

The present invention relates to a device for the selective amplification of radioelectric signals.

It applies to the production of band-pass filters for signals with a high energy level, which are very selective, have a very high off-band signal-to-noise ratio and a very high rejection of parasitic spectrum lines outside the pass band.

A commonly used method of producing filters having the abovementioned characteristics consists in performing a crude filtering of the signal before amplifying it in order to apply it to the input of a filter which is distinctly more complex in order to satisfy the required filtering conditions. However, when the energy of the filtered signal is high, this method does not give complete satisfaction since it is difficult to obtain, in the current state of technology, very selective filters with a high off-band signal-to-noise ratio and without parasitic resonances outside the filtering band produced.

The object of the invention is to overcome the abovementioned disadvantages.

For this purpose, the subject of the invention is a device for the selective amplification of radioelectric signals comprising a first amplifier, receiving at its input the signal to be amplified, a second amplifier coupled to the output of the first amplifier via a first band-pass filter, and a second band-pass filter coupled to the output of the second amplifier delivering the resulting filtered signal, characterized in that the first amplifier has an amplification characteristic determined in such a manner that the ratio between the energies of the signal obtained at the output of the first filter and of the thermal noise existing at the output of the first filter is approximately equal to the ratio which is desired to exist between the energies of the signal and the thermal noise at the output of the second filter, the first and second filters having identical pass bands and the second filter having an

attenuation value off band which is approximately equal to the value of the noise factor of the second amplifier.

The invention has the advantage that it offers an effective means which is both simple and economic of
5 optimizing the filtering systems for radioelectric signals when this filtering is performed at a very high signal energy level. This simplicity of production enables it to be applied to all transmission systems and to signal generators requiring a band-pass filtering at
10 high level with a very low noise level and a very low off-band parasitic signal level. In particular, the invention can be effectively applied to the production of intermediate-frequency filtering systems for radio transmitters.

15 Other characteristics and advantages of the invention will also become apparent with the help of the following description given with reference to the appended drawings in which:

- 20 - Figure 1 shows a device for the selective filtering of radioelectric signals according to the invention;
- Figures 2 to 4 show spectra of signals obtained at the different points of the filtering system of the device according to the invention which are shown in Figure 1 (sic).

The filtering device according to the invention
25 which is shown at 1 in Figure 1 inside a dotted rectangle comprises a first amplifier 2, a first band-pass filter 3, a second amplifier 4 and a second band-pass filter 5 connected together in that order in series. The band-pass filters 3 and 5 are of known types, such filters are
30 in particular marketed by the Applicant with the references THOMSON-CSF 20856617 and 20856618, and consequently their details of embodiment do not need to be described in greater detail in order to gain a good understanding of the invention. In Figure 1, the input of the filtering device is indicated by the letter A and its output
35 by the letter E. The letter B indicates the connection between the output of the amplifier 2 and the input of

the filters 3, the letter C indicates the link between the output of the filter 3 and the input of the amplifier 4 and the letter D indicates the link between the output of the amplifier 4 and the input of the filter 5. According to the device shown, the signal to be filtered is applied to the input A of the device and is successively transmitted through the amplifier 2, the filter 3, the amplifier 4 and the filter 5 and then emerges filtered at the output E of the device.

10 This arrangement permits the obtaining at the output E of the filtering device 1 of very high energy level filtered signals with a high signal-to-noise ratio and a very good rejection of the parasitic spectrum lines outside the filtering band. In order to achieve these results, the first section of the filtering device 1 constituted by the amplifier 2 and the filter 3 has a filtering characteristic which corresponds, except in terms of amplitude, to the filtering envelope provided for the complete filtering device 1. The second section of the filtering device 1 constituted by the amplifier 4 and the filter 3 has, at the output of the filter 5, an amplitude-frequency response which has the level and pass-band characteristics corresponding to the filtering envelope desired for the complete device 1 with, however, an off-band attenuation factor which has a value approximately equal to the value of the noise factor of the amplifier 4. When these conditions are complied with, the high-level filtering of the signal performed by the filter 5 compensates for the noise degradation which is contributed the amplifier 4 (sic) and the signal-to-noise ratio obtained at the output E of the device is the same as the signal-to-noise ratio obtained at the link C at the output of the filter 5.

35 In fact, if N_C and B_T respectively denote the level of the signal and the level of the thermal noise obtained at the output of the filter 3, and G_{CD} and F_B respectively denote the gain and the noise factor of

the amplifier 4, the signal-to-noise ratio obtained at the link D at the output of the amplifier 4 is expressed as follows:

$$B \cdot \frac{N_C}{N_T} \cdot \frac{G_{CD}}{F_B \cdot G_{CD}} = \frac{N_C}{N_T} \cdot \frac{1}{F_B}$$

5 If G_{DE} denotes the loss of signal level caused by the filter 5, the signal level N_E at the output of the device 1, is expressed as follows:

$$N_E = N_C \cdot G_{CD} \cdot G_{DE}$$

and if F denotes the off-band attenuation of the filter
10 5, the noise level B_E obtained at the output E of the device is expressed as follows:

$$B_E = \frac{B_T \cdot F_B \cdot G_{CD} \cdot G_{DE}}{F}$$

and as F is approximately equal to F_B
the signal-to-noise ratio obtained at the output E of
15 the device is expressed as:

$$\frac{N_E}{B_E} = \frac{N_C}{B_T}$$

which well verifies the previously given result.

A functioning of the device which has just been described is illustrated in Figures 2, 3 and 4 which
20 respectively show the amplitude-frequency responses of the filter 3, of the amplifier 4 and of the filter 5 in a practical case in which the signal-to-noise ratio obtained at the output E of the device 1 is fixed at 139 dBm, the level N_E is 10 dBm and the losses of level
25 in each of the filters 3 and 5 are 3 dBm. In order to

obtain the result illustrated in Figure 2, the gain of the amplifier 2 was adjusted in such a way that the level of the signal at the link C at the output of the filter 3 is 0 dBm corresponding to a power of 1 mW with a signal-to-noise ratio of 139 dBm. The gain of the amplifier 4 is set at + 13 dBm in order to compensate for the 3 dBm loss of the filter 5 and in order to obtain the desired level, i.e. 10 dBm, at the output E. In Figure 3, the off-band noise level at the output of the amplifier 4 is raised by 19 dBm with respect to the thermal noise level -139 dBm, which corresponds, for the amplifier 4, to a noise factor of 6 dBm. In order to obtain the desired amplitude levels and the desired signal-to-noise ratio at the output E of the device 1, the filter 5 is defined in such a way that at the signal level + 13 dBm applied to its input, the rejection of the parasitic spectrum lines and the off-band attenuation are just higher than the noise factor value (6 dBm) of the amplifier 4. The spectrum of the signal which is obtained under these conditions at the output E of the device 1 is shown in Figure 4, its amplitude is 10 dBm inside the filtering band and the off-band noise level is -129 dBm which corresponds well to the anticipated signal-to-noise ratio of 139 dBm.

CLAIMS

1. Device (1) for the selective amplification of radioelectric signals comprising a first amplifier (2), receiving at its input the signal to be amplified, a second amplifier (4) coupled to the output of the first amplifier (2) via a first band-pass filter (3), and a second band-pass filter (5) coupled to the output of the second amplifier (4) delivering the resulting filtered signal, characterized in that the first amplifier has an amplification characteristic determined in such a manner that the ratio between the energies of the signal obtained at the output of the first filter (3) and of the thermal noise existing at the output of the first filter (3) is approximately equal to the ratio which is desired to exist between the energies of the signal and the thermal noise at the output of the second filter (5), the first and second filters (3, 5) having identical pass bands and the second filter (5) having an attenuation value off band which is approximately equal to the value of the noise factor of the second amplifier (4).

2. Device according to Claim 1, characterized in that the energy of the signal at the output of the first filter (3) is lower than the energy level of the signal obtained at the output of the second filter (5).

3. Use of the device according to Claims 1 and 2 in the production of intermediate-frequency filtering systems for radio transmitters.

