

RECOMMENDATION 332-4

SELECTIVITY OF RECEIVERS

(Question 57/1)

(1953-1956-1959-1963-1966-1970-1974-1978)

The CCIR,

CONSIDERING

- (a) that the selectivity of a receiver is a measure of its ability to discriminate between a wanted signal to which the receiver is tuned and unwanted signals;
- (b) that economy in the use of the radio spectrum requires the maximum selectivity compatible with the technical and economic considerations relating to the particular class of receiver;
- (c) that the method of single-signal selectivity is used to express the performance of certain characteristics of the receiver. The measurements are made with sufficiently low levels of input to avoid non-linearity (e.g. overloading) affecting the results; automatic gain control, automatic frequency control, etc., being rendered inoperative;
- (d) that measurement of selectivity with more than one signal should be the general method for measuring the selectivity. Sometimes the non-linear effects are numerous, then it will be necessary to select the most representative cases to simplify the measurements;
- (e) that defined methods of single-signal and multiple-signal selectivity measurements are desirable to permit comparison of receivers,

UNANIMOUSLY RECOMMENDS

1. that the bandwidth of the receiver shall be no wider than is essential for the transmission of the necessary modulation of the wanted signal without significant distortion (see also Recommendation 328 § 1.1);
2. that in establishing the selectivity of a receiver, account should be taken of:
 - 2.1 the unavoidable spread of the spectrum of signals in adjacent channels (see Recommendation 328, § 3);
 - 2.2 the limitations of the selectivity of the receiver by unavoidable amplitude non-linearity, e.g. cross-modulation;
 - 2.3 the fact that an excessively large attenuation-slope may lead to serious distortion of the phase/frequency characteristic in the passband;
 - 2.4 the fact that *selectivity* and *protection ratios* are different characteristics, the first being a property of the receiver only, the second being an agreed minimum value, taking into account characteristics of the emission, propagation and reception;
3. that the filters which determine the selectivity shall be included as near as possible to the receiver input, and the amplifying stages preceding the filters shall be sufficiently linear, to avoid significant loss of selectivity, e.g. by cross-modulation of the wanted signal by strong unwanted signals;
4. that, for the purpose of studying bandwidth or single-signal selectivity, the following definitions are used:
 - 4.1 for amplitude-modulated signals (including single-sideband and independent-sideband emissions), the *passband* is the band of radio frequencies accepted by the receiver and measured at the detector input, limited by the two frequencies for which the attenuation exceeds that of the most favoured frequency by some agreed value; in general this value is 6 dB, except for high-quality radiotelephony receivers where the value is 2 dB;
 - 4.2 for frequency- or phase-modulated signals, the modulation acceptance *bandwidth* of a receiver, other than those used for broadcast reception, is twice the frequency deviation of an input signal which, when applied at a level 6 dB higher than the maximum usable sensitivity level, and measured in accordance with Recommendation 331, § 11, will produce a

$$\frac{\text{Signal} + \text{noise} + \text{distortion}}{\text{noise} + \text{distortion}}$$

ratio equal to that specified for the maximum usable sensitivity level. This is an indication of the frequency deviation which the receiver will accept without excessive degradation of the ratio

$$\frac{\text{Signal} + \text{noise} + \text{distortion}}{\text{noise} + \text{distortion}}$$

4.3 *attenuation-slope*: the attenuation-slope on each side of the passband is the ratio:

- of the difference in the attenuations corresponding to two different frequencies beyond the passband,
- to the difference between these frequencies;

4.4 *image-rejection ratio*: the image-rejection ratio is the ratio:

- of the input signal level at the image frequency required to produce a specified output power from the receiver,
- to the level of the wanted signal required to produce the same output power.

The image frequency is the wanted signal-frequency plus or minus twice the intermediate frequency, according to whether the frequency-change oscillator is respectively higher or lower in frequency than the wanted signal-frequency.

If the receiver incorporates more than one frequency change, there will be more than one image frequency, and for each of these will be a corresponding image-rejection ratio;

4.5 *intermediate-frequency rejection ratio*: the intermediate-frequency rejection ratio is the ratio:

- of the level of a signal at the intermediate frequency applied to the receiver input and which produces a specified output power from the receiver,
- to the level of the wanted signal required to produce the same output power;

4.6 other spurious responses can occur when the intermediate frequency arises as the sum or the difference of the frequency of an interfering signal and a harmonic of the local oscillator frequency, etc.,

spurious-response rejection ratio: the spurious-response rejection ratio is the ratio:

- of the input level at the interfering frequency required to produce a specified output power from the receiver,
- to the level of the wanted signal to produce the same output power;

5. that single-signal measurements be made of the passband, the attenuation slope, the image response, the intermediate-frequency rejection and other spurious-response rejection ratios as defined above and also, in frequency-modulation receivers, the modulation acceptance-bandwidth.

For the attenuation-slope, sufficient indication is generally obtained by considering the frequency difference corresponding to attenuations of 20, 40, 60 and if possible, 80 dB, reckoned from the limit frequencies of the passband. When the values thus obtained are essentially equal for the two sides of the passband, it is sufficient to give mean values.

For some purposes it is of interest to know the bandwidth at fixed levels corresponding to the above-mentioned attenuations. These figures can easily be deduced from the passband and the attenuation-slopes at the different levels (see Fig. 1).

Since, when plotted in decibels to a logarithmic scale of frequency, the sides of the selectivity characteristics are often almost straight beyond a certain frequency difference relative to the mid-band frequency, the attenuation outside the passband can also be expressed as the slope of the attenuation/frequency characteristic, in decibels per octave of the frequency difference. The frequency and attenuation at the starting point of such a slope, relative to the mid-band frequency, should be stated;

6. that, for the purpose of studying the selectivity in the non-linear region with *two or more input signals* the following definitions are used:

6.1 *effective selectivity*: the effective selectivity is the ability of the receiver to discriminate between the wanted signal (to which the receiver is tuned) and unwanted signals (having frequencies generally outside the passband), the level of which is such as to produce non-linear effects, the wanted and unwanted signals acting simultaneously. The effective selectivity can be investigated by measuring blocking, adjacent-signal selectivity (or adjacent-channel selectivity, if there is regular channelling) and radio-frequency intermodulation, as follows:

6.2 *blocking*: blocking is measured by the level of an unwanted signal on a nearby frequency, e.g., in an adjacent channel, which results in a given change (generally a reduction) e.g., 3 dB, in the output power due to a modulated* wanted signal of specified level applied to the receiver input;

6.3 *adjacent signal selectivity*: one of two following principles of measurement is used:

6.3.1 The adjacent-signal selectivity is measured by the level of an unwanted modulated signal at a frequency near to that of the wanted signal which results in an output power from the receiver (sum of the power of all unwanted components) of a specified amount (e.g., 20 dB) below the power due to the modulation of the wanted signal (adjacent-signal selectivity type A).

* Except for class of emissions A1A and A1B when an unmodulated carrier is used.