ANTENTOP

ANTENTOP 02 2010 # 014

ANTENTOP is *FREE* e-magazine devoted to ANTENna's
Theory,
Operation, and
Practice
Edited by hams for hams

2-2010

In the Issue:
Antennas Theory!

Practical design of HF Antennas!

Underground Antennas!

EH- Antennas!

TV- Antennas!!

QRP Transceiver!

And More….

EH- Antenna 160- m
UA1ACO

Thanks to our authors:

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And others…..

UA6HJQ Experimenters with hand- held

EDITORIAL:

Well, my friends, new ANTENTOP – 02 -2009 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 –2010 contains antenna articles, description of antenna patent, QRP- Stuff. 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, VA3ZNW

ex: RK3ZK, UA3-117-386, UA3ZNW, UA3ZNW/UA1N, UZ3ZK
op: UK3ZAM, UK5LAP, EN1NWB, EN5QRP, EN100GM

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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 8-10 month or so. A whole issue of ANTENTOP 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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Your opinion is important for me, so, contact if you want to say something!

Copyright Note:

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73! ***Igor Grigorov***, VA3ZNW

ex: UA3-117-386, UA3ZNW, UA3ZNW/UA1N, UZ3ZK, RK3ZK

op: UK3ZAM, UK5LAP,EN1NWB, EN5QRP, EN100GM

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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.

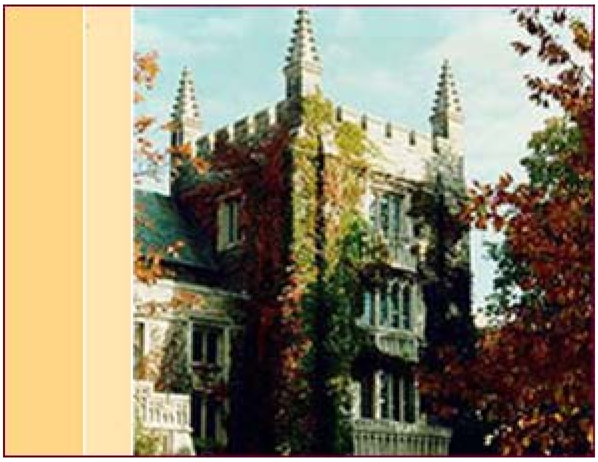
Now I know, that the Lecture is one of popular topics of ANTENTOP. Every Antenna Lecture was downloaded more than 1000 times!

Now I want to present to you one more very interesting Lecture - it is a Lecture Antenna Noise Temperature and System Signal-to Noise Ratio. I believe, you cannot find such info anywhere for free! 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

Antenna Noise Temperature and System Signal-to Noise Ratio

(The performance of a telecommunication system depends very much on the signal-to-noise ratio (SNR) at the receiver's input. The electronic circuitry of the receiver (amplifiers, mixers, etc.) has its own contribution to the noise generation. However, the antenna itself is a significant source of noise…)

by Prof. Natalia K. Nikolova

Lecture 7: Antenna Noise Temperature and System Signal-to-Noise Ratio

1. Antenna temperature

The performance of a telecommunication system depends very much on the signal-to-noise ratio (SNR) at the receiver's input. The electronic circuitry of the receiver (amplifiers, mixers, etc.) has its own contribution to the noise generation. However, the antenna itself is a significant source of noise. The antenna noise can be divided into two types of noise according to its physical source:

- noise due to the loss resistance of the antenna itself; and
- noise, which the antenna picks up from the surrounding environment.

Any object whose temperature is above the absolute zero radiates EM energy. Thus, each antenna is surrounded by noise sources, which create noise power at the antenna terminals. Here, we will not be concerned with technological sources of noise, which are a subject of the electromagnetic interference science. We are also not concerned with intentional sources of electromagnetic interference. We are concerned with natural sources of EM noise, such as sky noise and ground noise.

The concept of antenna temperature is not only associated with the EM noise. The relation between the object's temperature and the power it can create at the antenna terminals is used in passive remote sensing (radiometry). A radiometer can create temperature images of objects. Typically, the remote object's temperature is measured by comparison with the noise due to background sources and the receiver itself.

Every object with a physical temperature above zero ($0^\circ \mathrm{K} = -273^\circ \mathrm{C}$) possesses heat energy. The noise power per unit bandwidth is proportional to the object's temperature and is given by the Nyquist's relation:

$$p_h = kT_P \text{, W/Hz} \tag{7.1}$$

where

T_P is the physical temperature of the object in K (Kelvin degrees); and

k is Boltzmann's constant (1.38×10^{-23} J/K).

Often, the heat energy is assumed evenly distributed in a certain frequency band Δf. Then, the associated heat power in the frequency band Δf is:

$$P_h = kT_P \Delta f \text{, W} \tag{7.2}$$

Every object with a physical temperature above zero and possessing some finite conductivity radiates EM power. This power depends on the ability of the object's surface to let the heat leak out. This radiated heat power is associated with the so-called ***equivalent temperature*** or ***brightness temperature*** of the body via the power-temperature relation in (7.2):

$$P_B = kT_B \Delta f \text{, W} \tag{7.3}$$

The brightness temperature T_B is proportional to the physical temperature of the body T_P:

$$T_B = (1 - |\Gamma_s|^2) \cdot T_P = \varepsilon T_P \text{, K} \tag{7.4}$$

where:

Γ_s is the reflection coefficient of the surface of the body for the given polarization of the wave; and

ε is called the ***emissivity*** of the body.

The power radiated by the body P_B (the power associated with the brightness temperature), when intercepted by the antenna, creates power at the antenna terminals P_A. The equivalent temperature associated with the received power P_A at the antenna terminals is called ***antenna temperature*** T_A of the object, where again $P_A = kT_A \vartriangle f$.

The received power can be calculated if the antenna effective aperture A_e (m^2) is known and if the power density W_B (W/m^2) created by the bright body at the antenna's location is known:

$$P_A = A_e W_B \text{, W} \tag{7.5}$$

If the body radiates isotropically in all directions, then

$$W_B = \frac{P_B}{4\pi R^2} \text{, W/m}^2 \tag{7.6}$$

where

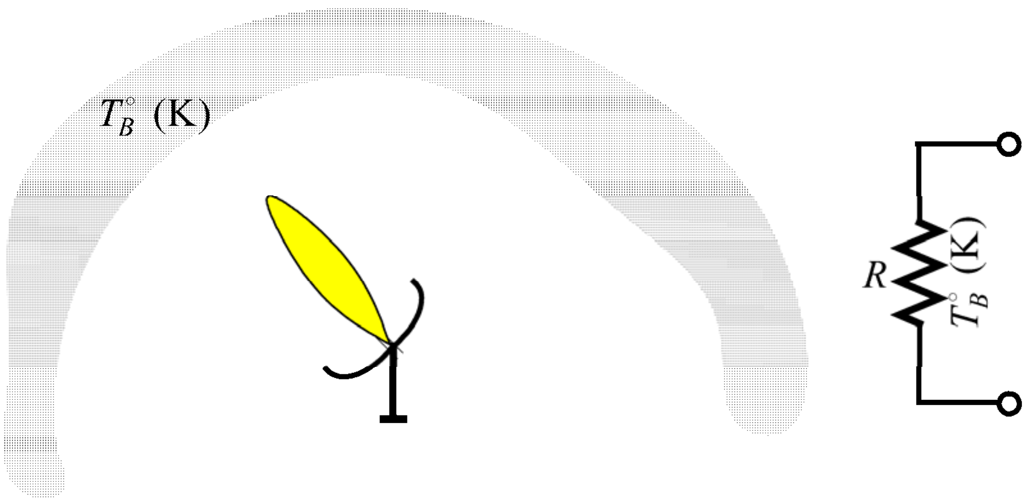
$P_B = kT_B \vartriangle f$ (W) is the brightness power radiated from the body,

R (m) is the distance between the object and the antenna.

Let us first assume that the entire antenna pattern (beam) “sees” an object of temperature T_B (K). We will assume that the antenna itself is lossless, i.e. it has no loss resistance, and, therefore, it does not generate noise itself. Then, certain noise power can be measured at its terminals as:

$$P_A = kT_B \Delta f \text{, W} \tag{7.7}$$

This is the same power as the power that would be generated by a resistor set at temperature T_B (K).



The antenna temperature is related to the measured noise power as:

$$P_A = kT_A \Delta f \tag{7.8}$$

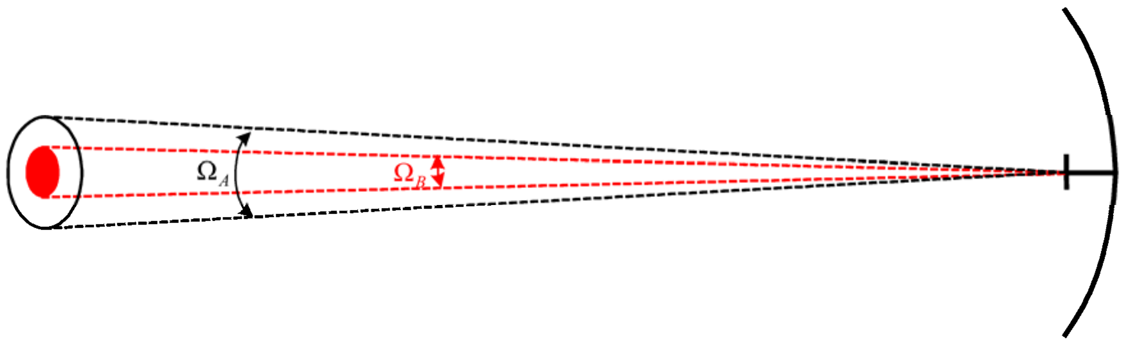
In the case described above (where the solid angle subtended by the noise source Ω_B is much larger than the antenna solid angle Ω_A), the antenna temperature T_A is exactly equal to the object’s temperature T_B (if the antenna is loss-free):

$$T_A = T_B, \text{ if } \Omega_A \ll \Omega_B \tag{7.9}$$

The situation described above is of practical importance to the overall antenna noise performance. When an antenna is pointed right at the night sky, its noise temperature is very low: $T = 3^\circ$ to 5° K at frequencies between 1 and 10 GHz. This is exactly the noise temperature of the night sky. The higher the elevation angle, the less the sky temperature is. Sky noise is very much dependent on the frequency. It depends on the time of the day, too. It is due to cosmic rays (emanating from the sun, the moon and other bright sky objects), to atmospheric noise and also to man-made noise.

The noise temperature of ground is about $\approx 300^\circ$ K, and, of course, varies during the day. The noise temperature at approximately zero elevation angle (horizon) is about 100° to 150° K.

The opposite special case arises in radiometry and radioastronomy. The bright object (noise source) subtends such a small solid angle that it is well inside the antenna solid angle when the antenna is pointed at the object: $\Omega_B \ll \Omega_A$.



To separate the power received from the bright body from the background noise, the difference in the antenna temperature ΔT_A is measured with the beam on and off the object.

In the above case, the difference in the antenna temperature is not equal to the bright body temperature T_B, as it was in the case of a large noise object. However, both temperatures are proportional. The relation is derived below. The noise power intercepted by the antenna depends on the antenna effective aperture A_e and on the power density at the antenna's location created by the noise source W_B:

$$P_A = A_e W_B \text{, W} \tag{7.10}$$

We will assume that the bright body radiates isotropically, and we will express the effective area by the antenna solid angle:

$$P_A = \frac{\lambda^2}{\Omega_A} \cdot \frac{P_B}{4\pi R^2} \text{, W} \tag{7.11}$$

The distance between the noise source and the antenna R is related to the effective area of the body and the solid angle Ω_B it subtends as:

$$R^2 = \frac{S_B}{\Omega_B} \text{, m}^2 \tag{7.12}$$

$$\Rightarrow P_A \Omega_A = \frac{\lambda^2}{4\pi S_B} P_B \Omega_B \tag{7.13}$$

Notice that

$$\frac{\lambda^2}{4\pi S_B} = \frac{1}{G_B} = 1 \tag{7.14}$$

Here, G_B is the gain of the bright body, which is unity because it was assumed that the body radiates isotropically. Thus,

$$P_A \Omega_A = P_B \Omega_B, \text{ if } \Omega_B \ll \Omega_A \tag{7.15}$$

Equation (7.15) leads directly to the relation between the brightness temperature of the observed object and the differential antenna temperature that is measured at the antenna terminals:

$$\Delta T_A = \frac{\Omega_B}{\Omega_A} T_B \text{, K} \tag{7.16}$$

In general, the total antenna noise power will be made up by the weighted contributions of various sources whose temperature will vary with the angle of observation (θ,φ). The weighting factor is the power pattern of the antenna $F(\theta,\varphi)$.

$$T_A = \frac{1}{\Omega_A} \oiint_{4\pi} F(\theta,\varphi) \cdot T_B(\theta,\varphi) d\Omega \qquad (7.17)$$

Expression (7.17) is general, and the previously discussed special cases are easily derived from it. For example, assume that the brightness temperature surrounding the antenna is the same at all observation angles, $T_B(\theta,\varphi) = const = T_{B0}$. Then,

$$T_A = \frac{T_{B0}}{\Omega_A} \cdot \underbrace{\oiint_{4\pi} F(\theta,\varphi) d\Omega}_{\Omega_A} = T_{B0} \qquad (7.18)$$

The above situation has already been discussed in TP8 and TP9.

Assume now that $T_B(\theta,\varphi) = const = T_{B0}$ but only inside a solid angle Ω_B, which is much smaller than the antenna solid angle Ω_A. Outside Ω_B, $T_B(\theta,\varphi) = 0$. Since $\Omega_B \ll \Omega_A$, when the antenna is pointed at the noise source, its normalized power pattern within Ω_B is $F(\theta,\varphi) \simeq 1$. Then,

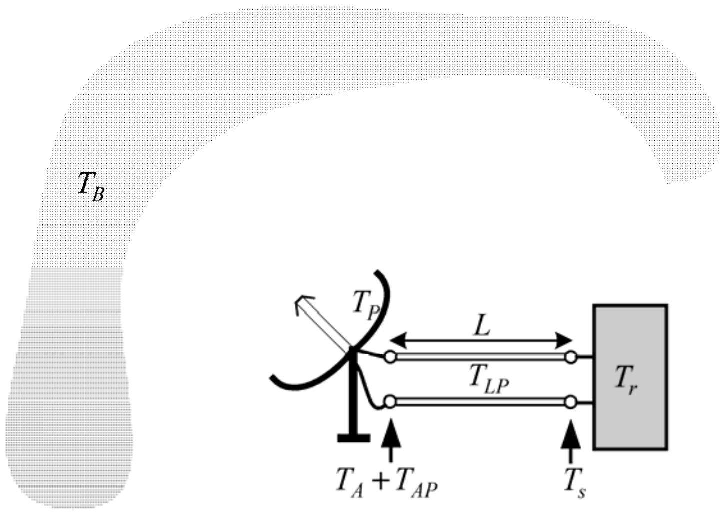
$$T_A = \frac{1}{\Omega_A} \oiint_{4\pi} F(\theta,\varphi) \cdot T_B(\theta,\varphi) d\Omega = \frac{1}{\Omega_A} \iint_{\Omega_B} 1 \cdot T_{B0} \cdot d\Omega = T_{B0} \frac{\Omega_B}{\Omega_A} \qquad (7.19)$$

This case has already been discussed in TP14, TP15 and TP16.

The antenna pattern strongly influences the antenna temperature. High-gain antennas (such as reflector systems), when pointed at elevation angles close to zenith, have negligibly low noise level. However, if an antenna has significant side and back lobes, which are pointed toward the ground or the horizon, its noise power is much higher. The worst case for an antenna is when its main beam points towards the ground or the horizon, as is often the case with radar and radio relay station antennas.

2. System temperature

An antenna is a part of a receiving system, which, in general, consists of a receiver, a transmission line and an antenna. All these system components have their contribution to the system noise. The system temperature (or the system noise level) is a critical factor in determining the sensitivity and the SNR of a receiving system.



If the antenna has some losses, then, at its terminals, the noise temperature consists of two terms: the antenna temperature due to the environment surrounding the antenna T_A, and the temperature due to the physical temperature of the antenna, T_{AP}. The last term is related to the physical temperature of the antenna T_P as:

$$T_{AP} = \left(\frac{1}{e_A} - 1\right) T_P, \text{ K} \qquad (7.20)$$

e_A is the *thermal efficiency* of the antenna $(0 \le e_A \le 1)$.

The transmission line itself is a source of noise if it has conduction losses. Its noise contribution at the antenna's terminals is:

$$T_L = \left(\frac{1}{e_L} - 1\right) T_{LP}, \text{ K} \qquad (7.21)$$

Here, $e_L = e^{-2\alpha L}$ is the *line thermal efficiency* $(0 \le e_L \le 1)$, T_{LP} is the physical temperature of the transmission line, α (Np/m) is the attenuation constant of the transmission line, and L is the length of the transmission line.

The total antenna noise power (which is proportional to the total antenna noise temperature) is transferred to the receiver's input through a transmission line, which is, in general, lossy with certain attenuation constant α (Np/m). So is the transmission-line noise power, as calculated with respect to the antenna terminals. Thus, at the receiver's input, the noise temperature due to the antenna and the transmission line is

$$T_{AL} = (T_A + T_{AP} + T_L) \cdot e^{-2\alpha L}, \text{ K} \qquad (7.22)$$

$$\Rightarrow T_{AL} = (T_A + T_{AP}) \cdot e^{-2\alpha L} + T_{LP}(1 - e^{-2\alpha L}), \text{ K} \qquad (7.23)$$

To the noise temperature calculated in (7.23) one has to add that of the receiver T_r. Thus, the system noise temperature is calculated as:

$$T_S = (T_A + T_{AP}) \cdot e^{-2\alpha L} + T_{LP}(1 - e^{-2\alpha L}) + T_r, \text{ K} \qquad (7.24)$$

The receiver's noise temperature is given by:

$$T_r = T_1 + \frac{T_2}{G_1} + \frac{T_3}{G_1 G_2} + \cdots, \text{ K} \qquad (7.25)$$

where:

T_1 is the noise temperature of the first amplifying stage;
G_1 is the gain of the first amplifying stage;
T_2 is the noise temperature of the second amplifying stage;
G_2 is the gain of the second amplifying stage.

3. System signal-to-noise ratio (SNR)

The system noise power is related to the system noise temperature as:

$$P_N = kT_s \triangle f, \text{ W} \qquad (7.26)$$

From Friis transmission equation:

$$P_r = (1 - |\Gamma_t|^2)(1 - |\Gamma_r|^2) e_t e_r |\hat{\rho}_t \cdot \hat{\rho}_r|^2 \left(\frac{\lambda}{4\pi R}\right)^2 D_t(\theta_t, \varphi_t) D_r(\theta_r, \varphi_r) \cdot P_t \qquad (7.27)$$

one can calculate the signal power P_r. Thus, the SNR ratio becomes:

$$SNR = \frac{P_r}{P_N} = \frac{(1 - |\Gamma_t|^2)(1 - |\Gamma_r|^2) e_t e_r |\hat{\rho}_t \cdot \hat{\rho}_r|^2 \left(\frac{\lambda}{4\pi R}\right)^2 D_t D_r \cdot P_t}{kT_s \triangle f} \qquad (7.28)$$

The above equation is fundamental for the design of telecommunication systems.

Grounded and Underground Antennas

Chapter from the book: Alpert, Bulatov, Runge: Antennas of the Third Reich: Published by Ministry of Defense of the USSR, Moscow, 1948. (Circulation: 300 copies). Credit line: http://www.radioscanner.ru/files/antennas/file10355/

Figure 131 shows that the closer a horizontal antenna to the ground the more horizontal component at Electro- Magnetic Radiation of the antenna. However the closer an antenna is to the ground the less efficiency of the antenna.

Efficiency is lowered because of the losses in the ground and in the antenna wire. The losses rise dramatically with increasing of the working frequency of the antenna.

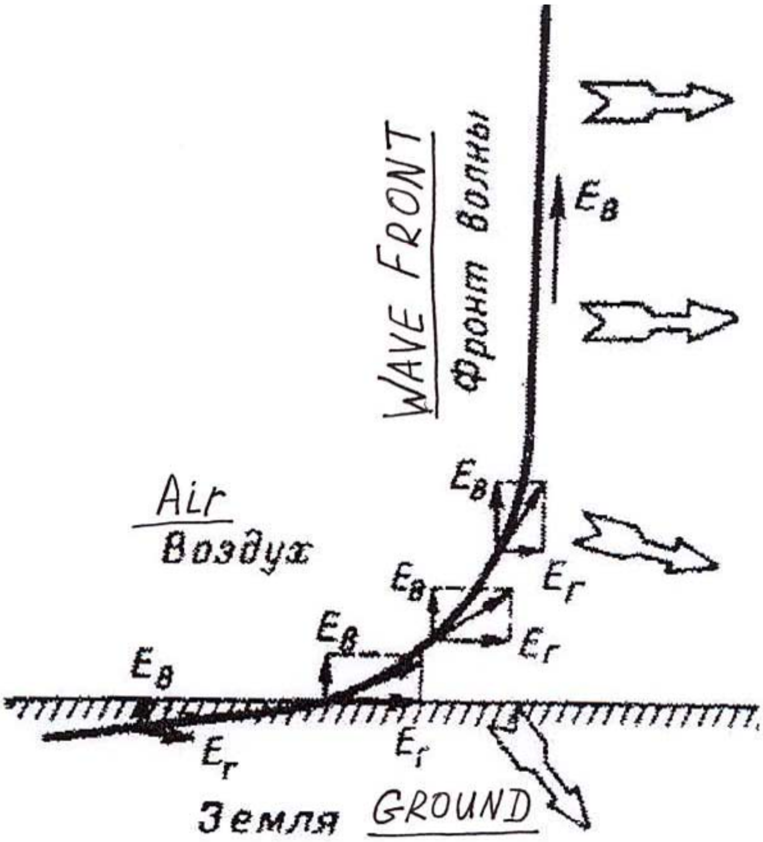


Рис. 131. Изменение наклона волны у поверхности земли

Figure 131 Changing the Front of a Radio-wave near the Ground

Figure 145 shows experimental data of the (antenna) gain by the ground wave for TWA of the 150 meter length of wire hanged at 2.8-meteres above the ground and Grounded Antenna - Insulated Wire in 150- meter length sitting on the ground. If the Grounded Antenna would be made from a naked wire the antenna dramatically decreased (compare to grounded antenna from the **Figure 145**).

Installation of the ground antenna is much easer the TWA. However, a ground antenna is much easer to damage compare to TWA. It is happened by moving vehicles. TWA is usually hang up at a height 2.8- 3 meter to avoid the damage by the vehicles.

Sometimes for grounded antennas is used a usual horizontal dipole antenna located straight over the ground.

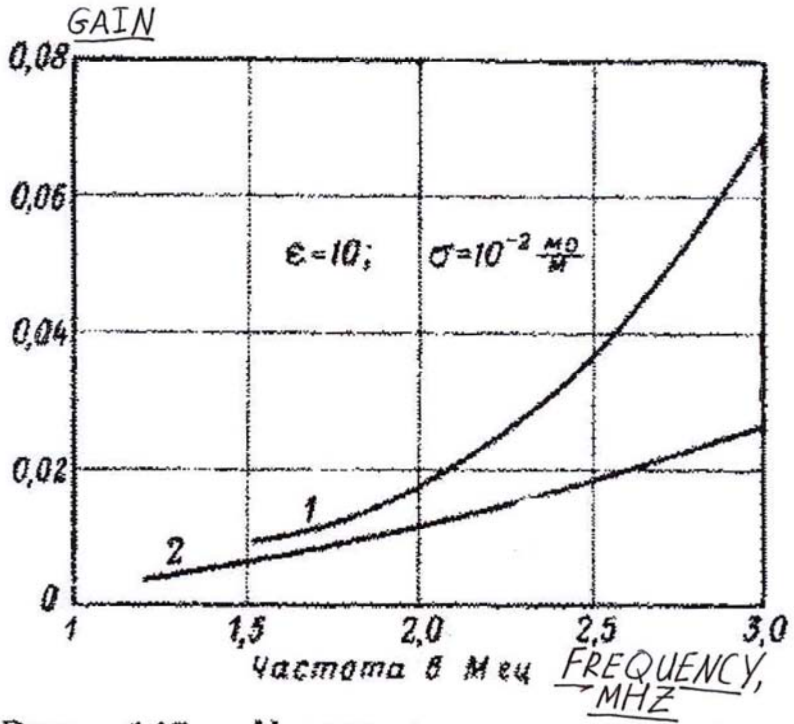


Рис. 145. Частотная зависимость коэффициента усиления по земной волне:
1 — для АБВ $\frac{150}{2,8}$; 2 — для 150-метрового изолированного провода, лежащего на поверхности земли

Figure 145 Experimental data of the (antenna) gain Vs frequency by the ground wave:

1. Travelled Wave Antenna - 150 meter length of wire hanged at 2.8-meteres above the ground
2. Grounded (sitting on the ground) Insulated Wire in 150- meter length

Underground antennas are more long life compare to TWA and Ground Antennas. Underground antennas can work because horizontal component of the EMF (Electromagnetic Field) can penetrate into the ground (**Figure 131**). So, as a rule a horizontal wires used for underground antennas.

Efficiency of the underground antennas is depended onto parameters of the soil. Antennas placed into wet soil have gain less compare to antennas placed into dry soil.

The decreasing of the antenna gain of the underground antenna in the wet soil can be explained by increasing of the attenuation of the radio- wave in the antenna wire (but not the attenuation of the radio- wave in the wet ground).

To increase the gain of the underground antenna it needs that a low- losses dielectric would be placed around the antenna wire and the soil. To this effect the wire of the underground antenna concludes in a rather thick plastic shield (Cable Underground Antenna) (*Note from I.G.:I had several pieces of the antenna wire from the underground antennas. It was copper wire inside the round (16-mm OD) white thick plastic shield. A strong black plastic (thickness near 1-mm) was above the white plastic shield*) or installed the antenna in the underground cavities or trench (Trench Antenna).

Often an usual coaxial cable is used for installing the Cable Underground Antenna. **Figure 146** shows real design of the Cable Underground Antenna.

The antenna is made from a length of 15-meters of a Russian coaxial cable **RK-3** (or **RK-6**). Table 1 shows data for some old- age Russian Coaxial Cables. Copper braid is removed at the length of 10 meters (part 1 of the antenna). Antenna is dug in a trench onto depth of 0.2- 0.5- meters.

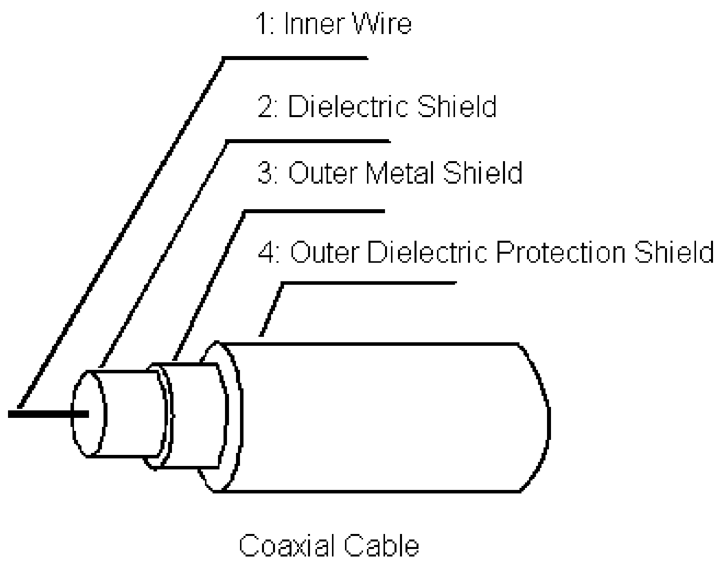
Antenna is located to the needed direction. Part 2 of the antenna is the feeder. The feeder is going to bunker 3 where a transmitter is installed. Part 4 shows terminal for connection with a transmitter.

Central conductor is connected to “antenna” terminal. Screen of the coaxial cable is connected to the “ground” terminal of the transmitter.

Figure 147 shows Diagram of Directivity in the horizon plane of the Cable Underground Antenna.

Table 1 Old Russian Coaxial Cables RK1, RK3 and RK6

Type	Zw, Ohm	Diameter 1, mm	Diameter 2, mm	Diameter 3, mm	Diameter 4, mm
RK1	77	1x0.68	4.6	5.2	7.3
RK3	68	1x1.37	9.0	9.6	13.0
RK6	52	7x0.85	9.2	9.8	12.4



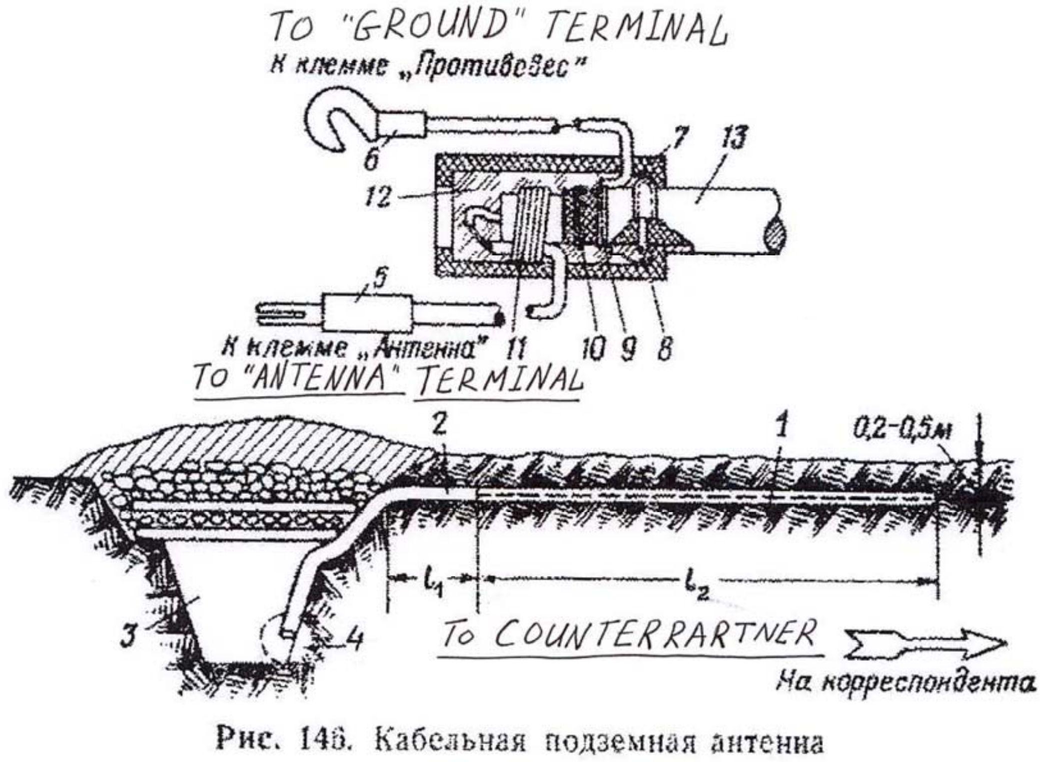


Figure 146 Cable Underground Antenna

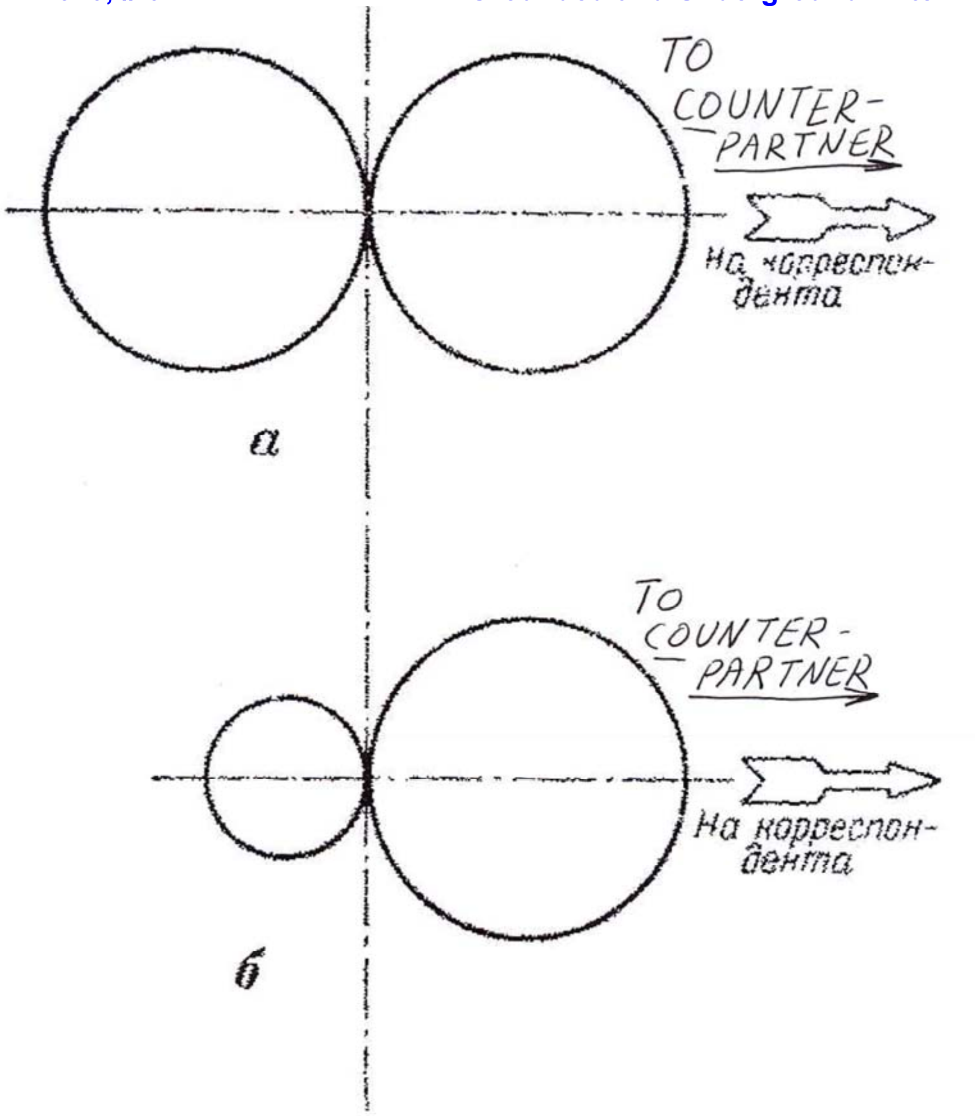


Рис. 147. Горизонтальные диаграммы направленности кабельной подземной антенны:
а — при работе на низких частотах; б — при работе на высоких частотах

Figure 147 Diagram of Directivity in the horizon plane of the Cable Underground Antenna

A For "Low" frequencies
B For "High" frequencies

(***Note I.G.:*** At the article no explaining the "Low" and "High" frequencies)

Two Cable Underground Antennas may make a Zenith Underground Antenna. The antenna made similar to symmetrical spreading antenna shown on **Figure 133 A**.
Note I.G.: Zenith Antenna is common known as NVIS (Near Vertical Incidence Skywave) Antenna.

Underground Cable Antenna has length of the radiation part (L2 at **Figure 146**) approximately 10 meters. The length was found by practice. There is no sense to use radiation part with length more the 10 meters because far parts of the Underground Cable Antenna do not radiate efficiently.

To increase efficiency of the Underground Cable Antenna (**Figure 146**) the radiation parts L2 placed into the trench above dry sticks or straw. Then the same dry sticks or straw put on above the parts L2. So, antenna wire is placed inside dielectric sleeve. Ground is placed above the dielectric sleeve. Such design allows easy remove the Underground Cable Antenna from the trench.

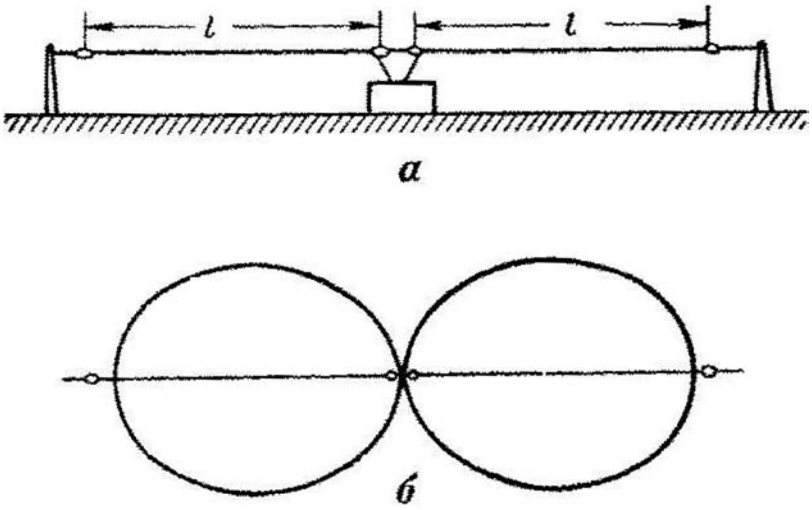


Рис. 133. Низкорасположенный горизонтальный вибратор (*а*) и его горизонтальная диаграмма направленности (*б*)

Figure 133 Spreading (Low-Height) Dipole Antenna (**A**) and its Diagram Directivity in the horizon plane (**B**)

Figure 148 shows design of the Trench Antenna. Trench Antenna consists of the three major parts. Part 1- radiation wire, part 2- feeder (as usual a coaxial cable), part 3- grounding system.

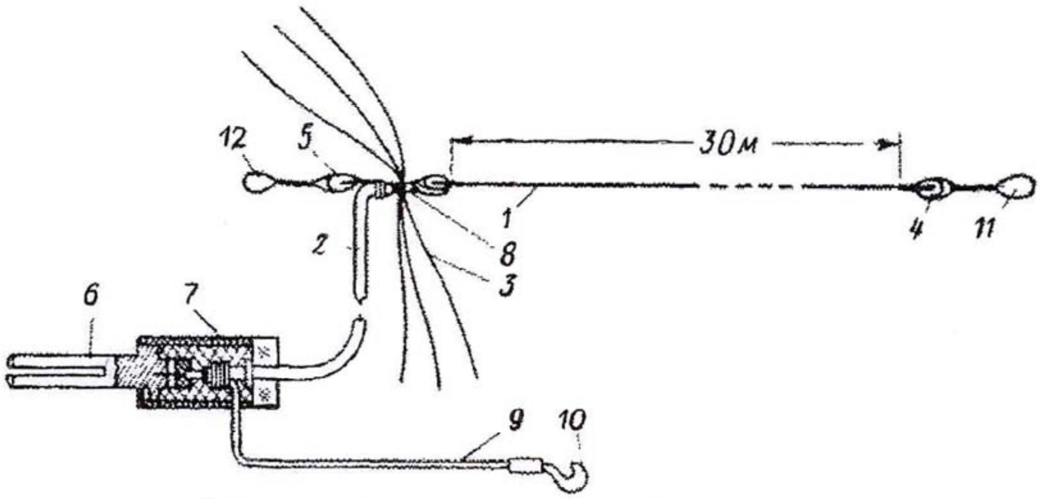


Рис. 148. Конструкция траншейной антенны

Figure 148 Design of the Trench Antenna

Radiation part (item 1) made of insulated wire in 30 meter length and diameter near 1-mm. Insulators (item 5 and 6) are placed at ends of the wire. Feeder (item 2) is length of coaxial cable in 10 meters. If antenna is used with low power transmitter it is possible fed it through thin coaxial cable RK-1. If antenna is used with middle or high power transmitter it is possible fed it through thick coaxial cable RK- 3 or RK-6. Central wire of the coaxial cable from the one side is soldered to Radiation part (item 1), from other side is soldered to plug (item 6) that is mounted inside insulated box (item 7).

Bandage (item 8) fastened the ground of the coaxial to additional bare wire between insulators (item 5).

Grounding system (item 3) made of six length of wire in 1.5- meters. Al the wires are soldered to wire between insulators (item 5). At the transmitter the ground of the coaxial through wire (item 9) with plug (item 10) is connected to the transmitter's "Ground."

Ropes (item 11 and 12) are stretched out the antenna inside the trench.
Trench Antenna may be installed in open or closed trenches as well as at low height (less the 100- 50- cm) near the ground. Radiation part is stretched between wooden pegs installed at the opposite sides of the trench.

Trench Antenna installed into closed trench is shown at the **Figure 149**. DD of the antenna is practically similar to DD shown on the **Figure 133 B**. However the back lobe has trend to decrease when the operation frequencies increase.

Keep in mind that efficiency of the Trench Antenna may be significantly decreased when the radiation part of the antenna is touched to the wet ground. Keep the radiation part at least 10- 15-cm out of trench wall. To keep good performance of the Trench Antenna do not place the radiation part more the 50 – cm from the ground level. Small masts with end insulator (or dry sticks) may be used in the design of the Trench Antenna to hold the radiation wire.

Counterpoises placed toward to radiation part of the antenna. Usually counterpoises dug on to small depth into the ground. At the band 1- 6 MHz the antenna (**Figure 149**) is almost equal to vertical antenna in 4-meters height.

In conclusion it is necessary to say that Underground and Trench Antennas are less efficiency in radiation of the ground and sky wave compare to antennas installed above the ground. So the Underground and Trench Antennas cannot provide far communication. However the good masking and survivability of the Underground and Trench Antennas allow use it in the military application.

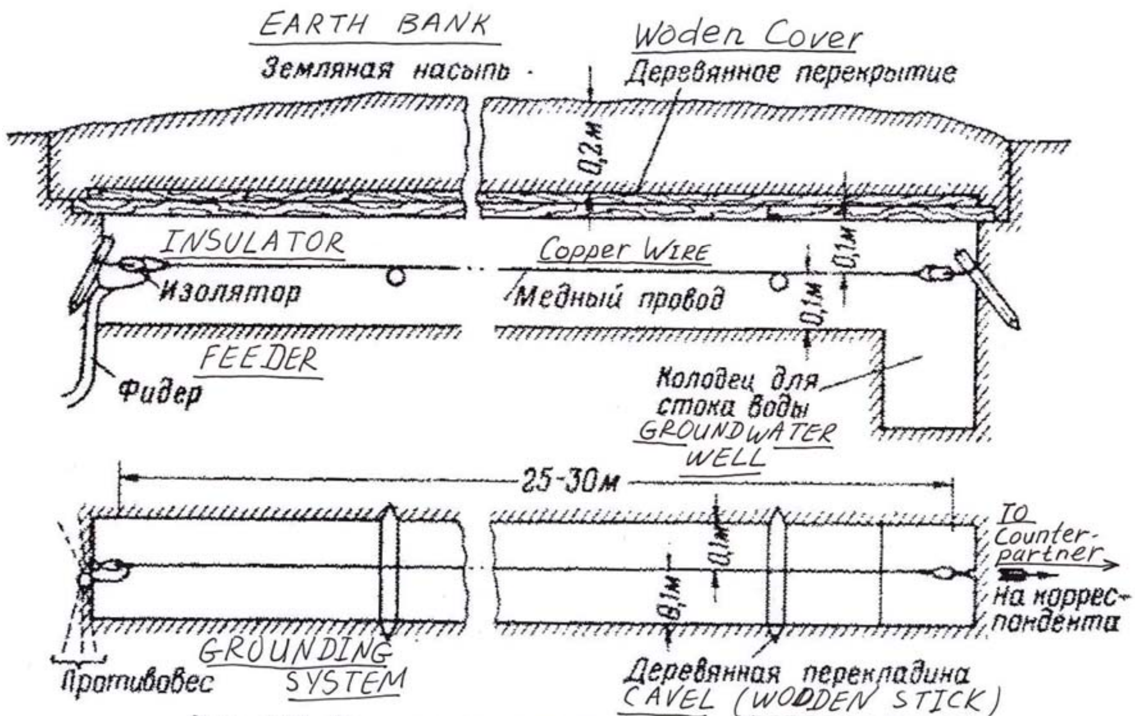


Рис. 149. Вариант размещения траншейной антенны

Figure 149 Trench Antenna installed in the closed trench

73! I. G.

Underground Antennas in Russia

Some information about Underground Antennas from a Russian Forum at **www.cqham.ru**
(There are some cuttings made. The whole version of the forum you can read (in Russian) at:

http://www.cqham.ru/forum/showthread.php?t=13489&page=0&perpage=30)

Igor VE3KAO

When I served in the Soviet Army I had contact with a military radio station that was used such Underground Antennas. The station was from Sverdlovsk (now Ekaterinburg). My station was near Moscow. (***I.G.: Distance Moscow- Sverdlovsk is 1800 km***.) We used band 3.0- 6.0 –MHz at the winter and 4.0- 8.0- MHz at the summer. The station with Underground Antennas was heard by S5- S6. When the station was used the usual stationary antennas it came to us by S9+.

I asked the chief of the radio- center about the Underground antennas. He told me that he saw how the antennas were installed. It was thick coaxial cable that was buried in trenches in 2.5- 3.0- meter depth…

yl2gl

The Underground Antennas were at the receiving radio- center where I was served (in the Soviet Army). There were symmetrical antennas. The antennas were reserved ones that supposed to be used at emergency situation (at nuclear war)...

UA9FBQ

I took part at installation of the Underground Antenna… It was coaxial cable (looks like) near 10-cm in diameter. The coaxial cable was buried on 50-cm into the ground. I used the antenna with a transmitter **"OKUN"**. The antenna matched well but the efficiency was low. The antenna was tested up to 6- MHz.

Okun:

http://www.radioscanner.ru/

Frequency Range: 1.5- 24.0 – MHz

Mode: CW (A1, 1-kWatt), SSB (J3E, 500- Watt)

RN6LIQ

I used the Underground Antenna at the radio- center where I served. However, I do not know nothing about design of the antenna. The antenna works worse compare to usual (placed) on ground antenna. It is a reserved antenna that would be used when the usual stationary antennas were destroyed. However, for survival purposes the radio center and its electro station also should be placed underground….

Viktor355

I constructed one of the Underground Antennas at 1984- 1986 years. It was not so far from Kaluga (Russia). The antennas were placed on a field with several km in (L/W) dimensions. There were installed (in some depth) coaxial cables and copper arrays. Then all were buried and the place was finished to flat surface by bulldozers **DT-500** and **DT-1000**. I do not know for what the frequency band the antenna were designed.

R3VA

I saw such antenna near **Tarusa**, Kaluga- region when I served in the Soviet Army. It was Summer – 1987. Soldiers (from unit where I served) for two days did masking of the antenna. It was practically flat filling (near 2 meters height) with size of a football pitch. There were crushed rocks in bitumen and some strange (looks like selicagel) “balls” in the filling Upper the filling there was a grid from thick (near 40- mm in diameter) coaxial cable. We took topsoil from a nearest water meadow and put those one a top of the filling.

RX9CC

When I served in the Soviet Army (it were 1976- 1978 years) I constructed the Underground Antenna near **Kozelsk**, Kaluga region. It was a grid from a coaxial cable RK-75-24x17. It was very heavy coaxial cable in 60-mm diameter. The antenna was tested from several tens kHz up to 20-MHz.

(***Note from I.G.:*** Russian coaxial cable RK- 75- 24x17 is special steel-clad, water and moldy protected cable that can be installed under the ground.)

UR5HUG

At the 80s I was served at a communication unit near Leningrad (today Sankt- Peterburg). There was an Underground Antenna. I remembered that we used to the antenna with radio **R-140** for communication with Monchegorsk. (***I.G.: Distance between Leningrad- Monchegorsk is 1200 km***.)

Note I.G.: Underground Antennas with fully automatically underground radio- centers were (or are) widely used in the Soviet/Russian military system Dead Hand (also known as Perimeter, Hand from Coffin).

More about the system:
http://en.wikipedia.org/wiki/Dead_Hand_(nuclear_war)

73!

R140

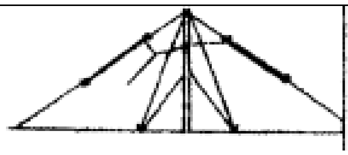
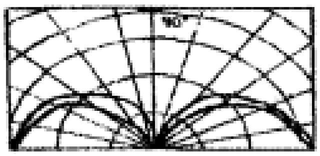
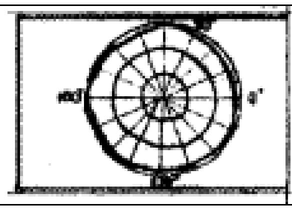
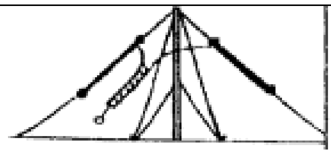
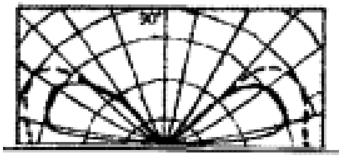
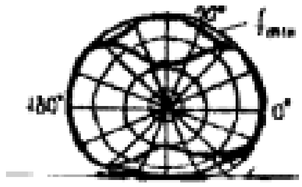
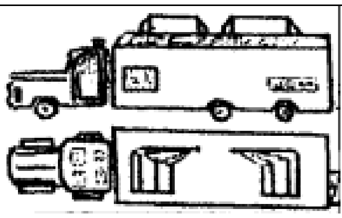
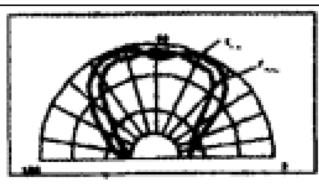
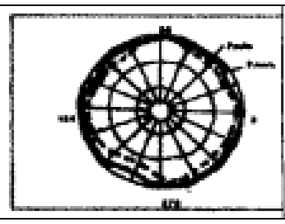
Photo from the GOOGLE

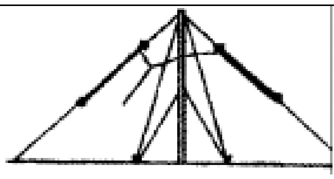
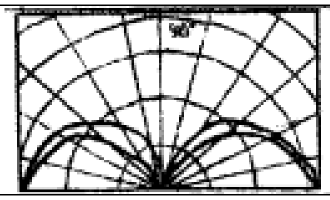
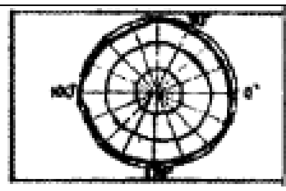
Frequency Range: 1.5- 30.0 – MHz

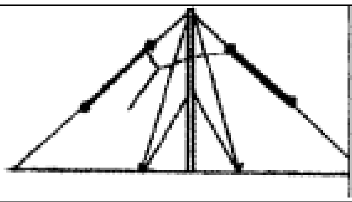
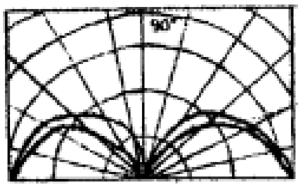
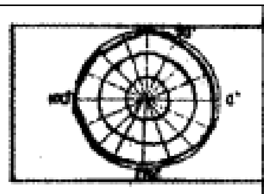
Mode: All mode, 1- kWatt

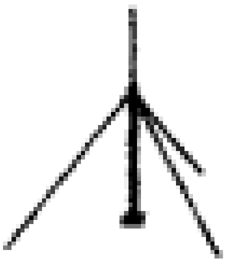
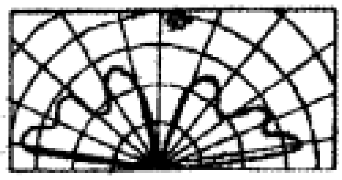
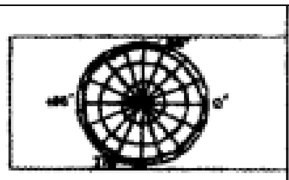
Russian Military Antennas
Some Data

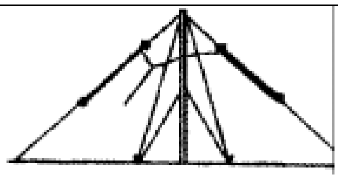
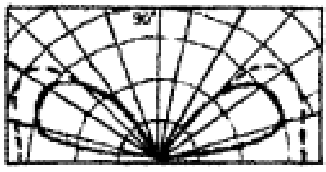
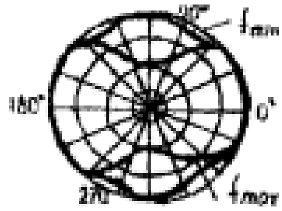
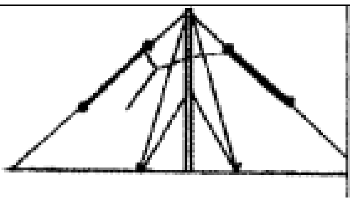
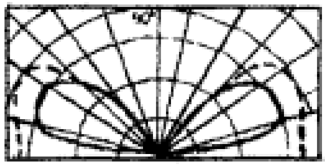
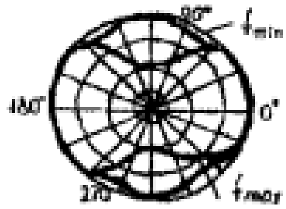
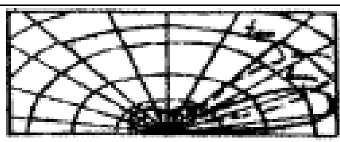
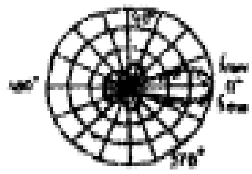
Credit Line: www.spvvius.ru

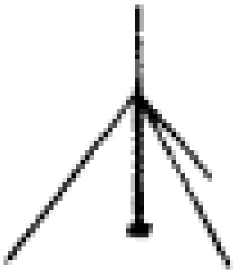
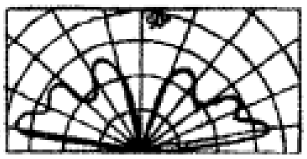
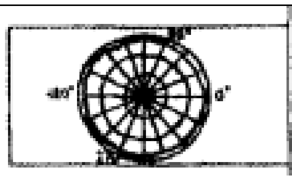
Antenna	Band, MHz	Communication Range, km	Comment
Slopped T- Antenna **T2- 40**	1.5- 2.0	0-60	For Mobile Radio Station R140, R161
	Design	DD in Vertical Plane	DD in Horizon Plane
			
Antenna	Band, MHz	Communication Range, km	Comment
Slopped Symmetrical Dipole Antenna	1.5- 5.0	0-800	For Mobile Radio Station R140, R161
	Design	DD in Vertical Plane	DD in Horizon Plane
			
Antenna	Band, MHz	Communication Range, km	Comment
NVIS Antenna **АЗИД**	1.5- 14.0	100-300	For Mobile Radio Station R140, R161
	Design	DD in Vertical Plane	DD in Horizon Plane
			

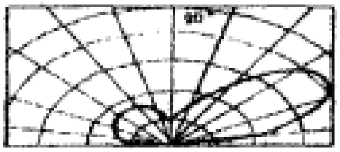
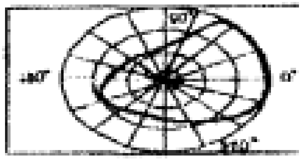
Antenna	Band, MHz	Communication Range, km	Comment
Slopped T- Antenna **T2- 11**	2.0- 4.0	0-60	For Mobile Radio Station R140, R161
	Design	DD in Vertical Plane	DD in Horizon Plane
			

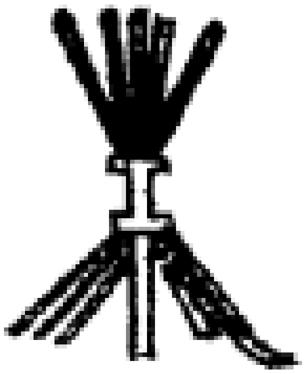
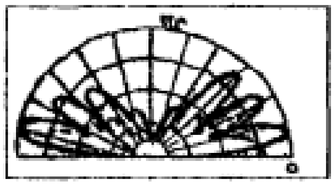
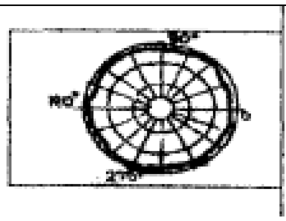
Antenna	Band, MHz	Communication Range, km	Comment
Slopped T- Antenna (RX- Antenna) **T2- 13**	2.5- 5.0	0-60	For Mobile Radio Station R140, R161
	Design	DD in Vertical Plane	DD in Horizon Plane
			

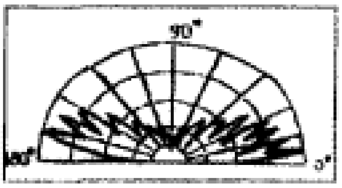
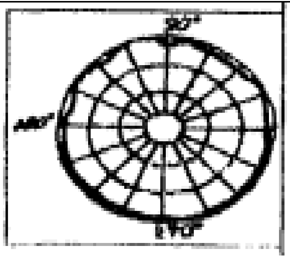
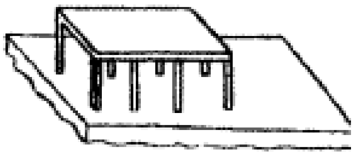
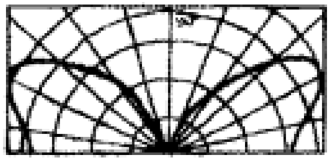
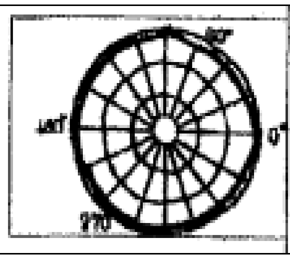
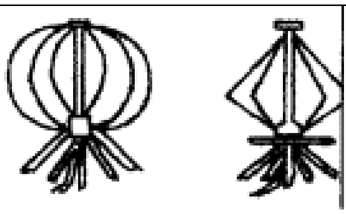
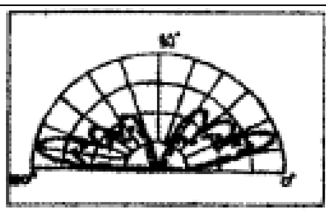
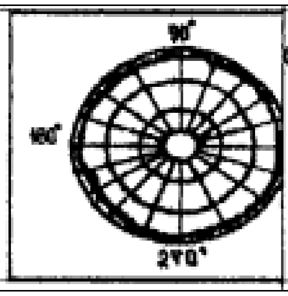
Antenna	Band, MHz	Communication Range, km	Comment
Vertical Antenna **ШТ-10**	4.0- 14.0	0-100	For Mobile and Fixed Radio Station, R140
	Design	DD in Vertical Plane	DD in Horizon Plane
			

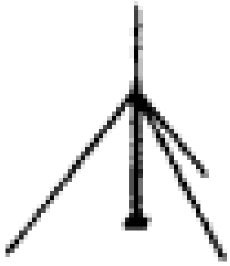
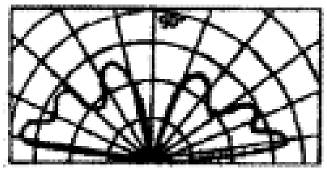
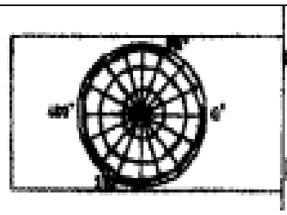
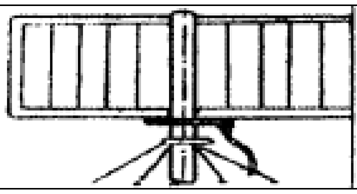
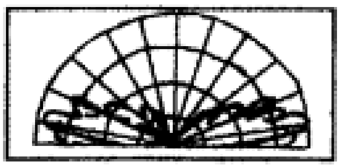
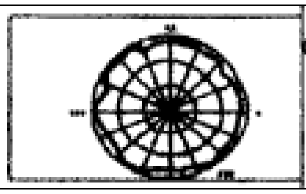
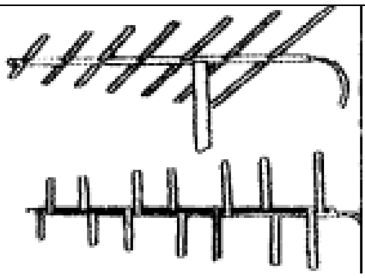
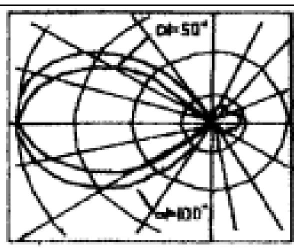
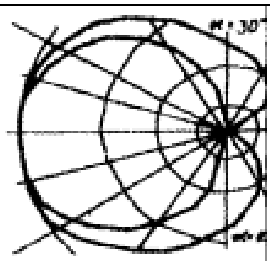
Antenna	Band, MHz	Communication Range, km	Comment
Slopped Symmetrical Dipole Antenna **Д2х13**	4.0- 16.0	0-800	For Mobile Radio Station R140, R161
	Design	DD in Vertical Plane	DD in Horizon Plane
			
Antenna	Band, MHz	Communication Range, km	Comment
Slopped Symmetrical Dipole Antenna **Д2х11**	5.0- 16.0	0-600	For Mobile Radio Station R140
	Design	DD in Vertical Plane	DD in Horizon Plane
			
Antenna	Band, MHz	Communication Range, km	Comment
Slopped V-Antenna **V2- 46**	10.0- 30.0	1000- 2000	For Mobile and Fixed Radio Station, R140, R161
	Design	DD in Vertical Plane	DD in Horizon Plane
			

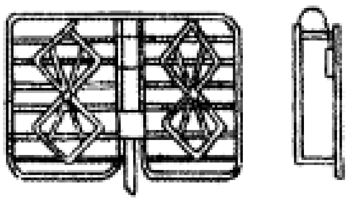
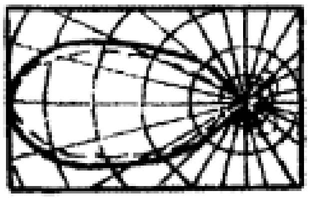
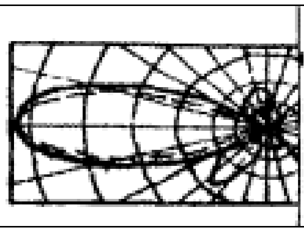
Antenna	Band, MHz	Communication Range, km	Comment
Vertical Antenna **ШТ-4**	14.0- 50.0	0-60	For Mobile Radio Station R140, R161, R134, R137, R171, R173
	Design	DD in Vertical Plane	DD in Horizon Plane
			

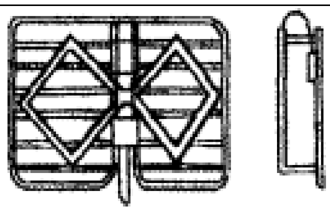
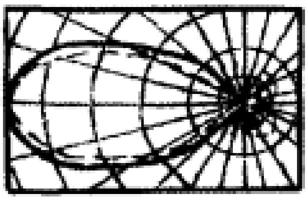
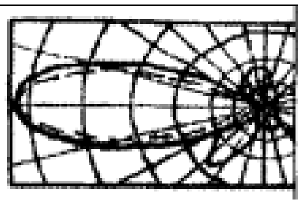
Antenna	Band, MHz	Communication Range, km	Comment
Lambda Antenna **λ-60/15**	20.0- 60.0	0-150	For Mobile Radio Station R140, R161, R137
	Design	DD in Vertical Plane	DD in Horizon Plane
			

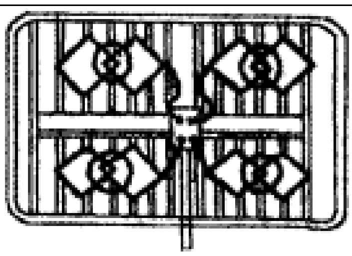
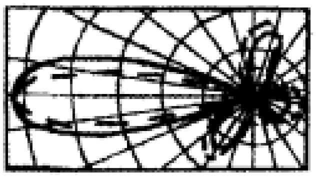
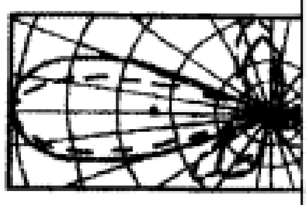
Antenna	Band, MHz	Communication Range, km	Comment
Bi-Conical Symmetrical Vertical Antenna **БКВ**	20.0- 60.0	0- 100	Mobile, Fixed “Brelok”, “Blesk”
	Design	DD in Vertical Plane	DD in Horizon Plane
			

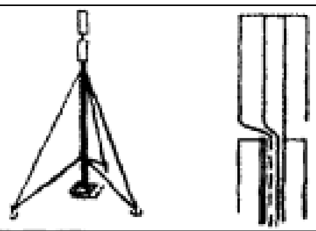
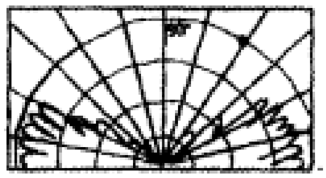
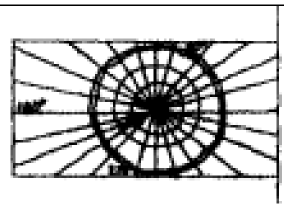
Antenna	Band, MHz	Communication Range, km	Comment
Disco- Conical VHF Antenna **ДКА**	240.0- 480.0	For Communication with Air Craft	R409
	Design	DD in Vertical Plane	DD in Horizon Plane
			
Antenna	Band, MHz	Communication Range, km	Comment
Roof Asymmetrical Antenna with Top Load **БК**	23.0- 60.0	0-60	For Mobile Version of Radio Station “Brelok”, “Blesk”
	Design	DD in Vertical Plane	DD in Horizon Plane
			
Antenna	Band, MHz	Communication Range, km	Comment
Extent Asymmetrical Vertical Antenna with Counterpoise **ОВ**	2.0- 80.0	0- 150	Mobile and Fixed “Brelok”, “Blesk” , R137
	Design	DD in Vertical Plane	DD in Horizon Plane
			

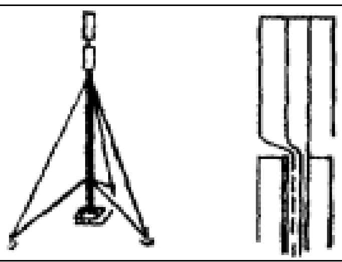
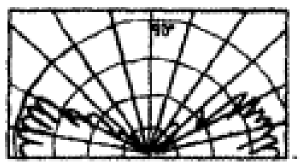
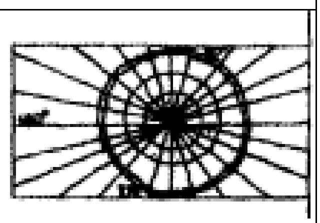
Antenna	Band, MHz	Communication Range, km	Comment
Vertical Antenna **ШТ-3**	50.0- 60.0	0- 75	Fixed and Mobile R161, R137
	Design	DD in Vertical Plane	DD in Horizon Plane
			
Antenna	Band, MHz	Communication Range, km	Comment
Flat Antenna with Counterpoise **ШДА**	30.0- 60.0	0-80	Fixed and Mobile R161
	Design	DD in Vertical Plane	DD in Horizon Plane
			
Antenna	Band, MHz	Communication Range, km	Comment
Dipole Log- Periodic Antenna **ЛПА 1БП**	4.0- 120.0	0- 150	Mobile and Fixed R137, R161, R409
	Design	DD in Vertical Plane	DD in Horizon Plane
			

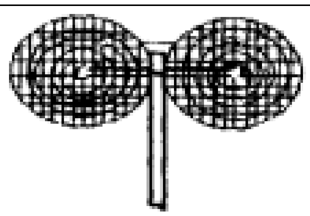
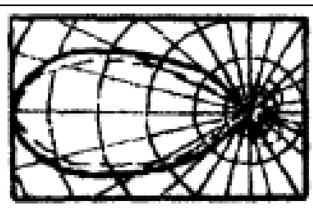
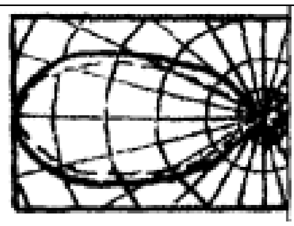
Antenna	Band, MHz	Communication Range, km	Comment
Double Cophased array Antenna with Reflector **ДБ-11**	120.0- 240.0 (390-429.8)	0- 60	Fixed and Mobile R415, R419
	Design	DD in Vertical Plane	DD in Horizon Plane
			

Antenna	Band, MHz	Communication Range, km	Comment
Cophased array Z- Antenna with Reflector	120.0- 240.0	0-60	Fixed and Mobile R409
	Design	DD in Vertical Plane	DD in Horizon Plane
			

Antenna	Band, MHz	Communication Range, km	Comment
Four- Element Cophased array Z- Antenna with Reflector	240.0- 480.0	0- 60	Mobile and Fixed R409
	Design	DD in Vertical Plane	DD in Horizon Plane
			

Antenna	Band, MHz	Communication Range, km	Comment
Coaxial Symmetrical Antenna **1Б12-1**	80.0- 119.95	0- 60	Fixed and Mobile R415
	Design	DD in Vertical Plane	DD in Horizon Plane
			

Antenna	Band, MHz	Communication Range, km	Comment
Coaxial Symmetrical Antenna **ДБ12**	390.0- 429.8	0-60	Fixed and Mobile R415
	Design	DD in Vertical Plane	DD in Horizon Plane
			

Antenna	Band, MHz	Communication Range, km	Comment
Bidirectional Antenna **D-2.5**	4438.0- 4557.98 4630.0- 4750.0	80- 200	Mobile and Fixed R412, R423
	Design	DD in Vertical Plane	DD in Horizon Plane
			

Conical Windom Antenna

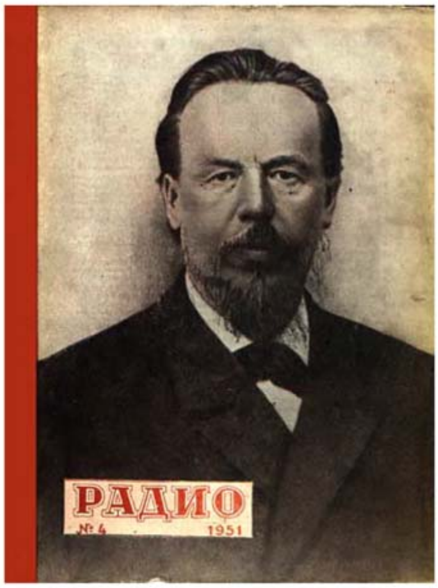
N. Tyutin, UA4QA, Kazan

Credit Line: Radio 1951, # 4, p. 39

The antenna was installed and tested by UA4QA. Despite of the antenna was installed at a small height between the roofs of a two houses, on the 20 – meters the antenna did + 2… + 4 balls (at S-Scale) compare to usual one- wire Windom designed for the band. **Figure 1** shows the design of the antenna.

Antenna made of seven lengths in 0.477- lambda and 3-mm diameter each. The wires were going through two ebonite rings and soldered in the places of the insulators and the connection of the one- wire feeder. (***Note by I.G.: There is no information about placement the rings on the antenna***).

Feeder should be athwart to the Antenna for the distance at least 2/3 lambda and then should not have sharp bending.



Radio # 4, 1951

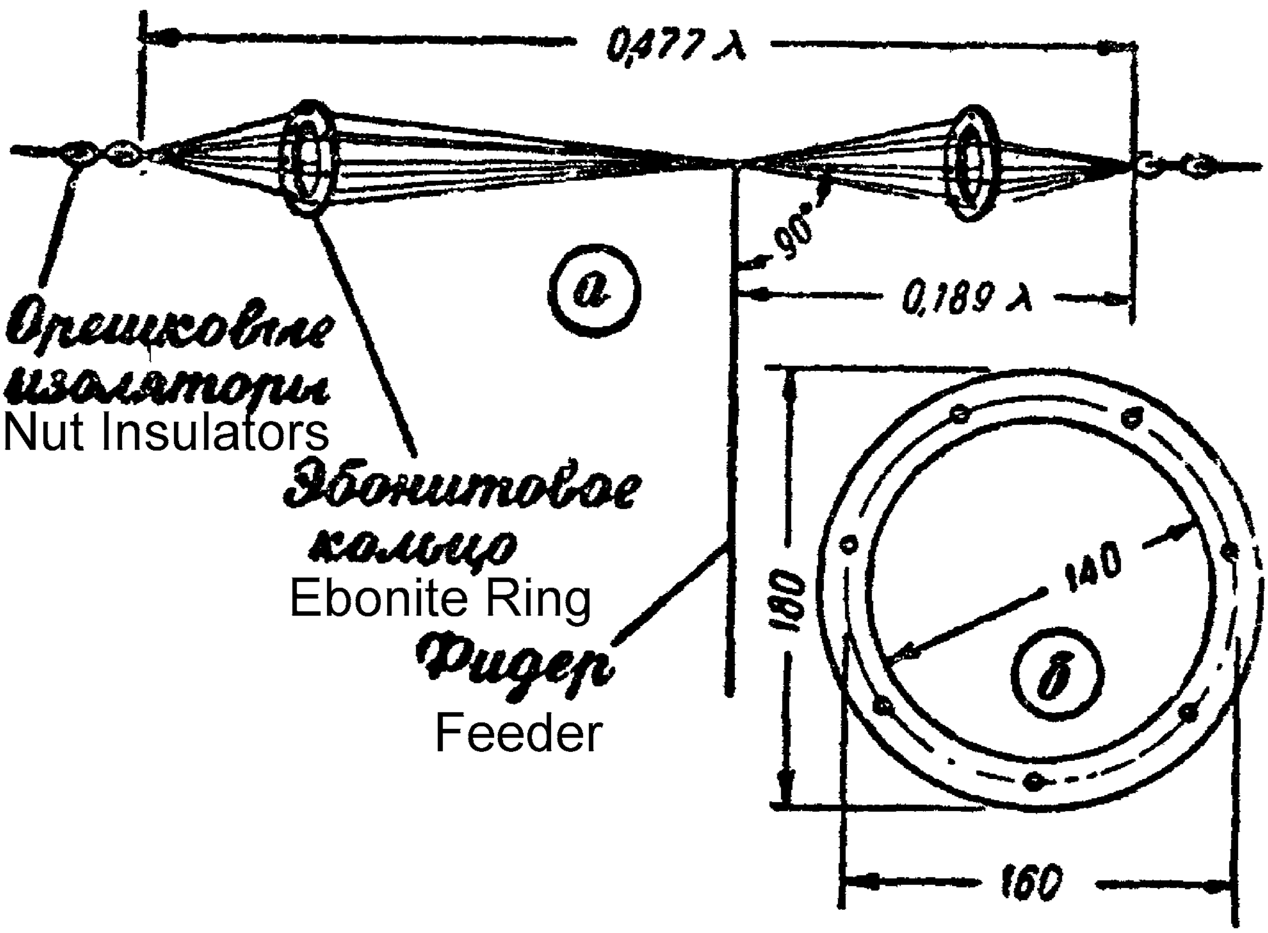


Figure 1 Conical Windom Antenna

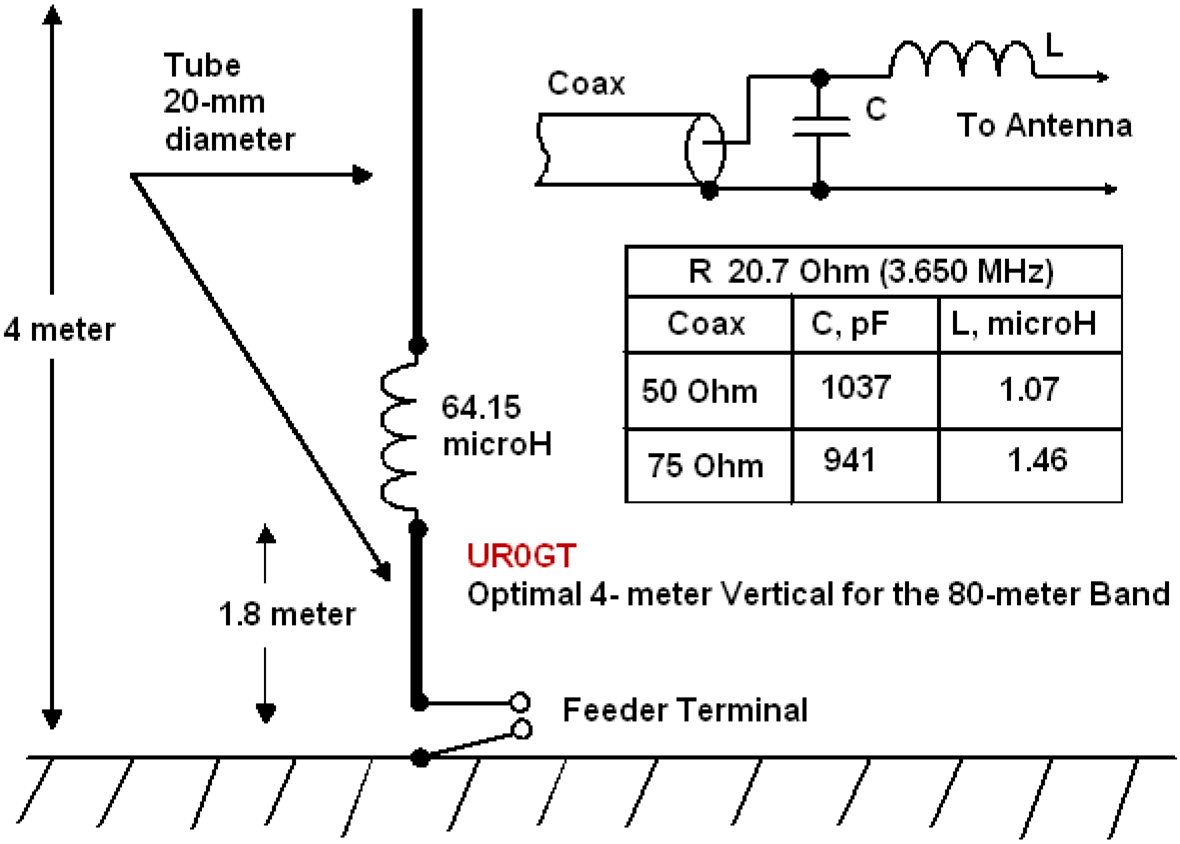
Small Vertical for the 80- meter Band

The publications devoted to memory UR0GT.

***By:* Nikolay Kudryavchenko, UR0GT**

Optimized Vertical in 4- meter length for the 80- meter band is shown on **Figure 1**.
Lengthening coil is placed at 1.8- meters from the base. Gain of the antenna is minus 9.1- dBi, input impedance (at the resonance) is 20.7- Ohm.

The MMANA model of the Optimized Vertical for the 80- meters may be loaded: http: //
www.antentop.org/014/sv_014.htm



R 20.7 Ohm (3.650 MHz)		
Coax	C, pF	L, microH
50 Ohm	1037	1.07
75 Ohm	941	1.46

Figure 1 Optimized Vertical in 4- meter length for the 80- meter band

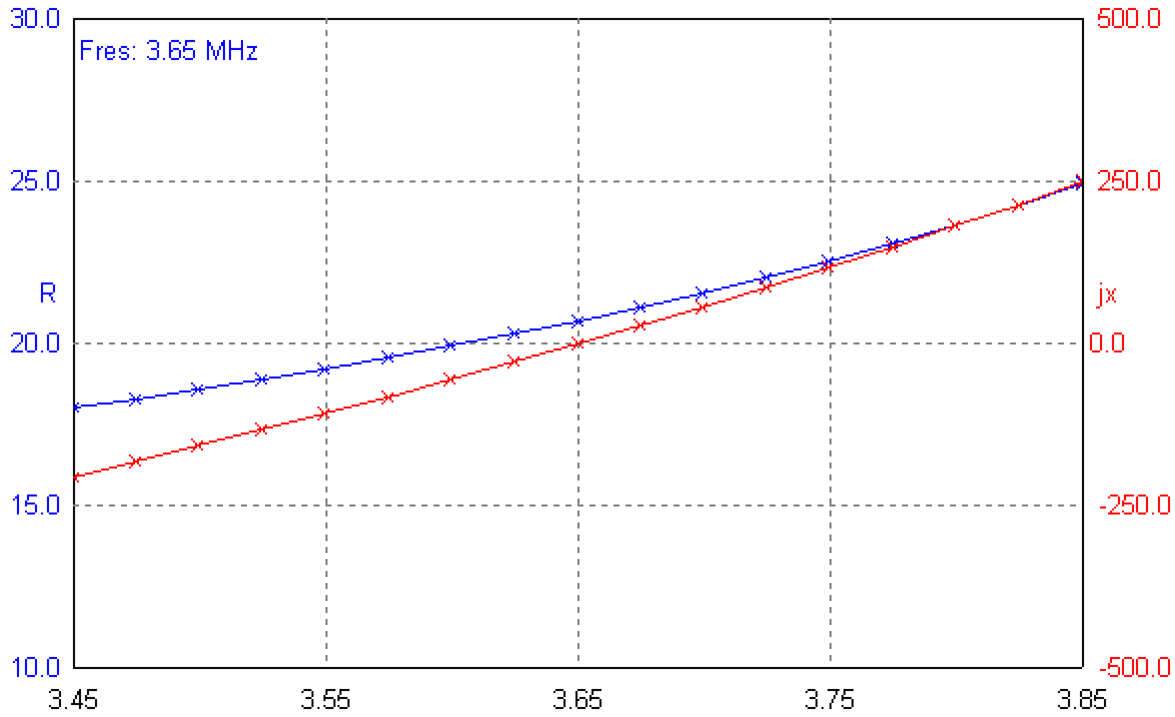


Figure 2 Z of the Optimized Vertical (above the real ground)

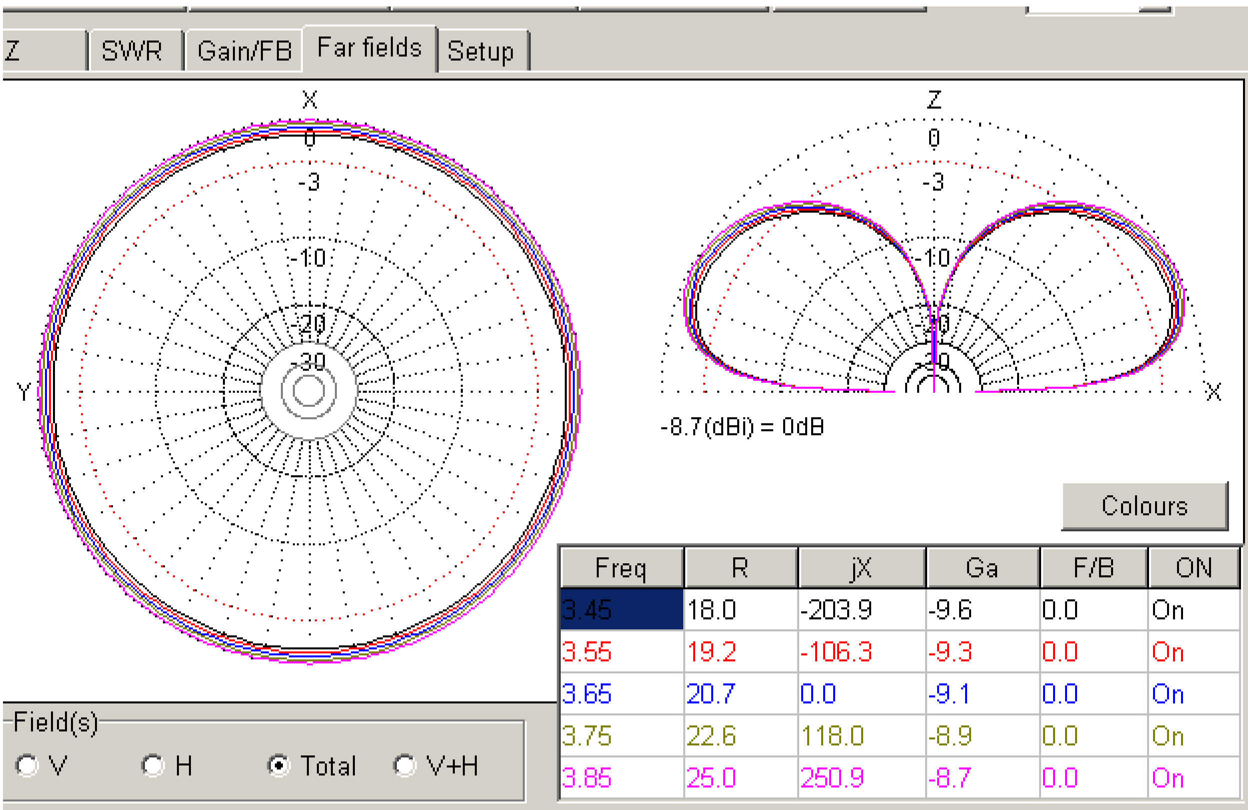


Figure 3 DD of the Optimized Vertical (above the real ground)

73 Nick

Credit Line: Forum from: www.cqham.ru

Multiband Asymmetrical Dipole Antennas

The publications devoted to memory UR0GT.

By: Nikolay Kudryavchenko, UR0GT

Asymmetrical dipole for 80/40/20/10- meter bands is shown on the **Figure 1**.

The MMANA model of the Asymmetrical dipole for 80/40/20/10- meter bands may be loaded: http://www.antentop.org/014/dipole_014.htm

Asymmetrical dipole for 80/40/20/15/10- meter bands is shown on the **Figure 2**.

The MMANA model of the Asymmetrical dipole for 80/40/20/10- meter bands may be loaded: http://www.antentop.org/014/dipole_014.htm

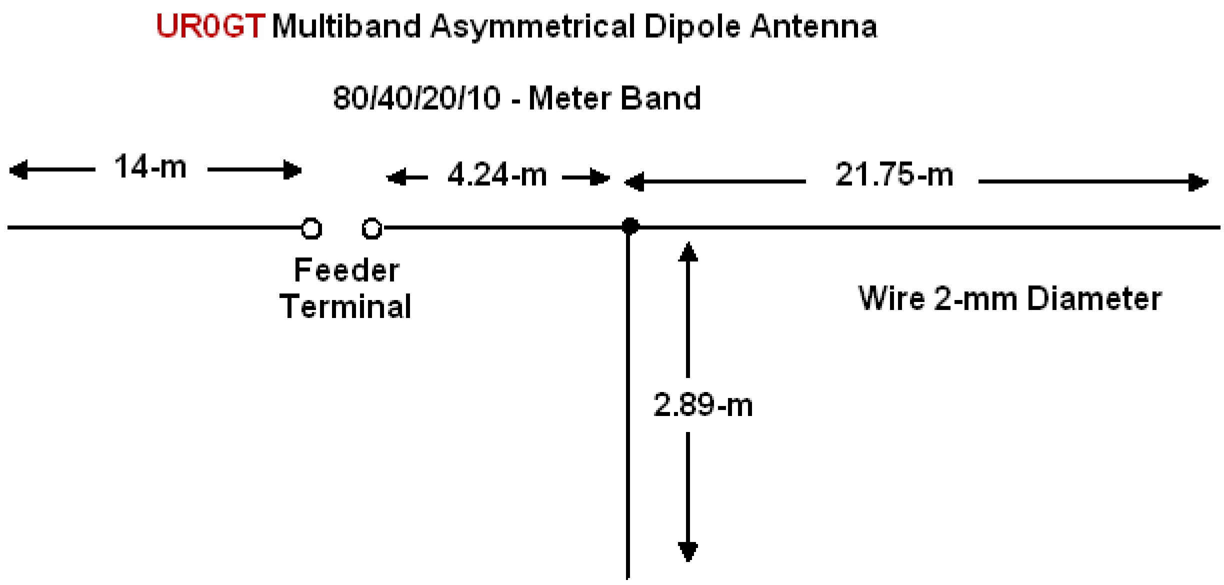


Figure 1 Asymmetrical dipole for 80/40/20/10- meter bands

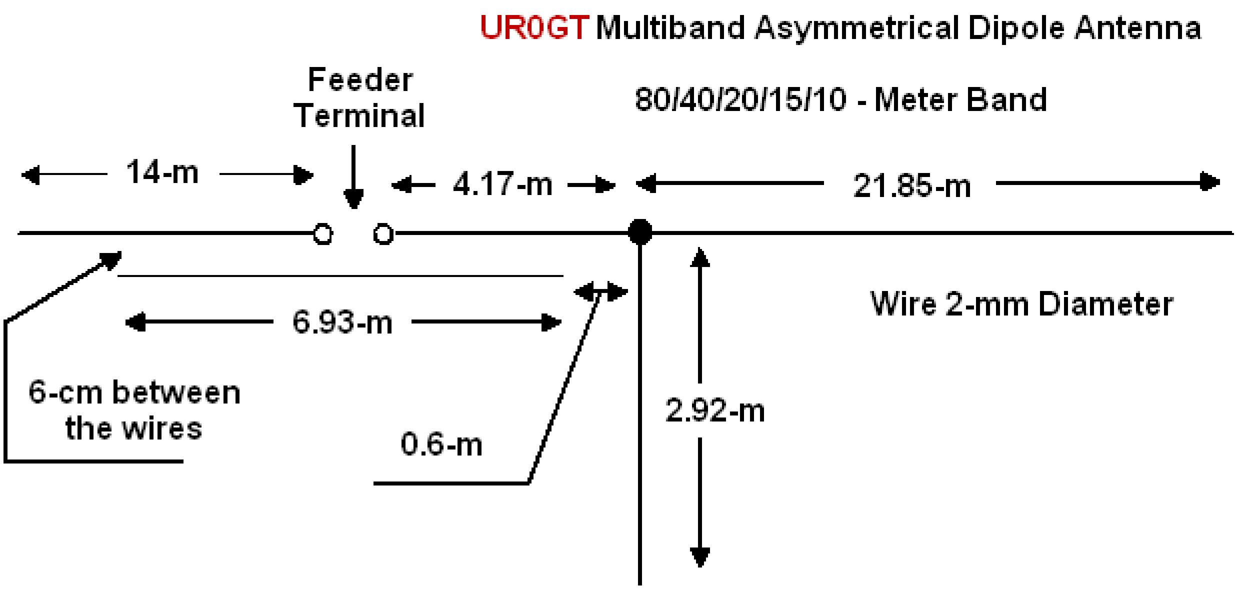


Figure 2 Asymmetrical dipole for 80/40/20/10- meter bands

Parameters for the antennas are shown below. The data were got at the antenna placed at 20 meters above a real ground.

To match the antenna with coaxial cable 50- Ohm it is need transformer 1:3 or may be 1:4 to improve the efficiency at the 10- meter Band.

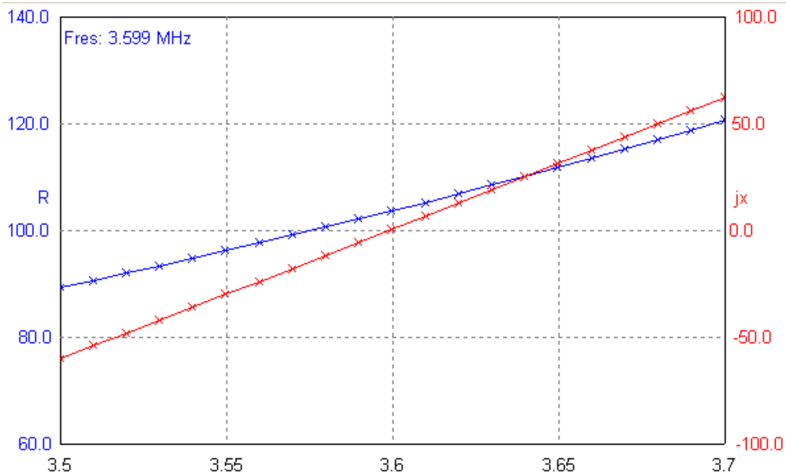


Figure 3 Z of the Asymmetrical dipole for 80/40/20/10- meter bands at 80 meter Band

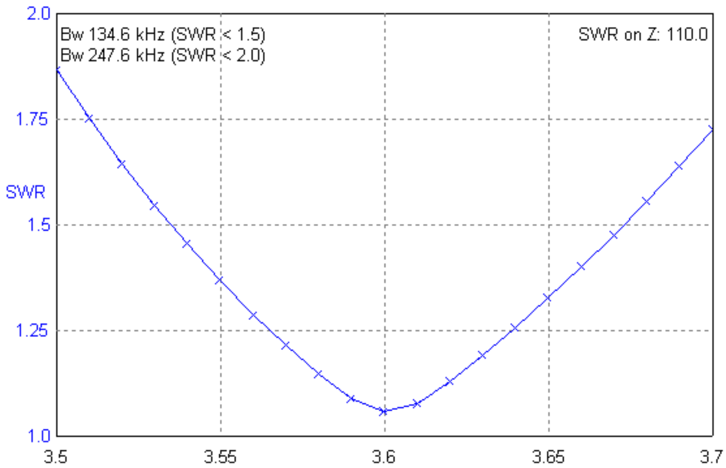


Figure 4 SWR of the Asymmetrical dipole for 80/40/20/10- meter bands at 80 meter Band

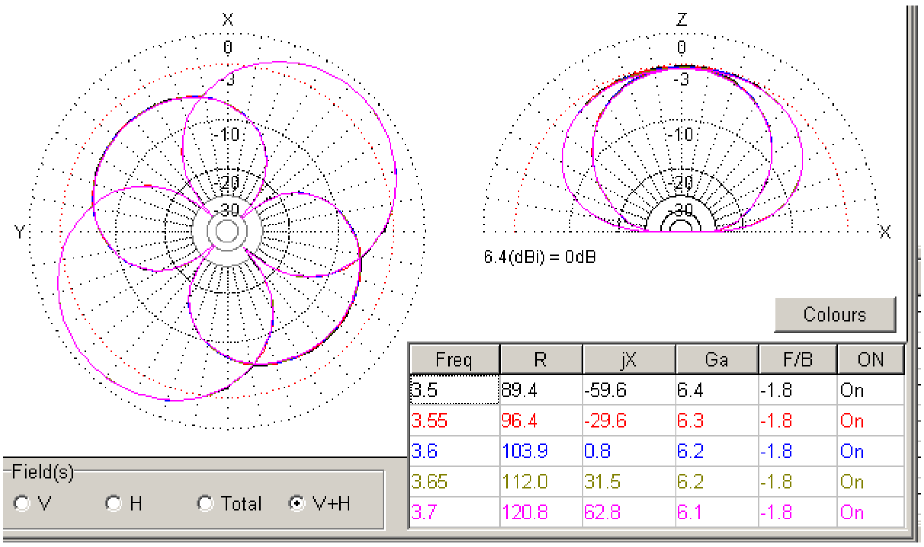


Figure 5 DD of the Asymmetrical dipole for 80/40/20/10- meter bands at 80 meter Band

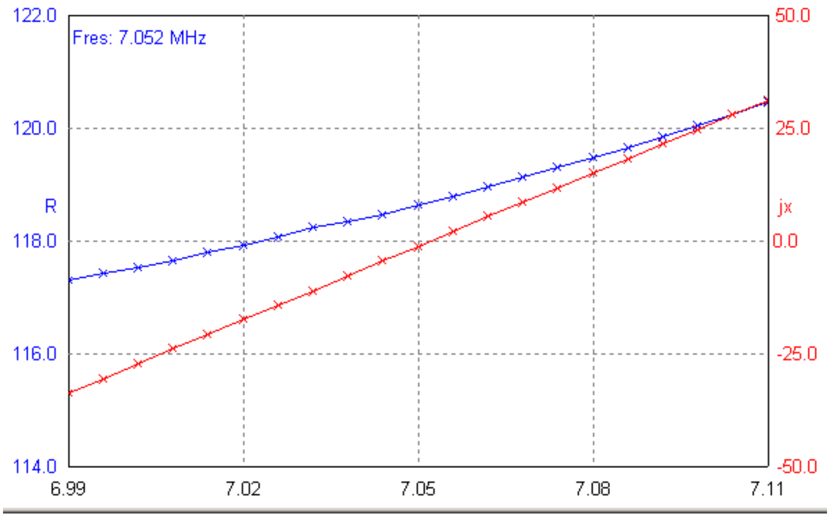


Figure 6 Z of the Asymmetrical dipole for 80/40/20/10- meter bands at 40 meter Band

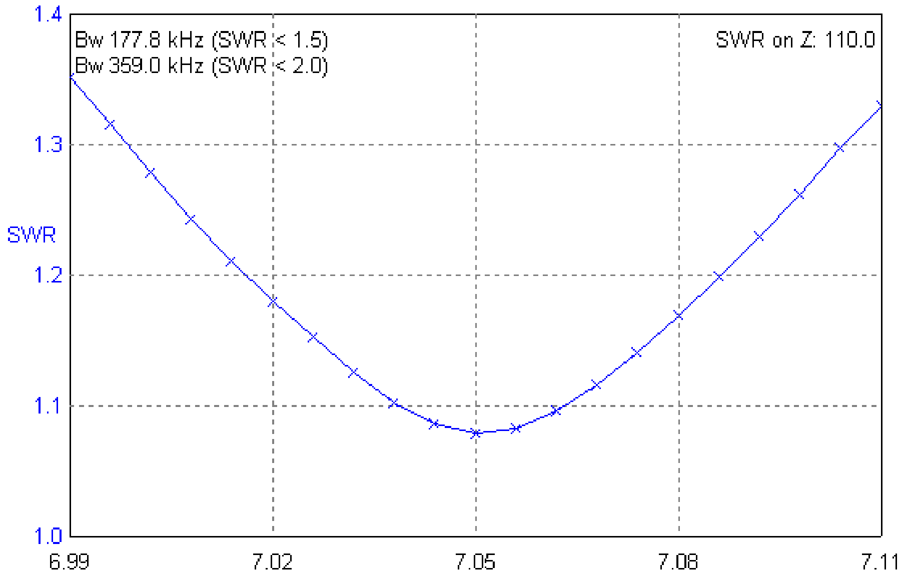
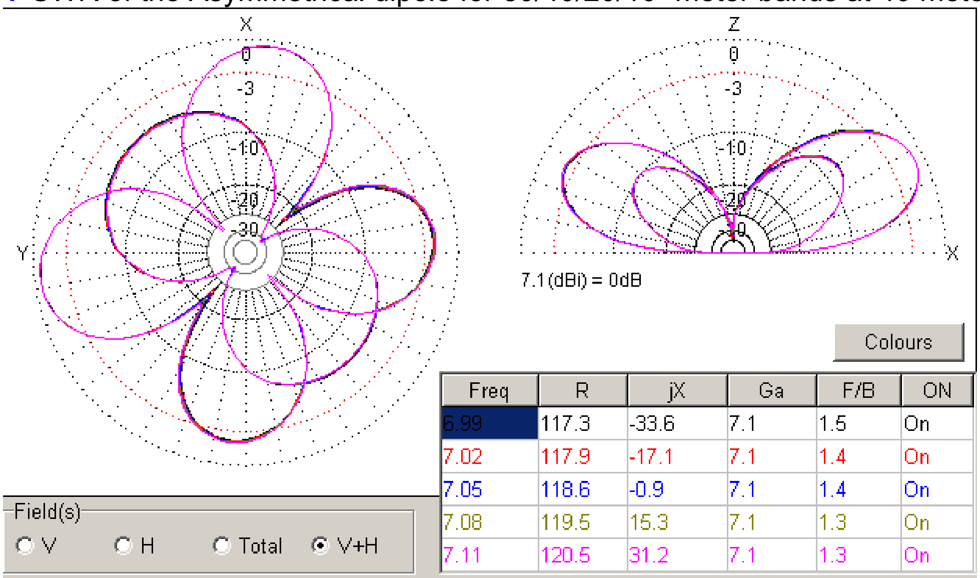


Figure 7 SWR of the Asymmetrical dipole for 80/40/20/10- meter bands at 40 meter Band



Freq	R	jX	Ga	F/B	ON
6.99	117.3	-33.6	7.1	1.5	On
7.02	117.9	-17.1	7.1	1.4	On
7.05	118.6	-0.9	7.1	1.4	On
7.08	119.5	15.3	7.1	1.3	On
7.11	120.5	31.2	7.1	1.3	On

Figure 8 DD of the Asymmetrical dipole for 80/40/20/10- meter bands at 40 meter Band

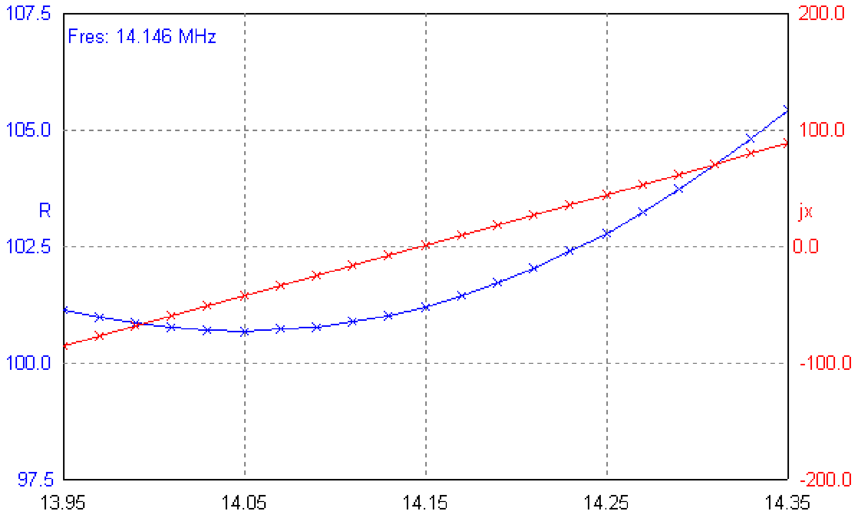


Figure 9 Z of the Asymmetrical dipole for 80/40/20/10- meter bands at 20 meter Band

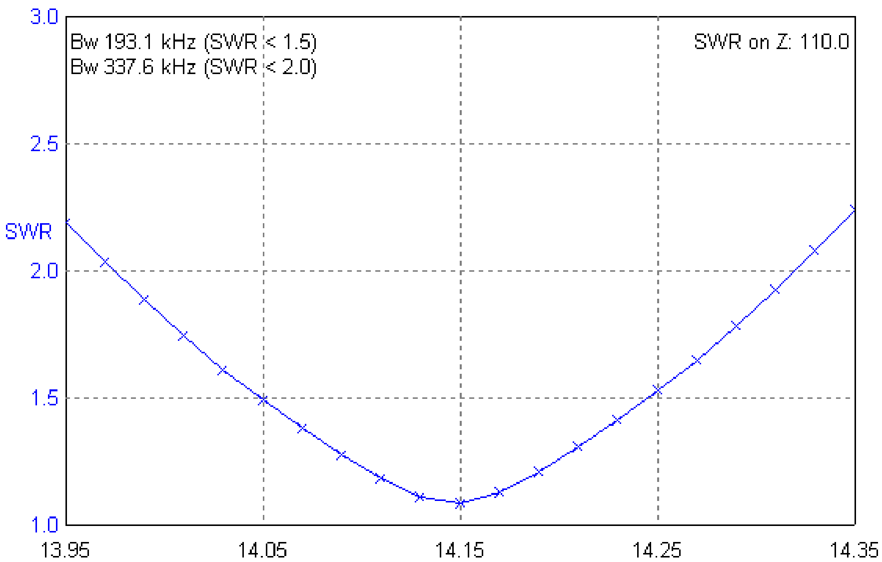


Figure 10 SWR of the Asymmetrical dipole for 80/40/20/10- meter bands at 20 meter Band

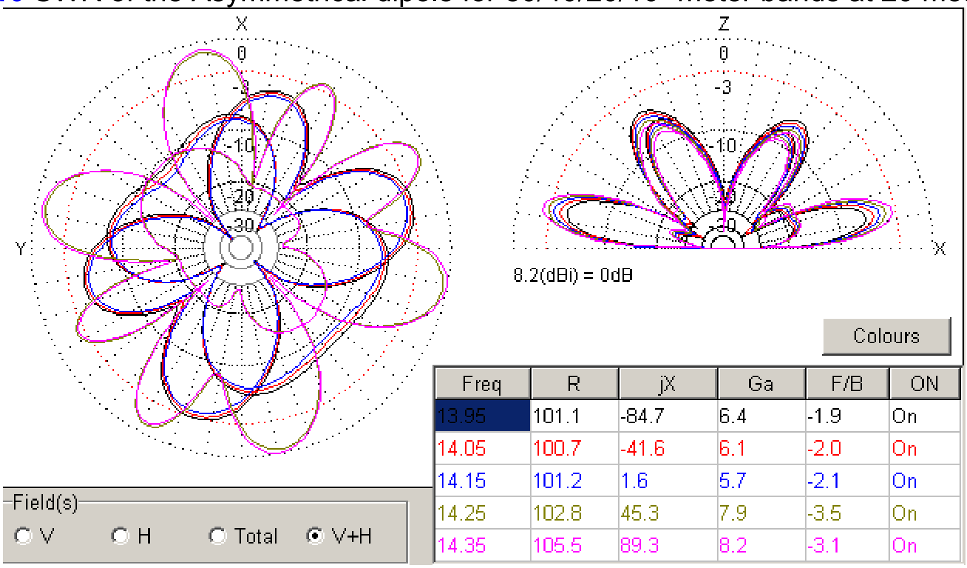


Figure 11 DD of the Asymmetrical dipole for 80/40/20/10- meter bands at 20 meter Band

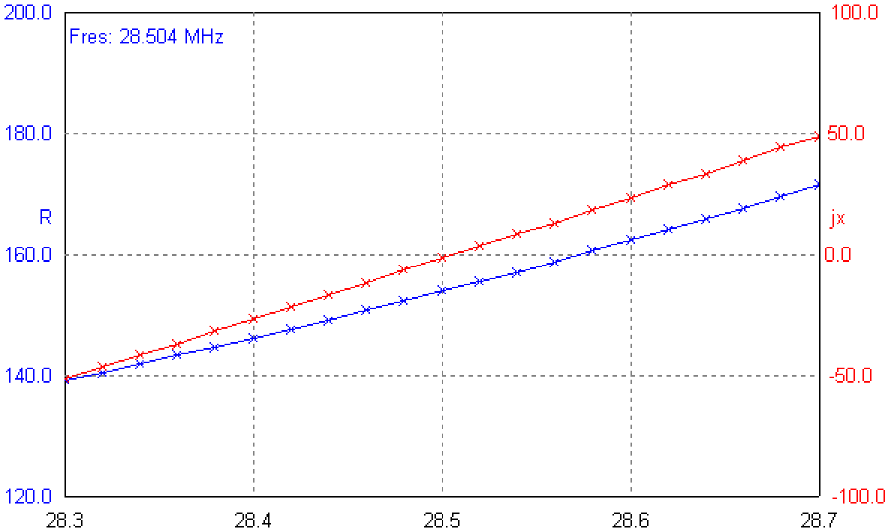


Figure 12 Z of the Asymmetrical dipole for 80/40/20/10- meter bands at 10 meter Band

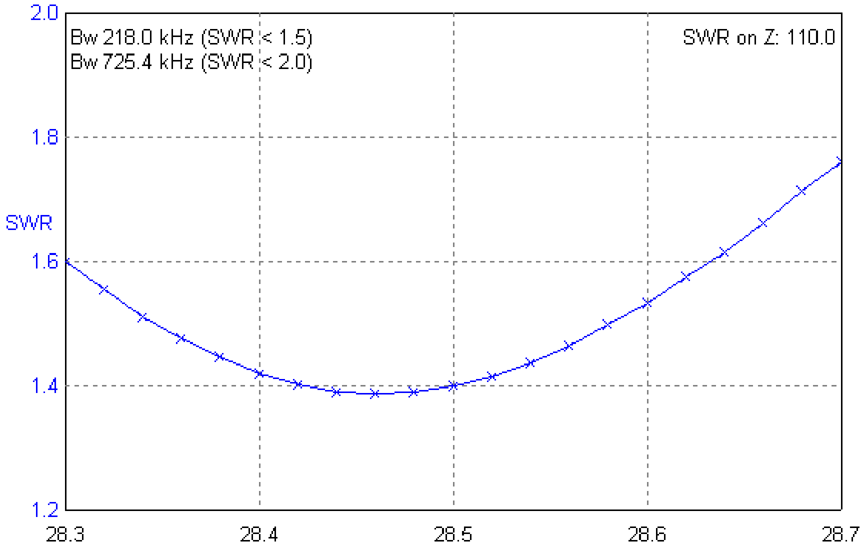
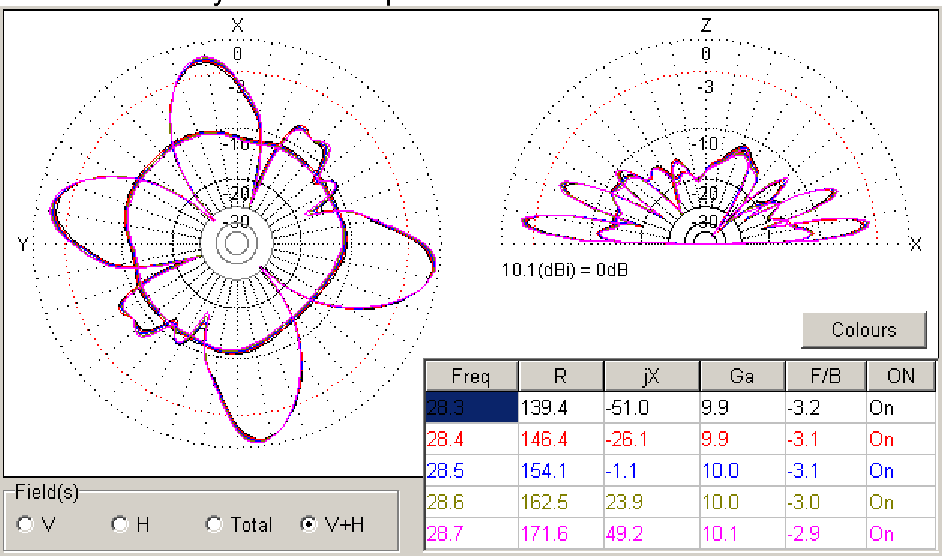


Figure 13 SWR of the Asymmetrical dipole for 80/40/20/10- meter bands at 10 meter Band



Freq	R	jX	Ga	F/B	ON
28.3	139.4	-51.0	9.9	-3.2	On
28.4	146.4	-26.1	9.9	-3.1	On
28.5	154.1	-1.1	10.0	-3.1	On
28.6	162.5	23.9	10.0	-3.0	On
28.7	171.6	49.2	10.1	-2.9	On

Figure 14 DD of the Asymmetrical dipole for 80/40/20/10- meter bands at 10 meter Band

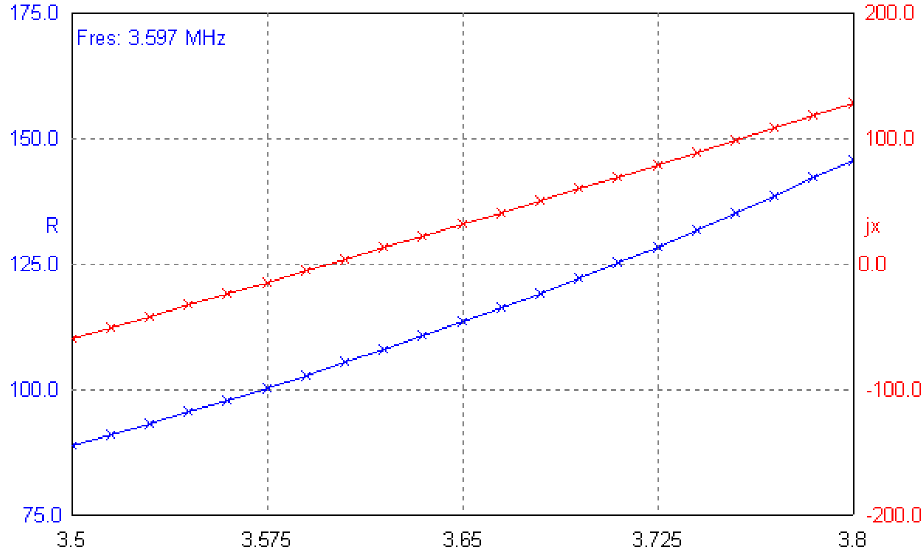
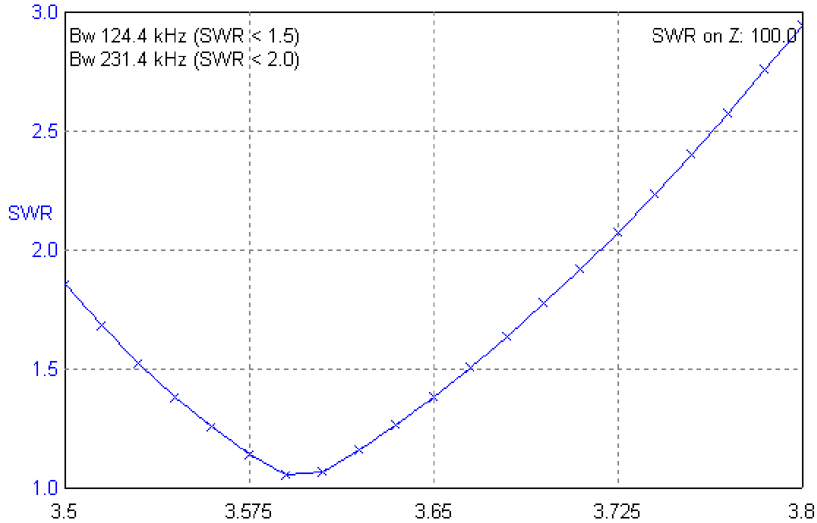
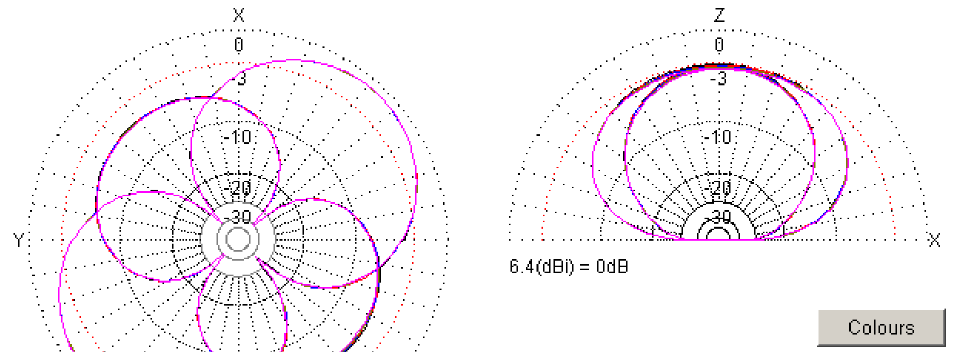


Figure 12 Z of the Asymmetrical dipole for 80/40/20/15/10- meter bands at 80 meter Band





Freq	R	jX	Ga	F/B	ON
3.5	89.1	-58.5	6.4	-1.8	On
3.575	100.5	-13.8	6.3	-1.8	On
3.65	113.6	32.3	6.2	-1.8	On
3.725	128.6	79.7	6.1	-1.8	On
3.8	146.0	129.1	6.0	-1.9	On

Figure 14 DD of the Asymmetrical dipole for 80/40/20/15/10- meter bands at 80 meter Band

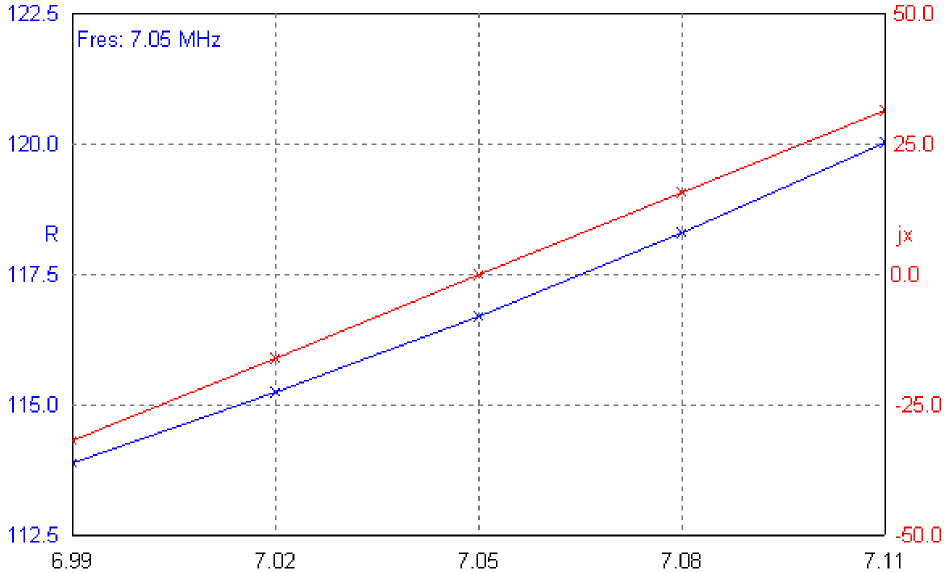


Figure 15 Z of the Asymmetrical dipole for 80/40/20/15/10- meter bands at 40 meter Band

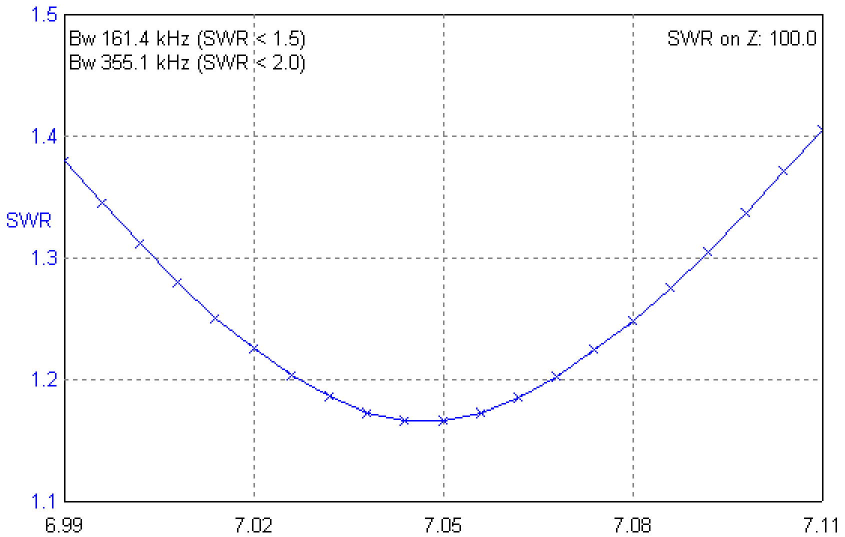


Figure 16 SWR of the Asymmetrical dipole for 80/40/20/15/10- meter bands at 40 meter Band

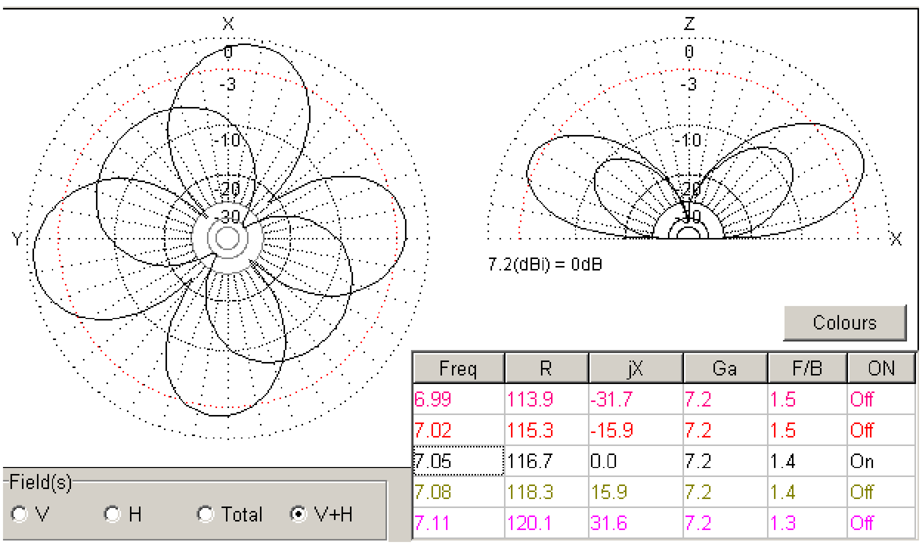


Figure 17 DD of the Asymmetrical dipole for 80/40/20/15/10- meter bands at 40 meter Band

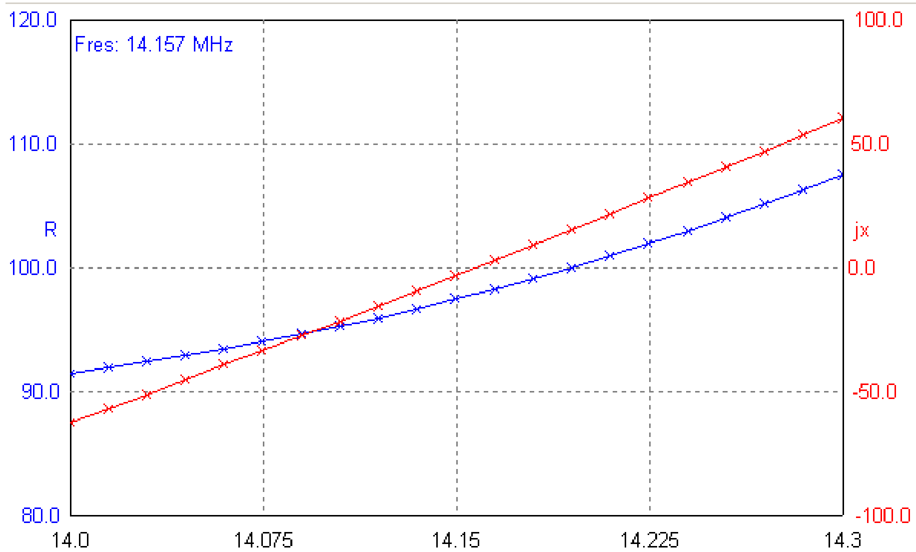


Figure 18 Z of the Asymmetrical dipole for 80/40/20/15/10- meter bands at 20 meter Band

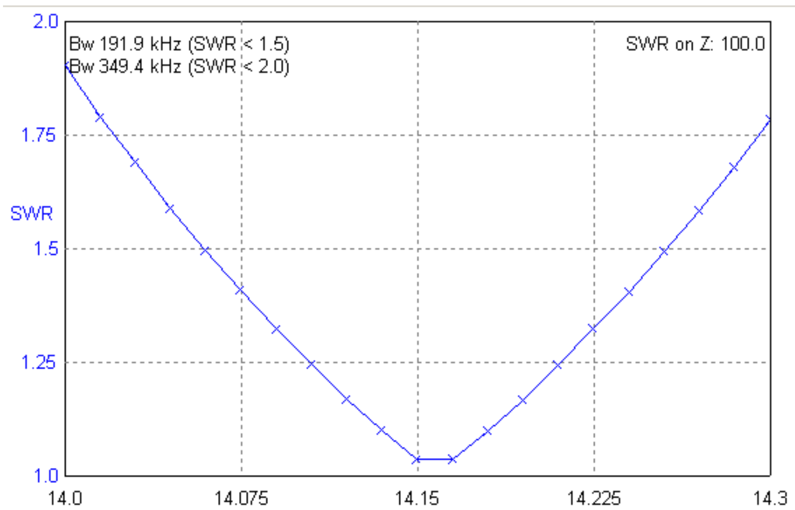
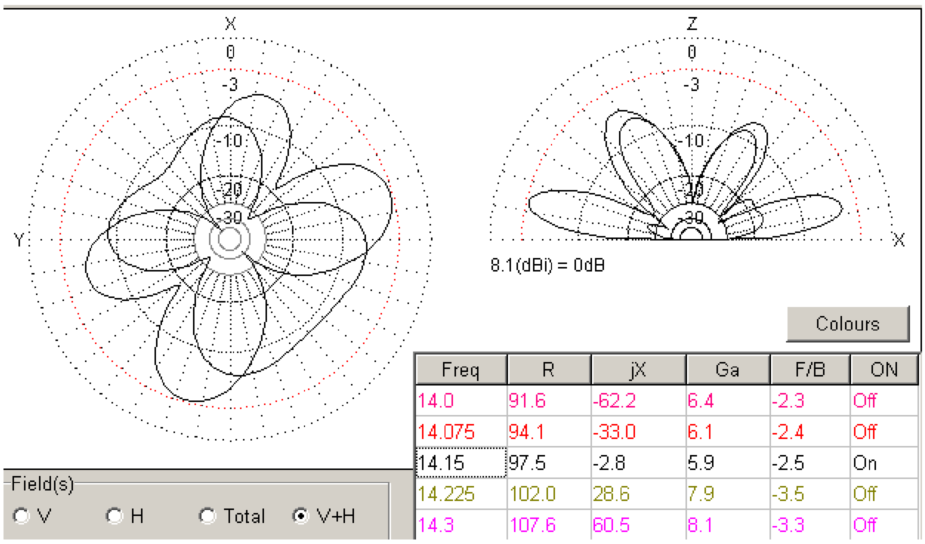


Figure 19 SWR of the Asymmetrical dipole for 80/40/20/15/10- meter bands at 20 meter Band



Freq	R	jX	Ga	F/B	ON
14.0	91.6	-62.2	6.4	-2.3	Off
14.075	94.1	-33.0	6.1	-2.4	Off
14.15	97.5	-2.8	5.9	-2.5	On
14.225	102.0	28.6	7.9	-3.5	Off
14.3	107.6	60.5	8.1	-3.3	Off

Figure 20 DD of the Asymmetrical dipole for 80/40/20/15/10- meter bands at 20 meter Band

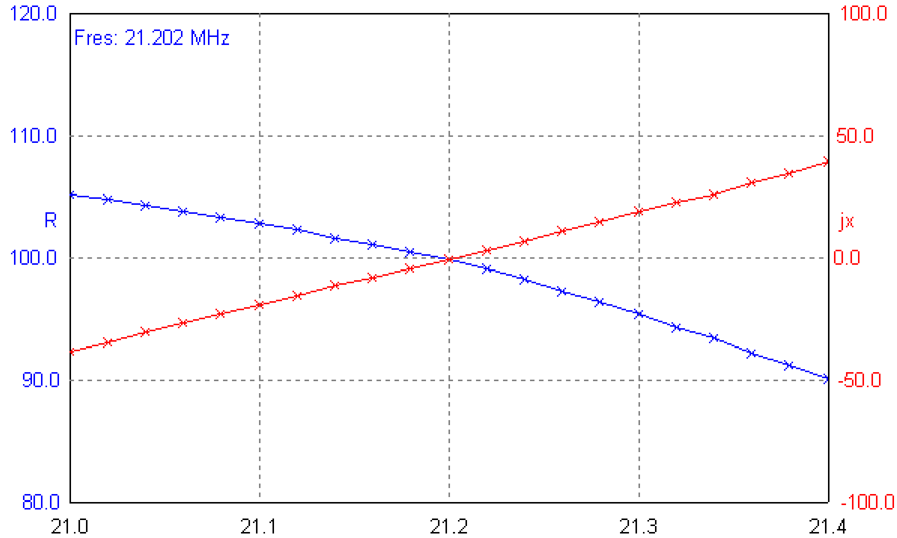


Figure 21 Z of the Asymmetrical dipole for 80/40/20/15/10- meter bands at 15 meter Band

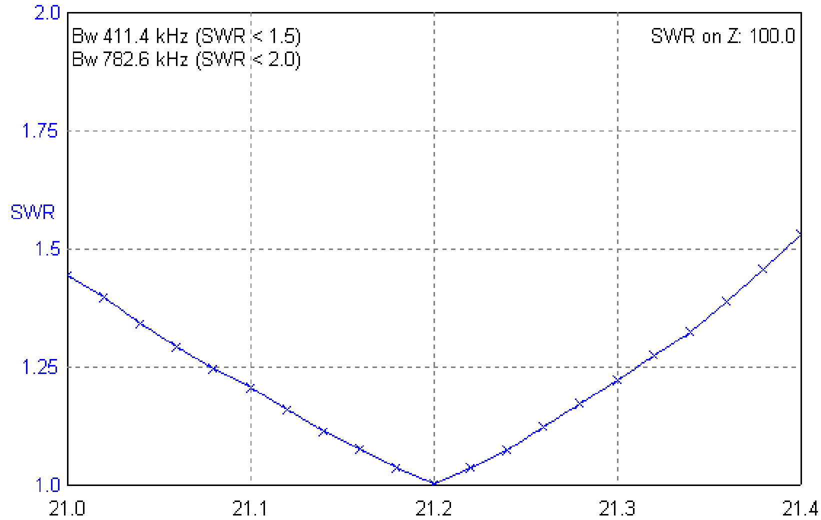
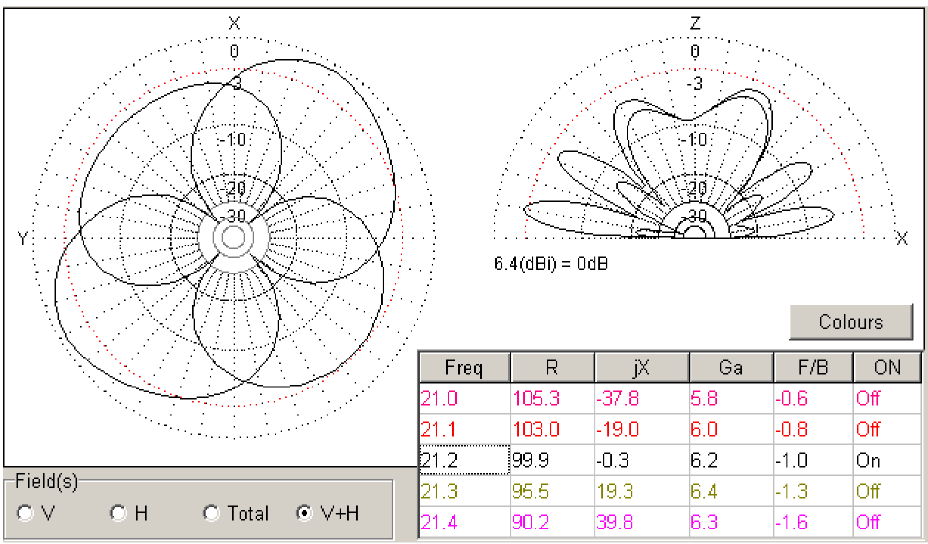


Figure 22 SWR of the Asymmetrical dipole for 80/40/20/15/10- meter bands at 15 meter Band



Freq	R	jX	Ga	F/B	ON
21.0	105.3	-37.8	5.8	-0.6	Off
21.1	103.0	-19.0	6.0	-0.8	Off
21.2	99.9	-0.3	6.2	-1.0	On
21.3	95.5	19.3	6.4	-1.3	Off
21.4	90.2	39.8	6.3	-1.6	Off

Figure 23 DD of the Asymmetrical dipole for 80/40/20/15/10- meter bands at 15 meter Band

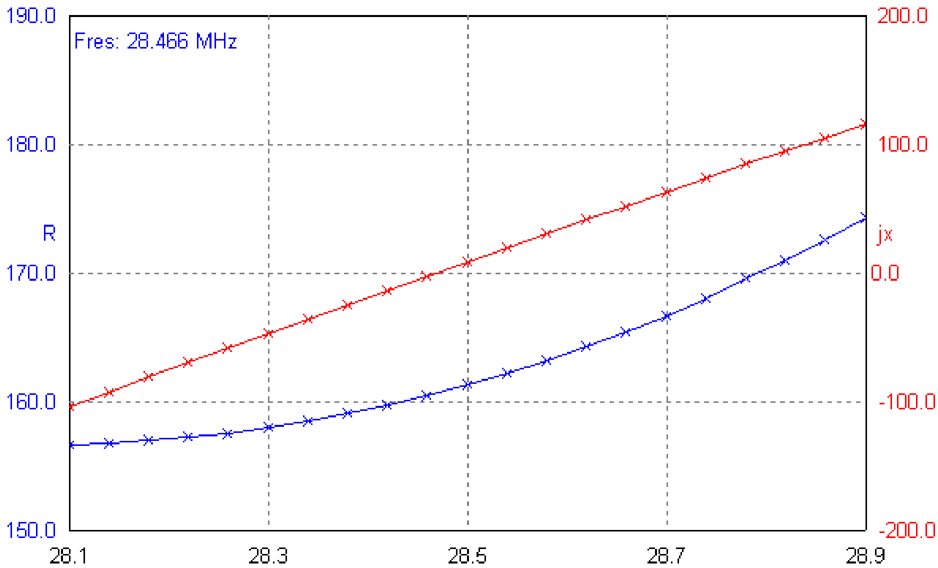


Figure 24 Z of the Asymmetrical dipole for 80/40/20/15/10- meter bands at 10 meter Band

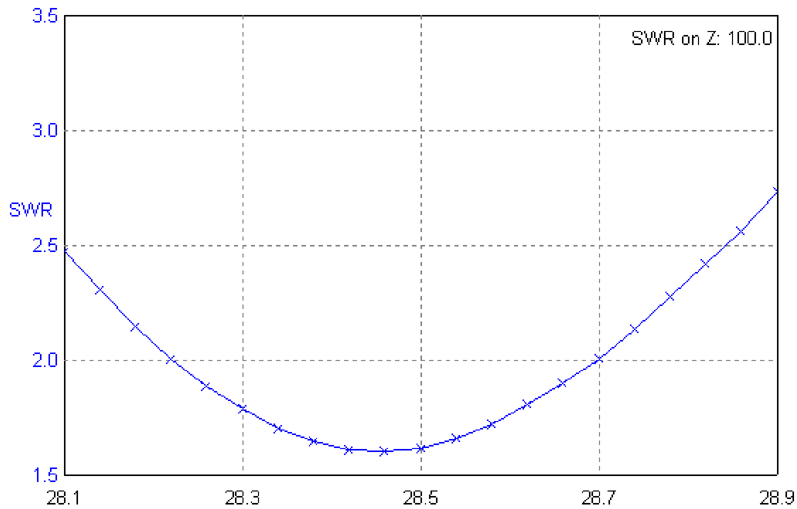


Figure 25 SWR of the Asymmetrical dipole for 80/40/20/15/10- meter bands at 10 meter Band

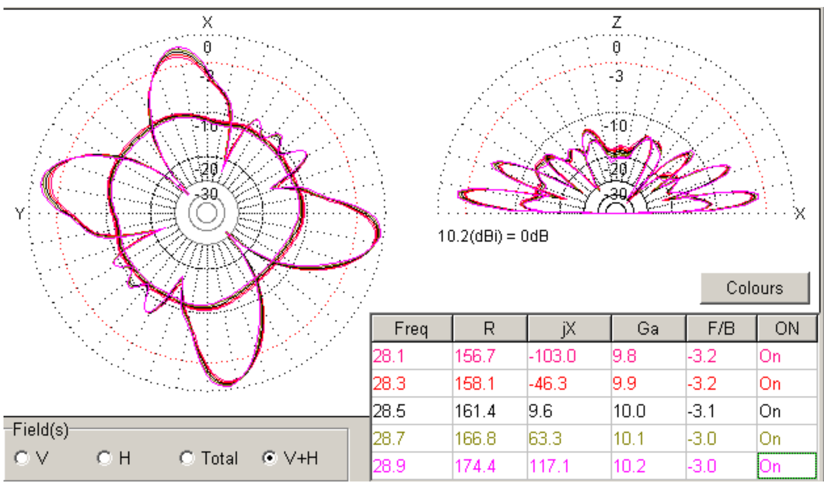


Figure 26 DD of the Asymmetrical dipole for 80/40/20/15/10- meter bands at 10 meter Band

73 Nick

Credit Line: Forum from: www.cqham.ru

Asymmetrical I.V. for the 80 and 40- meters

The publication is devoted to the memory UR0GT.

By: Nikolay Kudryavchenko, UR0GT

Asymmetrical I.V. for the 80- and 40- meter band is shown on **Figure 1**.

Parameters of the antenna are shown below.

73 Nick

The MMANA model of the Optimized Vertical for the 80- meters may be loaded: http: // www.antentop.org/014/iv_014.htm

Credit Line: Forum from: www.cqham.ru

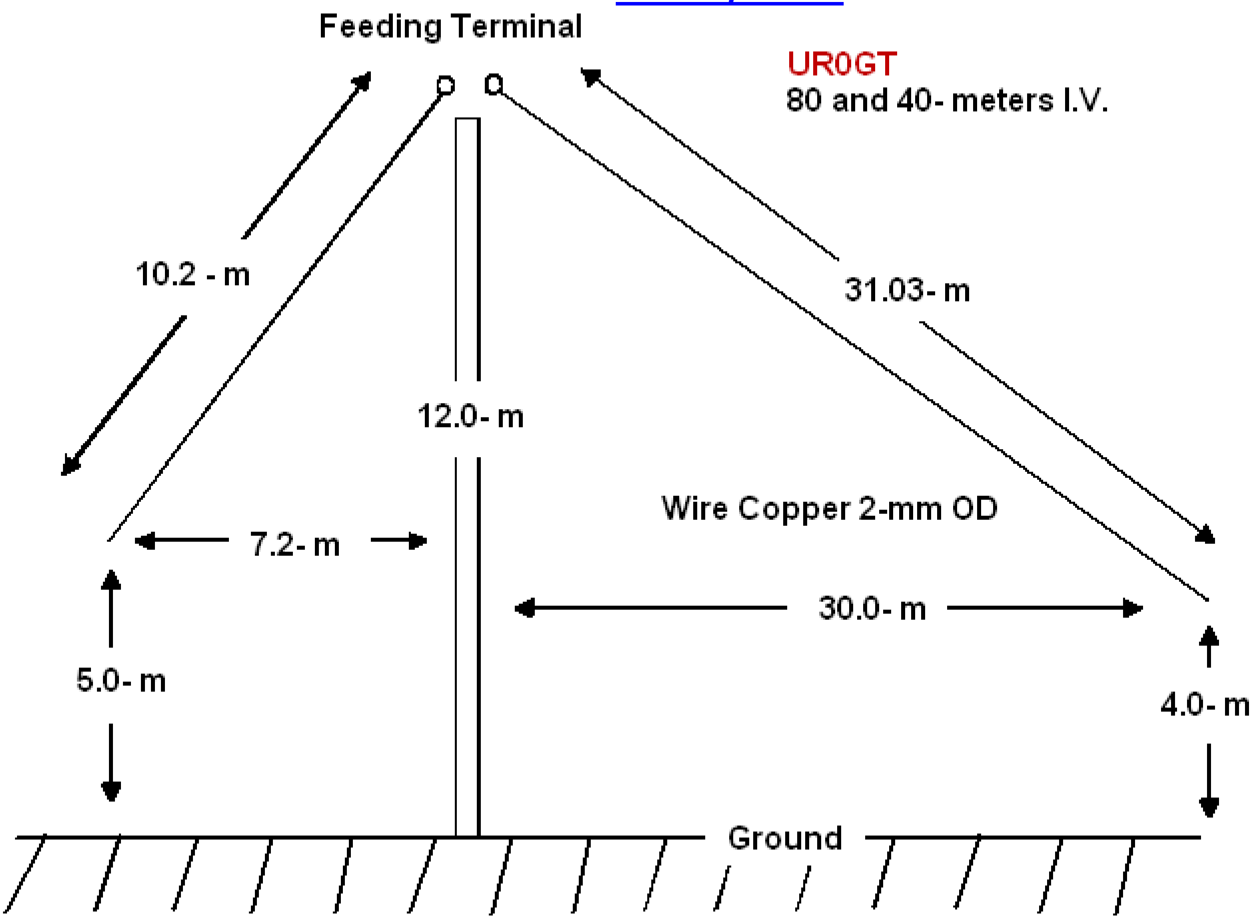


Figure 1 Asymmetrical I.V. for the 80- and 40- meter band

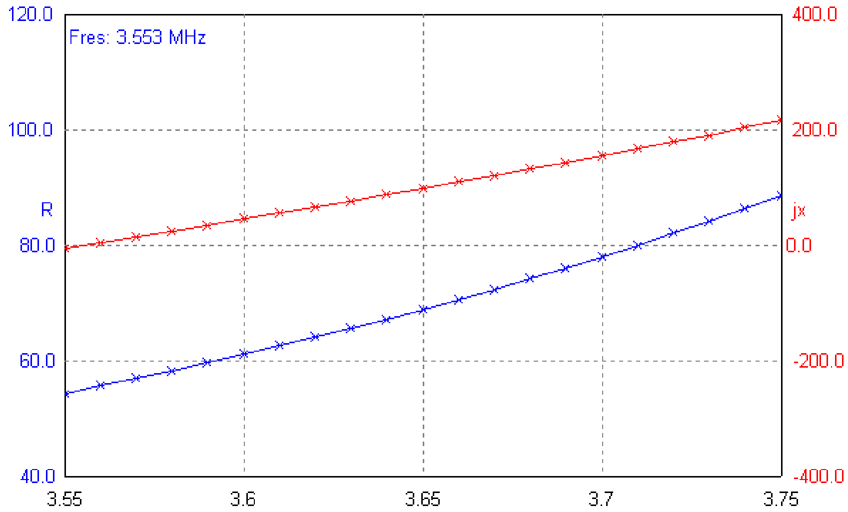


Figure 2 Z of the Asymmetrical I.V. at the 80- meter band (above the real ground)

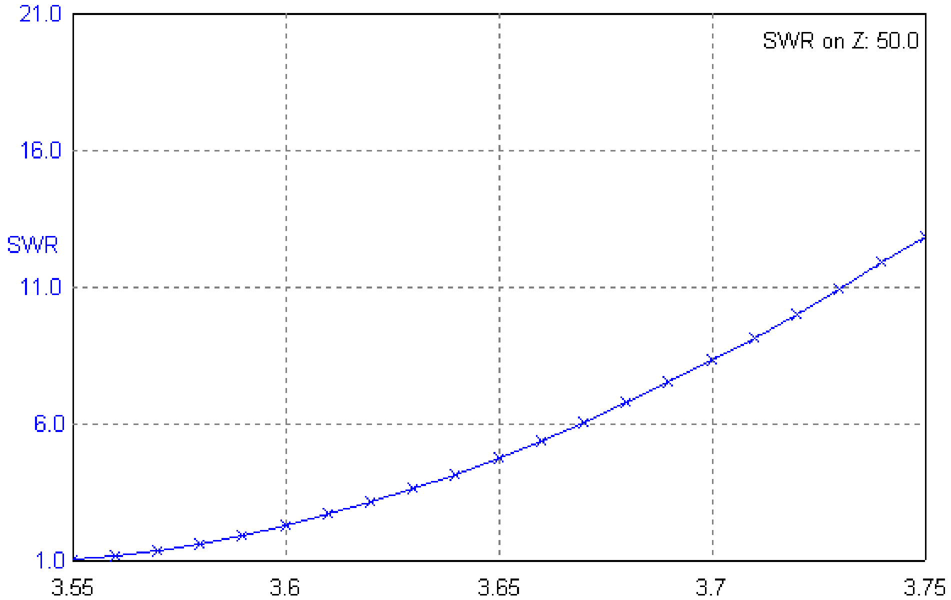
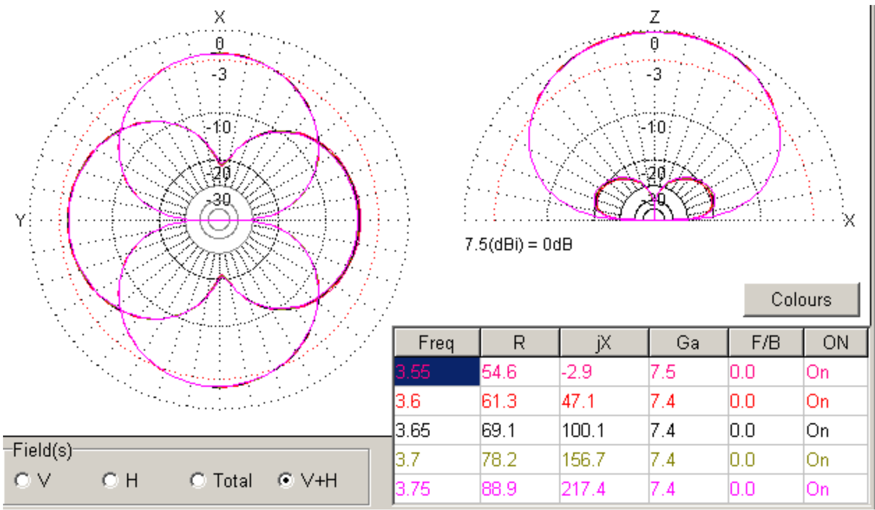


Figure 3 SWR of the Asymmetrical I.V. at the 80- meter band (above the real ground)



Freq	R	jX	Ga	F/B	ON
3.55	54.6	-2.9	7.5	0.0	On
3.6	61.3	47.1	7.4	0.0	On
3.65	69.1	100.1	7.4	0.0	On
3.7	78.2	156.7	7.4	0.0	On
3.75	88.9	217.4	7.4	0.0	On

Figure 4 DD of the Asymmetrical I.V. at the 80- meter band (above the real ground)

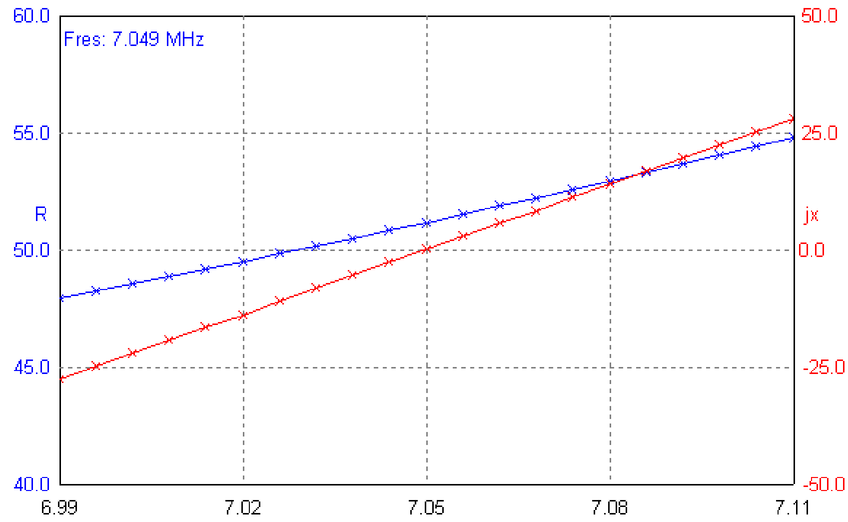


Figure 5 Z of the Asymmetrical I.V. at the 40- meter band (above the real ground)

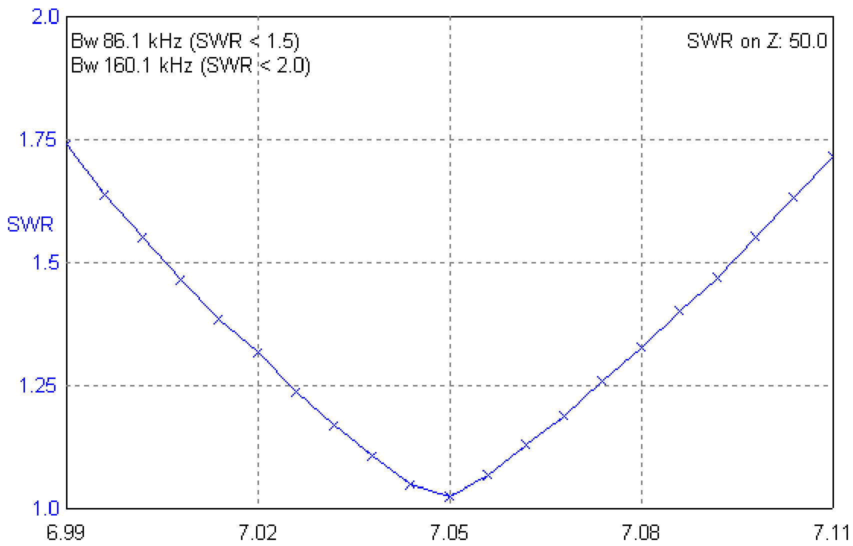
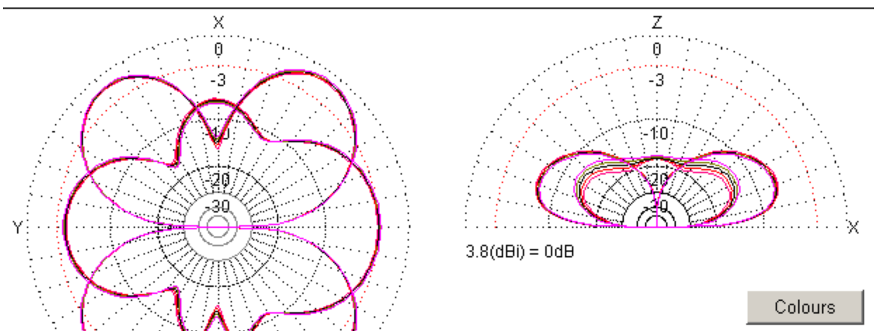


Figure 6 SWR of the Asymmetrical I.V. at the 40- meter band (above the real ground)



Freq	R	jX	Ga	F/B	ON
6.99	48.0	-27.4	3.5	0.0	On
7.02	49.6	-13.8	3.5	0.0	On
7.05	51.2	0.4	3.6	0.0	On
7.08	53.0	14.4	3.7	0.0	On
7.11	54.8	28.3	3.8	0.0	On

Figure 7 DD of the Asymmetrical I.V. at the 40- meter band (above the real ground)

Vertical Inverted L for the 160, 80 and 40- meter Bands

The publication is devoted to the memory UR0GT.

By: **Nikolay Kudryavchenko, UR0GT**

Vertical Inverted L for the160, 80 and 40- meter bands is shown on **Figure 1**.

Parameters of the antenna are shown below.

73 Nick

The MMANA model of the Vertical Inverted L for the 160, 80 and 40- meter Bands may be loaded: http: // www.antentop.org/014/il_014.htm

Credit Line: Forum from: www.cqham.ru

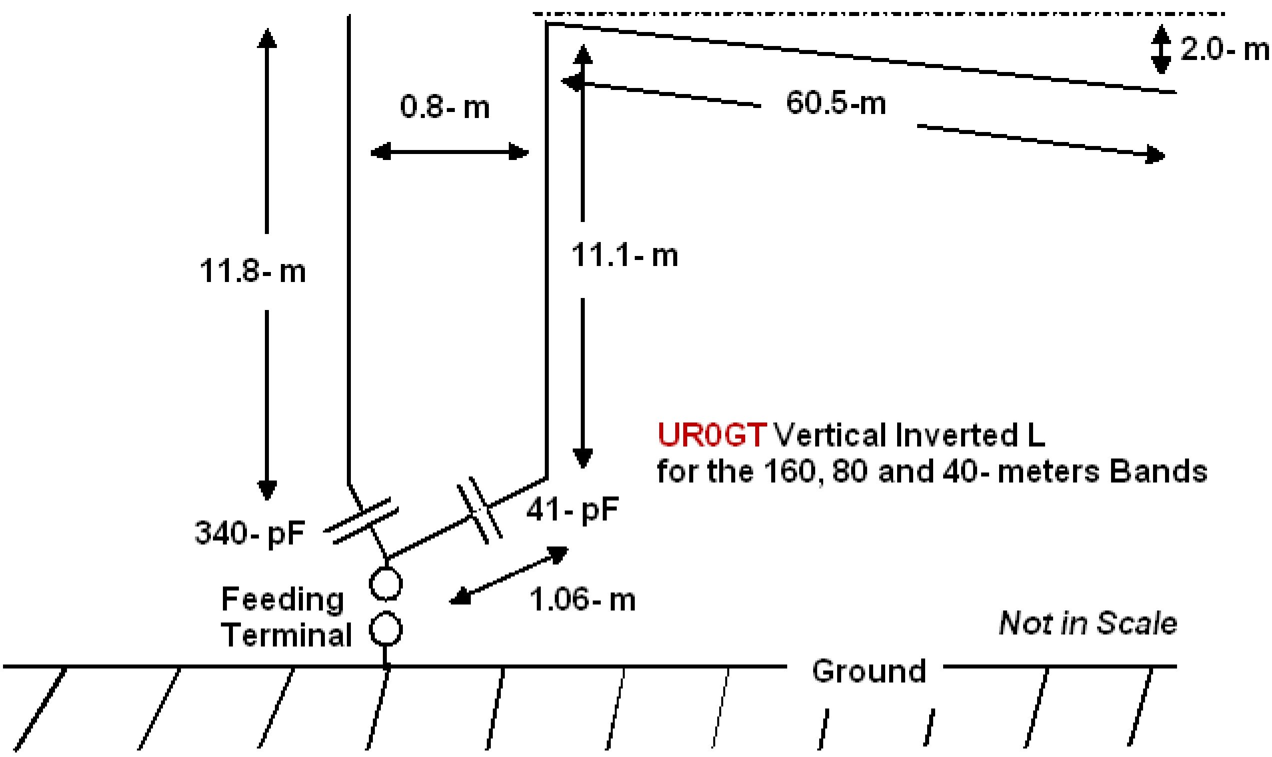


Figure 1 Vertical Inverted L for the 160, 80 and 40- meter Bands

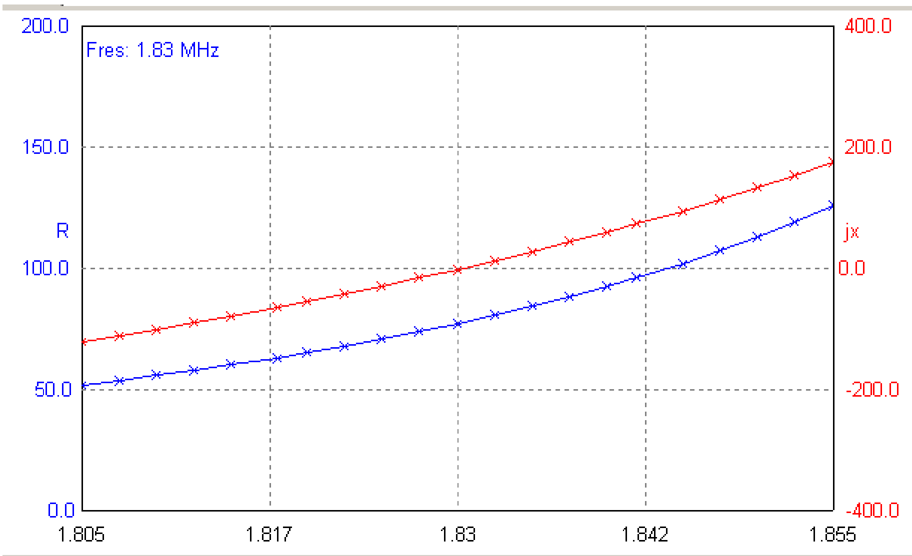


Figure 2 Z of the Vertical Inverted L at the 160 - meter band (above the real ground)

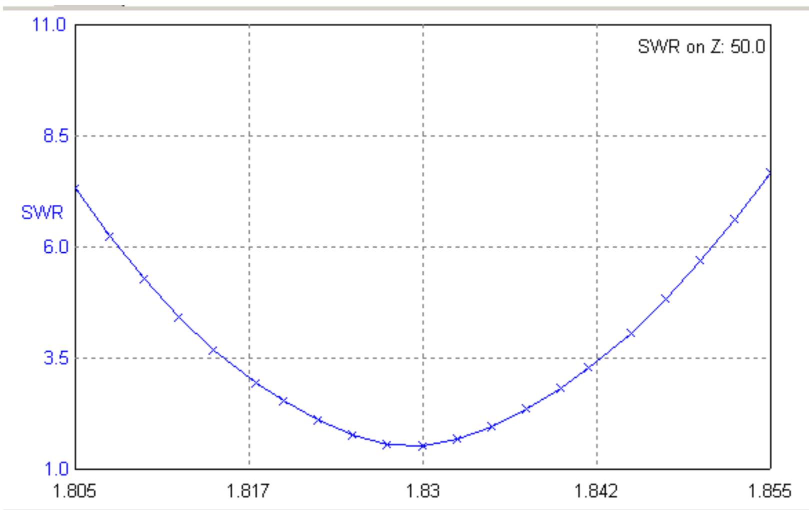
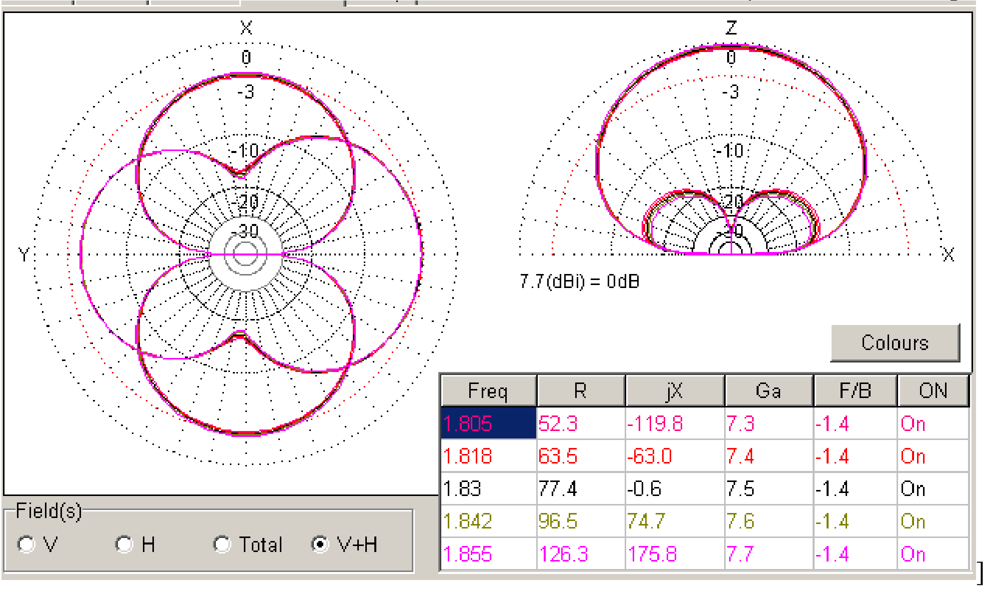


Figure 3 SWR of the Vertical Inverted L at the 160 - meter band (above the real ground)



Freq	R	jX	Ga	F/B	ON
1.805	52.3	-119.8	7.3	-1.4	On
1.818	63.5	-63.0	7.4	-1.4	On
1.83	77.4	-0.6	7.5	-1.4	On
1.842	96.5	74.7	7.6	-1.4	On
1.855	126.3	175.8	7.7	-1.4	On

Figure 4 DD of the Vertical Inverted L at the 160 - meter band (above the real ground)

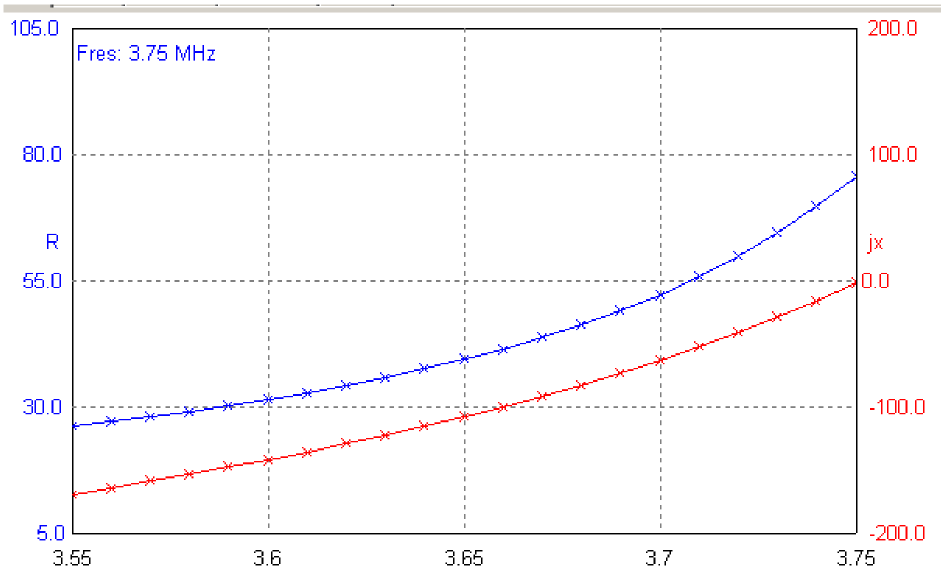


Figure 5 Z of the Vertical Inverted L at the 60 - meter band (above the real ground)

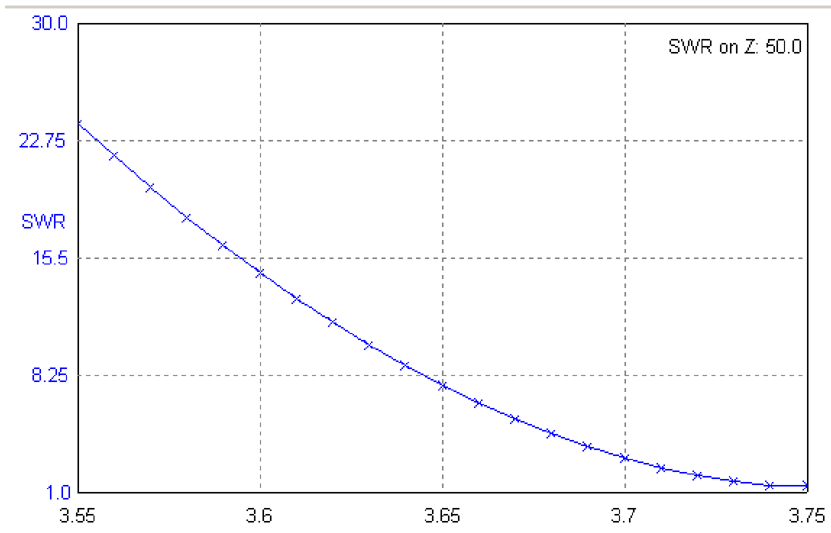


Figure 6 SWR of the Vertical Inverted L at the 80 - meter band (above the real ground)

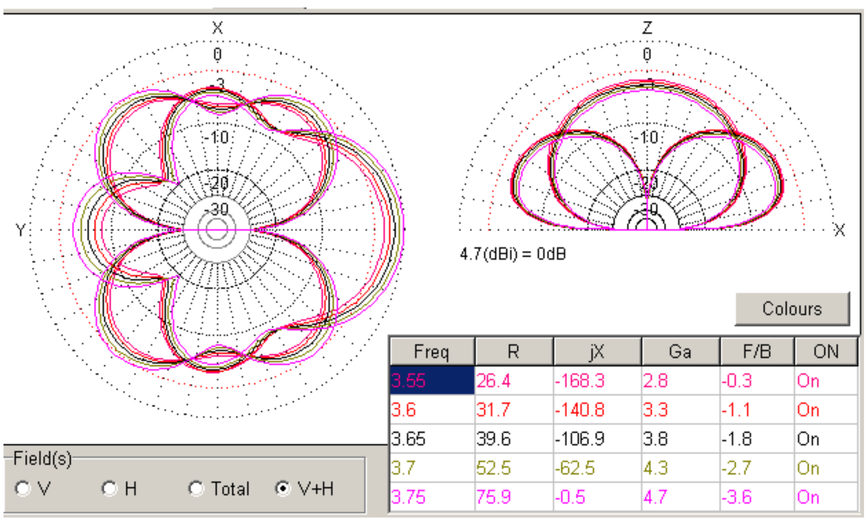


Figure 7 DD of the Vertical Inverted L at the 80 - meter band (above the real ground)

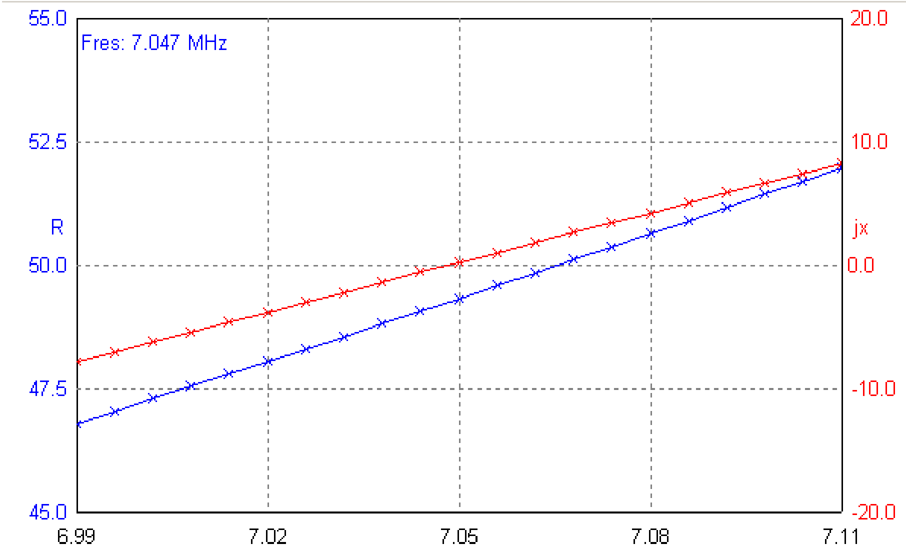


Figure 8 Z of the Vertical Inverted L at the 40 - meter band (above the real ground)

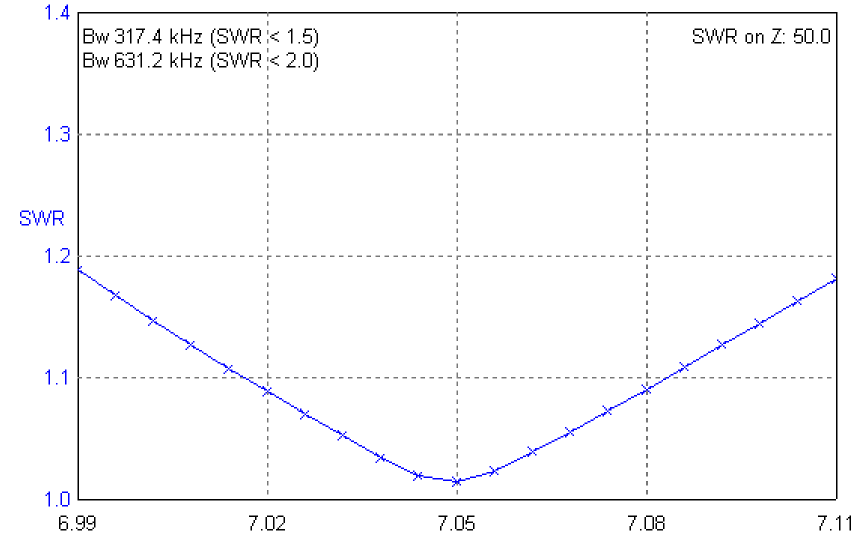
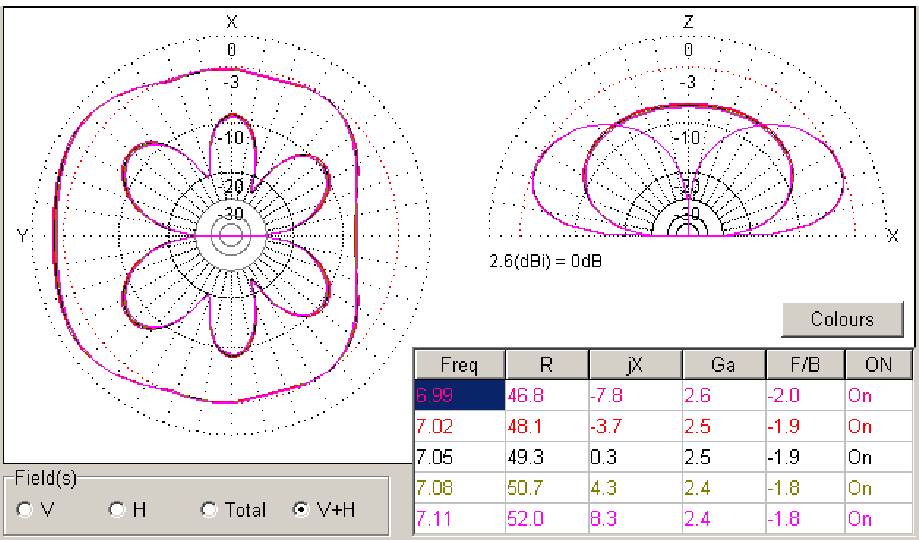


Figure 9 SWR of the Vertical Inverted L at the 40 - meter band (above the real ground)



Freq	R	jX	Ga	F/B	ON
6.99	46.8	-7.8	2.6	-2.0	On
7.02	48.1	-3.7	2.5	-1.9	On
7.05	49.3	0.3	2.5	-1.9	On
7.08	50.7	4.3	2.4	-1.8	On
7.11	52.0	8.3	2.4	-1.8	On

Figure 10 DD of the Vertical Inverted L at the 40 - meter band (above the real ground)

EH- Antenna for the 160- meter Band

Vladimir Kononov, UA1ACO, St- Petersburg

Credit Line: http://ehant.qrz.ru/exp_eh33.htm

The antenna has diameter 110- mm and is 2 meter in length. The sizes are without protected enclosure (indoor variant).

Antenna was calculated with help of program VK4ANW. **Figure 1** shows the calculation.

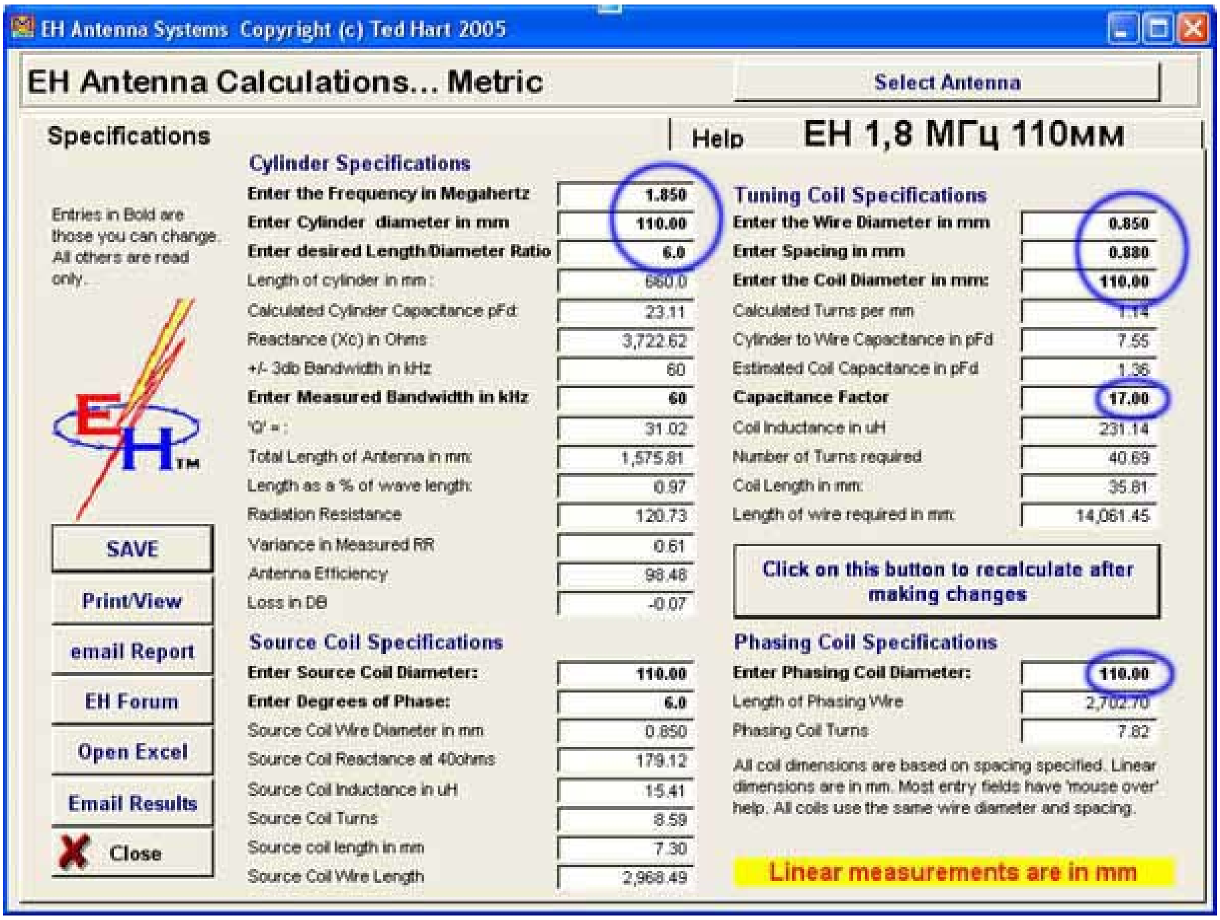


Figure 1 Calculation EH-Antenna for 160 meter with help VK4ANW program

Here are some explanations about the antenna data.

1. Diameter plastic tube for the antenna is 110- mm.

Standard row for the tube is: 75, 110, 165, 215- mm. If we take tube with smaller diameter 75- mm we get twice decreased Pass Band and twice increased turns in the inductor (so, losses in the inductor also highly increased). If we take tube with bigger diameter 215- mm we get twice increased Pass Band and twice decreased turns in the inductor (so, losses in the inductor also decreased). Good parameters, but antenna is too bulky!

2. Diameter of the wire in the inductor is 0.85- mm (20- AWG). It is compromise variant that depends on power (10- Wtts allowed in Russia) allowed for using and losses in the inductor. For bigger power it needs to use wire with bigger diameter.

3. Copper foil is 0.05- mm in the thickness. Thickness of the using copper foil for the EH antenna depends on power going into antenna and to mechanical strength of the foil. 0.05- mm foil should be enough for the antenna.

4. Length to the cylinder diameter is 6. I took the digit from my experience. If the digit less the 6 the Pass Band is decreased. If the digit more the 6 the antenna design going to be complicated.

Figure 2 shows design of the EH-Antenna for the 160-meters.

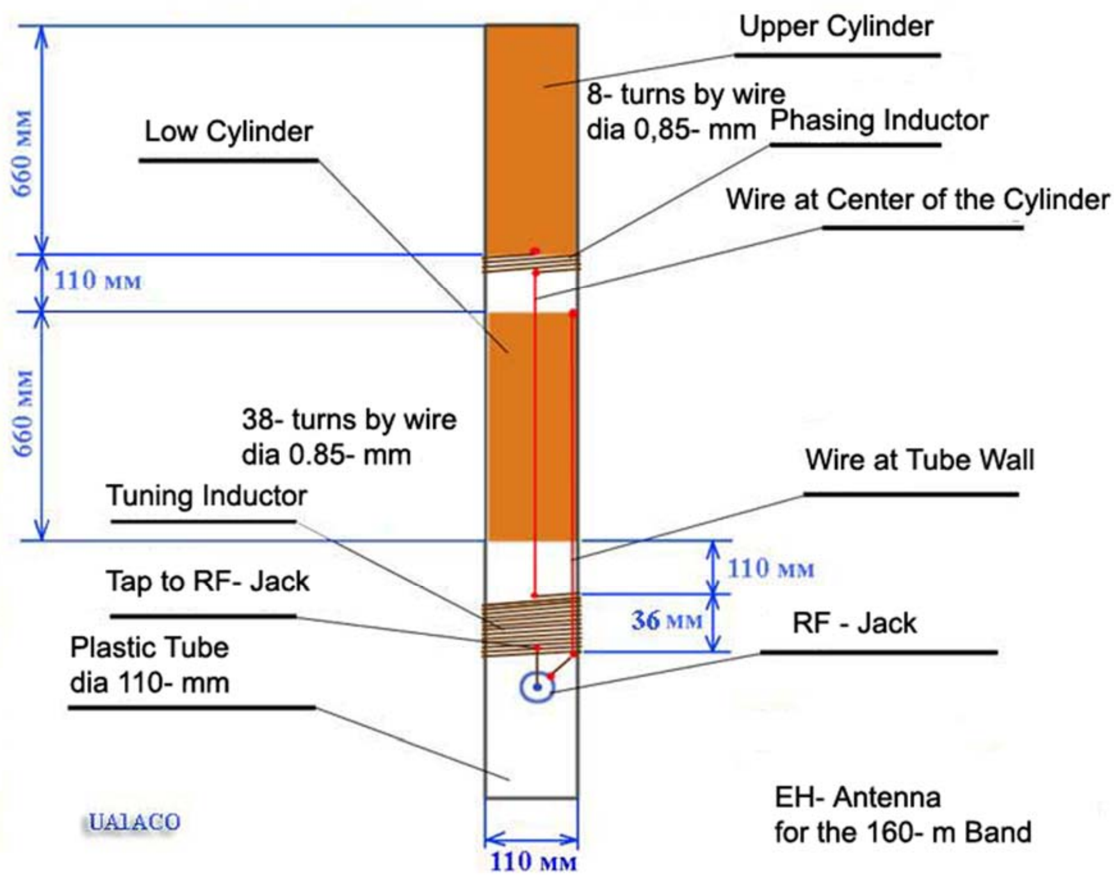


Figure 2 Design of the EH-Antenna for the 160- meters

Red dots are marked the solder places. Tuning coil should be coiled with gap between the turns at the beginning and at the end.

It needs for antenna tuning. Figure 3 shows the design of the coil.

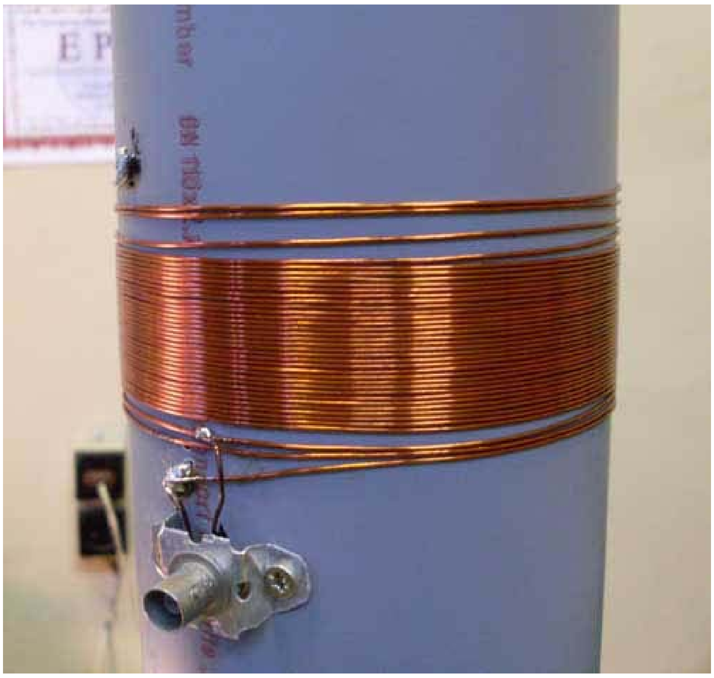


Figure 3 Design of the Tuning Coil

Resonance frequency of the antenna is adjusting by moving coils between together at the upper part of the coil. SWR is changed by moving coils between together at the lower part at the coil. Both of the tuning is influenced to each other. In my case the tap for SWR 1:1.02 was taken from second turn.

Note from I.G.

BEWARE:

All the information you find at ***AntenTop website*** and any hard (printed) copy of the ***AnTentop Publications*** are only for educational and/or private use! I and/or authors of the ***AntenTop e- magazine*** are not responsible for everything including disasters/deaths coming from the usage of the data/info given at ***AntenTop website/hard (printed) copy of the magazine***.

You use all these information of your own risk.

Be careful! The antenna has no protected enclosure! At the parts of the antenna is high RF that is dangerous for live!

Antenna was tuned to the 160- meter band according to routine tuning for the EH-Antennas.

Figure 4 shows parameters of the antenna obtained with “miniVNA.”.

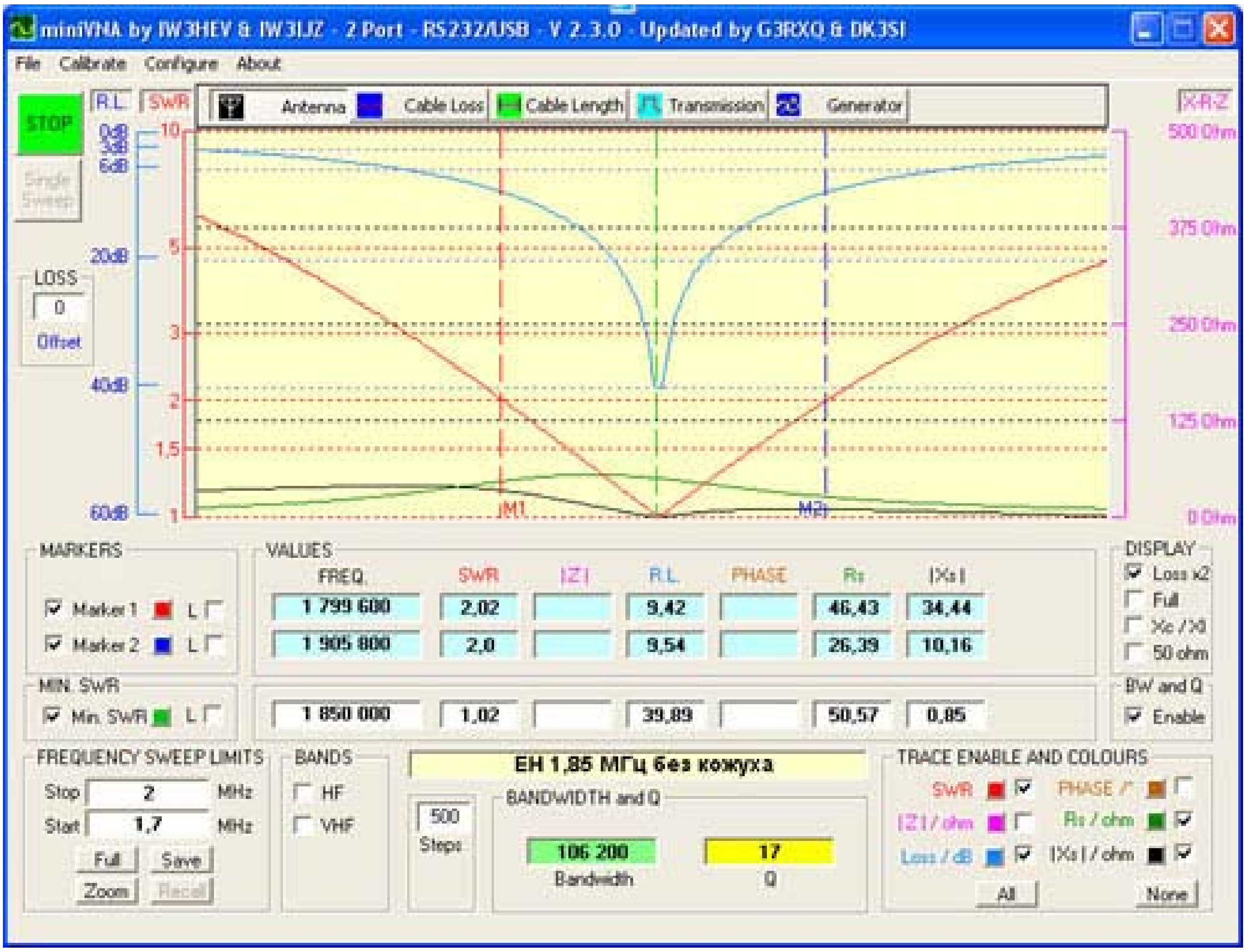


Figure 4 Parameters of the EH- Antenna

Parameters of the antenna are really good. At the frequency 1.85- MHz it is Pass Band more the 100- kHz at SWR 1.0: 1.02. The antenna has big sizes so tune the antenna at its working position. Remember, that all objects near the antenna could influence to the parameters of the antenna. Try to keep space near the antenna at radius 2…- 3 length of the antenna free from anything.

However, above stated is not about me. I have no free place for the EH- Antenna. The antenna was installed at my workplace at the ground floor. Near the antenna there are lots objects that hindered the antenna operation. At the background it is showed a EH- Antenna for the 40-meter (25- cm in length). **Figure 5** shows the installation. ***Do not repeat my installation of the EH-antenna because it is dangerous for life!***

I turn on the EH- Antenna to my transceiver through a 1.5- meter coaxial cable. Near the antenna an RF- Choke is installed. It is six coils coiled by the coaxial cable around a ferrite ring. I turn on my transceiver and take my straight key. Time is near 13.00- GMT, not good time for QSO on the 160- meter. However, I hear several stations and first QSO with RK3PA is done!

Next week (I have no lots time to work in the Air) I made QSO with UR4LPQ, LA6YEA, RU4SU, OZ1LXJ… All QSOs were made at EH- Antenna in 2- meter height and 10- 15 Watts going into the antenna!

Final test the EH- Antenna was made when I installed the antenna at 1.5- meter above the roof of my house, that is near 8- meter above the ground. **Figure 6** shows the antenna on the roof.

Figure 5 EH- Antenna for the 160- meter on the table

Figure 6 EH- Antenna for the 160- meters on the roof of the house

I decided take part in the CQ- WWW 160-m DX CONTEST in class CW. For the test I used my ICOM-7000 and 80 Watts going to the EH- Antenna.

Before the contest lots stations do training in the Air. I have QSO with OH8X, UA1ANA, RV2FZ, RU3BB, OK1AXB, SM6VJA/p, OM8LA, UA3UDE, RX3APM, OH4XX, LY3W, UT4UJ, UY2UA, OM3BH, RV9YZ, RW9TR, RN3GM/2, RV9CX, EN1IFF/p, RN3QY, RU4PU, SP2LNW, S56P, DK2OY, UP2L, OM5KM, LY1CM, HA1TJ, UW5U, OK1DSZ, UA3QDX…

It is 22.00- GMT, contest is started. EH-Antenna works well and I already have QSO with UA3BS, UZ1H, UA2FL, LY6A, LY2OU, YL9T, UA1QM, LY9A, EW6GF, YR5N, RG3K… **Figure 7** shows pages from the contest. Log in Cabrillo may be downloaded from: http://ehant.qrz.ru/ua1aco.cbr

I made 200 QSOs with 32- WAZ- zones and got near 27000 points.

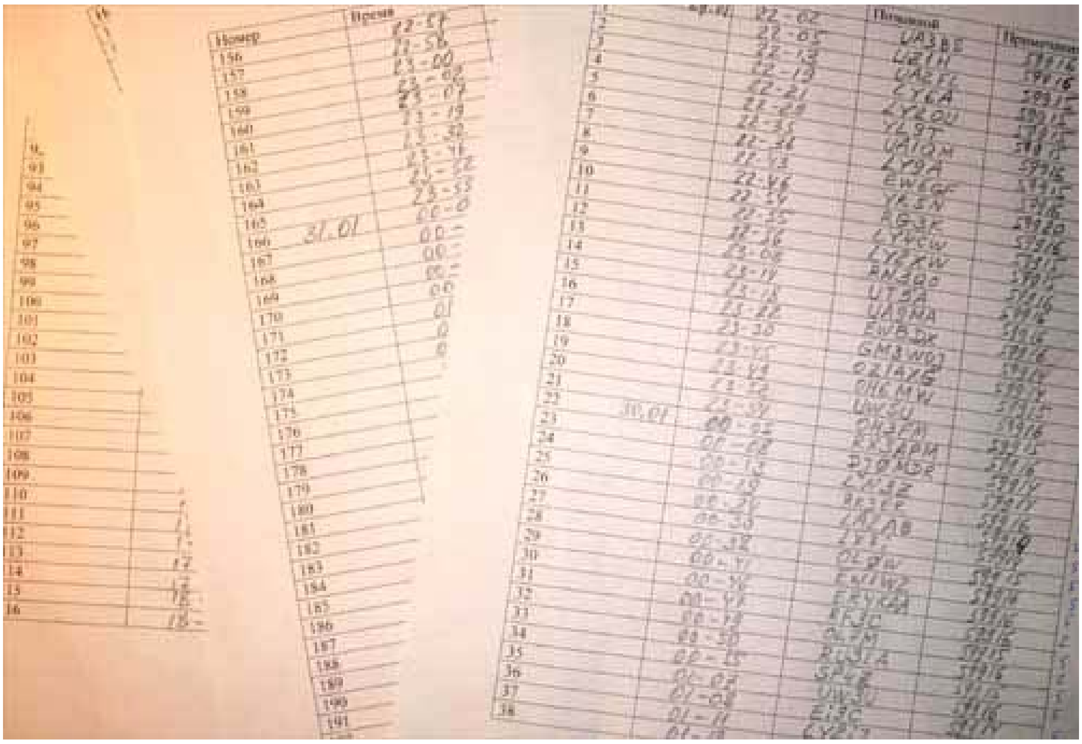
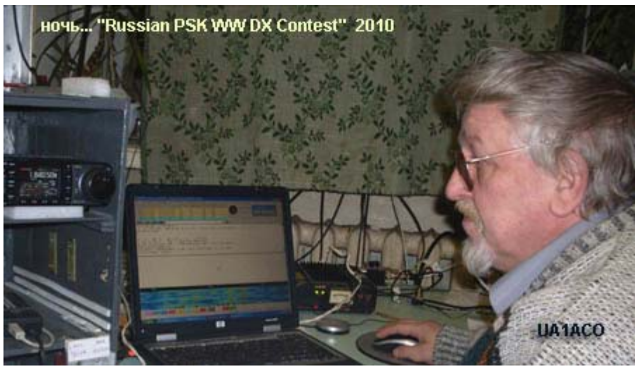


Figure 7 Pages from the contest

I proved by my routine work in the Air and by the contest that my EH- Antenna for 160-m worked and it is worked not bad. Off course, it is not a "Mamont" antenna that is installed by the hams from Finland

Figure 8 "Mamont" from Finland

But the antenna works and I believe that is good variant for those who cannot install traditional antennas at the 160-m.



UA1ACO tested the EH-Antenna in Russian PSK WWW DX- CONTEST- 2010

73 and DX from UA1ACO!

EH- Antenna from 1928

UA1ACO at forum at qrz.ru (Credit Line: http://forum.qrz.ru/thread22310-40.htm) wrote:

All new is forgotten old. I remembered that somewhere there were published link to a prototype of the EH- Antenna. The antenna was published in the Soviet magazine “Radio vsem” # 9, 1928 pp.: 43- 44, “QRP for Summer” (“Radio for All” in English). Off course, the transmitter would be worked perfect if it will be connected to modern EH- Antenna

Note from I.G.: “Radio Vsem” (# 9, 1928 pp.: 43- 44, “QRP for Summer”) is described several antennas that was used at military training at 1927. One of the antennas, is a prototype of the EH- Antenna, showed very good result. Some words about the design of the antenna. Upper and lower grid had sizes 1.0-m x 4.0-m. The grids (K1 and K2) were hanged up with help of insulators. L1 and L2 were inductors with variable coupling from an old spark transmitter. To the needed wavelength the tuning performed by tapping and coupling. The antenna worked great compare to the other antennas. **Figure 1** shows the antenna. At the TX there were used Russian tubes UT- 1, R-5.

Front Cover Magazine “Radio Vsem” # 9, 1928

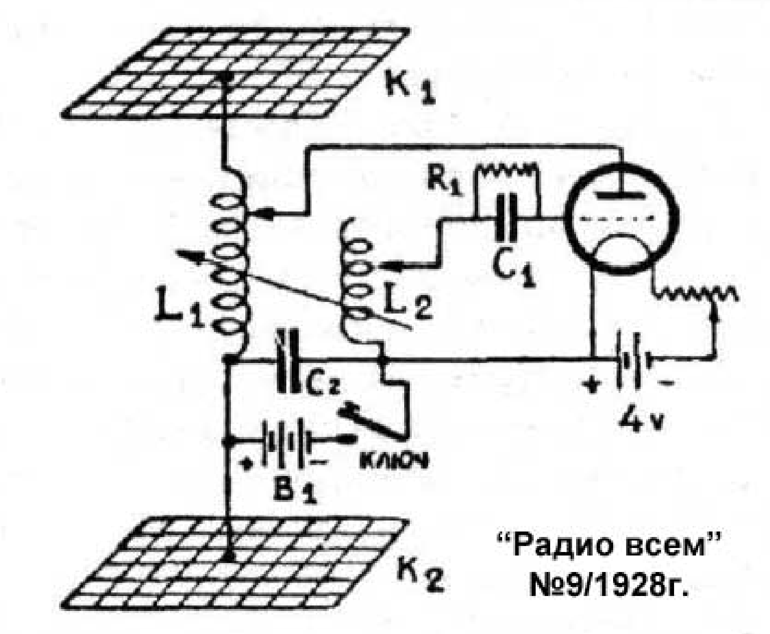


Figure 1 Prototype of the EH- Antenna

Magnetic Loop from the 1928

Note from I.G.: "Radio vsem" (# 9, 1928 pp.: 43- 44, "QRP for Summer") is described several antennas that was used at a military training at 1927. Another antenna that worked well is antenna that for now named as "Magnetic Loop" Antenna. In the old times the antenna was named as "Frame" Antenna. In the article were described two such antennas. **Figure 1** shows Transmitter with Frame Antenna with capacity adjustment.

Description of the antenna: Antenna has 3 turn, length of the each size of the square is 60- cm. Antenna wound by insulated wire, diameter of the wire 1.5… 2.5- mm (15- 10- AWG). Capacitor C1 has capacity up to 250- pF, capacitor C2 has capacity up to 500- pF. Antenna covered wavelength from 40- to 120- meters. Wavelength is switched (roughly) by choosing turns of the loop (1, 2 or three), then smoothly by C1. C2 is tined by maximum power (checking by the glow of the bulb) going to the antenna.

The capacitors should be work at 500- V. L2 and L3 are RF- Chokes. Those ones are identical with each other. RF choke contained 200 turns by wire in diameter of 0.5- mm (24- AWG), wound on the form in diameter ¾-inch. R2- 10.000 Ohm.

Figure 2 shows simplified version of transmitter with frame antenna. Tap is taken from the middle of the loop. The transmitter is tuned to the needed frequency just with help of capacitor C1.

Transmitters with the Frame Antenna had strong directivity. Each turning of the frame caused to the small changing of the wavelength. Transmitter should be placed far from any metal subjects. The transmitters provided confident radio communication to 20-km.

The transmitters with the frame antennas has small sizes, easy to hide and has directivity in transmission that is useful in military application. At the TX there were used Russian tubes UT- 1, R-5.

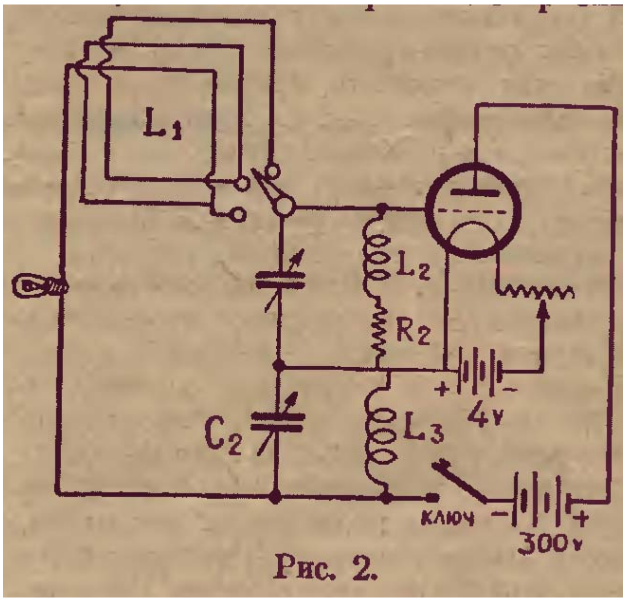


Figure 1 Transmitter with Frame Antenna with capacity adjustment

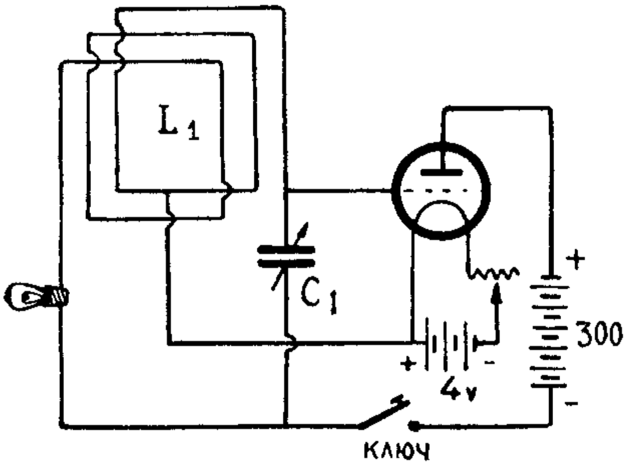


Рис. 3.

Figure 2 Simplified Version of Transmitter with Frame Antenna

Low Noise HF- Antenna

Published in "Radio" 1956

Credit Line: http://cqham.ru/oldradio/ana.htm

Low noise antenna could be used at environment with interferences from car and home appliances. **Figure 1** show the design of the Low Noise HF- Antenna for HF- Band 16- 50- meters.

Antenna consists of two cross- dipoles that are connected with receiver through twisted two- wire cord. It is possible to use usual main wire with twisted (artificially) wires.

However, it is better to use special RF- Twisted cable. Such cable was produced at the USSR at trademark RD- 16

The antenna has almost omnidirection diagram of directivity. However, stations that are in orthogonal direction (compare to the antenna wires) should be received better then stations that are in parallel (compare to the antenna wires) direction.

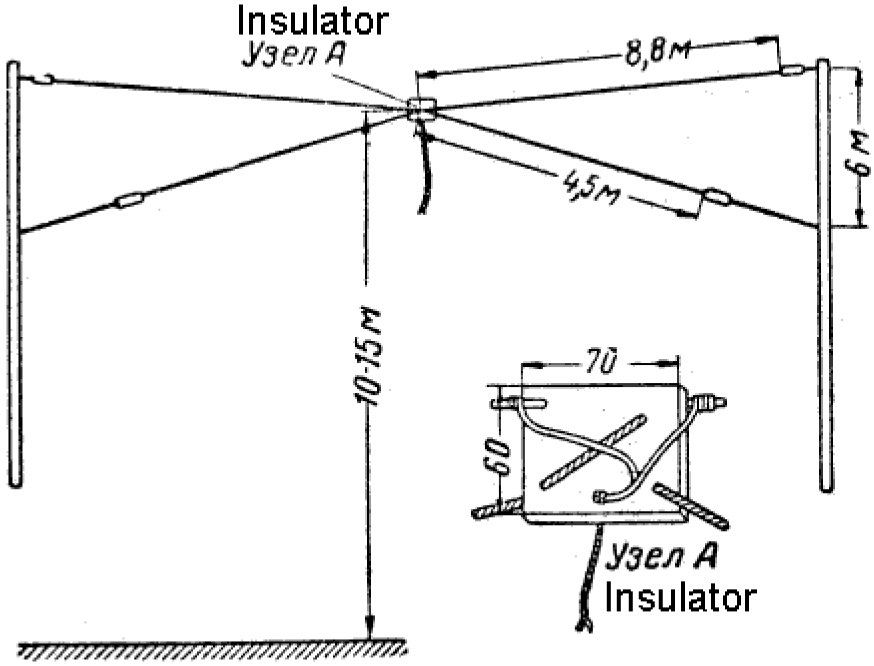


Figure 1 Design of the Low Noise HF- Antenna

Good result at strong interferences could be provided antenna shown in the **Figure 2**.

Antenna wire is hanged up at height 10-12- meters between two masts. Feeder of the antenna has cross-wires. At strong interferences part of the feeder, that it is placed in the zone of the strong interferences, may be made like feeder for antenna from **Figure 1**.

Antenna coupled with the receiver with help of a special symmetrical coil that is placed at the beginning and at the end of the input inductor of the receiver. Each part of the coil consists of 2…4 turns of the wire in diameter 0.5- 0.8- mm (24- 20- AWG).

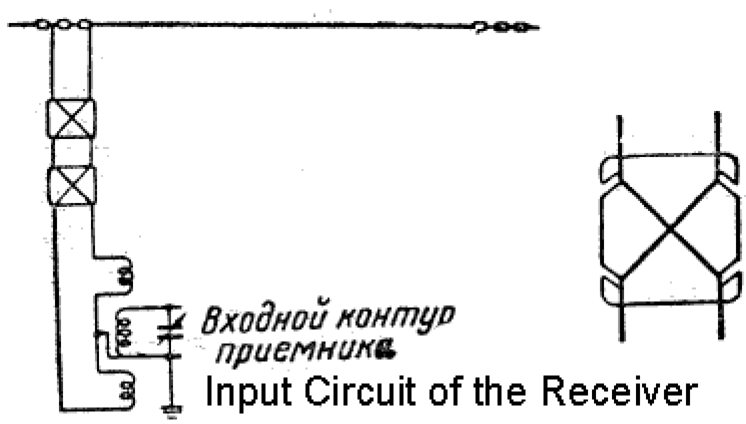


Figure 2 One Wire Low Noise HF- Antenna

Considerable lowering of the noise the antenna (Figure 2) provides at 80 and 160- meters.

TV- Antenna from Reused Beer Cans

A practical design of a TV- Antenna made on the base of the Beer Cans

Credit Line: http://mirsovetov.ru/a/housing/make-myself/homemade-tv-antenna.html

Unusual TV- Antenna

Magazine “Radio” has received letter about unusual TV- Antenna. Author of the letter, mr. D. Abyzov, wondered, if the antenna should be worked.
Description of the antenna (that was designed by mr. V. Arhipov) was published at region (Voronezh region) newspaper “Molodoy Kommunar.” Article about the antenna was named “Tiny Antenna.”

A little later magazine “Radio” has received letter from mr. I. Sokol from town Klenoviy (Lugansk region). Mr. Sokol wrote that he made the “Tiny Antenna” and that the antenna worked well. The antenna is used for reception of 4th- channel TV (TV- center located far from 55- km) and for reception of 1st- channel TV (TV- center located far from 105- km). A representative from magazine “Radio” took visit to mr. Sokol and prove his words.

Below is a description of the antenna.

It is a dipole, halves of the dipole is a copper rod in diameter 6- mm (3- AWG). Above the rod a plastic tube in diameter 36- mm (1-1/2 – inch) is placed. The tube is filled by iron sawdust. The length of the plastic tube is 2/3 from the length of the copper rod. **Figure 1** shows the antenna.

Front Cover Magazine “Radio” # 10, 1966

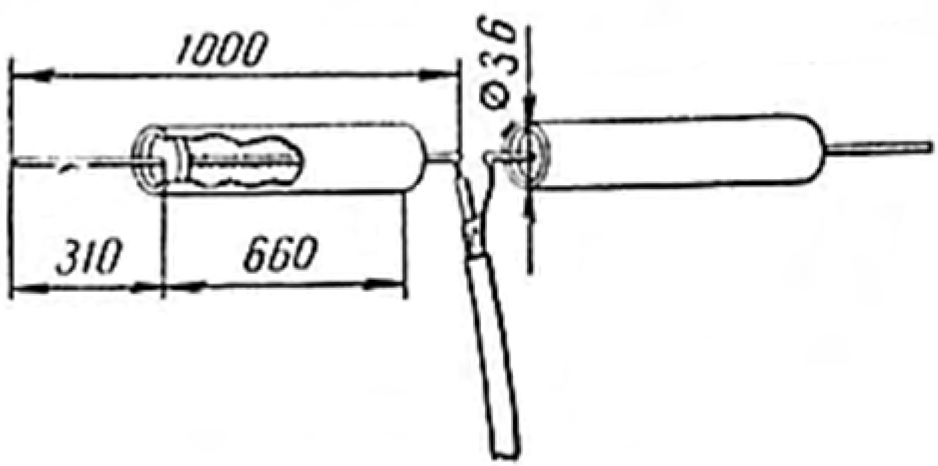


Figure 1 Unusual TV- Antenna

Dual Band Vertical for 145 and 430- MHz

The publication is devoted to the memory UR0GT.

By: Nikolay Kudryavchenko, UR0GT

Here is a simple design of the dual band 145/430- MHz vertical antenna.

The MMANA model of the Dual Band Vertical 145/430- MHz may be loaded: http: // www.antentop.org/014/145and430_014.htm

73 Nick

Credit Line: Forum from: www.cqham.ru

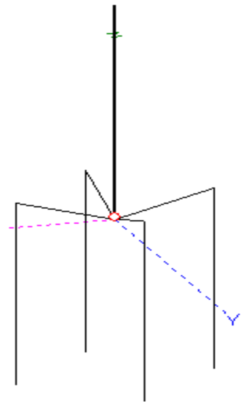


Figure 1 3D View of the Dual Band Vertical 145/430- MHz

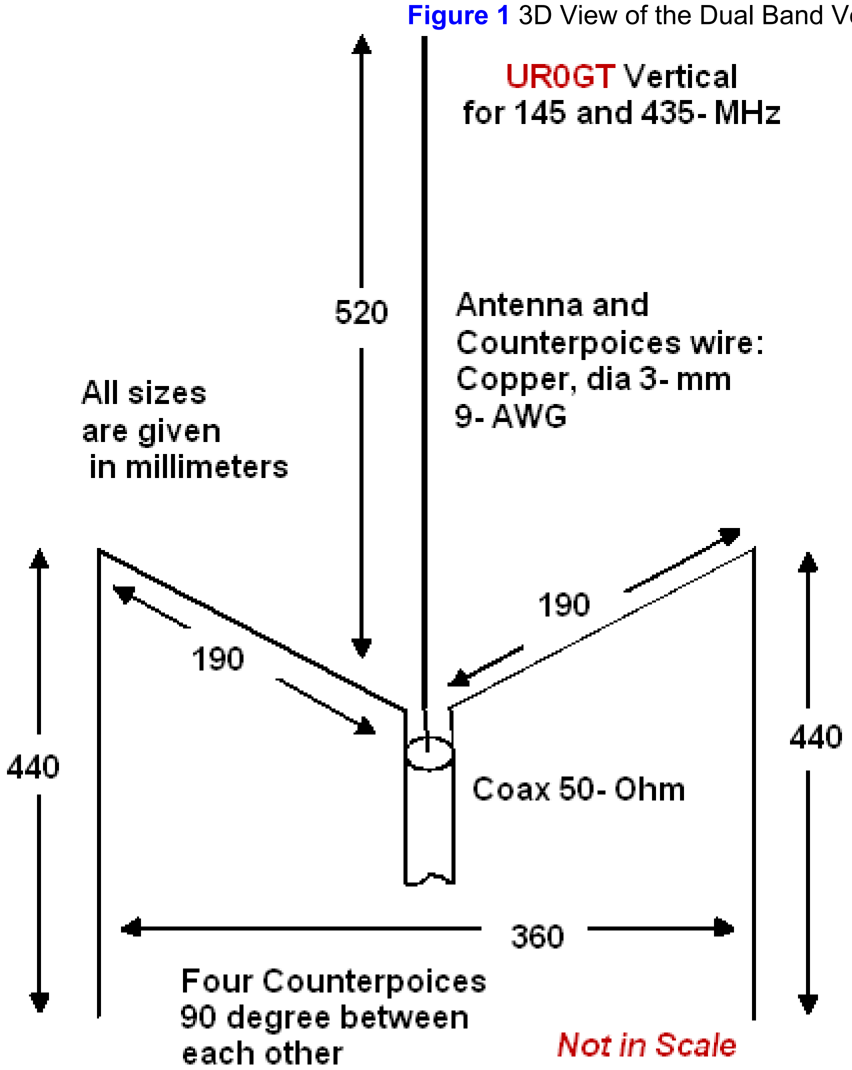


Figure 2 Design of the Dual Band Vertical 145/430- MHz

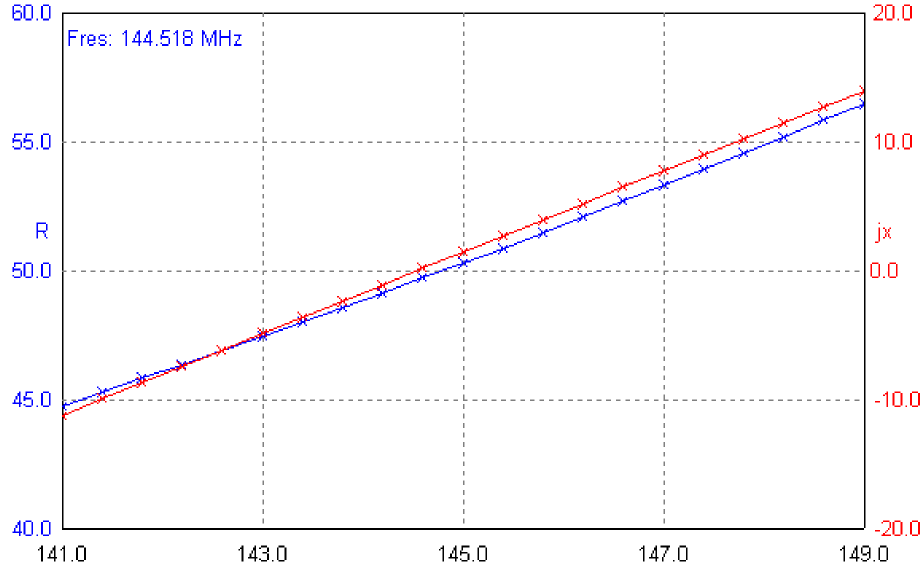


Figure 3 Z of the Dual Band Vertical 145/430- MHz at the 145-MHz- Band

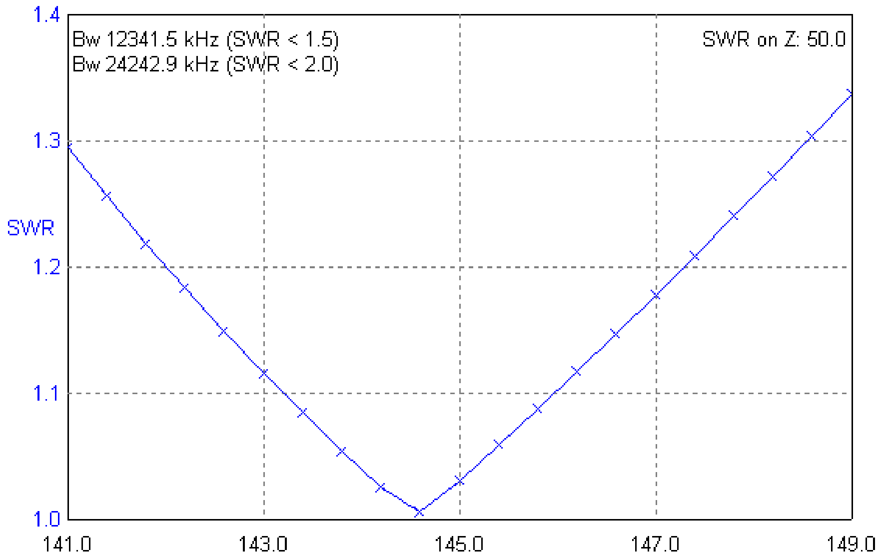


Figure SWR of the Dual Band Vertical 145/430- MHz at the 145-MHz- Band

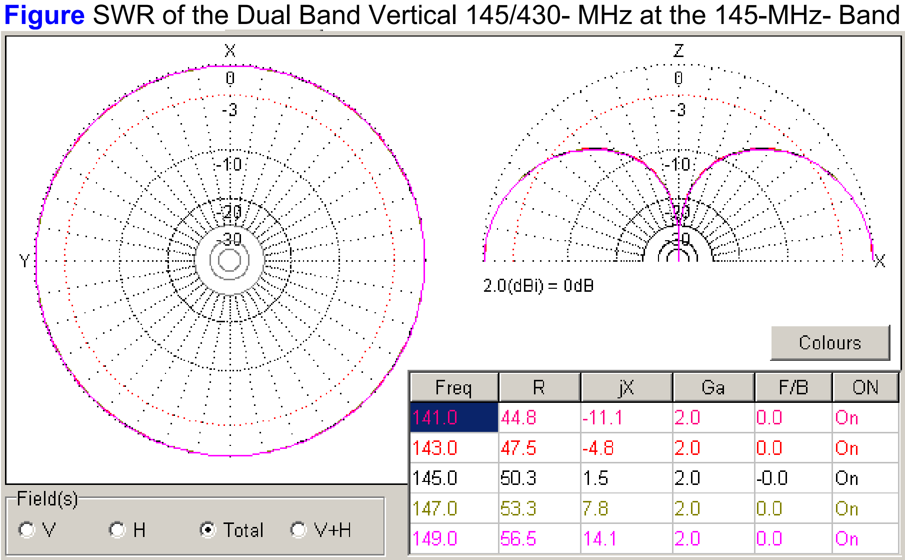


Figure 5 DD of the Dual Band Vertical 145/430- MHz at the 145-MHz- Band

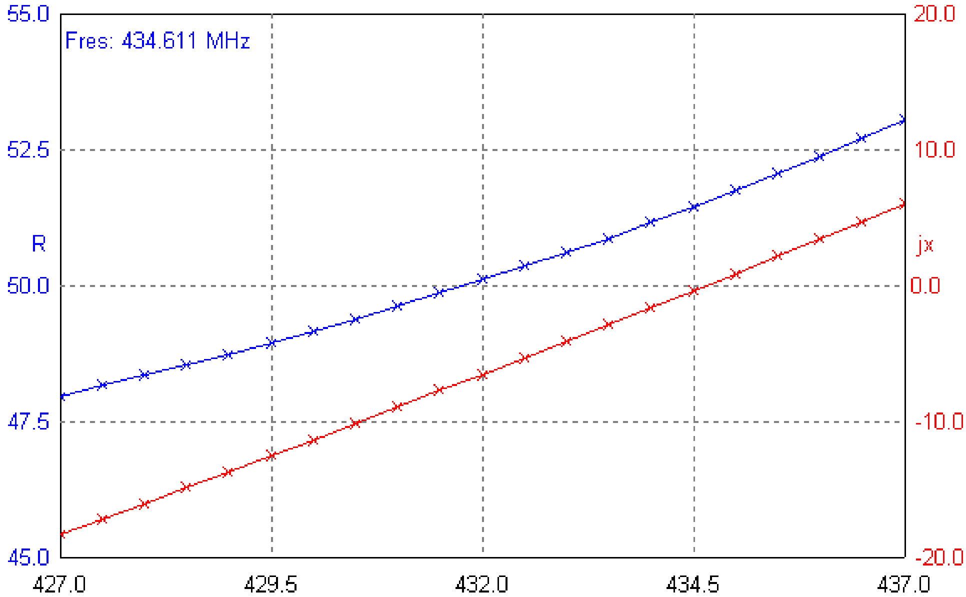


Figure 6 Z of the Dual Band Vertical 145/430- MHz at the 430-MHz- Band

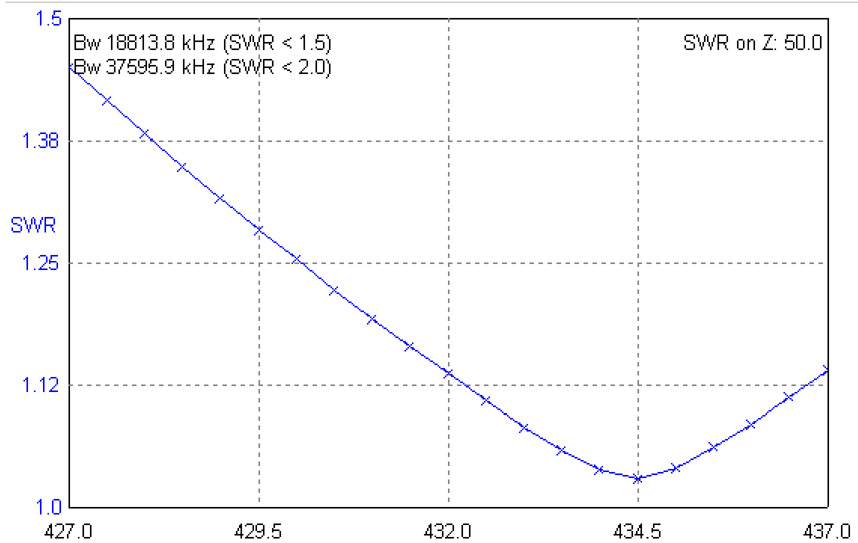


Figure 7 SWR of the Dual Band Vertical 145/430- MHz at the 430-MHz- Band

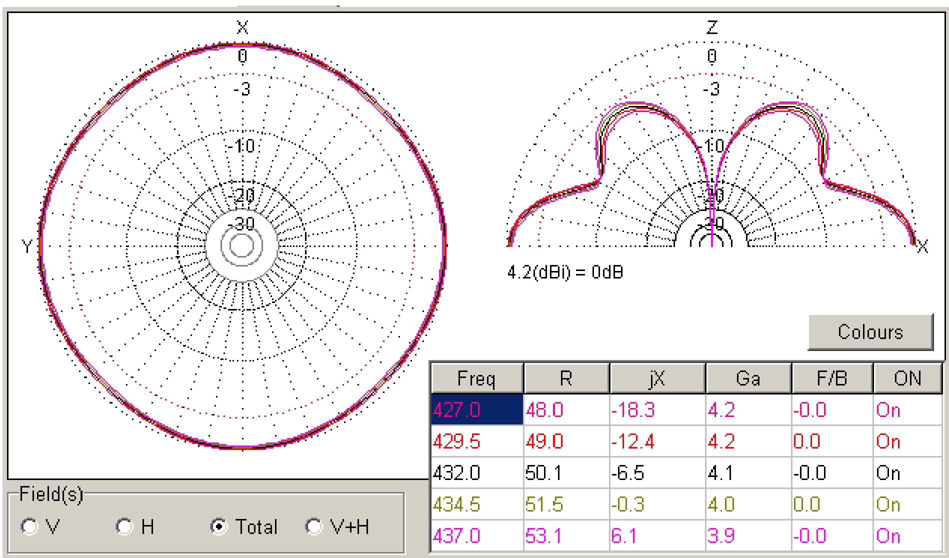


Figure 8 DD of the Dual Band Vertical 145/430- MHz at the 430-MHz- Band

Directional Antenna for 434- MHz

The publication is devoted to the memory UR0GT.

By: Nikolay Kudryavchenko, UR0GT

The antenna for the 430- MHz has wide lobe in the diagram directivity at the horizon plane with good gain.

As reflectors for the antenna there may be used aluminum or copper foil, metal grid, or perforated metal plate.

The MMANA model of the Directional Antenna for the 430- MHz may be loaded: http: // www.antentop.org/014/430mhz_014.htm

Credit Line: Forum from: www.cqham.ru

Parameters of the antenna are shown below.

73 Nick

Credit Line: Forum from: www.cqham.ru

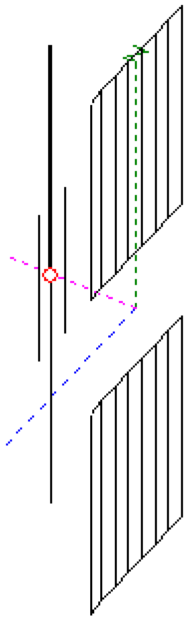


Figure 1 3D View of the Directional Antenna for the 430- MHz

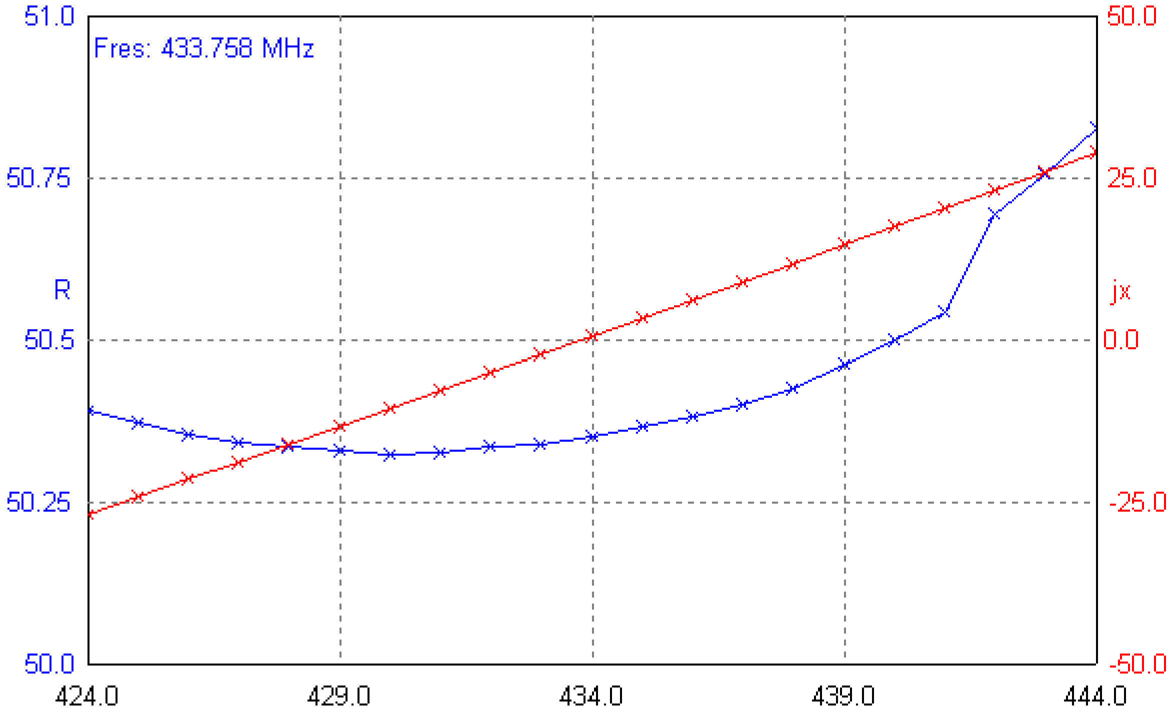


Figure 3 Z of the Directional Antenna for the 430- MHz

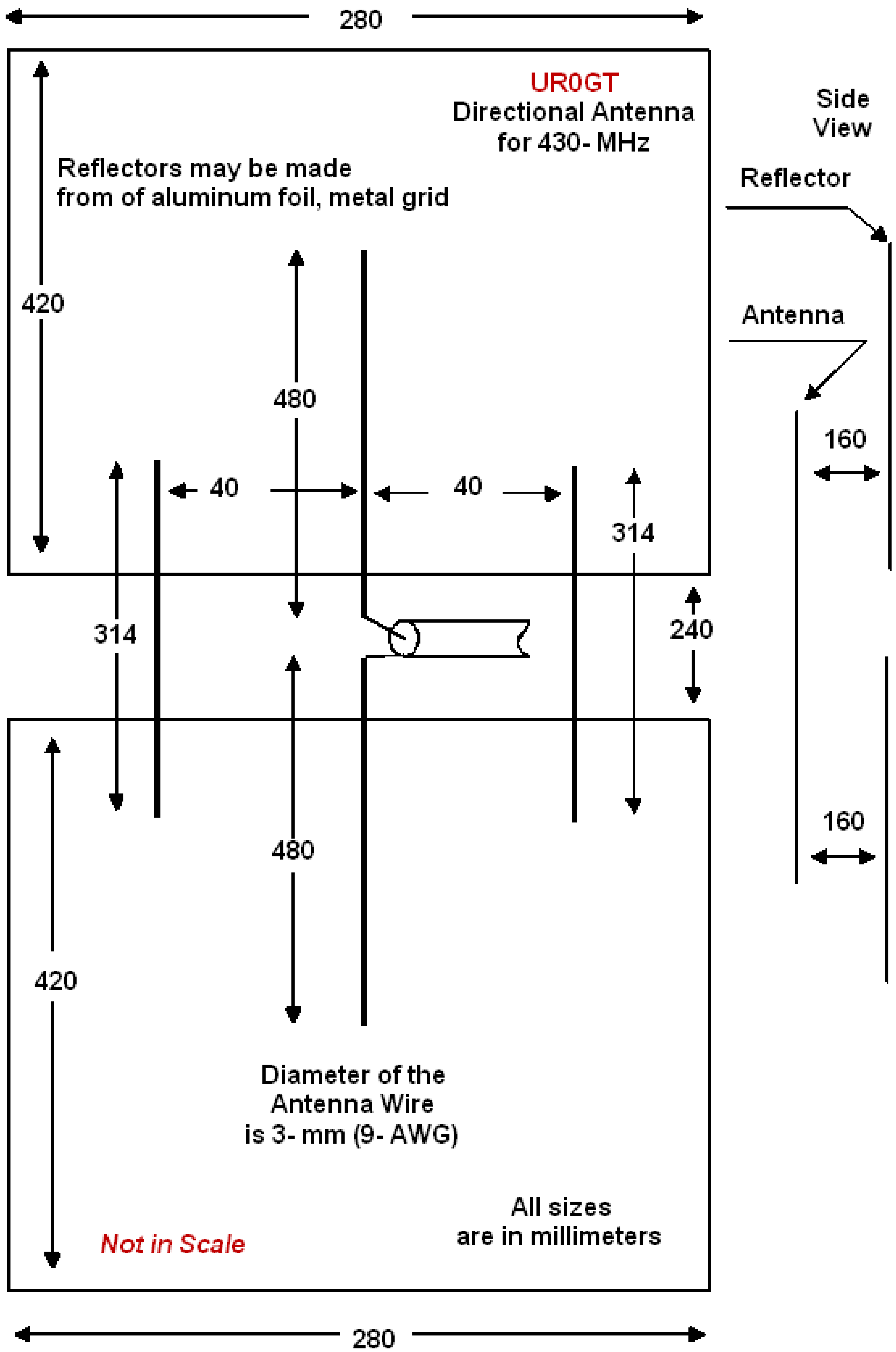


Figure 2 Design of the Directional Antenna for the 430- MHz

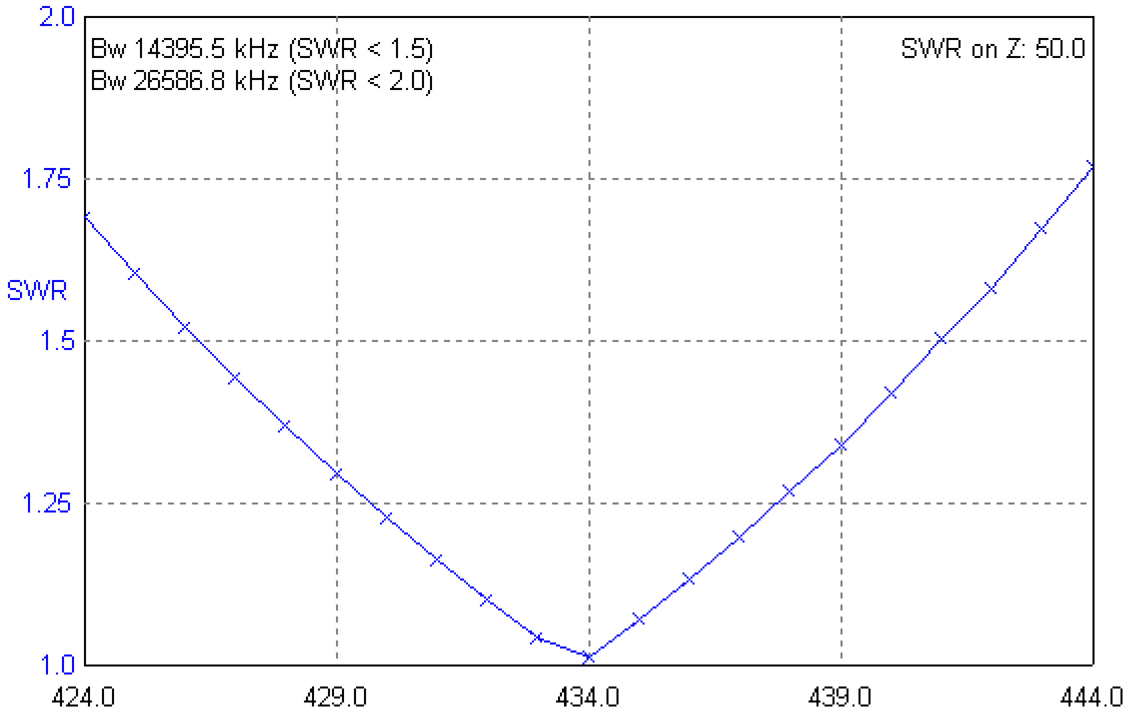


Figure 4 SWR of the Directional Antenna for the 430- MHz

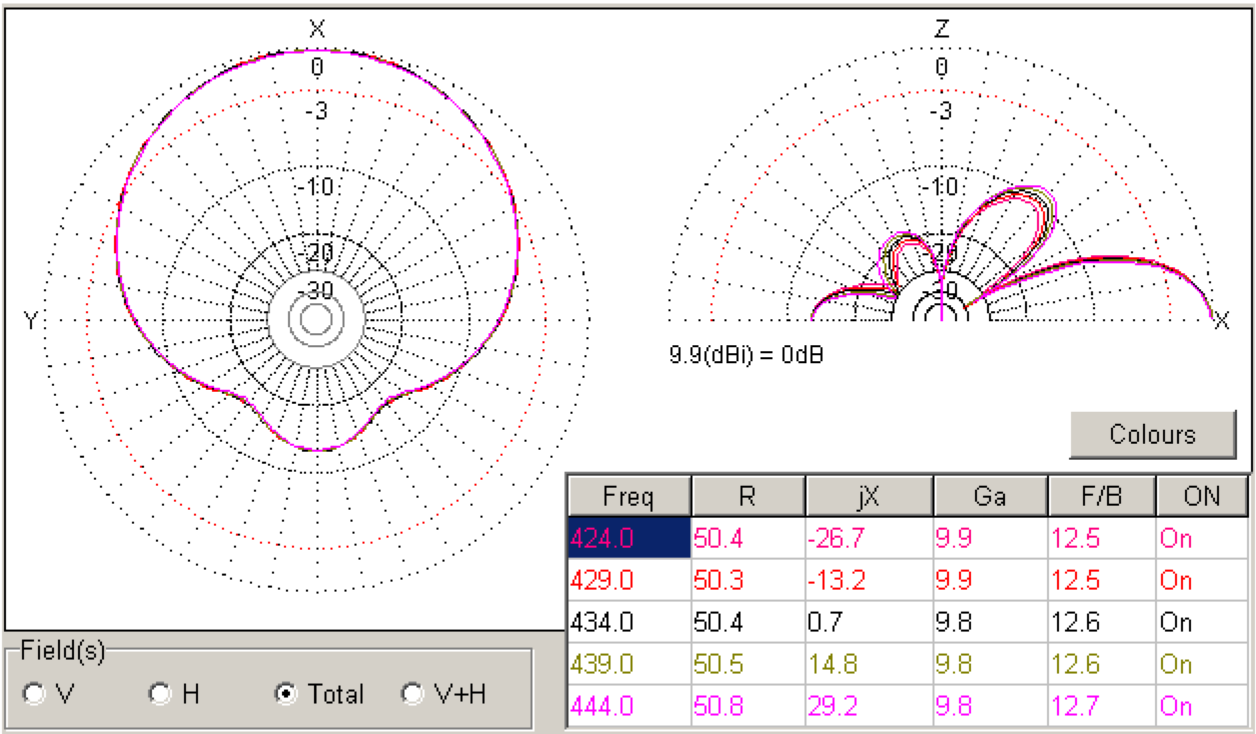


Figure 5 DD of the Directional Antenna for the 430- MHz

Vertical ZL- Beam Antenna for 430- MHz

Vladimir Polyakov, RA3AAE, Moscow

Credit Line: HF- magazine, 1998, pp.: 27- 31 (published in Russian in Moscow).

I would like to make a simple directional antenna. After I had observed lots variants I stopped at ZL- beam with two elements with active feeding. The antenna looked very attractive for me. This one at its small sizes (only lambda/8… lambda/10 in length) was practically the same parameters as 3- element YAGI.

Figure 1 shows a simple design of the ZL- beam. Points X-X is the feeding terminal of the antenna. ZL- beam consists of two dipoles (simple or folded) that connected together by crossed wires. Depending on the length of the fires the dipoles fed by some phase shift that helps form the diagram of directivity. (***Note by I.G.:*** More about ZL-Beam see **References 1** and **2**)

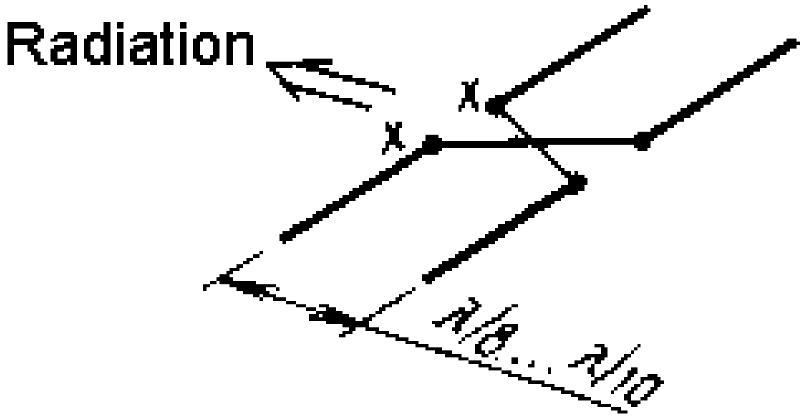


Figure 1 ZL- Beam

Required phase shift between the antenna's elements are obtained by two ways. At first, it needs change the length of the crossed line. The second, (it is fine tuning) by changing of the length of the dipoles. If the tuning may be made then no matter at which points at the crossed line would be connected feeder of the antenna.

Usually ZL-beam is used as antenna with horizontal polarization i.e. the dipoles are placed in parallel to ground. That is because of the simplicity of that antenna design.

I decided to make antenna with vertical placement of the dipoles to ground. For the antenna's element should be suitable J- Antenna. (Note by I.G.: More about J- Antenna see **References 3** and **4**). **Figure 2** shows two version of that J- Antenna. Version of the antenna with the grounded stub (right at the **Figure 2**) is mostly suitable for my design. It is possible to connect the lower point of the grounded stub with any ground- roof of the car, metal mast and so on. It is possible to match the antenna with any coaxial cable by choosing the feeding points.

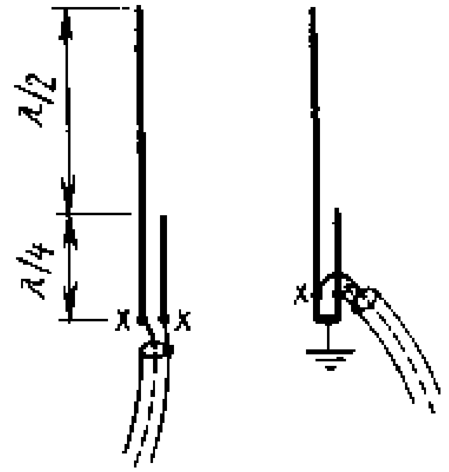


Figure 2 J- Antenna

Stub provides two antiphased RF voltages at its ends. Dipoles at the ZL- beam fed by antiphased RF voltages. So, it is possible to connect vertical dipoles to the ends of the stub. Phase shift between dipoles should be got by shortening left one and lengthening right one.

To obtain space between the dipoles lambda/8 it needs just bend each dipole. **Figure 3** shows the ready Vertical ZL- Beam Antenna for 430- MHz. Antenna. Antenna was made from one length of a copper wire in diameter 1.7- mm (14- AWG).

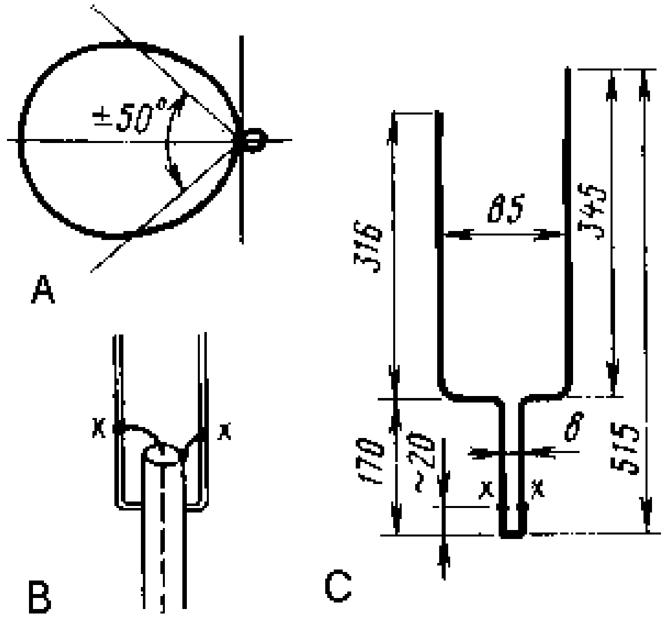


Figure 3 Vertical ZL- Beam Antenna for 430- MHz

A Diagram of Directivity

B Feeding Points

C Dimensions of the Antenna

My practical measurement showed that the antenna had one sided lobe (**Figure 3, A**) and 4- dB gain over a usual half – wave dipole.

References

1. http://www.eham.net/ehamforum/smf/index.php?topic=13700.0
2. www.hamuniverse.com/gi6jpozl-special.pdf
3. http://www.dxzone.com/catalog/Antennas/J-Pole/
4. http://en.wikipedia.org/wiki/J-pole_antenna

Simple Ways to Increase Communication Range of a Hand- Held Radio

Several simple tips to increase the communication range of a hand- held radio with help of anything near by.

Igor Lavrushov , UA6HJQ

Credit Line: http://www.hamradio.cmw.ru/antenna/experiment.htm

At the pictures you see a hand- held with its “rubber” antenna (100- mm long). The radio is received R4- repiter, which is located 130- km away.

At the pictures you see a hand- held with its “rubber” antenna plus counterpoise. The radio is received the same R4- repiter.

Compare the S- meters. From the noise level the repiter jump up to good level.

Now the hand- held used to a ¼ lambda antenna. I communicate with the same R4- repiter

The picture shows the radio without counterpoise.

The picture shows the radio with counterpoise.
Compare the difference. With the counterpoise I can communicate with the repiter.

The radio is received the R4 repiter located 130- km away.

I held the radio by hand in glove, so, my body is isolated from the radio. I get strength by S- scale: 42.

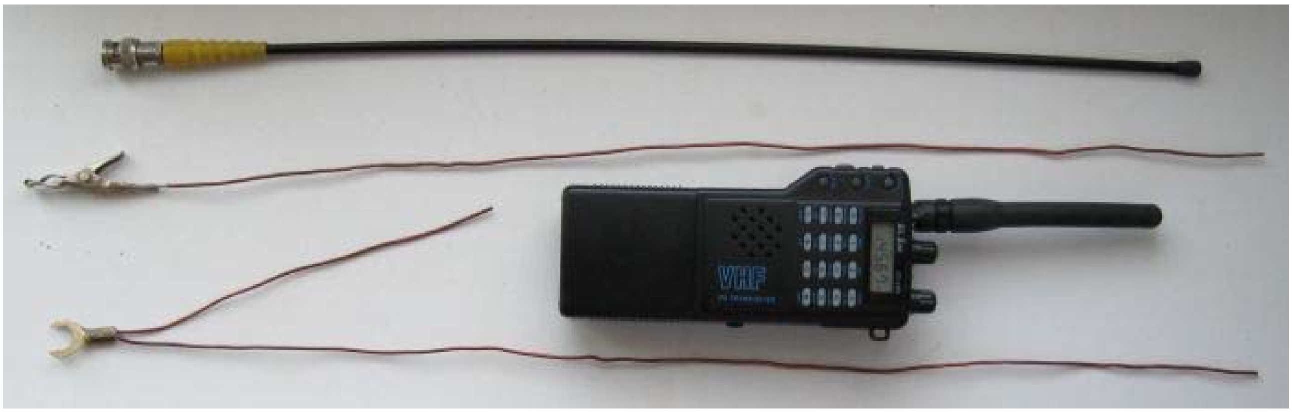
Now my hand is touched metal parts of the radio. I get strength by S- scale: 53. With a ¼ lambda antenna and my hand is touched metal parts of the radio I get 59!

Note: Some hand- held radios do not have outer metal parts. In this case counterpoise helps to increase the communication range.

In the mountains I have used instead a counterpoise a knife in length 300- mm. I got increasing in the level from 54 to 56.

For good operation it should be used a resonance counterpoise. The length for the counterpoise should be 480- 510-mm depending on used diameter of the wire. Counterpoise should be placed at 90 degree to antenna. Use only rigid wire. Counterpoise from a soft wire does not work properly.

Note: With a counterpoise the radio antenna has directivity. Therefore after connection a counterpoise to the radio you should turn the radio to find maximum of the reception.



Picture shows antenna “ALAN” (470- mm in length), counterpoise with “crocodile,” hand- held radio, two- band counterpoise for 145/435- MGz for two- band hand- held.

The same experimenters were made with hand- held VX-3, VX- 800 and C- 568. The experimenters prove above writing.

73, ua6hjq

Transceiver Fetter - 80

Dmitriy Goroh, Ukraine, UR4MCK

Credit Line: CQ- QRP # 31

The transceiver is a practical implementation of the theoretical schematic made by RA3AAE [**References 1, 2**]. Transceiver was made on a piece of PCB of suitable sizes. Transceiver was made on 80- m band however, this one may be tuned to another ham band. **Figure 1** shows schematic of the transceiver. The transceiver took part at MAS contest [**References 3, 4**], so parts at the schematic labelled according to MAS rules. According to the MAS rules the transceiver has only 36 components and it belongs to category "A36."

Data:

Supply Voltage: DC, 10.0… 14.0- V
Consumer Current RX/TX (at 12.0- V): 15.0… 20.0- mA/ 0.5- 0.7- A
Frequencies Range: 3500… 3580- kHz
Sensitivity (at 10- dB S/N): near 10.0- microV
Output power (at Dummy Load 50- Ohm): near 3.0- Watts

RX mode: Signal from Antenna WA1 through low-pass filter L2, L3, C3, C6, C8, C9 is going to mixer on VT3, VT5. RF from the VFO on VT1 goes to the buffer on VT2 and then is going to the mixer on VT3, VT5. VFO generate on the frequencies twice below the receiving frequency [**References 5**].

From the mixer audio signal goes to Audio Filter L4, C11, C12 AND THEN TO Audio Amplifier on VT6, VT7. Transformer T3 does matching of impedance of the 32-Ohms headphones with the Audio Amplifier.

TX mode: Key S1 is down at TX mode. Switch on VT4 provides DC ground for VT3, VT5. These transistors now are working like doubler/amplifier. RF for the 80-meter band goes to the antenna WA1 through low-pass filter L2, L3, C3, C6, C8, C9. The filter should be tuned with a real antenna to match output impedance of the amplifier with the antenna. **Figure 2** shows PCB of the FETter. VFO was made on the another board.

Coils L2, L3 may be wounded on a form not less the 6-mm in diameter. Numbers of turn depend on used antenna. As coil L1 should be used any stable- made inductor, for example, coiled on a ceramic form from an old military radio. Transformers T2 and T3 coiled by trifiliar twisted wire, 8 turns. It was used insulated wire from a computer network cable. Core for T2 and T3 is ferrite ring permeability 1000 with OD- 20, ID- 10 and H- 5-mm.


CQ-QRP

Издание Российского Клуба Радиооператоров Малой Мощности

31 лето 2010

Участники слета Вятка – 2010

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Cover: CQ- QRP # 31

Transformer T3 is from an old transistor radio. The transceiver should be powered from a battery to avoid hum.

Tuning: Audio Amplifier is adjusted by R7 to ½ of the supply voltage on the collector of VT7.
VFO is tuned to the frequency half of the working one. Pick to Pick RF voltage across the ground and the gate of VT3 (VT5) should be 4… 5- V. Filter L2, L3, C3, C6, C8, C9 is tuned (by its L and C) to the maximum of RF across the real antenna (or across the dummy load). **Figure 3** shows output RF from the transceiver at TX- mode across a dummy load 50-Ohm. Vrms there is equal to 12.1- V, so, output power is 3.0- Watts. However, at proper tuning the transceiver it is possible to get more RF power from the PA.

The transceiver was tested at MAS- 2010 contest. It was made 3 QSO with other contesters: UU7JF, RW3AI and UA9FAX (distance more the 1,500.0- km).

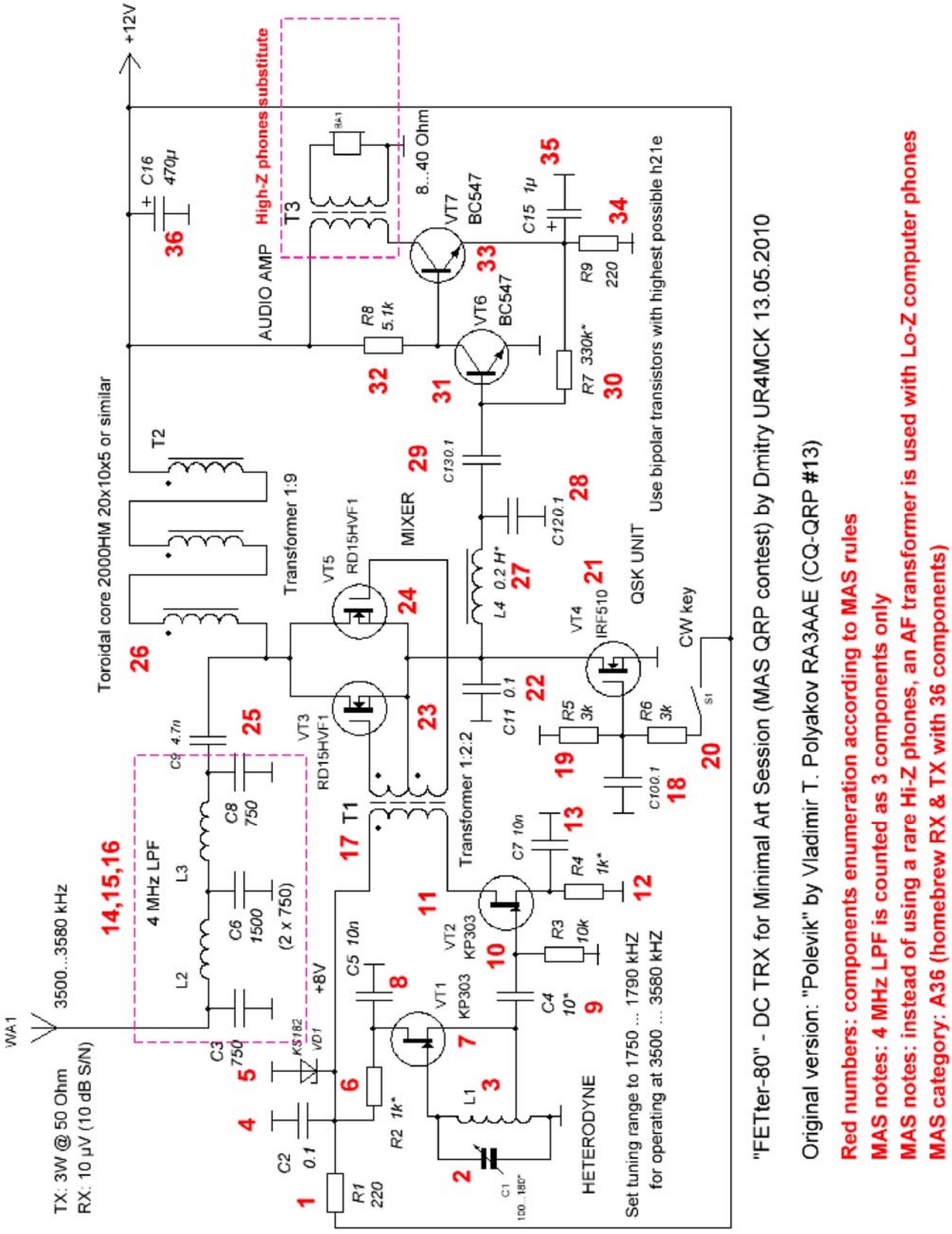


Figure 1 FETter 80

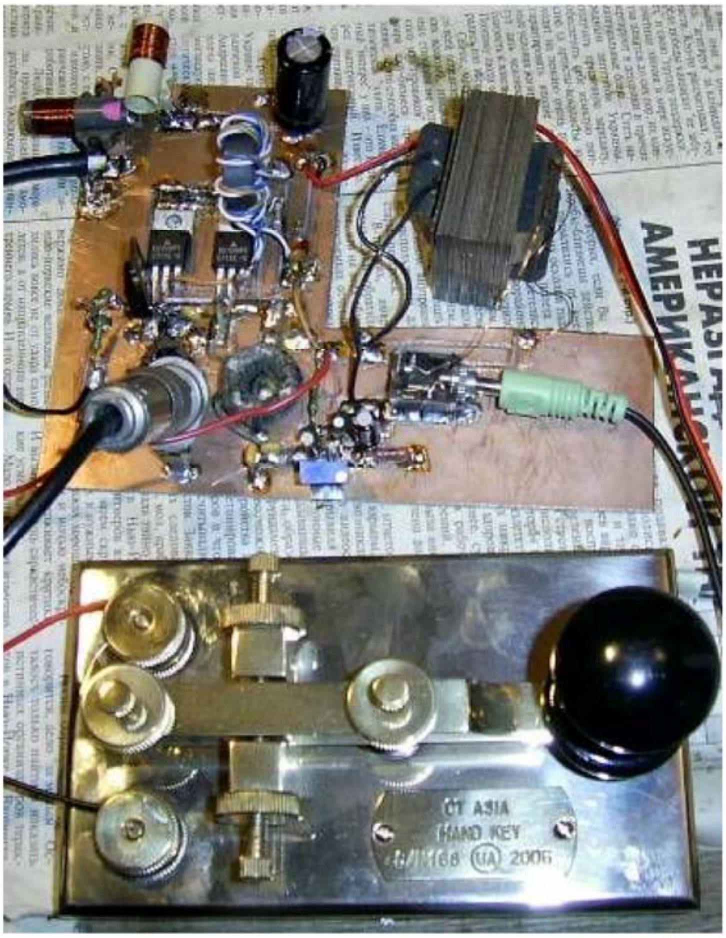


Figure 2 Sample of the FETter (without VFO)

References:

1. Transceiver "POLEVIK": By: Vladimir Polaykov, RA3AAE
http://www.antentop.org/011/ra3aae_011.htm
2. CQ QRP #13,
http://qrp.ru/modules/mydownloads/cache/files/cq-qrp/13.pdf
3. QRP Contest Community, http://www.qrpcc.de/
4. QRP MAS, http://www.qrz.ru/contest/detail/477.html
5. V. T. Polyakov, "Ham book about Direct Conversation technique"- Moscow, Publishing House "Soviet Patriot", 1990, 264 pages. (in Russian)
http://www.cqham.ru/ftp2/RLTPP.djvu

72/73 de UR4MCK

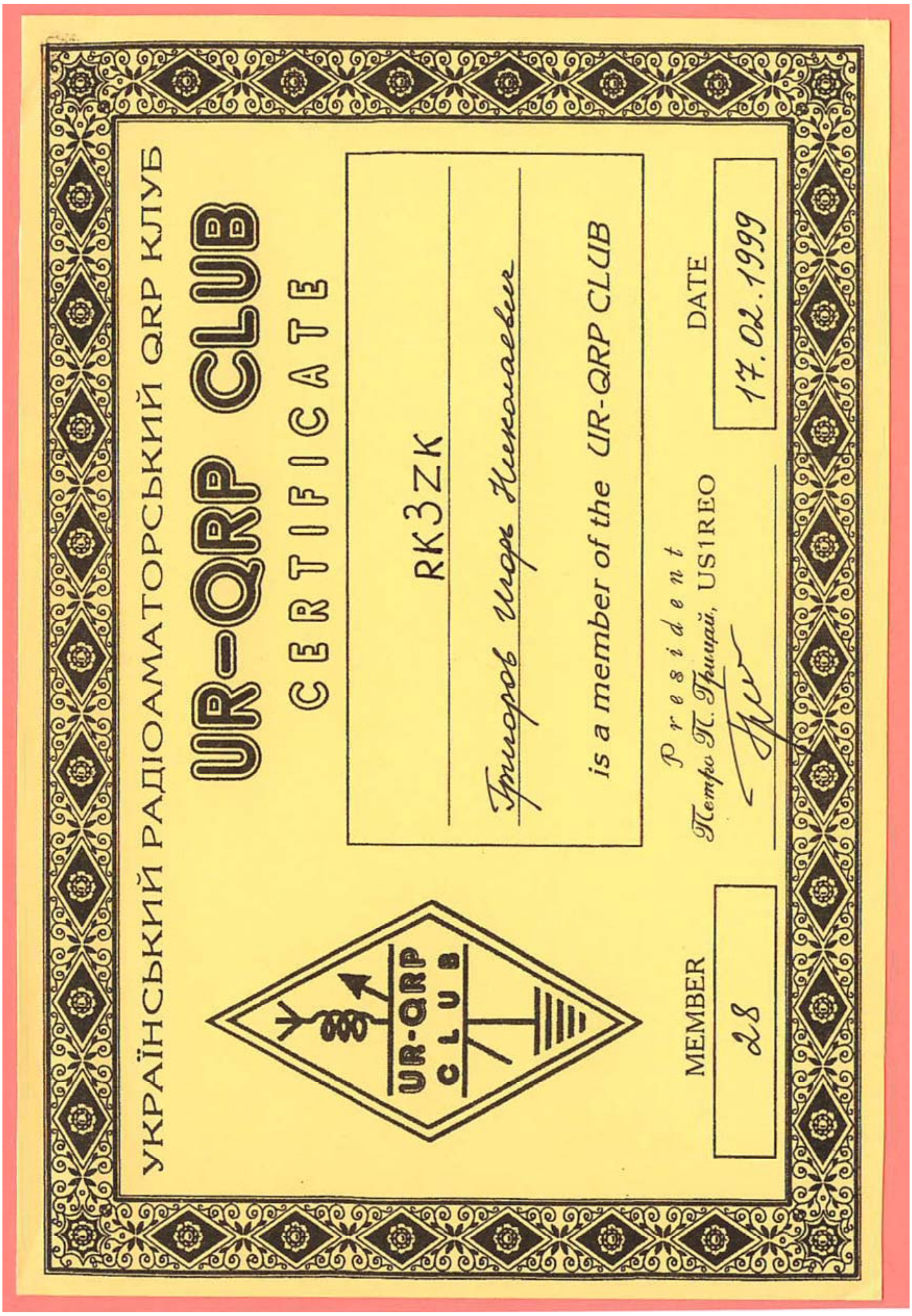
Figure 3 Output RF from the transceiver at TX- mode across a dummy load.

QRP Membership Certificates

So it is ours history, ours old amateurs ID. I just would like to show some of old Amateurs Membership Certificates, certificates from international QRP Clubs.

Membership Certificate: G- QRP- C. UA3ZNW, 04/06/1991

Membership Certificate: UR- QRP- C. RK3ZK, 17/02/1999



Membership Certificate: OK- QRP- C. UZ3ZK, 16/11/1992

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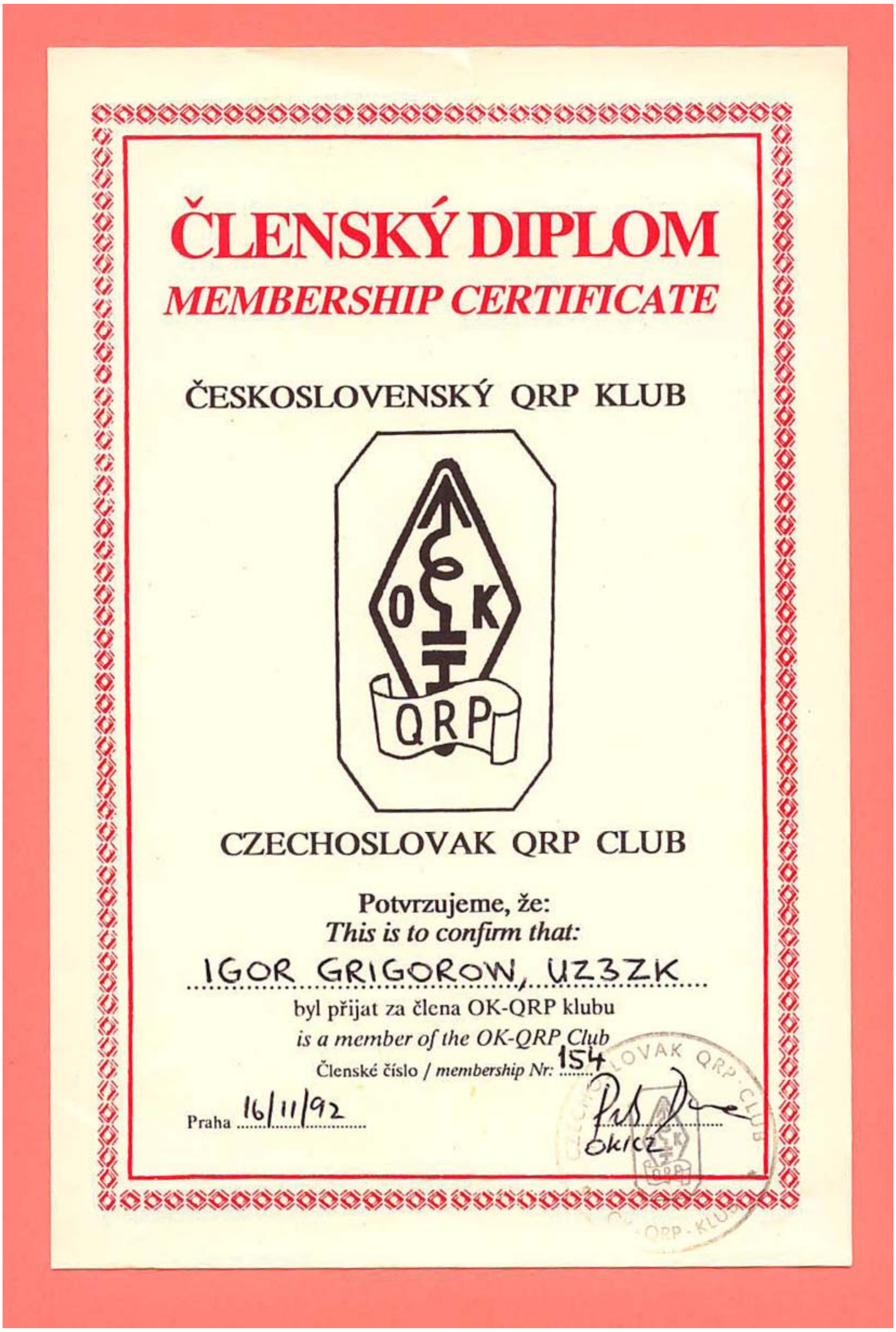

ČLENSKÝ DIPLOM

MEMBERSHIP CERTIFICATE

ČESKOSLOVENSKÝ QRP KLUB

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Potvrzujeme, že:

This is to confirm that:

IGOR GRIGOROW, UZ3ZK

byl přijat za člena OK-QRP klubu

is a member of the OK-QRP Club

Členské číslo / *membership Nr:* 154

Praha 16/11/92

OK1CZ

Membership Certificate: U- QRP- C. UA3ZNW, 15/06/1991

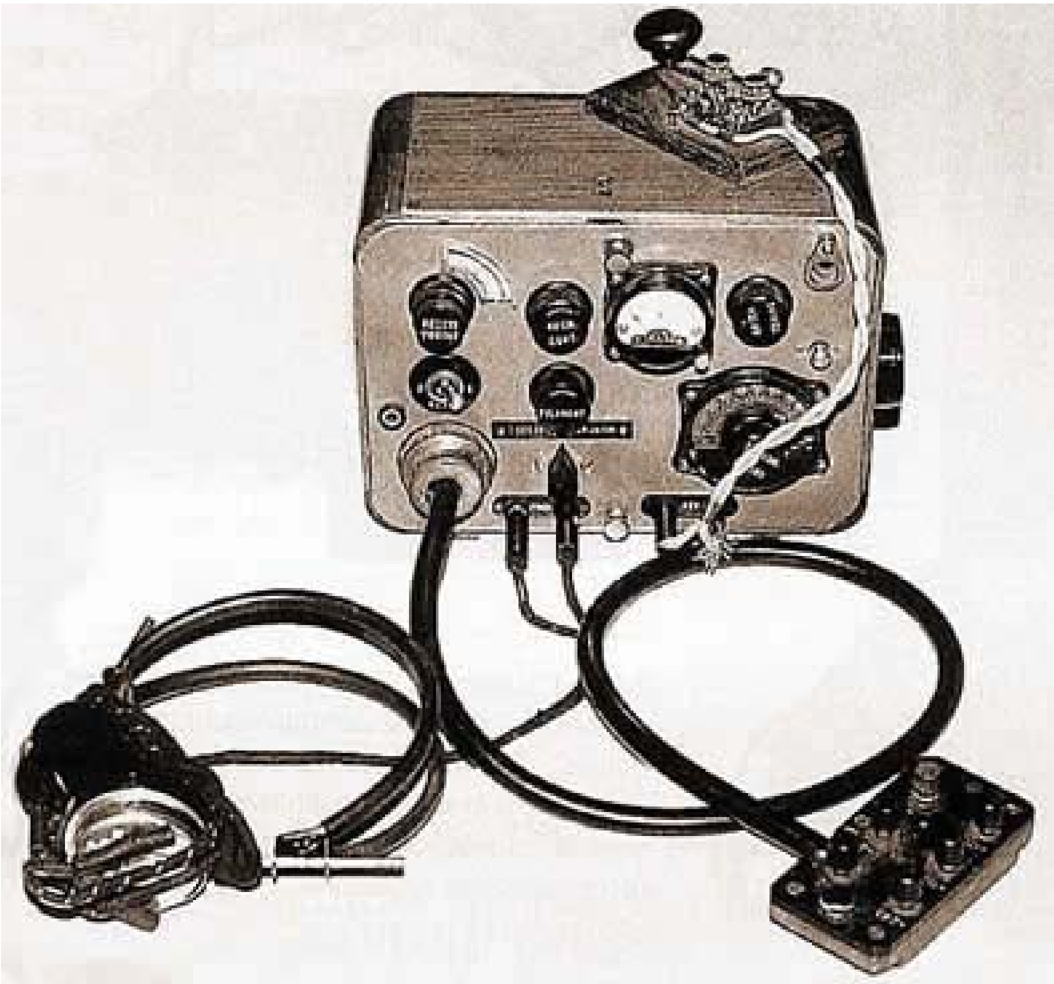
VA3ZNW QSL CARD

Soviet Spy Radio "SEVER"

Credit Line: www.cqham.ru

The radio was designed at 1939. Schematic for the Radio “Sever” (“North” in English) was designed by Boris Mikhalin. At first it was designed for civil applications. Only one experimental sample was made before 1941. At the 1941 the radio was adapted for military applications by Boris Mikhalin, Pokrovstiy and Muhachev (mechanical design). It was so named “Project Omega.”

Serial release of the station was begun in Leningrad, at “Kozitskiy” factory. At the factory the station got name “Sever.” The station was produced by supervising of Nikolay Stromilov- famous polar radio operator and ham. 7000 samples of the radio were produced during ww-II.

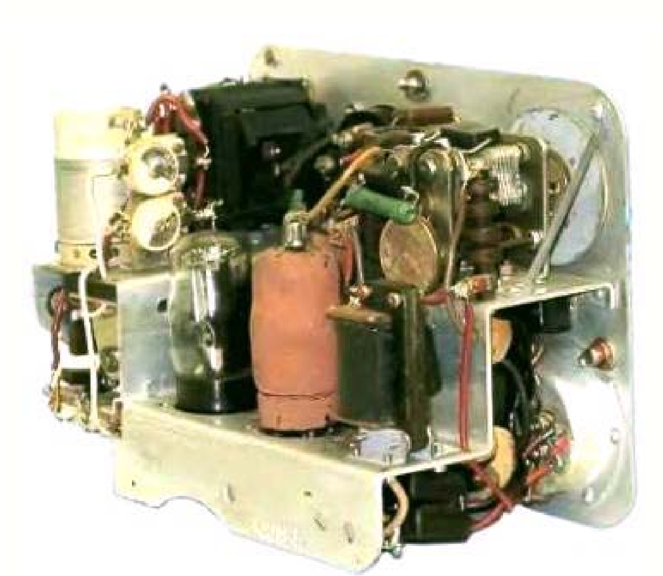


Spy Radio “Sever”

The radio had excellent parameters for the times. To reduce dimension and consumer power so- called transceiver schematic (when the same parts are used for receiving and transmitting) was used. So, the radio had weight only 2- kg (or 4 pounds) that was perfect for ww-II radio. Antennas and spare parts had weight 2- kg (or 4 pounds). Batteries weighted 6- kg (or 13 pounds). The radio set was packed in two small fabric bags. **Figure 1** shows the schematic. Some of the samples of the “Sever” were marked in English and American or English parts were made for producing of the stations.

Receiver was made by usual at the times scheme 1-V-1. It had one aperiodic RF-Amplifier and then a Regenerative stage. Hi-ohmic head set was used by a radio operator.

Transmitter had output power near 2-Watts. It has RF generator and then power amplifier. RF generator could work in two modes- first, using external quartz resonator (usual there were several of them in the radio spare parts), second, in self-excitation mode covered a wide frequencies range. A small key was used for transmitting.



Credit Line for Pictures: http://msevm.com/oldradio/sever/

Tube 2P4M (used in the Radio “Sever”)

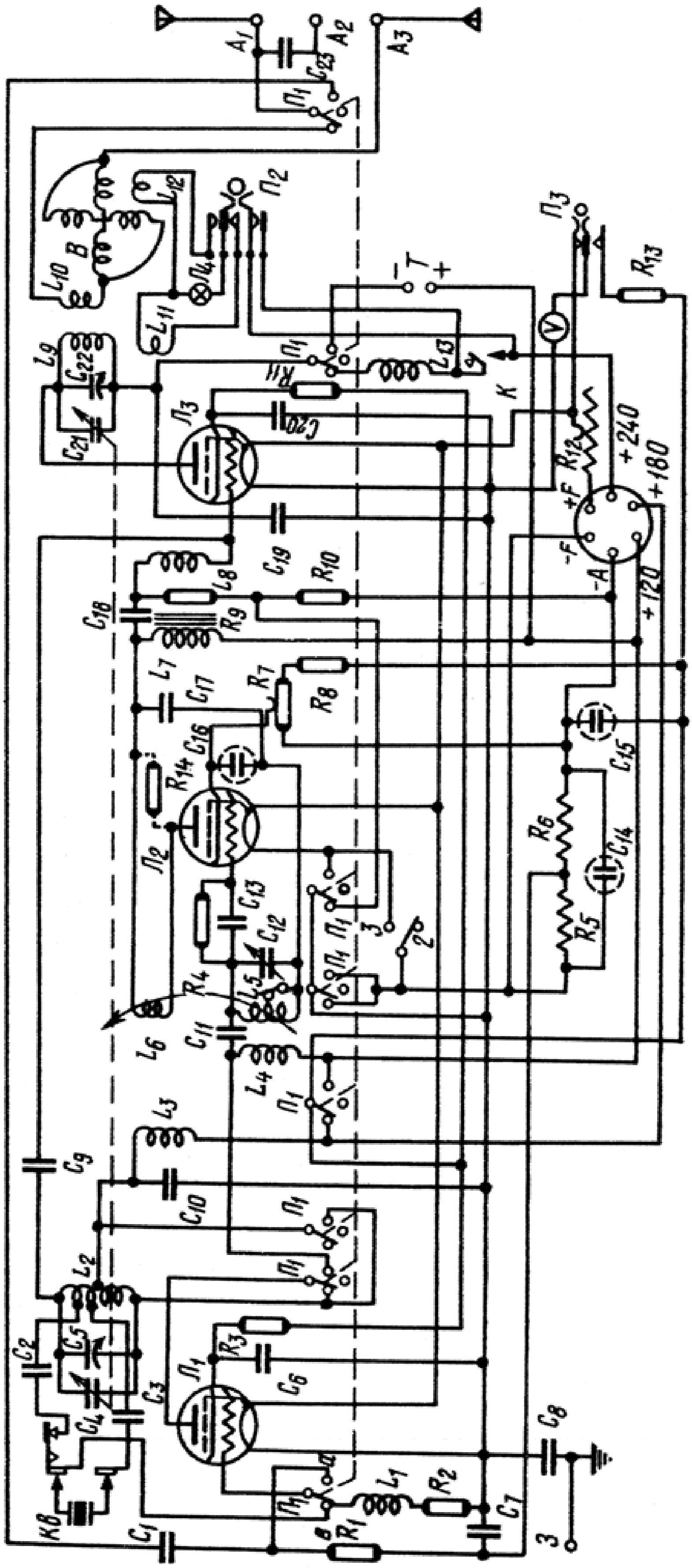


Figure 1 Radio “Sever”

It was produced "Sever" and "Sever-bis." The radio differed by frequencies and a little in design. RX/TX for radio "Sever"- 3,62—12,25/3,62—6,25 –MHz. RX/TX for radio "Sever- bis"- 2,22—6,66/2,56- 5,77- MHz.

There were used anode and heater battery for feeding the radio. For high voltage there were used 4 batteries BAS- 60 (each battery has 60-V and 0.45A/H). For heater there were used 2 battery 3S (each battery has 1.5- V and 29.0 A/H). It was produced in small quantity radio "Sever" with feeding from the main.

Antenna for the radio was length of wire in 12 meters long. The wire could hang up at any object (for example, at tree). There were two counterpoises, 3 and 12 meter long each.

Depending on the transmitting frequency a proper counterpoise was used. As usual, for low frequencies it was used counterpoise in 12 meter length, for high frequencies it was used counterpoise in 3 meter length. Counterpoise placed near one meter above the ground. **Figure 2** shows the antenna configuration for the station. The radio could provide reliable communication (with a stationare radiocenter with special directed antennas and high sensitivity receivers) up to 700- km.

British spy Radio "Paraset" was the nearest analog of the radio "Sever."

Manual for radio Sever may be loaded: www.antentop.org/014/sever_014.htm

Credit Line: http://www.rkk-museum.ru

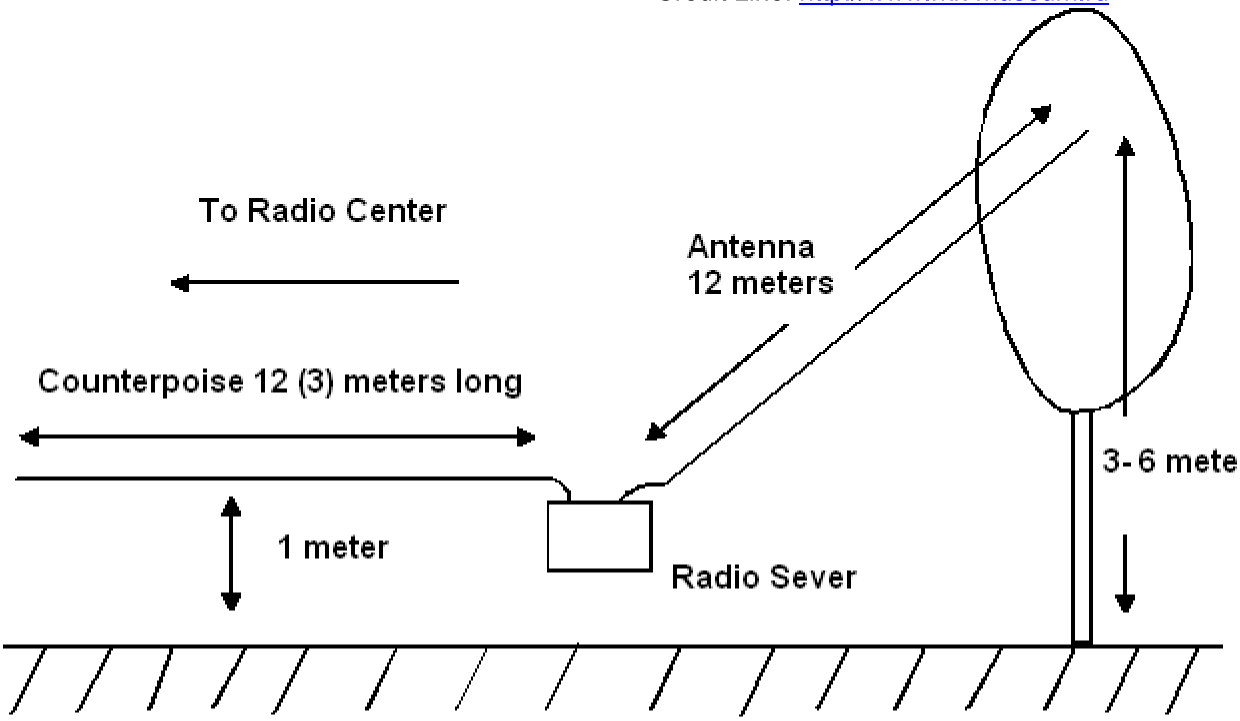
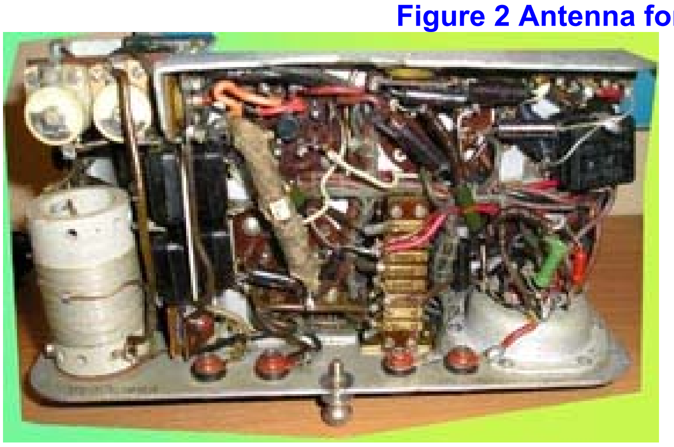


Figure 2 Antenna for the Radio "Sever"



Spy Radio "Sever"

Credit Line for Pictures: http://rv3bc.narod.ru/Stat/rtx-sever.htm

Some Notes about LDE from G- QRP- C Forum

Date:2 December 2010 11:27
Subject: [GQRP] Long delay echos
Mailing list: <GQRP.yahoogroups.com>

Just seen the link to the long delay echos from Peter Brogl, DK6NP on the Southgate Amateur radio website:
http://www.southgatearc.org/news/december2010/long_delay_echoes.htm
I've not yet seen anything about the power he used or details showing if the echoes spaces were EXACTLY the same on each transmission. A detailed comparison between the transmitter and echo keying envelops may confirm that they really came from DK6NP's transmitter and not some elaborate hoax. If genuine, surely this is a remarkable and tangible example of this very odd (and rare?) phenomenon.

Regards,

Ian, G4JQT

Date: 2 December 2010 14:45
Subject: [GQRP] Re: Long delay echos
Mailing list: <GQRP.yahoogroups.com>

At the peak of recent sunspot cycles it was not that unusual to hear echoes on 10m from signals that had gone around the globe both ways even several times. One could certainly envisage occasions when signals get trapped between some ionospheric layers and eventually "escape" back to earth - like a very extended chordal hop.

73s
Roger G3XBM

Logo G-QRP-C
(Credit Line: http://www.zerobeat.net/g3ycc/club.htm)

Date: 2 December 2010 15:40
Subject: Re: [GQRP] Long delay echos
Mailing list: <GQRP.yahoogroups.com

See also:

Did you hear Long Delayed Echos on November 27 ?
http://www.southgatearc.org/news/december2010/lde_reports_wanted.htm

Long Delayed Echos on TV
http://www.southgatearc.org/news/december2010/lde_on_tv.htm

73 Trevor M5AKA

GQRP Club

http://www.gqrp.com/

Date: 2 December 2010 17:44
Subject: [GQRP] Re: Long delay echos
Mailing list: <GQRP.yahoogroups.com>

I have always had a fascination with the subject of LDE's and also just
heard about this event.

I have heard very short echos before. However, this past weekend during
the contest on Saturday evening I heard what I thought was a LDE in the
range of 2 to 4 seconds. It was on 40 meters and I had just tuned in a
station and it sounded like whatever that station was sending was being
repeater that 2 to 4 seconds later. The echo interfered with the
original but was slightly off frequency but even at that I didn't manage
to get the call sign. It was a German call sign but not DK6NP that I
recall.

I was otherwise distracted by the contest at the time and didn't give it
much more thought til today when I stumbled some of the reports of Peter
Brogl's experience. Makes me wish I had paid more attention.

Cheers, Graham ve3gtc

China Power Automobile Relay.
Inside View

Date: 3 December 2010 06:51
Subject: Re: [GQRP] Re: Long delay echos
Mailing list: <GQRP.yahoogroups.com>

I remember hearing echoes as a not unusual occurrence back in my days as a broadcast band SWL in the early 60s.
These were on AM commercial broadcast stations, if I recall correctly, on the 49mtr and 41mtr bands.
I was using an old EKCO valve domestic receiver and I remember talking to my 'tame' local radio amateur who pooh-poohed the whole idea based on "I haven't heard them on my equipment so they can't exist".
He was convinced I was wrong but I knew what I had heard was real.
The echoes weren't terribly delayed, maybe no more than 1 or 2 seconds but the effect was reminiscent of the old early tape loop echo chambers used in the music business.
I seem to recall, though through the distorting fog of age, reading about this effect some years later suggesting that it was similar to total internal reflection in light travelling through a refractive medium.
Now I suppose that if (and bear with my somewhat hairbrain hypothesis here) a radio wave got injected into the atmosphere and then, due to some abnormal atmospheric condition was repeatedly bounced up and down between two similar levels of refraction as it travelled around the earth until it emerged at a point of lower refractive index, then that possibly might create the effect observed.
Something similar is, as I understand, the manner by which light is fed down fibre optic cables without it emerging from the sides.

Far fetched possibly but I just wonder......

Slim Haines G4IPZ

More about LDE and Strange phenomenon of the Propagation read at AntenTop Magazine:

http://www.antentop.org/book/c_LDE.htm

http://www.antentop.org/book/c_propagation.htm

Underground Antenna

United States Patent

[11] 3,594,798

[72] Inventors George F. Leydorf
Birmingham, Mich.;
Lucien W. Rawls, Leesburg, Va.
[21] Appl. No. 556,248
[22] Filed Mar. 9, 1966
[45] Patented July 20, 1971
[73] Assignee Westinghouse Electric Corporation
Pittsburgh, Pa.
Continuation-in-part of application Ser. No. 77,587, Dec. 22, 1960.

[54] **UNDERGROUND ANTENNA**
6 Claims, 9 Drawing Figs.

[52] U.S. Cl. 343/719, 343/797, 343/873

[51] Int. Cl. H01q 1/04
[50] Field of Search 343/719

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Primary Examiner—Rodney D. Bennett, Jr.
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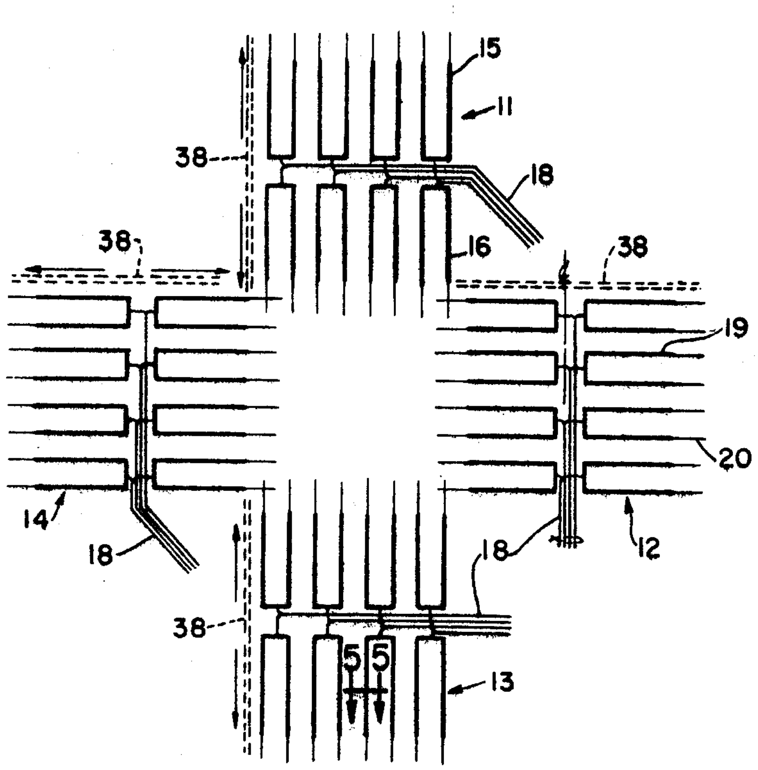
ABSTRACT: The present invention relates in general to a hardened antenna, and in particular to a broadside array antenna which is placed at or below the surface of the ground, which is capable of withstanding the shock of explosions such as nuclear blasts.



PATENTED JUL 20 1971 3,594,798

SHEET 1 OF 3

FIG. 1

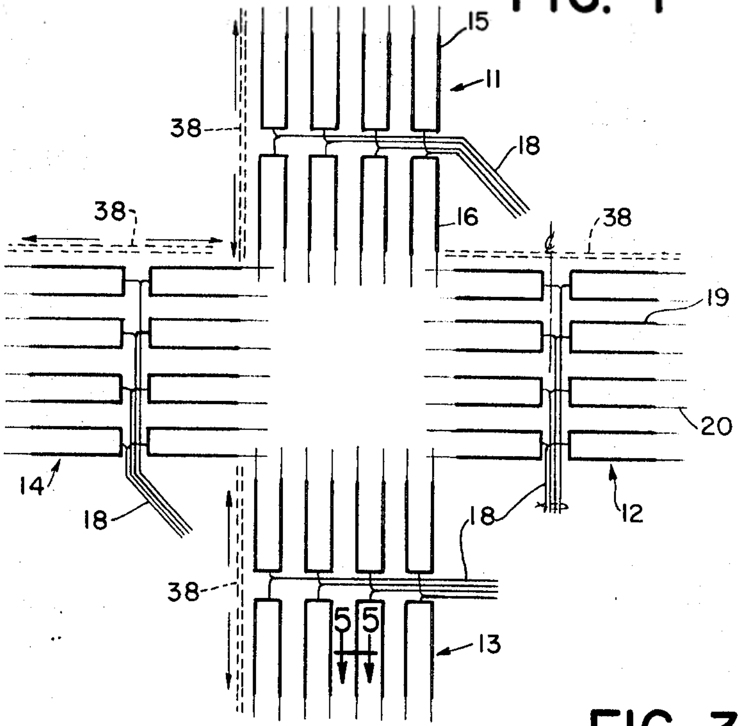


FIG. 2

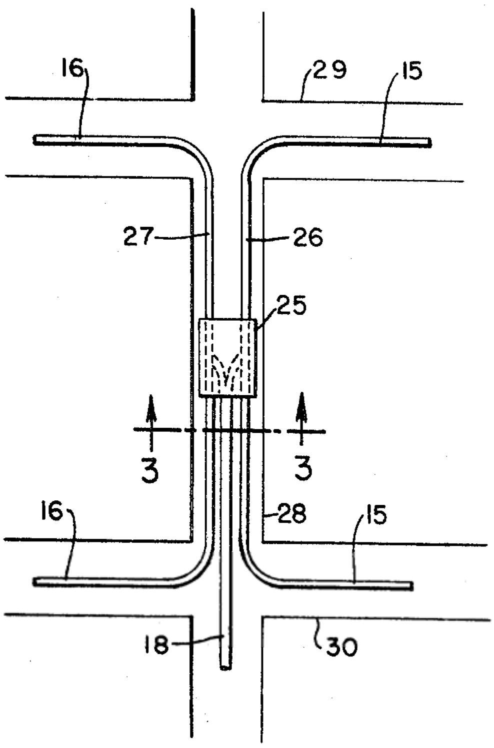
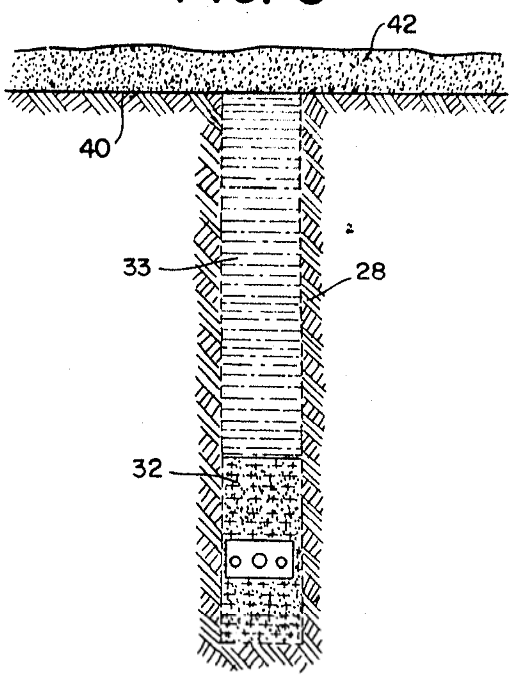


FIG. 3



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SHEET 2 OF 3

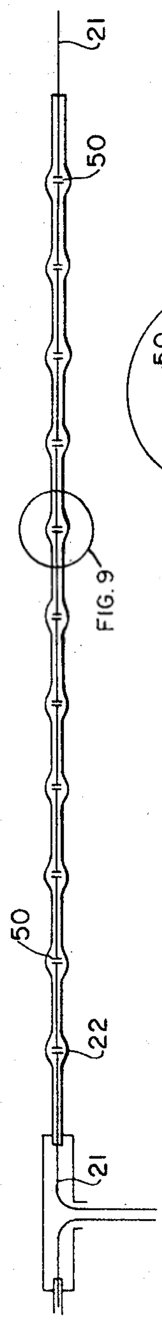

FIG. 4

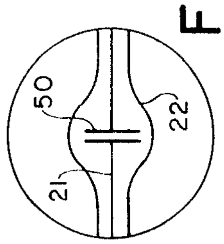

FIG. 9

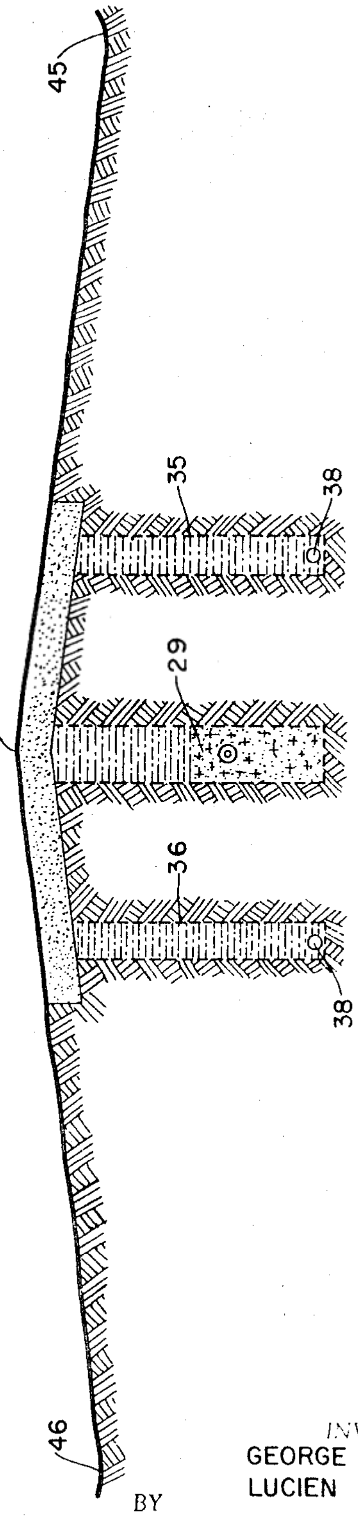

FIG. 5

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SHEET 3 OF 3

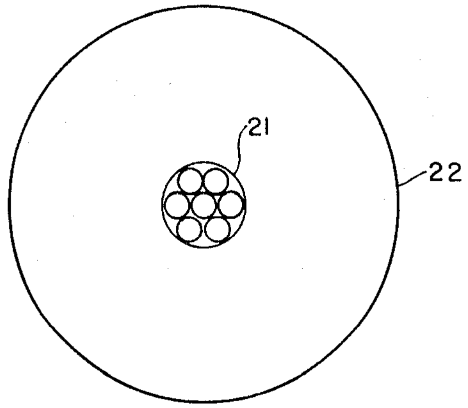


FIG. 6

FIG. 7

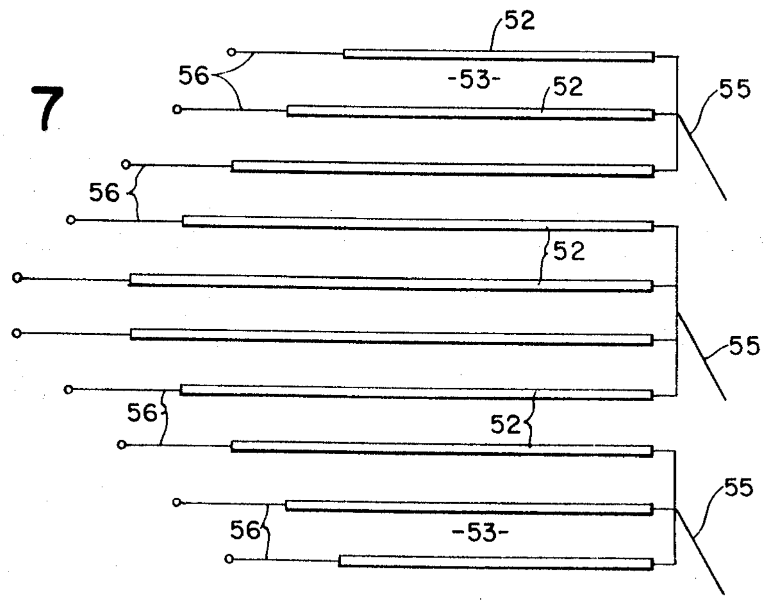
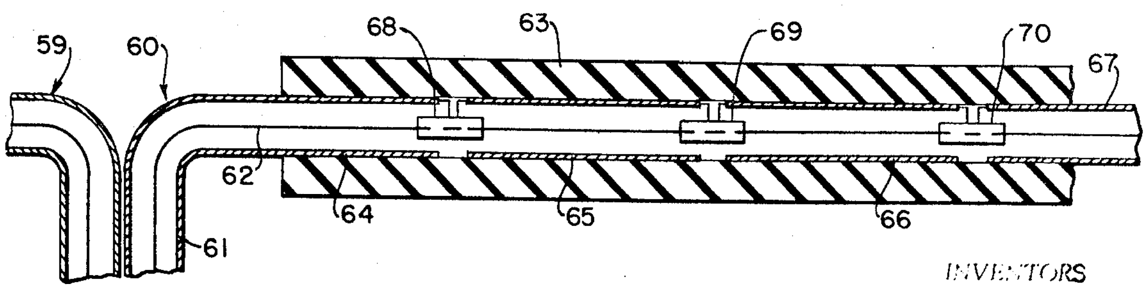


FIG. 8



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UNDERGROUND ANTENNA

This application is a continuation-in-part of application Ser. No. 77,587, filed on Dec. 22, 1960.

In the context of the present world situation, in which each year sees a proliferation of the number of nuclear weapons, and in which the nations of the world are approaching the problems facing them with increasing belligerency, it has become apparent that the need for a strong, adequate defense against nuclear weapons is increasingly more important. A critical part of such a defense system is a communications system by which the retaliatory weapons within the disposal of the defensive striking force can be quickly and efficiently brought into effect once a nuclear attack has been initiated against this country.

Therefore, the need for a communications system which can withstand the unparalleled destructive forces of a nuclear weapon becomes an essential part of the national defenses. The effects of the nuclear blast produce tremendous pressures and shock, and creates temperatures in the range of 2,000° C. near the center of the blast.

It has therefore been suggested to place communication systems including transmitting and receiving antennas, beneath the surface of the earth, which would be able to withstand the shock of a nuclear blast, and which will be readily operable moments after the blast occurs, to coordinate a retaliation strike by this country against an aggressive nation.

It is therefore an object of this invention to provide a novel antenna which is disposed at or beneath the surface of the earth and which, because of this novel construction, permits for efficient radiation of electromagnetic energy.

It is therefore another object of the present invention to provide such an underground, or hardened antenna, which will have the required ability to function after a nuclear blast and which also provides a high radiation efficiency relative to cost, which provides a broader band radiation pattern, which is relatively easy to construct and placed into position for operation, and which can produce radiation patterns which can be readily adjusted in both horizontal and radiation patterns.

It is also an object of the present invention to provide redundancy of antenna elements so that even if a portion of the antenna were destroyed by the blast, the antenna would still be able to operate at relatively high efficiencies.

It has been found that the high conductivity of the medium near or surrounding a buried antenna, or an antenna lying on or near the ground, creates an evironmental condition which is considerably different from that of the conventional above ground antenna elements. It is therefore necessary to develop new design considerations to provide for effective operation by buried underground antennas. In this respect, it has been noted that the attenuation of the ground to electromagnetic radiation is high compared with that of air, but that the mutual effect between antenna elements based relative to one another is considerably affected by the placement of these elements below the surface of the earth.

According to the present invention an antenna system is provided which consists of a series of electric dipole elements having a length of approximately a quarter of a wave length in air at the central operating frequency. The antenna is of the type which is referred to as a current sheet antenna, the basic portions of which are referred to as panels. The dipole elements or wires are spaced in a horizontal plane, parallel to each other at a depth of a few feet below the surface of the earth. This configuration is a broadside array in which each of the equally spaced radiating elements placed along the line carries currents of the same phase. An arrangement is known which has the ability of concentrating radiation in a plane perpendicular to the line of the array while producing relatively little radiation in other directions. The resulting radiation pattern approximates that of a short dipole in which the horizontal radiation pattern, which is vertically polarized, substantially is a "figure eight" pattern with the maximum field

strength being radiated in the direction in line with the dipole elements having substantially a null in the direction normal to the axis of the elements, as the side lobes are substantially less in radiating power than the main lobes.

The launching efficiency of the current-sheet panel is largely a function of the launching efficiency of one element as established principally by the characteristics of the earth environment and of the number of parallel elements employed in the sheet, up to a limited number. A further factor increasing the efficiency of the antenna is the addition of a plurality of capacitors or impedance matching circuits placed in series with the dipole elements to keep the currents more or less uniform and prevent the buildup of large voltages thereon and consequent dielectric losses.

The invention will be fully understood from the following description and the accompanying drawings wherein:

FIG. 1 is a plan view of an antenna according to the invention;

FIG. 2 is a detailed plan view showing the connections to a junction box;

FIG. 3 is a partial sectional view along line 3–3 of FIG. 2 of the earth in the vicinity of a dipole element;

FIG. 4 is a schematic partial view of a dipole element showing the series capacitors;

FIG. 5 is a cross section view on line 5–5 of FIG. 1 of the earth in the vicinity of a dipole element;

FIG. 6 is an end view of the wire of a dipole element;

FIG. 7 is a plan view of a modified dipole panel;

FIG. 8 is a schematic representation of a portion of a modified dipole element; and

FIG. 9 is the enlarged view of the portion shown included in FIG. 4.

Referring to the drawings, there is shown an antenna which is located below the surface of the earth at a suitable depth such as 1—2 meters. The depth at which the antenna is buried will depend on the local soil conditions and other factors, such as the degree of hardness desired. The antenna consists of a plurality of dipoles 11, 12, 13 and 14 which are energized in phase quadrature and provide a pattern similar to that of a short vertical monopole above the ground plane. The reduced vertical radiation materially reduces the deleterious effects of sky wave selective fading at distances of 100 miles or thereabouts, depending on the frequency of operation and the conductivity of the terrain between the transmitter and receiver sites. Suitable operating frequencies are in the range of 5 kc. or less to 500 kc. or higher. For the sake of definiteness the invention will be described with reference to an antenna designed for 500 kc., which is an optimum frequency for long range radiation.

Each antenna panel is essentially a dipole consisting of a large number of parallel wires 15 and 16 connected to suitable feed cables 18. Cables 18 may consist, for example, of four two-wire cables, each two-wire cable being connected to opposite dipole elements as is well understood in the art. The cables are preferably twin-coax lines having an extra heavy metallic outer sheath for protection against breakage. Panels 11—14 are arranged in a quadrangular pattern as shown in FIG. 1, panels 11 and 13 being energized in phase quadrature with panels 12 and 14. The dipole elements or wires 15, 16 may consist of a core of preferably stranded wires surrounded by a large sheath of dielectric insulation. The insulation preferably has a low dielectric constant of say, 2 or less, and has a diameter of about 2 inches. Where the earth adjacent the wire has high dielectric losses it is preferable to make the diameter of the insulation as large as practical, but where the earth has low loss characteristics it is practical to make the diameter of the insulating sheath smaller. Portions 19 of the dipole elements 15 and 16 are covered with the insulating sheath 22 but the ends 20 of the dipole elements for a considerable distance, of about 20 meters, are left bare to provide grounding wires 20 for the dipole elements. Other and additional means for grounding the ends of the dipole elements can be used when required. Feed cables 18 for all panels are connected to the same radio receiving or transmitting apparatus.

Dipole elements **15** and **16** are connected to the feed cables **18** as shown in FIG. **2**. Cable **18** enters a junction box **25** wherein it is connected to conductors **26** and **27** extending through a trench **28** and then into cross trenches **29** and **30** to conductors **15** and **16** of the dipole elements.

In order to reduce losses, trenches **28** to **30** are dug and then, after the cables and junction boxes and dipole elements are placed therein, are refilled with low dielectric loss materials such as treated coarse silicia sand or treated vermiculite **32**, except at the ends **20** of wires **15** and **16**, to a level slightly above the cables and dipole elements as indicated in FIG. **3**. Above the layers **32** the trenches are then back filled with earth **33**, to a level slightly below the earth's surface. Adjacent each trench **29** and **30** containing the dipole elements there is preferably dug another trench **35**, **36** on either side of trenches **29** and **30** to provide water drainage. For this purpose drainage pipes **38** are placed in trenches **35** and **36** which drain from the center of each dipole towards the ends. Drainage pipes **38** are formed of a nonconducting material such as clay tile. Over an area extending beyond the trenches **29**, **35** and **36**, and along substantially the entire length thereof there is placed a suitable water proof film of plastic or other material to act as a roof over the trenches. Film **40** is then covered with stabilized and compacted soil **42**. The film **40** and compacted soil **42** do not extend over the bare wire ends **20**. To further facilitate water drainage, the surface of the earth is sloped as indicated in FIG. **5**, so that there is a peak **44** over trench **29** and a slope down to a trough **45**, **46**, midway between two dipole wires **15** or **16**. In typical ground having a conductivity of 10^{12} mhos per meter, a wire antenna $\lambda o/3$ long, buried 2 meters below the surface of the earth, and operating at a frequency of 500 kc., is found to have its launching loss reduced from approximately 32 db. to 22 db. λo being the wavelength in air.

A power loss in an underground antenna occurs in the end connection **20**. This loss is reduced by insuring sufficient bare surface at the end of each of the insulated wires **15** and **16** to reduce its resistance much below the irreducible value of the ground return around the wire. Other losses that can be reduced in order to further increase efficiency are caused by radial E-field voltages across the capacitance of the wire. This loss is reduced by adding series capacitors **50** in the insulated portion of wires **15** and **16**. Capacitors **50** are embedded in insulating sheath **22**, as shown in FIGS. **4** and **9**. The spacing and size of the capacitors are adjusted to minimize the loss, and, hence, maximize launching efficiency. The capacitors tune out the reactance of the wire. The resulting feed impedance at the center input terminals of wires **15** and **16** approximates a pure resistance equal that of the feed line **18**.

The 500 kilocycle frequency selection lies within a broad range of useable frequencies covering several decades. The choice frequency, however, is governed by factors such as propagation of the waves and total system costs. Once a frequency is chosen, the size of each element of $\lambda o/3$ where λo is a wavelength in free space, becomes fixed and when a site for the antenna is chose, the frequency and the electrical parameters of the earth define the skin depth δ. The skin depth is a function of resistivity and frequency and is a well known term in the art which can be calculated by well-known design equations once the frequency and resistivity are known.

As is the case in most engineering applications, the choice of spacing between elements is a trade between cost and performance. For wire spacing in excess of 2δ, the impedance of each pair of conductors is independent of the spacing. That is, mutual impedances are negligible for most practical purposes when the conductors are spaced more than two skin depths apart. In this range of spacing, the efficiency of a set of N pairs of conductors is N times the efficiency of single pair. If a pair of conductors is shorted or effectively removed, the impedances of the remaining terminals in the configuration remain the same and operation can be resumed at an efficiency decrease of N−1/N, once the transmission line connection to the shorter or defective pair is removed.

The relatively simple operational situations which is available with spacings greater than 2δ, coupled with the near optimum efficiency versus cost, produces an optimum design which produces a substantial reduction of mutual coupling between the array elements.

When the spacings are made less than 2δ, the resistance of individual pairs of antenna elements begins to rise in such a manner that relatively little gain in efficiency can be made, but improvement in band width is still realizable. Disabling a pair of elements will effect the impedance of the pairs on either side. In those cases where a gain in band width, slight gains in efficiency, and increased redundancy, outweigh the increases in cost and impedance instability, the designer would then use spacing of less than 2δ. Thus the spacing between adjacent pairs of conductors of 2δ provides a substantial reduction of mutual coupling between the conductors, but in some circumstances a spacing of δ might well provide a sufficient reduction of mutual impedance and thus this might be regarded as substantial in some circumstances. Also, if extreme stability of feed point impedance is important, spacings of as high as 3δ might be required. However, on the other hand, if a large tolerance on impedance stability were imposed, other design considerations might require a spacing of δ or even less and still provide sufficient reduction of mutual coupling.

In a broadside in-phase array, the directivity is dependent on the overall electrical distance between the outer conductors. When this distance is restricted to $\lambda o/3$, the directivity effect is small enough to be neglected. This is the basis for the $\lambda o/3$ limitation on overall dimensions. When the array of four current sheet elements is operating a null at the zenith is realized. The "figure of eight" pattern refers to the ground plane pattern of a single element, the maximum point of which carries the vertical plane through the zenith and back to the other side of the "figure eight" ground plane pattern. Actually the zenith is between 1 and 2 db. stronger for the single current sheet when the full $\lambda o/3$ overall dimension is used.

For a fuller understanding of the theoretical considerations between spacing of the array elements and mutual coupling between the underground element, the following mathematical analysis is presented.

Practical considerations now introduce the question as to the number of conductors actually needed. Although the field distribution in air will not be materially altered by relatively few conductors, the nonuniform distribution of currents in the earth may lead to greater losses and a lower overall field.

Consideration of losses leads again to the grounding arrangement. In some practical loss trades the loss in the grounds could lead to current distributions where the energy transmitted or radiated into the ground and into the air cannot readily be separated from that dissipated at or near the ground terminals. It is not theoretically necessary to make this separation, but the alternative is to be specific about all currents both in the grounding systems and in the parallel conductors running between them. A straight-forward and rather general procedure of this kind could be carried out, but would lead to an excessive amount of computation to obtain all the necessary impedances.

Since losses in the ground terminals affect both the air radiation and the earth radiation alike, the losses in the ground will be neglected. The ground system then is in effect a large plate at each end of the array perpendicular to the interconnecting conductors, (parallel to the $y-z$ plane).

To a good degree of approximation there will be one component of electric intensity, in the x-direction, that is, parallel to the wires. This electric intensity is produced by all the wires. For the vicinity of a given wire the greatest contribution comes from the wire itself, and the next largest contributions from the two wires on either side, and so on. When each of the wires carry a current I, all of the impedance relations follow, once the expression for E in terms of distance from a single wire is known. The relation between E and I in the case at hand is:

$$E = I\,\omega\mu\,Z^{(2)}\sigma(\gamma s)$$

where

$\omega = 2f$

$\mu = 4 \times 10^{17}$

$Z^{(2)}\sigma(\gamma s)$ = the Hankel function of the second kind of zero order.

γs = the independent variable of the Hankel function,

γ = the propagation constant of the ground ($\gamma = \sqrt{j\omega\mu\sigma}$ and

s = the perpendicular distance to the wire.

σ = the conductivity of the earth

This Hankel function will be found in tables such as those of Jahnke and Emde, or Abramowitz and Stegun.

When s=radius of the conductor, a, carrying the current I, E/I becomes the self impedance per unit length of the conductor, z_{11}. Since (γa) is a small number, of the order of $10^{1}3$ in the example to follow, a close approximation to the impedance is:

$$z_{11} = \frac{\omega\mu}{4}\left(\frac{1}{2} - j\frac{2}{\pi}\ln|\gamma a|\right)\Omega/\text{meter}$$

when $|\gamma a| = 10^{-3}$ this becomes

$$z_{11} = \frac{\omega\mu}{4}\left(\frac{1}{2} + j4.4\right)\Omega/\text{meter}$$

if the frequency 10^5 cycles per second; (100 kc):

$z_{11} = 0.099 + j0.87$ ohms/meter.

In the table to follow, the mutual impedance per unit length versus spacing is tabulated in somewhat general terms. The real part is the resistance and has an influence on efficiency. The imaginary part (preceded by j) is the reactance and affects stored energy and bandwidth.

TABLE 1

Mutual Impedance vs Spacing

(γs)	s/δ	$4/\omega\mu$ (Mutual Impedance) ohm/m.
0.02	0.01414	0.4997+j 2.564
0.05	0.0353	0.4984+j 1.981
0.1	0.0707	0.4946+j 1.541
0.2	0.1414	0.4826+j 1.103
0.5	0.353	0.4275+j 0.5449
0.7	0.495	0.3834+j 0.3574
1.0	0.707	0.3151+j 0.1825
1.2	0.847	0.2713+j 0.1075
1.4	0.99	0.2302+j 0.0786
1.6	1.13	0.1926+j 0.0162
1.8	1.27	0.1588−j 0.0094
2.0	1.414	0.1289−j 0.02652

$$\delta = \frac{\sqrt{2}}{\gamma} = \sqrt{\frac{2}{\omega\mu\sigma}} \text{ is the skin-depth}$$

The analysis to follow depends upon resistance and mutual resistance and even then on relative values. The significant contribution to resistance are added for a conductor 5 conductors or more in from the edge. Hence there are always two mutual impedances for each spacing, corresponding to the conductors on either side. Corrections for "edge effects" where this condition is not met, will not materially alter the results, and will therefore be omitted in the following.

The total resistance per unit length for the typical conductor is found for four separations:

$s=\delta/2$, $s=\delta$, $s=2\delta$ and $s=4\delta$

The distant field for a given power input falls of rapidly when s exceeds 2δ.

If the frequency is 100 kc. and $\delta=10^{12}$, $(\omega\mu\sigma)^{1/2}=0.089$, $\sigma=15.9$ m., $\lambda o=3000$ m. $\lambda o/4=750$ m., $w=\lambda o/4=750$m.

The number of conductors for a spacing of δ is $N=w/\delta=750/15.9=46.2\approx46$.

$$\text{For } s=\delta/2,\ N=92,\ \frac{4}{\omega\mu}R_{11}=0.500$$

$$|\gamma\delta|\ \frac{4}{\omega\mu}(2\times R_m)\quad R_n=R_{11}+\sum R_m=2.049$$

0.707	0.760
1.414	0.458
2.121	0.226
2.83	0.087
3.54	0.018
	1.549

$P=N\,I_n^2\,R$

Solving for $N\,I_n$ which is proportional to the distant field

$N\,I_n=(NP/R)^{1/2}$

$$92I_{92}=\left(\frac{P.92}{2.05}\right)^{1/2}=6.67P^{1/2}$$

$$s=\delta\quad N=46\quad R_n=R_{11}+\sum R_m=1.052$$

$\|\gamma\delta\|$	$\frac{4}{\omega\mu}(2\times R_m)$
1.414	0.456
2.83	0.087
4.23	0.0085
	.552

$$46I_{46}=\left(\frac{P.46}{1.052}\right)^{1/2}=6.61P^{1/2}$$

$$s=2\delta\quad N=23\quad R_n=R_{11}+R_m=.597$$

γs	$\frac{4}{\omega\mu}(2\times R_m)$
2.82	0.087
5.65	0.01
	.097

$$23I_{23}=6.18P^{1/2}\ (.59\text{ db down})$$

$$s=4\delta\quad N=11.5$$

$$R_n=.51$$

$$11.5I_{11.5}=4.75P^{1/2}\ (3\text{ db down})$$

Note that these calculations are relative, such terms as l, $\frac{\omega\mu}{4}$, K, etc. have been dropped from all calculations.

From this example the advantages of the two skin depth spacing is apparent. The efficiency for this spacing is only 0.6 db. down from a spacing of $\delta/2$ involving four times as many conductors. The removal of one conductor, or the drive to one conductor, does not significantly change the impedance of the adjacent conductors. Depending on the problems posed, a somewhat greater or smaller spacing might prove more suitable when all factors are taken into account.

Not all wires of a panel need be the same length. As shown in FIG. 7, the wires 52 constituting the dipole elements of one side of a dipole have different lengths, being shorter at the outer sides of the panel than at the middle of the panel. The shape of the panel shown in FIG. 7 is illustrative of one of the forms the panel may take. Particularly, the insulated portions 53 of the dipole elements may vary in length in order to control the directivity and increase the efficiency of the dipole relative to its extent and cost. In FIG. 7, the dipole elements are formed essentially in the same manner as shown in FIGS. 1 and 4 and are connected to suitable feed cables 55 and have bare ends 56.

Another modification of the invention is shown in FIG. 8 illustrating portions of dipole elements 59 and 60 consisting of a coaxial cable having an outer conductor 61 and inner conductor 62, the input end of which extends to a transmitter. The dipole element 60 constitutes one of the wires 15, 16 of FIG. 1, or wire 52 of FIG. 7. Dipole element 60 is provided with an insulating sheath 63 over the radiating portion thereof. The radiating portion of the dipole consist of a number of sections 64, 65, 66,67, which are separated from one another. Radiating elements 64 to 67 are connected to inner conductor 62 through impedance matching circuits 68—70, which may include a transformer and amplifier and an impedance matching pad. Essentially, impedance matching circuits **68**—**70** take the place of capacitors shown in FIG. **4** and serve to energize the radiating elements **64**—**67** while minimizing the voltage variations along the radiating elements. Thus, the impedance matching circuits reduce dielectric losses due to radial electrical fields produced by the dipole elements. At the right end **67** of the dipole element shown in FIG. **8**, the outer conductor may extend for a considerable distance without insulation to form a bare end similar to the ends **20** in FIG. **1**.

It will be understood that instead of using the entire array of FIG. **1** in some instances a single dipole may be used. The radiation from a single dipole of the type disclosed herein is in the direction of the dipole elements. The reason for this is that the waves radiated from the dipole elements toward the surface of the earth encounter a refraction of substantially 90° at the surface of the earth, so that the waves become vertically polarized and travel in a generally horizontal direction parallel to the direction of the wires and provide a "figure eight" pattern having nulls in the direction perpendicular to the dipole wires.

For the sake of definiteness the dimensions of an embodiment of the invention suitable for a frequency of 500 kc. are shown in the drawing.

It will be understood, however, that the embodiments herein disclosed are exemplary and that it will be evident to those skilled in the art that many variations may be made without departing from the principles of the invention embodied in the structures defined in the following claims.

What We claim is:

1. An underground high redundancy antenna system comprising a plurality of dipole antennas, each dipole antenna comprising feed line means and a plurality of parallel wires forming each side of each dipole antenna, said wires extending in opposite direction from said feed line means and connected to said feed line means in parallel, the wires of each of said sides being spaced apart a sufficient distance at a sufficient depth to enable the earth to substantially reduce the mutual coupling between the wires, each of said antennas being insulated over a major portion thereof, and conductive means in contact with the earth connected to the ends of said wires to reduce the power loss, said dipole antennas being spaced from each other in the direction in which said wires extend.

2. An antenna system according to claim **1** including a second plurality of dipole antennas constructed similarly to said first plurality of dipole antennas, said second dipole antennas having their wires extending substantially at right angles to the wires of the first plurality of dipole antennas and feed line means connected to said second dipole antennas.

3. For use in the transmission of radio frequencies, an underground antenna comprising at least one dipole antenna, each side of said dipole antenna including a plurality of substantially parallel wires to thereby increase the launching efficiency of said antenna, said parallel wires being spaced apart a sufficient distance at a specified depth within the earth to enable the earth to substantially reduce the mutual coupling between the wires, said wires being insulated over at least a portion of their length, the thickness of said insulation being related to the loss characteristics of the adjacent earth.

4. An underground antenna according to claim **3**, wherein a sufficient length of the end of each of said wires is in a conductive relationship with the earth to reduce the power loss in the antenna.

5. An underground array antenna comprising a plurality of spaced pairs of colinear conductors lying beneath and in close proximity to the surface of the earth, each of said conductors having a coating of insulation over a portion thereof, the other portion of each of said conductors being in direct contact with the earth, each of said pair of conductors being of a length not greater that one-third of a wavelength in free space of the energy radiated thereby, the spacing between each of said pairs of conductors being substantially equal to 2δ, δbeing the skin depth of the earth, for substantially reducing the mutual coupling between adjacent pairs of conductors.

6. The antenna of claim **5** wherein said plurality is chosen to be of such a number that the overall distance between the outermost conductors is substantially equal to one-third of the wavelength in free space of the energy radiated thereby.

Tuning System for Tower Antennas

United States Patent [19]

Vye

[11] **4,184,165**

[45] **Jan. 15, 1980**

[54] **TUNING SYSTEM FOR TOWER ANTENNAS**

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[73] Assignee: **Stuart Electronics**, Akron, Ohio

[21] Appl. No.: **940,216**

[22] Filed: **Sep. 7, 1978**

[51] **Int. Cl.**[2] **H01Q 9/34**; H01Q 1/12; H01Q 1/50

[52] **U.S. Cl.** **343/874**; 343/861; 343/890

[58] **Field of Search** 343/874, 875, 861, 890, 343/891

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Assistant Examiner—Harry E. Barlow
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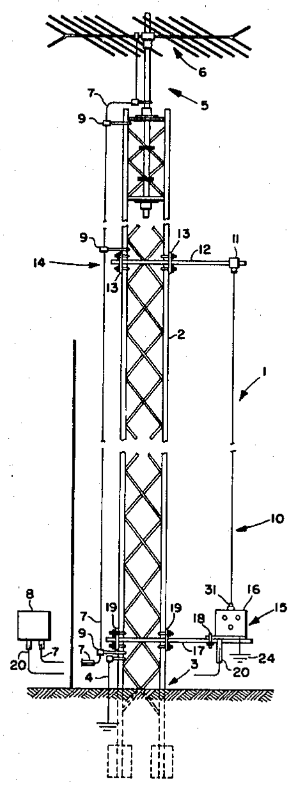
[57] **ABSTRACT**

In accordance with the present invention, a single shunt feed mechanism, including a single gamma section and a single impedance matching circuit, is employed to enable an antenna tower as an effective radiator in plural wave length bands without having to alter the upper tie point of the gamma section to the antenna tower. In one embodiment, the shunt feed of the invention enables the antenna tower as an effective radiator in either two of the adjacent bands mentioned, namely the 40 and 80 meter bands or the 80 and 160 meter bands. In accordance with another embodiment of the invention, a single shunt feed mechanism, including a single gamma section, a single impedance matching circuit, and a filter, enables an antenna tower as an effective radiator in all three of the indicated bands.

15 Claims, 3 Drawing Figures



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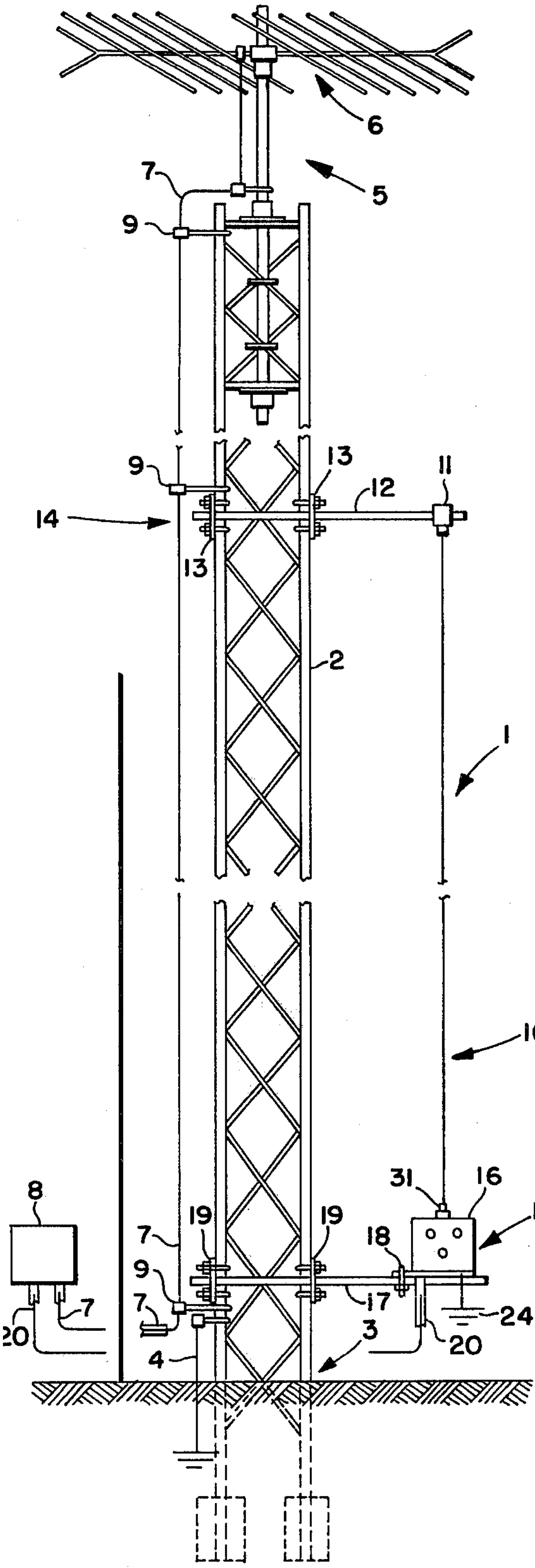

FIG. 1

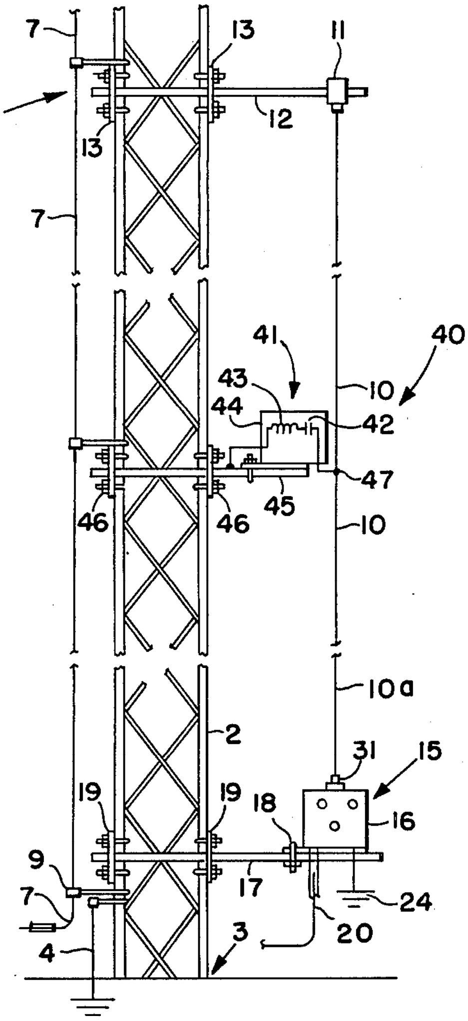

FIG. 2

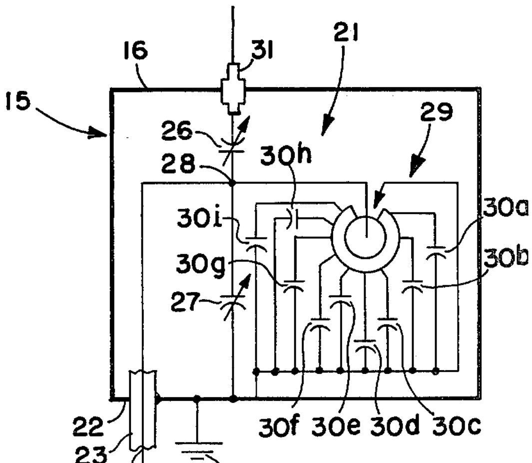

FIG. 3

TUNING SYSTEM FOR TOWER ANTENNAS

TECHNICAL FIELD

The present invention relates generally, as indicated, to antennas and, more particularly, to a system that facilitates tuning of tower antennas to multiple wave length bands, thus increasing the versatility of antennas.

BACKGROUND OF PRIOR ART

Conventional grounded antenna towers have mounted on the top, for example, a directional antenna array for radiating (radiating and radiator being used to indicate the radiating and/or receiving of electromagnetic signals) signals at selected relatively high frequencies with wave lengths, for example, on the order of 20, 15 and 10 meters and V.H.F. A coaxial cable from the radio equipment extends along the tower and is connected to the directional array. Sometimes plural cables may be connected to respective directional arrays adapted to selected respective frequencies.

A grounded antenna tower also may be fed an electrical signal and used in conjunction with additional equipment as the radiator for signals having lower frequencies than those to which directional arrays are adapted. Such additional equipment includes a gamma section and impedance matching circuitry. Such equipment, as is known, can adapt a relatively short antenna tower on the order of, for example, 5 meters to about 30 meters in height, for use on the amateur radio bands of 40 meters, 80 meters, or 160 meters, with each having frequencies in ranges of about 7–7.3 MHz., 3.5–4 MHz., and 1.8–2 MHz., respectively. By using such a gamma section and impedance matching circuitry to shunt feed an antenna tower and to thus convert the tower itself to a radiator, even though the tower height may be relatively small, the versatility of the tower is increased.

To shunt feed a tower so as to use the same as a radiator in the 40, 80 or 160 meter wave length bands, a gamma rod or gamma matching section, which may be simply an electrically conductive rod or wire, is mounted in substantially parallel relation to the tower spaced apart a relatively small distance therefrom. The bottom end of the gamma section is connected by impedance matching circuitry to the bottom of the tower, which is grounded, and to a coaxial cable from the radio equipment, which is generally located remotely from the antenna. In the past, the gamma section has been about 4 or 5 meters in length and has had its upper end electrically tied or connected to the tower at a height along the latter that was specifically adjusted for tuning purposes to obtain a signal strength of adequate value.

The purpose of the impedance matching circuitry, such as conventional gamma matching or omega matching circuitry, was to provide about 120 to about 500 pf. capacitance to match the shunt fed radiator with the impedance of coaxial cable coupling the same to the radio equipment. Such coaxial cable typically has an impedance on the order of about 50 ohms. When shunt feeding an antenna tower, it is desirable that the standing wave ratio (SWR) be as close to 1 as possible. Conventional impedance matching circuitry generally can be adjusted with an SWR meter connected in series therewith to obtain such condition.

To the best knowledge of the applicant, in the past, the shunt feeding of an antenna tower was provided to enable the tower as an effective radiator only in a single one of the 40, 80, or 160 meter wave length bands. In

one instance, though, the antenna tower was shunt fed with a single gamma section to enable the tower as a radiator in both the 40 and 80 meter bands, but in that instance it was necessary to adjust the height of the upper tie point of the gamma section to the tower in dependence on the particular wave length being utilized. Moreover, in another instance that a shunt fed tower was enabled as a radiator in more than one of the 40, 80 and 160 meter bands, a separate gamma section and impedance matching circuit was used for each respective band.

It would be desirable to be able to utilize a single shunt feed mechanism, i.e. with only a single gamma section and a single impedance matching circuit, to enable an antenna tower as effective radiator in plural wave length bands, such as, for example, the 40 and 80 meter bands or the 80 and 160 meter bands. Moreover, it would be desirable to be able to use a single shunt feed mechanism to enable a single antenna tower as an effective radiator for all three of those bands. Further, it would be desirable to accomplish the foregoing without having to adjust the upper tie point of the gamma section to the antenna tower.

BRIEF SUMMARY OF INVENTION

In accordance with the present invention, a single shunt feed mechanism, including a single gamma section and a single impedance matching circuit, is employed to enable an antenna tower as an effective radiator in plural wave length bands without having to alter the upper tie point of the gamma section to the antenna tower. In one embodiment, the shunt feed of the invention enables the antenna tower as an effective radiator in either two of the adjacent bands mentioned, namely the 40 and 80 meter bands or the 80 and 160 meter bands. In accordance with another embodiment of the invention, a single shunt feed mechanism, including a single gamma section, a single impedance matching circuit, and a filter, enables an antenna tower as an effective radiator in all three of the indicated bands.

It has been discovered that by locating the vertical gamma section relatively far from the antenna tower, for example at a distance of about 65 cm., as compared to the more closely located vertical gamma sections employed in the prior art, and/or by appreciably increasing the magnitude of the capacitance available in the impedance matching circuitry, a single gamma matching section and impedance matching circuit may be employed to enable effective operation of an antenna tower as a radiator in the indicated plural bands. For example, when the vertical gamma section has a length of about 7 meters, is positioned parallel to the antenna tower about 65 cm. spaced therefrom, is mechanically and electrically connected at the top of the gamma section to a parallel height on the tower, and the impedance matching circuit is adjustable for optimum impedance match with the coaxial cable by capacitance up to about 3,000 pf., the shunt feed system enables the antenna tower as an effective radiator in the wave length bands of 80 and 160 meters. Similarly, by reducing the length of the gamma section to about 3.5 meters and effectively adjusting the impedance matching circuit for optimum standing wave ratio, the antenna tower can be enabled as an effective radiator in the wave length bands of 40 and 80 meters. In both cases, a current flow path is provided from the impedance matching circuit via the gamma section, a connecting rod from the upper end of the gamma section to the antenna tower, down through the antenna tower, and back via a support rod coupled to the tower for supporting the impedance matching circuit back to the latter.

A further embodiment of the invention enables the antenna tower as an effective radiator in all three of the 40, 80 and 160 meter bands. In accordance with this embodiment, the shunt feed employed for both the 80 and 160 meter operation is employed, namely the 7 meter length gamma section. However, coupled at about the mid point of the gamma section, i.e. at about 3.5 meters, is a circuit for connection to a parallel height location on the tower. Such circuit includes an LC series resonant circuit tuned, for example, to 7 MHz. Therefore, when the 40 meter wave length radiation is desired, and approximately a 7 MHz. signal is employed, such signal will circulate from the impedance matching circuit, through the lower half of the gamma section and the LC series resonant circuit to the antenna tower, via the antenna tower, and via the lower support back to the impedance matching circuit. However, when the antenna tower is to be utilized in the 80 or 160 meter band at about 3.5 or about 1.8 MHz., respectively, such electrical signal will bypass the LC series resonant circuit and will use the entire length of the vertical gamma section so that operation is as described above for 80 and 160 meter operation.

In accordance with each embodiment of the invention, the only adjustment necessary to effect efficient enabling and tuning of the antenna tower as a radiator in one of plural, e.g. two or three, bands, is via the impedance matching circuit, which preferably is of the omega matching type, to alter the effective capacitance thereof for optimum impedance matching coupling of the shunt fed antenna system with respect to the coaxial cable.

With the foregoing in mind, it is a primary object of the invention to facilitate enabling an antenna tower as an effective radiator in plural bands and, especially, to enable the same for those antenna towers that lack the size and space requirements for a direct feed arrangement.

Another object is to improve the versatility of an antenna tower.

An additional object is to enable an antenna tower as an effective radiator in plural wave length bands, for example, in two or three such bands.

A further object is to enable a single gamma feed system for a shunt fed antenna tower to permit use of the antenna tower efficiently at different wave lengths with minimum adjustment.

Still another object is to enable an existing grounded antenna tower to be used as an effective radiator for dual band or tri-band operation with only a single gamma section and impedance matching circuit without altering the physical connections to the tower.

These and other objects and advantages of the present invention will become more apparent as the following description proceeds.

To the accomplishment of the foregoing and related ends, the invention, then, comprises the features hereinafter fully described in the specification and particularly pointed out in the claims, the following description and the annexed drawing setting forth in detail certain illustrative embodiments of the invention, these being indicative, however, of but several of the various ways in which the principles of the invention may be employed.

BRIEF DESCRIPTION OF DRAWING

In the annexed drawing:

FIG. 1 is an illustration of a grounded antenna tower including the shunt feed and tuning system in accordance with the present invention for enabling the tower as an effective radiator in at least two wave length bands;

FIG. 2 is a view similar to FIG. 1 illustrating the invention to enable the antenna tower as an effective radiator in at least three wave length bands; and

FIG. 3 is a schematic diagram of the impedance matching circuit for the invention.

DETAILED DESCRIPTION OF INVENTION

Referring initially to FIG. 1, a tuning system 1 in accordance with the present invention is illustrated in association with a conventional antenna tower 2 that is grounded at its base 3 by a grounding rod 4. The antenna tower includes a plurality of electrically conductive and mechanically connected sections that extend upwardly to a height on the order of from about 10 meters to about 30 meters so as to support at the top 5 of the antenna tower conventional directional radiating arrays or antennas 6. A coaxial cable 7 extending up the antenna tower 2 provides electrical coupling between the antenna array 6 and conventional radio equipment 8, which is usually located remotely from the tower 2. The cable 7 may be mechanically supported from the tower by a plurality of insulators 9.

The tuning system 1 is in effect a shunt feed mechanism that enables the tower 2 to radiate in plural wave length bands. The tuning system 1 includes a vertical gamma section 10, such as an electrically conductive wire, rod, pipe, or the like that is positioned in parallel vertical relation with respect to the tower 2. The gamma section 10 is mechanically and electrically connected at its upper end by a clamp 11 to a horizontal rod support 12, for example of aluminum, which is in turn connected by one or more clamps 13 to the tower 2 to provide vertical support for the gamma section while at the same time providing an electrical connection thereof to the parallel height location 14 on the tower 2.

The tuning system 1 also includes an impedance matching circuit 15, shown in detail in FIG. 3, which is preferably enclosed in a metal, weatherproof housing 16 that is mounted on a further horizontal support 17, such as a further aluminum rod. The support 17 is mechanically and electrically coupled by one or more clamps 18 to the impedance matching circuit housing 16 and by one or more clamps 19 for mechanical and electrical connection to the tower 2 proximate the base 3. A further coaxial cable 20 of, for example 50 ohms impedance, is connected to the radio equipment 8 to couple electrical signals between the radio equipment and the shunt feed tuning system 1 of the invention.

The impedance matching circuit 15, as mentioned above, preferably is of the omega matching circuit type as opposed to the gamma matching circuit type, although the latter may be employed, if desired. The omega matching circuit 21 within the housing 16 includes a mechanical and electrical connector 22 for connection with the coaxial cable 20 such that the coaxial cable shield 23 and housing 16 are coupled to ground reference potential, as is indicated at 24. The main center conductor 25 from the coaxial cable is connected to the junction of a pair of variable capacitors 26, 27, each of which has a maximum value of 300 pf. Also connected to the same junction **28** is a progressive shorting switch **29**, which provides for selectively connecting from 0 to 9 additional fixed 300 pf. capacitors **30***a*–**30***i* in parallel with the variable capacitor **27**. The capacitor **27** and the capacitors **30***a*–**30***i* are also connected remotely of the junction **28** to the housing **16** which provides an electrical path to the ground reference potential **24**. Moreover, the gamma section **10** is mechanically connected to the housing **16** by a feed through insulator **31** and is electrically connected to the capacitor **26** remotely of the junction **28**.

It has been discovered that by positioning the gamma section **10** relatively far, say about 65 cm., from the tower **2** and by using a relatively large capacity impedance matching circuit **15**, the tuning system **1** enables the antenna tower **2** as an effective radiator in plural wave length bands of, for example, 40 and 80 meters or 80 and 160 meters without additional gamma sections or the need to vary the vertical location of the upper tie point, e.g. via the rod **12** to the antenna tower. In particular, using a vertical gamma section having a 3.5 meter length, the tower **2** may be enabled as a radiator in the 40 or 80 meter band; the capacitors in the impedance matching circuit **15** may be adjusted as noted below to obtain an optimum SWR, depending on whether the antenna is utilized in the 40 meter or 80 meter band. Similarly, by utilizing a vertical gamma section **10** having a length of about 7 meters, the antenna tower **2** may be utilized as an effective radiator at 80 and 160 meter bands with optimum SWR being provided by simple conventional adjustment of the impedance matching circuit **15**. Such enablement has been found independent of total antenna tower length in a range of from about 10 meters to about 30 meters in height and it is expected that the tuning system **1** would be similarly effective with antenna towers outside that range.

The capacitor **26** and the switch **29** effectively provide rough tuning and the capacitor **27** provides fine tuning. For tuning the impedance matching circuit **15**, then, first, the capcitor **27** is turned to its lowest value. Second, capacitor **26** is adjusted to obtain the lowest standing wave ratio (SWR) as monitored, for example, in conventional manner by a series connected SWR meter. Third, the switch **29** is adjusted to obtain the lowest SWR and, fourth, subsequently the capacitor **27** is adjusted to obtain the lowest SWR. If necessary, these tuning steps, from the second through the fourth steps, can be repeated for optimum tuning to obtain a minimum SWR.

Adjustment of the capacitors within the housing **16** may be effected by externally accessible control knobs that pass into the housing via weatherproof seals. The objective of such weatherproof integrity of the housing **16** is to assure optimum protection for the impedance matching circuit therewithin, although the environment external of the housing **16** may be relatively hostile.

Turning now more particularly to FIG. **2**, another embodiment of the tuning system in accordance with the present invention is generally indicated at **40**. The elements of the tuning system **40** as illustrated in FIG. **2** that correspond with the elements described above with reference to FIG. **1** are represented by the same reference numerals. However, in accordance with the tuning system **40** it is preferred that the length of the vertical gamma section **10** be approximately 7 meters to provide for enablement of the antenna tower **2** as a radiator in both the 80 and 160 meter wave length bands. The tuning system **40** also includes an LC series resonant tuned filter circuit **41**. The tuned circuit **41** is comprised of a capacitor **42** and an inductor **43** which are tuned to a frequency of, for example, about 7 MHz. which is the frequency at which signals are produced in the 40 meter wave length band. The tuned circuit **41** preferably is contained in a weatherproof housing **44** that is mounted on a support **45**, such as an electrically conductive aluminum rod in turn mechanically and electrically connected by clamps **46** to the tower **2**. One side of the tuned circuit **41** is electrically connected via the rod **45** and the clamps **46** to the tower **2**, and the other end of the tuned circuit **41** is electrically connected at a junction **47** to the vertical gamma section **10** at a location approximately half-way along its length, thus being about 3.5 meters above the lower support rod **17** and impedance matching circuit **15**.

Preferably the tuned circuit **41** is so highly tuned that it effectively rejects current at the 3.5 and 1.8 MHz. frequencies employed in conjunction with signals in the 80 and 160 meter wave length bands. Therefore, in operation of the tuning system **40** in association with the antenna tower **2** to enable operation of the latter as an effective radiator in the 40 meter wave length band, current from the coaxial cable **20**, for example, will flow via the impedance matching circuit, the lower half **10***a* of the gamma section **10**, the tuned circuit **41**, the rod **45** and clamps **46**, the antenna tower **2**, and the lower support **17** back to the impedance matching circuit **15** to complete a loop. The frequency of the electrical signals thus radiated or received by the antenna tower **2** will have a frequency on the order of about 7 MHz. that is passed with facility by the tuned circuit **41**. Of course, it will be appreciated that the impedance matching circuit **15** would ordinarily be adjusted to provide during such operation optimum SWR condition.

Moreover, for use of the tuning system **40** in connection with the antenna **2** to enable the latter as an effective radiator in the 80 and 160 meter wave length bands, 3.5 or 1.8 MHz. signals are employed. Those signals will be rejected by the tuned circuit **41**, and, therefore, their current loop will include the impedance matching circuit **15**, the entire length of the vertical gamma section **10**, the upper support **12**, the antenna tower **2**, and the lower support **17** back to the impedance matching circuit, which will be adjusted in conventional manner to obtain preferably an optimum SWR condition.

STATEMENT OF INDUSTRIAL APPLICATION

In view of the foregoing, it will be clear that the tuning systems **1** and **40** in accordance with the present invention enable a grounded shunt fed antenna tower to operate as an effective radiator in plural wave length bands with only a single vertical gamma section and without the need to alter the upper tie point of the latter to the antenna tower.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A tuning system for enabling an antenna tower as an effective radiator in plural wave length bands in connection with radio equipment having a plural conductor signal carrier for connection with said antenna tower, comprising:

- an electrically conductive gamma section vertically parallel to said antenna tower and horizontally spaced therefrom,
- connector means for electrically connecting the upper end of said gamma section to said antenna

tower at a substantially parallel height location between the top and base of the latter, and

capacitive feed means for shunt connecting said plural conductor signal carrier to said antenna tower and gamma section, including adjustable capacitor means for adjustably matching the input impedance of said antenna tower and gamma section relative to the impedance of said plural conductor signal carrier,

said gamma section having a length shorter than said antenna tower but otherwise independent of antenna tower length and being spaced from said antenna tower for enabling said gamma section and antenna tower to cooperate in transmitting and receiving signals in plural wave length bands, and said capacitive feed means having a range to tune said antenna tower for efficient operation in at least two bands which are separated in frequency by at least substantially an octave without changing the upper end connection of said gamma section to said antenna tower.

2. The system of claim **1**, wherein said gamma section is spaced about 65 cm. from said antenna tower.

3. The system of claim **1**, wherein said connector means comprises a rigid rod-like member and means for connecting the same mechanically and electrically in a generally horizontal plane to said antenna tower and to said gamma section.

4. The system of claim **1**, further comprising further connector means for supporting said capacitive feed means at a location approximately parallel to the base of said antenna tower and for electrically connecting said capacitive feed means approximately to the base of said antenna tower.

5. The system of claim **1**, wherein said capacitive feed means has a variable capacitance with a maximum capacity of at least 3,000 pf.

6. The system of claim **1**, wherein said wave length bands are 40 meters and 80 meters.

7. The system of claim **6**, wherein the length of said gamma section is about 3.5 meters.

8. The system of claim **1**, wherein said bands are 80 meters and 160 meters.

9. The system of claim **8**, wherein the length of said gamma section is about 7 meters.

10. The system of claim **1**, further comprising filter means coupled between said gamma section and said antenna tower for passing an electrical signal of one wave length band therebetween and rejecting other electrical signal from such passage.

11. The system of claim **10**, wherein said filter means comprises an LC series resonant circuit.

12. The system of claim **11**, said filter means being connected to said gamma section at a location approximately half-way along the length thereof and to said antenna tower at a height parallel to such connection to said gamma section.

13. The system of claim **12**, wherein said gamma section has a length on the order of about 7 meters and said filter means is tuned to a frequency on the order of about 7 MHz. and to reject signals on the order of about 3.5 MHz. and on the order of about 1.8 MHz.

14. The system of claim **13**, said filter means including a substantially weatherproof housing, connector means for electrically connecting one side of said filter means to said gamma section, electrically conductive rod-like support means for mechanically supporting said filter means at a height above the base of said antenna tower equal to approximately one-half the vertical length of said gamma section and for electrically connecting said filter means to said antenna tower.

15. The system of claim **13**, said filter means being so tuned to pass current therethrough when the tuning system cooperates with said antenna tower in transmitting and receiving signals approximately in a 40 meter wave length band and to impede the passage of current to cause current flow through the entire length of said gamma section when the tuning system cooperates with said antenna tower in transmitting and receiving signals approximately in an 80 meter or 160 meter wave length band.

* * * * *

ANTENTOP

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