ISM 2.4 GHz BAND LINEAR ANTENNAS DESIGN

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ABSTRACT

The paper describes 2.4 GHz linear antennas design. The 4-element stack array with reflector and 21-element Yagi antenna design process are shown. Realized antennas parameters were measured and their patterns are presented. The design is based on reality that if dimension to wavelength ratio is kept, properties are roughly identical. Then wide family of verified UHF TV antennas is offered.

1 INTRODUCTION

The 2.4 GHz band (2400 - 2483 MHz) is reserved for industrial, scientific and medical (ISM) applications. According to general licence GL-01/1994, operating radio-transmitting stations for wideband data transmission on the spread spectrum principle with limited power is permitted in the Czech Republic. Typical applications are Wireless LAN (IEEE 802.11), BlueTooth wireless technology (IEEE 802.15) etc. [1].

In this band (wavelength $\lambda \approx 12$ cm) direct-wave connection dominates. By reason of small propagation attenuation and high antenna directivity factor achievement, quite small transmitter power level is sufficient. The intensive atmospheric precipitation attenuation effect makes itself felt.

The planar, microstrip and linear antennas are possible to use in this band. Rectangular horn antenna is typical representative of planar antennas. The gain of 10 dBi at dimensions 115×160×318 mm is available [2]. The disadvantage of planar antennas is their 3D structure. The use of microstrip antennas can eliminate this. By using microstrip patch antenna the gain of 10 dBi is possibly achieved with dimensions 120×120×25 mm [3]. On the other hand their manufacture requires quality substrate bringing higher factory price. Linear antennas are the last option. Their basic element is dipole. For attainable gain enhancing, dipoles are assembled into arrays. According to their configuration synphase (transversal radiation) and antiphase (axial radiation) arrays are recognized.

2 TRANSVERSAL RADIATION ARRAY

Stack array with reflector is most frequently used realization. Each element is fed in a phase. Feed distribution is made by half-wave transmission line with crossing in the middle. The basic element is fan dipole.

Fig. 1: *4-element stack array with reflector realization*

The first step in projection is active element design. Due to the connective transmission line length, the input impedance of the array is roughly in virtue of each element impedance parallel combination. Starting parameters are following: stack spacing λ/2, reflector spacing $\lambda/4$. Dipole arm length 0.75λ and opening angle 30° refers to required input impedance [4].

The gain of 16.3 dBi was measured and SWR (50Ω) of less than 1.2 was reached in whole band. The symetrization is made by half-wave loop.

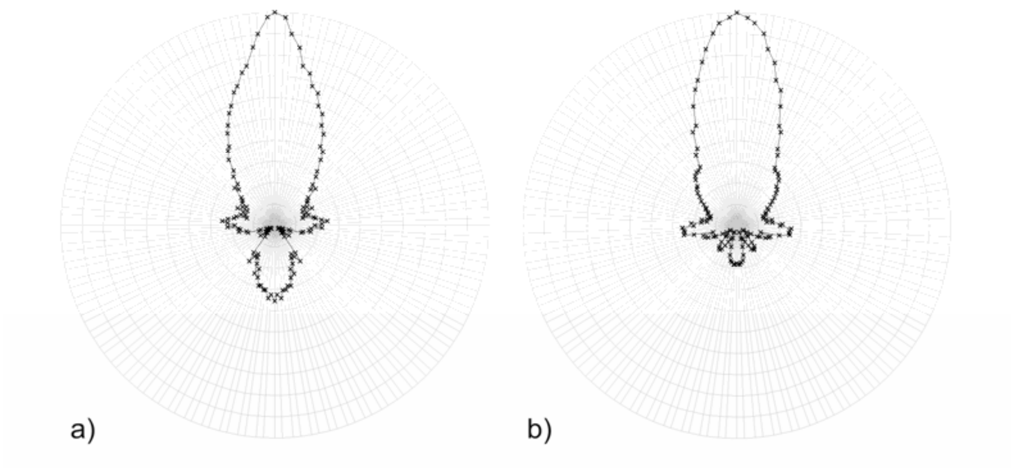

Fig. 2: *4-element stack array with reflector patterns*
a) horizontal plane, b) vertical plane

3 AXIAL RADIATION ARRAY

The trait of this configuration is coexistence of one active and more passive elements (directors, reflectors). The typical representatives are Log-Periodic antenna (LPA) and Yagi antenna. LPA is low gain levelled in a wide band, while Yagi antenna is usually high gain levelled in a narrower band. The easy construction is an advantage, but design difficulty is a disadvantage.

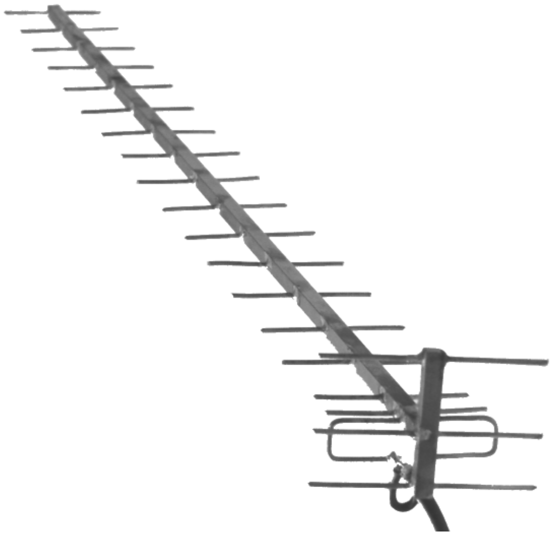

Fig. 3: *21-element Yagi realization*

In our work 21-element antenna for TV channels 56-60 (center frequency 770 MHz, band 40 MHz and input impedance 75 Ω) was starting position [5]. By transformation to 2440 MHz center frequency, similar properties are achieved in 125 MHz band. The correction for 50 Ω feeding was designed in 4nec2 (Numerical Electromagnetics Code, double precision version) by optimizing the length of dipole, first director and reflector.

After antenna construction following parameters were measured: the gain of 18.5 dBi, SWR (50Ω) of less than 1.3, patterns are shown in figure 4.

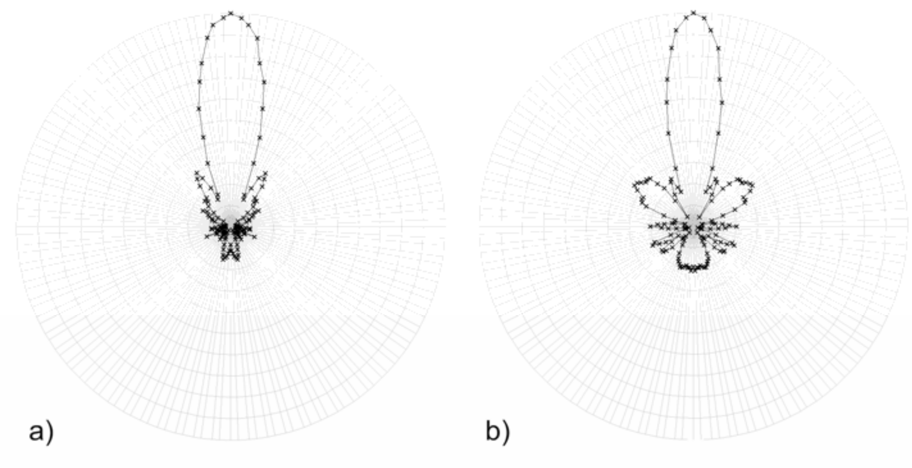

Fig. 4: *21-element Yagi patterns*
a) horizontal plane, b) vertical plane

4 CONCLUSIONS

The paper presents obtained experiences and measurement results of two 2.4 GHz linear antennas. The starting points were UHF TV antennas.

In our work 4-element stack array with reflector was optimised, realized and tested with following results:

Gain	16.3 dB
Front to Back Ratio	> 10 dB
Standing Wave Ratio	< 1.2

The 21-element Yagi antenna was also optimised, realized and tested with following results:

Gain	18.5 dB
Front to Back Ratio	> 16 dB
Standing Wave Ratio	< 1.3 dB

Antennas were successfully tested on real link.

REFERENCES

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