ANTENTOP

ANTENTOP 02 2004 # 006

ANTENTOP is *FREE* e-magazine devoted to ANTENnas Theory, Operation, and Practice

2-2004

Edited by hams for hams

In the Issue:
Antennas Theory!

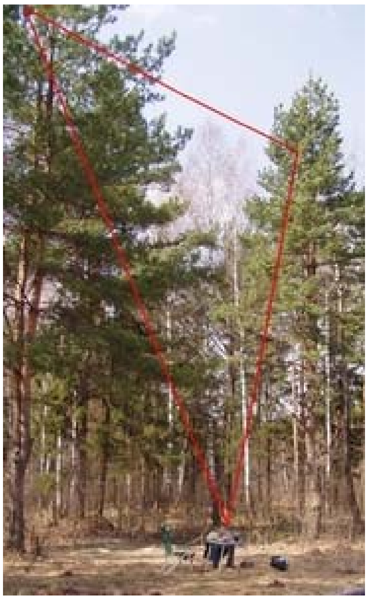
Practical design of HF Antennas!

Practical design of UHF Antennas!

Interferences!

And More….

RV3DA Antenna



900-MHz Antenna

EDITORIAL:

Well, my friends, new ANTENTOP – 02 -2006 come in! ANTENTOP is just authors' opinions in the world of amateur radio. I do not correct and re-edit yours articles, the articles are printed "as are". A little note, I am not a native English, so, of course, there are some sentence and grammatical mistakes there… Please, be indulgent!

ANTENTOP 02 –2004 contains antenna articles, and several historical articles. Hope, it will be interesting for you.

Our pages are opened for all amateurs, so, you are welcome always, both as a reader as a writer.

73! Igor Grigorov, RK3ZK

ex: UA3-117-386, UA3ZNW, UA3ZNW/UA1N, UZ3ZK
op: UK3ZAM, UK5LAP, EN1NWB, EN5QRP, EN100GM

Thanks to our authors:

Prof. Natalia K.Nikolova

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S. Ershov, UW3TU

Petr Gritcay, US1REO

Vitaly Brousnikin

And others…..

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Welcome to ANTENTOP, FREE e - magazine!

ANTENTOP is ***FREE e- magazine***, made in **PDF**, devoted to antennas and amateur radio. Everyone may share his experience with others hams on the pages. Your opinions and articles are published without any changes, as I know, every your word has the mean.

Every issue of ANTENTOP is going to have 100 pages and this one will be paste in whole on the site. Preview's files will be removed in this case. I do not know what a term for one issue will need, may be 3-4 month or so. As I have counted, a whole issue of ANTENTOP will hold nearly 10 MB.

A little note, I am not a native English, so, of course, there are some sentence and grammatical mistakes there… Please, be indulgent!

Preview: Some articles from "cooking" issue will be pasted for preview on this site, others no. Because, as I think, it must be something mysterious in every issue.

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73! ***Igor Grigorov***, RK3ZK

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Table of Contents

Antenna Theory

Page

Introduction into the Theory of Radiation*: by Prof. Natalia K.Nikolova*

1 Dear friends, I would like to give to you an interesting and reliable antenna theory. Hours searching in the web gave me lots theoretical information about antennas. Really, at first I did not know what information to chose for ANTENTOP.

Now I want to present to you one more very interesting Lecture - it is Introduction into the Theory of Radiation. I believe, you cannot find such info anywhere for free! Very interesting and very useful info for every ham, for every radio- engineer. **5- 23**

HF- Antenna Practice

Field Universal HF Antenna RV3DA: *by Igor Grigor'ev, RV3DA*

2 Russia summer traditionally is the season for radio expeditions. So, the question about a field antenna stands before hundreds radio amateurs. Certainly, it is impossible to give one answer to this question. A design of an antenna for fields depends on many factors. There are frequencies bands used by radio expedition, local factors for antenna installation, time and money and so on. Igor, RV3DA, has developed universal wire antenna. This one with ATU works well on all amateurs short-wave ranges, including WARC. factors. There are frequencies bands used by radio expedition, local factors for antenna installation, time and money and so on. Igor, RV3DA, has developed universal wire antenna. This one with ATU works well on all amateurs short-wave ranges, including WARC. **24- 35**

Shunt Vertical Universal HF Antenna: *by Igor Grigorov, RK3ZK*

3 Field universal antenna RV3DA (see pp.:24- 35 of ANTENTOP- 02- 2004) works well even at a bad grounding. To hammer into the ground a metal rod in 1 meter length is enough for the grounding. Installation of the antenna takes a little time, it is another its advantage.However, if there is an opportunity to provide a good ground, and there is some free time to spend of for installation of an antenna, it is possible to use a Shunt Vertical Universal HF Antenna **36- 46**

Multirange Trap Antennas: *by Igor Grigorov, RK3ZK*

4 *Recently multirange trap antennas are widespread among radioamateurs. As matter of fact, the type of antennas was invented in the USA by H. K. Morgan, US patent # 2229856, 1938 (by reference [1]). Probably the first article about a trap antenna was published in reference [2] at 1940. So, what is the antenna and how is it work? Let's see it on the example of a ham vertical trap antenna in order to simplify a problem. Figure 1 shows us a schematic of such antenna.* **47- 61**

Log Periodic Antenna for 21, 24, 27, 28 and 30- MHz: *by S. Ershov, UW3TU*

5 *The Log Periodic Antenna works at 21, 24, 27, 28 and 30 - MHz. As all antennas of the type, the LPDA is easy tuned and works with a high efficiency. The antenna contains additional directors for 21 and 28- MHz and reflector for 21- MHz.* **62- 63**

Table of Contents

Page

Dipole Nadenenko *by Igor Grigorov, RK3ZK*

6 *Soviet radio amateurs well know the broadband dipole named in Russia "dipole Nadednenko." The antenna is widely used at serve radio centers of Russia. Russian radio amateurs also are used the dipole. Below we take up a design of the antenna.* **64- 67**

VHF Antenna Practice

Forgotten Antenna : *by Igor Grigorov, RK3ZK*

7 *Some of former USSR's radio amateurs still remember the "TV spherical antenna". Earlier, at 60- 70s the antenna was rather widely used for reception of TV. What is the "TV spherical antenna"?* **68**

Antenna for 900 MHz: *by Petr Gritcay, US1REO*

8 *I have got a radio telephone DAEWOO DWP-5000 working in a range 900-MHz at the radio market in Kiev . I checked up the phone with its antennas. I could reach only 300- 350 meters when the phone saw the radio base. I need 2 kms communication range. I decided to increase the communication range of my radio phone by using an effective antenna.* **69- 71**

Feeders

Losses of RF Power when Feeder works at SWR mode: *by Igor Grigorov, RK3ZK*

9 *If a feeder has a characteristic impedance differ compare to the load a part of RF power going from the transmitter in the feeder is reflected from the load back to the transmitter. In this case the load uses a part of RF power of the transmitter. Table 1 shows the losses of RF power when a feeder has SWR.* **72**

Interferences

An absorbing Filter: *by Igor Grigorov, RK3ZK*

10 *At ANTENTOP - 2, 2003 it was described a trap filter on main wires. However, the filter cannot be used at a high power or at super- broad bands transmitters. One reason is that it is impossible to retune a trap at a wide frequency range, other reason is the trap filter does reflection of the high-frequency energy back. So, wire to the filter can radiate also the high- frequency energy goes to transmitter and does additional interferences. So, in some case a trap filter can do more trouble the use.* **73**

Table of Contents

Page

Free Radio e- BOOKS in the Internet

Crystal Sets to Sideband: Contents and Path to Free e- book

11 Dear friends, I have read the book with great interest. The book really captivates and I cannot tear myself away the book. The book contains 16 very interesting chapters, and every chapter says us a separately story about radio. I can strongly recommend to you have read this book. Below you can see the Contents of the book and path to load this one. 74- 77

Antennas for Radio Amateurs: Contents and Path to Free e- book

12 If you can read in Russian you can download a free e- book "Antennas for Radio Amateurs" by Igor Grigorov, RK3ZK. The book is e- variant of a paper book with the same title. Paper book contains 256 pages and was issued in 1998 in Russia. One fragment of the book was translated in the English and was published at ANTENTOP- 1, 2003. Other fragments of the book also going to translated in the English. Below you can see the Contents of the book and path to load the Russian variant. 78- 79

History.

Russian Transceiver EFIR*: by Igor Grigorov, RK3ZK*

13 *Transceiver Efir was produced since the end of 70s of the 20 Century. Functional chart of the transceiver was the same as UW3D1- 2 transceiver had. However, Efir was made all of semiconductors, it did not contained any tubes. Transceiver Efir was produced for Soviet collective amateur radio stations, but sometimes, hams can buy Efir for private amateur radio stations.* 80

UW3DI- the Timeless Transceiver: *By Igor Grigorov, RK3ZK*

14 *Schematic of the transceiver UW3DI at first time was published in 1970 at a Soviet ham magazine "Radio" # 5-6. The transceiver was named UW3DI by the callsign of its author, Jury Kudrjavtsev. Jury probably did not ever suspect, that his transceiver would be the most popular transceiver in the USSR and tens thousands copies of the transceiver would be made by Soviet hams.* 81- 85

Table of Contents

Page

Russian Districts Award: credit line http://rdaward.org/rda_eng.htm

15 RDA" (Russian District Award) is an International Awards Program with the goal of attracting interest in Amateur Radio through the communication with various Districts in the Russian Federation. The "RDA" program is established to encourage confirmed contacts with the greatest variety of areas in Russia. There are currently 6 different certificate awards varying in difficulty and complexity, and two plaque awards available for "Honor Roll" and "#1 Honor Roll". **86**

Old Receiving Magnetic Loop Antennas: *by Igor Grigorov, RK3ZK*

16 *Receiving magnetic loop antennas were widely used in the professional radio communication from the beginning of the 20 Century. Since 1906 magnetic loop antennas were used for direction finding purposes needed for navigation of ships and planes. Later, from 20s, magnetic loop antennas were used for broadcasting reception. In the USSR in 20- 40 years of the 20 Century when broadcasting was gone on LW and MW, huge loop antennas were used on Reception Broadcasting Centers (see pages 93- 94 about USSRs RBC). Magnetic loop antennas worldwide were used for reception service radio stations working in VLW, LW and MW. The article writes up several designs of such old receiving loop antennas.* **87- 92**

Broadcasting Receivers of the USSR Wire Radio Centers: *by Vitaly Brousnikin* **94- 93**

17 *Vitaliy says us some historical notes about old USSR broadcasting receivers of Wire Radio Centers*

The First Steps (Part- I): *by Vitaly Brousnikin*

18 Vitaliy says us a story about beginning and the First Steps of Russian radio industry **95- 97**

The First Steps (Part-II): *by Vitaly Brousnikin* **98- 99**

19 Vitaliy says us a story about beginning and the First Steps of Russian radio industry

Useful Data

Wire Metric Diameter/Gauge Standard

20 *Just a table for transfer Number # (AWG, BWG and SWG) to diameter in millimeter.* **100**

Feel Yourself a Student!

Dear friends, I would like to give to you an interesting and reliable antenna theory. Hours searching in the web gave me lots theoretical information about antennas. Really, at first I did not know what information to chose for ANTENTOP. Finally, I stopped on lectures "Modern Antennas in Wireless Telecommunications" written by Prof. Natalia K. Nikolova from McMaster University, Hamilton, Canada.

You ask me: Why?

Well, I have read many textbooks on Antennas, both, as in Russian as in English. So, I have the possibility to compare different textbook, and I think, that the lectures give knowledge in antenna field in great way. Here first lecture "Introduction into Antenna Study" is here. Next issues of ANTENTOP will contain some other lectures.

So, feel yourself a student! Go to Antenna Studies!

I.G.

My Friends, the above placed Intro was given at ANTENTOP- 01- 2003 to Antennas Lectures.

Now I know, that the Lecture is one of popular topics of ANTENTOP. Every of Antenna Lectures was downloaded more than 1000 times!

Now I want to present to you one more very interesting Lecture - it is *Introduction into the Theory of Radiation*. I believe, you cannot find such info anywhere for free! It is very interesting and very useful info for every ham, for every radio- engineer.

So, feel yourself a student! Go to Antenna Studies!

I.G.

McMaster University Hall

Prof. Natalia K. Nikolova

LECTURE 2: Introduction into the Theory of Radiation

(*Maxwell's equations – revision. Power density and Poynting vector – revision. Radiated power – definition. Basic principle of radiation. Vector and scalar potentials – revision. Far fields and vector potentials.*)

by Prof. Natalia K. Nikolova

LECTURE 2: Introduction into the Theory of Radiation

(*Maxwell's equations – revision. Power density and Poynting vector – revision. Radiated power – definition. Basic principle of radiation. Vector and scalar potentials – revision. Far fields and vector potentials.*)

1. Maxwell's equations – revision.

(a) the law of induction (Faraday's law):

$$-\nabla\times\vec{E}=\frac{\partial\vec{B}}{\partial t}+\vec{M}^{\clubsuit} \qquad (2.1)$$

$$\oint_c \vec{E}d\vec{c}=-\frac{\partial}{\partial t}\iint_{S_{[c]}}\vec{B}d\vec{s} \quad\Leftrightarrow\quad e=-\frac{\partial\Psi}{\partial t} \qquad (2.1\text{-i})$$

$\vec{E}$ (V/m)	electric field (electric field intensity)
$\vec{B}$ (T=Wb/m^2)	magnetic flux density
$\vec{M}$ (V/m^2)	magnetic current density$^\clubsuit$
Ψ (Wb=V$\cdot$s)	magnetic flux
e (V)	electromotive force

(b) Ampere's law, generalized by Maxwell to include the displacement current $\partial\vec{D}/\partial t$:

$$\nabla\times\vec{H}=\frac{\partial\vec{D}}{\partial t}+\vec{J} \qquad (2.2)$$

$$\oint_c \vec{H}d\vec{c}=\iint_{S_{[c]}}\left(\frac{\partial\vec{D}}{\partial t}+\vec{J}\right)d\vec{s} \quad\Leftrightarrow\quad I=\oint_c \vec{H}d\vec{c} \qquad (2.2\text{-i})$$

$\vec{H}$ (A/m)	magnetic field (magnetic field intensity)
$\vec{D}$ (C/m^2)	electric flux density (electric displacement)
$\vec{J}$ (A/m^2)	electric current density
I (A)	electric current

$^\clubsuit$ $\vec{M}$ is a fictitious quantity, which renders Maxwell's equations symmetrical and which proves a very useful mathematical tool when solving EM boundary value problems applying equivalence theorem.

(c) Gauss' electric law:

$$\nabla \cdot \vec{D} = \rho \quad (2.3)$$

$$\oint\!\!\!\oint_S \vec{D} d\vec{s} = \iiint_{V_{[s]}} \rho dv = Q \quad (2.3\text{-i})$$

ρ (C/m^3) electric charge density
Q (C) electric charge

Equation (2.3) follows from equation (2.2) and the continuity relation:

$$\nabla \cdot \vec{J} = -\frac{\partial \rho}{\partial t} \quad (2.4)$$

Hint: Take the divergence of both sides of (2.2).

(d) Gauss' magnetic law:

$$\nabla \cdot \vec{B} = \rho_m{}^{**} \quad (2.5)$$

The equation $\nabla \cdot \vec{B} = 0$ follows from equation (2.1), provided that $\vec{M} = 0$.

Maxwell's equations alone are insufficient to solve for the four vector quantities: $\vec{E}, \vec{D}, \vec{H}$ and $\vec{B}$ (twelve scalar quantities). Two additional vector equations are needed.

(e) Constitutive relationships

The constitutive relationships describe the properties of matter with respect to electric and magnetic forces.

$$\vec{D} = \ddot{\varepsilon} \cdot \vec{E} \quad (2.6)$$

$$\vec{B} = \ddot{\mu} \cdot \vec{H} \quad (2.7)$$

In the most general case of anisotropic medium, the dielectric permittivity and the magnetic permeability are *tensors*. In vacuum, which is isotropic, the dielectric permittivity and the magnetic permeability are constants (or tensors whose *diagonal elements only* are non-zero and are the same): $\varepsilon_0 = 8.854187817 \times 10^{-12}$ F/m, $\mu_0 = 4\pi \times 10^{-7}$ H/m. In isotropic medium, the vectors $\vec{D}$ and $\vec{E}$ are collinear, and so are the vectors $\vec{B}$ and $\vec{H}$.

** ρ_m is a fictitious quantity introduced via the continuity relation $\nabla \cdot \vec{M} = -\partial \rho_m / \partial t$. In nature, $\nabla \cdot \vec{B} = 0$.

Dielectric properties relate to the electric field (electric force). Dielectric materials with relative dielectric permittivity (dielectric constant) $\varepsilon_r > 1$ are built of atomic/molecular sub-domains, which have the properties of dipoles. In external electric field, the dipoles tend to orient in such a way that their own fields have a cancellation effect on the external field. The electric force $\vec{F}_e = Q\vec{E}$ exerted on a point charge Q from a source Q_s in such medium will be ε_r times weaker than the electric force of the same source in vacuum.

On the contrary, magnetic materials with relative permeability (magnetic constant) $\mu_r > 1$ are made of sub-domains, which tend to orient in external magnetic field in such a way, that their own magnetic fields align with the external field. The magnetic force $\vec{F}_m = Q\vec{v} \times \vec{B}$ exerted on a moving point charge Q in such a medium will be μ_r times stronger than the force that this same source (e.g. electric currents) would create in vacuum.

We shall be mostly concerned with isotropic media, i.e. media where the equations $\vec{B} = \mu_0 \mu_r \vec{H}$ and $\vec{D} = \varepsilon_0 \varepsilon_r \vec{E}$ hold.

(f) Time-harmonic field analysis

In harmonic analysis of EM fields, the field phasors are introduced:

$$\vec{e}(x,y,z,t) = \mathrm{Re}\left\{\vec{E}(x,y,z)e^{j\omega t}\right\}$$
$$\vec{h}(x,y,z,t) = \mathrm{Re}\left\{\vec{H}(x,y,z)e^{j\omega t}\right\} \quad (2.8)$$

For clarity, from this point on, we shall denote time dependent field vectors with lower-case letters, while their phasors will be denoted with upper-case letters. Complex-conjugate quantities will be denoted with the * sign.

The phasor equations are obtained from the time dependent equations by simple substitution of the following correspondences:

$$f(x,y,z,t) \doteq F(x,y,z)$$
$$\frac{\partial f_{(x,y,z,t)}}{\partial t} \doteq j\omega F(x,y,z)$$
$$\frac{\partial f}{\partial \xi} \doteq \frac{\partial F}{\partial \xi} \quad , \quad \xi = x,y,z$$

For example, Maxwell's equations in phasor form are obtained as:

$$\nabla \times \vec{H} = j\omega(\varepsilon' - j\varepsilon'')\vec{E} + \sigma\vec{E} + \vec{J} = j\omega\bar{\varepsilon}\vec{E} + \vec{J}, \ \bar{\varepsilon} = \varepsilon' - j\left(\varepsilon'' + \frac{\sigma}{\omega}\right) \quad (2.9)$$

$$-\nabla\times\vec{E} = j\omega(\mu' - j\mu'')\vec{H} + \vec{M} = j\omega\bar{\mu}\vec{H} + \vec{M} \qquad (2.10)$$

This is the general form of Maxwell's equations. They include the equivalent (fictitious) magnetic currents $\vec{M}$. The dielectric losses (due to alternate field conductivity $\omega\varepsilon''$) and the static field conductivity losses σ are both represented by the imaginary part of the *complex dielectric permittivity* $\bar{\varepsilon}$. Often, the dielectric losses are represented by the dielectric loss-angle δ_d:

$$\bar{\varepsilon} = \varepsilon'\left[1 - j\left(\frac{\varepsilon''}{\varepsilon'} + \frac{\sigma}{\omega\varepsilon'}\right)\right] = \varepsilon'\left[1 - j\left(\tan\delta_d + \frac{\sigma}{\omega\varepsilon'}\right)\right]$$

Similarly, the magnetic losses are described by the imaginary part of the *complex magnetic permeability* $\bar{\mu}$ or by the magnetic loss-angle δ_m:

$$\bar{\mu} = \mu' - j\mu'' = \mu'\left(1 - j\frac{\mu''}{\mu'}\right) = \mu'(1 - j\tan\delta_m)$$

In antenna theory, we are mostly concerned with *isotropic*, *homogeneous* and *loss-free* regions.

2. Power density and vector of Poynting - revision. Radiated power.

2.1. Poynting vector – revision.

In time-domain analysis, the Poynting vector is defined as

$$\vec{p}(t) = \vec{e}(t)\times\vec{h}(t), \text{ W/m}^2 \qquad (2.11)$$

As follows from Poynting's theorem, $\vec{p}$ is a vector representing the density and the direction of the EM power flow. Thus, the total power leaving certain volume V is obtained as:

$$\Pi(t) = \oint\!\!\oint_{S_{[V]}} \vec{p}_{(t)} d\vec{s}, \text{ W} \qquad (2.12)$$

Since

$$e(t) = \mathrm{Re}\left\{\vec{E}e^{j\omega t}\right\} = \frac{1}{2}\left(\vec{E}e^{j\omega t} + \vec{E}^{*}e^{-j\omega t}\right), \qquad (2.13)$$

and

$$h(t) = \mathrm{Re}\left\{\vec{H}e^{j\omega t}\right\} = \frac{1}{2}\left(\vec{H}e^{j\omega t} + \vec{H}^{*}e^{-j\omega t}\right), \qquad (2.14)$$

it can be derived that

$$\vec{p}(t) = \underbrace{\frac{1}{2}\mathrm{Re}\left\{\vec{E}\times\vec{H}^*\right\}}_{\vec{p}_{av}} + \frac{1}{2}\mathrm{Re}\left\{\vec{E}\times\vec{H}\cdot e^{2\cdot j\omega t}\right\} \qquad (2.15)$$

The first term in (2.15) has no time dependence. It is the average value, around which the power flux density fluctuates. It is a vector of unchanging direction showing a constant outflow (positive value) or inflow (negative value) of EM power. In terms of circuit theory, it describes the active power flow, which is the time-average power flux:

$$\Pi_{av} = \oint\!\!\oint_{S_{[V]}} \vec{p}_{av} d\vec{s} \qquad (2.16)$$

The second term in (2.15) is a vector changing its direction with a double frequency (2ω). It describes the reactive power flow, i.e. the power, which fluctuates in space (propagates to and fro) without contribution to the overall transport of energy in any direction.

Definition: The complex Poynting vector is the vector

$$\vec{P} = \frac{1}{2}\vec{E}\times\vec{H}^*, \qquad (2.17)$$

whose real part is equal to the average power flux density.

2.2. Radiated power.

Definition: Radiated power is the average power radiated by the antenna:

$$\Pi_{rad} = \oint\!\!\oint_{S_{[V]}} \vec{p}_{av} d\vec{s} = \oint\!\!\oint_{S_{[V]}} \mathrm{Re}\left\{\vec{P}\right\} d\vec{s} = \frac{1}{2}\oint\!\!\oint_{S_{[V]}} \mathrm{Re}\left\{\vec{E}\times\vec{H}^*\right\} d\vec{s} \qquad (2.18)$$

3. Basic principle of radiation.

Radiation is produced by accelerated or decelerated charge (time-varying current element)

Definition: A current element ($I\Delta l$) is a filament of length Δl and current I.

The concept of current element is essential in the theory of EM wave radiation, since the time-varying current element is the elementary source of EM radiation. It has the same significance as the concept of a point charge in electrostatics. The field radiated by a complex antenna in a linear medium can be analyzed by making use of the superposition principle after decomposing the antenna into elementary sources (i.e. into current elements).

Assume the existence of a piece of very thin wire, where electric currents can be excited. The current i flowing through the wire cross-section ΔS is defined as the amount of charge passing through ΔS in 1 second:

$$i = \rho \cdot \Delta S \cdot \Delta l_1 = \rho \cdot \Delta S \cdot v, \quad \text{A} \tag{2.19}$$

where:

ρ (C/m^3) is the electric charge volume density

v (m/s) is the velocity of the charges normal to the cross-section

Δl_1 (m/s) is the distance traveled by a charge in 1 second

Equation (2.19) can be also written as

$$\vec{j} = \rho \cdot \vec{v}, \quad \text{A/m}^2 \tag{2.20}$$

where $\vec{j}$ is the electric current density. The product $\lambda = \rho \cdot \Delta S$ is the charge per unit length (charge line density) along the wire. Thus, from (2.19) it follows that

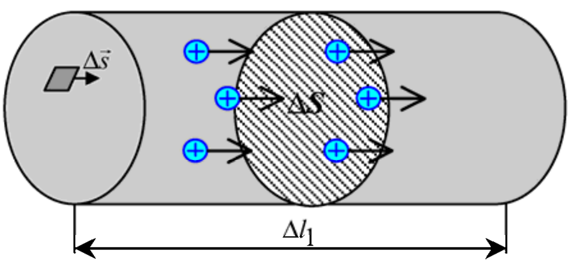
$$i = v \cdot \lambda \tag{2.21}$$

It is then obvious that

$$\frac{di}{dt} = \lambda \frac{dv}{dt} = \lambda a, \tag{2.22}$$

where a (m/s^2) is the acceleration of the charge. A time-varying current source would then be proportional to the amount of charge q enclosed in the volume of the current element and to its acceleration:

$$\Delta l \frac{di}{dt} = \Delta l \cdot \lambda \cdot a = q \cdot a \tag{2.23}$$



It is not immediately obvious from Maxwell's equations that the time-varying current is the source of propagating EM field. The system of the two first-order Maxwell's equations in isotropic medium, though, can be easily reduced to a single second-order equation either for the $\vec{E}$ vector, or for the $\vec{H}$ vector.

$$\begin{vmatrix} -\nabla\times\vec{e} = \mu\dfrac{\partial\vec{h}}{\partial t} \\ \nabla\times\vec{h} = \varepsilon\dfrac{\partial\vec{e}}{\partial t} + \vec{j} \end{vmatrix} \tag{2.24}$$

By taking the curl of both sides of the first equation in (2.24) and by making use of the second equation in (2.24), one obtains:

$$\nabla\times\nabla\times\vec{e} + \mu\varepsilon\frac{\partial^2\vec{e}}{\partial t^2} = -\mu\frac{\partial\vec{j}}{\partial t} \tag{2.25}$$

From equation (2.25), it is obvious that the time derivative of the electric currents is the source for the wave-like propagation of the vector $\vec{e}$ in homogeneous and isotropic medium. In an analogous way, one can obtain the wave equation for the magnetic field $\vec{H}$ and its sources:

$$\nabla\times\nabla\times\vec{h} + \mu\varepsilon\frac{\partial^2\vec{h}}{\partial t^2} = \nabla\times\vec{j} \tag{2.26}$$

To create charge acceleration/deceleration one needs sources of electromotive force and/or discontinuities of the medium in which the charges move. Such discontinuities can be bends or open ends of wires, change in the electrical properties of the region, etc. There is the summary of the causes for radiation:

- If charge is not moving, current is zero $\Rightarrow$ no radiation
- If charge is moving with a uniform velocity $\Rightarrow$ no radiation
- If charge is accelerated due to electromotive force or is decelerated due to discontinuities, such as termination, bend, curvature $\Rightarrow$ radiation occurs

4. Vector and scalar potentials – review.

With very few exceptions, antennas are assumed to radiate in open (free) space, which determines the specifics of the arising EM problems. Often, the EM sources (currents and charges) are more or less accurately known. These sources are then assumed to radiate (in unbounded free space) and it is required to determine the resulting EM field. Such problems, where the sources are known, and the reaction (result) is to be determined are called *analysis* problems (direct problems). The inverse (*design*) problem of finding the sources of a known result (reaction) are much more difficult and we shall not consider them here. To ensure the uniqueness of the solution in an open (unbounded) problem, one has to impose the radiation boundary condition (BC) on the EM field vectors, i.e. for distances far away from the source ($r \to \infty$)

$$\begin{vmatrix} r(\vec{E} - \eta \vec{H} \times \hat{r}) \to 0 \\ r(\vec{H} - \frac{1}{\eta} \hat{r} \times \vec{E}) \to 0 \end{vmatrix} \qquad (2.27)$$

The above BCs are also known as the Sommerfeld radiation BCs. Here, η is the intrinsic impedance of the medium.

The specifics of the antenna problems lead to the introduction of auxiliary vector potential functions, which allow simpler and compact solutions.

It is customary to perform the EM analysis for the case of time-harmonic fields, i.e. in terms of phasors. This course will adhere to the tradition. Therefore, from now on, all field quantities (vectors and scalars) are to be understood as ***complex phasor quantities, whose magnitudes correspond to the magnitudes of the respective sine waves***.

4.1. The magnetic vector potential $\vec{A}$

We shall first consider only electric sources ($\vec{J}$ and ρ), which are actual currents and charges.

$$\begin{vmatrix} \nabla \times \vec{E} = -j\omega\mu \vec{H} \\ \nabla \times \vec{H} = j\omega\varepsilon \vec{E} + \vec{J} \end{vmatrix} \qquad (2.28)$$

Since $\nabla \cdot \vec{B} = 0$, one can assume that

$$\vec{B} = \nabla \times \vec{A} \qquad (2.29)$$

Substituting (2.29) in (2.28) yields:

$$\begin{vmatrix} \vec{E} = -j\omega\vec{A} - \nabla\Phi \\ j\omega\varepsilon\vec{E} = \nabla \times \left(\frac{1}{\mu} \nabla \times \vec{A} \right) - \vec{J} \end{vmatrix} \qquad (2.30)$$

From (2.30) it is obvious that a single equation can be written for $\vec{A}$. In isotropic, homogeneous region, this equation is obtained as:

$$\nabla \times \nabla \times \vec{A} + j\omega\mu\varepsilon(j\omega\vec{A} + \nabla\Phi) = \mu\vec{J} \qquad (2.31)$$

Here, Φ denotes the electric scalar potential, which plays essential role in the analysis of electrostatic fields. To uniquely define the vector field $\vec{A}$, we need to define not only its curl, but also its divergence. There are no restrictions in defining $\nabla \cdot \vec{A}$. Since $\nabla \times \nabla \times = \nabla\nabla \cdot - \nabla^2$, equation (2.31) can be simplified by assuming that

$$\nabla \cdot \vec{A} = -j\omega\mu\varepsilon\Phi \tag{2.32}$$

Equation (2.32) is known as the Lorentz' gauge condition. It reduces (2.31) to

$$\nabla^2 \vec{A} + \omega^2 \mu\varepsilon \vec{A} = -\mu \vec{J} \tag{2.33}$$

If the region is lossless, then μ and ε are real numbers, and (2.33) can be written as:

$$\nabla^2 \vec{A} + \beta^2 \vec{A} = -\mu \vec{J}, \tag{2.34}$$

where $\beta = \omega\sqrt{\mu\varepsilon}$ is the phase constant. If the region is lossy (which is rarely the case in antenna problems), complex permittivity $\overline{\varepsilon}$ and complex permeability $\overline{\mu}$ are introduced. Then, (2.33) can be written in the form:

$$\nabla^2 \vec{A} - \gamma^2 \vec{A} = -\mu \vec{J} \tag{2.35}$$

Here, $\gamma = \alpha + j\beta = j\omega\sqrt{\overline{\mu}\overline{\varepsilon}}$ is the propagation constant, and α is the attenuation constant. For example, if the region has losses due to non-zero conductivity σ, the complex dielectric permittivity is introduced as:

$$\gamma^2 = j\omega\mu(\sigma + j\omega\varepsilon) = -\omega^2 \mu \underbrace{\left(\varepsilon + \frac{\sigma}{j\omega}\right)}_{\overline{\varepsilon}} \tag{2.36}$$

4.2. The electric vector potential $\vec{F}$.

The magnetic field is a solenoidal field, i.e. $\nabla \cdot \vec{B} = 0$, because there are no physically existing magnetic charges. Therefore, there are no physically existing magnetic currents either. However, the fictitious (equivalent) magnetic currents $\vec{M}$ are a very useful tool when applied with the equivalence principle. These currents are introduced in Maxwell's equations in a manner dual to that of the electric currents $\vec{J}$. Now, we shall consider the field due to magnetic sources *only*, i.e. we assume that $\vec{J} = 0$ and that $\rho = 0$, and therefore $\nabla \cdot \vec{D} = 0$. Then, the system of Maxwell's equations is:

$$\left| \begin{array}{l} \nabla \times \vec{E} = -j\omega\mu\vec{H} - \vec{M} \\ \nabla \times \vec{H} = j\omega\varepsilon\vec{E} \end{array} \right. \tag{2.37}$$

Since $\vec{D}$ is solenoidal, it can be expressed as the curl of a vector, namely the electric vector potential $\vec{F}$:

$$\vec{D} = -\nabla \times \vec{F} \qquad (2.38)$$

Equation (2.38) is substituted in the system (2.37). All mathematical transformations are analogous to those made in Section 4.1. Finally, it is shown that a field due to magnetic sources is entirely described by a single vector $\vec{F}$, which satisfies the Helmholtz' equation

$$\nabla^2 \vec{F} + \omega^2 \mu\varepsilon \vec{F} = -\varepsilon \vec{M}, \qquad (2.39)$$

provided that the Lorentz' gauge is imposed in the form

$$\nabla \cdot \vec{F} = -j\omega\mu\varepsilon\Psi \qquad (2.40)$$

Here, Ψ represents the magnetic scalar potential.

In linear medium, a field due to both types of sources (magnetic and electric) can be solved for by superimposing the partial field due to the electric sources only and the one due to magnetic sources only.

TABLE 2.1: FIELD VECTORS IN TERMS OF VECTOR-POTENTIALS

Magnetic vector-potential $\vec{A}$ (electric sources only)	Electric vector-potential $\vec{F}$ (magnetic sources only)
$\vec{B} = \nabla \times \vec{A}$, $\vec{H} = \frac{1}{\mu}\nabla \times \vec{A}$	$\vec{D} = -\nabla \times \vec{F}$, $\vec{E} = -\frac{1}{\varepsilon}\nabla \times \vec{F}$
$\vec{E} = -j\omega\vec{A} - \frac{j}{\omega\mu\varepsilon}\nabla\nabla \cdot \vec{A}$ or	$\vec{H} = -j\omega\vec{F} - \frac{j}{\omega\mu\varepsilon}\nabla\nabla \cdot \vec{F}$ or
$\vec{E} = \frac{1}{j\omega\mu\varepsilon}\nabla \times \nabla \times \vec{A} - \frac{\vec{J}}{j\omega\varepsilon}$	$\vec{H} = \frac{1}{j\omega\mu\varepsilon}\nabla \times \nabla \times \vec{F} - \frac{\vec{M}}{j\omega\mu}$

5. Retarded potentials - review.

Retarded potential is a term usually used to denote the solution of the inhomogeneous Helmholtz' equation (in the frequency domain) or that of the inhomogeneous wave equation (in the time domain) in an unbounded region.

Assume that an infinitesimal current source (in the form of a Dirac δ-function) exists at the origin of the coordinate system, and that it has a current density vector with a z-component only, i.e.

$$d\vec{J} = \hat{z}\, J_z \delta(x)\delta(y)\delta(z) \qquad (2.41)$$

Then, according to (2.34), the magnetic vector potential $\vec{A}$ will also have only a z-component governed by the following equation in lossless medium:

$$\nabla^2 A_z + \beta^2 A_z = -\mu J_z \tag{2.42}$$

The field A_z has a spherical symmetry (no dependence on the observation angles θ and φ) as implied by the spherical symmetry of a point source. Thus, equation (2.42) reduces to an ordinary differential equation (ODE) with derivatives only with respect to the distance *r*, when one writes the Laplace operator $\nabla^2 \equiv \Delta$ in spherical coordinates:

$$\frac{d^2 A_z}{dr^2} + \frac{2}{r}\frac{dA_z}{dr} + \beta^2 A_z = -\mu J_z \tag{2.43}$$

Except at the source, the field A_z satisfies the homogeneous version of (2.43):

$$\frac{d^2 A_z}{dr^2} + \frac{2}{r}\frac{dA_z}{dr} + \beta^2 A_z = 0 \tag{2.44}$$

The solutions of (2.44) are well known in the case of an unbounded region:

$$A_{z_1} = C_1 \frac{e^{-j\beta r}}{r} \tag{2.45}$$

$$A_{z_2} = C_2 \frac{e^{+j\beta r}}{r} \tag{2.46}$$

The solution (2.46) represents an incoming wave, which cannot be a contribution of the given source. It is discarded. The solution (2.45) represents an outgoing wave and is physically feasible. This solution is called a retarded potential, which refers to the finite velocity with which the field disturbances (waves) travel and the finite time interval they need in order to reach certain point of observation. The constant C_1 has to be determined, making use of the source and the boundary conditions. Since the region is unbounded, the only BC left is the scalar radiation BC*, which is already satisfied by (2.45). By integrating (2.43) inside a spherical volume surrounding the source (see Appendix I), one obtains $C_1 = (1/4\pi)\mu J_z$. Therefore, the elementary field produced by an infinitesimal current source, is described only by the *z*-component of the magnetic vector potential, which is:

$$dA_z = \mu J_z \frac{e^{-j\beta r}}{4\pi r} \tag{2.47}$$

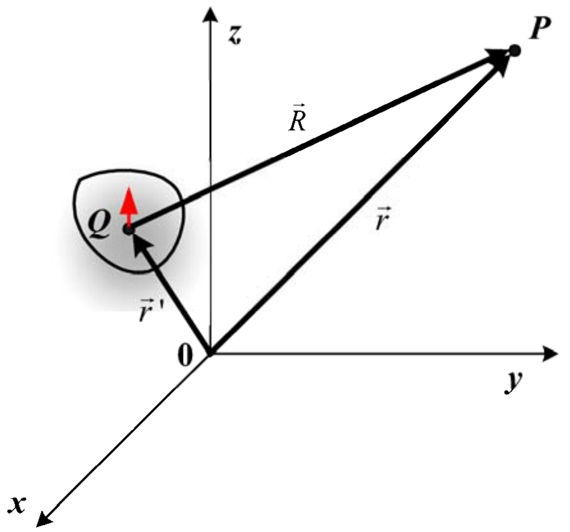
If the point source is not at the origin, but is at some point, *Q*, of a radius-vector $\vec{r}\,'$, then the variable *r* in (2.50) must be substituted by *R*, where *R* is the

---

* The radiation BC for a scalar function Φ satisfying the wave equation states that $\lim_{r\to\infty} r \cdot \left(\frac{\partial \Phi}{\partial r} + j\beta\Phi\right) = 0$

distance between the source at $Q(\vec{r}\,')$ and the observation point $P(\vec{r}\,)$: $R = |\vec{r} - \vec{r}\,'|$. Explicitly:

$$dA_z = \mu J_z \frac{e^{-j\beta R}}{4\pi R} \tag{2.48}$$



Let us consider the case of a continuously distributed source in the form of $J_z(x', y', z')$. It can be viewed as a cluster of point sources whose joint retarded potential will produce the overall A_z potential in linear medium (principle of superposition):

$$A_z(P) = \iiint_V dA_z = \iiint_V \mu J_z(Q) \frac{e^{-j\beta R}}{4\pi R} dv_Q \tag{2.49}$$

To further generalize the above formula, one should assume the existence of source currents of arbitrary directions, which would produce partial magnetic vector potentials in any directions. Note that a current element in the $\hat{\xi}$ direction will result in a vector potential $\vec{A} = A_\xi \hat{\xi}$ in the same direction (unless the medium is anisotropic). Thus,

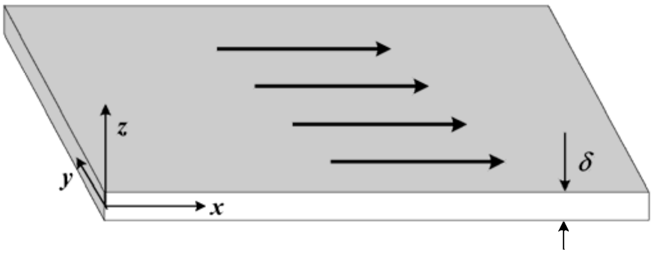
$$\vec{A}(P) = \iiint_V \mu \vec{J}(Q) \frac{e^{-j\beta R}}{4\pi R} dv_Q \tag{2.50}$$

The solution for the electric vector potential due to magnetic current sources $\vec{M}(Q)$ is analogous:

$$\vec{F}(P) = \iiint_V \varepsilon \vec{M}(Q) \frac{e^{-j\beta R}}{4\pi R} dv_Q \qquad (2.51)$$

Finally, one should recall that not only *volume* sources are used to model the currents of a radiator. A useful approximation, especially of currents at conducting boundaries, is the *surface* current density (or simply surface currents):

$$\vec{J}_s(x,y) = \lim_{\delta \to 0} \int_{-\delta/2}^{\delta/2} \vec{J}(x,y,z)dz \text{, A/m}$$

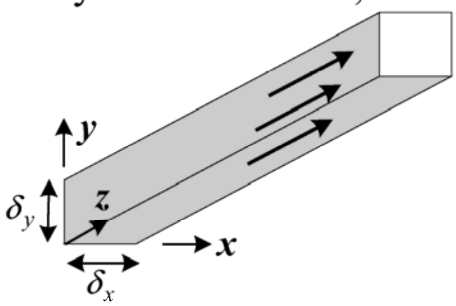


The magnetic vector potential $\vec{A}$ produced by distributed surface currents will then be expressed as:

$$\vec{A}(P) = \iint_S \mu \vec{J}_s(Q) \frac{e^{-j\beta R}}{4\pi R} ds_Q \qquad (2.52)$$

Currents on a very thin wire are nicely approximated by a linear source, which is exactly the current *I* flowing through the wire:

$$\vec{I}(z) = \lim_{\substack{\delta_x \to 0 \\ \delta_y \to 0}} \iint_{\delta_x \delta_y} \vec{J}(x,y,z)dxdy \text{, A}$$



The respective potential is:

$$\vec{A}(P) = \int_L \mu \vec{I}(Q) \frac{e^{-j\beta R}}{4\pi R} d\vec{l}_Q \qquad (2.53)$$

6. Far fields and vector potentials.

Antennas are sources of finite physical dimensions. The further away from the antenna the observation point is, the more the wave looks like a spherical wave and the more the antenna looks like a point source regardless of its actual shape. In such cases, we talk about *far fields* and *far zone*. The exact meaning of these terms will be discussed later. For now, we will simply assume that the vector potentials behave like spherical waves, when the observation point is far from the source:

$$\vec{A} \simeq \left[\hat{R}\cdot A_R(\theta,\varphi)+\hat{\theta}\cdot A_\theta(\theta,\varphi)+\hat{\varphi}\cdot A_\varphi(\theta,\varphi)\right]\frac{e^{-jkR}}{R}, \quad R\to\infty \qquad (2.54)$$

Here, $(\hat{R},\hat{\theta},\hat{\varphi})$ are the unit vectors of the spherical coordinate system centred on the antenna. The term e^{-jkR} shows propagation along $\hat{R}$ away from the antenna with the speed of light. The term $1/R$ shows the spherical spread of the potential in space, which results in a decrease of its magnitude as the radius of the sphere increases.

Notice an important feature of the far-field potential: the dependence on the distance R is separable from the dependence on the observation angle (θ,φ), and it is the same for any antenna: e^{-jkR}/R.

Formula (2.54) is a *far-field approximation* of the vector potential at distant points. One can arrive at it starting from the original integral in (2.50). When the observation point is very far from the source volume, the distance R_{PQ} between the observation and the integration points varies only slightly as Q sweeps the volume. It is almost the same as the distance from the origin to the observation point R since we usually centre the coordinate system close to the sources. The following first-order approximation is made for the integrand:

$$\frac{e^{-jkR_{PQ}}}{R_{PQ}} \approx \frac{e^{-jk(R-\hat{R}\cdot\vec{R}')}}{R} \qquad (2.55)$$

Here,

$\vec{R}$ is the position vector of the observation point P, and $R=|\vec{R}|$;

$\vec{R}'$ is the position vector of the integration point Q.

Equation (2.55) is called the *far-field approximation*. It is illustrated in the figures below. The first figure shows the real problem. The second one shows the approximated problem, where it is in effect assumed that the vectors $\vec{R}_{PQ}$ and $\vec{R}$ are parallel.

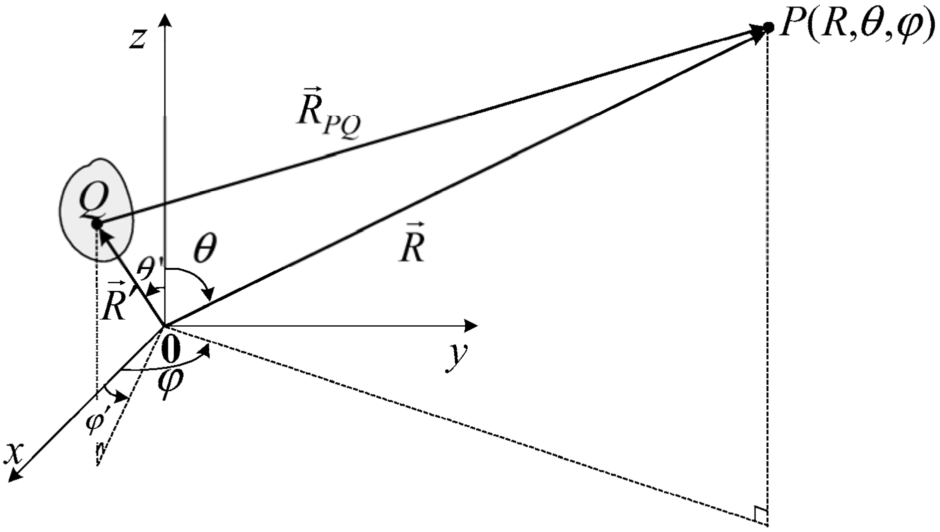


Figure 1: Original problem.

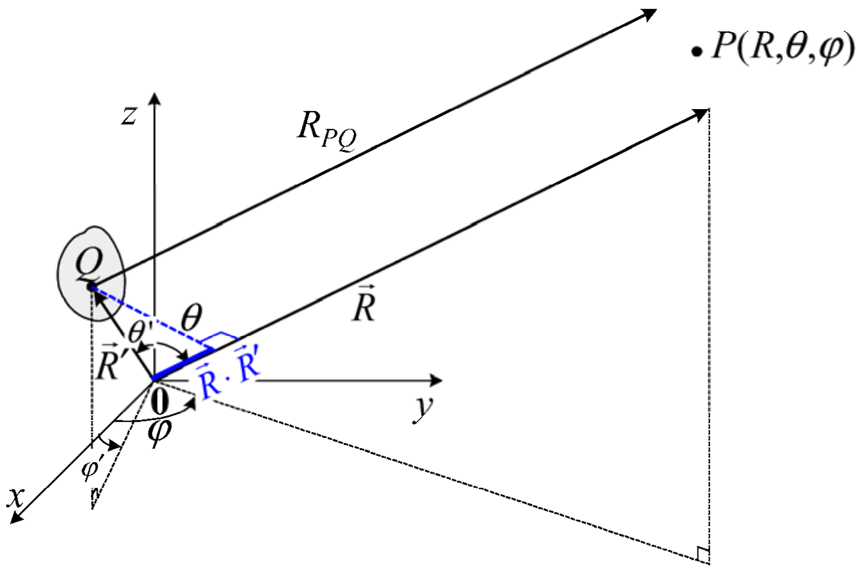


Figure 2: Far-field approximation of the original problem.

We will now apply the far-field approximation to the vector potential in (2.50). Since R depends only on P:

$$\vec{A}(P) = \mu \frac{e^{-jkR}}{4\pi R} \iiint_V \vec{J}(Q) e^{-jk\vec{R}\cdot\vec{R}'} dv_Q \tag{2.56}$$

The integrand (in (2.56)) does not depend on the distance between source and observation point. It depends only on the current distribution in the source volume and the angle between the position vector of the integration point $\vec{R}'$ and the position vector of the observation point $\vec{R}$. This finally explains the general equation for the far-field vector potential in (2.54).

The far-field approximation of the vector potential leads to much simpler equations for the far-field vectors. Assume that there are only electrical currents radiating. Then the EM field is fully described only by the magnetic vector potential $\vec{A}$. One has to substitute (2.54) into the equations of Table 2.1, where $\vec{F}=0$:

$$\begin{aligned}\vec{E}&=-j\omega\vec{A}-\frac{j}{\omega\mu\varepsilon}\nabla\nabla\cdot\vec{A}\\ \vec{H}&=\frac{1}{\mu}\nabla\times\vec{A}\end{aligned}\tag{2.57}$$

The differential operators $\nabla\times$ and $\nabla\nabla\cdot$ have to be expressed in spherical coordinates. All terms decreasing with the distance as $1/R^2$ and faster are neglected. What remains is as follows.

$$\vec{E}=\frac{1}{R}\left\{-j\omega e^{-jkR}\left[\hat{\theta}A_\theta(\theta,\varphi)+\hat{\varphi}A_\varphi(\theta,\varphi)\right]\right\}+\frac{1}{R^2}\{\ \}+\cdots,\quad R\to\infty \tag{2.58}$$

$$\vec{H}=\frac{1}{R}\left\{j\frac{\omega}{\eta}e^{-jkR}\left[\hat{\theta}A_\varphi(\theta,\varphi)-\hat{\varphi}A_\theta(\theta,\varphi)\right]\right\}+\frac{1}{R^2}\{\ \}+\cdots,\quad R\to\infty \tag{2.59}$$

Here, $\eta=\sqrt{\mu/\varepsilon}$ denotes the wave impedance of the medium. One can write equations (2.58) and (2.59) in a more compact way as:

$$\left.\begin{aligned}E_R&\simeq 0\\ E_\theta&\simeq -j\omega A_\theta\\ E_\varphi&\simeq -j\omega A_\varphi\end{aligned}\right\}\Rightarrow \vec{E}^A\simeq -j\omega\vec{A},\quad E_R^A\simeq 0 \tag{2.60}$$

$$\left.\begin{aligned}H_R&\simeq 0\\ H_\theta&\simeq +j\frac{\omega}{\eta}A_\varphi=-\frac{E_\varphi}{\eta}\\ H_\varphi&\simeq -j\frac{\omega}{\eta}A_\theta=+\frac{E_\theta}{\eta}\end{aligned}\right\}\Rightarrow \vec{H}^A\simeq -j\frac{\omega}{\eta}\hat{R}\times\vec{A}=\frac{1}{\eta}\hat{R}\times\vec{E}^A \tag{2.61}$$

In an analogous manner, one can obtain the relations between the field vectors and the electric vector potential $\vec{F}$, when magnetic sources only are present.

$$\left.\begin{array}{l} H_R \simeq 0 \\ H_\theta \simeq -j\omega F_\theta \\ H_\varphi \simeq -j\omega F_\varphi \end{array}\right\} \Rightarrow \vec{H}^F \simeq -j\omega \vec{F}, \quad H_R^F \simeq 0 \tag{2.62}$$

$$\left.\begin{array}{l} E_R \simeq 0 \\ E_\theta \simeq -j\omega\eta F_\varphi = \eta H_\varphi \\ E_\varphi \simeq +j\omega\eta F_\theta = -\eta H_\theta \end{array}\right\} \Rightarrow \vec{E}^F \simeq j\omega\eta \hat{R} \times \vec{F} = -\eta \hat{R} \times \vec{H}^F \tag{2.63}$$

The far field of any antenna (any source) has the following important features, which become obvious from equations (2.60) through (2.63):

- The far field has no radial components, $E_R = H_R = 0$. Since the radial direction is also the direction of propagation, the far field is a typical TEM (Transverse Electro-Magnetic) wave.
- The $\vec{E}$ vector and the $\vec{H}$ vector are mutually orthogonal, both of them being also orthogonal to the direction of propagation.
- The magnitudes of the electric field and the magnetic field are related always as $|\vec{E}| = \eta |\vec{H}|$.

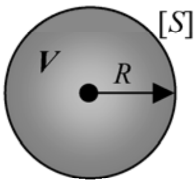
APPENDIX I

Consider the equation

$$\nabla^2\Phi + k^2\Phi = -f\delta(x)\delta(y)\delta(z) \tag{A-1}$$

Integrate (A-1) within a sphere with its center at (0,0,0) and a radius R:

$$\iiint_{V[S]} \nabla^2\Phi dv + \iiint_{V[S]} k^2\Phi dv = -f$$



The field Φ, which is due to this point source, has a spherical symmetry, i.e. it depends on r only: $\Phi = C\frac{e^{-jkr}}{r}$, where C is the constant to be determined. Consider first the integral:

$$I_1 = \iiint_{V[S]} k^2\Phi dv \tag{A-3}$$

$$I_1 = \iiint_{V[S]} k^2 C\frac{e^{-jkr}}{r} dv = \int_0^R \int_0^{2\pi} \int_0^{\pi} k^2 C\frac{e^{-jkr}}{r} r^2 \sin\theta d\theta d\varphi dr$$

$$I_1(R) = j4\pi kC\left(R\cdot e^{-jkR} + \frac{e^{-jkR}}{jk} - \frac{1}{jk}\right)$$

To evaluate the integrals in the point of singularity (0,0,0), we let $R \to 0$, i.e. we let the sphere collapse into a point. It is obvious that

$$\lim_{R\to 0} I_1(R) = 0 \tag{A-4}$$

Secondly, consider the integral:

$$I_2 = \iiint_V \nabla^2\Phi dv = \iiint_V \nabla\cdot(\nabla\Phi)\, dv = \oiint_S \nabla\Phi d\vec{s} \tag{A-5}$$

Here, $d\vec{s} = R^2 \sin\theta dr d\theta d\varphi \hat{r}$ is a surface element on [S], and

$$\nabla\Phi = \frac{\partial\Phi}{\partial r}\hat{r} = -C\left(jk\frac{e^{-jkr}}{r} + \frac{e^{-jkr}}{r^2}\right)\hat{r}$$

$$\Rightarrow I_2(R) = -C\left(jkR\cdot e^{-jkR} + e^{-jkR}\right)\int_0^{\pi}\int_0^{2\pi} \sin\theta d\varphi d\theta$$

$$\lim_{R\to 0} I_2(R) = -4\pi C \tag{A-6}$$

Substituting (A-4) and (A-6) into (A-2) and taking $\lim_{R\to 0}$, yields:

$$C = \frac{f}{4\pi} \tag{A-7}$$

In equation (2.43), the source function is $f = \mu J_z$, that is why $C_1 = (1/4\pi)\mu J_z$.

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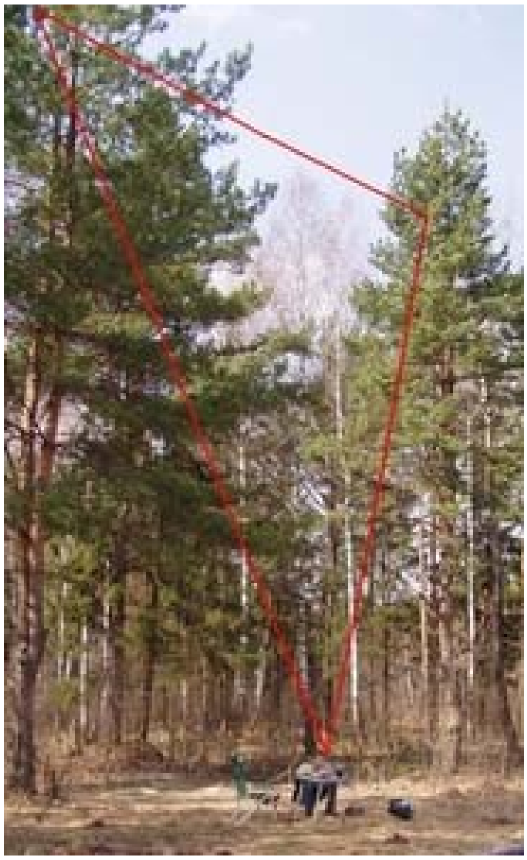
In Russia summer traditionally is the season for radio expeditions. So, the question about a field antenna stands before hundreds radio amateurs. Certainly, it is impossible to give one answer to this question. A design of an antenna for fields depends on many factors. There are frequencies bands used by radio expedition, local factors for antenna installation, time and money and so on. Igor, RV3DA, has developed universal wire antenna. This one with ATU works well on all amateurs short-wave ranges, including WARC. *factors. There are frequencies bands used by radio expedition, local factors for antenna installation, time and money and so on. Igor, RV3DA, has developed universal wire antenna. This one with ATU works well on all amateurs short-wave ranges, including WARC.*



The antenna has a triangular shape, one of the ends of the triangular is grounded. **Figure 1** shows the circuit of the antenna. A good grounding is necessary for successful work of the antenna. However, the antenna provides good work without good grounding also.

The antenna was tested by team of collective radio station RK3DZD in field conditions.

On Eastern Sunday April 11 we have been going to RDA- pedition. About RDA program you can see ***page 86, ANTENTOP# 2- 2004***. Our team (RD3DT, UA3DUS, RZ3DT and RV3DA) and buys settled down at picturesque surroundings of the edge of Tsna river, Egor'evskoe area **MO-62** at Moscow oblast.

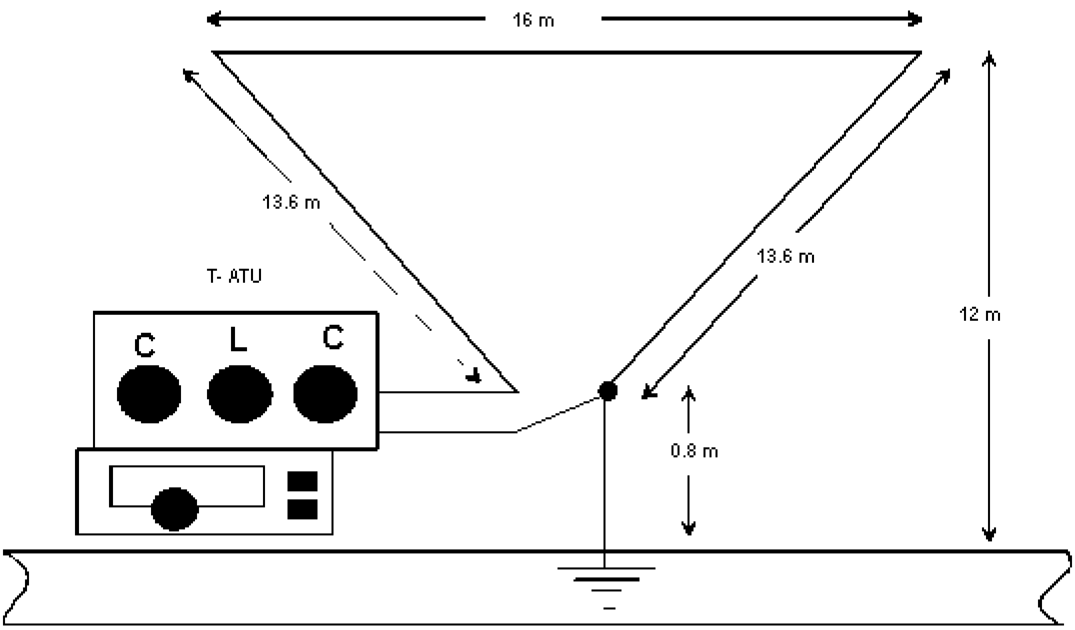


Figure 1

Yuri, RA3DUF, hanged our antenna on the nearest pines. TNX to Yuri, RK3DUF for steeplejack works! You can see a photo of the antenna (antenna colored by red). The antenna had no feeder and was connected directly to a transceiver FT-847 through a home- made T- ATU that was placed at the table. We used an automobile accumulator 55-A/h and gas-generator Honda for feeding our equipment.

Grounding was very bad - a pipe in diameter of ½" and in length of 1 meter. The ground was very damp, ten meters father from the antenna a river was. The antenna was hanged between two high pines.

What we have had:

1. 40 meters - is higher than any praises. Really, we ruled by pile- up from tens calling stations. Simultaneously we received as local as DX- stations.

2. 20 meters – the directivity of the antenna did bad effect for us. The antenna was directed to the North - South, that it was not good for us. Southern radio stations simply rattled in the Air!

3. 15 meters- Japanese called us very loudly.

4. On 10 meters was dead (no propagation).

5. 80 meters – we received very loudly many radio station from Siberia (2000- 3000 kms from us) but our sign was received poor in Siberia because, as we think, of poor grounding.

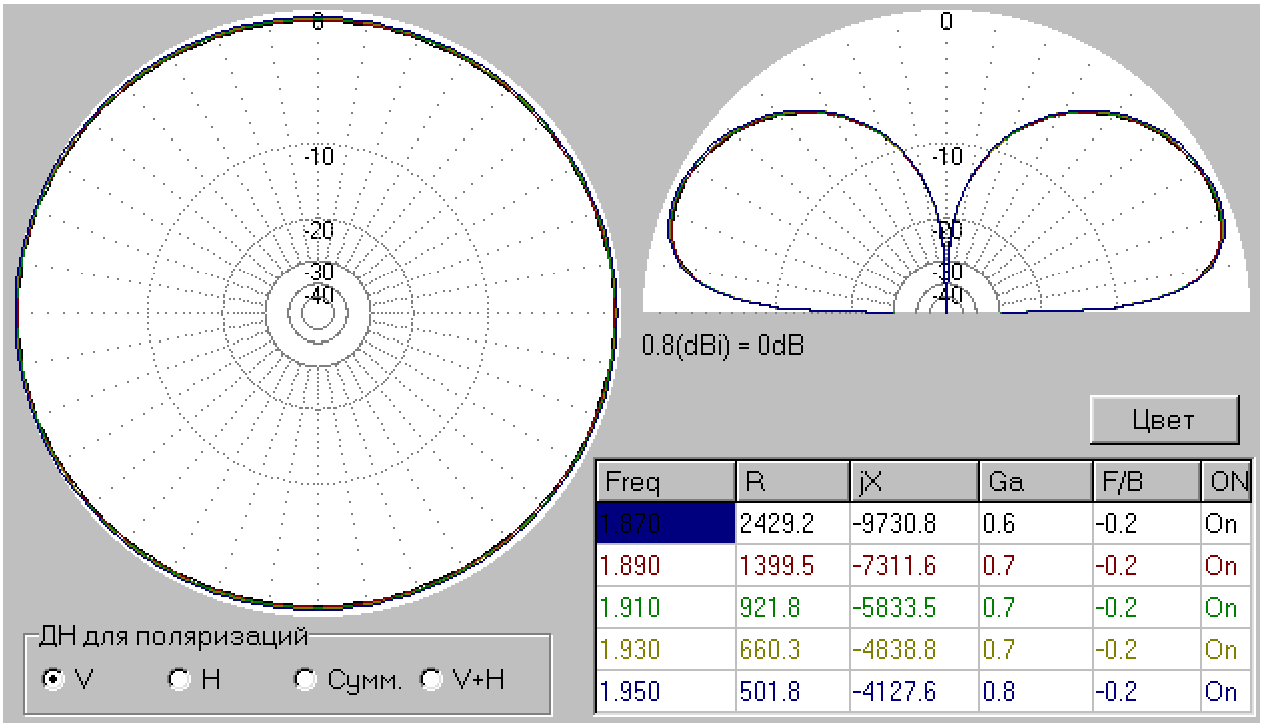
Below given diagram directivity for the antenna obtained with help of free antenna program MMANA (MININEC based). Left diagram is a section of the volumetric diagram directivity of plane X-Y at a zenith corner of the maximum radiation. The right diagram is section of the volumetric diagram directivity of plane X-Z. Also at the right down corner of the pictures is a table with antenna impedance. Please, take attention to the data, you can do decision how you ATU does match of the

73!
Igor Grigor'ev, RV3DA

So our first workplace looked. As usual, we had too little time for preparing before our pedition, so, we have used "table" T-ATU. Two air variable capacitors and a variable inductor placed on the table without any case. Yury, RK3DUF, did DX- QSO.

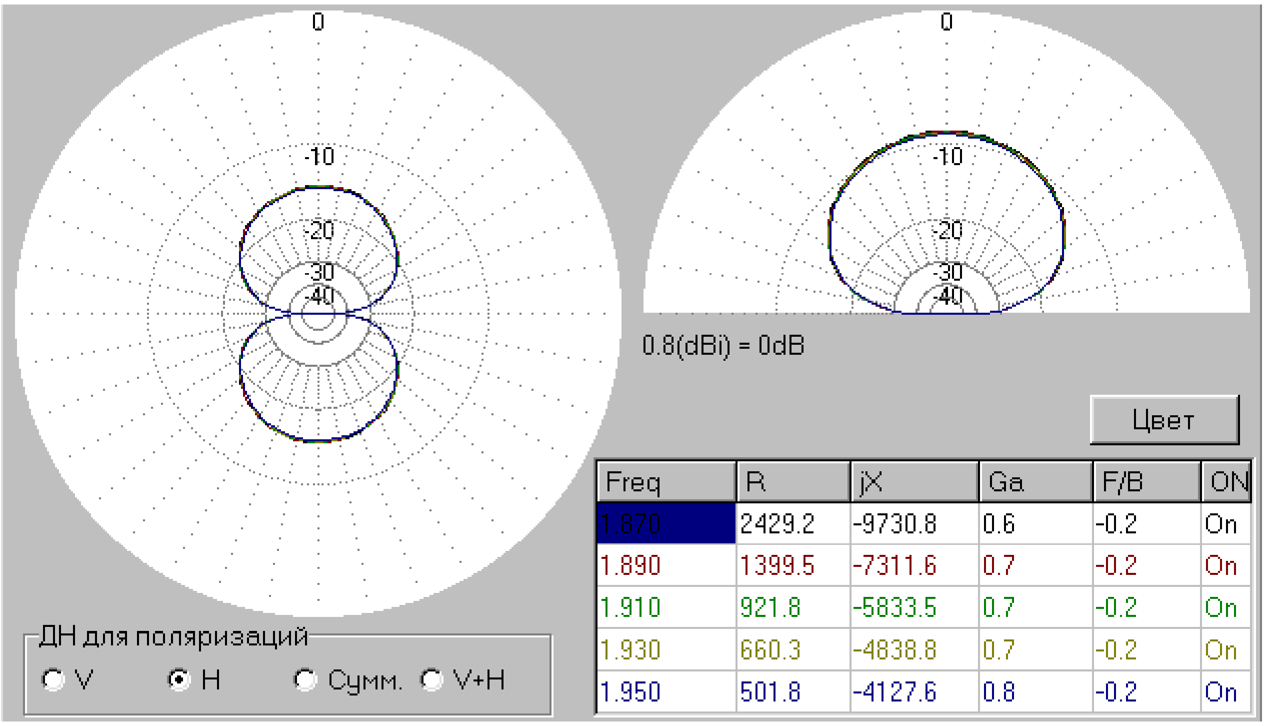
Antenna RV3DA at 160-m

Vertical Radiation Pattern



Freq	R	jX	Ga	F/B	ON
1.870	2429.2	-9730.8	0.6	-0.2	On
1.890	1399.5	-7311.6	0.7	-0.2	On
1.910	921.8	-5833.5	0.7	-0.2	On
1.930	660.3	-4838.8	0.7	-0.2	On
1.950	501.8	-4127.6	0.8	-0.2	On

Horizon Radiation Pattern

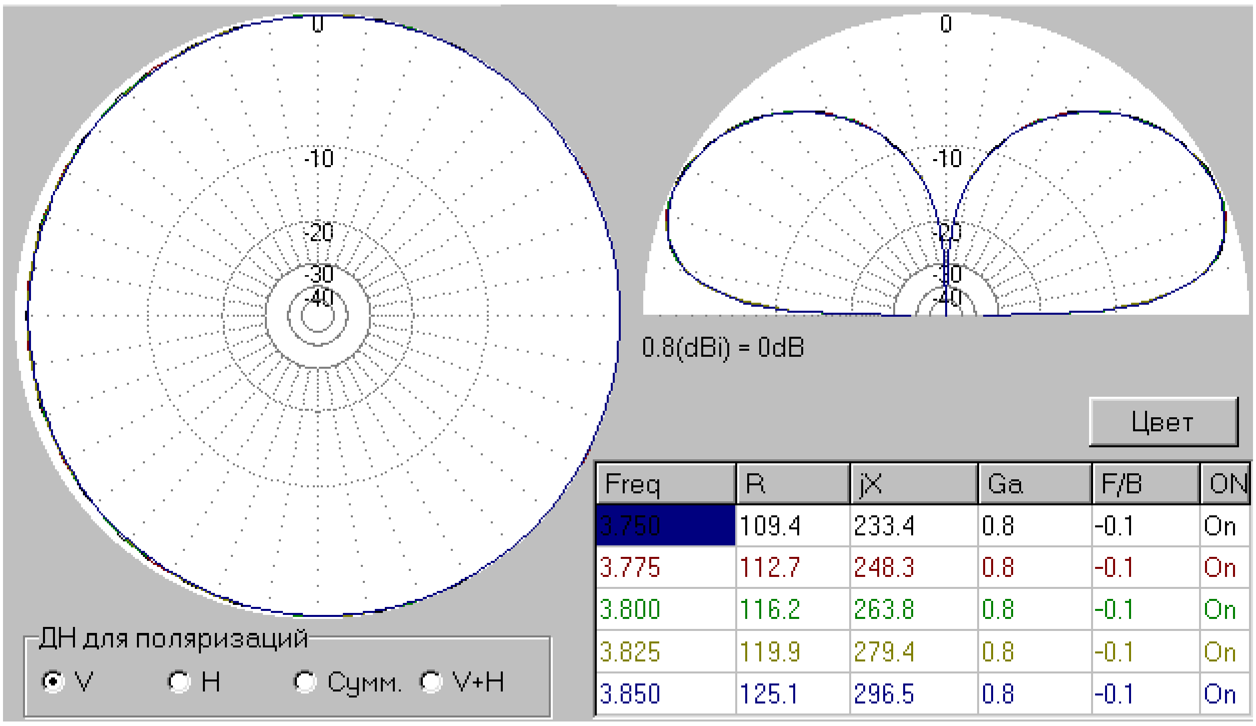


Freq	R	jX	Ga	F/B	ON
1.870	2429.2	-9730.8	0.6	-0.2	On
1.890	1399.5	-7311.6	0.7	-0.2	On
1.910	921.8	-5833.5	0.7	-0.2	On
1.930	660.3	-4838.8	0.7	-0.2	On
1.950	501.8	-4127.6	0.8	-0.2	On

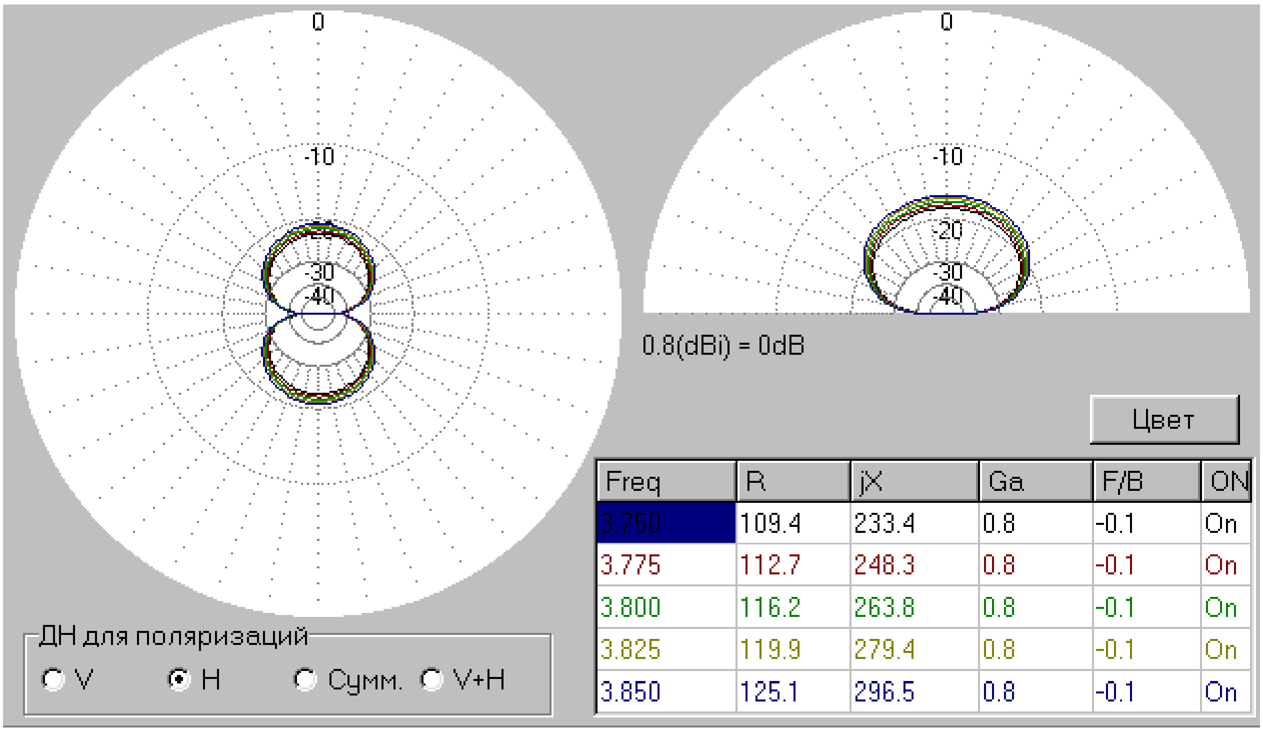
Comments: Antenna radiates mainly radio waves with vertical polarization. A very good pattern with low lobes in the vertical plane. Circular pattern in horizontal plane. It is fine for DX- QSO. But antenna has Z= 921-j5833-Ohms at 1910-kHz. Not all ATUs do good matching for such load.

Antenna RV3DA at 80-m

Vertical Radiation Pattern



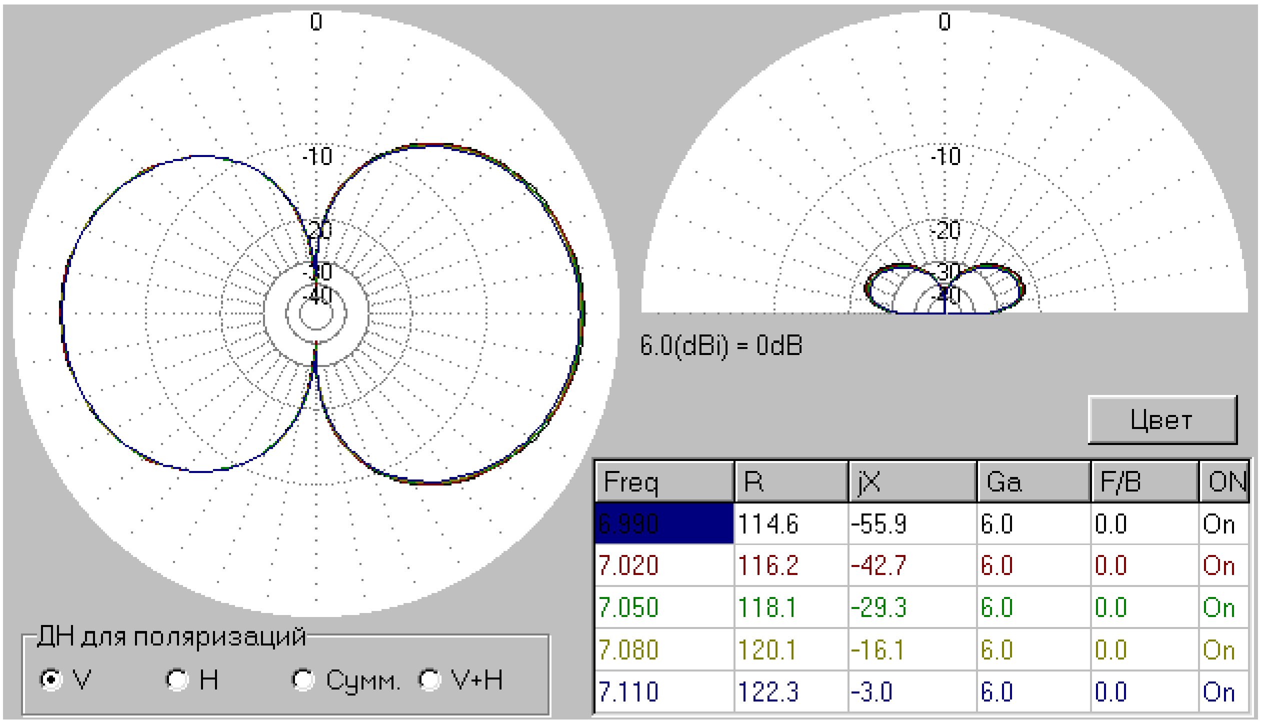
Horizon Radiation Pattern



Comments: Antenna radiates mainly radio waves with vertical polarization. A very good pattern with low lobes in the vertical plane. Circular pattern in horizontal plane. It is fine for DX- QSO. Antenna has Z= 116+ j263-Ohms at 3800-kHz. Almost any ATU does good matching for such load.

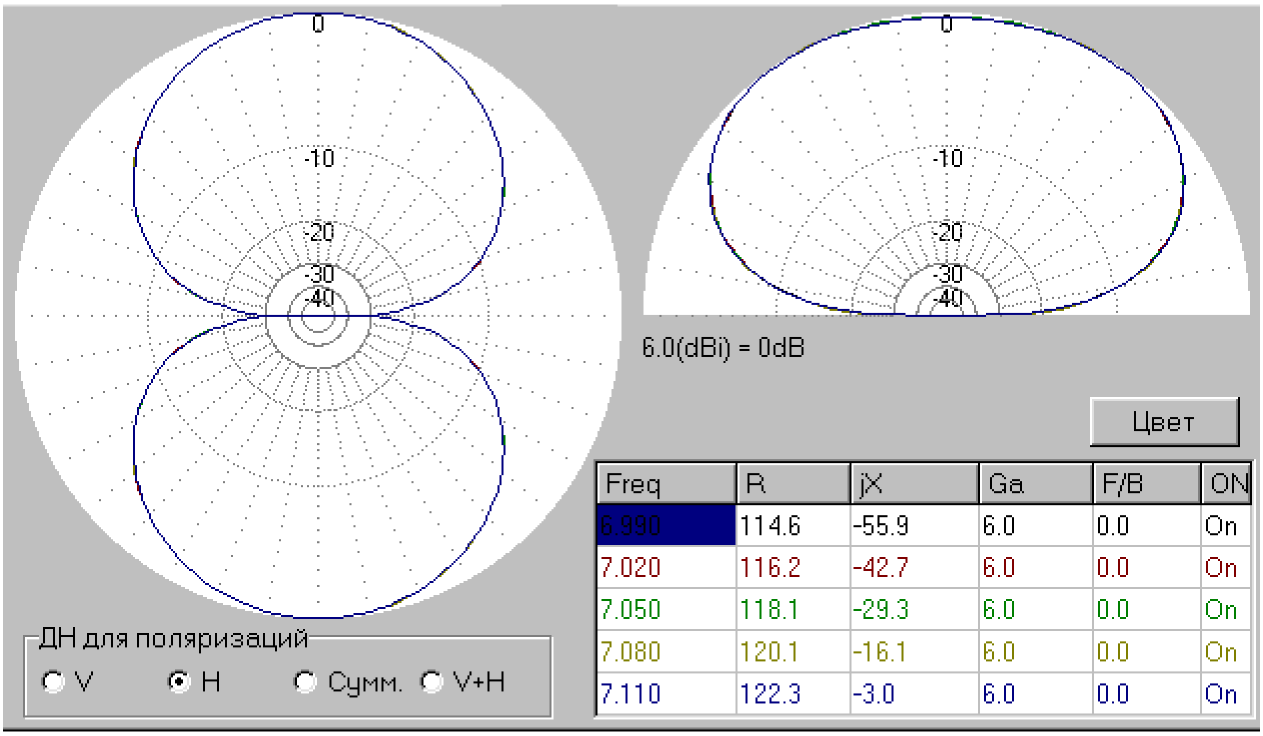
Antenna RV3DA at 40-m

Vertical Radiation Pattern



Freq	R	jX	Ga	F/B	ON
6.990	114.6	-55.9	6.0	0.0	On
7.020	116.2	-42.7	6.0	0.0	On
7.050	118.1	-29.3	6.0	0.0	On
7.080	120.1	-16.1	6.0	0.0	On
7.110	122.3	-3.0	6.0	0.0	On

Horizon Radiation Pattern

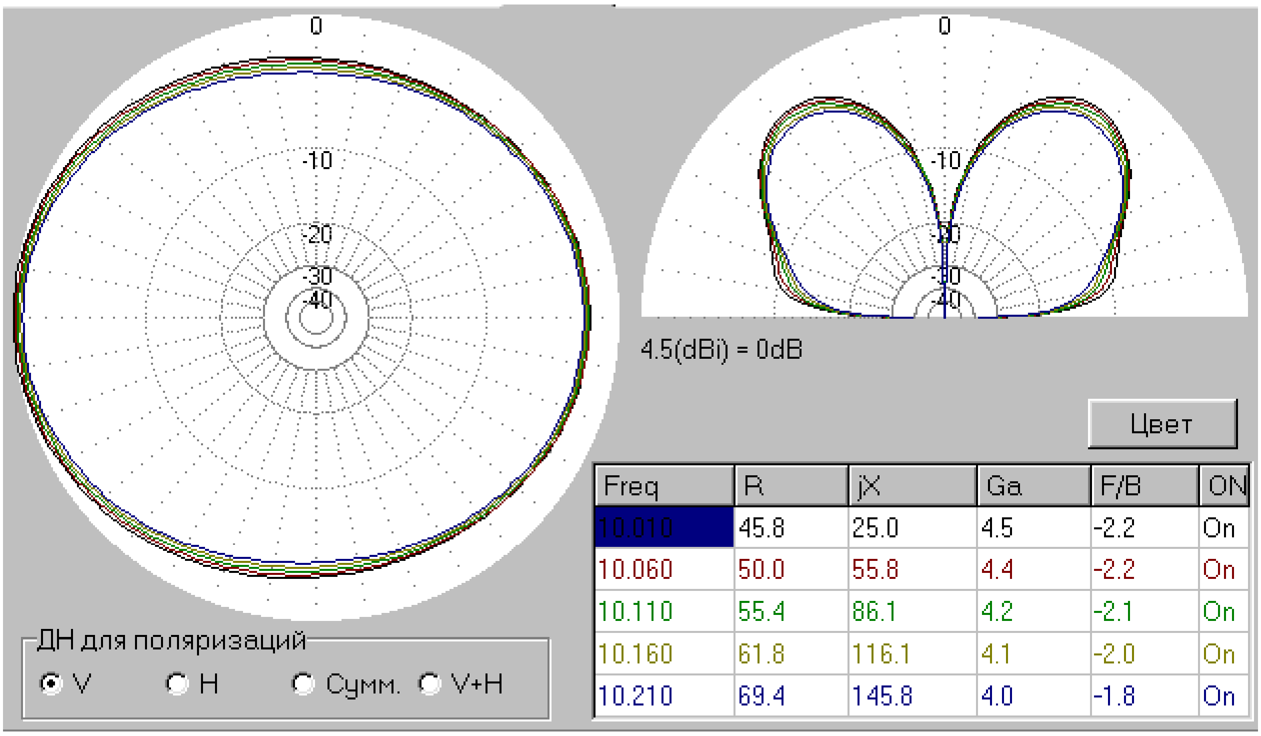


Freq	R	jX	Ga	F/B	ON
6.990	114.6	-55.9	6.0	0.0	On
7.020	116.2	-42.7	6.0	0.0	On
7.050	118.1	-29.3	6.0	0.0	On
7.080	120.1	-16.1	6.0	0.0	On
7.110	122.3	-3.0	6.0	0.0	On

Comments: Antenna radiates mainly radio waves with horizontal polarization. A good pattern in the vertical plane. Antenna has strong zenith radiation that allows to do local QSOs. "Eight- figure" pattern in horizontal plane, so, it demands to choose a proper direction before an installation of the antenna. Antenna is fine for DX and local QSOs. Antenna has Z= 116+ j263-Ohms at 3800-kHz. Almost any ATU does good matching for such load.

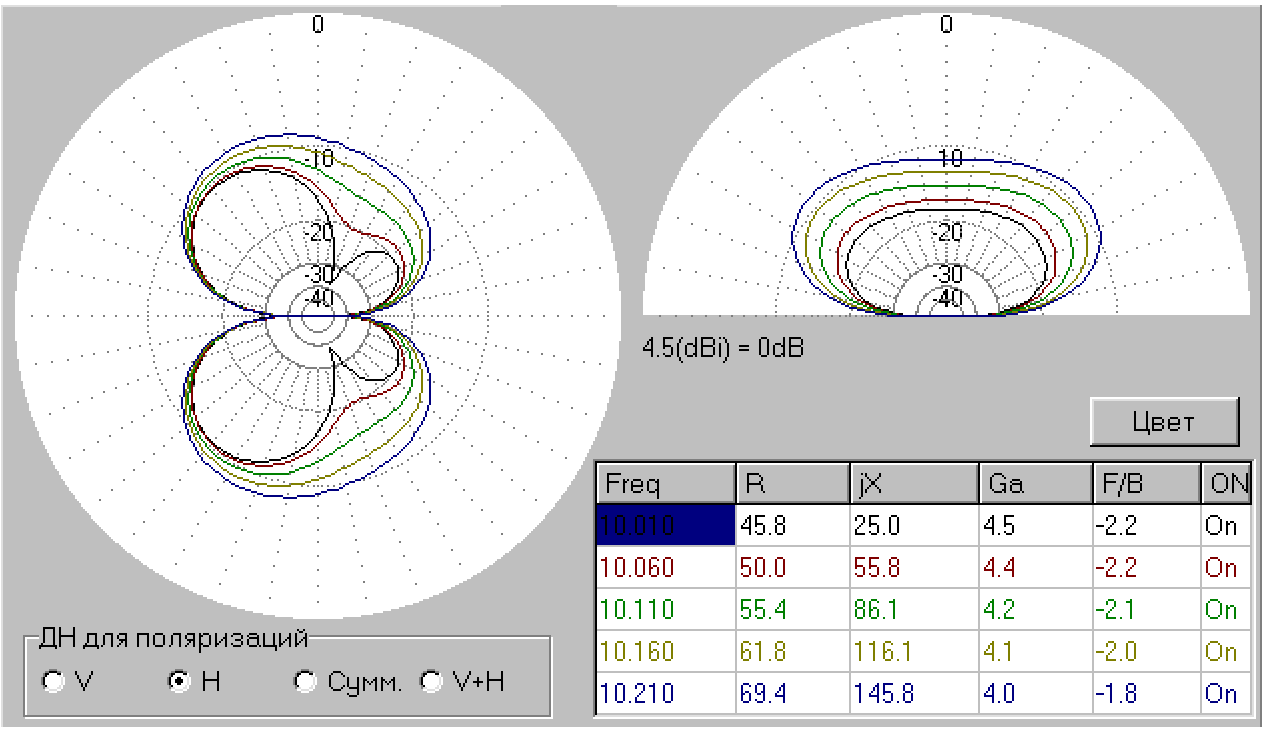
Antenna RV3DA at 30-m

Vertical Radiation Pattern



Freq	R	jX	Ga	F/B	ON
10.010	45.8	25.0	4.5	-2.2	On
10.060	50.0	55.8	4.4	-2.2	On
10.110	55.4	86.1	4.2	-2.1	On
10.160	61.8	116.1	4.1	-2.0	On
10.210	69.4	145.8	4.0	-1.8	On

Horizon Radiation Pattern

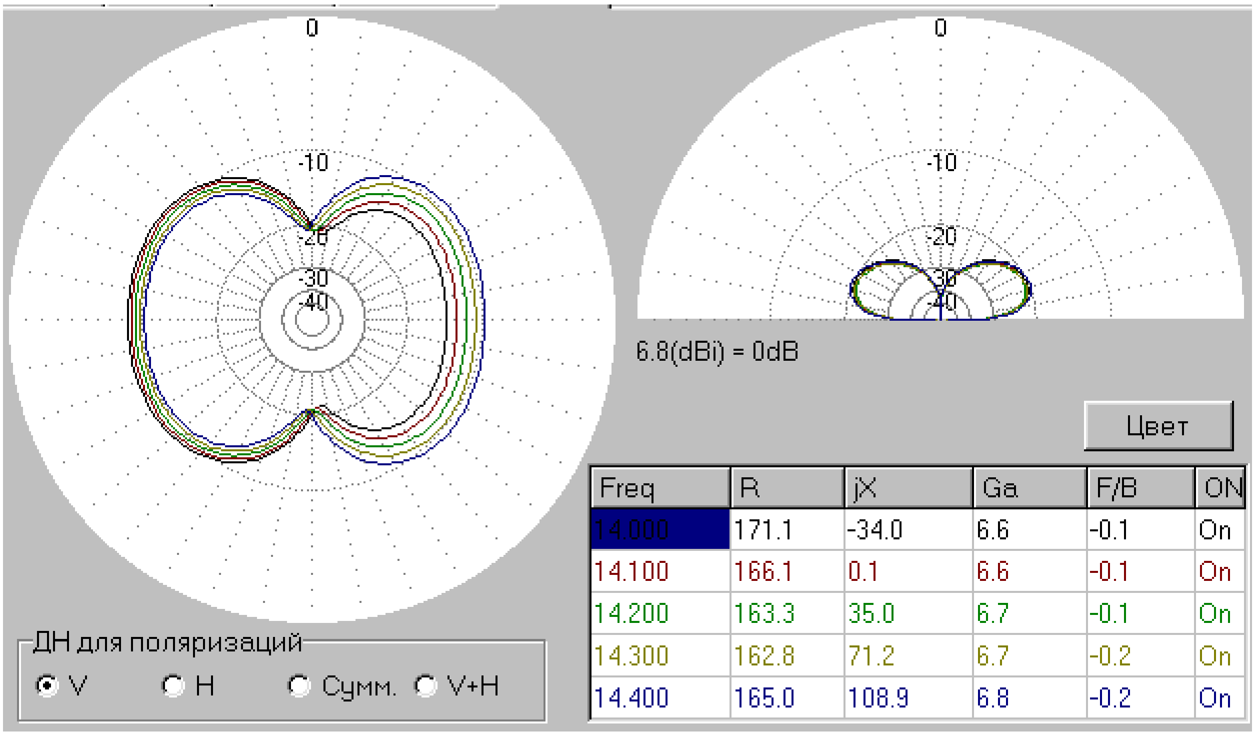


Freq	R	jX	Ga	F/B	ON
10.010	45.8	25.0	4.5	-2.2	On
10.060	50.0	55.8	4.4	-2.2	On
10.110	55.4	86.1	4.2	-2.1	On
10.160	61.8	116.1	4.1	-2.0	On
10.210	69.4	145.8	4.0	-1.8	On

Comments: Antenna has strong vertical radiation. Not bad pattern in the vertical plane. Antenna has strong radiation at high corners that allows to do local QSOs. Antenna has almost circular pattern in horizontal plane. Antenna provides DX and local QSOs. Antenna has Z= 55+ j86-Ohms at 1010-kHz. Any ATU does good matching for such load.

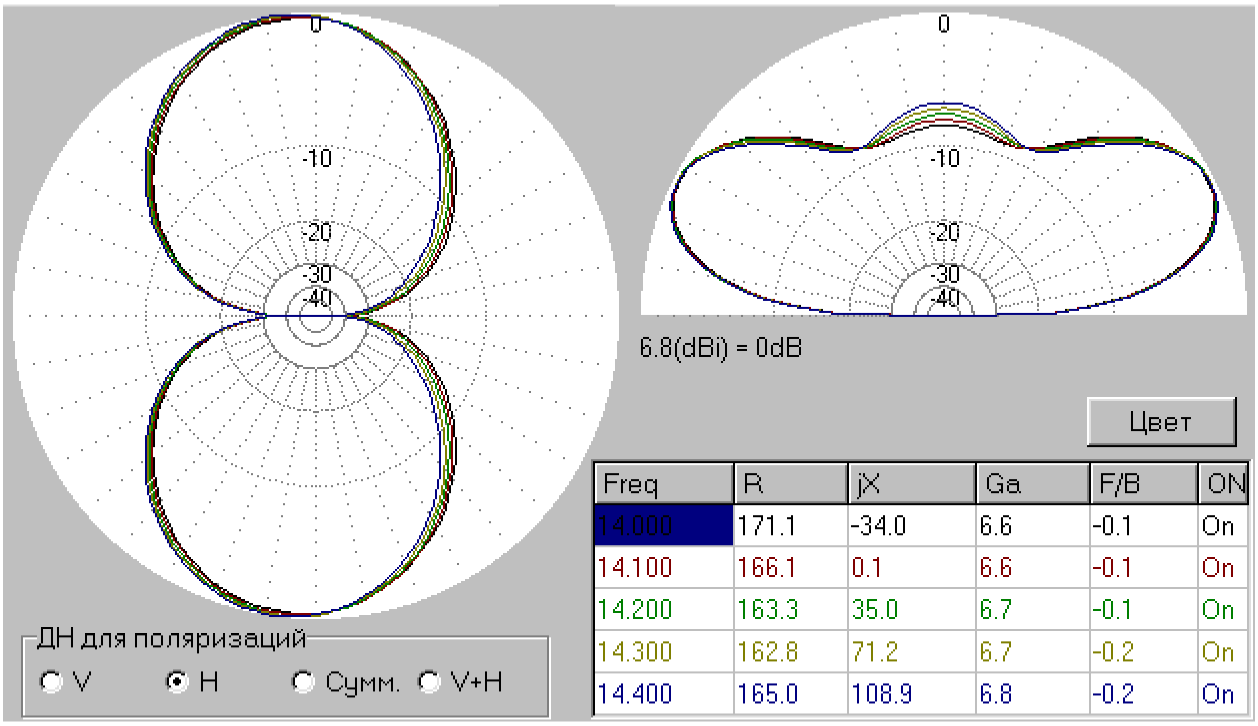
Antenna RV3DA at 20-m

Vertical Radiation Pattern



Freq	R	jX	Ga	F/B	ON
14.000	171.1	-34.0	6.6	-0.1	On
14.100	166.1	0.1	6.6	-0.1	On
14.200	163.3	35.0	6.7	-0.1	On
14.300	162.8	71.2	6.7	-0.2	On
14.400	165.0	108.9	6.8	-0.2	On

Horizon Radiation Pattern

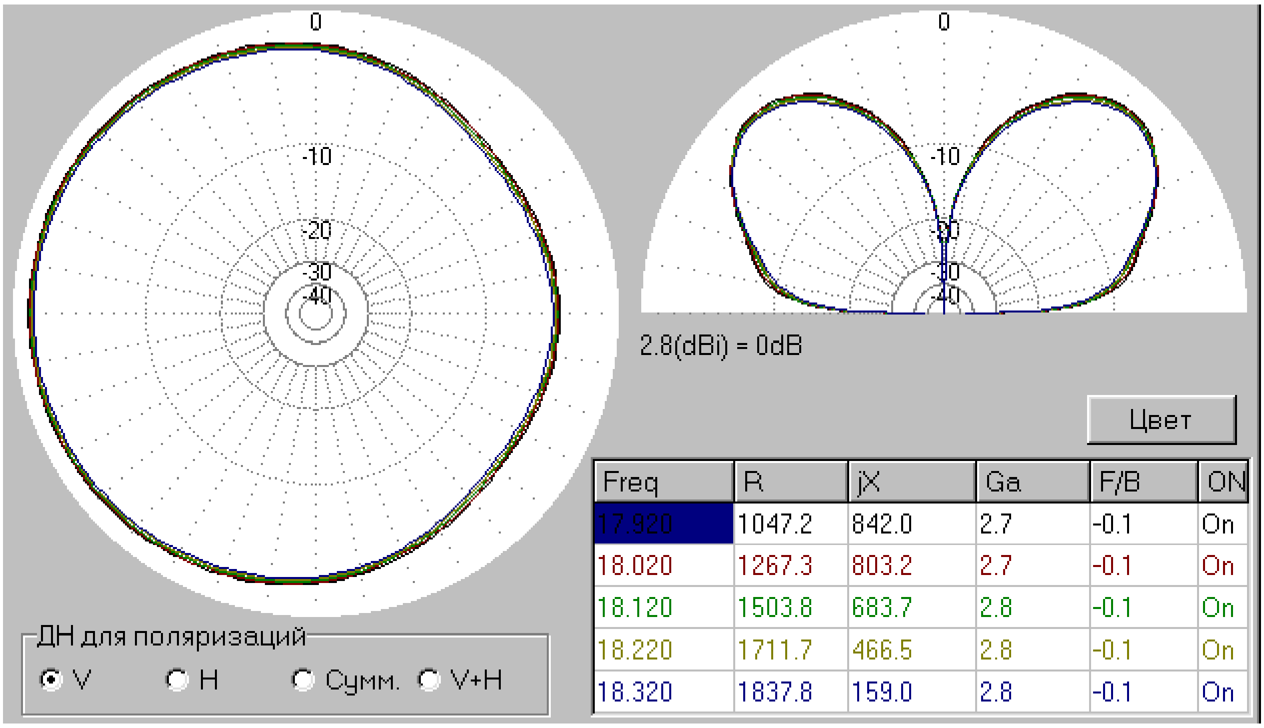


Freq	R	jX	Ga	F/B	ON
14.000	171.1	-34.0	6.6	-0.1	On
14.100	166.1	0.1	6.6	-0.1	On
14.200	163.3	35.0	6.7	-0.1	On
14.300	162.8	71.2	6.7	-0.2	On
14.400	165.0	108.9	6.8	-0.2	On

Comments: Antenna has strong horizon radiation. A good pattern in the vertical plane. Antenna has a strong radiation at low corners that allows to do DX QSOs. Antenna has almost “eight- figure” pattern in horizontal plane, so, it demands to choose a proper direction before an installation of the antenna. Antenna provides DX QSOs. Antenna has the resonance at 14100-kHz at 166 Ohms. Any ATU does good matching for the antenna.

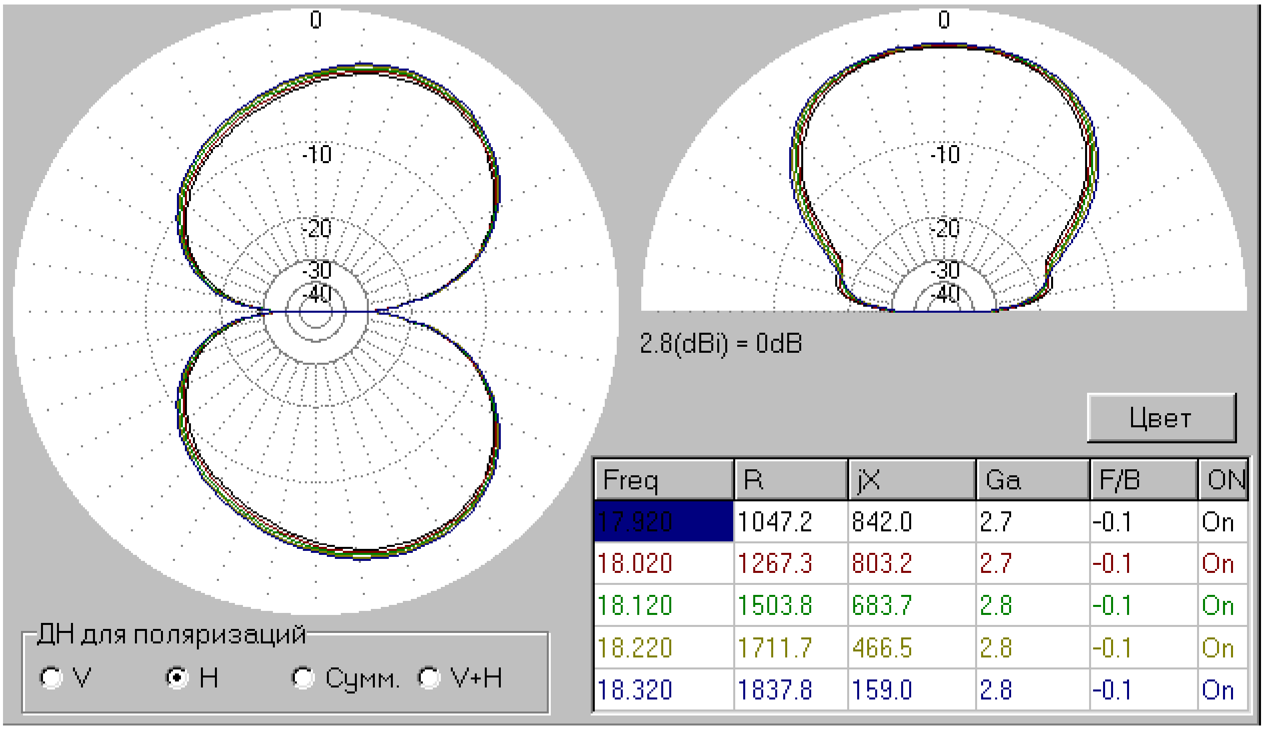
Antenna RV3DA at 17-m

Vertical Radiation Pattern



Freq	R	jX	Ga	F/B	ON
17.920	1047.2	842.0	2.7	-0.1	On
18.020	1267.3	803.2	2.7	-0.1	On
18.120	1503.8	683.7	2.8	-0.1	On
18.220	1711.7	466.5	2.8	-0.1	On
18.320	1837.8	159.0	2.8	-0.1	On

Horizon Radiation Pattern

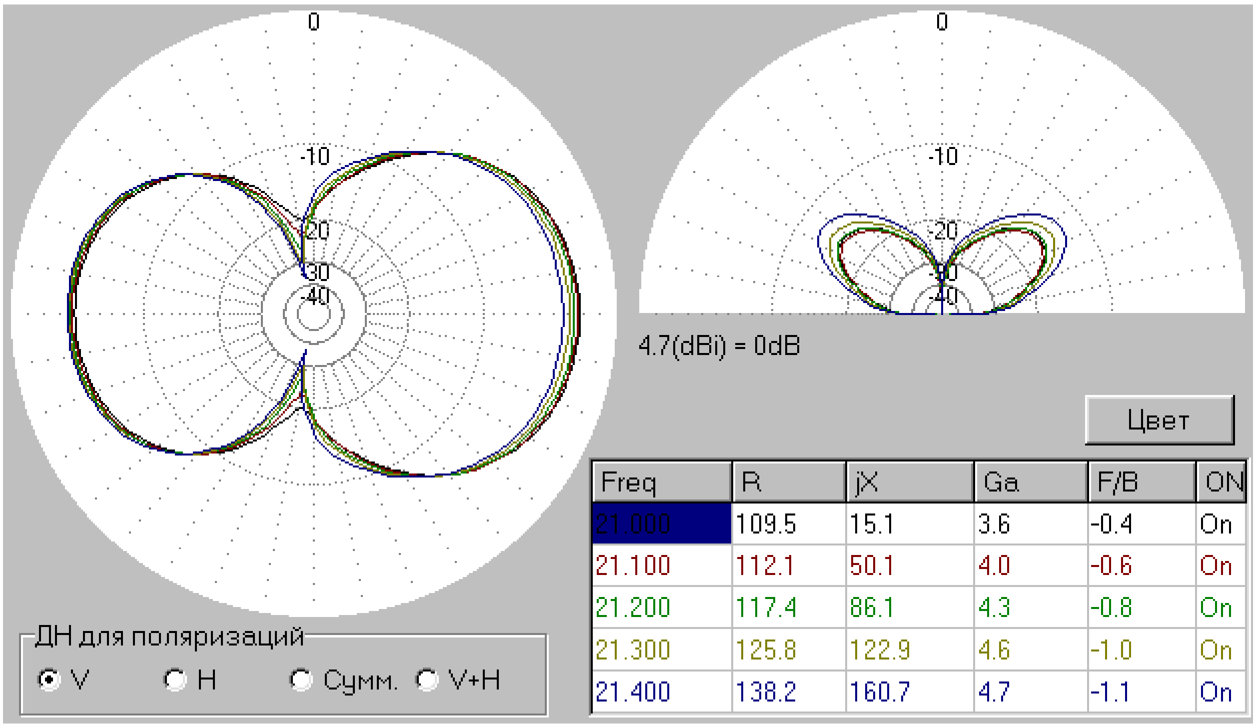


Freq	R	jX	Ga	F/B	ON
17.920	1047.2	842.0	2.7	-0.1	On
18.020	1267.3	803.2	2.7	-0.1	On
18.120	1503.8	683.7	2.8	-0.1	On
18.220	1711.7	466.5	2.8	-0.1	On
18.320	1837.8	159.0	2.8	-0.1	On

Comments: Antenna has both, a strong vertical and strong horizon radiation. For the vertical radiation antenna has a good pattern in the vertical plane, and almost circular pattern in the horizon plane. Pattern for horizon radiation is not so good as to vertical polarization. Antenna can provide DX QSOs at vertical and horizon radiation. Antenna has impedance 1711+j466-Ohms at 18220-kHz. Not all ATUs do good matching for such load.

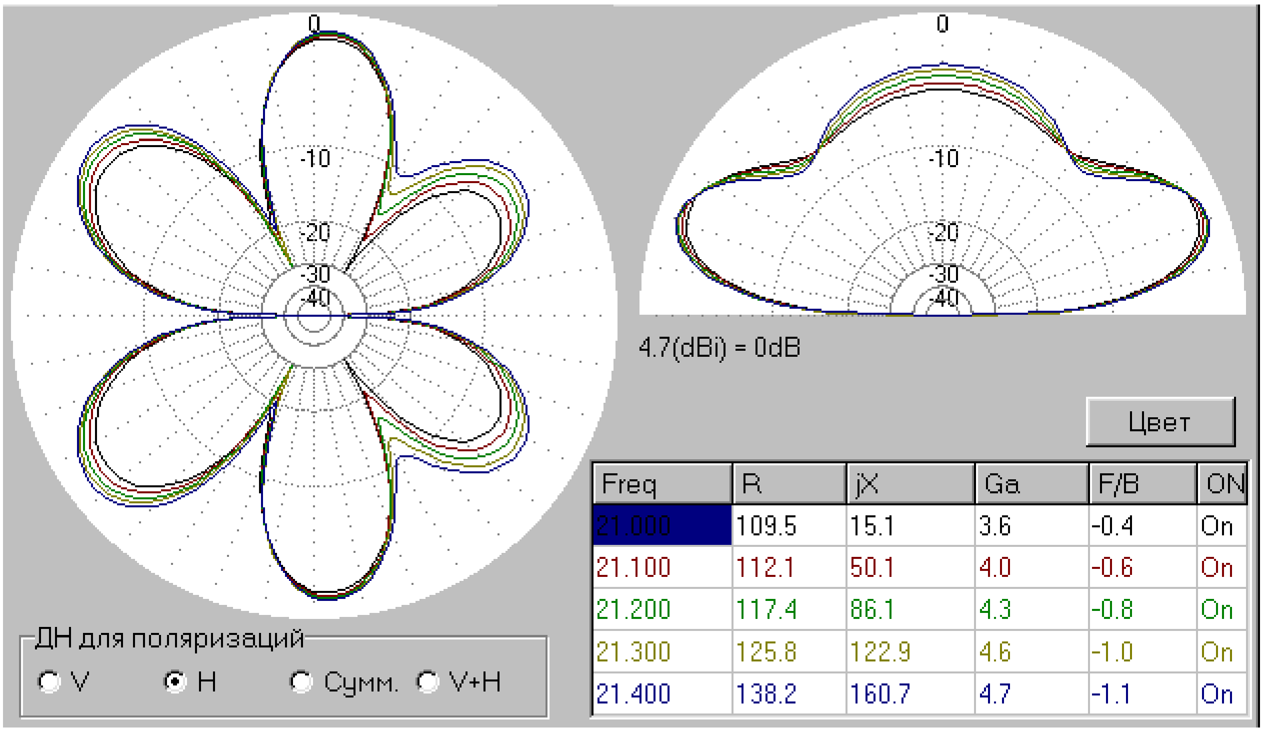
Antenna RV3DA at 15-m

Vertical Radiation Pattern



Freq	R	jX	Ga	F/B	ON
21.000	109.5	15.1	3.6	-0.4	On
21.100	112.1	50.1	4.0	-0.6	On
21.200	117.4	86.1	4.3	-0.8	On
21.300	125.8	122.9	4.6	-1.0	On
21.400	138.2	160.7	4.7	-1.1	On

Horizon Radiation Pattern

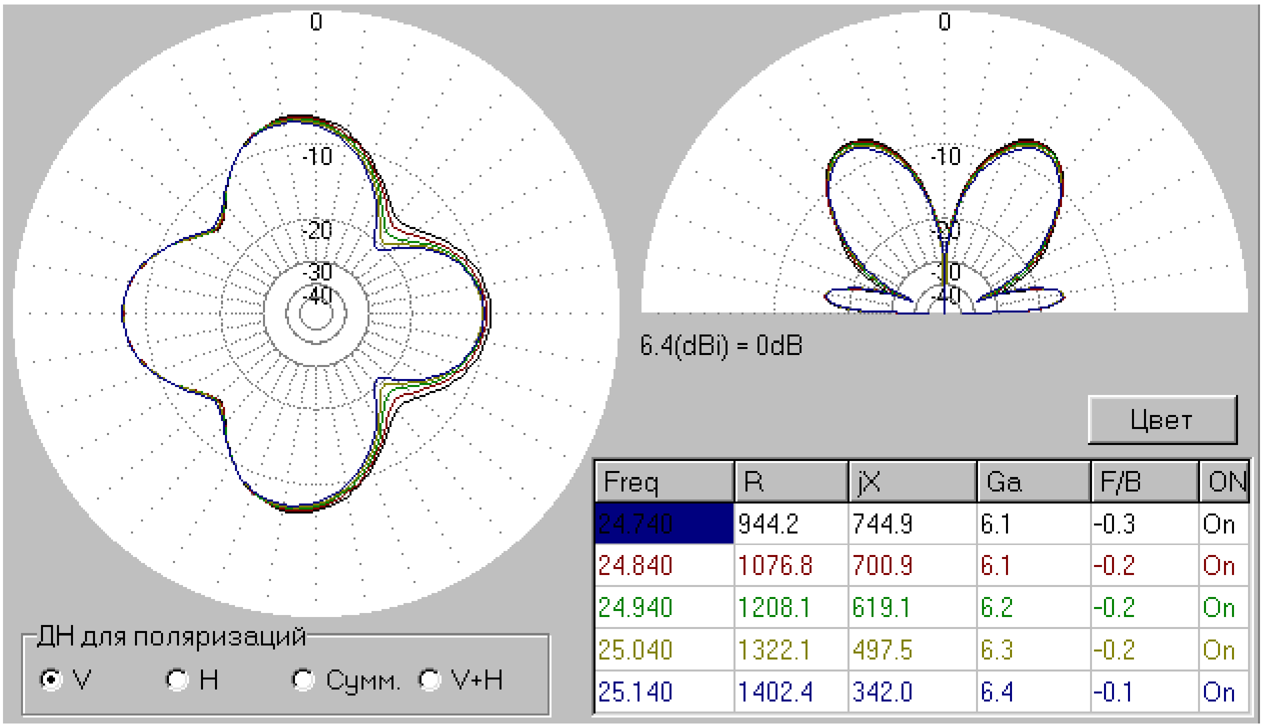


Freq	R	jX	Ga	F/B	ON
21.000	109.5	15.1	3.6	-0.4	On
21.100	112.1	50.1	4.0	-0.6	On
21.200	117.4	86.1	4.3	-0.8	On
21.300	125.8	122.9	4.6	-1.0	On
21.400	138.2	160.7	4.7	-1.1	On

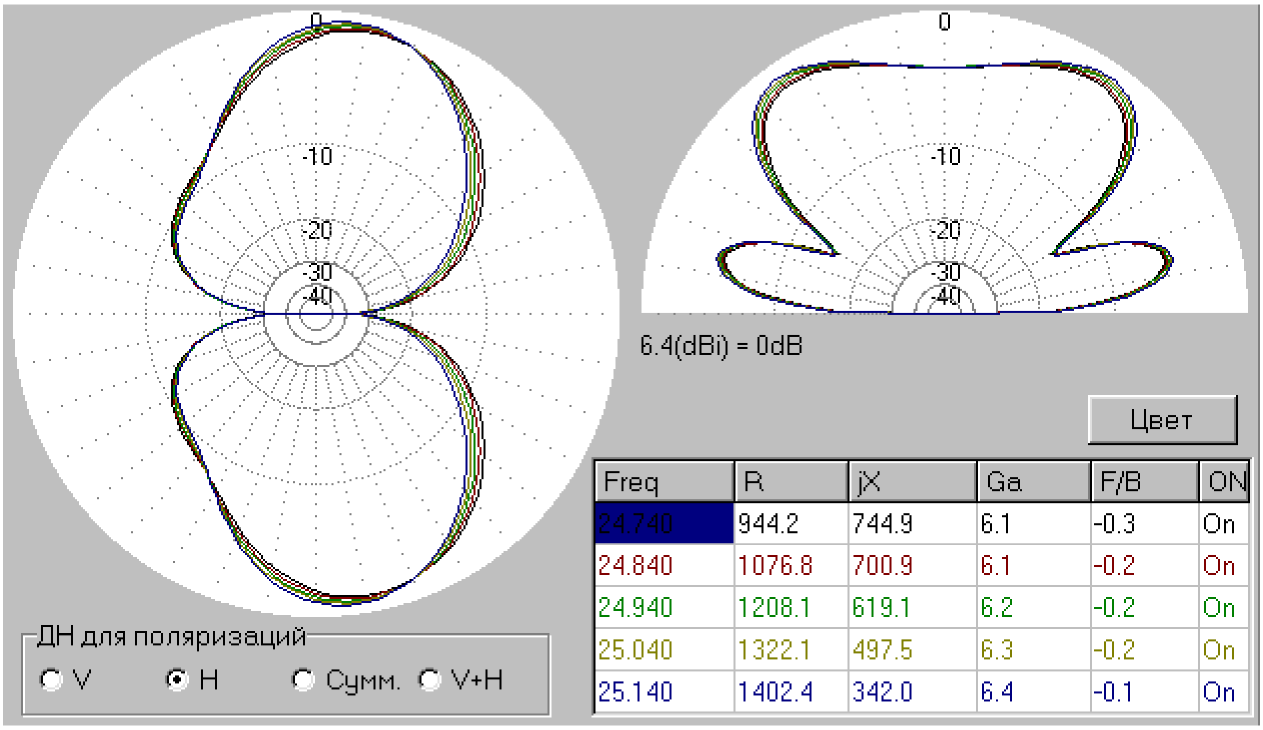
Comments: Antenna has both, a strong vertical and strong horizon radiation. For the horizon radiation antenna has a good pattern in the vertical plane with low lobes, and six-lobes pattern in the horizon plane. Pattern for the horizon radiation is not so good as to vertical polarization. Antenna can provide DX QSOs at vertical radiation. Antenna has impedance 117+j86-Ohms at 21200-kHz. Any ATU makes good matching for such load.

Antenna RV3DA at 12-m

Vertical Radiation Pattern



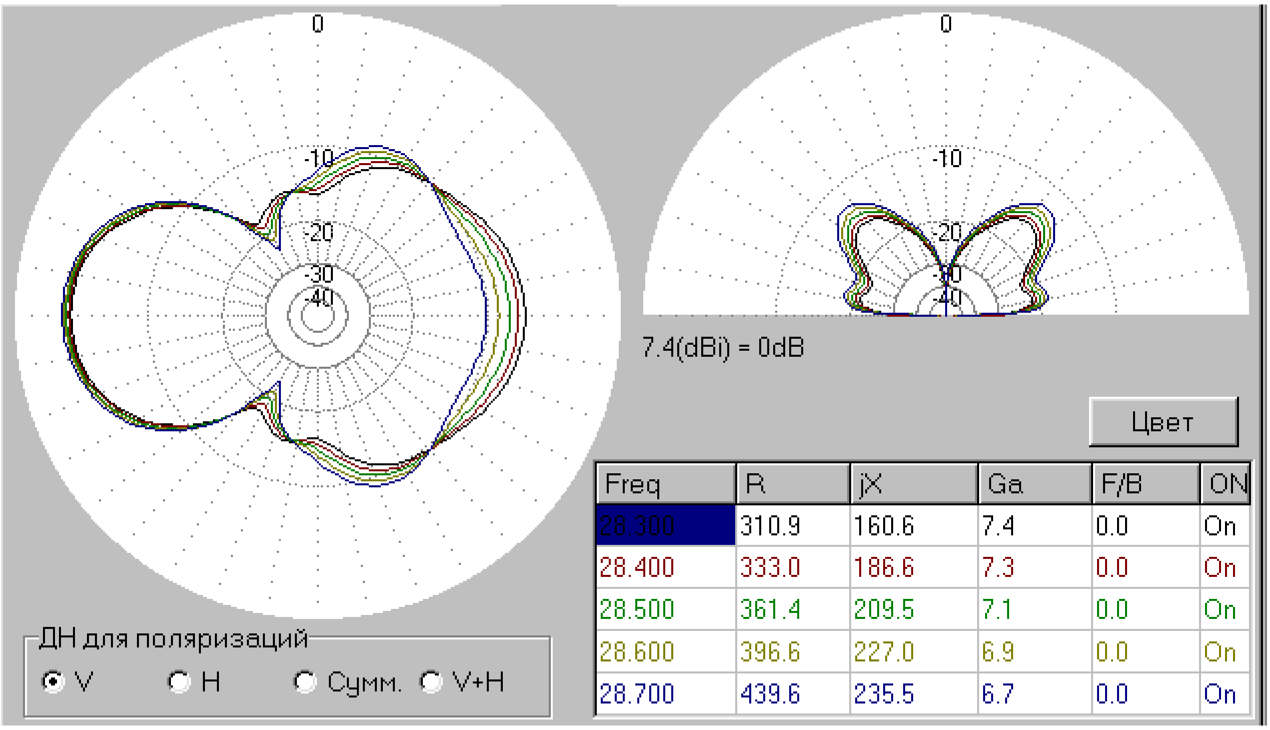
Horizon Radiation Pattern



Comments: Antenna has strong horizon radiation. For the horizon radiation antenna has a not bad pattern in the vertical plane, and “eight- figure” pattern in the horizon plane. Antenna can provide DX QSOs at horizon radiation. Antenna has impedance 1208+j619-Ohms at 21200-kHz. Not all ATUs do good matching for such load.

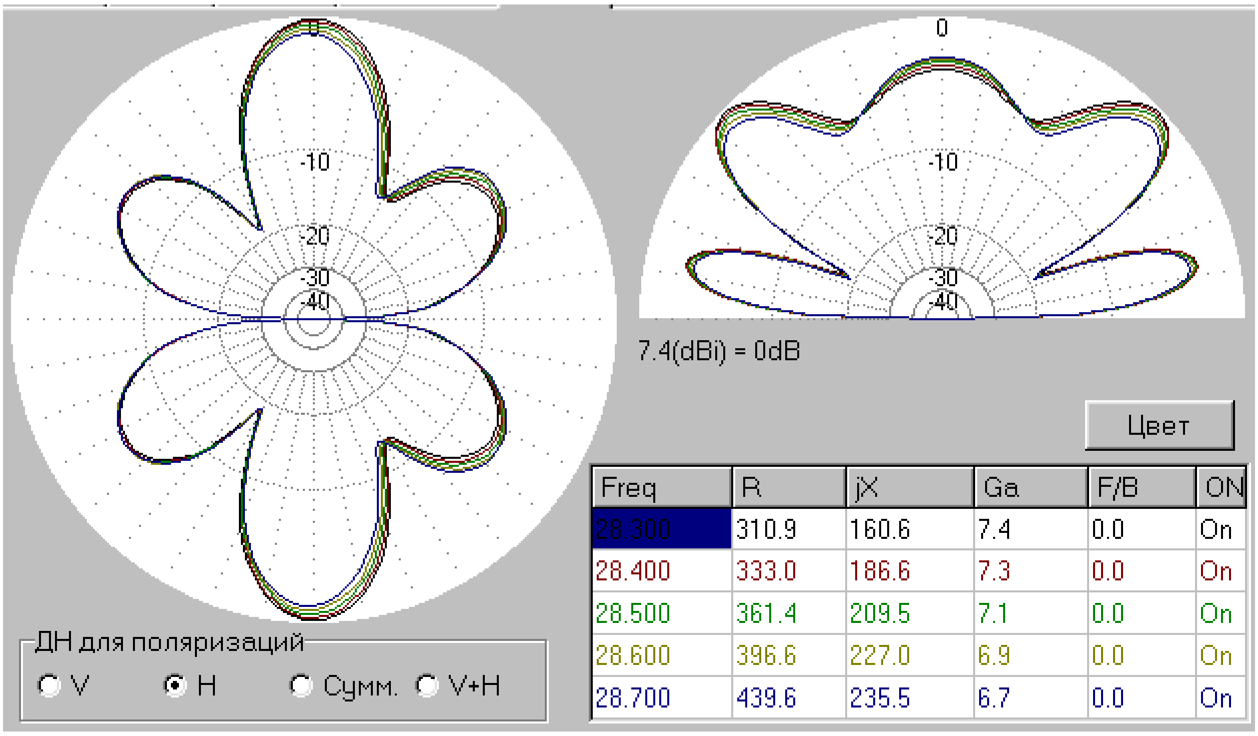
Antenna RV3DA at 10-m

Vertical Radiation Pattern



Freq	R	jX	Ga	F/B	ON
28.300	310.9	160.6	7.4	0.0	On
28.400	333.0	186.6	7.3	0.0	On
28.500	361.4	209.5	7.1	0.0	On
28.600	396.6	227.0	6.9	0.0	On
28.700	439.6	235.5	6.7	0.0	On

Horizon Radiation Pattern

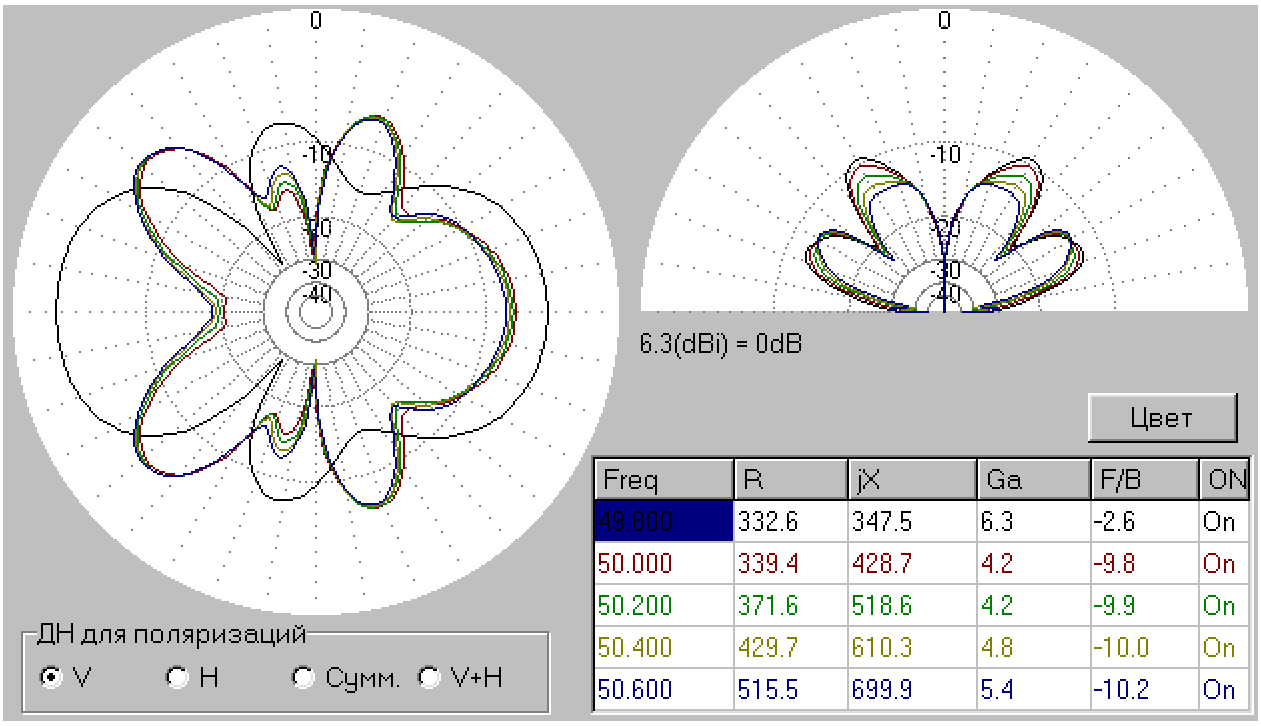


Freq	R	jX	Ga	F/B	ON
28.300	310.9	160.6	7.4	0.0	On
28.400	333.0	186.6	7.3	0.0	On
28.500	361.4	209.5	7.1	0.0	On
28.600	396.6	227.0	6.9	0.0	On
28.700	439.6	235.5	6.7	0.0	On

Comments: Antenna has strong horizon radiation. For the horizon radiation antenna has a not bad pattern in the vertical plane, and "eight- figure" pattern dropped to lobes in the horizon plane. Antenna can provide DX QSOs at the horizon radiation. Antenna has impedance 396+j227-Ohms at 28600-kHz. Not all ATUs do good matching for such load.

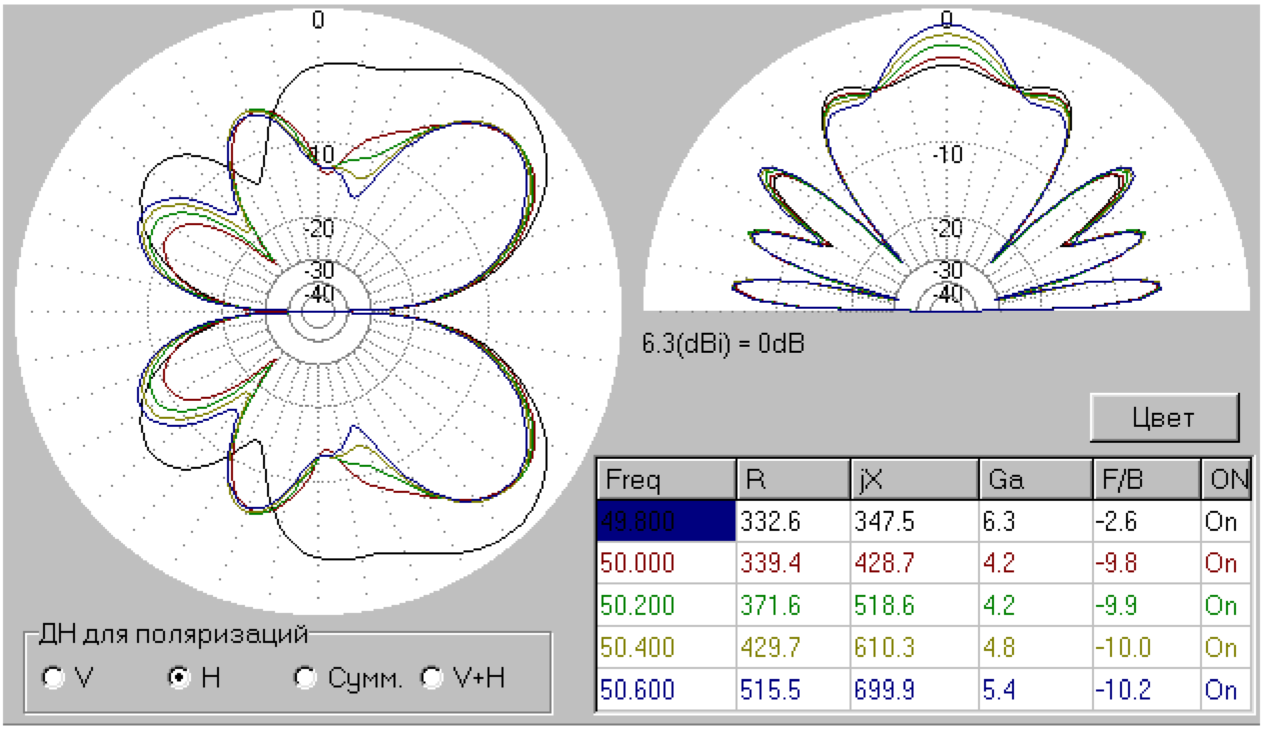
Antenna RV3DA at 6-m

Vertical Radiation Pattern



Freq	R	jX	Ga	F/B	ON
49.800	332.6	347.5	6.3	-2.6	On
50.000	339.4	428.7	4.2	-9.8	On
50.200	371.6	518.6	4.2	-9.9	On
50.400	429.7	610.3	4.8	-10.0	On
50.600	515.5	699.9	5.4	-10.2	On

Horizon Radiation Pattern



Freq	R	jX	Ga	F/B	ON
49.800	332.6	347.5	6.3	-2.6	On
50.000	339.4	428.7	4.2	-9.8	On
50.200	371.6	518.6	4.2	-9.9	On
50.400	429.7	610.3	4.8	-10.0	On
50.600	515.5	699.9	5.4	-10.2	On

Comments: Antenna has horizon and vertical radiation. For the horizon radiation antenna has a not bad pattern in the vertical plane, and "eight- figure" pattern dropped to lobes in the horizon plane. Antenna can provide DX QSOs at horizon radiation. Antenna has impedance 429+j599-Ohms at 50600-kHz. Not all ATUs do good matching for such load.

Shunt Vertical Universal HF Antenna

Igor Grigorov, Rk3ZK

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*Field universal antenna RV3DA (**see pp.:24- 35 of ANTENTOP- 02- 2004**) works well even at a bad grounding. To hammer into the ground a metal rod in 1 meter length is enough for the grounding. Installation of the antenna takes a little time, it is another its advantage.However, if there is an opportunity to provide a good ground, and there is some free time to spend of for installation of an antenna, it is possible to use a **Shunt Vertical Universal HF Antenna** .*

Figure 1 shows the schematic of the Shunt Vertical Universal HF Antenna. A detailed description of the theory of a Shunt Vertical Universal is given at reference **[1]**.

Apparently, the circuit of the antenna only a bit differs from field universal antenna RV3DA. The differences are: the loop is isolated from the ground, its terminals are shortened, shunts go down from two tops of the triangle loop to the ground. To ground shunts is possible as to universal antenna RV3DA it is done, i.e., a metal rod in 1 meter length is enough for the grounding. Of course, several counterpoises (three and more) in length 0f 5 meters (and more) help to improve the antenna operation. Counterpoises can lay on a surface of the ground.

Shunt Vertical Universal HF Antenna radiates mainly vertical radiation. It is required to use the antenna at woodless surrounding or big losses of high-frequency energy will be. Please, take attention Shunt Vertical Universal HF Antenna has a gain less then universal antenna RV3DA. It is possible to do a design of the Shunt Vertical Universal HF Antenna so, that this one can be easy turned to the field universal antenna RV3DA.

Below given diagram directivity for the antenna obtained with help of free antenna program MMANA (MININEC based). Left diagram is a section of the volumetric diagram directivity of plane X-Y at a zenith corner of the maximum radiation. The right diagram is section of the volumetric diagram directivity of plane X-Z. Also at the right down corner of the pictures is a table with antenna impedance. Please, take attention to the data, you can do decision how you ATU does match of the

Reference:

1. Aizenberg G. Z. Antennas of Short Waves.: Moscow, “Svyaz”, 1985.

73!
Igor Grigorov, RK3ZK

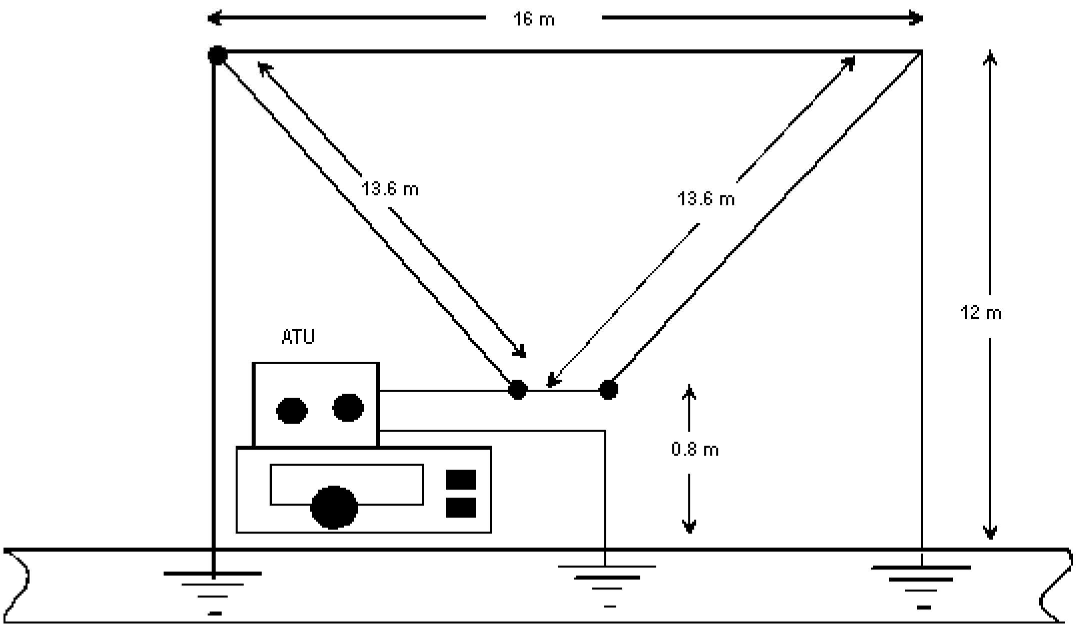
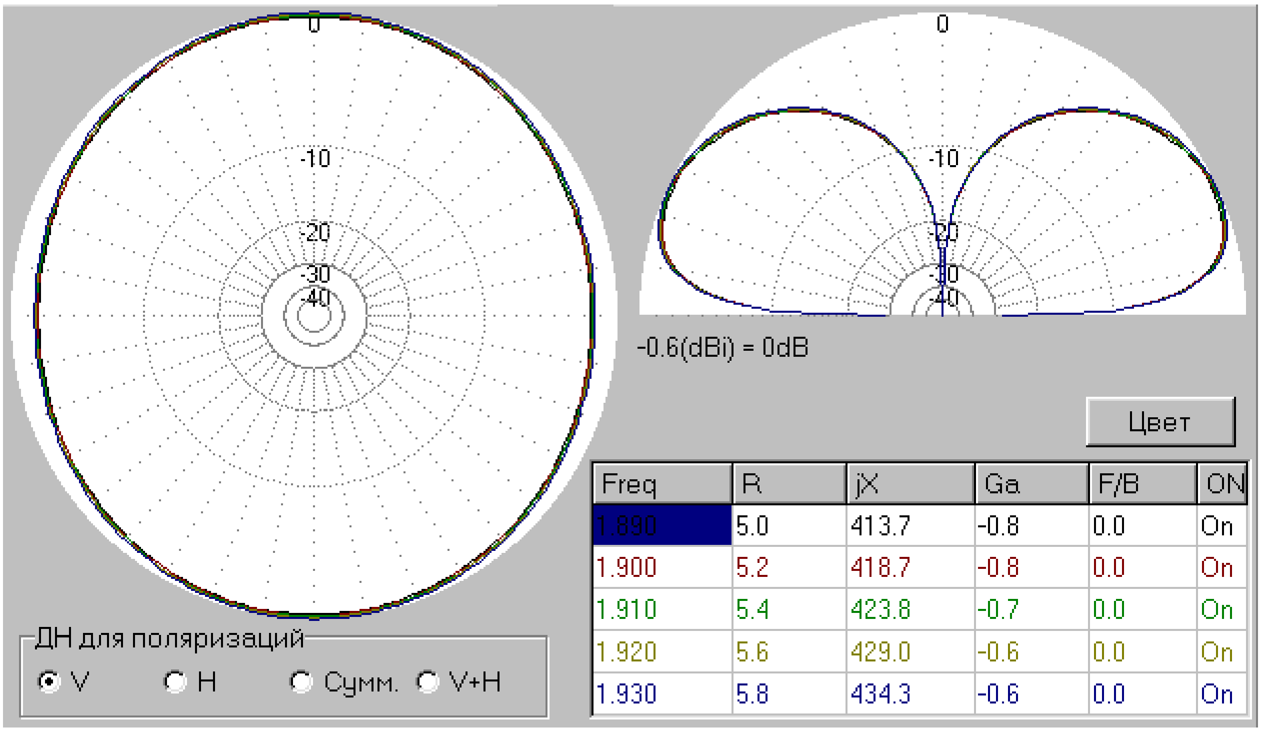


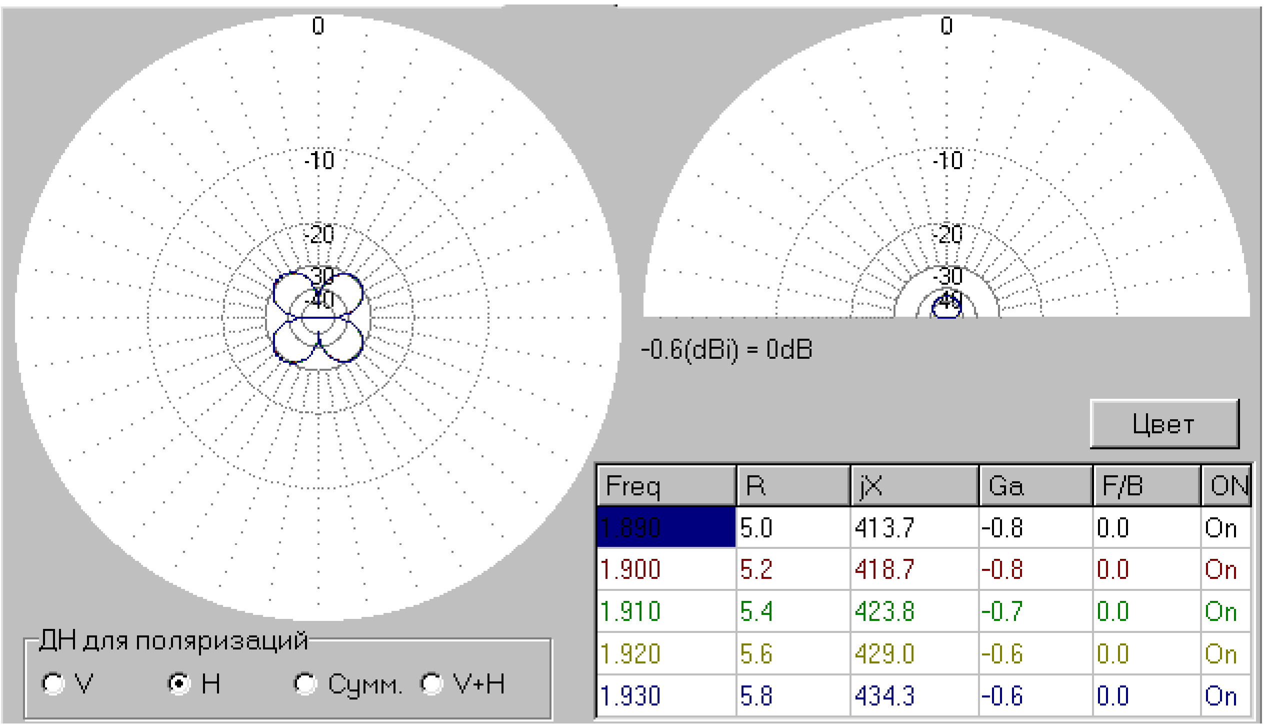
Figure 1

Shunt Vertical Universal HF Antenna at 160-m

Vertical Radiation Pattern



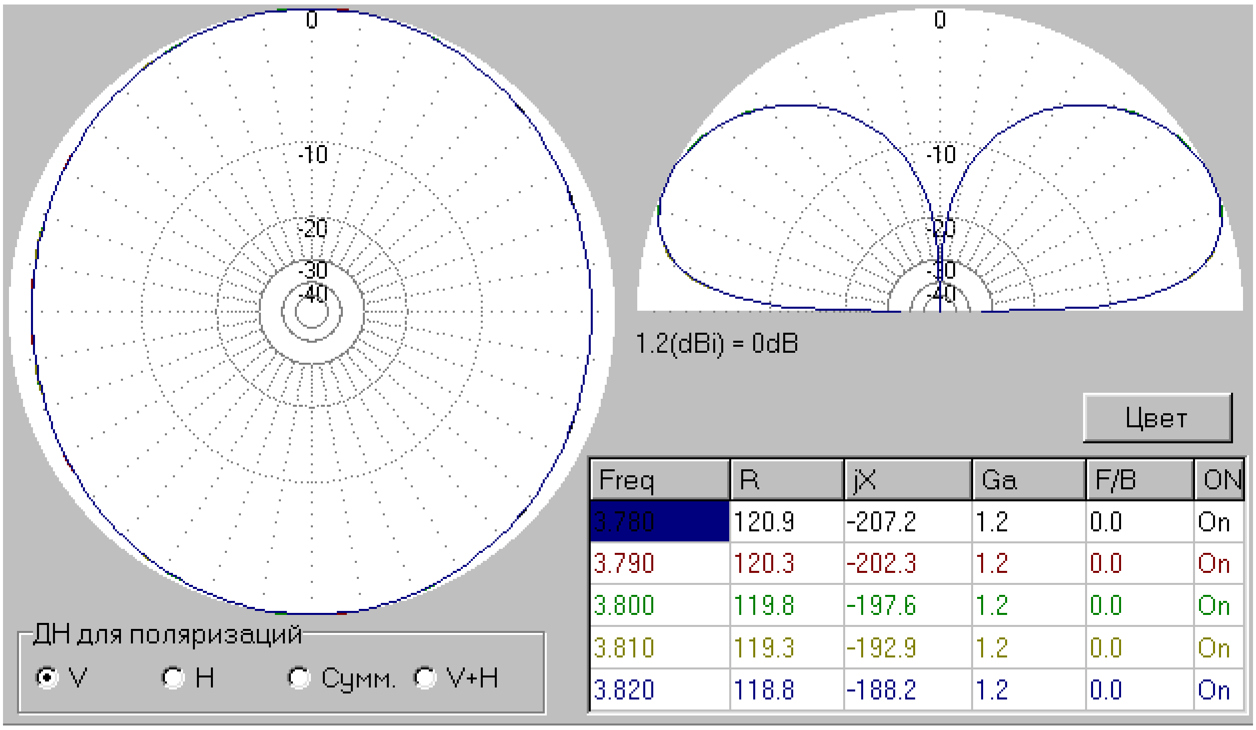
Horizon Radiation Pattern



Comments: Antenna radiates radio waves with vertical polarization. A very good pattern with low lobes in the vertical plane. Circular pattern in horizontal plane. It is fine for DX- QSO. But antenna has Z= 5.4+ j423-Ohms at 1910-kHz. Not all ATUs do good matching for such load.

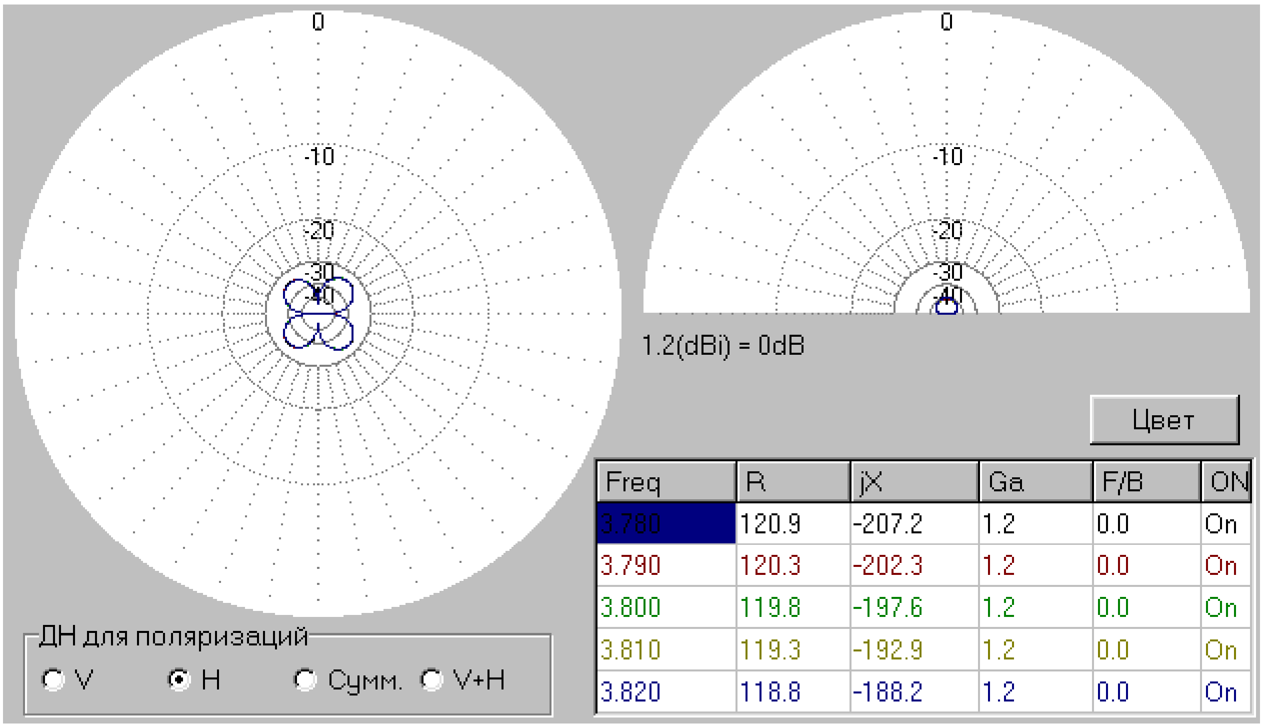
Shunt Vertical Universal HF Antenna at 80-m

Vertical Radiation Pattern



Freq	R	jX	Ga	F/B	ON
3.780	120.9	-207.2	1.2	0.0	On
3.790	120.3	-202.3	1.2	0.0	On
3.800	119.8	-197.6	1.2	0.0	On
3.810	119.3	-192.9	1.2	0.0	On
3.820	118.8	-188.2	1.2	0.0	On

Horizon Radiation Pattern

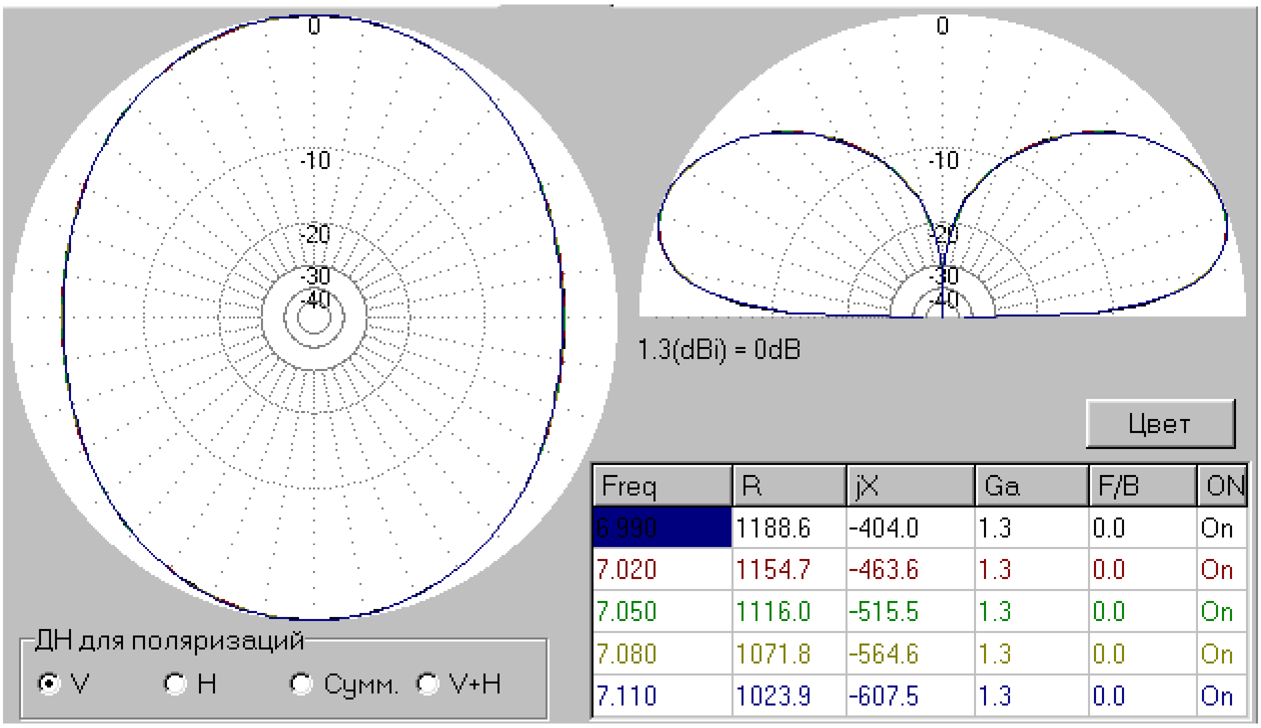


Freq	R	jX	Ga	F/B	ON
3.780	120.9	-207.2	1.2	0.0	On
3.790	120.3	-202.3	1.2	0.0	On
3.800	119.8	-197.6	1.2	0.0	On
3.810	119.3	-192.9	1.2	0.0	On
3.820	118.8	-188.2	1.2	0.0	On

Comments: Antenna radiates radio waves with vertical polarization. A very good pattern with low lobes in the vertical plane. Circular pattern in horizontal plane. It is fine for DX- QSO. Antenna has Z= 119-j197-Ohms at 3800-kHz. Almost any ATU does good matching for such load.

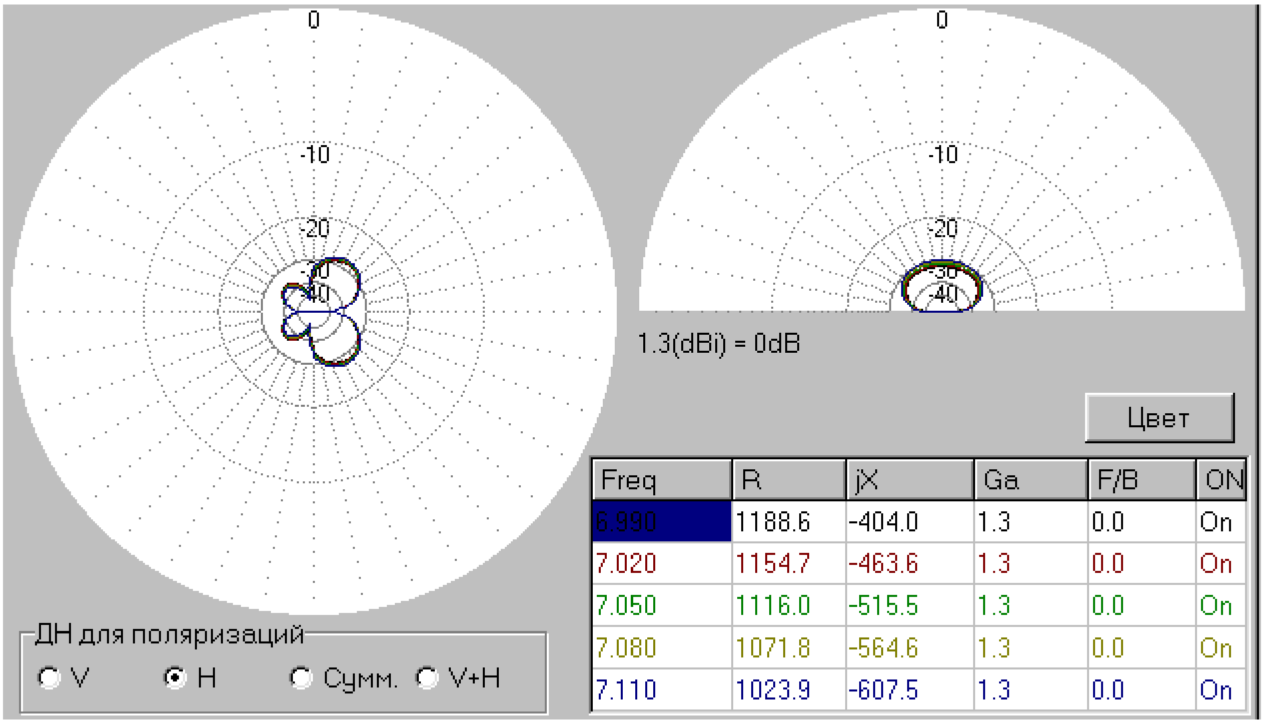
Shunt Vertical Universal HF Antenna at 40-m

Vertical Radiation Pattern



Freq	R	jX	Ga	F/B	ON
6.990	1188.6	-404.0	1.3	0.0	On
7.020	1154.7	-463.6	1.3	0.0	On
7.050	1116.0	-515.5	1.3	0.0	On
7.080	1071.8	-564.6	1.3	0.0	On
7.110	1023.9	-607.5	1.3	0.0	On

Horizon Radiation Pattern

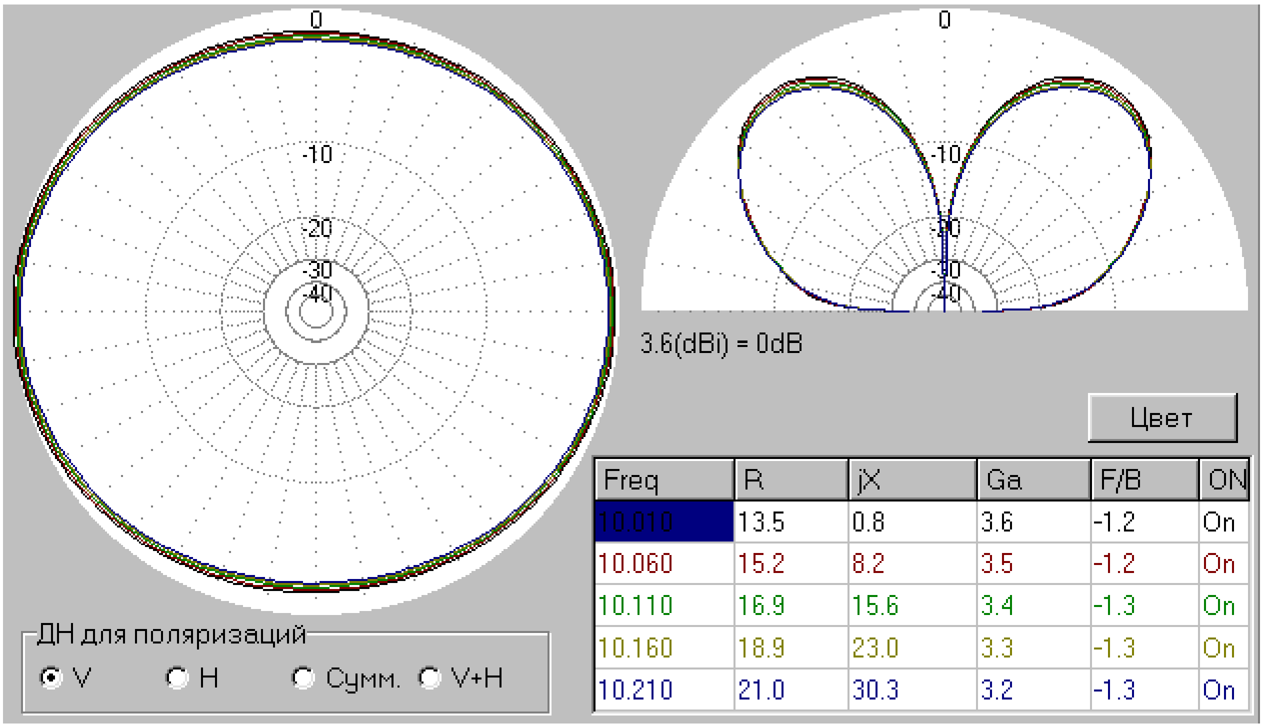


Freq	R	jX	Ga	F/B	ON
6.990	1188.6	-404.0	1.3	0.0	On
7.020	1154.7	-463.6	1.3	0.0	On
7.050	1116.0	-515.5	1.3	0.0	On
7.080	1071.8	-564.6	1.3	0.0	On
7.110	1023.9	-607.5	1.3	0.0	On

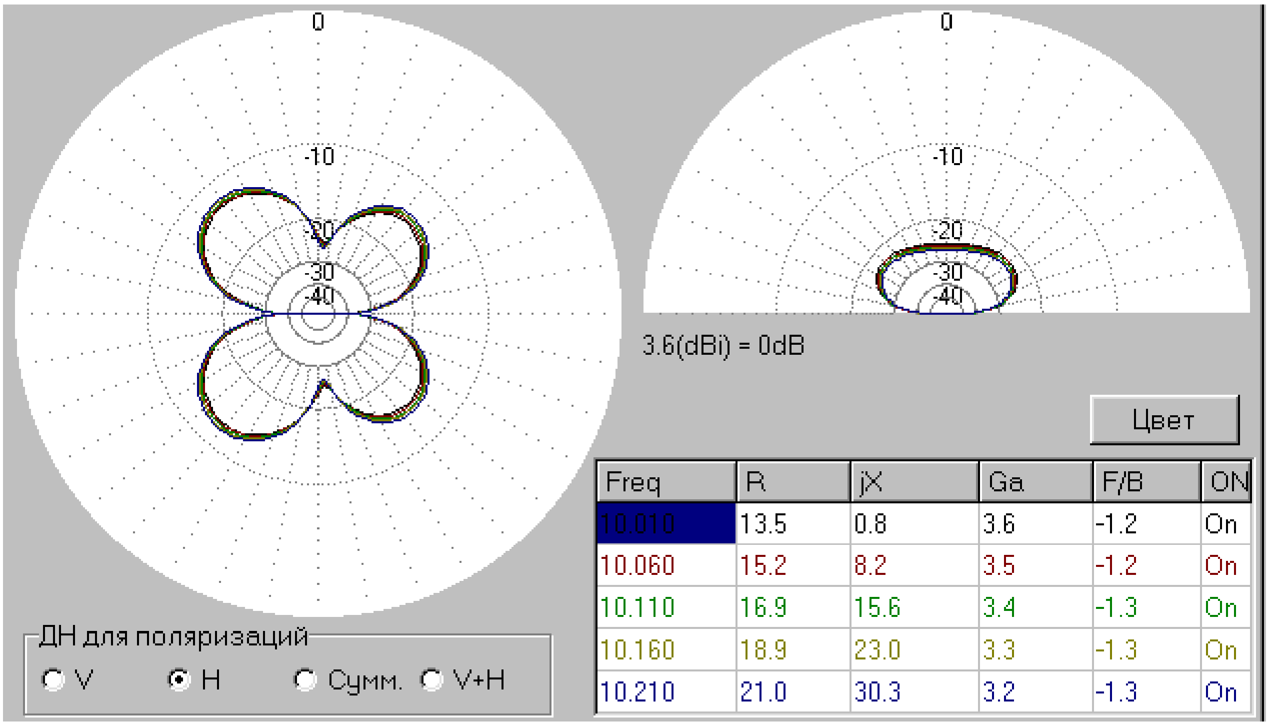
Comments: Antenna radiates radio waves with vertical polarization. A very good pattern with low lobes in the vertical plane. Almost a circular pattern in horizontal plane. It is fine for DX- QSO. Antenna has Z=1116- j515-Ohms at 7050-kHz. Not all ATUs do good matching for such load.

Shunt Vertical Universal HF Antenna at 30-m

Vertical Radiation Pattern



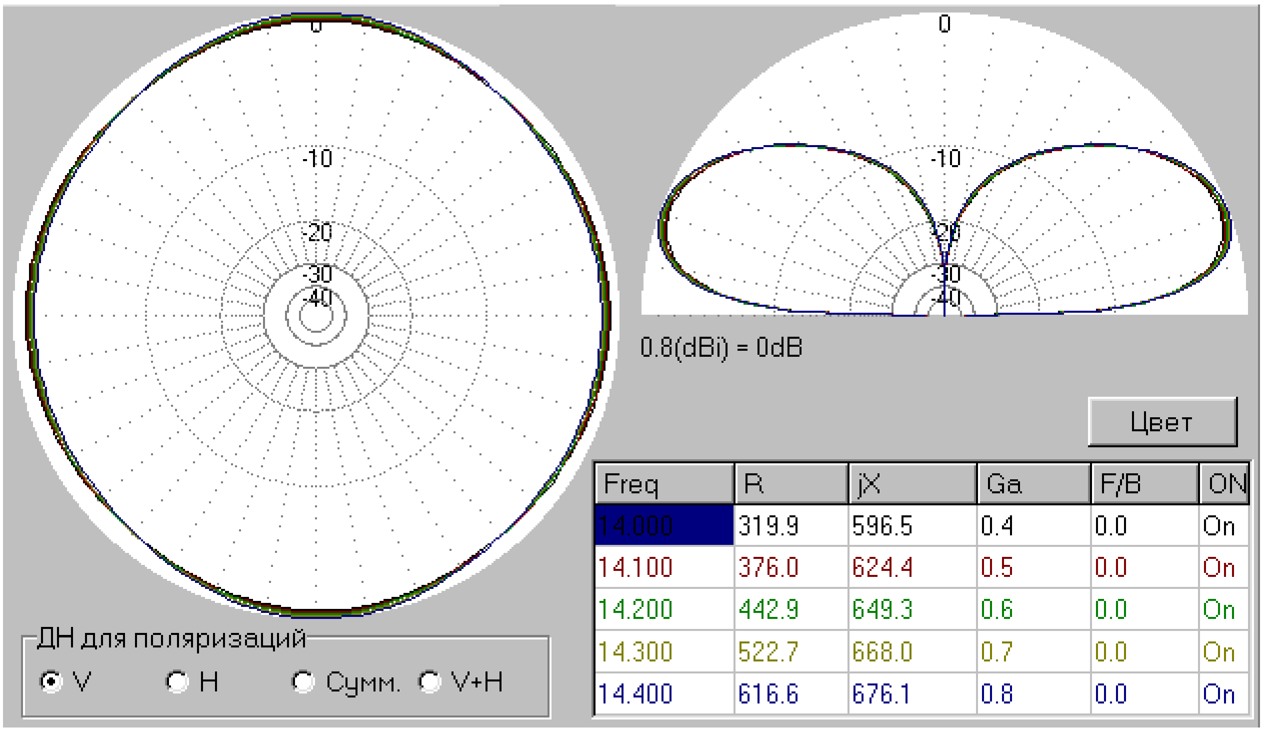
Horizon Radiation Pattern



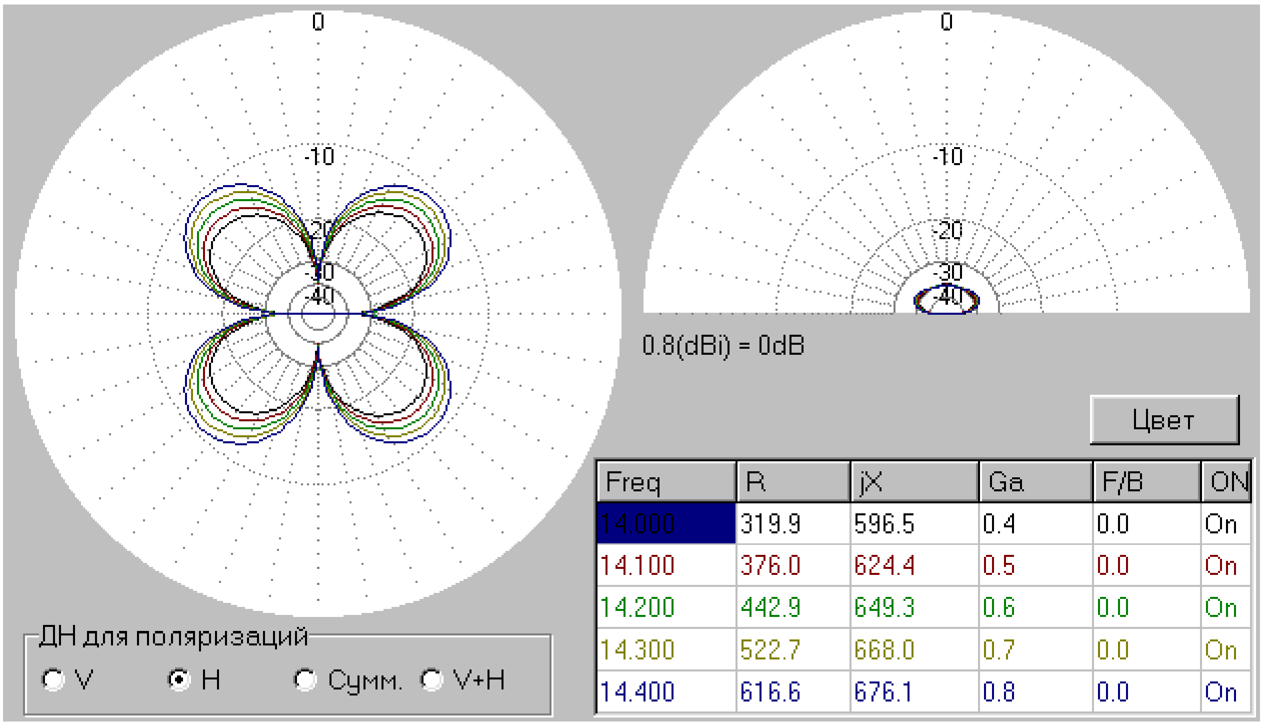
Comments: Antenna has strong vertical radiation. A good pattern in the vertical plane. Antenna has strong radiation at high corners that allows to do local QSOs. Antenna has almost circular pattern in horizontal plane. Antenna provides DX and local QSOs. Antenna has Z= 16.9+ j15.6-Ohms at 10110-kHz. Any ATU does good matching for such load.

Shunt Vertical Universal HF Antenna at 20-m

Vertical Radiation Pattern



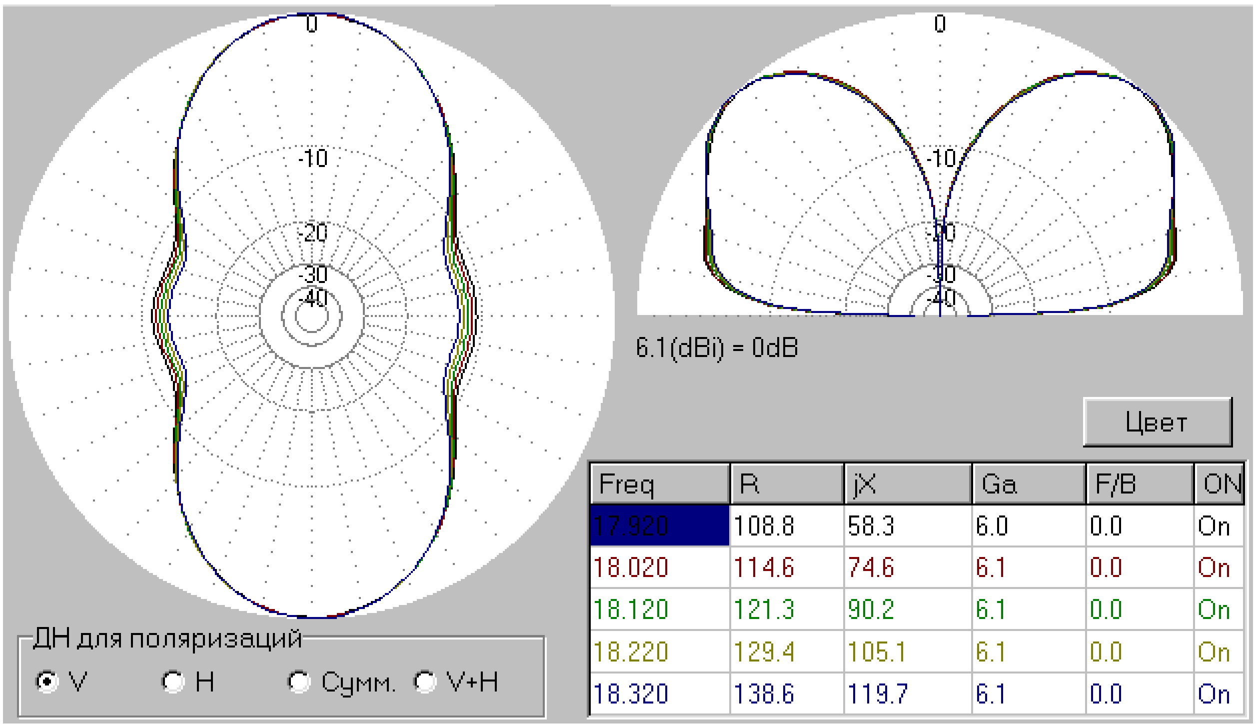
Horizon Radiation Pattern



Comments: Antenna has strong vertical radiation. A very good pattern in the vertical plane. Antenna has almost circular pattern in horizontal plane. Antenna provides DX QSOs. Antenna has Z= 442+ j649-Ohms at 14200-kHz. Not all ATUs do good matching for such load.

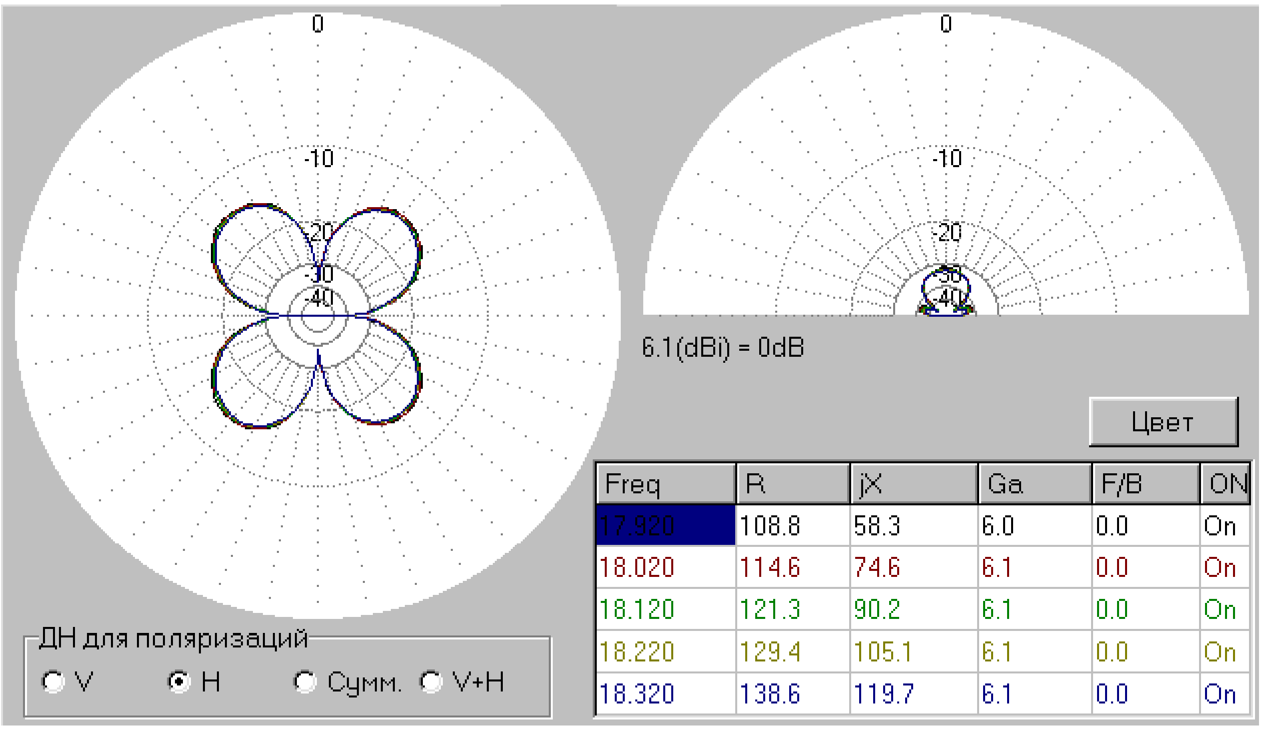
Shunt Vertical Universal HF Antenna at 17-m

Vertical Radiation Pattern



Freq	R	jX	Ga	F/B	ON
17.920	108.8	58.3	6.0	0.0	On
18.020	114.6	74.6	6.1	0.0	On
18.120	121.3	90.2	6.1	0.0	On
18.220	129.4	105.1	6.1	0.0	On
18.320	138.6	119.7	6.1	0.0	On

Horizon Radiation Pattern



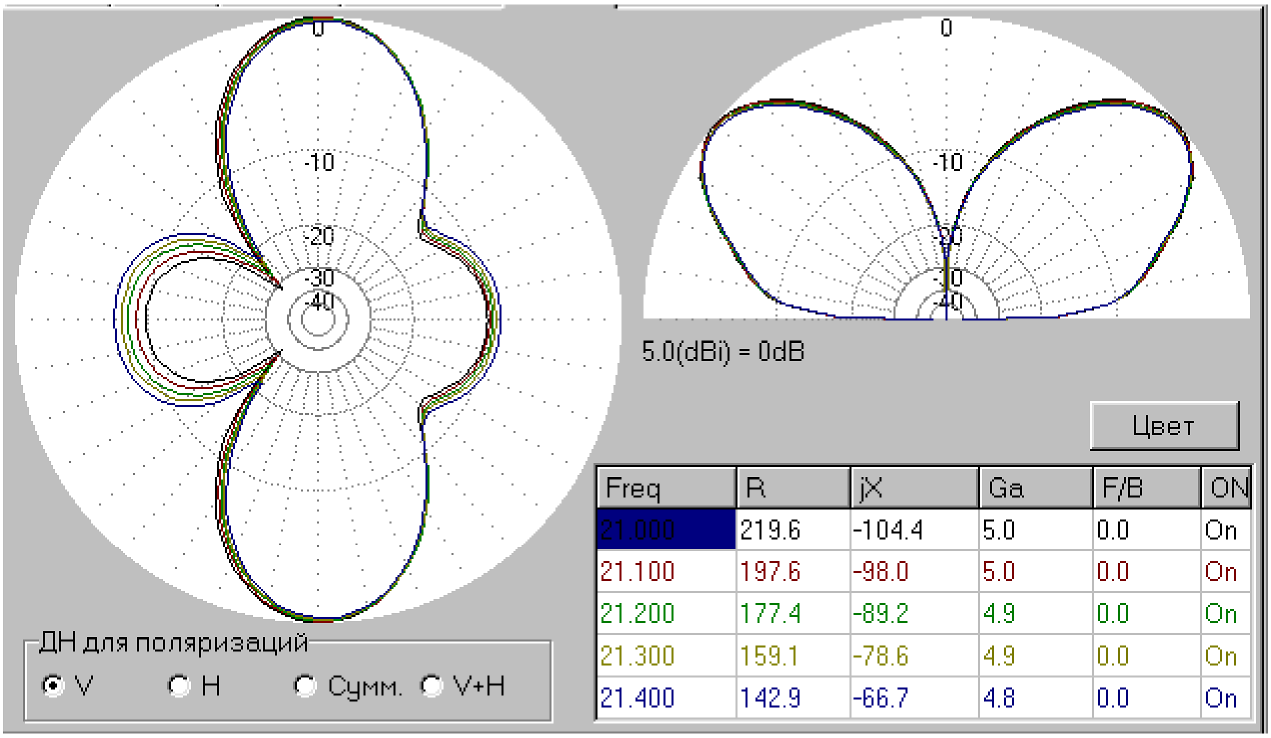
Freq	R	jX	Ga	F/B	ON
17.920	108.8	58.3	6.0	0.0	On
18.020	114.6	74.6	6.1	0.0	On
18.120	121.3	90.2	6.1	0.0	On
18.220	129.4	105.1	6.1	0.0	On
18.320	138.6	119.7	6.1	0.0	On

Comments: Antenna has strong vertical radiation. A good pattern in the vertical plane. Antenna has egg shape pattern in horizontal plane, so, it demands to choose a proper direction before an installation of the antenna. Antenna provides DX QSOs. Antenna has Z= 121+ j90-Ohms at 18120-kHz. Any ATU does good matching for such load.

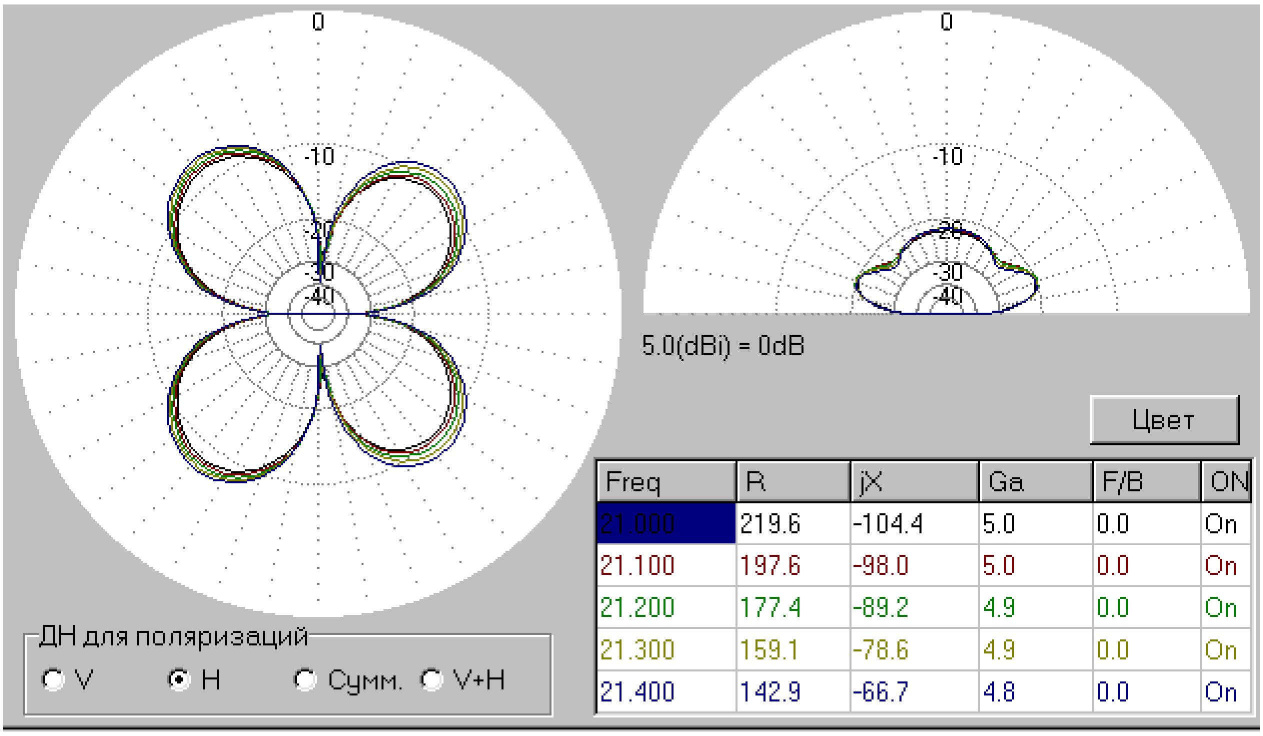
RUSSIAN DISTRICTS AWARD PROGRAM

Shunt Vertical Universal HF Antenna at 15-m

Vertical Radiation Pattern



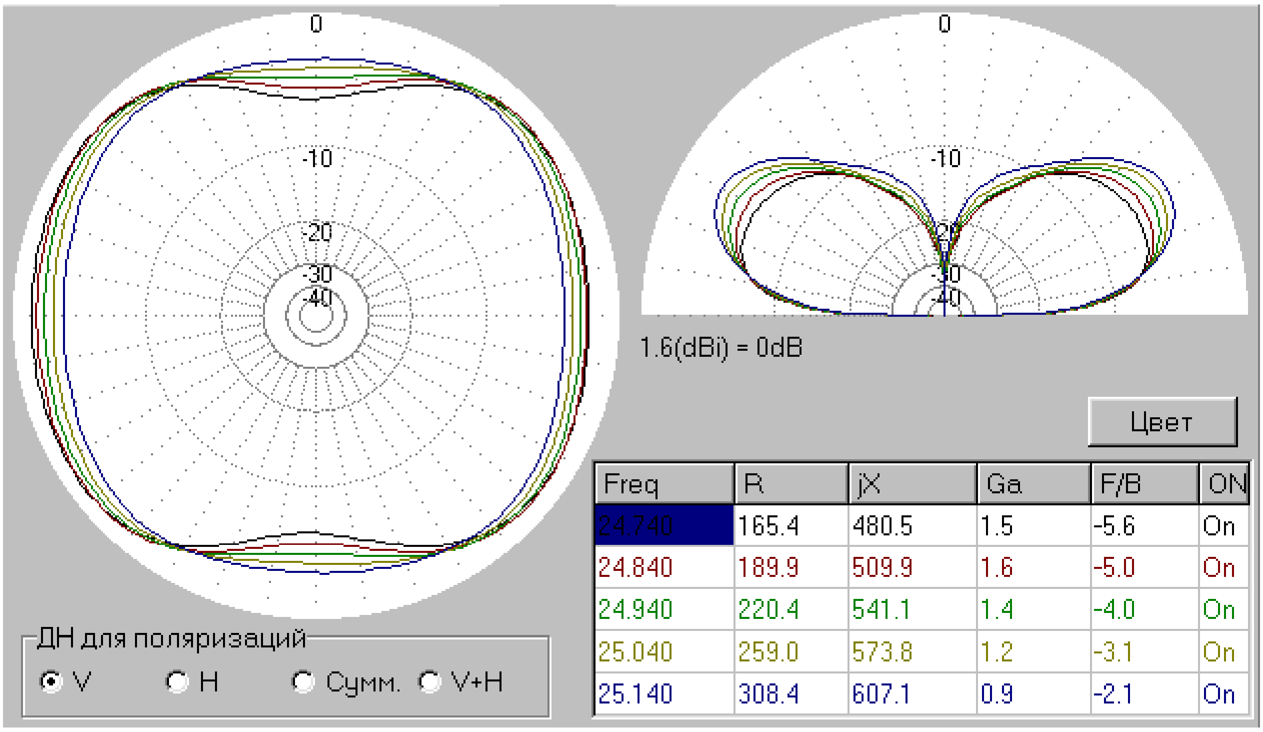
Horizon Radiation Pattern



Comments: Antenna has strong vertical radiation. A good pattern in the vertical plane. Antenna has almost egg shape pattern dropped to four lobes in horizontal plane, so, it demands to choose a proper direction before an installation of the antenna. Antenna provides DX QSOs. Antenna has Z= 177- j89-Ohms at 21200-kHz. Any ATU does good matching for such load.

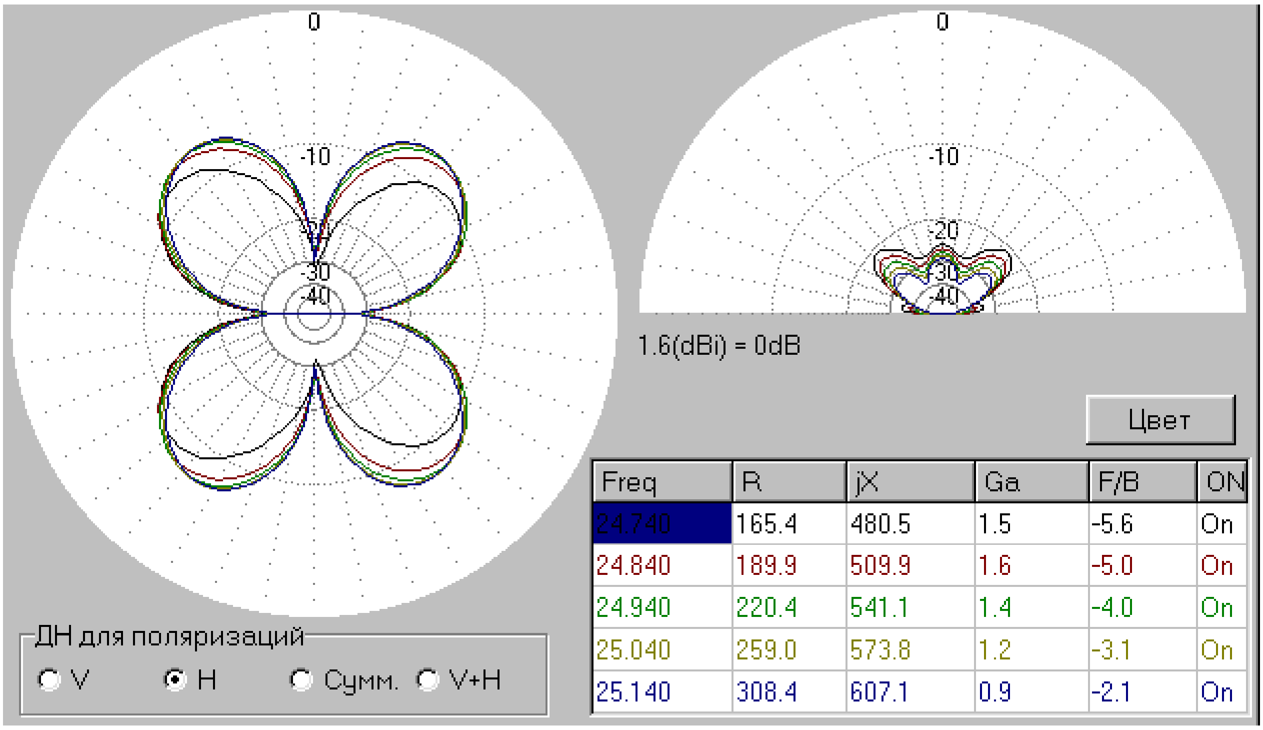
Shunt Vertical Universal HF Antenna at 12-m

Vertical Radiation Pattern



Freq	R	jX	Ga	F/B	ON
24.740	165.4	480.5	1.5	-5.6	On
24.840	189.9	509.9	1.6	-5.0	On
24.940	220.4	541.1	1.4	-4.0	On
25.040	259.0	573.8	1.2	-3.1	On
25.140	308.4	607.1	0.9	-2.1	On

Horizon Radiation Pattern



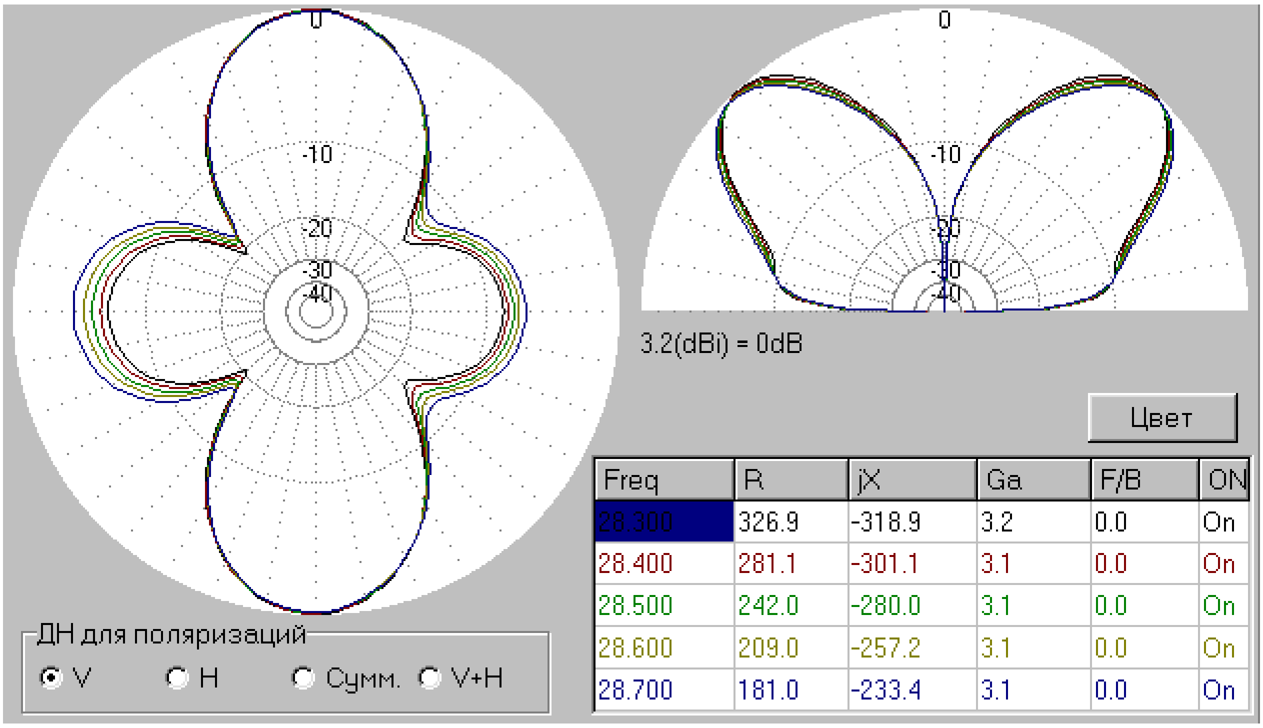
Freq	R	jX	Ga	F/B	ON
24.740	165.4	480.5	1.5	-5.6	On
24.840	189.9	509.9	1.6	-5.0	On
24.940	220.4	541.1	1.4	-4.0	On
25.040	259.0	573.8	1.2	-3.1	On
25.140	308.4	607.1	0.9	-2.1	On

Comments: Antenna has strong vertical radiation. A good pattern in the vertical plane. Antenna has almost circular pattern in horizontal plane. Antenna provides DX QSOs. Antenna has Z= 259- j573-Ohms at 25040-kHz. Not all ATUs do good matching for such load.

RUSSIAN DISTRICTS AWARD PROGRAM

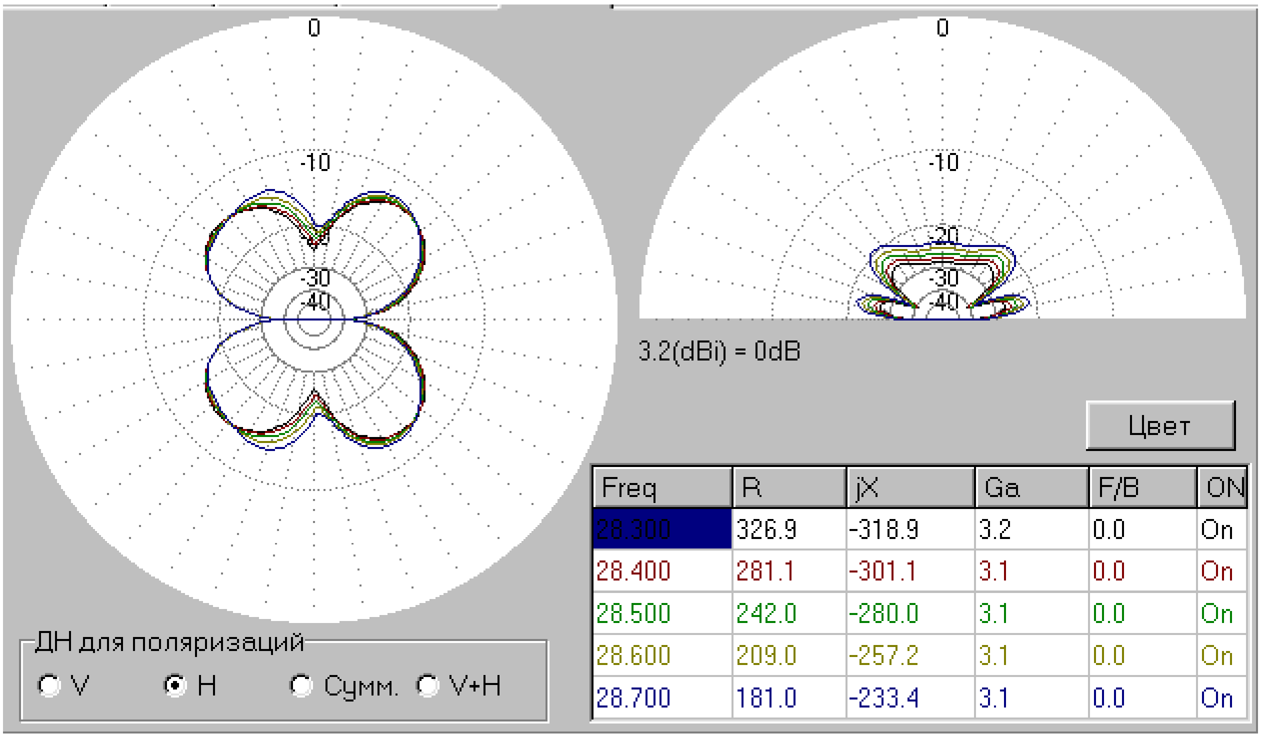
Shunt Vertical Universal HF Antenna at 10-m

Vertical Radiation Pattern



Freq	R	jX	Ga	F/B	ON
28.300	326.9	-318.9	3.2	0.0	On
28.400	281.1	-301.1	3.1	0.0	On
28.500	242.0	-280.0	3.1	0.0	On
28.600	209.0	-257.2	3.1	0.0	On
28.700	181.0	-233.4	3.1	0.0	On

Horizon Radiation Pattern

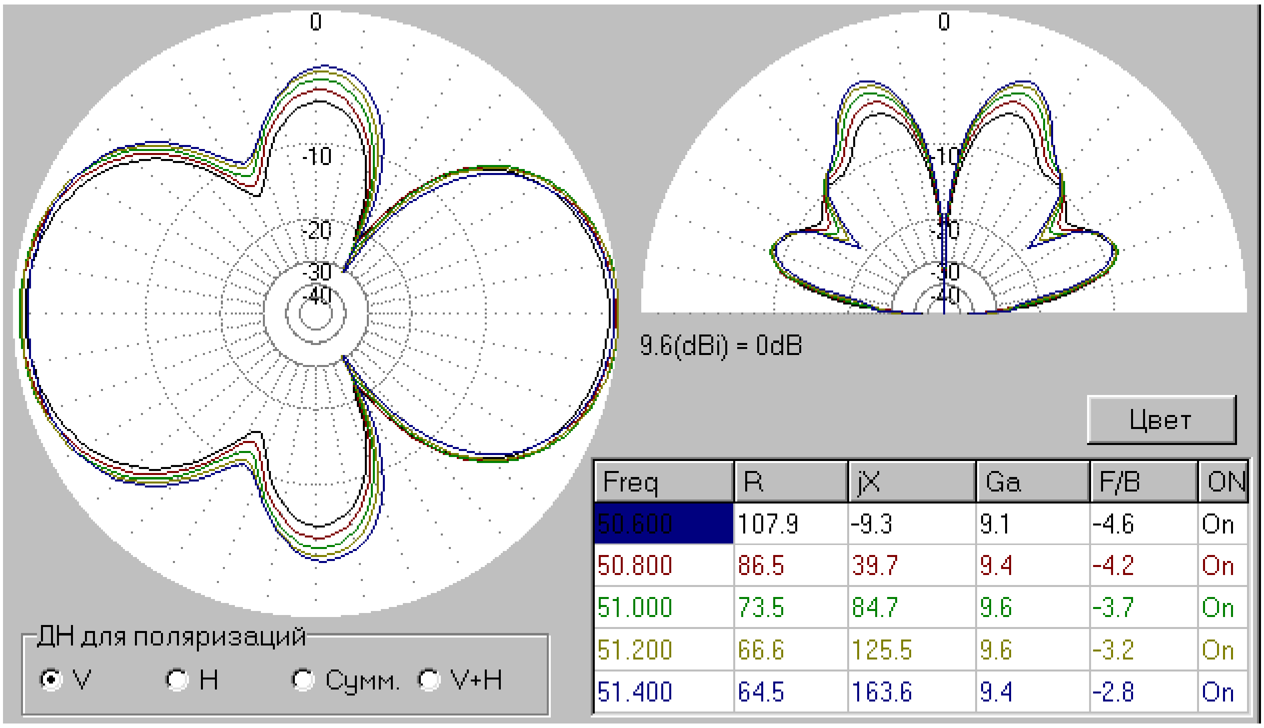


Freq	R	jX	Ga	F/B	ON
28.300	326.9	-318.9	3.2	0.0	On
28.400	281.1	-301.1	3.1	0.0	On
28.500	242.0	-280.0	3.1	0.0	On
28.600	209.0	-257.2	3.1	0.0	On
28.700	181.0	-233.4	3.1	0.0	On

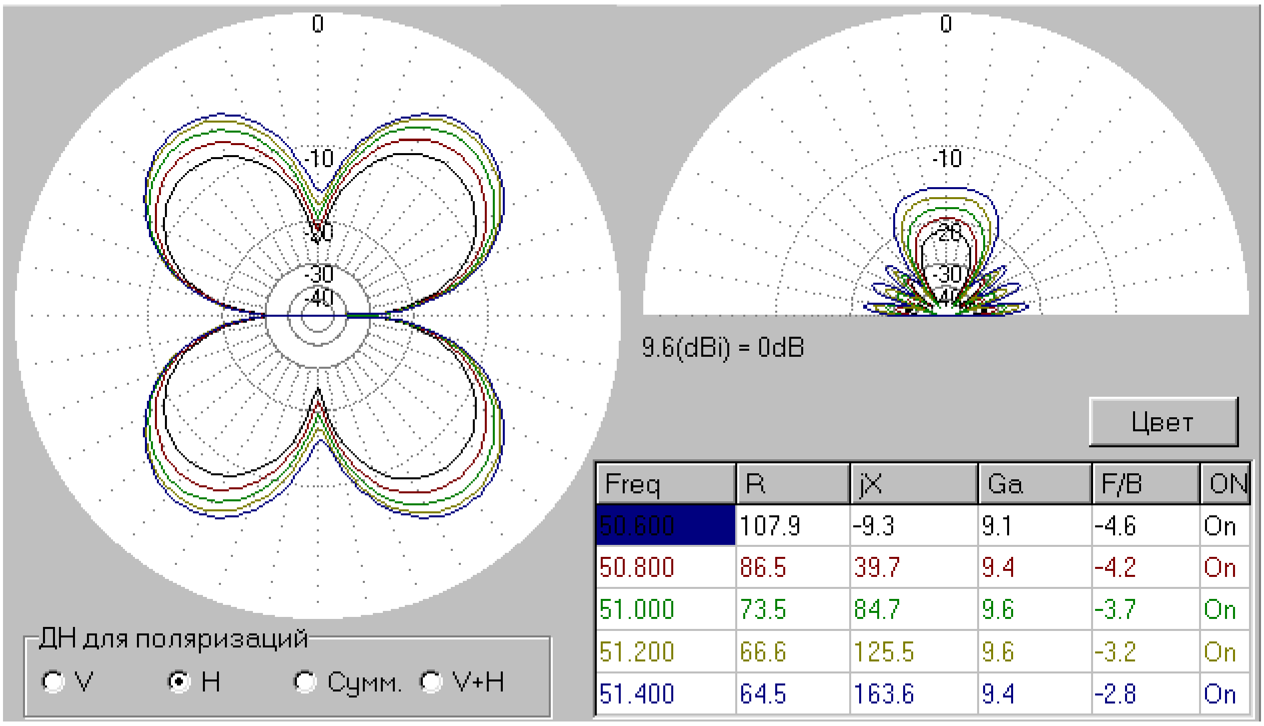
Comments: Antenna has strong vertical radiation. A not bad pattern in the vertical plane. Antenna has a four- shaped lobes pattern in horizontal plane, so, it demands to choose a proper direction before an installation of the antenna.. Antenna can provide DX QSOs. Antenna has Z= 242- j280-Ohms at 28500-kHz. Any ATU does good matching for such load.

Shunt Vertical Universal HF Antenna at 6-m

Vertical Radiation Pattern



Horizon Radiation Pattern



Comments: Antenna has strong vertical radiation. A not bad pattern in the vertical plane. Antenna has an "eight- shape" pattern in horizontal plane, so, it demands to choose a proper direction before an installation of the antenna.. Antenna can provide DX QSOs. Antenna has Z= 86+ j40-Ohms at 50800-kHz. The resonance is at the 6- meters band. Any ATU does good matching for such load.

Multirange Trap Antennas

Multirange trap antenna: history and fundamentals

Igor Grigorov, Rk3ZK
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Recently multirange trap antennas are widespread among radioamateurs. As matter of fact, the type of antennas was invented in the USA by H. K. Morgan, US patent # 2229856, 1938 (by reference **[1]**). Probably the first article about a trap antenna was published in reference **[2]** at 1940. So, what is the antenna and how is it work? Let's see it on the example of a ham vertical trap antenna in order to simplify a problem. **Figure 1** shows us a schematic of such antenna.

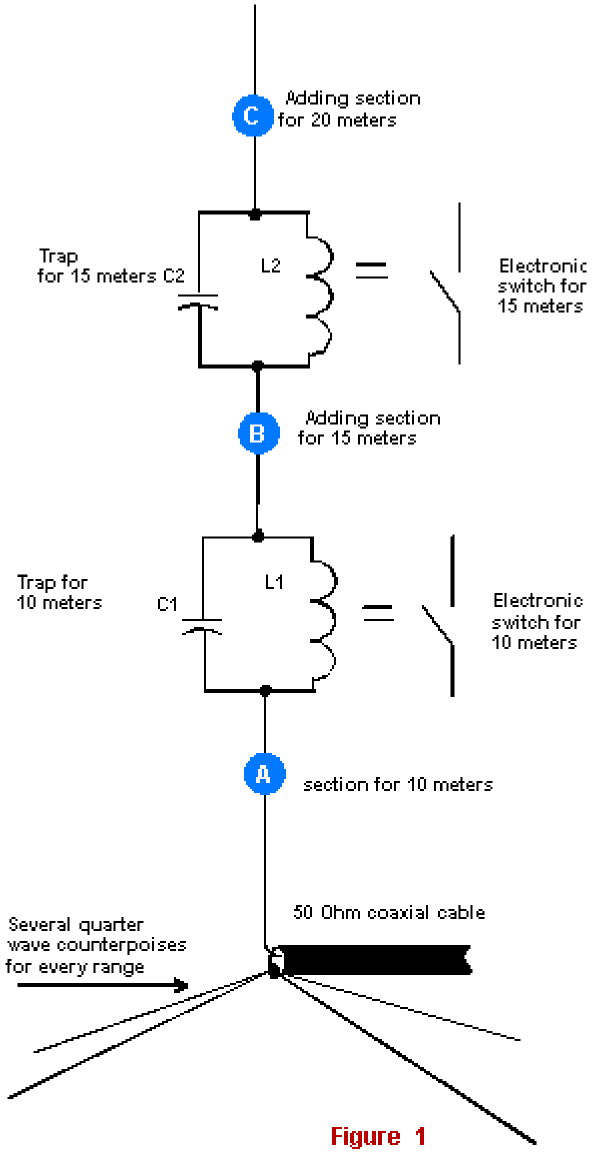


Figure 1 A ham vertical trap antenna

10 meters: Section A is tuned for operation on 10-meters by its length. Trap L1C1 turn off upper antenna parts behind the trap from operation of the antenna when 10 meters range is used.

15 meters: By length of the Section B we tune the antenna parts "Section 1 plus L1C1 plus Section B" to resonance to 15-meters. Trap L2C2 turn off upper antenna parts behind the trap from operation of the antenna when 15 meters range is used.

20 meters: By length of the Section C we tune the antenna parts "Section 1 plus L1C1 plus Section B plus Section C" to resonance to 20-meters.

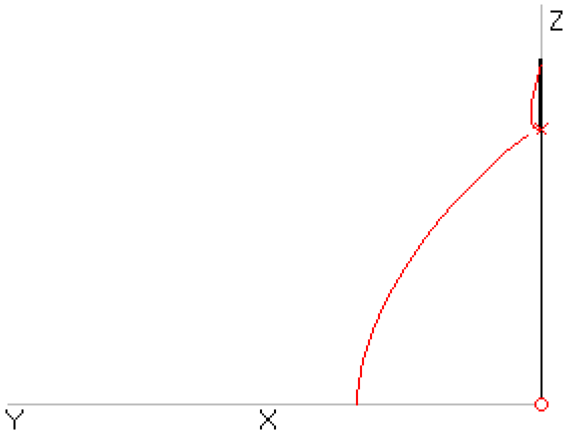
And so on for other ranges: In the similar way the antenna would be tuned for others ham HF- ranges. You see, it is possible to do an antenna for any number of HF- ranges! But there are several lacks. Upper parts of the antenna behind a proper trap do not use (or, practically do not use) for radiation. Another lack is that the antenna wire is broken at several places by trap circuits. Every trap circuits should be tune in to own resonance frequency. Trap circuits must have high temperature stability, because the antenna is used at the open air. Traps work at a resonance mode so a high level of RF voltage is across trap capacitors at transmission mode. Thereof it needs to use a high quality capacitor for every of the traps.

Vertical trap antenna WA1LNQ: One of the most popular sample vertical trap antenna is the antenna WA1LNQ **[2]**. The antenna is used on 10 and 15 meters. **Figure 2** shows the scheme for the antenna.

The antenna made from two insulated from each other metal tubes by length of 240,7 (section A) and 62,9 (section B) centimeters and in OD 18 to 25 millimeters. The length of an insulating insertion is 5,8 centimeters. Over the insulating part is spooled the trap spool. A copper tube in diameter of 3 to 5 mm is used for the spool, and the spool contains 2 turns with step 1 turn on 25-mm of winding. Average diameter of the trap spool is 55-mm. As a trap capacitor is used a length of a 50-Ohm coaxial cable with an initial length equal to 80 centimeters.

Tuning of the Antenna WA1LNQ: At first, tune the antenna in 10-m range. At the tuning the length of the coaxial cable, that makes the trap capacitor, is gradually shortened to minimum SWR in 10 meters. After this, tune the antenna to minimum SWR at 15 meters. It is possible to do by a small changing of the length of the upper section B.

Below you can see input impedance, SWR and DD of the antenna W1LNQ. The figures are obtained with the help of Free Antenna Simulation Program



Current Distribution at 10 meters

Current Distribution at 15 meters

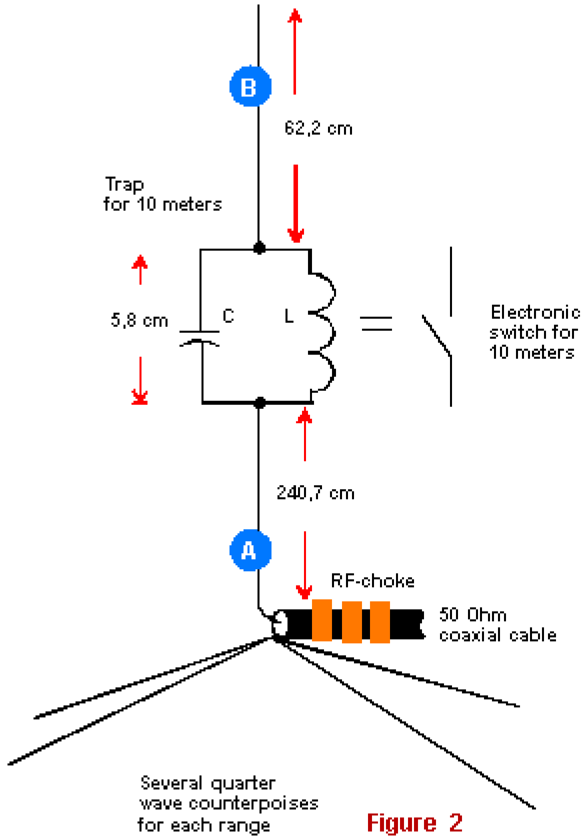
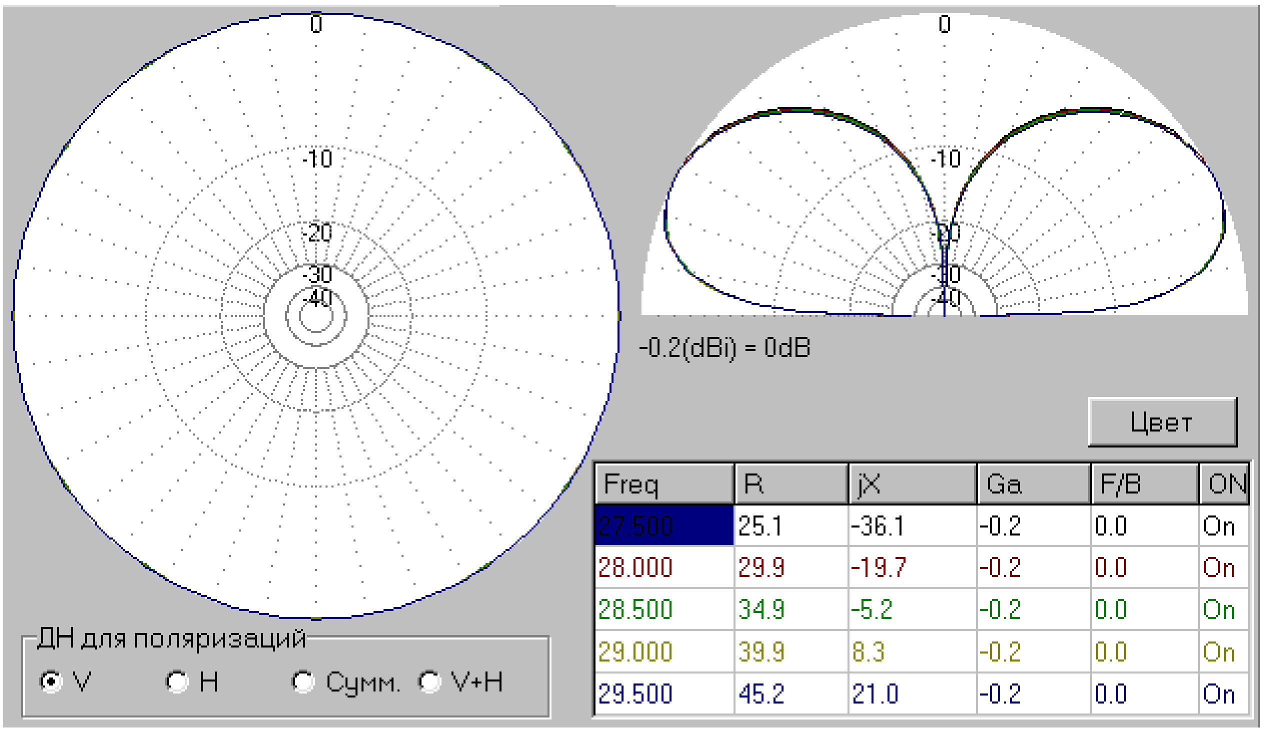


Figure 2 Antenna WA1LNQ

Diagram Directivity and Input Impedance at 10 meters W1LNQ Antenna



Freq	R	jX	Ga	F/B	ON
27.500	25.1	-36.1	-0.2	0.0	On
28.000	29.9	-19.7	-0.2	0.0	On
28.500	34.9	-5.2	-0.2	0.0	On
29.000	39.9	8.3	-0.2	0.0	On
29.500	45.2	21.0	-0.2	0.0	On

MMANA (MININEC based). Section A has diameter of 24 millimeters, section B has diameter of 18 millimeters.

Antenna input impedance. Vertical Trap antenna: You can see that only first antenna part, it is section A at **Figure 1**, has length in λ/4. So, the input

SWR at 10 meters W1LNQ Antenna

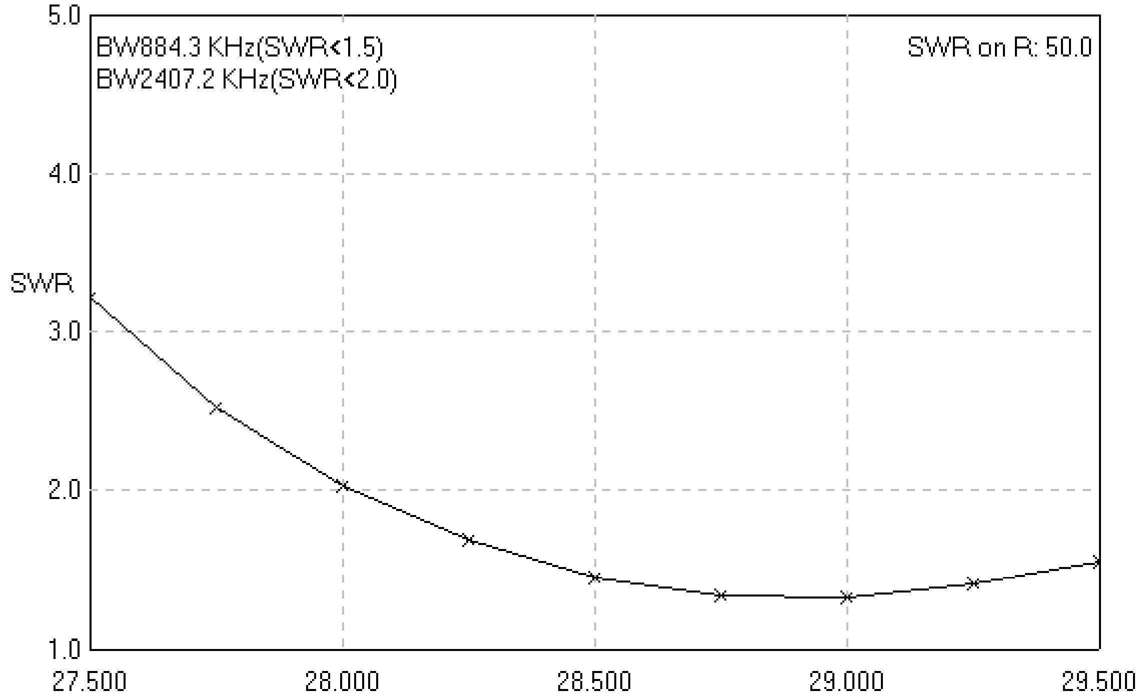
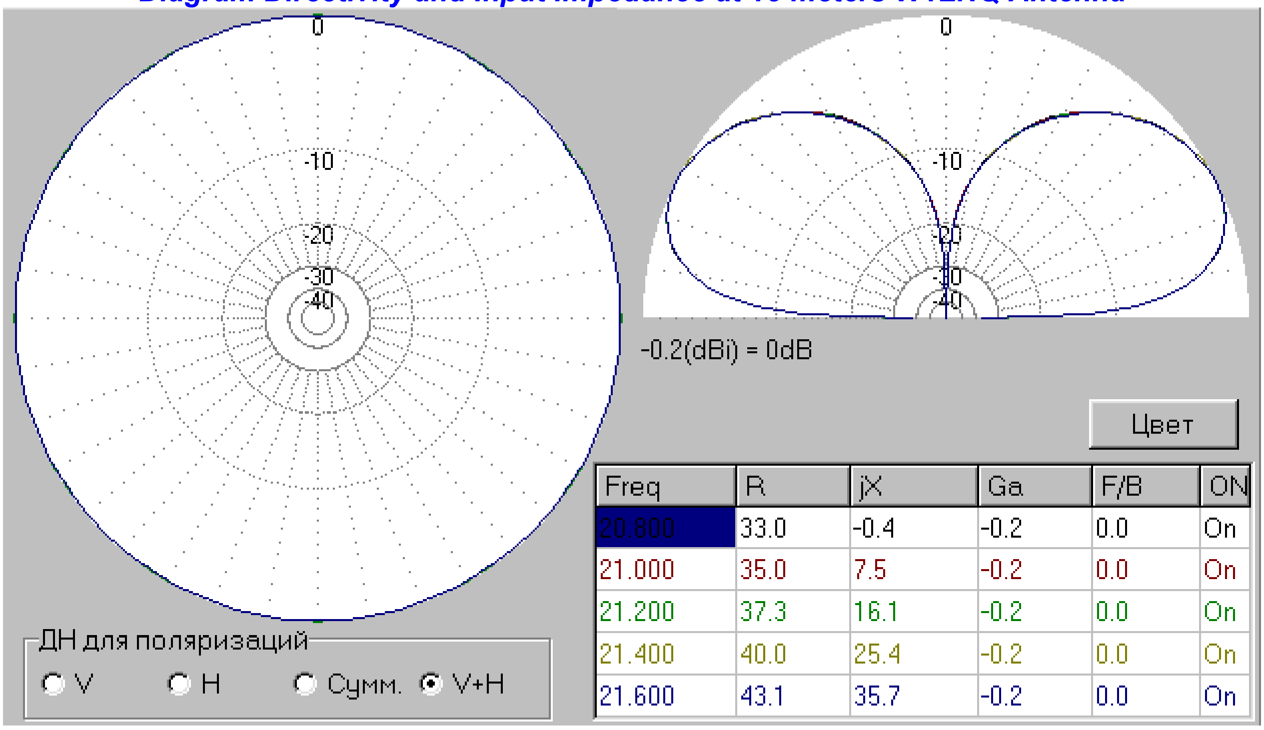
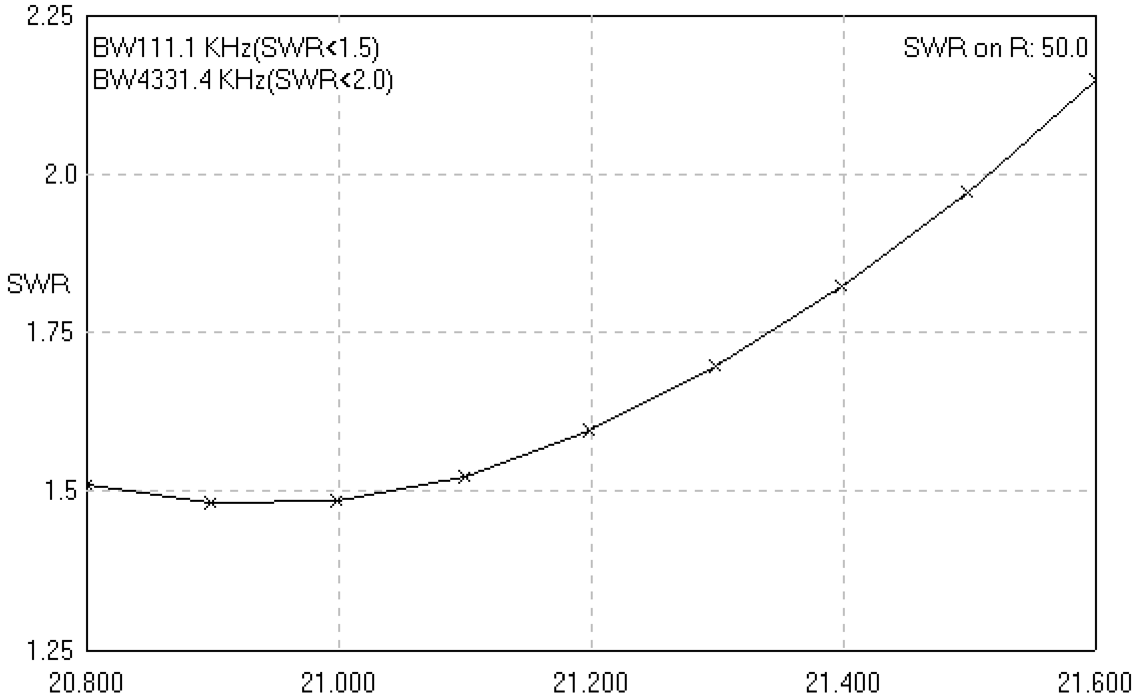


Diagram Directivity and Input Impedance at 15 meters W1LNQ Antenna



impedance of the antenna at 10 meters is close to 40-Ohms, and50-Ohms coaxial cable can be used for feeding of the antenna at the range. However, physical length of antenna consisting of another following section plus the previously section (or sections) is less then λ/4. Inductors of the traps work as a lengthening spools for the proper section. Input impedance of the antenna working at lower then 10 meters range is less then 30 Ohms in the theory, but in practice, the input impedance for 15 and 20 meters range is close to 40 Ohms because losses in antenna parts and antenna ground. So, a 50-Ohms coaxial cable can be used for feeding of the antenna at all of the ranges. For a proper work a vertical trap antenna must have several counterpoises for every of operation ranges, especially for low amateur HF ranges 40-, 80- and 160-m.

Antenna input impedance. Dipole Trap antenna: Morgan trap antenna **[1]** was done as a dipole. It is known, that a λ/2 (physical length) dipole antenna has input impedance close to 75 Ohms, see **Figure 3A**. A shortened by a lengthening spool dipole



antenna with electrical length in λ/2 (having physical length bit less then λ/2) has input impedance less them 75 Ohms and maybe, close to 60- 50-Ohms, see **Figure 3B**. So, for feeding a dipole trap antenna a 50-Ohms coaxial cable can be used with a high efficiency.

A dipole trap antenna is very easy for tuning and has high efficiency, however, radio amateurs very seldom make as a vertical as dipole trap antenna having a number of traps more than one. The reason is that the antenna sections should be electrically insulated from each other. It is hard enough to do a mechanical strength design of such antenna in radio amateur conditions. Radio amateurs usually prefer a W3DZZ antenna. The antenna has only one trap, and, as it seems by many hams, works at several amateur ranges. What is a W3DZZ?

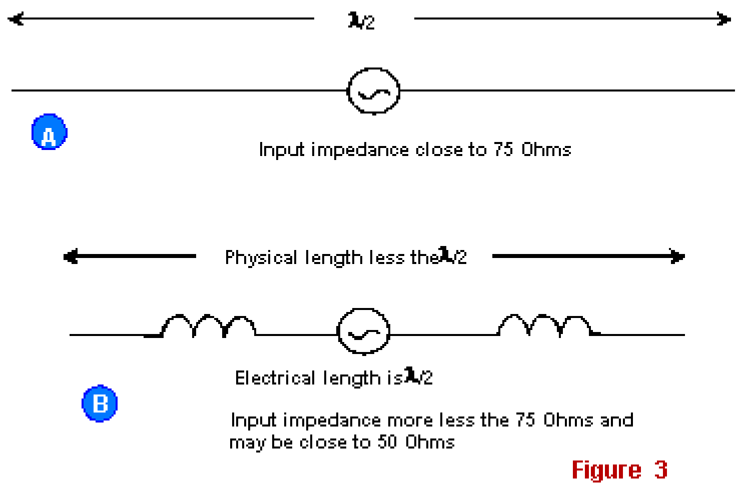


***Figure 3** A shortening and full size dipole antenna*

Antenna W3DZZ: In1955 C. L. Buchanan. W3DZZ, developed a multirange dipole antenna with only one trap, see reference **[4]**. Recently the antenna is known as "antenna W3DZZ." **Figure 4** shows schematic of the antenna W3DZZ.

Antenna W3DZZ works in several amateurs range with low SWR in its feeder. Proper choosing data of the trap turns the trap or to lengthening inductor at low range (ranges) or to shortening capacitor at high range (ranges), or to only a trap at a proper range. For the antenna shown at **Figure 4**, trap LC is the trap for 40

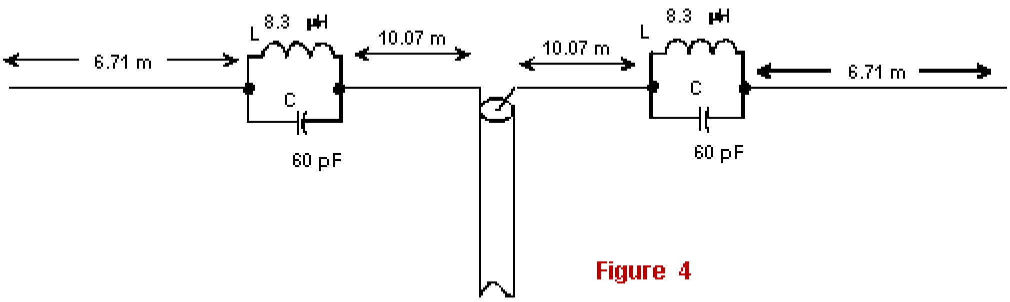
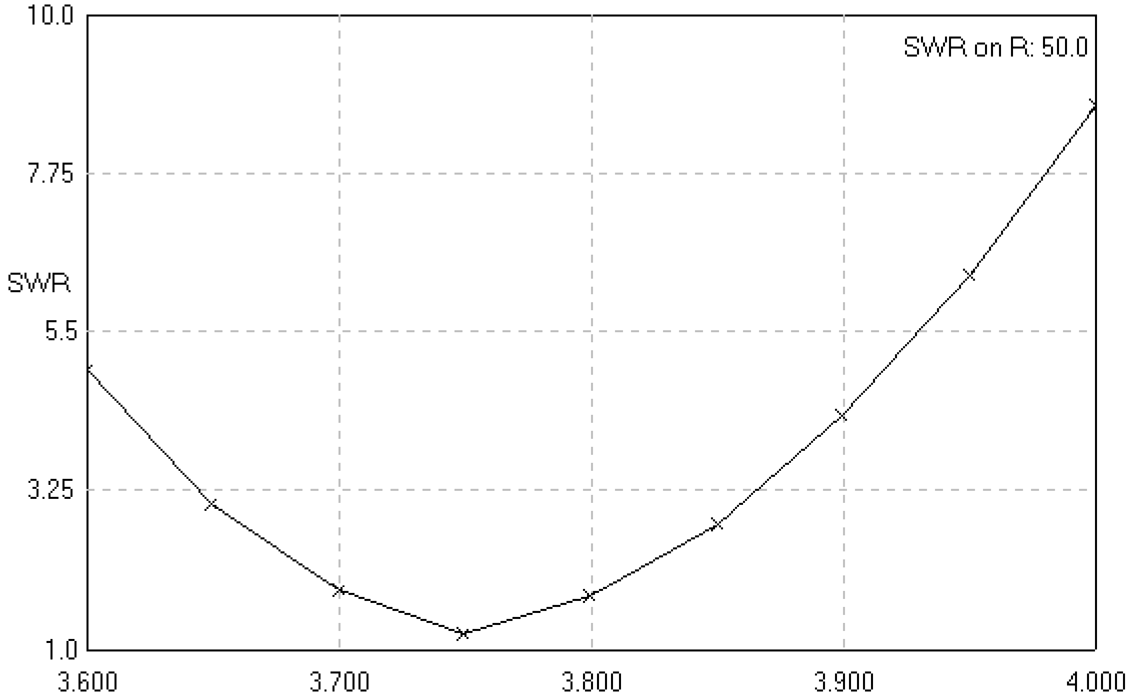
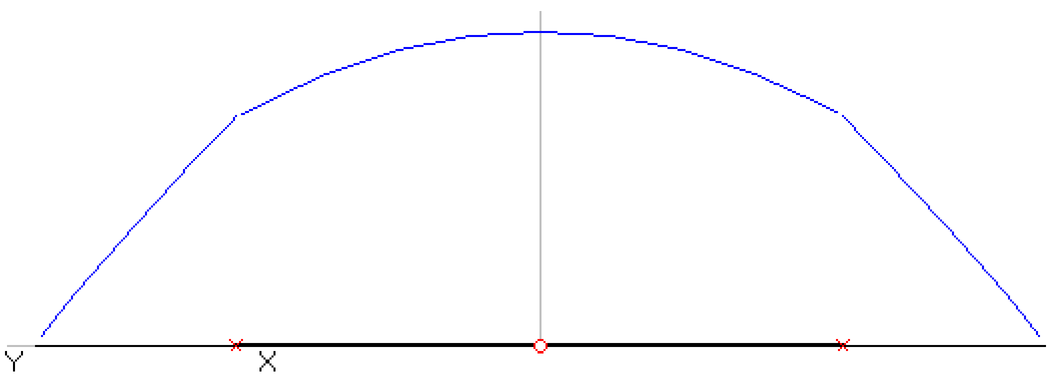


Figure 4 *Antenna W3DZZ*

meters, lengthening inductor for 80 meters, and shortening capacitor for 20, 15 and 10 meters. The antenna (**Figure 4)** does not work at WARC bands. However, the antenna does not work properly at 20, 15 and 10 meters. You can see data obtained with ***Free Antenna Simulation Program MMANA*** ***(MININEC based)*** for the W3DZZ (see **Figure 4**). Antenna wire has diameter of 2 millimeters. You can see, that a SWR at 20, 15 and 10 meters is too high. It is impossible to find such length of the antenna and data for trap that the antenna works at all of the ranges! So, an ATU and a good coax is need for the antenna if you work at 20, 15 and 10 meters.

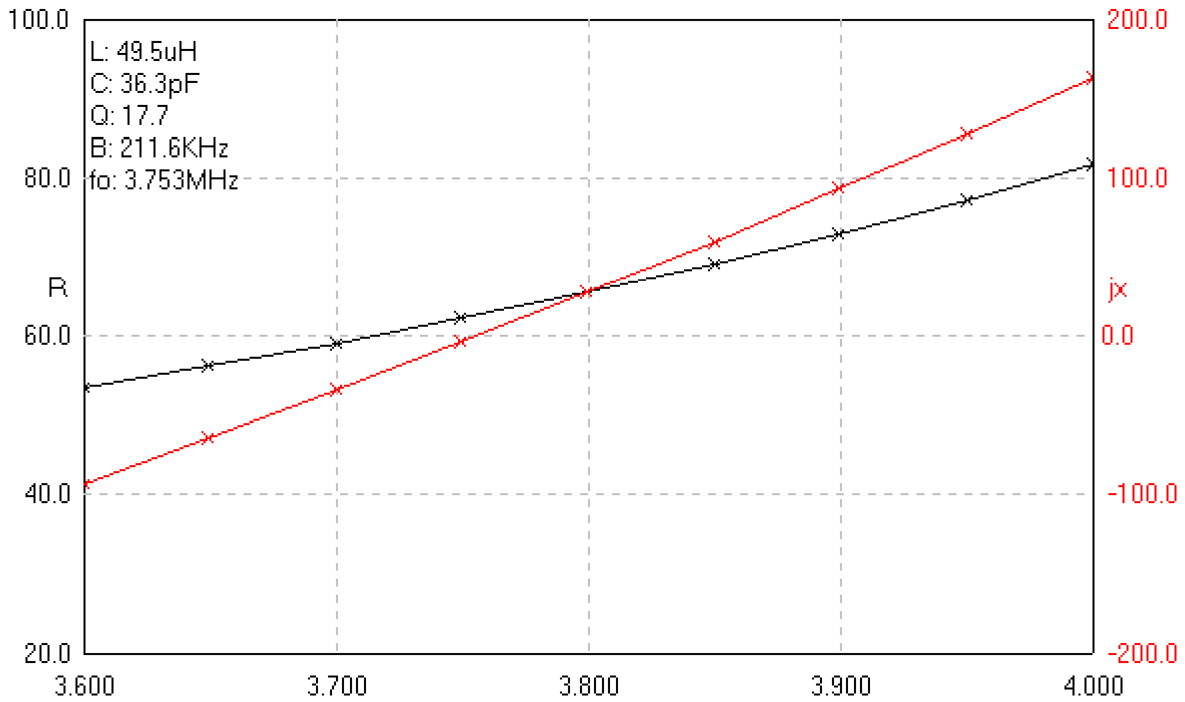
SWR at 80 meters W3DZZ Antenna



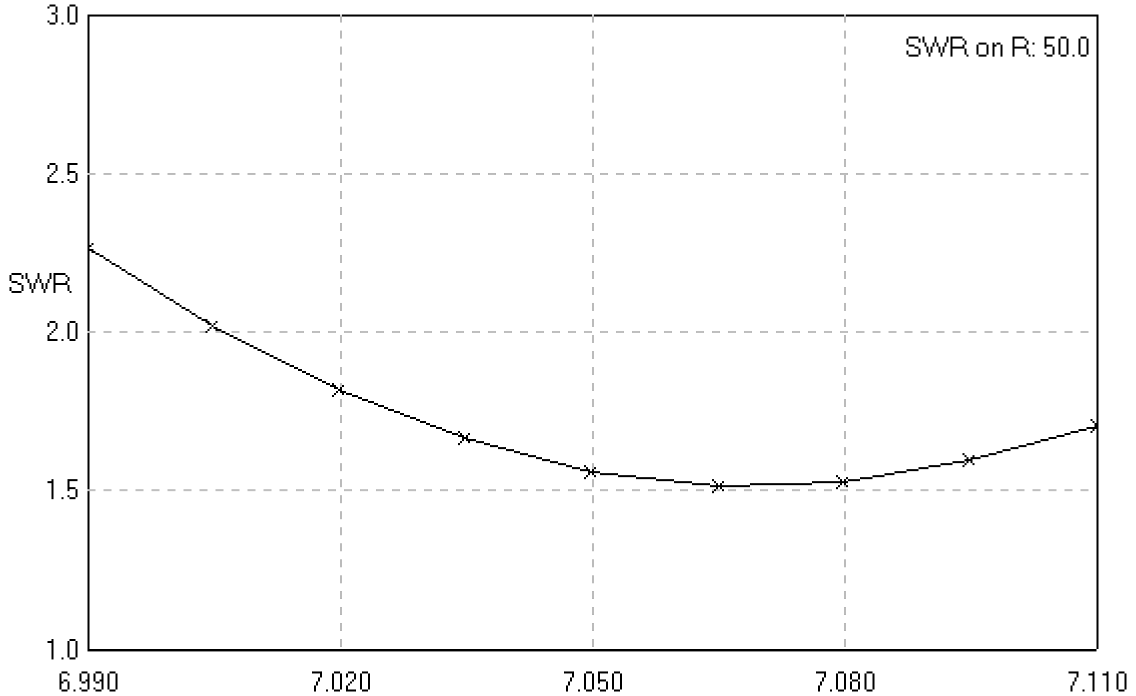


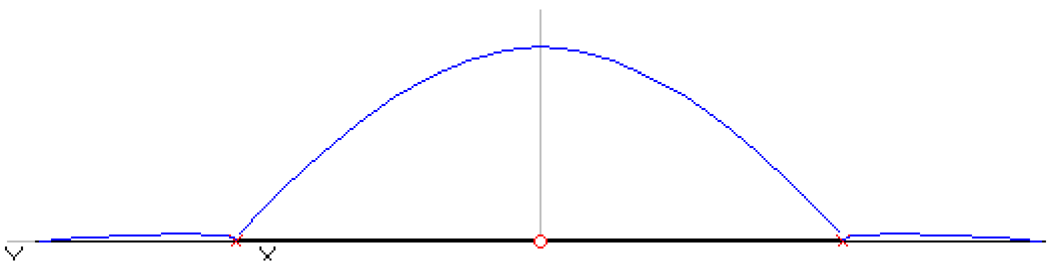
Current Distribution at 80 meters W3DZZ Antenna

Input Impedance at 80 meters W3DZZ Antenna



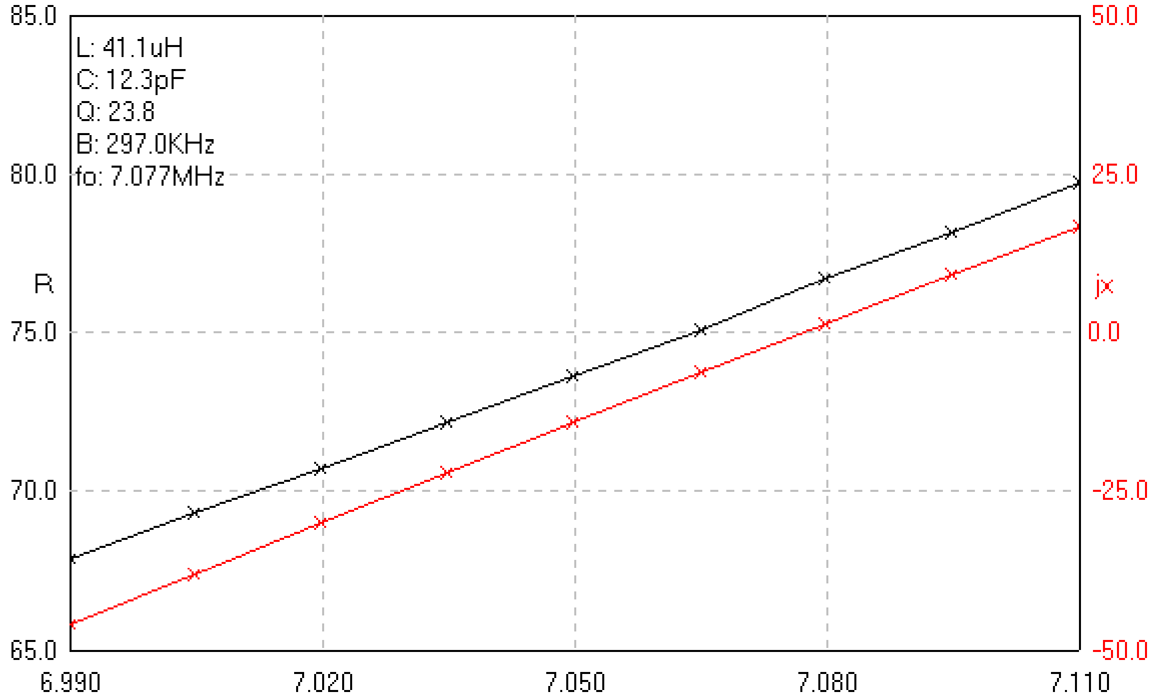
SWR at 40 meters W3DZZ Antenna



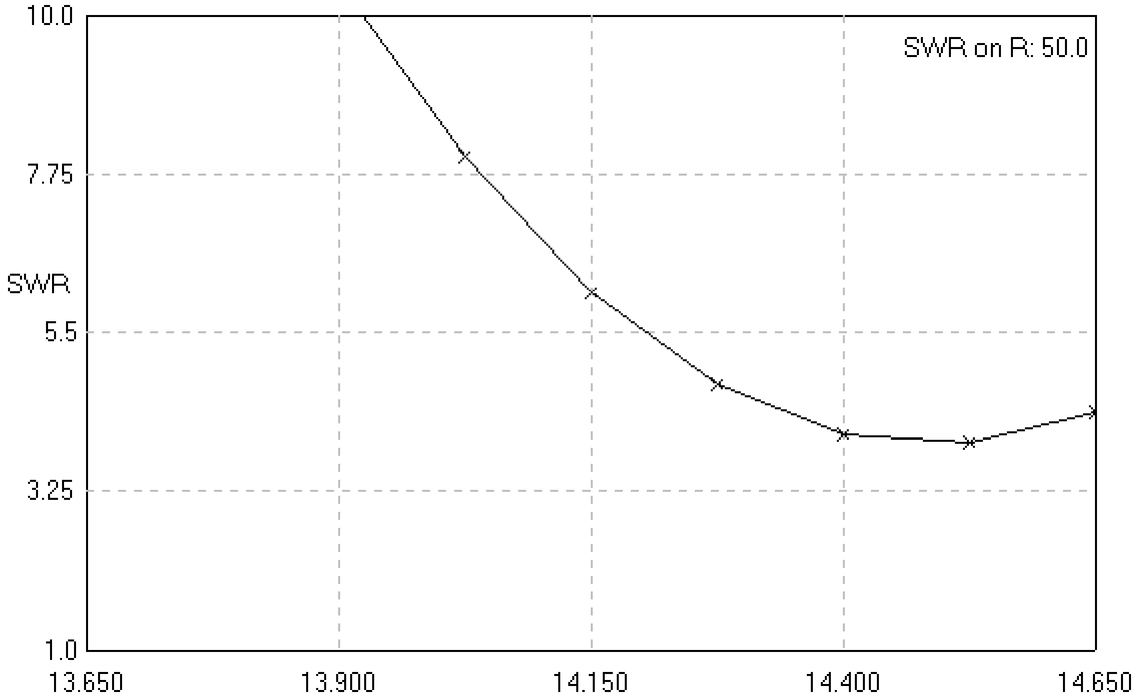


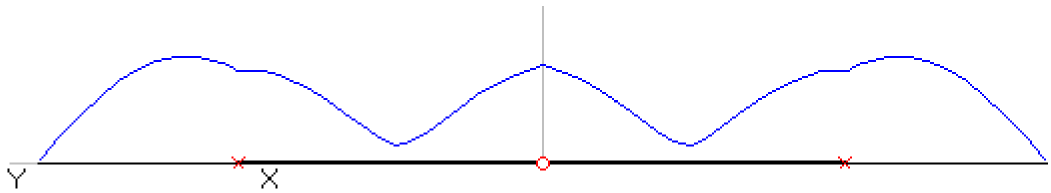
Current Distribution at 40 meters W3DZZ Antenna

Input Impedance at 40 meters W3DZZ Antenna



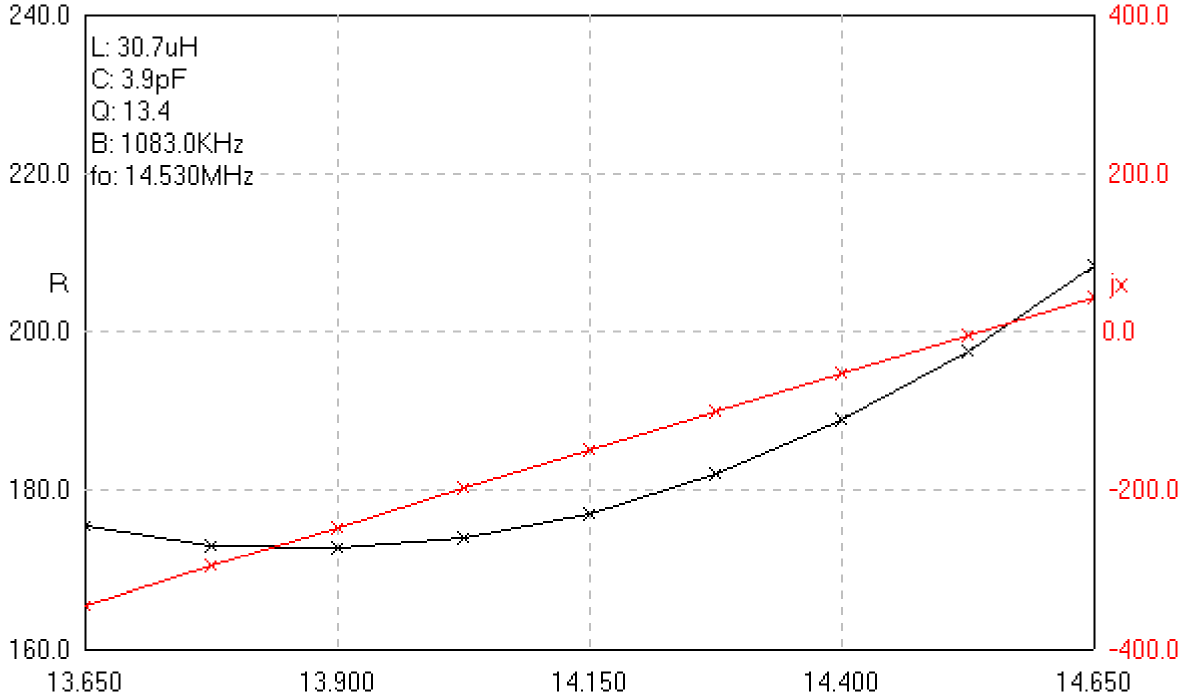
SWR at 20 meters W3DZZ Antenna



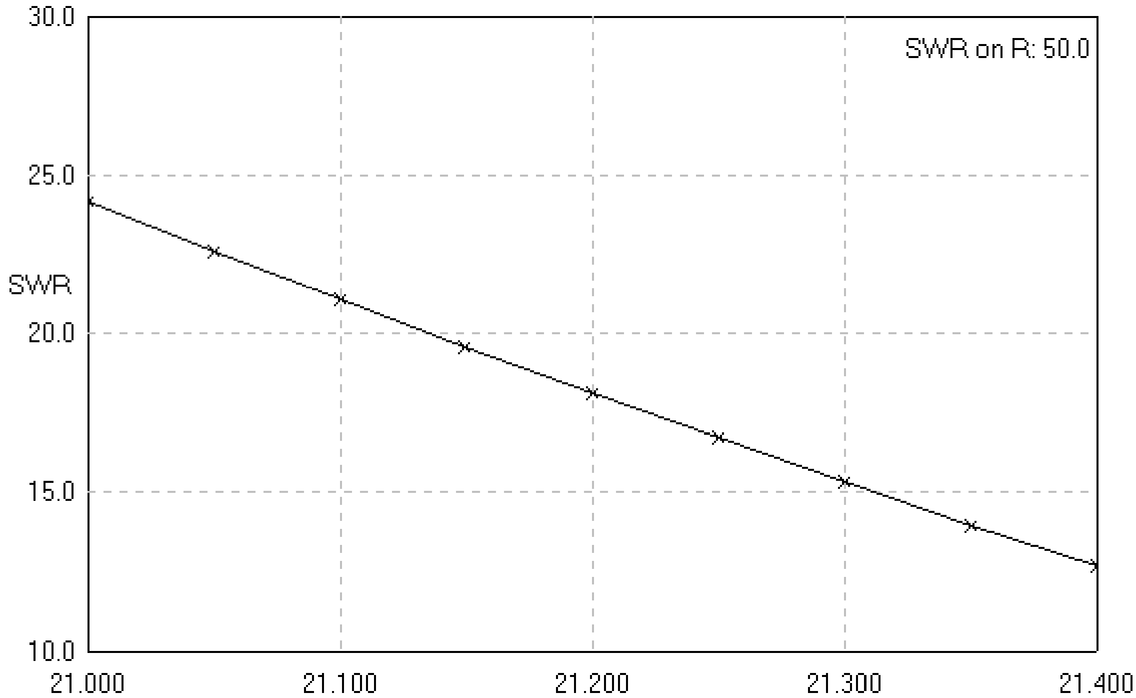


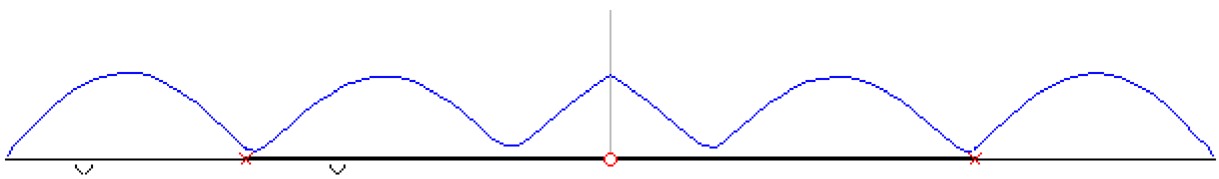
Current Distribution at 20 meters W3DZZ Antenna

Input Impedance at 20 meters W3DZZ Antenna



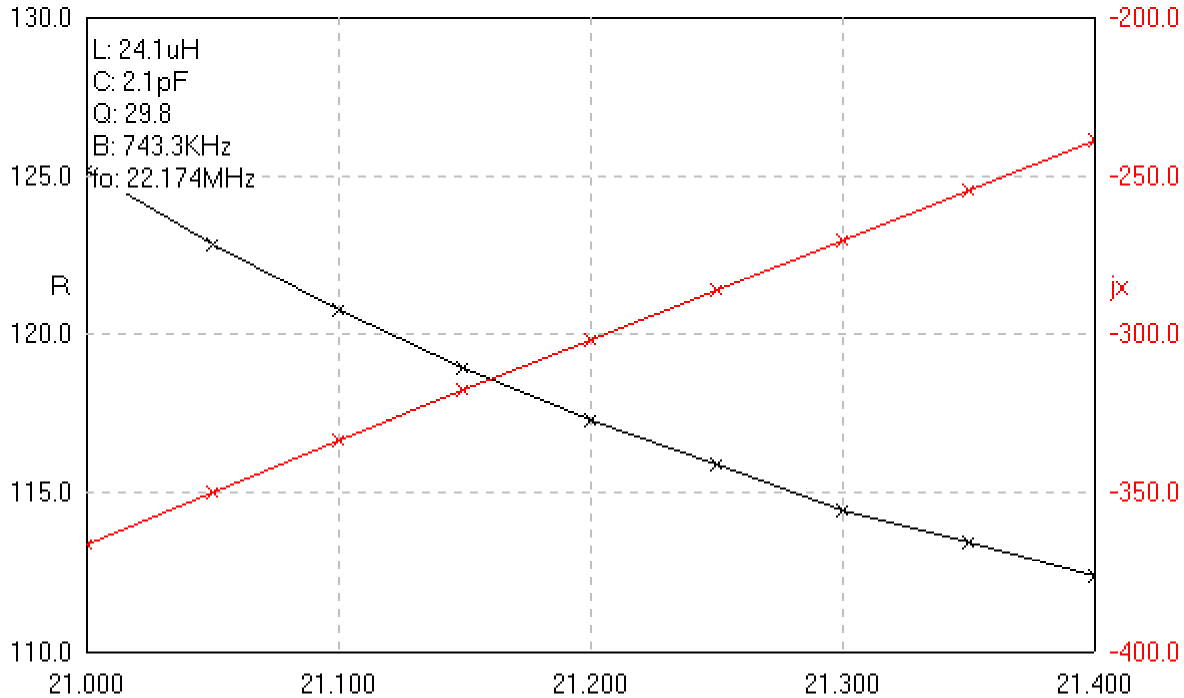
SWR at 15 meters W3DZZ Antenna



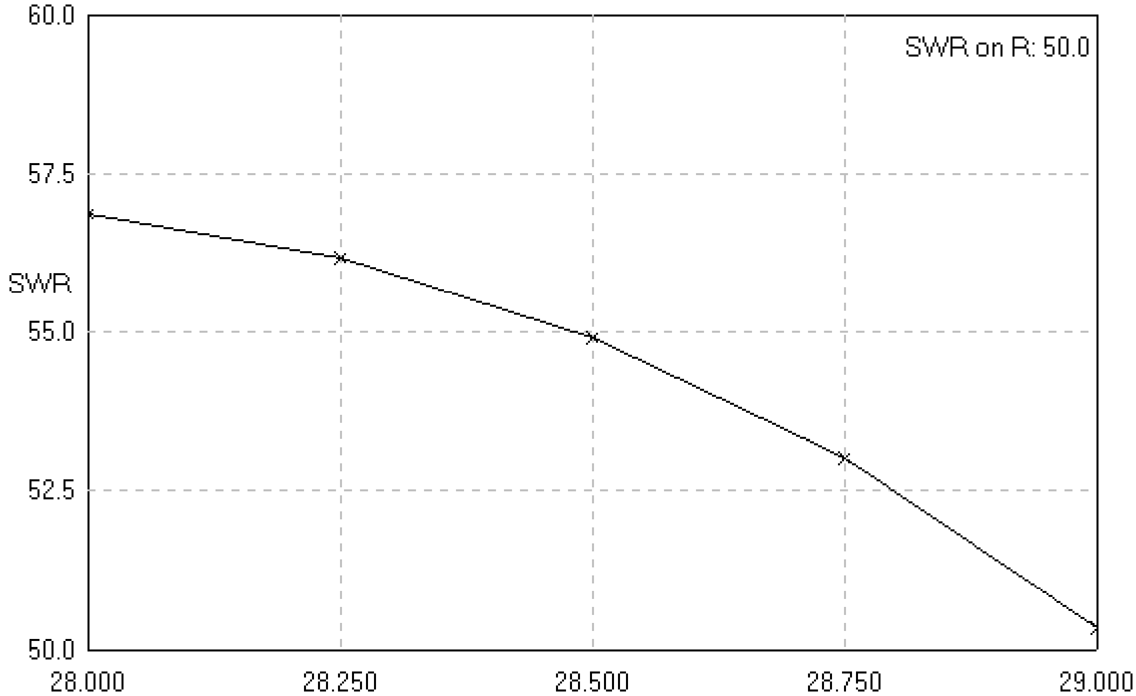


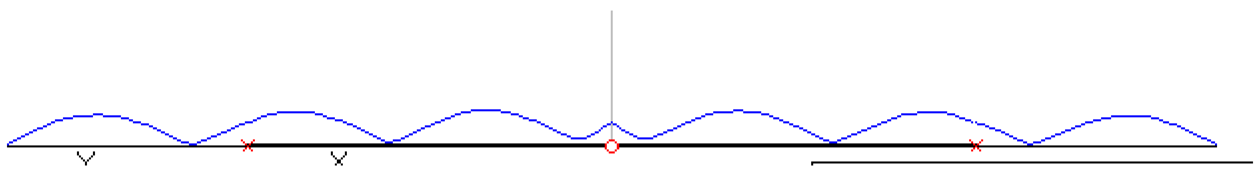
Current Distribution at 15 meters W3DZZ Antenna

Input Impedance at 15 meters W3DZZ Antenna

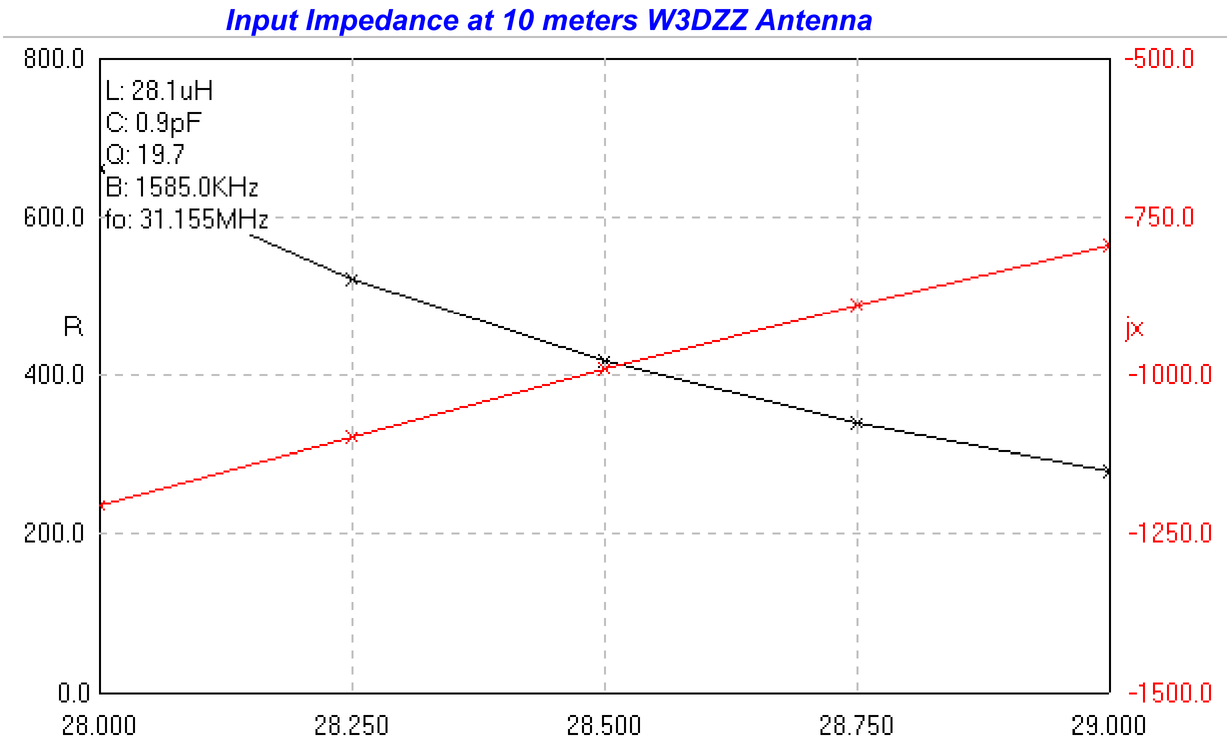


SWR at 15 meters W3DZZ Antenna





Current Distribution at 10 meters W3DZZ Antenna



Antenna W3DZZ has input impedance close to 60 Ohms at 80 and 75 at 40, , so, a 75-Ohms coaxial cable can be used for feeding of the antenna.

Hams make antenna W3DZZ also in a vertical installation, where the antenna has input impedance close to 30- 40 Ohms (in twice less the dipole design), so a 50-Ohms coaxial cable can be used for feeding of the antenna at all of the ranges. For a proper work a vertical trap antenna must have several counterpoises for every of operation ranges, especially for low amateur HF ranges 40-, 80- and 160-m.

LC trap design: Trap spool has 8.3-μH and contains 19 turns of silvered copper wire of diameter in 3-mm. Diameter of winding is 50-mm. Length of winding is 80-mm. The trap should be tuned to resonance to the frequency 7,05 (7.2 for USA) MHz. It is possible use a GDO for the tuning. A capacitor at 3-pF is bridged to trap capacitor when the trap is tuning to the resonance. The capacitor is simulated a stray capacitance of the antenna sections.

Antenna tuning: At first, with the help of a GDO tune trap to 7,05 (7.2 for USA) MHz. Trap is tuned separately from antenna. At second, get a minimum SWR on 40 meters by length A. At third, get a minimum

SWR on 80 meters by length B. At thus, you can get SWR (well, see in the above figures, the SWR is not so at 20, 15 and 10 meters.

Four band vertical one-trap antenna:

Hams often use a shortened sample of the W3DZZ antenna intended for 40, 20, 15, and 10 meters. At radio amateurs literature there are several description of the antenna, as at dipole as at vertical installation. However, the first description, which I found off for a vertical four band trap antenna, was made by K2GU in reference **[5]**. **Figure 5** shows the schematic of the antenna.

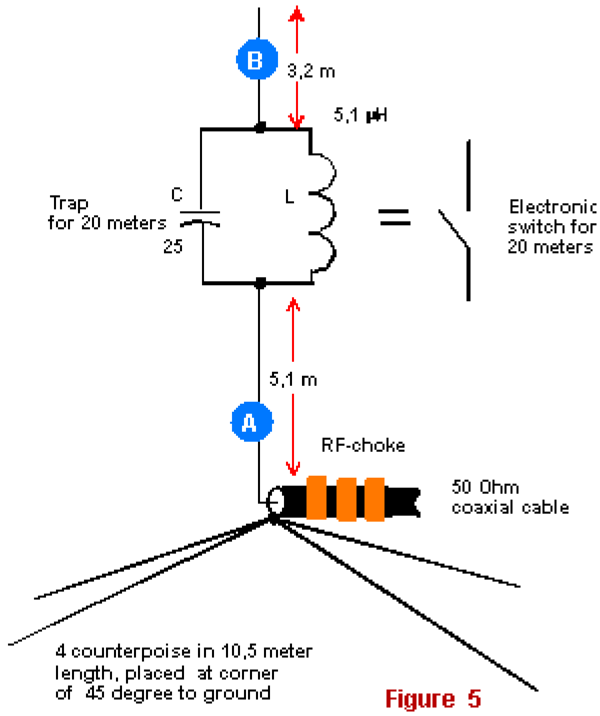


Figure 5 *A four-band trap vertical antenna*

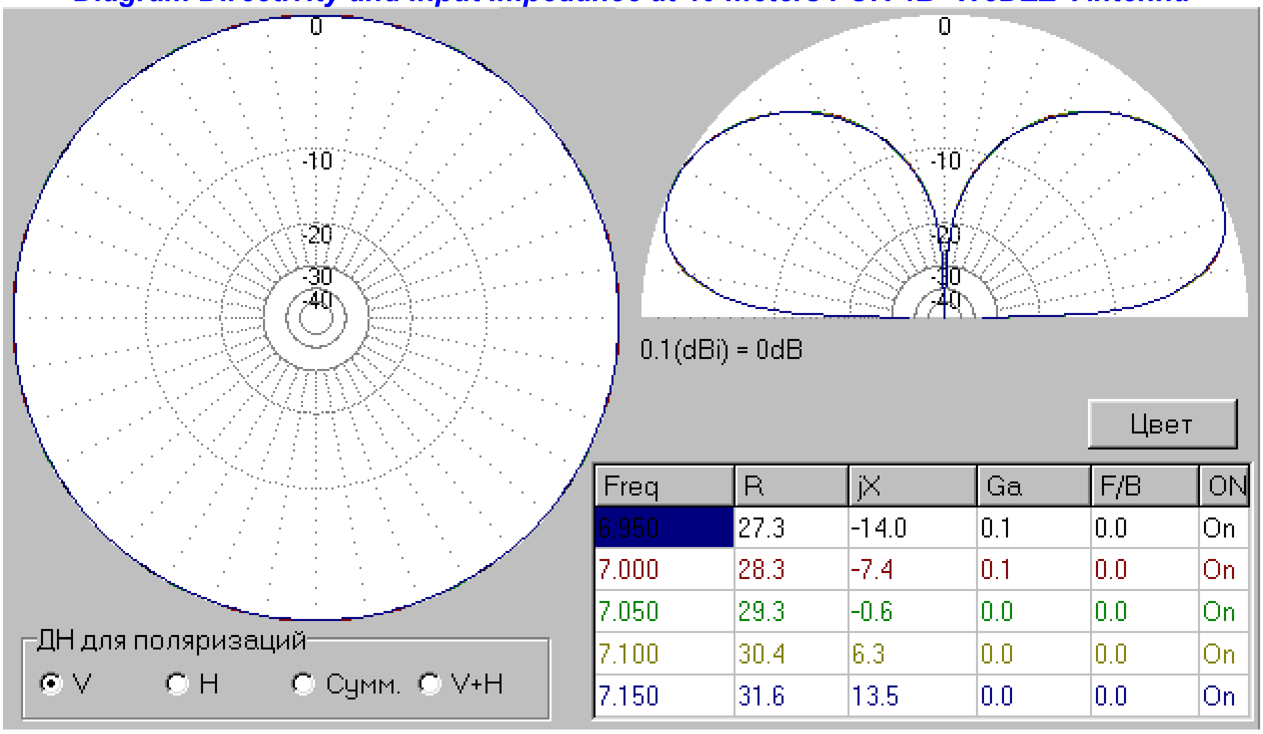
20 meters: Section A is tuned for operation on 20-meters by its length. Trap LC turn off upper antenna parts behind the trap from operation of the antenna when 10 meters range is used.

40 meters: By length of the Section B we tune the antenna parts "Section 1 plus LC plus Section B" to resonance to 40-meters.

15 and 10 meters: The trap serves as a shortening capacitor at that ranges.

Below you can see input impedance, SWR and DD of the antenna W1LNQ. The figures are obtained with the help of Free Antenna Simulation Program MMANA (MININEC based). Section A has diameter of 20 millimeters, section B has diameter of 10 millimeters. You can see, that a SWR at 15 meters is too high. It is impossible to find such length of the antenna and data for trap that the antenna works at all of the ranges. So, an ATU and a good coax is need for the antenna if you work at 15 meters. A 50-Ohm coaxial cable can be used for feeding of the antenna at all of the ranges.

Diagram Directivity and Input Impedance at 40 meters FOR 4B- W3DZZ Antenna



SWR at 40 meters FOR 4B- W3DZZ Antenna

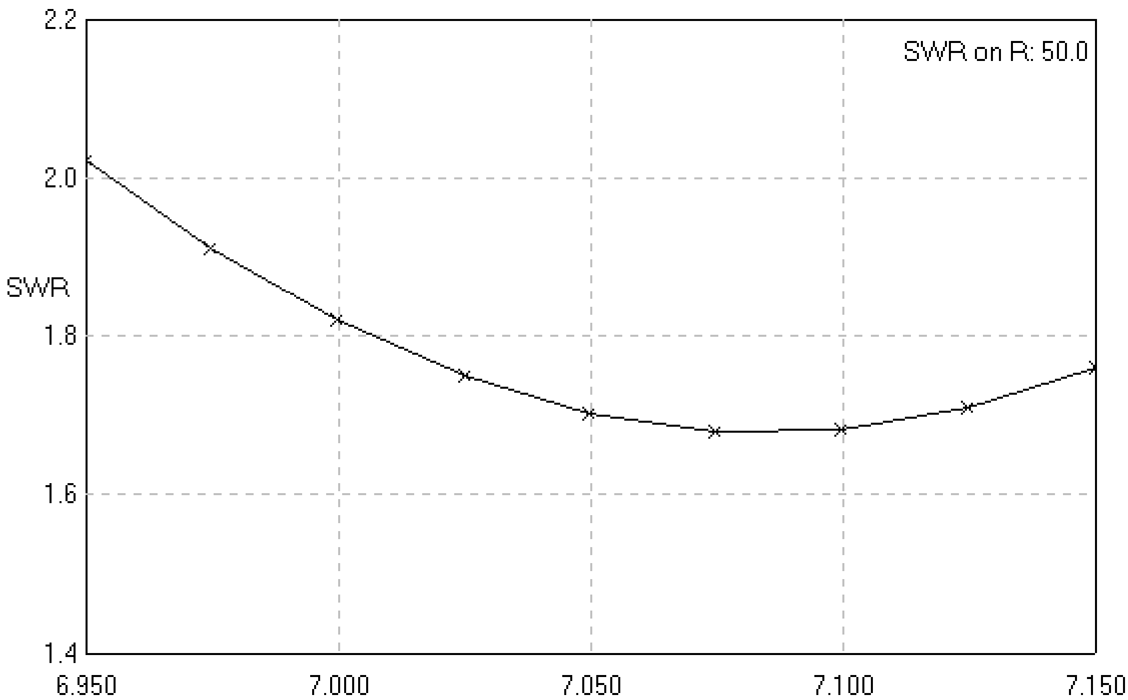
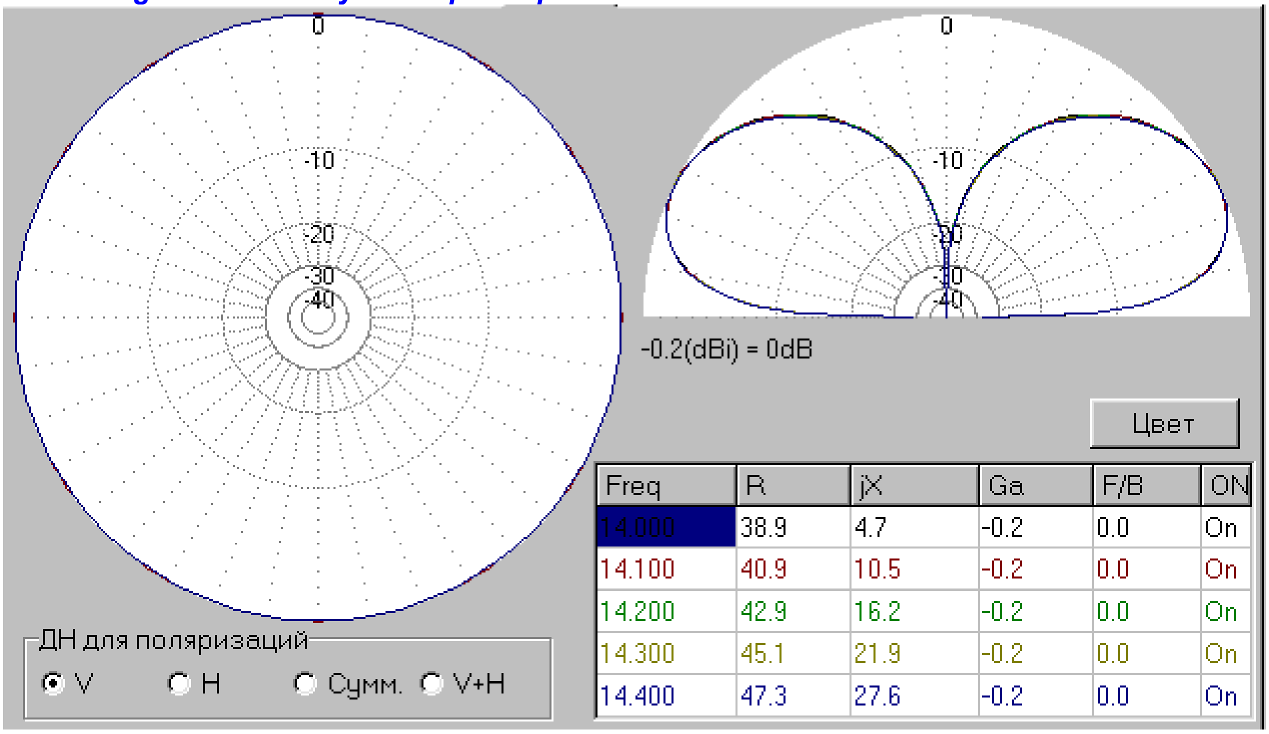
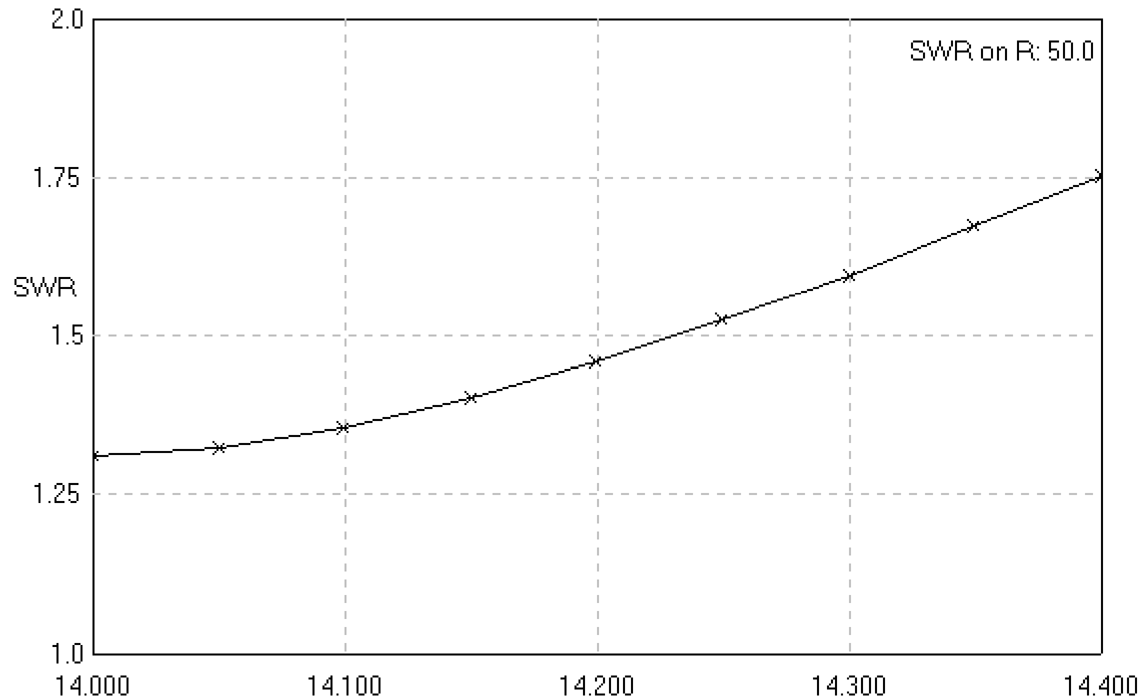


Diagram Directivity and Input Impedance at 20 meters for 4B- W3DZZ Antenna

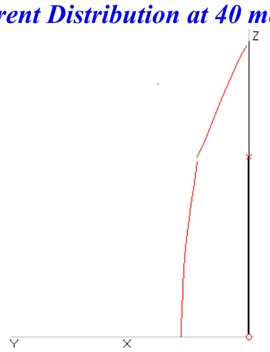


Freq	R	jX	Ga	F/B	ON
14.000	38.9	4.7	-0.2	0.0	On
14.100	40.9	10.5	-0.2	0.0	On
14.200	42.9	16.2	-0.2	0.0	On
14.300	45.1	21.9	-0.2	0.0	On
14.400	47.3	27.6	-0.2	0.0	On

SWR at 20 meters FOR 4B- W3DZZ Antenna



Current Distribution at 40 meters



Current Distribution at 20 meters

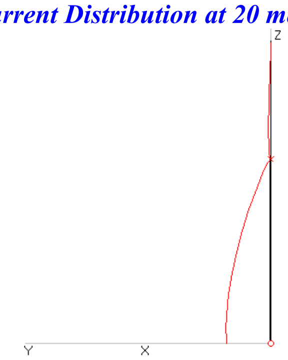
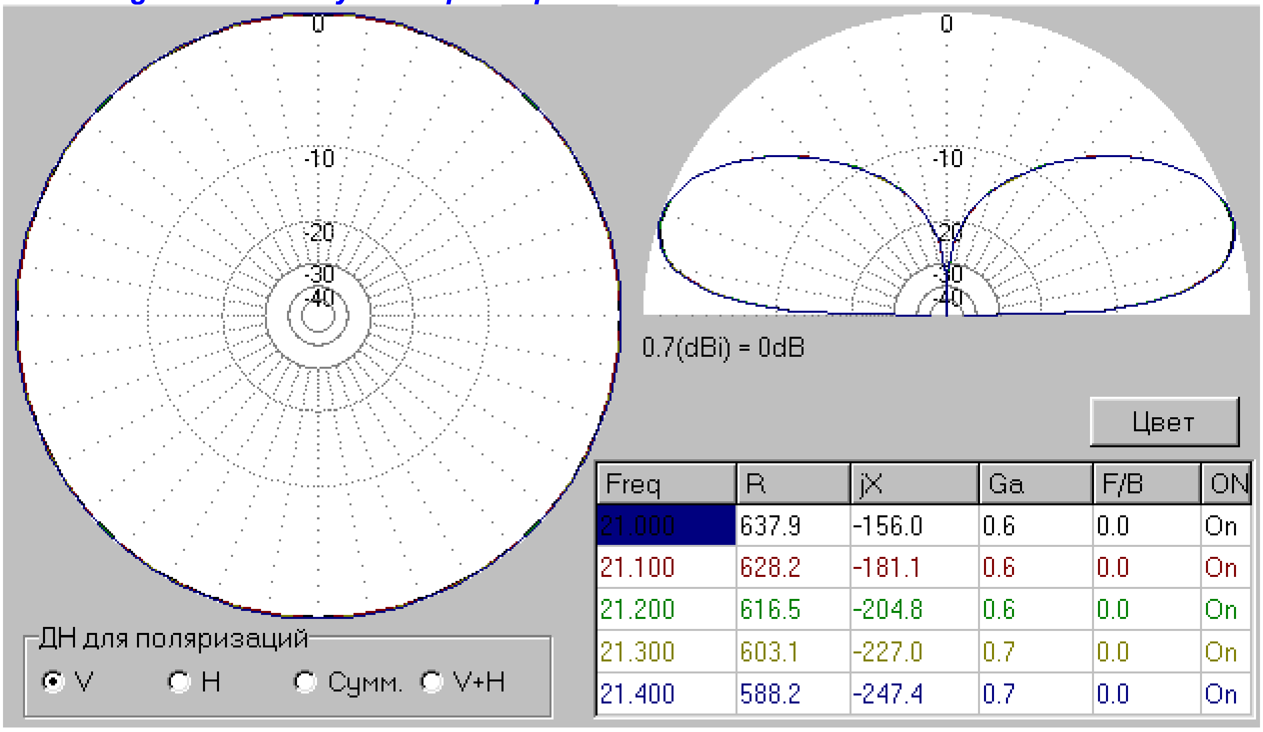
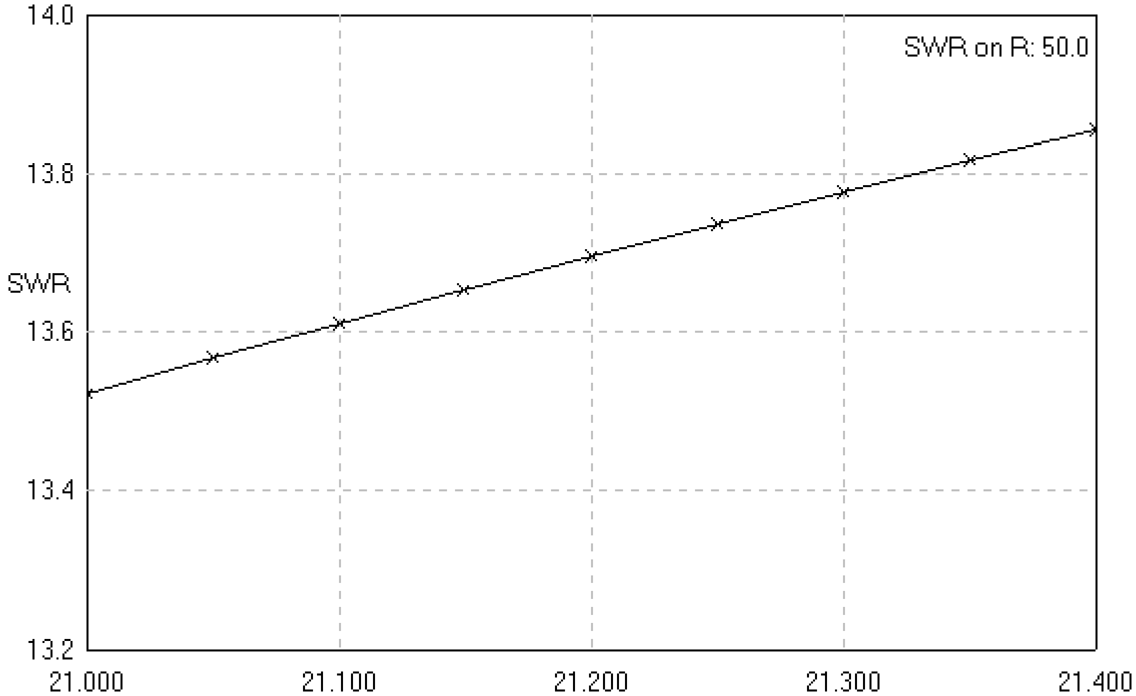


Diagram Directivity and Input Impedance at 15 meters for 4B- W3DZZ Antenna

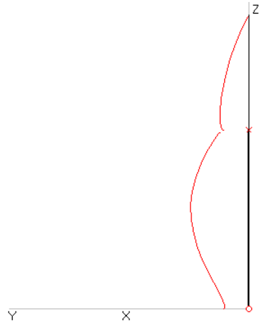


Freq	R	jX	Ga	F/B	ON
21.000	637.9	-156.0	0.6	0.0	On
21.100	628.2	-181.1	0.6	0.0	On
21.200	616.5	-204.8	0.6	0.0	On
21.300	603.1	-227.0	0.7	0.0	On
21.400	588.2	-247.4	0.7	0.0	On

SWR at 15 meters FOR 4B- W3DZZ Antenna



Current Distribution at 15 meters



Current Distribution at 10 meters

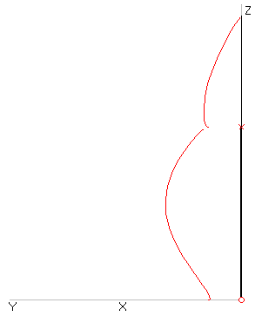
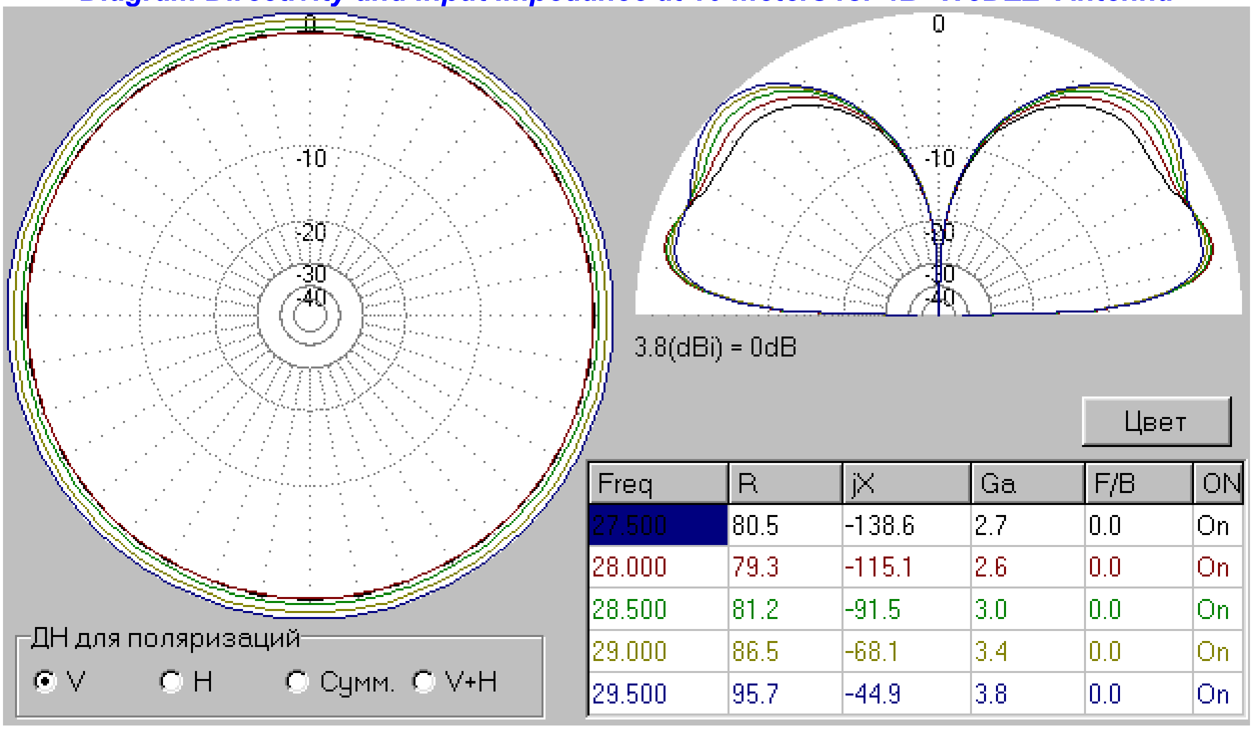
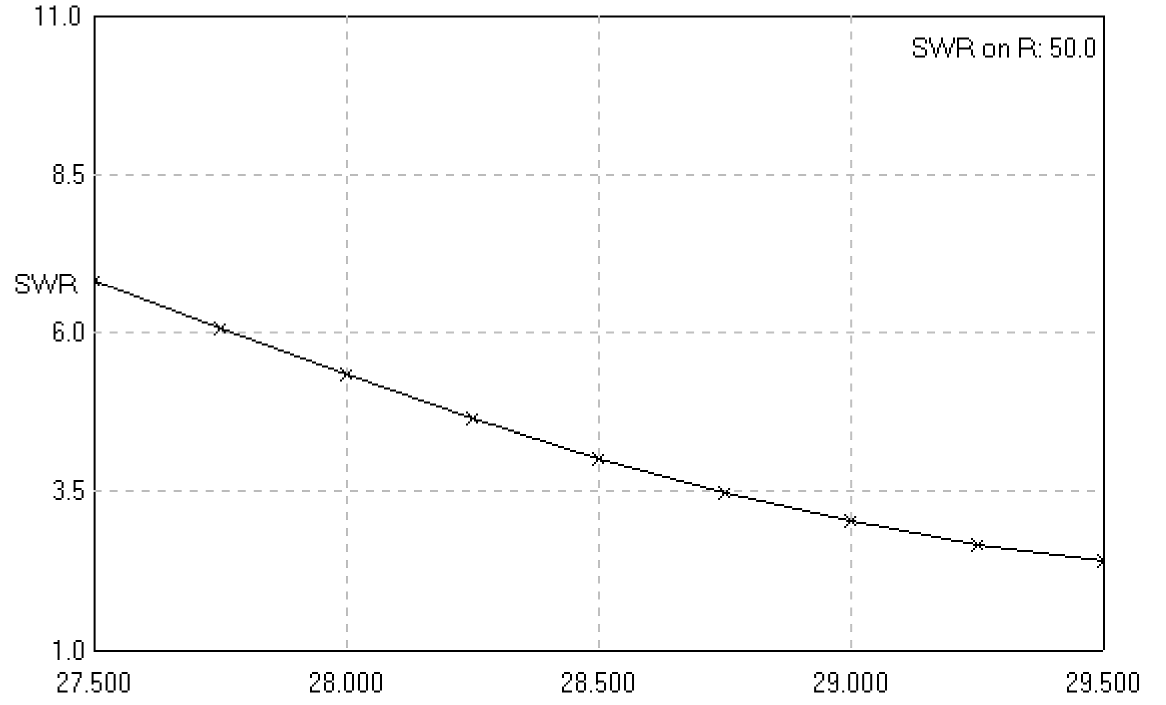


Diagram Directivity and Input Impedance at 10 meters for 4B- W3DZZ Antenna



Freq	R	jX	Ga	F/B	ON
27.500	80.5	-138.6	2.7	0.0	On
28.000	79.3	-115.1	2.6	0.0	On
28.500	81.2	-91.5	3.0	0.0	On
29.000	86.5	-68.1	3.4	0.0	On
29.500	95.7	-44.9	3.8	0.0	On

SWR at 10 meters FOR 4B- W3DZZ Antenna



Trap design: Trap spool contains 10 turns of copper wire diameter in diameter of 2-mm, form of the spool has diameter of 60-mm, distance between turn is 4 mm. The LC circuit should be tuned to frequency of 14.2-MHz. It is possible use a GDO for the tuning. A capacitor at 3-pF is bridged to trap capacitor when the trap is tuning to the resonance. The capacitor is simulated a stray capacitance of the antenna sections. It is necessary to safe trap capacitor from the atmospheric effect.

Antenna tuning: At first, with the help of a GDO tune trap to 14.2-MHz. The circuit tune separately from antenna. At second, tune length A to a minimum SWR in 20 meters. At third tune length of the Section B to minimum SWR at 40 meters.

Common notice for vertical multi range trap antennas

Counterpoises: For a proper work a vertical trap

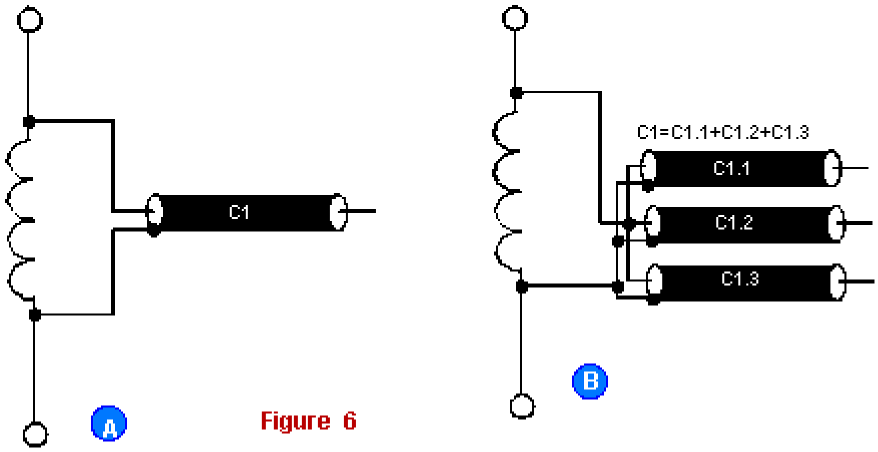


Figure 6 *A coaxial cable capacitor*

antenna need resonance (a quarter wave) counterpoises for each operation range. Use not less than two counterpoises. If the antenna is placed at a small altitude above a metal roof and braiding of feeding coaxial cable have good electrical contact with the metal roof, the antenna can be used without any counterpoises.

Antenna feeding: Quite possible to use a 50- Ohm coaxial cable for vertical trap antenna feeding. Also it is possible to use a two wire line for dipole and vertical trap antenna feeding. In this case it need ATU between the line and the transceiver.

A trap capacitor: A high voltage is at a trap capacitor when the antenna works to transmission. So it need a high voltage capacitor trap to be used at a trap. Such capacitor is costly and rather rare. Hams often use a length of a coaxial cable instead of a high-voltage capacitor. A 50- 0hm coax has near 100-pF/meter, a 75-0hm coax has near 70-pF/meter. Coaxial cable capacity can be find off from a data sheet for the coaxial cable or is metered practically. **Figure 6** shows a coaxial cable capacitor. For a capacitor with a small capacity (up to 30-pF) it is possible to use whole coaxial cable length, see **Figure 6A**. For a capacitor with a high capacity cut the coaxial cable on to several lengths, as it shown in **Figure 6B.**As a high-voltage capacitor in trap it is possible to use a bilateral PC-board by width of 1 to 3 millimeters. In this case capacitor get more bulky the made on coaxial cable basis. It is possible to tune the PC – capacitor on necessary capacity by slitting a foil on one of two sides of this capacitor. Do not forget about atmospheric protection of the trap capacitor.

Other way for trap design: It seems to me in the end of 70s in different radio amateur literature were appeared articles about using “coaxial cable trap” for W3DZZ. There is very simple method for trap making. **Figure 7** shows the trap. It is wise way for trap design, but radio amateur should have an experience using the method. In different radio amateur literature there are a lot of data for design of the trap, but classical methods are described at reference **[6]**.

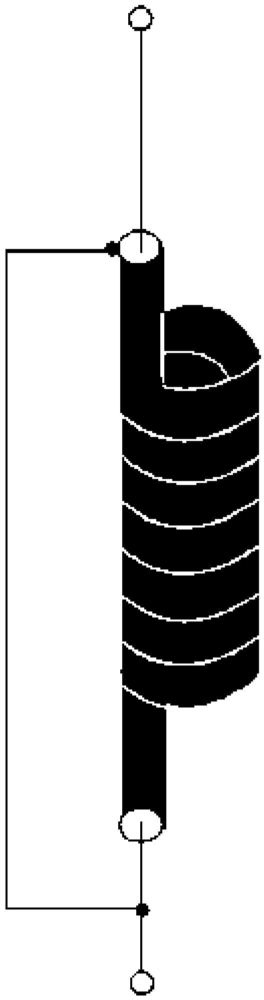


Figure 7 *A coaxial cable trap*

References:

1. By Alois Krischke : Rothammels Antennenbuch.- Franckh – Kosmos, V GmbH@Co., Stuttgart, 1995, 11 edition.
2. Jay Rusgrove, WA1LNQ: The Cheapie GP // QST, 1976, February, p31.
3. Morgan h. K. : Multifrequency Tuned Antenna System. - Electronics, vol. 13, August 1940, pp. 42-50.
4. Buchman C. L., W3DZZ : The multimatch Antenna System. // QST, March 1955, pp.22-23, 130.
5. The Radio Amateur’s Handbook, 1970, by ARRL publication.
6. The ARRRL Antenna Book, 19 Editions // ARRL Amateur Radio, 2000.

Log Periodic Antenna for 21, 24, 27, 28 and 30- MHz

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603000, Nizhniy Novgorod, Box 114 Russia

The Log Periodic Antenna works at 21, 24, 27, 28 and 30 – MHz. As all antennas of the type, the LPDA is easy tuned and works with a high efficiency. The antenna contains additional directors for 21 and 28- MHz and reflector for 21- MHz.

The 10-element Log- Periodic Antenna (see **Figure 1, at page 63**) was designed by UA3THQ and modified by me, UW3TU.

Data

Boom = 7000 mm
G at 28-MHz= 9 dB; F/b=30 dB
G at 24- MHz= 6 dB; F/b=20 dB
G at 2l- MHz =8 dB; F/b=24 Db
Input resistance at X-X is 200- Ohms

Stuff: Aluminum tubes of 24 mm OD. Vibrators W1 - W7 are isolated from the boom, the gap in all vibrators is 80 mm (see **Figure 2**). Stub has initial length in 1.5 meters, and made of a copper wire of 1.5- mm diameter

Adjustment of the antenna consists of the selection of a minimum SWR by the length of the stub (see **Figure 1**) at 21- MHz. After that the SWR should be not more than 1.3:1 at all operated ranges.

Feeding is done by a 50- Ohm coaxial cable through a broadband transformer 1:4.

Reference:

Radiolubitel # 9, 1992, p. 43

73! DX!

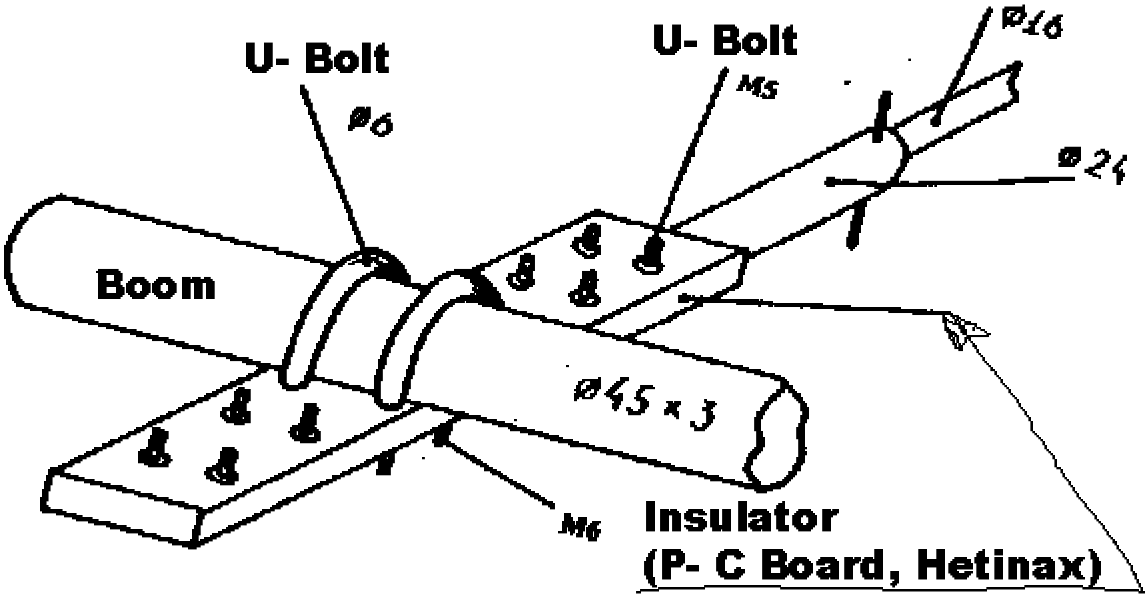


Figure 2

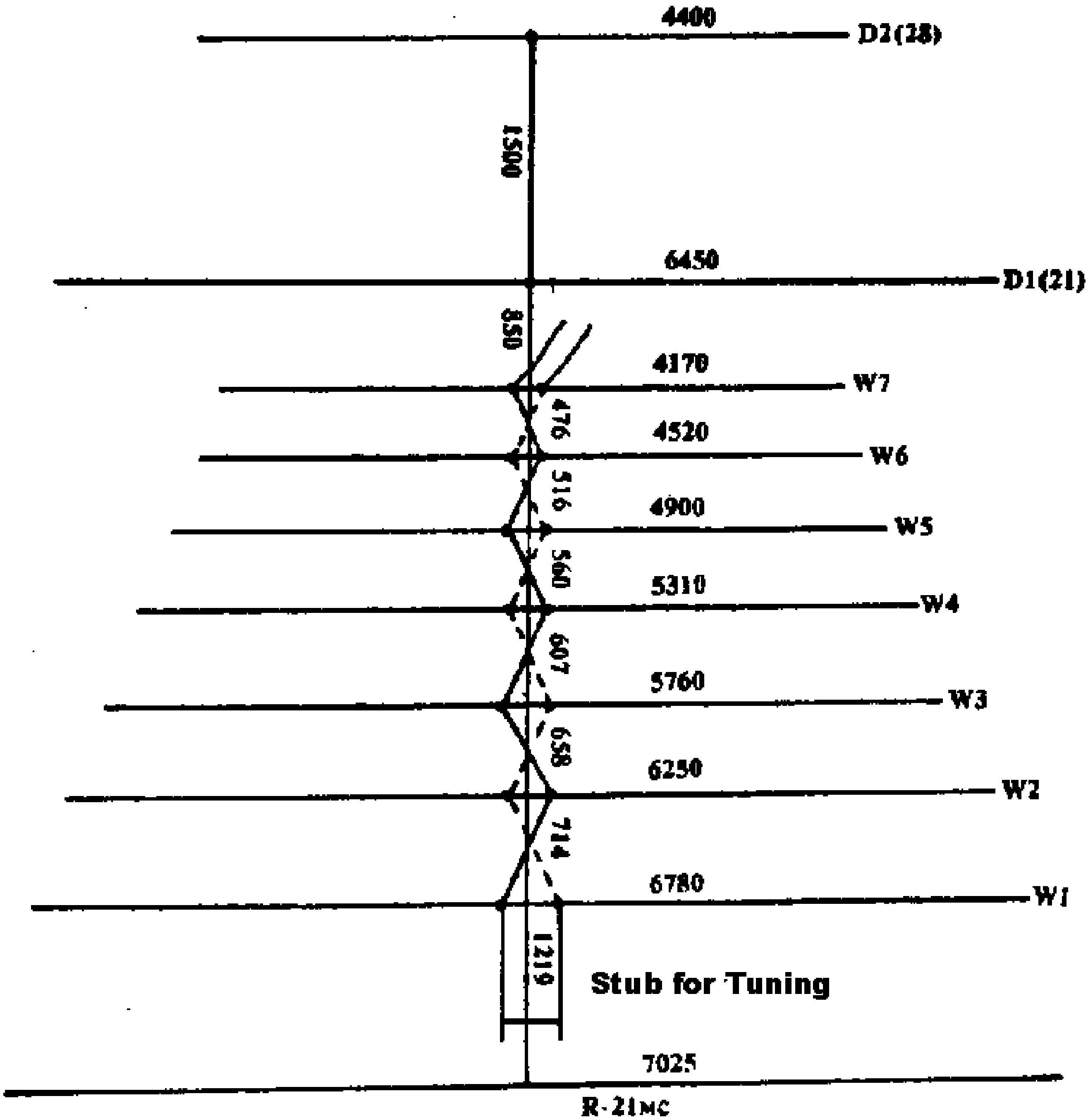

4400
D2(28)
1500
6450
D1(21)
850
4170
W7
476
4520
W6
516
4900
W5
560
5310
W4
607
5760
W3
658
6250
W2
714
6780
W1
1219
Stub for Tuning
7025
R-21MC

Figure 1

DIPOLE NADENENKO

Soviet radio amateurs well know the broadband dipole named in Russia "dipole Nadednenko." The antenna is widely used at serve radio centers of Russia. Russian radio amateurs also are used the dipole. Below we take up a design of the antenna.

The dipole contains several wires at each shoulders shaped as a cylinder. Figure 1 shows the dipole Nadednenko. For working at 40- 10 meters the sizes are: L= 8 meters, L1= 3 meters, L2= 1 meter, 2R= 1 meter. Diameter of wires is 1.5- 3 millimeters.

Dipole struts can be both as metal as wooden. As usual, struts has the shape as a circle, wooden struts has the s polygon. Wires are attached to struts any possible way. ' ends of shoulders carefully are welded. As usual, a 300- wire line is used for feeding of the antenna. Antenna rad with horizon polarization.

By Radio 1959

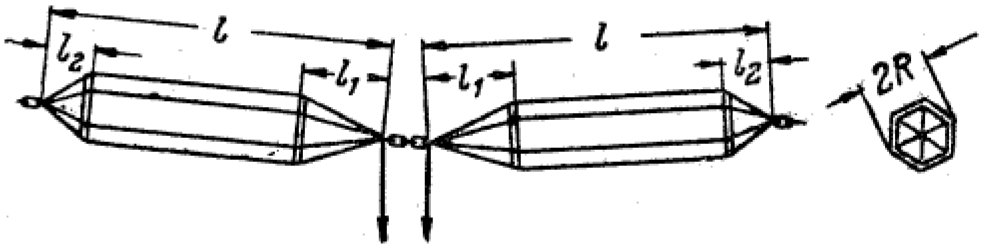
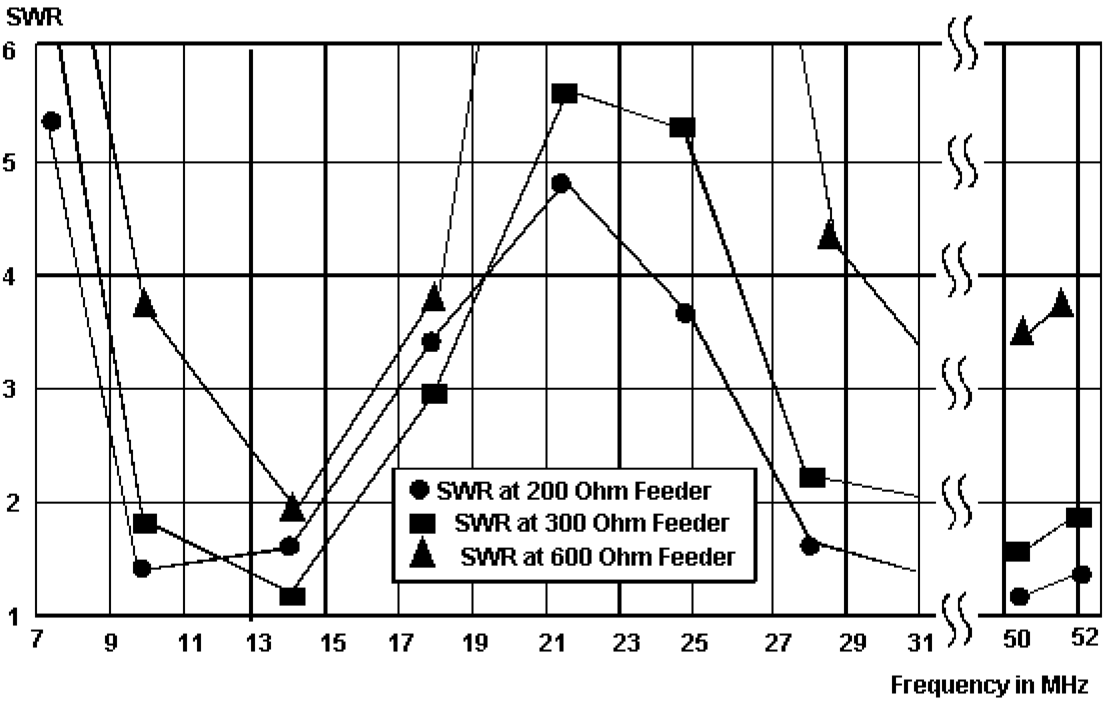
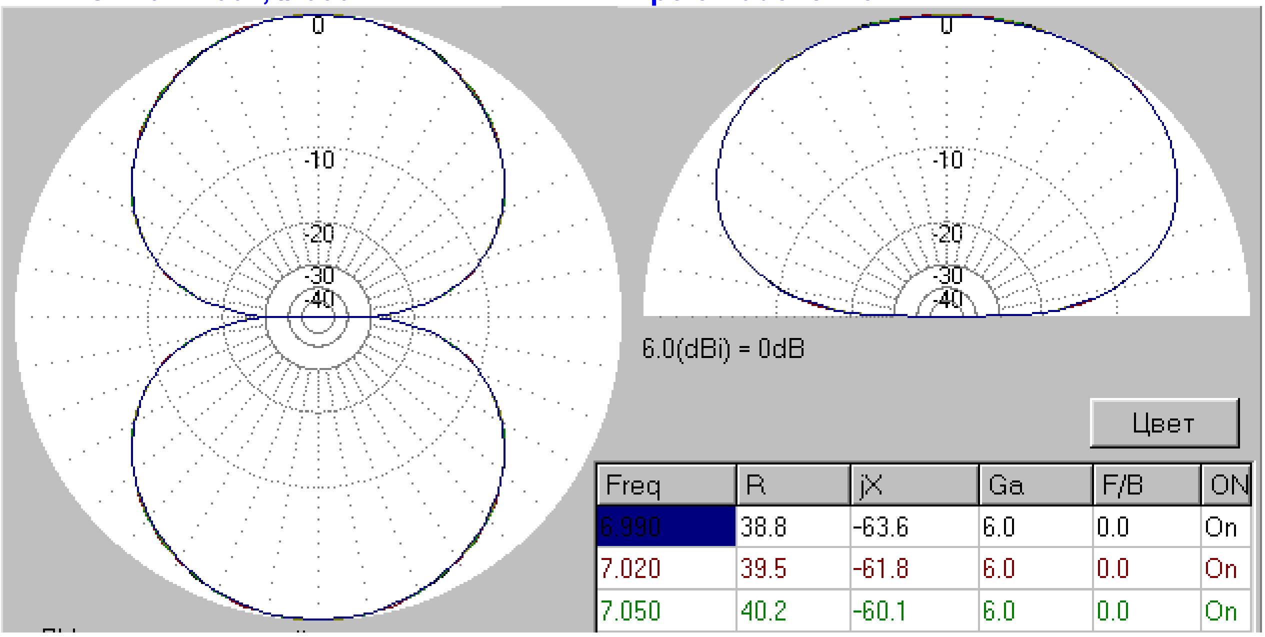


Figure 1

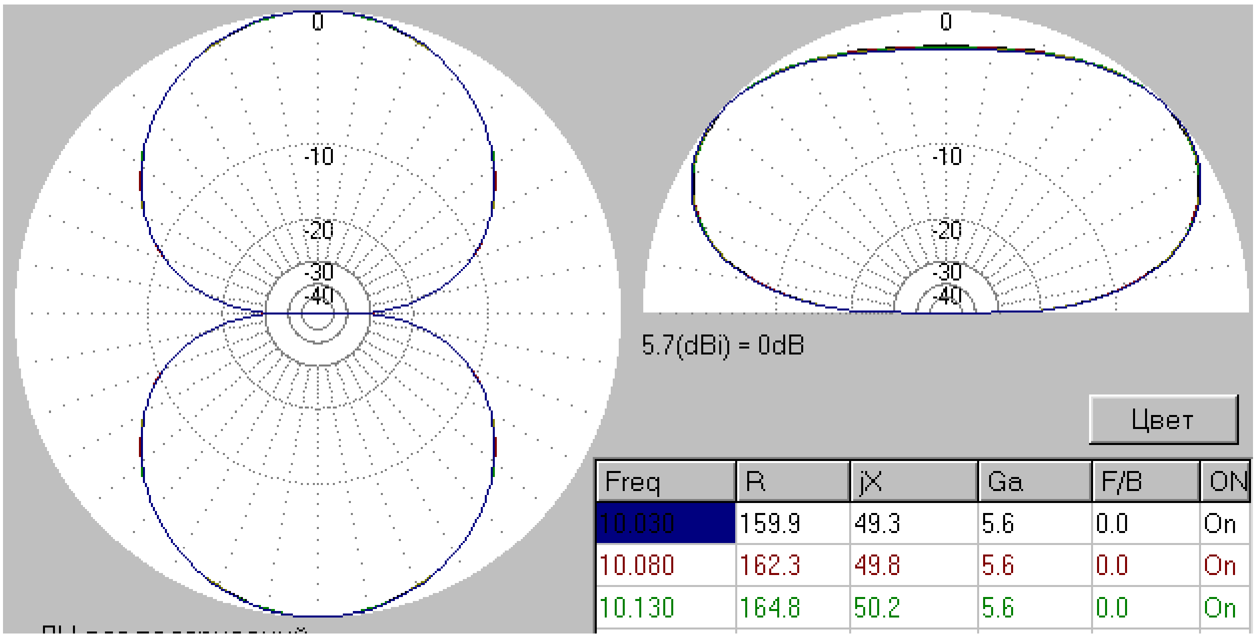
Calculations of input impedance and DD (***for horizon radiation***) of the dipole Nadenenko located at 10 meters above real ground with above mention dimensions (L= 8 meters, L1= 3 meters, L2= 1 meter, 2R= 1 meter, diameter of wires is 2 millimeters) are shown below. You can see, it is possible to use a 50- Ohm coaxial cable with a 1:4 transformer if restricted bands (30, 20, 10 and 6 meters) are used.

The data is obtained with help of a free antenna program MMANA (MININEC based). Left diagram is a section of the volumetric diagram directivity of plane X- Y at a zenith corner of the maximum radiation. The right diagram is section of the volumetric diagram directivity of plane X- Z. Also at the right down corner of the pictures is a table with antenna impedance.

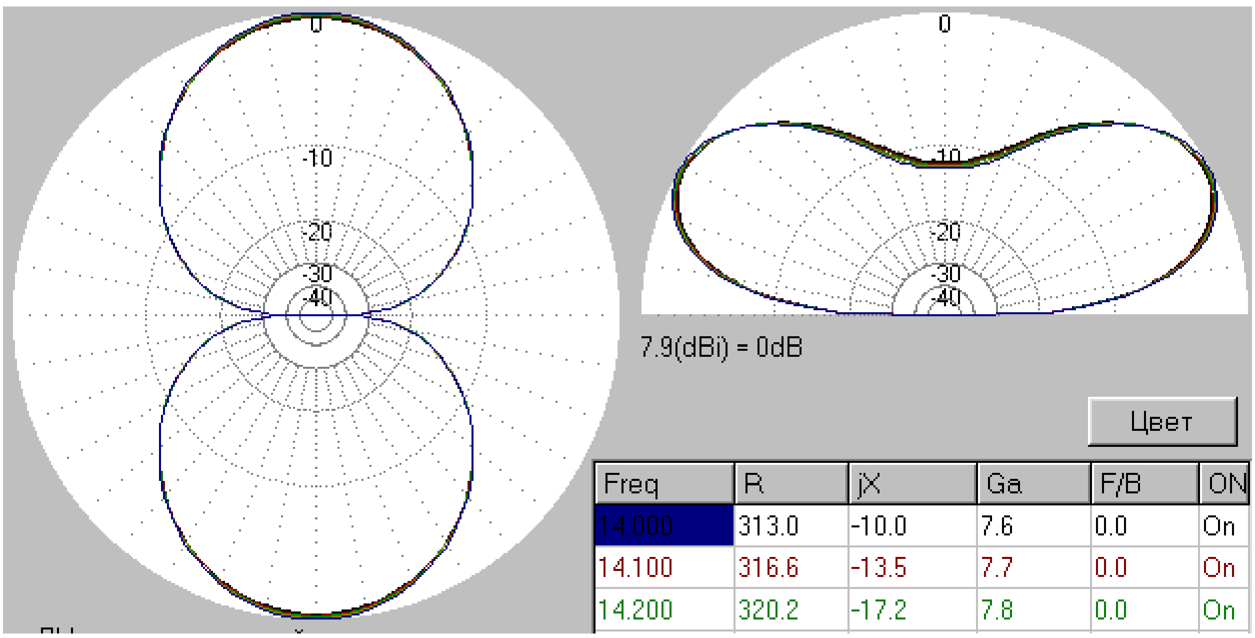




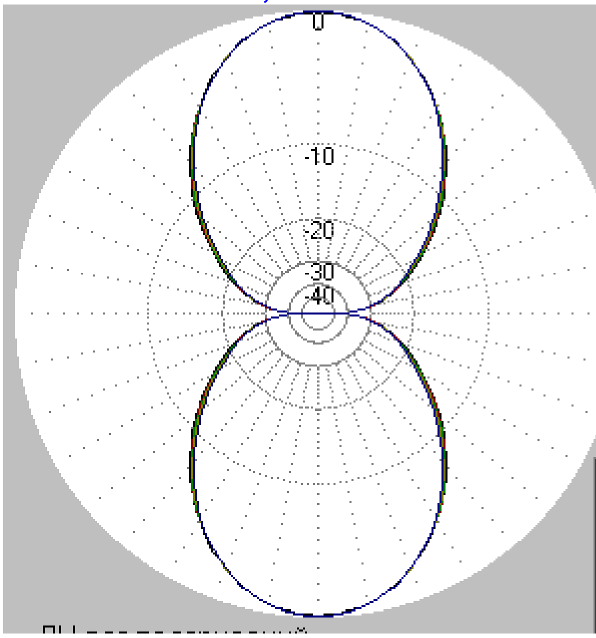
Freq	R	jX	Ga	F/B	ON
6.990	38.8	-63.6	6.0	0.0	On
7.020	39.5	-61.8	6.0	0.0	On
7.050	40.2	-60.1	6.0	0.0	On

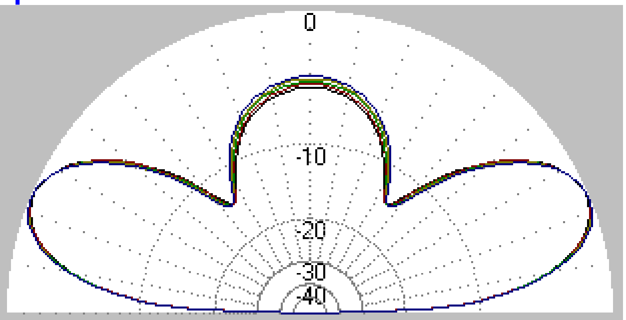


Freq	R	jX	Ga	F/B	ON
10.030	159.9	49.3	5.6	0.0	On
10.080	162.3	49.8	5.6	0.0	On
10.130	164.8	50.2	5.6	0.0	On



Freq	R	jX	Ga	F/B	ON
14.000	313.0	-10.0	7.6	0.0	On
14.100	316.6	-13.5	7.7	0.0	On
14.200	320.2	-17.2	7.8	0.0	On

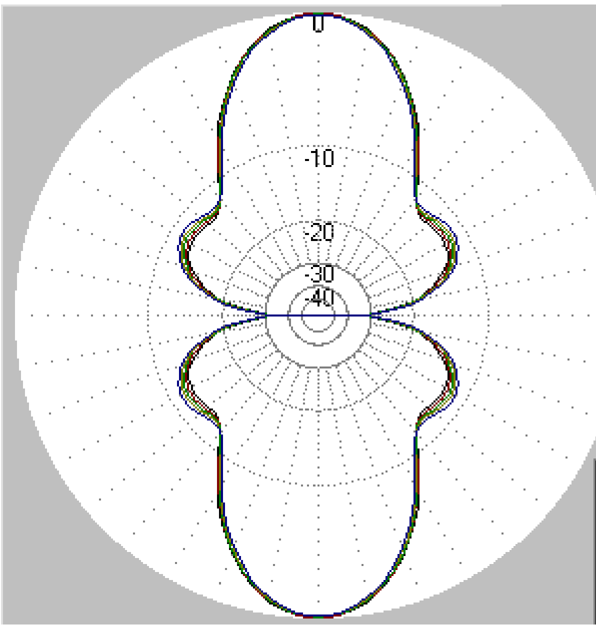


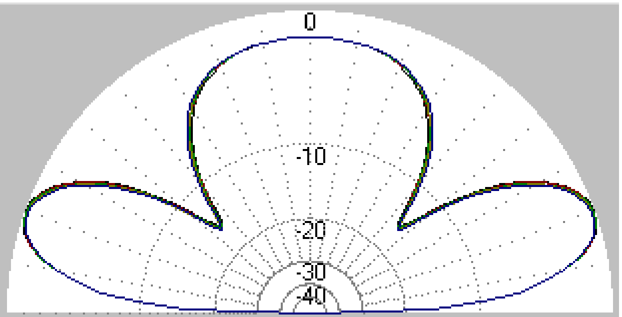


10.2(dBi) = 0dB

Цвет

Freq	R	jX	Ga	F/B	ON
17.920	207.0	-260.7	10.1	0.0	On
18.020	197.5	-259.6	10.2	0.0	On
18.120	188.3	-257.9	10.2	0.0	On

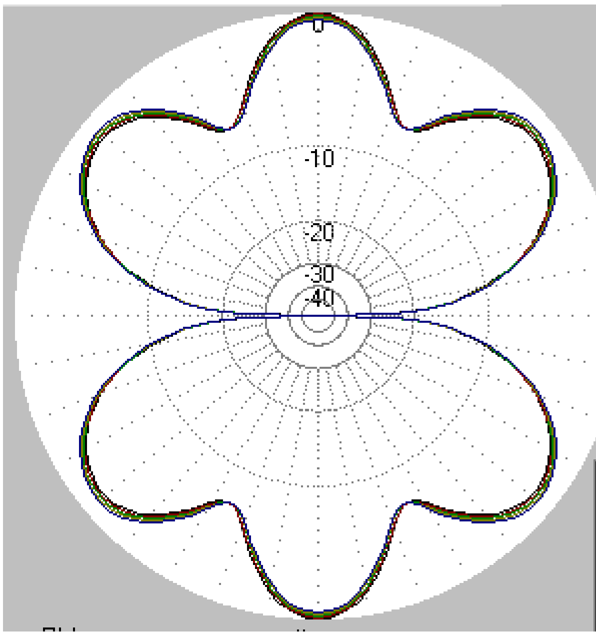


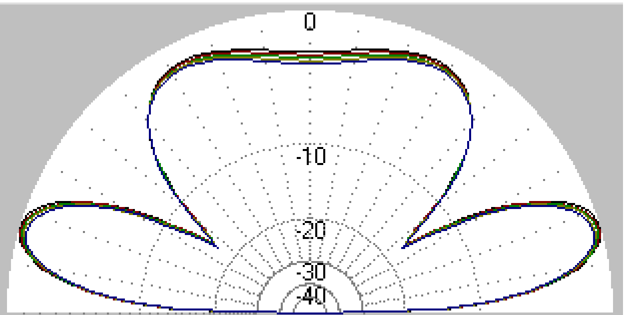


9.9(dBi) = 0dB

Цвет

Freq	R	jX	Ga	F/B	ON
21.000	65.6	-147.5	9.9	0.0	On
21.100	64.2	-143.9	9.8	0.0	On
21.200	63.0	-140.4	9.8	0.0	On

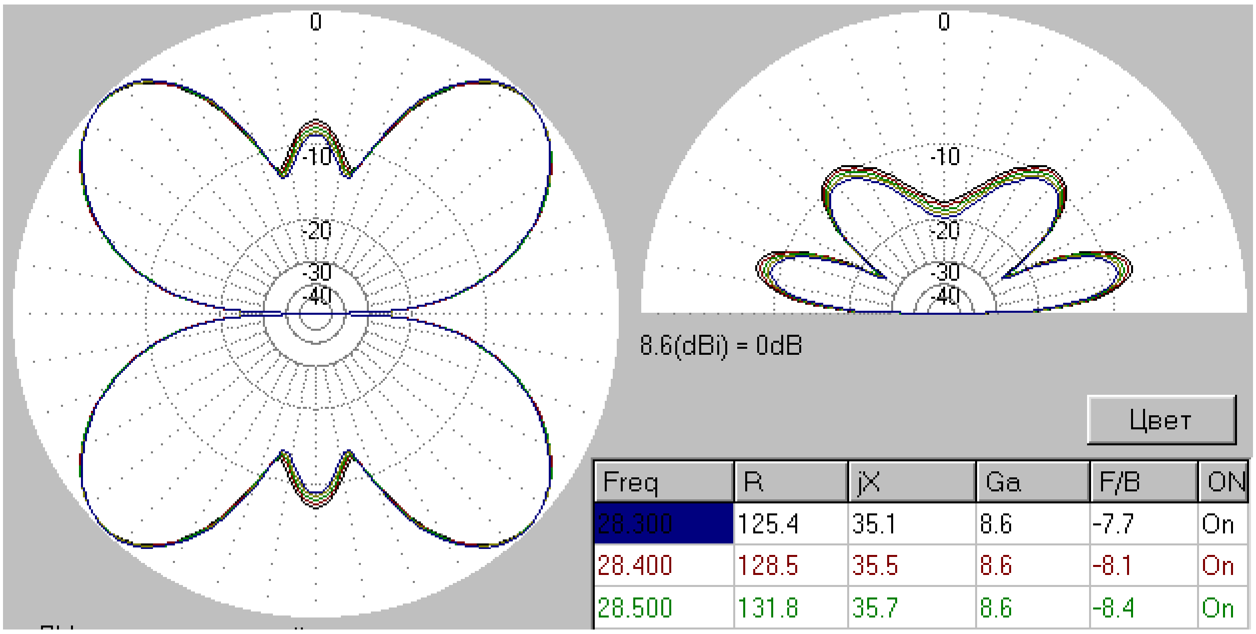




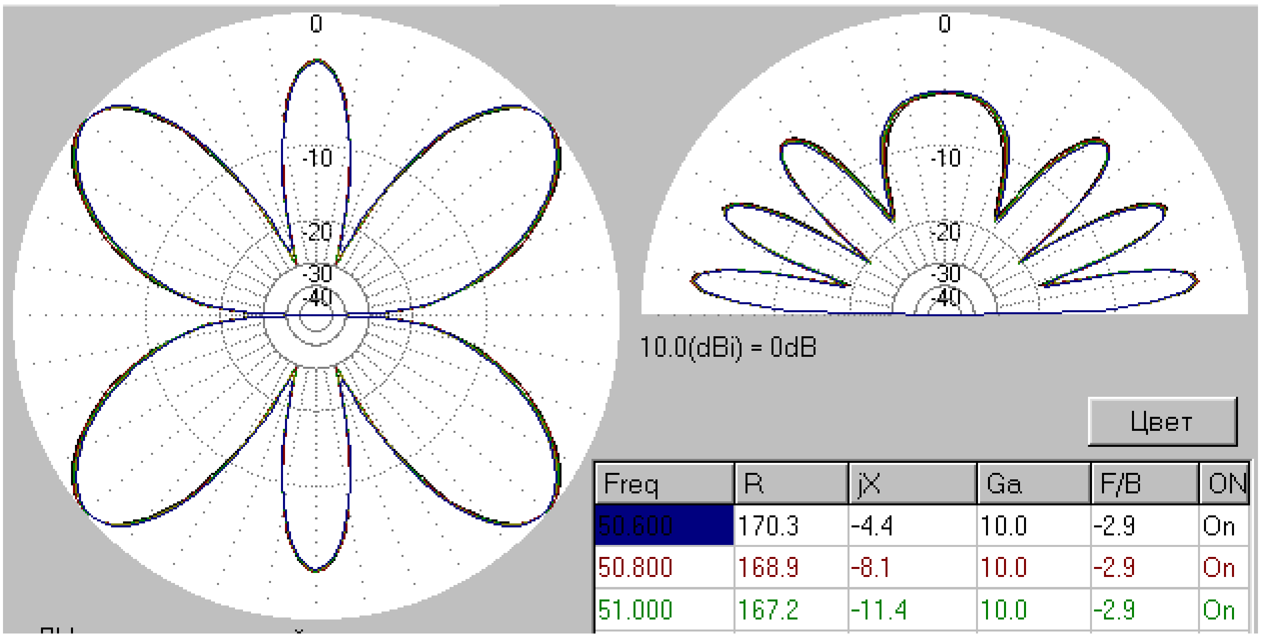
7.5(dBi) = 0dB

Цвет

Freq	R	jX	Ga	F/B	ON
24.740	56.0	-37.3	7.5	0.0	On
24.840	56.7	-34.7	7.4	0.0	On
24.940	57.4	-32.1	7.3	0.0	On



Freq	R	jX	Ga	F/B	ON
28.300	125.4	35.1	8.6	-7.7	On
28.400	128.5	35.5	8.6	-8.1	On
28.500	131.8	35.7	8.6	-8.4	On



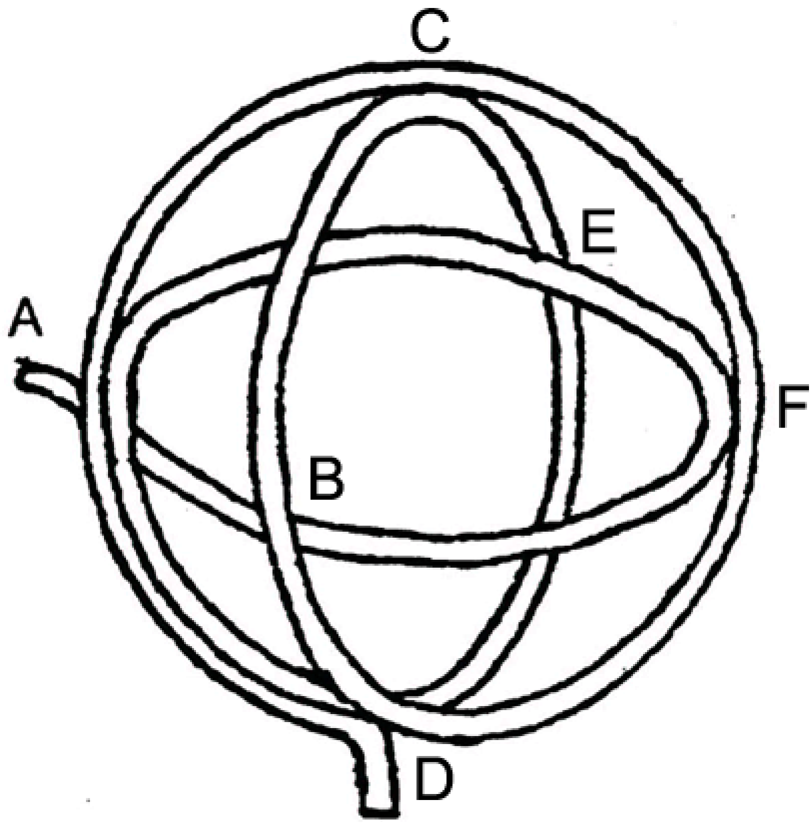
Freq	R	jX	Ga	F/B	ON
50.600	170.3	-4.4	10.0	-2.9	On
50.800	168.9	-8.1	10.0	-2.9	On
51.000	167.2	-11.4	10.0	-2.9	On

Forgotten Antenna

Some of former USSR's radio amateurs still remember the "TV spherical antenna". Earlier, at 60-70s the antenna was rather widely used for reception of TV. What is the "TV spherical antenna"? I dare quote a fragment from A. Pochepa's book "TV: questions and answers", Odessa, "Mayak" 1966, pp.: 64-65.

By Igor Grigorov, RK3ZK

antentop@mail.ru



Quota

"The Spherical antenna is a copper, aluminum or steel wire of diameter 1,5-2 mm, coiled in three rings. Length of antenna wire is equal to average length of a wave of the used TV channel but if it possible to use the wire in twice smaller length.

If an insulated wire is used, separate rings tie with each other by a cotton cord. If a bare wire is used separate rings tie with each other by a Scotch, the Scotch does insulation the rings at points A, B, C, D, E, F. "

End of quota

The Spherical antenna made by me and by my friends to meter and decimeters TV channels. Any coax cable connected to points A-D can be used as a feeder of the antenna. At my experience, the antenna has a spherical pattern and the gain compared with a lambda/2 dipole.

Made in the USSR

MEN WHO IGNORE THE PAST ARE DOOMED TO RELIVE IT

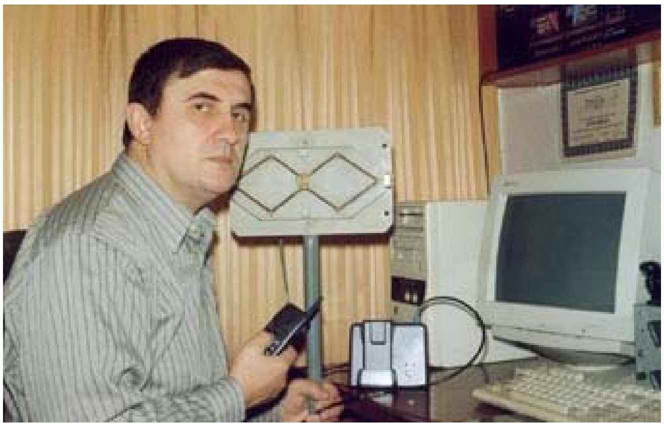
Santayana

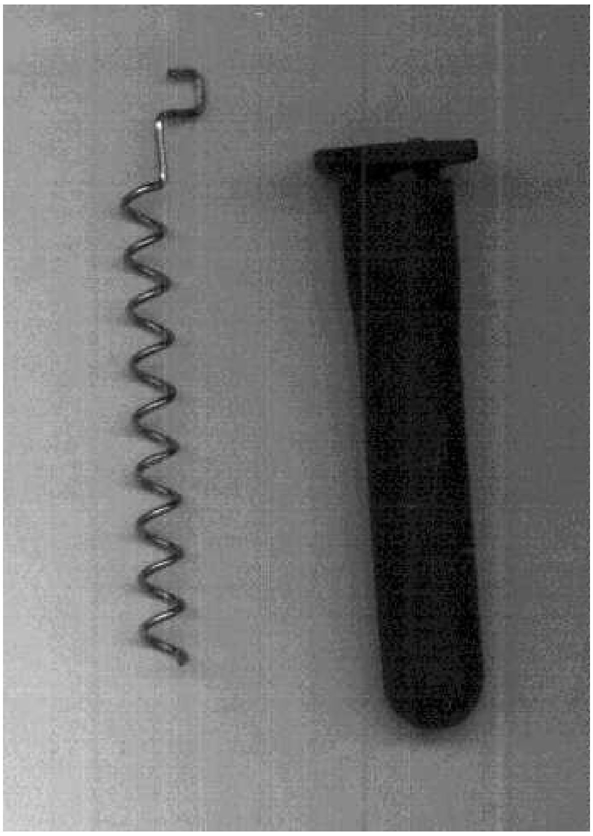
Antenna for 900 - MHz

Petr Gritcay, US1REO
pg@ne.cg.ukrtel.net

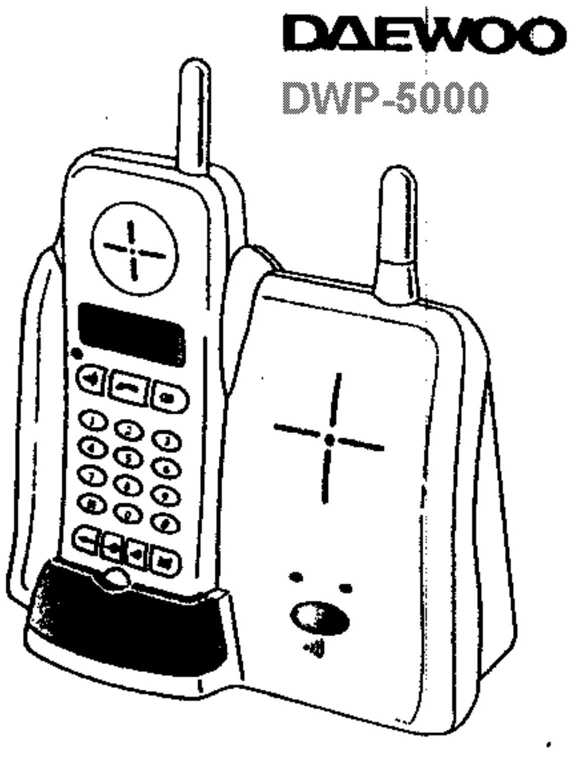
I have got a radio telephone DAEWOO DWP-5000 working in a range 900-MHz at the radio market in Kiev (**see Figure DAEWOO DWP-5000**). I checked up the phone with its antennas. I could reach only 300- 350 meters when the phone saw the radio base. I need 2 kms communication range. I decided to increase the communication range of my radio phone by using an effective antennas. By the way, the antenna placed at the base was made as a steel spiral, located into a rubber tube (**see photo Base Antenna)**. The length of the antenna was 4 centimeters.

So, for my phone I decided to use well known in the former USSR so-called antenna Harchenko. The antenna has a wide range and can work at the range of 886 – 931- MHz with a low SWR.





Base Antenna

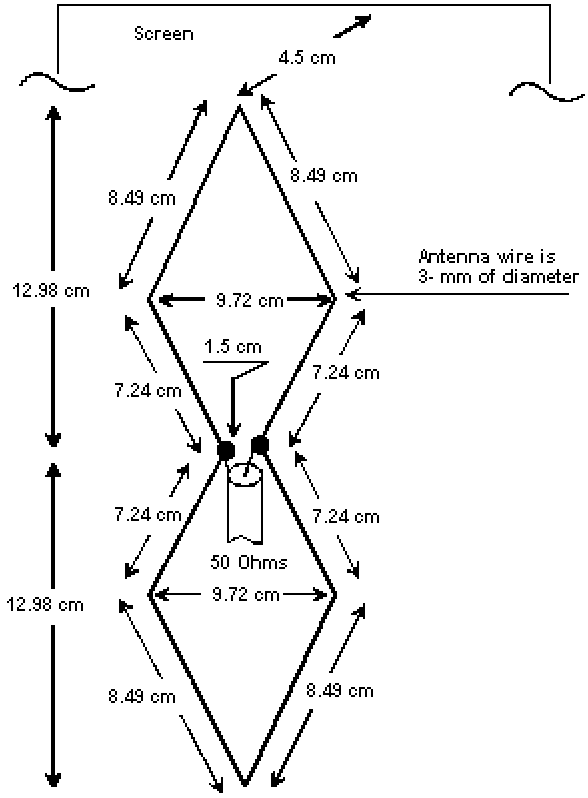


DAEWOO DWP-5000

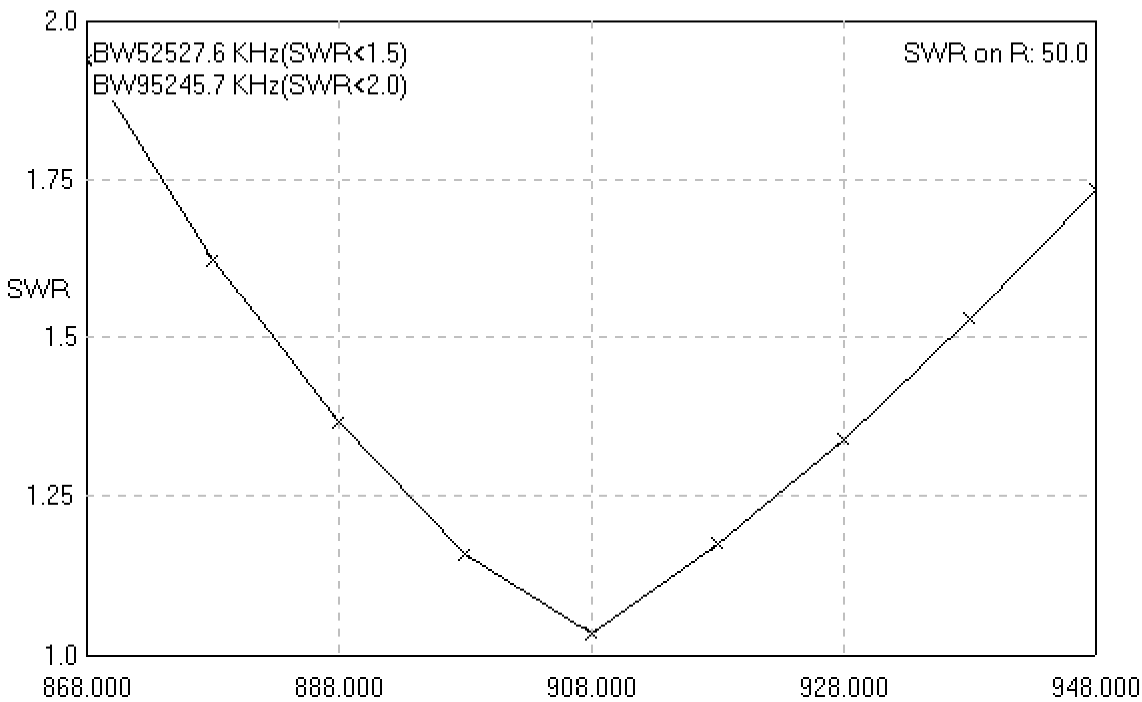
Do not forget, transmitting and receiving frequencies differ each other to 45- MHz at the 900-MHz phones. Antenna Harchenko was calculated by ***Free Antenna Simulation Program MMANA***. Parameters of the antenna are shown below. Left diagram is a section of the volumetric diagram directivity of plane X-Y at a zenith corner of the maximum radiation.

The right diagram is section of the volumetric diagram directivity of plane X- Z. Also at the right down corner of the pictures is a table with antenna impedance. (***see Figures: Schematic of the Antenna, Antenna Z, Antenna SWR, Antenna Pattern***)

Antenna on the Roof



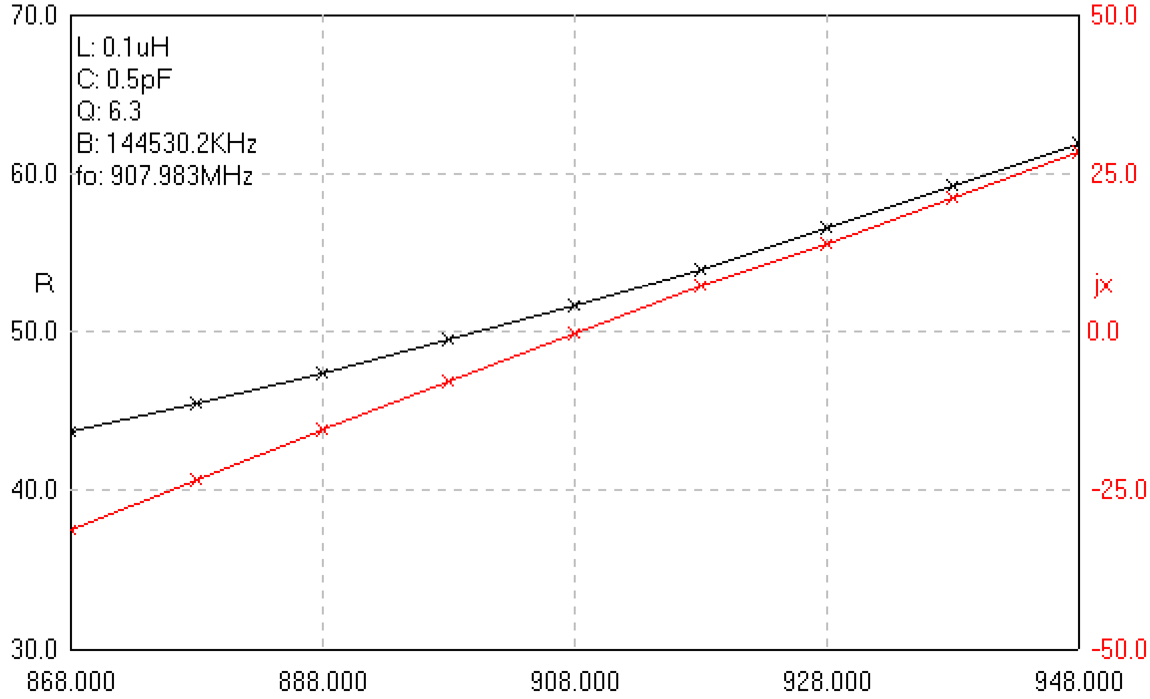
Schematic of the Antenna



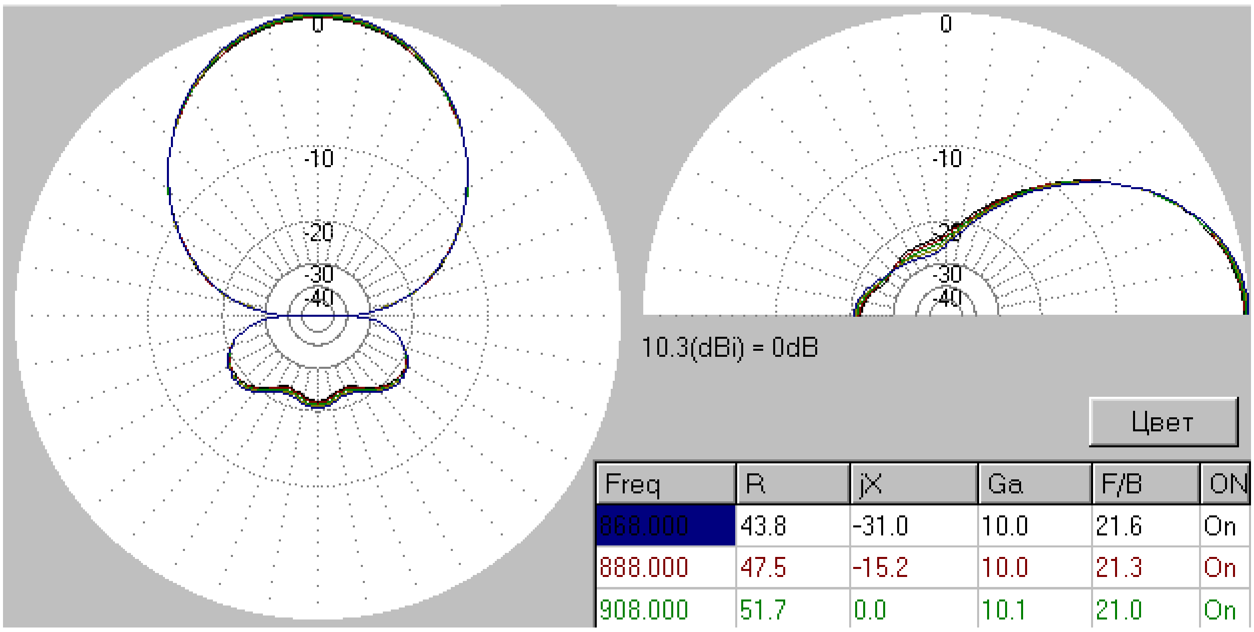
Antenna SWR

The antenna was placed on a plate made of a Plexiglas. The plate was installed by Plexiglas rods above the aluminum reflector.

The aluminum reflector was attached to a wooden mast. The antenna was connected to the base by a 5 meters length of a RG-58 coax cable.



Antenna Z



Antenna Pattern

The steel spiral antenna and antenna Harchenko were compared by means a commercial made UHF FSM. The steel spiral antenna lighted one LED on the FSM, the antenna Harchenko lighted five LEDs on the FSM.

Test of the antenna Harchenko with the base gives the communication range more then 2 kms when phone saw the antenna. Away from the main lobe the communication range is decreased. Buildings screening the antenna essentially weak the communication range, too. Certainly, to increase the communication range ever more is possible to make an external antenna for the phone too, but it is possible only for stationary placement of the hand-held phone.

73! Petr, US1REO

Losses of RF Power when Feeder Works at SWR Mode

Igor Grigorov, RK3ZK
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If a feeder has a characteristic impedance differ compare to the load a part of RF power going from the transmitter in the feeder is reflected from the load back to the transmitter. In this case the load uses a part of RF power of the transmitter. **Table 1** shows the losses of RF power when a feeder has SWR.

This table does not take into account losses of RF power peculiars to the feeder. The losses you can find of data for the feeder. To calculate real losses needs to sum losses at SWR with losses peculiars to the feeder. Pay attention, data for losses at feeder are given for SWR 1:1 in the feeder. For large SWR the losses do increases. As usual, commercial made transceivers is designed for work with SWR in feeder not above 1:2.0.

Note: A mismatch of a transmitter's output impedance to the feeder's characteristic impedance does not cause a SWR mode if the antenna (load) is matched to the feeder's characteristic impedance.

SWR in the Feeder	Losses at Reflection from the Load, %	RF Power going to the load from the transmitter, %	Losses at Reflection from the Load, dB
1:1.0	0.00	100.0	0.00
1:1.1	0.23	99.8	-0.01
1:1.2	0.83	99.2	-0.04
1:1.3	1.7	98.3	-0.08
1:1.4	2.78	97.2	-0.12
1:1.5	4.0	96.0	-0.18
1:1.6	5.33	94.5	-0.25
1:1.7	6.72	93.7	-0.28
1:1.8	8.16	91.8	-0.37
1:1.9	9.63	90.4	-0.44
1.2.0	11.1	88.9	-0.51
1:2.2	14.1	85.9	-0.66
1:2.4	17.0	83.0	-0.81
1:2.6	19.8	80.2	-0.96
1:2.8	22.4	77.6	-1.10
1:3.0	25.0	75.0	-1.25
1:3.5	30.9	69.1	-1.61
1:4.0	36.0	64.0	-1.94
1:5.0	44.4	55.6	-2.55
1:7.0	56.3	43.7	-3.6
1:10	67.0	33.0	-4.81
1:20	81.9	18.1	-7.42
1:50	92.3	7.7	-11.10

AN ABSORBING FILTER

At ANTENTOP – 2, 2003 it was described a trap filter on main wires. However, the filter cannot be used at a high power or at super- broad bands transmitters. One reason is that it is impossible to retune a trap at a wide frequency range, other reason is the trap filter does reflection of the high-frequency energy back. So, wire to the filter can radiate also the high-frequency energy goes to transmitter and does additional interferences. So, in some case a trap filter can do more trouble the use.

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In the case it is possible to use an absorbing filter. Absorbing filter is made as a coil reeled - up by a double wire (or main wire) and placed in a metal box with a stuff that does absorbing of high-frequency energy. Absorbing material consists of dust of soot mixed with another stuff, as usual, with an epoxy compound. As a rule, absorbing filters are installed as on input of a power supply (on the main wires) as on the output of the power supply (on the wires feeding the transmitter). **Figure 1** shows a design of an absorbing filter and places of its installation. Absorbing filter is an active load for high frequency currents that are distributed or from the transmitter in the main. Hence, there is no reflection of high-frequency energy from the filter, there is no mode of standing waves on wires going from power units, and in the time high-frequency energy will not penetrate from the transmitter into the main, and back.

Self-made absorbing filters were made and tested by me. The coil had approximately 20 turns of the main wire. Diameter of the coil was 30 millimeters. The coil was placed in an old coffee tinned can. The can was filled with absorbing mix. The mix consists of a pounded coal with chalk. The proportion was of 70 percents of coal and 30 percents of chalk. The mix was carefully stirred in solution of paraffin with rosin, 80 percents of paraffin and 20 percents of rosin. It should get out a compound of very rich consistence.
Then the compound was filled the can with the coil inside. After full cooling of the compound the absorbing filter is ready for a work.

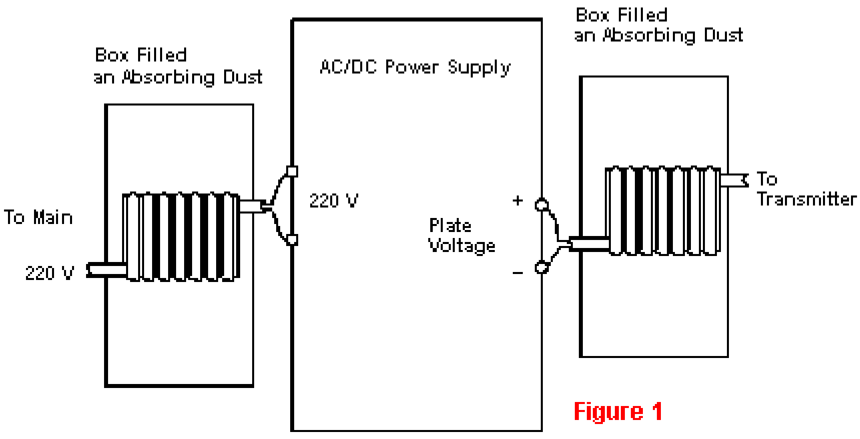

Figure 1 *Absorbing Filter*

http://www.antentop.bel.ru/

Crystal Sets to Sideband

Dear friends, I have read the book with great interest. The book really captivates and I cannot tear myself away the book. The book contains 16 very interesting chapters, and every chapter says us a separately story about radio. I can strongly recommend to you have read this book. Below you can see the Contents of the book and path to load this one.

73! I.G.

CRYSTAL SETS TO SIDEBAND

A Guide to Building an Amateur Radio Station

By Frank W. Harris, KØIYE

Free e- book!

Download!

http://www.qsl.net/k3pd/book.html

Contents

Chapter 1

THE FASCINATION OF RADIO

- Exploring the shortwave bands
- Growing up in the Morse code era
- The joy of building it yourself
- A brief history of radio communication
- Henry, Maxwell, Hertz, Tesla and Marconi.
- Fessenden, Edison, Flemming, DeForest and Armstrong
- The sinking of the RMS Republic and the birth of ham radio
- Ham radio in the last 80 years
- Becoming a radio amateur

Chapter 2

HOMEBUILDING AMATEUR RADIO EQUIPMENT

- What qualifies as homebuilding?
- When homebrewing is not appropriate
- Barriers to modern homebuilding –
- Time, frequency stability and lead inductance
- Basic electrical knowledge
- Magnets & static electricity
- Voltage, current, resistance, energy and power
- (Illustrated with drawings of water & mechanical analogies)
- Conductors, Insulators and semiconductors
- Capacitors, inductors, transformers & alternators
- Home power distribution, transformers at low and high frequencies

Chapter 3

SETTING UP AN ELECTRONICS WORKSHOP

- R&D as recreation
- How to build radios (or anything else) in your basement
- Persistence, read books, keep a notebook, & work in small increments
- Minimum tools needed
- The ARRL Amateur Radio Handbook
- Soldering irons and small tools
- Drills & thread taps
- Wood carving gouges for making PC boards
- >50 MHz Oscilloscope
- Frequency counter
- Quality multimeter
- Lab power supply
- Calculator
- Lab notebook
- Collection of electronic junk
- Parts catalogs
- Capacitance meter
- Test leads & socket boards
- Nice-to-have tools
- RF & audio generators, spice software & spectrum analyzer

Chapter 4

HERTZIAN WAVES IN THE BASEMENT

- The nature of radio waves
- Mechanical and LC electrical oscillators
- Antenna and transmission line theory

- Crystal set components
- LC tuner
- PN junction diode detectors
- P-type and N-type semiconductors
- Detection of AM signals
- Homebuilding the parts for a crystal set
- The Jamestown diode
- The Caribou headphone
- Recreating Hertz's radio equipment
- Transmitting and receiving as simply as possible
- The 1880 ten-meter communicator
- Proving that radio waves exist and aren't just capacitive or magnetic coupling
- Demonstrating standing waves to measure frequency
- Building homebrew transistors
- Bipolar transistors, PNP and NPN
- Demonstrating voltage gain
- The Boulder Rock Radio

Chapter 5

GETTING ON THE AIR - DECIDING WHAT TO DO FIRST

- How to earn a license
- The rules of the homebuilding game – Whatever makes you happy!
- Picking an HF band
- Getting acquainted with the HF ham bands, 160 – 10 meters
- Instant high quality HF communications
- VHF/ UHF handheld transceivers
- Building an antenna
- Dipoles, regular and folded
- Multi-band dipoles
- 80 meters when you don't have room for a dipole
- The curtain rod vertical
- A multi-band vertical antenna
- Lightning protection

Chapter 6

BUILDING A QRP HOMEBREW

- A single-band, crystal-controlled, QRP module
- The transmitter mainframe
- HF construction methods
- Making your own PC boards
- "Dead Bug" and "Gouged Board" construction
- Superglue "Island Boards"
- Coax jumpers
- Shielded boxes
- The complete QRP crystal-controlled transmitter
- Transistor amplifiers and oscillators
- How an amplifier becomes an oscillator
- Class A and Class C amplifiers
- Stabilizing the operating point, bypass caps and emitter resistors
- Quartz crystals – the key to frequency stability
- The 40 meter QRP circuit
- Oscillator and buffer
- Inductors, RF transformers and impedance matching
- Tapped toroid inductors
- How to wind them (and mistakes you might make)
- The final amplifier stages for the QRP
- Tuned versus broadband - Use both for best results
- Bifilar wound, broadband transformers
- How to wind them (and how you might screw up)
- Ferrite bead RF chokes, expensive RF power transistors, heat sinks & output connectors
- Conquering inductors
- Calculating resonance
- Calibrating trimmer capacitors
- Calculating turns on powdered iron and ferrite toroids
- Chebyshev output low pass filters
- Keying your QRP
- MOSFET power transistors
- A "spot switch" for the QRP

Chapter 7

BUILDING A CODE PRACTICE RECEIVER

- A simple, direct-conversion receiver
- A great first project for a new ham
- Excellent sensitivity and good stability
- Poor selectivity
- Adding 700 Hz audio filtering
- High pass and low pass filters
- Cascaded bandpass filters increase selectivity
- Operational amplifiers
- Building with integrated circuits
- AM broadcast filter
- Getting rid of the image

Chapter 8

POWER SUPPLIES

- Line powered power supplies
- Power supply safety features
- Isolation, 3-conductor cords, fuses, switches, ratings
- Supply performance and regulation
- Rectification, ripple, chokes, capacitors, & bleeders
- Zeners, linear regulators, switching regulators

- A QRP regulated power supply
- A battery power supply for the radio shack
- Solar cell charging, low drop-out regulators
- Battery powered shack lighting

Chapter 9

ACCESSORIES FOR THE TRANSMITTER

- A straight key
- An electronic bug
- Building dummy loads
- "T" type antenna coupler
- A low pass filter
- How to stay legal with a homebrew transmitter
- Antenna and power relays
- Homebrew QSL cards

Chapter 10

VARIABLE FREQUENCY OSCILLATORS

- Drift is a big deal today
- Low frequency VFOs drift less than high frequency VFOs
- JFET transistors
- The oscillator circuit
- The buffer, final amplifier and output filter
- The 50 secrets of avoiding drift
- JFETs, single-side PC boards, cast metal box, multiple NPO caps, small variable caps, precision voltage regulation and more
- Vernier tuning
- Varactor tuning elements – advantages and disadvantages
- A precision power supply
- A voltage doubler power supply for battery use
- Square wave generator with a multivibrator
- Squaring up the square wave
- Charge pump, diode/ capacitor voltage doubler
- Schottky diodes for efficiency
- Temperature compensation methods
- Positive coefficient capacitive trimmer compensation
- How to adjust the compensator
- Thermistor/ varactor temperature compensation

Chapter 11

Building a VFO for the higher bands (PMOs)

- Old approaches that no longer work
- Frequency multiplication
- High frequency oscillators
- PreMix Oscillator method of frequency translation
- A VFO-controlled QRP module
- Crystal oscillators are stable, aren't they?
- Crystal oscillator circuits
- Butler oscillators and big crystals
- Mixers, bipolar transistor and dual-gate MOSFET
- Optimum drive requirements
- Direction of tuning, drift error cancellation
- Multistage filters and filter/amplifiers
- The QRP final amplifier stages

Chapter 12

FINAL AMPLIFIERS

- The basic features of a modern linear power amplifier
- It looked easier in the Handbook
- Linear "noise mode" operation
- A tuned 50 watt class B amplifier
- Ferrite balun transformers
- An untuned, sort-of-linear, class B, amplifier
- Keying the 50 watt transmitter
- A linear Class AB amplifier, this time for sure
- Single Sideband (SSB) needs a linear
- Biasing without thermal runaway
- Clamp diodes prevent runaway
- Mechanical construction

Chapter 13

BUILDING A HOMEBREW HF RECEIVER

- Building a receiver - an unusual adventure
- What's a reasonable goal?
- An "adequate performance" HF communication receiver
- Does it have to be so complicated?
- Planning your receiver
- Direct conversion versus superhetrodyne
- Why not single conversion?
- Start with a single-band, single-conversion superhetrodyne
- How do modern digital receivers do it?
- Receiver construction – build with shielded modules connected by thin coax.
- The 80 meter preselector
- Reception on 80 meter and 160 meters is aided by a tuned transmatch
- The Variable Frequency Oscillator
- Mixer magic
- Mixers will give you lots of static – and howls and squeals
- A practical homebrew mixer made from discrete parts – it's harder than it looks
- Dual gate MOSFET mixers
- Not all MOSFETS work equally well
- Crystal ladder filters – essential for CW
- All 9.000 MHz crystals aren't equal

- Using the BFO oscillator to match crystals
- Switch in filters with a rotary switch
- The IF amplifier
- The cascode amplifier strip - variable gain with constant Q
- Automatic Gain Control (AGC) - not a luxury
- The product detector
- Nearly anything works at least a little
- The AF amplifier – a vital part of the signal dynamic range
- Protecting your ears from strong signals
- How Hi-Fi should it be?
- Driving a speaker
- HF converters for the other ham bands
- Crystal oscillators
- Bandswitching
- Receiver power supplies
- Use a linear regulator, not a switching regulator

Chapter 14

OLD-TECH VACUUM TUBE RADIO

- How old can radio technology be and still be used on the air today?
- Why bother with vacuum tubes?
- Glowing filaments, colored plasmas & Jules Verne glass envelopes
- Power supplies for tubes
- High voltage power supply safety
- The old-tech QRP transmitter
- Vacuum tube amplifiers
- The three roles of the triode filament
- RF sinewave oscillator
- Quartz crystals
- Triode and pentode oscillators
- Old-tech voltage regulation – big, crude, expensive, but beautiful
- The travails of triode tubes
- The oscillator and buffer
- The final amplifier – triodes chirp
- The transmitter power supply
- An inadequate supply from a 1935 radio
- A good power supply made from cheap, modern, boring parts
- How to check out junk power transformers
- A complex but adequate supply made from ancient parts
- It works! No one suspects it's old and it's a success on today's 40 meter band
- An old-tech receiver
- A super regenerative receiver made from ancient tubes
- The power supply
- Super-regen on the modern hambands
- Lots of fun, but not up to modern QRM & QRPs - back to the drawing board!

Chapter 15

THE NOBEL PRIZE FOR SIDEBAND

- It can't be that hard! Want to bet?
- The sideband generator – how it works
- The 9 MHz oscillator / amplifier
- The audio amplifier
- The balanced modulator
- Building your own crystal ladder filter
- Decoupling the power supply leads
- Getting rid of RF feedback - RF filtering for all inputs
- Tuning and testing
- Using the generator for AM modulation and CW
- Moving the 9 MHz SSB signal to a hamband
- Move the SSB only once!
- No wonder most ham rigs are tranceivers
- Moving the 9 MHz signal to the difficult HF hambands
- Move the VFO first, <u>then</u> mix it with the SSB 9 MHz.
- Pick your oscillator and VFO frequencies carefully
- Hearing your own VFO in the receiver
- The hardest band – 17 meters
- Covering the widest band – 10 meters
- A linear sideband QRP, VFO-tuned module
- All stages must be linear and low distortion
- All gain stages should be broadband to prevent oscillation
- Sometimes high pass filter output is needed & not the usual low pass
- Checking out the generator
- Driving a 50 watt linear amplifier

Chapter 16
ANCIENT MODULATION

- Defining amplitude modulation
- Modulating vacuum tube final amplifiers
- Plate, screen & cathode modulation
- A "collector modulator"
- Converting a MOSFET keyer into a modulator
- Generating AM with an SSB balanced modulator
- Compensating for non-linearity
- Compression by accident
- You probably don't need to build a compressor

In conclusion:

Homebrew ham radio is never complete - when it works perfectly and does all the latest stuff, the hobby is over. Not likely. Long live homebuilding!
Thanks for reading my book.

73's Frank W. Harris, KØIYE

Antennas for Radio Amateurs

If you can read in Russian you can download a free e-book "Antennas for Radio Amateurs" by Igor Grigorov, RK3ZK. The book is e- variant of a paper book with the same title. Paper book contains 256 pages and was issued in 1998 in Russia. One fragment of the book was translated in the English and was published at ANTENTOP- 1, 2003. Other fragments of the book also going to translated in the English. Below you can see the Contents of the book and path to load the Russian variant.

Antennas for Radio Amateurs
By Igor Grigorov, RK3ZK.

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Contents
Part- 1

Chapter- 1Vertical Antennas

1. Definitions and concepts.
2. Ground of a vertical antenna
3. Protection of the vertical antenna against atmospheric influences
4. Length of the vertical antenna.
5. Direction diagrams of vertical antennas installed above the ground
6. Matching of the vertical antenna
7. Kinds of vertical antennas
8. Vertical antennas placed to a corner to the ground
9. Influence of neighbouring subjects to a work of the vertical antenna
10. Influence of atmospheric electricity to the vertical antenna
11. Matching of vertical antennas of VHF mobile stations
12. Ground of the short vertical antennas
13. Whether is it necessary to dig counterpoises
14. Base of design of the multielement directed verticals
15. Base of design of the multielement directed verticals with passive elements
16. Phased vertical antenna systems
17. Asymmetrical verticals for the 160-meter range.
18. A broadband phased vertical antenna system with the adjustable directional diagram

Chapter 2 The Magnetic Loop Antenna

1. Using of magnetic loop antennas
2. Directional diagram of magnetic loop antennas
3. Ferrite antennas
4. Low- noise antennas 3. Ferrite antennas
4. Low- noise antennas
5. Effective height of the loop antenna.
6. Input resistance of the loop antenna
7. Ground for loop antennas
8. Matching a coaxial cable with transmitting magnetic loop antennas
9. Dimensions and design of magnetic loop antennas
12. Influence of atmospheric electricity and rain to the magnetic loop antennas
13. Magnetic loop antennas with aerials with cardioid pattern
14. Once more about about magnetic loop antennas

Chapter- 2 Loop Antennas

1. What is a loop antenna.
2. Input resistance, efficiency, gain and pattern of the classical loop antenna
3. Dimensions of the classical loop antenna
4. Loop with perimeter more than one wavelength
5. Feeding of the loop antenna
6. Horizontal loop antenna
7. Vertical loop antenna
8. Loop placed to a corner to the ground
9. Folded loop antennas
10. Short stub loop
11. Three-band loop antenna
12. Loop antenna shortening by a capacitor or inductor
13. Shunt loop antenna.
14. Helix loop antenna
15. Multiturn loop antennas
16. Broadband loaded loop antennas
17. Doubled loop antenna
18. Broadband and short zigzag loop antennas
19. Opened loop antennas
20. Multielement loop antennas with active elements
21. Multielement loop antennas with passive elements
22. Dimensions and design of multielement loop antennas
23. Multielement loop antennas with opened loops
24. Two-element antenna G4ZU
25. Placement of loop antenna near other subjects
26. Influence of atmospheric to the loop antenna

Chapter- 4 Rhombic Antenna

1. From antenna Beverage to rhombic antenna
2. Not optimal rhombic antenna
3. Optimal rhombic antenna
4. Efficiency and power
5. Pattern of the rhombic antenna

6. Substitute rhombic antennas
7. Lightening protection of rhombic antennas
8. Placement of rhombic antenna near other subjects

Part 2 Little-known antennas

Chapter 1 Antenna Beverage

1. Optimal antenna Beverage
2. Ground for antenna Beverage
3. Quarter wave counterpoises as ground for antenna Beverage
4. Load of the antenna Beverage
5. Length of the antenna Beverage
6. Efficiency of the antenna Beverage
7. Change of direction of lobes at pattern of the antenna Beverage
8. Practical design sides of the antenna feeding and load
9. Simplified antenna Beverage with the switched pattern
10. Installation of the antenna Beverage.
11. Lightening protection of the antenna Beverage

Chapter 2 Antenna DDRR

1. Type of antennas DDRR.
2. DDRR - a vertical radiator
3. Feeding of the antenna DDRR.
4. Efficiency of the antenna DDRR.
5. Half-wave antenna DDRR.
6. Spiral and line antenna DDRR.
7. Influence of atmospheric influences to antenna DDRR.
8. Influence of nearby subjects to antenna DDRR.
9. Practical design of feeding of antenna DDRR.
10. Broadband antenna DDRR.
11. Practical design of antenna DDRR.
12. Vertical design of antenna DDRR.

Part- 3 Invisible and substitute antennas

Chapter- 1 Invisible and substitute antennas

1. Electric antennas
2. Substitute asymmetrical antennas
3. Dipole substitute antennas

Chapter- 2 Making TV antennas work for amateur radio

Chapter- 3 Simple antennas for amateur radio expeditions

1. Dipole and loop antennas
2. Beam antennas
3. Vertical antennas

Part- 4 Antennas for the 6- meters range

Part- 5 Antennas for the 11- meters range

Part- 6 Feeders of radio amateur radio stations

Chapter- 1 Transmission lines

1. Work of transmission lines
2. Coaxial cables
3. Two wire lines
4. SWR at transmission lines
5. Substitute transmission lines
6. Home brew transmission lines

Chapter- 2 Symmetrical devices at transmission lines

Chapter- 3 The truth and lies of a SWR- meter

Part- 7 Interferences at amateur radio

1. Elimination of interferences at MW- SW ranges
2. Elimination of interferences making of VHF- stations
3. One more way of elimination TVI (***It was published at ANTENTOP-1, 2003, at the title***: **Nonlinear Effect on Antennas**)

Supplementary

Antennas Vocabulary

Russian Transceiver EFIR

EFIR- M

(credit line http://www.ruqrp.narod.ru/)

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Transceiver Efir was produced since the end of 70s of the 20 Century. Functional chart of the transceiver was the same as UW3D1- 2 transceiver had. However, Efir was made all of semiconductors, it did not contained any tubes. Transceiver Efir was produced for Soviet collective amateur radio stations, but sometimes, hams can buy Efir for private amateur radio stations. As a rule, the Efir need tuning because it was usually sold very crude by a plant.

In middle of 80s, the transceiver Efir- M has replaced the transceiver Efir. The transceiver Efir- M had a digital frequency scale, the transceiver contained modern semiconductors element base compare to the Efir.

Alas, the Efir- M also as the Efir was sold in very crude state. Its digital frequency scale gave big interferences at some ranges. Main transformer could not bear all output power there were also other serious lacks.

However the transceiver Efir has allowed to many Soviet collective amateur radio stations to work in the Air. Probably, approximately 5 percents of amateur radio stations in the USSR in the beginning of 90s used the Ether. Till now lots of hams use the transceiver. I did not have an Efir in the personal using, but I worked on it at a collective radio stations, and my opinion about the transceiver is enough warm.

- I used to the transceiver about 10 years for my work in the Air. Certainly, it is not FT-1000D, but my Efir worked very well. I installed an audio filter 300- 3500- Herz of an old Soviet VHF- radio at audio input, noise down at the transceiver. I think, it is quite good rig that could successfully work in the Air. Recently lots of old Efir are keeping at box- room because new ones equipment goes to ham shack. ***RK1NA***

- Well and I shall speak about lacks.
1.Efir has a backlash at the vernier.

2. Separate jacks for receiving input and transmitting output. It reduces to zero convenience both from VOX and from QSK.

3. Dynamic range is too poor, and sensitivity is not for reception of QRP-stations (by the way, I have not heard any QRP-station by my Efir

The used by me Efir was borrowed to me by a friend of mine, so, can not do any improving in this rig. I worked on SSB with Europe by a simple LW using the Efir, but I could not do any QSOs on CW. I think, it is not good rig, especially for QRP. ***RV3GM***

- I several times had deals with the Efir, one of the Efir worked at a club station where I was attended. I can only speak, Efir is a very good rig, but if it is tuned. Every Efir need to tune before operation because producers did not properly did tuning of the.
One my friend from Belgorod, did the tuning for lots of Efirs, and after that the tuned Efir worked fine, certainly, not as FT-1000D, but may be close (Hi). Yes, RV3GM is right, the vernier has a little backlash, but it is treated very easy. I awfully agree with RK1NA, Efir (tuned Efir) is a very good rig, ***RK3ZK***

UW3DI - THE TIMELESS TRANSCIEVER

Igor Grigorov, RK3ZK

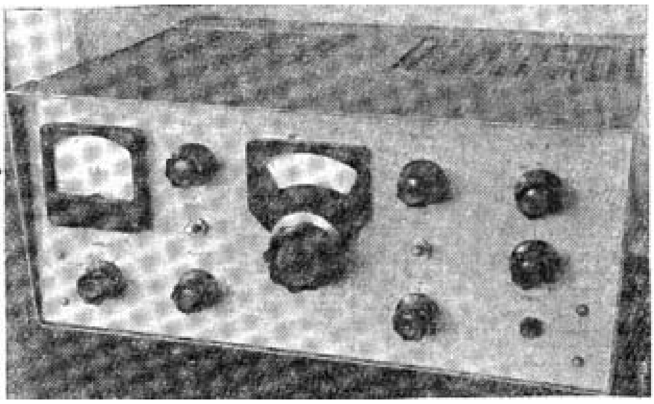
antentop@mail.ru

Schematic of the transceiver UW3DI at first time was published in 1970 at a Soviet ham magazine "Radio" # 5-6. The transceiver was named UW3DI by the callsign of its author, Jury Kudrjavtsev. Jury probably did not ever suspect, that his transceiver would be the most popular transceiver in the USSR and tens thousands copies of the transceiver would be made by Soviet hams.

Transceiver UW3DI was intended for work on cw/ssb at 80, 40, 20, 15 and 10 meters. The range of 10 meters was broken on two bands, 28,0- 28,5 and 28,5-29 MHz (when the WARC was obtained UW3DI got them also). Sensitivity of the receiver at ratio signal/noise of 10 dB is close to 0,5 µV. Power going to anode plate is close to 100 Wtts. Transceiver UW3DI contains 15 tubes and 24 semi-conductor diodes. At 21 exhibition of Creativity of Radio Amateurs, Moscow, the USSR, the transceiver took 1 place.
Later, in 1974, "Radio" was published a new schematic of UW3DI, known as UW3DI-2.

Local collectives of radio amateurs developed their own variants of UW3DI known as UW3DI-3, UW3DI-4, Donetskiy UW3DI, Krasnodarskiy UW3DI. Certainly, the classical variant is UW3DI-1, by "Radio" #5- 6, 1970.

Well, UW3DI is the most popular transceiver in the former USSR. Unfortunately, I do not have exact statistics on use of the transceiver by hams, but USSR's magazine "Radio" wrote, that in 70s approximately 75 percents of Soviet hams used the transceiver, 60 percents of Soviet hams used the transceiver in 80, and approximately 40-50 percents of Russian radio hams used UW3DI at 90s of the 20 Century. Recently at the 21 Century, only about 25 percents of Russian radio hams used UW3DI because wide spread of used Japanese transceivers and surplus military radio equipment. UW3DI was the constant member almost all of USSR's radioamateur expeditions. Till now UW3DI takes part at lots of radio expeditions.You can wonder, what gives to UW3DI such great popularity among hams. Certainly, it is simplicity of its circuit, good repeatability, and opportunity to reach high parameters by simple methods. Even an inexperienced ham can get good results making UW3DI. Probably, practically each ham of 70- 80s have made own UW3DI. By me was made two UW3DIIt was a very good practice for making and adjustment of the radio amateur equipment.



UW3DI (Radio #5, 1970)

UW3DI (A ham design of 90s)

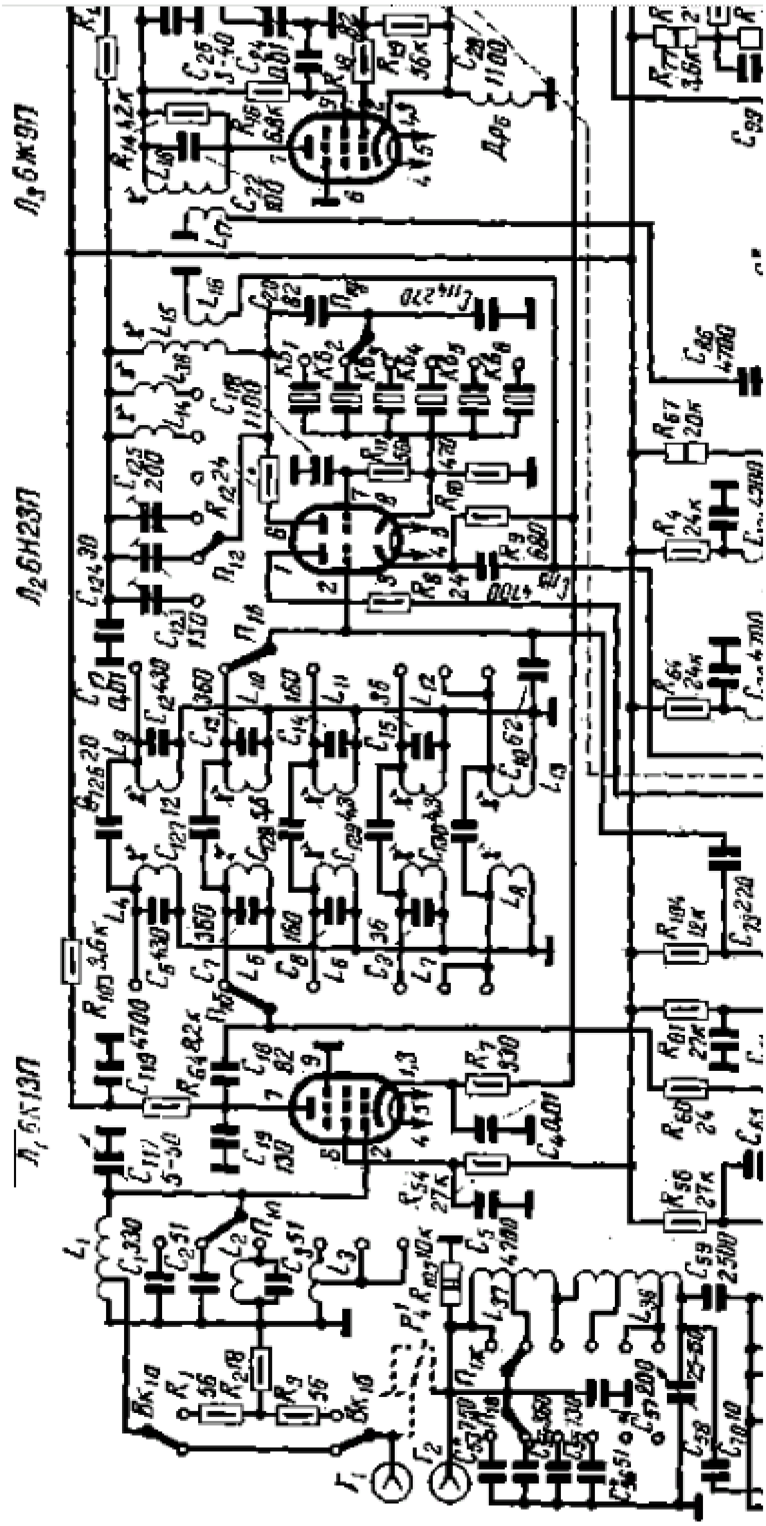
Till now, as I think, it is not present any alternative for UW3DI. In Russia there is no such simple and repeated transceiver. I can not understand, why lots of hams instead of doing the reliable tube UW3DI have started to do bulky transceivers on semiconductors. In a result, we have in the Air thousand of lame transceivers radiating poor signal

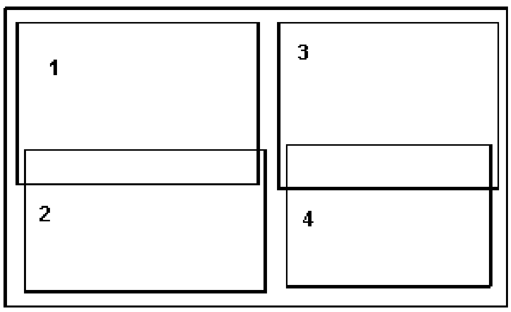
Correctly adjusted UW3DI has very good signal, as a rule, UW3DI has no TVI. Many times I have seen as in the same room a ham uses an UW3DI with a wire antenna, and his family watches TV free from any interferences.

Certainly, UW3DI is timeless transceiver and it leave for ever in memory of Soviet and Russian hams.

73! I.G.

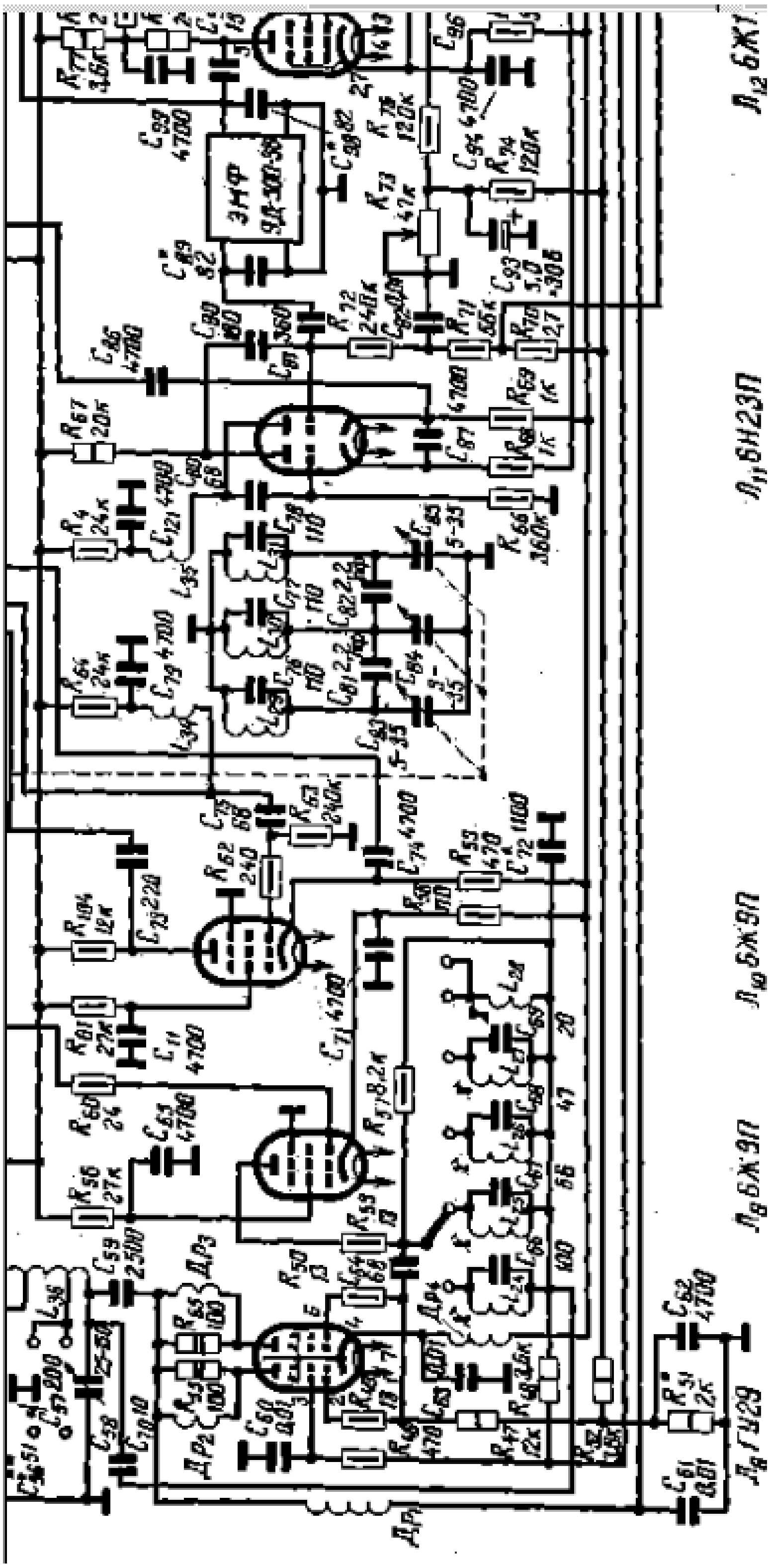
PART-1





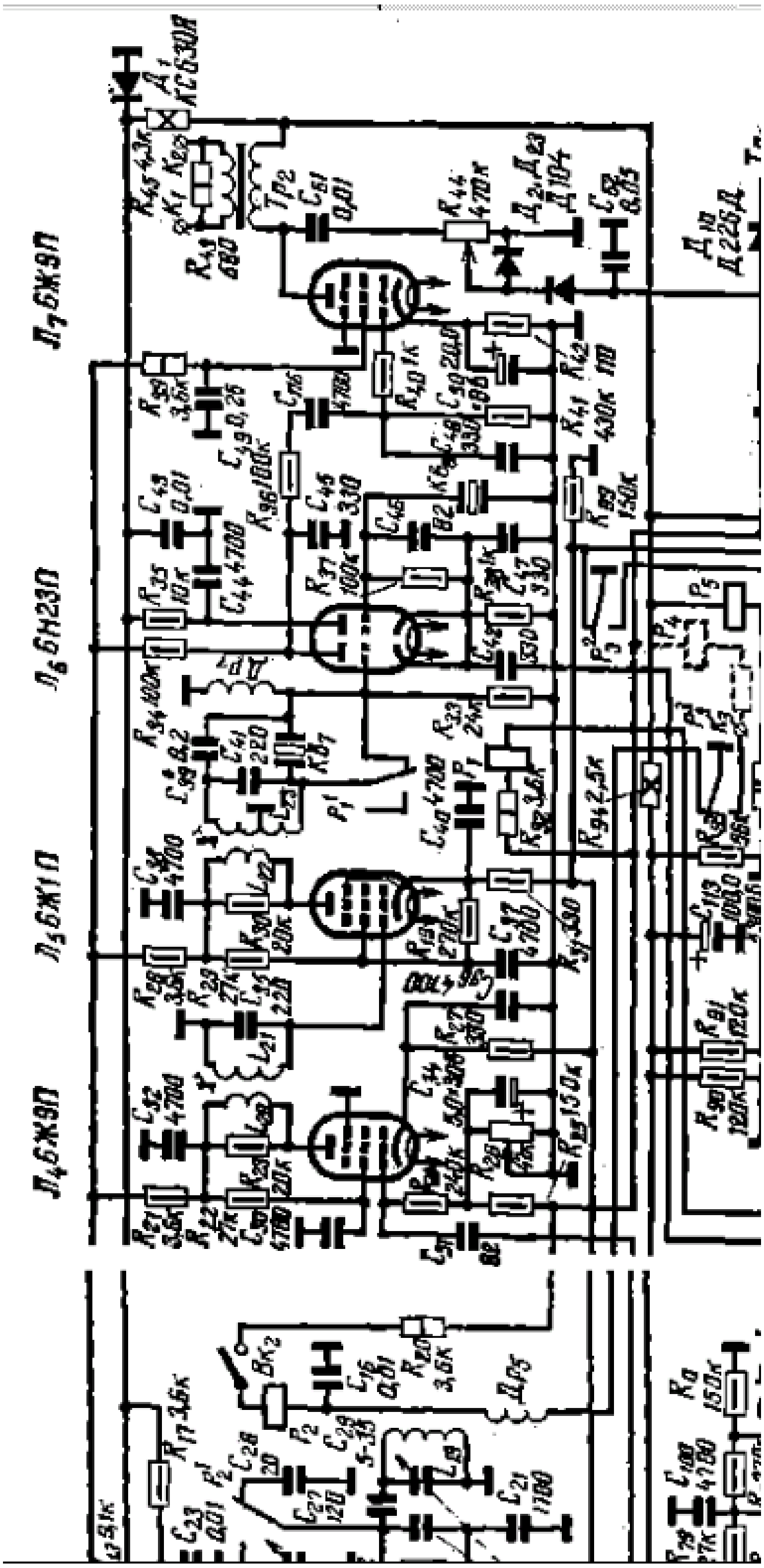
See the schematic of the UW3DI broken to four parts at pp.:82- 85

PART-2



http://www.antentop.bel.ru/

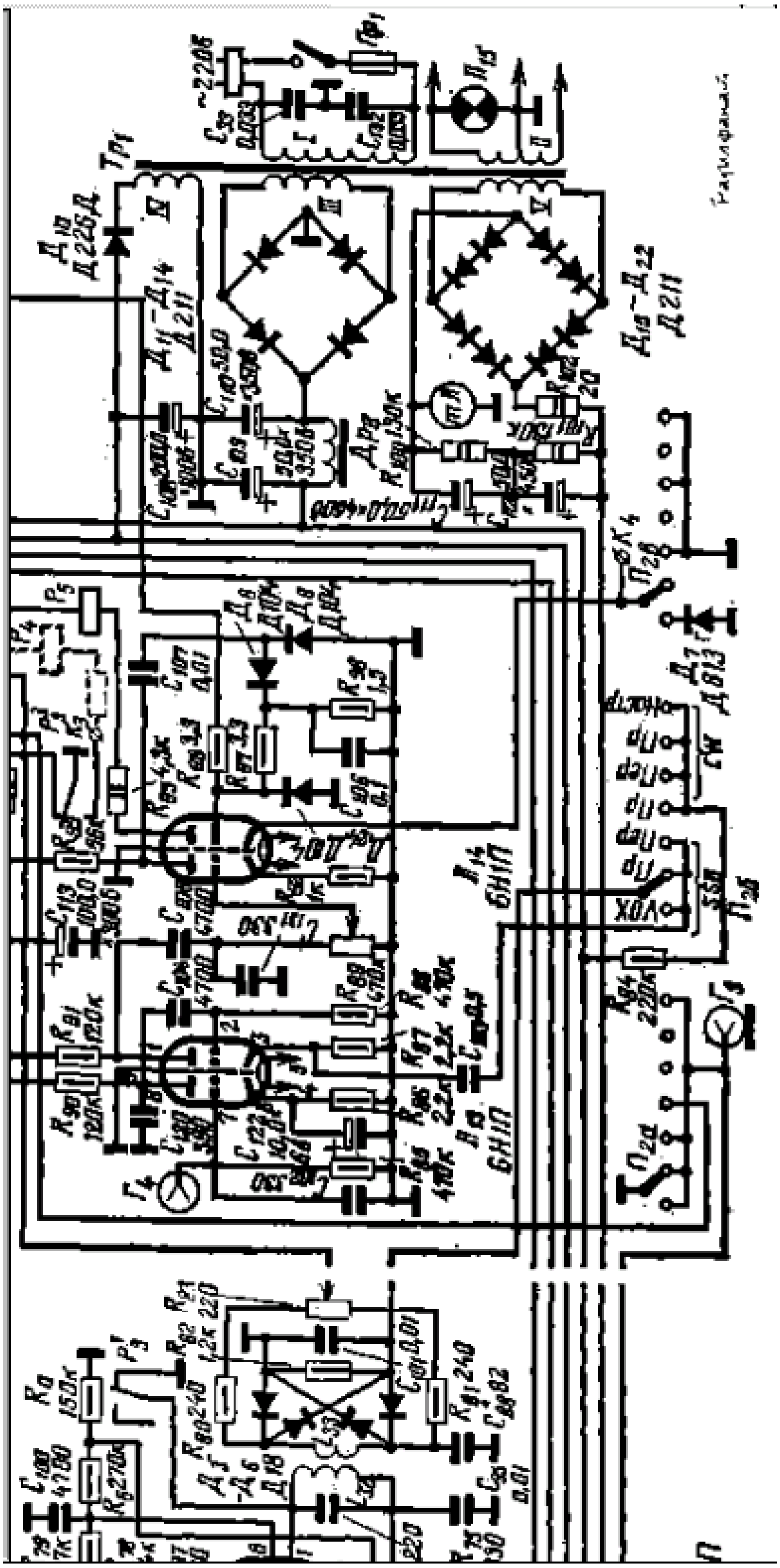
PART- 3



UW3DI

- *born in the USSR,*
- *may, 1970*

PART- 4



Scheme of UW3DI on djvu is at http://www.cqham.ru/

RUSSIAN DISTRICTS AWARD

A.] ATTENTION!!!
The Tambov award group ("TAG") would like to announce award program "RDA" (Russian Districts Award).

http://rdaward.org/rda_eng.htm

[B.] What is "RDA"?
"RDA" (Russian District Award) is an International Awards Program with the goal of attracting interest in Amateur Radio through the communication with various Districts in the Russian Federation. The "RDA" program is established to encourage confirmed contacts with the greatest variety of areas in Russia. There are currently 6 different certificate awards varying in difficulty and complexity, and two plaque awards available for "Honor Roll" and "#1 Honor Roll".

[C.] District assignments in the Russian Federation
The "RDA" Russian Districts Awards includes entities designated by the Russian Federation. These include a total of 2774 different districts inside 89 different Oblast. Many hours of work went into the dividing of Russian into territories. A unique number has been assigned to each district within an Oblast. For example the Oktjabrsky district in Tambov has been assigned TB-02. Confirmation of this information on the air and also on the QSL Card must be specified for credit to be awarded for the contact.

[D.] What system of calculation of results?
In offset radio communications with each district of Russia having unique number and only once are accepted. Repeated QSO with this district in offset are not accepted irrespective of you worked with radio station on the other band, or with other station from the same district.

[E.] Russian Districts Awards "RDA" Program Organization
"RDA" - committee is division "TAG" (Tambov Award Group), the radioamateur group engaged in the organization of radioamateur expeditions to various "districts" of Russia. The chairman "RDA" – committee and "RDA" - manager are appointed council "TAG". Decisions "RDA" - committee are published in various radioamateur DX-bulletins and are located on "RDA" a web-site. All financing of the program "RDA" is carried out from personal means of members of club "TAG".

[F.] Only for Russian dx-peditions

[G.] "RDA" Commitee Liability
The "RDA" manager, commitee and club members will not be responsible for any loss, financial or otherwise, caused by any actions of operators participating in the "RDA" awards program. The "RDA" holds no liability for actions taken by any member or non member active in the pursuit of "RDA" awards. Anyone entering the "RDA" program agrees to the terms disclosed here and can not hold the "RDA", "TAG" or any of its members, non-members, commiteemen, chairmen or other officers or officials liable for any actions taken by those involved in the program.

[H.] ALL DECISIONS MADE BY THE "RDA" COMMITEE ARE FINAL

http://rdaward.org/rda_photo.htm

Old Receiving Magnetic Loop Antennas

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*Receiving magnetic loop antennas were widely used in the professional radio communication from the beginning of the 20 Century. Since 1906 magnetic loop antennas were used for direction finding purposes needed for navigation of ships and planes. Later, from 20s, magnetic loop antennas were used for broadcasting reception. In the USSR in 20- 40 years of the 20 Century when broadcasting was gone on LW and MW, huge loop antennas were used on Reception Broadcasting Centers (**see pages 93- 94 about USSRs RBC**). Magnetic loop antennas worldwide were used for reception service radio stations working in VLW, LW and MW. The article writes up several designs of such old receiving loop antennas.*

LW- MW Huge Receiving Loop Antennas for Broadcasting and Direction Finding

In old radio textbooks you can find description of old magnetic receiving loop antennas. As a rule, old magnetic receiving loop antennas had a triangle or square shape, a side of the triangle or square had length in 10-20 meters. The huge square was put on to a corner. The distance from the ground up to lower wires of the magnetic receiving loop usually was not less than 4 meters. **Fig. 1A** shows a triangular receiving loop antenna consisting of two perpendicular loops, used for direction finding at airports **[1]**, **Fig. 1B** shows a square receiving loop antenna used on Broadcasting Radio Centers of the USSR at the end of 30s of the 20 Century **[15]**. Usually the receiving magnetic loop contained from one up to eight turns.

Fig. 2 shows a typical connection of the above mention huge magnetic receiving loop antennas designed for working on one fixing frequency to the receiver. To a resonance the loop A1 is tuned by lengthening coil L1 (sometimes two lengthening coils switched symmetrically to both side of the loop were used) and variable air-dielectric capacitor C1. T1 did connection with antenna feedline. L1, C1 and T1, as a rule, are placed directly near the antenna keeping minimum length for wires from the antenna to the parts. Certainly, there were others circuits for connection magnetic loops to a receiver, but the circuits were insignificantly distinguished from **Fig. 2**.

Small- Sized Magnetic Loop of a Local Broadcasting Radio Center

Huge loop antennas were used for cities Broadcasting Radio Centers, for local Broadcasting Radio Centers a small- sized loops were used.

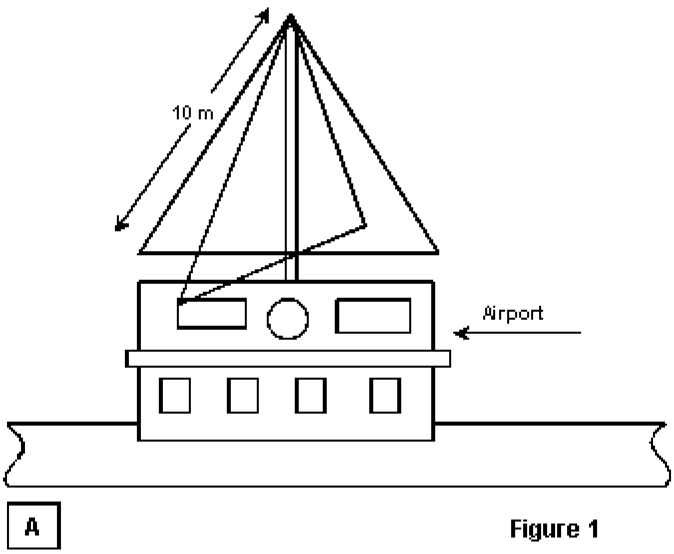

Figure 1 Old huge magnetic receiving loop antennas

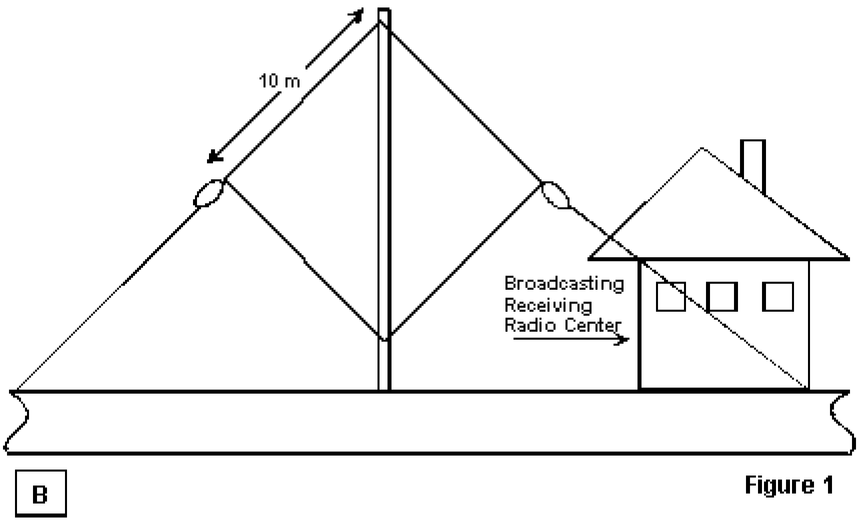

Figure 1 Old huge magnetic receiving loop antennas

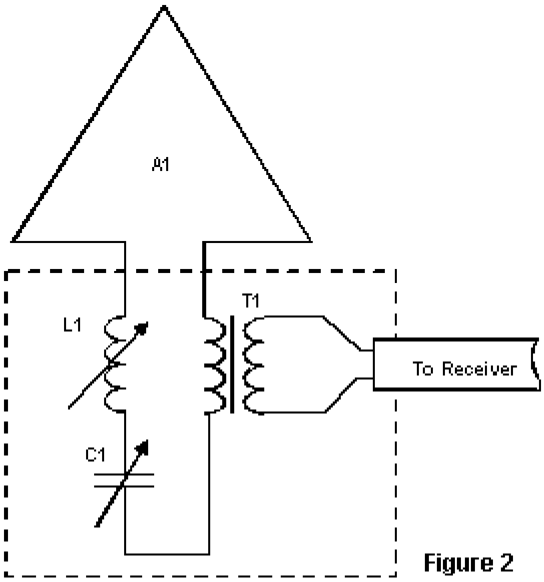

Figure 2 Connection of the reception magnetic loop to a radio receiver

Such small- sized receiving loop I have seen in an old village Broadcasting Radio Center in Central Russia, where I was occasionally in 80s of the 20 Century. The center was build in the beginning of 50 years of the 20 Century and till now was in work practically without changes. The broadcasting center settled down in a small room on a ground floor.

This rural Broadcasting Center contained a receiver PTS (see page 93- 94 about USSRs RBC) together with a small-sized loop antenna and an old tube audio amplifier, but I could not remember its type. All equipment was produced at the 50s. As I was told, the radio receiver and the audio amplifier of low frequency never were switched off from the main since the Broadcasting Center was in operation, so, the equipment were in continuous work already more than thirty years. Time to time the tubes of the receivers and amplifiers were changed, it was only that was done. Quality of work of the Broadcasting Center was great.

The most interesting part of this Broadcasting Center was a small-sized (certainly, small-sized in comparison with the antennas shown on **Fig. 1**) receiving magnetic loop antenna. By nameplate from the antenna I have known, that the antenna was made in 1949 on one of plants of Gorky (now Nizhniy Novgorod), Russia. **Fig. 3A** shows a design of the small-sized magnetic loop, and **Fig. 3B** shows the electric circuit of the antenna. Design and circuit, both, were pictured by me from the real loop.

The loop antenna (item 1) had diamond shape, sides had length in 105-cm (it was measured by a roulette), the loop was attached to a wooden cross (item 2), this one was covered by light lacquer. Overall height of the magnetic loop antenna was near to 2 meters. Antenna wires were more than 1-millimeter in diameter and were covered by thick black cotton isolation, a strong thin layer of light varnish covered the isolation.

The loop contained about 20 turns of the wire. The turns were rigidly settled down in trenches of plates (item 3), the plates were probably made of an ebonite. The distance between turns on the plates was equal to the diameter of the wire. The loop antenna was coupled to a receiver through a coupling loop (item 4) that contained 4 turns. The coupling loop was connected to a receiver through a feedline (item 5). The feedline has length near 3 meters and looks like a main wire.

A small wooden box (item 6) was in the bottom of the loop. A big three-section (each section has 12-500-pF) variable capacitor with vernier intended for tuning the loop to a resonance was in the box. Also there were taps switch S1 and two trap (L1C2 and L2C3) tuning to hindered broadcasting radio stations. The trap is switched to the feedline instead of crosspieces between clamping contacts K1K2 and K4K5. These contacts were established inside the box. Feedline contacts K3K6 were installed at a cheek of the box.

However small-sized magnetic loop antennas were used not only to Broadcasting Radio Centers. Earlier, in 30-50 years of the 20 Century such antennas frequently installed inside broadcasting receivers. Some designs of the inner loop antennas are shown below.

Basket Magnetic Loop Antenna

Receiving basket loop antennas were widely used for work with LW and MW receivers of direct amplification since of the end of 20s of the 20 Century. As a matter of fact, basket loop antennas are ones of the first types of magnetic loop antennas used by radio amateurs. Basket loop antennas were used both as to stationary receivers as to so called "suitcase receivers', i.e. tube receivers made inside a suitcase and intended to a movable work. Old radio magazines of 30- 50s of the last century contained hundreds designs of basket loop antennas.

Basket loop antennas were earlier so popular because, in the first, ever a radio amateur having a minimal experience of designing easily can make this one, in the second, a basket loop antenna can be made of any improvised material, and in the third, a basket loop antenna made even in home conditions works very effectively. The essence of the design of a basket loop antenna is that at its winding the step between turns is constant and equal to the diameter of the used wire (practically this step even bit more).

A coil, which has been reeled - up with such step, has rather small own parasitic capacity of turns to each other. It is possible to show, that the more parasitic own capacity of a coil is the less its Q is (see, for example, reference **[3]**). So, at a small own capacity a loop has high Q.

There are several basic points to pay attention at design of a basket loop antenna. A basket loop antenna can be reeled up on a plate from any dielectric stuff having small losses on frequencies where the antenna works. A basket loop antenna of LW- MW ranges can be made of a cardboard, wooden plate, PC- board, getinaks or ebonite. Pay attention, that some grey cardboard made of so-called "not washed" recycling paper (a paper

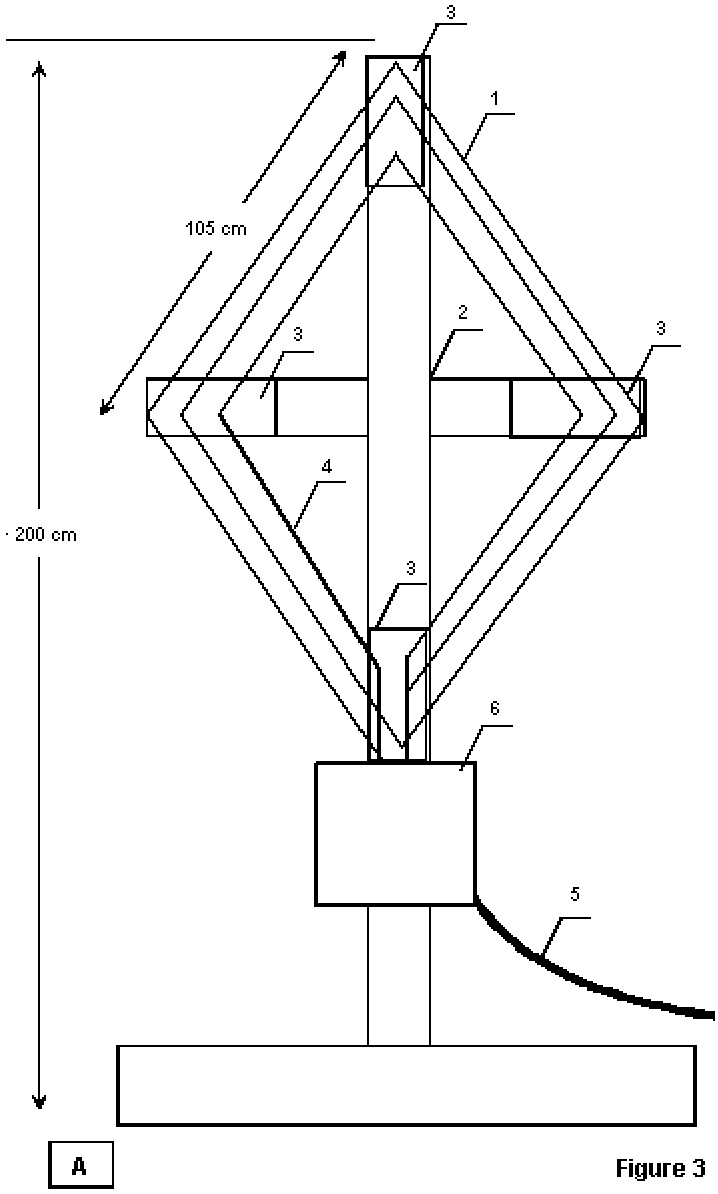

Figure 3 Small-sized receiving loop of a rural Broadcasting Radio Center

that is not washed off typographical paint) can have a big losses at LW- MW ranges, at least, in a microwave this cardboard is strongly heated up. Certainly, do not use the grey cardboard for a form of a basket loop antenna. Odd number slots are made in this dielectric plate, the more slots are done, the winding has more density Number of turns and sizes of an antenna form are depended on frequencies range used.

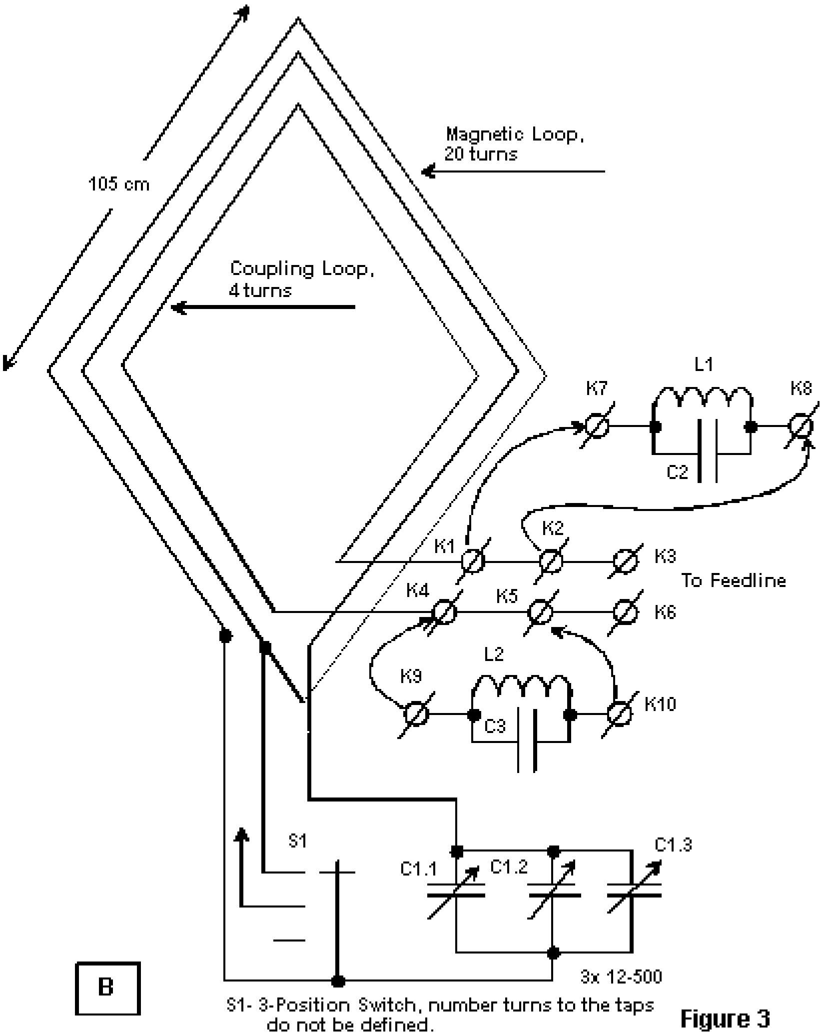

Figure 3 Small-sized receiving loop of a rural Broadcasting Radio Center

Basket Loop Antenna of a Simple Tube Receiver of Direct Amplification

Fig. 4 shows the circuit and design of a basket loop antenna intended for use in a simple three-tubes regenerative receiver for LW- MW. The receiver was described in the reference [5]. For design of the antenna a disk made of a cardboard or plywoods is used. The disk has diameter in 120 millimeters and the thickness in 3 millimeters. Five slots of 45 millimeters in the length of and 2-3 millimeters in width are done on the disk at equal distance one after the other. A special ledge for fastening the loop antenna is made on the disk. Magnetic loop antenna contained 250 turns of an insulated copper wire in diameter of 0,15-0,25 millimeters. Beginning of the reeling is up of the centre of the disk.

Taps are tapped from the loop for tuning the loop to a resonance. Taps are made from 50, 100, 150 and 200 turns. When you doing the taps, do not break off antenna wire, wind wire

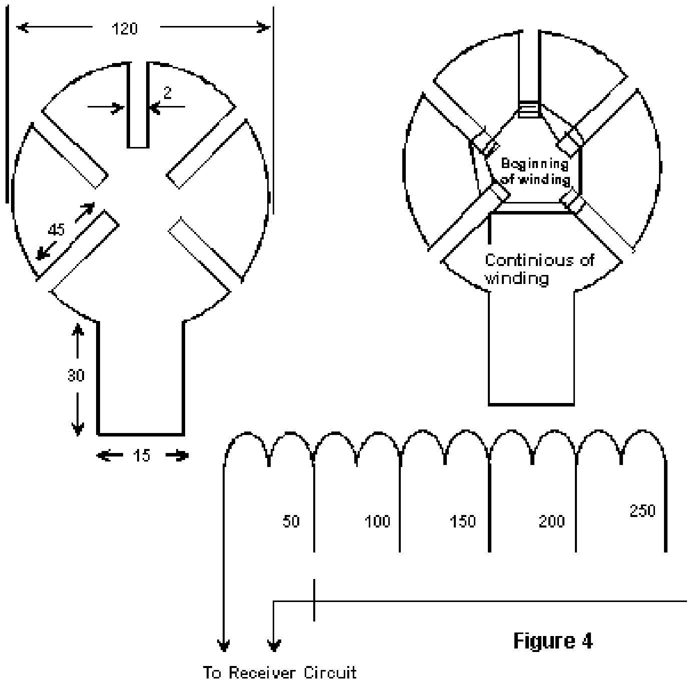

Figure 4 Magnetic basket loop antenna of a regenerative receiver of LW- MW

into a loop in length approximately 200 millimeters, then continue winding.

Basket Loop Antenna of a Simple Suitcase Tube Superheterodyne

Fig. 5 shows a basket loop antenna of a superheterodyne receiver of LW- MW made in a suitcase. The receiver was described in the reference [5]. The basket magnetic loop antenna is placed on a cover of a suitcase in which the receiver is placed. More slots - more density of winding of the loop.

The first section of the antenna contains 29 turns, it is winded by a Litz wire 10x0,07 (10 wire in diameter of 0,07 millimeters), as a last resort, this winding can be made by a wire of 0,4-0,5 millimeters in diameter. The first section starts to reel up from the internal part of the form. The second section of the antenna continues winding the first section, it is winded by a copper insulated wire of 0,2 millimeters in diameter and contains 70 coils. When the antenna works at MW the first section is shortened. At LW both section of the loop antenna are in work.

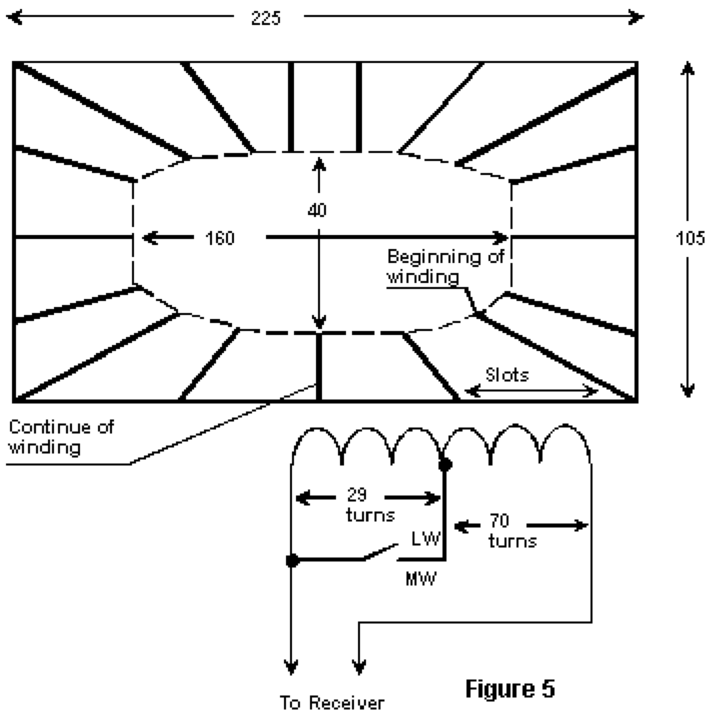

Figure 5 Magnetic basket loop antenna of a superheterodyne receiver of LW- MW

Magnetic Loop Antenna of a Suitcase Tube Superheterodyne

Certainly, not only basket loop antennas were used in old receivers. Simple loop antennas were widely used also. A simple superheterodyne LW- MW receiver made in

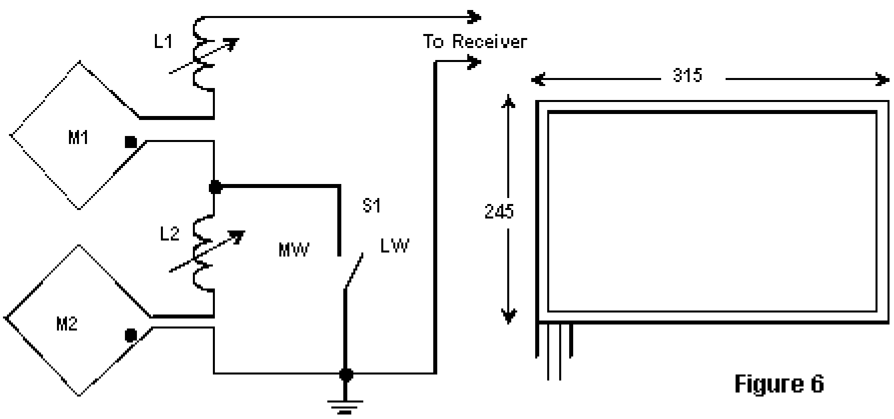

Figure 6 Magnetic loop antenna of a superheterodyne receiver of LW- MW

a suitcase and using a loop magnet antenna is described in the reference [5]. Fig. 6 shows the circuit and design of the loop antenna. It was used two magnetic loop antennas, M1 and M2. Lengthening coils are switched in serial with each loop antenna (L1 to M1 and L2 to M2), necessary for exact tuning of the loops to frequencies range needed. Both, M1 and M2 are used at LW. When the loop works at MW, M2 is shortened, and only M1 does receiving.

Magnetic antennas M1 and M2 have sizes 315x245 millimeters, M1 contains 14 turns of Litz wire 30x0,06, M2 contains 50 turns of Litz wire 15x0,05. As a last resort, instead of a Litz it is possible to use a copper insulated wire in diameter of 0,15 millimeters.

Lengthening inductor L1 contains 50 turns, lengthening inductor L2 contains 125 turns, the wire is Litz 15x0,05. These inductors are reeled on a form in diameter of 8 millimeters. The width of winding is 7 millimeters for both inductors.

Short Wave Magnetic Loop Antenna

Magnetic loop antennas were used not only for LW and MW, also the antennas were used for SW. For example, in the reference [5] it was described a SW magnetic loop antenna which was used for 19-75 meters. The loop antenna was simultaneously the input circuit of the receiver. A variable capacitor 12x500-pF does tuning to a resonance of the loop. Fig. 7 shows design of the antenna.

The antenna is made of a copper strip 6x3 (width in 6 millimeters, thickness in 3 millimeters). Such strip is used for winding welding transformers. The loop antenna contains 2 turns, the distance between the turns is 10 millimeters, inductance of the magnetic loop is 3,1-μH.

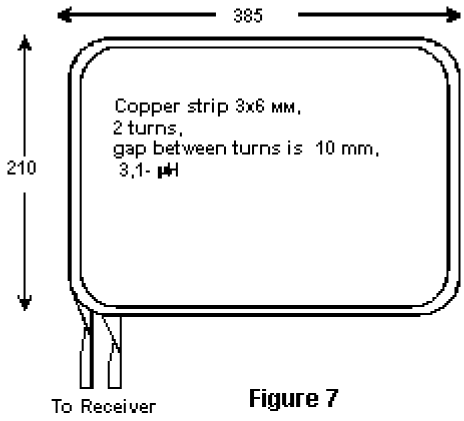

Figure 7 SW magnetic loop antenna

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2.. Sheinman A. Z. A collective- farm broadcasting center. Moscow, Zhurgazob'edinenie, 1938.

3. Atabekov G. I. Linear electric circuits. Moscow, Energy, 1978.

4. Amateur Battery Radio Receivers. Moscow, MRB, Gosenergoizdat, 1950.

5. Troickiy L. V. Circuits of Amateur Receivers. Moscow, MRB, Gosenergoizdat, 1956.

73! I.G.

BROADCASTING RECEIVERS OF THE USSR WIRE RADIO CENTERS

Vitaliy says us some historical notes about old USSR broadcasting receivers of Wire Radio Centers

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A broadcasting receiver is a specific type of radio-receiving devices designed for installation in the centers of wire broadcasting (***See Note***). The scope of their implementation was very wide: from miniature school R-centers to big rural and town ones. Those multi-tube superheterodynes of improved quality ensured stable and reliable tuning to the most far-off stations. By assembling of those receivers welding was applied instead of soldering to attain a better durability. For millions of citizens living in remote regions of this country that had no AC-nets in 1930-40's using a wire loudspeaker was almost a sole means of learning the latest news and getting all other kinds of information. The first special receivers for re-broadcasting were the TM-7 and TM-8 produced in 1938. The "Volna-T" set and the "Kazakhstan" with FM band were the last of the series of Soviet tube broadcasting receivers.

Note: Wire broadcasting center (**Figure 1**) had a directional antenna (item 1), as usual, at LW, MW and SW it is a magnetic loop antenna, a high-quality receiver (item 2) for a proper band, and a high powerful audio amplifier (item 3). Amplified audio signal is distributed through wire lines (item 4) to consumers living in to hundreds and ever thousands cities building (item 5). Consumers must have a simple loud speaker to be hearing the broadcasting. Wire broadcasting was widely used in the USSR since 30s till the end of the 20 century. Wire broadcasting has the profit that consumer must have only a simple loud speaker not a costly receiver. However, a consumer has not a choice, and must be hearing only the distributed through the wire broadcasting. Also wire broadcasting was widely used at Germany since 1935 till 1945. As usual, the directional antenna and high-quality receiver were situated in rural, where radio interferences have small level, a high powerful audio amplifier can be as in rural as in the city. (***I. G.***)

"Volna-T" broadcasting receiver. 1970's.

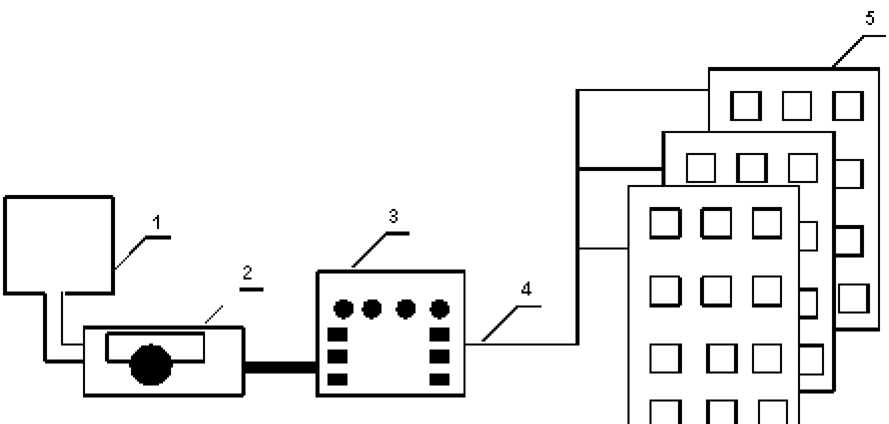
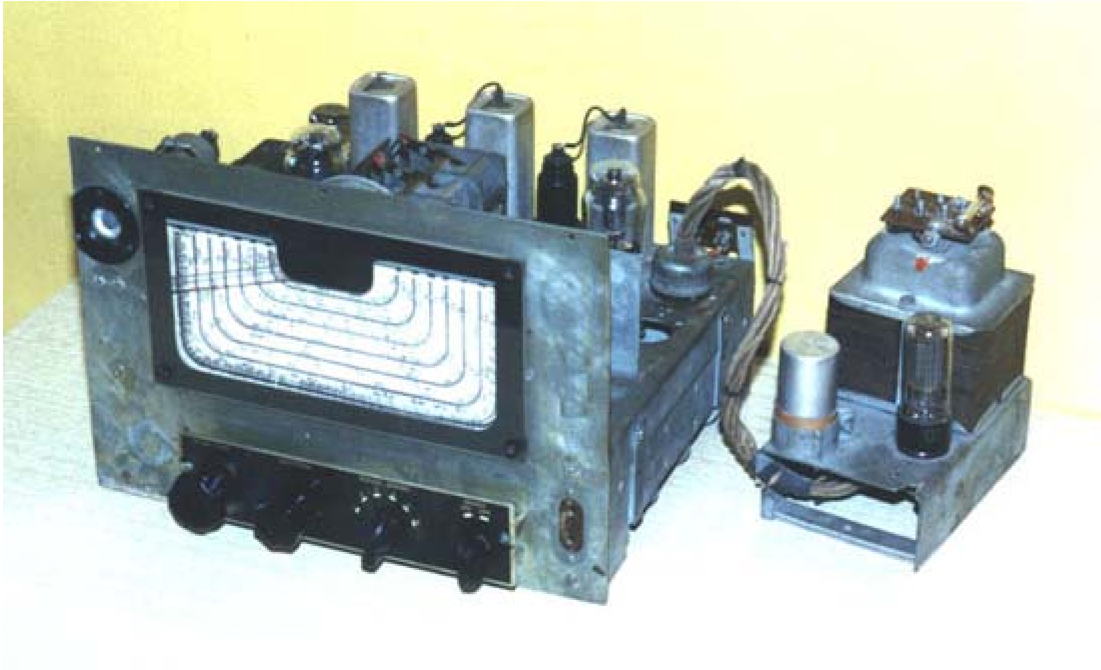


Figure 1

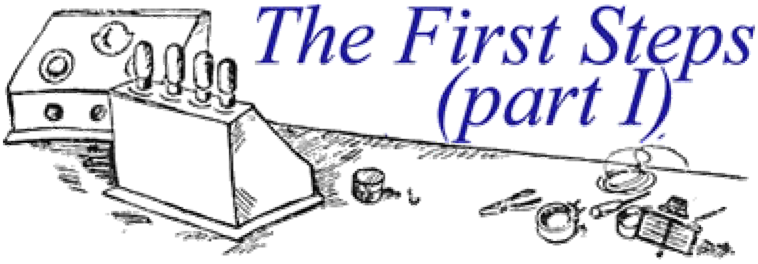


"PTS-47". Built-in broadcasting receiver. Model 1947.

"TPS-54". Built-in broadcasting receiver. Model 1954.

"TPS-58" Broadcasting receiver. Model 1958.

"Kazakhstan". Broadcasting receiver. Model 1963.



Vitaliy says us a story about beginning and the First Steps of Russian radio industry

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http://oldradio.onego.ru/

July 28, 1924 can be considered as the starting point of production of home receiving devices in the USSR. On that day The Soviet of People's Commissars (The Government) of the USSR passed a decree "On private receiving radio stations", which gave the citizens the right to own a radio set. And already in autumn of 1924 the Trust of Low Voltage Factories in Moscow put out the first industrial home radio receiver - **"LDV"** (Home Detector Broadcasting"). It had a fixed tuning to the wave of the Comintern Radiostation (3200 m). But it did not mean that tuning was no problem. The radio was based on a crystal detector with "an active point". The edge of a steel wire was touching a polycrystal of natural semiconductor. With a small knob the position of the steel pin could be changed.

After some attempts one could "feel" the detecting p-n-transition on the border of the "pin-crystal" and the broadcast was heard in the headphones. No one could move about the room not to "shake off" the active point.

The author has a similar detector at his disposal and tests showed that the ratio of direct and opposite resistance at the active point could reach 1:20. Of course, it is much lower than with a modern diode , but then it was sufficient for detection of signals of powerful local R-stations.

The modifications of radio "LDV" are known as **"LDV-2"** and **"LDV-4"**. Then followed **"LDV-3"**, **"LDV-5"** and **"LDV-7"** - complicated devices with changeable inductivity of the coil in 200-1500 m band. The detector receiver **"Proletary"** was also very popular.

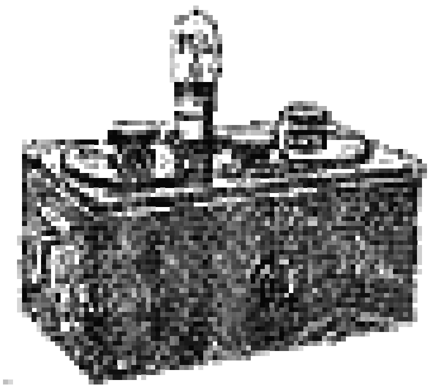
The first in USSR valve radio was produced at the end of 1924 by the above-mentioned Trust of Low-Voltage Factories. It was the receiving set "Radiolina", consisting of several blocks. The first of them contained a tunable coil with a span of 450-3400 m. The blocks of detector and RF-Audio amplifiers were connected to it.

The crystal DS-4

The first Rrussian vacuum tube was created in 1915 by M.A.Bonch-Brouyevich, a talented engeneer, when he was Chief of the military telegraphic receiver in Tver. This tube later nicknamed as the "Babushka" (Grandma) honestly worked in the receiver of telegraphic signals, successfully compete with imported French valves

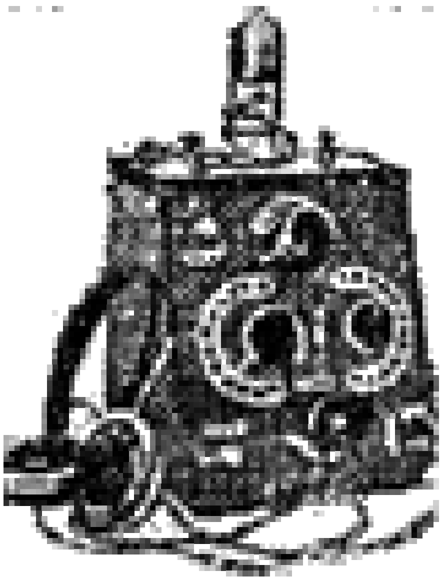
"Radiolina"

They were assembled in a separate case by 2,3 and 4 pieces. The anodes of the receiver's tubes were battery-sourced. In the first lots of the "Radiolina" the tubes R-5 with tungsten cathode were installed using the current of about 0,6 A. That is why accumulating battery was needed to feed the heater. The necessity of frequent recharging the battery strongly restricted the use of the radio set even in towns and cities. When new tubes of the "micro"-type appeared which used 10 times less energy there was a possibility to change the accumulators for galvanic elements. The "Radiolina" set had only one resonance coil and a very low sensitivity and selectivity. An electromagnetic horn speaker "DP" or (later) a diffusion-type "Rekord-2" was included into the set.



R-1

Almost simultaneously with the "Radiolina" a cheaper single-tube regenerative receiver **"R-1"** was produced in which headphones were used.



BV

The next series of Soviet radio receivers became really "mass media". It was a line of type "B" sets designed by E.Borusewich (an engineer of the Trust of Low-Voltage Factories). The production of those sets opened in 1926 with models **"BV"** (one-tube), **"BT"** (three-tube) and **"B4"** (four-tube). The "BT" and "B4" had equivalent schemes - two tunable coils and the structure 1-V-1 and 1-V-2 respectively. The "BV"-receiver could work with a usual crystal detector without any batteries. In all the stages of these radios 3-electrode tubes of the single type were used. The R-sets worked within 250-2000 m bands and enabled to receive broadcasts on the electromagnetic speaker "Rekord". In 1928 an improved version of the "B4"-set appeared, which was named **"B4N"**. It was also tuned out by the "Moselectric Works" (in Moscow). A more powerful tube of UO-3 type was used in audio output. The model **"B4Z"** ("B4"-closed) became a further modification of the "B4N" set. The scheme being unchanged all the tubes were put inside a case.

Together with the "B4N"-set a universal 2-tube receiver 0-V-2 of **"PL-2"**- type was produced. It could operate as both one- or two-tubed. Besides, in its construction usual "micro"-tubes and two-grid tubes of MDS-2 type could be used, the latter working on low anode voltage.

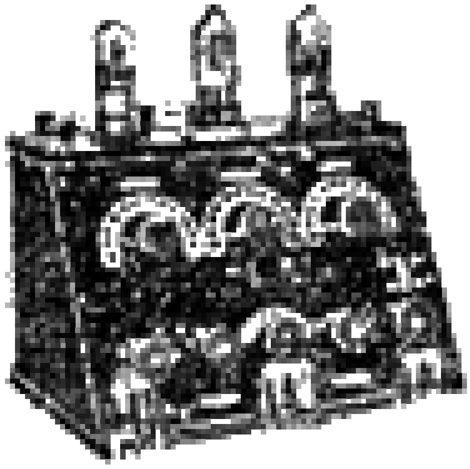
In all the above-mentioned receivers tubes of direct heating were installed. The output of radio model **"DLS-2"** was the first attempt to make net-supplied receivers. It is a device with a crystal detector combined with a 2-tube audio amp and a vacuum rectifier. It works using UO-3 tubes of direct heating. The output of tubes with indirect heating was the beginning of a new era in development of radiotechnics because then the problem of complete sourcing of radios from AC net was solved.

Among the first receivers of this type one can mention radio **"E4S-2"** of Orjonikidze Works ("Screened 4-tube AC-sourced") constructed by E.N.Genishta and radio **"EKL-4"** of Kozitsky Works (Leningrad). In both new tetrode tubes were applied. The further improvement of the former became radios "E4S-3" and "E4S-4" and of the latter - radio of **"EKL-34"** type. All those AC receivers were assembled according to the structure of direct amplification 1-V-2 using 4-volt glass tubes of indirect heating types SO-124 and SO-118. A triode UO-104 of direct heating was used in audio output. Those receivers enjoyed a wide spread among urban listeners. Just to mention also radios **"5NR-3"** and **"RP-8"** with the schematics similar to the above. The "U4S-1" set of Ukrainian make was also known.

In 1934 the Orjonikidze Works produced a battery-supply receiver **"BI-234"** ("Battery Individual") which gained a wide popularity among the rural listeners. A similar radio named **"RPK-9"** was later produced by Leningrad "Radist" Works. The difference was in their outlook.. The peculiarity of the set was that it could work using not a full set of tubes. Depending on their quantity the set could be switched on in the configurations 1-V-1, 1-V-0, 0-V-1 or 0-V-0. The mode of reception was set by replacement of the bridges. Its modifications are known to be the **"RPK-10"** and **"RPK-11"** .

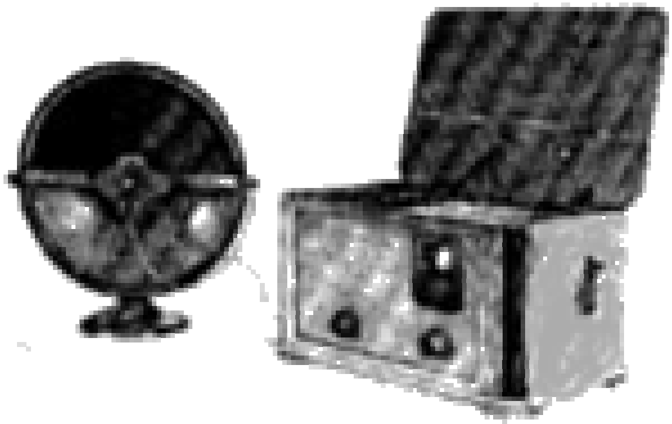
In 1935 the same Orjonikidze Works produced a new AC-radio **"SI-235"** ("AC-supply Individual" - constructed by P.A.Lokhvitsky), wich soon became the most numerous receiver among the urban listeners of the USSR. With this radio the era or direct amplification receivers ends. They were followed by multi-band superheterodynes - the ancestors of modern radio receiving systems.

In 1930's the output of cheap crystal radios continued. Among them there were the **"DV"** , **"P-8"** and some others.

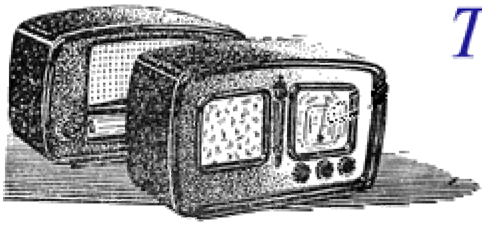


BT

B4N



E4S-2 with "Rekord" speaker



The First Steps (part II)

Vitaliy says us a story about beginning and the First Steps of Russian radio industry

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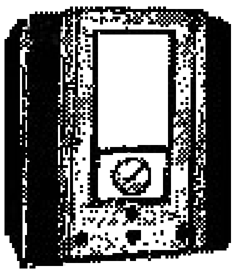
The first Soviet mass superheterodyne R-set model **"CRL-8"** designed by the Central Radio Laboratory was produced by the Leningrad Kozitsky Works at the end of 1935. On its base the a radiogramophone was created. The set used the tubes SO-182 (RF amp), SO-183 (mixer-oscillator), SO-182 (IF amp), SO-185 (detector-AF amp), SO-118 (AF step II), SO-187 (2 tubes in output "push-pull"), VO-188 (rectifier). It had 4 bands including 2 SW: 17-30 m and 30-60 m.

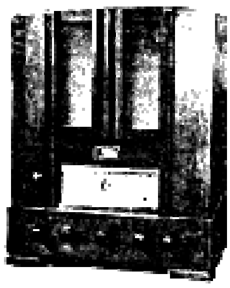


CRL-8

*However, attempts to construct a home superheterodyne were made earlier. For instance, as early as 1931 the Kozitsky Works produced some units of 6-tube battery-sourced "super" model **"SG-6"**. The set included a loop aerial and worked on tubes of PT-2 type.*

SG-6

Soon afterwards the Orjonikidze Works in Moscow commenced output of the **"SI-646"** superheterodyne(AC-net Individual Six-coil Four-tube Model of 1936"). In the first detector a SO-183 tube worked, in IF amp - a SO-182 one. The AF-step was using a SO-187 tube. The set had three quite modern bands - SW of 19-50 m, MW of 200-550 m and LW of 714-2000 m. It had a number of interesting constructive peculiarities. Among them there was a device for fine tuning in the form of an additional round scale with a revolving pointer and a tuning indicator on the base of a shadow galvanometer - "orthoscope". Similar indicators were used in some imported sets of that time (**"Tefag"** etc.).Unfortunately the super "SI-646" was produced only in small lots. Soon after the Kozitsky Works produced its all-band "super" - **"CRL-10K"**.



SG-646

Almost sumultaneously the Alexandrov Radio Works started production of its famous superheterodynes of first-class series **"SVD"** ("Superheterodyne All-band with a Loudspeaker") using as models the best American receivers of that time.The RCA radiotrones 6D6, 6A7, 6D6, 6V7, 76, 53, 80 were installed in the set.

At the beginning of 1938 the "Electrosignal" Works in Voronezh began mass production of none the less notorious radio of those times - the **"6N-1"** (initially spelled "6NG-1": 6-tube Tabletop with a Loudspeaker). It worked using metallic tubes with 6,3 V heating, production of which successfully began in the USSR in1937(6A8, 6K7, 6F5 - with a connection to the cap of the tube, 6F6, 5C4, 6X6, the 6E5 "magic eye"). The first batches of the this set were equipped with American tubes produced by the companies "RCA", "Ken-Rad", "Tung-Sol", "Sylvania" etc.

Then followed: the **"SVD-M"** using home-made metal tubes, the **"SVD-9"** and **"SVD-10"**. They were followed by the console radio-gramophone **"SVG-K"** (on the base of the "SVD-9" receiver), the receivers models **"9N-4", "10N-15", "5NU-8"**, **"5N-12"**, and the R-gramophone **"D-11", "10MG-16"**. Shortly before the Great Patriotic War (WW2), the following models were constructed: the **"Marshall"**, the **"Pioneer"**(the R-set and the radiogramophone), the **"KIM"**, the **"Orlionok"**, the **"Moskva"** (Factory of Culture Goods of the Rostokin District Industrial Trust), the new outer design of the "6N-1" receiver.

*Together with the superheterodynes cheaper receivers of direct amplification models **"T-35"** and **"T-37"** were produced by Tula Radio Works. The set **"TESD-2"** was manufactured by the same works.*

During the war the output of home receivers was practically stopped but by the end of the war the working out of new models was resumed. The first set produced at the end of the war was a mass "super" model **"Rekord"** with many later modifications **(1 ,2)**. It was turned out by several works. By 1946 mass production of receivers of pre-war models started and many new models followed. Some of them are the **"VEF M-557"**, the **"Moskvich"**(not to be confused with the mass R-set **"Moskvich-B"** of 1949's make), the **"Salyut"**, the **"M-648"**(Moskow Krasin Radio Works), the **"VV-661"**, the **"Riga T-689"**and the cheaper **"Riga T-755"**, the **"Minsk"**, the **"6N-25"**, the **"Vostok 7N-27"**, the **"Ural-47"** (the R-set and the radiogramophone), the **"VEF M-697"**, the **"Baku 6S-47"**, multi-tube the **"Belarus"** and the **"Leningrad"**. With introduction of 2-volt glass direct-heated tubes battery-sourced "supers" the **"4NBS-6"** and **"Rodina"**("Electosignal" Works in Voronezh) appeared. The modification of the latter the **"Rodina-47" ("Electrosignal-3")** gained a wide popularity. The AC-fed version of this set was produced by the works named **"Electrosignal-2"**.

The first attempt to create a light portable R-set was working out and production of a trial lot of the **"Efeer-48"** produced by the radio works in the town of Alexandrov (Central Russia). It used direct heating tubes with 1 V filament: 1A1P, 1B1P, 1K1P, 2P1P which had appeared by that time. The set looked like a small suitcase weighing 2,5 kG and had a built-in frame aerial. Later the portable models **"Tourist"**, **"Novj"**, **"Dorozhny"** using tubes of the same series became more popular.

Before the war the **"VEF M-1357"** receiver was also constructed. It was a 14-tube(!) device with auto tunning heterodyne, with an expander widening the dynamic range of the sound. It also had a preset tunning. A small lot of such R-sets was produced soon after the war. But it was a simplified version - without preset tuning.

All AC-net receivers produced after the war applied home metallic tubes of rather a high quality or their glass analogs (appeared later). Many receivers are in working condition even now and rather often use originally installed tubes of those times. The mass R-sets models the **"Moskvich-B"**, **"Minsk S-4"**, and **"ARZ"** were constructed with an economical reflex circuit which by the way showed a good stability.

To make the radios cheaper and reduce their weight universal power- transformerless source was provided in some models (the "Rekord", **"Rekord-47"**, "Leningrader", "Moskvich", "Moskva"). In models the "Moskvich-B", **"Record-52"** and "ARZ" a power autotransformer was installed. For transformerless schemes with series connection of tube filaments the tubes 30C1S, 25P1S, 30P1S with high-tension heating were specially designed. In basic models of few-tube receivers selenium pillars were applied to rectify the anode tension. In further modifications they were, as a rule, substituted for the vacuum rectifiers because of instability of the selenium ones which were produced then (the "Moskvich-B", "ARZ").

In those years fixed tuning to prechosen R-stations was applied not only in expensive sets (the "Belarus", "Leningrad") but also in mass ones (the "Moskva", "Leningrader"). As material for making cabinets apart from wood bakelite was used (the "Moskvich-B" and later the **"Ogonyok"**, **"Strela"**, **"Zarya"**, **"Riga-6"**) as well as metal (the "ARZ", "Riga T-755", later the **"Zvezda-54"**).

*Perhaps the biggest achievement of the home tube radio industry of the USSR of those days became the high-grade radiogramophone **"Riga"** put out by the "Radiotechnika" works in Riga. This apparatus absorbed all theoretic and practical achievements in the field of home radio of that period. The set was placed in a console of 1,3x0,5x1,0 m and consisted of a gramophone block with an auto 10-disk changer and an electronic block on 21 tubes. The characteristics of the set were considered very high which was ensured by the following schematic peculiarities: a complex speaker system of 3 woofers and a horn tweeter, a powerful push-pull output step using 2x2 6P3S (6L6) tubes, a deep tone control with bass boost system, wide range three-coil IF transformers with auto changing the range according to the level of incoming signal, a supereffective automatic gain control system, a noiseless tuning block. However, this "monster" did not go into mass production and existed only in several units. One of them is exposed at the Polytechnical Museum in Moscow. It is interesting to note that a mixed variety of tubes was applied in the receiver's scheme. For instance, in the IF-tract "old" 6K7 tubes were installed, but the oscillator was assembled on a Noval-penthode - 6G3P. All the rest are octal tubes quite usual in those years.*

The further development of home radio industry was connected with improvement of technical characteristics and technology of production of R-sets. But it were the first years after the war which laid a foundation of diversity of models and makes of the Soviet tube R-receivers reflected in the virtual exposition of ***http://oldradio.onego.ru/***

WIRE METRIC DIAMETER/GAUGE STANDARD

Number #		0000	000	00	0	1	2	3	4	5	6	7
Diameter in mm	SWG	10.16	9.45	8.84	8.23	7.62	7.01	6.40	5.89	5.38	4.88	4.47
	AWG	11.68	10.41	9.27	8.25	7.35	6.54	5.83	5.19	4.62	4.11	3.66
	BWG	11.53	10.80	9.65	8.64	7.62	7.21	6.58	6.05	5.59	5.16	4.57

Number #		8	9	10	11	12	13	14	15	16	17	18
Diameter in mm	SWG	4.08	3.68	3.25	2.95	2.64	2.34	2.03	1.83	1.63	1.42	1.22
	AWG	3.25	2.90	2.59	2.30	2.05	1.83	1.63	1.45	1.29	1.15	1.02
	BWG	4.19	3.76	3.40	3.05	2.77	2.41	2.11	1.83	1.65	1.47	1.24

Number #		19	20	21	22	23	24	25	26	27	28	29
Diameter in mm	SWG	1.02	0.92	0.81	0.71	0.61	0.56	0.51	0.46	0.41	0.38	0.35
	AWG	0.91	0.81	0.72	0.64	0.57	0.51	0.45	0.40	0.36	0.32	0.29
	BWG	1.07	0.89	0.81	0.71	0.64	0.56	0.51	0.46	0.41	0.35	0.33

Number #		30	31	32	33	34	35	36	37	38	39
Diameter in mm	SWG	0.30	0.29	0.27	0.254	0.229	0.203	0.178	0.17	0.15	0.127
	AWG	0.25	0.23	0.20	0.18	0.16	0.14	0.13	0.11	0.10	0.08
	BWG	0.30	0.25	0.229	0.203	0.178	0.127	0.102			

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