# ANALYSIS METHOD OF FLUCTUATION NOISE IN THE TV RADIOCOMMUNICATION CHANNELS

**George NICOLAE***, **Dan LOZNEANU****

*„Transilvania" University of Braşov, ** Siemens P.S.E. România

***Abstract:*** *Statistics and probability calculus may be used in television to characterize noise in TV channels. This paper presents the experimentally results of noise indicators measuring in different receiving conditions at TV receiver input. The experimentally measurements were concentrated onto determining the parameters of the noise in UHF frequency band TV channels. The data acquisition system was used to measure various parameters of fluctuation noise at TV receiver input for identifying the character of the noise that predominantly affects image quality. Noise parameters are important in understanding the noise influence on the quality of received images and for selection radio channels which permissive optimum radio links.*

***Keywords:*** *fluctuation noise, TV channel noise, measuring fluctuation noise.*

## 1. INTRODUCTION

The TV channel establishes the one-way connection between the transmitter and the TV receiver, being destined for video and audio information carrier signals transmission. Usually, by TV channel we understand only the part allocated for video signals, the sound being independently transmitted on a radio frequency carrier $f_{ps}$, having its frequency greater than $f_{pi}$, the image carrier.

The physics of noise are based on the material particles movement, which generates electrical free oscillations. The radio receivers' and TV sounds and images reproduction is perturbed by the oscillations and the magnetic fields produced by atmosphere, planets and galaxies. If we have a good signal – to – noise - ratio SNR at the TV receiver input, the perturbations effects are reduced, but not totally eliminated, this effect being one of the causes for TV image quality deterioration [1,2]. The noise is a random electrical signal, undesirable, which is superposed over the information signal, modifying it. Its character is completely aleatory, chaotic, because the noise is created from many components, which have random amplitudes and phases. We can measure the noise effective value, but we cannot predict in any moment its amplitude and phase.

From the radio communication system point of view, concerning the transmitting – receiving equipments, the noises can be classified as been inside noises or outside noises. The outside noises are produced by the natural environment or by the human activities. Their power is +15 dB for urban noise (for a large bandwidth), between –5 dB and –50 dB for atmospheric noise (10 – 40 MHz bandwidth) and – 45 dB to –35 dB for solar noise (10 – 100 MHz bandwidth).

For the TV spectrum (30 MHz – 1 GHz), the cosmic noise is greater than that produced by terrestrial atmosphere. The inside noises appear due to the electronic device characteristics, their source being the electric resistance and the semiconductors. This kind of noise can be thermic, flicker (1/f) and pulses noise.

The noises that can be predicted only by averaging, using probabilistic laws are named ergotic noises or Gaussian noises. A large majority of noises can be considered gaussian, having constant power in bandwidth. The gaussian noises (fluctuation noises) have a normal probability law (Gauss) with the same distribution in every moment of time and it cannot be rejected using ordinary technical procedures (filtering, limitations).

The equivalent generators of the noise sources can be serial connected and the total noise voltage value for n gaussian sources $E_{Ntot}$ is calculated using the equation (1).

$$E_{Ntot} = \sqrt{\sum_{i=1}^{n} E_{Ni}^{2}} \quad (1)$$

The fluctuation noise from the TV channel produces image quality deterioration, for fine details and contrast. A noisy image on the TV receiver appears due to the noise power and its distribution on the channel frequency spectrum [4].

## 2. SNR DETERMINATION OF THE RECEIVER INPUT

The size of the fluctuation noise from the input of the TV receiver influence to the TV image quality with is received. Using the digital system measuring of the noise (see Fig.1) was made experimental measurements for determine the signal – to – noise - ratio SNR.

The signal – to – noise ratio was calculated with relation (2).

$$SNR_{inR} = 20\lg\frac{U_{inR}}{U_{inN}} \quad (2)$$

where: $U_{inR}$ – the level of the TV signal to the receiver's input; $U_{inN}$ – effective value of the noise to the receiver's input.

The level of the TV signal to the receiver's input was measured in dBmW using the spectrum analyzer from the structure of the system used.

The expression in volts of the signal can be made using the table of the transformation relations [3] or can be calculated according to the relations (3, 4).In case of the TV receivers the impedance input $R_{inR}$ has de value of 75Ω.

$$P_{inR}[dBm] = 10\lg\frac{P_{inR}[mW]}{1mW} \quad (3)$$

where:

$$P_{inR}[W] = \frac{U_{inR}^{2}[V]}{R_{inR}} \quad (4)$$

The effective value of the noise to the receiver's input can be determined according to the knowledge of the total gain of the used measuring system.

$$G_{tot}[dB] = 20\lg\frac{U_{outN}}{U_{inN}} \quad (5)$$

$$50[dB] = 20\lg\frac{U_{outN}}{U_{inN}} \quad (6)$$

$$\frac{U_{outN}}{U_{inN}} = 10^{2.5} \quad (7)$$

$$U_{inN} = \frac{U_{outN}}{316.23} \quad \mathbf{(8)}$$

where: $U_{outN}$ - the effective value of the noise to the exit of measuring system.

The results of the experimental measuring and of the performed determinations for different quality grades of the received TV image are presented in the table 1. To can be observed the dependence between the received TV image quality and the size of the signal – to – noise – ratio of the receiver input. For the values of the signal - noise - ratio higher than 60 dB can be obtain TV image of very good (excellent) quality, with imperceptible noise. For the values of the signal - noise - ratio less than 50 dB can be obtain TV image of good quality, with troublesome noise.

## 3. THE CORRELATION BETWEEN THE NOISE INDICATORS AND TV IMAGE QUALITY

From the experimental results high lights the importance of knowledge for the indicators noise value for the radio communication channel. The size of the noise indicators can give information's about the quality of received TV image. In table 2 are presented the main noise indicators depending on the received TV image quality and the SNR determined on receiver's input.

<u>Standard deviation (noise effective value) σ</u>, offers conclusive information's about the size of the noise and the power noise which establish the distortions of the useful received signal. The value of the standard deviation indicator controls the width of the noise Gauss curve (see Fig. 2 a, b) which is getting bigger once with the growing of the noise levels number in time unit.

Fig. 1 The equipments for noise measurement in TV channels

Table 1 The noise indicators and SNR for different quality grades of the received TV image

| Noise indicators | | TV image quality | | | |
|---|---|---|---|---|---|
| | | Q = 5 | Q = 4 | Q = 3 | Q = 2 |
| $U_{inR}$ | [dBm] | - 42 | - 45 | - 49 | - 53 |
| $U_{inR}$ | [dBμV] | 65 | 62 | 58 | 54 |
| $U_{inR}$ | [μV] | 2130 | 1030 | 712 | 663 |
| $U_{outN}$ | [V] | 0.479 | 0.477 | 0.562 | 0.706 |
| $U_{inN}$ | [μV] | 1.514 | 1.508 | 1.778 | 2.232 |
| SNR | [dB] | 62.96 | 56.68 | 52.05 | 49.45 |

Table 2 Noise indicators values measuring at receiver input for different TV image quality

| Noise indicators | TV image quality | | | |
|---|---|---|---|---|
| | Excellent Q = 5 | Good Q = 4 | Acceptable Q = 3 | Poor Q = 2 |
| Standard deviation (Effective value) - σ | 0.460 | 0.477 | 0.562 | 0.706 |
| Gaussian noise average value $\mu_{av}$ | 0.140 | 0.142 | 0.143 | 0.145 |
| Variation coefficient [%] - $CV = 100\text{x}\sigma/\mu$ | 61.68 | 62.01 | 62.64 | 62.98 |
| Peak factor of the Gaussian noise [dB] - $FV = \mu_{av}/\sigma$ | -10.48 | -10.55 | -10.82 | -16.40 |
| Repetition frequency of the noise levels - *FR* | 2 | 4 | 7 | 14 |
| Signal Noise - to - Ratio – SNR [dB] | 62.96 | 56.68 | 52.05 | 49.45 |

After this in case of one reception with a quality image Q = 2, the number of noise levels was 1460, while for a quality image Q = 5, the number of noise levels was 893.

Variation coefficient of the noise CV, established like a report between the effective value and average value of the noise offer information's about the weight of uniform noise, of Gaussian type in the total of the noise from the radio communication channel.

This rising of the noise variation coefficient value shows a degradation of the received TV image. Thus, for a quality image Q = 2, the calculated value of variation coefficient was 62.98 % and for a quality image Q = 5, the calculated value of variation coefficient was 61.68 %.

The graphic representation of the correlation between the variation coefficient noise value and the quality of the received TV image quality is showed in Figure 3.

Signal – to – Noise Ratio SNR, at the receiver input represents a technical main parameter for establishing the radio communications links, because the size of this depends the received information's quality. For each experimental situation shoved in table 2 was calculated the value of the signal – to - noise ratio.

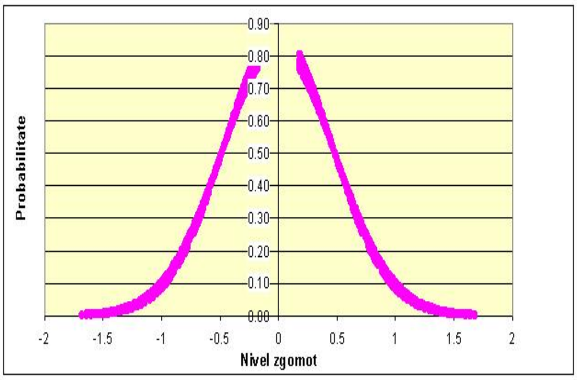
In case of one reception of a quality image Q = 2, the value of the signal – to - noise ratio was 49.45 dB, and for a quality Q = 5, the value of the signal – to - noise ratio was 62.96dB.

The diagram representation in MatCAD software (see Fig. 3), of the correlation between the received image quality and the size of the signal – to - noise ratio highlights he necessity to ensure a signal – to - noise ratio with high values for obtaining a good quality reception.

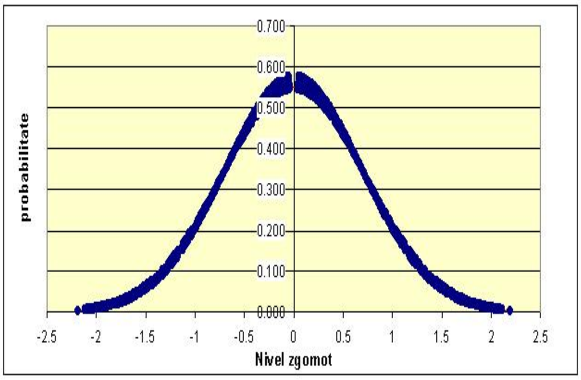
## 4. CONCLUSIONS

The effectuated experimental measurement with the noise from the TV radio communication channel allowed the determined of the next conclusions for selection radio communication channels:

- A large majority of noises can be considered gaussian (fluctuation noise), having constant power in bandwidth and the fluctuation noise has a normal probability law (Gauss) with the same distribution in every moment of time.
- Very importance is the correlation between TV image quality Q and noise indicator values:




a) Gauss curve for TV image "excellent"
Q = 5; σ = 0.460; SNR = 62.96




b) Gauss curve for TV image "poor"
Q = 2; σ = 0.706; SNR = 49.45

Fig. 2 The probability distribution Gauss curve for different TV image quality Q.

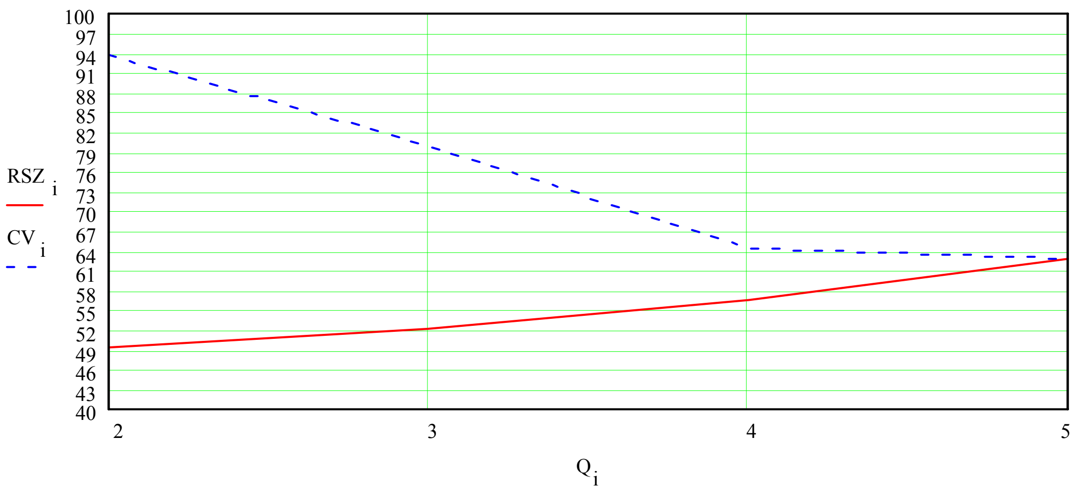



Fig. 3 Diagram of the dependence received image quality $Q_i$ from the noise variation coefficient value and the signal – to - noise ratio value

| Noise indicators | Q=5 | Q=2 |
|---|---|---|
| - Maximum value | 1.68 | 2.19 |
| - Peak-to-peak value | 1.50 | 2.15 |
| - Standard deviation | 0.47 | 0.70 |
| - Variation coefficient [%] | 61.68 | 62.9 |
| - Repetition frequency | 2 | 14 |

- Constant maintaining of the gaussian noise average value ($\mu_{av}$ = 0,14) means that the noise has amplitude normal distribution, a constant power in the TV channel bandwidth where the measurements have been performed and can be treated as a gaussian (white) noise. Also, that noise from the TV channels is gaussian and its effective value doesn't cause TV image important deteriorations.
- Standard deviation controls the width of the probability distribution Gauss curve. The width the Gauss curve is there on the increase proportional the standard deviation and image TV quality losses.
- The noise parameters (standard deviation, variation coefficient, repetition frequency) are practically interesting in selection radio channels which permissive optimum radio communication links.

## REFERENCES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