DESIGN OF EH ANTENNA AS NEW POSIBLE TYPE OF AIRCRAFT ANTENNAS

Juraj TARJÁNYI, Ing.
Technical university of Kosice, Faculty of aeronautics, Rampova 7, 041 21 Kosice
jtarjanyi@gmail.com
Martin KRCHŇÁK, Ing.
Technical university of Kosice, Faculty of aeronautics, Rampova 7, 041 21 Kosice
martin.krchnak@tuke.sk
Ján LABUN, doc. Ing. PhD
Technical university of Kosice, Faculty of aeronautics, Rampova 7, 041 21 Kosice
jan.labun@tuke.sk

Summary. The aim of the article is a technical analysis of this new type of antennas. From theoretical background are obvious real benefits of this type of antenna. This article describes theoretical elements of EH antenna, prototyping of EH antenna and real measurements in anechoic chamber. Results are visualised in graphs. Conclusion of article compares two types of antennas: linear and EH. Results are supported by measurements.

Keywords: EH antenna, aircraft, prototype antennas, anechoic chamber, electromagnetic field, Magnetic field, measurements

1. INTRODUCTION

On 23.5.2000, Mr. Ted Hart (W5QJR) had a new type of antenna, which he called EH antenna, patented. From publicly accessible information's, it is obvious that it is only a modification of a known concept of Hertz antenna, invented 120 years ago. EH antenna was categorized as a small antenna. It found its use mainly in ham radio fields, mostly because of its exceptional electric (in some cases, the effectivity exceeded 90% and antenna gain was between 0 and 2 dB) and design features. Today, the EH antenna is a commercially produced product of many companies specialized in antenna design and manufacturing. Portions of work concern manufacturing of experimental and EH antennas and measuring the impedance and frequency characteristics of antennas. A specific chapter consists of a series of electrical measurements for the analysis of processes resulting from the radiation of electromagnetic fields.

2. EH ANTENNA

EH antenna (electromagnetic antenna) is the name of a new type of communication antenna. The principle of operation of this new type of communication antennas is based on the transmission and reception of electromagnetic waves that are perpendicular to each other. It follows that electric field E and magnetic field H cross each other during emitting. A special feature of EH antenna compared to conventional electrically short antenna is the fact the radiating element is not the conductor of certain length supplemented by extension coil, but the radiating element is a conductor with major terminal capacities. This antenna was created on concept of Hertz antenna (Hertz dipole), but a phasing part was added, which provides phase shift.

Hertz antenna can be conceived as an antenna which is represented by radiating resistance RVST and loss resistance RSTR, together with appropriate reactive component having an inductive or capacitive character and is expressed as +jXL and jXC. Resonance is a condition, which occurs when current, that powers the antenna, is in phase with voltage, thus reaching the maximum power transfer from VF source to the antenna. If there is a widening of the antenna, capacitance and inductance increase to the point, where respective absolute values of reactance's are the same. The antenna reaches this point, if the radiant has a length of approx. $\lambda/4$. Antenna in this state becomes self-resonating (it has resonating length). EH antenna originates from the Hertz antenna after the implementation of phasing component which removes the phase shift. This component is marked as –jD. If the current supplied by VF source has a phase delay of 90° from the voltage supplied by the source, the electric component E and magnetic component H are in phase. At the same time the condition of radiation creation by Poynting theorem is fulfilled. Additional radiating resistance RR is designed to improve the efficiency of the antenna and the inductance + JXL is designed to properly compensate current shift which refers to the natural capacity of the antenna. These elements result in an overall reduction of inductance required to achieve a resonant state of the system and reduce Q.

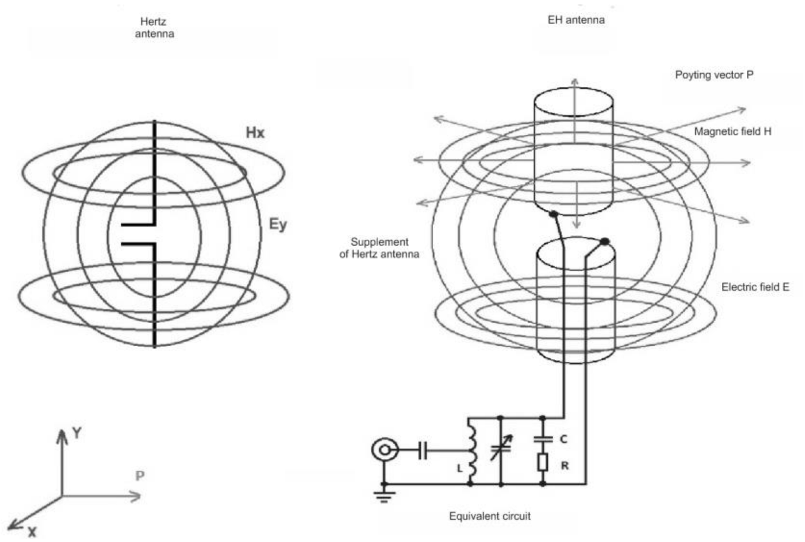

Figure 1 Complete general scheme of EH antenna and radiation principle

2.4. EH antenna advantages and disadvantages

EH antenna, as one of the electrically short antennas has some positive characteristics. Because it is a new type of communication antenna used primarily in ham radio sphere in CB bandwidth (27 MHz), a big positive feature is its compact proportions. Relatively large radiation effectivity and reaching very good parameters in receiving and emitting mode are other pros of this antenna. EH antenna has a very good efficiency, in some cases exceeding 90%. The antenna can work efficiently even at low intensities of electric and magnetic fields and compared to other antennas is resistant to interference from ambient electromagnetic fields. This fact is positively reflected in significantly higher proportion of S/N ratio.

Disadvantages of EH antennas are high requirements on construction design of these antennas. Inaccurate construction design antennas can negatively affect the phase shifting and the inability to precisely tune the antenna to the desired frequency at a satisfactory PSV. Another con is higher sensitivity to the local magnetic field homogeneity.

Table 1 Parameters of two types of antennas

Parameter	Hertz antenna	EH antenna
Dipole size	1/2 λ	1 - 5% λ
Dipole height	1/4 λ	few cm
Vertical dimension	1/4 λ	1 - 5 % λ
Frequency bandwith	Narrowband	Broadband
Efficiency	Standard efficiency	Many times higher
Polarization	Vertical	Round

3. ANTENNAS PROTOTYPING

The basic part of EH antenna is Hertz dipole. If Hertz dipole are supplement by phases, tuning and matching circuits we get EH antenna. For testing purposes was designed these types of antennas:

1. EH antenna
2. Symmetrical dipole λ/2
3. Ferrite core antenna
4. Loop antenna

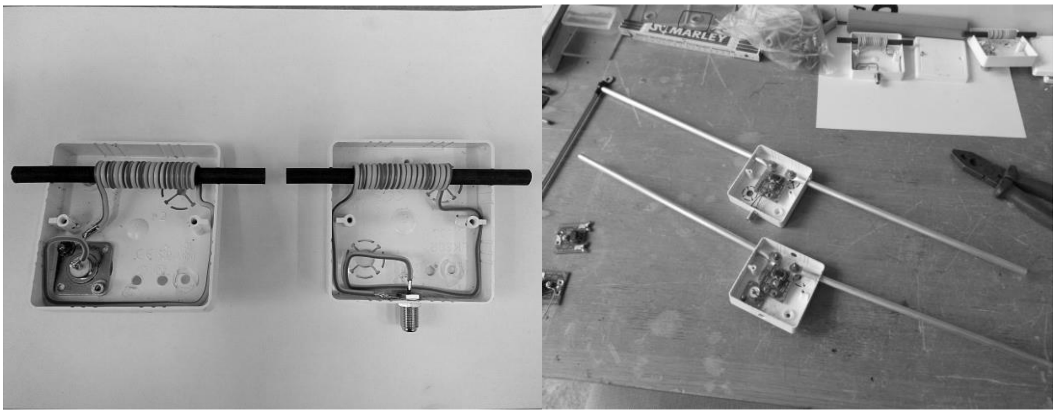

Figure 2 Prototypes of ferite antenna and symmetrical dipole

ISSN 1339-9853 (online), acta-avionica.tuke.sk ISSN 1335-9479 (print) © 2015 LF TUKE

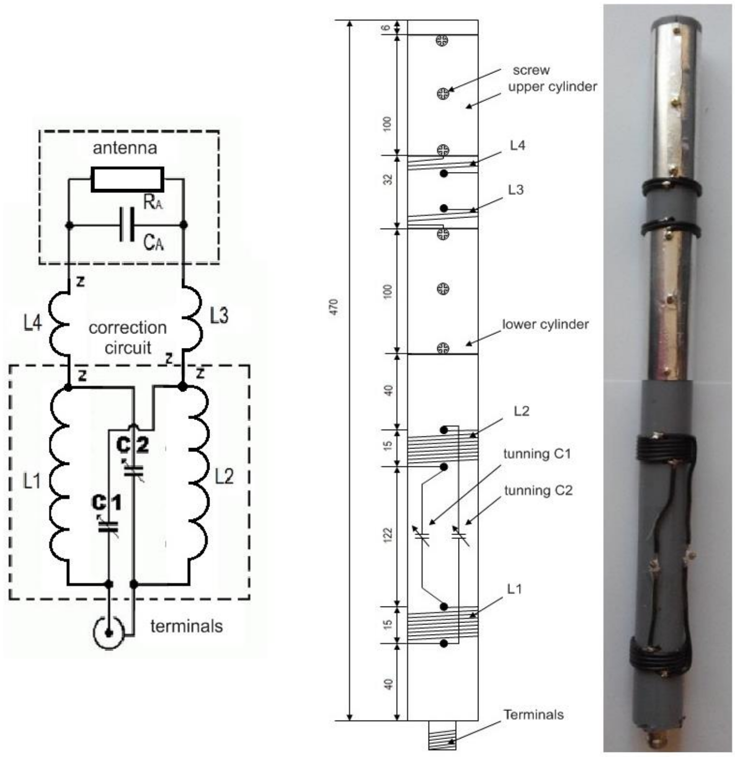

Figure 3 Prototype of EH antenna

4. MEASUREMENTS OF PROTOTYPES

4.1. SWR measurements

One of basic electric parameter used in measurements of antennas is standing wave ratio – SWR. These parameters evaluate quality and effectiveness all parts of antenna system. By measuring of SWR we can determine impedance matching of antenna system. For best results antenna should have impedance as coaxial wiring close as possible. In real this status are identified by SWR = 1.

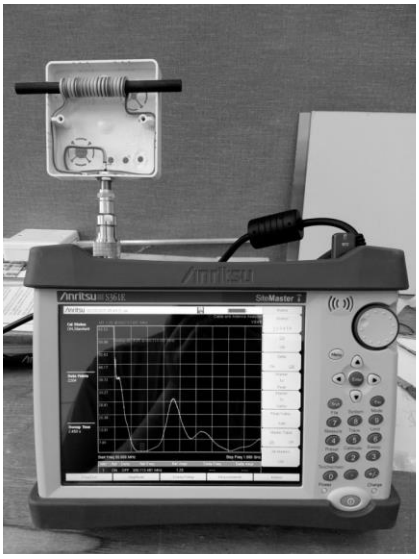

Figure 4 Measurement of SWR on antenna analyser

Table 2 Measured SWR of antennas

Antenna type	Resonance frequency [MHz]	SWR
Symmetric dipole λ/2 (N-connector)	324.69	1,04
Symmetric dipole λ/2 (F-connector)	325.37	1,04
Ferrite antenna (N-connector)	300.97	1,36
Ferrite antenna (F-connector)	300.11	1,16
Loop antenna (electric loop)	918.11	1,49
EH antenna	46,46	1,17

4.2. Intensity of electromagnetic field

Radiation of electromagnetic waves is the basic function of antennas. Theory of electromagnetic field in close range of antenna is much specified. Picture show few parts of generation electromagnetic field by antenna.

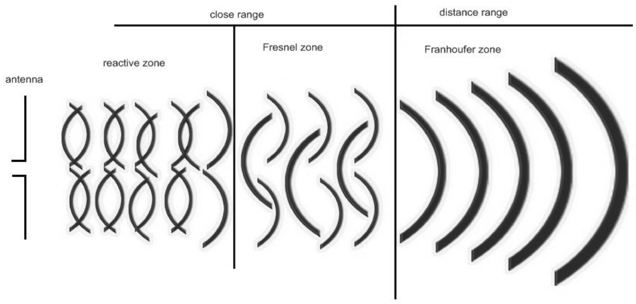

Figure 5 Parts of electromagnetic field from antenna

Antennas were placed to anechoic chamber Franconia. In this chamber, a measurement was not affected by parasite interference. The main part was square wood rod of 3m length mounted 1,5m from ground. On wood rod was placed scale for better reading. Transmitted antenna was fixed mounted on one end of rod and receiving antenna moved to the rod in 10cm steps in 0cm to 2m.

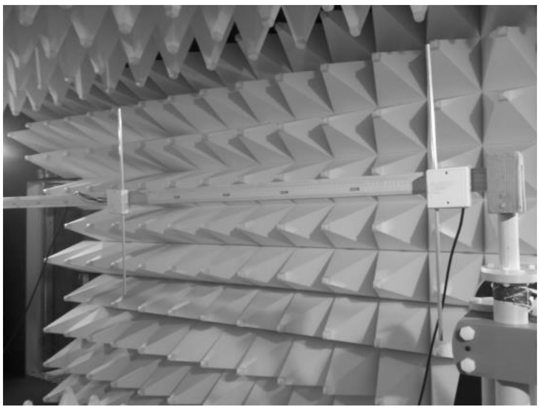

Figure 6 Photo on measuring system

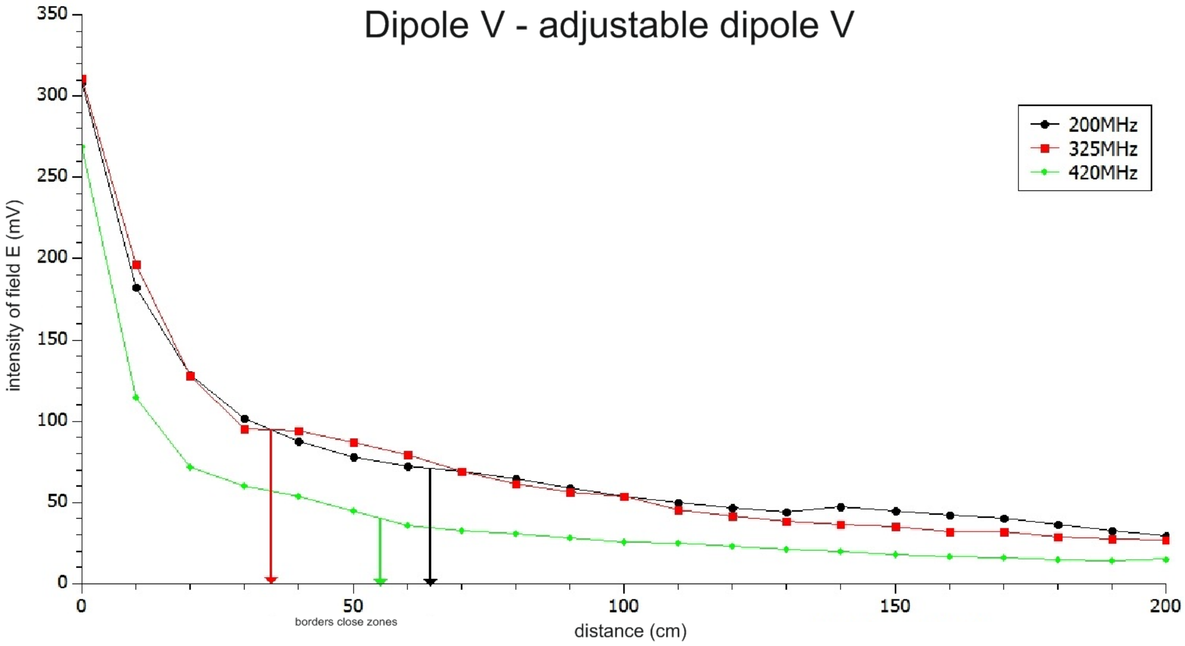

Figure 7 The course of radiation intensities obtained from measurements of antennas

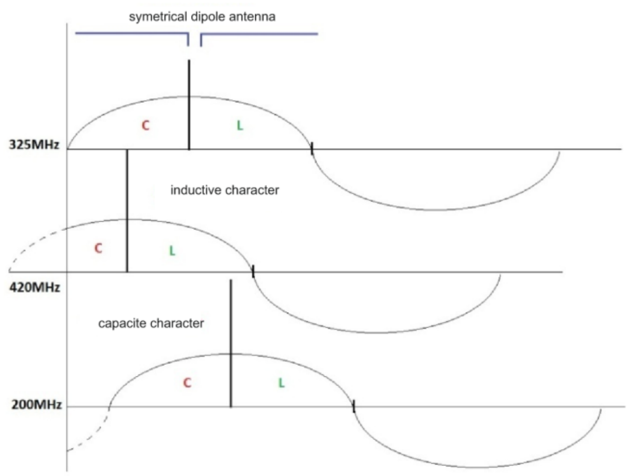

Figure 8 Character of symetrical dipole antenna

5. CONCLUSION

Measurement at frequency of 420MHz : with the same transmitting antenna dimensions and increased frequency to 420 MHz, wavelength λ decreases, while l/λ ratio increases (size l is the antenna) and the antenna has inductive character.

Measurement at frequency of 200MHz : with the same transmitting antenna dimensions and decreased frequency to 200 MHz, wavelength λ increases, while l/λ ratio decreases (size l is the antenna) and the antenna has capacitive character. Measurements were to explain how the change of L and C ratio affects the close field. It is clear that increasing operating frequency reduces the electrical component of the field, while decreasing frequency the electrical component is the same as when measured in resonance.

From the process of measurement, it is obvious that used receiving dipole antenna makes it possible to measure the electrical component of the electromagnetic field. It allows to measure in both cases (of higher and lower frequencies). Results clearly show that using dipole receiver antenna allows measurement of electric component of electromagnetic field. At a higher frequency (420 MHz), when the antenna has inductive character, lower level of electric component was measured than at a lower frequency.

7. LITERATURE LIST

[1] ČERNOHORSKÝ, D., TICHÝ, J.: Vyzařování a šíření rádiových vln, II. Díl Antény. Vojenská akademie Antonína Zápotockého, 1977.
[2] http://fei1.vsb.cz/kat420/vyuka/FEI/sireni_vln/teze/otazka_18.pdf
[3] http://ok1ike.c-a-v.com/soubory/prij_ant_soubory/image004.jpg
[4] Amatérske rádio 2/2004 , Anténa EH - mýtus a realita
[5] http://ehant.qrz.ru/book.pdf
[6] http://www.antennex.com/shack/Apr03/ontheeh.pdf
[7] Matuszczyk J. : ANTÉNY Prakticky : BEN – Technická literatúra, Praha 2005, ISBN 80-7300-178-0
[8] CAHA,V. –PROCHÁZKA, M. : ANTÉNY : Státnína kladatelství technické literatury n.p. Praha 1956, typové číslo 26-C3-4-II
[9] KURDEL, P. - LAZAR, T. - NOVÁK SEDLÁČKOVÁ, A.: Operator - pilot learning success with aviation ergatic system control. In: Transport and communications. č.1 2015, s. 6-10 ISSN 1339-5130
[11] ŽIPAJ,R – EH antenna for civil band: http://www.tubeamp.sk/cb_eh_antena.html

This work was funded by the European Regional Development Fund under the Research & Development Operational Programme project entitled “Construction of a research & development laboratory for airborne antenna equipment, ITMS: 26220220130.”