An Introduction to Operating on 160m

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Operating on 160 meters has always been a challenge. Two of the biggest challenges are the physical size of efficient antennas and noise when receiving. The purpose of this article is to provide appropriate information to address these two challenges, along with general information about other issues necessary to get your feet wet on topband (also known as the Gentleman's Band).

A Short History of 160m

The 160m band has been around for a long time. In the First Edition of the Radio Amateur's Handbook (1926, published by the ARRL), Amateurs had an allocation from 150 meters to 200 meters in wavelength (that's 2 MHz down to 1.5 MHz). Due to AM broadcast stations and other services, the 160m band was eventually narrowed up to 1.8 – 2.0 MHz.

Because of LORAN issues (LORAN is a radio location service), there have been power and frequency restrictions over the years. For example, during my early years in Amateur Radio in northwest Indiana (early 1960s) I could only operate from 1800 to 1825 KHz with a maximum power of 200 W during the day and 50 W during the night. There were similar restrictions in other areas of the country.

Nowadays those of us in the US can operate anywhere from 1.8 to 2.0 MHz at up to 1500 W PEP output. Of course you should always strive to use the minimum power to make the QSO.

The first order of business for an introduction to 160m is to look at the band plan for 160m – what frequencies should we use for CW, what frequencies should we use for SSB, what frequencies should we use for AM, etc.

160m Band Plan

Unlike our HF bands, the FCC (Federal Communications Commission) does not regulate 160m with respect to band segmentation by mode. Legally any mode can operate anywhere. But obviously this could cause (and has caused) conflicts.

To impart order to this issue, a "Gentleman's Agreement" band plan was developed by an ARRL Ad Hoc committee with input from users of 160m. The recommended band plan is shown in Table 1. You are <u>strongly</u> encouraged to adhere to this plan. A little cooperation among fellow Amateurs can go a long way!

1.800 - 2.000	CW
1.800 - 1.810	Digital Modes
1.810	CW QRP
1.843-2.000	SSB, SSTV and other wideband modes
1.910	SSB QRP
1.995 - 2.000	Experimental
1.999 - 2.000	Beacons

Table 1 – 160m Band Plan

With the band plan outlined, a couple comments on where 'common' activities take place is in order. Rag chewing on 160m starts around 1.843 MHz and extends all the way up to 2.0 MHz. There's a lot of spectrum above 1.9 MHz that is relatively lightly used, so you might want to consider moving up there for your rag chewing activities. AM aficionados hang out around 1.885 MHz, and it's an enjoyable side hobby to fix up old radios and put them on the air (I can vouch for this through my efforts with my Viking Ranger II and Drake 2B with a homebrew converter). Finally, most DXing on 160m outside of contests is done on CW in the lower 35 KHz or so of the band. If you want to work DX on 160m, knowing code is almost a must due to CW's inherent weak signal advantage over SSB and the CW bandwidth letting in less noise (more on this latter aspect in a bit).

Since LSB (lower side band) is normally used on 160m, note that 1.843 MHz refers to the carrier frequency for LSB. The intent here is to keep the side bands at 1.840 MHz and above (since the bandwidth of an SSB signal is about 3 KHz). And there is no segmentation by license class – General, Advanced, and Extra class licenses have equal access to the entire band.

When Is 160m Good?

Now that we know where we should operate in the 160m band, the next issue to address is when should we operate – that is, when is 160m good?

If your interest is only for local QSOs (rag chewing, nets, etc), then 160m is good anytime – day or night, summer or winter. And where we are in a solar cycle won't matter, either.

If your interest in 160m is DXing, then there are times, seasons, and phases of a sunspot cycle when 160m is best. Due to excessive daytime D region absorption, 160m is useful for DXing when the path is in darkness or very near darkness. Because of geomagnetic field activity considerations, 160m is best during the winter months and from solar minimum to a couple years thereafter. The latter portion of the previous sentence says now is the time to get on 160m if you're pursuing DXCC or WAZ. We are at solar minimum between Cycles 23 and 24, and the next couple of winter seasons (2006-2007, 2007-2008, and possibly 2008-2009) should offer excellent opportunities for the DX minded.

Simple Transmitting Antennas

As stated in the introduction to this article, the first biggest challenge for operating on 160m is the physical size of an efficient transmitting antenna. The length of a half wavelength dipole at 1.85 MHz is approximately 253 feet (each side would be about 127 feet). That's quite a bit of a horizontal span for those on small lots.

An easy way to overcome this horizontal span requirement is to make the dipole into an inverted-vee. For example, the top of a 50 foot tower or 50 foot support could be used as the center point for the inverted-vee. The sloping portion of each side of the inverted-vee could be approximately 70 feet, with the remaining 57 feet running horizontal to the ground and even snaked around a bit to fit the lot. Figure 1 shows this configuration. This would make an excellent antenna for local activity on 160m (but don't be surprised if you work DX with it – the ionosphere can be the great equalizer among different stations).

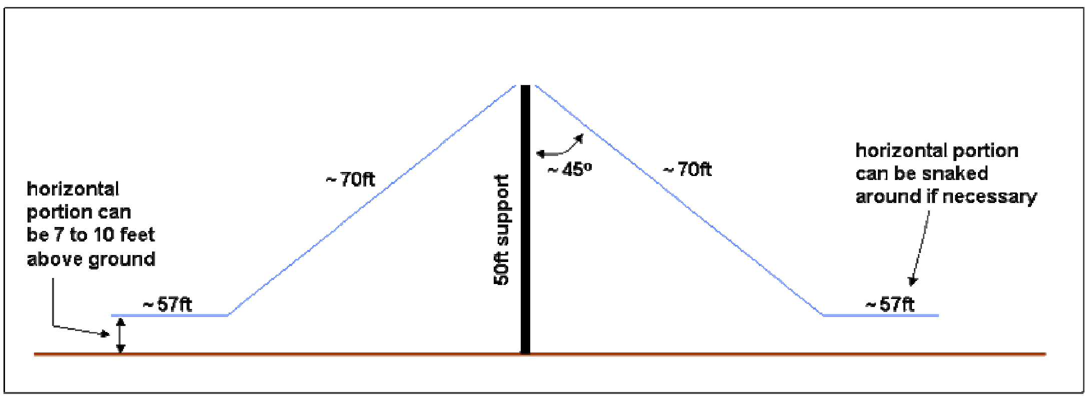

Figure 1 – Inverted-Vee Installation

If your interest is DXing, generally you'll want an antenna that puts more of its energy at the lower elevation angles. Perhaps the simplest antenna to fit this bill is the inverted-L. The total radiator length needed would only be about 127 feet, as this is essentially a vertical antenna operated against ground. A tree could be used to support the vertical portion of the inverted-L, with the remaining length (127 feet minus the vertical portion) sloping down to a convenient support. Figure 2 shows this configuration using a tree for the support. Either buried radials, radials lying on the ground, or elevated radials could be used to provide the ground image for this antenna.

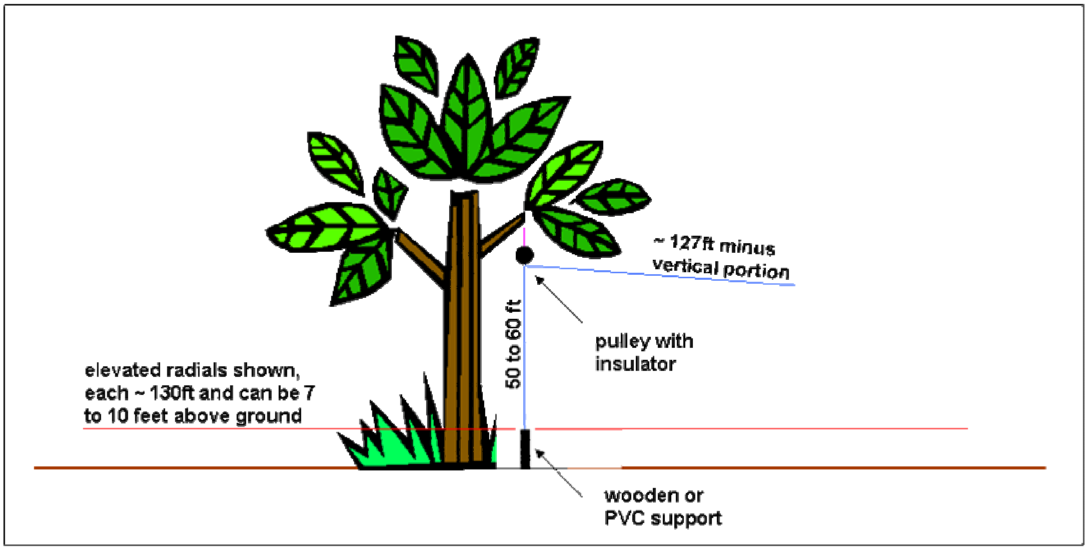

Figure 2 – Inverted-L Installation

Figure 2 is what I use on 160m, with a pulley in a nice tall tree anchoring the vertical portion and six elevated radials at about 7 feet to keep the deer from running into them.

Noise

The second biggest challenge noted in the opening paragraph (mostly affecting those interested in DXing) is noise and is noise and its impact on the ability to hear weak signals. There are two sources of noise that make receiving on 160m difficult: man-made noise (machinery, appliances, lights, and so forth) and atmospheric noise (static from lightning discharges propagating into your QTH). Figure 3 shows the magnitude of the noise problem (from data in the International Telecommunications Union document Rec. ITU-R P.372-7).

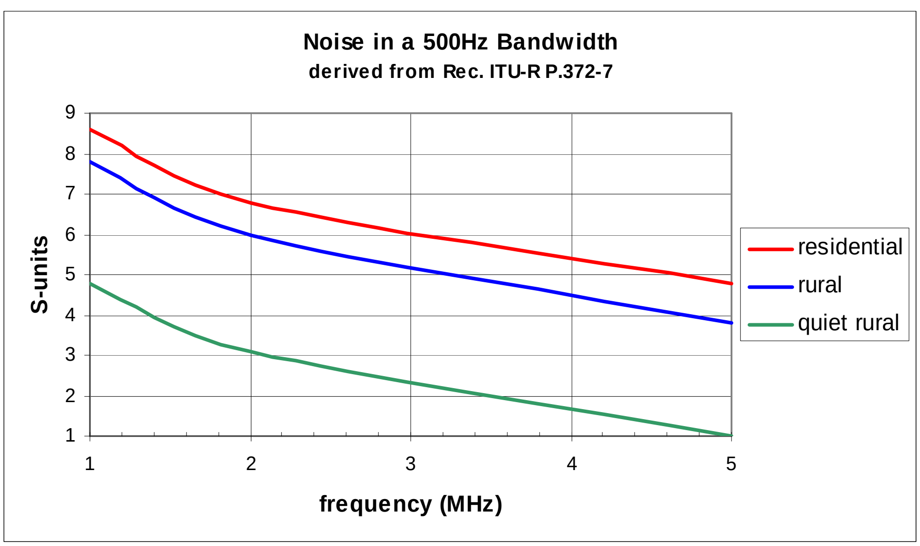

Figure 3 – Expected Noise Levels

The three curves in Figure 3 are the expected noise from a short monopole antenna in a CW bandwidth (500Hz) in terms of S-units for three noise environments: residential, rural, and quiet rural. This plot should be used as a ballpark guideline, as your mileage may vary according to your specific local conditions. I would expect the noise received by the inverted-L in Figure 2 to roughly agree with the short monopole data in Figure 3, with the inverted-vee of Figure 1 maybe a bit better due to some directivity (see the next section). For the data in Figure 3, I assumed S9 was -73 dBm (50 microvolts) and an S-unit was 5 dB (based on my measurements, this is typical of current receivers).

In a residential area, the expected noise on 160m in a CW bandwidth is around S7. Wow! Even moving to a rural area only knocks this down to S6. Heading out into the country puts the noise at S3. That S3 value is the level of noise in a CW bandwidth on my OMNI VI Plus using my inverted-L.

The S3 value doesn't sound like much, but remember that the noise floor of a modern receiver is around -130 dBm. Using a signal generator, the S3 value on my OMNI VI translates to about -103 dBm. Thus I am giving up almost 30 dB of "hear-ability", which is the difference between my external noise level and my receiver's noise floor when using my inverted-L for receive.

Be aware that the data in Figure 3 assumes you don't have a particularly troublesome local man-made noise source that masks everything else (for example, a noisy utility line). If you do, then you have your work cut out to eliminate it. On a personal note, the most interesting noise source I've had to find and resolve was an electric blanket used by our neighbors to keep their cat warm.

Simple Receiving Antennas

When you first start out on 160m, you'll probably use your transmit antenna for receive. As you progress with your 160m activities, you may need to work weaker signals that are at or even below the noise level resulting from using your transmit antenna.

This is where low-noise receiving antennas come into play. Regardless of the category of the low-noise antenna, they all work on the same principle – increase the directivity of the antenna (make front-to-back and front-to-side ratios larger) to reduce the total amount of noise being received from around the compass. This assumes the arriving noise is not a localized source as mentioned in the previous section. And if there is a noise source in the direction you want to receive, you have a real problem.

The improvement in "hear-ability" for a given low-noise receiving antenna will generally follow the narrowness of the pattern – a narrower pattern will let less noise into your receiver and lower your noise level, and thus will thus allow you to hear closer to your receiver's noise floor. From this consideration, we can make a first-order list of how effective some of the common low-noise receiving antennas will be. In order of least effective to most effective, they are:

Short Beverage (80m long)
Elongated terminated loops (EWE, Flag, K9AY, etc)
Standard Beverage (160m long)
4-Square (quarter wavelength spacing)
Long Beverage (300m long)

Remember that new layers of DX may be heard with noise reductions of as little as 3 dB. So don't rule out the antennas in the first two categories. Even though they are small, they will probably fit on almost any lot. And they might just make the difference for you in making a QSO.

If your only problem is that of a troublesome localized noise source mentioned earlier that defies elimination, consider using a small loop antenna to null out that direction.

Propagation and Predictions

If we look at worldwide electron densities, we'll see that the ionosphere always has enough ionization to refract 160m back to Earth for multi-hop propagation – even during the dead of night at solar minimum. Thus the problem on 160m is not with the MUF (maximum usable frequency) – it's with the amount of absorption and the resulting signal strength. This was the basic premise mentioned previously in the "When Is 160m Good?" section – due to absorption, the best place for 160m RF is in the dark ionosphere.

Now if you've used propagation predictions on our HF bands, you've probably noticed that most of them do not include 160m. There's a very good reason for this – it's because of the impact of the Earth's magnetic field on three basic propagation parameters. With 160m being so close to the electron gyro-frequency, the magnitude of the magnetic field and the direction of propagation with respect to the direction of the magnetic field modify the amount of absorption incurred, the amount of refraction incurred, and the polarization of the wave(s). This can get very complicated very quickly over long paths, and the proper way to address this rigorously is with full-blown ray tracing software.

Over the years there have been several studies by 160m enthusiasts to come up with a simple method to predict whether 160m is going to be good on a given night. These studies have usually been based on solar flux and K or A indices. These efforts have not met with much success, as they do not consider all the variables that appear to be involved with propagation on 160m – especially events that happen in the lower ionosphere to enable ducting mechanisms and reduce absorption. In general a quiet geomagnetic field seems to be a requisite, but it doesn't appear to be the <u>only</u> requisite.

This all comes down to two simple pieces of advice with respect to propagation on 160m:

1. Use the excellent mapping feature in many of our propagation prediction programs to determine the best times for 160m propagation over the desired path with respect to darkness along the path. Pay

particular attention to sunrise and sunset times at your QTH and at the other end of the path for possible signal strength enhancements.

2. Get on the band to check it out in real-time. Watching PackerCluster spots also helps to get a real-time assessment.

Worldwide Allocations

If your goal on 160m is to work DX, then it would be helpful to know where all the DX entities can operate on 160m. An up-to-date list of these allocations can be found at **www.qsl.net/n1eu/topband/160FreqAlloc.xls**.

Aids for 160m Operating

The side bar accompanying this article lists several sources of information to learn more about 160m – from more effective transmitting antennas (better than those described earlier) to low-noise receiving antennas (like those mentioned earlier) to the intracasies of propagation on 160m to planned DXpeditions to general topics. If you have the desire to go deeper into any of theses areas, check out those references.

Summary

As mentioned several times in this article, 160m is also known as the Gentleman's Band. The current users of 160m would like it to stay that way. So regardless of your operating preference (rag chewer, DXer, contester, digital enthusiast, QRPer, or whatever) please strive to uphold the reputation of 160m.

The advice and solutions offered in this article probably won't get you to the Top of the DXCC Honor Roll on 160m. But they will allow you to sample the challenge and adventure of 160m. Where you go from there is up to you.

160m Tips

The following is a list of tips, slanted toward the DX aspect of operation on 160mn, to help you enjoy your experience on 160m.

Station issues

- Put out as much wire as possible for your transmit antenna
- Work with the utility company and/or neighbors to fix noise sources
- Further improve your ability to hear by using low-noise receive antennas

Operating issues

- Listen, listen, listen
- Don’t call incessantly in a DX pile-up
- Be courteous and uphold the reputation of 160m as the Gentleman’s Band

Propagation issues

- Know when the desired path is in or very near darkness
- Pay particular attention to sunrise and sunset times
- Don’t shy away from elevated K indices – there may be skewed paths
- Check paths to the southwest at your sunrise and southeast at your sunset

Aids for 160m Operating

ON4UN's Low-Band DXing by John Devoldere ON4UN (Fourth Edition, published by the ARRL)

> This book is an excellent source of vast technical information for serious 160m aficionados. It covers propagation, transmitting antennas, receiving antennas, receiver performance, transmitter performance, and more. The ranking of the effectiveness of common low-noise receiving antennas in the text of the article came from the RDF values on page 7-97 of this book.

DXing on the Edge – The Thrill of 160 Meters by Jeff Briggs K1ZM (published by the ARRL)

> This is an easy-read book with a chronology of 160m DXing from the 1930s to the present, many operator biographies and station descriptions, descriptions of simple antenna systems, and general operating information. It includes a CD with memorable moments on 160m.

The TopBand reflector

> The TopBand reflector, moderated by Bill Tippett W4ZV, is an on-line source of 160m information. It includes help information, operating practices, early announcements of 160m DXpeditions, and technical discussions. You can subscribe to it by going to www.contesting.com, and then clicking on Other Lists on the left.

W8JI website

> Tom Rauch W8JI maintains a website (www.w8ji.com) dedicated to many low band topics, with many informative technical discussions.

The Low Band Monitor

> This is a monthly periodical edited and published by Steve Gecewicz K0CS (under the pen name Lance Johnson) devoted to 160m, 80m, and 40m operating. Several annual operating awards are offered to low band enthusiasts. For more information, visit www.lowbandmonitor.com.