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**This page contains lots of material.
Expect a long, facinating read!**

THE REAL SWR PAGE!

Used with the kind permission of
Stephen C. Ward, WC7I

www.wc7i.com

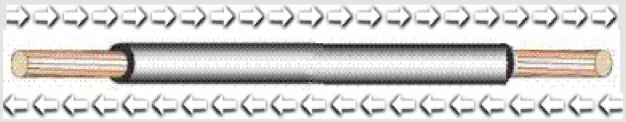
This page is in 2 parts, all about.......

**Part 1. Where the energy really goes in an antenna system.
Will a high SWR blow up my transmitter?
(No, it will not, but POOR TUNING can.)**

Part 2. Antenna SWR Should NOT measure 1:1 in Simple Antennas!

PART 1
---The Reflection Section---

The purpose of this section is to explain what happens when un-used energy comes back down the coax from the antenna.



(Center conductor only of coax shown)

Rf moves both ways in center conductor of coax!

Here are some simple truths that you probably knew before you got here, but when they are all put together, you will have 7 different things happening.

It is a little difficult to keep track of all 7 things that are happening, but this section will try to help you do that. Please go slow here. Take breaks if you would like to.

It helped me to draw diagrams of all this. Please feel free to stop and grab some paper to draw a diagram or two, or more.

This page is the most difficult page to understand of all the pages in this site. It uses high school algebra but I show you every move. Please feel free to skip all the math stuff, but please read the discussion parts so you can learn what is really going on.

The simple truths start here.

- Your SWR meter reads the reverse energy in a coax, and converts that number into a value called the "Standing Wave Ratio". That number has very little meaning. The value is when you convert that number back into what it measured in the first place, which is the percent of returning energy. That is why you need a SWR meter.

-

You should always use an antenna tuner. It goes near your rig, in the shack. Its duty is to match your antenna and coax to the impedance of your rig, not to change the SWR in the coax that goes from the antenna down to the antenna tuner. Many radios have tuners built in. Some tuners are automatic.

- Electrical energy moves forward and backward in a coaxial cable and in ladder line. (Everything I tell you about Coax is also true for ladder line, except that ladder line has far less loss.)

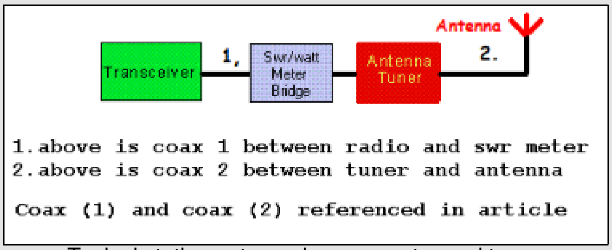
- Electrical energy moves forward because the generator (your rig) pushes it toward the antenna.

- It moves backwards because the antenna can not absorb all the energy, so the un-absorbed energy goes back down the coax. (The absorbed energy is converted into Electro-Magnetic energy and is transmitted out into space.)

- The reflected energy will be re-reflected when it reaches the tuner or the tuned circuit in the output stage of the transmitter. NO LOSSES happen at the reflection points, and your rig will not blow up because reflected energy got into the tuned circuit.

OK, nothing is perfect, and there will be a very very small amount of resistance in the coil and capacitor in the tuner which will create a very small loss, but it is truly tiny. (0.01 dB is a good estimate) This is absolutely true, Honest!

- There are usually two coaxial cables between the transmitter and the antenna.



Typical station setup using swr meter and tuner.
Note that everything between the transceiver and the "air" in drawing above is considered as your **"antenna system"** referenced later in the article.

Coax #1 in drawing above is usually quite short, and coax #2 is **far** longer because it goes from your desk (tuner) up to the antenna.

Controversy ahead.

The following information is absolutely correct, no matter what you have heard from your engineering professors or your favorite ham radio magazine.
I know you can read many articles that disagree with what I have written here, but I have some important people who agree with me.

The two most important people who agree with me are:

L. B. Cebik, W4RNL who has written many articles for the ARRL on transmission lines and antenna tuners.
http://www.cebik.com

and

M. Walt Maxwell, W2DU who has written the book "Reflections:Transmission Lines and Antennas". This book was

M. Walt Maxwell, W2DU who has written the book "Reflections:Transmission Lines and Antennas". This book was published by the ARRL.
See source for his book at bottom of article.

and while not a person, just as important. . . .

The ARRL Antenna Book, published by the ARRL.
(See a source for it at bottom or article)

Note from the author : This statement is not to imply that L. B. Cebik, W4RNL and M. Walt Maxwell, W2DU have read this web site and sent me a message telling me that they approve of what is written here. What it does mean is that nearly 100% of what is here comes from what they have written in books or on the internet. I did not create these thoughts, but I report them in as simple a manner as I can. Naturally, I agree with them and believe them to be absolutely correct.

The reason this is controversial is because so many people have been told a different story. When you hear any story over and over again, it becomes part of the "common knowledge" of the culture, and it tends to be considered the truth, even when it is clearly not true at all. That is what has happened here.

This is the last, but long, simple truth.

The antenna tuner adjusts the ***electrical length of the antenna and coax #2*** so that the reflected energy has the exactly correct phase to be re-reflected at the antenna tuner. When the tuner is correctly tuned, no energy gets back into coax #1. An SWR meter is usually placed into coax #1 as a tuning aid, to measure the reflected energy. *That meter will show an SWR of 1:1 when the reflected energy has been 100% re-reflected.*

Coax #2 still has reflected waves because of the mis-match between coax #2 and the antenna, but those reflections will be re-reflected at the tuner and they will add to the transmitter energy output. It may seem strange that the system is resonant and still has reflections due to mismatched impedance, but the coax and antenna are not the same impedance.

Actually, except for the losses in the coax, 100% of the energy that leaves the transmitter will be radiated out of the antenna, no matter how high the SWR, *because of the re-reflection.* A high SWR will create a higher loss in the coax because a higher amount of energy travels backwards in the coax. This energy going backwards is subject to the same losses as the forward moving energy.

The tuner provides a conjugate match (equal magnitude but opposite reactance) for the system from the antenna tuner, through coax #2, to the tip of the antenna ends. This makes the antenna appear to be resonant, and coax #2 becomes the correct electrical length for re-reflections to happen.

Many authors have stated that an antenna tuner tunes coax #1, but has no effect on coax #2 or the antenna. That is not a good explanation. A much better explanation is that when the antenna and coax #2 are tuned, the tuner can re-reflect the reflected energy from the antenna. That is one important reason reflected energy does not get into coax #1. The other reason is that since coax #2 is now without reactance at the matching point, the impedance of coax #1 (50 ohms) exactly matches the impedance of coax #2 (50 ohms) so no reflections happen at the front end of the tuner and all the transmitter energy gets through to the tuner and into coax #2.

happen at the front end of the tuner and all the transmitter energy gets through to the tuner and into coax #2.

This is a very sticky point. According to M. Walter Maxwell in his book Reflections:Transmission Lines and Antennas, published by the ARRL, on Page 13 - 4, he says " **The antenna tuner really does tune the antenna to resonance, in spite of opinions to the contrary of those who are unaware of the principles of conjugate matching. The tuner obtains a match, by which all reactances throughout the entire antenna system are canceled, including that of the off-resonant antenna, thereby tuning it to resonance."**

An even better way to describe what happens is to point out that the specific spot called the "matching point" is where the impedance is 50 Ohms with zero reactance and it exactly matches the impedance of coax #1 at that point. There is really no need to claim that coax #1 or coax #2 have been tuned, because it is the "matching point" that is connected to coax #1, not the complete length of coax #2.

Please be patient here. This explanation has lots of steps, and each one is critical to understanding what really happens in the coax of an antenna system that is not perfectly matched.

This is the end of the simple truths.
The explanations are below.

The antenna tuner can not change the SWR of your antenna, or its coax, so you will need to follow these 7 steps to see what actually happens with a higher SWR than the SWR meter in coax #1 says is there. The SWR meter is reporting on that very short connection between the tuner and the rig, **not the coax that goes between the tuner and the antenna**, but that is "where the action is."

There are 7 things you need to know. First, I will list the 7 things, and then each one will be explained in detail.

The reason this following information is not well known is because most people do not take the time to understand each step that follows.
Each step is easy if you go slow and draw things out on paper. You will gain quite a lot of understanding of what really happens to a signal in a coax if you go slow, and have patience. Do not read quickly. Do not continue on if even one little thing is not clear to you. You will be proud of yourself if you learn this.

1) Reflections happen at the coax - antenna connection and **they also happen at the coax - tuner connection.** The last part of this statement seems to be missing from most discussions of SWR and mis-matched conditions.
This is why a lot of people think that reflected power gets into the radio and does damage. **That does not happen!**
What does kill radios is at the bottom of this page!

2) These reflections do not cause energy loss. **All losses are due to the coax itself.**

3) Energy moving backwards in the coax is subject to the exact same losses as energy moving in the forward direction.

4) The amount of energy reflected at the coax - antenna connection depends on the amount of impedance mis-match (read SWR) between the antenna and the coax. The greater the mis-match, the greater the reflection.

5) The amount of energy re-reflected at the coax - tuner connection is 100% of the energy that gets there, but not all the energy that was originally reflected gets back to the coax - tuner connection. **There will be losses in the coax.** All the reflected energy that reaches the coax - tuner connection is re-reflected back into the coax headed for the antenna. (Yup, another lossy trip in the coax.

6) The re-reflected energy will be in phase with the generator so the two signals will add. This can create more forward power in the coax than the transmitter is actually producing. It is possible to measure 125 Watts forward power from a 100 Watt transmitter because the re-reflected power adds to the transmitter power.

7) Coax losses are the only losses in the whole system. These losses can be significant, but they are the ONLY losses in the antenna system. If you have been paying attention, you know that this last step is just a re-statement of other steps above.

Here come the details! Do not skip this section. It is full of math, but you can do it.

Use a calculator that has X^2 and square root functions.

- 1) Reflections happen at the coax - antenna connection, and again at the coax - tuner connection.

This means that energy will zoom up the coax between the antenna and the tuner and some of it will return down the coax. The "lost" energy is both lost in the coax, and radiated out into space by the antenna.

Another detail must be introduced here. Every time the signal is reflected (or re-reflected) a 180 degree phase shift happens to the current. This means that the current turns around and goes the other way, and it also turns upside down. Both things happen at the reflection points.

Let me say this again. In the case where the impedance of the antenna is greater than the impedance of the coax, [$Z_{Antenna} > Z_{coax}$] the reflected voltage will just turn around and go in the other direction, but the reflected current will become upside down as it also travels in reverse. This means that the forward voltage and reverse voltage are in phase with each other, but the forward current and reflected current are 180 degrees out of phase with each other. When the reverse (and upside down) current reaches the tuner, another 180 degree phase reversal and direction change will happen.

Now the re-reflected current is back in phase with the generator current, and the forward and reverse voltage are also in phase.This phase reversal is a good thing because it allows the forward and reverse current to ADD together when the re-reflection happens at the tuner.
Try drawing a picture of this. Be patient. Go slow.

2) These reflections do not cause energy loss.

Energy losses are caused by heating ($I^2 * R$) or radiation, but not by reflection. The law of conservation of energy tells us that what ever goes into a reflection will come out if there is no radiation and no heating.

3) Energy moving in a coax will have losses due to leakage and ($I^2 * R$) heating.

These losses are well documented by the companies that make the coax. One of my favorite places to find the losses in different kinds of coax is **http://www.kc7hxc.us/links/radio/Coax%20Calc/Coax%**

http://www.kc7hxc.us/links/radio/Coax%20Calc/Coax%20Calculator.html They have a calculator that will help you convert the dB losses into actual Watts for a better understanding of what is happening.

Follow the zig - zag path of power!
Here is an example of a typical coax with its typical loss in an antenna system with a SWR of 1.4 to 1. Go to the web site listed directly above and scroll down to the calculator. Press the little "down arrow" and pick Belden 9913 (RG-8). It is a high quality coax used by many amateurs. Do not change anything else yet. When you have chosen the Belden 9913 coax, press the "calculate" button.

Do it now.
If you have done this correctly, the calculator will tell you that Belden 9913 has a dB loss of only 0.388 dB and that calculates out to 91.461 Watts output from the coax if you put 100 Watts in to it.
Where did the rest of that power go?
It was lost to leakage inside the coax and to ($I^2 * R$) heating.

4) How much of that 91.461 Watts will be used by the antenna and how much will be reflected?
The reflection coefficient is a number that tells you the percentage of reflection at the antenna - coax connection. The symbol "p" is used to represent this reflection coefficient. The math is easy to do.

p = (SWR -1) / (SWR + 1)

We started by assuming that the SWR is 1.4 to 1. Use that 1.4 value to fill in the formula.

p = (1.4 - 1) / (1.4 + 1) = 0.4 / 2.4 = 0.166

The reflection coefficient is used for voltage, current, and when squared, it is used for power.
Since the reflection coefficient is 0.166 in this example, the voltage reflected will be 16.6% of what arrives from the generator, and the current reflected will also be 16.6% of what arrives from the generator. The power that is reflected will be the **square of the reflection coefficient.**

To find out how much power is reflected, you will need to use the following formula.

Reflected Power = p^2 times the Power available
Reflected Power = $(.166)^2$ times 91.461 Watts.
Reflected Power = (0.02775) Times 91.461 Watts
Reflected Power = 2.54 Watts

This means that 2.54 Watts of the forward power will be reflected back down the coax toward the tuner, and the rest (91.461 W - 2.54 W = 88.921 Watts) 88.921 Watts will be used by the antenna and be radiated into space.
===================================
Try drawing a picture of this. Be patient. Go slow.
Is it break time yet?
===================================
The power that reached the coax - antenna connection was 91.461 Watts and 97.25% of that power will be radiated into space, leaving 2.75% to be reflected back down the coax. Both of these percentages come from the Reflection Coefficient that has been squared.
(Reflection Coefficient)^2 = $(0.166)^2$ = .0275, which means that 2.75 % will be reflected.

Power used by the antenna = 100% - 2.75 % = 97.25%

How much power will be radiated by the antenna?
The antenna will radiate 88.921 Watts into space.
This number will get slightly larger after the reflected power is returned to the antenna, but for now, during the first cycle, only 88.921 Watts are transmitted.
How much power is headed toward the tuner?
Only 91.461 Watts was available at the antenna - coax connection, and 2.75 percent of that will be reflected back down the coax toward the tuner.
(91.461 Watts times 2.75% = 2.54 Watts) 2.54 Watts will be returned to the coax to go back to the tuner.
How much power gets to the tuner? **http://www.ocarc.ca/coax.htm**
We must use the calculator again. Put 2.54 Watts in the place of the 100 Watts just above the "calculate" button. Press the "calculate" button.
Do it now please.

Notice that 2.323 Watts gets to the tuner and the rest was lost to heat and leakage.

5) How much power is re-reflected at the tuner?
100 % of the reflected power that gets to the tuner will be re-reflected. In this case, the power that is re-reflected is 2.323 Watts. This 2.323 Watts now starts its way back to the antenna.
6) The re-reflected energy will be in phase with the generator so the two signals will add. [Note: If the two signals were not exactly in phase, the addition still happens, but the method is messy, and the result is not the same. This would be the case if the antenna was not exactly tuned to the operating frequency as it is in this example or if an antenna tuner was not correctly adjusted.]
The generator is producing 100 Watts and now it will have an additional 2.323 Watts added to it, for a total of 102.323 Watts heading for the antenna.

-

This is the official end of the first cycle of the generator. This first cycle started with a 100 Watt signal leaving the generator, but only 88.921 Watts was transmitted. The total loss so far due to heating and leakage was

(100W - 91.46 W = 8.55W) 8.55 Watts on the trip up to the antenna, and
(2.54 W - 2.32 W = 0.217 W) 0.217 Watts loss on the way back down the coax.
This makes a total of (8.55 W + 0.217 W = 8.76 W) 8.76 Watts actually lost in the form of heat and leakage.

There are still 2.32 Watts stored in the coax(and tuner) about to be added to the generator power.
All the power is accounted for. This is important because it helps you realize this explanation is correct.

That's a lot of information. What is the actual result ?
What's the Score?

Input Power -100 W
Loss of power going up the Coax- - - - - - - - - - - - - **8.55 W**
Power reaching the Antenna - - - - - - - - - - - - - - - 91.46 W
Power Radiated by the Antenna- - - - - - - - - - - - - 88.91 W

Reflected Power returned to the Coax- - - - - - - - - -2.54 W
Loss of Power going back down the Coax - - - - - - **0.217 W**
Power that arrives at the Tuner - - - - - - - - - - - - - - 2.32 W
Radiated power eventually evens out to?- - - - - - - - - 91 W.
(after about 5 cycles)

This shows where the power is lost, and what is radiated. This is far too much information, but it is necessary to tell the whole story truthfully.
As you know, this is only the first cycle.

Make a diagram of all this information so you can see where all these numbers fit in. That will help you understand this.

The power that is still in the coax (and tuner) will add to the generator power which will add a little to the output and add to the losses. This will continue for a few cycles until the system settles out to finally produce 91 Watts radiated power.

Finally, take a look at what happens when the SWR is high and what happens when the coax loss is great.

First, lets look at what happens when the SWR is high (SWR = 3) compared to low, 1.4 in the chaart below.
This uses the same 50 ohm coax as before.

	SWR =1.4	**SWR= 3.0**
Input Power	**100W**	**100 W**
Loss of power going up Coax	**8.55W**	**8.55W**
Power reaching Antenna	**91.46W**	**91.46W**
Power Radiated by Antenna	**88.91W**	**68.59W**
Reflected Power returned to coax	**2.6W**	**22.86W**
Loss of Power back down coax	**0.217W**	**1.95W**
Power that arrives at tuner	**2.32W**	**20.9W**
Radiated power eventually settles out at >	**91W**	**86.7W**

Even when there is a high SWR as in the chart above,
the final power output is nearly the same.

-

SWR is not a killer at all.

This example below uses the same SWR = 1.4, as in the example above, but the COAX now has a loss of 2.5 dB using (Belden 8216) which is Rg - 174 compared with much better Belden 9913

Belden 9913 Belden 8216
Coax loss = .388 dB Coax loss =
2.5dB
Input Power- -100
W 100 W
Loss of power going up the Coax- - - - - - - - - - - - - - **8.55 W** **43.7**
W
Power reaching the Antenna - - - - - - - - - - - - - - - - 91.46 W 56.2
W
Power Radiated by the Antenna- - - - - - - - - - - - - - -88.91 W 54.6
W
Reflected Power returned to the Coax- - - - - - - - - - - 2.54 W 1.56
W

W
Loss of Power going back down the Coax- - - - - - - - **0.217 W** **0.68 W**
Power that arrives at the Tuner- - - - - - - - - - - - - - - - 2.32 W .87 W
Radiated power eventually settles out at- - - - - - - - - - 91 W **55.1 W**

These losses are terrible! The coax losses have ruined the output power!!

- Finally we have come to the very last subject on this page.

So, why do people think they can blow up their rigs or linear amplifiers when there is a high SWR on the antenna?

Because that can happen, but it is not due to the reflected power!
There is a totally different reason.
A high SWR on an antenna probably means that the antenna is not tuned to the frequency that is being used. This, in turn, means that the antenna has some inductive or capacitive reactance that is de-tuning the final amplifier. De-tuned final amplifiers draw far too much current and can burn up. The rig or linear amplifier will have to be re-tuned to avoid creating too much heat.
Many linears and nearly all tube amplifiers have some tuning knobs that allow you to "dip the plate current" or adjust the SWR by adjusting something on the front of the device.
Transistor rigs usually do not have any tuning adjustments. To avoid the extra heat created when running a de-tuned amplifier, there is a protection circuit that will significantly reduce the output power if the SWR is high.

The conclusion section.

Finally we are at the conclusion section. I hope you have seen that . . . . .

- High SWR at the transmitter can ruin that rig because the final amplifier is de-tuned. Using an antenna tuner will tune the rig back to where it should be.
- High SWR at the antenna will not significantly reduce your power (if you are using an antenna tuner)

unless:
• you are not using a tuner and

• there is a circuit inside the rig that shuts down power when it sees a high SWR.

- High loss coax can really reduce your output power. A coax with a 3 dB loss will suck up half the power, allowing the antenna to radiate the other half.

End of part 1.

Part 2

Antenna SWR

Have you ever measured the SWR of a simple antenna?

Have you ever measured the SWR of a simple antenna?

It should NOT have been 1:1

Lots of people think that a good antenna should have a 1:1 SWR as measured by an antenna analyzer. That is just not true, and this article will explain why.

We need to look at what SWR means, and how an "antenna system" is different from a simple antenna.

Unfortunately, we need some 6th grade mathematics for this explanation. I will do the math, you can just read. OK, you can do the math with me if you like.

One way to find SWR is to make a fraction of the coax and load impedance. There are other ways that work well also, but this is really simple.

SWR is really a simple fraction that puts the larger impedance in the top of the fraction, and the smaller impedance in the bottom of the fraction.

It is done this way so the answer is always equal to, or greater than, 1.

Let's try this to see what I mean. Assume that you have a 50 ohm coax and a 72 ohm dipole antenna as a load. Write the larger number on top, which in this case is the 72 ohms.

SWR =72/50 = 1.44 which means the SWR is 1.44:1

Lets try this again using a 36 ohm vertical antenna with at least three un-grounded radials.

Remember to put the 50 ohms on top this time. (50 is larger than 36)

SWR = 50/36= 1.389 which means the SWR is 1.389:1

OK, lets stop right here and look at the results. Both answers are almost 1.4:1 but notice that neither answer is 1.0 :1. This is the whole point of this article. Antennas do not have a SWR of 1:1.

Since you now know the whole point of this article, you might think, "Why should I read the rest of this article?" The reason is to learn more, and see how to use this information.

The numbers that I picked for the characteristic impedance for the two types of antennas are actually real, and correct numbers that are found with these types of antennas. Nearly every single wire resonant dipole has an impedance of 72 ohms. Nearly every resonant vertical antenna with 3 or more un-grounded radials has 36 ohms.

The conclusion here is that these antennas have an SWR of 1.4:1 when correctly made.

Let me say that again....they do NOT have a SWR of 1:1. They are NOT supposed to have an SWR of 1:1. They ARE supposed to have an SWR of 1.4 :1.

Does it seem to you that I am getting really excited about this? Yes, I am.

Why do I make such a big deal out of this?

Because many amateurs think they have heard that antennas should have an

Because many amateurs think they have heard that antennas should have an SWR of 1:1.

What they have most likely heard is that an antenna system should have an SWR of 1:1.

I will deal with the idea of the antenna system in a minute, but before I do, it seems like a good place to tell you that there is a type of antenna that has a characteristic impedance of 50 ohms. The ground plane vertical antenna with 3 or more drooping (at 45 degrees) un-grounded radials can have a characteristic impedance of 50 ohms, BUT that is only true for the one frequency where that antenna is resonant. If you ever change frequency, the impedance of that antenna will also change which will change that SWR from 1:1 to some higher value.

Antenna systems **(Remember these words!)**

It is true that an "antenna system" should have a 1:1 SWR. An antenna system includes all the stuff that goes between the output of the rig and the tips of the antenna. Usually that includes the short coax that leaves the rig, the SWR meter, the antenna tuner, the long coax that goes up to the antenna, and the antenna itself.

That 1:1 SWR is measured just after the signal leaves the rig, so the 1:1 SWR is located in that short coax between the rig and the SWR meter. The antenna tuner is responsible for making the antenna system resonant and creates a 50 ohm impedance at the connection at the rig.

That short coax is the only place where the SWR is 1:1, and it is the only place where it needs to be 1:1. That is the place where the 50 ohm rig attaches to the 50 ohm coax. All the rest of the antenna system will have a higher SWR.

Please remember that the impedance of the long coax will not match the impedance of the antenna. The connection between the long coax and the antenna will NOT have a SWR of 1:1.

Where can I use this information?

The place where this is most useful is for amateurs who use vertical antennas with grounded radials. I have heard several hams say "I only need 2 radials for a 1:1 SWR on my grounded vertical antenna!"

First, please note that a 1:1 SWR means the antenna has 50 ohms of impedance. A vertical is supposed to have 36 ohms of impedance.

Here are some questions that need to be asked.....

Where did those extra 14 ohms come from?

The most likely place is in the ground system where only 2 radials are working.

What effect do those extra 14 ohms have on the signal?

The 100 Watts of power that are delivered to the antenna system will be divided among each individual impedance.

How much power will the antenna get?

The total impedance is 50 ohms and the antenna impedance is 36 ohms so the antenna will receive the fraction of 36/50 times the full 100 Watts.

The total impedance is 50 ohms and the antenna impedance is 36 ohms so the antenna will receive the fraction of 36/50 times the full 100 Watts.

36/50 times 100 Watts = 72 Watts

How much power will the ground get?

The ground system will have 14 ohms in it, so the ground will receive 14/50 times the full 100 Watts.

14/50 times 100 Watts = 28 Watts.

Please notice that 28 Watts is being used to heat the ground. The worms may thank you for this kind gesture, but it seems like a waste to me. I would add some radials to this antenna to reduce the impedance. Let those worms wear coats to stay warm.

A grounded vertical antenna needs all the help it can get to be good antenna. Eight radials is not too many.

My choice would be to have the full 100 Watts be delivered through an antenna tuner into a 36 ohm antenna with a good ground system (meaning at least 8 radials). Adding more radials will reduce the impedance, and increase the SWR of the antenna, but that can be tuned away with an antenna tuner so the whole system is resonant and will have 50 ohms of system impedance right where the rig connects to the short coax.

Knowing what the antenna impedance should be (without having your antenna tuner on) is valuable so you will know if the impedance is wrong. You can find out if the impedance is wrong by temporarily removing the antenna tuner and measuring the antenna impedance with an antenna analyzer.

Now you know

1) Why an antenna should not have a 1:1 SWR.

2) Why it is important to know what the antenna impedance is.

3) That the system impedance should have a 1:1 SWR.

4) And while it was not the purpose of this article, now you know that a vertical antenna with grounded radials needs lots of radials.

5) Actually, I have never seen worms wear coats.

73, Steve, WC7I August 2009 for Hamuniverse.com

Feel free to visit wc7i.com for even more simple antenna ideas.

End of part 2! Know you know the answers to these questions:

Questions:
1. Will a high SWR blow up my transmitter?

2. What should the SWR of a simple antenna be?

Answers:
1. It should NOT have been 1:1

2. You will not blow up your transmitter!

NOW FIGURE OUT WHICH ANSWER GOES WITH THE QUESTIONS ABOVE!
(If you can't, you need to start over... and this time, read each word slower.
Stop skimming it as if your transmitter was about to blow up! It will wait for you!)

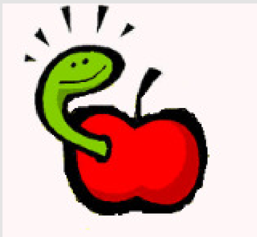
More good reading about SWR from QST:
"The SWR Obsession"
by Steve Ford, WB8IMY
QST Editor and Publications Manager of the ARRL
(This is a pdf file download) You'll need Adobe reader.

More info on SWR here.

A note from N4UJW at Hamuniverse.com:
In Steve's excellent, very informative article, there is lots of mention of the terms "antenna system", tuners, coax loss, etc.

*In my opinion, I don't believe his intention is to get you to run out and get a tuner at all costs just to get rid of that last little bit of swr. This article, in simple words, for those who still do not understand, means that as long as your radio is working into a properly tuned **"antenna system" designed for the output load requirements of the radio,** you should not worry about getting that unrealistic "perfect" 1:1 swr that you have heard so much about.*

*If you do show a "high" swr at the **output** of the radio greater than it can handle, either your connectors, feedline, or **anything** and **everything** between the swr meter and **including the antenna and it's surroundings** should be completely checked. This includes the inputs of your linear. If one or more of the parts of the total **antenna system** is "showing" the radio more or less than a 50 ohm load, then your modern transmitter will not put out it's maximum power! You will never get that "perfect" 1:1 swr unless you use a tuner due to losses in that non-perfect feed line that is 20 years old OR in that new coax due to small losses .... remember the "antenna system" performing at or near 100% effeciency **is your goal and...... your station!***
I also have never seen a worm wearing a coat, but here is proof of one wearing an apple!



"What is worse than finding a worm in your apple? Finding half a worm! WC7I"

Now go build yourself a good "antenna system"
and leave the worms alone!!!!!.....

Maxwell's book and the ARRL Antenna Book mentioned in article.