INTERNATIONAL TELECOMMUNICATION UNION

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OF ITU

SPECIFICATIONS FOR MEASURING EQUIPMENT

QUANTIZING DISTORTION MEASURING EQUIPMENT USING A PSEUDO-RANDOM NOISE TEST SIGNAL

ITU-T Recommendation O.131

(Extract from the *Blue Book*)

NOTES

1 ITU-T Recommendation O.131 was published in Fascicle IV.4 of the *Blue Book*. This file is an extract from the *Blue Book*. While the presentation and layout of the text might be slightly different from the *Blue Book* version, the contents of the file are identical to the *Blue Book* version and copyright conditions remain unchanged (see below).

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

Recommendation O.131

QUANTIZING DISTORTION MEASURING EQUIPMENT USING A PSEUDO-RANDOM NOISE TEST SIGNAL

(Geneva, 1976; amended at Geneva, 1980, and at Melbourne, 1988)

1 Preamble

It is important that the characteristics of quantizing distortion measuring apparatus are specified with sufficient precision to ensure that all future designs of measuring apparatus conforming to the recommended specification shall be compatible with one another, i.e., they shall be capable of interworking and give results of specified accuracy without the need for any special procedures or corrections to the measurements results. It is considered equally important that all designs of measuring apparatus conforming to the recommended specification shall be capable of interworking with existing designs of measuring apparatus already in use by various Administrations, who will thus not be placed at any economic disadvantage. The following specification is based on the proposals studied by Study Group XVIII and is specifically aimed at the foregoing compatibility objectives.

Note – The question of interworking between existing designs of quantizing distortion measuring apparatus is not, in itself, directly relevant to this specification, but it is worth recording that this topic has been studied by the Federal Republic of Germany and the United Kingdom Post Office. Satisfactory rules have been established to facilitate interworking between the different existing types of measuring apparatus which use a band-limited pseudo-random noise source.

2 Testing method proposed

The method proposed is that described in Method 1 in § 9 of Recommendation G.712 [1]. The proposed noise source is band-limited pseudo-random noise having a probability density distribution of amplitudes which is substantially near to a Gaussian distribution[1)].

The signal-to-total distortion power, including quantizing distortion, is measured as the ratio of the power of received stimulus in the reference band, to the noise power in the measured band. A correction is included to relate the measurement to the full PCM speech channel bandwidth.

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1) The receive measuring apparatus specified in § 3.2 may also be used to measure quantizing distortion using a sinusoidal test signal in the frequency range 350-550 Hz (preferably at 420 ± 20 Hz) instead of the pseudo-random noise stimulus. It should be noted, however, that while the measurement is similar to Method 2 described in Recommendation G.712 [1], the obtained measurement results are related to a bandwidth of 3.1 kHz and that no noise weighting is provided. It should also be noted that results given by the pseudo-random noise and sinusoidal methods may not be the same.

The principle of the measurement is illustrated in Figure 1/O.131.

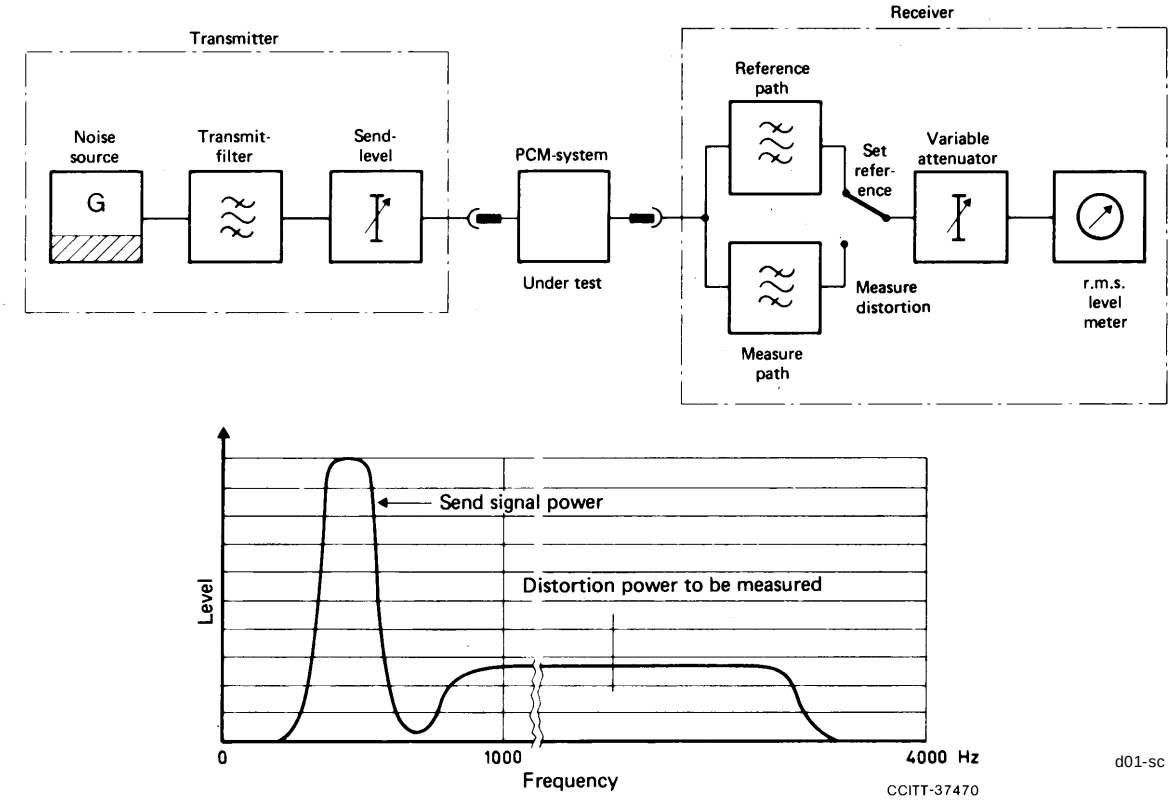


FIGURE 1/O.131

Principle of quantizing distortion measurement

3 Basic specification clauses

3.1 *Send*

The sending signal is a band-limited pseudo-random noise having the following characteristics:

3.1.1 *Band limited noise stimulus*

Approximately Gaussian distribution of the amplitudes within the bandwidth of the send filter. The bandwidth can have any value from 100 Hz to 200 Hz between the 3-dB points (see §§ 3.1.4 and 3.1.5 below).

3.1.2 *Number of spectral lines*

Not less than 25 spectral lines with a spacing not greater than 8 Hz measured at the output of the send filter.

3.1.3 *Peak-to-r.m.s. ratio*

10.5 dB. Tolerance ± 0.5 dB.

Note 1 – The requirements according to §§ 3.1.1 to 3.1.3 above may be accomplished by a noise stimulus derived from the output of a 17-stage shift register with exclusive OR gating with the outputs of stages 3 and 17 returned to the input of stage 1. The shift register produces a maximally long sequence of $(2^{17} - 1)$ bits.

The shift register is driven at a clock frequency f_c Hz such that the spectral line spacing f_s Hz of the output signal is less than or equal to 8 Hz.

In order to meet the specified limits of the peak-to-r.m.s. ratio of the sent signal as given in § 3.1.3 above, the clock frequency can be adjusted to:

$$f_C = f_S\,(2^{17} - 1)\ \text{Hz}$$

To keep the peak factor within the specified limits, a stability of the clock frequency f_c on the order of 1% is required.

Note 2 – Instead of using a shift register to generate the noise signal, other principles may be adopted as long as the generated signal has the characteristics recommended in §§ 3.1.1 and 3.1.3 above.

3.1.4 *Frequency position of sent signal*

Between 350 and 550 Hz.

3.1.5 *Sending filter characteristics*

The attenuation of the bandpass filter with reference to minimum attenuations should be as follows:

not lower than 350 Hz	3 dB point at lower frequency
not exceeding 550 Hz	3 dB point at upper frequency
below 250 Hz	greater than 55 dB
at 300 Hz	greater than 20 dB
at 580 Hz	greater than 6 dB
at 650 Hz	greater than 20 dB
at 700 Hz	greater than 40 dB
at 750 Hz	greater than 50 dB
at and above 800 Hz	greater than 60 dB

The response characteristic of a filter designed to these limits should give a bandwidth between 3-dB points of at least 100 Hz.

The performance requirements for the sending filter characteristics conforming to the above limits is given in Figure 2/O.131.

3.1.6 *Sending reference level range*

0 dBm0 to at least –55 dBm0 for relative levels according to Recommendation G.232, § 11 [2] with a setting accuracy of ± 0.5 dB.

3.1.7 *Output impedance* (frequency range 300 Hz to 4 kHz)

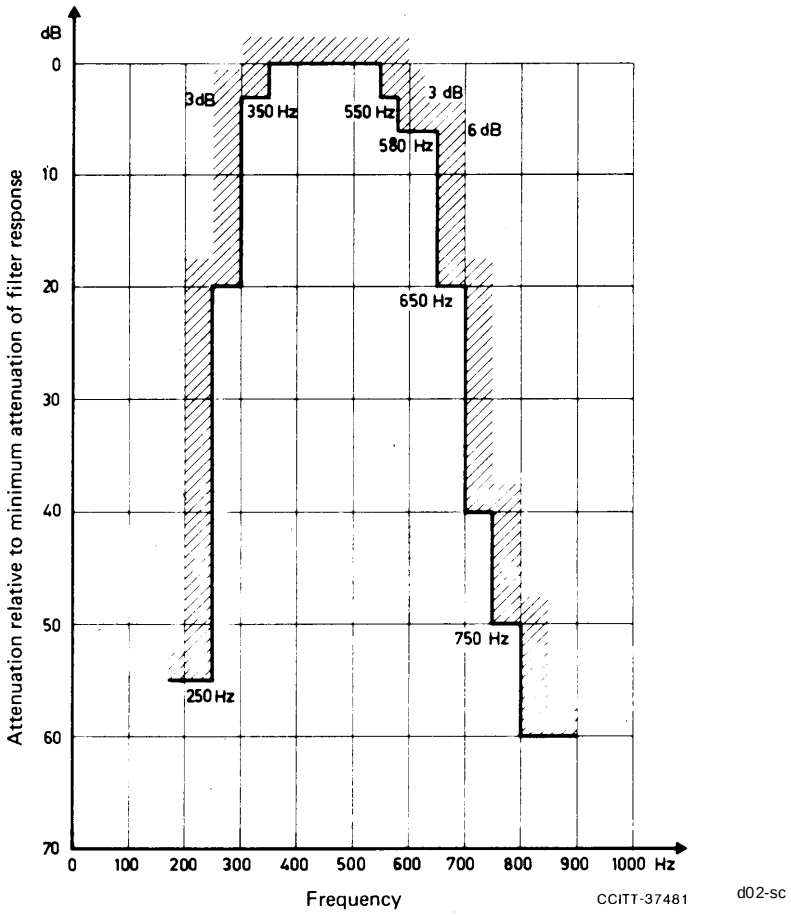
– Balanced, earth free (other impedances optional)..... 600 ohms
– Return loss ..... ≥ 30 dB
– Output signal balance..... ≥ 40 dB

3.2 *Receive*

3.2.1 *Receive reference filter*

Nominal bandwidth of reference path 350-550 Hz. (See Note below).

The characteristic of the filter is chosen to prevent inaccuracy in the measurement of the received noise stimulus in the presence of quantizing distortion and other system noise conditions. The filter should not diminish the power of a noise band between 350 Hz and 550 Hz by more than 0.25 dB.



Note – Refer to § 3.1.5 of this Recommendation, for bandpass characteristics.

FIGURE 2/O.131

Performance requirements for bandpass filter used in sending section of quantizing distortion measuring apparatus

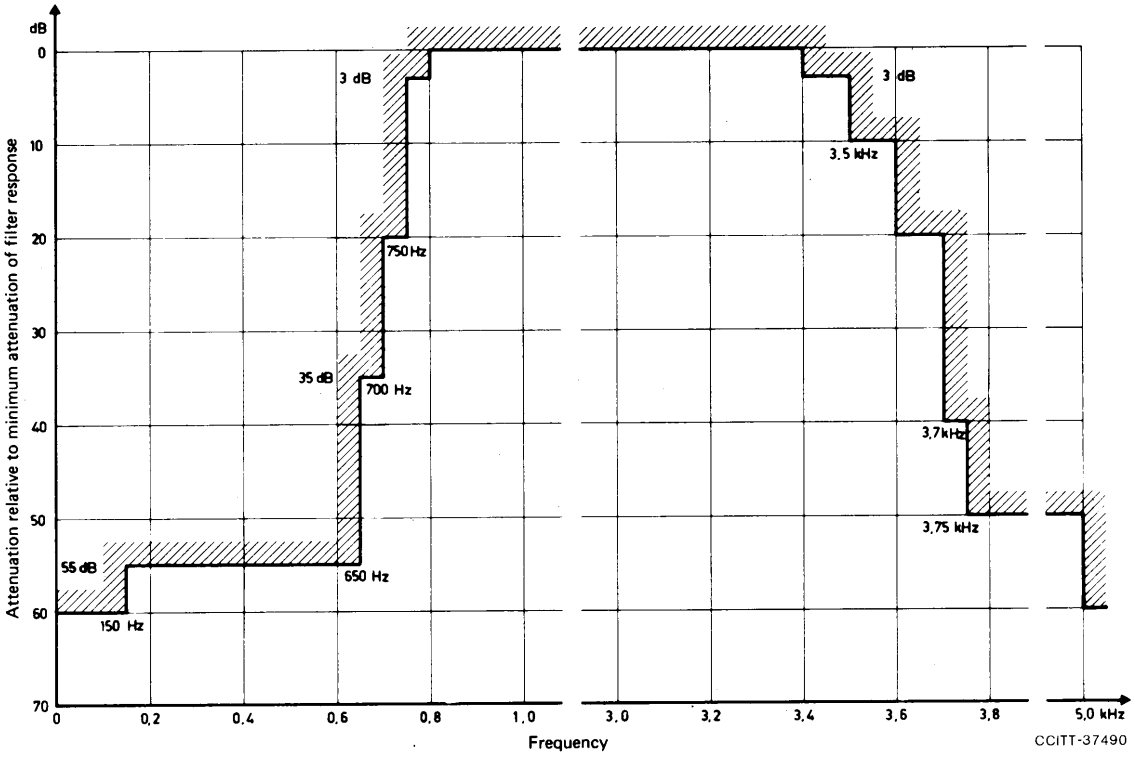
Note – The receive reference filter ideally restricts the bandwidth of the reference path to respond only to the spectrum of the received noise stimulus. However, the bandwidth of 350-550 Hz is chosen to allow for the need to interwork with test apparatus having a noise source bandwidth of up to 200 Hz.

3.2.2 *Bandwidth of measuring path*

At least 2.4 kHz (with a loss variation of less than 2 dB). The required bandpass characteristic of the filters for measurement of distortion products is indicated below and is such that received noise stimulus does not affect measurements. Attenuation with reference to the minimum attenuation:

150 Hz and below	greater than 60 dB
650 Hz	greater than 55 dB
700 Hz	greater than 35 dB
750 Hz	greater than 20 dB
800 Hz	3 dB or greater
3.4 kHz	3 dB or greater
3.5 kHz	greater than 10 dB
3.6 kHz	greater than 20 dB
3.7 kHz	greater than 40 dB
3.75 kHz	greater than 50 dB
5.0 kHz and above	greater than 60 dB

The performance requirements for the measurement filter characteristic conforming to the above limits is given in Figure 3/O.131.



Note – Refer to § 3.2.2 of this Recommendation, for bandpass characteristics.

FIGURE 3/O.131

Performance requirements for measuring path filter response used in receive section of quantizing distortion measuring apparatus

3.2.3 *Bandwidth correction*

The calibration of the test apparatus shall include a correction factor of appropriate value to relate the signal to total distortion power measured to the total distortion power present in the full PCM channel bandwidth of 3100 Hz. The correction factor is given by the following expression, which assumes a uniform distribution of distortion power over the channel bandwidth:

$$10 \log_{10} \frac{3100}{y} \text{ (dB)}$$

where y is the effective noise bandwidth of the measuring filter in Hz.

3.2.4 *Input impedance*

–	Balanced, earth free (other impedances optional)	600 ohms
–	Return loss	≥ 30 dB
–	Input longitudinal interference loss (below 4 kHz)	≥ 46 dB
–	Input longitudinal interference loss (at 40 Hz)	≥ 60 dB

3.2.5 *Input reference level range*

0 dBm0 to at least –55 dBm0 for relative levels according to Recommendation G.232 [2].

3.2.6 *Accuracy of the signal-to-total distortion ratio indication*

For reference levels in the range –6 dBm0 to –55 dBm0 and an absolute distortion signal not less than –72 dBm0:

– Measuring range 10 dB to 40 dB: Accuracy ± 0.5 dB.

– Measuring range 0 dB to 10 dB: Accuracy ± 1.0 dB.

For reference levels in the range 0 dBm0 to –6 dBm0:

– Measuring range 20 dB to 40 dB: Accuracy ± 1.5 dB.

– Measuring range 0 dB to 20 dB: Accuracy ± 2.0 dB.

Note 1 – These limits include the inaccuracies which are caused by:

– the effective bandwidth of the measuring filter,

– the receive reference filter,

– the attenuator in the measuring path,

– the characteristics of the indicating circuit.

Note 2 – For reference level ranges 0 dBm0 to –6 dBm0, the wider tolerances are not only required by the measuring apparatus but reflect also the characteristics of PCM coders and decoders when operated near the overload point.

4 Operating environment

The electrical performance requirements shall be met when operating at the climatic conditions as specified in Recommendation O.3, § 2.1.

References

[1] CCITT Recommendation *Performance characteristics of PCM channels between 4-wire interfaces at voice frequencies*, Vol. III, Rec. G.712.

[2] CCITT Recommendation *12-channel terminal equipments*, Vol. III, Rec. G.232.