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Category II specification for 2 400 bits per second  
duplex modems standardized for use on the PSTN**

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## Foreword

This final draft second edition European Telecommunication Standard (ETS) has been produced by the Terminal Equipment (TE) Technical Committee of the European Telecommunications Standards Institute (ETSI), and is now submitted for the Voting phase of the ETSI standards approval procedure.

This ETS contains the technical characteristics required for end-to-end interworking over the Public Switched Telephone Network (PSTN), for 2 400 bits per second duplex modems standardized for use over the PSTN.

These requirements are based upon, and do not conflict with, CCITT Recommendation V.22bis [2]. Additionally, requirements are included relating to end-to-end inter-operability over PSTN connections. Such requirements are in excess of the CCITT/ITU-T Recommendations.

Except where otherwise stated, a modem which complies with CCITT Recommendation V.22bis [2] should always meet the requirements of this ETS which relate to parameters specified in that CCITT Recommendation.

Clause 4 of this ETS references the requirements which are common to both Category I and Category II modems, which are contained in clause 4 of final draft prETS 300 114 [1]. The definition of Category I and Category II modems can be found in the foreword of final draft ETS 300 114 [1].

Clause 5 of this ETS contains Category II requirements specific to 2 400 bits per second duplex modems. In the case of certain functions common to a number of different types of modem (e.g. Auto-answering sequence) reference is made to clause 5 of final draft prETS 300 114 [1] which contains the relevant requirements.

<b>Proposed transposition dates</b>	
Date of latest announcement of this ETS (doa):	3 months after ETSI publication
Date of latest publication of new National Standard or endorsement of this ETS (dop/e):	6 months after doa
Date of withdrawal of any conflicting National Standard (dow):	6 months after doa

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## 1 Scope

This ETS contains the technical characteristics required for end-to-end interworking over the Public Switched Telephone Network (PSTN) of 2 400 bits per second (bit/s) duplex modems standardized for use over the PSTN, in accordance with CCITT Recommendation V.22bis [2].

The term "modem" in the context of this ETS includes all physical implementation practices for a voice band modem, which is conductively connected to the PSTN.

This ETS specifies four modes of operation each with up to five modes of use (see subclause 5.2).

This ETS also contains descriptions of the tests to be performed in order to confirm compliance with the functional requirements contained herein. A general description of the test conditions and test requirements is given in annex A.

## 2 Normative references

This 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 ETS only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

- [1] Final draft prETS 300 114 (1996): "Public Switched Telephone Network (PSTN); Basic Category I and Category II specification for modems standardized for use on the PSTN".
- [2] CCITT Recommendation V.22bis (1988): "2 400 bits per second duplex modem using the frequency division technique standardized for use on the General Switched Telephone Network and on point-to-point 2-wire leased telephone-type circuits".
- [3] CCITT Recommendation V.22 (1984): "1 200 bits per second duplex modem standardized for use in the General Switched Telephone Network and on point-to-point 2-wire leased telephone-type circuits".
- [4] ETS 300 001: "Attachments to the Public Switched Telephone Network (PSTN); General technical requirements for equipment connected to an analogue subscriber interface in the PSTN".
- [5] CCITT Recommendation V.25 (1984): "Automatic answering equipment and/or parallel automatic calling equipment on the general switched telephone network including procedures for disabling of echo control devices for both manually and automatically established calls".
- [6] CCITT Recommendation S.33 (1984): "Standardization of an international text for the measurement of the margin of start-stop machines using International Alphabet No 5".
- [7] CCITT Recommendation V.52 (1984): "Characteristics of distortion and error-rate measuring apparatus for data transmission".

### 3 Definitions and abbreviations

#### 3.1 Definitions

For the purpose of this ETS the definitions of final draft prETS 300 114 [1] apply, together with the following:

**Initiation and Acknowledgement Signal (S1):** Comprises an unscrambled repetitive double dibit pattern of '00' and '11' at 1 200 bit/s.

**Modem Conformance Tester (MCT):** This is essentially a modem to the same recommendation as the modem under test, but the individual sub-systems within it are both accessible (e.g. provide test points and permit functions to be enabled or disabled when required) and externally controllable (e.g. permit sequences such as the start up procedure to be selectively repeated). The sub-systems within a conformance tester may be constructed as discrete items of equipment, so as to permit their assembly into varying configurations required to suit the tests (e.g. the asynchronous to synchronous converter may be simply applied to a synchronous CCITT Recommendation V.22 [3] conformance tester to achieve an asynchronous CCITT Recommendation V.22 [3] conformance tester).

As an interim measure, until the conformance tester is defined, its definition agreed to be appropriate by ETSI, and such a tester is available, a modem used for reference may be used in its place. In the case that the modem used for reference has not been shown to conform to the ETS in the relevant modes of operation/use, in the relevant modes of use/operation, the testing authority ensures that the modem used for reference complies with the relevant ETS to the extent necessary for the performance of the test.

#### 3.2 Abbreviations

For the purposes of this ETS, the following abbreviations apply:

AMM	Answer Mode Modem
CcT	Circuit
CMM	Call Mode Modem
DCE	Data Circuit-Terminating Equipment
DTE	Data Terminal Equipment
MCT	Modem Conformance Tester
PSTN	Public Switched Telephone Network
TE	Terminal Equipment

## 4 General requirements

### 4.1 References to other ETSS

The modem shall comply with final draft prETS 300 114 [1], clause 4.

NOTE: Final draft prETS 300 114 [1] in turn refers to ETS 300 001 [4] for the majority, if not all, of its requirements.

### 4.2 Information to be provided by the applicant

#### 4.2.1 Information required for testing purposes

The applicant shall declare for which of the modes of operation/use identified in this ETS the modem is supposed to undergo tests.

Compliance is considered to have been accomplished by provision of the relevant information.

NOTE: This could be accomplished by completion of forms such as those provided in annex C (informative).

#### 4.2.2 Instructions for use

Instructions for use shall be made available with the apparatus. The instructions for use shall include:

- a) the apparatus or types of apparatus to which the instructions apply;
- b) any information specifically indicated in this ETS for inclusion in the "Instructions for use";
- c) any national restrictions on the use of the apparatus.

Any additional information that has been included shall be disregarded unless it is the subject of another ETS.

Compliance shall be checked by inspection.

## 5 Functional requirements specific to Category II modems

### 5.1 General requirements

To comply with the requirements of this ETS, the modem shall provide:

- a) duplex mode of operation with continuous carrier, by means of the modulation scheme specified in CCITT Recommendation V.22bis [2];
- b) channel separation by frequency division;
- c) means by which the channels may be selected either manually and/or automatically, where a modem is capable of transmitting in either of the two channels;
- d) provision of a guard tone of  $1\ 800\ \text{Hz} \pm 20\ \text{Hz}$ , which a modem is to transmit while transmitting in the high channel;
- e) signalling rates of 2 400 bit/s and 1 200 bit/s;
- f) the interchange circuits (or equivalent) that are required to change state after an identifiable event or point in time, shall have changed state within a maximum of 3 seconds of that event, unless otherwise specified (see note 4).

NOTE 1: The general requirements described above are a subset of those given in CCITT Recommendation V.22bis [2]. In the requirements which follow any deviations from the strict interpretation of the CCITT Recommendation V.22bis [2] have been identified.

NOTE 2: In the following, references are made to interchange circuits between the modem and the Data Terminal Equipment (DTE), as defined in CCITT Recommendation V.24. However, not all modems provide an interface with such circuits. For these cases the references to CCITT Recommendation V.24 type interchange circuits indicate equivalent operation of a DTE and of a modem where this exists.

NOTE 3: To perform certain tests specified herein, it is desirable that it be possible to disable the transmit scrambler of the modem.

NOTE 4: This requirement is in addition to CCITT Recommendation V.22 [3].

## 5.2 Modes

It shall be possible to configure the modem to operate at 2 400 bit/s and at 1 200 bit/s in at least one of the following modes of use for either the call mode or the answer mode or, optionally, both the call and answer modes:

- a) asynchronous with 8 bits per character;
- b) asynchronous with 9 bits per character;
- c) asynchronous with 10 bits per character;
- d) asynchronous with 11 bits per character;
- e) synchronous.

In the asynchronous (start-stop) modes of use, the modem shall accept a data stream from the DTE at a nominal rate of 2 400 bit/s and 1 200 bit/s. The asynchronous data to be transmitted shall be converted into a synchronous data stream in accordance with subclause 5.9 to be suitable for transmission.

Demodulated data shall be decoded in accordance with subclause 5.5, then descrambled in accordance with subclause 5.10, it shall then be passed for reconversion into an asynchronous data stream in accordance with subclause 5.9.

In the synchronous modes of use, the modem shall accept synchronous data from the DTE. The data shall then be scrambled in accordance with subclause 5.10 and passed to the modulator for encoding in accordance with subclause 5.5.

Demodulated data shall be decoded in accordance with subclause 5.5, then descrambled in accordance with subclause 5.10.

Optionally, the modem may also provide facilities to instigate:

- a) a retrain procedure during data transmission if the modem detects a loss of equalization; and/or
- b) a rate change in a remote modem and also to respond to a rate change request. This facility, when provided, permits modems to alter their rate of operation from 2 400 bit/s to 1 200 bit/s, and vice versa, without disconnection from the PSTN.

It shall be the applicant's responsibility to specify for which of these modes of operation/use testing for conformance to this ETS is required.

## 5.3 Line signals

### 5.3.1 Carrier frequencies

The carrier frequencies shall be 1 200 Hz  $\pm$  0,5 Hz for the low channel and 2 400 Hz  $\pm$  1 Hz for the high channel.

Compliance shall be checked by the method described in annex A, clause A.2.

### **5.3.2 Guard tone**

#### **5.3.2.1 Guard tone - call mode modem**

When the modem is transmitting in the low channel, it shall not transmit the guard tone specified in subclause 5.3.2.2.

Compliance shall be checked by the method described in annex A, subclause A.3.1.

#### **5.3.2.2 Guard tone - Answer Mode Modem (AMM)**

When the modem is transmitting in the high channel, a guard tone at  $1\ 800\ \text{Hz} \pm 20\ \text{Hz}$  shall be transmitted simultaneously. The level of the guard tone shall be  $6\ \text{dB} \pm 1\ \text{dB}$  below the level of the data signal in the high channel.

Optionally, facilities may be provided to disable the transmission of the guard tone of  $1\ 800\ \text{Hz}$ . Since the provision of the guard tone is mandatory, all tests in this ETS shall be carried out with guard tone present.

Compliance shall be checked by the method described in annex A, subclause A.3.2.

The overall level of the guard tone and the data signal of a CCITT Recommendation V.22bis [2] modem shall remain in compliance with the in-band spectral power limits for the network to which they are being connected (see final draft prETS 300 114 [1], clause 4).

NOTE: The purpose of the guard tone is to inhibit the false operation of in-band signalling systems such as in international networks (see CCITT Recommendation Q.144). It is thought by some that a marginal performance advantage may be gained as a result of the slightly higher transmit level possible when the guard tone is disabled and therefore this option is permitted.

### **5.3.3 Transmitted spectrum**

The national network specific spectral power limits are specified in final draft prETS 300 114 [1], clause 4.

NOTE: Final draft prETS 300 114 [1], clause 4 in turn refers to ETS 300 001 [4]. There are no requirements in this ETS relating to the spectrum of signals presented to the PSTN over and above those for PSTN access invoked by subclause 4.1.

### **5.4 Line signalling rates**

The signalling rates transmitted to line shall be  $2\ 400\ \text{bit/s}$  and  $1\ 200\ \text{bit/s} \pm 0,01\ \%$ .

Compliance shall be checked by the method described in annex A, clause A.4.

### **5.5 Encoding and decoding of data**

The encoding and decoding of data shall be in accordance with CCITT Recommendation V.22bis [2], section 2.5.2 and table 1/V.22bis.

Until a Modem Conformance Tester (MCT) is available, compliance shall be checked by inspection of the applicant's declaration of conformance. When a MCT is available, compliance shall be checked by the method described in annex A, clause A.5.

### **5.6 Threshold of the received line signal detector**

The modem shall comply with the requirements of final draft prETS 300 114 [1], subclause 5.4, when receiving a data signal corresponding to scrambled binary 1 at  $2\ 400\ \text{bit/s}$  and at  $1\ 200\ \text{bit/s}$  in the respective receive channel for the modem.

Compliance shall be checked by the method described in annex A, clause A.6.

## **5.7 Channel allocation**

A Call Mode Modem (CMM) shall be capable of transmitting signals in the low channel and responding to signals received in the high channel. An AMM shall be capable of transmitting signals in the high channel and responding to signals received in the low channel.

### **5.7.1 Channel selection**

A modem which is capable of being configured as both a CMM and an AMM shall provide facilities for at least one of the following techniques of channel selection:

- a) manual selection of the channels using facilities provided on the modem;
- b) selection of the channels by the DTE (equivalent: CcT 126 control);
- c) automatic selection of the channels as described in subclause 5.7.2.

NOTE: Other means of channel selection may also be provided but verification of the correct functioning of such facilities is not a requirement of this ETS.

For techniques a) and b), compliance shall be checked by the method described in annex A, subclause A.7.1.

### **5.7.2 Automatic channel selection**

A modem providing this facility shall, in the absence of manual intervention or a contrary command e.g. via a digital interface (e.g. an equivalent to control using CcT 126), be automatically configured as:

- a) a CMM when exchanging data on-line to another compatible modem, and when the modem has entered the on-line state other than in response to an incoming PSTN call;
- b) an AMM when exchanging data on-line to another compatible modem, and when the modem has entered the on-line state in response to an incoming PSTN call.

Compliance shall be checked by the method described in annex A, subclause A.7.2.

## **5.8 Hand-shaking sequences**

In the following sequences the signal described shall be sent contiguously unless the description indicates that a period of silence be present.

### **5.8.1 Auto-calling and auto-answering procedures**

#### **5.8.1.1 Auto-calling - calling tone**

This ETS does not require the provision of the calling tone defined in CCITT Recommendation V.25 [5].

#### **5.8.1.2 Auto-calling - recognition of answering tone**

For modems to be used for automatically originated calls, the modem, or its associated call establishment equipment, shall comply with the requirements for answering tone detection given in final draft prETS 300 114 [1], subclause 5.2.1.

#### **5.8.1.3 Auto-answering**

For modems to be used for automatically answered calls, the modem, or its associated call answering equipment, shall comply with the requirements for answering tone generation given in final draft prETS 300 114 [1], subclause 5.2.2.

## 5.8.2 Start-up procedures

Initially, the modem shall indicate that:

- a) it is not detecting a valid carrier signal (equivalent: CcT 109 OFF);
- b) it is not ready to transmit data (equivalent: CcT 106 OFF).

NOTE: For a modem to indicate that it is ready to transmit data (equivalent: turning ON CcT 106) requires that the DTE has indicated that it wishes to transmit data (equivalent: turning ON CcT 105).

### 5.8.2.1 Call Mode Modem (CMM)

After connection to line and when presented with contiguous unscrambled binary 1 at 1 200 bit/s and guard tone from an AMM, the CMM shall remain silent for a minimum of 591 ms. The CMM shall then transmit Signal S1 (see clause 3) for 100 ms  $\pm$  3 ms, followed by scrambled binary 1 at 1 200 bit/s.

The handshake sequence which follows depends upon whether the AMM is set to operate at 2 400 bit/s or at 1 200 bit/s. This is described in subclauses 5.8.2.1.1 and 5.8.2.1.2.

#### 5.8.2.1.1 AMM set to 2 400 bit/s (CCITT Recommendation V.22bis)

The MCT (the AMM) shall respond by replacing the unscrambled binary 1 at 1 200 bit/s with Signal S1 for 100 ms  $\pm$  3 ms followed by scrambled binary 1 at 1 200 bit/s.

When a change from unscrambled binary 1 at 1 200 bit/s to signal S1 occurs in the data received by the CMM, it shall continue to transmit the scrambled binary 1 at 1 200 bit/s for 600 ms  $\pm$  10 ms timed from the end of receipt of Signal S1, followed by scrambled binary 1s at 2 400 bit/s for 200 ms  $\pm$  10 ms.

At the end of this period, the CMM shall:

- a) give an indication to the DTE that the modem has detected a valid carrier signal (equivalent: turning ON CcT 109);
- b) give an indication to the DTE that the modem is now ready to transmit data (equivalent: turning ON CcT 106); and
- c) enter the data transmission phase.

For a CMM, condition a) should always occur before condition b) although the criteria for test is simply that these indications are now ON.

Compliance shall be checked by the method described in annex A, subclause A.8.1.1.1.

#### 5.8.2.1.2 AMM set to 1 200 bit/s (CCITT Recommendation V.22 or V.22bis)

The MCT (the AMM) shall respond by replacing the unscrambled binary 1 with scrambled binary 1 at 1 200 bit/s.

When a change from unscrambled binary 1 to scrambled binary 1 at 1 200 bit/s occurs in the data received by the CMM, it shall continue to transmit the scrambled binary 1 at 1 200 bit/s for 1 035 ms  $\pm$  50 ms.

At the end of this period, the CMM shall:

- a) give an indication to the DTE that the modem has detected a valid carrier signal (equivalent: turning ON CcT 109);
- b) give an indication to the DTE that the modem is now ready to transmit data (equivalent: turning ON CcT 106); and

- c) enter the data transmission phase.

For a CMM, condition a) should always occur before condition b) although the criteria for test is simply that these indications are now ON.

Compliance shall be checked by the method described in annex A, subclause A.8.1.1.2.

### **5.8.2.2 Answer Mode Modem (AMM)**

On completion of the CCITT Recommendation V.25 [5] auto-answering sequence or, when manually answered, on connection to line, the AMM shall transmit unscrambled binary 1 at 1 200 bit/s and guard tone.

The handshake sequence which follows this depends upon whether the CMM is set to operate at 2 400 bit/s or at 1 200 bit/s, as described in subclauses 5.8.2.2.1 and 5.8.2.2.2.

#### **5.8.2.2.1 CMM set to 2 400 bit/s (CCITT Recommendation V.22bis)**

The MCT (the CMM) shall respond by transmitting Signal S1 for 100 ms  $\pm$  3 ms followed by scrambled binary 1 at 1 200 bit/s.

When a change from Signal S1 to scrambled binary 1 at 1 200 bit/s occurs in the data received by the AMM, it shall transmit Signal S1 for 100 ms  $\pm$  3 ms followed by scrambled binary 1 at 1 200 bit/s such that the total period for Signal S1 and this scrambled binary 1 is 600 ms  $\pm$  10 ms. This shall be followed by a scrambled binary 1 signal at 2 400 bit/s for 200 ms  $\pm$  10 ms.

The MCT shall now also be transmitting scrambled binary 1 at 2 400 bit/s. At the end of this period, the CMM shall:

- a) give an indication to the DTE that the modem has detected a valid carrier signal (equivalent: turning ON CcT 109);
- b) give an indication to the DTE that the modem is now ready to transmit data (equivalent: turning ON CcT 106); and
- c) enter the data transmission phase.

For an AMM, conditions a) and b) should occur almost simultaneously. The order is therefore of no importance.

NOTE: In the event that the rate change option has been established, the AMM may delay transmission of the Signal S1 by more than 32 dibit duration after receipt of Signal S1 from the CMM.

Compliance shall be checked by the method described in annex A, subclause A.8.1.2.1.

#### **5.8.2.2.2 CMM set to 1 200 bit/s**

The MCT (the CMM) shall respond by transmitting scrambled binary 1 at 1 200 bit/s.

When a change from silence to scrambled binary 1 at 1 200 bit/s occurs in the data received by the AMM, it shall continue to transmit unscrambled binary 1 at 1 200 bit/s for a further 270 ms  $\pm$  40 ms, followed by scrambled binary 1 at 1 200 bit/s for 765 ms  $\pm$  10 ms.

At the end of this period, the CMM shall:

- a) give an indication to the DTE that the modem has detected a valid carrier signal (equivalent: turning ON CcT 109);
- b) give an indication to the DTE that the modem is now ready to transmit data (equivalent: turning ON CcT 106); and



- c) enter the data transmission phase.

For an AMM, conditions a) and b) should occur almost simultaneously. The order is therefore of no importance.

NOTE: In the event that the rate change option has been established, the AMM may delay transmission of the Signal S1 by more than 32 dibit duration after receipt of Signal S1 from the CMM.

Compliance shall be checked by the method described in annex A, subclause A.8.1.2.2.

### **5.8.3 Retrain sequence (2 400 bit/s operation)**

The requirements of this clause apply to modems for which the applicant has requested testing of this facility for conformance to this ETS.

#### **5.8.3.1 Initiating signal**

The applicant shall indicate a method by which the modem may be caused to initiate a retrain.

Using the method described by the applicant, while the modem is transmitting at 2 400 bit/s, it is caused to initiate a retrain. The modem shall, give an indication to the DTE that the modem is not ready to transmit data (equivalent: turning OFF CcT 106), and transmit Signal S1 (see clause 3) for 100 ms  $\pm$  3 ms. This shall be followed by scrambled binary 1 at 1 200 bit/s for a minimum period of 687 ms which shall be followed, in turn, by scrambled binary 1 at 2 400 bit/s for 200 ms  $\pm$  10 ms.

At the end of this period, the modem shall re-enter the data transfer phase at 2 400 bit/s and give an indication to the DTE that the modem is now ready to transmit data (equivalent: turning ON CcT 106).

Compliance shall be checked by the method described in annex A, subclause A.8.2.1.

#### **5.8.3.2 Response signal**

When the modem detects loss of scrambled data at 2 400 bit/s followed by Signal S1, on detection of the transition from Signal S1 to scrambled binary 1, the modem shall give an indication to the DTE that the modem is not ready to transmit data (equivalent: turning OFF CcT 106), and transmit Signal S1 for 100 ms  $\pm$  3 ms. This shall be followed by scrambled binary 1 at 1 200 bit/s. The total time for which Signal S1 and the subsequent scrambled binary 1 signal are transmitted shall be 600 ms  $\pm$  10 ms. The modem shall replace the scrambled binary 1 at 1 200 bit/s by scrambled binary 1 at 2 400 bit/s for 200 ms  $\pm$  10 ms.

At the end of this period, the modem shall re-enter the data transfer phase at 2 400 bit/s and give an indication to the DTE that the modem is now ready to transmit data (equivalent: turning ON CcT 106).

NOTE: In the event that the rate change option has been established, the modem may delay transmission of the Signal S1 by more than 32 dibit durations after receipt of Signal S1 from the MCT.

Compliance shall be checked by the method described in annex A, subclause A.8.2.2.

### **5.8.4 Rate change request**

NOTE: The following subclauses relate to an optional feature published in CCITT Recommendation V.22bis [2]. This enables a V.22bis modem to signal a rate change request in the data channel to a remote V.22bis modem.

In order for this facility to conform to the requirements of this ETS, where a modem provides the facility to signal from one V.22bis modem a rate change request either from 2 400 bit/s to 1 200 bit/s or vice versa to a remote V.22bis modem by means of the temporary cessation of transmission in the data channel of scrambled data and by its substitution by the transmission of special symbols, or to act upon such a request, the operation of that facility shall be in accordance with the requirements of subclauses 5.8.4.1 and 5.8.4.2.

Table 1: Coding of rate change dibits

Signal Dibit		Operating Rate
R1	R2	
11	11	2 400 bit/s
01 or 10	01 or 10	1 200 bit/s

**5.8.4.1 2 400 bit/s to 1 200 bit/s**

**5.8.4.1.1 Instigation of a rate change**

The rate change request shall be initiated by the modem indicating to the DTE that it is not ready to transmit data (equivalent: turning OFF CcT 106) and transmitting Signal S1 (see clause 3) for 100 ms  $\pm$  3 ms. This shall then be followed by transmission of scrambled Signal R1 as defined in table 1, i.e. alternating binary 1 and 0 at 1 200 bit/s for a minimum period of 687 ms.

- If Signal R2 from the remote modem indicates its disagreement, i.e. it responds with contiguous binary 1, then scrambled Signal R1 shall be followed by scrambled binary 1 at 2 400 bit/s for 200 ms  $\pm$  10 ms;
- otherwise it shall be followed by scrambled binary 1 at 1 200 bit/s for 200 ms  $\pm$  10 ms.

At the end of this period, the modem shall indicate that it is ready to transmit data (equivalent: turning ON CcT 106) and re-enter the data transfer phase at the agreed data rate.

Compliance shall be checked by the method described in annex A, subclause A.8.3.1.1.

**5.8.4.1.2 Response to a request for rate change**

On detection of Signal S1 during the data transmission phase, the modem shall give an indication to the DTE that the modem is no longer able to transmit data (equivalent: turning OFF CcT 106), clamp the received data to constant binary 1 (equivalent: clamping CcT 104 to constant binary 1), and respond by transmitting Signal S1 for 100 ms  $\pm$  3 ms. This shall be followed by transmission of scrambled Signal R2 as defined in table 1 for a period such that the total period for S1 and R2 is 600 ms  $\pm$  10 ms and where R2 is either:

- a) alternating binary 1 and 0 at 1 200 bit/s; or
- b) binary 1 at 1 200 bits.

NOTE: Transmission of b) above indicates a refusal or an inability to change the signalling rate.

This shall be followed by scrambled binary 1 at the rate indicated in R2 above.

At the end of this period, the modem gives an indication to the DTE that the modem is again ready to transmit data (equivalent: turning ON CcT 106) and remove the clamp from the received data (equivalent: output decoded data on CcT 104) and shall re-enter the data transfer phase at the agreed data rate.

For the purposes of test, the applicant shall indicate, what facilities, if any, could prevent a rate change.

Compliance shall be checked by the method described in annex A, subclause A.8.3.1.2.

**5.8.4.2 1 200 bit/s to 2 400 bit/s**

**5.8.4.2.1 Instigation of a rate change**

The rate change request shall be initiated by the modem indicating to the DTE that it is no longer ready to transmit data (equivalent: turning OFF CcT 106) and transmitting Signal S1 for 100 ms  $\pm$  3 ms. This shall then be followed by transmission of scrambled Signal R1 as defined in table 1, i.e. contiguous binary 1 at 1 200 bit/s for a minimum period of 687 ms.

- If Signal R2 from the remote modem indicates its disagreement, i.e. it responds with alternating binary 1 and 0, then this shall be followed by scrambled binary 1 at 1 200 bit/s for 200 ms  $\pm$  10 ms;
- otherwise it shall be followed by scrambled binary 1 at 2 400 bit/s for 200 ms  $\pm$  10 ms.

At the end of this period, the modem shall indicate to the DTE that it is ready to transmit data (equivalent: turning ON CcT 106) and re-enter the data transfer phase at the agreed data rate.

Compliance shall be checked by the method described in annex A, subclause A.8.3.2.1.

#### **5.8.4.2.2 Response to a request for rate change**

On detection of Signal S1 during the data transmission phase, the modem shall respond by transmitting Signal S1 for 100 ms  $\pm$  3 ms. This shall be followed by transmission of scrambled Signal R2 as defined in table 1 for a period such that the total period for S1 and R2 is 600 ms  $\pm$  10 ms and where R2 is either:

- a) binary 1 at 1 200 bits;
- b) alternating binary 1 and 0 at 1 200 bit/s.

NOTE: Transmission of b) above indicates a refusal or an inability to change the signalling rate.

This shall be followed by scrambled binary 1 at the rate indicated in R2 above.

At the end of this period, the modem shall re-enter the data transfer phase at the agreed data rate.

For the purposes of test, the applicant shall indicate, what facilities, if any, could prevent a rate change.

Compliance shall be checked by the method described in annex A, subclause A.8.3.2.2.

#### **5.9 Transmission of start-stop characters**

If the modem is capable of transmitting start-stop characters without error correction, speed conversion or flow control, it shall provide at least one of the following modes of use at 2 400 bit/s and at 1 200 bit/s:

- a) asynchronous with 8 bits per character;
- b) asynchronous with 9 bits per character;
- c) asynchronous with 10 bits per character;
- d) asynchronous with 11 bits per character.

The asynchronous-to-synchronous conversion shall be in accordance with final draft prETS 300 114 [1], subclause 5.5.

NOTE: The tests for compliance with the above requirements are described in final draft prETS 300 114 [1], annex B, clause B.5.

#### **5.10 Scrambler and de-scrambler**

A self-synchronizing scrambler and a self-synchronizing de-scrambler as specified in CCITT Recommendation V.22bis [2], subclauses 5.1 and 5.2, shall be provided in the transmitting part and the receiving part, respectively, of the modem.

This implies that:

- a) the scrambler includes circuitry to detect a sequence of 64 consecutive binary 1s at its output and, if detected, invert the next bit input to the scrambler;

- b) the de-scrambler may or may not include a circuitry to detect sequences of 64 consecutive binary 1s at its input and, when detected, to invert the next bit output from the de-scrambler. Where such a circuitry is included, it shall not begin operating prior to the initial hand-shaking sequence being completed. Furthermore, where this circuitry is included, the detection of the test loop 2 initiating signal of unscrambled binary 1s (see subclause 5.11.1, b)) shall be performed before the inversion described above can take place.

Compliance shall be checked by the method described in annex A, clause A.9.

### 5.11 Test loop 2

The modem shall provide facilities for the implementation and remote control of test loop 2. The description of test loop 2 is given in final draft prETS 300 114 [1], subclause 5.3.2.

NOTE: The inter-DCE signalling for control of test loop 2 as specified in CCITT Recommendation V.54 has not been adopted for modems according to CCITT Recommendation V.22bis [2]. Instead a different procedure has been defined in that Recommendation.

In subclauses 5.11.1 and 5.11.2 the sequences for the remote control of test loop 2 are defined irrespective of the line signalling rate (1 200 bit/s or 2 400 bit/s).

#### 5.11.1 Instigation of a remote loop 2

- a) controlling modem

The modem which is instructed, either manually or by the DTE (equivalent: turning ON CcT 140), to instigate a remote loop 2, shall transmit an initiation signal of unscrambled binary 1.

When the modem is presented with scrambled reversals it shall detect them and, after a period of not less than 231 ms and not more than 308 ms, transmit scrambled binary 1.

When presented with scrambled binary 1, the modem shall indicate to the user or the DTE (equivalent: turning ON CcT 142) that the modem is now in a test mode.

Compliance shall be checked by the method described in annex A, subclause A.10.1.1.

- b) controlled modem

When the modem is presented with the initiation signal of unscrambled binary 1, transmitted by the remote modem, for not less than 154 ms and not more than 231 ms, it shall detect it and transmit scrambled reversals.

When presented with scrambled binary 1 signal the modem shall activate loop 2 and indicate to the user or the DTE (equivalent: turning ON CcT 142) that the modem is in a test mode.

Compliance shall be checked by the method described in annex A, subclause A.10.1.2.

#### 5.11.2 Termination of a remote loop 2

- a) controlling modem

When the modem, from which a remote loop 2 has been instigated, is instructed to terminate that loop (equivalent: turning OFF CcT 140, where the remote loop 2 instigation was controlled by the DTE), it shall suppress the line signal for  $77 \text{ ms} \pm 10 \text{ ms}$  after which data transmission shall be restored. The modem shall indicate to the user or to the DTE (equivalent: turning OFF CcT 142) that the modem is no longer in a test mode.

Compliance shall be checked by the method described in annex A, subclause A.10.2.1.

## b) controlled modem

When the modem, inside which a loop 2 was remotely instigated, is presented with a loss of line signal for 40 ms to 65 ms followed by the reappearance of the signal, it shall de-activate test loop 2 and restore normal operation within 145 ms to 270 ms, after which data transmission shall be restored. The modem shall give an indication to the user or to the DTE (equivalent: turning OFF CcT 142) that the modem is no longer in a test mode.

Compliance shall be checked by the method described in annex A, subclause A.10.2.2.

**5.12 Receiver performance**

When tested as described in final draft prETS 300 114 [1], subclause 5.6, the modem operated to the modem used for reference shall accumulate during each of the performance testing periods as error free seconds a) not less than 75 % for 1 200 bit/s operation and b) not less than 70 % for 2 400 bit/s operation.

NOTE 1: Since CCITT Recommendation V.22bis [2] does not define performance criteria, the requirements of this subclause are additional to those of the CCITT Recommendation.

NOTE 2: The figures of 70 % and 75 % are provisional, and are based on reasoned estimations.

## **Annex A (normative): Testing methods**

### **A.1 General testing conditions**

#### **A.1.1 General notes**

The general conditions for test apply, as described in final draft prETS 300 114 [1], annex B.

For the testing of the modem it is generally necessary to simulate the PSTN in the test set-up in order for the modem under test and the MCT to remain in an on-line state. Unless otherwise indicated, Test Line 3 (see final draft prETS 300 114 [1], annex C, clause C.5) should be used to connect the modem under test and the MCT.

The following information is given to aid the testing authority in determining the signals present on the line.

Unscrambled binary 1 at 1 200 bit/s is characterized by tones at 1 050 Hz and 1 650 Hz for the low channel; and 2 250 Hz and 2 850 Hz for the high channel.

Whatever the binary input, scrambled binary signals are characterized by a general distribution of signal power throughout the frequency band allocated to the particular mode (i.e. 650 Hz to 1 750 Hz for Call Mode and 1 850 Hz to 2 950 Hz for Answer Mode). It shall, therefore, not be possible without de-modulation to determine the binary content of the transmitted data signal.

Where it is required to confirm that the data transfer phase has been established a single message is transmitted in each direction. This message shall be:

- for asynchronous modems, " THE QUICK BROWN FOX...." text in the international alphabet N° 5 (IA5), according to CCITT Recommendation S.33 [6];

NOTE 1: Alternatively, the French version of the test text (VOYEZ LE BRICK GEANT...) as specified in CCITT Recommendation S.33 [6] may be used.

NOTE 2: Either the 64-character set version or the 95-character set version of the test texts as specified in CCITT Recommendation S.33 [6] may be used.

- for synchronous modems, approximately 1 022 bits of pseudo-random data.

There is no need to specifically check the text or data for errors since all Category II modems are subjected to a performance check.

#### **A.1.2 Proposed order for performing the tests**

Except where otherwise stated, tests may be carried out in any order. The order of tests shall be at the discretion of the testing authority. The following proposal is, therefore, only as a guide-line:

NOTE: The following presentation is used for the designation of entries summarized hereafter:  
subject/clause where the requirement is specified/clause where the test is specified (or other means of conformance check).

- 1) Carrier frequencies / subclause 5.3.1 / clause A.2;
- 2) Channel allocation / subclauses 5.7.1 and 5.7.2 / subclauses A.7.1 and A.7.2;
- 3) Encoding and decoding of data / subclause 5.5 / Applicant's declaration of conformance;
- 4) Auto-calling and auto-answering procedures / subclause 5.8.1 and final draft prETS 300 114 [1], subclauses 5.2.1 and 5.2.2 / (final draft prETS 300 114 [1], subclause B.2);
- 5) Start-up procedures / subclauses 5.8.2.1 and 5.8.2.2 / subclauses A.8.1.1 and A.8.1.2;
- 6) Transmitted spectrum / subclause 5.3.3 / (final draft prETS 300 114 [1], clause 4; ETS 300 001 [4]);

- 7) Line signalling rates / subclause 5.4 / clause A.4;
- 8) Guard tone, CMM / subclause 5.3.2.1 / subclause A.3.1;
- 9) Guard tone, AMM / subclause 5.3.2.2 / subclause A.3.2;
- 10) Threshold of received line signal detector / (subclause 5.6; final draft prETS 300 114 [1], subclause 5.4) / clause A.6 and final draft prETS 300 114 [1], clause B.4;
- 11) Scrambler and de-scrambler / subclause 5.10 / clause A.9;
- 12) Asynchronous to synchronous converter / subclause 5.9 and final draft prETS 300 114 [1], subclause 5.5 / (final draft prETS 300 114 [1], clause B.5);
- 13) Instigation to a remote test loop 2 / subclause 5.11.1 a) / subclause A.10.1.1;
- 14) Termination of a remote test loop 2 / subclause 5.11.2 a) / subclause A.10.2.1;
- 15) Retrain sequence initiation / subclause 5.8.3.1 / subclause A.8.2.1;
- 16) Retrain sequence response / subclause 5.8.3.2 / subclause A.8.2.2;
- 17) Rate Change Request 2 400 to 1 200 initiation / subclause 5.8.4.1.1 / subclause A.8.3.1.1;
- 18) Rate Change Request 2 400 to 1 200 response / subclause 5.8.4.1.2 / subclause A.8.3.1.2;
- 19) Rate Change Request 1 200 to 2 400 initiation / subclause 5.8.4.2.1 / subclause A.8.3.2.1;
- 20) Rate Change Request 1 200 to 2 400 response / subclause 5.8.4.2.2 / subclause A.8.3.2.2;
- 21) Response to an activate test loop 2 command / subclause 5.11.1 b) / subclause A.10.1.2;
- 22) Response to a terminate test loop 2 command / subclause 5.11.2 b) / subclause A.10.2.2;
- 23) General requirements / subclause 5.1 / Results of the relevant tests specified above;
- 24) Modes / subclause 5.2 / Results of the relevant tests specified above;
- 25) Receiver performance / subclause 5.12 / (final draft prETS 300 114 [1], subclauses B.6.4.2 and B.6.4.3).

### **A.1.3 Limitation of number of tests**

#### **A.1.3.1 Introduction**

This ETS describes four modes of operation, each of which may have up to five modes of use.

The requirements, as stated in this ETS, are valid for all 20 possible modes. However, it is clear that the performance of all the tests in all the possible modes is both unnecessary and undesirable.

The following subclauses of A.1.3 define the combinations of tests which shall be carried out in order to test conformity with this ETS.

The words "modes of operation" and "modes of use" in the following subclauses refer only to those modes for which the applicant has requested Category II conformance testing.

#### **A.1.3.2 General rules**

For each mode of operation, only one mode of use shall be tested. Where this is available this shall be the synchronous mode. Where tests are performed in the asynchronous mode one character length shall be chosen using the following rule: the first choice is 10 bits/character, then 11 bits/character, then 9 bits/character and finally 8 bits/character.

#### **A.1.3.3 Specific rules**

After selection using the general rules given in subclause A.1.3.2, the following specific rules shall be applied:

The following tests shall be performed, where relevant, for all modes of operation:

- carrier frequencies (requirement subclause 5.3.1 - test clause A.2);
- guard tone (requirement subclause 5.3.2 - test clause A.3);
- start-up procedures (requirement subclause 5.8.2 - test subclause A.8.1);
- rate change request (requirement subclause 5.8.4 - test subclause A.8.3);
- performance (requirement subclause 5.12).

The following tests shall be performed in both the call and answer modes of operation, where relevant, at the highest available data signalling rate for the mode being tested:

- auto-call and auto-answer (requirement subclause 5.8.1);
- channel allocation (requirement subclause 5.7 - test clause A.7);
- threshold of received line signal detector (subclause 5.6 - test clause A.6).

The following tests shall be performed for one 2 400 bit/s mode of operation and, where relevant, for one 1 200 bit/s mode of operation. Where the tests are to be performed at differing data signalling rates, where possible one test shall be performed in the call mode of operation and the other in the answer mode of operation:

- data signalling rates (requirement subclause 5.4 - test clause A.4);
- encoding and decoding (requirement subclause 5.5 - test clause A.5).



The following tests shall be performed for one 2 400 bit/s mode of operation:

- transmission of start/stop characters (requirement subclause 5.9);
- retrain sequence (requirement subclause 5.8.3 - test subclause A.8.2);
- scrambler and de-scrambler (requirement subclause 5.10 - test clause A.9);
- test loop 2 (requirement subclause 5.11 - test clause A.10).

## **A.2 Test for subclause 5.3.1 (Carrier frequencies)**

NOTE 1: The following test may be performed in conjunction with the tests described in clause A.7.

NOTE 2: Tests A.2.2, A.2.3 and A.2.4 are specified in order to provide an alternative route for assessment of conformance to Category II while awaiting the assessment of an MCT for modems to CCITT Recommendation V.22 [3]. Once the MCT is available, tests should only be performed to subclause A.2.1.

### **A.2.1 Test for subclause 5.3.1 using the MCT**

The MCT and the modem under test shall be caused to enter the data phase. The MCT shall derive the carrier frequency from the received data signal. This could be done by de-modulating the incoming signal with an accurately known carrier frequency. The frequency and phase of the carrier is then adapted until proper de-modulation occurs. The measurement accuracy shall be  $0 \pm 0,1$  Hz.

### **A.2.2 Test for modems where the scrambler can be inhibited**

For a modem that is capable of operating as both a CMM and an AMM, these tests are performed in conjunction with the tests for subclause 5.7.1. The modem is caused to assume the appropriate mode of operation by one of the methods described in subclause A.7.1.

NOTE: Several attempts may be required before the desired result can be obtained because there is a 50 % chance that the modem may detect the input "10" signal as "01" which is not the same.

For a modem that is capable of operating as a CMM, the modem is caused to transmit a signal of contiguous dibits of the form '10' (not '01') with the scrambler de-activate. The frequency transmitted by the modem to line shall be  $1\ 200\ \text{Hz} \pm 0,5$  Hz.

For a modem that is capable of operating as an AMM, the modem is caused to transmit a signal of contiguous dibits of the form '10' (not '01') with the scrambler de-activate. The frequency transmitted by the modem to line shall be  $2\ 400\ \text{Hz} \pm 1,0$  Hz.

### **A.2.3 Tests for modems where test points are accessible**

If the scrambler cannot be de-activated in the modem under test, then the applicant shall designate points of measurement where a signal is accessible from which the carrier frequencies can be deduced.

#### **A.2.4 Test for modems where neither subclauses A.2.2 nor A.2.3 applies**

In cases where neither the scrambler can be inhibited nor test points with the property described in subclause A.2.2 above are available, the applicant shall submit a declaration of conformance to the testing authority stating that the requirements of subclause 5.3.1 are met.

### **A.3 Test for subclause 5.3.2 (Guard tone)**

NOTE: The following test may be performed in conjunction with the test of clause A.4.

#### **A.3.1 Test for subclause 5.3.2.1 (Guard tone, CMM)**

The modem under test shall be configured as a CMM, the MCT shall be configured as an AMM.

The PSTN simulator shall be conditioned to provide both modems with appropriate dial tone and d.c. conditions. An outgoing call attempt is made from the modem under test to the MCT. With both modems in the on-line state and transferring data, the spectrum of the signal transmitted by the modem under test at its line terminals shall be checked to verify that no discrete spectral component measured in a 10 Hz bandwidth and emitted in the band 1 780 Hz to 1 820 Hz is greater than - 32 dBm.

#### **A.3.2 Test for subclause 5.3.2.2 (Guard tone, AMM)**

The modem under test shall be configured as an AMM, the MCT shall be configured as a CMM. The PSTN simulator shall be conditioned to provide modems with appropriate ringing signals and d.c. conditions. Using the MCT or any other appropriate means, a call shall be established between the two modems. Once the modem under test is on line, and following, if present, the answering tone according to CCITT Recommendation V.25 [5], the spectrum of the signal transmitted to line shall be checked to verify that the guard tone as specified in subclause 5.3.2 is emitted in the band 1 780 Hz to 1 820 Hz, and that the level of the guard tone measured in a 10 Hz bandwidth is  $6 \text{ dB} \pm 1 \text{ dB}$  lower than the data signals transmitted in the band 1 850 Hz to 2 950 Hz. The level of the data signals shall be measured in a 1 kHz bandwidth, the centre frequency of which is 2 400 Hz.

### **A.4 Test for subclause 5.4 (Line signalling rates)**

NOTE: The following test may be performed subsequently to the tests described in clause A.8. The modem is required to have completed the sequences described in subclause 5.8 before it reaches the state in which the requirements according to subclause 5.4 can be tested.

#### **CMM**

The MCT shall be configured to operate as an AMM in the synchronous mode of use.

After completion of the tests described in clause A.8 for a modem under test which is a CMM, the modem under test is caused to enter the data transfer phase and transmit data.

The frequency of the signal appearing on the receiver element timing circuit (equivalent: CcT 115) of the MCT shall be measured. The average value of the frequency, measured over five periods of ten seconds, shall be within the limits of the line signalling rate specified in subclause 5.4.

## AMM

The MCT shall be configured to operate as a CMM in the synchronous mode of use.

After completion of the tests described in clause A.8 for a modem under test which is an AMM, the modem under test is caused to enter the data transfer phase and transmit data.

The frequency of the signal appearing on the receiver element timing circuit (equivalent: CcT 115) of the MCT shall be measured. The average value of the frequency, measured over five periods of ten seconds, shall be within the limits of the line signalling rate specified in subclause 5.4.

### A.5 Test for subclause 5.5 (Encoding and decoding of data)

The MCT and the modem under test shall be caused to enter the data phase. A test pattern consisting of continuous binary 1 shall be transmitted from the MCT to the modem under test for  $125\text{ s} \pm 5\text{ s}$ . No errors shall occur during transmission of these bits. If errors occur, the test shall be repeated once. If any errors occur during this second attempt, the modem shall be assumed to have failed this test.

### A.6 Test for subclause 5.6 (Threshold of received line signal detector)

The test shall be performed as described in final draft prETS 300 114 [1], annex B, clause B.4. The modem under test shall consecutively be configured to operate as an AMM and as a CMM (if applicable).

The signal to be applied to the modem under test shall be a data signal corresponding to scrambled binary 1 at 2 400 bit/s or 1 200 bit/s in the respective receive channel for that modem.

### A.7 Test for subclause 5.7 (Channel allocation)

NOTE: A suitable mechanism to assist discrimination between the signals transmitted by the MCT and the modem under test would be to arrange for the signals transmitted by the MCT to be at a lower level (e.g. 10 dB - 15 dB lower) than those of the modem under test.

For the purpose of the tests in this clause a signal is present when total signal power within the specified band exceeds a level of - 30 dBm.

For each of the tests in this clause, the modem under test shall be connected to the MCT via Test Line 3. Calls are established between the modem under test and the MCT and, in each case, the MCT shall be caused to assume the complementary mode to the modem under test.

The following tests specified in subclauses A.7.1 and A.7.2 shall be performed for each of the modes of operation which the applicant has identified.

#### A.7.1 Test for subclause 5.7.1 (General)

- For modems providing the technique of channel selection (a), using the means of manual selection, the modem under test is caused to transmit a signal at 2 400 bit/s as a CMM. The spectrum of the signals transmitted by the modem shall be checked to verify that it contains signal power within the permitted range 650 Hz to 1 750 Hz, but not in the range 1 850 Hz to 2 950 Hz. The modem is now caused to transmit a signal as an AMM. The spectrum of the signals transmitted by the modem under test shall be checked to verify that it contains signal power within the permitted range 1 850 Hz to 2 950 Hz, but not in the range 650 Hz to 1 750 Hz.

- For modems providing the technique of channel selection (b), using the information supplied by the applicant, the modem is caused to transmit a signal at 2 400 bit/s as a CMM, the spectrum of the signals transmitted by the modem under test shall be checked to verify that it contains signal power within the permitted range 650 Hz to 1 750 Hz, but not in the range 1 850 Hz to 2 950 Hz. The modem is now caused to transmit a signal as an AMM, the spectrum of the signals transmitted by the modem under test shall be checked to verify that it contains signal power within the permitted range 1 850 Hz to 2 950 Hz, but not in the range 650 Hz to 1 750 Hz.
- For modems providing the technique of channel selection (c), compliance shall be checked by the method described in the tests for subclause 5.7.2 (see subclause A.7.2).

During any one of the above tests, the checks of the frequencies required by the test of clause A.2, may be performed.

## **A.7.2 Test for subclause 5.7.2 (Automatic channel selection)**

### **CMM**

The MCT shall be configured to operate as an AMM in the synchronous mode of use. An outgoing call is made to the MCT. With both modems in the on-line state and transferring data at 2 400 bit/s, the spectrum of the signal transmitted by the modem under test shall be checked at the line terminals of the modem under test to verify that it contains signal power within the permitted range 650 Hz to 1 750 Hz, but not in the range 1 850 Hz to 2 950 Hz.

### **AMM**

The MCT shall be configured to operate as a CMM in the synchronous mode of use. The PSTN simulator shall be conditioned to provide the modem under test with appropriate ringing signals and, when the call is answered, to supply the d.c. conditions to the modem under test.

Once the modem under test is on line and following, if present, the answering tone according to CCITT Recommendation V.25 [5], and both modems are transferring data at 2 400 bit/s, the spectrum of the signal transmitted by the modem under test shall be checked at the line terminals of the modem under test to verify that it contains signal power within the permitted range 1 850 Hz to 2 950 Hz, but not in the range 650 Hz to 1 750 Hz.

## **A.8 Test for subclause 5.8 (Hand-shaking sequences)**

### **A.8.1 Tests for subclause 5.8.2 (Start-up procedures)**

#### **A.8.1.1 Test for subclause 5.8.2.1 (Call Mode Modem under test)**

The MCT shall be configured to operate as an AMM in the synchronous mode of use.

A call is originated from the modem under test to the MCT. The MCT answers the call and generates the CCITT Recommendation V.25 [5] answer sequence. A data pattern other than continuous binary 1 shall be applied to the transmit data connection(s) of the digital interface (equivalent: CcT 103) of the modem under test.

The MCT then transmits unscrambled binary 1 at 1 200 bit/s accompanied by guard tone.

For not less than 591 ms and not more than 631 ms from the moment at which the MCT commences transmitting unscrambled binary 1, the total power of signals transmitted by the modem under test in the band 700 Hz to 1 700 Hz shall be less than - 50 dBm.

The modem under test shall transmit Signal S1 for not less than 97 ms and not more than 103 ms followed by scrambled binary 1 at 1 200 bit/s.

**A.8.1.1.1 Test for subclause 5.8.2.1.1 (CMM calling a CCITT Recommendation V.22bis AMM at 2 400 bit/s)**

The MCT is caused to transmit:

- Signal S1 for 98 ms  $\pm$  1 ms, followed by;
- scrambled binary 1 at 1 200 bit/s for 494 ms  $\pm$  1 ms; and
- scrambled binary 1 at 2 400 bit/s for 191 ms  $\pm$  1 ms.

A timer is started, initiated by the transition from Signal S1 to scrambled binary 1 at the line terminals of the MCT.

From the moment the Signal S1 to scrambled binary 1 transition appears at the line terminals of the modem under test, it shall continue to transmit scrambled binary 1 at 1 200 bit/s for not less than 590 ms and not more than 610 ms.

The modem under test shall then transmit scrambled binary 1 at 2 400 bit/s for not less than 190 ms and not more than 210 ms.

At the end of this period, the modem under test shall commence transmission of the data pattern being presented to its digital interface and give an indication to the DTE that the modem is now ready to transmit data (equivalent: turning ON CcT 106).

The times at which the following events occur shall be recorded:

- the indication that the modem under test is ready to transmit data (equivalent: turning ON CcT 106);
- the modem under test entering the data transfer phase.

All of these events shall occur:

- at least 780 ms after the start of the timer; and
- within 3 s of the start of the timer.

**A.8.1.1.2 Test for subclause 5.8.2.1.2 (CMM calling a CCITT Recommendation V.22 or V.22bis AMM at 1 200 bit/s)**

The MCT is caused to transmit scrambled binary 1 at 1 200 bit/s.

A timer is started, initiated by the transition from unscrambled binary 1 to scrambled binary 1 at the line terminals of the MCT.

From the moment this signal is present on the line terminals of the modem under test, the modem under test shall continue to transmit scrambled binary 1 at 1 200 bit/s for a further period of not less than 985 ms and not more than 1 085 ms.

At the end of this period, the modem under test shall commence transmission of the data pattern being presented to its digital interface and give an indication to the DTE that the modem is now ready to transmit data (equivalent: turning ON CcT 106).

The times at which the following events occur shall be recorded:

- the indication that the modem under test is ready to transmit data (equivalent: turning ON CcT 106);
- the modem under test entering the data transfer phase.

All of these events shall occur:

- at least 985 ms after the start of the timer;  
and
- within 3 s of the start of the timer.

**A.8.1.2 Test for subclause 5.8.2.2 (Answer Mode Modem under test)**

The MCT shall be configured to operate as a CMM in the synchronous mode of use.

A call attempt shall be made from the MCT to the modem under test. Once the modem under test is on line, and following, if present, the answering tone according to CCITT Recommendation V.25 [5], a data pattern other than continuous binary 1 is applied to the transmit data connection (equivalent: transmit data CcT 103).

The modem under test shall transmit unscrambled binary 1 at 1 200 bit/s and guard tone.

**A.8.1.2.1 Test for subclause 5.8.2.2.1 (AMM called by a CCITT Recommendation V.22bis CMM at 2 400 bit/s)**

The MCT is caused to transmit:

- Signal S1 for 98 ms  $\pm$  1 ms; followed by
- scrambled binary 1 at 1 200 bit/s. This signal shall continue for 591 ms  $\pm$  1 ms after the receipt of a Signal S1 to scrambled binary 1 at 1 200 bit/s transition;
- scrambled binary 1 at 2 400 bit/s for 191 ms  $\pm$  1 ms.

A timer is started, initiated the transition from Signal S1 to scrambled binary 1 at 1 200 bit/s at the line terminals of the MCT.

The modem under test shall, on receipt of Signal S1, transmit:

- Signal S1 for not less than 97 ms and not more than 103 ms; followed by
- scrambled binary 1 at 1 200 bit/s for not less than such that the total time for transmission of these signals is not less than 590 ms and not more than 610 ms;
- scrambled binary 1 at 2 400 bit/s for not less than 190 ms and not more than 210 ms.

At the end of this period, the modem under test shall commence transmission of the data pattern being presented to its digital interface.

The times at which the following events occur shall be recorded:

- the indication that the modem under test is ready to transmit data (equivalent: turning ON CcT 106);
- the modem under test entering the data transfer phase.

All of these events shall occur:

- at least 780 ms after the start of the timer; and
- within 3 s of the start of the timer.

**A.8.1.2.2 Test for subclause 5.8.2.2.2 (AMM called by a CCITT Recommendation V.22 or V.22bis CMM at 1 200 bit/s)**

The MCT is caused to transmit scrambled binary 1 at 1 200 bit/s.

A timer is started, initiated by the appearance of scrambled binary 1 at 1 200 bit/s at the line terminals of the MCT.

The modem under test shall, on receipt of the scrambled binary 1, continue to transmit unscrambled binary 1 for a further period of not less than 230 ms and not more than 310 ms.

The modem under test shall terminate the period specified above by transmitting scrambled binary 1 for not less than 755 ms and not more than 775 ms.

At the end of this period, the modem under test shall commence transmission of the data pattern being presented to its digital interface.

The times at which the following events occur shall be recorded:

- the indication that the modem under test is ready to transmit data (equivalent: turning ON CcT 106).
- the modem under test entering the data transfer phase.

All of these events shall occur:

- at least 985 ms after the start of the timer; and
- within 3 s of the start of the timer.

#### **A.8.2 Tests for subclause 5.8.3 (Retrain sequence)**

Initially, the modem under test and the MCT shall be in the on-line state and exchanging data at 2 400 bit/s.

##### **A.8.2.1 Tests for subclause 5.8.3.1 (Initiating signal)**

Using the method described by the applicant, the modem under test shall be caused to initiate a retrain.

The modem under test shall transmit:

- Signal S1 for not less than 97 ms; followed by
- scrambled binary 1 at 1 200 bit/s for not less than 687 ms; followed by
- scrambled binary 1 at 2 400 bit/s for not less than 190 ms and not more than 210 ms.

The MCT shall respond to the change from Signal S1 to scrambled binary 1 in the received data, by transmitting:

- Signal S1 (see note in subclause 3.8.3.2) for not less than  $98 \text{ ms} \pm 1 \text{ ms}$ ;
- scrambled binary 1 at 1 200 bit/s for  $494 \text{ ms} \pm 1 \text{ ms}$ ; followed by
- scrambled binary 1 at 2 400 bit/s for  $191 \text{ ms} \pm 1 \text{ ms}$ .

The modem under test and the MCT shall now be capable of exchanging data at 2 400 bit/s.

##### **A.8.2.2 Tests for subclause 5.8.3.2 (Response signal)**

The MCT shall be caused to:

- stop transmitting data at 2 400 bit/s;
- transmit Signal S1 for  $98 \text{ ms} \pm 1 \text{ ms}$ ;
- transmit scrambled binary 1 at 1 200 bit/s for  $688 \text{ ms} \pm 1 \text{ ms}$ ;

- transmit scrambled binary 1 at 2 400 bit/s for 191 ms  $\pm$  1 ms.

The modem under test shall, on receipt of Signal S1, transmit:

- Signal S1 (see note in subclause 5.8.3.2) for not less than 97 ms and not more than 103 ms;
- transmit scrambled binary 1 at 1 200 bit/s for 591 ms  $\pm$  1 ms after the MCT has detected the beginning of scrambled binary 1 at 1 200 bit/s from the responding modem;
- scrambled binary 1 at 2 400 bit/s for not less than 190 ms and not more than 210 ms.

The modem under test and the MCT shall now be capable of exchanging data at 2 400 bit/s.

### **A.8.3 Tests for subclause 5.8.4 (Rate change request)**

Initially, the modem under test and the MCT shall be in the on-line state and exchanging data at the rate specified in the testing subclauses below.

#### **A.8.3.1 Tests for subclause 5.8.4.1 (2 400 bit/s to 1 200 bit/s)**

The modem under test and the MCT are initially exchanging data at 2 400 bit/s.

##### **A.8.3.1.1 Tests for subclause 5.8.4.1.1 (Instigation of a rate change from 2 400 bit/s to 1 200 bit/s)**

The tests shall be performed twice, once as described in a), b) and d); and then as described in a), c) and d).

- a) The modem under test is caused to initiate a rate change by the method described by the applicant. The modem under test shall transmit:
- Signal S1 for not less than 97 ms and not more than 103 ms; followed by
  - scrambled contiguous '10' or '01' dibits at 1 200 bit/s for not less than 687 ms.
- b) Refusal.

The MCT is caused to transmit:

- Signal S1 for 98 ms  $\pm$  1 ms; followed by
- scrambled contiguous binary 1 at 1 200 bit/s for 494 ms  $\pm$  1 ms; followed by
- scrambled binary 1 at 2 400 bit/s for 191 ms  $\pm$  1 ms.

A timer is started, initiated by the transition of Signal S1 to scrambled binary 1 at 1 200 bit/s at the line terminals of the MCT.

The modem under test shall transmit scrambled binary 1 at 2 400 bit/s for not less than 190 ms and not more than 210 ms.

- c) Acceptance

The MCT is caused to transmit:

- Signal S1 for 98 ms  $\pm$  1 ms; followed by
- scrambled contiguous "10" dibit at 1 200 bit/s for 494 ms  $\pm$  1 ms; followed by
- scrambled binary 1 at 1 200 bit/s for 191 ms  $\pm$  1 ms.



A timer is started, initiated by the transition of Signal S1 to scrambled contiguous "10" dibit at 1 200 bit/s at the line terminals of the MCT.

The modem under test shall transmit:

- scrambled binary 1 at 1 200 bit/s for not less than 190 ms and not more than 210 ms.
- d) The modem under test shall give an indication to the DTE that the modem is now ready to transmit data (equivalent: turning ON CcT 106). The modem under test and the MCT shall be exchanging data at the agreed rate.

The times at which the following events occur, shall be recorded:

- the indication that the modem under test is ready to transmit data (equivalent: turning ON CcT 106);
- the modem under test exchanging data at the agreed rate.

All of these events shall occur:

- at least 780 ms after the start of the timer; and
- within 3 s of the start of the timer.

**A.8.3.1.2 Tests for subclause 5.8.4.1.2 (Response to a request for a rate change from 2 400 bit/s to 1 200 bit/s)**

The tests shall be performed twice, once as described in a), b) and d); and then as described in a), c) and d).

a) The MCT is caused to transmit:

- Signal S1 for not less than 98 ms  $\pm$  1 ms; followed by
- scrambled contiguous "10" dibits at 1 200 bit/s for not less than 687 ms.

b) Refusal

The modem under test shall transmit:

- Signal S1 for not less than 97 ms and not more than 103 ms; followed by
- scrambled contiguous binary 1 at 1 200 bit/s such that the total period for Signal S1 and the binary 1 is not less than 590 ms and not more 610 ms;
- scrambled binary 1 at 2 400 bit/s for not less than 190 ms and not more than 210 ms.

A timer is started, initiated by the transition of Signal S1 to scrambled binary 1 at 1 200 bit/s at the line terminals of the MCT.

The MCT shall transmit scrambled binary 1 at 2 400 bit/s for 191 ms  $\pm$  1 ms.

c) Acceptance

Where the modem under test is free to select the data rate, it shall transmit:

- Signal S1 for not less than 97 ms and not more than 103 ms; followed by
- scrambled contiguous "10" dibit at 1 200 bit/s such that the total period for Signal S1 and the "10" dibits is not less than 590 ms and not more than 610 ms; followed by
- scrambled binary 1 at 1 200 bit/s for not less than 190 ms and not more than 210 ms.

A timer is started at the line terminals of the MCT, initiated by the transition of Signal S1 to scrambled contiguous "10" dibit at 1 200 bit/s.

The MCT shall transmit scrambled binary 1 at 1 200 bit/s 191 ms  $\pm$  1 ms.

- d) The modem under test shall give an indication to the DTE that the modem is now ready to transmit data (equivalent: turning ON CcT 106). The modem under test and the MCT shall be exchanging data at the agreed rate.

The times at which the following events occur, shall be recorded:

- the indication that the modem under test is ready to transmit data (equivalent: turning ON CcT 106);
- the modem under test exchanging data at the agreed rate.

All of these events shall occur:

- at least 780 ms after the start of the timer; and
- within 3 s of the start of the timer.

#### **A.8.3.2 Tests for subclause 5.8.4.2 (1 200 bit/s to 2 400 bit/s)**

The modem under test and the MCT are initially exchanging data at 1 200 bit/s.

##### **A.8.3.2.1 Tests for subclause 5.8.4.2.1 (Instigation of a rate change from 1 200 bit/s to 2 400 bit/s)**

The tests are performed twice, once as described in a), b) and d); and then as described in a), c) and d).

- a) The modem under test is caused to initiate a rate change by the method described by the applicant. The modem shall transmit:
- Signal S1 for not less than 97 ms and not more than 103 ms; followed by
  - scrambled contiguous "11" dibits at 1 200 bit/s for not less than 687 ms.
- b) Refusal.

The MCT is caused to transmit:

- Signal S1 for 98 ms  $\pm$  1 ms; followed by
- scrambled contiguous "10" or "01" dibits at 1 200 bit/s for 494 ms  $\pm$  1 ms; followed by
- scrambled binary 1 at 1 200 bit/s for 191 ms  $\pm$  1 ms.

A timer is started, initiated by the transition of Signal S1 to scrambled contiguous "10" or "01" dibits at 1 200 bit/s at the line terminals of the MCT.

The modem under test shall transmit scrambled binary 1 at 1 200 bit/s for not less than 190 ms and not more than 210 ms.

- c) Acceptance

The MCT is caused to transmit:

- Signal S1 for 98 ms  $\pm$  1 ms; followed by
- scrambled contiguous "11" dibit at 1 200 bit/s for 494 ms  $\pm$  1 ms; followed by
- scrambled binary 1 at 2 400 bit/s for 191 ms  $\pm$  1 ms.

A timer is started, initiated by the transition of Signal S1 to scrambled contiguous "11" dibits at 1 200 bit/s at the line terminals of the MCT. The modem under test shall transmit:

- scrambled binary 1 at 2 400 bit/s for not less than 190 ms and not more than 210 ms.
- d) The modem under test shall give an indication to the DTE that the modem is now ready to transmit data (equivalent: turning ON CcT 106). The modem under test and the MCT shall be exchanging data at the agreed rate.

The times at which the following events occur, shall be recorded:

- the indication that the modem under test is ready to transmit data (equivalent: turning ON CcT 106);
- the modem under test exchanging data at the agreed rate.

All of these events shall occur:

- at least 780 ms after the start of the timer; and
- within 3 s of the start of the timer.

#### **A.8.3.2.2 Tests for subclause 5.8.4.2.2 (Response to a request for a rate change from 1 200 bit/s to 2 400 bit/s)**

The tests are performed twice, once as described in a), b) and d); and then as described in a), c) and d).

a) The MCT is caused to transmit:

- Signal S1 for not less than 98 ms  $\pm$  1 ms; followed by
- scrambled contiguous '11' dibits at 1 200 bit/s for not less than 687 ms.

b) Refusal.

The modem under test shall transmit:

- Signal S1 at 1 200 bit/s for not less than 97 ms and not more than 103 ms; followed by
- scrambled contiguous '10' or '01' dibits at 1 200 bit/s such that the total period for Signal S1 and the '10' or '01' dibits is not less than 590 ms and not more 610 ms;
- scrambled binary 1 at 1 200 bit/s for not less than 190 ms and not more than 210 ms.

A timer is started, initiated by the transition of Signal S1 to scrambled contiguous '10' or '01' dibits at 1 200 bit/s at the line terminals of the MCT. The MCT shall transmit scrambled binary 1 at 1 200 bit/s for 191 ms  $\pm$  1 ms.

c) Acceptance

Where the modem under test is free to select the data rate, it shall transmit:

- Signal S1 for not less than 97 ms and not more than 103 ms; followed by
- contiguous '11' dibit at 1 200 bit/s such that the total period for Signal S1 and the "10" dibits is not less than 590 ms and not more than 610 ms; followed by
- scrambled binary 1 at 2 400 bit/s for not less than 190 ms and not more than 210 ms.

A timer is started, initiated by the transition of Signal S1 to scrambled contiguous "11" dibit at 1 200 bit/s at the line terminals of the MCT. The MCT shall transmit scrambled binary 1 at 2 400 bit/s for 191 ms  $\pm$  1 ms.

- d) The modem under test shall give an indication to the DTE that the modem is now ready to transmit data (equivalent: turning ON CcT 106). The modem under test and the MCT shall be exchanging data at the agreed rate.

The times at which the following events occur, shall be recorded:

- the indication that the modem under test is ready to transmit data (equivalent: turning ON CcT 106);
- the modem under test exchanging data at the agreed rate.

All of these events shall occur:

- at least 780 ms after the start of the timer; and
- within 3 s of the start of the timer.

## **A.9 Test for subclause 5.10 (Scrambler and de-scrambler)**

The tests described hereafter shall be carried out at a data signalling rate of 2 400 bit/s. If a modem used for reference has not been approved as Category II, then it shall be possible to inhibit the scrambler and the de-scrambler in this modem, and to apply an external scrambler and de-scrambler, e.g. scrambler and de-scrambler integrated into the data test equipment. The scrambler and the de-scrambler external to the MCT shall have the properties specified in CCITT Recommendation V.22 [3], section 5.

If the modem under test can be operated, for the purpose of test, in the synchronous mode of use, then it shall be configured to this mode.

With the scrambler and the de-scrambler enabled in the MCT, a call shall be initiated from the modem under test across Test Line 3 (see final draft prETS 300 114 [1], annex C, clause C.5). After completion of the initial handshake sequence between the two modems and both modems being in the on-line state, the scrambler and the de-scrambler in the MCT shall be inhibited.

### **A.9.1 Test for modems which can be operated in the synchronous mode of use**

The following tests shall be performed when the modem under test can be operated in the synchronous mode of use:

- a) a constant binary 1 condition shall be transmitted from the modem under test to the MCT, and vice versa, for a duration of  $125\text{ s} \pm 5\text{ s}$  each (this may be done simultaneously, if possible, with the data test equipment used). The data received and de-scrambled at either end of the connection shall be verified for the appearance of binary 0 conditions. No more than three bits with a binary 0 value shall be received at either end. If more bits with a binary 0 value are received, the test shall be repeated once. If any errors occur during the second attempt, the modem shall be assumed to have failed the test;
- b) the test of a) shall be repeated with a constant binary 0 condition. The data received and de-scrambled at either end of the connection shall be verified for the appearance of binary 1 conditions. No more than three bits with a binary 1 value shall be received at either end. If more bits with a binary 1 value are received, the test shall be repeated once. If any errors occur during the second attempt, the modem shall be assumed to have failed the test;
- c) a 511-bit data test pattern according to CCITT Recommendation V.52 [7] shall be transmitted for a period of  $125\text{ s} \pm 5\text{ s}$  from the modem under test to the MCT (and through the external de-scrambler, if present), and vice versa (through the external scrambler, if present). No more than three bits error in either direction shall be encountered under this test. If more than three bit errors is encountered, the test shall be repeated once. If any errors occur during the second attempt, the modem shall be assumed to have failed the test.

### **A.9.2 Test for modems which can only be operated in a asynchronous mode of use**

These tests shall only be performed if the modem under test cannot be operated in the synchronous mode of use, for the purposes of test.

NOTE: The tests specified hereafter may be performed in conjunction with the tests of the asynchronous converter as specified in final draft prETS 300 114 [1], annex B, subclause B.4.3. If, however, the test fails, it is not clear whether the cause of the failure was the scrambler/de-scrambler or the asynchronous converter. For this reason, where possible, it is preferable to test the scrambler and the de-scrambler in the synchronous mode of use.

An asynchronous to synchronous and synchronous to asynchronous converter shall be inserted between the scrambler and de-scrambler used with the MCT and the data source and sink. The data test equipment shall be capable of recognizing the standard test text (see final draft prETS 300 114 [1], annex B, subclause B.4.1.2) and the discrete start-stop characters (DTCs) N° 1 and N° 3 (see final draft prETS 300 114 [1], annex B, subclause B.4.1.3), and indicating whether sequences of characters are correctly received.

- a) DTCs N° 3 shall be transmitted from the modem under test to the MCT, and vice versa for a period of  $125\text{ s} \pm 5\text{ s}$ . The characters received at either end of the connection shall be verified for their correctness. No more than one character shall be received corrupted at either end. If more than one corrupted character has been received, the test shall be repeated once. If any errors occur during the second attempt, the modem shall be assumed to have failed the test.
- b) The test a) shall be repeated with DTCs N° 1.
- c) The standard test text shall be transmitted from the modem under test to the MCT and vice versa for a period of  $125\text{ s} \pm 5\text{ s}$ . No more than one character of the test text shall be received corrupted at either end. If more than one corrupted character has been received, the test shall be repeated once. If any errors occur during the second attempt, the modem shall be assumed to have failed the test.

## **A.10 Test for subclause 3.11 (Test loop 2)**

### **A.10.1 Instigation of remote test loop 2**

#### **A.10.1.1 Transmission of the test loop initiation signal (Controlling modem under test)**

The modem under test shall be in the on-line state and transmitting data signals at a data signalling rate of 2 400 bit/s (e.g. after performing the tests of specified in clause A.2). Using the means described by the applicant, the modem is commanded to issue a request for remote Test Loop 2. The line signals transmitted and received by the modem under test are monitored to observe the following:

- as a result of the command the modem under test shall change the transmitted signal from scrambled data to unscrambled binary 1;
- the MCT is caused to respond by sending contiguous scrambled reversals;
- within a time of not less than 231 ms and not more than 308 ms, starting from the reception of a line signal equivalent to scrambled reversals to its line terminals, the modem under test shall transmit scrambled binary 1;
- upon receipt of its own scrambled binary 1 from the MCT, indicating the activation of the remote loop, and for not less than 231 ms and not more than 308 ms, the modem under test shall now indicate to the terminal that the modem is in a test mode (equivalent: turning ON CcT 142).

#### **A.10.1.2 Response to the test loop initiation signal (Controlled modem under test)**

The modem under test is conditioned to be in the on-line state and to transmit data signals (e.g. after performing the tests according to clause A.2). The line signals transmitted and received by the modem under test are monitored to observe the following:

- upon receipt of unscrambled binary 1 for not less than 154 ms and not more than 231 ms from the MCT, the modem under test shall transmit contiguous scrambled reversals;

- upon detection of loss of unscrambled binary 1 (loop initiation signal) from the MCT, the modem under test shall apply the test loop 2 condition within itself. This condition can be detected at the digital interface of the MCT as the data signals which it transmits being returned to it. The modem under test shall now indicate to the terminal that the modem is in a test mode (equivalent: turning ON CcT 142).

## **A.10.2 De-activation of remote test loop 2**

### **A.10.2.1 Transmission of the de-activation signal (Controlling modem under test)**

The two modems should be in the configuration obtained when the test described in subclause A.10.1.1 was completed (viz Controlling modem under test). Using the means described by the applicant, the modem is commanded to issue a request to de-activate remote test loop 2.

The line signals transmitted by the modem under test are monitored to observe that for not less than 67 ms and not more than 87 ms the level of the transmitted signal at the output of the modem shall fall to below - 50 dBm.

The modem under test shall now give an indication to the DTE that the modem is no longer in a test mode (equivalent: turning OFF CcT 142).

### **A.10.2.2 Response to the de-activation signal (Controlled modem under test)**

The two modems should be in the configuration obtained when the test to subclause A.10.1.2 was completed (i.e. Controlled modem under test).

The signal transmitted by the MCT shall be interrupted for  $38 \text{ ms} \pm 1 \text{ ms}$ . The loop shall remain activated.

The signal transmitted by the MCT shall be interrupted for  $67 \text{ ms} \pm 1 \text{ ms}$ . The modem under test shall release the test loop and restore end to end data transmission within not less than 145 ms and not more than 270 ms, timed from the presentation of the interruption to the modem under test, and give an indication to the DTE that the modem is no longer in a test mode (equivalent: turning OFF CcT 142).

**Annex B (informative): Derivation of timings**

Table B.1 gives the time, in ascending order, of the various signals mentioned in the requirements and tests of this ETS, together with an explanation of how they were derived when this is not immediately obvious. The first value is the time in ms followed, in parentheses, by the number of bits at 1 200 bit/s and, where appropriate, at 2 400 bit/s.

**Table B.1**

<b>40 ms to 65 ms</b>			
40 ms (48/96)		65 ms (78/156)	
<b>77 ms ± 10 ms</b>			
67 ms (80,4/160,8)		77 ms (92,4/184,8)	
87 ms (104,4/208,8)			
<b>100 ms ± 3 ms</b>			
97 ms (116,4)		100 ms (120)	
103 ms (123,6)			
<b>145 ms to 270 ms</b>			
145 ms (174/348)		270 ms (324/648)	
These are the maximum and minimum values of the sum of 40 ms to 65 ms and 155 ms ± 50 ms			
NOTE 1: The tolerance on the 155 ms is greater (i.e. ± 50 ms) in CCITT Recommendation V.22 [3].			
<b>154 ms to 231 ms</b>			
154 ms (184,8/369,6)		231 ms (277,2/554,4)	
<b>200 ms ± 10 ms</b>			
190 ms (228/456)		191 ms (229,2/458,4)	
200 ms (240/480)		210 ms (252/504)	
<b>231 ms to 308 ms</b>			
231 ms (277,2/554,4)		308 ms (369,6/739,2)	
<b>270 ms ± 40 ms</b>			
230 ms (276)	270 ms (324)	310 ms (372)	
<b>494 ms</b>			
493 (591,6)	494 (592,8)	495 (594)	
This is derived by taking the shortest possible S1 (97 ms) from the minimum time for S1 and scrambled binary 1 (590 ms) which leaves 493 ms. To provide a tolerance for the MCT and at the same time not cause the time to go below 493 ms; the figure is revised to 494 ms ± 1 ms.			
<b>Minimum of 591 ms</b>			
591 ms (709,2)			
This is derived from the sum of the minimums of 155 ms ± 10 ms (145 ms) and 456 ms ± 10 ms (446 ms).			
<b>600 ms ± 10 ms</b>			
590 ms (708)	591 ms (709,2)	600 ms (720)	610 ms (732)
<b>Minimum of 687 ms</b>			
687 ms (824,4)			
The sum of the minimums of 100 ms ± 3 ms (97 ms) and 600 ms ± 10 ms (590 ms). This assumes the modem can detect and react immediately and therefore a compliant modem will always have a longer time, although how much longer cannot be assessed.			
<b>765 ms ± 10 ms</b>			
755 ms (906)	765 ms (918)	775 ms (930)	
<b>1 035 ms ± 50 ms</b>			
985 ms (1 182)	1 035 ms (1 242)	1 085 ms (1 302)	
This is derived from the sum of 270 ms ± 40 ms and 765 ms ± 10 ms.			
NOTE 2: Where the MCT is required to generate signals, the limits placed on the time for which these signals are transmitted are generally the shortest possible, thus making them as difficult as possible to detect. A tolerance of ± 1 ms is specified for the time of such signals to permit integer numbers of bits to be generated.			

**Annex C (informative): Example proforma for the declaration of modes of operation/use**

Declaration of modes of operation/use for 2 400 bit/s/1 200 bit/s modems based on CCITT Recommendation V.22bis [2].

The modem submitted for assessment of conformance is capable of operating in the modes indicated in the tables below.

Proforma for declaring modes of operation/use.

**Table C.1: Transmission at 2 400 bit/s**

<b>2 400 bits per second</b>	
a)	Asynchronous with 8 bit characters.
b)	Asynchronous with 9 bit characters.
c)	Asynchronous with 10 bit characters.
d)	Asynchronous with 11 bit characters.
e)	Synchronous.

**Table C.2: Transmission at 1 200 bit/s**

<b>1 200 bits per second</b>	
a1)	Asynchronous with 8 bit characters.
b1)	Asynchronous with 9 bit characters.
c1)	Asynchronous with 10 bit characters.
d1)	Asynchronous with 11 bit characters.
e1)	Synchronous.

**Table C.3: Encoding and decoding of data**

<b>Encoding and decoding of data</b>	
Declaration of conformance.	

**Table C.4: Channel selection**

<b>Channel Selection</b>	
a)	Call mode.
b)	Answer mode.
Where the answer to both a) and b) is YES. The method or methods of mode selection as required by subclause 3.4 of CCITT Recommendation V22bis [2].	
c)	Automatic selection by detection of an incoming PSTN call.
d)	Selection via the digital interface (equivalent: CcT 126).
e)	Manual selection using means provided on the modem.

**Table C.5: Auto-calling and/or answering**

<b>Auto calling and/or answering</b>	
a)	Auto calling.
b)	Auto answering.



**Table C.6: Retrain request**

<b>Retrain request</b>	
Is this provided ?	
If so, how can it be initiated ?	

**Table C.7: Rate change request**

<b>Rate change request</b>	
Is this provided ?	
If so, how can it be instigated ?	

**Table C.8: Test loop**

<b>Test loop</b>		
a)	Method of generating initiation signal.	
b)	Method of de-activating test loop.	
c)	Means of indicating that the modem is in a test mode.	
d)	Means of indicating that the modem is no longer in a test mode.	

## **Annex D (informative): Bibliography**

For the purposes of this ETS, the following documents have been referenced for information in this ETS:

- CCITT Recommendation V.24: "List of definitions for interchange circuits between data terminal equipment (DTE) and data circuit-terminating equipment (DCE)".
- CCITT Recommendation Q.144 (1984): "Specifications of signalling system no.5 - line signal receiver".
- CCITT Recommendation V.54 (1988): "Loop test devices for modems".

**History**

<b>Document history</b>			
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