POSSIBLITIES OF USING EH ANTENNAS IN AIRCRAFT COMMUNICATION

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Summary. The aim of the article Possibilities of using EH antennas in aircraft communication is a technical analysis of this type of antennas, construction of classic experimental antennas and construction of experimental EH antenna, as well as verification of theoretical informations by series of laboratory measurements while considering specific processes, created in the process of radiation of electromagnetic fields

Keywords: EH antenna, Linear antenna, Loop antenna, Electric field, Magnetic field

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 informations, it is obvious that it is only a modification of a known concept of Hertz antenna, invented 120 years ago. EH antenna was categorised 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 specialised 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. DIVISION OF ANTENNA ACCORDING TO THE ELEMENTARY RESOURCES

2.1. Linear antenna

Linear antennas are made of conductors of various shapes, but always more or less lenghtened, meaning that on every location, we can determine in advance the direction of the current which flows in a given location. Linear antennas are widely use in real life, where they are used in communication systems operating at frequencies from 100 to 102 GHz. Linear antennas can work independently, but in many cases they are used in more complex antenna systems. Linear antenna can thus be regarded as the set of elementary dipoles. Basic type of linear antennas is elementary electric dipole, so called Hertz dipole.

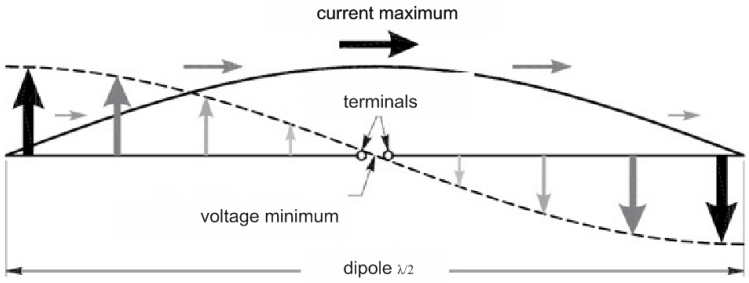

Figure 1 The current and voltage waveforms on a balanced dipole λ/2

2.2. Loop antennas

Loop antennas respond primarily to the magnetic component of the elctromagnetic field. In the category of magnetic antennas belong loop and ferrite antennas. Loop antenna may have loop in circular, rectangular, triangular or other shape. Antenna may have one or more turns. Elementar loop antenna consists of electrical loop. Analysis of electric and magnetic elementar dipole showed they differ only in orientation of E and H lectors. A small current loop with a constant stream of radiation produces the same field as the elementary magnetic dipole lying on its axis, but it is different in near area of radiation elements. Properties of loop antenna can be described directly from its function as receiving antenna. Effective length of the loop antenna increases after inserting the ferromagnetic core into loop antenna coil. This is due to the concentration of magnetic field lines, and by increasing the magnetic flux in the loop.

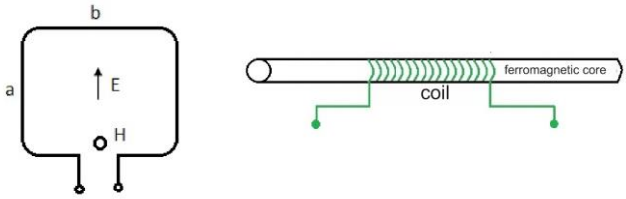

Figure 2 Loop and ferite core anntena

2.3. EH antennas

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 elemtn is not the conductor of certain lenght 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.

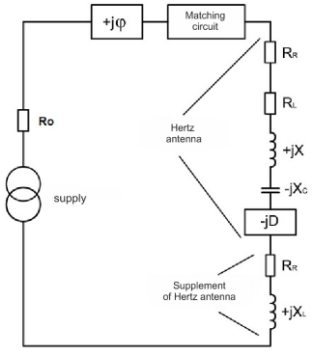

Figure 3 Hertz antenna equivalent circuit

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 +jXLa 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 reactances are the same. The antenna reaches this point, if the radiant has a lenght of approx. λ/4. Antenna in this state becomes self-resonating (it has resonating lenght). Principled basis for EH antenna has become a Hertz antenna only with the application of certain structural modifications. 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 magnetick component H are in phase. A tthe same time ,the condition of radiation creation by Poynting theorem is fullfilled. 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.

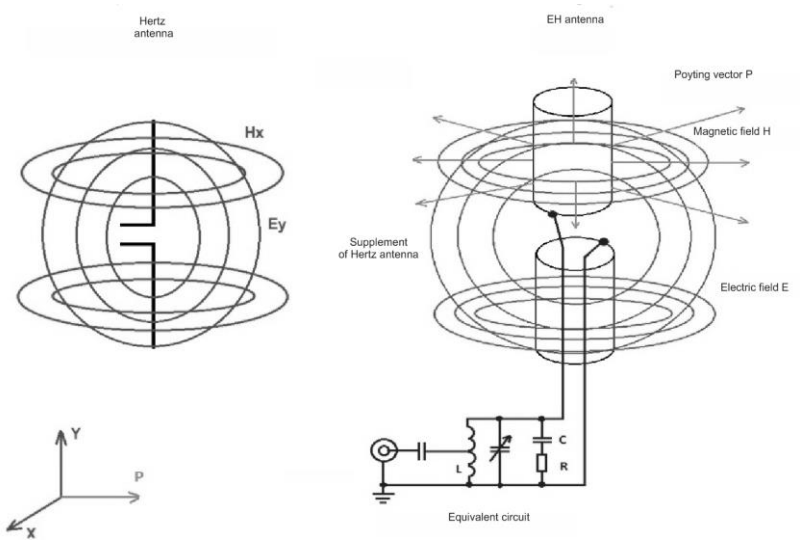

Figure 4 Complete general scheme of EH antenna and radiation principle

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 bandwith (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 another 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 homogenity.

3. EH ANTENNAS IN AIRCRAFT HF RADIO COMMUNICATION

Aircraft radio communication in HF spectrum use antennas mounted in tail section. In most cases are non symmetrical dipole antenna – monopole λ/4. These antennas has smaller mechanical dimension. It is important use tuning circuit made from coils and capacitors for tune correct resonance frequency of antennas. This type of correnction has negative effect on connection range.
Advantages of EH antenna determine it for this application. In theory, frequency of radio communication is 22MHz. Monopole antenna must have 6.81m length but for EH antenna is it only 20cm length and diameter 8cm with frequency range 10-30MHz

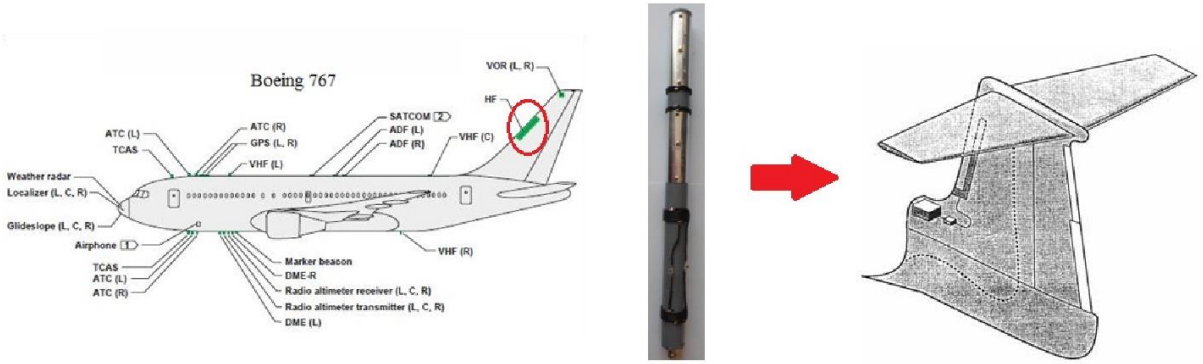

Figure 5 EH antenna for HF radio communication

6. CONCLUSION

In the process of measuring symetrical dipoles and emitting a signal with frequency of 325MHz it is possible to observe a balance of two frequency characteristics of the signal and both measured antennas, which was reflected in field intensity of 250mV in the immediate vicinity of the two antennas. Border of the near zone (area) of radiation reached 55.33cm. In case the receiving symmetrical dipole was in horizontal polarisation, there were large fluctuations in field strenght. The source of these anomalies could be the fact that the very symmetrical dipoles are of narrowband character and are suitable exclusively for operation in vertical polarization. One of the aims of near

field measurements was an experimental measurement which was to establish how inducted voltage in measured antenna is affected when the antenna is not in resonance. For this purpose, two further measurements at frequencies where the antenna had unsatisfactory SWR, but on the other hand, one component was always highlighted, were carried out.

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