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ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

G.722

Appendix II
Test sequences
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SERIES G: TRANSMISSION SYSTEMS AND MEDIA

Digital transmission systems – Terminal equipments – Coding of analogue signals by methods other than PCM

Description of the digital test sequences for the verification of the G.722 64 kbit/s SB-ADPCM 7 kHz codec

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DESCRIPTION OF THE DIGITAL TEST SEQUENCES FOR THE VERIFICATION OF THE G.722 64 kbit/s SB-ADPCM 7 kHz CODEC

This guide gives information concerning the digital test sequences which should be used to aid verification of implementation of the ADPCM codec part of the wideband coding algorithm.

The guide reproduces mainly the text in Recommendation G.722 Appendix II as it was first published in *Blue Book* Fascicle III.4 (1988), and more particularly the tables and figures of that Appendix with the same numbering. The amendments correspond to the grouping on a single 3½" disk of the files which were previously on three 5¼" disks.

1 Input and output signals

Table 1 defines the input and output signals for the test sequences. It contains some signals (indicated by #) peculiar to these test sequences in order to facilitate the interface between the test sequence generator/receiver and the encoder/decoder. 16-bit word formats for these input and output signals are shown in Figures 1, 2 and 3.

Table 1 – Description of input and output signals for test sequence

Name	Description
XL	15-bit uniformly quantized input signal to the lower sub-band encoder
XH	15-bit uniformly quantized input signal to the higher sub-band encoder
X#	Input test sequence with 16-bit word format as shown in Figure 1
IL	6-bit lower sub-band ADPCM codeword
ILR	Received 6-bit lower sub-band ADPCM codeword
IH	2-bit higher sub-band ADPCM codeword
I#	Output (in Configuration 1) and Input (in Configuration 2) test sequence with 16-bit word format as shown in Figure 2
RL	15-bit uniformly quantized output signal from the lower sub-band decoder
RH	15-bit uniformly quantized output signal from the higher sub-band decoder
RL#	Output test sequence with 16-bit word format as shown in Figure 3
RH#	Output test sequence with 16-bit word format as shown in Figure 3
RSS	Reset/synchronization signal
VI	Valid data indication signal

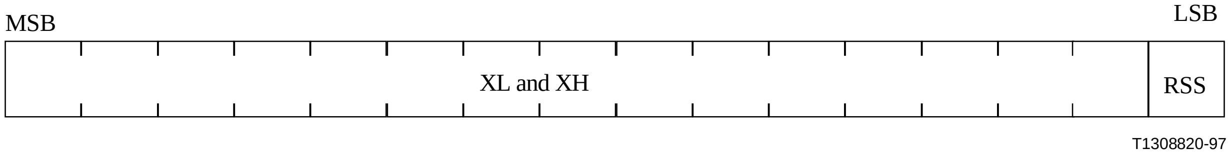
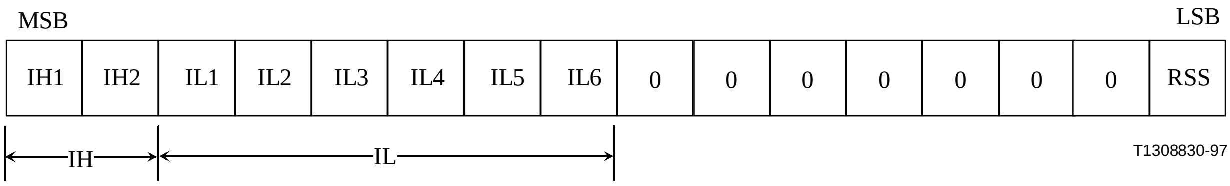


Figure 1 – Word format of X#



NOTE 1 – IH1 and IL1 are MSBs of IH and IL, respectively.
NOTE 2 – IL is read as ILR in Configuration 2.

Figure 2 – Word format of I#

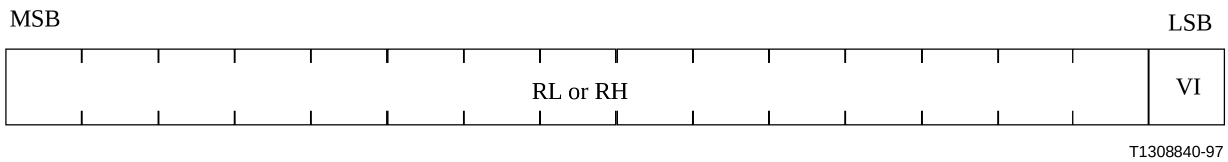


Figure 3 – Word format of RL# and RH#

2 Configurations for the application of test sequences

Two configurations (Configuration 1 and Configuration 2) are appropriate for use with test sequences. In both configurations, a TEST signal is used to make the encoder and decoder ready to be tested with the digital test sequences. When the TEST signal is provided, the QMFs are by-passed and the test sequences are applied directly to the ADPCM encoders or decoders. An RSS signal is extracted from the input test sequences X# (I# in decoder) and results in a reset signal RS for the encoder and decoder. The RS signal will be used to initialize state variables (those indicated by * in Table 13/G.722 to zero or specific values.

2.1 Configuration 1

Configuration 1 shown in Figure 4 is a simplified version of Figures 4/G.722 and 5/G.722. The encoder input signals, XL and XH, are described in Table 12/G.722. These input signals are directly fed to the respective lower and higher sub-band ADPCM encoders, by-passing the QMF. The encoder output signals, IL and IH, are defined in the sub-block QUANTL and QUANTH, respectively.

This sequence is used for testing the quantizer/predictor feedback loop in the encoder.

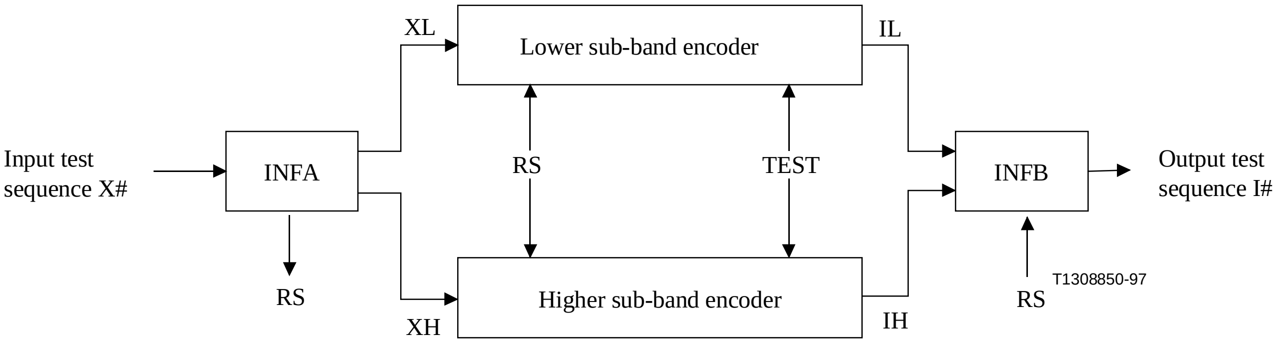


Figure 4 – Configuration 1 – Encoder only

2.2 Configuration 2

Configuration 2 shown in Figure 5 is a simplified version of Figures 7/G.722 and 8/G.722. The test signals, ILR and IH, and the MODE signal are described in Table 12/G.722. The corresponding decoder output signals, RL and RH, are defined in the sub-blocks LIMIT in 6.2.1.6/G.722 and 6.2.2.5/G.722. For the lower sub-band, the ADPCM decoder output signals are derived for three basic modes of operation (Modes 1, 2 and 3). By-passing the QMF, the output signals, RL and RH, are separately obtained from the lower and higher sub-band ADPCM decoders, respectively.

Configuration 2 is used for testing the inverse quantizer operation and the predictor adaptation without a quantizer/predictor feedback loop in the decoder.

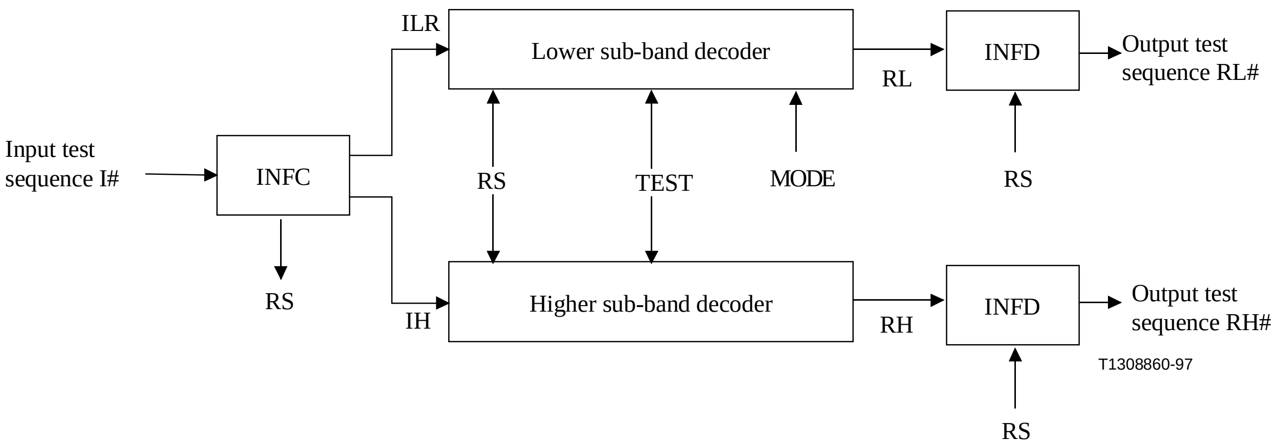


Figure 5 – Configuration 2 – Decoder only
(Rl and RL# are derived for Modes 1, 2 and 3)

2.3 Reset/Synchronization Signal (RSS) and Valid data Indication (VI)

All memory states in the two test configurations must be initialized to the exact states specified in this Recommendation prior to the start of an input test sequence in order to obtain the correct output values for the test.

In Configuration 1, the input test sequence, X#, is composed of encoder input test signals and the reset/synchronization signal (RSS) as shown in Figure 1. The RSS signal is located at the first LSB of the input sequence. If RSS is "1", the lower and higher sub-band encoders are initialized, and the outputs of the encoders are set to "0", i.e., IH = "0" and IL = "0". This normally forbidden output code is used to indicate "non-valid data" of the outputs. After the RSS signal goes to "0", the input test sequence will be valid and the ADPCM algorithm begins to operate.

In Configuration 2, the input test sequence, I#, is composed of the first 8 bits of lower and higher sub-band decoder input codewords, and the last 8 bits consists of 7-bit zeroes and "RSS" in the LSB as shown in Figure 2. The RSS signal has the same role as in Configuration 1. That is, if the RSS signal equals "1", the lower and higher sub-band decoders are initialized. After the RSS signal goes to "0", the ADPCM algorithm will be in the operational state. The output test sequences, RL# and RH#, are made up of a decoder output signal of 15 bits and a valid data indication signal (VI) as shown in Figure 3. While the RSS signal to the decoder is "1", the signal "VI" is set to "1" and the decoder output set to "0", which indicates "non-valid data" of the output. When "VI" is "0", the output test sequence is valid.

In order to establish the connection between the test sequence generator/receiver and the encoder/decoder, four sub-blocks, INFA, INFB, INFC, INFD in Figures 4 and 5 are provided. A detailed expansion of these sub-blocks is described below using the same notations specified in 6.2/G.722.

INFA

Input: X#

Outputs: XL, XH, RS

Function: Extract reset/synchronization signal and input signals to lower and higher sub-band ADPCM encoder.

```
RS = X# & 1                | Extract RSS signal
XL = S# >> 1               | Lower sub-band input signal
XH = XL                    | Higher sub-band input signal
```

INFB

Inputs: IL, IH, RS

Outputs: I#

Function: Create an output test sequence by combining lower and higher sub-band ADPCM encoder output signals and the reset/synchronization signal.

$$I = \begin{cases} (IH <<< 6) + IL & \text{if } RS == 0 \quad \text{| Combine IH and IL} \\ 0 & \text{if } RS == 1 \quad \text{| Set output to zero} \end{cases}$$

```
I# = (I <<< 8) + RS        | Add RSS signal
```

INFC

Input: I#

Outputs: ILR, IH, RS

Function: Extract reset/synchronization signal and input signals to lower and higher sub-band ADPCM decoder

RS = I# & 1	| Extract RSS signal
ILR = (I# >>> 8) & 63	| Lower sub-band ADPCM input
IH = I# >>> 14	| Higher sub-band ADPCM input

INFD

Inputs: RL (RH in higher sub-band), RS

Output: RL#(RH# in higher sub-band)

Function: Create output test sequence by combining lower (higher) sub-band ADPCM decoder output signal and the valid data indication signal.

$$RLX = \begin{cases} RL \ll 1 & \text{if } RS == 0 \quad \text{| Scaling by 1-bit shift} \\ 0 & \text{if } RS == 1 \quad \text{| Set output to zero} \end{cases}$$

RL# = RLX + RS	| Add VI signal

3 Test sequences

3.1 Input sequences for Configuration 1

For Configuration 1, two types of input test sequences are provided:

1) sequence containing tones, d.c. and white noise;
2) sequence for testing overflow controls in the ADPCM encoders.

The first input sequence contains tones with various frequencies, d.c. and white noise with two levels. The signal segments and lengths are given in Table 2.

The tones are used to move the predictor poles over their operating range and to test the stability control. Although the second pole coefficients are settled only in the vicinity of their lower limit for tone inputs, the upper limit is examined at the beginning of the d.c.-positive input. d.c. and white noise are used to vary the quantizer scale factors over their entire range.

The second input sequence permits testing of frequent overflows. The signal segments and lengths are given in Table 3.

The sequence produces large prediction errors, so it is used to check the overflow controls in pole and zero section output computations.

In Configuration 1, the coefficient values of the zero predictor do not move to the range limits of −2 and +2.

3.2 Input sequences for Configuration 2

For Configuration 2, these types of input test sequences are provided:

1) The sequence generated by the encoder is used when applying the input test sequence described in Table 2.
2) The sequence generated by the encoder is used when applying the input test sequence described in Table 3.

3) An artificial sequence containing consecutive sub-sequences is used that would not ordinarily emanate from an encoder.

The third test sequence, consisting of 16 384 values, is described below.

Table 2 – Sequence of tones, d.c. and white noise

Signal segments	Length (16-bit words)
3504 Hz toneable	1 024
2054 Hz tone	1 024
1504 Hz tone	1 024
504 Hz tone	1 024
254 Hz tone	1 024
1254 Hz tone	1 024
2254 Hz tone	1 024
3254 Hz tone	1 024
4000 Hz tone	512
d.c., positive, low level	512
d.c., value of zero	512
d.c., negative, low level	512
White noise, low level	3 072
White noise, high level	3 072
Total length of sequence	16 384

Table 3 – Overflow test sequence

Signal segments	Length (16-bit words)
−16 384, +16 383; repeated	639
0, −10 000, −8192	3
−16 384, +16 383, −16 384; repeated	126
Total length of sequence	768

3.2.1 Lower sub-band ADPCM codewords

The 6-bit lower sub-band decoder input sequence consists of an MSB sequence and a distinct sequence of the remaining 5 bits. The MSB sequence consists of eight artificial sub-sequences, each 2048 bits in length, as follows:

(1) 0 0 1 0 0 1 0 0 1 0 0 1 0 0 1 0 0 . . . .

(2) 1 1 1 1 0 0 0 0 1 1 1 1 0 0 0 0 1 . . . .

(3) 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 . . . .

(4) 1 1 0 0 1 1 0 0 1 1 0 0 1 1 0 0 1 . . . .

(5) 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 . . . .

(6) 0 0 0 0 0 1 0 0 0 0 0 0 0 0 1 0 0 0 . . . .

(7) 0 0 1 0 1 0 0 1 0 1 0 0 1 0 1 0 0 . . . .

(8) 1 1 0 0 0 1 1 0 0 0 1 1 0 0 0 1 1 . . . .

These MSB sequences are used to force the coefficients of the zero predictor to vary across the entire range of ± 2.

The associated 5-bit word sequence consists of 64 concatenated artificial sub-sequences, each 256 values long, as described in Table 4. This 5-bit word sequence was chosen to exercise the logarithmic quantizer scale factor over its entire range, and the log-to-linear conversion.

The composite sequence of ILR also tests the pole predictor and varies its coefficients over their allowable range. The sequences from sub-sequence numbers (56) to (64) test the conversion from the suppressed codewords, which can occur due to transmission errors, to specified quantizer intervals.

Table 4 – Sequence of last 5 bits of ILR

Repetitive pattern, each 256 values long	
(1) 31 31 31 31 31 31	(33) 15 15 15 15 15 15 . . . .
(2) alternating sixteen 31s, sixteen 30s	(34) alternating sixteen 15s, sixteen 14s
(3) 30 30 30 30 30 30	(35) 14 14 14 14 14 14 . . . .
(4) alternating sixteen 30s, sixteen 29s	(36) alternating sixteen 14s, sixteen 13s
(5) 29 29 29 29 29 29	(37) 13 13 13 13 13 13 . . . .
(6) alternating sixteen 29s, sixteen 28s	(38) alternating sixteen 13s, sixteen 12s
(7) 28 28 28 28 28 28	(39) 12 12 12 12 12 12 . . . .
(8) alternating sixteen 28s, sixteen 27s	(40) alternating sixteen 12s, sixteen 11s
(9) 27 27 27 27 27 27	(41) 11 11 11 11 11 11 . . . .
(10) alternating sixteen 27s, sixteen 26s	(42) alternating sixteen 11s, sixteen 10s
(11) 26 26 26 26 26 26	(43) 10 10 10 10 10 10 . . . .
(12) alternating sixteen 26s, sixteen 25s	(44) alternating sixteen 10s, sixteen 9s
(13) 25 25 25 25 25 25	(45) 9 9 9 9 9 9 . . . .
(14) alternating sixteen 25s, sixteen 24s	(46) alternating sixteen 9s, sixteen 8s
(15) 24 24 24 24 24 24	(47) 8 8 8 8 8 8 . . . .
(16) alternating sixteen 24s, sixteen 23s	(48) alternating sixteen 8s, sixteen 7s
(17) 23 23 23 23 23 23	(49) 7 7 7 7 7 7 . . . .
(18) alternating sixteen 23s, sixteen 22s	(50) alternating sixteen 7s, sixteen 6s
(19) 22 22 22 22 22 22	(51) 6 6 6 6 6 6 . . . .
(20) alternating sixteen 22s, sixteen 21s	(52) alternating sixteen 6s, sixteen 5s
(21) 21 21 21 21 21 21	(53) 5 5 5 5 5 5 . . . .
(22) alternating sixteen 21s, sixteen 20s	(54) alternating sixteen 5s, sixteen 4s
(23) 20 20 20 20 20 20	(55) 4 4 4 4 4 4 . . . .
(24) alternating sixteen 20s, sixteen 19s	(56) alternating sixteen 4s, sixteen 3s
(25) 19 19 19 19 19 19	(57) 3 3 3 3 3 3 . . . .
(26) alternating sixteen 19s, sixteen 18s	(58) alternating sixteen 3s, sixteen 2s
(27) 18 18 18 18 18 18	(59) 2 2 2 2 2 2 . . . .
(28) alternating sixteen 18s, sixteen 17s	(60) alternating sixteen 2s, sixteen 1s
(29) 17 17 17 17 17 17	(61) 1 1 1 1 1 1 . . . .
(30) alternating sixteen 17s, sixteen 16s	(62) alternating sixteen 1s, sixteen 0s
(31) 16 16 16 16 16 16	(63) 0 0 0 0 0 0 . . . .
(32) alternating sixteen 16s, sixteen 15s	(64) alternating sixteen 0s, sixteen 3s

3.2.2 Higher sub-band ADPCM codewords

The 2-bit higher sub-band decoder input sequence consists of an MSB sequence and a distinct LSB sequence.

The MSB sequence consists of eight artificial sub-sequences, identical to those used in the MSB sequence for the lower sub-band ADPCM.

The LSB sequence consists of 8 concatenated artificial sub-sequences, each 2048 bits long, as follows:

(1) 1 1 1 1 1 1 . . . . . .

(2) alternating sixteen 1s, sixteen 0s

(3) 0 0 0 0 0 0 . . . . . .

(4) alternating eight 1s, eight 0s

(5) 0 0 0 0 0 0 . . . . . .

(6) alternating four 1s, four 0s

(7) 1 1 1 1 1 1 . . . . . .

(8) alternating two 1s, two 0s.

The role of the composite sequence formed by appending the 1-bit LSB to the 1-bit MSB is equivalent to that for the lower sub-band ADPCM codeword described in 3.2.1.

4 Format for test sequence distribution

4.1 Type of files provided

The test sequences are arranged into 17 files. These 17 files are classified in three groups according to the following description:

Class T1: Source files to be input to the ADPCM codec. Class T1 includes two files to be used in Configuration 1 (encoder only) and one file to be used in Configuration 2 (decoder only).

Class T2: Combined source-comparison files. There are two files in class T2. Both are used for comparison purposes at the output of the encoder in Configuration 1. Also they are used as source files to test the decoder in Configuration 2.

Class T3: Comparison files used to check the output of the decoder in different modes. There are nine files in class T3 to test the lower sub-band decoder and three files in the same class to test the higher sub-band decoder. In class T3, the suffix H or L in the file name distinguishes the higher and lower sub-band. Also, a number from 1 to 3 in the file name indicates the corresponding mode used for the test.

4.2 Directory of the test sequence files

This subclause gives the name and the content of each file provided for the digital test sequences. Figure 6 shows which files are to be used in the different configurations of test.

Class T1 file names

T1C1.XMT: 16 416 test values (16-bit words) containing various frequencies, d.c., white noise for encoder test.

T1C2.XMT: 800 test values (16-bit words) containing the artificial sequence to test overflow in the encoder.

T1D3.COD: 16 416 test values (16-bit words) containing the artificial sequence for the decoder test. The most significant 8 bits contain the ADPCM code (IH, IL) and the least significant 8 bits contain the RSS information (reset/synchronisation signal).

Class T2 file names

T2R1.COD: 16 416 test values (16-bit words) containing the output code for the T1C1.XMT file. This file is also used as an input to test the decoder, and consequently has the same structure as the T1D3.COD file.

T2R2.COD: 800 test values (16-bit words) containing the output code for the T1C2.XMT file. This file is also used as source to test the decoder and consequently has the same structure as the T1D3.COD file.

Class T3 file names

T3L1.RC1 16 416 test values (16-bit words) containing the output of the lower sub-band decoder in Mode 1 when the file T2R1.COD is used as an input.

T3L1.RC2 same meaning as for T3L1.RC1 file but when Mode 2 is used.

T3L1.RC3 same meaning as for T3L1.RC1 file but when Mode 3 is used.

T3H1.RC0 16 416 test values (16-bit words) containing the output of the higher sub-band decoder when the file T2R1.COD is used as an input.

T3L2.RC1 800 test values (16-bit words) containing the output of the lower sub-band decoder in Mode 1 when the file T2R2.COD is used as an input.

T3L2.RC2 same meaning as for T3L2.RC1 file but when Mode 2 is used.

T3L2.RC3 same meaning as for T3L2.RC1 file but when Mode 3 is used.

T3H2.RC0 800 test values (16-bit words) containing the output of the higher sub-band decoder when the file T2R2.COD is used as an input.

T3L3.RC1 16 416 test values (16-bit words) containing the output of the lower sub-band decoder in Mode 1 when the file T1D3.COD is used as an input.

T3L3.RC2 same meaning as for T3L3.RC1 file but when Mode 2 is used.

T3L3.RC3 same meaning as for T3L3.RC1 file but when Mode 3 is used.

T3H3.RC0 16 416 test values (16-bit words) containing the output of the higher sub-band decoder when the file T1D3.COD is used as an input.

NOTE – Mode indication must be set by the user of the digital test sequences.

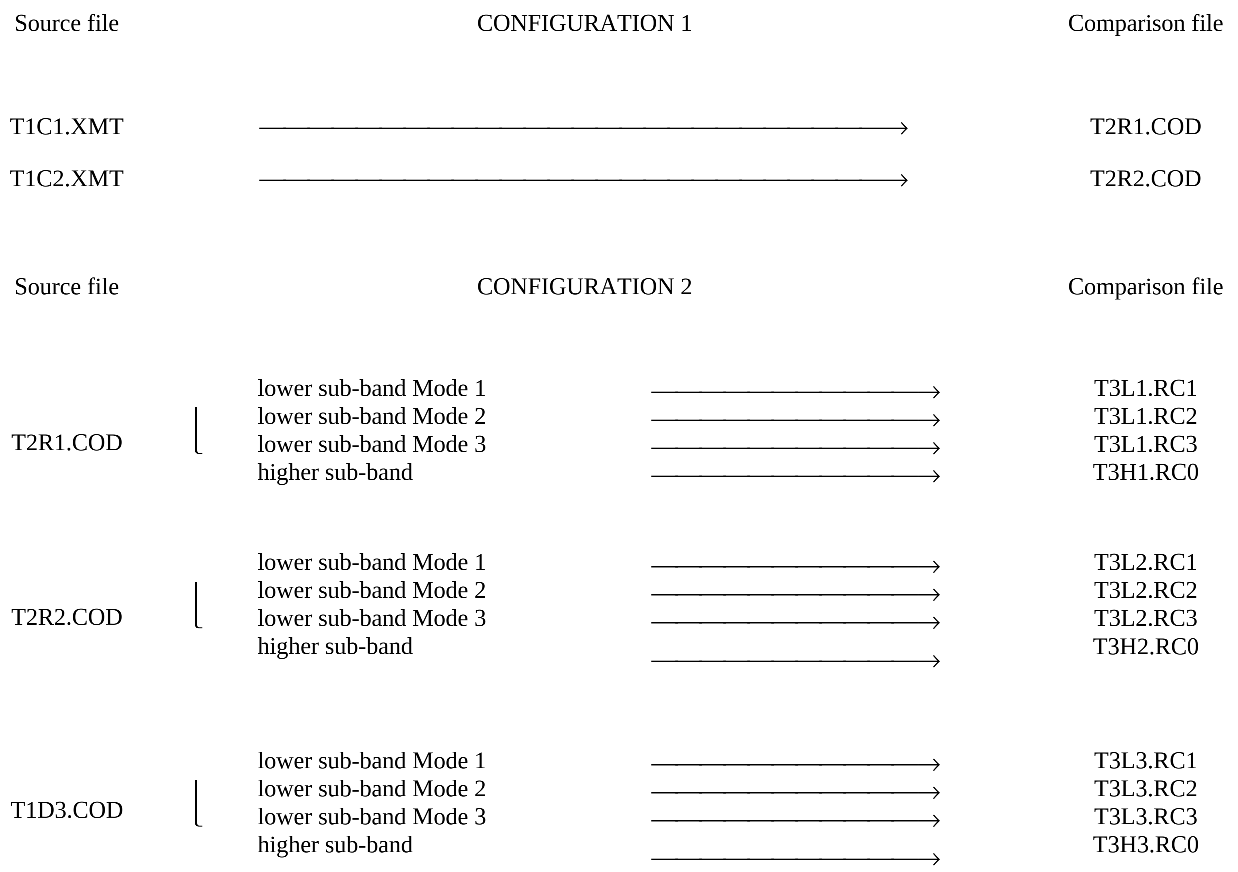


Figure 6 – Configuration of test

4.3 File format description

All the files are written in ASCII with a line structure. The first two lines of each file give some information on the file content. The following format is used for the two first lines:

/* CCITT 64 KBIT/S SB-ADPCM DIGITAL TEST SEQUENCE G.722 */

/* FILE NAME: xxxx.eee DATE: mm-dd-yy VERSION: V 1.0 */

For the subsequent lines of the file, 16 test values (16-bit words, 64 hexadecimal characters) are followed by a checksum on 1 byte (2 hexadecimal characters), a carriage return (ASCII code 0D in hexadecimal), and a line feed (ASCII code 0A in hexadecimal). These last two characters are non-printable.

The checksum is the two's complement of the least significant 8 bits of the summation of all the preceding characters (ASCII codes) in the line. If the least significant 8 bits of the summation are all zero, the corresponding two's complement is set all zero.

At the end of each file, a line of comment closes the file. This line is:

/* END OF FILE: xxxx.eee

4.4 Internal line description

4.4.1 File with extension .XMT

– 16 words of 16 bits with the LSB set to 1, all others set to zero (RSS = 1: reset mode);

– 16 384 or 768 words of 16 bits of digital test sequence with RSS = 0 (RSS is the LSB of the lower byte of the word);

– 16 words of 16 bits with the LSB set to 1, all others set to 0 (marks for end of test sequence).

4.4.2 File with extension .COD

– 16 words of 16 bits with the LSB set to 1, all others set to 0 (RSS = 1: reset mode and the ADPCM code set to 0);

– 16 384 or 768 words of 16 bits of digital test sequence with RSS = 0 (RSS is the LSB of the lower byte of the word and the upper byte is the ADPCM code);

– 16 words of 16 bits with the LSB set to 1, all others set to zero (marks for end of test sequence).

4.4.3 File with extension .RCx

– 16 words of 16 bits with the LSB set to 1, all others set to 0 (this means that these words are non-valid data);

– 16 384 or 768 words of 16 bits of digital test sequence with the LSB of the lower byte set to 0 to indicate valid data;

– 16 words of 16 bits with the LSB set to 1, all others set to 0 (marks for end of test sequence).

4.5 Electronic media

Digital test sequences are registered on one MS-DOS 3½" disk. The directory of the disk is given in Table 5.

Table 5 – Directory digital test sequence diskettes

Filename	Extension	Number of bytes
T1C1	XMT	69 973
T1C2	XMT	3 605
T1D3	COD	69 973
T2R1	COD	69 973
T2R2	COD	3 605
T3L1	RC1	69 973
T3L1	RC2	69 973
T3L1	RC3	69 973
T3H1	RC0	69 973
T3L2	RC1	3 605
T3L2	RC2	3 605
T3L2	RC3	3 605
T3L2	RC3	3 605
T3H2	RC0	3 605
T3L3	RC1	69 973
T3L3	RC2	69 973
T3L3	RC3	69 973
T3H3	RC0	69 973

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