Old computer's PSU gives useful parts for antennas

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Continue from ANTENTOP 01- 2003, #002

An autotransformer

AT-33T transformer works satisfactorily in connection shown in **Fig. 1**. It is ***an autotransformer connection***. Mind, the secondary winding must be connected to the primary one at the right phase (**A** or **B** to **C**).

The experiment shows the right connection. Data for the RF autotransformer are shown in **Tab. 1- 3**. **Tab. 1** shows data for the RF autotransformer while this one is loaded to 300 Ohms. **Tab. 2** shows data for the RF autotransformer while this one is loaded to 450 Ohms. **Tab. 3** shows data for the RF autotransformer while this one is loaded to 600 Ohms. The autotransformer has rather big input resistance on ranges of 160 and 80 meters therefore values of a VSWR relative to 75 Ohms are shown in these tables.

An autotransformer

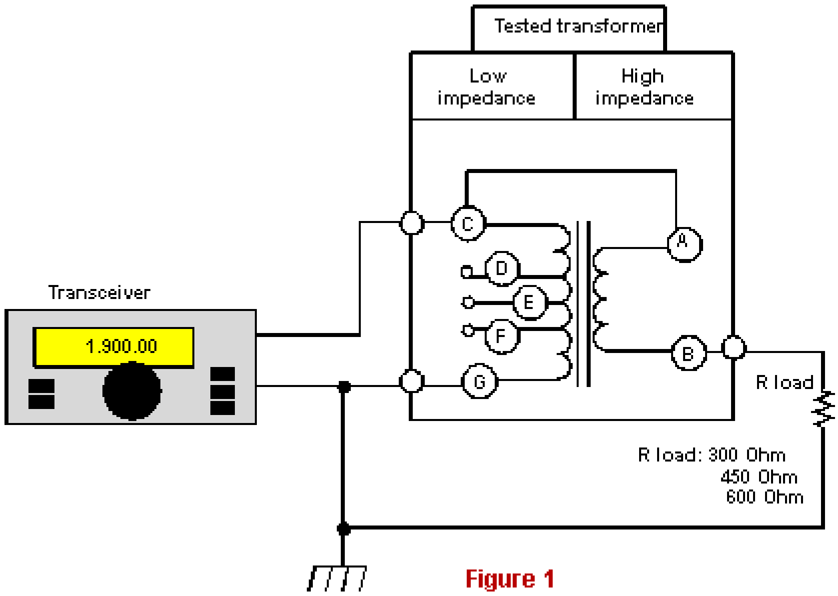


Figure 1

Table 1 RF - autotransformer loaded to 300 Ohms

Frequency, MHz	1.9	3.7	7.1	10.1	14.2
Input resistance, Ohms	80	60	45	40	35
VSWR relative to 50 Ohms	1:1.53	1:1.15	1:1.16	1:1.31	1:1.49
VSWR relative to 75 Ohms	1:1.07	1:1.25	1:1.67	1:1.88	1:2.15
Efficiency, %	76	62	46	28	8

Table 2 RF - autotransformer loaded to 450 Ohms

Frequency, MHz	1.9	3.7	7.1	10.1	14.2
Input resistance, Ohms	100	65	30	25	20
VSWR relative to 50 Ohms	1:1.92	1:1.25	1:1.74	1:2	1:2.61
VSWR relative to 75 Ohms	1:1.33	1:1.16	1:2.51	1:3.01	1:3.76
Efficiency, %	67	69	60	45	12

Table 3 RF - autotransformer loaded to 600 Ohms

Frequency, MHz	1.9	3.7	7.1	10.1	14.2
Input resistance, Ohms	110	70	18	15	8
VSWR relative to 50 Ohms	1:2.11	1:1.34	1:2.9	1:3.48	1:6.53
VSWR relative to 75 Ohms	1:1.46	1:1.08	1:4.18	1:5.01	1:9.4
Efficiency, %	61	87	65	52	12

Using data from **Tab. 1- 3**, I made diagrams for three transformer's loads – 300, 450 and 600 Ohms. The diagrams show:

- An input resistance vs. frequency (**Fig. 2**),
- A VSWR relative to 50 Ohms vs. frequency (**Fig. 3**),
- A VSWR relative to 75 Ohms vs. frequency (**Fig. 4**),
- The efficiency vs. frequency (**Fig. 5**).

As it was mentioned above, the efficiency is the most important parameter of any RF transformer. The RF autotransformer has a high efficiency (87 percent) only on a range of 160 meters while this one is loaded to 600 Ohms. The efficiency falls sharply on other amateur HF ranges.

As for a range of 40 meters the RF autotransformer has the efficiency of 65-35 percent (it depends on the transformer's load). As for a range of 30 meters the RF autotransformer has the efficiency of 52 and 45 percent while this one is accordingly loaded to 600 and 450 Ohms. The efficiency is more in comparison with RF- transformers shown in **Fig. 3** and **7, Part- I**. Alas, while the autotransformer has a high efficiency, it has a low input resistance and accordingly, a high VSWR! Therefore it is impossible to use a 50 or 75-Ohm coaxial cable together with the autotransformer.

An input resistance vs. frequency

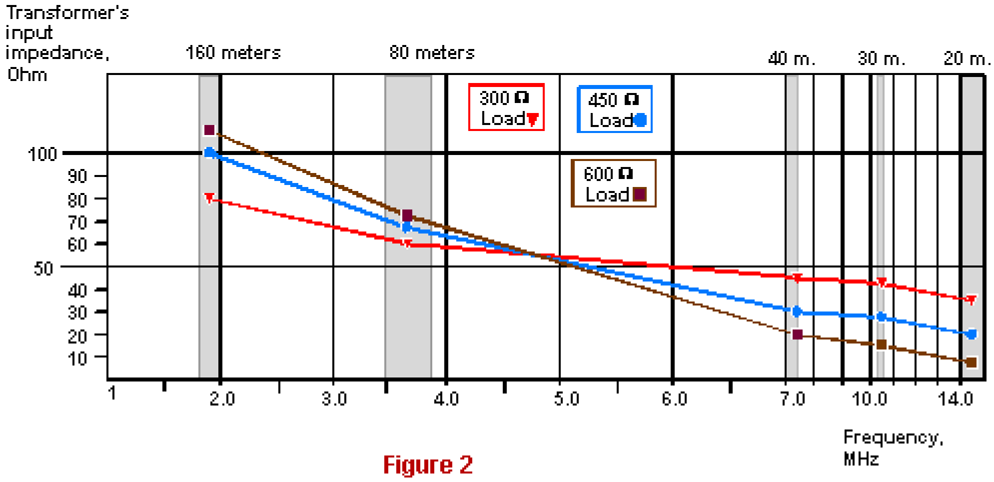


Figure 2

VSWR relative to 50 Ohms vs. frequency

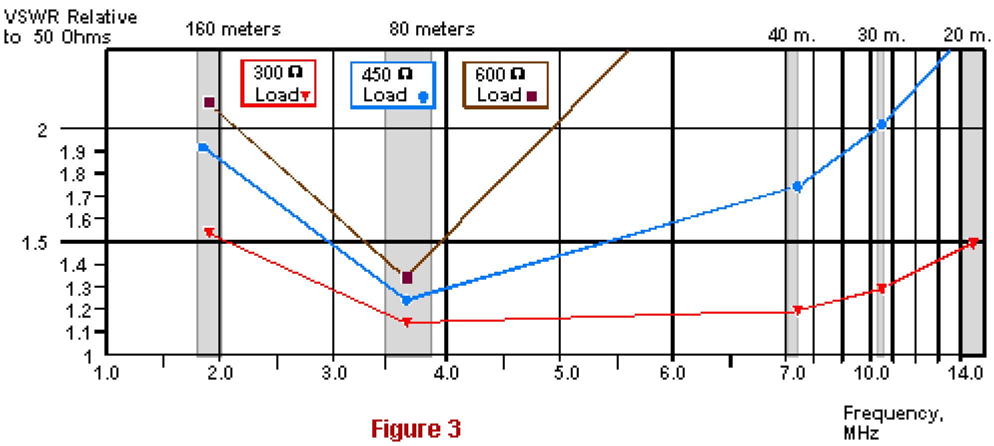


Figure 3

VSWR relative to 75 Ohms vs. frequency

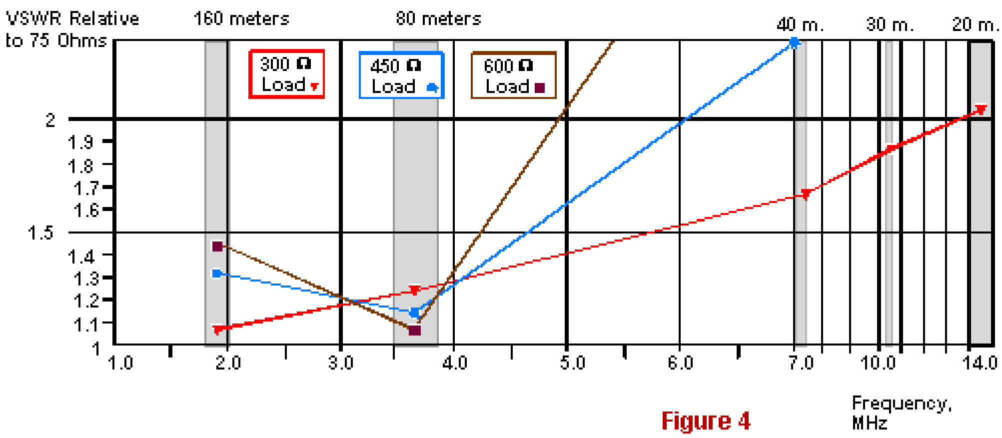


Figure 4

Conclusion for the connection shown in Fig. 1: The autotransformer can be used in a transmission and reception mode on a range of 80 meters while this one loaded to 600 Ohms. (An antenna Beverage or T2FD can be such a load.) The autotransformer should be used with a 75-Ohm coaxial cable. The maximum of the RF power going to the transformer must be limited to 50 watts.

The efficiency vs. frequency

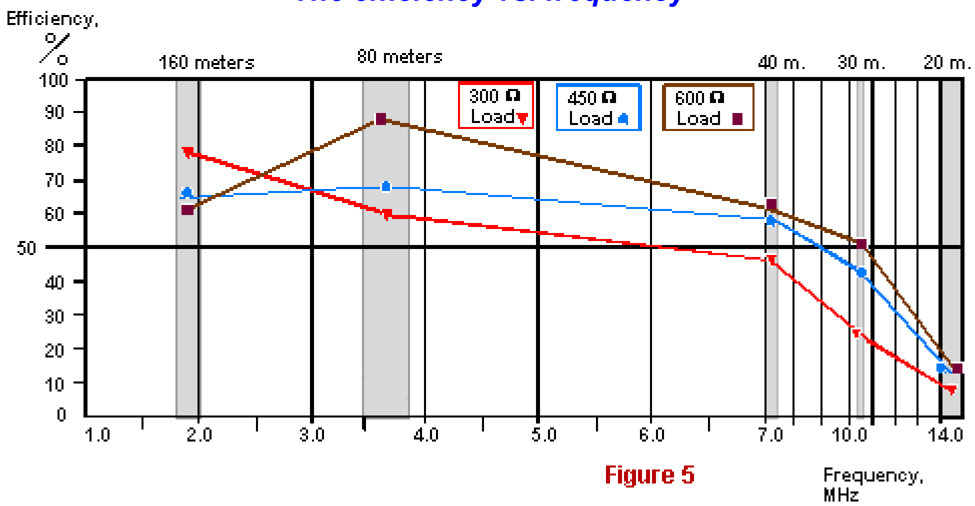


Figure 5

On ranges of 160 -80 meters it is possible to use the autotransformer only for a reception mode with the transformer loaded to 450 or 600 Ohms and its primary winding is connected to a 75-Ohm coaxial cable. On ranges of 160 -40 meters it is possible to use the autotransformer only for a reception mode with the transformer loaded to 300 Ohms and its primary winding is connected to a 50-Ohm coaxial cable.

Note: Do not use the transformer without a load! It causes a high VSWR and damage to the transformer. If the transformer is used outside it should be protected against atmospheric influences. It is possible to use an egg from a sweet – surprise "Chupa - Chups" for such a protection.

One more application - An RF ammeter

I found one more useful application for AT-33T transformer. This one was turned to **a current transform for an RF ammeter.** You need to add only a current loop to AT-33T transformer and this one will be a current transformer for an RF ammeter. The current loop (or a current winding) contains only one turn of a wire placed on a cheek of transformer's core (see **Fig. 6**). There was used a copper wire of 0.8 mm in diameter/# 20 AWG.

I found that the 24 volt winding (**Fig. 7A**) as well as the inverter's winding (**Fig. 7B**) works as well as the meter's winding. A germanium diode was used in an RF detector at the meter's winding. A d.c. meter had a 1mA full scale deflection and 140-Ohm resistance. To verify the work of the RF ammeter made on the base of AT-33T transformer I connected it in serial with a control ammeter. **Fig. 8** shows the circuit. **Note:** A control ammeter was a home brew RF ammeter designed by the reference **[1]**. The RF ammeter was calibrated with the help of a standard measuring equipment.

Tab. 4 contains testing data for the RF ammeter shown in **Fig. 8.** Using data from **Tab. 4** I made diagrams "meter reading vs. frequency" to the 24 volt winding and to the inverter's winding (see **Fig. 9**). The curve shows that the inverter's winding (**A- B**) is the optimal winding for application in the RF ammeter made on the base of AT-33T transformer.

Current loop on the transformer side

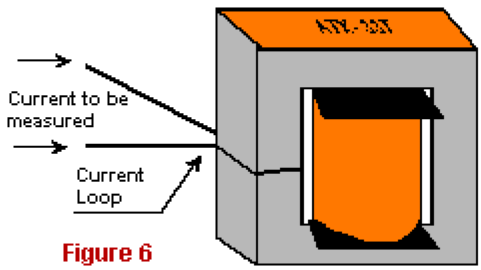
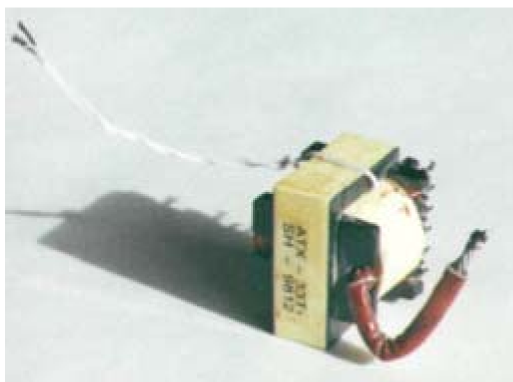
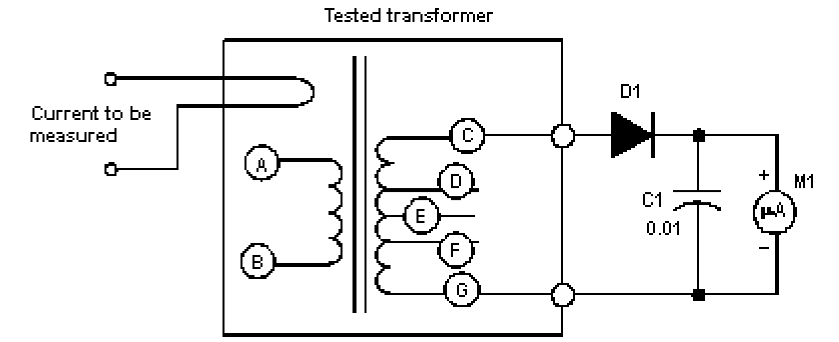


Figure 6

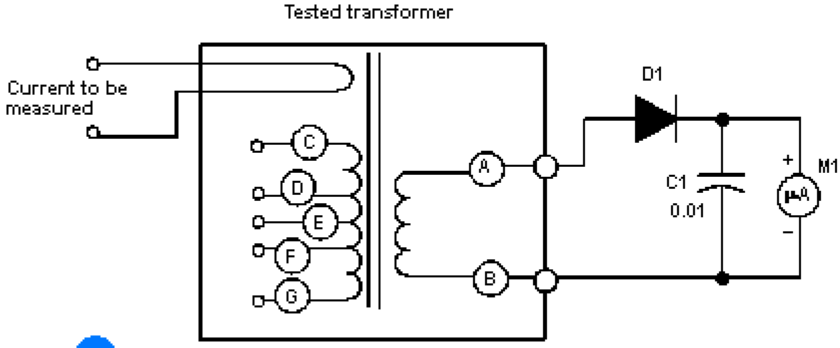
Current loop on the transformer side



Schematic diagram of the current transformer



A Figure 7 D1- RF - diode, germanium, 1N34A, 1N82A
M1- DC - μ ammeter, 0-1000 μA



B Figure 7 D1- RF - diode, germanium, 1N34A, 1N82A
M1- DC - μ ammeter, 0-1000 μA

Circuit for testing of the RF ammeter

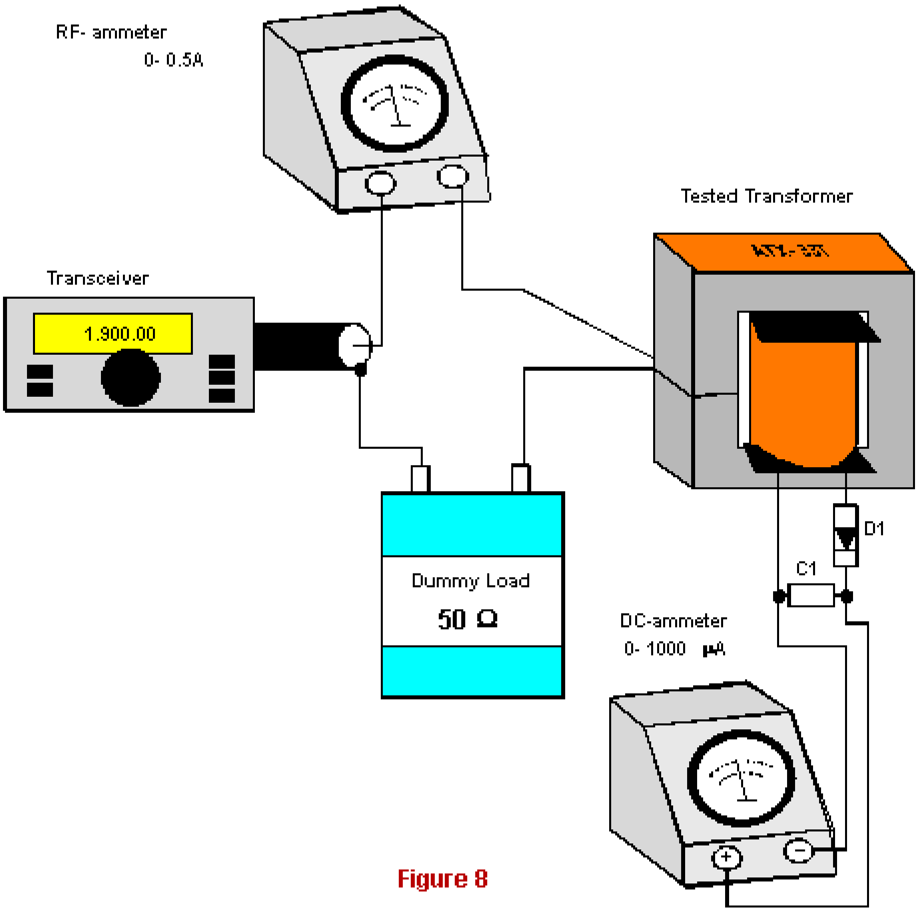


Figure 8

Table 4 Data for the 24 volts winding and for inverter's winding

Frequency, MHz	1.9	2.0	2.3	2.5	2.8	3.0	3.4	3.7	4.2	5.0	6.2	7.1	10.0	14.2
24-V winding, Meter reading, µA	1000	900	750	700	660	580	500	410	250	160	80	80	60	15
Inverter's winding, Meter reading, µA	700	680	660	650	630	600	550	520	500	420	380	380	280	120

Note: The RF current through a current loop is constant on all frequencies and equals to 0.26A

Meter reading vs. frequency

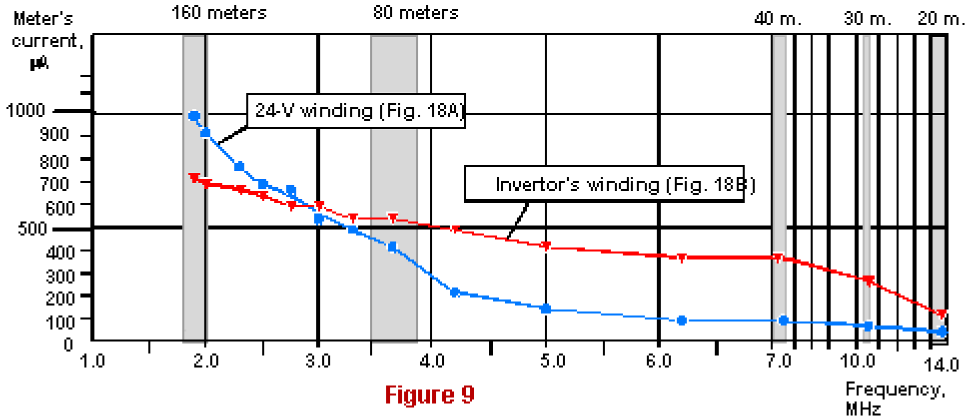


Figure 9

Linear RF ammeter

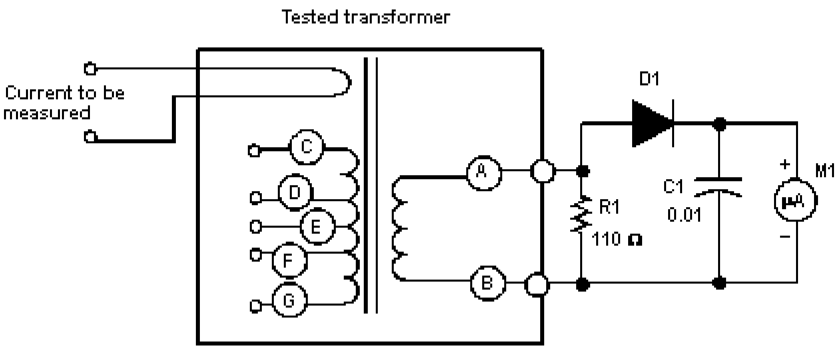


Figure 10

D1- RF - diode, germanium, 1N34A, 1N82A
M1- DC - µ ammeter, 0-100 µA

The RF ammeter has two drawbacks. Firstly, it works on a limited frequency range, to 7 MHz for my test. Secondly, the RF ammeter is too frequency dependent. I eliminated these defects to a certain extent. A low- resistance resistor R1 bridged to the meter's winding reduces the frequency dependence and extends the frequency range. **Fig. 10** shows the circuit for the "linear" RF ammeter. A germanium diode was used in the RF detector of the "linear" RF ammeter. A d.c. meter had a 100μA full scale deflection and 320-Ohm resistance.

I picked up a value of the R1 that while at 1.5 MHz the control RF ammeter showed the RF current of 0.1A the detector's meter had a full-scale deflection of 100μA. R1 had 110 Ohms in this case. All other measurements were made at RF current of 0.1A and R1 of 110 Ohms. Data for the measurements are shown in **Tab. 5**. Using data from this table I constructed diagrams "meter reading vs. frequency" (see **Fig. 11**).

Table 5 Linear RF ammeter

Frequency, MHz	1.5	3.0	3.6	7.0	10.0	14.2
Meter reading, μA	100	95	93	90	90	50

Note: The RF current through a current loop is constant on all frequencies and equals to 0.1A

Fig. 11 shows that the RF ammeter (**Fig. 10**) provides almost linear measurement of the RF current on ranges of 160- 30 meters. It is possible to expand the measuring range of the RF ammeter with the help of a variable resistor connected in serial with the d.c. meter. **Fig. 12** shows such a RF ammeter with an expanded scale.

Meter reading vs. frequency

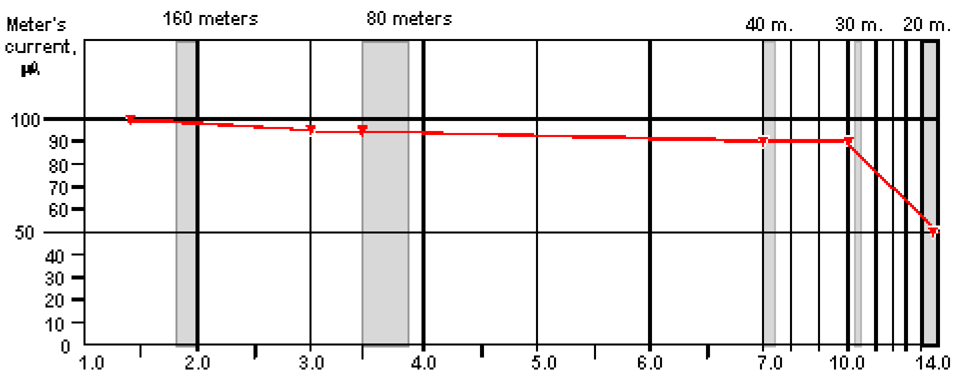


Figure 11

RF ammeter with an expanded scale

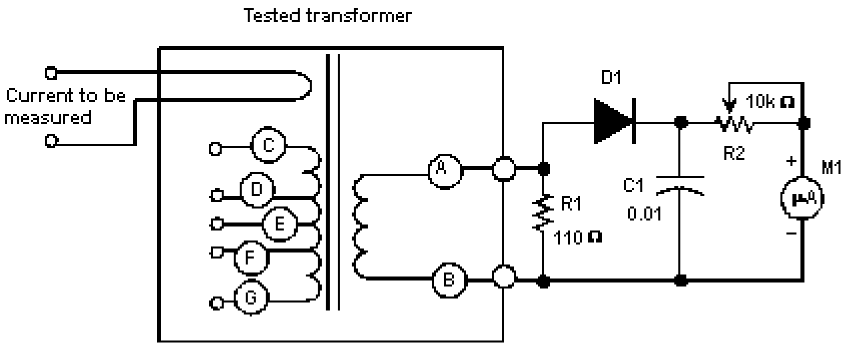


Figure 12

D1- RF - diode, germanium, 1N34A, 1N82A
M1- DC - μ ammeter, 0-100 μA

Conclusion: It is possible to use AT-33T transformer in design of an RF ammeter. However, large dimensions of AT-33T transformer and the limited frequency range of an RF ammeter made on its base are the drawbacks of its application.

If you want the RF ammeter to work linearly on 160 - 30 meters use circuits given in **Fig. 11 –12.** The drawback of these circuits is that an expensive d.c. micro - ammeter of a 100μA full- scale deflection is used there.

If you need an RF ammeter for only one amateur range of 160, 80 or 40 meters, or you do not need linearity from your RF ammeter while this one is working on these ranges, use the circuit given in **Fig. 7.** In this case an inexpensive micro-ammeter with a 1000μA full- scale deflection will do well.

SUPPLEMENTARY,

….or several words about my researches of the AT-33T- transformer….

Researches the opportunity

Fig. 13 3 shows the measurement circuit for researches the opportunity. The primary winding (**A - B** in **Fig. 3**) was loaded to 300, 450, 600 Ohms. Using different ways the secondary winding (**C- G** in **Fig. 13)** was connected to my home brew RF-bridge (this one was described in the reference **[1]**). My transceiver K-116 fed the RF-bridge. I made a lot of experiments and a lot of data for using of the ATX-33T by way of an RF transformer were obtained. Most interesting data will show below.

Measurement circuit

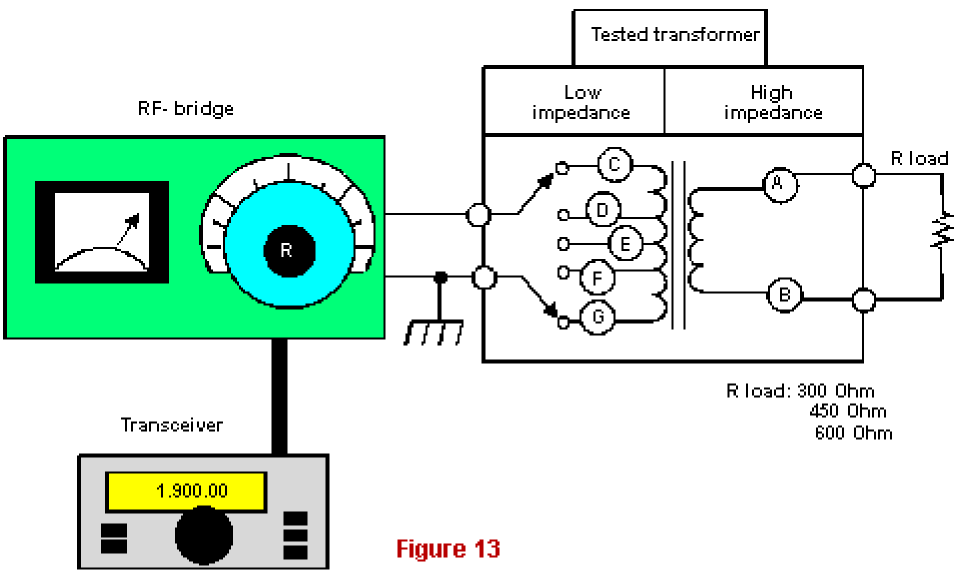


Figure 13

Efficiency is the first

However, what about an RF transformer has own input resistance close to 50 Ohms, when it loaded to 300-600 Ohms? It cannot serve as a final confirmation about its suitability for transfer an RF energy. Any RF transformer should have a good ***efficiency***. Efficiency (Eff) is relation of a power, which transformer's load is dissipated (P_1), to a power going from a transmitter to the transformer (P_2). We can write the formula as:

$$Eff = P_1/P_2,$$

Thus I took an important attention to measuring of the efficiency. I used only one circuit (see **Fig. 13**) for measurement of an input resistance, but I used three different circuits for metering of the efficiency! Each of the circuits gave own metering error, and demanded specific measuring devices. I want to write about all of the three circuits, because, they can be useful to hams who wants to do own experiments with other types of PSU transformers.

Fixing of the efficiency with the help of RF-ammeters

Fig. 14 shows very obvious and simple circuit for "current" method of measurement of the efficiency. Both RF currents, going to the transformer and to the load, were metered. I metered the RF currents by self-made RF ammeters (the RF ammeters were described in reference **[1]**, pp. 21-22, 27- 31). When the RF currents are fixed, it is possible to find the efficiency of the RF transformer. The efficiency (Eff) is equal:

$Eff = P_1/P_2,$

Where:

P_1- a dissipated power by the load,
P_2 - a consumed power by the transformer.

P1 and P2 are equal:

$$P_1 = I^2R,$$

$$P_2 = It^2Rt,$$

Where:
I - a current going to transformer load,
It - a current going to the transformer from a transmitter,
R – the transformer's load resistance,
Rt – an input resistance of the transformer.
Here **P** is in watts, **V**, **I**, **R** are in volts, amperes and ohms.

Finding the efficiency by means of metering of RF currents

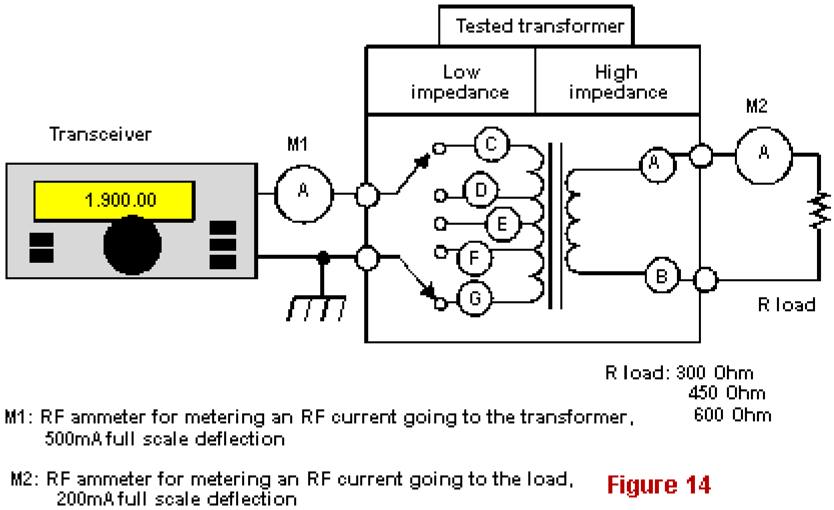


Figure 14

A transformer load resistance is known. Transformer's input resistance was early obtained by the circuit shown in **Fig. 13**. Thereby it is easy to find the efficiency. **Note:** The efficiency of the transformer was defined when a RF power of 10 watts gone to the transformer.

Instead of this it is possible to use another method.

Fixing of the efficiency with the help of RF-voltmeters

It is very easy to find the efficiency using the circuit shown on **Fig. 14.** However, RF ammeters are not widely used in a ham practice, on other hand RF voltmeters are common used devices. As result of this many hams would prefer to find the efficiency using only RF voltmeters. The "voltage" method is shown in **Fig. 15**. I used several RF voltmeters for my experimenters. One RF voltmeter was a commercial made Russian RF voltmeter, model VC-7 -4. Others voltmeters were home made, the reference **[1]** shows its circuits. I used a commercial made Russian oscilloscope model N-3015 like an RF voltmeter for several experimenters. Remember an oscilloscope shows a peak – to peak (p-p) value of RF voltage, the RF Vrms (root – mean – square) is root square from V p-p. Certainly, usually an oscilloscope has much more metering error then a good RF voltmeter.

It is possible to find the efficiency of the RF transformer when both RF voltages, one at a transformer load another at the primary winding, are fixed. The efficiency (Eff) is equal:

$$Eff = P_1/P_2,$$

Where:

P_1- a dissipated power by the load,
P_2 - a consumed power by the transformer.

P_1 and P_2 are equal:

$$P_1 = V_1^2/R;$$

$$P_2 = V_2^2/Rt,$$

Where:

V_1 – an RF voltage across a transformer load,
V_2 - an RF voltage across the primary winding of an RF transformer,
Rt – an input resistance of an RF transformer,
R – a resistance of a transformer load.

Where:

P_1- a dissipated power by the load,
P_2 - a consumed power by the transformer.

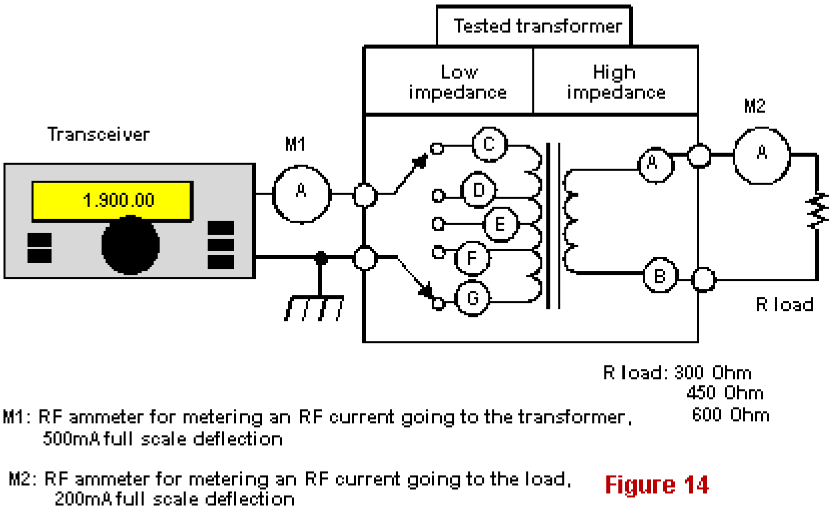
P1 and P2 are equal:

$$P_1 = I^2R,$$

$$P_2 = It^2Rt,$$

Where:
I - a current going to transformer load,
It - a current going to the transformer from a transmitter,
R – the transformer's load resistance,
Rt – an input resistance of the transformer.
Here **P** is in watts, **V**, **I**, **R** are in volts, amperes and ohms.

Finding the efficiency by means of metering of RF currents



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$$P_1 = V_1^2/R;$$

$$P_2 = V_2^2/Rt,$$

Where:

V_1 – an RF voltage across a transformer load,
V_2 - an RF voltage across the primary winding of an RF transformer,
Rt – an input resistance of an RF transformer,
R – a resistance of a transformer load.

Finding the efficiency by RF voltages

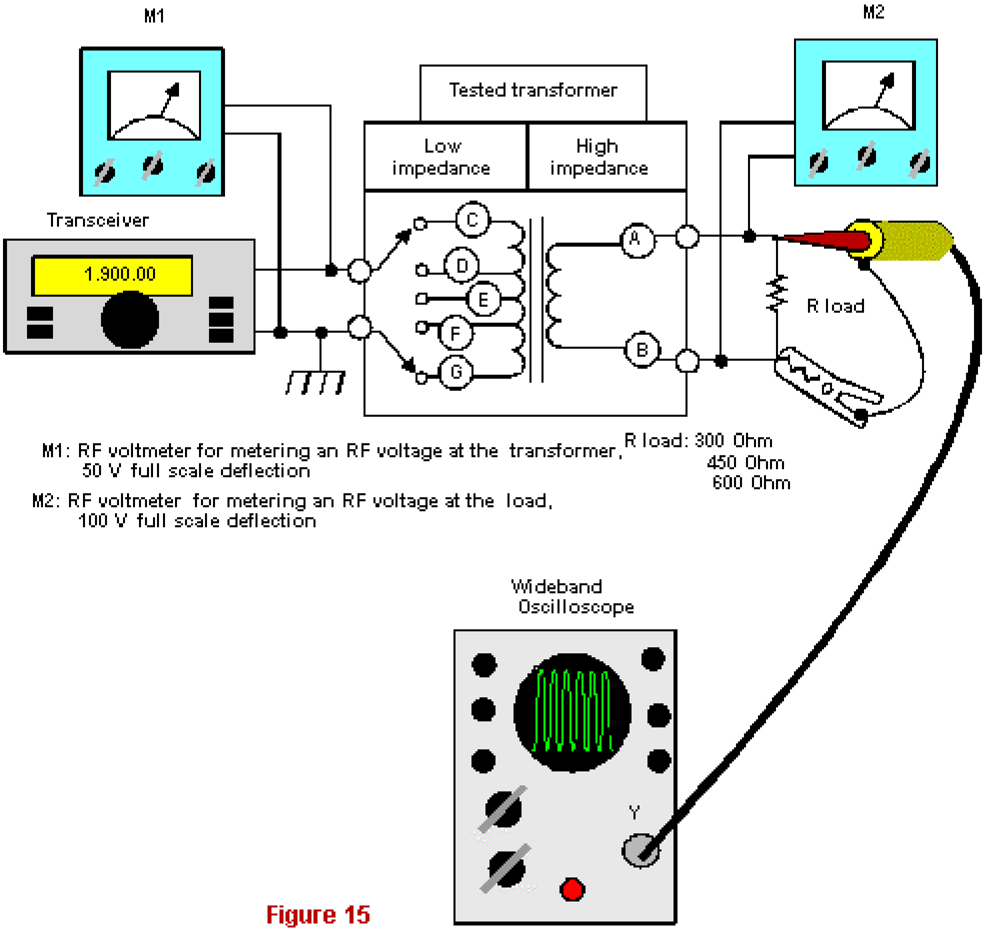

Figure 15

Here **P** is in watts, **V**, **I**, **R** are in volts, amperes and ohms. A transformer load resistance is known. Transformer's input resistance was early obtained by the circuit shown in **Fig. 13**. Thereby it is easy to find the efficiency. **Note:** The efficiency of the transformer was defined when a RF power of 10 watts gone to the transformer.

Both above described methods gave almost identical values of the efficiency for my RF transformer. However all the methods demanded special measuring RF equipment, such as an RF ammeter, an RF voltmeter or an RF oscilloscope. Not each of hams has the equipment. So I used one more method for finding of the efficiency. The method is named "a method of a poor ham", because it does not demand any RF measuring equipment!

"A method of a poor ham"

If a ham has not any special measuring RF equipment, he can use an indirect method for definition of the efficiency. **Fig. 16** shows the measuring scheme for the indirect method. The RF transformer is connected to a transmitter having a variable power. An incandescent bulb is bridged to the primary winding of the RF transformer. Other incandescent bulb is connected in serial with a load resistor at the load side. The bulb and the resistor form a load for the RF transformer.

I used incandescent bulbs of 26-V/0.12-A both at the primary winding side and at the load side. The common resistance (a serial resistor + a bulb) should provide one of standard load resistances - 300, 450 or 600 Ohms. **Tab. 6** shows needed values of the serial resistor for forming the standard load resistances. Columns of **Tab. 6** contain two values of the serial resistor. The upper value is a calculated value. The down value (in brackets) is the closest value of a standard resistance to the calculated value.

Note: The serial resistor was calculated under the hypothesis, that the incandescent bulb has 216 Ohms when 26 volts of RF is across this one (26 volts/0.12 amperes = 216.6 Ohms). Certainly, a bulb has a different resistance at the same value of direct or RF current through it, so, the bulb gives not the same shining at the same value of direct or RF current through it, but for our case the difference in the shining is very small.

Poor ham method of measuring of the efficiency

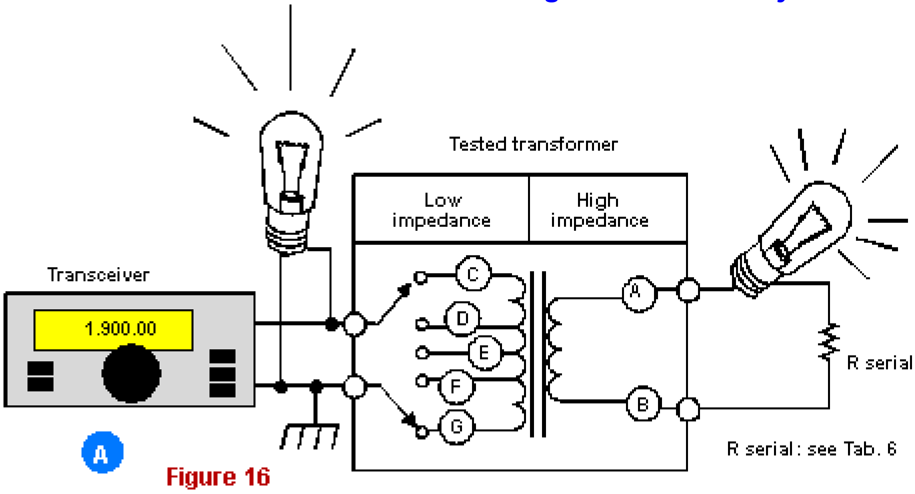

Figure 16

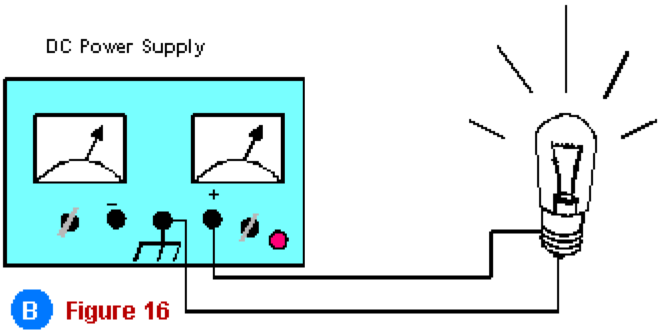

Figure 16

Table 6 Serial resistor and dissipated power at transformer's load

Load resistance, Ohms	300	450	600
Resistance of the serial resistor, Ohms	84 (75)	234 (220)	384 (390)
Dissipated power at transformer's load (the serial resistor plus the bulb), Watts	4.3	6.55	8.46

How to find the efficiency:

- A transmitter stands at a minimal RF power.
- Smoothly to increase the RF power of the transmitter.
- The load bulb should have the same glow like this one has at 26 volts d.c.
- In this case we make a decision, that, an RF voltage of 26 volts is acting across the bulb and an RF current of 0.12 amperes is going through the bulb. Hence it is possible to calculate a power, which is dissipated at transformer's load (the bulb plus the resistor). Use **Tab. 6** for this. The table shows a full power, which is dissipated at transformer's load at a full glow the incandescent bulb.

The first stage in definition of the efficiency of the RF transformer is completed. Go to the second stage. We should find going an RF power to the transformer.

- Take attention to the incandescent bulb, which is bridged to the input winding, and fix (at your memory) its glow.

- Then do this bulb connected to a variable d.c. PSU (see **Fig. 16B**).

- Smoothly to increase the d.c voltage up to the level, when the bulb has the same glow that this one has had at the RF current.
- Fix the d.c voltage on PSU's meter.
- In this case we make a decision, the d.c voltage has the same level like that RF voltage across the bulb.
- Hence it is possible to calculate going from the transmitter into the RF transformer power. The power is:

$$P = V^2/R,$$

Where: P- a power, going to the transformer,
V – an RF voltage across input winding,
R – a resistance of input winding.

We know both the dissipated power at the load and the power going into the input winding. So, it is possible to find the efficiency. Certainly, the indirect method gives us a big error. However it is a very simple method, and even a beginner radio amateur can do it.

Note: When the incandescent bulb at the input winding is glowing to its full brightness, the RF power, going to the RF transformer, is close to 10-15 watts. When the incandescent bulb at transformer's load is glowing to a full brightness, the dissipated RF power (in the load) is of 4-9 watts (see **Tab. 6**). Hence, using the indirect method, and at a full luminescence of load's bulb of 26V/0.12A, it is possible to find values of the efficiency in limits of 40-90 percents. To increase the limits, it need connect a resistor (either the same bulb) in serial together with the bulb at the input winding.

Reference:

1. Grigorov I.N.: Antenna. Matching and tuning.- Moscow, RadioSoft, 2002.
ISBN: 5- 93037- 087- 7

Good Bye Buran and Station "MIR" Good Fly in our Memory!