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SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

Testing equipments

Test methodology for Group 3 facsimile processing equipment in the Public Switched Telephone Network

ITU-T Recommendation G.511

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ITU-T RECOMMENDATION G.511

**TEST METHODOLOGY FOR GROUP 3 FACSIMILE PROCESSING EQUIPMENT
IN THE PUBLIC SWITCHED TELEPHONE NETWORK**

Summary

This Recommendation defines the testing methodology for evaluating the performance of Group 3 facsimile processing equipment incorporated in Signal Processing Network Element (SPNE) of the Public Switched Telephone Network.

FOREWORD

ITU (International Telecommunication Union) is the United Nations Specialized Agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of the ITU. The ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Conference (WTSC), which meets every four years, establishes the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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As of the date of approval of this Recommendation, the ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

CONTENTS

Recommendation G.511

TEST METHODOLOGY FOR GROUP 3 FACSIMILE PROCESSING EQUIPMENT IN THE PUBLIC SWITCHED TELEPHONE NETWORK

(Geneva, 1998)

1   Scope

This Recommendation defines the testing methodology for evaluating the performance of Group 3 facsimile processing equipment incorporated in Signal Processing Network Element (SPNE) of the Public Switched Telephone Network.

The testing methodology covers the following aspects:

1)   facsimile recognition (i.e. detection and classification);

2)   proprietary facsimile fall-back to ADPCM path;

3)   Group 3 facsimile image quality in presence of:

    a)   combined access link impairments and bearer link impairments;

    b)   bearer link impairments;

4)   recovery following unexpected events during the facsimile call set-up;

5)   voiceband data quality;

6)   effect of variability in the implementation of the T.30 protocol;

7)   effects of transmission level variation and echo return loss;

8)   impact of transmission integrity due to timing deviations on facsimile call quality.

The basic configuration employed in these tests is shown in Figure 1.
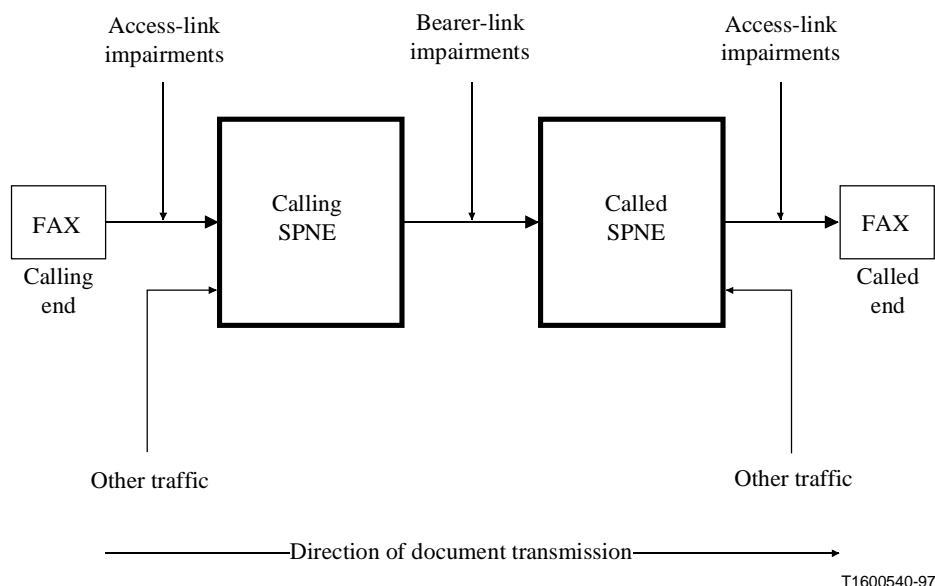
Figure 1/G.511 – Basic configuration for testing facsimile processing equipment in Signal Processing Network Element (SPNE)

In Figure 1, SPNE represents a signal processing network element. In general, this SPNE can process other signals than facsimile signals. However, only the Group 3 facsimile processing aspects of Circuit Multiplication Equipment (CME) and Echo Cancellers (EC) is discussed in this Recommendation. Other types of SPNE are for further study.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

– ITU-T Recommendation E.451 (1993), *Facsimile call cut-off performance.*

– ITU-T Recommendation E.452 (1993), *Facsimile modem speed reductions and transaction time.*

– ITU-T Recommendation E.453 (1994*), Facsimile image quality as corrupted by transmission-induced scan line errors.*

– ITU-T Recommendation E.456 (1994), *Test transaction for facsimile transmission performance.*

– ITU-T Recommendation G.701 (1993), *Vocabulary of digital transmission and multiplexing, and Pulse Code Modulation (PCM) terms.*

– CCITT Recommendation G.711 (1998), *Pulse Code Modulation (CPM) of Voice-Frequencies.*

– ITU-T Recommendation G.165 (1993), *Echo cancellers.*

– ITU-T Recommendation G.720 (1995), *Characterization of low-rate digital voice coder performance with non-voice signals.*

– CCITT Recommendation G.726 (1990), *40, 32, 24, 16 kbit/s Adaptive Differential Pulse Code Modulation (ADPCM).*

– CCITT Recommendation G.727 (1990), *5-, 4-, 3- and 2-bits/sample embedded Adaptive Differential Pulse Code Modulation (ADPCM).*

– CCITT Recommendation G.728 (1992), *Coding of speech at 16 kbit/s using low-delay code excited linear prediction.*

– ITU-T Recommendation G.729 (1996), *Coding of speech at 8 kbit/s using conjugate structure Algebraic-Code-Excited Linear Prediction (CS-ACELP).*

– CCITT Recommendation G.763 (1991), *Digital circuit multiplication equipment using ADPCM Recommendation G.726 and digital speech interpolation.*

– CCITT Recommendation G.764 (1990), *Voice packetization – Packetized voice protocols.*

– CCITT Recommendation G.765 (1992), *Packet circuit multiplication equipment.*

– CCITT Recommendation G.766 (1992), *Facsimile demodulation/remodulation for DCME.*

– ITU-T Recommendation G.826 (1993), *Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate.*

– ITU-T Recommendation T.4 (1996), *Standardization of Group 3 facsimile apparatus for document transmission.*

- ITU-T Recommendation T.22 (1993), *Standardized test charts for document facsimile transmission.*

- ITU-T Recommendation T.30 (1996), *Procedures for document facsimile transmission in the general switched telephone network.*

- CCITT Recommendation V.17 (1991), *2-Wire modem for facsimile applications with rates up to 14 400 bit/s.*

- CCITT Recommendation V.21 (1984), *300 bits per second duplex modem standardized for use in the general switched telephone network.*

- CCITT Recommendation V.27 *ter* (1984), *4800/2400 bits per second modem standardized for use in the general switched telephone network.*

- CCITT Recommendation V.29 (1988), *9600 bits per second modem standardized for use on point-to-point 4-wire leased telephone-type circuits.*

- CCITT Recommendation V.33 (1988), *14 400 bits per second modem standardized for use on point-to-point 4-wire leased telephone-type circuits.*

- ITU-T Recommendation V.34 (1996), *A modem operating at data signalling rates of up to 33 600 bit/s for use on the general switched telephone network and on leased point-to-point 2-wire telephone type circuits.*

3   Abbreviations and definitions

3.1   Abbreviations

This Recommendation uses the following abbreviations:

CME   Circuit Multiplexing Equipment

DCME   Digital Circuit Multiplexing Equipment (see Recommendation G.763)

EC   Echo Canceller (see Recommendation G.165)

HOL   Heavy overload condition with speech traffic in a CME

OL   Overload condition with speech traffic in a CME

OLF   Overload condition due to facsimile in a CME

PCME   Packet Circuit Multiplexing Equipment (see Recommendation G.765)

SPNE   Signal Processing Network Element. Examples: DCME, PCME, EC

UL   Underload condition with speech traffic in a CME

3.2   Definitions

This Recommendation defines the following terms:

3.2.1   ADPCM path: This is the transmission path within the CME when the facsimile signal is going through the ADPCM encoder/decoder.

3.2.2   control channel: In a circuit-oriented circuit multiplication equipment, the control channel is a unidirectional transmission path from the transmit unit of one CME to the receive unit of one or more associated CMEs. This control channel is dedicated primarily to carrying channel assignment messages. In addition, the control channel transmits other messages such as idle noise level, dynamic load control, alarm messages and optionally, line signalling information.

For a packet-oriented circuit multiplication equipment, the CME control channel is either the packet header of a packet carrying the user's traffic or a special packet carrying control information.

3.2.3 **demodulated transmission path**: This is the path of the facsimile signal when the baseband signal has been extracted by demodulation.

3.2.4 **facsimile demodulation/remodulation**: This is the processing function in a CME where facsimile is discriminated from voiceband data and subsequently demodulated to recover the baseband digital signal. It is then remodulated at the terminating CME.

3.2.5 **forward bearer channel**: This is the bearer channel from the calling to the called CME. The direction of facsimile document transmission is assumed to be from the calling to the called CME (see Figure 2).

3.2.6 **grouped errors**: These are the digital impairments that either affect each bit of a contiguous stream of CME bearer channel bits, or a group of contiguous bits (but not necessarily all bits) according to a pattern determined *a priori*.

3.2.7 **non-demodulated transmission path**: This is the path of the facsimile signal when the baseband signal is not demodulated, but is either PCM or ADPCM coded.

3.2.8 **non-standard/mode 1**: This is the mode of transmission where the facsimile terminals at both ends transmit in proprietary mode, although the CME is capable of demodulating and remodulating the high-speed image/message transmissions.

3.2.9 **non-standard/mode 2**: This is the mode of transmission where the facsimile terminals at both ends transmit in proprietary mode, although the CME is **not capable** of demodulating and remodulating the high speed image/message transmissions.

3.2.10 **return bearer channel**: This is the bearer channel from the called to the calling CME (see Figure 2).

4 Overview

4.1 Addressed issues

The test methodology presented in this Recommendation makes provisions for the insertion of impairments on the access links and the bearer links for a variety of test conditions, and also the evaluation of the quality of facsimile image, after processing by the terminating SPNE.

In particular, the following issues will be addressed:

1) Recognition of Group 3 facsimile calls by the calling CME, and routing to an appropriate facsimile ADPCM or demodulation/remodulation module, if any;

2) In case of facsimile demodulation/remodulation equipment, fall-back from a demodulated signal path to an ADPCM signal path, during the set-up process of a facsimile call;

3) Assessment of the Group 3 facsimile received image quality when transmitted in CME over the non-demodulated signal path in the presence of access link impairments in the forward calling access link and the forward called access link. Figure 2 shows the location of the forward calling and called access link impairments when testing CME;
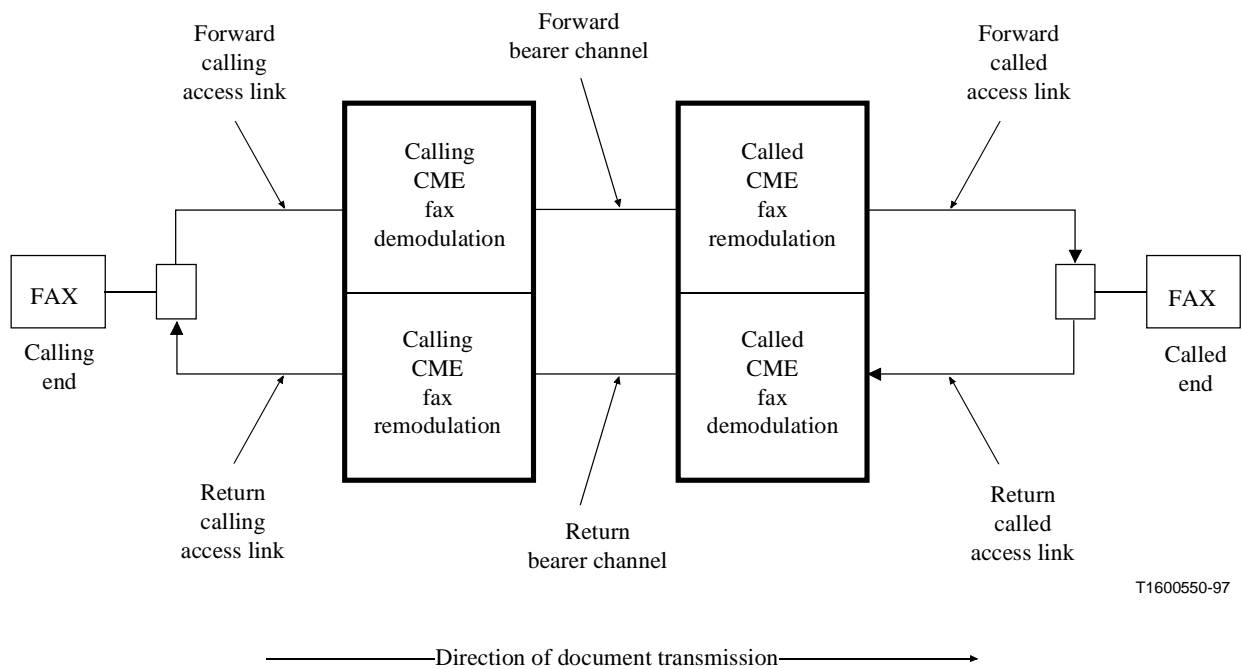
Figure 2/G.511 – Designation of end-to-end communication links

4) Assessment of the Group 3 facsimile received image quality when transmitted in the CME over the demodulated signal path, with and without Forward Error Correction (FEC) and with:

• random errors in forward and/or return bearer channels;

• grouped errors in forward and/or return bearer channels;

• burst errors in forward and/or return bearer channels.

5) Impact of "heavy" loading on Group 3 facsimile;

6) CME recovery following premature call disconnections and/or abnormal behaviour at the facsimile end-customer premises;

7) Processing of voiceband data, using the same modulation schemes as used in the facsimile signal facsimile, by CME systems that support both ADPCM coding and facsimile demodulation/remodulation capabilities;

8) Impact of Group 3 facsimile protocol variability on CME system behaviour and facsimile call quality;

9) Impact of transmission level variation and echo return loss on CME system behaviour and facsimile call quality;

10) Impact of transmission integrity due to timing deviations on facsimile call quality;

11) Verification of retransmission level at remodulated output.

4.2 Direction of transmission

In each test condition the direction of document transmission shall be the same as the direction under test (standard mode of communication). Optionally, the direction of document transmission may be the opposite of the direction under test (polling mode of communication). Tests shall be conducted by transmitting three consecutive pages of documentation. It is preferable that the calling facsimile terminal be fully electronic (or with electronic memory) so that the document scanning process is only undertaken once, and thus does not become a variable in this investigation.

4.3 Number of calls

For each test condition, at least 20 calls shall be initiated (60 attempted page transmissions in total) so that the error count of measured performance parameters is not less than 100.

In Table 1 the percentage error intervals (at a 95% confidence level) for four different rates of transmission failures are shown as a function of the total number of pages transmitted. For example, when 60 transmitted pages result in 30 of them being unacceptable (i.e. failure rate of 50%) the mean percentage of pages in error is 50% ± 13%. In this case, the magnitude of the error is approximately 1/3 of the size of the mean. As the failure rate increases to 70%, the error magnitude stays approximately the same (12%, therefore resulting in a mean percentage of pages in error of 70% ± 12%) but, as a proportion to the mean, the error size decreases to approximately 1/5.

4.4 Test pages

Test charts Nos. 4 and 5 of Recommendation T.22 shall be used.

NOTE – Test chart No. 4 is the same as test chart No. 2 in Recommendation T.21, which is mentioned in Recommendation E.456.

To evaluate the performance of facsimile transmissions as a function of transmitted page length, pages with different image content may also be used, so that the time it takes to transmit one page of documentation varies between 20 seconds and 200 seconds (at a user signalling rate of 9.6 kbit/s). The density of information content for such pages, expressed as the average number of bits (after one-dimensional run length encoding) per scan-line is defined to be equal to 250 bit/scan-line.

Table 1/G.511 – Percentage error intervals at 95% confidence level

Pages per call	Total number of calls	Total number of pages	Mean failure rate 5%	Mean failure rate 20%	Mean failure rate 50%	Mean failure rate 70%
3	10	30	± 4%	± 15%	± 18%	± 16%
3	20	60	± 3%	± 10%	± 13%	± 12%
3	30	90	± 2%	± 8%	± 11%	± 9%
3	40	120	± 2%	± 4%	± 5%	± 4%

4.5 Facsimile terminal selection

Terminals shall be selected so that the test operator can control whether they operate in a standard or proprietary mode.

5 Facsimile terminal configurations

Three basic types of end-customer facsimile terminal set-ups are used in these tests:
- terminals operating in the standard Group 3 facsimile mode;
- terminals capable of communicating in a non-standard/mode 1 configuration;
- terminals capable of communicating in a non-standard/mode 2 configuration.

5.1 Standard Group 3 facsimile mode

This subclause addresses equipment set-up to control the variability that may exist among terminals conforming to Recommendations T.4 and T.30. Four standard facsimile call configurations are defined. All configurations shall be tested.

The first configuration, denoted as Std/Conf/1, is the reference configuration.

5.1.1 Std/Conf/1: Reference configuration

The purpose of this test configuration is to test the operation with the V.29 modulation scheme at 9600 bit/s. The objective is to minimize the variability of protocol paths that can be followed by the facsimile terminals, so that image data obtained at different times, and over different CME, can be more conveniently compared against each other.

The test steps are as follows:

i)   The facsimile terminals shall be set-up in such a way, so that only the 9600 bit/s of the V.29 modulation scheme is employed.

ii)   The terminals shall be set up in the standard resolution mode.

iii)   The terminals shall be set up to employ the one-dimensional coding scheme (Run Length Coding – RLC).

iv)   Terminals shall be used with non-standard facility options disabled. If this is not possible, terminals from different manufacturers shall be used at opposite ends of the circuit connection.

v)   The transmitting and receiving units shall be configured in the auto-calling and auto-answering modes respectively.

vi)   The error-correction mode shall be disabled. If it is not possible to disable this function, at least one of the terminals selected must not support this capability.

5.1.2 Std/Conf/2

The purpose of this test configuration is to test the operation at rates lower than 9600 bit/s modulation. The objective is to minimize the variability of protocol paths that can be followed by the facsimile terminals, so that image data obtained at different times, and over different CME, can be more conveniently compared against each other.

In this configuration, the facsimile terminals may employ any of the following user data signalling rates for facsimile image communication:

•   V.29 at 7200 bit/s;

•   V.27 *ter* at 4800 bit/s;

•   V.27 *ter* at 2400 bit/s.

Other rates and modulation schemes are for further study.

5.1.3 Std/Conf/3

In this configuration, limitations imposed upon Std/Conf/1 and Std/Conf/2, such as resolution, error-correction, two-dimensional coding, and polling are removed.

5.1.4 Std/Conf/4

The purpose of this test configuration is to test the capability of the CME for rate negotiation during fall-back.

5.2 Non-standard Group 3 facsimile mode

5.2.1 Non-standard Group 3 facsimile mode 1

Terminals shall be selected so that proprietary communication can be successfully established through "Phase B" of the Group 3 facsimile protocols. In this case, the transmission over the CME bearer takes place over a demodulated signal path.

5.2.2 Non-standard Group 3 facsimile mode 2

Terminals shall be selected so that proprietary communication can only be successfully established through "Phase B" of the Group 3 facsimile protocols if this takes place over an ADPCM path. Initial establishment over a demodulated path during "Phase A" of the Group 3 facsimile protocols with subsequent reassignment to an ADPCM encoded path during "Phase B" is permitted under this mode.

6 Network conditions

This clause presents the various parameters used in the tests.

6.1 Access-link impairments

6.1.1 Definition

Impairments are injected in the facsimile signal in the voiceband domain primarily in the direction of transmission of image information. Figure 3 shows where access-link impairments are injected in the forward access link between the calling facsimile terminal and the calling CME demodulator. Similarly, Figure 4 shows the injection of access-link impairments between the called CME remodulator and the called facsimile terminal. In both figures, the notations PCM and PCM^{-1} indicate a G.711 PCM encoder and a G.711 PCM decoder, respectively.
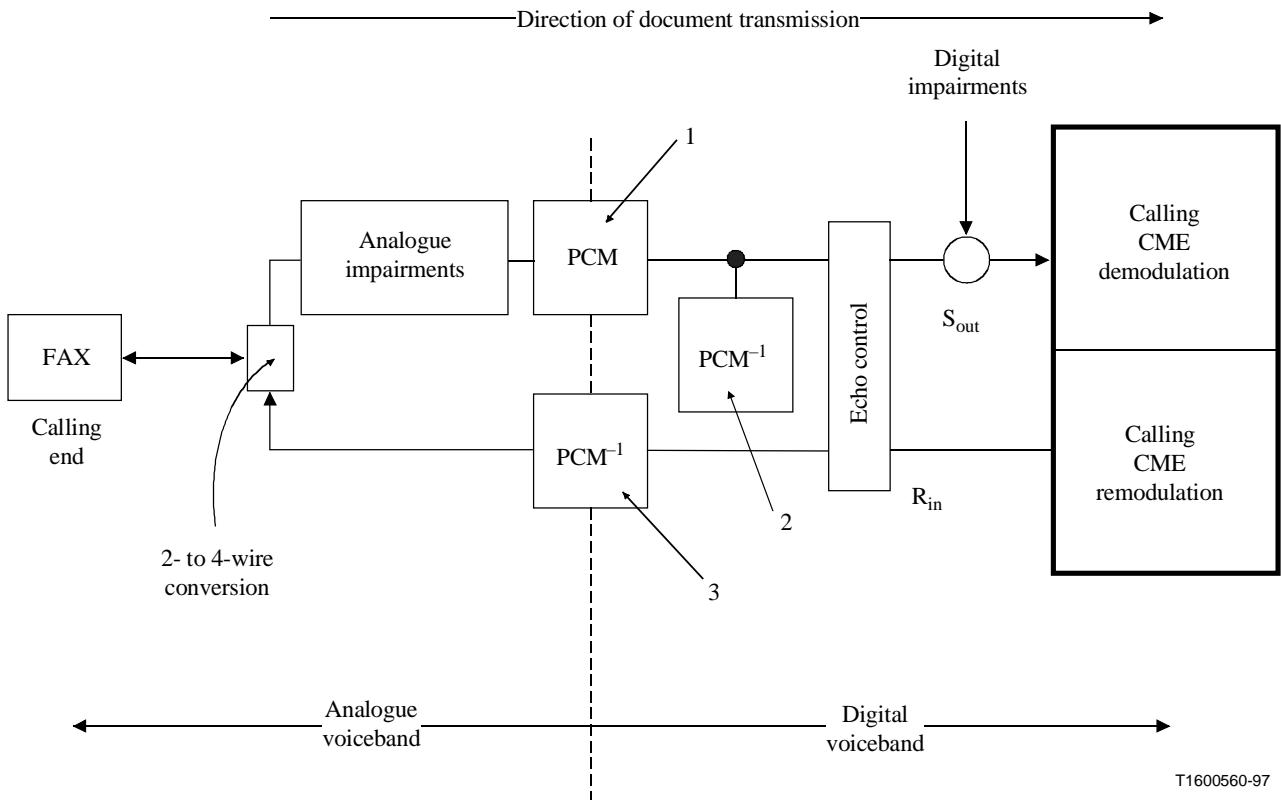
NOTE – PCM represents a G.711 encoder and PCM^{-1} represents a G.711 decoder.

Figure 3/G.511 – Injection of access-link impairments in the forward access links between the calling facsimile terminal and the calling CME demodulator

Figure 4/G.511 – Injection of access-link impairments in the return access links
between the called CME demodulator and the called facsimile terminal

NOTE – PCM represents a G.711 encoder and PCM^{-1} represents a G.711 decoder.

The calling access-link impairments depicted in Figure 3 comprise voiceband analogue impairments (see 6.1.1.1) and voiceband digital impairments (see 6.1.1.2). The level of network performance degradation that the digital impairments introduce will depend on the location where these impairments are injected. PCM encoder No. 1 and PCM decoder No. 3 are used for interfacing the input and output CME channels to the analogue part of the network. PCM decoder No. 2 is used for calibration procedures only, and is not required when tests are actually undertaken.

Similarly, the called access-link impairments shown in Figure 4 comprise voiceband analogue impairments and voiceband digital impairments. PCM decoder No. 4 and PCM encoder No. 5 are used for interfacing the input and output CME channels to the analogue part of the network.

The (single channel) input to the CME system is assumed to be encoded according to the Recommendation G.711 64 kbit/s PCM (A-law, or µ-law, as necessary for CME compatibility) format. An echo canceller, which is necessary for the correct functioning of CME, is inserted on the line side of the PCM conversion. Note that if echo control is not available, then the termination shall be balanced so that the echo return loss exceeds 40 dB.

Note that when end-to-end performance is evaluated, a local office network/simulating loop is used between the facsimile terminals and the 2- to 4-wire conversion to provide ringing, voltage drop, DTMF decoding and other locally generated signals. This end-loop is not shown in the figure to avoid unnecessary details.

6.1.1.1 Analogue impairments

The analogue channel shall permit the introduction of two types of network impairments: variable and fixed. Variable impairments consist of the linear addition of controlled amounts of band-limited analogue white noise prior to the digitally encoded channel. Fixed impairments consist of group and attenuation distortion, phase jitter, and second and third order non-linear distortion. The impairments to be injected in the analogue channel should be in accordance with Tables 1/G.720 and 2/G.720.

The test configuration is the same as shown in Figures 1/G.720 and 2/G.720.

6.1.1.2 Digital impairments

For further study.

6.1.2 Access link impairments conditions

1)   Analogue voiceband impairments will be as specified in Tables 1/G.720 and 2/G.720.

2)   Selected PCM-path digital errors are introduced between the calling CME and calling facsimile terminal (i.e. between the calling CME decoder and PCM decoder No. 2). This is used to investigate the CME recovery procedures during unexpected signal-type transmissions resulting from procedural signal corruption.

6.2 Traffic loading

6.2.1 Definition

Four conditions for loading the CME are defined for the purposes of investigating facsimile quality and CME behaviour. These are:

•   CME in an Underload (UL) condition with speech traffic;

•   CME in an Overload (OL) condition with speech traffic;

•   CME in a Heavy Overload (HOL) condition with speech traffic;

•   CME in an Overload condition due to Facsimile (OLF).

To simulate the four loading conditions defined above, a channel activity simulator shall be employed. For all CME input channels which carry traffic, other than facsimile, the simulated voice activity factor shall be equal to 37%. This activity factor shall be used for both calling and called CME, although the loading conditions will, typically, be separately defined (see 6.2.2) at each end, thus implying that traffic asymmetry may be desirable for some test conditions.

6.2.1.1 CME in a UL condition

In this case, the number of CME input trunks carrying speech are less than or equal (including any facsimile traffic under test) to the number of CME bearer channels available for carrying speech. No CME bearer channels are thus in overload in this configuration and, for simulated speech traffic, the average bits per sample equals 4.0. Any facsimile traffic is applied on a single CME input channel only.

6.2.1.2 CME in an OL condition

In this case, the number of CME input trunks carrying speech exceeds (including any facsimile traffic under test) the number of CME bearer channels available for carrying speech. Therefore, a significant number of channels (**but not all**) may be in overload thus causing, for simulated speech traffic, the average bits per sample to equal 3.7 to 3.8. Any facsimile traffic is applied on a single CME input channel only.

6.2.1.3 CME in an HOL condition

In this case, the average bit per sample equals 3.3 to 3.4 (for simulated speech traffic). Any facsimile traffic is applied on a single CME input channel only.

6.2.1.4 CME in an OLF condition

In this case, 70% of the CME bearer channel capacity is occupied due to the transport of facsimile traffic and the remaining capacity is used to carry simulated speech traffic at a lower average but per sample than what achieves toll quality. (This is defined for each coding algorithm and for each type of equipment.) The facsimile traffic is real, rather than simulated, using repeated 3-page transmissions in the standard configurations defined in 5.4 are employed. These transmissions are used for the purpose of loading the CME in a controlled fashion; however, their quality is not monitored. In this case, a new facsimile call is initiated every 10 s.

NOTE – Testing of CME with other voice coding algorithms than ADPCM, e.g. G.728 and G.729, is for further study.

6.2.2 Loading conditions

Seven different configurations are described. The first four to be used in every case, and the last three to be used in multiple or multinode only.

Loading Condition	Calling CME	Called CME	Remarks
1	UL	UL	All cases
2	OL	OL	All cases
3	HOL	HOL	All cases
4	OLF	OLF	All cases
5	OL	UL	Multidestination and multinode only
6	HOL	UL	Multidestination and multinode only
7	OLF	UL	Multidestination and multinode only

6.3 Delay

To simulate different types of possible connections, delay should be introduced in the CME bearer link, when undertaking laboratory tests.

Three conditions will be tested:

- LD: Low Delay to represent fibre or submarine cable connections – **40 ms one-way delay**.
- MD: Medium Delay to represent one-hop satellite connections – **270 ms one-way delay**.
- HD: High Delay to represent two-hop satellite connections – **540 ms one-way delay**.

6.4 Bearer impairments

The digital errors introduced here shall be as representative as possible of the actual conditions on the transmission link.

The purpose of introducing bearer impairments is to:

1) observe the effect of bearer channel impairments on the end-user facsimile terminal customer performance;

2) observe the CME behaviour when particular types of traffic are being transmitted under specific bearer channel impairment conditions;

3)   mark customer traffic so that the CME path employed can be determined at the destination end-user terminal location.

Injection of errors on the bearer depends on whether the CME is based on circuit or packet transmission. In case of circuit-based transmission, two different methods to generate and inject impairments in the CME bearer channel are possible.

6.4.1   Circuit-oriented CME

There are two aspects to be considered in circuit-oriented CME, the generation of the bearer channels with injection of markers.

6.4.1.1   Generation of bearer errors

The purpose of this method is:

1)   to assess the performance obtained at the end-user facsimile terminal under simulated operating conditions;

2)   to observe the CME's behaviour under specific impairment conditions (that may include and/or exceed the extreme values of the CME operating range).

The reference condition will be a time interval during which there are no bit errors (i.e. error-free interval).

Digital errors in the bearer channel shall be injected according to one of the following formats:

1)   Random bit errors over the entire bearer representing the operating range of interest;

2)   Grouped errors according to the following patterns:

   •   Specific bit errors over the customer traffic-carrying bearer slots only (i.e. CME control channel excluded, assuming there is one);

   •   Specific bit errors over the CME control channel slots only (assuming there is one);

   •   Specific burst errors over the entire CME bearer channel;

   •   Specific multiple errors over the entire CME bearer channel.

3)   Random burst errors of controlled duration over the entire CME bearer channel.

In particular, for the grouped and burst errors:

1)   The specific errors patterns to be introduced in circuit-oriented CME customer traffic-carrying slots are generated as follows:

   •   For ADPCM encoded channels:

      –   Least Significant Bit (LSB);

      –   Second LSB;

      –   Third LSB (or Most Significant Bit − 1);

      –   Fourth LSB (= Most Significant Bit) (if there is one).

   Other types of traffic are for further study.

2)   The specific error patterns to be introduced in circuit-oriented CME control channels are defined as follows:

      –   LSB;

      –   LSB and second LSB;

      –   LSB, second LSB and third LSB;

      –   LSB, second LSB and third LSB.

3) For the introduction of specific burst-error patterns over the entire CME bearer, a "burst-error injector" is required. This equipment permits the selective (by position) inversion of a specified number of bits, starting after the expiration of a predetermined time interval where no bit errors are injected. Three parameters are defined:

- length of burst;
- bit-error distribution within burst;
- frequency of burst occurrence.

4) Specific multiple-error patterns over the entire bearer channel are generated by corruption of contiguous CME bearer bits. This is accomplished by employing an impulse generator to inject single errors at a preselectable rate. A custom-built unit which permits the corruption of the next one, two, three, four, or five contiguous bits for every bit error inserted in the digitally transmitted signal is used for this test configuration. This will give rise to contiguous single, double, triple, quadruple, quintuple, and sextuple error events respectively.

5) Random burst errors of controlled duration over the entire bearer may be generated by utilization of a burst-error generator to directly inject errors into the CME bearer channel. This method permits the corruption of N randomly distributed bits within a contiguous window of 2N bits of transmitted data. This method of burst-error generation (which are no longer specific) utilizes commercially available bit-error equipment.

6.4.2 Identification of the bearer channels with markers

The purpose here is to mark the end-user traffic to tag the CME path employed at the destination end-user terminal location. The idea is to exploit the difference in transmission error properties of the ADPCM encoded path and the facsimile demodulated/remodulated path.

In particular, it is known that errors are injected in the ADPCM encoded path, the recovered baseband signal at the receiving facsimile terminal will experience more bits with errors for every erroneous bit of the encoded bit-stream. This effect is known as the error multiplication effect. By contrast, errors introduced on a demodulated CME path (in the now baseband signal), the recovered baseband signal at the receiving facsimile terminal will only contain the same number of bits in error as the number of erroneous bits in the CME bearer bit-stream. It is assumed, of course, that no further impairments are introduced in the facsimile signal between the CME remodulation point and the receiving end-user terminal.

This property can be used to tag the traffic so that the correct routing of facsimile messages can be determined at the called facsimile terminal without decoding the CME input to bearer channel assignment information.

These type of "marking" errors are introduced as follows:

The entire bearer stream of one (and only one) CME frame is impaired so that every bit (preferably excluding any CME control channels) is in error. The type of frame to be in error is for further study and may be CME terminal dependent. Since each bearer slot that can carry voiceband data is either 4, 5 or 8 bits, inverting the user traffic will result in:

1) no more than 8 bits in error, if the facsimile traffic is carried in the demodulated path; or

2) several bits in error (typically > 15) if the facsimile traffic is carried in the ADPCM path.

This observation is obtained at the receiving (called) facsimile terminal, and is based on the assumption that the baseband Run-Length Coded bit-stream transmitted by the calling terminal is known at the called terminal. It is preferable to avoid traffic "error marking" and rely on CME internal reporting capabilities, if possible.

6.4.3   Packet-oriented CME

In packet-oriented CME, the concepts of a bearer channel separate from a control channel do not apply. Therefore, the concern will be only the generation of bearer errors.

The reference condition will be a time interval during which there are no bit-errors (i.e. error-free interval).

Digital errors in the bearer channel shall be injected according to one of the following formats:

1)   random bit errors over the entire bearer representing the operating range of interest;

2)   random burst errors of controlled duration over the entire CME bearer channel.

For the introduction of specific burst errors over the entire CME bearer a "burst-error injector" is required. Four parameters are defined:

•   length of burst;

•   bit-error distribution within burst;

•   frequency of burst occurrence.

Random burst errors of controlled duration over the entire bearer may be generated by utilization of a burst-error generator to directly inject errors into the CME bearer channel. This method permits the corruption of N randomly distributed bits within a contiguous window of 2N bits of transmitted data. This method of burst-error generation (which are no longer specific) utilizes commercially available bit-error equipment.

6.4.4   Bearer conditions

Four different configurations will be used.

NOTE – Burst errors introduced into the return CME bearer channel are for further study.

6.4.4.1   BC1: Bearer Condition 1

Specific burst errors capable of affecting the entire bearer are included. The types of burst errors to be used in the forward channel for these tests reflect the characteristics of the communication system being simulated.

As explained in Recommendation G.826, the following characteristics need to be defined:

•   length of burst;

•   bit-error distribution within burst;

•   frequency of burst occurrence;

•   time interval where no bit errors are present (i.e. error-free interval).

For circuit-oriented CME, if the equipment provides a mechanism for internally accessing the channel assignment maps, then these maps shall be used for the identification of the path assigned to the facsimile call. If the CME does not permit such access, "marking" errors, as described in 6.4.1.2, shall be employed. When marking errors are used, these shall be introduced either in the forward channel for standard transmission, or in the return channel when polling is employed. If marking errors are employed, the burst errors defined above shall not be utilized in the same CME bearer channel direction.

The introduction of marking errors shall be undertaken so that the CME maintains synchronization. The marking errors shall be introduced once for each page of documentation transmitted.

6.4.4.2   BC2: Bearer Condition 2

Two sets of conditions shall be exercised: the first with no impairments in the forward CME bearer channel, and the second with three types of impairment conditions. These are:

- random bit errors over the entire bearer at an error rate reflecting the test-range of interest;
- grouped errors:
  - specific bit errors over the customer traffic-carrying bearer slots only (i.e. CME control channel excluded, assuming there is one – see 6.4.1.1);
  - specific bit errors over the CME control channel slots only (assuming there is one – see 6.4.1.1);
- medium-specific burst errors over the entire bearer to reflect the actual (see 6.4.1.1 and 6.4.2).

6.5   Forward error correction

Some tests will be with done with and without forward correction as shown in 6.7.

6.6   Return echo level

Some tests will be with done with and without echo level control as shown in 6.7. The values of the echo return loss will be as defined in 5.4/G.720.

6.7   Reference conditions

This subclause defines the various conditions that will be used during testing. Each condition can be the combination of some of the above subclauses. To minimize the number of tests, only the necessary combinations are listed.

6.7.1   Reference test condition 1

The purpose of this test condition is to study the capability of CME to detect and classify facsimile signals, and to handle proprietary facsimile fall-back to ADPCM.

Access-link impairments	Traffic loading	Delay	Bearer impairments	Forward error correction	Echo control
None	All seven loading conditions	• Low • Medium • High	Bearer condition 1	OFF	• OFF • ON

6.7.2   Reference test condition 2

The purpose of this condition is to study the combined effect of access link and bearer link impairments.

Access-link impairments	Traffic loading	Delay	Bearer impairments	Forward error correction	Echo control
• None • Digital and analogue	Loading condition 1	• Low • Medium • High	Bearer condition ?	• OFF • ON	• OFF • ON

6.7.3   Reference test condition 3

The purpose of this condition is to study the effect of bearer link impairments.

Access-link impairments	Traffic loading	Delay	Bearer impairments	Forward error correction	Echo control
None	Loading condition 1	• Low • Medium • High	Bearer condition 2	• OFF • ON ?	ON

6.7.4   Reference test condition 4

The purpose is to test CME recovery following unexpected event during facsimile call set-up.

Access-link impairments	Traffic loading	Delay	Bearer impairments	Forward error correction	Echo control
PCM-Path Digital Errors	Loading condition 1	• Low • Medium • High	None	• OFF • ON	• OFF • ON

6.7.5   Reference test condition 5

The purpose is to study the effect of echo on voiceband data quality.

Access-link impairments	Traffic loading	Delay	Bearer impairments	Forward error correction	Echo control
None	All seven loading conditions	• Low • Medium • High	None	OFF	• OFF • ON

6.7.6   Reference test condition 6

The purpose is to study the effect of facsimile protocol variability on facsimile quality.

Access-link impairments	Traffic loading	Delay	Bearer impairments	Forward error correction	Echo control
None	From • Loading condition 1 to • Loading condition 3	• Low • Medium • High	Bearer condition ?	• OFF • ON	ON

6.7.7 Reference test condition 7

The purpose is to study the effect of transmission level variability and echo return conditions.

Access-link impairments	Traffic loading	Delay	Bearer impairments	Forward error correction	Echo control
None	Loading condition 1	• Low • Medium • High	Bearer condition ?	OFF	• OFF • ON

Other test conditions to be considered are:

• transmit levels of calling facsimile terminal varying from 0 to –40 dBm0 in 5 dB decrements;

• primary 2- to 4-wire termination loss varying from 2 to 26 dB, in 4 dB increments.

6.7.8 Reference test condition 8

The purpose is to test the effect of transmission integrity due to timing deviations on facsimile quality.

Access-link impairments	Traffic loading	Delay	Bearer impairments	Forward error correction	Echo control
None	Loading condition 1	• Low • Medium • High	None	OFF	ON

7 Facsimile call quality assessment

The assessment of facsimile call cut-off performance shall conform to Recommendations E.450, E.451, E.452, E.453. In addition, the following performance parameters shall also be noted:

i) The data rate employed for the transmission of each document page (e.g. transmission rate employed during "Phase C" of the Group 3 facsimile protocol procedures as defined in Recommendation T.30).

ii) The type of post-message response issued by the receiving terminal indicating the quality of the T.30 message received (MCF, RTP, or RTN). A facsimile protocol analyser is necessary for this measurement. When such an analyser is employed, it shall be attached between the called CME and called Group 3 facsimile equipment.

iii) The ability to satisfactorily complete twenty 3-page calls. Other number of pages is for further study.

Accordingly, the facsimile call quality shall be reported in terms of the following parameters:

1) circuit configuration/condition number (includes loading characteristics, impairments introduced, CME systems used, calling and called facsimile terminal types, etc.);

2) average number of single scan-line errors per page;

3) average number of minor errors per page;

4) average number of major errors per page;

5) ratio of unacceptable pages to total pages transmitted;

6) negotiated rate for first page transmitted;

7)   negotiated rate for last page transmitted;

8)   number of RTP indications issued by the called facsimile terminal;

9)   number of RTN indications issued by the called facsimile terminal;

10)   number of calls failed prior to transmission of page 1;

11)   number of calls failing to complete the 3-page test document transmission;

12)   total pages received by called facsimile terminal;

13)   type of facsimile path provided by CME (i.e. ADPCM encoded, demodulated).

When the optional T.4 Error Correction Mode (ECM) is employed by the end-user facsimile terminals, the facsimile transmission performance indicators to be additionally reported are for further study.

When the received facsimile message can be compared to the original transmitted message (Run-Length Coded) the following additional performance indicators shall be obtained:

1)   bit-error ratios;

2)   block-error ratios (1000 bit/block and 511 bit/block);

3)   distributions of lengths of error events (from the first to the last bit in error);

4)   distributions of the number of bits in error in the error event.

8   Baseline measurements

Baseline measurements are required for two purposes (other than calibrating the analogue impairment channel). First, the behaviour and correct operation of the end-user facsimile terminals needs to be characterized in the absence of CME type of circuits, or channel impairments. Second, the correct operation of the CME needs to be assessed prior to undertaking facsimile tests.

8.1   Facsimile terminal baseline tests

The behaviour and correct operation of the end-user facsimile terminals shall be characterized in the absence of CME-type of circuits, or channel impairments. There are two basic configurations defined for this purpose. In baseline configuration No. 1, the facsimile terminals are directly connected over a circuit employing 64 kbit/s PCM encoding. Attenuation or gain controls are provided, as appropriate, in order to preserve the signal levels at the facsimile terminal and PCM encoder/decoder interfaces. This baseline measurement circuit is shown in Figure 5.
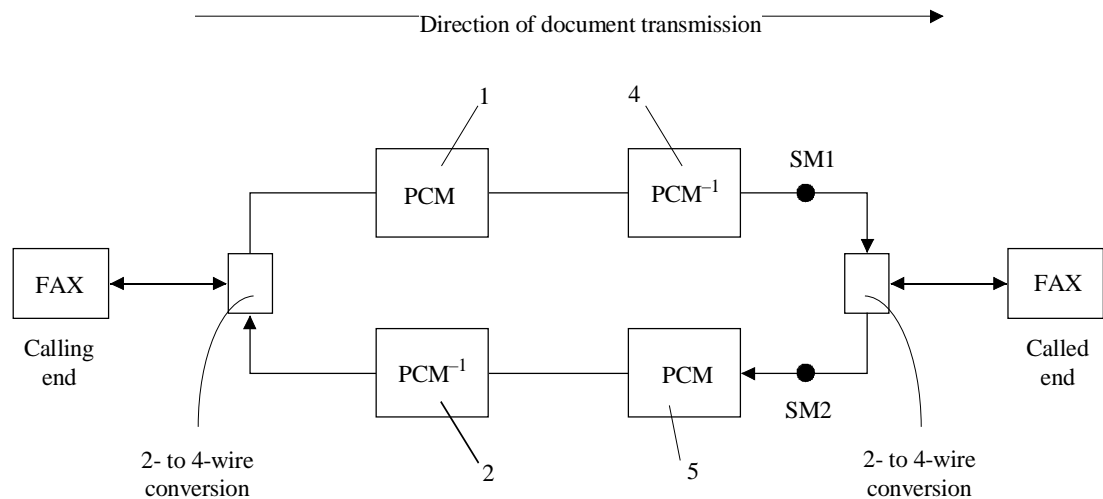
Figure 5/G.511 – Facsimile terminal baseline circuit configuration No. 1

Note that a local office network/simulating loop which provides ringing, voltage drop, DTMF decoding and other locally generated signals will also be required, but is not shown in the figures throughout this test methodology. It is assumed that such equipment will be provided to permit normal facsimile equipment operation.

It is suggested that a facsimile protocol analyser that provides facsimile protocol signal decoding and facsimile signal activity timing be employed, at least at one end of the circuit, connected at an appropriate interface point between the facsimile terminal and the PCM equipment. Appropriate interface points for signal activity monitoring are denoted as SM1, and SM2 in Figure 5. It is recommended that the timing acquisition between points SM1 and SM2 be synchronized.

In baseline configuration No. 2, Figure 6 the facsimile terminals are directly connected over a circuit employing 64 kbit/s PCM encoding and echo control equipment. In addition, simulated circuit and CME processing delay τ is introduced between the calling and called ends (this is shown in the PCM encoded paths. The introduction of simulated delay in the analogue circuit may also be acceptable, provided that resulting echo path does not exceed any echo control processing window constraints).

It is suggested that in baseline configuration No. 2, facsimile protocol analysers which provide facsimile protocol signal decoding and facsimile signal activity timing be employed, at both ends of the circuit, connected at appropriate interface points between the facsimile terminals and the PCM equipment. Appropriate interface points for signal activity monitoring are denoted as SM1, SM2, SM3, and SM4 in Figure 6. If all four points are accessed, it is recommended that, as a minimum, the timing acquisition between points SM1 and SM2 be synchronized. The synchronization of points SM3 and SM1 is also recommended.
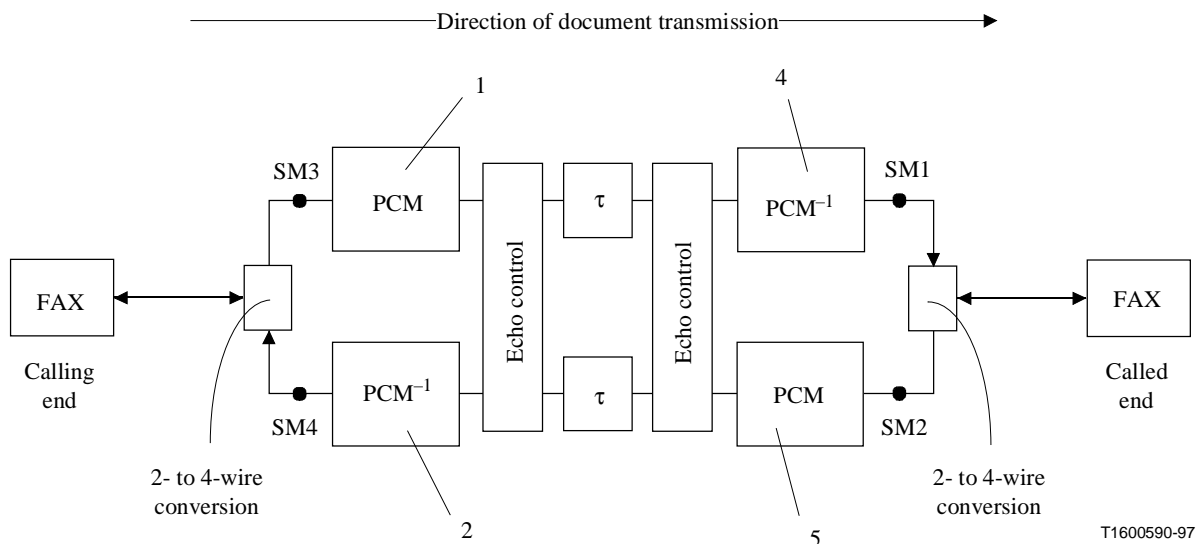
Figure 6/G.511 – Facsimile terminal baseline circuit configuration No. 2

8.2 CME baseline tests

In addition to the facsimile terminal baseline tests, the correct operation of the CME needs to be assessed prior to undertaking facsimile tests. This can be accomplished by verifying the long term CME timing synchronization and bit integrity using a digital test pattern and data error analyser.

This baseline configuration is shown in Figure 7. During these baseline measurements (it is recommended that CME synchronization be verified over a 72-hour period) related status alarms should be monitored, as appropriate, depending on the CME system's diagnostic capabilities.
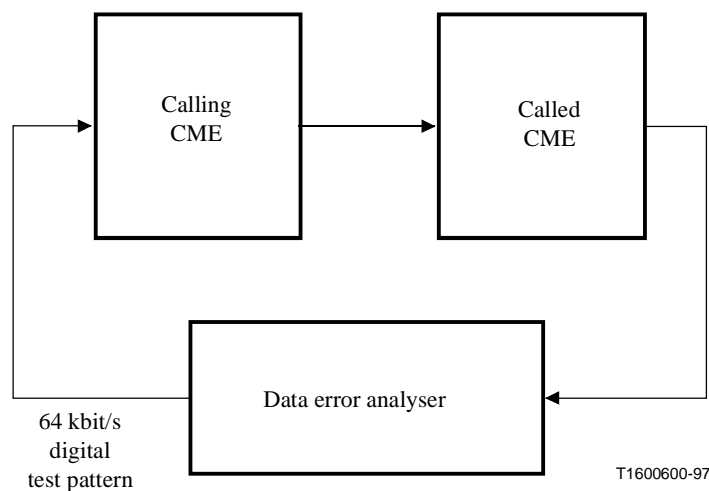
Figure 7/G.511 – CME baseline circuit configuration

9 Test methodology

A functional block diagram of the generic experimental configuration to be used in these tests is shown in Figures 8 and 9. In this configuration, τ represents a simulated one-way propagation delay. When the tests are conducted in a laboratory, $\tau = 250$ ms (simulated one-way satellite propagation delay). When field tests are being undertaken, $\tau = 0$ ms. Throughout this test-methodology, nominal transmission levels shall be employed, as indicated in Figures 8 and 9, unless otherwise noted.

Direction of document transmission (standard)

Direction of document transmission (polling)

dBm
TLP

dBm
TLP

dBm
TLP

Digital
impairments

Bearer
impairments
(forward channel)

dBm
TLP

dBm
TLP

Fax

Analogue
impairments

PCM

Echo control

S_{out}

Calling
CME
encoder

τ

Calling
CME
decoder

R_{in}

Echo control

PCM^{-1}

Analogue
impairments

Fax

Calling
end

PCM^{-1}

R_{in}

Calling
CME
decoder

τ

Calling
CME
encoder

S_{out}

PCM

Called
end

Bearer
impairments
(reverse channel)

Digital
impairments

dBm
TLP

dBm
TLP

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**Figure 8/G.511 – First example of functional block diagram of the
generic experimental configuration**

Direction of document transmission (standard)

Direction of document transmission (polling)

#1

#1

Digital
impairments

Bearer
impairments
(forward channel)

#4

#2

Analogue
impairments

PCM

Echo control

S_{out}

Calling
CME
encoder

τ

Calling
CME
decoder

R_{in}

Echo control

PCM^{-1}

Analogue
impairments

Fax

Calling
end

PCM^{-1}

R_{in}

Calling
CME
decoder

τ

Calling
CME
encoder

S_{out}

PCM

Fax

Called
end

2- to 4- wire
conversion

#2

Bearer
impairments
(reverse channel)

Digital
impairments

#5

2- to 4- wire
conversion

T1600620-97

**Figure 9/G.511 – Second example of functional block diagram of the
generic experimental configuration**

ANNEX A

Group 3 facsimile procedures

A.1   Group 3 facsimile recognition: detection and classification

A.1.1   Objective

When a Group 3 facsimile call is initiated, and if a demodulation/remodulation capability is provided by both the calling and called CMEs, the call will be routed to the demodulated path shortly after its establishment. The decision process that dictates when the facsimile call will be switched to the demodulated path may vary between CME systems, although the demodulated path is likely to be used shortly after the completion of the Phase A procedures defined in Recommendation T.30 [e.g. no later than following the transmission of the Digital Command Signal (DCS) by the calling facsimile terminal]. The objective of these tests is to determine the facility selection reliability, or alternatively whether, and under what circuit or CME loading conditions, is a demodulated path selected when a compatible facsimile call is being established.

A.1.2   Settings

Facsimile terminal configuration:

Group 3 facsimile terminal in configuration Std/Conf/3 will be selected (see 5.1.3).

A.1.3   Test conditions

Use reference test condition 1, as defined in 6.7.1.

A.1.4   Parameters of investigation

The following parameters shall be varied during these tests:
•   direction of transmission (normal and polling);
•   type of burst characteristics in the CME bearer channels; and
•   loading characteristics of calling and called CMEs.

A.1.5   Monitoring/measurement points

If the CMEs provide a mechanism for internally accessing the channel assignment maps, then these maps shall be used for the identification of the path (or facility) assigned to the facsimile call, as stated above. Otherwise, marking errors may be employed (depending on CME design), and the received RLC encoded bit-image shall be compared against the transmitted RLC encoded bit-image to determine the presence (or absence) of error-multiplication effects.

A.2   Proprietary facsimile fall-back to ADPCM path

A.2.1   Objective

When a Group 3 facsimile call is initiated, and if a demodulated path can be provided by both the calling and called CMEs, the call will be routed through the demodulated path during or after its establishment. The demodulated path is likely to be used shortly after the completion of the Phase A procedures defined in Recommendation T.30 [e.g. no later than following the transmission of the Digital Command Signal (DCS) by the calling facsimile terminal]. The decision process which dictates when the facsimile call will be switched to the demodulated path may vary between CME systems. In addition, the capability to accommodate proprietary facsimile transmissions over the

demodulated signal path may be limited and, in certain cases, fall-back into the ADPCM encoded path may be necessary if the facsimile mode of negotiated communication is incompatible with the CME demodulated path capabilities. The objective of these tests will be to determine whether, and under what circuit or CME loading conditions, a selected demodulated path will be substituted by an ADPCM encoded path when a incompatible facsimile call (initially through demodulated path) is established following the completion of T.30/Phase A.

A.2.2 Settings

A.2.2.1 Facsimile terminal configuration

Non-standard Group 3 facsimile mode 2 (see 5.2.2) terminals shall be selected. Experimentation (or collaboration with the CME system manufacturer) may be required to select a suitable pair of terminals.

A.2.2.2 Mode of transmission

Two modes are defined:

- The calling terminal which initiates the communication (e.g. by transmitting the CNG tone to the called terminal) wishes to transmit to the called terminal (standard configuration);
- The calling terminal which initiates the communication (e.g. by transmitting the CNG tone to the called terminal) wishes to receive from the called terminal (polling configuration).

A.2.3 Test conditions

Use reference test condition 1, as defined in 6.7.1.

A.2.4 Parameters of investigation

From the above it can be seen that the following parameters will be varied during these tests:

- direction of transmission (normal and polling);
- type of burst characteristics in the CME bearer channel; and
- loading characteristics of calling and called CMEs.

A.2.5 Monitoring/measurement points

The same procedures shall be used as those defined for the tests of A.9.4.

A.3 Group 3 facsimile image quality in presence of combined access link and bearer link impairments

A.3.1 Objective

The objective of these tests will be to evaluate the impact of access link degradation on facsimile quality over different CME processing path conditions and in the presence of nominal CME bearer impairments.

A.3.2 Settings

A.3.2.1 CME configuration

When the CMEs provide alternate paths for the transmission of facsimile that can be selected (such as compressed with error protection, compressed without error protection, and ADCPM encoded) the paths shall be separately exercised.

A.3.2.2 Facsimile terminal configuration

Group 3 facsimile terminal in Std/Conf/1 or Std/Conf/2 configuration will be selected (see 5.1.1 and 5.1.2).

A.3.3 Test conditions

Use reference test condition 2, as defined in 6.7.2.

A.3.4 Monitoring/measurement points

The quality of the facsimile image transmission is monitored at the called facsimile terminal in accordance with the methods defined in clause 4.

A.4 Group 3 facsimile image quality in presence of bearer link impairments

A.4.1 Objective

The objective of these tests is to evaluate the impact of CME bearer degradation on facsimile quality over different CME processing path conditions as a function of CME access link impairments.

A.4.2 Settings

A.4.2.1 CME configuration

When the CMEs provide selectable alternate paths for the transmission of facsimile (such as compressed with error protection, compressed without error protection, and ADCPM encoded) the paths shall be separately exercised.

A.4.2.2 Facsimile terminal configuration

Group 3 facsimile terminal in Std/Conf/1 or Std/Conf/2 configurations will be selected (see 5.1.1 and 5.1.2).

A.4.3 Test conditions

Use reference test condition 3, as defined in 6.7.3.

A.4.4 Monitoring/measurement points

The quality of the facsimile image transmission is monitored at the called facsimile terminal in accordance with the methods defined in clause 4.

A.5 CME recovery following unexpected events during facsimile call progress

A.5.1 Objective

The purpose of this test is to assess the adaptability of CME behaviour when the progression of a facsimile call is disturbed, either by premature facsimile terminal disconnection, or by unexpected signal-type transmissions resulting from a procedural signal corruption between the calling CME and the calling facsimile terminal (see Figures A.1 and A.2 for an example of an unexpected signal-type transmission).

A.5.2 Settings

Facsimile terminal configuration:

Group 3 facsimile terminal in Std/Conf/1 configuration will be selected (see 5.1.1).

A.5.3 Test conditions

Use reference test condition 4, as defined in 6.7.4.

Other test conditions to be considered:

Two test conditions are defined. First, corruption of the Confirmation to Receive (CFR) signal in the T.30 sequence is introduced between the calling CME and the calling facsimile terminal. Second, the call is prematurely terminated and the recovery of the CME equipment is observed. (It is noted that these tests may be more easily conducted using the protocol test set described in A.7.2.2).
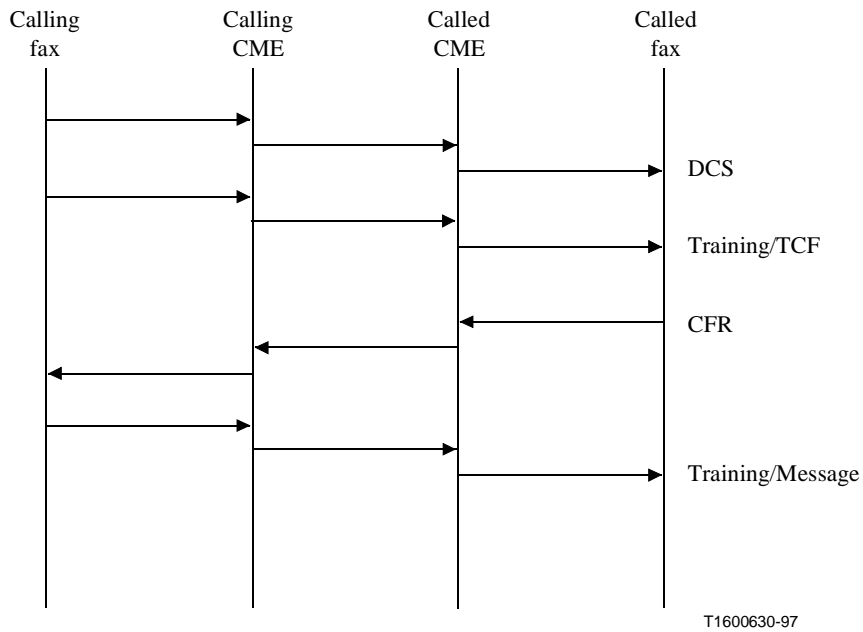

Figure A.1/G511 – T.30 normal signal transaction in the presence of CME
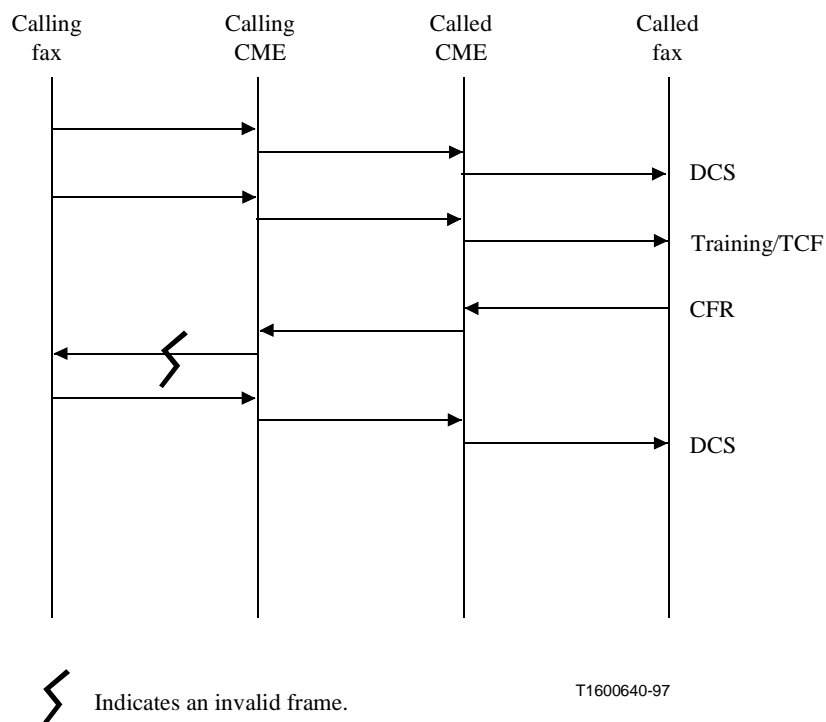
**Figure A.2/G.511 – T.30 signal transaction in the presence of CME
when CFR signal is corrupted**

A.6 Voiceband data quality

A.6.1 Objective

The objective of these tests is to verify that voiceband data are assigned to an appropriate CME facility, and are not directed to a demodulated facsimile path unless this is fully compatible with the modulation scheme and protocols used by the end-user terminal.

A.6.2 Settings

Facsimile terminal configuration:

No facsimile terminals are employed. Instead, the following modems are used in a two-wire dial-up configurations:

• V.27 *ter* operating at 4.8 kbit/s;

• V.17 operating at 14.4 and 12 kbit/s;

• V.29 operating at 9.6 kbit/s.

Other rates are for further study.

A.6.3 Test conditions

Use reference test condition 5, as defined in 6.7.5.

A.6.4 Monitoring/measurement points

The integrity of the transmission shall be determined by computation of the received data bit (or block) error rate, and by comparison of this against available Modem/ADPCM codec performance data. Alternatively, a simpler monitoring configuration may be used whereby the CME

routing of the voiceband data channel can be determined by examination of the CME channel assignment data, if accessible.

A.7 Effect of Group 3 facsimile protocol variability

A.7.1 Objective

Recommendation T.30 leaves considerable margin in the implementation of conformant terminals operating in Group 3 mode. In addition, many terminals purposely violate Recommendation T.30 in minor ways in order to overcome inherent limitations arising, primarily, from incorrect provisioning of echo control devices. In this, the impact of Group 3 facsimile protocol variability on the behaviour of CME systems and associated impact on facsimile quality will be addressed.

A.7.2 Settings

A.7.2.1 Facsimile terminal configuration

Group 3 facsimile terminal in Std/Conf/2 configuration will be selected.

A.7.2.2 Instrumentation

A facsimile test-set is required to study the effect of Group 3 facsimile protocol variation on CME and facsimile terminal behaviour. The facsimile protocol test set comprises a tool capable of operating in a real-time baseband facsimile signal domain so that signals and protocols exchanged between two facsimile terminals may be modified under operator control on a selective basis. (Note that test 9 may be administered more conveniently using such a facsimile protocol test-set). A functional configuration of such a device (as well as the suggested location of the instrumentation) is shown in Figure A.3. In Figure A.3 only the calling side of the test configuration is shown. The called side remains configured in accordance with the functional diagram shown in Figure 8.

A.7.3 Test conditions

Use reference test condition 6, as defined in 6.7.6.

A.7.4 Parameters of investigation

The following test conditions will be investigated with these tests.

NOTE – Cases marked with an asterisk (*) shall be tested with the different times of delay: (low/medium/long).

- Variation of T.30 signal timing
    - Adjacent signals*
    - Response signals*
- Selective degradation of message content
    - High-Speed message signals
    - Training check sequence*
    - Binary coded handshaking signals*
- Addition or deletion of handshaking signal preamble*
- Addition, removal, or alteration of handshaking signal units*
- Enforcement of specific facsimile terminal negotiation constraints

- Addition and removal of echo protection tones in the following signal exchanges:
  - Training/TCF*
  - Training/Message signals*

A.8   Effect of transmission level and echo return loss

A.8.1   Objective

The objective is to observe the effect of the reconstructed image.

### A.8.2   Settings

Facsimile terminal configuration:

Group 3 facsimile terminal in Std/Conf/2 configuration will be selected.

A.8.3   Test conditions

Use reference test condition 7, as defined in 6.7.7.

A.8.4   Parameters of investigation

Two primary parameters are varied in this investigation. The first is the called facsimile terminal transmission level. The second is the 2- to 4-wire termination loss interconnecting the called CME with the called facsimile terminal. The configuration where these parameters are to be varied is shown in Figure A.3 (In Figure A.3 only the called side of the test configuration is shown. The calling side remains configured in accordance with the functional diagram shown in Figure 8).
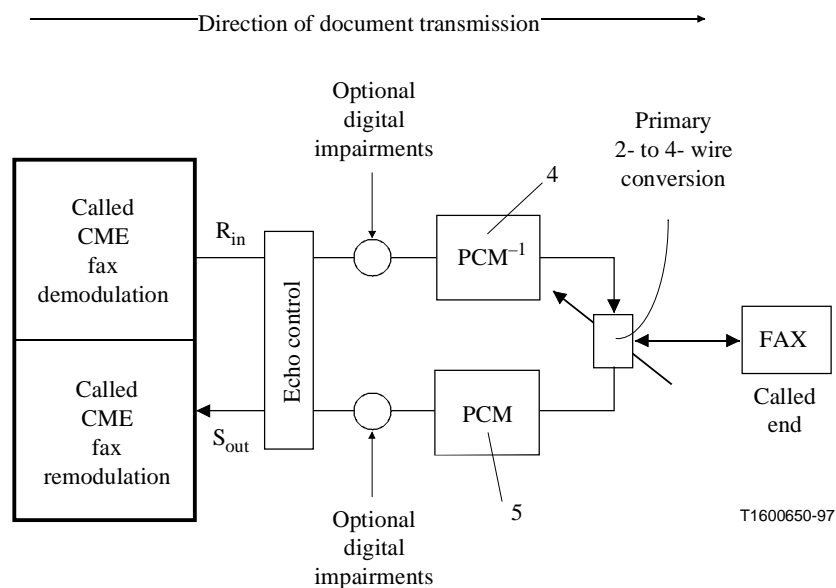
Figure A.3/G.511 – Test configuration for level/loss tests
(End of test configuration only shown)

A.8.5   Monitoring/measurement points

The called CME input channel activity detectors shall be monitored when a facsimile (half-duplex) signal is being sent from the calling to the called facsimile terminal. If direct (or indirect) monitoring

of the activity detector output is not possible, the signal output of the calling CME decoder shall be monitored.

A.9   Impact of transmission integrity due to timing deviations on facsimile call quality

A.9.1   Objective

The objective of this test is to assess the integrity of communication when the CME demodulated facility is used and the length of transmitted document exceeds the average page length of 30 seconds. In this manner, the provision of adequate message buffering required to accommodate the independence of the bearer and facsimile terminal clocks can be verified.

A.9.2   Settings

A.9.2.1   CME configuration

When the CMEs provide selectable alternate paths for the transmission of facsimile, the demodulated path shall only be exercised.

A.9.2.2   Transmitted document characteristics

The same tests pages as defined in 4.4 shall be employed for reference (baseline) measurements. Documents of different lengths conformant to the characteristics defined in clause 3 shall however be used to verify the page integrity as a function of page length.

A.9.3   Test conditions

Use reference test condition 8, as defined in 6.7.8.

A.9.4   Monitoring/measurement points

The quality of the facsimile image transmission is monitored at the called facsimile terminal in accordance with the methods defined in clause 4.

A.10   Items for further study

This subclause summarizes the different points that have been identified as potential items in future revisions of this Recommendation.

A.10.1   Rates and modulation schemes
- V.29 at 7200 bit/s and 9600 bit/s;
- V.27 *ter* at 4800 bit/s;
- V.27 *ter* at 2400 bit/s;
- V.34;
- V.17.

A.10.2   Facsimile quality assessment

The ability to satisfactorily complete twenty calls with a number of pages different from 3.

The facsimile transmission performance indicators to be additionally reported, when the optional T.4 Error Correction Mode (ECM) is employed.

A.10.3   Coding algorithms

Testing of CME with other voice coding algorithms, e.g. G.728 and G.729, is for further study.

A.10.4 Errors

The entire bearer stream of one (and only one) CME frame is impaired so that every bit (preferably excluding any CME control channels) is in error. The type of frame to be in error is for further study and may be CME terminal dependent.

Burst errors introduced into the return CME bearer channel.

Impairments introduced into the return CME bearer channel.

A.10.5 CME networks

The issues related to the tandeming of CMEs.

A.10.6 Other SPNE

Other types of SPNE, such as devices for automatic level control, are for further study.

APPENDIX I

Identifying a demodulated call in a DCME

The purpose of this appendix is to suggest a method for determining if a specific call passed through the facsimile demodulation/remodulation path. The method is non-intrusive and is simple to implement.

I.1   Principles

When a facsimile call is switched to the demodulation/remodulation path, an additional delay is introduced. The specific delay is of between 70 and 100 ms.

In a DCME, the switch is after the originating endpoint DCME sees the DIS signal transmitted by the called fax machine. Monitoring this additional delay can be used to determine if a specific call passes through the facsimile demod/remod path.

One of the following methods can be used:

–   **Method 1**

Measure end-to-end delay of the DIS signal and of the next V.21 signal transmitted from the called to calling side (CFR signal in case of a normally progressing call) and compare the two values. The delay is measured between measurement points ① and ② in Figure I.1.

–   **Method 2**

Measure the gap between the DIS signal and the next V.21 signal transmitted from the called to calling side. The measurements are performed at the transmitting side (measurement point ①) and at the receiving side (measurement point ②). The values are then compared to see if the difference is about 100 ms.

When the two CMEs are not located in the same geographical site, it should be possible to configure DCME 2 to split and loopback the incoming channel over a clear (preassigned) channel back to DCME 1 and use measurement point ③ instead of ②. The additional delay over the path between ② and ③ remains constant for the entire measurement procedure so the method is still valid.
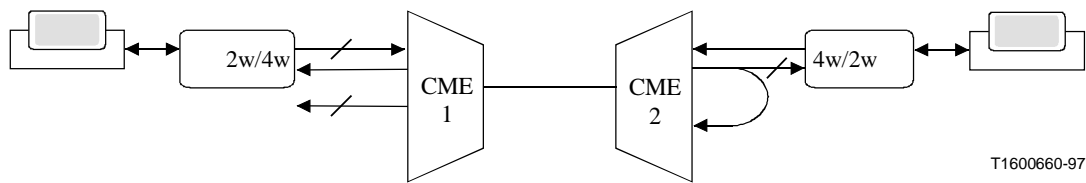
Figure I.1/G.511 – Measurement set-up

I.2 Implementation

– Method 1

Connect the two measurement points to two channels of a digital oscilloscope. Set the sweep trigger to measurement point ① and use Single Scan mode (i.e. after the scope is triggered, it performs one scan and stops). Set the time span to the time between the DIS and the next V.21 signal from the called machine plus the end-to-end delay. Start the fax transaction and use the DIS to trigger the single scan. Use the scope markers to measure the end-to-end delays.

– Method 2

A facsimile protocol analyser identifies each signal in a facsimile call protocol, its length (in seconds) and the duration of silence gaps between each pair of consecutive signals. Use one at each measurement point and compare the readouts for the duration of the silence gaps between the DIS and the following V.21 signal at both ends.

Bibliography

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