INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

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SPECIFICATIONS FOR MEASURING EQUIPMENT

PHASE JITTER MEASURING EQUIPMENT FOR TELEPHONE-TYPE CIRCUITS

ITU-T Recommendation O.91

(Extract from the *Blue Book*)

NOTES

1 ITU-T Recommendation O.91 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.

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Recommendation O.91

PHASE JITTER MEASURING EQUIPMENT FOR TELEPHONE-TYPE CIRCUITS

(Geneva, 1972; amended at Malaga-Torremolinos, 1984, and at Melbourne, 1988)

Introduction

The most commonly found single-frequency components of phase jitter on transmitted data signals are those of ringing current, commercial a.c. power and the second to fifth harmonics of these. Since the peak phase deviation caused by such components rarely exceeds 25° peak-to-peak (i.e. low index phase modulation) only one pair of significant sidebands is produced for each sinusoidal component. Hence the main phase jitter modulation usually exists within ± 300 Hz of a voice-frequency tone acting as a carrier.

Since random noise can cause what would appear to be a significant amount of phase jitter, a message weighted noise measurement should always be made in conjunction with phase jitter measurements. Also, because quantizing noise can cause a significant phase jitter reading, care must be exercised in the choice of the carrier frequency and in the filtering to suppress the effect of noise on the measurement.

Whilst this Recommendation is concerned with measurements in the frequency bands 4-300 Hz, 4-20 Hz and 20-300 Hz, it is also applicable for measuring in the frequency band 3-300 Hz and 3-20 Hz.

The following specifications for phase jitter measuring equipment are proposed.

1 Measuring principle

A sinusoidal tone, free of phase jitter, is applied to the circuit under test at normal data transmission level. The phase jitter measuring receiver processes the received tone as follows:

1) band limit around carrier frequency;

2) amplify and amplitude-limit carrier to remove amplitude modulation;

3) detect the phase modulation (jitter);

4) display filtered jitter (up to about 300 Hz) on a peak-to-peak indicating meter or digital display.

2 Proposed specifications

2.1 *Measurement accuracy*

Objective is better than ± 5 per cent of the measured value plus ± 0.2 degrees.

2.2 *Transmitter*

2.2.1 Test signal frequency .... 1020 ± 10 Hz

2.2.2 Send level .... –30 dBm to 0 dBm

2.2.3 *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

2.2.4 Phase jitter at source .... ≤ 0.1 degree peak-to-peak

2.3 *Receiver*

2.3.1 *Measurement range*

At least as great as .... 0.2 to 30 degrees peak-to-peak

2.3.2 *Sensitivity and frequency range*

The receiver should be capable of measuring the phase jitter of signals at input levels between – 40 and +10 dBm and frequencies between 990 and 1030 Hz.

2.3.2 *Input selectivity*

Power line hum protection: highpass filter with a nominal cut-off frequency of 400 Hz with at least 12 dB per octave slope.

Protection for limiter against channel noise: lowpass filter with a nominal cut-off frequency of 1800 Hz with at least 24 dB per octave slope.

2.3.4 *Input impedance* (frequency range 300 Hz to 4 kHz)

– Balanced, earth free

– Input longitudinal interference loss .... ≥ 46 dB

2.3.5 *Terminating impedance* (other impedances optional).. 600 ohms

– Return loss .... ≥ 30 dB

2.3.6 *High impedance*.. approx. 20 kohms

– Bridging loss across 300 ohms .... ≤ 0.15 dB

Note – Definitions and measurement to be in accordance with Recommendation O.9.

2.4 *Modulation measurement weighting characteristics*

The phase jitter modulation is measured on a weighted basis defined as follows:

Three weighting characteristics are specified to measure phase jitter in the frequency bands 4 Hz to 20 Hz, 4 Hz to 300 Hz and 20 Hz to 300 Hz. Jitter components in these frequency bands are measured with full sensitivity and attenuated beyond the frequency bands.

The weighting characteristics may be measured by a 2-tone test as follows: if a pure[1)] 1000 Hz, +10 dBm tone is applied to the input and a second pure tone 20 dB lower in level is added to this tone, values of phase jitter shall be observed according to the frequency of this added tone as shown in Table 1/O.91. Other weighting selections may be provided on a switchable basis.

2.5 *Amplitude-to-phase conversion*

With the second tone at 1100 Hz, an external attenuator is used to insert flat loss in 10 dB steps up to 50 dB between the sources of the tones and the receiver. The spread of the readings should not exceed 0.7 degrees. All of the requirements in Table 1/O.91 should also be met at any of the flat loss settings up to 50 dB. Also, a 10 per cent modulated (20 Hz-300 Hz) AM signal in the operating level range of the set applied in place of the above tones should cause less than 0.2 degrees jitter indication.

[1)] A single frequency signal with a total nonlinear distortion at least 40 dB below the level of the fundamental signal.

TABLE 1/O.91

Frequency of the second tone (Hz)	Phase jitter (degrees)		
	Frequency band (Hz)		
	4 to 300	4 to 20	20 to 300
999.7 and 1000.3	< 1	< 1	xxx
999.25 and 1000.75	< 3	< 3	xxx
998.5 and 1001.5	< 8	< 8	xxx
998.0 and 1002.0	xxx	xxx	< 3
996.0 and 1004.0	10.7 ± 1.5	10.7 ± 1.5	xxx
994.0 and 1006.0	11.2 ± 1.0	11.2 ± 1.0	xxx
992.0 and 1008.0	11.5 ± 0.7	11.5 ± 0.7	xxx
988.0 and 1012.0	↓	↓	< 10
984.0 and 1016.0	↓	11.5 ± 0.7	xxx
980.0 and 1020.0	↓	11.1 ± 1.1	11.5 ± 0.7
967.0 and 1033.0	↓	< 3	↓
953.0 and 1047.0	↓	< 1	↓
760.0 and 1240.0	11.5 ± 0.7	xxx	11.5 ± 0.7
700.0 and 1300.0	11.1 ± 1.1	xxx	11.1 ± 1.1
500.0 and 1500.0	< 3	xxx	< 3
300.0 and 1700.0	< 1	xxx	< 1

xxx = Does not apply.

2.6 Noise rejection

A 3.5-kHz band-limited white-noise signal 30 dB below 1000 Hz sine-wave carrier should indicate less than 4 degrees peak-to-peak jitter.

2.7 *Test for peak detection*

The peak detector should measure white noise at the 2.58 σ (99%) point. This may be tested as follows:

a) Apply the two tones as described in § 2.4 above. For measurements in the frequency bands of 4 to 300 Hz and 20 to 300 Hz, the second tone should be approximately 1240 Hz. For measurements in the frequency band of 4 to 20 Hz the second tone should be at approximately 1010 Hz. Measure and record the r.m.s. value of the demodulated signal being fed to the peak detector. The signal from this point is normally provided as an output for spectrum analysis.

b) Remove only the second tone and apply a band limited (to at least 2 kHz) Gaussian noise signal along with the 1000-Hz carrier. Adjust the level of the Gaussian noise for the same 11.5-degree reading on the meter as in a). Measure the r.m.s. value of the demodulated signal being fed to the peak detector. This value shall lie between 52 and 58 per cent of the value recorded in a).

2.8 *Time to display correct reading*

It is desirable that the display be within 5% ± 0.2 degrees of its final value within 4 seconds of application of the test signal for the frequency band 20-300 Hz and within 30 seconds for the frequency band 4-20 Hz and 4-300 Hz.

2.9 *Operating environment*

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