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Transmission and interface characteristics of the galvanic leased lines service

Table of Contents

0. Document history

Every update of this document results in a complete new version with new version number and release date.

Version	Date	Main or important changes since previous version
1.0	02 JUN 1999	First version
2.0	18 MAY 2001	Addition of technical specifications
2.1	13 AUG 2001	Correction of a typographical error

1. Introduction

The purpose of this document is to describe the transmission and interface characteristics of the galvanic leased lines service. With the galvanic leased line service Proximus wants to offer to its customers copper pairs of its cables belonging to the same local network.

Please keep in mind that the local cable, which is described in annex A of this document, was essentially designed for transmitting analog telephone signals; obviously, this means that optimal use of this cable requires that certain conditions have to be met. For these reasons, Proximus splitted its galvanic leased lines offer in 3 types, namely:

- galvanic leased lines, type A:
  This type of galvanic leased line refers to transmission of signals within the voice band.

- galvanic leased lines, type B:
  This type of galvanic leased line refers to transmission of signals for which the binary rate is smaller or equal to 64 kbit/s.

- galvanic leased lines, type C:
  This type of galvanic leased line refers to transmission of signals using an ISDN Basic Access line code (as defined in ETR 80).

2. Network interface characteristics

2.1 mechanical characteristics

- The customer can choose between a two-wire and a four-wire galvanic line.

- The interface offered to galvanic leased line customers consists of a wall socket which is compatible with the plug described in the technical specification to be find in annex D.

2.2 electrical characteristics

- The characteristics of the transmission signal that may be offered by the customer's terminal to the input of the galvanic leased line are described in the technical specification to be find in annex B, namely:

  ∗ in paragraph B.3.2 of annex B, for the galvanic leased lines, type A; ∗ in paragraph B.3.3 of annex B, for the galvanic leased lines, type B; ∗ in paragraph B.3.4 of annex B, for the galvanic leased lines, type C.

3. Transmission characteristics

- The galvanic leased line is established by means of one or more cable sections of which the conductors can be connected to one another. The characteristics of this cable are described in annex A.

- The transmission characteristics (cf. attenuation, passband, etc.) of the galvanic leased line are mainly a function of the primary parameters of the local cable which is being used to establish the galvanic leased line, as well as of the line signal which is transmitted by the customer's terminal and of course also of the length of the galvanic leased line:

  * The primary parameters of the local cable, used for setting up the galvanic leased line, are described in annex A of this document.

  * The characteristics of the line signal transmitted by the customer's terminal, in particular the maximum allowed values for the transmitting signal, are described in the technical specification to be find in annex B.

  * To be able to offer its customers the best possible quality, Proximus very carefully selects the pairs in his local cable that can be used for the services it provides, especially those services requiring higher transmission speeds.

  * The use of a low-band passive filter in order to protect the network against spurious signals is possible. In that case, this filter will be installed by Proximus at the LEX (local exchange) side. The theoretical characteristics of those filters should be the following ones:

    * Bandwidth at - 3 dB : 0 - 100 kHz

    * Attenuation : 60 dB/decade

    But practically the used filters will present the following characteristics:

    * Attenuation : at 100 kHz : - 5 dB
      at 160 kHz : -19 dB

  * The length of the galvanic line is of course a function of the location or address where the customer's terminals are set up. Since galvanic lines can only be set up in the local Proximus network, it is safe to say that the distance to be crossed should be between less than 1 km and 15 km.

    The local network is built in a star-shaped architecture around the LEX. Because of this, the client has to consider the fact that the distance between the 2 end points of his galvanic line can highly differ from the bird's-eye view distance between his 2 end locations. This can be important if the above mentioned distances are a critical factor for the signal to transport.

4. Customer's terminal

The customer's terminal that will be connected to a galvanic leased line has to be compliant with the technical specification to be find in annex B according to the desired type of galvanic leased line.

5. References

ETR 80: ETSI Technical Report: Transmission and Multiplexing (TM) ; Integrated Services Digital Network (ISDN) basic rate access; Digital transmission system on metallic local lines. (second edition, November 1996)

Annex A Characteristics of local network cables

A telecommunications cable consists of a number of *cores* surrounded by a layer of insulating material. The cores of such a cable are always grouped in *pairs* or *conductors*.

Cables in the local network are designed to ensure optimum transmission and to guarantee minimum mechanical resistance. For this reason, the description of the cables below consists of a section dealing with electrical characteristics and one dealing with mechanical characteristics.

Mechanical characteristics

- The conductors of a local cable are round, full wires consisting of 98%-99% pure electrolytic copper.
- A conductor is isolated by a layer of synthetic material (usually polyethylene).
- Conductors have a 0.5 mm or 0.6 mm diameter (*exceptionally, in some areas, the local network still contains cables with pairs having a diameter of 0,4 mm, 0,8 mm, or even 1 mm*)
- The set of conductors is covered by a waterproof extruded cable sheath (usually polyethylene). Under normal circumstances, the cable is also longitudinally waterproof.
- The cable cores are arranged in a specific manner. Two conductors (e.g. of a telephone circuit) must be arranged symmetrically in relation to all other conductors. For this reason, conductors are twisted and placed in coaxial cylindrical layers *(a base unit consists, for example, of four conductors twisted around one another and from which two telephone circuits can be created; a cross section shows that these four conductors form the corners of a square. Conductors located on two opposite angular points form a circuit).*

Electrical characteristics

- Since the signals to be transmitted are variable electrical voltages and currents, the cable conductor must be a good transmission medium for electrical signals. The important elements are defined for a unit length of one kilometer and are called primary electrical parameters of a conductor. These parameters are kilometer resistance R, kilometer inductance L, kilometer capacity C and kilometer transverse conductance G.

  ∗ kilometer resistance R
  - ♦ Kilometer resistance is the input resistance of a one kilometer conductor that is looped at the remote end; the value of this parameter is therefore the resistance of a conductor with a length of two kilometers.
    - ♦ R is 180 Ohm for a conductor diameter of 0.5 mm (at 20°C); ♦ R is 123 Ohm for a conductor diameter of 0.6 mm (at 20°C).
  - ♦ It should be noted that due to the skin effect, the alternating current resistance is higher than the direct current resistance indicated above.

  ∗ kilometer inductance L
  - ♦ In a symmetrical pair cable, conductors forming a pair lie very close to one another; kilometer inductance L is therefore very low (approx. 0.5 mH per kilometer).

  ∗ kilometer capacity C
  - ♦ The capacity between two conductors of the same pair can be measured while the rest of the cable conductors are connected to each other and to an equipotential point of the measuring device. This is the kilometer capacity C having a nominal value between 38.5 nF/km and 50 nF/km at 800 Hz.

* kilometer transverse conductance G

- ♦ Kilometer transverse conductance G depends on the frequency concerned and the kilometer capacity C. In principle, the kilometer transverse conductance may be considered as negligible.
- ♦ G can roughly be calculated with the help of the following formula, in which k has a value between 0.005 and 0.02 (w = frequency in rad/s):

$$G=k.w.C$$

- The insulation resistance of each conductor in relation to the rest of the conductors (and eventually the shielding) is at least 5,000 MOhm/km.

Annex B BGC/SP-102: Technical specification concerning terminal equipment intended to be connected to the point-to-point galvanic leased lines of the Proximus telephone network

B.1 Introduction

This specification pertains to telecom terminal equipment intended to be connected to symmetrical point-to-point galvanic leased circuits of the Proximus telecommunication network consisting of infrastructure cables. It applies irrespective of the type of signals transmitted (data, voice, images, signalling, etc.).

B.2 Definitions and abbreviations

* *Symmetrical point-to-point galvanic leased circuit*

The point-to-point galvanic leased circuit is a two-wire or four-wire circuit made of unloaded twisted copper pairs linking up two end points by means of the telephone cables of the local network. These circuits have no separation, coupling, correction, amplification or other such devices, but are usually made of various sections of conductors that have different characteristics.

A few technical values are given below for information:

> The diameter of the conductors is usually 0.5 mm or 0.6 mm (sometimes 0.8 mm and 1.0 mm)
> In the case of a 0.5 mm diameter, the nominal loop resistance is 180 Ohm/km, and the nominal capacity 50 nF/km.
> In the case of a 0.6 mm diameter, the nominal loop resistance is 123 Ohm/km, and the nominal capacity 38.5 or 46.0 nF/km.

* *Voice-band transmission*

Systems that do not require the transmission of signals comprising frequencies outside what is known as the "telephone" band (here: 0 to 4000 Hz) such as voice frequency modems, faxes, telephone sets, PBXs, etc.

* *Broadband transmission (limited to 100 kHz at - 3dB)*

Systems that generate a frequency spectrum on line not limited to what is known as the "telephone" band.

* *Pass band*:

The width of the useful and total band is defined as follows:

F= The highest frequency of the spectrum measured at point -10 dB in relation to the level of the useful component of the spectrum with the highest level.

F_1 = The highest frequency of the spectrum measured, including the harmonics. Components below - 60 dBm/600 Ohm will be ignored.

B.3 Technical requirements

To cover as much as possible the extended range of terminal equipments intended to be connected to galvanic lines:

* Type A: equipment using a voice band transmission

* Type B: equipment using a broadband transmission and not covered by an ETR, or TS, referenced in this specification (limited to 100 kHz at - 3 dB).

* Type C: Equipment using a broadband transmission covered by elements found in ETR 080.

B.3.1 General technical specifications valid for all the types considered

B.3.1.a) Line polarity

The line must be insensitive to polarity. The reversal of the line wires must not affect the operation of the equipment.

B.3.1.b) Insulation

Different line accesses must always be isolated from each other. The insulation resistance must be greater than 10 MOhm under 200 VDC. This is also valid for the insulation between the transmission and reception circuits. This requirement is lifted in the case of multi-line equipment using a centralised power supply to provide direct current on the line. In the latter case, the line interfaces of this equipment must be symmetrical to the earth.

B.3.1.c) Signalling and power feed

For systems that use direct current signalling and/or a power feed and/or a ring voltage, the safety requirements for the data processing equipment (IEC 950 standard) apply. The overall aspect concerning electric safety has to be covered by a declaration of conformance (Directive N° 1999/5/EC of the European Parliament and the Council of 09/03/1999). The direct current is limited to 120 mA in ALL cases.
When a dialling signalling by loop opening is used, it will have a maximum rhythm of 10 Hz ± 1 Hz.
If a ring voltage is used, it must be sinusoidal, with a frequency between 20 and 55 Hz. The internal impedance of the ring current generator (seen from the access to the line) must be at least 400 Ohm.

Note: When a feeding bridge is needed for conformity tests, it will be compliant with that used for the specification BGC/SP-201 (document available by Belcomlab).

B.3.2 General technical specifications valid for "Type A" (equipment using a voice-band transmission)

B.3.2.a) Access characteristics

In all operating modes, the equipment must comply with points C.4.1.1. and C.4.1.2. of BGC/SP-202 (to be find in Annex C).

B.3.2.b) Line signal specifications:

Transmission level: Point 4.4.1. of ETS 300 001 (Belgian values) applies (measurements to be carried out without feeding bridge, if necessary).
Under no circumstances must the transmission power of the voice band (300 Hz - 3400 Hz) exceed 0 dBm / 600 Ohm.
Aside from the voice band, point 4.4.3 of ETS 300 001 (Belgian values) shall apply.

B.3.3 General technical specifications valid for "Type B" (equipment using a broadband transmission not covered by an ETR, or TS, referenced in this specification.

B.3.3.1 Information baud rate

Equipment for binary information interchange must have a baud rate lower than or equal to 64 kbits/sec.

B.3.3.2 Impedance

The impedance of the line interface, at different transmission speeds and/or with different types of coding or signals transmitted, will be preferably adapted to the characteristic impedance of the line at the central frequency of the useful spectrum of the modem.

Typical values of the line impedance:

600 Ohm at 1600 Hz 300
Ohm at 6000 Hz
150 Ohm at 32 kHz 120
Ohm at 64 kHz
100 Ohm at 200 kHz and beyond

The impedances of the transmission and reception circuits will be the same with a tolerance of ± 20% measured at the central frequency of the useful spectrum. The measurement will be repeated for each impedance when different options are provided.

The assembly to be carried out in order to measure the impedance is described in paragraph App.A.1. of Appendix A.

B.3.3.3. *Symmetry*

The symmetry of the input and output interfaces in relation to the earth must comply with the following specifications:

From 10 Hz to $F_{[Hz]}$: > = 48 db
From $F_{[Hz]}$ to $F_{1[Hz]}$: 48 db - 10 dB/ decade

(F and F_1 are defined in paragraph B.2).

The assembly to be carried out in order to measure the symmetry is described in Paragraph App.A.2. of Appendix A.

B.3.3.4 *Transmitted frequencies spectrum*

The spectrum will be limited to 130 kHz (point - 30 dBm / 600 Ohm) in all cases. The measuring assembly used is the same as for the test described in paragraph App.A.2.1. of Appendix A.

B.3.3.5 *Crosstalk*

The noise level induced in neighbouring pairs of the cable by the signal transmitted on line by the equipment will be limited to - 72 dBmP/600 Ohm (or 0.2 mV), measured through a psophometric filter. If this limit is exceeded, the transmission level will have to be reduced accordingly.

The measurement must be carried out with the maximum transmission level for each binary rate and for each type of signal coding, as the impedance of the interface is adapted according to paragraph B.3.3.2. The assembly to be carried out in order to measure the crosstalk is described in paragraph App.A.3. of Appendix A.

B.3.3.6 *Transmission level*

The maximum transmission level must under no circumstances exceed 0 dBm/ref. 600 Ohm.

For signals transmitted in the voice band, paragraph 4.4.1. of specification BGC/SP-201 (document available by Belcomlab) shall apply. Beyond the voice band, the maximum voltage of the signal emitted on line will be limited to 3 Vpp. The equipment must feature operating modes that can differentiate an "exclusive signal transmission in the voice band" from a "signal transmission outside the voice band." Where necessary, if no differentiation is possible, the latter requirement shall apply exclusively.

Any programming possibility whereby the levels specified above are exceeded, in view also of the limitations resulting from the test described in paragraph B.3.3.5, must be made impossible.

The assembly to be carried out in order to measure the transmission level is described in paragraph App.A.4. of Appendix A.

B.3.4 General technical specifications valid for "Type C" (equipment using a broadband transmission covered by elements in ETR 080)

This point concerns the equipment using a digital transmission as defined in Appendices A or B of ETR 080.

B.3.4.1 The on-line coding will be compliant with either paragraph A1, or paragraph B1 of ETR 080.

B.3.4.2 Depending on the on-line coding used, the modulation speed will be compliant with either paragraph A2, or paragraph B2 of ETR 080.

B.3.4.3 Depending on the on-line coding used, the output transmission characteristics will be compliant with either paragraph A12 or paragraph B12 of ETR 080.

B.3.4.4 Depending on the on-line coding used, the transmission / reception interface characteristics will be compliant with either paragraph A13 or paragraph B13 of ETR 080.

APPENDIX A

App.A.1. Assembly for measuring the impedance

As the equipment is fed and does not transmit any signal, an impedance measuring bridge is connected in succession to the transmission and reception interface.

App.A.2. Assembly for measuring the symmetry

App.A.2.1. F and F_1 frequency search.

The assembly described in paragraph App.A.4. is used. A symmetrical 10 MOhm and 40 MHz broadband impedance spectrum analyser is connected to the transmission circuit of one of the terminals; F and F_1 are sought.

App.A.2.2. *Measuring the symmetry*

The equipment is then disconnected from the line and the symmetry is measured in compliance with recommendation 0.9 of the CCITT on transmission and reception circuits.

For this test, the equipment must be capable of not emitting any signal on the line output.

App.A.3. Assembly for measuring the crosstalk

The measurement will be carried out with the maximum transmission level for each binary rate and for each type of signal coding; the impedance of the line interface being adapted according to paragraph B.3.3.2.

Two terminals will be interconnected by a simulated line, 3.5 km long and 0.4 mm or 0.5 mm in diameter, with a crosstalk attenuation of 70 dB at 800 Hz on an identical adjacent circuit.

A high impedance psophometer is connected to this adjacent circuit, which ends at the two ends with a resistance of 600 Ohm. The measurement will be carried out on the two ends of the adjacent circuit.

App.A.4. Assembly for measuring the transmission level

Two identical terminals will be interconnected by means of a galvanic artificial line with the following characteristics:

- Diameter: 0.5 mm or 0.6 mm (loop resistance: 180 Ohm/km, or 120 Ohm/km, 700 micro H/km);
- Capacity: 56 nF/km; - Pass band: 500 kHz;
- Length: adjusted to the maximum value for which the modems function without errors.

App.A.4.1. *Measuring the level*

A level measurer covering the entire spectral band transmitted on line (harmonics included) with a 10 kOhm internal impedance is connected to the transmission circuit of one of the terminals. The 600 Ohm reference is used for reading the level.

App.A.4.2. *Measuring the voltage*

A symmetrical 10 MOhm internal impedance and 200 MHz pass band oscilloscope is connected to he transmission circuit of one of the terminals. The biggest difference in voltage between two successive opposite voltage points (Vpp) is measured.

Annex C BGC/SP-202: Technical specification for terminals intended to be connected to analogue leased circuits of the Proximus telecommunication network.

C.1. Introduction

This specification was written with due account of the following essential requirements, as defined in Directive 91/263/EEC, namely:

a) the safety of the user, insofar as not provided by Directive 73/23/CEE;
b) the safety of the staff of the Proximus telecommunication network, insofar as not provided by Directive 73/23/CEE;
c) the electromagnetic compatibility requirements, insofar as they are specific to the terminal equipment;
d) the protection of the public telecommunication network against all damages;
e) if necessary, the efficacious use of the radio frequency spectrum;
f) the inter-operation of terminal equipment with the equipment of the Proximus telecommunication network to establish, modify, charge, maintain and release real and virtual connections;
g) the inter-operation of terminal equipment through the Proximus telecommunication network, in cases where justified.

C.2. Scope

This specification is applicable for all terminal equipment intended to be connected to analogue leased circuits belonging to the Proximus telecommunication network.

It covers only the access to this network, without dealing with the end-to-end inter-operation.

In addition to this specification, other specifications also apply, in particular:

BGC/SP-001 for PBXs (document available by Belcomlab);
BGC/SP-217 for the voice cards of digital transmission systems (document available by Belcomlab).

All these specifications in no way modify the requirements contained in this document.

C.3. Definitions and abbreviations

ETS:	European Telecommunication Standard
ITU-T:	International Telecommunication Union - Telecommunication Standardisation Sector;
PSTN:	Public Switched Telephone Network
Analogue leased circuit:	Leased circuit according to ITU-T recommendations M. 1040, M.1025 or M.1020.
Z_c:	Complex impedance (defined in ETS 300 001, section 4.1.2 (B) 1), applicable for analogue access to digital PBX equipment.

C.4. Technical requirements

C.4.1. Access characteristics

C.4.1.1. As regards the impedance of the terminal, the requirements in ETS 300 001, paragraph 4.1.2 apply.

Note: 1. The test method described in this ETS applies, with the exception of the feeding bridge, which does not of course apply to a leased circuit.

2. For the analogue access to digital PBXs, the reference impedance for 4-wire applications can be 600 Ohm or Z_c, according to the applicant's choice.

C.4.1.2. As regards the symmetry of the terminal, the requirement in ETS 300 001 paragraph 4.2. applies.

Note: 1. The test method described in this ETS applies, with the exception of the feeding bridge, which does not of course apply to a leased circuit.

2. For the analogue access to digital PBXs, the reference impedance for 4-wire applications can be 600 Ohm or Z_c, according to the applicant's choice.

C.4.1.3. Different line accesses (e.g. transmission and reception pairs of a terminal intended to be connected to a 4-wire connection) will be electrically insulated from each other. The insulation resistance will be at least 10 MOhm, measured with a test voltage of 500 VDC.

C.4.2. Specifications for the line signal

C.4.2.1. Transmission level

C.4.2.1.1. For the maximum power emitted by the terminal, the requirement in ETS 300 001 paragraph 4.4.1. applies.

Note: The test method described in this ETS applies, with the exception of the feeding bridge, which does not of course apply to a leased circuit.

C.4.2.1.2. The terminal will have at least one transmission level adjustment point less than or equal to - 15 dBm (absolute value greater than or equal to 15 dBm).

Note: For the analogue access to digital PBXs, the reference impedance for 4-wire applications can be 600 Ohm or Z_c, according to the applicant's choice.

C.4.2.1.3. The maximum transmission level will have a value between - 15 dBm and 0 dBm.

Note: For the analogue access to digital PBXs, the reference impedance for 4-wire applications can be 600 Ohm or Z_c, according to the applicant's choice.

C.4.2.1.4. Between the limits - 15 dBM and the maximum transmission level, the transmission level will be adjustable by steps of 3 dB maximum.

Note: For the analogue access to digital PBXs, the reference impedance for 4-wire applications can be 600 Ohm or Z_c, according to the applicant's choice.

C.4.2.2. Spectra

The specification in the paragraph of Document BGC/SP-201 (document available by Belcomlab) referring to paragraph 4.4.3. of ETS 300 001 applies.

Note: 1. The test method described in this ETS applies, with the exception of the feeding bridge, which does not of course apply to a leased circuit.

2. For the analogue access to digital PBXs, the reference impedance for 4-wire applications can be 600 Ohm or Z_c, according to the applicant's choice.

C.4.2.3. If no signal is sent online, the level of every undesirable signal must not exceed - 60 dBm.

C.4.3. Instructions concerning the physical connection

The terminals with individual connection to the line must be equipped with a connector according to specification BGC/SP-222 (to be find in Annex D).

The cabling of this connector will be carried out as follows (for the numbering of the pins, see Document BGC/SP-223 (document available by Belcomlab)):

2-wire connection: pins 1 and 4;
4-wire connection: Transmission pair: pins 5 and 7;
reception pair: pins 1 and 4.

C.5. Open Network Provision (ONP) leased lines

Terminals intended to be connected to analogue ONP leased lines comply with the Technical Bases for Regulation (TBR) documents.

Annex D BGC/SP-222: Technical specification for connectors to be used with terminals intended to be connected to analogue leased circuits of the Proximus telecommunication network.

D.1. Scope

This specification set out the technical instructions to be complied with by the plugs of devices intended to be connected to analogue leased circuits or leased circuits operating on the base band.

REMARKS: 1. The plugs in question are known as "ADO plugs" or "8-pole plugs."

2. The regulations used by the Proximus operator for the termination mode of the analogue leased circuits are given in Document BGC/DT-34 (document available by Belcomlab).

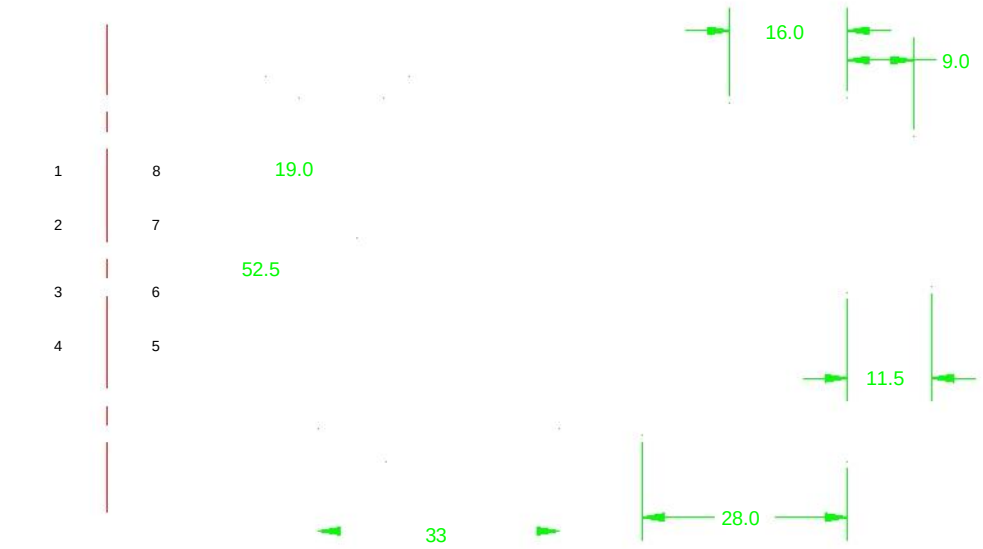
The specification BGC/SP-202 (to be find in Annex C) refers to the present specification.

D.2. Definitions and abbreviations

Analogue leased circuit:	Leased circuit according to ITU-T Recommendations M. 1040, M.1020 or M.1025.
Base band circuit:	Galvanic point-to-point leased circuit.

D.3. Technical instructions

The (ADO) plugs must be compliant with the reference technical plans in Figure 1 as regards the mechanical dimensions.



Note : The measures are in millimetre

Fig.1. Diagrams of principle with numbering of contacts and reference plans.

The welded connections other than the simple plug and the line cord, as indicated in Figure 1, can also be replaced by an RJ11 modular connector. The wiring will be adapted in such cases as indicated above.

For 2-wire circuit:

ADO side		Modem side
1 ----------	----------	34
4 ----------	----------	

For 4-wire circuit:

ADO side		Modem side
1 ----------	----------	5 (REC A) 4 -----
----------	----------	2 (REC B)
7 ----------	----------	3 (TR A)
5 ----------	----------	4 (TR B)