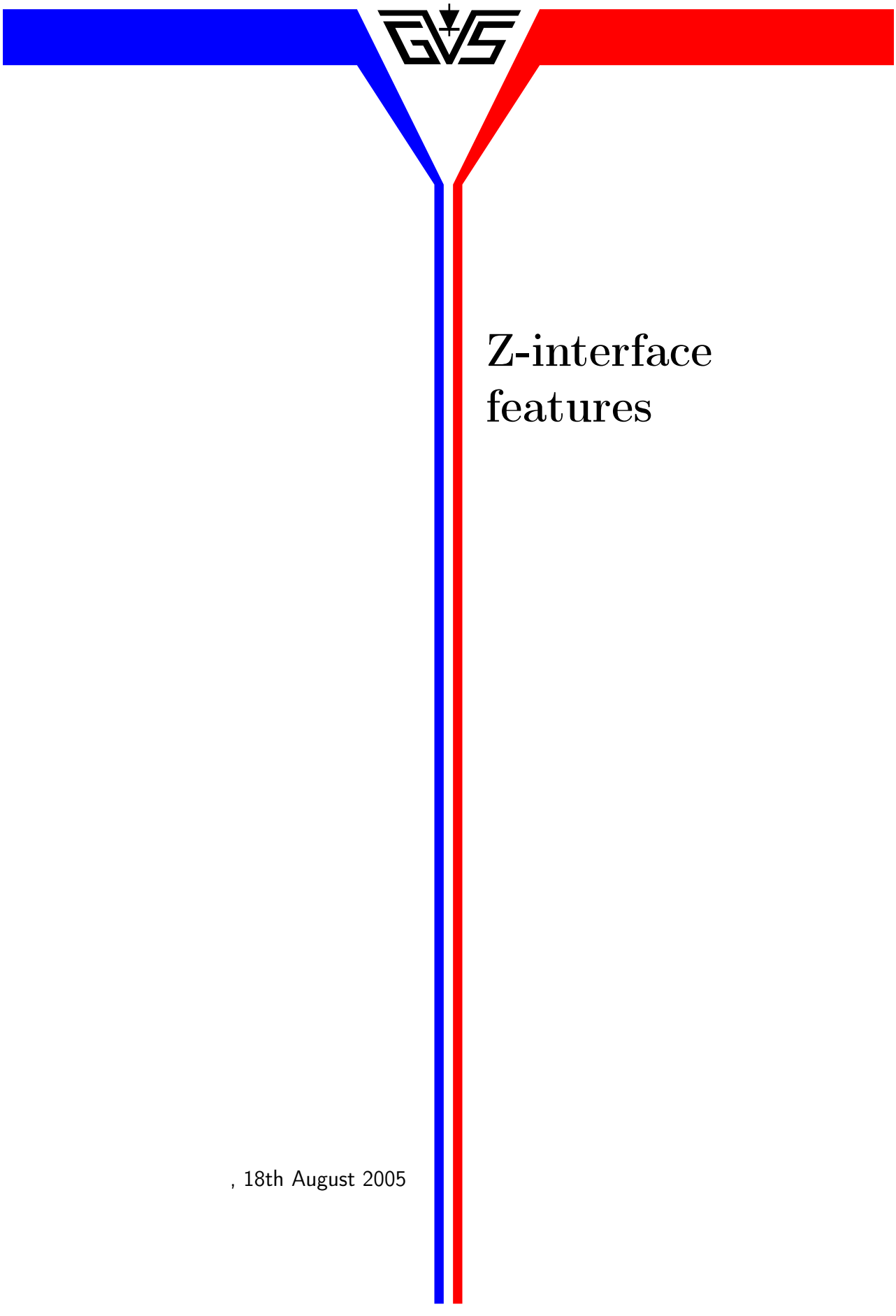

Z-interface features

, 18th August 2005

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1 Basic characteristics

1.1 Impedance

The impedance may be realistic, with 600Ω - 900Ω nominal value or complex, with 600Ω - 900Ω realistic value.

1.2 Return loss

Return loss should be in tolerances as shown in figure 1 (in accordance with ITU-T Q.552 §2.1.1.2.).

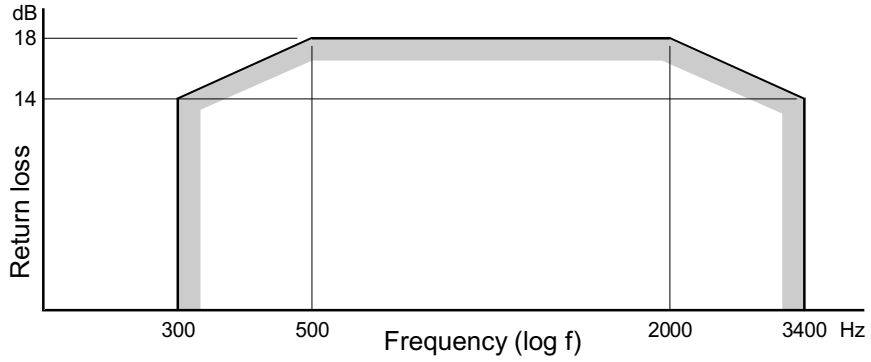

Figure 1: *Return loss with test signal frequency*

1.3 Impedance unbalance about earth

Minimum unbalance about earth in the range of 300-600Hz amounts to 40dB, and 46dB in the range of 600-3400Hz (in accordance with ITU-T Q.552 §2.1.2.) as shown in figure 2.

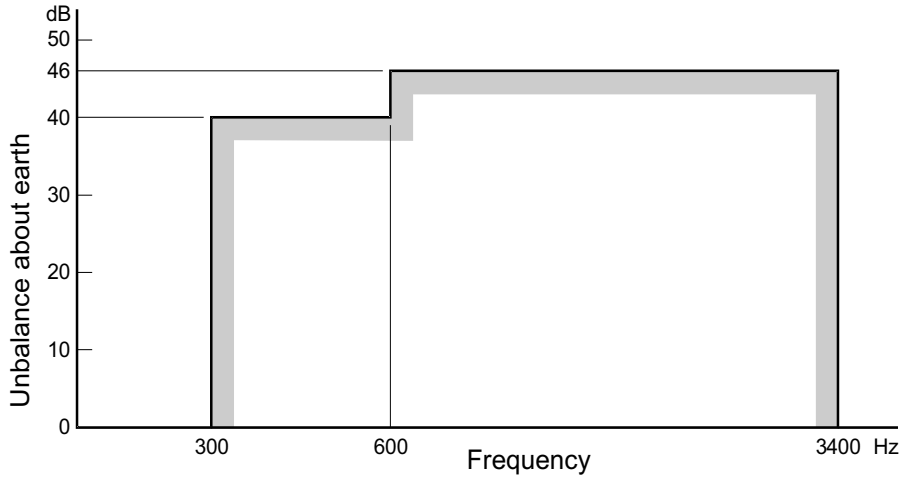

Figure 2: *Unbalance about earth dependant on test signal frequency*

1.4 Nominal levels

1.4.1 Input relative level

For all connection types (internal, local, national and international) the input relative level should range between 0dBr and 2dBr (in accordance with ITU-T Q552.§2.2.4.1.1. and ITU-T G.121, Annex C).

1.4.2 Output relative level

The output relative level for international connections should range between 5dBr and -8dBr (in accordance with ITU-T Q.552 §2.2.4.1.2.).

The output relative level for local and national connections should range between 0dBr and -8dBr (in accordance with ITU-T Q.552 §2.2.4.1.3.).

1.4.3 Tolerances of relative levels

The difference between actual and nominal relative levels should be within following limits (in accordance with ITU-T Q.552 §2.2.4.2.):

- input relative level L_i: -0.3dBr to + 0.7dBr
- output relative level L_o: -0.7dBr to + 0.3dBr

1.4.4 Consideration of short and long subscriber lines

In order to compensate for the loss of short or long subscriber lines, following relative levels derived from the basic values may be used:

- input relative level $L'_i = L_i + x$dB
- output relative level $L'_o = L_o - x$dB,

with x value equal to 3dB for the case of short subscriber lines. X values below zero require careful selection of balance line. Values below -3dB are not recommended (in accordance with ITU-T Q.552 §2.2.4.3.).

2 Half-connection characteristics

2.1 Transmission loss

2.1.1 Transmission loss nominal value

Nominal transmission loss for a connection through the exchange is equal to the difference of input and output relative levels (in accordance with ITU-T Q.552 §3.1.1.1.).

2.1.2 Transmission loss tolerances

The difference between actual and nominal transmission loss for the input and output connection should be within tolerances of -0.3dB to 0.7dB (in accordance with ITU-T Q.552 §3.1.1.2.).

2.2 Short-term variation of loss with time

When a sine-wave test signal at the frequency of 1020 Hz and the level of -10 dBm0 with +2Hz -7Hz (ITU-T O.6) tolerances is applied to the 2-wire interface of any input connection, or a digitally simulated sine-wave signal of the same characteristic is applied to the exchange test point T_i of any output connection, the level at the corresponding exchange test point T_o and the 2-wire analog interface respectively should not vary by more than ±0.2dB during any 10-minute interval of normal operation under the steady state condition of permitted variations in the power supply voltage and temperature (in accordance with ITU-T Q.552. §3.1.1.3.).

2.3 Variation of gain with input level

When a sine-wave test signal at the reference frequency 1020 Hz and at a level between -55 dBm0 and +3 dBm0 is applied to the 2-wire analog interface of any input connection, or when a digitally simulated sine-wave signal of the same characteristic is applied to the exchange test point T_i of any output connection, the gain variation of that connection, relative to the gain at an input level of -10 dBm0, should lie within the limits defined in figure 3 (in accordance with ITU-T Q.552 §3.1.1.4.).

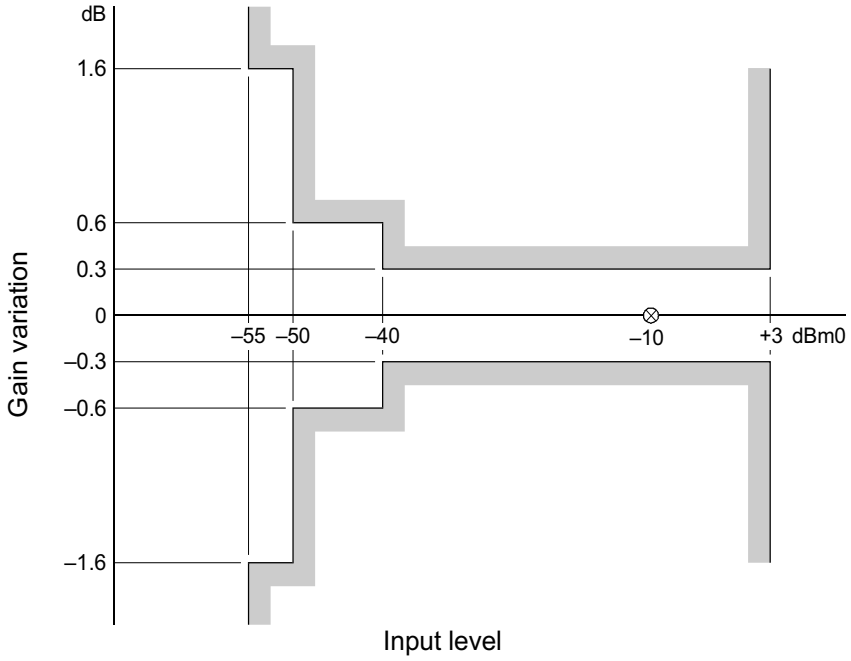

Figure 3: *Variation of gain with the input signal level*

2.4 Amplitude distortion with frequency

Amplitude distortion with frequency of an input connection respectively using an input level of -10dBm0 should be within limits shown in figure 4 (in accordance with ITU-T Q.552 §3.1.1.5.).

Amplitude distortion with frequency of an output connection respectively using test signal level of -10dBm0 should be within limits shown in figure 5 (in accordance with ITU-T Q.552 §3.1.1.5.).

Within designated (*) frequency range, moderated limits apply when using maximum cable length in the exchange.

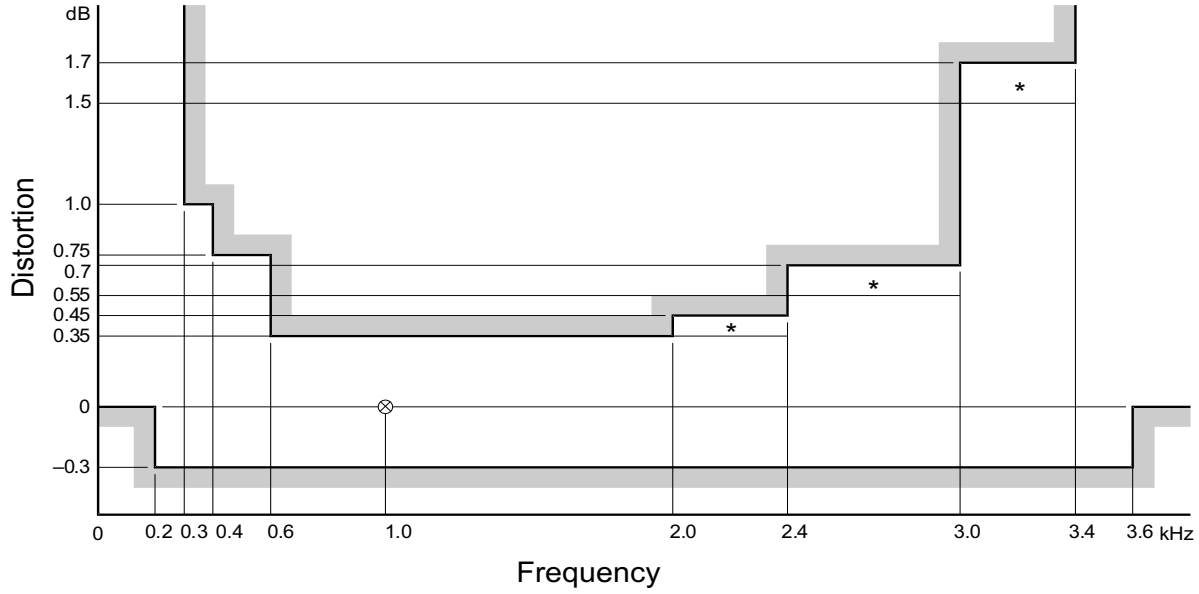

Figure 4: *Amplitude distortion with frequency (input connection)*

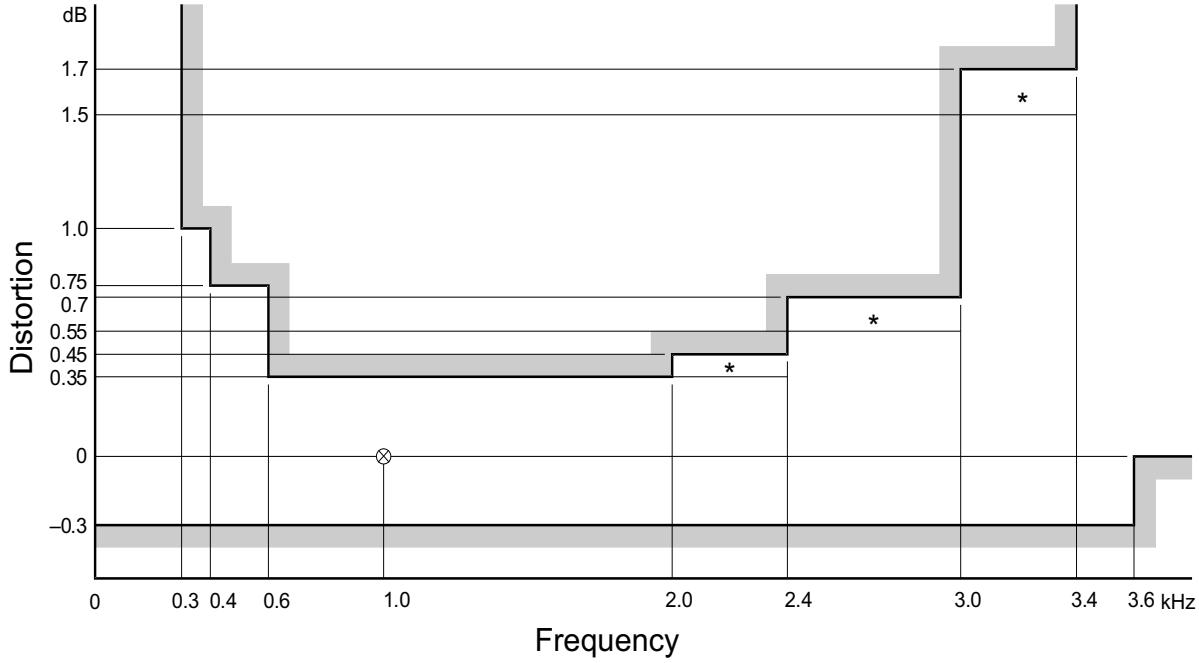

Figure 5: *Amplitude distortion with frequency (output connection)*

2.5 Group delay

Group delay represents propagation time between two specified positions of an envelope point of the group containing two sine waves of close frequencies.

2.5.1 Absolute group delay

Absolute group delay refers to minimum group delay measured in the frequency band 500Hz-2800Hz. Absolute delay depends on the connection type and exchange architecture. Table 1 defines mean and maximum delay for three connection types (in accordance with ITU-T Q.551 §3.3.1.):

Connection interface - interface	Mean value	95% probability of not exceeding
digital-digital	900μs	1500μs
analog-digital	1950μs	2700μs
analog-analog	3000μs	3900μs

Table 1: *Group delay in both directions through the exchange*

2.5.2 Group delay distortion

Taking the minimum group delay as the reference, in the frequency range between 500 Hz and 2800 Hz and for the input level of -10dBm0, the group delay distortion of the output and input connection should lie within the limits shown in the figure 6 (in accordance with ITU-T Q.552 §3.1.2.2.).

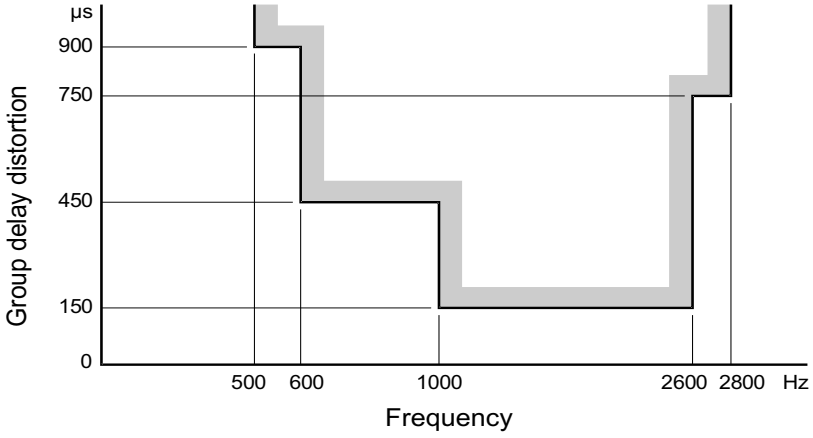

Figure 6: *Group delay distortion*

2.6 Single frequency noise

The level of any single frequency (in particular the 8000Hz frequency and its multiples), measured selectively at the interface of an output connection, should not exceed -50 dBm0 (in accordance with ITU-T Q.552 §3.1.3.).

In the frequency band of 300 to 3400 Hz, the level of any single frequency measured selectively and corrected by the psophometric weighting factor should not exceed -73 dBm0 value (in accordance with ITU-T Q.552 §3.1.3.).

Psophometric weighting factors are presented in table 2 (in accordance with ITU-T O.41 §3.5.).

Frequency [Hz]	Relative weight [dB]	Tolerance [dB]
16.66	-85.0	-
50	-63.0	2
100	-41.0	2
200	-21.0	2
300	-10.6	1
400	-6.3	1
500	-3.6	1
600	-2.0	1
700	-0.9	1
800	0.0	0.0 (reference)
900	+0.6	1
1000	+1.0	1
1200	0.0	1
1400	-0.9	1
1600	-1.7	1
1800	-2.4	1
2000	-3.0	1
2500	-4.2	1
3000	-5.6	1
3500	-8.5	2
4000	-15.0	3
4500	-25.0	3
5000	-36.0	3
6000	-43.0	-

Table 2: *Psophometric weighting coefficients and tolerances*

2.7 Crosstalk

Following test signals are used for crosstalk measurements (in accordance with ITU-T Q.552 §3.1.4.):

- the quiet code, referring to 0xD5 bit sequence (in accordance with ITU-T Q.551 §1.2.3.1. and ITU-T G.711.3)
- a low level activating signal, e.g. a sine-wave signal at a level in the range from -33 to -40 dBm0

2.7.1 Far-end and near-end crosstalk measured with analog test signal

When a sine-wave test signal at the reference frequency of 1020 Hz and at a level of 0 dBm0 is applied to an analog 2-wire interface, noise level in any half-connection should not exceed -73 dBm0 for near-end crosstalk and -70 dBm0 for far-end crosstalk (in accordance with ITU-T Q.552 §3.1.4.1.).

2.7.2 Far-end and near-end crosstalk measured with digital test signal

When a digitally simulated sine-wave test signal at the reference frequency of 1020 Hz applied at a level of 0 dBm0 to an exchange test point T_i, a noise level in any half-connection should not exceed -70 dBm0 for near-end crosstalk and -73 dBm0 for far-end crosstalk (in accordance with ITU-T Q.552 §3.1.4.2.).

2.8 Total distortion (including quantizing distortion)

In case of a sine-wave test signal at the reference frequency of 1020 Hz applied to the 2-wire interface of an input connection, or in case of a digitally simulated sine-wave signal of the same characteristic applied to the exchange test point T_i of an output connection, the signal/total-distortion ratio, measured at the corresponding outputs of the half-connection with a proper noise weighting should lie above the limits shown in figures 7 and 8 (in accordance with ITU-T Q.552 §3.1.5.).

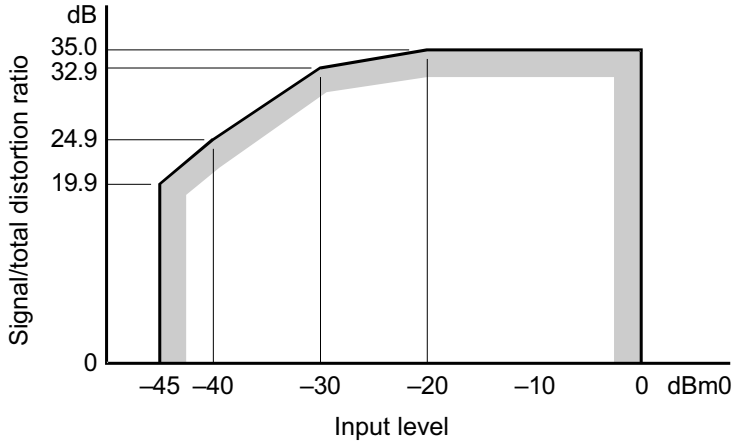

Figure 7: *Signal/total-distortion ratio as a function of input level for input connection*

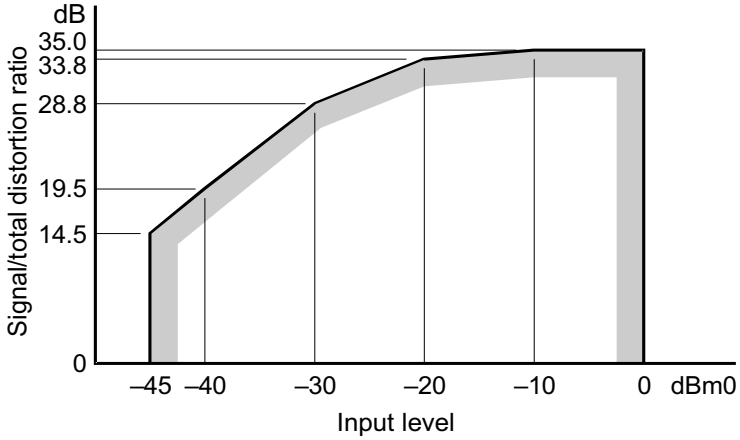

Figure 8: *Signal/total-distortion ratio as a function of input level for output connection*

2.9 Signal loss above the voice band

This requirement refers only to an input connection.

2.9.1 Input signals above 4.6kHz

When the sine-wave signal at a level of -25 dBm0, in the range from 4.6 kHz to 72 kHz is applied to the 2-wire interface of an input connection, the level of any signal frequency produced in the time slot at the testing point of the corresponding input connection should be at least 25 dB below the level of the test signal (in accordance with ITU-T Q.552 §3.1.6.1.).

2.9.2 Overall requirements

Under the "worst" conditions encountered in a national network, the half-connection should not contribute more than 100 pW0p of additional noise in the band 10 Hz to 4 kHz at the input and output connection, as a result of the presence of out-of-band signals at the 2-wire analog interface of the input connection (in accordance with ITU-T Q.552 §3.1.6.2.).

2.10 Spurious out-of-band signals

This requirement is applied only for an output connection.

2.10.1 Levels of individual components

With a digitally simulated sine-wave signal in the frequency range 300-3400 Hz and at a level of 0 dBm0 applied to the exchange test point T_i of a half-connection, the level of spurious out-of-band signals measured selectively at the 2-wire analog interface of the output connection should be lower than -25 dBm0 (in accordance with ITU-T Q.552 §3.1.7.1.).

2.10.2 Overall requirements

Spurious out-of-band signals should not produce unacceptable interference in the equipment connected to the digital exchange. In particular, the intelligible and unintelligible crosstalk in a channel connected to the exchange should not exceed a level of -65 dBm0 as a consequence of spurious out-of-band signals at the half-connections (in accordance with ITU-T Q.552 §3.1.7.2.).

2.11 Echo and stability

2.11.1 Balance loss

Balance loss should be in limits as shown in figure 9 (in accordance with ITU-T Q.552 §3.1.8.1.).

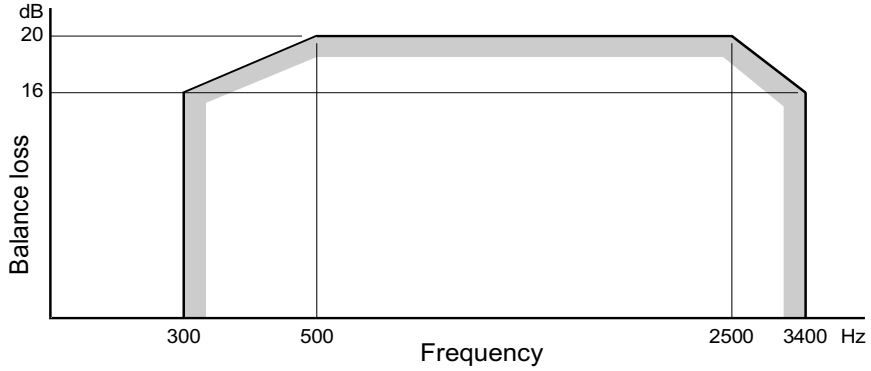

Figure 9: *Balance loss*

2.12 Transmission loss

Nominal value for the transmission loss should be as follows (in accordance with ITU-T G.552 §3.3.1.):

- NL_i = 0dB to 2dB for all connection types
- NL_o = 5dB to 8dB for the international connections
- NL_o = 0dB to 8dB for local, internal and national connections

2.13 Noise

2.13.1 Weighted noise

For the calculation of noise, worst-case Z-interface conditions are assumed (in accordance with ITU-T G.552 §3.3.2.1.).

1. Output connection

   Two components of noise are prevailing. The first one is the noise arising from the decoding process and is dependent on the output relative level. The other component is a. power supply noise from the feeding bridge and circuit noise, independent of the output relative level. The first component is limited to -70 dBm0p (in accordance with ITU-T G.712 §9.); the other component is limited to 200 pWp (-67 dBmp) (in accordance with ITU-T G.123 Annex A and §3.). For an output relative level of -7.0 dBr the resulting total noise level for the output connection amounts to -66.6dBmp (in accordance with ITU-T G.552 §3.3.2.1.1.).

2. Input connection

   Two components of noise are considered at test point T_o. One of these results from the encoding process and is independent from the input relative level. The other one, e.g. power supply noise from the feeding bridge and the circuit noise, is dependent upon the input relative level. The first component is limited to -67 dBm0p (in accordance with ITU-T G.712 §9.); the other component is limited to 200 pWp (-67 dBmp) (in accordance with ITU-T G.123 Annex A and §3.).

   The total psophometric power of the weighted noise at the test point T_o for an input relative level of 0 dBr amounts to 451pW0p (in accordance with ITU-T G.552 §3.3.2.1.2.).

   The total level of the weighted noise is -64.0dBm0p (in accordance with ITU-T G.552 §3.3.2.1.2.).