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Terminal Equipment (TE);
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Part 3: Special studies

ETSI

European Telecommunications Standards Institute

ETSI Secretariat

Postal address: F-06921 Sophia Antipolis CEDEX - FRANCE
Office address: 650 Route des Lucioles - Sophia Antipolis - Valbonne - FRANCE
X.400: c=fr, a=atlas, p=etsi, s=secretariat - **Internet:** secretariat@etsi.fr

Tel.: +33 92 94 42 00 - Fax: +33 93 65 47 16

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Foreword

This ETR was produced by the Terminal Equipment (TE) Technical Committee of the European Telecommunications Standards Institute (ETSI).

ETSI Technical Reports (ETRs) are informative documents resulting from ETSI studies which are not appropriate for European Telecommunication Standards (ETS) or Interim Telecommunications Standard (I-ETS) status. An ETR may be used to publish material which is either of an informative nature, relating to the use or application of ETSs or I-ETSs, or which is immature and not yet suitable for formal adoption as an ETS or I-ETS.

ETR 075 comprises three parts:

"Terminal Equipment (TE); Study and investigation into the feasibility of further harmonization of the requirements and associated tests of ETS 300 001 (NET 4):,

Part 1: Overview and conclusion - containing a summary of the overview and conclusions of the main report (ETR 075-2 [1]) and is provided for those readers who do not need the detail which is contained in that Part.

Part 2: Comprehensive study - giving a detailed analysis of the content of ETS 300 001 [2] together with findings and recommendations.

Part 3: Special studies - contains four sections giving the results of some detailed technical studies which formed the basis of the analysis.

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1 Scope

This is the third Part of ETR 075 contains a detailed analysis of the requirements dealing with the DC Characteristic, the Input Impedance in loop conditions, the Degree of Unbalance about Earth, and a preliminary report for the harmonization feasibility for testing methods, classified in four independant sections as detailed below:

SECTION 1: Report on DC masks for ETS 300 001 [2], Chapter 2 (subclause 2.3);

SECTION 2: Report on Input Impedance in the On-line condition (ETS 300 001 [2], Chapter 4, subclause 4.1.2);

SECTION 3: Annex to ETS 300 001 [2], Chapter 4, subclause 4.2, "Degree of unbalance about earth;

SECTION 4: Harmonization feasibility for testing methods, preliminary report.

2 References

Part 3 of this ETR incorporates by dated or undated reference, provisions from other publications. These references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this Part of ETR 075 only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1] ETR 075-2: "Terminal Equipment (TE); Study and investigation into the feasibility of further harmonization of the requirements and associated tests of ETS 300 001 (Candidate NET 4); Part 2: Main report".

[2] ETS 300 001: "Attachments to the Public Switched Telephone Network (PSTN); General technical requirements for equipment connected to an analogue subscriber interface in the PSTN".

[3] CCITT Recommendation G.122 (1988): "Influence of national systems on stability talker echo in international connections".

[4] CCITT Recommendation Q.552 (1988): "Transmission characteristics at 2-wire analogue interfaces of digital exchanges".

[5] CCITT Recommendation G.117 (1988):"Transmission aspects of unbalance about earth (definitions and methods)".

3 Definitions

For the purposes of this Part of ETR 075, the following definitions apply:

SEIZE/HOLD AREA: The DC mask area of the characteristic V (v)= f (I (mA)) where the allowed (V,I) values insure the line seizure and the loop condition, (see annex A, figure A.4).

UPPER MASK AREA: The DC mask area of the characteristic V (v)= f (I (mA)) where the allowed (V,I) values are conditioned by a short line condition (see annex A, figure A.4).

PARALLEL/TRANSFER AREA: The DC mask area of the characteristic V (v)= f (I (mA)) where the allowed (V,I) values permit a temporary parallel association of two Terminal Equipments in loop condition in order to allow a live voice transfer (this feature applies mostly to telephones), (see annex A, figure A.4).

TARGET MASK 1: A DC mask of the allowed (V,I) points of the characteristic V (v)= f (I (mA)) proposed by TC-TE as a target which requires further study in order to check its validity,(see annex A, figure A.16).

TARGET MASK 2: A DC mask of the allowed (V,I) points of the characteristic V (v)= f (I (mA)) proposed by TC-TE as a target which is the common area of the four masks of the largest countries in Europe (D, F, I, GB), (see annex A, figure A.21).

4 Basis of the special studies

4.1 SECTION 1: Report on DC masks for Chapter 2 (subclause 2.3 of ETS 300 001)

4.1.1 Summary

This ETR compares , for the most part using a graphical representation (DC masks), the various national DC characteristic requirements. A common format for all the various country masks has been used for their representation. A common mask has been drawn inside all national masks to give a common allowed value area. Also a statistical method attempts to average the distribution.of the various country values. The result of this study shows a narrow and incomplete common allowed-values area, which exhibits two main problems inhibiting the harmonization feasibility:

1) In the upper mask area an identified "DEAD-END", prevents the access towards the maximal feeding conditions found throughout Europe, (R feeding minimum which induce Vmax and Imax).

2) In the **SEIZE/HOLD AREA** the too low voltage permitted in the upper limit (around 5 V) restricts the available voltage across the terminal to an unacceptable limit.

Further analysis is required to clarify the reasons for the existence of the most restricting points which inhibit the harmonization feasibility. The information included within ETS 300 001 [2] is not detailed enough for the progress of the analysis. This occurs if the various phases of a call progress are not defined to solve the problem of the low voltage in the **seize/hold area** and where some requirements should be reconsidered so as to solve the problem of the DEAD-END of the upper mask area.

In this Part of the ETR some targets are discussed to find solutions with the least cost, which means preventing as much as possible the PSTN interface modifications which could entail very large costs. Bearing in mind the least cost solution, TC-TE suggests that further study should be undertaken to identify the causes of a barrier to harmonization, for four main reasons:

1) the values of the DC masks generally take into account the old and obsolete network equipment which can no longer be used before ETS 300 001 [2] applies (seize/hold area matter);

2) most of the DC masks do not discern between the steady-state and the transient-state (seizure) of the DC characteristic for which the DC values are generally more restricting during the seizure phase (seize/hold area matter);

3) some DC characteristics could include, the constraints of the pulse dialling for which the voltage across the TE is generally required to be lower than in the steady-state (seize/hold area matter);

4) the specifications of maximum loop-resistance ($Vt / It \leq 400\ \Omega$ to $500\ \Omega$), out of the seize/hold area ($It \geq 35$ mA) seems to be an excessive requirement. The feeding current drawn is over the minimum which ensures the PSTN interfaces remain in loop condition (**upper mask area** matter).

The study of the above points could be achieved by an individual questionnaire addressed to each administration and completed by a verification on site. The cost of such a study is insignificant considering the enormous cost of the eventual PSTN modifications, and that the benefits from the probable success would be substantial.

Further study, in co-operation with the STC-TE 4 will be necessary, bearing in mind that the basic telephone, and terminals incorporating a telephone unit, use the transmission level regulation as the line length function.This is reflected by the DC values (voltage or current across the terminal), and this regulation characteristic is not an ETS 300 001 [2] requirement.

4.1.2 Analysis method

The different information about the DC characteristic, provided by the 19 countries, has been reformatted in a common format to allow a graphical comparison, in order to attempt the construction of a common mask.

To this end the nineteen graphs, one for each country, have been created and can be found in annex A, figures A.20.1 to A.20.19.

Figures A.5 to A.11 in annex A show the 19 country masks dots sorted out by mask areas and feeding conditions superimposed.

A common allowed value (Vt, It) area ,has been built by the intersection of all the various DC masks as shown in annex A, figures A.12 to A.14.

The quarter plane (V, I) has been divided into three parts so as to split the study in three main areas (see annex A, figure A.4):

1) **SEIZE/HOLD AREA** (I < 35 mA, 5 v < V < 10 v) which is the area of the maximum voltage permitted to ensure the minimum operating current for the seizure signalling and the on-line hold;

2) **UPPER MASK AREA** (I > 35 mA, V > 10 v) which is the area where the current is sufficient for the on-line hold and also where the current and the voltage could reach some values limited by etheir the specifications or the feeding conditions;

3) **PARALLEL/TRANSFER AREA** (0 < V < 5 v to 8 v, for 0 < I < Imax) which is the area of the minimum voltage across the parallel TE in the loop condition, to ensure a minimum feeding voltage when the second TE is initiated in loop condition for a live voice transfer.

A statistical correlation method (Regression lines and Discrete average) between the values provided by all countries, has been attempted for each distinct plane area, to highlight the averaged values and as to measure the correlation coefficient between them. The aim of this study was not to build a mask average, but to give an indication of the consistency of the various values and to provide some guidelines for an acceptable correlation.

The statistical lines have the benefit of giving the tendency of the overall values and in some cases where the correlation is correct, may be a useful indication for the target mask. In the first approach it could say that the values which exceed the statistic lines towards the allowed area might be problematic and the others which remain in the non-allowed area will not pose any problems.

The results of this statistical calculation are shown in annex A, figure A.15:

> The values (V, I) and the results of the statistical calculation are recorded in annex A, in the following tables: (tables A.2, A.3, A.4, A.5, A.6, A.7, A.8, A.9.1 to A.9.10, A.10.1 to A.10.7).

The country masks have been split in three categories and respectively superimposed:

- **Category 1** (see annex A, figure A.8).

  The DC characteristics which specify a maximum loop resistance (R loop _400 ohms to 500 ohms) in the UPPER MASK AREA (I>35 mA) for the twelve following countries (**A, CY, DK, SF, D, GR, IS, L, NL, N, E, CH**).

- **Category 2** (see annex A, figure A.9).

  The DC characteristics which permit a vertical voltage growth (R loop > 600 _ for I > 35 mA) in the UPPER MASK AREA (I > 35 mA) for the seven following countries (**B, F, IRL, I, P, S, GB**).

- **Category 3** (see annex A, figure A.19)

  Gathering the masks of the 4 main European countries (**D, F, I, GB**) representing the largest number of lines in Europe.

In addition the following remarks have to be considered:

- eleven countries (**B, CY, DK, IS, I, NL, P, S, CH, GB,**) do not limit the line current which is limited only by the feeding condition (feeding bridge resistance and line resistance);

- six countries (**A[60mA], SF[50mA], D[60mA], GR[80mA], IRL[100mA], L[60mA], E[100mA]**) limit the current somewhere with respect to the indicated values (either in the PSTN interfaces or by the feeding bridge resistance or by switching added resistance in case of short lines within the PSTN interface), but the method, is not identified;

- one country (**F**) limits the line current at **60mA** inside the terminal.

4.1.3 Analysis comments

The analysis is split in three parts, the **seize/hold area**, the **upper mask area** and the **parallel transfer area:**

4.1.3.1 Seize/hold area

Considering the COMMON ALLOWED AREA, (see annex A, figures A.12, A.13 and A.14) the maximum voltage allowed from I = 0 to I = 35 mA across the terminal is too restrictive to feed the features of the terminals which are only fed by the line energy. This low voltage could induce significant extra costs in terminal design, because it is, low voltage and low consumption technology dependent (see annex A, figures A.6 and A.14 and the related data in the table A.6).

The statistical data, both averaged mask and regression line, shows a tendency to increase the low voltage limit in the seize/hold area. The correlation coefficient which exhibits an acceptable value (**ρ= 0,76**) encourages the statistical line use as a guideline for the target mask construction.

A minimum voltage of (7 V to10 V) respectively for a current of (5 mA to 35 mA) should be available in this area.

Assuming this target, figure A.17, shows the critical points, with respect to the target mask 1, which inhibit harmonization.

This critical values with respect to the DC TARGET MASK 1, are situated within the SEIZE/HOLD AREA, restricting the voltage available across the terminal input.

The following countries, for the value couple [I (mA); V (v)] respectively seem to be concerned:

A [1,25; 5], **B** [25; 8], **CY** [17; 6,8], **DK** [16; 6,4], **SF** [20; 8], **D** [1,9; 4,36], **GR** [20; 8], **IS** [14; 5,6], **IRL** [20; 8], **I** [25; 8,75], **L** [14; 5,6], **NL** [36; 9], **N** [0; 4] [0,7; 4] [13,8; 5,5], **P** [15; 6,95] [27; 8,24] [31; 8,92], **E** [18,5; 7,4], **S** [10; 7,5], **CH** [20; 8], **GB** [25,9; 9] [33,5; 10] [42; 12,5].

Further analysis is required, taking into account the various phases of call progress (as depicted in the figures A.1 to A.3 in annex A) to distinguish the seizing feature (caller), the seizing feature during the calling signal, the on-line hold feature, and the decadic dialling feature, which seem in most cases to be amalgamated into the global requirement declared by each country.

Benefits could be achieved by separating the requirements of these various phases. The DC characteristic requirement should only be applicable during the **loop steady state** and where the other should be considered as **loop transient state** or **pulsing period** in distinctive requirements:

- specification of DC characteristic during a period of 400 ms just after the start of the line seizure for both cases, caller seizure and seizure during calling signal. This start period is initiated and controlled by the terminal itself;

- Specification of DC characteristic during the pulsing and possibly during the pre-pulsing pauses and the interdigital pauses, whithin the decadic dialling phases, which are initiated and controlled by the terminal itself. In the near future the decadic dialling, could probably be replaced by the Multi Frequency Push Button (MFPB) dialling, in which case the requirement could be withdrawn.

In most cases the result of distinguishing the phases allows a higher maximum voltage during the steady state of the DC characteristic.

Another solution for increasing the low voltage allowed in this area is to increase the EMF minimum of the feeding battery. This value could be either specified higher or increased and regulated by the use of a voltage booster in series with the battery. The ΔV increase of the battery EMF is also gained for the low voltage in this area by a ΔV translation of the characteristic (see figure A.2).

Finally, in the case of old and obsolete network equipment, it could be of great benefit to relax the constraints from the requirement, when they are no longer to be used in the next three to five years.

To sum up, with the application of some or all of the above considerations, it might be possible to reach the TARGET MASK 1 in the seize/hold area.

4.1.3.2 Upper mask area

A conflict exists between the current limiting requirement at 60 mA within the terminal (**F**) and the maximum loop resistance requirement at 400 ohms to 500 ohms, in the UPPER MASK AREA, over I = 35 mA, where the latter seems to be excessive, although it is legitimate in the SEIZE/HOLD AREA (see annex A, figures A.5 and A.12 and the related data in the table A.7).

The poor correlation coefficient (**ρ = 0,24**) confirms the harmonization difficulties in this area, but the discrete averaging of the overall masks shows a tendency towards a vertical voltage growth. Due to the low correlation of the values the statistical analysis in this area cannot be used as a guideline in the target mask construction.

Considering the exorbitant cost in the case of French PSTN modifications in the current limiting, and making the assumption that the loop resistance might only be a specification modification, for which the cost is minimal, although applied by 12 countries, the TARGET MASK 1 suggest a vertical area where the voltage growth is allowed up to 45 V in case of maximal feeding condition (R feeding minimum) (see annex A, figures A.16 and A.18).

The suggested DC characteristic could be a non-linear resistance with two segments of variable slope: The first in the SEIZE/HOLD AREA, with a slope $\Delta V/\Delta I$ of around 100 Ω, and the second one in the UPPER MASK AREA, with a slope $\Delta V/\Delta I$ of around 1,2 KΩ , linked by a bend of around I = 35 mA. In addition the second segment should have a maximum slope of 2 KΩ to be compatible with a constant current feeding, in order to prevent any unsteady effects.

This non-linear DC characteristic which is not a current limitation but a variable resistance over a threshold of 35 mA, is able to provide a universal solution throughout Europe. In addition it provide a maximum consumption from the terminal which could be a substantial advantage in energy savings in the network energy shop, especially during the intensive traffic period and during power failure.

To sum up, this solution has the advantage of being low cost, but nevertheless requires further research and experimentation in order to confirm the above assumption.

4.1.3.3 Parallel/transfer area

This requirement is only applicable in case of parallel terminal use, in the loop condition (permitted for the live voice transfer) during a short period which allows the transfer of the communication from a first terminal to a second one, connected in parallel. The DC characteristic in this area is intended to provide a minimum voltage across the terminal to ensure sufficient feeding conditions for the second terminal which has to draw a minimum current in order to guard the loop after the release of the first terminal (see annex A, figures A.7, A.13 and A.14 and the related data in the table A.5).

The harmonization of this mask part does not seem to be problematical (see annex A, figures A.16.and A.18). The following precautions should be taken to ensure a steady state when the terminals are both, in parallel and in loop condition, and to provide a sufficient voltage ensuring the correct start and feeding of the second terminal during the off-hook period:

- minimum voltage equal to 5 V at 20 mA;

- a 100 ohm slope in order to encourage a DC characteristic with at least 100 ohms of slope. The slope ensures the steady state which could not be obtained with a horizontal zener characteristic;

- the terminal has to be able to vlose the loop, to draw a sufficient current and to be initialized under a voltage of less than 5 V, which could be encouraged by the shape of the mask in the SEIZE/HOLD AREA between) to 2 mA, starting at the point A = (0 mA; 4,2 V).

4.1.4 Target solutions

Two target solutions TARGET MASK 1 (see in annex A, figures A.16 and A.17) and TARGET MASK 2, (see in annex A, figure A.21), have been constructed, oriented towards, firstly the lower cost of the harmonization without PSTN interface modification. Secondly, towards two different objectives which are, respectively, the terminal cost effectiveness regarding the minimum voltage available in the low current area to provide sufficient power and the compatibility with the largest number of installed lines in Europe.

4.1.4.1 TARGET MASK 1

The **TARGET MASK 1** is shown and compared to the country DC characteristic points (see annex A, figures A.16, A.17, A.18 and A.20).

In the SEIZE/HOLD AREA the following countries are relatively close to the TARGET 1 definition: (**A, SF, F, D, GR, IRL, NL, E, S, CH, GB**). The remainder (**B, CY, DK, IS, I, L, N, P**) could meet a serious problem. Only a few of these (**A, F, D, NL, S**) could fully meet the TARGET MASK 1 requirement at this moment . Further study as described above could achieve success.

In the UPPER MASK AREA the 12 following countries (**A, CY, DK, SF, D, GR, IS, L, NL, N, E, CH**) should reconsider the said "excessive specification" of the maximum loop resistance over 35 mA and the country GB could find some difficulties with the value couple [42 mA; 12,5 v].

To sum up, the TARGET MASK 1 which seems to be a reasonable target, requires further study with the cooperation of the administrations, in order to progress towards a common and acceptable allowed values mask.

The DC characteristic feature complying with the TARGET MASK 1 can be **low cost** by using several sources of standard integrated circuits available on the market. The extra cost of this solution (less than 1% of the cheaper basic telephone set), consists only in power dissipation. The two peripheral transistors necessary for the register recall loop disconnect achieve the slope variation of the DC characteristic without extra components.

4.1.4.2 TARGET MASK 2

The **TARGET MASK 2** is shown and compared to the country DC characteristic points (see in annex A, figure A.19 and A.21):

In the SEIZE/HOLD AREA in addition to the four countries (**F, D, I, GB**) which are the basis of the TARGET MASK 2 construction, the following country requirements are compatible: (**A, SF, GR, IRL, NL, E, S, CH,**). The remainder (**B, CY, DK, IS, L, N, P**) will meet a serious problem. The TARGET MASK 2 involves more candidates (**13 /19**), who meet a common allowed area for I< 35mA but the question of insufficient voltage available across the terminal remains.

In the UPPER MASK AREA the 12 following countries (**A, CY, DK, SF, D, GR, IS, L, NL, N, E, CH**) should reconsider the said "excessive specification" of the maximum loop resistance over 35 mA (see figures A.2, A.12 and A.13).

Finally, although the TARGET MASK 2 involves more countries in a possible harmonization, the question of the terminal powering with a sufficient voltage under a loop current of 35 mA, remains. For this reason the target priority should be the TARGET 1 for further study and the TARGET 2 could be a backup in case of solution one failure.

4.1.5 Suggested method for further study

Substantial progress towards the harmonization of the DC characteristic, might be made considering in detail the purpose and the implication of the following main features in the various European PSTN interfaces:

- Attachment to the network:

  a) feeding the TE with sufficient power (minimum DC current and voltage) to ensure an adequate power supply to the apparatus that has to perform the basic features of telephony (dialling, speech, speaker, features);

  b) limiting the line current in case of low resistance lines;

  c) ability to associate several TE and/or equipment (in parallel and/or series);

  d) in general, to ensure a stable steady state in loop condition.

- Interoperability with the network:

  a) energize and hold in working state the interface for the caller loop seizure (e.g. minimum current to energize the relays for incoming and outgoing loop seizure) (Quiescent state to loop state detection (calling or called party off hook));

  b) hold in working state the dialling register interface until a clear occurs or until a maximum delay elapses;

  c) hold in working state the subscriber voice interface until a clear occurs;

  d) hold in working state the park warning interface until a clear occurs;

  e) ensure a warning in case of faulty call (park state);

  f) in general, to ensure a stable steady state in loop condition.

- Interworking with another terminal:

  a) in general, the DC characteristic is used as an automatic transmission level regulator in the audio band in order to compensate the line attenuation according to its length. The voltage or the current across the terminal or across the PSTN transmission interface is used as a line length measurement. This aspect needs to be taken into account when considering the variation of the DC values (delta V/delta I) in the terminal or in the PSTN interface function of the line variation in the various cases of the feeding parameters. This characteristic needs to be an entry point as a parameter for the transmission mask into the chapter in order to protect the requirements of the transmission plan;

b) in the case of loop current excess, if the current is not limited to very low line resistance and low feeding bridge resistance, the interworking of speech characteristics in the audio band could be affected by saturation of the magnetic core of the feeding bridge, or by action of some overfeeding protection systems;

c) the interworking with another terminal could also be affected in case of loop instability (steady state);

d) it is obvious that the parallel TE or telephones in the loop condition could also affect the interworking into the audio band.

In addition, a detailed study should be undertaken, discerning the following parameters for each critical identified value (V, I) on the country mask:

1) Is it obsolete equipment?
2) Life "in use" expected?
3) Number of national lines involved?
4) Will the number of installed lines increase or decrease in the future?
5) Which phase of the call progress is relevant?

   a) Incoming seizure with AC calling signal (Ringing Interface);
   b) Outgoing seizure (Quescient Interface);
   c) Decadic dialling (Dialling Interface);
   d) Speech band transmission (Transmission Interface).

The various call progress phases are described and can be found in the annex A, figures A.1 to A.3.

In accordance with the DC characteristic parameters described in figures A.1 to A.3, a questionnaire could be completed by each administrative body to identify the problematical constraints at the PSTN interfaces.

NOTE: The EMF minimum available at the PSTN interface access for each call progress phase is equal to the EMF minimum of the battery from which the (VF) is deducted (VF is Continuous Forward voltage at current equal to zero, of the non-linear devices connected in series with the PSTN interface.

4.1.6 Testing method

The testing methods should be a part of a common handbook: "**Analogue test and measurement methods hand-book**" (see in annex D, clause D.2, in section 4, figures D.12 and D.13).

The test of the DC characteristic should have four steps:

1) plotting the DC characteristic Vt = f(It) from I min to I max and from I max to I min for both polarities, superimposed on the DC mask;

2) checking the stability of the steady state with a constant current feeding from I min to I max for both polarities (case of PSTN feeding with constant current);

3) checking the stability of the steady state with a constant voltage feeding from Vmin to Vmax for both polarities (case of parallel association in loop condition);

4) checking the ability of starting loop closure under a constant low voltage for both polarities (case of parallel association in loop condition).

The testing method should be general enough to take into account various DC characteristics which could be compatible with the DC mask, e.g. the characteristic could be non-linear, or even discontinuous with trigger switching at some thresholds, controlled by software, etc,...

The plotting of the DC characteristic should be continuous between Imin and Imax or at least achieved by sampling a sufficient number of points (especially around the bend or discontinuities), with respect to the time constant of the AC/DC decoupling.

The plotting method should be independent of the real feeding conditions. These can be different from one PSTN interface to another (constant voltage or constant current feeding) and a complementary test should check the stability in each case.

In the case of constant current feeding, it is necessary to check the stability of the steady state of the TE DC characteristic by applying a constant source current from I = 20 mA to I max. If the TE also presents a current limitation with too steep a gradient ($\Delta V / \Delta I$), the association of both might be unstable. For this reason a maximum gradient is required for the DC characteristic to be compatible with eventual constant current feeding.

In the case of parallel TE association in loop condition complementary tests should be made firstly to check the ability of the terminal to start the loop closure under a low voltage and, secondly, to check the steady state stability when two TE are in loop condition in parallel. The constant voltage feeding is the corollary of the constant current feeding. There a DC characteristic with a flat gradient ($\Delta V / \Delta I = 0$) (such as a zener characteristic) might induce some steady state instability or might avoid feeding one of the parallel TE. So as to avoid this unexpected situation, the DC characteristic should exhibit a minimun slope of $\Delta V / \Delta I \geq 50\ \Omega$ to $100\ \Omega$.

The stability measurement could be achieved by an AC measurement during a period of time in the steady state.

The testing arrangements and the range values tables are shown in annex D, clause D.2, in section 4, figures D.12, and D.13, and tables D.1 to D.4.

Annex A: DC current and loop resistance, Country DC masks

A.1 PSTN interfaces and feeding condition in the various call progress phases

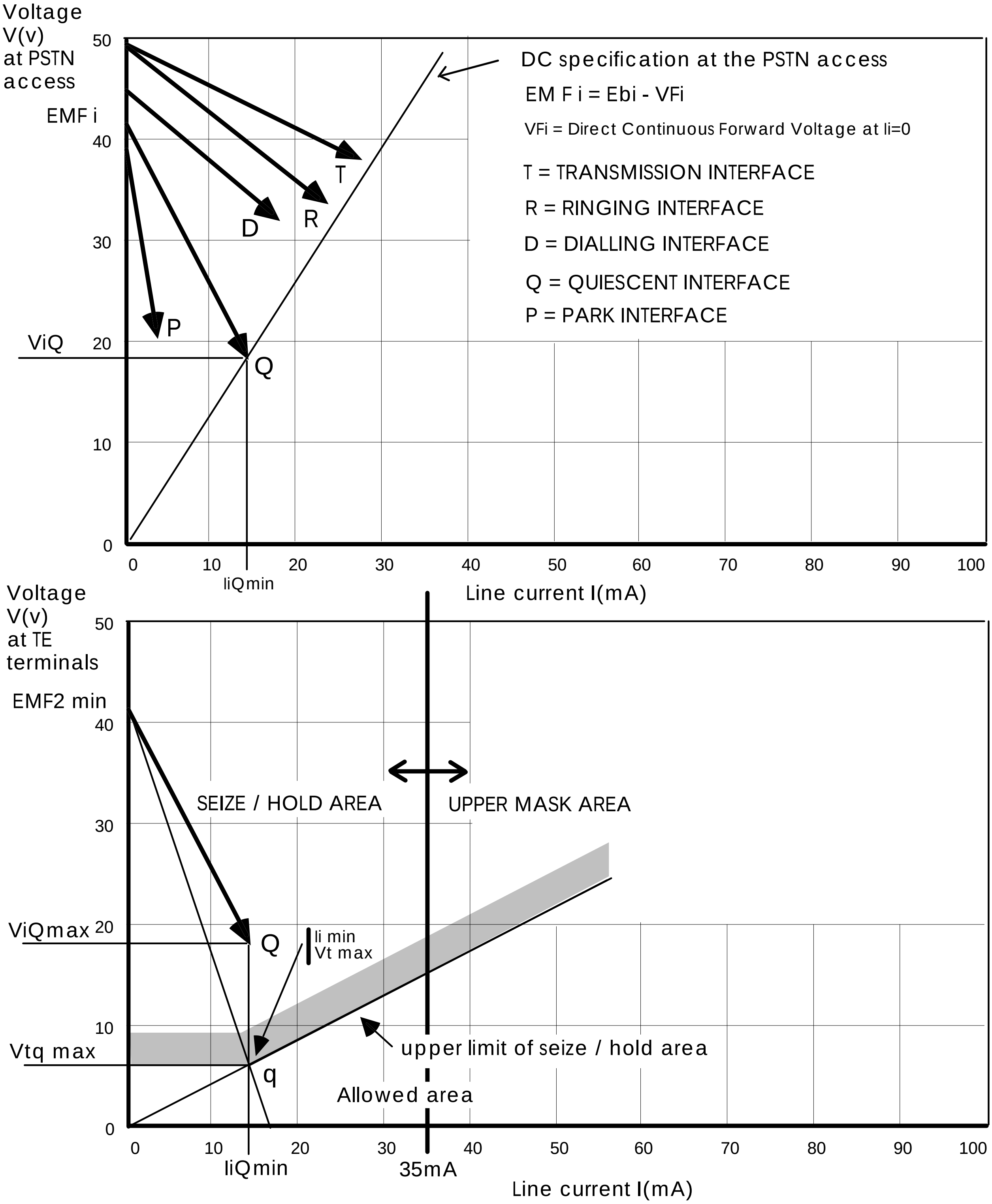


Figure A.1: DC characteristic translation from PSTN access to TE terminals

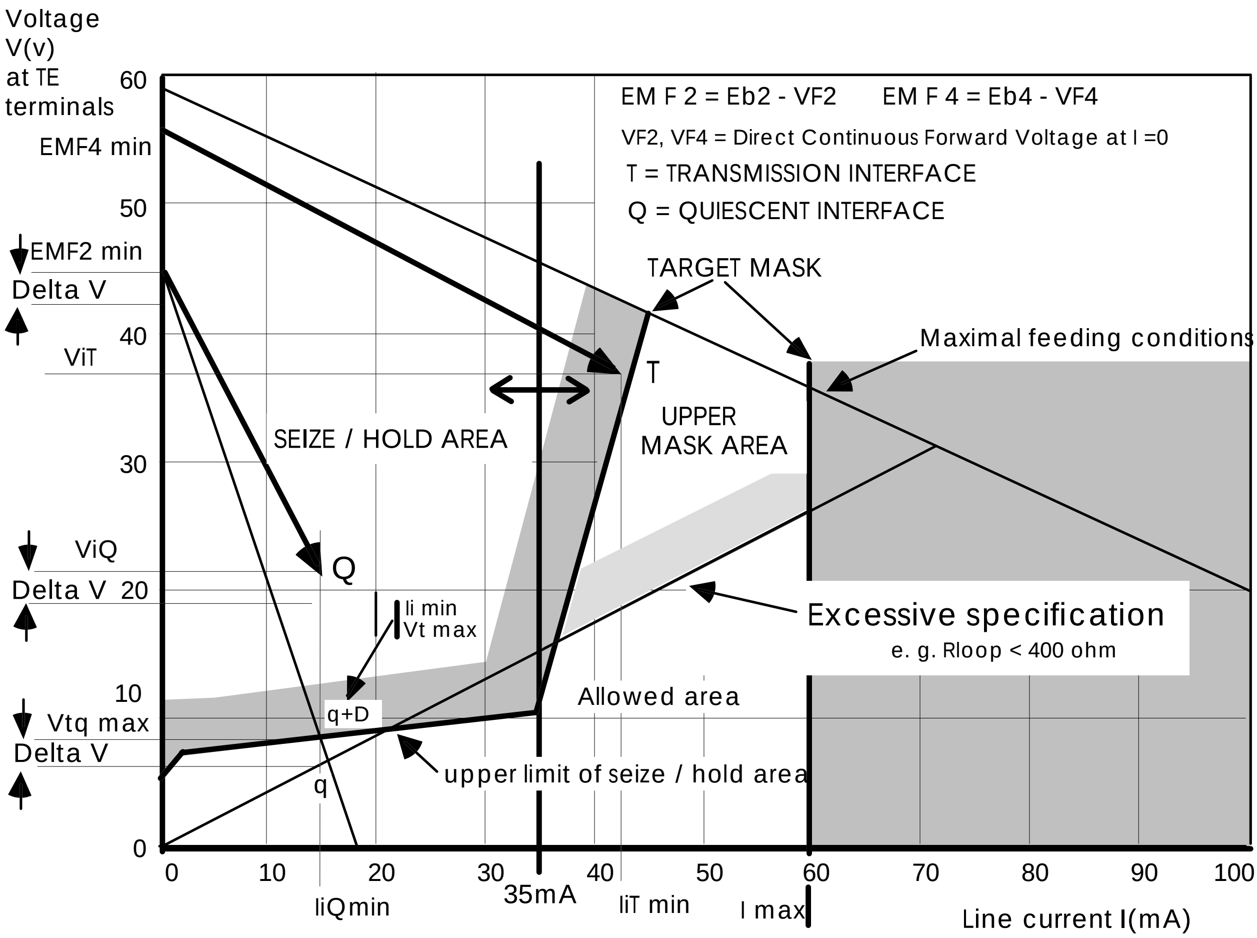


Figure A.2: DC characteristic at TE terminals, improvement of the low voltage (V) and excessive specification

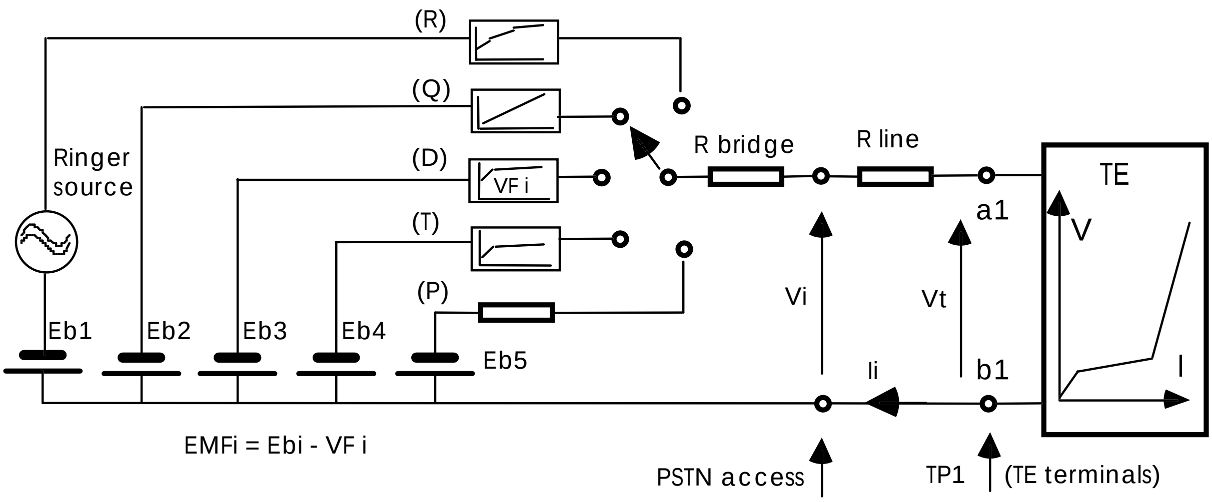


Figure A.3: PSTN interfaces and feeding conditions in the various call progress phases

A.2 Mask area definitions for the DC characteristic masks study

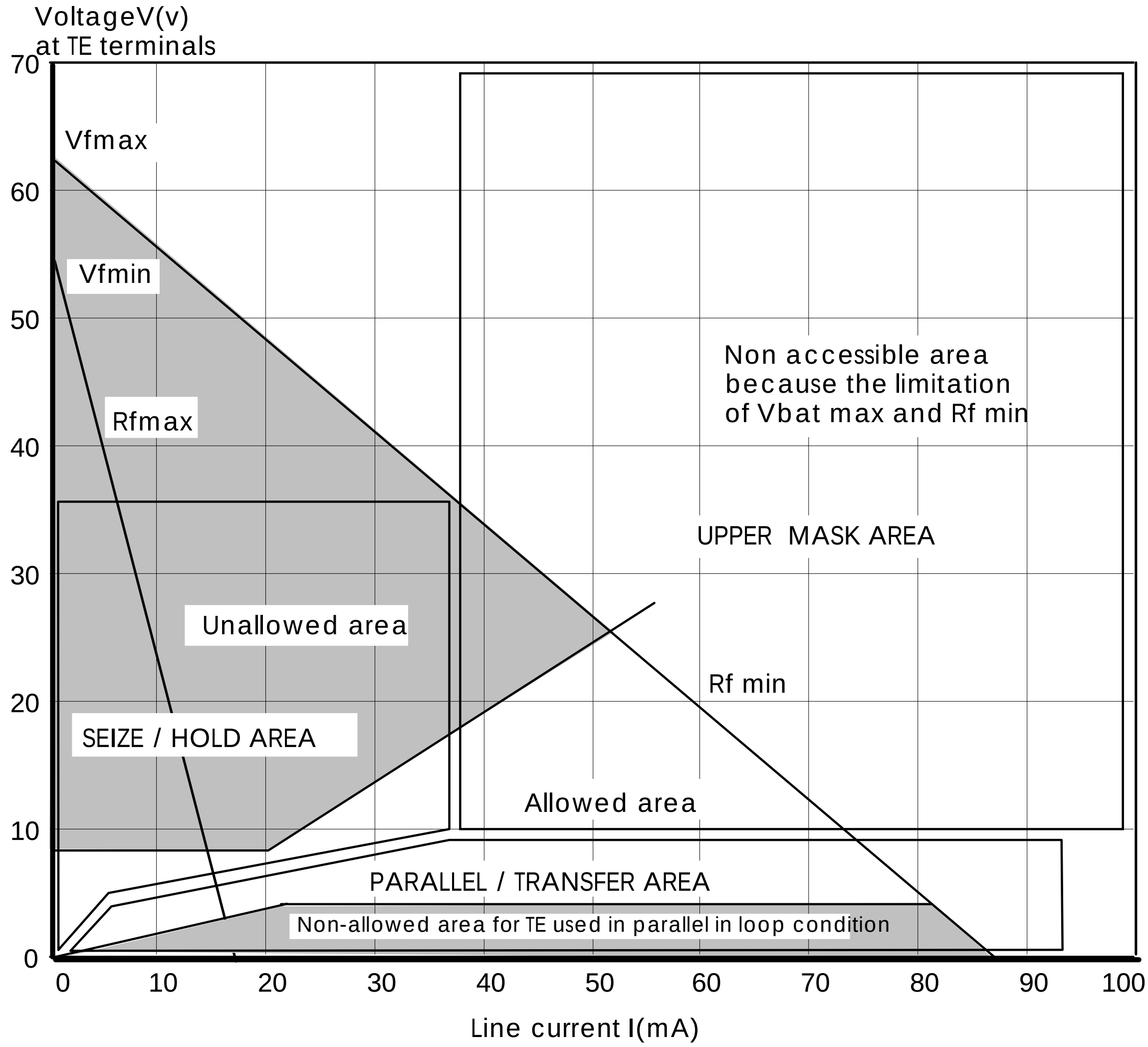


Figure A.4: Area definitions to split the study in three parts

A.3 Superimposition area by area of the 19 country DC characteristic dots

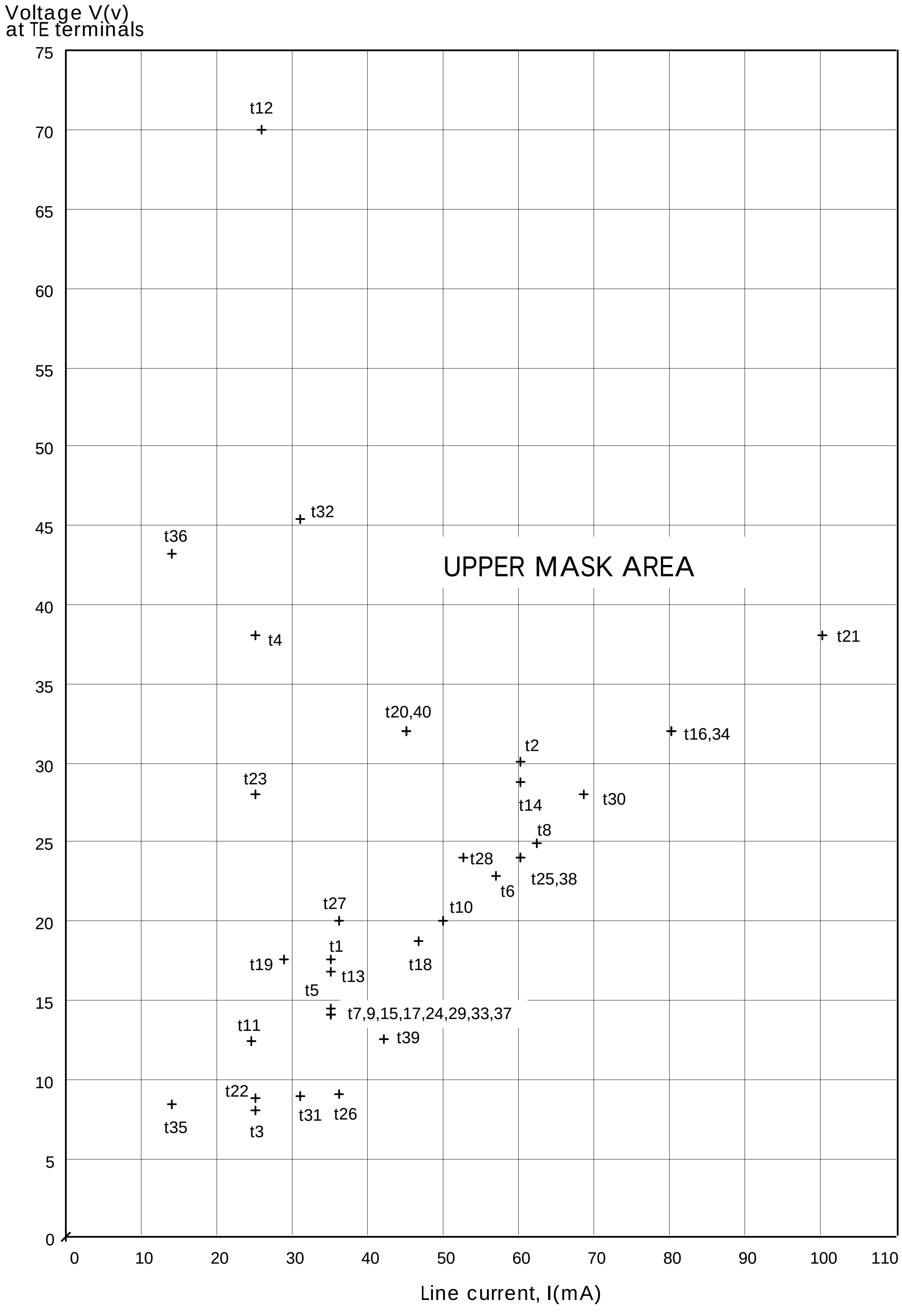


Figure A.5: Superimposition of all the dots of the DC characteristic in the upper mask area

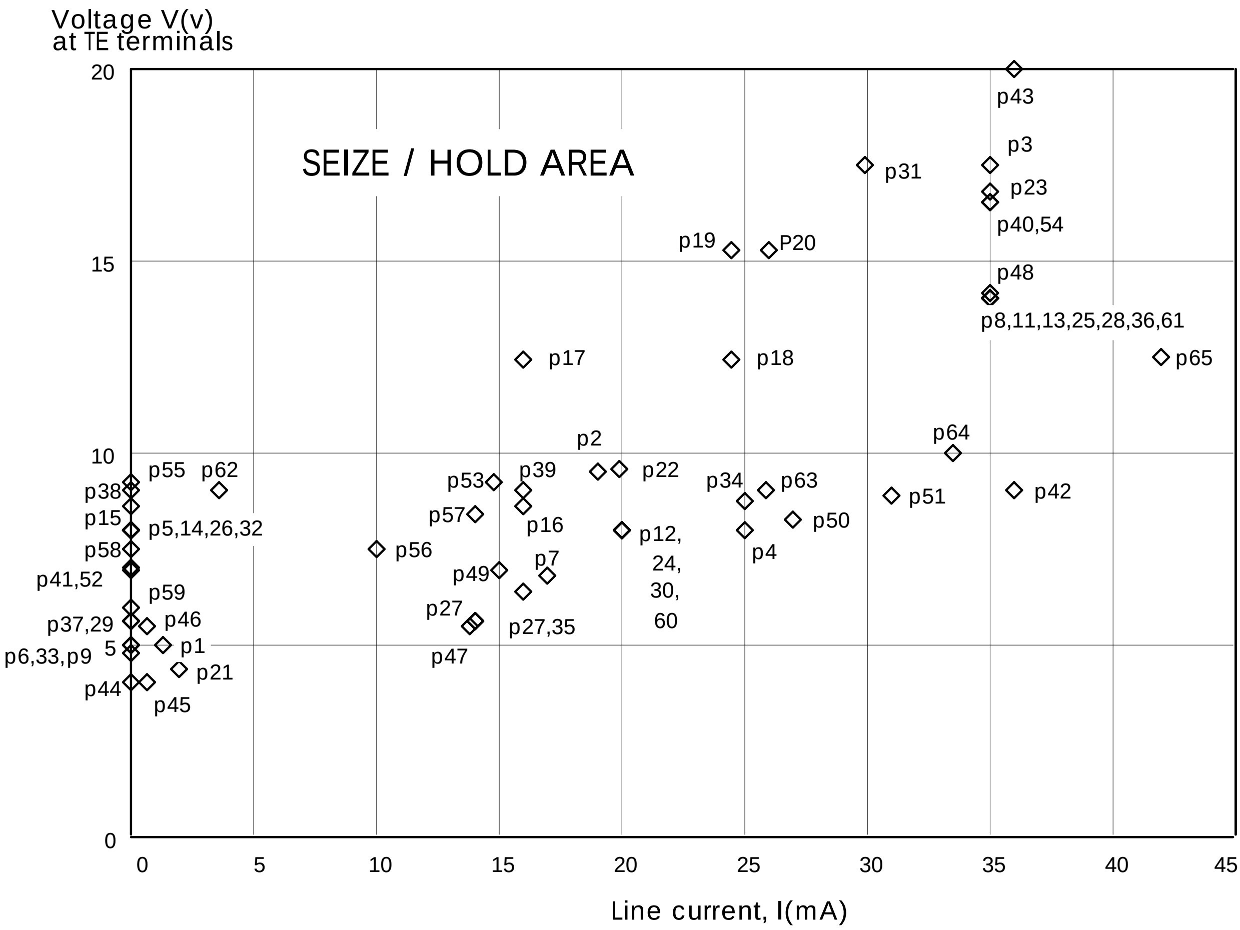


Figure A.6: Superimposition of all the dots of the DC characteristic in the seize/hold area

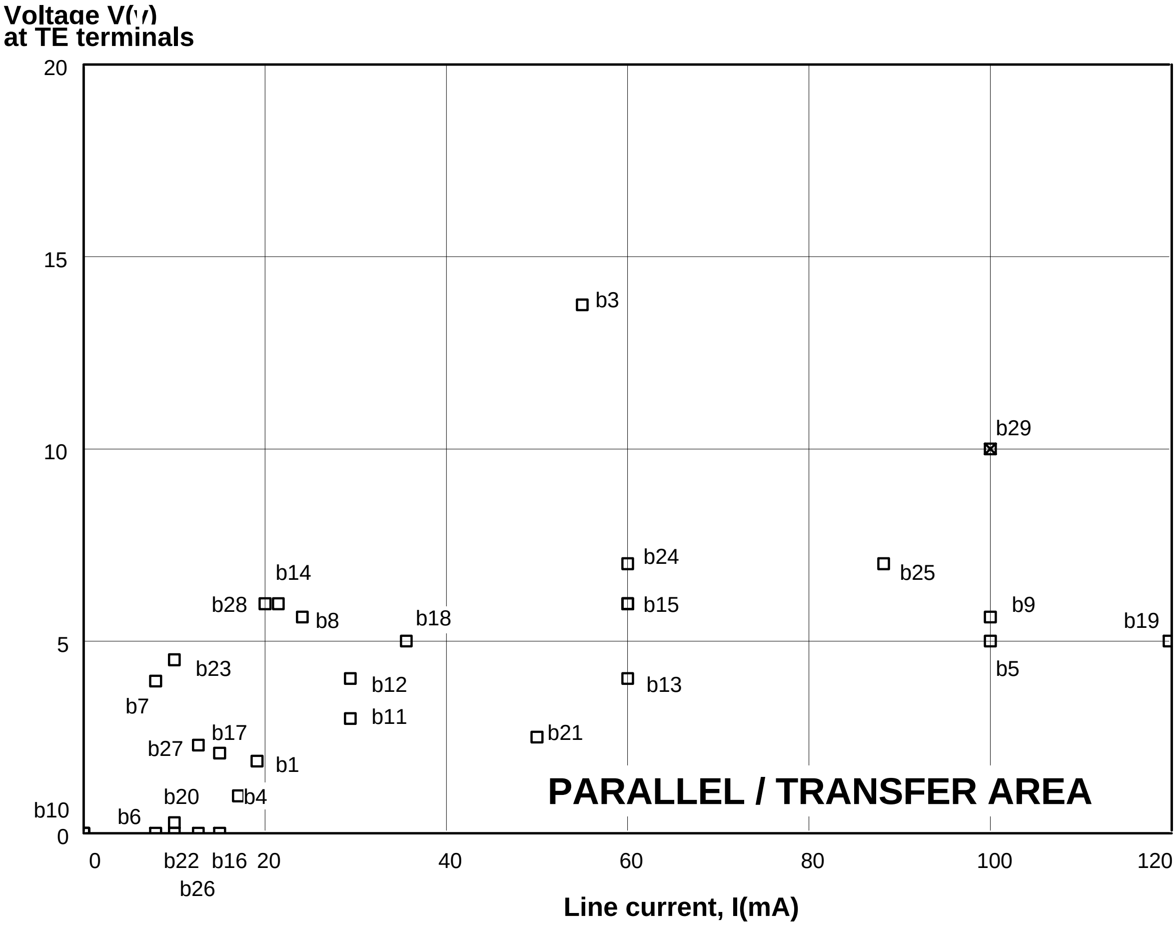


Figure A.7: Superimposition of all the dots of the DC characteristic in the parallel transfer area

A.4 Sorting out of the 19 DC masks by shape category

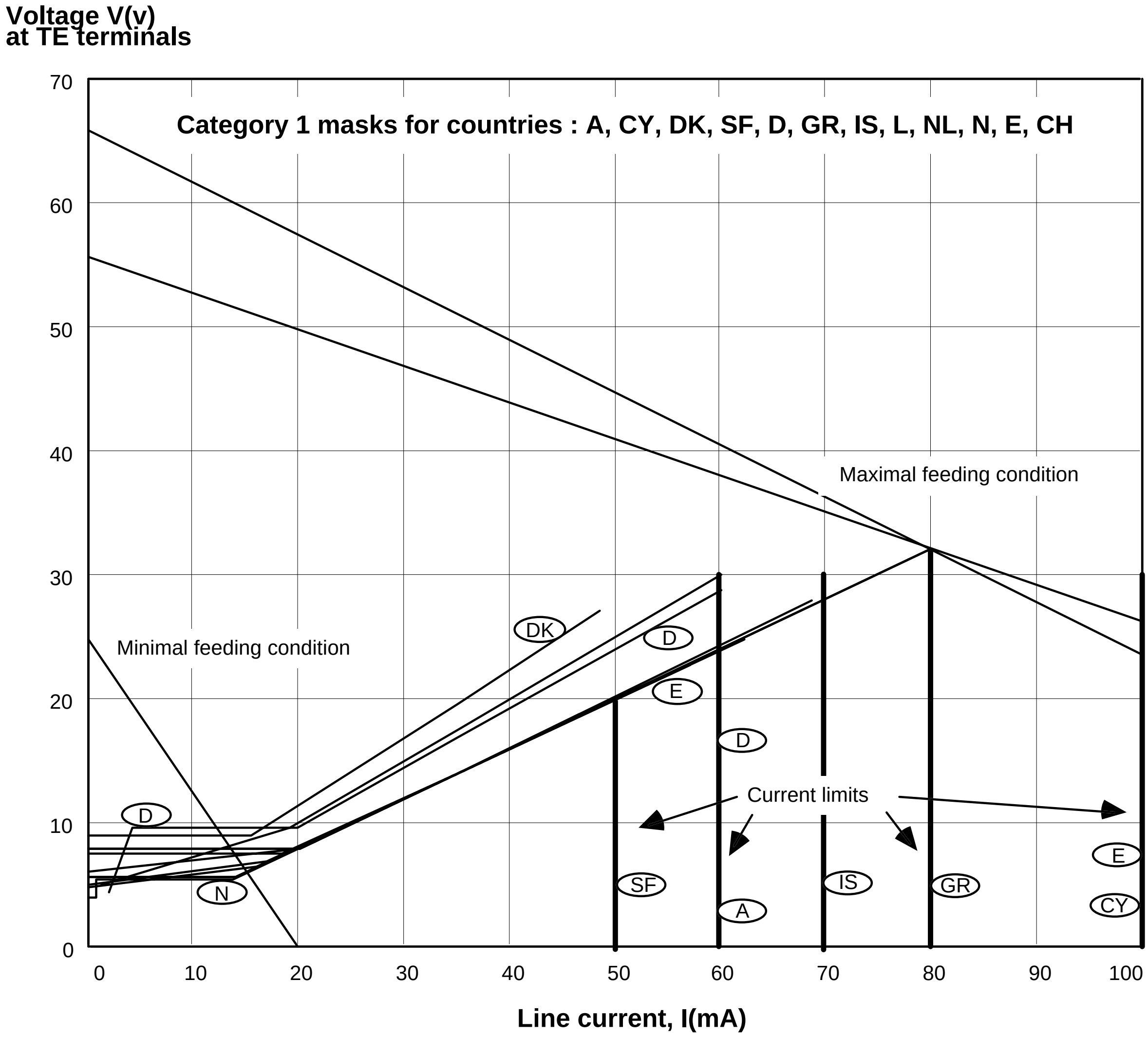


Figure A.8: Twelve country masks of the category 1 (limited by Rloop max in the upper mask area)

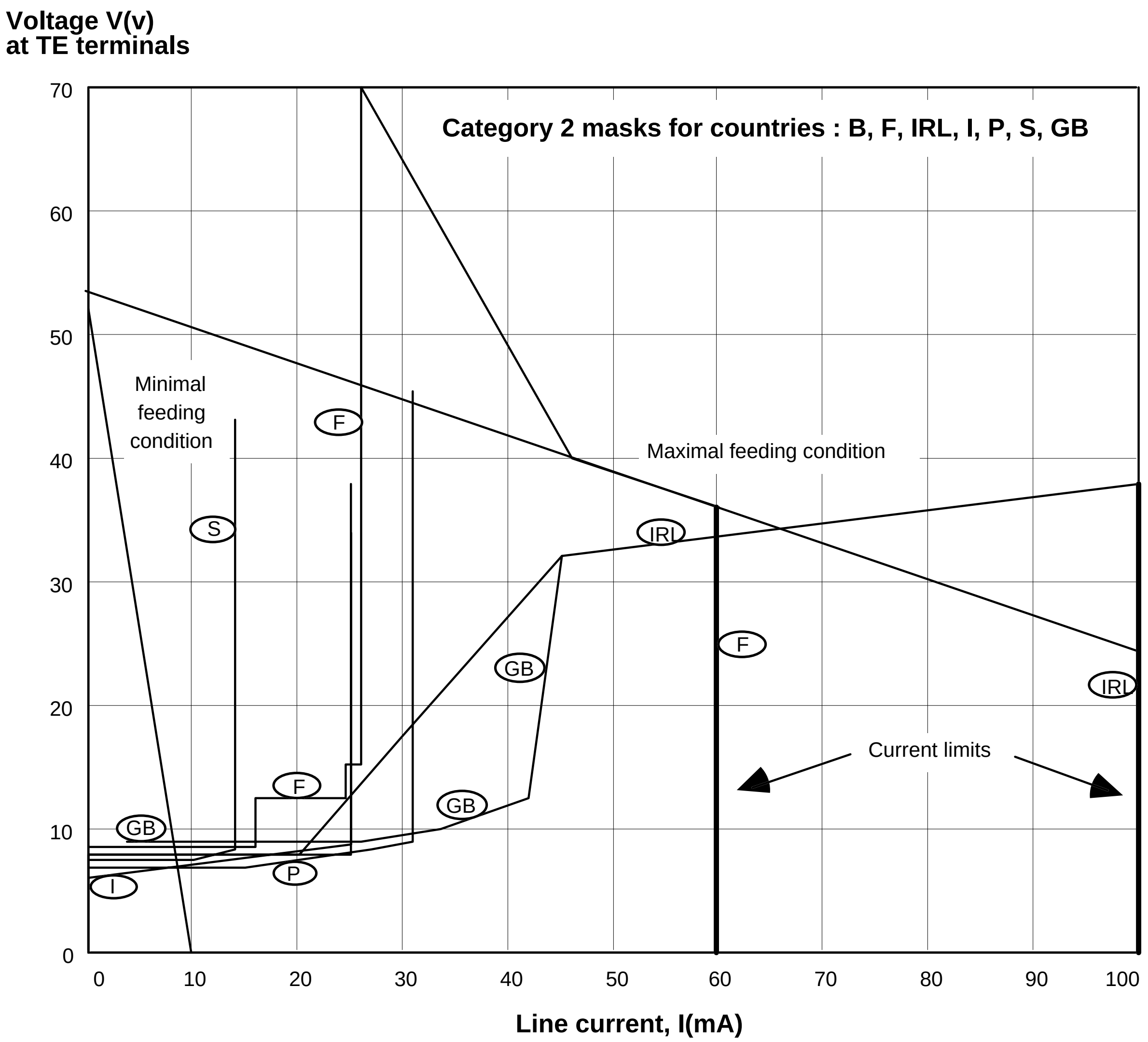


Figure A.9: Seven country masks of the category 2 (allowing higher voltage in upper mask area)

A.5 Maximal and maximal feeding condition superimposition for 19 country DC masks

Table A.1: Feeding condition summary for the 19 countries

c	ctry c =		Vbmin c =	Rfmax c =	Vbmax c =	Rfmin c =	Imin c =	Imax c =
1	A		50	2132	60	500	19	60
2	B		44.5	1725	53	360	21.2	147
3	CY		43	1740	53	400	20	100
4	DK		44	2400	56	500	15.7	112
5	SF		43.2	1710	52.8	800	20	50
6	F1	Conv	46	1400	54	300	25	60
7	F2	Quiesc	45	3600	54	300	10.1	60
8	F3	Dialpuls	45	1845	54	300	17.7	60
9	F4	DialFV	46	1450	54	300	23.2	60
10	F5	Howler	52	8225	54	300	5.2	60
11	F6	Conv overf	89	2960	104	1400	25	60
12	F7	Quiesc overf	86	3000	104	1400	24.5	60
13	F8	Dialpuls overf	86	3350	104	1400	21.9	60
14	F9	DialFV overf	89	2960	104	1400	25.8	60
15	F10	Howler overf	82	5225	104	1400	14	60
16	D		60	3500	60	1000	20	60
17	GR		44	1800	66	425	20	80
18	IS		43	2400	56	800	14	70
19	IR		48	5000	48	480	20	100
20	I		44	5000	52	720	18	72.2
21	L		60	3886	60	600	14	60
22	NL		42	2140	66	800	16	80
23	N1		24	1200	24	460	14.9	52.17
24	N2		60	3500	60	460	15.36	130.4
25	P		45	5500	55	300	6.9	183
26	E		43	2300	56	300	18.5	100
27	S		36	3000	60	1200	10	50
28	CH		43	2200	60	600	16.5	100
29	GB		50	1640	50	400	25	125

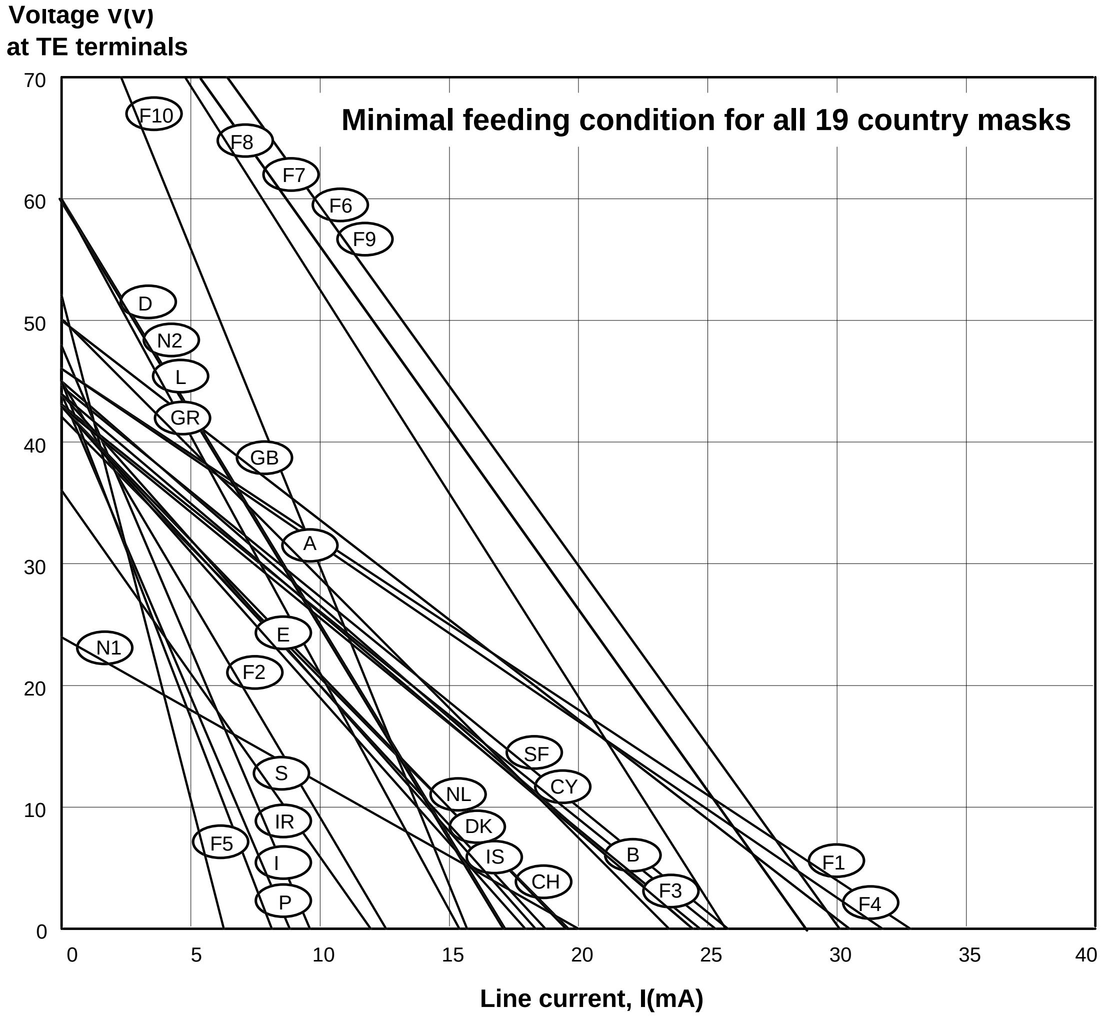


Figure A.10: Minimal feeding condition limits of the 19 country masks

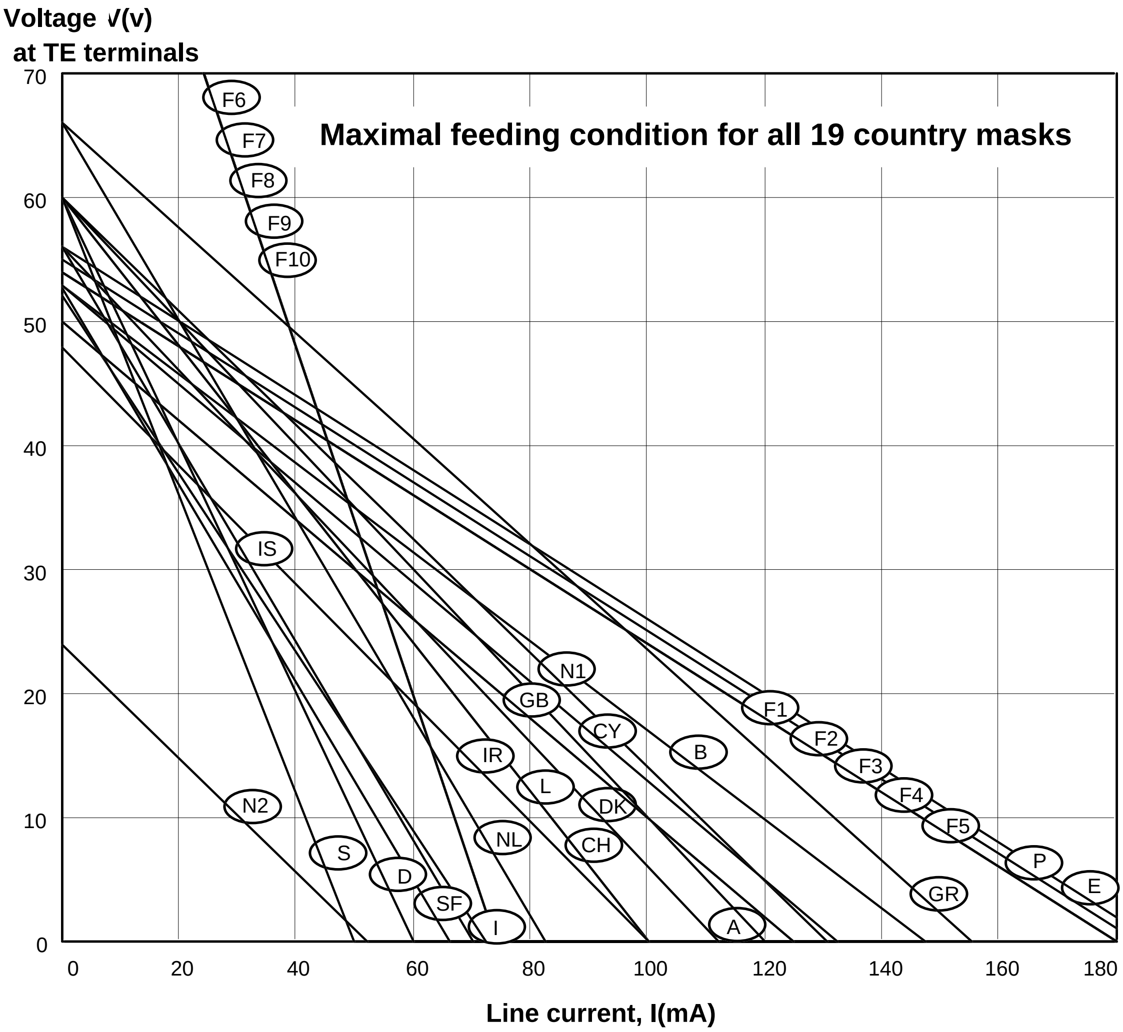


Figure A.11: Maximal feeding condition limits of the 19 country masks

A.6 Common allowed area inside the 19 country masks

A.6.1 Common allowed area for TE which are never used in parallel in loop condition

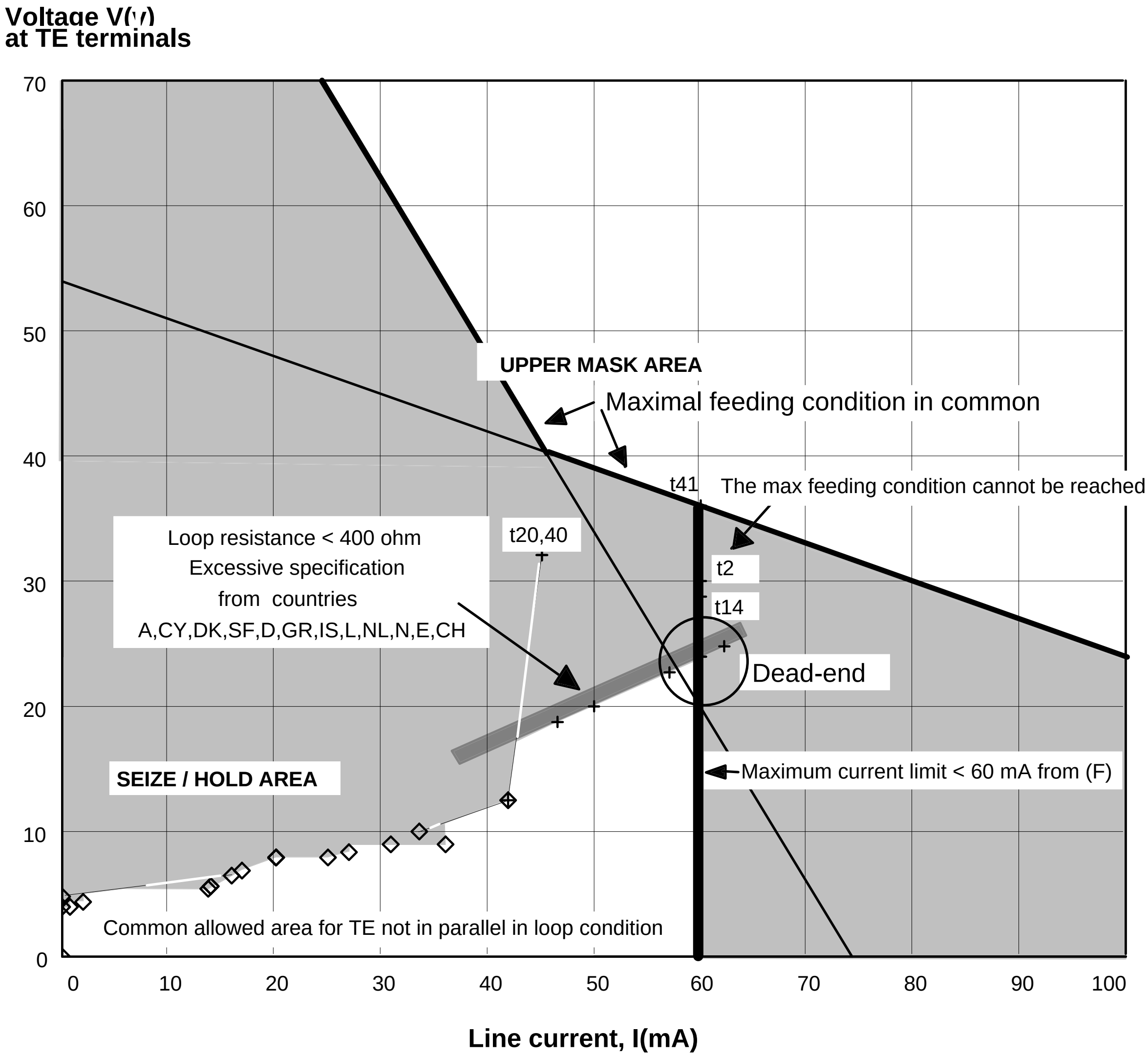


Figure A.12: Common allowed area available in the intersection of the 19 country masks (case of TE never in parallel in loop condition)

The mask is drawn inside all national mask to give a common allowed value area. In the UPPER MASK AREA the identified dead-end inhibits the harmonization possibility, preventing the access toward the maximal feeding condition met in Europe.

In the SEIZE/HOLD AREA the too low voltage of the upper limit (5 V) restricts the harmonization feasibility too much, leading to high cost design and technical constraints about the TE.

In the PARALLEL/TRANSFER AREA the lower limit of the allowed value is too high leading to a too narrow allowed value area, but this matter is not dealt with by the PSTN feeding condition and in the area the harmonization is more feasible considering mainly the parallel terminal association aspects in loop condition.

Further analysis is requested to clarify the most constraining points which inhibit or restrict the harmonization feasibility and most of those points used to build the common allowed area have to be clarified under a questionnaire adressed to the technical administration bodies, case-by-case.

The regression lines in the figures of annex B show an indication as to the average of the distribution of the singular points supplied as national inputs.

A.6.2 Common allowed area for TE which could be used in parallel in loop condition

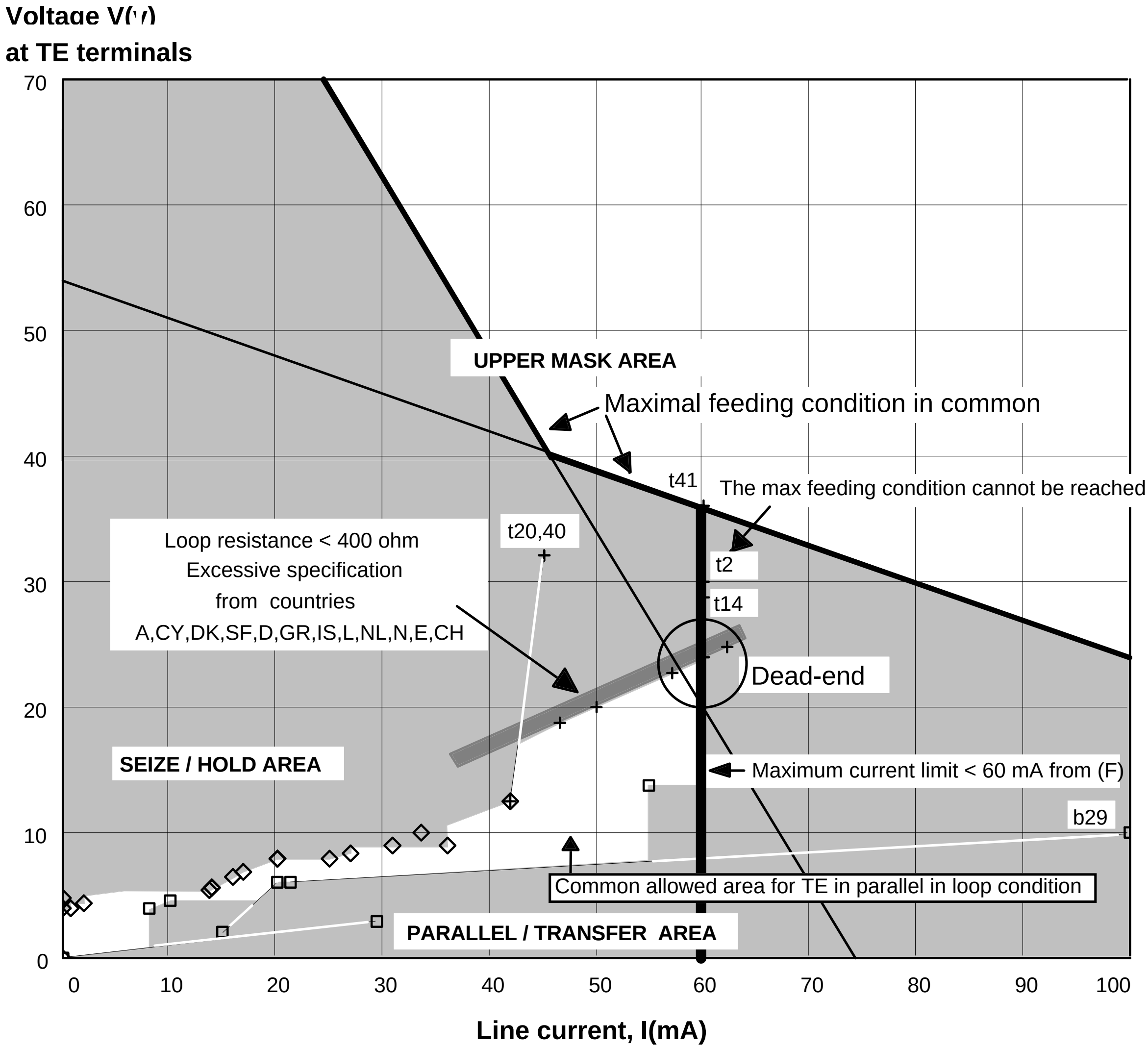


Figure A.13: Common allowed area available in the intersection of the 19 country masks (case of TE in parallel in loop condition)

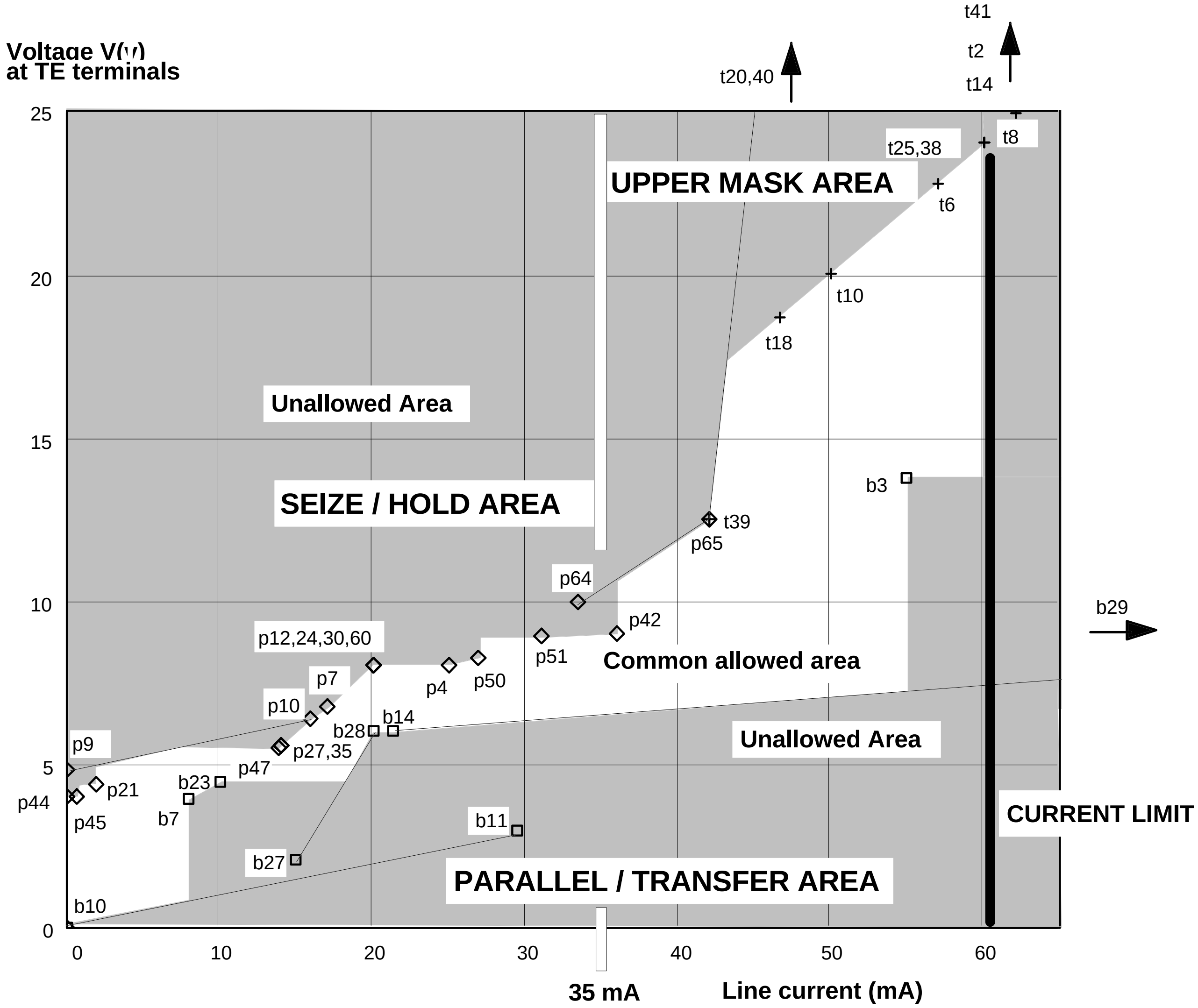


Figure A.14: Details of the common allowed area construction

A.7 Statistical study on the DC characteristics of the 19 country masks

The statistical study consists of the compilation of the DC characteristic values provided by the country inputs, as linear regression, correlation and averaged DC mask limits (D,F,I,GB) in order to evaluate the harmonization feasibility and to suggest some future target harmonized masks.

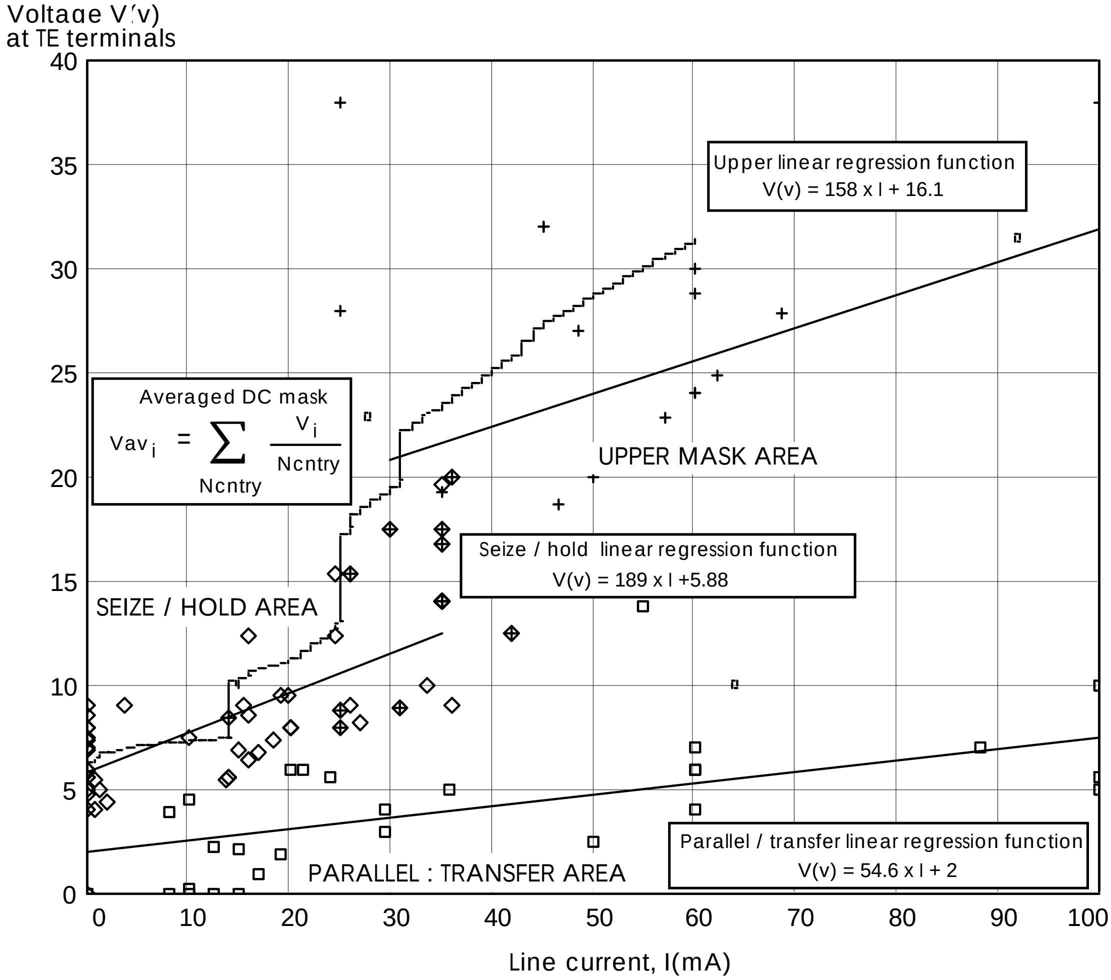


Figure A.15: Results of the statistical functions applied to DC characteristic mask limits

A.7.1 Linear regression and correlation of the seize/hold area points of all DC characteristics

The following formula has been used to determine the linear regression function and the correlation between the points:

$$V = a \cdot I + b \qquad a = slope(I,V) \qquad b = Intercept(I,V) \qquad r = correlation(I,V)$$

$$a = \frac{n \cdot \sum_n I_i \cdot V_i - \sum_n I_i \cdot \sum_n V_i}{n \cdot \sum_n I_i^2 - \sum_n I_i} \qquad b = \frac{\sum_n V_i \cdot \sum_n I_i^2 - \sum_n I_i \cdot \sum_n I_i \cdot V_i}{n \cdot \sum_n I_i^2 - \left(\sum_n I_i\right)^2}$$

$$r = \frac{n \cdot \sum_n I_i \cdot V_i - \sum_n I_i \cdot \sum_n V_i}{n \cdot \sum_n I_i^2 - \left(\sum_n I_i\right)^2 \cdot n \cdot \sum_n V_i^2 - \left(\sum_n V_i\right)^2}.$$

The linear regression of the DC characteristic in the seize/hold area is obtained by the compilation of the data contained in tables A.9.1 to A.9.10 as follows. The results are summarized in the following table A.2:

Table A.2: Results of the statistical compilation for the seize/hold mask area

slope (I, V) = a1	intercept (I,V) = b1	correlation = r1	linear function	comments
0,19 ohms	5,88 v	0,75	$V = 0{,}19 \cdot I + 5{,}88$	

V(v) for I=0		V(v) for I=35 mA		
5,88 v		12,5 v		

A.7.2 Linear regression and correlation of the upper mask area points of all DC characteristics

The linear regression of the DC characteristic in the upper mask area is obtained by the compilation of the data contained in the below table A.7. The results are summarized in the following table A.3:

Table A.3: Results of the statistical compilation for the upper mask area

slope (I, V) = a2	intercept (I,V) = b2	correlation = r2	linear function	comments
0,16 ohms	16,1 v	0,24	$V = 0{,}16 \cdot I + 16{,}1$	

V(v) for I=30 mA		V(v) for I=60 mA		
20,82v		25,56v		

A.7.3 Linear regression and correlation of the parallel/transfer area points of all DC characteristics

The linear regression of the DC characteristic in the parallel / transfer is obtained by the compilation of the data contained in the below table A.8. The results are summarized in the following table A.4:

Table A.4: Results of the statistical compilation for the parallel / transfer area

slope (I, V) = a3	intercept (I,V) = b3	correlation = r3	linear function	comments
0,05 ohms	2 v	0,56	$V = 0{,}05 \cdot I + 2$	

V(v) for I=0		V(v) for I=60 mA		
2 v		5,28v		

A.7.4 Averaged DC characteristic of the all country DC characteristics

The averaged DC mask is calculated according the following formula: $Vaver = \frac{\sum_{Nctry} V_i}{Nctry}$

The average of the DC mask limits of the points in the seize/hold and upper mask areas is obtained by the compilation of the data contained in the below tables A.10.1 to A.10.7. The results are summarized in the following table A.5. and are depicted in the figure A.15.

A.7.5 Datas used for the statistical study from the country inputs (chapter 2.3 DC current and loop resistance, of the ETS 300 001)

Table A.5: Results of the averaged mask limits compilation

(V,I) points of the averaged mask limits											
		continuation		continuation		continuation		continuation		continuation	
I(mA)	Vave (v)	I(mA)	Vave (v)	I(mA)	Vave (v)	I(mA)	Vave (v)	I(mA)	Vave (v)	I(mA)	Vave (v)
0	6,36	10	7,33	19,93	11,31	28	18,87	38	24,56	52	29,34
0,7	6,52	11	7,38	20	11,32	29	19,20	39	24,88	53	29,61
1	6,58	12	7,43	21	11,65	29,89	19,49	40	25,21	54	29,88
1,25	6,73	13	7,48	22	11,97	30	19,52	41	25,54	55	30,15
1,938	6,76	13,8	7,52	23	12,30	31	19,85	42	25,87	56	30,42
2	6,77	14	7,53	24	12,63	31	22,28	43	26,52	57	30,68
3	6,92	14	10,24	24,5	12,79	32	22,60	44	27,15	58	30,95
3,6	7,02	14,8	9,92	24,5	12,94	33	22,92	45	27,47	59	31,22
4	7,08	15	10,34	25	13,11	33,5	23,08	46	27,73	60	31,49
5	7,14	16	10,43	25	17,28	34	23,24	47	28,00		
6	7,18	16	10,66	25,9	17,56	35	23,57	48	28,27		
7	7,22	17	10,80	26	18,21	36	23,90	49	28,54		
8	7,26	18	10,96	26	18,21	36	23,90	50	28,81		
9	7,29	19	11,13	27	18,54	37	24,23	51	29,07		

Table A.6: Seize/hold area dots of the country DC masks

Country			I(mA)	V(v)	Comment	Country			I(mA)	V(v)	Comment
AUSTRIA	p	1	1,25	5,00		LUXEMBOURG	p	37	0	5,60	
AUSTRIA	p	2	19	9,50		LUXEMBOURG	p	35	14	5,60	
AUSTRIA	p	3	35	17,50		LUXEMBOURG	p	36	35	14,00	
BELGIUM	p	5	0	8,00		NETHERLAND	p	38	0	9,00	
BELGIUM	p	4	25	8,00		NETHERLAND	p	39	15,5	9,00	
CYPRUS	p	6	0	5,00		NETHERLAND	p	40	35	19,63	
CYPRUS	p	7	17	6,80		NETHERLAND	p	41	0	7	
CYPRUS	p	8	35	14,00		NL diallling	p	42	36	9,00	
DENMARK	p	9	0	4,80		NL diallling	p	43	36	20	
DENMARK	p	10	16	6,40		NORWAY	p	44	0	4,00	
DENMARK	p	11	35	14,00		NORWAY	p	45	0,7	4,00	
FINLAND	p	14	0	8,00		NORWAY	p	46	0,7	5,50	
FINLAND	p	12	20	8,00		NORWAY	p	47	13,8	5,50	
FINLAND	p	13	35	14,00		NORWAY	p	48	35	14	
FRANCE	p	15	0	8,60		PORTUGAL	p	52	0	6,95	
FRANCE	p	16	16	8,60		PORTUGAL	p	49	15	6,95	
FRANCE	p	17	16	12,40		PORTUGAL	p	50	27	8,24	
FRANCE	p	18	24,5	12,40		PORTUGAL	p	51	31	8,92	
FRANCE	p	19	24,5	15,30		SPAIN	p	55	0	7,4	
FRANCE	p	20	26	15,30		SPAIN	p	53	18,5	7,4	
GERMANY	p	21	1,938	4,36		SPAIN	p	54	35	14	
GERMANY	p	22	19,93	9,57		SWEDEN	p	58	0	7,50	
GERMANY	p	23	35	16,80		SWEDEN	p	56	10	7,50	
GREECE	p	26	0	8,00		SWEDEN	p	57	14	8,40	
GREECE	p	24	20	8,00		SWITZERLAND	p	59	0	6,00	
GREECE	p	25	35	14,00		SWITZERLAND	p	60	20	8,00	
ICELAND	p	29	0	5,60		SWITZERLAND	p	61	35	14,00	
ICELAND	p	27	14	5,60		GB	p	62	3,6	9,00	
ICELAND	p	28	35	14,00		GB	p	63	25,9	9,00	
IRELAND	p	32	0	8,00		GB	p	64	33,5	10,00	
IRELAND	p	30	20	8,00		GB	p	65	42	12,50	
IRELAND	p	31	29,89	17,50							
ITALY	p	33	0	6,00							
ITALY	p	34	25	8,75							

Table A.7: Upper mask area dots of the country DC masks

Country	Dots		I(mA)	V(v)	Comment
AUSTRIA	t	1	35	17,5	
AUSTRIA	t	2	60	30	
BELGIUM	t	3	25	8	
BELGIUM	t	4	25	38	
CYPRUS	t	5	35	14	
CYPRUS	t	6	57	22,8	
DENMARK	t	7	35	14	
DENMARK	t	8	62,2	24,89	
FINLAND	t	9	35	14	
FINLAND	t	10	50	20	
FRANCE	t	11	26	15,3	
FRANCE	t	12	26	70	
GERMANY	t	13	35	16,8	
GERMANY	t	14	60	28,8	
GREECE	t	15	35	14	
GREECE	t	16	80	32	
ICELAND	t	17	35	14	
ICELAND	t	18	46,67	18,67	
IRELAND	t	19	29,89	17,5	
IRELAND	t	20	45	32	
IRELAND	t	21	100	38	
ITALY	t	22	25	8,75	
ITALY	t	23	25	34	
LUXEMBOURG	t	24	35	14	
LUXEMBOURG	t	25	60	24	
NETHERLAND	t	26	36	20	
NETHERLAND	t	27	48,5	27	
NETHERLAND	t	28	35	19,63	
NORWAY	t	29	35	14	
NORWAY	t	30	68,6	27,9	
PORTUGAL	t	31	31	8,92	
PORTUGAL	t	32	31	45,4	
SPAIN	t	33	35	14	
SPAIN	t	34	80	32	
SWEDEN	t	35	14	8,4	
SWEDEN	t	36	14	43,2	
SWITZERLAND	t	37	35	14	
SWITZERLAND	t	38	60	24	
GB	t	39	42	12,5	
GB	t	40	45	32	

Table A.8: Parallel/transfer area dots of the country DC masks

Country	Dots		I(mA)	V(v)	Comment
AUSTRIA	b	1	19	1,9	
AUSTRIA	b	2	60	6	
BELGIUM	b	3	55	13,75	
CYPRUS	b	4	17	0,95	
CYPRUS	b	5	100	5	
DENMARK	b	6	8	0	
DENMARK	b	7	8	3,945	
DENMARK	b	8	24	5,6	
DENMARK	b	9	100	5,6	
FRANCE	b	10	0	0	
FRANCE	b	11	29,5	3	
FRANCE	b	12	29,5	4	
FRANCE	b	13	60	4	
GERMANY	b	14	21,34	6	
GERMANY	b	15	60	6	
NORWAY	b	16	15	0	
NORWAY	b	17	15	2,085	
NORWAY	b	18	35,7	5	
NORWAY	b	19	119,6	5	
SWEDEN	b	20	10	0,25	
SWEDEN	b	21	50	2,5	
SWITZERLAND	b	22	10	0	
SWITZERLAND	b	23	10	4,5	
SWITZERLAND	b	24	60	7	
SWITZERLAND	b	25	88,33	7	
GB	b	26	12,5	0	
GB	b	27	12,5	2,3	
GB	b	28	20	6	
GB	b	29	100	10	

Table A.9.1: Seize/hold area data of the country DC mask (1/10)

Country			I(mA)	V(v)	Comment	Country			I(mA)	V(v)	Comment
AUSTRIA			0	0,00		BELGIUM	p	5	0	8,00	
AUSTRIA			0,7	2,80		BELGIUM			0,7	8,00	
AUSTRIA	p	1	1,25	5,00		BELGIUM			1	8,00	
AUSTRIA			1,938	5,17		BELGIUM			1,25	8,00	
AUSTRIA			2	5,19		BELGIUM			1,938	8,00	
AUSTRIA			3	5,44		BELGIUM			2	8,00	
AUSTRIA			3,6	5,60		BELGIUM			3	8,00	
AUSTRIA			4	5,70		BELGIUM			3,6	8,00	
AUSTRIA			5	5,95		BELGIUM			4	8,00	
AUSTRIA			6	6,20		BELGIUM			5	8,00	
AUSTRIA			7	6,46		BELGIUM			6	8,00	
AUSTRIA			8	6,71		BELGIUM			7	8,00	
AUSTRIA			9	6,96		BELGIUM			8	8,00	
AUSTRIA			10	7,22		BELGIUM			9	8,00	
AUSTRIA			11	7,47		BELGIUM			10	8,00	
AUSTRIA			12	7,73		BELGIUM			11	8,00	
AUSTRIA			13	7,98		BELGIUM			12	8,00	
AUSTRIA			13,8	8,18		BELGIUM			13	8,00	
AUSTRIA			14	8,23		BELGIUM			13,8	8,00	
AUSTRIA			14,8	8,44		BELGIUM			14	8,00	
AUSTRIA			15	8,49		BELGIUM			14,8	8,00	
AUSTRIA			16	8,74		BELGIUM			15	8,00	
AUSTRIA			17	8,99		BELGIUM			16	8,00	
AUSTRIA			18	9,25		BELGIUM			17	8,00	
AUSTRIA	p	2	19	9,50		BELGIUM			18	8,00	
AUSTRIA			19,93	9,97		BELGIUM			19	8,00	
AUSTRIA			20	10,00		BELGIUM			19,93	8,00	
AUSTRIA			21	10,50		BELGIUM			20	8,00	
AUSTRIA			22	11,00		BELGIUM			21	8,00	
AUSTRIA			23	11,50		BELGIUM			22	8,00	
AUSTRIA			24	12,00		BELGIUM			23	8,00	
AUSTRIA			24,5	12,25		BELGIUM			24	8,00	
AUSTRIA			25	12,50		BELGIUM			24,5	8,00	
AUSTRIA			25,9	12,95		BELGIUM	p	4	25	8,00	
AUSTRIA			26	13,00							
AUSTRIA			27	13,50							
AUSTRIA			28	14,00							
AUSTRIA			29	14,50							
AUSTRIA			29,89	14,95							
AUSTRIA			30	15,00							
AUSTRIA			31	15,50							
AUSTRIA			32	16,00							
AUSTRIA			33	16,50							
AUSTRIA			33,5	16,75							
AUSTRIA			34	17,00							
AUSTRIA	p	3	35	17,50							

Table A.9.2 (continued): Seize/hold area data of the country DC mask (2/10)

Country			I(mA)	V(v)	Comment	Country			I(mA)	V(v)	Comment
CYPRUS	p	6	0	5,00		DENMARK	p	9	0	4,80	
CYPRUS			0,7	5,07		DENMARK			0,7	4,87	
CYPRUS			1	5,11		DENMARK			1	4,90	
CYPRUS			1,25	5,13		DENMARK			1,25	4,93	
CYPRUS			1,938	5,21		DENMARK			1,938	4,99	
CYPRUS			2	5,21		DENMARK			2	5,00	
CYPRUS			3	5,32		DENMARK			3	5,10	
CYPRUS			3,6	5,38		DENMARK			3,6	5,16	
CYPRUS			4	5,42		DENMARK			4	5,20	
CYPRUS			5	5,53		DENMARK			5	5,30	
CYPRUS			6	5,64		DENMARK			6	5,40	
CYPRUS			7	5,74		DENMARK			7	5,50	
CYPRUS			8	5,85		DENMARK			8	5,60	
CYPRUS			9	5,95		DENMARK			9	5,70	
CYPRUS			10	6,06		DENMARK			10	5,80	
CYPRUS			11	6,16		DENMARK			11	5,90	
CYPRUS			12	6,27		DENMARK			12	6,00	
CYPRUS			13	6,38		DENMARK			13	6,10	
CYPRUS			13,8	6,46		DENMARK			13,8	6,18	
CYPRUS			14	6,48		DENMARK			14	6,20	
CYPRUS			14,8	6,57		DENMARK			14,8	6,28	
CYPRUS			15	6,59		DENMARK			15	6,30	
CYPRUS			16	6,69		DENMARK	p	10	16	6,40	
CYPRUS	p	7	17	6,80		DENMARK			17	6,80	
CYPRUS			18	7,20		DENMARK			18	7,20	
CYPRUS			19	7,60		DENMARK			19	7,60	
CYPRUS			19,93	7,97		DENMARK			19,93	7,97	
CYPRUS			20	8,00		DENMARK			20	8,00	
CYPRUS			21	8,40		DENMARK			21	8,40	
CYPRUS			22	8,80		DENMARK			22	8,80	
CYPRUS			23	9,20		DENMARK			23	9,20	
CYPRUS			24	9,60		DENMARK			24	9,60	
CYPRUS			24,5	9,80		DENMARK			24,5	9,80	
CYPRUS			25	10,00		DENMARK			25	10,00	
CYPRUS			25,9	10,36		DENMARK			25,9	10,36	
CYPRUS			26	10,40		DENMARK			26	10,40	
CYPRUS			27	10,80		DENMARK			27	10,80	
CYPRUS			28	11,20		DENMARK			28	11,20	
CYPRUS			29	11,60		DENMARK			29	11,60	
CYPRUS			29,89	11,96		DENMARK			29,89	11,96	
CYPRUS			30	12,00		DENMARK			30	12,00	
CYPRUS			31	12,40		DENMARK			31	12,40	
CYPRUS			32	12,80		DENMARK			32	12,80	
CYPRUS			33	13,20		DENMARK			33	13,20	
CYPRUS			33,5	13,40		DENMARK			33,5	13,40	
CYPRUS			34	13,60		DENMARK			34	13,60	
CYPRUS	p	8	35	14,00		DENMARK	p	11	35	14,00	

Table A.9.3 (continued): Seize/hold area data of the country DC mask (3/10)

Country			I(mA)	V(v)	Comment	Country			I(mA)	V(v)	Comment
FINLAND	p	14	0	8,00	ded. point	FRANCE	p	15	0	8,60	
FINLAND			0,7	8,00		FRANCE			0,7	8,60	
FINLAND			1	8,00		FRANCE			1	8,60	
FINLAND			1,25	8,00		FRANCE			1,25	8,60	
FINLAND			1,938	8,00		FRANCE			1,938	8,60	
FINLAND			2	8,00		FRANCE			2	8,60	
FINLAND			3	8,00		FRANCE			3	8,60	
FINLAND			3,6	8,00		FRANCE			3,6	8,60	
FINLAND			4	8,00		FRANCE			4	8,60	
FINLAND			5	8,00		FRANCE			5	8,60	
FINLAND			6	8,00		FRANCE			6	8,60	
FINLAND			7	8,00		FRANCE			7	8,60	
FINLAND			8	8,00		FRANCE			8	8,60	
FINLAND			9	8,00		FRANCE			9	8,60	
FINLAND			10	8,00		FRANCE			10	8,60	
FINLAND			11	8,00		FRANCE			11	8,60	
FINLAND			12	8,00		FRANCE			12	8,60	
FINLAND			13	8,00		FRANCE			13	8,60	
FINLAND			13,8	8,00		FRANCE			13,8	8,60	
FINLAND			14	8,00		FRANCE			14	8,60	
FINLAND			14,8	8,00		FRANCE			14,8	8,60	
FINLAND			15	8,00		FRANCE			15	8,60	
FINLAND			16	8,00		FRANCE	p	16	16	8,60	
FINLAND			17	8,00		FRANCE	p	17	16	12,40	
FINLAND			18	8,00		FRANCE			17	12,40	
FINLAND			19	8,00		FRANCE			18	12,40	
FINLAND			19,93	8,00		FRANCE			19	12,40	
FINLAND	p	12	20	8,00		FRANCE			19,93	12,40	
FINLAND			21	8,40		FRANCE			20	12,40	
FINLAND			22	8,80		FRANCE			21	12,40	
FINLAND			23	9,20		FRANCE			22	12,40	
FINLAND			24	9,60		FRANCE			23	12,40	
FINLAND			24,5	9,80		FRANCE			24	12,40	
FINLAND			25	10,00		FRANCE	p	18	24,5	12,40	
FINLAND			25,9	10,36		FRANCE	p	19	24,5	15,30	
FINLAND			26	10,40		FRANCE			25	15,30	
FINLAND			27	10,80		FRANCE			25,9	15,30	
FINLAND			28	11,20		FRANCE	p	20	26	15,30	
FINLAND			29	11,60							
FINLAND			29,89	11,96							
FINLAND			30	12,00							
FINLAND			31	12,40							
FINLAND			32	12,80							
FINLAND			33	13,20							
FINLAND			33,5	13,40							
FINLAND			34	13,60							
FINLAND	p	13	35	14,00							

Table A.9.4 (continued): Seize/hold area data of the country DC mask (4/10)

Country			I(mA)	V(v)	Comment	Country			I(mA)	V(v)	Comment
GERMANY			0	4,36	ded. value	GREECE	p	26	0	8,00	ded. point
GERMANY			0,7	4,36	ded. value	GREECE			0,7	8,00	
GERMANY			1,25	4,36	ded. value	GREECE			1	8,00	
GERMANY	p	21	1,938	4,36		GREECE			1,25	8,00	
GERMANY			2	4,50		GREECE			1,938	8,00	
GERMANY			3	6,75		GREECE			2	8,00	
GERMANY			3,6	8,10	ded. value	GREECE			3	8,00	
GERMANY			4	9,00		GREECE			3,6	8,00	
GERMANY			5	9,57		GREECE			4	8,00	
GERMANY			6	9,57		GREECE			5	8,00	
GERMANY			7	9,57		GREECE			6	8,00	
GERMANY			8	9,57		GREECE			7	8,00	
GERMANY			9	9,57		GREECE			8	8,00	
GERMANY			10	9,57		GREECE			9	8,00	
GERMANY			11	9,57		GREECE			10	8,00	
GERMANY			12	9,57		GREECE			11	8,00	
GERMANY			13	9,57		GREECE			12	8,00	
GERMANY			13,8	9,57		GREECE			13	8,00	
GERMANY			14	9,57		GREECE			13,8	8,00	
GERMANY			14,8	9,57		GREECE			14	8,00	
GERMANY			15	9,57		GREECE			14,8	8,00	
GERMANY			16	9,57		GREECE			15	8,00	
GERMANY			17	9,57		GREECE			16	8,00	
GERMANY			18	9,57		GREECE			17	8,00	
GERMANY			19	9,57		GREECE			18	8,00	
GERMANY	p	22	19,93	9,57		GREECE			19	8,00	
GERMANY			20	9,60		GREECE			19,93	8,00	
GERMANY			21	10,08		GREECE	p	24	20	8,00	
GERMANY			22	10,56		GREECE			21	8,40	
GERMANY			23	11,04		GREECE			22	8,80	
GERMANY			24	11,52		GREECE			23	9,20	
GERMANY			24,5	11,76		GREECE			24	9,60	
GERMANY			25	12,00		GREECE			24,5	9,80	
GERMANY			25,9	12,43		GREECE			25	10,00	
GERMANY			26	12,48		GREECE			25,9	10,36	
GERMANY			27	12,96		GREECE			26	10,40	
GERMANY			28	13,44		GREECE			27	10,80	
GERMANY			29	13,92		GREECE			28	11,20	
GERMANY			29,89	14,35		GREECE			29	11,60	
GERMANY			30	14,40		GREECE			29,89	11,96	
GERMANY			31	14,88		GREECE			30	12,00	
GERMANY			32	15,36		GREECE			31	12,40	
GERMANY			33	15,84		GREECE			32	12,80	
GERMANY			33,5	16,08		GREECE			33	13,20	
GERMANY			34	16,32		GREECE			33,5	13,40	
GERMANY	p	23	35	16,80		GREECE			34	13,60	
						GREECE	p	25	35	14,00	

Table A.9.5 (continued): Seize/hold area data of the country DC mask (5/10)

Country			I(mA)	V(v)	Comment	Country			I(mA)	V(v)	Comment
ICELAND	p	29	0	5,60	ded. point	IRELAND	p	32	0	8,00	
ICELAND			0,7	5,60		IRELAND			0,7	8,00	
ICELAND			1	5,60		IRELAND			1	8,00	
ICELAND			1,25	5,60		IRELAND			1,25	8,00	
ICELAND			1,938	5,60		IRELAND			1,938	8,00	
ICELAND			2	5,60		IRELAND			2	8,00	
ICELAND			3	5,60		IRELAND			3	8,00	
ICELAND			3,6	5,60		IRELAND			3,6	8,00	
ICELAND			4	5,60		IRELAND			4	8,00	
ICELAND			5	5,60		IRELAND			5	8,00	
ICELAND			6	5,60		IRELAND			6	8,00	
ICELAND			7	5,60		IRELAND			7	8,00	
ICELAND			8	5,60		IRELAND			8	8,00	
ICELAND			9	5,60		IRELAND			9	8,00	
ICELAND			10	5,60		IRELAND			10	8,00	
ICELAND			11	5,60		IRELAND			11	8,00	
ICELAND			12	5,60		IRELAND			12	8,00	
ICELAND			13	5,60		IRELAND			13	8,00	
ICELAND			13,8	5,60		IRELAND			13,8	8,00	
ICELAND	p	27	14	5,60		IRELAND			14	8,00	
ICELAND			14,8	5,92		IRELAND			14,8	8,00	
ICELAND			15	6,00		IRELAND			15	8,00	
ICELAND			16	6,40		IRELAND			16	8,00	
ICELAND			17	6,80		IRELAND			17	8,00	
ICELAND			18	7,20		IRELAND			18	8,00	
ICELAND			19	7,60		IRELAND			19	8,00	
ICELAND			19,93	7,97		IRELAND			19,93	8,00	
ICELAND			20	8,00		IRELAND	p	30	20	8,00	
ICELAND			21	8,40		IRELAND			21	8,60	
ICELAND			22	8,80		IRELAND			22	9,20	
ICELAND			23	9,20		IRELAND			23	9,79	
ICELAND			24	9,60		IRELAND			24	10,39	
ICELAND			24,5	9,80		IRELAND			24,5	10,69	
ICELAND			25	10,00		IRELAND			25	10,99	
ICELAND			25,9	10,36		IRELAND			25,9	11,53	
ICELAND			26	10,40		IRELAND			26	11,59	
ICELAND			27	10,80		IRELAND			27	12,19	
ICELAND			28	11,20		IRELAND			28	12,78	
ICELAND			29	11,60		IRELAND			29	13,38	
ICELAND			29,89	11,96		IRELAND	p	31	29,89	17,50	
ICELAND			30	12,00							
ICELAND			31	12,40							
ICELAND			32	12,80							
ICELAND			33	13,20							
ICELAND			33,5	13,40							
ICELAND			34	13,60							
ICELAND	p	28	35	14,00							

Table A.9.6 (continued): Seize/hold area data of the country DC mask (6/10)

Country			I(mA)	V(v)	Comment	Country			I(mA)	V(v)	Comment
ITALY	p	33	0	5,00		LUXEMBOURG	p	37	0	5,60	ded. point
ITALY			0,7	5,11		LUXEMBOURG			0,7	5,60	
ITALY			1	5,15		LUXEMBOURG			1	5,60	
ITALY			1,25	5,19		LUXEMBOURG			1,25	5,60	
ITALY			1,938	5,29		LUXEMBOURG			1,938	5,60	
ITALY			2	5,30		LUXEMBOURG			2	5,60	
ITALY			3	5,45		LUXEMBOURG			3	5,60	
ITALY			3,6	5,54		LUXEMBOURG			3,6	5,60	
ITALY			4	5,60		LUXEMBOURG			4	5,60	
ITALY			5	5,75		LUXEMBOURG			5	5,60	
ITALY			6	5,90		LUXEMBOURG			6	5,60	
ITALY			7	6,05		LUXEMBOURG			7	5,60	
ITALY			8	6,20		LUXEMBOURG			8	5,60	
ITALY			9	6,35		LUXEMBOURG			9	5,60	
ITALY			10	6,50		LUXEMBOURG			10	5,60	
ITALY			11	6,65		LUXEMBOURG			11	5,60	
ITALY			12	6,80		LUXEMBOURG			12	5,60	
ITALY			13	6,95		LUXEMBOURG			13	5,60	
ITALY			13,8	7,07		LUXEMBOURG			13,8	5,60	
ITALY			14	7,10		LUXEMBOURG	p	35	14	5,60	
ITALY			14,8	7,22		LUXEMBOURG			14,8	5,92	
ITALY			15	7,25		LUXEMBOURG			15	6,00	
ITALY			16	7,40		LUXEMBOURG			16	6,40	
ITALY			17	7,55		LUXEMBOURG			17	6,80	
ITALY			18	7,70		LUXEMBOURG			18	7,20	
ITALY			19	7,85		LUXEMBOURG			19	7,60	
ITALY			19,93	7,99		LUXEMBOURG			19,93	7,97	
ITALY			20	8,00		LUXEMBOURG			20	8,00	
ITALY			21	8,15		LUXEMBOURG			21	8,40	
ITALY			22	8,30		LUXEMBOURG			22	8,80	
ITALY			23	8,45		LUXEMBOURG			23	9,20	
ITALY			24	8,60		LUXEMBOURG			24	9,60	
ITALY			24,5	8,68		LUXEMBOURG			24,5	9,80	
ITALY	p	34	25	8,75		LUXEMBOURG			25	10,00	
						LUXEMBOURG			25,9	10,36	
						LUXEMBOURG			26	10,40	
						LUXEMBOURG			27	10,80	
						LUXEMBOURG			28	11,20	
						LUXEMBOURG			29	11,60	
						LUXEMBOURG			29,89	11,96	
						LUXEMBOURG			30	12,00	
						LUXEMBOURG			31	12,40	
						LUXEMBOURG			32	12,80	
						LUXEMBOURG			33	13,20	
						LUXEMBOURG			33,5	13,40	
						LUXEMBOURG			34	13,60	
						LUXEMBOURG	p	36	35	14,00	

Table A.9.7 (continued): Seize/hold area data of the country DC mask (7/10)

Country			I(mA)	V(v)	Comment	Country			I(mA)	V(v)	Comment
NETHERLAND	p	38	0	9,00		NL diallling	p	41	0	7,00	
NETHERLAND			0,7	9,00		NL diallling			0,7	7,04	
NETHERLAND			1	9,00		NL diallling			1	7,06	
NETHERLAND			1,25	9,00		NL diallling			1,25	7,07	
NETHERLAND			1,938	9,00		NL diallling			1,938	7,11	
NETHERLAND			2	9,00		NL diallling			2	7,11	
NETHERLAND			3	9,00		NL diallling			3	7,17	
NETHERLAND			3,6	9,00		NL diallling			3,6	7,20	
NETHERLAND			4	9,00		NL diallling			4	7,22	
NETHERLAND			5	9,00		NL diallling			5	7,28	
NETHERLAND			6	9,00		NL diallling			6	7,33	
NETHERLAND			7	9,00		NL diallling			7	7,39	
NETHERLAND			8	9,00		NL diallling			8	7,44	
NETHERLAND			9	9,00		NL diallling			9	7,50	
NETHERLAND			10	9,00		NL diallling			10	7,56	
NETHERLAND			11	9,00		NL diallling			11	7,61	
NETHERLAND			12	9,00		NL diallling			12	7,67	
NETHERLAND			13	9,00		NL diallling			13	7,72	
NETHERLAND			13,8	9,00		NL diallling			13,8	7,77	
NETHERLAND			14	9,00		NL diallling			14	7,78	
NETHERLAND			14,8	9,00		NL diallling			14,8	7,82	
NETHERLAND			15	9,00		NL diallling			15	7,83	
NETHERLAND	p	39	16	9,00		NL diallling			16	7,89	
NETHERLAND			17	9,40		NL diallling			17	7,94	
NETHERLAND			18	9,79		NL diallling			18	8,00	
NETHERLAND			19	10,19		NL diallling			19	8,06	
NETHERLAND			19,93	10,56		NL diallling			19,93	8,11	
NETHERLAND			20	10,59		NL diallling			20	8,11	
NETHERLAND			21	10,98		NL diallling			21	8,17	
NETHERLAND			22	11,38		NL diallling			22	8,22	
NETHERLAND			23	11,78		NL diallling			23	8,28	
NETHERLAND			24	12,17		NL diallling			24	8,33	
NETHERLAND			24,5	12,37		NL diallling			24,5	8,36	
NETHERLAND			25	12,57		NL diallling			25	8,39	
NETHERLAND			25,9	12,93		NL diallling			25,9	8,44	
NETHERLAND			26	12,97		NL diallling			26	8,44	
NETHERLAND			27	13,37		NL diallling			27	8,50	
NETHERLAND			28	13,76		NL diallling			28	8,56	
NETHERLAND			29	14,16		NL diallling			29	8,61	
NETHERLAND			29,89	14,51		NL diallling			29,89	8,66	
NETHERLAND			30	14,56		NL diallling			30	8,67	
NETHERLAND			31	14,95		NL diallling			31	8,72	
NETHERLAND			32	15,35		NL diallling			32	8,78	
NETHERLAND			33	15,75		NL diallling			33	8,83	
NETHERLAND			33,5	15,94		NL diallling			33,5	8,86	
NETHERLAND			34	16,14		NL diallling			34	8,89	
NETHERLAND	p	40	35	16,54		NL diallling			35	8,94	
						NL diallling	p	42	36	9,00	
						NL diallling	p	43	36	20,00	

Table A.9.8 (continued): Seize/hold area data of the country DC mask (8/10)

Country			I(mA)	V(v)	Comment	Country			I(mA)	V(v)	Comment
NORWAY	p	44	0	4,00		PORTUGAL	p	52	0	6,95	ded. point
NORWAY	p	45	0,7	4,00		PORTUGAL			0,7	6,95	
NORWAY	p	46	0,7	5,50		PORTUGAL			1	6,95	
NORWAY			1	5,50		PORTUGAL			1,25	6,95	
NORWAY			1,25	5,50		PORTUGAL			1,938	6,95	
NORWAY			1,938	5,50		PORTUGAL			2	6,95	
NORWAY			2	5,50		PORTUGAL			3	6,95	
NORWAY			3	5,50		PORTUGAL			3,6	6,95	
NORWAY			3,6	5,50		PORTUGAL			4	6,95	
NORWAY			4	5,50		PORTUGAL			5	6,95	
NORWAY			5	5,50		PORTUGAL			6	6,95	
NORWAY			6	5,50		PORTUGAL			7	6,95	
NORWAY			7	5,50		PORTUGAL			8	6,95	
NORWAY			8	5,50		PORTUGAL			9	6,95	
NORWAY			9	5,50		PORTUGAL			10	6,95	
NORWAY			10	5,50		PORTUGAL			11	6,95	
NORWAY			11	5,50		PORTUGAL			12	6,95	
NORWAY			12	5,50		PORTUGAL			13	6,95	
NORWAY			13	5,50		PORTUGAL			13,8	6,95	
NORWAY	p	47	13,8	5,50		PORTUGAL			14	6,95	
NORWAY			14	5,58		PORTUGAL			14,8	6,95	
NORWAY			14,8	5,91		PORTUGAL	p	49	15	6,95	
NORWAY			15	5,99		PORTUGAL			16	7,06	
NORWAY			16	6,40		PORTUGAL			17	7,17	
NORWAY			17	6,81		PORTUGAL			18	7,27	
NORWAY			18	7,22		PORTUGAL			19	7,38	
NORWAY			19	7,63		PORTUGAL			20	7,49	
NORWAY			19,93	8,01		PORTUGAL			21	7,60	
NORWAY			20	8,03		PORTUGAL			22	7,70	
NORWAY			21	8,44		PORTUGAL			23	7,81	
NORWAY			22	8,85		PORTUGAL			24	7,92	
NORWAY			23	9,26		PORTUGAL			24,5	7,97	
NORWAY			24	9,67		PORTUGAL			25	8,03	
NORWAY			24,5	9,87		PORTUGAL			25,9	8,12	
NORWAY			25	10,08		PORTUGAL			26	8,13	
NORWAY			25,9	10,45		PORTUGAL	p	50	27	8,24	
NORWAY			26	10,49		PORTUGAL			28	8,41	
NORWAY			27	10,90		PORTUGAL			29	8,58	
NORWAY			28	11,30		PORTUGAL			29,89	8,73	
NORWAY			29	11,71		PORTUGAL			30	8,75	
NORWAY			29,89	12,08		PORTUGAL	p	51	31	8,92	
NORWAY			30	12,12							
NORWAY			31	12,53							
NORWAY			32	12,94							
NORWAY			33	13,35							
NORWAY			33,5	13,55							
NORWAY			34	13,76							
NORWAY	p	48	35	14,17							

Table A.9.9 (continued): Seize/hold area data of the country DC mask (9/10)

Country			I(mA)	V(v)	Comment	Country			I(mA)	V(v)	Comment
SPAIN	p	55	0	9,25	ded. point	SWEDEN	p	58	0	7,50	ded. point
SPAIN			0,7	9,25		SWEDEN			0,7	7,50	
SPAIN			1	9,25		SWEDEN			1	7,50	
SPAIN			1,25	9,25		SWEDEN			1,25	7,50	
SPAIN			1,938	9,25		SWEDEN			1,938	7,50	
SPAIN			2	9,25		SWEDEN			2	7,50	
SPAIN			3	9,25		SWEDEN			3	7,50	
SPAIN			3,6	9,25		SWEDEN			3,6	7,50	
SPAIN			4	9,25		SWEDEN			4	7,50	
SPAIN			5	9,25		SWEDEN			5	7,50	
SPAIN			6	9,25		SWEDEN			6	7,50	
SPAIN			7	9,25		SWEDEN			7	7,50	
SPAIN			8	9,25		SWEDEN			8	7,50	
SPAIN			9	9,25		SWEDEN			9	7,50	
SPAIN			10	9,25		SWEDEN	p	56	10	7,50	
SPAIN			11	9,25		SWEDEN			11	7,73	
SPAIN			12	9,25		SWEDEN			12	7,95	
SPAIN			13	9,25		SWEDEN			13	8,18	
SPAIN			13,8	9,25		SWEDEN			13,8	8,36	
SPAIN			14	9,25		SWEDEN	p	57	14	8,40	
SPAIN	p	53	14,8	9,25							
SPAIN			15	9,32							
SPAIN			16	9,68							
SPAIN			17	10,04							
SPAIN			18	10,40							
SPAIN			19	10,76							
SPAIN			19,93	11,09							
SPAIN			20	11,12							
SPAIN			21	11,48							
SPAIN			22	11,83							
SPAIN			23	12,19							
SPAIN			24	12,55							
SPAIN			24,5	12,73							
SPAIN			25	12,91							
SPAIN			25,9	13,23							
SPAIN			26	13,27							
SPAIN			27	13,63							
SPAIN			28	13,99							
SPAIN			29	14,35							
SPAIN			29,89	14,67							
SPAIN			30	14,71							
SPAIN			31	15,06							
SPAIN			32	15,42							
SPAIN			33	15,78							
SPAIN			33,5	15,96							
SPAIN			34	16,14							
SPAIN	p	54	35	16,50							

Table A.9.10 (continued): Seize/hold area data of the country DC mask (10/10)

Country			I(mA)	V(v)	Comment	Country			I(mA)	V(v)	Comment
SWITZERLAND	p	59	0	6,00		GB			0	9,00	ded. point
SWITZERLAND			0,7	6,07		GB			0,7	9,00	
SWITZERLAND			1	6,10		GB			1	9,00	
SWITZERLAND			1,25	6,13		GB			1,25	9,00	
SWITZERLAND			1,938	6,19		GB			1,938	9,00	
SWITZERLAND			2	6,20		GB			2	9,00	
SWITZERLAND			3	6,30		GB			3	9,00	
SWITZERLAND			3,6	6,36		GB	p	62	3,6	9,00	
SWITZERLAND			4	6,40		GB			4	9,00	
SWITZERLAND			5	6,50		GB			5	9,00	
SWITZERLAND			6	6,60		GB			6	9,00	
SWITZERLAND			7	6,70		GB			7	9,00	
SWITZERLAND			8	6,80		GB			8	9,00	
SWITZERLAND			9	6,90		GB			9	9,00	
SWITZERLAND			10	7,00		GB			10	9,00	
SWITZERLAND			11	7,10		GB			11	9,00	
SWITZERLAND			12	7,20		GB			12	9,00	
SWITZERLAND			13	7,30		GB			13	9,00	
SWITZERLAND			13,8	7,38		GB			13,8	9,00	
SWITZERLAND			14	7,40		GB			14	9,00	
SWITZERLAND			14,8	0,00		GB			14,8	9,00	
SWITZERLAND			15	7,50		GB			15	9,00	
SWITZERLAND			16	7,60		GB			16	9,00	
SWITZERLAND			17	7,70		GB			17	9,00	
SWITZERLAND			18	7,80		GB			18	9,00	
SWITZERLAND			19	7,90		GB			19	9,00	
SWITZERLAND			19,93	7,99		GB			19,93	9,00	
SWITZERLAND	p	60	20	8,00		GB			20	9,00	
SWITZERLAND			21	8,40		GB			21	9,00	
SWITZERLAND			22	8,80		GB			22	9,00	
SWITZERLAND			23	9,20		GB			23	9,00	
SWITZERLAND			24	9,60		GB			24	9,00	
SWITZERLAND			24,5	9,80		GB			24,5	9,00	
SWITZERLAND			25	10,00		GB			25	9,00	
SWITZERLAND			25,9	10,36		GB	p	63	25,9	9,00	
SWITZERLAND			26	10,40		GB			26	9,01	
SWITZERLAND			27	10,80		GB			27	9,14	
SWITZERLAND			28	11,20		GB			28	9,28	
SWITZERLAND			29	11,60		GB			29	9,41	
SWITZERLAND			29,89	11,96		GB			29,89	9,53	
SWITZERLAND			30	12,00		GB			30	9,54	
SWITZERLAND			31	12,40		GB			31	9,67	
SWITZERLAND			32	12,80		GB			32	9,80	
SWITZERLAND			33	13,20		GB			33	9,93	
SWITZERLAND			33,5	13,40		GB	p	64	33,5	10,00	
SWITZERLAND			34	13,60		GB			34	10,15	
SWITZERLAND	p	61	35	14,00		GB			35	10,44	
						GB			36	10,74	
						GB			37	11,03	
						GB			38	11,32	
						GB			39	11,62	
						GB			40	11,91	
						GB			41	12,21	
						GB	p	65	42	12,50	

Table A.10.1: Data of the DC characteristic masks used for the discrete average compilation (1/7)

Data of the DC characteristic mask for the discrete average compilation											
AUSTRIA				**BELGIUM**				**CYPRUS**			
		continuation				continuation				continuation	
I(mA)	**V(v)**	**I(mA)**	**V(v)**	**I(mA)**	**V(v)**	**I(mA)**	**V(v)**	**I(mA)**	**V(v)**	**I(mA)**	**V(v)**
0	0,00	27	13,50	0	8,00	27	48,00	0	5,00	27	10,80
0,7	2,80	28	14,00	0,7	8,00	28	48,00	0,7	5,07	28	11,20
1	2,24	29	14,50	1	8,00	29	48,00	1	5,11	29	11,60
1,25	5,00	29,89	14,95	1,25	8,00	29,89	48,00	1,25	5,13	29,89	11,96
1,938	5,17	30	15,00	1,938	8,00	30	48,00	1,938	5,21	30	12,00
2	5,19	31	15,50	2	8,00	31	48,00	2	5,21	31	12,40
3	5,44	31	15,50	3	8,00	31	48,00	3	5,32	31	12,40
3,6	5,60	32	16,00	3,6	8,00	32	48,00	3,6	5,38	32	12,80
4	5,70	33	16,50	4	8,00	33	48,00	4	5,42	33	13,20
5	5,95	33,5	16,75	5	8,00	33,5	48,00	5	5,53	33,5	13,40
6	6,20	34	17,00	6	8,00	34	48,00	6	5,64	34	13,60
7	6,46	35	17,50	7	8,00	35	48,00	7	5,74	35	14,00
8	6,71	36	18,00	8	8,00	36	48,00	8	5,85	36	14,40
9	6,96	36	18,00	9	8,00	36	48,00	9	5,95	36	14,40
10	7,22	37	18,50	10	8,00	37	48,00	10	6,06	37	14,80
11	7,47	38	19,00	11	8,00	38	48,00	11	6,16	38	15,20
12	7,73	39	19,50	12	8,00	39	48,00	12	6,27	39	15,60
13	7,98	40	20,00	13	8,00	40	48,00	13	6,38	40	16,00
13,8	8,18	41	20,50	13,8	8,00	41	48,00	13,8	6,46	41	16,40
14	8,23	42	21,00	14	8,00	42	48,00	14	6,48	42	16,80
14	8,23	43	21,50	14	8,00	43	48,00	14	6,48	43	17,20
14,8	8,44	44	22,00	14,8	8,00	44	48,00	14,8	6,57	44	17,60
15	8,49	45	22,50	15	8,00	45	48,00	15	6,59	45	18,00
16	8,74	46	23,00	16	8,00	46	48,00	16	6,69	46	18,40
16	8,74	47	23,50	16	8,00	47	48,00	16	6,69	47	18,80
17	8,99	48	24,00	17	8,00	48	48,00	17	6,80	48	19,20
18	9,25	49	24,50	18	8,00	49	48,00	18	7,20	49	19,60
19	9,50	50	25,00	19	8,00	50	48,00	19	7,60	50	20,00
19,93	9,97	51	25,50	19,93	8,00	51	48,00	19,93	7,97	51	20,40
20	10,00	52	26,00	20	8,00	52	48,00	20	8,00	52	20,80
21	10,50	53	26,50	21	8,00	53	48,00	21	8,40	53	21,20
22	11,00	54	27,00	22	8,00	54	48,00	22	8,80	54	21,60
23	11,50	55	27,50	23	8,00	55	48,00	23	9,20	55	22,00
24	12,00	56	28,00	24	8,00	56	48,00	24	9,60	56	22,40
24,5	12,25	57	28,50	24,5	8,00	57	48,00	24,5	9,80	57	22,80
24,5	12,25	58	29,00	24,5	8,00	58	48,00	24,5	9,80	58	23,20
25	12,50	59	29,50	25	8,00	59	48,00	25	10,00	59	23,60
25	12,50	60	30,00	25	48,00	60	48,00	25	10,00	60	24,00
25,9	12,95			25,9	48,00			25,9	10,36		
26	13,00			26	48,00			26	10,40		
26	13,00			26	48,00			26	10,40		

Table A.10.2 (continued): Data of the DC characteristic masks used for the discrete average compilation (2/7)

Data of the DC characteristic mask for the discrete average compilation											
DENMARK				**FINLAND**				**FRANCE**			
		continuation				continuation				continuation	
I(mA)	**V(v)**	**I(mA)**	**V(v)**	**I(mA)**	**V(v)**	**I(mA)**	**V(v)**	**I(mA)**	**V(v)**	**I(mA)**	**V(v)**
0	4,80	27	10,80	0	8,00	27	10,80	0	8,60	27	27,00
0,7	4,87	28	11,20	0,7	8,00	28	11,20	0,7	8,60	28	27,00
1	4,90	29	11,60	1	8,00	29	11,60	1	8,60	29	27,00
1,25	4,93	29,89	11,96	1,25	8,00	29,89	11,96	1,25	8,60	29,89	27,00
1,938	4,99	30	12,00	1,938	8,00	30	12,00	1,938	8,60	30	27,00
2	5,00	31	12,40	2	8,00	31	12,40	2	8,60	31	27,00
3	5,10	31	12,40	3	8,00	31	12,40	3	8,60	31	27,00
3,6	5,16	32	12,80	3,6	8,00	32	12,80	3,6	8,60	32	27,00
4	5,20	33	13,20	4	8,00	33	13,20	4	8,60	33	27,00
5	5,30	33,5	13,40	5	8,00	33,5	13,40	5	8,60	33,5	27,00
6	5,40	34	13,60	6	8,00	34	13,60	6	8,60	34	27,00
7	5,50	35	14,00	7	8,00	35	14,00	7	8,60	35	27,00
8	5,60	36	14,40	8	8,00	36	14,40	8	8,60	36	27,00
9	5,70	36	14,40	9	8,00	36	14,40	9	8,60	36	27,00
10	5,80	37	14,80	10	8,00	37	14,80	10	8,60	37	27,00
11	5,90	38	15,20	11	8,00	38	15,20	11	8,60	38	27,00
12	6,00	39	15,60	12	8,00	39	15,60	12	8,60	39	27,00
13	6,10	40	16,00	13	8,00	40	16,00	13	8,60	40	27,00
13,8	6,18	41	16,40	13,8	8,00	41	16,40	13,8	8,60	41	27,00
14	6,20	42	16,80	14	8,00	42	16,80	14	8,60	42	27,00
14	6,20	43	17,20	14	8,00	43	17,20	14	8,60	43	27,00
14,8	6,28	44	17,60	14,8	8,00	44	17,60	14,8	8,60	44	27,00
15	6,30	45	18,00	15	8,00	45	18,00	15	8,60	45	27,00
16	6,40	46	18,40	16	8,00	46	18,40	16	8,60	46	27,00
16	6,40	47	18,80	16	8,00	47	18,80	16	12,40	47	27,00
17	6,80	48	19,20	17	8,00	48	19,20	17	12,40	48	27,00
18	7,20	49	19,60	18	8,00	49	19,60	18	12,40	49	27,00
19	7,60	50	20,00	19	8,00	50	20,00	19	12,40	50	27,00
19,93	7,97	51	20,40	19,93	8,00	51	20,40	19,93	12,40	51	27,00
20	8,00	52	20,80	20	8,00	52	20,80	20	12,40	52	27,00
21	8,40	53	21,20	21	8,40	53	21,20	21	12,40	53	27,00
22	8,80	54	21,60	22	8,80	54	21,60	22	12,40	54	27,00
23	9,20	55	22,00	23	9,20	55	22,00	23	12,40	55	27,00
24	9,60	56	22,40	24	9,60	56	22,40	24	12,40	56	27,00
24,5	9,80	57	22,80	24,5	9,80	57	22,80	24,5	12,40	57	27,00
24,5	9,80	58	23,20	24,5	9,80	58	23,20	24,5	15,30	58	27,00
25	10,00	59	23,60	25	10,00	59	23,60	25	15,30	59	27,00
25	10,00	60	24,00	25	10,00	60	24,00	25	15,30	60	27,00
25,9	10,36			25,9	10,36			25,9	15,30		
26	10,40			26	10,40			26	27,00		
26	10,40			26	10,40			26	27,00		

Table A.10.3 (continued): Data of the DC characteristic masks used for the discrete average compilation (3/7)

Data of the DC characteristic mask for the discrete average compilation											
GERMANY				GREECE				ICELAND			
		continuation				continuation				continuation	
I(mA)	**V(v)**	**I(mA)**	**V(v)**	**I(mA)**	**V(v)**	**I(mA)**	**V(v)**	**I(mA)**	**V(v)**	**I(mA)**	**V(v)**
0	4,36	27	12,96	0	8,00	27	10,80	0	5,60	27	10,80
0,7	4,36	28	13,44	0,7	8,00	28	11,20	0,7	5,60	28	11,20
1	4,36	29	13,92	1	8,00	29	11,60	1	5,60	29	11,60
1,25	4,36	29,89	14,35	1,25	8,00	29,89	11,96	1,25	5,60	29,89	11,96
1,938	4,36	30	14,40	1,938	8,00	30	12,00	1,938	5,60	30	12,00
2	4,50	31	14,88	2	8,00	31	12,40	2	5,60	31	12,40
3	6,75	31	14,88	3	8,00	31	12,40	3	5,60	31	12,40
3,6	8,10	32	15,36	3,6	8,00	32	12,80	3,6	5,60	32	12,80
4	9,00	33	15,84	4	8,00	33	13,20	4	5,60	33	13,20
5	9,57	33,5	16,08	5	8,00	33,5	13,40	5	5,60	33,5	13,40
6	9,57	34	16,32	6	8,00	34	13,60	6	5,60	34	13,60
7	9,57	35	16,80	7	8,00	35	14,00	7	5,60	35	14,00
8	9,57	36	17,28	8	8,00	36	14,40	8	5,60	36	14,40
9	9,57	36	17,28	9	8,00	36	14,40	9	5,60	36	14,40
10	9,57	37	17,76	10	8,00	37	14,80	10	5,60	37	14,80
11	9,57	38	18,24	11	8,00	38	15,20	11	5,60	38	15,20
12	9,57	39	18,72	12	8,00	39	15,60	12	5,60	39	15,60
13	9,57	40	19,20	13	8,00	40	16,00	13	5,60	40	16,00
13,8	9,57	41	19,68	13,8	8,00	41	16,40	13,8	5,60	41	16,40
14	9,57	42	20,16	14	8,00	42	16,80	14	5,60	42	16,80
14	9,57	43	20,64	14	8,00	43	17,20	14	5,60	43	17,20
14,8	9,57	44	21,12	14,8	8,00	44	17,60	14,8	5,92	44	17,60
15	9,57	45	21,60	15	8,00	45	18,00	15	6,00	45	18,00
16	9,57	46	22,08	16	8,00	46	18,40	16	6,40	46	18,40
16	9,57	47	22,56	16	8,00	47	18,80	16	6,40	47	18,80
17	9,57	48	23,04	17	8,00	48	19,20	17	6,80	48	19,20
18	9,57	49	23,52	18	8,00	49	19,60	18	7,20	49	19,60
19	9,57	50	24,00	19	8,00	50	20,00	19	7,60	50	20,00
19,93	9,57	51	24,48	19,93	8,00	51	20,40	19,93	7,97	51	20,40
20	9,60	52	24,96	20	8,00	52	20,80	20	8,00	52	20,80
21	10,08	53	25,44	21	8,40	53	21,20	21	8,40	53	21,20
22	10,56	54	25,92	22	8,80	54	21,60	22	8,80	54	21,60
23	11,04	55	26,40	23	9,20	55	22,00	23	9,20	55	22,00
24	11,52	56	26,87	24	9,60	56	22,40	24	9,60	56	22,40
24,5	11,76	57	27,35	24,5	9,80	57	22,80	24,5	9,80	57	22,80
24,5	11,76	58	27,83	24,5	9,80	58	23,20	24,5	9,80	58	23,20
25	12,00	59	28,31	25	10,00	59	23,60	25	10,00	59	23,60
25	12,00	60	28,79	25	10,00	60	24,00	25	10,00	60	24,00
25,9	12,43			25,9	10,36			25,9	10,36		
26	12,48			26	10,40			26	10,40		
26	12,48			26	10,40			26	10,40		

Table A.10.4 (continued): Data of the DC characteristic masks used for the discrete average compilation (4/7)

Data of the DC characteristic mask for the discrete average compilation											
IRELAND				**ITALY**				**LUXEMBOURG**			
		continuation				continuation				continuation	
I(mA)	**V(v)**	**I(mA)**	**V(v)**	**I(mA)**	**V(v)**	**I(mA)**	**V(v)**	**I(mA)**	**V(v)**	**I(mA)**	**V(v)**
0	8,00	27	14,72	0	5,00	27	48,00	0	5,60	27	10,80
0,7	8,00	28	15,68	0,7	5,11	28	48,00	0,7	5,60	28	11,20
1	8,00	29	16,64	1	5,15	29	48,00	1	5,60	29	11,60
1,25	8,00	29,89	17,49	1,25	5,19	29,89	48,00	1,25	5,60	29,89	11,96
1,938	8,00	30	17,60	1,938	5,29	30	48,00	1,938	5,60	30	12,00
2	8,00	31	18,56	2	5,30	31	48,00	2	5,60	31	12,40
3	8,00	31	18,56	3	5,45	31	48,00	3	5,60	31	12,40
3,6	8,00	32	19,52	3,6	5,54	32	48,00	3,6	5,60	32	12,80
4	8,00	33	20,48	4	5,60	33	48,00	4	5,60	33	13,20
5	8,00	33,5	20,96	5	5,75	33,5	48,00	5	5,60	33,5	13,40
6	8,00	34	21,44	6	5,90	34	48,00	6	5,60	34	13,60
7	8,00	35	22,40	7	6,05	35	48,00	7	5,60	35	14,00
8	8,00	36	23,36	8	6,20	36	48,00	8	5,60	36	14,40
9	8,00	36	23,36	9	6,35	36	48,00	9	5,60	36	14,40
10	8,00	37	24,32	10	6,50	37	48,00	10	5,60	37	14,80
11	8,00	38	25,28	11	6,65	38	48,00	11	5,60	38	15,20
12	8,00	39	26,24	12	6,80	39	48,00	12	5,60	39	15,60
13	8,00	40	27,20	13	6,95	40	48,00	13	5,60	40	16,00
13,8	8,00	41	28,16	13,8	7,07	41	48,00	13,8	5,60	41	16,40
14	8,00	42	29,12	14	7,10	42	48,00	14	5,60	42	16,80
14	8,00	43	30,08	14	7,10	43	48,00	14	5,60	43	17,20
14,8	8,00	44	31,04	14,8	7,22	44	48,00	14,8	5,92	44	17,60
15	8,00	45	32,00	15	7,25	45	48,00	15	6,00	45	18,00
16	8,00	46	32,11	16	7,40	46	48,00	16	6,40	46	18,40
16	8,00	47	32,22	16	7,40	47	48,00	16	6,40	47	18,80
17	8,00	48	32,33	17	7,55	48	48,00	17	6,80	48	19,20
18	8,00	49	32,44	18	7,70	49	48,00	18	7,20	49	19,60
19	8,00	50	32,55	19	7,85	50	48,00	19	7,60	50	20,00
19,93	8,00	51	32,65	19,93	7,99	51	48,00	19,93	7,97	51	20,40
20	8,00	52	32,76	20	8,00	52	48,00	20	8,00	52	20,80
21	8,96	53	32,87	21	8,15	53	48,00	21	8,40	53	21,20
22	9,92	54	32,98	22	8,30	54	48,00	22	8,80	54	21,60
23	10,88	55	33,09	23	8,45	55	48,00	23	9,20	55	22,00
24	11,84	56	33,20	24	8,60	56	48,00	24	9,60	56	22,40
24,5	12,32	57	33,31	24,5	8,68	57	48,00	24,5	9,80	57	22,80
24,5	12,32	58	33,42	24,5	8,68	58	48,00	24,5	9,80	58	23,20
25	12,80	59	33,53	25	8,75	59	48,00	25	10,00	59	23,60
25	12,80	60	33,64	25	48,00	60	48,00	25	10,00	60	24,00
25,9	13,66			25,9	48,00			25,9	10,36		
26	13,76			26	48,00			26	10,40		
26	13,76			26	48,00			26	10,40		

Table A.10.5 (continued): Data of the DC characteristic masks used for the discrete average compilation (5/7)

Data of the DC characteristic mask for the discrete average compilation											
THE NETHERLAND				**THE NETHERLAND, pulse dialling**				**NORWAY**			
		continuation				continuation				continuation	
I(mA)	**V(v)**	**I(mA)**	**V(v)**	**I(mA)**	**V(v)**	**I(mA)**	**V(v)**	**I(mA)**	**V(v)**	**I(mA)**	**V(v)**
0	9,00	27	13,37	0	7,00	27	8,50	0	4,00	27	10,90
0,7	9,00	28	13,76	0,7	7,04	28	8,56	0,7	4,00	28	11,30
1	9,00	29	14,16	1	7,06	29	8,61	0,7	5,50	29	11,71
1,25	9,00	29,89	14,51	1,25	7,07	29,89	8,66	1	5,50	29,89	12,08
1,938	9,00	30	14,56	1,938	7,11	30	8,67	1,25	5,50	30	12,12
2	9,00	31	14,95	2	7,11	31	8,72	1,938	5,50	31	12,53
3	9,00	31	14,95	3	7,17	31	8,72	2	5,50	31	12,53
3,6	9,00	32	15,35	3,6	7,20	32	8,78	3	5,50	32	12,94
4	9,00	33	15,75	4	7,22	33	8,83	3,6	5,50	33	13,35
5	9,00	33,5	15,94	5	7,28	33,5	8,86	4	5,50	33,5	13,55
6	9,00	34	16,14	6	7,33	34	8,89	5	5,50	34	13,76
7	9,00	35	16,54	7	7,39	35	8,94	6	5,50	35	14,17
8	9,00	36	16,94	8	7,44	36	9,00	7	5,50	36	14,57
9	9,00	36	16,94	9	7,50	36	20,00	8	5,50	36	14,57
10	9,00	37	17,33	10	7,56	37	20,24	9	5,50	37	14,98
11	9,00	38	17,73	11	7,61	38	20,47	10	5,50	38	15,39
12	9,00	39	18,13	12	7,67	39	20,71	11	5,50	39	15,80
13	9,00	40	18,52	13	7,72	40	20,94	12	5,50	40	16,21
13,8	9,00	41	18,92	13,8	7,77	41	21,18	13	5,50	41	16,62
14	9,00	42	19,32	14	7,78	42	21,42	13,8	5,50	42	17,03
14	9,00	43	19,71	14	7,78	43	21,65	13,8	5,50	43	17,43
14,8	9,00	44	20,11	14,8	7,82	44	21,89	14	5,58	44	17,84
15	9,00	45	20,51	15	7,83	45	22,13	14,8	5,91	45	18,25
16	9,00	46	20,91	16	7,89	46	22,36	15	5,99	46	18,66
16	9,00	47	21,30	16	7,89	47	22,60	16	6,40	47	19,07
17	9,40	48	21,70	17	7,94	48	22,83	17	6,81	48	19,48
18	9,79	49	22,10	18	8,00	49	23,07	18	7,22	49	19,89
19	10,19	50	22,49	19	8,06	50	23,31	19	7,63	50	20,30
19,93	10,56	51	22,89	19,93	8,11	51	23,54	19,93	8,01	51	20,70
20	10,59	52	23,29	20	8,11	52	23,78	20	8,03	52	21,11
21	10,98	53	23,68	21	8,17	53	24,01	21	8,44	53	21,52
22	11,38	54	24,08	22	8,22	54	24,25	22	8,85	54	21,93
23	11,78	55	24,48	23	8,28	55	24,49	23	9,26	55	22,34
24	12,17	56	24,87	24	8,33	56	24,72	24	9,67	56	22,75
24,5	12,37	57	25,27	24,5	8,36	57	24,96	24,5	9,87	57	23,16
24,5	12,37	58	25,67	24,5	8,36	58	25,19	24,5	9,87	58	23,57
25	12,57	59	26,06	25	8,39	59	25,43	25	10,08	59	23,97
25	12,57	60	26,46	25	8,39	60	25,67	25	10,08	60	24,38
25,9	12,93			25,9	8,44			25,9	10,45		
26	12,97			26	8,44			26	10,49		
26	12,97			26	8,44			26	10,49		

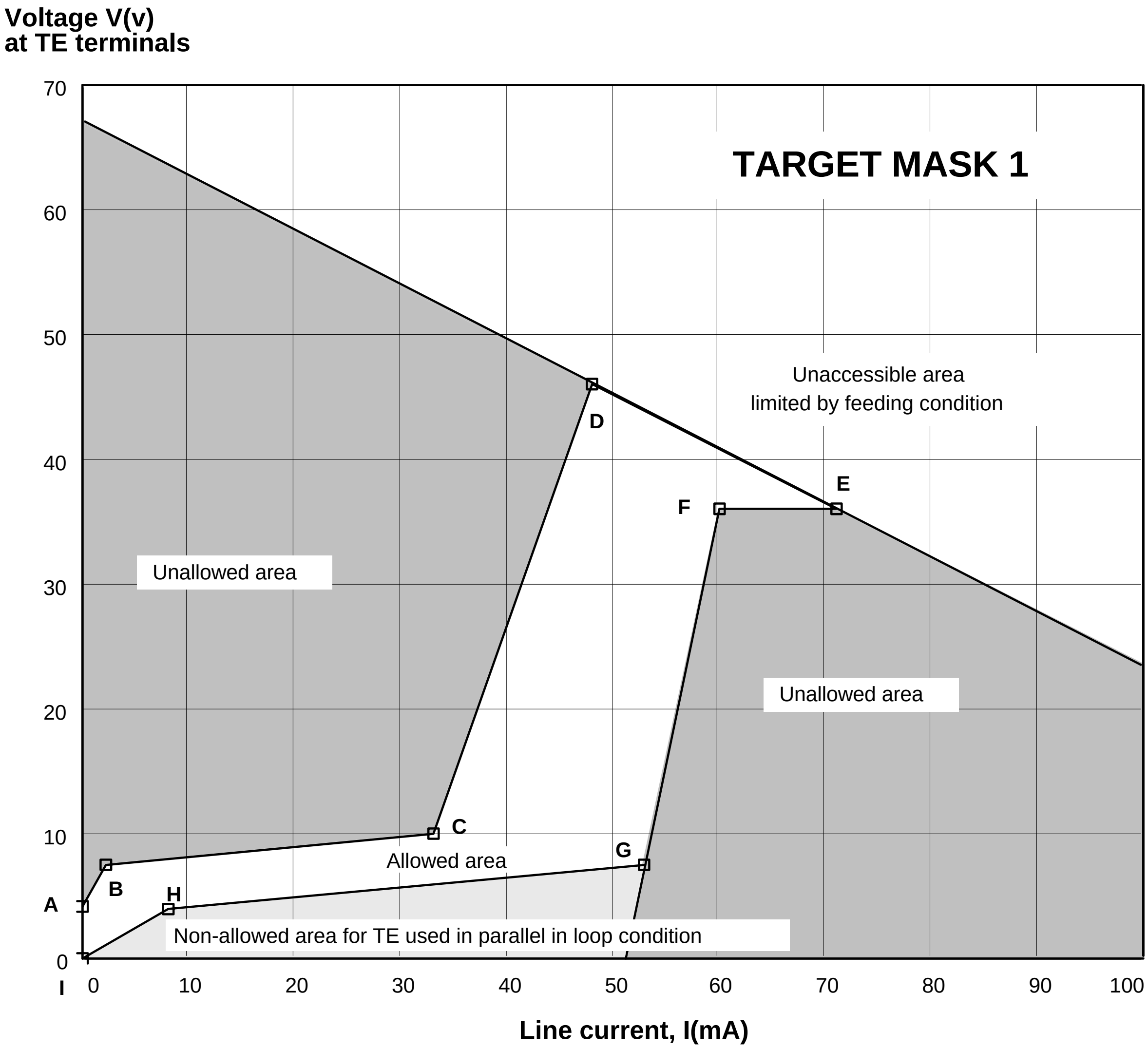
Table A.10.6 (continued): Data of the DC characteristic masks used for the discrete average compilation (6/7)

Data of the DC characteristic mask for the discrete average compilation											
PORTUGAL				SPAIN				SWEDEN			
		continuation				continuation				continuation	
I(mA)	**V(v)**	**I(mA)**	**V(v)**	**I(mA)**	**V(v)**	**I(mA)**	**V(v)**	**I(mA)**	**V(v)**	**I(mA)**	**V(v)**
0	6,95	27	8,24	0	7,40	27	10,80	0	7,50	27	60,00
0,7	6,95	28	8,41	0,7	7,40	28	11,20	0,7	7,50	28	60,00
1	6,95	29	8,58	1	7,40	29	11,60	1	7,50	29	60,00
1,25	6,95	29,89	8,73	1,25	7,40	29,89	11,96	1,25	7,50	29,89	60,00
1,938	6,95	30	8,75	1,938	7,40	30	12,00	1,938	7,50	30	60,00
2	6,95	31	8,92	2	7,40	31	12,40	2	7,50	31	60,00
3	6,95	31	55,00	3	7,40	31	12,40	3	7,50	31	60,00
3,6	6,95	32	55,00	3,6	7,40	32	12,80	3,6	7,50	32	60,00
4	6,95	33	55,00	4	7,40	33	13,20	4	7,50	33	60,00
5	6,95	33,5	55,00	5	7,40	33,5	13,40	5	7,50	33,5	60,00
6	6,95	34	55,00	6	7,40	34	13,60	6	7,50	34	60,00
7	6,95	35	55,00	7	7,40	35	14,00	7	7,50	35	60,00
8	6,95	36	55,00	8	7,40	36	14,40	8	7,50	36	60,00
9	6,95	36	55,00	9	7,40	36	14,40	9	7,50	36	60,00
10	6,95	37	55,00	10	7,40	37	14,80	10	7,50	37	60,00
11	6,95	38	55,00	11	7,40	38	15,20	11	7,73	38	60,00
12	6,95	39	55,00	12	7,40	39	15,60	12	7,95	39	60,00
13	6,95	40	55,00	13	7,40	40	16,00	13	8,18	40	60,00
13,8	6,95	41	55,00	13,8	7,40	41	16,40	13,8	8,36	41	60,00
14	6,95	42	55,00	14	7,40	42	16,80	14	8,40	42	60,00
14	6,95	43	55,00	14	7,40	43	17,20	14	60,00	43	60,00
14,8	6,95	44	55,00	14,8	7,40	44	17,60	14,8	60,00	44	60,00
15	6,95	45	55,00	15	7,40	45	18,00	15	60,00	45	60,00
16	7,06	46	55,00	16	7,40	46	18,40	16	60,00	46	60,00
16	7,06	47	55,00	16	7,40	47	18,80	16	60,00	47	60,00
17	7,17	48	55,00	17	7,40	48	19,20	17	60,00	48	60,00
18	7,27	49	55,00	18	7,40	49	19,60	18	60,00	49	60,00
19	7,38	50	55,00	19	7,60	50	20,00	19	60,00	50	60,00
19,93	7,48	51	55,00	19,93	7,97	51	20,40	19,93	60,00	51	60,00
20	7,49	52	55,00	20	8,00	52	20,80	20	60,00	52	60,00
21	7,60	53	55,00	21	8,40	53	21,20	21	60,00	53	60,00
22	7,70	54	55,00	22	8,80	54	21,60	22	60,00	54	60,00
23	7,81	55	55,00	23	9,20	55	22,00	23	60,00	55	60,00
24	7,92	56	55,00	24	9,60	56	22,40	24	60,00	56	60,00
24,5	7,97	57	55,00	24,5	9,80	57	22,80	24,5	60,00	57	60,00
24,5	7,97	58	55,00	24,5	9,80	58	23,20	24,5	60,00	58	60,00
25	8,03	59	55,00	25	10,00	59	23,60	25	60,00	59	60,00
25	8,03	60	55,00	25	10,00	60	24,00	25	60,00	60	60,00
25,9	8,12			25,9	10,36			25,9	60,00		
26	8,13			26	10,40			26	60,00		
26	8,13			26	10,40			26	60,00		

Table A.10.7 (continued): Data of the DC characteristic masks used for the discrete average compilation (7/7)

Data of the DC characteristic mask for the discrete average compilation											
SWITZERLAND				GB				Averaged values			
		continuation				continuation				continuation	
I(mA)	**V(v)**	**I(mA)**	**V(v)**	**I(mA)**	**V(v)**	**I(mA)**	**V(v)**	**I(mA)**	**V(v)**	**I(mA)**	**V(v)**
0	6,00	27	10,80	0	9,00	27	9,14	0	6,36	27	18,54
0,7	6,07	28	11,20	0,7	9,00	28	9,28	0,7	6,52	28	18,87
1	6,10	29	11,60	1	9,00	29	9,41	1	6,58	29	19,20
1,25	6,13	29,89	11,96	1,25	9,00	29,89	9,53	1,25	6,73	29,89	19,49
1,938	6,19	30	12,00	1,938	9,00	30	9,54	1,938	6,76	30	19,52
2	6,20	31	12,40	2	9,00	31	9,67	2	6,77	31	19,85
3	6,30	31	12,40	3	9,00	31	9,67	3	6,92	31	22,28
3,6	6,36	32	12,80	3,6	9,00	32	9,80	3,6	7,02	32	22,60
4	6,40	33	13,20	4	9,00	33	9,93	4	7,08	33	22,92
5	6,50	33,5	13,40	5	9,00	33,5	10,00	5	7,14	33,5	23,08
6	6,60	34	13,60	6	9,00	34	10,15	6	7,18	34	23,24
7	6,70	35	14,00	7	9,00	35	10,44	7	7,22	35	23,57
8	6,80	36	14,40	8	9,00	36	10,74	8	7,26	36	23,90
9	6,90	36	14,40	9	9,00	36	10,74	9	7,29	36	23,90
10	7,00	37	14,80	10	9,00	37	11,03	10	7,33	37	24,23
11	7,10	38	15,20	11	9,00	38	11,32	11	7,38	38	24,56
12	7,20	39	15,60	12	9,00	39	11,62	12	7,43	39	24,88
13	7,30	40	16,00	13	9,00	40	11,91	13	7,48	40	25,21
13,8	7,38	41	16,40	13,8	9,00	41	12,21	13,8	7,52	41	25,54
14	7,40	42	16,80	14	9,00	42	12,50	14	7,53	42	25,87
14	7,40	43	17,20	14	9,00	43	19,00	14	10,24	43	26,52
14,8	0,00	44	17,60	14,8	9,00	44	25,00	14,8	9,92	44	27,15
15	7,50	45	18,00	15	9,00	45	25,00	15	10,34	45	27,47
16	7,60	46	18,40	16	9,00	46	25,00	16	10,43	46	27,73
16	7,60	47	18,80	16	9,00	47	25,00	16	10,66	47	28,00
17	7,70	48	19,20	17	9,00	48	25,00	17	10,80	48	28,27
18	7,80	49	19,60	18	9,00	49	25,00	18	10,96	49	28,54
19	7,90	50	20,00	19	9,00	50	25,00	19	11,13	50	28,81
19,93	7,99	51	20,40	19,93	9,00	51	25,00	19,93	11,31	51	29,07
20	8,00	52	20,80	20	9,00	52	25,00	20	11,32	52	29,34
21	8,40	53	21,20	21	9,00	53	25,00	21	11,65	53	29,61
22	8,80	54	21,60	22	9,00	54	25,00	22	11,97	54	29,88
23	9,20	55	22,00	23	9,00	55	25,00	23	12,30	55	30,15
24	9,60	56	22,40	24	9,00	56	25,00	24	12,63	56	30,42
24,5	9,80	57	22,80	24,5	9,00	57	25,00	24,5	12,79	57	30,68
24,5	9,80	58	23,20	24,5	9,00	58	25,00	24,5	12,94	58	30,95
25	10,00	59	23,60	25	9,00	59	25,00	25	13,11	59	31,22
25	10,00	60	24,00	25	9,00	60	25,00	25	17,28	60	31,49
25,9	10,36			25,9	9,00			25,9	17,56		
26	10,40			26	9,01			26	18,21		
26	10,40			26	9,01			26	18,21		

A.8 Suggested target mask 1

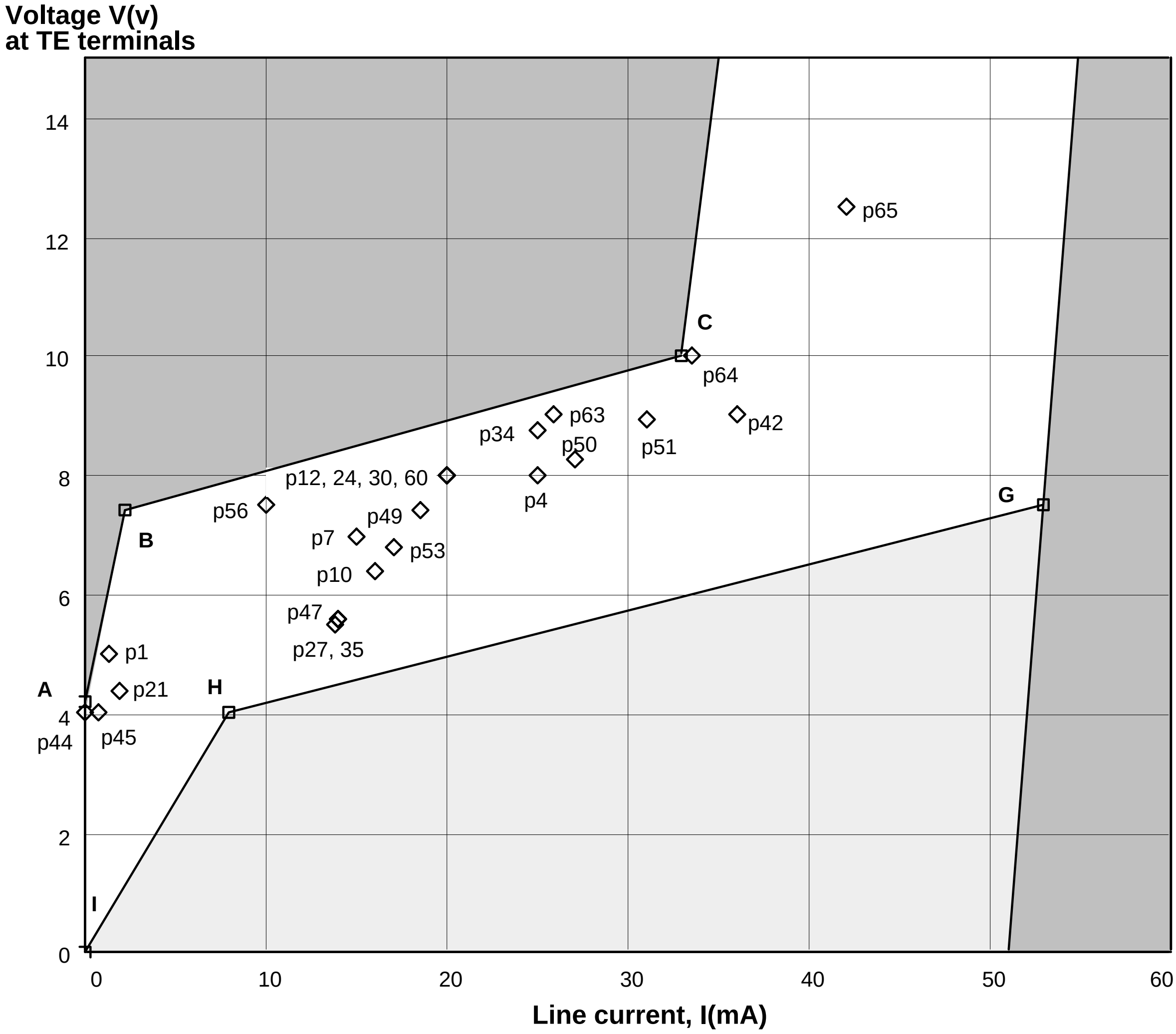


Co-ordinates of the target mask 1:

Dots	I(mA)	V(v)	Dots	I(mA)	V(v)	Dots	I(mA)	V(v)
A	0	4,2	**D**	48	46	**G**	53	7,5
B	2,2	7,4	**E**	71	36	**H**	8	4
C	33	10	**F**	60	36	**I**	0	0

Figure A.16: Target mask 1

A.9 Critical points with respect to the target mask 1



Co-ordinates of the target mask 1 and of the critical points.

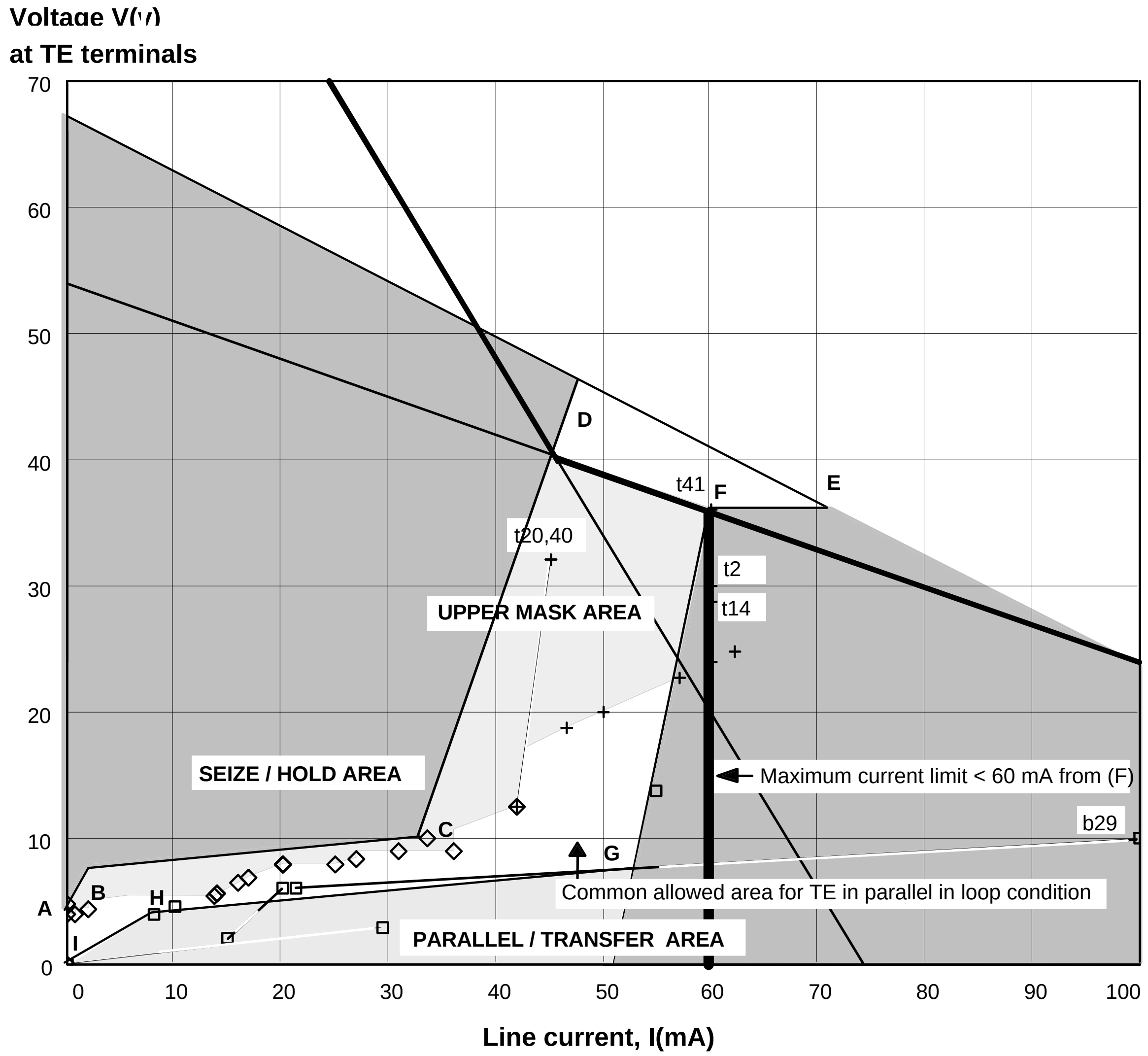
The critical values listed in the above table, which inhibit the harmonization with respect to the DC target mask 1 are located within the SEIZE/HOLD AREA, restricting the voltage available across the terminal input.

Dots	I(mA)	V(v)	Dots	I(mA)	V(v)	Dots	I(mA)	V(v)
A	0	4,2	**D**	48	46	**G**	53	7,5
B	2,2	7,4	**E**	71	36	**H**	8	4
C	33	10	**F**	60	36	**I**	0	0

Country	Dots	I(mA)	V(v)	Country	Dots	I(mA)	V(v)	Country	Dots	I(mA)	V(v)
A	p1	1,25	5	**IRL**	p30	20	8	**P**	p50	27	8,24
B	p4	25	8	**I**	p34	25	8,75	**P**	p51	31	8,92
CY	p7	17	6,8	**L**	p35	14	5,6	**E**	p53	18,5	7,4
DK	p10	16	6,4	**NL**	p42	36	9	**S**	p56	10	7,5
SF	p12	20	8	**N**	p44	0	4	**CH**	p60	20	8
D	p21	1,9	4,36	**N**	p45	0,7	4	**GB**	p63	25,9	9
GR	p24	20	8	**N**	p47	13,8	5,5	**GB**	p64	33,5	10
IS	p27	14	5,6	**P**	p49	15	6,95	**GB**	p65	42	12,5

Figure A.17: Critical points with respect to the target mask 1

A.10 Target mask 1 compared to the common allowed area



Co-ordinates of the target mask 1:

Dots	**I(mA)**	**V(v)**	**Dots**	**I(mA)**	**V(v)**	**Dots**	**I(mA)**	**V(v)**
A	0	4,2	**D**	48	46	**G**	53	7,5
B	2,2	7,4	**E**	71	36	**H**	8	4
C	33	10	**F**	60	36	**I**	0	0

Figure A.18: Target mask 1 comparison with the common allowed area

A.11 Superimposition of the 4 DC masks of the widest PSTN network in Europe

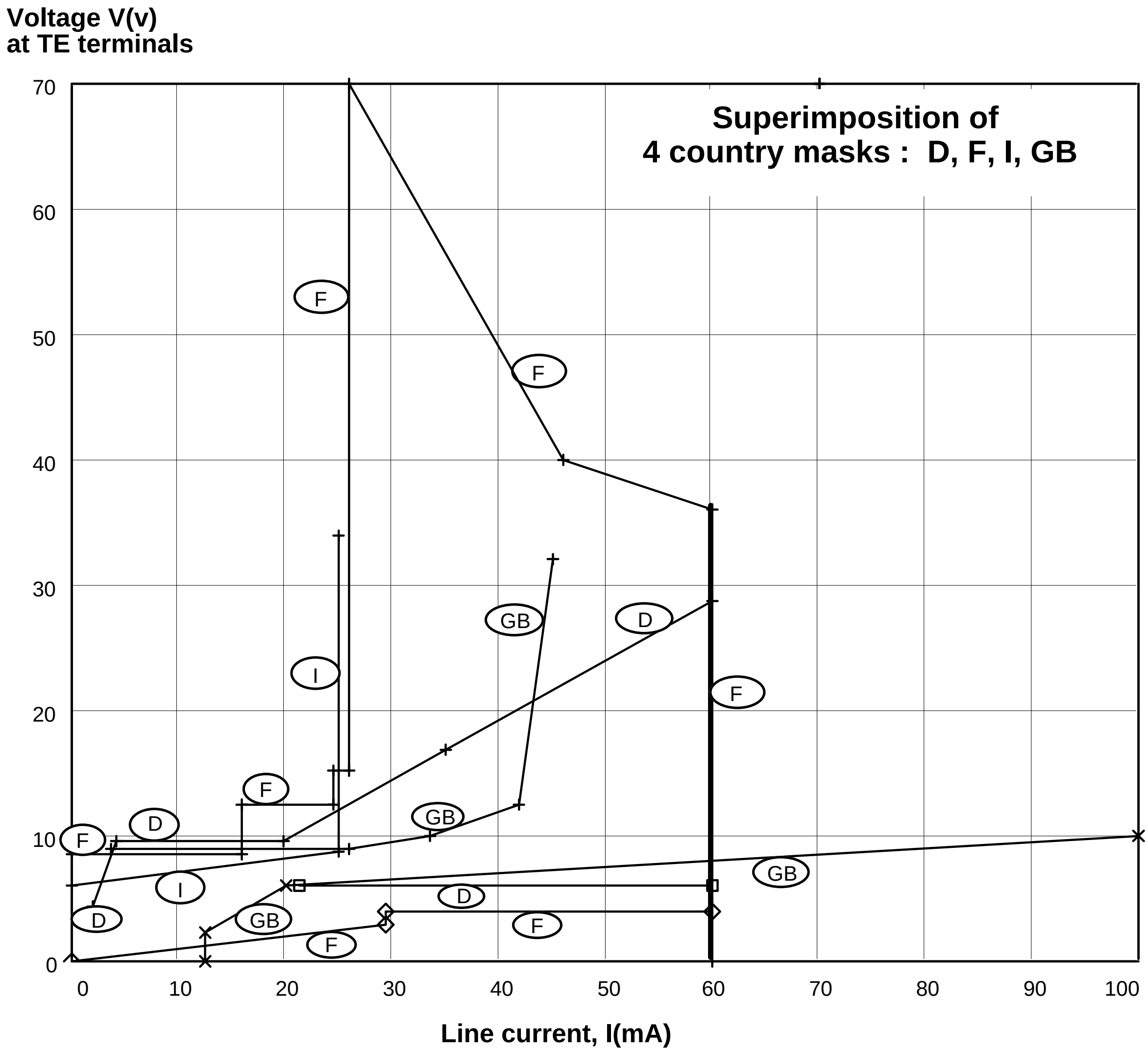


Figure A.19: Superimposition of the country mask: D, F, I, GB

A.12 Comparison of the (D,F,I,GB) masks with respect to the target mask 1

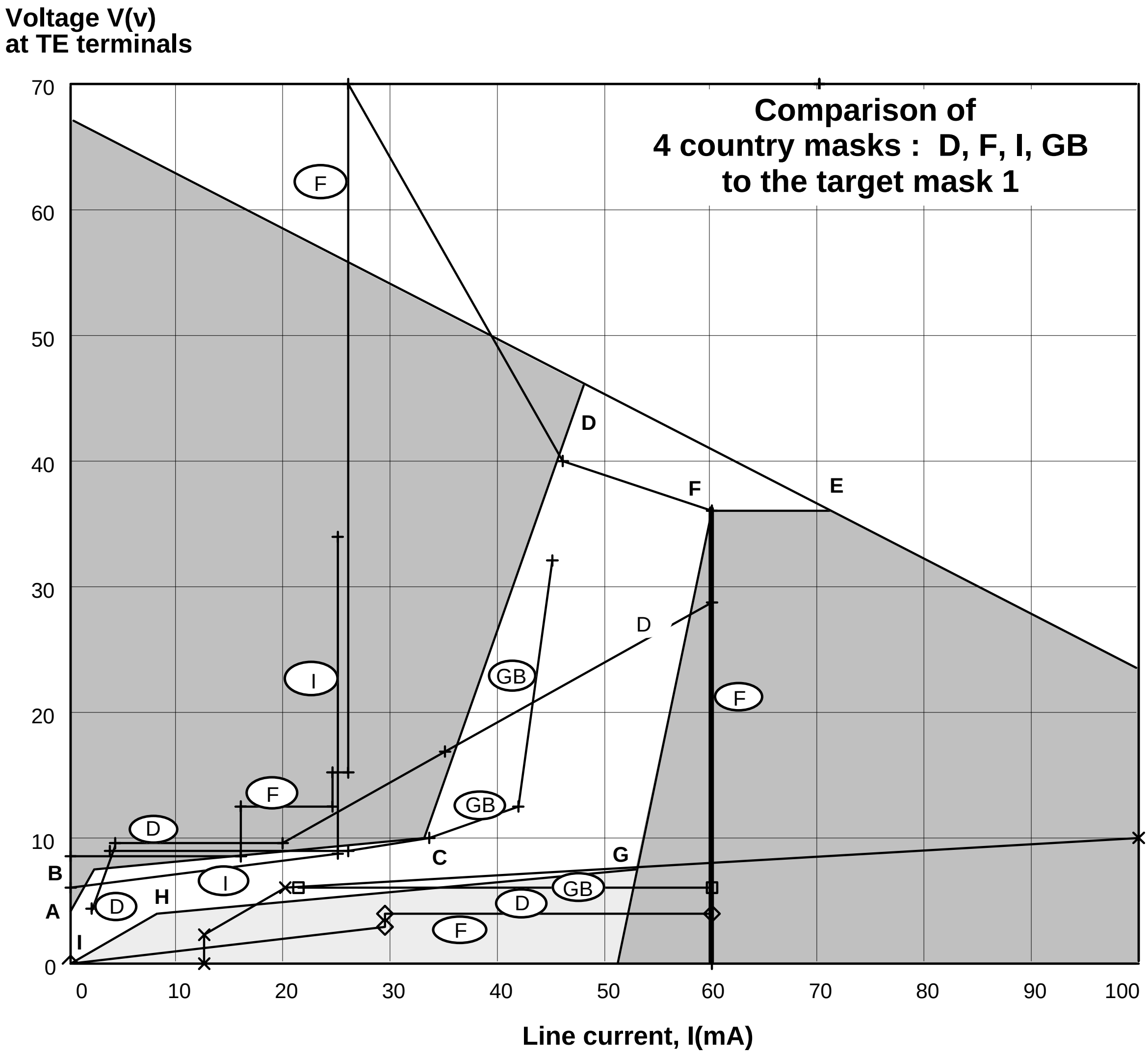


Figure A.20: Comparison of the country mask (D, F, I, GB) to the target mask 1

A.13 Suggested target mask 2

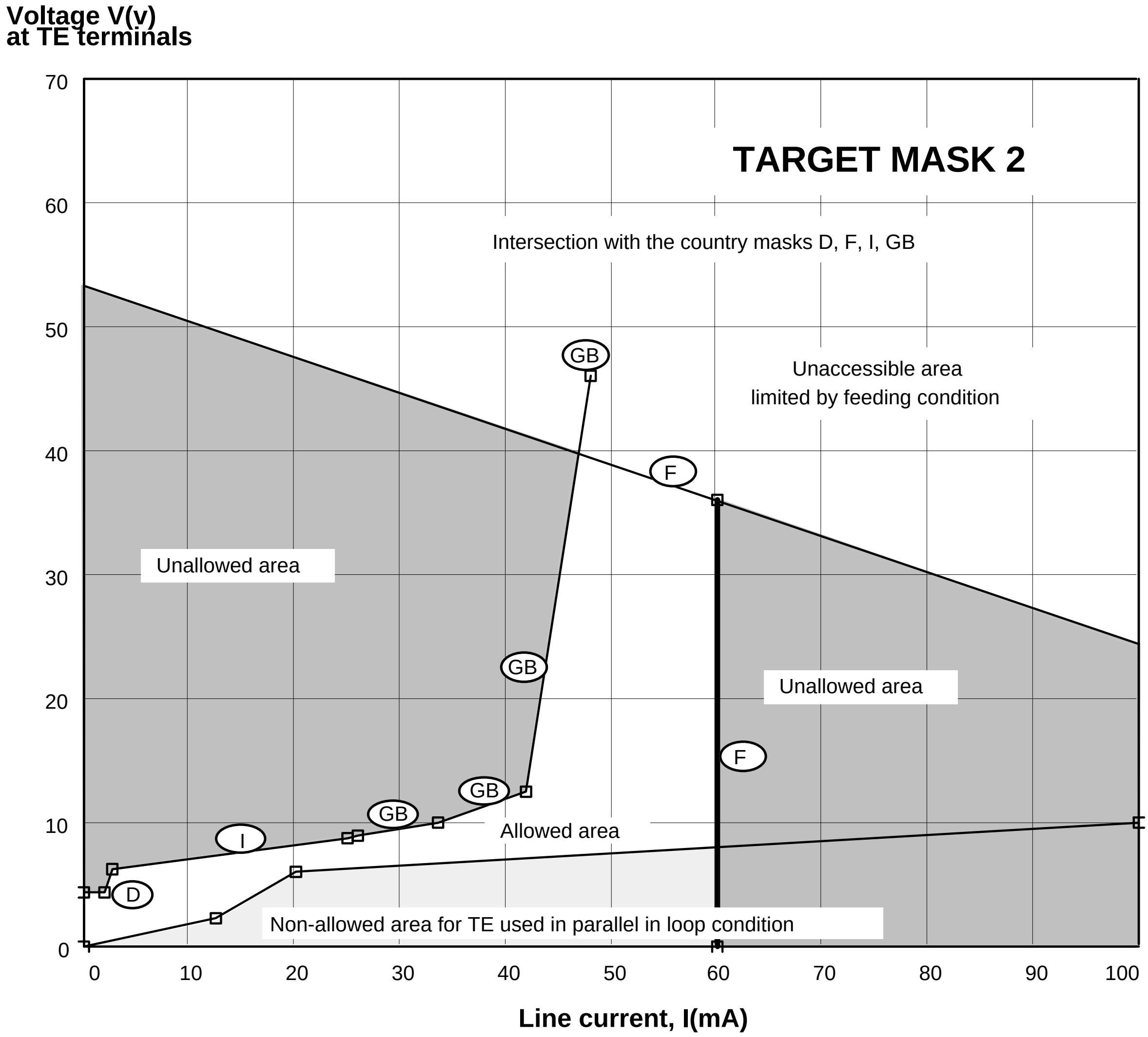


Figure A.21: Target mask 2

A.14 Nineteen Country DC mask

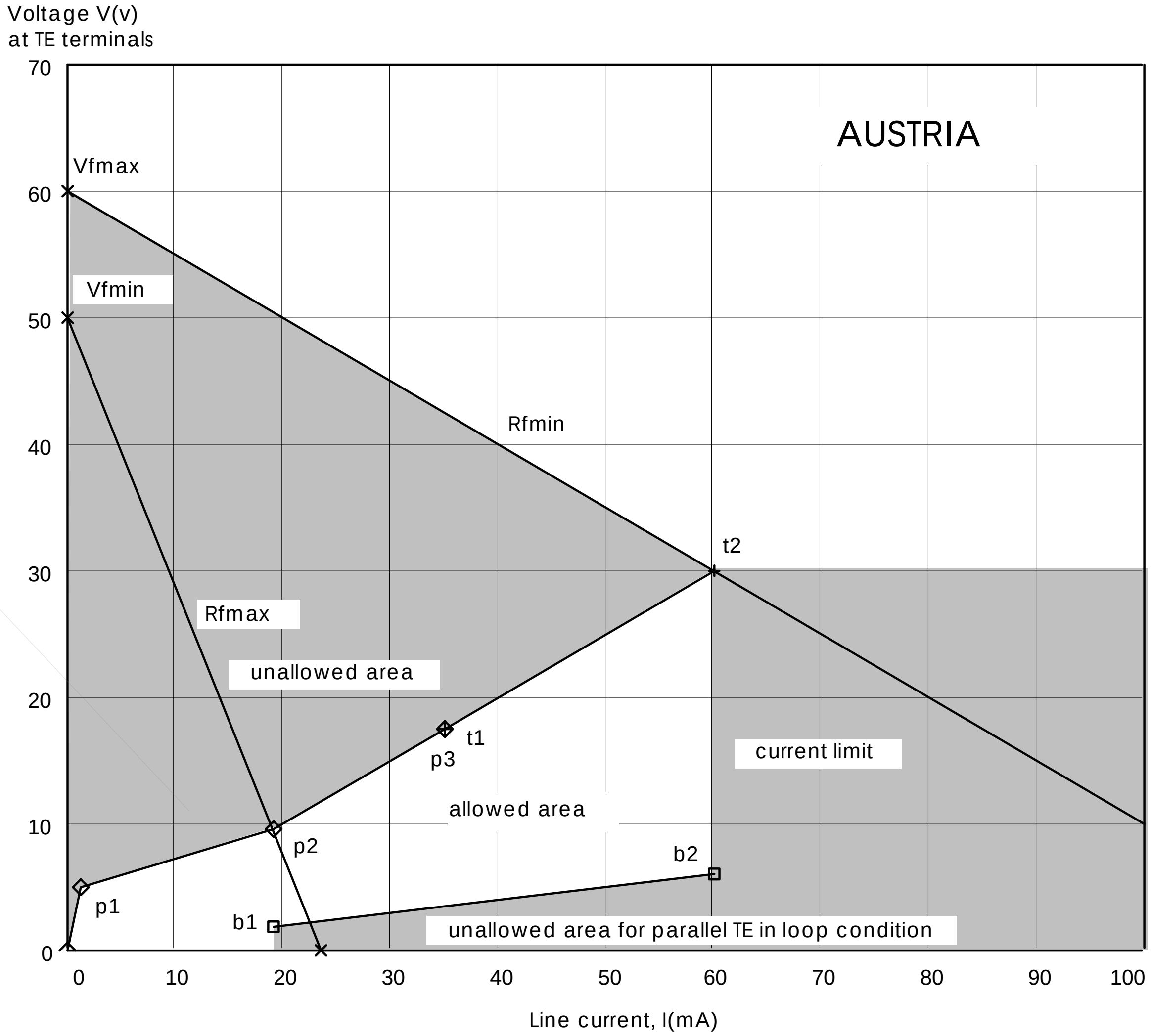


Figure A.22.1: DC current and loop resistance mask for the country AUSTRIA

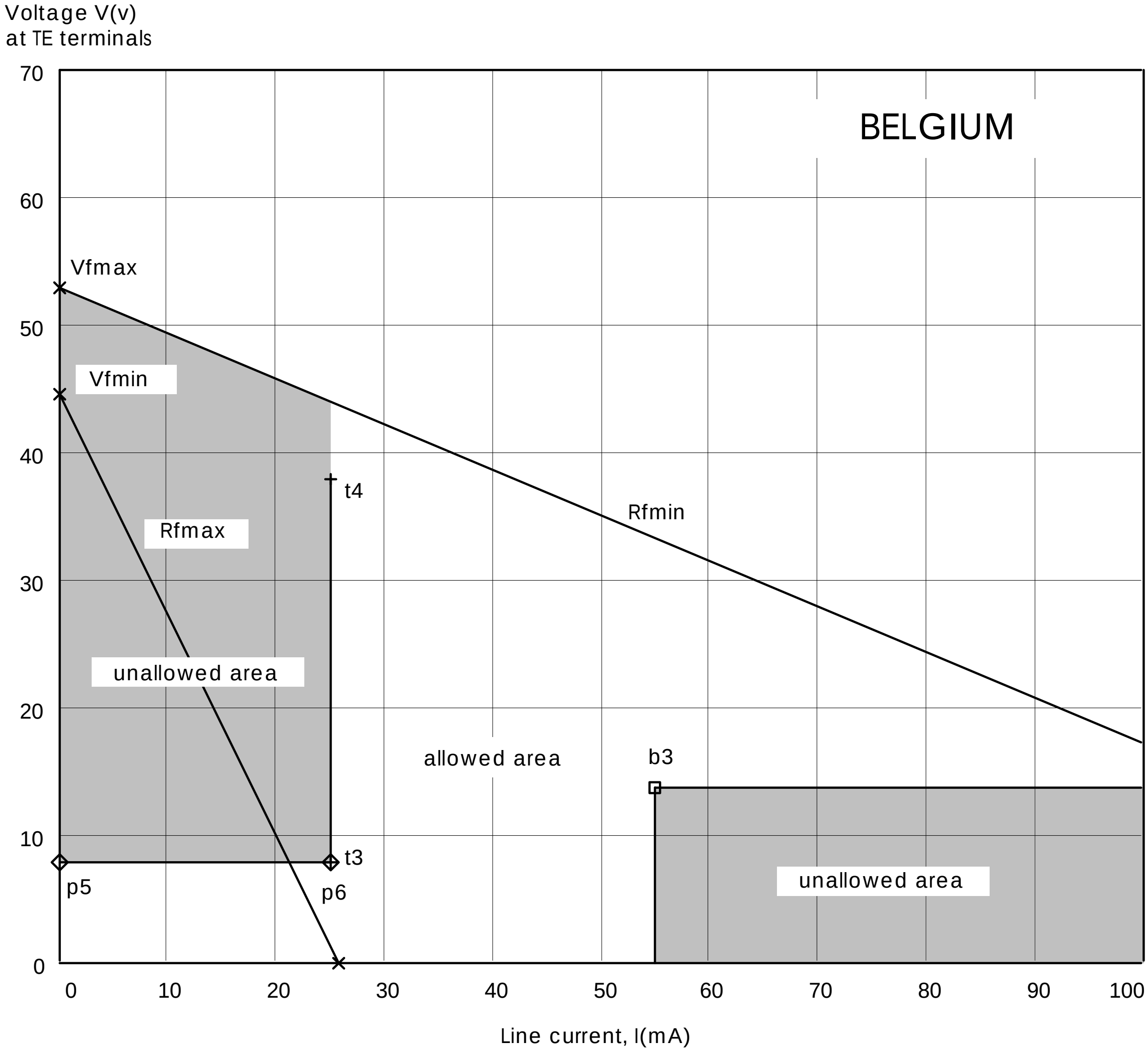


Figure A.22.2: DC current and loop resistance mask for the country BELGIUM

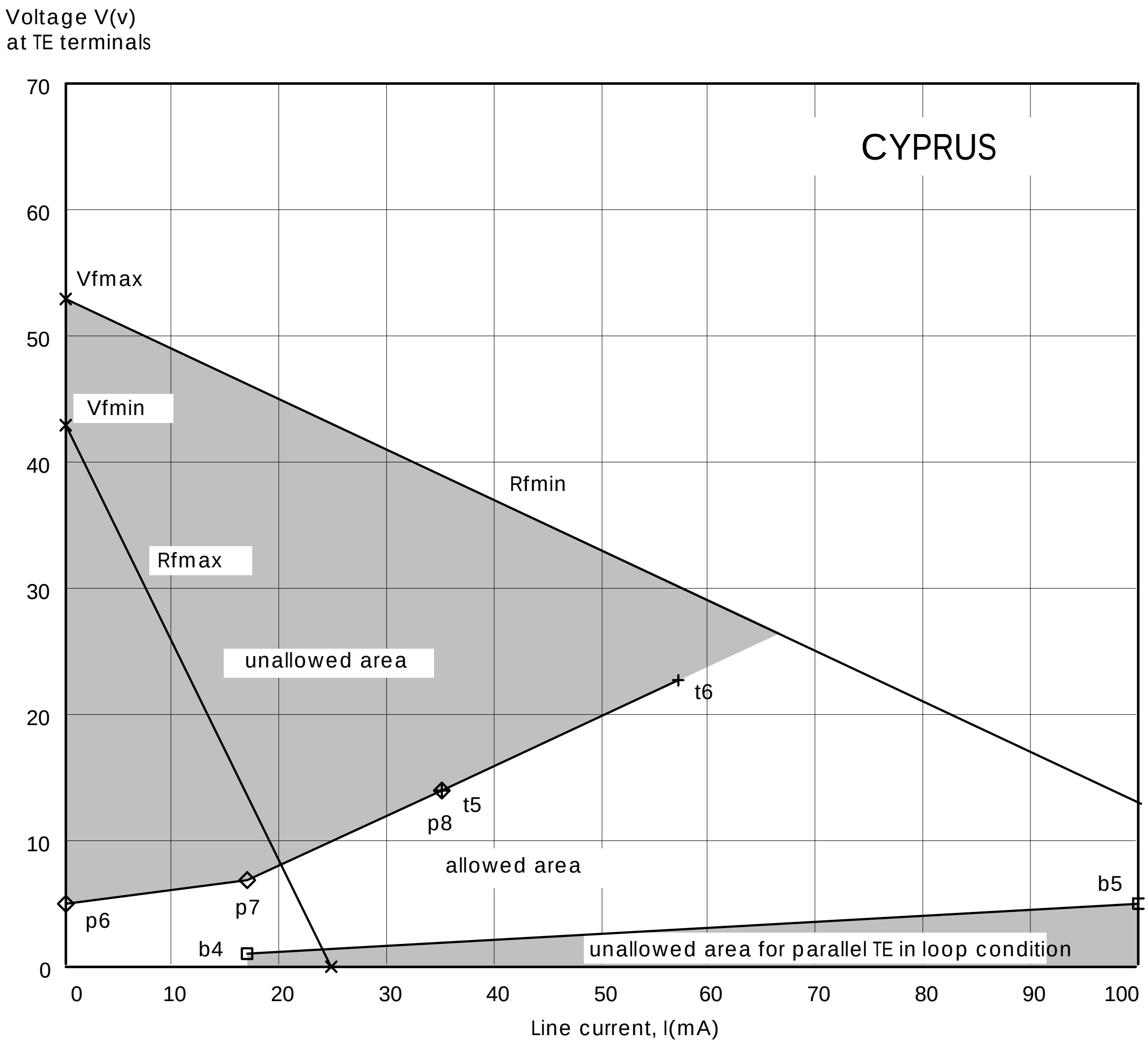


Figure A.22.3: DC current and loop resistance mask for the country CYPRUS

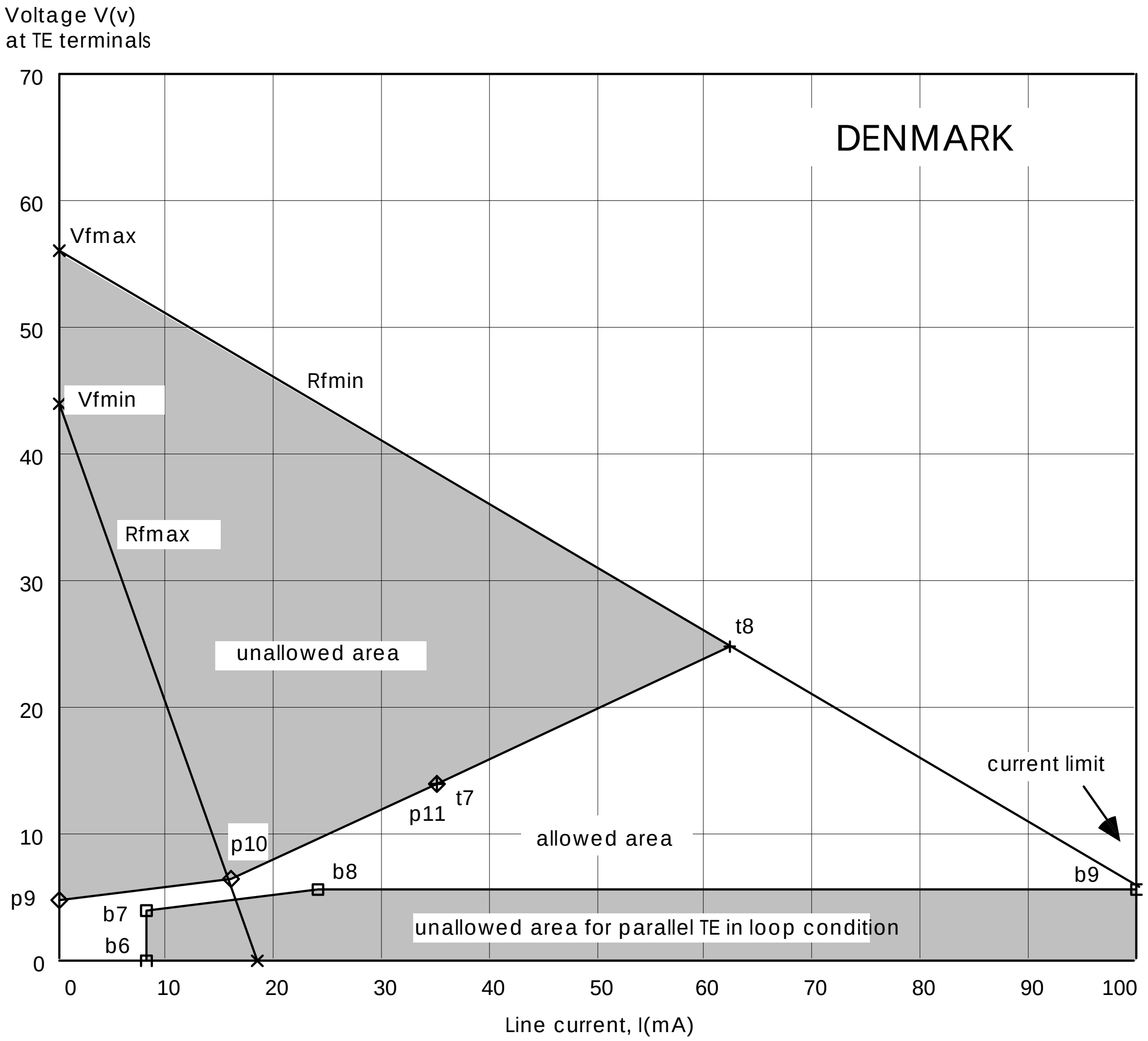


Figure A.22.4: DC current and loop resistance mask for the country DENMARK

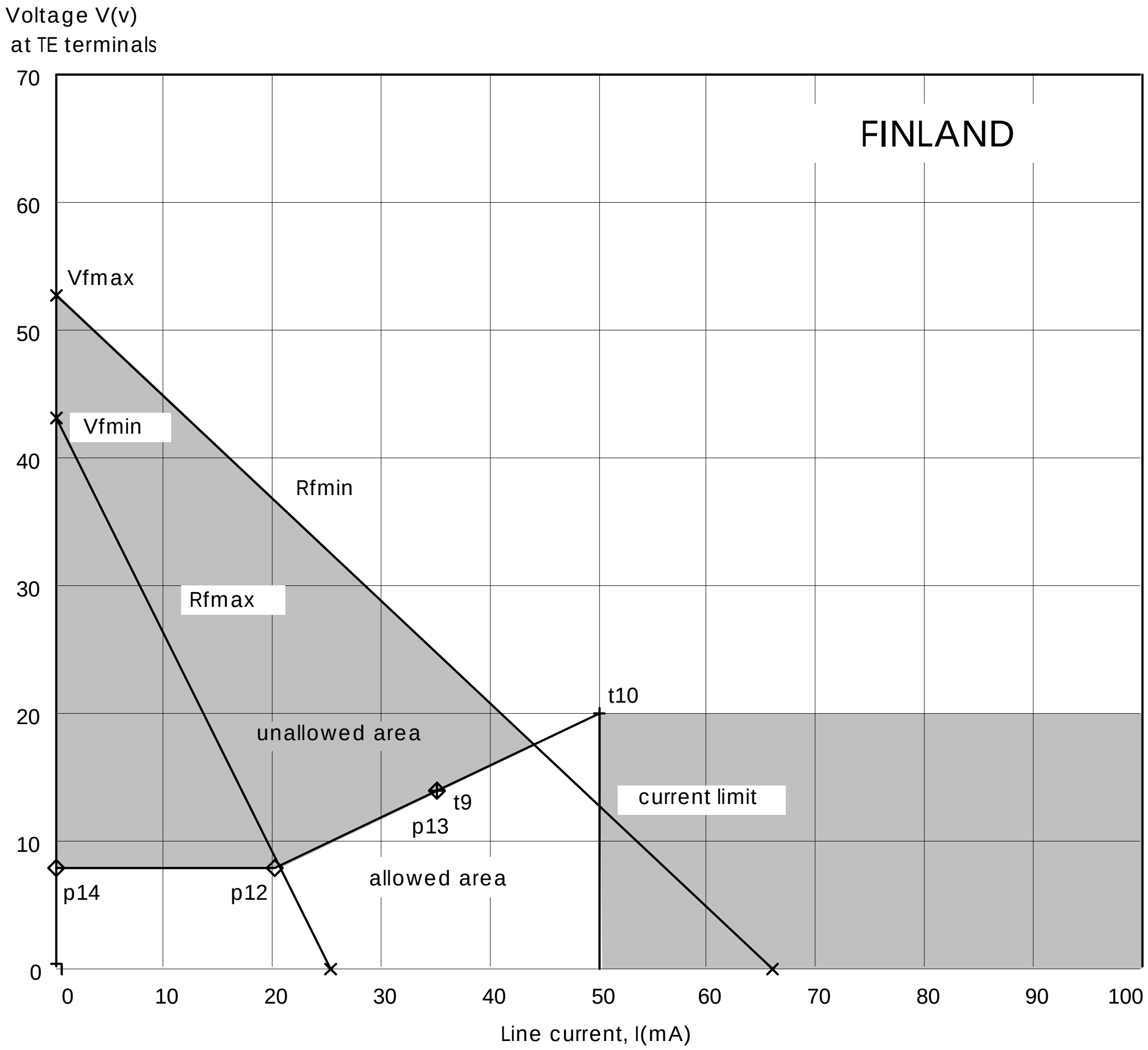


Figure A.22.5: DC current and loop resistance mask for the country FINLAND

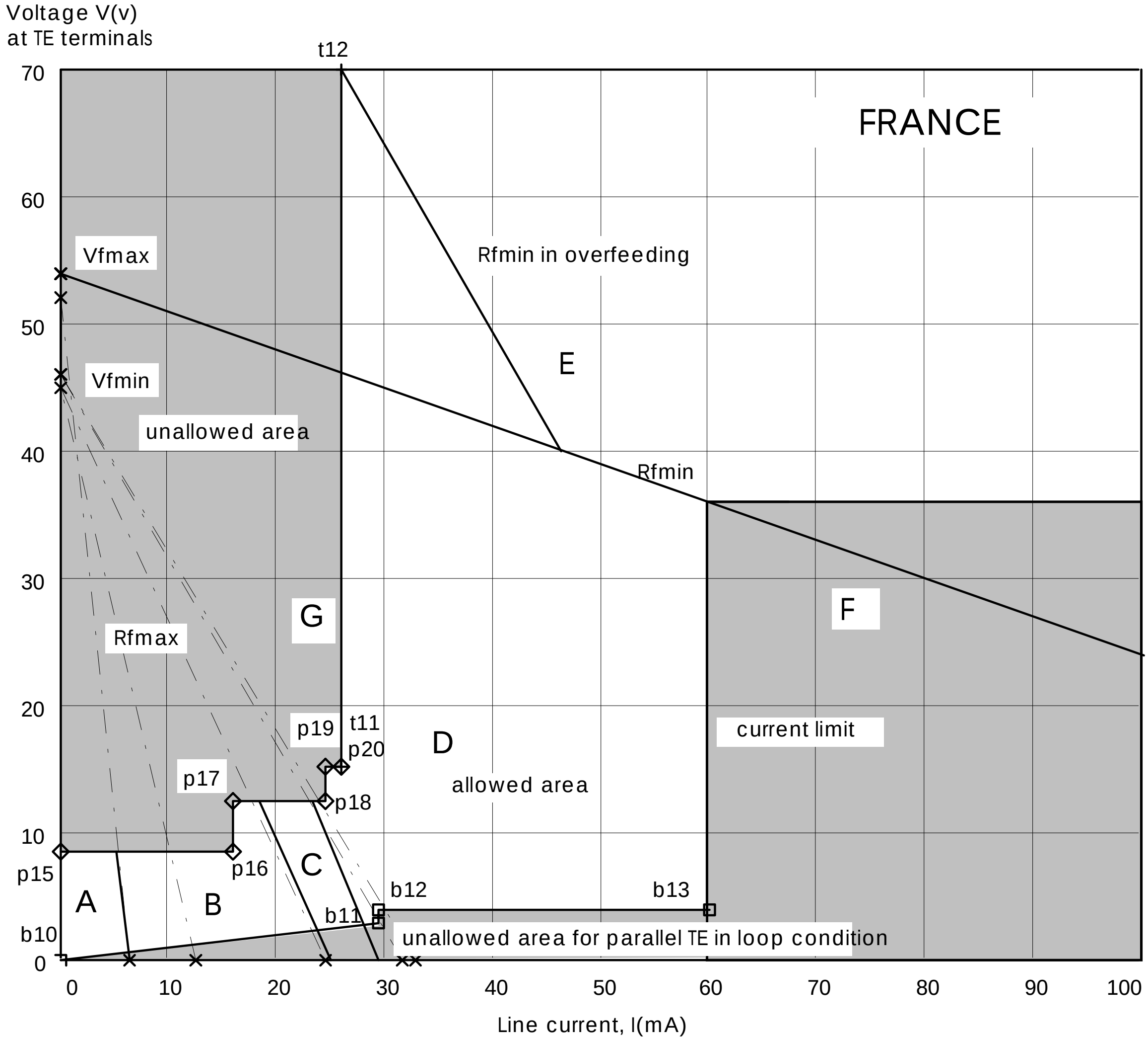


Figure A.22.6: DC current and loop resistance mask for the country FRANCE

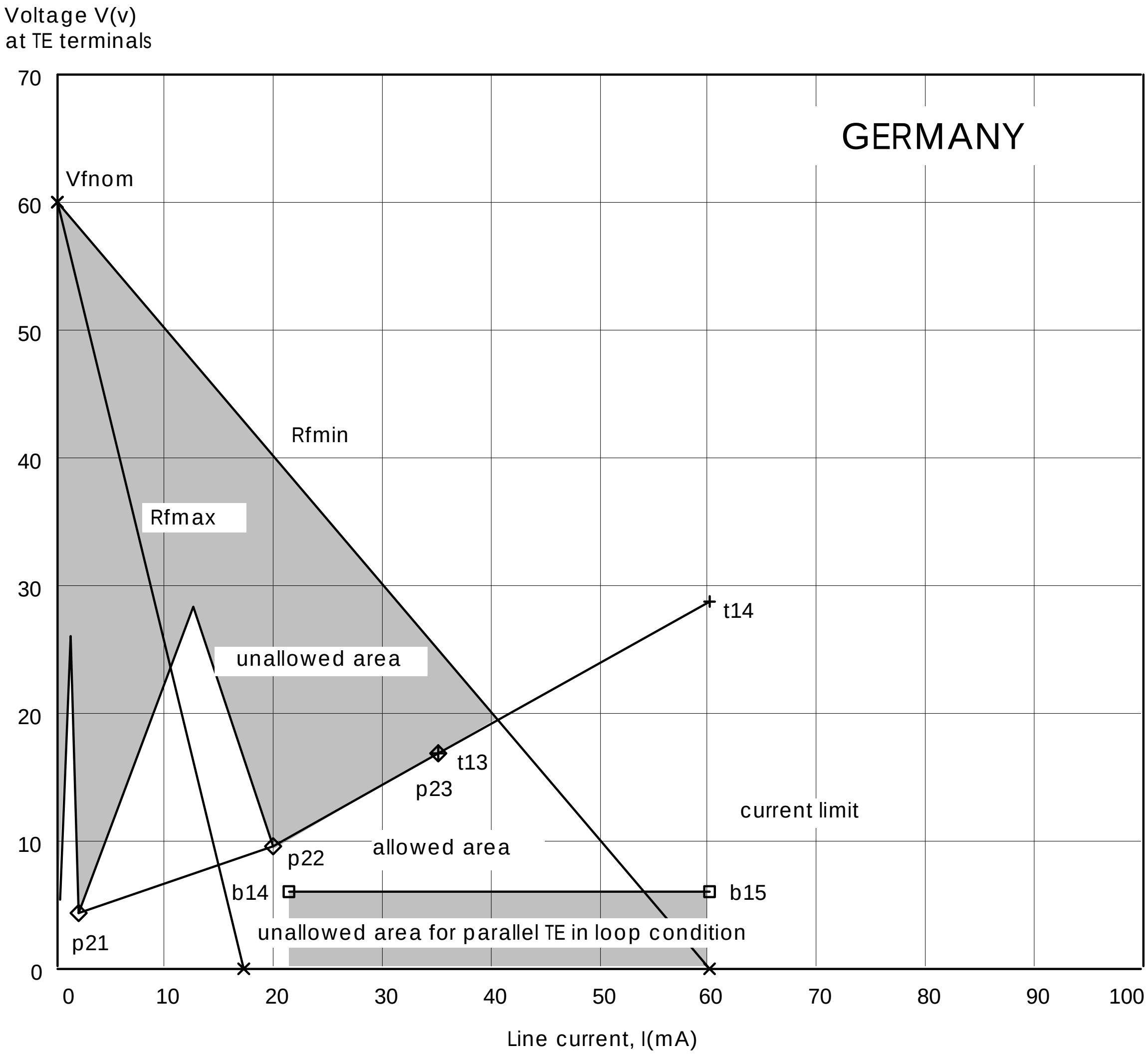


Figure A.22.7: DC current and loop resistance mask for the country GERMANY

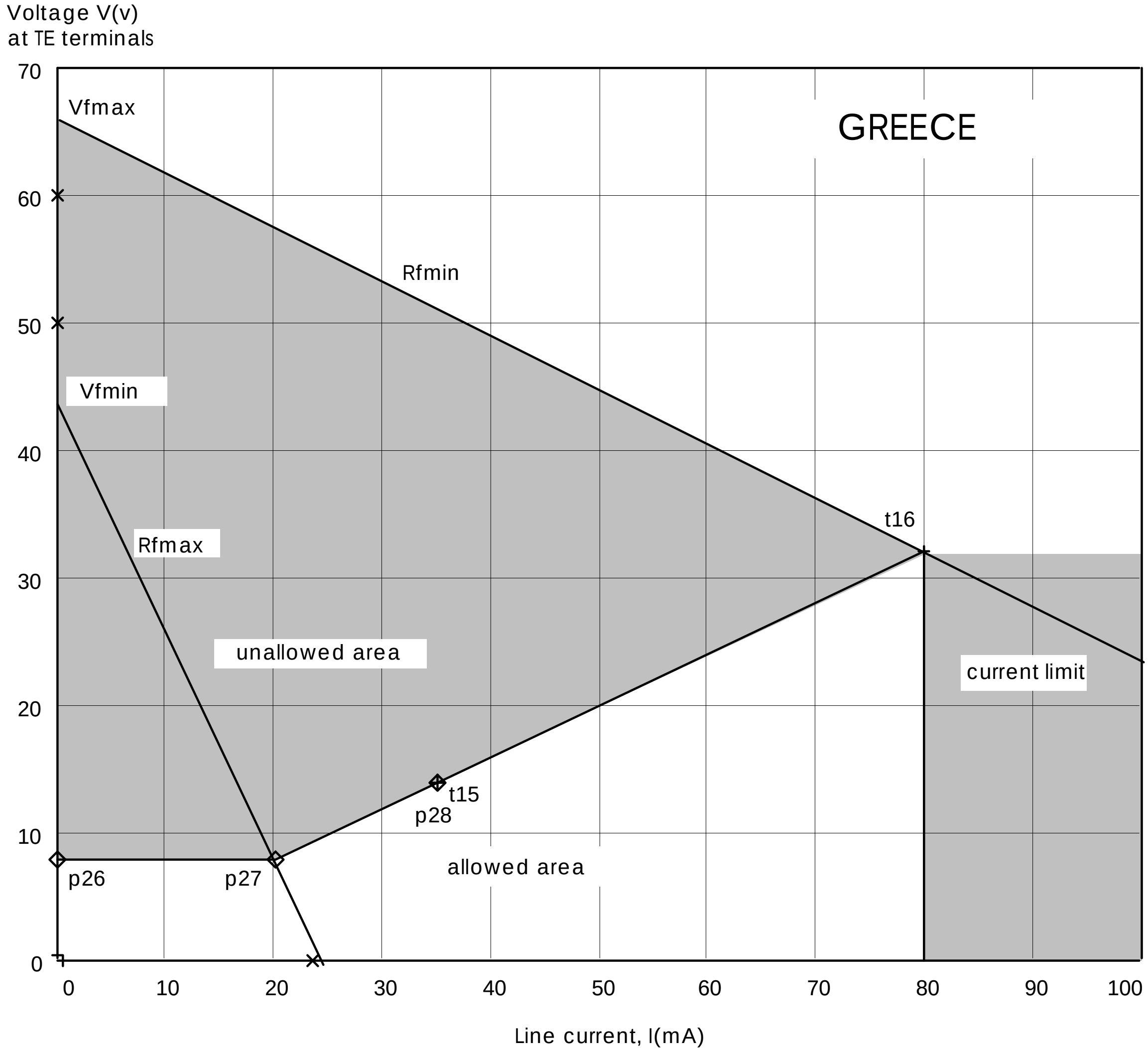


Figure A.22.8: DC current and loop resistance mask for the country GREECE

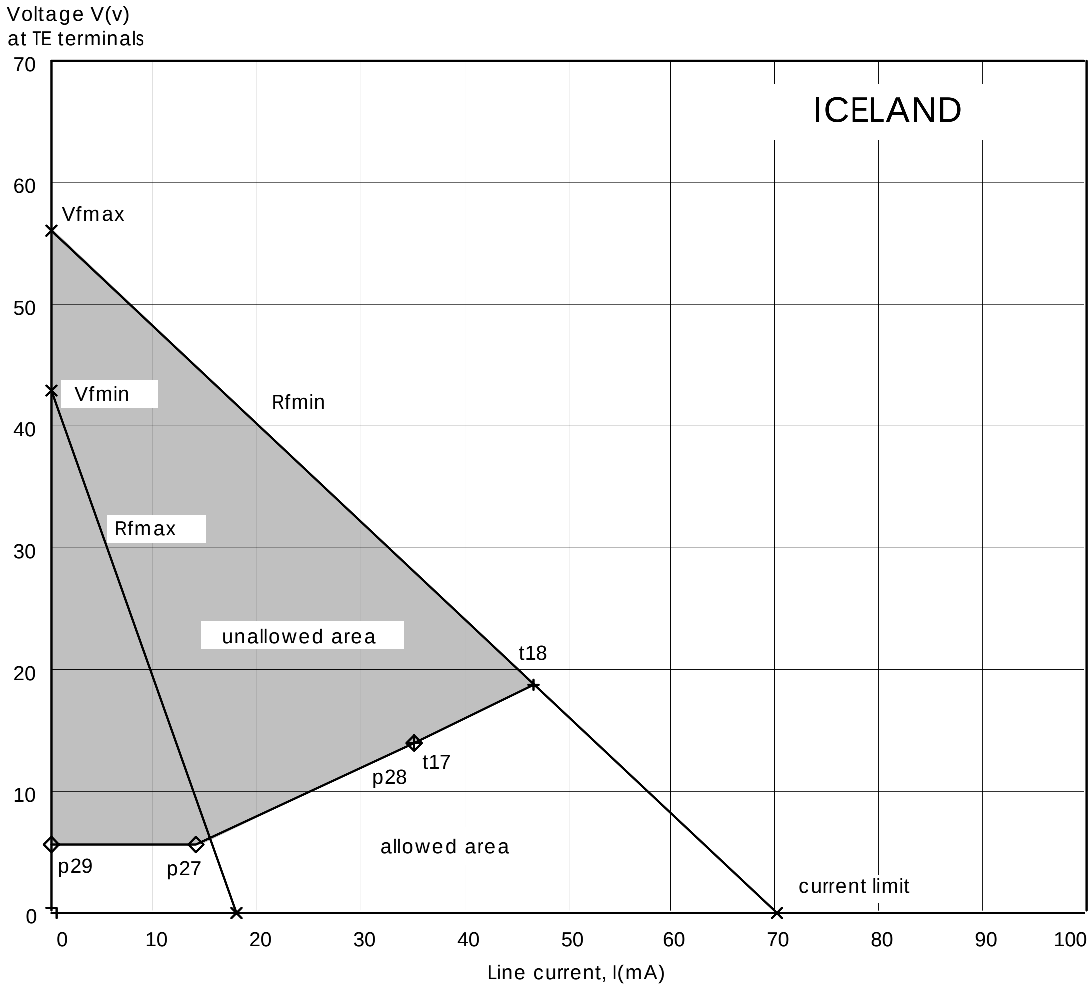


Figure A.22.9: DC current and loop resistance mask for the country ICELAND

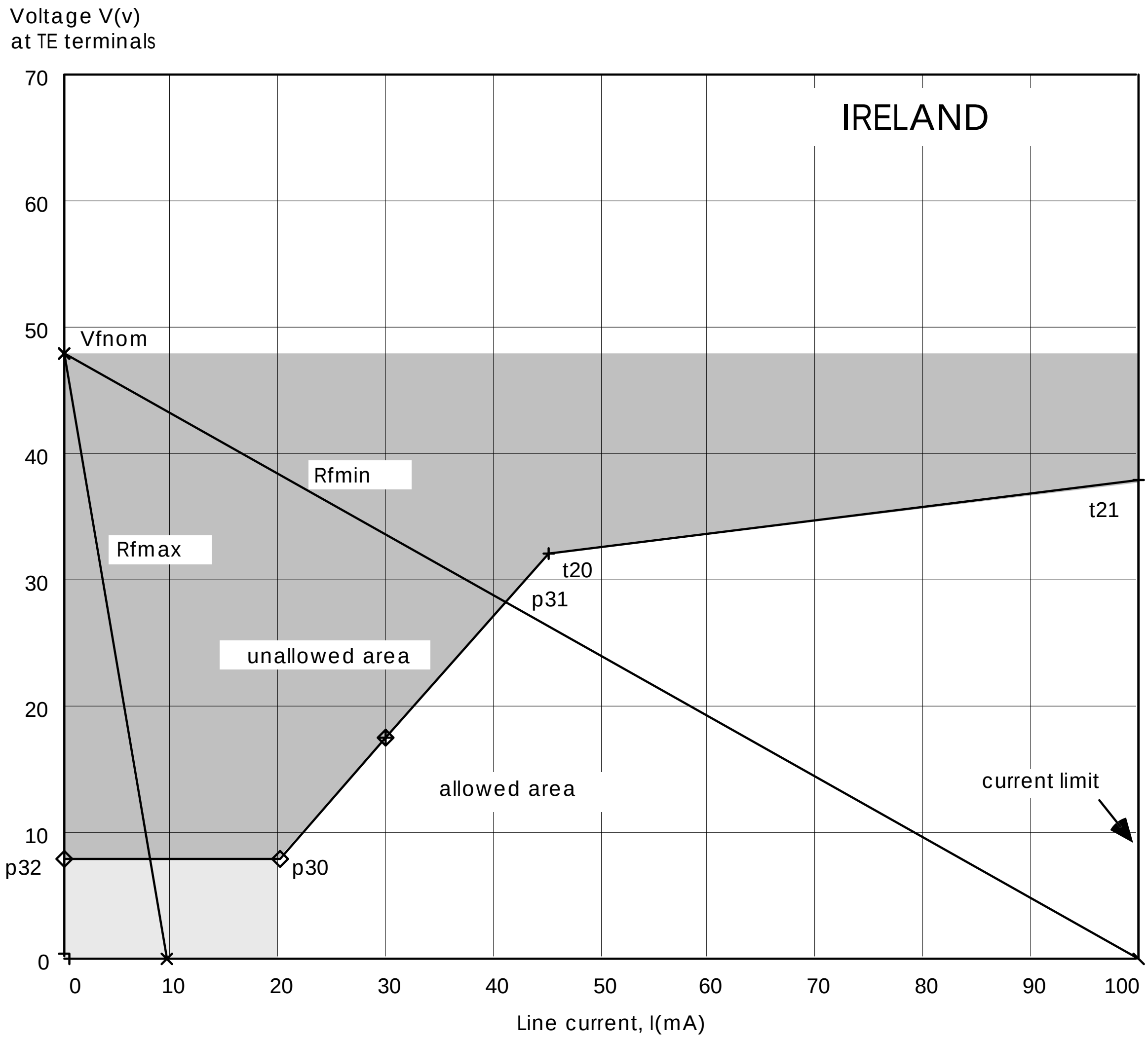


Figure A.22.10: DC current and loop resistance mask for the country IRELAND

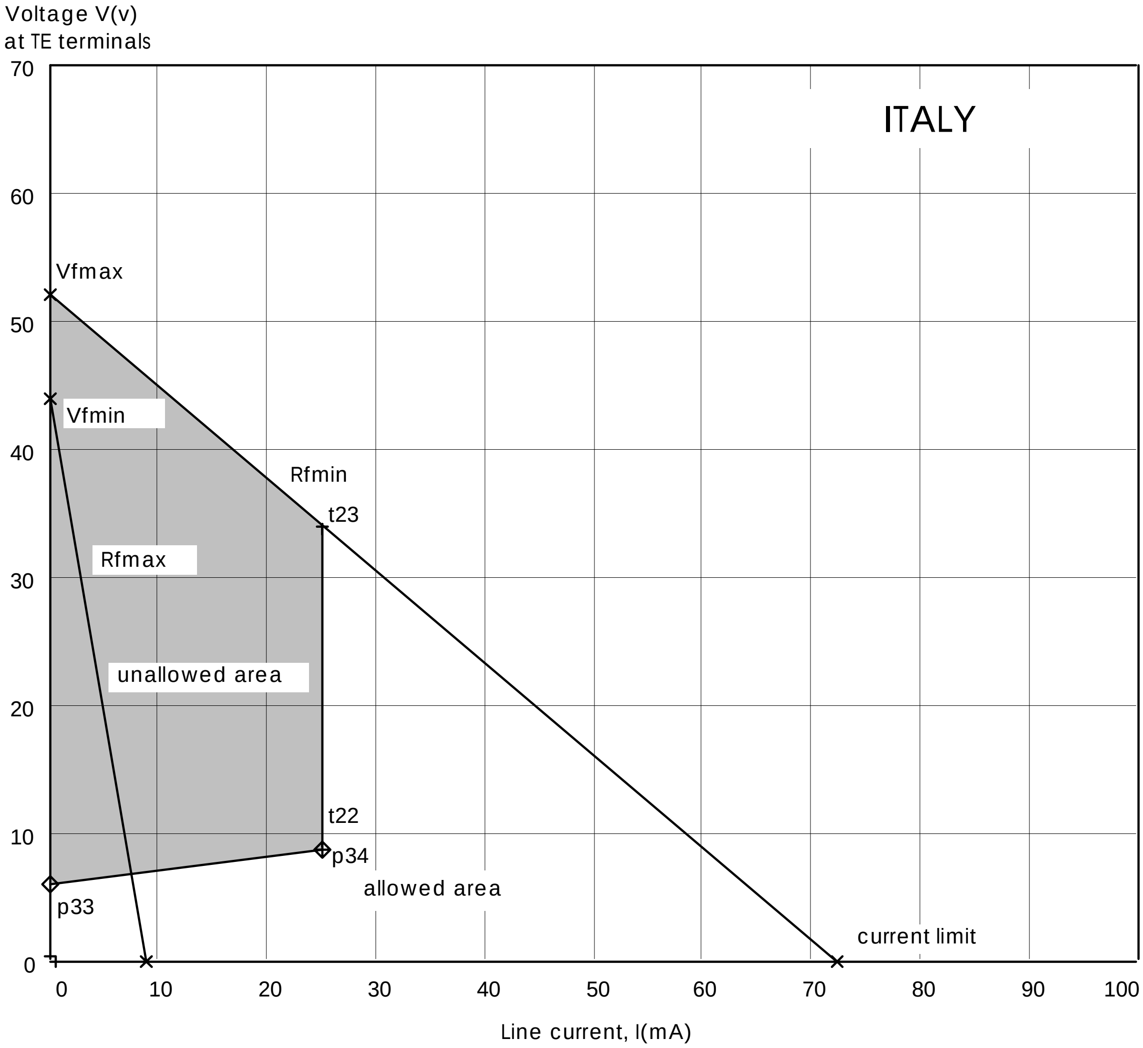


Figure A.22.11: DC current and loop resistance mask for the country ITALY

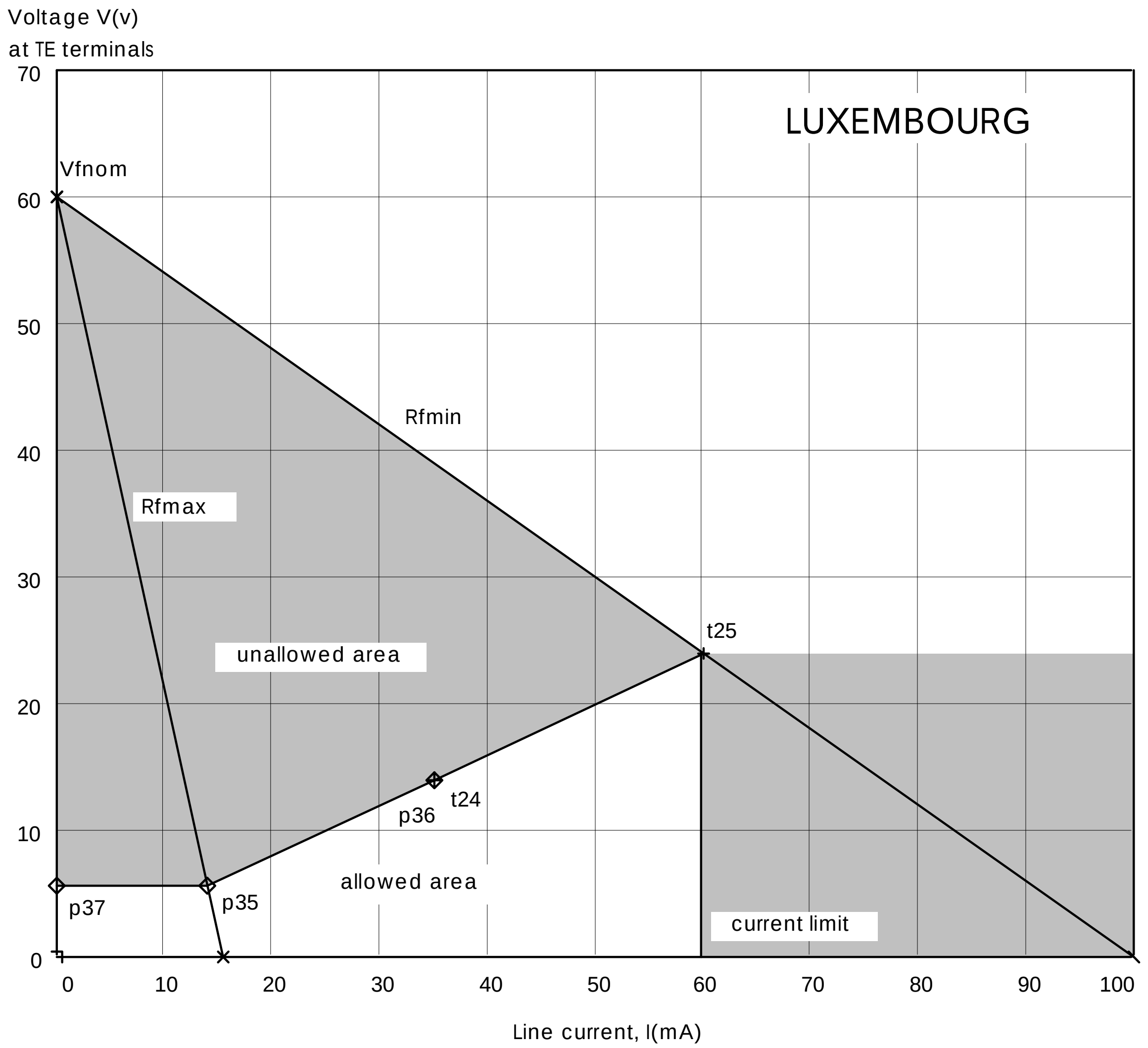


Figure A.22.12: DC current and loop resistance mask for the country LUXEMBOURG

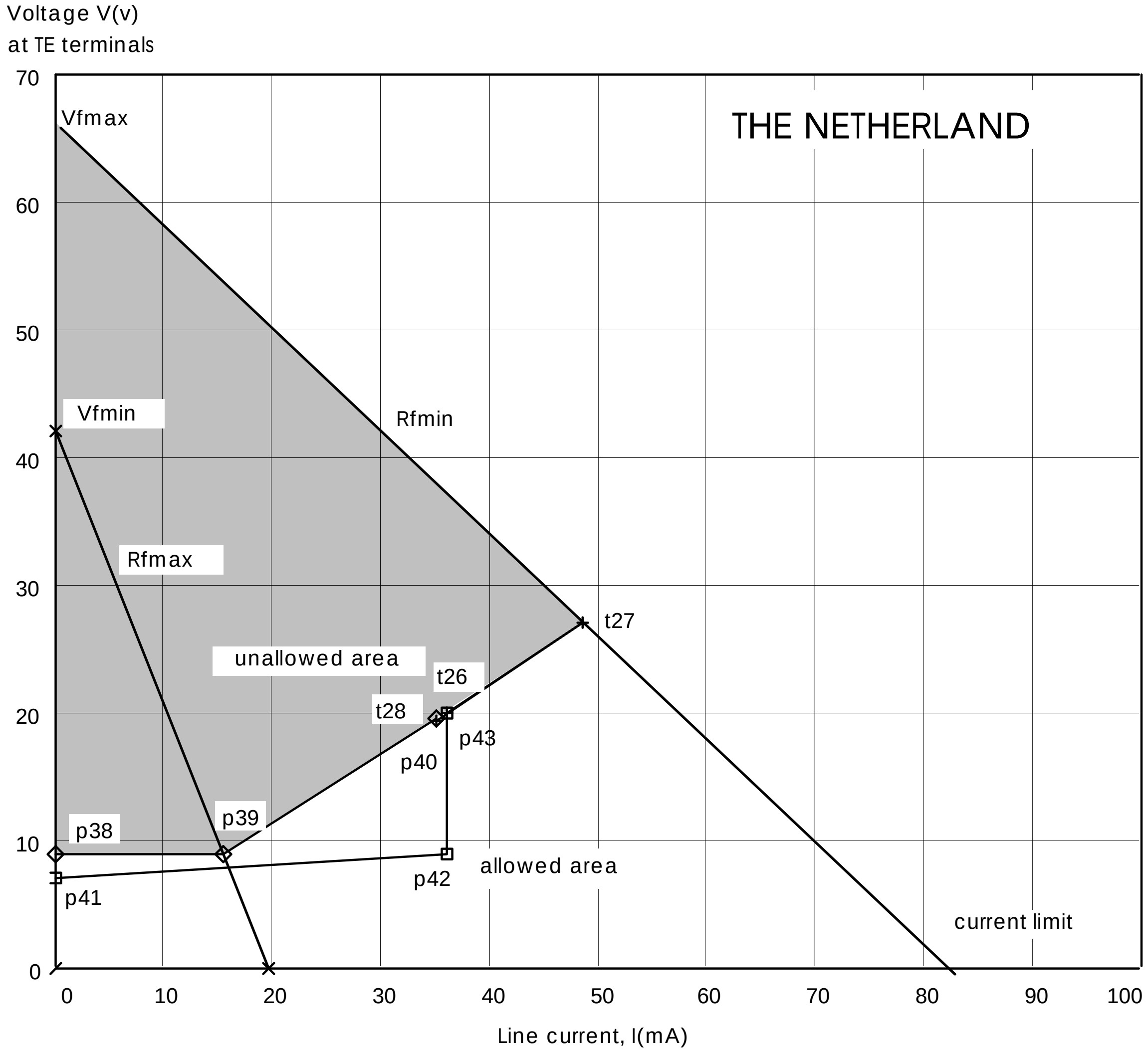


Figure A.22.13: DC current and loop resistance mask for the country THE NETHERLANDS

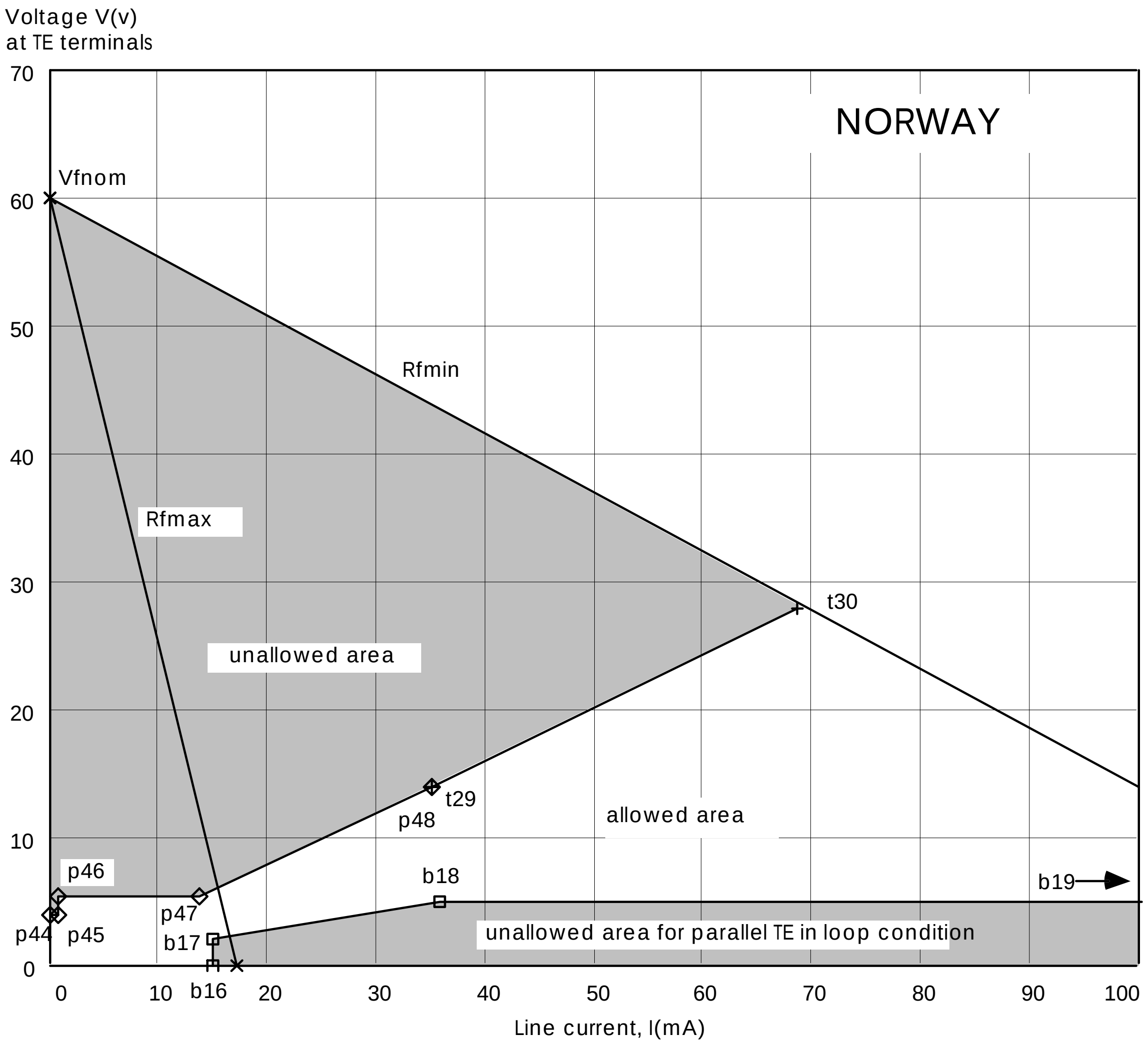


Figure A.22.14: DC current and loop resistance mask for the country NORWAY

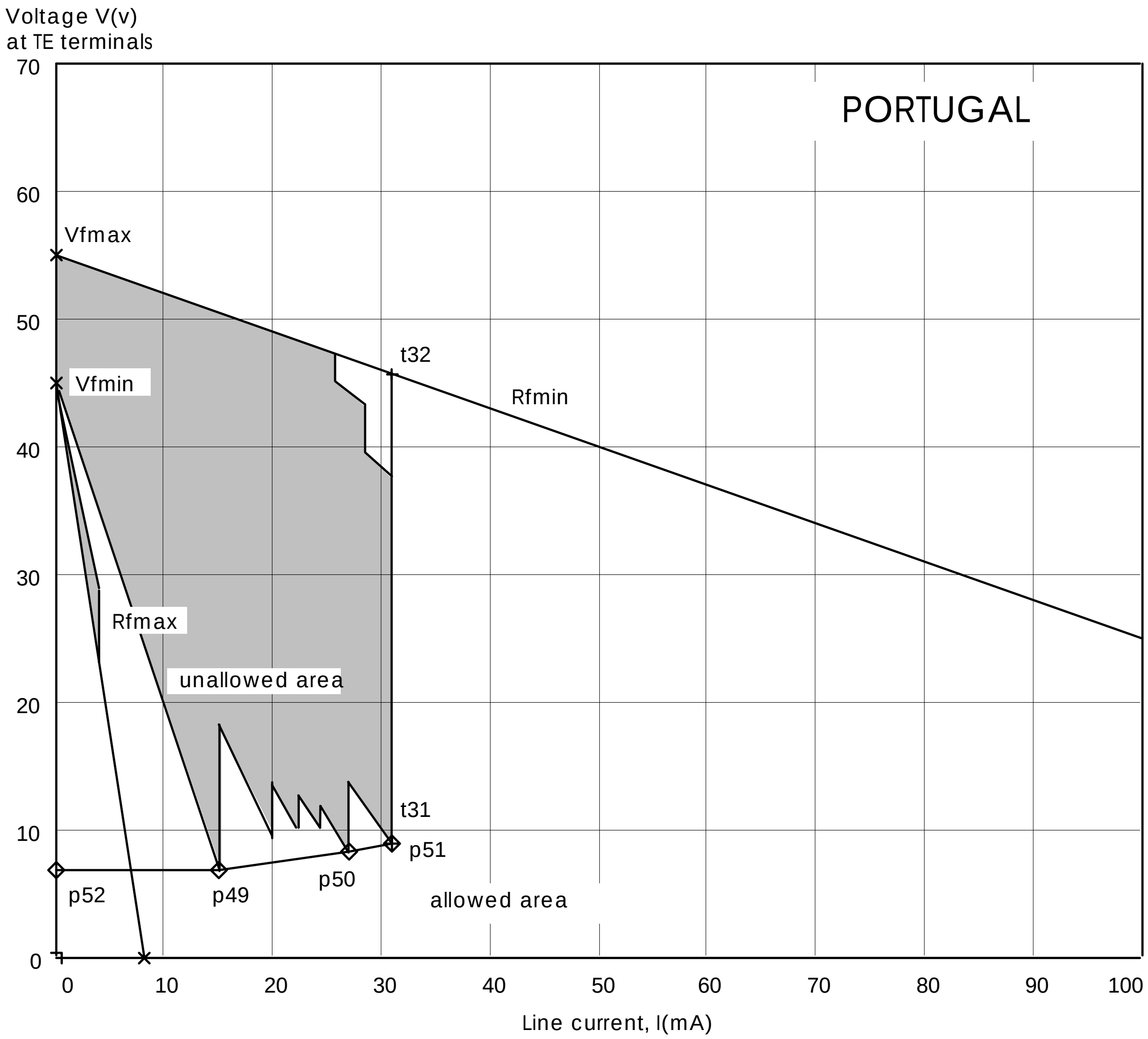


Figure A.22.15: DC current and loop resistance mask for the country PORTUGAL

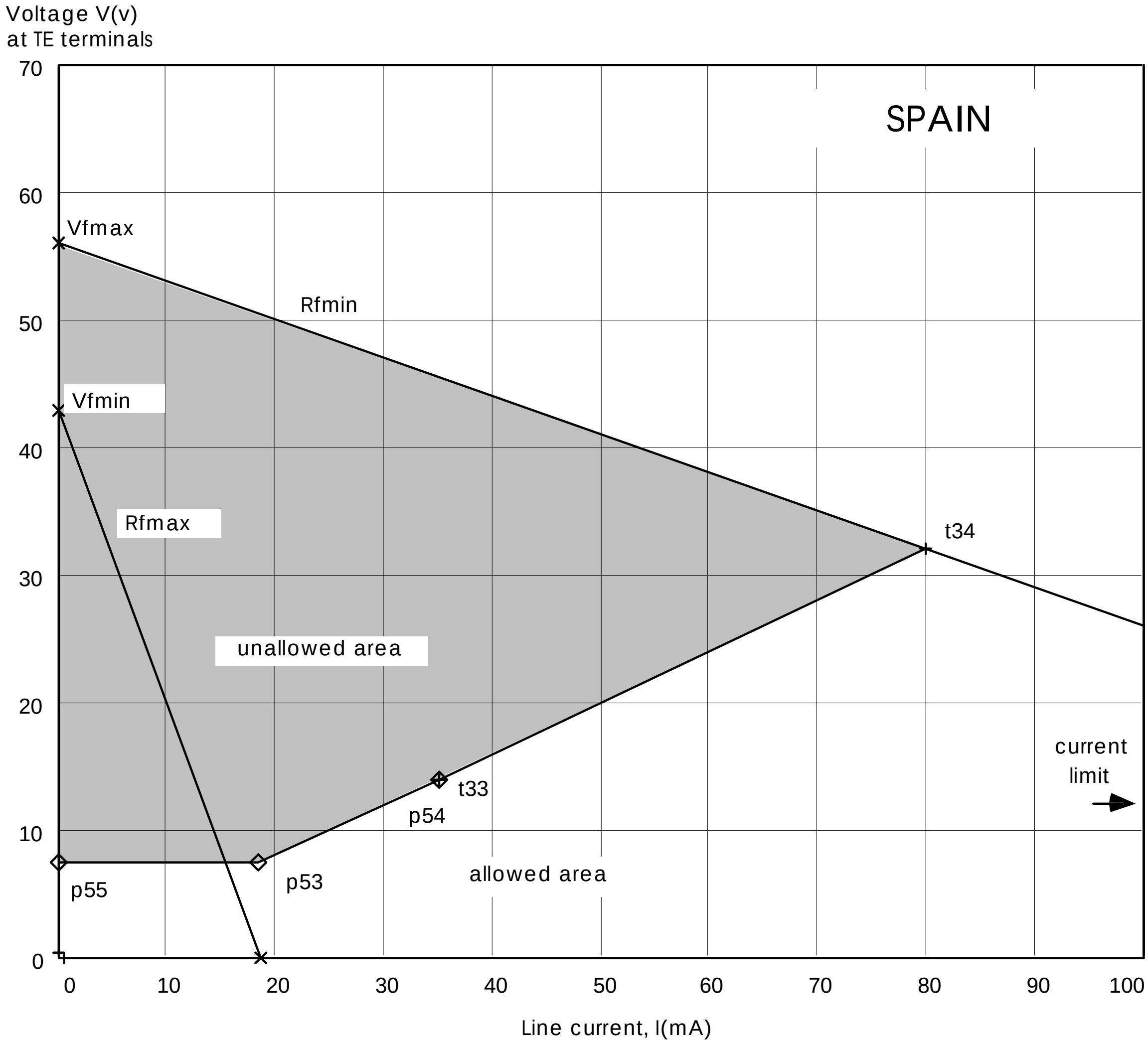


Figure A.22.16: DC current and loop resistance mask for the country SPAIN

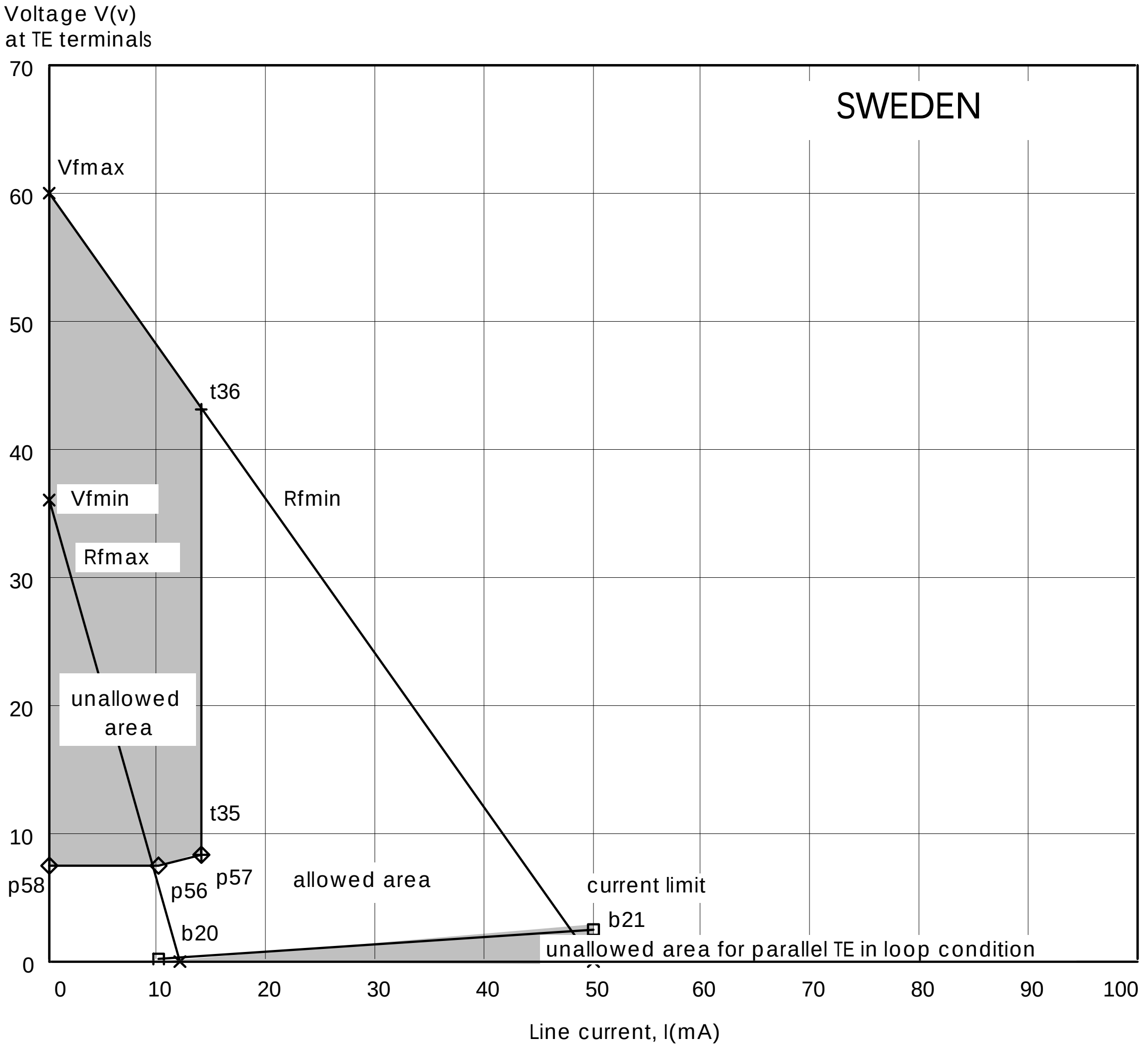


Figure A.22.17: DC current and loop resistance mask for the country SWEDEN

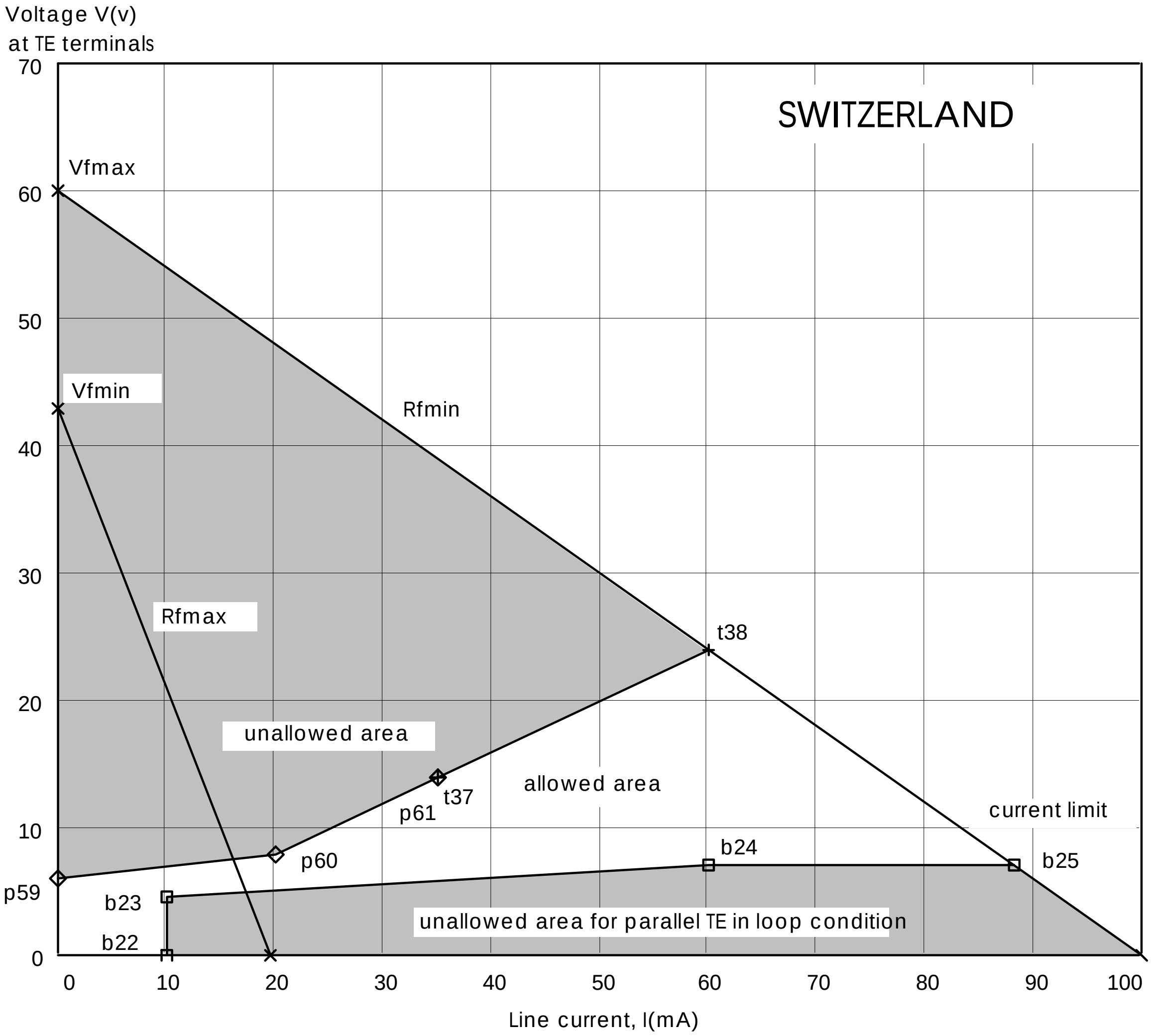


Figure A.22.18: DC current and loop resistance mask for the country SWITZERLAND

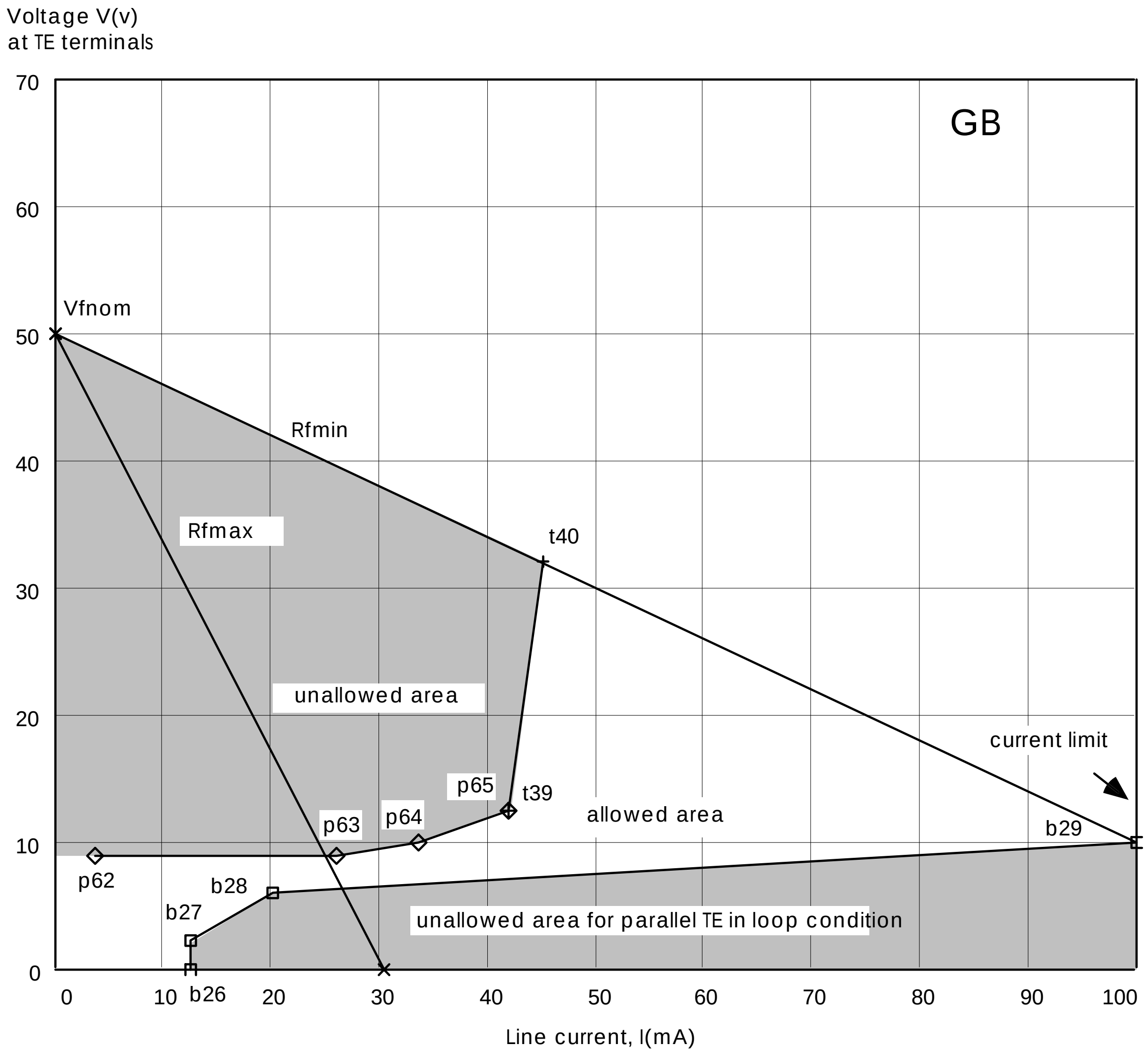


Figure A.22.19: DC current and loop resistance mask for the country GB

4.2 SECTION 2: Report on Input Impedance in the On-line condition (subclause 4.1.2)

Report on Input Impedance in the loop condition (subclause 4.1.2 of ETS 300 001)

4.2.1 Summary

This ETR compares, for the most part using a graphical representation, the various national requirements. A common area for terminal impedance does exist at some frequencies for all national impedances but this becomes progressively smaller, and hence more difficult to meet, as the frequency increases. At 1 000 Hz the area of common impedance is already small and by a frequency of 1 600 Hz it has disappeared altogether. For any acceptable compromise to be achieved, the echo and stability margins cannot be made worse than the limits given in CCITT Recommendation G 122 [3], but this first requires an alternative impedance against which to assess the PSTN performance. ETSI STC-BTC 2 has suggested an impedance (but no return loss figure) and TC-TE has suggested an alternative. It is now for the Network Operators to assess these two alternatives and determine which one provides the best prospects for the future.

4.2.2 Purpose of the requirement

This requirement has many implications:

1 As a result of international agreements designed to enable a minimum quality to be sustained, Network Operators are required to ensure their networks exhibit minimum levels of stability and echo performance (see CCITT Recommendation G.122 [3]). The introduction of a low loss digital network enhances this problem because, whilst in the past delay and echo were only a problem on international calls, the delay used to effect digital switching coupled with lower losses means that even national calls now need to be considered. The levels of echo and the stability of the network are, for practical purposes, determined by the range of impedances presented by TE. These impedances are, however, always a compromise and this implies that a change will not always make things worse; an alternative could, in some cases achieve the same, or better, results. Determining the extent to which any alternative impedance might affect the level of echo and the stability of the network including the ability to comply with the international recognised standards is something that the Network Operator alone has the data and resources to compute. It also has to be borne in mind that:

   a) such data is dynamic, that is the Network is always changing and evolving so that any data that a Network Operator might be prepared to divulge is unlikely to be of enduring value;

   b) it takes time to collect. Most of the major PSTNs in Europe have in excess of 10 million lines, or is a sample sufficient? A (small) sample may not be representative, i.e. it may not indicate the extremes and the nature of the distribution in between.

2. Assuming that parallel connection of TEs continues to be permitted, the on-line impedance presented by a TE needs, in part, to determine the tolerable range for the quiescent condition impedance. If the on-line impedance is high, then the impedance in the quiescent condition is substantially higher, otherwise the signal transmitted by the TE will be shunted or the output signal modified, by any other TEs that are in the quiescent condition. The effective collective shunt impedance of all the TEs connected to a single line can be represented by the minimum individual quiescent impedance/the number of terminals less one (this one is in the on-line condition). A high on-line impedances will force the impedance in the quiescent condition to be still higher if any serious "shunting" effect is.to be avoided. Assuming that a maximum of four terminals were permitted to be connected to one line and the highest value of on-line impedance was 1 400 Ω, in order to achieve a factor of 5 to 1 would require 7 000 Ω and that means each quiescent TE would need to exhibit a minimum of 21 000 Ω.

3 The reference impedance and its associated return loss give an indication of the range of impedances a TE should exhibit in order to inter-work correctly with the network. This will be particularly important when designing telephony terminals in order to achieve reasonable levels of Sidetone Masking Rating (STMR). Sidetone is very important in encouraging a user to speak at a level, or place the telephone such that appropriate levels are sent to line. If the sidetone is too low, the user will be encouraged to speak loudly or shout when the transmission path may be perfectly adequate. The result is that the distant end user has to hold the ear piece of the telephone away from their ear in order to listen comfortably. This in turn reduces the effect of their sidetone and

encourages them to talk more loudly. The result could be ear ache, but is almost certainly a less effective conversation than if the sidetone had been set correctly. In order to set the STMR, a designer needs to be aware of the range of impedances likely to be presented by the network, since he is setting the range of losses for the "trans-hybrid" in the telephone.

4 When considering alternative impedances, the areas that need to be considered will be those that fall outside the national requirement since these should be the only areas likely to prove a problem. Anything that falls inside might constitute an improvement but it certainly will be no worse.

4.2.3 Analysis

The documentation provided for the analysis, primarily consists of 46 pages of tables and graphs that illustrate the strategy for on-line impedance for the various countries contributing to ETS 300 001 [2].

4.2.3.1 National reference impedance

Within the context of this Part of the ETR, the reference impedance is considered to be the value of impedance determined at each of 17 frequencies, from the components specified by each nation.

The first is a graphical analysis of the values of the reference impedances at various frequencies, chosen to reflect where changes occur in the national value for return loss as well as the CCITT preferred range of frequencies. Due to an oversight the values were calculated at 650 Hz instead of 630 Hz. Since a change of 20 Hz was unlikely to have any significant impact on the analysis and most of the 45 sheets would need to be reprinted it was decided to leave things as they were and save paper.

The graph illustrates the disparity in the national approach. The angle of the reference impedance at 200 Hz for all countries falls within 0° (all 600 Ω nations) to 8,4° (GB) of the origin (0,0); angles that exceed 10° are generally considered to be inadvisable. At this frequency (200 Hz) the value of impedance for complex impedances varies between a value of R = 899,0 Xc = 30,5; for Sweden and R = 1 066,4 Xc = 142,1. The alternative impedance, provided by STC-BTC 2 extends this still further specifying an impedance of by R = 1 103,7 Xc = 132,8. If for no other reason than that given in Purpose of the Requirement (3), this impedance should be discouraged because it invites the on-line impedance to be higher with consequent problems for the quiescent impedance.

4.2.3.2 Impedance strategy

The values of impedance owe much to the development of Public Switched Telephony in Europe, since these have evolved primarily in isolation with a need to continue to support existing terminals and in some cases the particular difficulties of the terrain. This needs to be distinguished from the USA where, from its infancy, the Public Telephone Network evolved under the control of AT &T.

Originally, telephone networks were established using metallic paths, with manual switching and later electro-mechanical or mechanical switches in most cases. The vast majority of such networks contained cables between exchanges that had inductance (loading) added at regular intervals so as to flatten the frequency response in the speech-band. In some cases this was also extended to the local network to enable subscribers that were remote from the exchange to be served whilst maintaining an acceptable level of end-to-end loss. Such exchanges were transparent in terms of their ac impedance characteristics in the speech-band and terminal apparatus either saw the impedance of the cable or, on local calls, the distant end terminal apparatus (in both cases possibly modified by transformers). Telephones generally had a coil to achieve sidetone balance while non-voice terminals had largish transformers to cope with the substantial levels of line current. The result was that TE also tended to have a primarily inductive input impedance. With the advent of digital exchanges and digital transmission came the possibility for a reduction in the overall loss of connections. However the requirement remained to limit echo loss and stability margins (see CCITT Recommendation G.122 [3]) to the agreed limits. With lower losses this implied either fitting echo suppressors (or cancellors) (activated initially on all calls) or increasing the trans-hybrid loss in the exchange (see below for the effect of echoes on impedance). For national calls the latter was considered to be the preferred solution. Given the population of telephone apparatus that was connected to the exchanges already, this posed a problem, especially when considered together with the fact that on short lines the predominant impedance was that of the terminal whilst on longer lines it was that of the local cable (capacitive). A new exchange trans-hybrid balance could be designed which optimised the performance of new terminals having a capacitive balance, but the performance of older terminals might be less than optimum. In choosing a new balance, the Network Operator therefore has to carefully balance the opportunities for the future whilst not unduly affecting those from the past. This is exacerbated in countries where the supply of telephone equipment is liberalised in that the Network Operator can no longer recover old or obsolete TE and replace them with a modern variant that his network might prefer since the TE in many cases may not belong to him.

4.2.3.3 Effect of echoes on Impedance

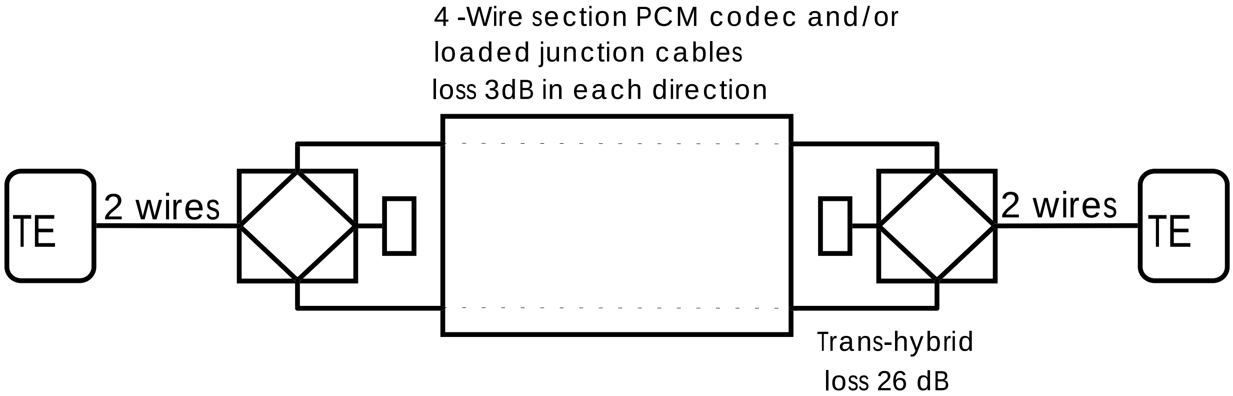


Figure B.1: Basic telecommunication interconnection for echo consideration

Initially, one might think that the introduction of digital transmission together with control of the input and balance impedances had cured impedance problems, since the codecs can offer known fixed impedances. However, this is not the case. Assume that 5 % of the signal (26 dB) leaks across the hybrid-transformer at each end of the circuit and the loss of the 4-wire circuit is 3 dB in each direction. Starting from the 2 W input to the hybrid the signal will typically lose 3 dB in transfer from the input to the 4-wire transmit, the loss of the circuit is 3 dB plus the trans-hybrid loss of 26 dB, the loss of the return circuit (3 dB) plus a further 3 dB for the 4 W receive path to the 2-wire input. This totals 38 dB in all. In order not to make things too complex, assume we consider only a single frequency and this signal when transmitted is delayed and returns attenuated (by 38 dB) but in phase with the transmitted signal. This for a given input voltage has increased the signal sent to line by 38 dB (1,3 %). This is equivalent to saying that the impedance at this point has decreased by 1,3 %. If we now consider the real world were many frequencies are being transmitted, the delays suffered by the signals are, for the most part, a function of frequency. Since the instant of transmission of information by a terminal is random, the possibility of transmiited signals and echoes being in phase is also random leading to the apparent impedance even at a single frequency varying, as a function of circuit loss. The change of impedance will have exacerbated this, in our case hopefully by only a very small amount, but imagine the results if the impedance had not been so tightly controlled. The trans-hybrid loss would certainly not be 26 dB, perhaps 12 dB might be obtained. So the overal loss is now 24 dB and the impedance varies by 24 dB or 6,3 % so the transhybrid loss will also vary.

4.2.3.4 National requirements

There really is no point in analysing individual contributions since harmonization is the objective. However, it is felt that there are some that deserve comment and this is the intention. The strategy was first to compare, for each frequency, those national complex reference impedances (and STC-BTC 2) that describe the extremes (DK, GR, N, BTC 2) with the value for the impedance proposed by TC-TE. Sweden could also be considered to be an extreme, if viewed in relation to their input to ETS 300 001 [2], but correspondance with them suggests that we should not take too much notice of their proposed complex impedance. For the most part these values are large (> 25 dB) indicating resonably close impedances.

The next process was to see how far it would be necessary to vary the return loss of the impedance proposed in order to encompass the fringe complex impedances since all other countries will be better than this. The complex impedance for Greece produces some problems (one extreme) as TC-TE are unsure of the technical basis for its choice since it does not seem to emulate local telephone cable or any other telephone based parameter that we can recall. Therefore it has been ignored in the following analysis.

It is clear that if one country decides that their requirement is for a return loss of 9 dB then the smallest return loss circle that can encompass this is 9 dB. In order to ensure that the results provided were easily comparable it was elected to choose 14 dB for all countries unless that country expessed a need for a tighter return loss. Six plots have been produced comparing the impedances proposed by BTC 2 and TC-TE against the complex national requirements for Denmark and Norway. The limit circles are as follows: continuous line national requirement, bold broken line reference impedance, broken line degraded reference impedance. The degraded reference was obtained by graphical methods i.e. reducing the return loss until it just encompassed the national requirement. The results can be summarised as follows: (see in annex B, figures B.6.1 to B.6.6)

- TC-TE w.r.t BTC 2 and BTC 2 w.r.t TC-TE requires 2,1 dB change at 300 Hz, 1,8 dB change at 1 000 Hz and 1,1 dB change at 3 150 Hz (see in annex B, figures B.6.5 and B.6.6).

- Denmark w.r.t. TC-TE requires 2,4 dB change at 300 Hz, 1 dB at 1 000 Hz and 4,3 dB at 3 150 Hz (see in annex B, figure B.6.4).

- Denmark w.r.t BTC 2 requires 3,8 dB change at 300 Hz, 2,4 dB at 1 000 Hz and 5,0 dB at 3 150 Hz (see in annex B, figure B.6.3).

- Norway w.r.t TC-TE requires 1,4 dB change at 300 Hz, 1,0 dB at 1 000 Hz and 4,3 dB at 3 150 Hz (see in annex B, figure B.6.2).

- Norway w.r.t BTC 2 requires 3,0 dB change at 300 Hz, 1,9 dB at 1 000 Hz and 3,8 dB at 3 150 Hz (see in annex B, figure B.6.1).

4.2.4 Conclusions

An impedance which is fairly close to the average of the national complex impedances such as the one proposed by TC-TE offers considerable prospects for harmonization. Any impedance which falls towards the edge of the national reference impedances is unlikely to be acceptable since, on the basis of the national declarations, this must offer, for any one frequency, worse values of return loss for those at the opposite extreme. Eventually, as with BTC 2, it seems that the only way to move things forward is to propose an alternative. The benefit of this is everyone can determine how the adoption of such a value will effect them and will provoke responses from anyone that is particularly adversely affected. Whilst, the value proposed need not be the final one, it has focused attention on the problem and from the responses received it should be possible to generate a truely European answer.

4.2.5 Effect on public exchange balance and input impedance.

This subject is outside the scope of, and therefore no requirements exist in, ETS 300 001 [2]. As a result it is probably also not appropriate to express an opinion. However, what can be done is to make some observations.

- Some values for the public exchange input impedance can be found in CCITT Recommendation Q 552 [4]. Not all the administrations provide details of both impedances, but of those that do 50 % do not the specify the terminal input and exchange input impedance to be the same.

- In an ideal world, the aim would be for all the impedances to be the same as the cable, for which the impedance proposed by BTC 2 seems a fairly close approximation. If, however, reference is made to the graph of input impedances specified for approval of apparatus to connect to the PSTN, all administrations specify an input impedance which has less capacitive reactance than the the one proposed by BTC 2 at low frequencies. Given the mix of impedances that each administration will need to address and the need to maintain stability and echo margins, it is unlikely that they will wish to be committed to having the exchange input impedance and the exchange balance impedance the same, and what ever value these take it is unlikely to be the terminal input impedance.

- It is important that any new exchange input impedance on the exchange input side does not differ so greatly from the existing values as to cause a major change in sidetone performance.

Annex B: Reference impedance in loop condition and country return-loss

B.1 Summary of the various impedance in the European countries

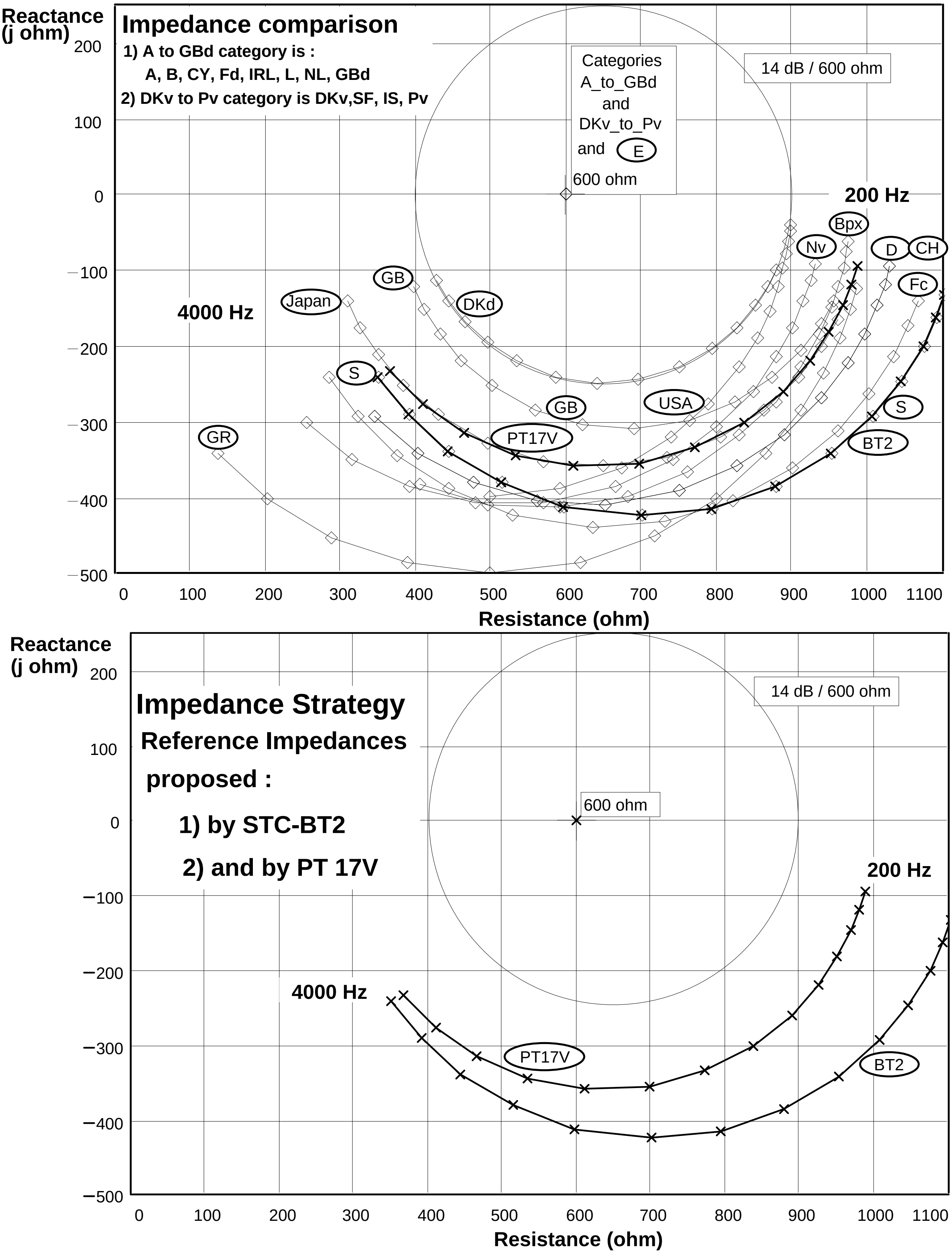
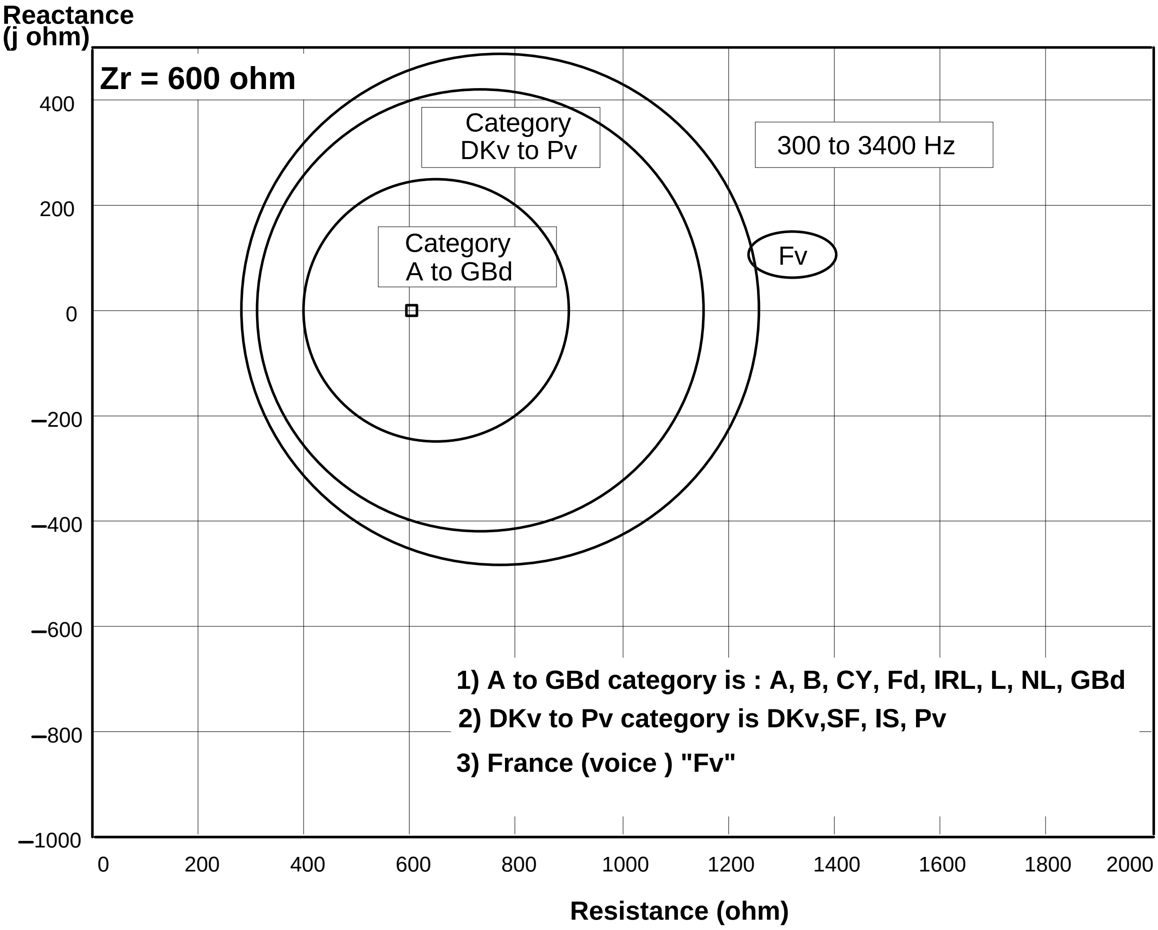


Figure B.2: Impedance strategy, ZBT2 and ZPT17V proposals compared to country impedances

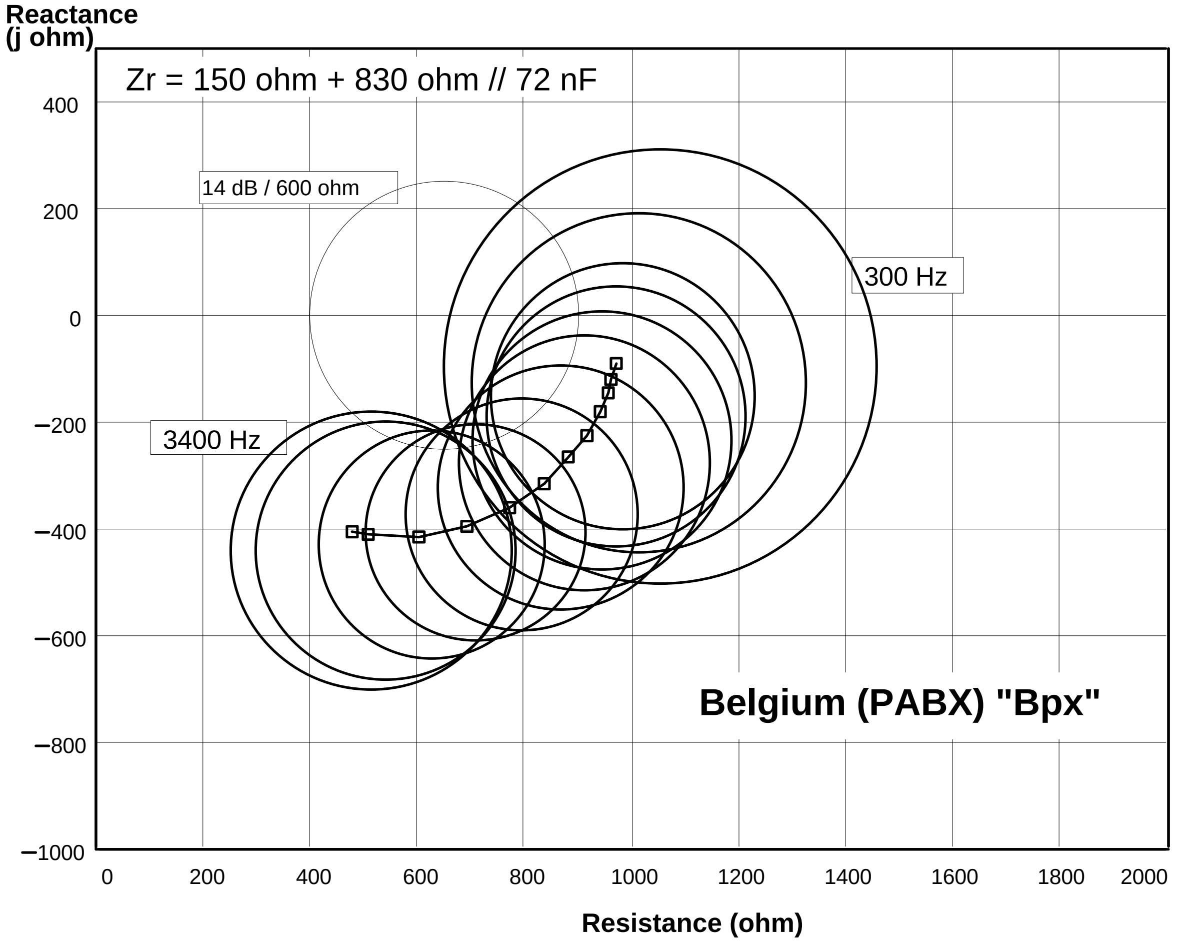
B.2 Reference impedance and return loss limits for the 19 countries by category



Values of the reference impedance and return loss limits for the country categories "A to GBd" and "DKv to Pv" and France voice "Fv":

Return_loss	Kd	Kr	Frequ	Real_imped	Imag_imped	p	Real_center	Imag_center	Radius
9	1.288	0.812	300	600	0	1	772.8	0	487.1
10	1.222	0.703	400	600	0	2	733.3	0	421.6
14	1.083	0.416	500	600	0	3	649.8	0	249.4

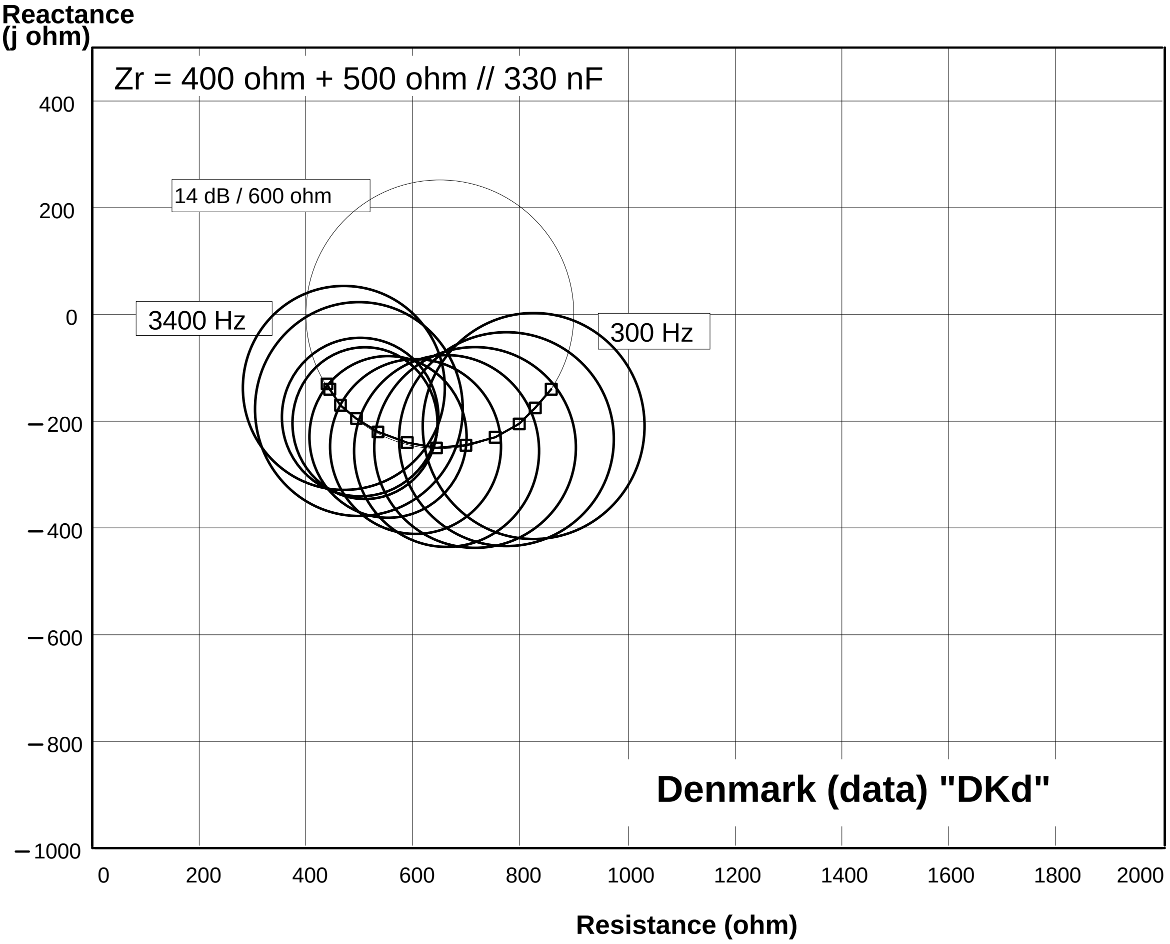
Figure B.3.1: Graph of the reference impedance and return-loss limits for country categories "A to GBd" and "DKv to Pv" and France voice "Fv"



Values of the reference impedance and return loss limits for Belgium PABX "Bpx":

Return_loss	Kd	Kr	Frequ	Real_imped	Imag_imped	p	Real_center	Imag_center	Radius
14	1.083	0.416	300	970.2	−89.8	1	1050.6	−97.3	404.9
16	1.052	0.325	400	962.7	−118.7	2	1012.3	−124.8	315.4
18	1.032	0.256	500	953.2	−146.6	3	983.9	−151.3	246.7
18	1.032	0.256	630	938.3	−181.3	4	968.5	−187.1	244.5
18	1.032	0.256	800	914.8	−223.3	5	944.2	−230.5	240.9
18	1.032	0.256	1000	882.4	−267.4	6	910.8	−276	235.9
18	1.032	0.256	1250	837	−313.5	7	863.9	−323.6	228.7
18	1.032	0.256	1600	768.9	−361.5	8	793.6	−373.1	217.4
18	1.032	0.256	2000	691.4	−395.3	9	713.7	−408	203.8
17	1.041	0.288	2500	602.8	−413.3	10	627.4	−430.1	210.7
15	1.065	0.367	3150	507.4	−411	11	540.5	−437.8	239.8
14	1.083	0.416	3400	476.7	−405.5	12	516.2	−439.1	260.1
dB			Hz	ohm	j ohm		ohm	j ohm	ohm

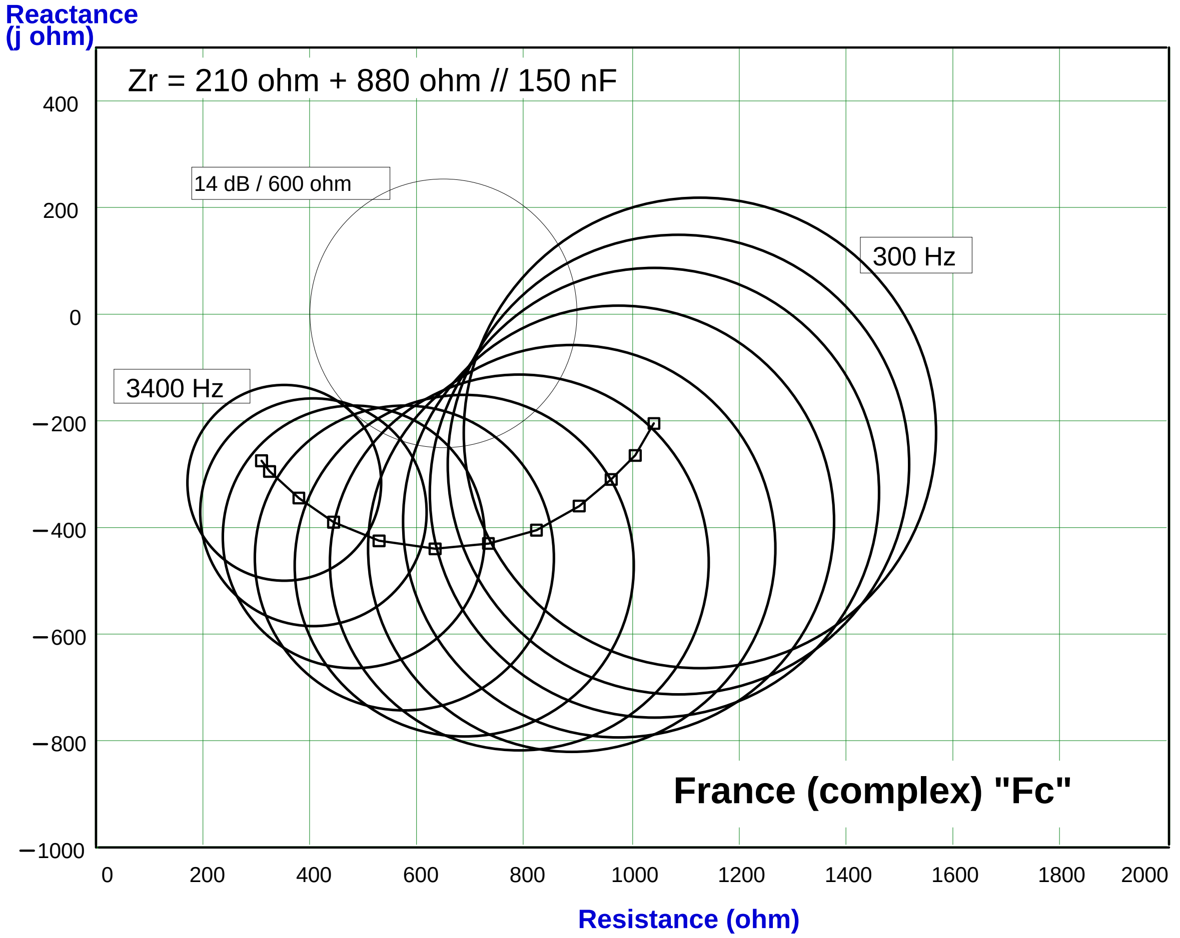
Figure B.3.2: Graph of the reference impedance and return-loss limits for Belgium PABX "Bpx"



Values of the reference impedance and return loss limits for Denmark data "DKd":

Return_loss	Kd	Kr	Frequ	Real_imped	Imag_imped	p	Real_center	Imag_center	Radius
			300	855.9	− 141.8	1			
			400	826.6	− 176.9	2			
18	1.032	0.256	500	794.1	− 204.3	3	819.7	− 210.9	209.8
18	1.032	0.256	630	750.5	− 228.9	4	774.7	− 236.3	200.7
18	1.032	0.256	800	696.2	− 245.7	5	718.7	− 253.6	188.9
18	1.032	0.256	1000	641	− 249.8	6	661.6	− 257.9	176
18	1.032	0.256	1250	586.6	− 241.8	7	605.5	− 249.6	162.3
18	1.032	0.256	1600	533.3	− 221.1	8	550.5	− 228.2	147.7
18	1.032	0.256	2000	494.4	− 195.6	9	510.3	− 201.9	136
18	1.032	0.256	2500	464.8	− 167.9	10	479.8	− 173.3	126.4
15	1.065	0.367	3150	442.9	− 140	11	471.8	− 149.1	170.6
14	1.083	0.416	3400	437.2	− 131.3	12	473.5	− 142.2	189.7
dB			Hz	ohm	j ohm		ohm	j ohm	ohm

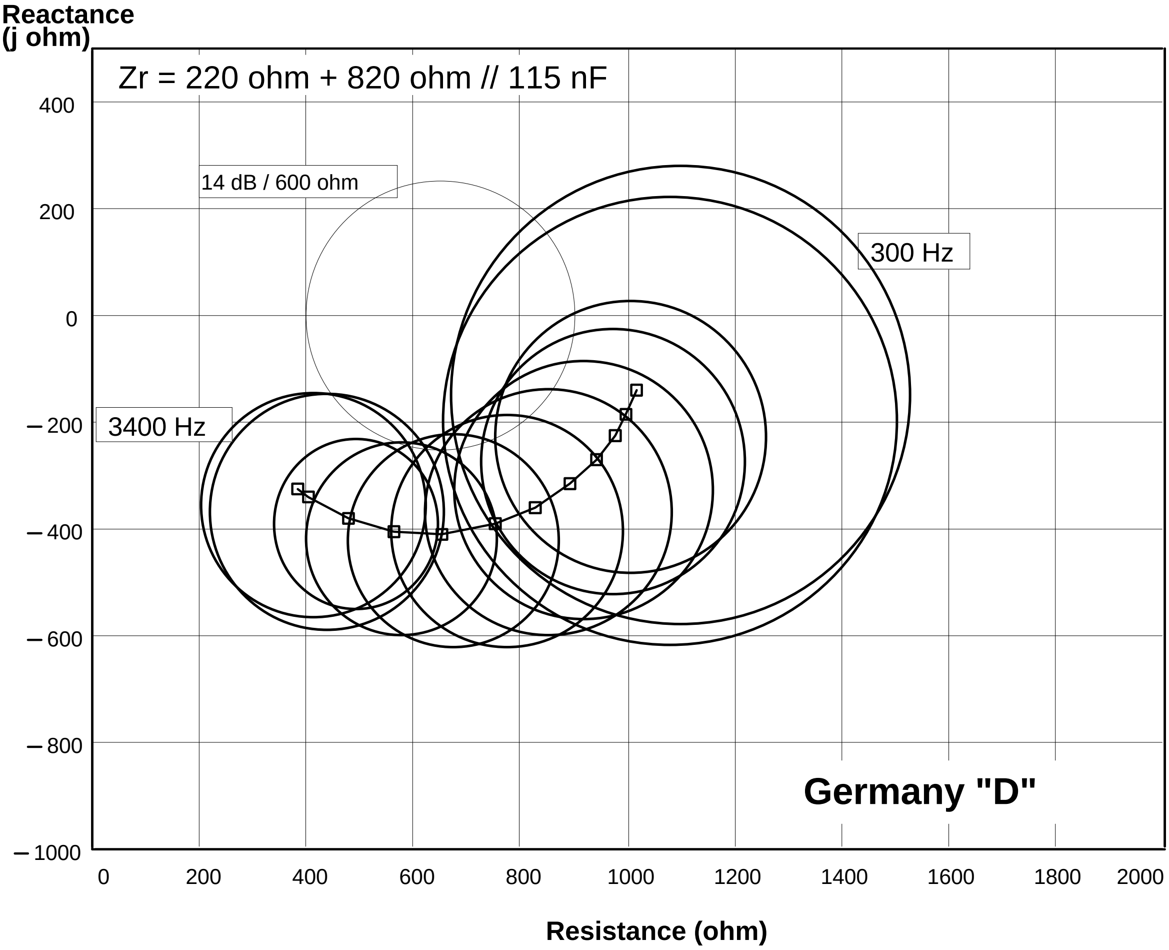
Figure B.3.3: Graph of the reference impedance and return-loss limits for Denmark data "DKd"



Values of the reference impedance and return loss limits for France complex "Fc":

Return_loss	Kd	Kr	Frequ	Real_imped	Imag_imped	p	Real_center	Imag_center	Radius
14	1.083	0.416	300	1038.7	− 206.2	1	1124.8	− 223.3	440.1
14	1.083	0.416	400	1002.8	− 263	2	1085.9	− 284.8	430.8
14	1.083	0.416	500	960.9	− 311.4	3	1040.6	− 337.2	419.8
14	1.083	0.416	630	901.3	− 361.2	4	976	− 391.1	403.5
14	1.083	0.416	800	821	− 405.4	5	889.1	− 439	380.5
14	1.083	0.416	1000	731.4	− 432.4	6	792	− 468.3	353.1
14	1.083	0.416	1250	634.1	− 439.7	7	686.7	− 476.2	320.7
14	1.083	0.416	1600	528.7	− 423	8	572.6	− 458	281.4
14	1.083	0.416	2000	444.6	− 389.1	9	481.4	− 421.4	245.5
14	1.083	0.416	2500	376.1	− 344.3	10	407.2	− 372.9	211.9
14	1.083	0.416	3150	322.5	− 293.8	11	349.2	− 318.2	181.3
14	1.083	0.416	3400	308.3	− 277.2	12	333.9	− 300.2	172.3
dB			Hz	ohm	j ohm		ohm	j ohm	ohm

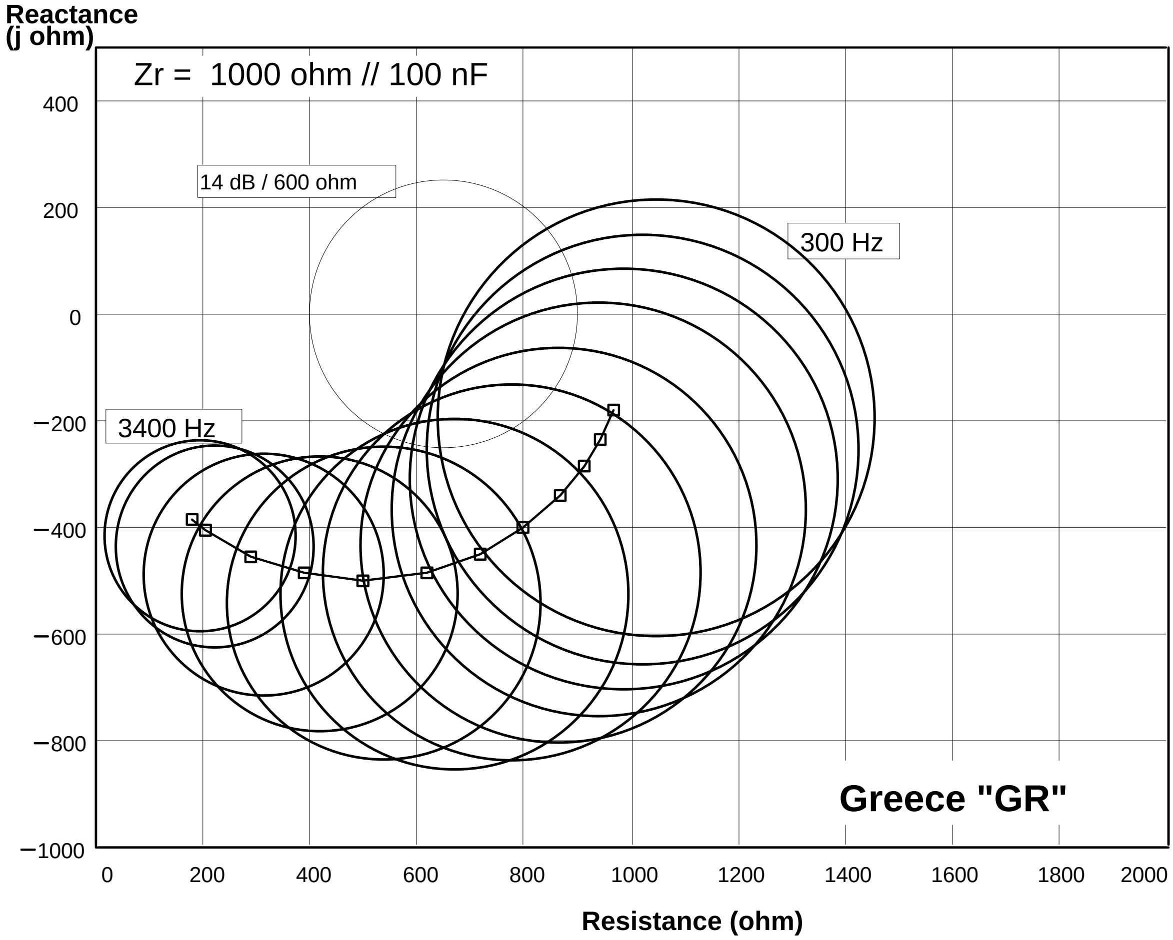
Figure B.3.4: Graph of the reference impedance and return-loss limits for France complex "Fc"



Values of the reference impedance and return loss limits for Germany "D":

Return_loss	Kd	Kr	Frequ	Real_imped	Imag_imped	p	Real_center	Imag_center	Radius
14	1.083	0.416	300	1014.9	− 141.3	1	1099	− 153	425.9
14	1.083	0.416	400	996.4	− 184	2	1079	− 199.3	421.1
18	1.032	0.256	500	973.8	− 223.3	3	1005.2	− 230.5	255.6
18	1.032	0.256	630	939.7	− 268.7	4	970	− 277.3	250
18	1.032	0.256	800	889.6	− 317.4	5	918.2	− 327.6	241.6
18	1.032	0.256	1000	826.9	− 359.6	6	853.6	− 371.2	230.7
18	1.032	0.256	1250	749.5	− 392.2	7	773.7	− 404.8	216.4
18	1.032	0.256	1600	651.9	− 409.4	8	672.9	− 422.6	196.9
18	1.032	0.256	2000	561.1	− 404.2	9	579.1	− 417.2	176.9
18	1.032	0.256	2500	476.7	− 380.3	10	492.1	− 392.5	156
14	1.083	0.416	3150	402.9	− 341.4	11	436.3	− 369.7	219.5
14	1.083	0.416	3400	382.1	− 326.6	12	413.8	− 353.7	208.9
dB			Hz	ohm	j ohm		ohm	j ohm	ohm

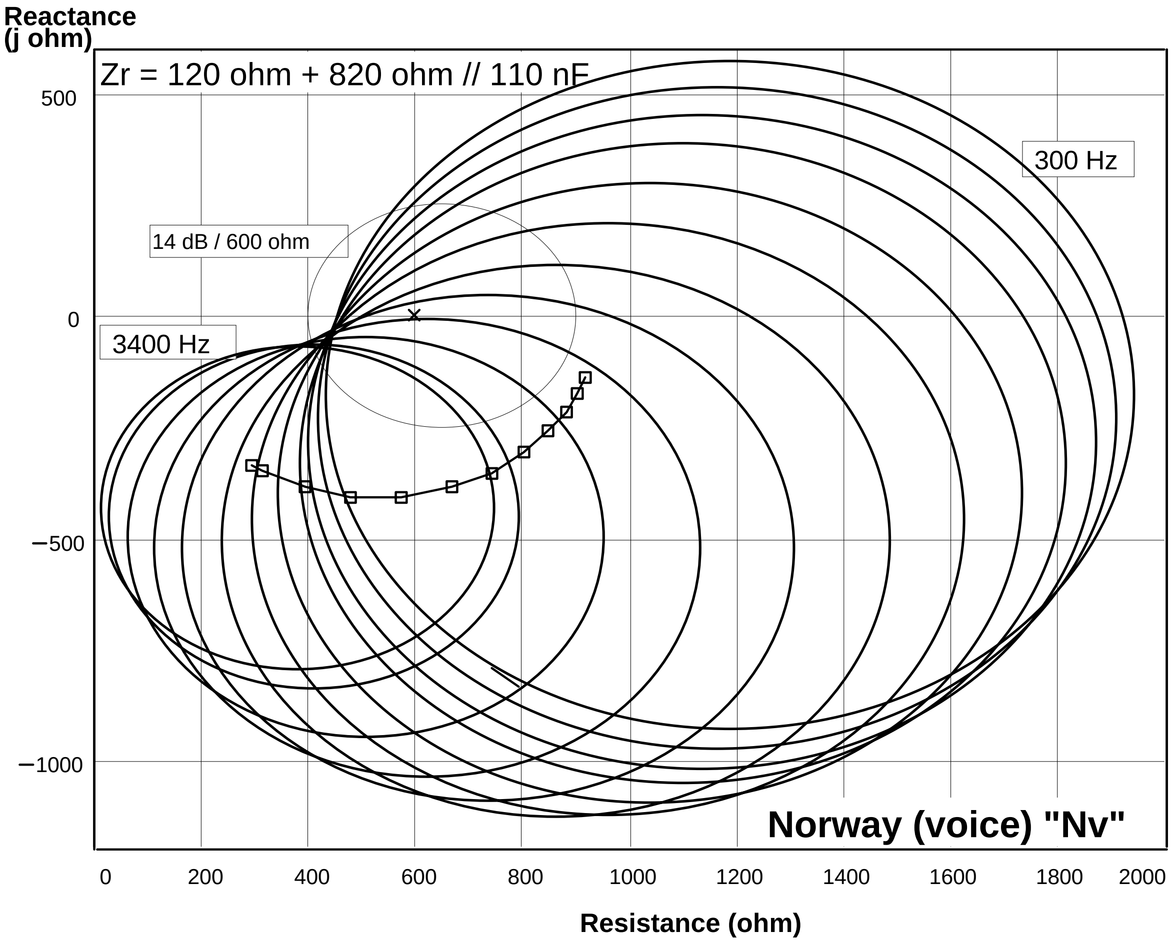
Figure B.3.5: Graph of the reference impedance and return-loss limits for Germany "D"



Values of the reference impedance and return loss limits for Greece "GR":

Return_loss	Kd	Kr	Frequ	Real_imped	Imag_imped	p	Real_center	Imag_center	Radius
14	1.083	0.416	300	965.7	− 182	1	1045.8	− 197.1	408.4
14	1.083	0.416	400	940.6	− 236.4	2	1018.6	− 256	403.1
14	1.083	0.416	500	910.2	− 285.9	3	985.6	− 309.6	396.5
14	1.083	0.416	630	864.5	− 342.2	4	936.2	− 370.6	386.4
14	1.083	0.416	800	798.3	− 401.3	5	864.5	− 434.5	371.3
14	1.083	0.416	1000	717	− 450.5	6	776.4	− 487.8	351.9
14	1.083	0.416	1250	618.5	− 485.8	7	669.8	− 526	326.8
14	1.083	0.416	1600	497.4	− 500	8	538.6	− 541.5	293.1
14	1.083	0.416	2000	387.7	− 487.2	9	419.9	− 527.6	258.8
14	1.083	0.416	2500	288.4	− 453	10	312.3	− 490.6	223.2
14	1.083	0.416	3150	203.4	− 402.5	11	220.2	− 435.9	187.4
14	1.083	0.416	3400	179.7	− 384	12	194.6	− 415.8	176.2
dB			Hz	ohm	j ohm		ohm	j ohm	ohm

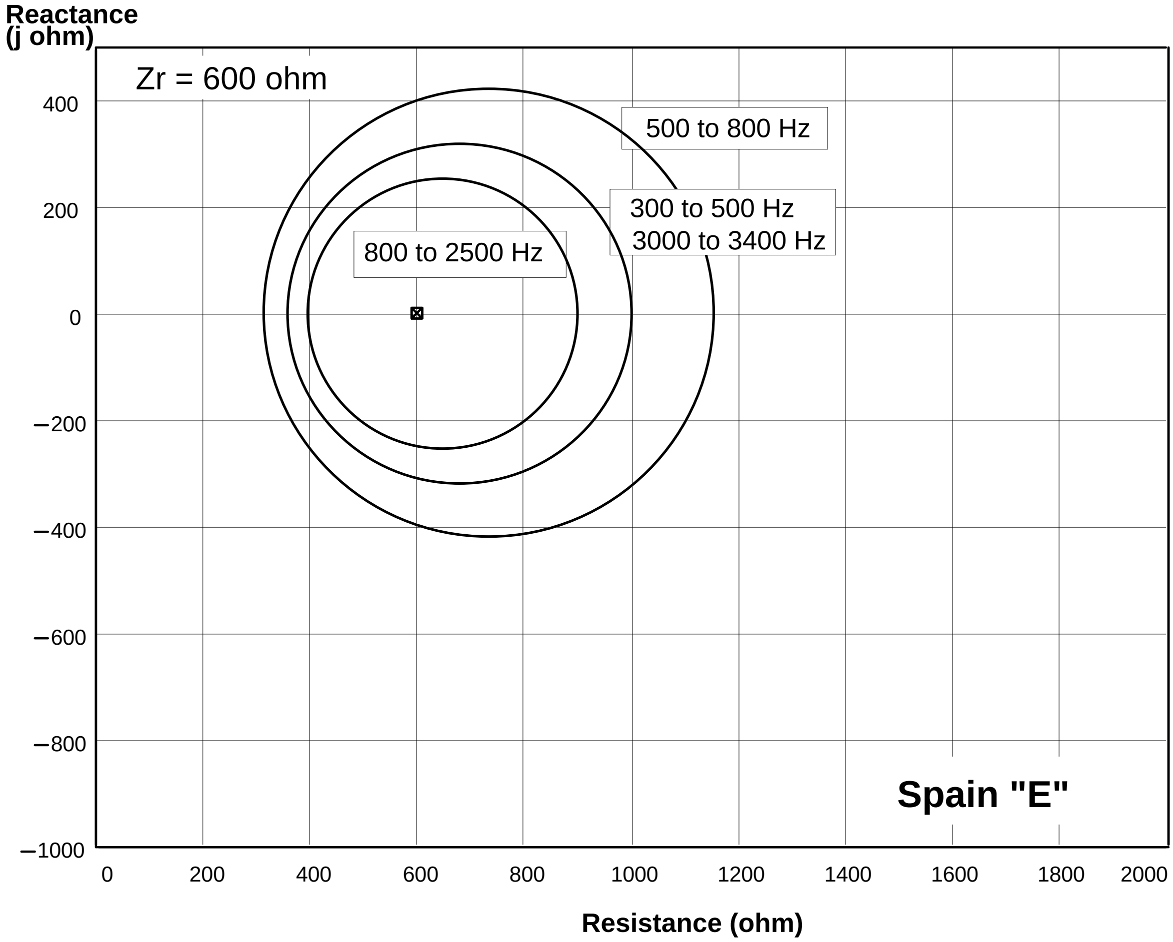
Figure B.3.6: Graph of the reference impedance and return-loss limits for Greece "GR"



Values of the reference impedance and return loss limits for Norway voice "Nv":

Return_loss	Kd	Kr	Frequ	Real_imped	Imag_imped	p	Real_center	Imag_center	Radius
9	1.288	0.812	300	917	− 135.5	1	1181.1	− 174.5	752.5
9	1.288	0.812	400	899.9	− 176.8	2	1159.1	− 227.7	744.5
9	1.288	0.812	500	879	− 215.1	3	1132.3	− 277.1	734.7
9	1.288	0.812	630	847.3	− 259.7	4	1091.3	− 334.5	719.4
9	1.288	0.812	800	800.2	− 308.4	5	1030.7	− 397.2	696.2
9	1.288	0.812	1000	740.6	− 351.7	6	954	− 453.1	665.6
9	1.288	0.812	1250	666	− 386.8	7	857.8	− 498.2	625.2
9	1.288	0.812	1600	570	− 408	8	734.2	− 525.6	569.1
9	1.288	0.812	2000	478.9	− 406.8	9	616.8	− 524	510.1
9	1.288	0.812	2500	392.7	− 386.3	10	505.8	− 497.6	447.2
9	1.288	0.812	3150	315.8	− 349.6	11	406.8	− 450.3	382.5
9	1.288	0.812	3400	294	− 335.3	12	378.7	− 431.8	362
dB			Hz	ohm	j ohm		ohm	j ohm	ohm

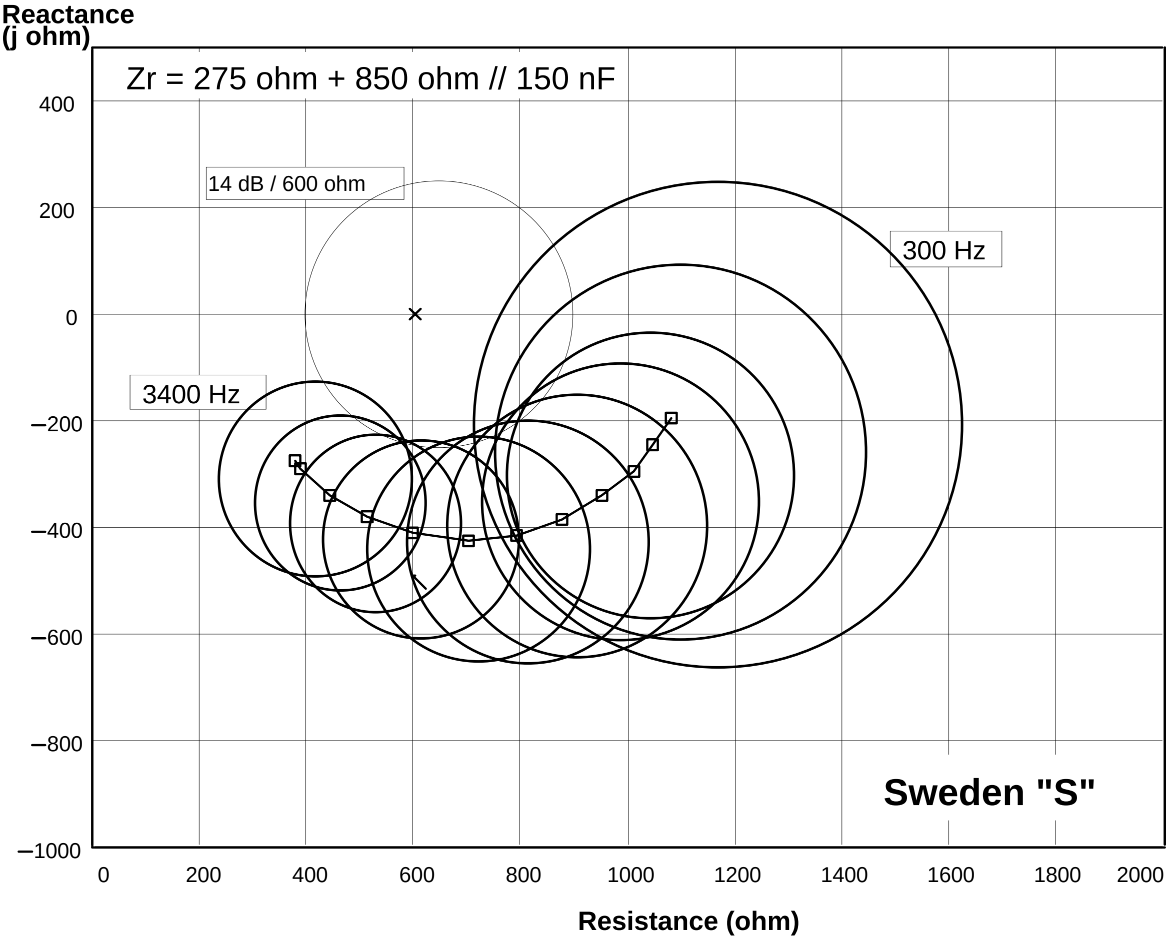
Figure B.3.7: Graph of the reference impedance and return-loss limits for Norway voice "Nv"



Values of the reference impedance and return loss limits for Spain "E":

Return_loss	Kd	Kr	Frequ	Real_imped	Imag_imped	p	Real_center	Imag_center	Radius
10	1.222	0.703	300	600	0	1	733.3	0	421.6
10	1.222	0.703	400	600	0	2	733.3	0	421.6
12	1.135	0.536	500	600	0	3	680.8	0	321.7
12	1.135	0.536	630	600	0	4	680.8	0	321.7
14	1.083	0.416	800	600	0	5	649.8	0	249.4
14	1.083	0.416	1000	600	0	6	649.8	0	249.4
14	1.083	0.416	1250	600	0	7	649.8	0	249.4
14	1.083	0.416	1600	600	0	8	649.8	0	249.4
14	1.083	0.416	2000	600	0	9	649.8	0	249.4
14	1.083	0.416	2500	600	0	10	649.8	0	249.4
10	1.222	0.703	3000	600	0	11	733.3	0	421.6
10	1.222	0.703	3400	600	0	12	733.3	0	421.6
dB			Hz	ohm	j ohm		ohm	j ohm	ohm

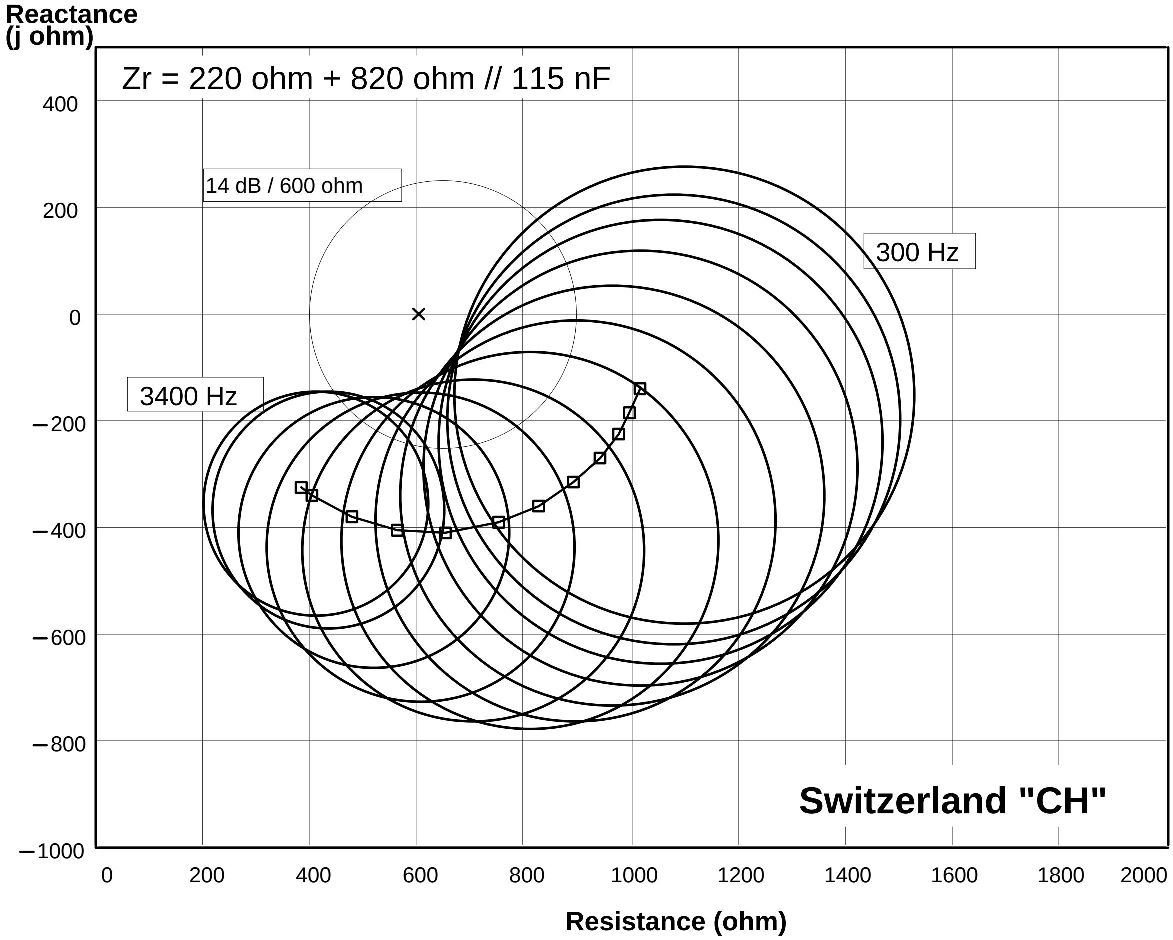
Figure B.3.8: Graph of the reference impedance and return-loss limits for Spain "E"



Values of the reference impedance and return loss limits for Sweden "S":

Return_loss	Kd	Kr	Frequ	Real_imped	Imag_imped	p	Real_center	Imag_center	Radius
14	1.083	0.416	300	1078.6	− 193.1	1	1168	− 209.1	455.4
16	1.052	0.325	400	1045.8	− 247	2	1099.7	− 259.7	349.4
18	1.032	0.256	500	1007.5	− 293.4	3	1039.9	− 302.8	268.5
18	1.032	0.256	630	952.4	− 341.9	4	983.1	− 352.9	258.9
18	1.032	0.256	800	877.5	− 386.1	5	905.8	− 398.6	245.3
18	1.032	0.256	1000	792.7	− 414.8	6	818.3	− 428.1	228.9
18	1.032	0.256	1250	699.4	− 425	7	721.9	− 438.7	209.4
18	1.032	0.256	1600	596.6	− 412.2	8	615.8	− 425.5	185.5
18	1.032	0.256	2000	513.3	− 381.8	9	529.8	− 394.1	163.7
17	1.041	0.288	2500	444.6	− 339.7	10	462.7	− 353.6	161.3
15	1.065	0.367	3150	390.4	− 291.1	11	415.9	− 310.1	178.8
14	1.083	0.416	3400	376	− 275	12	407.1	− 297.8	193.6
dB			Hz	ohm	j ohm		ohm	j ohm	ohm

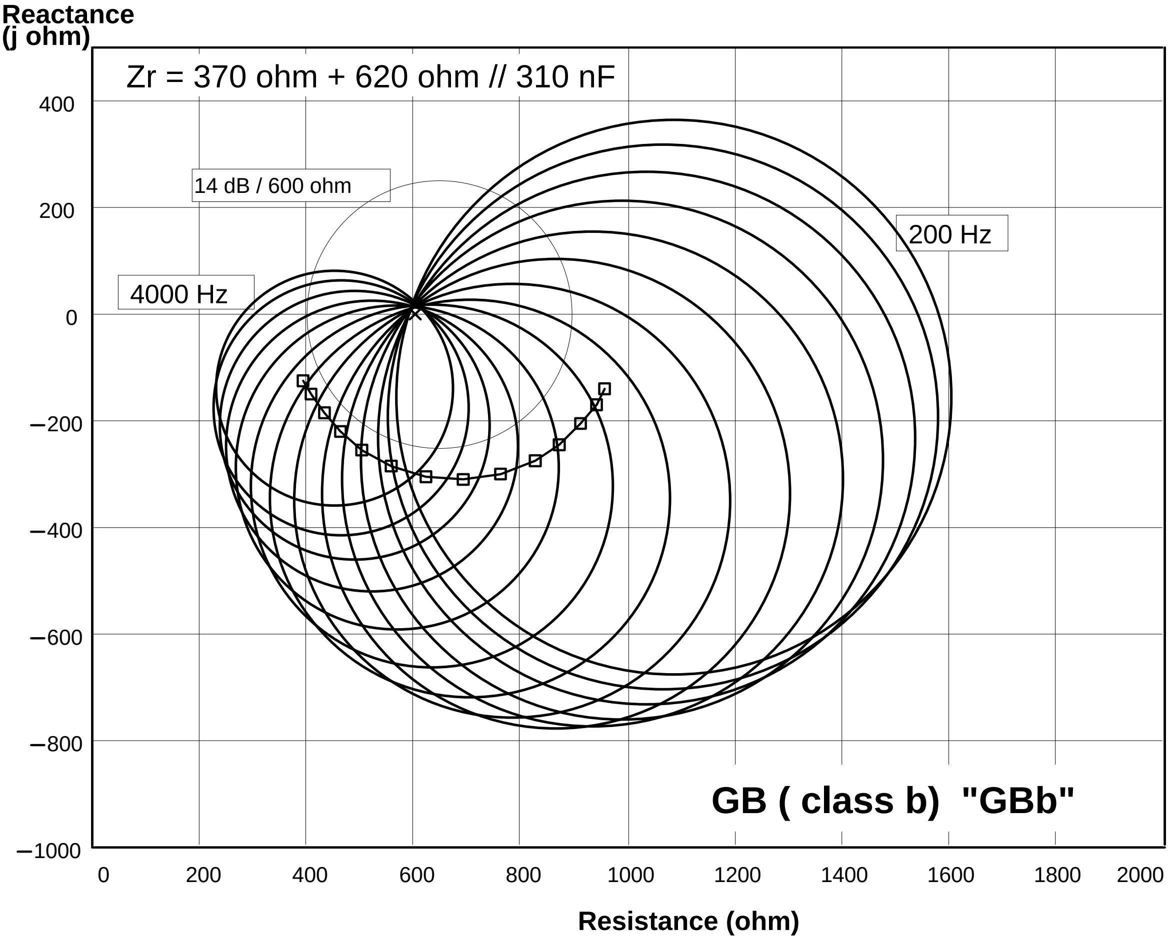
Figure B.3.9: Graph of the reference impedance and return-loss limits for Sweden "S"



Values of the reference impedance and return loss limits for Switzerland "CH":

Return_loss	Kd	Kr	Frequ	Real_imped	Imag_imped	p	Real_center	Imag_center	Radius
14	1.083	0.416	300	1014.9	− 141.3	1	1099	− 153	425.9
14	1.083	0.416	400	996.4	− 184	2	1079	− 199.3	421.1
14	1.083	0.416	500	973.8	− 223.3	3	1054.6	− 241.8	415.2
14	1.083	0.416	630	939.7	− 268.7	4	1017.6	− 290.9	406.2
14	1.083	0.416	800	889.6	− 317.4	5	963.3	− 343.7	392.5
14	1.083	0.416	1000	826.9	− 359.6	6	895.5	− 389.4	374.8
14	1.083	0.416	1250	749.5	− 392.2	7	811.7	− 424.7	351.6
14	1.083	0.416	1600	651.9	− 409.4	8	705.9	− 443.4	319.9
14	1.083	0.416	2000	561.1	− 404.2	9	607.6	− 437.7	287.4
14	1.083	0.416	2500	476.7	− 380.3	10	516.3	− 411.8	253.4
14	1.083	0.416	3150	402.9	− 341.4	11	436.3	− 369.7	219.5
14	1.083	0.416	3400	382.1	− 326.6	12	413.8	− 353.7	208.9
dB			Hz	ohm	j ohm		ohm	j ohm	ohm

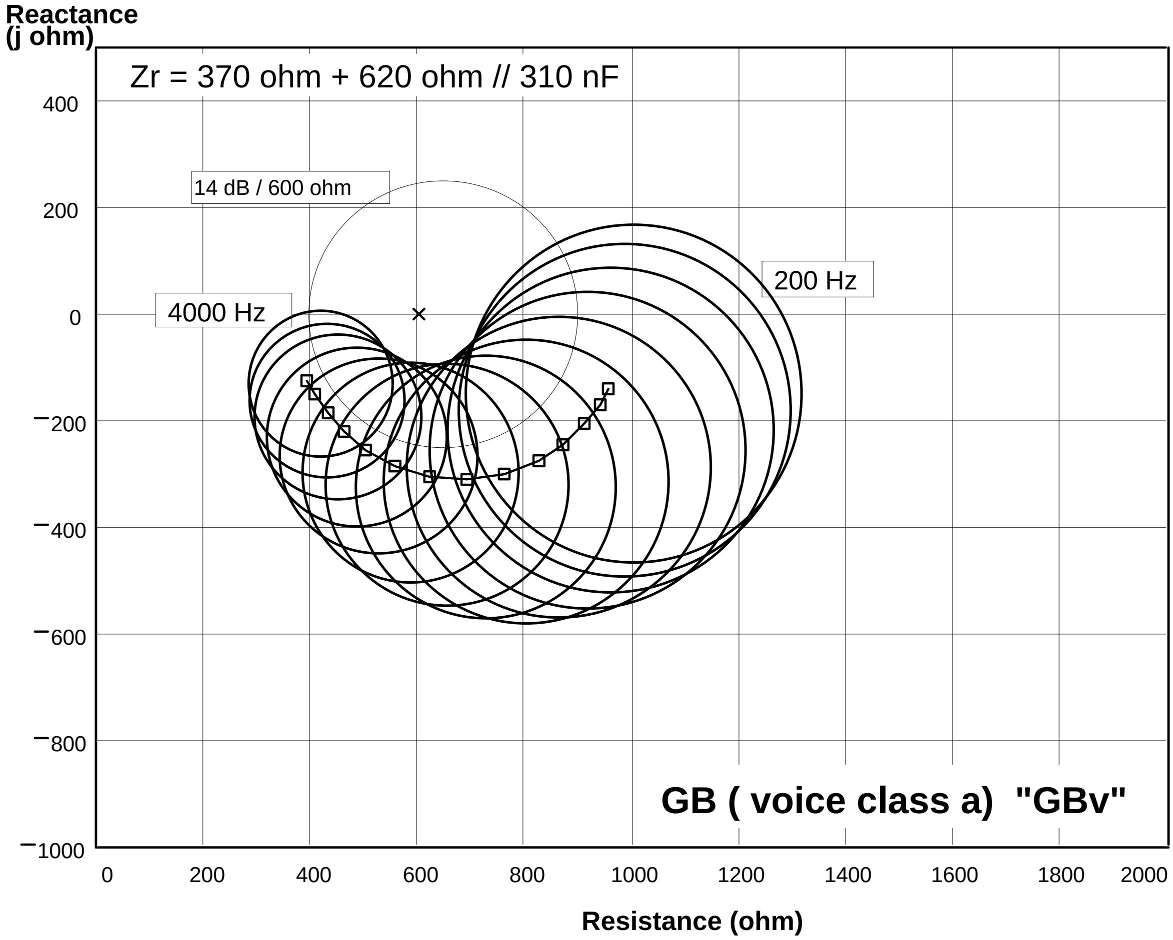
Figure B.3.10: Graph of the reference impedance and return-loss limits for Switzerland "CH"



Values of the reference impedance and return loss limits for Great Britain voice "GB(a)":

Return_loss	Kd	Kr	Frequ	Real_imped	Imag_imped	p	Real_center	Imag_center	Radius
12	1.135	0.536	200	955.8	−141.5	1	1084.6	−160.5	518.1
12	1.135	0.536	250	938.2	−171.5	2	1064.6	−194.7	511.4
12	1.135	0.536	315	911.6	−206	3	1034.4	−233.8	501.2
12	1.135	0.536	400	872.7	−242.8	4	990.2	−275.5	485.7
12	1.135	0.536	500	824.3	−274.3	5	935.4	−311.3	465.9
12	1.135	0.536	630	762.7	−298.8	6	865.4	−339	439.2
12	1.135	0.536	800	690.7	−309.8	7	783.7	−351.5	405.9
12	1.135	0.536	1000	622.2	−304.6	8	706	−345.6	371.5
12	1.135	0.536	1250	559.1	−285.5	9	634.4	−323.9	336.6
12	1.135	0.536	1600	501	−253.1	10	568.5	−287.2	301
12	1.135	0.536	2000	460.7	−219.1	11	522.8	−248.7	273.6
12	1.135	0.536	2500	431.3	−185.1	12	489.4	−210	251.7
12	1.135	0.536	3150	410.1	−152.4	13	465.3	−173	234.6
12	1.135	0.536	4000	395.5	−123.1	14	448.7	−139.7	222.1
dB			Hz	ohm	j ohm		ohm	j ohm	ohm

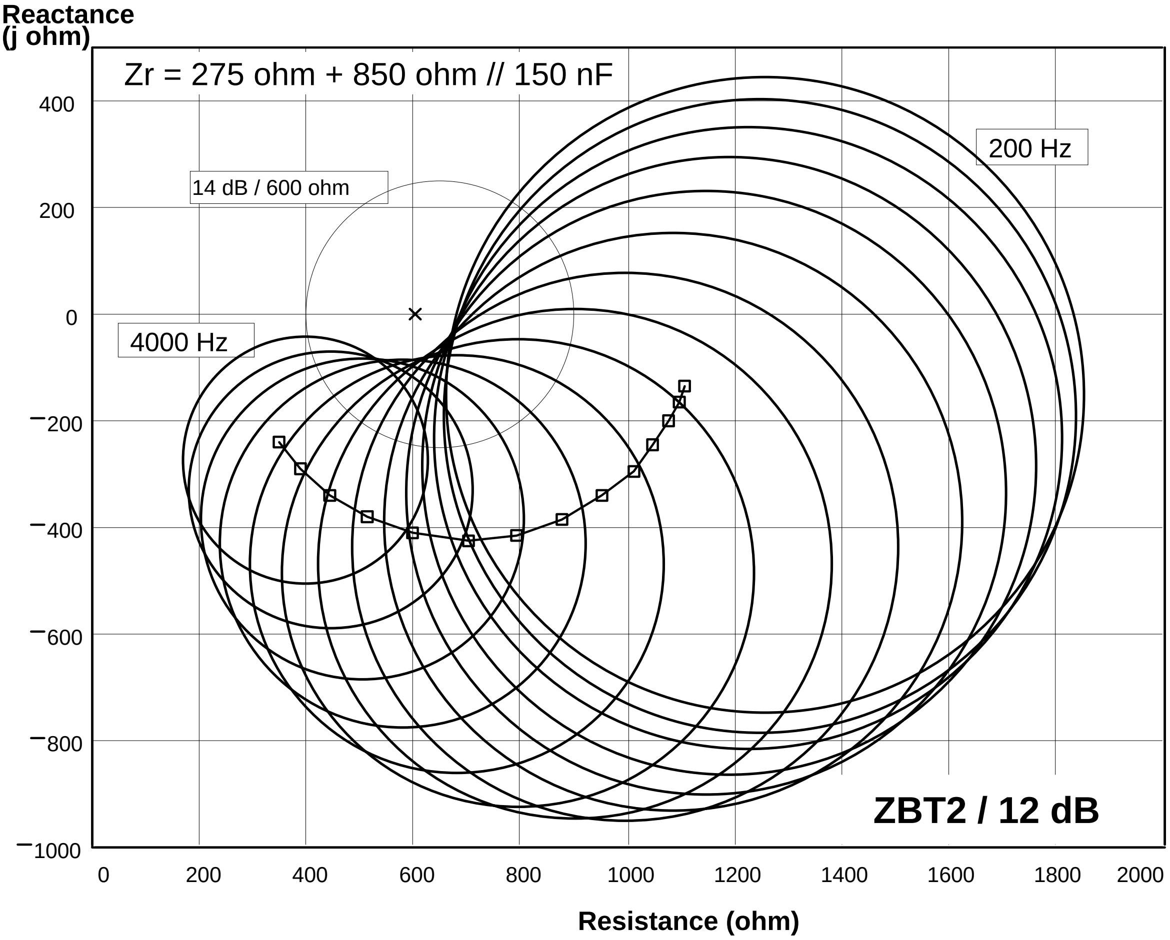
Figure B.3.11: Graph of the reference impedance and return-loss limits for Great Britain voice "GB(a)"



Values of the reference impedance and return loss limits for Great Britain voice "GBv":

Return_loss	Kd	Kr	Frequ	Real_imped	Imag_imped	p	Real_center	Imag_center	Radius
16	1.052	0.325	200	955.8	− 141.5	1	1005.1	− 148.8	314.2
16	1.052	0.325	250	938.2	− 171.5	2	986.6	− 180.4	310.1
16	1.052	0.325	315	911.6	− 206	3	958.6	− 216.7	303.9
16	1.052	0.325	400	872.7	− 242.8	4	917.7	− 255.3	294.5
16	1.052	0.325	500	824.3	− 274.3	5	866.8	− 288.5	282.5
16	1.052	0.325	630	762.7	− 298.8	6	802	− 314.2	266.3
16	1.052	0.325	800	690.7	− 309.8	7	726.3	− 325.8	246.1
16	1.052	0.325	1000	622.2	− 304.6	8	654.3	− 320.3	225.2
16	1.052	0.325	1250	559.1	− 285.5	9	587.9	− 300.2	204.1
16	1.052	0.325	1600	501	− 253.1	10	526.8	− 266.1	182.5
16	1.052	0.325	2000	460.7	− 219.1	11	484.5	− 230.4	165.9
16	1.052	0.325	2500	431.3	− 185.1	12	453.5	− 194.6	152.6
16	1.052	0.325	3150	410.1	− 152.4	13	431.2	− 160.3	142.3
16	1.052	0.325	4000	395.5	− 123.1	14	415.9	− 129.4	134.7
dB			Hz	ohm	j ohm		ohm	j ohm	ohm

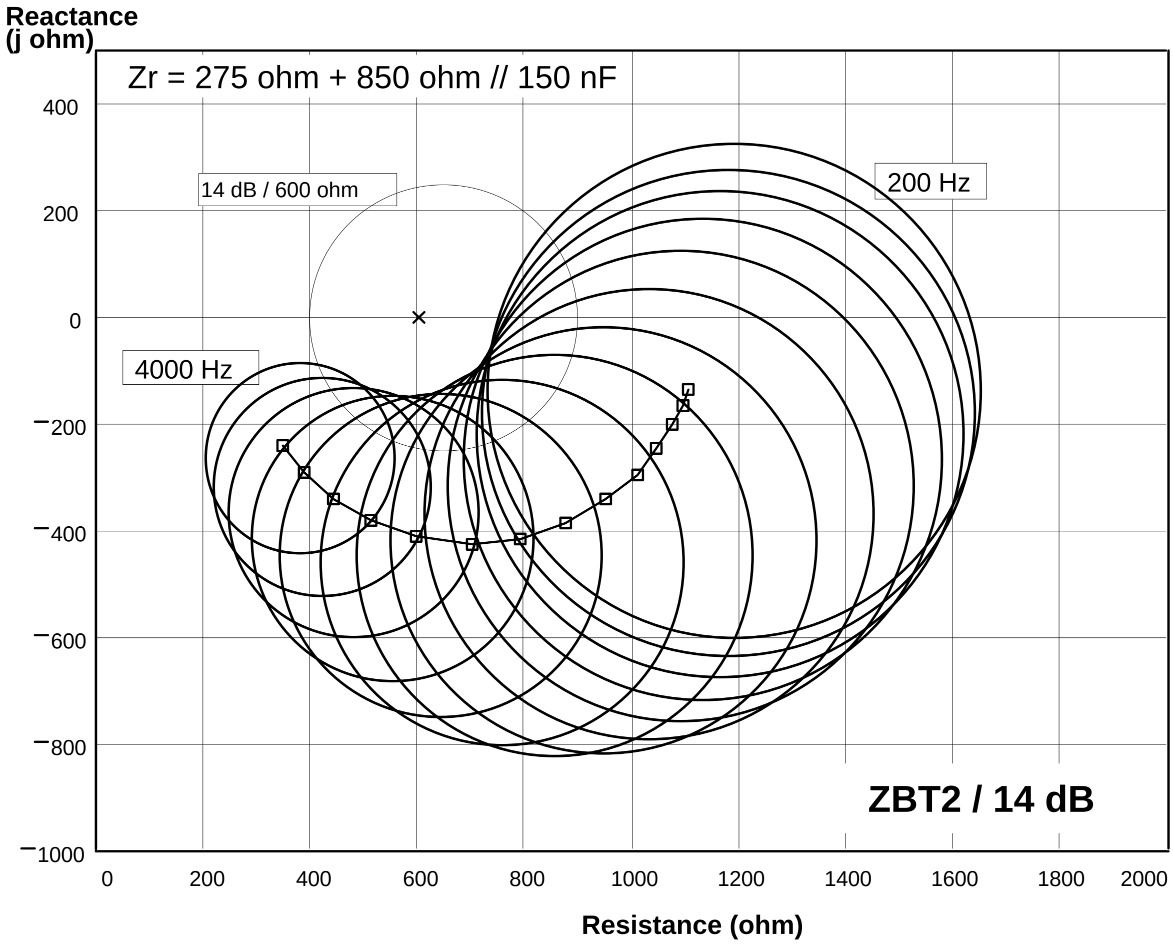
Figure B.3.12: Graph of the reference impedance and return-loss limits for Great Britain voice "GBv"



Values of the reference impedance and return loss limits for ZBT2 12dB:

Return_loss	Kd	Kr	Frequ	Real_imped	Imag_imped	p	Real_center	Imag_center	Radius
12	1.135	0.536	200	1103.7	− 132.8	1	1252.4	− 150.7	596.1
12	1.135	0.536	250	1092.2	− 163.7	2	1239.3	− 185.7	592.2
12	1.135	0.536	315	1074.1	− 201.7	3	1218.8	− 228.8	586
12	1.135	0.536	400	1045.8	− 247	4	1186.7	− 280.3	576.2
12	1.135	0.536	500	1007.5	− 293.4	5	1143.2	− 332.9	562.7
12	1.135	0.536	630	952.4	− 341.9	6	1080.7	− 388	542.6
12	1.135	0.536	800	877.5	− 386.1	7	995.7	− 438.2	514.1
12	1.135	0.536	1000	792.7	− 414.8	8	899.5	− 470.6	479.7
12	1.135	0.536	1250	699.4	− 425	9	793.6	− 482.2	438.8
12	1.135	0.536	1600	596.6	− 412.2	10	677	− 467.8	388.8
12	1.135	0.536	2000	513.3	− 381.8	11	582.4	− 433.2	343
12	1.135	0.536	2500	444.6	− 339.7	12	504.5	− 385.5	300
12	1.135	0.536	3150	390.4	− 291.1	13	442.9	− 330.3	261.1
12	1.135	0.536	4000	350.4	− 241.7	14	397.6	− 274.3	228.3
dB			Hz	ohm	j ohm		ohm	j ohm	ohm

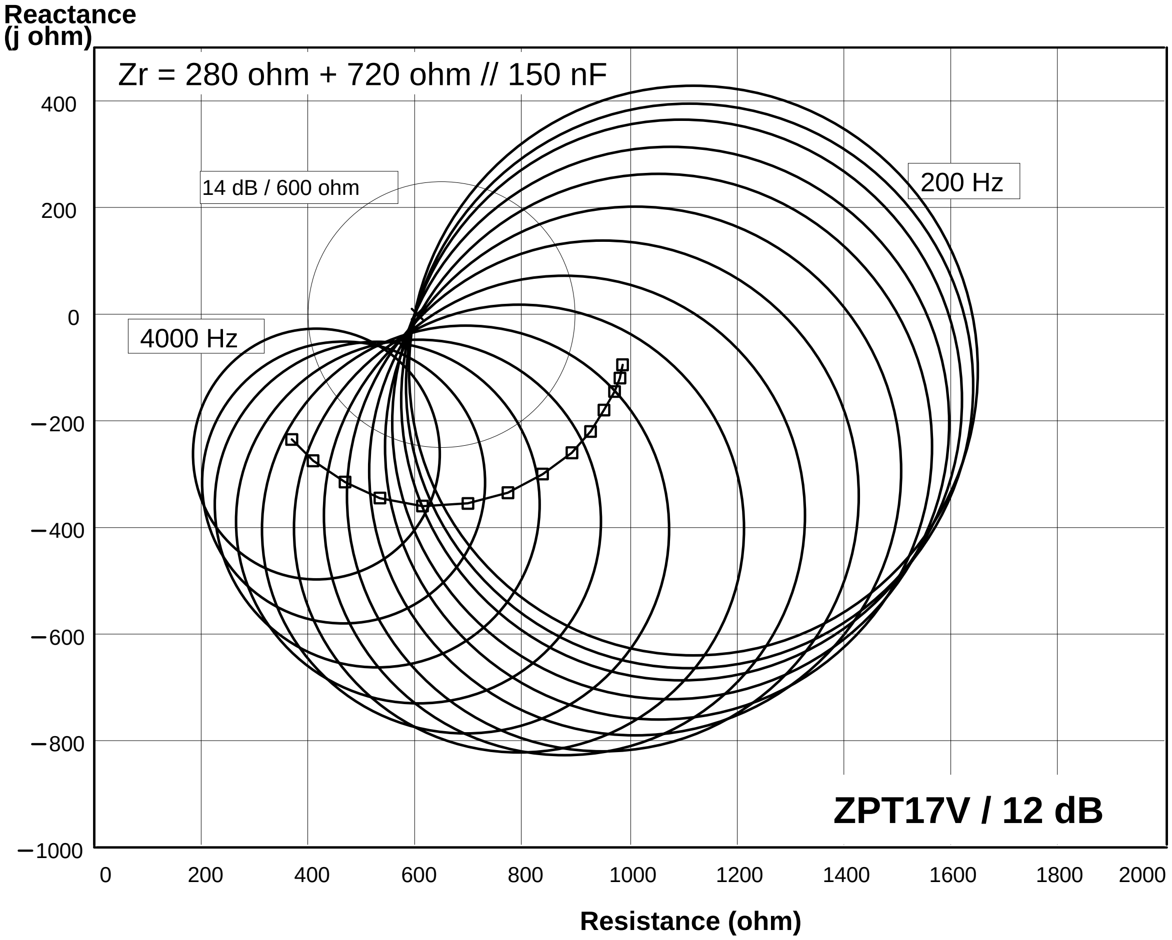
Figure B.3.13: Graph of the reference impedance and return-loss limits for ZBT2 12dB



Values of the reference impedance and return loss limits for ZBT2 14dB:

Return_loss	Kd	Kr	Frequ	Real_imped	Imag_imped	p	Real_center	Imag_center	Radius
14	1.083	0.416	200	1103.7	− 132.8	1	1195.2	− 143.8	462
14	1.083	0.416	250	1092.2	− 163.7	2	1182.8	− 177.2	459
14	1.083	0.416	315	1074.1	− 201.7	3	1163.2	− 218.4	454.2
14	1.083	0.416	400	1045.8	− 247	4	1132.6	− 267.5	446.6
14	1.083	0.416	500	1007.5	− 293.4	5	1091	− 317.7	436.1
14	1.083	0.416	630	952.4	− 341.9	6	1031.4	− 370.3	420.6
14	1.083	0.416	800	877.5	− 386.1	7	950.3	− 418.2	398.4
14	1.083	0.416	1000	792.7	− 414.8	8	858.5	− 449.2	371.8
14	1.083	0.416	1250	699.4	− 425	9	757.4	− 460.2	340.1
14	1.083	0.416	1600	596.6	− 412.2	10	646.1	− 446.4	301.4
14	1.083	0.416	2000	513.3	− 381.8	11	555.9	− 413.5	265.9
14	1.083	0.416	2500	444.6	− 339.7	12	481.5	− 367.9	232.5
14	1.083	0.416	3150	390.4	− 291.1	13	422.7	− 315.3	202.4
14	1.083	0.416	4000	350.4	− 241.7	14	379.5	− 261.8	176.9
dB			Hz	ohm	j ohm		ohm	j ohm	ohm

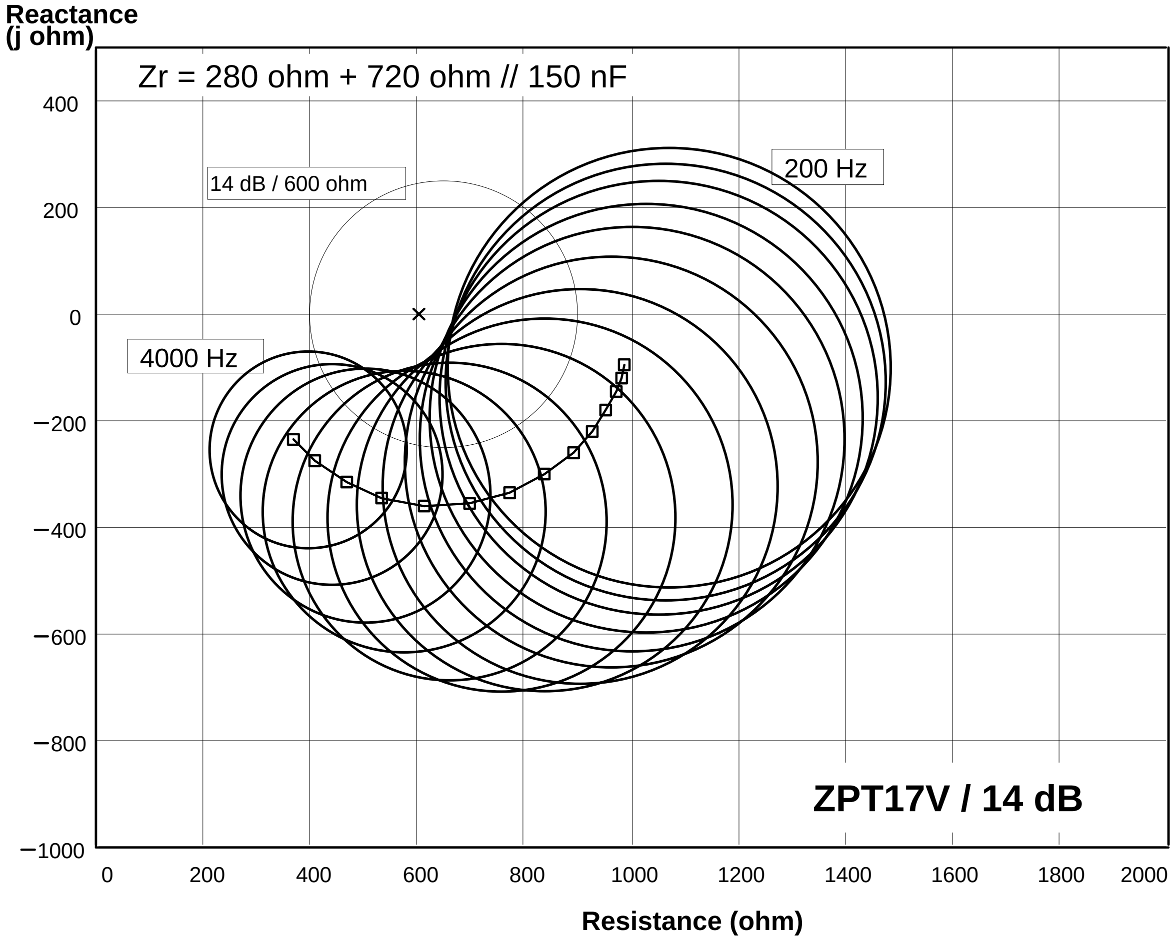
Figure B.3.14: Graph of the reference impedance and return-loss limits for ZBT2 14dB



Values of the reference impedance and return loss limits for ZPT17V 12dB:

Return_loss	Kd	Kr	Frequ	Real_imped	Imag_imped	p	Real_center	Imag_center	Radius
12	1.135	0.536	200	987	− 95.9	1	1119.9	− 108.9	531.7
12	1.135	0.536	250	979.9	− 118.7	2	1111.8	− 134.7	529.3
12	1.135	0.536	315	968.5	− 147.2	3	1099	− 167	525.3
12	1.135	0.536	400	950.6	− 182	4	1078.6	− 206.5	519
12	1.135	0.536	500	925.7	− 219.1	5	1050.3	− 248.6	510.1
12	1.135	0.536	630	888.7	− 260.2	6	1008.4	− 295.3	496.6
12	1.135	0.536	800	836.1	− 301.9	7	948.7	− 342.6	476.7
12	1.135	0.536	1000	773	− 334.5	8	877.1	− 379.6	451.6
12	1.135	0.536	1250	698.7	− 355.2	9	792.8	− 403	420.3
12	1.135	0.536	1600	610.5	− 358.8	10	692.7	− 407.1	379.7
12	1.135	0.536	2000	533.4	− 343.8	11	605.2	− 390.2	340.3
12	1.135	0.536	2500	465.7	− 315	12	528.4	− 357.4	301.4
12	1.135	0.536	3150	409.3	− 276.4	13	464.4	− 313.6	264.8
12	1.135	0.536	4000	366	− 233.6	14	415.3	− 265	232.8
dB			Hz	ohm	j ohm		ohm	j ohm	ohm

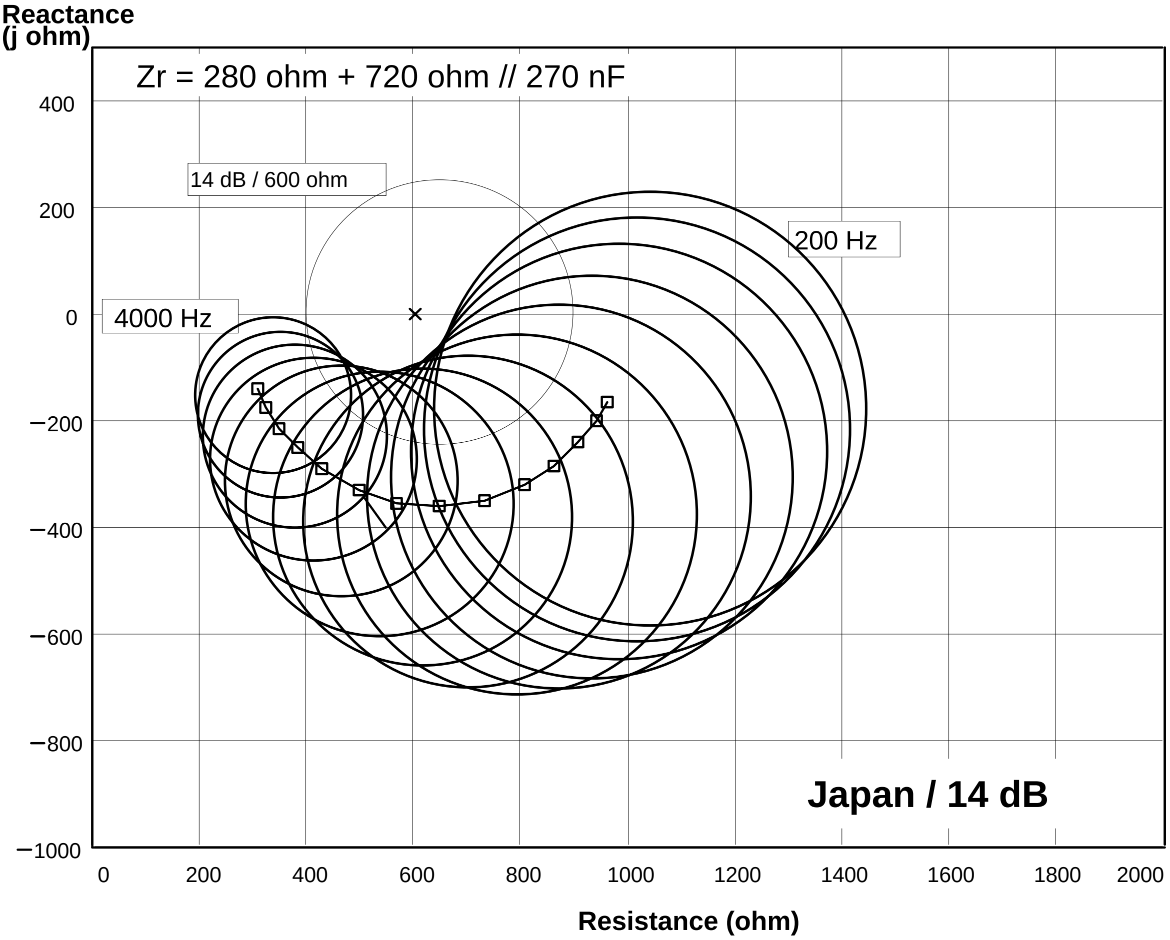
Figure B.3.15: Graph of the reference impedance and return-loss limits for ZPT17V 12dB



Values of the reference impedance and return loss limits for ZPT17V 14dB:

Return_loss	Kd	Kr	Frequ	Real_imped	Imag_imped	p	Real_center	Imag_center	Radius
14	1.083	0.416	200	987	− 95.9	1	1068.8	− 103.9	412.1
14	1.083	0.416	250	979.9	− 118.7	2	1061.1	− 128.6	410.2
14	1.083	0.416	315	968.5	− 147.2	3	1048.9	− 159.4	407.1
14	1.083	0.416	400	950.6	− 182	4	1029.4	− 197.1	402.2
14	1.083	0.416	500	925.7	− 219.1	5	1002.4	− 237.2	395.3
14	1.083	0.416	630	888.7	− 260.2	6	962.4	− 281.8	384.9
14	1.083	0.416	800	836.1	− 301.9	7	905.4	− 326.9	369.4
14	1.083	0.416	1000	773	− 334.5	8	837.1	− 362.3	350
14	1.083	0.416	1250	698.7	− 355.2	9	756.7	− 384.6	325.8
14	1.083	0.416	1600	610.5	− 358.8	10	661.1	− 388.5	294.3
14	1.083	0.416	2000	533.4	− 343.8	11	577.6	− 372.4	263.7
14	1.083	0.416	2500	465.7	− 315	12	504.3	− 341.1	233.6
14	1.083	0.416	3150	409.3	− 276.4	13	443.2	− 299.3	205.2
14	1.083	0.416	4000	366	− 233.6	14	396.4	− 252.9	180.5
dB			Hz	ohm	j ohm		ohm	j ohm	ohm

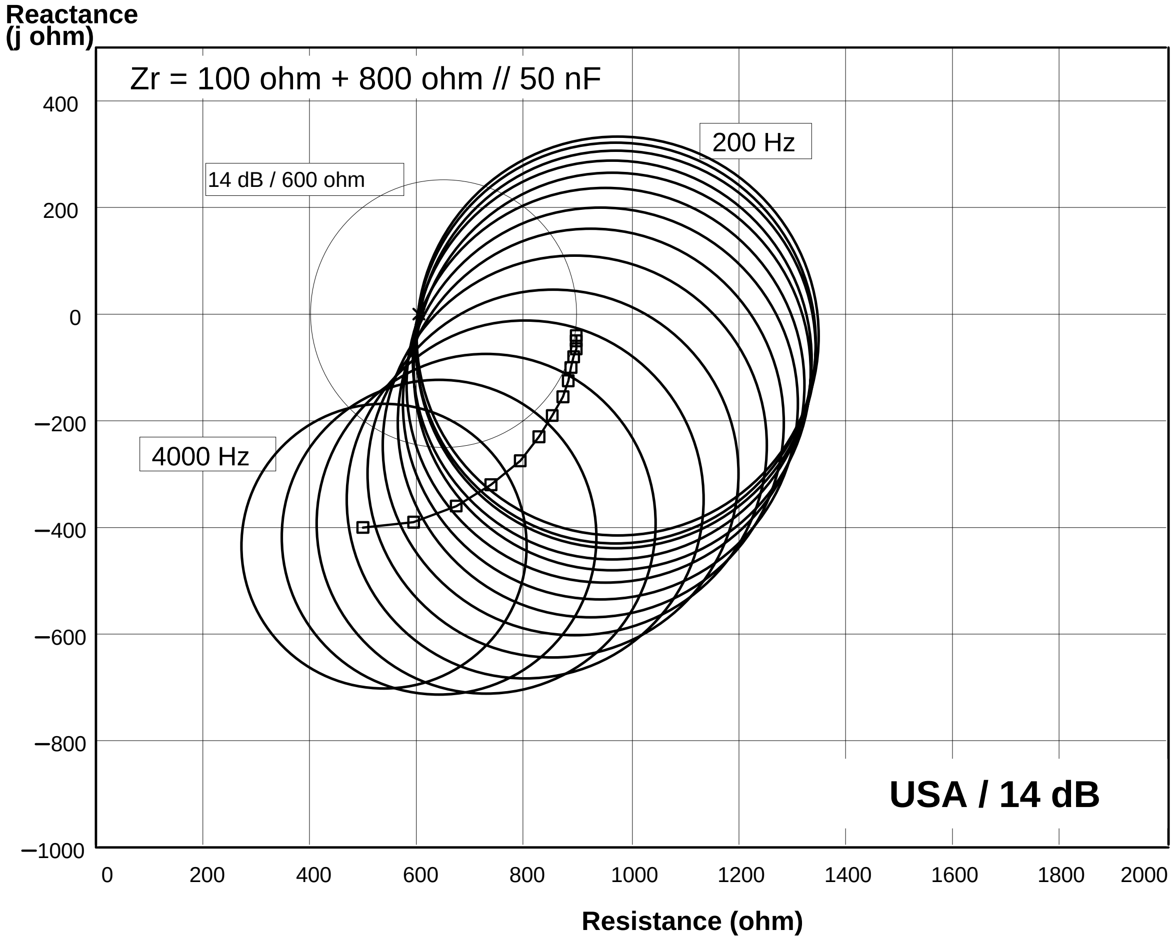
Figure B.3.16: Graph of the reference impedance and return-loss limits for ZPT17V 14dB



Values of the reference impedance and return loss limits for Japan:

Return_loss	Kd	Kr	Frequ	Real_imped	Imag_imped	p	Real_center	Imag_center	Radius
14	1.083	0.416	200	959.5	− 166	1	1039	− 179.7	404.7
14	1.083	0.416	250	938.6	− 201.1	2	1016.4	− 217.8	398.9
14	1.083	0.416	315	907.2	− 241.3	3	982.4	− 261.3	390.1
14	1.083	0.416	400	861.2	− 284	4	932.7	− 307.5	376.9
14	1.083	0.416	500	804.4	− 320.3	5	871.1	− 346.8	359.8
14	1.083	0.416	630	732.2	− 348	6	792.9	− 376.8	336.9
14	1.083	0.416	800	648.3	− 359.9	7	702.1	− 389.7	308.2
14	1.083	0.416	1000	568.9	− 352.9	8	616.1	− 382.2	278.2
14	1.083	0.416	1250	496.1	− 330	9	537.3	− 357.4	247.6
14	1.083	0.416	1600	429.4	− 292	10	465	− 316.2	215.8
14	1.083	0.416	2000	383.3	− 252.4	11	415.1	− 273.4	190.8
14	1.083	0.416	2500	349.7	− 212.9	12	378.7	− 230.6	170.2
14	1.083	0.416	3150	325.6	− 175.3	13	352.6	− 189.8	153.7
14	1.083	0.416	4000	308.9	− 141.4	14	334.6	− 153.2	141.2
dB			Hz	ohm	j ohm		ohm	j ohm	ohm

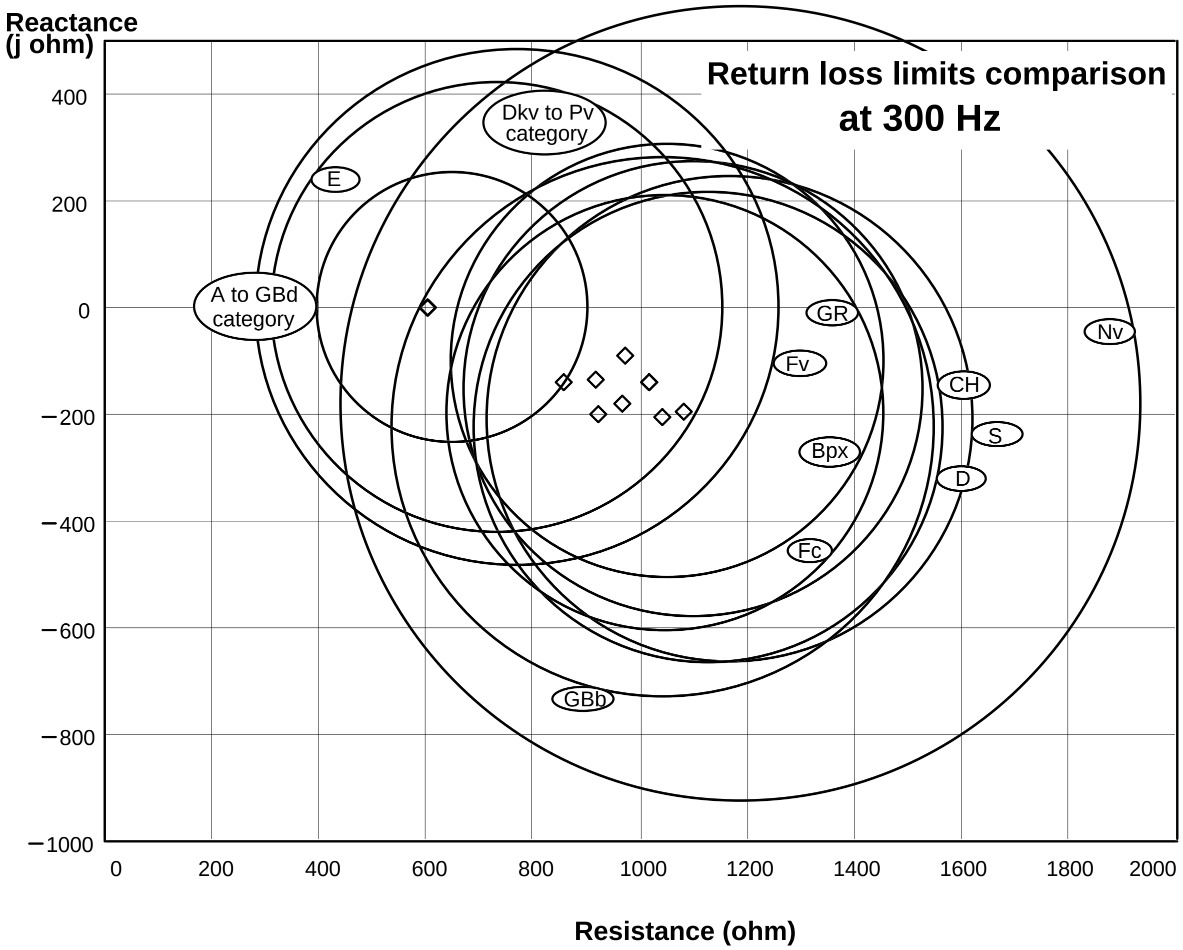
Figure B.3.17: Graph of the reference impedance and return-loss limits for Japan



Values of the reference impedance and return loss limits for USA:

Return_loss	Kd	Kr	Frequ	Real_imped	Imag_imped	p	Real_center	Imag_center	Radius
14	1.083	0.416	200	898	− 40.1	1	972.4	− 43.4	373.6
14	1.083	0.416	250	896.9	− 50.1	2	971.2	− 54.2	373.3
14	1.083	0.416	315	895	− 62.9	3	969.2	− 68.2	372.9
14	1.083	0.416	400	892	− 79.6	4	966	− 86.2	372.2
14	1.083	0.416	500	887.6	− 99	5	961.2	− 107.2	371.2
14	1.083	0.416	630	880.4	− 123.6	6	953.4	− 133.8	369.5
14	1.083	0.416	800	868.9	− 154.6	7	941	− 167.4	366.8
14	1.083	0.416	1000	852.5	− 189.1	8	923.2	− 204.8	362.9
14	1.083	0.416	1250	828.1	− 228.8	9	896.8	− 247.7	357.1
14	1.083	0.416	1600	788.6	− 276.9	10	854	− 299.9	347.4
14	1.083	0.416	2000	738.6	− 321	11	799.9	− 347.6	334.7
14	1.083	0.416	2500	673.6	− 360.4	12	729.4	− 390.3	317.5
14	1.083	0.416	3150	591.8	− 389.3	13	640.8	− 421.6	294.4
14	1.083	0.416	4000	497.9	− 400	14	539.2	− 433.2	265.4
dB			Hz	ohm	j ohm		ohm	j ohm	ohm

Figure B.3.18: Graph of the reference impedance and return-loss limits for USA

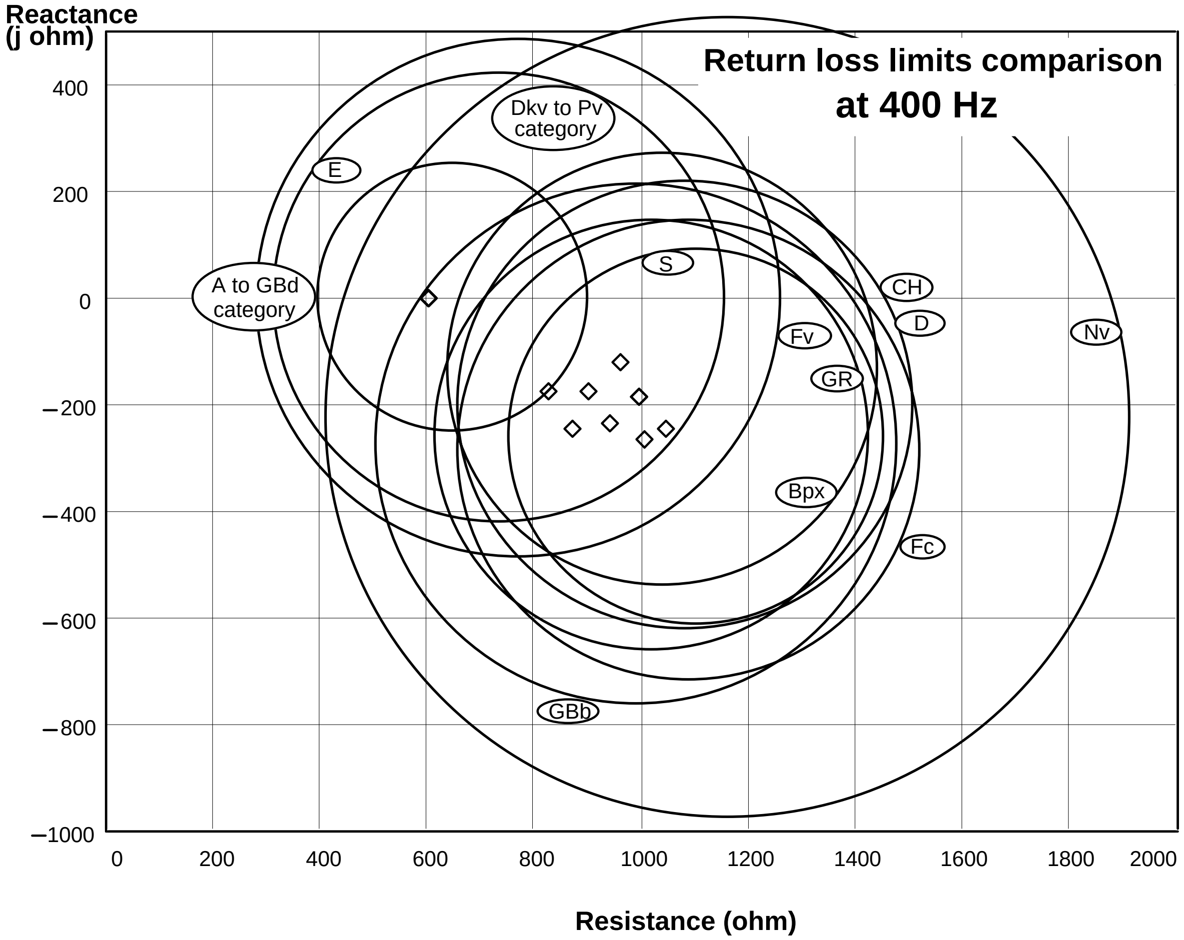


Return-loss limits and reference impedance values at 300 Hz for the country categories:

f = 300 · Hz

Country	Return loss	Re_imped.	Im_imped.	Kd	Kr	Re_centre	Im_centre	Radius
A_to_GBd	14	600	0	1.083	0.416	650	0	249
Bpx	14	970	− 92	1.083	0.416	1050	− 100	405
DKv_to_Pv	10	600	0	1.222	0.703	733	0	422
DKd	1	856	− 142	8.724	8.667	7467	− 1237	7519
Fv	9	600	0	1.288	0.812	773	0	487
Fc	14	1039	− 206	1.083	0.416	1125	− 223	440
D	14	1015	− 141	1.083	0.416	1099	− 153	426
GR	14	966	− 182	1.083	0.416	1046	− 197	408
Nv	9	917	− 136	1.288	0.812	1181	− 175	753
E	10	600	0	1.222	0.703	733	0	422
S	14	1079	− 193	1.083	0.416	1168	− 209	455
CH	14	1015	− 141	1.083	0.416	1099	− 153	426
GBb	12	918	− 199	1.135	0.536	1042	− 225	504
Category	dB	ohm	j ohm			ohm	j ohm	ohm

Figure B.4.1: Return-loss limits comparison at 300 Hz between country categories

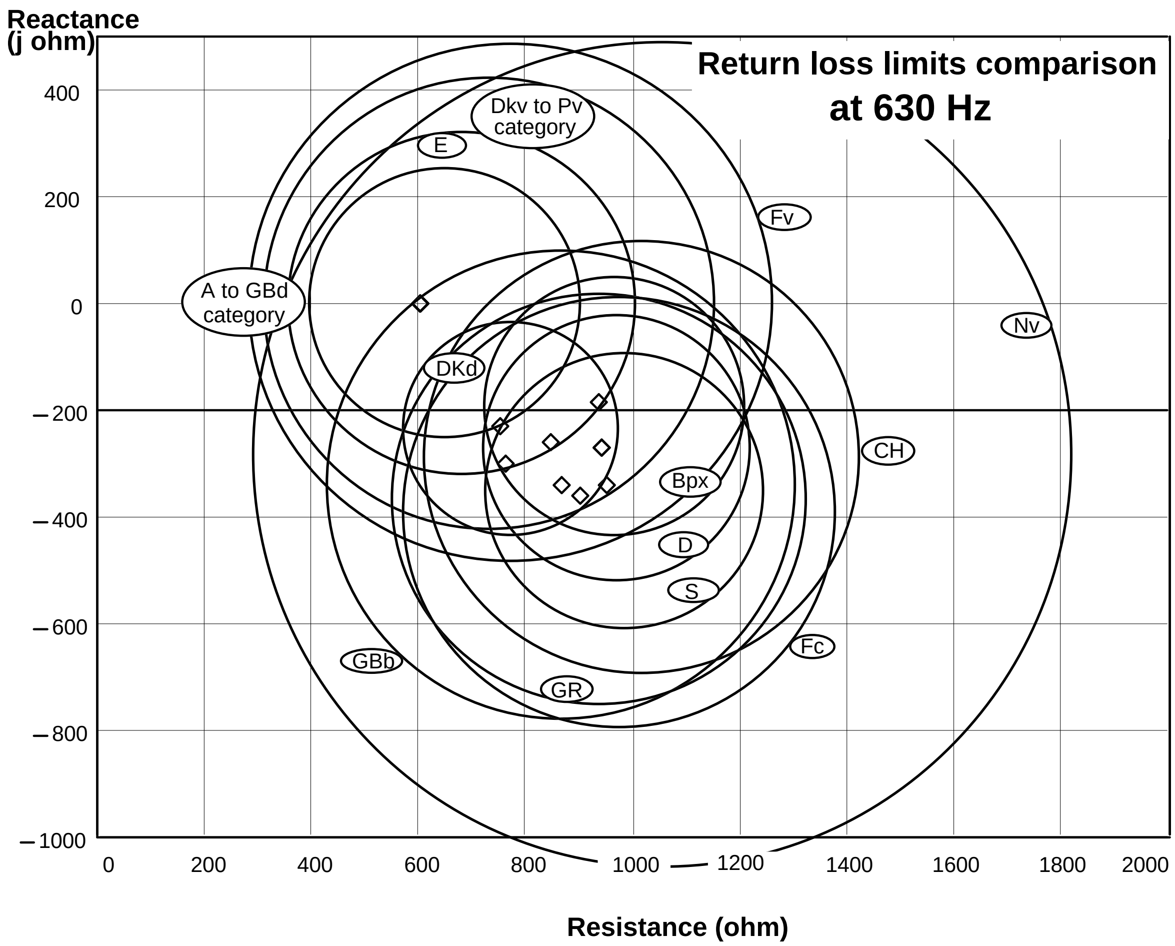


Return-loss limits and reference impedance values at 400 Hz for the country categories:

f_u = 400 ·Hz

Country	Return loss	Re_imped.	Im_imped.	Kd	Kr	Re_centre	Im_centre	Radius
A_to_GBd	14	600	0	1.083	0.416	650	0	249
Bpx	14	962	− 122	1.083	0.416	1041	− 132	403
DKv_to_Pv	10	600	0	1.222	0.703	733	0	422
DKd	1	827	− 177	8.724	8.667	7212	− 1543	7326
Fv	9	600	0	1.288	0.812	773	0	487
Fc	14	1003	− 263	1.083	0.416	1086	− 285	431
D	14	996	− 184	1.083	0.416	1079	− 199	421
GR	14	941	− 236	1.083	0.416	1019	− 256	403
Nv	9	900	− 177	1.288	0.812	1159	− 228	745
E	10	600	0	1.222	0.703	733	0	422
S	16	1046	− 247	1.052	0.325	1100	− 260	349
CH	14	996	− 184	1.083	0.416	1079	− 199	421
GBb	12	873	− 243	1.135	0.536	990	− 276	486
Category	dB	ohm	j ohm			ohm	j ohm	ohm

Figure B.4.2: Return-loss limits comparison at 400 Hz between country categories

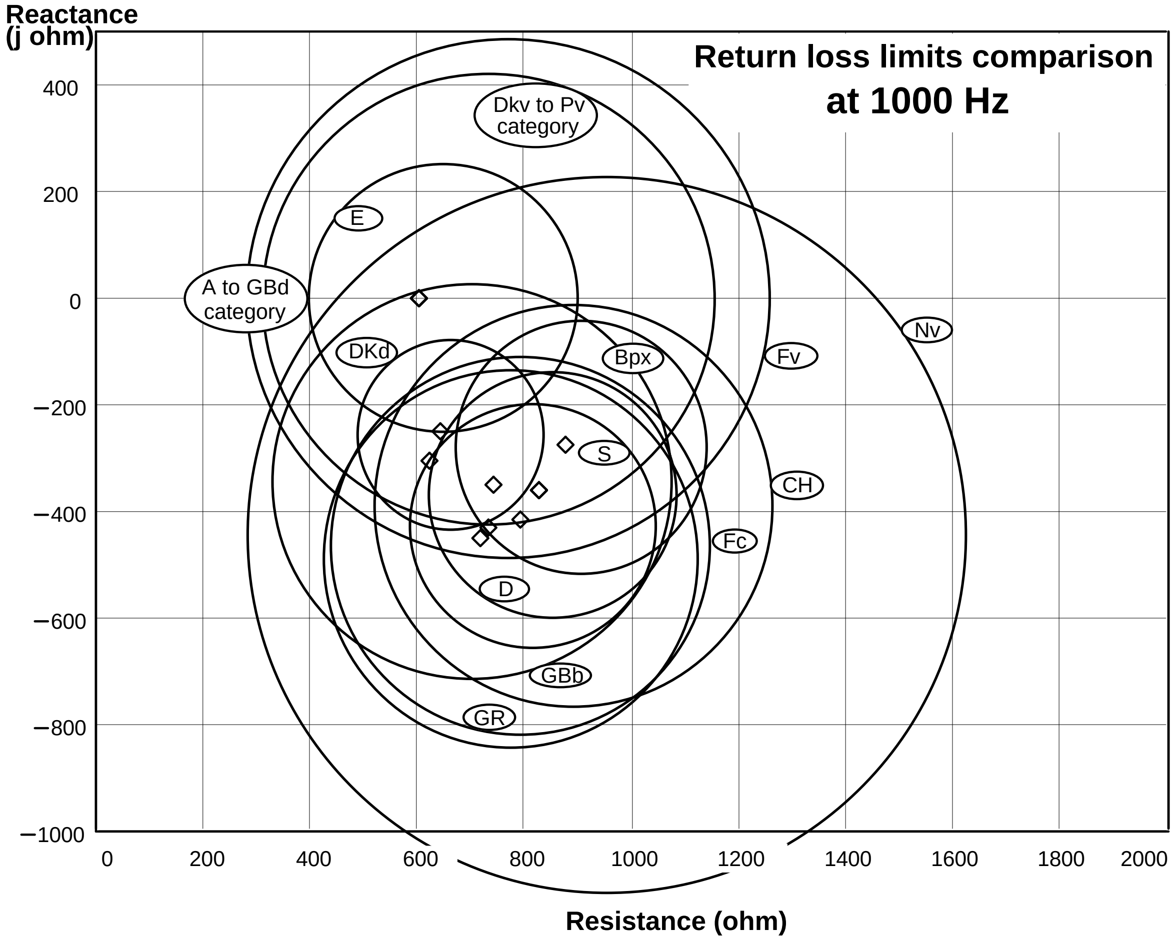


Return-loss limits and reference impedance values at 630 Hz for the country categories:

$f_u = 630 \cdot Hz$

Country	Return loss	Re_imped.	Im_imped.	Kd	Kr	Re_centre	Im_centre	Radius
A_to_GBd	14	600	0	1.083	0.416	650	0	249
Bpx	18	936	−186	1.032	0.256	966	−192	244
DKv_to_Pv	10	600	0	1.222	0.703	733	0	422
DKd	18	750	−229	1.032	0.256	775	−236	201
Fv	9	600	0	1.288	0.812	773	0	487
Fc	14	901	−361	1.083	0.416	976	−391	404
D	18	940	−269	1.032	0.256	970	−277	250
GR	14	865	−342	1.083	0.416	936	−371	386
Nv	9	847	−260	1.288	0.812	1091	−334	719
E	12	600	0	1.135	0.536	681	0	322
S	18	952	−342	1.032	0.256	983	−353	259
CH	14	940	−269	1.083	0.416	1018	−291	406
GBb	12	763	−299	1.135	0.536	865	−339	439
Category	dB	ohm	j ohm			ohm	j ohm	ohm

Figure B.4.3: Return-loss limits comparison at 630 Hz between country categories

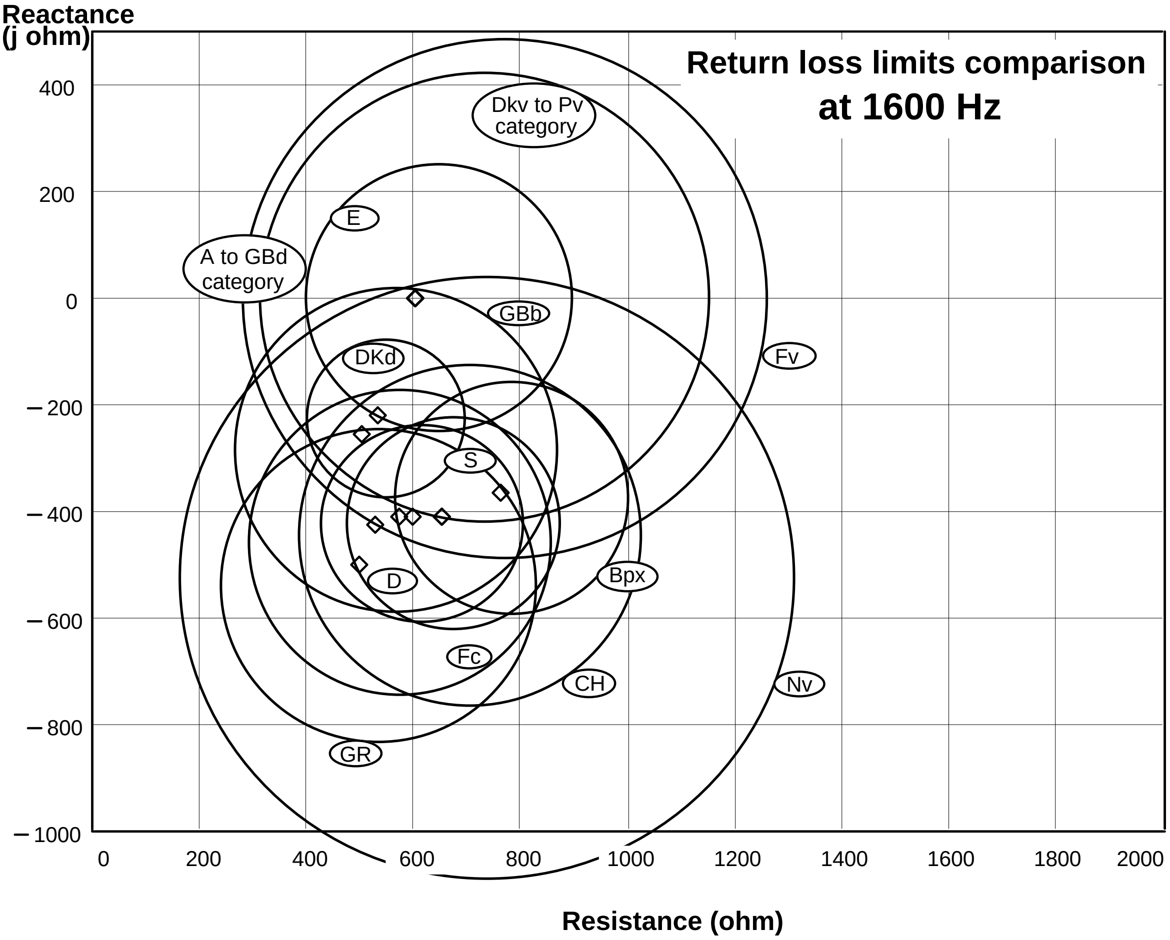


Return-loss limits and reference impedance values at 1 000 Hz for the country categories:

f_u = 1000 •Hz

Country	Return loss	Re_imped.	Im_imped.	Kd	Kr	Re_centre	Im_centre	Radius
A_to_GBd	14	600	0	1.083	0.416	650	0	249
Bpx	18	877	− 273	1.032	0.256	906	− 282	235
DKv_to_Pv	10	600	0	1.222	0.703	733	0	422
DKd	18	641	− 250	1.032	0.256	662	− 258	176
Fv	9	600	0	1.288	0.812	773	0	487
Fc	14	731	− 432	1.083	0.416	792	− 468	353
D	18	827	− 360	1.032	0.256	854	− 371	231
GR	14	717	− 450	1.083	0.416	776	− 488	352
Nv	9	741	− 352	1.288	0.812	954	− 453	666
E	14	600	0	1.083	0.416	650	0	249
S	18	793	− 415	1.032	0.256	818	− 428	229
CH	14	827	− 360	1.083	0.416	896	− 389	375
GBb	12	622	− 305	1.135	0.536	706	− 346	371
Category	dB	ohm	j ohm			ohm	j ohm	ohm

Figure B.4.4: Return-loss limits comparison at 1 000 Hz between country categories

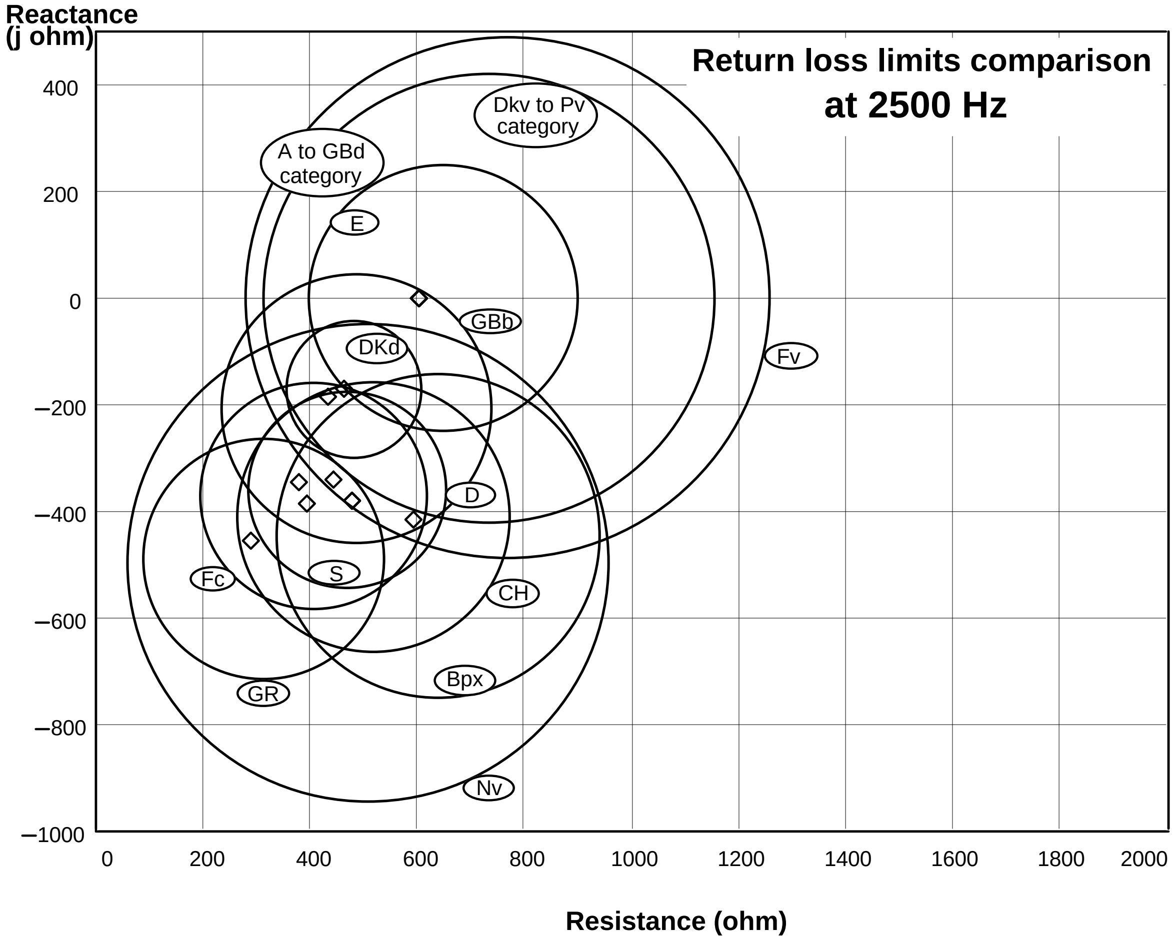


Return-loss limits and reference impedance values at 1 600 Hz for the country categories:

f_u = 1600 ·Hz

Country	Return loss	Re_imped.	Im_imped.	Kd	Kr	Re_centre	Im_centre	Radius
A_to_GBd	14	600	0	1.083	0.416	650	0	249
Bpx	18	760	– 366	1.032	0.256	784	– 378	216
DKv_to_Pv	10	600	0	1.222	0.703	733	0	422
DKd	18	533	– 221	1.032	0.256	550	– 228	148
Fv	9	600	0	1.288	0.812	773	0	487
Fc	14	529	– 423	1.083	0.416	573	– 458	281
D	18	652	– 409	1.032	0.256	673	– 423	197
GR	14	497	– 500	1.083	0.416	539	– 541	293
Nv	9	570	– 408	1.288	0.812	734	– 526	569
E	14	600	0	1.083	0.416	650	0	249
S	18	597	– 412	1.032	0.256	616	– 426	186
CH	14	652	– 409	1.083	0.416	706	– 443	320
GBb	12	501	– 253	1.135	0.536	568	– 287	301
Category	dB	ohm	j ohm			ohm	j ohm	ohm

Figure B.4.5: Return-loss limits comparison at 1 600 Hz between country categories

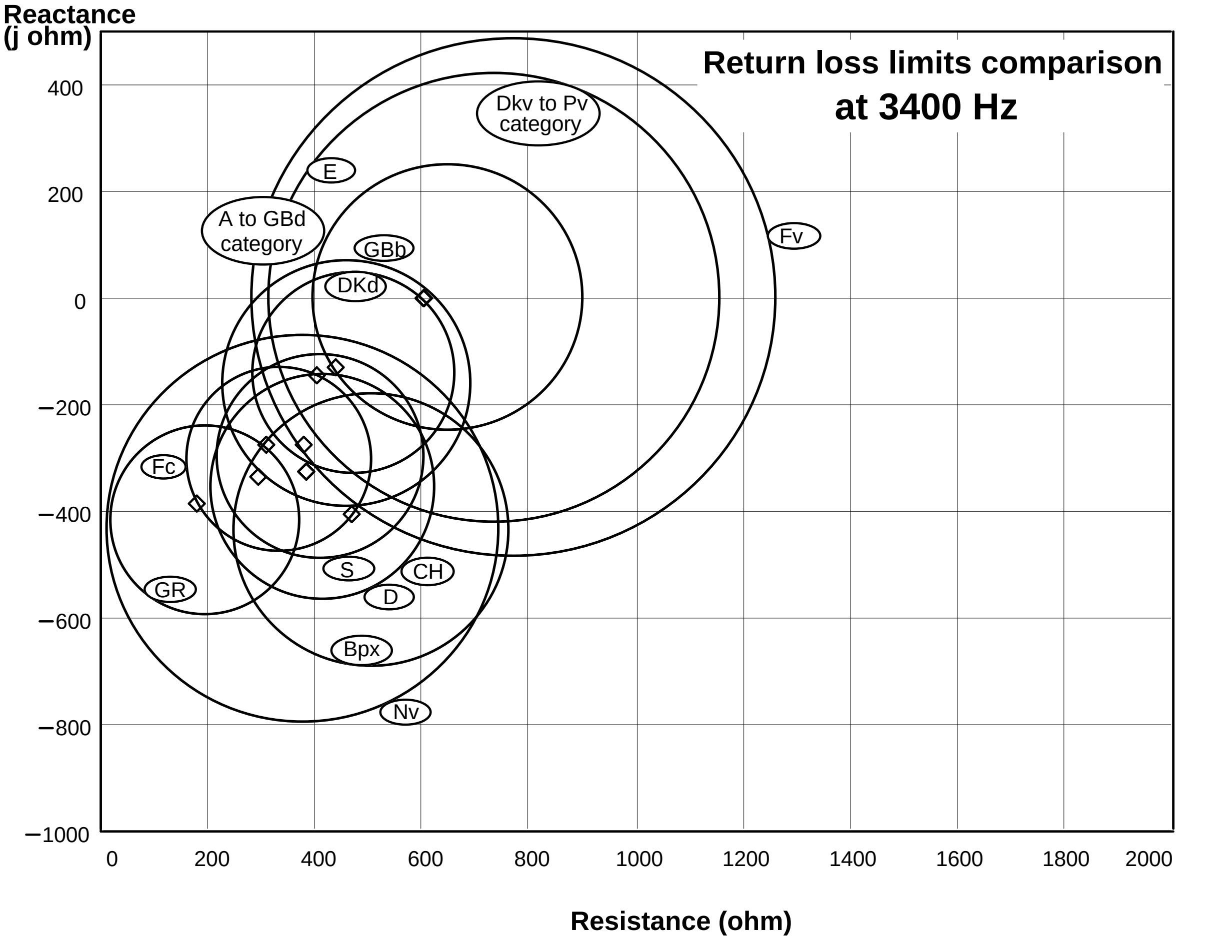


Return-loss limits and reference impedance values at 2 500 Hz for the country categories:

f_u = 2500 ·Hz

Country	Return loss	Re_imped.	Im_imped.	Kd	Kr	Re_centre	Im_centre	Radius
A_to_GBd	14	600	0	1.083	0.416	650	0	249
Bpx	14	591	−414	1.083	0.416	640	−449	300
DKv_to_Pv	10	600	0	1.222	0.703	733	0	422
DKd	18	465	−168	1.032	0.256	480	−173	126
Fv	9	600	0	1.288	0.812	773	0	487
Fc	14	376	−344	1.083	0.416	407	−373	212
D	18	477	−380	1.032	0.256	492	−393	156
GR	14	288	−453	1.083	0.416	312	−491	223
Nv	9	393	−386	1.288	0.812	506	−498	447
E	14	600	0	1.083	0.416	650	0	249
S	16	445	−340	1.052	0.325	468	−357	182
CH	14	477	−380	1.083	0.416	516	−412	253
GBb	12	431	−185	1.135	0.536	489	−210	252
Category	dB	ohm	j ohm			ohm	j ohm	ohm

Figure B.4.6: Return-loss limits comparison at 2 500 Hz between country categories

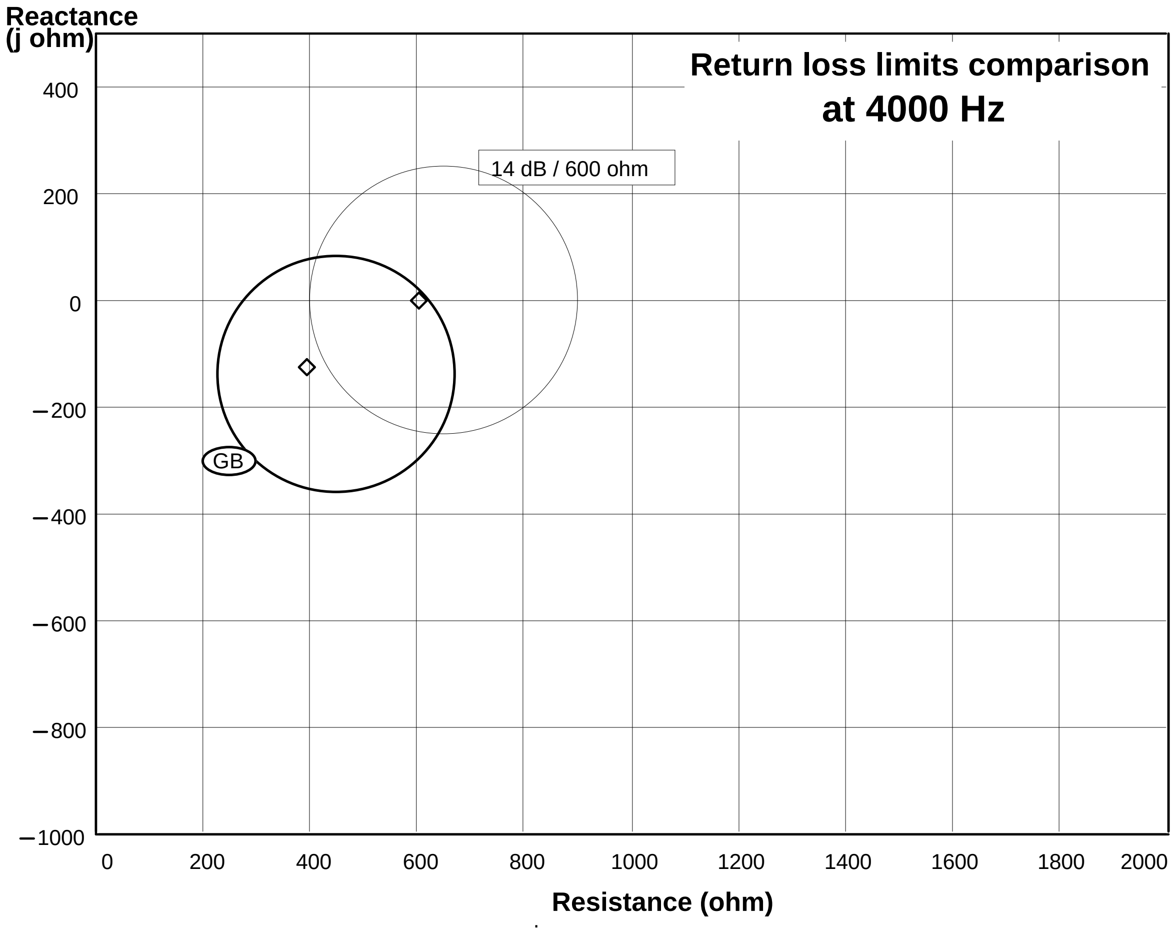


Return-loss limits and reference impedance values at 3 400 Hz for the country categories:

f_u = 3400 ·Hz

Country	Return loss	Re_imped.	Im_imped.	Kd	Kr	Re_centre	Im_centre	Radius
A_to_GBd	14	600	0	1.083	0.416	650	0	249
Bpx	14	466	-403	1.083	0.416	504	-436	256
DKv_to_Pv	10	600	0	1.222	0.703	733	0	422
DKd	14	437	-131	1.083	0.416	474	-142	190
Fv	9	600	0	1.288	0.812	773	0	487
Fc	14	308	-277	1.083	0.416	334	-300	172
D	14	382	-327	1.083	0.416	414	-354	209
GR	14	180	-384	1.083	0.416	195	-416	176
Nv	9	294	-335	1.288	0.812	379	-432	362
E	10	600	0	1.222	0.703	733	0	422
S	14	376	-275	1.083	0.416	407	-298	194
CH	14	382	-327	1.083	0.416	414	-354	209
GBb	12	405	-143	1.135	0.536	459	-162	230
Category	dB	ohm	j ohm			ohm	j ohm	ohm

Figure B.4.7: Return-loss limits comparison at 3 400 Hz between country categories

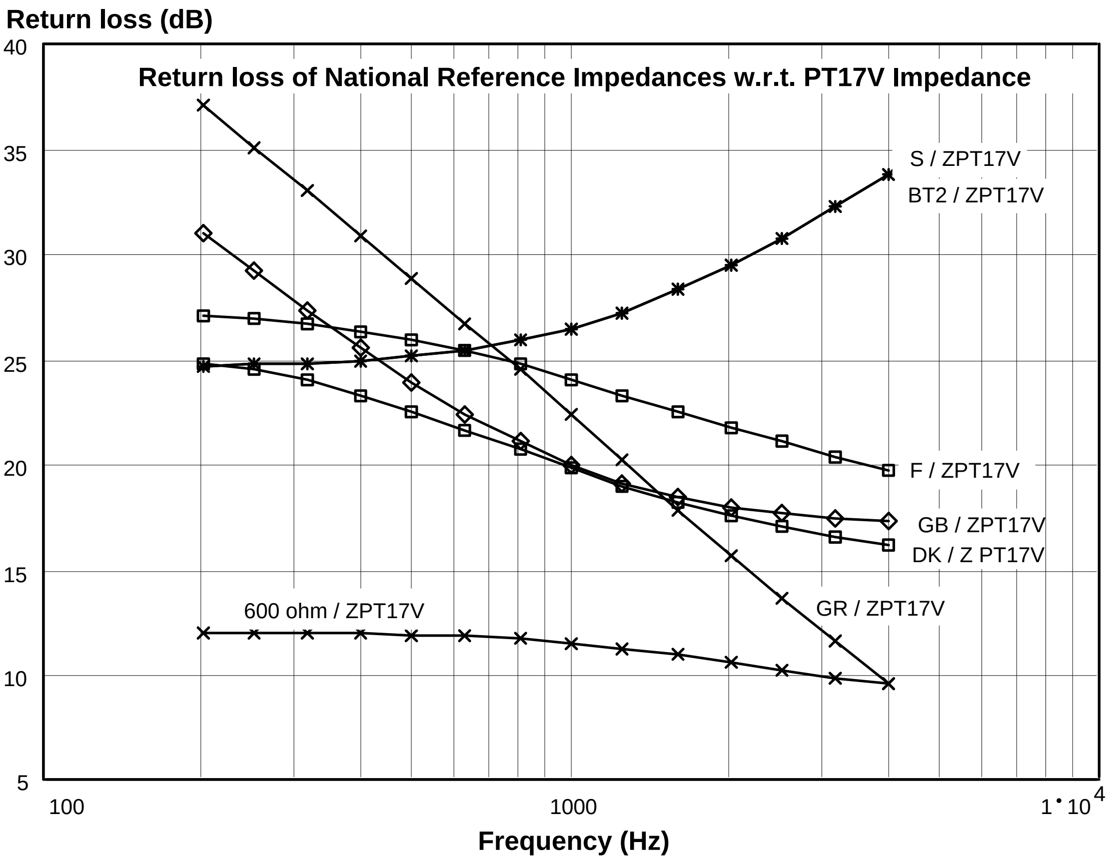


Return-loss limits and reference impedance values at 4 000 Hz for the country categories:

$f_u = 4000 \cdot Hz$

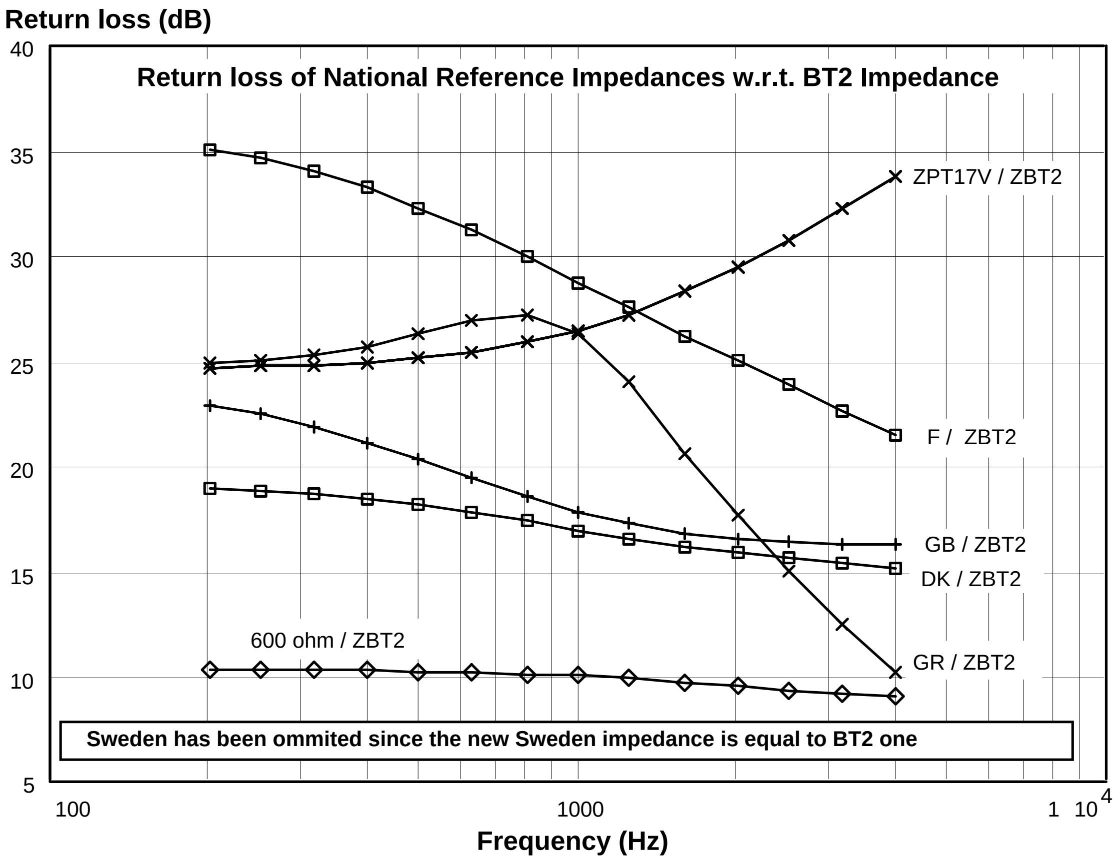
Country	Return loss	Re_imped.	Im_imped.	Kd	Kr	Re_centre	Im_centre	Radius
C14dB600	14	600	0	1.083	0.416	650	0	249
GBb	12	395	− 123	1.135	0.536	449	− 140	222
Category	dB	ohm	j ohm			ohm	j ohm	ohm

Figure B.4.8: Return-loss limits comparison at 4 000 Hz between country categories



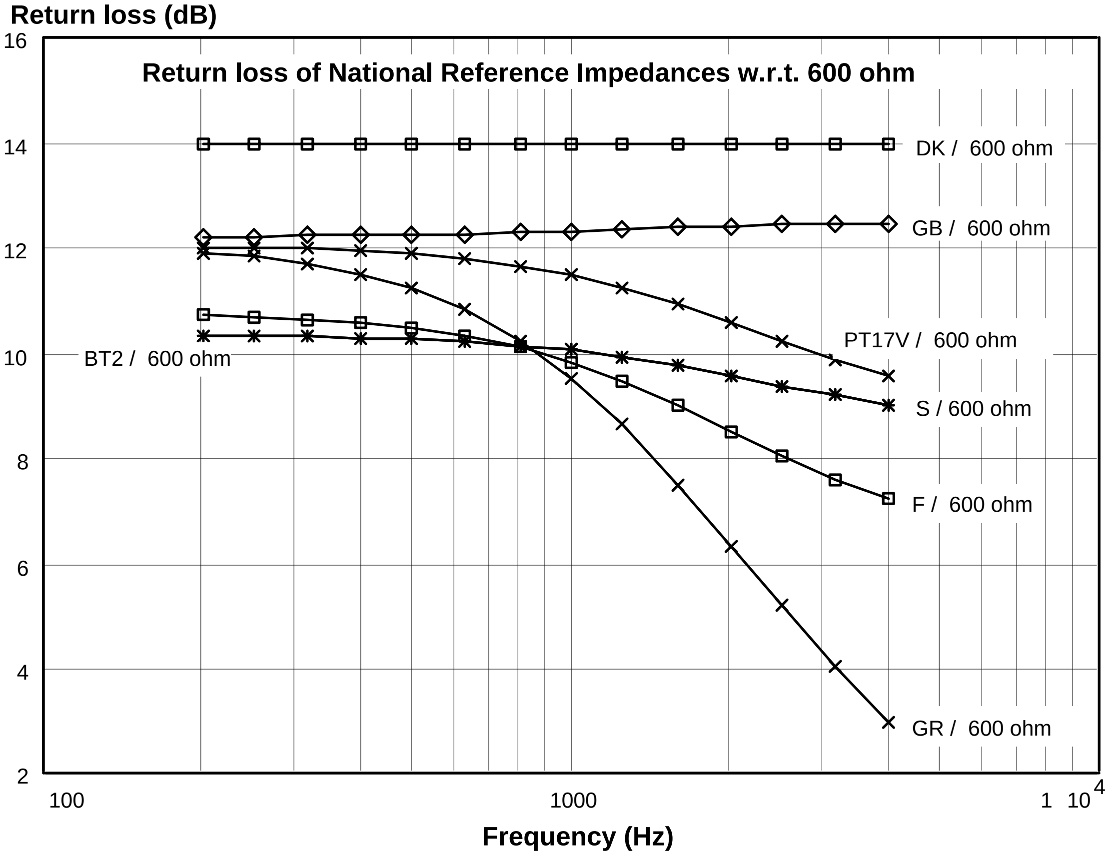
Frequency	DK / ZPT17V	F /ZPT17V	GR / ZPT17V	S / ZPT17V	GB / ZPT17V	600ohm /ZPT17V	ZBT2 / ZPT17V
200	24.8	27	37	24.7	31	12	24.7
250	24.5	26.9	35.1	24.8	29.2	12	24.8
315	24	26.7	33	24.8	27.4	12	24.8
400	23.3	26.4	30.9	25	25.6	11.9	25
500	22.5	25.9	28.9	25.2	23.9	11.9	25.2
630	21.6	25.4	26.7	25.4	22.4	11.8	25.4
800	20.7	24.7	24.5	25.9	21.1	11.7	25.9
1000	19.8	24	22.3	26.4	20	11.5	26.4
1250	19	23.3	20.2	27.2	19.1	11.3	27.2
1600	18.2	22.5	17.8	28.3	18.4	10.9	28.3
2000	17.6	21.8	15.7	29.4	18	10.6	29.4
2500	17.1	21.1	13.6	30.8	17.7	10.2	30.8
3150	16.6	20.4	11.6	32.2	17.5	9.9	32.2
4000	16.2	19.7	9.6	33.8	17.3	9.6	33.8

Figure B.5.1: Degradation of typical impedances with respect to PT17V impedance



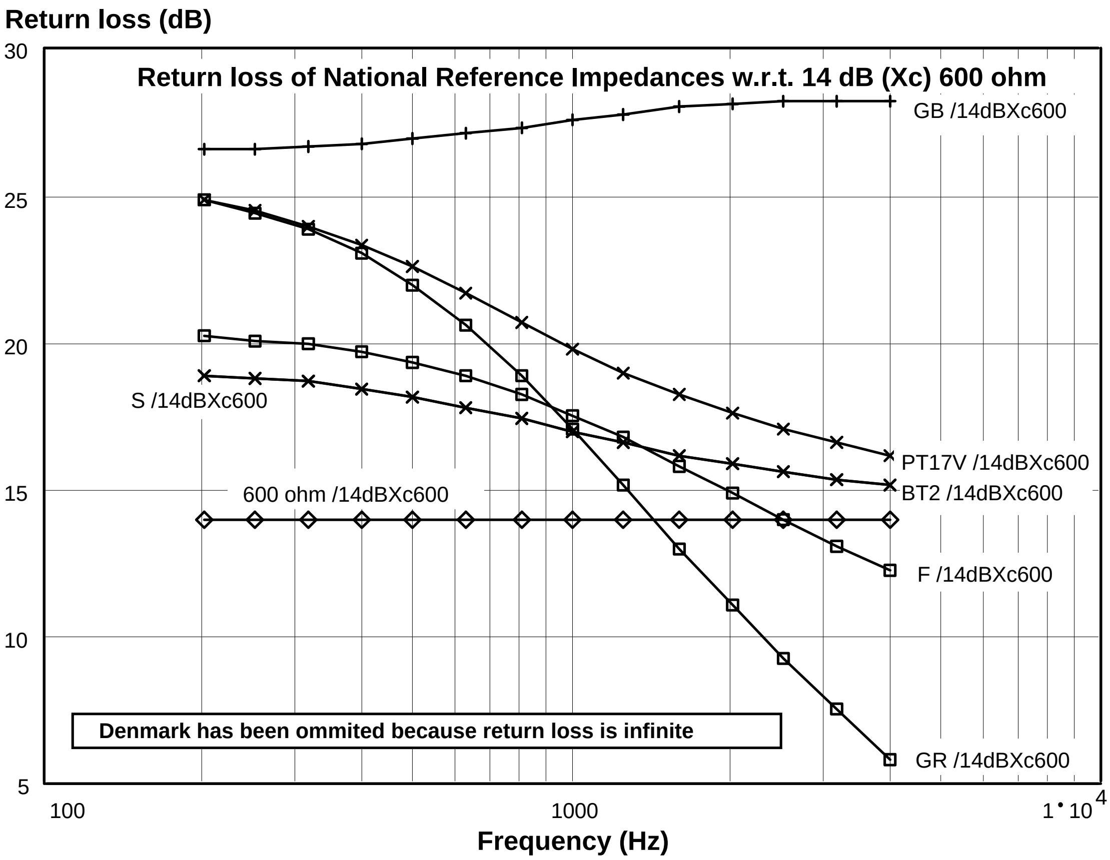
Frequency	DK / ZBT2	F / ZBT2	GR / ZBT2	GB / ZBT2	600ohm / ZBT2	ZPT17V / ZBT2
200	18.9	35.1	24.9	22.9	10.3	24.7
250	18.8	34.7	25.1	22.5	10.3	24.8
315	18.6	34.1	25.3	21.9	10.3	24.8
400	18.4	33.2	25.7	21.2	10.3	25
500	18.2	32.3	26.2	20.4	10.2	25.2
630	17.8	31.2	26.9	19.5	10.2	25.4
800	17.4	29.9	27.2	18.6	10.1	25.9
1000	17	28.7	26.3	17.9	10	26.4
1250	16.6	27.5	24	17.3	9.9	27.2
1600	16.2	26.2	20.6	16.8	9.7	28.3
2000	15.9	25	17.7	16.5	9.6	29.4
2500	15.6	23.8	15	16.4	9.4	30.8
3150	15.4	22.6	12.5	16.3	9.2	32.2
4000	15.2	21.5	10.1	16.3	9	33.8

Figure B.5.2: Degradation of typical impedances with respect to BT2 impedance



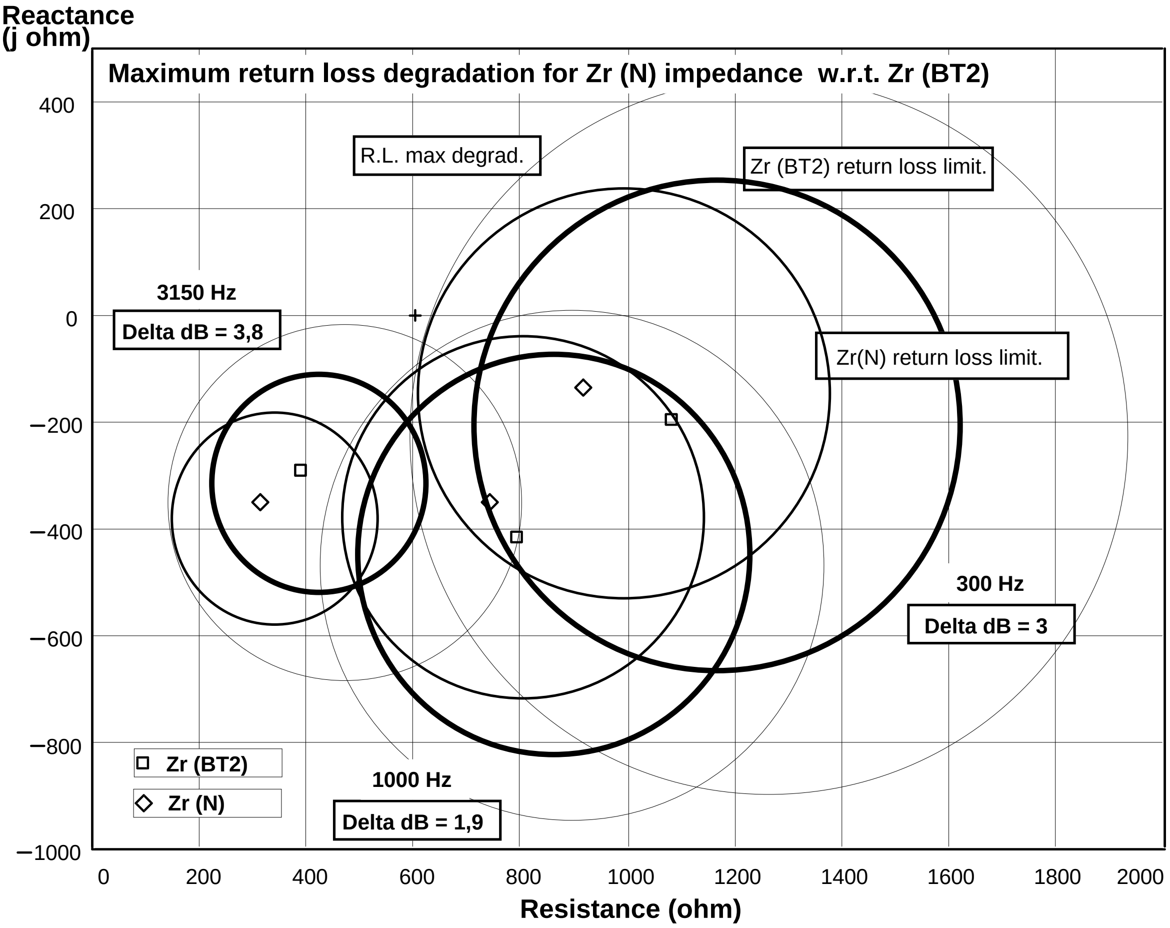
Frequency	DK /600ohm	F /600ohm	GR / 600ohm	S / 600ohm	GB / 600ohm	ZBT2 / 600ohm	PT17V / 600ohm
200	14	10.7	11.9	10.3	12.2	10.3	12
250	14	10.7	11.8	10.3	12.2	10.3	12
315	14	10.6	11.7	10.3	12.2	10.3	12
400	14	10.6	11.5	10.3	12.2	10.3	11.9
500	14	10.5	11.2	10.2	12.2	10.2	11.9
630	14	10.3	10.8	10.2	12.3	10.2	11.8
800	14	10.1	10.2	10.1	12.3	10.1	11.7
1000	14	9.8	9.5	10	12.3	10	11.5
1250	14	9.5	8.6	9.9	12.3	9.9	11.3
1600	14	9	7.5	9.7	12.4	9.7	10.9
2000	14	8.5	6.3	9.6	12.4	9.6	10.6
2500	14	8	5.2	9.4	12.4	9.4	10.2
3150	14	7.6	4	9.2	12.5	9.2	9.9
4000	14	7.2	3	9	12.5	9	9.6

Figure B.5.3: Distance (return loss) of typical impedances with respect to 600 ohm impedance



Frequency	F / 14dBXc600	GR / 14dBXc600	S / 14dBXc600	GB / 14dBXc600	600ohm / 14dBXc600	ZBT2 / 14dBXc600	PT17V / 14dBXc600
200	20.2	24.8	18.9	26.5	14	18.9	24.8
250	20.1	24.4	18.8	26.6	14	18.8	24.5
315	19.9	23.8	18.6	26.6	14	18.6	24
400	19.6	23	18.4	26.8	14	18.4	23.3
500	19.3	21.9	18.2	26.9	14	18.2	22.5
630	18.8	20.6	17.8	27.1	14	17.8	21.6
800	18.2	18.8	17.4	27.3	14	17.4	20.7
1000	17.5	17.1	17	27.5	14	17	19.8
1250	16.7	15.2	16.6	27.8	14	16.6	19
1600	15.8	13	16.2	28	14	16.2	18.2
2000	14.9	11.1	15.9	28.1	14	15.9	17.6
2500	14	9.3	15.6	28.2	14	15.6	17.1
3150	13.1	7.5	15.4	28.2	14	15.4	16.6
4000	12.3	5.8	15.2	28.2	14	15.2	16.2

Figure B.5.4: Distance (return loss) of typical impedances with respect to the half-circle of the return loss limit equal to 14 dB w.r.t. 600 ohm (Xc)



Zr (BT2) impedance and return loss limits :

Return_lossr	Kdr	Krr	Frequ	Real_impedr	Imag_impedr	p	Real_centerr	Imag_centerr	Radiusr
14	1.083	0.416	300	1078.6	– 193.1	1	1168	– 209.1	455.4
14	1.083	0.416	1000	792.7	– 414.8	2	858.5	– 449.2	371.8
14	1.083	0.416	3150	390.4	– 291.1	3	422.7	– 315.3	202.4

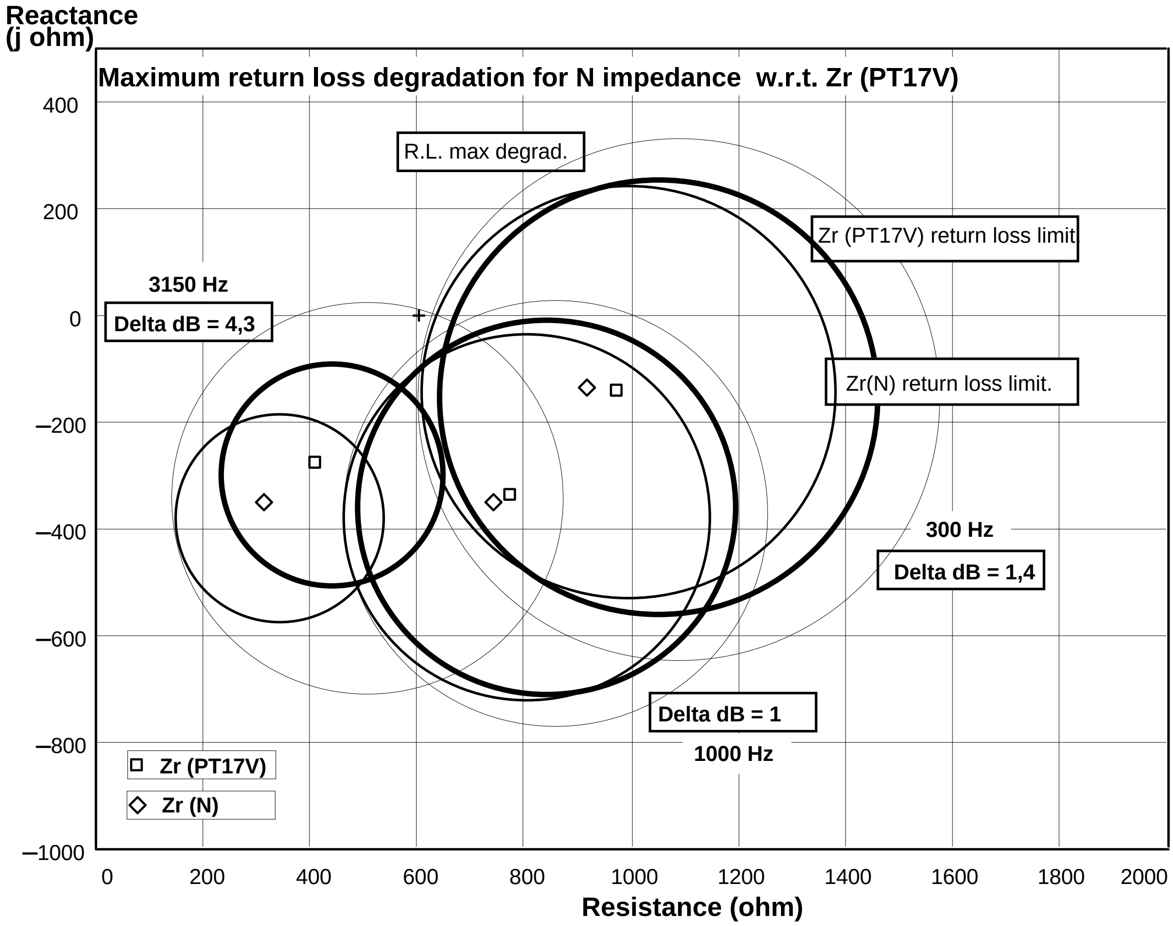
Zr (N) impedance and return loss limits :

Return_lossc	Kdc	Krc	Frequ	Real_impedc	Imag_impedc	p	Real_centerc	Imag_centerc	Radiusc
14	1.083	0.416	300	917	– 135.5	1	993	– 146.7	385.2
14	1.083	0.416	1000	740.6	– 351.7	2	802.1	– 380.9	340.8
14	1.083	0.416	3150	315.8	– 349.6	3	342	– 378.6	195.8

Maximum degradation of the Zr (N) return loss with respect to Zr (BT2) :

Return_lossm	Kdm	Kr m	Frequ	Real_impedr	Imag_impedr	p	Real_centerm	Imag_centerm	Radiusm
11	1.173	0.612	300	1078.6	– 193.1	1	1264.7	– 226.5	670.9
12.1	1.131	0.529	1000	792.7	– 414.8	2	896.9	– 469.3	473.5
10.2	1.211	0.683	3150	390.4	– 291.1	3	472.8	– 352.6	332.8
dB			Hz	ohm	j ohm		ohm	j ohm	ohm

Figure B.6.1: Maximum degradation for the Norway impedance with respect to BT2 impedance



Zr (PT17V) impedance and return loss limits :

Return_lossr	Kdr	Krr	Frequ	Real_impedr	Imag_impedr	p	Real_centerr	Imag_centerr	Radiusr
14	1.083	0.416	300	971.3	– 140.7	1	1051.9	– 152.4	407.9
14	1.083	0.416	1000	773	– 334.5	2	837.1	– 362.3	350
14	1.083	0.416	3150	409.3	– 276.4	3	443.2	– 299.3	205.2

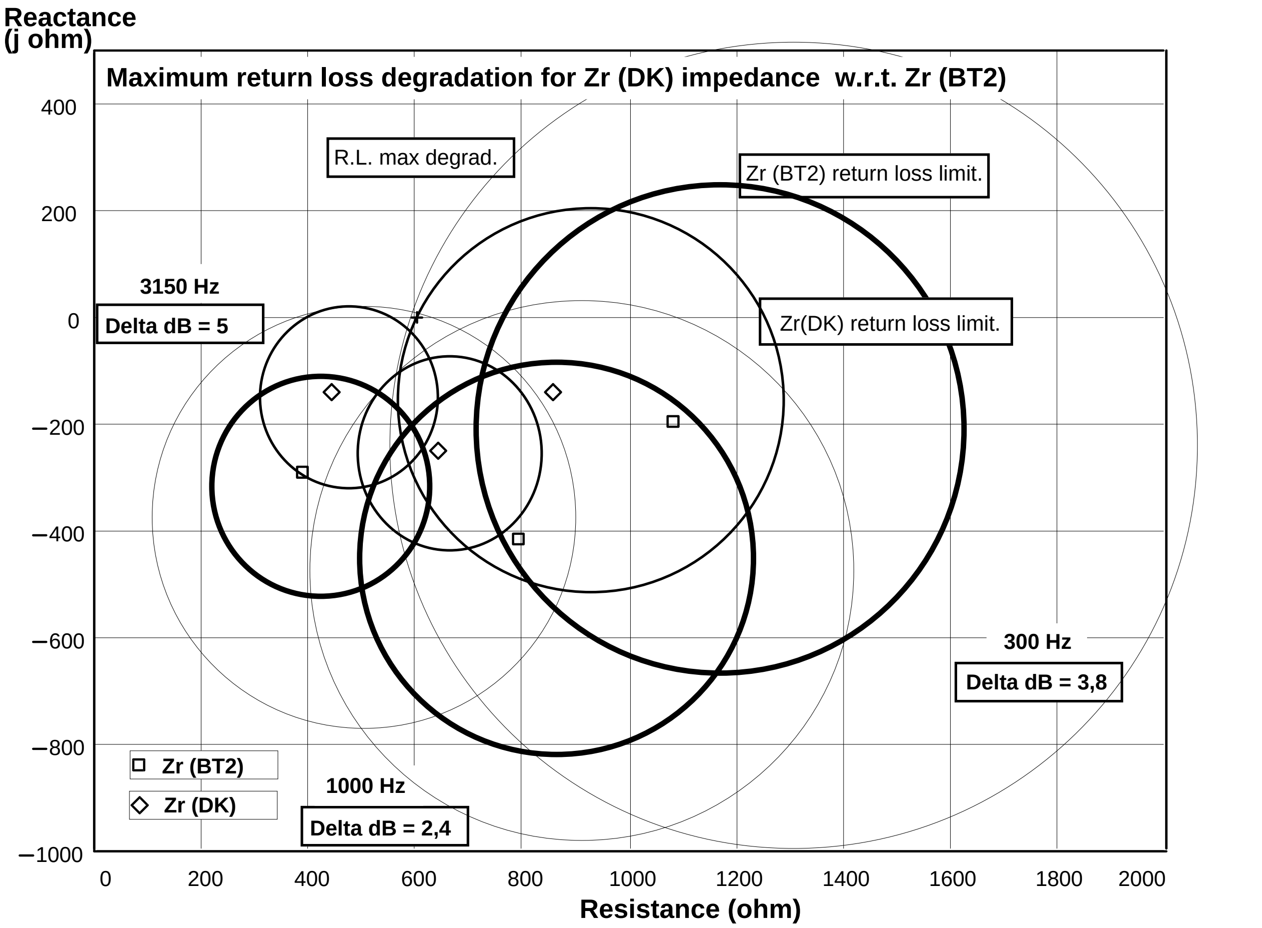
Zr (N) impedance and return loss limits :

Return_lossc	Kdc	Krc	Frequ	Real_impedc	Imag_impedc	p	Real_centerc	Imag_centerc	Radiusc
14	1.083	0.416	300	917	– 135.5	1	993	– 146.7	385.2
14	1.083	0.416	1000	740.6	– 351.7	2	802.1	– 380.9	340.8
14	1.083	0.416	3150	315.8	– 349.6	3	342	– 378.6	195.8

Maximum degradation of the Zr (N) return loss with respect to Zr (PT17V) :

Return_lossm	Kdm	Kr m	Frequ	Real_impedr	Imag_impedr	p	Real_centerm	Imag_centerm	Radiusm
12.6	1.116	0.496	300	971.3	– 140.7	1	1084.3	– 157.1	486.9
13	1.106	0.471	1000	773	– 334.5	2	854.6	– 369.8	397
9.7	1.24	0.733	3150	409.3	– 276.4	3	507.5	– 342.7	362.1
dB			Hz	ohm	j ohm		ohm	j ohm	ohm

Figure B.6.2: Maximum degradation for the Norway impedance with respect to PT17V impedance



Zr (BT2) impedance and return loss limits :

Return_lossr	Kdr	Krr	Frequ	Real_impedr	Imag_impedr	p	Real_centerr	Imag_centerr	Radiusr
14	1.083	0.416	300	1078.6	– 193.1	1	1168	– 209.1	455.4
14	1.083	0.416	1000	792.7	– 414.8	2	858.5	– 449.2	371.8
14	1.083	0.416	3150	390.4	– 291.1	3	422.7	– 315.3	202.4

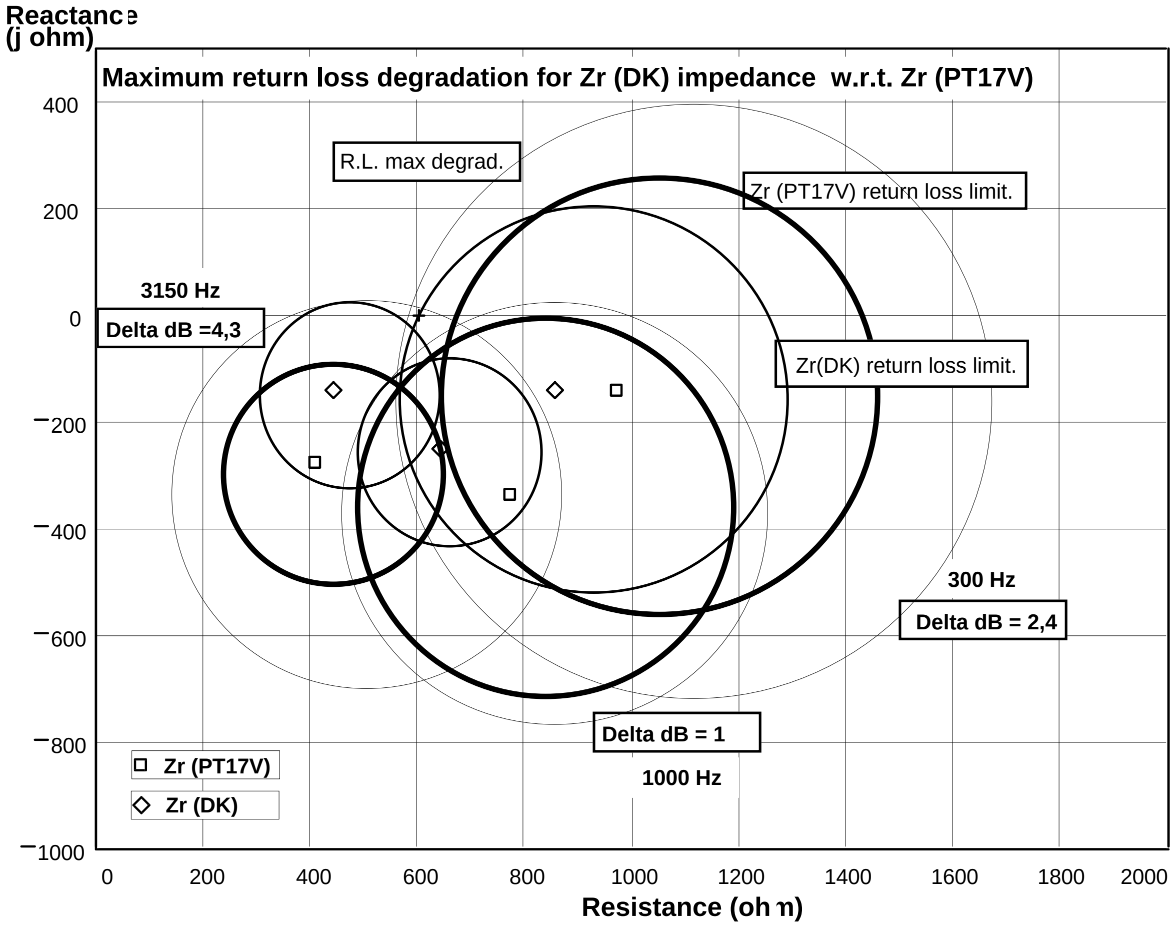
Zr (DK) impedance and return loss limits :

Return_lossc	Kdc	Krc	Frequ	Real_impedc	Imag_impedc	p	Real_centerc	Imag_centerc	Radiusc
14	1.083	0.416	300	855.9	– 141.8	1	926.9	– 153.6	360.6
18	1.032	0.256	1000	641	– 249.8	2	661.6	– 257.9	176
15	1.065	0.367	3150	442.9	– 140	3	471.8	– 149.1	170.6

Maximum degradation of the Zr (DK) return loss with respect to Zr (BT2) :

Return_lossm	Kdm	Krm	Frequ	Real_impedr	Imag_impedr	p	Real_centerm	Imag_centerm	Radiusm
10.2	1.211	0.683	300	1078.6	– 193.1	1	1306.3	– 233.9	748.7
11.6	1.149	0.565	1000	792.7	– 414.8	2	910.6	– 476.4	505.6
9	1.288	0.812	3150	390.4	– 291.1	3	502.8	– 375	395.3
dB			Hz	ohm	j ohm		ohm	j ohm	ohm

Figure B.6.3: Maximum degradation for the Denmark impedance with respect to BT2 impedance



Zr (PT17V) impedance and return loss limits :

Return_lossr	Kdr	Krr	Frequ	Real_impedr	Imag_impedr	p	Real_centerr	Imag_centerr	Radiusr
14	1.083	0.416	300	971.3	− 140.7	1	1051.9	− 152.4	407.9
14	1.083	0.416	1000	773	− 334.5	2	837.1	− 362.3	350
14	1.083	0.416	3150	409.3	− 276.4	3	443.2	− 299.3	205.2

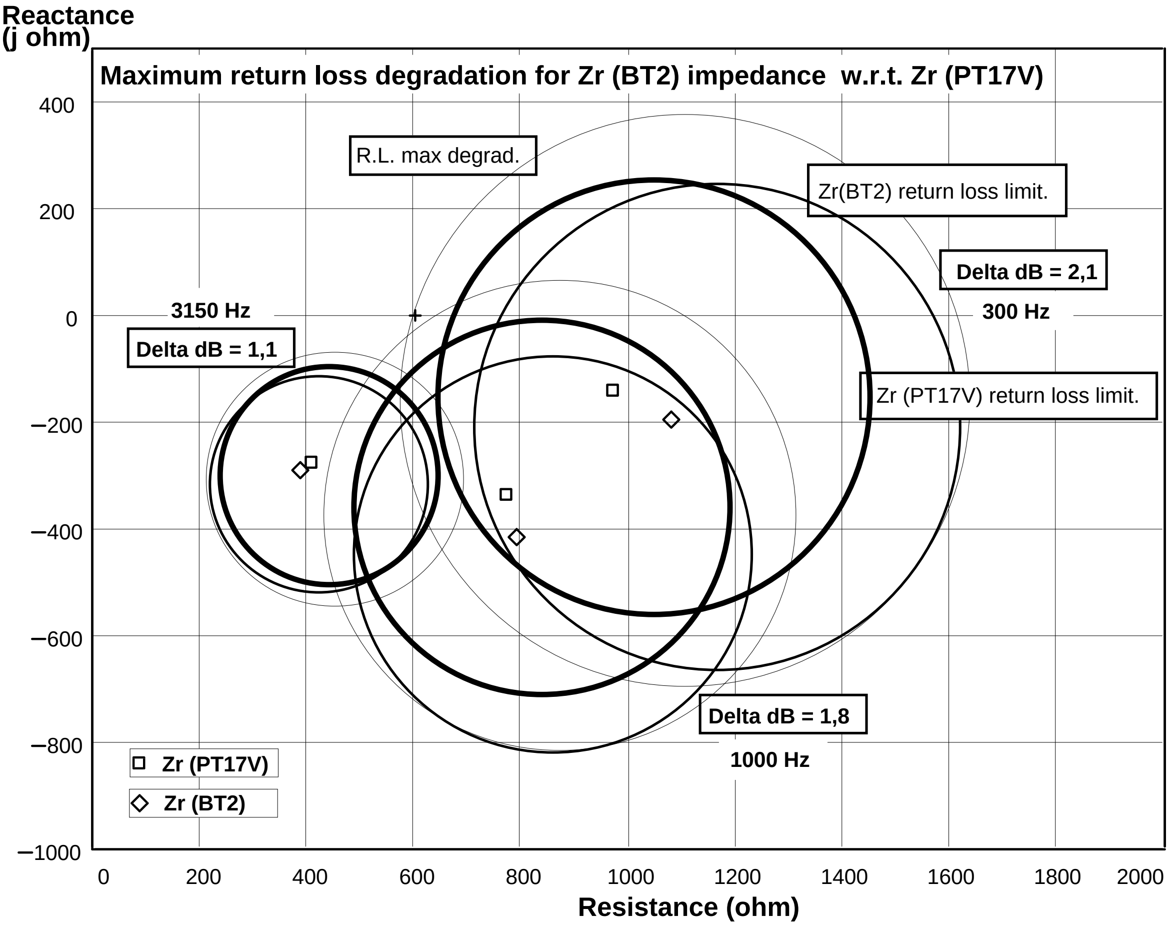
Zr (DK) impedance and return loss limits :

Return_lossc	Kdc	Krc	Frequ	Real_impedc	Imag_impedc	p	Real_centerc	Imag_centerc	Radiusc
14	1.083	0.416	300	855.9	− 141.8	1	926.9	− 153.6	360.6
18	1.032	0.256	1000	641	− 249.8	2	661.6	− 257.9	176
15	1.065	0.367	3150	442.9	− 140	3	471.8	− 149.1	170.6

Maximum degradation of the Zr (DK) return loss with respect to Zr (PT17V) :

Return_lossm	Kdm	Kr m	Frequ	Real_impedr	Imag_impedr	p	Real_centerm	Imag_centerm	Radiusm
11.6	1.149	0.565	300	971.3	− 140.7	1	1115.7	− 161.7	554.7
13	1.106	0.471	1000	773	− 334.5	2	854.6	− 369.8	397
9.7	1.24	0.733	3150	409.3	− 276.4	3	507.5	− 342.7	362.1
dB			Hz	ohm	j ohm		ohm	j ohm	ohm

Figure B.6.4: Maximum degradation for the Denmark impedance with respect to PT17V impedance



Zr (PT17V) impedance and return loss limits :

Return_lossr	Kdr	Krr	Frequ	Real_impedr	Imag_impedr	p	Real_centerr	Imag_centerr	Radiusr
14	1.083	0.416	300	971.3	− 140.7	1	1051.9	− 152.4	407.9
14	1.083	0.416	1000	773	− 334.5	2	837.1	− 362.3	350
14	1.083	0.416	3150	409.3	− 276.4	3	443.2	− 299.3	205.2

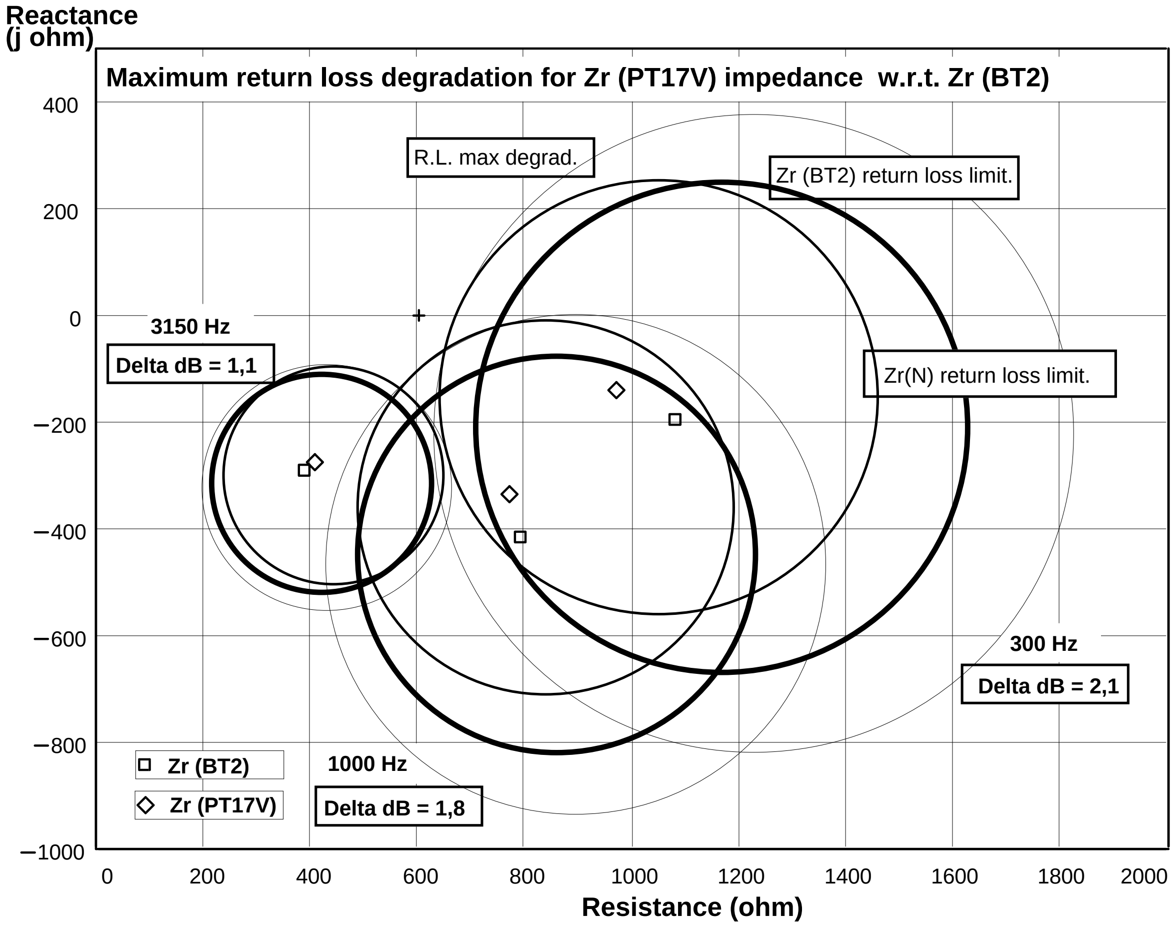
Zr (BT2) impedance and return loss limits :

Return_lossc	Kdc	Krc	Frequ	Real_impedc	Imag_impedc	p	Real_centerc	Imag_centerc	Radiusc
14	1.083	0.416	300	1078.6	− 193.1	1	1168	− 209.1	455.4
14	1.083	0.416	1000	792.7	− 414.8	2	858.5	− 449.2	371.8
14	1.083	0.416	3150	390.4	− 291.1	3	422.7	− 315.3	202.4

Maximum degradation of the Zr (BT2) return loss with respect to Zr (PT17V) :

Return_lossm	Kdm	Kr m	Frequ	Real_impedr	Imag_impedr	p	Real_centerm	Imag_centerm	Radiusm
11.9	1.138	0.543	300	971.3	− 140.7	1	1105.4	− 160.2	533.2
12.2	1.128	0.522	1000	773	− 334.5	2	872.1	− 377.4	440
12.9	1.108	0.477	3150	409.3	− 276.4	3	453.5	− 306.2	235.8
dB			Hz	ohm	j ohm		ohm	j ohm	ohm

Figure B.6.5: Maximum degradation for the BT2 impedance with respect to PT17V impedance



Zr (BT2) impedance and return loss limits :

Return_lossr	Kdr	Krr	Frequ	Real_impedr	Imag_impedr	p	Real_centerr	Imag_centerr	Radiusr
14	1.083	0.416	300	1078.6	− 193.1	1	1168	− 209.1	455.4
14	1.083	0.416	1000	792.7	− 414.8	2	858.5	− 449.2	371.8
14	1.083	0.416	3150	390.4	− 291.1	3	422.7	− 315.3	202.4

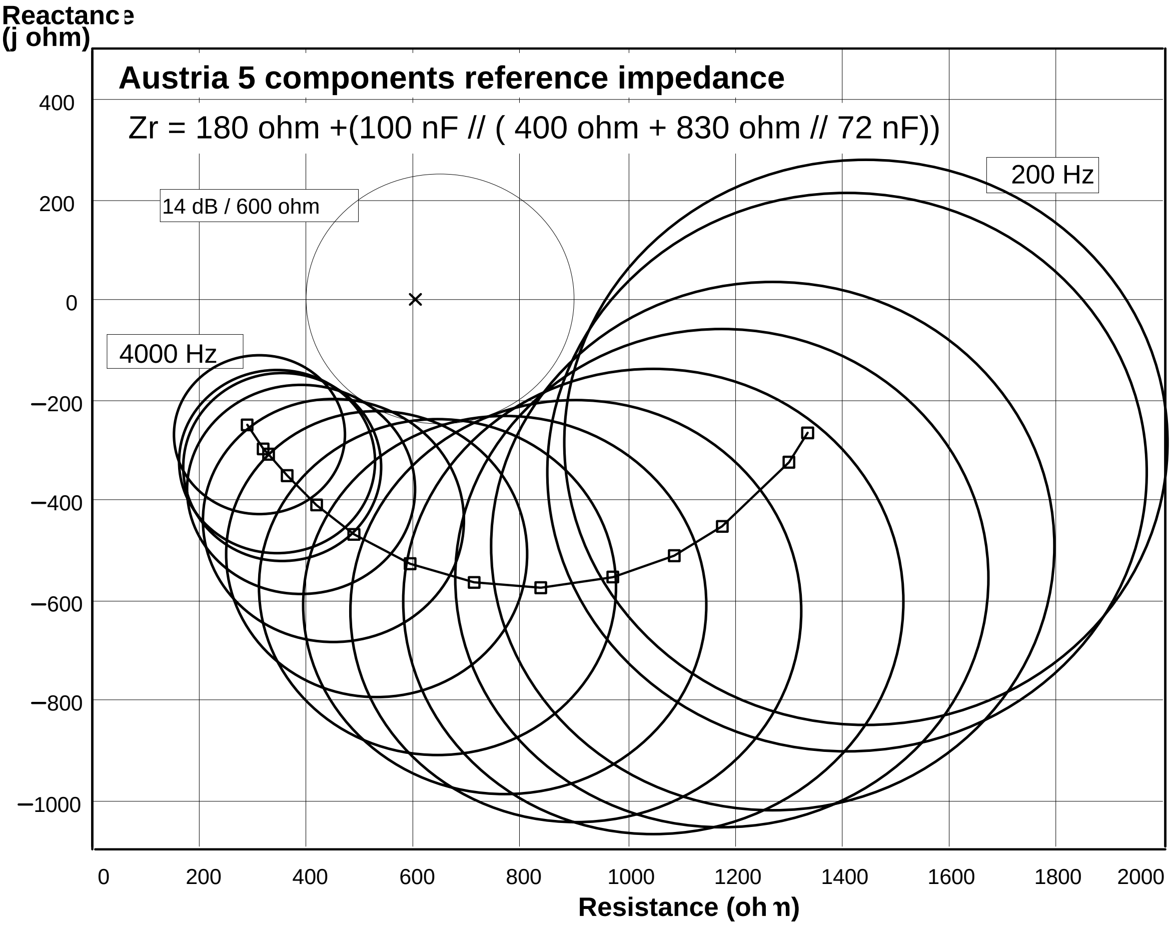
Zr (PT17V) impedance and return loss limits :

Return_lossc	Kdc	Krc	Frequ	Real_impedc	Imag_impedc	p	Real_centerc	Imag_centerc	Radiusc
14	1.083	0.416	300	971.3	− 140.7	1	1051.9	− 152.4	407.9
14	1.083	0.416	1000	773	− 334.5	2	837.1	− 362.3	350
14	1.083	0.416	3150	409.3	− 276.4	3	443.2	− 299.3	205.2

Maximum degradation of the Zr (PT17V) return loss with respect to Zr (BT2) :

Return_lossm	Kdm		Frequ	Real_impedr	Imag_impedr	p	Real_centerm	Imag_centerm	Radiusm
11.9	1.138	0.543	300	1078.6	− 193.1	1	1227.5	− 219.8	595.3
12.2	1.128	0.522	1000	792.7	− 414.8	2	894.4	− 467.9	467.4
12.9	1.108	0.477	3150	390.4	− 291.1	3	432.6	− 322.6	232.5
dB			Hz	ohm	j ohm		ohm	j ohm	ohm

Figure B.6.6: Maximum degradation for the PT17V impedance with respect to BT2 impedance



Values of the 5 components reference impedance and return loss limits for Austria "A":

Return_loss	Kd	Kr	Frequ	Real_imped	Imag_imped	p	Real_center	Imag_center	Radius
14	1.083	0.416	200	1334.1	−267.9	1	1444.7	−290.1	565.5
14	1.083	0.416	250	1300.2	−324.4	2	1408	−351.3	556.9
14	1.083	0.416	400	1175.2	−457.1	3	1272.7	−495	524.1
14	1.083	0.416	500	1083.8	−514.8	4	1173.7	−557.5	498.7
14	1.083	0.416	630	968.3	−558.6	5	1048.6	−605	464.6
14	1.083	0.416	800	834.7	−577.3	6	904	−625.2	421.8
14	1.083	0.416	1000	709.1	−566.4	7	767.9	−613.3	377.2
14	1.083	0.416	1250	594.2	−531	8	643.5	−575.1	331.2
14	1.083	0.416	1600	489	−473.1	9	529.6	−512.3	282.8
14	1.083	0.416	2000	415.9	−413.7	10	450.4	−448.1	243.8
14	1.083	0.416	2500	361.6	−355.4	11	391.6	−384.8	210.7
14	1.083	0.416	3000	328.4	−311.6	12	355.6	−337.4	188.1
14	1.083	0.416	3150	320.8	−300.7	13	347.4	−325.6	182.7
14	1.083	0.416	4000	290.2	−252.4	14	314.2	−273.4	159.8
dB			Hz	ohm	j ohm		ohm	j ohm	ohm

Figure B.7: Austria reference impedance data sheet SIMIMP_A

4.3 SECTION 3: Annex to the Chapter 4.2, Degree of Unbalance about earth

Annex to the Clause 4.2 of ETS 300 001, Unbalance about earth

4.3.1 Summary

This ETR compares, for the most part using a graphical representation, the various requirements values declared by each country, summarises country input status in a table, highlights the problems arising with the 4.2 paragraph structure and also assembles useful technical comments in detail.

4.3.2 Graph of the requirement values

The scattering of the requirements values provided by the ETS 300 001 [2] country inputs is depicted in the five graphs below for the following main requirements (see figures C.1 to C.5):

1) Attenuation value for all countries for the degree of unbalance about earth, case of LCL in quiescent condition (QC) for one-port TE (see figure C.1).

2) Attenuation value for all countries for the degree of unbalance about earth, case of LCL in quiescent condition (QC) for two-ports TE (see figure C.2).

3) Attenuation value for all countries for the degree of unbalance about earth, case of LCL in loop condition (LC) for one-port TE (see figure C.3).

4) Attenuation value for all countries for the degree of unbalance about earth, case of LCL in loop condition (LC) for two-ports TE (see figure C.4).

5) Attenuation value for all countries for the degree of unbalance about earth, case of LCTL in quiescent and loop condition (QC & LC) for two-ports TE (see figure C.5).

4.3.3 Summary status of the ETS 300 001 tables about the country inputs

Table 1: Replies figure on ETS 300 001, chapter 4.2, unbalance about earth

COUNTRY	Earth path	General test values	Specific test values	One-port LCL-QC	Two-port LCL-LC	Two-port LCL-QC	Two-port LCTL-QC	Two-port LCL-LC	Two-port LCTL-LC
Austria	**N.M.**	**N.F.**	**N.C.**			**N.M.**	**N.M.**	**N.M.**	**N.M.**
Belgium (B)	**N.M.**						**N.M.**		**N.M.**
Cyprus (CY)			**N.C.**				**N.M.**		**N.M.**
Czeckoslovakia	*N.I.*	*N.I.*	*N.I.*	*N.I.*	*N.I.*	*N.I.*	*N.I.*	*N.I.*	*N.I.*
Denmark (DK)		**N.F.**			**N.C.**	**N.M.**	**N.M.**	**N.M.**	**N.M.**
Finland (SF)							**N.M.**		**N.M.**
France (F)			**N.C.**				**N.M**		**N.M.**
Germany(D)			**N.C.**				**N.M.**		**N.M.**
Greece (GR)							**N.M.**		**N.M.**
Iceland (IS)							**N.M.**		**N.M.**
Ireland (IRL)	**N.F.**	**N.F.**			**R.M.**		**R.M.**		
Italy (I)							**N.M.**		**N.M.**
Luxembourg (L)	**N.M.**	**N.F.**		**N.F.**			**N.M.**		**N.M.**
Malta (M)	NI	NI	NI	NI	NI	NI	NI	NI	NI
Netherlands (NL)									
Norway (N)			**N.C.**				**N.M.**		**N.M.**
Poland	*N.I.*	*N.I.*	*N.I.*	*N.I.*	*N.I.*	*N.I.*	*N.I.*	*N.I.*	*N.I.*
Portugal (P)							**N.M.**		**N.M**.
Romania	*N.I.*	*N.I.*	*N.I.*	*N.I.*	*N.I.*	*N.I.*	*N.I.*	*N.I.*	*N.I.*
Spain (E)									
Sweden			**N.C.**	**N.F.**	**N.C.**	**N.F.**	**N.C.**	**N.C.**	**N.C.**
Switzerland (CH)			**N.C.**						
Turkey	*N.I.*	*N.I.*	*N.I.*	*N.I.*	*N.I.*	*N.I.*	*N.I.*	*N.I.*	*N.I.*
United King. (GB)	**N.F.**			**N.M.**	**R.M.**	**N.M.**	**N.M.**	**R.M.**	**N.M.**

Note: **Table 1 key:**

N.M.: Not Mandatory; **N.F.**: Not Filled; **N.C.**: Not Complete **R.M.**: Restricted Mandatory; *N.I.*: No Input (new country); NI: No Input (Malta) .

The **empty cells** mean there is nothing special concerning the country input for the related item.

4.3.4 Chapter structure matter in the ETS 300 001

The structure of paragraph 4.2 of the ETS 300 001 is very confusing, which has probably induced some wrong country inputs, conflicting values and sometimes unfilled table cells:

Table 2: Chapter and table structure of the ETS 300 001

GENERAL TABLES	Test conditions	Values of test figures
	Table A.4.2.a	**#Table A.4.2.**

SPECIFIC TABLES	**One-port TE**		**Two-port TE**	
	Requirements	**Test**	**Requirements**	**Test**
LCL-QC	**Table 4.2.1.1**	**Table A.4.2.1.1**	**Table 4.2.2.1.a**	**#Table A.4.2.2.1**
CL - LC	**Table 4.2.1.2** **Table A.4.2.1.2.b**	**Table A4.2.1.2.**	**Table 4.2.2.2.a**	**#Table A.4.2.2.2.b** **#Table A.4.2.2.2.b**
LCTL - QC			**Table 4.2.2.1.b**	
LCTL - LC			**Table 4.2.2.2.b**	**#Table A.4.2.2.2.a** **#Table A.4.2.2.2b** **#Table A.4.2.2.2.c**

As shown in the above table 2, **the test value tables** for the LCTL - QC (Longitudinal Conversion Transfer Loss in the Quiescent Condition) of the two-port TE is missed and table A.4.2.2.2.a & table A.4.2.2.2.b are allocated for both LCL - LC and LCTL - LC test values, making some confusions and also the general table (#table A.4.2.b) specifies similar test values as the specific tables (#table A.4.2.2.1, #table A.4.2.2.2.a, #table A.4.2.2.2.b) where some are repeated in contradiction with the others for at least 15 values.

Some test values are not appropriate for the purpose of the associated measurement, for example the values of RL are wrongly specified in the table A.4.2.2.1 where the purpose is to make the test in quiescent condition which means an infinite value or open circuit (not 300 Ω or other...) and also some range of feeding conditions are specified in quiescent state for which it is not really appropriate when the TE is off-line.

The above examples confirm that there has been some confusion when the tables have been filled, because the structure of chapter 4.2 is really unclear, the consequence is that some inputs need to be checked and clarified under a questionnaire that should be addressed to some national bodies.

4.3.5 Technical comments

The **Not Mandatory** indication probably means that the parameters proposed as requirements (**LCL, LCTL**) are not significant to the network performance when the TE input is unbalanced about earth, those parameters are rather relevant to the receiving quality in the TE side.

Other **Not Mandatory** indications, considering in the TE side, mean that the parameter's effect on the receiving quality is negligible as is the case of the **LCTL requirement,** but the question remains when some significant parameters such as **LCL requirement** are declared not mandatory or remain unfilled (**NF**), or when some test values are declared not mandatory with an associate mandatory requirement, or where the indications are not complete (**NC**) (see above the summary status table about the country inputs).

4.3.5.1 About LCL requirement in quiescent condition

In quiescent condition, CCITT Recommendation G.117 [5] and the figures A.4.2.a & A.4.2.b specify the addition in parallel of the entry-port an impedance Z2 when the input impedance of the TE under test is high; this case arise when the TE is in quiescent condition or a high input impedance type; the result of the measurement is very sensitive about the value of Z2, the fact that some countries do not specify Z2 or use a different value of Z2 induces inconsistencies in the measurement results

4.3.5.2 About test figures

The results of these measurements are not easily reproducible and their repeatability is not ensured if no care are taken about the position with respect to earth, about the specified earth path, about the hand-set and hand-set cord position, about the electromagnetic interferences and about the circuits and measurement apparatus balance or components matching.

A simplified test arrangement is suggested in a preliminary report in the next section 4 "**Harmonization feasibility for testing methods"**, for the measurement of the LCL parameters, which would be easily adaptable to the OSB parameter.

The measurement circuit including the feeding bridge and the measurement apparatus need to be as well balanced as possible (greater than 20 dB more of the loss requirement), consequently one comprehensive description and specification of the feeding bridge is suggested with the associated method intended to verify globally the testing arrangement balance.

An optional arrangement suppressing the unbalance effect of the feeding bridge is also suggested.

For the series-connected TE measurement a more simple simulation of the reference one-port TE connected to the second port of the two-port TE is proposed.

A comprehensive test figure should be described, including the earth path description around the TE, also special care should be taken around the handset and the handset cord, for which the position in relation to earth is very sensitive on the measurement result.

We suggest for the quiescent state to specify the test and requirement values about feeding components at their nominal values not a range of values (e.g. Vfnom=60v, Rfnom=600Ω rather than +Vf, +Rf in the quiescent state test) and for the loop condition we suggest to specify the test for only three values of DC current loop (If minimum, If nominal, If maximum), the requirement being obviously apply in all the current loop range (If minimum to If maximum).

4.3.5.3 About requirements values

The maximum number of terminals (N) which could be connected in parallel should be settled in terms of the value of balance degradation in dB when adding one terminal more, in the worst relative polarity case. (e.g. if the balance degradation is around 3 dB per terminal then four to six terminals could be associated in parallel without degradation of the requirement applied to one terminal in loop condition).

Regarding the large distribution of overall values available, as depicted in the figures C.1 to C.2, **27 dB** in the frequency range (50 Hz to 300 Hz) and **17 dB** in the frequency range (300 Hz to 3 400 Hz) it is likely that the various measurements of the countries were made without consistent conditions, the result being very sensitive to the various positions with respect to earth of the terminal and its accessories as we already demonstrate above.

A wise attitude should be to retain the more stringent requirements as harmonized values, in example in this case the requirement of Switzerland **(CH)** for which a foil earth path is applied around the whole handset, but there are no indications about the distance of the TE and the earth plane. If an assessment is made that the feet of the TE are probably input directly on the metallic plane it can be asserted that the **(CH)** requirements are the most stringent.

The most stringent requirement would not overcome problems caused by the old range of terminals and might induce some higher difficulties and higher costs into the terminal design.

The less stringent requirements might degrade too much the receiving quality of the terminal especially when several terminals are connected in parallel.

In fact the LCL parameter seems to reflect the receiving quality of the terminal with respect to the common mode rejection., but it is recognised that the longitudinal signal generated by unbalanced TE input could harm also the network by cross-talk effects. Therefore, it is cautious to consider the LCL parameter as being relevant, although the Output Signal Balance loss (**OSB**) might also be relevant for the determination of the degree of the unbalance about earth, because it is not sure that a TE presents the same balance value for **OSB parameter** and for **LCL parameter.**

The (**OSB**) parameter should be also required in the case of series-connected TE where the simulated-one-port TE would be caused to output the signal test with a high degree of balance about earth.

In view of the above considerations it is unreasonable to define a harmonized value in the present situation. A questionnaire should be addressed to the national bodies in order to collect the requirement values according a common test method and arrangement which should be clearly described.

Annex C: Degree of unbalance about earth graphs

C.1 Degree of unbalance about earth LCL-QC one port-TE

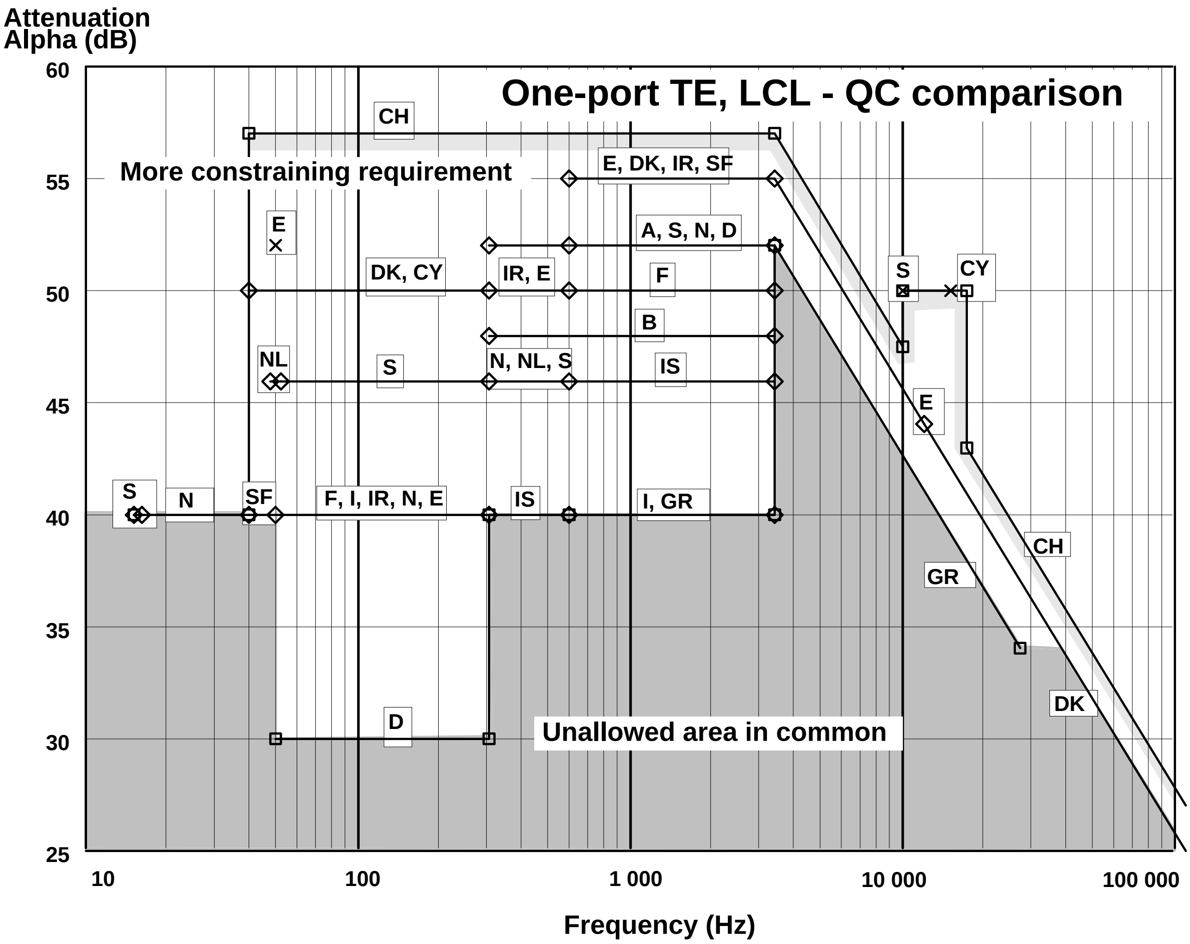


Figure C.1: Comparison of the attenuation value for all countries for the degree of unbalance about earth, case of LCL in quiescent condition (QC) for one port TE

C.2 Degree of unbalance about earth LCL-LC one port-TE

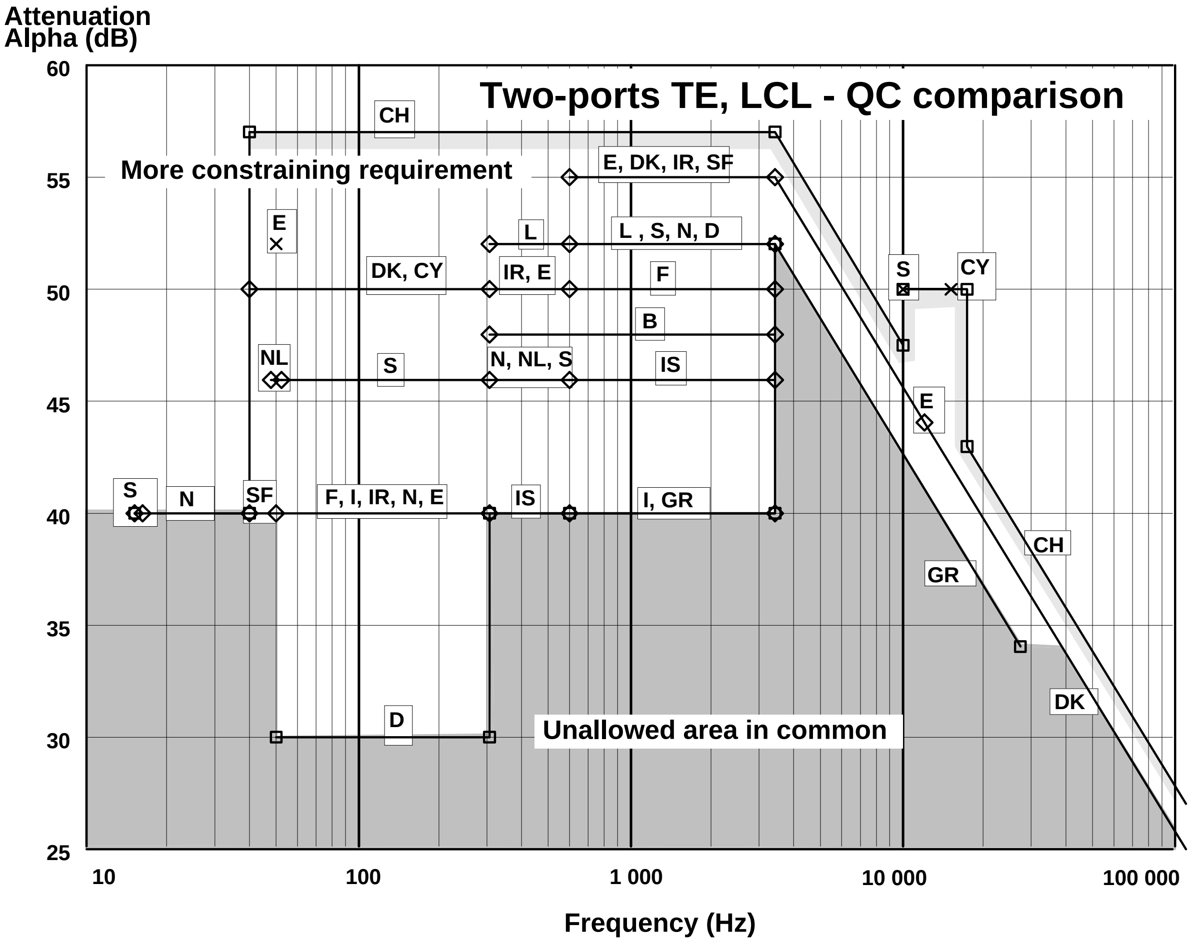


Figure C.2: Comparison of the attenuation value for all countries for the degree of unbalance about earth, case of LCL in loop condition (LC) for one port TE

C.3 Degree of unbalance about earth LCL-QC two ports-TE

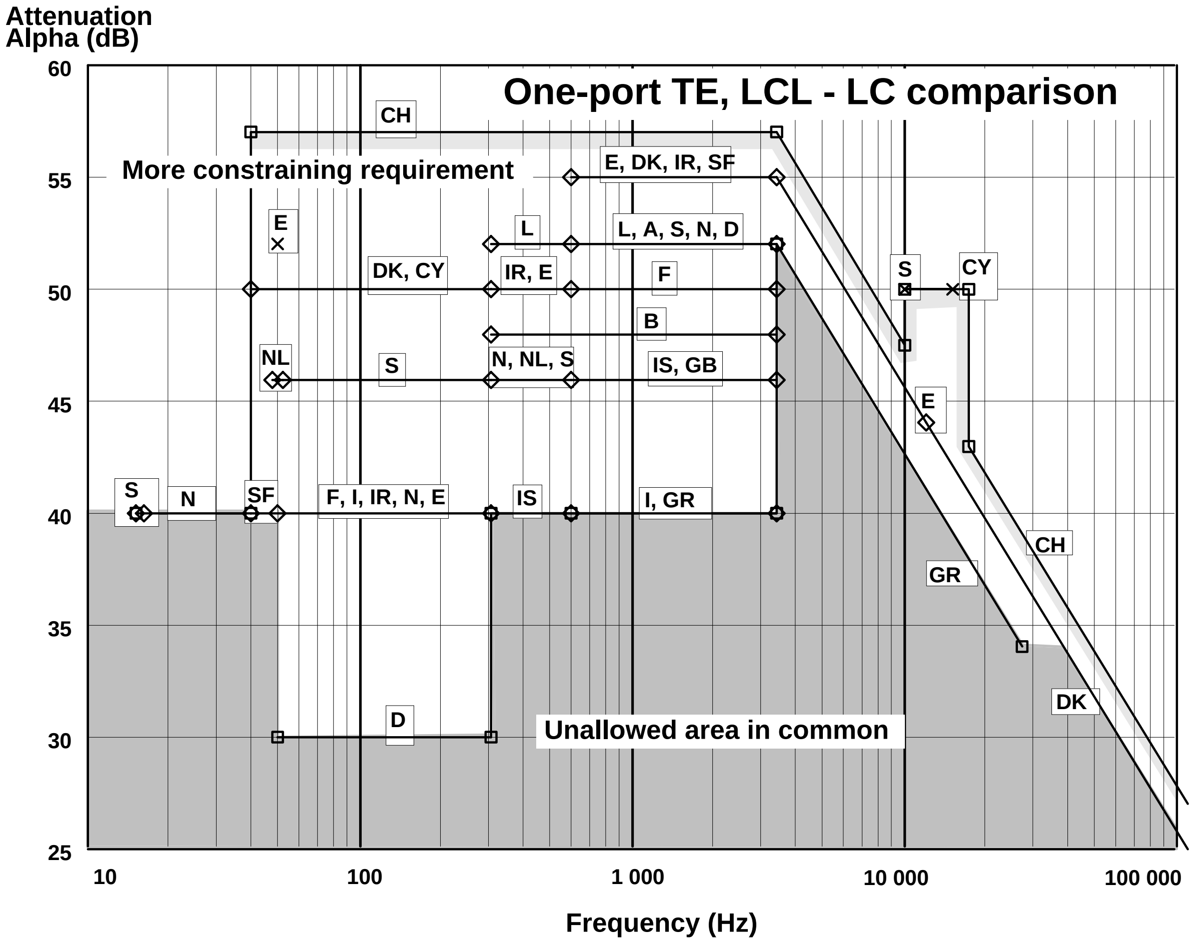


Figure C.3: Comparison of the attenuation value for all countries for the degree of unbalance about earth, case of LCL in quiescent condition (QC) for two ports TE

C.4 Degree of unbalance about earth LCL-LC one port-TE

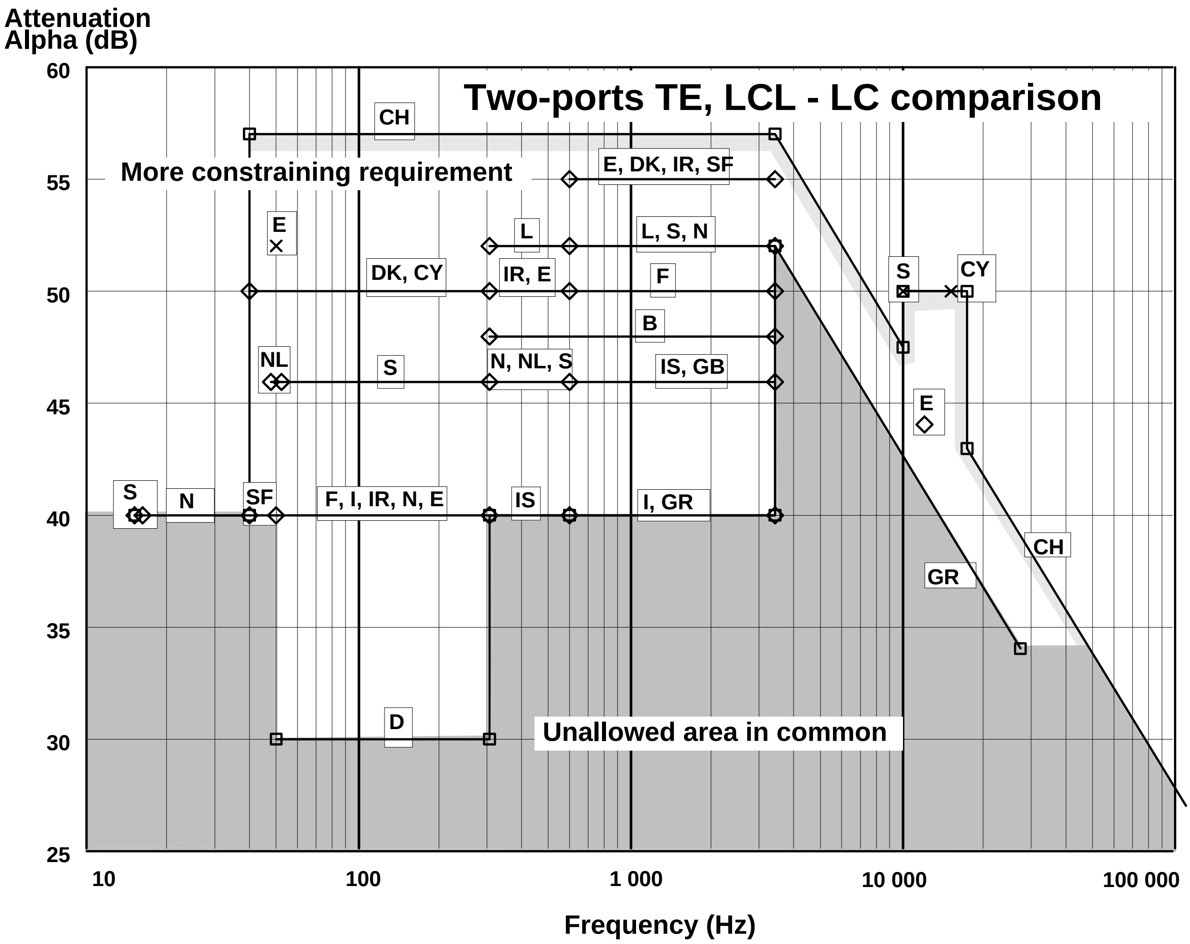


Figure C.4: Comparison of the attenuation value for all countries for the degree of unbalance about earth, case of LCL in loop condition (LC) for one port TE

C.5 Degree of unbalance about earth LCL-QC & LC two ports-TE

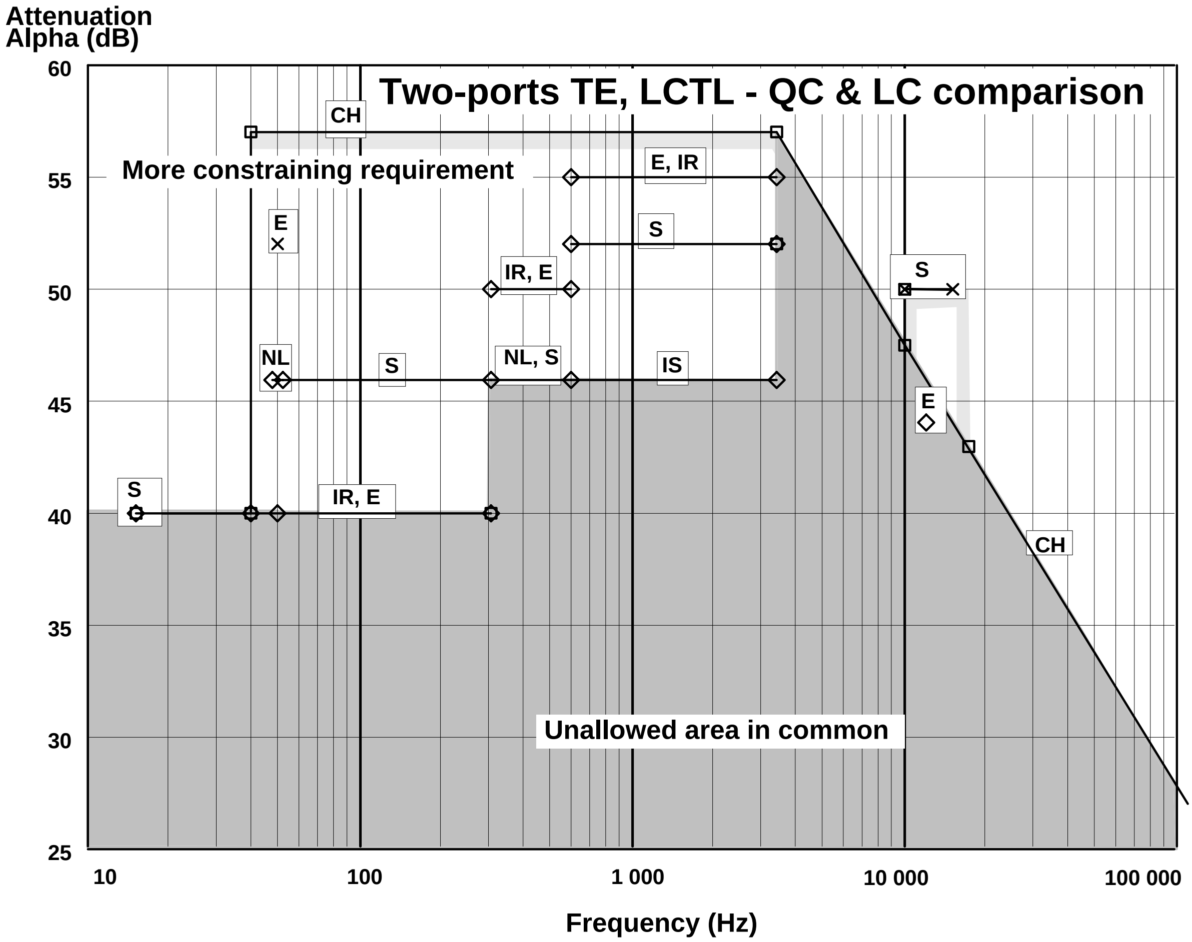


Figure C.5: Comparison of the attenuation value for all countries for the degree of unbalance about earth, case of LCL in quiescent and loop condition (QC and LC) for two ports TE

4.4 SECTION 4: Harmonization feasibility for testing methods Preliminary Report

Harmonization feasibility for testing methods Preliminary Report

4.4.1 Foreword

This subclause sets out general considerations concerning testing methods in ETS 300 001 [2] and the feasibility of their harmonization so as to ensure consistent results between the different test houses. It does not pretend to be an exhaustive study giving the final solutions. It only highlights the main problems, suggests some target solutions, gives some practicable examples on the most important matters, and recommends further study so as to propose harmonized testing methods.

4.4.2 General

Bearing in mind that it is not practicable to measure continuously all the values in a domain and to apply all the combinations of the conditions parameters, due to the infinite time necessary and excessive cost, it is recognised that the test is only a subset of the characteristics required. Therefore in the test procedure the measurements points need to be chosen with a knowledge of the behaviour of the physical phenomenon so as to predict or assess the intermediate values as a continuous function. In the case of discontinuous phenomenon, it should be possible to make additional tests around the suspected domain.

In order to reduce the cost of the test it is also necessary to take into account the correlation between the parameters so as to reduce the number of the measurements (e.g. a low current in the line is normally related to a long line condition).

The measurement answer is closely dependent on the conditions applied (e.g. feeding conditions) and on the test arrangement effects (e.g. feeding bridge impedance leakages). It is also affected by the accuracy of the measuring apparatus and by the measuring method used. It is necessary to reduce these unwanted effects to a value which will not affect the desired accuracy of the measurement

The measurement method needs to ensure the reproducibility of the results and protect the validity of the measurement (e.g. against noise, saturation effects, non-linearity, etc...).

The measurement method should also describe the process required to set the TE to an appropriate state or to cause it to produce the required signal with the right characteristics so as to permit the relevant test to be carried out. In certain cases, a full description may be difficult or impracticable.

It is also recognised that the use of automated test processes should contribute to the reproducibility and the accuracy of the measurements, and would allow the unwanted effects of the test arrangements to be corrected by straightforward calculations. Such techniques are now possible due to the availability of sophisticated technology at a reasonable price. Although there is a need to harmonize the test methods, it is necessary to take into account the existing apparatus actually used in the test houses, which represents a significant investment The method specified should also be suitable for manual operation. Therefore the descriptions given in this document must be considered as a target in the future in order to progress towards **"the mutual recognition of test methods"** between test houses.

4.4.3 Comments

In the testing the following main problems arise

> **Feeding bridge effects:** The series and parallel path impedances of the feeding bridge have significant undesired effects increasing in the low and high frequency ranges (see annex D.1 and figure D.11)
>
> **Impedance (return loss) and transfer measurements:** The values of the impedance under measurement and the transmission levels need to be recalculated to take into account the unwanted effects of the feeding bridge (see annex D.1, figure D.8).

Feeding conditions: Most of the tests have results which vary with to the line current (which is normally correlated with the line length). Some results are made deliberately dependent on the line length. Different feeding condition might be necessary in cases where constant feeding current is used (as for the AXE10 interfaces in GB).

DC current and loop resistance test: The test for the DC characteristic appears insufficient to ensure the compliance of the loop closure starting condition at low voltage and the stability with constant current feeding (see annex D.2).

Validity of the measurements: In AC measurements the results are widely dependent on the input/output signal correlation which could be affected by non-linearity, extraneous noise, information lost in processing, uncompensated delays, etc... Therefore a coherence calculation could be useful to confirm the validity of the measurement conditions.

Balance about earth of measurement arrangements: For the unbalance measurements the test arrangements and the input of measurement apparatus needs to be better balanced than the terminal under test. Methods to control the balance of the testing equipment needs therefore to be described (see annex D.3).

Physical position of the TE under test with respect to earth: In the unbalance about earth measurement the most sensitive part of the test arrangement is the earth path, which is very dependent on the terminal position with respect to earth. Therefore a harmonized geometric description with respect to an artificial earth needs to be defined.

Loop disconnect rise and fall times: Because the performance of a spark quench circuit can be affected by the feed conditions, further study is needed in this area.

MFPB rise time measurement: Because it is difficult to measure the frequency spectrum during the MFPB rise time, a simple and pragmatic solution is suggested (see annex D.4, figure D.17).

Setting up the TE in the relevant test phase and conditions: For some type of equipment it may be necessary to perform special actions to set them into the correct mode for the detector to operate. Such problems, which are terminal specific, need to be dealt with in the test description.

Causing the TE to output the signals: When the test requires output signals from the TE, the means to cause it to provide such signals at the expected levels (e.g. maximum transmission level) have to be described specifically according the type of terminal.

Adaptive terminals: Some modern TEs adapt their performance according to the characteristics of the circuit to which they are connected. It is therefore important to make sure that the test apparatus presents appropriate conditions to the apparatus under test.

Compliance by noting the detection result: It may be difficult to determine directly the operation of the detector without modification to the apparatus or its software. Such problems, which are terminal specific, need to be dealt with in the test description.

Compliance by inspection: The specification of such a test needs to be treated with caution because it is subject to interpretation and might be not objective.

4.4.4 Analysis

4.4.4.1 Feeding bridge effects

The feeding bridge is a part of the test arrangement that significantly affects the measurement results especially in the low frequency range. There are three possible approaches to the provision of the feeding bridge (see annex D.1):

the use of a "normal" feeding bridge giving typical performance degradations and losses;

the use of a "perfect" feeding bridge with less than 1 % effect on the measurements;

the use of a good feeding bridge using mathematical correction for its effects;

is not practicable for harmonization because there are many types of "normal" bridge in each country and different types throughout Europe.

In order to ensure consistent results between the various test laboratories in Europe, it is desirable for the feeding bridge to have negligible effect on the result (see annex D.1). Therefore a solution to reduce the systematic effects of the feeding bridge is necessary.

Considerable simulations have been performed in the preparation of this ETR in order to evaluate the effects of the feeding bridge on the measurements made with various impedances which could be found in the field of analogue data transmission and telephony.

The feeding bridge should exhibit sufficiently high impedance and small transfer losses in the frequency band in question to ensure that the results are not affected.

At the lower frequency (200 Hz) the majority of the feeding bridge values provided by the different countries give very poor accuracy and for some of them (e.g. those with Cf = 2 µF, Lf = 2H for Denmark, see ETS 300 001 Chapter 1, table 1.5) the errors are significant (see annex D.1, figures D.1, to D.4).

It is difficult to specify a feeding bridge with practicable values of Cf and Lf, appropriate to the impedance of the TE under test. For example, if the aim is to reduce the undesired effects to below 1 % the corresponding return loss is 46 dB and the value of the feeding bridge components are Cf = 700 µF, Lf = 50H, which are really impracticable (see annex D.1, figure D.2).

The aim of the following analysis is to derive a feeding arrangement which allows consistent and repeatable measurement results in the various test houses.

The R,L,C feeding bridge specified in the ETS 300 001 (see Annex D.2, figures D.9 to D.11) has the disadvantage of producing variable series and parallel disturbances depending mainly on the frequency and DC current value.

The feeding bridge used for the AC and DC path decoupling, can have a significant effect on the AC measurements such as transmission levels or impedance measurements, especially at low frequencies where the parallel impedance Lfw decreases and the series impedance 1/Cfw increases but also at the high frequencies where the losses of the magnetic core of the inductance increase with the frequency, acting as a non-linear resistor dependent on frequency [R(w)] (see figure D.11).

The inductance Lf decreases when the DC current reaches the saturation region of the magnetic core material.

The effects produced by the feeding bridge depend on the impedance value under measurement, and are more significant in the case of higher impedance. The largest impedance under test chosen as the worst case of the impedance in the loop condition for this evaluation is Zum max = 200 ohm + (1 500 ohm // 100 nF // 0,5 H) (see annex D.1, figure D.5).

The feeding bridge is also used for some measurements outside the speech band. On the low frequency side in the case of unbalance about earth (from 15 Hz) and on the high frequency side for the case of pulse meter frequency range (10 kHz and 20 kHz). It is also used for the unwanted outband signal levels sent to line up to 100 kHz - 200 kHz and even up to several MHz for some country. It is not really possible to build a feeding bridge with negligible effects covering all these frequency bands and it is anyway not realistic to use it for very high frequencies such as 100 kHz to several MHz where self-resonance of the inductances may occur and the hysteresis losses are very high.

It is very difficult to build several feeding bridges in various countries with negligible differences and repeatable effects. An expected accuracy of 1 % entails the use of very large value of inductances and capacitors(**Lf = 50H**, **Cf = 700 µF)** which requires a very **big magnetic core** with very **low losses** with **linear characteristics** B=f(NI) and **high saturation threshold values** (see annex D.1, figure D.2).

The national inputs to the chapter 1.5 of ETS 300 001 [2] show various feeding bridge values. Some of them are very low and seem to be the usual values of the PSTN interface (DK, 2 µF, 2H) rather than values for a testing purpose. The other typical values are spread as follows: (N, 10 µF, 2,5H); (D, 47 µF, 5H); (F, 100 µF, 5H); (GB, 400 µF, 10H) (see annex D.1, figures D.1, D.3, D.4). The effect of these feeding bridge values are shown in the graph in the annex D.1, expressed as impedance and as accuracy of the impedance in term of return-loss tolerances. The national inputs do not indicate if the inductances are coupled or not. This is very important because when coupled, the mutual inductance needs to be considered, and in this case, two inductances of 2H closely coupled present a total inductance value equal to 8H!

The values of the feeding bridge of DK are not acceptable for measurement purposes, because the accuracy of the measurement is very poor. The best accuracy is exhibited by GB where the component values are high. The case of the France and Germany exhibits a medium accuracy with medium components values and it is interesting to notice that the German case, using a smaller capacitor than France, gives a better accuracy than the French case for impedances around 600 ohm, because the image impedance of the feeding bridge is very close to 600 ohm (2Lf = 10H, Cf/2 = 27,78 µF) which means that the accuracy is better for impedances under measurement that are close to 600 ohm.

In practice a feeding bridge with high value and high quality of the inductance over a wide frequency spectrum seems very difficult to build in an acceptable size, It should be better to build a feeding bridge with normal values such as the German case **(Lf = 5H, Cf = 55 µF),** so minimising the disturbances at 600 ohm (which is a centre value of the complex impedance area) and then to take into account the disturbances by calculations according the process described below.

4.4.4.2 Impedance (return loss) and transfer measurements

1) Transfer measurements

See Annex D.2, Figure D.11.

Where: $Zum = Rum + j \cdot Xum$ is the impedance under measurement.

$Zp = Rp + j \cdot Xp$ is the parallel impedance of the feeding bridge.

$Zs = Rs + j \cdot Xs$ is the series impedance of the feeding bridge.

$Zx = Rx + j \cdot Xx$ is the measured impedance including the bridge effects.

- The impedances of the feeding bridge, Zp and Zs are previously measured for each frequency (at different DC currents for Zp) and stored in the memory of the associated computer. This method has the advantage of taking into account the imperfections of the feeding bridge for each point of measurements.

- The impedance Zx is measured when the impedance under measurement is connected at the output AC/DC path of the feeding bridge using the usual method: $Zx = \frac{V(t)}{I(t)}$ where $V(t) = V \cdot Cos\,(w \cdot t)$ and $I(t) = I \cdot Cos\,(w \cdot t + q)$, $Rx = |Zx| \cdot Cos\,(q)$ and $Xx = |Zx| \cdot Sin\,(q)$; or using a dual channel FFT analyser by means of cross-spectrum.

- The Zum impedance is calculated by using the following formulae by means of the associated computer:

$$Xum = \frac{(Xx - Xs)\cdot\left(Rp^2 + Xp^2\right) - Xp\cdot\left(Rx^2 + (Xx - Xs)^2\right)}{(Rp - Rx)^2 + (Xp + Xs - Xx)^2}$$

- The return-loss is then calculated using the following formula:

$$m(dB) = 10\cdot\log\left[\frac{(Rum + Rr)^2 + (Xum + Xr)^2}{(Rum - Rr)^2 + (Xum - Xr)^2}\right]$$

2) Transfer measurements

Using similar methods the transfer performance could be derived using the transfer parameters of the feeding bridge, in order to correct its insertion effects.

4.4.4.3 Feeding conditions

- Most of the requirements apply within overall the range of DC feeding conditions from a minimal condition to a maximal condition, which correspond respectively to the longest line of the smallest copper gauge, with the minimum battery voltage through the maximum feeding bridge resistance and to the shortest line (length=0) feeds with the maximum battery voltage through the minimum feeding bridge resistance.

In other words the DC feeding conditions range from the minimum current which occurs at maximal feeding resistance (Rfmax) and minimal feeding voltage (Vfmin), to the maximum current which occurs at the minimal feeding resistance (Rfmin) and maximal feeding voltage (Vfmax), taking into account the DC characteristic of the terminal which is commonly non-linear. Therefore it should be preferable to specify for the testing values the feeding voltage (Vf) and the feeding resistance (Rf) instead the feeding current (If), bearing in mind that the specification of all three parameters (Vf, Rf, If) at the same time has to be avoided so as to prevent over specification which could be inconsistent. Nevertheless the existing case of constant current feeding needs further study although it is not highlighted in the ETS 300 001 [2].

It is essential to make the test in all the range of the feeding conditions including the extreme conditions, because some transmission parameters are variable with respect to the line length which is commonly deduced from the DC line current (If). Therefore in some tests the correlation between the line length and the feeding condition should be taken into account so as to reduce the combination of dependent parameters in order to reduce the testing cost.

The various countries exhibit different extreme feeding conditions which are very difficult to manage into one common set of testing conditions and which are closely dependent on the DC characteristic mask harmonization. Therefore for this reason and also for the case of constant current feeding, further study is necessary in accordance with the final DC characteristic mask so as to define the feeding parameters for the majority of the ETS 300 001 [2] tests (see annex A in the section 1 of this report, figures A.10, A.11 and also the DC mask of each country figures A.22.1 to A.22.19).

4.4.4.4 DC current and loop resistance test

(See annex D.2, figures D.12 and D.13).

In addition to the plotting of the DC (V=f(i)) characteristics, it seems indispensable to check the ability of the terminal to loop the line at a low voltage and also to check the stability of the static state in the case of constant current feeding.

In the case of parallel association in the loop condition, where a first TE is already on-line and a second TE attempts to be also on-line at the same time, this second TE must close the loop with an applied voltage of around 5 v to 10 v, so as to comply with the DC mask. It appears also in ETS 300 001 [2] that some low minimum feeding voltages are declared by the countries (such as 15 v, 24 v, 36 v) under which the TE also needs to ensure loop closure.

Although constant current feeding is not highlighted in ETS 300 001 [2], it is known that such PSTN interfaces exist in the field. With this type of feed it is possible for instability of the DC characteristics to occur with some terminal designs, and therefore such a test could be useful.

4.4.4.5 Validity of the measurements

In order to ensure an acceptable accuracy in the AC measurements, where a quadripole transfer is measured (e.g. Input/output transfer or impedance measurement with Voltage/current transfer), It is of great importance to assess the degree of the linear relationship between the input and output signals and to have some evaluation means for some other disturbances such as uncorrelated extraneous noise contamination, or information lost in the analysis process (resolution-bias errors).

To achieve this the use of a very interesting parameter is suggested, which is the **correlation coefficient** (rxy) between the input (x) and the output (y) signals:

$$\rho_{\mathrm{xy}} = \frac{\sigma_{\mathrm{xy}}}{\sigma_{\mathrm{x}} \cdot \sigma_{\mathrm{y}}}$$

Where σxy is the covariance of x and y given by

$$\sigma_{\mathrm{xy}} = \mathrm{E}\left[\left(X-\mu_x\right)\cdot\left(Y-\mu_y\right)\right]$$

and σx and σy are the standard deviations of x and y defined by

$$\sigma_x = \sqrt{\mathrm{E}\left[\left(X-\mu_x\right)^2\right]} \text{ where } \mu_x = \mathrm{E}[\mathrm{X}]$$

$$\sigma_y = \sqrt{\mathrm{E}\left[\left(Y-\mu_y\right)^2\right]} \text{ where } \mu_y = \mathrm{E}[\mathrm{Y}]$$

The $\left|\rho_{xy}\right|$ will have a value between 0 and 1 and the value will be 1 if there is a perfect linear relationship between X and Y. If there is some extraneous noise in the measurements of the input X and/or the output Y or if the relation between the values X and Y is well defined but non-linear the value of **correlation coefficient** will be less than 1. In case of the variables X and Y are not at all related to each other, then the **correlation coefficient** will be 0.

The **correlation coefficient** assesses the validity of the measurement for each value of the spectrum against:

- the uncorrelated extraneous noise in the measurement;
- the non linearity of the system under test (e.g. case of overloading);
- leakages in the analysis process (e.g. resolution-bias errors);
- delays in the system not compensated.

Using modern automated digital equipment such as Dual channel FFT analysers it is very easy to use the **coherence definition** which in fact reflects the degree of linear relationship between the two signals at any given frequency using the cross-spectrum and auto-spectrum facilities of the dual channels FFT analyser.

The **coherence definition** corresponds to the **Correlation coefficient squared:** $\rho_{xy}{}^{2}$

The coherence definition is:

$$\gamma^2(f) = \frac{\left|S_{AB}(f)\right|^2}{S_{AA}(f) \cdot S_{BB}(f)}$$

Where $S_{AB}(f)$ is the cross-spectrum between the two signals a(t) and b(t) defined by:

$$S_{AB}(f) = A^*(f) \cdot B^*(f) \text{ where } * \text{ indicates the complex conjugate}$$

Where $S_{AA}(f)$ is the auto spectrum of the input signal a(t) defined by:

$$S_{AA}(f) = A^*(f) \cdot A^*(f) \text{ where } * \text{ indicates the complex conjugate}$$

Where $S_{BB}(f)$ is the auto spectrum of the input signal b(t) defined by:

$$S_{BB}(f) = B^*(f) \cdot B^*(f) \text{ where } * \text{ indicates the complex conjugate}$$

Where $A(f)$ and $B(f)$ are respectively the Fourier Transform complex spectrum of the time signals $a(t)$ and $b(t)$.

It is realistic to use such modern digital processes inside automated testing equipment which is available in the marketplace from many sources.

Measurement arrangement's balance about earth: (see annex D.3, figures D.14 and D.15).

Further study is necessary in order to specify the balance of the measurement arrangement, which should be at least 20 dB better than the required value for the Terminal Under Test in order to define a practicable method to check the validity of the measurement of balance but also of the correlation of the input/output signals as described above because it is known that this test is very sensitive to uncorrelated interference.

4.4.4.6 Physical position of the TE under test with respect to earth

Special precautions have to be considered for the physical position of the TEUT and the position of any external accessories such as the handset and its cord in relation to the earth plane, the result of the measurement being closely dependent on the capacitive path between the TE circuits and the earth plane.

The worst case in use is when the feet of the TE are standing on a metallic table connected to earth, but the problem is to define the position of the mobile accessories with respect to the earth plane. Various proposals are in the national inputs: earth-plane, foil around the whole apparatus, the use of an artificial hand. The earth plane and the handset in the telephonometry position on the artificial head connected to the earth plane seems the more popular and the more realistic method practised by the majority of the test houses, but in any case, a geometrical description needs to be set out.

4.4.4.7 Loop disconnect rise and fall times

The source impedance of the feed circuit affects the operation of any spark quench circuit used in a loop disconnect circuit such as a decadic dialler or a recall facility.

The feed circuit currently specified in ETS 300 001 [2] with its variable feed resistor will produce varying results for the differing national test conditions.

Further study is necessary to derive a satisfactory solution.

4.4.4.8 MFPB rise time measurement

(See annex D.4, figure D.17).

It is difficult in practice to measure the duration of the MFPB rise time where the transient is not a simple time function threshold, but has a spectral component content which is not correct during the transient period because the contribution of several effects as a stepping function due to the DC characteristic transient followed by an exponential function due to the time constant of the circuit, superimposed with a random start of the MF generator (and in some case contact bounces), including the expected frequency components which progress towards their final shape (see the MFPB signal graph in the annex). Therefore, a practicable and pragmatic method is suggested below so as to permit a simple and low cost test.

The measurement of the useful spectrum signal should start after a period equal to the maximum rise time period specified counted from the time where the signal exceed a low threshold for example equal to - 33 dBm. Then if the signal spectrum complies with the requirement we could assume that the rise time does not exceed the maximum required value. In the case of failure to comply, the reason could be due to the rise time contribution or other effects, but in any case the test is not passed.

4.4.4.9 Setting up the TE in the relevant test phase and conditions

The test method needs a precise description of the relevant test phase and condition into which the TE needs to be set for each particular test.

Obviously the set-up procedure is terminal specific and so cannot be included into the test part of the ETS 300 001 [2], nevertheless the set-up procedure "how to do it" should be described somewhere, perhaps in the TE instruction-book, connected to the test specifications with consistent editorial terms and format so as to allow coherent understanding. Therefore, further study is necessary in order to find a practical and helpful solution.

4.4.4.10 Causing the TE to output the signals

The test method needs precise wording calling for the TE to be caused to output the desired signals.

As for paragraph 8 above, further study is needed in order to connect the test specification in a common form to the specific terminal procedure.

4.4.4.11 Adaptive terminals

Some types of modern terminal equipment are able to adapt their performance according to the characteristics of the circuit to which they are connected. Some modems adjust their input impedance to match the source impedance of the circuit to which they are connected. Some loudspeaking telephones adjust their balance impedance in the same way.

In these circumstances it is important that the test circuit presents to the terminal the specified target impedance. Otherwise the equipment under test would be caused to fail, when in practice it should have passed.

4.4.4.12 Compliance by noting the detection result

The test method needs a precise definition of the detection result in a form which could be used for measurement purposes without requiring any special modification to the apparatus submitted for test.. Where this cannot be achieved, the requirement will need to be suitably amended.

As for paragraph 8 above, further study is needed in order to connect the test specification in a common form to the specific terminal procedure.

4.4.4.13 Compliance by inspection

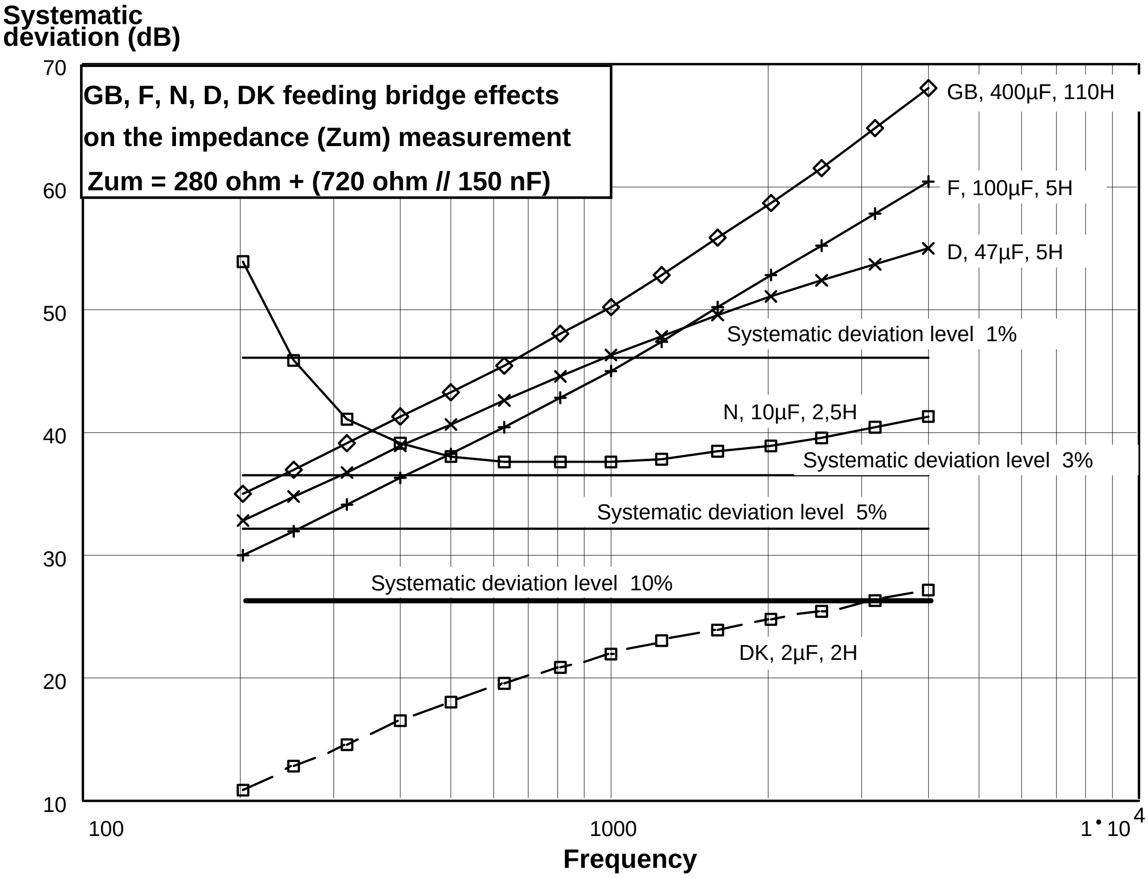
In a few cases in the common text and in many cases in the National parts of ETS 300 001 [2], compliance by inspection is called for. In some instances this form is used when compliance is obvious. In others, it is used when the compliance parameter is terminal specific and is difficult to describe.

For example, a requirement that the TE shall check the voltage across its line terminals and shall not initiate a call attempt until the line becomes free cannot be simply checked by inspection as called for in subclause 5.6.2 of ETS 300 001 [2]. Each national test house may have its own interpretation of the range of line voltages which indicate that the line is busy and so apply differing test standards. For such a case it is necessary to define the test condition to be applied. It is also not clear what constitutes a call attempt in this case. It is not defined whether the act of assuming the loop condition constitutes an attempt or whether the subsequent dialling of a number is the criterion for pass or fail.

Any such compliance requirement needs to be used with extreme caution, as it is subject to interpretation and might not be applied objectively.

Annex D: Effects of the testing arrangements and MFPB signal timing

D.1 Feeding bridge effects



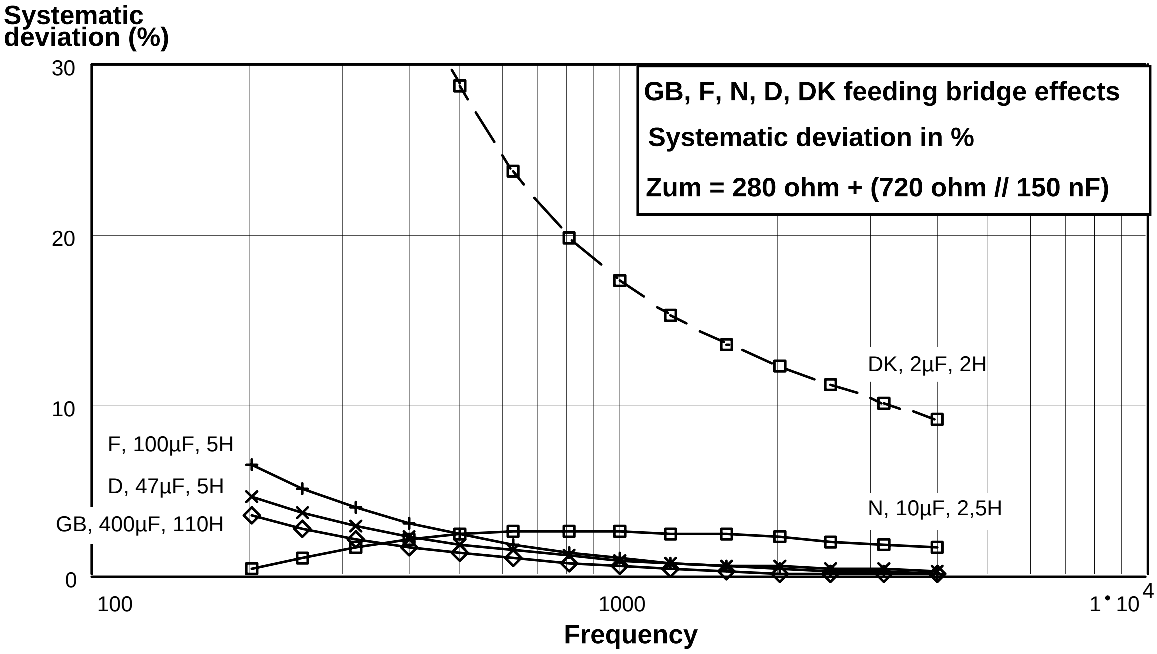
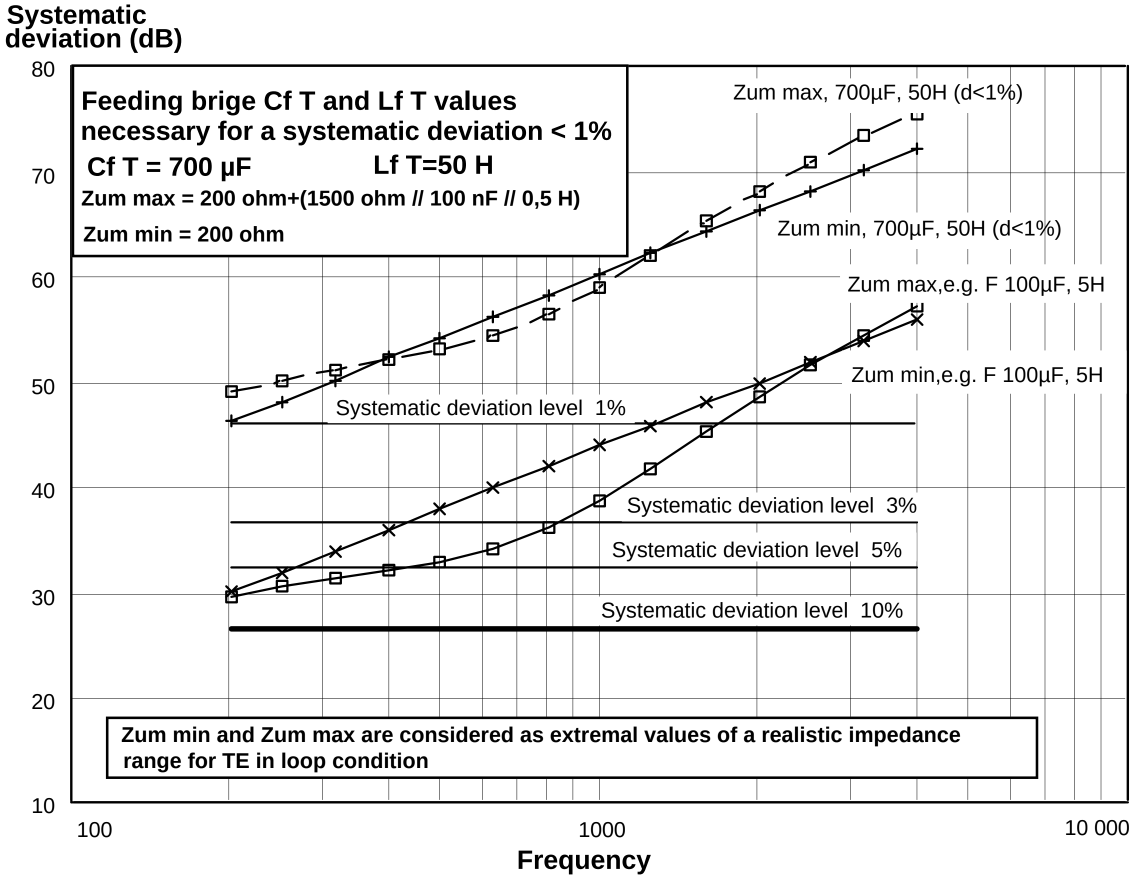


Figure D.1: GB, F, N, D, DK feeding bridge effect on the impedance (ZrPT17V) measurement and related systematic deviation



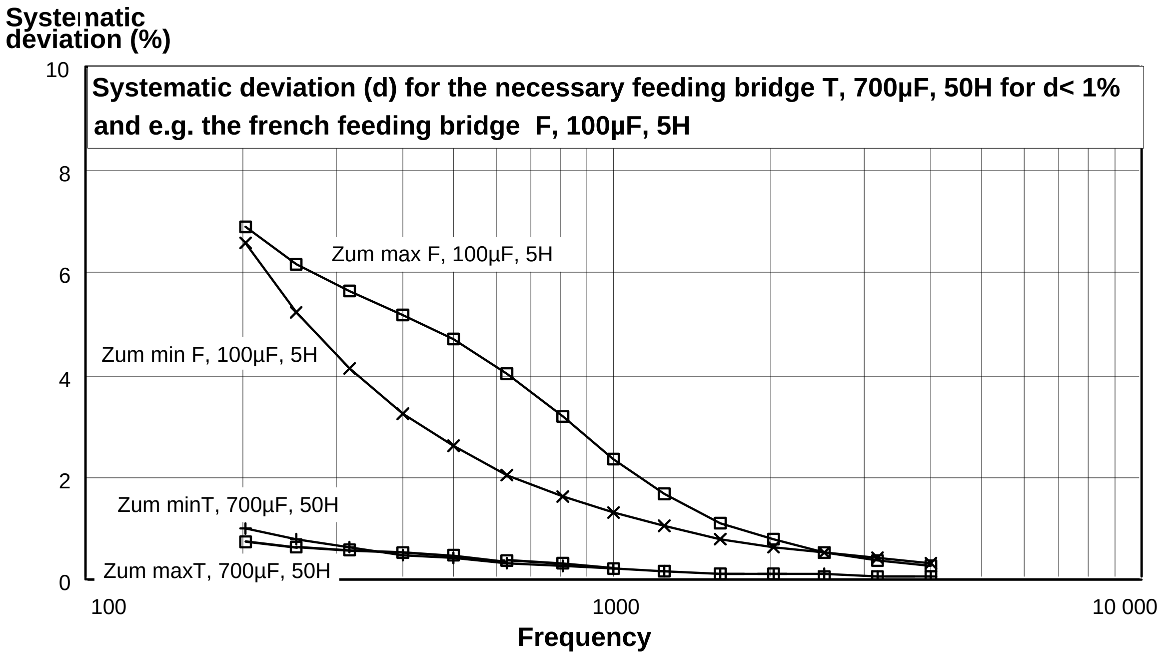
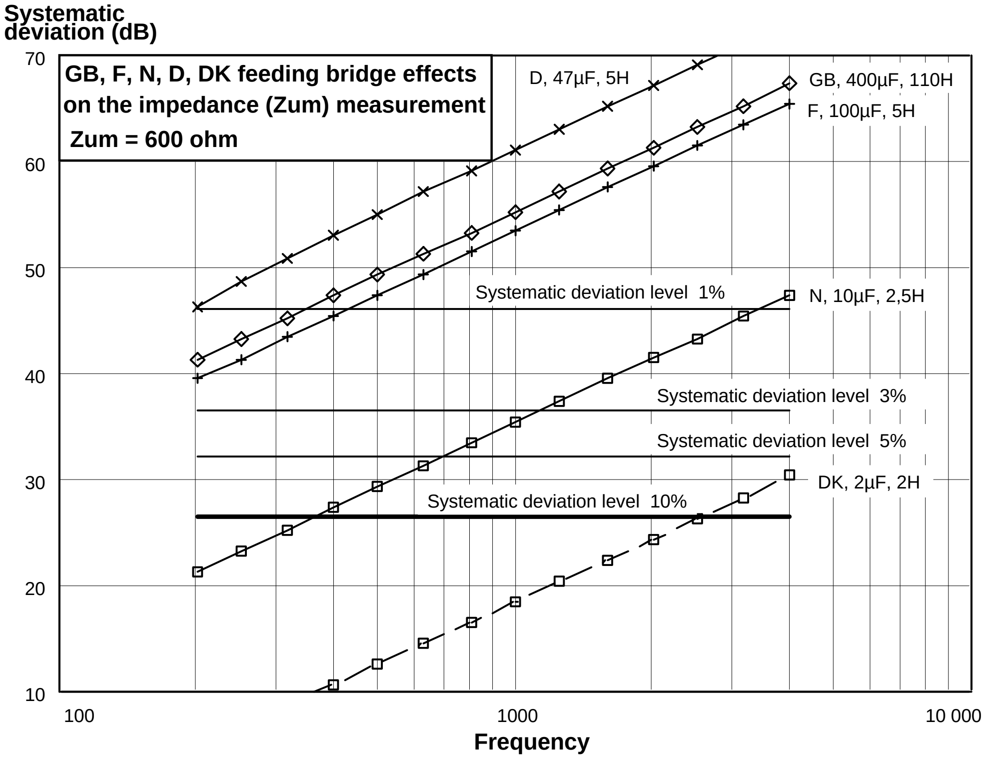


Figure D.2: Determination of the feeding bridge characteristic to limit the systematic deviation at 1 % and the related systematic deviation



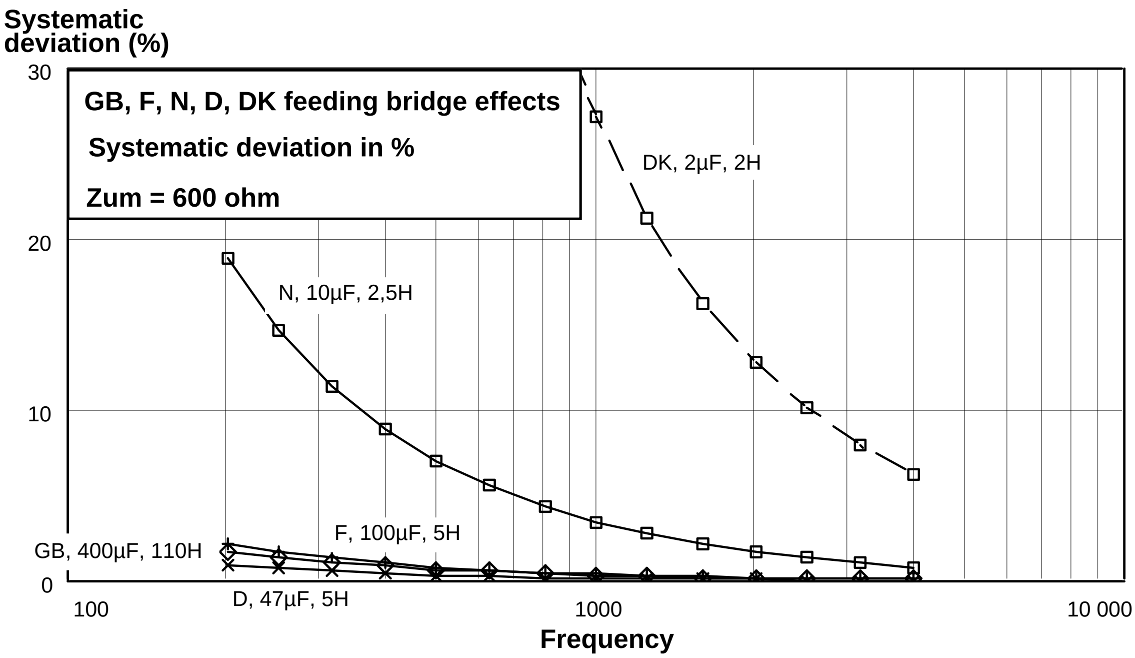
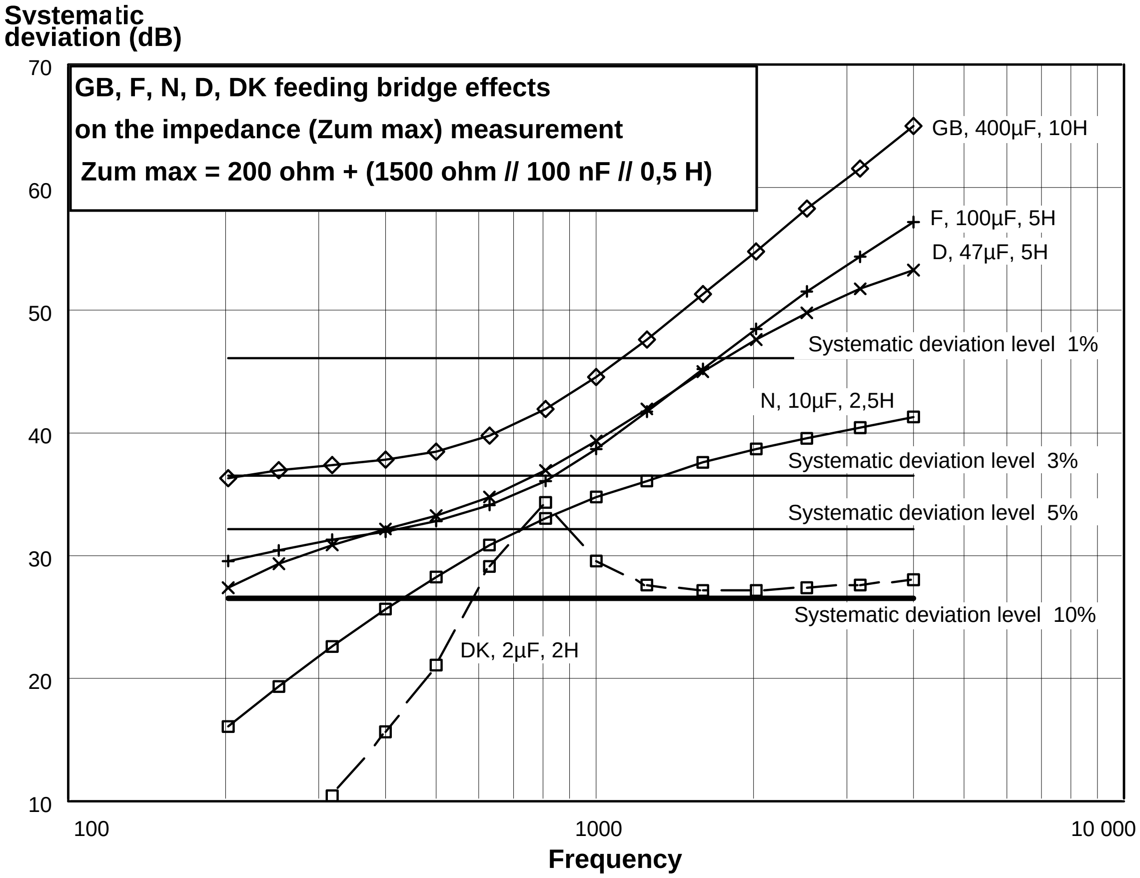


Figure D.3: GB, F, N, D, DK feeding bridge effect on the impedance (600 ohm) measurement and related systematic deviation



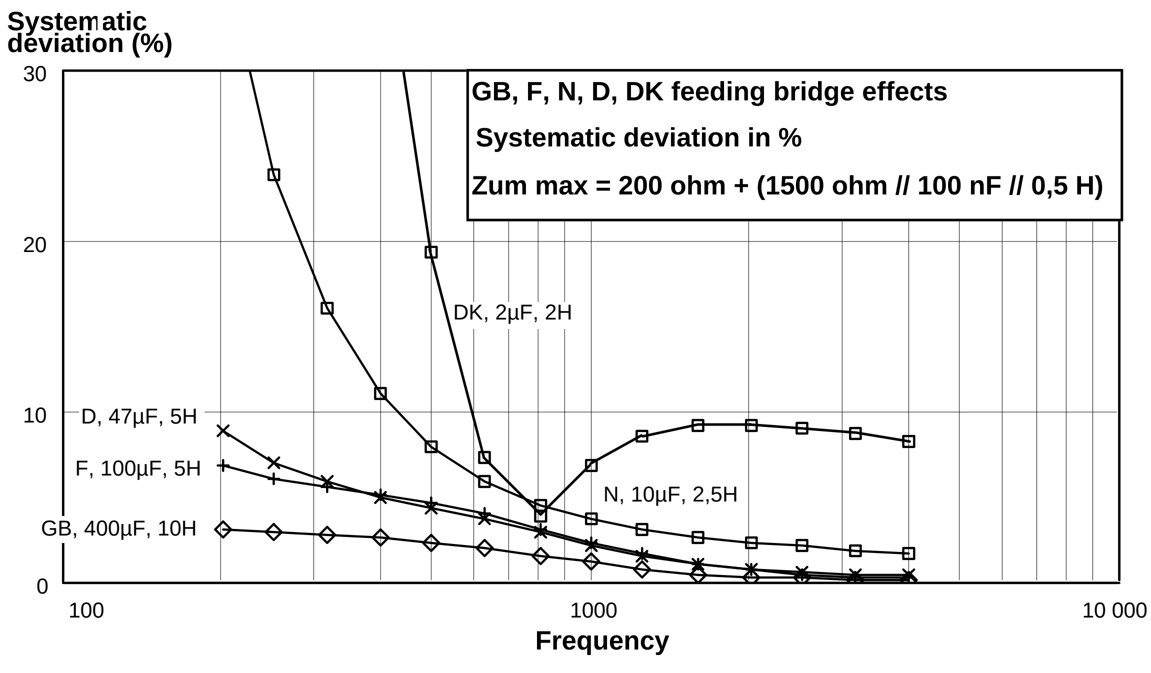


Figure D.4: GB, F, N, D, DK feeding bridge effect on the impedance (Zum max) measurement and related systematic deviation

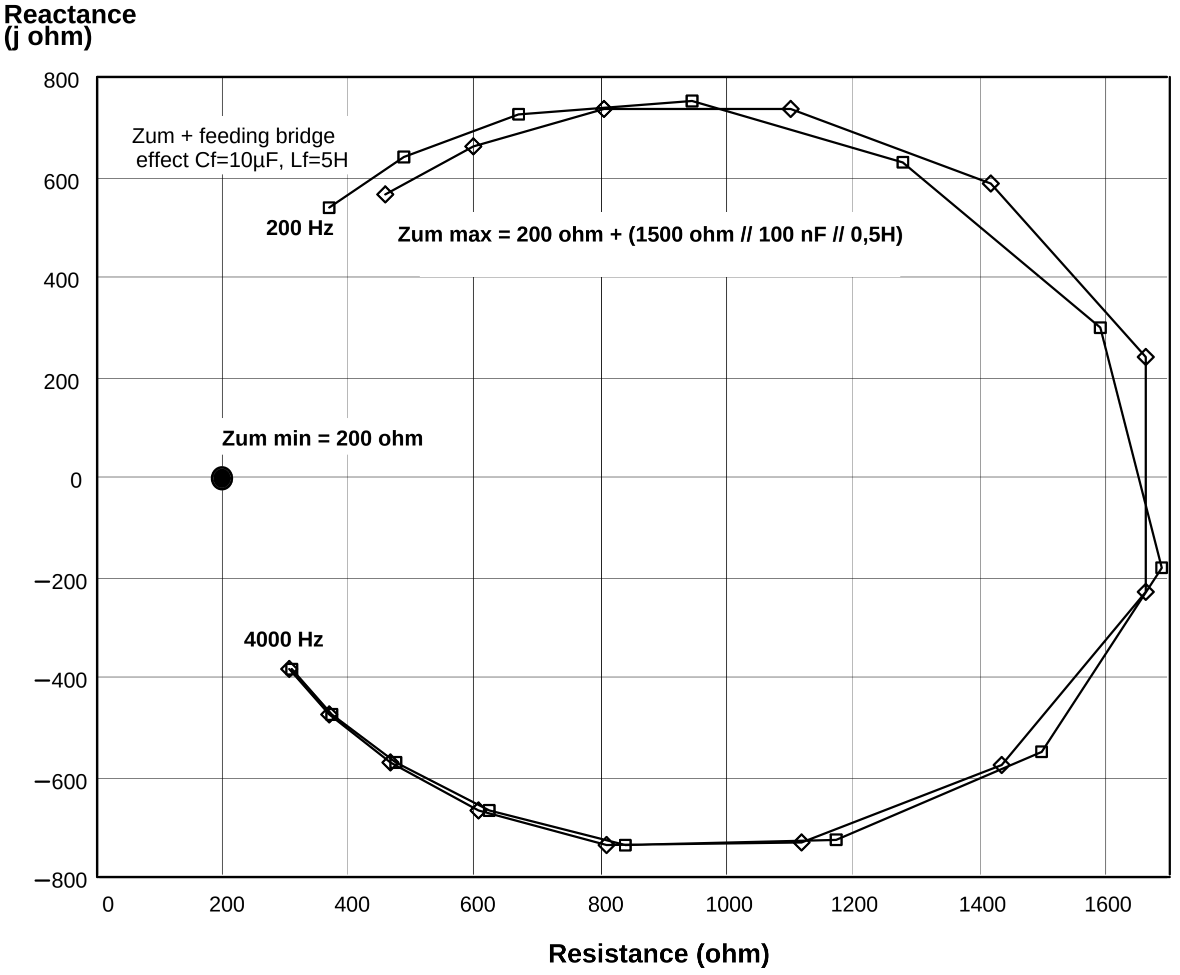


Figure D.5: Realistic external impedances (Zum min and Zum max) for the systematic effects study

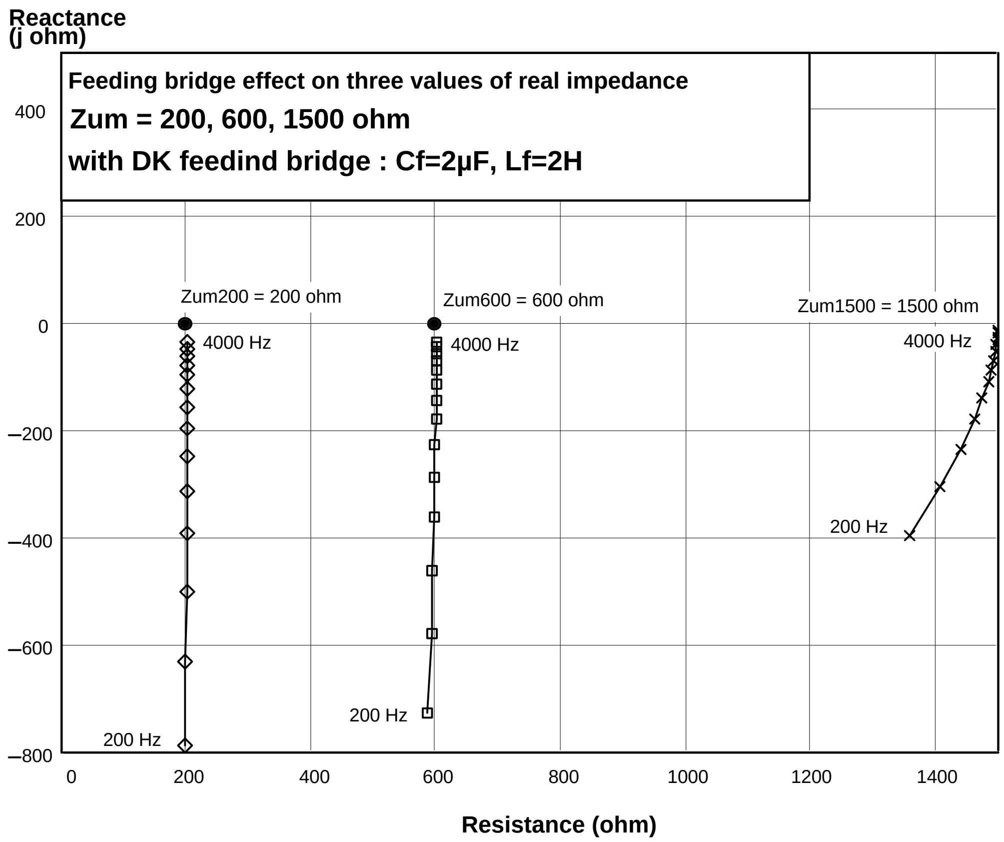


Figure D.6: DK feeding bridge effects on some real impedances

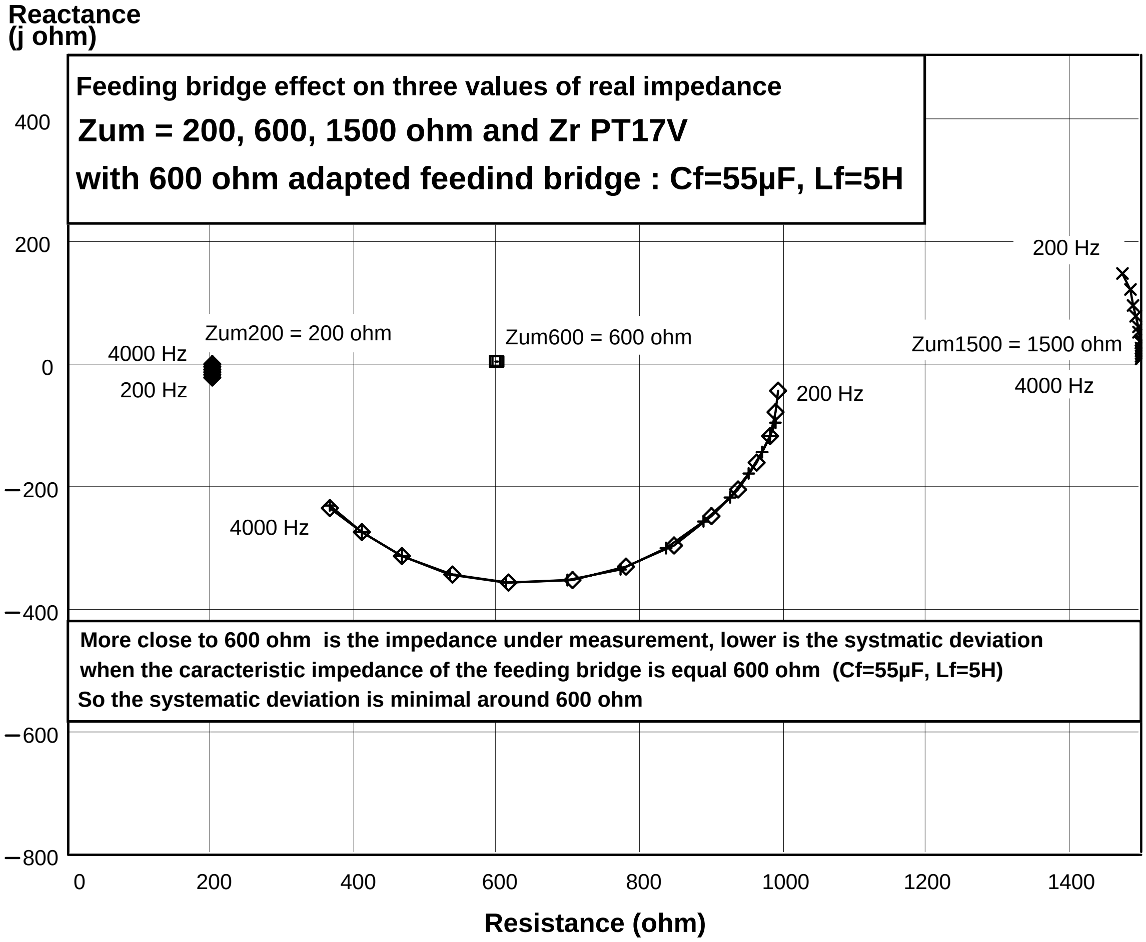


Figure D.7: Systematic deviation reduction around 600 ohm by the use of adapted feeding bridge

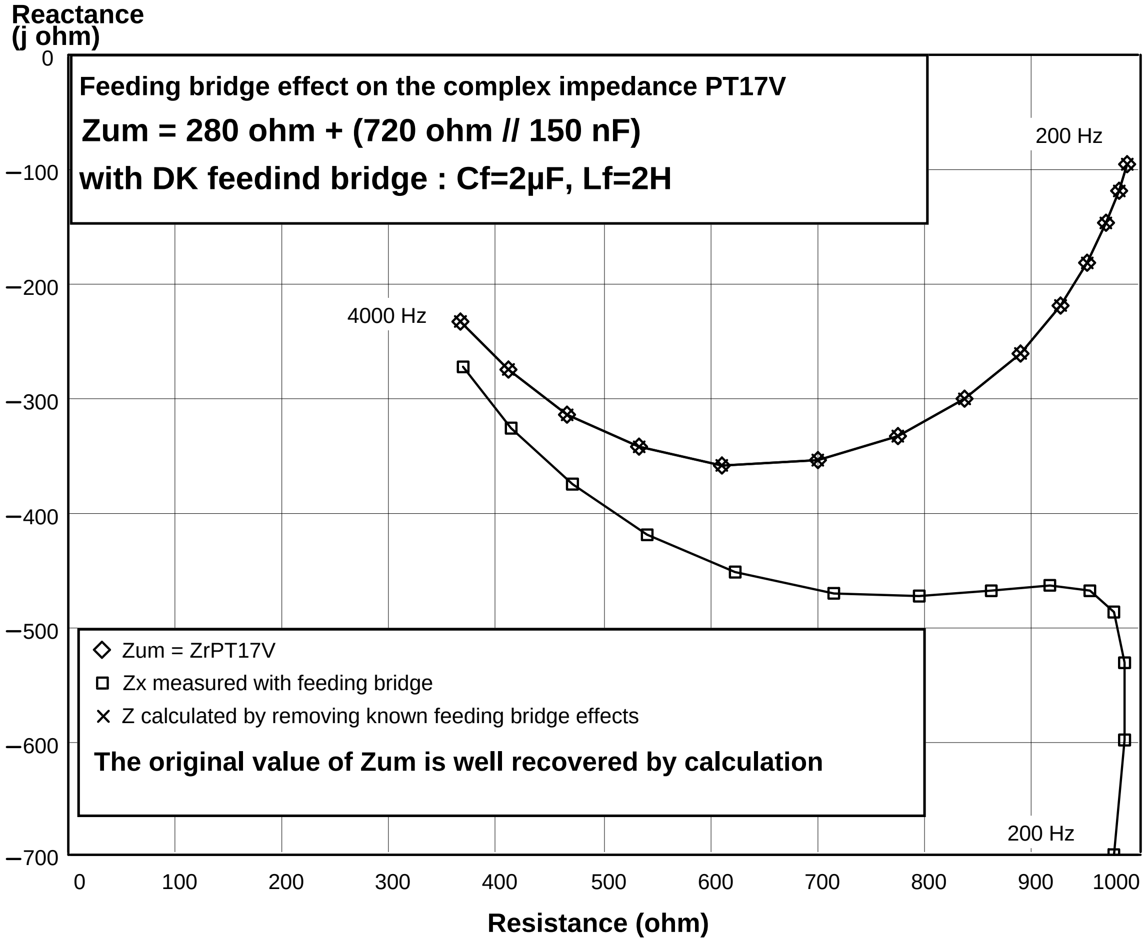


Figure D.8: Reduction of the systematic deviation due to the feeding bridge by calculation

D.2 DC current and loop resistance testing method and testing topology

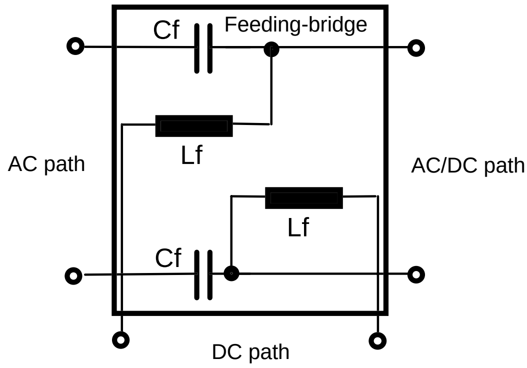


Figure D.9: Feeding bridge circuit

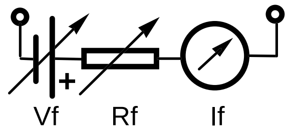


Figure D.10: DC feeding supply and adjustable feeding resistance

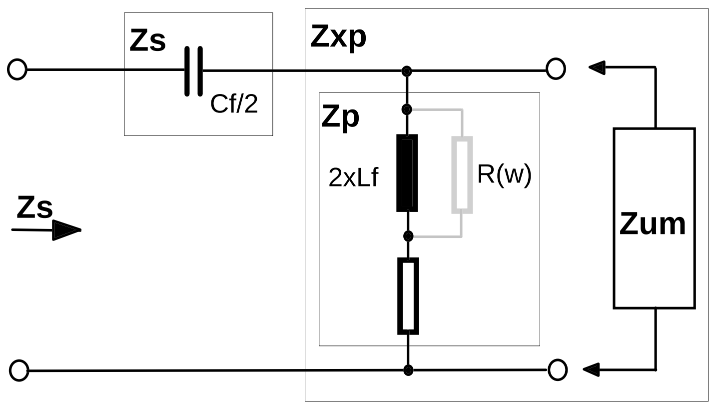


Figure D.11: Feeding bridge equivalent circuit

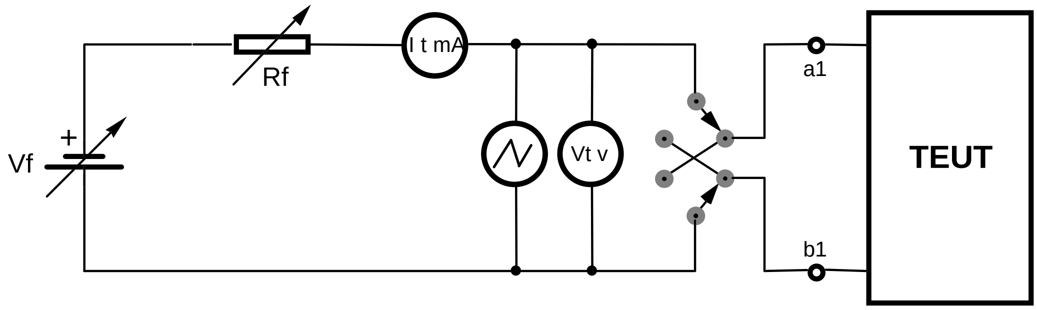


Figure D.12: DC current and loop resistance, Test 1, Test 3, Test 4 for respectively, DC characteristic plotting, constant voltage feeding stability, loop starting closure voltage

Table D.1: Testing condition range for DC current and loop resistance, test 1, DC characteristic plotting

TEST RANGE	Minimum	Intermediate values	Maximum
Vf (v)			
Rf (ohm)			

Table D.2: Testing condition range for DC current and loop resistance, test 2, constant voltage feeding stability

TEST RANGE	Minimum	Intermediate values	Maximum
Vf (v)			
Rf (ohm)			

Table D.3: Testing condition range for DC current and loop resistance, test 4, loop starting closure voltage

TEST RANGE	Minimum	Intermediate values	Maximum
Vf (v)			
Rf (ohm)			

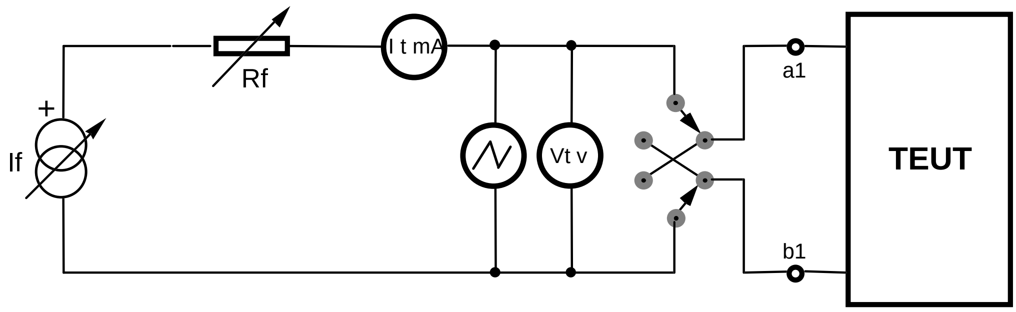


Figure D.13: DC current and loop resistance, Test 2, Constant current feeding for stability test

Table D.4: Testing condition range for DC current and loop resistance, test 3, constant current feeding stability

TEST RANGE	Minimum	Intermediate values	Maximum
Vf (v)			
Rf (ohm)			

D.3 LCL unbalance about earth testing method

D.3.1 Degree of unbalance about earth for one port-TE (LCL) test

As depicted in figure D.14, the capacitor Csc realize an AC short-circuit preventing the influence of the unbalance about earth of the feeding bridge. The disadvantage of this method is to have a DC resistance greater than 600 ohm. Nevertheless, the maximal current limit can be reached by increasing the Vf voltage.

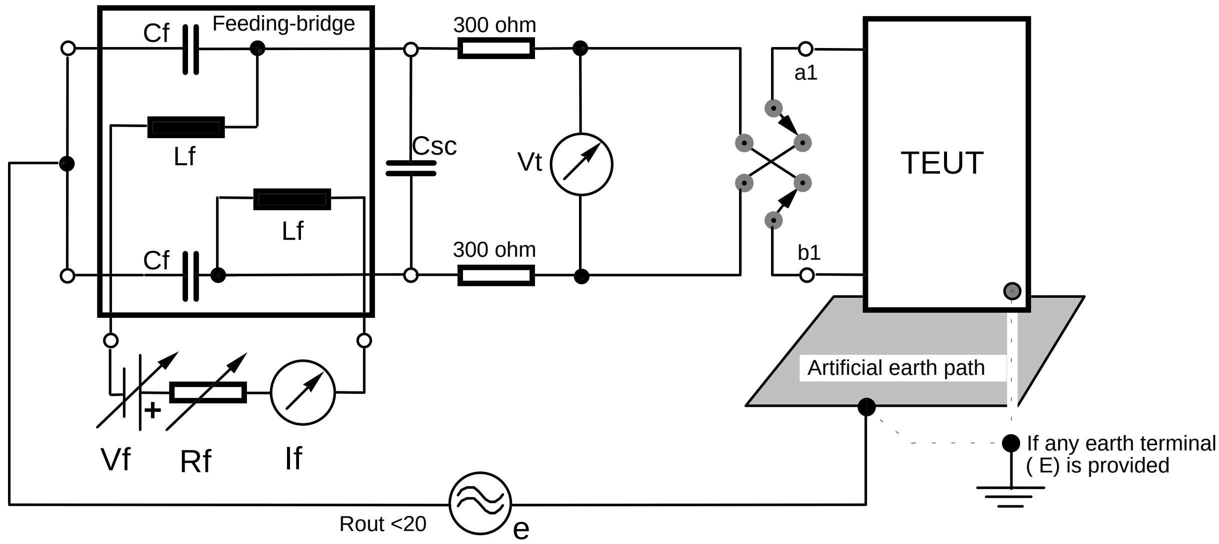


Figure D.14: Degree of unbalance about earth test arrangement for one-port TE (LCL)

Table D.5: Testing condition range for one-port TE (LCL)

TEST RANGE	Minimum	Nominal	Maximum
Vf (v)			
Rf (ohm)			
If (mA)			
e (dBm)			
Frequency of e (Hz)	25, 50, 100, 150, 300	200, 250, 315, 400, 500, 630, 800, 1 000, 1 250, 1 600, 2 000, 2 500, 3 150, 4 000	10 000, 12 500, 16 000,

D.3.2 Degree of unbalance about earth for series-connected-TE (LCL) test

Testing arrangement description:

The test arrangement for series-TE is similar to the one-port one, except that a simulated-TE is used connected to the second port of the two-port TE. The simulated-TE is depicted in the figure D.11.

The simulated-TE needs to present a very good balanced characteristic with respect to earth (at least 20 dB greater than the value of the most severe requirement for the two-port TEUT). The simulated-TE is defined in the next paragraph.

The simulated-TE ensures the on/off line condition by means of the QC/LC switch.

In quiescent condition the second QC/LC switch insert a parallel impedance Z through Cq.

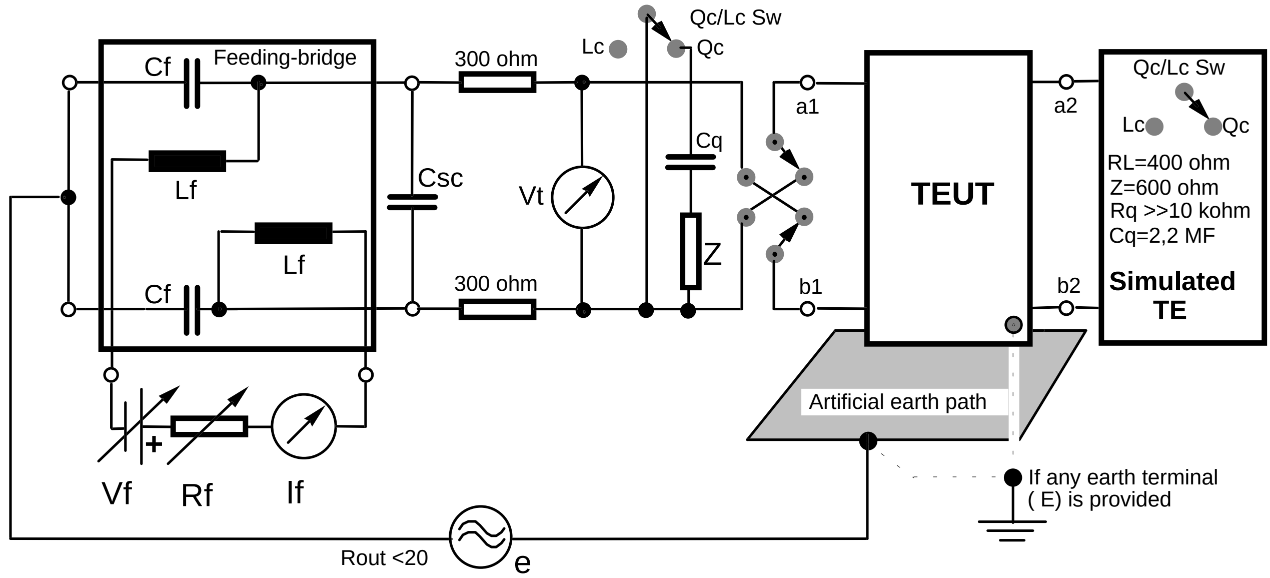


Figure D.15: Degree of unbalance about earth test arrangement for two-ports TE (LCL)

Table D.6: Testing condition range for two-ports TE (LCL)

TEST RANGE	Minimum	Nominal	Maximum
Vf (v)			
Rf (ohm)			
If (mA)			
e (dBm)			
Frequency of e (Hz)	25, 50, 100, 150, 300	200, 250, 315, 400, 500, 630, 800, 1 000, 1 250, 1 600, 2 000, 2 500, 3 150, 4 000	10 000, 12 500, 16 000,

D.3.3 Simulated-TE suggestion

The simulation of the TE is achieved by using a feeding bridge in order to separate properly the DC and AC paths.

Z may be either 600 ohm or the reference complex impedance according the impedance strategy selected.

RL simulates the DC resistance of the TE.

The dipole (Cq, Rq) simulates the quiescent state impedance.

The switch LC/QC cause the TE in quiescent or loop state as a hook-switch of a TE.

The feeding-bridge used is specified with an inherent LCL greater of 20 dB than the more stringent requirement value.

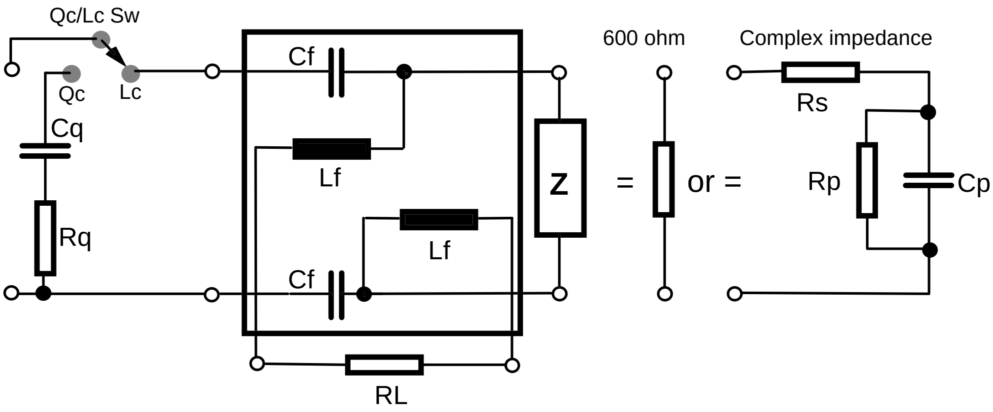


Figure D.16: Suggested simulated - TE

D.4 MFPB signal timing

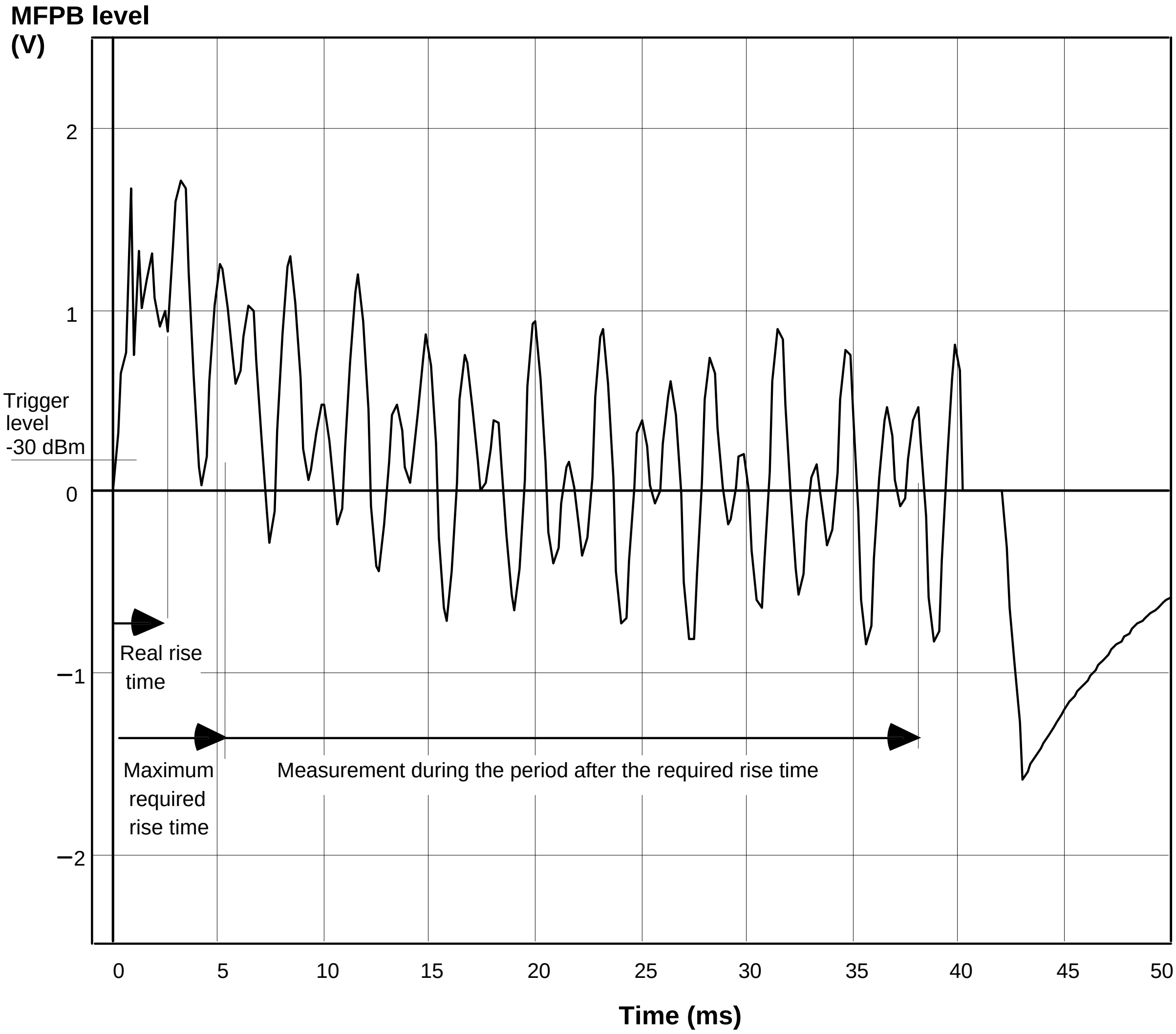


Figure D.17: MFPB transient timing, pragmatic measurement method

History

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