

## RECOMMENDATION ITU-R F.1111-1\*

**IMPROVED LINCOMPLEX SYSTEM FOR HF RADIOTELEPHONE CIRCUITS**

(Question ITU-R 146/9)

(1994-1995)

The ITU Radiocommunication Assembly,

*considering*

- a) that, to maintain a satisfactory standard on international radiotelephone circuits operating at frequencies below 30 MHz and connected to the national network, it is necessary to compensate, at the transmitting end, for most, if not all, of the variations in the subscriber's speech volume and of the losses between the subscriber and the international exchange;
- b) that, as a result, the circuit often operates under a condition of overall gain (two-wire to two-wire) and it is necessary to use a singing-suppressor to maintain stability;
- c) that, the singing-suppressor markedly degrades the performance of the circuit, due to its switching action and its tendency to mis-operation by noise or interference on the radio path;
- d) that the use of a singing-suppressor to maintain overall stability of the radiotelephone channel inhibits the interconnection, on a four-wire basis (see ITU-T Recommendation G.101), of radio circuits and long-distance cable or satellite circuits;
- e) that, if HF radiotelephone circuits were operated at a nearly constant overall transmission loss, the singing-suppressor could be eliminated and a radio circuit could be integrated into an international chain;
- f) that, to maintain a constant overall loss, while catering for variations in subscribers' speech volume and line loss, it is necessary to insert, at the receiving end of the circuit, a loss equivalent to the gain inserted at the transmitting end;
- g) that the advantages of compandor operation, as used on some line transmission systems, are well established, but cannot be directly realized on a radio circuit subject to fading;
- h) that, on such a radio circuit, an alternative means of conveying information as to the state of the compressor is necessary to control the expander;
- j) that these alternative means enable advantage to be taken of a compression ratio in excess of that employed in line compandors, which is generally 2/1 or 4/1;
- k) that the behaviour and advantages of a system employing a linked compressor and expander have been established as applicable to various communications environments; that for HF one administration has reported 22 dB average improvement across time for typical speech signals under varying propagation conditions with a maximum improvement of 47 dB;
- l) that these system behaviour and advantages are desired for use with radio circuits having only modest frequency stabilities and various voice channel bandwidths;
- m) that with such radio circuits loss of voice naturalness can occur as a result of end-to-end frequency error, and that in many cases it is not practical or possible to eliminate the error;

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\* This Recommendation should be brought to the attention of Radiocommunication Study Groups 8 and 10.

- n) that such end-to-end frequency error has an adverse effect on system behaviour and advantages;
- o) that the alternative means employed to convey compression information to the expander can also be used to eliminate the effect of end-to-end frequency errors and thereby provide system behaviour and advantages with voice naturalness;
- p) that the alternative means employed to convey compression information to the expander and the speech compression band must both reside within available voice channel bandwidths;
- q) that it is highly desirable that this system be interoperable with non-equipped stations for applications in networks handling mixed traffic;
- r) that for applications wherein all stations are equipped with the system and interoperability is not an issue, the system receive end should maintain silence when no Lincompex signals are being received;
- s) that with such an arrangement the two ends of a circuit will be complementary and the essential parameters of the system will have to be standardized,

*recommends*

- 1 that, wherever possible, HF radiotelephone circuits should be operated on the basis of a constant overall transmission loss (two-wire to two-wire) and that the system is equally applicable to full-duplex and half-duplex (simplex) circuits;
- 2 that a system comprising a compressor and expander linked by a control channel, which is separate from the speech channel and is resistant to fading distortion, should be used to achieve this performance (such a system is commonly known as Lincompex which is a convenient acronym for the phrase “linked compressor and expander”. Lincompex is neither a proprietary name nor does it refer to the manufacturer of a particular equipment); and that the control channel should be utilized to correct baseband frequency errors due to radio circuit equipment so as to provide the advantages of companding and natural voice for the majority of radio circuits;
- 3 that the system should maintain optimum loading of the transmitter at all times despite variations in subscribers’ speech volumes and line losses;
- 4 that the speech and control signals should both be contained within a single voice channel (the usable upper audio frequency of a voice channel in existing equipments is known to vary from 3 kHz to less than 2 kHz depending on equipment design) so that the system is generally applicable to any transmission medium which outputs a usable baseband signal;
- 5 that such a system should be in accordance with the description and parameters listed below:

## 5.1 General

For convenience, the performance requirements of this Recommendation are based on a system configuration (one end is shown in Fig. 1) which on the transmit side employs pre-compressor delay in conjunction with a voice-signal amplitude assessor. This does not preclude other configurations which meet the requirements. If desirable, a privacy device could be added within the circuit.

Four sets of specifications are presented to accommodate the most common voice channel bandwidths found in user equipments. When specifications differ between these sets, then each set is identified separately as (A), (B), (C), or (D). (A) provides interoperability with equipment conforming to Recommendation ITU-R F.455 (RF Series, Geneva, 1992).

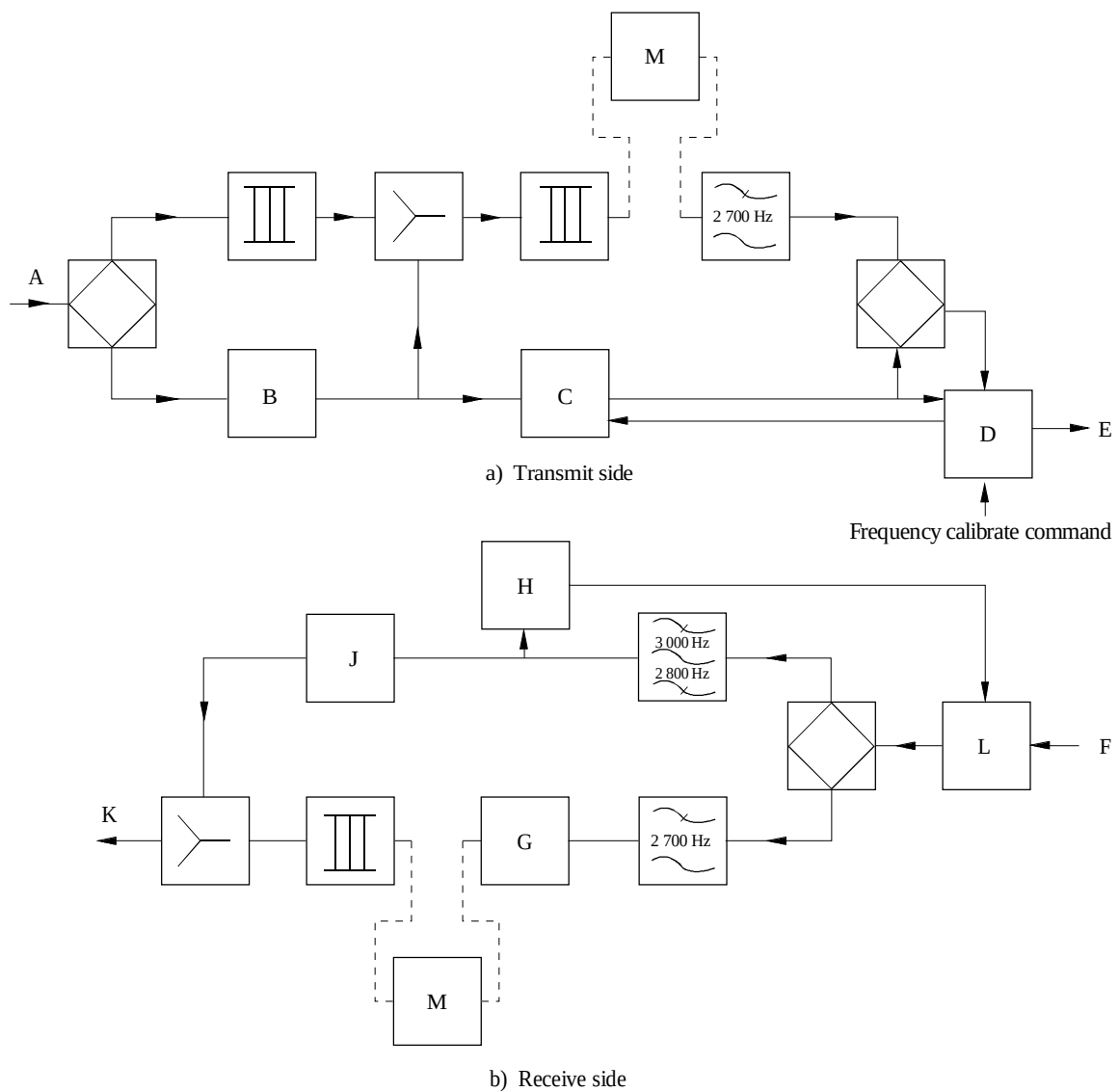
## 5.2 Transmit side (Fig. 1a))

### 5.2.1 Speech channel

#### 5.2.1.1 Steady-state conditions (compression and overall characteristics)

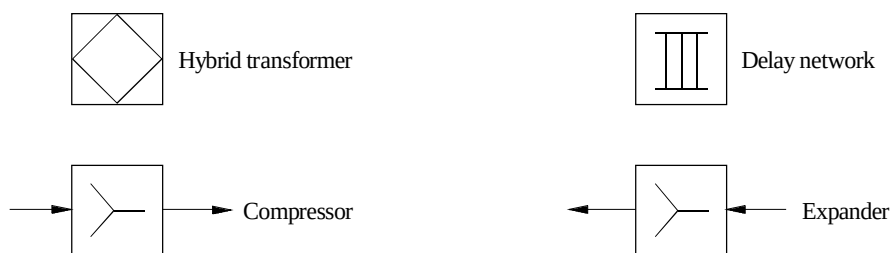
For input levels between +5 dBm0 to –55 dBm0 (see Note 1 at the end of § 5.8) the output should lie within the limits shown in Fig. 2.

FIGURE 1  
Schematic diagram of system



A: from landline  
B: amplitude assessor  
C: frequency-modulated oscillator  
D: frequency calibrate generator  
E: to radio transmitter  
F: audio from radio receiver

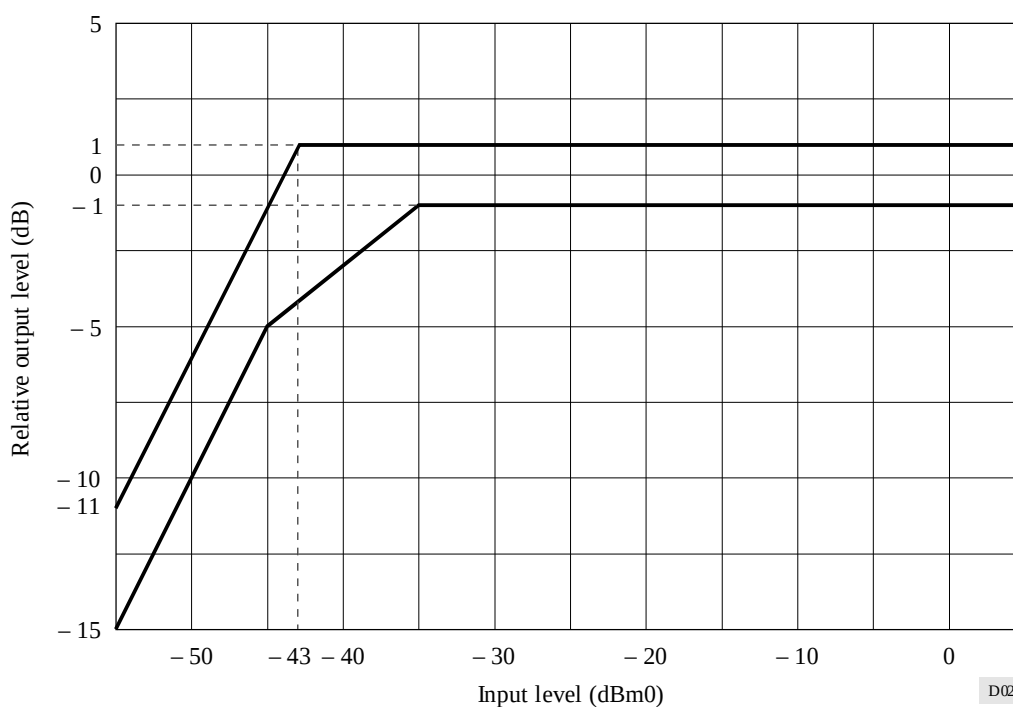
G: fading regulator (constant-volume amplifier)  
H: frequency calibrate detector  
J: frequency discriminator  
K: to landline  
L: frequency shifter  
M: privacy device



Note – The frequencies in a) and b) are for system (A).

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FIGURE 2  
Input/output characteristic of transmit side



The overall amplitude/frequency response for the speech channel under both fixed-gain and assessor-controlled conditions at any level within the range +5 dBm0 to -55 dBm0 should be in the range stated in Table 1.

TABLE 1

## Amplitude/frequency response

| System                                                                  | A                  | B                  | C                  | D                  | Attenuation (dB) |
|-------------------------------------------------------------------------|--------------------|--------------------|--------------------|--------------------|------------------|
| Audio bandwidth (Hz)                                                    | 250-2 500          | 250-2 380          | 250-2 000          | 250-1 575          |                  |
| Frequency response<br>(attenuation relative to the<br>maximum response) | 250-2 500          | 250-2 200          | 250-1 850          | 250-1 455          | ≤ 2              |
|                                                                         | 2 500-2 700        | 2 200-2 380        | 1 850-2 000        | 1 455-1 575        | ≤ 6              |
|                                                                         | 2 800<br>and above | 2 480<br>and above | 2 100<br>and above | 1 675<br>and above | > 55             |
|                                                                         | 250 and below      |                    |                    |                    | > 0              |

### 5.2.1.2 Transient response (overall, including amplitude assessor but excluding additional delay)

Attack time, Fig. 3a) (see Note 2 at the end of § 5.8)

07 ± 2 ms

Recovery time, Fig. 3b) (see Note 2 at the end of § 5.8)

20 ± 5 ms

