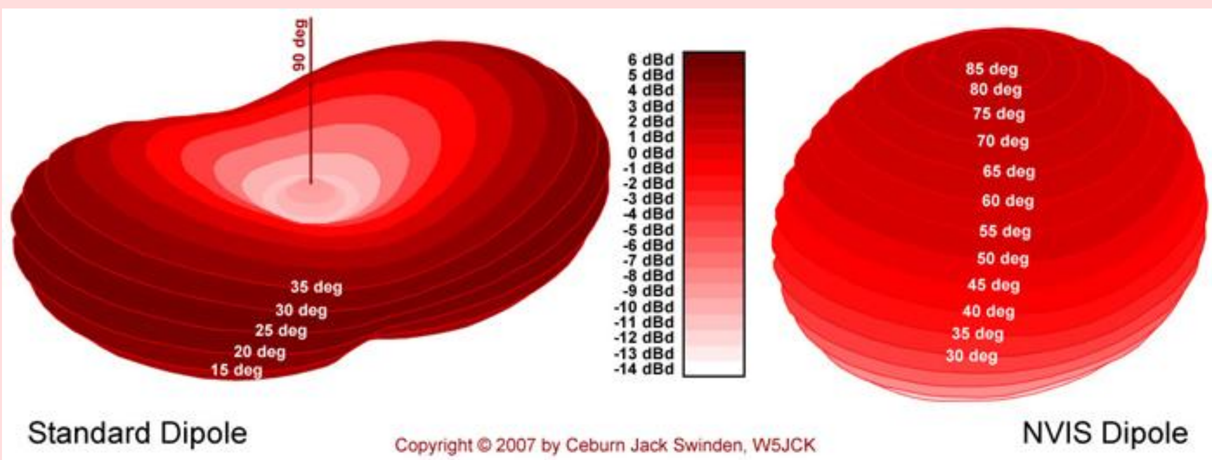
Near Vertical Incident Skywave Dipole Antenna

A Near Vertical Incident Skywave (NVIS) antenna is designed to radiate most of the signal up at a high angle thus making local/regional HF communications out to a few hundred miles much more reliable.

One type of NVIS antenna is a center fed dipole that is mounted low to the ground, normally within 0.05 wavelength. Because of the low mounting height, an NVIS dipole is omnidirectional with most of the signal being radiated at a high angle between 75 and 90 degrees to the earth's surface.

Comparing an NVIS Dipole to a Standard Dipole

The following is a brief comparison of a standard 1/2 wavelength dipole and a 1/2 wavelength NVIS dipole with a reflector wire (5% longer than the total length of the dipole) mounted below it.



Standard Dipole

- Good for DX communications—exhibits a high average gain of 4.9 dBd between 15 to 35 degrees to the earth's surface
- Maximum gain—5.5 dBd at 30 degrees to the earth's surface
- Attenuates high angle signals—virtually deaf from above due to an average loss of –6.9 dBd between 50 to 90 degrees to the earth's surface
- Bidirectional radiation pattern
- Optimum performance when mounted 1/2 wavelength above ground

NVIS Dipole with Reflector Wire

- Good for local/regional communications—exhibits an average gain of 1.4 dBd between 50 to 90 degrees to the earth's surface
- Maximum gain—2.1 dBd at 90 degrees to the earth's surface
- Attenuates low angle signals—exhibits an average loss of –4.7 dBd between 15 to 35 degrees to the earth's surface
- Omnidirectional radiation pattern
- Optimum performance when mounted 0.05 wavelength above ground with a reflector wire mounted 0.02 wavelength above ground

As you can see, a standard 1/2 wavelength dipole mounted horizontally at 1/2 wavelength above the ground is an excellent antenna for working DX. However, it is virtually useless for working stations within a few hundred mile radius (its null area). The opposite can be said of an NVIS dipole since it does an excellent job of hearing nearby signals. However, the NVIS dipole is virtually useless for working DX stations.

Good Option for Limited Space or Code Restricted Installations

I am a firm believer in the adage, "Do you what you can with what you have." Many HAMs have limited space on their property, and they often have building restrictions on antennas and towers. Therefore, they find themselves somewhat limited by space and code restrictions when it comes to constructing an HF antenna. Yet there are practical antenna designs for nearly every circumstance. The NVIS dipole is a good option for working 80m/40m if you have limited space and/or restrictions, or if you require local and regional communications abilities.

Excellent Option for Local and Regional Communications (Emergency and Disaster Relief)

The NVIS dipole is an excellent option for working emergency and disaster relief communications within your local area and regional area (out to a 150 mile radius, or more). This antenna provides omnidirectional communications with most of the signal being radiated at a high angle between 75 and 90 degrees to the earth's surface. This is important as it naturally helps to attenuate DX signals arriving at low angles, while amplifying nearby signals arriving at high angles. This results in more reliable local and regional communications with much less DX noise. However, all communicating stations must have antennas designed for high angle radiation. (More on this below.)

For R.A.C.E.S. and ARES organizations, this means reliable HF communications that can cover a regional area of 70,000 square miles (150 mile radius) or more without repeaters. As a comparison, if your 2m or 70cm repeaters go down during a disaster, expect to cover a maximum of about 2,500 square miles (30 mile radius) using simplex, and that is a very optimistic figure.

What makes the NVIS dipole an excellent option for local/regional emergency and disaster relief communications?

- Extremely portable as it weighs only a few pounds.
- Easy to install temporarily or permanently.
- Omnidirectional, so you are more likely to hear other stations from any direction.
- It is adapted to local and regional communications while keeping DX noise to a minimum.

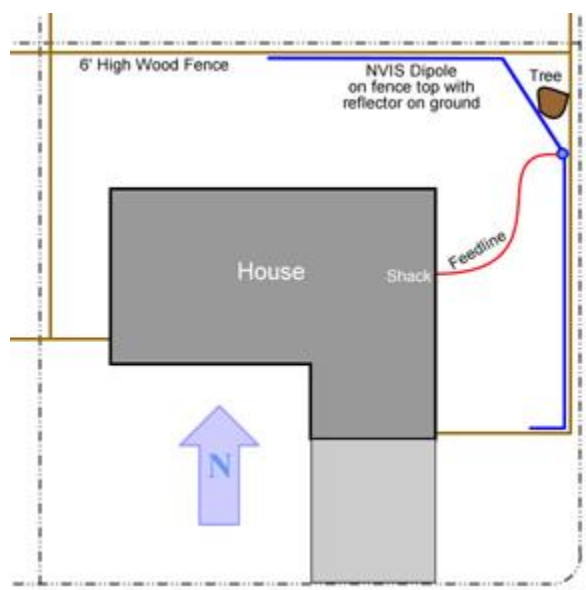
What kind of coverage can I expect from an NVIS dipole with reflector?

As they say, you mileage will vary. There are many factors to consider which we will not go into in depth in this document. Factors include band conditions, time of day, time of year, weather conditions, atmospheric conditions, frequency, et cetera. What I can tell you is how well mine performs.

My shack is located in EM12ko in Arlington, Texas. I can usually work stations in about a 600 mile radius on 80 meters. That is over 1 million square miles. However a 600 mile radius is approaching the limitations of this antenna and communications are not always good, or even possible, at that range. As you can see from the coverage map, that includes the entire states of Texas, Oklahoma, Kansas, Arkansas, Lousiana, and Mississippi, most of Missouri and New Mexico, plus the Gulf Coast region from Southern Texas through Mississippi—hurricane alley.

I can very reliably and consistently work stations within about 150 mile radius, illustrated by the small circle in the coverage map. That is 70,000 square miles and more than adequetely covers the greater Dallas/Fort Worth metroplex.

What if my lot is too small to stretch out a 130 foot antenna in a straight line?



The coverage from my NVIS dipole and reflector is pretty good, and mine isn't even mounted under ideal conditions—not by a long shot. I strung the dipole along the top of my wood fence about 6 feet above the ground. That is a height of less than half the recommended height of 13 feet. I merely laid the reflector on the ground directly beneath the dipole rather than elevating it to the recommended height of 5 feet. Plus my lot is too small to conveniently stretch out the whole dipole/reflector in a straight line, so as you can see from the image I had to bend it around quite a bit.

It might look like a strange configuration for a dipole, but it still works, and quite well I might add.

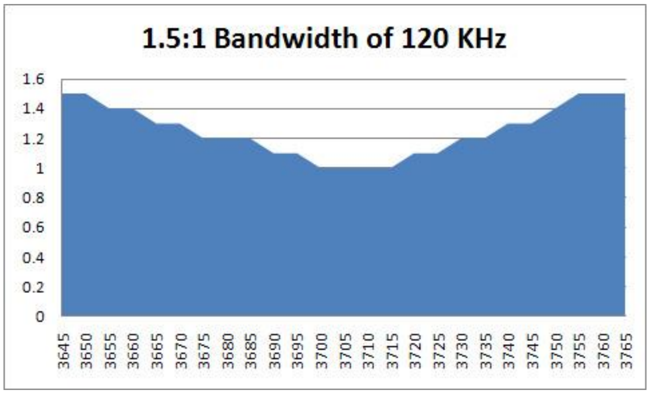
Once again, do you what you can with what you have.

How well does it tune?

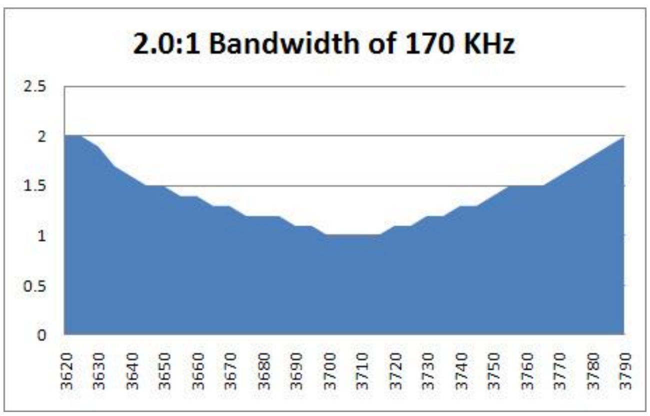
I chose to tune my 80m NVIS dipole with reflector to be resonant on 3.7 MHz, the middle of the Extra Class phone allocation for the 80m band.

The following charts how well my antenna tuned. These figures are without the use of a tuner.

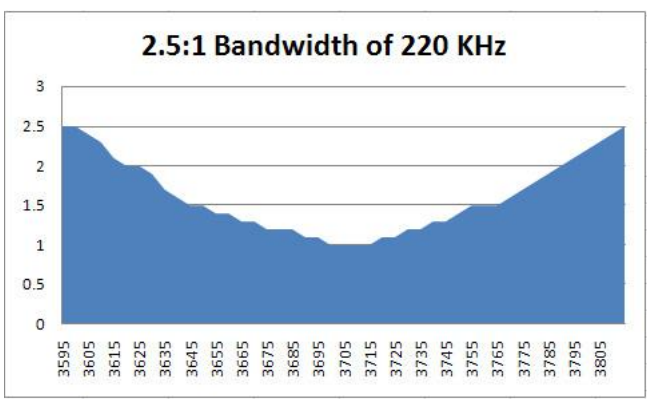
- **1.5:1 bandwidth of 120 KHz**—from 3.645 to 3.765 MHz



- **2.0:1 bandwidth of 170 KHz**—from 3.620 to 3.790 MHz

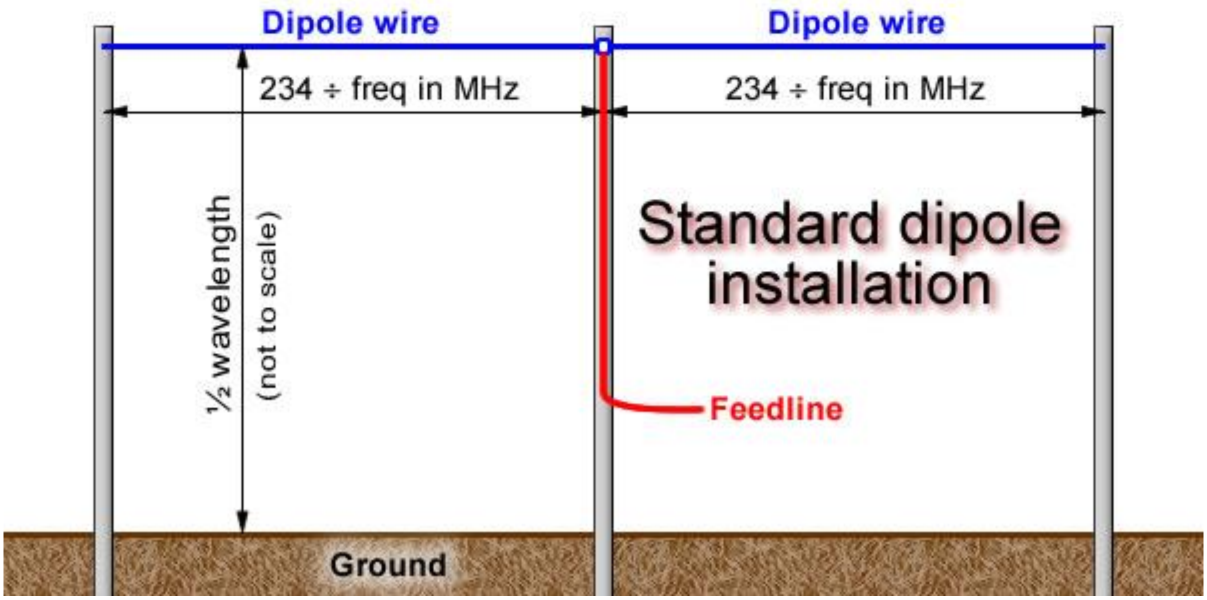


- **2.5:1 bandwidth of 220 KHz**—from 3595 to 3.805 MHz

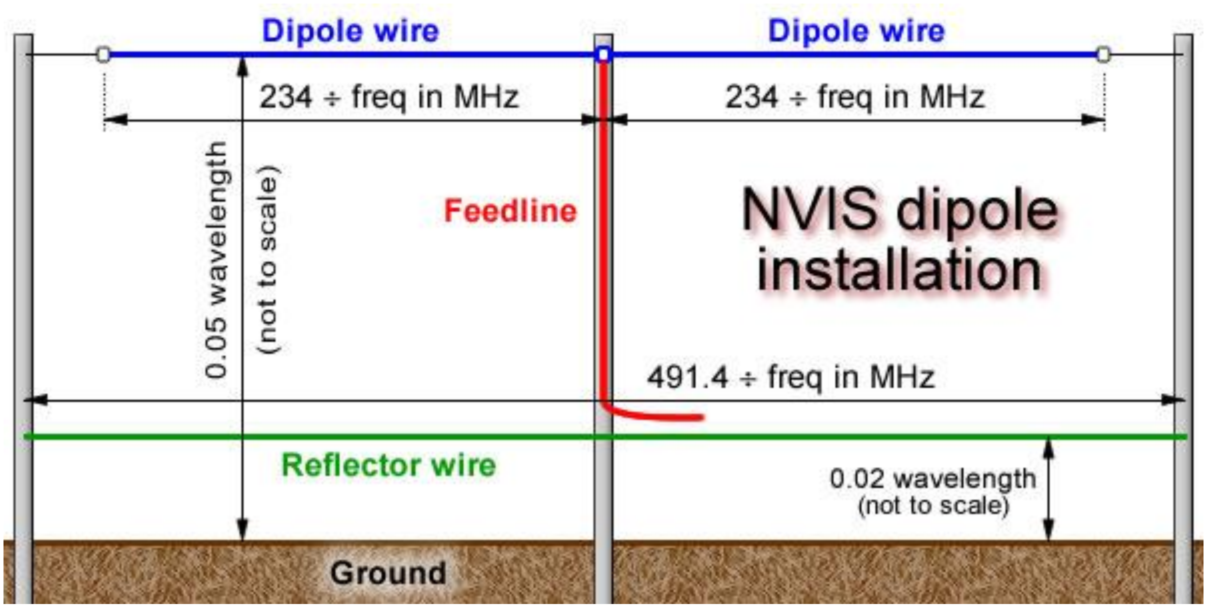


Construction and Installation

The Near Vertical Incident Skywave (NVIS) dipole antenna is a center fed dipole that is mounted low to the ground. A normal dipole installation in a perfect world would call for mounting the antenna horizontal to the ground at a height of at least 1/2 wavelength for the resonant frequency. For 80m that is about 130 feet above ground, or about 68 feet for 40m.



On the other hand, an NVIS dipole works best when mounted 0.05 wavelengths above the ground: about 13 feet for 80m or 7 feet for 40m. To make an NVIS dipole work even better, you can mount a reflector wire (that is 5% longer than than the total dipole length) at 0.02 wavelengths above the ground: about 5 feet for 80m or 3 feet for 40m. This basically turns the antenna into an upward pointing yagi.



The mounting height figures of 0.05 and 0.02 wavelength are for the optimum installation. However, as I showed with my antenna, you do not need to stick with those exact heights. A dipole laying on the ground will radiate—not well, but it will radiate. Try to get your dipole a few feet off the ground, as close as possible to the 13 feet recommendation. Also try to elevate your reflector, but it will definately work even if it is on the ground. Do use a reflector as it will add up to 3 dBd of gain over just a low mounted dipole by itself.

NVIS Dipole and Reflector Formulas (in Feet)

- **length of each side of dipole** = 234 ÷ freq in MHz

  80m Example: `234 ÷ 3.8 MHz = 61.58 feet`

  40m Example: `234 ÷ 7.2 MHz = 32.5 feet`

- **total length of dipole** = 468 ÷ freq in MHz

  80m Example: `468 ÷ 3.8 MHz = 123.16 feet`

  40m Example: `468 ÷ 7.2 MHz = 65 feet`

- **0.05 wavelegth** = 49.1785 ÷ freq in MHz

  80m Example: `49.1785 ÷ 3.8 MHz = 12.94 feet`

  40m Example: `49.1785 ÷ 7.2 MHz = 6.83 feet`

- **0.02 wavelegth** = 19.6714 ÷ freq in MHz

  80m Example: `19.6714 ÷ 3.8 MHz = 5.18 feet`

  40m Example: `19.6714 ÷ 7.2 MHz = 2.73 feet`

- **length of reflector wire** = 491.4 ÷ freq in MHz

  80m Example: `491.4 ÷ 3.8 MHz = 129.32 feet`

  40m Example: `491.4 ÷ 7.2 MHz = 68.25 feet`

RF Choke 1:1 Balun

This is optional, but recommended. Using an easy to build RF choke 1:1 balun will help keep RFI from traveling down the coax feedline and back into your shack.

a. Obtain a piece of 4 inch (10 cm) diameter PVC pipe. Or you can use a plastic container like I did. I found a small 4 inch diameter Gatorade container and used it.

b. Make 12 winds of your coax cable around the pipe/container and tape into place, as shown below.

I used a short 10 foot (3 meter) piece of RG-58 coax to make my RF choke balun. I connected the short end of the RF choke balun to my antenna, and the other end was connected to a 50 foot (15 meter) RG-8 coax cable that runs to the tuner in my shack. This method allows me to use the RF choke balun with any coax cable, which is handy for portable use.

73 de W5JCK