Employment Guide for the Arete "COBRA" Miniature HF BALUN

Arete Wireless, LLC.

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About Arete Wireless

Arete is pronounced *air-a-tay,* from the ancient Greek. It means the virtue of excellence. Arete is committed to engineering excellence. Everything made by Arete Wireless must be better in some way than other options on the market. If it isn't more rugged, lighter weight, or more efficient than other designs I won't build it.

Gary "Padre" Priest
K8JOK
Proprietor

About this Employment Guide

This document is an employment guide, not a technical manual. The purpose of this document is to quickly familiarize the reader with the Arete COBRA HF BALUN and provide useful suggestions in terms of practical antennas and kits that can be built using the COBRA as a base component. While every effort has been made to keep this document as simple as possible, this employment guide relies on your knowledge of RF communications as a foundation. HF radio communications is as much art as science, so no antenna or book can guarantee connectivity under all conditions. Your radio knowledge, however, combined with the suggestions in this guide, will get you on the air as quickly as possible in as many varied conditions as possible.

For a full technical overview of antenna theory, design, and employment, please see the *ARRL Antenna Handbook*.

Safety

RF Safety: The Federal Communications Commission (FCC) has established maximum permissible exposure limits for amateur radio operators and bystanders. Always operate within established exposure limits. For more information, see https://www.arrl.org/rf-exposure. Additionally, high voltages may be present on exposed wires. Always deploy your antennas high enough to ensure they are out of reach of innocent bystanders, especially children and pets. Clearly mark all hazardous wires, cables, and lines with high visibility marking tape, hazard cones, or signs as needed to prevent contact with energized wires.

Lightning: Deploying antennas and operating radio equipment when lightning is present is extremely dangerous. Lightning strikes may cause severe injury or death. Never operate portable radio equipment and antennas in a lightning storm. Permanently installed antennas and radio equipment must be grounded, bonded, and arrested in accordance with National Electric Code requirements and local ordinances.

Power Lines: Overhead power lines carry high voltages and pose a serious hazard to radio operators. Never deploy an antenna in the vicinity of overhead power lines. Contact with power lines may cause serious injury or death.

Trip & Fall Hazard: Antenna wires, coax cabling, and halyard lines are tripping hazards for both radio operators and bystanders. Do not deploy antennas in areas where bystanders may inadvertently walk. Clearly mark all hazardous wires, cables, and lines with high visibility marking tape, hazard cones, or signs as needed to prevent contact with trip & fall hazards.

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I. Introduction

This employment guide covers the use of the Arete COBRA Miniature HF BALUN. The COBRA is unique product on the amateur radio market. Unlike its competitors, the COBRA has been designed as a no compromises product. Every design choice has been made to maximize ruggedness, stealthiness, flexibility and RF performance while minimizing weight. You can trust the COBRA to give you many years of service through sun, wind, rain, heat, cold, and wherever your adventures take you.

Resonant antenna tuning varies according to ground conductivity, height above ground, and deployment configuration. Building and tuning your own wire elements ensures maximum performance in your environment. This guide will suggest possible antenna configurations and kit possibilities to help you build the best field antenna kit for your application.

II. Features & Specifications

Features

- UV, shock, and water-resistant polycarbonate enclosure
- IP65 rated enclosure & vent*
- Durable, low-visibility federal-standard coyote brown Ceracote finish
- Corrosion resistant stainless-steel hardware
- Convenient built-in shock cord for stabilization on portable masts or supports of opportunity

* An IP65 rating provides complete protection from particle ingress and is resistant to water jets sprayed from any direction. The COBRA is assembled from components that meet or exceed this rating but has not been independently tested and certified. The COBRA is not submersible.

Specifications

- Frequency Coverage: 3-30Mhz (extended coverage down to 1.8Mhz with reduced common mode attenuation performance)
- Power Rating: 125W @ 50% duty cycle
- Weight: 5.5 ounces / 155 grams
- Dimensions: 3.9" W x 3.9" H x 1.7" D /99mm W x 99mm H x 43mm D
- Characteristic Impedance: 50 ohms unbalanced to 50 ohms balanced
- Choking Attenuation: Greater than 20dB from 3-30Mhz
- Insertion VSWR: Less than 1.2:1 @ 30Mhz
- Insertion Loss: 0.1dB nominal @ 30Mhz
- Screw Down Terminals: #10-32

III. Physical Description

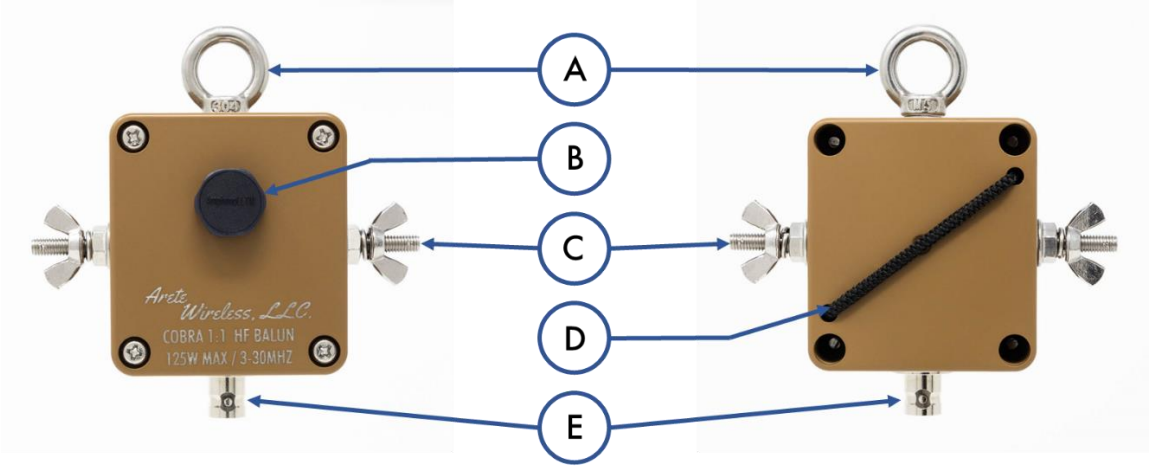

Figure 1: Arete COBRA component parts

A. Eye Bolt: This is used both to suspend the COBRA and to attach the dipole wires. In this way, the stainless-steel component carries the tension of the suspended wires.

B. Hydroscopic Vent: Allows warm air to leave the enclosure while preventing water from entering.

C. Screw Terminal: This #10-32 stainless screw and wingnut provide a connection point for your wire antenna elements. Includes a split washer to prevent loosening of the connections. The screw is lightly staked to prevent the wingnut from backing off and getting lost in the field.

D. Shock Cord: Provided to stabilize the COBRA when used with a fiberglass mast or other supports of opportunity.

E. BNC Connector: Connect your 50-ohm coax to this connection.

IV. Theory of Operation

The Arete COBRA is a 1:1 current BALUN, sometimes called a Guanella BALUN. BALUN is an acronym that stands for Balanced-to-Unbalanced. BALUNs are transmission line transformers that convert unbalanced RF signals to balanced RF signals and vice versa. Coax cables carry unbalanced signals (the signal on the coax center conductor can differ from that on the shield) but dipole antennas generate balanced signals (the signal on each half of the dipole is the same).

In addition to ensuring the currents are balanced on your antenna, a 1:1 current BALUN also acts as a common-mode choke. Common-mode currents flow in a single direction along a conductor and therefore are not canceled the way differential-mode currents are. Common-mode currents are undesirable for several reasons:

1. *Common-mode currents cause your feedline to radiate.* When your coax radiates it acts as part of the antenna and will distort your radiation pattern. Power radiated by the coax is generally considered wasted unless the coax is deliberately included as part of the antenna.

2. *Radio Frequency Interference (RFI) can result from uncontrolled common-mode currents.* RFI may cause harmful interference to your radio, attached computers, or other nearby electronic devices.

3. *Feedline radiation can cause undesired ground wave transmission and noise reception.* Generally, your coax will hang vertically below your dipole. If the coax is part of the antenna, it will act as a vertically polarized element. When transmitting, this will create potentially undesired ground wave radiation. On receive, this makes your antenna system more susceptible to picking up noise sources as they are usually vertically polarized.

Your Arete COBRA provides greater than 20dB of common-mode attenuation from 3-30 Mhz and nearly 20dB on 160m. 20dB of attenuation is considered the threshold for acceptable attenuation in a common-mode choke or BALUN[1].

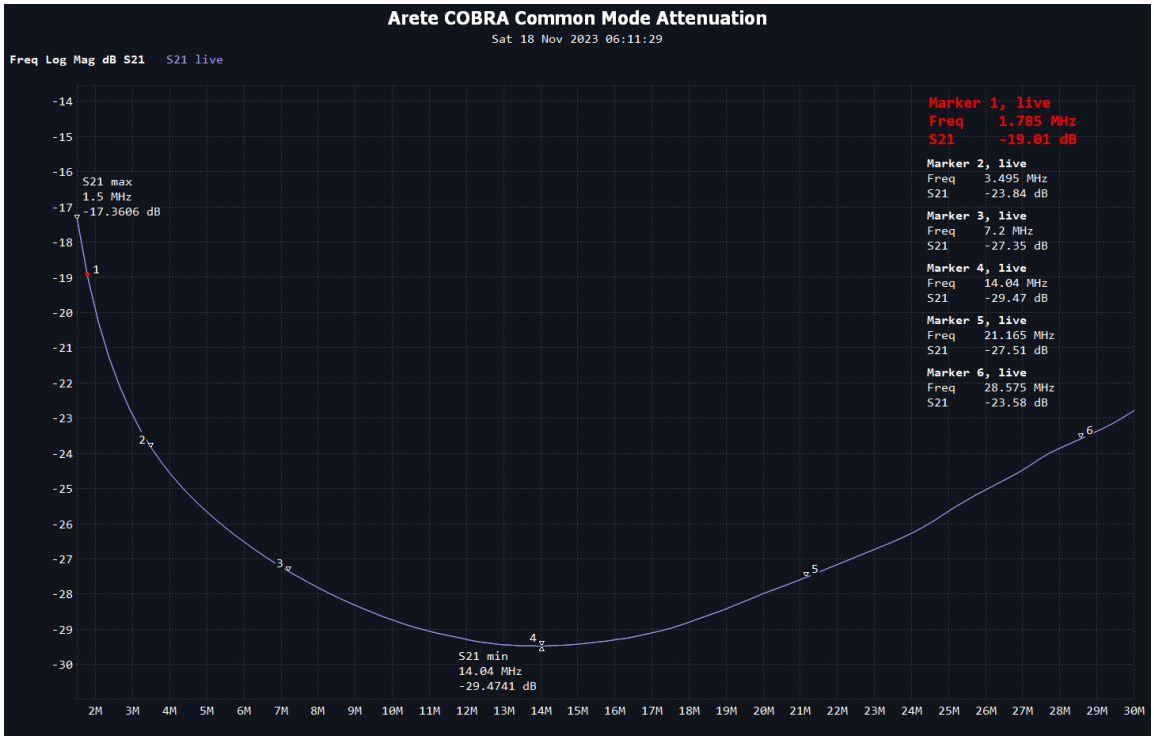

Figure 2: Arete COBRA common-code attenuation performance (lower is better)

Figure 2 illustrates the typical common-mode attenuation performance of the Arete COBRA (individual samples will vary slightly but will always exceed 20dB from 3-30 Mhz). A 20dB reduction equates to a 99% reduction in common-mode current. The 160m band falls just below the 20dB threshold but should be entirely usable as well in all but the most extreme cases.

Coax lengths near ¼ wavelength at the frequency of operation may entice RF current from the antenna system and exacerbate RFI issues. The Arete COBRA will suppress these RF currents regardless of frequency of operation or coax length.

V. Deployment & Recovery

The Arete COBRA is very flexible and can support any number of different deployment configurations. Your imagination is the only limit. Several possibilities are suggested below to help get you started.

General

In all cases, best performance is achieved when your antenna is deployed in a clear area, free from interfering buildings and terrain features.

Any wire of sufficient gauge to be pulled taught as a dipole is electrically suitable for the RF currents generated by the Arete COBRA. In other words, choose antenna wire for mechanical strength. Wire with 50lbs or greater tensile strength is preferred. Usually, 20AWG or larger stranded wire will meet this requirement. 22AWG copper coated steel wire and specialty Kevlar or Aramid core antenna wires also meet this requirement. Bare wire is suitable but insulated wire is more forgiving of contact with wet vegetation or other objects. Bare wires must use insulators to electrically isolate them from attached objects. Always test wires for suitability before relying on them in the field.

WARNING: When connecting wires, only tighten the wingnut enough to compress the split washer. Excessive torque is not necessary for a good connection and will damage the COBRA.

Figure 3 below illustrates one method to attach deliberate wire elements to your COBRA. In this example, the #10 fork terminals are at the end of a 5-inch leader attached to the plastic carabiner. A loop is made in the wire for attaching the carabiner using a permanently crimped aluminum ferrule. If you want a wire set that is easier to service in the field, use a 3mm wire rope clamp

instead of the aluminum crimp ferrule. Attaching the carabiner to the eye bolt in this way keeps tension off the screw down terminal connections.

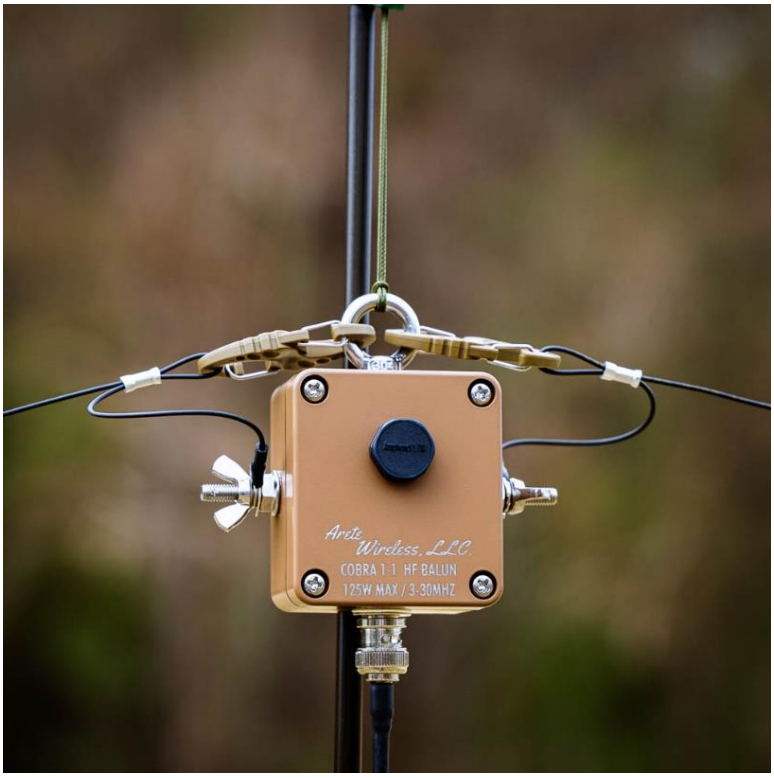

Figure 3: Arete COBRA deliberate wire attachment

Figure 4 below illustrates a method to attach hasty or improvised wire elements to your COBRA. In this example, the wire is attached directly to the eye bolt using a girth hitch. Leave a 5-6 inch leader to reach the screw down terminals. Strip enough of the wire insulation away from your elements to wrap around the screw down terminals and tighten the wire to the terminals using the wingnut.

When using the hasty wire technique, take care to inspect your wires to ensure the insulating jacket is not damaged. A small amount of black vinyl electrical tape added to the eye bolt will provide additional protection from electrical shorts.

WARNING: Never attach uninsulated wires directly to the COBRA's eye bolt or damage to your radio will occur.

Figure 4: Arete COBRA hasty wire attachment

A. Low Horizontal Dipole

For the purposes of this guide, a dipole is considered low if it is suspended less than ¼ wavelength above ground at the frequency of operation. Low dipoles are preferred for Near-Vertical Incident Skywave (NVIS) propagation and for rapid deployment. NVIS propagation, good for 0-300 miles of coverage, may be expected from 3-10Mhz with low dipoles. A trained operator can deploy a full size 80m dipole in low configuration in less than 10 minutes.

WARNING: *High RF voltage is present on the wire elements during operation. Always keep the wire elements out of reach of people and animals.*

For NVIS, a dipole deployed horizontally a few feet above ground is often sufficient and is quick and easy to deploy.

Any convenient supports may be used. A minimum of two supports are required, one for each end of the dipole. A third support to suspend the COBRA and prevent drooping may be used but is not required if sufficiently strong antenna wire is used. Naturally occurring materials such as trees and shrubs make good antenna supports. Man-made materials may also be used. Dipoles can be suspended between buildings or parked vehicles. Trekking poles or other objects can be used to help suspend long runs.

For reliable performance, horizontal dipoles should be suspended no lower than three feet above the ground. While usable performance is sometimes achievable below this height it is not reliable except in certain desert conditions where the water table is very low or when using modes that tolerate very low signal to noise ratios such as CW or JS8CALL.

B. High Horizontal Dipole

For the purposes of this guide, a dipole is considered high if it is suspended above ¼ wavelength above ground. For DX operation, choose the high horizontal dipole deployment. This configuration can be achieved in 15 minutes or less for use on 14-30Mhz provided suitable trees are available.

A minimum of two supports are required, one for each end of the dipole. A third support to suspend the COBRA may be used but is not required if sufficiently strong antenna wire is used (tensile strength of 50lbs or greater recommended). Trees are convenient natural supports for this deployment and are made easily accessible with light halyard line and an arborist throw weight. Purpose made antenna launchers are also available to help place wire antennas in high trees. Artificial supports may also be used but will require rigid metallic or fiberglass masts and guying.

C. The Inverted-V & Portable Collapsible Masts

The inverted-V is a variant of the high-dipole. It trades a small amount of gain for convenience of deployment. The inverted-V uses a single support to elevate the COBRA with the wire elements pulled tight and staked down towards the ground. Insulating string or cordage should be used so the wires do not touch the ground directly.

WARNING: *High RF voltage is present on the wire elements during operation. Always keep the wire elements out of reach of people and animals.*

A popular way to deploy portable antennas when no trees or other supports are available is to use a portable collapsible mast. These are commonly made from carbon fiber or fiberglass and are not usually stiff enough to be used without supplemental guying but are often light enough to be carried in a rucksack with your other outdoor gear.

When using a portable carbon fiber or fiberglass mast, the Arete COBRA should be suspended directly from the mast and the wire elements deployed in an inverted-V. To reduce unwanted flexing of your mast (a.k.a. the fishing pole effect), your COBRA provides a section of elastic shock cord to keep the weight of the BALUN centered over the center line of the mast. To use this feature, first open up the shock cord and lower the COBRA over the mast as per Figure 2 below. Then secure the COBRA using the eye-bolt as per normal.

Figure 5: Use of the Arete COBRA's shock cord stabilizer with a portable fiberglass mast.

D. Multi-Band Dipoles

Your COBRA can be used as the foundation for any number of multi-band dipoles. Common examples include fan, linked, and trapped dipoles. For a full explanation of these dipole variants see the *ARRL Antenna Handbook*.

Field Expediency

In an emergency, improvised wires, insulators, and supports may be used with little or no degradation of electrical performance. For a detailed description of expedient antenna techniques, see the *Electromagnetic Compatibility Analysis Center's Field Antenna Handbook, Section V.*[2]

Wet Weather Operations

The COBRA enclosure is weather sealed but the BNC connector on your coax is not. For extended operation in wet weather, seal this connection with electrical tape. Start 2-3" below the connection and work the tape up in a spiral. This will create a shingle effect to encourage water to shed down and away from your BNC connector. The electrical tape seal doesn't need to be submersible. Rather it simply needs to give the water a path away from the connector, so water doesn't penetrate the coax and degrade it over time.

Recovery

Ensure your radio equipment is powered off and can no longer transmit. Slowly lower your wire elements and the COBRA taking care to avoid bystanders. Disconnect your halyard lines from your wire elements. Start from the distal end (end furthest from the COBRA) and wind your elements in Figure-8 pattern towards the COBRA. The Figure-8 wind keeps your wires tangle free.[3] If using removable wire elements, remove them for storage.

Wind all halyard lines. Disconnect your coax and coil carefully to avoid kinks. Pack the wires, halyard lines, coax, and COBRA in your antenna kit and stow.

Be an ambassador to the hobby. Practice leave-no -race principles. Do not leave halyard lines, wires, or other detritus in public places.

VI. References

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[1] For a thorough discussion on BALUN performance, see "Measuring HF BALUN Performance" by Ron Skelton, W6WO. Available from: https://www.arrl.org/files/file/QEX_Next_Issue/Nov-Dec_2010/Skelton_QEX_Nov-Dec.pdf
[2] Available as a free resource from: https://archive.org/details/FieldAntennaHandbook
[3] If you are unfamiliar with the Figure-8 winding technique see: https://practicalantennas.com/construction/masts/winding/