Ten things to know for more success on 60 m

December 2016, by PA2S

At the time of writing, the WRC 2015 allocation of the 60 m band is going into force. Administrations can grant permission to operate in the 5 MHz band. It is expected that many amateurs want to explore the new allocation.

In The Netherlands, we were allowed to use 100 kHz in the 60 m band in December 2015. Our allocation is expected to change to 15 kHz in the near future, which I regret (and consider not at all necessary).
With the limited space, it is very important to cooperate and to use the band with care and respect for each other.

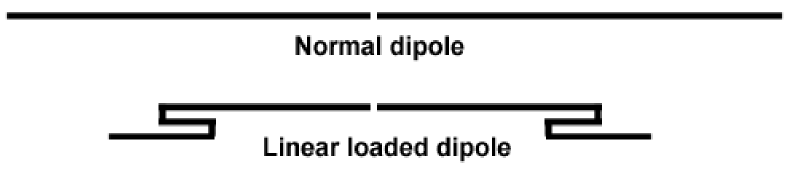
As the WRC allocation only allows about 15 to 20 W (EIRP) it is extremely important to optimise the station. Therefore, I would like to share some ideas that may help to be more successful. At the bottom of this article, you will find information about weak signal modes and a suggestion to promote JT-9.

Antennas

Everyone knows that the antenna largely determines the performance of a station. The most important properties are size and height. Of course, you can have success with small loops and such, but you cannot break physical laws. Miracles do not exist. But even in limited situations, you can make the most out of it, by keeping some things in mind.

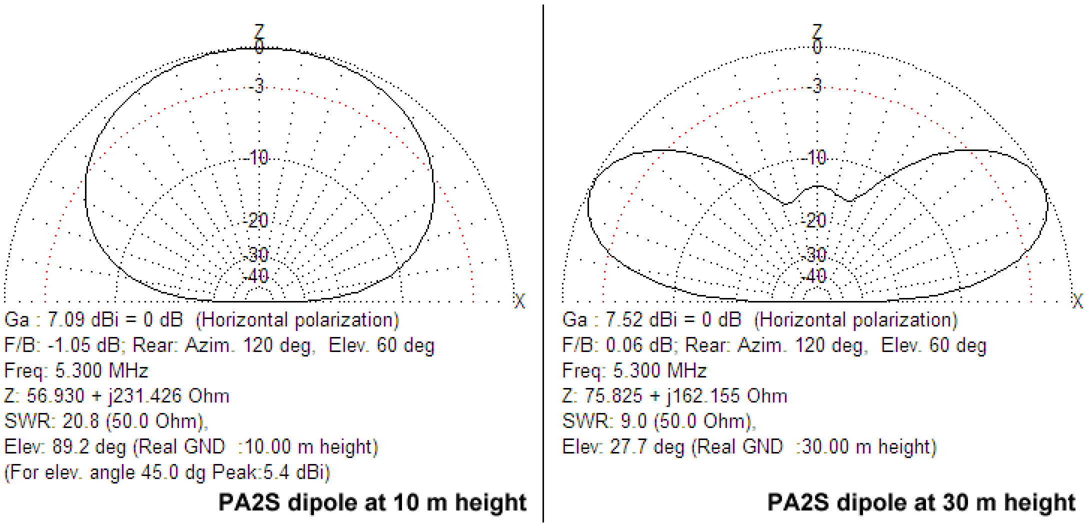
1. **Size matters**
   If you have space for a dipole or the like, use it. It is simple, effective and low cost. Do not spend money on fancy commercial loops with remote tuning or similar "miracle" antennas, because you will find that your signal is a weaker compared to many others, even those with just a RPW antenna (RPW = Random Piece of Wire). Loops can be great for receiving, but for transmitting, you have to accept that size matters. I will get back to receiving later.

2. **Current radiates, not voltage**
   The antenna radiates with the part where the current flows. So, a dipole will radiate most from the centre. If you want to make a shorter antenna, try to do that at the ends. You could use coils, but a much simpler method is linear loading (picture 1). The shorter the overall antenna, the less the gain, but shortening the antenna by 25% has no noticeable reduction in gain.



Picture 1 - Linear loaded dipole

3. **Height helps a great deal**
This classic rule will also never change. Picture 2 shows my dipole antenna, at heights of about 10 m (as it is) and 30 m (as I wish I had...). The diagram shows that the high antenna has low gain upwards. So, for near vertical skywave propagation, that height is not suitable. But it is also clearly seen, that the low angle radiation from the higher antenna is stronger. For an angle of 10 degrees, the difference is about 6 dB or a 1:4 power ratio. For DX, the high antenna is the better one. If you are interested in working stations within a shorter range, the lower antenna is fine. When lifting the antenna to about 20 m, the low angle gain improves with about 3 to 4 dB.



Picture 2 - Comparison of dipole at 10 m and 30 m above ground

4. **What about verticals?**
Verticals are often said to be good DX antennas, because of the low radiation angle. But it is important not to forget some other aspects as well. Computer models show that only at the lowest angles, verticals can be better than horizontal antennas. But that is only true when the antenna can radiate freely. Nearby buildings, for example, can spoil things. It is also very important to use radials, otherwise your antenna will perform poorly.

I tested verticals, but found that it did not improve my signal. I tested that with a web SDR in Andorra. Although that was not the ultimate low angle destination, the signal was not better than the dipole. For receiving, the vertical was very noisy, picking up man made noise from several sources, like a plasma TV. With the dipole, my background noise level is about S 4 to S 5, rising to S 6 when the noise sources are on. The vertical had over S 9 noise. In my opinion, verticals are best when you have a quiet location without nearby obstructions.

5. **Balance is very important**
   Do not connect a dipole *directly* to a coax cable. Do not fool yourself because the SWR is good. Your SWR meter or antenna analyser does not show you if a dipole is balanced. Without a balun, the feeder may become part of your antenna and will radiate and receive. In many cases, the gain drops and your feeder will also pickup man made noise. You can experience RF in the shack as well. Use a 1:1 balun or choke (like the ugly balun, see below) to get it right.

6. **Man made noise**
   Nowadays, man made noise is a big problem. EMC directives protect manufacturers of electronic crap, instead of those who really need protection: the users of RF spectrum. Nevertheless, I tried to see what I could do to mitigate the problem (somewhat). I noticed that the man made noise at my location was mostly vertically polarised. That explained the noisy vertical antenna, but it also triggered me to experiment with the dipole. A commercial 1:1 balun (Diamond) performed better than my coil balun also known as "ugly balun" (picture 3). Moving the legs of the dipole around, revealed that it is worth experimenting with height and position. I assume that with height, you can improve the balance.

   The ugly balun is very simple and can improve balance and help to avoid noise and RF in the shack. For just a few $ or €, add a few extra dB of emitted power and improve your reception considerably.

Picture 3 - Ugly balun - Red and black wires connect the dipole with the inner and outer conductors of the coax

7. **Receiving antennas**

Atmospheric noise on 60 m is quite strong. That is the bad news. I have never seen less than S 4. However, the good news is that you can use antennas with low gain and still get good reception. Remember that S 4 noise is about 4 * 6 = 24 dB, so even if the receiving antenna would have 20 dB less gain than a dipole, the background noise is stronger than that of the receiver. You will not loose sensitivity as long as you can hear the antenna noise.

It is certainly worth experimenting with receive antennas. When your transceiver has a separate receive input, it is time to get out of your operating chair and start improving your reception! The easiest receive antenna is a loop. These have a sharp null and that null can be used to cancel out noise or interference. A terminated loop can also be a good receive antenna. This type of antenna has been around for many years. It is a loop with a terminating resistor at one end and the feeder at the other. The impedance of the antenna is about 800-1000 Ohms, so a transformer is needed to match it to a coax feeder. Use a variable resistor as terminator when testing. As soon as you have found the optimum value, replace it with a fixed resistor. There are numerous articles about this antenna, search for "flag antenna" and you will find many. It works from 160 to 40, so it can be used for reception on a number of bands.

The advantage of the terminated loop over usual small loops is that the antenna has nulls to the side and a null to the back. So you get a true directional antenna, that can even be rotated. The output is low, using a preamplifier is an option to reduce pickup of noise by the feeder.
A well known variant is the K9AY loop, that uses two loops with a control box, that switches between loops and direction.

The "mother of all low band receiving antennas" is the Beverage. It was invented by Harold Beverage in 1921. Long beverages have a sharp directional pattern and that explains the lower noise. Remember that the noise usually comes from all directions and if the antenna is directional, it will receive less noise from the side and back, whilst leaving the wanted signal intact. There are several demonstrations on Youtube showing the remarkable difference between dipoles and Beverages. If you have space, you may consider putting up one or more Beverages. A simple internet search will do! Do not forget to check options to reverse direction and to switch antennas.

8. **Practical examples of antennas for 60 m**

A dipole is very easy to construct. As said, use a balun to adapt a coax feeder to the balanced antenna. On 60 m, the wire thickness is not so important, I am using surplus army telephone wire, that has both steel and copper wires. Steel is strong and copper conducts good, so a perfect combination.

The WRC band segment is only 15 kHz wide (ehhm narrow), so there is not much to worry about bandwidth. Optimise it for around 5360 kHz and you are done. Even if your band allocation is wider, a dipole will be almost 1:1

over the whole band. Linear loading could reduce the bandwidth a bit, but with 15 kHz, you will not notice that.

The centre of the antenna (where the current flows) should be as high as possible and an inverted-V is just fine. Make sure that the legs are not too close to anything, as that can detune the antenna. I was using a fibreglass mast at first, using pulleys and ropes to fix the wires. I attach little plastic bottles with water to the ends of the ropes, to regulate tension, without risking breaking wires with heavy winds. This is also very useful when trees are used as supports, so that moving trees do not cause problems.

Another relatively easy made antenna is the flagpole vertical. If your local noise level is low, this is something to consider. The antenna is made of a quarter wave vertical with a reflector, that goes diagonally down from the top and then back to the radiating element. You need an isolating mast, like a fibreglass mast. The reflector can be moved around so you can “turn your antenna”. Check OU5U on QRZ.com for a description of his antenna.

Recently, I replaced my 60 m dipole with a doublet, balanced feeder and a tuner. The legs are about 16 m each and the feeder is 450 Ohm ladder line, that is matched with a tuner. The length of the ladder line is about 12 meters. My shack is right below my antenna. The doublet is as good as the dipole I had before and it operates on all bands, even with limitations on 160. Last November, I worked about 96 entities during the CQWW CW contest with only 100 Watts. Nearly DXCC in a weekend with a simple antenna!

My balanced feeder system - wooden supports keep the ladder line away from the tower

One of the first antennas I tried, was an off centre fed (OCF) dipole, hoping to get a "multiband" solution. But this antenna has a major disadvantage. The coax feeder carries heavy currents over its shield, unless a very good choke is used. A coil of coax improved things, but the overall performance was not what I hoped it would be. The dipole was simply a lot better.

End fed antennas are quite popular and I have worked stations with good signals, but some stations did not get out so well. End fed antennas should be about a half wavelength at which they have a high radiation resistance. The high impedance does the "trick", because it avoids earth losses. With a low antenna impedance, a very low impedance earth is necessary to get the RF current into the antenna. Setting up an end fed antenna can take quite a bit of time. If you want a dedicated 60 meter antenna, I would prefer a dipole over an end fed, because with a dipole, you do not have to worry about earth resistance. An end fed could be noisier as well. But if it works, it is just fine.

9. **Propagation**

Many books have been written about the ionosphere and radio wave propagation. I will only summarise some interesting aspects.

If you ask me, the 60 meter band has interesting properties and has its own "character". The D-layer absorption level roughly between those of 80 m and 40 m. During daytime in the summer, the attenuation is highest and signals are weak, but not as bad as 80. The lower the sun, the less the absorption gets and especially during twilight, signals can be strong.

60 is definitely a band for night owls. During the night, propagation can be very interesting, because the D-layer disappears. With low solar activity, the nighttime F2 layer critical frequency is below 5 MHz and the skip distance increases during the course of the evening and night. Conditions on 60 are usually fairly stable over longer periods. After sunset, the F2 layer can change quickly and sometimes, signals from not too distant stations can drop within 10 minutes from over S9 to next to nothing.

The magnetic activity is also important. When the K-indices are low, the best propagation occurs on east-west paths on middle and higher latitudes. Paths across or near the equator are less sensitive to magnetic activity and it is observed that these paths are even better when the magnetosphere is active. The polar regions experience high absorption and conditions on higher latitudes are usually poor when the magnetic field is active of at storm levels. If a path crosses a polar region, it can suffer from strong absorption when the magnetosphere is active. As a general rule, the ionosphere is better near the equator and weakest in polar areas.

My experience is that the ionospheric attenuation also depends on the magnetic activity. For example, stations from the USA can be weak during active periods, but after a few days of quiet magnetic conditions, the signals improve.

It is good to pay attention to the grey line. Low band DXers know that paths near the greyline can be interesting. A recent experiment with 60 m transmissions to Australia showed that propagation peaks just after sunrise in Australia. So keep an eye on the greyline map!

As the sun rotates, regions can reappear the next rotation. One rotation takes roughly 27 days. Periods with good or disturbed conditions can repeat, because the same area of the sun faces the earth.

Some nice DX examples from my logbook are CE3WW, VP8ALJ and ZD8V. My signals are regularly received by VK7BO, who hopes to be able to transmit soon. Also reports from DP1POL on Antarctica were surprising. Over time, more can be expected.

Before I forget: long path propagation is certainly possible. Expect the unexpected!

10. Band plans

60 m allocations vary from country to country. The 15 kHz “WRC” band is harmonised, but some countries have different bands. The USA and UK have little segments (block allocations) for example, whilst Norway, Denmark and The Netherlands have band allocations. It is expected that changes will take place.

There is a Wikipedia page about 60 m and that page is being maintained well and provides useful information about the different allocations. This is definitely a specific feature of 60 m. Sometimes, you have to be aware that stations cannot answer on your frequency.

At this time, 5357 kHz is much used for JT modes, also because this frequency is shared amongst the WRC band as well as the US and UK allocations.

I would like to add a critical note about a IARU Region 1 band plan for 60 m. In my humble opinion, this plan is useless and also denies reality. Because of the block allocations in the USA and UK, 5357 is heavily used for JT modes but according to the IARU plan, digimodes should be between 5351.5 and 5354.0 kHz. This is outside the UK and USA allocations and thus useless. The plan also suggests to use very narrow weak signal modes with 20 Hz bandwidth between 5366.0 and 5366.5 kHz. This is next to the SSB segment and it is very likely that the weak signal segment would render useless because of splatter and QRM from SSB signals. I am sorry, but those who made this plan, seem to have little insight in the utilisation of the 60 m band. I suggest to forget about the plan and instead, be respectful. In cases, working split can help, certainly as long as the allocations differ. Even when everyone had the same frequency band, it would be much more sensible to allocate narrow modes at the bottom and wider modes at the top, just like it has been for many years on the other amateur bands.

Weak signal modes

1. **Introduction**
   Joe Taylor, K1JT is a true innovator with regard to amateur radio. He applied fundamental physical principles to software, that makes contacts possible with very low signal to noise ratios. Not only effective for moonbounce (EME) but also for shortwave. The most popular mode is JT65. It "beats" CW with about 10 dB. Stations that are just too weak with CW and therefore "out of range", can still be worked with JT modes.
   The gain comes at a price: time. A QSO takes about 6 minutes to complete, but it patience pays off. Without JT, the number of entities worked would have been considerably less.

2. **Crowded bands: JT9 is the solution**
   With the expected activity next January, the band can get very crowded. Overlapping JT65 signals cause QRM and decodes can be lost, thus slowing things down and operators might get irritated. If we want to avoid that, it is a good idea to use JT9 instead of JT65. The bandwidth of JT9-1 is less than 20 Hz, compared with 200 Hz for JT65A. Many more stations will fit in the narrow band, with less QRM and more fun.
   According to K1JT, JT9 should be a bit more sensitive than JT65, so there is nothing lost if you use JT9 instead of JT65.

3. **Two modes and transceiver control**
   The WSJT-X software can decode JT65 and JT9 simultaneously, so if you select that option, you can see both modes. WSJT-X can control transceivers. For example, I connect via USB to my Icom IC7600 and no other cables are necessary. The audio quality is very good, thus reducing problems, like audio distortion that can cause unwanted emissions.

4. **JTAlert**
   A nice add-on is JTAlert, that does a number of things. It can connect to various logging programs, it uploads spots to hamspots.net and has a lot of other features that help you to identify stations of interest. It also has a chat feature.

5. **JTDX**
   At the moment. I am using JTDX (a fork created by UA3DJY and others). It is based on WSJT-X but has more options, like a more "aggressive" decoder. The latest version of JTAlert works with JTDX.

Links

WSJT-X:	http://physics.princeton.edu/pulsar/K1JT/wsjtx.html
JTDX:	https://www.qrz.com/db/UA3DJY
JTAlert:	http://hamapps.com

Seasons greetings!
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