# Specification of the Access Network Frequency Plan applicable to transmission systems used on the BT Access Network

Issue 1
Approved: September 2000

## Contents



## Foreword

This document has been produced by the NICC Task Group on Digital Subscriber Line (DSL) – Spectrum Management Plan. Network Operators, switch and terminal equipment manufacturers, test laboratories, DTI (CII and RA), and OFTEL participated in the Task Group.

# 1 Scope

This specification defines the Access Network Frequency Plan (ANFP) applicable to transmission systems to be used on the BT access network. It is applicable to the whole of the BT access network provided using unscreened twisted metallic pairs (i.e. it does not apply to the access network provided by optical fibre).

To ensure the prevention of undue interference between transmission systems used on different metallic pairs in the same access cable, transmission systems (whether provided by BT, OLO or customer) connected to metallic pairs of the BT access network need to conform to this specification.

This specification is applicable to all BT switched and leased line analogue services, and to OLOs using the BT access network as defined in condition 83 of the public telecommunications operator's license issued to BT [1].

The limits specified in the ANFP apply when measured according to the associated reference measurement technique given in Annex 2.

This issue of this specification considers frequencies up to 1.1 MHz (e.g. for systems up to and including ADSL). The use of frequencies above 1.1 MHz has yet to be allocated and this specification restricts the use of these frequencies in order to protect their allocation later. It is planned that a future issue of the specification will be produced to cover frequencies above 1.1 MHz (e.g. to include the use of VDSL).

It is recognised that a customer's installation may comprise wiring and a number of items of CPE. Further, there may be other items of equipment between the customer's installation and the metallic pair (i.e. on the network side of the NTP), e.g. filters or active line termination equipment. The limits in this ANFP apply at the interface to the metallic pair of the BT access cable.

Where a customer's installation causes, or can reasonably be foreseen to cause, harmful interference to transmission systems used on different metallic pairs in the same [or other] access cable[s], BT may require that the interference be prevented, for instance by means of mitigation measures (e.g. by the addition of a filter), or by requesting authorisation for disconnection under Article 7.4 of the RTTE directive [2] or other relevant powers.

Note 1: Although, from a regulatory perspective, it is not a mandatory requirement for customer premises equipment (CPE) to conform to this ANFP, since this would be contrary to the RTTE directive [2], it is strongly recommended that CPE does conform to this ANFP.

Note 2: This specification only considers the limits relevant to control of interference between DSL systems on different lines. There may be other limits also applicable, and conformance to this specification does not necessarily satisfy those limits. Such other limits may include, for example, safety limits on line voltages, RFI balance requirements, line sharing limits, and POTS band signals.

Note 3: Analogue POTS type functions of terminals may exceed the limits stated in this ANFP in the frequency range 100 Hz to 5 kHz where they would otherwise be acceptable under the provisions of the UK implementation of the RTTE directive [2]. It is intended that future issues of the ANFP will provide a more detailed specification in the frequency range 100 Hz to 5 kHz.

# 2 ANFP Construction

The ANFP as specified in this document was developed as a result of the proposals defined in the OFTEL Access to Bandwidth statement (November 1999) [3]. The construction of the ANFP was based on the criteria:

- set out in the OFTEL Access to Bandwidth statement
- defined by the DSL Task Group.

These criteria are documented in the ANFP User Guide (see Annex 4). This ANFP aligns with the OFTEL ANFP Determination (September 2000) [4].

In deciding the criteria to be used and the method of construction for the ANFP, the DSL Task Group took account of the work on this subject being undertaken in ANSI T1E1 [9] and ETSI TM6 [6].

The ANFP has been constructed using the following method:

- the management of the ANFP will be by hard Power Spectrum Density (PSD) masks [5].
- each interface giving access into the cable plant will have a PSD mask defined for it. Interfaces at different locations may have different masks.
- the mask will apply to any equipment connected at the location, irrespective of modem type[1].
- the mask will define the limit for power transmitted (or leaked) into the cable plant.
- at each frequency, the PSD of the transmitter must be at or lower than the permitted PSD mask.

The permitted PSD masks are produced as follows:

- The systems already deployed in significant volumes are identified[2]. These are taken as the existing noise environment (any transmission system will be permitted to be used on the BT access network provided that it conforms to the ANFP masks).
- A PSD mask is produced for each transmitter of each identified system.
- Locations are categorised according to which identified system transmitters may have been installed there.
- For each location category the permitted PSD mask is, at each frequency independently, the maximum of the masks for those transmitters which may have been installed there.

This method of construction is consistent with the work so far undertaken in ETSI TM6. It derives from the fact that the identified systems in the network have been deployed such that they will operate reliably in the presence of the crosstalk from other identified systems.

Any increase in the level of pollution that is permitted will directly result in decreased margin of performance in already deployed systems. Any substantial increase would cause these systems to fail.

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[1] Strictly the ANFP is applied to the point of connection, so applies even in the absence of any equipment.

[2] The xDSL systems that have been taken into account in this ANFP specification are ISDN basic access, 2-pair and 3-pair 2 Mbit/s 2B1Q HSDL systems, and ADSL over POTS. All deployed as per BT's historical deployment rules. SDSL technology was also admitted, but limited to a selection of rates with minimal impact on the ANFP masks.

It should be noted that the ANFP is constructed with masks that are more realistic than those in current equipment standards. The equipment standards typically have a generous margin between what a system is limited to and what a real system actually produces, so a good implementation passes the standard easily. However some real systems already deployed would fail if their neighbours were to fully exploit a mask based on the equipment standards' masks. It has been necessary to use masks from FSAN[3] for the identified systems' transmitters. However every effort has been made to enable the deployment of the maximum variety of future DSL systems where this can be done without impact to the identified systems.

[3] Full Services Access Networks – a group of network operators and suppliers who co-operate in driving standards work towards specifying equipment that is usable by operators.

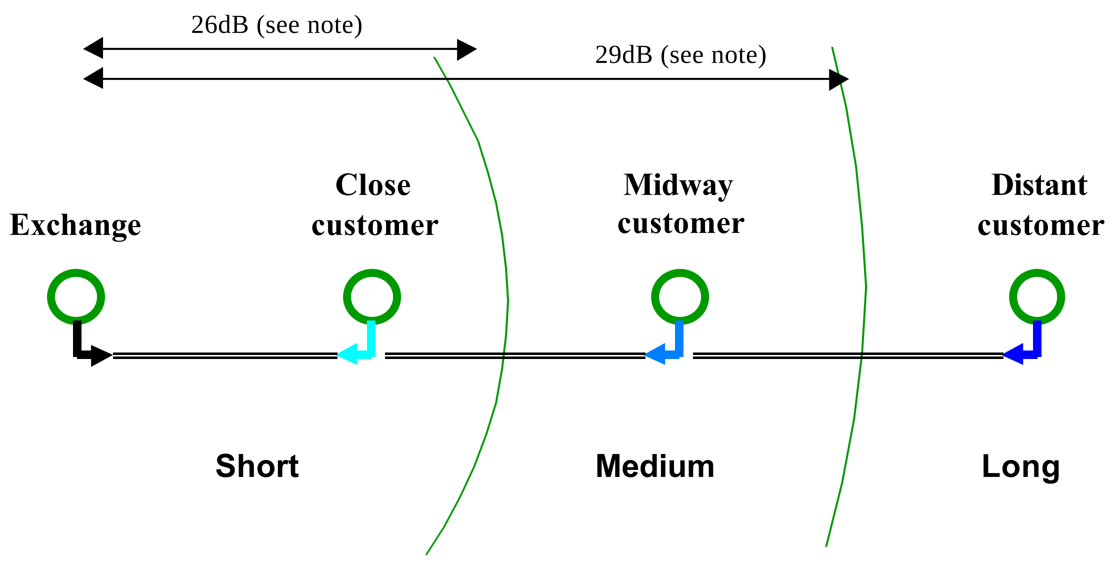
# 3 ANFP Specification

The ANFP is currently defined by a set of four PSDs.

| mask name | defines PSD permitted at: |
|---|---|
| down exch | the MDF of the exchange |
| up short | the NTP of near customers |
| up medium | the NTP of mid distance customers |
| up long | the NTP of far customers |

Mask ‘down exch’ is a downstream mask, for lines toward the customers. It is the only downstream mask currently defined. The other three masks are upstream masks, for lines toward the exchange.

The definition of ‘near’, ‘mid distance’ and ‘far’ customers is given in figure 1 and is based on BT’s historical deployment of HDSL. Note, however, that neighbouring line ends should have the same limits, irrespective of the lengths of their respective pairs - this is because spectrum management is about limiting harm to neighbours, not directly about what a given line is capable of. Hence in general all lines sharing a given DP[4] will be in the same zone[5].



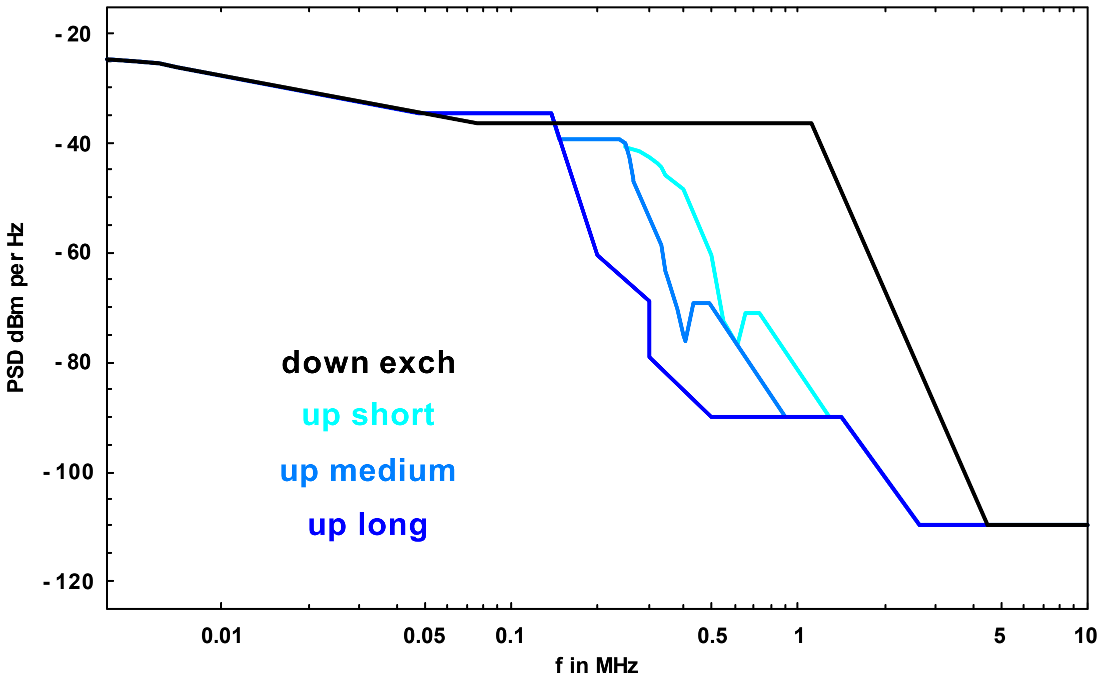

Note: The 26 and 29 dB insertion loss figures are notional. In practice classification of loops into ANFP zones will be based on estimation and in particular all loops at a given DP will receive the same classification independent of individual loop lengths.

**Figure 1 – ANFP Zone Definition**

[4] Distribution Point – the final flexibility point in the BT access network before the line reaches its customer.

[5] The zone category of a given line will be determined once. The zone category will not be re-assessed unless there is a major cabling re-arrangement affecting the lines to that DP.

The set of 4 permitted masks is specified by the data given in Annex 1, which is definitive. Figure 2 illustrates this data. The data is also available in machine readable format [7].




Notes: best viewed in colour
all PSD masks are defined over the range 100 Hz to 30 MHz, although only a subset of this range is shown in the figure above.
where the PSD masks overlap only one is shown.
the PSD axis captions range from –20 dBm/Hz to –120 dBm/Hz (ed[6]).

**Figure 2 – Permitted PSD Masks**

# 4 Key Features of the ANFP

The ANFP defined in this specification is able to fulfil the requirements for a spectral management plan as set out in licence condition 83 [1]. The ANFP controls the spectrum and power that can be launched into each of the Exchange end and the Customer premise end of the wire-pair. The limits vary with distance from the exchange, and a set of three zones is defined based on notional insertion loss at 100 kHz.

The ANFP does not preclude use of broadband equipment on any line, although serviceability on a line is subject to the electrical qualities of the line and the technical capability of the xDSL systems used. There will be some very long lines on which it will be difficult to give satisfactory service using ADSL or HDSL. However, future advances in xDSL may enable even these lines to have substantially more capability than currently provided by voiceband modems.

The ANFP balances the need for provision of symmetric services to the business (and residential) sector against the desire for widespread deployment of ADSL to mass-market residential, enabling the Government's vision of Broadband Britain.

[6] Editor: sorry, the font used sometimes fails to print the minus signs

The ANFP has been made as simple as possible whilst still being fit for purpose. It does not place any special restrictions on wire-pair selection, and in principle allows for 100% cable fill. (While it is unlikely that BT's network would reach 100% xDSL fill, there are credible situations that give equivalent interference.) Adopting a policy of no additional special pair selection processes means that engineering costs are minimised.

The ANFP is technology neutral, and as such is as future proof as possible. The PSDs used in the ANFP are consistent with the levels used by internationally standardised xDSL systems. This minimises the risk of introduction of rogue xDSL systems with strong line spectra that may cause objectionable radiated emissions.

The potential use of SDSL systems (as currently being defined in ETSI TM6) has been factored into the ANFP and will be permitted by the plan (the data rate that may be attempted by these SDSL systems will be dependent on the zone of the customer's end).

For further information on the features of the ANFP and guidance on conformance to the ANFP, see the ANFP User Guide (Annex4)

# 5 Change Control

A change control process for this specification is given in the ANFP User Guide (see Annex 4). Any proposals to change the ANFP should be submitted to OFTEL.

As indicated in the scope, the Task Group already plans to increase the scope of the plan to cover frequencies up to 30 MHz (i.e. to include VDSL). This change is not expected to impact existing systems deployed in conformance to this issue of the ANFP.

# 6 Abbreviations

| | |
|---|---|
| **ADSL** | Asymmetric Digital Subscriber Line |
| **ANFP** | Access Network Frequency Plan |
| **ANSI**<br>**ANSI T1E1.4** | American National Standards Institute<br>T1E1.4 is their working group concerned with DSL<br>Homepage: http://www.t1.org/t1e1/_e14home.htm |
| **BT** | British Telecommunications plc<br>*(bridged taps are not discussed in this document)* |
| **CPE** | Customer Premises Equipment |
| **CSV** | Comma Separated Variable - a file format based on plain text, readable by many common spreadsheet programs. |
| **DP** | Distribution Point – the final flexibility point in the BT access network before the line reaches its customer |
| **DSL** | Digital Subscriber Line - any of the modem technologies which send high speed data over metallic telephone pairs. A DSL line has a dedicated modem at each end of the physical wire pair; typically one of these is in the exchange |
| **DSL TG** | Digital Subscriber Line Task Group<br>A subcommittee of PNO-IG |
| **ETSI**<br>**ETSI TM6** | European Telecommunications Standards Institute<br>TM6 is the working group on Access Networks<br>Homepage: http://webapp.etsi.org/tbhomepage/TBDetails.asp?TB_ID=240 |
| **FSAN** | Full Services Access Networks – a group of network operators and suppliers who co-operate in driving standards work towards specifying equipment that is usable by operators |
| **HDSL** | High bit rate Digital Subscriber Line |
| **MDF** | Main Distribution Frame |
| **NICC** | Network Interoperability Consultative Committee<br>- a committee of UK industry set up to advise OFTEL<br>homepage: http://www.oftel.gov.uk/NICC/ |
| **OLO** | Other Licensed Operator |
| **PNO-IG** | Public Network Operators Interest Group<br>- an interest group within NICC |
| **POTS** | Plain Ordinary Telephone Service - analogue voiceband telephony |
| **NTP** | Network Termination Point |
| **PSD** | Power Spectral Density - [5] |
| **RFI** | Radio Frequency Interference |
| **RTTE** | Radio and Telecommunications Terminal Equipment - [2] |
| **SDSL** | Symmetric Digital Subscriber Line - in this document 'SDSL' refers to that technology currently being defined in ETSI TM6 |
| **VDSL** | Very high rate asymmetric Digital Subscriber Line |

# 7 References

[1] OFTEL
"REQUIREMENT TO PROVIDE ACCESS NETWORK FACILITIES"
April 2000
may be downloaded from http://www.oftel.gov.uk/competition/acnf0400.htm

[1] is condition 83 of the public telecommunications operator's license issued to BT by Oftel

[2] EC
"Directive 99/5/EC
of the European Parliament and of the Council Relating to Radio Equipment and Telecommunications Terminal Equipment and the Mutual recognition of their Conformity"
Official Journal of the European Communities : OJ L 91, Vol 41 of 7th April 1999
the full text may be downloaded from http://www.tapc.org.uk

The UK Statutory Instrument 2000 No 730 ("The RTTE Regulations") was published on 13 March 2000. It transposes the provisions of the Directive into UK law. It is also available at http://www.tapc.org.uk

[3] OFTEL
"Access to Bandwidth: Delivering Competition for the Information Age"
November 1999
may be downloaded from http://www.oftel.gov.uk/competition/a2b1199.htm

[4] OFTEL
"Access to Bandwidth: Determination on the Access Network Frequency Plan (ANFP) for BTs Metallic Access Network"
To be published September 2000

look under http://www.oftel.gov.uk/publicat.htm#Local Loop Unbundling

[5] FSAN
"Interpretation of PSD for PSD masks"
TD 15 at the ETSI TM6 Meeting, Sophia Antipolis, 24-27 November, 1998

also presented to ANSI T1E1.4 as paper 98-327

[6] ETSI TM6
"Part 1 : Definitions and Signals Library"
Permanent Document TM6(99)07

[6] is the first product of the ETSI TM6 Spectral Management project

[7] ANFP PSD Mask Definitions
published with this document on the same web site, with file name ANFPmask.csv

[7] is a machine readable form of the table in Annex 1. *Read to interpret this data. Any differences are errors, in which case Annex 1 is definitive.*

[8] ADLNB WG-2 (chairman C. P. Raymont)
"Guidance Notes on Measurement Uncertainty"
GN/WG2/1 issue 3 dated 19 March 1998
may be obtained from http://www.adlnb.com

In the methods of [8] there is separation between requirements specification and the capabilities of any particular test house. ADLNB has recently been incorporated into a larger body, the "R&TTE

[9] ANSI T1E1.4
"Spectrum Management For Loop Transmission Systems"
T1E1.4/2000-002R3 DRAFT T1.XXX-2000
may be downloaded from ftp://ftp.t1.org/pub/t1e1/e1.4/dir2000/0e140023.pdf

[10] "General requirements for the competence of testing and calibration laboratories"
ISO/IEC 17025: 1999

[11] "Essential requirements for terminal equipment intended for Connection to unstructured digital leased circuits of the public Telecommunications network using a CCITT Recommendation G.703 interface at a rate of 2048 kbit/s with a 75 Ω unbalanced presentation"
PD 7024: 1994
available from BSI, see URL http://www.bsi.org.uk/

# 8 History

| | |
|---|---|
| Issue 1 | First Issue, September 2000 |

The NICC Task Group on Digital Subscriber Line wishes to acknowledge its editors

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# Annex 1 - ANFP PSD Mask Definitions

The masks are defined by the data given in this Annex. The tabulated data define the corners of each mask. Between the given corners the mask values are defined by interpolation (as a straight line on log frequency / linear dB axes). Frequency is in MHz; PSD is in dBm/Hz.

This data is also available in a machine readable format [7]. This version is made available to help prevent input errors when performing modelling evaluation. Note that the CSV file contains "a" for the blank fields (to be interpolated) in the table below. This has been done to increase compatibility with some applications which don't treat blank entries correctly.

| Frequency | up short PSD | up medium PSD | up long PSD | down exch PSD |
|---|---|---|---|---|
| 0.0001 | -24.2438 | -24.2438 | -24.2438 | -24.2438 |
| 0.001 | -24.3086 | -24.3086 | -24.3086 | -24.3086 |
| 0.002 | -24.4406 | -24.4406 | -24.4406 | -24.4406 |
| 0.003 | -24.6366 | -24.6366 | -24.6366 | -24.6366 |
| 0.004 | -24.898 | -24.898 | -24.898 | -24.898 |
| 0.005 | -25.2272 | -25.2272 | -25.2272 | -25.2272 |
| 0.006 | -25.6302 | -25.6302 | -25.6302 | -25.6302 |
| 0.007 | -26.1266 | -26.1266 | -26.1266 | -26.1266 |
| 0.047884 | | | -34.5 | |
| 0.048147 | | -34.5 | | |
| 0.048187 | -34.5 | | | |
| 0.076391 | | | | -36.5 |
| 0.138 | -34.5 | -34.5 | -34.5 | |
| 0.147654 | -39.1935 | -39.1935 | | |
| 0.199722 | | | -60.1591 | |
| 0.239 | -39.2014 | -39.2014 | | |
| 0.248 | -40.1521 | -40.1521 | | |
| 0.249819 | -40.6974 | | | |
| 0.256 | | -42.5212 | | |
| 0.262988 | | -46.6735 | | |
| 0.266667 | | -46.9391 | | |
| 0.281 | -41.569 | | | |
| 0.3 | | | -69 | |
| 0.301 | | | -79 | |
| 0.303 | -42.5516 | | | |
| 0.319 | -43.5645 | | | |
| 0.333 | -44.7054 | | | |
| 0.333333 | | -58.7391 | | |
| 0.344065 | | -63.2129 | | |
| 0.34445 | -45.8415 | | | |
| 0.351 | | -64.6154 | | |
| 0.378 | | -70.3487 | | |
| 0.399 | | -74.958 | | |
| 0.4 | -48.7 | | | |
| 0.404253 | | -76.1821 | | |
| 0.433333 | | -69.2391 | | |
| 0.492 | | -69.2391 | | |
| 0.5 | -60.5 | | -90 | |
| 0.545545 | -72.8087 | | | |
| 0.613094 | -76.8423 | | | |
| 0.65 | -71 | | | |
| 0.735 | -71 | | | |
| 0.897226 | | -90 | | |
| 1.104 | | | | -36.5 |
| 1.26891 | -90 | | | |
| 1.4 | -90 | -90 | -90 | |
| 2.64569 | -110 | -110 | -110 | |
| 4.545 | | | | -110 |
| 30 | -110 | -110 | -110 | -110 |

# Annex 2 - ANFP Laboratory Test Specification

## Contents



## 1 Scope

This test specification defines tests to be used in a laboratory environment to determine conformance of telecommunications equipment to the requirements specified in the main body of the ANFP.

The tests here only relate to the requirements of the ANFP. Other limits, for example those related to safety, line balance, and interactions between systems on the same pair are out of scope.

Note 1: As stated in the scope of the ANFP, Issue 1 of the ANFP specification considers frequencies up to 1.1 MHz (e.g. for systems up to and including ADSL) and the specification restricts the use of higher frequencies in order to protect their future allocation. The NICC DSL Task Group plan a future issue of the ANFP specification to cover frequencies above 1.1 MHz (e.g. to include the use of VDSL). This Test Specification only covers Issue 1 of the ANFP.

Note 2: This test specification is for use in a laboratory environment only. The development of a test specification for use in the field is the subject of on-going work in the DSL Task Group.

Note 3: Strictly the ANFP specifies limits at the ports of the access network, not for individual equipment per se. This specification is to verify that when deployed equipment would not violate the ANFP.

Note 4: Section 5 of this document is based on the equivalent specification contained in the ANSI Spectrum Management For Loop Transmission Systems standard [9]. The use and reproduction of extracts from that standard is provided with kind permission of ANSI (American National Standards Institute).

# 2 Reference Model

The ANFP limits the power that may be injected into a metallic pair in the BT access network at two interfaces, the NTP[7] at the customer premises, and the MDF[8] at the exchange.

In the case of Local Loop Unbundling, there is a third interface, the HDF[9]. Managing crosstalk interference in the cabling between the HDF and the MDF is the responsibility of the network operator(s) using that cabling. The ANFP is applied at the MDF.

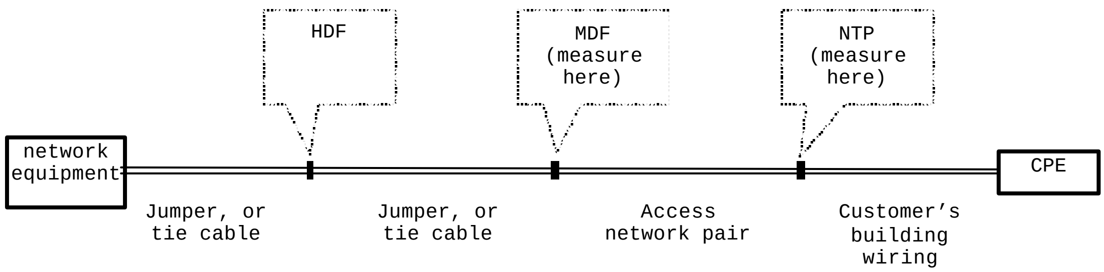


**Figure 3 : Network Interfaces to which the ANFP applies**

# 3 Test Configuration

The equipment under test ("EUT") will comprise the end equipment, any ancillaries which are always present[10], and a load to represent the access network.

The equipment at each end is tested independently.

Equipment will be tested in all modes which the operator proposes to use. Other modes, perhaps provided for use in other countries, need not be tested.

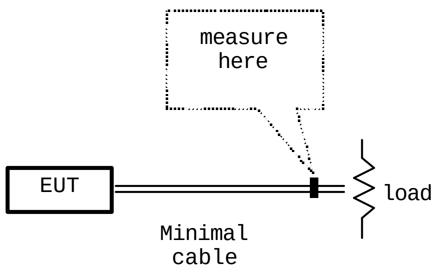


**Figure 4 : Test configuration**

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7 "Network Termination Point", is the legal demarcation between the network provider's cabling and the customer's in-house wiring. On a telephone line this point often has a master socket or NTE

8 "Main Distribution Frame", is the equipment which terminates the access network cables.

9 "Handover Distribution Frame", is the equipment which terminates the tie cables.

10 For example splitter filters, and connecting leads which are part of the kit supplied with the end equipment

The limits applicable to each end vary depending where the end is. For exchange end equipment there is one set of limits. For customer end equipment there are three, for locations at different distances from the exchange. An end equipment shall be tested against all the limits applicable to those places where it is proposed to be deployed.

# 4 Measurement Conditions

The prospective operator shall declare his deployment intentions for the equipment under test. This determines which modes the equipment is tested in, and which ANFP mask(s) it is tested against.

The measurement conditions below are derived from ISO/IEC 17025 [10], "Guidance Notes on Measurement Uncertainty" [8], and PD 7024 [11]

## 4.1 Estimation of uncertainty of measurement

A laboratory or facility performing testing shall have and shall apply procedures for estimating uncertainty of measurement.

When estimating the uncertainty of measurement, all uncertainty components which are of importance in a given situation shall be taken into account using appropriate methods of analysis.

The test report or compliance statement shall include the uncertainty of measurement.

Note: 1 It is recommended that measurement uncertainty is calculated as defined in [8]

Note: 2 Sources contributing to uncertainty include, but are not necessarily limited to, the reference standards and reference materials used, methods and equipment used, properties and condition of the item being tested.

## 4.2 Compliance

Compliance to the requirements of this standard shall be reported on the shared risk principle as specified in [8] figures 1 to 3.

Compliance to these requirements shall be determined either by use of the test methods defined within this standard or by use of test methods and results obtained from other standards accompanied with a technical justification detailing how such results demonstrate compliance to this standard.

Note: Since the requirements of this standard are derived from a number of technology specific standards in many cases it will be sufficient to test equipment to the specific design standard for their technology , and make a compliance statement to this standard following technical review of the results. The technical review should not be omitted as some options of specific technologies are excluded from these requirements and would present non-compliant results to this standard.

## 4.3 Calibration of test equipment

Equipment and its software used for testing shall be capable of achieving the accuracy required. Calibration programs shall be established for values of the instruments where these properties have a significant effect on the result

The equipment shall be calibrated to provide a 95% confidence level in the accuracy of the results.

## 4.4 General Conditions for Test

If the supplier has specified a temperature range within which the TE will be operational, the testing shall be performed within this range. The testing shall be performed within the temperature range 15 ºC to 25 ºC, if consistent with the temperature range declared by the supplier.

If the supplier has specified a humidity range within which the TE will be operational, the testing shall be performed within this range. The testing shall be performed within the humidity range 45% to 75%, if consistent with the humidity range declared by the supplier.

For equipment that is directly powered from the mains supply all tests shall be carried out within ±5% of the normal operating voltage.

If the equipment is powered by other means and those means are not supplied as part of the equipment, (e.g. batteries, stabilized AC supplies, DC) all tests shall be carried out within the power supply limit declared by the supplier.

If the power supply is AC the tests shall be conducted within ±4% of the stated frequency as declared by the supplier.

## 4.5 Independence of polarity

The equipment shall conform independent of the polarity of the pair it uses. For a line powered EUT the tests shall be carried out twice, once with each polarity of connection of the power supply.

# 5 Conformance testing methodology below 5 kHz

No formal tests are currently specified here.

Note: The absence of tests here should not be interpreted as license : the ANFP does set limits below 5 kHz. Conformance testing methodology is for further study.

# 6 Conformance testing methodology above 5 kHz

The conformance testing methodology in this clause is derived from "Spectrum Management For Loop Transmission Systems" [9]. It shall be used to determine compliance with the signal power limitations requirements in the ANFP.

Note: Where the ANFP, Issue 1 makes no requirements (e.g. longitudinal output, nonstationary signals), this annex specifies no tests.

## 6.1 PSD measurement procedure

The limits applicable to a particular end equipment are discussed above, in section 4.2.

### 6.1.1 Test circuit for PSD measurement

A test setup as pictorially shown in figure 5 shall be used for measuring PSD. Examples of specific embodiments of this test setup are shown in figures 6 and 7. The difference between figures 6 and 7 is the input impedance of the instrument to be connected to $V_{out}$; figure 6 assumes a high-impedance port, figure 7 assumes a 50 Ω port (typical for a spectrum analyzer). The PSD may be tested while line powered or locally powered as required by the intended application of the EUT.

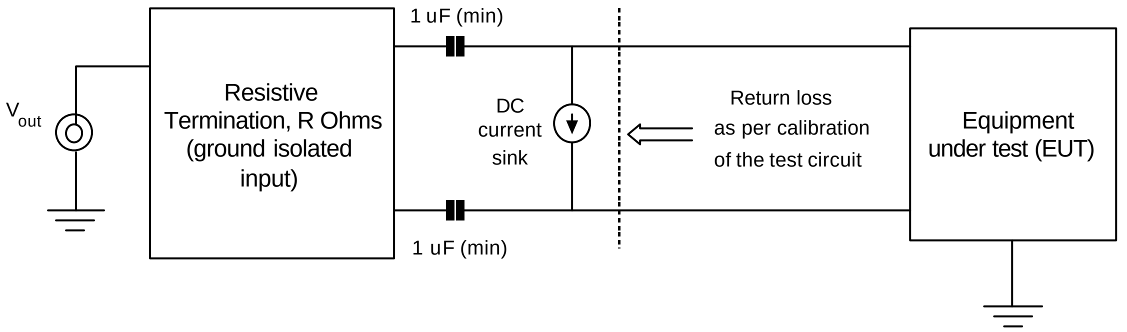


**Figure 5 - PSD measurement setup**

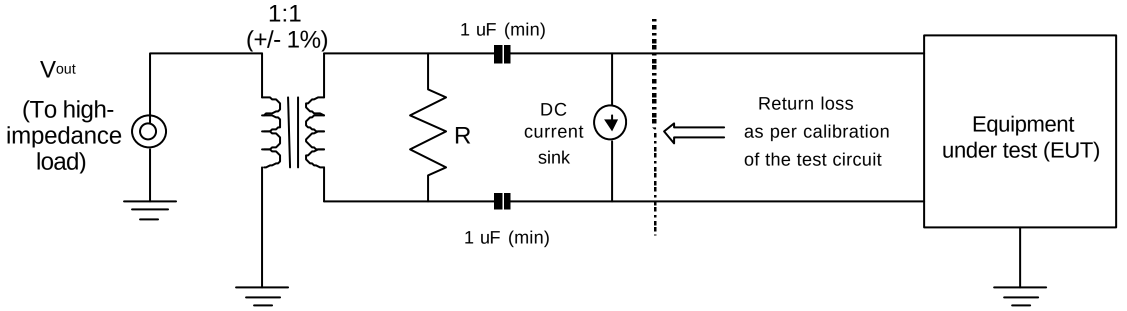


**Figure 6 - Example PSD measurement setup for high impedance instrument**

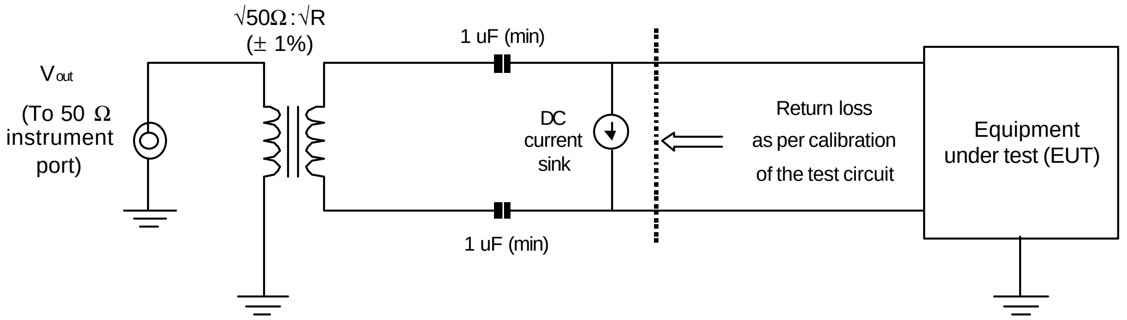


**Figure 7 - Example PSD measurement setup for 50 ohm instrument**

If the EUT neither sources nor sinks power the blocking capacitors may be omitted, as may the current sink. If present the capacitors shall be matched in value to within 1%.

If the EUT is line powered then the test circuit shall contain provisions for DC power feed, instead of the current sink.

For line powered applications, if the EUT is a TU-C the test shall be performed with the line power supply activated and an appropriate DC current sink (with high AC impedance) attached to the test circuit. If the EUT is a TU-R the test shall be performed with power (DC voltage) applied at the line interface by an external voltage source feeding through an AC blocking impedance. Note that the DC current source/sink must present high impedance (at signal frequencies) to common ground. The test circuit contains provisions for transformer isolation for the measurement instrumentation. Transformer isolation of the instrumentation input prevents measurement errors from unintentional circuit paths through the common ground of the instrumentation and the EUT power feed circuitry. When the termination impedance of the test circuit seen by the EUT output meets the calibration requirements defined in 4.3 the test circuit will not introduce more than ± 0.25 dB error with respect to a perfect test load of exactly the specified resistance.

If the EUT is supplied with a voiceband splitter filter[11] then the tests shall be carried out with the splitter in circuit but with no voiceband signal applied. Where the splitter has a connector for the voiceband connection, this shall be open circuit during tests. Where voiceband equipment is integrated with the splitter this equipment shall be quiescent during tests.

The EUT shall be measured by equipment that is not synchronous with the transmitted symbols of the EUT, and there shall be no synchronization between the measurement equipment and the EUT. This is to avoid any cyclo-stationarity effects causing a misleading measurement.

### 6.1.2 Calibration of the test circuit and termination impedance

The nominal termination impedance of the test circuit as seen by the EUT output shall be resistive with a resistance of R between 100 Ω and 135 Ω. If the EUT has been designed to a published standard then the resistive impedance specified in that standard shall be used (providing it is between 100 Ω and 135 Ω). The minimum return loss with respect to the termination impedance R shall be 35 dB from 10 kHz to 2 MHz with a reduction of 20 dB/decade below and above these corner frequencies.

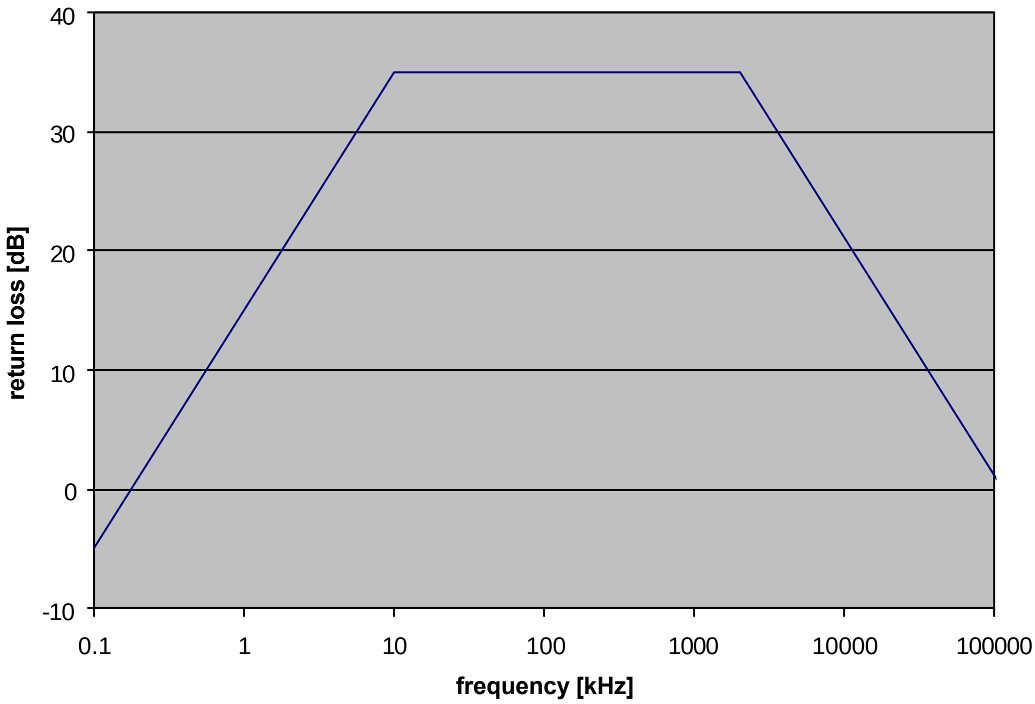


**Figure 8 – Return loss mask**

Figure 8 shows the return loss mask. The test circuit must exhibit this loss or higher at all frequencies.

Note 1: No passive circuit can exhibit a negative return loss, so calibration has implied limits on the frequency band to be measured over.

Note 2: 35 dB return loss will allow ±0.20 dB measurement error with respect to the nominal termination impedance value, R.

[11] e.g. to allow DSL and ordinary telephony to share the line

### 6.1.3 Operation of the EUT

The EUT shall be tested while it transmits maximum power and maximum PSD levels at all measured frequencies, which it can transmit data when deployed. The EUT shall have power cutback or boost configured to match the proposed deployment. The EUT shall be tested under steady state conditions, after all start-up and initialization procedures have been completed and while the EUT is transmitting data. To ensure that the EUT is in a steady-state condition, while undergoing test the EUT shall not have measured total average powers in distinct 1.25 millisecond time intervals that differ by more than 8 dB. The EUT input shall consist of a pseudo-random uniformly distributed data sequence, and the EUT output shall be a fully modulated transmit signal with all overhead, framing, coding, scrambling, modulation, filtering and all other operations performed on the data stream that the modem would normally perform while transmitting data.

Note: Although specific measurements of average power and PSD during start-up and other non-data transmission phases are not provided, a EUT that transmits inordinately high power or PSD levels during these phases may be considered to be in non-compliance with this standard.

### 6.1.4 Power spectral density (PSD) measurement procedure

#### 6.1.4.1 PSD resolution bandwidth

The nominal frequency of a measurement will be the centre frequency of its resolution bandwidth. Instrument RBW shall be 10 kHz. Measurements will be at integer multiples of 10 kHz, starting at 10 kHz, so the lowest frequency measurement will be nominally 10 kHz and actually a window from 5 kHz to 15 kHz.

Inside the signal bands the measured values for each 10 kHz band shall be compared against the masks individually. Outside the signal bands the measured values will be averaged in overlapping groups of 100 10 kHz bands, to produce the effect of a 1 MHz RBW sliding window; the averaged values will be compared against the masks.

The mask value to be compared against shall be the maximum value the mask takes within the effective window. (Typically the first few steps of the 1 MHz sliding window will be compared against substantially higher values than the mask at the nominal centre frequency would suggest).

For the ANFP, Issue 1 masks this means:

**Table 1 - Resolution bandwidth for measuring against the down exch mask**

| Frequency Band | Resolution Bandwidth |
|---|---|
| 5 kHz to 3095 kHz | 10 kHz |
| 3095 kHz to 30005 kHz | 1 MHz |

**Table 2 - Resolution bandwidth for measuring against the up short mask**

| Frequency Band | Resolution Bandwidth |
|---|---|
| 5 kHz to 1265 kHz | 10 kHz |
| 1265 kHz to 30005 kHz | 1 MHz |

**Table 3 - Resolution bandwidth for measuring against the up medium mask**

| Frequency Band | Resolution Bandwidth |
|---|---|
| 5 kHz to 895 kHz | 10 kHz |
| 895 kHz to 30005 kHz | 1 MHz |

**Table 4 - Resolution bandwidth for measuring against the up long mask**

| Frequency Band | Resolution Bandwidth |
|---|---|
| 5 kHz to 505 kHz | 10 kHz |
| 505 kHz to 30005 kHz | 1 MHz |

In each band the PSD of an EUT shall be recorded with frequency spacing equal to 10 kHz.

#### 6.1.4.2 PSD Integration Time

Measurements shall be averaged over a sufficiently long time that the contribution to measurement uncertainty shall be no worse than 0.1 dB with 95% confidence. (For some spectrum analysers this will imply limits on video bandwidth and sweep time).

# 7 References

Now integrated into the main document references. See section 7 of the main document.

# A Informative Appendix : Nonstationary Signals

This appendix concerns equipment which only transmits power intermittently – typically when there is data to send. The significant impact of such signals is due to their power when transmitting, not an average over all time.

It is technically difficult to specify how to measure intermittent signals, unless the equipment has a continuous signal test mode (in which case it may be sufficient to conduct tests in that mode, as for normal equipment). Furthermore, at time of writing there is little practical interest in deploying such equipment under the ANFP. Therefore a normative laboratory test specification is not provided.

Note: The ANSI Spectrum Management specification [9] does specify some tests for such signals, in its section 6.4 "Short-term stationary conformance criteria".

# Annex 3 - ANFP Field Test Specification

Not yet defined.  The NICC DSL Task Group is studying this subject but it is not yet clear if and when such a specification will be available.

# Annex 4 - ANFP User Guide

This Annex is under production in the NICC DSL Task Group and Issue 1 is planned to be available by end October 2000.

**- End -**