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Terrestrial television reception disturbances

Abstract. *The aim of the article is comparison of analogue and digital terrestrial television reception susceptibility to external disturbances. Advantages and disadvantages DTT versus analogue TV are represented. Different sources of television reception interference are depicted and special attention is paid to echo signals.*

Streszczenie. *W artykule przedstawiono porównanie wrażliwości na zakłócenia odbioru naziemnej telewizji analogowej i cyfrowej. (**Zakłócenia odbioru telewizji naziemnej**).*

Keywords: television reception disturbances, electrical interferences, multi-path signal, terrestrial television.
Słowa kluczowe: zakłócenia odbioru telewizyjnego, zakłócenia elektryczne, sygnały echowe, telewizja naziemna.

Introduction

Poland is now during switch over from analogue to digital terrestrial television. The digital signal is very different from the familiar PAL analogue signal (see figure 1.). The DVB-T standard uses the COFDM modulation. The COFDM signal, as used in Poland, comprises 6,817 individually modulated carriers and is known as the 8K mode. This means that the power in a DTT signal is spread evenly across its 7.61 MHz bandwidth. In contrast most of the power in an analogue TV signal is concentrated around the vision carrier.

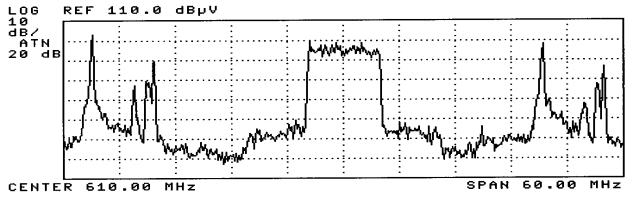

Fig. 1. A part of UHF frequency spectrum in Bialystok: ch. 35 TVP Info (PAL), ch. 38 MUX3 (digital), ch. 42 TVN (PAL)

Fundamental factors affecting domestic TV reception

A. Large buildings and structures.

These may lead to a degrading or even a complete loss of a transmitting signal. Problems are more likely to occur if a building or structure is significantly taller than those around it or is on high terrain. There are two potential mechanisms that can cause problems: physical blocking of the signal by the structure and reflections from the sides of the structure.

Signal reflections are commonplace - buildings or metal structures (like bridges), roads, moving vehicles and even natural features such as hills, cliff faces and trees can reflect signals. In many cases, these surfaces are not very good reflectors, so the reflected signals are relatively weak. However, if a building is clad in a reflective material (e.g. metal sheeting) or has a steel frame or reinforcing, the reflections can be quite strong.

B. Impulsive interferences.

There are many potential sources of pulse interference in a domestic TV installation. House appliances (a washing machine, dish washers, food mixers, irons, ovens, kettles, electric razors, drills, etc.), central heating thermostats, light switches and ignition systems (traffic, lawn mower, etc.) are among them. The first three types can affect the TV receiver through ingress into the down lead. Ignition interference is received by the rooftop antenna. Significant interference is LEMP, that reaches a TV-set directly and by the antenna, the down lead and the power leads.

C. Radio transmitter interferences.

Disturbances are caused by transmitters on the same or similar frequency to the one we are receiving i.e. cordless phones, wireless microphones, amateur or personal radio transmitter, oscillating amplifiers (e.g. radiating antenna amplifiers, audio amplifiers), etc. At times we may receive interference from a powerful nearby transmitter that is over loading the receiving equipment i.e. taxis, carrier, etc.

A special case of radio transmitter interferences are co-channel interferences when two or more television signals on the same frequency appear at the television receiver input.

The consequences of TV reception disturbances

A. Analogue television is quite seriously affected by signal reflections, which can give rise to an effect known as “ghosting”. Ghosting (or delayed image interference) is where a pale shadow or shadows appear to the right or left of the main picture on television screens. Leading ghosts (pre-echoes) are caused by signals arriving at the receiver a split-second ahead of the direct (primary) signal. They are usually caused by direct pick up (pick up other than the antenna).

Trailing ghosts are usually caused by TV signals that bounce off hills, tall buildings or other structures. Because these signals take a longer path to the antenna, they show up on the screen later than the primary signal. The reception of teletext on analogue TV can also be affected with an increase in the number of corrupted characters displayed. Digital television pictures do not suffer from ghosting.

B. There are two primary types of electrical interferences created from house hold appliances causing different interference patterns on analogue television screen. One is caused by electrical motors/thermostats and the other is from microprocessor/switch mode power supply controlled devices. The effect of the first type (the result of working e.g. hair dryer, electric razor, electric drill, etc.) is a dense band of long, dash like, black and white or coloured flecks that can appear anywhere on the screen. It may be accompanied by a buzz in the sound channel. The effect of the interferences from the appliances using microprocessors and switch mode power supplies (e.g. computers, printers, microwaves, etc.) is an even pattern of black and white or coloured flecks which are often diagonal in movement but may vary form horizontal to diagonal in a random manner. At times the pattern may form into two wide bands. The pattern may vary between all effects over a period of time. The picture is normally present behind the pattern in all but severe cases where the picture may tear or roll. On digital television in both cases TV picture disappears, locks, or goes into little squares.

The most destructive interference, that can even destroy the tv installation and the receiver is lightning [3]. In most

cases it causes only temporary flecks on an analogue television and a temporary picture freeze on a digital one. These effects are clearly visible during testing a TV installation with use of surge generator [1].

C. The result of radio transmitter interferences on analogue television is a course or fine RF pattern completely covering the screen. The pattern will normally be diagonal but may vary between vertical and horizontal. These lines usually form a zigzag wavy pattern which may vary as the signal is modulated. On digital television TV picture disappears, freezes, or goes into little squares.

Co-channel interferences on analogue television produce usually evenly spaced horizontal bars of varying width overlaying the whole picture i.e. the picture is usually still present behind the opaque bars. In severe cases the unwanted television picture will appear in place of the wanted picture. On digital television TV picture disappears, locks, or breaks up into little squares.

Is a DTT resistant to echo signals overall?

The basic idea is that knowing reflections (echoes) will be produced during the transmission, the pause times called guard intervals will enable these echoes to fade away and do not affect the signal reception. The guard interval is the time interval, after the transmission of each symbol, during which the transmitter does not emit any essential signal. This will allow echoes - reflections of the emitted signal, or signals from other isofrequency emissions of the same network reaching the receiver with a certain delay - to extinguish themselves before transmitting the next symbol. So, receivers are not disturbed by a possible "overlap" of symbols that could make the received signal impossible to demodulate, even if its level is sufficient or good. The longer the guard interval, the greater the time allowed to extinguish unwanted echoes, but the lower the quantity of data that can be transmitted (bit-rate – number and/or quality of programs).

The guard interval can be set from few microseconds to over 200 microseconds, which means that it can be set so that the system can tolerate reflections/signals coming from other transmitters located a few kilometres, up to about 70 km away. The possible guard intervals have a duration, being always expressed as a fraction of the duration of the symbol time (1/4, 1/8, 1/16, 1/32). A DTT is commonly using a guard interval of 224 μs (GI = 1/4). In general we can say that the echoes arriving within the guard interval do not affect the signal reception as opposite to those arriving outside.

COFDM receivers been aware of the presence of echoes in the received signal and the correction mechanisms available will locate the strongest signal/echo and identify it as "main signal". The remaining echoes will therefore be weaker and may arrive either later or before compared to the main signal. Delayed echoes are known as post-echoes while the other ones are known as pre-echoes. Once the primary and all the secondary echoes have been identified, the receiver calculates the ideal position for the guard interval so as to embrace the maximum number of echoes possible and thus minimize their impact on signal reception. This process is repeated continuously. The echoes that fall within the guard interval will not affect the correct signal reception unless they are particularly strong or are located near its limits.

Micro-echoes are very short, so close to each other that the receiver is not able to determine which one should be considered the main signal and which one the echo. They are typically found when the receiver is located in an area at the same distance from more than one transmitter (in the case of SFN) or when the signal is reflected from nearby metal structures. If those echoes are sufficiently close to each other and have similar power levels they may even make the reception impossible.

A DTT advantages and disadvantages

A digital television, compared to an analogue one, has numerous advantages:

- a greater number of programs in the same occupied RF bandwidth;
- a lower RF power required to cover the same distance;
- a greater immunity to noise and disturbances (a DTT is not affected by ghosting, it is much more tolerant of co-channel interferences);
- a better picture quality (digital reception tends to be better overall, particularly with a good signal - it is easier to obtain the optimum digital picture than the optimum analogue picture);
- the possibility of building isofrequency terrestrial broadcasting networks (SFN);
- the possibility of mobile reception without the typical problems affecting analogue systems;
- the possibility of transmitting data and auxiliary services.

But a DTT has also some disadvantages:

- it can be quite difficult to adjust the antenna (without special equipment e.g. signal level meter), because of the lack of feedback that would be provided by a gradually degraded analogue picture – the digital picture is usually either totally on or totally off, providing no information about which direction to move the antenna;
- analogue requires lower signal strength to get a viewable picture; with low signal strength an analogue picture gets fuzzy (but is still viewable) while a digital picture becomes blocky, freezes and stops updating;
- switching channels is slower because of the time delays in decoding digital signals.

Conclusions

Disturbances in wireless communication are unavoidable. It is only necessary to limit or better remove their influence on reception. To do that the best it is necessary to know the nature of the disturbance i.e. to identify it. An analogue television let for easy and quick identification only on the basis of interference symptom in the TV picture. A digital television does not let for this without special equipment – the effect of any interference can be the same - a digital picture becomes blocky, locks or disappears. Generally digital reception is more resistant to transmission signal disturbances and gives a better picture quality, but with a weaker signal analogue reception can be better - a "snowy" and "grainy" but still viewable and readable picture is better than none.

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