How to Set Up a Radio Station

By

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What are the primary characteristics of a good radio station setup?

The Outside Stuff

• Antennas
• Feedlines
• Antenna/Tower Ground
• Antenna Lightening Arrestors
• Station Ground
What are the primary characteristics of a good radio station setup?

The Inside Stuff

- Getting Antenna Feedlines and Grounds into the Radio Shack
- Station Ground
- AC Surge Protectors
- The Operating Table and Station Organization
The Outside Stuff
The Outside Stuff
Antennas
Antennas

• **The Antenna is the most important part of your radio station!!**

• There are many different kinds of antennas.

• The most common Ham Antennas are:
  - Dipole and Off-Center Fed Dipole or Windom
  - Beam or Yagi
  - Vertical
The Dipole Antenna

- The dipole is one of the simplest antennas there is to build
The Off-Center Fed Dipole or Windom Antenna

- You’ll notice the pulley and counterweight used to attach the antenna to the tree. The pulley and counterweight prevent the antenna wire from breaking when the tree sways with the wind.
The Beam or Yagi Antenna

This is a photo of my Cushcraft A-3S Tri-Bander Beam atop a US Towers MA40 Tower

The A-3S Beam is turned by A Ham IV Rotor

You can also see my 40 Meter Double Bazooka Antenna hanging in an Inverted V configuration.

A Double Bazooka Antenna is essentially a dipole made of coax instead of plain wire
The Vertical Antenna

• The Vertical Antenna is the most common type of mobile antenna.
What Antenna Should You Choose for Your Station?

- The type of antenna you should choose for your station depends on several variables:

  - What band(s) will you operate on? HF, VHF, or UHF?
  - What will be your primary operational goal? Local, DX, Contesting, Rag Chewing, Emergency Services, Etc.
  - How much space do you have for antennas?
  - Is there a need to conceal your antennas?
What Antenna Should You Choose for Your Station?

- DX and Contesting are typically done on the HF bands.
- HF antennas are larger and need considerably more room to erect than VHF or UHF antennas.
- Local and Emergency Services Communications are typically done on the VHF and UHF bands.
- Most mobile communication is done on the VHF and UHF bands.
- VHF and UHF antennas are significantly smaller than HF antennas and easier to hide from prying eyes.
- There is an article titled, “Choosing the Correct Antenna”, at http://www.marcspages.co.uk/tech/antchose.htm that may be of some help.
- There are many “Elmers” in this club that will gladly help you with your antenna selection. All you need to do is ask someone.
The Outside Stuff
Feedlines
Feedlines

• The feedline connects your radio to the antenna.

• All antennas, feedlines, and radios have a property called impedance.

• Most Ham Radios have an antenna connection impedance of 50 ohms.

• Most resonant antennas have an impedance of ~50 ohms.

• So, the feedline connected to the resonant antenna and the radio should also have an impedance of 50 ohms!
Feedlines

• The most commonly used feedline in amateur radio is coaxial cable or coax for short.

• The kind of coax you choose to use for your station depends primarily on three factors
  
  ➢ The highest frequency used
  
  ➢ The distance from your radio to the antenna
  
  ➢ The maximum amount of RF power you will use
Feedlines

- All coaxial cable has signal loss/attenuation

- Signal loss and attenuation are measured in dB.

- The larger the dB value the greater the loss.

- RG 58 has a higher loss rate than 9913/RG 8U.

- RG 58 is also much smaller in diameter than 9913/RG 8U

- So, RG 58 is okay to use for short coax runs like mobile installations because the loss is negligible in a short coax run.

- For longer coax runs or for high power 9913/RG 8U is a better choice than RG 58 because it has a lower loss rate and is a larger diameter wire.
### Feedlines

**Attenuation (dB per 100 feet)**

<table>
<thead>
<tr>
<th>Loss*</th>
<th>RG-174</th>
<th>RG-58</th>
<th>RG-8X</th>
<th>RG-213</th>
<th>RG-6</th>
<th>RG-11</th>
<th>RF-9914</th>
<th>RF-9913</th>
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<tbody>
<tr>
<td>1MHz</td>
<td>1.9dB</td>
<td>0.4dB</td>
<td>0.5dB</td>
<td>0.2dB</td>
<td>0.2dB</td>
<td>0.2dB</td>
<td>0.3dB</td>
<td>0.2dB</td>
</tr>
<tr>
<td>10MHz</td>
<td>3.3dB</td>
<td>1.4dB</td>
<td>1.0dB</td>
<td>0.6dB</td>
<td>0.6dB</td>
<td>0.4dB</td>
<td>0.5dB</td>
<td>0.4dB</td>
</tr>
<tr>
<td>50MHz</td>
<td>6.6dB</td>
<td>3.3dB</td>
<td>2.5dB</td>
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<td>1.4dB</td>
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<td>1.1dB</td>
<td>0.9dB</td>
</tr>
<tr>
<td>100MHz</td>
<td>8.9dB</td>
<td>4.9dB</td>
<td>3.6dB</td>
<td>2.2dB</td>
<td>2.0dB</td>
<td>1.6dB</td>
<td>1.5dB</td>
<td>1.4dB</td>
</tr>
<tr>
<td>200MHz</td>
<td>11.9dB</td>
<td>7.3dB</td>
<td>5.4dB</td>
<td>3.3dB</td>
<td>2.8dB</td>
<td>2.3dB</td>
<td>2.0dB</td>
<td>1.8dB</td>
</tr>
<tr>
<td>400MHz</td>
<td>17.3B</td>
<td>11.2dB</td>
<td>7.9dB</td>
<td>4.8dB</td>
<td>4.3dB</td>
<td>3.5dB</td>
<td>2.9dB</td>
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<tr>
<td>700MHz</td>
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<td>16.9dB</td>
<td>11.0dB</td>
<td>6.6dB</td>
<td>5.6dB</td>
<td>4.7dB</td>
<td>3.8dB</td>
<td>3.6dB</td>
</tr>
<tr>
<td>900MHz</td>
<td>27.9B</td>
<td>20.1dB</td>
<td>12.6dB</td>
<td>7.7dB</td>
<td>6.0dB</td>
<td>5.4dB</td>
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<td>1GHz</td>
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<td>6.1dB</td>
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<tr>
<td>Imped</td>
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<td>50ohm</td>
<td>50ohm</td>
<td>50ohm</td>
<td>75ohm</td>
<td>75ohm</td>
<td>50ohm</td>
<td>50ohm</td>
</tr>
</tbody>
</table>

*Note: Coax losses shown above are for 100 feet lengths. Loss is a length multiplier, so a 200 ft length would have twice the loss shown above and a 50 ft length would have half the loss. This multiplier factor is why you should keep cable installation lengths between radios and antennas as short as practical!
The Outside Stuff

Antenna/Tower Ground
Antenna/Tower Earth Ground

• All fixed base antennas need to be earth grounded through a lightening arrestor!

• Earth ground is the antenna’s and tower’s ONLY protection against lightening strikes.
Antenna/Tower Earth Ground

The tower mounting bolts are encased in concrete. No part of the steel tower touches Earth Ground directly. Therefore, there is no danger of galvanic erosion of the tower steel from being connected to a copper ground rod.
The Outside Stuff
Lightening Arrestors

Coaxial Lighting Surge Protector

DC-500MHz  50 ohm  400W
VSWR: LESS THAN 1.1:1 1000MHz
LESS THAN 1.3:1 1500MHz
Insertion Loss: LESS THAN 0.1 dB
Discharge Voltage: DC350V

Grounding
Antenna Lightening Arrestors

A properly installed lightening arrestor is a MUST for every antenna in Alabama.

Lightening during thunderstorms can be prolific and dangerous in Alabama.

The 8 ft. copper ground rod driven into the ground together with a 10 ft. copper pipe buried alongside the house is my lightening-protection ground. They are also used as my station electrical-safety ground and RF ground.
Station Grounds

• There are three types of Station Ground

1. Electrical Safety Ground

2. Lightening-Protection Ground

3. RF-Signal Ground
Station Ground

- All three types of Station Ground Systems are **CRITICAL** to the **SAFE OPERATION** of your radio station!

- A good Electrical Safety Ground prevents electrical shocks from your equipment

- A good lightening-protection ground reduces the chance of damage to your station from lightening strikes
Electrical-Safety Station Ground

The best electrical-safety ground for your station is the ground rod the utility company connected to your power meter.

Connecting your electrical-safety station ground to the utility company’s ground rod puts your electrical-safety station ground at the same electrical potential as the AC sockets in your home.

NEC Standards actually require that your Station Electrical-Safety Ground be Connected To your homes AC electrical ground.
Electrical-Safety Station Ground

• If it isn’t practical to connect your station’s electrical-safety ground to the utility company’s ground rod then...

• The next best ground is an 8 ft. copper ground rod as close to your shack as possible

• Keep the ground wire connecting your station to ground as short and free of bends as possible

• Do not use anything smaller than 8 gauge wire for grounds
Station Ground

My radio shack is on the opposite side of the house from the utility company’s ground rod.

It is impractical to run 200 ft. of ground wire from my station to the utility company’s ground rod.

My station electrical-safety ground is an 8 ft. copper ground rod driven into the earth and a 10 ft. copper pipe buried alongside of the house.

My electrical-safety ground also serves as part of my lightning-Protection ground system and my RF-signal ground system.
RF Station Ground
RF Station Ground

• A Good RF-Ground System

➤ Reduces the chance of getting an RF shock/burn from your radio equipment

➤ Reduces the potential for RF in the Radio Shack

➤ Reduces the potential for generating RFI

➤ Can significantly reduce the noise level picked up by your receiver

➤ Can improve the signal output strength of your transmitter
RF Station Ground

- This is an end-fed random length wire antenna
- The only return path for the antenna current \( I_t \) is through ground \( I_g \)... therefore \( I_t = I_g \)
- In this case an RF-Signal ground is ABSOLUTELY NECESSARY!
- Without an RF-Signal ground we have an open circuit so the station will not work.
• This transceiver uses a feedline to a remote antenna

• The RF current coming from the transceiver equals the RF current returning from the antenna plus the RF current coming from ground

• \[ I_t = I_a + I_g \]
RF Station Ground

- If this is a perfectly balanced system where the transceiver’s impedance = 50 ohms, the feedline’s impedance = 50 ohms, and the antenna’s impedance = 50 ohms then
  \[ I_t = I_a, \quad I_g = 0 \]
- An RF-Ground is not necessary in a perfectly balanced system
- A perfectly balanced system is very rare. So, I strongly recommend that every station include a good RF-ground!
The Inside Stuff
What are the primary characteristics of a good radio station setup?

The Inside Stuff

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The Inside Stuff
Getting Antenna Feedlines and Ground into the Radio Shack
Getting Antenna Feedlines and Ground into the Radio Shack

• During my 55 years as a Ham I guess I’ve tried just about every way possible to get my feedlines and grounds into my shack

• I’ve drilled holes through:
  - Cinder block foundations
  - Exterior walls
  - Window sills

• I even closed a window on a bare copper long wire antenna. It wasn’t long before I started smelling smoke while I was operating...
Getting Antenna Feedlines and Grounds into the Radio Shack

• Outside View of Window Feedthrough Panel
• My wife highly approves of the no holes in the house method
Getting Antenna Feedlines and Ground into the Radio Shack

Inside view of the Feedthrough Panel
Getting Antenna Feedlines and Ground into the Radio Shack

Using a Feedthrough Panel gives me the ability to easily disconnect my station from the antennas and outside ground during thunderstorms.

Disconnecting everything from the outside world is the best protection you can have from lightening strikes.
The Inside Stuff
Station Grounds
RF Station Ground
How NOT to ground your equipment

- The “Daisy Chain” ground system is an okay electrical-safety ground to protect against electrical shock and lightening

- **But the “Daisy Chain” ground system is a terrible RF ground!**
RF Station Ground
How NOT to ground your equipment

- The “Daisy Chain” ground system can create “RF Ground Loops”
- RF Ground Loops can cause a hum in your receiver
- Even worse...RF Ground Loops can cause:
  - RF to be all over your equipment and bite you every time you touch something
  - Severe RFI Problems for you and your neighbors
  - You’ll think your shack is haunted by “Gremlins” by all the weird things a poor RF-ground can cause
RF Station Ground
How to build a GOOD RF-Ground System

- A Good RF Station Ground connects every piece of equipment to a single ground point in the shack.
- The ground wire from the single ground point to the ground rod outside is kept as short as possible to minimize reactance.
- Reactance is the resistance inherent in any wire. The longer the wire the greater the reactance.
- We want as little reactance/resistance as possible in our RF ground system so our station is connected as directly as possible to earth ground.
RF Station Ground
How to build a GOOD RF-Ground System
The Inside Stuff
AC Surge Protectors
AC Surge Protectors

• AC Surge Protectors will protect your equipment against sudden voltage spikes

• Lightening is one of the most common sources of voltage spikes coming into your home on an AC power line.

• Joule is a measure of energy absorption

• Buy and use an AC Surge Protector with the highest joule rating you can afford
AC Surge Protectors

- I use two AC Surge Protectors for my Radio Station Equipment

- Each AC Surge Protector is plugged into a separate AC socket to minimize the possibility of an overloaded AC socket
The Inside Stuff
The Operating Table and Station Organization

pic by: Dor Garbash
The Operating Table and Station Organization

This is my original station setup in Alabama. It looks pretty good at first glance....

Let's take a closer look...
The Operating Table and Station Organization

There is no space on this table to work with paper documents.
The Operating Table and Station Organization

I cannot stand up so the transceiver power supply on/off button is almost out of reach.
When I'm sitting forward using the computer I cannot see the transceiver without taking my eyes completely away from the computer. This becomes awkward while operating digital modes.
The USB cable connecting the transceiver to the computer ran parallel to the coax runs and underneath the linear. As a result some RF got into the computer from that USB cable causing the computer to have intermittent fits.
I like to use a desk mike but there is no good place to put a desk mike with this station layout. I can't put the desk mike on either side of the computer because it would interfere with the mouse or the linear tuning. There is no place to attach a boom mike either. So, I end up holding the desk mike.
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I can’t even get to this desk in my wheelchair! So, I have to maneuver my wheelchair as close as I can get to it and transfer to the desk chair. There just isn’t any other option...

P.S. This picture was taken while I could still walk.
The Operating Table and Station Organization

• I need an Operating Table that will overcome all of the problems we’ve looked at

• I need an Operating Table that will allow me to organize my station in a way that makes sense for me

• I need an operating table that will put the fun back into operating my station...
The Operating Table and Station Organization
The Operating Table and Station Organization

• I got on the internet and researched desks and tables

• There just wasn’t anything commercially available that came close to being what I needed

• So, I decided to design a table to fit my needs

• Once I had a design I decided that I would build it myself

• My wife said, “Hold on there just a minute Robert Harley! Just how in the heck are you going to build a desk yourself? Did you forget… you’re in a wheelchair?”

• I replied with a chest full of confidence, “Adapt and Overcome, Honey…. Adapt and Overcome… besides…

• you’ll help me when I need it… won’t you?”
Building the Table
Building the Table
Building the Table
Building the Table
Building the Table
My New Station
The Operating Table and Station Organization

Document & Writing Space

Extra wide keyboard tray with plenty of room for the mouse
The Operating Table and Station Organization

Everything I need can easily be reached from a seated position. Nothing is high too high to reach!
The Operating Table and Station Organization

I never need to take my eyes off the computer screen to see anything I want to see. Everything I need is right in front of me.
The Operating Table and Station Organization

No USB cable is in immediate proximity to any RF source. The Digital Rotor Controller's USB cable runs perpendicular to the coax runs it encounters. The computer no longer goes into convulsive fits...
The Operating Table and Station Organization

The Heil PR 781 Mike on a boom mount is easily swung into position for use or out of the way when not needed.
The table legs are on casters. We removed the old carpeting and replaced it with laminate flooring. Now I can easily move the table anywhere I need it from my wheelchair. I can now fix or change the wiring any time I want to all by myself.
Summary

• We’ve covered all of the basic “outside and inside stuff” you need to know to set up your own Amateur Radio Station

• A poorly organized station, outside and/or inside will lead to frustration and dissatisfaction

• A well thought out station, outside and inside, will give you years of operating pleasure
Questions

Questions are guaranteed in life; Answers aren’t.