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Foreword

Part 4 of this Interim European Telecommunication Standard (I-ETS) was produced by the Terminal Equipment (TE) Technical Committee of the European Telecommunications Standards Institute (ETSI).

An ETSI standard may be given I-ETS status either because it is regarded as a provisional solution ahead of a more advanced standard, or because it is immature and requires a "trial period". The life of an I-ETS is limited to three years after which it can be converted into a European Telecommunication Standard (ETS), have it's life extended for a further two years, be replaced by a new version or, be withdrawn.

This is the fourth Part of an I-ETS which is currently intended to comprise eight Parts.

This I-ETS specifies technical characteristics for Integrated Services Digital Network (ISDN) telephony terminals as described in the scope of this I-ETS. The characteristics are additional to type approval requirements to which the terminal equipment is subject. The additional characteristics are meant to give improved performance.

In the present version of the I-ETS the following Parts are included:

Part 1: General (I-ETS 300 245-1);

Part 2: PCM A-Law, Handset Terminals;

Part 3: PCM A-Law, Loudspeaking and Handsfree Telephony;

Part 4: Additional Equipment Interface;

Part 5: Wideband Coding Handset Functions;

Part 6: Wideband Coding Loudspeaking and Handsfree Telephony;

Part 7: Locally Generated Information Tones;

Part 8: Terminal Application of 16 kbit/s Speech Coding Algorithms.

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1 Scope

This Interim European Telecommunication Standard (I-ETS) specifies the technical characteristics (physical, electrical, logical and functional) of a family of interfaces for the connection of additional equipment to ISDN telephony terminals. These interfaces support the facilities and services applicable mainly to ISDN telephony teleservices associated with those functions.

Two interfaces allow bi-directional transparent analogue transmission of B-channel information between the telephony terminal and the additional equipment with a bandwidth of 3,1 kHz or 7 kHz. Both a "2-wire" (Z_A-I)and a "4-wire" interface (X-I) are described.

Two other interfaces allow the transmission of D-channel related information between the telephony terminal and the additional equipment. One (Y-I) uses a "4-wire" bi-directional data line with an asynchronous digital transmission. This interface can be implemented separately or in combination with any of the two interfaces for B-channel information. The second one (ZB-I) transmits ON/OFF signalling data in both directions. This interface can be implemented separately or in combination with the "2-wire" interface.

The digital telephony terminal may support one or a combination of the following interfaces as an option:

- "4-wire" analogue interface (3 wires, including common ground);
- "4-wire" digital signalling interface (3 wires, including common ground);
- "2-wire" analogue interface;
- ON/OFF signalling interface (3 wires, including common ground).

Annex A to this I-ETS specifies the methods of testing required to identify conformance to this I-ETS.

This fourth Part of I-ETS 300 245 is applicable as one option to telephony terminals as specified in other Parts of this I-ETS, and additional equipment intended to be connected to these terminals.

NOTE: The specification of the "2-wire" interface is presently based on the requirements which can be satisfied by many analogue terminals connected through a very short line directly or via an adapter (Videotext terminals, PC modem, etc.). Appropriate alternatives could be the requirements resulting from the on-going harmonisation activities aiming enhancement of I-ETS 300 004 [2] or ETS 300 001 [1] (related respectively to the Private Branch eXchange (PBX) or Public Network analogue interface).

2 Normative references

This fourth Part of the I-ETS incorporates by dated or undated reference, provisions from other publications. These normative 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 fourth Part of the I-ETS only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1] ETS 300 001: "Attachments to Public Switched Telephone Network (PSTN); General technical requirements for equipment connected to an analogue subscriber interface in the PSTN (Candidate NET 4)".

[2] I-ETS 300 004 (1991): "Business Telecommunications (BT); Transmission characteristics at 2-wire analogue interfaces of a digital Private Automatic Branch Exchange (PABX)".

[3] ETS 300 047, Parts 1-3 (1992): "Integrated Services Digital Network (ISDN); Basic access; Safety and Protection".

[4] ETS 300 085 (1990): "Integrated Services Digital Network (ISDN) - 3,1 kHz telephony teleservice - Attachment requirements for handset terminals".

[5] ETS 300 102-1 (1990): "Integrated Services Digital Network (ISDN) - User-network interface layer 3 - Specifications for basic call control".

[6] ETS 300 102-2 (1990): "Integrated Services Digital Network (ISDN) - User-network interface layer 3 - Specifications for basic call control - Specification Description Language (SDL) diagrams".

[7] I-ETS 300 245: "Integrated Services Digital Network (ISDN) - Technical characteristics of telephony terminals - Parts 1, 2, 3, 5, 6".

[8] I-ETS 300 281 (1994): "Integrated Services Digital Network (ISDN) - Telephony 7 kHz teleservice - Terminal requirements necessary for end-to-end compatibility".

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

[10] CCITT Recommendation G.223 (1988): "Assumptions for the calculation of noise on hypothetical reference circuits for telephony".

[11] CCITT Recommendation G.711 (1988): "Pulse code modulation (PCM) of voice frequencies".

[12] ITU-T Recommendation G.712 (1992): "Transmission performance characteristics of pulse code modulation channels".

[13] CCITT Recommendation G.722 (1988): "7 kHz audio-coding within 64 kbit/s".

[14] CCITT Recommendation 0.41 (1988): "Psophometer for use on telephone-type circuits".

[15] FCC 68.500 (1988): "Code of federal regulations/telecommunication 47 - parts 40 to 69".

[16] ISO Publication 3 (1973): "Preferred numbers - series of preferred numbers".

[17] ETS 300 082 (1992): "Integrated Services Digital Network (ISDN) - 3,1 kHz telephony teleservice - End-to-end compatibility".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this Part of the I-ETS, the relevant definitions used in the referenced CCITT Recommendations and ETSs, and the following definitions apply:

Additional Equipment (AE): Equipment to be connected at the ISDN telephony terminal to support additional functions.

Additional Equipment Interface (AEI): Interface to connect an additional equipment.

dBr: Relative level to the 0 dBr point basic user-network interface according to CCITT Recommendation G.101.

X-Interface (X-I): Analogue interface which provides bi-directional transmission of B-channel related information between a telephony terminal and an additional equipment.

XTE-Interface: X-interface on the Terminal Equipment side.

XAE-Interface: X-interface on the Additional Equipment side.

Y-Interface (Y-I): Digital interface which provides bi-directional transmission of signalling messages between a telephony terminal and an additional equipment.

YTE-Interface: Y-interface on the Terminal Equipment side.

YAE-Interface: Y-interface on the Additional Equipment side.

Z_A-Interface (Z_A-I): Analogue interface which provides bi-directional transmission over the access channel.

Z_B-Interface (Z_B-I): Interface to transmit signalling information.

3.2 Abbreviations

For the purposes of this Part of the I-ETS, the abbreviations used in the referenced CCITT Recommendations, ETSs and the following abbreviations apply:

AE	Additional Equipment
AEI	Additional Equipment Interface
ET	Exchange Termination
ETS	European Telecommunication Standard
I-ETS	Interim European Telecommunication Standard
ISDN	Integrated Services Digital Network
PBX	Private Branch eXchange
S/T	ISDN-Basic User Network Interface
TE	Terminal Equipment
X-I	X-Interface
Y-I	Y-Interface
Z_A-I	Z_A-Interface
Z_B-I	Z_B-Interface

4 Applications and functionality

4.1 General

The AEI supports and extends the functionality of an ISDN telephony terminal. Various sets of equipment and applications can be realised using the interfaces as specified in clauses 5 and 6 (Physical and Transmission requirements) and in clauses 7 and 8 (Protocols of layers 2 and 3).

The additional functionality's require appropriate extensions of the terminal software in order to take into account the interface towards the AE and/or the application itself.

According to the type of additional equipment, which is connected to the ISDN terminal, it should be noted that not only the functionality is influenced due to supporting or extending by the additional equipment, but also the transmission performance for speech is influenced additionally according to the special transmission parameters of the additional equipment and the transmission characteristics of the interface as far as the access channel is concerned. But the specification of these parameters is out of the scope of this I-ETS. The overall performance of the terminal configuration may be determined mainly by the additional equipment. For these cases the ISDN terminal could be considered functionally as a carrier. That could be important for aspects for network planning whereby the effective Terminal Coupling Loss (TCL) respectively the echo return loss should be considered particularly.

4.2 Applications

This equipment and applications use parts or the whole functionality of the various interface types.

A possible set is described in table 1.

Table 1: Possible applications

X	Y	Z_A	Z_B	Application
X		X note 1		Second earphone
X				Loudspeaking equipment
note 2				Handsfree equipment
	note 3		note 3	Additional alerting module
	X			Call monitor AE which interprets the call related D-channel messages and supports additional information to them.
X	X	X	X	Automatic answering machine It answers an incoming call and allows the store of an incoming message.
X	X	X	X	Speech recording
	X	note 4		Dialling function To set-up an outgoing call by an AE.
X	X	X	X	Alarm equipment
	X		X	Charging device An AE which prints or stores the charging information (e.g. called party number and charging units).
X	X			Speech cryptography
note 5	note 5	note 5	X	Modem / Videotexterminal Support of data transmission (e.g. file transfer) or Videotex.
X note 6	X note 6	X note 6	X note 6	PSTN - adapter Adapter to connect conventional analogue PSTN-terminals. The analogue line-interface shall be compatible with ETS 300 001 [1].
FFS	FFS	FFS	FFS	Tele-Writing
FFS	FFS	FFS	FFS	Tele-Drafting
FFS	FFS	FFS	FFS	Control of videophone terminal
FFS	FFS	FFS	FFS	Test utility
FFS	FFS	FFS	FFS	Down loading

NOTE 1: This application is listed only with respect to completeness of possibilities, but is not recommended.
NOTE 2: TE need a procedure to activate the X-input channel without the use of the Y-signalling information.
NOTE 3: Additional alerting module can be realised either by the Y-interface or the Z_B-interface.
NOTE 4: DTMF signalling may be transmitted through the Z_A-interface.
NOTE 5: Application can be realised either by the X and Y-interface or the Z_A-interface.
NOTE 6: Not intended for connection of normal telephones.

4.3 Functionality

4.3.1 Functionality of the X/Y-interface

To realise the various applications and equipment the different interface types need special functions. These functions have been defined on the basis of existing and future additional equipment.

The main functions are listed in the following:

- **call establishment**
  A call can be established by an AE via the telephony terminal.
- **call release**
  A connection can be released by an AE (e.g. automatic answering machine).
- **sending dialling information**
  Dialling information can be sent by an AE in case of call establishment (e.g. dialling equipment, alarm equipment, etc...).
- **receiving dialling information**
  - **receiving calling line identity**
    An AE can know the calling party number receiving in an incoming call.
  - **receiving called party number**
    An AE can receive information or acknowledgement of the called party number transmitted by the TE when a new call is established.
- **priority control**
  - **priority for the AE**
    In the case of alarm equipment, the AE shall have the possibility to disconnect an established connection of the telephony terminal, to send its alarm message.
  - **priority for the telephony terminal**
    If an automatic answering machine is connected to the telephony terminal and a connection is held by the AE, the telephony terminal can take over the connection from the AE.
- **call transfer between TE and AE**
  An established call can be transferred between the telephony terminal and an AE by a manual procedure or in case of priority control by an automatic procedure.
- **receiving charging information**
- **handling of user-to-user information**
  For further study.
- **exit for manufacturer specific signalling information**
  See subclause 8.4.2.5.(message type ESCAPE).
- t**ransmission of transparent access channel information**
  Send and receive direction.
- **cascading of AE**
  Restriction with respect to cascading of AE (see subclauses 5.1 and 8.1).

4.3.2 Functionality of the Z_A/Z_B interfaces

According to the application, this interface allows the functions listed below:

- **call set-up**
  - by the user dialling on the TE;
  - automatically to an address previously registered in the TE.
- **call answer**
  - from the TE by the user;
  - automatically from the AE by activation of incoming call forwarding or using a different address (or another bearer capability).
- **connection switching**
  - from TE to AE and possibly reduced to one direction (e.g. additional earphone).
- **call release**
  - from the TE;
  - from the AE.
- **transmission of control signals**
  - for instance: additional alerting module, charging pulse counter, automatic answering machine.

4.4 Operating modes

4.4.1 General

The TE may have different operating modes according to the following options:

a) availability of one or two codecs;
b) use of one or two addresses;
c) use of one or several bearer services.

When the terminal has two codecs it can handle two calls simultaneously, however, care shall be taken to avoid blocking; this means that one B-channel (any one) shall be used for the TE while the other is connected to the AE.

When the terminal has been given different addresses (or subaddresses, or bearer services), one could be associated to the TE while the other one is attached to the AE.

If the destination of the call cannot be determined from the incoming call set-up parameters, the user may answer the calls as a telephony call, listen to the audio signals (speech, tones) before controlling the final destination of the B-channel (connection transfer). When such a situation occurs while a telephony call is already established, this one may be put on hold in order to allow the user to access the audio signals as above.

On the contrary, a call answered or transferred to the AE shall never be put on hold.

4.4.2 D-channel signalling

4.4.2.1 Outgoing call

Coding of the Bearer Capability (BC) information element depends on the application and shall comply with the requirements specified in other Parts of this I-ETS (e.g. speech, 3,1 kHz audio, 7 kHz telephony).

Transmission of High Layer Compatibility and Low Layer Compatibility (HLC and LLC) information elements is optional.

4.4.2.2 Incoming call

For the telephony function of the TE, the requirements of ETS 300 085 [4] subclause 4.2 shall apply.

An incoming call with BC = 3,1 kHz audio without call progress information element may be used to directly address the AE when this has been programmed for the application.

4.4.3 Operating modes with X-/Y- interface

The signalling facilities available through the Y- interface can be used to establish outgoing calls dialled from the TE or from the AE, according to the application.

For incoming calls, compatibility checking can be performed simultaneously in the TE and the AE, and any one may answer the call.

Connection switching can be controlled through the Y- interface without putting the call on hold at the S interface.

4.4.4 Operating modes with Z_A/Z_B- interface

As a consequence of the limited signalling capacity of the Z_B- interface, any outgoing call shall be dialled from the TE. In the case of manual dialling, the user shall indicate whether the call concerns the TE or not. However, an automatic call set-up (pre registered address, bearer service, etc.) may be controlled through the Z_B- interface.

NOTE: Other signalling capabilities may be offered through the Z_A interface: one consists of loop closure detection when this loop is fed under low voltage; another one could be transmission of DTMF dialling from the AE.

Compatibility checking shall always be performed in the TE. When necessary, the AE shall be alerted via the Z_B- interface, which is also used to transmit its answer to the TE.

Connection switching is also controlled (manually or automatically) on the TE.

5 Physical and transmission requirements for X- and Y- interface

5.1 General

The use of the B-channel and signalling-channel in sending and receiving direction is independent of and decoupled from the use and the applied function of the terminal equipment.

The interface supports, in both directions only one AE. If it is necessary to connect more than one AE then the AE should be cascaded in a row (max. 3 AEs). The principle of cascading is given in figure 1. This arrangement may be useful if different access channel related functions and/or signalling related functions are separately implemented in different AE.

However, in any case, it is in the responsibility of the manufacturers of AE and the user for correct cascading so that only one logical and physical unit is given at the interface according to the specified AE-characteristics. The principle of line connection is shown in figure 2.

If an AE does not use the XTE-interface or the YTE-interface for its own applications but only for the transmission of the signals from and to cascaded AEs, then the specifications of clause 5 are not applicable to the concerned interface.

The transmission of both B-channel and signalling-channel is unsymmetrical. Therefore, 6 conductors are necessary for the digital and analogue transmission in both directions. This includes advantageously separate grounds for the different transmission systems. All 6 wires for the B-channel and the signalling-channel are put together into one cord. The length of the cord between the equipments shall be not longer than 6 metres. The principle of the electrical interface is shown in figure 3.

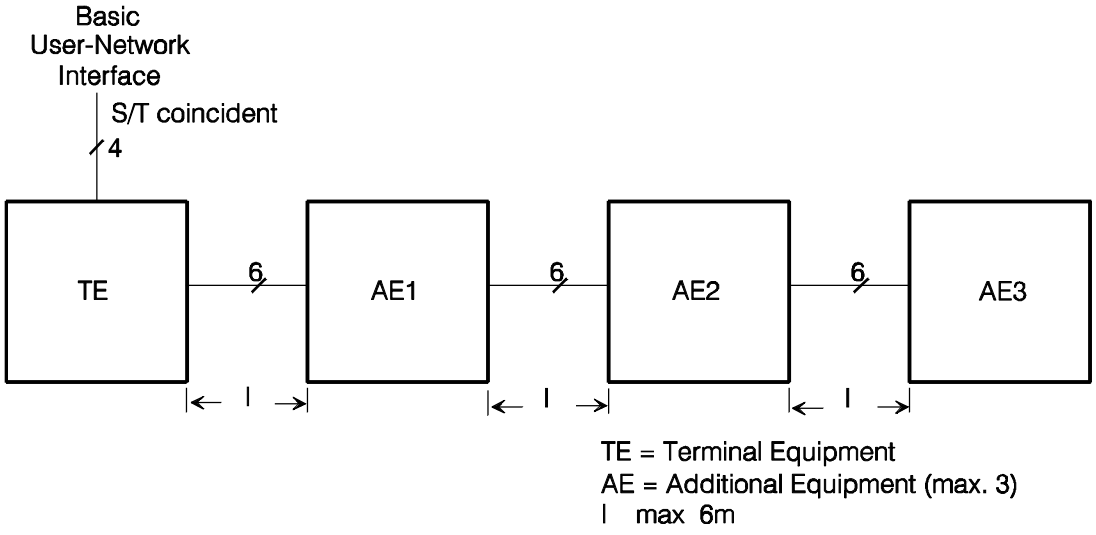


Figure 1: Principle of cascaded additional interface

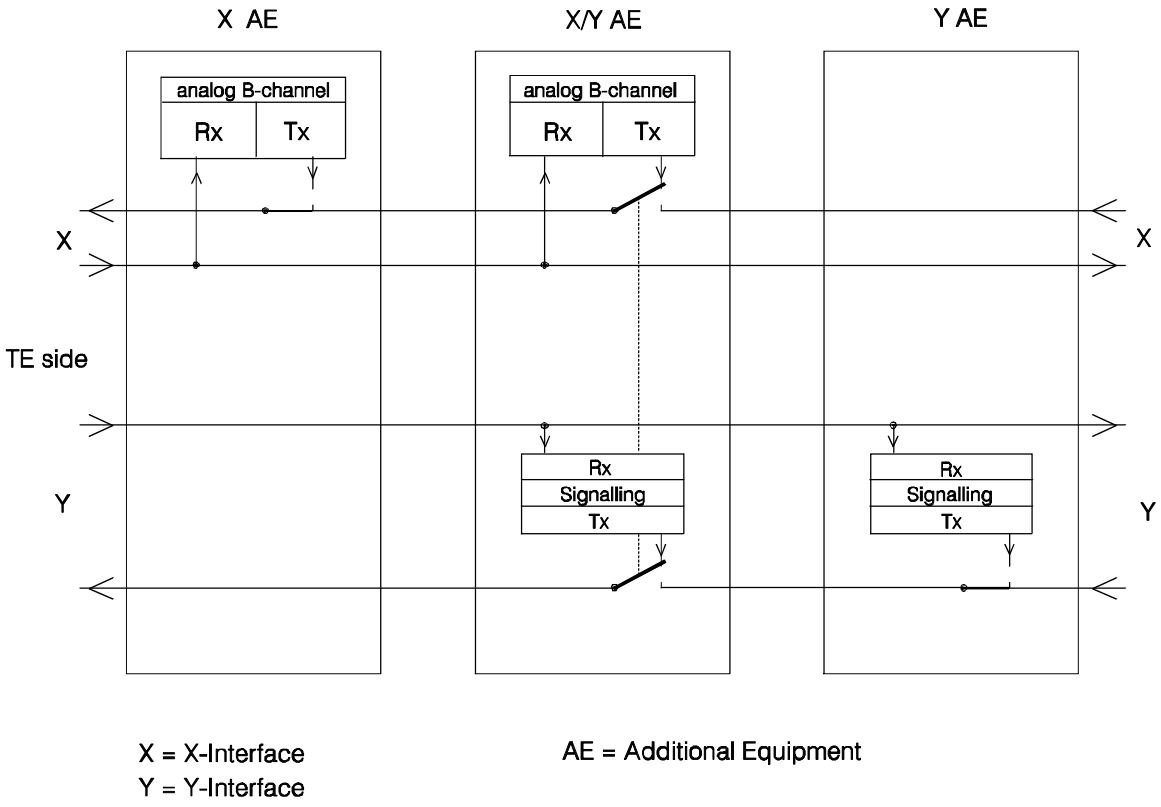


Figure 2: Principle of line connection

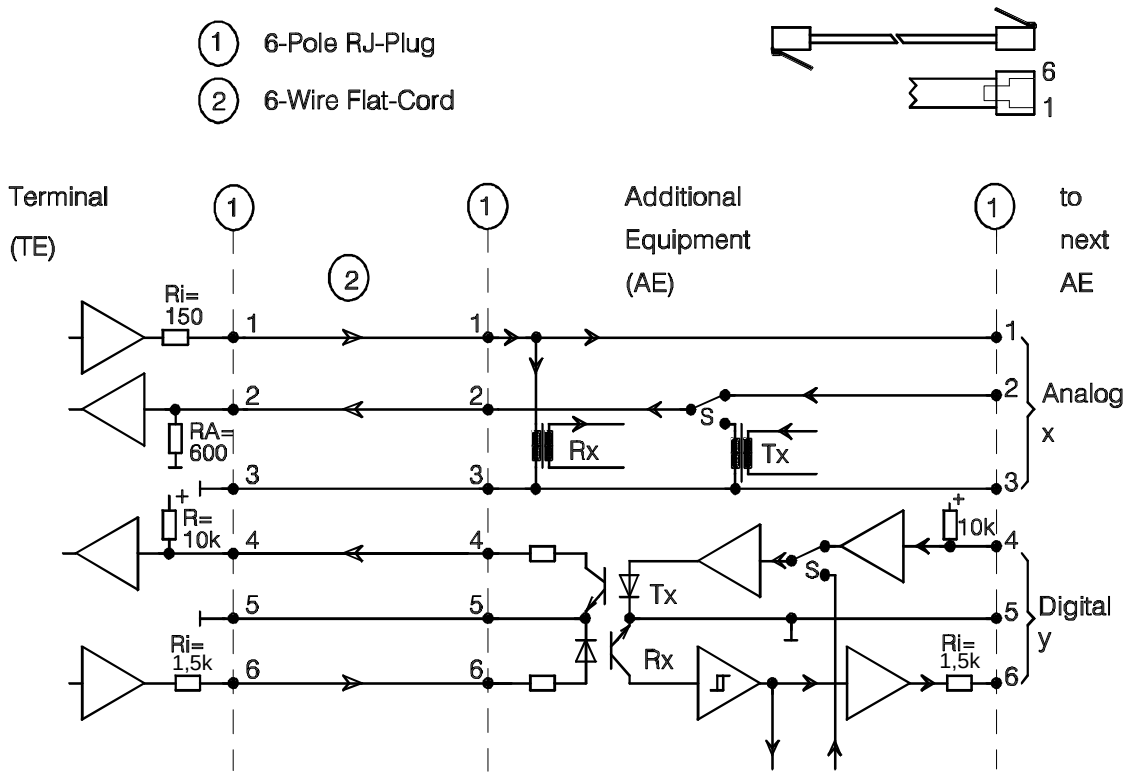


Figure 3: Principle of electrical interface

The cord shall be detachable, at least on the TE-side. It is recommended to terminate the cord on both ends with identical plugs (see FCC 68.500 [15]).

If the TE is power supplied from the S/T-interface and the power source 1 is in restricted power condition, the provision of the AEI-function is optional. It is assumed that the AEs are locally powered. The Additional Equipment Interface (AEI) provides no power supply for any AE.

5.2 XTE-interface

5.2.1 General

The interface provides one B-channel in an analogue version with simultaneous transmission in both directions.

The bandwidth is equivalent to that of the terminal equipment.

The sending direction from the terminal equipment to the additional equipment shall always be unrestrictedly available. In the receiving direction the input is controlled by the terminal equipment and is normally switched off. The connection through the terminal equipment is determined by the signalling between the terminal equipment and the additional equipment.

The galvanic decoupling between the terminal equipment and the additional equipment shall be provided at the interface (e.g. with transformers) as an integral part of the AE.

Therefore, the requirements of ETS 300 047 [3] do not apply for the TE-side. The safety and protection requirements of ETS 300 047 [3] shall be fulfilled by the additional equipment. Inductive or capacitive coupling may not occur because of the restricted cord-length between AE and TE (max. 3 x 6 m).

A high level transmission in both directions is advantageous against noise, avoids additional receiving amplification in the terminal equipment and allows for example a direct connection of a second earphone at the output or other similar use.

The interface is protected against short circuit. The analogue ground is reference for measurement.

Fundamental for the definition of the transfer function in this specification is the related specification of the terminal equipment. ITU-T Recommendation G.712 [12] and ETS 300 082 [17] is the basis for terminal equipment which supports the 3,1 kHz telephony teleservice. Correspondingly CCITT Recommendation G.722 [13] and I-ETS 300 281 [8] apply for 7 kHz telephony.

The basic user network interface is a 0 dBr point according to the CCITT Recommendation G.101.

If not otherwise specified, the output load impedance shall be 150 ohm and the source impedance for the input measurements shall be 600 ohm.

NOTE: This interface specification describes characteristics for a circuit consisting of electrical components only. Common main function for both transmissions between basic user network interface to the acoustic interface is the codec specified by the CCITT/ITU. Obviously, the specification for the AE interface is related to these CCITT Recommendations.

5.2.2 Relative levels

Input: - 8 dBr ±1 dB.

The level variation includes the manufacturing tolerance.

Output: - 10 dBr ± 6 dB (load 150 ohm),

- 10 dB ± 6 dB rel. 1 mW at 150 ohm for 0 dBm0 at the 0 dBr point (S/T coincident interface) with an equivalent nominal voltage of 122,5 mV.

The load of 150 ohm covers the connection of a second earphone.

The output level for 7 kHz telephony is for further study.

The level variation covers different terminal implementations (e.g. influences from transducers and codec sensitivities). Where a user-controlled receiving volume control is provided (see ETS 300 085 [4]), at the setting where the Receive Loudness Rating (RLR) is equal to the nominal value, the output level shall meet the requirement given above.

The output level may follow the volume control of the handset.

Compliance shall be checked by the tests described in annex A, subclause A.6.1.1.1 for the input (TP No.1) and subclause A.6.1.1.2 for the output (TP No.2).

5.2.3 Interface impedances

Input: 600 ohms

Output: 150 ohms

The manufacturing tolerances are ± 10% in the frequency range from 300 Hz to 3,4 kHz for the 3,1 kHz telephony or 50 Hz to 7 kHz for 7 kHz telephony resp..

Compliance shall be checked by the test described in annex A subclause A.6.1.2.1 for the input (TP No.3) and subclause A.6.1.2.2 for the output (TP No.4).

5.2.4 Variation of gain with the input level

The variation of gain shall be according to the ITU-T Recommendation G.712 [12] or G.722 [13] respectively.

The compliance for the encoding and decoding side shall be checked by the tests described in annex A, subclause A.6.1.3.1 for encoding (TP No.5) and subclause A.6.1.3.2 for decoding (TP No.6).

5.2.5 Distortion

The distortion shall be according to the ITU-T Recommendation G.712 [12] or G.722 [13] respectively.

a) Encoding side
Compliance shall be checked by the test described in annex A, subclause A.6.1.4.1.1 (TP No.7) respectively annex A, subclause A.6.1.4.1.2 (TP No.8).
b) Decoding side
Compliance shall be checked by the test described in annex A, subclause A.6.1.4.2.1 (TP No.9) respectively annex A, subclause A.6.1.4.2.2 (TP No.10).

5.2.6 Attenuation/Frequency distortion of the encoding or the decoding side

The inband frequency attenuation shall be according to the ITU-T Recommendation G.712 [12] or G.722 [13] respectively.

Compliance shall be checked by the test described in annex A, subclause A.6.1.5.1 for encoding (TP No.11) and subclause A.6.1.5.2 for decoding (TP No.12).

5.2.7 Out-of-band signals

The out-of-band characteristic shall be according to the ITU-T Recommendation G.712 [12] or I-ETS 300 281 [8] respectively (only for the values, no measurement methods).

a) Discrimination against out-of-band input signals
Compliance shall be checked by the test described in annex A, subclause A.6.1.6.1 for sending (TP No.13).
b) Spurious out-of-band signals at the output
Compliance shall be checked by the test described in annex A, subclause A.6.1.6.2 for receiving (TP No.14).

5.2.8 Single frequency noise from the encoding or decoding side

The single frequency noise shall be according to the ITU-T Recommendation G.712 [12] or G.722 [13] respectively.

Compliance shall be checked by the test described in annex A, subclause A.6.1.7.1 for encoding (TP No.15) and A.6.1.7.2 for decoding (TP No.16).

5.2.9 Noise

a) Input
The noise produced by the terminal equipment in the sending direction to the basic user-network interface shall not exceed - 66 dBm0p for 3,1 kHz telephony or - 66 dBm0 for 7 kHz telephony respectively.
Compliance shall be checked by the test described in annex A, subclause A.6.1.8.1 (TP No.17).

b) Output
The noise contributed by the receiving equipment alone shall not exceed - 75 dBmp at the analogue output for 3,1 kHz telephony or -75 dBm for 7 kHz telephony respectively.
Compliance shall be checked by the test described in annex A, subclause A.6.1.8.2 (TP No.18).

5.2.10 Group Delay

a) Absolute Group Delay
The sum of the absolute group delay from the analogue input to the basic user-network interface and from the basic user-network interface to the analogue output shall not exceed 1,5 ms for 3,1 kHz and 4 ms for the 7 kHz telephony.

NOTE: 2,0 ms and 7,0 ms are specified for 3,1 kHz and 7 kHz handset telephony. These values include the delay for the transducers. The delay between the additional equipment interface and the basic user-network interface concerns only the electrical part.

Compliance shall be checked by the test described in annex A, subclause A.6.1.9. (TPs No.19 and 20).

b) Group Delay Distortion
The group delay distortion shall be according to the ITU-T Recommendation G.712 [12] or G.722 [13] respectively.

Compliance shall be checked by the test described in annex A, subclause A.6.1.9 (TPs No.19 and 20).

5.2.11 Short-circuit protection

A short-circuit of the analogue output shall not increase the RLR of the terminal equipment by more than 3 dB for the 3,1 kHz telephony.

Compliance shall be checked by the test described in annex A, subclause A.6.1.10 (TP No.21).

5.2.12 Terminal Coupling Loss (TCL)

The TCL measured between the digital input and the digital output at the S/T-interface without connection of an additional equipment to the X-interface shall be not less than 55 dB.

Compliance shall be checked by the test described in annex A, subclause A.6.1.11 (TP No.22).

5.3 YTE-interface

5.3.1 General

The interface provides one digital signalling-channel with simultaneous transmission in both directions.

The transmission shall be serial and asynchronous with a bit rate of 1 200 bit/s. The character format shall be one start bit, 8 data bits, one parity bit (odd) and one stop bit. The interface is only active for real transmission.

The active state drives current for logical 0. The idle state is given with leakage current for logical 1 and transmission pause. The signal level at the interface is in the range from 0 to 5 V ± 5 %.

The low bit rate is caused by a small data volume and is advantageous for low crosstalk to the B-channel in the cord and for radiated emission.

The interface is protected against short circuit. The digital ground is reference for measurement.

The galvanic decoupling between the terminal equipment and the additional equipment shall be provided at the interface (e.g. with optocouplers) as an integral part of the AE.

Therefore, the requirements of ETS 300 047 [3] do not apply for the TE-side. The safety and protection requirements of ETS 300 047 [3] shall be fulfilled by the AE. Inductive or capacitive coupling may not occur because of the restricted cord-length between AE and TE (max. 3 m x 6 m).

5.3.2 Bit rate

The transmitting bit rate shall be 1 200 bit/s ± 1%.

The received data shall be correctly detected at a bit rate of 1 200 bit/s ± 3 %.

Compliance shall be checked by the test described in annex A, subclause A.6.2.1.1 for transmitting (TP No.23) and subclause A.6.2.1.2 for receiving (TP No.24).

5.3.3 Format

The character format shall consist of:

1 start bit (logical 0);
8 data bits (beginning with LSB);
1 parity bit (odd);
1 stop bit (logical 1).

Active state is logical 0, idle state is logical 1.

Compliance shall be checked by the test described in annex A, subclause A.6.2.2 (TP No.25).

5.3.4 Sending

a) Active state
The output voltage shall not exceed 5,25 V. The output current shall not be less than 1,2 mA at 1,8 kohm load.
Compliance shall be checked by the test described in annex A, subclause A.6.2.3.1 with load (TP No.26) and subclause A.6.2.3.2 without load (TP No.27).

b) Idle state
The output voltage shall not exceed 0,8 V.
Compliance shall be checked by the test described in annex A, subclause A.6.2.3.3 (TP No.28).

c) Output resistance
The output resistance shall be 1,5 kohm ±10%.
Compliance shall be checked by the test described in annex A, subclause A.6.2.3.4 (TP No.29).

5.3.5 Receiving

The input resistance has a typical value of 10 kohm (e.g. pull-up).

a) Short circuit current
The input short circuit current shall be in the range of 0,4 mA to 0,6 mA.
Compliance shall be checked by the test described in annex A, subclause A.6.2.4.1 (TP No.30).

b) Open circuit voltage
The open circuit voltage shall be in the range of 4,0 V to 5,25 V.
Compliance shall be checked by the test described in annex A, subclause A.6.2.4.2 (TP No.31).

NOTE: The receiving thresholds should meet the following values:
- the idle state is achieved at any input voltage greater than 3,5 V;
- the active state is achieved at any input voltage less than 1,5 V.

These values are deducted from the following characteristics of the XAE-output and the considerations that a certain margin needs to be reserved for the immunity of the interface against interference:
- the output voltage achieved at idle state is at least 3,75 V;
- the output voltage achieved at active state is at most 0,8 V.

5.4 XAE-interface

5.4.1 General

This Part defines the basic requirements of the XAE-interface. The provision of X-interface is optional.

The transmission requirements of terminal equipment (XTE) shall apply to the forwarding X-interfaces of cascadable AE.

The transmission of the B-channel in the sending direction shall only be achieved by that AE which is in the "active mode". For that the release is given by the Y-signalling. In this situation all the other AEs are in "idle mode". Idle mode is characterised by a direct connection of the sending output to the backward input for cascaded AEs. The connection between the sending output and the control unit of the AE is open.

In receiving direction, the AEs are always in "receiving mode" so that the reception of B-channel information and signalling information is assured.

The interface is protected against short circuit.

Additionally, the transmission elements shall provide the galvanic decoupling and isolation as an integral part of the additional equipment.

The requirements for galvanic decoupling are given in ETS 300 047 [3].

Detailed requirements depend on application and may be specified in special standards for AE.

5.4.2 Sending

In sending mode the AE shall not activate its output before successful signalisation (YTE/YAE).

If no Y-interface is provided the AE shall be manually controlled. When the feature of cascading is not provided for the XAE-interface, there is no manual control for the XAE-output required in the AE. In this case, only the receiving direction is available independent from the TE. The sending direction is usable only if the TE provides a manual user control for its XTE-input.

a) Output level
The maximum voltage at the analogue output shall not exceed 2,0 Vpp.
Compliance shall be checked by the test described in annex A, subclause A.6.3.1.1 (TP No.32).

b) Output impedance/Insertion loss
The output impedance shall be in active mode 600 ohm ± 20% in the frequency ranges of 300 Hz to 3 400 Hz for 3,1 kHz telephony or 100 Hz to 7,0 kHz for 7 kHz telephony, depending on application.
Compliance shall be checked by the test described in annex A, subclause A.6.3.1.2 for the active mode (TP No.33).
The insertion loss in idle mode for the sending signals of cascaded AEs shall be 0 dB ± 0,5 dB at 1 kHz.
Compliance shall be checked by the test described in annex A, subclause A.6.3.1.3 for the idle mode (TP No.34).

c) Noise
The noise produced by the AE at the analogue output in idle mode shall not exceed - 70 dBmp.
In active mode the signal to noise ratio depends on the application.
Compliance shall be checked by the test described in annex A, subclause A.6.3.1.4 (TP No.35).

5.4.3 Receiving

a) Input voltage
The maximum receiving voltage shall be 0,7 Vrms.

b) Input impedance
The impedance at the analogue input shall be greater than 10 kohm in the frequency ranges of 300 Hz to 3 400 Hz for 3,1 kHz telephony or 100 Hz to 7,0 kHz for 7 kHz telephony, depending on application.
Compliance shall be checked by the test described in annex A, subclause A.6.3.2.1 (TP No.36).

5.5 YAE-interface

5.5.1 General

This Part defines the basic requirements of the YAE-interface. The provision of Y-interface is optional.

The transmission requirements of terminal equipment (YTE) shall apply to the Y-interfaces of cascadable AEs.

The transmission shall be serial and asynchronous with a bit rate of 1 200 bit/s. The character format shall be one start bit, 8 data bits, one parity bit (odd) and one stop bit.

The transmission of the signalling-channel in sending direction shall only be achieved by that AE which is in the "active mode". For that the release is given by the Y-signalling. In this situation all the other AEs are in "idle mode". Idle mode is characterised by a direct connection of the sending output to the backward input for cascaded AEs. The connection between the sending output and the control unit of the AE is open.

In receiving direction the AEs are always in "receiving mode" so that the reception of the signalling-channel information is assured.

The interface is protected against short circuit.

Additionally, the transmission elements shall provide the galvanic decoupling and isolation (e.g. opto couplers). These elements shall be integral parts of the AE in the same manner as for the B-channel. A low power consumption, especially a low drive current for the transmission, should correspond with the low bit rate.

The sending and receiving circuit shall be galvanically decoupled both between the TE and AE.

The requirements for galvanic decoupling are given in ETS 300 047 [3].

5.5.2 Bit rate

The transmitting bit rate shall be 1 200 bit/s ±1%.

The received data shall be correctly detected at a bit rate of 1 200 bit/s ± 3%.

Compliance shall be checked by the test described in annex A, subclause A.6.4.1.1 for transmitting (TP No.37) and subclause A.6.4.1.2 for receiving (TP No.38).

5.5.3 Format

The character format shall consist of:

1 start bit (logical 0);
8 data bits (beginning with LSB);
1 parity bit (odd);
1 stop bit (logical 1).

Active state is logical 0, idle state is logical 1.

Compliance shall be checked by the test described in annex A, subclause A.6.4.2 (TP No.39).

5.5.4 Sending

The output shall be realised with a floating switch (e.g. open collector of an optocoupler).

a) Active state
The output voltage drop shall not exceed 0,8 V at a current of 0,5 mA.
Compliance shall be checked by the test described in annex A, subclause A.6.4.3.1 (TP No.40).

b) Idle state
The output leakage current shall not exceed 25 μA at a voltage of 5,25 V.
Compliance shall be checked by the test described in annex A, subclause A.6.4.3.2 (TP No.41).

5.5.5 Receiving

a) Active state
The active state shall be achieved at a current of not more than 1 mA. At a current of 1 mA the input voltage shall not exceed 2,0 V.
Compliance shall be checked by the test described in annex A, subclause A.6.4.4.1 (TP No.42).

b) Idle state
The idle state shall be achieved at any voltage not greater than 0,8 V. At a voltage of 0,8 V the current shall not be greater than 50 μA.
Compliance shall be checked by the test described in annex A, subclause A.6.4.4.2 (TP No.43).

5.6 AEI-connector (X,Y)

The cord shall be a 6 wire cable (flat recommended). The length of the cord shall not be longer than 6 m. The cord shall be detachable at least on the TE-side. It is recommended to terminate the cord on both ends with identical plugs. The plug is given in FCC 68.500 [15] ("western plug"). The pinning on both ends is identical for each conductor.

Table 2: Interface wiring

Function	TE	pin number	AE
B-channel	XTE out	1	XAE in
B-channel	XTE in	2	XAE out
Ground analogue		3	
Signalling	YTE in	4	YAE out
Ground digital		5	
Signalling	YTE out	6	YAE in

6 Z_A/Z_B Interfaces Specifications

6.1 2-Wire Z_A analogue interface specification

6.1.1 General configuration for testing Z_A analogue interface

6.1.2 2-Wire Z_A analogue interface characteristics

The interface provides one analogue access channel with simultaneous transmission in both directions on two wires.

a) Interface resistance
Nominal value: Z_i = 600 ohm

b) Return loss
The return loss of the impedance presented by the 2-wire port against the nominal impedance shall comply with the limits given in the template of figure 2 of I-ETS 300 004 [2].
Compliance shall be checked by the test described in annex A, subclause A.6.5.1.1 (TP No. 44).

c) Loop current
DC voltage without load: 3,5 V to 10 V
Closed loop threshold: 200 ± 50 µA
Maximum short-circuit current: 10 mA.
Compliance shall be checked by the tests described in annex A, subclauses A.6.5.1.2 (TP No. 45), A.6.5.1.3 (TP No. 46) and A.6.5.1.4 (TP No. 47).

d) Relative levels
input relative level: L_i = 0 dBr ± 0,3 dB
output relative level: L_o = -7 dBr ± 0,3 dB

e) Allowable levels
The levels of signals at the Z_A interface emitted to the AE, or received from the AE, shall be compatible with the relative levels at the Z_A interface as defined above, taking into account the load capacity T_{max} (3,14 dBm0) of the codec and CCITT Recommendation G. 223 [10].

6.1.3 Voice frequency parameters of the connection between the 2-wire Z_A interface and the digital interface of the TE and reverse

a) Transmission loss
The nominal transmission loss corresponds to the difference of the nominal relative levels at the two interfaces of the TE: the 2-wire Z_A interface and the S/T digital interface.

NOTE 1: The S/T digital interface is a 0 dBr point according to CCITT Recommendation G.101.

1) Nominal transmission loss between the 2-wire Z_A interface and the S/T digital interface (encoding side)
$NL_i = 0\ dB \pm 0,3\ dB$.
Compliance shall be checked by the test described in annex A, subclause A.6.5.2.1 (TP No. 48).

2) Nominal transmission loss between the S/T digital interface and the 2-wire Z_A interface (decoding side):
$NL_o = 7\ dB \pm 0,3\ dB$.
Compliance shall be checked by the test described in annex A, subclause A.6.5.2.2 (TP 49).

b) Variation of gain with input level
With a sine wave test signal at the reference frequency 1 020 Hz applied to the 2-wire analogue interface of input connection, or with a digitally simulated sine wave signal of the same characteristics (frequency and levels) applied to the digital interface, the gain variation of the connection, relative to the gain at an input level of - 10 dBm0, shall lie within limits given in figure 4 of I-ETS 300 004 [2].

Compliance shall be checked by the tests described in annex A, subclauses A.6.5.2.3 (TP No. 50) and A.6.5.2.4 (TP No. 51).

c) Loss distortion with frequency (Attenuation/frequency distortion)
The loss distortion with frequency of the encoding or the decoding side shall be within the limits shown in the mask of figures 5a and 5b of I-ETS 300 004 [2], taking into account the more stringent limits.

Compliance shall be checked by the tests described in annex A, subclauses A.6.5.2.5 (TP No. 52) and A.6.5.2.6 (TP No. 53).

d) Discrimination against out of band signals applied to the 2-wire analogue interface (sending direction)
With a sine wave signal in the range from 4,6 kHz to 8 kHz applied to the 2-wire interface at a level of - 25 dBm0, the level of any image frequency produced at the digital interface shall, as a minimum requirement, be at least the value 25 dB below the level of the test signal, taking into account the nominal loss of the connection.

Compliance shall be checked by the test described in annex A, subclause A.6.5.2.7 (TP No. 54).

e) Spurious out of band (receiving direction)
With a digitally simulated sine-wave signal in the frequency range 300 Hz - 3 400 Hz at a level of 0 dBm0 applied to the digital interface, the level of spurious out of band image signals measured selectively at the 2-wire interface of the output connection shall be lower than - 25 dBm0.

Compliance shall be checked by the test described in annex A, subclause A.6.5.2.8 (TP No. 55).

f) Total distortion, including quantizing distortion
With a sine wave test signal at the reference frequency of 1 020 Hz applied to the 2 wire interface of the input connection, or with a digitally simulated sine wave signal of the same characteristic applied to the digital input interface, the ratio of signal-to-total distortion, measured at the corresponding outputs with a proper noise weighting shall lie above the limits given in CCITT Recommendation G. 712 [12], figure 12.

NOTE 2: For this requirement, reference is not made to I-ETS 300 004 [2] which includes in its values, the allowance for the noise contributed from the digital PABX power supply (interface with feeding bridge).

Compliance shall be checked by the tests described in annex A, subclauses A.6.5.2.9 (TP No. 56) and A.6.5.2.10 (TP No. 57).

g) Noise

1) Weighted noise measured at the digital interface (sending direction)
With the 2-wire Z_A interface terminated in the nominal impedance, the idle channel noise shall not exceed -64 dBm0p.
Compliance shall be checked by the test described in annex A, subclause A.6.5.2.11 (TP No. 58).

2) Weighted noise measured at the 2-wire Z_A interface (receiving direction)
Noise contributed by the decoding part shall be less than - 75 dBm0p when the digital input is driven by a PCM signal (quiet code) corresponding to the decoder output value number 1 for the A-law.
Compliance shall be checked by the test described in annex A, subclause A.6.5.2.12 (TP No. 59).

6.1.4 Terminal balance return loss

For a sinusoidal test signal, the terminal balance return loss which characterises the impedance balancing property of the 2-wire part shall be greater than the limits shown in figure 9 of I-ETS 300 004 [2].

Compliance shall be checked by the test described in annex A, subclause A.6.5.3.1 (TP No. 60).

6.2 Z_B interface specification

Information transmitted through the Z_B interface shall be signalling semi-permanent "states" (e.g.: connection or switching on of the AE is requested, AE is ready to operate, etc,...).

At least, three wires are required at the Z_B interface:

Z_{BR}: is used to transmit a signalling data from the ISDN TE to the AE;
Z_{BT}: is used to transmit a signalling data in the reverse direction;
Z_{BG}: is a ground reference for the two digital signals.

Z_{BR} and Z_{BT} access shall be protected against short circuit or connection to voltages lower than 50 V referenced to Z_{BG}.

6.2.1 Z_{BR} electrical requirements (TE output access)

a) Active state (high level)
- maximum output voltage: 5,5 V (without load);
- minimum output voltage: 3,3 V (feeding 1 mA).

b) Idle state (low level)
- maximum output voltage: 0,9 V (sinking 1 mA).

Compliance shall be checked by the tests described in annex A, subclauses A.6.6.1.1 (TP No. 61), A.6.6.1.2 (TP No. 62) and A.6.6.1.3 (TP No. 63).

6.2.2 Z_{BT} electrical requirements (TE input access)

a) Active state (high level)
   - minimum input voltage: 3,2 V;
   - maximum input current: 10 µA.

b) Idle state (low level)
   - maximum input voltage: 1,2 V;
   - maximum driving current: 1 mA.

Compliance shall be checked by the tests described in annex A, subclauses A.6.6.2.1 (TP No. 64), A.6.6.2.2 (TP No. 65), A.6.6.2.3 (TP No. 66) and A.6.6.2.4 (TP No. 67).

6.3 Safety and protection

The galvanic decoupling between the terminal equipment and the additional equipment shall be provided at the interface (e.g. with transformers or optocouplers) as an integral part of the AE.

Therefore, the requirements of ETS 300 047 [3] do not apply for the TE-side. The safety and protection requirements of ETS 300 047 [3] shall be fulfilled by the AE. Inductive or capacitive coupling may not occur because of the restricted cord-length between AE and TE (max. 6 m).

6.4 AEI connector (Z)

A connector should be used with six pins (see note below).

The plug is given in FCC 68 500 [15] ("western plug").

Table 3: Interface wiring

TE pin number	Interface wire
1	Z_A+
2	Z_A-
3	Ground
4	Z_{BR}
5	Ground
6	Z_{BT}

NOTE: A connector with six pins seems the most appropriate to avoid jumble between the different cords connectable to the TE, in particular with the connector ISDN with 8 pins for S interface.

7 Signalling protocol on the Z_A/Z_B interface

7.1 Significance of the signals at the Z_B interface

7.1.1 At Z_{BR}

The Active State uses one of the following conditions to transmit signals from TE to AE according to the application selected in TE.

Table 4: Signals at the Z_{BR} interface

APPLICATION	SIGNIFICANCE
Additional alerting module	Alerting
Charging pulse counter	Pulse present (100 ms)
Incoming call for AE	Activation of AE
Outgoing call for AE	Remote party answer

7.1.2 At Z_{BT}

The Active State is used as described in table 5.

Table 5: Signals at the Z_{BT} interface

APPLICATION	SIGNIFICANCE
Incoming call for AE	AE ready
Outgoing call for AE	Call request by AE

8 Protocol of the Y-interface

8.1 Model of protocol specification

The present specification describes the protocol of the AEI between an ISDN-TE and ISDN-AE.

The protocol specification is based on the model as given below (see figure 4). The complete protocol handling is divided into the layers 1, 2 and 3. Each layer is allocated to an unambiguous function.

Physically, only layer 1 between the TE and AE is existent. Between layers Y- TE- L2 <---> Y- AE- L2 and Y- TE- L3 <---> Y-AE- L3 there is only a virtual connection. For the transmission of information, layer 3 uses layer 2 and layer 2 uses layer 1.

The model only serves as the description of the protocol and does not represent an implementation regulation.

With respect to cascading of AE the protocol mechanism handles only one automatic sending/answering AE.

The number of listening AE is restricted by the physical requirements given in subclause 5.1.

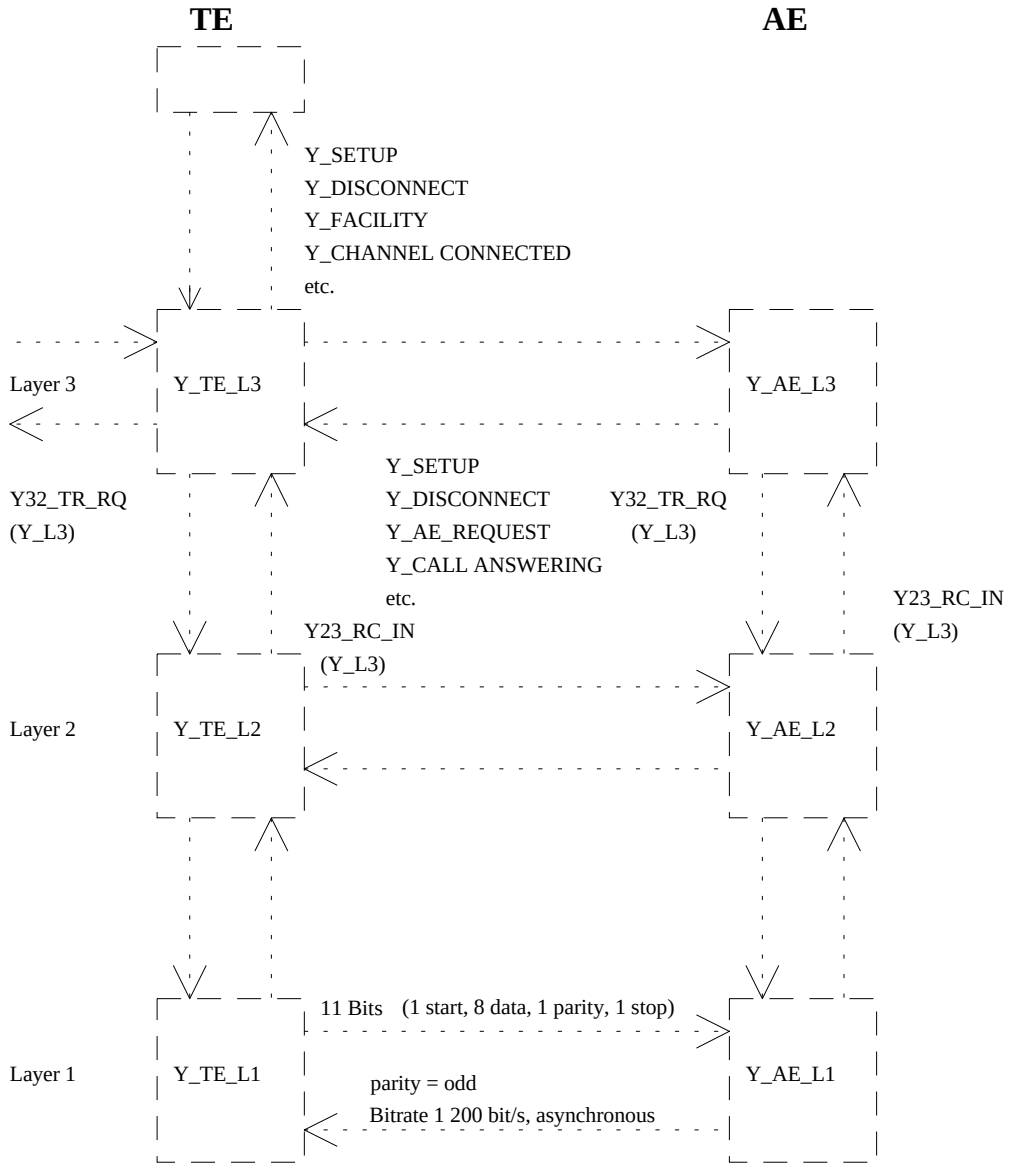


Figure 4: Model of protocol specification

8.2 Layer 1

The following definitions are valid for layer 1:

- asynchronous transfer mode;
- data format (11 Bit, 1 start-, 8 data-, 1 parity-, 1 stopbit);
- parity = odd;
- transmission rate = 1 200 bit/s.

8.3 Layer 2

8.3.1 Layer 2 functions

Y TE L2:
- transmission of layer 3 messages;
- acknowledgement of the messages from the AE;
- error detection.

Y AE L2:
- repetition of transmission;
- transmission of layer 3 messages;
- error detection.

8.3.2 Structure of layer 2 messages

The structure of a layer 2 message is described in figure 5.

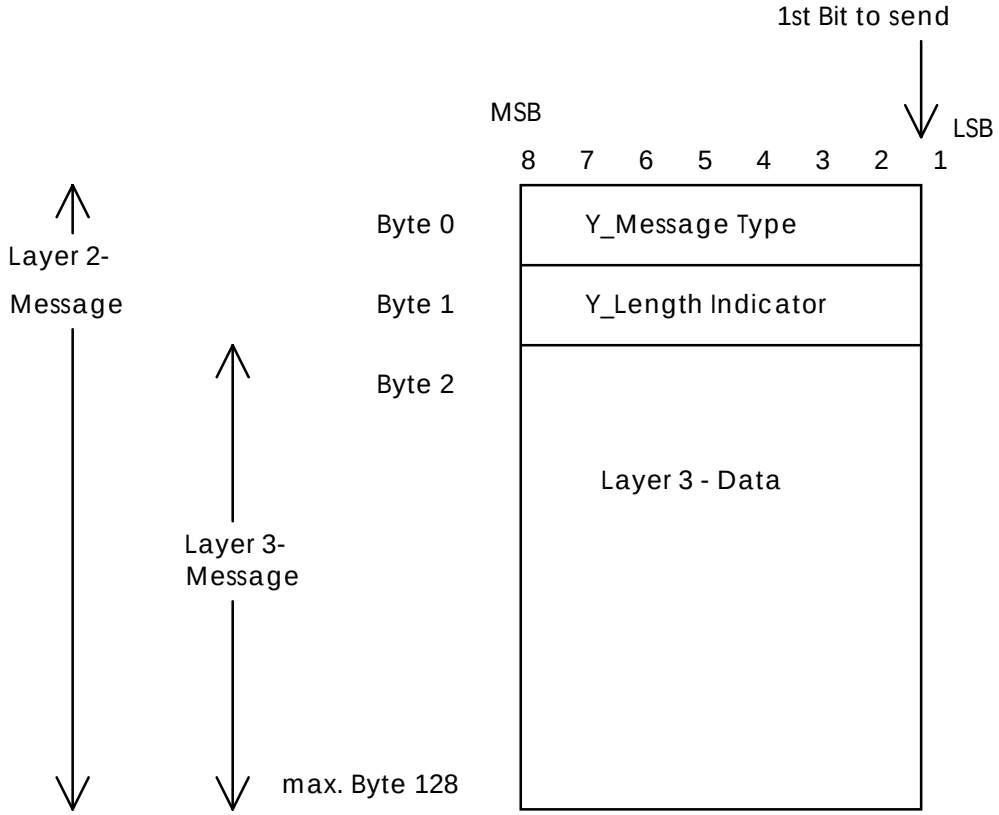


Figure 5: Structure of a layer 2 message with layer 3 content

8.3.3 Y-Message types of layer 2

Table 6: Y-Message types of layer 2

Message-Type	Designation	Code Bit 8 7 6 5 4 3 2 1	Direction	Layer 3 elements possible?
Y2_REQA	Request	0 0 0 0 0 0 0 1	AE ---> TE	Yes
Y2_REQT	Request	0 0 0 0 0 0 1 0	TE --> AE	Yes
Y2_ACK	Acknowledge	0 0 0 0 0 1 0 0	TE --> AE	No
Y2_ERR	Error	0 0 0 0 0 1 0 1	TE --> AE	No

8.3.4 Length indicator of layer 2

The byte 1 of a layer 2 message gives, binary coded, the length in bytes of a message. The count of the length starts with byte 2, that means with the beginning of the layer 3 contents.

Layer 2 messages without layer 3 contents have the length indicator "0000 0000".

The values of the length indicator have to be in the range of:

0 <= length indicator <= 127

8.3.5 Additional message on layer 2

The following message is exchanged within layer 2 of the TE.

Table 7: Additional message on layer 2 of the TE

Message Type	Designation	Code
TTE2 Timeout	TTE2 expires	implementation dependent

The following messages are exchanged within layer 2 of the AE.

Table 8: Additional messages on layer 2 of the AE

Message Type	Designation	Code
TAE2_Timeout	Timer TAE2 expired	implementation dependent
TAE3_Timeout	Timer TAE3 expired	implementation dependent

TAE2, TAE3: Layer 2 timer in the AE.

8.3.6 Layer 2 to layer 3 service elements

The following messages are sent between the layers 2 and 3.

Table 9: Messages between layer 2 and layer 3

Message Type	Designation	Meaning	Location	
			TE	AE
Y32_TR_RQ	Transmit Request	Request to transmit a layer 3 message	X	X
Y23_RC_IN	Receive Indication	Layer 3-message received	X	X
Y23_ERR_IN	Error Indication	Layer 3 message not confirmed		X
Y2_Timeout	TTE2 Timeout	TTE2 expired	X	

8.3.7 Layer 2 timer

Timer in the TE:

Table 10: Layer 2 timers in the TE

Timer	Value	Type	Cause for start	Normal Stop	Action after expiry
TTE1	1,5 s	m 1)	First received byte of Y2_REQA	Last received byte of Y2_REQA	Send Y2_ERR + ignore L2-frame 3)
TTE2 2)	30 s	m 1)	Sending of Y2_ACK	Receiving of a layer 2 frame	Y2_Timeout (subclause 8.4.10)

Key:
1) m = mandatory.
2) Timer to check, if the AE, which started a transaction, is still connected to the TE.
3) To ignore means to behave as if no message has been received.

Timer in the AE:

Table 11: Layer 2 timers in the AE

Timer	Value	Type	Cause for start	Normal Stop	Action after expiry
TAE1	1,5 s	m [1)]	First received byte of a layer 2 frame	Last received byte of the same layer 2 frame	ignore layer 2 frame [2)]
TAE2	5 s	m [1)]	Sending of Y2_REQA or Y2_REQA(Y_L3)	Receiving of a Y2_ACK or Y2_ERR	Repeat of Y2_REQA and restart TAE2; after the 5. expiry sending Y23_ERR_IN
TAE3	15 s	m [1)]	Sending of Y2_REQA	see action after expiry	Repeat Y2_REQA to show the TE that the transaction is still going on
Key: 1) m = mandatory. 2) To ignore means to behave as if no message has been received.					

8.3.8 Protocol principles of layer 2

The following description of the protocol procedures on layer 2 only serves the purpose to clarify the different procedures and does not represent an implementation regulation. There is a description for the TE-side as well as for the AE-side.

TE-State:

S0: Active

AE-States:

S0: Active

S1: Transmit Request

The procedures are described in form of SDL-diagrams (see subclause 8.3.9).

The following assumptions apply:

- the message Y2_REQA from the AE to TE can have layer 3 content or not. Therefore, there are 2 possibilities to write the message:
  Y2_REQA(Y_L3) Y2_REQA with layer 3 content;
  Y2_REQA Y2_REQA without layer 3 content.

- all other messages are written as described in the subclauses 8.3.3, 8.3.5 and 8.3.6;

- to ignore means that there is no action on an input;

- start and stop of timer TAE1 and TTE1 are not shown in the SDL-description.

8.3.9 Layer 2 SDL-description

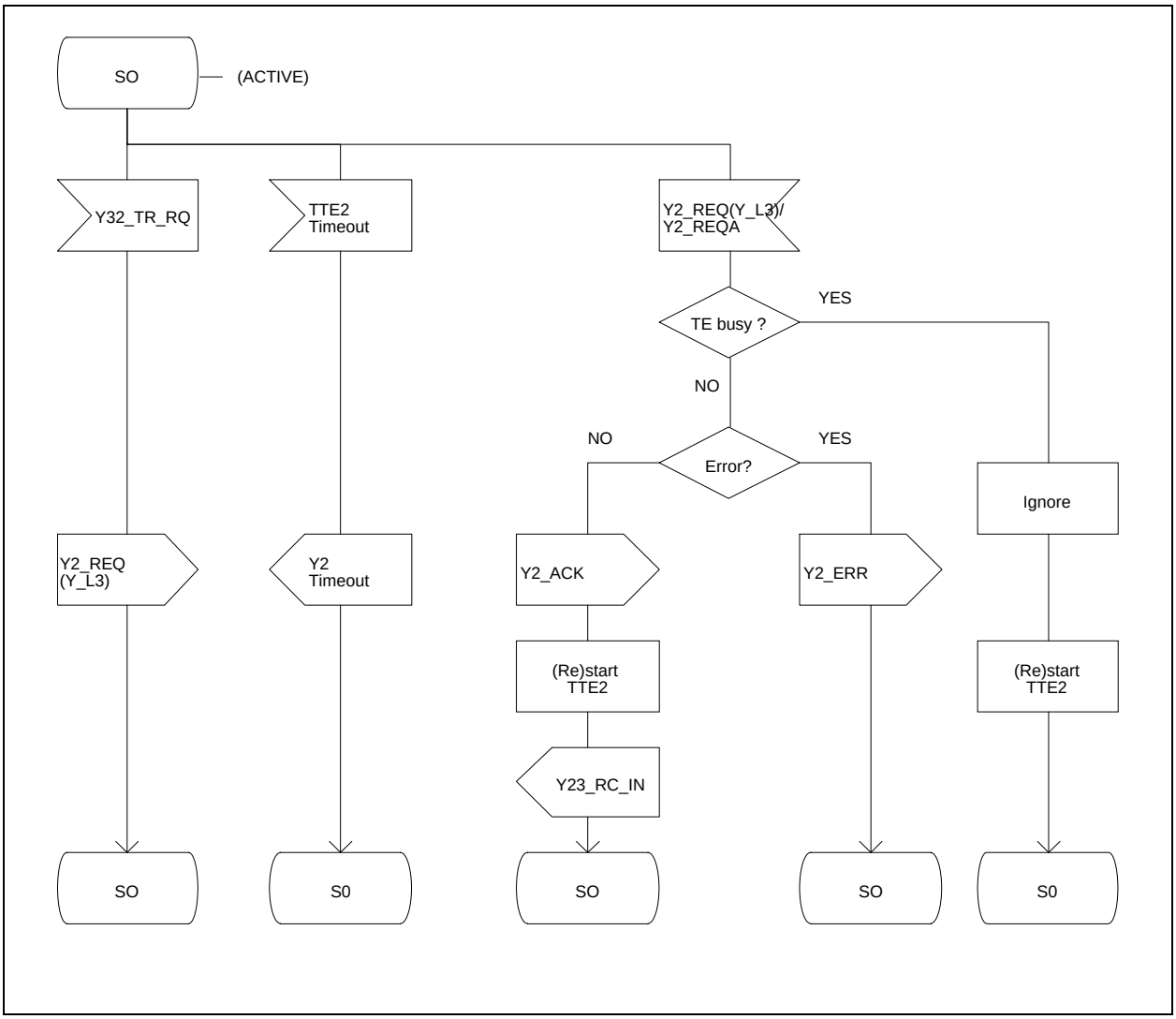


Figure 6: Layer 2 procedures on TE side

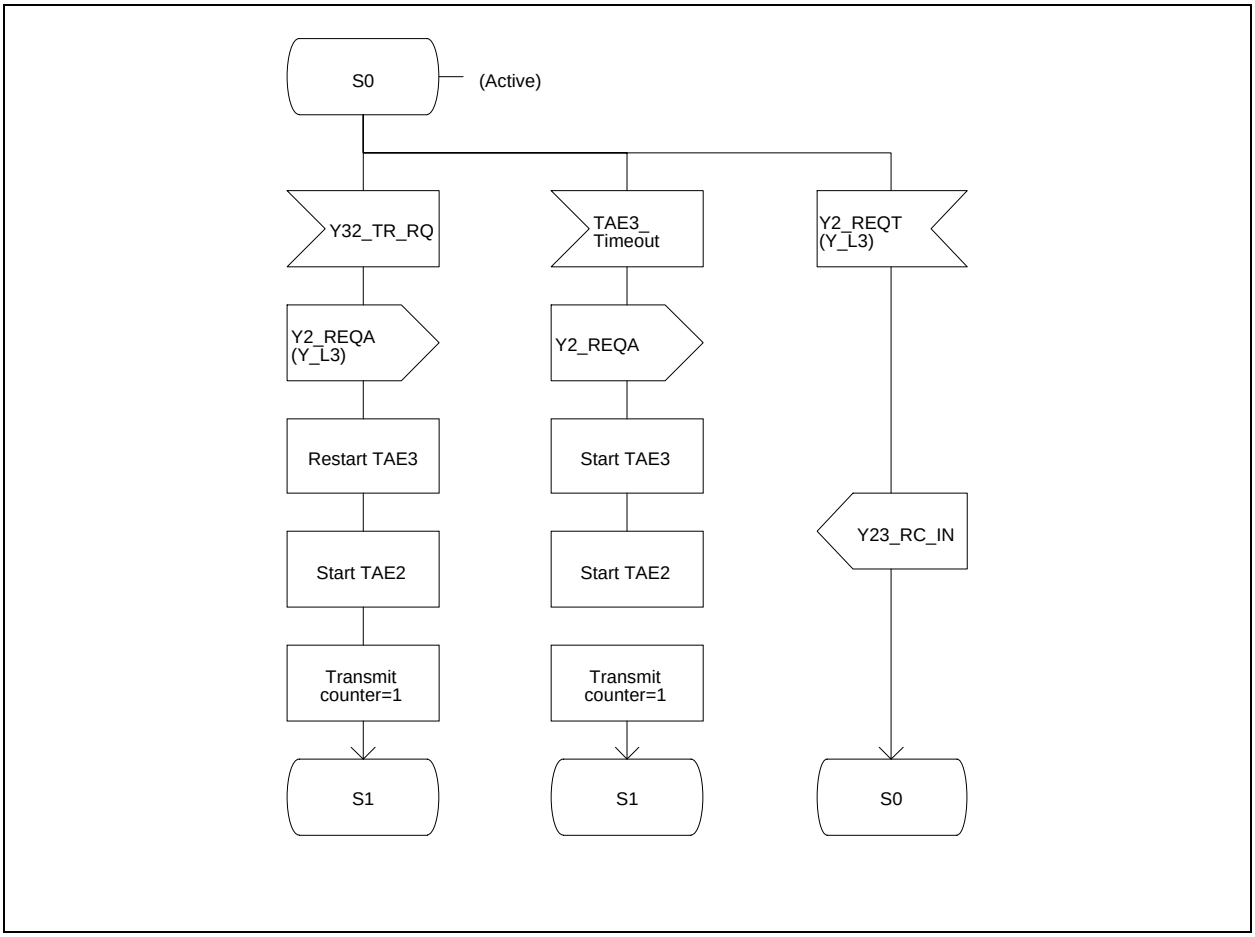


Figure 7: Layer 2 procedures AE state S0 Active

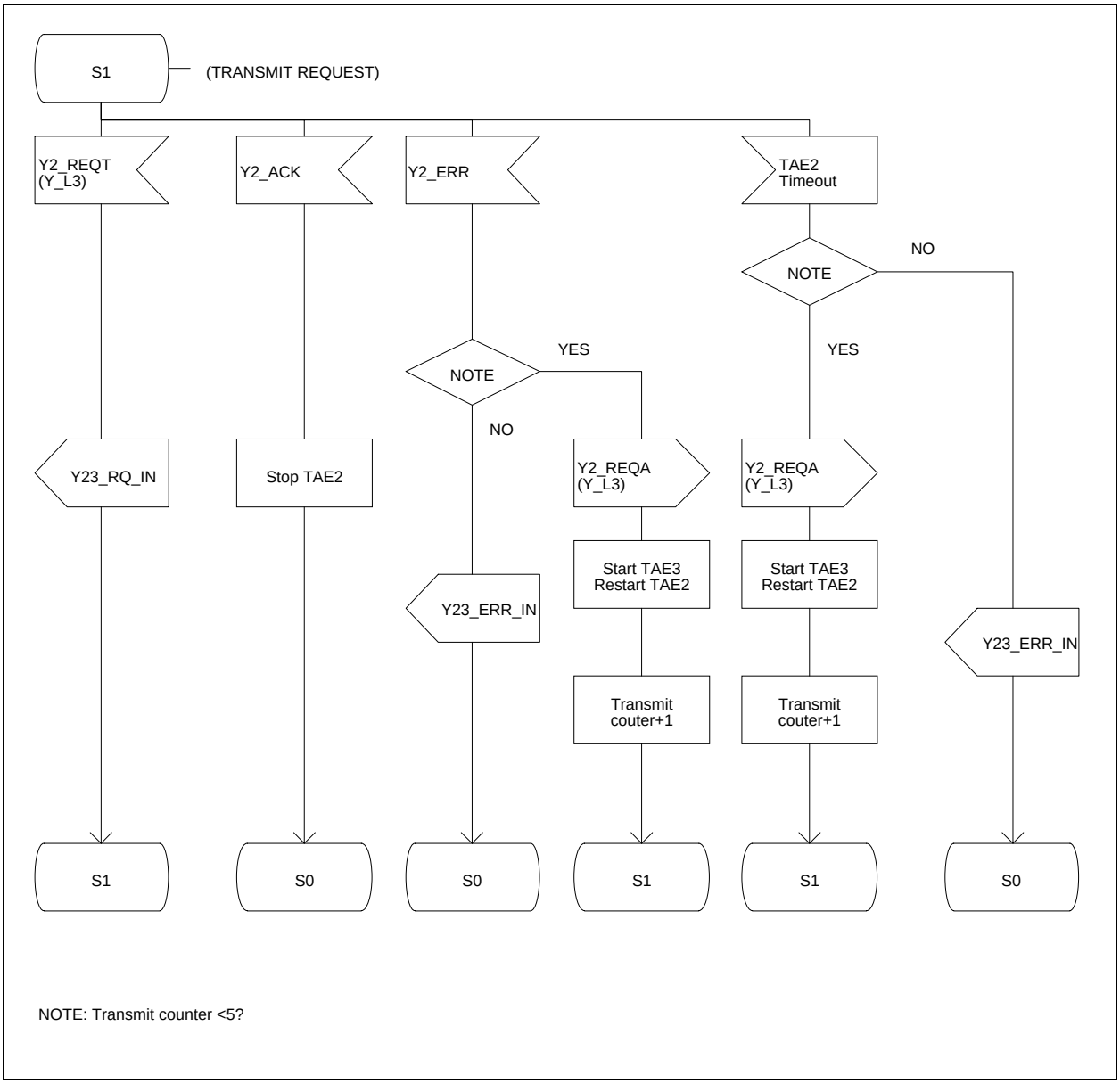


Figure 8: Layer 2 procedures AE state S1 Transmit request

8.3.10 Error handling

Table 12: Error handling

Error Type	Layer 2 TE	Layer 2 AE
Error in layer 1	Y2_ERR ignore Y2_frame	ignore Y2_frame
Message type not defined	Y2_ERR ignore Y2_frame	ignore Y2_frame
max. time to receive a layer 2 frame exceeded	Time check TTE1; after timeout: Y2_ERR ignore Y2_frame	Time check TAE1; after timeout: ignore Y2_frame
Length indicator > 127	Y2_ERR ignore Y2_frame	ignore Y2_frame
Unexpected message	ignore Y2_frame	ignore Y2_frame
Sequence blocked - Line disconnected - Message loss	time check TTE2 (subclause 8.3.7)	time check TAE2 (subclause 8.3.7)

8.4 Layer 3

8.4.1 Layer 3 functions

Y_TE_L3: conversion of the D-channel protocol of layer 3 to the Y_L3_protocol and vice versa;
error correction.

Y_AE_L3: conversion of the Y_L3_protocol to the special application and vice versa;
error correction.

8.4.2 Examples for layer 3 message handling

8.4.2.1 Call establishment (outgoing call initiated by the AE)

ET	TE with AEI	AE
		<-- Y_SETUP (BC, HLC, LLC, CDPN)
	<-- SETUP (CR) BC,HLC,LLC,CDPN	--> Y_INFO (CDPN)
SETUP ACK	-->	
		<-- Y_INFO (CDPN)
	<-- INFO (CDPN)	--> Y_INFO (CDPN)
		CALL PROCEEDING --> -->Y_CALL PROCEEDING
ALERTING	-->	
		--> Y_ALERT
CONNECT	-->	--> Y_ CHANNEL CONNECTED

Successful call establishment

		Charging information		
FACILITY (FAC)	-->		-->	Y_ FACILITY (FAC)
		Taking over of the current connection by the TE		
			-->	Y_ TERMINAL ACTIVE

8.4.2.2 Call release in case of a complete established connection

There are 3 different cases:

a) the connection is released by the TE;
b) the connection is released by the AE;
c) the connection is released by the ET.

ET		TE with AEI	AE	
	a)	**the connection is released by the TE**		
		<-- DISCONNECT	-->	Y_ CHANNEL DISCONNECTED
RELEASE	-->			
		<-- RELEASE COMPLETE	-->	Y_ END
	b)	**the connection is released by the AE**		
			<--	Y_DISCONNECT
		<-- DISCONNECT	-->	Y_ CHANNEL DISCONNECTED
RELEASE	-->			
		<-- RELEASE COMPLETE	-->	Y_ END
	c)	**the connection is released by the ET**		
DISCONNECT	-->			
			-->	Y_DISCONNECT
			-->	Y_CHANNEL DISCONNECTED
		<-- RELEASE		
RELEASE COMPLETE	-->		-->	Y_END

8.4.2.3 Takeover of the current connection

Start state.

There is a completely established connection to the TE. 2 cases shall be distinguished:

a) the takeover and the return of a connection from the AE to the TE and vice versa;
b) the takeover of a connection with priority (e.g. an alarm system).

ET		TE with AEI		AE
	a)	**Takeover of the connection by the AE**		
			<--	Y_ADDITIONAL EQUIPMENT REQUEST
		Handset down		
			-->	Y_ADDITIONAL EQUIPMENT ACKNOWLEDGE
		Return of the connection to the TE		
			<--	Y_TRANSFER TO TE
		Handset up		
			-->	Y_TERMINAL ACTIVE

ET		TE with AEI		AE
	b)	**Takeover of the connection by an AE with priority**		
			<--	Y_ADDITIONAL EQUIPMENT REQUEST(Priority)
			-->	Y_ADDITIONAL EQUIPMENT ACKNOWLEDGE
		Release of the current connection		
			<--	Y_DISCONNECT (Priority)
		<-- DISCONNECT	-->	Y_ CHANNEL DISCONNECTED
RELEASE		-->		
		<-- RELEASE COMPLETE	-- >	Y_ END
		Call establishing with priority		
			<--	Y_SETUP (Priority)
		<-- SETUP		.

8.4.2.4 Incoming call

ET	TE with AEI	AE
	Incoming call (e.g. telephony)	
SETUP(BC, HLC, LLC)	-->	
		--> Y_SETUP (BC, HLC, LLC)
	<-- ALERT	<-- Y_ALERT
	The call is accepted by the AE	
		<-- Y_CALL ANSWERING
	<-- CONNECT	
CONNECT ACK	-->	--> Y_CHANNEL CONNECTED
	Incoming call (e.g. facsimile group 2/3)	
SETUP(BC, HLC, LLC)	-->	--> Y_SETUP (BC, HLC, LLC)
		<-- Y_ALERT
	<-- ALERT	
	The call is accepted by the AE	
		<-- Y_CALL ANSWERING
	<-- CONNECT	
CONNECT ACK	-->	--> Y_CHANNEL CONNECTED

8.4.2.5 Manufacturer specified applications

TE with AEI	AE		NOTES
	Beginning from AE with specific call-reference		
	<--	Y-ESCAPE	Message without call reference (CR).
	-->	Y-ESCAPE (CR)	TE assigns a CR-value.
	<-->	Y-ESCAPE (CR)	AE and TE can exchange (MID) information about manufacturer specified application.
	Beginning from TE with specific call-reference		
	-->	Y-ESCAPE (CR) (MID)	TE assigns a CR-value. AE shall decide if it accepts the message, this depends on the contents of the message.
	<-->	Y-ESCAPE (CR)	AE and TE can exchange (MID) information about manufacturer specified application.
	Release with a specific call-reference		
	-->	Y-END (CR)	Only the TE can release caused by: - information from AE; - user activity; - D-channel information.
ESCAPE-sequence on an existing call-reference, e.g. during a connection			
	<-->	Y-ESCAPE (CR)	AE and TE can exchange (MID) information about manufacturer specified application related to an existing connection.
ESCAPE without a call reference (AE to TE only)			
	<--	Y-ESCAPE	AE can transfer information about a manufacturer specified application. The TE shall decide to assign a CR-.value or not.

8.4.3 Structure of layer 3 message

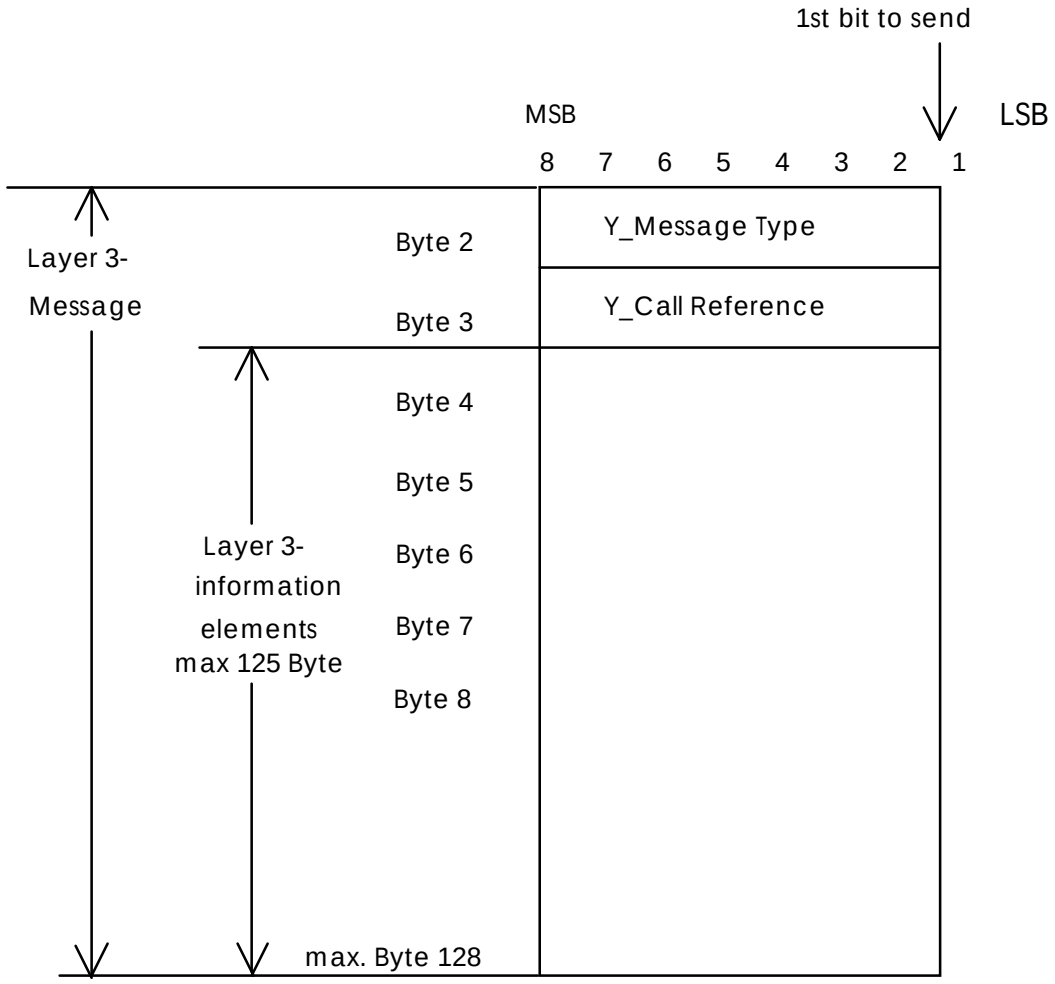


Figure 9: Structure of a layer 3 message

8.4.4 Message functional definitions and contents

This subclause provides an overview of the messages of the AEI and describes the functional definition and information contents of each message. Each definition includes:

a) a brief description of the use and the significance of the message. Significance means whether the message has:

   1) local significance, i. e. the message is relevant at the AEI; there is no relation to the D-channel;

   or,

   2) global significance, i.e. there is a relation between the messages in the D-channel and the messages of the AEI;

b) a table listing the information elements and the direction in which they may be sent. The table also shows whether the inclusion of an information element is mandatory ("M") or optional ("O");

c) further explanatory notes.

8.4.4.1 Messages

Table 13 summarises the messages on the AEI.

Table 13: Messages on the AEI

Message	Reference (subclause)
Y-SETUP	8.4.4.2
Y-CALL ANSWERING	8.4.4.3
Y-CHANNEL CONNECTED	8.4.4.4
Y-CHANNEL DISCONNECTED	8.4.4.5
Y-INFO	8.4.4.6
Y-ALERT	8.4.4.7
Y-CALL PROCEEDING	8.4.4.8
Y-USER INFO	8.4.4.9
Y-TRANSFER TO TE	8.4.4.10
Y-ADDITIONAL EQUIPMENT REQUEST	8.4.4.11
Y-ADDITIONAL EQUIPMENT ACKNOWLEDGE	8.4.4.12
Y-ADDITIONAL EQUIPMENT REJECT	8.4.4.13
Y-END	8.4.4.14
Y-RESET	8.4.4.15
Y-TERMINAL ACTIVE	8.4.4.16
Y-FACILITY	8.4.4.17
Y-ESCAPE	8.4.4.18
Y-DISCONNECT	8.4.4.19
Y-CONGESTION CONTROL	8.4.4.20

8.4.4.2 Y_Setup

This message is sent by the TE to the AE to signal an incoming call and by the AE to the TE to initiate call establishment (see table 14).

Table 14: Message type: Y_SETUP Significance: global

Information Element	Direction	
	AE-> TE	TE -> AE
Message type	M	M
Y-Call reference	M (note 1)	M
Sending complete	O	O
Bearer Capability	M (note 2)	M
Facility	O	O
Calling party number	O	O
Calling party subaddress	O	O
Called party number	O	O
Called party subaddress	O	O
Low Layer Compatibility	O	O
High Layer Compatibility	O	O
User-User (note 3)	O	O
Priority (note 4)	O	

NOTE 1: The AE does not assign the Y_Call reference in the case of initiating a call. The TE shall accept any value.
NOTE 2: The following values are possible: speech, 3,1 kHz audio, 7 kHz audio.
NOTE 3: The maximum length is for further study, due to timing problems with timer T303.
NOTE 4: May be included in the direction AE to TE but not in the D-channel.

8.4.4.3 Y_Call answering

This message is sent by the AE to the TE to indicate call acceptance by the AE (see table 15).

Table 15: Message type: Y_CALL ANSWERING significance: global

Information Element	Direction	
	AE -> TE	TE -> AE
Message type	M	
Y-Call reference	M	
Low Layer Compatibility	O	
User-User	O	
Priority (note)	O	
NOTE: May be included in the direction AE to TE but not in the D-channel.		

8.4.4.4 Y_Channel connected

This message is sent by the TE to the AE to indicate a successful call establishment, i.e. the B-channel has been connected to the other subscriber (see table 16).

Table 16: Message type: Y_CHANNEL CONNECTED significance: global

Information Element	Direction	
	AE -> TE	TE -> AE
Message type		M
Y-Call reference		M
Date/Time		O
Low Layer Compatibility		O
User-User		O

8.4.4.5 Y_Channel disconnected

This message is sent from the TE to the AE to indicate that the B-channel to the other subscriber has been disconnected (see table 17).

Table 17: Message type: Y_CHANNEL DISCONNECTED significance: global

Information Element	Direction	
	AE -> TE	TE -> AE
Message type		M
Call reference		M
Cause		M
User-User		O

8.4.4.6 Y_Info

This message is sent from the TE to the AE,

- if the TE has sent dialling information to the network,
- to mirror back the dialling information received from the AE,

and from the AE to the TE to provide dialling information for call establishment (see table 18).

Table 18: Message type: Y_INFO significance: global

Information Element	Direction	
	AE -> TE	TE -> AE
Message type	M	M
Y-Call reference	M	M
Sending complete	O	O
Called party number	M	O

8.4.4.7 Y_Alert

This message is sent from the TE to the AE to indicate that called user alerting has been initiated and from the AE to the TE to indicate that the AE is able to accept an incoming call (see table 19).

Table 19: Message type: Y_ALERT significance: global

Information Element	Direction	
	AE -> TE	TE -> AE
Message type	M	M
Y-Call reference	M	M
User-User (note)	O	O
NOTE: The maximum length is for further study, due to timing problems with timer T303.		

8.4.4.8 Y_Call proceeding

This message is sent from the TE to the AE to indicate that the requested call establishment has been initiated and no more call establishment information is accepted (see table 20).

Table 20: Message type: Y_CALL PROCEEDING significance: global

Information Element	Direction	
	AE -> TE	TE -> AE
Message type		M
Y-Call reference		M

8.4.4.9 Y_User info

This message is sent from the TE to the AE to deliver information from the other user and is also sent from the AE to the TE to transfer information to the remote user (see table 21).

Table 21: Message type: Y_USER INFO Significance: global

Information Element	Direction	
	AE -> TE	**TE -> AE**
Message type	M	M
Y-Call reference	M	M
More data	O	O
User-User	M	M

8.4.4.10 Y_Transfer to TE

This message is sent from the AE to the TE to transfer the current connection from the AE to the TE (see table 22).

Table 22: Message type: Y_TRANSFER TO TE significance: local

Information Element	Direction	
	AE -> TE	TE -> AE
Message type	M	
Y-Call reference	M	
Bearer Capability	M	
Low Layer Compatibility	O	
High Layer Compatibility	O	

8.4.4.11 Y_Additional Equipment Request

This message is sent from the AE to the TE to request the takeover of the current connection from the TE (see table 23).

Table 23: Message type: Y_ADDITIONAL EQUIPMENT REQUEST significance: local

Information Element	**Direction**	
	AE -> TE	**TE -> AE**
Message type	M	
Y-Call reference	M	
Priority (note)	O	
NOTE: May be included in the direction AE to TE but not in the D-channel.		

8.4.4.12 Y_additional equipment acknowledge

This message is sent from the TE to the AE to indicate the completion of a request to take over the current connection (see table 24).

Table 24: Message type: Y_ADDITIONAL EQUIPMENT ACKNOWLEDGE significance: local

Information Element	Direction	
	AE -> TE	TE -> AE
Message type		M
Y-Call reference		M

8.4.4.13 Y_Additional Equipment Reject

This message is sent from the TE to the AE to reject the request to take over the current connection (see table 25).

Table 25: Message type: Y_ADDITIONAL EQUIPMENT REJECT significance: local

Information Element	Direction	
	AE -> TE	TE -> AE
Message type		M
Y-Call reference		M

8.4.4.14 Y_End

This message is sent from the TE to the AE to indicate that the corresponding transaction has been cleared, i.e. the TE and the AE shall clear the indicated Y_ Call reference (see table 26).

Table 26: Message type: Y_END significance: global

Information Element	Direction	
	AE -> TE	TE -> AE
Message type		M
Y-Call reference		M
Cause		O
Facility		O
User-User		O

8.4.4.15 Y_Reset

This message is sent from the TE to the AE to clear all the existing Y_Call references and to achieve Y0 state (see table 27).

Table 27: Message type: Y_RESET significance: local

Information Element	Direction	
	AE -> TE	TE -> AE
Message type		M
Y-Call reference		M

8.4.4.16 Y_Terminal Active

This message is sent from the TE to the AE to indicate that the TE has initiated an outgoing call or the TE has accepted an incoming call. This message is also sent whenever the TE has taken over the current connection from the AE (see table 28).

Table 28: Message type: Y_TERMINAL ACTIVE significance: global

Information Element	Direction	
	AE -> TE	TE -> AE
Message type		M
Y-Call reference		M

8.4.4.17 Y_Facility

This message is sent from the TE to the AE to transfer charging information to the AE and is only used in the active state of a connection (see table 29).

Table 29: Message type: Y_FACILITY significance: global

Information Element	Direction	
	AE -> TE	TE -> AE
Message type		M
Y-Call reference		M
Facility		M

8.4.4.18 Y_Escape

This message is sent from the TE or AE to indicate a manufacturer-specified application (see table 30).

Table 30: Message type: Y_ESCAPE significance: local

Information Element	Direction	
	AE -> TE	TE -> AE
Message type	M	M
Y-Call reference	M (note)	M
Manufacturer identifier	O	O
User-User	O	O
NOTE: The AE does not assign the Y-Call reference in the case of initiating a manufacturer specific application. The TE shall accept any value.		

8.4.4.19 Y_Disconnect

This message is sent from the TE to the AE to indicate that the connection has been cleared by the network. The message is sent from the AE to request the TE to clear the connection (see table 31).

Table 31: Message type: Y_DISCONNECT significance: global

Information Element	Direction	
	AE -> TE	TE -> AE
Message type	M	M
Y-Call reference	M	M
Cause		M
Facility	O	O
User-User	O	O
Priority (note)	O	
NOTE: May be included in the direction AE to TE but not in the D-channel.		

8.4.4.20 Y_Congestion Control

This message is sent by the TE or the AE to indicate the establishment or termination of flow control on the transmission of Y_USER INFO (see table 32).

Table 32: Message type: Y_CONGESTION CONTROL significance: global

Information Element	Direction	
	AE -> TE	TE -> AE
Message type	M	M
Y-Call reference	M	M
Congestion level	M	M
Cause	O	O

8.4.5 Coding of message types

The purpose of the message type is to identify the function of the message being sent. The message is coded as shown in table 33.

Table 33: Coding of message types

Bits								
8	7	6	5	4	3	2	1	Message Type
0	0	0	-	-	-	-	-	Call establishment messages:
			0	0	0	0	1	Y_ALERT
			0	0	0	1	0	Y_CALL PROCEEDING
			0	0	1	0	0	Y_TERMINAL ACTIV
			0	0	1	0	1	Y_SETUP
			0	0	1	1	0	Y_CHANNEL CONNECTED
			0	0	1	1	1	Y_CALL ANSWERING
0	0	1	-	-	-	-	-	Call information messages:
			0	0	0	0	0	Y_USER INFORMATION
0	1	0	-	-	-	-	-	Call clearing messages:
			0	0	0	0	1	Y_CHANNEL DISCONNECTED
			0	0	1	0	1	Y_DISCONNECT
			1	1	0	1	0	Y_END
	1	1	-	-	-	-	-	Miscellaneous message:
			0	0	0	1	0	Y_FACILITY
			1	1	0	0	1	Y_CONGESTION CONTROL
0			1	1	0	1	1	Y_INFO
1	0	0	-	-	-	-	-	Local messages:
			0	0	0	0	1	Y_TRANSFER TO TE
			0	0	0	1	0	Y_ADDITIONAL EQUIPMENT REQUEST
			0	0	0	1	1	Y_ADDITIONAL EQUIPMENT ACKNOWLEDGE
			0	0	1	0	0	Y_ADDITIONAL EQUIPMENT REJECT
			0	0	1	0	1	Y_RESET
			0	0	1	1	0	Y_ESCAPE
NOTE: If bit 8 is set to "1" the message only has local significance.								

8.4.6 Y_Call Reference

The purpose of the Y_Call reference is to identify a call at the interface between AE and TE.

In case of call establishment from AE the Y_Call reference shall be assigned by the TE. The answer to the Y_SETUP or Y_ESCAPE from the AE contains the value of the Y_Call reference.

8.4.7 Information elements

8.4.7.1 Coding of information elements

Table 34: Coding of the information elements

Bits								
8	7	6	5	4	3	2	1	Information Element
0	0	0	0	0	1	0	0	Bearer Capability
0	0	0	0	1	0	0	0	Cause
0	0	0	1	1	1	0	0	Facility
0	0	1	0	1	0	0	1	Date Time
0	1	1	0	1	1	0	0	Calling party number
0	1	1	0	1	1	0	1	Calling party subaddress
0	1	1	1	0	0	0	0	Called party number
0	1	1	1	0	0	0	1	Called party subaddress
0	1	1	1	1	1	0	0	Low Layer Compatibility
0	1	1	1	1	1	0	1	High Layer Compatibility
0	1	1	1	1	1	1	0	User-User
1	0	0	1	-	-	-	-	Shift
1	0	1	0	0	0	0	0	More data
1	0	1	0	0	0	0	1	Sending complete
1	0	1	1	-	-	-	-	Congestion level

The contents and application of the above mentioned information elements are according to ETS 300 102-1 [5].

Table 35: Local information elements

Bits								
8	7	6	5	4	3	2	1	Information elements
1	1	0	0	0	0	0	0	Priority
0	0	1	0	0	0	1	1	Manufacturer identifier
NOTE: The elements priority and manufacturer identifier belong to code set to "0".								

8.4.7.2 Priority

The element priority gives AE priority over the TE; e.g. an alarm system.

The coding is as shown in table 35 above.

8.4.7.3 Manufacturer identifier

The purpose of the manufacturer identifier element is to transmit a manufacturer code.

Table 36: Manufacturer identifier

Bits									
8	7	6	5	4	3	2	1	Octet	
0	0	1	0	0	0	1	1	1	Manufacturer identifier
X	X	X	X	X	X	X	X	2	Length
X	X	X	X	X	X	X	X	3	Manufacturer code (note)
NOTE: For further study.									

8.4.8 Layer 3 timer

There are no layer 3 timers defined in the TE and the AE.

NOTE: It is recommended to implement in the AE the supervision of the call handling.

8.4.9 State transition diagram

The description only refers to a layer 3 model in the TE.

The selected division of layer 3 for the Y-interface into three single processes (see figure 10) only serves the purpose of illustrating the protocol procedures and does not represent an implementation regulation.

The layer 3 model follows the corresponding architecture for layer 3 as described under "User-SDL" in ETS 300 102-2 [6] and has been restricted to all information relevant to the Y-interface. The modification of the model is based on the introduction of a signalling process for handling the Y-interface protocol and on the division of the layer-internal interfaces into a user-oriented and a network-oriented interface.

These internal interfaces are completely arbitrary and are only intended to inform about possible correlations between the process on the Y-interface and the related transaction on the network interface.

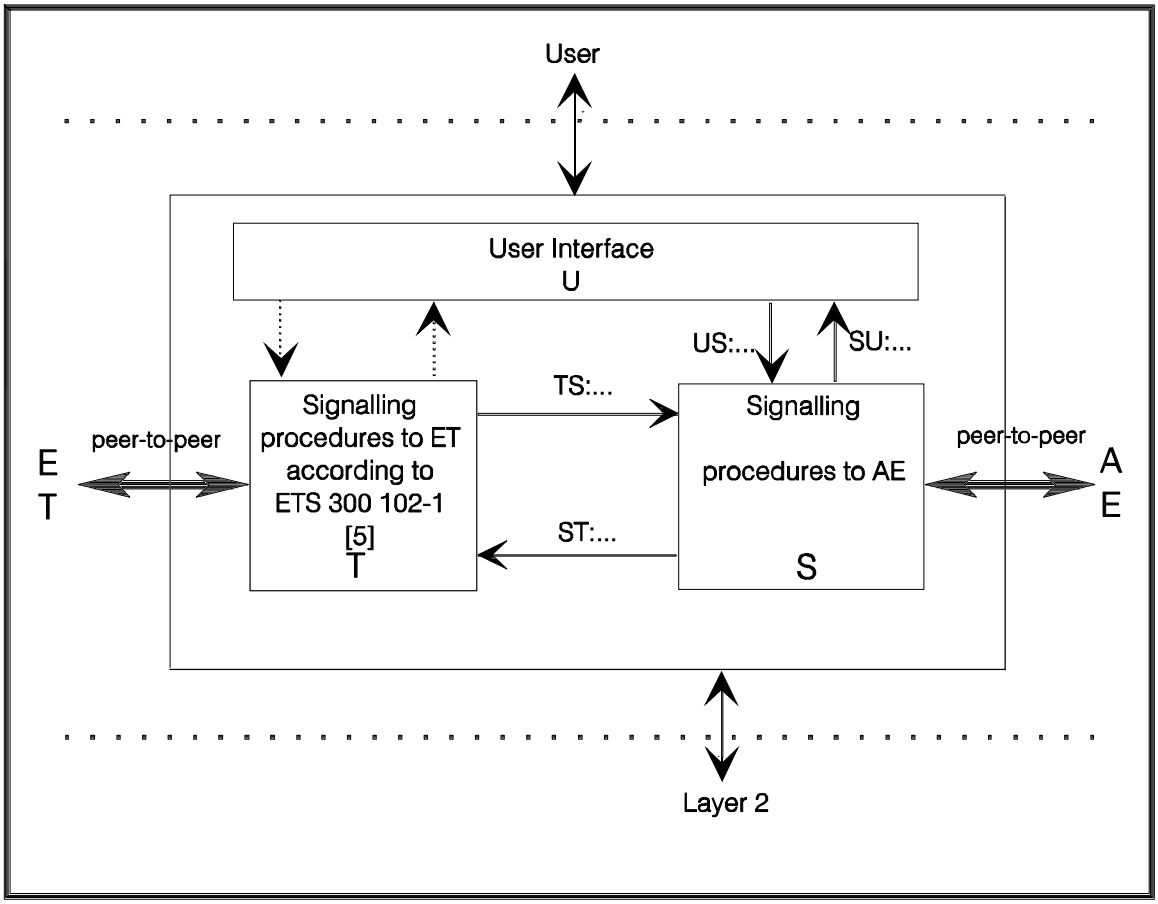


Figure 10: Layer 3 process on the telephone side

Layer 3 is divided into the following processes:

S: Signalling process for handling the Y-protocol at the interface to the AE;

T: Transaction process for handling the D-channel protocol at the network interface (ETS 300 102-1 [5]);

U: User process for handling the interaction with higher layers (user interface) of the telephone.

The individual processes are independent of each other to the extent that:

- a received message need not in any case generate a response;
- a response may be the result of various events (e.g. received messages);

EXAMPLE: The signalling process receives a message TS:... generated by the transaction process. This message may have been generated within the transaction process not only as a response to a received but also to a transmitted layer 3 D-channel protocol message.

- a layer 3 D-channel protocol message received by the transaction process need not necessarily generate a message TS:... and vice versa.

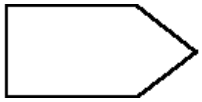
The following description only refers to the model for the signalling process S.

For better clarity, the messages are preceded by identifiers resulting from the transmit/receive direction and from the respective process identifiers (see above).

1) Messages used for communication with other components.

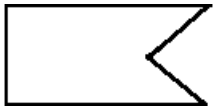
The following messages are received or sent by the signalling process:

a) Messages between signalling process and AE.
a1) From the signalling process to the AE (peer-to-peer).
SDL symbol



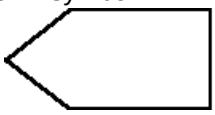
Identifier: SY.
Messages:
Y_ESCAPE, Y_INFO, Y_TERMINAL ACTIVE, Y_RESET, Y_SETUP, Y_CALL PROCEEDING, Y_DISCONNECT, Y_END, Y_ALERT, Y_CHANNEL CONNECTED, Y_USER INFO, Y_CHANNEL DISCONNECTED, Y_CONGESTION CONTROL, Y_AE ACKNOWLEDGE, Y_AE REJECT.

a2) From the AE to the signalling process (peer-to-peer).
SDL symbol



Identifier: YS.
Messages:
Y_SETUP, Y_ESCAPE, Y_INFO, Y_DISCONNECTED, Y_ALERT, Y-CALL ANSWERING, Y_USER INFO, Y_TRANSFER TO TE, Y_CONGESTION CONTROL, Y_AE REQUEST.

b) Messages between signalling and transaction process.
b1) From the signalling to the transaction process:
SDL symbol



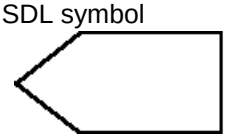
Identifier: ST.
Messages:
Internal messages which may result in a message on the D-channel:
CONN, DISC, INFO, REL, SETUP, ALERTING, USER INFO, CONGESTION CONTROL.

b2) From the transaction to the signalling process:
SDL symbol

Identifier: TS.
Messages:
Internal messages which may result in a message on the D-channel:
SETUP, Layer 2 Error, SETUP ACK, CALL PROCEEDING, DISC, REL COMPLETE, ALERT, CONN, CONNACK, USER INFO, INFO, CONGESTION CONTROL.

c) Internal messages between signalling process and user interface.

c1) From the signalling process to the user interface:
SDL symbol



Identifier: SU.
Messages:
Internal messages which may be used for user interaction and control functions:
ESCAPE.

c2) From the user component to the signalling process.
SDL symbol

Identifier: US.
Messages:
Internal messages which may be used for user interaction and control functions:
ESCAPE, Handset, TE Reset, Transfer possible, Transfer not possible.

d) Internal messages between signalling process (layer 3) and layer 2.
SDL symbol

Identifier: Y2.
Only the message Y2_Timeout of TTE2 is represented.

2) The following assumptions apply:

- the events at the interface telephone to layer 2 of the Y-interface are correct (e.g. sequence, message setup);

- after the transition into state Y2, the saved messages Y_INFO are treated in the order of their reception;

- if layer 3 of the Y-interface opens another transaction besides the existing transaction (e.g. Call Waiting), state Y0 shall always be reached. Afterwards a different state is achieved, for instance Y1, which can clearly be identified by the call reference;

- the telephone can achieve the following states during the signalling process:

Y0: NULL
Y1: CALL INIT
Y2: OVERLAP SENDING
Y3: OUTGOING CALL PROCEEDING
Y4: CALL DELIVERED
Y7: CALL RECEIVED
Y8: CONNECT REQUEST
Y10: ACTIVE
Y11: DISCONNECT REQUEST
Y12: DISCONNECT INDICATION
Y30: HANDSET OFFHOOK
Y31: TRANSITION STATE
MS: MANUFACTURE STATE.

The numerical labelling of the layer 3-states of the Y-interface on the telephone side (signalling process) took place with reference to the layer 3-states on the user's side (transaction process) according to ETS 300 102-2 [6].

- Only message events which cause a reaction at the Y-interface and vice versa are described, that means only messages for call establishment and call clearing are stated.

- Messages for the transmission of charging information are not stated. Generally, the AE should always be informed about charging information.

- Clearing and blocking of the analogue input/output is not stated.

- Message types in the SDL-description which are not stated shall be ignored and shall not cause a change of a state.

3) The states Y0 to Y31 have the following meaning:

Y0: NULL — No connection exists. This state marks the initial state of the signalling process. This state is reached when the telephone informs the AE with Y_END about the end of a transaction.

Y1: CALL INIT — This state is reached when the AE initiated a transaction with Y_SETUP which had not yet been confirmed by the ET with SETUP_ACK.

Y2: OVERLAP SENDING

This state is reached when the AE initiated a call, and the ET confirmed the call request with SETUP_ACK and waits for the reception of destination information. During this state the AE can transmit Y_INFO to the telephone.

Y3: OUTGOING CALL PROCEEDING

This state is reached when the AE initiated a call, and the ET confirmed the call request with CALL_SENT. During this state the telephone shall ignore Y_INFO information from the AE.

Y4: CALL DELIVERED — This state is reached when the AE initiated a call, and the ET informs the subscriber about the delivered call with ALERT. During this state the telephone shall ignore Y_INFO information from the AE.

Y7: CALL RECEIVED — This state is reached when the telephone informs the AE about an incoming call with Y_SETUP.

Y8: CONNECT REQUEST

This state is reached when the AE informs the telephone about the possibility to answer the incoming call with Y_CALL ANSWERING.

Y10: ACTIVE — This state is reached when either an incoming call was answered or the AE established a call, and the telephone has sent a Y_B-CHANNEL ACTIVE.

Y11: DISCONNECT REQUEST

This state is reached when an AE, that initiated or answered an incoming call, has sent out an Y_DISC to clear a call and the ET has not yet confirmed the message.
A transaction, which is led by the telephone, shall be disconnected.

Y12: DISCONNECT INDICATION

This state is reached when the ET initiated a call clearing procedure.

Y30: HANDSET OFF HOOK

This state is reached when a telephone initiated a new transaction or an existing transaction was taken over by the telephone. In this case, a Y_TERMINAL_ACTIVE message is sent to the AE. In this state the AE is not allowed to start a new transaction but it can send or receive Y_INFO messages. The analogue input of the telephone is locked in this state.

Y31: TRANSITION STATE

This state is reached when an AE requests a transaction from the telephone or the AE wants to forward a transaction to the telephone.

MS: MANUFACTURE STATE

This state is reached when an AE indicates with Y_ESCAPE that it will use manufacturer-specified applications. This state is manufacturer specific.

In the state transition tables on the following pages the following regulations apply.

- at the transition-arrows the events and the reactions are stated in the form event/reaction (reaction,...);
- a message is considered as an event if it comes from a different process to the signalling process;
- a message is considered as a reaction if it is based on an event from the signalling process which shall be transmitted to a different process;
- if several reactions are anticipated on an event, they shall be separated with a comma;
- if no reaction is expected, a "-" is stated;
- events, which can be received alternatively are stated each time in a new line;
- for clarification only events are stated which occur on regular call establishment and call clearing procedures and cause a change of states;
- a call clearing before reaching state Y10 is not stated;
- with the event TS:DISC during the states Y1 to Y8, the telephone shall change to state Y12 with the reaction SY:Y_DISC;
- with the event TS:REL_COM during the states Y1 to Y8, the telephone shall change to state Y0 with the reaction SY:Y_DISC;
- with the event YS:Y_DISC during the states Y1 to Y4 and during state Y8, the telephone shall change to state Y11 with the reaction SY:Y_DISC;
- events based on timer processes are not stated;
- events which do not result in a change of state are not stated;
- a complete description of the model is included in the SDL-description in subclause 8.4.10.

State transition diagram

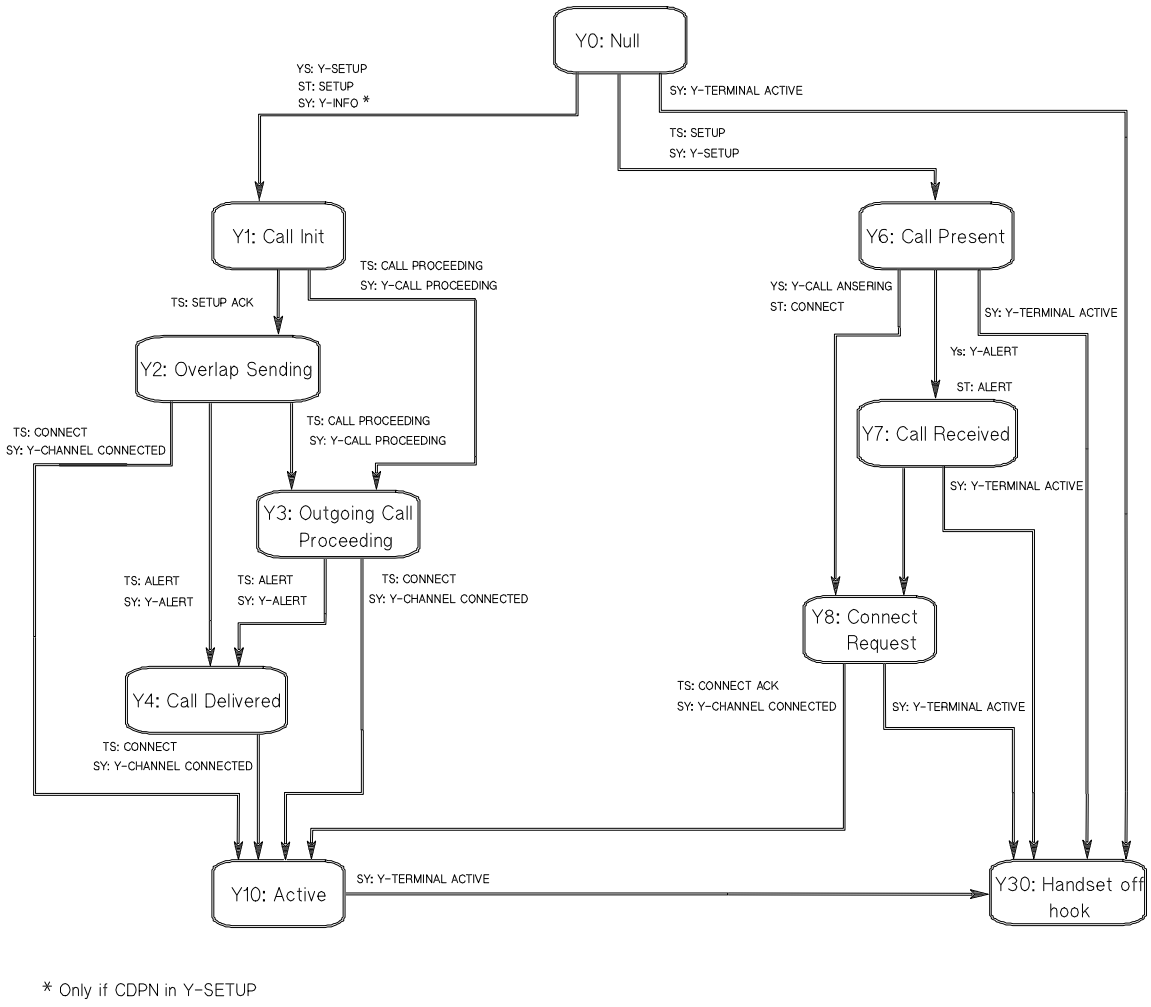


Figure 11: State transition diagram if CDPN was in SETUP

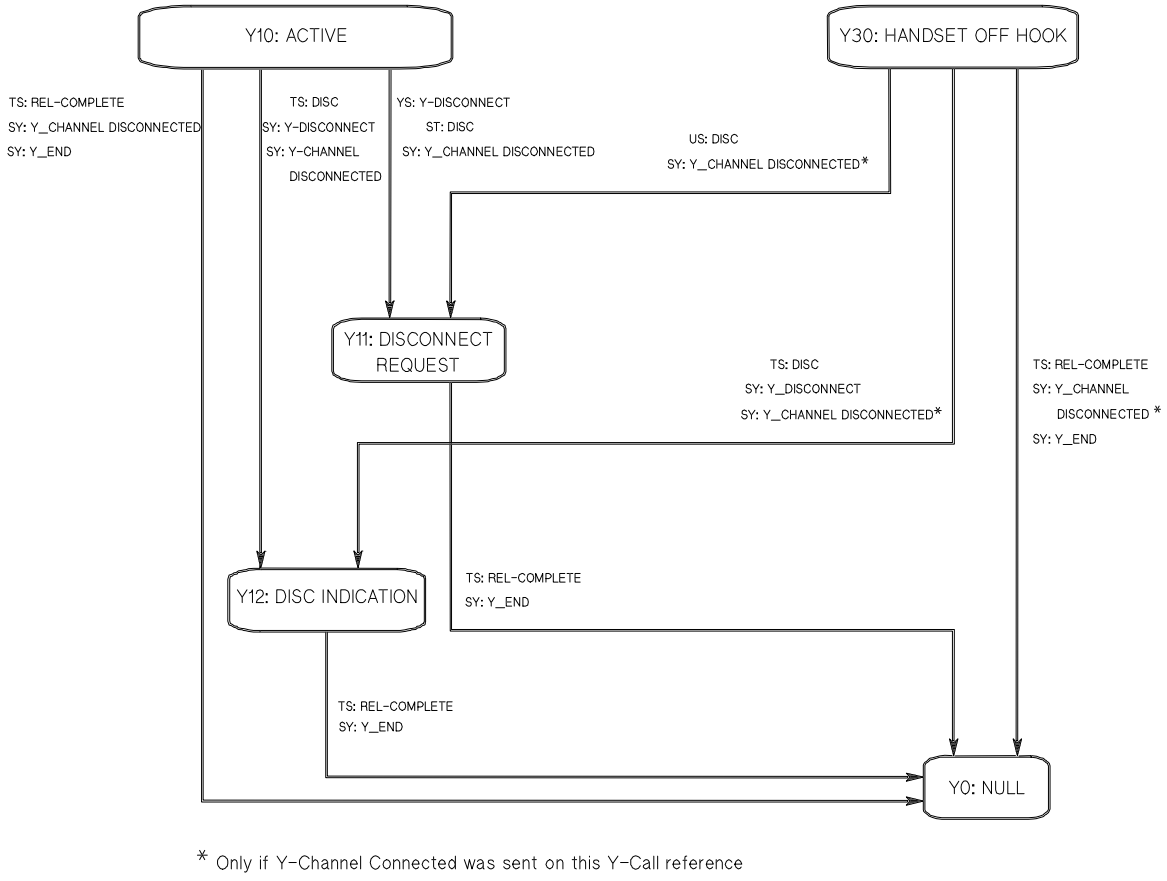


Figure 12: State transition diagram if Y-channel connected was sent on this Y-call reference

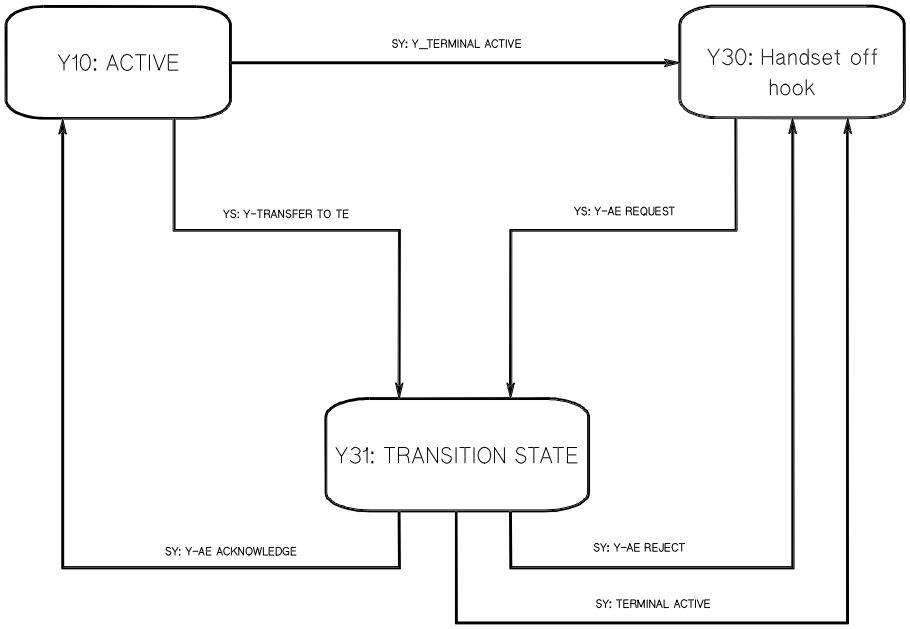


Figure 13: State transition diagram

8.4.10 Layer 3 SDL-Description

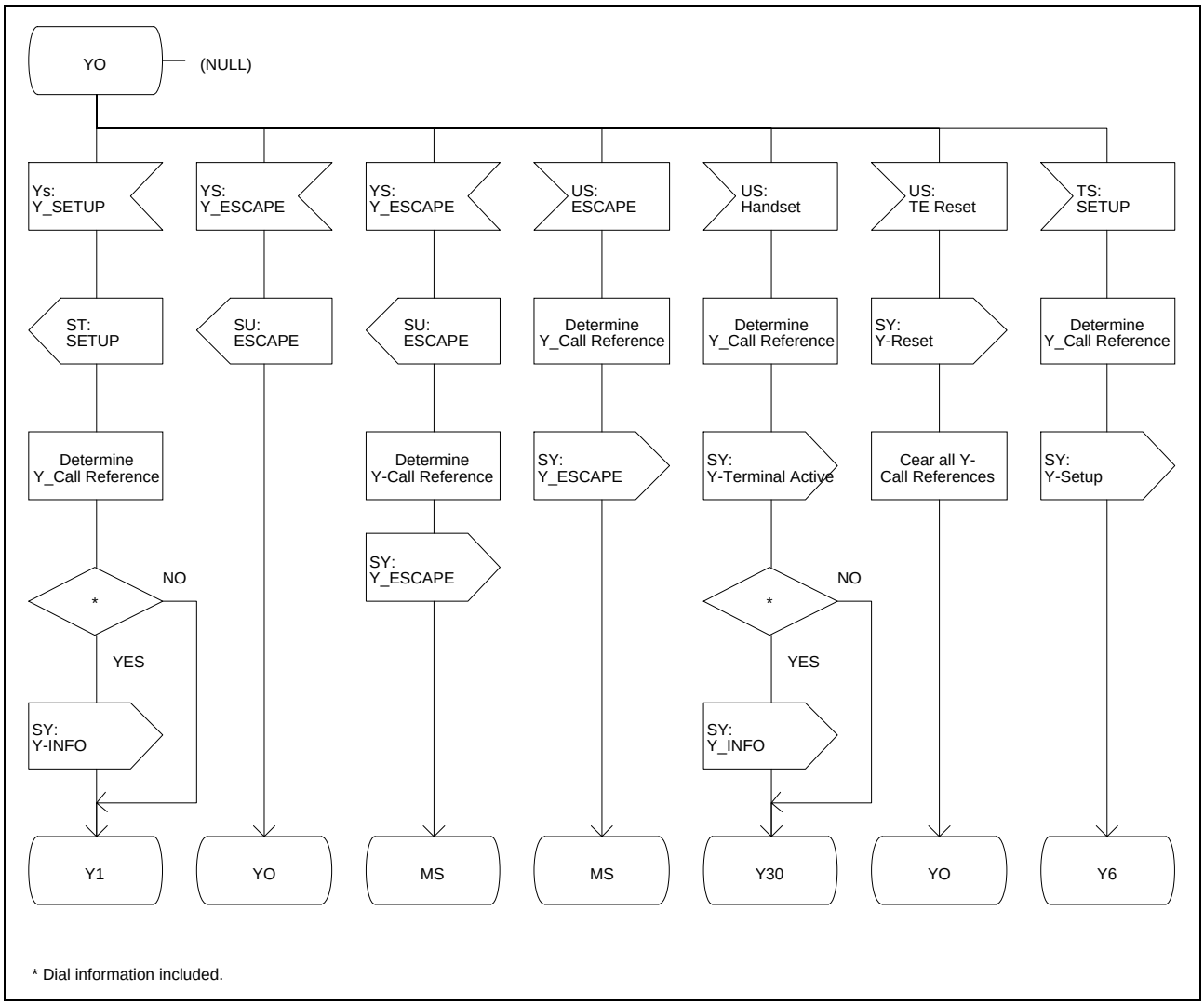


Figure 14: Layer 3 description Y0 Null

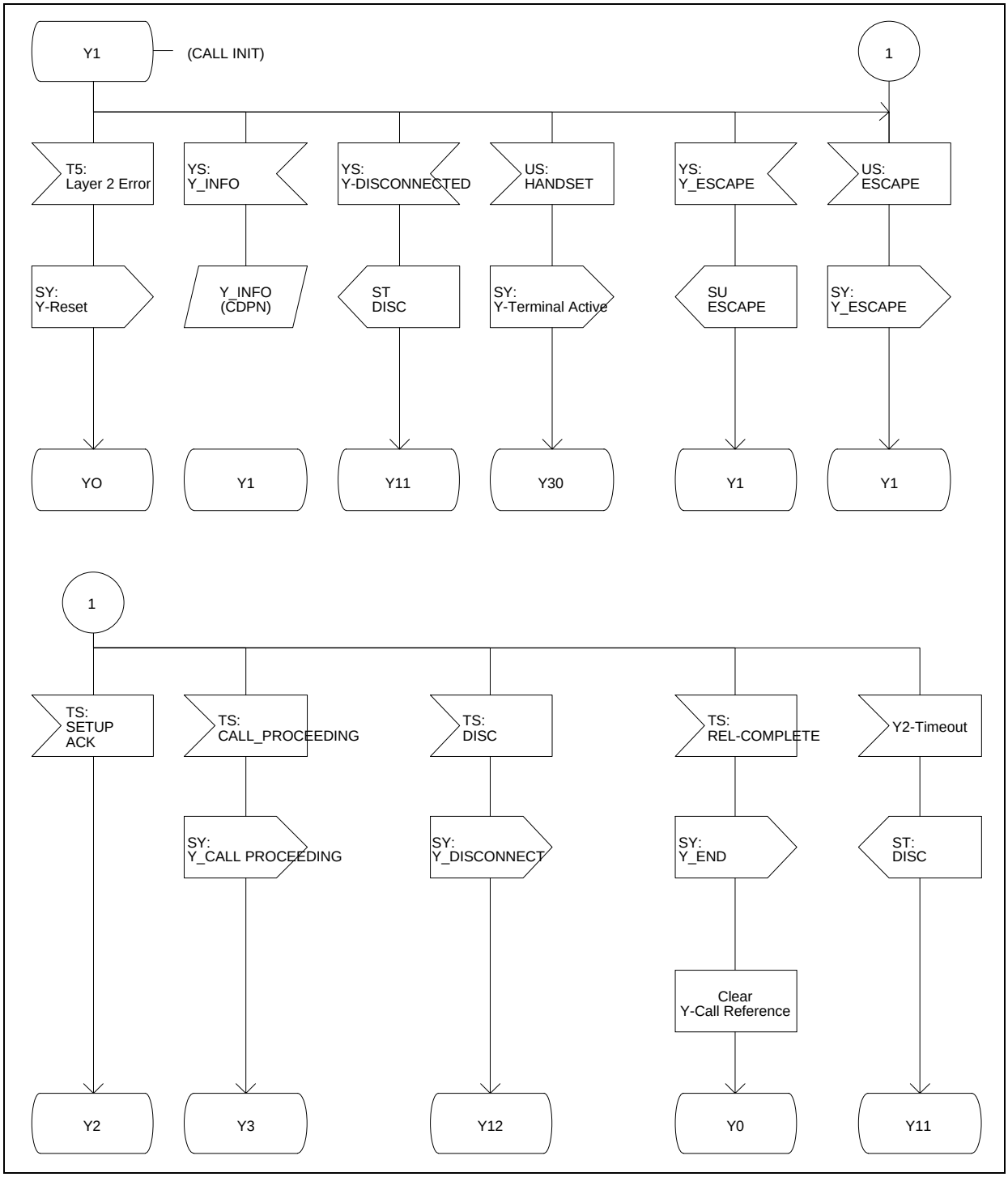


Figure 15: Layer 3 description Y1 Call init

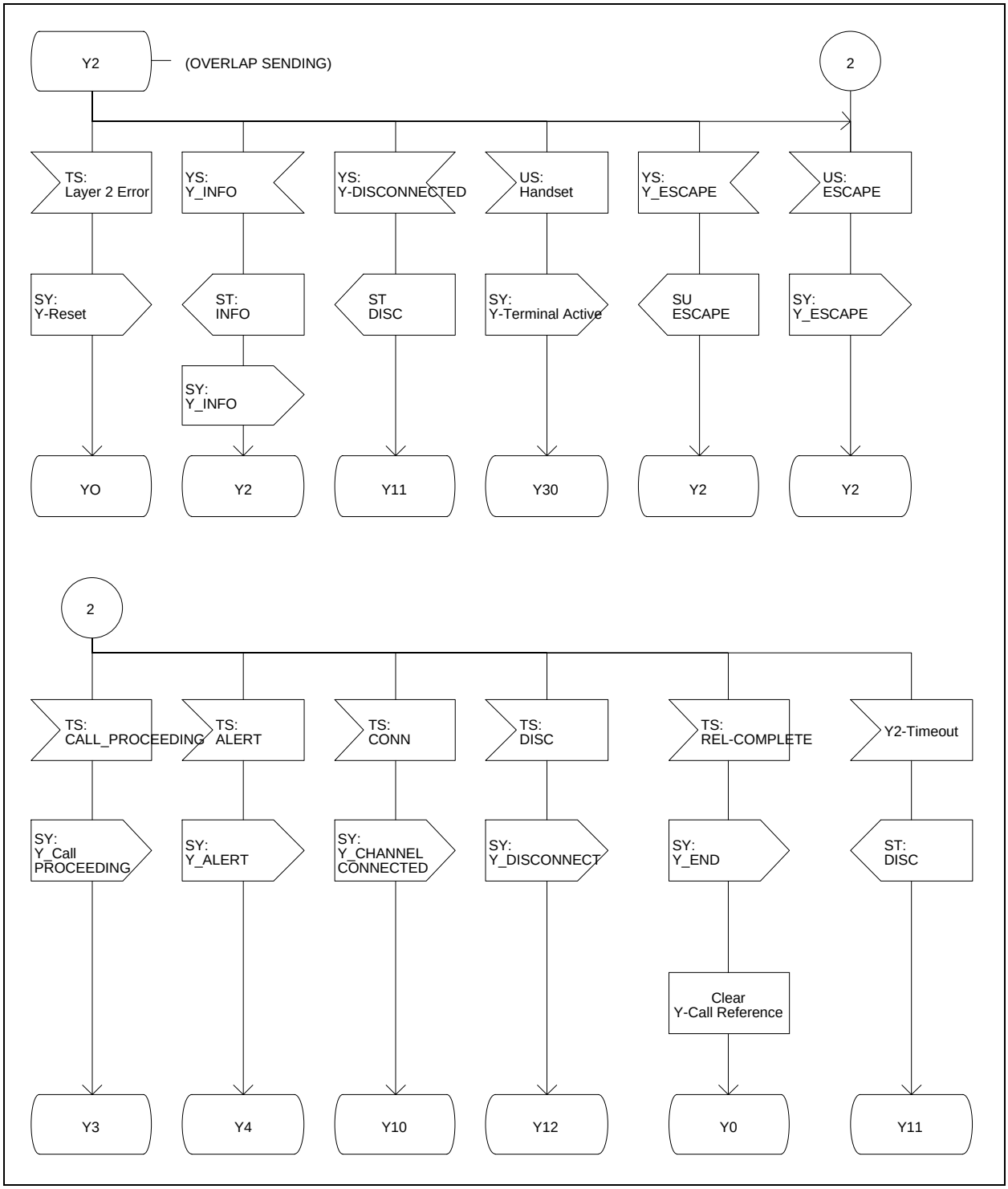


Figure 16: Layer 3 description Y2 overlap sending

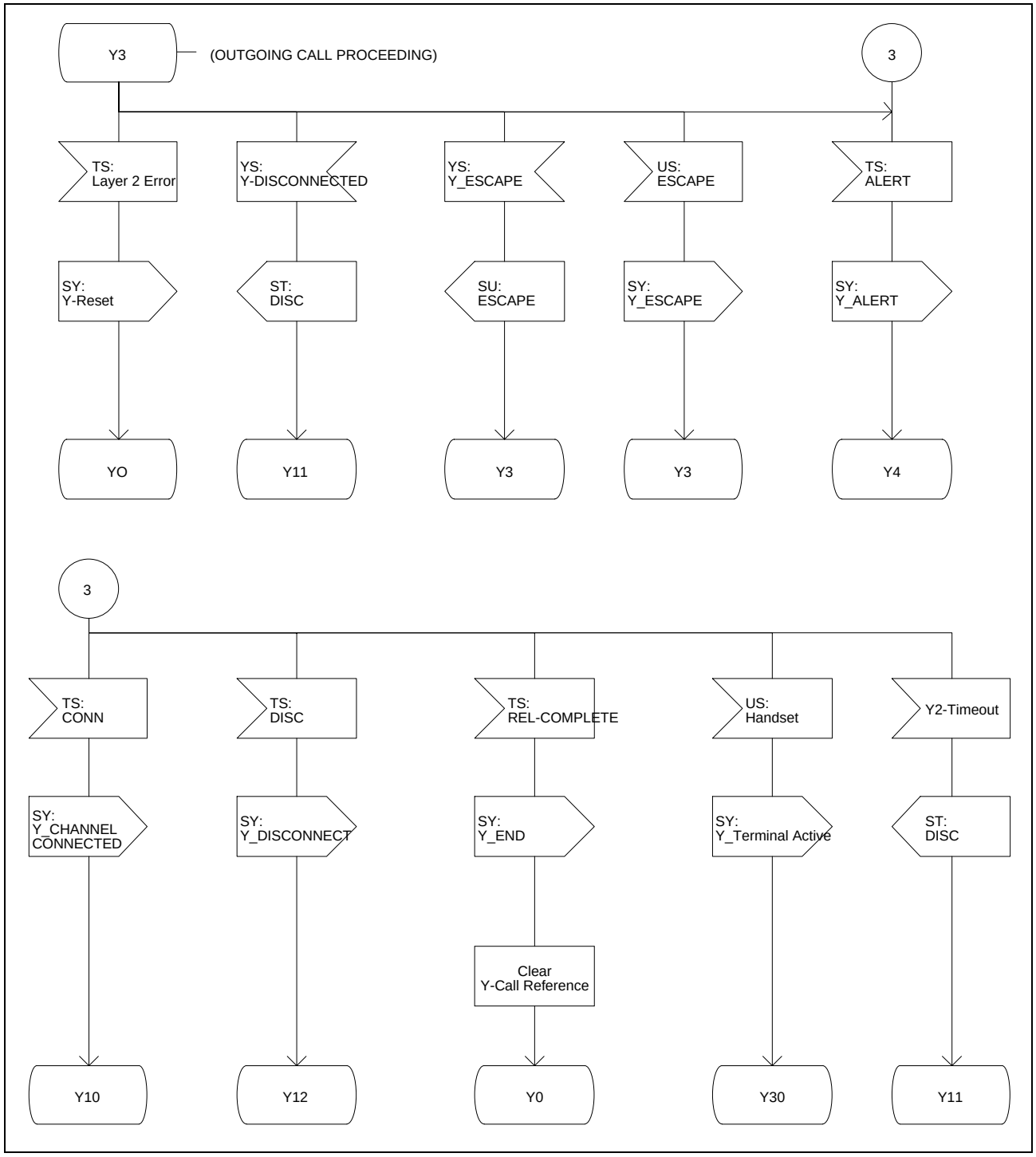


Figure 17: Layer 3 description Y3 outgoing call proceeding

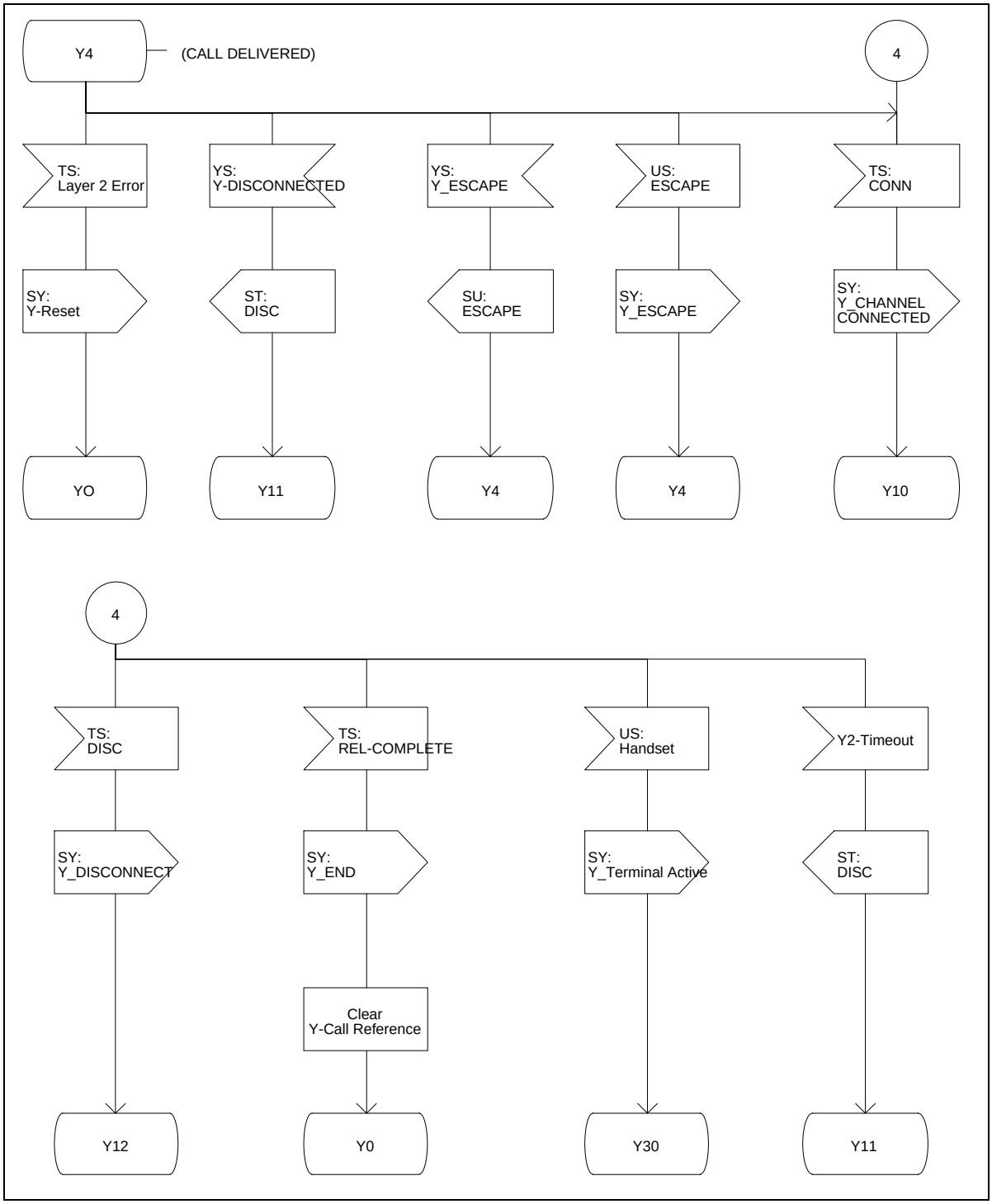


Figure 18: Layer 3 description Y4 Call Delivered

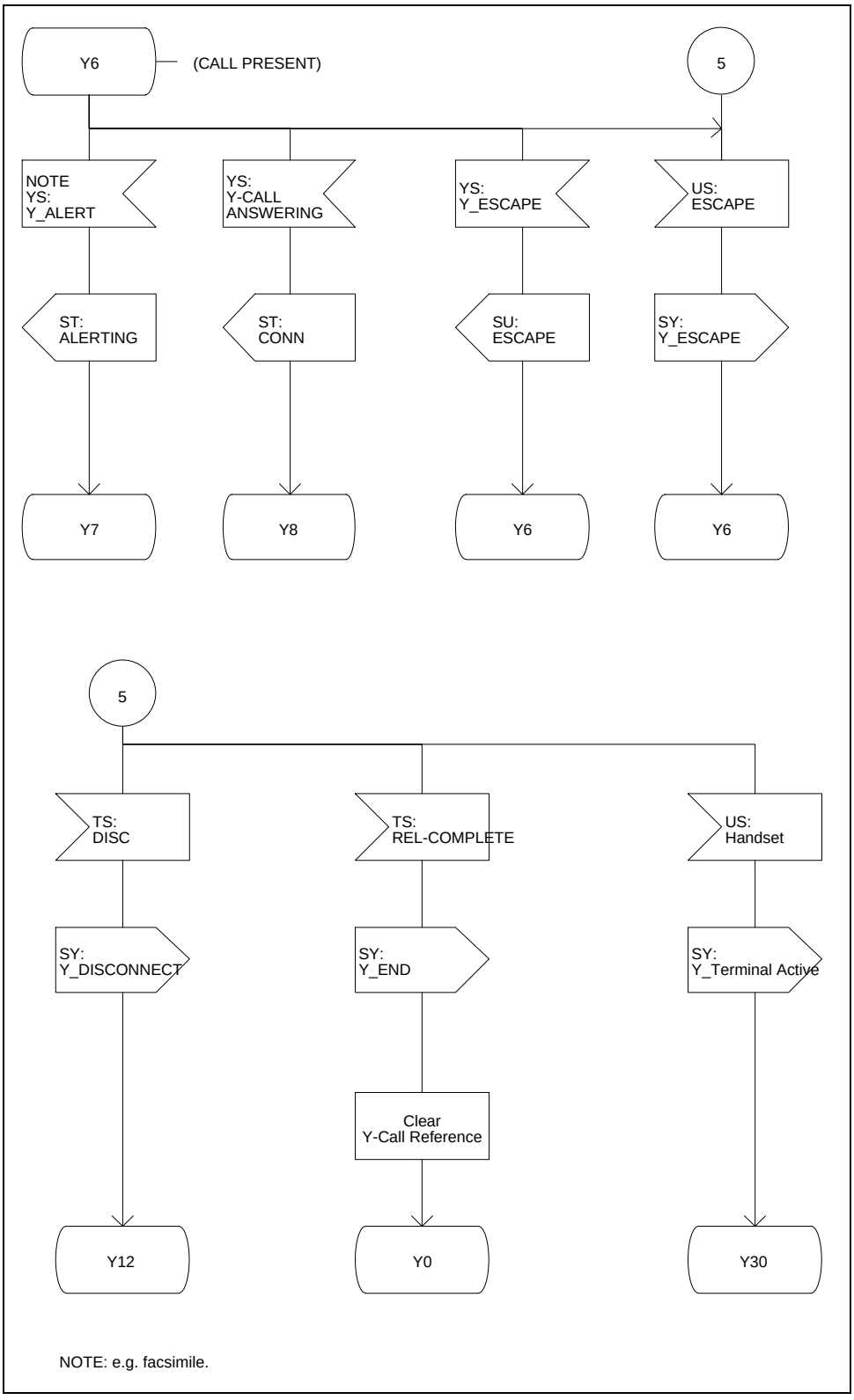


Figure 19: Layer 3 description Y6 call present

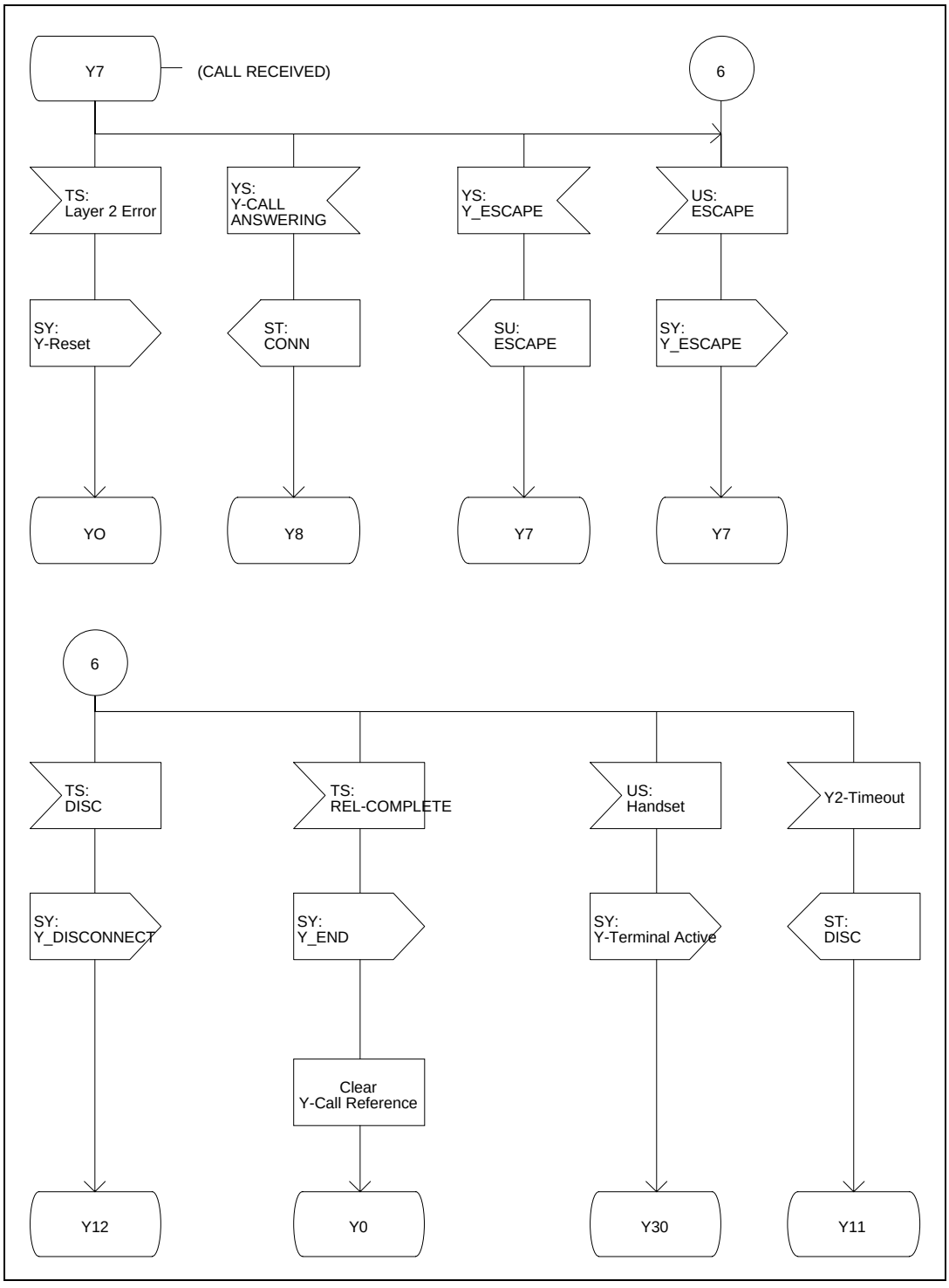


Figure 20: Layer 3 description Y7 call received

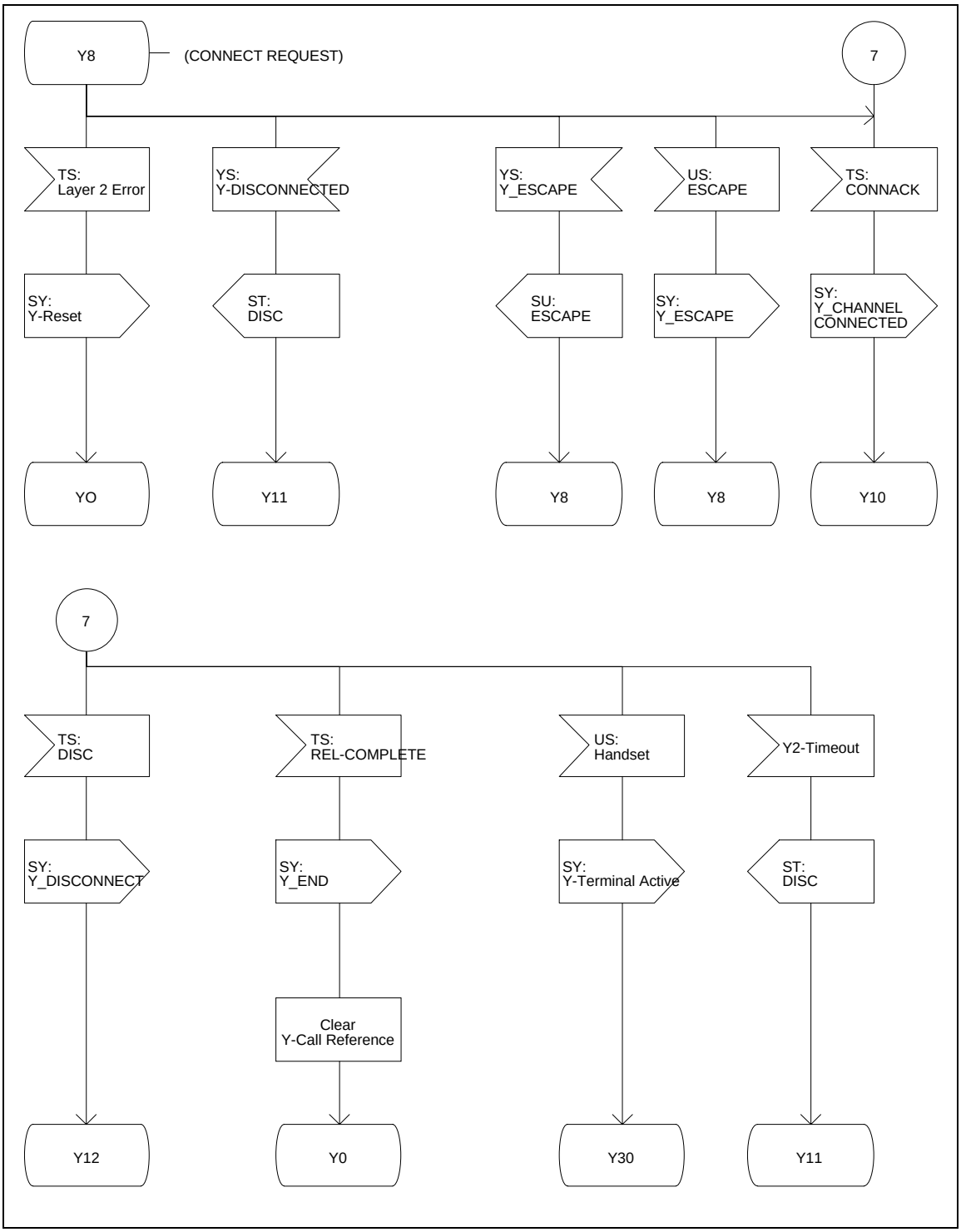


Figure 21: Layer 3 description Y8 connect request

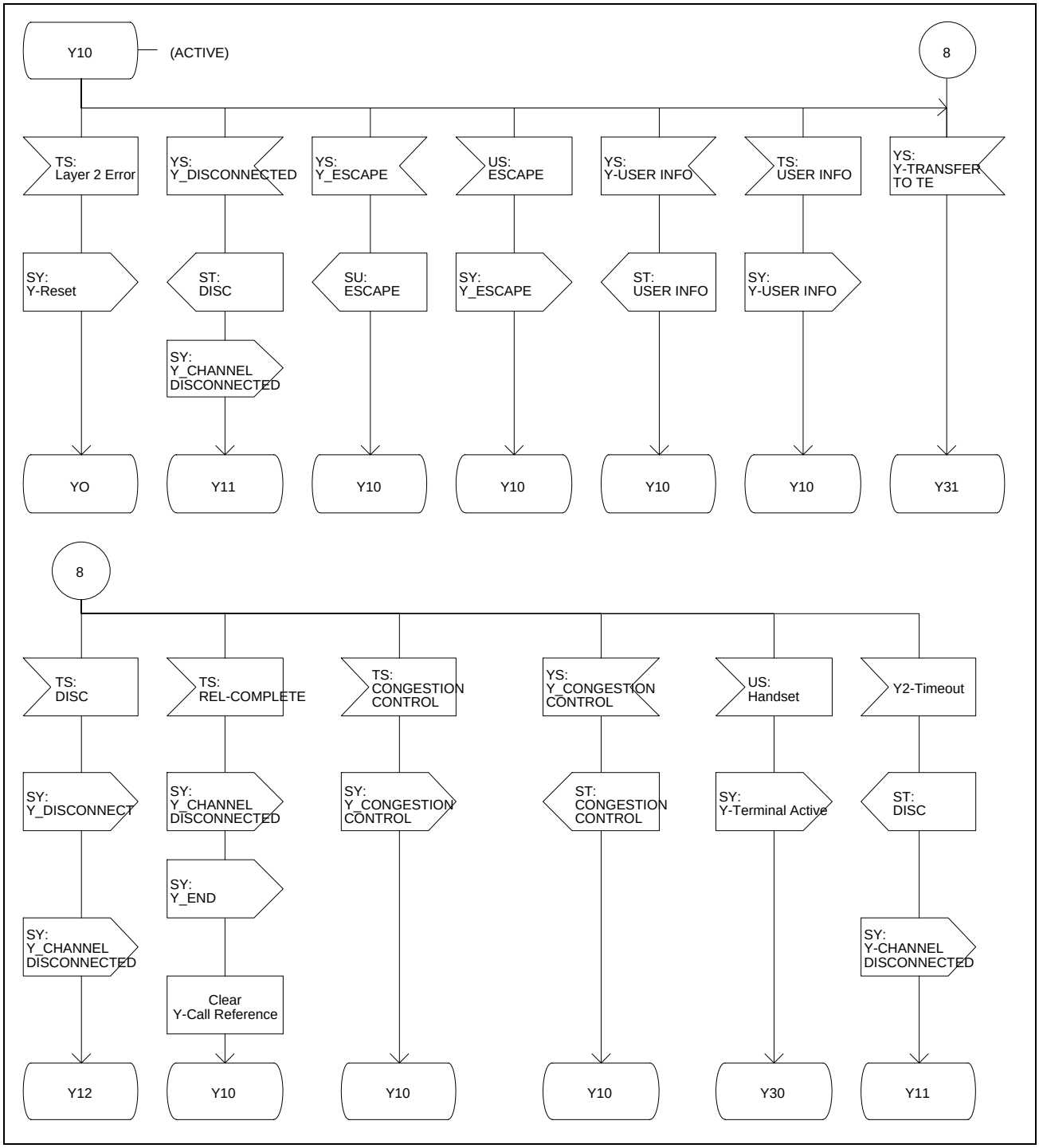


Figure 22: Layer 3 description Y10 Active

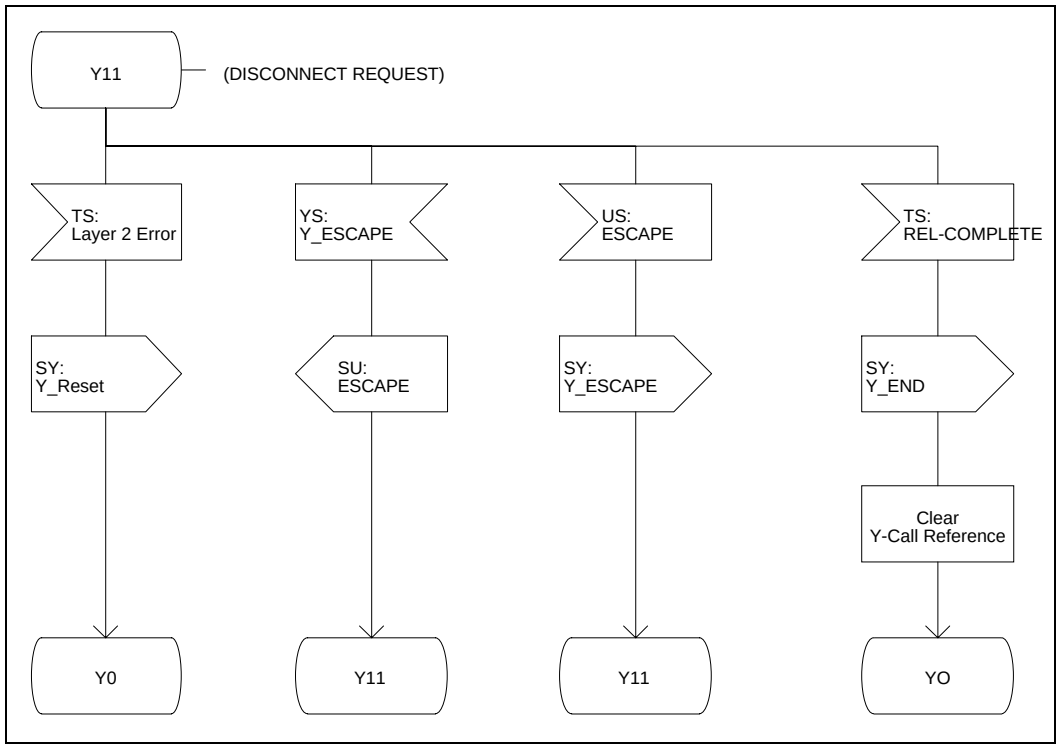


Figure 23: Layer 3 description Y11 disconnect request

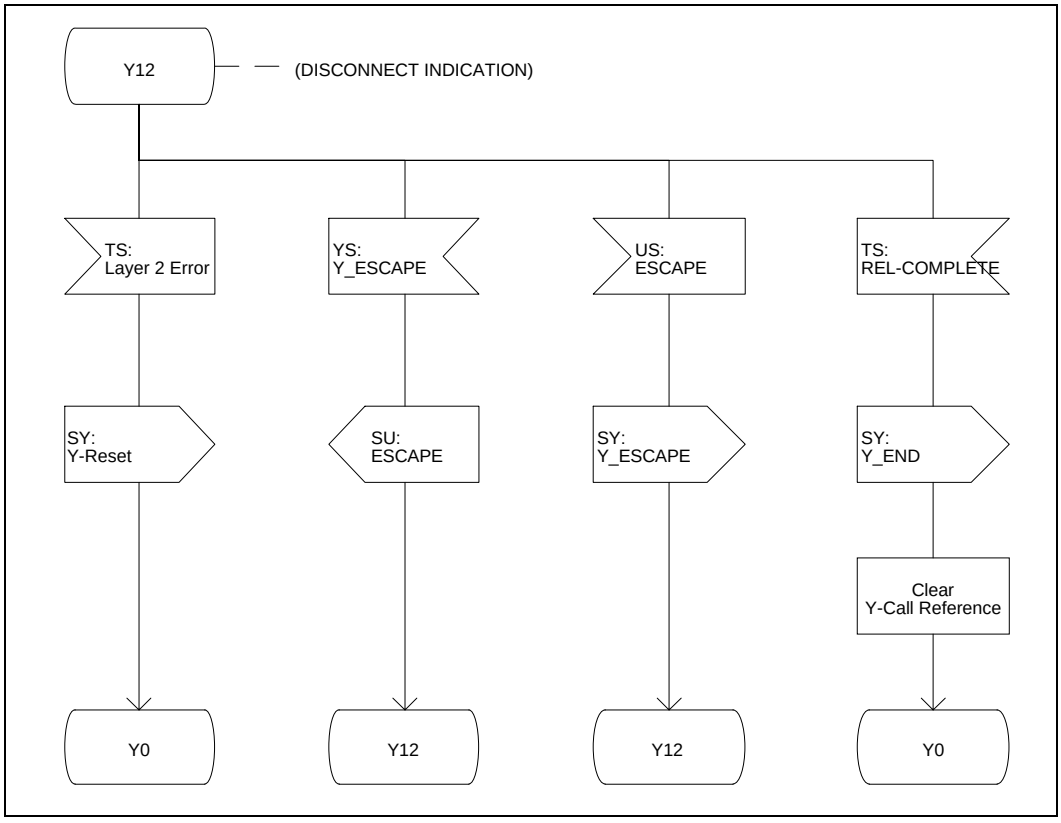


Figure 24: Layer 3 description Y12 disconnect indication

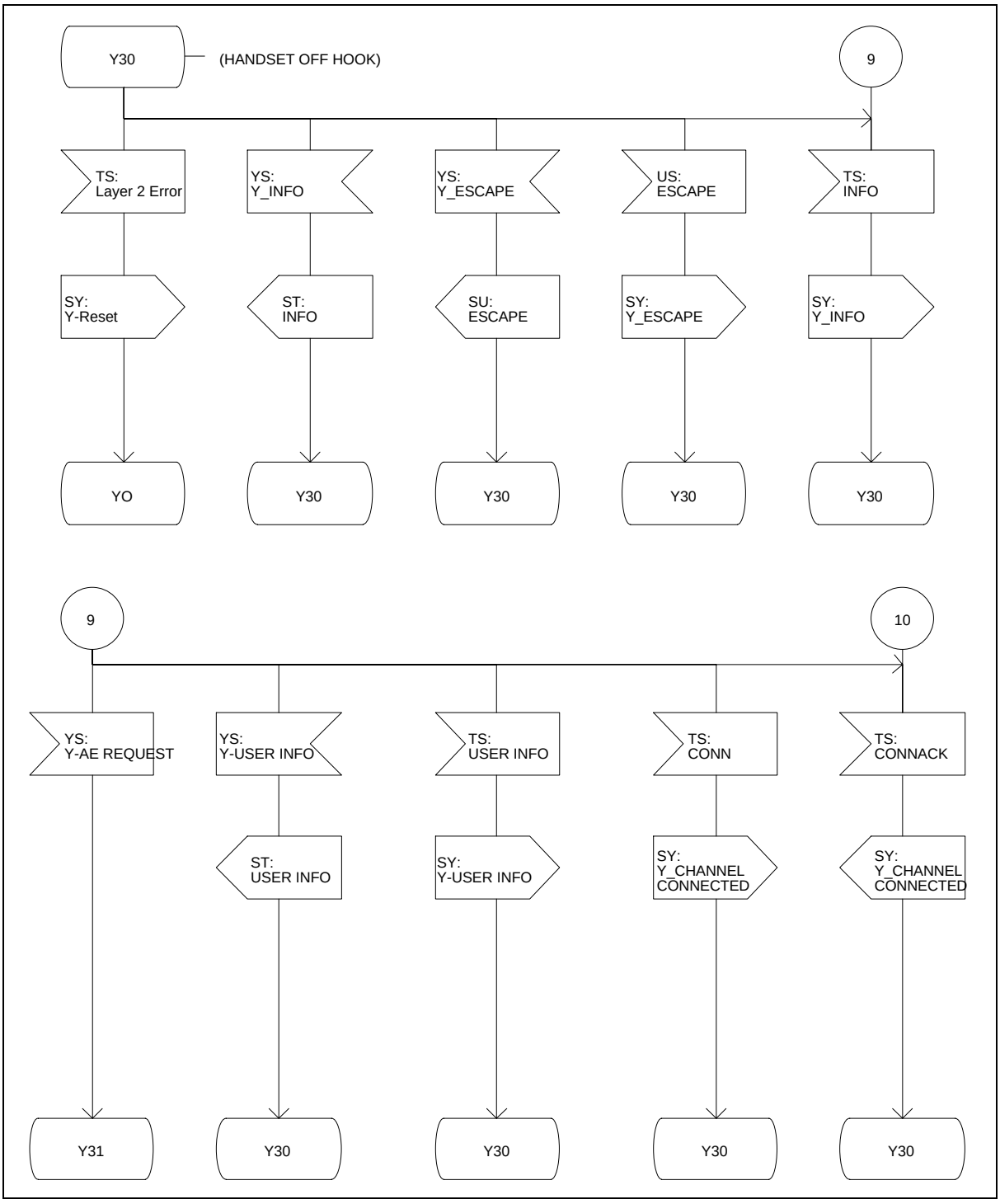


Figure 25: Layer 3 description Y30 handset off hook (continued)

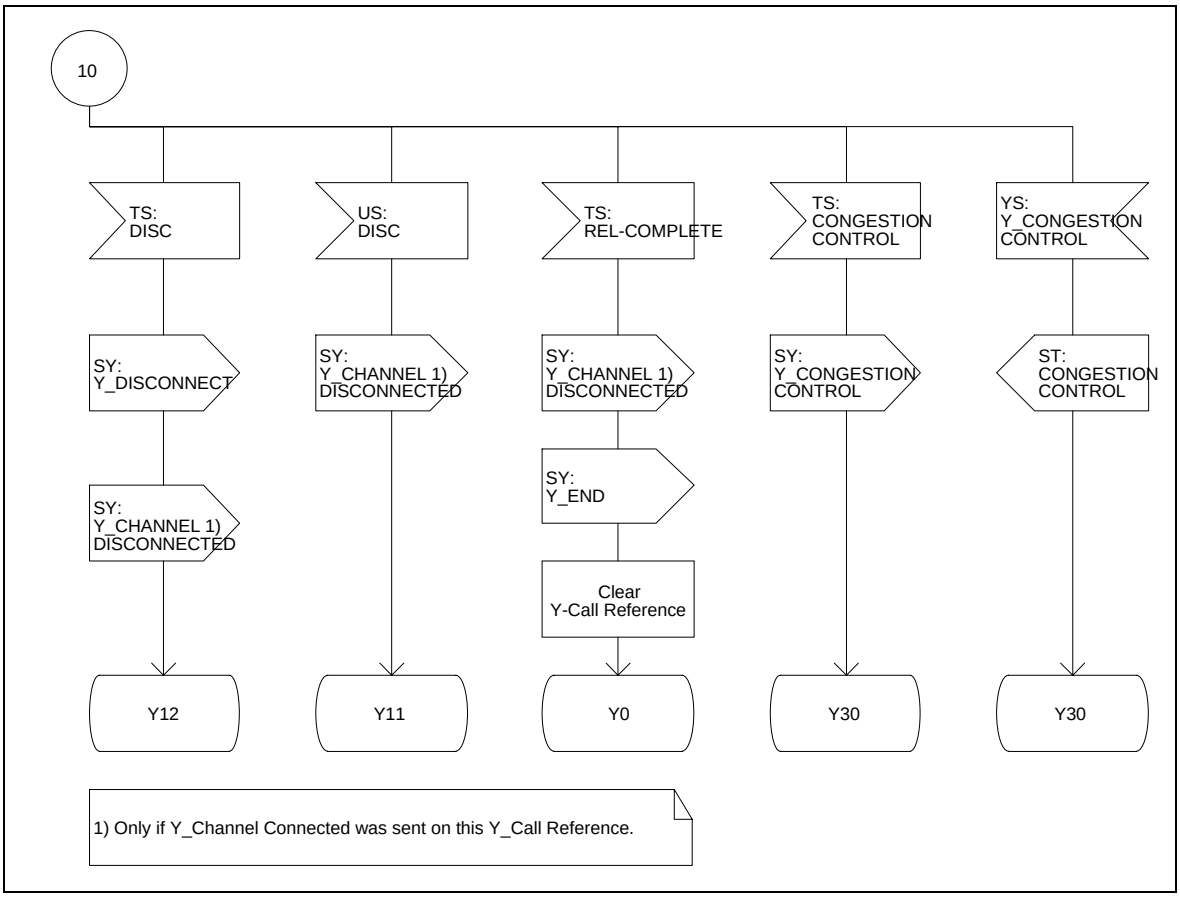
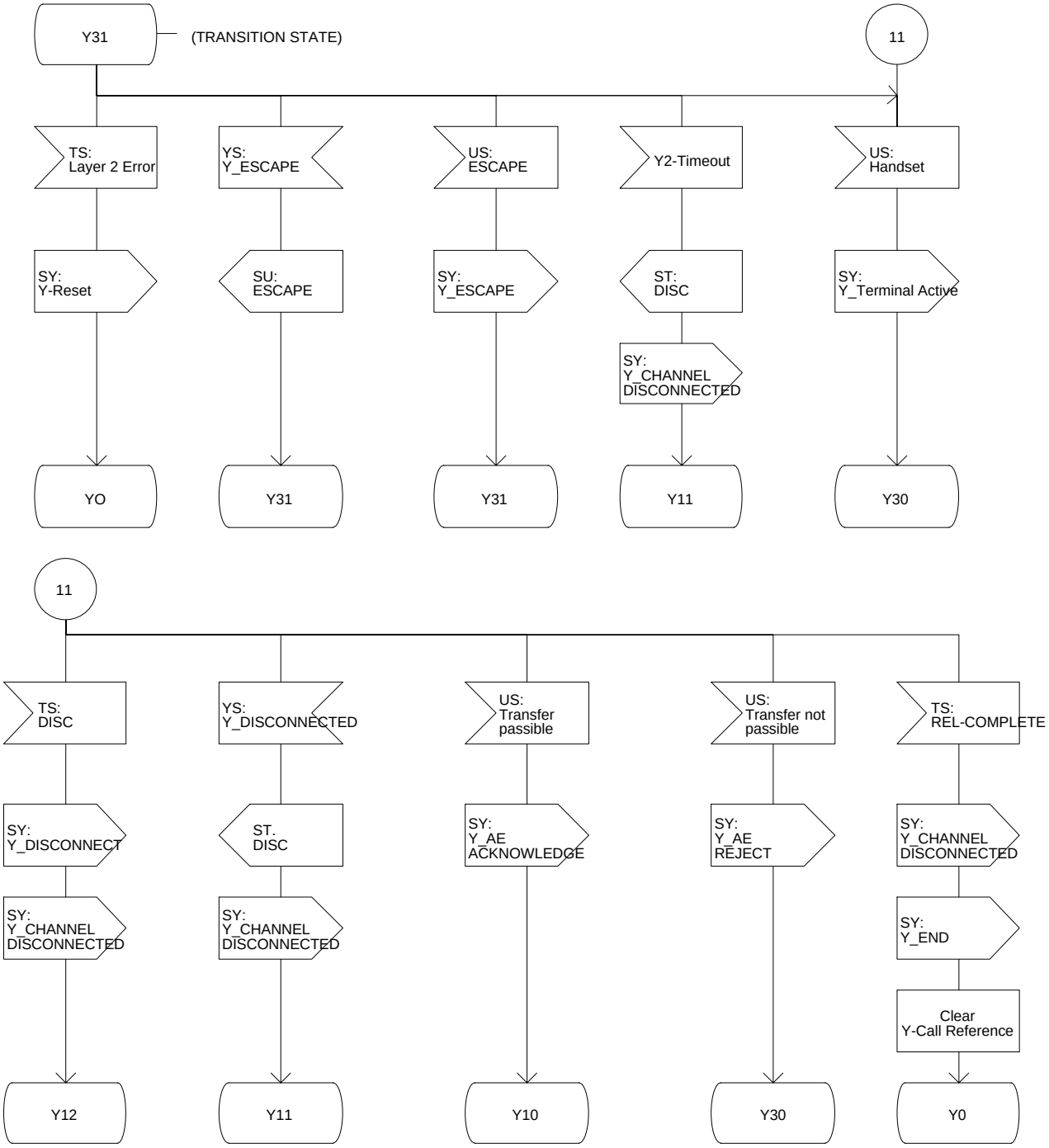


Figure 26: Layer 3 description Y30 handset off hook (concluded)



If Y-Channel connected was sent on this call reference.

Figure 27: Layer 3 description Y31 transition state

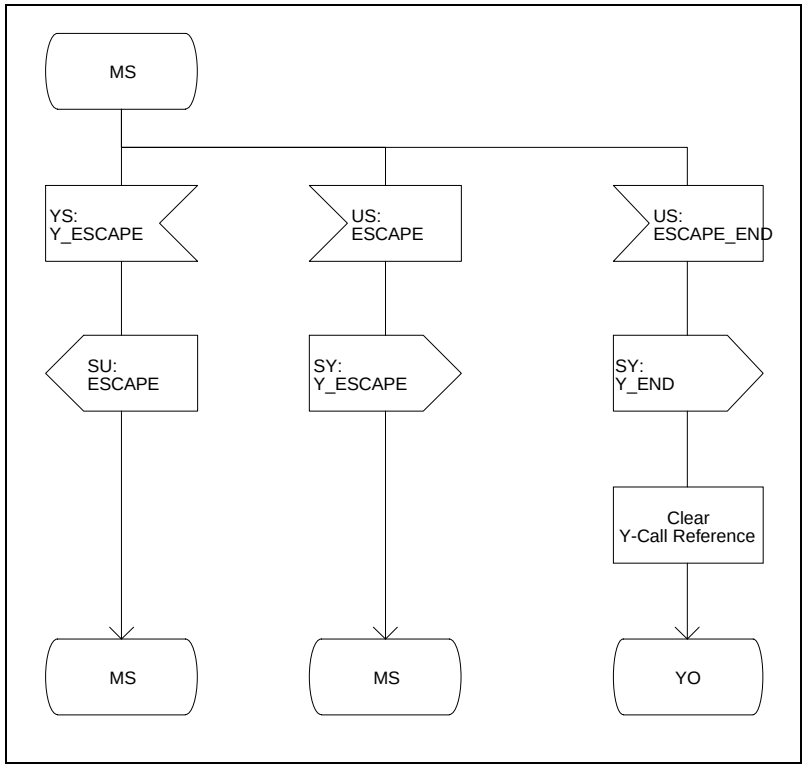


Figure 28: Layer 3 description MS

8.4.11 Error handling

Table 37: Error handling

Error Type	Layer 3 TE	Layer 3 AE
Protocol element not defined: - message type - message element	ignore	ignore
Message sequence not defined	ignore	ignore
Reset (note)	Sending Y_Reset	----
Sequence blocked: - message loss	-----	Timer TAE 4, see subclause 8.4.8
NOTE: Return of power supply.		

Annex A (normative): Test specification

A.1 Definitions of the aim of the test specification

The specification of the tests describes only the principle and not a complete specification for measurement in detail. As a main aim, the test principle should illustrate the idea and the purpose of the test. It is an overview for necessary equipment and signals as well as for the complete configuration. There is no special specification with a detailed list of measurement or test equipment, cables, connectors, plugs, accuracy of the measurement equipment, etc.

The aim of the specification of "Test Principles" is to describe, in a simple way, the "Purpose" of the test, the "Test Configuration" of the item under test with other measurement and test equipment, the required "System State", the "Stimulus Signal" for the correct initiation of the measurement and the "Monitoring". The "Result" repeats the specified values in the main Part of the I-ETS. With this structure, all tests are described in a uniform manner.

It is assumed that the "Test Principles" give sufficient guidelines so that the tests and measurements can be carried out with technical knowledge, care and accuracy. Furthermore, the "Test Principles" as a minimal presentation of test description allow an easy check of compliance between requirements and necessary tests.

A.2 Definition of the structure of the test principles

a) Purpose

This is a short description and definition of the aim and the task of the measurement or test.

b) Test Configuration

This is a simple structured block-diagram of the required configuration of equipment with connections between the blocks.

c) System State

This is the state definition of the Item Under Test (IUT) in the "Test Configuration".

d) Stimulus

This is a description and definition of the signals, the parameters or the required provisions for the initiation of the measurement or the test of the IUT.

e) Monitor

This is a description for testing - what, where and how should be measured to get the result.

f) Result

This repeats the specified parameters which shall be achieved and gives, as far as necessary, an interpretation of the monitor values (formula, limits).

A.3 Definition of terms

The closed, short description of the terms used gives an overview and highlights the features, definitions and assumptions.

a) Ongoing Communication

"Ongoing Communication" is given when the activation of layer 1, 2 and 3 for the S/T-interface is finished completely in the TE. It is assumed that the S/T-interface is connected to a simulator of the network access point (network termination resp. line termination for layers 1, 2 and 3).

One of the B-channels is available in both directions. The transmission path is active. It is switched transparently in receiving direction from the S/T-interface to the XTE-output. In sending direction the transparency between the XTE-input and the S/T-interface is not given before the activation of the X-interface is finished by signalling (Y-signalling or direct user manual controlled by key).

b) Activated X-interface

The availability of the X-input is assured after the complete activation of layers 1, 2 and 3 by signalling at the Y-interface or, alternatively, direct user manual controlled by key (depending on application).

The XTE-output is always available at ongoing communication and is independent from the activation of the XTE-input.

c) Test State

The "Test State" of the IUT is a necessary assumption for most of the test cases. The control of the test state shall be provided by the signalling of the Y-interface in interworking with an AE-simulator or, alternatively, direct user manual controlled by key at the man-machine interface (depending on application, manufacturer declaration).

In the Test State the TE is disabled for layer 2 interworking via the S/T interface (no activation from the TE and no reaction to requests from the network simulation).

d) Y-Loop

The loop is used for YTE-tests or YAE-tests resp. in connection with an AE-simulator or TE-simulator respectively.

The signalling information shall be received via the implemented universal serial asynchronous link controller and shall be transmitted immediately in the same manner without change or modification of the character (no hardware loop via short circuit). Therefore, it is a quasi-reflection with test of the complete input/output circuit.

e) Active Mode (AE)

The "Active Mode" of AE concerns only the outputs (XAE, YAE) in direction to the TE. This means that the outputs are disconnected from the inputs for cascaded AEs. In detail, the XAE-output is switched to the internal source (output resistance of 600 ohms) for generation of voice, tones or announcement. For the YAE-output the information shall be generated from the AE which is in active mode. The information transfer from cascaded AEs is halted.

The XAE-input is not affected by the Active Mode. The X-input shall always be connected to the internal AE-receiver and to the X-output to cascaded AEs.

That AE, which is in the active mode, shall control the information transfer to the TE. The active mode is controlled by Y-signalling messages from the TE or by a key input from the user.

f) Idle Mode (AE)

"Idle mode" is the standard default state of the AE. In this mode the outputs (XAE, YAE) for the transmission from the AE to the TE are inside connected directly to the backward inputs for cascaded AEs (B-channel or Y-signalling resp.). Therefore, in the "Idle Mode" the AE is not able to generate voice, tones or announcements or to send out a signalling.

g) 224 kbit/s Loop

According to CCITT Recommendation G 722 [13], the 224 kbit/s loop, which is implemented in the codec, is required for transmission tests at 7 kHz telephony.

The analogue input signal received at the XTE-input shall be A-to-D converted. The uncompressed 224 kbit/s output data of the A-to-D stage is looped back to the D-to-A stage of the 7 kHz codec. The analogue signal at the output of the D-to-A stage shall be transmitted to the XTE-output pins of the TE.

A.4 Definition of special test equipment

A.4.1 AE and TE - simulator

The AE-simulator and the TE-simulator are equipment for testing the protocol (layers 2 and 3) of the Y-interface. The AE-simulator is the opposite partner for the TE under test and correspondingly the TE-simulator should be used for the AE under test.

The simulator shall use the Y-protocol of layers 2 and 3. Helpful for the test is a step-by-step running mode as an additional feature to the normal free running mode.

The bit rate and the data bits of the character format shall be adjustable. If it is not stated otherwise, the electrical interface should be implemented with nominal values.

A.4.2 Test instruments

For the choice of test instruments, the following features shall be considered:

- necessary accuracy;
- frequency - and level - range;
- kind of test signals (stimulus);
- overall performance with respect to noise, selectivity and linearity;
- reference codec.

For more information, see CCITT Recommendation O.133.

Basically, the test instrumentation can be divided into the following functional units:

a) an analogue signal generator to apply test signals to the analogue interface of the TE or AE;
b) an analogue signal analyser to process received signals from analogue interface of the TE or AE;
c) a digital signal generator to apply test-signals to the S/T-interface of the TE;
d) a digital signal analyser to process signals received from the S/T-interface of the TE;
e) a signal generator and analyser for the measurement of the signal level and timing at the YTE- and the YAE-interface;
f) an acoustic measurement equipment for the determination of the RLR;
g) a set of terminations as defined loads for the XTE-interface.

A.5 General condition for testing

A.5.1 General

If not otherwise specified, the output load impedance shall be 150 ohms and the source impedance for the input measurements shall be 600 ohms.

All conditions for testing concerning,

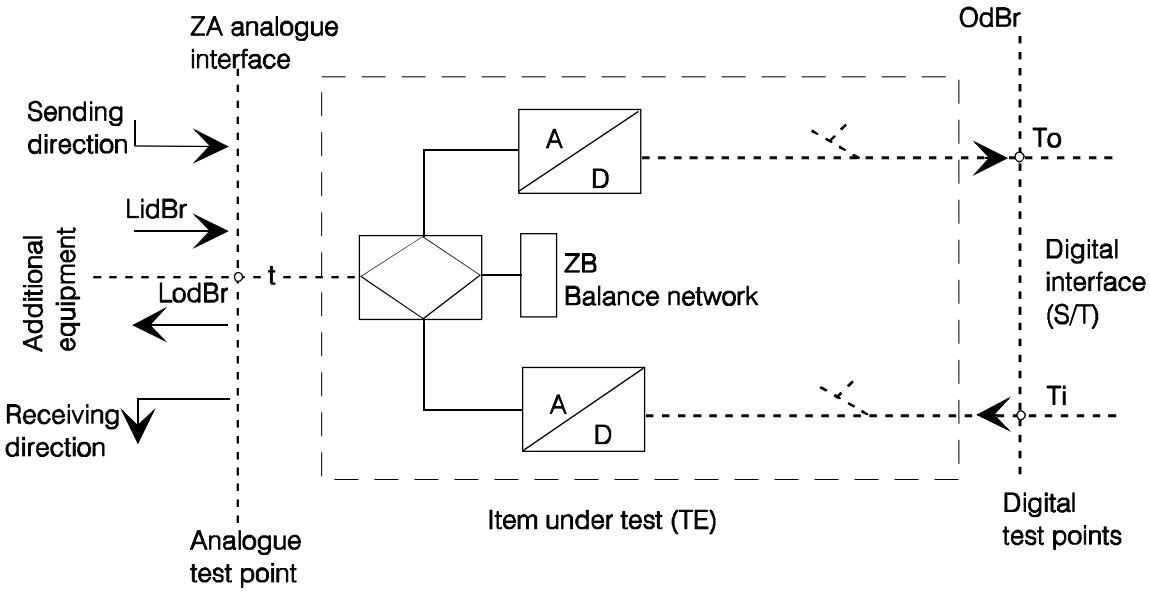
- environment,
- power supply limitations,
- test equipment requirements,
- test equipment interface,
- alternative test methods,
- accuracy of test measurements,
- bandwidth,

which are listed in ETS 300 085 [4], annex A, clause A.1 and are relevant for tests of the TE-side and AE-side shall be valid in the same manner.

NOTE: When sinusoidal test signal frequencies and digitally encoded sine wave test signal frequencies are not specified, the frequencies to be provided as a minimum can be found in CCITT Recommendation O.133.

A.5.2 Conditions for testing Z_A analogue interface

Interfaces and tests points at the Terminal Equipment (TE).



NOTE 1: Where measuring transmission parameters between 2-wire port and digital port, a quiet code (as defined below) shall be applied to the TE test point T_i, when no test signal is stipulated or where the digital input of this test point is not used, in order to avoid disturbing effects due to reflections at hybrid. Quiet code = PCM signal corresponding to decoder output value 1 (A-law) with the sign bit in a fixed state.

NOTE 2: Measurement at analogue interface shall be made under matched conditions to the nominal impedance of the Z_A interface under test.

NOTE 3: Where no value is given for test level, this test level shall be - 10 dBm0.

NOTE 4: Digital Reference Sequence (DRS) used in this I-ETS represents a nominal reference frequency of 1 020 Hz at a nominal level of 0 dBm0, as defined in CCITT Recommendation G.711 [11].

Figure A.1: General configuration of the Terminal Equipment (TE) under test (when a B-channel is connected to the Additional Equipment)

A.6 Test principles

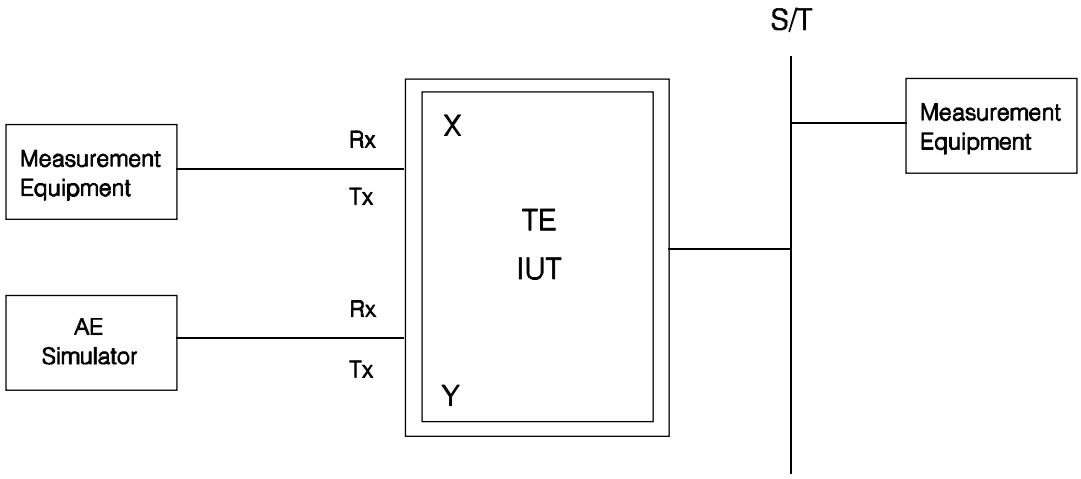
A.6.1 Test principles XTE (X-interface at TE)

A.6.1.1 Relative levels

A.6.1.1.1 Input (TP No. 1)

Purpose: To check the gain from the XTE-input to the B-channel output on the S/T-reference point.

Test Configuration:



System State: Ongoing communication, activated X-interface

Stimulus: - XTE-input level: - 18 dBm

- input-frequency: - between 1 004 Hz and 1 025 Hz.

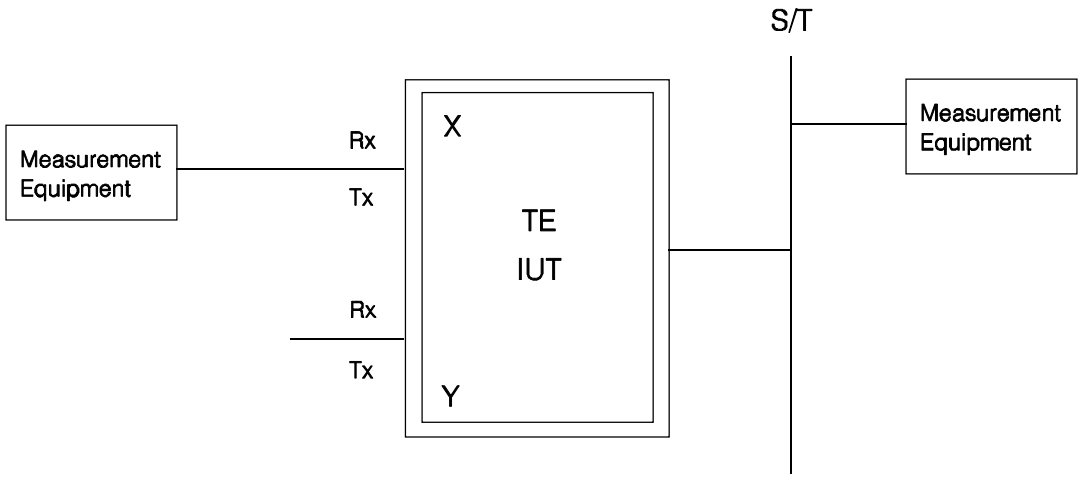
Monitor: Level on the B-channel

Result: The level shall be in the range from - 11 dBm0 to - 9 dBm0.

A.6.1.1.2 Output (TP No. 2)

Purpose: To check the gain from the B-channel input on the S/T reference point to the XTE-output.

Test Configuration:



System State: Ongoing communication.
When a user controlled receiving volume control is provided, the setting shall be used where the RLR is equal to the nominal value.

Stimulus: Sending level at the S/T-reference point: + 3 dBm0.

Monitor: Level at the XTE output.

Result: The level shall be in the range from -1 dBm to -13 dBm at a load of 150 ohms.

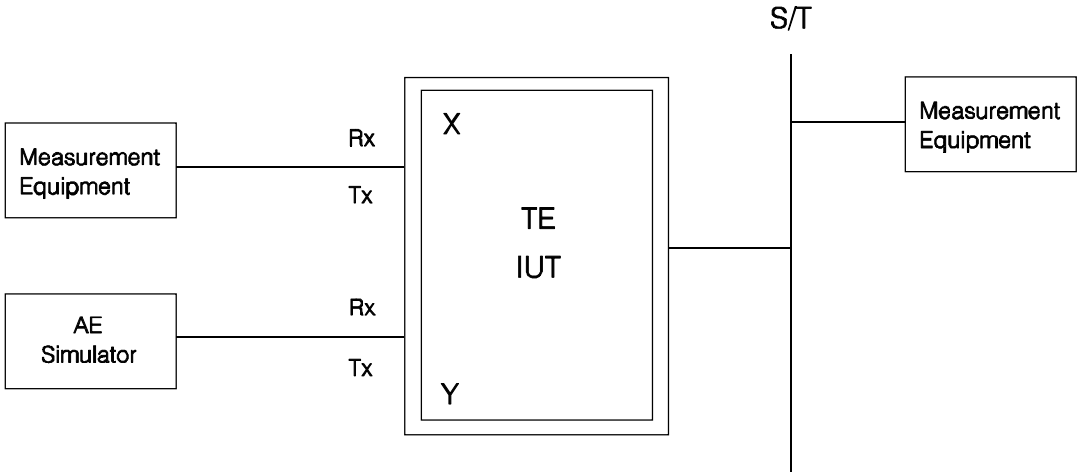
The output level may follow the volume control of the handset but shall not exceed -1 dBm at the maximum setting.

A.6.1.2 Interface impedances

A.6.1.2.1 Input (TP No. 3)

Purpose: To check the impedance of the XTE-input.

Test Configuration:



System State: Ongoing communication, activated X-interface.

Stimulus: Sinusoidal voltage from a generator with an output impedance of 600 ohms (±1%) and an open circuit voltage of U0 = 400 mVrms applied to the XTE-input at the frequencies of 300 Hz and 3,4 kHz for 3,1 kHz telephony respectively 50 Hz and 7 kHz for 7 kHz telephony.

Monitor: Voltage U at the XTE-input.

Result: The absolute impedance ¦Z¦ is given by:

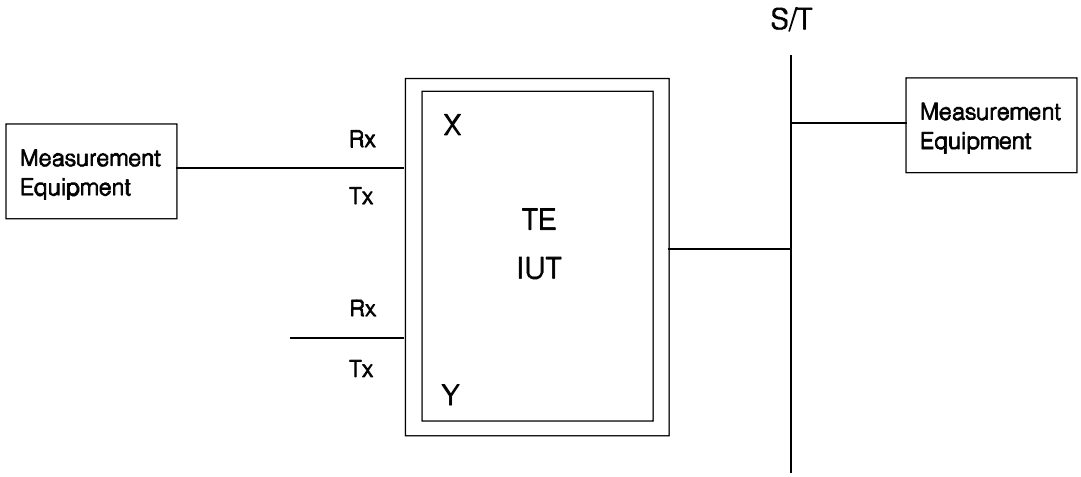
$$|Z| = 600 * \frac{1}{\frac{U0}{|U|} - 1}$$

and shall be in the range from 540 ohms to 660 ohms (600 ohms ± 10%) for the above specified frequencies.

A.6.1.2.2 Output (TP No. 4)

Purpose: To check the impedance of the XTE-output.

Test Configuration:



System State: Ongoing communication.

Stimulus: A digitally simulated sine wave signal applied at the S/T-reference point drives at the X-output an open circuit voltage U0 at the frequencies of 300 Hz and 3,4 kHz for 3,1 kHz telephony respectively 50 Hz and 7 kHz for 7 kHz telephony.

The digitally simulated sine wave should be adjusted so that U0 = 150 mVrms.

Monitor: - Output voltage U0 without load;

- Output voltage U at a load of 150 ohms ± 1%.

Result: The absolute impedance $|Z|$ is given by:

$$|Z| = 150 * \left(\frac{U0}{|U|} - 1 \right)$$

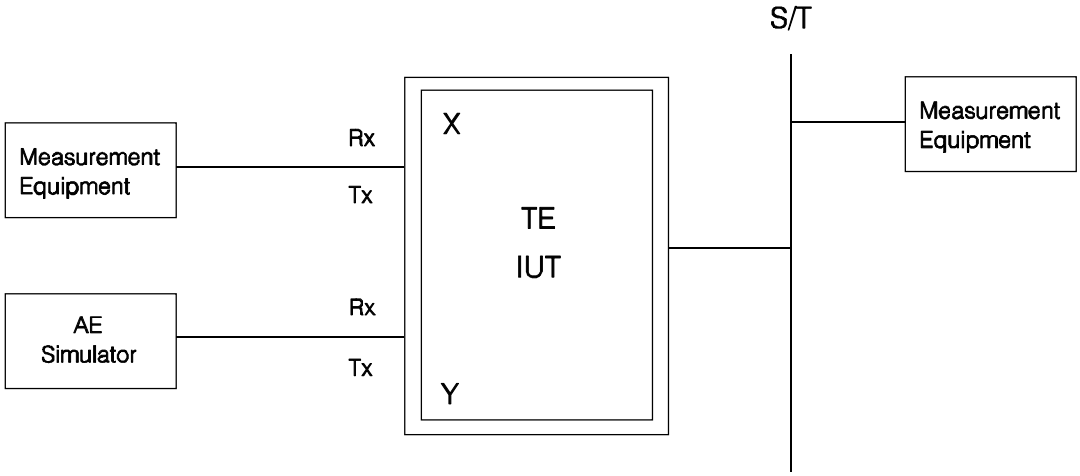
and shall be in the range from 135 ohms to 165 ohms (150 ohms ± 10%) for the above specified frequencies.

A.6.1.3 Variation of gain with input level

A.6.1.3.1 Encoding side (TP No. 5)

Purpose: To check the variation of gain with input level from the XTE-input to the S/T-reference point.

Test Configuration:



System State: Ongoing communication, activated X-interface.

Stimulus: Sine-wave signal in accordance to method 2 of ITU-T Recommendation G.712 [12] for 3,1 kHz telephony respectively CCITT Recommendation G.722 [13] for 7 kHz telephony, applied to the XTE-input.

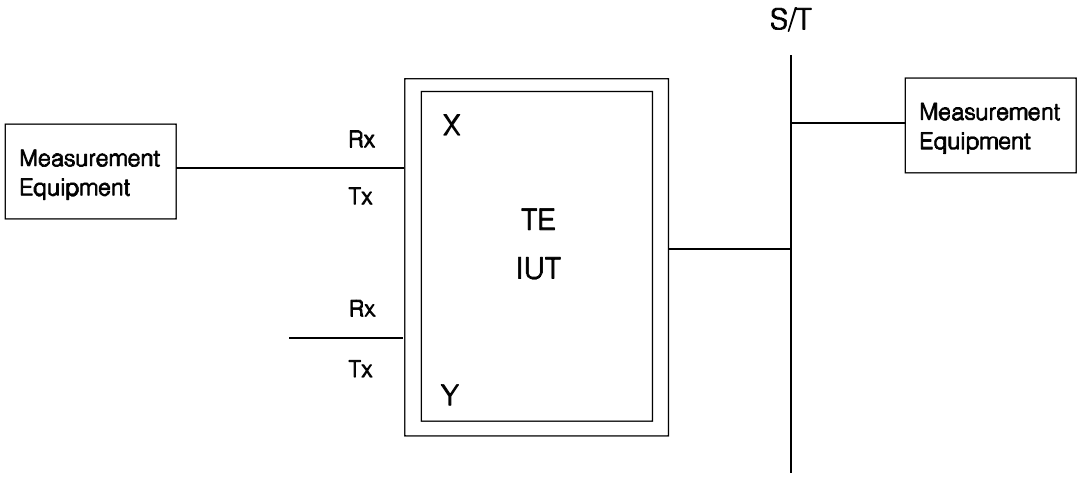
Monitor: Level on the B-channel at the S/T interface.

Result: The variation of gain as a function of the input level, relative to the gain at an input level of -10 dBm0, shall be within the limits of figure 14 of CCITT Recommendations G.712 [12] for 3,1 kHz telephony and, respectively figure 16 of CCITT Recommendation G.722 [13] for 7 kHz telephony.

A.6.1.3.2 Decoding side (TP No. 6)

Purpose: To check the variation of gain with input level from the S/T reference point to the XTE-output.

Test Configuration:



System State: Ongoing communication.

Stimulus: Digitally simulated sine-wave signal in accordance with method 2 of ITU-T Recommendation G.712 [12] for 3,1 kHz telephony and, respectively, CCITT Recommendation G. 722 [13] for 7 kHz telephony applied to the S/T reference point.

Monitor: Level at XTE-output.

Result: The variation of gain as a function of the input level, relative to the gain at an input level of - 10 dBm0, shall be within the limits of figure 14 of ITU-T Recommendation G.712 [12] for 3,1 kHz telephony and, respectively, figure 16 of CCITT Recommendation G.722 [13] for 7 kHz telephony.

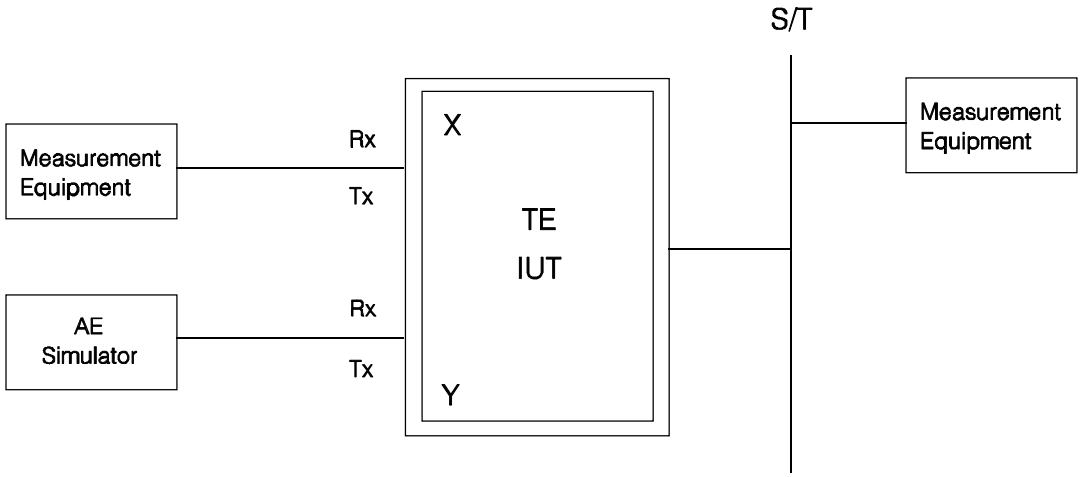
A.6.1.4 Distortion

A.6.1.4.1 Encoding side

A.6.1.4.1.1 Distortion as a function of input level (TP No. 7)

Purpose: To check the total distortion from the XTE-input to the S/T reference point.

Test Configuration:



System State: Ongoing communication, activated X-interface.

Stimulus: Sine-wave signal in accordance to method 2 of ITU-T Recommendation G.712 [12] for 3,1 kHz telephony and, respectively, CCITT Recommendation G.722 [13] for 7 kHz telephony, applied to the X-input.

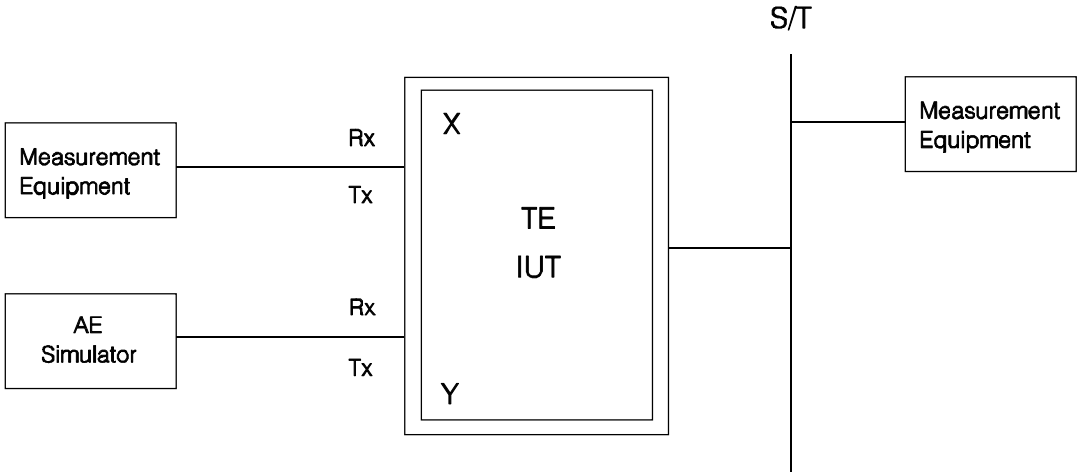
Monitor: Signal on the B-channel at the S/T interface.

Result: The ratio of signal-to-total distortion power as a function of the input level, shall be above the limits of figure 12 of ITU-T Recommendation G.712 [12] for 3,1 kHz telephony and, respectively, figure 14 of CCITT Recommendation G.722 [13] for 7 kHz telephony.

A.6.1.4.1.2 Distortion as a function of frequency (7 kHz telephony) (TP No. 8)

Purpose: To check the total distortion from the XTE-input to the S/T reference point versus frequency.

Test Configuration:



System State: Ongoing communication, activated X-interface.

Stimulus: Sine-wave signal in accordance to CCITT Recommendation G.722 [13] applied to the X-input.

Monitor: Signal on the B-channel at the S/T-interface.

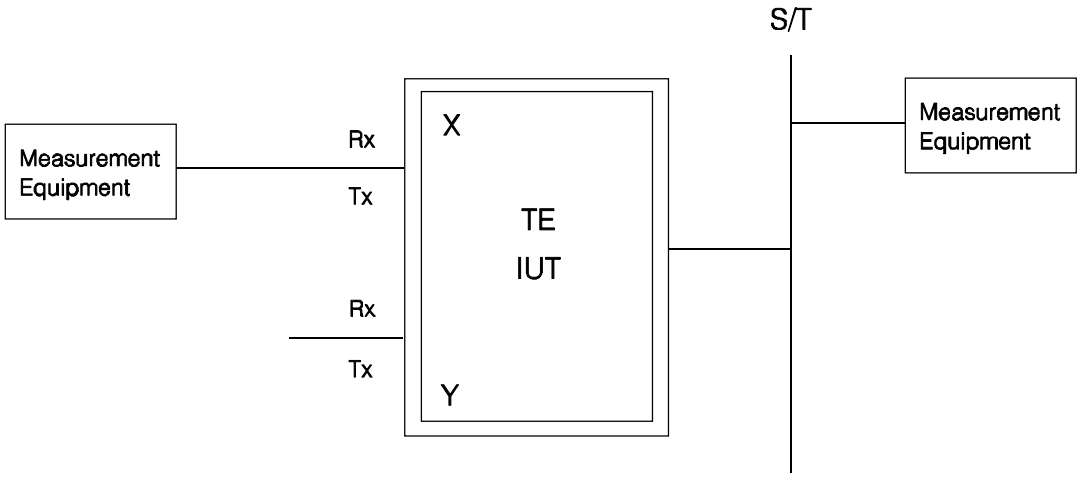
Result: The ratio of signal-to-total distortion power as a function of the input frequency, shall be above the limits of figure 15 of CCITT Recommendation G.722 [13].

A.6.1.4.2 Decoding side

A.6.1.4.2.1 Distortion as a function of input level (TP No. 9)

Purpose: To check the total distortion from the S/T reference point to the XTE-output.

Test Configuration:



System State: Ongoing communication.

Stimulus: Digitally simulated sine-wave signal in accordance to method 2 of ITU-T Recommendation G.712 [12] for 3,1 kHz telephony and, respectively, CCITT Recommendation G.722 [13] for 7 kHz telephony applied to the S/T reference point.

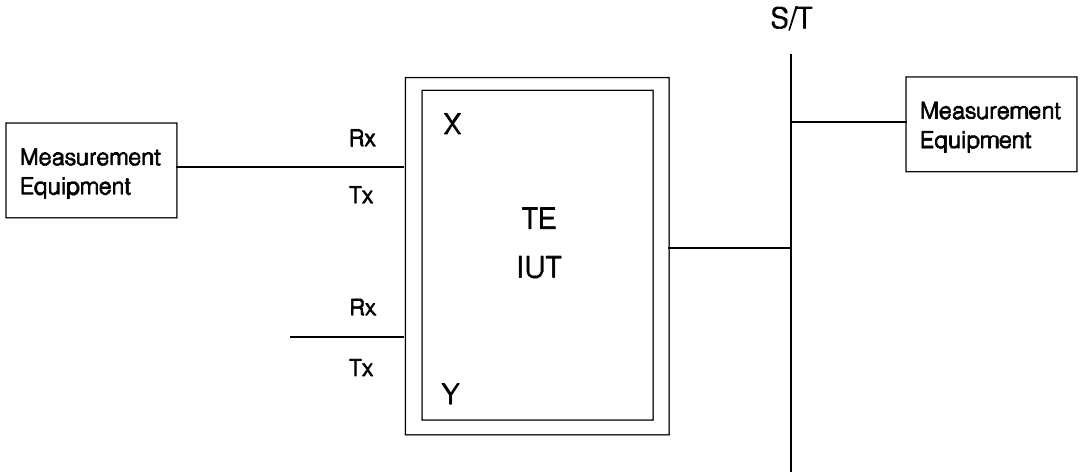
Monitor: Signal at the XTE-output.

Result: The ratio of signal-to-total distortion power as a function of the input level, shall be above the limits of figure 12 of ITU-T Recommendation G.712 [12] for 3,1 kHz telephony and, respectively, figure 14 of CCITT Recommendation G.722 [13] for 7 kHz telephony.

A.6.1.4.2.2 Distortion as a function of frequency (7 kHz telephony) (TP No. 10)

Purpose: To check the total distortion from the S/T reference to the XTE-output versus frequency.

Test Configuration:



System State: Ongoing communication.

Stimulus: Digitally simulated sine-wave signal in accordance with CCITT Recommendation G.722 [13] applied to the S/T-reference point.

Monitor: Signal at XTE-output.

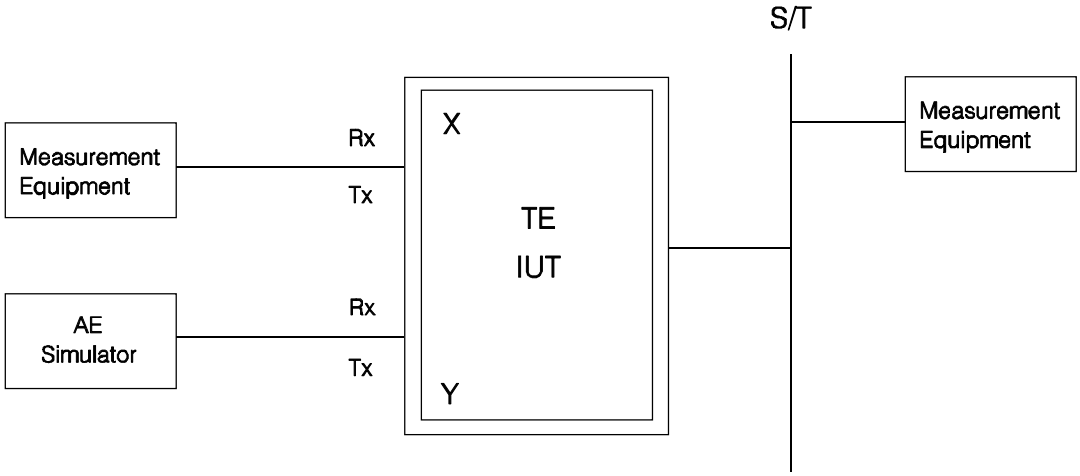
Result: The ratio of signal-to-total distortion power as a function of the input frequency, shall be above the limits of figure 15 of CCITT Recommendation G.722 [13].

A.6.1.5 Attenuation/Frequency distortion of the encoding or decoding side

A.6.1.5.1 Encoding side (TP No. 11)

Purpose: To check the variation of attenuation versus frequency from the XTE-input to the B-channel output at the S/T reference point.

Test Configuration:



System State: Ongoing communication, activated X-interface.

Stimulus: Sine-wave signal with variable frequency between 200 Hz and 3 600 Hz for 3,1 kHz telephony resp. 50 Hz and 8 000 Hz for 7 kHz telephony at the XTE-input with a level of -18 dBm.

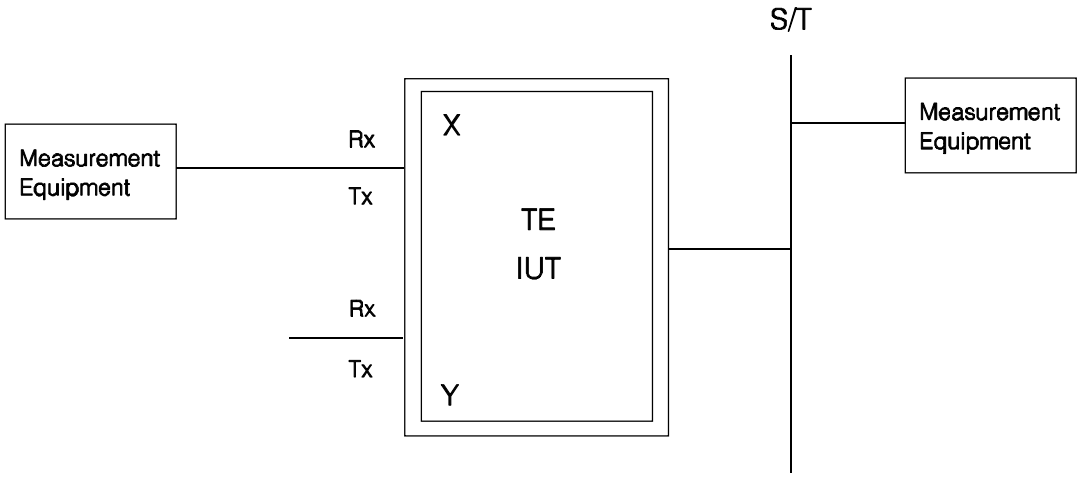
Monitor: Signal on the B-channel at the S/T reference point.

Result: The attenuation referred to the level at 1 020 Hz shall satisfy the limits given in figure 4 of ITU-T Recommendation G.712 [12] for 3,1 kHz telephony and, respectively, figure 10 of CCITT Recommendation G.722 [13] for 7 kHz telephony.

A.6.1.5.2 Decoding side (TP No. 12)

Purpose: to check the variation of attenuation versus frequency from the B-channel input at the S/T reference point to the XTE-output.

Test Configuration:



System State: Ongoing communication.

Stimulus: Digitally simulated sine-wave signal with variable frequency between 200 Hz and 3 600 Hz for 3,1 kHz telephony and, respectively, 50 Hz and 8 000 Hz for 7 kHz telephony with a level of -10 dBm0 at the S/T reference point.

Monitor: Signal on the XTE-output.

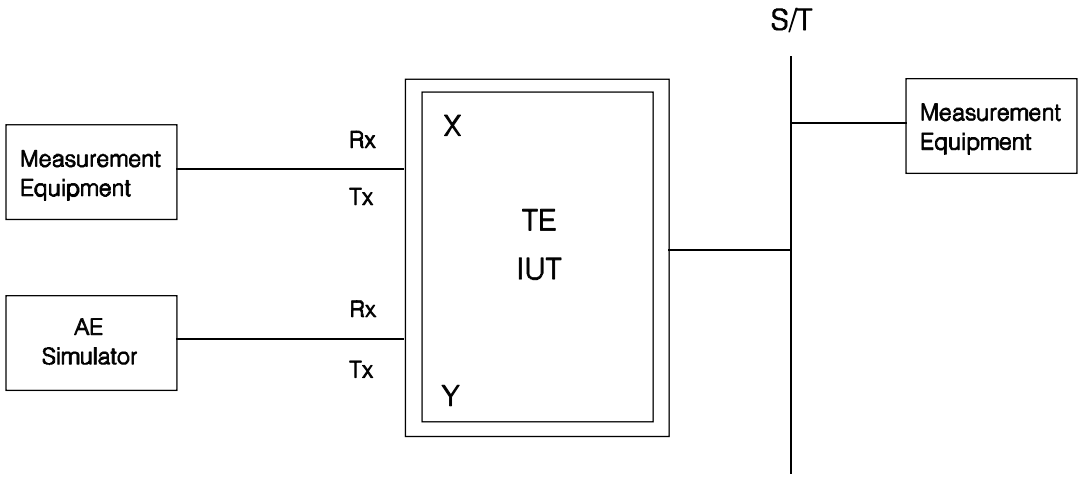
Result: The attenuation referred to the level at 1 020 Hz shall satisfy the limits given in figure 4 of CCITT of Recommendation G.712 [12] for 3,1 kHz telephony and respectively, figure 10 of CCITT Recommendation G.722 [13] for 7 kHz telephony.

A.6.1.6 Out-of-band signals

A.6.1.6.1 Discrimination against out-of-band input signals (TP No. 13)

Purpose: To check for aliasing effects, producing in-band signals from input frequencies above the half sampling frequency.

Test Configuration:



System State: Ongoing communication, activated X-interface.

Stimulus: Sine waves with discrete frequencies of 4,65 kHz, 5 kHz, 6 kHz, 6,5 kHz, 7 kHz and 7,5 kHz for 3,1 kHz telephony, and 9 kHz, 10 kHz, 12 kHz, 13 kHz and 15 kHz for 7 kHz telephony at the XTE-input with a level of - 18 dBm.

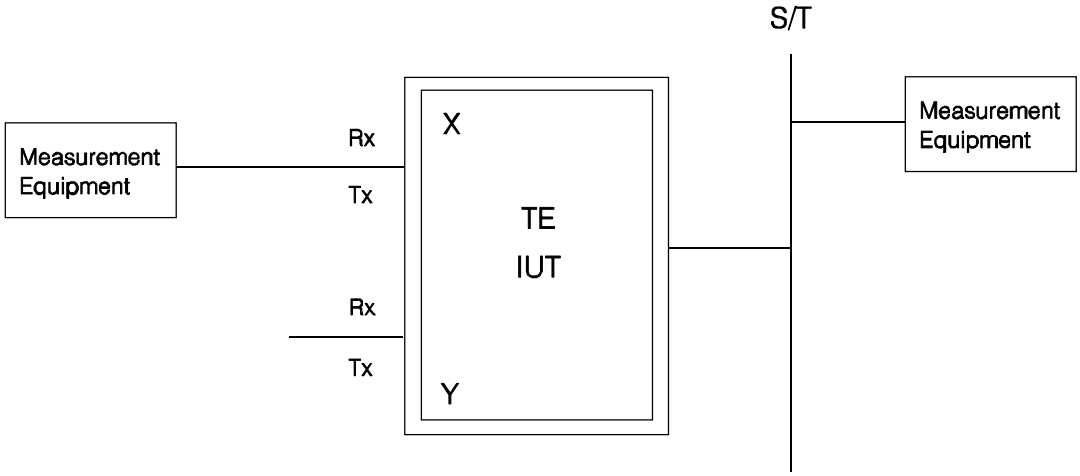
Monitor: Level on the B-channel at the S/T reference point.

Result: The levels of all produced image-frequencies shall be below the reference level, obtained for 1 020 Hz and -18 dBm at the XTE-input, by at least 25 dB for 3,1 kHz telephony, and by at least 25 dB for 7 kHz telephony.

A.6.1.6.2 Spurious out-of-band signals at the output (TP No. 14)

Purpose: To check for aliasing effects of in-band frequencies, producing image frequencies above 4 kHz.

Test Configuration:



System State: Ongoing communication.

Stimulus: Digitally simulated sine-wave signals with discrete frequencies of 500 Hz, 1 000 Hz, 2 000 Hz and 3 150 Hz for 3,1 kHz telephony, and 200 Hz, 350 Hz, 500 Hz, 1 000 Hz, 2 000 Hz, 3 500 Hz, 5 000 Hz and 7 000 Hz for 7 kHz telephony at the S/T reference point with a level of 0 dBm0.

Monitor: Selectively measured level at the XTE-output. Measured aliasing frequencies fm = fs - fi, where fs = sampling frequency (8 kHz) and fi = input frequency.

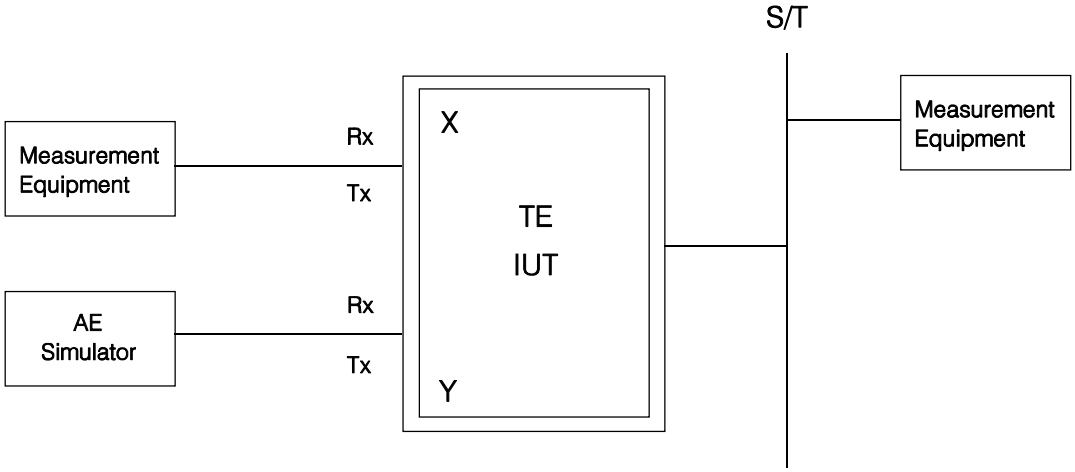
Result: The levels of the produced image-frequencies shall be lower than the inband level, produced by a digitally simulated sine-wave signal of 1 020 Hz with a level of - 25 dBm0 for 3,1 kHz telephony; and set at the level specified below for 7 kHz telephony: At an image frequency of 9 kHz, the discrimination level is equivalent to an input signal level of - 50 dBm0, at 16 kHz of - 60 dBm0. The limit at intermediate frequencies lies on a straight line between the given values on a linear (dB) - log (frequency) scale.

A.6.1.7 Single frequency noise

A.6.1.7.1 Encoding side (TP No. 15)

Purpose: To check the maximum of the spectrum of the transmitted idle channel noise.

Test Configuration:



System State: Ongoing communication, activated X-interface.

Stimulus: XTE-input terminated with 600 ohms.

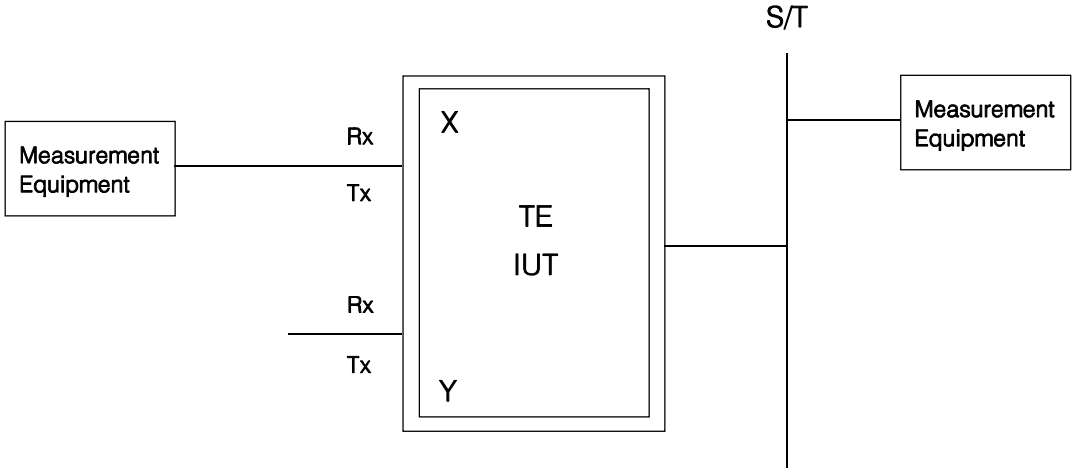
Monitor: Spectrum of the noise on the B-channel at the S/T interface.

Result: The level of each single frequency component shall not exceed - 50 dBm0 for 3,1 kHz telephony (ITU-T Recommendation G.712 [12]) and, respectively, - 70 dBm0 for 7 kHz telephony (CCITT Recommendation G.722 [13]).

A.6.1.7.2 Decoding side (TP No. 16)

Purpose: To check the maximum of the noise spectrum at the XTE-output.

Test Configuration:



System State: Ongoing communication.

When a user controlled receiving volume control is provided, the setting shall be used where the RLR is equal to the minimum value (i.e. maximum gain).

Stimulus: Sending level at the S/T reference point:

PCM signal corresponding to the decoder output value number 1.

Monitor: Spectrum of the noise up to 16 kHz at the XTE-output.

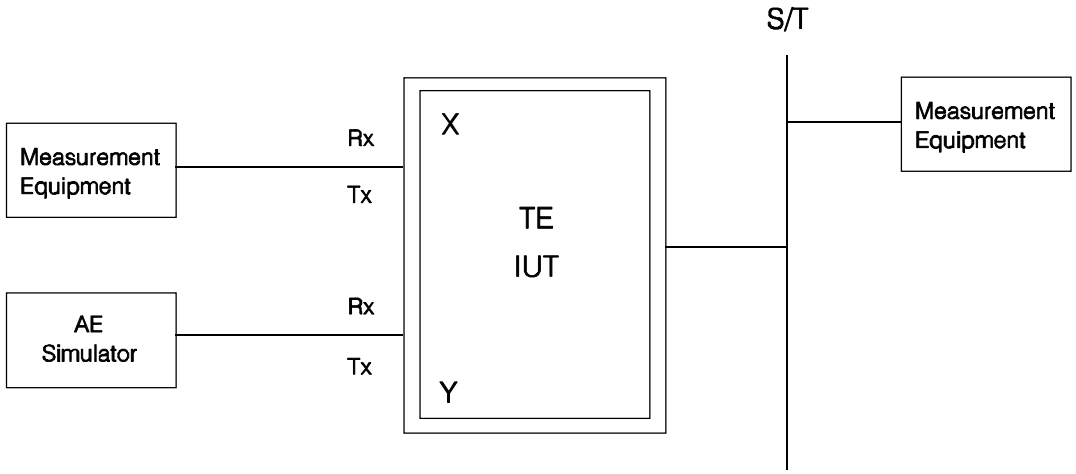
Result: The level of each single frequency component shall not exceed - 50 dBm0 for 3,1 kHz telephony (ITU-T Recommendation G.712 [12]) and, respectively, - 70 dBm0 for 7 kHz telephony (CCITT Recommendation G.722 [13]).

A.6.1.8 Noise

A.6.1.8.1 Input (TP No. 17)

Purpose: To check the idle channel noise transmitted by the encoding side.

Test Configuration:



System State: Ongoing communication, activated X-interface.

Stimulus: XTE-input terminated with 600 ohms.

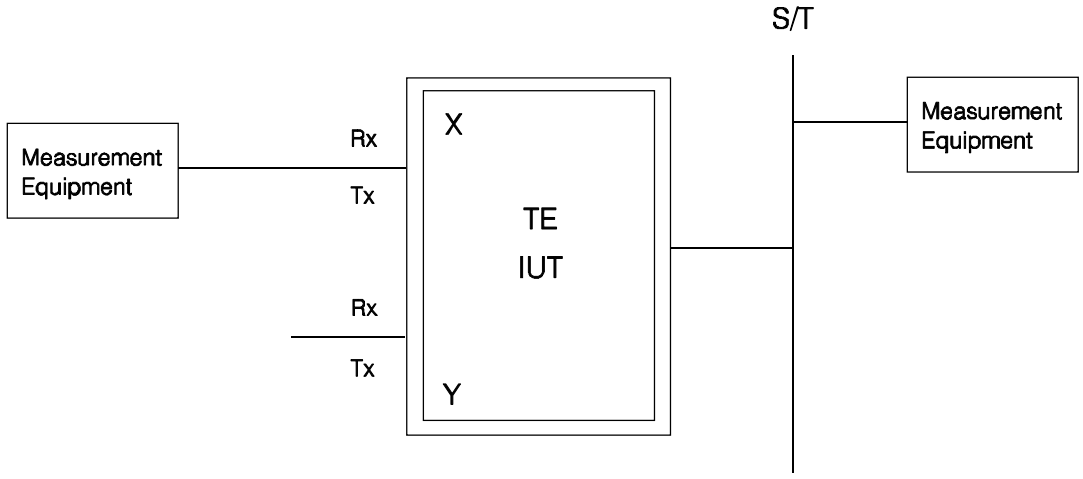
Monitor: Noise on the B-channel at the S/T interface.

Result: The level shall not exceed - 66 dBm0p for 3,1 kHz telephony (ITU-T Recommendation G.712 [12]) and, respectively, - 66 dBm0 from 50 Hz to 7 kHz for 7 kHz telephony (CCITT Recommendation G.722 [13]).

A.6.1.8.2 Output (TP No. 18)

Purpose: To check the noise at the XTE-output.

Test Configuration:



System State: Ongoing communication.
When a user controlled receiving volume control is provided, the setting shall be used where the RLR is equal to the minimum value (i.e. maximum gain).

Stimulus: Sending level at the S/T-reference point:

PCM signal corresponding to the decoder output value number 1.

Monitor: Noise at the XTE-output.

Result: The level at a load of 150 ohms shall not exceed:

- 75 dBmp for 3,1 kHz telephony (ITU-T Recommendation G.712 [12]);

- 75 dBm from 50 Hz to 7 kHz for 7 kHz telephony (CCITT Recommendation G.722 [13]).

A.6.1.9 Group delay

Purpose: **Absolute group delay**

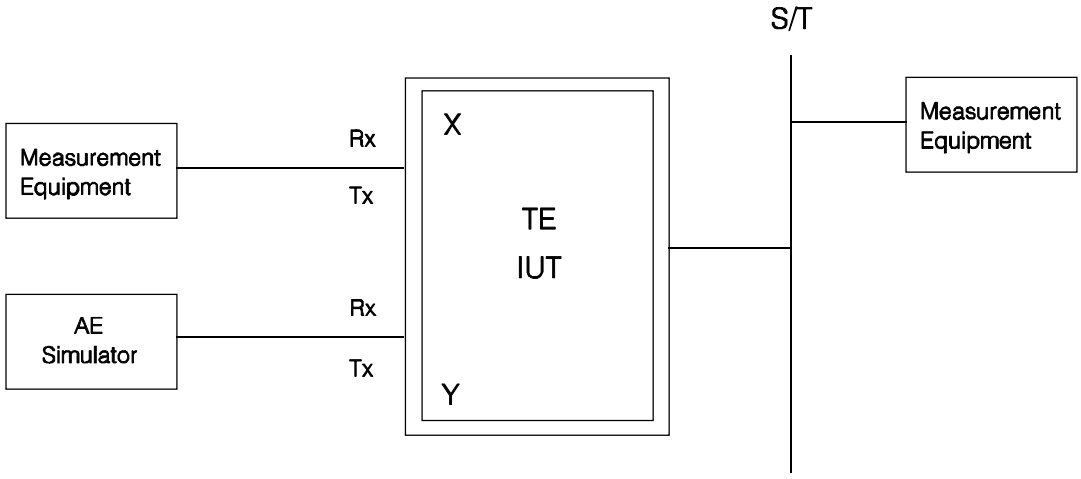
To check the sum of both absolute group delays from the analogue input to the basic user-network interface (encoding side) and from the basic user-network interface to the analogue output (decoding side).

Group delay distortion:

To check the variation of the group delay with frequency.

A.6.1.9.1 Encoding side (TP No. 19)

Test Configuration:



System State: Ongoing communication, activated X-interface:

Stimulus: XTE-input level: - 18 dBm

Input-frequencies:

F1 and F2 according to the following table (table A.1).

Table A.1: Frequencies for group delay testing

F0 (Hz)	F1 (Hz)	F2 (Hz)
100	95	105
300	285	315
500	475	525
630	605	655
800	775	825
1 000	975	1 025
1 250	1 225	1 275
1 600	1 575	1 625
2 000	1 975	2 025
2 500	2 475	2 525
2 800	2 775	2 825
4 000	3 975	4 025
6 400	6 375	6 425
NOTE: Frequencies of F0 below 500 Hz and above 2 800 Hz apply to 7 kHz telephony alone.		

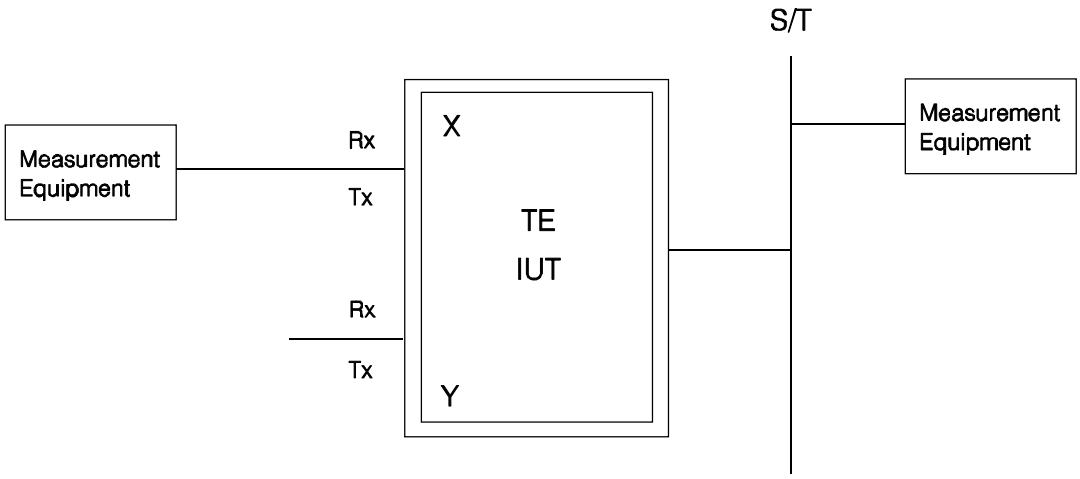
Monitor: For each value of F0 the phase shifts Pi (i = 1;2) in degrees between the XTE-input signal and the signal on the B-channel at the frequencies Fi.

Intermediate result: Compute the delay in milliseconds from the formula:

$$D = \frac{|1000 * (P2 - P1)|}{360 * (F2 - F1)} \text{ for each value of } F0$$

A.6.1.9.2 Decoding side (TP No. 20)

Test Configuration:



System State: Ongoing communication.

Stimulus: Digitally simulated sine wave signal applied at the S/T reference point:

Level: - 10 dBm0;

Frequencies: the same as for the encoding side.

Monitor: For each value of F0 the phase shifts Pi (i= 1;2) in degrees between the XTE-input signal and the signal on the B-channel at the frequencies Fi.

Intermediate result: Compute the delay in milliseconds from the same formula as for the encoding side for each value of F0.

Final results: **Absolute group Delay**

Compute the sums of the delays of the encoding side and the decoding side for each value of F0. For 3,1 kHz telephony the absolute group delay is defined as an average sum of the delays in the range from 500 Hz to 2 500 Hz inclusive. This absolute group delay shall not exceed 1,5 ms.
For 7 kHz telephony the absolute group delay is defined as minimum sum of the delays in the range from 100 Hz to 6,4 kHz. This absolute group delay shall not exceed 4 ms

Group delay distortion

The absolute differences between the minimum sum of the delays of the encoding side and decoding side, and the corresponding sums for the different frequencies shall be below the limits given in table A.2.

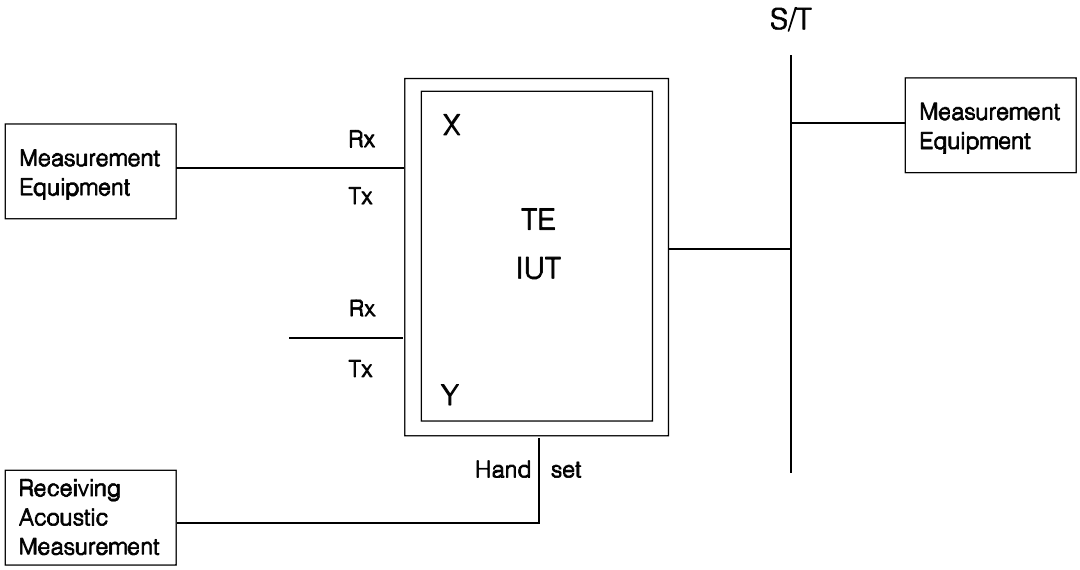
Table A.2: Group delay distortion

	Group delay distortion (ms) = D(encode) + D(decode) - Minimum group delay	
F0 (Hz)	3,1 kHz telephony	7 kHz telephony
100	----	1
300	----	0,25
500	1,5	0,25
630	0,75	0,25
800	0,75	0,25
1 000	0,25	0,25
2 500	0,25	0,25
2 800	1,5	0,25
4 000	----	0,25
6 400	----	1

A.6.1.10 Short circuit protection (TP No. 21)

Purpose: To check the RLR with a short circuit at the XTE-output.

Test Configuration:



System State: Ongoing communication.

Stimulus: Short circuit at the XTE-output.

Monitor: RLR at the handset (measurement identical to I-ETS 300 245, Part 2 [7]).

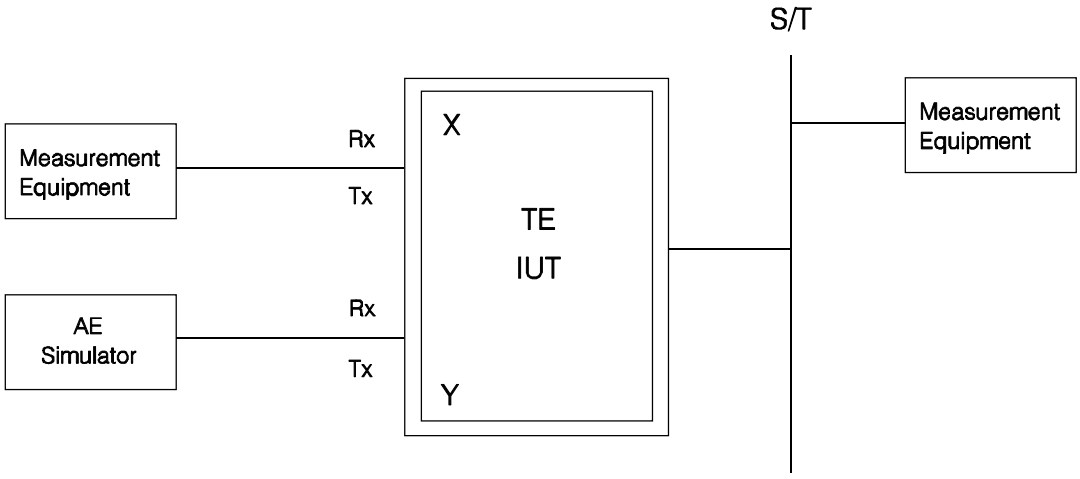
Result: The receiving loudness rating RLR shall not increase by more than 3 dB.

A.6.1.11 Terminal Coupling Loss (TCL) (TP No. 22)

Purpose: To measure the attenuation between the TE receiving direction and the TE sending direction at the S/T interface.

The X-interface is not connected to an AE.

Test Configuration:



System State: Ongoing communication, activated X-interface (terminated load).

Disabled acoustic interface (no handset or handsfree operation).

When a user controlled receiving volume control is provided, the setting shall be used where the RLR is equal to the nominal value.

Stimulus: The test level at the digital interface (S/T) is 0 dBm0 with a digitally simulated sine wave in the frequency range of 300 Hz to 3,4 kHz in one-twelfth octave intervals as given by the R.40 series of preferred numbers in ISO Publication 3 [16].

Monitor: Receiving level at the S/T-interface on the sending port of the TE.

Result: The level shall be lower than - 55 dBm0 (TCL ≥ 55 dB, no weighting).

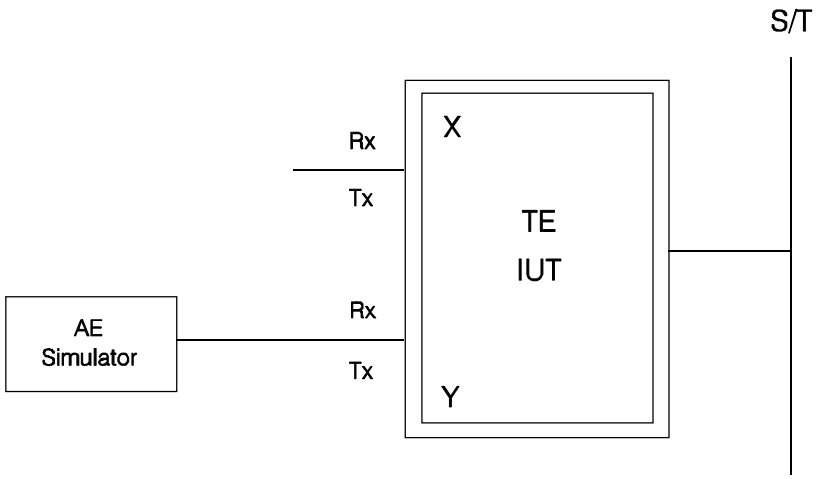
A.6.2 Test principles YTE (Y-interface at TE)

A.6.2.1 Bit rate

A.6.2.1.1 Transmitting bit rate (TP No. 23)

Purpose: To check the bit rate of the transmitter.

Test Configuration:



System State: TE in test state with YTE-loop.

Stimulus: Bit-pattern "55H" at the YTE-input with a bit rate of 1 200 bit/s varied in the range of ± 3%.

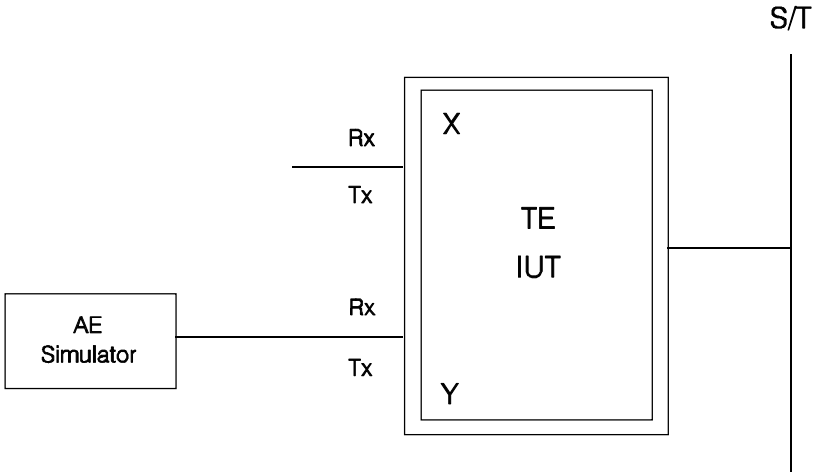
Monitor: Analysing of the looped bit pattern at the YTE-output.

Result: The time T between the rising edge of one pulse to the rising edge of the next one shall be measured. The resulting bit rate is calculated with 2/T and shall be 1 200 bit/s ± 1%.

A.6.2.1.2 Receiving bit rate (TP No. 24)

Purpose: To check the bit rate of the receiver.

Test Configuration:



System State: TE in test state with YTE-loop.

Stimulus: Bit-pattern "55H" at the YTE-input with a bit rate of 1 200 bit/s, varied in the range of ± 3%.

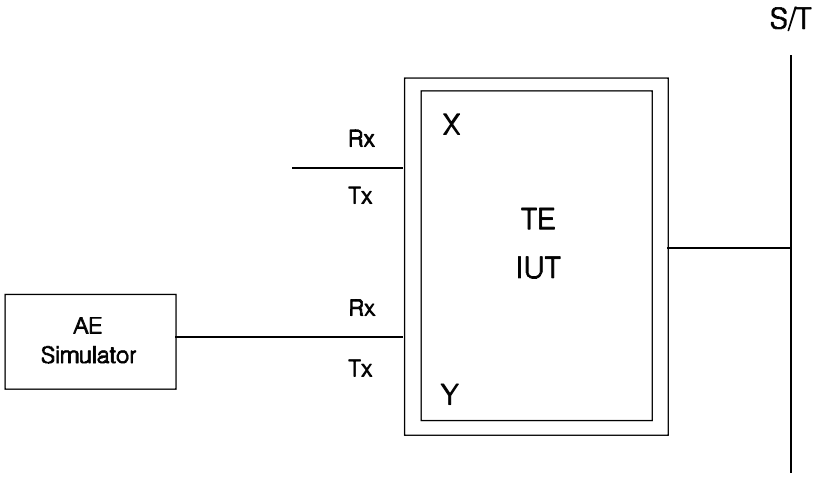
Monitor: Analysing of the looped bit pattern at the YTE-output.

Result: The looped bit-pattern shall be equal to the sent pattern in the specified range of the bit rate.

A.6.2.2 Format (TP No. 25)

Purpose: To check the character format.

Test Configuration:



System State: TE in test state with YTE-loop.

Stimulus: Bit-pattern "55H" at the YTE-input (from AE-simulator).

Monitor: Monitoring of YTE-output with storage oscilloscope or logic analyser.

Result: The looped data bit pattern shall be equal to the sent pattern.

The character format shall consist of:

- 1 start bit (log. 0);
- 8 data bits (beginning with the LSB);
- 1 parity bit (odd);
- 1 stop bit (log. 1);

logical 0 = active state;

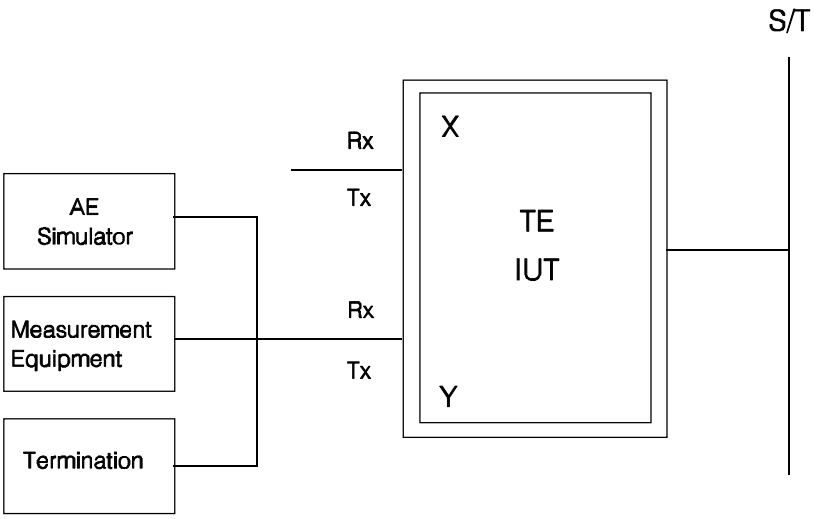
logical 1 = idle state.

A.6.2.3 Sending

A.6.2.3.1 Active state, with load (TP No. 26)

Purpose: To check the drive current of the YTE-output in active state (log.0).

Test Configuration:



System State: TE in test state with YTE-loop.

Stimulus: Logical "0" signal at the YTE-input (data bit pattern "00H" from the AE-simulator).

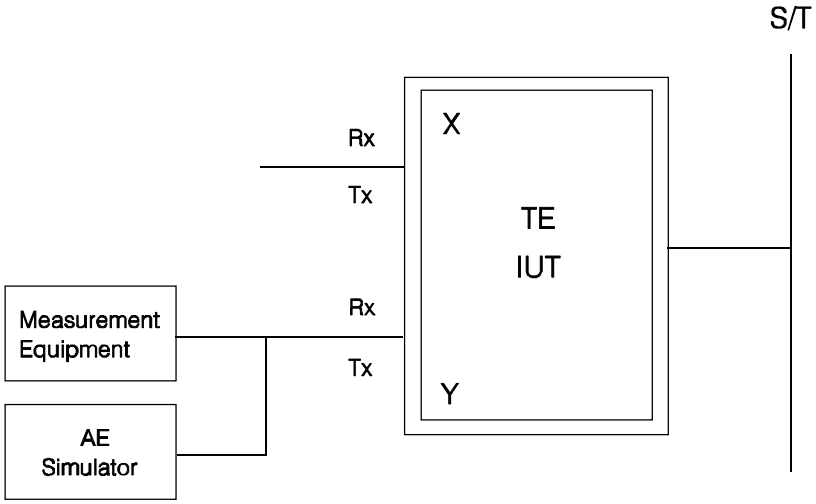
Monitor: YTE-output at a load of 1,8 kohms ± 1% (no connection to the AE-simulator Rx).

Result: The output current shall not be less than 1,2 mA.

A.6.2.3.2 Active state, without load (TP No. 27)

Purpose: To check the sending voltage of the YTE-output in active state (log.0).

Test Configuration:



System State: TE in test state with YTE-loop.

Stimulus: Logical "0" signal at the YTE-input (data bit pattern "00H" from the AE-simulator).

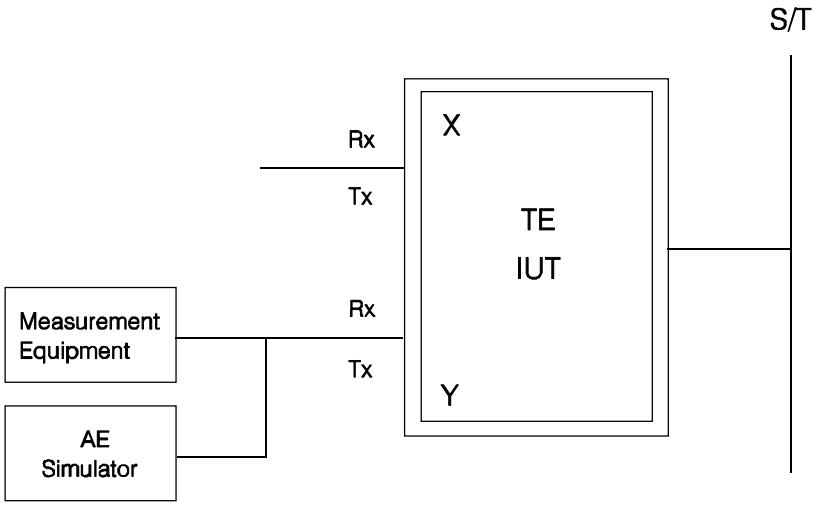
Monitor: Open circuit voltage at the YTE-output (no connection to the AE-simulator Rx).

Result: The output voltage shall not exceed 5,25 V.

A.6.2.3.3 Idle state (TP No. 28)

Purpose: To check the sending voltage of the YTE-output in the idle state (log.1).

Test Configuration:



System State: TE in test state with YTE-loop.

Stimulus: Logical "1" signal at the YTE-input (data bit pattern "FFH" from the AE-simulator).

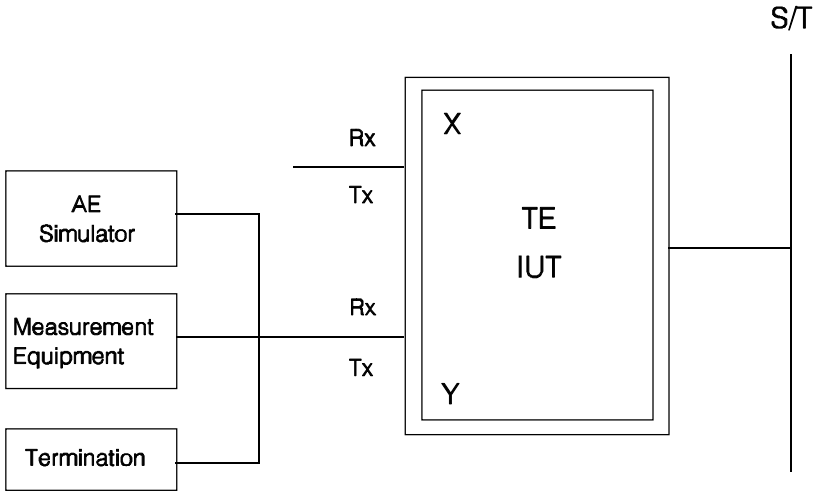
Monitor: Voltage at the YTE-output (normal connection to the AE-simulator).

Result: The output voltage shall not exceed 0,8 V.

A.6.2.3.4 Output resistance (TP No. 29)

Purpose: To check the output resistance R of the transmitter.

Test Configuration:



System State: TE in test state with YTE-loop

Stimulus: Data bit pattern 55H at the YTE-input (from the AE-simulator) - load at the YTE-output with R_L =1,8 kohms ±1%.

Monitor: Open circuit voltage U at the YTE-output (without load) - voltage U_L for logical 0 at the YTE-output (with load).

Result: The resistance is given by:

$$= 1\,800 * \left(\frac{U}{U_L} - 1 \right)$$

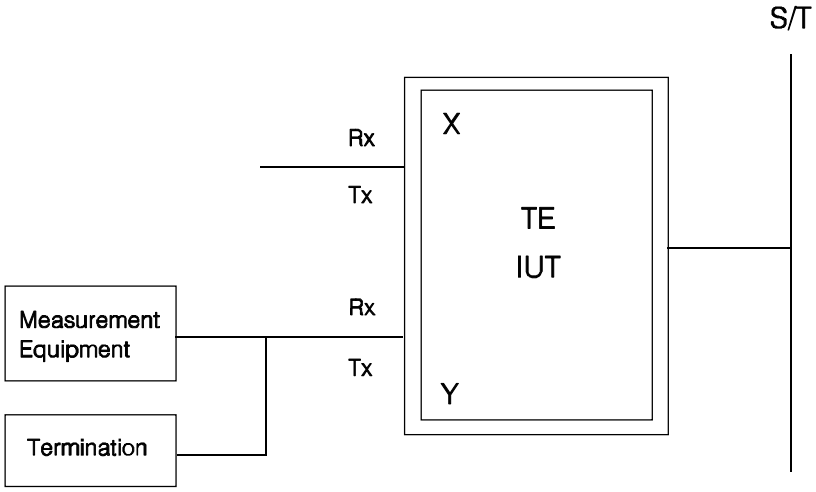
and shall be in the range from 1,35 kohms to 1,65 kohms (1,5 kohms ± 10%).

A.6.2.4 Receiving

A.6.2.4.1 Short-circuit current (TP No. 30)

Purpose: To check the short-circuit current of the YTE-input.

Test Configuration:



System State: TE in test state.

Stimulus: Short circuit at the YTE-input.

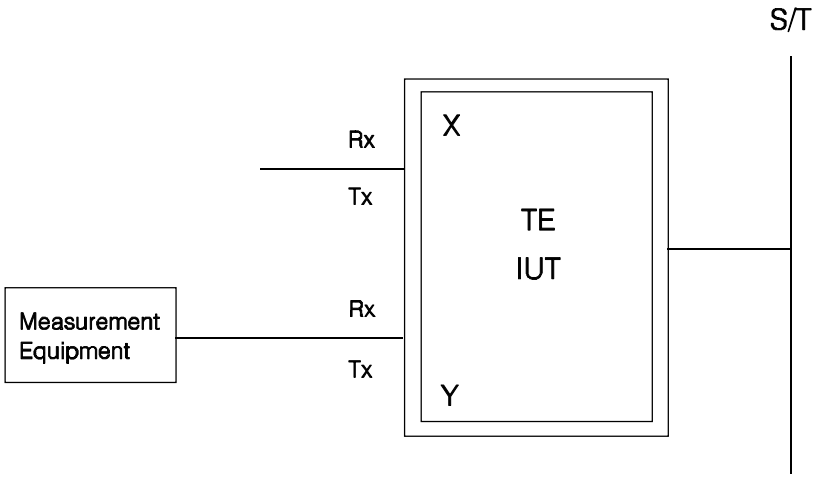
Monitor: Current at YTE-input.

Result: The input current shall be in the range of 0,4 mA to 0,6 mA.

A.6.2.4.2 Open-circuit voltage (TP No. 31)

Purpose: To check the open-circuit voltage of the YTE-input.

Test Configuration:



System State: TE in test state.

Stimulus: Not relevant.

Monitor: Open circuit voltage at YTE-input.

Result: The voltage of the input shall be in the range of 4,0 V to 5,25 V.

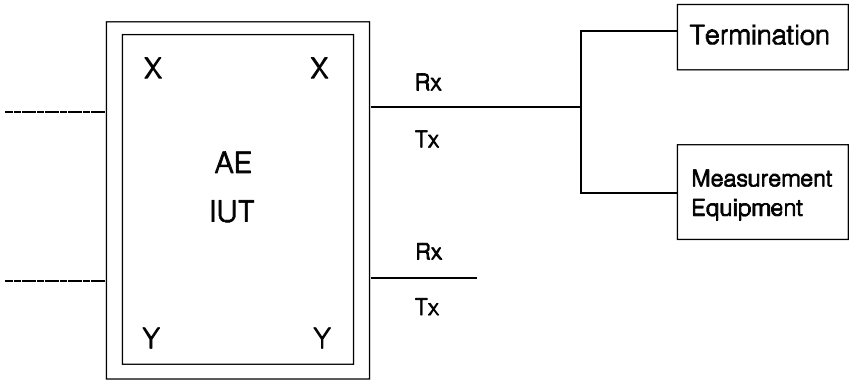
A.6.3 Test principles XAE (X-interface at AE)

A.6.3.1 Sending

A.6.3.1.1 Output level (TP No. 32)

Purpose: To check the maximum sending level of the XAE-output.

Test Configuration:



System State: AE in test state and sending mode. It shall be assured that the maximum level is achievable.

Stimulus: Frequency 1 kHz, maximum level, any wave form.

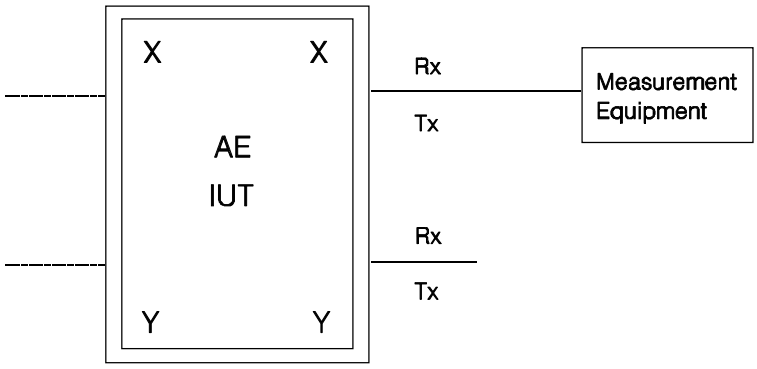
Monitor: Peak-to-peak voltage at the XAE-output at a load of 600 ohms (±1%).

Result: The peak-to-peak voltage shall not exceed 2,0 Vpp.

A.6.3.1.2 Active mode output impedance (TP No. 33)

Purpose: To check the output impedance of the XAE-output in active mode.

Test Configuration:



System State: AE in test state and active mode.

Stimulus: Sinusoidal voltage from a generator with an output impedance of 600 ohms (±1%) and an open circuit voltage of U0 = 400 mVrms applied to the XAE-output at the frequencies 300 Hz and 3 400 Hz for the 3,1 kHz telephony and, respectively, 100 Hz and 7 kHz for the 7 kHz telephony.

Monitor: Open circuit voltage U0 of the generator - voltage U at the XAE-output.

Result: The absolute impedance $|Z|$ is given by:

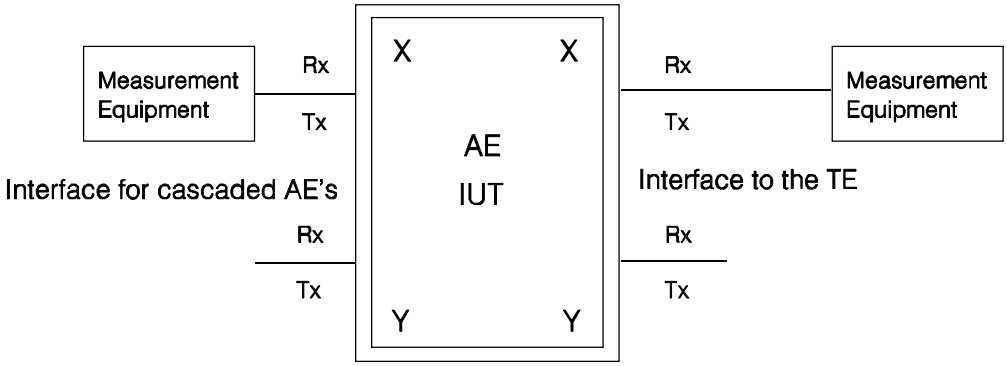
$$|Z| = 600 * \frac{1}{\frac{U0}{|U|} - 1}$$

and shall be in the range from 480 ohms to 720 ohms (600 ohms ±20%) for the above specified frequencies.

A.6.3.1.3 Idle mode insertion loss (TP No. 34)

Purpose: To check the insertion loss of the AE in idle mode between the XAE-input to cascaded AEs and the XAE-output to the TE.

Test Configuration:



System State: AE in test state and idle mode.

Stimulus: Sinusoidal voltage with a frequency of 1 kHz from a generator with an output impedance of 600 ohms and an open circuit voltage of 400 mVrms applied at the XTE-input.

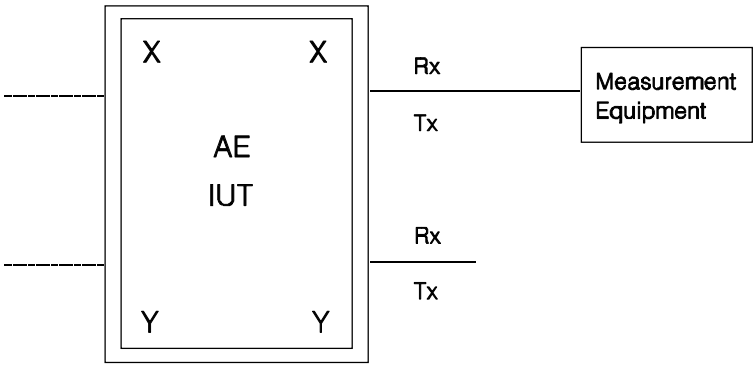
Monitor: rms voltage at the XAE-output at a load of 600 ohms.

Result: The rms voltage shall be 200 mV ± 10 mV.

A.6.3.1.4 Noise (TP No. 35)

Purpose: To check the level of noise at the XAE-output.

Test Configuration:



System State: AE in test state, idle mode.

Stimulus: Not relevant.

Monitor: Level at the XAE-output.

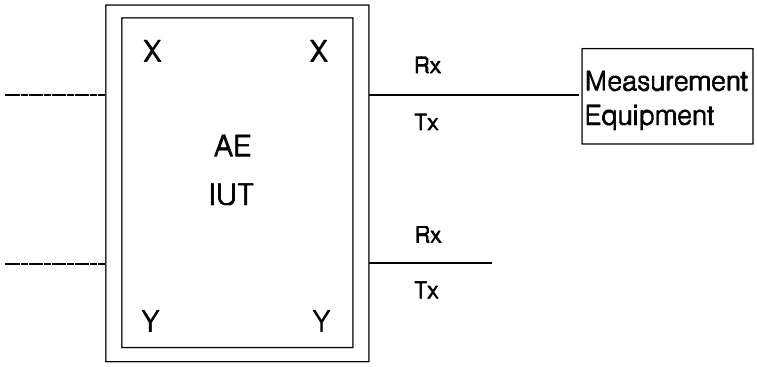
Result: The noise level shall not exceed - 70 dBmp.

A.6.3.2 Receiving

A.6.3.2.1 Input impedance (TP No. 36)

Purpose: To check the input impedance of the XAE-input.

Test Configuration:



System State: AE in test state and receiving mode.

Stimulus: The input voltage at the X-input shall be 0,7 Vrms at the frequencies 300 Hz and 3 400 Hz for the 3,1 kHz telephony and, 100 Hz and 7 kHz for 7 kHz telephony.

Monitor: Current at the XAE-input.

Result: The input current shall not exceed 70 µArms in the specified frequency ranges (input impedance >10 kohms).

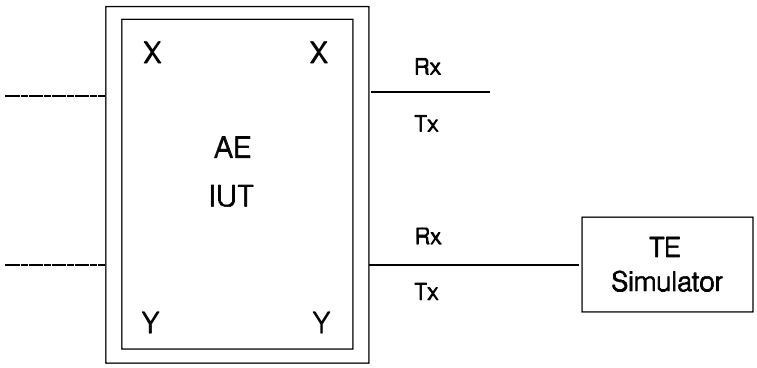
A.6.4 Test principles YAE (Y-interface at AE)

A.6.4.1 Bit rate

A.6.4.1.1 Transmitting bit rate (TP No. 37)

Purpose: To check the bit rate of the transmitter.

Test Configuration:



System State: AE in test state with YAE-loop.

Stimulus: Bit-pattern "55H" at the YAE-input with a bit rate of 1 200 bit/s, varied in the range of ± 3%.

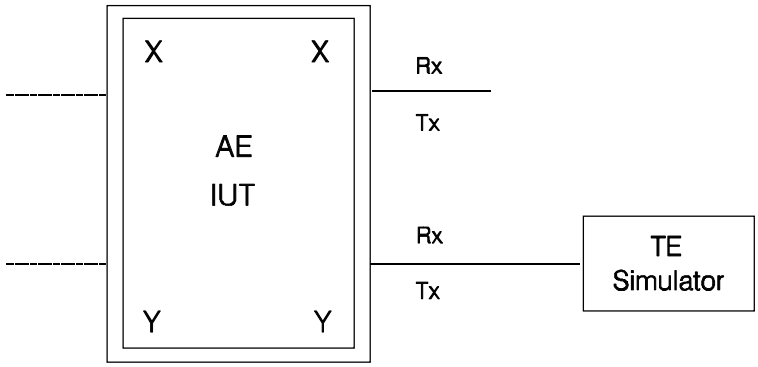
Monitor: Analysing of the looped bit pattern at the YAE-output.

Result: The time T between the rising edge of one pulse to the rising edge of the next one shall be measured. The resulting bit rate is calculated with 2/T and shall be 1 200 bit/s ±1%.

A.6.4.1.2 Receiving bit rate (TP No. 38)

Purpose: To check the bit rate of the receiver.

Test Configuration:



System State: AE in test state with YAE-loop.

Stimulus: Data bit-pattern "55H" at the YAE-input with a bit rate of 1 200 bit/s, varied in the range of ± 3%.

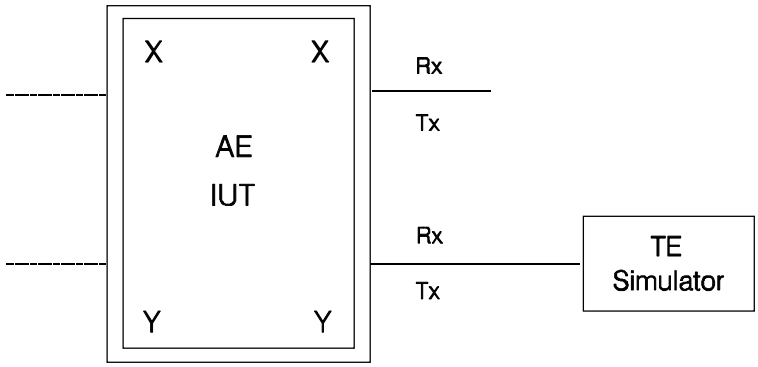
Monitor: Analysing of the looped bit patterns at the YAE-output.

Result: The looped bit pattern shall be equal to the sent pattern in the specified range of the bit rate.

A.6.4.2 Format (TP No. 39)

Purpose: To check the character format.

Test Configuration:



System State: AE in test state with YAE-loop.

Stimulus: Data bit-pattern "55H" from the TE-simulator at the YAE-input.

Monitor: Monitoring of YAE-output with storage oscilloscope or logic analyser.

Result: The looped bit pattern shall be equal to the sent pattern.

The character format shall consist of:

- 1 start bit (log. 0);
- 8 data bits (beginning with the LSB);
- 1 parity bit (odd);
- 1 stop bit (log. 1);

logical 0 = active state;

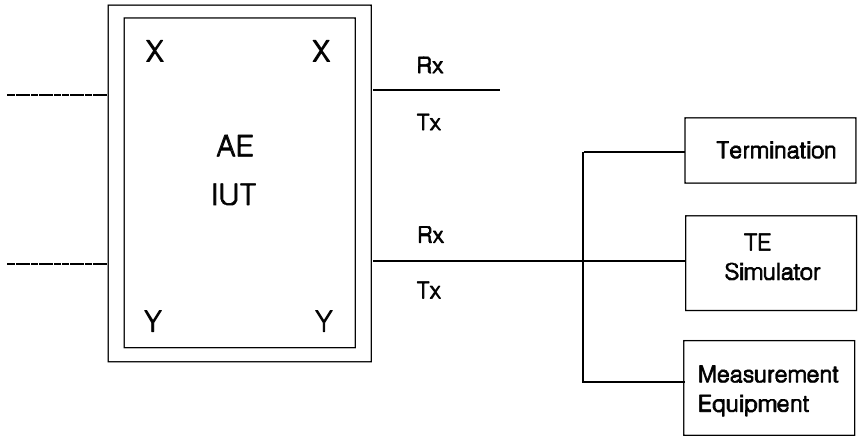
logical 1 = idle state.

A.6.4.3 Sending

A.6.4.3.1 Active state (TP No. 40)

Purpose: To check the sending voltage of the YAE-output in active state (log.0).

Test Configuration:



System State: AE in test state with YAE-loop.

Stimulus: Logical "0" signal at the YAE-input (data bit pattern "00H" from the TE-simulator).

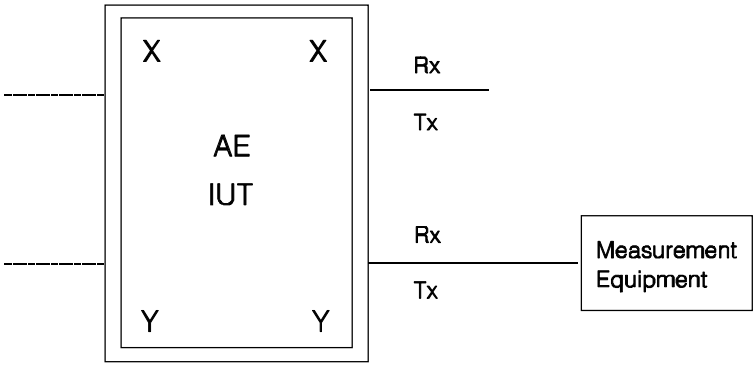
Monitor: YAE-output voltage at a current of 0,5 mA. The current shall be provided externally by a voltage source of 5,0 V over a resistor of 8,4 kohms.

Result: The output voltage shall not exceed 0,8 V.

A.6.4.3.2 Idle state (TP No. 41)

Purpose: To check the output leakage current of the YAE-output in the idle state (log.1).

Test Configuration:



System State: AE in idle state.

Stimulus: 5,25 V applied to the YAE-output.

Monitor: Current at the YAE-output.

Result: The leakage current shall not exceed 25 µA.

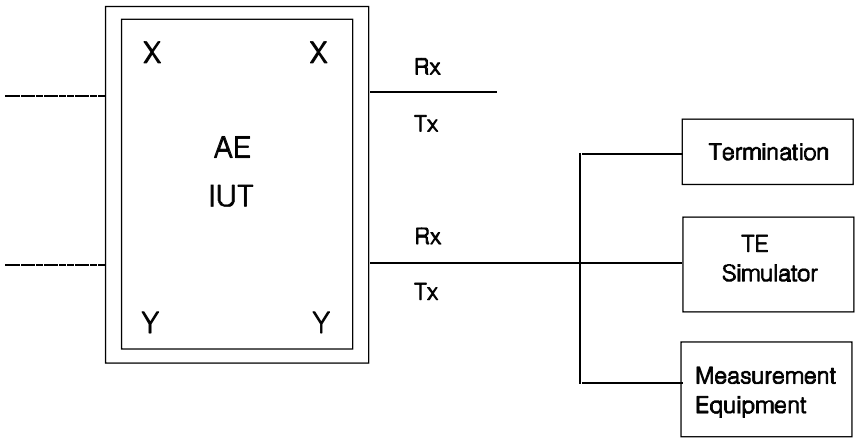
A.6.4.4 Receiving

A.6.4.4.1 Active state (TP No. 42)

Purpose: To check the input voltage of the YAE-input at the maximum current.

To check that the active state is achievable.

Test Configuration:



System State: AE in test state with YAE-loop.

Stimulus:
- Data bit-pattern "00H" at YAE-input with a current of 1 mA.
- The current shall be provided at a voltage of 5,0 V over a resistor of 3 kohms.

Monitor:
- YAE-input voltage.
- Bit pattern at the YAE-output.

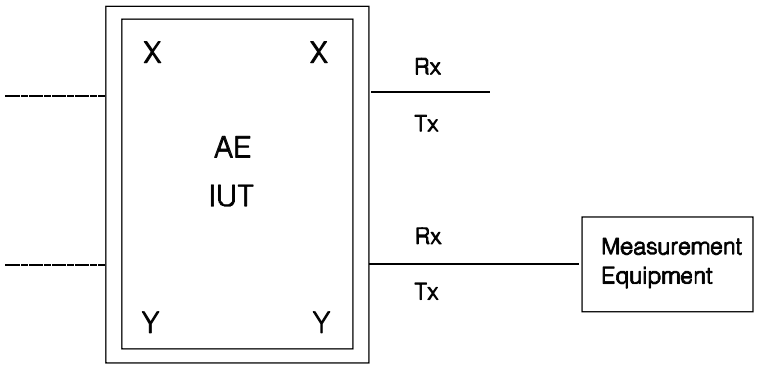
Result:
- The voltage at the YAE-input shall not exceed 2,0 V.
- The bit pattern shall be looped correctly.

A.6.4.4.2 Idle state (TP No. 43)

Purpose: To check the input current in the idle state at the maximum voltage.

To check that the idle state is achievable.

Test Configuration:



System State: AE in test state with YAE-loop.

Stimulus: Data bit-pattern "FFH" with a level of 0,8 V at the YAE-input.

Monitor:
- Current at the YAE-input;
- Bit-pattern at the YAE-output.

Result:
- The current at YAE-input shall not exceed 50 µA;
- The bit pattern shall be looped correctly.

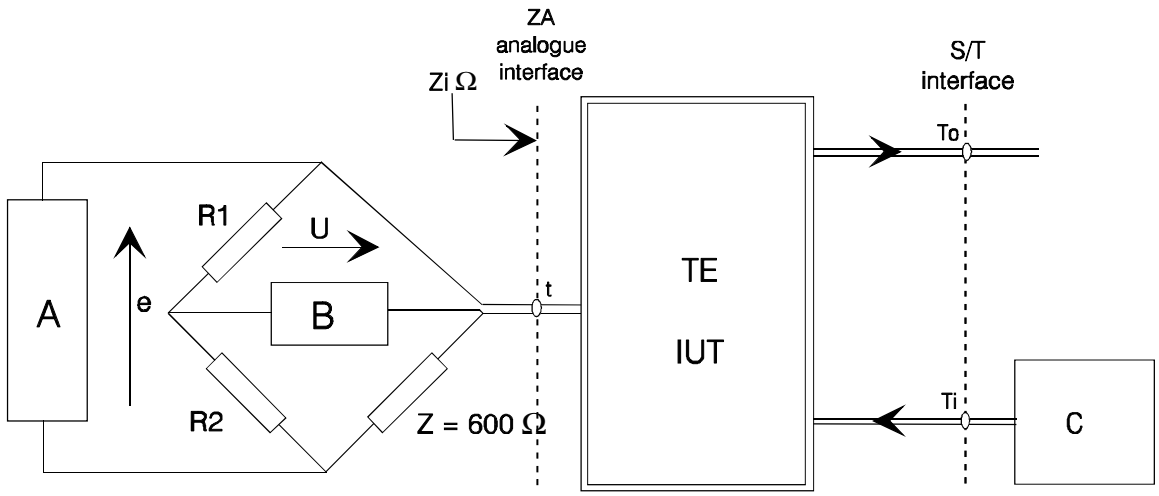
A.6.5 Test principles Z_A

A.6.5.1 2-wire Z_A analogue interface requirements testing

A.6.5.1.1 Return loss (TP No. 44)

Purpose: To check the return loss of the Z_A interface impedance Z_i measured against the nominal impedance Z = 600 ohms.

Test Configuration:



R_1 and R_2: Resistors in the range 100 ohms to 800 ohms matched to each other ≤ 0,2%.

A: Analogue signal generator: low impedance ≤ 10 ohms.

B: Analogue level measuring instrument: high input impedance > 20 kohms.

C: Digital signal generator.

Stimulus: Set C to input a quiet code.

Adjust A, the analogue generator to give an input test level of - 10 dBm0 at 1 020 Hz. At frequencies different from the reference frequency, tests levels are defined as having the same voltage as the test level at the reference frequency.

Monitor: Measurement of U for frequencies between 300 Hz and 3 400 Hz.

Result: $a_r = 20 \log_{10} \left| \frac{e}{2U} \right|$

NOTE: Return loss may be determined by direct impedance measurements and calculation:

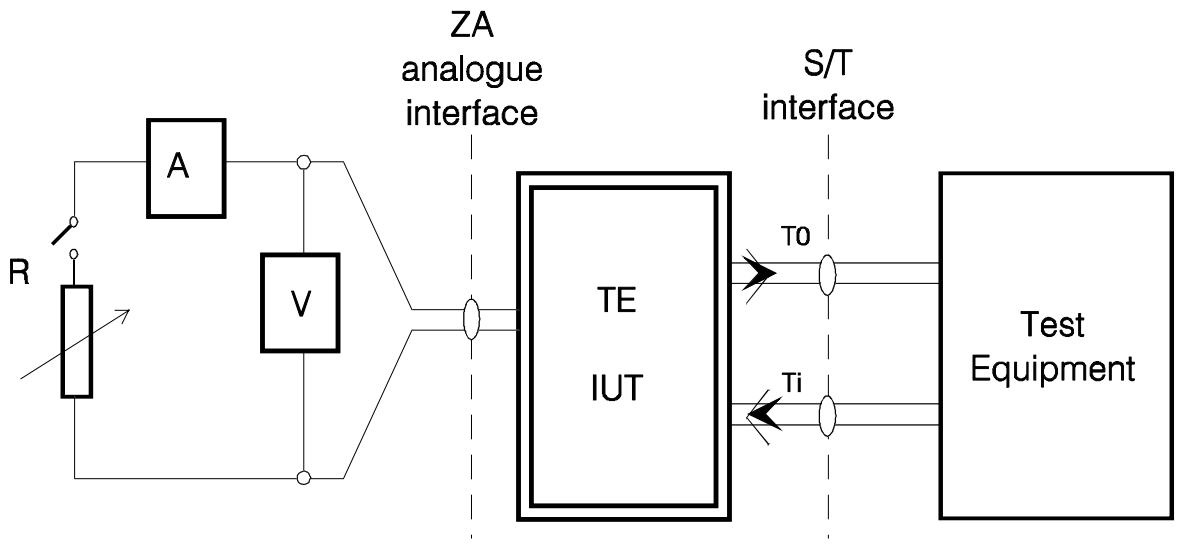
$$a_r = 20 \log_{10} \frac{Zi + 600}{Zi - 600}$$

with Z_i = f (frequency).

A.6.5.1.2 Superimposed DC voltage (TP No. 45)

Purpose: To check the DC voltage applied to the external loop (AE).

Test Configuration:



V: DC voltmeter.

A: DC ammeter.

R: Adjustable resistor (0 to 1 Mohm).

Stimulus: None; however, the IUT shall be connected to, and supplied by, the S interface. The loop switch is open.

Monitor: DC voltage across Z_A.

Result: $3,5\ V \leq V_0 \leq 10\ V$.

A.6.5.1.3 Maximum loop current (TP No. 46)

Purpose: To check the current limitation in case of short circuit across the Z_A interface.

Test Configuration: See subclause A.6.5.1.2.

Stimulus: See subclause A.6.5.1.2, R is set to 0 ohm.

Monitor: The DC current through Z_A.

Result: $IS \leq 10\ mA$.

A.6.5.1.4 Loop threshold current (TP No. 47)

Purpose: To measure the current thresholds related to loop closing and/or loop opening.

Test Configuration: See subclause A.6.5.1.2.

Stimulus:

1) A call SETUP message aiming at the AE is sent by the special Test Equipment and then R is slowly decreased from 1 Mohms to 300 ohms.

2) The call being established, R is slowly increased.

Monitor: 1) The DC current I_C when the test equipment receives the call answer (a CONNECT message).

2) The DC current I_O when the call is released (when the test equipment receives a DISCONNECT message).

Result: 1) 150 µA ≤ I_C ≤ 250 µA.

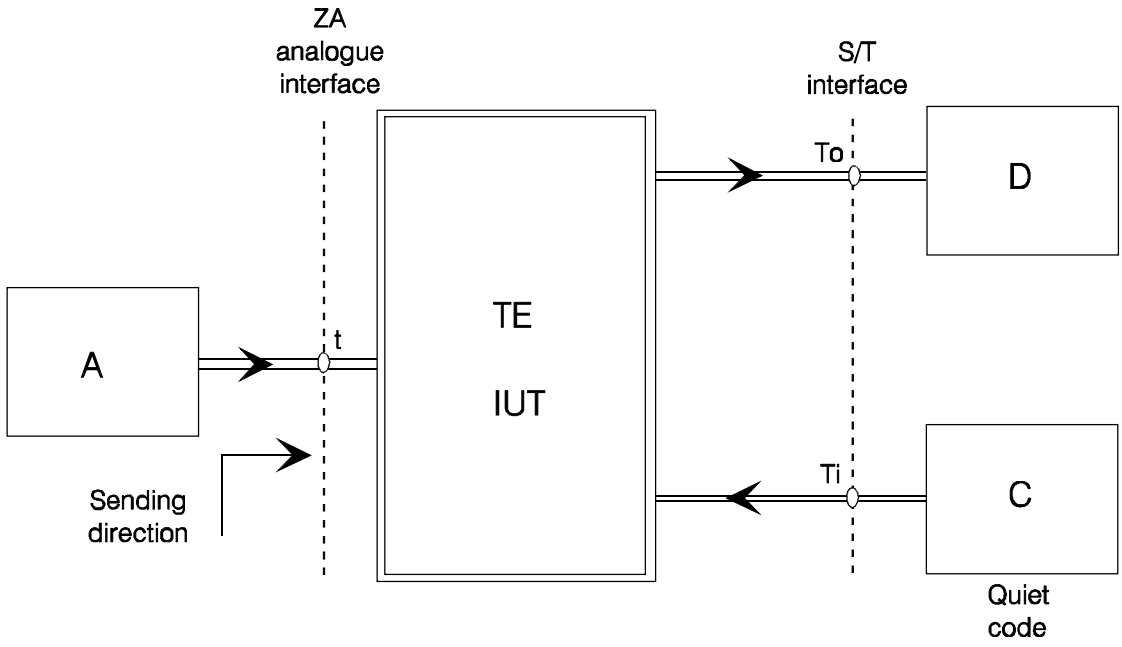
2) 50 µA ≤ I_O ≤ 150 µA.

A.6.5.2 Voice frequency parameters of the connection between the 2-wire Z_A interface and the digital interface of the TE and reverse

A.6.5.2.1 Transmission loss (sending direction) (TP No. 48)

Purpose: To check the transmission loss from the Z_A interface to the S interface (T_0 test point).

Test Configuration:



A: Signal generator (sine wave).

C: Digital signal generator.

D: Digital level measuring instrument.

Stimulus: Set A the signal generator to the Z_A interface to provide the input level of 0 dBm0 at a frequency of 1 020 Hz.

Monitor: Measure the output level at T_0 test point on D the digital level measuring instrument.

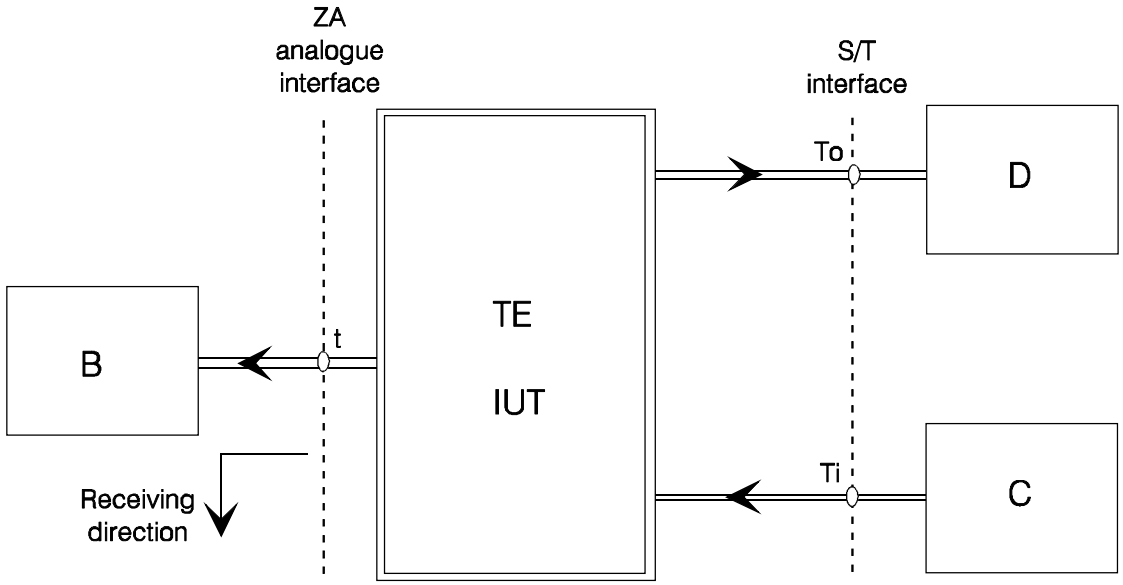
NOTE: It can be advantageous to check the load capacity T_{max} of the encoding side for both positive and negative amplitudes. Procedure for checking T_{max} can be found in ITU-T Recommendation G.712 [12].

Result: Adjust the gain of the encoding side until a Digital Reference Sequence (DRS) appears in the digital stream at T_0 test point.

A.6.5.2.2 Transmission loss (receiving direction) (TP No. 49)

Purpose: To check the transmission loss from the S interface to the analogue interface.

Test Configuration:



B: Analogue level measuring instrument.

C: Digital signal generator.

D: Digital level measuring instrument.

Stimulus: Set C, the signal generator, at T_i test point to provide a DRS.

Monitor: Measure the output level at the Z_A analogue interface on B, analogue level measuring instrument.

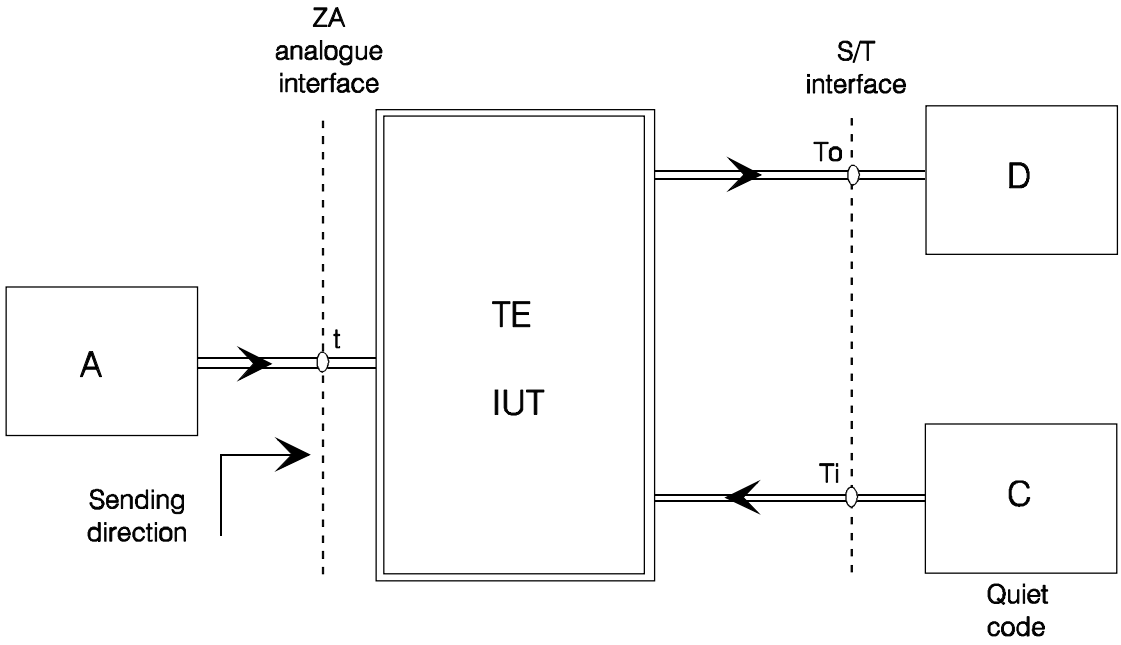
Result: Adjust the gain of the decoding side until the analogue output level is 0 dBm0.

When L_O = - 7 dB_r, the analogue output level is - 7 dBm.

A.6.5.2.3 Variation of gain with input level (sending direction) (TP No. 50)

Purpose: To check the variation of gain with the input level between Z_A interface and the S interface.

Test Configuration:



A: Signal generator (sine wave).

C: Digital signal generator.

D: Digital level measuring instrument (frequency selective).

Stimulus:. Set A, the signal generator, at Z_A analogue interface to provide a sine-wave test signal at a frequency of 1 020 Hz at input levels in the range - 55 dBm0 to + 3 dBm0.

Set C, the digital signal generator, at T_i test point to input a quiet code.

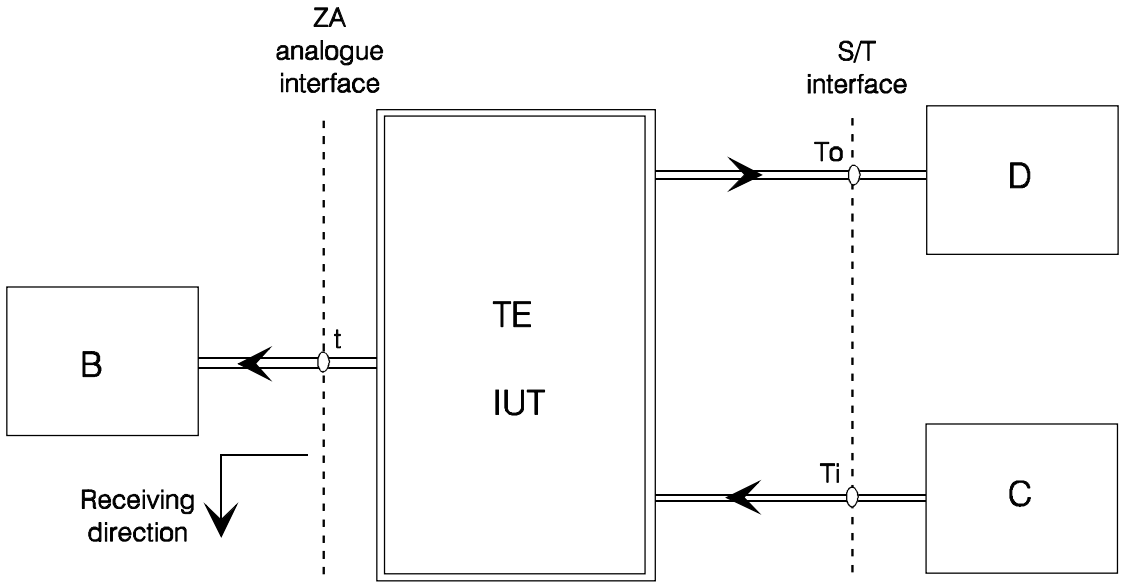
Monitor: Measure the output level at T_0 test point on D, the digital level measuring instrument.

Result: The gain variation of that connection, relative to the gain at an input level of - 10 dBm0, shall lie within the limits given in figure 4 of I-ETS 300 004 [2].

A.6.5.2.4 Variation of gain with input level (receiving direction) (TP No. 51)

Purpose: To check the variation of gain with the input level between the S interface and the Z_A analogue interface.

Test Configuration:



B: Level measuring instrument (frequency selective).

C: Digital signal generator.

D: Digital level measuring instrument.

Stimulus: Set C, the digital signal generator, to provide a digitally simulated sine-wave signal at a frequency of 1 020 Hz at input levels in the range of - 55 dBm0 to + 3 dBm0.

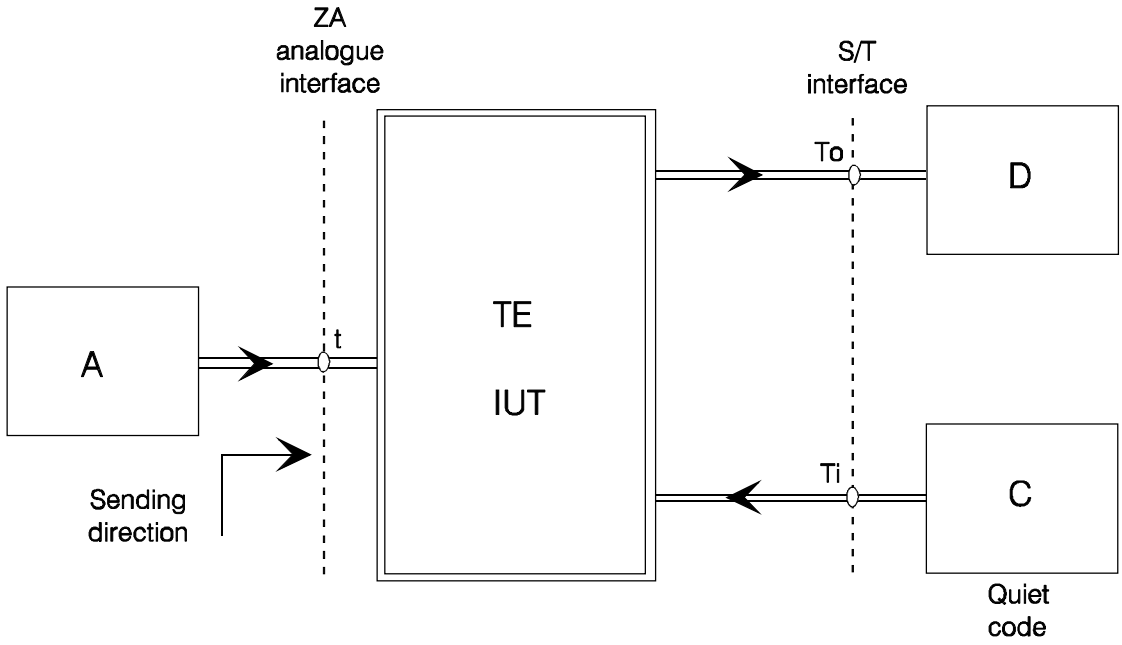
Monitor: Measure the output level at the Z_A analogue interface on B, the level measuring instrument.

Result: The gain variation of that connection, relative to the gain at an input level of - 10 dBm0, shall lie within the limits given in figure 4 of I-ETS 300 004 [2].

A.6.5.2.5 Loss distortion with frequency (sending direction) (TP No. 52)

Purpose: To check the loss distortion with frequency between the Z_A analogue interface and the S interface.

Test Configuration:



A: Signal generator.

C: Digital signal generator.

D: Digital level measuring instrument.

Stimulus: Set A, the signal generator, at the Z_A analogue interface to provide the input level of 0 dBm0 in the frequency range 200 to 3 600 Hz. One of the frequencies used for measurement shall be the reference frequency 1 020 Hz.

Set C, the digital signal generator, to input a quiet code.

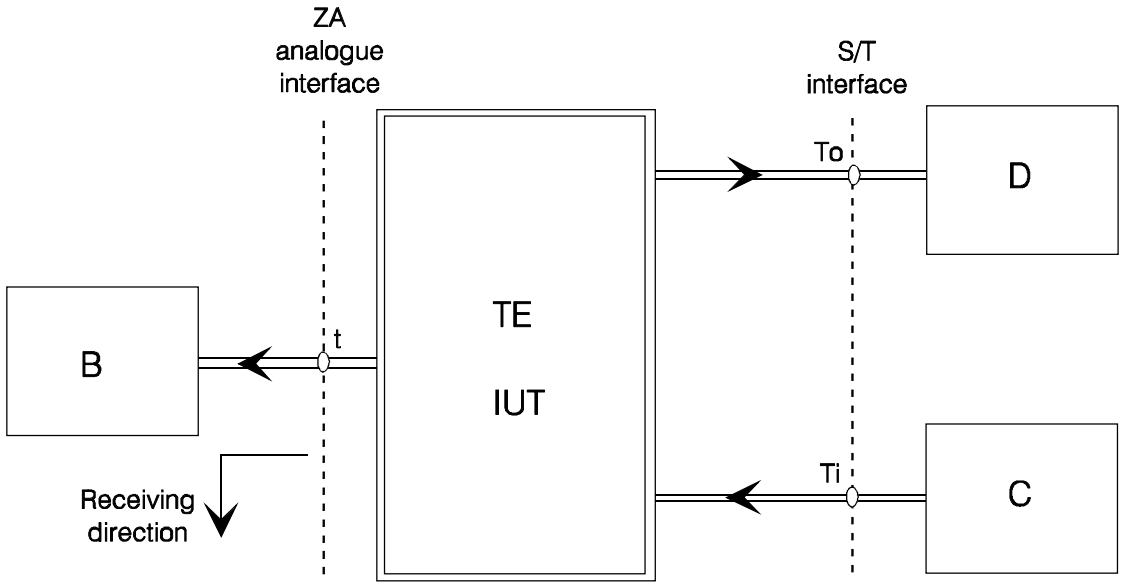
Monitor: Measure the output levels at the S interface (T_0 test point) on D, the digital level measuring instrument.

Result: The loss distortion with frequency (1 020 Hz is the nominal reference frequency) shall be within the limits shown in the mask of figure 5a of I-ETS 300 004 [2], taking into account the more stringent limits.

A.6.5.2.6 Loss distortion with frequency (receiving direction) (TP No. 53)

Purpose: To check the loss distortion with frequency between the S interface and the Z_A analogue interface.

Test Configuration:



B: Analogue level measuring instrument.

C: Digital signal generator.

D: Digital level measuring instrument.

Stimulus: Set C, the digital signal generator, at the S interface to provide an input level of 0 dBm0 in the range frequency 200 Hz to 3 600 Hz. One of the frequencies used for measurement shall be the reference frequency 1 020 Hz.

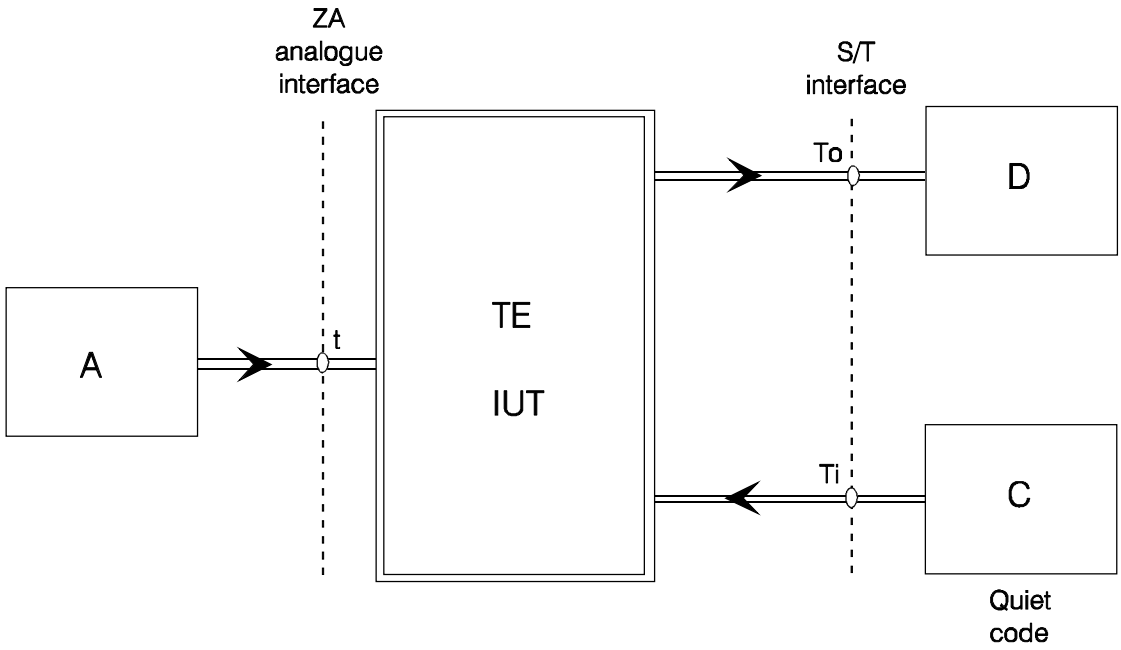
Monitor: Measure the output at the Z_A analogue interface on B, the analogue level measuring instrument.

Result: The loss distortion with frequency (1 020 Hz is the nominal reference frequency) shall be within the limits shown in the mask of figure 5b of I-ETS 300 004 [2], taking into account the more stringent limits.

A.6.5.2.7 Discrimination against out of band signals applied to the Z_A analogue interface (TP No. 54)

Purpose: To limit the frequency spectrum of the signal emitted by the AE in order to avoid an overlapping of the translated elements.

Test Configuration:



A: Signal generator (sine wave 4,6 kHz - 8 kHz).

C: Digital signal generator.

D: Digital level measuring instrument.

Stimulus: Set A, the signal generator, at the Z_A analogue interface to provide an input level of - 25 dBm0 in the frequency range 4,6 kHz - 8 kHz.

Set C, the digital signal generator, at the S interface (T_i test point) to input a quiet code.

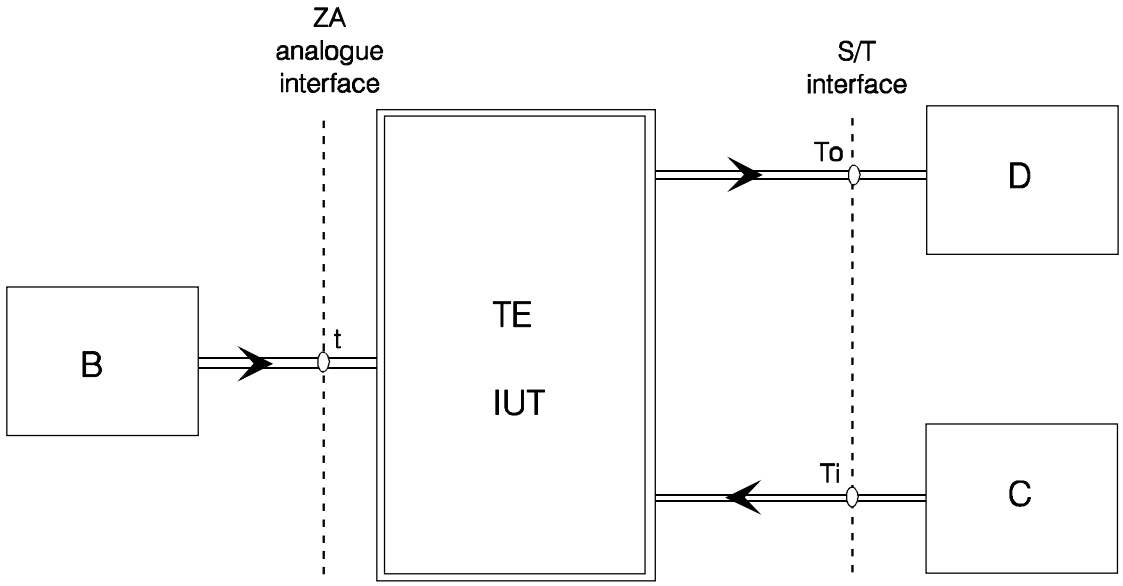
Monitor: Measure the level of any image frequency produced at the S digital interface (T_o point test).

Result: The level of any image frequency shall be at least 25 dB below the level of the test signal.

A.6.5.2.8 Spurious out of band received at the Z_A analogue interface (TP No. 55)

Purpose: To eliminate the "translated" frequency spectrums by filtering the samples, using a low pass filter.

Test Configuration:



B: Level measuring instrument.

C: Digital signal generator.

D: Digital level measuring instrument.

Stimulus: Set C, the digital signal generator, at the S interface (T_i test point) to provide the input level of 0 dBm0 of a digitally simulated sine-wave signal in the frequency range 300 Hz - 3 400 Hz.

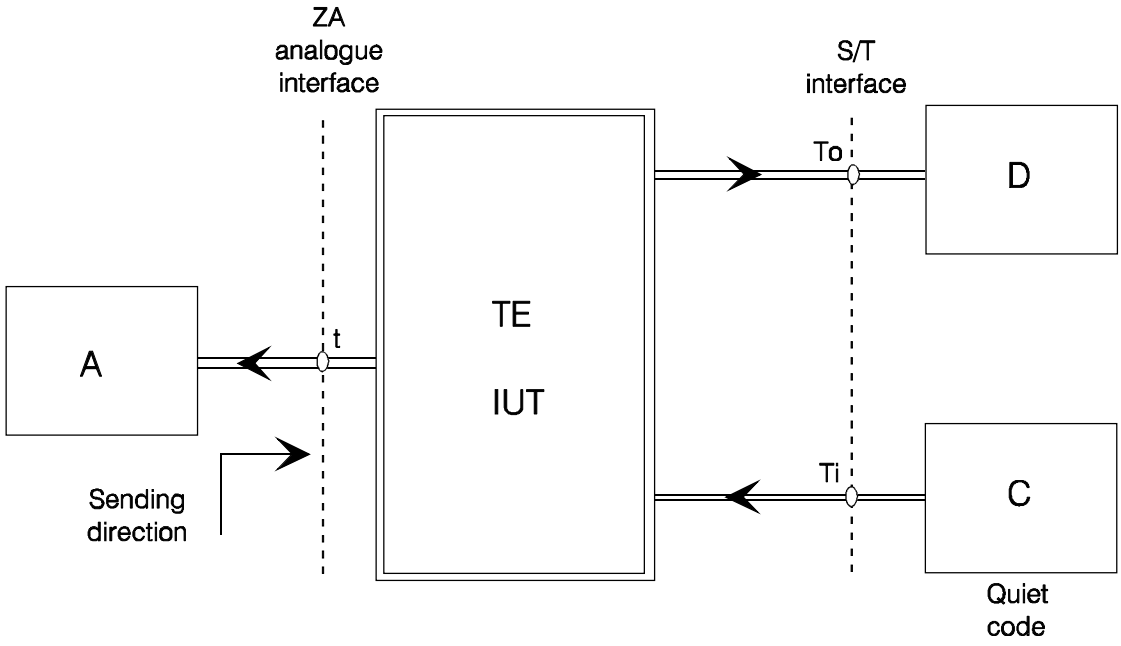
Monitor: Measure the output level of spurious out-of-band image signals on B, the digital level measuring instrument.

Result: The level of spurious out of band image signals measured selectively at the Z_A analogue interface shall be lower than - 25 dBm0.

A.6.5.2.9 Total distortion, including quantizing distortion (sending direction) (TP No. 56)

Purpose: To check the total distortion at the S interface (T_O test point).

Test Configuration:



A: Analogue digital generator (sine wave).

C: Digital signal generator.

D: Digital level measuring instrument.

NOTE: CCITT Recommendation 0.132 gives basic clauses describing the essential features to be provided in test equipment using a sinusoidal test signal for quantizing distortion measurements.

Stimulus: Set A, the signal generator, at the Z_A analogue interface to provide a sine-wave at a frequency of 1 020 Hz of input level in the range - 45 dBm0 + 0 dBm0.

Set C, the digital signal generator, at S interface (T_i test point) to input a quiet code.

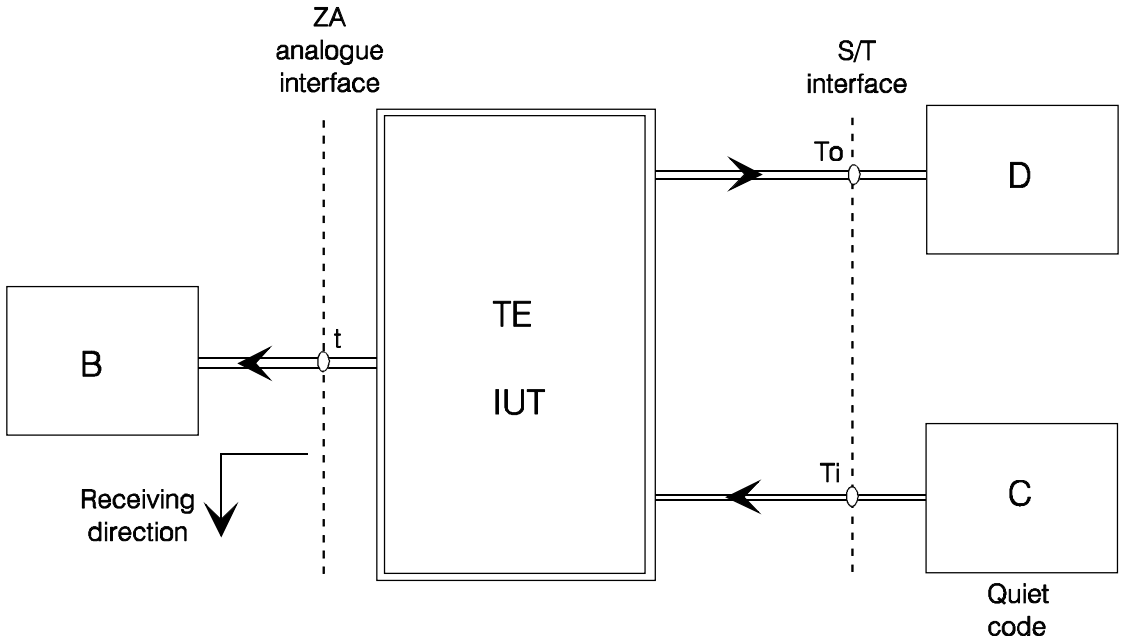
Monitor: Measure the level of the total signal received and the level of the distortion signal weighted by the standard CCITT noise weighting filter for telephony (see table 4 of CCITT Recommendation G.223 [10]) at S interface.

Result: The ratio of signal-to-total distortion power measured with the standard CCITT noise weighting filter for telephony shall lie above the limits given in figure 12 of ITU-T Recommendation G.712 [12].

A.6.5.2.10 Total distortion including quantizing distortion (receiving direction) (TP No. 57)

Purpose: To check the total distortion at the Z_A analogue interface.

Test Configuration:



B: Analogue level measuring instrument.

C: Digital signal generator.

D: Digital level measuring instrument.

NOTE: CCITT Recommendation 0.132 gives basic clauses describing the essential features to be provided in test equipment using a sinusoidal test signal for quantizing distortion measurements.

Stimulus: Set C, the digital signal generator, at the S interface (Ti test point) to provide a digitally simulated sine-wave signal at a nominal frequency of 1 020 Hz of input level in the range - 45 dBm0, + 0 dBm0.

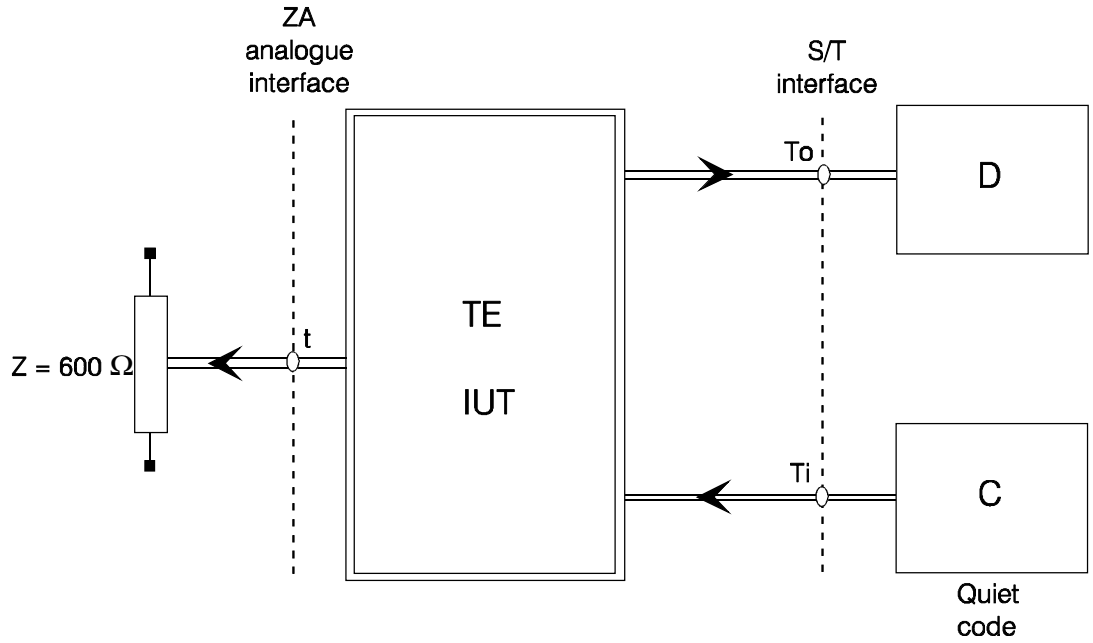
Monitor: Measure the level of the total signal received and the level of the distortion signal weighted by the standard CCITT noise weighting filter for telephony (see table 4 of CCITT Recommendation G.223 [10]) at Z_A analogue interface.

Result: The ratio of signal-to-total distortion power measured with the standard CCITT noise weighting filter for telephony shall lie above the limits given in figure 12 of ITU-T Recommendation G.712 [12].

A.6.5.2.11 Weighted noise at S digital interface (TP No. 58)

Purpose: To check the noise arising principally from the encoding process.

Test Configuration:



C: Digital signal generator.

D: Digital signal analyser.

The digital signal analyser shall be able to measure weighted noise in accordance with CCITT Recommendation 0.41 [14] (weighting coefficients are given in table 1 of CCITT Recommendation 0.41 [14]). Requirements for this equipment are given in paragraph 3.5.2 of CCITT Recommendation 0.133. The noise level indicated by this equipment is related to the psophometrically weighted noise power dissipated in 600 ohms.

Z_A Analogue interface is terminated in the nominal impedance (Z = 600 ohms).

Stimulus: Set C, the digital signal generator to apply a quiet code at S interface (Ti test point).

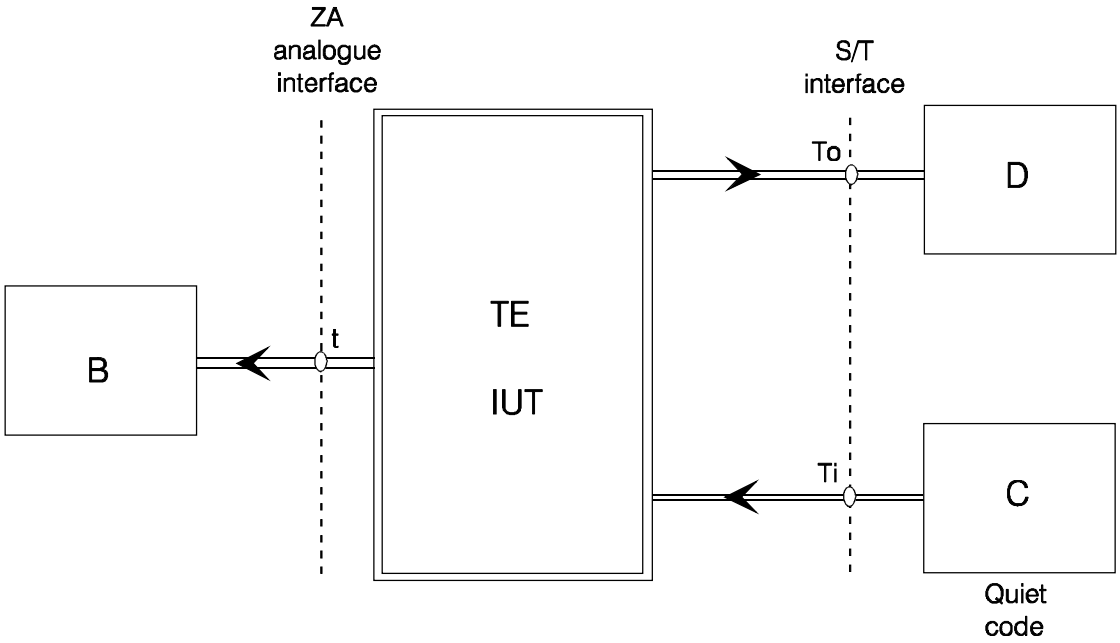
Monitor: Measure the weighted noise level on D, the digital signal analyser, on S/T interface (T0 test point).

Result: The weighted noise shall not exceed - 66 dBm0p.

A.6.5.2.12 Weighted noise at Z_A analogue interface (TP No. 59)

Purpose: To check the noise arising principally from the decoding process.

Test Configuration:



B: Analogue signal analyser.

The analogue signal analyser shall have a linear impedance of 600 ohms as specified in CCITT Recommendation 0.41 [14] when used in terminating mode.

C: Digital signal analyser.

The noise measurement is weighted psophometrically

Stimulus: Set C, the digital signal generator, to apply a quiet code (Ti test point).

Monitor: Measure the weighted noise level on B, the analogue signal generator, on Z_A analogue interface.

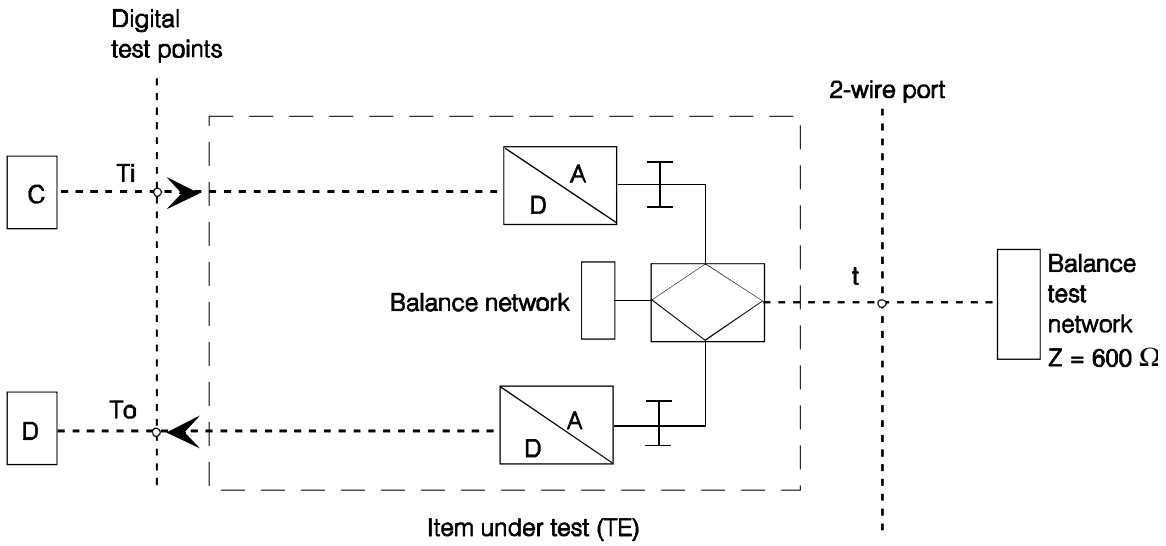
Result: The noise contributed by the decoding part shall not be less than - 75 dBm0p.

A.6.5.3 S/T digital interface testing

A.6.5.3.1 Terminal balance return loss (TP No. 60)

Purpose: To measure the terminal balance return loss as defined in I-ETS 300 004 [2] in order to characterise the total equipment performance (AE connected to the TE) required to comply with the network performance objective of CCITT Recommendation G.122 [9] with respect to echo.

Test Configuration:



C: Digital signal generator.

D: Digital level measuring instrument.

(Z=600 ohms).

Terminate the Z_A analogue interface with the balance test network.

Stimulus: Set C, the digital signal generator, at the S/T interface (Ti test point) to provide the input level of - 10 dBm0 of digitally encoded sine waves in the range 300 Hz to 3 400 Hz

Monitor: Measure the levels P_{out} at the S/T interface on D, the digital level measuring instrument.

Calculate the TBRL using the formula:

TBRL = - P_{out} - Li + Lo - 10 dB.

Where Li and Lo are the nominal relative input and output levels at Z_A analogue interface.

Record the result for each input frequency used.

Result: The terminal balance return loss shall be greater than the limits given in figure 9 of I-ETS 300 004 [2].

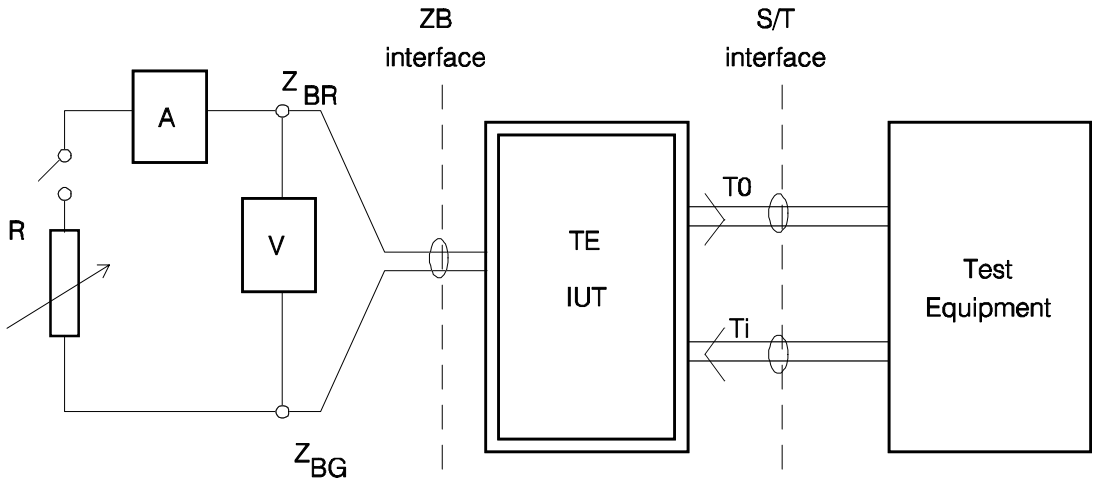
A.6.6 Test principles Z_B (B-interface at TE)

A.6.6.1 Z_{BR} electrical requirements (TE output access)

A.6.6.1.1 Active state without load (TP No. 61)

Purpose: To check the output voltage in active state.

Test Configuration:



V: DC voltmeter.

A: DC ammeter.

R: Adjustable resistor (3 kohms to 6 kohms).

Stimulus: A call SETUP message aiming at the AE is sent by the test equipment, the switch is open.

Monitor: Z_{BR} output level.

Result: $V_{Ho} \leq 5{,}5$ V.

A.6.6.1.2 Active state with load (TP No. 62)

Purpose: To check the output voltage in active state.

Test Configuration: See subclause A.6.6.1.1.

Stimulus: See subclause A.6.6.1.1. Close the switch and adjust R to read 1 mA on the ammeter.

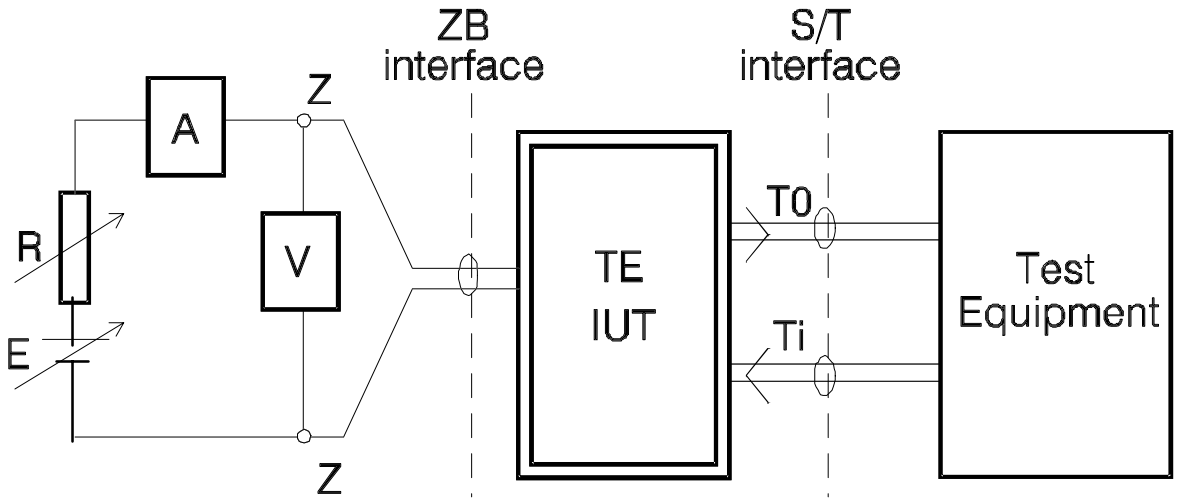
Monitor: Z_{BR} output level.

Result: $V_{He} > 3{,}3$ V.

A.6.6.1.3 Idle state with load (TP No. 63)

Purpose: To check the output voltage in idle state.

Test Configuration:



V: DC voltmeter.

A: DC ammeter.

R: Adjustable resistor (3 kohms to 6 kohms).

E: Variable DC source (0 V to 6 V).

Stimulus: The TE is in any call status which does not concern the AE. E is pre-set to 5 V (measured without TE), then TE access is connected and R adjusted to read 1 mA on the ammeter.

Monitor: Z_{BR} output level.

Result: $V_{Le} \leq 0,9$ V.

A.6.6.2 Z_{BT} electrical requirements/TE input access

A.6.6.2.1 Active state control voltage (TP No. 64)

Purpose: To check the minimum input voltage to control an active state.

Test Configuration: See subclause A.6.6.1.3. Instead of the interface $Z_{BR}$the interface Z_{BT} is used.

Stimulus: The TE is programmed in order to answer a call aiming to AE when a high level is applied to Z_{BT}, and to release the call when Z_{BT} comes back to a low level. The related SETUP message is sent by the test equipment, and E is slowly increased.

Monitor: Z_{BT} input level when the test equipment receives a CONNECT message.

Result: $V_{Hm} \leq 3,2$ V.

A.6.6.2.2 Active state input current (TP No. 65)

Purpose: To check the maximum input current in active state.

Test Configuration: See subclause A.6.6.1.3, R is set to 0. Instead of the interface Z_{BR} the interface Z_{BT} is used.

Stimulus: See subclause A.6.6.1.1, E is varied from V_{Hm} to 5,5 V.

Monitor: The input current and note its maximum value.

Result: $I_H \leq 10$ µA.

A.6.6.2.3 Idle state control voltage (TP No. 66)

Purpose: To check the maximum voltage to control an idle state.

Test Configuration: See subclause A.6.6.1.3, R is set to 0. Instead of the interface $Z_{BR}$the interface Z_{BT} is used.

Stimulus: See subclause A.6.6.1.3, E is slowly decreased from 5 V.

Monitor: Z_{BT} input level when the call is released (when a DISCONNECT message is received by the test equipment).

Result: $V_{OM} \geq 1{,}2$ V.

A.6.6.2.4 Idle state driving current (TP No. 67)

Purpose: To check the maximum input current in idle state.

Test Configuration: See subclause A.6.6.1.3, R is set to 0. Instead of the interface $Z_{BR}$the interface Z_{BT} is used.

Stimulus: See subclause A.6.6.1.3, E is varied from V_{OM} to 0.

Monitor: The input current and note its maximum value.

Result: $I_{LM} \leq 1$ mA.

Annex B (informative): Bibliography

For the purposes of this fourth Part of the I-ETS, the following references are given for information:

1) CCITT Recommendation G.101 (1988): "The transmission plan".

2) CCITT Recommendation O.133 (1988): "Equipment for measuring the performance of PCM encodes and decoders".

3) CCITT Recommendation O.132 (1988): "Quantizing distortion measuring equipment using a sinusoidal test signal".

History

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