14 to 28MHz Wire Antenna

This article describes installing a multi band wire antenna for use on 14,18,21,24 and 28MHz.

In order to operate the radio some compromises had to be made and with having the antenna size restricted also came having a limited number of bands to operate on.

Wanting to operate on as many bands as possible, the deciding factor on what antenna could be installed would depend on the space available at this QTH and the supports that could be used or erected which in turn would govern the number of bands that I could operate on.

What did I have or could have? I could secure 1 x 18ft pole to a garden wall, I also had a 8ft garden wall which had a 1ft metal railing on top to which I could attach a 2ft x 1" diameter galvanized pipe raising that one end height to 10 ft, the distance between the 18ft and the 10ft pipe was 24ft, measuring what I have scaled down onto paper I could fit 26ft total top antenna length minus the end insulators, I settled for a total top length of 24ft and the center of the antenna would be 14ft above the ground.

With a doublet antenna and using 300 or 450 ladder feeder (or open wire feeder) operation on the 20/17/15/12/10 meter bands with the 24ft antenna length using an ATU would be possible.

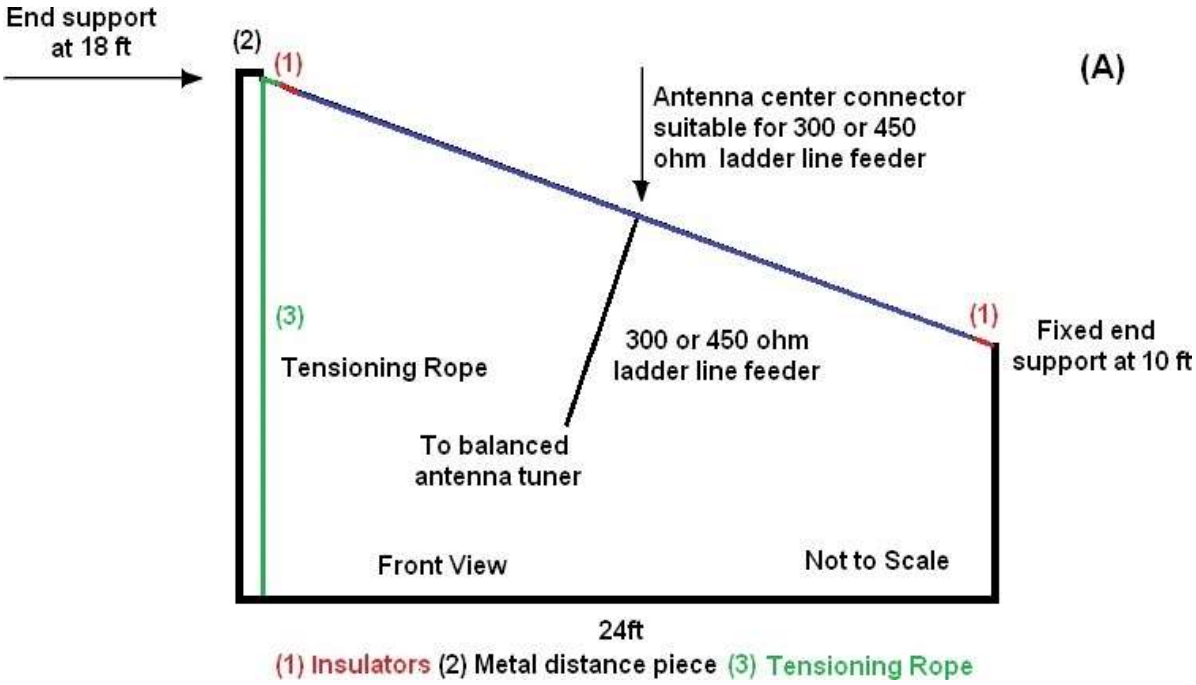

Fig (A) shows a front view of the antenna, one end of the 24 ft antenna is fixed using an insulator to the 10ft support and the other end is connected using an insulator to a tensioning rope at the 18ft support.

It is preferable to have the ladder feeder come away from the antenna at a 90 degree angle.

When amateurs speak or write about a dipole, they usually mean a half wave (1/2λ) dipole, using 5/8,1/2, 3/8, 1/4 etc wavelength, the wavelength is with reference to a full wavelength (λ) at the operating frequency. In amateur radio the full wave dipole antenna is seldom used due to the high input impedance and the full wave is double the length of a 1/2 wave dipole.

The length of a full wavelength (λ) dipole antenna can be found by 984/MHz = feet, for practical purposes due to the end effects, antenna wire etc 936/MHz = feet can be used. Full wavelength dipole for 20 meters would be 984/14MHz = 70ft or 936/14MHz = 67ft.

The 1/2 wave dipole is widely used because it: Has reasonable length. Efficient when used at the resonant frequency. Matches well with transmission line impedance.

The theoretical 1/2 wave dipole is 492/MHz, taking into account end effects etc for the physical length of a typical half wave dipole antenna we can use 468/MHz.

Using 468/MHz, for a 1/2 wave dipole on 20 meters the total length would be 468/14MHz that is around 33 ft and each leg would be around 16.5ft.

Height for a dipole? Read; for best results 1/2 wavelength above ground and when the dipole is lowered to 1/3 wavelength it will have higher radiation angles.

Within certain limitations a reduced center height will still allow the user to operate their radio. My antenna center would be at 14ft so I am stuck with the center height I have.

Not wanting to be limited to one band next was to find an antenna which would allow me to operate on as many bands as possible including 20 meters and using no traps or baluns.

In this age of political correctness, I state for the record that I have nothing personal against traps or baluns.

What antenna could fit into the 24ft? A half wave 20 meter dipole with a total top length of 33ft wouldn't fit into the 24ft, a half wave dipole for 15 (22ft), 12 (19ft) or 10 (17ft) meter bands would fit into the 24ft with operating being limited to a single band.

The doublet antenna is a form of dipole but unlike the half wave dipole the antenna top length is not cut to resonate at any particular frequency and the length may be chosen to suit an individual location, in my case the length that would be 24ft.

The doublet antenna is essentially a balanced system, each half of the top plus each wire in the feeder must be equal in length and when used with ladder line or open wire feeder enables operation on multiple bands which don't always have the lowest SWR on each and every band and being a non-resonant antenna on some frequencies the antenna impedance could be high.

The ladder or open wire feeder is able to operate with levels of standing waves along its length and effectively becomes part of the antenna.

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As a guide for the minimum total top length of the multi band doublet, a 1/2λ length at the lowest operating frequency, a doublet with a minimum of 1/4λ to 1/3λ length at the lowest frequency of operation will work but with reduced effectiveness.

The doublet top length can be reduced to about 3/8λ without any major reduction in performance and has about 98% of the efficiency relative to a half wave dipole.

Example: If space for the doublet antenna top length is limited, a rough guide using as the minimum top length of 1/3λ (or 1/4λ) and one full wavelength (λ) for lowest operating band.

For 20 meters using 936/14MHz = 67ft, a minimum 1/3λ = 22ft for operation on 20/17/15/12/10

For 15 meters using 936/21 MHz = 45ft, a minimum 1/3λ = 15ft for operation on 15/12/10

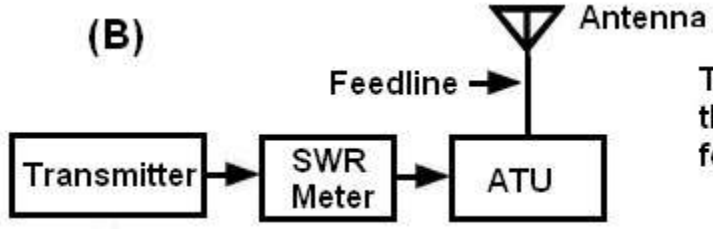
For 10 meters 936/28 MHz = 33 ft, a minimum 1/3λ = 11ft for operation on the 10 meter band

The doublet like the dipole is a balanced antenna, that is neither side of the antenna and feed line is grounded whereas the transceiver output impedance (50Ω) is unbalanced. On many modern transceivers, one side of the transmitter output is at the chassis-ground potential.

The multi-band doublet; the antenna and feed line impedance can vary over a wide range depending on frequency and other factors, to present the transceiver with the required impedance (50Ω) a balanced antenna tuning unit (ATU) is used.

If the ATU does not have a balanced output, an internal or external balun is sometimes used so that the unbalanced to balanced transition is present

If the impedance seen by the transceiver departs from the design load, modern transceivers automatically cut back the power output to protect the equipment from the consequences of the impedance mismatch.



The ATU is an impedance matching device that matches the impedance of the antenna/ feeder to the 50 ohm output of the transmitter

The ATU does not actually tune the antenna; using an ATU doesn't change the SWR on the feeder or antenna.

The ATU is used to make the antenna appear as a resistive load of 50Ω at the transceiver by matching the resistive impedance of the transceiver (50Ω) to the impedance presented by the combined input impedance of the feed line and the antenna.

When selecting an ATU points to consider: Frequency coverage: Power capability: Impedance matching range: Manual or Auto: Balanced or unbalanced: balun or no balun

I use a Z match manual antenna tuner, there are other ATU types which would be suitable to use with the doublet and ladder feeder.

Ladder line offers extremely low RF loss on HF frequencies, even when the SWR is relatively high and when using a ladder line the operator can completely forget about antenna resonance and SWR with the matching of the transceiver to the antenna being at the done at ATU by adjusting the length of the feeder.

A problem with ladder line is that it tends to change characteristics when wet which means slightly re tuning the ATU but soon returns to normal when dry.

With ladder feeder the user needs to avoid getting it too close to metal or laying it on the ground. Both can upset the line's balance. I have the ladder feeder coming into my house next to a metal window frame.

My doublet antenna center is approx. 50ft from the ATU. I routed the ladder feeder from the antenna center to the ATU, cut the feeder and this created a fixed length of feeder, additional lengths of feeder can be added to this fixed length to bring the varying antenna impedances to within range of the ATU impedance to allow matching on the different bands.

Using the multi-band doublet with a manual ATU, first is to find the correct antenna tuner settings for each band and to make a list of the settings to be used when changing bands.

As I use cw, I looked at matching the antenna on the cw section of the HF bands starting with the 20 meter band.

With the feeder connected between the antenna and ATU.

1) Turn on the transceiver and found a clear frequency on the cw part of the 20 meter band.
2) Adjust the ATU for the loudest noise.
3) Set the transceiver mode to give constant output, I chose cw.
4) Adjusted the transceiver output power to say 5 to 10 watts.
5) Making sure the frequency is clear, select ATU SWR forward.
6) Transmit, for cw the key will need to be held down.
7) Adjusted the ATU SWR sensitivity for a high forward reading,
8) Stopped transmitting and selected ATU SWR reflection.
9) Transmit (key down) and adjusted the ATU controls for minimum reflection
10) Made a note of the ATU settings.

The above was repeated on the 17 meter band etc. I now had a list of the ATU settings for the different bands, to be used when changing bands.

On some bands the SWR meter could be sensitive when adjusting for minimum SWR reflection requiring careful ATU adjustment.

I was able to adjust the ATU for minimum SWR reflection (less that 1.5) on the 20/17/15/12/10 meter bands without having to add or trim the ladder feeder.

Sometimes no matter how much the ATU is adjusted an acceptable SWR cannot be achieved on some bands, additional feeder can be switched in to allow operation on those bands.

Changing bands with a manual ATU, select a clear frequency on that band, select mode to produce a constant output, adjust the ATU for the loudest noise, select SWR forward and apply low power to the ATU, adjust SWR forward for a high reading, stop transmitting and select SWR reflection and if necessary trim the ATU settings for the minimum SWR reflection, stop transmitting and adjust the transceiver output power to the required level.

The doublet antenna using ladder feeder has advantages and disadvantages for more information look at other sources for the doublet antenna, ladder feeder, ATU, balun etc

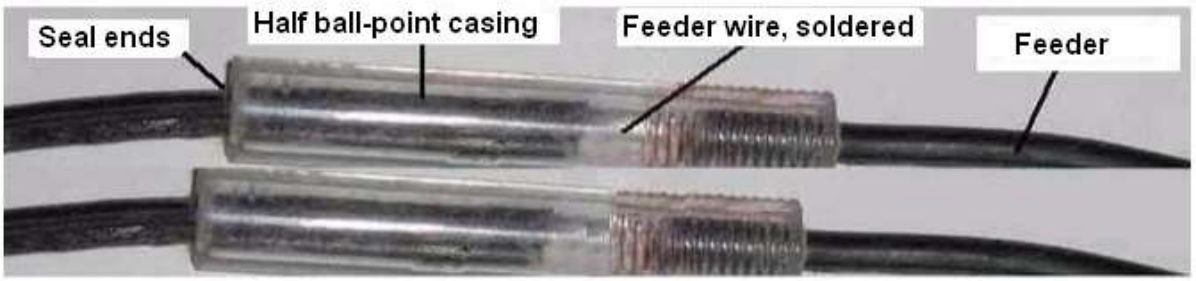
The minimum parameters mentioned in the article are a guide and sometimes not always achievable, this is where compromises have to be made in order to operate the radio.

The above article is for general interest and could contain errors and is my understanding as to the information contained in the article.

Lots of enjoyment with the hobby. 73 de John (age 78) GM4DKO / 4F3EW 25 March 2021

Distance piece used to secure the mast to the wall railing.

Using empty paint tin filled with cement at the base of the mast.



One way to connect two ends of a ladder feeder using half ball point casing.