
# Discover the Magic Of HF Radio

*By Norm Fusaro, W3IZ*

# HF is FUN

With a 100 watt transceiver and a simple wire antenna you can start to communicate and make friends with other hams all over the country or the world.

HF is different than FM repeaters.

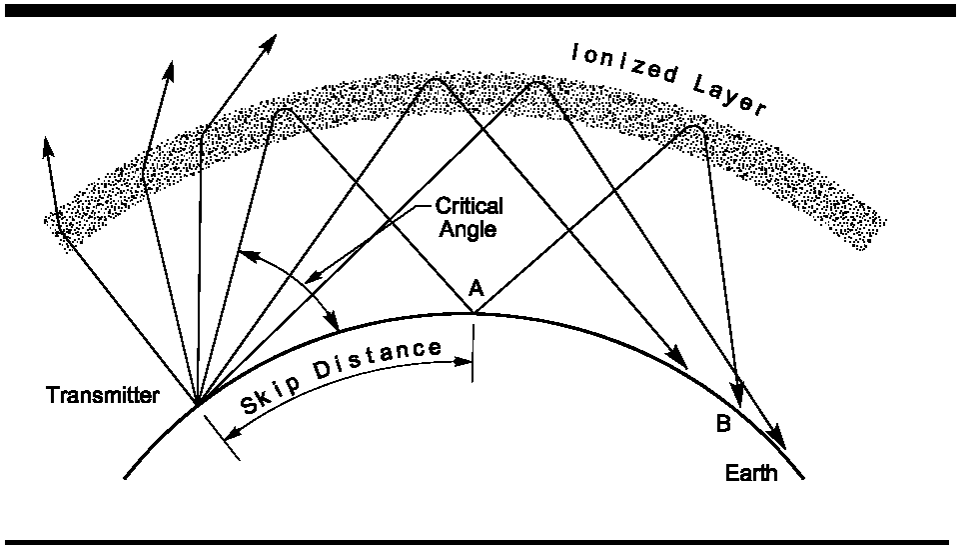
- No “machine” or infrastructure is used.
- Allows communication beyond line of sight. Contacts are generally a couple of hundred miles to over several thousand miles.
- Propagation is strongly effected by solar activity.
- Several communication modes are available to use. SSB, CW, RTTY, SSTV, Digital, AM

When most people hear the term “ham radio” they generally think of HF or shortwave and long distance communications.

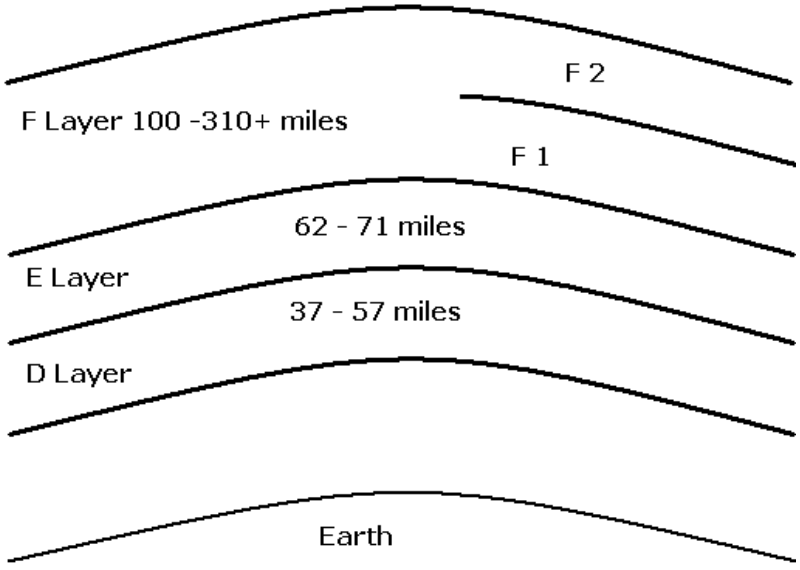
HF stands for HIGH FREQUENCY
These are the frequencies from 1.8* to 30 MHz or the 160 meter to 10 meter bands.

HF is also known as *shortwave*.

*160m is actually a Mid Frequency (MF) band but it is included in the Amateur HF bands for ease of discussion.




The sun charges particles (ions) in the upper atmosphere. Radio waves change direction when they enter the *ionosphere*.




**The Layers of the Ionosphere**

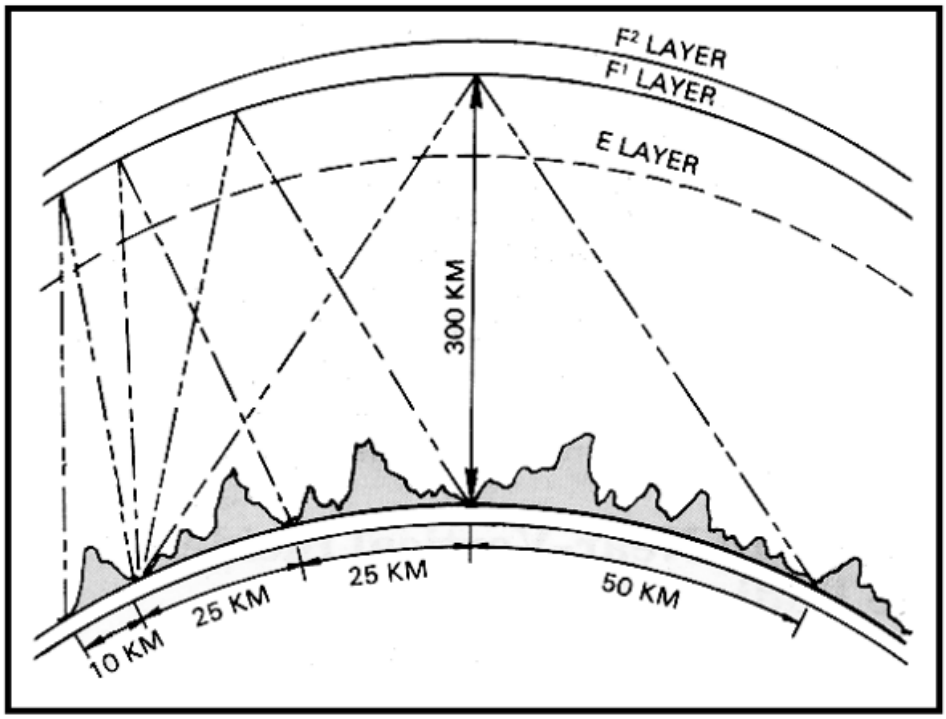
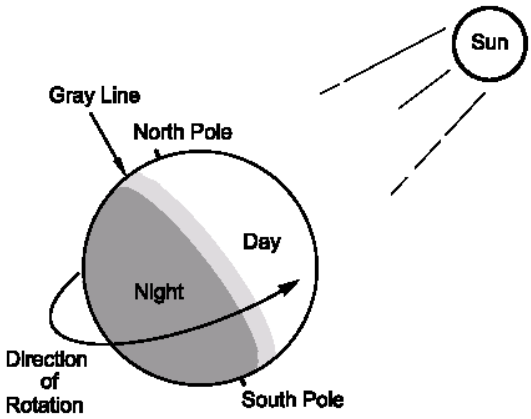



*Figure M-1. Near-vertical incidence sky-wave propagation concept.*

NVIS - Radio Waves that take off at very high angles are reflected straight back to Earth.




The gray line or terminator is a transition region between daylight and darkness. One side of the Earth is coming into sunrise, and the other is just past sunset.

# Building a Station

There are basically two main components involved:

1. A 100 watt Transceiver and
2. An antenna *system*. The antenna system consists of the radiator, feedline and matching network.

## Transceivers

**What makes a good radio?**

- Scanning, memories and other "bells & whistles" are *not* the important features that make a good HF rig.
- The receiver's ability to hear weak signals and separate the incoming signals are what makes a good HF rig.
- The numbers to look at when selecting a transceiver are:
    1. *sensitivity* (ability to hear signals) and
    2. *selectivity* (ability to distinguish signals)

**Remember, you can't work them if you can't hear them.**

## Physical Safety
## NEVER attempt to erect antennas near powerlines. You will be killed.

## Antennas

An antenna system consists of:

1. The antenna or radiator
2. The feedline
3. The matching network or tuner

## SWR

- A good SWR is not an indicator of an effective antenna system.
- Think of a dummy load; it has a good SWR but it is not an effective antenna.

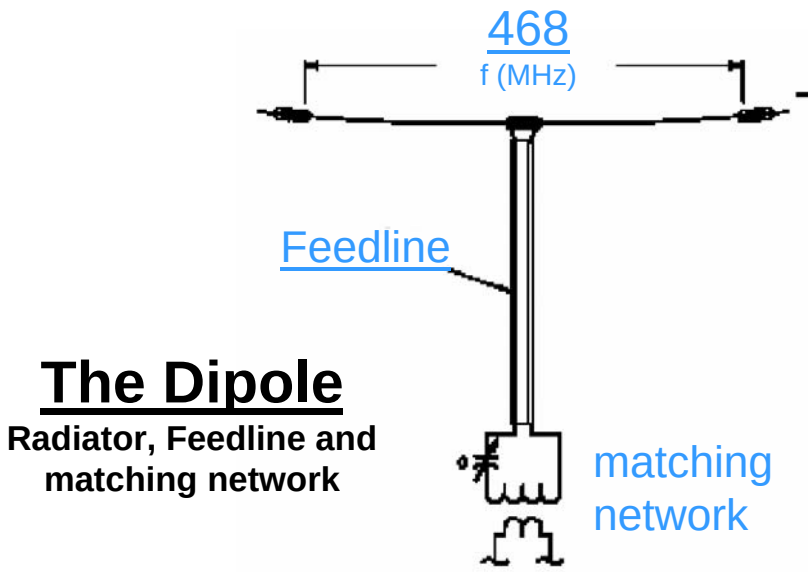
## The dipole

- The dipole is the simplest antenna that any amateur can use on HF.
- Whether fed with coax or open wire, dipoles are cheap and easy to build and install.

- A dipole can be made for a single band. The total length of the antenna can be calculated by using the formula:

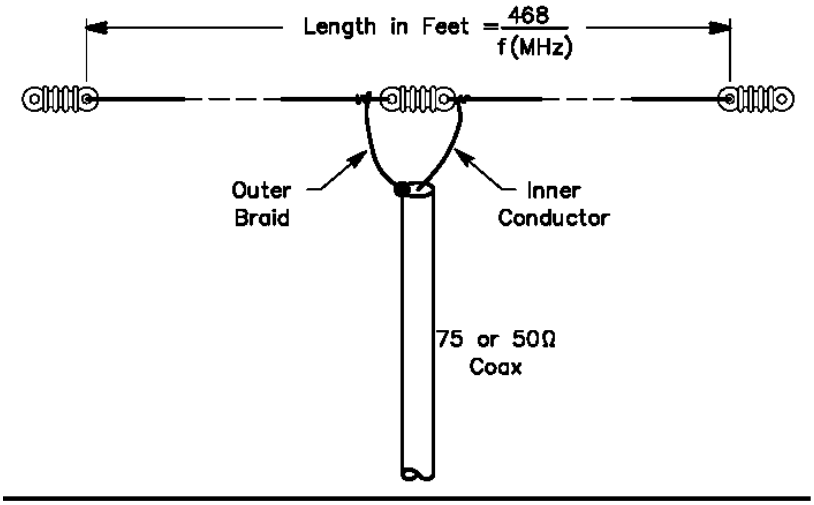
**468 ÷ freq (MHz) = length in feet**

- Each side, or leg, of the dipole is going to be one half of the total length.
- Fed with 50 or 75 ohm coax, this antenna will be resonant on a single band that it was cut for.
- A dipole fed with balanced line (twin lead) and a matching network can be used on multiple bands.




## The Dipole

**Radiator, Feedline and matching network**



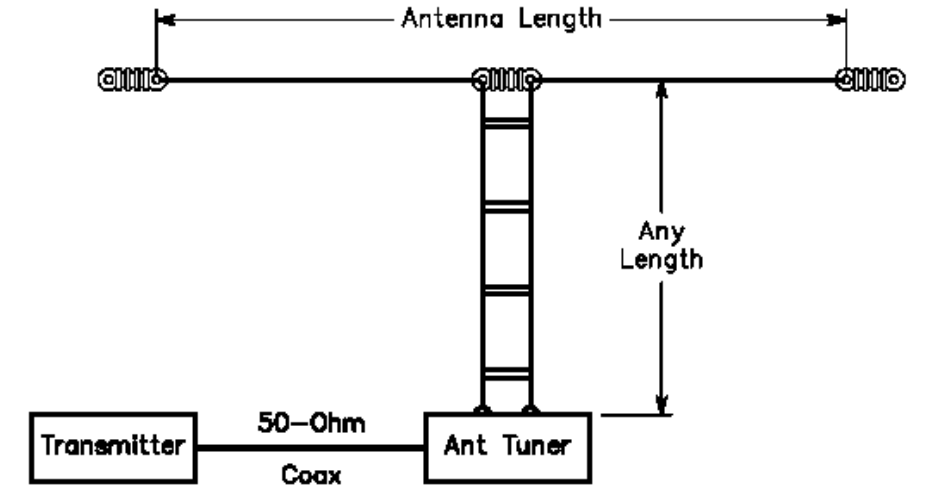
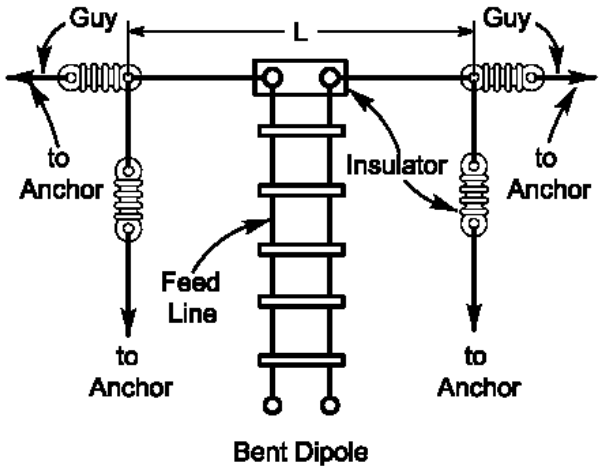
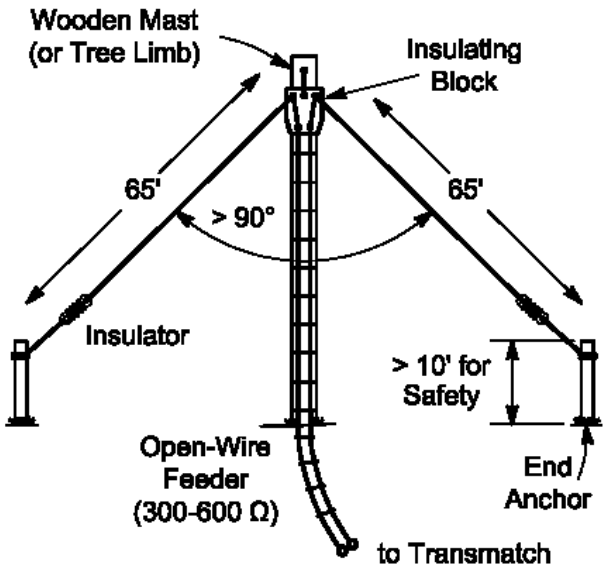



Fig 6—A center-fed antenna system for multiband use.

**It is not necessary to install dipoles in a horizontal straight line.**






**Inverted "VEE"**

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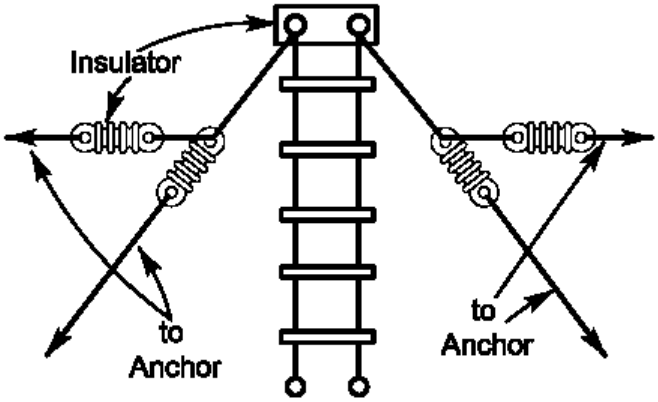


Bent Drooping Dipole

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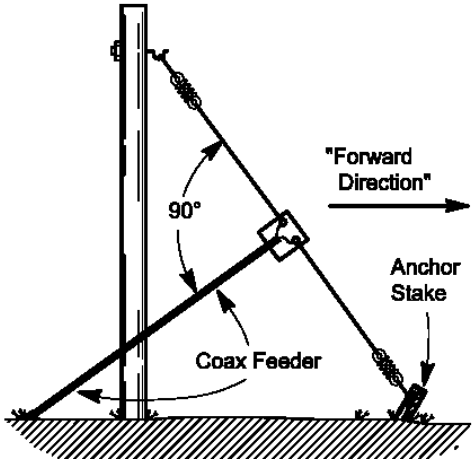
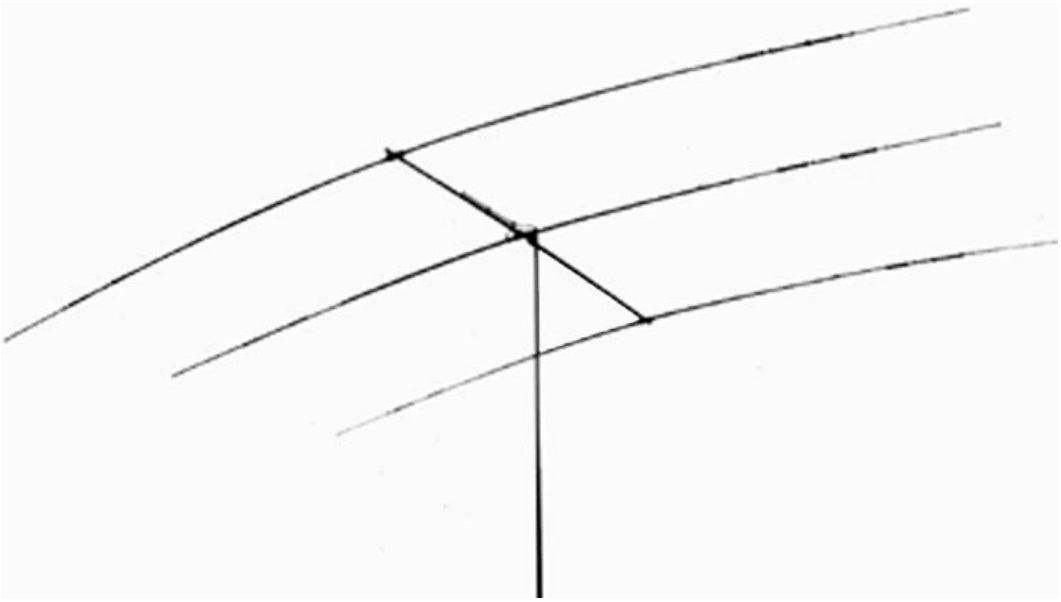



**Sloping Dipole or "Sloper"**

# Beams

- The tri-band Yagi or beam antenna is popular among a lot of HF operators.
- A modest 3 element model at heights as low as 40 ft can greatly improve your signal.
- Many hams have earned their DXCC award using a small tri-band beam and 100 watts of power.



Three Element Tri-band Yagi

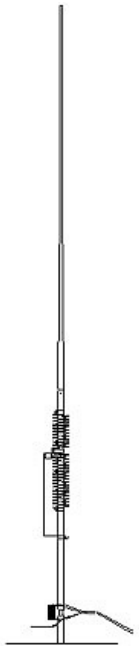
## Physical Safety

**NEVER attempt to erect antennas near powerlines.**
**You will be killed.**

# Vertical Antennas

- It is recommended that you read about vertical antennas in the ARRL Antenna Book before installing one.
- Many hams new to HF can become disappointed by vertical antennas because they don't understand how they work or listen to myths about them.
- Once you read and understand about vertical antennas you will find that they are excellent low angle radiators and are great for DXing. A lot of big gun stations have verticals in their arsenal of antennas.

- Vertical antennas are excellent low angle radiators.
- Ground mounted verticals require an extensive radial system.
- Elevated mono-band verticals only require 4 radials to be effective.



## Physical Safety

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# Station Grounding

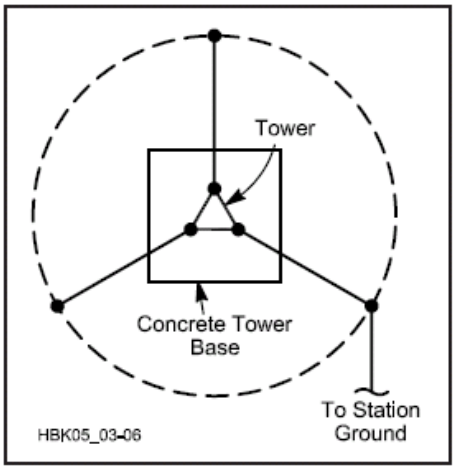



**Fig 3.6 — Schematic of a properly grounded tower. A bonding conductor connects each tower leg to a ground rod and a buried (1 ft deep) bare, tinned copper ring (dashed line), which is also connected to the station ground and then to the ac safety ground. Locate ground rods on the ring, as close as possible to their respective tower legs. All connectors should be compatible with the tower and conductor materials to prevent corrosion. See text for conductor sizes and details of lightning and voltage transient protection.**

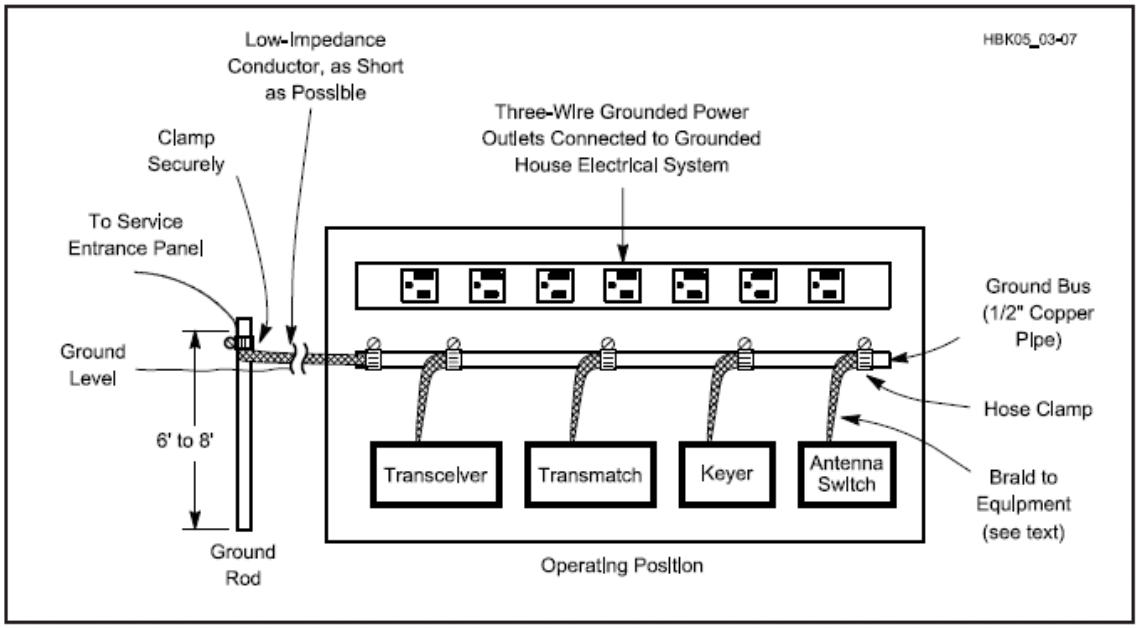
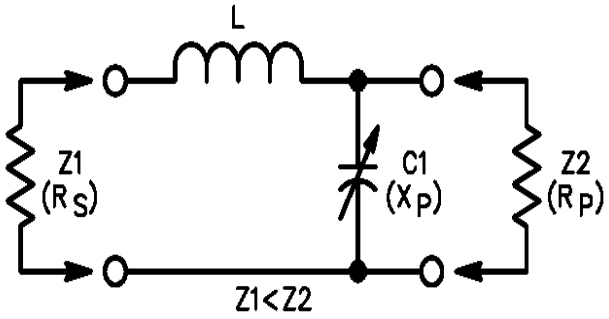


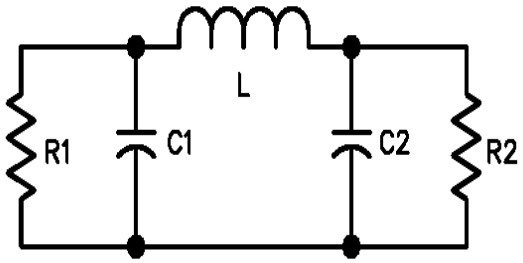

**Fig 3.7 — An effective station ground bonds the chassis of all equipment together with low-impedance conductors and ties into a good earth ground. Note that the ground bus is in turn bonded to the service entrance panel. This connection should be made by a licensed electrician with #6 AWG (minimum size) copper wire.**

# Matching Networks

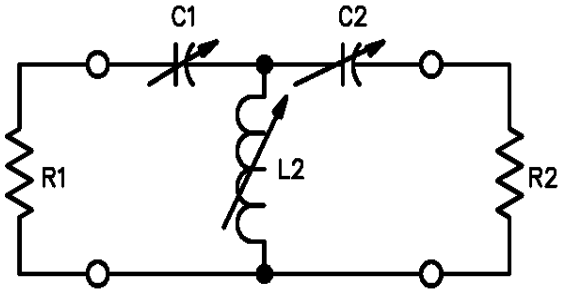
- The terms antenna tuner, match box, Transmatch and antenna coupler, are all synonyms for a matching network.
- A matching network is a combination of inductance and capacitance used to cancel out unwanted reactance to better couple the transmitter power to the antenna.
- The matching network provides an efficient transfer of power from the transceiver to the antenna.
- The use of a matching network to achieve low SWR does not make a poor antenna radiate better.




## "L" Network




## Pi Network




## "T" Network

# Keeping a Log Book

(From the ARRL Handbook)

At one time, keeping a log of your contacts was an FCC requirement. The FCC has dropped this requirement in recent years, but many amateurs, both new and old, still keep logs.

**Why Keep a Log?**

If keeping a log is optional, why do it? Some of the more important reasons for keeping a log include:

Legal protection — If you can show a complete log of your activity, it can help you deal with interference complaints. Good recordkeeping can help you protect yourself if you are ever accused of intentional interference, or have a problem with unauthorized use of your call sign.

Awards tracking — A log helps you keep track of contacts required for DXCC, WAS, or other awards. Keeping a log lets you quickly see how well you are progressing toward your goal.

An operating diary — Your log book is a good place for recording general information about your station. You may be able to tell just how well that new antenna is working compared to the old one by comparing recent QSOs with older contacts. The log book is also a logical place to record new acquisitions (complete with serial numbers in case your gear is ever stolen). You can also record other events, such as the names and calls of visiting operators, license upgrades, or contests, in your log.

**Paper and Computer Logs**

Many hams, even those with computers, choose to keep their logs on paper. Paper logs still offer several advantages (such as flexibility) and do not require power. Paper logs also survive hard-drive crashes!

Preprinted log sheets are available, or you can create your own. Computers with word processing and publishing software let you create customized log sheets in no time. On the other hand, computer logs offer many advantages to the serious contester or DXer. For example, the computer can search a log and instantly tell you whether you need a particular station for DXCC. Contesters use computer logs in place of dupe sheets to weed out duplicate contacts before they happen, saving valuable time. Computer logs can also tell you at a glance how far along you are toward certain awards. Computer logging programs are available from commercial vendors. Some programs may be available as shareware (you can download it from a website and pay for the program if you like the way it works). If you can program your computer, you can also create your own custom logging program, and then give it to your friends or even sell it!

# QSLing

(From the ARRL Handbook)

A QSL card (or just “QSL”) is an Amateur Radio tradition. QSL cards are nearly as old as Amateur Radio itself, and the practice has spread so that short-wave listeners (SWLs) can get cards from shortwave and
AM broadcast stations. Most amateurs have printed QSL cards. QSL card printers usually have several standard layouts from which to choose. Some offer customized designs at extra cost. If you are just starting out, or anticipate changing your call sign (just think, you could get a call like “KC4WZK”), you may want to purchase a pack of “generic” QSL cards available from many ham stores and mail-order outlets.

**Filling Out Your Cards**

QSL cards must have certain information for them to be usable for award qualification. At a minimum, the card must have:

• Your call sign, street address, city, state or province and country. This information should be preprinted on one side of your QSL card.
• The call of the station worked.
• The date and time (in UTC) of the contact.
• The signal report.
• The band and mode used for the contact.

Awards for VHF and UHF operations may also require the grid locator (or “grid square”) in which your station is located. Current practice is to include your 6-digit grid square on your QSL card even if you have no plans to operate VHF and UHF, since some HF competitions and awards require your grid square designator.

Many hams provide additional information on their QSL cards such as the equipment and antennas used during the contact, power levels, former calls and friendly comments.

**Sending and Receiving Domestic QSLs**

Although most QSL cards can be sent as post cards within the United States, usually saving some postage costs, post card style QSL cards often arrive with multiple cancellations and other unintended markings that can obscure or obliterate the printed and written information. It is best to send all QSL cards in a protective envelope. Back when postage was cheap, you could send out 100 post cards for a few dollars and domestic stations would send QSLs as a matter of course. Currently, if you really need a particular QSL, it is best to send a selfaddressed stamped envelope along with your card. QSLing for DX stations is somewhat more involved and is discussed elsewhere in this chapter.

***How-to’s of DXCC — Direct QSLs and DX Bureaus***

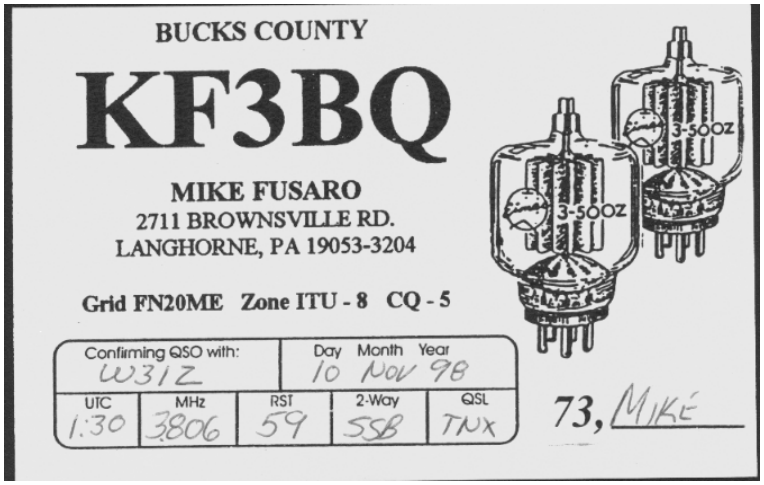
Since DX stations are often inundated with QSL cards (and QSL requests) from US hams, it is financially impossible for most of them to pay for the return postage. Hams have hit upon several ways to lighten the load on popular DX stations.

The fastest, but most expensive, way to get QSL cards is the *direct* approach. You send your QSL card, with one or two International Reply Coupons (IRCs) or one or two dollars and a self-addressed airmail envelope to the DX station. International Reply Coupons are available from your local post office and can be used nearly anywhere in the world for return postage. Some DX hams prefer that you send one or two "green stamps" (dollar bills) because they can be used to defray posting, printing and other expenses. However, it is illegal in some countries to possess foreign currency. If you're not sure, ask the DX station or check DX bulletins available on the DX Cluster System, accessible by either packet radio or Telnet.

Many DX hams have recruited *QSL managers*, hams who handle the QSL chores of one or more DX stations. QSL managers are convenient for everyone. The DX station need only send batches of blank cards and a copy of the logs; hams wanting that station's card need only send a First Class stamp for US return postage and can expect a prompt reply. (In the case of QSL managers located outside the United States, you must still send IRCs (or dollars) and a self-addressed return envelope.)

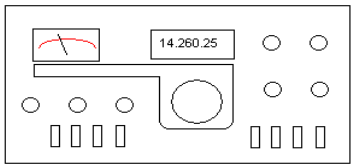
The easiest (and slowest) way to send and receive large batches of QSL cards is through the incoming and outgoing QSL bureaus. The outgoing bureau is available to ARRL members. The incoming bureaus are available to all amateurs. Bureau instructions and addresses are printed periodically in *QST;* they appear in the *ARRL Operating Manual*, and they are available from ARRL Headquarters for an SASE.

Alternatively, you can submit your QSO log electronically to ARRL's Logbook of The World. All submissions are free; you only pay when you "redeem" your QSO credits for an award, such as DXCC. Once you are signed up as a Logbook user, you can submit new contact records whenever you wish. Your contacts will be matched against the logs of other Logbook users. Whenever a match occurs, you receive instant credit for the contact. You can learn more about Logbook of The World by visiting its Web site at **www.arrl.org/logbook-of-the-world**




**QSL Card**

# Some Common Controls Found On Amateur Radio Transceivers.




The placement of the controls may vary from manufacturer to manufacturer or on various models from the same manufacturer, however, the basic controls perform the same functions on all radios.

1. **VFO** – This is the main tuning knob used to tune in a station. This tunes your transmit and receive frequency and is shown on the **MAIN DISPLAY.**
2. **METER**- The meter in most radios is a multi function meter and shows a lot of information. Use this like the speedometer in your car; don't stare at it, but glance at it to make sure all things are proper.
    - **"S" or Signal strength –** This indicates the relative strength of a received signal on a scale of 1 through 9.
    - **RF POWER** – This shows how much power the transmitter is putting out. MAX is good
    - **SWR** – This shows the **S**tanding **W**ave **R**atio of the antenna or how much power is being reflected back to the radio. MIN is good.
    - **ALC** – This shows the condition of the **A**utomatic **L**imiting **C**ontrol circuitry. You want to make sure that you are not overdriving your transmitter. A good reading is when the peaks top the scale and stay within the range marked on the meter scale.

3. **AF (**gain) **–** This is the **VOLUME** control for the receiver. **A**udio **F**requency gain.

4. **RF GAIN –** This adjust the gain of the receiver amplifier circuits. It allows you to make these circuits less sensitive so that you can dampen really strong signals.
   It is normal to see the **S METER** rise as you decrease the gain of the receiver by adjusting the **RF GAIN.**

5. **MIC GAIN-** This control the loudness of the microphone in any voice mode. It is best to adjust this for a good "in range" reading on the **ALC** meter.

6. **MODE –** This allows you to choose the mode of operation.
   **CW –** Continuous Wave (Morse code)
   **USB –** Upper Sideband
   **LSB –** Lower Sideband
   **RTTY –** Radio Teletype (Also **FSK** – Frequency Shift Keying)
   **PKT** – Packet (Also **AFSK** – Audio Frequency Shift Keying)
   **FM –** Frequency Modulation

7. **RIT** – This stands for **R**eceive **I**ncremental **T**uning and is used to fine tune a station you are listening to without changing your transmit frequency. It is sometimes called a **Clarifier.**

8. **XIT-** This is similar to RIT but it adjust your transmit frequency. It is **T**ransmit **I**ncremental **T**uning.

9. **RF PWR –** Adjust the amount of transmitter power.

10. **IF SHIFT-** This shifts the center of the receiver's pass band. It allows you to avoid a signal that is close to yours by not letting it in the window of the receiver's pass band.

11. **NOTCH –** This is another good filter for reducing nearby interference. Unlike a window, it acts like a cover and blocks the signal that is in your window.

12. **DSP – D**igital **S**ignal **P**rocessing

Imagine looking through a Cracker Jack box and looking at street lights. You can only view the lights that are in your window. That's how the receiver's IF works. It can only receive signal it it's window or **PASSBAND**. If you are looking at the lights and there is one to either side that you want to avoid then you can **SHIFT** the window. On the other hand, if there is a light in your viewing window that is distracting and if you shifted your window you would loose the light you want to look at, then you could slide your finger along the front of the viewing window until it just covered the unwanted light. That's how the **NOTCH** works. These two controls will help you pull out signals in a crowded band.

# US Amateur Radio Bands

**Effective Date**
**February 23, 2007**

ARRL The national association for AMATEUR RADIO

US AMATEUR POWER LIMITS

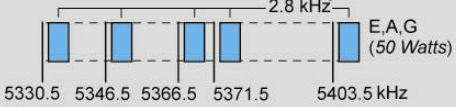
At all times, transmitter power should be kept down to that necessary to carry out the desired communications. Power is rated in watts PEP output. Except where noted, the maximum power output is ***1500 Watts***.

### 160 Meters (1.8 MHz)

Avoid interference to radiolocation operations from 1900 to 2000 kHz

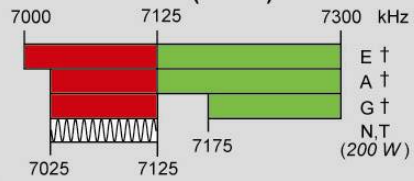

### 80 Meters (3.5 MHz)


### 60 Meters (5.3 MHz) USB *only*




General, Advanced, and Amateur Extra licensees may use the following five channels on a secondary basis with a maximum effective radiated power of 50 W PEP relative to a half wave dipole. Only upper sideband suppressed carrier voice transmissions may be used. The frequencies are 5330.5, 5346.5, 5366.5, 5371.5 and 5403.5 kHz. The occupied bandwidth is limited to 2.8 kHz centered on 5332, 5348, 5368, 5373, and 5405 kHz respectively.

### 40 Meters (7 MHz)

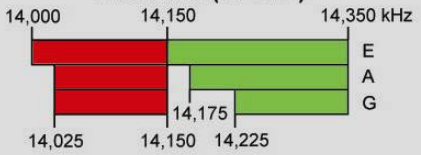



† Phone and Image modes are permitted between 7075 and 7100 kHz for FCC licensed stations in ITU Regions 1 and 3 and by FCC licensed stations in ITU Region 2 West of 130 degrees West longitude or South of 20 degrees North latitude. See Sections 97.305(c) and 97.307(f)(11). Novice and Technician licensees outside ITU Region 2 may use CW only between 7025 and 7075 kHz. See Section 97.301(e). These exemptions do not apply to stations in the continental US.

### 30 Meters (10.1 MHz)

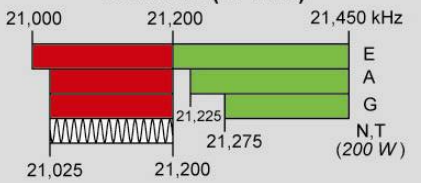
Avoid interference to fixed services outside the US.


### 20 Meters (14 MHz)




### 17 Meters (18 MHz)

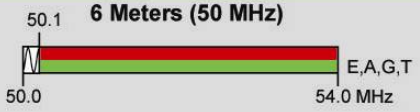

### 15 Meters (21 MHz)




### 12 Meters (24 MHz)

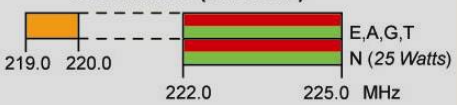

### 10 Meters (28 MHz)


### 6 Meters (50 MHz)




### 2 Meters (144 MHz)

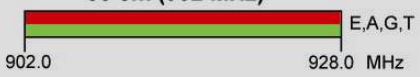

### 1.25 Meters (222 MHz)



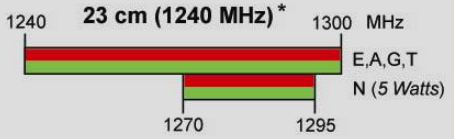

*Geographical and power restrictions may apply to all bands above 420 MHz. See *The ARRL Operating Manual* for information about your area.

### 70 cm (420 MHz)*


### 33 cm (902 MHz)*




### 23 cm (1240 MHz)*




All licensees except Novices are authorized all modes on the following frequencies:

| | | |
|---|---|---|
| 2300-2310 MHz | 10.0-10.5 GHz | 122.25-123.0 GHz |
| 2390-2450 MHz | 24.0-24.25 GHz | 134-141 GHz |
| 3300-3500 MHz | 47.0-47.2 GHz | 241-250 GHz |
| 5650-5925 MHz | 76.0-81.0 GHz | All above 275 GHz |

### KEY

***Note:***
**CW** operation is permitted throughout all amateur bands except 60 meters.
**MCW** is authorized above 50.1 MHz, except for 219-220 MHz.
**Test** transmissions are authorized above 51 MHz, except for 219-220 MHz

- = RTTY and data
- = phone and image
- = CW *only*
- = SSB phone
- = USB phone *only*
- = Fixed digital message forwarding systems *only*

**E** = Amateur Extra
**A** = Advanced
**G** = General
**T** = Technician
**N** = Novice

See *ARRLWeb at www.arrl.org* for more detailed band plans.

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# 60 Meter Band

Maximum Power is 50 watts ERP

Maximum Bandwidth is 2.8 KHz

The new 60 meter band is a secondary allocation--federal government users are primary--and the first on which the *only* permitted mode will be upper-sideband (USB) phone (emission type 2K8J3E). The FCC has granted hams access to five discrete 2.8-kHz-wide channels in the vicinity of 5 MHz.

The NTIA advised in a letter to the FCC Office of Engineering and Technology (OET) that users of 60 meters should set their carrier frequency 1.5 kHz *lower* than the channel center frequency, according to this NTIA chart:

| **Channel Center** | **Amateur Tuning Frequency** |
|---|---|
| 5332 kHz | 5330.5 kHz |
| 5348 kHz | 5346.5 kHz |
| 5368 kHz | 5366.5 kHz |
| 5373 kHz | 5371.5 kHz |
| 5405 kHz (common US/UK) | 5403.5 kHz |

Noting that high-frequency audio response can vary considerably from radio to radio, Hare has suggested a more conservative approach. He suggests restricting audio bandwidth to 200 Hz on the low end, and 2800 Hz on the high end--for a total bandwidth of 2.6 kHz. Hare notes that some transmitters that the Lab has looked at are capable of bandwidths of 3.0 kHz or greater.

In its letter to the FCC, the NTIA also stipulated that radiated power should not exceed "the equivalent of 50 W PEP transmitter output power into an antenna with a gain of 0 dBd." The FCC *R&O* set the requirement at 50 W ERP (Effective Radiated Power) and said it would consider a typical half-wave dipole to exhibit no gain.

# Publications for the HF operator

Order Toll-Free 1-888-277-5289
or
order on line at www.arrl.org/catalog/

ARRL Handbook  ARRL Order No. 9760
http://www.arrl.org/catalog/?item=9760

ARRL Antenna Book ARRL Order No. 9043
http://www.arrl.org/catalog/?item=9043

ON4UN's Low Band DXing ARRL Order No. 7040
http://www.arrl.org/catalog/7040/

The Complete DX'er -- 3rd Edition - by Bob Locher, W9KNI.  ARRL Order No. 9073
http://www.arrl.org/catalog/?item=9073

On the Air with Ham Radio - By Steve Ford, WB8IMY.  ARRL Order No. 8276
http://www.arrl.org/catalog/?item=8276

RF Exposure and You - by Ed Hare, W1RFI.  ARRL Order No. 6621
http://www.arrl.org/catalog/?item=6621

Ham Radio for Dummies - by Ward Silver, N0AX.  ARRL Order No. 9392
http://www.arrl.org/catalog/?item=9392

**ARRL Multi Media Library** < www.arrl.org/multimedia >has additional presentations for those who may want to learn more about contesting, DXing, NVIS or operating HF mobile.

Here are some NVIS websites of interest

- http://www.tactical-link.com/field_deployed_nvis.htm
- http://www.qsl.net/wb5ude/nvis/
- This is the NVIS reflector
  http://groups.yahoo.com/group/nvis/

# Contact


Norm Fusaro, W3IZ
ARRL Affiliated Clubs/Mentor
Program Manager
225 Main St. Newington, CT 06111
860-594-0230
w3iz@arrl.org