associated with the **first channel** (usually the **analog** channel). It contains the high-frequency output coaxial connector and associated configuration elements, the line test points, the dummy load, and the elements for selecting the bandwidth of the line filter of channel **1** and output impedance of the high-frequency amplifier of channel **1.**

The second **3** s.u. back panel (**WPPU.00**) contains the elements associated with the **second channel** (usually the **digital** channel). It contains the high-frequency output coaxial connector and associated configuration elements, the line test points, the dummy load, and the elements for selecting the bandwidth of the line filter of channel **2** and output impedance of the high-frequency amplifier of channel **2.**

The **6** s.u. back panel (**WOPU**) contains the main switch, the fuses and the main connectors. It also has a setting to connect chassis to earth.

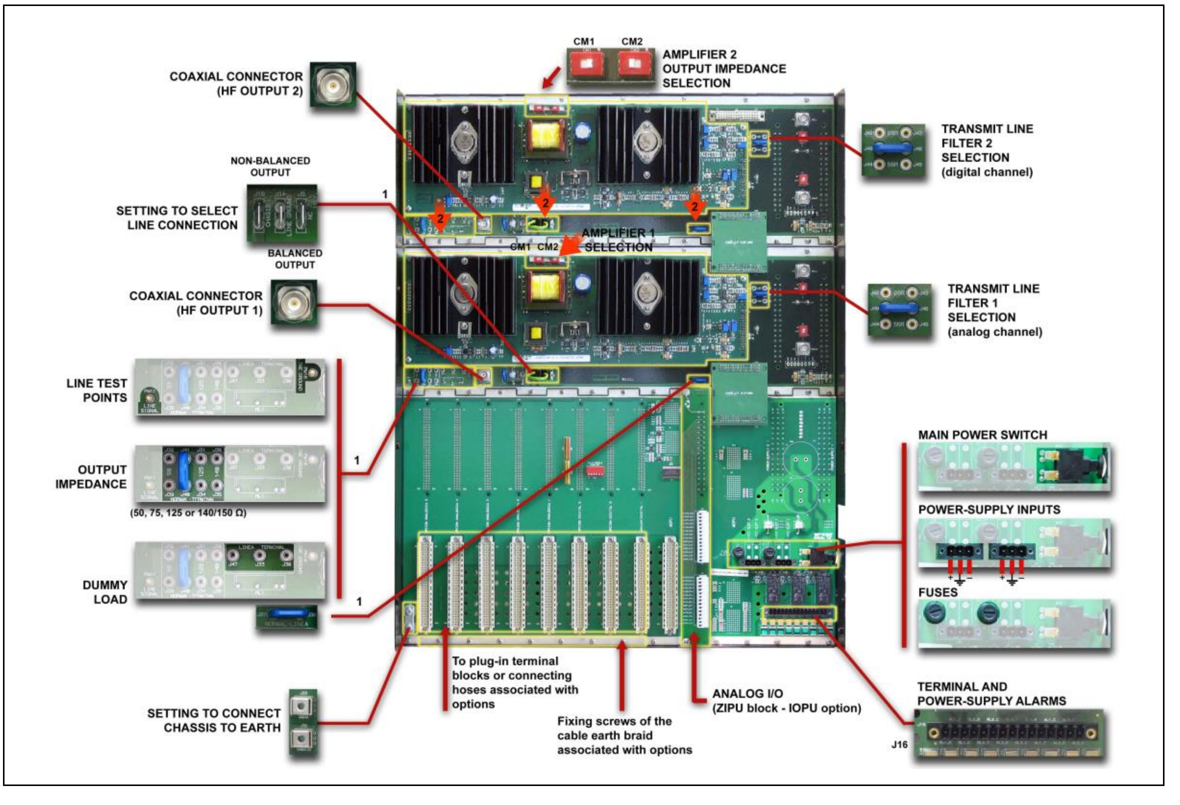


Figure 5.75 Back panel elements of the OPU-1 for 20 W & 40 W with additional filter.

5.5.4.a Microswitches & jumpers of the first 3 s.u. back panel (WPPU.00)

Microswitches CM1 & CM2

Selection of the output impedance of the HF amplifier (channel **1**).

- **S** position: **8** kHz filter.
- **D** position: **16** kHz filter.
- **T** position: **24** kHz filter.

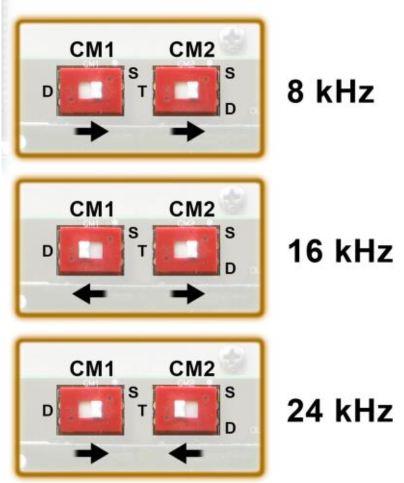


Figure 5.76 Selection of the output impedance of the HF amplifier (channel 1).

Jumpers 28R (J42-J43), 56R (J44-J45), 84R (J48-J46)

Selection of the bandwidth of the line filter (channel **1**).

- **28R (J42-J43)** linked: **8** kHz filter.
- **56R (J44-J45)** linked: **16** kHz filter.
- **84R (J48-J46)** linked: **24** kHz filter.

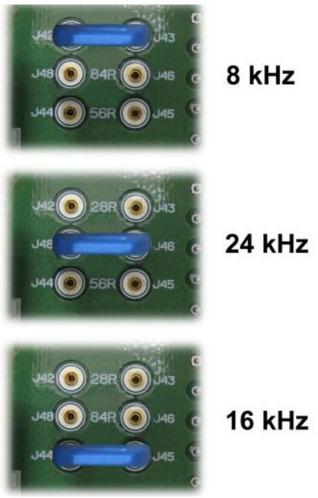


Figure 5.77 Selection of the bandwidth of the line filter (channel 1).

Jumpers 50 (J32-J39), 75 (J41-J40), 125 (J31-J34), 140 (J36-J35)

Selection of the output impedance (channel **1**).

- **50 (J32-J39)** linked: **50** Ω
- **75 (J41-J40)** linked: **75** Ω
- **125 (J31-J34)** linked: **125** Ω
- **140 (J36-J35)** linked: **140 / 150** Ω

Strap J47-J33-J30 & jumper J37-J38

Selection of the dummy-load connection (channel **1**).

- **J47-J33** linked & **J37-J38** linked: Dummy load connected **line side**.
- **J33-J30** linked & **J37-J38** NOT linked: Dummy load connected **terminal side**.
- **J47-J33-J30** NOT linked & **J37-J38** linked: **Normal** position.

J37-J38 *can be* ***removed*** *if complete isolation of the terminal with respect to the line is required.*

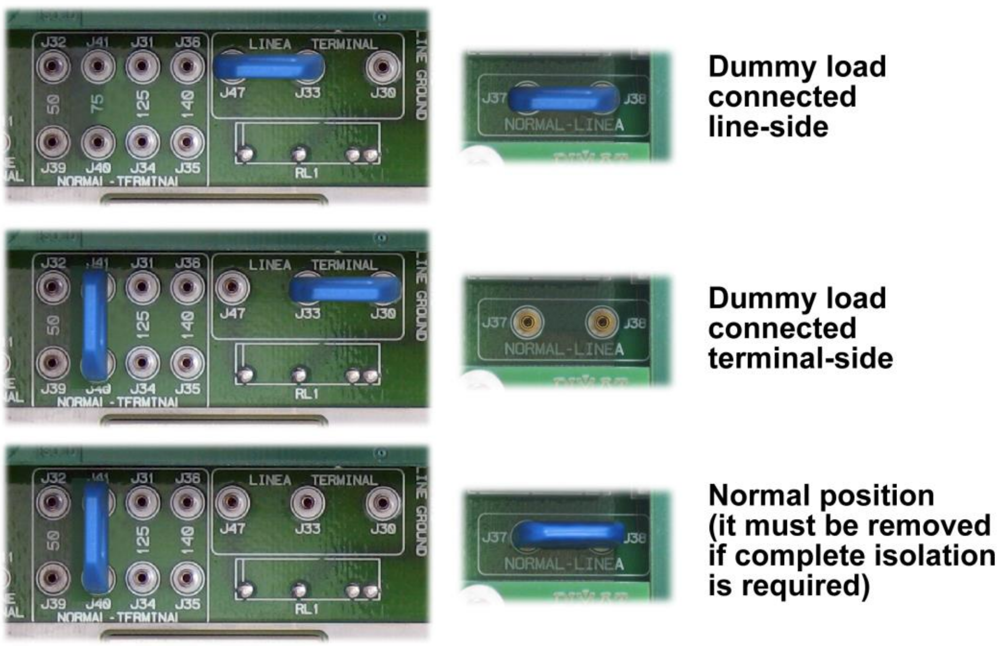
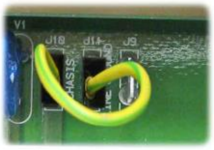


Figure 5.78 Selection of the dummy-load connection (channel 1).

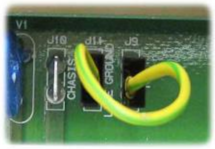
Strap J10-J11-J9

Selection of the line connection (channel **1**).

- **J10-J11** linked: **Non-balanced**.
- **J11-J9** linked: **Balanced** output.

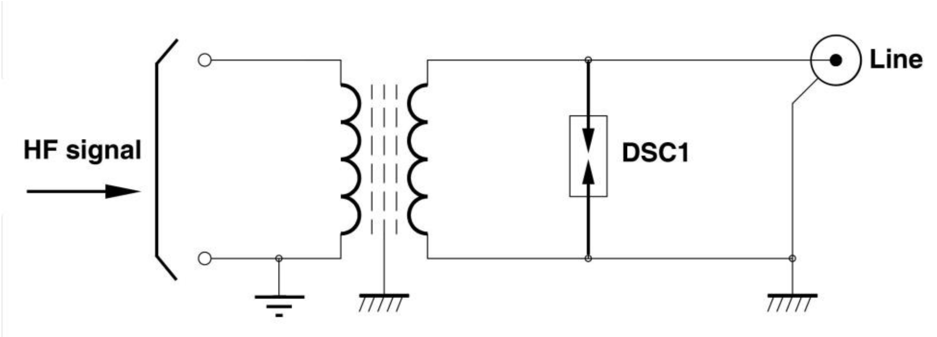


Non-balanced (Coaxial-cable shield connected to chassis)



Balanced (Coaxial-cable shield not connected to chassis)

Figure 5.79 Selection of the balanced or non-balanced line connection (channel 1).



*When the shield is connected to the chassis, the **DSC2** surge arrester is short circuited.*

Figure 5.80 Non-balanced output.

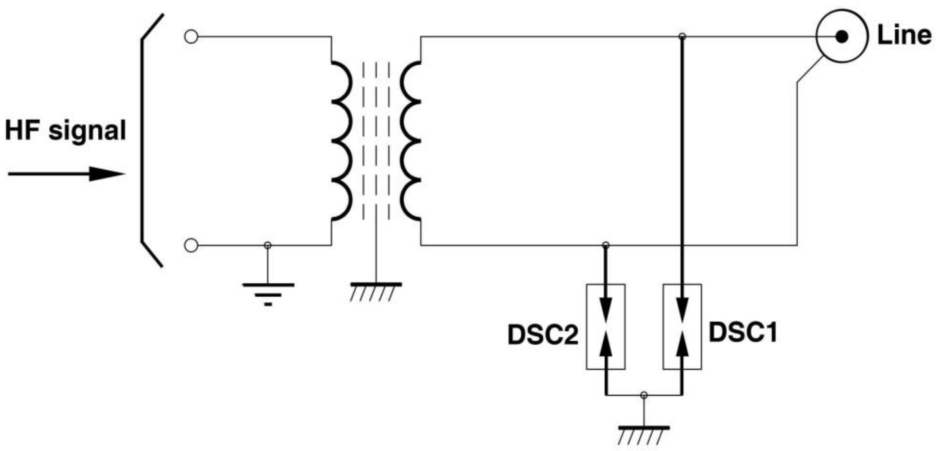


Figure 5.81 Balanced output.

5.5.4.b Microswitches & jumpers of the second 3 s.u. back panel (WPPU.00)

Microswitches CM1 & CM2

Selection of the output impedance of the HF amplifier (channel **2**).

- **S** position: **8** kHz filter.
- **D** position: **16** kHz filter.
- **T** position: **24** kHz filter.

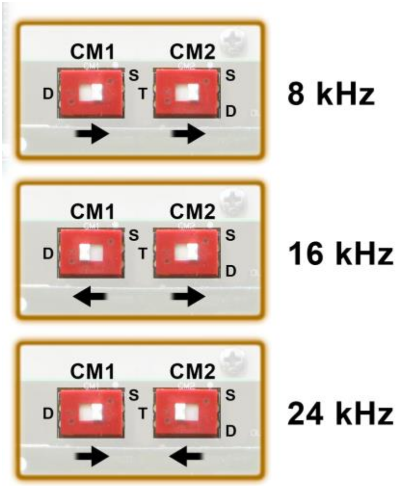


Figure 5.82 Selection of the output impedance of the HF amplifier (channel 2).

Jumpers 28R (J42-J43), 56R (J44-J45), 84R (J48-J46)

Selection of the bandwidth of the line filter (channel **2**).

- **28R (J42-J43)** linked: **8** kHz filter.
- **56R (J44-J45)** linked: **16** kHz filter.
- **84R (J48-J46)** linked: **24** kHz filter.

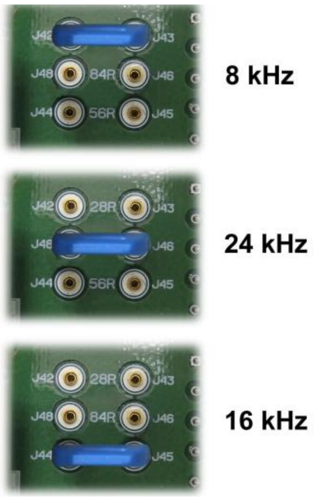


Figure 5.83 Selection of the bandwidth of the line filter (channel 2).

Jumpers 50 (J32-J39), 75 (J41-J40), 125 (J31-J34), 140 (J36-J35)

Selection of the output impedance (channel **2**).

- **50 (J32-J39)** linked: **50** Ω
- **75 (J41-J40)** linked: **75** Ω
- **125 (J31-J34)** linked: **125** Ω
- **140 (J36-J35)** linked: **140 / 150** Ω

Strap J47-J33-J30 & jumper J37-J38

Selection of the dummy-load connection (channel **2**).

- **J47-J33** linked & **J37-J38** linked: Dummy load connected **line side**.
- **J33-J30** linked & **J37-J38** NOT linked: Dummy load connected **terminal side**.
- **J47-J33-J30** NOT linked & **J37-J38** linked: **Normal** position.

__J37-J38__ can be __removed__ if complete isolation of the terminal with respect to the line is required.

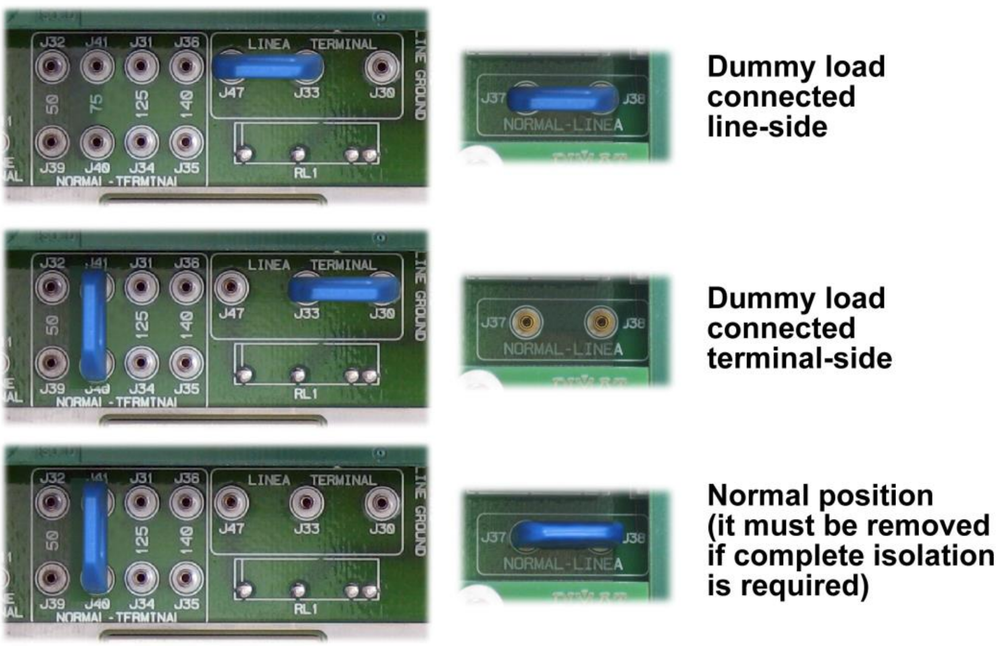
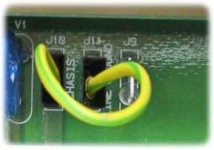


Figure 5.84 Selection of the dummy-load connection (channel 2).

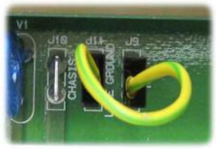
Strap J10-J11-J9

Selection of the line connection (channel **2**).

- **J10-J11** linked: **Non-balanced**.
- **J11-J9** linked: **Balanced** output.

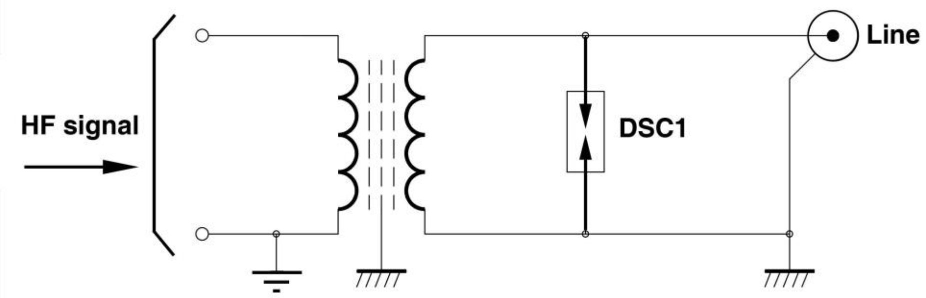


Non-balanced (Coaxial-cable shield connected to chassis)



Balanced (Coaxial-cable shield not connected to chassis)

Figure 5.85 Selection of the balanced or non-balanced line connection (channel 2).



*When the shield is connected to the chassis, the **DSC2** surge arrester is short circuited.*

Figure 5.86 Non-balanced output.

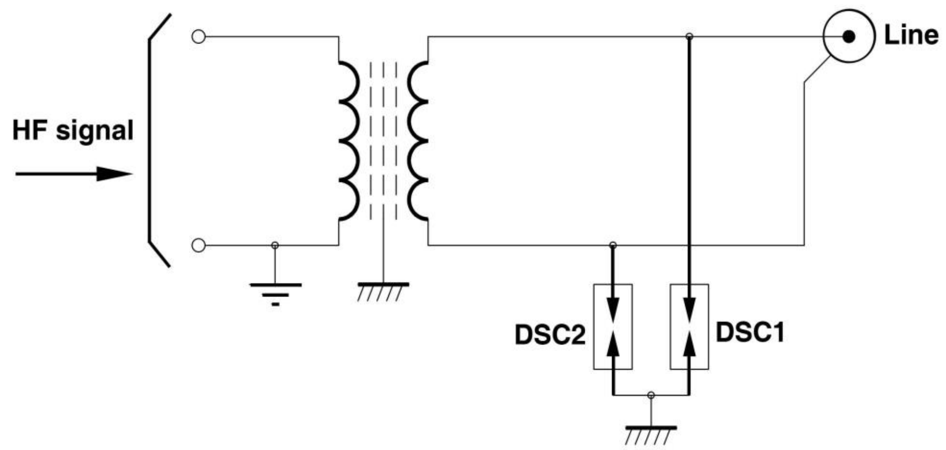


Figure 5.87 Balanced output.

5.5.4.c Use of main connectors of the 6 s.u. back panel (WOPU)

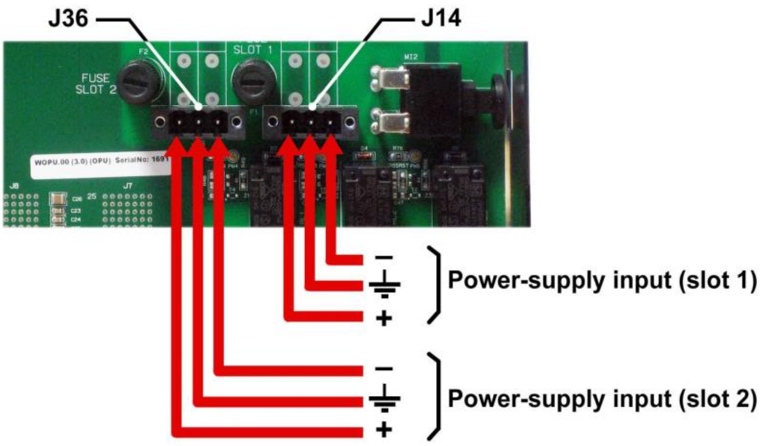
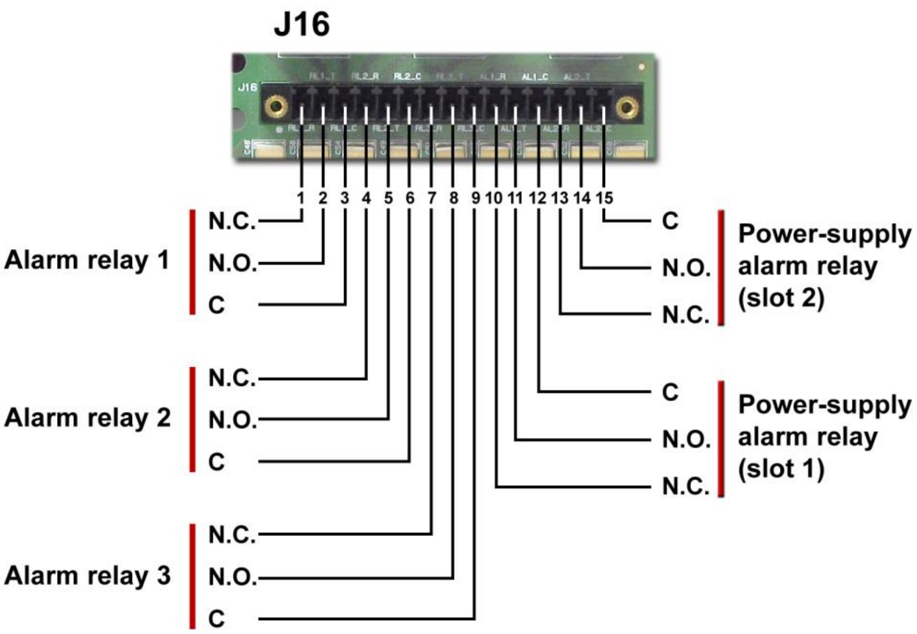


Figure 5.88 Use of the power-supply sockets.



*In **normal** operation conditions the relays are **energized**, that is, the **N.O.** and **C** contacts are short-circuited.*

Figure 5.89 Use of the alarm relay connector.

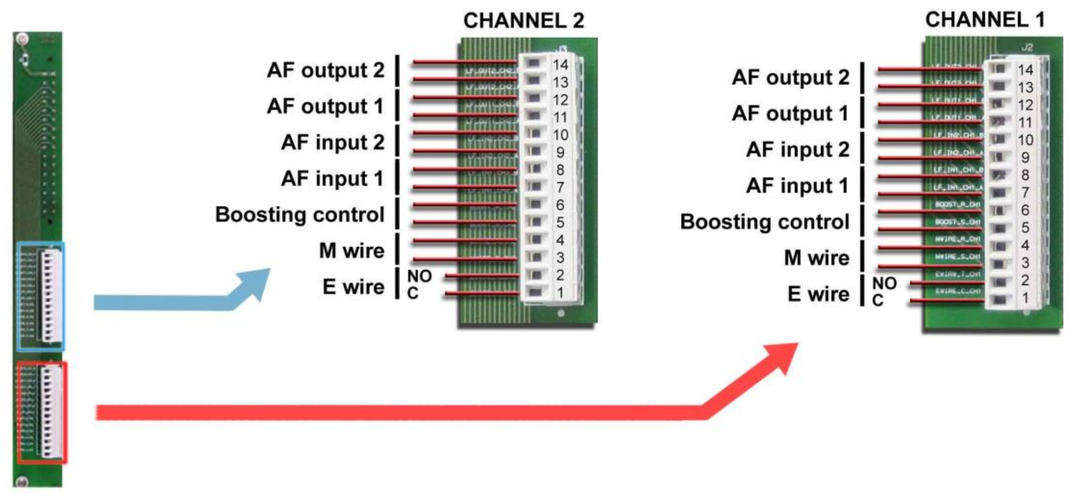
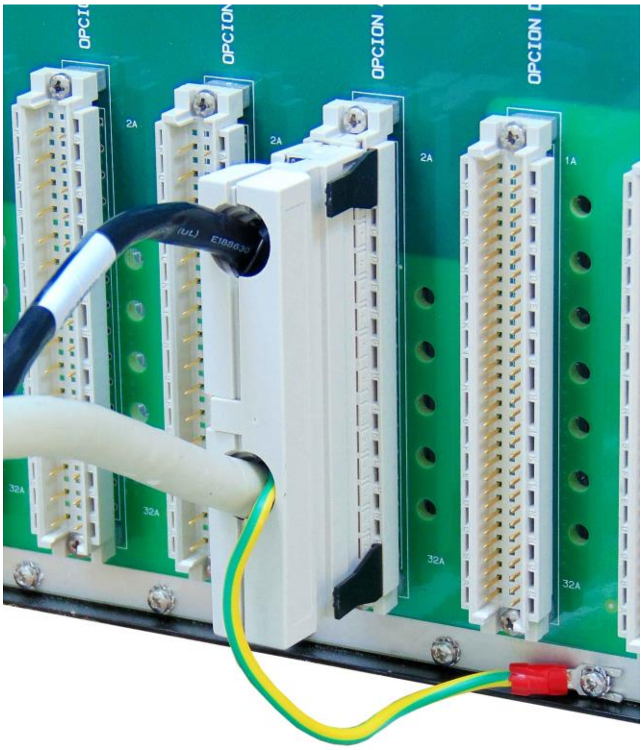


Figure 5.90 Use of the ZIPU plug-in terminal block associated with the AF input/output analog signals (IOPU option).



*When connecting a cable to the corresponding connector on the shelf associated with options, attach the earth cable to the **screw** at the bottom of the chassis.*

Figure 5.91 Detail of the earth cable fixing.

5.5.5 OPU-1 for HF Teleprotection

The elements available on the back of the **OPU-1** for **20** W & **40** W for high-frequency teleprotection functionality are indicated in the attached figure.

The **3** s.u. back panel (**WAPU**) contains the high-frequency output coaxial connector and associated configuration elements, the dummy load, and the elements for selecting the output impedance of the high-frequency amplifier.

The **6** s.u. back panel (**WOPU**) contains the main switch, the fuses and the main connectors. It also has a setting to connect chassis to earth.

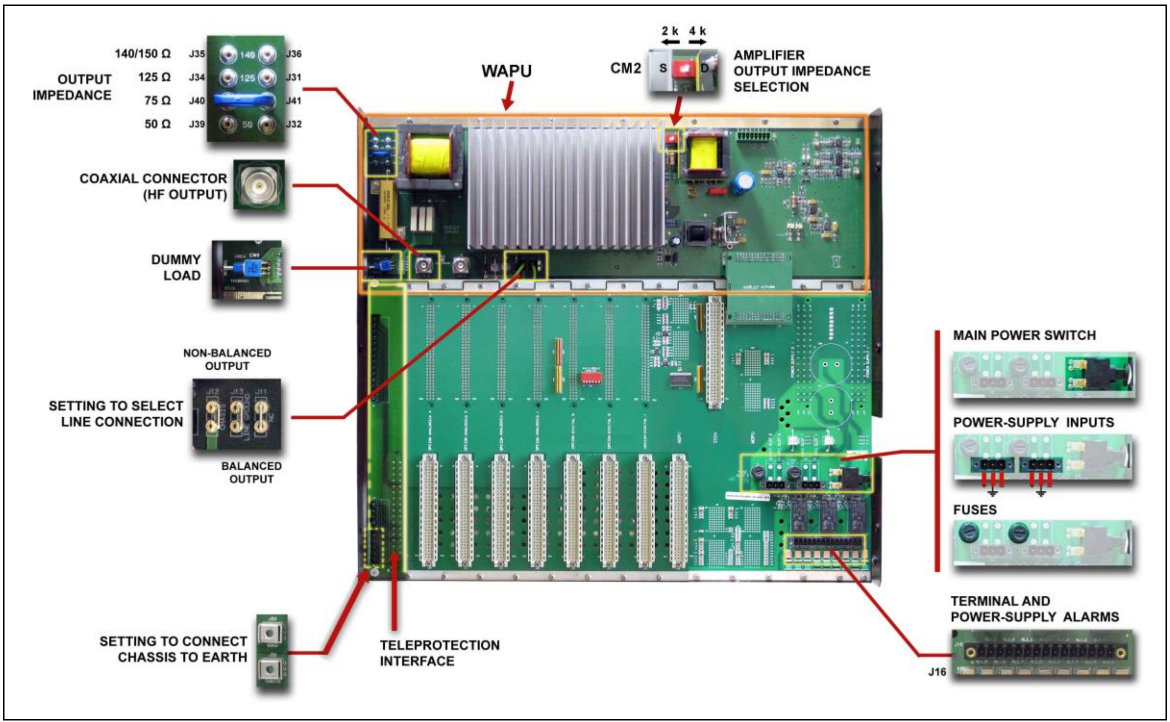


Figure 5.92 **Back panel elements of the OPU-1 for 20 W & 40 W for HF Teleprotection functionality.**

5.5.5.a Microswitches & jumpers of the 3 s.u. back panel (WAPU)

Microswitch CM2

Selection of the output impedance of the HF amplifier.

- **D** position: **4** kHz filter (**2** kHz + **2** kHz).
- **S** position: **2** kHz filter (**1** kHz + **1** kHz).

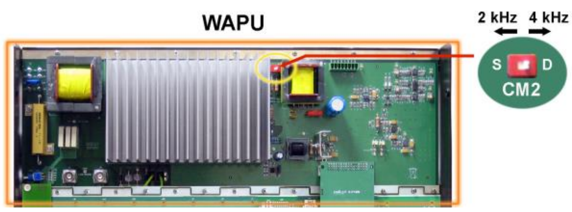


Figure 5.93 Selection of the output impedance of the HF amplifier.

Jumpers 50 (J39-J32), 75 (J40-J41), 125 (J34-J31), 140 (J35-J36)

Selection of the output impedance.

- **50 (J39-J32)** linked: **50** Ω
- **75 (J40-J41)** linked: **75** Ω
- **125 (J34-J31)** linked: **125** Ω
- **140 (J35-J36)** linked: **140 / 150** Ω

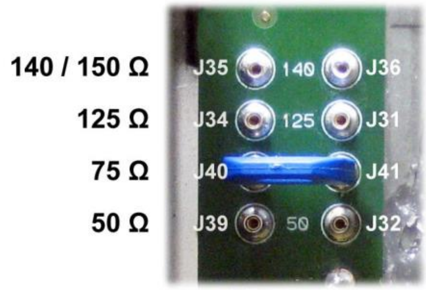


Figure 5.94 Selection of the output impedance.

Switch CM5

Selection of the dummy-load connection.

- **LINE** (top): Dummy load connected **line** side.
- **NORMAL** (central): **Normal** position.
- **TERMINAL** (down): Dummy load connected **terminal** side.

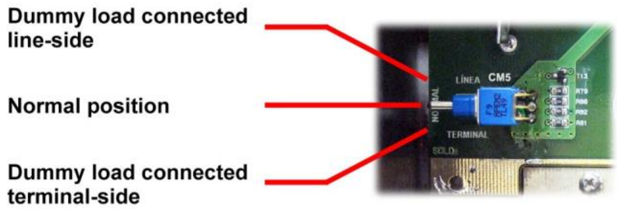


Figure 5.95 Selection of the dummy-load connection.

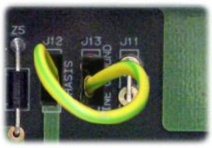
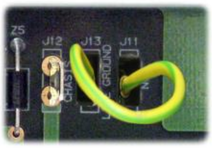
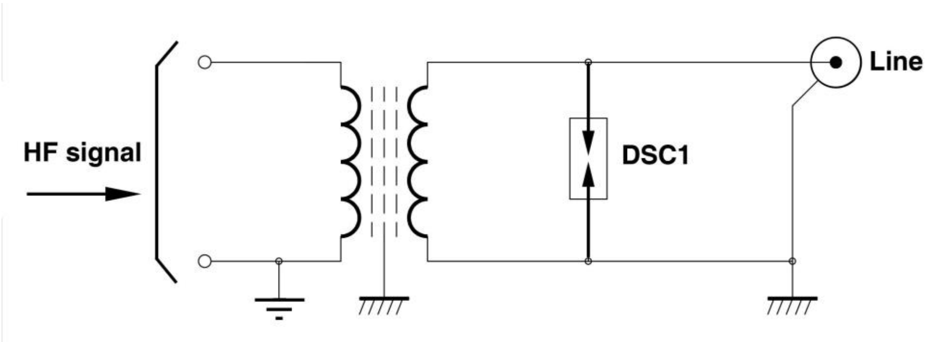
Strap J12-J13-J11 Selection of the line connection. • **J12-J13** linked: **Non-balanced**. • **J13-J11** linked: **Balanced** output.	 **Non-balanced (Coaxial-cable shield connected to chassis)**  **Balanced (Coaxial-cable shield not connected to chassis)**

Figure 5.96 Selection of the balanced or non-balanced line connection.



*When the shield is connected to the chassis, the **DSC2** surge arrester is short circuited.*

Figure 5.97 Non-balanced output.

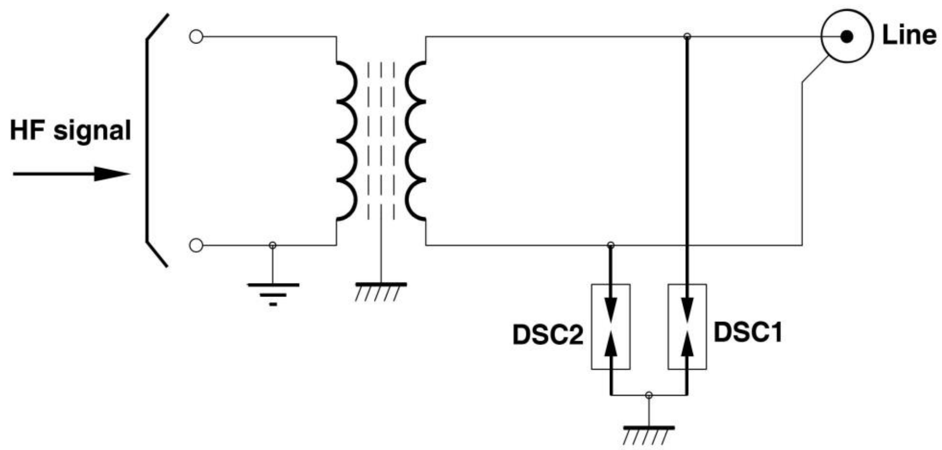


Figure 5.98 Balanced output.

5.5.5.b Use of main connectors of the 6 s.u. back panel (WOPU)

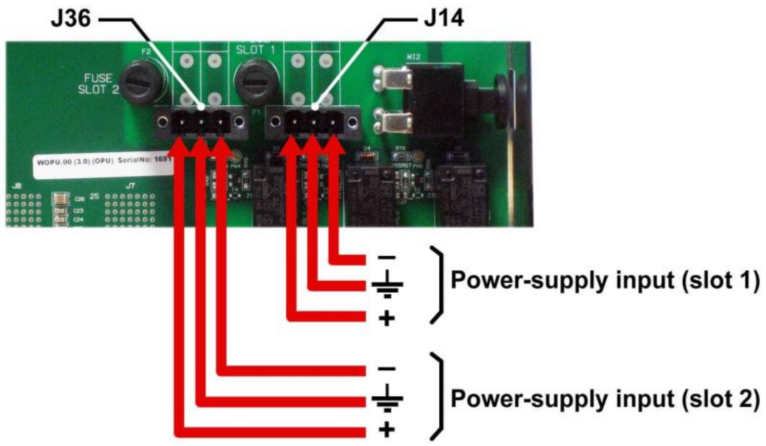
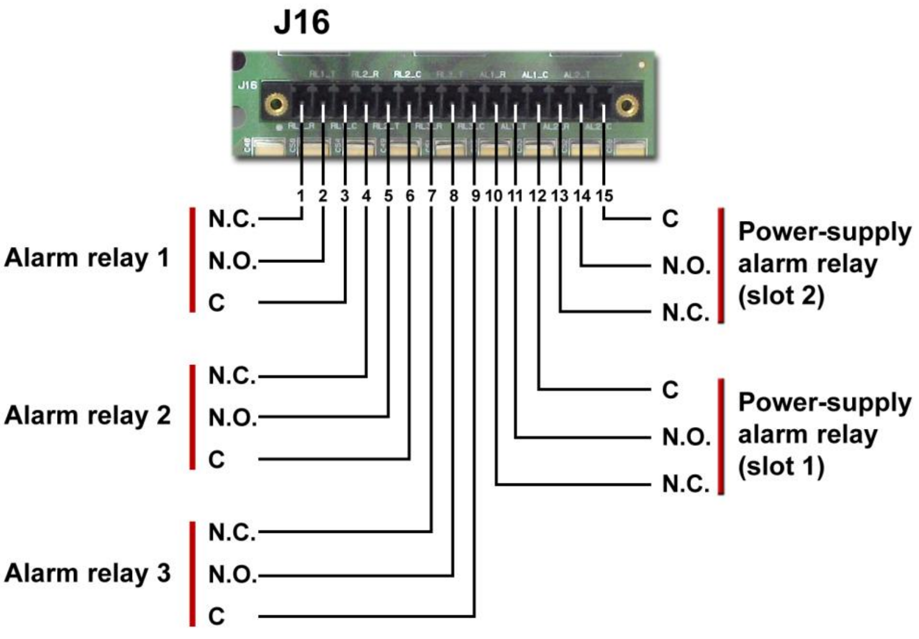


Figure 5.99 Use of the power-supply sockets.



*In **normal** operation conditions the relays are **energized**, that is, the **N.O.** and **C** contacts are short-circuited.*

Figure 5.100 Use of the alarm relay connector.

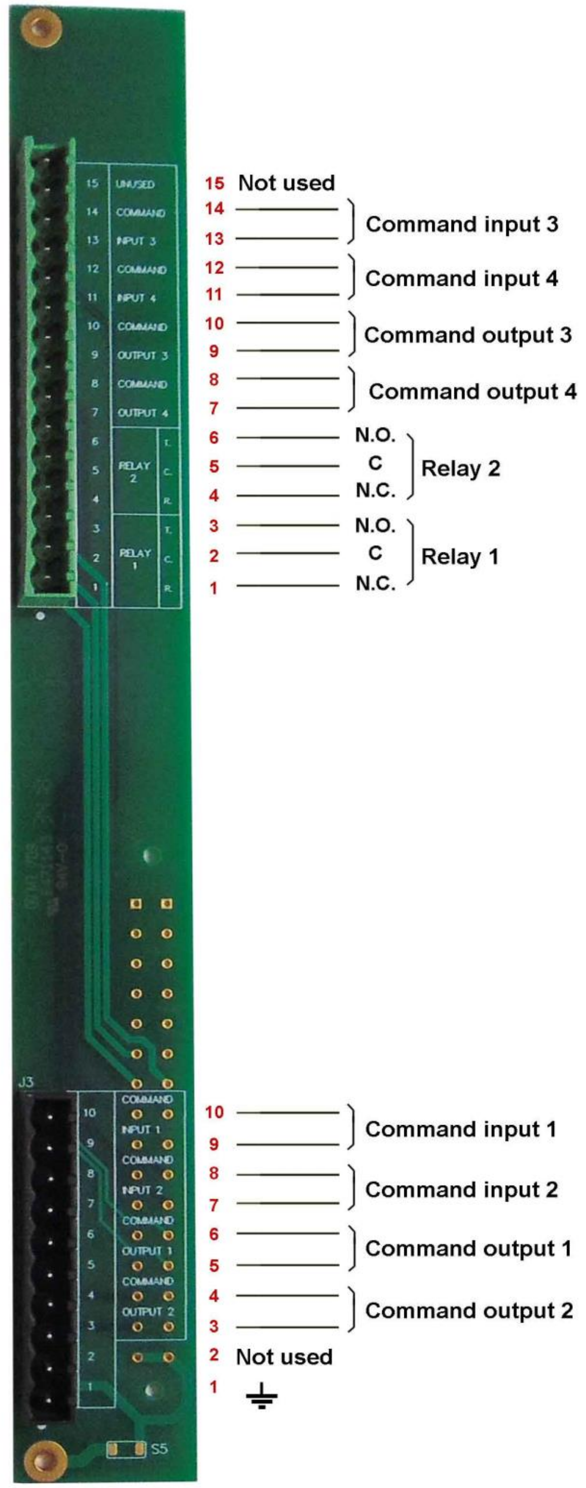


Figure 5.101 Use of the ZBPU plug-in terminal block associated with the teleprotection interface (TPPU module).

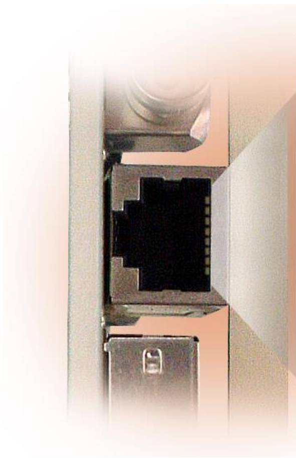
5.6 Connections on front connectors

5.6.1 Management connection (MOPU)

The **OPU-1** has a **10/100Base-Tx** LAN interface and can thus be integrated into a **LAN**. The associated connector is on the front of the **MOPU** module and is a female **8-pin RJ-45**.

The cable used to carry out the connection between the terminal and the computer must be a category five unshielded twisted **4**-pair cable (**UTP-5**) with **8**-pin **RJ-45** connectors.

The **UTP-5** cable is made up of eight copper wires that form the four twisted pairs, covered in different coloured insulating material. The colour of the wires that make up each one of the pairs is in accordance with the **ANSI/TIA/EIA-568-A** standard.



Pin	Pair	Assignment
1	3	TD+
2	3	TD-
3	2	RD+
4	1	Not used
5	1	Not used
6	2	RD-
7	4	Not used
8	4	Not used

Figure 5.102 RJ-45 connector signals (10/100Base-Tx LAN interface).

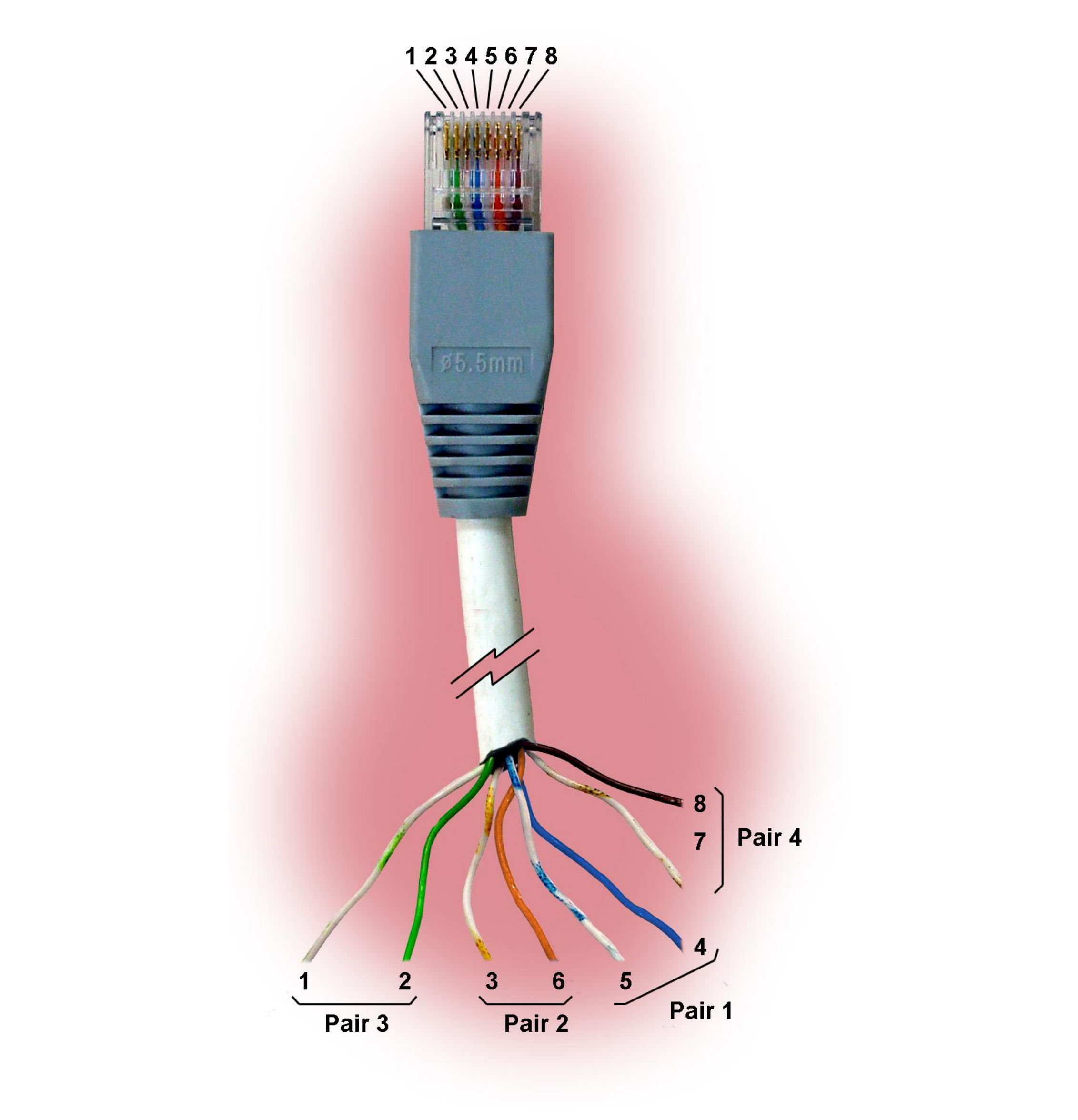


Figure 5.103 Unshielded twisted pair cable (UTP-5) according to ANSI/TIA/EIA-568-A standard.

5.6.2 Port 1 (MQPU)

The **PORT 1** of the **MQPU**-1 module is one of the two basic ports of the **OPU-1** equipment.

It corresponds to a **synchronous** data port at **64** kbit/s with interface **G.703** codirectional.

The **OPU-1** equipment is **DCE**.

Pin	Assignment	
4 5	Tx– Tx+	Transmitted data
1 2	Rx– Rx+	Received data

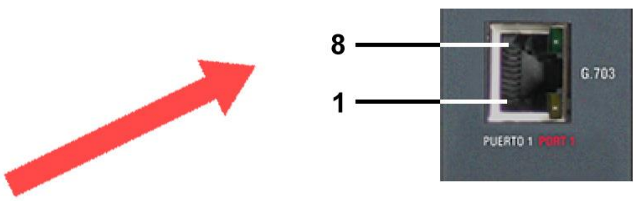


Figure 5.104 G.703 signals of PORT 1 connector (MQPU).

5.6.3 Port 2 (MQPU)

The **PORT 2** of the **MQPU**-1 module is one of the two basic ports of the **OPU-1** equipment.

It corresponds to an **asynchronous** data port of up to **14400** bit/s with interface **V.24 / V.28** of the ITU-T.

The **OPU-1** equipment is **DCE**.

Pin	Assignment	
3	TD	Transmitted data
2	RD	Received data
8	CTS	Ready for sending
7	RTS	Request to send
1	DCD	Data channel received line signal detector
6	DSR	Data set ready
5	GND	Signal ground

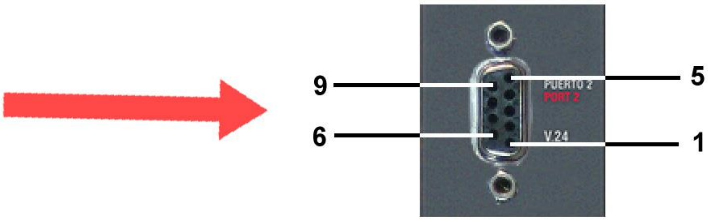


Figure 5.105 V.24 signals of PORT 2 connector (MQPU).

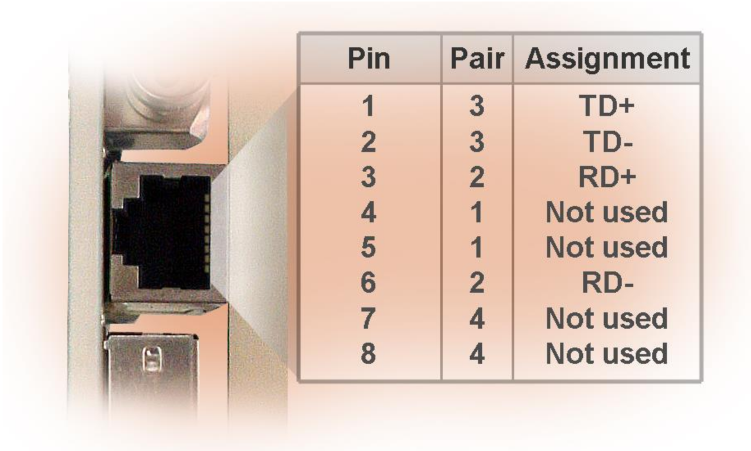
5.6.4 Ethernet port (MQPU)

The **MQPU** module has two **Ethernet** interfaces whose connector corresponds to a female **8-pin RJ-45**.

The two Ethernet ports (**ETH1** & **ETH2**) work as a part of a two-port hub.

The cable used to carry out the connection must be a category five unshielded twisted **4**-pair cable (**UTP-5**) with **8**-pin **RJ-45** connectors.

*The **Ethernet bridge** of the link is enabled by default. This means that this port has an assigned position in the internal frame, being able to transmit information by using the remaining bits of the frame.*



Pin	Pair	Assignment
1	3	TD+
2	3	TD-
3	2	RD+
4	1	Not used
5	1	Not used
6	2	RD-
7	4	Not used
8	4	Not used

Figure 5.106 RJ-45 connector signals (ETH1 & ETH2).

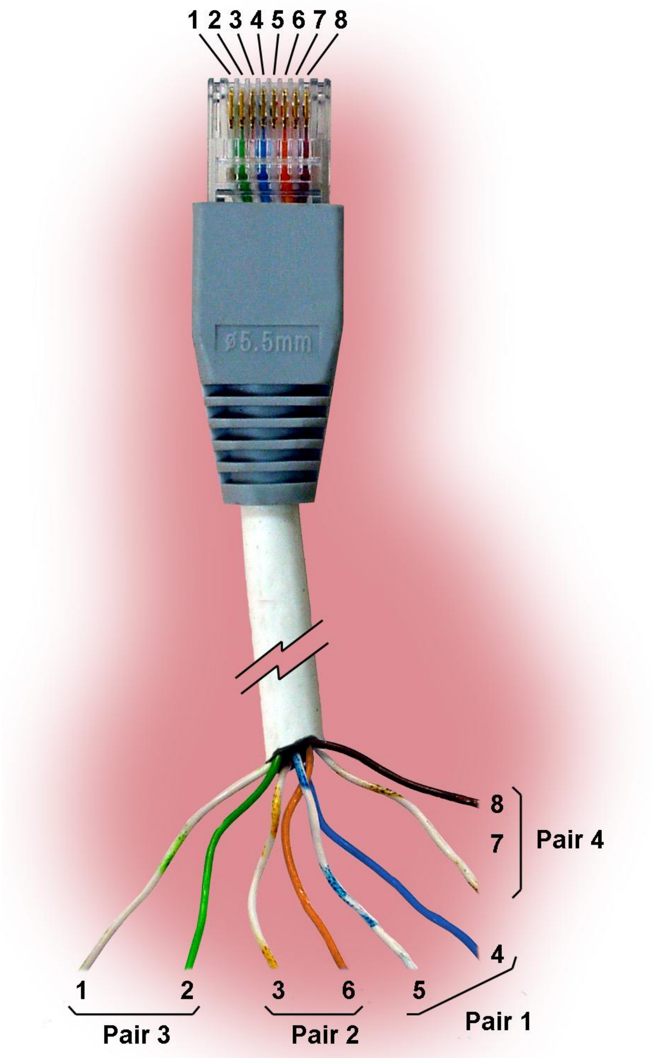


Figure 5.107 Unshielded twisted pair cable (UTP-5) according to ANSI/TIA/EIA-568-A standard.

5.6.5 DMPU front data ports

The number of ports and their arrangement depends on the module type.

There are the following module types:
DMPU.02 Two **front** data ports, identified as **3/9/15** and **4/10/16**
DMPU.04 Four **front** data ports, identified as **3/9/15**, **4/10/16**, **5/11/17** and **6/12/18**
DMPU.06 Six **front** data ports, identified as **3/9/15**, **4/10/16**, **5/11/17**, **6/12/18**, **7/13/19** and **8/14/20**

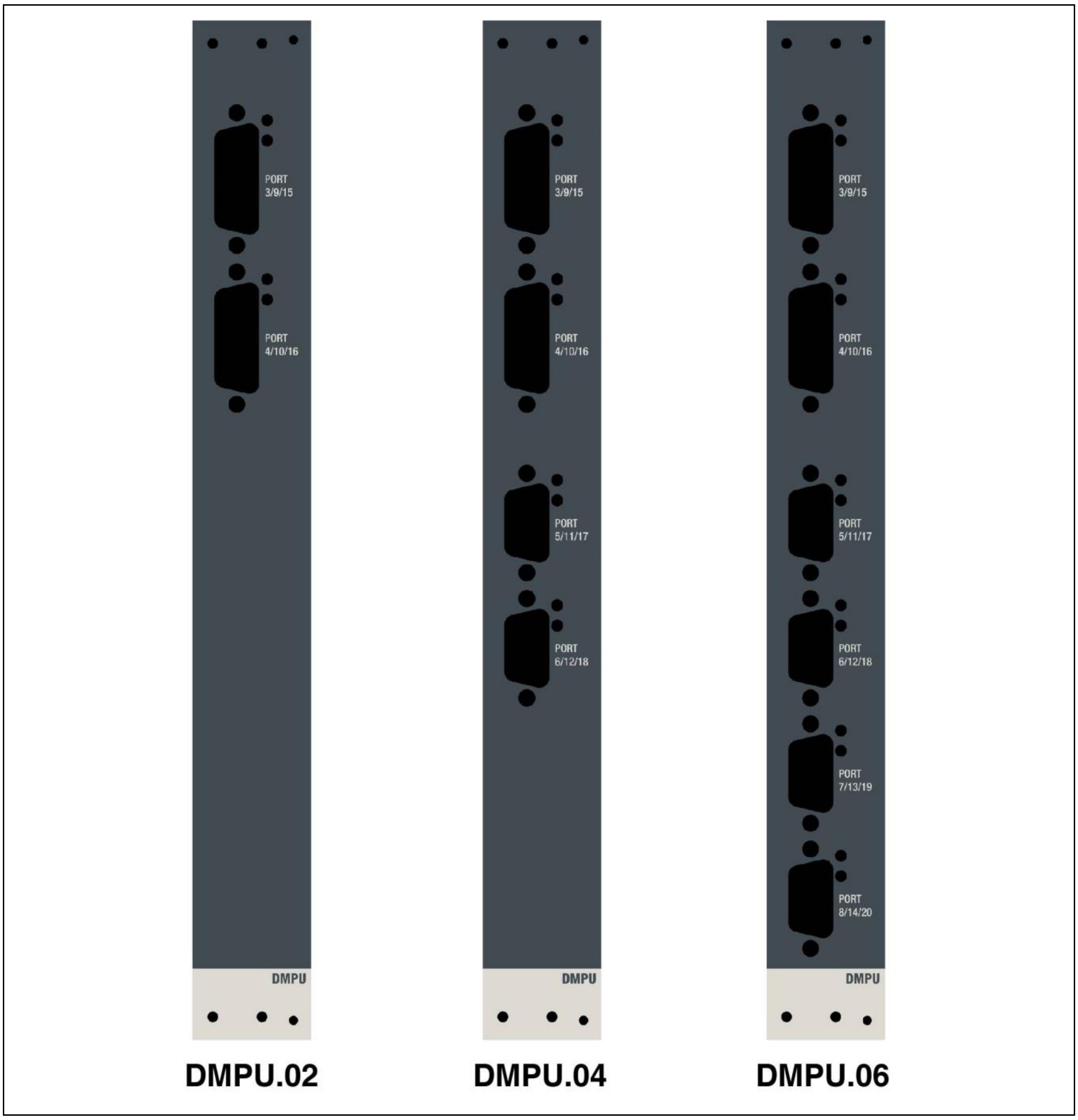


Figure 5.108 Front views of the differents types of DMPU with connection at the front.

Port identification (connector type)	Interfaces supported by the port
Port **3/9/15** (DB15 female)	V.24/V.28 (RS-232C), X.21, RS-422, RS-485 (HD/FD)
Port **4/10/16** (DB15 female)	V.24/V.28 (RS-232C), X.21, RS-422, RS-485 (HD/FD)
Port **5/11/17** (DB9 female)	V.24 asynchronous, RS-422, RS-485 (HD/FD)
Port **6/12/18** (DB9 female)	V.24 asynchronous, RS-422, RS-485 (HD/FD)
Port **7/13/19** (DB9 female)	V.24 asynchronous, RS-422, RS-485 (HD/FD)
Port **8/14/20** (DB9 female)	V.24 asynchronous, RS-422, RS-485 (HD/FD)

Table 5-13: Interfaces supported by the DMPU-ports

Interfaces supported by the DB15 connector

*(1) The **OPU-1** terminal behaves as communications equipment (**DCE**).*

DB15 pin	V.24/V.28 signal	DCE (1) / DTE
1	EARTH	–
2	TXD	⇐
3	RTS	⇐
4	RXD	⇒
5	DCD	⇒
6	RXCLK	⇒
8	GND	-
9	DTR	⇐
11	DSR	⇒
12	CTS	⇒
13	TXCLK	⇒

Table 5-14: Signals V.24/V.28 of the ITU-T (EIA RS-232C) in DB15 female connector

[(1)] *The **OPU-1** terminal behaves as communications equipment (**DCE**).*

DB15 pin	standard X.21 signal	DCE [(1)] / DTE
1	EARTH	–
2	TXD (A)	⇐
3	CTRL (A)	⇐
4	RXD (A)	⇒
5	Indication (A)	⇒
6	Signal timing (A)	⇒
8	GND	–
9	TXD (B)	⇐
10	CTRL (B)	⇐
11	RXD (B)	⇒
12	Indication (B)	⇒
13	Signal timing (B)	⇒

Table 5-15: Signals X.21 of the ITU-T in DB15 female connector

DB15 pin	standard RS-422 signal	DCE [(1)] / DTE
1	EARTH	–
9	TXD- (A)	⇐
2	TXD+ (B)	⇐
4	RXD- (A)	⇒
11	RXD+ (B)	⇒
8	GND	–

Table 5-16: Signals RS-422 of the ITU-T in DB15 female connector

DB15 pin	RS-485 signal (HD/FD)
1	EARTH
2	TXD/RXD- (A)
3	TXD/RXD+ (B)

Table 5-17: Signals RS-485 (HD/FD) in DB15 female connector

Interfaces supported by the DB9 connector

[(1)] *The **OPU-1** terminal behaves as communications equipment (**DCE**).*

DB9 pin	standard V.24 signal	DCE [(1)] / DTE
1	DCD	⇒
2	RXD	⇒
3	TXD	⇐
4	DTR	⇐
5	GND	-
6	DSR	⇒
7	RTS	⇐
8	CTS	⇒

Table 5-18: Signals V.24 asynchronous in DB9 female connector

DB9 pin	standard RS-422 signal	DCE [(1)] / DTE
2	RXD- (A)	⇒
7	TXD- (A)	⇐
3	TXD+ (B)	⇐
8	RXD+ (B)	⇒

Table 5-19: Signals RS-422 of the ITU-T in DB9 female connector

DB9 pin	standard RS-485 (HD/FD) signal
3	TXD/RXD- (A)
7	TXD/RXD+ (B)

Table 5-20: Signals RS-485 (HD/FD) in DB9 female connector

5.6.6 TMPU front data port

Any type of **TMPU** module includes one **front** data port, identified as **3/9/15**.

The connector type is **DB15** female and the interface supported is **V.24/V.28** of the ITU-T (RS-232C) and **X.21** of the ITU-T.

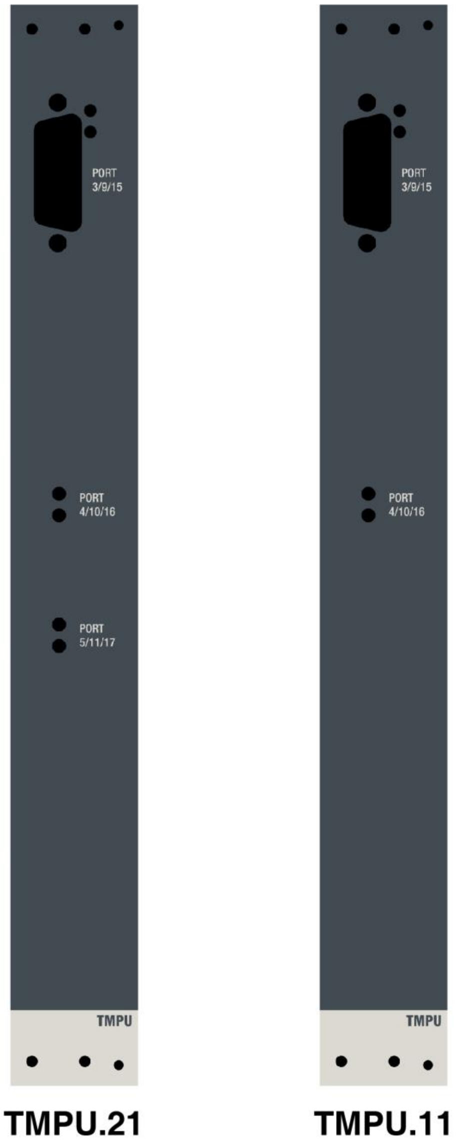


Figure 5.109 Front views of the different types of TMPU.

[(1)] *The **OPU-1** terminal behaves as communications equipment (**DCE**).*

DB15 pin	V.24/V.28 signal	DCE [(1)] / DTE
1	EARTH	–
2	TXD	⇐
3	RTS	⇐
4	RXD	⇒
5	DCD	⇒
6	RXCLK	⇒
8	GND	-
9	DTR	⇐
11	DSR	⇒
12	CTS	⇒
13	TXCLK	⇒

Table 5-21: Signals V.24/V.28 of the ITU-T (EIA RS-232C) in DB15 female connector

DB15 pin	standard X.21 signal	DCE [(1)] / DTE
1	EARTH	–
2	TXD (A)	⇐
3	CTRL (A)	⇐
4	RXD (A)	⇒
5	Indication (A)	⇒
6	Signal timing (A)	⇒
8	GND	–
9	TXD (B)	⇐
10	CTRL (B)	⇐
11	RXD (B)	⇒
12	Indication (B)	⇒
13	Signal timing (B)	⇒

Table 5-22: Signals X.21 of the ITU-T in DB15 female connector

5.7 Plug-in terminal blocks

*A **plug-in terminal block** consists of a printed-circuit board containing all the necessary terminals and connectors.*

*The connection is **direct** and does not require a cable. It is only necessary to insert the plug-in terminal block connector into the corresponding **6** s.u. back panel connector.*

*Once connected, the plug-in terminal block is **fastened** to the shelf by means of two screws.*

5.7.1 ZIPU plug-in terminal block (IOPU module)

The **ZIPU** plug-in terminal block is associated with the baseband analog I/O option (**IOPU** module).

It has **NON-disconnect** terminal blocks suitable for **AWG 16** conductors (geometric conversion: **1.31** mm^2 ; nominal section: **1.5** mm^2).

One terminal block is associated with channel **1** (**IOPU.01**) and the other one with channel **2** (**IOPU.02**).

*The **ZIPU** block occupies a fixed position on the **6** s.u. back panel. See Figure 5.110.*

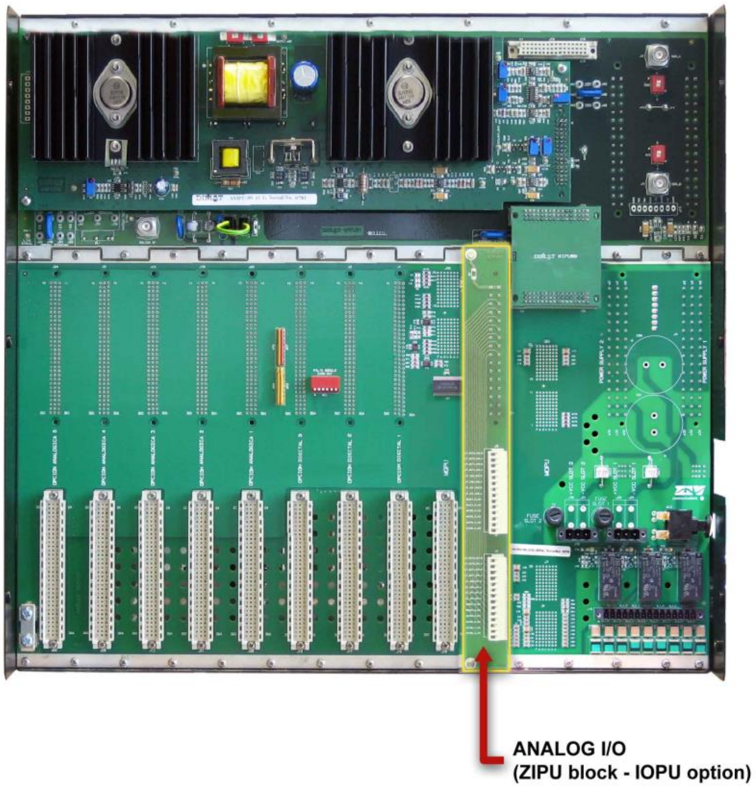


Figure 5.110 Location of the ZIPU plug-in terminal block on the 6 s.u. back panel.

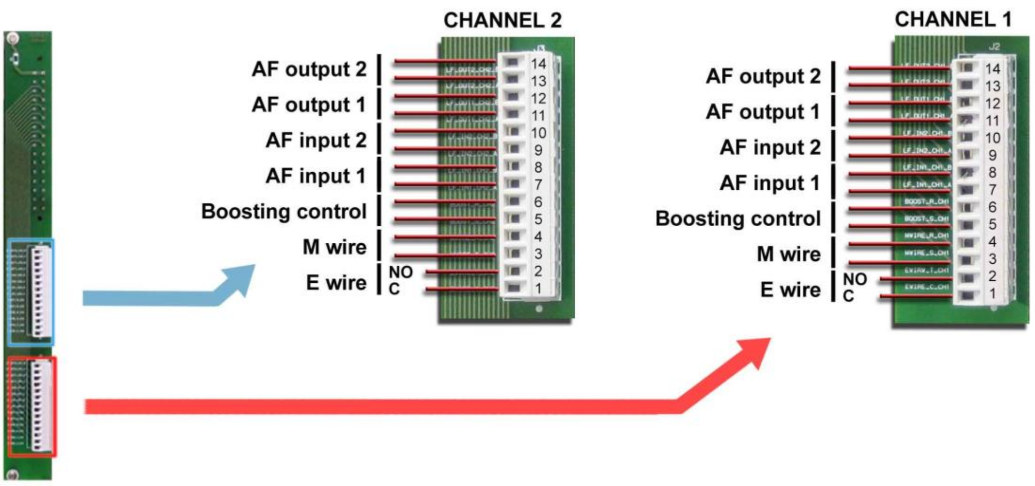


Figure 5.111 Use of the ZIPU plug-in terminal block (IOPU module).

5.7.2 Multiplexer plug-in terminal blocks

The multiplexer plug-in terminal blocks occupies any of the three positions on the **6** s.u. back panel which are starting from the position corresponding to the digital modem (**MQPU**). See Figure 5.112.

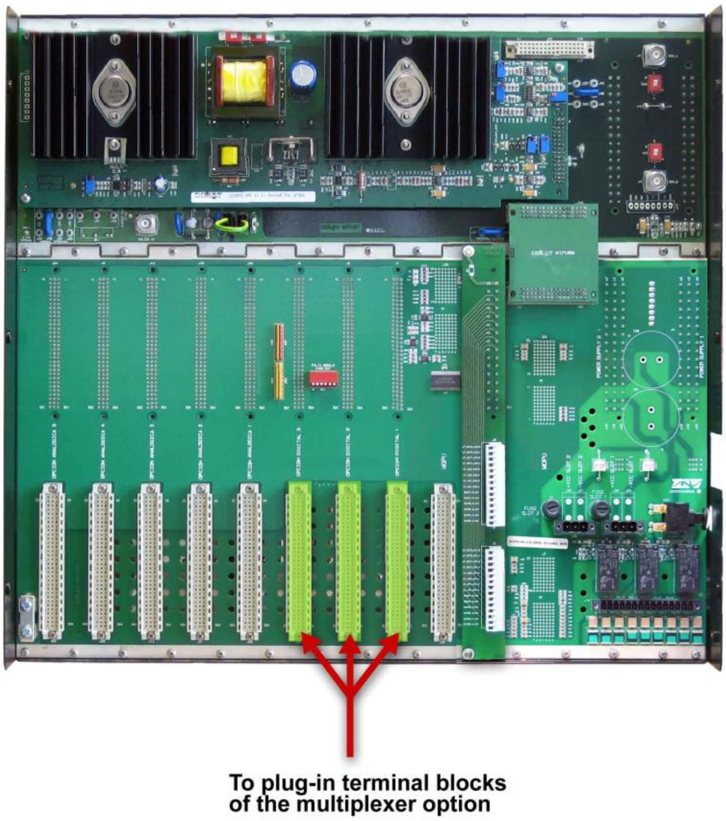


Figure 5.112 Possible position of the multiplexer plug-in terminal blocks on the 6 s.u. back panel.

5.7.2.a ZDPU.02 & ZDPU.04 (DMPU rear data ports)

The **ZDPU.02** plug-in terminal block is associated with the **DMPU.02R** rear data port module.

The **ZDPU.04** plug-in terminal block is associated with the **DMPU.04R** rear data port module.

*The **ZDPU.02** has two data ports (**DB9** female), identified as **5/11/17** and **6/12/18**.*

*The **ZDPU.04** has four data ports (**DB9** female), identified as **5/11/17**, **6/12/18**, **7/13/19** & **8/14/20**.*

*The interfaces supported by each port are: **V.24** asynchronous, **RS-422**, and **RS-485** (HD/FD).*

ZDPU.02 **ZDPU.04**

Figure 5.113 ZDPU.02 (DMPU.02R) & ZDPU.04 (DMPU.04R) plug-in terminal blocks.

[(1)] *The **OPU-1** terminal behaves as communications equipment (**DCE**).*

DB9 pin	standard V.24 signal	DCE [(1)] / DTE
1	DCD	⇒
2	RXD	⇒
3	TXD	⇐
4	DTR	⇐
5	GND	-
6	DSR	⇒
7	RTS	⇐
8	CTS	⇒

Table 5-23: Signals V.24 asynchronous in DB9 female connector

DB9 pin	standard RS-422 signal	DCE [(1)] / DTE
2	RXD- (A)	⇒
7	TXD- (A)	⇐
3	TXD+ (B)	⇐
8	RXD+ (B)	⇒

Table 5-24: Signals RS-422 of the ITU-T in DB9 female connector

DB9 pin	standard RS-485 (HD/FD) signal
3	TXD/RXD- (A)
7	TXD/RXD+ (B)

Table 5-25: Signals RS-485 (HD/FD) in DB9 female connector

5.7.2.b ZTPU.11 & ZTPU.21 (TMPU speech ports)

The **ZTPU.11** plug-in terminal block is associated with the **TMPU.11** speech module, and contains one speech port identified as **4/10/16**.

The **ZTPU.21** plug-in terminal block is associated with the **TMPU.21** speech module, and contains two speech ports identified as **4/10/16** & **5/11/17**.

The **M**-wire and the **2W/4W** switching inputs (optional) are optocoupled.

The **E**-wire and **T**-wire (optional) outputs are relay voltage-free contacts.

In normal operation conditions, the **T**-wire (optional) is activated, that is to say, **N.O.** and **C** contacts are short-circuited.

*Each **speech** port is associated with two terminal blocks of five terminals:*

- ***J1** & **J4** for port **4/10/16***
- ***J2** & **J5** for port **5/11/17***

*For direct connection of a telephone, each **speech** port is associated with one **RJ-11** connector:*

- ***J8** for port **4/10/16***
- ***J9** for port **5/11/17***

*Optionally, each **speech** port is associated with one terminal block of five terminals:*

- ***J6** for port **4/10/16***
- ***J7** for port **5/11/17***

*The **NON-disconnect** terminal blocks are suitable for **AWG 12** conductors (geometric conversion: **3.31** mm^2; nominal section: **4** mm^2).*

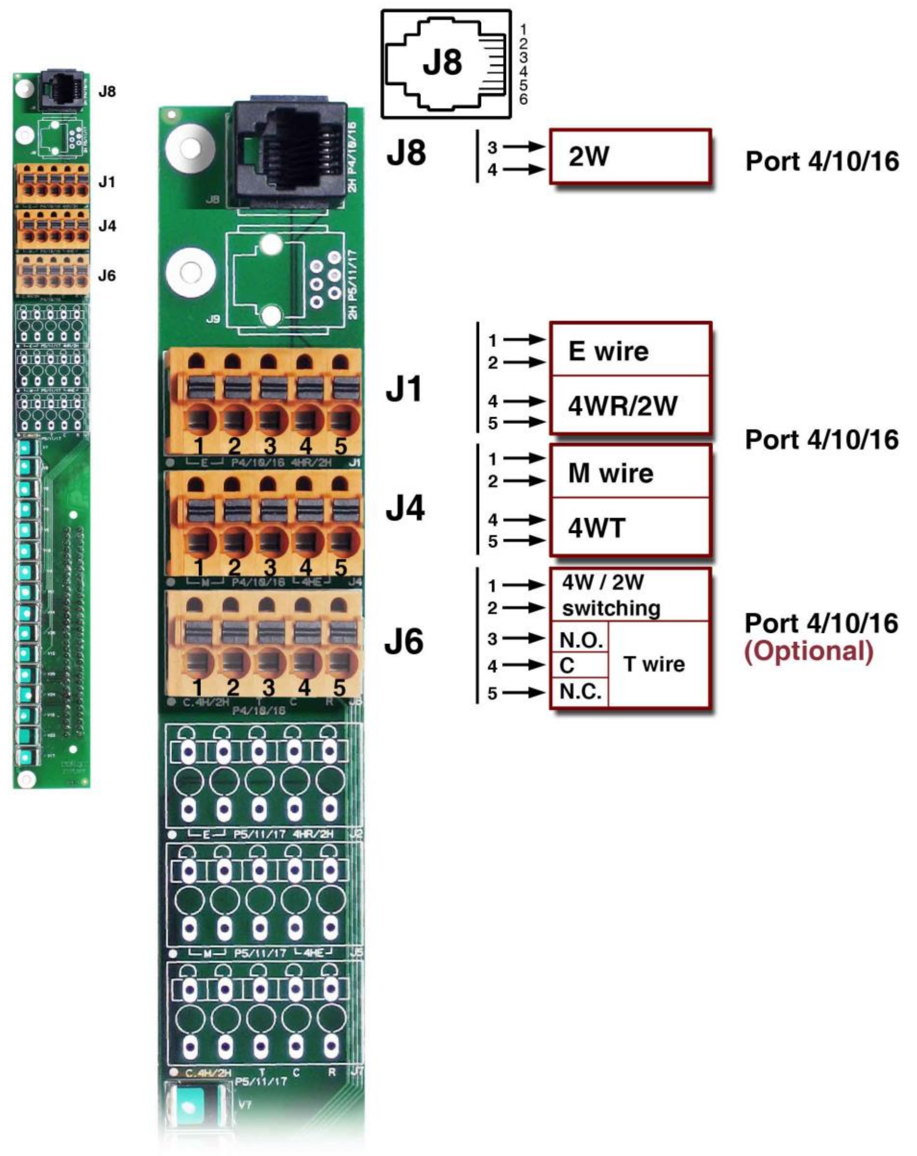


Figure 5.114 Use of the ZTPU.11 (TMPU.11) plug-in terminal block for one speech port.

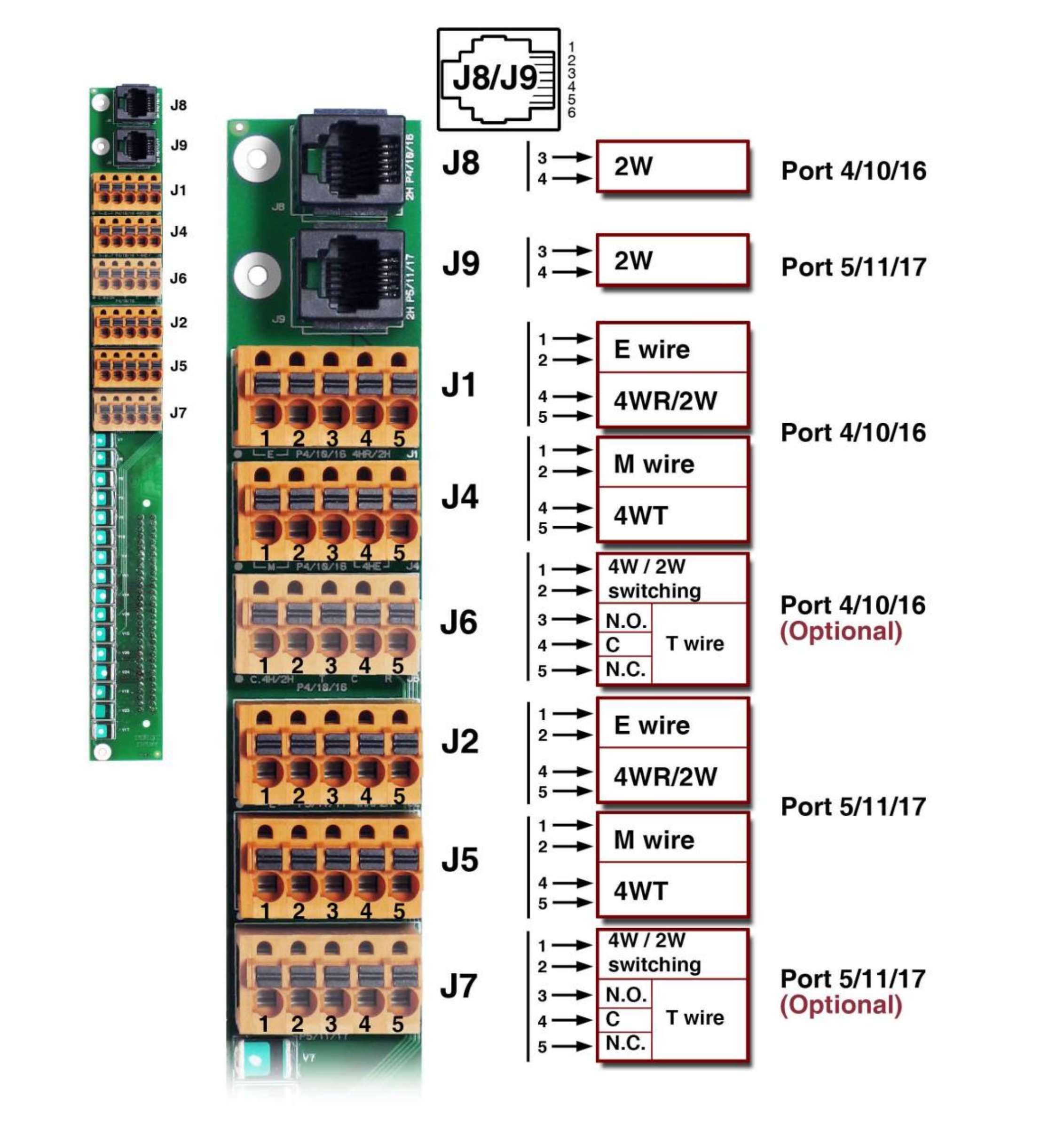


Figure 5.115 Use of the ZTPU.21 (TMPU.21) plug-in terminal block for two speech ports.

5.7.3 Teleprotection plug-in terminal blocks

The teleprotection plug-in terminal blocks occupies any of the left-side five positions on the **6** s.u. back panel. See Figure 5.116.

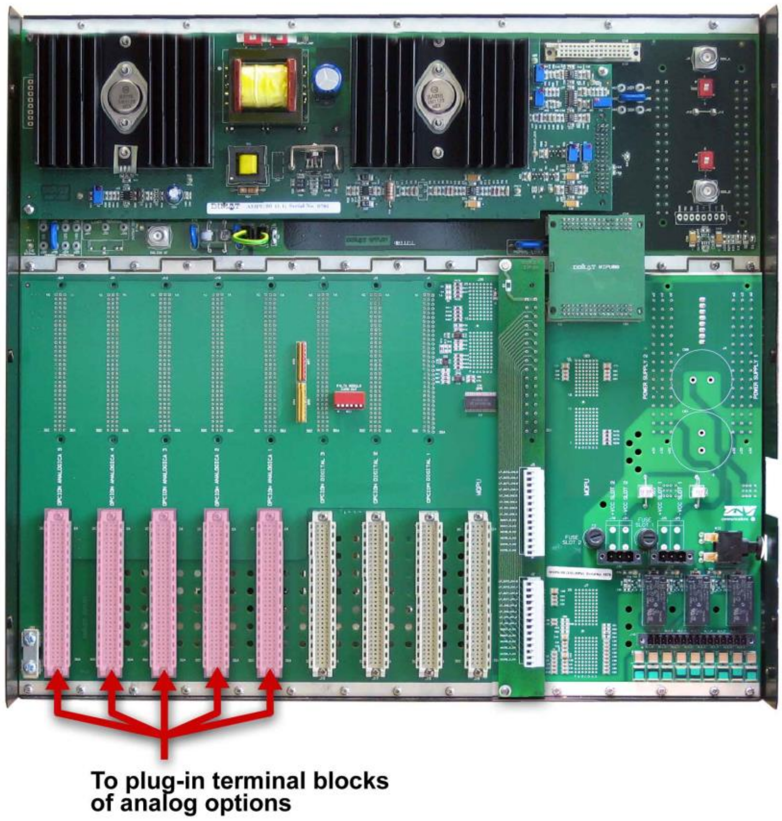


Figure 5.116 Possible position of the teleprotection plug-in terminal blocks on the 6 s.u. back panel.

5.7.3.a ZBPU (TPPU option)

The **ZBPU** plug-in terminal block is associated with the teleprotection (**TPPU**).

It has **NON-disconnect** terminal blocks suitable for up to **2.5** mm^2 conductors.

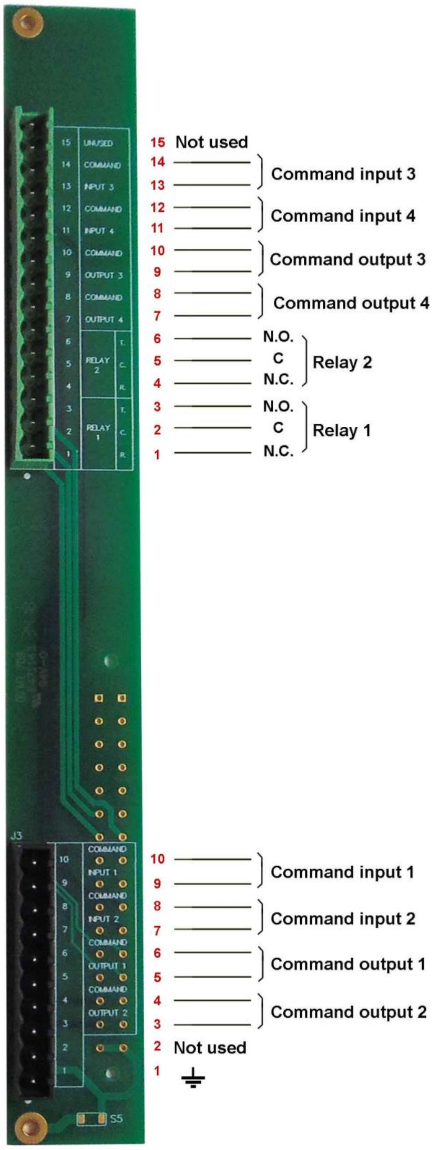


Figure 5.117 Use of the ZBPU plug-in terminal block (TPPU option).

5.7.3.b ZCPU (REPU option)

The **ZCPU** plug-in terminal block is associated with the optional relay interface (**REPU**).

It has **NON-disconnect** terminal blocks suitable for up to **2.5** mm^2 conductors.

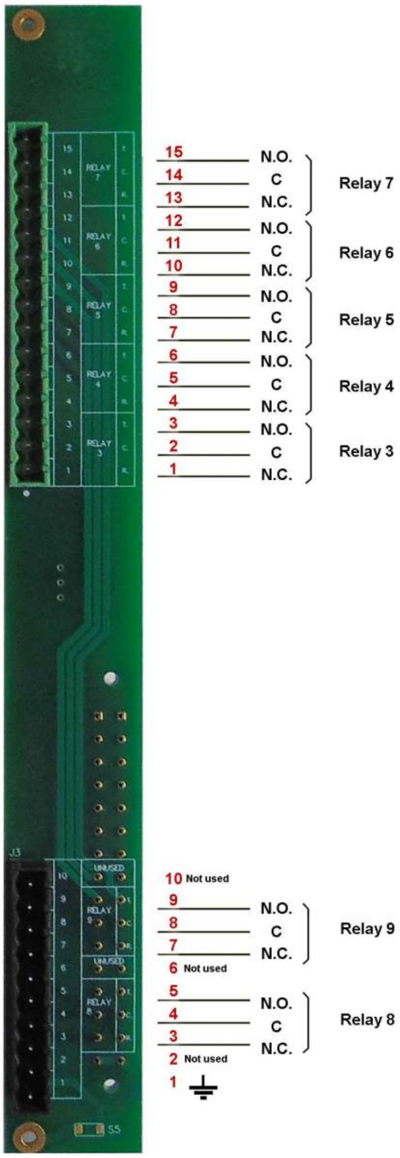


Figure 5.118 Use of the ZCPU plug-in terminal block (REPU option).

5.7.4 Other plug-in terminal blocks

The plug-in terminal blocks associated with analog options occupies any of the left-side five positions on the **6** s.u. back panel. See Figure 5.119.

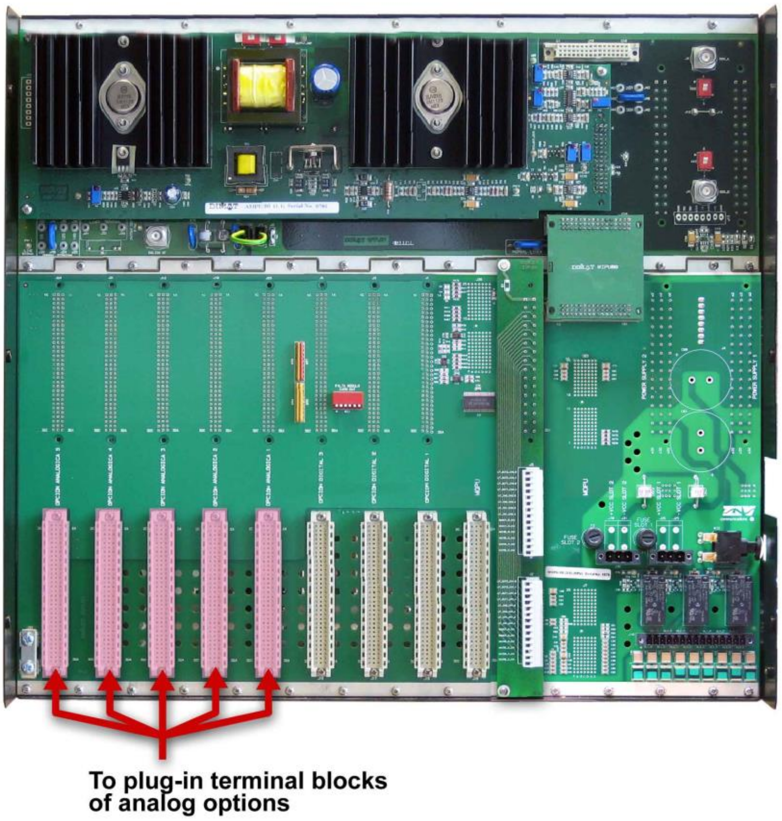


Figure 5.119 Possible position of the plug-in terminal blocks associated with options on the 6 s.u. back panel.

5.7.4.a ZAPU (TDPU.20 option)

The **ZAPU** plug-in terminal block is associated with the speech option (**TDPU.20**).

It has **NON-disconnect** terminal blocks suitable for up to **2.5** mm^2 conductors.

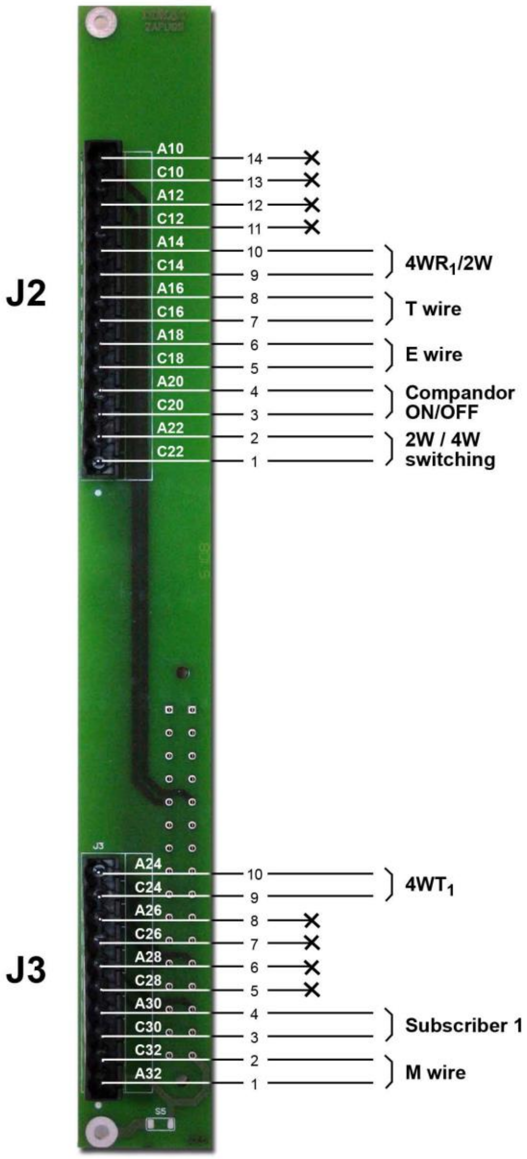


Figure 5.120 Use of the ZAPU plug-in terminal block for the TDPU.20 speech option.

5.7.4.b ZAPU (MFPU option)

The **ZAPU** plug-in terminal block is associated with the asynchronous modem option (**MFPU**).

It has **NON-disconnect** terminal blocks suitable for up to **2.5** mm^2 conductors.

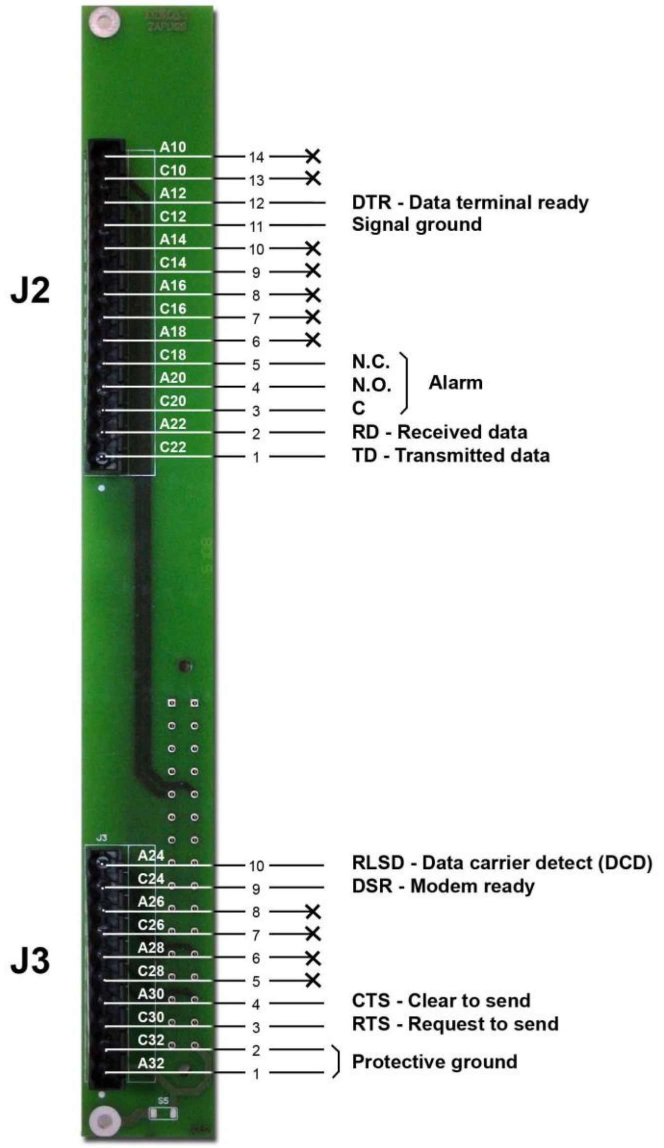


Figure 5.121 Use of the ZAPU plug-in terminal block for the MFPU asynchronous modem option.

5.7.4.c ZAPU (FDPU option)

The **ZAPU** plug-in terminal block is associated with the digital transit filter option (**FDPU**).

It has **NON-disconnect** terminal blocks suitable for up to **2.5** mm^2 conductors.

Figure 5.122 Use of the ZAPU plug-in terminal block for the FDPU digital transit filter option.

5.7.4.d ZAPU (FTPU option)

The **ZAPU** plug-in terminal block is associated with the VFT-transit filter option (**FTPU**).

It has **NON-disconnect** terminal blocks suitable for up to **2.5** mm^2 conductors.

Figure 5.123 Use of the ZAPU plug-in terminal block for the FTPU VFT-transit filter option.

5.8 Cabinet-mounting terminal blocks

*The **cabinet-mounting terminal block** is made up of various parts mounted on a **metal plate**, forming a compact unit.*

This plate is fixed by means of non-slips nuts to the vertical guide rails located at the inside back wall of the cabinet.

*The **cabinet-mounting terminal block** contains:*

- *The basic equipment terminal block (**ZOPU.0#**).*
- *The terminal block (**ZBBA.14**) associated with channel **2** of the baseband analog I/O interface (**IOPU.02** option).*
- *Terminal blocks of other options.*
- *Ducts for securing the cables.*
- *The mechanical assembly for line output protection.*

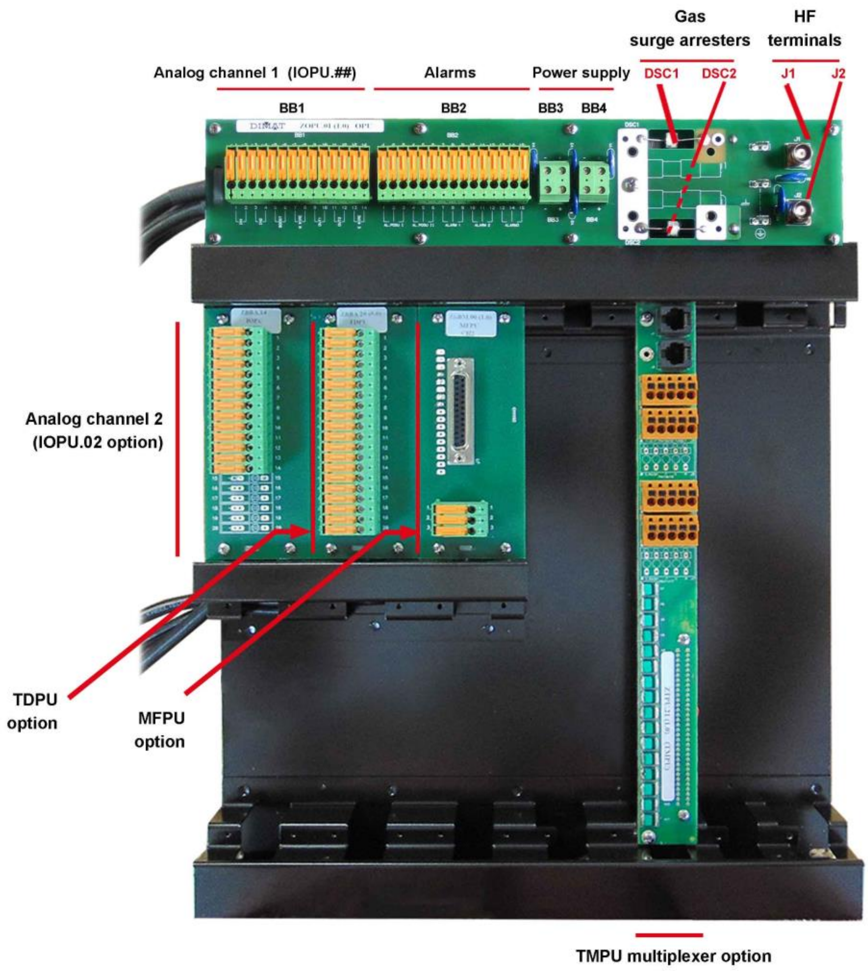


Figure 5.124 Example of OPU-1 cabinet-mounting terminal block.

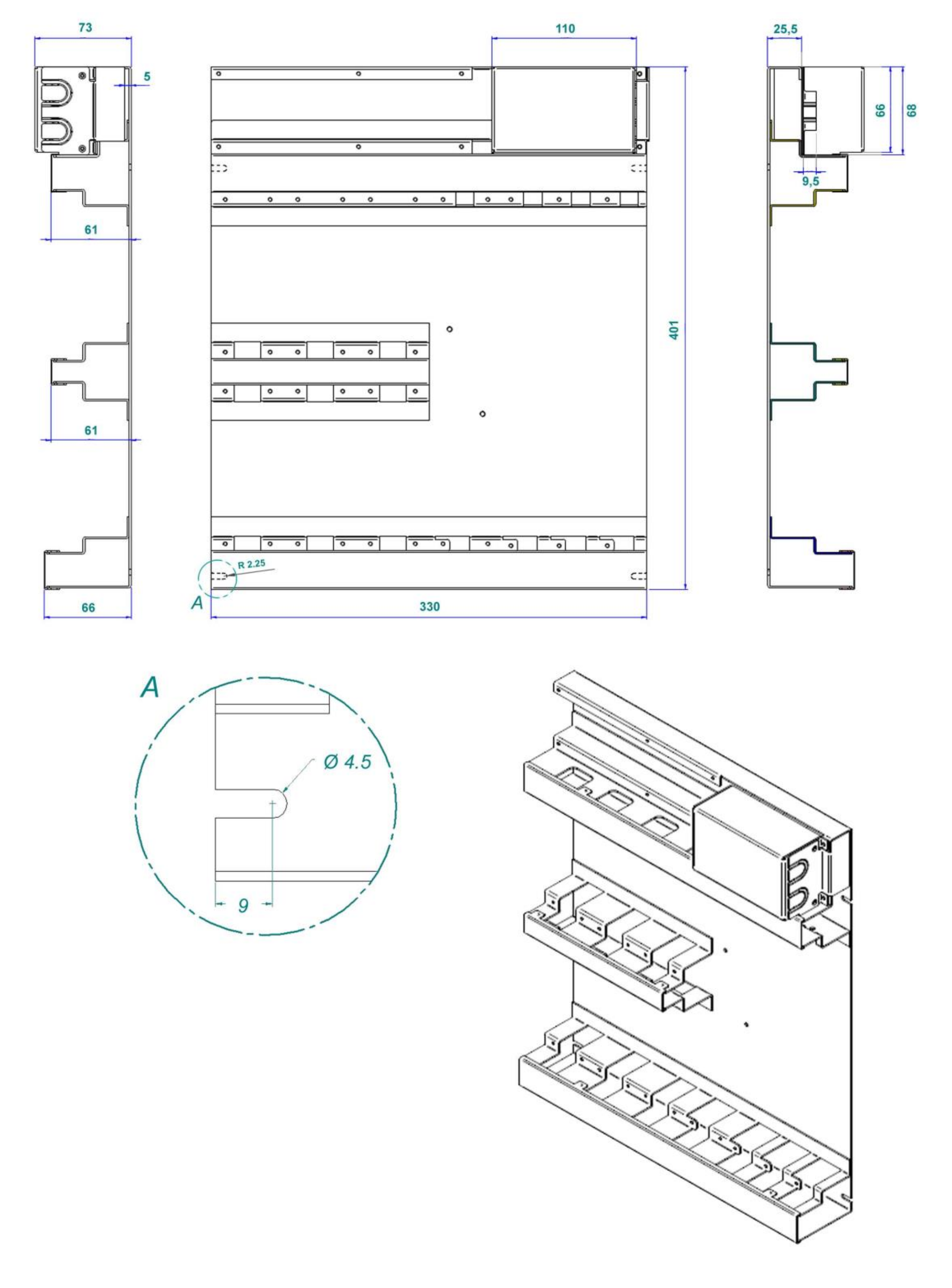


Figure 5.125 Dimensions in mm of the OPU-1 cabinet-mounting terminal block.

*Line output is protected against accidental contact by means of a **mechanical assembly**.*

The customer must adapt this mechanical set according to the type of cable used. See the attached example.

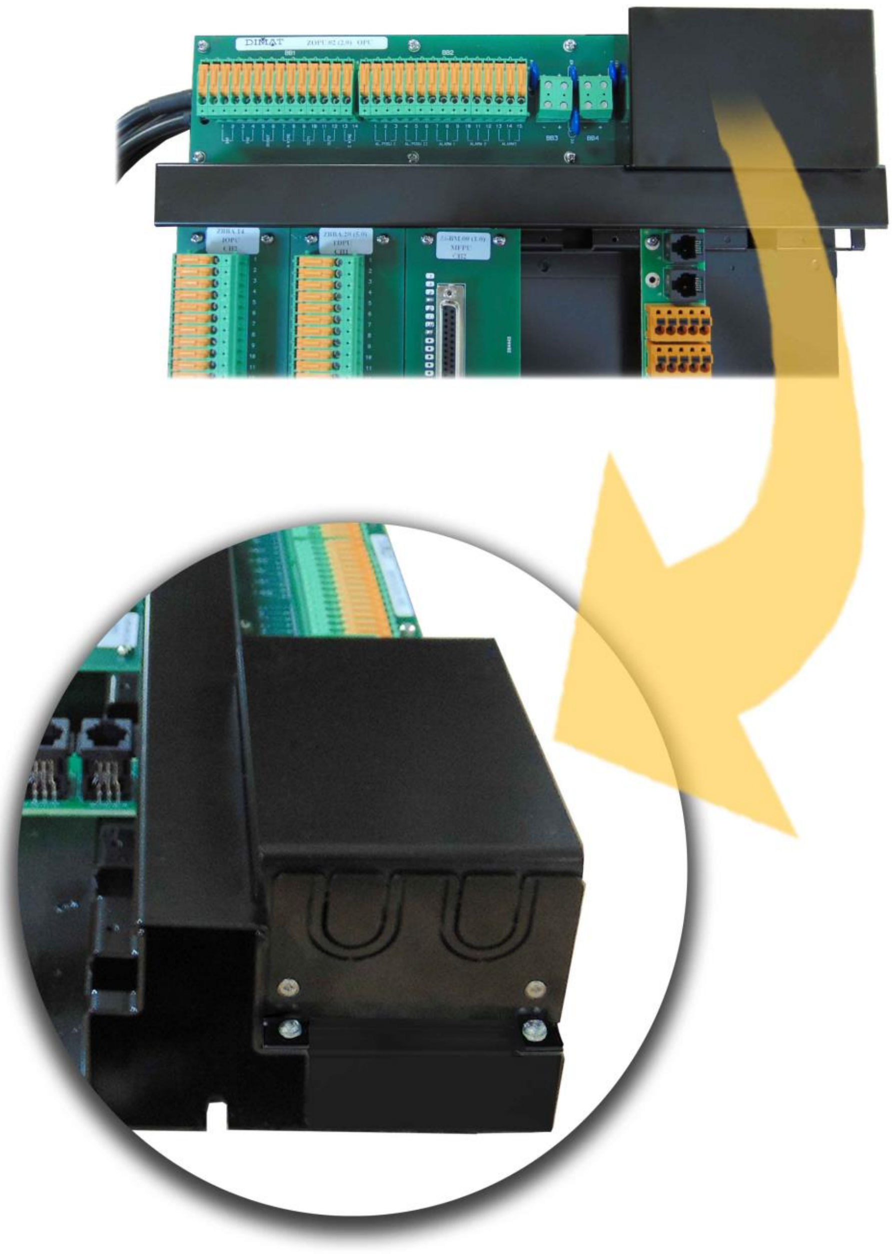
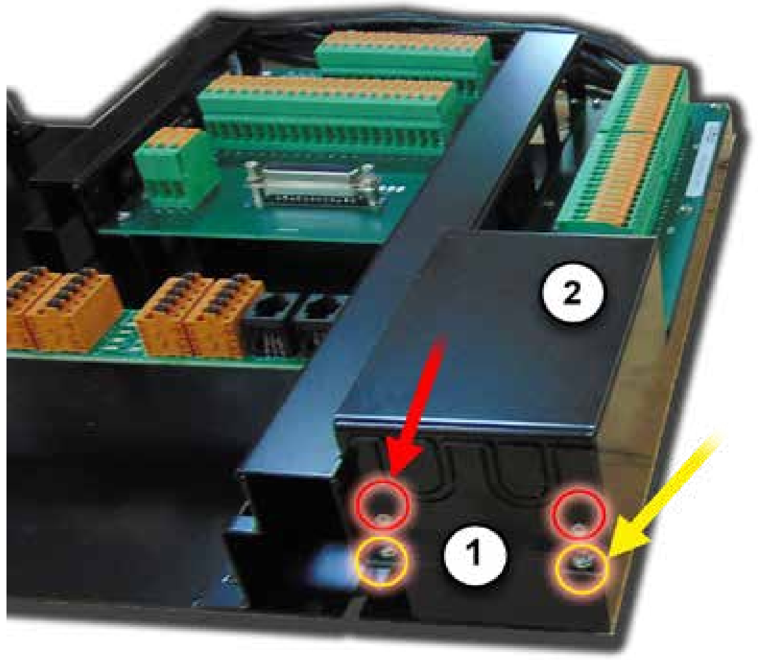
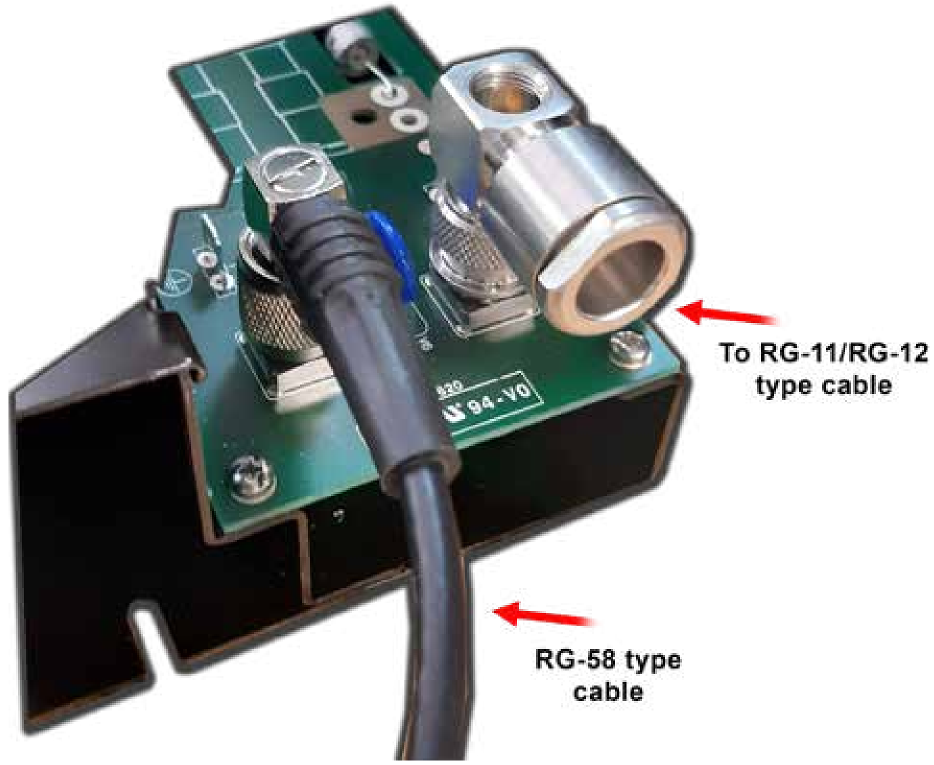


Figure 5.126 Detail of the mechanical assembly for the output protection.



Step 1 Remove the fixing screws of piece 1
and then remove those of piece 2.
Turn them anticlockwise.
Keep the four fixing screws in reserve.

Step 2 Depending on the type of cable to be used in
the line output connection, if applicable,
in pieces 1 & 2, preform (enlarge) the
corresponding window.



Step 3 Insert the line TNC connector
and associated cable.
The example shows two possibilities:
an angled male TNC connector
for RG-11 / RG-12 cable or a
male TNC connector for RG-58.

Step 4 Insert piece 2 and secure it by using the two reserved fixing screws.
Turn them clockwise.

Step 5 Insert piece 1 taking into account the properly position (see position of windows)
and secure it by using the two reserved fixing screws.
Turn them clockwise.

Pertenece a: OPU-1R				Cód. Prod. -	Rev. 0
Fecha 16-02-21	Realizado V° B° M.Ucero	Comprobado V° B° D.Gil	Aprobado V° B° D.Gil	Archivo MGZOPU0002	
ZIV	Example of line output installation depending on the cable type			Siglas OPU-1R	Hoja 1/1

5.8.1 Basic equipment terminal block

The **ZOPU.00** basic equipment terminal block is formed by:

- *two HF coaxial connectors, connected in parallel, for external connection to the coupling devices.*
- *two gas surge arresters.*
- *the power-supply terminals.*
- *the alarm terminals.*
- *if applicable, the terminals assigned to channel **1** of the **IOPU.01** option (**ZOPU.01**).*
- *if applicable, the terminals assigned to channel **1** of the **IOPU.02** option (**ZOPU.02**).*

*The **BB3** & **BB4** power-supply terminals are **non-disconnect terminals** and are suitable for flexible conductors of up to **4** mm² of section or rigid conductors of up to **6** mm² of section.*

*The **BB2** alarm terminals are **disconnect terminals** and are suitable for flexible conductors of up to **2.5** mm² of section or rigid conductors of up to **4** mm² of section.*

*The **BB1** terminals associated with the **IOPU.0#** option are **disconnect terminals** and are suitable for flexible conductors of up to **2.5** mm² of section or rigid conductors of up to **4** mm² of section.*

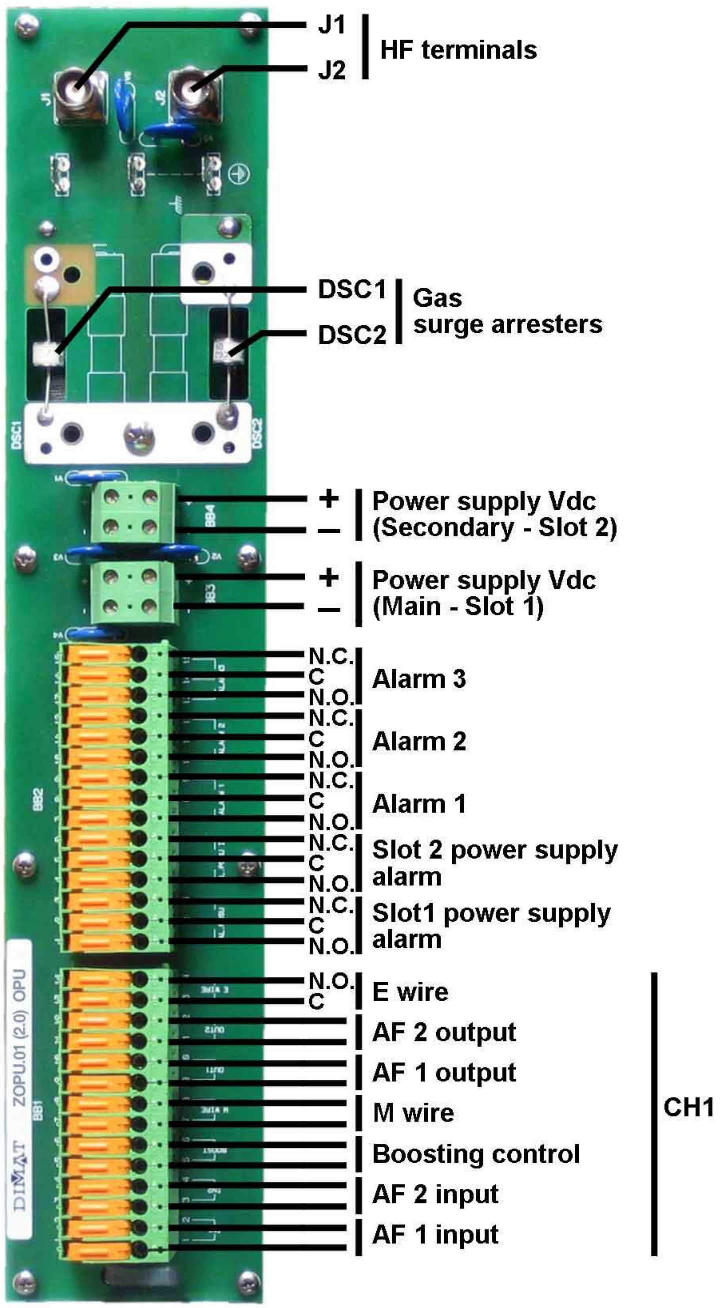


Figure 5.127 Use of the ZOPU.0# basic equipment terminal block.

5.8.2 Analog channel-2 terminal block

The **ZBBA.14** terminal block is associated with channel **2** of the **IOPU.02** baseband analog I/O interface option.

*The **disconnect** terminals are suitable for flexible conductors of up to **2.5** mm² of section or rigid conductors of up to **4** mm² of section.*

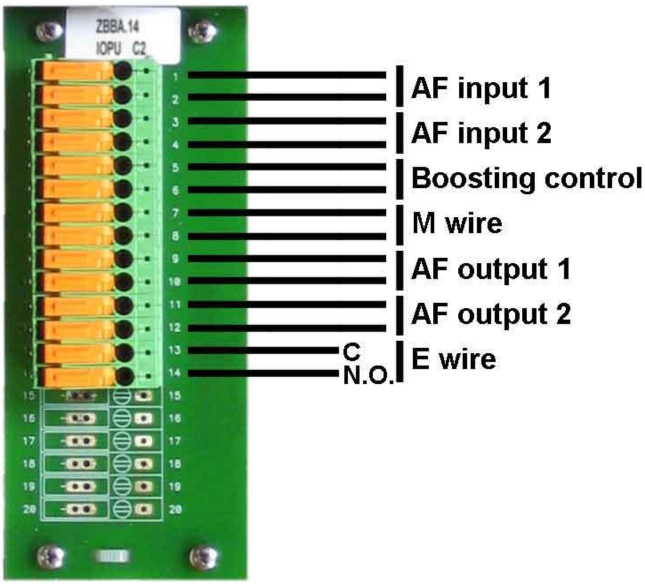


Figure 5.128 Use of the ZBBA.14 terminal block associated with channel 2 of the IOPU.02 option.

5.8.3 Multiplexer terminal blocks

5.8.3.a ZTPU.10 & ZTPU.20 (TMPU speech ports)

The **ZTPU.10** cabinet-mounted terminal block is associated with the **TMPU.11** speech module, and contains one **speech** port identified as **4/10/16**.

The **ZTPU.20** cabinet-mounted terminal block is associated with the **TMPU.21** speech module, and contains two **speech** ports identified as **4/10/16** & **5/11/17**.

The **M**-wire and the **2W/4W** switching inputs (optional) are optocoupled.

The **E**-wire and **T**-wire (optional) outputs are relay voltage-free contacts.

In normal operation conditions, the **T**-wire (optional) is activated, that is to say, **N.O.** and **C** contacts are short-circuited.

*Each **speech** port is associated with two terminal blocks of five terminals:*

- ***J1** & **J4** for port **4/10/16***
- ***J2** & **J5** for port **5/11/17***

*For direct connection of a telephone, each **speech** port is associated with one **RJ-11** connector:*

- ***J8** for port **4/10/16***
- ***J9** for port **5/11/17***

*Optionally, each **speech** port is associated with one terminal block of five terminals:*

- ***J6** for port **4/10/16***
- ***J7** for port **5/11/17***

*The **NON-disconnect** terminal blocks are suitable for **AWG 12** conductors (geometric conversion: **3.31** mm^2; nominal section: **4** mm^2).*

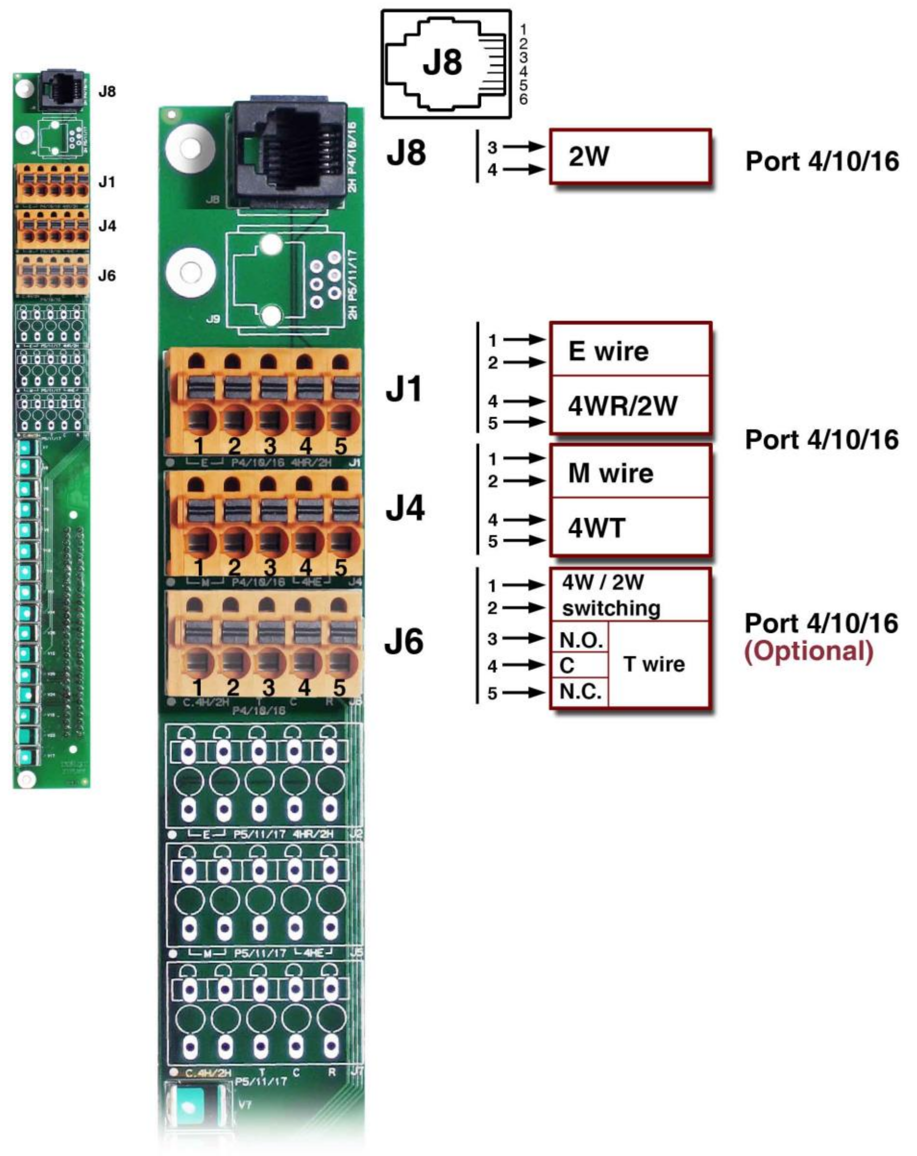


Figure 5.129 Use of the ZTPU.10 (TMPU.11) cabinet-mounted terminal block for one speech port.

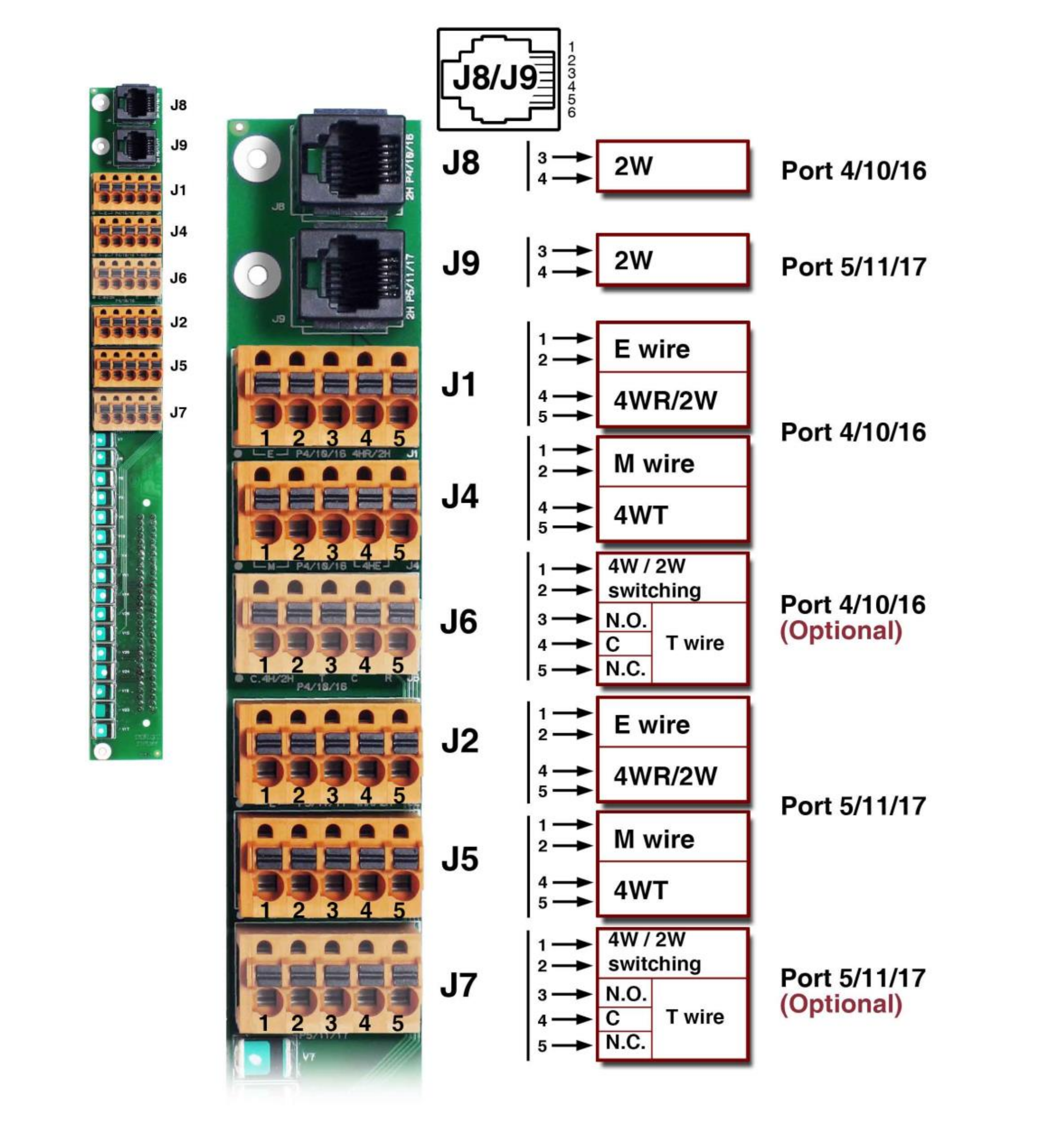


Figure 5.130 Use of the ZTPU.20 (TMPU.21) cabinet-mounted terminal block for two speech ports.

5.8.4 Teleprotection terminal blocks

The **ZBBA.16-BB1** & **ZBBA.06-BB2** cabinet-mounted terminal blocks are associated with the teleprotection option (**TPPU**).

*The **disconnect** terminals are suitable for flexible conductors of up to **2.5** mm² of section or rigid conductors of up to **4** mm² of section.*

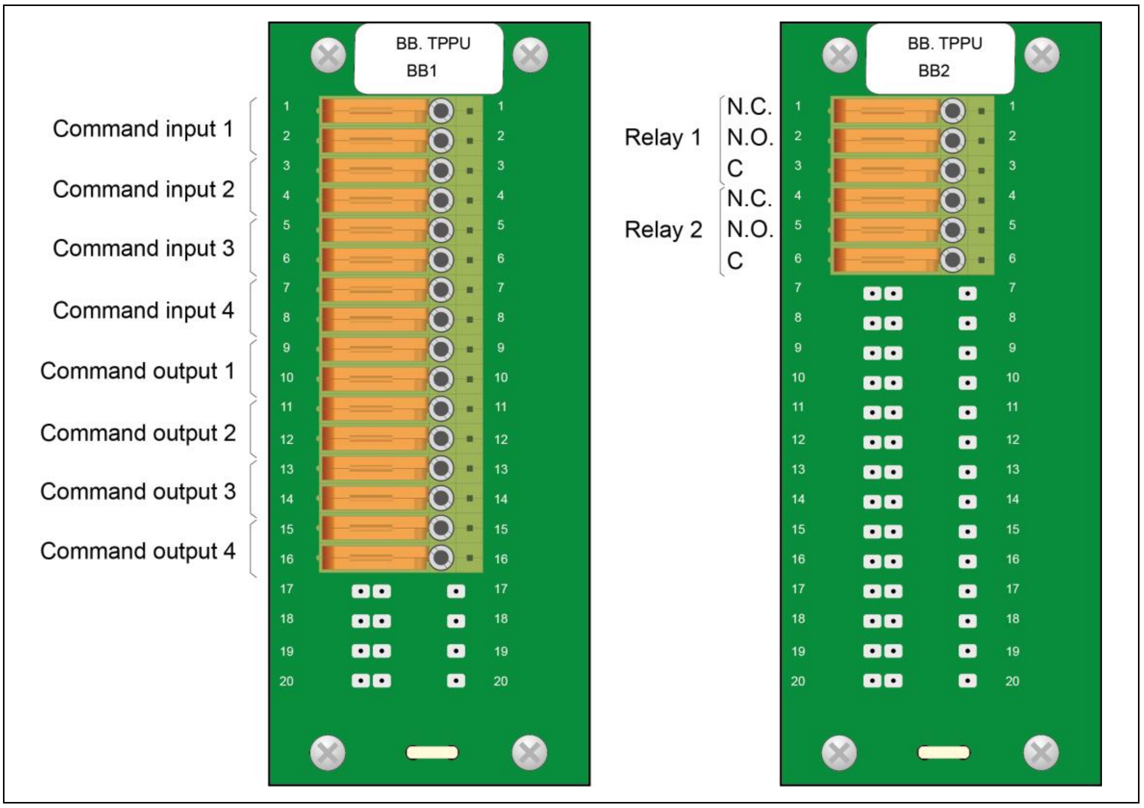


Figure 5.131 Use of the ZBBA.16-BB1 & ZBBA.06-BB2 cabinet-mounted terminal blocks associated with the TPPU teleprotection option.

5.8.5 Other terminal blocks

5.8.5.a ZBBA.20 (TDPU.20 option)

The **ZBBA.20** cabinet-mounted terminal block associated with the speech option (**TDPU.20**) has twenty terminals the use of which is detailed in Figure 5.132.

*The **disconnect** terminals are suitable for flexible conductors of up to **2.5** mm² of section or rigid conductors of up to **4** mm² of section.*

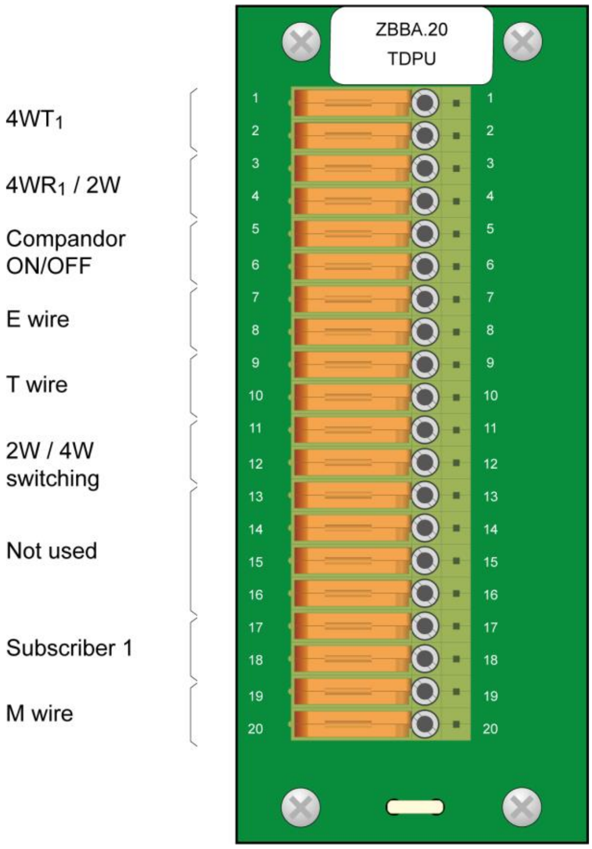


Figure 5.132 Use of the ZBBA.20 cabinet-mounted terminal block for the TDPU.20 speech option.

5.8.5.b ZBBM.00 (MFPU option)

The **ZBBM.00** cabinet-mounted terminal block associated with the asynchronous modem option (**MFPU**) consists of three terminals for general alarm of the modem, and a female **25**-pin **SUB-D** connector for the connection of an **RS-232C** interface.

*The **disconnect** terminals are suitable for flexible conductors of up to **2.5** mm² of section or rigid conductors of up to **4** mm² of section.*

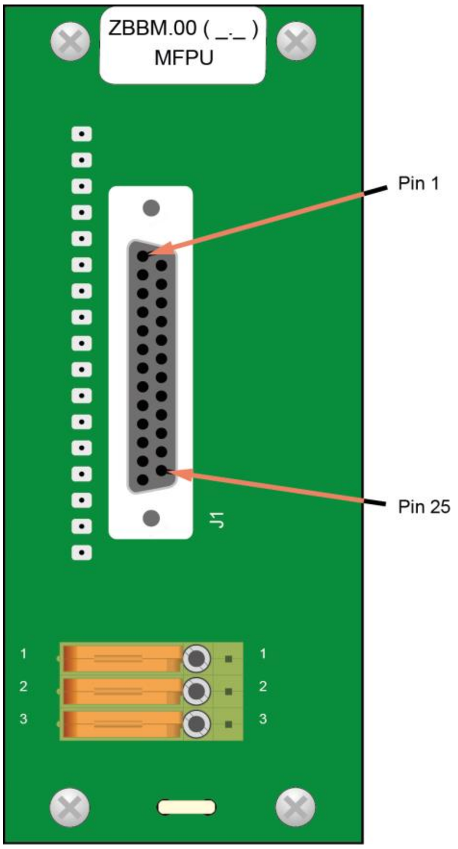


Figure 5.133 ZBBM.00 cabinet-mounted terminal block for the MFPU option.

ZBBM.01 terminal block	Pins of the associated connector	Use	
1	20a	N. O.	Alarm
2	20c	C	
3	18c	N. C.	

Table 5-26: Use of the terminals of the ZBBM.00 cabinet-mounted terminal block

J1 connector ZBBM.01	J2 connector MFPU	Use	DTE/DCE
2	22c	TD - Transmitted data	⇒
3	22a	RD - Received data	⇐
4	30c	RTS - Request to send	⇒
5	30a	CTS - Clear to send	⇐
8	24a	RLSD - Data carrier detect (DCD)	⇐
6	24c	DSR - Modem ready	⇐
20	12a	DTR – Data terminal ready	⇐
7	12c	Signal ground (common return)	-
1	32ac	Protective ground	-

Table 5-27: Use of connector J1 of the ZBBM.00 cabinet-mounted terminal block

5.8.5.c ZBBA.04 (FDPU option)

The **ZBBA.04** cabinet-mounted terminal block associated with the digital transit filter option (**FDPU**) has four terminals the use of which is detailed in Figure 5.134.

*The **disconnect** terminals are suitable for flexible conductors of up to **2.5** mm² of section or rigid conductors of up to **4** mm² of section.*

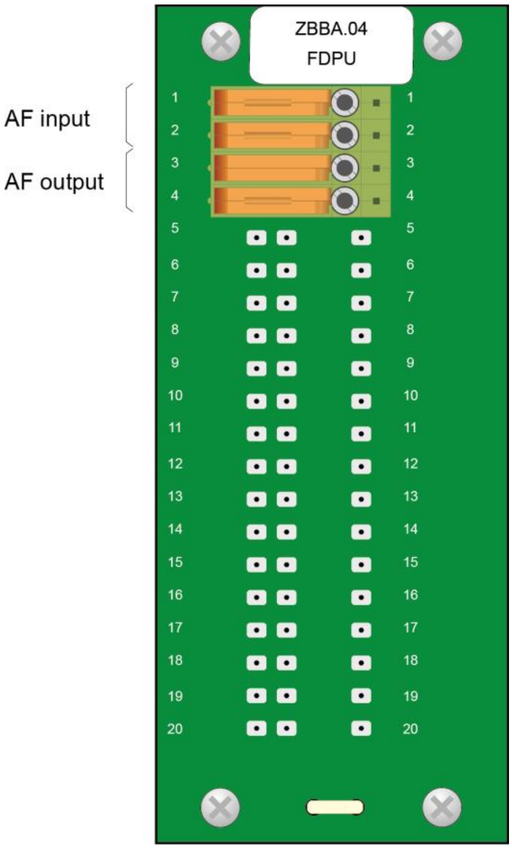


Figure 5.134 Use of the ZBBA.04 cabinet-mounted terminal block for the FDPU option.

5.8.5.d ZBBA.02 (FTPU option)

The **ZBBA.02** cabinet-mounted terminal block associated with the VFT-transit filter option (**FTPU**) has two terminals the use of which is detailed in Figure 5.135.

*The **disconnect** terminals are suitable for flexible conductors of up to **2.5** mm² of section or rigid conductors of up to **4** mm² of section.*

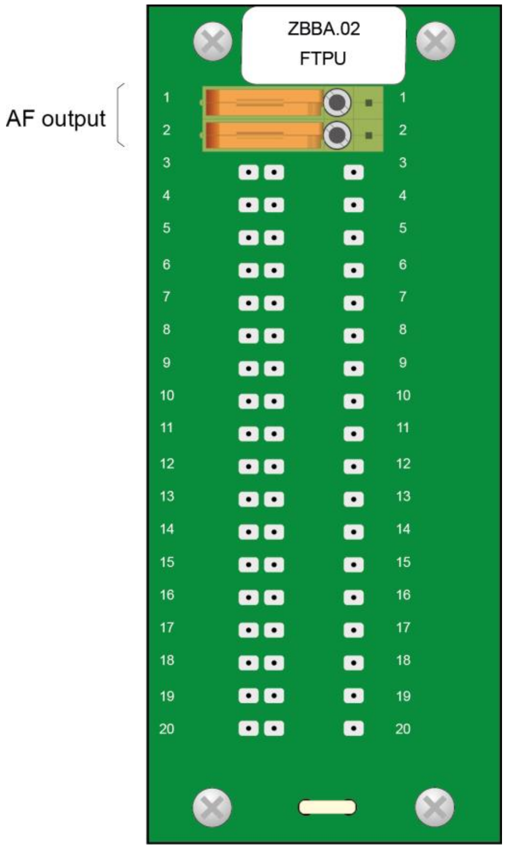


Figure 5.135 Use of the ZBBA.02 cabinet-mounted terminal block for the FTPU option.

5.8.5.e ZBBA.16 (EYPU option)

The **ZBBA.16** cabinet-mounted terminal block associated with the Input/Output combiner option (**EYPU**) has sixteen terminals the use of which is detailed in Figure 5.136.

*The **disconnect** terminals are suitable for flexible conductors of up to **2.5** mm² of section or rigid conductors of up to **4** mm² of section.*

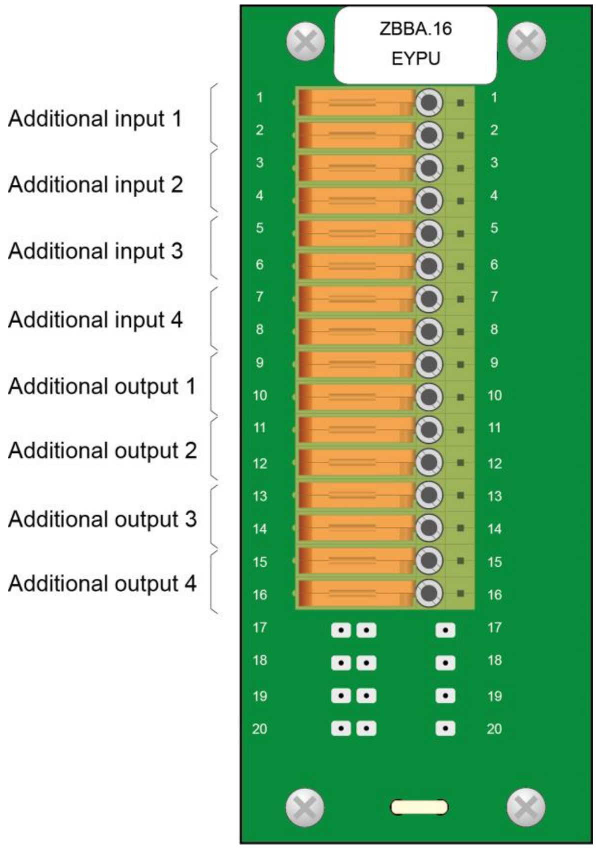


Figure 5.136 Use of the ZBBA.16 cabinet-mounted terminal block for the EYPU option.

Chapter 6.

Commissioning

6. Commissioning

6.1 Warnings

1 **DO NOT** insert or remove modules when the terminal is powered on.

2 The installation must take into account then **NO** obstruction of the ventilation grids.

The shelves that make up the **OPU-1** terminal have ventilation grids, at the top and at the bottom.

3 Modules contain components sensitive to **static electricity** and, therefore, special handling precautions should be taken.

An anti-static wristband connected to earth should be worn.

4 When installing the **OPU-1** terminal in a frame of a cabinet, check that the braided earth cable of each shelf is connected to the cabinet earth bar.

5 When connecting a hose to any of the back-panel connectors associated with options, **attach** the cable earth braid to the **fixing screw** available for this purpose at the bottom of the back panel.

6 In disturbed environments it is recommended to use **screened cables** for the connections.

The screen of the connection cables must be connected to earth only at one end of the cable, in order to ensure the protection of personnel and to avoid interference.

7 Before carrying out any adjustment, **disconnect** the coaxial cable to avoid possible interference with other equipment connected to the same line.

After carrying out the adjustment, check that the dummy load is in the proper position.

8 To carry out measurements at the terminal test points, use instruments with **high** input impedance.

9 **DO NOT** disconnect the programming cable until the **PC** indicates that the programming or supervision task in progress is complete.

10 The state of the relays in normal operation is as follows:

- **Power-supply alarm** signalling relay (one per power-supply module): **energized** (N.O. and C contacts short-circuited).
- Relays programmed for **terminal alarm** condition (3 basic relays plus the **TPPU** & **REPU** relays): **energized** (N.O. and C contacts short-circuited).
- Relays programmed for **teleprotection signalling** condition (**TPPU** & **REPU** relays): **non-energized** (N.C. and C contacts short-circuited).

6.2 How to access modules

*A module must **NOT** be inserted or extracted when the terminal is powered on.*

*Disconnect the main power-supply switch at the rear of the **6** s.u. shelf before doing so.*

6.2.1 3 s.u. shelf

To access the modules of the **3** s.u. shelf, in a first step, the cover on the front must be released. The release process is shown in the enclosed figure.

Once the cover is released, the modules are accessible and can already be extracted.

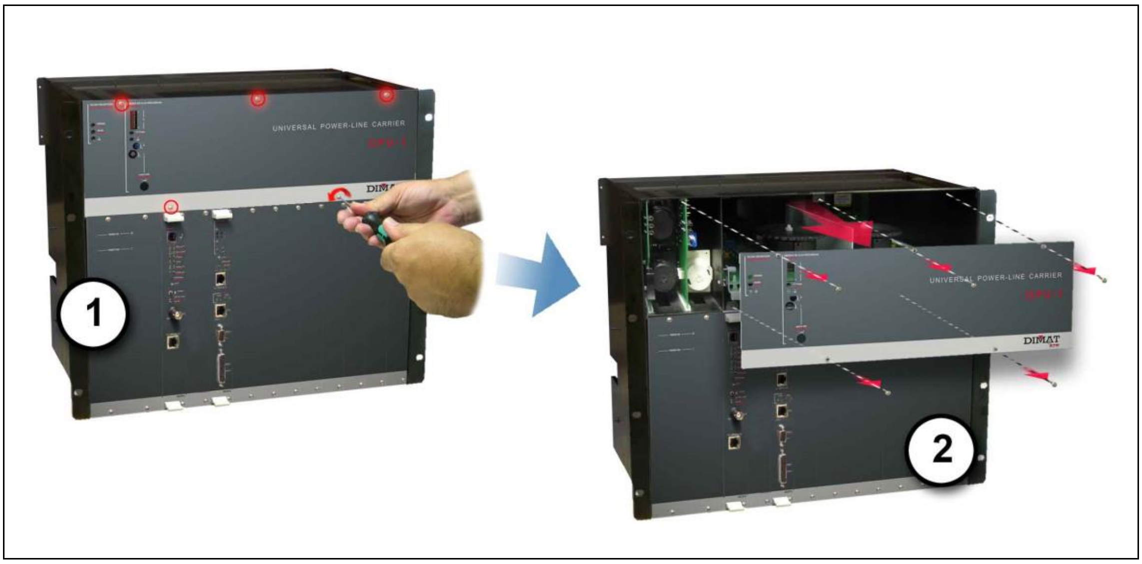


Figure 6.1 How to release the front cover of the 3 s.u.

Figure 6.2 An example of module (AFPU/AFPR & TAPU) extraction.

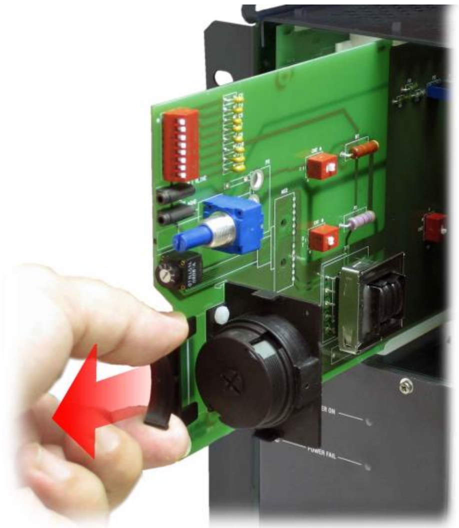


Figure 6.3 An example of module (RXPU/RXPR & HIPU) extraction.

6.2.2 6 s.u. shelf

The modules of the **6** s.u. shelf have two fixing screws, one at the top and one at the bottom of the front plate. The position of the fixing screws in a module is shown in the enclosed figure.

To extract a module, turn the two fixing screws anti-clockwise as far as allowed. Then by means of the handles pull the module out of the shelf.

*Putting a module back into the **6** s.u. shelf is achieved by carrying out the process for extracting the module, but this time in reverse.*
Once the module has been inserted, turn the two fixing screws clockwise.

Figure 6.4 Arrangement of modules in the 6 s.u. shelf.

Figure 6.5 Position of the fixing screws in a module.

6.3 Important considerations

1 Output impedance of the **OPU-1** terminal must be in accordance with the type of cable used to carry out connection with the coupling system.

The output impedance may be of **50** Ω, **75** Ω, **125** Ω or **140**/**150** Ω.

The impedance of the shielded-pair cables is normally at about **140** Ω.

Use of the dummy load is independent of the output impedance selected for the terminal.

2 Line connection is carried out in one of two ways.

- **Balanced configuration.**
It must be used when the cable connecting with the coupling system is a shielded pair. The screen of the pair is the one that must be connected to earth, equipment side.

- **Non-balanced configuration**.
It must be used when the cable connecting with the coupling system is coaxial. The earthing of the screen of the coaxial cable must be carried out equipment side.

3 In normal operation of the terminal, the dummy load must be in **NORMAL** position. If complete isolation of the terminal with respect to the line is required, the **NORMAL** jumper must not be carried out.

The **TERMINAL** jumper carried out, opens the transmission line and loads the local terminal with the dummy load. Remember that the dummy load is independent of the impedance selected for the terminal.

The **LINE** jumper carried out, places the dummy load in the line and leaves the terminal in open circuit, without load.

4 In normal operation condition, the receive filter, the line filter and the high-frequency hybrid must be included. It means that the associated internal switches must be in the included position.

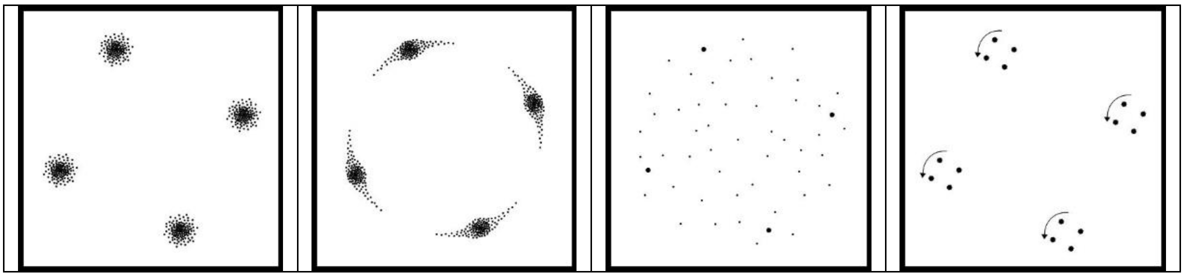
5 When the digital modem is installed in the terminal, observation of the signal space could help to solve some terminal malfunctions due to external or internal causes.
In this way, it is possible to detect:

- **Random noise** generated by the high-voltage line.
It generates a cloud of points around the nominal positions for signal space.

- **Jitter** due to the use of an external clock causing jitter or by breakdown of the process for recovery of synchronism incorporated in the system.
The shafts of the constellation rotate to the left and right of their central position.

- **Impulse noise** due to saturation of any of the transmission or reception stages. It causes the appearance of random points in the signal space.

- **Excessive re-entry** if the hybrid is not correctly adapted. It generates a constellation with ill-defined points.



a) Random noise b) Jitter c) Impulse noise d) Excessive re-entry

Figure 6.6 Examples of constellation view.

6 When the L.F. limiter activates in an analog channel, it means that the level of the signal injected in the equipment is higher than the maximum programmed value.
It is then necessary to adjust the level of the service or, from the Management System, reprogram the audio-frequency input level.

7 Each management system page refers to the local terminal. To display the page of the remote terminal, it is necessary to press the **REMOTE TERMINAL** button that appears in the top left-hand corner of all the pages referring to the local terminal.

The page will change colour, the **LOCAL TERMINAL** button appearing in the top left-hand corner.

8 In a **mixed** terminal (analog+digital), the guard signal is transmitted over the analog channel.

9 In most cases, a misoperation of the terminal will need one or more of the following actions:

- check levels.
- readjust high-frequency hybrid.
- perform a high-frequency test loop.
- check proper operation of filters.

10 The Management System has many options for alignment facilities. In addition to providing help in filter and hybrid adjustment, it offers:

- test loops in high and low frequency.
- real-time alarm monitoring.
- alarms/events chronological register.
- monitoring of received-pilot level.
- monitoring of S/N ratio level.
- transmit-level adjustment.
- receive-level adjustment (analog link).
- amplitude-response adjustment (analog link).
- constellation view (digital link).
- G.821 statistics monitoring (digital link).
- Signal spectrum monitoring (digital link).

6.4 Commissioning procedure

1 Please ensure that you have read the section 6.1, ***Warnings***.

2 Make sure that the operating conditions in which the terminal will operate are suitable.

3 Obtain a clear **equipment definition** in order to make a correct programming.
Important features are:

- **Operation mode**: **analog** (single/twin channel), **digital** (with/without in-band teleprotection and modulation type), **mixed** (analog+digital with common or independent filters), **HF Teleprotection** functionality (**4** kHz or **2** kHz bandwidth).
- **Output power.** Bear in mind that **80** W needs the second **WPPU.80** back panel.
- **Frequency range.** Bear in mind that from **40** kHz to **500** kHz needs the **RXPU** & **AFPU** modules and from **500** kHz to **1** MHz the **RXPR** & **AFPR** modules.
- **Bandwidth of line filter.** Bear in mind that 8/16/24 kHz needs the **WPPU.00** back panel and **AMPU.00** amplifier and that 8/16/32 kHz the **WPPU.01** back panel and **AMPU.02** amplifier.

4 Obtain a detailed planning of **bands and frequencies** in order to make a correct programming.
Important features are:

- **Analog** channel: Adjacent or non-adjacent, erect or inverted.
- **QAM** digital channel: Superimposed or adjacent or non-adjacent.
- **OFDM/OQAM** digital channel: Adjacent or non-adjacent.
- **HF teleprotection** functionality: Adjacent, Erect (Tx) & Inverted (Rx) or Inverted (Tx) & Erect (Rx).

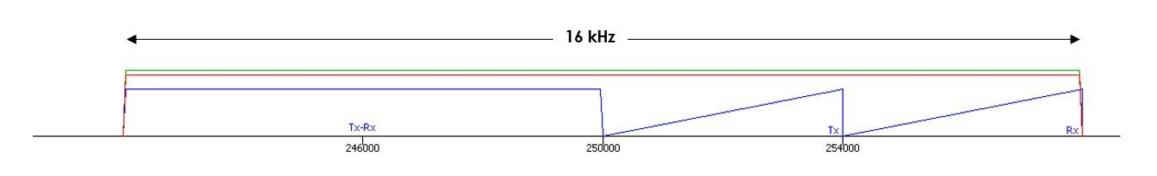


Figure 6.7 Example of filters set at 16 **kHz for superimposed bands in digital channel (**QAM **of BW=**8 **kHz) and adjacent** erect **bands in an analog** single **channel.**

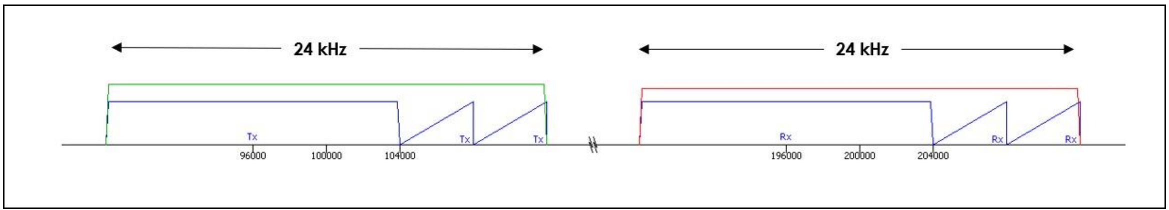


Figure 6.8 Example of filters set at 24 **kHz for non-adjacent bands both in digital channel (**QAM **of BW=**16 **kHz) and analog** twin **channel.**

5 Configure back-panel elements and internal settings of the modules according to required bandwidth and terminal configuration.
For module handling, previously, refer to section 6.2, ***How to access modules***.

- The output impedance of the high-frequency amplifier must be consistent with the bandwidth of the line filter. Back-panel configuration and switch selection for this purpose must be the right one.
- In the same way, the impedance configured in the receive filter and in the high-frequency hybrid must be consistent. Switch selection for this purpose must be the right one.
- In operation as High-Frequency teleprotection system, the settings configured in the **TPPU** module must be the right ones. Mainly, the nominal activation voltage of the command inputs.

6 Regarding line connection, output impedance and dummy load, take into account the considerations indicated at points **1**, **2** & **3** of section 6.3, ***Important considerations***, respectively.

7 Connect the power supply of the terminal by means of the main switch located at the rear of the **6** s.u. shelf.

When connected, the **POWER ON** LED lights up. Once the internal voltages become stabilized, the **STATUS** LED of the **MOPU** module lights up in green and, if it is installed, that of the **MQPU** module.

8 Connect the PC to the terminal and start up the Management System.

Program the terminal in accordance with **equipment definition** and **frequency planning**.

All the operating conditions must be set, including those of the optional modules.

9 Carry out the receive filter adjustment as indicated in section 6.5, ***Filter adjustment***.

In terminals for **20** W & **40** W with additional filter, it is necessary to adjust the receive filter located in each of the two shelves.

10 Carry out the line filter adjustment as indicated in section 6.5, ***Filter adjustment***.

In terminals for **20** W & **40** W with additional filter, it is necessary to adjust the line filter located in each of the two shelves.

For **80** W terminals, it is necessary to adjust the line filter located in the **AFPU** module (first **3** s.u. shelf) and the line filter located in the **DTPU** module (second **3** s.u. shelf).

11 Revise the hardware configuration because it may not be in the correct position after filter adjustment. See the enclosed tables.
In normal operation condition, the dummy load must be in **NORMAL** position. However, if complete isolation of the terminal with respect to the line is required, the **NORMAL** jumper must not be carried out.

	AFPU (AFPR)			RXPU (RXPR)								
	CM4	CM5	CM6	CM12	CM13	CM14	CM8	CM9	CM10	CM11	CM15	CM16
8 kHz filter	ON	ON	OFF	A	S	T	A	ON	ON	ON	S	S
16 kHz filter	ON	ON	OFF	A	S	T	A	ON	ON	ON	D	D
24 kHz filter	ON	ON	OFF	A	S	T	A	ON	ON	ON	T	T_{24K}
32 kHz filter	ON	ON	OFF	A	S	T	A	ON	ON	ON	T	T_{32K}

	HIPU			AMPU		WPPU		
	CM1	CM2	CM3	CM1	CM2	28R	56R	84R
8 kHz filter	S	S	A	S	S	ON	OFF	OFF
16 kHz filter	D	D	A	D	D	OFF	ON	OFF
24 kHz filter or 32 kHz filter	T	T	A	-	T	OFF	OFF	ON

Table 6-1: Hardware configuration in normal operation

	TAPU						WAPU
	CM1	CM2	CM3	CM4	J44-J45	J46-J47	CM2
2 kHz filter	ON	ON	ON	2k	OFF	ON	S
4 kHz filter	ON	ON	ON	4k	ON	OFF	D

Table 6-2: Hardware configuration in normal operation (HF TP functionality)

12 Carry out transmit-pilot level adjustment following the instructions given in section 6.7, ***Levels***.

13 Adjust the high-frequency hybrid as indicated in section 6.6, ***Hybrid adjustment***.

In terminals for **20** W & **40** W with additional filter, it is necessary to adjust the HF hybrid located in each of the two shelves.

14 In the analog channel, with the aid of the Management System (*Alignment help* menu), carry out receive-level adjustment.

Information about receive-pilot level measurement can be found in section 6.7, ***Levels.***

If applicable, also carry out amplitude-response adjustment.

15 Carry out some type of loop.

- **High-frequency loop.**
  Carry out a loop in the local terminal at high frequency (**MAKE HF LOOP** command button of the *Basic equipment* option of the *Configuration* menu).
  Transmission is looped over reception at local level, allowing verification of all transmission and reception processes.
  It is available in digital and analog channels.
  If the terminal has an internal teleprotection unit, block the teleprotection receiver to prevent false commands.

- **Low-frequency loops.**
  It is only available in analog channels.
  Two types of **low-frequency loops** can be executed to obtain information about the response curve of the link.
  One loop, **with level recovery** at the looped end, allows the losses of the backward-channel to be known.
  The other, **direct**, allows the response curve of the looped circuit to be known. The received signal is sent back without altering its level, that is, without level recovery.

- **Data loop.**
  It is available in a digital channel.
  It is possible to carry out a loop in each of the data ports of the **MQPU** module and, if it is installed, those of the optional built-in multiplexer. The loop is ordered by means of the corresponding **PROGRAM** command button (*Multiplexer loops* option of the *Digital part* submenu of the *Alignment help* menu).
  When a loop is carried out in a port, the port input data returns at input/output level to its original source, whilst the data received from line is sent back to the line.
  A data analyzer (data interface) or tone generator (speech interface) will be required.

16 Revise that there is nothing left to be programmed such as:

- alarm-relay activation conditions.
- conditions to activate and deactivate outputs in the analog channel.
- unavailable link-signal condition in the analog channel.
- SNMP parameters.
- External time synchronization (SNTP / IRIG-B / none).
- Operating parameters related with optional modules.

17 **DO NOT** forget to set the date and time of the terminal clock using the *Setting the clock* option of the *Basic equipment* submenu of the *Aligment help* menu.

18 Reset the chronological register of the terminal using the *Chronological register* option of the *Basic equipment* submenu of the *Monitoring* menu.

If applicable, reset the chronological register of the teleprotection module using the *Chronological register* option of the *Teleprotection* submenu of the *Monitoring* menu, and set to zero the teleprotection counters using the *Initializations* option of the *Teleprotection* submenu of the *Alignment help* menu.

6.5 Filter adjustment

The **OPU-1** Management System can generate high-frequency tones to carry out the adjustment of the line filter and receive filter, as well as perform a manual or automatic sweep to check the filter frequency response.

The figures below show the physical location of the filters.

*Remember that a module must **NOT** be inserted or extracted when the terminal is powered on.*

*Disconnect the main power-supply switch at the rear of the **6** s.u. shelf before doing so.*

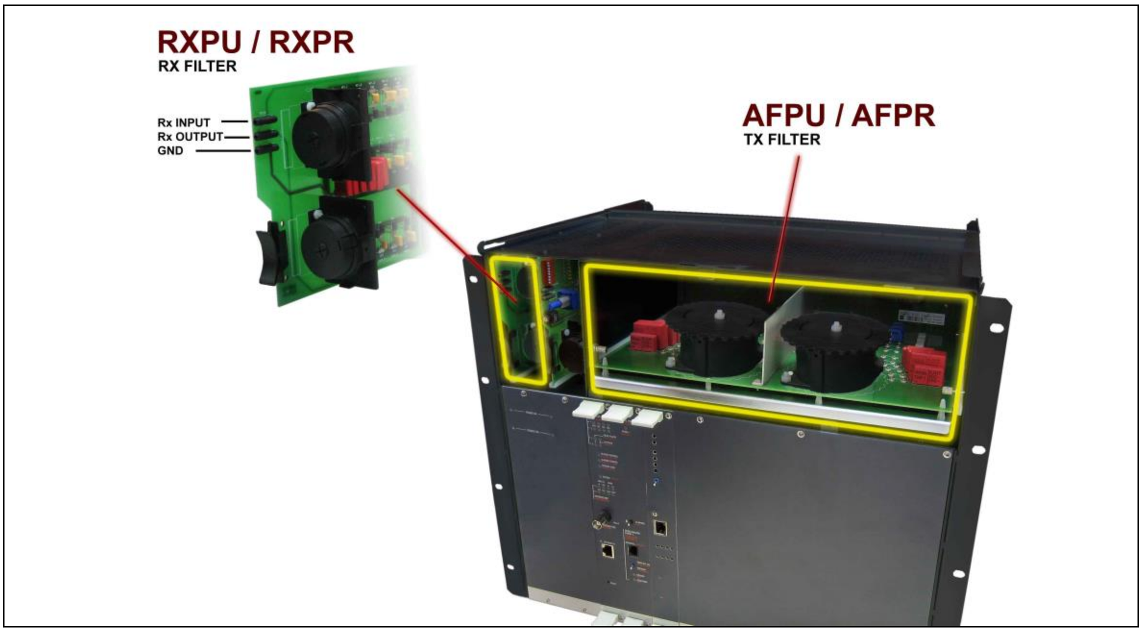


Figure 6.9 Location of filters for OPU-1 of 20 W & 40 W.

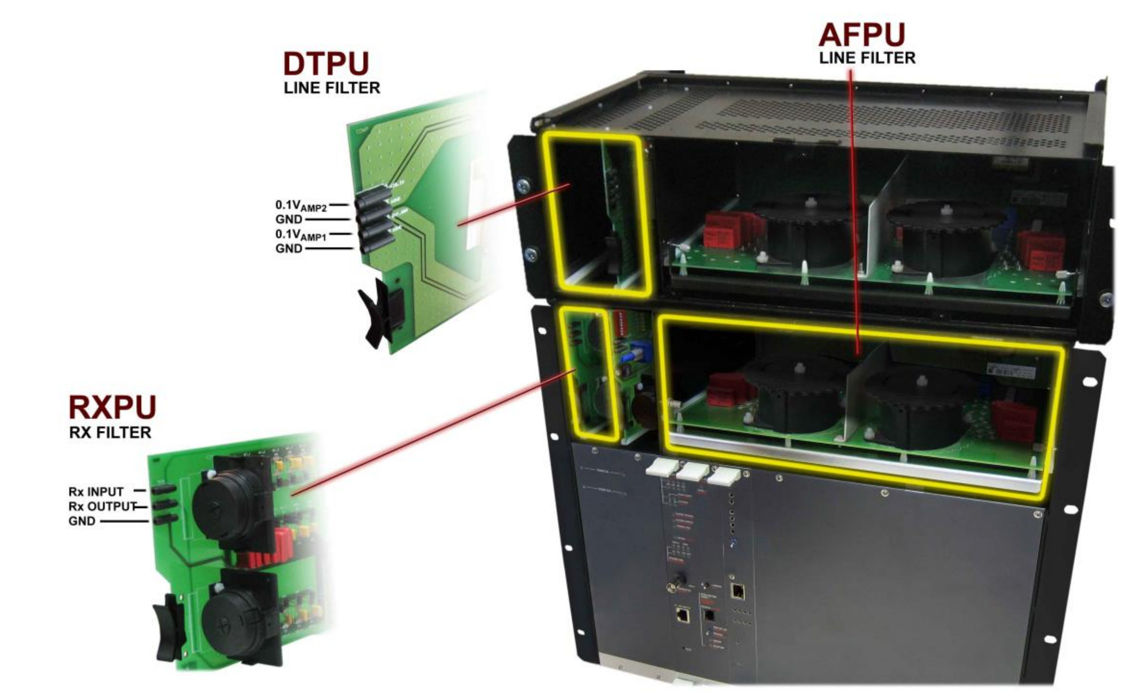


Figure 6.10 Location of filters for OPU-1 of 80 W.

6.5.1 Receive filter adjustment

Section 6.5.1a, ***Jumpers in RXPU***, describes the jumpers to carry out in the **RXPU** module according to **Rx** frequency.

Section 6.5.1b, ***Jumpers in RXPR***, describes the jumpers to carry out in the **RXPR** module according to **Rx** frequency.

The receive filter adjustment procedure is the following:

1 From the Management System, access the option *Receive-filter adjustment* of the *Basic equipment* submenu of the *Alignment help* menu.

2 In the associated screen, enter the configuration values, manually, or acquire them from the terminal by means of the **RETRIEVE** command button.

3 Press the **CONTINUE** command button, after which a list box labelled **TYPE OF ADJUSTMENT** will appear where it is possible to select any of the options:

- *L3 inductance adjustment.*
- *L4 inductance adjustment.*
- *Whole filter.*

4 Access the option *L3 inductance adjustment* to start the adjustment of the **input** resonance circuit.

5 Disconnect the power supply from the **OPU-1** terminal.

6 Put the dummy load in **TERMINAL** position.

7 Extract the **RXPU (RXPR)** module and set the jumpers and switches as indicated in the figure that appears when the **VIEW** command button is pressed.

The **AFPU (AFPR)** and **HIPU** modules must be configured as indicated at the bottom of the screen.

The position of the jumpers in the **RXPU (RXPR)** module is summarized in section 6.5.1a (6.5.1b).

The position of all the jumpers and switches of the terminal is summarized in the table below.

	AFPU (AFPR)			RXPU (RXPR)								
	CM4	CM5	CM6	CM12	CM13	CM14	CM8	CM9	CM10	CM11	CM15	CM16
8 kHz filter	OFF	OFF	OFF	NA	S	T	NA	ON	OFF	ON	S	S
16 kHz filter	OFF	OFF	OFF	NA	S	T	NA	ON	OFF	ON	D	D
24 kHz filter	OFF	OFF	OFF	NA	S	T	NA	ON	OFF	ON	T	T_{24K}
32 kHz filter	OFF	OFF	OFF	NA	S	T	NA	ON	OFF	ON	T	T_{32K}

	HIPU			AMPU		WPPU		
	CM1	CM2	CM3	CM1	CM2	28R	56R	84R
8 kHz filter	S	S	NA	S	S	OFF	OFF	OFF
16 kHz filter	D	D	NA	D	D	OFF	OFF	OFF
24 kHz filter or 32 kHz filter	T	T	NA	-	T	OFF	OFF	OFF

Table 6-3: Position of all the jumpers and switches of the terminal in L3 adjustment

8 Insert the modules once again, and connect the power supply of the **OPU-1** terminal.

Wait until the voltages become stabilized and the management connection is active.

9 From the Management System, generate a test tone by pressing the **GENERATE** command button.

10 Adjust inductance **L3** until the minimum voltage possible is obtained at the **0.1V$_{\mathbf{LINE}}$** and ground test points of the **HIPU** module.

11 Once the inductance has been adjusted, press the **STOP** command button.

12 Access the option *L4 inductance adjustment* to start the adjustment of the **output** resonance circuit.

13 Disconnect the power supply from the **OPU-1** terminal.

14 Extract the **RXPU (RXPR)** module and set the jumpers and switches as indicated in the figure that appears when the **VIEW** command button is pressed.

The **AFPU (AFPR)** and **HIPU** modules must be configured as indicated at the bottom of the screen.

The position of the jumpers in the **RXPU (RXPR)** module is summarized in section 6.5.1a (6.5.1b).

The position of all the jumpers and switches of the terminal is summarized in the table below.

	AFPU (AFPR)			RXPU (RXPR)								
	CM4	CM5	CM6	CM12	CM13	CM14	CM8	CM9	CM10	CM11	CM15	CM16
8 kHz filter	OFF	OFF	OFF	NA	S	T	NA	OFF	OFF	ON	S	S
16 kHz filter	OFF	OFF	OFF	NA	S	T	NA	OFF	OFF	ON	D	D
24 kHz filter	OFF	OFF	OFF	NA	S	T	NA	OFF	OFF	ON	T	T_{24K}
32 kHz filter	OFF	OFF	OFF	NA	S	T	NA	OFF	OFF	ON	T	T_{32K}

	HIPU			AMPU		WPPU		
	CM1	CM2	CM3	CM1	CM2	28R	56R	84R
8 kHz filter	S	S	NA	S	S	OFF	OFF	OFF
16 kHz filter	D	D	NA	D	D	OFF	OFF	OFF
24 kHz filter or 32 kHz filter	T	T	NA	-	T	OFF	OFF	OFF

Table 6-4: Position of all the jumpers and switches of the terminal in L4 adjustment

15 Insert the modules once again, and connect the power supply of the **OPU-1** terminal.

Wait until the voltages become stabilized and the management connection is active.

16 From the Management System, generate a new test tone by pressing the **GENERATE** command button.

17 Adjust inductance **L4** until the minimum voltage possible is obtained at the **0.1V$_{LINE}$** and ground test points of the **HIPU** module.

18 Once the inductance has been adjusted, press the **STOP** command button.

19 Check proper operation of the filter.

Section 6.5.2, ***Checking of receive filter***, describes how to do this.

6.5.1.a Jumpers in RXPU

This section describes the jumpers in **RXPU** module according to receive frequency.

- **For 8 kHz filter**

FREQUENCY in kHz

	From 40 to 46	From 48 a 56	From 58 a 66	From 68 a 82	From 84 a 100	From 102 a 108	From 110 a 120	From 122 a 134	From 136 a 156	From 158 a 164	From 166 a 194	From 196 a 228	From 230 a 242	From 244 a 276	From 278 a 324	From 326 a 374	From 376 a 398	From 400 a 458	From 460 a 500
S100																			
S10											●		●		●				●
S11									●			●		●	●	●			●
S12					●		●		●	●	●	●	●		●	●	●	●	
S13			●	●		●	●	●	●	●		●	●	●					
S14				●	●	●			●	●	●								
S15				●		●	●	●											
S16	●	●	●	●	●														
S17	●		●																
S18	●	●																	
S19																			
S20																			
S21																			
S22									●		●		●	●		●	●		●
S23			●	●	●	●			●	●	●		●						●
S24			●		●	●	●	●	●		●		●			●			●
S25				●		●	●		●	●			●	●	●				●
S26				●		●	●	●					●	●	●	●	●	●	
S27		●	●			●	●	●	●	●	●	●							
S28	●		●	●	●														
S29	●	●																	
S300																			
S30											●		●		●				●
S31									●			●		●	●	●			●
S32					●		●		●	●	●	●	●		●	●	●	●	
S33			●	●		●	●	●	●	●		●	●	●					
S34				●	●	●			●	●	●								
S35				●		●	●	●											
S36	●	●	●	●	●														
S37	●		●																
S38	●	●																	
S39																			

● JUMPERS TO PUT IN (RXPU MODULE)

- **For 16 kHz filter**

FREQUENCY in kHz

	From 40 to 56	From 58 to 66	From 68 to 78	From 80 to 92	From 94 to 110	From 112 to 132	From 134 to 158	From 160 to 192	From 194 to 218	From 220 to 262	From 264 to 288	From 290 to 300	From 302 to 340	From 342 to 398	From 400 to 478	From 480 to 500
S100																
S10										●			●	●	●	●
S11									●	●			●		●	●
S12					●								●	●		
S13					●			●		●	●	●				
S14				●		●		●	●							
S15		●		●		●	●									
S16	●		●	●	●											
S17	●		●													
S18	●	●														
S19																
S20																
S21																
S22																
S23		●					●	●	●	●		●	●		●	
S24		●	●		●		●		●			●	●	●		
S25		●					●	●				●	●	●	●	●
S26		●	●	●			●	●	●	●	●					
S27		●	●	●	●	●										
S28	●															
S29																
S300																
S30										●			●	●	●	●
S31									●	●			●		●	●
S32					●								●	●		
S33					●			●		●	●	●				
S34				●		●		●	●							
S35		●		●		●	●									
S36	●		●	●	●											
S37	●		●													
S38	●	●														
S39																

● JUMPERS TO PUT IN (RXPU MODULE)

- **For 24 kHz filter**

FREQUENCY in kHz

	From 52 to 62	From 64 to 74	From 76 to 88	From 90 to 106	From 108 to 124	From 126 to 136	From 138 to 156	From 158 to 172	From 174 to 204	From 206 to 238	From 240 to 268	From 270 to 330	From 332 to 348	From 350 to 394	From 396 to 440	From 442 to 500
S100																
S10										●	●				●	●
S11													●	●		●
S12										●	●		●	●	●	
S13						●	●		●	●	●	●				
S14						●			●							
S15		●				●	●	●								
S16	●		●		●											
S17	●		●	●												
S18	●	●														
S19																
S20																
S21																
S22											●	●	●			●
S23			●	●	●			●		●		●				●
S24				●			●			●	●					●
S25		●		●	●	●				●	●	●	●	●	●	
S26	●			●	●	●	●	●	●							
S27	●	●	●													
S28																
S29																
S300																
S30										●	●				●	●
S31													●	●		●
S32										●	●		●	●	●	
S33						●	●		●	●	●	●				
S34						●			●							
S35		●				●	●	●								
S36	●		●		●											
S37	●		●	●												
S38	●	●														
S39																

● JUMPERS TO PUT IN (RXPU MODULE)

6.5.1.b Jumpers in RXPR

This section describes the jumpers in **RXPR** module according to receive frequency.

- **For 8 kHz filter**

FREQUENCY in kHz

	From 326 to 374	From 376 to 398	From 400 to 458	From 460 to 500
S11				
S12				
S13				
S14				●
S15	●			●
S16	●	●	●	
S200				
S20				
S21				
S22	●	●		●
S23				●
S24	●			●
S25				●
S26	●	●	●	
S27				
S31				
S32				
S33				
S34				●
S35	●			●
S36	●	●	●	

● JUMPERS TO PUT IN (RXPR MODULE)

- **For 16 kHz filter**

FREQUENCY in kHz

	From 342 to 398	From 400 to 478	From 480 to 500	From 502 to 524	From 526 to 568	From 570 to 656	From 658 to 738	From 740 to 808	From 810 to 888	From 890 to 912	From 914 to 1000
S11											
S12					●			●	●		
S13				●		●		●	●	●	●
S14	●	●	●			●	●				
S15		●	●	●	●						
S16	●										
S200					●		●				●
S20											●
S21				●	●	●	●		●	●	
S22				●		●			●		
S23		●		●	●	●	●	●			
S24	●			●	●						
S25	●	●	●								
S26											
S27						●	●	●	●	●	●
S31											
S32					●			●	●		
S33				●		●		●	●	●	●
S34	●	●	●			●	●				
S35		●	●	●	●						
S36	●										

● JUMPERS TO PUT IN (RXPR MODULE)

- **For 32 kHz filter**

FREQUENCY in kHz

	From 312 to 386	From 388 to 500	From 502 to 530	From 532 to 574	From 576 to 636	From 638 to 692	From 694 to 772	From 774 to 860	From 862 to 974	From 976 to 1000
S11										
S12				●		●	●		●	
S13				●		●			●	●
S14	●	●	●			●	●	●		
S15		●	●	●	●					
S16	●									
S200			●					●	●	
S20			●	●		●		●		
S21		●		●	●					●
S22				●	●	●	●			●
S23	●		●	●	●	●	●	●	●	
S24	●	●								
S25										
S26										
S27			●							
S31										
S32				●		●	●		●	
S33				●		●			●	●
S34	●	●	●			●	●	●		
S35		●	●	●	●					
S36	●									

● JUMPERS TO PUT IN (RXPR MODULE)

6.5.2 Checking of receive filter

The procedure for checking proper operation of the receive filter is the following:

1 Disconnect the power supply from the **OPU-1** terminal.

2 Put the dummy load in **TERMINAL** position.

3 Remove the jumpers for selection of the bandwidth of the line filter. That is, jumpers 28R (J42-J43), 56R (J44-J45), 84R (J48-J46).

4 Exclude the line filter. To do this, put switches CM4, CM5 and CM6 of the **AFPU (AFPR)** module in **OFF** position.

5 Exclude the high-frequency hybrid. To do this, put switch CM3 of the **HIPU** module in **NA** position.

6 Insert the modules once again, and connect the power supply of the **OPU-1** terminal.

Wait until the voltages become stabilized and the management connection is active.

7 From the Management System, access the option *RCV-filter adjustment* of the *Basic equipment* submenu of the *Alignment help* menu.

8 In the associated screen, acquire the configuration values from the terminal by means of the **RETRIEVE** command button.

9 Press the **CONTINUE** command button, after which a list box labelled **TYPE OF ADJUSTMENT** will appear where it is possible to select the *Whole filter* option.

10 In the *Whole filter* option, select the manual or automatic sweep, introduce the required data and measure in the **OUTPUT** and ground test points of the **RXPU (RXPR)** module.

11 Check that the frequency response of the filter, obtained by using a wideband voltmeter, does not present valleys or ripples within the band in question and that its ends coincide with the filter cut-off frequencies.

See the enclosed figures and explanatory text.

Manual sweep

On performing a manual sweep, it is necessary to select the frequencies that the terminal will generate, starting from the initial frequency, according to the intervals specified in the **FREQUENCY INCREMENT** text box.

By pressing the **START** command button, the terminal will generate the tone at the specified frequency.

To stop the generation of the tone, the **STOP** command button must be pressed.

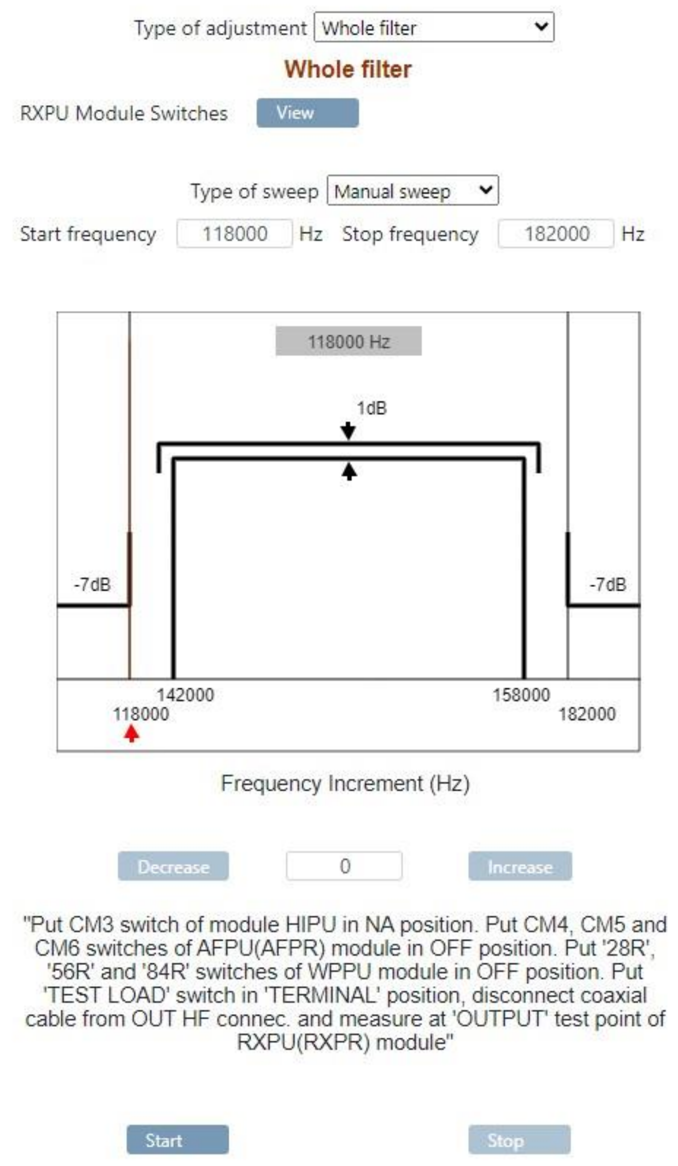


Figure 6.11 Manual sweep.

Automatic sweep

If an automatic sweep is selected, two text boxes appear labelled **FREQUENCY INCREMENT** and **TIME INCREASE** where it is necessary to enter, respectively, the interval of frequencies at which tones will be generated and the time that each of the tones will last.

Once these values are entered, the text box labelled **TOTAL ESTIMATED TIME** shows an estimation of the time that it will take to perform the sweep.

The frequency sweep is started by pressing the **START** command button and stopped with the **STOP** command button.

If the generation of a tone is stopped by means of the **PAUSE** command button, it is possible to resume the transmission of the tone at the same frequency by pressing **START**.

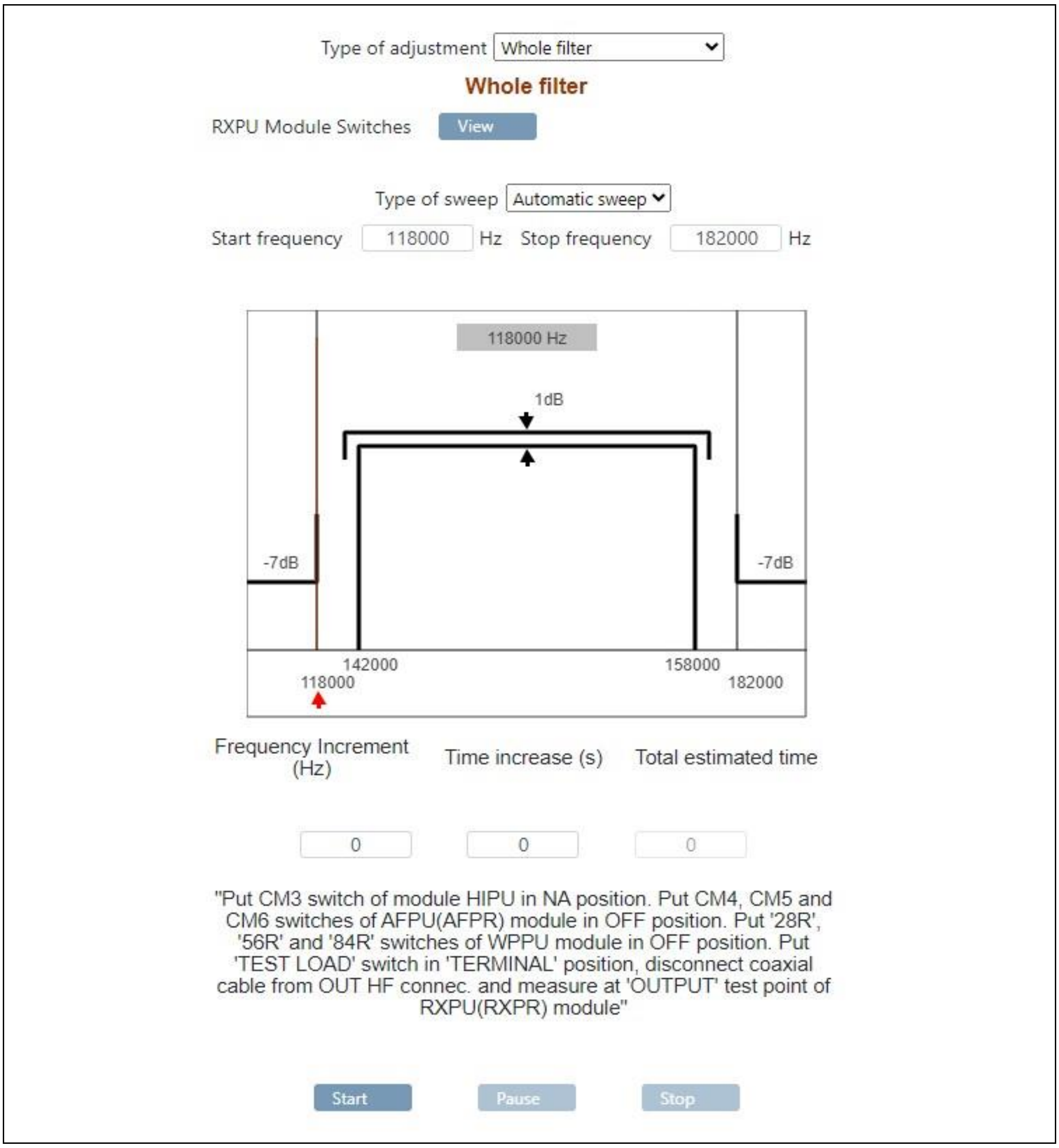


Figure 6.12 Automatic sweep.

12 Once the check is finished, disconnect the power supply and configure the jumpers for selection of the bandwidth of the line filter. That is, jumpers 28R (J42-J43), 56R (J44-J45), 84R (J48-J46).

13 Include the line filter. To do this, put switches CM4, CM5 and CM6 of the **AFPU (AFPR)** module, respectively, in **ON**, **ON** and **OFF** position.

14 Include the high-frequency hybrid. To do this, put switch CM3 of the **HIPU** module in **A** position.

15 Configure the dummy load in **NORMAL** position (if complete isolation of the terminal with respect to the line is required, the **NORMAL** jumper must not be carried out).

The position of all the jumpers and switches of the terminal in normal operation condition is summarized in the table below.

	AFPU (AFPR)			RXPU (RXPR)								
	CM4	CM5	CM6	CM12	CM13	CM14	CM8	CM9	CM10	CM11	CM15	CM16
8 kHz filter	ON	ON	OFF	A	S	T	A	ON	ON	ON	S	S
16 kHz filter	ON	ON	OFF	A	S	T	A	ON	ON	ON	D	D
24 kHz filter	ON	ON	OFF	A	S	T	A	ON	ON	ON	T	T_{24K}
32 kHz filter	ON	ON	OFF	A	S	T	A	ON	ON	ON	T	T_{32K}

	HIPU			AMPU		WPPU		
	CM1	CM2	CM3	CM1	CM2	28R	56R	84R
8 kHz filter	S	S	A	S	S	ON	OFF	OFF
16 kHz filter	D	D	A	D	D	OFF	ON	OFF
24 kHz filter or 32 kHz filter	T	T	A	-	T	OFF	OFF	ON

Table 6-5: Position of all the jumpers and switches of the terminal in normal operation condition

16 Insert the modules once again and connect the power supply of the **OPU-1** terminal.

If necessary, carry out the receive filter adjustment.

Section 6.5.1, ***Receive filter adjustment***, describes the procedure.

6.5.3 Line filter adjustment

Section 6.5.3a, ***Jumpers in AFPU***, describes the jumpers to carry out in the **AFPU** module according to **Tx** frequency.

Section 6.5.3b, ***Jumpers in AFPR***, describes the jumpers to carry out in the **AFPR** module according to **Tx** frequency.

The line filter adjustment procedure is the following:

1 From the Management System, access the option *Line-filter adjustment* of the *Basic equipment* submenu of the *Alignment help* menu.

2 In the associated screen, enter the configuration values, manually, or acquire them from the terminal by means of the **RETRIEVE** command button.

3 Press the **CONTINUE** command button, after which a list box labelled **TYPE OF ADJUSTMENT** will appear where it is possible to select any of the options:

- *L1 inductance adjustment.*
- *L2 inductance adjustment.*
- *Whole filter.*

4 Access the option *L1 inductance adjustment* to start the adjustment of the **input** resonance circuit.

5 Disconnect the power supply from the **OPU-1** terminal.

6 Put the dummy load in **TERMINAL** position.

7 Extract the **AFPU (AFPR)** module and set the jumpers and switches as indicated in the figure that appears when the **VIEW** command button is pressed.

The **RXPU (RXPR)** and **HIPU** modules must be configured as indicated at the bottom of the screen.

The position of the jumpers in the **AFPU (AFPR)** module is summarized in section 6.5.3a (6.5.3b).

The position of all the jumpers and switches of the terminal is summarized in the table below.

	AFPU (AFPR)			RXPU (RXPR)								
	CM4	CM5	CM6	CM12	CM13	CM14	CM8	CM9	CM10	CM11	CM15	CM16
8 kHz filter	OFF	ON	ON	A	S	T	A	ON	ON	ON	S	S
16 kHz filter	OFF	ON	ON	A	S	T	A	ON	ON	ON	D	D
24 kHz filter	OFF	ON	ON	A	S	T	A	ON	ON	ON	T	T_{24K}
32 kHz filter	OFF	ON	ON	A	S	T	A	ON	ON	ON	T	T_{32K}

	HIPU			AMPU		WPPU		
	CM1	CM2	CM3	CM1	CM2	28R	56R	84R
8 kHz filter	S	S	A	S	S	ON	OFF	OFF
16 kHz filter	D	D	A	D	D	OFF	ON	OFF
24 kHz filter or 32 kHz filter	T	T	A	-	T	OFF	OFF	ON

Table 6-6: Position of all the jumpers and switches of the terminal in L1 adjustment

8 Insert the modules once again, and connect the power supply of the **OPU-1** terminal.

Wait until the voltages become stabilized and the management connection is active.

9 From the Management System, generate a test tone by pressing the **GENERATE** command button.

10 Adjust inductance **L1** until the minimum voltage possible is obtained at the **0.1V$_{LINE}$** and ground test points of the **HIPU** module.

> In the **80** W terminal, for the line filter located in the **AFPU** module, measurement is carried out in the **0.1 V$_{AMP1}$** and ground test points of the **DTPU** module.
>
> For the line filter located in the **DTPU** module itself, measurement is carried out in the **0.1 V$_{AMP2}$** and ground test points.

11 Once the inductance has been adjusted, press the **STOP** command button.

12 Access the option *L2 inductance adjustment* to start the adjustment of the **output** resonance circuit.

13 Disconnect the power supply from the **OPU-1** terminal.

14 Extract the **AFPU (AFPR)** module and set the jumpers and switches as indicated in the figure that appears when the **VIEW** command button is pressed.

The **RXPU (RXPR)** and **HIPU** modules must be configured as indicated at the bottom of the screen.

The position of the jumpers in the **AFPU (AFPR)** module is summarized in section 6.5.3a (6.5.3b).

The position of all the jumpers and switches of the terminal is summarized in the table below.

	AFPU (AFPR)			RXPU (RXPR)								
	CM4	CM5	CM6	CM12	CM13	CM14	CM8	CM9	CM10	CM11	CM15	CM16
8 kHz filter	ON	OFF	OFF	A	S	T	A	ON	ON	ON	S	S
16 kHz filter	ON	OFF	OFF	A	S	T	A	ON	ON	ON	D	D
24 kHz filter	ON	OFF	OFF	A	S	T	A	ON	ON	ON	T	T$_{24K}$
32 kHz filter	ON	OFF	OFF	A	S	T	A	ON	ON	ON	T	T$_{32K}$

	HIPU			AMPU		WPPU		
	CM1	CM2	CM3	CM1	CM2	28R	56R	84R
8 kHz filter	S	S	A	S	S	ON	OFF	OFF
16 kHz filter	D	D	A	D	D	OFF	ON	OFF
24 kHz filter or 32 kHz filter	T	T	A	-	T	OFF	OFF	ON

Table 6-7: Position of all the jumpers and switches of the terminal in L2 adjustment

15 Insert the modules once again, and connect the power supply of the **OPU-1** terminal.

Wait until the voltages become stabilized and the management connection is active.

16 From the Management System, generate a new test tone by pressing the **GENERATE** command button.

17 Adjust inductance **L2** until the minimum voltage possible is obtained at the **0.1V$_{LINE}$** and ground test points of the **HIPU** module.

> In the **80** W terminal, for the line filter located in the **AFPU** module, measurement is carried out in the **0.1 V$_{AMP1}$** and ground test points of the **DTPU** module.
>
> For the line filter located in the **DTPU** module itself, measurement is carried out in the **0.1 V$_{AMP2}$** and ground test points.

18 Once the inductance has been adjusted, press the **STOP** command button.

19 Check proper operation of the filter.

Section 6.5.4, ***Checking of line filter***, describes how to do this.

6.5.3.a Jumpers in AFPU

This section describes the jumpers in **AFPU** module according to receive frequency.

- **For 8 kHz filter**

FREQUENCY in kHz

	From 40 to 44	From 46 to 52	From 54 to 62	From 64 to 74	From 76 to 82	From 84 to 98	From 100 to 116	From 118 to 134	From 136 to 160	From 162 to 188	From 190 to 216	From 218 to 250	From 252 to 268	From 270 to 298	From 300 to 328	From 330 to 362	From 364 to 398	From 400 to 428	From 430 to 464	From 466 to 500
KPFL1_1										●			●	●				●		●
KPFL1_2										●	●	●		●		●		●	●	
KPFL1_3							●	●		●	●	●		●	●			●	●	●
KPFL1_4							●	●	●		●			●	●	●	●			
KPFL1_5						●			●		●	●	●							
KPFL1_6	●		●	●			●		●	●										
KPFL1_7	●	●	●	●	●		●	●												
KPFL1_8	●	●	●		●	●														
KPFL1_9	●		●	●																
KPFL1_10	●	●																		
KPFL1_11																				
KPFL2_1																				
KPFL2_2																				
KPFL2_3								●					●	●	●			●	●	●
KPFL2_4			●	●				●			●		●		●		●		●	
KPFL2_5																				
KPFL2_6		●	●	●		●		●		●	●		●	●			●	●		
KPFL2_7		●	●	●	●	●		●	●	●			●	●	●	●				
KPFL2_8	●	●	●		●			●	●				●	●	●	●	●	●	●	●
KPFL2_9		●						●	●	●	●	●								
KPFL2_10	●				●	●	●													
KPFL2_11	●	●	●	●																
KPFL3_1										●			●	●				●		●
KPFL3_2										●	●	●		●		●		●	●	
KPFL3_3							●	●		●	●	●		●	●			●	●	●
KPFL3_4							●	●	●		●			●	●	●	●			
KPFL3_5						●			●		●	●	●							
KPFL3_6	●		●	●			●		●	●										
KPFL3_7	●	●	●	●	●		●	●												
KPFL3_8	●	●	●		●	●														
KPFL3_9	●		●	●																
KPFL3_10	●	●																		
KPFL3_11																				

● JUMPERS TO PUT IN (AFPU MODULE)

- **For 16 kHz filter**

FREQUENCY in kHz

	From 48 to 50	From 52 to 56	From 58 to 62	From 64 to 72	From 74 to 82	From 84 to 94	From 96 to 106	From 108 to 120	From 122 to 132	From 134 to 142	From 144 to 170	From 172 to 194	From 196 to 230	From 232 to 266	From 268 to 308	From 310 to 320	From 322 to 366	From 368 to 408	From 410 to 446	From 448 to 500
KPFL1_1											●				●					●
KPFL1_2							●		●						●		●		●	
KPFL1_3						●	●			●	●	●	●	●	●	●			●	●
KPFL1_4		●	●						●				●		●	●	●	●		
KPFL1_5		●			●			●	●		●		●	●						
KPFL1_6	●	●	●		●	●		●			●	●								
KPFL1_7	●	●	●		●			●	●	●										
KPFL1_8	●		●	●	●	●	●													
KPFL1_9			●	●																
KPFL1_10	●	●																		
KPFL1_11																				
KPFL2_1																				
KPFL2_2																				
KPFL2_3		●	●							●						●			●	
KPFL2_4			●			●				●	●		●	●		●	●		●	●
KPFL2_5																				
KPFL2_6			●		●		●			●	●		●			●	●	●		
KPFL2_7	●		●	●		●				●	●	●				●	●	●	●	●
KPFL2_8			●	●	●					●	●	●	●	●	●					
KPFL2_9			●	●	●	●	●	●	●											
KPFL2_10	●	●																		
KPFL2_11																				
KPFL3_1											●				●					●
KPFL3_2							●		●						●		●		●	
KPFL3_3						●	●			●	●	●	●	●	●	●			●	●
KPFL3_4		●	●						●				●		●	●	●	●		
KPFL3_5		●			●			●	●		●		●	●						
KPFL3_6	●	●	●		●	●		●			●	●								
KPFL3_7	●	●	●		●			●	●	●										
KPFL3_8	●		●	●	●	●	●													
KPFL3_9			●	●																
KPFL3_10	●	●																		
KPFL3_11																				

● JUMPERS TO PUT IN (AFPU MODULE)

- **For 24 kHz filter**

FREQUENCY in kHz

	From 48 to 54	From 56 to 62	From 64 to 70	From 72 to 84	From 86 to 92	From 94 to 104	From 106 to 120	From 122 to 138	From 140 to 162	From 164 to 184	From 186 to 208	From 210 to 234	From 236 to 262	From 264 to 292	From 294 to 342	From 344 to 382	From 384 to 434	From 436 to 466	From 468 to 500
KPFL1_1													●		●		●		●
KPFL1_2					●				●			●				●	●	●	
KPFL1_3			●	●			●		●		●		●		●		●	●	●
KPFL1_4			●	●			●		●			●			●	●			
KPFL1_5			●	●			●	●	●	●		●	●	●					
KPFL1_6					●	●	●		●	●	●								
KPFL1_7			●	●	●		●	●											
KPFL1_8		●	●		●	●													
KPFL1_9			●	●															
KPFL1_10		●																	
KPFL1_11	●																		
KPFL2_1																			
KPFL2_2																			
KPFL2_3					●					●	●	●	●		●	●			●
KPFL2_4					●			●			●			●				●	
KPFL2_5		●			●	●	●	●			●	●		●	●			●	●
KPFL2_6	●	●	●		●	●		●	●		●	●	●					●	●
KPFL2_7		●			●	●	●				●	●	●	●	●	●	●		
KPFL2_8	●				●	●	●	●	●	●									
KPFL2_9	●	●	●	●															
KPFL2_10																			
KPFL2_11																			
KPFL3_1													●		●		●		●
KPFL3_2					●				●			●				●	●	●	
KPFL3_3			●	●			●		●		●		●		●		●	●	●
KPFL3_4			●	●			●		●			●			●	●			
KPFL3_5			●	●			●	●	●	●		●	●	●					
KPFL3_6					●	●	●		●	●	●								
KPFL3_7			●	●	●		●	●											
KPFL3_8		●	●		●	●													
KPFL3_9			●	●															
KPFL3_10		●																	
KPFL3_11	●																		

● JUMPERS TO PUT IN (AFPU MODULE)

6.5.3.b Jumpers in AFPR

This section describes the jumpers in **AFPR** module according to receive frequency.

- **For 8 kHz filter**

FREQUENCY in kHz

	From 340 to 376	From 378 to 402	From 404 to 428	From 430 to 452	From 454 to 474	From 476 to 500
KPFL1_1						
KPFL1_2						
KPFL1_3						
KPFL1_4			●			●
KPFL1_5	●		●	●	●	
KPFL1_6			●	●	●	●
KPFL1_7	●	●				
KPFL2_1						
KPFL2_2		●				
KPFL2_3		●				
KPFL2_4						●
KPFL2_5	●	●	●	●	●	
KPFL2_6				●		
KPFL2_7		●	●			
KPFL2_8	●					
KPFL2_9	●	●	●	●	●	●
KPFL3_1						
KPFL3_2						
KPFL3_3						
KPFL3_4			●			●
KPFL3_5	●		●	●	●	
KPFL3_6			●	●	●	●
KPFL3_7	●	●				

● JUMPERS TO PUT IN (AFPR MODULE)

- **For 16 kHz filter**

FREQUENCY in kHz

	From 350 to 388	From 390 to 416	From 418 to 458	From 460 to 500	From 502 to 524	From 526 to 556	From 558 to 590	From 592 to 636	From 638 to 688	From 690 to 750	From 752 to 800	From 802 to 858	From 860 to 914	From 916 to 948	From 950 to 960	From 962 to 1000
KPFL1_1					●	●		●						●		
KPFL1_2					●	●	●	●		●		●		●	●	●
KPFL1_3						●		●	●			●	●			
KPFL1_4	●	●		●		●	●					●	●	●	●	●
KPFL1_5		●	●			●	●	●	●	●	●					
KPFL1_6		●	●	●	●											
KPFL1_7	●															
KPFL2_1											●	●	●	●	●	●
KPFL2_2	●	●				●			●		●	●		●	●	
KPFL2_3	●	●			●		●			●	●	●	●		●	
KPFL2_4		●	●		●	●			●		●	●	●	●		●
KPFL2_5	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●
KPFL2_6	●				●	●	●	●				●	●	●	●	●
KPFL2_7					●	●	●	●	●	●	●					
KPFL2_8	●	●	●	●												
KPFL2_9																
KPFL3_1					●	●		●						●		
KPFL3_2					●	●	●	●		●		●		●	●	●
KPFL3_3						●		●	●			●	●			
KPFL3_4	●	●		●		●	●					●	●	●	●	●
KPFL3_5		●	●			●	●	●	●	●	●					
KPFL3_6		●	●	●	●											
KPFL3_7	●															

● JUMPERS TO PUT IN (AFPR MODULE)

- **For 32 kHz filter**

FREQUENCY in kHz

	From 322 to 362	From 364 to 406	From 408 to 438	From 440 to 472	From 474 to 500	From 502 to 550	From 552 to 600	From 602 to 638	From 640 to 700	From 702 to 750	From 752 to 798	From 800 to 848	From 850 to 908	From 910 to 956	From 958 to 1000
KPFL1_1															●
KPFL1_2							●		●			●		●	
KPFL1_3						●	●		●	●		●	●		
KPFL1_4		●	●		●		●	●				●	●	●	●
KPFL1_5			●	●			●	●	●	●	●				
KPFL1_6	●		●	●	●	●									
KPFL1_7	●	●													
KPFL2_1						●	●		●		●		●		
KPFL2_2	●	●		●	●		●	●		●	●	●			
KPFL2_3			●			●				●					●
KPFL2_4	●		●	●	●					●	●	●	●	●	
KPFL2_5	●	●			●	●	●	●	●	●	●	●	●	●	●
KPFL2_6					●	●	●	●	●						
KPFL2_7	●	●	●	●											
KPFL2_8															
KPFL2_9															
KPFL3_1															●
KPFL3_2							●		●			●		●	
KPFL3_3						●	●		●	●		●	●		
KPFL3_4		●	●		●		●	●				●	●	●	●
KPFL3_5			●	●			●	●	●	●	●				
KPFL3_6	●		●	●	●	●									
KPFL3_7	●	●													

● JUMPERS TO PUT IN (AFPR MODULE)

6.5.4 Checking of line filter

The procedure for checking proper operation of the line filter is the following:

1 Disconnect the power supply from the **OPU-1** terminal.

2 Put the dummy load in **TERMINAL** position.

3 Connect the power supply of the **OPU-1** terminal.

Wait until the voltages become stabilized and the management connection is active.

4 From the Management System, access the option *Line-filter adjustment* of the *Basic equipment* submenu of the *Alignment help* menu.

5 In the associated screen, acquire the configuration values from the terminal by means of the **RETRIEVE** command button.

6 Press the **CONTINUE** command button, after which a list box labelled **TYPE OF ADJUSTMENT** will appear where it is possible to select the *Whole filter* option.

7 In the *Whole filter* option, select the manual or automatic sweep, introduce the required data and measure in the **0.1V$_{LINE}$** and ground test points of the **HIPU** module.

> In the **80** W terminal, for the line filter located in the **AFPU** module, measurement is carried out in the **0.1 V$_{AMP1}$** and ground test points of the **DTPU** module.
>
> For the line filter located in the **DTPU** module itself, measurement is carried out in the **0.1 V$_{AMP2}$** and ground test points.

8 Check that the frequency response of the filter, obtained by using a wideband voltmeter, does not present valleys or ripples within the band in question and that its ends coincide with the filter cut-off frequencies.

See the enclosed figures and explanatory text.

Manual sweep

On performing a manual sweep, it is necessary to select the frequencies that the terminal will generate, starting from the initial frequency, according to the intervals specified in the **FREQUENCY INCREMENT** text box.

By pressing the **START** command button, the terminal will generate the tone at the specified frequency.

To stop the generation of the tone, the **STOP** command button must be pressed.

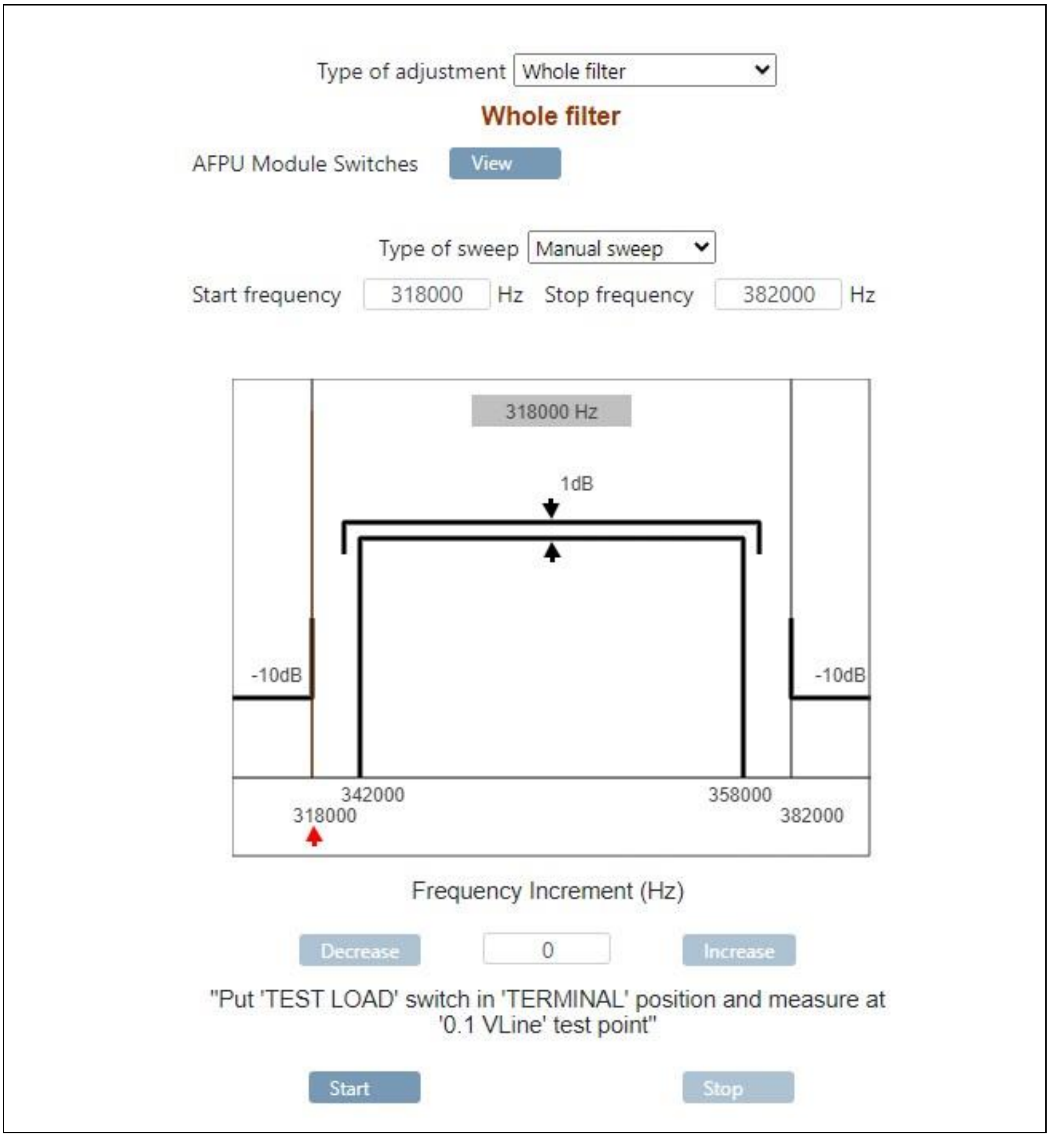


Figure 6.13 Manual sweep.

Automatic sweep

If an automatic sweep is selected, two text boxes appear labelled **FREQUENCY INCREMENT** and **TIME INCREASE** where it is necessary to enter, respectively, the interval of frequencies at which tones will be generated and the time that each of the tones will last.

Once these values are entered, the text box labelled **TOTAL ESTIMATED TIME** shows an estimation of the time that it will take to perform the sweep.

The frequency sweep is started by pressing the **START** command button and stopped with the **STOP** command button.

If the generation of a tone is stopped by means of the **PAUSE** command button, it is possible to resume the transmission of the tone at the same frequency by pressing **START**.

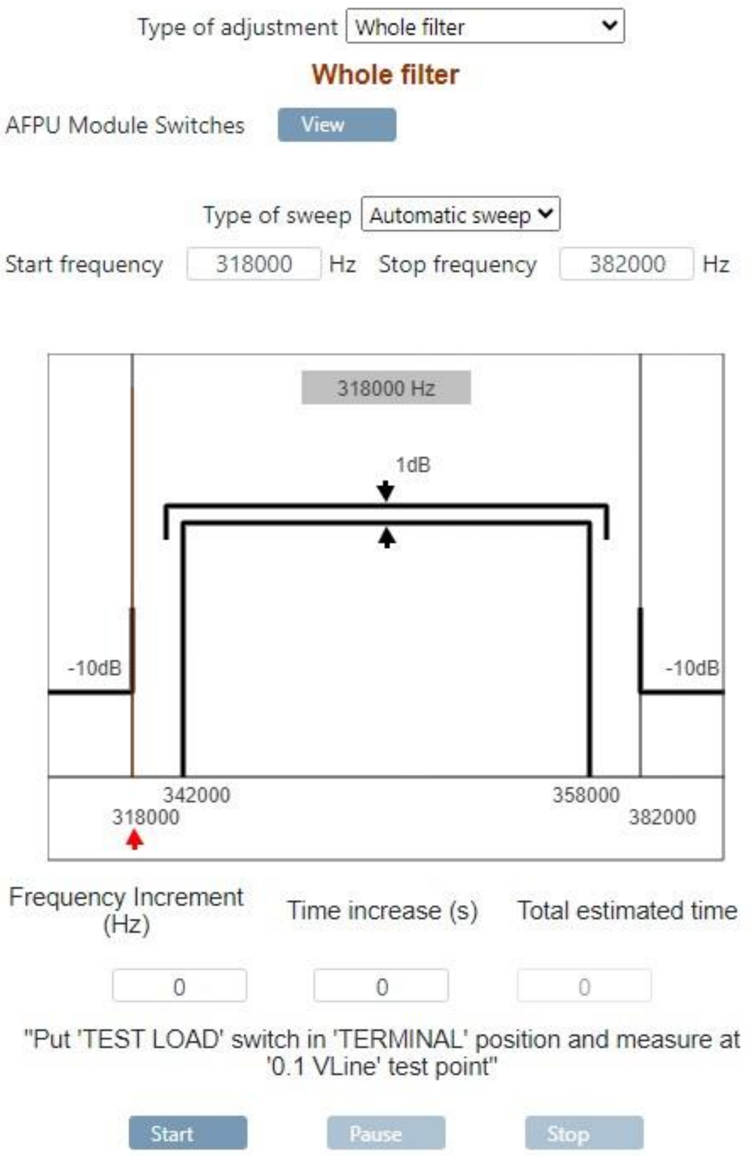


Figure 6.14 Automatic sweep.

9 Once the check is finished, disconnect the power supply and configure the dummy load in **NORMAL** position (if complete isolation of the terminal with respect to the line is required, the **NORMAL** jumper must not be carried out).

10 Connect the power supply of the **OPU-1** terminal.

If necessary, carry out the line filter adjustment.

Section 6.5.3, ***Line filter adjustment***, describes the procedure.

6.5.5 Line filter adjustment (HF Teleprotection functionality)

Section 6.5.5a, ***Jumpers in TAPU***, describes the jumpers to carry out in the **TAPU** module according to central frequency.

The line filter adjustment procedure for a terminal with High-Frequency Teleprotection functionality is the following:

1 From the Management System, access the option *Line-filter adjustment* of the *Basic equipment* submenu of the *Alignment help* menu.

2 In the associated screen, enter the configuration values, manually, or acquire them from the terminal by means of the **RETRIEVE** command button.

3 Press the **CONTINUE** command button, after which a list box labelled **TYPE OF ADJUSTMENT** will appear where it is possible to select any of the options:

- *L2 inductance adjustment.*
- *Whole filter.*

4 Access the option *L2 inductance adjustment* to start the adjustment of the **input** resonance circuit.

5 Disconnect the power supply from the **OPU-1** HF teleprotection terminal.

6 Put the dummy load in **TERMINAL** position.

7 Extract the **TAPU** module and set the jumpers and switches as indicated in the figure that appears when the **VIEW** command button is pressed.

The position of the jumpers in the **TAPU** module is summarized in section 6.5.5a.

The position of all the jumpers and switches of the terminal is summarized in the table below.

	TAPU						WAPU
	CM1	CM2	CM3	CM4	J44-J45	J46-J47	CM2
2 kHz filter	OFF	OFF	OFF	2k	OFF	ON	S
4 kHz filter	OFF	OFF	OFF	4k	ON	OFF	D

Table 6-8: Position of all the jumpers and switches of the terminal in L2 adjustment

8 Insert the **TAPU** module once again, and connect the power supply of the **OPU-1** HF teleprotection terminal.

Wait until the voltages become stabilized and the management connection is active.

9 From the Management System, generate a test tone by pressing the **GENERATE** command button.

10 Adjust inductance **L2** until the minimum voltage possible is obtained at the **0.1V$_{LINE}$** and ground test points of the **TAPU** module.

11 Once the inductance has been adjusted, press the **STOP** command button.

12 Access the option *Whole filer* to verify the adjustment of the whole filter.

13 Disconnect the power supply from the **OPU-1** HF teleprotection terminal.

14 Extract the **TAPU** module and set the jumpers and switches as indicated in the figure that appears when the **VIEW** command button is pressed.

The position is summarized in the table below.

	TAPU						WAPU
	CM1	CM2	CM3	CM4	J44-J45	J46-J47	CM2
2 kHz filter	ON	ON	ON	2k	OFF	ON	S
4 kHz filter	ON	ON	ON	4k	ON	OFF	D

Table 6-9: Position of all the jumpers and switches of the terminal in Whole filter adjustment

15 Insert the **TAPU** module once again, and connect the power supply of the **OPU-1** HF teleprotection terminal.

Wait until the voltages become stabilized and the management connection is active.

16 Select the manual or automatic sweep, introduce the required data and measure at the **0.1V$_{LINE}$** and ground test points of the **TAPU** module.

17 Check that the frequency response of the filter, obtained by using a wideband voltmeter, does not present valleys or ripples within the band in question and that its ends coincide with the filter cut-off frequencies.

See the enclosed figures and explanatory text.

Manual sweep

On performing a manual sweep, it is necessary to select the frequencies that the terminal will generate, starting from the initial frequency, according to the intervals specified in the **FREQUENCY INCREMENT** text box.

By pressing the **START** command button, the terminal will generate the tone at the specified frequency.

To stop the generation of the tone, the **STOP** command button must be pressed.

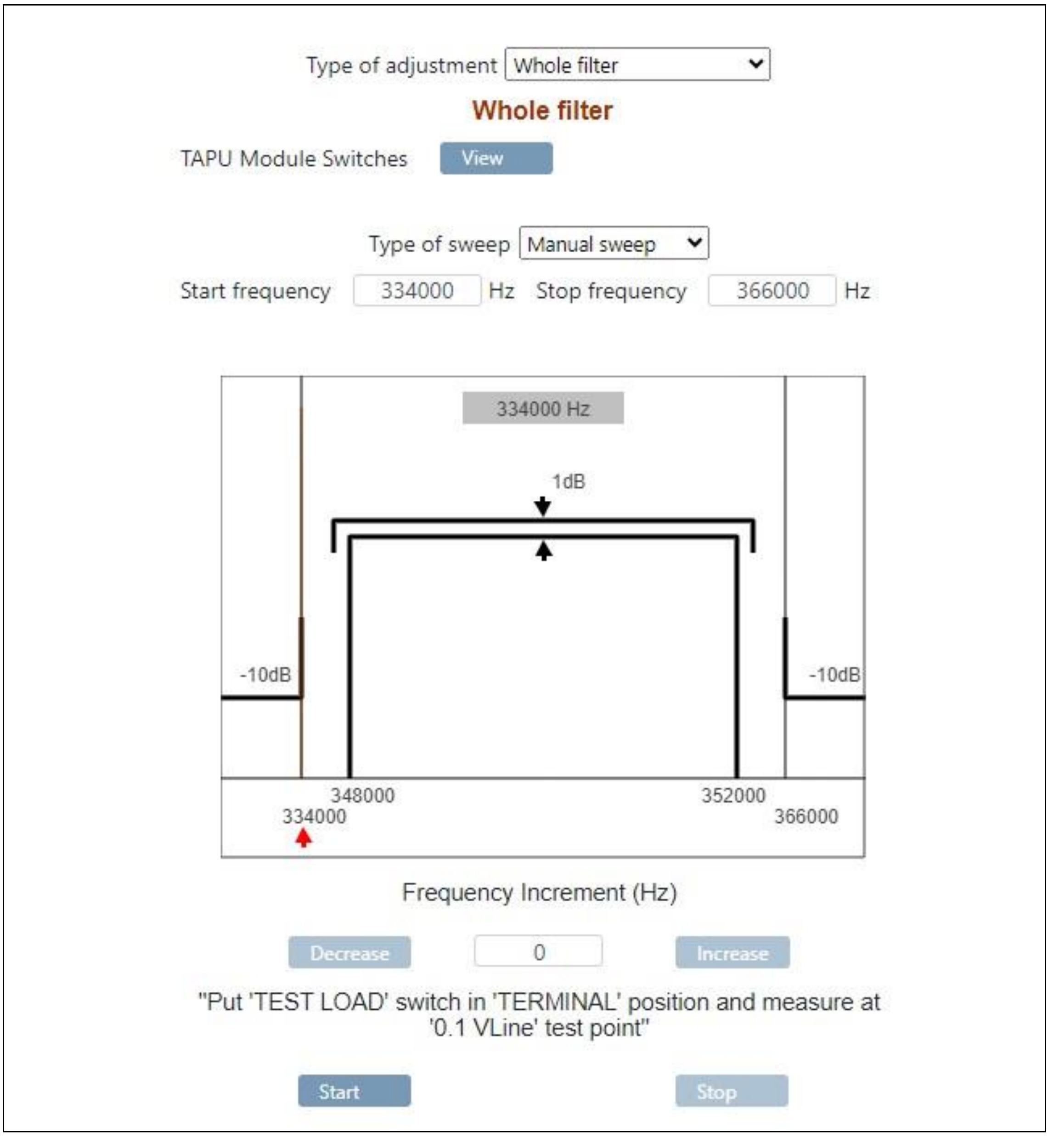


Figure 6.15 Manual sweep.

Automatic sweep

If an automatic sweep is selected, two text boxes appear labelled **FREQUENCY INCREMENT** and **TIME INCREASE** where it is necessary to enter, respectively, the interval of frequencies at which tones will be generated and the time that each of the tones will last.

Once these values are entered, the text box labelled **TOTAL ESTIMATED TIME** shows an estimation of the time that it will take to perform the sweep.

The frequency sweep is started by pressing the **START** command button and stopped with the **STOP** command button.

If the generation of a tone is stopped by means of the **PAUSE** command button, it is possible to resume the transmission of the tone at the same frequency by pressing **START**.

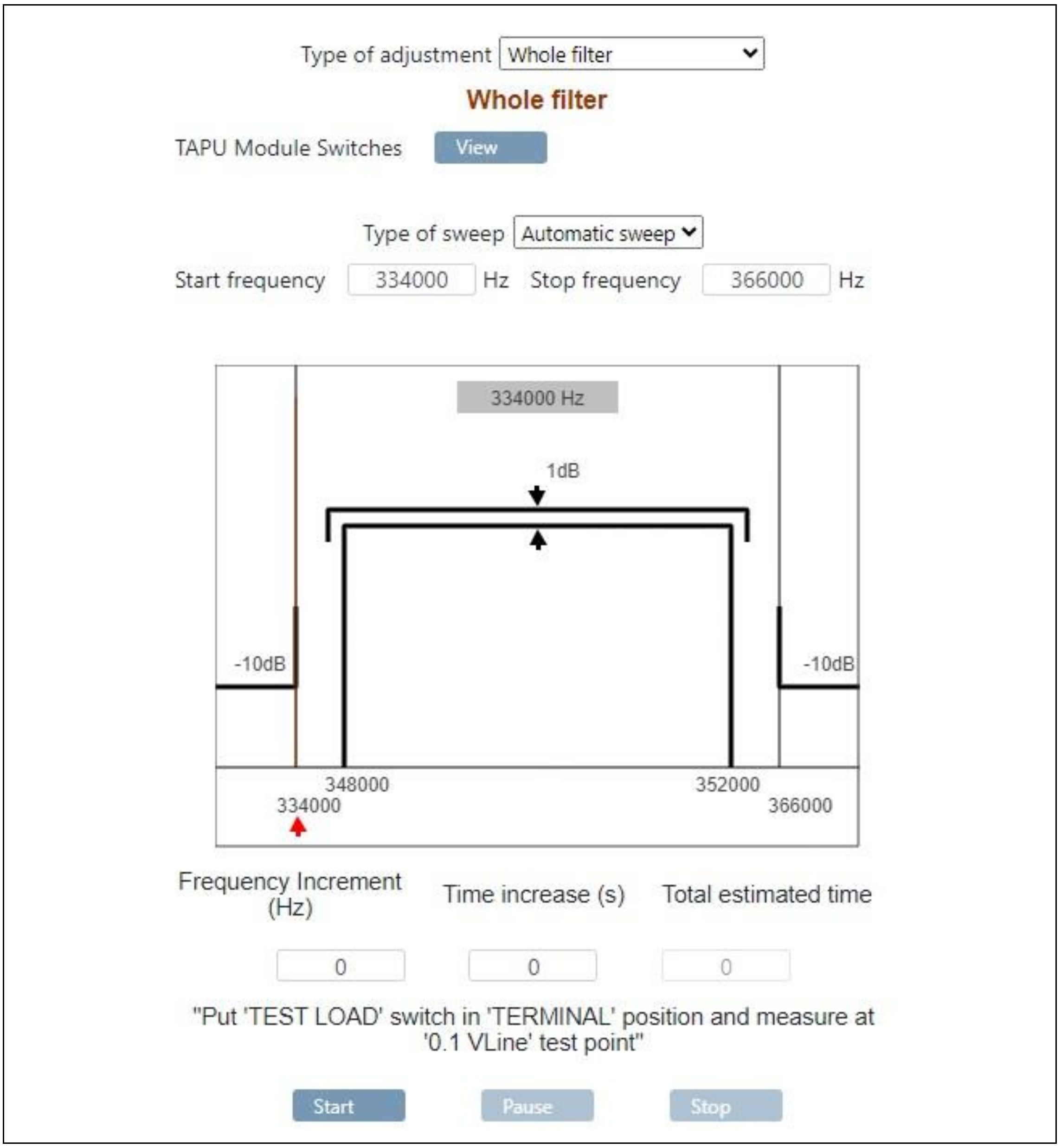


Figure 6.16 Automatic sweep.

18 Once the check is finished, disconnect the power supply and configure the dummy load in **NORMAL** position (if complete isolation of the terminal with respect to the line is required, the **NORMAL** jumper must not be carried out).

19 Connect the power supply of the **OPU-1** HF teleprotection terminal.

If necessary, carry out line filter adjustment again.

6.5.5.a Jumpers in TAPU

This section describes the jumpers in **TAPU** module according to central frequency and for a 4 kHz filter.

- **For 4 kHz filter**

Frequency (kHz)	CAP_1	CAP_2	CAP_3	CAP_4	CAP_5	CAP_6	CAP_7	CAP_8	CAP_9	CAP_10	CAP_11
42						●			●		●
44							●	●			●
46						●	●				●
48											●
50								●	●	●	
52			●				●		●	●	
54					●				●	●	
56			●			●	●	●		●	
58				●	●	●		●		●	
60		●	●	●				●		●	
62		●				●	●	●	●		
64			●				●	●	●		
66				●		●		●	●		
68	●	●	●	●				●	●		
70		●		●	●	●	●		●		
72	●	●				●	●		●		
74					●		●		●		
76	●	●	●	●	●	●			●		
78					●	●			●		
80						●			●		
82	●				●				●		
84	●	●							●		
86		●	●	●	●	●	●	●			
88		●	●	●		●	●	●			
90	●	●				●	●	●			
92	●	●		●	●		●	●			
94	●				●		●	●			
96	●			●			●	●			
98							●	●			
100		●		●	●	●		●			
102		●			●	●		●			
104			●	●		●		●			
106	●		●			●		●			
108						●		●			
110	●	●		●	●			●			
112	●		●		●			●			
114	●	●	●	●				●			
116		●		●				●			
118	●		●					●			
120								●			
122		●	●	●	●	●	●				
124		●		●	●	●	●				
126		●	●		●	●	●				
128		●			●	●	●				
130		●	●	●		●	●				
132		●		●		●	●				
134		●	●			●	●				
136	●	●				●	●				
138						●	●				
140		●	●	●	●		●				

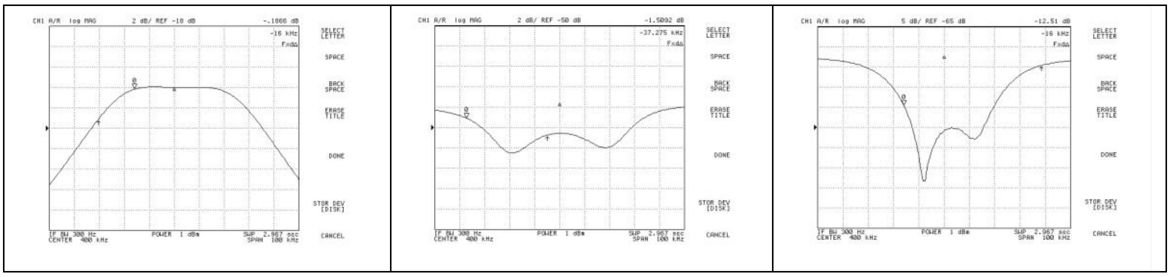
Frequency (kHz)	CAP_1	CAP_2	CAP_3	CAP_4	CAP_5	CAP_6	CAP_7	CAP_8	CAP_9	CAP_10	CAP_11
142			●	●	●		●				
144		●		●	●		●				
146	●	●	●		●		●				
148	●		●		●		●				
150	●	●			●		●				
152	●				●		●				
154	●	●	●	●			●				
156	●		●	●			●				
158	●	●		●			●				
160	●			●			●				
162	●	●	●				●				
164	●		●				●				
166	●	●					●				
168		●					●				
170	●						●				
172							●				
174	●	●	●	●	●	●					
176	●		●	●	●	●					
178			●	●	●	●					
180	●	●		●	●	●					
182	●			●	●	●					
184				●	●	●					
186		●	●		●	●					
188	●		●		●	●					
190	●	●			●	●					
192		●			●	●					
194 – 198	●				●	●					
200 – 218	●	●	●	●		●					
220 – 238	●	●	●			●					
240 – 264	●	●				●					
266 – 278	●	●	●	●	●						
280 – 302			●	●	●						
304 – 322				●	●						
324 – 348	●		●		●						
350 – 380		●			●						
382 – 392	●	●	●	●							
394 – 408		●	●	●							
410 – 428	●		●	●							
430 – 448			●	●							
450 – 470	●	●		●							
472 – 490		●		●							
492 – 498	●			●							

● JUMPERS TO CARRY OUT IN THE TAPU MODULE

6.5.6 Graphical examples of filters

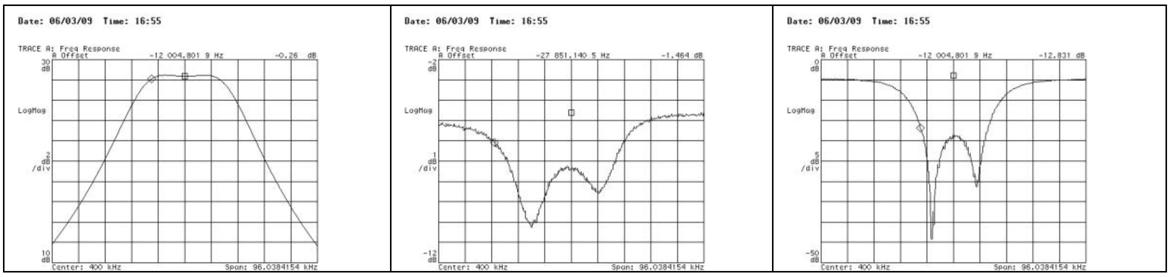
The following figures show examples of:

- **32** kHz filter, adjusted and centered at **400** kHz
- **24** kHz filter, adjusted and centered at **400** kHz
- **16** kHz filter, adjusted and centered at **200** kHz
- **8** kHz filter, adjusted and centered at **400** kHz



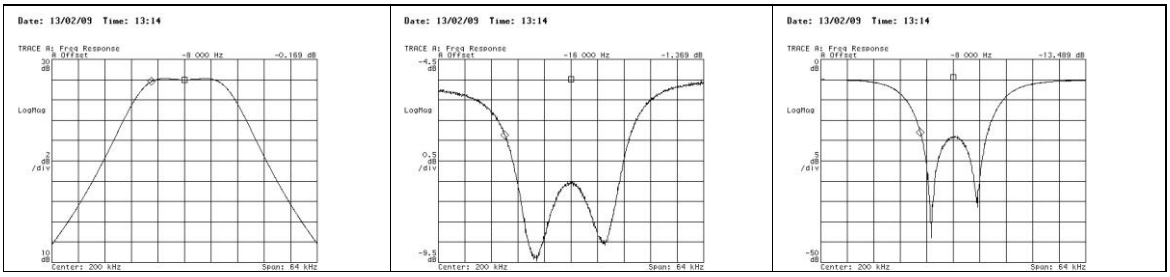
a) Filter shape **b) Tapping loss** **c) Return loss**

Figure 6.17 Graphical example for the 32 **kHz filter.**



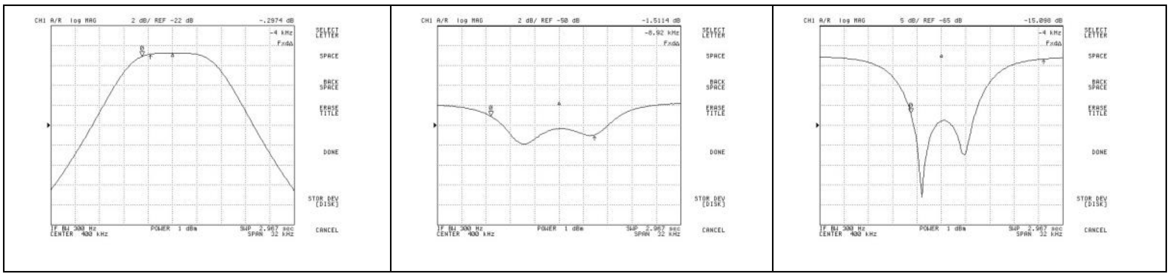
a) Filter shape **b) Tapping loss** **c) Return loss**

Figure 6.18 Graphical example for the 24 **kHz filter.**



a) Filter shape **b) Tapping loss** **c) Return loss**

Figure 6.19 Graphical example for the 16 **kHz filter.**

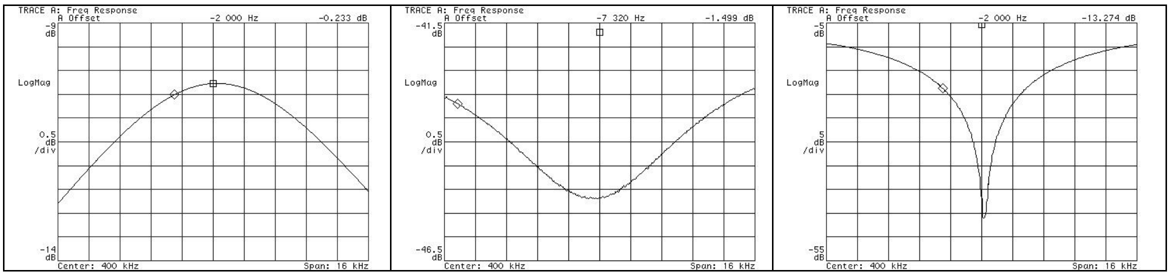


a) Filter shape　　b) Tapping loss　　c) Return loss

Figure 6.20 Graphical example for the 8 **kHz filter.**

6.5.7 Graphical examples (HF Teleprotection)

The following figures show an example of **4** kHz filter, adjusted and centered at **400** kHz



a) Filter shape　　b) Tapping loss　　c) Return loss

Figure 6.21 Graphical example (HF Teleprotection) for the 4 **kHz filter.**

6.6 Hybrid adjustment

6.6.1 Location of adjustment elements

The high-frequency hybrid is located in the **HIPU** module. The adjustment is carried out by means of resistive (**R**), inductive (**L**) and capacitive (**C**) elements, which are accessible from the front of the **3** s.u. shelf.

C (microswitches 1 to 8)	To adjust the capacitive component.
R (potentiometer P1)	To adjust the resistive component.
Thickness adjustment – **L** (microswitch MI3)	Thickness adjustment of the inductive component. Position **0** corresponds to open circuit.
Fine adjustment – **La** (TF3)	Fine adjustment of the inductive component.

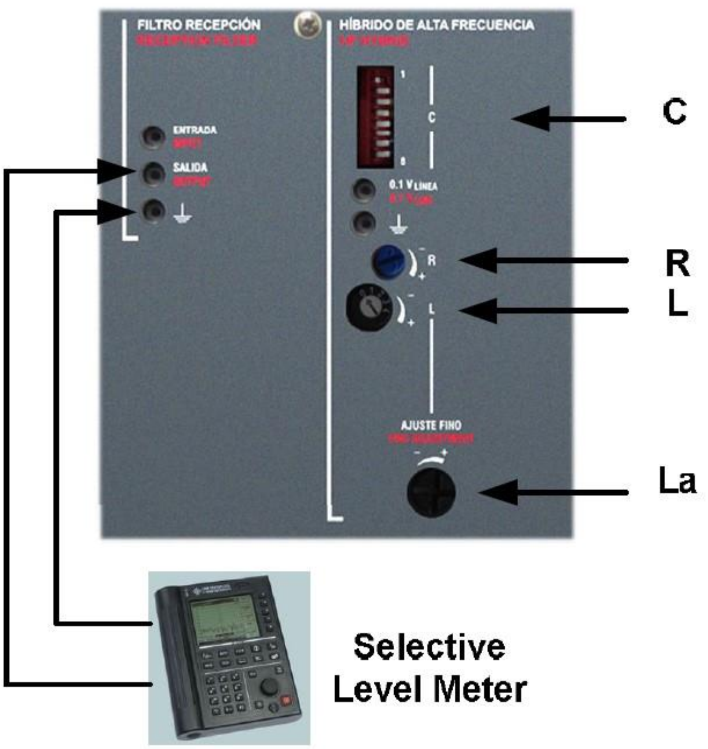


Figure 6.22 **Detail of the adjustment elements accessible from the front.**

6.6.2 Points to be taken into account

- If the noise of the line it makes it possible, the measurement should be made with a **selective voltmeter** (does not load the line), being the collateral terminal in rest state (without transmitting any signal).
- The adjustment is achieved by varying **R**, **L** and **C** in order to obtain the minimum re-injected level at the receive input.
- The level of the re-injected signals is measured at the **OUTPUT** and ground test points of the **RXPU (RXPR)** module.
- The **OPU-1** Management System can generate high-frequency tones to carry out the hybrid adjustment.
  The tones are activated from the *Hybrid adjust* option of the *Basic equipment* submenu of the *Alignment help* menu.
- In the associated screen, the options are:
  - **TEST SIGNAL GENERATION**.
    It is used in digital equipment to verify the transmit level.
    When the **GENERATE** command button is pressed a **QAM** test signal is generated.
  - **TEST TONE GENERATION**.
    In analog equipment, the frequency must be entered.
    In digital equipment, a specific tone is generated.
    If the equipment is mixed (analog+digital), any of the two tones can be used. As the level of the digital tone is higher than that of the analog tone, it is recommended to use the digital test tone.
  - **BLOCK TRANSMISSION OF REMOTE EQUIPMENT**.
    It blocks the transmission of the collateral terminal for five minutes (default value).
    This action is essential in digital equipment before beginning the hybrid adjustment process.
    In analog equipment, it allows the line noise to be measured as the tones (pilot, guard) coming from the remote equipment are eliminated.

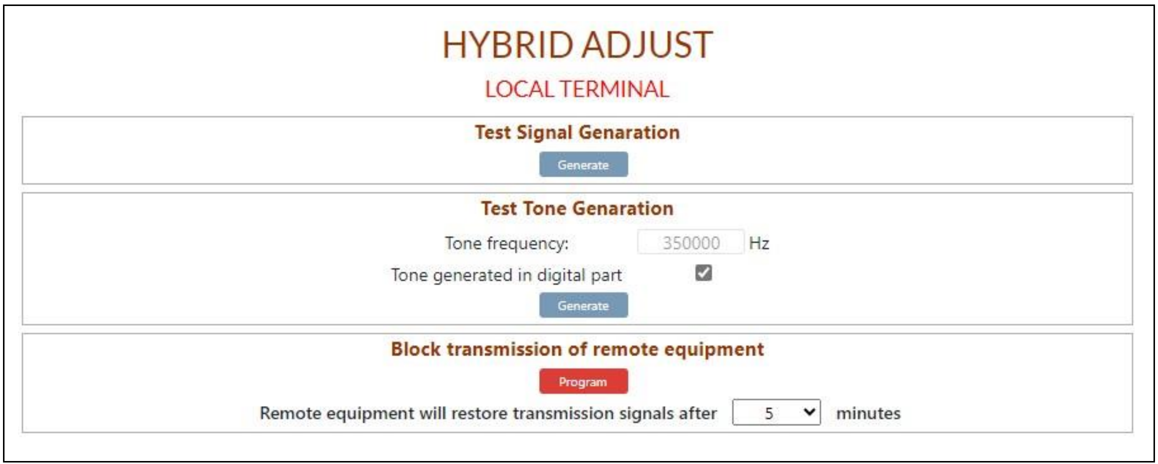


Figure 6.23 Page associated with the *Hybrid adjust* option of the Management System.

6.6.3 Adjustment procedure

The high-frequency hybrid adjustment procedure is the following:

1 Block the transmission of the remote terminal by means of the **BLOCK TRANSMISSION OF REMOTE EQUIPMENT** programming option.

2 Verify that the modulation percentage of the pilot is **10**%, and that the different services have a modulation percentage assigned.

In digital equipment, verify that the modulation percentage of the **QAM** signal is **90**%.

3 Activate the test tone by means of the **TEST TONE GENERATION** programming option.

If the equipment is mixed (analog+digital), any of the two tones can be used. As the level of the digital tone is higher than that of the analog tone, it is recommended to use the digital test tone.

4 Set the selective voltmeter at the test tone.

5 Connect the selective voltmeter at the **OUTPUT** and ground test points of the **RXPU (RXPR)** module.

6 Follow the instructions of the flow diagram (see Figure 6.24).

The maximum attenuation must be obtained in the transmission band (minimum **60** dB).

7 Once the adjustment is completed, the test tone must be deactivated by pressing the **STOP** command button.

*The microswitch configuration that increase and decrease the capacity (**pF**) is detailed in Table 6.10 of section 6.6.4, **Capacity values**.*

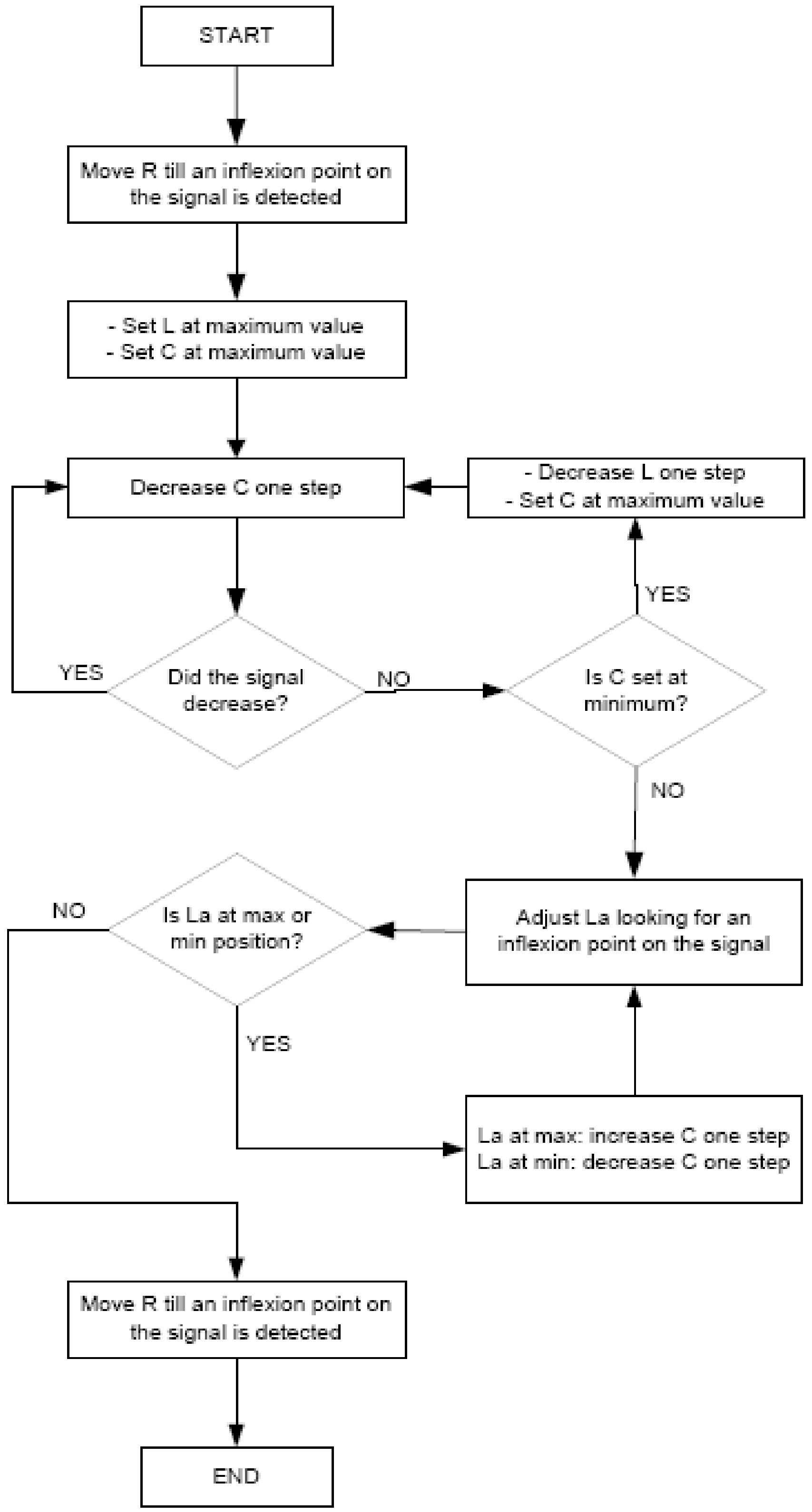


Figure 6.24 Flow diagram of the hybrid adjustment procedure.

6.6.4 Capacity values

The table below shows the microswitch configuration that increase and decrease the capacity (**pF**).

CAPACITY (pF)	MICROSWITCH	CAPACITY (pF)	MICROSWITCH	CAPACITY (pF)	MICROSWITCH
10	M1	313	M7+M4+M1	698	M8+M6+M5
15	M2	325	M7+M4+M3	708	M8+M6+M5+M1
22	M3	338	M7+M5	720	M8+M6+M5+M3
25	M1+M2	348	M7+M5+M1	730	M8+M6+M5+M3+M1
33	M4	360	M7+M5+M3	741	M8+M6+M5+M4+M1
43	M4+M1	371	M7+M5+M4	753	M8+M6+M5+M4+M3
48	M4+M2	381	M7+M5+M4+M1	763	M8+M6+M5+M4+M3+M1
55	M4+M3	390	M7+M6	780	M8+M7
58	M4+M1+M2	400	M7+M6+M1	790	M8+M7+M1
65	M4+M3+M1	412	M7+M6+M3	802	M8+M7+M3
68	M5	423	M7+M6+M4	813	M8+M7+M4
78	M5+M1	433	M7+M6+M4+M1	823	M8+M7+M4+M1
83	M5+M2	445	M7+M6+M4+M3	835	M8+M7+M4+M3
90	M5+M3	458	M7+M6+M5	848	M8+M7+M5
101	M5+M4	468	M7+M6+M5+M1	858	M8+M7+M5+M1
111	M5+M4+M1	480	M7+M6+M5+M3	870	M8+M7+M5+M3
116	M5+M4+M2	490	M7+M6+M5+M3+M1	881	M8+M7+M5+M4
120	M6	501	M7+M6+M5+M4+M1	891	M8+M7+M5+M4+M1
130	M6+M1	510	M8	900	M8+M7+M6
135	M6+M2	520	M8+M1	910	M8+M7+M6+M1
142	M6+M3	532	M8+M3	922	M8+M7+M6+M3
152	M6+M3+M1	543	M8+M4	933	M8+M7+M6+M4
163	M6+M4+M1	553	M8+M4+M1	943	M8+M7+M6+M4+M1
175	M6+M4+M3	565	M8+M4+M3	955	M8+M7+M6+M4+M3
188	M6+M5	578	M8+M5	968	M8+M7+M6+M5
198	M6+M5+M1	588	M8+M5+M1	978	M8+M7+M6+M5+M1
210	M6+M5+M3	600	M8+M5+M3	990	M8+M7+M6+M5+M3
221	M6+M5+M4	611	M8+M5+M4	1000	M8+M7+M6+M5+M3+M1
231	M6+M5+M4+M1	621	M8+M5+M4+M1	1011	M8+M7+M6+M5+M4+M1
242	M6+M5+M4+M3	630	M8+M6	1023	M8+M7+M6+M5+M4+M3
257	M6+M5+M4+M3+M1	640	M8+M6+M1	1033	M8+M7+M6+M5+M4+M3+M1
270	M7	652	M8+M6+M3	1048	M8+M7+M6+M5+M4+M3+M2+M1
280	M7+M1	663	M8+M6+M4		
292	M7+M3	673	M8+M6+M4+M1		
303	M7+M4	685	M8+M6+M4+M3		

Table 6-10: Capacity values

6.6.5 Hybrid adjustment (HF Teleprotection functionality)

The high-frequency hybrid is located in the **TAPU** module. The adjustment is carried out by means of resistive (**R**), inductive (**L**) and capacitive (**C**) elements, which are accessible from the front of the **3** s.u. shelf.

R (potentiometer P1)	To adjust the resistive component.
C (microswitches 1 to 10)	To adjust the capacitive component.
Thickness adjustment – **L** (microswitch CM5)	Thickness adjustment of the inductive component. Position **0** corresponds to open circuit.
Fine adjustment – **L** (TF1)	Fine adjustment of the inductive component.

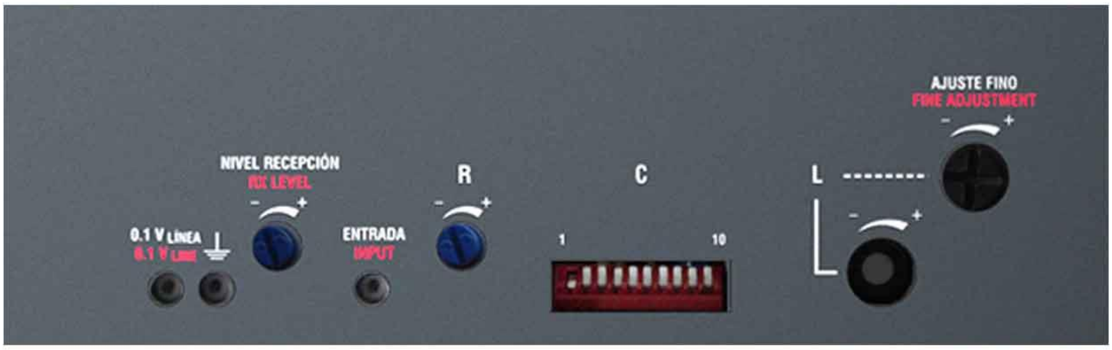


Figure 6.25 Detail of the adjustment elements accessible from the front.

Points to be taken into account.

- If the noise of the line it makes it possible, the measurement should be made with a **selective voltmeter** (does not load the line).
- The adjustment is achieved by varying **R**, **L** and **C** in order to obtain the minimum re-injected level at the receive input.
- The level of the re-injected signals is measured at the **INPUT** and ground test points of the **TAPU** module.
- The **OPU-1** Management System can generate high-frequency tones to carry out the hybrid adjustment.
  The tones are activated from the *Hybrid adjust* option of the *Basic equipment* submenu of the *Alignment help* menu.

Adjustment procedure.

The high-frequency hybrid adjustment procedure is the following:

1 Activate the test tone by means of the **TEST TONE GENERATION** programming option.

2 Without any microswitch associated with **C** being configured (all **OFF**) and with the thickness adjustment control of **L** in position **0**, vary **R** until the minimum level of the re-injected signal is achieved at the **INPUT** and ground test points.

3 Place the thickness adjustment control of **L** to position **1** and then vary **R** and the fine adjustment of **L** until the minimum level of the re-injected signal is achieved at the **INPUT** and ground test points.

 The inductance of the fine adjustment of **L** increases when the control is turned clockwise.

 Turn **L** from **1** onwards and if the minimum set in each case is lower than that obtained in position **0**, return to the configuration obtained in position **0** and go to point **7**. If a higher value is obtained in any one of the positions, set this configuration and go to point **7**.

4 Place the thickness adjustment control of **L** to position **2** and then vary **R** and decrease the fine adjustment of **L** until the minimum level of the re-injected signal is achieved at the **INPUT** and ground test point.

 If the minimum set is not lower than the previous one, return to the previous configuration and go to point **7**.

5 Place the thickness adjustment control of **L** to position **3** and then vary **R** and decrease the fine adjustment of **L** until the minimum level of the re-injected signal is achieved at the **INPUT** and ground test point.

 If the minimum set is not lower than the previous one, return to the previous configuration and go to point **7**.

6 Place the thickness adjustment control of **L** to position **4** and then vary **R** and decrease the fine adjustment of **L** until the minimum level of the re-injected signal is achieved at the **INPUT** and ground test point.

 If the minimum set is not lower than the previous one, return to the previous configuration and go to point **7**.

7 Increase the value of **C** (microswitches 1 to 10), see Table 6.11.

8 Vary **R** and the fine adjustment of **L** until trying to achieve the minimum level of re-injected signal at the **INPUT** and ground test points.

 Increasing **C** generally requires decreasing **L**. Inductance decreases by turning the fine adjustment of **L** anti-clockwise (it could also be necessary to modify the thickness adjustment of **L** if the fine adjustment is at one end).

 If the minimum set is not lower than the previous one, return to the previous configuration, adjust the previous minimum and finish the adjustment. **(*)**

 The maximum attenuation must be obtained in the transmission band (minimum **60** dB).

***(*)** In order to be able to finish adjusting with **R**:*

- *If the best minimum set corresponds with **R** to the minimum (position "-"), if the **CM4** switch is in position **4k**, place it in position **2k**.*
- *On the contrary, if the best minimum set corresponds with **R** to the maximum (position "+"), if the **CM4** switch is in position **2k**, place it in position **4k**.*

The table below shows the microswitch configuration that increase and decrease the capacity (**pF**).

MICROSWITCH MI2 AND ASSOCIATED CAPACITY										TOTAL CAPACITY (pF)
1	2	3	4	5	6	7	8	9	10	
C2 (10)	C4 (22)	C5 (47)	C7 (100)	C8 (200)	C11 (390)	C12 (820)	C14 (2200)	C16 (4700)	C17 (10000)	
●										10
	●									22
●	●									32
		●								47
●		●								57
	●	●								69
●	●	●								79
			●							100
●			●							110
	●		●							122
●	●		●							132
		●	●							147
●		●	●							157
	●	●	●							169
●	●	●	●							179
				●						200
●				●						210
	●			●						222
●	●			●						232
		●		●						247
●		●		●						257
	●	●		●						269
●	●	●		●						279
			●	●						300
●			●	●						310
	●		●	●						322
●	●		●	●						332
		●	●	●						347
●		●	●	●						357
	●	●	●	●						369
●	●	●	●	●						379
					●					390
●					●					400
	●				●					412
●	●				●					422
		●			●					437
●		●			●					447
	●	●			●					459
●	●	●			●					469
			●		●					490
●			●		●					500
	●		●		●					512
					. . .					
●		●		●	●	●	●	●	●	18367
	●	●		●	●	●	●	●	●	18379
●	●	●		●	●	●	●	●	●	18389
			●	●	●	●	●	●	●	18410
●			●	●	●	●	●	●	●	18420
	●		●	●	●	●	●	●	●	18432
●	●		●	●	●	●	●	●	●	18442
		●	●	●	●	●	●	●	●	18457
●		●	●	●	●	●	●	●	●	18467
	●	●	●	●	●	●	●	●	●	18479
●	●	●	●	●	●	●	●	●	●	18489

● Microswitch in **ON**

Table 6-11: Capacity values (HF Teleprotection functionality)

6.7 Levels

6.7.1 Transmit levels

The transmit pilot level is measured in the **LINE SIGNAL** and **LINE GROUND** test points, which are next to the coaxial connector, at the rear of the **3** s.u. shelf.

To perform measurements, use a **selective** voltmeter tuned at the corresponding frequency. See figures.

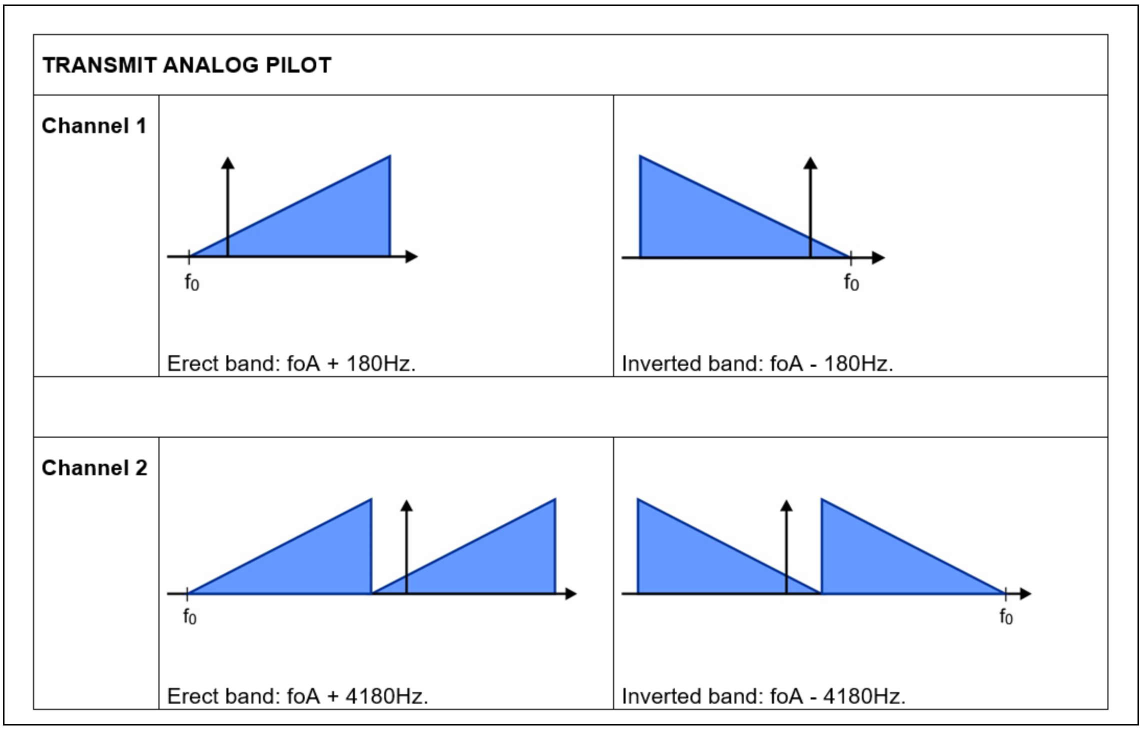
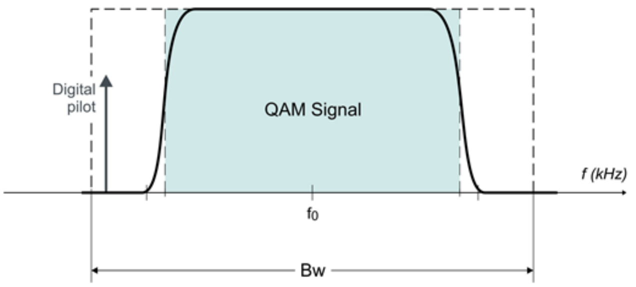


Figure 6.26 Frequencies of the transmit pilot in analog channel.

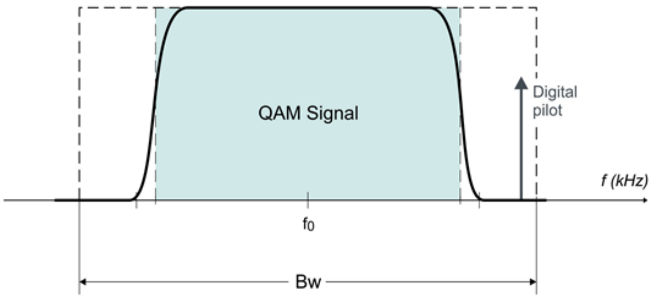
TRANSMIT DIGITAL PILOT

MASTER



Bw 4 kHz: foD - 1987.5 Hz.
Bw 8 kHz: foD - 3975 Hz.
Bw 16 kHz: foD - 7950 Hz.

SLAVE



Bw 4 kHz: foD + 1987.5 Hz.
Bw 8 kHz: foD + 3975 Hz.
Bw 16 kHz: foD + 7950 Hz.

Figure 6.27 Frequencies of the transmit pilot in digital channel.

The value measured with the voltmeter should correspond to the one indicated in the following tables, for each equipment type. If not, the adjustment should be done.

To adjust the transmit value, put the dummy load in **TERMINAL** position and, from the Management System, access the *Transmit level* option of the *Configuration* menu. In the page, use the quantity command buttons to modify the value until the required value is measured in the voltmeter.

Put the dummy load back to **NORMAL** position.

SIGNAL	20 W single channel	20 W twin channel	40 W single channel	40 W twin channel
Analog pilot (10%)	3.87 Vrms (+23 dBm)	1.94 Vrms (+17 dBm)	5.48 Vrms (+26 dBm)	2.74 Vrms (+20 dBm)
AF signal (20%)	7.75 Vrms (+29 dBm)	3.87 Vrms (+23 dBm)	10.95 Vrms (+32 dBm)	5.48 Vrms (+26 dBm)
Speech (50%)	15.21 Vrms (+34.8 dBm)	7.62 Vrms (+28.8 dBm)	21.53 Vrms (+37.9 dBm)	10.77 Vrms (+31.8 dBm)
Speech (40%)	12.17 Vrms (+32.9 dBm)	6.1 Vrms (+26.9 dBm)	17.22 Vrms (+35.9 dBm)	8.61 Vrms (+29.9 dBm)
Guard signal (SINGLE TONE 20%)	7.75 Vrms (+29 dBm)	3.87 Vrms (+23 dBm)	10.95 Vrms (+32 dBm)	5.48 Vrms (+26 dBm)
Guard signal (DUAL TONE 30%)	11.63 Vrms (+32.5 dBm)	5.81 Vrms (+26.5 dBm)	16.43 Vrms (+35.5 dBm)	8.22 Vrms (+29.5 dBm)
Trip signal (SINGLE TONE 90%)	34.86 Vrms (+42 dBm)	17.43 Vrms (+36 dBm)	49.29 Vrms (+45.1 dBm)	24.65 Vrms (+39 dBm)
Trip signal closest to guard (DUAL TONE 90%)	17.43 Vrms (+36 dBm)	8.72 Vrms (+30 dBm)	24.65 Vrms (+39 dBm)	12.32 Vrms (+33 dBm)

Table 6-12: Transmit levels over dummy load for analog OPU-1 of 20W-40W

SIGNAL	20 W mix single channel	20 W mix twin channel	40 W mix single channel	40 W mix twin channel
Analog pilot (10%)	1.94 Vrms (+17 dBm)	0.97 Vrms (+11 dBm)	2.74 Vrms (+20 dBm)	1.37 Vrms (+14 dBm)
Digital pilot (10%)	1.94 Vrms (+17 dBm)	1.94 Vrms (+17 dBm)	2.74 Vrms (+20 dBm)	2.74 Vrms (+20 dBm)
AF signal (20%)	3.87 Vrms (+23 dBm)	1.94 Vrms (+17 dBm)	5.48 Vrms (+26 dBm)	2.74 Vrms (+20 dBm)
Speech (50%)	7.62 Vrms (+28.8 dBm)	3.81 Vrms (+22.8 dBm)	10.77 Vrms (+31 dBm)	5.38 Vrms (+25 dBm)
Speech (40%)	6.1 Vrms (+26.9 dBm)	3.05 Vrms (+20.9 dBm)	8.61 Vrms (+29.9 dBm)	4.31 Vrms (+23.9 dBm)
Guard signal (SINGLE TONE 20%)	3.87 Vrms (+23 dBm)	1.94 Vrms (+17 dBm)	5.48 Vrms (+26 dBm)	2.74 Vrms (+20 dBm)
Guard signal (DUAL TONE 30%)	5.81 Vrms (+26.5 dBm)	2.91 Vrms (+20.5 dBm)	8.22 Vrms (+29.5 dBm)	4.11 Vrms (+23.5 dBm)
Trip signal (SINGLE TONE 90%)	17.43 Vrms (+36 dBm)	8.71 Vrms (+30 dBm)	24.65 Vrms (+39 dBm)	12.32 Vrms (+33 dBm)
Trip signal closest to guard (DUAL TONE 90%)	8.72 Vrms (+30 dBm)	4.36 Vrms (+24 dBm)	12.33 Vrms (+33 dBm)	6.16 Vrms (+27 dBm)
QAM without TP in digital channel (90%)	+29.1 dBm	+29.1 dBm	+32.1 dBm	+32.1 dBm

Table 6-13: Transmit levels over dummy load for mix OPU-1 of 20W-40W

SIGNAL	20 W digital	40 W digital
Digital pilot (10%)	3.87 Vrms (+23 dBm)	5.48 Vrms (+26 dBm)
Guard signal (SINGLE TONE 20%)	7.75 Vrms (+29 dBm)	10.95 Vrms (+32 dBm)
Guard signal (DUAL TONE 30%)	11.63 Vrms (+32.5 dBm)	16.44 Vrms (+35.5 dBm)
Trip signal (SINGLE TONE 90%)	34.86 Vrms (+42 dBm)	49.29 Vrms (+45.1 dBm)
Trip signal closest to guard (DUAL TONE 90%)	17.43 Vrms (+36 dBm)	24.65 Vrms (+39 dBm)
QAM without TP in digital channel (90%)	+35.1 dBm	+38.1 dBm
QAM with TP in digital channel (SINGLE TONE 70%)	+32.91 dBm	+35.92 dBm
QAM with TP in digital channel (DUAL TONE 60%)	+31.57 dBm	+34.57 dBm

Table 6-14: Transmit levels over dummy load for digital OPU-1 of 20W-40W

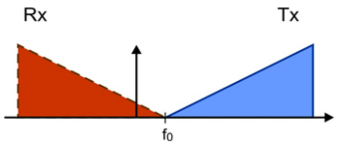
SIGNAL	80 W single channel	80 W twin channel	80 W mix single channel	80 W mix twin channel	80 W digital
Analog pilot (10%)	7.75 Vrms (+29 dBm)	3.87 Vrms (+23 dBm)	3.87 Vrms (+23 dBm)	1.94 Vrms (+17 dBm)	
Digital pilot (10%)			3.87 Vrms (+23 dBm)	3.87 Vrms (+23 dBm)	7.75 Vrms (+29 dBm)
AF signal (20%)	15.49 Vrms (+35 dBm)	7.75 Vrms (+29 dBm)	7.75 Vrms (+29 dBm)	3.87 Vrms (+23 dBm)	
Speech (50%)	30.5 Vrms (+40.9 dBm)	15.21 Vrms (+34.8 dBm)	15.21 Vrms (+34.8 dBm)	7.62 Vrms (+28.8 dBm)	
Speech (40%)	24.37 Vrms (+38.9 dBm)	12.17 Vrms (+32.9 dBm)	12.17 Vrms (+32.9 dBm)	6.1 Vrms (+26.9 dBm)	
Guard signal (SINGLE TONE 20%)	15.49 Vrms (+35 dBm)	7.75 Vrms (+29 dBm)	7.75 Vrms (+29 dBm)	3.87 Vrms (+23 dBm)	15.49 Vrms (+35 dBm)
Guard signal (DUAL TONE 30%)	23.24 Vrms (+38.5 dBm)	11.62 Vrms (+32.5 dBm)	11.62 Vrms (+32.5 dBm)	5.81 Vrms (+26.5 dBm)	23.24 Vrms (+38.5 dBm)
Trip signal (SINGLE TONE 90%)	69.71 Vrms (+48.1 dBm)	34.86 Vrms (+42 dBm)	34.86 Vrms (+42 dBm)	17.43 Vrms (+36 dBm)	69.71 Vrms (+48.1 dBm)
Trip signal closest to guard (DUAL TONE 90%)	34.86 Vrms (+42 dBm)	17.43 Vrms (+36 dBm)	17.43 Vrms (+36 dBm)	8.72 Vrms (+30 dBm)	34.86 Vrms (+42 dBm)
QAM without TP in digital channel (90%)			+35.1 dBm	+35.1 dBm	+41.1 dBm
QAM with TP in digital channel (SINGLE TONE 70%)					+38.93 dBm
QAM with TP in digital channel (DUAL TONE 60%)					+37.57 dBm

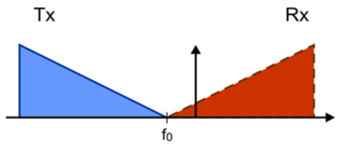
Table 6-15: Transmit levels over dummy load for OPU-1 of 80 W

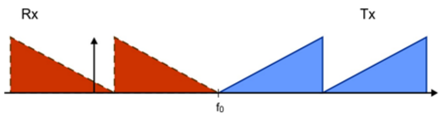
6.7.2 Receive levels

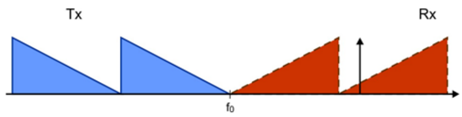
The receive pilot level is measured in the **LINE SIGNAL** and **LINE GROUND** test points, which are next to the coaxial connector, at the rear of the **3** s.u. shelf.

To perform measurements, use a **selective** voltmeter tuned at the corresponding frequency. See figures.

<table>
<tr><th colspan="3">RECEIVE ANALOG PILOT</th></tr>
<tr><td>Channel 1</td><td>

Erect band: foA - 180Hz.</td><td>

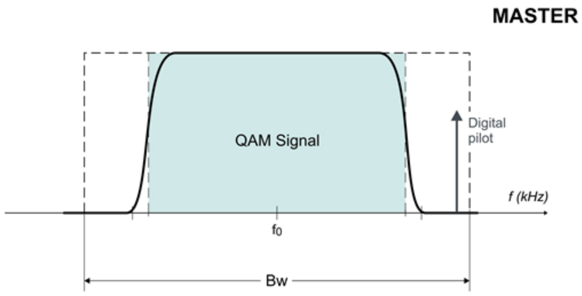
Inverted band: foA + 180Hz.</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td>Channel 2</td><td>

Erect band: foA - 4180Hz.</td><td>

Inverted band: foA + 4180Hz.</td></tr>
</table>

Figure 6.28 Frequencies of the receive pilot in analog channel.

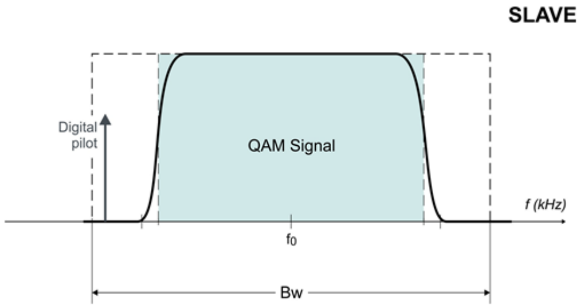
RECEIVE DIGITAL PILOT



Bw 4 kHz: foD + 1987.5 Hz.

Bw 8 kHz: foD + 3975 Hz.

Bw 16 kHz: foD + 7950 Hz.



Bw 4 kHz: foD - 1987.5 Hz.

Bw 8 kHz: foD - 3975 Hz.

Bw 16 kHz: foD - 7950 Hz.

Figure 6.29 Frequencies of the receive pilot in digital channel.

The minimum receive level for proper operation of the automatic gain control (AGC) is **-30** dBm. Below this value, the link is interrupted.

Display the measurement from the Management System, by accessing the *Received pilot level* option of the *Analog part / Digital part* submenu of the *Monitoring* menu.

In the analog channel, the value can be modified by means of the *Receive level* option of the *Alignment help* menu.

6.7.3 Signal/Noise ratio levels

Analog Signal/Noise ratio.

- The S/N ratio of the analog channel can be monitored from the *S/N ratio* option of the *Analog part* submenu of the *Monitoring* menu.
- The signal-to-noise ratio is evaluated independently for each channel. It is indicated for channel **1** and channel **2**, if applicable.
- The estimation is carried out by measuring the noise power in the pilot-tone band with the hypothesis that the noise is constant, in the whole **4** kHz channel.
  The value obtained is compared with the configured threshold and, if lower, the audio-frequency outputs are blocked (if programmed) and the signal/noise ratio alarm is activated.

Digital Signal/Noise ratio.

- The S/N ratio of the digital channel can be monitored from the *S/N ratio* option of the *Digital part* submenu of the *Monitoring* menu.
- Unlike analog links, where the S/N alarm thresholds are configurable, in digital links the **BER** alarm thresholds have pre-set values. See Table 6.16.
- The S/N ratio may be degraded either by the line noise or by a misadjustment of the output hybrid. Readjust the HF hybrid, if necessary.

	Minimum S/N ratio, with white Gaussian noise (AWGN), at receiver input and for an error probability better than 10^{-3} and 10^{-6}
16 kHz QAM bandwidth	➢ BER = 10^{-3}: 20 dB at 81 kbit/s. 12 dB at 40.5 kbit/s. 8 dB at 27 kbit/s. ➢ BER = 10^{-6}: 23 dB at 81 kbit/s. 16 dB at 40.5 kbit/s. 12 dB at 27 kbit/s
8 kHz QAM bandwidth	➢ BER = 10^{-3}: 20 dB at 40.5 kbit/s. 12 dB at 20.25 kbit/s. 8 dB at 13.5 kbit/s. ➢ BER = 10^{-6}: 23 dB at 40.5 kbit/s. 16 dB at 20.25 kbit/s. 12 dB at 13.5 kbit/s
4 kHz QAM bandwidth	➢ BER = 10^{-3}: 20 dB at 20.25 kbit/s. 12 dB at 10.125 kbit/s. 8 dB at 6.75 kbit/s. ➢ BER = 10^{-6}: 23 dB at 20.25 kbit/s. 16 dB at 10.125 kbit/s. 12 dB at 6.75 kbit/s

Table 6-16: BER alarm thresholds in digital links

6.7.4 Teleprotection levels

The transmit level is measured, in **high frequency**, in the **LINE SIGNAL** and **LINE GROUND** test points, which are next to the coaxial connector, at the rear of the **3** s.u. shelf.

The measurement is carried out with the aid of a selective voltmeter, set at the corresponding frequency.

The transmit values in **HF line** can be consulted in the tables of section 6.7.1, *Transmit levels*.

Situation of the guard signal when the teleprotection is integrated into the digital QAM band.

Dual and single tone:

- f_0 ± ***7850*** *Hz (BW=* ***16*** *kHz)*
- f_0 ± ***3925*** *Hz (BW=* ***8*** *kHz)*
- f_0 ± ***1962.5*** *Hz (BW=* ***4*** *kHz)*

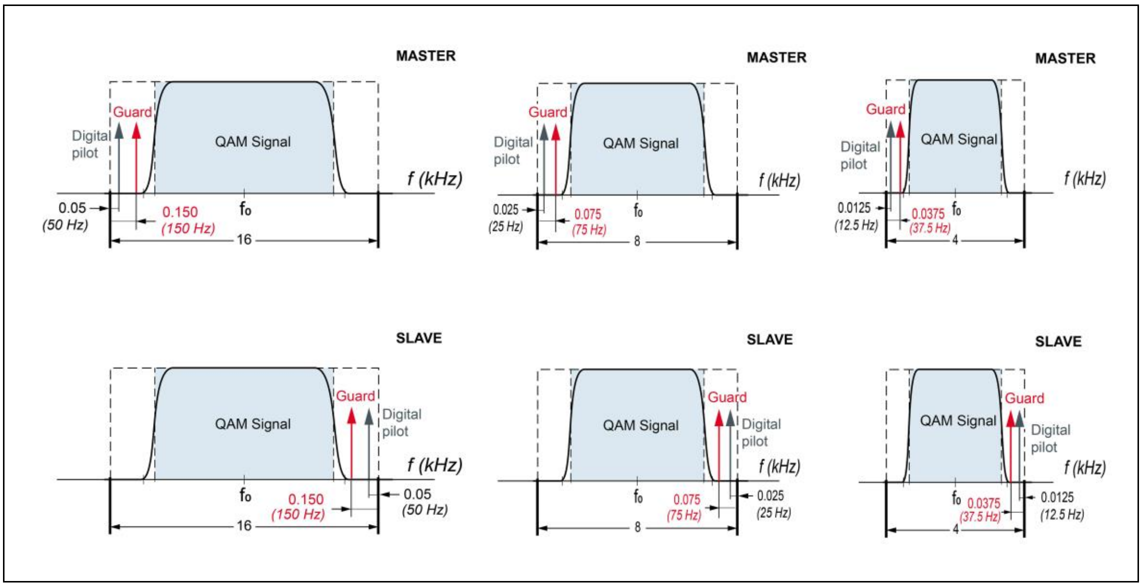


Figure 6.30 Guard signal situation in the QAM band.

The receive level of the teleprotection is measured, in **low frequency**, at the **RCV** and ground test points of the **TPPU** module with the aid of a selective voltmeter.

RCV / ⏚ : Test points of the **TPPU** module to measure the **receive** signal level after being band limited.	
- **Single tone (analog band)**: **210** mV_{rms} ±10% should be obtained for guard level at 20% modulation and command level at 90% modulation in the remote terminal. - **Dual tone (analog band)**: **315** mV_{rms} ±10% should be obtained for guard level at 30% modulation and command level at 90% modulation in the remote terminal.	- **Single and dual tone (digital band)**: **35** mV_{rms} ±5%.

Guard and command frequencies over dedicated analog band.

Single tone

The **guard** signal and each of the **command** signals are assigned a single frequency, which is configurable from among those defined in Recs. R.35, R.37 and R.38 of the ITU-T and the frequencies: 3300 Hz, 3360 Hz, 3420 Hz, 3480 Hz, 3540 Hz, 3600 Hz, 3660 Hz, 3780 Hz and 3800 Hz

Dual tone

Each of the **command** signals is assigned two frequencies whose amplitude is half the amplitude of the **guard** signal, which is assigned a single frequency.

- BW=**1** kHz

  The **guard** is at **150** Hz from the end of band. The distance between tones is **100** Hz

  NOTE 1: When working with two teleprotection bands per channel, the **guard** of *Teleprotection A* must be of **2900** Hz and that of *Teleprotection B* of **3800** Hz

  NOTE 2: When working with four teleprotection bands per channel, the **guard** of *Teleprotection A* must be of **1100** Hz, that of *Teleprotection B* of **2000** Hz, that of *Teleprotection C* of **2900** Hz and that of *Teleprotection D* of **3800** Hz

- BW=**2** kHz

  The **guard** is at **300** Hz from the end of band. The distance between tones is **200** Hz

  NOTE: When working with two teleprotection bands per channel, the **guard** of *Teleprotection A* must be of **1850** Hz and that of *Teleprotection B* of **3650** Hz

- BW=**4** kHz

  The **guard** is at **416.6** Hz from the end of band. The distance between tones is **277.7** Hz

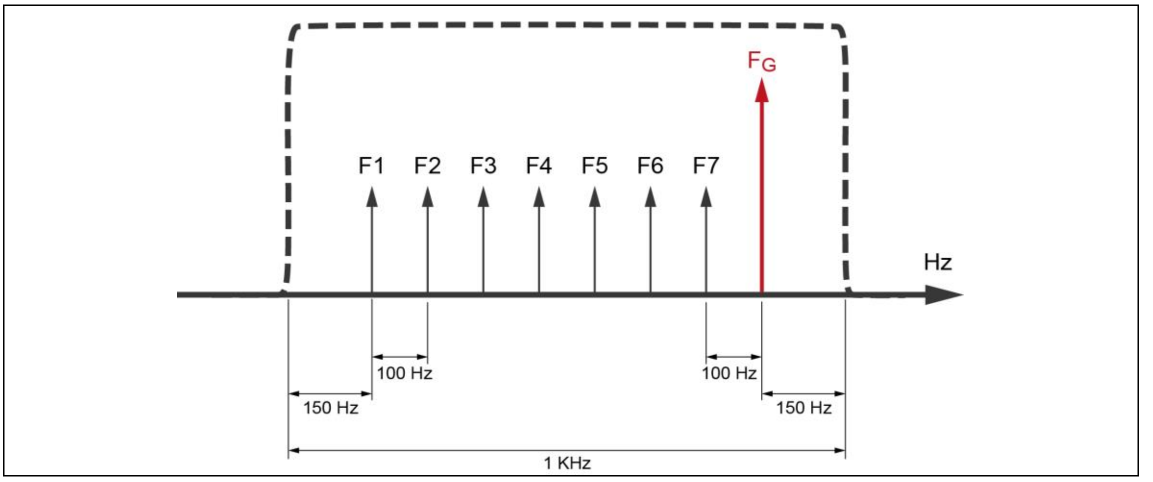


Figure 6.31 Distance between tones (BW=1 kHz).

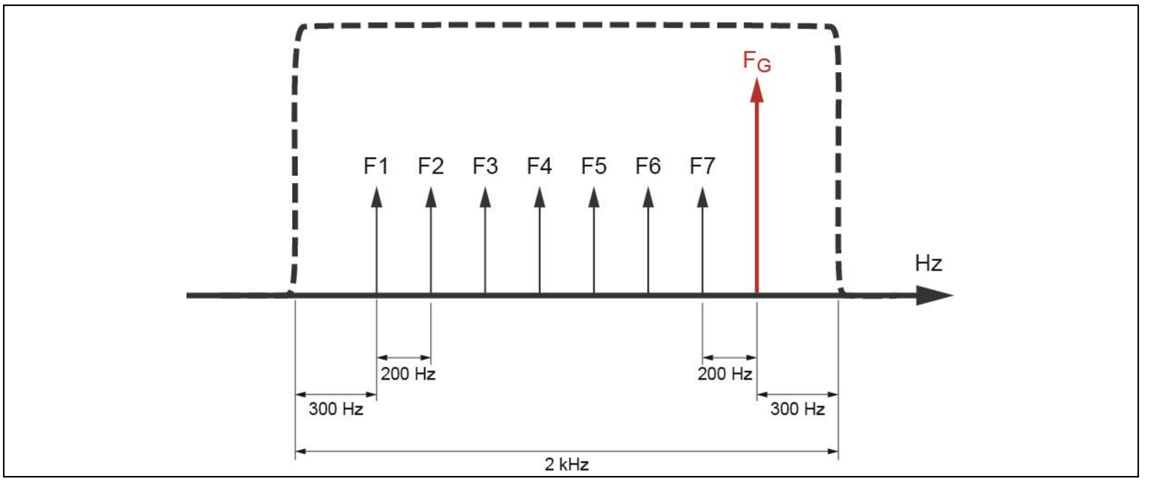


Figure 6.32 Distance between tones (BW=2 kHz).

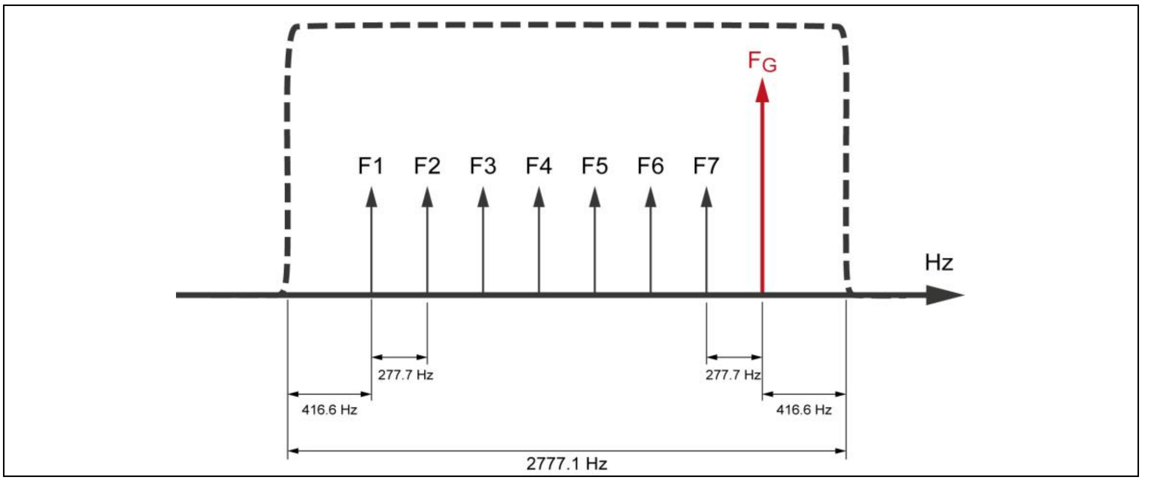


Figure 6.33 Distance between tones (BW=4 kHz).

Guard and command frequencies for teleprotection integrated into the digital band.

Dual tone

The **command** signals have two fixed and specific frequencies whose amplitude is half the amplitude of the guard signal, which has a fixed and specific frequency.

- Guard frequency
  3800 Hz (QAM of **16** kHz and **8** kHz)
- Command frequencies
  From the guard, the distance between tones is **100** Hz

Single tone

The system sets a fixed and specific frequency for the **guard** signal and each of the **command** signals.

- Guard frequency
  3800 Hz (QAM of **16** kHz and **8** kHz)
- Command frequencies
  Fixed and according to the table below (Table 6.17).

Scheme ≤3 commands	Mode 1 (2+2)	Mode 2 (3+1(1))	Mode 3 (3+1(2))
Command A: 3540 Hz Command B: 3300 Hz Command C: 2700 Hz Commands A+B: 3000 Hz Commands A+C: 2400 Hz Commands B+C: 2100 Hz Commands A+B+C: 1140 Hz	Command A: 3540 Hz Command B: 3300 Hz Command C: 2700 Hz Command D: 1860 Hz Commands A+B: 3000 Hz Commands A+D: 2400 Hz Commands B+C: 2100 Hz Commands C+D: 1140 Hz	Command A: 3540 Hz Command B: 3300 Hz Command C: 2700 Hz Command D: 1860 Hz Commands A+B: 3000 Hz Commands A+C: 2400 Hz Commands B+C: 2100 Hz Commands A+B+C:1140 Hz	Command A: 3540 Hz Command B: 3300 Hz Command C: 2700 Hz Command D: 1860 Hz

Table 6-17: Command frequencies for QAM digital band (single tone)

6.8 Optional modules

*A module must **NOT** be inserted or extracted when the terminal is powered on.*

*Disconnect the main power-supply switch at the rear of the **6** s.u. shelf before doing so.*

6.8.1 IOPU

The commissioning of the *baseband analog input/output interface* (**IOPU**) module should consider the following:

1 Physical connection of the services in the corresponding terminals.

- ***ZIPU** plug-in terminal block is associated with the **IOPU.0#** option.*
- *Terminals **BB1** of **ZOPU.01** terminal block are assigned to channel 1 of the **IOPU.01** option.*
- *Terminals **BB1** of **ZOPU.02** terminal block are assigned to channel 1 of the **IOPU.02** option and **ZBBA.14** terminal block is associated with channel 2 of the **IOPU.02** option.*

2 Consistent configuration of analog channels (single/twin) according to **IOPU.0#** type (*Equipment definition* option of the *Configuration* menu).

Consistent *VTF signal* in the *Analog configuration* option of the *Analog part* submenu of the *Configuration* menu.

3 Programming of levels and modulation percentages of input/output signals (corresponding level options of the *Analog part* submenu of the *Configuration* menu).

4 Programming of deactivation conditions of the outputs by pilot loss and low S/N ratio (*Activation and deactivation cond.* option of the *Analog part* submenu of the *Configuration* menu).

6.8.2 TDPU.20

The commissioning of the *speech* (**TDPU.20**) module should consider the following:

1 Physical connection of the services in the corresponding terminals.

- ***ZAPU*** *plug-in terminal block.*
- ***ZBBA.20*** *terminal block.*

2 Consistent configuration of the internal microswitch for incorporating the module in channel **1** or channel **2**.

3 Consistent configuration of the **TDPU** option in the **OPU-1** terminal (*Analog configuration* option of the *Analog part* submenu of the *Configuration* menu).

4 Programming of levels and modulation percentages of input/output signals (corresponding level options of the *Analog part* submenu of the *Configuration* menu).

5 Programming of deactivation conditions of the outputs by pilot loss and low S/N ratio (*Activation and deactivation cond.* option of the *Analog part* submenu of the *Configuration* menu).

6 Programming of speech-band cut-off frequency, compandor activation/deactivation and operating mode of the configurable termination (*Speech* option of the *Analog part* submenu of the *Configuration* menu).

7 The module contains two hybrids: the low-frequency hybrid (used for the conversion from four to two wires) and the telephone hybrid (associated with the subscriber-side 2-wire termination).

Both hybrids are supplied factory adjusted.

6.8.3 MFPU

The commissioning of the *asynchronous programmable modem* (**MFPU**) module should consider the following:

1 Physical connection of the services in the corresponding terminals.

- ***ZAPU*** *plug-in terminal block.*
- ***ZBBM.00*** *terminal block.*

2 Consistent configuration of the internal microswitch for incorporating the module in channel **1** or channel **2**.

3 Consistent configuration of the **MFPU** option in the **OPU-1** terminal (*Analog configuration* option of the *Analog part* submenu of the *Configuration* menu*).*

When two modems are used in the same analog channel, one of them must be configured as modem **A** and the other as modem **B**. The programming must be consistent with the configuration in jumper **S27**.

4 Programming of modulation percentages of input/output signals (corresponding level options of the *Analog part* submenu of the *Configuration* menu).

5 Programming of deactivation conditions of the outputs by pilot loss and low S/N ratio (*Activation and deactivation cond.* option of the *Analog part* submenu of the *Configuration* menu).

6 Programming of operation mode (normal or V.23), and transmission speed and central frequency (*FSK asynchronous modem* option of the *Analog part* submenu of the *Configuration* menu).

This programming has priority over the hardware configuration, as long as microswitches **3** to **10** of **MI2** are in the **OFF** position.

7 The modem is equipped with test devices for a rapid operational check:

- *Microswitch **5** (front plate) for data loop.*
- *Microswitch **6** (front plate) for line loop.*
- *Microswitches **9** & **10** (front plate) for transmission of logic levels.*

Bear in mind that in **V.23** mode, it is not possible to carry out a loop as the transmission and reception speeds do not coincide.

Bear in mind that when a loop or sending of test signals is carried out, the **DSR** signal is disabled.

8 Data reception remains blocked in the following cases:

- *when the level of the received carrier falls below the general alarm threshold.*
- *when microswitch **8** (front plate) is in **ON** position.*
- *in half-duplex operation when the modem is transmitting.*

6.8.4 FTPU

The commissioning of the *VFT transit filter* (**FTPU**) module should consider the following:

1 Physical connection of the services in the corresponding terminals.

- ***ZAPU*** *plug-in terminal block.*
- ***ZBBA.02*** *terminal block.*

2 Consistent configuration of the internal microswitch for incorporating the module in channel **1** or channel **2**

3 Consistent configuration of the **FTPU** option in the **OPU-1** terminal (*Analog configuration* option of the *Analog part* submenu of the *Configuration* menu).

4 Programming of levels and modulation percentages of output signals (*Output levels* options of the *Analog part* submenu of the *Configuration* menu).

5 Programming of deactivation conditions of the outputs by pilot loss and low S/N ratio (*Activation and deactivation cond.* option of the *Analog part* submenu of the *Configuration* menu).

6 If soldered jumper **B** is carried out, VFT receive signals are filtered by means of a low-pass filter.

7 The adjustment of the phase equalizer is carried out in the factory.

6.8.5 FDPU

The commissioning of the *digital transit filter* (**FDPU**) module should consider the following:

1 Physical connection of the services in the corresponding terminals.

- ***ZAPU*** *plug-in terminal block.*
- ***ZBBA.04*** *terminal block.*

2 Consistent configuration of the internal microswitch for incorporating the module in channel **1** or channel **2**

3 Consistent configuration of the **FDPU** option in the **OPU-1** terminal (*Analog configuration* option of the *Analog part* submenu of the *Configuration* menu). The *Digital Transit Filter* and *FSK Asynchronous Modem B* cannot coexist in the same channel.

4 Programming of levels and modulation percentages of input/output signals (corresponding level options of the *Analog part* submenu of the *Configuration* menu).

5 Programming of deactivation conditions of the outputs by pilot loss and low S/N ratio (*Activation and deactivation cond.* option of the *Analog part* submenu of the *Configuration* menu).

6.8.6 EYPU

The commissioning of the *input/output combiner* (**EYPU**) module should consider the following:

1 Detailed application diagram. Important aspects are:

- *All the inputs that are connected to an output must be programmed with the same modulation percentage.*
- *The sum of the modulation percentages of all the inputs and services connected to the corresponding **AF XMT** bus must not exceed **100**%.*
- *The level at which the input signals are to be injected into the **OPU-1** system **AF XMT** bus must be expressed as a modulation percentage.*
- *The level at which a service is to be extracted from the **AF RCV** bus for injection into one of the output circuits must be expressed as a modulation percentage.*

2 Physical connection of the services in the corresponding terminals.

- ***ZBBA.16** terminal block.*

3 Verification of the presence of the **EYPU** option in the **OPU-1** terminal (*Analog configuration* option of the *Analog part* submenu of the *Configuration* menu).

4 Programming of the desired input/output connections and nominal levels and modulation percentages of the used inputs and outputs (*Input/Output combiner* option of the *Analog part* submenu of the *Configuration* menu).

5 Programming of deactivation conditions of the outputs by pilot loss and low S/N ratio (*Activation and deactivation cond.* option of the *Analog part* submenu of the *Configuration* menu).

If the activation/deactivation thresholds are different for channel **1** and channel **2**, the output deactivates when the strictest limits are surpassed and activates when the thresholds of the two channels are reached.

6.8.7 DMPU/TMPU

The commissioning of the *built-in multiplexer for additional voice & data channels* (**DMPU/TMPU**) modules should consider the following:

1 Physical connection of the services in the corresponding connectors and terminals.

- *Data channels in front-plate connectors (**DMPU** option with front ports, and data port of **TMPU** option).*
- *Plug-in terminal blocks (**ZTPU.11** & **ZTPU.21**) associated with the multiplexer speech channels (**TMPU** option).*
- *Plug-in terminal blocks (**ZDPU.02** & **ZDPU.04**) associated with the multiplexer data channels (**DMPU** option with rear ports).*
- *Terminal blocks (**ZTPU.10** & **ZTPU.20**) associated with the multiplexer speech channels (**TMPU** option).*

2 Multiplexer clear definition. Important aspects are:

- *Physical position of the multiplexer modules in the **6** s.u. shelf.*
- *Number of data ports (**DMPU** option and data port of **TMPU** option) and number of speech ports (**TMPU** option).*
- *Using only **DMPU** modules, the number of data ports of the **OPU-1** terminal can be extended to a total of twenty (two belonging to **MQPU** module).*
- *Using only **TMPU** modules, the ports of the **OPU-1** terminal can be extended with six speech ports and five data ports (two belonging to **MQPU** module).*

3 Configuration of up to three multiplexer modules (*Digital channel options* section of the *Digital configuration* option of the *Digital part* submenu of the *Configuration* menu).

Port numbering and data connector type (**DB15** or **DB9**) corresponds to the one specified on the module front plate.

Bear in mind that **six** port positions are reserved per module although there is no associated port.

4 Programming of the characteristics of each port (*Multiplexer* option of the *Digital part* submenu of the *Configuration* menu).

- *In a synchronous data port, it is necessary to specify the speed, the interface type and, if desired, an associated channel for signalling.*
- *In an asynchronous data port, it is necessary to specify the speed, the interface type, data bits, stop bits and, if desired, an associated channel for signalling.*
- *In an anisochronous data port, it is necessary to specify the speed and, if desired, an associated channel for signalling.*
- *In a speech port, it is necessary to specify the speed, the termination type and the speech levels in transmission and reception.*

  2-wire operating mode (exchange or subscriber side) requires the use of signalling.

5 If applicable, configure for the **DMPU** modules the point-to-multipoint function (*Drop-insert options* section of the *Digital configuration* option of the *Digital part* submenu of the *Configuration* menu.

6.8.8 TPPU

The commissioning of the *built-in teleprotection* (**TPPU**) module should consider the following:

1 Physical connection of the services in the corresponding terminals.

- ***ZBPU** plug-in terminal block (**TPPU** option).*
- ***ZCPU** plug-in terminal block (**REPU** option).*
- ***ZBBA.16-BB1 & ZBBA.06-BB2** terminal blocks (**TPPU** option).*

In order to avoid undesired operations under commissioning, it is convenient to disconnect the terminals associated with the output relays used to activate the protections.

2 Consistent configuration of the internal jumper (**J8**) for incorporating the module in channel **1** or channel **2**.

3 Internal jumpers configuration must be consistent with the desired nominal activation voltage and desired command-input activation logic.

4 Consistent configuration of the **TPPU** option in the **OPU-1** terminal (*Analog configuration* option of the *Analog part* submenu of the *Configuration* menu).

If there is more than one module per channel, up to four maximum, identification **A** to **D** must be consistent with the configuration of jumpers **P1-P2**.

For digital operation with in-band teleprotection, hardware configuration (**P3-P4**) must be consistent.

5 Programming of all the teleprotection parameters.

- *In a dedicated analog band (**Teleprotection** option of the Analog part submenu of the Configuration menu).*
- *Integrated into the digital operation band (**Teleprotection** option of the Digital part submenu of the Configuration menu).*
- *For HF teleprotection functionality (**Teleprotection** option of the Configuration menu).*

6 Transmit and reception levels should be checked with the aid of a selective voltmeter.

See section 6.7.4, *Teleprotection levels*.

7 It is important the checking of command transmission. One way of doing this is to force the transmission of commands (*Command transmission* option of the *Teleprotection* submenu of the *Alignment help* menu) and verify command transmission and state of inputs and counters (*State option* of the *Teleprotection* submenu of the *Monitoring*).

8 It is important the checking of the relays. One way of doing this is to program the relay activation for receiver blocking alarm and then program the output blocking (*Output blocking* option of the *Alignment help* menu).

9 It is important to program the periodicity of the local test (*Tests* option of the *Alignment help* menu).

10 Finally, it is important to check that no terminal of the terminal block is open.

Reset the teleprotection chronological register (*Chronological register* option of the *Teleprotection* submenu of the *Monitoring* menu).

Reset the teleprotection counters (*Initializations* option of the *Teleprotection* submenu of the *Alignment help* menu.

6.9 System management access

6.9.1 Access control

Access to the management of **OPU-1** terminals requires a user **password**, made up of a user identification and a password.

By default, the system has two created **profiles**, one basic and the other administrator, whose management capacities are different.

The **basic** user can only retrieve or supervise the parameters of the terminal, but without the possibility for change.

The **administrator** user can modify and supervise any parameter of the terminal, as well as modify the default user passwords of the system.

*A good practice (**cybersecurity**) consists of changing from the start the default user passwords of the system.*

	User identification	**Password**
Basic User	basic	basic **or** Basic@01
Administrator User	admin	admin **or** Admin@01

Table 6-18: Default user passwords of the system

6.9.2 Starting the web server

The **OPU-1** terminals include a web server containing all the necessary pages for system programming and monitoring.

Access **to OPU-1** embedded web server is done by typing its IP address (**http://<IP>**) from a browser.

*The IP ADDRESS in factory is the **172.16.20.24** or the **172.16.20.25**.*

The **network parameters** of the **OPU-1** web server must be compatible with those of the management **PC** that will connect to the **OPU-1**, when making the management connection.

To point out that certain browsers respond with an error message when they are unable to verify the origin of the **certificate**. When that happens, access to the Management System is possible when the error message is accepted.

To avoid the initial error message from the browser because of the certificate, it is recommended to **install the certificate from the start**. To do this, it is possible to download the certificate from the error message itself and, once downloaded, import it into the "*Trusted Root Certification Authorities*" certificate store.

Depending on the browser type and version, it could happen incorrect monitoring of some management pages. In this regard:

- *With **Microsoft Internet Explorer**, **OPU-1** management cannot be executed.*
- *With **Microsoft Edge**, correct operation of the **OPU-1** management application is guaranteed.*
- *With **Mozilla Firefox** (and Windows 10), correct operation of the **OPU-1** management application is guaranteed from version v.90 onwards.*
- *With **Google Chrome** (and Windows 10), correct operation of the **OPU-1** management application is guaranteed from version v.92 onwards.*

6.9.3 User interface

Once the IP address of the **OPU-1** web server has been entered, the system requests the user **authentication** data (user and password).

When the **authentication** entered data is correct, the management application is loaded and the main page is displayed.

On the **right** side of the main **page**, there is the **language** selection button and, next to it, the **blue button** for leaving the Management System.

In the **central** part, the relevant **comment** specified for the equipment is displayed.

On the **left** side, a folder is shown which, when selected by clicking on the "**>**" symbol, displays the **four** main management menus.

Figure 6.34 Authentication data entry page.

Figure 6.35 Main menus of the OPU-1 Management System.

6.9.4 Types of controls and notifications

Controls.

Web pages have **controls** to allow data to be displayed or programmed in the terminal.

- **Text box:**
  It looks like a text box and allows to display or enter any numerical or alphanumerical value from the keyboard.

Figure 6.36 Text box example.

- **List box:**
  It looks like a text box, but unlike a text box, it contains a drop-down list or items to select.

Figure 6.37 List box example.

- **Command button:**
  It has the appearance of a button which, when selected, performs an action. Depending on the action it performs, it is of a different colour.

Figure 6.38 Command button example.

- **Check box:**
  It has the appearance of a box that allows a **True/False** or **Yes/No** option to be selected. Shows a checkmark when selected. This mark disappears if the check box is unchecked by selecting it.

Figure 6.39 Check box example.

Notifications.

During handling of the web application, different types of **notifications** may appear.

- Some notifications require the user to **select the option** to carry out from among the possibilities presented.

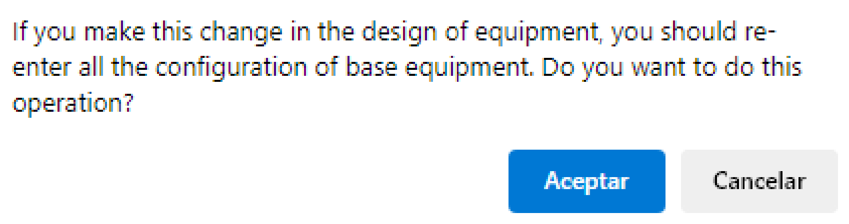


Figure 6.40 Example of notification for selection of the action.

- Other notifications indicate a **failure** or **error** as a result of an action. This type of notification disappears from the screen when it is closed using the "**X**" button, located in the upper right corner.

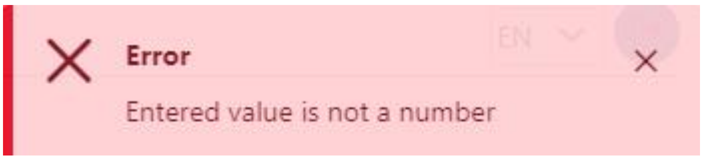


Figure 6.41 Example of error notification.

6.9.5 Leaving the management application

The **OPU-1** Management System is closed by clicking on the top-right hand-corner **blue button**, which is next to the language selection button.

Remember to save the data on the disk or the terminal before leaving.

Figure 6.42 Button to logout the OPU-1 Management System.

Chapter 7.

Configuration

7. Configuration

7.1 System menu

7.1.1 Files

Gives access to the disk or terminal **reading** functions, as well as **writing** functions on disk or terminal.

These operations are carried out using the appropriate command buttons.

- In **disk acquisition**, the path of the file to be read must be specified.
  In **writing on disk**, it is necessary to specify the name of the file and the path where the file must be saved.

- In **terminal acquisition**, if it is not possible to establish communication with the terminal, a communication failure warning will be displayed.
  In **writing on terminal**, it must be taken into account that the previous programming of the terminal cannot be retrieved unless it had previously been kept in a file.

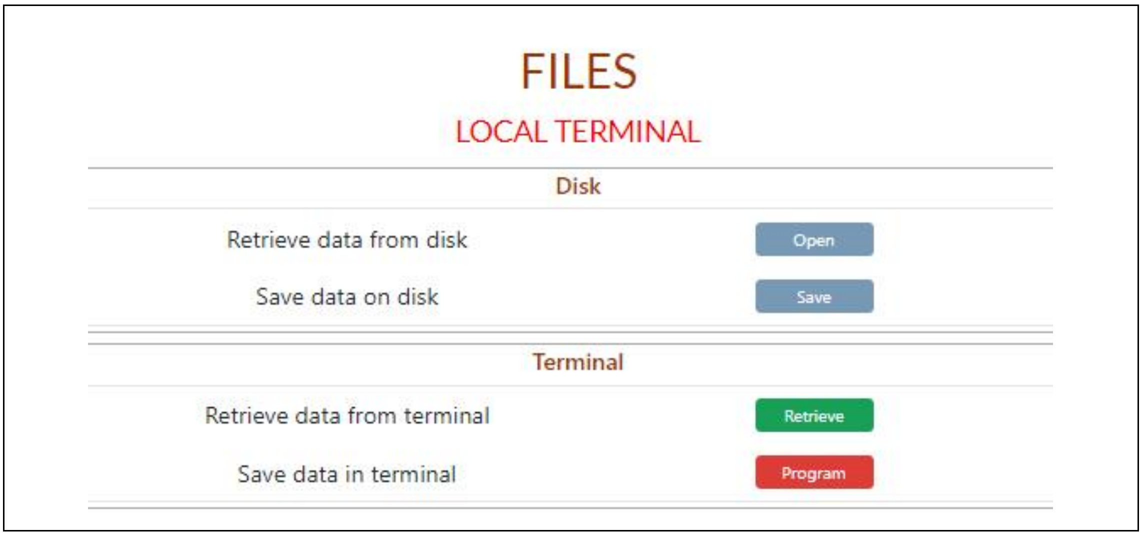


Figure 7.1 Files option.

7.1.2 Software updating

This menu contains an option for the **MOPU** module, and an option for the **MQPU** module if the equipment is digital or mixed.

It also contains as many options as optional modules configured.

- The associated page displays the current **version** of the module together with the **checksum**.
- The **software** update must be carried out following the instructions of the **ZIV** technical department.

*In the **MOPU** module, the file corresponding to the web pages is named **Control and management software**.*

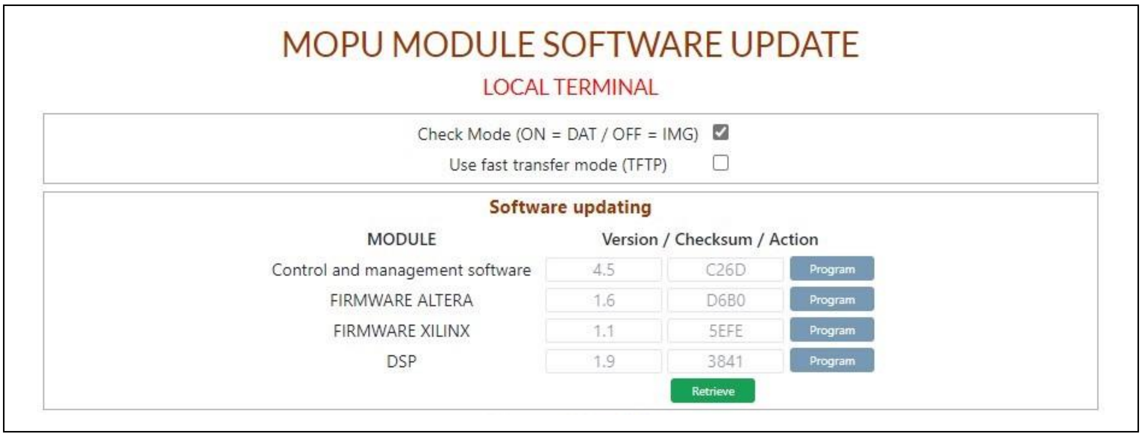


Figure 7.2 Update page example (MOPU option).

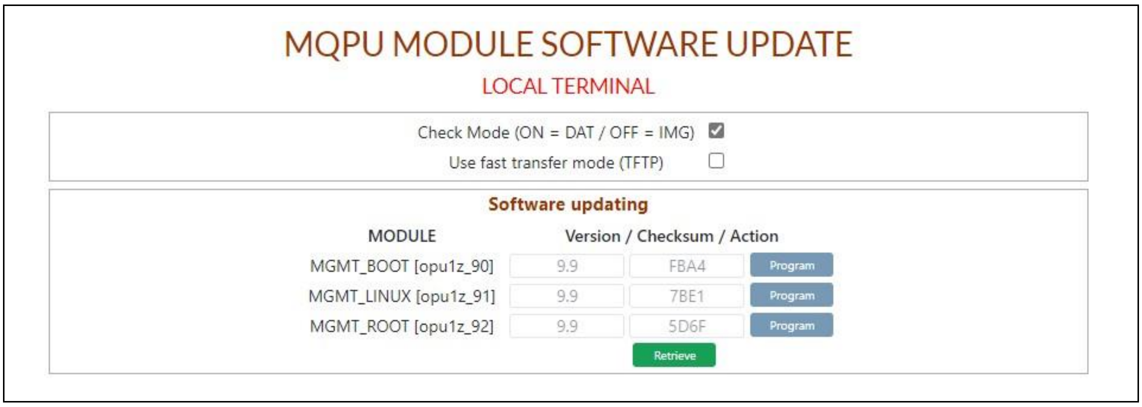


Figure 7.3 Update page example (MQPU option).

7.1.3 Network

7.1.3.a User passwords

- The first section of the page allows the user, with **Administrator** profile, to modify the default user **passwords** of the system.

- The second and third sections are associated with **cybersecurity**.
By means of the **ALLOW CONNECTION TO 1 USER ONLY** parameter, it is possible to set that the management session can only be used by one user.
If the password introduced is not correct, the terminal will **block** after three failed attempts. By means of the **BLOCKING TIME AFTER 3 FAILED LOGINS** parameter, it is possible to configure the time that the terminal will be blocked. Once this time has elapsed, the user could attempt to **enter** a new session.

*The **password** must be at least **8** characters long and include at least one **uppercase**, one **lowercase**, one **number** and one **symbol**.*

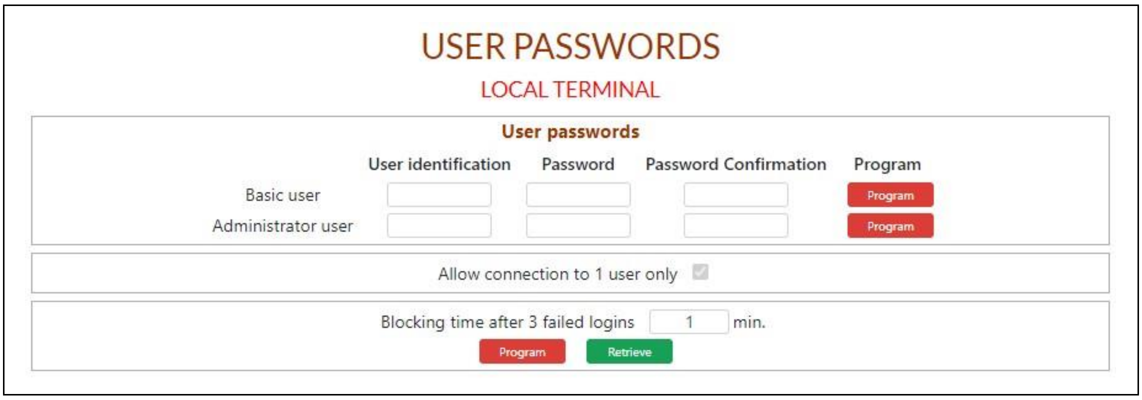


Figure 7.4 User passwords option.

If the user does not use the management session, after five minutes of **inactivity**, the session will have **expired** and the user will have to start a new session.

An example of session **expired message** is shown in the enclosed figure.

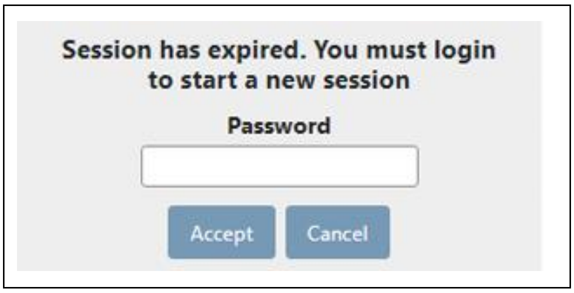


Figure 7.5 Example of session expired message.

7.1.3.b Network parameters

It allows the network parameters to be updated, that is, the **IP** address, subnet **mask** and **gateway**.

It allows the **SNMP agent** to be activated. The configuration of the parameters that will set its behaviour for terminal alarm and event notifications is made by means of the *SNMP agent configuration* option.

It also allows the **SNMP** port to be configured and the sending of notifications (*traps*) to be activated.

*By default, the **IP** address of the terminal is **172.16.20.22**.*

When it is modified, it is advisable to store the new address in some type of register as, should the new address be forgotten, it will not be possible to access the web server.

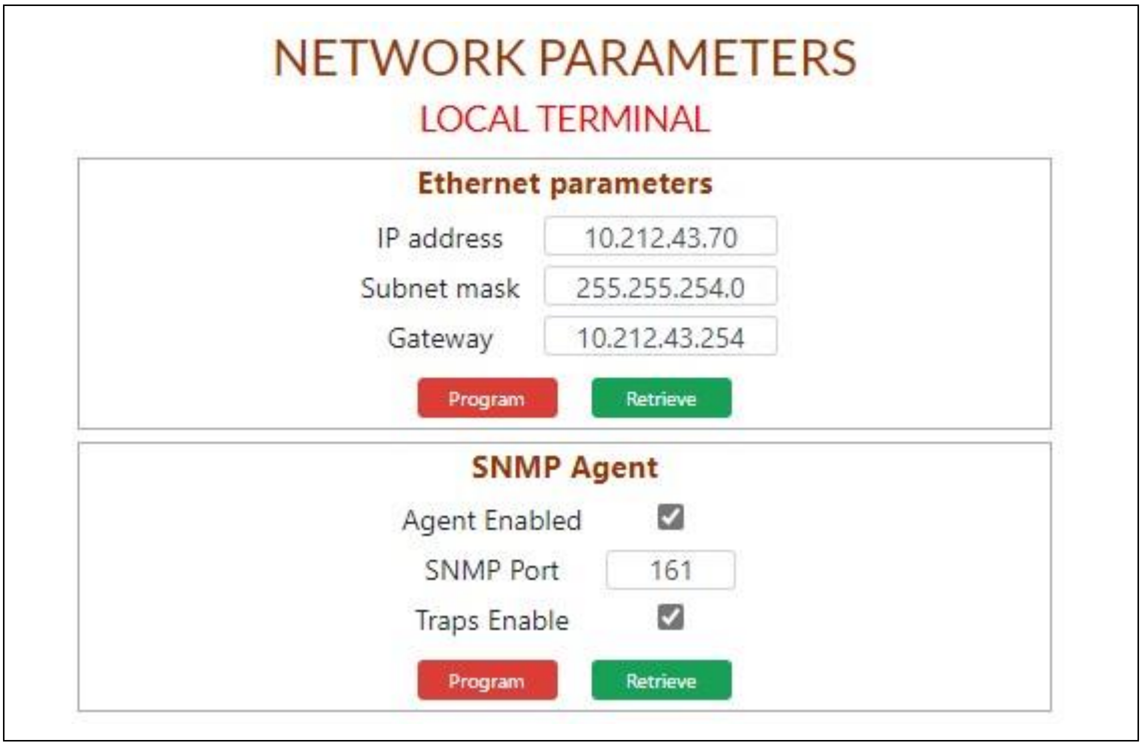


Figure 7.6 Network parameters option.

7.1.3.c SNMP agent configuration

It allows the parameters of the **SNMP agent** that will set its behaviour for sending terminal alarm and event notifications to be configured.

When the **AGENT ENABLE** box is selected, the agent is enabled and the following parameters are displayed:

- **Agent parameters**
  There is a control to activate the sending of notifications (*traps*) and a control for the configuration of the UDP port. The value by default of the UDP port to be used for SNMP is **161**.
  There are also controls to select the versions of the SNMP protocol. The values **V1/V2c** and **V3** are supported.

- **SNMP V1, V2c parameters**
  When the **SNMP V1/V2c enabled** box is selected, the V2c protocol user profiles are shown.

- **SNMP V3 parameters**
  When the **SNMP V3 enabled** is selected, apart from the display of user profiles, it is possible to configure the **authentication** and **privacy** protocols.
  In **AUTHENTICATION**, the **MD5** or **SHA** algorithm is selected.
  In **PASSWORD**, the word to be used as authentication information is configured with a length of at least eight characters.
  The password by default for a **basic** profile user (only reading) is **snmpbasic** and for an **administrator** profile user (reading and writing) is **snmpadmin**.
  The authentication word must be known by the receiver in order to be able to verify the authenticity of the identity of the transmitter.

- **Notification handling parameters**
  It allows the data of the notification **receivers** to be configured so that the terminal transmits appropriately the notifications to each one of them. A maximum of five receivers is allowed. The activation of the receivers is carried out by selecting the **ENABLE** box.
  The receivers are identified by means of their **IP** address and the **UDP** port to which the notifications are to be sent. The standard UDP port for the SNMP notifications is the **162**, which is the value by default.
  The **TRAP MODE** control is used to set whether the transmission of the notifications of the alarms and events of the terminal is carried out in an unconfirmed (*trap*) or confirmed (*inform*) way. The last option is only accepted for the **v2c** and **v3** versions of the protocol.
  For confirmed notifications (*inform*), the wait time for confirmation is **1**s and the maximum number of attempts is five.

- **Local configuration parameters**
  The last three controls correspond to local configuration parameters of the terminal housed in the System object of MIB-2 (SNMPv2-SMI). Its contents must comply with the requirements established by the standard in reference to the alphanumeric characters permitted.

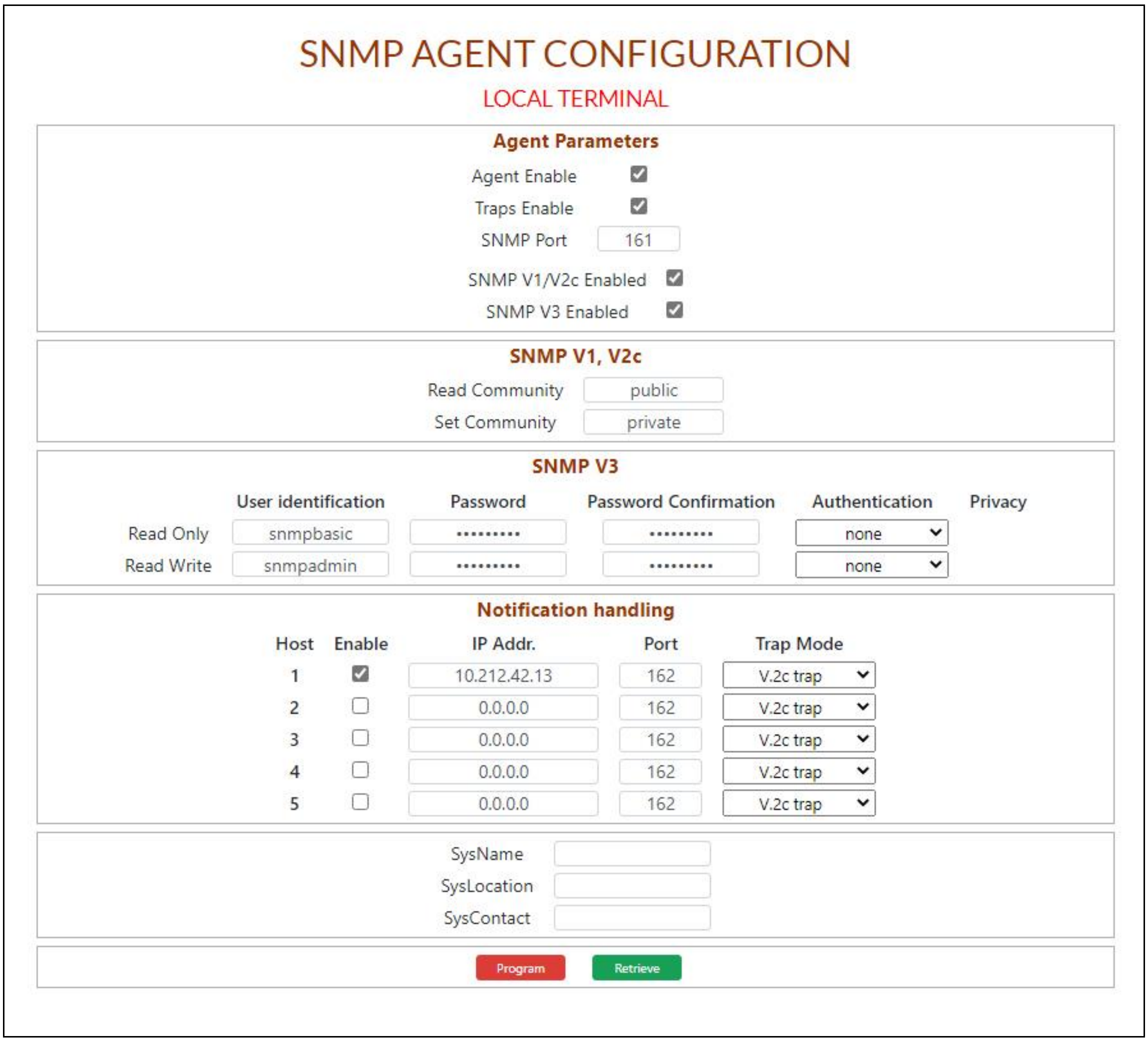


Figure 7.7 SNMP agent configuration option.

7.1.3.d SNMP traps enable

It sets which notifications of alarms and events related to the **SNMP agent** must be transmitted.

The notifications are configured by selecting the corresponding boxes.

The notifications are associated with the **MOPU** module and, depending on the operating mode, with the **MQPU** module and teleprotection module.

Figure 7.8 SNMP traps enable option.

7.1.3.e MAC

It allows the value of the **MAC address** (medium access address) of the **10/100 Base-Tx** interface of the **MOPU** module to be displayed.

If the equipment is digital or mixed, it also displays the value of the **MAC address** of the **10/100 Base-Tx** interface of the **MQPU** module.

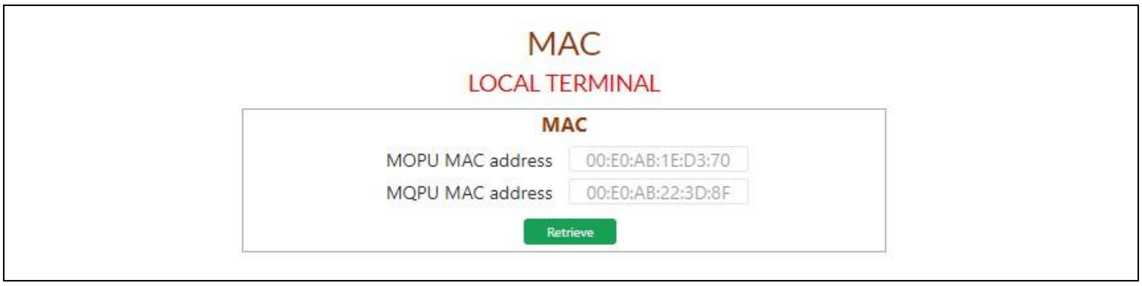


Figure 7.9 MAC option.

7.2 Configuration menu - General options

7.2.1 Terminal identification

It allows a numeric identification and a description of up to **49** characters to be programmed in the terminal.

The **OPU-1** terminal leaves the factory with its serial number programmed in the *Identification code* field.

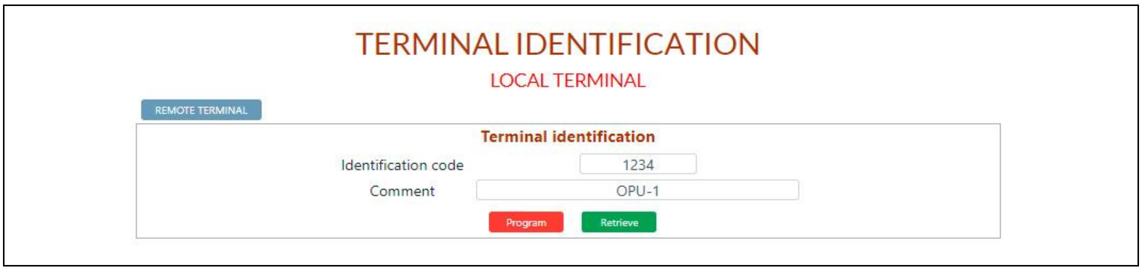


Figure 7.10 Terminal identification option.

7.2.2 Equipment definition

It contains controls for defining the **OPU-1** terminal configuration and power-stage characteristics.

In the **WORK MODE** control, the operating mode of the terminal is selected from:
- Analog
- Digital
- Mixed (analog + digital)
- HF Teleprotection

The number of analog channels must be indicated in **analog** and **mixed** work mode.

- In **digital** work mode, the modulation schema (**QAM** or **OFDM/OQAM**) must be specified. The **In-band Teleprotection** control allows the use of the digital band for the teleprotection signals to be specified.

- In **mixed** work mode, it is possible to work with independent filters for the digital and analog channels.
  To do so, **Double** must be selected in the **Amplifier+Filter Module** control.

The power-stage characteristics are defined by specifying:
- Output power
- Frequency range
- Bandwidth

In **HF Teleprotection** work mode, it is only necessary to define the output power.

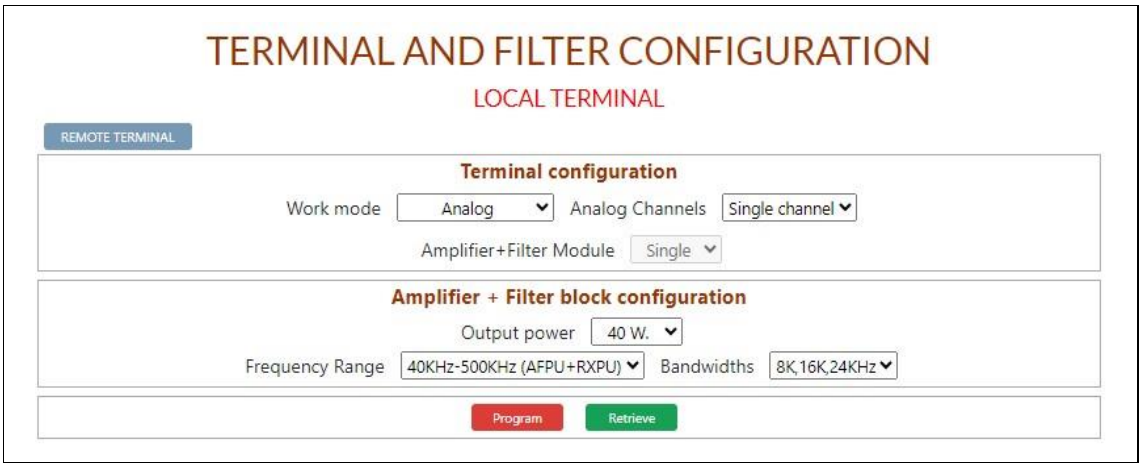


Figure 7.11 Equipment definition page example (Analog).

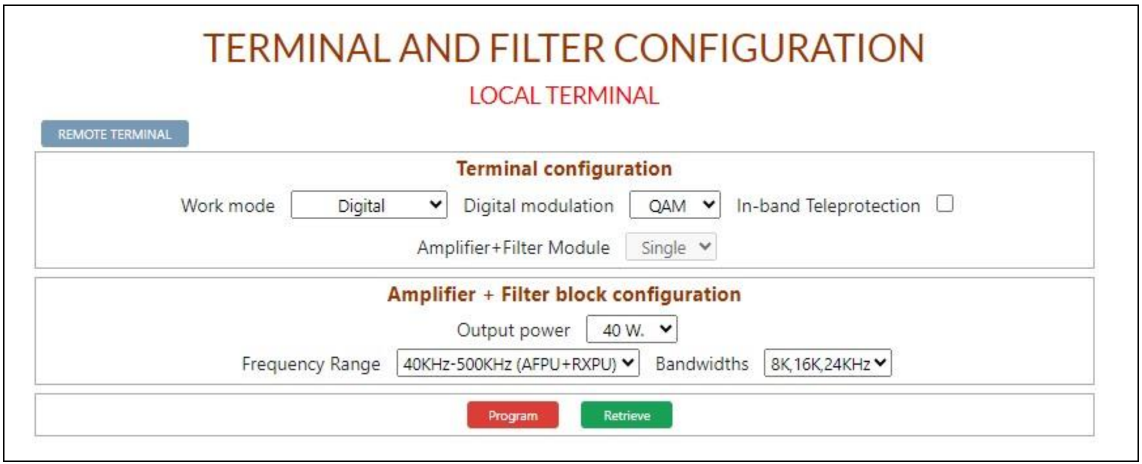


Figure 7.12 Equipment definition page example (Digital).

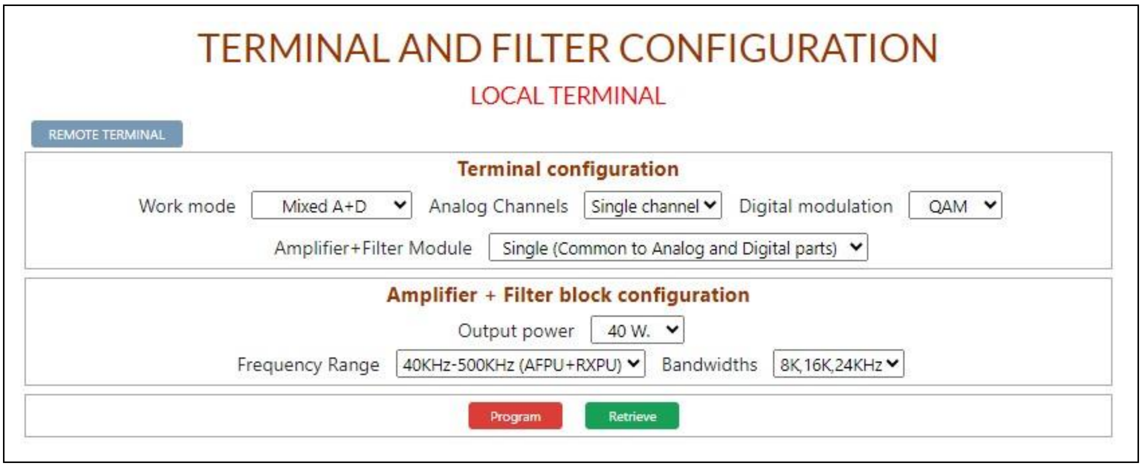


Figure 7.13 Equipment definition page example (Mixed A+D).

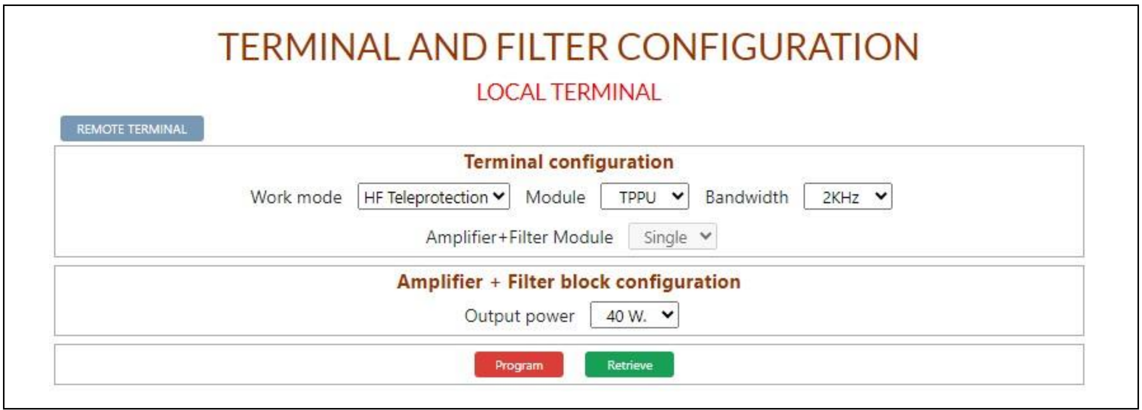


Figure 7.14 Equipment definition page example (HF Teleprotection).

7.2.3 Basic equipment

It contains the controls associated with the work mode set in the ***Equipment definition*** option.

It also allows a loop at high frequency to be carried out in the terminal.

Loop activation is carried out by means of the **Make HF loop** command button. When activated, the system automatically matches the receive frequency to the transmit frequency. When deactivated, the system restores the receive frequency to its original value.

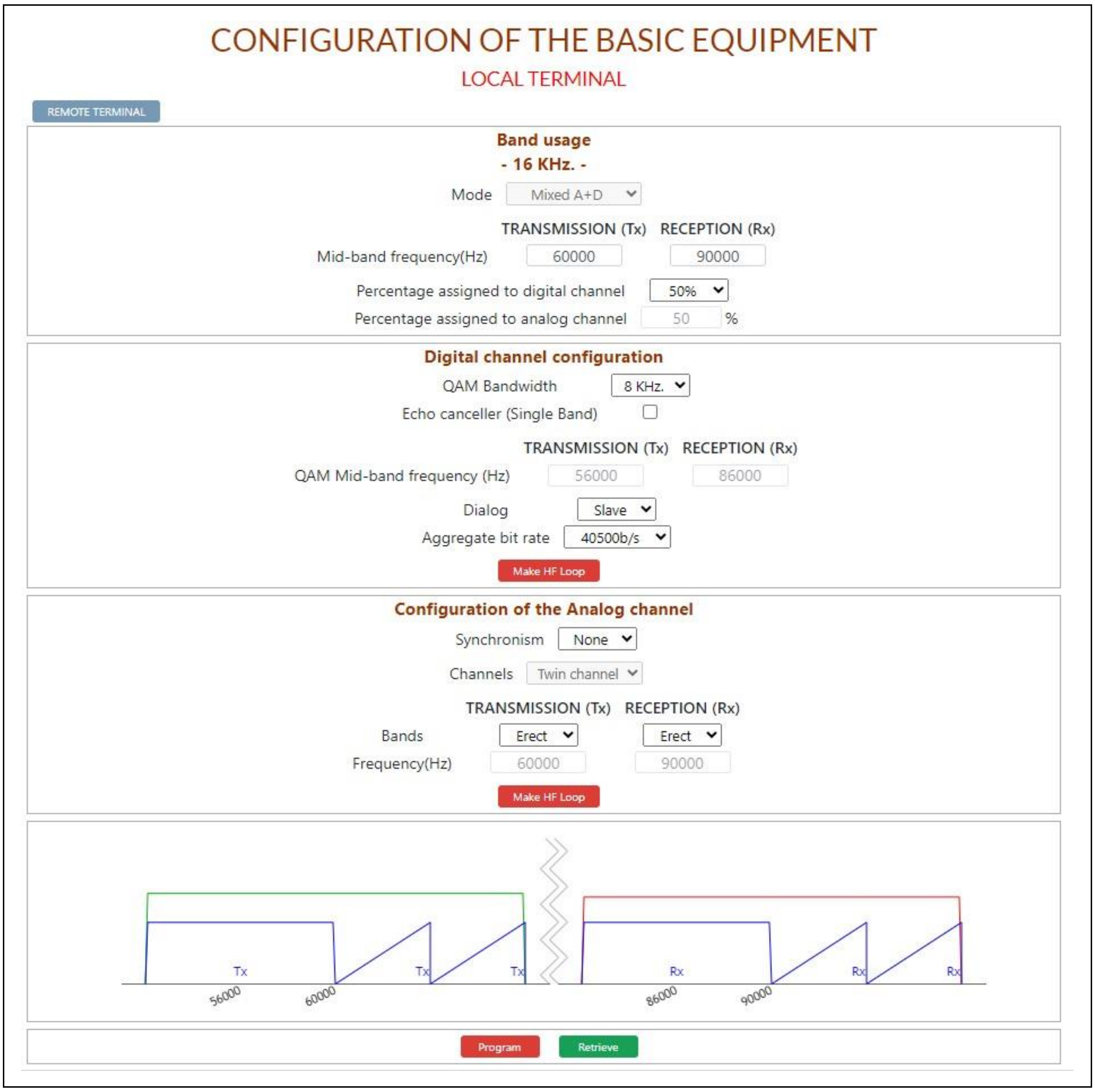


Figure 7.15 Basic equipment page example (Mixed A+D).

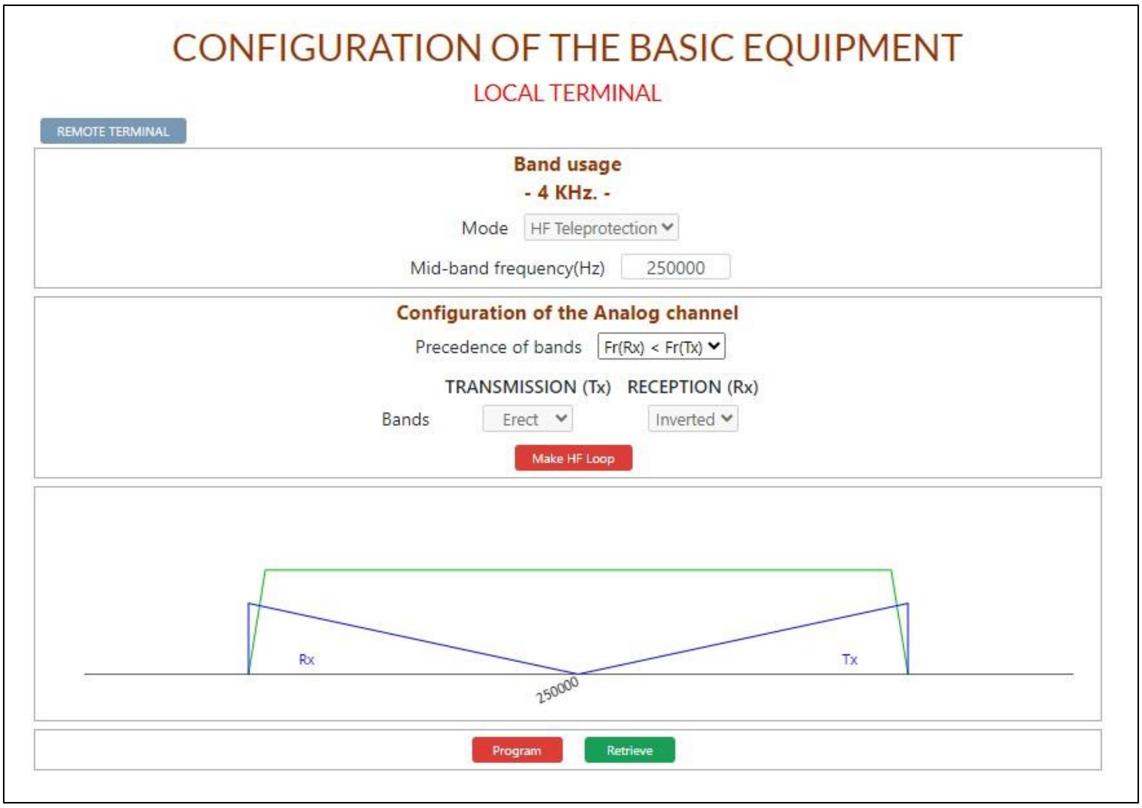


Figure 7.16 Basic equipment page example (HF Teleprotection).

- **Mid-band frequency**
  In **HF Teleprotection** work mode, only one **Mid-band frequency** box will be displayed.

  In **mixed** work mode, it is necessary to configure the transmission and reception **Mid-band frequency**, bearing in mind that the digital signal will always be on the left and the analog signal on the right.
  Once specified, for the digital channel, is displayed the corresponding **Mid-band frequency** and, for the analog channel, is displayed the corresponding **carrier frequency** in transmission and reception.

  In **mixed** work mode, it is also necessary to configure the output power percentage given to the analog and digital channels.

- **Band direction in analog channel**
  With analog channels, the direction of the band (**erect** or **inverted**) must be selected for both transmission and reception.

  In **HF Teleprotection** work mode, the transmission and reception bands are Adjacent, Erect (Tx) & Inverted (Rx) or Inverted (Tx) & Erect (Rx).

- **Bandwidth of digital channel**
  In **digital** work mode, it is necessary to configure the channel bandwidth.

  For the **QAM**, it is also possible to configure the use of the **echo canceller** in superimposed bands.

  In superimposed-band operation mode, the central frequencies to be programmed must be the same. For this reason, only one **QAM Mid-band frequency** box will be displayed.

- **Synchronism**
  With analog channels, it is possible to work either **plesiochronous**, that is, each terminal works with its own master clock, or in a **synchronized way**, that is, each terminal uses its internal oscillator as mater transmission clock and synchronizes its reception using the pilot received.

  If *Yes* is selected, it means that the terminal works in a synchronized way.
  If *None* is selected, it means non-synchronism operation (plesiochronous).

  The **QAM** digital channel works with only one clock, which is internal.
  The system determines a *Master-Slave* operating mode for the recovery of synchronism.

  The *Master* terminal generates the transmit synchronism from the internal oscillator.
  The *Slave* terminal always uses the clock recovered from the data received from the line to generate the transmit synchronism.

- **Transmission speed of digital channel**
  The **OFDM** has associated *Gross bit rate*, *Current bit rate* and *User bit rate parameters*.

  The **QAM** has associated the *Aggregate bit rate* parameter which determines the transmission speed available in the programming pages of the multiplexer ports.

  When *Autobauding* is selected, in case the transmission speed selected be automatically reduced and redistribution of information in the frame is not possible, the modification of the transmission speed of the multiplexer ports will be required as the maximum capacity of the channel will have been exceeded.

7.2.4 Alarm-relay conditions

It allows the operation of the **three** auxiliary relays of the terminal to be programmed. These are: *Relay 1*, *Relay 2* and *Relay 3*.

Each relay is configurable for signalling of alarm or a combination of alarms.

The number and type of the alarms displayed in the page are in accordance with the work mode selected.

- It is possible to program an **activation timing** between **0** and **60** s.
  This timing is used as a security measure as, once configured, the relay will not be activated until it is verified that the configured alarm condition is really satisfied during the programmed time.

In normal operation conditions, the relays are ***Energized*** *(N.O. and C contacts short-circuited).*

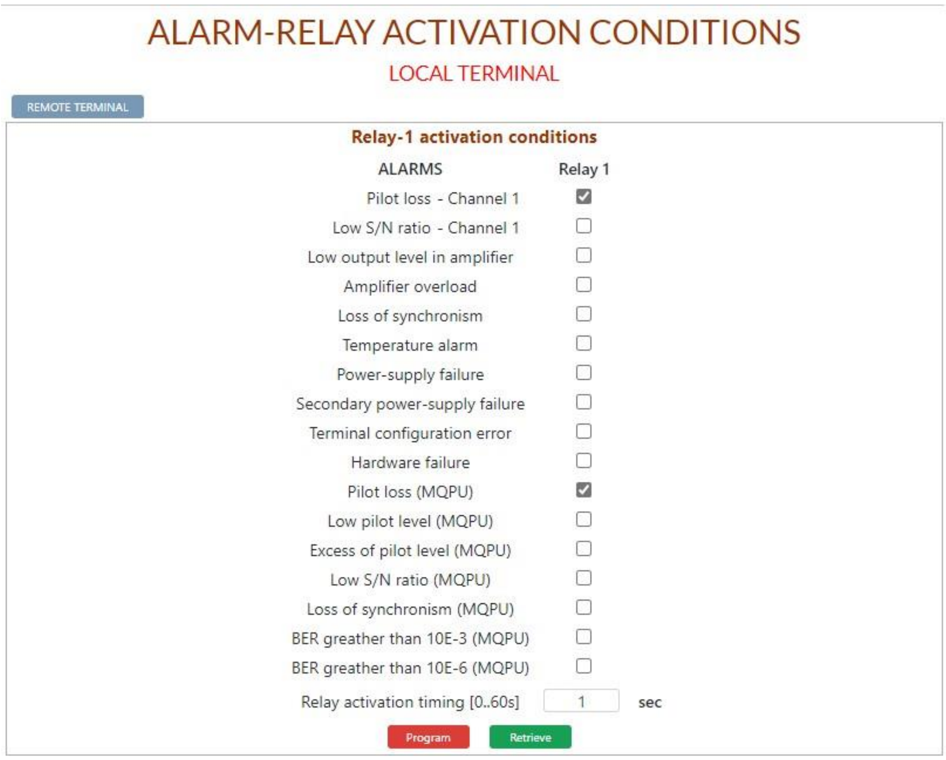


Figure 7.17 Alarm-relay conditions page example (Mixed work mode).

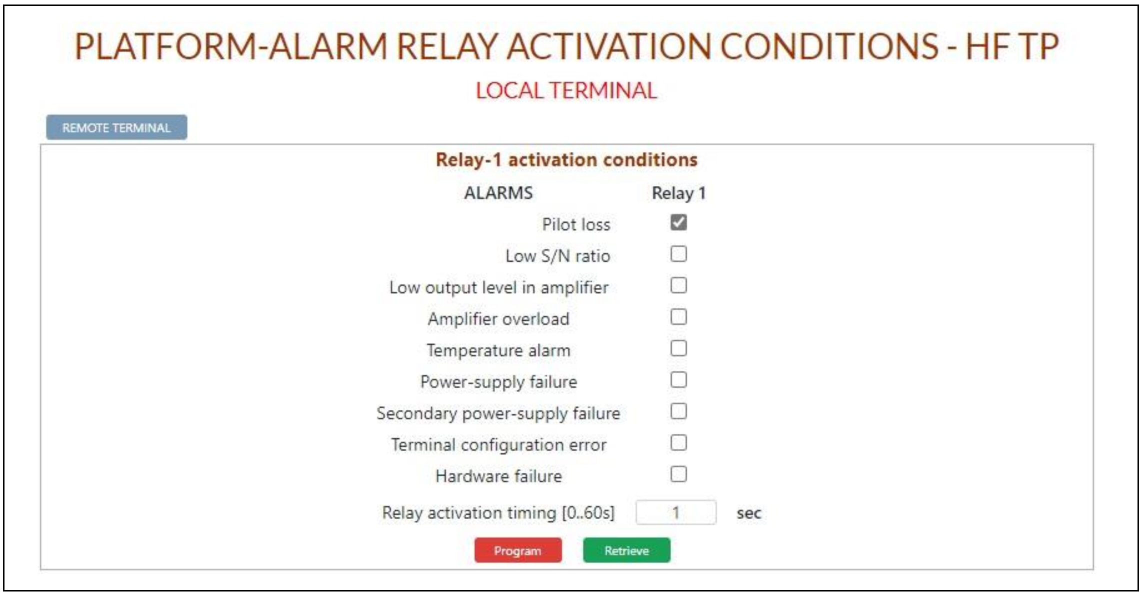


Figure 7.18 Alarm-relay conditions page example (HF Teleprotection work mode).

7.2.5 Transmit level

This page gives the possibility to adjust the transmit-level value.

A selective voltmeter must be connected to the **LINE** test points of the terminal, being the dummy load in **TERMINAL** position.

- In the page, use the quantity command buttons to modify the value until the desired value be measured in the voltmeter.
  See values in section 6.7.1, *Transmit Levels,* of Chapter 6, *Commissioning*.
  When finished, put the dummy load back to **NORMAL** position.

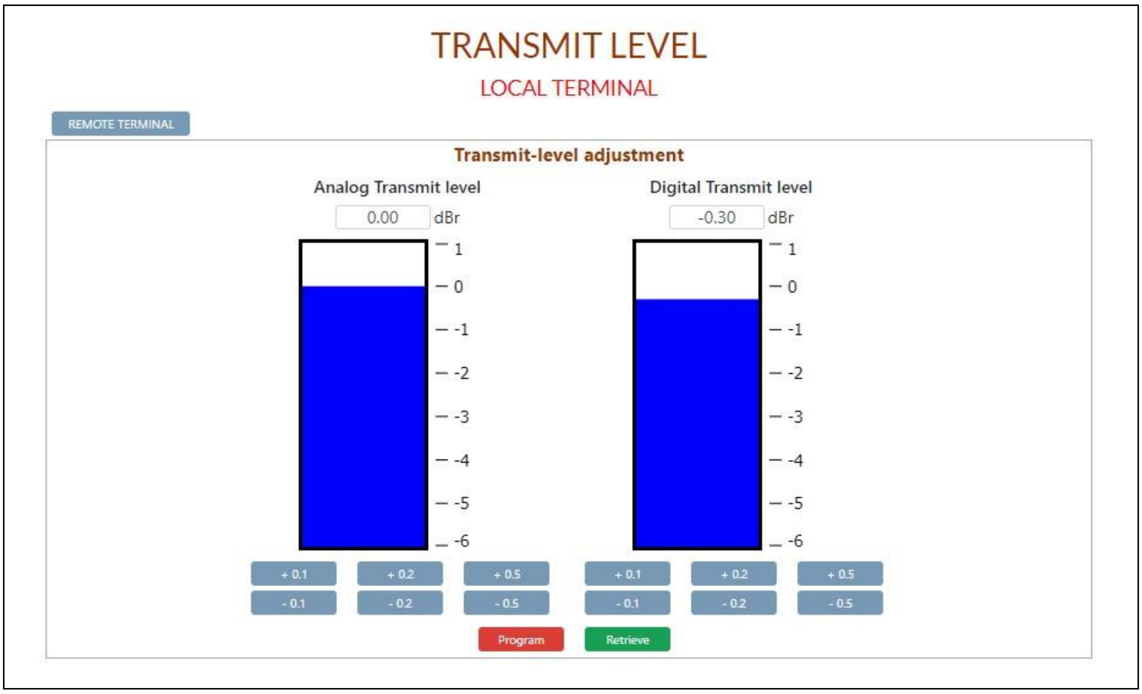


Figure 7.19 Transmit level option.

7.2.6 Modulation percentages (HF Teleprotection only)

This page is associated with the HF Teleprotection work mode, and gives the possibility to assign the modulation percentages of the pilot and guard signals in transmission (normal and boosting condition) and reception.

A value can be introduced or modified by directly introducing it in the corresponding text box.

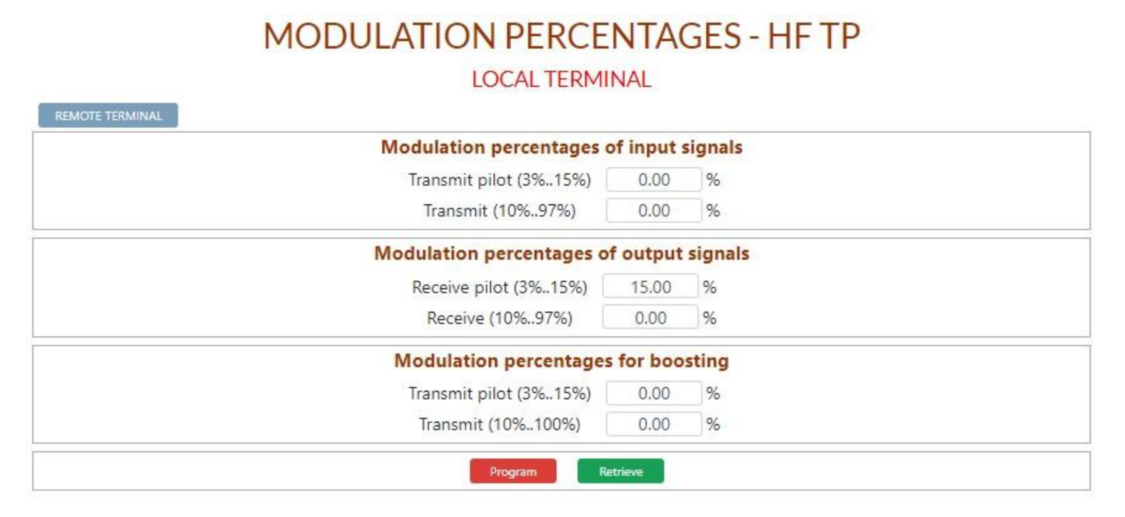


Figure 7.20 Modulation percentages option (HF Teleprotection work mode only).

7.3 Configuration menu - Analog part

7.3.1 Analog configuration

It displays the configuration of the analog channel that was set from the *Basic equipment* option.

It shows the analog options that are assigned to each of the two possible analog channels of the **OPU-1** terminal, and allows analog option assignment.

In twin-channel terminals, it allows the service telephony to be assigned to channel **1** or channel **2**.

- It is possible to use two modems (FSK asynchronous modem **A** and FSK asynchronous modem **B**) per channel.
  The modem will be considered as type **A** or **B** according to its internal configuration (**S27** strap).

- The teleprotection will be considered as **A**, **B**, **C** or **D** according to its internal configuration (**P1-P2** jumper).

The use of the speech-service channel demands the 4-kHz whole band for service telephony and, therefore, the deactivation of all the services inside this band.

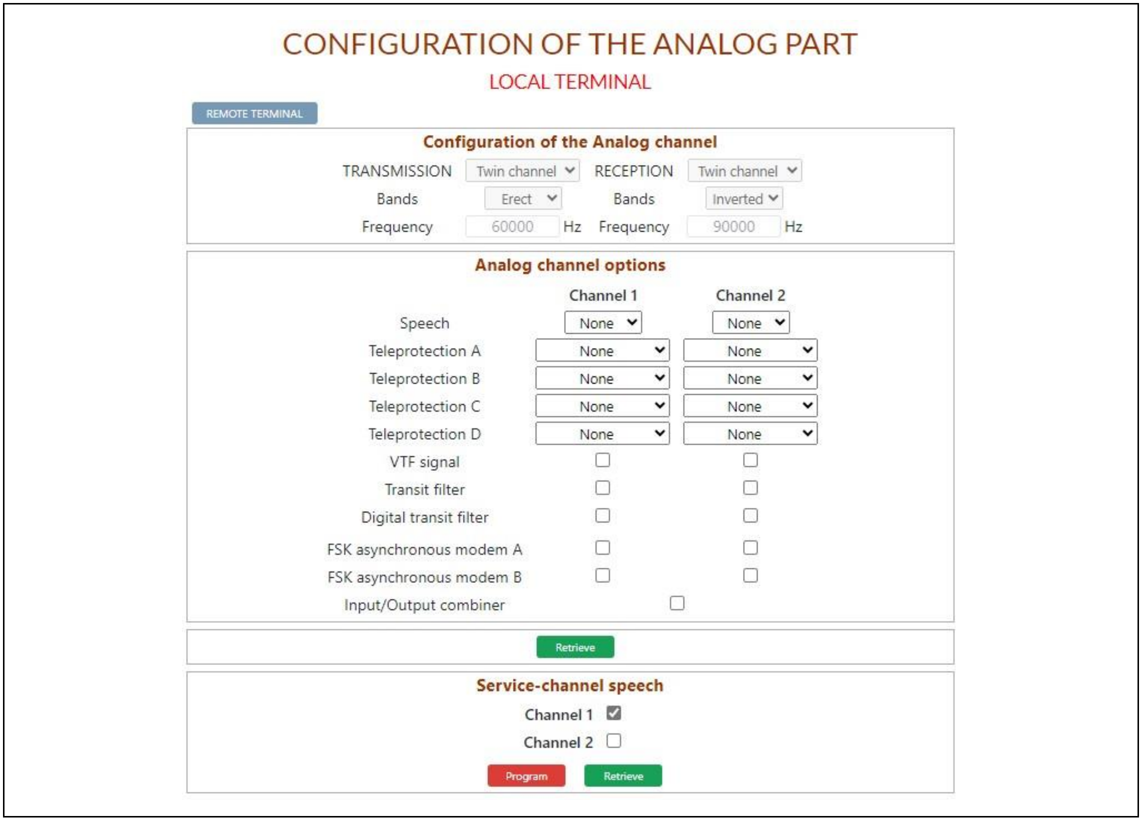


Figure 7.21 Analog configuration option.

7.3.2 Input levels

It allows the levels and modulation percentages of the input signals to be assigned, in normal operation condition.

Overmodulation (modulation over 100%) is permitted. When the inputs are programmed with a percentage of modulation that is greater than 100%, a warning window appears indicating: "*Total modulation percentage is greater than 100%. Do you want to program*?".

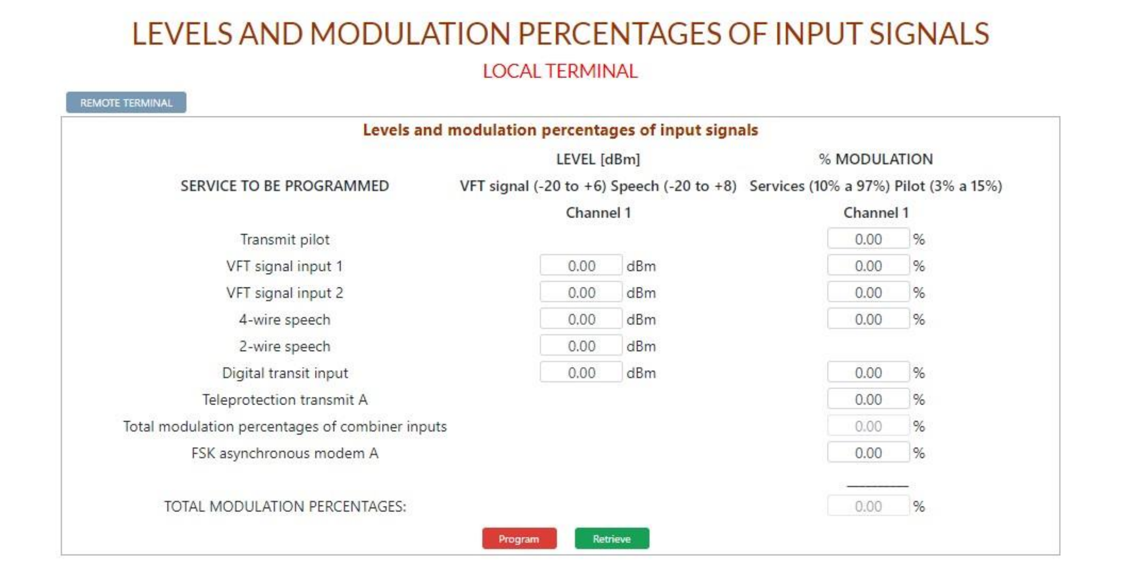


Figure 7.22 Input levels option.

7.3.3 Output levels

It allows the levels and modulation percentages of the output signals to be assigned.

The user must verify if the modulation percentages introduced in the remote terminal agree with those programmed in the local terminal.

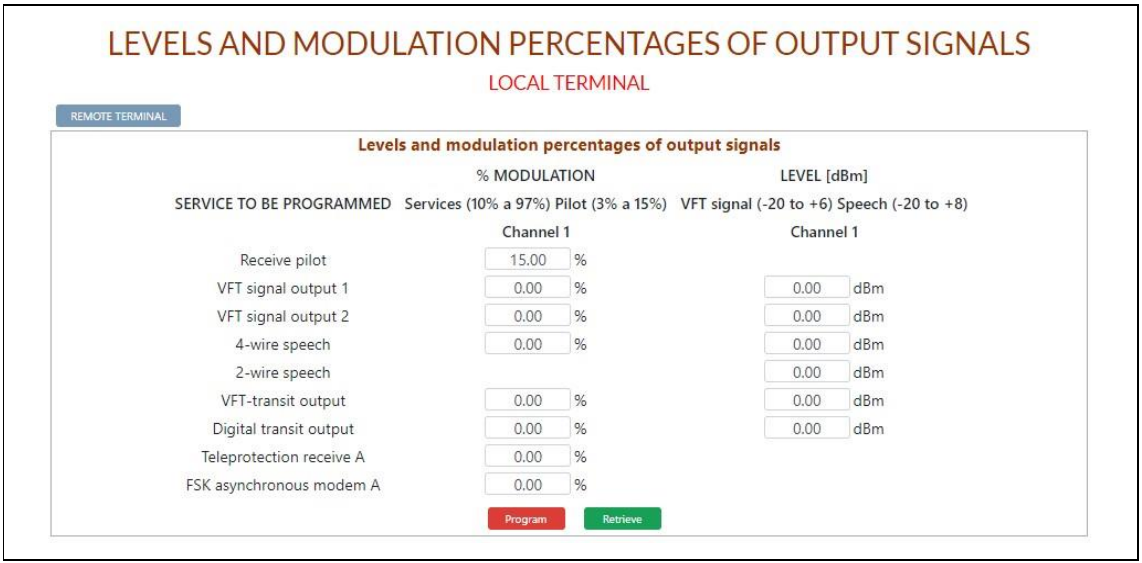


Figure 7.23 Output levels option.

7.3.4 Boosting levels

It allows the levels and modulation percentages of the input signals to be assigned, in power boosting condition.

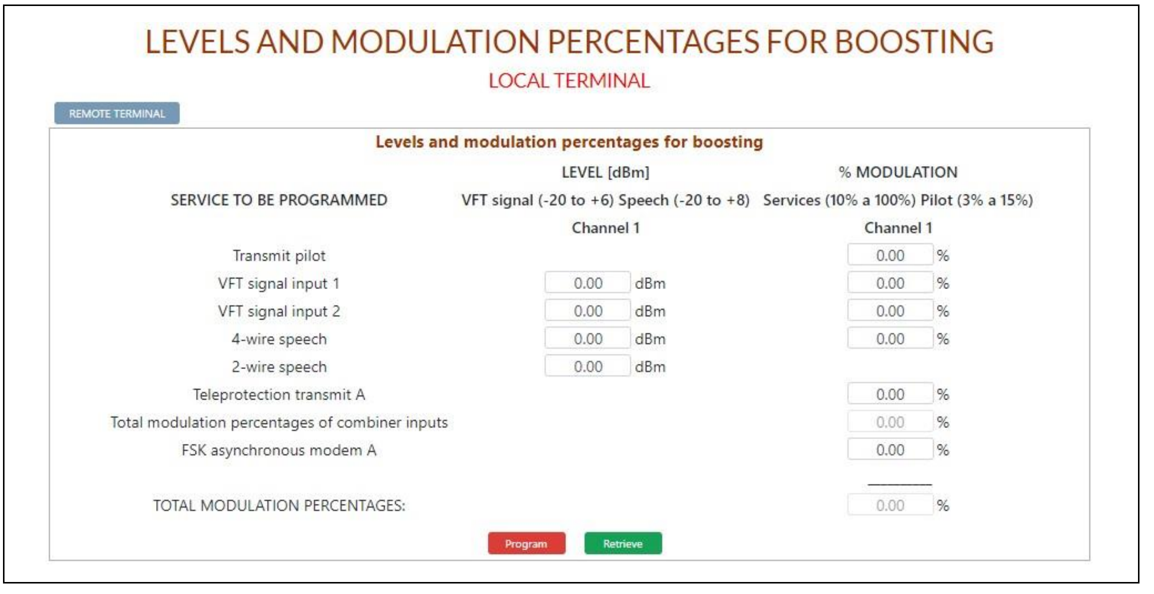


Figure 7.24 Boosting levels option.

7.3.5 Activation and deactivation conditions

It allows the blocking of outputs because of pilot loss to be configured.

It also allows the configuration of the Signal/Noise ratio value that will deactivate and activate the outputs, and the S/N ratio alarm.

The range of valid values for the S/N ratio goes from +**4** dB to +**36** dB. When the modulation percentage assigned to the receive pilot is modified (*Output levels* option), it is necessary to change signal-to-noise ratio values.

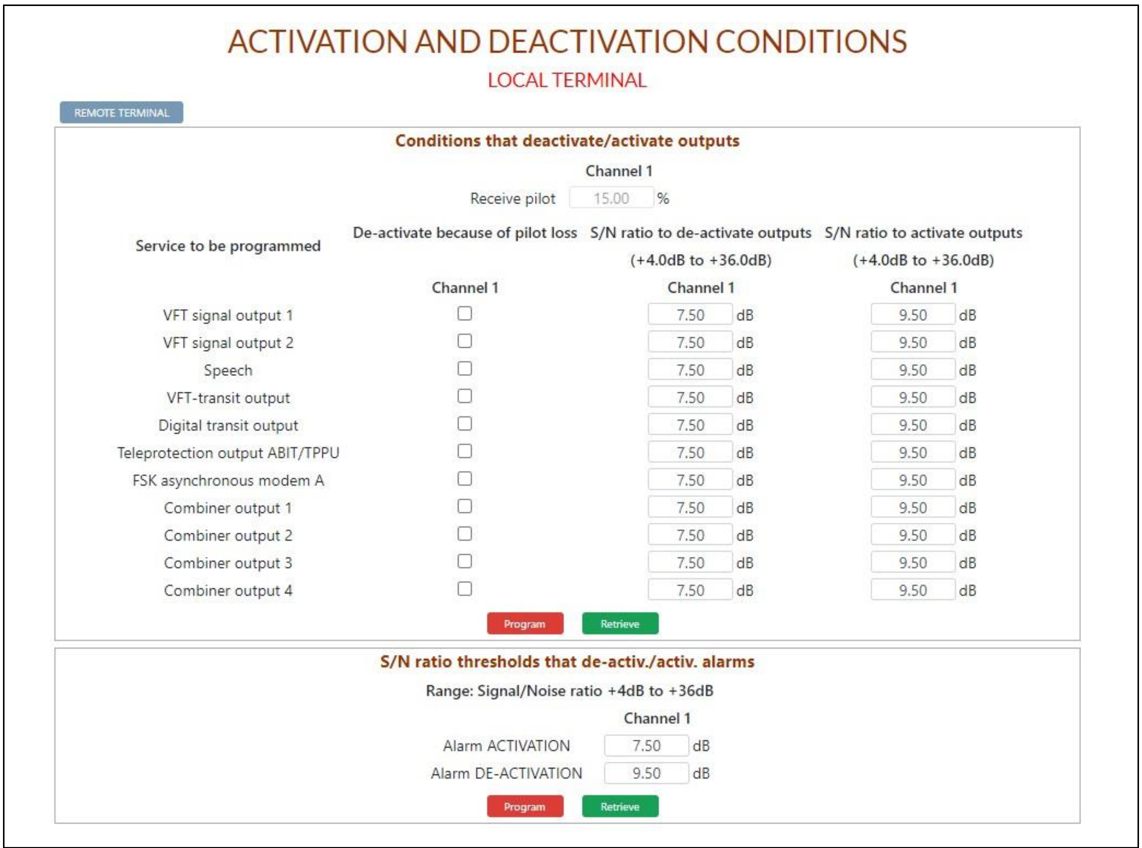


Figure 7.25 Activation and deactivation conditions option.

The **deactivation threshold** specifies the S/N ratio below which the output is deactivated and above which the alarm is deactivated.

The **activation threshold** specifies the value above which the output is activated and below which the alarm is activated.

The change of state presents **hysteresis**. This means that the activation threshold must be at least **2** dB higher than that of deactivation.

The output activation and deactivation is also delayed in order to prevent them from activating due to noise impulses of a short duration.

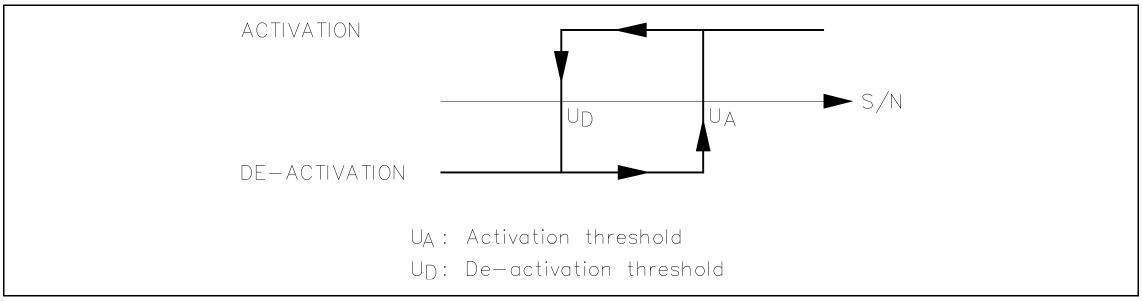


Figure 7.26 Hysteresis in the activation and deactivation.

The programmed thresholds are referred to a total-band signal with 100% modulation. The S/N ratio in these conditions *[S/N]*$_{total}$ can be calculated from the desired ratio *[S/N]*$_{service}$ given for a bandwidth *B*$_{service}$ and for a modulation percentage *%modulation*$_{service}$ by means of the following formula:

$$\left(\frac{S}{N}\right)_{total} = \left(\frac{S}{N}\right)_{service} + 10\text{Log}\left(\frac{B_{service}}{3550\text{Hz}}\right) - 20\text{Log}\left(\frac{\%\,\text{modulation}_{service}}{100\%}\right)$$

7.3.6 Unavailable link-signal condition

It allows the conditions that activate the unavailable-link signal to be configured.

The conditions selected can be alarms or local boosting.

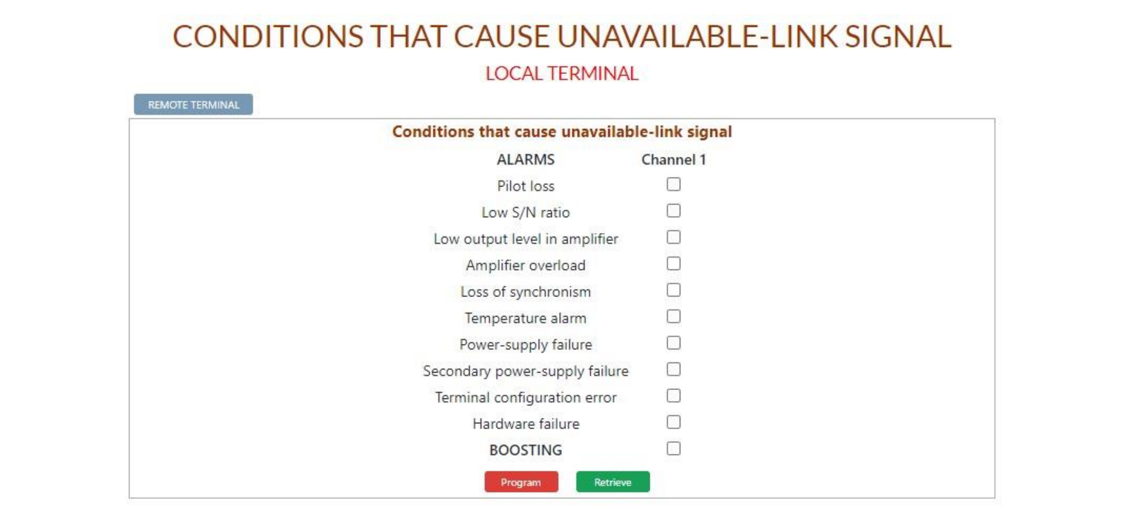


Figure 7.27 Unavailable link-signal conditions option.

7.3.7 Speech configuration

It allows in the speech (**TDPU.20**) module the configuration of:

- Speech-band cut-off frequency. The speech band is limited from **300** Hz to a frequency programmable between **2000** Hz and **3400** Hz.
- Activation and deactivation of the dynamic compressor/expander (compandor).
- Operating mode of the 4-wire configurable termination.

The page shows a graphical representation of the frequencies used by the speech option and the other options, in the transmission and reception bands. In this way, it is possible to detect frequency overlap in the channel.

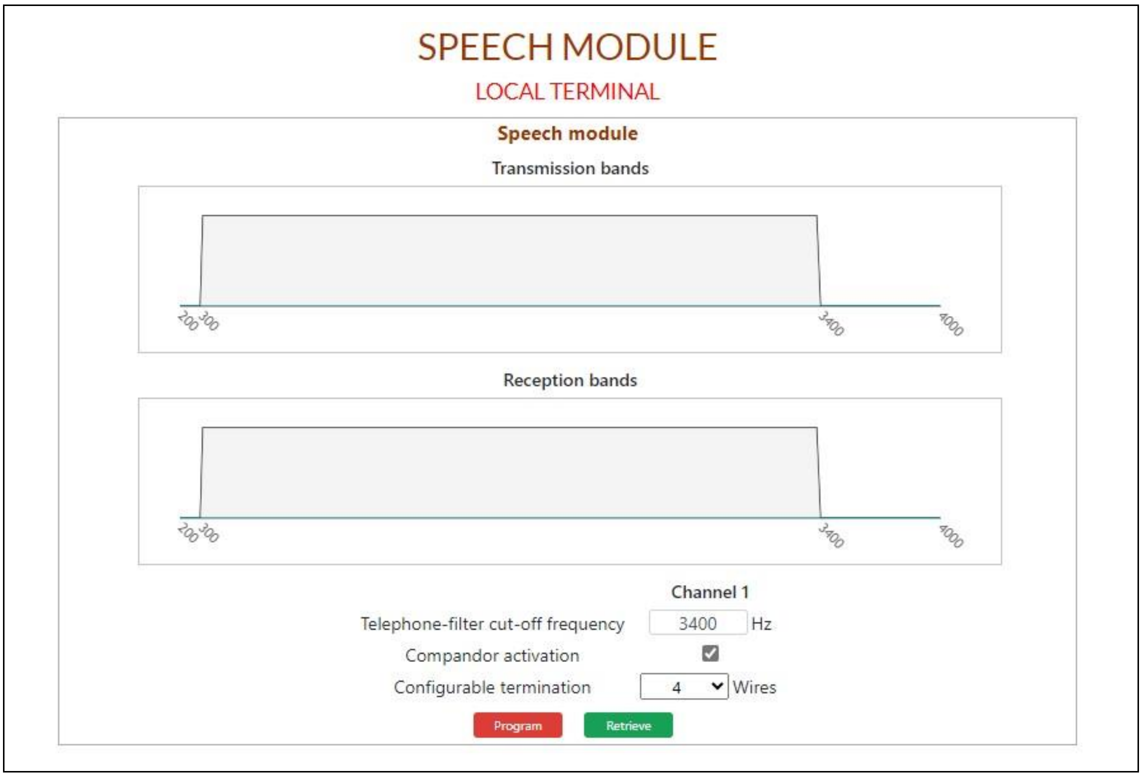


Figure 7.28 Speech configuration option.

7.3.8 Modem configuration

It allows in the FSK asynchronous modem (**MFPU**) module the configuration of:

- Operation mode. **Normal** or **V.23**.
- Transmission speed.
- Central frequency.

The page shows a graphical representation of the frequencies used by the modem option and the other options, in the transmission and reception bands. In this way, it is possible to detect frequency overlap in the channel.

*To be able to program the transmission speed and central frequency of the modem from the Management System, microswitches **3** to **10** of **MI2** must be in the **OFF** position.*

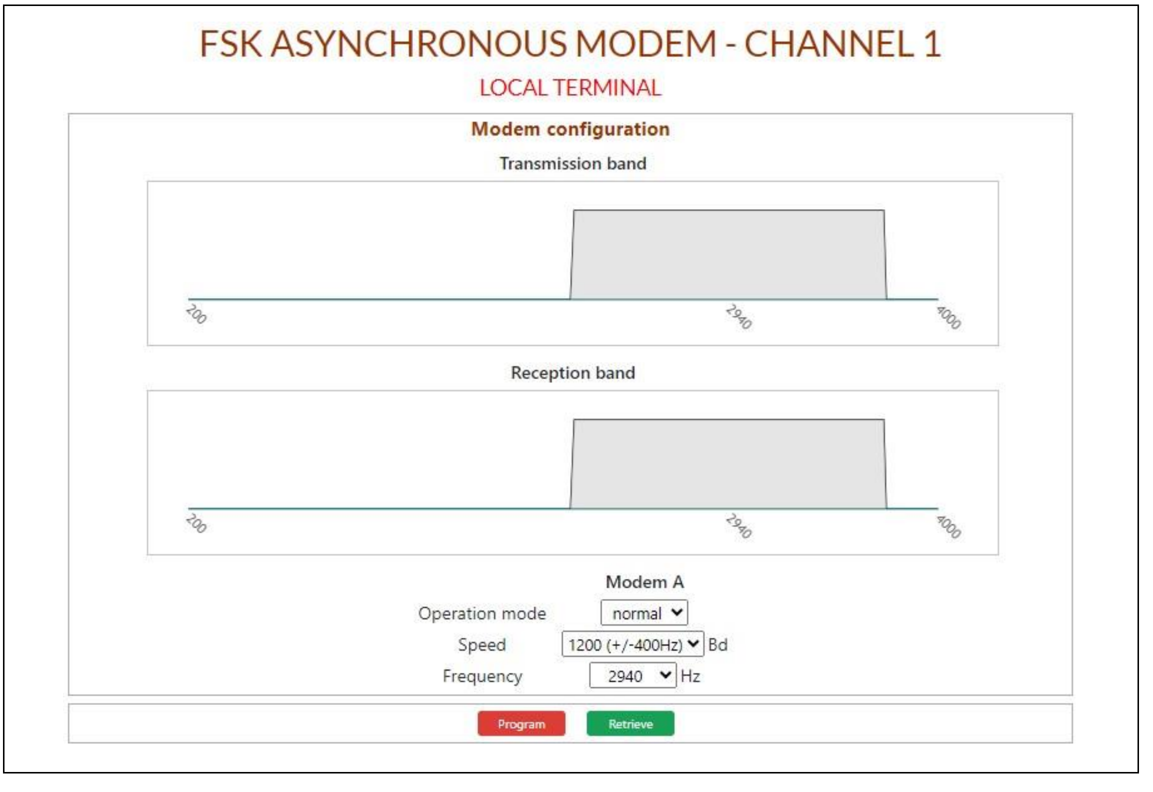


Figure 7.29 FSK asynchronous modem configuration option.

7.3.9 Input/Output combiner configuration

It allows in the Input/Output combiner (**EYPU**) module the configuration of:

- Desired input/output connections.
- Nominal levels and modulation percentages of the additional inputs and outputs .
  The percentages assigned to the inputs will be added to the modulation percentages set in the **OPU-1** terminal.
- Output frequency condition. Outputs can be blocked due to pilot loss and low S/N ratio. See *Activation and deactivation conditions* option.

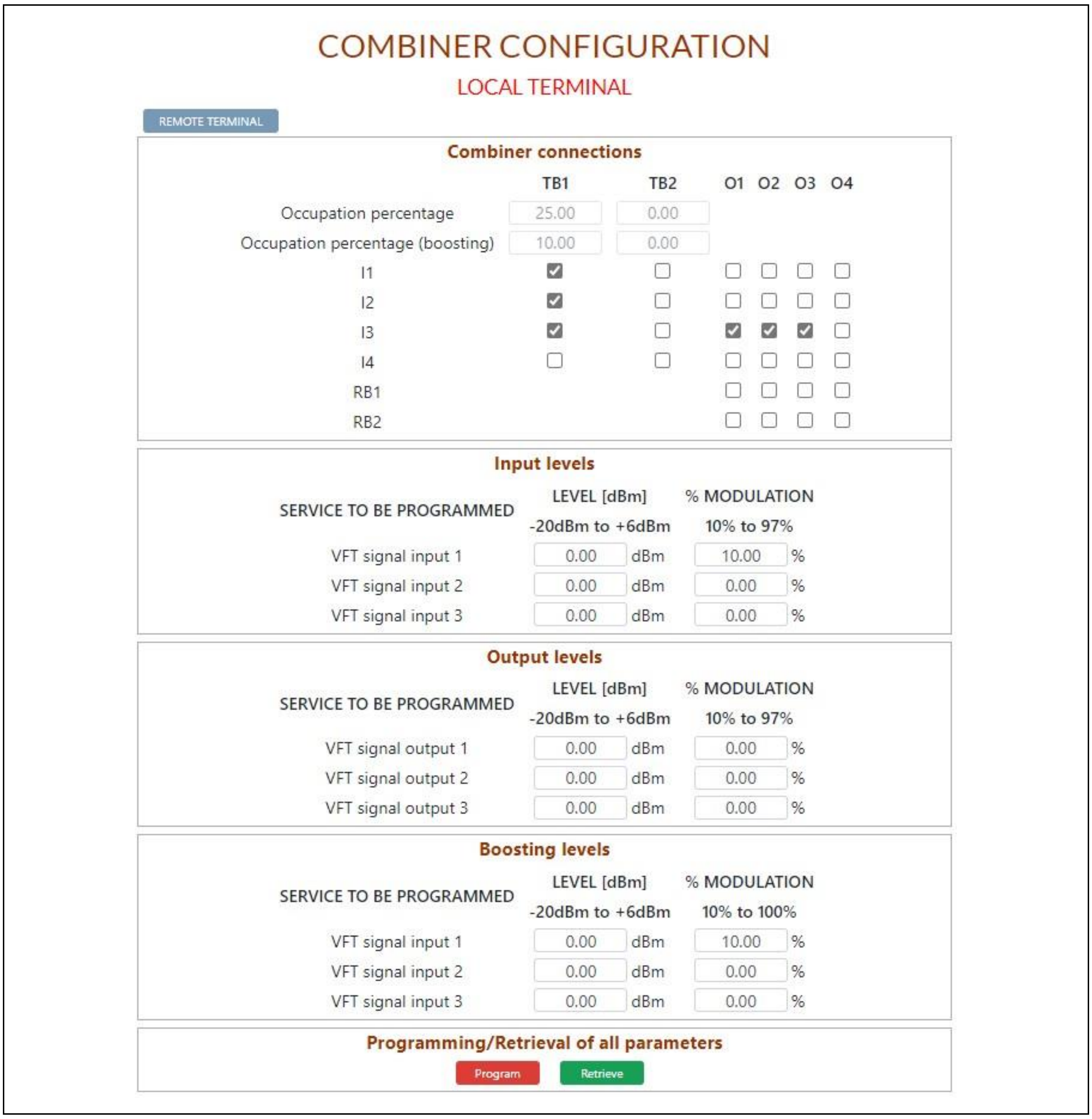


Figure 7.30 **Input/Output combiner configuration option.**

Combiner connections

- The rows correspond to the inputs. The four additional inputs are identified as **I1**, **I2**, **I3** and **I4**, and the inputs of the **OPU-1** reception buses of channels **1** & **2** are identified as **RB1** & **RB2**.
- The columns correspond to the outputs. The four additional outputs are identified as **O1**, **O2**, **O3** and **O4**, and the outputs of the **OPU-1** transmission buses of channels **1** & **2** are identified as **TB1** & **TB2**.
- Rows **RB1** and **RB2** do not have check boxes associated to columns **TB1** and **TB2** because it is not possible to connect the reception and transmission buses of the **OPU-1** terminal to each other. However, it is possible to carry out any combination in the connection of four inputs and six outputs or of six inputs and four outputs.
- When the same input is assigned to the two AF transmission buses, a warning indicates that: "*The level of this input will be affected by the boosting of either of the channels*".
- When the same output is assigned to the two AF reception buses, a warning indicates that: "*The deactivation of this output will be affected by the Pilot loss and Low S/N ratio alarms of either of the channels*".
- Concerning the S/N ratio alarm, if the activation/deactivation thresholds are different for channel **1** and channel **2**, the output deactivates when the strictest limits are surpassed and activate when the thresholds of the two channels are reached.
- The **OCCUPATION PERCENTAGE** text box associated with columns **TB1** and **TB2** considers the modulation percentages of the services programmed in the **OPU-1** terminal, in addition to showing the total modulation percentage of the associated inputs.

Output levels

- It is essential that all the input signals that are connected to one output be programmed with the same modulation percentage that has been selected for the output.

Boosting levels

- Inputs connected to the two AF transmission buses (**1** & **2**) will be programmed with the value selected for the power-boosting condition when any of the two power-boosting inputs are enabled.
- The page associated to *Boosting levels* option should be programmed if the **OPU-1** terminal power-boosting inputs are being used.

An example of an EYPU application

The following is an example of a typical application for the **EYPU** module. The main function performed by the **EYPU** module is to permit the connection of an FSK modem operating at **1200** bit/s, which is used for communications between a central telecontrol site and various remote sites, by means of a polling system.

The remote sites are radially distributed along three high-voltage lines. PLC systems are used for the communications between the first substations.

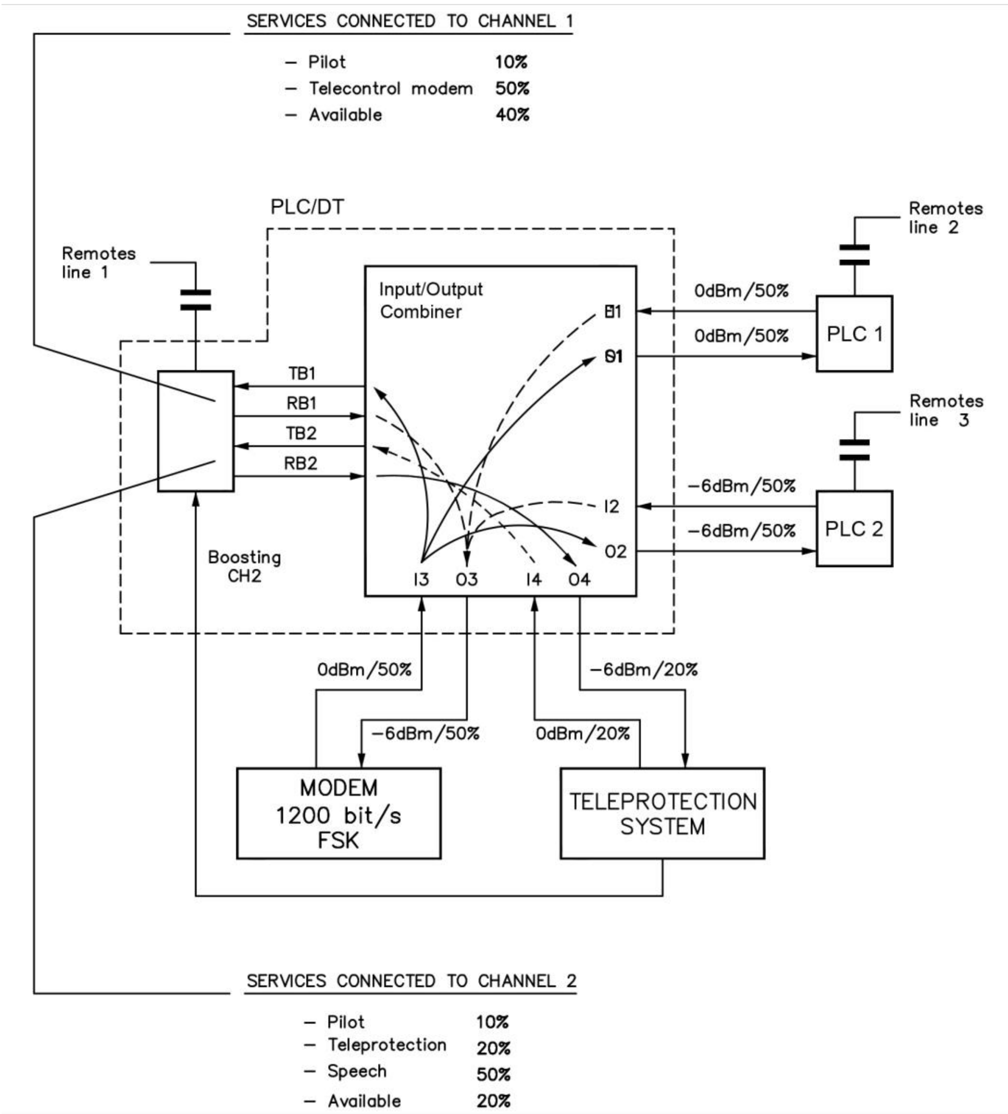


Figure 7.31 An example of an EYPU application.

- All the inputs associated with the modem are programmed with the same modulation percentage (**50**%) in order to obtain level coincidence at **O3**.

- Number **4** input and output behave as additional whole-band input/output circuits associated to channel **2**.

- Given that the power-boosting input associated with channel **2** is being used, it is essential to program the boosting levels of at least input number **4**.

- If the modulation percentage assigned to **I4** is varied in power-boosting condition, it is necessary to eliminate some other service in order not to exceed **100**% modulation. For example, if **I4** is assigned a value of **90**% in power-boosting condition, then the modulation percentage assigned to the speech service in the same condition must be set to **0**%.

- In the example, modem reception should be blocked when pilot signal loss occurs in channel **1** and in addition, when the S/N ratio over the whole channel **1** band is less than **12** dB.

- The remaining outputs should not be blocked under any circumstances.

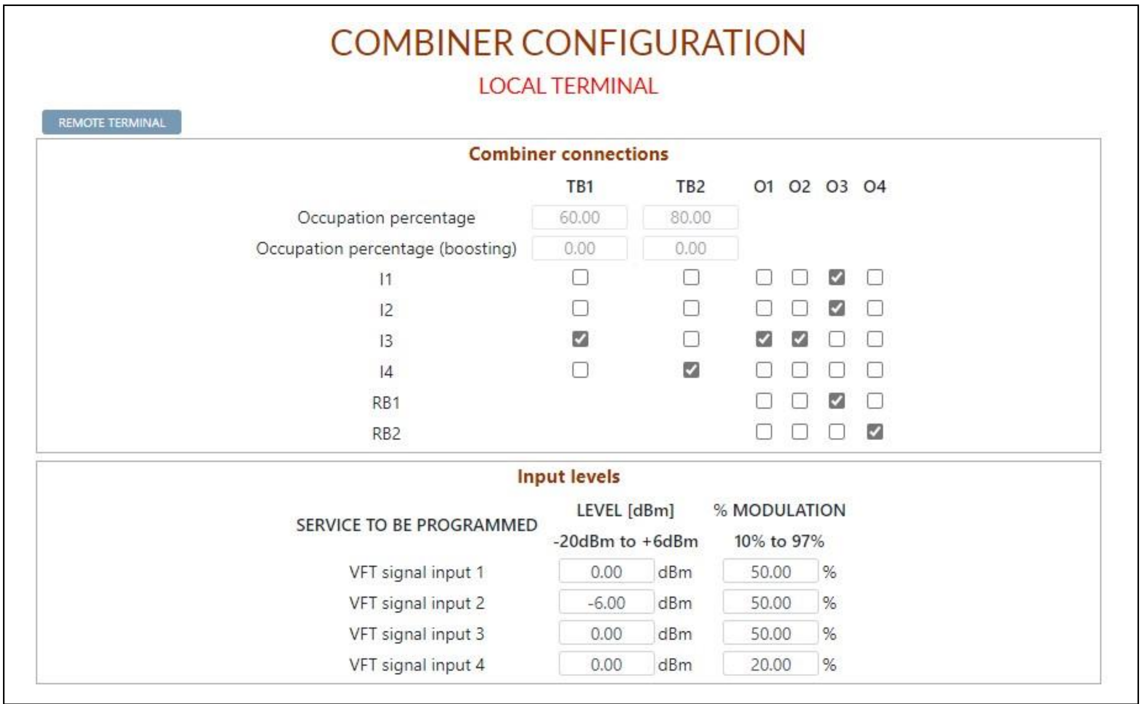


Figure 7.32 Combiner configuration according to EYPU application.

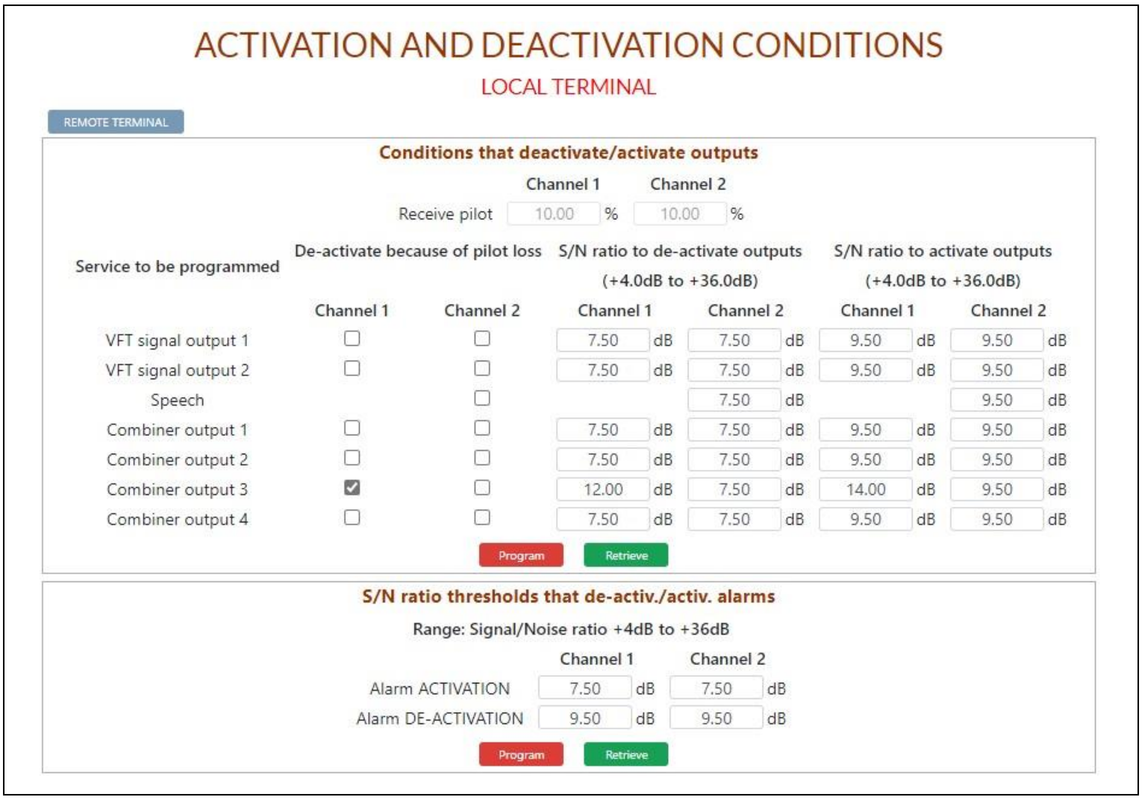


Figure 7.33 Output blocking configuration according to EYPU application.

7.3.10 Teleprotection by DUAL tone

7.3.10.a Inputs and outputs

Input configuration

- The assignment of inputs to each of the commands is configured.
  When **four** commands have been set, the assignment is fixed.
  When **three** commands have been set, various inputs can be assigned to the same command. It is then possible to select the logic for the transmission:
  - All the inputs must be active for the transmission of the command.
  - Either of the inputs causes the command to be transmitted.

- The duration of the transmission of each command is also configured. The duration can be:
  - whilst command is present.
  - prolonged time.
  - limited time.
  - fixed duration.

- In **prolonged**, **limited** or **fixed duration**, a time between **20** and **2500** ms can be programmed.

*In each command input, an **additional timing** can be configured in order for command transmission to take place only if the active-input condition persists for at least the time set in the timing.*

*A time value between **0** and **30** ms can be set.*

Output configuration

- The assignment of outputs to each of the commands is configured.
  When **four** commands have been set, the assignment is fixed.
  When **three** commands have been set, various outputs can be assigned to the same command.

- The time during which each of the output relays must remain active is also configured. The duration can be:
  - whilst receiving command.
  - prolonged time.
  - limited time.
  - fixed duration.

- In **prolonged**, **limited** or **fixed duration**, a time between **20** and **2500** ms can be programmed.

The periodicity of automatic execution of the test in local loop can also be programmed. Any value no exceeding **24** hours can be used.

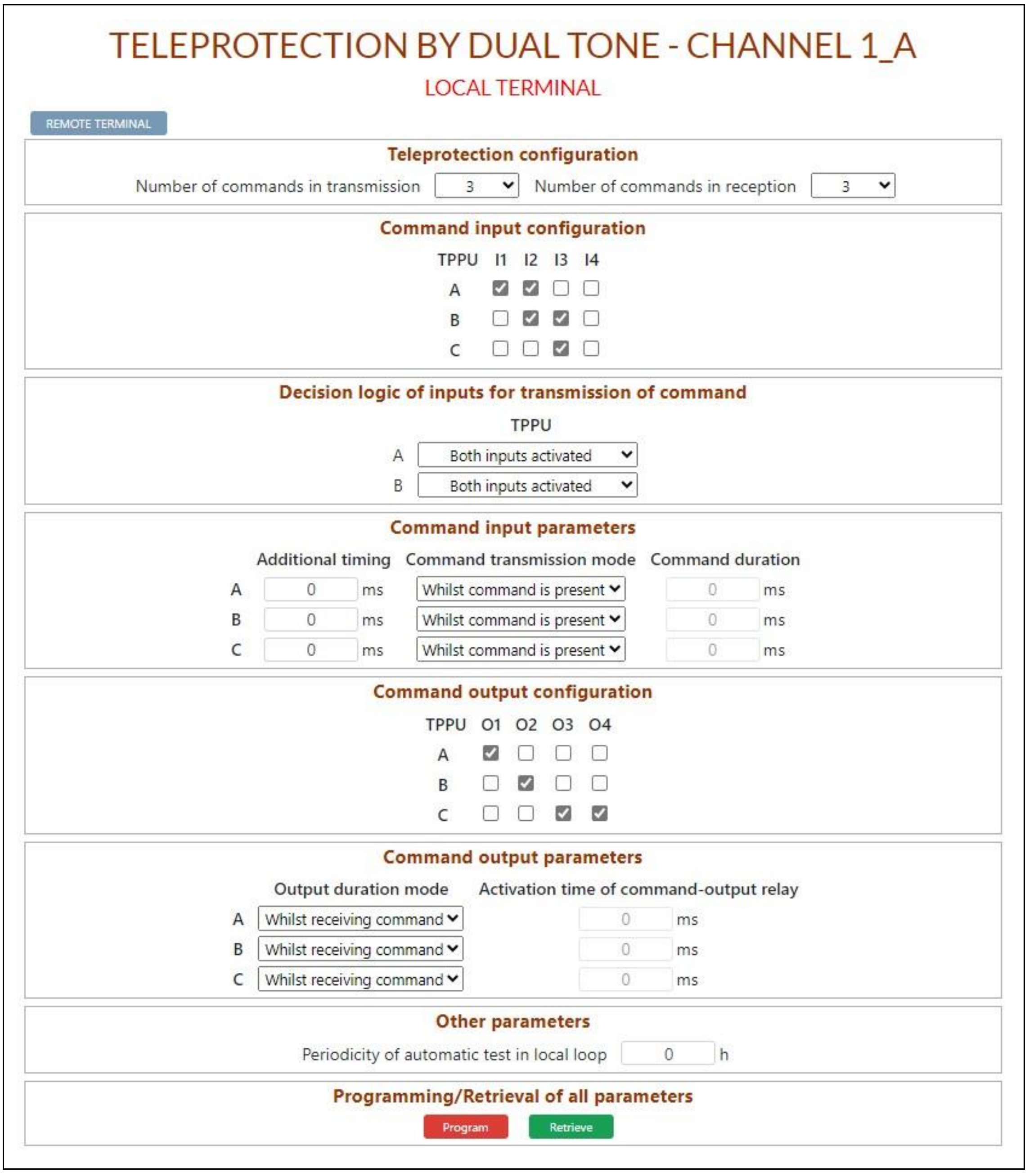


Figure 7.34 Inputs and Outputs page example (3 commands).

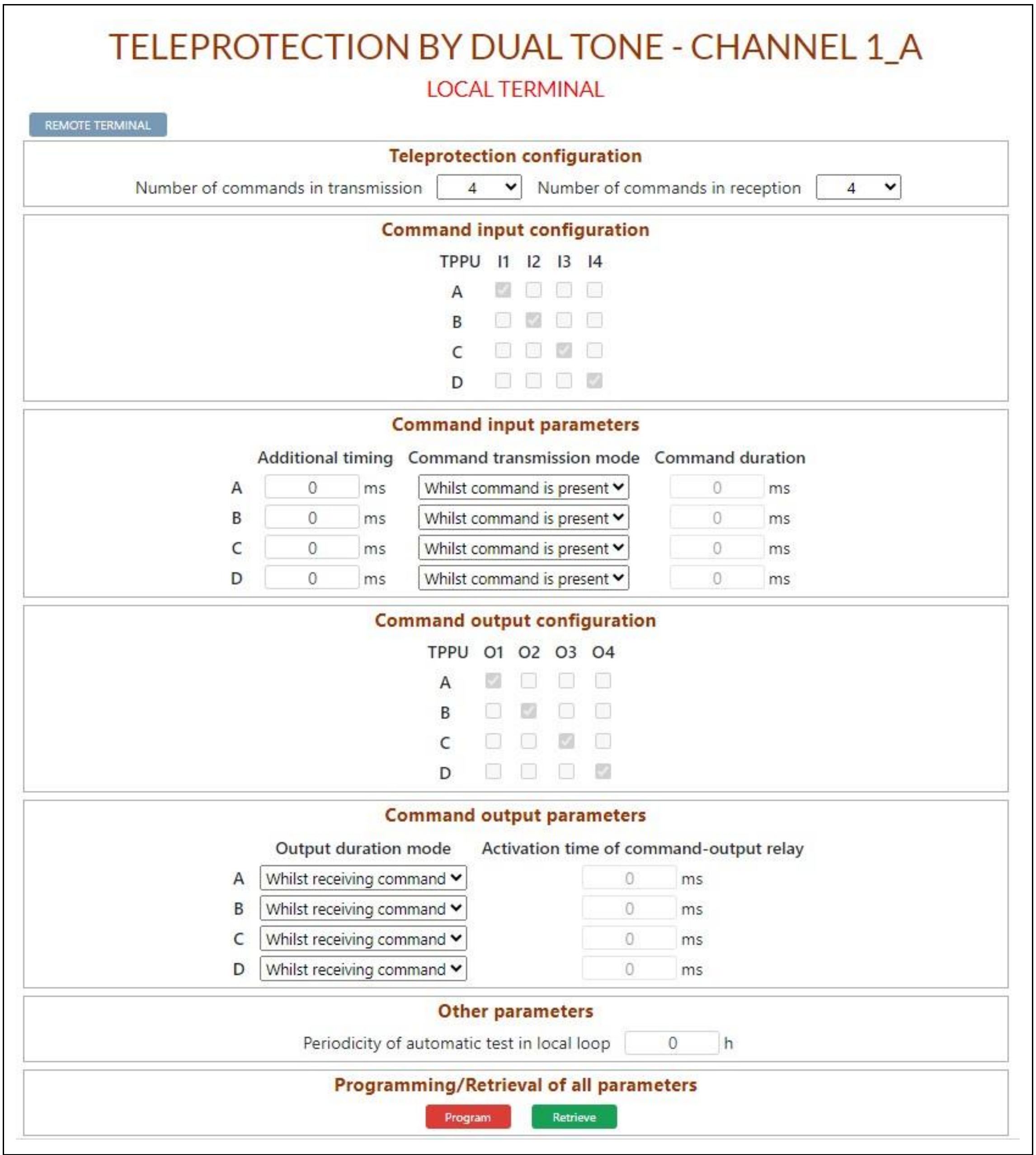


Figure 7.35 Inputs and Outputs page example (4 commands).

7.3.10.b Command configuration

It allows the teleprotection *bandwidth* and the *guard* frequency, both in transmission and reception, to be selected.

It allows the transmission time to be set in accordance with the programmed scheme (*Direct tripping, Permissive tripping and Blocking*).

It also allows the activation and deactivation thresholds for the low signal-to-noise ratio alarm to be configured.

- If the same configuration is desired for transmission and reception, the **USE SYMMETRICAL CONFIGURATION FOR Tx-Rx** check box must be selected.

- When pressed, the **FREQUENCY SELECTION** command button displays the list of possible frequencies.

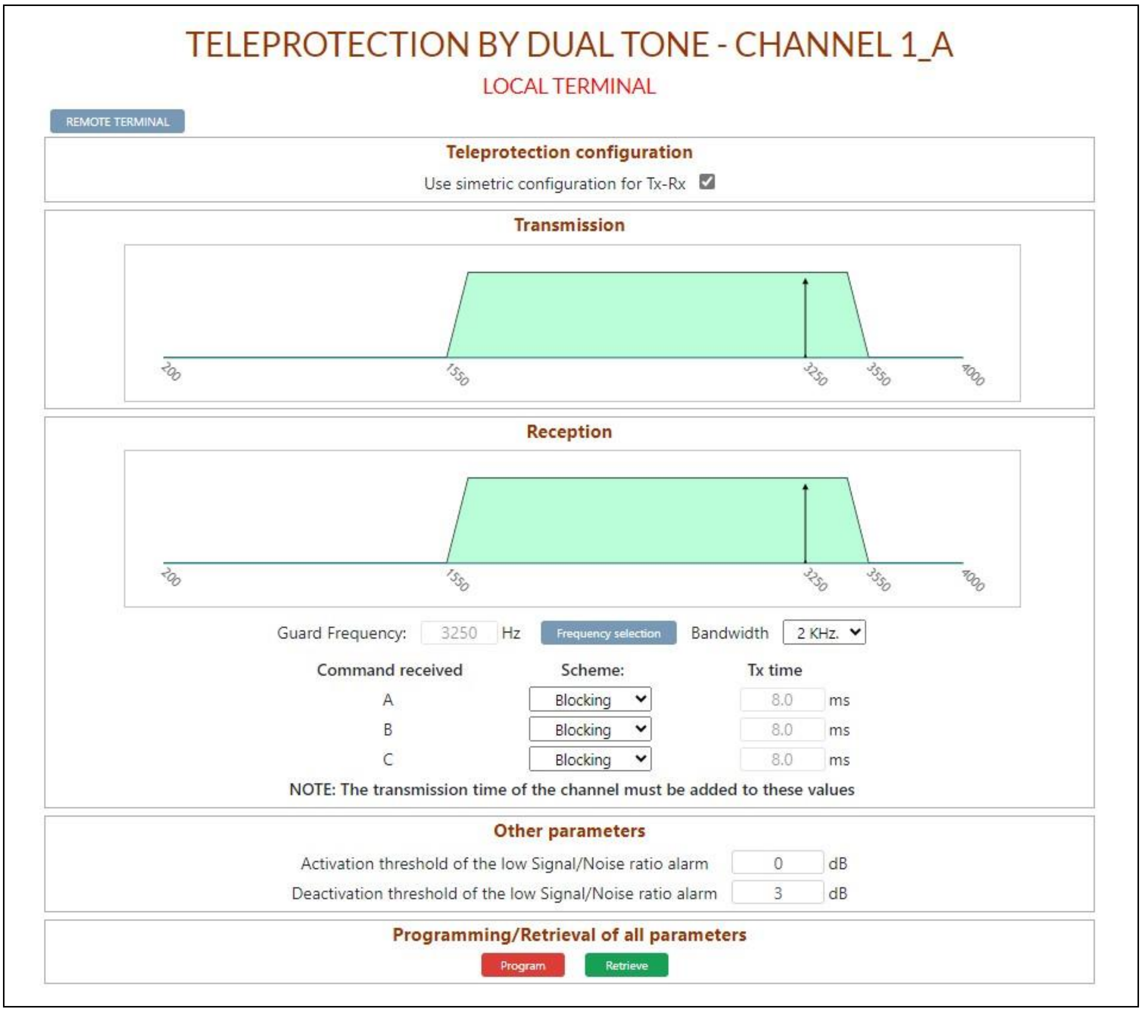


Figure 7.36 Command configuration option.

7.3.10.c Relays

It allows the operation of the **two** relays of the **TPPU** module to be programmed.

If a relay interface (**REPU**) module is installed, it also allows the operation of the **seven** additional relays to be programmed.

The relays can be configured for:

- Command transmission signalling (A, B, C and D).
- Command output circuit activation signalling (1, 2, 3 and 4).
- Alarm signalling, the following being available: *Receiver blocking, Signal loss, Low Signal/Noise ratio, Incorrect guard signal level, Local test failure and Device error*.

It is not possible to configure a relay for both signalling and alarm.

When the conditions are selected, a **relay activation timing** between **0** and **60** s must be programmed. This timing is used as a security measure as, once configured, the relay will not be activated until it is verified that the configured condition is really satisfied during the programmed time.

> *The relays programmed for **signalling** are in **rest condition** in normal operation, that is, contacts **C** and **N.C.** are closed.*
>
> *The relays programmed for **alarm** are **energized** in normal operation, that is, contacts **C** and **N.O.** are closed.*
>
> ***C**: Common **N.C.**: Rest (normally closed) **N.O.**: Working (normally open)*

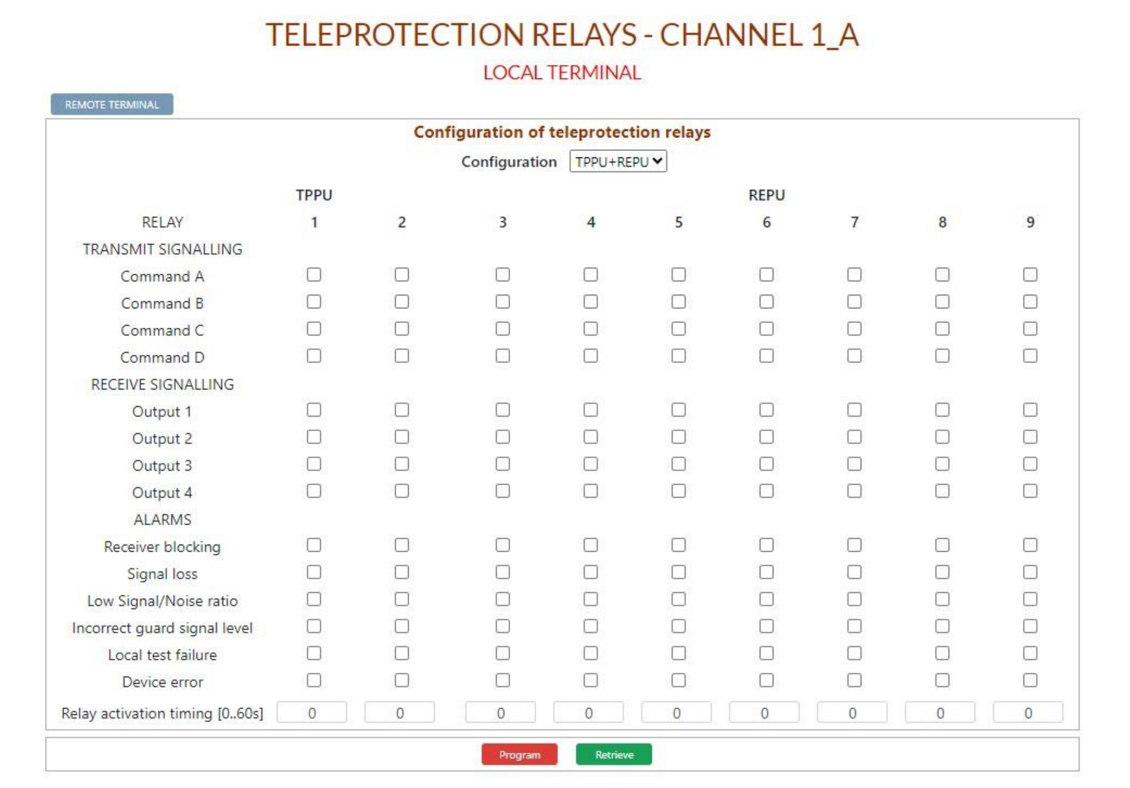


Figure 7.37 Relays option.

7.3.11 Teleprotection by DUAL tone (HF Teleprotection)

7.3.11.a Inputs and outputs

Input configuration

- The assignment of inputs to each of the commands is configured.
  When **four** commands have been set, the assignment is fixed.
  When **three** commands have been set, various inputs can be assigned to the same command. It is then possible to select the logic for the transmission:
  - All the inputs must be active for the transmission of the command.
  - Either of the inputs causes the command to be transmitted.

- The duration of the transmission of each command is also configured. The duration can be:
  - whilst command is present.
  - prolonged time.
  - limited time.
  - fixed duration.

- In **prolonged**, **limited** or **fixed duration**, a time between **20** and **2500** ms can be programmed.

*In each command input, an **additional timing** can be configured in order for command transmission to take place only if the active-input condition persists for at least the time set in the timing.*

*A time value between **0** and **30** ms can be set.*

Output configuration

- The assignment of outputs to each of the commands is configured.
  When **four** commands have been set, the assignment is fixed.
  When **three** commands have been set, various outputs can be assigned to the same command.

- The time during which each of the output relays must remain active is also configured. The duration can be:
  - whilst receiving command.
  - prolonged time.
  - limited time.
  - fixed duration.

- In **prolonged**, **limited** or **fixed duration**, a time between **20** and **2500** ms can be programmed.

The periodicity of automatic execution of the test in local loop can also be programmed. Any value no exceeding **24** hours can be used.

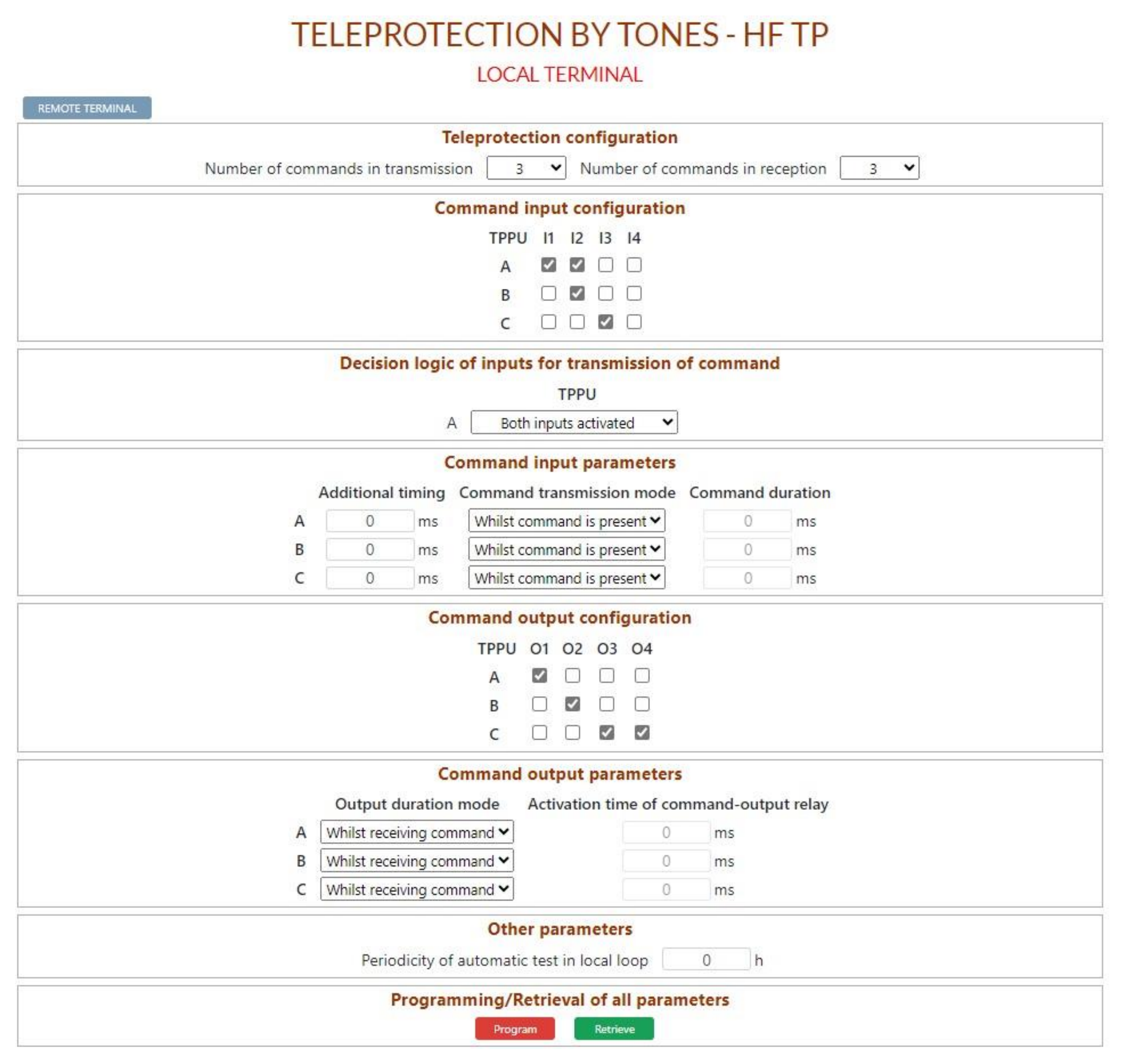


Figure 7.38 Inputs and Outputs page example (3 commands).

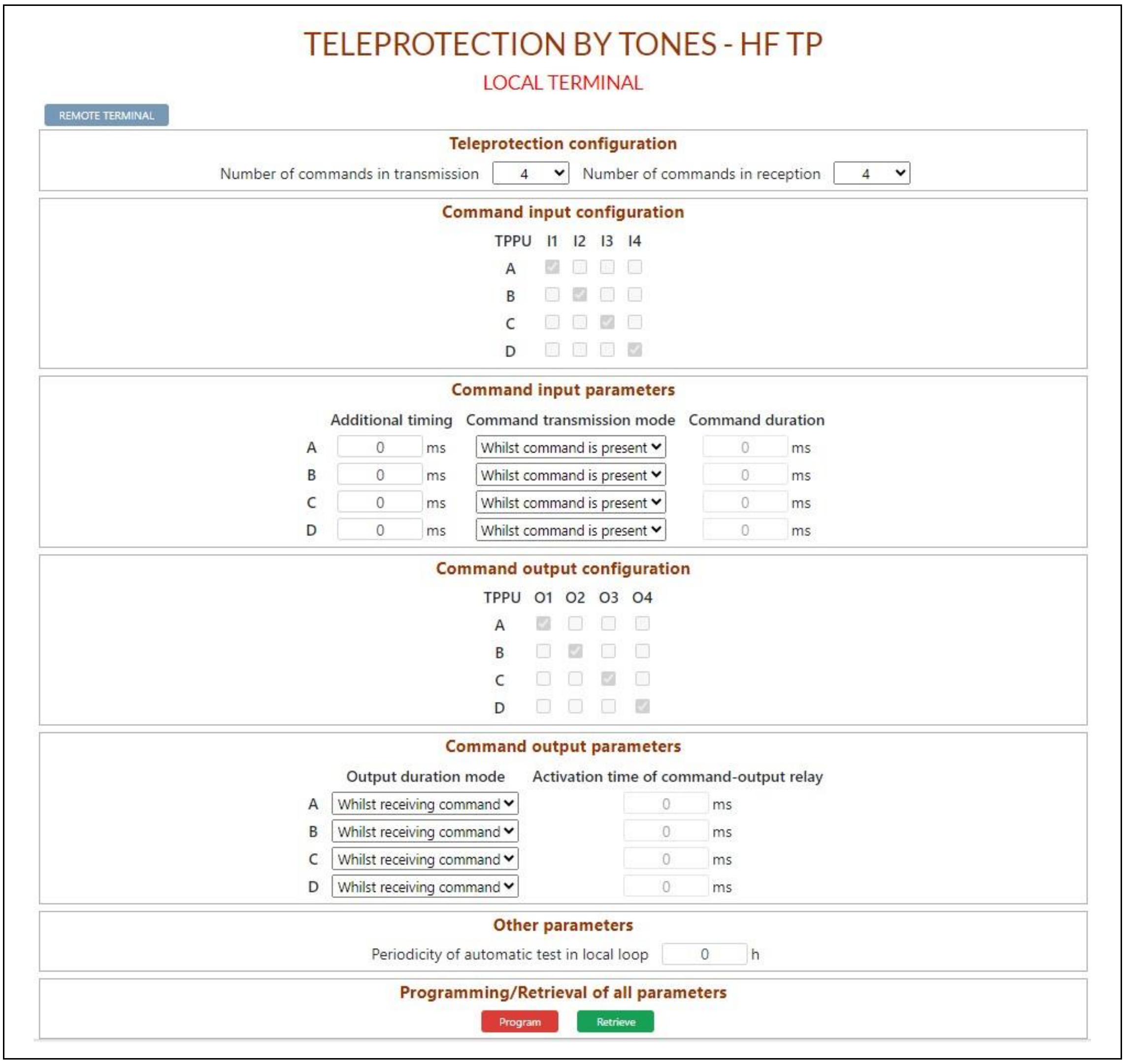


Figure 7.39 Inputs and Outputs page example (4 commands).

7.3.11.b Teleprotection

It allows the teleprotection *bandwidth* and the *guard* frequency, both in transmission and reception, to be selected.

It allows the transmission time to be set in accordance with the programmed scheme (*Direct tripping, Permissive tripping and Blocking*).

It also allows the activation and deactivation thresholds for the low signal-to-noise ratio alarm to be configured.

- If the same configuration is desired for transmission and reception, the **USE SYMMETRICAL CONFIGURATION FOR Tx-Rx** check box must be selected.
- When pressed, the **FREQUENCY SELECTION** command button displays the list of possible frequencies.

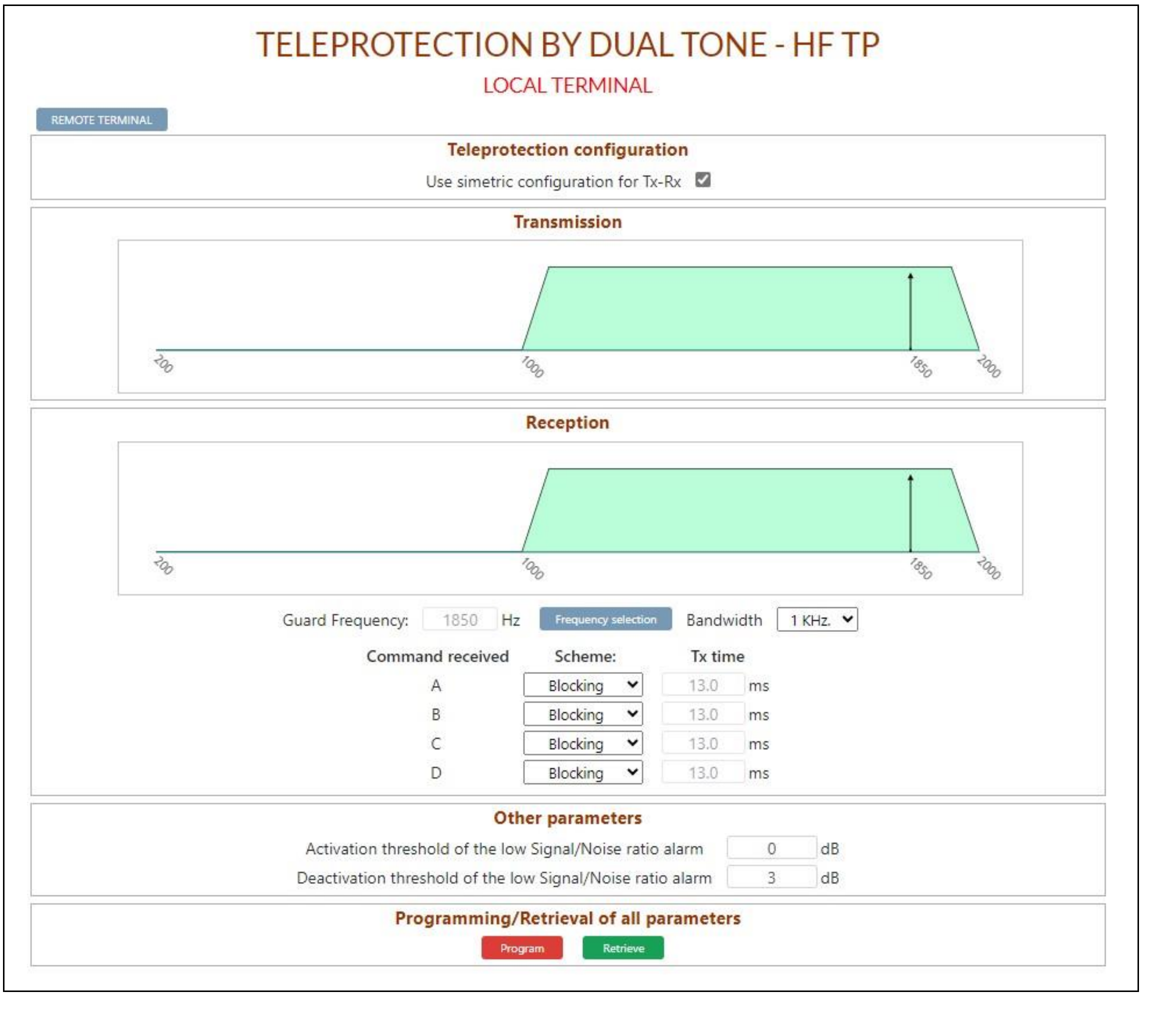


Figure 7.40 Teleprotection option.

7.3.11.c Relays

It allows the operation of the **two** relays of the **TPPU** module to be programmed.

If a relay interface (**REPU**) module is installed, it also allows the operation of the **seven** additional relays to be programmed.

The relays can be configured for:

- Command transmission signalling (A, B, C and D).
- Command output circuit activation signalling (1, 2, 3 and 4).
- Alarm signalling, the following being available: *Receiver blocking, Signal loss, Low Signal/Noise ratio, Incorrect guard signal level, Local test failure and Device error*.

It is not possible to configure a relay for both signalling and alarm.

When the conditions are selected, a **relay activation timing** between **0** and **60** s must be programmed. This timing is used as a security measure as, once configured, the relay will not be activated until it is verified that the configured condition is really satisfied during the programmed time.

*The relays programmed for **signalling** are in **rest condition** in normal operation, that is, contacts **C** and **N.C.** are closed.*

*The relays programmed for **alarm** are **energized** in normal operation, that is, contacts **C** and **N.O.** are closed.*

***C**: Common **N.C.**: Rest (normally closed) **N.O.**: Working (normally open)*

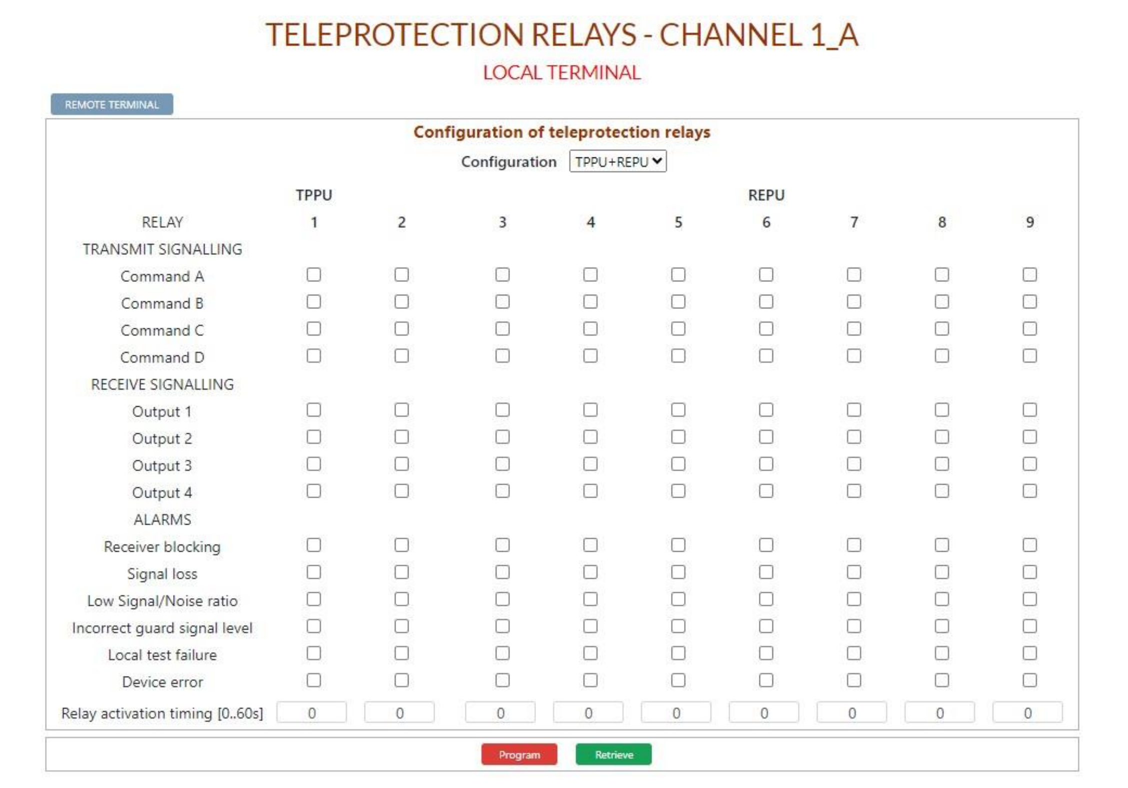


Figure 7.41 Relays option.

7.4 Configuration menu - Digital part

7.4.1 QAM digital configuration

It displays the digital channel configuration that was set from the *Basic equipment* option.

It allows the modulation percentages associated with the **QAM** and **pilot** signals to be configured.

It allows the type of modules of the optional internal multiplexer to be configured.

It also allows the configuration of the Signal/Noise ratio value that will deactivate and activate the low S/N alarm.

- The **deactivation threshold** specifies the S/N ratio above which the alarm is deactivated.
- The **activation threshold** specifies the value below which the alarm is activated.

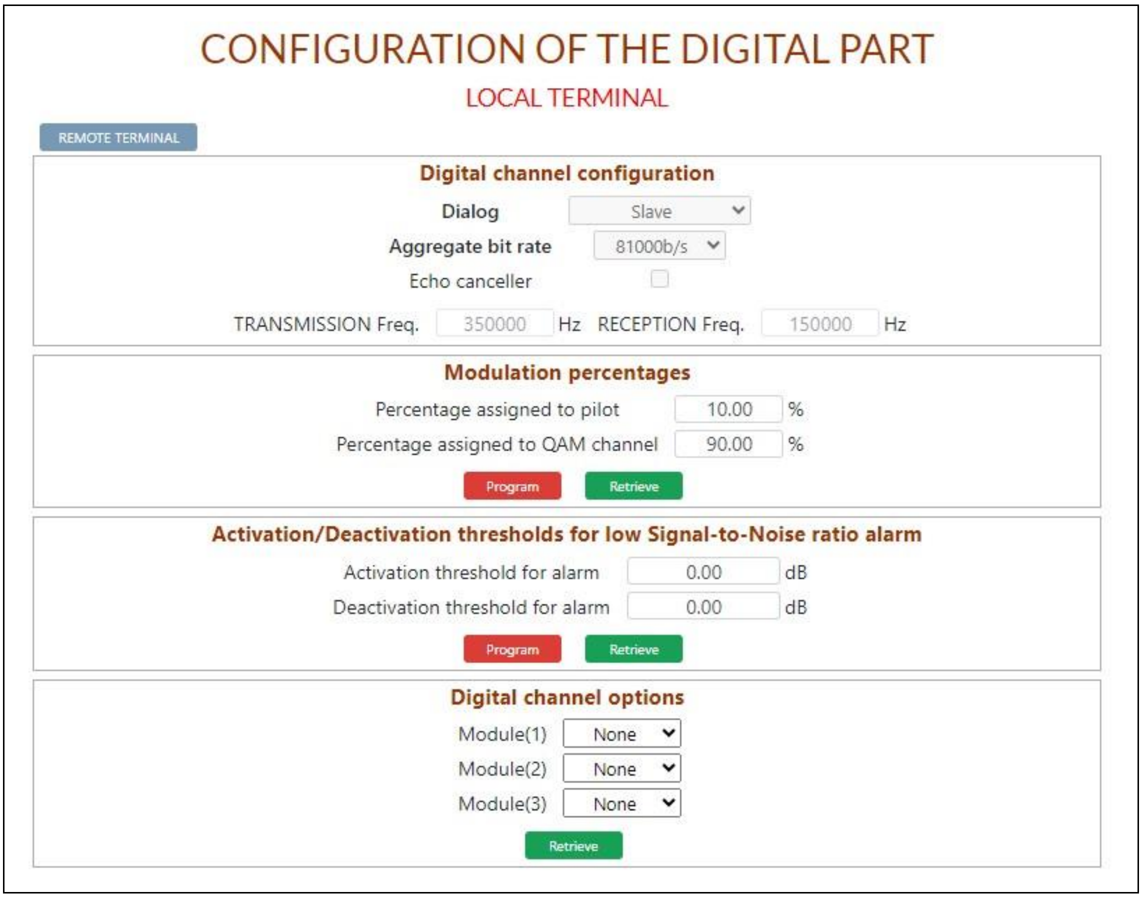


Figure 7.42 Digital configuration page example (QAM).

The optional internal multiplexer of the **OPU-1** terminal consists of up to three modules. Each of the three **MODULE** list box allows the type of module to be selected.

- Using only **DMPU** modules, the number of data ports can be extended to a total of twenty, belonging two of the data ports to the basic equipment and the remaining eighteen to the three optional **DMPU** modules.
- Using only **TMPU** modules, in addition to the two data ports of the basic equipment, the number of ports can be extended with six speech ports and with three data ports, all of them of the three **TMPU** modules.

Six ports are reserved per module.

The ports remain reserved although there is no associated physical port. In this way:

- ***P3** to **P8** are reserved for module (**1**)*
- ***P9** to **P14** are reserved for module (**2**)*
- ***P15** to **P20** are reserved for module (**3**)*

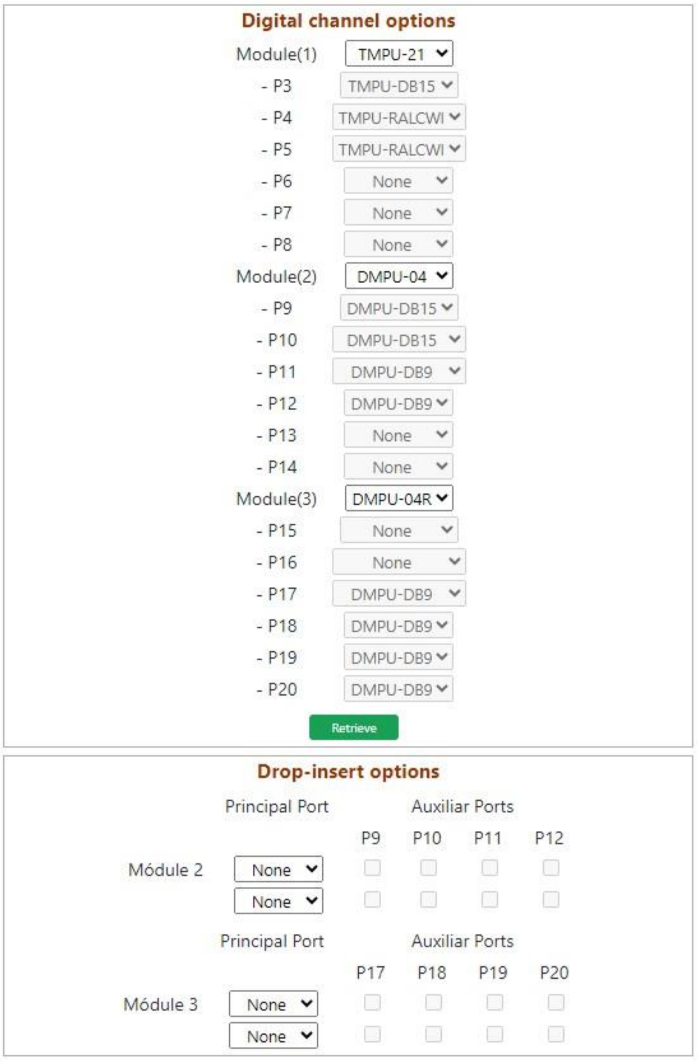


Figure 7.43 Configuration example of multiplexer modules.

An example of drop-insert function

The main application of the **drop-insert** is the transmission of a *polling* message from a central unit to various RTUs and the reception of the response from the interrogated RTU.

The **drop-insert** is therefore a configuration suitable for half duplex point-to-multipoint structures and *polling* systems.

The **drop-insert** function allows the port incoming information (*main port*) to be replicated in various destination ports (*auxiliary ports*). In the example, the required modules that are to be configured are: a **DMPU.06**, a **DMPU.04**, and a **DMPU.02**.

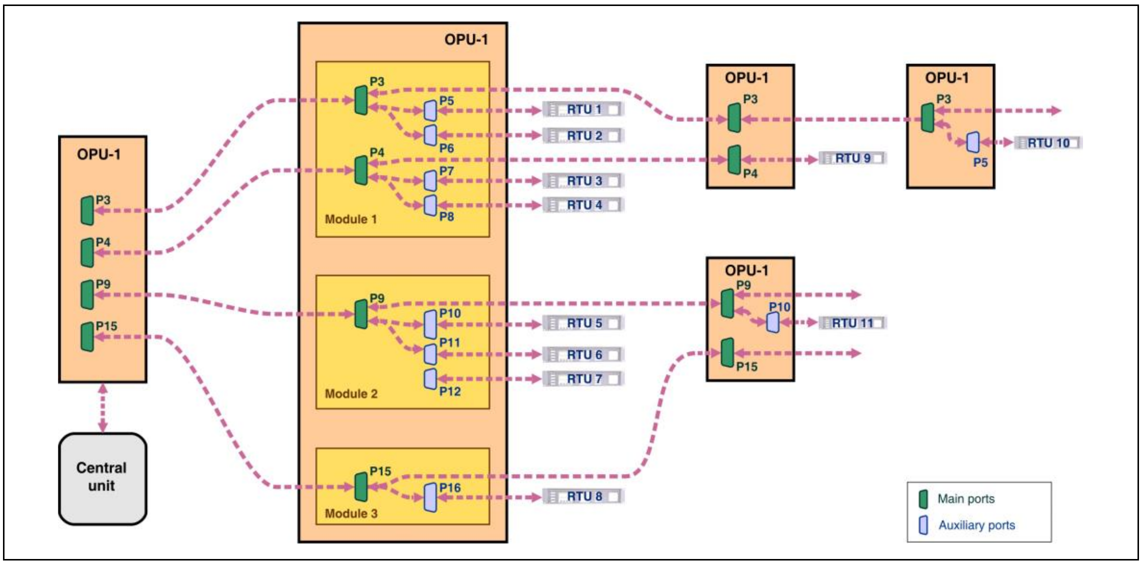


Figure 7.44 An example of drop-insert function.

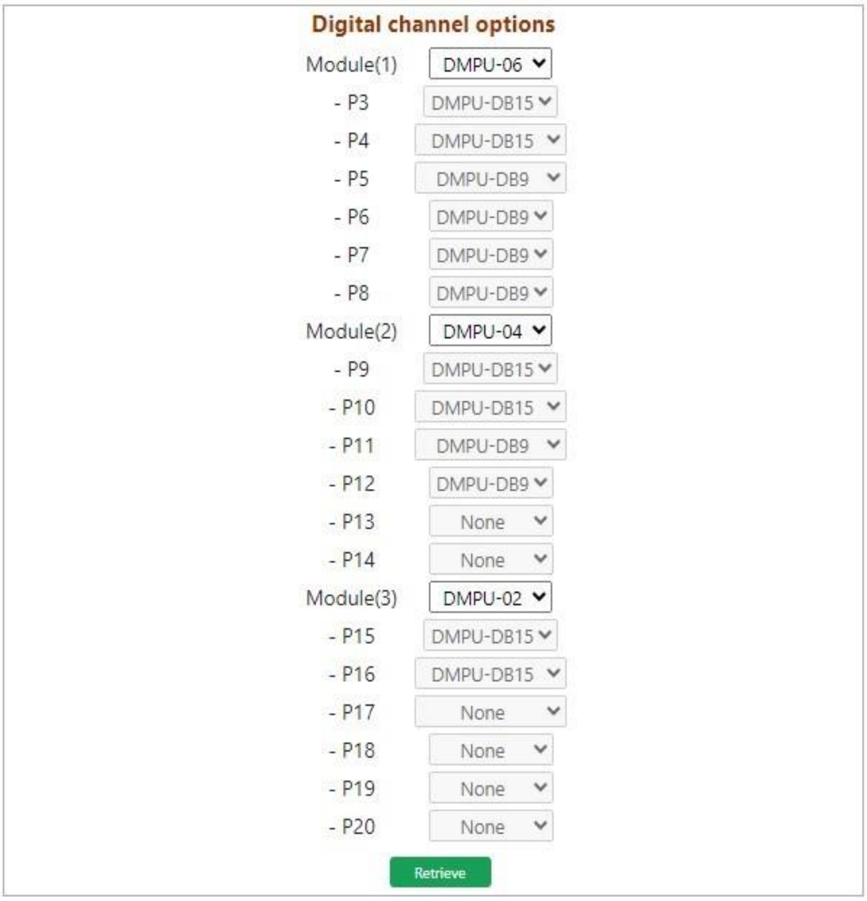


Figure 7.45 Required modules according to the drop-insert example.

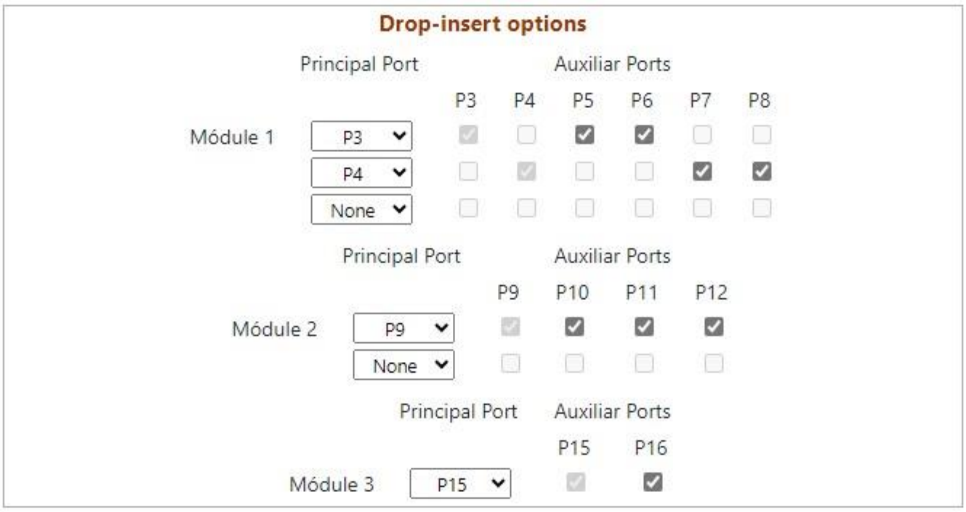


Figure 7.46 Main and auxiliary ports according to the drop-insert example.

7.4.2 OFDM digital configuration

It displays the digital channel configuration that was set from the *Basic equipment* option.

It allows the type of modules of the optional internal multiplexer to be configured.

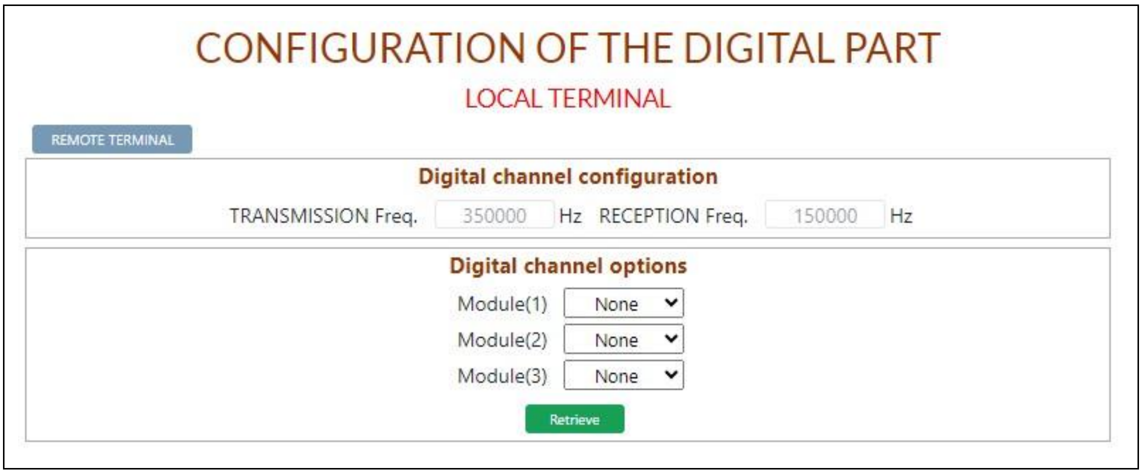


Figure 7.47 Digital configuration page example (OFDM).

The optional internal multiplexer of the **OPU-1** terminal consists of up to three modules. Each of the three **MODULE** list box allows the type of module to be selected.

- Using only **DMPU** modules, the number of data ports can be extended to a total of twenty, belonging two of the data ports to the basic equipment and the remaining eighteen to the three optional **DMPU** modules.
- Using only **TMPU** modules, in addition to the two data ports of the basic equipment, the number of ports can be extended with six speech ports and with three data ports, all of them of the three **TMPU** modules.

Six ports are reserved per module.

The ports remain reserved although there is no associated physical port. In this way:

- ***P3** to **P8** are reserved for module (**1**)*
- ***P9** to **P14** are reserved for module (**2**)*
- ***P15** to **P20** are reserved for module (**3**)*

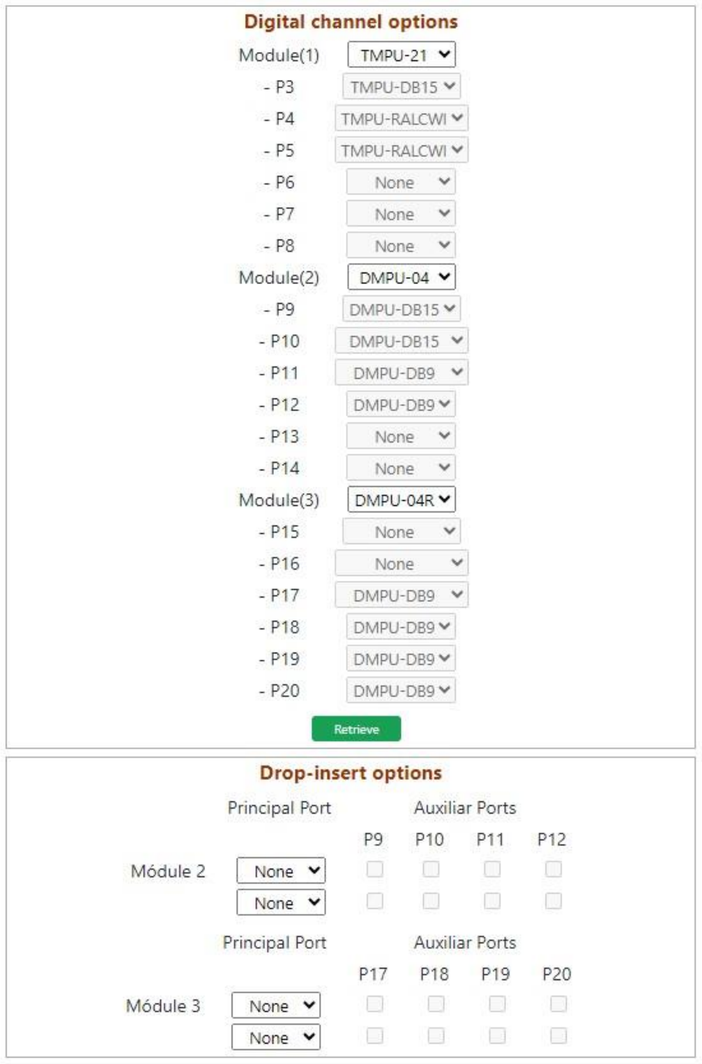


Figure 7.48 Configuration example of multiplexer modules.

An example of drop-insert function

The main application of the **drop-insert** is the transmission of a *polling* message from a central unit to various RTUs and the reception of the response from the interrogated RTU.

The **drop-insert** is therefore a configuration suitable for half duplex point-to-multipoint structures and *polling* systems.

The **drop-insert** function allows the port incoming information (*main port*) to be replicated in various destination ports (*auxiliary ports*). In the example, the required modules that are to be configured are: a **DMPU.06**, a **DMPU.04**, and a **DMPU.02**.

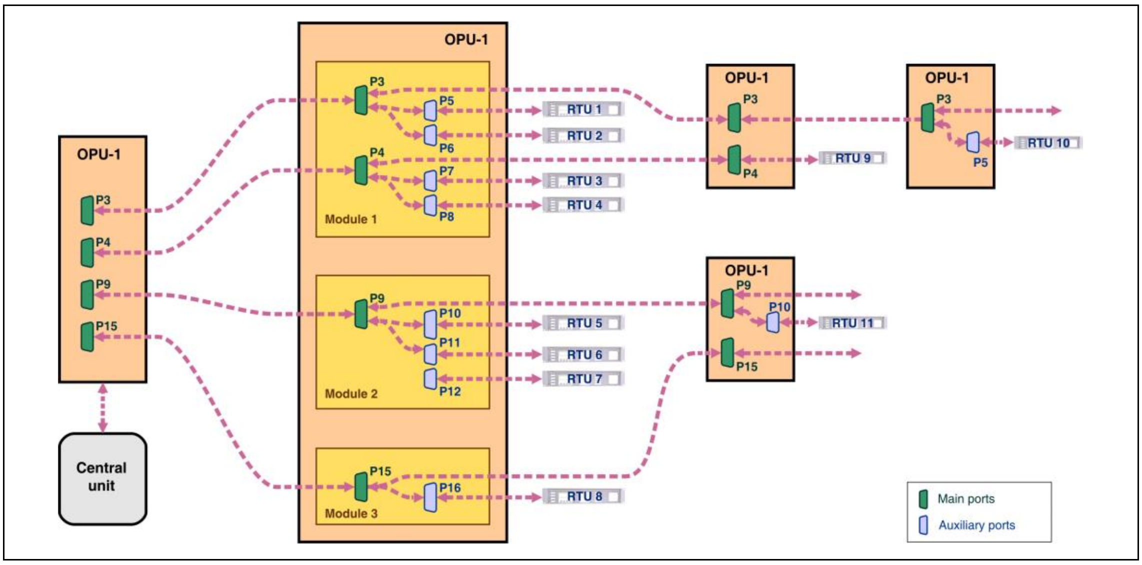


Figure 7.49 An example of drop-insert function.

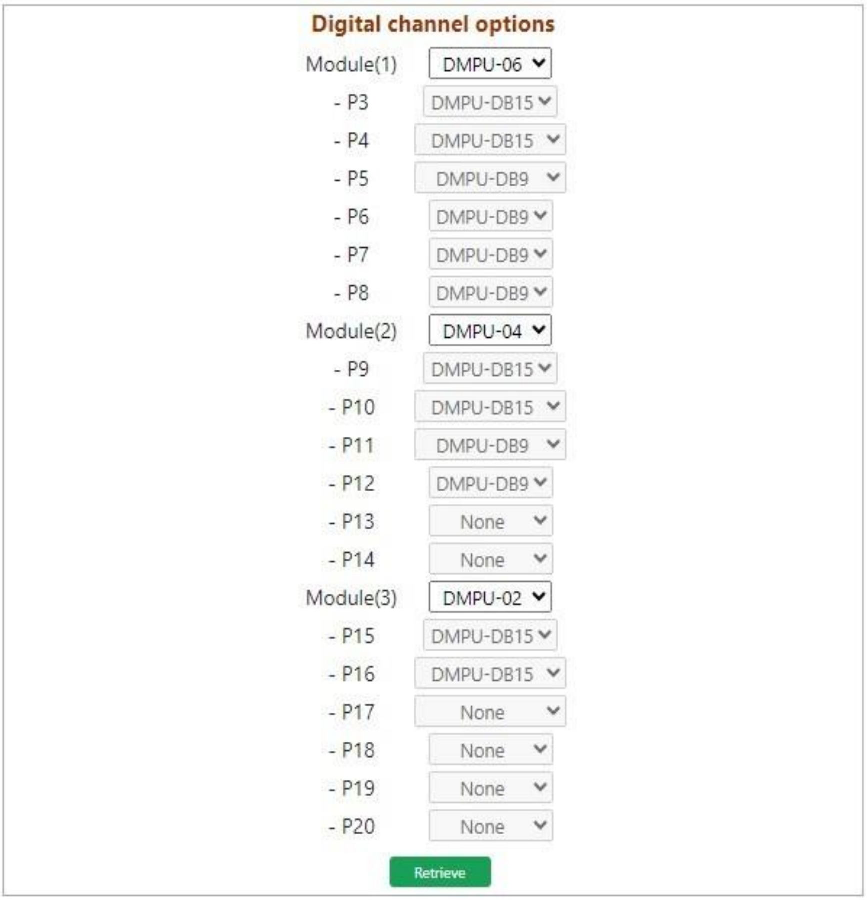


Figure 7.50 Required modules according to the drop-insert example.

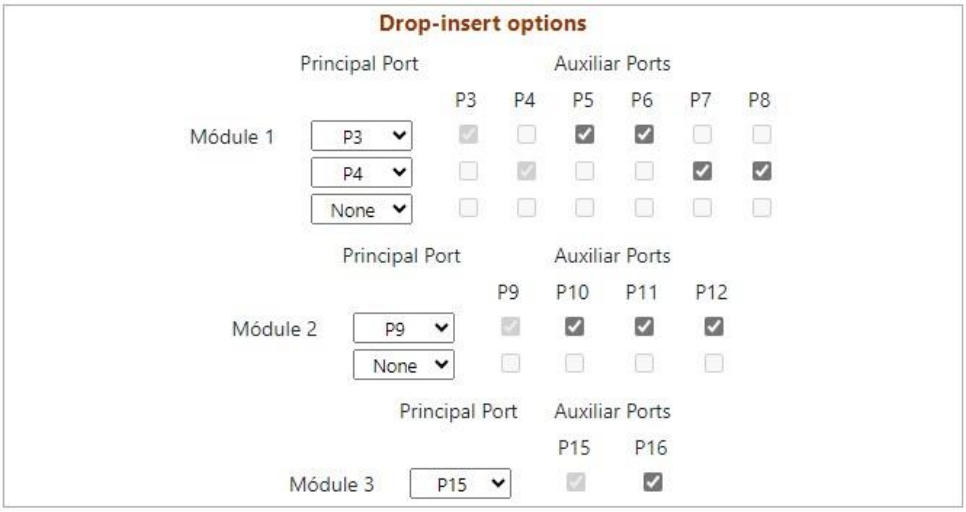


Figure 7.51 Main and auxiliary ports according to the drop-insert example.

7.4.3 Multiplexer configuration

Once the type of each of the three possible multiplexer modules is configured, port configuration is carried out from this option.

To see graphically the occupation of the ports in the corresponding frame (**QAM** or **OFDM**), a different colour is associated with each port. The first bit of each frame (S) is used for the frame synchronism and the second (C) for the internal service channel.

The **P1** and **P2** ports, integrated into the **MQPU** module, are the two basic ports of the **OPU-1** terminal.

*The **P1** port corresponds to a synchronous data port with interface ITU-T **G.703** codirectional at **64** kbit/s.*

*The **P2** port corresponds to an asynchronous data port with interface ITU-T **V.24/V.28** of up to **14400** bit/s.*

Ports **P3** to **P20** are associated with the multiplexer modules.

The **MQPU** module also has two Ethernet interfaces that work as a part of a two-port hub with bridge-link functionality. The **ETH BRIDGE** is enabled by default. This means that it has an assigned position in the internal frame, being able to transmit information by using the remaining bits of the frame.

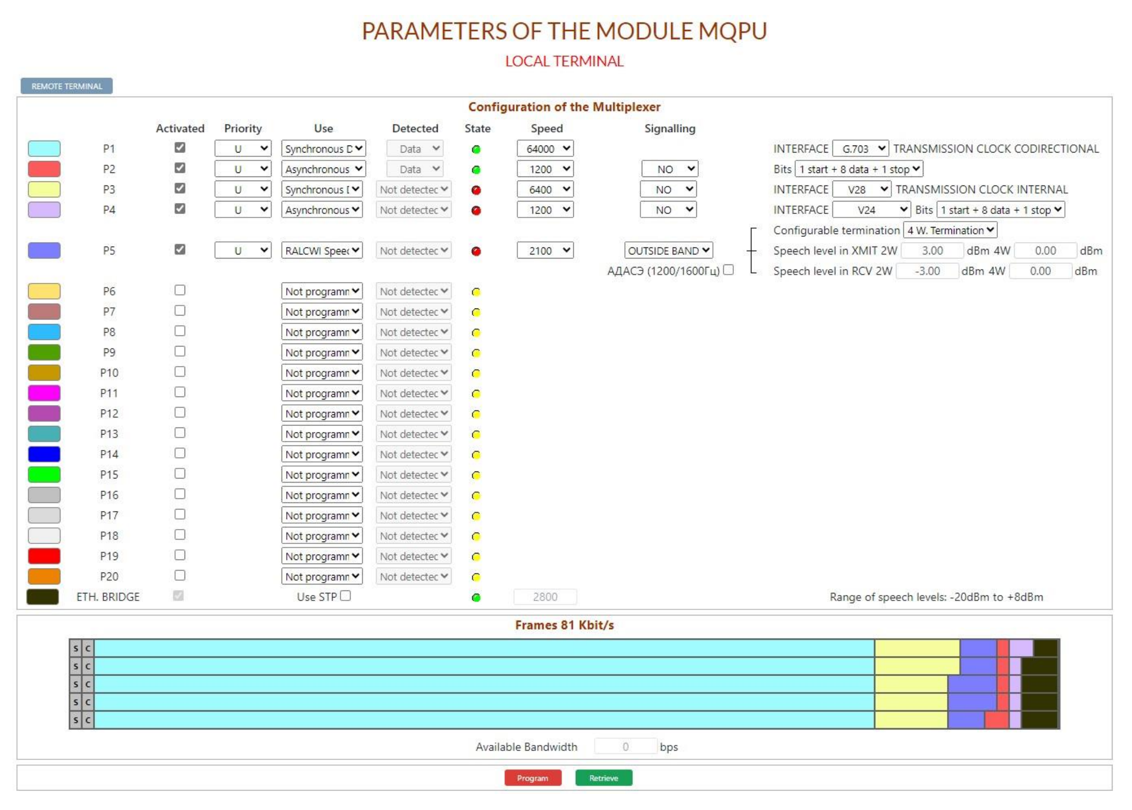


Figure 7.52 Multiplexer page example.

- The non-installed ports are shown as *Not detected*, with the associated **STATE** indicator in yellow.

- When a configured port is activated, if it is not physically installed in the terminal, the indicator **STATE** lights up in red.

- When a configured port is deactivated (unmarked *Activated* check box), it does not lose its assigned position in the internal frame and, if it physically installed, only stops transmitting information.

Synchronous data port

When programming a synchronous data port, it is necessary to specify speed, type of interface and, if required, to establish an associated channel in the port for signalling (RTS and DCD).

- The selection of the *Yes* in the **SIGNALLING** list box involves the use of one bit of the internal frame. For **QAM**, signalling will occupy **200** bit/s (gross bit rate of **81** kbit/s), **100** bit/s (gross bit rate of **40.5** kbit/s) or **66** bit/s (gross bit rate of **27** kbit/s).

- With respect to speed, the range of possible values is a function of the gross bit rate. For **QAM**, at **81** kbit/s and **40.5** kbit/s, the value range is comprised between **600** bit/s and **38400** bit/s and, at **27** kbit/s, between **600** bit/s and **19200** bit/s.

Asynchronous data port

When programming an asynchronous data port, it is necessary to specify speed, type of interface, data bits and stop bits, and, if required, to establish an associated channel in the port for signalling (RTS and DCD).

- The selection of the *Yes* in the **SIGNALLING** list box involves the use of one bit of the internal frame. For **QAM**, signalling will occupy **200** bit/s (gross bit rate of **81** kbit/s), **100** bit/s (gross bit rate of **40.5** kbit/s) or **66** bit/s (gross bit rate of **27** kbit/s).

- With respect to speed, the range of possible values is a function of the gross bit rate. For **QAM**, at **81** kbit/s and **40.5** kbit/s, the value range is comprised between **50** bit/s and **28800** bit/s and, at **27** kbit/s, between **50** bit/s and **19200** bit/s.

- The data format is: START BIT + DATA BITS + STOP BITS = **8**, **9**, **10** or **11** bits/character.
  If a format with parity bit is used, the parity bit must be contained in the data bit field.

Anisochronous data port

To transmit anisochronous data, a synchronous channel is used with a standard speed, which is ten times higher than the one selected.

The anisochronous data is not referred to any clock signal and has no format. The transitions take place at random moments. Therefore, the speed to be programmed should correspond to the speed that permits the minimum pulse time to be transmitted.

- The **SIGNALLING** list box allows an associated channel for signalling (RTS and DCD) to be configured in the port. The selection of signalling (*Yes*) involves the use of one bit of the internal frame. For **QAM**, signalling will occupy **200** bit/s (gross bit rate of **81** kbit/s), **100** bit/s (gross bit rate of **40.5** kbit/s) or **66** bit/s (gross bit rate of **27** kbit/s).

Speech port (RALCWI)

When programming a **RALCWI** speech port, it is necessary to specify speed (**2100** bit/s, **2450** bit/s or **2800** bit/s), termination type, and speech levels in transmission and reception (-**20** dBm to +**8** dBm).

- With respect termination type, it is possible: **4** wire, **2** wire, 2-wire exchange side (**FXO**) or 2-wire subscriber side (**FXS**).
  2-wire operating mode, either exchange side or subscriber side, requires the use of signalling.

- The **SIGNALLING** list box sets an associated channel for signalling (E&M wires) in the port, *Out-of-Band*.

7.5 Monitoring menu – Basic equipment

7.5.1 Display of alarms

This page monitors the state of the alarms of the **OPU-1** terminal. The number of alarms depends on the configured work mode.

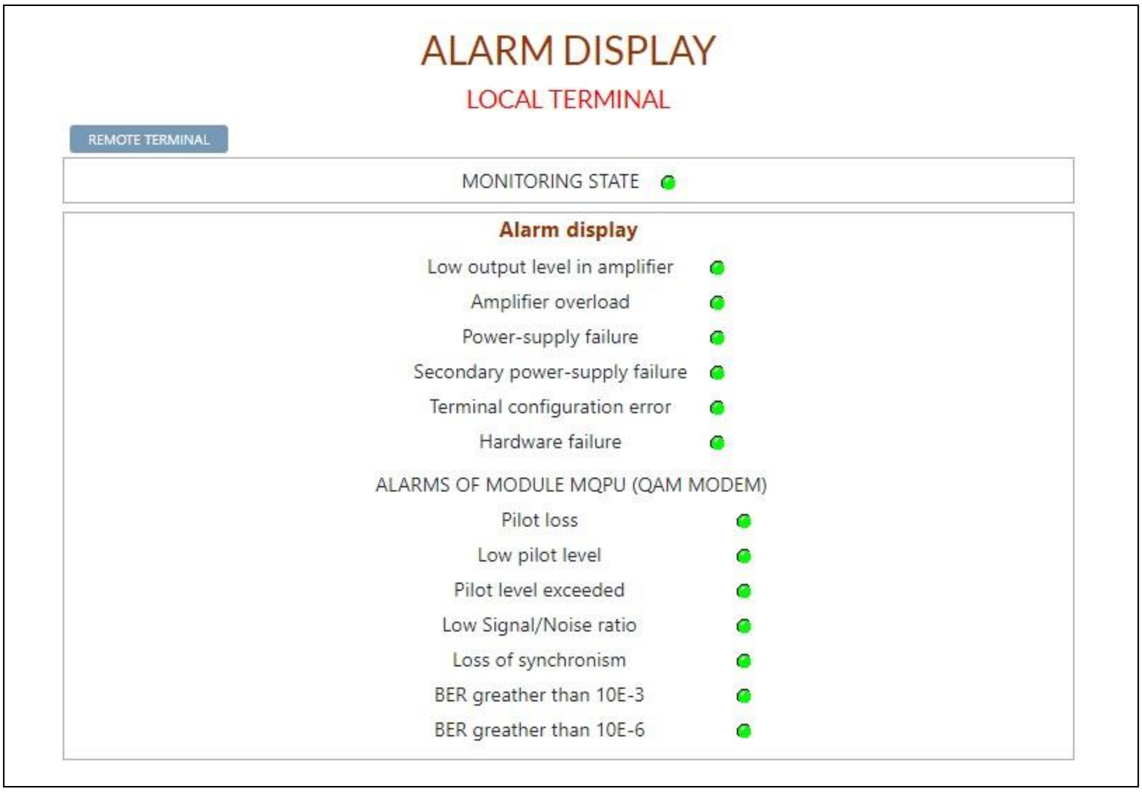


Figure 7.53 Display of alarms page example (Digital work mode).

7.5.1.a General alarms

The control in the form of **LED** is shown in **green** if there are no alarm presence, and in **red** in an alarm situation.

- **Low output level in amplifier**.
  This alarm indicates failure of the line amplifier module due to low transmission level.
- **Amplifier overload**.
  This alarm indicates failure of the line amplifier due to overload.
- **Loss of synchronism**.
  This alarm activates when the **MOPU** module detects that the synchronism of the link has been lost. This alarm can only appear in a terminal programmed to operate with synchronism.
  With synchronism, the terminal uses its internal oscillator as the master transmission clock and synchronizes its reception with the other terminal using the pilot received.
- **Power-supply failure**.
  This alarm indicates that any of the power-supply voltages of the main power-supply is not within the correct range.
- **Secondary power-supply failure**.
  This alarm only appears when the terminal operates with redundant power-supply, that is, when it is equipped with two power-supply (**FAPU**) modules.
  This alarm indicates that any of the power-supply voltages of the secondary power-supply is not within the correct range.
- **Terminal configuration error**.
  This alarm activates when the **MOPU** module detects that any of the configuration parameters is corrupt but can possibly be recovered by reprogramming.
- **Hardware failure**.
  This alarm activates when the **MOPU** module detects a hardware failure due to a communication failure with the DSP, the options or the **IOPU** module.
  Each type of failure has an associated code:

  0 General hardware error.
  1 Serious error in configuration parameters.
  2 Communication failure with IOPU module.
  3 Failure of any of the DSPs.
  4 Power-supply failure in simple options.
  5 Teleprotection module failure - channel 1.
  6 Teleprotection module failure - channel 2.

7.5.1.b Alarms associated with an analog channel

The control in the form of **LED** is shown in **green** if there are no alarm presence, and in **red** in an alarm situation.

- **Pilot loss - channel 1.**
  This alarm activates when **MOPU** module detects that the pilot of channel 1 has been lost in reception.
- **Pilot loss - channel 2.**
  Exactly the same as the previous one but referring to channel 2.
- **Low S/N ratio - channel 1.**
  This alarm activates when the **MOPU** module detects that the S/N ratio in channel 1 is below the specified threshold.
- **Low S/N ratio - channel 2.**
  Exactly the same as the previous one but referring to channel 2.
- **L.F. limiter action - channel 1.**
  This alarm activates when the low frequency input, associated with channel 1, is higher than the programmed values.
- **L.F. limiter action - channel 2.**
  Exactly the same as the previous one but referring to channel 2.

7.5.1.c Alarms associated with a digital channel

The control in the form of **LED** is shown in **green** if there are no alarm presence, and in **red** in an alarm situation.

- **Pilot loss.**
  This alarm activates when the **MQPU** module detects that the pilot has been lost in reception.
- **Low pilot level.**
  This alarm activates when the **MQPU** module detects that the pilot has low level.
- **Pilot level exceeded.**
  This alarm activates when the **MQPU** module detects that the pilot has high level.
- **Low Signal/Noise ratio.**
  This alarm activates when the **MQPU** module detects that the level of noise is too high.
- **Loss of synchronism.**
  This alarm activates when the **MQPU** module detects that frame synchronism has been lost, either due to excessive noise level in the channel, or because the link is interrupted.
- **BER greater than 10E-3.**
  This alarm activates when the error rate evaluated by the system is higher than the maximum error rate permitted. The link could be interrupted if the error rate does not improve.
- **BER greater than 10E-6.**
  It is considered to be a preventive alarm. This alarm activates when the system is not working in optimum conditions.

7.5.2 Chronological register

This option gives access to a page that displays the **chronological register** of the terminal.

There are two main types of logs identified as: *User* and *Cybersecurity*.

In *User* mode, the events related to the link service are registered, as well as the appearance and disappearance of alarms.

In *Cybersecurity* mode, the events related to cybersecurity are registered. This is: users who have accessed the **OPU-1**, users who have made an unsuccessful access attempt, users who have made a modification of the **OPU-1** programming, if the **OPU-1** terminal has been blocked because of incorrect passwords, if the management software has been updated, etc.

For each alarm or event, a brief description and the date (day, month and year) and hour (with minute, second and millisecond) that they occurred is presented.

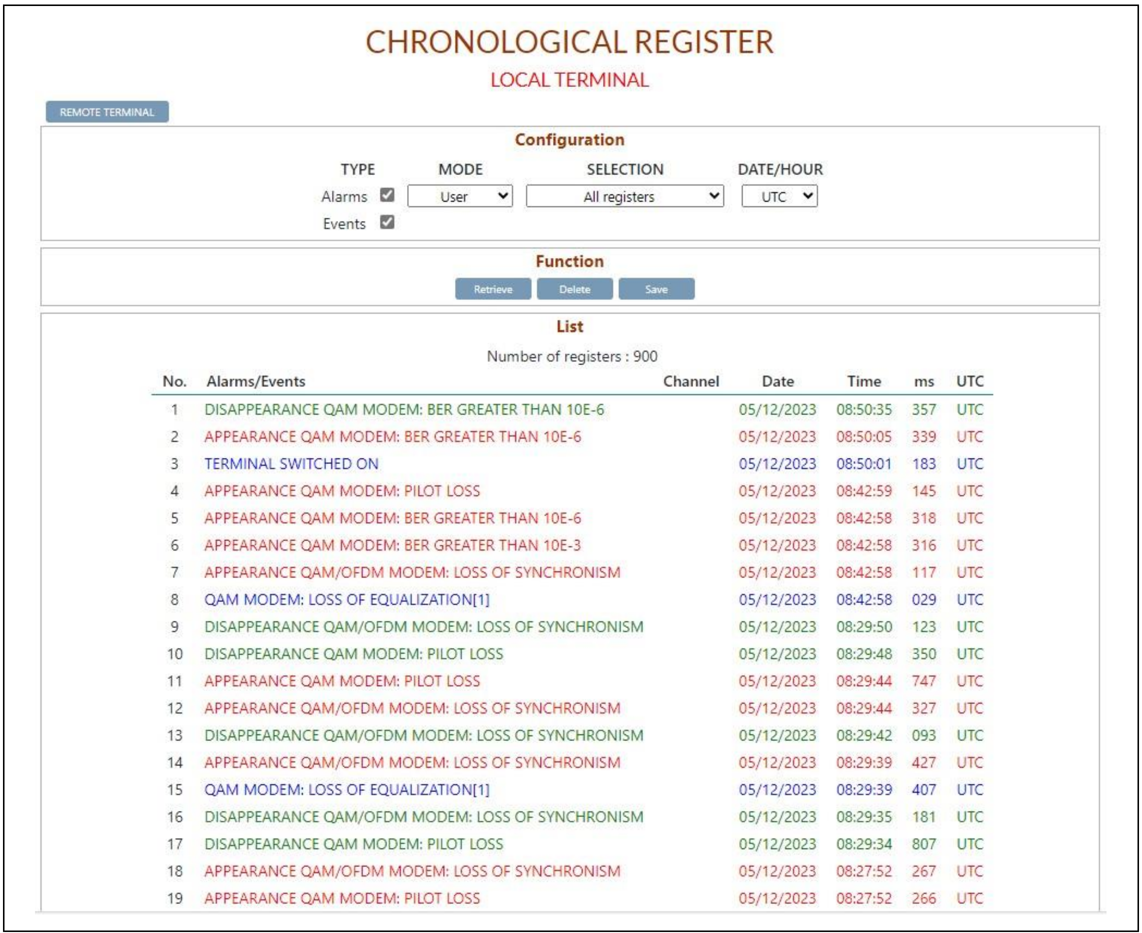
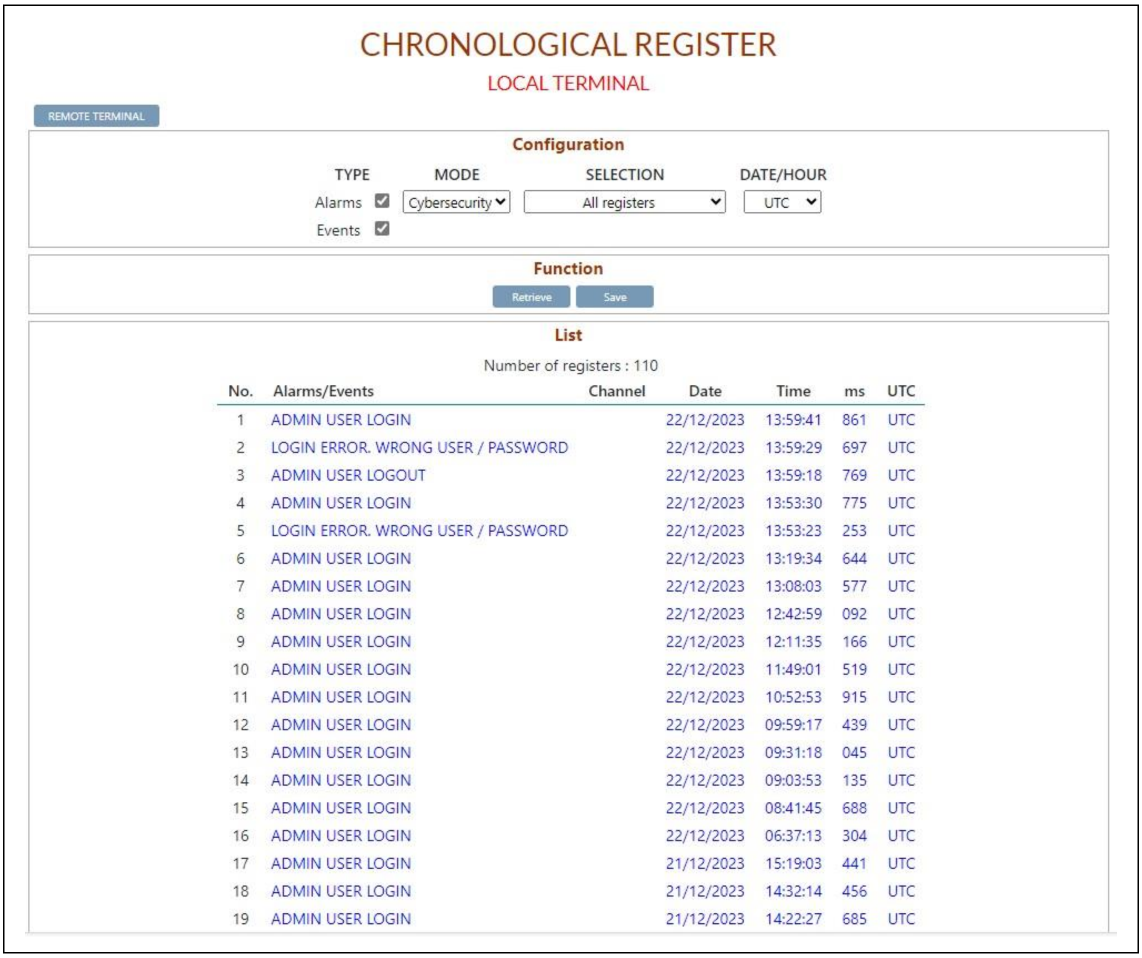


Figure 7.54 Chronological register page example (User mode).

- The type of logs to be displayed must be selected in the **MODE** control.
- The operation to carry out must be selected in the **FUNCTION** control.
  - The page contents can be displayed by pressing **RETRIEVE**.
  - The page contents can be stored in a text file by selecting **SAVE**.
  - The **DELETE** function is not possible in *Cybersecurity* mode.
- The parameters to be displayed must be selected in the **TYPE** control.
- In **SELECTION**, it is specified that the whole register will be presented or, specifically, by date and time or chronologically beginning with the last log.
  When date and time is selected, the controls for entering the **initial** date and time and the **final** date and time appear.
- In **DATE/HOUR**, it is specified that the information should be shown in LOCAL time or UTC time.
- The list of events and/or alarms that meet the selected criteria, as well as the total number of existing logs, is displayed in the **LIST** area.



No.	Alarms/Events	Channel	Date	Time	ms	UTC
1	ADMIN USER LOGIN		22/12/2023	13:59:41	861	UTC
2	LOGIN ERROR. WRONG USER / PASSWORD		22/12/2023	13:59:29	697	UTC
3	ADMIN USER LOGOUT		22/12/2023	13:59:18	769	UTC
4	ADMIN USER LOGIN		22/12/2023	13:53:30	775	UTC
5	LOGIN ERROR. WRONG USER / PASSWORD		22/12/2023	13:53:23	253	UTC
6	ADMIN USER LOGIN		22/12/2023	13:19:34	644	UTC
7	ADMIN USER LOGIN		22/12/2023	13:08:03	577	UTC
8	ADMIN USER LOGIN		22/12/2023	12:42:59	092	UTC
9	ADMIN USER LOGIN		22/12/2023	12:11:35	166	UTC
10	ADMIN USER LOGIN		22/12/2023	11:49:01	519	UTC
11	ADMIN USER LOGIN		22/12/2023	10:52:53	915	UTC
12	ADMIN USER LOGIN		22/12/2023	09:59:17	439	UTC
13	ADMIN USER LOGIN		22/12/2023	09:31:18	045	UTC
14	ADMIN USER LOGIN		22/12/2023	09:03:53	135	UTC
15	ADMIN USER LOGIN		22/12/2023	08:41:45	688	UTC
16	ADMIN USER LOGIN		22/12/2023	06:37:13	304	UTC
17	ADMIN USER LOGIN		21/12/2023	15:19:03	441	UTC
18	ADMIN USER LOGIN		21/12/2023	14:32:14	456	UTC
19	ADMIN USER LOGIN		21/12/2023	14:22:27	685	UTC

Figure 7.55 Chronological register page example (Cybersecurity mode).

7.6 Monitoring menu – Analog part

7.6.1 S/N ratio

This page presents the value of Signal/Noise ratio for channel **1** and, if applicable, for channel **2**.

The S/N ratio is referred to a total-band signal with a modulation percentage of 100%.

It also indicates if an alarm state exists for low Signal/Noise ratio and pilot loss.

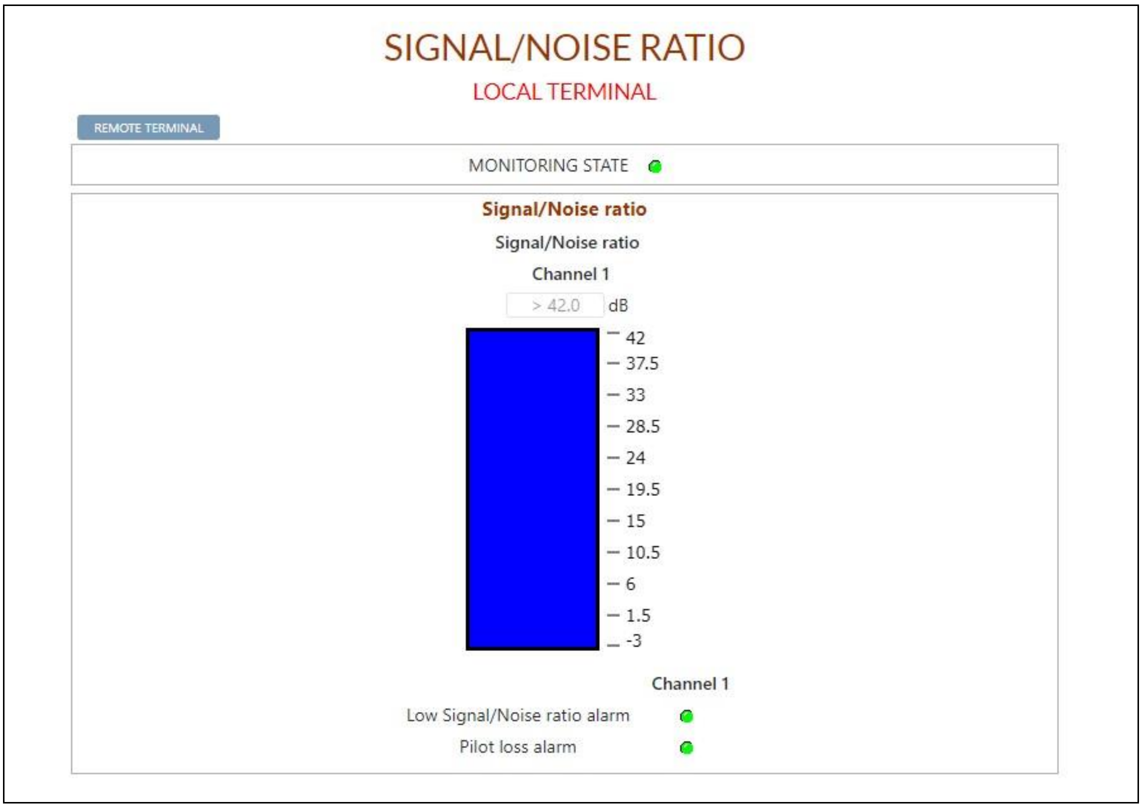


Figure 7.56 Signal/Noise ratio page example.

7.6.2 Received pilot level

This page presents the level of the received pilot signal for channel **1** and, if applicable, for channel **2**.

It also indicates if an alarm state exists for pilot loss.

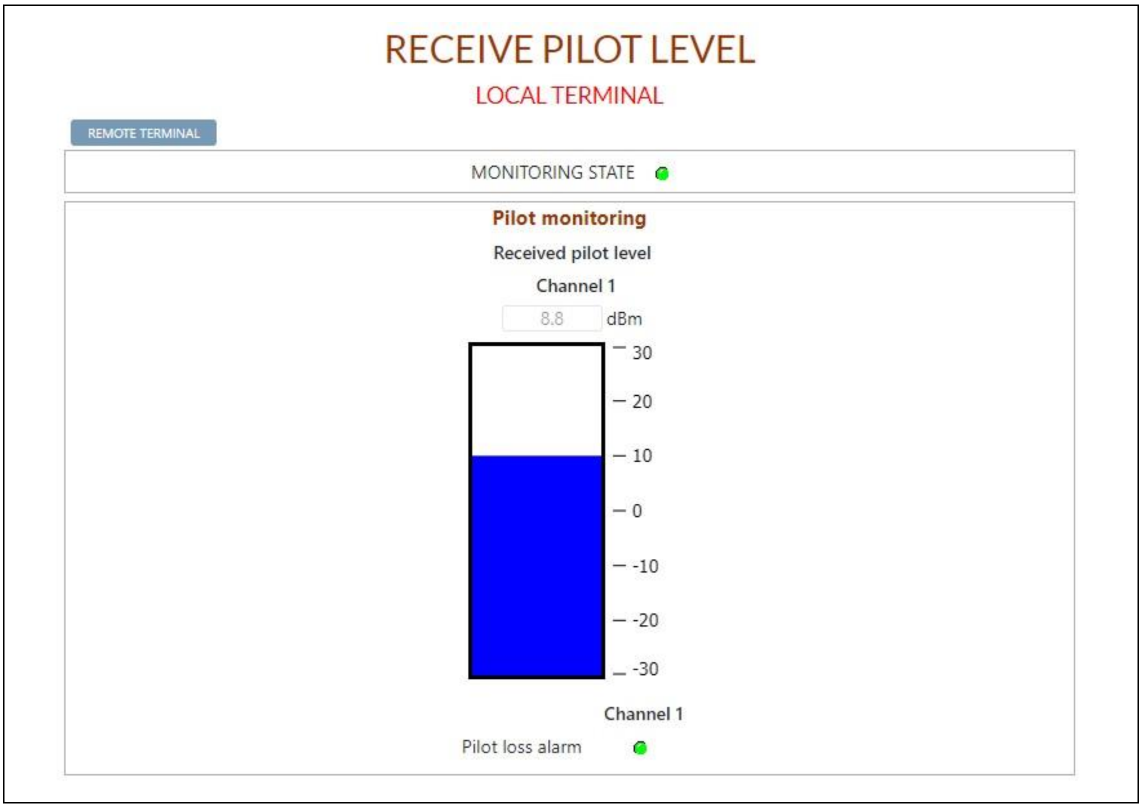


Figure 7.57 Received pilot level page example.

7.6.3 Speech monitoring

This option is associated with the speech (**TDPU.20**) module.

It displays the configurable termination that was set from the speech configuration option.

It also indicates, by means of a marked box:

- if the handset is plugged.
- if connection exists in subscriber 1.
- if the compandor is included.

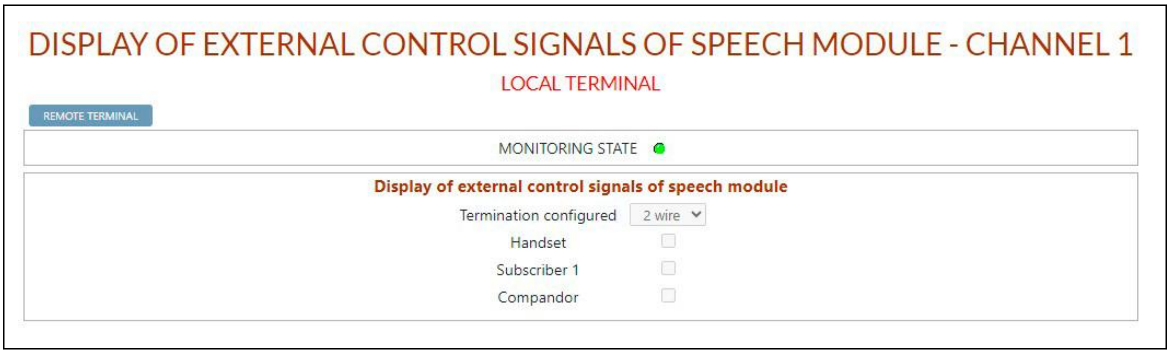


Figure 7.58 State of external control signals option (TDPU.20).

7.6.4 Teleprotection by DUAL tone

7.6.4.a Signal/Noise ratio

This option is associated with the teleprotection (**TPPU**) module.

It displays the value of Signal/Noise ratio.

The S/N ratio measurement is performed by evaluating the noise present in the band configured for the teleprotection. The relation is set with respect to the nominal guard level assuming, in addition, that the noise measured in the guard channel is uniform in a bandwidth of **4** kHz.

It also indicates if an alarm state exists for low Signal/Noise ratio and signal loss.

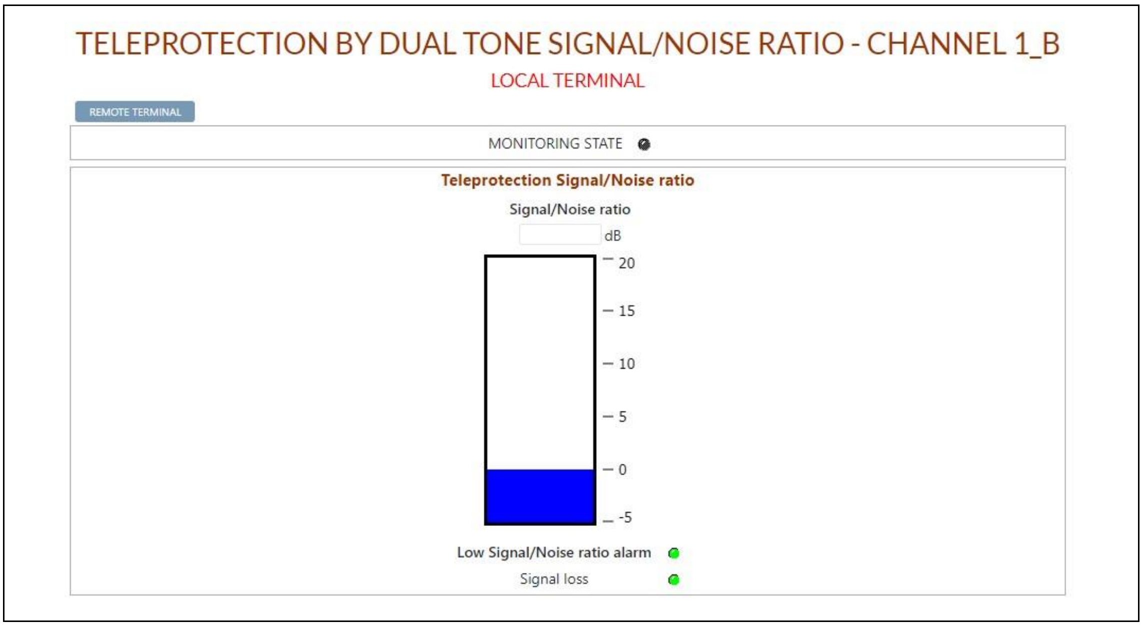


Figure 7.59 Signal/Noise ratio option (TPPU).

7.6.4.b State

This option is associated with the teleprotection (**TPPU**) module.

It displays the state of the transmitted command counters and that of the received command counters.

It displays the state of the counters of number of command input activations and that of the counters of number of command output activations.

It also indicates, by means of a marked box:

- if command inputs (**I1**, **I2**, **I3** and **I4**) and outputs (**O1**, **O2**, **O3** and **O4**) are active.
- if a command (**A**, **B**, **C** and **D**) is being transmitted or received.

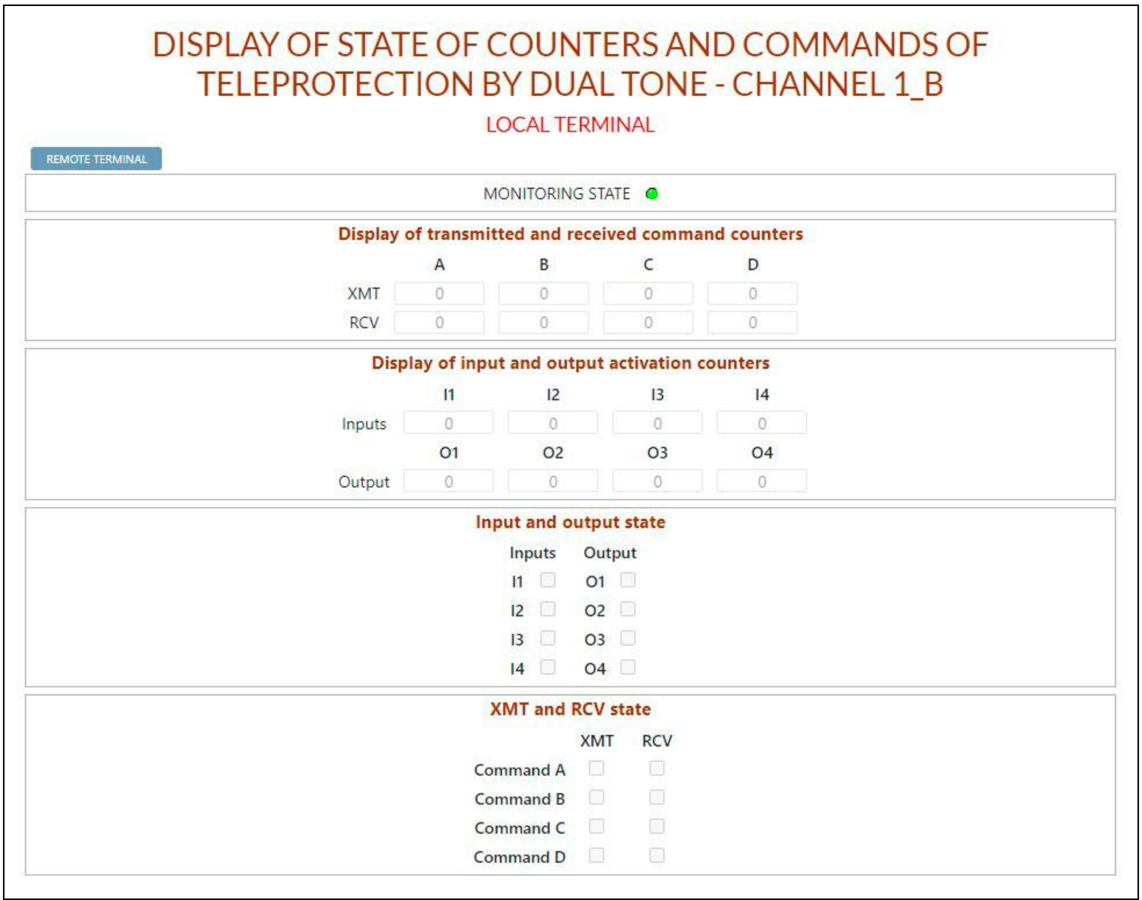


Figure 7.60 State option (TPPU).

7.6.4.c Display of alarms

This page monitors the state of the alarms of the teleprotection (**TPPU**) module.

The control in the form of **LED** is shown in **green** if there are no alarm presence, and in **red** in an alarm situation.

Figure 7.61 Display of alarms option (TPPU).

- **Receiver blocking.**
  This alarm is generated when the receiver blocks due to any of the following:
  - The command output circuits, protection side, have been blocked from the Management System.
  - The guard signal received is below the prefixed minimum level and **50** ms have elapsed without a trip command being received.
  - After starting the terminal, **500** ms have elapsed without the guard signal being received.

  For the receiver to be unblocked, guard must be received for at least **50** ms.

  If a blocking situation occurs for a time longer than **500** ms, the guard signal must be received for at least **2.5** s.

- **Signal loss.**
  This alarm is generated due to any of the following:
  - After the disappearance of the guard signal, **50** ms have elapsed without a command signal being received.
  - After starting the terminal, no signal is received for more than **500** ms.

- **Low Signal/Noise ratio.**
  This alarm is generated when the Signal/Noise ratio in reception is lower than the value specified in the programming (*Command configuration* option).
- **Low guard level.**
  This alarm is generated when the received guard-signal level is **5** dB below the programmed nominal level.
- **Excessive guard level.**
  This alarm is generated when the received guard-signal level exceeds the programmed nominal level by **6** dB.
- **Local test failure.**
  This alarm is generated when the local loop test is not correct.
- **Device error.**
  This alarm is generated when hardware failure is detected in the **TPPU** module due to failure of the FLASH memory, EEPROM memory or RTC device.
- **Manual blocking.**
  This alarm is generated when the blocking of the terminal is forced from the Management System (*Output blocking* option of the *Teleprotection* submenu of the *Alignment help* menu).
- **Erroneous configuration data.**
  This alarm is generated when the **TPPU** module, after the self-check process carried out when the power supply is connected, detects a failure in the configuration parameters.

7.6.4.d Chronological register

This option gives access to a page that displays the chronological register associated with the teleprotection **(TPPU)** module.

There are two main types of logs identified as: *User* and *Cybersecurity*.

In *User* mode, the events related to the teleprotection link service are registered, as well as the appearance and disappearance of alarms.

In *Cybersecurity* mode, the events related to cybersecurity are registered.

For each alarm or event, a brief description and the date (day, month and year) and hour (with minute, second and millisecond) that they occurred is presented.

- The type of logs to be displayed must be selected in the **MODE** control.
- The operation to carry out must be selected in the **FUNCTION** control.
  - The page contents can be displayed by pressing **RETRIEVE**.
  - The page contents can be stored in a text file by selecting **SAVE**.
  - The **DELETE** function is not possible in *Cybersecurity* mode.
- The parameters to be displayed must be selected in the **TYPE** control.
- In **SELECTION**, it is specified that the whole register will be presented or, specifically, by date and time or chronologically beginning with the last log.
  When date and time is selected, the controls for entering the **initial** date and time and the **final** date and time appear.
- In **DATE/HOUR**, it is specified that the information should be shown in LOCAL time or UTC time.
- The list of events and/or alarms that meet the selected criteria, as well as the total number of existing logs, is displayed in the **LIST** area.

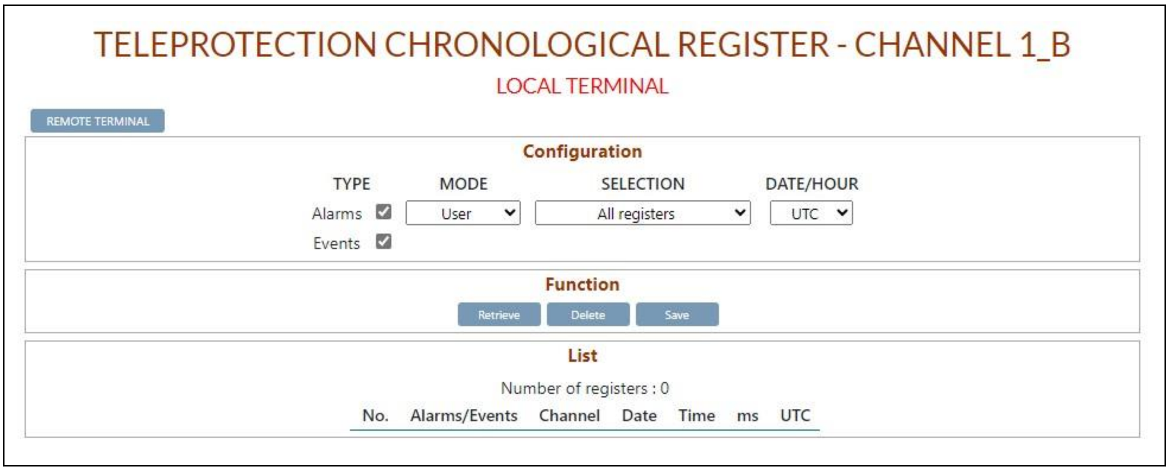


Figure 7.62 Chronological register option (TPPU).

7.7 Monitoring menu – Digital part

7.7.1 Multiplexer state

This page monitors the state of the data and speech ports of the **OPU-1** terminal.

Data ports

The page associated with the *Data* option monitors the state of the **MQPU** data ports and, if installed, that of the multiplexer data ports.

Data port signalling can be supervised by means of the **DCD**, **RTS**, **CTS** and **DSR** indicators.

Speech ports

The page associated with the *Speech* option monitors the state of the multiplexer speech ports, as long as they are installed in the equipment.

Speech port signalling can be supervised by means of the **E** and **M** indicators.

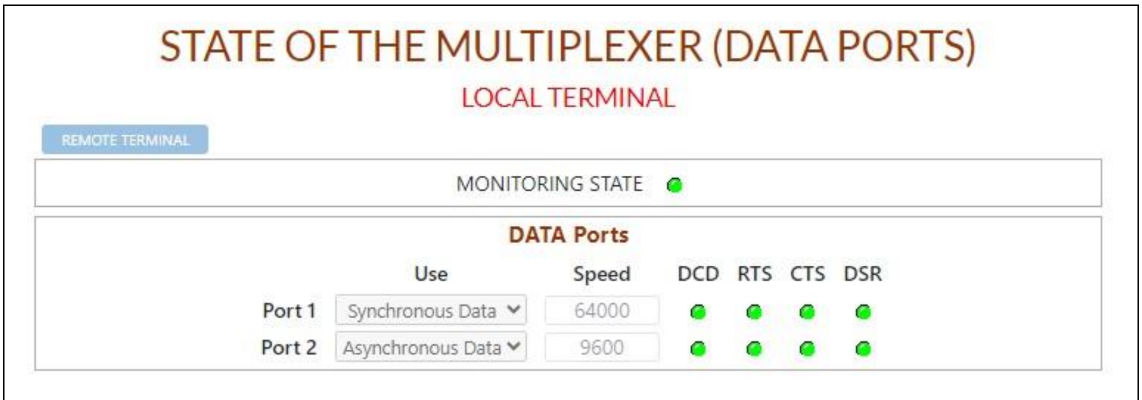


Figure 7.63 Multiplexer state page example (Data ports).

7.7.2 G.821 statistics

For **QAM**, this page presents an evaluation of the quality of the link based on the **G.821** standard concepts.

- **NUMBER OF SECONDS OF COMMUNICATION AVAILABLE** shows the number of seconds in which, according to the G.821 standard concepts, the connection was available after the last statistics reset or terminal reset.
- **NUMBER OF SECONDS FROM THE LAST RESET** shows the number of seconds that have elapsed since the last statistics reset or terminal reset.
- **NUMBER OF SECONDS WITH CONNECTION. (BER)** shows the number of seconds in which, for the bit error rate shown in the field BER, the connection was available after the last statistics reset or terminal reset.
- **BER (bit error rate)** shows the relation between the erroneous bits received and the total number of bits received after the last reset.
- **ES (errored second)** shows the total number of seconds with errors in which the connection was available after the last reset.
- **SES (severely errored second)** shows the total number of seconds with a lot of errors in which the connection was available after the last reset.

For the three previous, the calculation is based on the frame synchronism bit.

The calculation is initialized in case of terminal reset or statistics reset (**RESET OF THE G.821 STATISTIC** command button).

Figure 7.64 G.821 statistics page example (QAM).

7.7.3 Signal/Noise ratio

This page presents the value of Signal/Noise ratio.

- For **QAM**, the value is shown in a text box and in a bar type analogue indicator.
- For **OFDM**, the value is plotted on a curve.

It also indicates if an alarm state exists for low Signal/Noise ratio and synchronism loss.

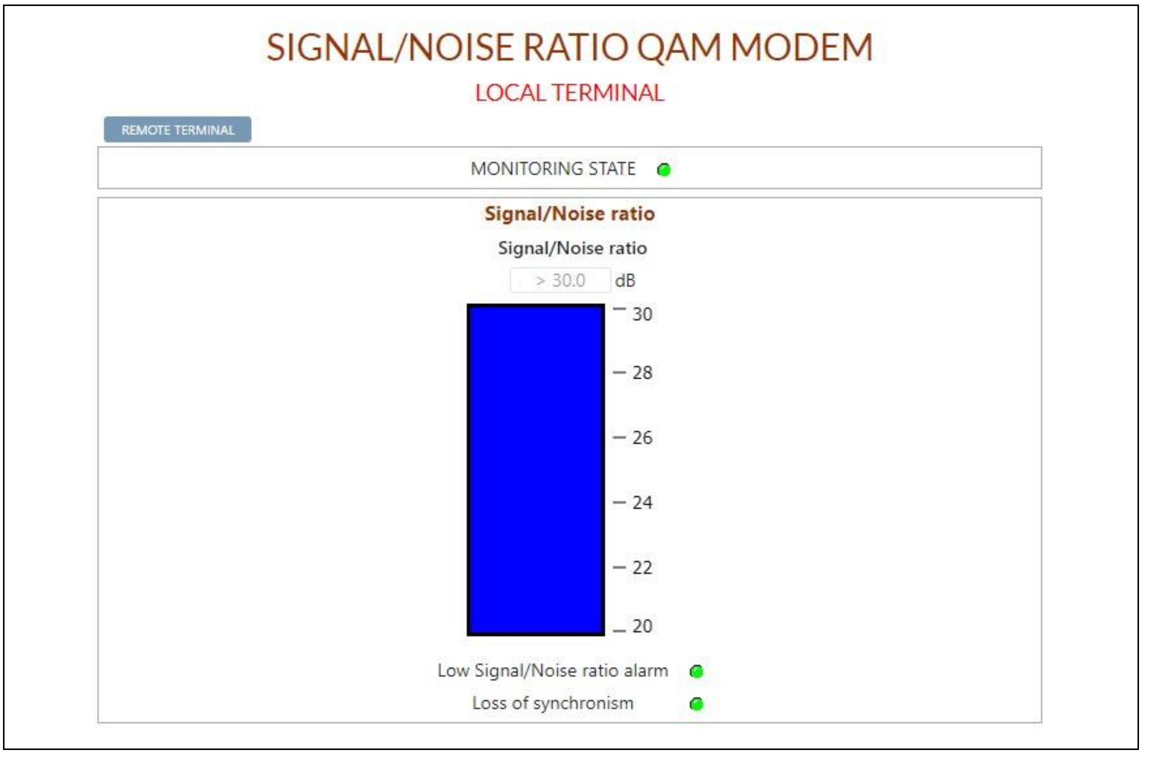


Figure 7.65 Signal/Noise ratio page example (QAM).

7.7.4 Received pilot level

This page presents the level of the received pilot signal.

It also indicates if an alarm state exists for synchronism loss.

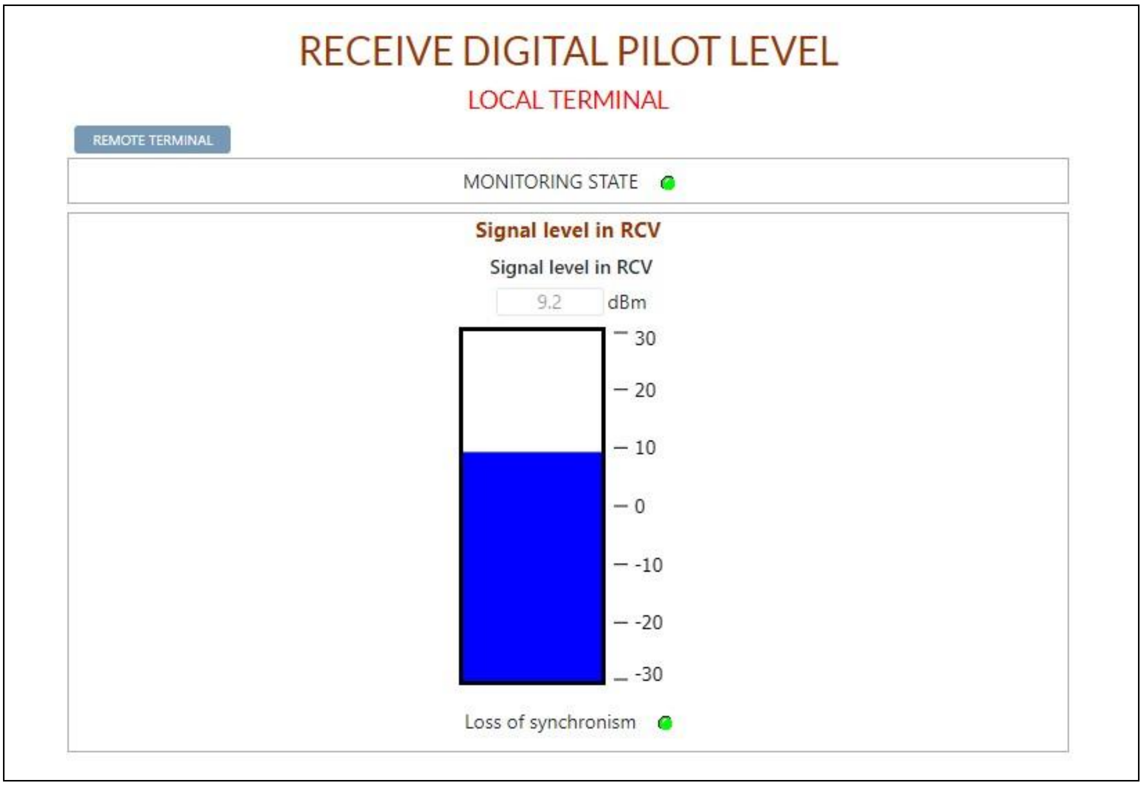


Figure 7.66 Received pilot level page example.

7.8 Alignment help menu – Basic equipment

7.8.1 Setting the clock

It allows an external synchronization reference to be configured.

It allows the date and time of the internal clock of the **OPU-1** to be programmed.

The **OPU-1** real time clock can be synchronized via the GPS (**IRIG-B**) system or **SNTP**.

When an external synchronization reference is used, the received time reference will always prevail over any time setting programming.

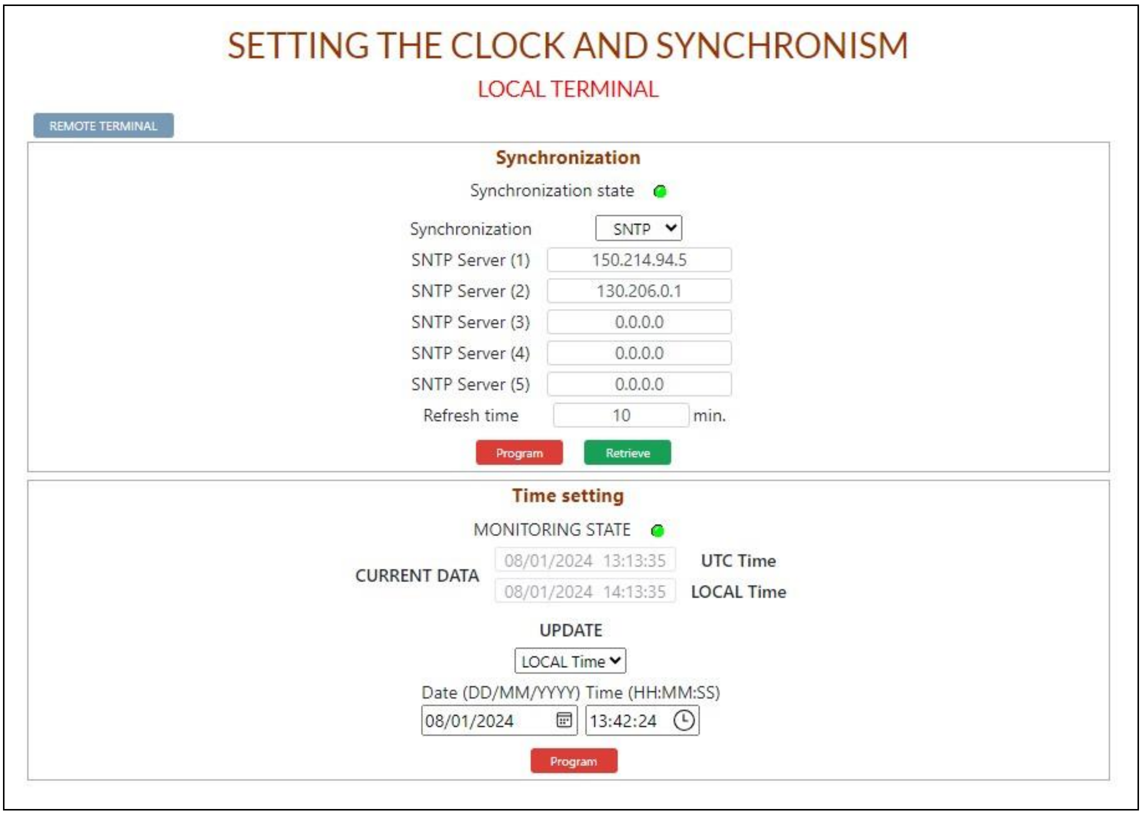


Figure 7.67 Setting the clock option.

In the **SYNCHRONIZATION** list box, the external synchronization reference is configured.

- When synchronization via **SNTP** is selected, it is possible to configure up to five addresses of **SNTP** servers.
- When synchronization via **IRIG-B** is selected, it is possible to select that the events relating to synchronization and internal-clock updating be saved in the chronological register.

To modify the date and time of the **OPU-1** clock, first of all, in the **UPDATE** field, it must be chosen between **UTC** time or **LOCAL** time. Both times are referenced to the **time zone** set in the management computer (PC).

Once the time reference is selected, the **date** (DD/MM/AAAA) and **time** data (HH:MM:SS) must be introduced in the corresponding fields.

7.8.2 Initializations

It allows the **OPU-1** terminal to be reset.

Depending on the configured work mode, it also allows certain operations to be carried out in the terminal such as Automatic Gain Control (AGC) circuit blocking and phase amplitude equalizer cancellation (**Analog** and **Mixed** work mode only).

The phase amplitude equalizer cancellation decreases the signal delay which can be useful, for example, when only working with teleprotection to obtain lower signal delays.

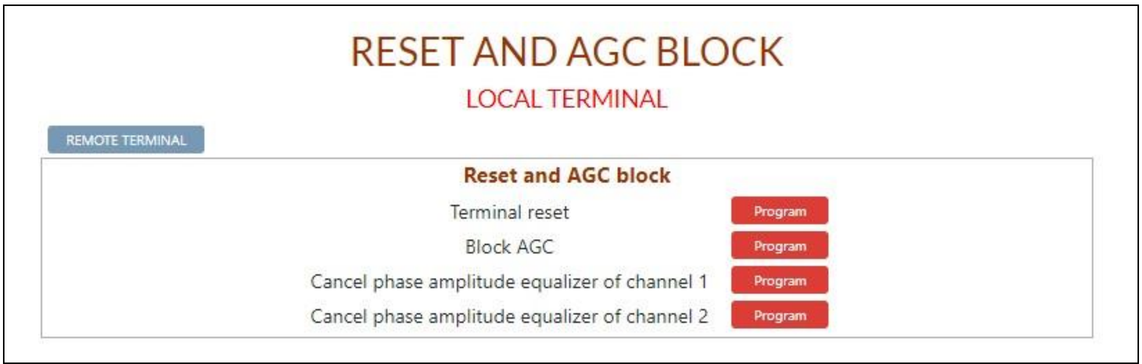


Figure 7.68 Initializations page example (Analog and Mixed work mode).

7.8.3 Receive-filter adjustment

This page is used to carry out the receive-filter adjustment, that is, adjust the inductances and, later, check the whole filter.

The adjustment procedure is described in detail in section 6.5.1, *Receive filter adjustment*, of chapter 6, *Commissioning*.

- First, the configuration values must be acquired from the **OPU-1** terminal by means of the **RETRIEVE** command button.
  Then, the **CONTINUE** command button must be pressed, after which a list box labelled **TYPE OF ADJUSTMENT** will appear where it is possible to select any of the options: *L3 inductance adjustment*, *L4 inductance adjustment* and *Whole filter*.

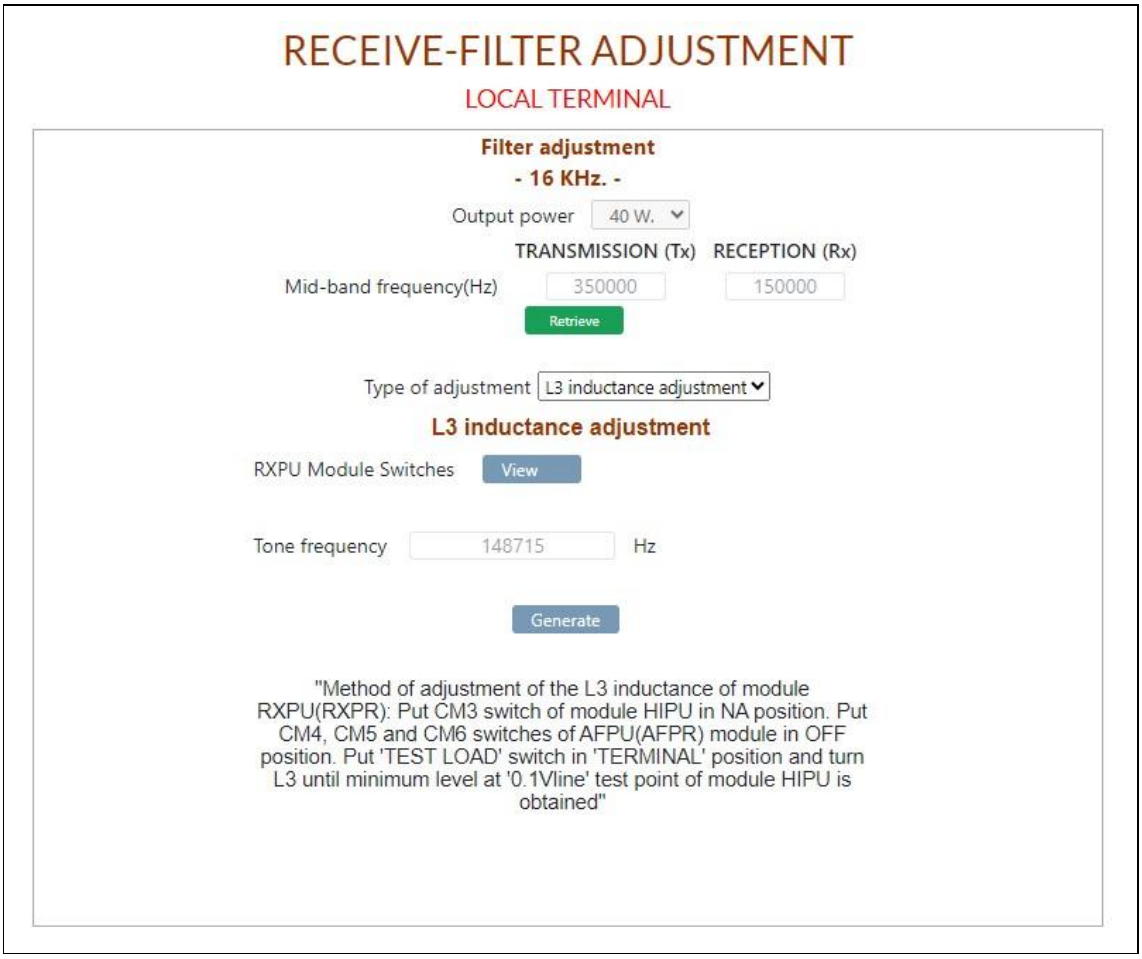


Figure 7.69 Receive-filter adjustment option.

7.8.4 Line-filter adjustment

This page is used to carry out the line-filter adjustment, that is, adjust the inductances and, later, check the whole filter.

The adjustment procedure is described in detail in section 6.5.3, *Line filter adjustment*, of chapter 6, *Commissioning*.

The adjustment procedure associated with the **HF Teleprotection functionality** is described in section 6.5.5, *Line filter adjustment (HF Teleprotection functionality)*, of chapter 6, *Commissioning*.

- First, the configuration values must be acquired from the **OPU-1** terminal by means of the **RETRIEVE** command button.
  Then, the **CONTINUE** command button must be pressed, after which a list box labelled **TYPE OF ADJUSTMENT** will appear where it is possible to select any of the options: *L1 inductance adjustment*, *L2 inductance adjustment* and *Whole filter*.
  In **HF Teleprotection functionality**, the options are: *L2 inductance adjustment* and *Whole filter*.

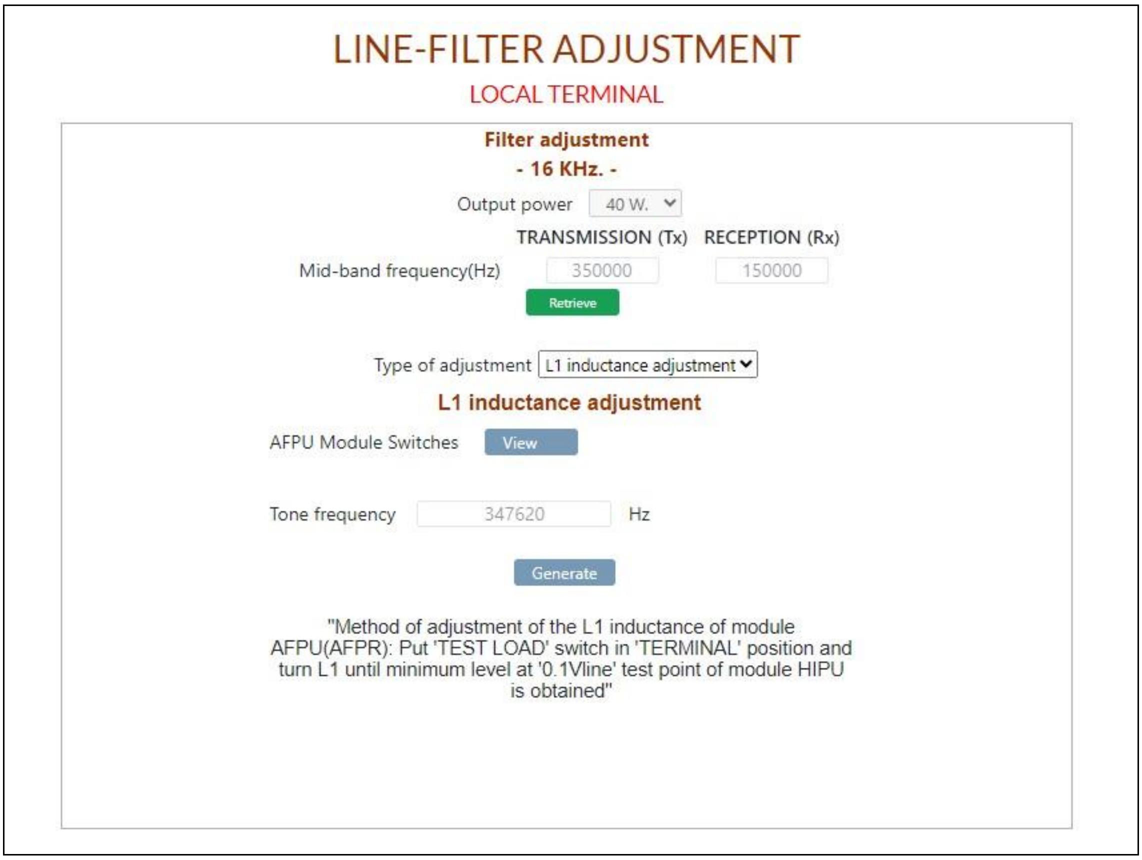


Figure 7.70 Line-filter adjustment option.

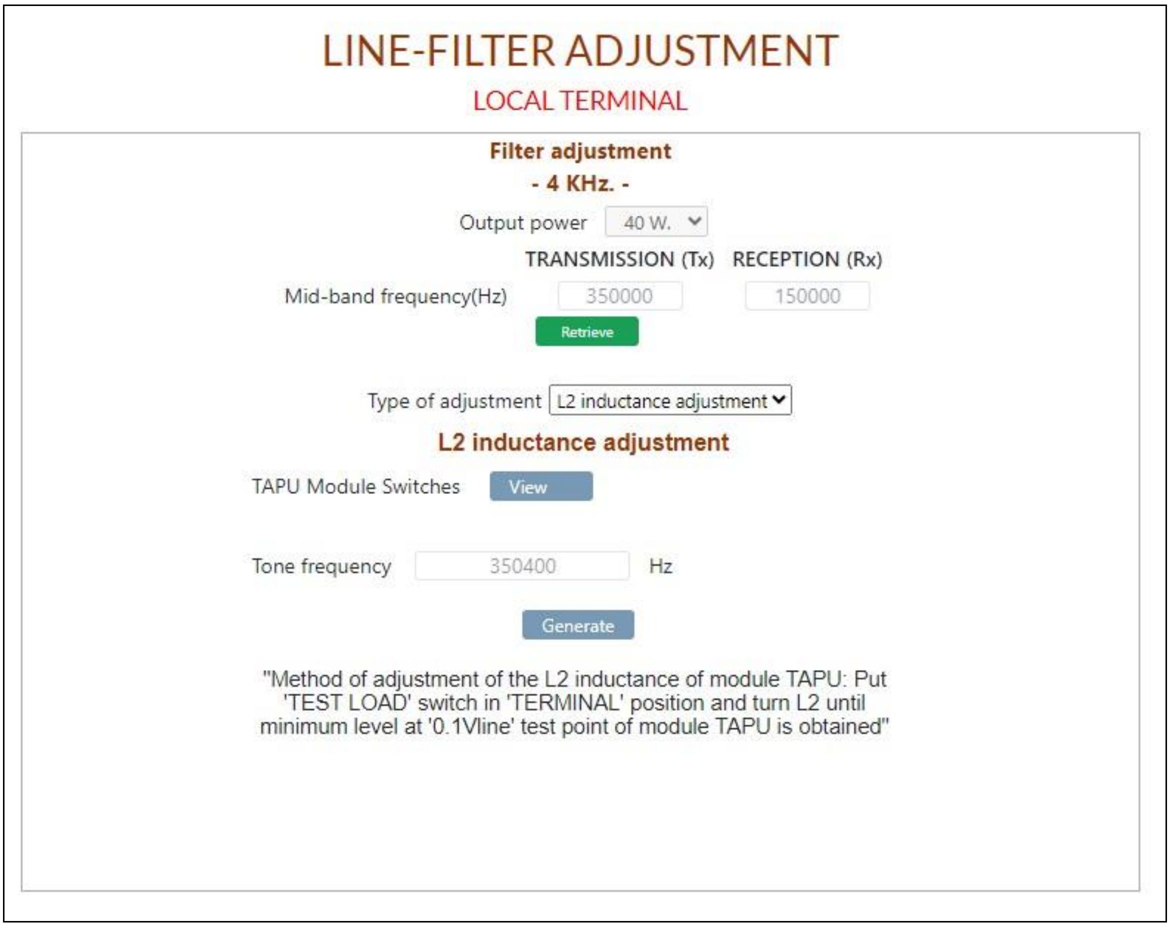


Figure 7.71 Line-filter adjustment option (HF Teleprotection functionality).

7.8.5 Hybrid adjust

This page can generate high-frequency tones to carry out the hybrid adjustment.

Depending on the configured work mode, it also allows the transmission of the remote equipment to be blocked.

The hybrid adjustment procedure is described in detail in section 6.6, *Hybrid adjustment*, of chapter 6, *Commissioning*.

The hybrid adjustment procedure associated with the **HF Teleprotection functionality** is described in section 6.6.5, *Hybrid adjustment (HF Teleprotection functionality)*, of chapter 6, *Commissioning*.

In the associated screen, the options are:

- **TEST SIGNAL GENERATION**.
  It is used in digital equipment to verify the transmit level. When the **GENERATE** command button is pressed a **QAM** test signal is generated.

- **TEST TONE GENERATION.**
  In analog equipment, the frequency must be entered. In digital equipment, a specific tone is generated.
  If the equipment is mixed (analog+digital), any of the two tones can be used. As the level of the digital tone is higher than that of the analog tone, it is recommended to use the digital test tone.

- **BLOCK TRANSMISSION OF REMOTE EQUIPMENT.**
  It blocks the transmission of the collateral terminal for five minutes (default value). This action is essential in digital equipment before beginning the hybrid adjustment process. If the equipment is mixed (analog+digital), it allows the line noise to be measured in the analog channel as the tones (pilot, guard) coming from the remote equipment are eliminated.

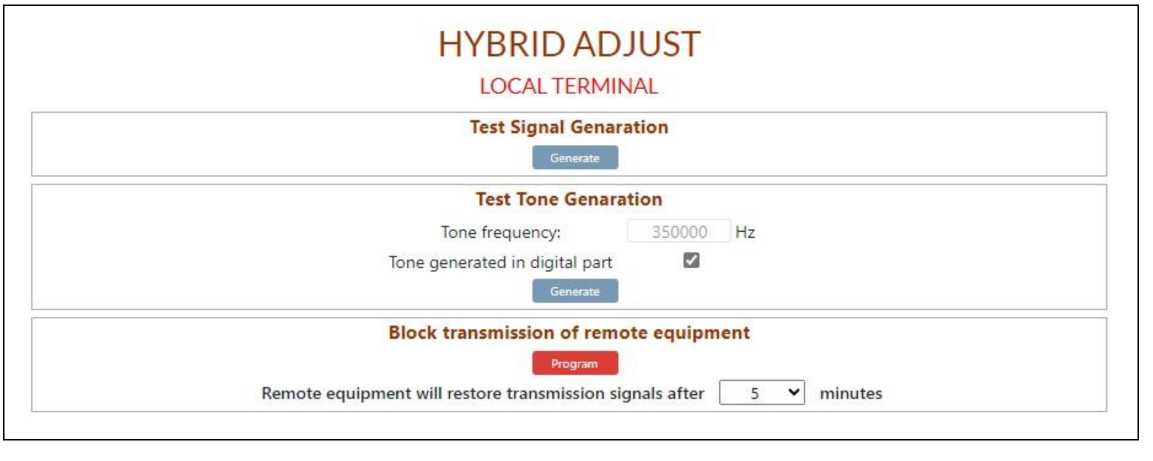


Figure 7.72 Hybrid adjust page example (Digital and Mixed work mode).

7.8.6 Switch configuration

This page indicates the required configuration of the internal elements (switches and jumpers) of the **OPU-1** modules according to some specific characteristics, which must first be selected on the page.

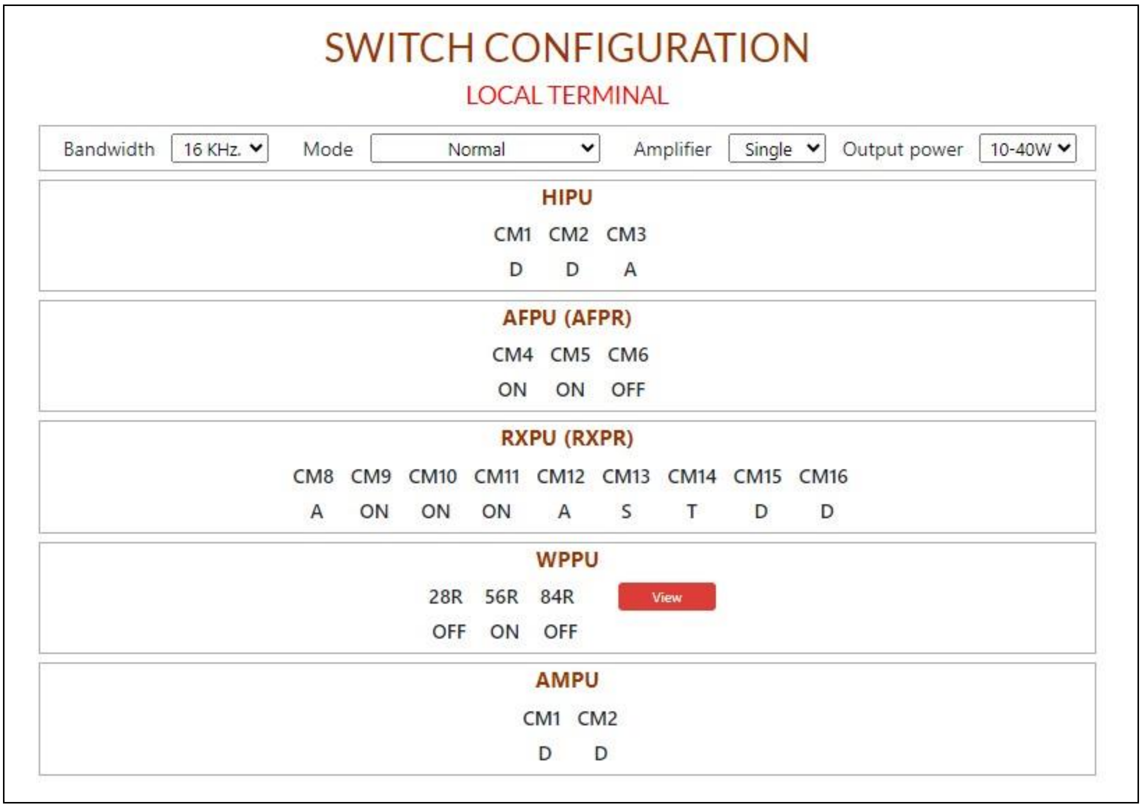


Figure 7.73 Switch configuration option.

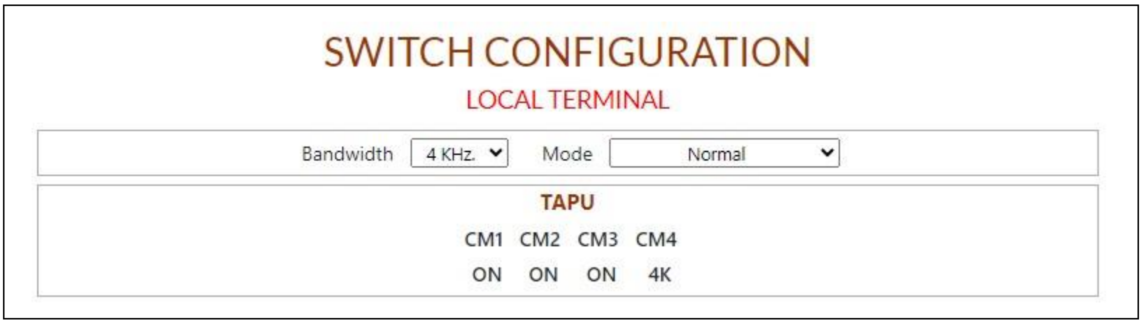


Figure 7.74 Switch configuration option (HF Teleprotection functionality).

7.8.7 Digital attenuator

This option is useful for specific adjustment of the **OPU-1** terminal at factory.

7.8.8 Master clock DAC adjustment

This option is useful for specific adjustment of the **OPU-1** terminal at factory.

7.8.9 Loop control (HF Teleprotection only)

This page is associated with the **HF Teleprotection** work mode, and gives the possibility to carry out low-frequency loops to obtain information about the response curve of the link.

It also gives the possibility to carry out a high-frequency loop. Transmission is looped over reception at local level, allowing verification of all transmission and reception processes.

It is necessary to block the teleprotection receiver to prevent false commands.

Two types of **low-frequency** loops can be executed:

- One loop, with **level recovery** at the looped end, allows the losses of the backward-channel to be known. The received-signal level will be amplified or attenuated so that it is sent back with a level equivalent to 50% modulation.

- The other, **direct**, allows the response curve of the looped circuit to be known. The received signal is sent back without altering its level in order for the terminal that sent it to know the total loss of the link, that is to say, the outward and return circuit.

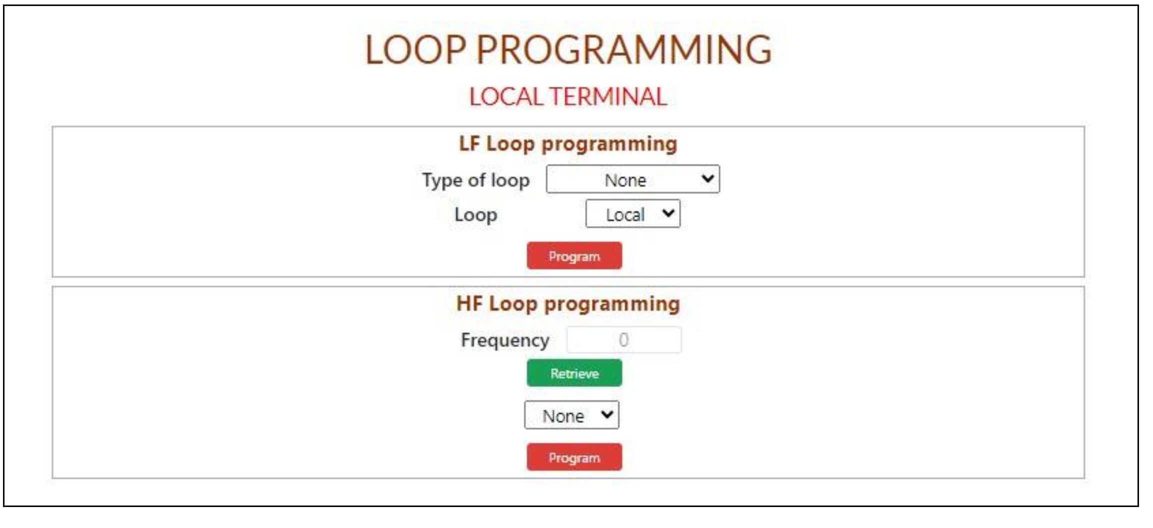


Figure 7.75 Loop control option (HF Teleprotection work mode only).

7.8.10 Receive level (HF Teleprotection only)

This page is associated with the **HF Teleprotection** work mode, and gives the possibility to carry out a receive-level adjustment in base band.

- When the **RETRIEVE** command button is pressed, the current receive-level value is presented.
  The receive level can be adjusted by directly introducing the desired value or by varying the existing value by fixed quantities using the quantity command buttons.

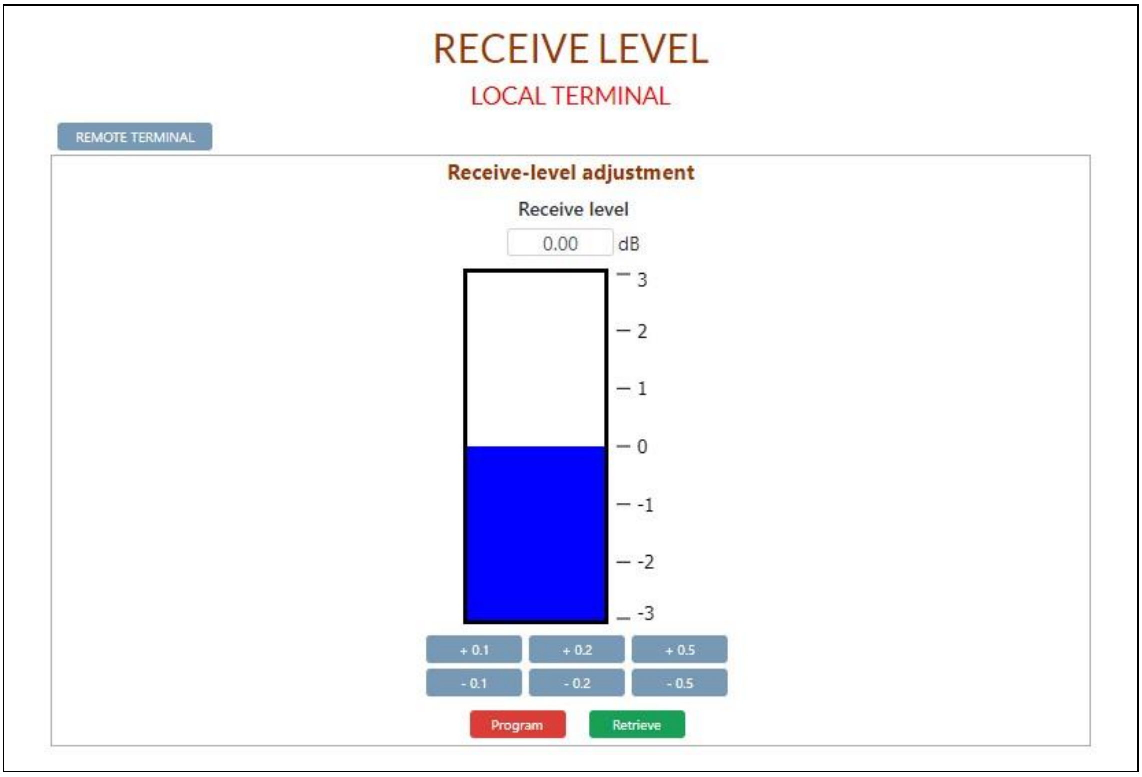


Figure 7.76 Receive level option (HF Teleprotection work mode only).

7.9 Alignment help menu – Analog part

7.9.1 Loop control

This option gives the possibility to carry out low-frequency loops to obtain information about the response curve of the link.

The loop can be carried out in both the local and remote terminals and, if the terminal is twin-channel, it can be carried out in either of the two channels.

Two types of loops can be executed:

- One loop, with **level recovery** at the looped end, allows the losses of the backward-channel to be known. The received-signal level will be amplified or attenuated so that it is sent back with a level equivalent to 50% modulation.
- The other, **direct**, allows the response curve of the looped circuit to be known. The received signal is sent back without altering its level in order for the terminal that sent it to know the total loss of the link, that is to say, the outward and return circuit.

Figure 7.77 Loop control option.

7.9.2 Amplitude-response adjustment

The frequency response in base band of the analog link may be altered when the connection to the high-voltage line is carried out.

In order to correct small variations, this option can be used to carry out a digital adjustment of the amplitude response in base band of the analog link.

First, it is necessary to obtain the response in base band in reception and, if necessary, correct the response by selecting a filter.

- The first section, *Amplitude response measurement in reception*, obtains the response in base band in reception. The facility is carried out by pressing the **GET Rx RESPONSE** command button.
  Once pressed, a message indicating *Operation in progress* is shown until the graphic response appears. In the enclosed example, it is given in red colour for channel **1** and in blue colour for channel **2**.

- The second section, *Filter selection*, allows the obtained response obtained to be corrected. The graphic for correcting the distortion is selected in the **FILTER** list box. There are about 60 available filter graphics.
  Once the desired graphic has been selected, it is possible to modify the value by pressing the **DECREASE** and **INCREASE** command buttons.

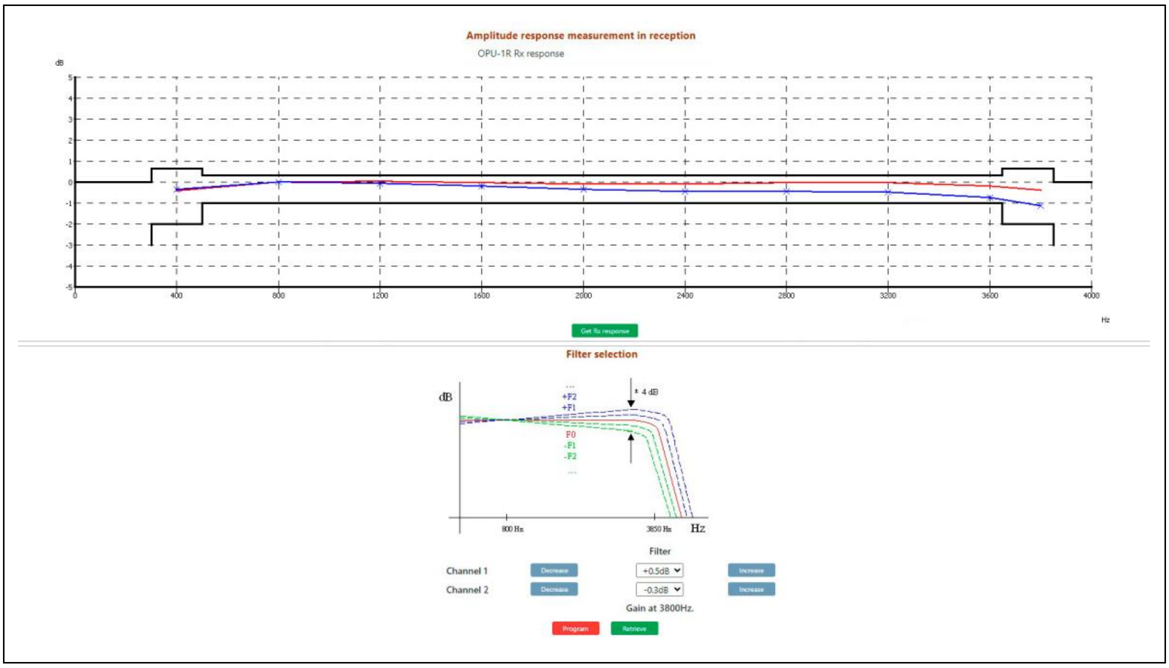


Figure 7.78 Amplitude-response adjustment page example.

7.9.3 Receive level

This option gives the possibility to carry out a receive-level adjustment in the analog channel.

The current value can be modified by using the quantity command buttons.

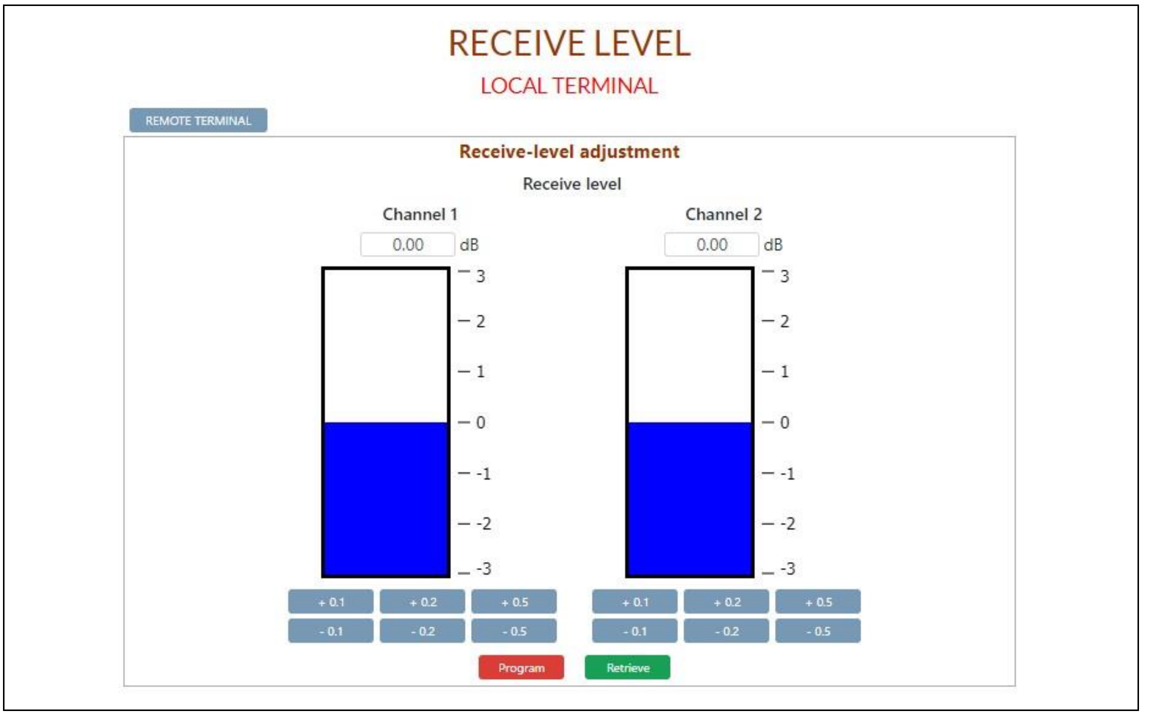


Figure 7.79 Receive level page example.

7.9.4 Teleprotection by DUAL tone

7.9.4.a Arrangement of TPPU jumpers

This option indicates the required configuration of the internal elements of the **TPPU** module according to some specific characteristics, which must first be selected.

In this way, the activation logic of all the command input circuits (by presence or absence of voltage) and nominal voltage applied to them must first be specified.

- When the selection is done, by pressing the **VIEW** command button, a figure appears showing what the position of the internal configuration elements of the **TPPU** module should be.

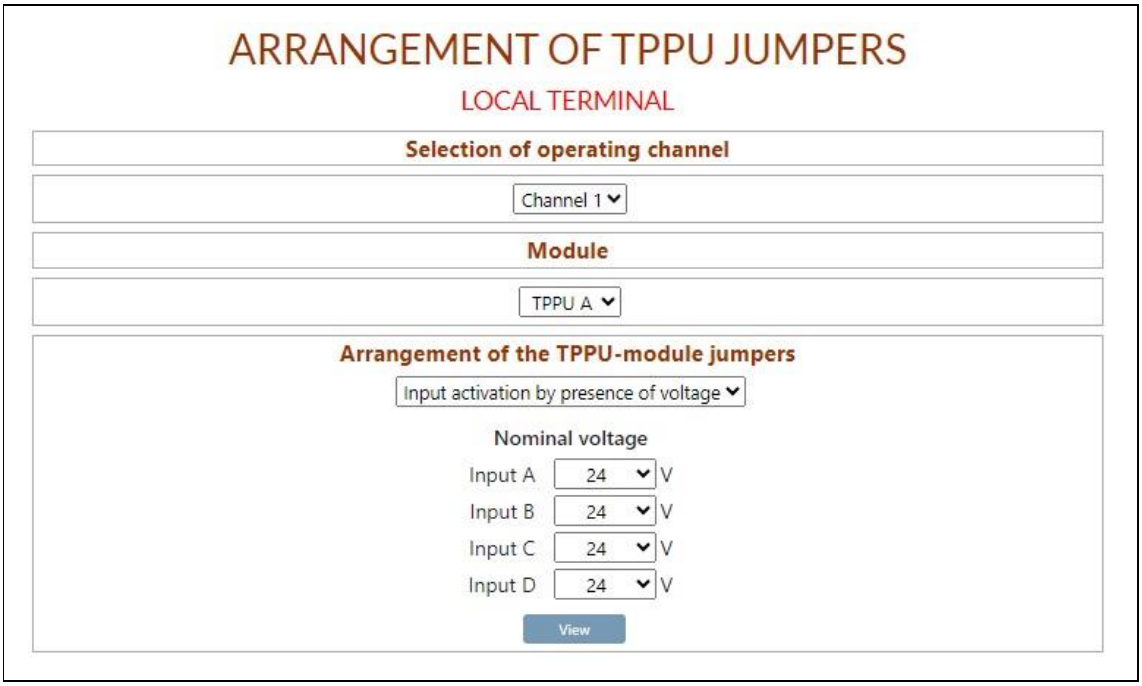


Figure 7.80 Arrangement of TPPU jumpers option.

7.9.4.b Initializations

This option gives the possibility to carry out a reset of the **TPPU** module, and to reset the counters of the number of commands transmitted and received as well as the counters of the number of input and output activations.

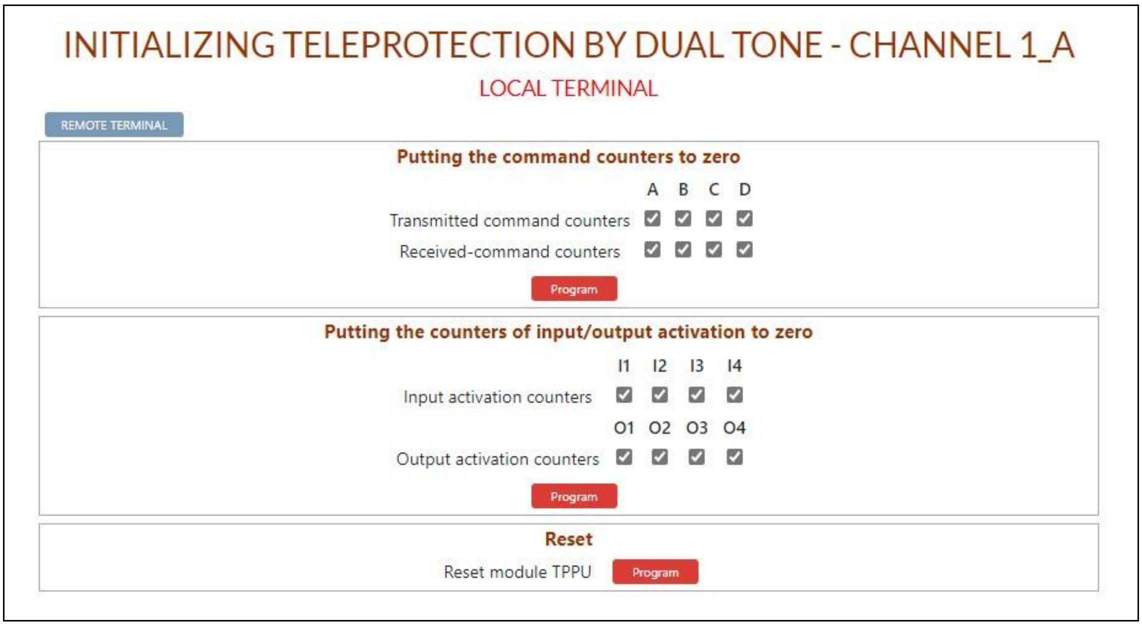


Figure 7.81 Initializations option (TPPU).

7.9.4.c Loops

This option gives the possibility to program a local loop in the teleprotection equipment, in such a way that the local transmitter remains connected to the local receiver.

The local loop, therefore, allows the correct transmission and reception of the command to be verified, on a local level, and the correct operation of the output logic configured for each command received.

- The loop can be set permanent or with a duration of **10** s, **30** s, **1** min, **10** min or **20** min. Once the loop is programmed, the page loads again and indicates the **STOP** action to facilitate loop deactivation without waiting for the configured duration end.

As no signal is transmitted to the remote terminal, the remote receiver blocks. *With respect to the local terminal, before loop programming, the command outputs of the terminal should be suitably treated in order to make sure that no undesired activations take place.*

Figure 7.82 Loops option (TPPU).

7.9.4.d Output blocking

This option gives the possibility to program a blocking of the command outputs, protection side.

- The blocking duration can be set permanent or with a duration of **10** s, **30** s, **1** min or **10** min.
  Once the blocking is programmed, the page loads again and indicates the **STOP** action to unblock the outputs without waiting for the configured duration end.

Figure 7.83 Output blocking option (TPPU).

7.9.4.e Tests

This option gives the possibility to program a local test in the teleprotection equipment.

The local test verifies the correct operation of the DSP and the microcontroller of teleprotection decisions as well as the communication between the two devices.

The result of the test, satisfactory or not, is indicated by a tick in the corresponding box (Correct or Test failure).

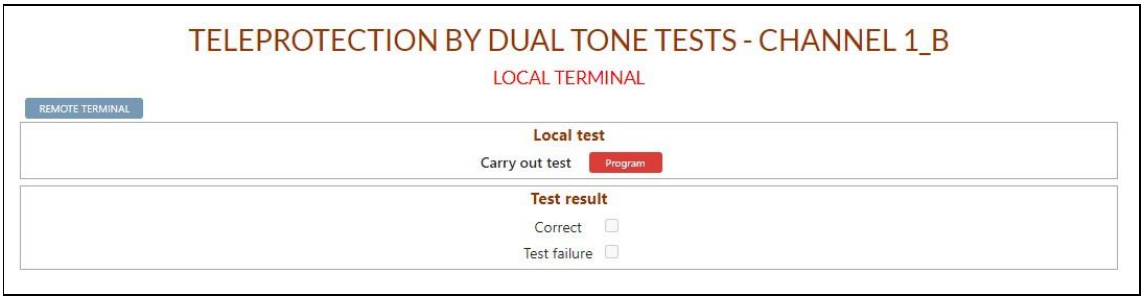


Figure 7.84 Tests option (TPPU).

7.9.4.f Command transmission

This option gives the possibility to program the transmission of the desired command.

- The duration of the command transmission can be set permanent or with a duration of **10** s, **30** s, **1** min or **10** min.
  Once programmed, the page loads again and indicates the **STOP** action to deactivate command transmission without waiting for the configured duration end.

Before programming, command transmission must be properly treated in order to make sure that no undesired activations take place.

Figure 7.85 Command transmission option (TPPU).

7.9.4.g Dacs Tx & Rx offset adjustment

This option is useful for specific adjustment of the **TPPU** module at factory.

7.10 Alignment help menu – Digital part

7.10.1 Multiplexer loops

This page allows a data loop to be carried out in any of the possible twenty ports of the **OPU-1** terminal, that is, two basic ports of the **MQPU** module and those of the optional internal multiplexer.

- When a loop is carried out, the port input data returns at input/output level to its original source, whilst the data received from line is sent back to the line.

- In order to deactivate the data loop it is necessary to unmark the associated box and press the **PROGRAM** command button.

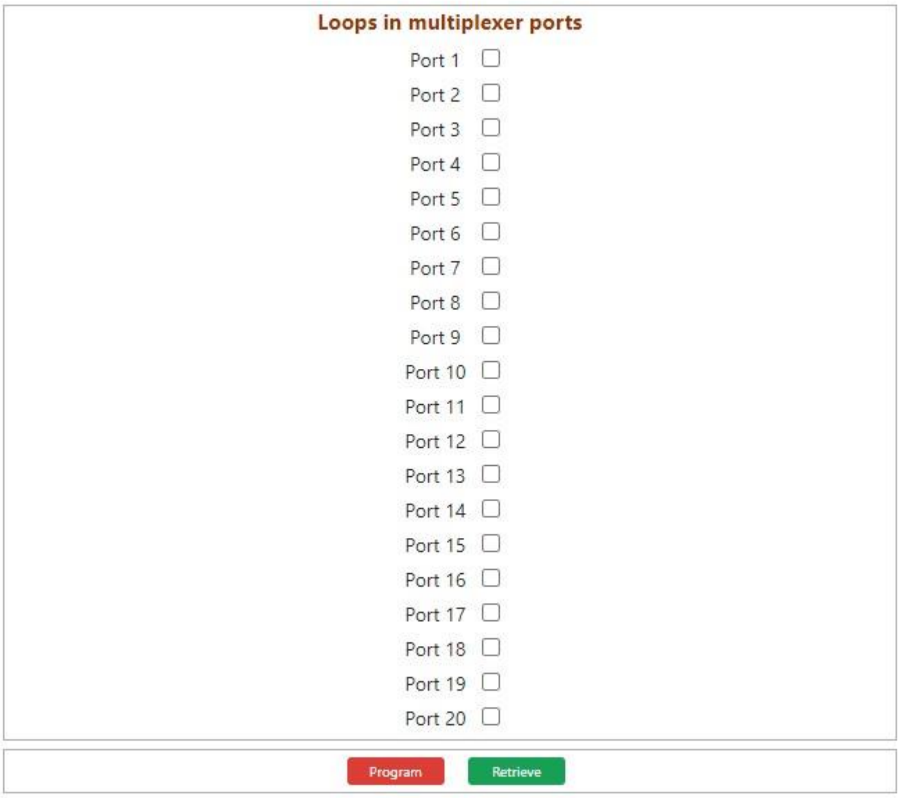


Figure 7.86 Multiplexer loops option.

7.10.2 Constellation view (QAM)

For **QAM**, this page allows the constellation of the digital signal to be displayed.

- The **X** axis corresponds to the in-phase component of the demodulated **QAM** signal.
- The **Y** axis corresponds to the quadrature component of the demodulated **QAM** signal.

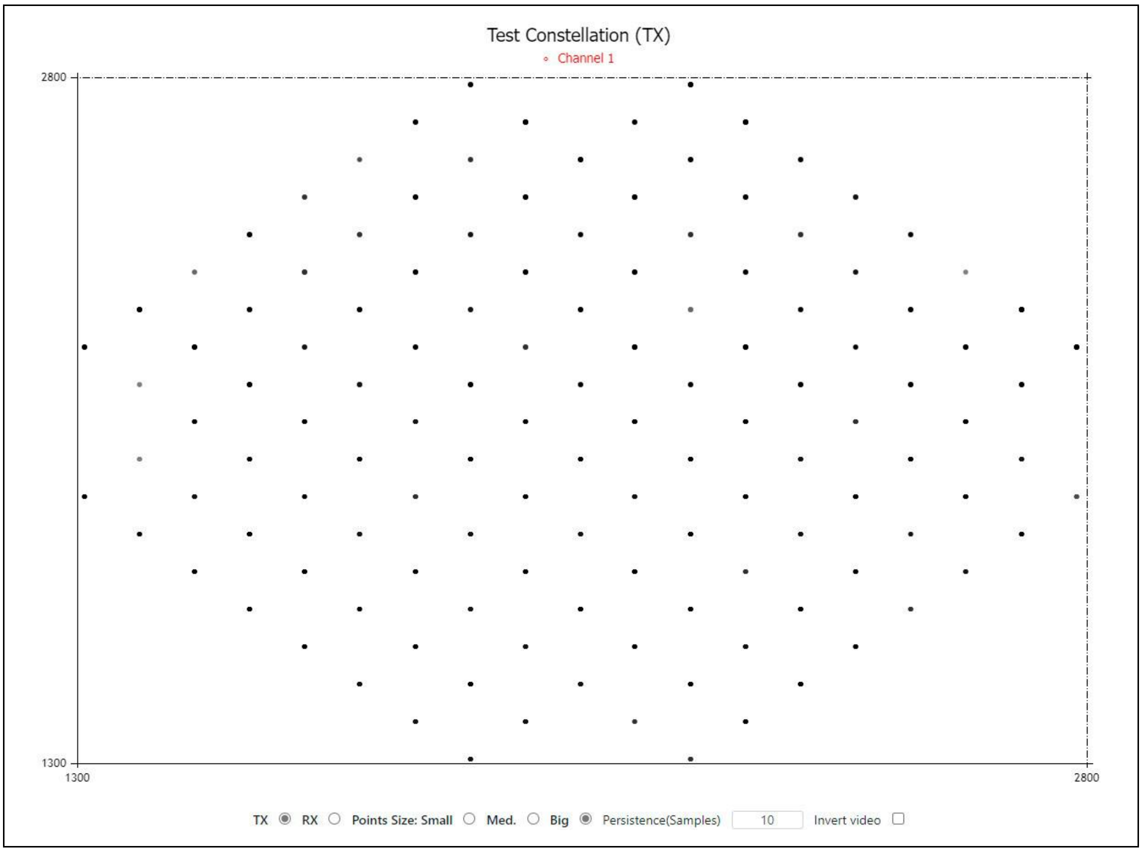


Figure 7.87 Constellation view option (QAM).

7.10.3 Down-converter spectrum (QAM)

For **QAM**, this page acts as an spectrum analyzer and allows the spectrum of the signal in reception to be monitored.

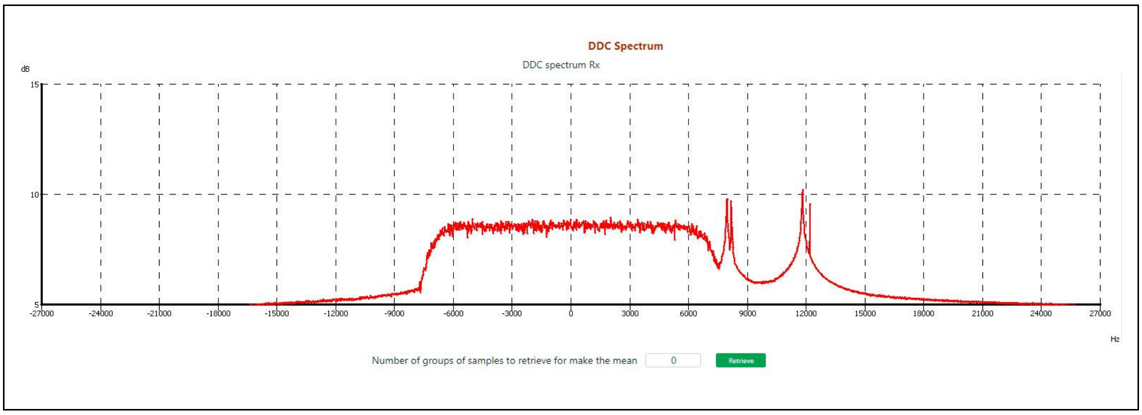


Figure 7.88 Down-converter spectrum option (QAM).

7.10.4 Spectrum at echo-canceller input (QAM)

For **QAM**, this page acts as an spectrum analyzer and allows the echo-canceller input to be monitored.

7.10.5 Spectrum at echo-canceller output (QAM)

For **QAM**, this page acts as an spectrum analyzer and allows the echo-canceller output to be monitored.

7.10.6 SNR penalization (OFDM)

For **OFDM**, this page gives the possibility to obtain information about SNR penalization.

7.10.7 Channel estimation (OFDM)

For **OFDM**, this page gives the possibility to plot on a curve channel estimation (**hEst**).

The system equalizes the **OFDM** data using channel estimates.

7.10.8 OFDM signal quality (OFDM)

For **OFDM**, this page gives the possibility to obtain information about link quality.

7.10.9 MQPU initializations

This option is useful for specific adjustment of the **MQPU** module at factory.

7.10.10 MQPU master/slave clock adjustment

This option is useful for specific adjustment of the **MQPU** module at factory.

Chapter 8.

Other information

8. Other information

8.1 Transport

The **OPU-1** terminals are packed in **wooden** boxes prepared for easy transportation.

Each **wooden** box contains, depending on the size, two or four **cardboard** boxes. Each **cardboard** box contains the equipment and **accessories**.

The equipment is wrapped in a bag alveolar film (bubble wrap) and is placed into the **cardboard** box together with the already packed accessories. It is then covered with porexpan chips to protect it from bumps. The **cardboard** box is closed with staples and adhesive band.

Inside the **wooden** box, the two or four **cardboard** boxes are covered with porexpan plates. In the case of the **80** W equipment with cabinet-mounting terminal blocks, accessories need an additional box which is also placed inside the **wooden** box.

In some specific cases, the terminal can be delivered packed only in a **cardboard** box. The **cardboard** boxes are stacked one on top of the other on a **pallet**, and the whole package is wrapped with **shrink film** and reinforced with **shrink plastic**. The maximum of **cardboard** boxes per **pallet** is four.

Each consignment is delivered with a delivery note and, if appropriate, with a packing list. The latter, in addition to the destination information and the "**total of package**", specifies the dimensions and weight of the boxes or pallet.

Each **consignment** is identified by means of a label, which is inside an adhesive bag, with the following information:

- delivery address
- customer order number
- box number
- contents of the box
- sender data
- internal order number

For shipments with **pallets**, each box is identified by a package label, which includes:

- box number
- contents
- number of item
- total of package

*The **OPU-1** terminals meet specifications **EN 60721-3-2** class 2M2 transport regarding vibration and shock.*

8.2 Storage

With respect to reception and storage of the **OPU-1** terminal, consider the following:

1. Check that the boxes received do not have bumps or dents and that the packaging is not damaged.
   The user must immediately notify **ZIV** of any anomaly about the original packaging.
2. Consult the enclosed delivery note and check that the material supplied corresponds to the requested.
   The user must immediately notify **ZIV** of any anomaly about the material received and, if applicable, return all material to **ZIV** in the original package.
3. The **OPU-1** terminals should be stored in its own packaging until installation.
4. Storage must be done in premises protected from the weather, Class C according to EN 60870-2-2 standard.
   In protected installations (Class C), neither the temperature nor the humidity are controlled. The equipment are protected from direct sunlight, rain and other precipitation and wind.
5. The storage temperature range is between **-20**°C and +**70**°C.

8.3 Maintenance

The following **verifications** are suggested, which can give a good indication of the state of the **OPU-1** terminal.

8.3.1 Checking of the power supply

Check that the equipment receives power-supply voltage within the range:
- From **36** to **72** Vdc for a nominal voltage of **48** Vdc

The **main** power supply (*slot 1*) is measured at connector **J14** at the rear of the **6** s.u. chassis, and the **secondary** power supply (*slot 2*) is measured at connector **J36**.

8.3.2 Checking of the transmit and receive pilot level

See measurement method in section ***Levels*** of chapter 6, ***Commissioning***.

8.3.3 Audio-frequency signals

When the L.F. limiter activates in an analog channel, it means that the level of the signal injected in the equipment is higher than the maximum programmed value.

To check the audio-frequency signal level in the equipment, follow these steps:

1 Locate the external-connection terminals associated with the service under inspection.
  - **ZIPU** plug-in terminal block is associated with the **IOPU.0#** option.
  - Terminals **BB1** of **ZOPU.01** terminal block are assigned to channel 1 of the **IOPU.01** option.
  - Terminals **BB1** of **ZOPU.02** terminal block are assigned to channel 1 of the **IOPU.02** option and **ZBBA.14** terminal block is associated with channel 2 of the **IOPU.02** option.

2 Connect a very high-impedance voltmeter to the terminals, and measure the signal level.

3 Check the level programmed in the **OPU-1** terminal by accessing the *Input levels* option of the *Analog part* submenu of the *Configuration* menu.

4 Check that the level measured in point 2 is consistent with the level programmed.
If these levels are inconsistent, adjust the level of the service under inspection or reprogram the audio-frequency input level.

8.3.4 Received QAM level

This check can be performed if the equipment is **digital** or mixed (analog+digital).

To check the **QAM** level reception, follow these steps:

1 In the terminal at the other end, remove any analog signals from the band. To do so, access the *Output levels* option of the *Analog part* submenu of the *Configuration* menu and assign **0**% to the modulation.

2 Remove the digital pilot. To do so, access the *Digital configuration* option of the *Digital part* submenu of the *Configuration* menu and assign **0**% to the modulation.

3 Generate the test signal. To do so, access the *Hybrid adjust* option of the *Basic equipment* submenu of the *Alignment help* menu.

4 In the local terminal, connect a true rms voltmeter in the **OUTPUT** and ground test points of the reception filter (**RXPU/RXPR**) module.

5 Measure the signal level. The difference between this point and the **LINE SIGNAL** test point is **21** dB ± **1** dB.

8.3.5 G.821 statistics

This check can be performed if the equipment is **digital** or mixed (analog+digital).

The **OPU-1** has circuits for measuring the quality of the link with regard to Recommendation **G.821** of the ITU-T, which is defined as *Error performance of an international digital connection forming part of an integrated services digital network*.

The **G.821** statistics can be displayed from the *G.821 statistics* option of the *Digital part* submenu of the *Monitoring* menu.

8.3.6 Checking of port 1

This check can be performed if the equipment is **digital** or mixed (analog+digital).

Connect a data analyser to the port and program a **loop** (*Multiplexer loops* option of the *Digital part* submenu of the *Alignment help* menu).

When a **loop** is carried out, the port input data returns to its original source and the data received from line is sent back to the line.

8.3.7 Checking of teleprotection command transmission

This check can be performed if the **OPU-1** terminal is equipped with the teleprotection (**TPPU**) module.

Before carrying out this check, the command transmission must be suitably treated in order to make sure that no undesired activations take place in the remote terminal.

In the local terminal, with the aid of the Management System (*Command transmission* option of the *Teleprotection* submenu of the *Alignment help* menu), force the transmission of the desired command.

Access the *State* option of the *Teleprotection* submenu of the *Monitoring* menu and verify command transmission and state of inputs and counters.

8.3.8 Final checks

- If port 1 have been left in **loop**, deactivate the loop.
- Check that no terminal of the terminal block is **open**.
- Set the terminal **clock** on **time** (*Setting the clock* option of the *Basic equipment* submenu of the *Alignment help* menu).
- Reset the **chronological register** (*Chronological register* option of the *Basic equipment* submenu of the *Monitoring* menu).
- If applicable, reset the **teleprotection chronological register** (*Chronological register* option of the *Teleprotection* submenu of the *Monitoring* menu).
- If applicable, reset the **teleprotection counters** (*Initializations* option of the *Teleprotection* submenu of the *Alignment help* menu).

Chapter 9.

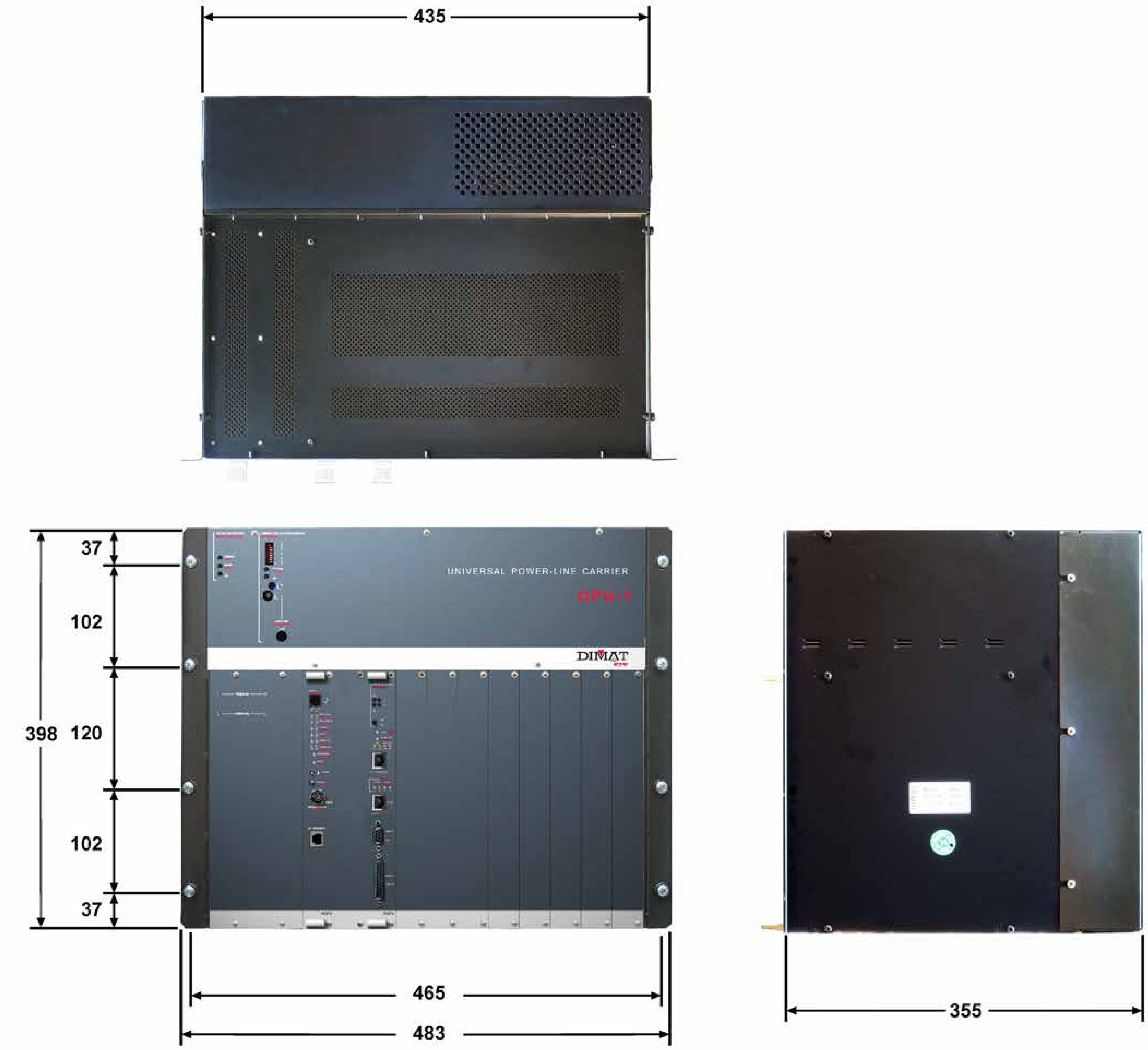
Dimensions and front view

9. Dimensions and front view

9.1 Dimensions of OPU-1 for 20 W & 40 W

The dimensions of the **OPU-1** terminal for **20** W & **40** W can be seen in the attached drawing.

*These dimensions are also valid for the **OPU-1** terminal for 20 W & 40 W (**500** kHz to **1** MHz) and for the **OPU-1** terminal for 20 W & 40 W with **HF TP functionality**.*

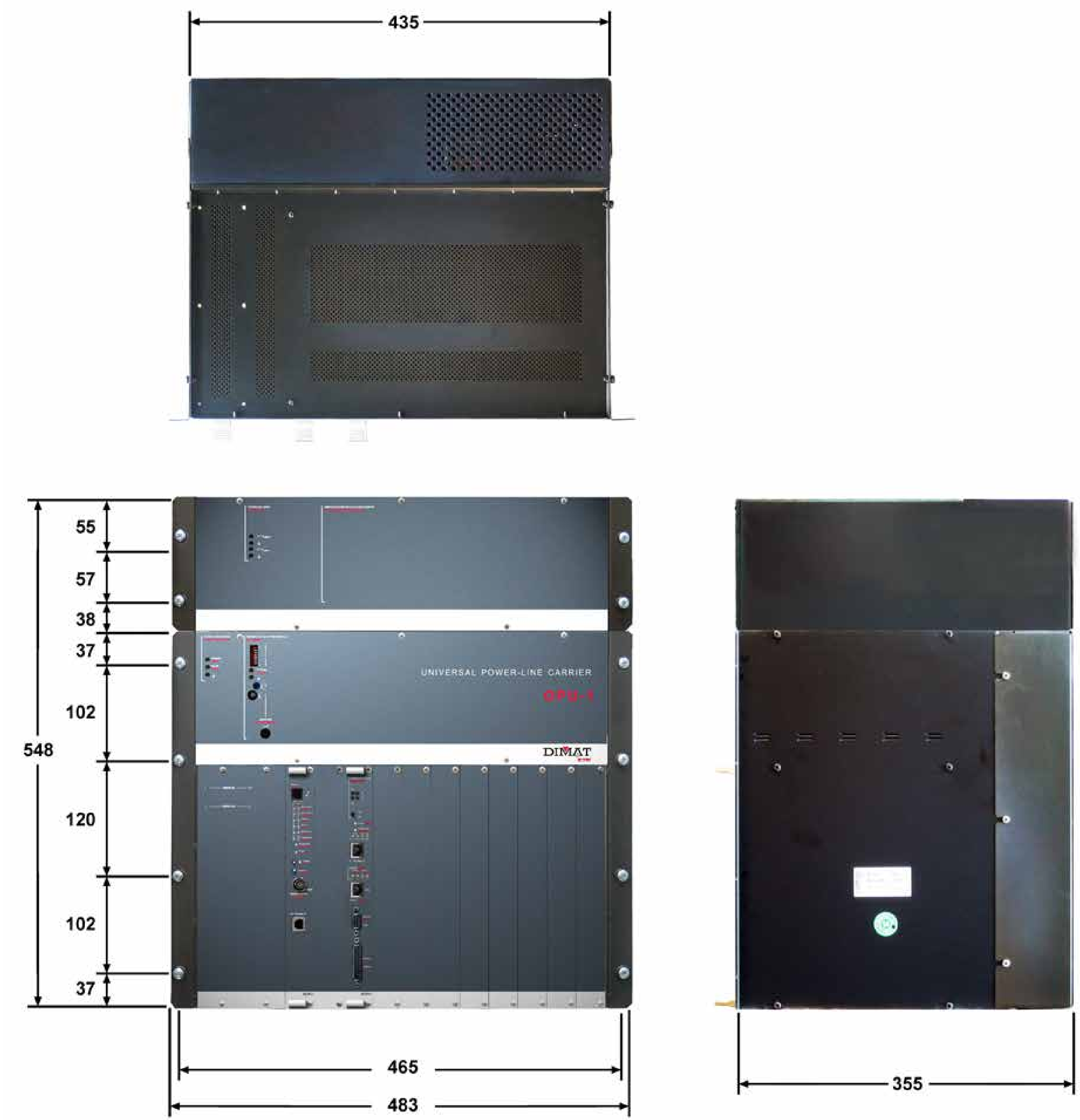


Fecha	Realizado	Comprobado	Aprobado	Archivo MAOPUX0000	
ZIV	Overall dimensions in mm of the basic OPU-1 for 20 W and 40 W			Siglas OPU-1	Hoja 1/1

9.2 Dimensions of OPU-1 for 80 W

The dimensions of the **OPU-1** terminal for **80** W can be seen in the attached drawing.

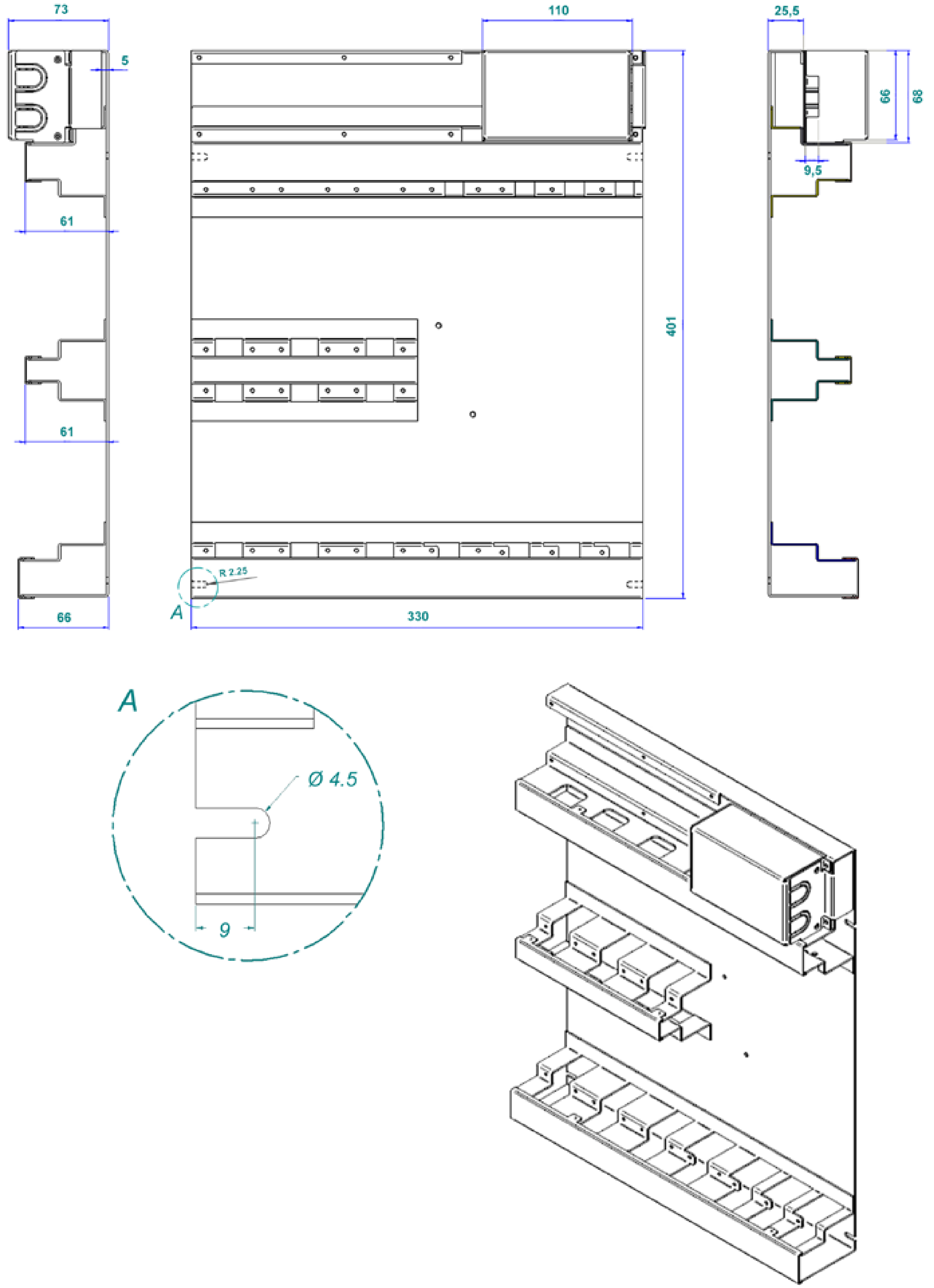
*These dimensions are also valid for the **OPU-1** terminal for 20 W & 40 W with **additional** filter.*



Fecha	Realizado	Comprobado	Aprobado	Archivo	
				MAOPUX0010	
	Overall dimensions in mm of the OPU-1 for 80 W			Siglas OPU-1	Hoja 1/1

9.3 Dimensions of cabinet-mounting terminal block

The dimensions of the **OPU-1** cabinet-mounting terminal block can be seen in the attached drawing.



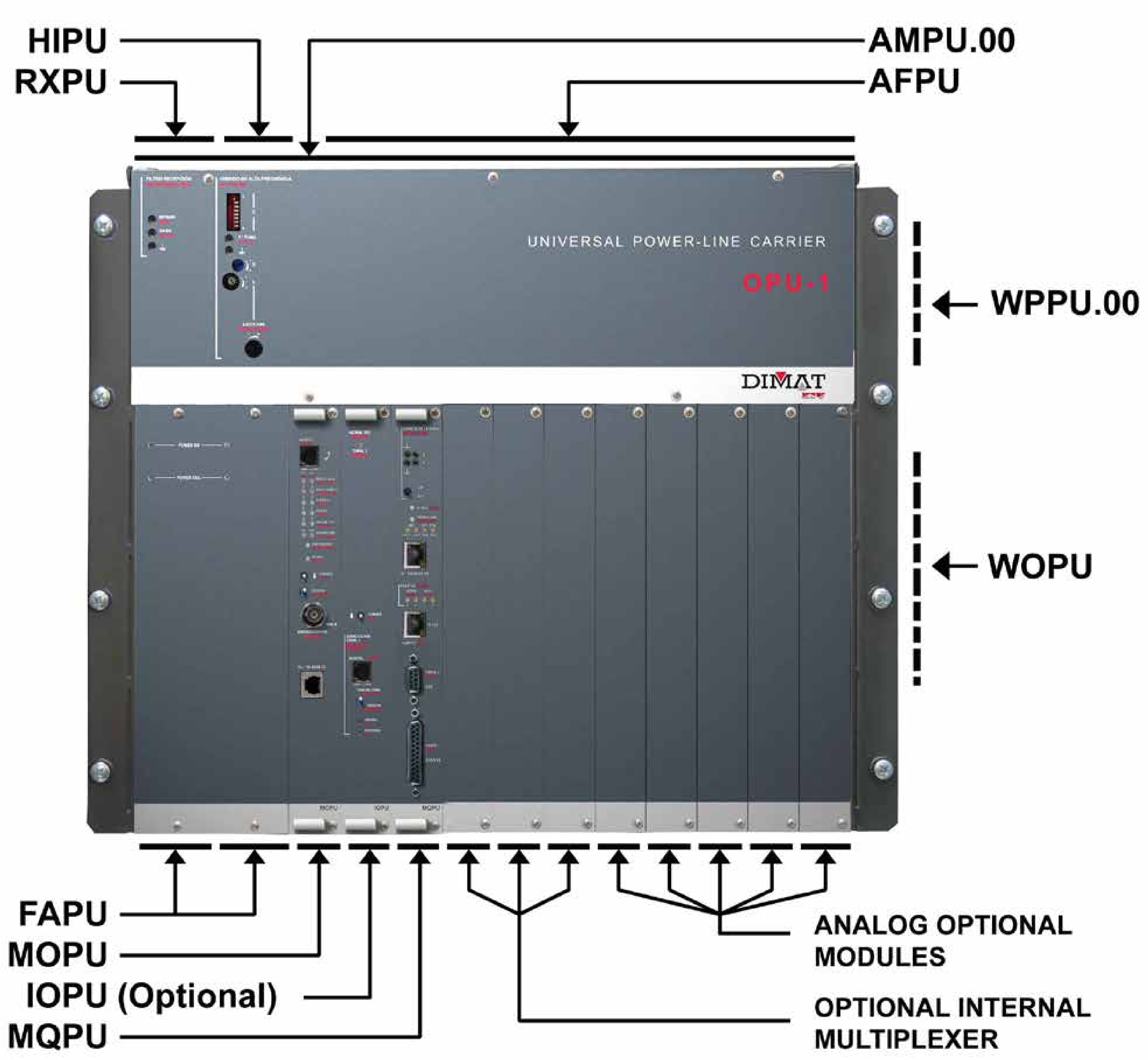
Fecha	Realizado	Comprobado	Aprobado	Archivo MHOPU10003	
	Overall dimensions in mm of the cabinet-mounting terminal block			Siglas OPU-1	Hoja 1/1

9.4 Front view of OPU-1 for 20 W & 40 W

The front view of the **OPU-1** terminal for **20** W & **40** W can be seen in the attached drawing.

See the description of each of the main front elements in chapter 5, ***Installation and connections****.*

See the description of the front elements of each of the 6 s.u. optional modules in chapter 5, ***Installation and connections****.*



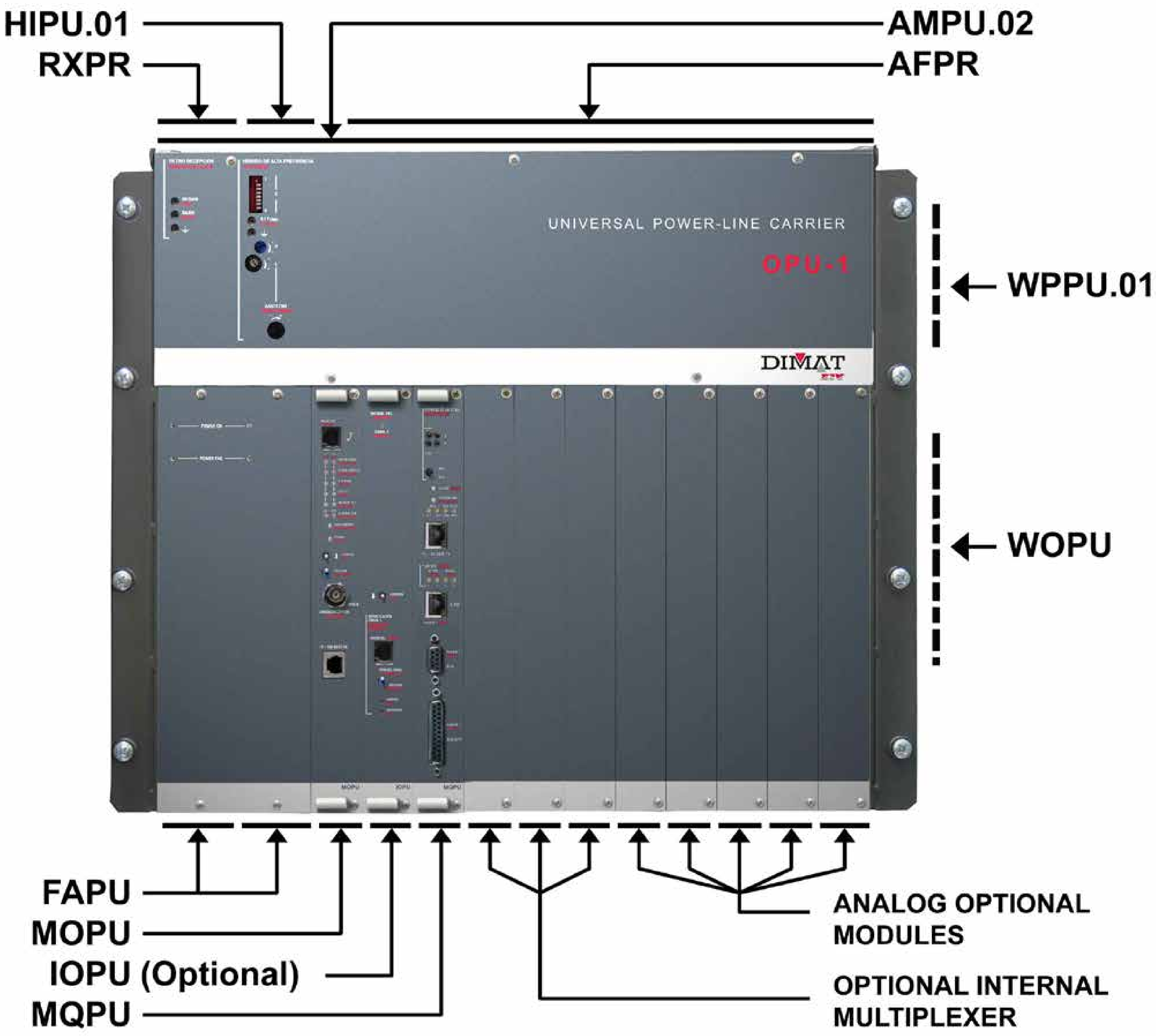
Fecha	Realizado	Comprobado	Aprobado	Archivo
				JFOPUX0402
	Front view of the basic OPU-1 for 20 W and 40 W			Siglas: OPU-1 / Hoja: 1/1

9.5 Front view of OPU-1 for 500 kHz to 1 MHz

The front view of the **OPU-1** terminal for **20** W & **40** W (from **500** kHz to **1** MHz) can be seen in the attached drawing.

See the description of each of the main front elements in chapter 5, ***Installation and connections****.*

See the description of the front elements of each of the 6 s.u. optional modules in chapter 5, ***Installation and connections****.*



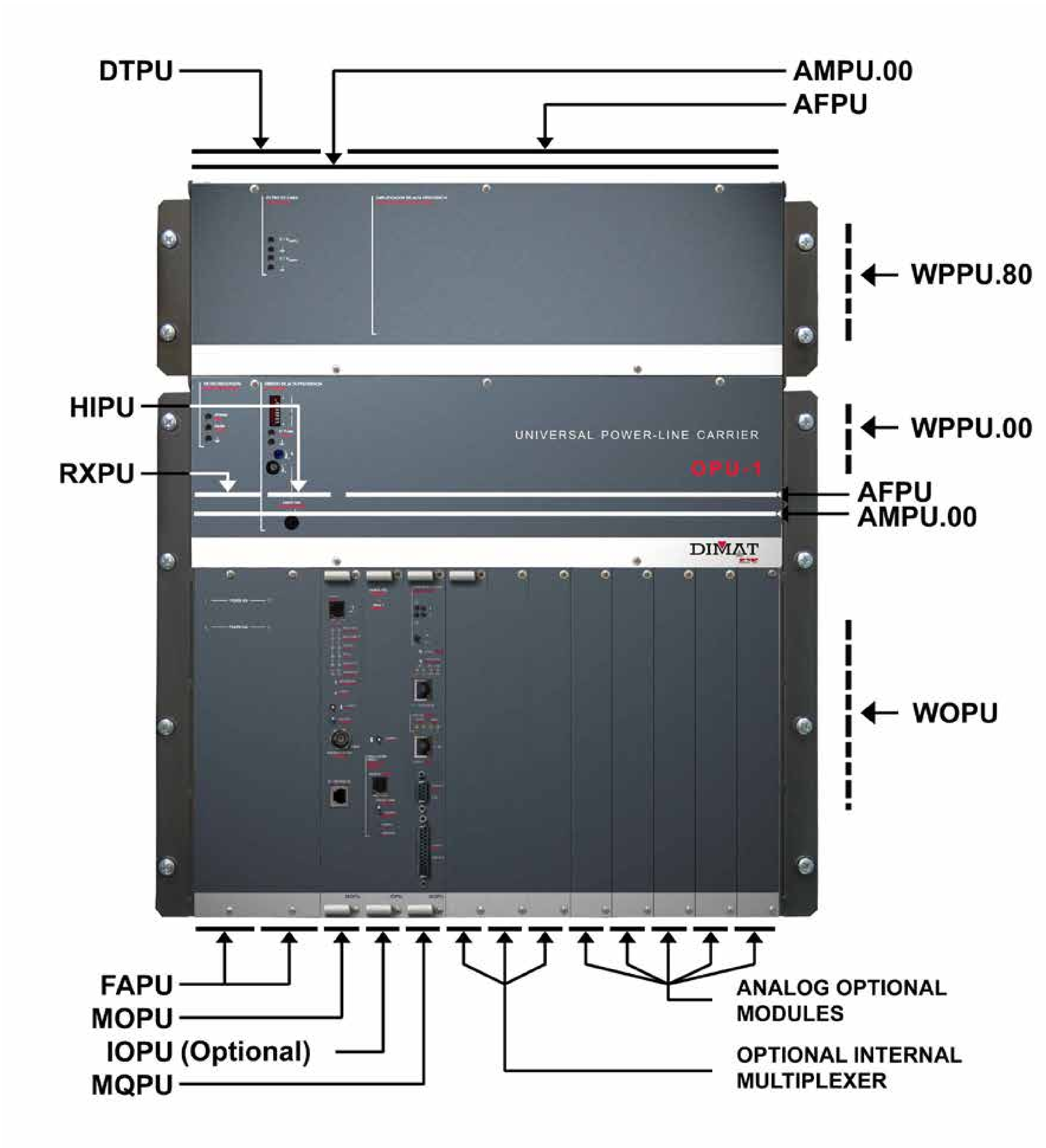
Fecha	Realizado	Comprobado	Aprobado	Archivo JFOPUX0403	
	Front view of the basic OPU-1 for 20 W and 40 W (500 kHz to 1 MHz)			Siglas OPU-1	Hoja 1/1

9.6 Front view of OPU-1 for 80 W

The front view of the **OPU-1** terminal for **80** W can be seen in the attached drawing.

*See the description of each of the main front elements in chapter 5, **Installation and connections**.*

*See the description of the front elements of each of the 6 s.u. optional modules in chapter 5, **Installation and connections**.*



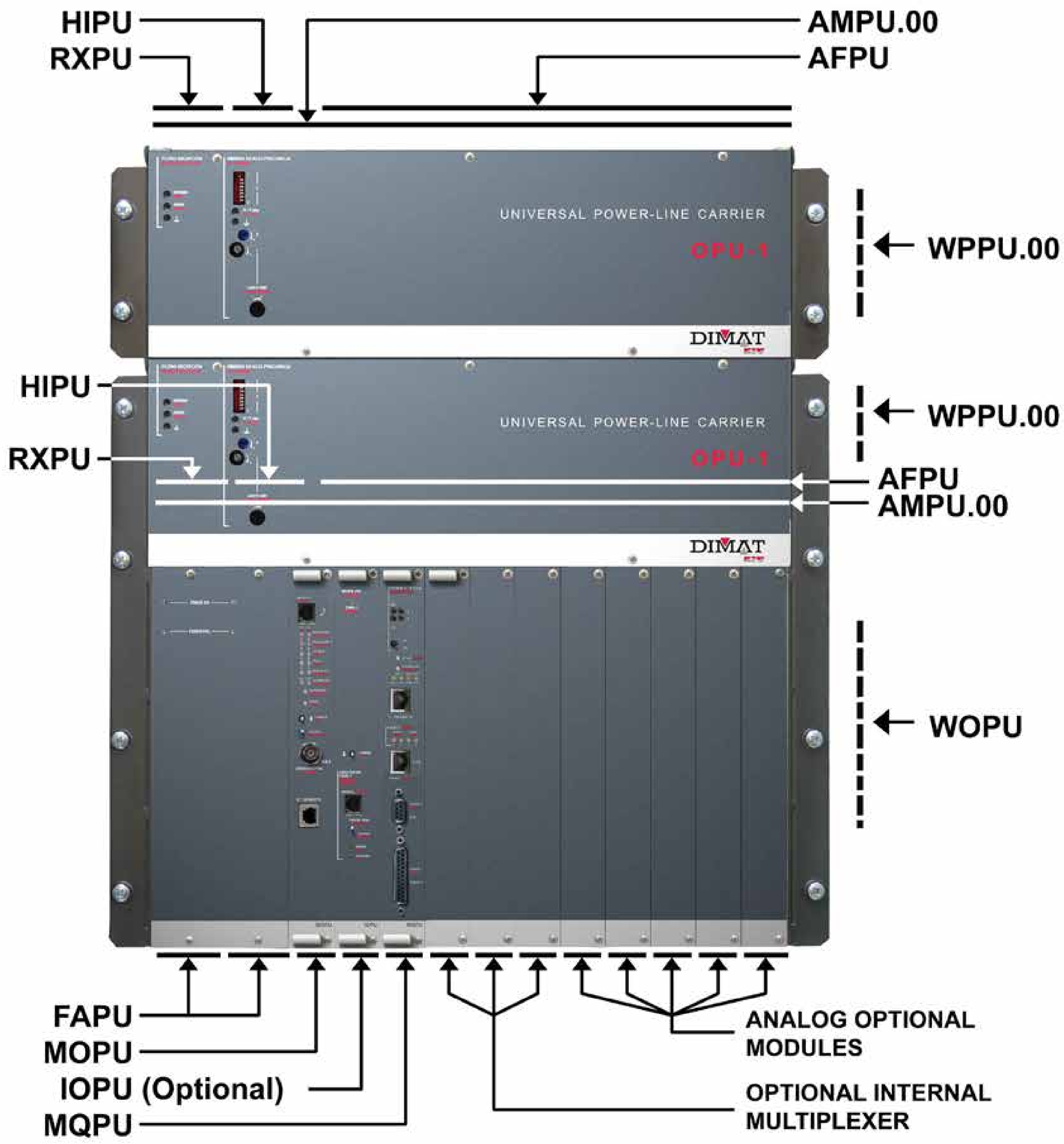
Fecha	Realizado	Comprobado	Aprobado	Archivo JFOPUX0502	
ZIV	Front view of the OPU-1 for 80 W			Siglas OPU-1	Hoja 1/1

9.7 Front view of OPU-1 with additional filter

The front view of the **OPU-1** terminal for **20** W & **40** W with **additional filter** can be seen in the attached drawing.

*See the description of each of the main front elements in chapter 5, **Installation and connections**.*

*See the description of the front elements of each of the 6 s.u. optional modules in chapter 5, **Installation and connections**.*



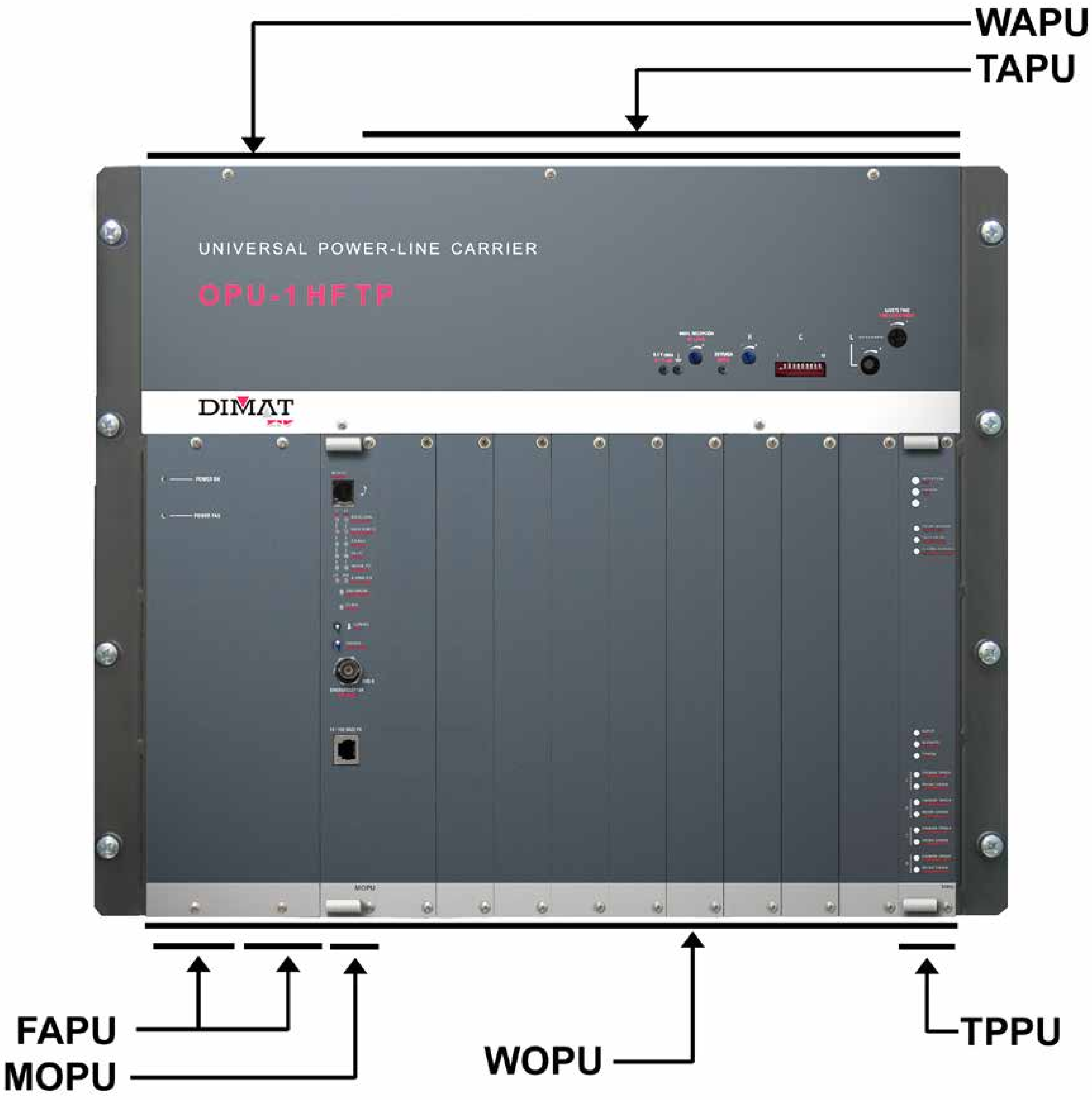
Fecha	Realizado	Comprobado	Aprobado	Archivo JFOPUX0602	
	Front view of the OPU-1 for 20 W and 40 W with additional filter			Siglas OPU-1	Hoja 1/1

9.8 Front view of OPU-1 for High-Frequency Teleprotection functionality

The front view of the **OPU-1** terminal for **20** W & **40** W with **High-Frequency Teleprotection functionality** can be seen in the attached drawing.

*See the description of each of the main front elements in chapter 5, **Installation and connections**.*

*See the description of the front elements of each of the 6 s.u. optional modules in chapter 5, **Installation and connections**.*



Fecha	Realizado	Comprobado	Aprobado	Archivo JFOPUH0002
	Front view of the OPU-1 for HF TP functionality			Siglas OPU-1 / Hoja 1/1

License agreement for Software Embedded in Equipment

ZIV APLICACIONES Y TECNOLOGÍA, S.L.
End-User Software License Agreement

THE EQUIPMENT YOU HAVE PURCHASED INCLUDES EMBEDDED SOFTWARE PROGRAM(S). THE PROGRAM IS COPYRIGHTED AND IS BEING LICENSED TO YOU (NOT SOLD) FOR USE WITH THE EQUIPMENT.

THIS IS A LEGAL AGREEMENT BETWEEN US (AS "LICENSEE) AND ZIV APLICACIONES Y TECNOLOGÍA, S.L. (AS "LICENSOR") FOR THE SOFTWARE PROGRAM INCLUDED WITH THE EQUIPMENT. PLEASE READ THE TERMS AND CONDITIONS OF THIS LICENSE AGREEMENT CAREFULLY BEFORE USING THE EQUIPMENT.

IF YOU INSTALL OR USE THE EQUIPMENT, YOU ARE ACCEPTING AND AGREEING TO THE TERMS OF THIS LICENSE AGREEMENT. IF YOU ARE NOT WILLING TO BE BOUND BY THE TERMS OF THIS LICENSE AGREEMENT, YOU SHOULD PROMPTLY RETURN THE EQUIPMENT UNUSED TO YOUR SELLER, AND YOU WILL RECEIVE A REFUND OF YOUR MONEY.

Terms and Conditions of License

1. **License Grant**. Licensor hereby grants to you, and your accept, a nonexclusive and non-transferable license to use the embedded programs and the accompanying documentation, if any (collectively referred to as the "Software"), only as authorized in this License Agreement.
2. **Restrictions.** You may not (a) use, copy, modify or transfer the Software except as expressly provided in this or another Agreement with Licensor, (b) reverse engineer, decompile or disassemble or separate the components of the Software, or (c) rent, sell or lease the Software or make the Software available to others to do any of the foregoing.
3. **No Assignment.** This License is intended for your exclusive use with the purchased equipment. You agree that you will not assign, sublicense, transfer, pledge, lease, rent or share your rights under this License Agreement.
4. **Licensor's Rights.** You acknowledge and agree that the Software is the proprietary product of Licensor protected under U.S. copyright law and international treaties.. You further acknowledge and agree that all right, title and interest in and to the Software, including associated intellectual property rights, are and shall remain with Licensor. This License Agreement does not convey to you an ownership interest in or to the Software, but only a limited right of use revocable in accordance with the terms of this License Agreement.
5. **Confidentiality**. The Software is confidential and no details or information relating to the same shall be disclosed to any third party without the prior written consent of Licensor. For the purposes of this clause, sub-contract staff, employed or retained by the Licensee to perform computer systems development work, shall not be deemed to be third parties provided such staff are subject to the disclosure restrictions set forth above. In no event, except with a prior written authorization duly signed by an officer of Licensor, may you disclose any such confidential information, even for subcontracted jobs, to persons or entities that may be considered to be direct competitors of Licensor.

6. **Term**. The License Agreement is effective upon delivery of the equipment to you and shall continue until terminated. You may terminate this License Agreement at any time by returning the equipment to Licensor, or by destroying the equipment. Licensor may terminate this License Agreement upon your breach of any term hereof. Upon such termination by Licensor, you agree to return the equipment to Licensor.
7. **Warranty and Disclaimer.** Licensor warrants, for your benefit only, that the Software, when and as delivered to you, will conform to the specifications described in the instruction manuals for the equipment purchased, or any specifications agreed to in writing by Licensor with a particular customer. This warranty does not cover any minor errors or deviations from the specifications that do not affect the proper functioning of the equipment. **EXCEPT FOR THE WARRANTIES SET FORTH ABOVE, THE SOFTWARE IS LICENSED "AS IS", AND LICENSOR DISCLAIMS ANY AND ALL OTHER WARRANTIES, WHETHER EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.**
8. **Licensee's Remedy.** You sole and exclusive remedy for any breach of Licensor's warranty shall be the repair or replacement, at Licensor's sole option, of any Software that does not conform to stated specifications. Licensor shall not be responsible for any failure arising from inadequate or improper use of the Software.
9. **Limitation of Liability.** Licensor's cumulative liability to you or any other party for any loss or damages resulting from any claims, demands, or actions arising out of or relating to this Agreement shall not exceed the purchase price paid to Licensor for the equipment. In no event shall Licensor be liable for any indirect, incidental, consequential, special, or exemplary damages or lost profits, even if licensor has been advised of the possibility of such damages.
10. **Trademark.** All ZIV trademarks (including ZIVERCOM, ZIVERLOG and ZIVERSYS) are common law trademarks of Licensor. No right, license or interest to such trademarks is granted hereunder, and you agree that no such right, license or interest shall be asserted by you with respect to such trademark.
11. **Licensee's Indemnity.** You shall defend, indemnify and hold Licensor harmless against any loss or damage of any kind arising from a breach by you of this License Agreement, or any use or misuse of the Software by you or your employees, agents or representatives, and from any other of your conduct or from any claim or action by any of your customers in connection with the Software or this License Agreement.
12. **Governing Law.** This License Agreement shall be construed and governed in accordance with the internal laws of the State of Illinois, U.S.A.
13. **No Waiv**er. The failure of either party to enforce any rights granted hereunder or to take action against the other party in the event of any breach hereunder shall not be deemed a waiver by that party as to subsequent enforcement of rights or subsequent actions in the event of future breaches.
14. **Entire Agreement**. This License Agreement is the entire agreement between you and Licensor with respect to the use of the software and supersedes all prior understandings or agreements between the parties. This License Agreement may be amended only by a writing signed by an officer of Licensor.

ZIV Aplicaciones y Tecnología S.L.
Parque Tecnológico, 210
48170 Zamudio (Bizkaia)
Apartado 757
48080 Bilbao - Spain
Tel.- (34) 94 452.20.03