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HF Active Antenna

Operating Manual

version 1.0

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Cross Country Wireless

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Cross Country Wireless

1 Introduction

Thank you for buying a Cross Country Wireless HF Active Antenna.

It was originally designed for use as a sensitive reference antenna for use with the Sentinel SDR HF noise measurement receiver.

It is a wideband active antenna with excellent performance designed and built with high quality materials to last for years.

2 Theory of operation

The Active Antenna uses a short balanced dipole to sense the electric component of the electromagnetic field. The pattern and polarity of the antenna are similar to a half wave dipole with a sharp null in line with each antenna element.

Unlike a half wave dipole that has a low feed impedance at a specific resonant frequency the short elements used in the Active Antenna have a very high impedance with a capacitance of 7.5 pF over a wide bandwidth.

In the head unit a balanced JFET amplifier is used to match the high impedance of the antenna elements with diode limiters and high voltage ceramic capacitors providing protection from local high RF fields and static electricity from falling rain and snow.

An E-PHEMT device is then used as a driver amplifier to feed an isolation transformer matched to the 100 ohm balanced load of the ethernet cable connecting the head and base units.

At the base unit another isolation transformer is used to match the 100 ohm balanced load of the ethernet cable.

Any RF signal or noise induced in the ethernet cable as a common mode signal is rejected by both transformers.

The RF signal is then fed through an Owen splitter. This reduces the signal by 10 dB and splits the signal to two separate BNC sockets. Diode limiters provide protection from excess RF voltages to receivers connected to the BNC connectors. Isolation between the two BNC sockets is 20 dB.

DC power is fed from the base unit to the head unit via a current sensing circuit indicating the remote connection of the head unit with the illumination of a red LED. Balanced filter networks at each end isolate common mode RF signals and noise from the head unit amplifier.

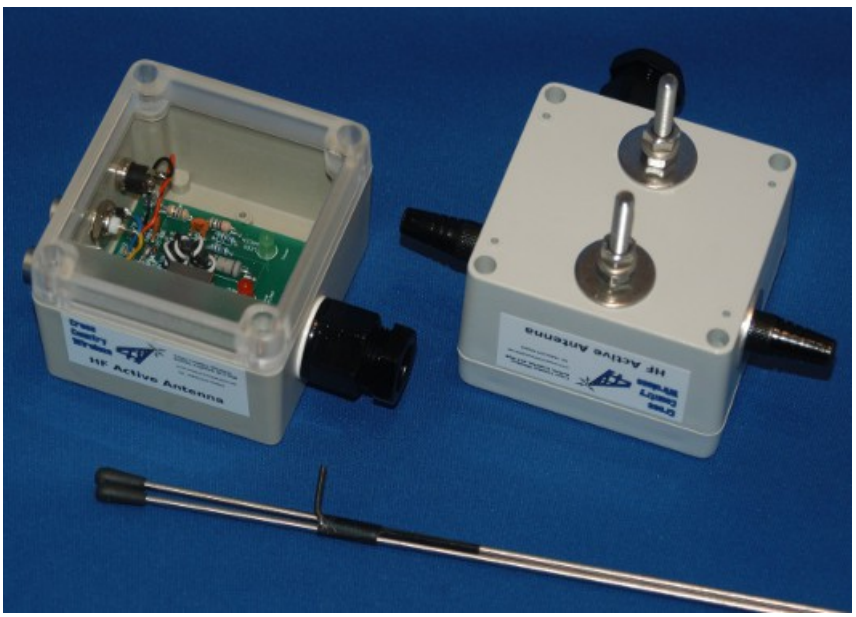
The amplifier gain and splitter loss as been equalised so that with the standard 20m ethernet cable supplied with the antenna the overall gain with 7.5 pF capacitance antenna elements is flat +/- 1 dB between 3 and 30 MHz.

The frequency response at the lower end is limited to 50 kHz by the transformers and coupling capacitors.

The amplifier is flat within -6dB up to 150 MHz but the elements change their electrical characteristics at higher frequencies so the working upper limit is around 108 MHz.

3 Package contents

2	Whip elements
2	Whip tips
1	Allen key
1	Active Antenna head unit
1	Active Antenna base unit
1	2.5mm DC power connector
20m	Ethernet cable with two nitrile rubber sleeves



4 Assembly

Head unit

Install the whip elements in the antenna mounts using the allen key. Make sure that the elements are securely fastened especially if the antenna is going to be mounted so that the elements are vertical.

The head unit can be mounted using the two M6 stainless steel threaded rods. The spacing between the rods is 45 mm.

Do not loosen the two nuts fastening the rods to the polycarbonate box as damage may occur to the internal PCB if these are removed.

Remove the box lid with a Phillips or flat bladed screwdriver.

Loosen the cable gland to allow the RJ-45 connector to go through the gland. Carefully connect the RJ-45 connector to the socket.

Slide the nitrile rubber sleeve into the cable gland and tighten the gland so that the sleeve is securely gripped by the cable gland. There is no need to over-tighten the gland to make a secure watertight seal.

Base unit

Remove the box lid with a Phillips or flat bladed screwdriver.

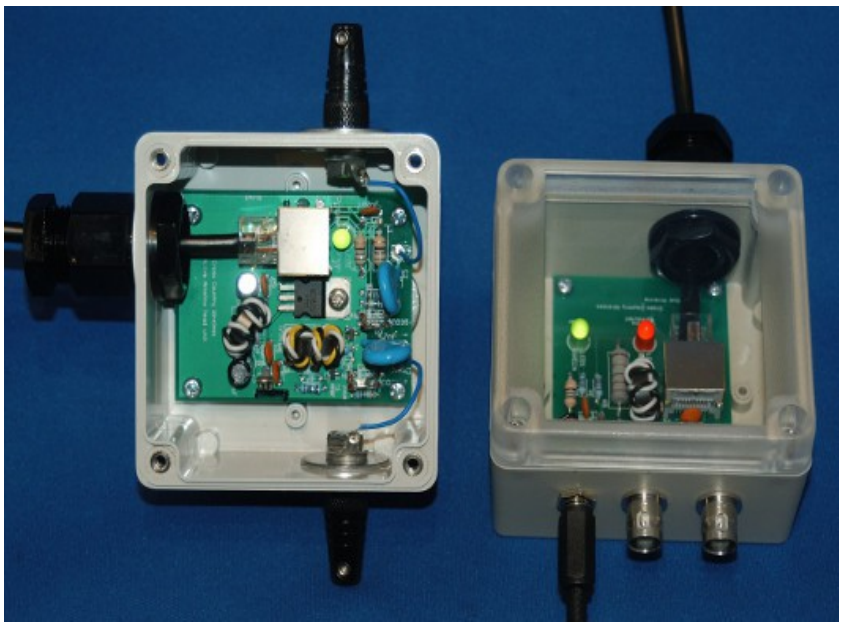
Loosen the cable gland to allow the RJ-45 connector to go through the gland. Carefully connect the RJ-45 connector to the socket.

Slide the nitrile rubber sleeve into the cable gland and tighten the gland so that the sleeve is securely gripped by the cable gland. There is no need to over-tighten the gland to make a secure watertight seal.

Connect a 12 to 15 V supply to the 2.5mm DC power connector. The centre pin is positive polarity.

The green LED should illuminate when power is applied. If the head unit is connected to the far end of the cable the red LED will also illuminate.

5 LEDs



The base unit has two LEDs. The green LED is for DC power indication. The red LED confirms that DC current is flowing to the head unit.

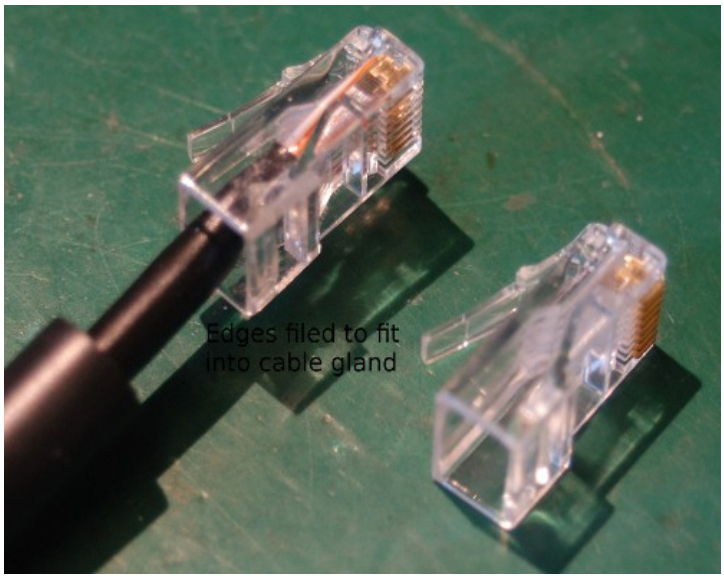
The head unit has a single green LED to confirm DC power during installation.

6 Ethernet cable

The ethernet cable supplied with the Active Antenna has a small modification to the RJ-45 connectors to allow them to fit through the cable gland.

This also acts as a safety interlock feature to stop normal RJ-45 cables carrying data to be connected to the head or base units.
The base unit has DC power connected to two of the pairs in the cable and this may cause serious damage to computers or data terminal equipment if connected to them.

The difference between a standard RJ-45 connector and the modified connector is shown below. If you want to make your own cables then a standard RJ-45 connector can be modified by filing the corners off the connector shell as shown.

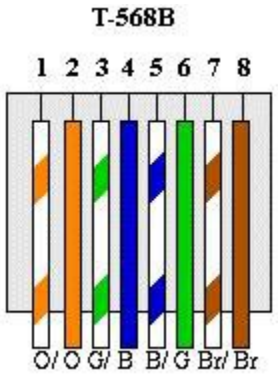


The nitrile rubber sleeve used to seal the cable in the cable gland is :

Smooth nitrile fuel tubing hose Type A DIN 73379 5.4mm ID 9.4mm OD

The cable wiring is straight through to the T-568B colour code below.

Following tests with different types of cable we don't recommend the use of shielded cable as the extra capacitance caused extra losses at higher frequencies.



7 Suggestions for installation

The Active Antenna uses a balanced short dipole as a sensor for the electric portion of the electromagnetic field.

Keep any nearby metal work as far away as possible.

If the antenna is mounted off a tower keep the distance from the tower to the antenna elements the same to ensure symmetry.

Mount the antenna as far away as possible from RF noise sources i.e. switch mode power supplies, computers, phone chargers, electric fences.

The mounting height isn't too critical. If you have a choice of locations go for the quietest location for RF noise rather than the strongest signal.

If mounting in a tree don't let any leaves or branches touch the antenna elements. When they get wet they will unbalance the short dipole and may reduce the antenna performance.

Horizontal mounting is ideal for the bands below 10 MHz as many signals come in at high angles.

If mounted horizontally the antenna can be aligned to null out local interference sources.

Vertical mounting is better for bands above 10 MHz as low angle signals come in from long distance stations.

Due to the small size of the antenna look at possible locations as far away from local RF noise sources as possible.

8 Installation - a case study

The author of this document lives in the UK in the middle of a suburban housing estate. His next door neighbour has a plasma TV set that can cause a large increase in background noise levels in a HF dipole and HF vertical antenna currently used. The author also has a range of computer equipment, phone chargers and other equipment generating small amounts of RF noise in his house.

Their are several possible mounting points for the antenna:

1) the chimney
2) the gable end at the opposite end of the house from the chimney
3) the loft space
4) a tree in the garden 10m from the house

The chimney would appear at first sight to be the ideal spot. However when the Active Antenna was mounted there incoming signals were extremely strong but there were also high levels of noise from the plasma TV as the neighbour's TV antenna was also on the same chimney and the interference was radiating from the co-axial cable running from the TV antenna to the TV set.

The gable end was further away from the TV antennas so the plasma TV noise was reduced especially if the antenna was mounted horizontally and the antenna null pointed at the TV antenna but there was still some noise from other electronic equipment inside the house.

The loft space was worse as the mains electrical wiring carrying the RF noise was fairly close to the antenna. The signal levels were reduced by the roof especially when wet so it wasn't ideal but could be used if there was no alternative.

The antenna was then mounted about 5m up in a tree 10m away from the house. Although lower in height than the other positions incoming signals were still strong. The RF noise from other equipment in the house had almost disappeared and best of all the noise from the neighbour's plasma TV could be nulled out so that it was barely noticeable.

In comparison to the full size half wave dipole and the HF vertical many more weaker stations could be heard as the receiver wasn't limited by the background interference from local RF noise sources any more.