HASviolet

900 MHz Antenna

The “A” in **HAS**violet

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Technical Manual V.05

About this technical manual

The HVDN HASviolet team has decided to make this technical manual available as an electronic copy only. There is no paper option available.

A major design consideration was reusing everyday objects in the construction of this antenna to cut down on waste, including its documentation.

While a paper manual would be helpful, it is also wasteful. Feel free to print your own copy if needed, but having this on a tablet, laptop, computer or smartphone will be more environmentally friendly.

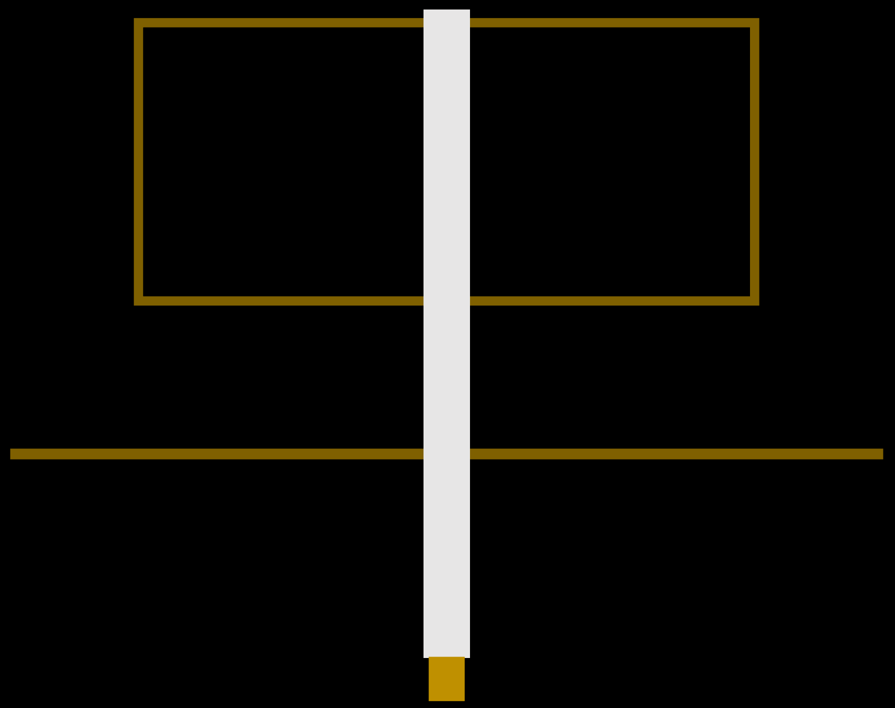
Thanks for your understanding.

About the HASviolet 900 MHz Antenna

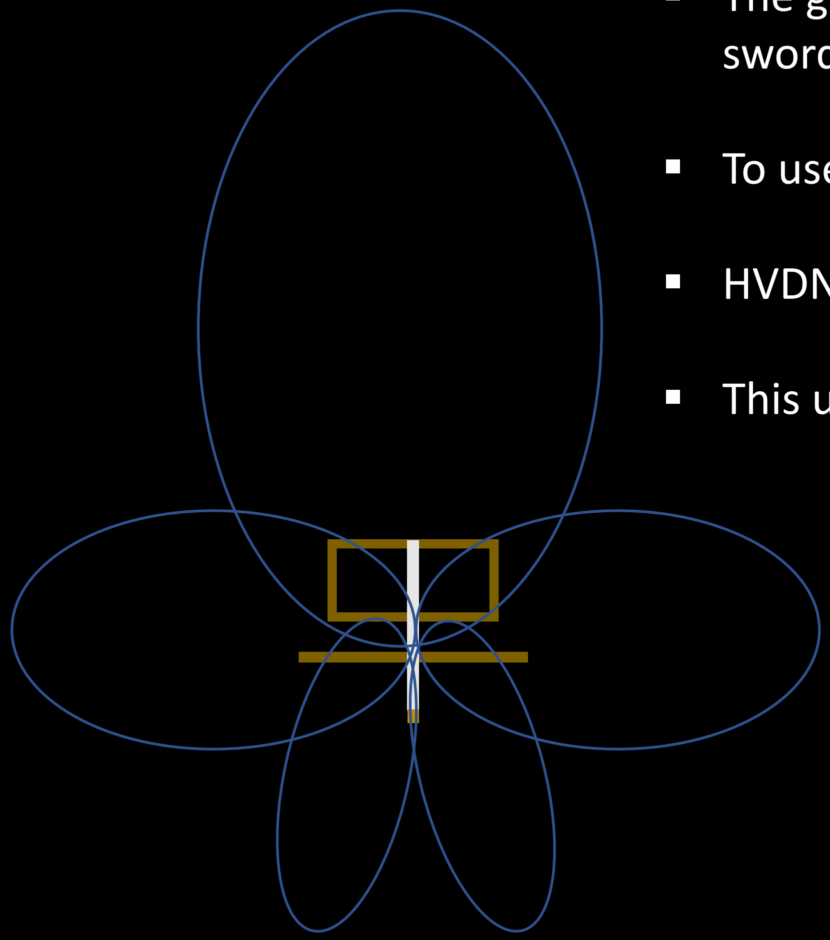
The design influence behind our antenna is to have something:

- Easy to build and have multiple uses
- Easy to source materials for and easy to construct
- Be mostly omnidirectional, but with some level of directivity (gain)
- Wide beam width & bandwidth for different use cases for transmit and receive applications

Introducing the HASviolet 900 MHz Antenna



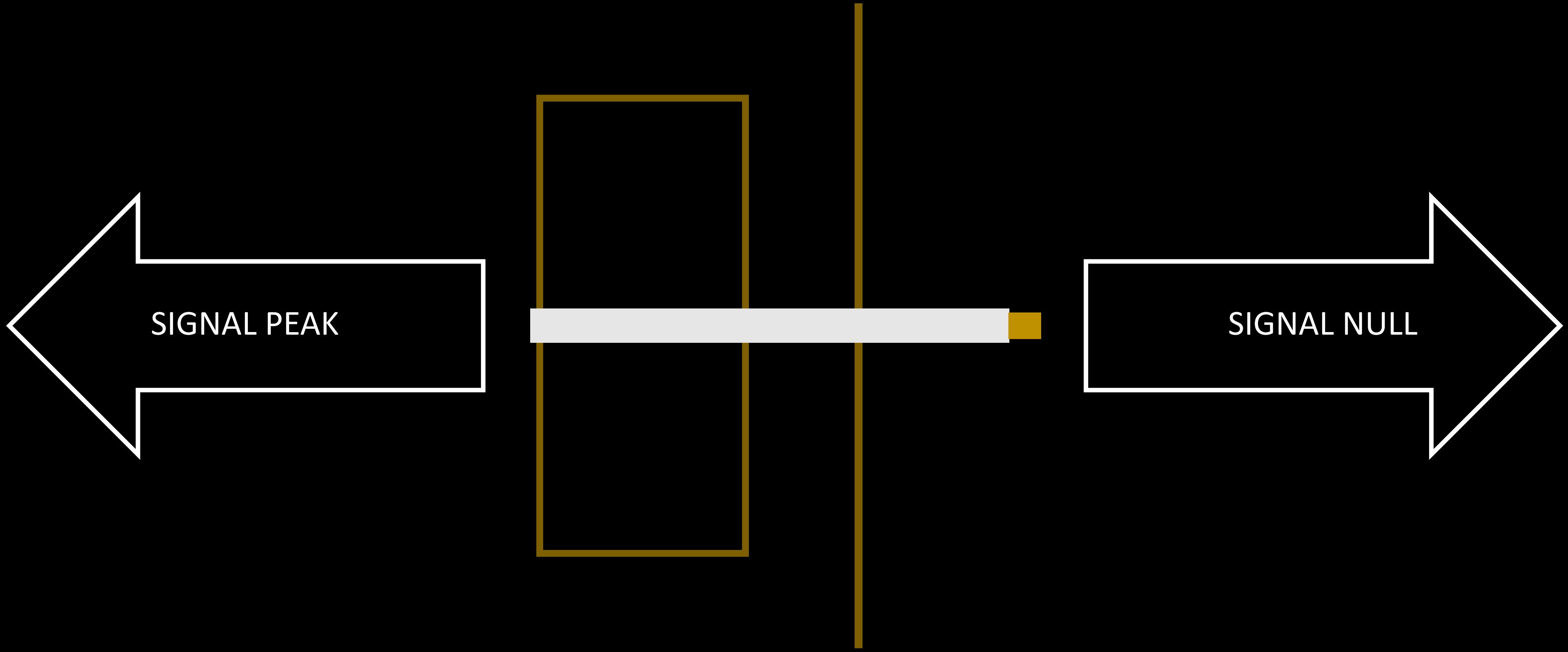
Reception: Radiation pattern



- The general radiation pattern for the HASviolet antenna resembles a "cartoonish sword".
- To use, just point the antenna towards or away where you want to direct its magic!
- HVDN does not promote illegal use or applications of this antenna.
- This user manual and its contents are provided for educational purposes only

The Link character from Nintendo's "Zelda" series of games is the sole property of Nintendo. HVDN is only using Link to show a typical "cartoonish" sword with wide appeal.

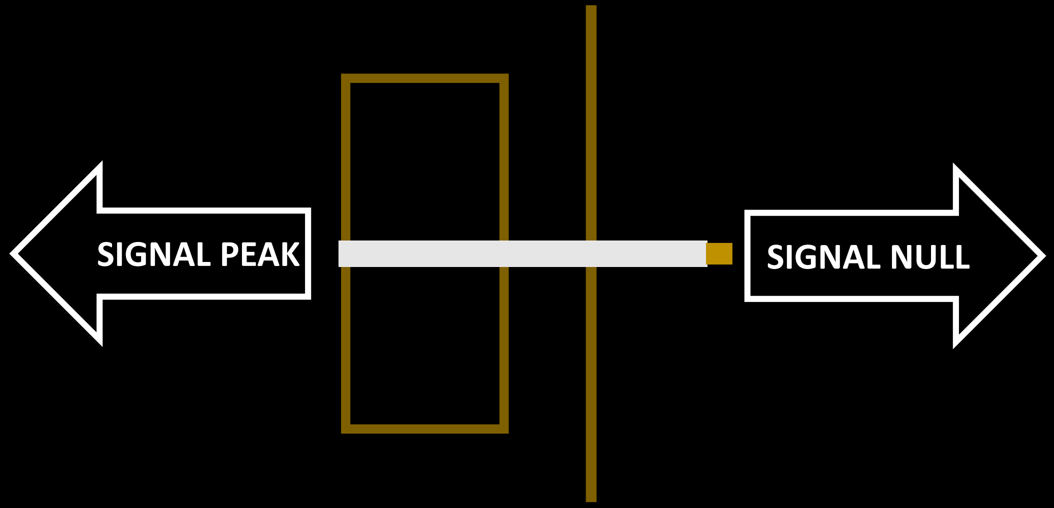
Reception: Maximum or minimum signal?



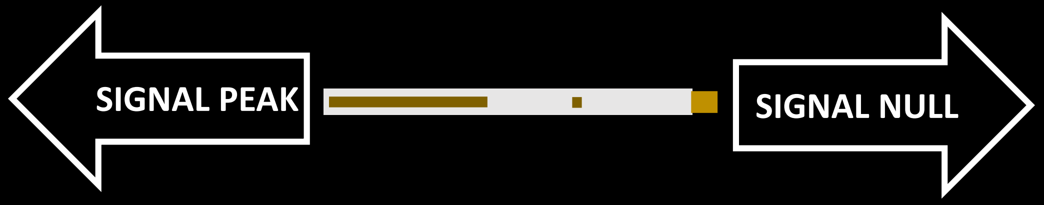
The HASviolet antenna "null" is finer compared to its "peak". This is helpful when trying to locate a transmitter. It is sometimes easier to find the direction of a signal by tuning towards its weak null compared to its maximum peak!

Reception: Maximum or minimum signal?

Vertical Polarization Position

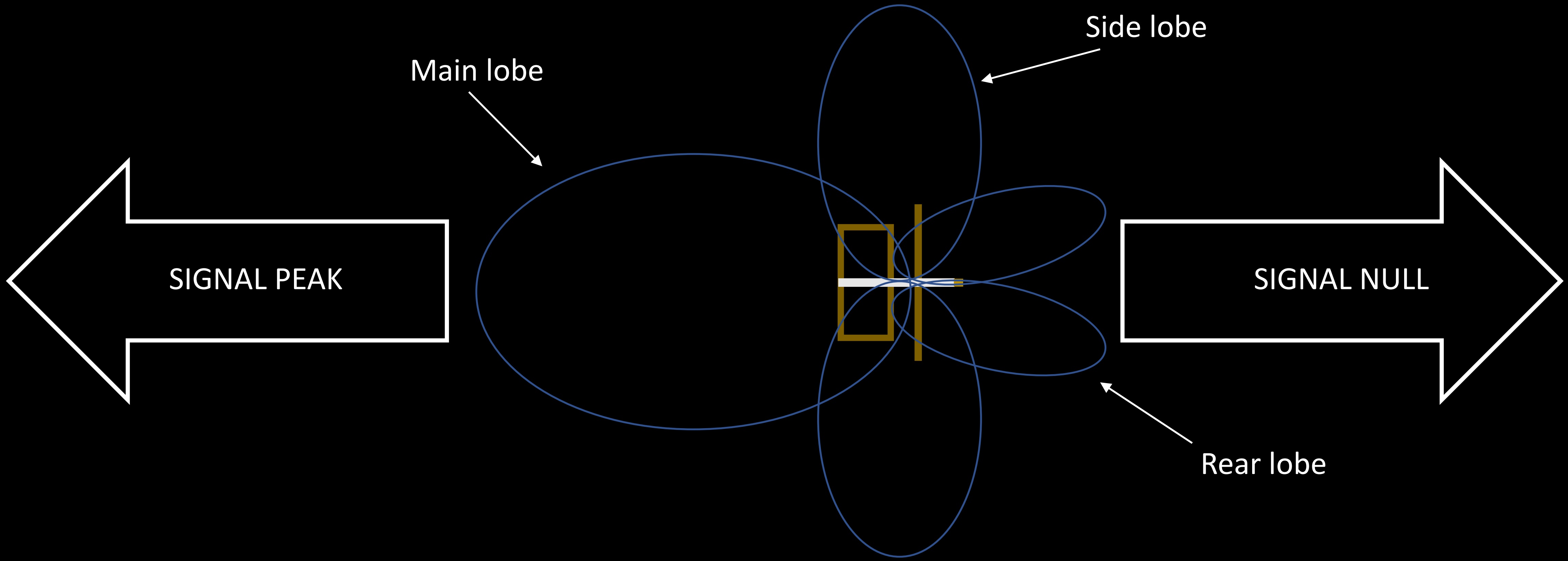


Horizontal Polarization Position



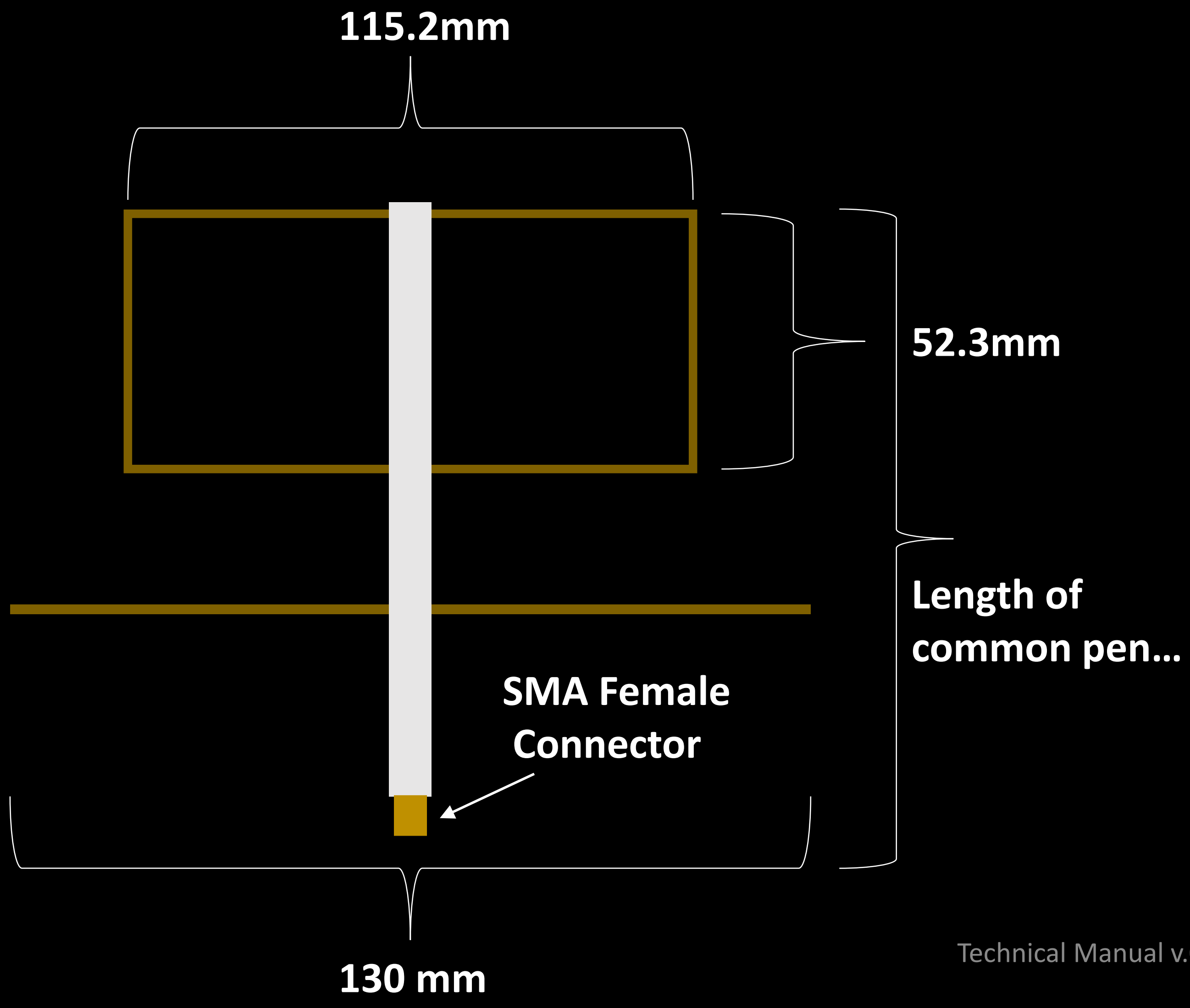
The HASviolet antenna is a single plane antenna. This means it is either **horizontal** or **vertical** polarization depending how it is positioned. Maximum signal received or transmitted may increase with changing its orientation, also known as “polarization”.

Reception: Maximum or minimum signal?

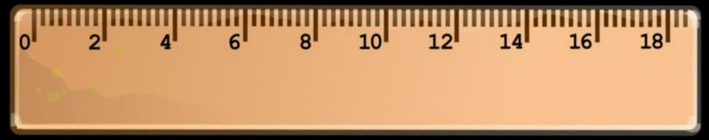


The HASviolet antenna main lobe or where the "**signal peak**" would appear is about 60 degrees wide. The rear lobe of "**signal null**" is about 25 degrees wide. Positioning your antenna correctly offers optimal reception or rejection of unwanted signals.

HASviolet 900 MHz Antenna Dimensions



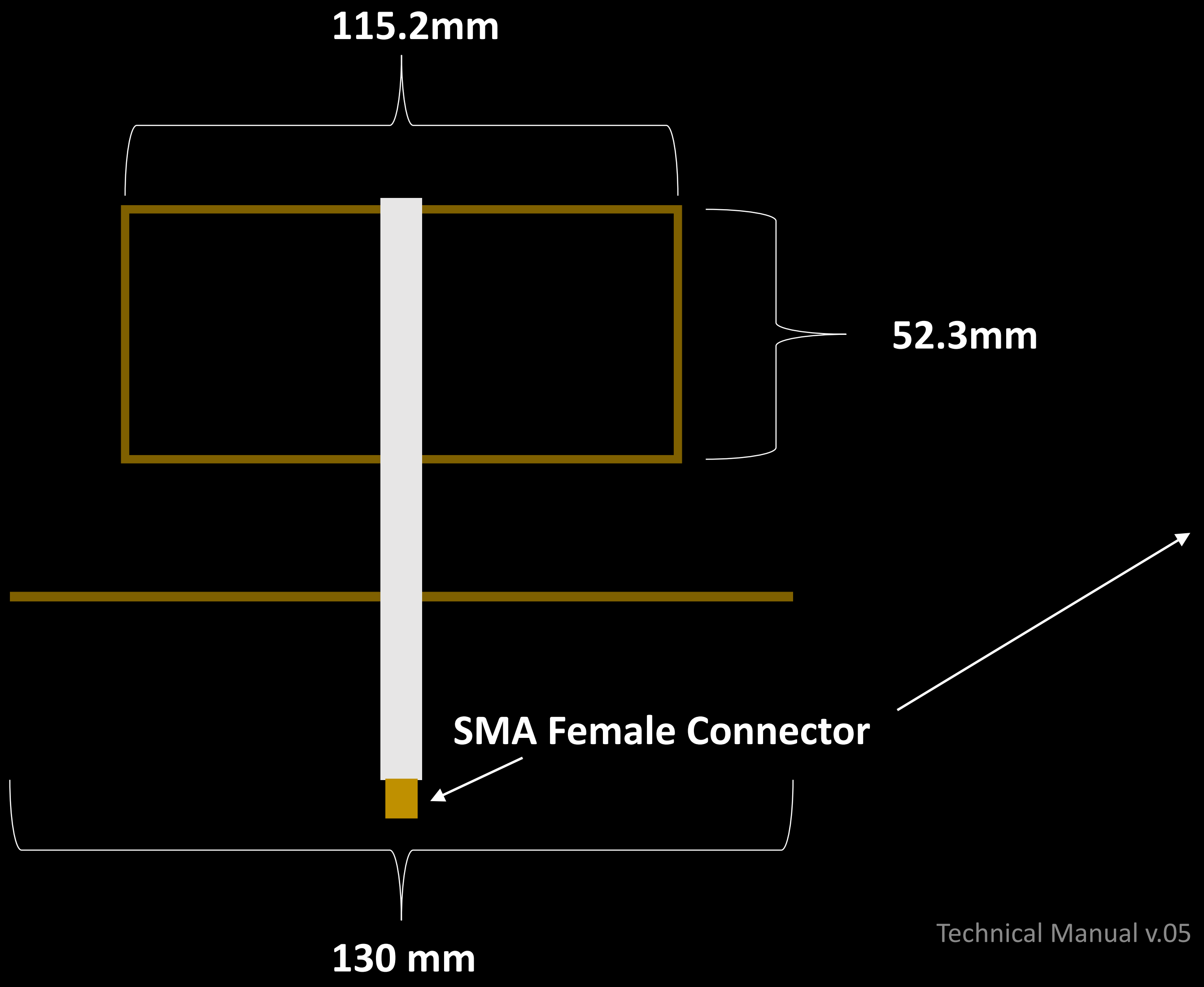
Metric units of measurement are used across the HASviolet antenna project. Standard measurements are only included for reference.



Dimensions are in millimeters for the HASviolet antenna to have a global appeal rather than being "United States centric".

Why? Precision measurements are required for the HASviolet antenna. Metric is easier when saying 52.3mm compared to 2.059 inches or 2 and 1/16th inches.

HASviolet 900 MHz Antenna Connector

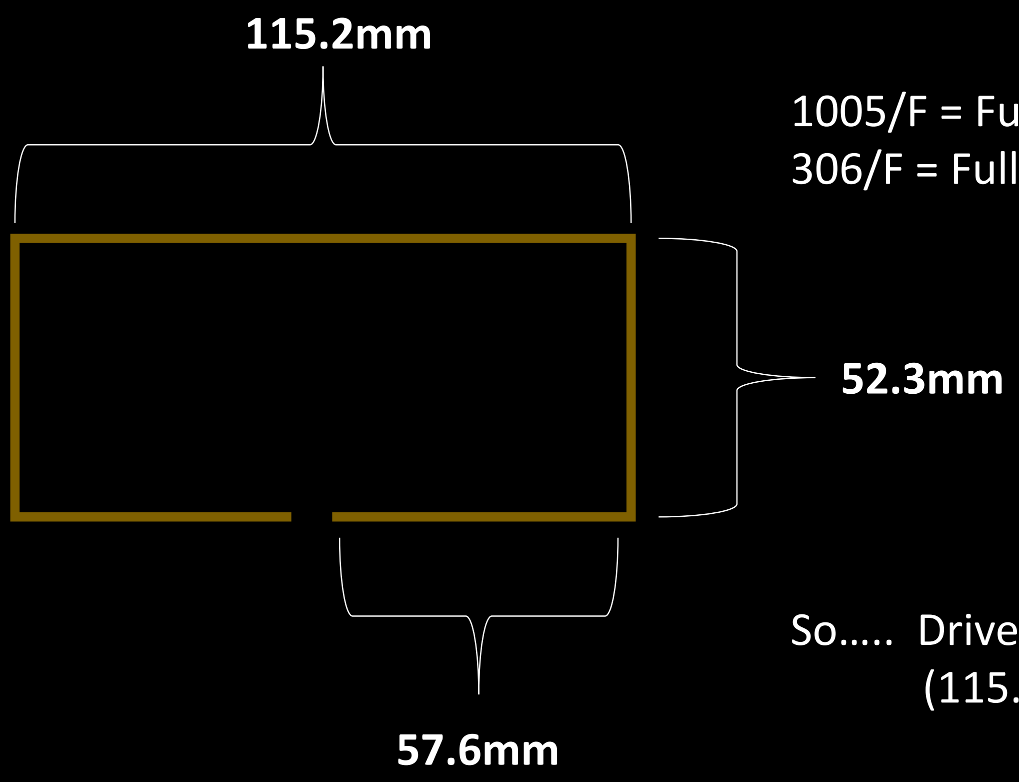


SMA Male | SMA Female | SMA-RP Male | SMA-RP Female

More common for commercial and precision applications. The SMA connector is considered the “standard version”.

Also known as SMA-J connector. Used in many lower cost, lower power and unlicensed spectrum use.

HASviolet 900 MHz Antenna Math: Driven Element



1005/F = Full Wave Loop Length in feet (We are NOT using feet, remember?)
306/F = Full Wave Loop Length in meters

So….. Driven element = 306/912 MHz = 0.3355 meters = 335 millimeters
(115.2mm + 52.3mm + 57.6mm + 52.3mm + 57.6mm)

Reflective element = Driven + 5% = 130 millimeters

HASviolet 900 MHz Antenna Math: Driven Element

Where did 1005 and 306 come from? Let's explain the math behind these numbers used to calculate the driven element of the antenna.

The speed of light (in a vacuum) is **299,792,458** meters per second

Atmosphere (on planet Earth) has a refraction index of 1.000293 which slows down the speed of light just slightly to **299,704,644.54** meters per second. Radio waves in general travel close to the speed of light.

Radio waves are generally calculated as how fast they travel in meters per second and are rounded to use MHz instead of Hz since 1 MHz is equal to 1,000,000 Hz. A simple equation of **300/F** is “good enough” to find the general wavelength of any frequency in metric.

Example: 911.250 MHz = .329 meters or 32.9cm or 33cm

Amateur radio language describes the 900-928 MHz band as 33cm

HASviolet 900 MHz Antenna Math: Driven Element

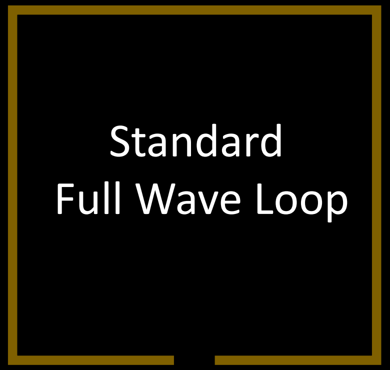
Considering the speed at which electrons flow within different metal (velocity factor) and the speed at which light or radio waves travel, we can use the equation of **306/F** to discover the length of one full wave in metals like silver, brass and copper.

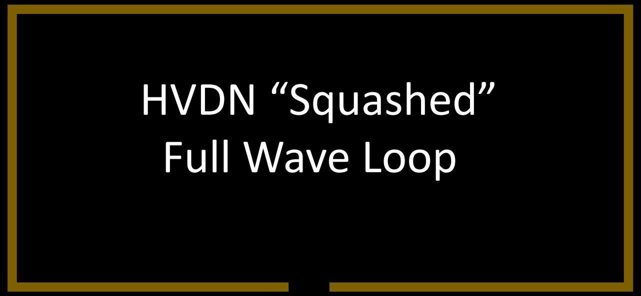
These three types of metal are considered the lowest cost and least amount of resistance metal to be used in antenna design. Lower resistance material is more efficient and converts any applied radio wave energy into signals rather than heat.

306/911.250 MHz = .3358 meters or 33.58 centimeters or 335.8 millimeters

So this is how the driven antenna element length was calculated in simplistic terms.

HASviolet 900 MHz Antenna Math: Driven Element





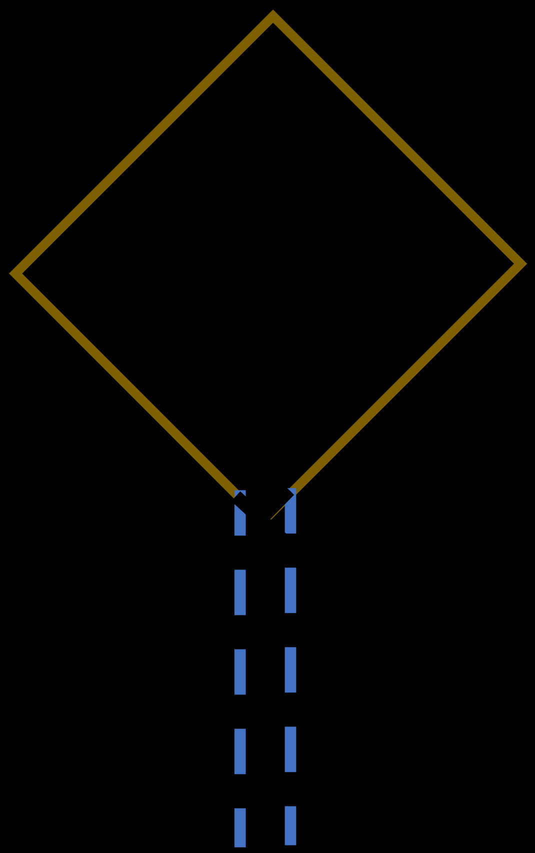
Normally, a full wave loop would be equal to 25% or a “quarter wavelength” on each of the four sides of the full wave. This would equal 83.75mm per side for the design frequency of **911.250 MHz**.

Changing the side lengths impacts two important factors:

- Impendence: Also known as resistance in wireless engineering
- Directivity: The directional characteristics of the antenna

The function of “squashing” the square loop to a “rectangular” one offers us Increased directivity of the driven element, but also changes the impedance for where we want to “feed” the antenna and connect it to the HASviolet hardware.

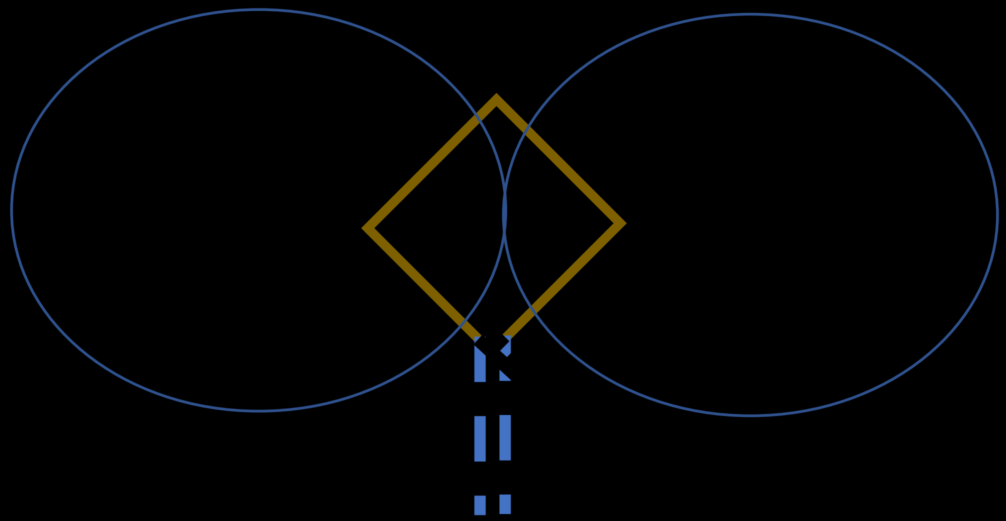
HASviolet 900 MHz Antenna Math: Driven Element



80-150 Ohm Impendence

If we choose to connect our feed to the corner of the loop, the impedance would be somewhere between 80 to 150 Ohms.

The antenna radiation pattern would look like:



For a small and portable 900 MHz antenna, this would not be ideal since we also want some directivity and gain in one direction.

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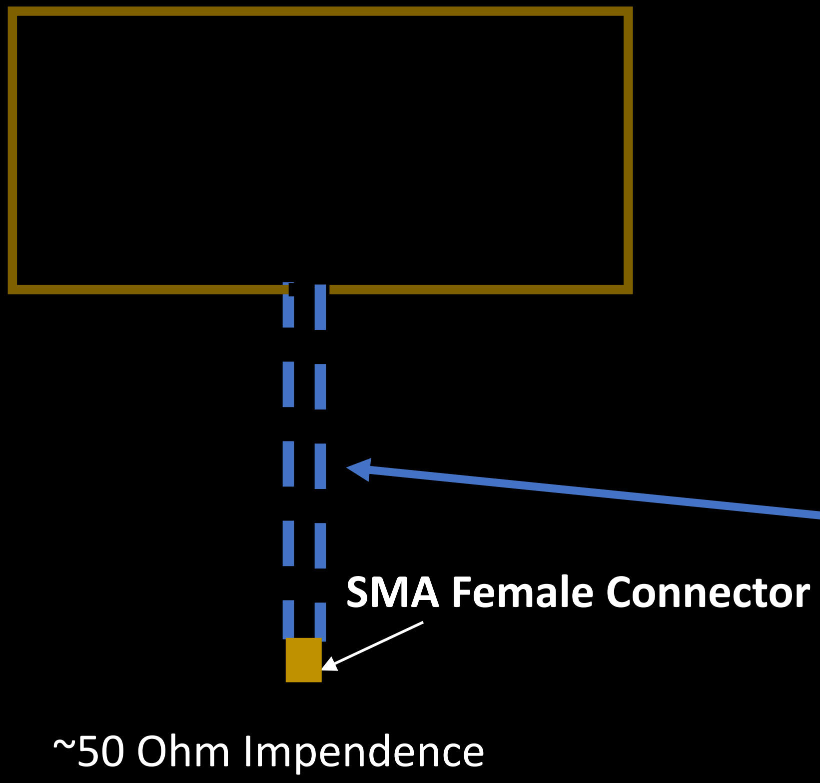
HASviolet 900 MHz Antenna Math: Match Element



In order to get a close to 50 Ohm match which the HASviolet radio needs, we need to find a way to make the now 300 Ohm driven element “play nice” with the radio to ensure efficiency for transmit and receive of radio energy.

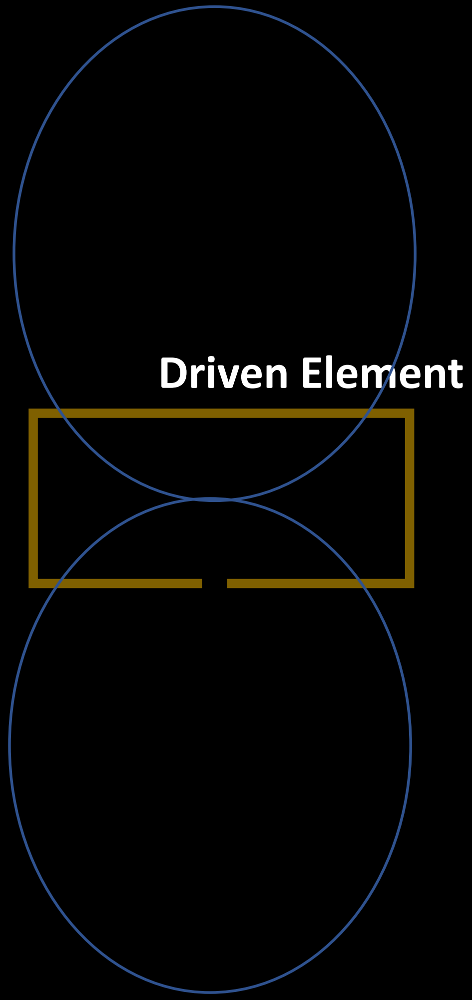
To do this, we use a “quarter wavelength” section of 75 Ohm miniature coaxial cable to “match” the driven antenna element to what the impedance the radio expects

75 X 0.70 /F = 75 Ohm matching section length in meters

RG-179 miniature coaxial cable has a velocity factor of 0.70 and is where that figure comes from

So….. 75 X 0.70/912MHz = 57.56mm matching section or roughly “one quarter wavelength” long, taking into account the slower speed of electrons in the coaxial cable.

HASviolet 900 MHz Antenna Math: Before Reflector



With no reflector, the driven element would be able to receive or transmit signals that would look like a figure "8" and is not what we want if we wish to have as much forward directivity as possible.

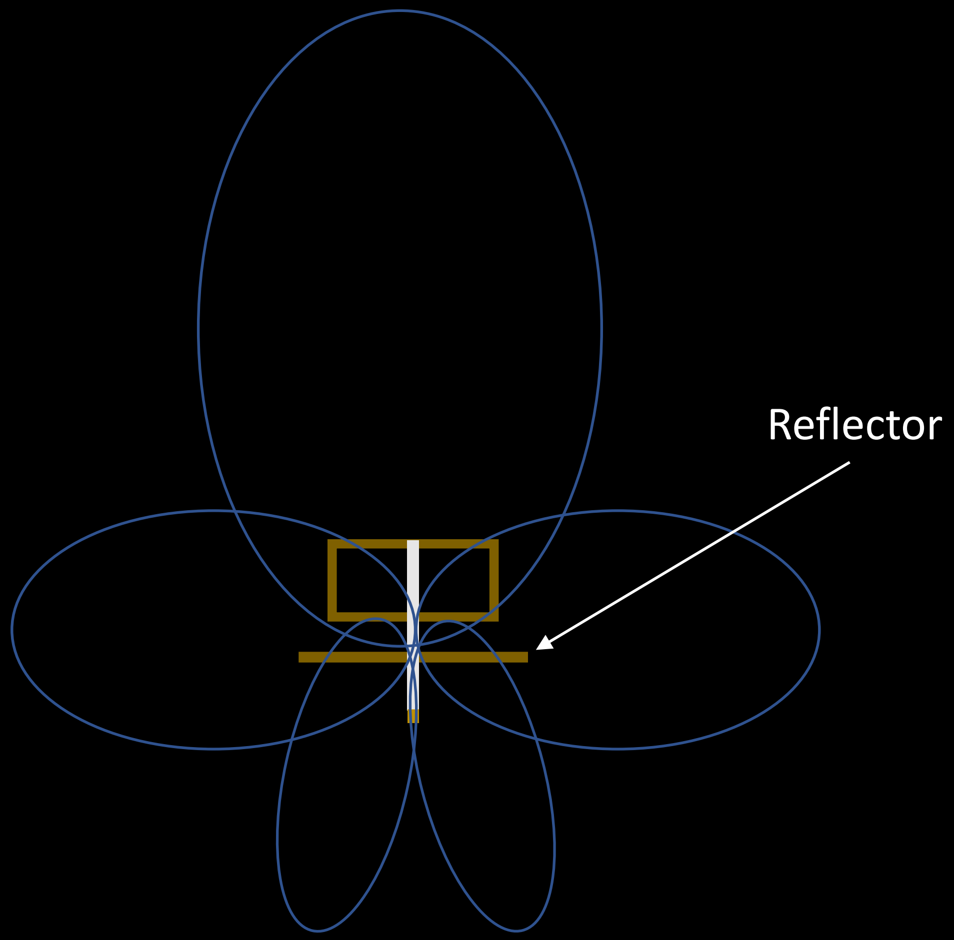
However, if we insert a "**reflector**" closely spaced behind the driven element, not only can we change the impedance of the driven element slightly, but we also change the radiation pattern too!

This is a very elegant way to get our desired results and at low cost and with minimal design engineering.

The reflector is simply 10-15% longer than the driven element.

Example: 115.2mm + 12.5% = 130mm

HASviolet 900 MHz Antenna Math: After Reflector



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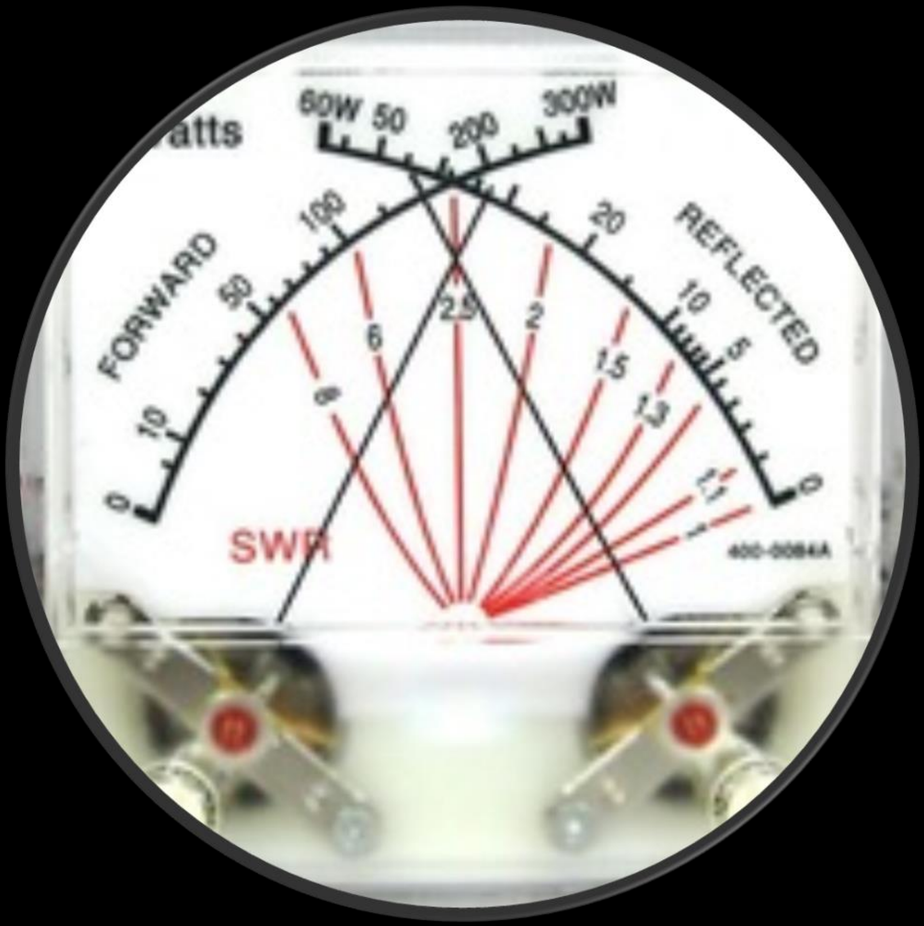
HASviolet 900 MHz Antenna Math: SWR



The "Standing Wave Ratio" or SWR is a term used to measure the efficiency of an antenna as a load when connected to a source, such as a radio. All waves should be moving which means they are efficient. Standing waves create issues.

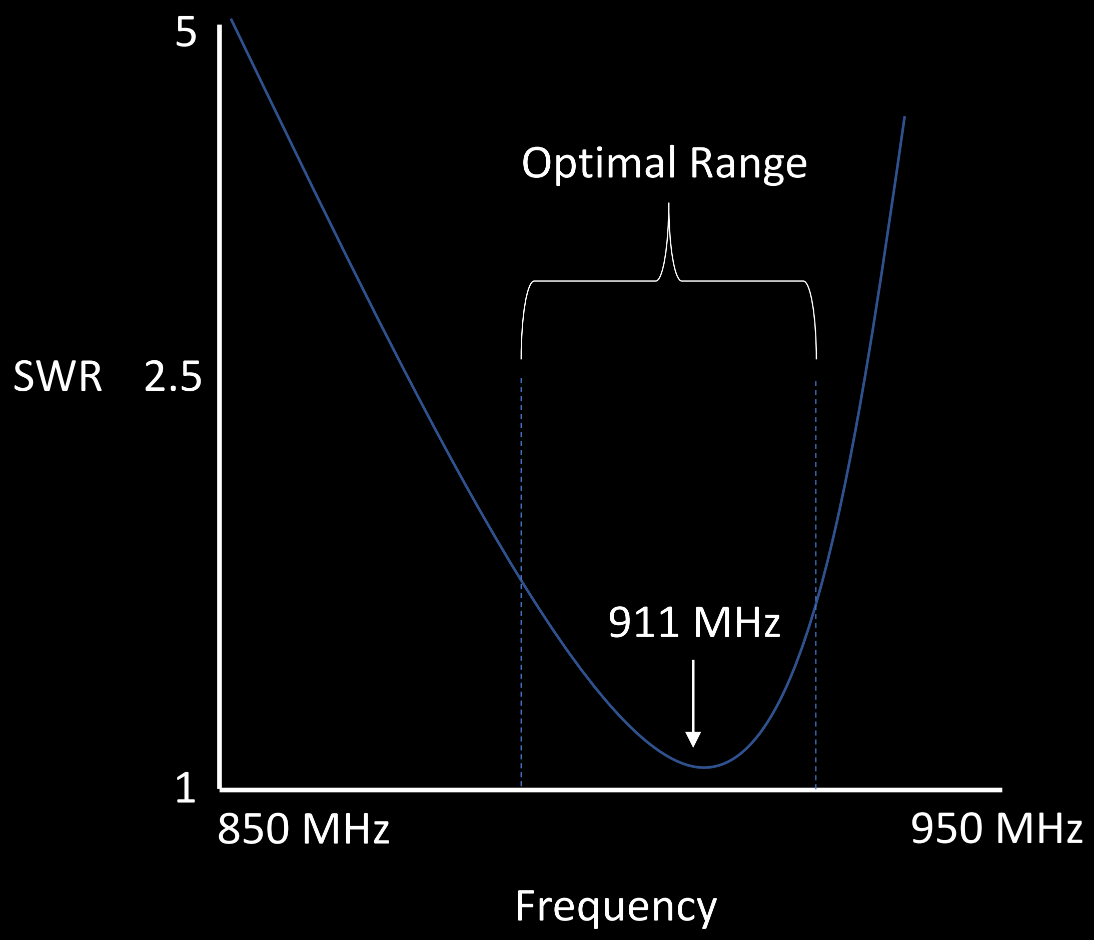
A **1.1:1 SWR** is consider a near perfect match between a radio and an antenna system that is expected to be close to 50 ohms.

If the SWR is high, such as a 3.1:1 ratio, this means the antenna is not well matched to what "impedance" the radio expects.

A mismatch like this turns the RF output energy into wasted heat energy or even reflected back into the radio which may create damage or suboptimal performance of the radio, antenna system or both. The HASviolet project needs to make the most out of the low output of most radios that transmit.

The careful design of the HASviolet antenna provides a good match between most radios that expect a 50-70 Ohm match.

HASviolet 900 MHz Antenna Math: Bandwidth

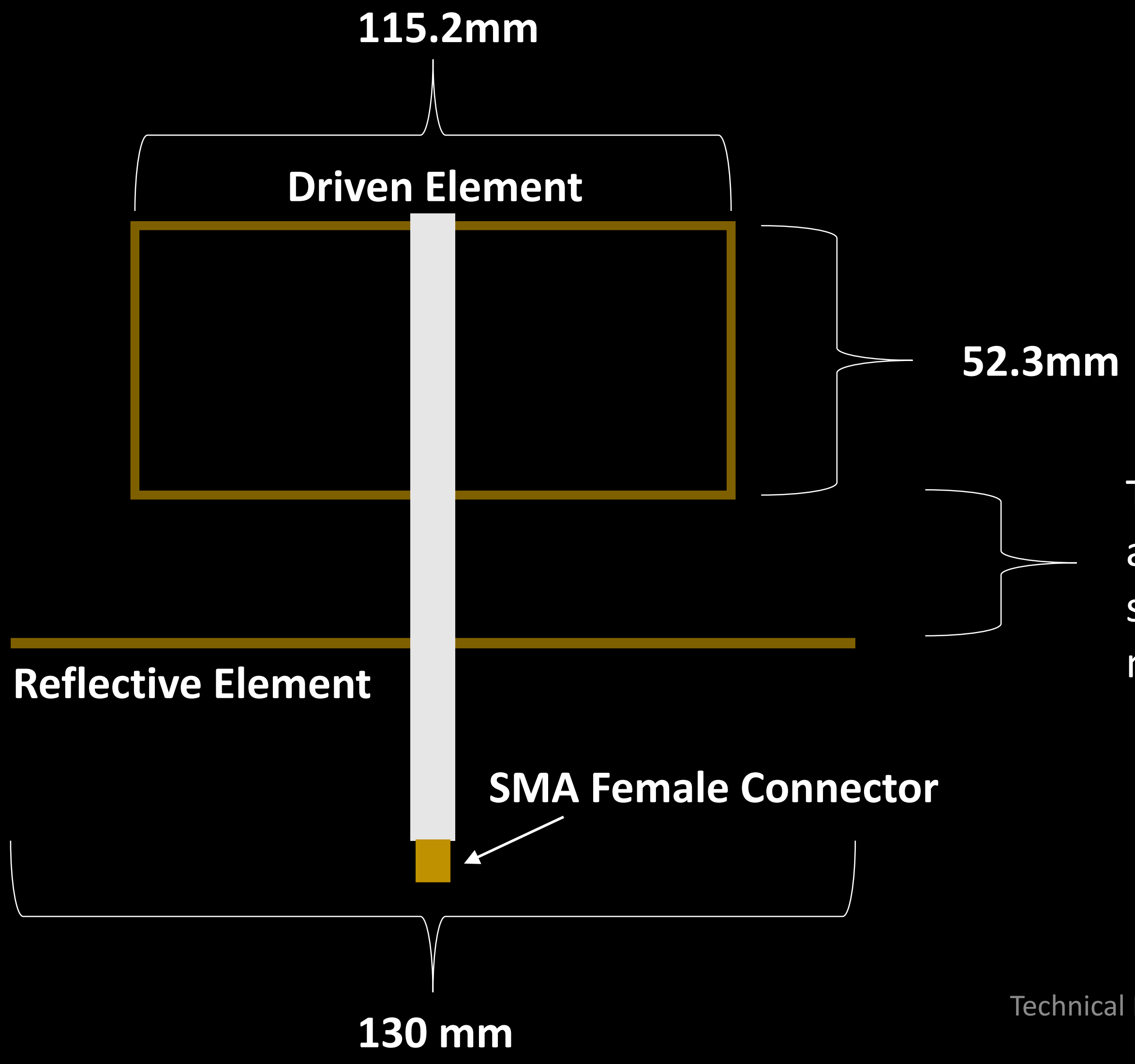


It is fairly easy to design antenna systems with a low SWR, but generally only have a narrow bandwidth, such as a dipole antenna.

In order to have both a low SWR and a wide bandwidth, HVDN has carefully designed this antenna for the 900 MHz ISM band of **902 to 928** MHz to provide a good user experience in terms of useable bandwidth.

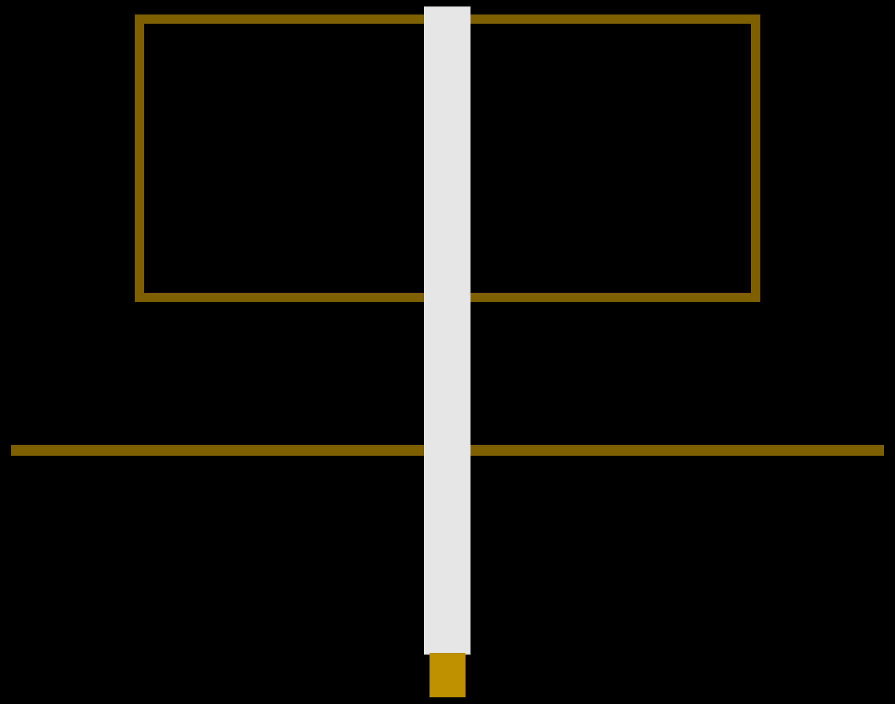
The folded loop design and diameter of the driven element of the HASviolet antenna help us reach our goals.

HASviolet 900 MHz Antenna Math: Reflector Spacing



There is **no secret** length of the gap between the driven and reflective elements. We have decided to just not share it to promote experimentation or for you to measure it on your own!

HASviolet 900 MHz Antenna Math: Thank You



The HVDN team hopes that the information presented in this user manual was simple to understand and accurate.

There is a lot of misinformation or lack of easy to understand information about antenna design.

It is our hope that the HASviolet antenna project inspires further experimentation based on our design and is attributed back to us correctly.

Our original design uses a common pen as its support for the antenna elements, matching element and connector.

Should you wish, we offer pre-assembled kits and a newer version that replaces the pen with a professionally designed circuit board that can also be used on 868, 978,1090 and 1245 MHz.

HASviolet

900 MHz Antenna

The "A" in **HAS**violet

If your organization is interested in a presentation based on this material, please contact us at info@hvdn.org

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