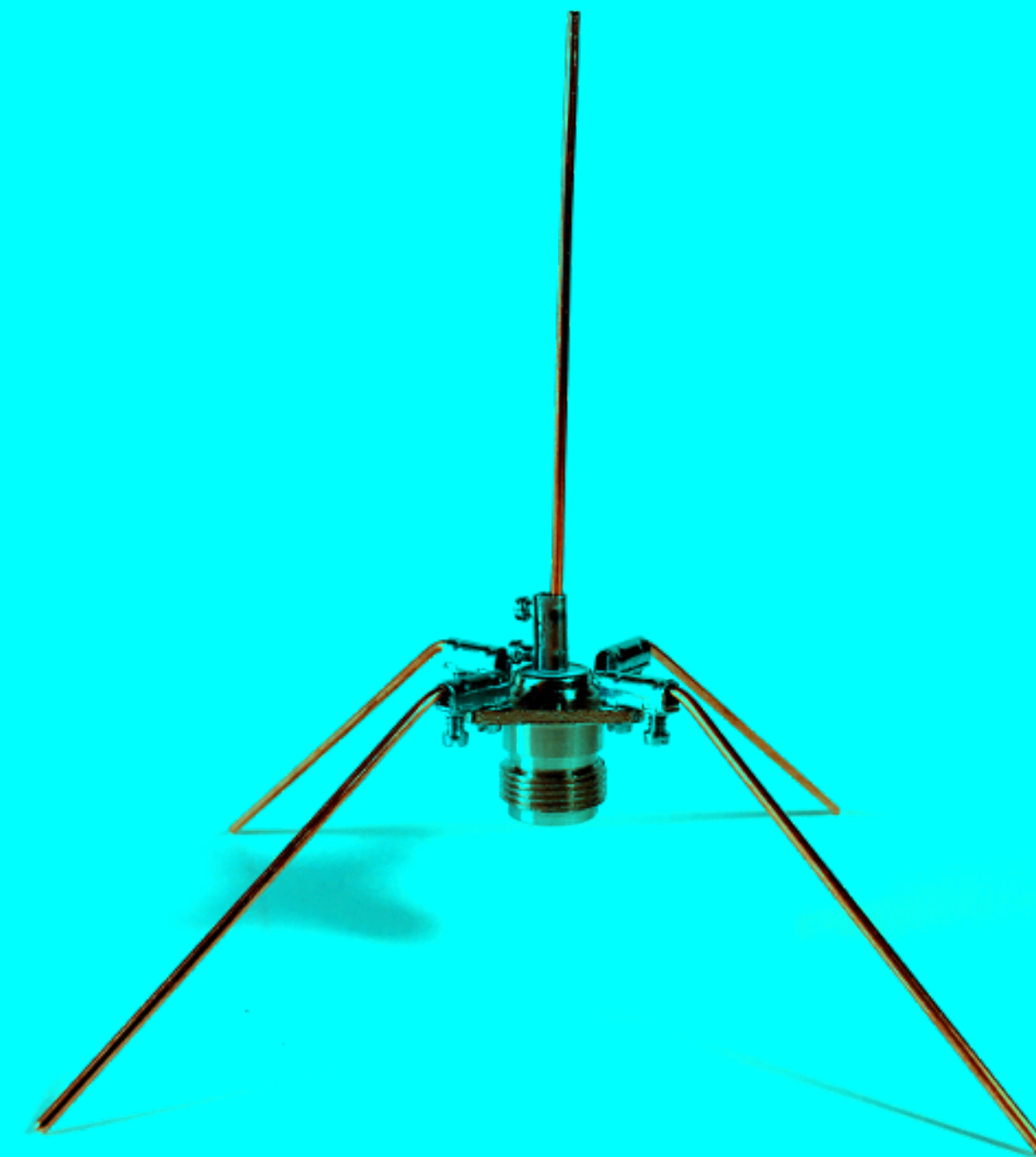
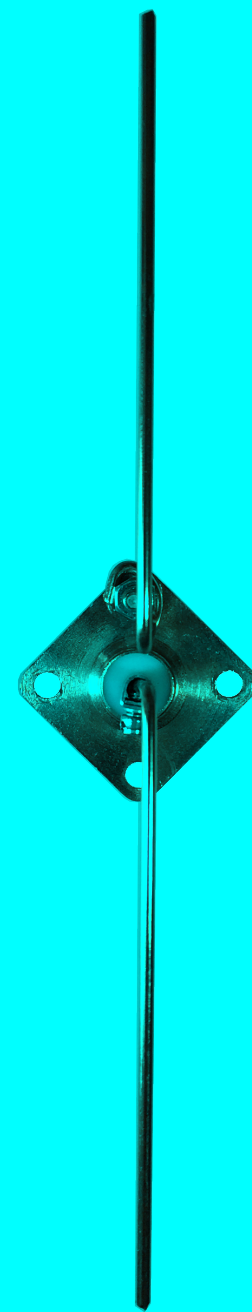


# LORA / LORAWAN TUTORIAL 37

## Balanced and Unbalanced feed lines and Antennas and Balun



# INTRO

- In this tutorial I will explain:
  - What balanced and unbalanced feed lines are,
  - What balanced and unbalanced antennas are,
  - And what the purpose is of a balun.

# BALANCED VS UNBALANCED FEED LINES

- Feed lines can be divided into balanced and unbalanced feed lines.
- A balanced feed line consists of two conductors of the same type. Current flows in opposite direction. The generated electromagnetic fields cancels each other out.

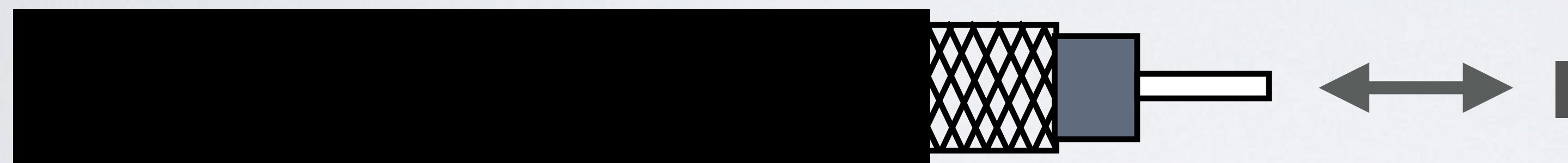


- A ladder line (twin lead with rectangular openings) is a balanced feed line. Ladder lines are used for example in amateur radio systems.



# BALANCED VS UNBALANCED FEED LINES

- An unbalanced feed line has a single conductor.



Current flows only thru the center conductor.

- A coax cable is an unbalanced feed line.
- In LoRa systems coax cables are used.



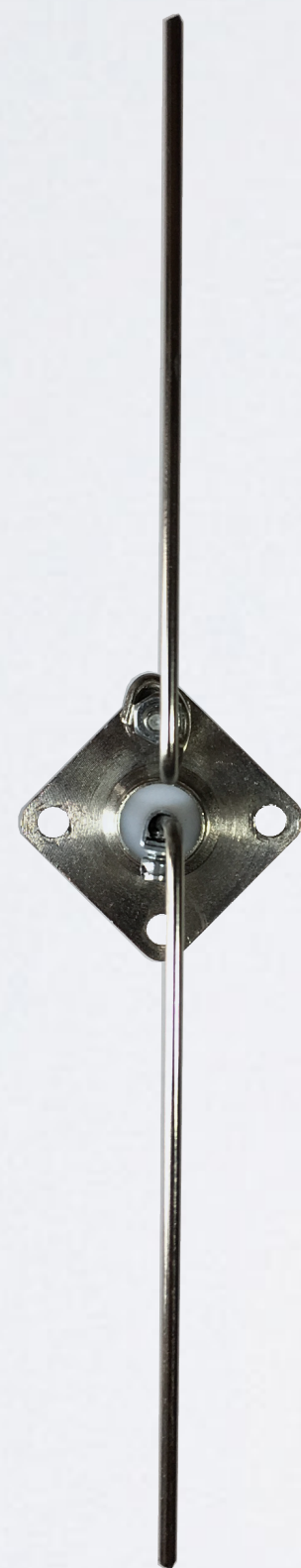
# BALANCED VS UNBALANCED ANTENNAS

- Antennas can be divided into balanced and unbalanced antennas.
- In general (in most but not all cases) a balanced antenna has more than one element which are fed and are of equal length.
- An unbalanced antenna has only one element which is fed.

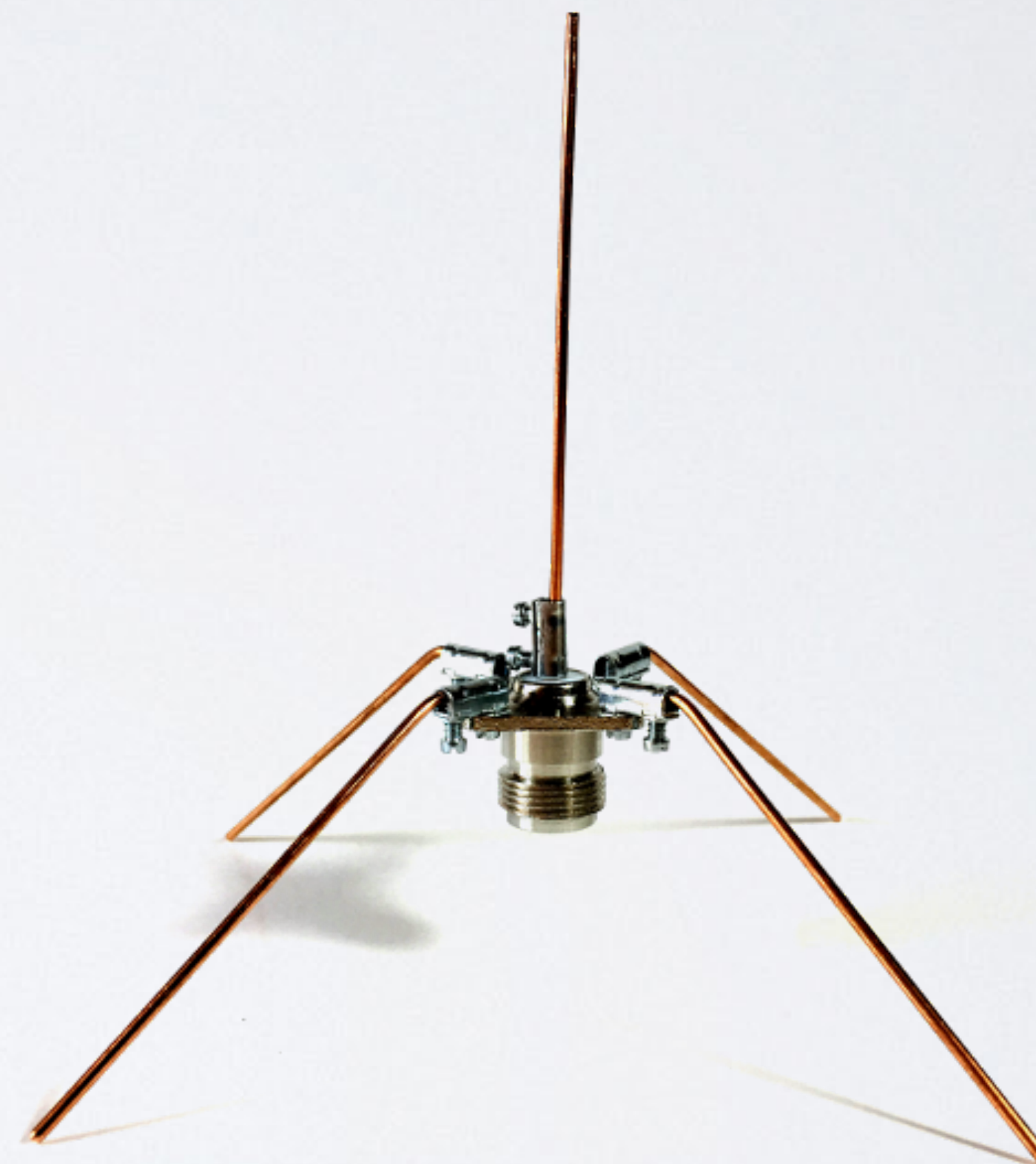


# BALANCED VS UNBALANCED ANTENNAS

**$1/2 \lambda$  dipole antenna  
balanced antenna**

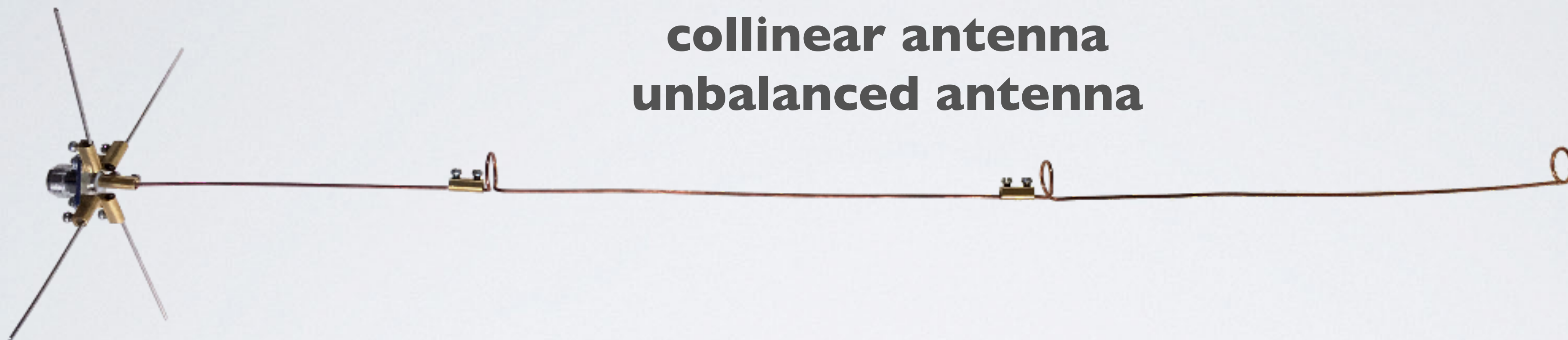


**$1/4 \lambda$  ground plane antenna  
unbalanced antenna**



# BALANCED VS UNBALANCED ANTENNAS

**collinear antenna  
unbalanced antenna**



**normal mode helical antenna  
unbalanced antenna**



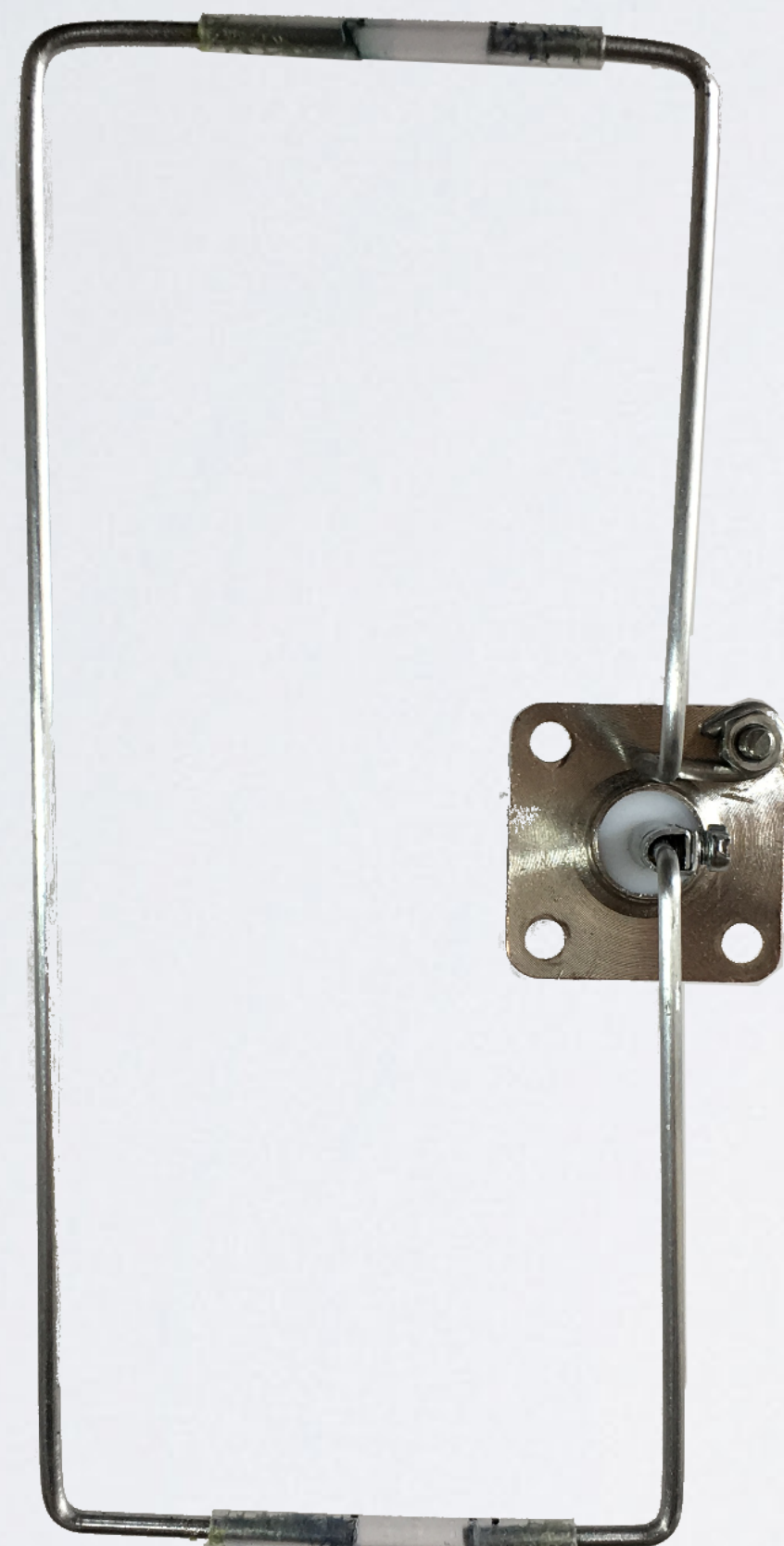
**sleeve dipole antenna  
balanced antenna**



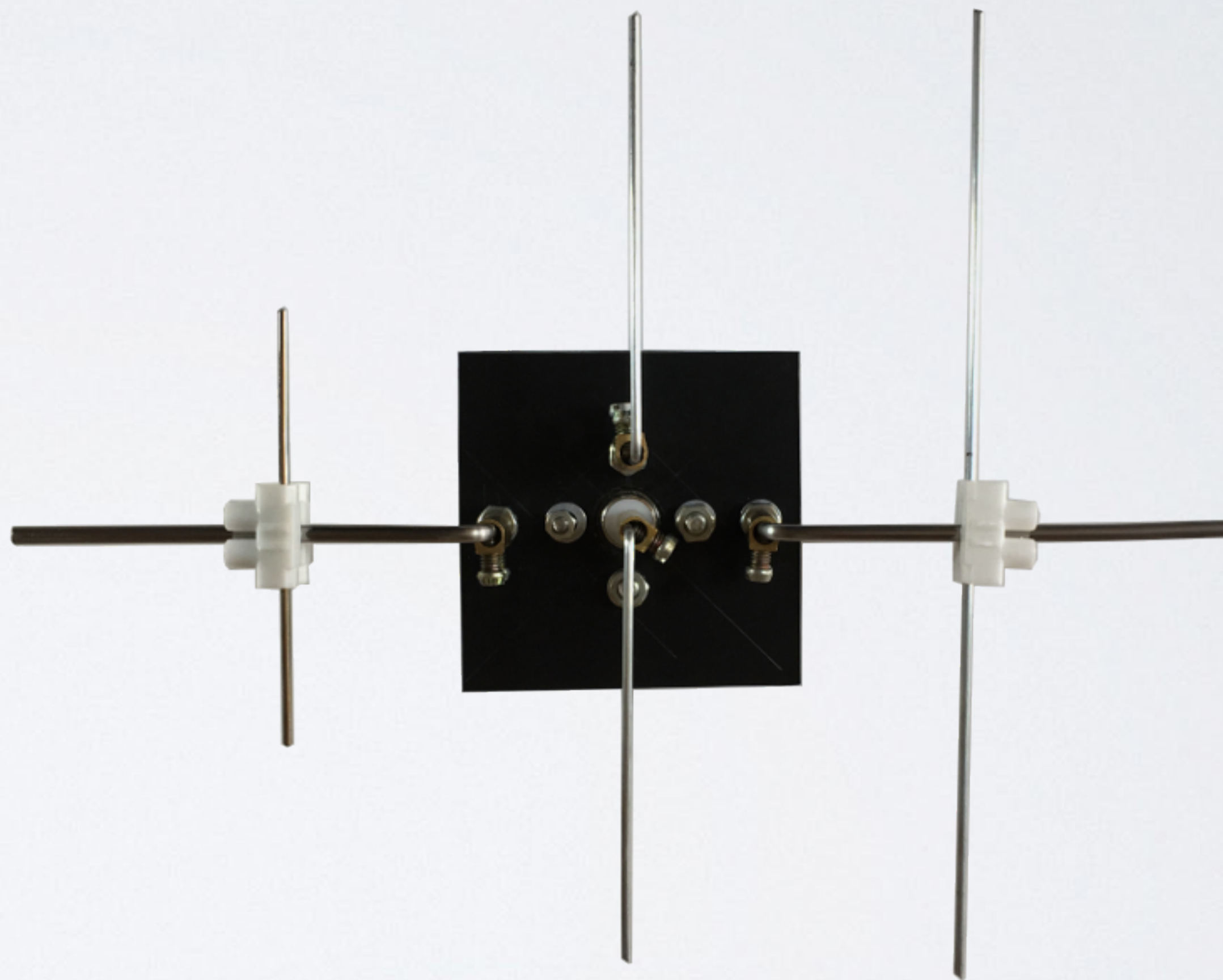


# BALANCED VS UNBALANCED ANTENNAS

**Moxon antenna  
balanced antenna**



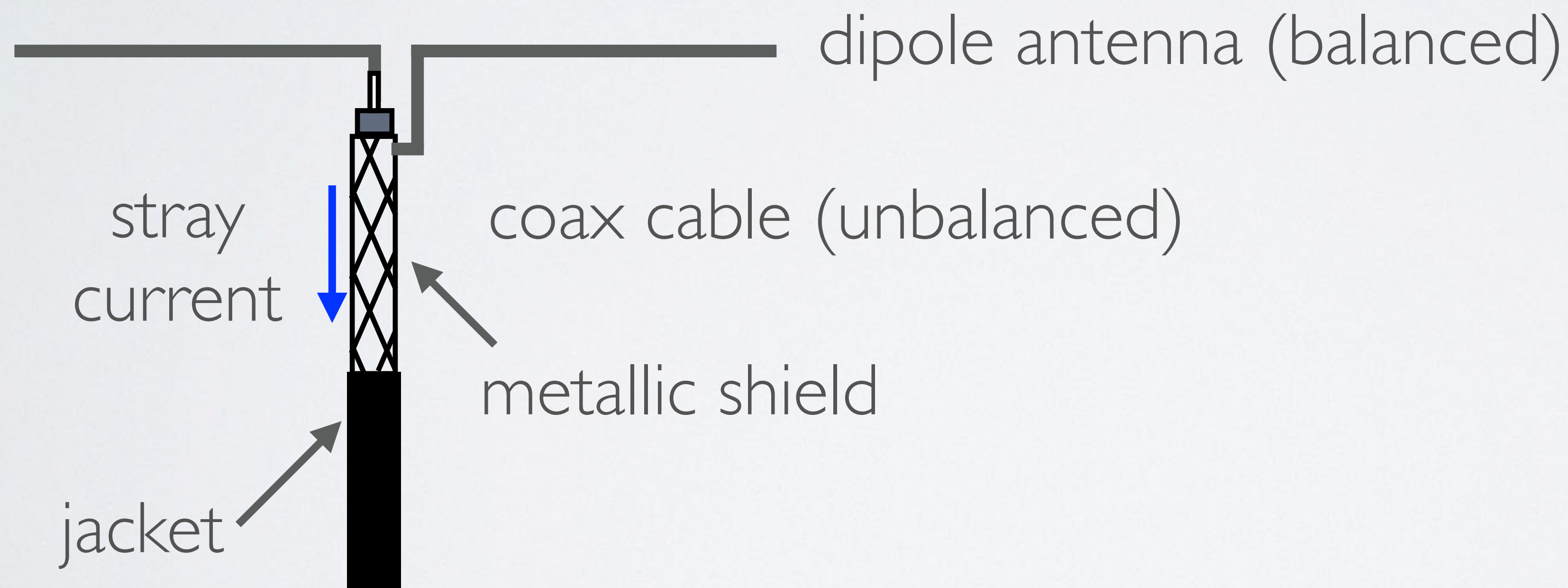
**Yagi-Uda antenna  
balanced antenna**





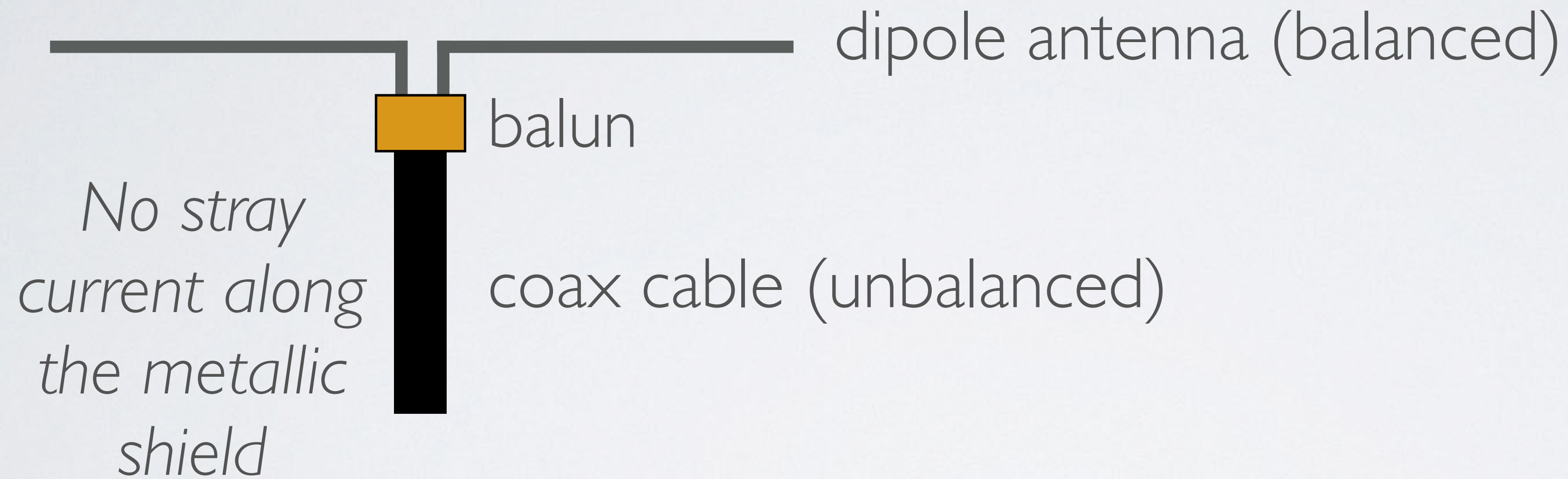
# BALUN

- If a coax cable is used to feed a balanced antenna, a small amount of current (lets call it stray current) can flow back along the metallic shield of the coax cable. The metallic shield acts like an antenna generating RF interference impacting the antenna itself as well as electrical systems nearby.



# BALUN

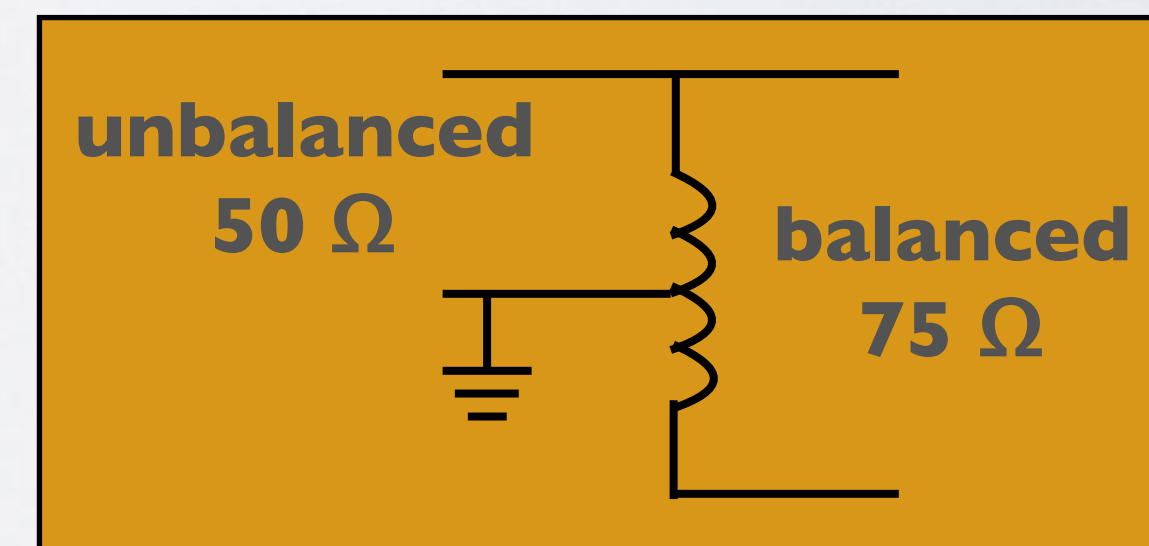
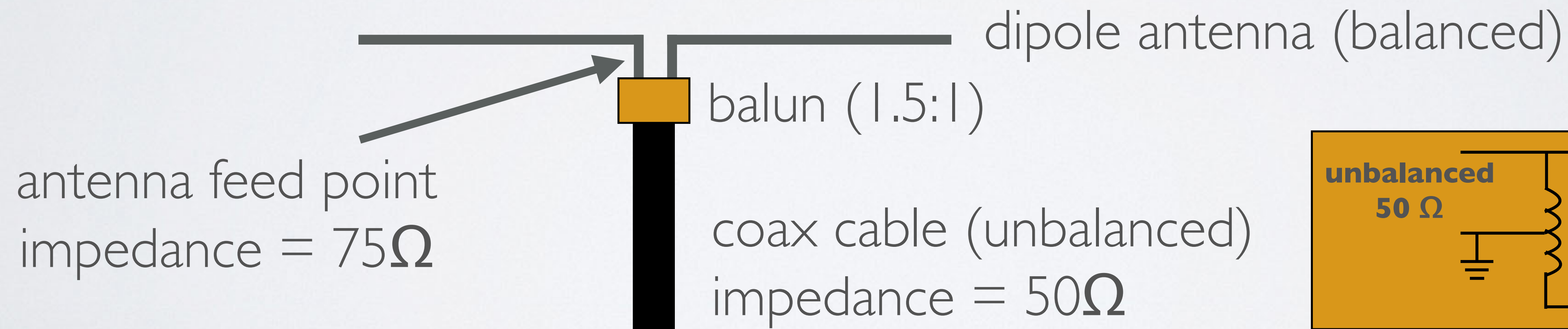
- A balun prevents stray current to flow back along the metallic shield of the coax cable.





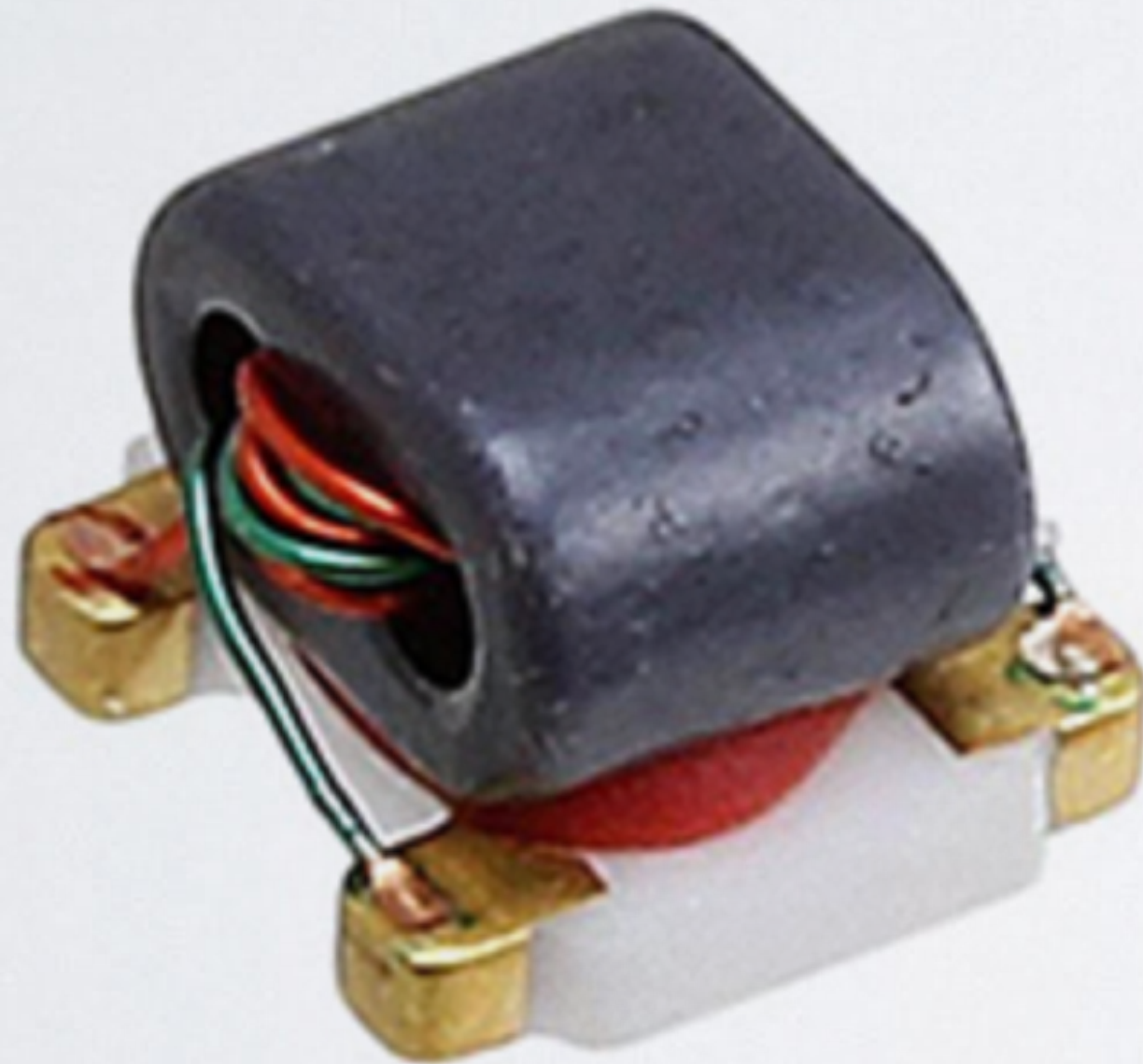
# BALUN

- A balun can also have another function. It can be used to connect lines of different impedance. It can fix the impedance mismatch between feed line and antenna feed point.
- For example a dipole antenna feed point has an impedance of  $75\Omega$  and the coax cable has an impedance of  $50\Omega$ . By using a 1.5:1 balun the impedance is converted from  $50\Omega$  to  $75\Omega$  ( $1.5 \times 50\Omega = 75\Omega$ )



# BALUN

- A dipole antenna can operate satisfactorily without the use of a balun. It has no significant effect on the VSWR but there may be a slight increase risk of interference if one is not used.
- In portable, handheld and IoT applications, tiny low power UHF baluns can be used. UHF means Ultra High Frequency. UHF frequency range is: 300 MHz - 3 GHz

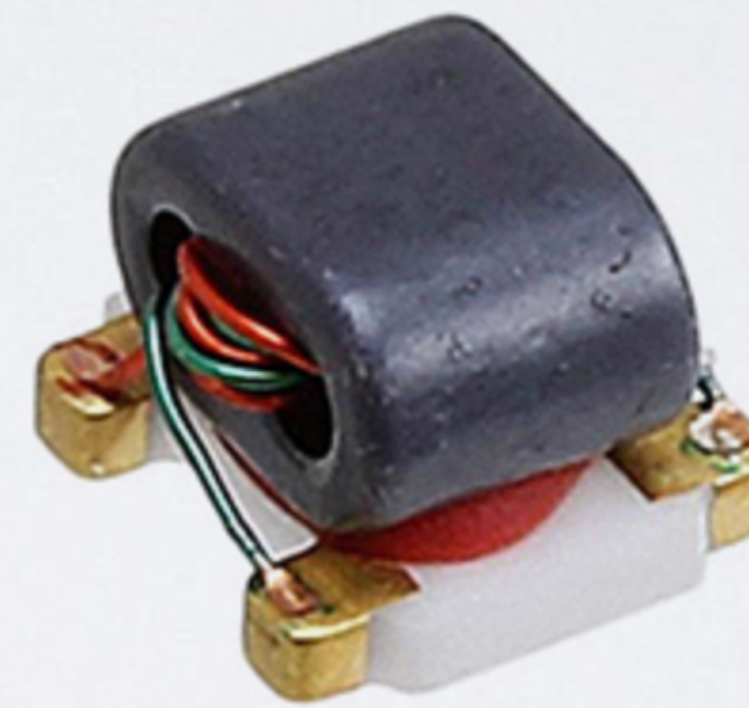
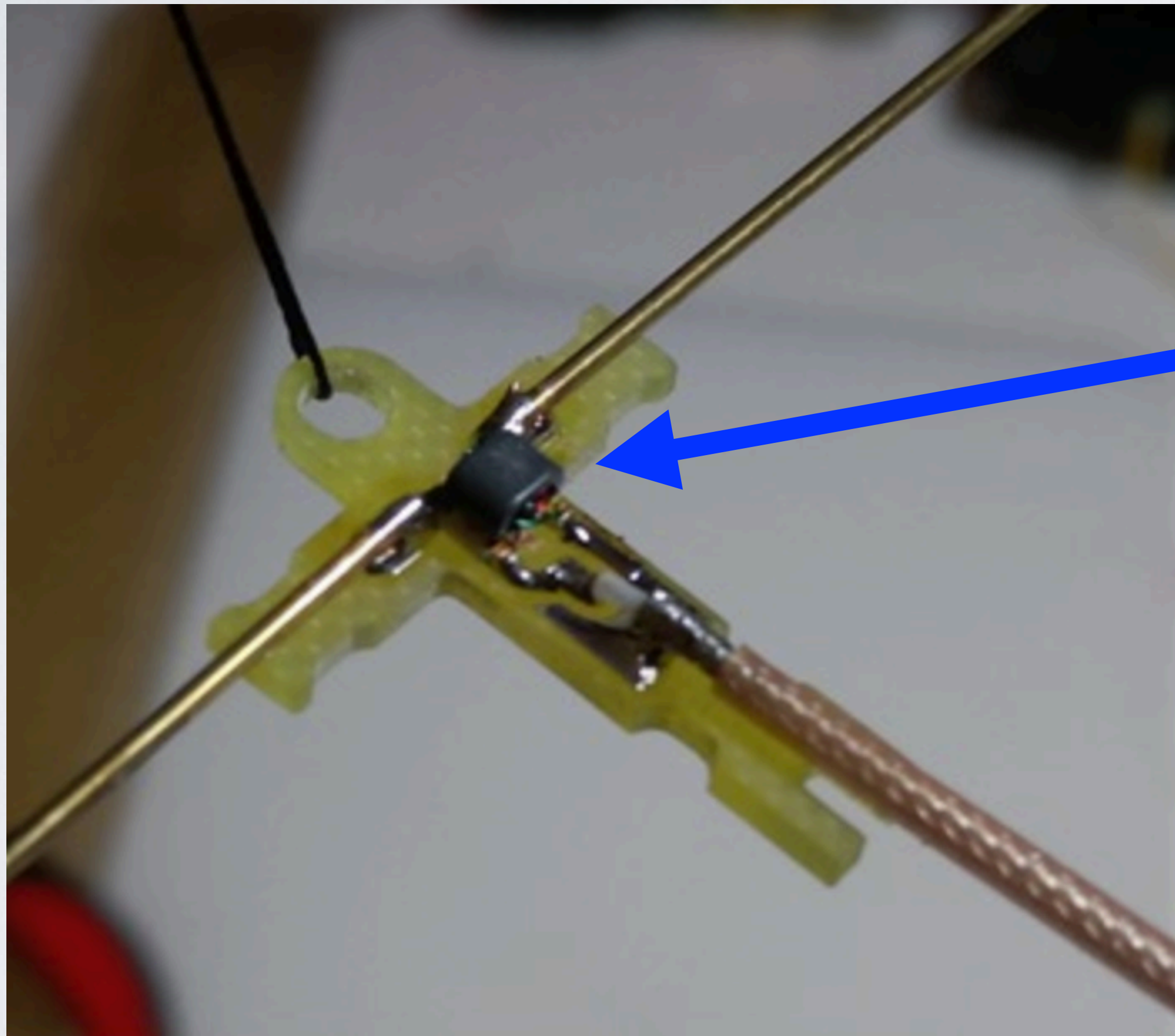


Example of a low power UHF balun



# BALUN

- Source: <https://www.kolins.cz/dipole-antenna-with-balun/>

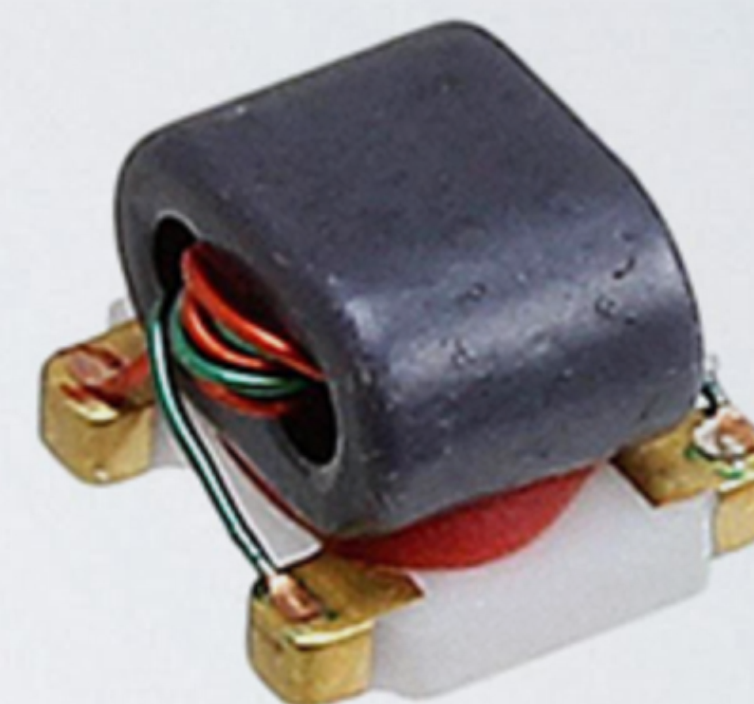
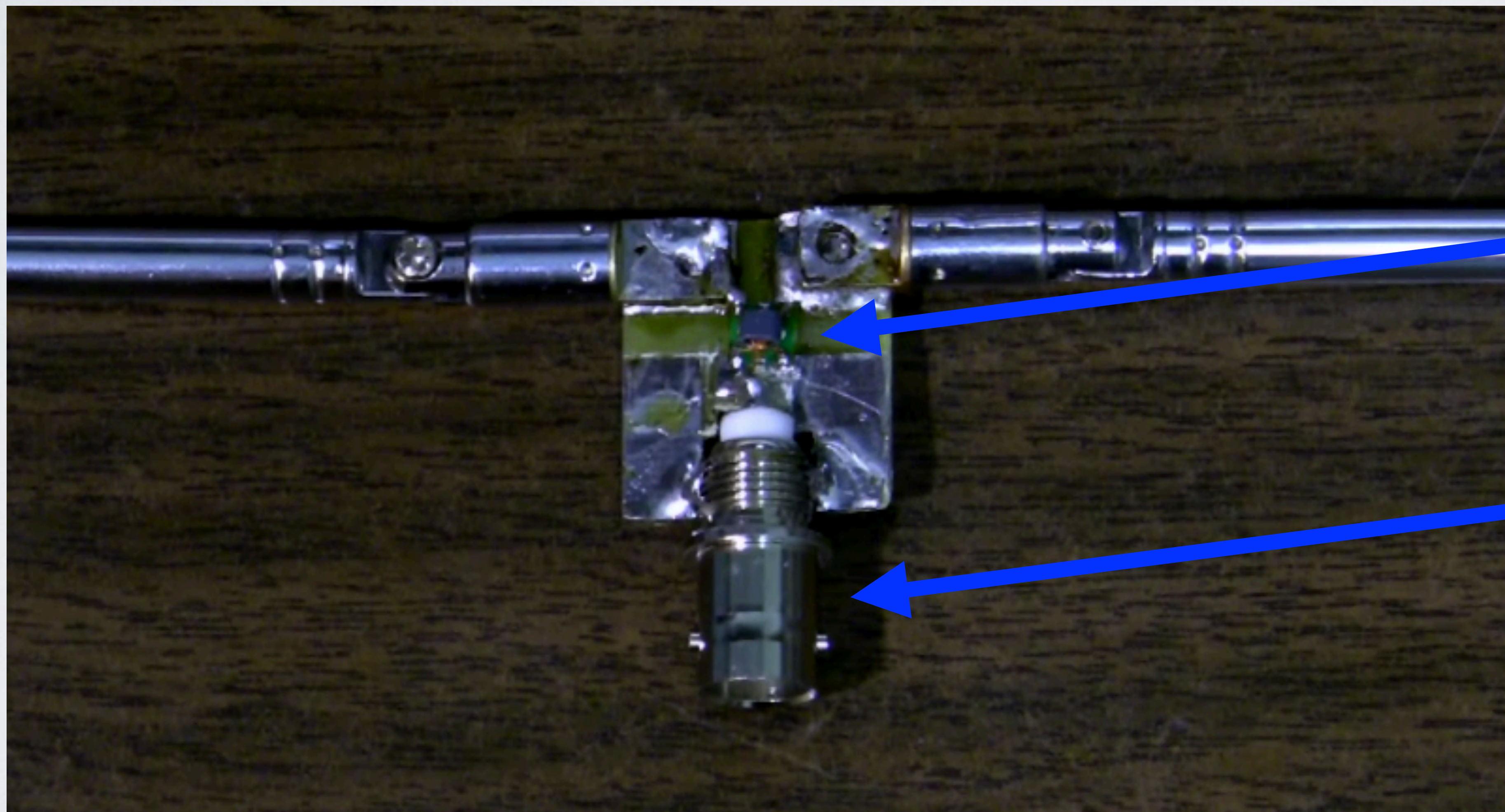


Example of a balun used in a dipole antenna.



# BALUN

- Source: <https://youtu.be/HI3twUISD30>



**BNC female connector**



# BALUN

- A **balun** is a **balanced** to **unbalanced** transformer. It takes the unbalanced input from a coax cable and provides a balanced output for the balanced antenna.
- A balun is not needed when:
  - **balanced** feed line feeds a **balanced** antenna
  - **unbalanced** feed line feeds an **unbalanced** antenna
- A balun should be used when:
  - **balanced** feed line feeds an **unbalanced** antenna
  - **unbalanced** feed line feeds an **balanced** antenna

# ATTENTION

- In the previous slides I have shown some of my self build antennas. I have not used baluns.
- An antenna can operate satisfactorily without the use of a balun but there may be a slight increased risk of interference if one is not used. My self build antennas are **not** properly constructed and the antenna performance can be improved by using better materials, parts or another way of construction.
- The antennas in this LoRa/LoRaWAN tutorial series are mainly intended for educational purpose.
- My antennas are constructed in such a way so it can be easily disassembled and its parts can be re-used in other antenna projects. This means the antenna performance will not be great.