INTERNATIONAL TELECOMMUNICATION UNION

# ITU-T O.111

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

## SPECIFICATIONS FOR MEASURING EQUIPMENT

# FREQUENCY SHIFT MEASURING EQUIPMENT FOR USE ON CARRIER CHANNELS

## ITU-T Recommendation O.111

(Extract from the *Blue Book*)

**NOTES**

1 ITU-T Recommendation O.111 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.111**

## FREQUENCY SHIFT MEASURING EQUIPMENT FOR USE ON CARRIER CHANNELS

*(Geneva, 1972; amended at Melbourne, 1988)*

### 1 General

The equipment described below is compatible with the measuring method described in Annex A to this Recommendation.

### 2 Principle of operation

The instrument shall be capable of measuring the error in the reconstituted frequency of a carrier channel in the following modes:

*Test 1: Measurement of frequency shift A → B (Δ Hz): transmitting from A and measuring at B (see Figure 1/O.111)*

The sinusoidal test frequencies having a 2 : 1 harmonic relationship are transmitted simultaneously from A. At B these two test signals, each shifted in frequency by an amount Δ Hz, are modulated together in such a way as to detect Δ, the frequency shift in the AB direction.

*Test 2: Measurement of loop frequency shift (Δ + Δ' Hz) transmitting and measuring at A with the channels looped at B (see Figure 2/O.111)*

This test is carried out in a similar manner to Test 1 and the loop frequency shift (Δ + Δ' Hz) is detected.

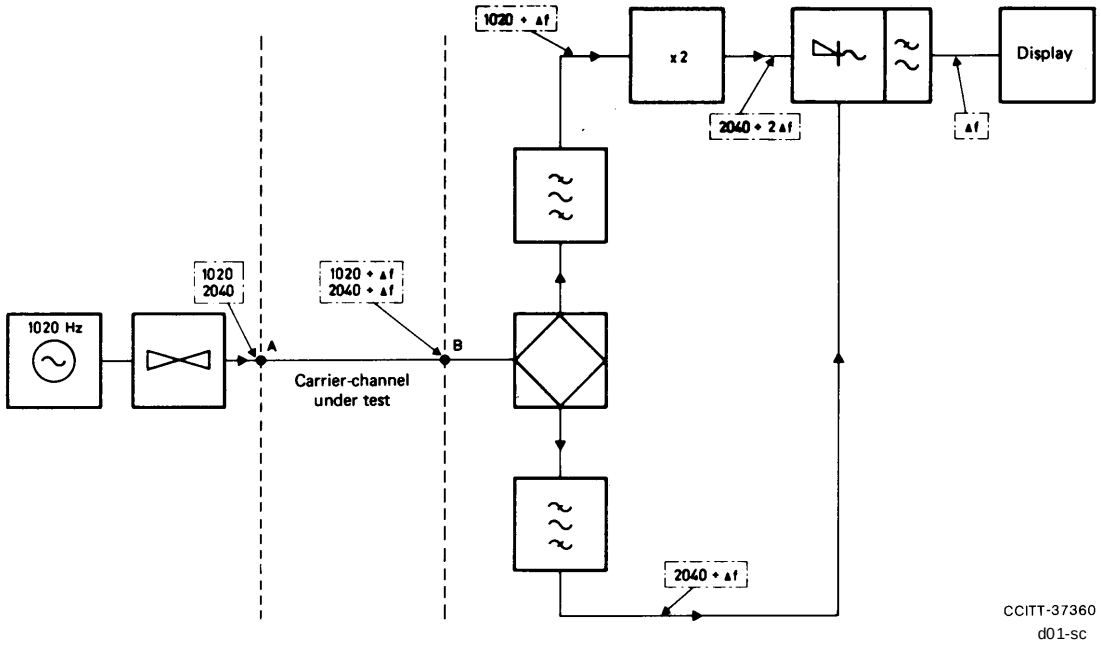



FIGURE 1/O.111

**Measurement of frequency shift on a carrier channel A→B, transmitting from A and measuring at B**

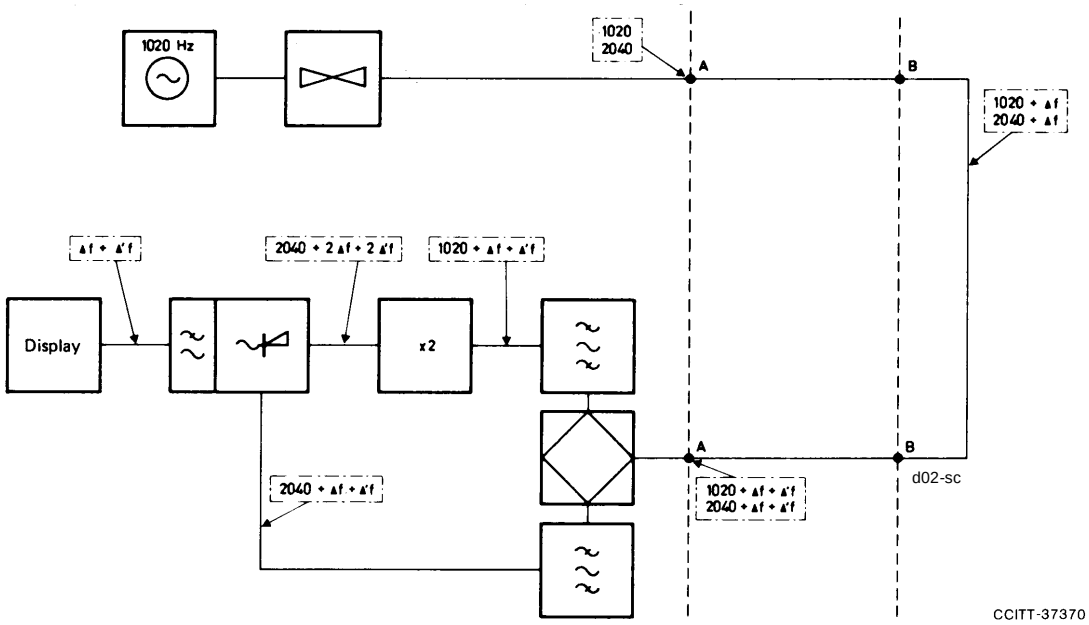



FIGURE 2/O.111

**Measurement of loop frequency shift (A→B) + (B→A), transmitting and receiving at A with a direct loop at B**

There may be a need to measure the frequency shift from B to A while the operator is still located at point A. This measurement can be accomplished in two ways:

*Test 3a: Measurement of frequency shift B → A (Δ' Hz) transmitting and measuring at A with B looped via a harmonic producing unit [see Part a) of Figure 3/O.111]*

A sinusoidal test frequency is transmitted from A and received at B where it passes through a harmonic producing unit. This received signal and its second harmonic are then returned to A, both undergoing a frequency shift of Δ' Hz where they are modulated together in such a way as to detect Δ', the frequency shift in the B → A direction.

*Test 3b: Measurement of frequency shift B → A, transmitting and measuring at A with an instrument at B,* which sends out two test tones having harmonic relationship as in Test 1, initiated by receiving a single 1020-Hz tone from A [see Part *b)* of Figure 3/O.111].

A sinusoidal test signal having a frequency of 1020 Hz is transmitted from A and received at B. If the receiver detects only a *single* tone at B, a generator producing 1020 Hz and 2040 Hz (harmonic relationship) is connected to line B → A, enabling the frequency shift measurement to be made in that direction.

If the receiver at B detects a measuring signal consisting of the *two* test tones 1020 Hz and 2040 Hz (level difference < 6 dB), the line is looped back at B automatically allowing the measurement described as Test 2 [see Part *c)* of Figure 3/O.111].

The use of the frequency shift measuring equipment for Tests 3a and 3b requires the transmission of a single 1020-Hz tone from A → B. Therefore this facility could be provided as an option for the instrument for this type of measurement. The specification of the equipment at B (harmonic producer or switched generator) should be left open for bilateral agreement between Administrations.

## 3 Transmitting equipment

The equipment shall transmit sinusoidal test signals as follows:

3.1 *Frequencies*

a) 1020 and 2040 Hz ± 2%. These two frequencies shall be in exact harmonic relationship

*Note* – If this transmitting equipment is intended to be used in phase jitter measurements, an accuracy of ± 1% will be required.

b) optional additional output for Administrations wishing to cooperate Figure 3/O.111 type measurements..... 1020 Hz ± 2%.

3.2 *Level*

The r.m.s. total output power of the transmitted signal shall be adjustable in the range 0 dBm to –30 dBm. Where two frequencies are transmitted the difference between the two levels shall be less than 0.5 dB.

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

– Balanced, earth free (other impedances optional)..... 600 ohms

– Return loss ..... ≥ 30 dB

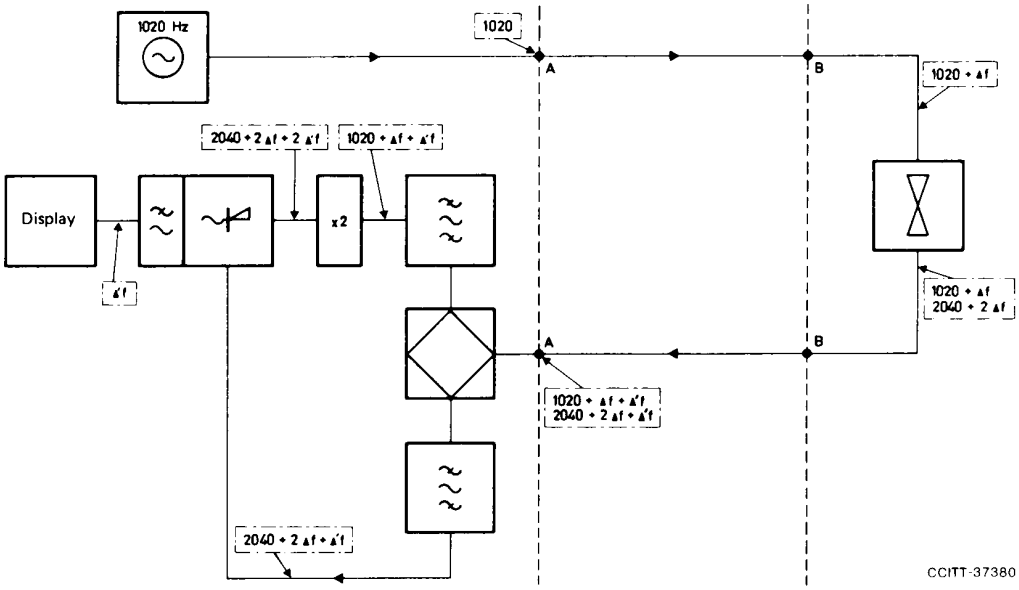
– Output signal balance..... ≥ 40 dB

## 4 Receiving equipment

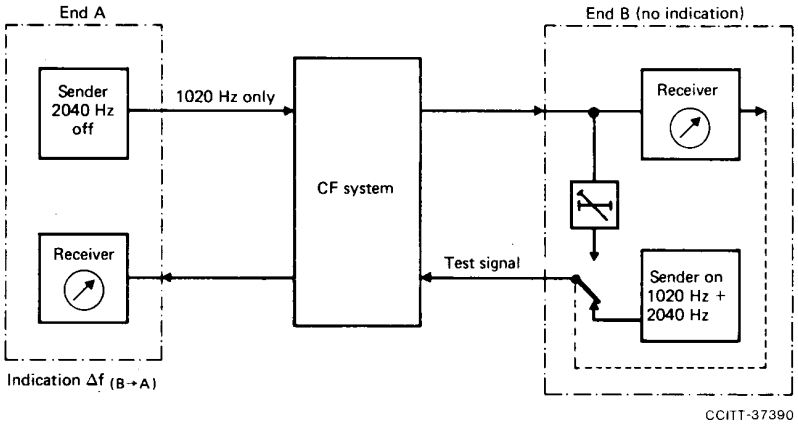
The receiving equipment shall accept the two test tones and shall indicate the frequency shift on a meter or other suitable indicator.

4.1 *Measuring ranges*

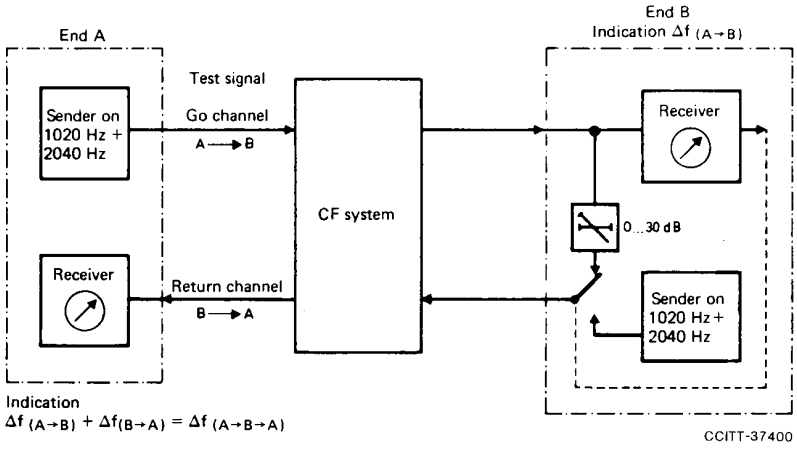
Full-scale measuring ranges of 0-1 Hz and 0-10 Hz shall be provided. The algebraic sign of the shift shall also be indicated.




a) *Measurement of frequency shift on a carrier channel B→A, transmitting and measuring at A with B looped via an harmonic producing unit*




b) *Frequency shift of the return channel B→A*




c) *Frequency shift measurement of the loop (A→B B→A)*

FIGURE 3/O.111

**Frequency shift measurement on a carrier channel transmitting and measuring at A**

4.2 *Measuring accuracy*

– ± 0.05 Hz on 0-1 Hz range,

– ± 0.5 Hz on 0-10 Hz range.

4.3 The meter or indicator shall be such that frequency shifts down to ± 0.1 Hz shall be readable.

4.4 It shall be possible to determine frequency shifts of less than 0.1 Hz by a suitable additional visual facility.

4.5 *Input level*

The receiving equipment shall give the specified accuracy with test signals having levels in the range +10 dBm to –30 dBm (see, however, § 4.8 below). A device shall be provided to confirm that test signals are being received.

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

– Balanced, earth free (other impedances optional)..... 600 ohms

– Return loss ..... ≥ 30 dB

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

4.7 *Input frequency*

The receiving equipment shall operate correctly with test signals up to ± 2% from nominal frequency as applied at the transmitting end and having experienced a frequency shift of up to ± 10 Hz in the transmission circuit concerned.

4.8 *Level difference*

When the two-frequency test signal is transmitted the receiving equipment shall operate correctly when, due to the insertion loss/frequency characteristic of the circuit, the two frequencies arrive at the input to the receiving equipment with a level difference of up to 6 dB.

4.9 *Recorder output*

A d.c. output for operating a recorder shall be provided.

4.10 *Noise immunity*

The r.m.s. value of the error in the indication due to a 300-3400 Hz band of white noise 26 dB below the level of the received test signal shall not exceed ± 0.05 Hz.

## 5 Operating environment

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

ANNEX A

(to Recommendation O.111)

**Method for measuring the frequency shift introduced by a carrier channel**

The principle of the method is that the harmonic relationship between two sinusoids is destroyed if to both is added the same frequency shift. Figure A-1/O.111 is a block schematic of the arrangement and is largely self-explanatory. From one 1000-Hz oscillator are derived two signals, one at 1000 Hz and the other at 2000 Hz, which are both transmitted. At the receiving end of a channel introducing Δ Hz shift they are no longer harmonically related and the frequency shift can be extracted and counted while at the same time a cathode-ray oscilloscope can be arranged to indicate the sense of the frequency shift. This method is used by the United Kingdom Administration and others.

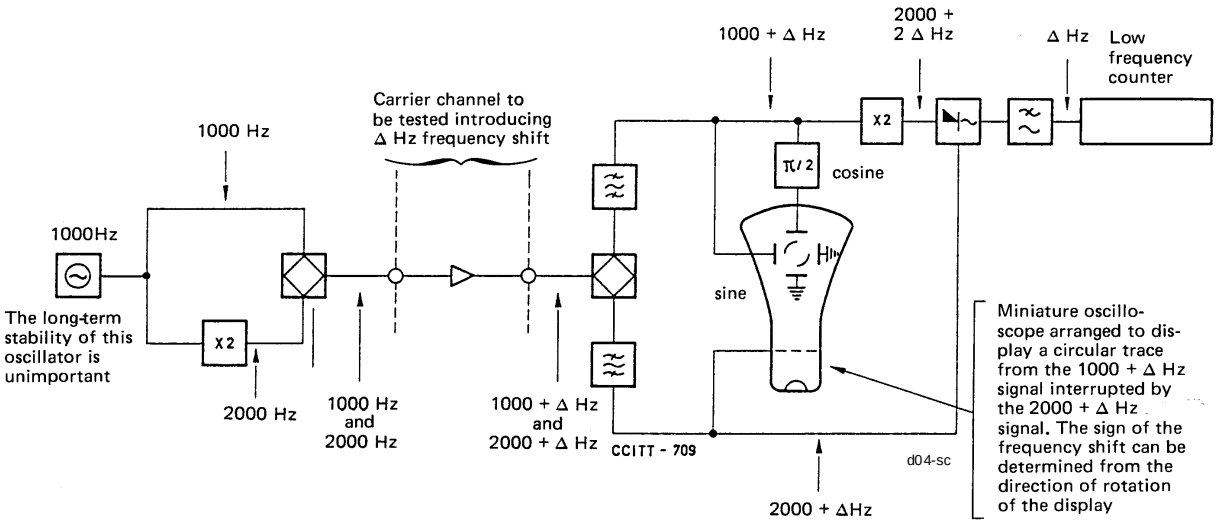



FIGURE A-1/O.111

**A method for measuring the frequency shift introduced by a carrier channel**