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Technical specifications for the use of raw copper and shared pairs on the Belgacom network

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	13 JUL 2001	First version

1. Introduction

This specification applies in matters of telecommunication terminal equipments designed to be connected on lines of the symetrical raw copper or shared pairs type, on the Belgacom telecommunication network. These lines will be realized on access network cables.
This specification applies independently of the transmitted signals nature (data, voice, pictures, signalling, ….).

The present User to Network Interface specification doesn't apply to the sub local loop unbundling.

In order to safeguard the integrity of local access lines and maintain the performance of higher bandwidth services, Customers must signify their acceptance of and willingness to comply with the Belgacom technical requirements before they can be supplied with the raw copper or shared pairs products.

Conformity with the Belgacom technical requirements is essential for all if the performance and reach of higher bandwidth services is to be maximised, and failure to comply is a serious matter.

In addition equipment has to conform to other relevant standards, such as those governing product safety and EMC [ETSI EN 300 386 V1.2.1].

This document contains a detailed description of the requirements that equipment must meet to be suitable for use on unbundled local loops. References are made to international standards and to official Belgacom User to Network Interface specifications.

2. Transmission properties of the access network

2.1. Generalities

A subscriber loop consists of sections of twisted pairs cables of different gauges. All the sections are buried and connected together by means of electrical joints, called splices, directly placed in the ground or sometimes in a manhole.

In the ideal situation, the Access Network has a star configuration with the feeder cable bundles going from the main distribution frame to the street cabinet. From the street cabinet, via distribution cables and drop wires, the wire pairs are terminated in the individual customer sites. The reality shows that cable arrangements leads sometimes to a meshed structure in the feeding network.

Each telecom cable consists of a number of copper conductors grouped in quads; these quads can be arranged in bundles or in layers, depending on the type of cable.

Definition:

We will consider 2-wire circuits realized by using unloaded twisted copper pairs. These will bind the two ends via infrastructure telephony cables. These circuits don't contain any separating, coupling, correcting, amplifying … elements. They are usually made of different conductor sections with different characteristics.

2.2. Physical characteristics of the cables

- A conductor can be isolated by a layer of paper (in the old generation cables) or synthetic material, usually polyethylene.
- Most of the conductors have a 0.5 mm or 0.6 mm diameter; distant customers however need to be connected via conductors of 0.8 and 1.0 mm; 2000 pairs cables going out of the central office are sometimes made of 0.4 mm conductors.
- In paper insulated cables, the conductors are surrounded by a lead sheath, generally protected by armouring and polyethylene sheath.
- In plastic insulated cables used in the distribution network, the conductors are surrounded by a polyethylene sheath.
- In plastic insulated cables used in the feeding network, the conductors are surrounded by an aluminium screen, a polyethylene internal sheath, an armouring and a polyethylene external sheath.
- The plastic cables are in the majority of the cases longitudinally waterproof.

2.3. Electrical characteristics of the cables

The table below gives some typical characteristics of the access network cables [figures given by the cable manufacturers or by measurements in the field]

Diameter	LR	KC	A800	A40.000	A150.000	A300.000
0.4 mm	275	55	2.0	7.5	12.5	14.5
0.5 mm	180	50-55	1.3	6	9	11
0.6 mm	123	38.5-46	1.0	4	6.5	9
0.8 mm	69	38.5	0.7	2.5	5	6

LR = Loop Resistance in Ohm/km
KC = average Kilometric Capacity in nF/km (it depends on the type of cable)
A800 = Attenuation measured at 800 Hz in dB/km
A40.000 = Attenuation measured at 40.000 Hz in dB/km
A150.000 = Attenuation measured at 150.000 Hz in dB/km
A300.000 = Attenuation measured at 300.000 Hz in dB/km

NB: the attenuation values are conditional. A loop is made of several pieces of cables and then additional attenuation and reflections due to the splices and the different cable gauges will occur.

3. References

In case a new version of the references below is published, the reader must always refer to the most recent version.

The User to Network Interface Specifications published on the Belgacom Website via Internet are available for your information but have no official value.

The only User to Network Interface documents with an official value are printed on a specific paper. If you want to get an official version of a User to Network Interface Specification, please order it by sending your request to:

Belgacom/Belcomlab
Rue Carlistraat 2
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When a reference is made to an international standard document and ETSI document and when a list of values is given (if the country particularities are foreseen), the Belgian value must always been taken.

3.1. General

ETSI TR 101 830-1 V1.1.1 (2000-09) :	Transmission and Multiplexing (TM); Spectral Management on Metallic Access Networks; Part 1: Definitions and Signal Library
EN 60950 (CENELEC) :	Safety of information technology equipment including electrical business equipment
ITU-T Rec. 0.153 :	Norme de l'ITU-T. Basic parameters for the measurement of error performance at bit rates below the primary rate.
CCITT Rec. 0.9 :	Measuring arrangements to assess the degree of unbalance about earth. (Blue book vol IV)
Directive 1999/5/CE :	Directive du Parlement Européen et du Conseil, du 09 mars 1999, concernant les équipements hertziens et les équipements terminaux de télécommunications et la reconnaissance mutuelle de leur conformité (1999/5/CE) publiée au journal officiel des Communautés européennes du 07.04.1999.

3.2. PSTN

ETS 300 001 :	European Telecommunication Standard. Attachments to the Public Switched telephone Network (PSTN) ; General requirements for equipment connected to an analogue subscriber interface in the PSTN (Edition 3 1996-03) (Belgian part)
ETSI-specification “EG 201 188 V1.1.1” :	Public Switched Network (PSTN); Network Termination Point (NTP) analog interface; Specification of physical and electrical characteristics at a 2-wire analog presented NTP for short to medium length loop applications (1999-06)
Belgacom – User to Network Interface (UNI) Specification :	“Analog Subscriber Line Signalling (Basic Call)” (ref.: BGC_D_48_9807_30_02_E.DOC) http://www.belgacom.be

3.3. ISDN

ETSI TS 102 080 V1.3.2. (2000-05*)* :	Transmission and Multiplexing (TM); Integrated Services Digital Network (ISDN) basic rate access, Digital transmission system on metallic local lines”.

3.4. ADSL

ETR 328:	Transmission and Multiplexing (TM) ; Asymmetric Digital Subscriber Line (ADSL) ; Requirements and performance
ITU-T Recommendation G.992.1:	“Asymmetrical Digital Subscriber Line (ADSL) Transceivers”.
ANSI Standard T1.413-1998 :	“Network and Customer Installation Interfaces – Asymmetrical Digital Subscriber Line (ADSL) Metallic Interface”.
ETSI Technical specification TS 101 388 :	“Transmission and Multiplexing ; Access transmission systems on metallic access cables ; Asymmetric Digital Subscriber Line (ADSL) – Coexistence of ADSL and ISDN-BA on the same pair “.
Belgacom – User to Network Interface (UNI) Specification	"ADSL over POTS" (ref.: BGC_D_48_0002_20_01_E.DOC) http://www.belgacom.be
Belgacom – User to Network Interface (UNI) Specification	"ADSL over ISDN" (ref.: BGC_D_48_0002_20_02_E.DOC) http://www.belgacom.be

3.5. SHDSL

ETSI TS 101 524-1:	Transmission and Multiplexing (TM) ; Access system on metallic access cables; Symmetrical single pair high bitrate Digital Subscriber Line (SDSL) ; Functional Requirements
ETSI TS 101 524-2:	Transmission and Multiplexing (TM) ; Access system on metallic access cables; Symmetrical single pair high bitrate Digital Subscriber Line (SDSL) ; Transceiver Requirements
ITU G.991.2	Single pair High Speed Digital Subscriber Line (SHDSL) Transceivers.

4. Technical specifications for the equipment to be connected to the raw copper loop

4.1. General requirements

The attention is attracted on the following points:

- The systems must be insensitive to the crossing of the wires in a pair.
- The direct current must be always limited to 120 mA.
- If a ringing voltage is to be used, when generating the signal, it must be assured that the signal is a sine and that zero – detection of the signal is applied.

Insulation

Different line access will always be isolated from each other. The insulation resistance will be greater than 10 MOhm under 200 VDC. This also applies for the insulation between the emission and reception circuits. This requirement is withdrawed when considering multi-line equipments using a centralised feeding for the disposal of direct current on the line. In this case, the line interfaces of this equipment must be symetrical towards the earth.

Signalisation and Remote feeding

The conformity towards the "connection to telecommunication networks" (EN 60950) aspect will be established by the delivery of a document testifying the conformity of the equipments for the considered application.

When a numbering signalling by loop opening is used, this one will have a rhythm of maximum 10 ± 1 Hz.

The internal impedance of the ringing current generator must be 400 Ohm minimum.

4.2. Requirements for PSTN equipment to be connected to the Raw Copper Loop

The document ETSI TR 101 830-1 V1.1.1 and the Belgacom User to Network Interface (UNI) specifications have to be considered as references. When both are mentioned, the Belgacom UNI is **the** document where the specifications have to be found, due to the Belgacom network specificity, whereas the ETSI document will give a general overview and eventually some additional pieces of information.

Requirements	**Requirements or reference to requirements**
Total signal voltage	ETSI TR 101 830-1 Subclause 7.1.1.
Peak amplitude	ETSI TR 101 830-1 Subclause 7.1.2.
Narrow-band signal power	ETSI TR 101 830-1 Subclause 7.1.3.
Unbalance about earth	ETSI TR 101 830-1 Subclause 7.1.4. Belgacom – User to Network Interface (UNI) Specification: "Analog Subscriber Line Signalling (Basic Call)" Subclause 5.4
Feeding power (from the LT-port)	ETSI TR 101 830-1 Subclause 7.1.5. Belgacom – User to Network Interface (UNI) Specification: "Analog Subscriber Line Signalling (Basic Call)" Subclause 5.1 and Subclause 5.2
Reference impedance Zr	ETSI TR 101 830-1 Subclause 7.1.6.
Ringing signal	ETSI TR 101 830-1 Subclause 7.1.7. Belgacom – User to Network Interface (UNI) Specification: "Analog Subscriber Line Signalling (Basic Call)" Subclause 8.1.1, Subclause 8.1.2, Subclause 8.1.4 **Frequency –** The nominal frequency must be between 20 Hz and 55 Hz with a tolerance of +/- 5% **Parasitic signals –** The total power of the parasitic signals (harmonic included) created by the generator shall be 26 dB lower than the power of the nominal frequency wave
Metering signals	ETSI TR 101 830-1 Subclause 7.1.8.

Except for voice band, the paragraph 4.4.3. of ETS 300 001 (Belgian values) applies.

4.3. Requirements for equipment delivering signals for which the binary rate is smaller or equal to 64 kbit/s

The major points are the following:

Impedance

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

Line impedance typical values:

Frequency (kHz)	Impedance (Ohms)
1.6	600
6	300
32	150
64	120
200 and more	100

The impedance of the transceivers and the receivers will be the same, with a tolerance of ± 20 %, as measured at the central frequency of the usable spectrum. The measurement needs to be done for each of the impedances as different options are foreseen.

Symmetry

The symmetry of the input and output interface with the earth will be in accordance with the following values:

- From 10 Hz to F (Hz) : $\geq$ 48 dB
- From F (Hz) to F_1 (Hz) : 48 dB – 10 dB/decade

where:

- F = the highest frequency of the spectrum, measured at the –10 dB point below the level of the spectrum usable component of the spectrum with the highest level.
- F_1 = the highest frequency of the measured spectrum, including the harmonics; the components below –60 dBm/600 Ohm will be ignored.

Spectrum of the transmitted frequencies

The spectrum will be limited to 130 kHz (point –30 dBm/600 Ohm) in all the cases.

Emission level

The emission level is maximum 0 dBm/ref 600 Ohm in the 300Hz-3400 Hz frequency range.

The signal emitted out of the voice band (300Hz-3400Hz) must be limited to 3 Vpp .

4.4. Requirements for equipment for the transmission of signals using ISDN basic access line code

4.4.1. ISDN 2B1Q signals

This category covers signals, generated by ISDN transmission equipment on a single pair, based on 2B1Q line coding. This subclause is based on the ETSI reports on ISDN equipment. A signal can be classified as an ISDN 2B1Q signal if it is compliant with all subclauses below.

The equipment must in particular be compliant to the ETS 102 080 (V1.3.2.).
In order to be compliant to the spectral management rules, the paragraph 8.1. of the recommendation ETSI ETR 101 830-1 V1.1.1 needs to be matched.

Requirements	**Reference to requirements**
Total signal power	TS102 080 Subclause A.12.3
Peak amplitude	TS102 080 Subclause A.12.1
Narrow-band signal power	ETSI TR 101 830-1 Subclause 8.1.3 TS102 080 Subclause A.12.4
Unbalance about earth	ETSI TR 101 830-1 Subclause 8.1.4 TS102 080 Subclause A.13.3.1
Feeding power (from the LT-port)	ETSI TR 101 830-1 Subclause 8.1.5 EN60950

4.4.2. ISDN MMS43 signals

This category covers signals, generated by ISDN transmission equipment on a single pair, based on MMS43 (also called 4B3T) line coding. This subclause is based on the ETSI reports on ISDN equipment. A signal can be classified as an ISDN MMS43 signal if it is compliant with all subclauses below.

The equipment must in particular be compliant to the ETS 102 080 (V1.3.2.).
In order to be compliant to the spectral management rules, the paragraph 8.2. of the recommendation ETSI ETR 101 830-1 V1.1.1 needs to be matched.

Requirements	**Reference to requirements**
Total signal power	ETSI TR 101 830-1 Subclause 8.2.1
Peak amplitude	TS102 080 Subclause B.12.1
Narrow-band signal power	ETSI TR 101 830-1 Subclause 8.2.3 TS102 080 Subclause B.12.4
Unbalance about earth	ETSI TR 101 830-1 Subclause 8.2.4 TS102 080 Subclause B.13.3
Feeding power (from the LT-port)	ETSI TR 101 830-1 Subclause 8.2.5 EN 60950

4.5. Requirements for equipment using ADSL over POTS to be connected to the Raw Copper Loop

This clause summarizes asymmetrical signals that are generated by digital transmission equipment up to 8 Mbit/s, including ADSL. Asymmetrical means a bitrate in the downstream direction and a significantly lower bitrate in the upstream direction.

Generally, the applied technology must comply with the following recommendations:

- ITU-T 992.1
- ANSI T1.413 Issue 2

Further, in order to comply with the spectral management rules, the equipment shall match the following requirements :

- No ADSL – systems with spectral overlap of upstream and downstream (Echo Cancelling systems) are allowed on the loops. Only ATU-C ‘s with a PSD – mask for reduced NEXT (FDD) are allowed on the loops.
- The power cutback mechanism for the upstream transmission, as described in ITU-T 992.1, needs to be applied.
- It is STRICTLY FORBIDDEN to reverse the transmission direction. ADSL systems are designed to maximize self – compatibility when all ‘downstream’ signals in one cable flow into the same direction. This for the reasons explained in ETSI TR 101 830-1 V1.1.1 clause 5.2 / Note 1.

In this case, the following naming convention is used in the present document :

- **Downstream** signal limits are mandatory for signals that are injected into an LT- port of the Local Loop Wiring. LT- ports are located at the central office side of the local loop wiring.
- **Upstream** signal limits are mandatory for signals that are injected into an NT-port of the local loop wiring. NT – ports are located at the customer side.

These ADSL–signals may share the same wire pair with POTS -signals.

The following clauses are based on ANSI and ITU-reports on ADSL-equipment. A signal can be classified as an ADSL over PSTN – signal if it is compliant with all subclauses below :

General Requirements	Reference to requirements
Total signal power (downstream only) < 100 mW = 20 dBm	ANSI T1.413 Issue 2 , subclauses 6.15.1 and 6.15.3 ITU-T Recommendation G.992.1 subclause A.1.2.3.1
Total signal power (upstream only) < 18 mW = 12.5 dBm	ANSI T1.413 Issue 2 , subclauses 7.15.1 and 7.15.3 ITU-T Recommendation G.992.1 subclause A.2.4.3.1
Narrow-band signal power (downstream only) For ADSL with DMT with carriers spaced at 4.3125 kHz the carriers 33 –255	ANSI-T1.413 Issue 2 ANNEX F (ATU-C Transmitter PSD mask for reduced NEXT) ITU-T Recommendation G.992.1 subclause A.1.3 (PSD – mask for Reduced NEXT)
Narrow-band signal power (upstream only) For ADSL with DMT with carriers spaced at 4.3125 kHz the carriers < 32	ANSI-T1.413 Issue 2 Subclause 7.14 ITU-T Recommendation G.992.1 subclause A.2.4
Unbalance about earth (upstream AND downstream)	ANSI T1.413 Issue 2 Subclause 12.3.1 ITU –T Recommendation G.992.1 subclause A.4.3.1
Feeding power (from the LT-port)	Not applicable

The requirements for any PSTN equipment operating in the frequency band below ADSL on the same wire pair appear from the PSTN requirements.

4.6. Requirements for ADSL over ISDN equipment to be connected to Raw Copper Loop

This category covers signals, generated by ADSL transmission equipment. These signals share the same wire pair with ISDN-signals.

Generally, the applied technology must comply with the following recommendations :

- ITU-T 992.1
- ETSI TS 101 388

Further, in order to comply with the spectral management rules, the equipment shall match the following requirements :

- No ADSL – systems with spectral overlap of upstream and downstream (Echo Canceling systems) are allowed on the loops. Only ATU-C ‘s with a PSD – mask for reduced NEXT (FDD) are allowed on the loops.
- The power cutback mechanism for the upstream transmission, as described in ITU-T 992.1, needs to be applied.
- It is STRICTLY FORBIDDEN to reverse the transmission direction. ADSL systems are designed to maximize self – compatibility when all ‘downstream’ signals in one cable flow into the same direction. This for the reasons explained in ETSI TR 101 830-1 V1.1.1 clause 5.2 / Note 1.
- (Note that the ISDN – lines in Belgium are operating with 4B3T line coding).

In this case, the following naming convention is used in the present document :

- **Downstream** signal limits are mandatory for signals that are injected into an LT- port of the Local Loop Wiring. LT- ports are located at the central office side of the local loop wiring.
- **Upstream** signal limits are mandatory for signals that are injected into an NT-port of the local loop wiring. NT – ports are located at the customer side.

The following clauses are based on ETSI and ITU-reports on ADSL-equipment. A signal can be classified as an ADSL over ISDN – signal if it is compliant with all subclauses below :

Requirements	**Reference to requirements**
Total signal power (downstream only) < 90 mW = 19.5 dBm	ETSI TS 101 388 Subclause 5.2
Total signal power (upstream only) < 22.5 mW = 13.5 dBm	ETSI TS 101 388 Subclause 6.3
Narrow-band signal power (downstream only) For ADSL with DMT with carriers spaced at 4.3125 kHz the carriers 56–255	Only FDD (Frequency Division Duplexed) systems allowed
Narrow-band signal power (upstream only) For ADSL with DMT with carriers spaced at 4.3125 kHz the carriers below 64	ETSI TS 101 388 Subclause 6.10 ITU-G992.1 Subclause B.2.2
Unbalance about earth (upstream AND downstream)	ITU –T Recommendation G.992.1 subclause A.4.3.1
Feeding power (from the LT-port)	Not applicable

The requirements for any ISDN basic access equipment operating in the frequency band below ADSL on the same wire pair appear from the ISDN requirements.

4.7. Specific requirements for spectral compatibility between ADSL over POTS and ADSL above ISDN

Additionally, the ATU-C ADSL above POTS must be capable to apply ‘tone suppression’ in the downstream part, in order to have the possibility to reduce additional NEXT (Near End Cross Talk) from a part of the downstream tones on a part of the upstream tones of an adjacent ADSL over ISDN transmission system.

Example: the ADSL above POTS downstream could be forced to start above carrier 40, to allow ADSL above ISDN upstream to be able to use all carriers below 40 without ADSL downstream NEXT.

The location of the masking frequency for ADSL over POTS downstream will be in the range of carrier 32 to 56.

A new PSD masker applies here, which is generated by applying the wider mask of the relevant PSDs defined under section 4.5 and 4.6 above, and by additionally masking the carriers of the DMT transmission in the passband.

4.8. Specific requirements for SHDSL equipment to be connected to Raw Copper Loop

The equipment must be conforming to the relevant ITU G.991.2 and ETSI Technical specifications.

Only SHDSL equipment with Line code PAM16 and Symetrical PSD – ANNEX B (European version) is allowed to be connected to the Raw Copper Loop.

5. Technical specifications for the equipment to be connected to the Shared Pair Loop

5.1. General requirements

For all applications the following general requirements are made for end user equipment.

- The systems must be insensitive to the crossing of the wires in a pair.

5.2. Requirements for ADSL over POTS equipment to be connected to Shared Pair Loop

The requirements are identical to the requirements given in 4.5.

Note that the only equipment that can be connected is ADSL equipment, no PSTN equipment can be connected to the Shared Pair Loop.

5.3. Requirements for ADSL over ISDN equipment to be connected to Shared Pair Loop

The requirements are identical to the requirements given in 4.6.

Note that the only equipment that can be connected is ADSL equipment, no ISDN equipment can be connected to the Shared Pair Loop.

5.4. Specific requirements for spectral compatibility between ADSL over POTS and ADSL over ISDN

The requirements are identical to the requirements given in 4.7.

6. Technical specifications of the splitter interface used by Belgacom in order to provide the Shared Pair

6.1. General

The interface that will be described is the interface between the splitter and the ADSL equipment from the Operator as depicted in the figure below:

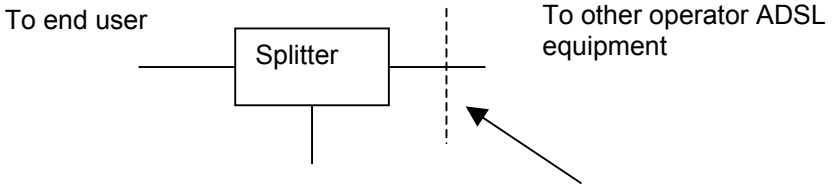

Figure 1

Two types of splitters will be used: the splitters to be used for ADSL over POTS and the splitters to be used for ADSL over ISDN.

6.2. Splitter specifications

The POTS splitter is fully compliant with the Recommendation found in ITU-T 992.1 Annex E Type 1 European.

Both splitters (POTS and ISDN) include a DC-blocking functionality.

The splitter does not include any High Pass Filter (HPF) Functionality.