

RECOMMENDATION 349-4

**FREQUENCY STABILITY REQUIRED FOR SYSTEMS
OPERATING IN THE HF FIXED SERVICE TO MAKE THE USE
OF AUTOMATIC FREQUENCY CONTROL SUPERFLUOUS**

(Question 1/3, Study Programme 1A/3)

(1963-1966-1970-1978-1986)

The CCIR,

CONSIDERING

- (a) that it is the practice with certain single-sideband (SSB) and independent-sideband (ISB) telephone systems, and with many telegraph systems, to employ automatic frequency control (a.f.c.) to adjust the receiver oscillator frequency in sympathy with variations in the frequency of the transmitted signal;
- (b) that such automatic frequency control systems may give rise to difficulty under unfavourable conditions of propagation, at frequencies below 30 MHz;
- (c) that the frequency stability, which can now be achieved, is much higher than that laid down in Appendix 7 to the Radio Regulations, and is approaching a value which could provide sufficient inherent stability to enable automatic frequency control to be dispensed with;
- (d) that, with systems dispensing with automatic frequency control, the frequency error of the modulating and demodulating stages and of the radio-frequency translating stages at the transmitting and the receiving ends, together with the frequency error due to the propagation path, contribute to an overall frequency error;
- (e) that the overall frequency error of the complete system is decisive and that as far as feasible this error should be shared equally by both the transmitting and the receiving ends;
- (f) that, however, in certain cases when narrow-shift telegraph systems are employed, reasons other than frequency stability of the equipment may still require the use of automatic frequency control,

UNANIMOUSLY RECOMMENDS

1. that the values of permissible frequency errors given in Table I, should be considered as suitable for use on systems giving access to the public service network and dispensing with automatic frequency control;
2. that the figures in column (1) of Table I are decisive for the system, and that those given in the columns (2), (3) and (4) should be considered as an example as to how the overall frequency error could be split up into errors permissible in the parts constituting a complete system;
3. that, however, the use of automatic frequency control may be retained for telephone systems using Lincompex terminals, as set forth in Recommendation 455, and for multichannel voice-frequency telegraph systems on circuits where significant frequency deviations, due to propagation conditions, are encountered (see Annex I).

TABLE I

System	Maximum permissible overall error (Hz)	Frequency error due to:		Frequency error due to the radio-frequency translating stages at both ends and to the propagation path ⁽³⁾ (Hz)
		Modulator stages (Hz)	Demodulator stages (Hz)	
	(1)	(2)	(3)	(4)
1. Single-sideband and independent-sideband telephony	20	5	5	10
2. Radiotelegraphy:				
2.1 Two-tone multi-channel telegraphy with 340 Hz tone spacing and MCVF frequency-shift telegraphy with 340 Hz channel spacing	12 ⁽¹⁾	3	3	6
2.2 Frequency-shift telegraphy F1B (e.g. 50 bauds, 200 Hz shift) and four-frequency duplex telegraphy F7B using narrow-band filters at the receiving end	12	3	3	6
2.3 Multichannel voice-frequency telegraph systems operating at modulation rates up to about 100 bauds, with 80 or 85 Hz frequency shift and 170 Hz channel spacing	12	3	3	6
2.4 F1B and F7B systems using a limiter/discriminator at the receiving end; modulation index ≈ 2 ; (e.g. 196 bauds, 400 Hz shift)	20 ⁽⁴⁾	3	3	14
2.5 Phototelegraphy ⁽²⁾	16	4	4	8

(1) See [CCIR, 1962].

(2) For short-term frequency stability, see Recommendation 344.

(3) This is the maximum error at the demodulator in the frequency of the carrier, if transmitted.

(4) For radiotelegraph systems, which use a device at the receiving end to correct for possible bias distortion due to frequency error, values larger than those indicated in the Table may be permitted.

REFERENCES

CCIR Documents

[1962] Geneva: III/27.

ANNEX I

FACTORS OTHER THAN FREQUENCY STABILITY WHICH MAY MAKE THE USE OF AUTOMATIC FREQUENCY CONTROL DESIRABLE

1. Introduction

The above Recommendation, which is a reply to Question 182 (Los Angeles, 1959), tabulates the permissible overall frequency errors for various systems.

2. Relationship between distortion and frequency error

A number of HF radiotelegraph circuits operating at modulation rates of about 100 bauds with a channel spacing of 170 Hz, use sub-carriers on independent-sideband transmissions.

Measurements made on various well-designed frequency-shift telegraphy receivers have indicated an increase in element distortion of approximately 1.25% for each 1 Hz frequency error. Poorer band-pass filter designs or narrower channelling will raise this distortion considerably.

It has been observed that frequency changes due to ionospheric propagation of up to 7 Hz may occur during periods of up to 15 min [Rishbeth and Garriott, 1964; Davies, 1963]. This can, therefore, result in an additional distortion of up to 9%, which could be reduced by the application of automatic frequency control. Further information about the statistical distribution of these phenomena would be desirable to permit fuller evaluation of their effect on circuit efficiency.

REFERENCES

- DAVIES, K. [1963] Doppler studies of the ionospheric effects of solar flares. Proc. International Conference on the Ionosphere, 76-83.
- RISHBETH, H. and GARRIOTT, O. K. [March, 1964] Relationship between simultaneous geomagnetic and ionospheric oscillations. *Radio Sci.*, Vol. 68D, 3, 339-343.
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