OPU-1
Universal Power Line Carrier Terminal

Modular design & advanced features

• Simultaneous transmission of analog and digital channels and teleprotection signals

• Two available modulation schemes for the transmission of digital channels (QAM & OFDM)

• Independent frequency slots to solve frequency congestion and special topologies
**OPU-1**

**Description**

**Introduction**

The modular design of the OPU-1 terminal and its advanced features ensure a perfect fit to every user need. It can integrate a great variety of interfaces that allow the transmission of all type of services through a high-voltage line.

This modularity allows OPU-1 terminals to transmit analog, digital or both analog and digital channels simultaneously, including teleprotection.

**Operational characteristics**

When working with analog channels, the OPU-1 can transmit one or two 4 kHz standard channels in each direction.

The effective band of the channel can be used for the transmission of data at high speed, various VF telegraph channels, teleprotection signals or for a speech-plus service.

When working with a digital channel, the OPU-1 can support two different digital modulation schemes (QAM or OFDM).

When using QAM, it offers a transmission rate of 81 kbit/s in a bandwidth of 16 kHz, in each direction. 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 or 4 kHz bandwidth is also possible, either in superimposed, adjacent or non-adjacent bands.

With the OFDM digital modulation scheme, the OPU-1 can support a maximum transmission rate of up to 320 / 160 / 72 / 32 kbit/s in a bandwidth of 32 / 16 / 8 / 4 kHz, in each direction.

Examples of transmission capacity are shown in Figure 4.

**Key features:**

- Modular design.
- Simultaneous transmission of analog and digital channels including teleprotection.
- Different possibilities for the transmission of teleprotection signals.
- QAM or OFDM for best compromise between SNR, BW and transmission rate.
- Fully programmable (full coverage of the transmission frequency range).

![Figure 1 OPU-1 used to overcome frequency congestion](image-url)
Product overview

The OPU-1 terminal for 20 and 40 W PEP is made up of two chassis, one of 6 U which integrates the power supply, the optional redundant power supply, the management, processing and control unit, the input and output interfaces, the digital modem, as well as the optional modules, and the other of 3 U which integrates the power stage modules.

There are five slots in the 6 U chassis available for different analog options (see Technical specifications), and three slots available for an optional internal multiplexer, of up to three modules.

The digital user interface can be chosen from a number of different possibilities: Ethernet, G.703, V.35, V.11 and V.24/V.28.

An additional 3 U chassis is required for 80 W PEP or for an extra line filter.

There is a specific model for the Narrow-band High-Frequency teleprotection application that permits the transmission of up to 4 independent commands in a standard 4 kHz channel, 2 kHz being used for Tx and 2 kHz for Rx.

Key features:

- Automatic fall-back increase rates.
- Web Management system with LAN connection.
- IRIG-B port for GPS time synchronization.
- Chronological register with 1 ms resolution.
**Description**

**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 (see Figure 1) or even independent lines (see Figure 2). Apart from frequency congestion solution, this additional filter allows special topology applications such as Teed lines (see Figure 3).

In a twin-channel analog terminal also allows the transmission and reception bands of each channel to be non-adjacent.

**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. Both QAM and OFDM are supported by the OPU-1 and can be selected from the programming software.

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.

**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. For QAM, when the line conditions improve, the transmission rate is automatically re-established.

This automatic feature can be disabled if necessary.

For 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.

**Different possibilities for the transmission of teleprotection signals**
The teleprotection signals can be transmitted over a dedicated 4 kHz analog band or integrated into the digital operation band.

When using the analog band the teleprotection can be transmitted using tones (SINGLE TONE or DUAL TONE), which can also be integrated into the digital operation band.

The high-frequency transmission bandwidth can be optimized in those cases where only teleprotection signals need to be transmitted, occupying 2 kHz for transmission and 2 kHz for reception (Narrow-band High-Frequency teleprotection application).

**Management System**
The OPU-1 terminals have a built-in Web server containing all the HTML pages necessary to carry out programming and monitoring of the system. In this way, OPU–1 terminals are fully programmed, monitored and managed from a PC running a standard Web browser, without the need for additional software.

**SNMP agent**
The OPU-1 terminals, furthermore, include an SNMP able to make GET and SET operations and send TRAP and INFORM notifications (unsolicited information spontaneously transmitted) about alarms and events of the terminal to the devices specified by the user, and this makes it possible to monitor the OPU-1 from an SNMP management application.
Technical specifications

General characteristics

Operating mode
Simultaneous transmission of analog and digital channels including TP

Modulation
Analog channel: Single side-band (SSB) with suppressed carrier.
Digital modem: QAM with Trellis Coding or OFDM

Transmit and receive bands
Analog channel: Erect or inverted, adjacent or non-adjacent
QAM: Superimposed, adjacent or non-adjacent
OFDM: Adjacent or non-adjacent

Basic bandwidth
Analog channel: 4 kHz per channel in each direction
QAM: 4 kHz, 8 kHz, 16 kHz, 32 kHz, in each direction
OFDM: 4 kHz, 8 kHz, 16 kHz, 32 kHz, in each direction

Transmission capacity
See some examples in Figure 4

Figure 4   Examples of transmission capacity

NOTE: These values depend on the line signal-to-noise ratio

Supervision of data link quality
According to the G.821 standard

GPS time synchronization
IRIG–B port

Chronological register
1 ms resolution. 1000 alarms and events
## Key features:

- 1 or 2 standard 4 kHz channels.
- 81 kbit/s in 16 kHz bandwidth (QAM).
- Up to 324 kbit/s in 32 kHz bandwidth (OFDM).
- 20, 40 or 80 W PEP, shared between the analog and digital channels.
- Compact 19”/9 U chassis for 20 W and 40 W.
- Additional 19”/3 U chassis for 80 W or an extra line filter.
- Dedicated 19”/3 U chassis for the Narrow-band High-Frequency teleprotection application.

## Technical specifications

### High-frequency characteristics

<table>
<thead>
<tr>
<th>Frequency range</th>
<th>From 36 kHz to 512 kHz (from 30 kHz to 1016 kHz upon request)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal impedance</td>
<td>Selectable among 50, 75, 125 and 140/150 Ω</td>
</tr>
<tr>
<td>Return loss</td>
<td>Better than 10 dB</td>
</tr>
<tr>
<td>Tapping loss</td>
<td>In accordance with IEC 495, Fig. A.1 with n=4 (digital channel), figure 5 (analog channel)</td>
</tr>
<tr>
<td>PEP</td>
<td>20, 40 or 80 W, shared between the analog and digital channels</td>
</tr>
<tr>
<td>Receiver sensitivity</td>
<td>-30 dBm (measured in the pilot signal)</td>
</tr>
<tr>
<td>Receiver selectivity</td>
<td>Higher than 65 dB at 300 Hz, and higher than 75 dB starting from 4 kHz (analog channel); in accordance with IEC 495 cls. 5.3.1.5 (analog and digital channels)</td>
</tr>
</tbody>
</table>

### General characteristics of the QAM digital modem

<table>
<thead>
<tr>
<th>Gross (Net) bit rate</th>
<th>QAM of 16 kHz: 81 kbit/s (79 kbit/s), 40.5 kbit/s (39.5 kbit/s) or 27 kbit/s (26.3 kbit/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>QAM of 8 kHz: 40.5 kbit/s (39.5 kbit/s), 20.25 kbit/s (19.75 kbit/s) or 13.5 kbit/s (13.15 kbit/s)</td>
</tr>
<tr>
<td></td>
<td>QAM of 4 kHz: 20.25 kbit/s (19.75 kbit/s), 10.125 kbit/s (9.87 kbit/s) or 6.75 kbit/s (6.55 kbit/s)</td>
</tr>
<tr>
<td>Minimum S/N ratio, with white gaussian noise (AWGN) at receiver input (16 kHz QAM)</td>
<td>BER = 10^{-3}: 20 dB at 81 kbit/s, 12 dB at 40.5 kbit/s, 8 dB at 27 kbit/s</td>
</tr>
<tr>
<td></td>
<td>BER = 10^{-6}: 23 dB at 81 kbit/s, 16 dB at 40.5 kbit/s, 12 dB at 27 kbit/s</td>
</tr>
<tr>
<td>Internal latency</td>
<td>10 ms</td>
</tr>
</tbody>
</table>

### General characteristics of the OFDM digital modem

| Max. Gross bit rate | 324 kbit/s (32 kHz), 160 kbit/s (16 kHz), 72 kbit/s (8 kHz), 32 kbit/s (4 kHz) |

### Web management interface

- 10/100 Base-Tx with RJ-45 connector

### SNMP agent

- **SNMP protocol**: v1, v2c and v3
- Transmission of both unconfirmed and confirmed notifications (traps and informs) of alarms and events of the terminal. INFORM available in V2c and V3 only
- Supervision of certain monitorable parameters of the terminal by means of a GET operation
- Modification of certain configurable parameters of the terminal by means of a SET operation

### Supervision by means of SNMP agent

- Possible from an SNMP application
### Technical specifications

#### User Interfaces

- **Analog channel**
  - **Available band**: From 300 Hz to 3850 Hz
  - **Interfaces**: Two 4-wire inputs and outputs per channel
  - **Nominal impedance**: 600 Ω, balanced
  - **Return loss**: Better than 14 dB
  - **Nominal level**: Programmable between -20 dBm and +6 dBm

- **Digital channel**
  - **Synchronous data port**: Configurable V.35 or V.11 (1200 to 72000 bit/s) or G 703 (64 kbit/s), co-directional
  - **Asynchronous data port**: V.24/V.28 (RS-232C, 200 to 14400 bit/s)
  - **Ethernet data port**: 10/100Base Tx with built-in bridge functionality
  - **Optional built-in multiplexer**: DMPU/TMPU modules for additional voice and data channels

- **Analog optional modules**
  - Speech module
  - Asynchronous programmable modem
  - 2 or 4-command teleprotection system using single tone in a 4 kHz bandwidth
  - 2 or 4-command teleprotection system using single tone or dual tone, which is integrated in the QAM digital band
  - Teleprotection system of up to four independent commands or in any combination for dual tone in a bandwidth of 1 kHz, 2 kHz or 4 kHz
  - Digital transit filter
  - Input/output combiner

#### Alarms

3 relays programmable by the user and 1 power-supply module relay, all of them with changeover contact

#### Power supply

48 VDC, 110 to 250 VDC and VAC ±20%. Possibility of having redundance on the power supply (optional)

#### Dimensions

- **Basic terminal**: 483 x 398 x 355 mm (one basic 19”/6 U chassis and one 19”/3 U chassis that integrates the power stage modules for the basic model or for the Narrow-band High-Frequency teleprotection application)
- **80 W or additional line filter**: 483 x 548 x 355 mm (one 19”/6 U chassis and two 19”/3 U chassis)
- **Weight**: 23 kg (20/40 W); 33 kg (80 W)

#### Operating conditions

- **Temperature and humidity**: From −5 °C to +55 °C and relative humidity not greater than 95%, in accordance with IEC 721-3-3 class 3K5 (climatogram 3K5)
7 Manufacturing facilities & 14 Customer support centers

Chicago (USA)  
Mexico (MEX)  
Niteroi (BRA)  

Dublin (IRL)  
Newcastle (GBR)  

Paris (FRA)  

Zamudio (ESP)  
Madrid (ESP)  
Barcelona (ESP)  

Dubai (ARE)  
Ryhad (SAU)  
Bangalore (IND)  
Singapore (SGP)  
Yakarta (IDN)  

Making the Smart Grid Real  ...with you