# Ground Loop Suppression

How to support proper power grounding, RF grounding, and lightning grounding, and still eliminate RF loops that impact amateur radio station performance.

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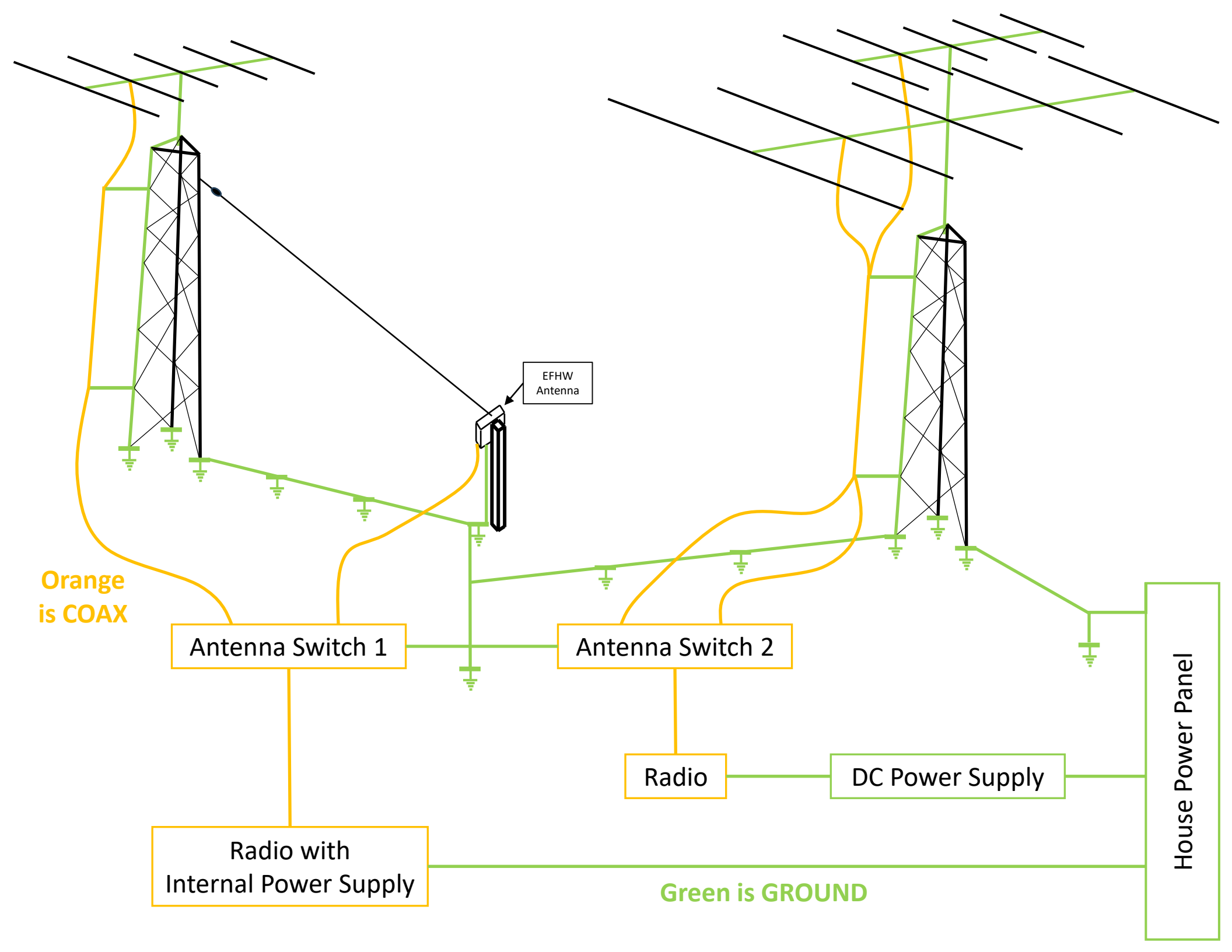
March 11, 2025

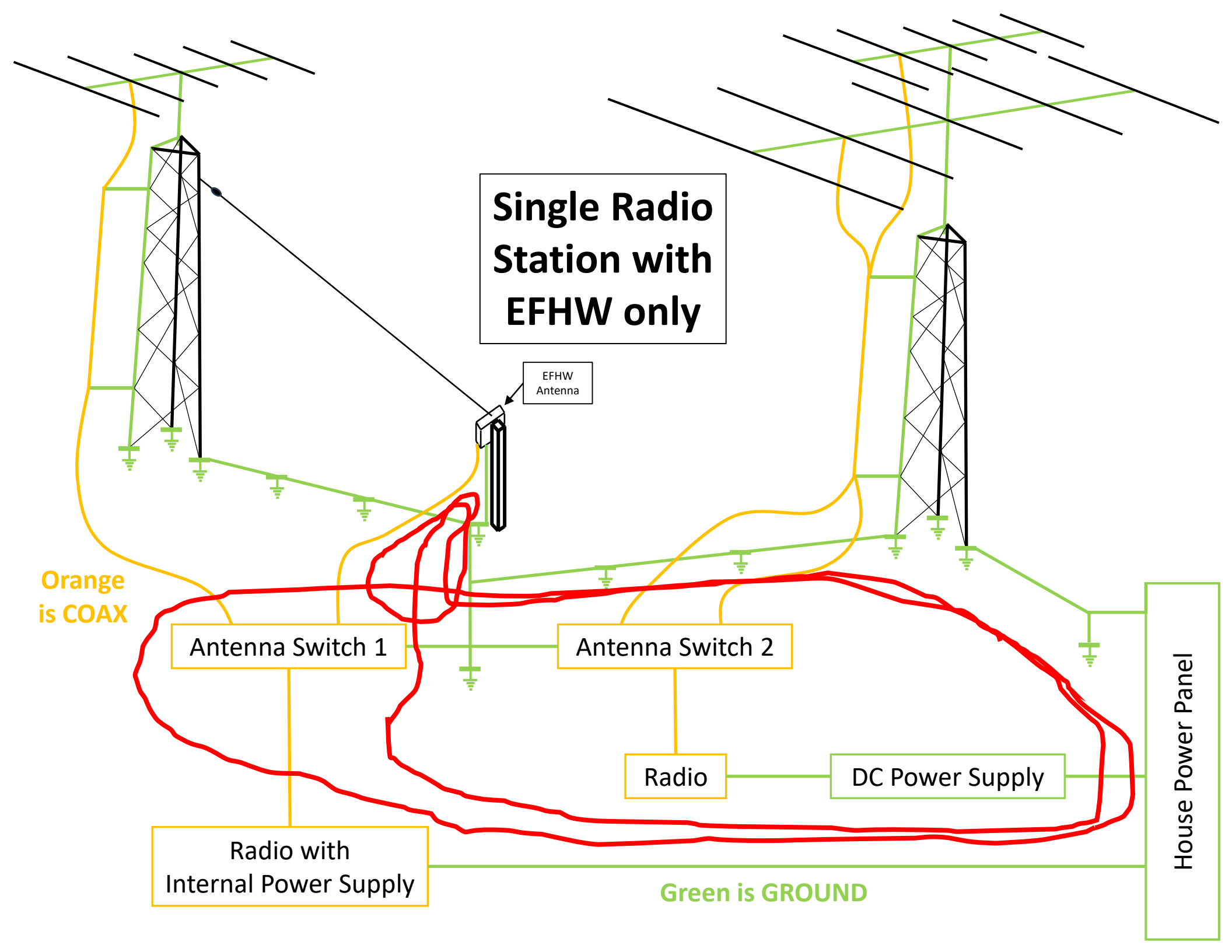
# Our Station for analysis

- Coax is in **Orange**
- Ground is in **Green**
- One Radio has a built in Power Supply
- One Radio has a separate DC Power Supply
- Two towers
- Three beam antennas
- One EFHW (End Fed Half Wave) antenna
- Two Antenna Switches
- For graphical clarity Polyphasors and grounded coax feed throughs not included


EFHW
Antenna
Orange
is COAX
Antenna Switch 1
Antenna Switch 2
Radio
DC Power Supply
Radio with
Internal Power Supply
Green is GROUND
House Power Panel

# The Ground Loop Problem

- Ground loops act as antennas, which causes desensitized reception and interference.
- Two major categories of ground loops exist.
  - Loops that include the radio power supply.
  - Loops that do not include the radio power supply.
  - Both loops have solutions.
- Ground loops are shown with **Red** circles.
- First slide is a single radio station with an EFHW antenna.
- Second slide is with multiple radios and antennas.


Single Radio Station with EFHW only
EFHW Antenna
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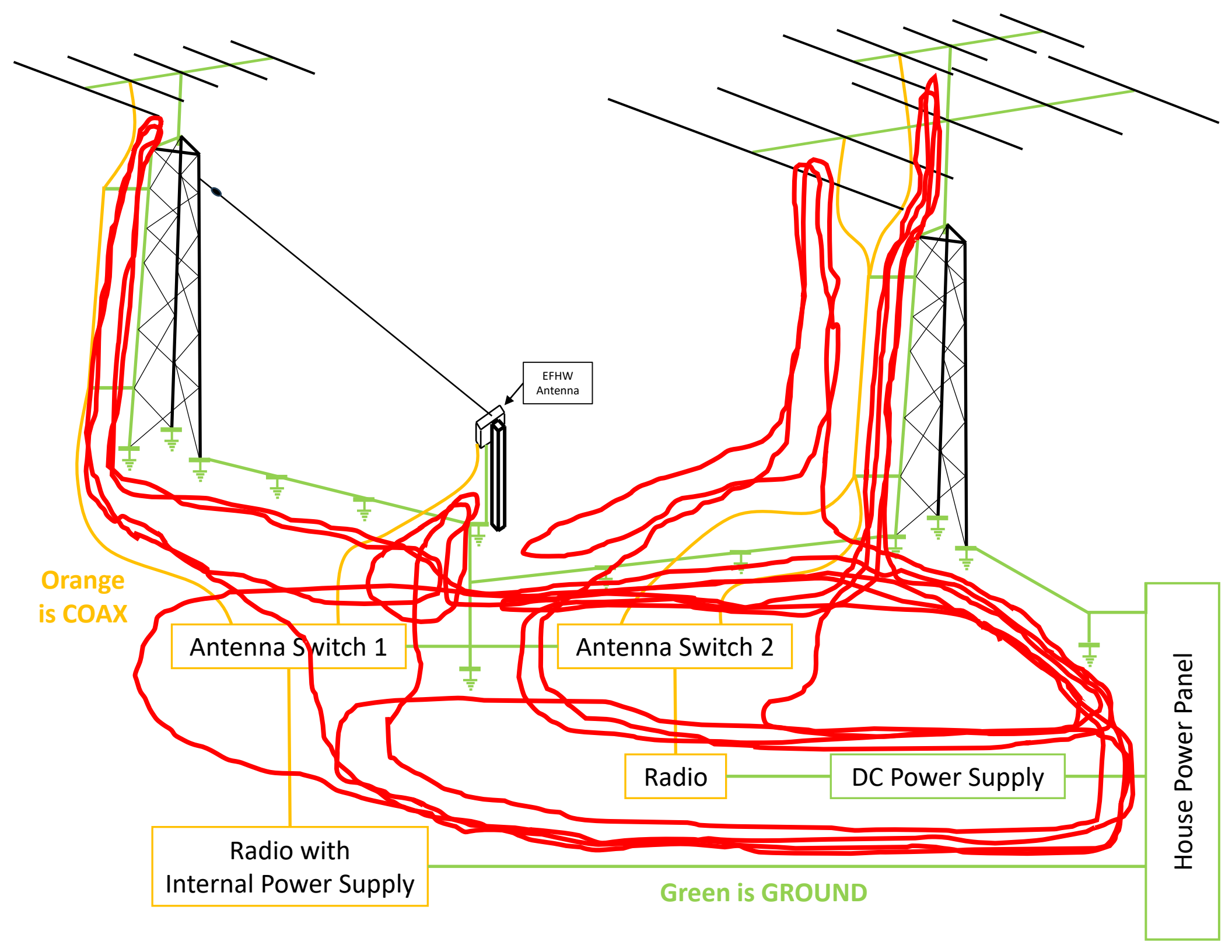
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# Reasons for Grounding

- Power safety.
  - Radio power supplies require grounding to house power. Improper power grounding can kill.
- RF safety and performance.
  - Many antennas require a RF ground counterpoise or stray RF grounding. RF burns can hurt.
- Lightning safety.
  - Lightning can take both your radio equipment and you out, permanently.

*Effective grounding of all three types is required for safety, and proper operation of your radio station.*

# Power Grounding

- Power grounding is required to assure voltages present inside the radio power supply are not present on the external chassis of the radio.
- Code does not allow interruption of the ground connection to house power.

# RF Grounding

- Many antenna designs require grounding as part of the antenna design for safety, and/or performance.
- A common mode signal received by a loop with coax creates an RF current on the outside skin of the coax shield. The RF current on the outside skin of the coax shield creates a magnetic field which induces an RF current on the inside skin of the coax shield. The induced RF current on the inside skin of the coax mixes with the received RF current from the antenna causing desensitized reception and interference.

# Lightning Grounding

- Florida lightning has twice the power of the lightning in the Northern CONUS.
- Lightning occurs frequently in Florida.
- Lightning does not need to strike your antenna to damage radio equipment.  Static fields and EMPs alone from lightning can damage radio equipment.
- Lightning has a major energy component at approx. 1 MHz

# Lightning Grounding (continued)

- Antenna grounds must have a low inductance connection to the radio power ground for effective lightning protection.  Otherwise your radio becomes a lightning fuse.  Lightning always finds the easiest path to ground.
- Eight foot grounding rods have an effective range of eight feet, so space rods 16 feet apart to maintain effectiveness.

# The Ground Loop Solution

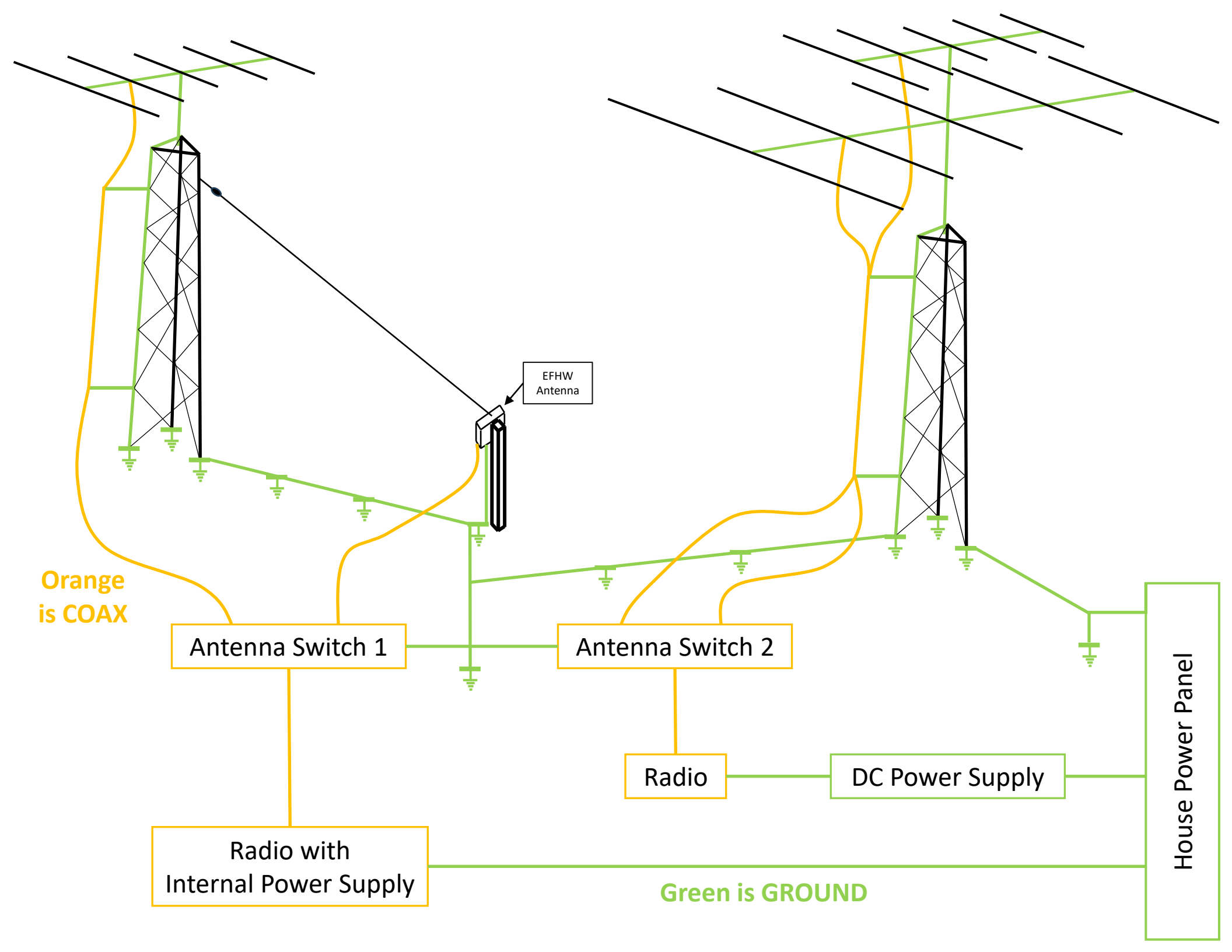
- Add common mode RF chokes where loops exist.
- Choose locations where a common mode RF choke does not impact either station operation nor safety performance.
- Many EFHW antenna designs use the feed coax as an antenna counterpois, therefor the common mode RF choke must be some distance from the 49 to 1 unun, often 17 feet.
- The counterpois of most beam antennas are connected to their boom, which is connected to ground. This creates loops that need to be addressed.

# The Ground Loop Solution (cont')

- Option A uses coax common mode RF chokes that consist of a minimum of 6 turns of tightly coupled transmission line coax.  Low bands require more.
- These coax common mode RF chokes are indicated by a circle on the **Orange** lines.
- Remember that Polyphasors add another connection of antenna coax shield to ground, creating more loops.
- Note that grounded coax feed throughs, that are often used on towers, add another connection of antenna coax shield to ground, creating more loops.

# The Ground Loop Solution (cont')

- Option B uses both coax common mode RF chokes and power supply common mode RF chokes that are indicated by a circle on the **Green** lines.
- Option B places a common mode RF choke on the DC power cables between a radio and it's DC power supply. If an isolated power ground does not exist, most of the time the negative lead also carries a ground. Then make a common mode RF choke by rapping 6 tightly coupled turns of the entire power cable. Low bands require more.
- If the power supply is built into the radio, isolate the house power ground and install a wire rapped around a toroid ferrite in series with the ground. The two power leads can be common mode wrapped around another toroid ferrite. Power considerations are needed here, commercial products are available for this very purpose.


EFHW
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Radio with
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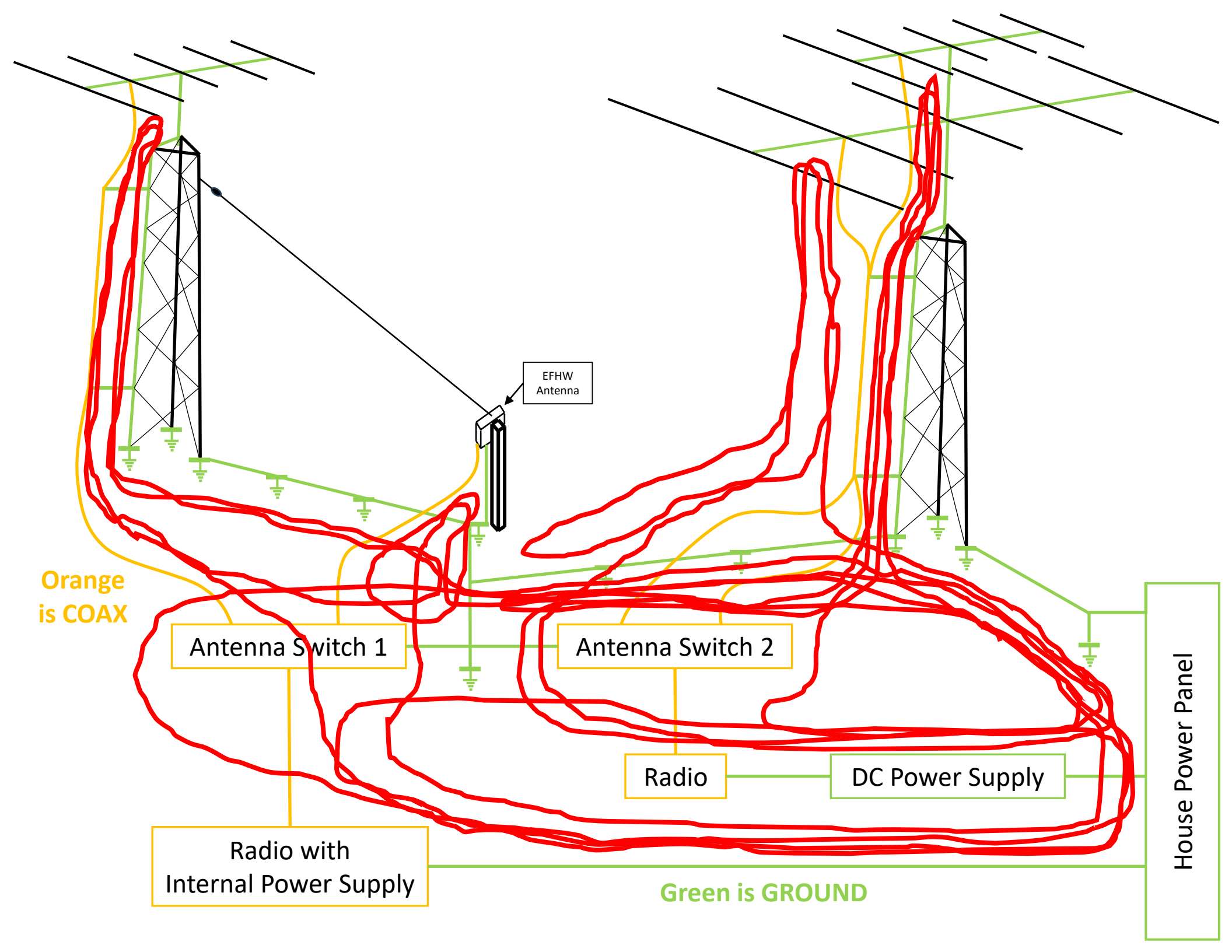
Green is GROUND
House Power Panel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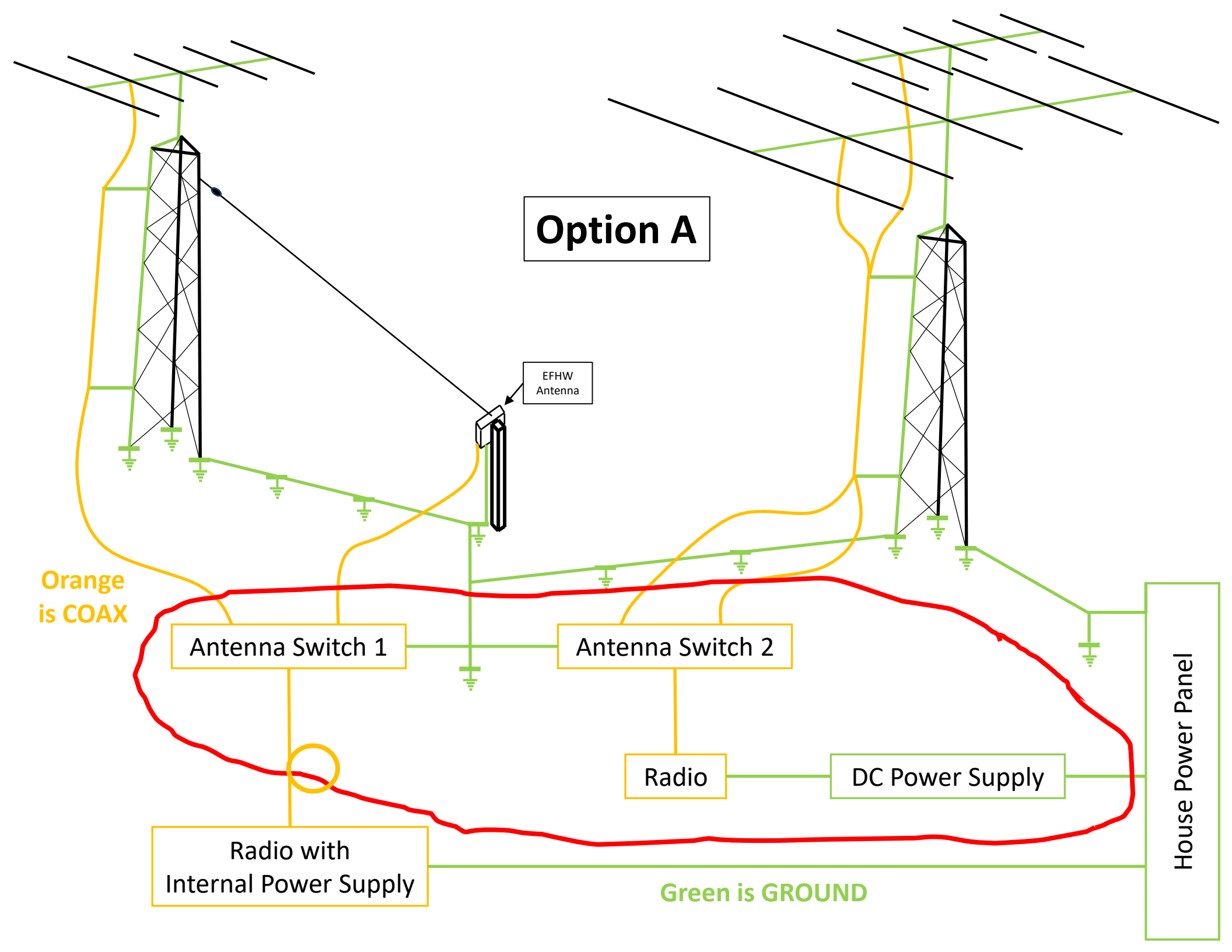
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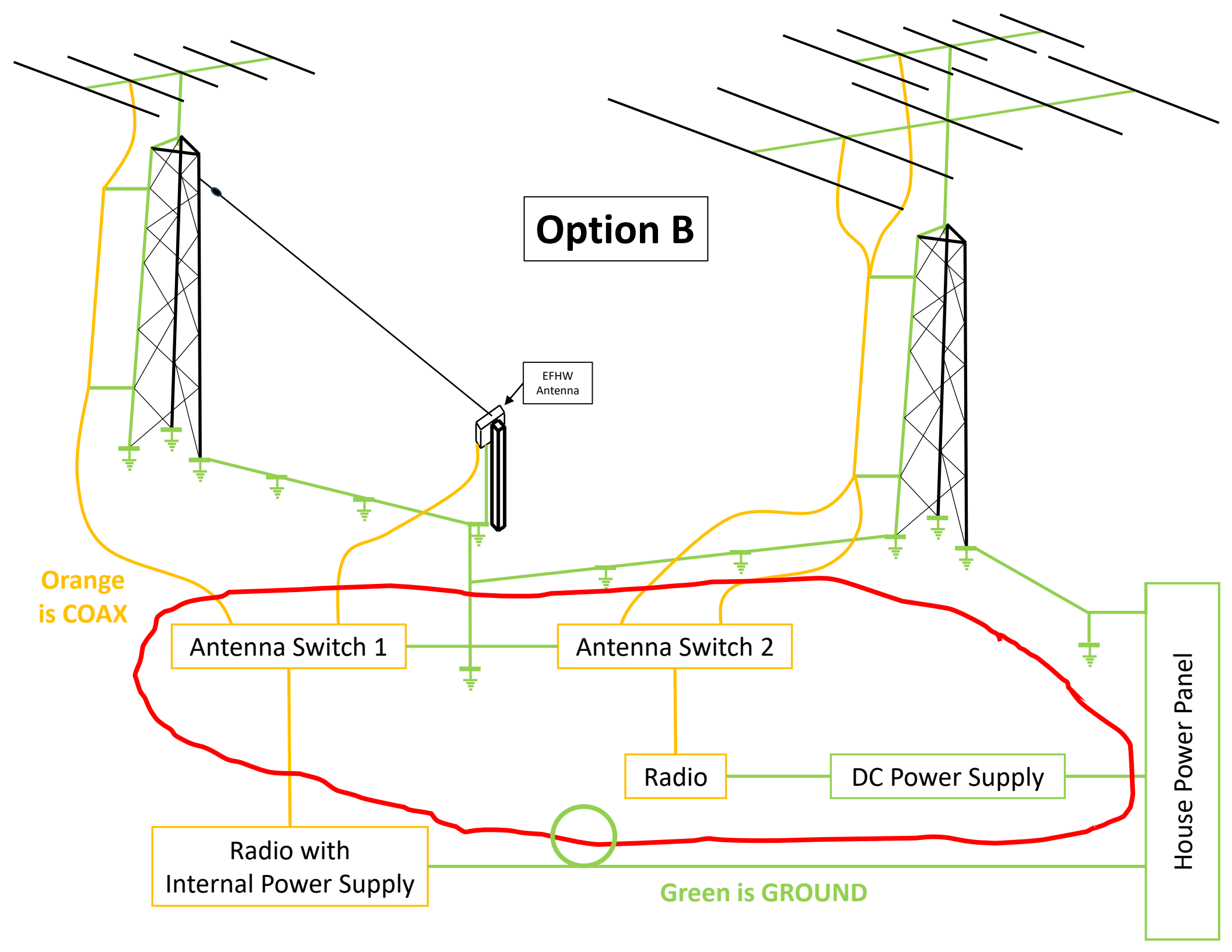
Option B
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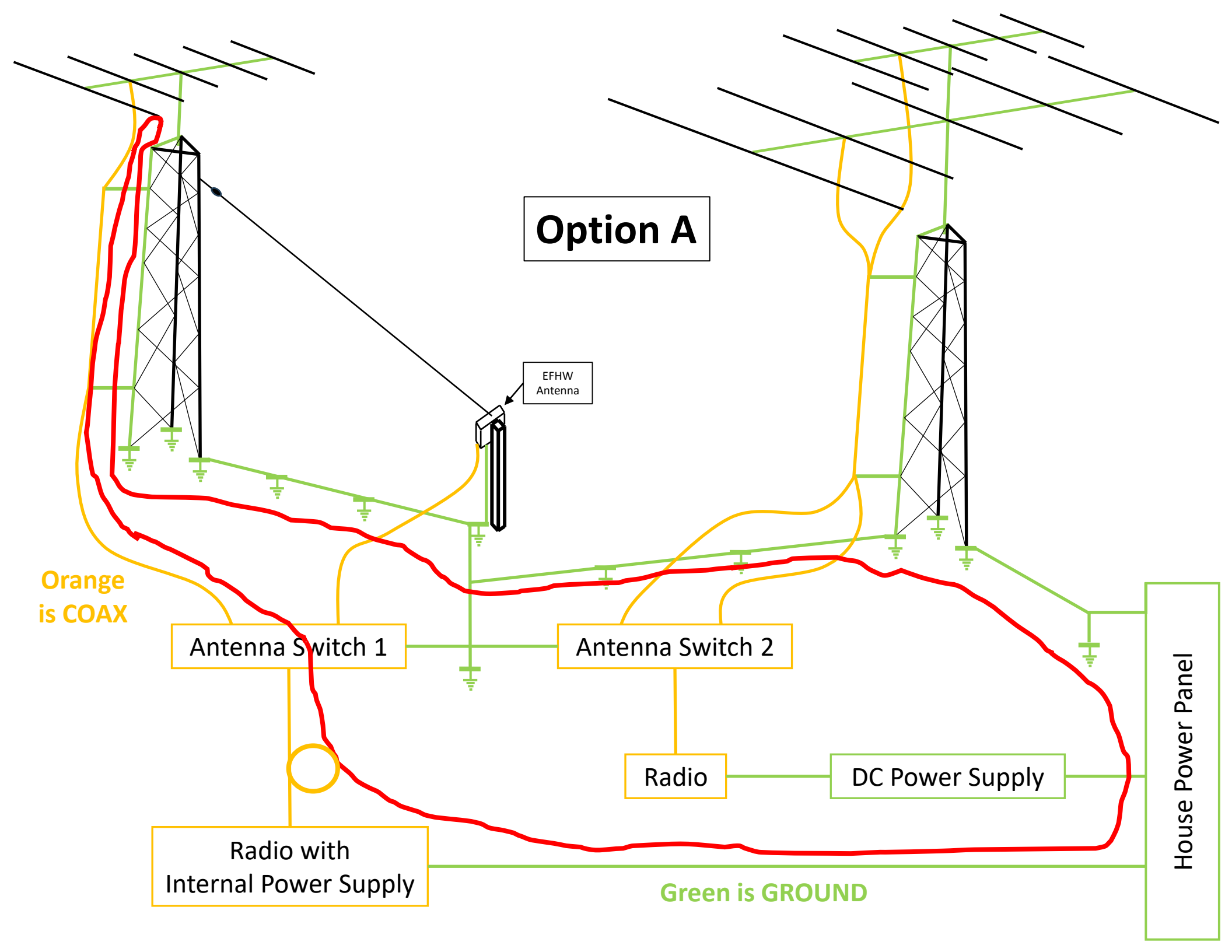
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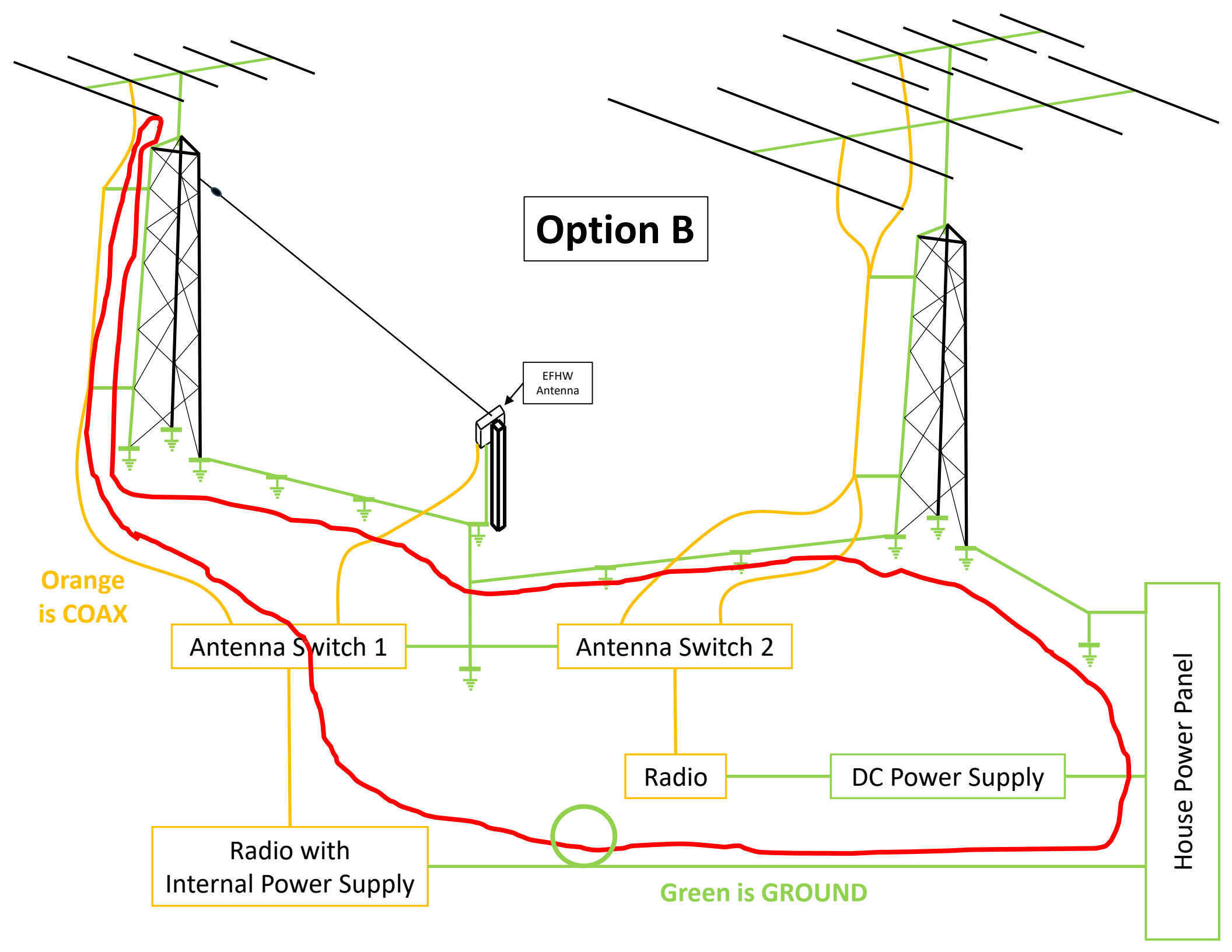
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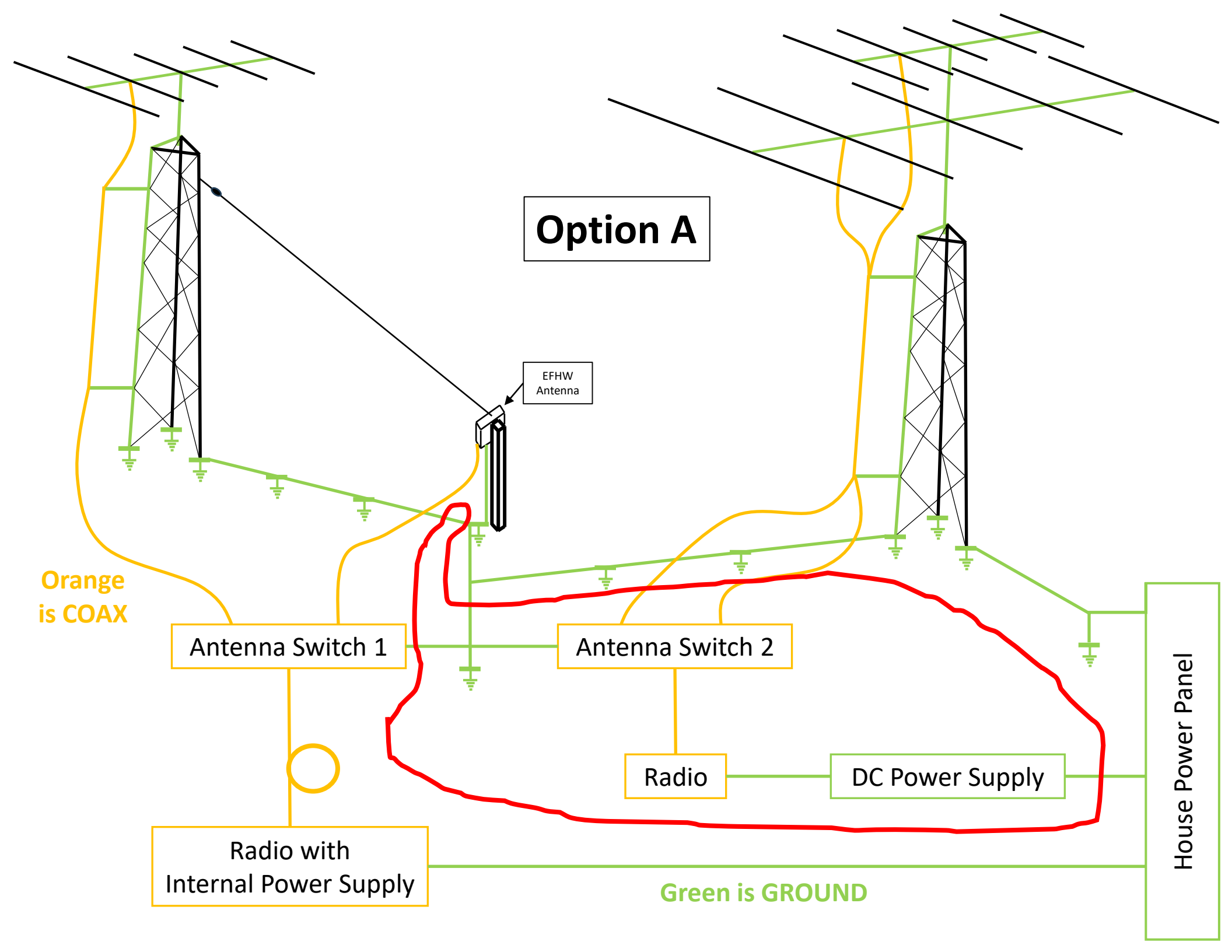
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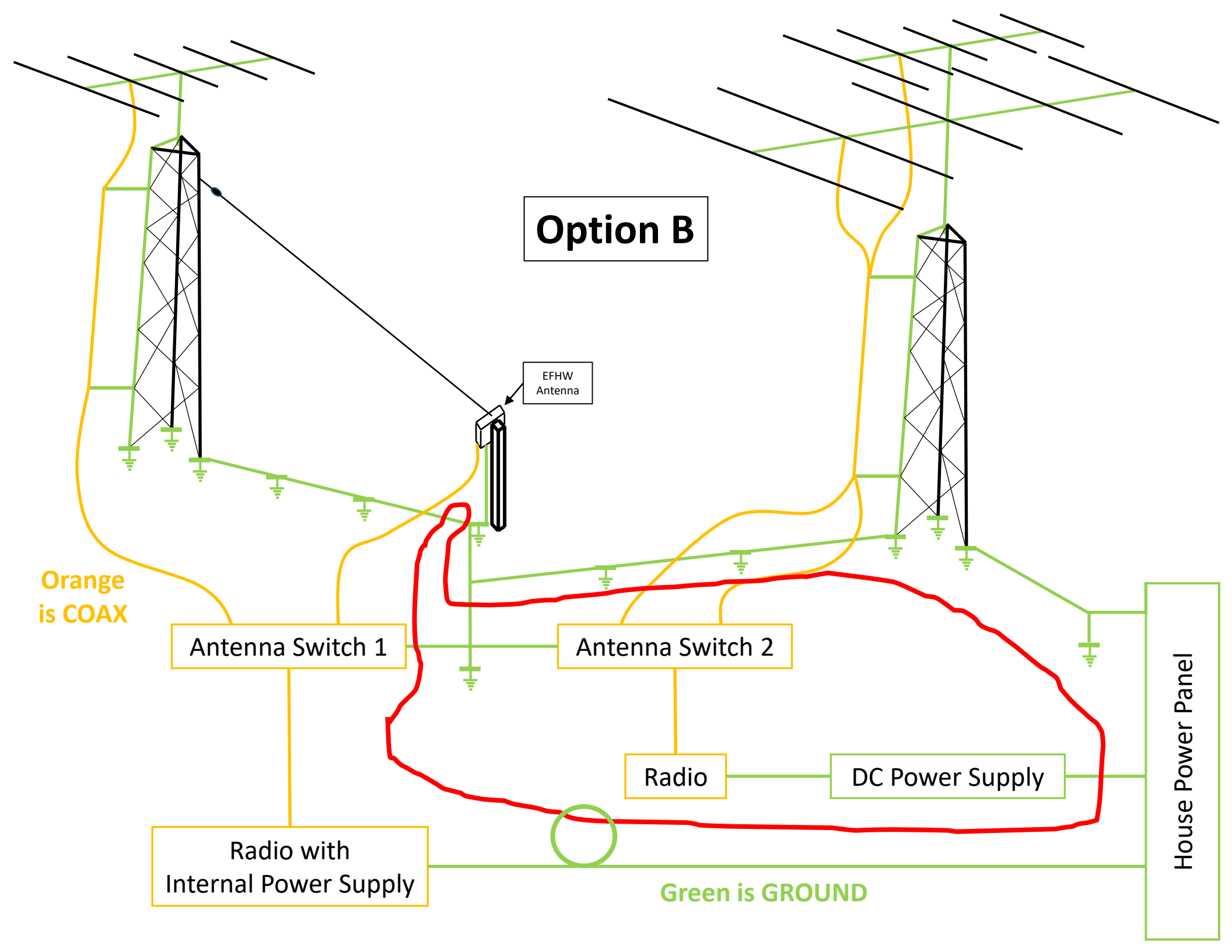
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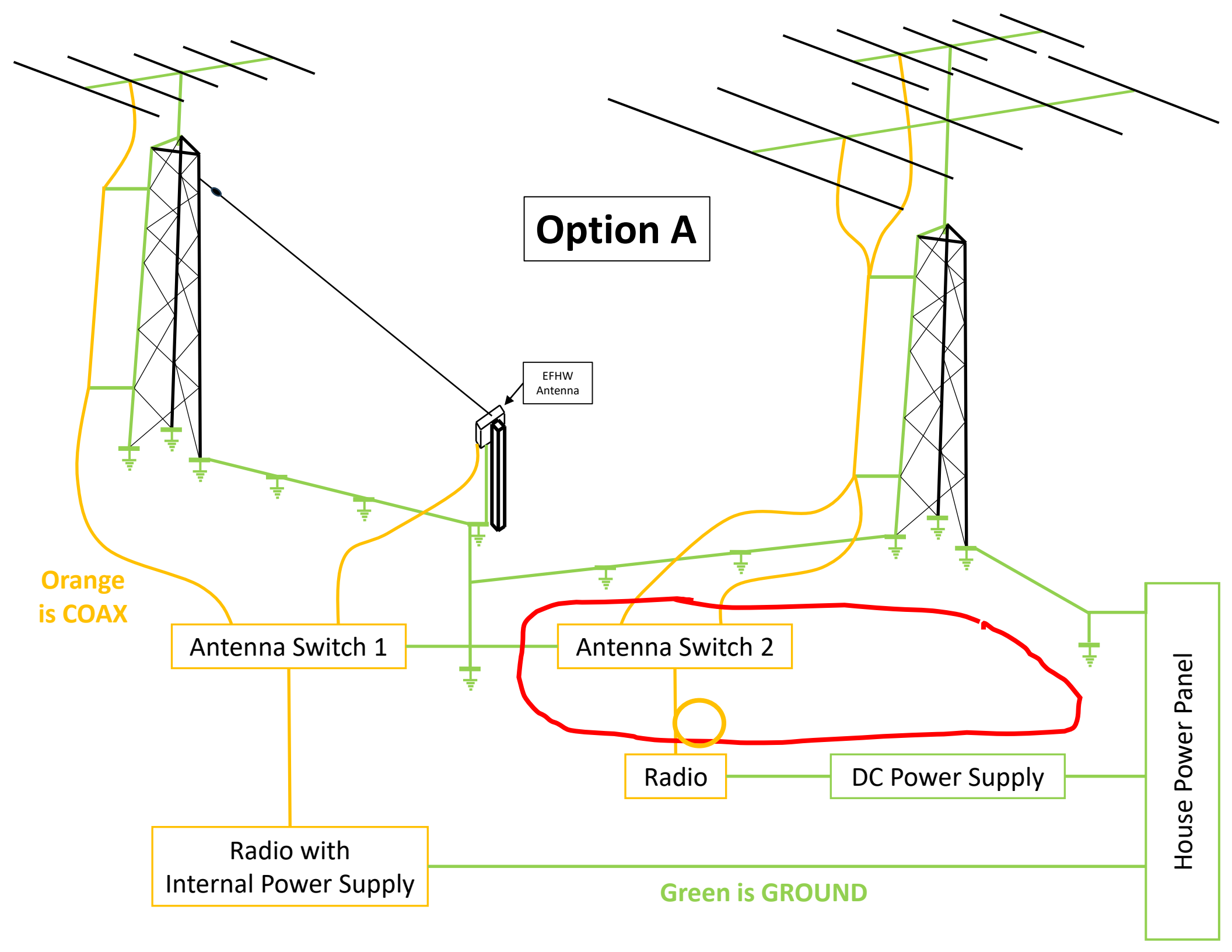
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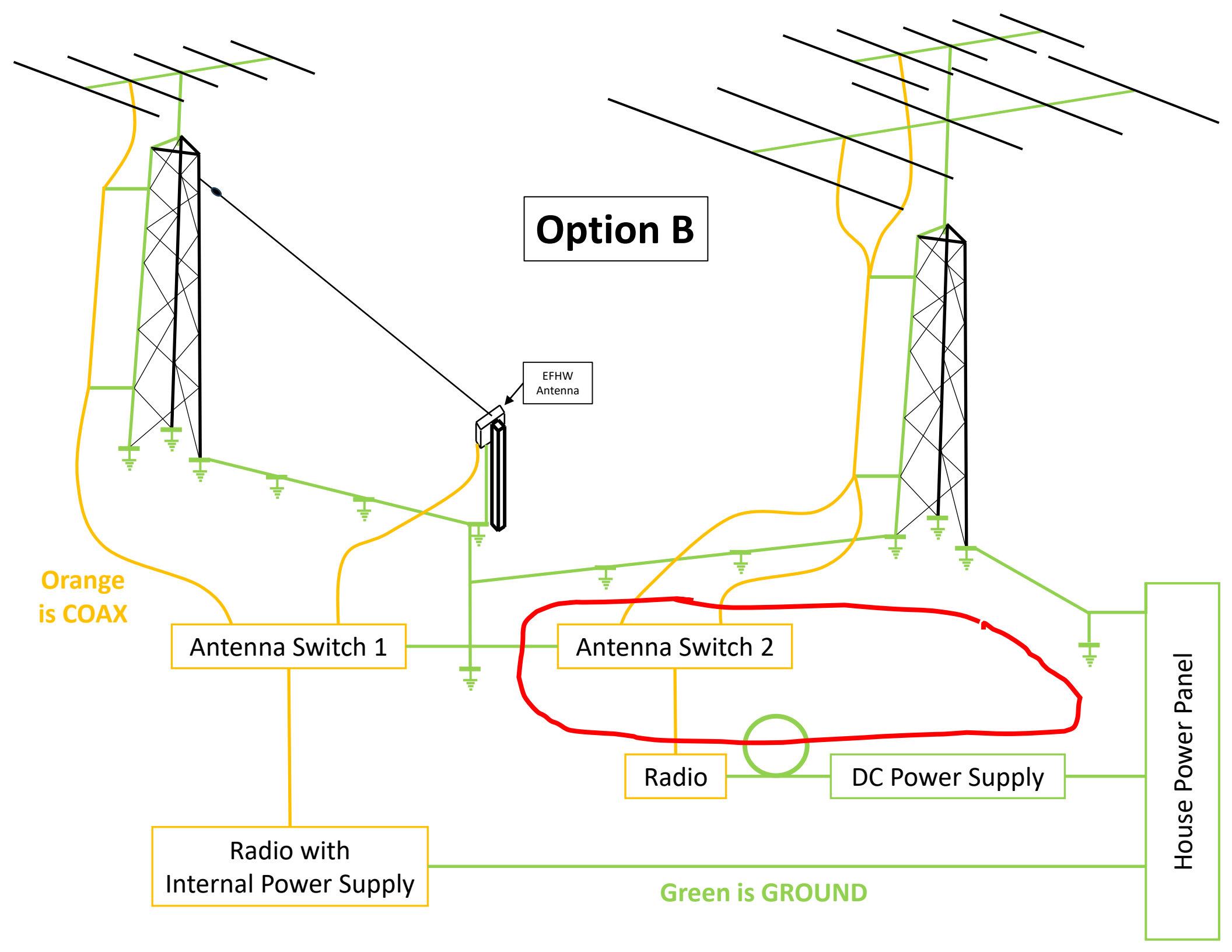
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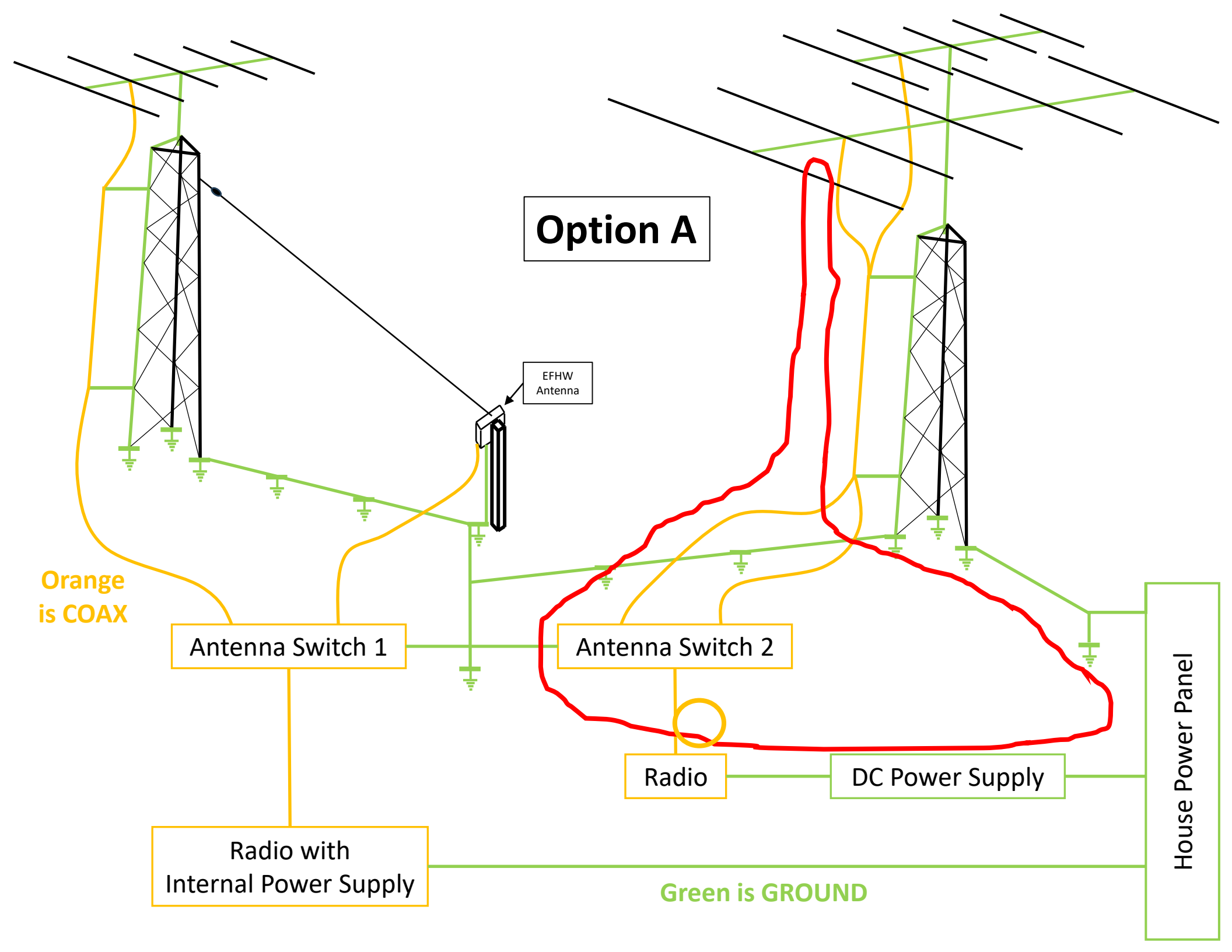
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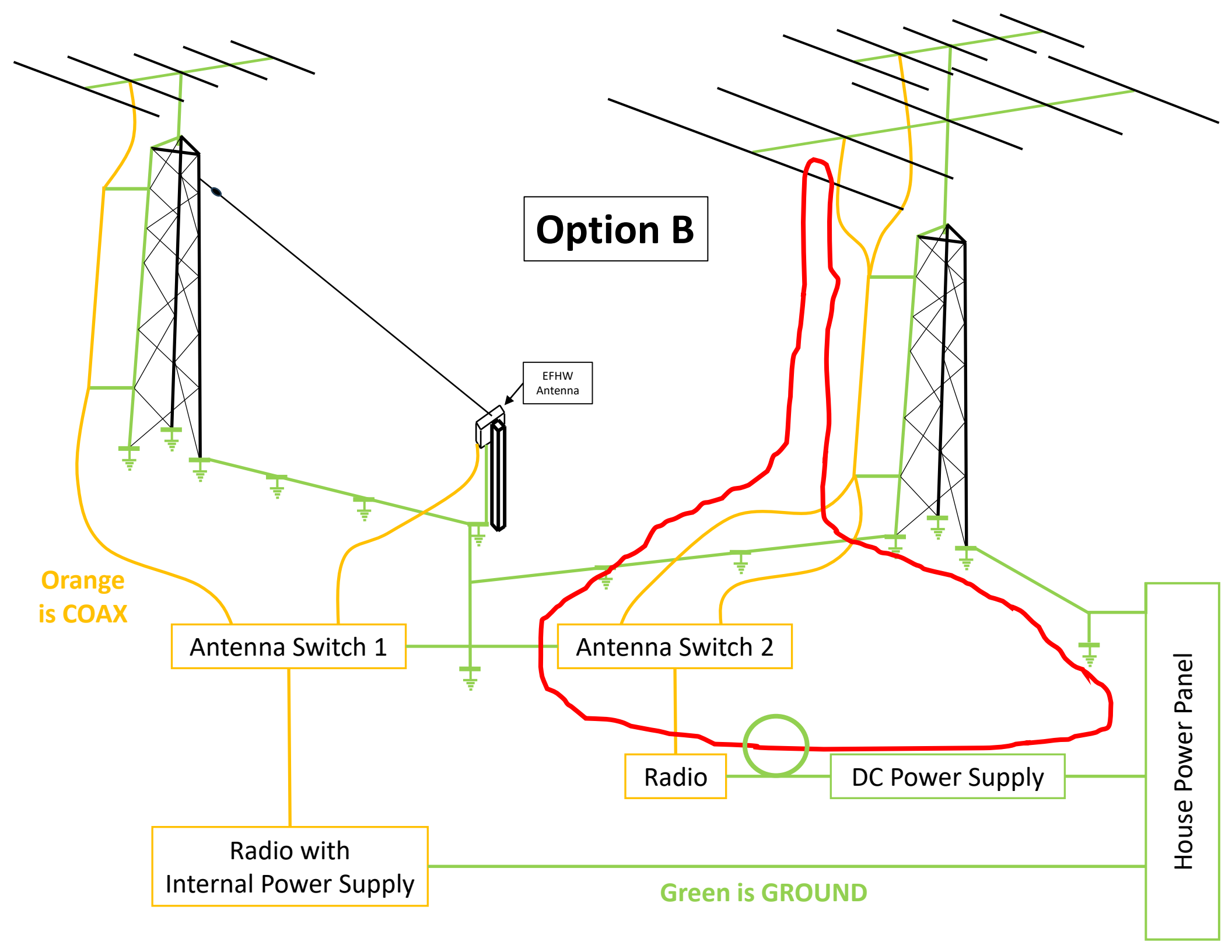
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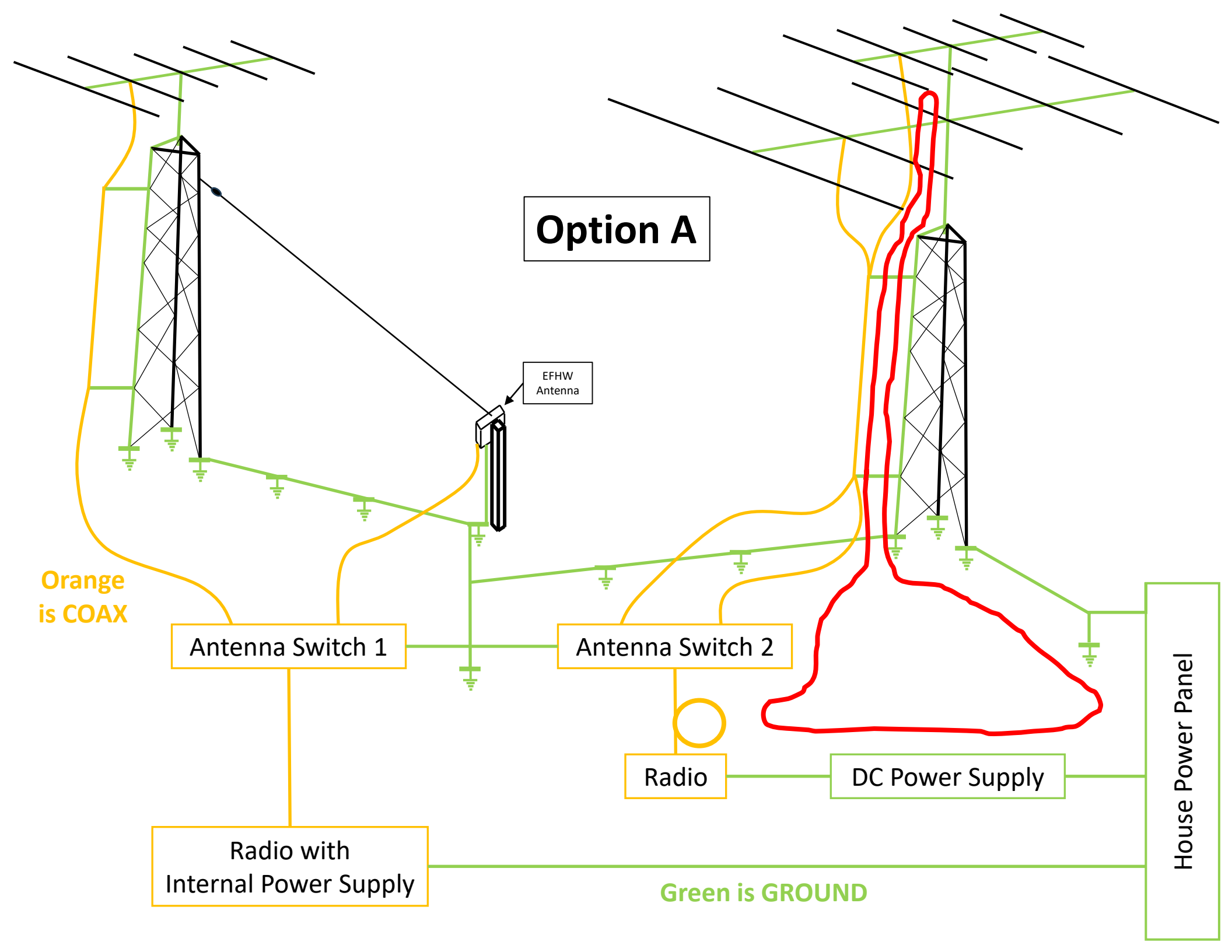
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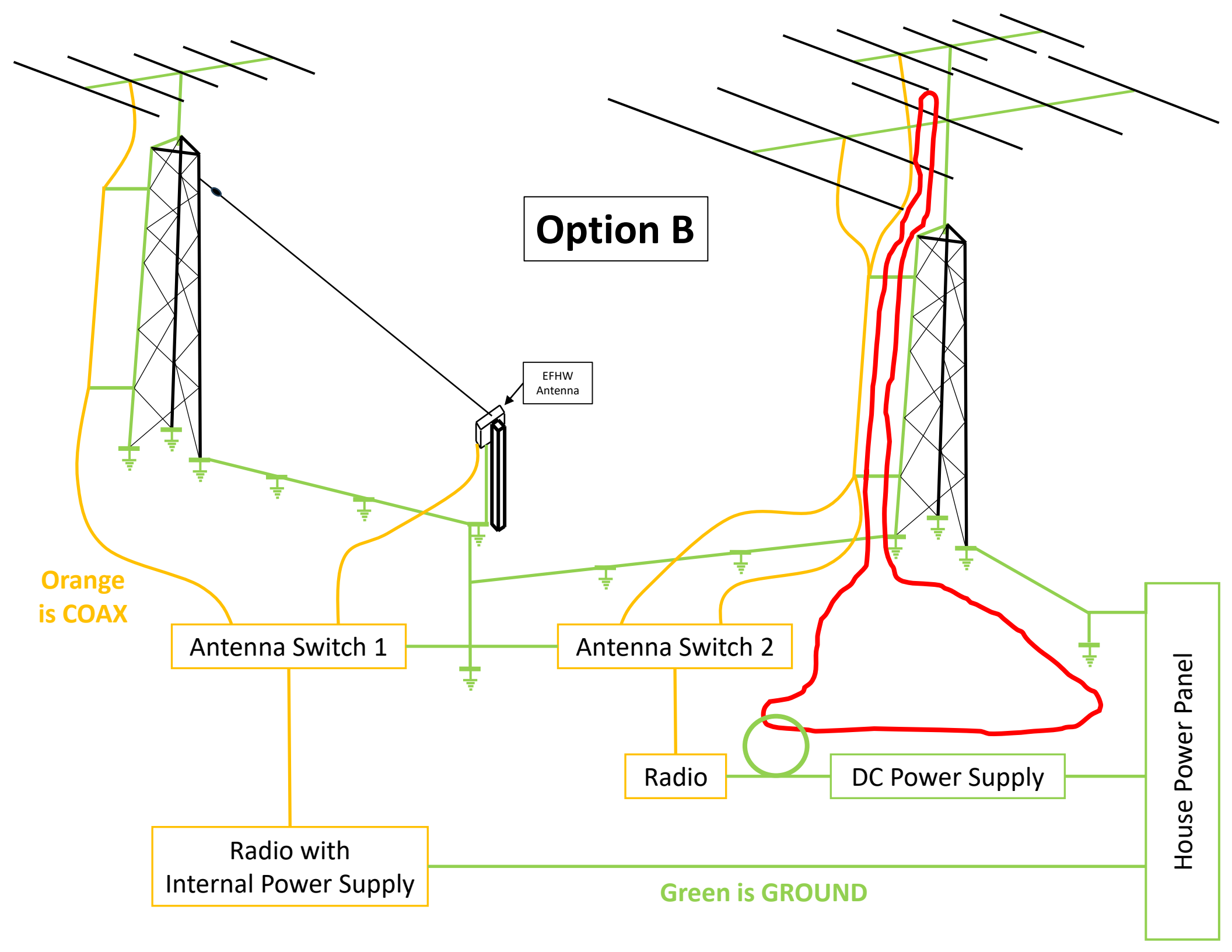
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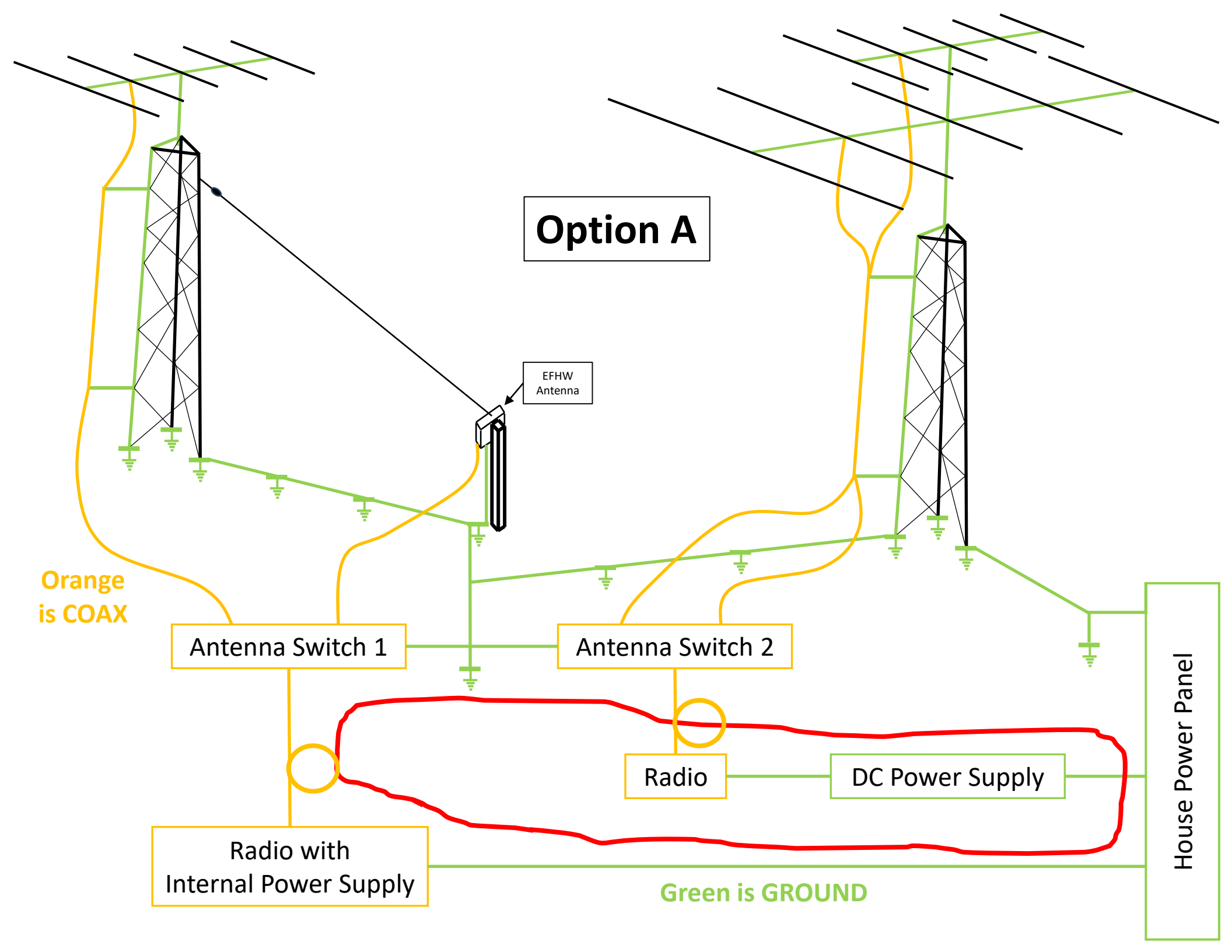
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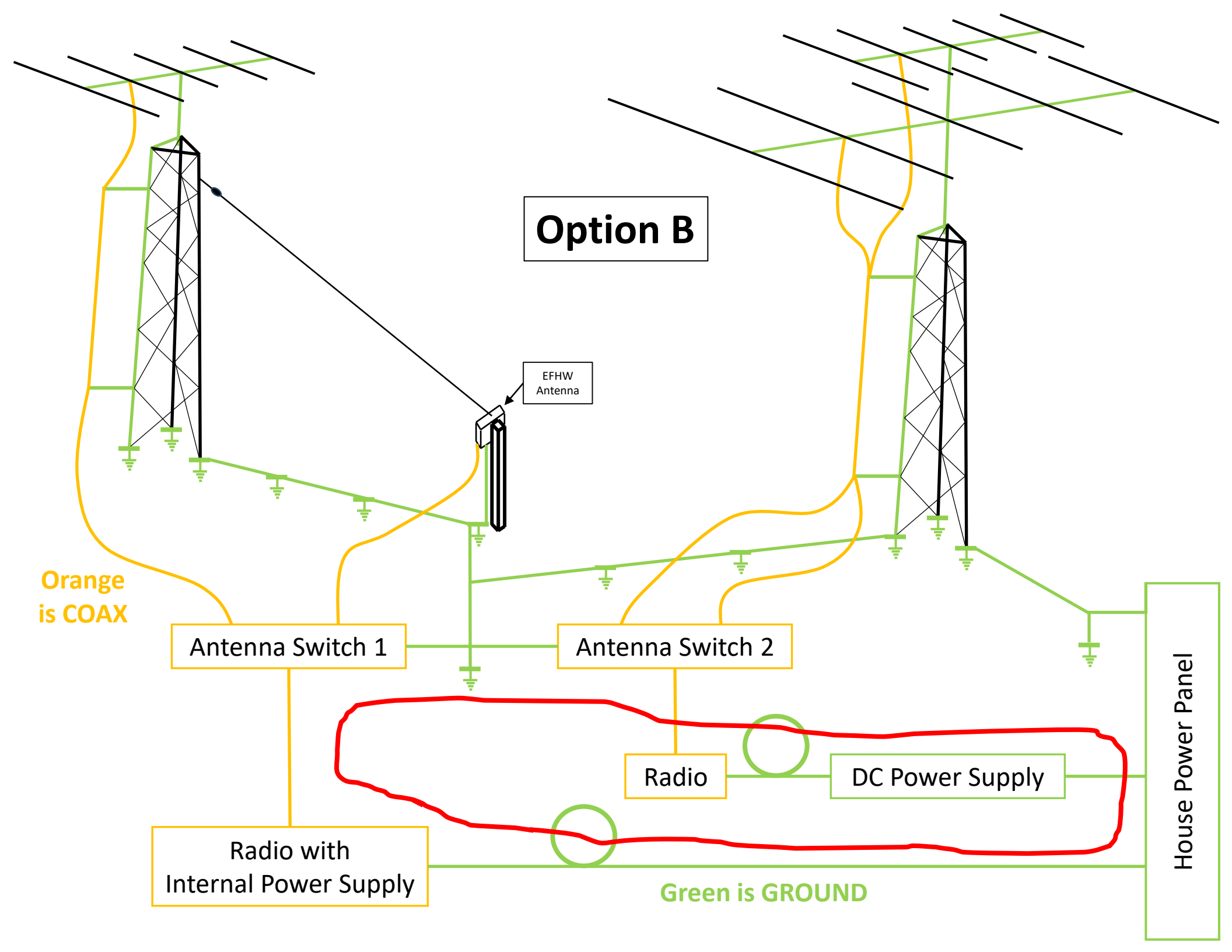
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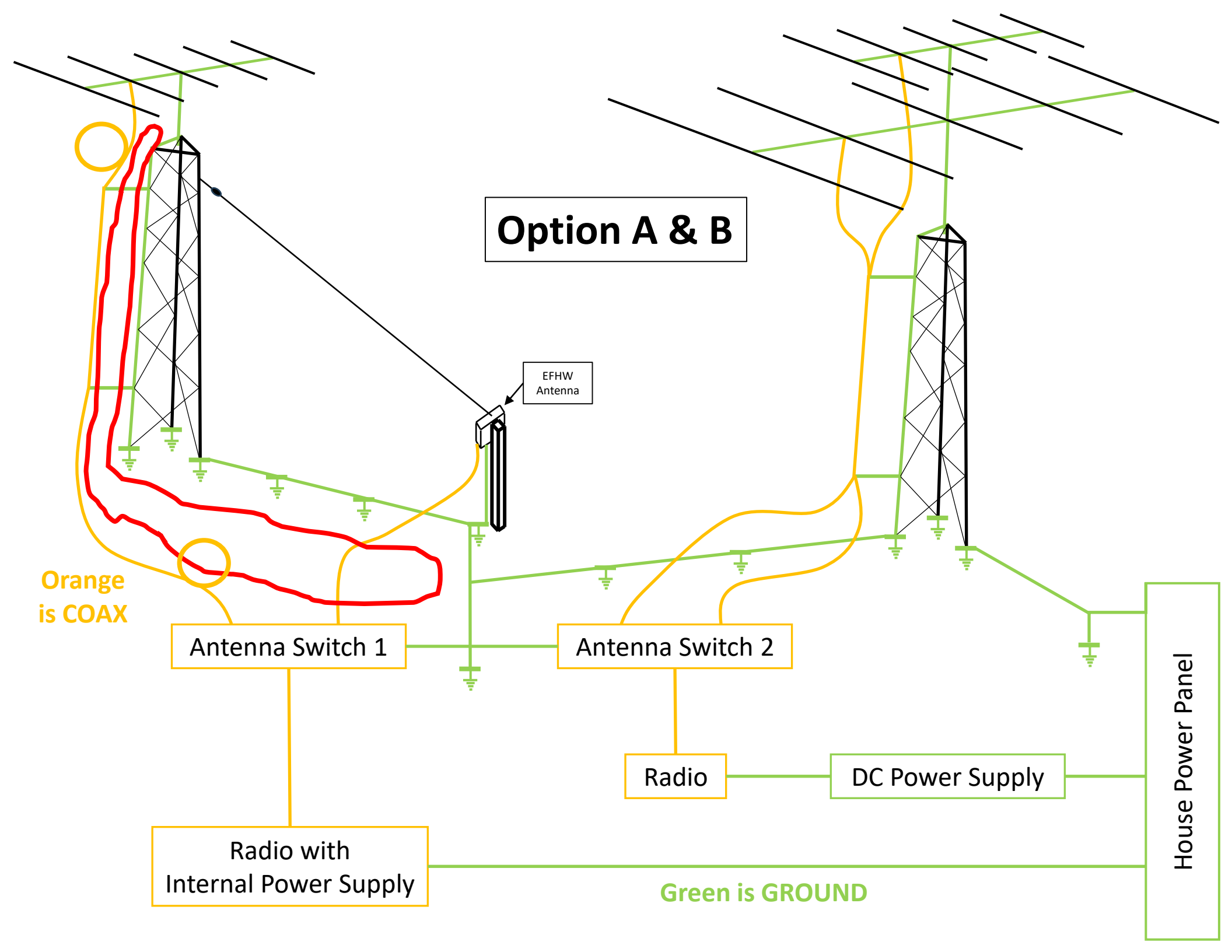
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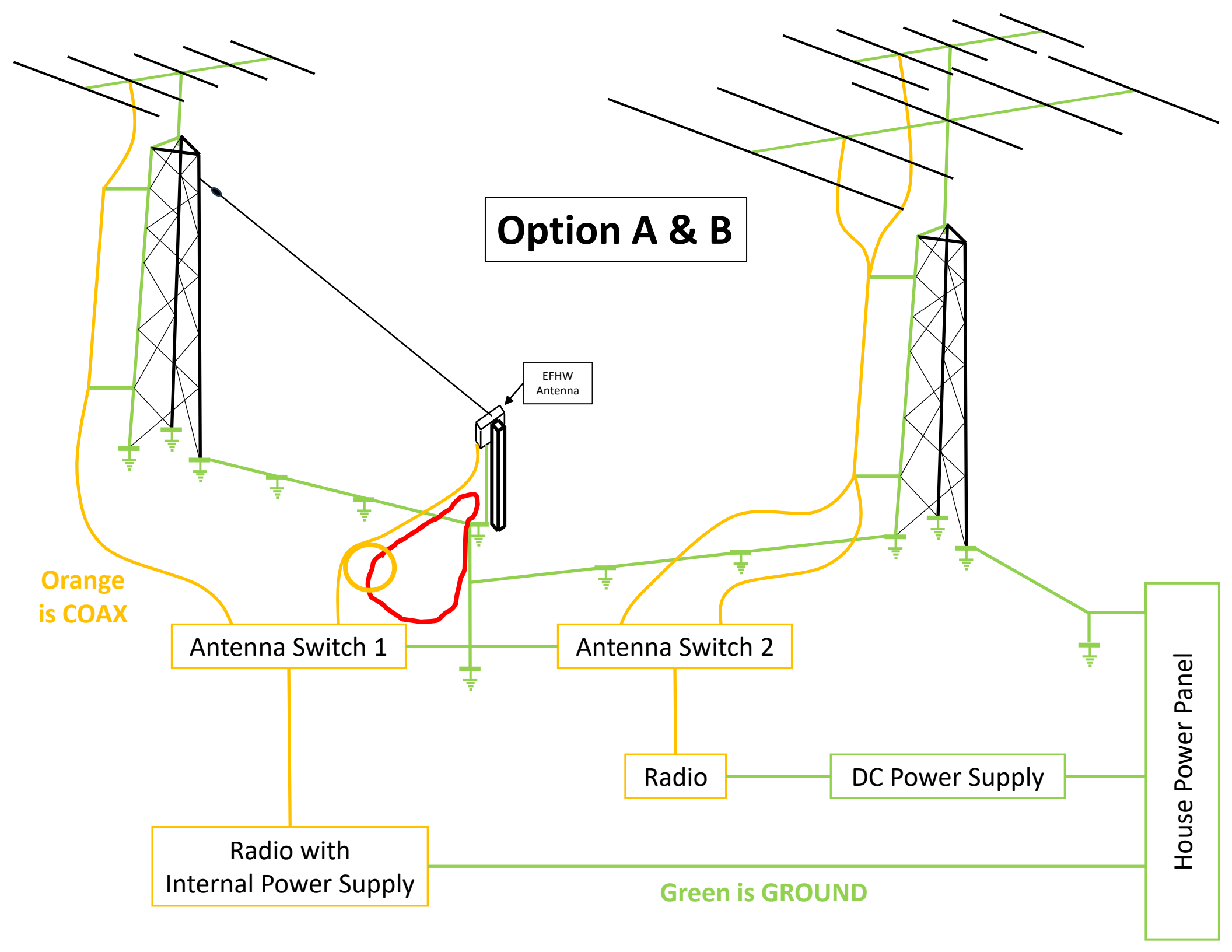
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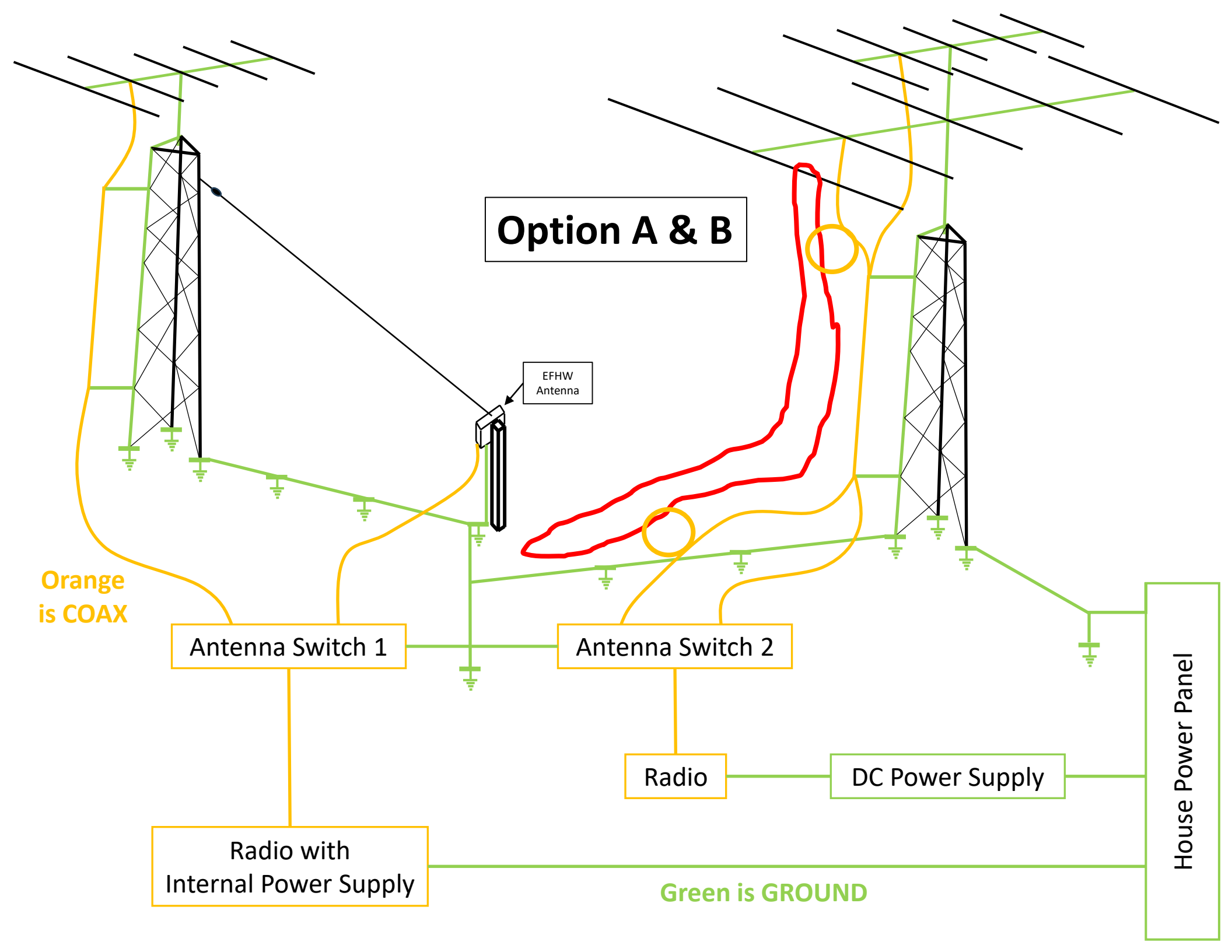
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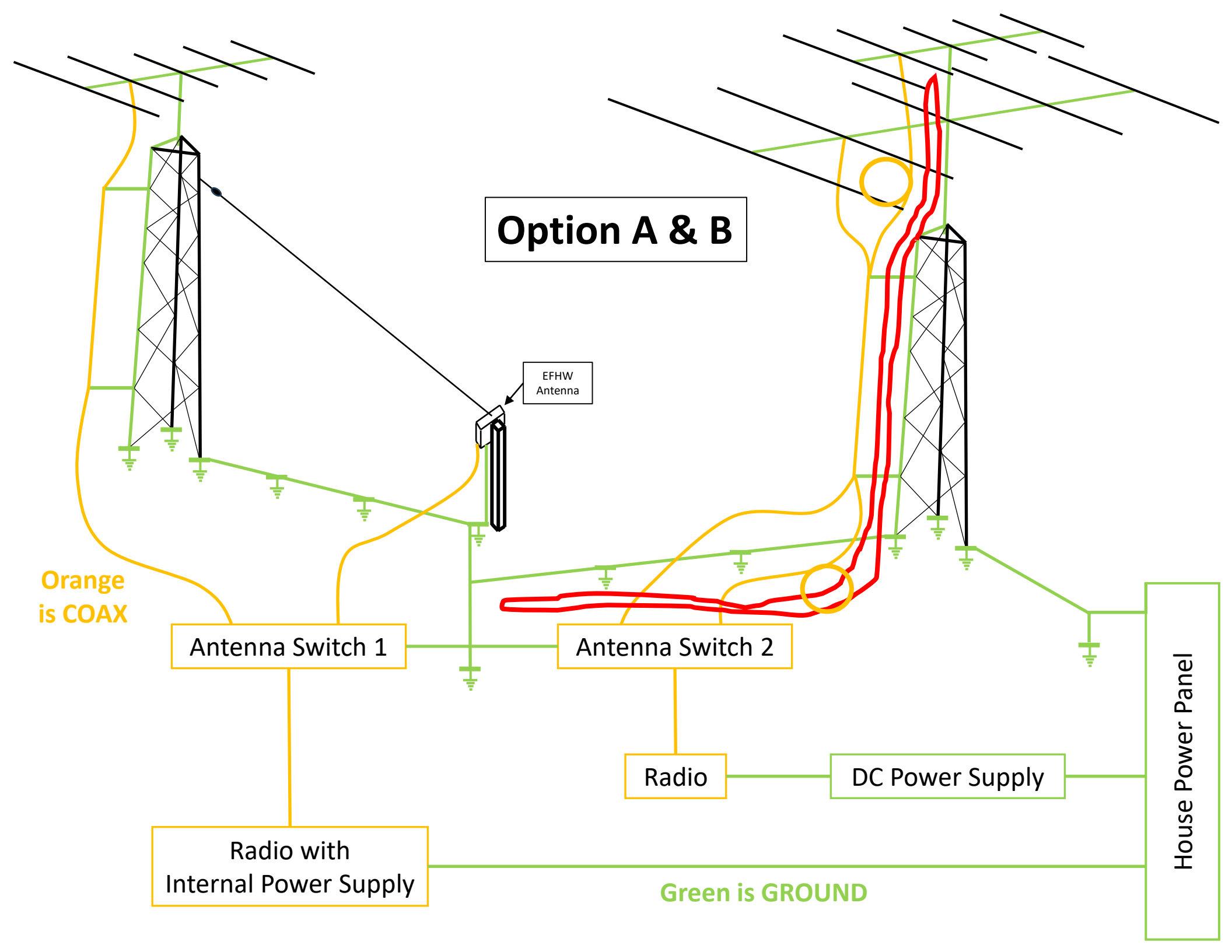
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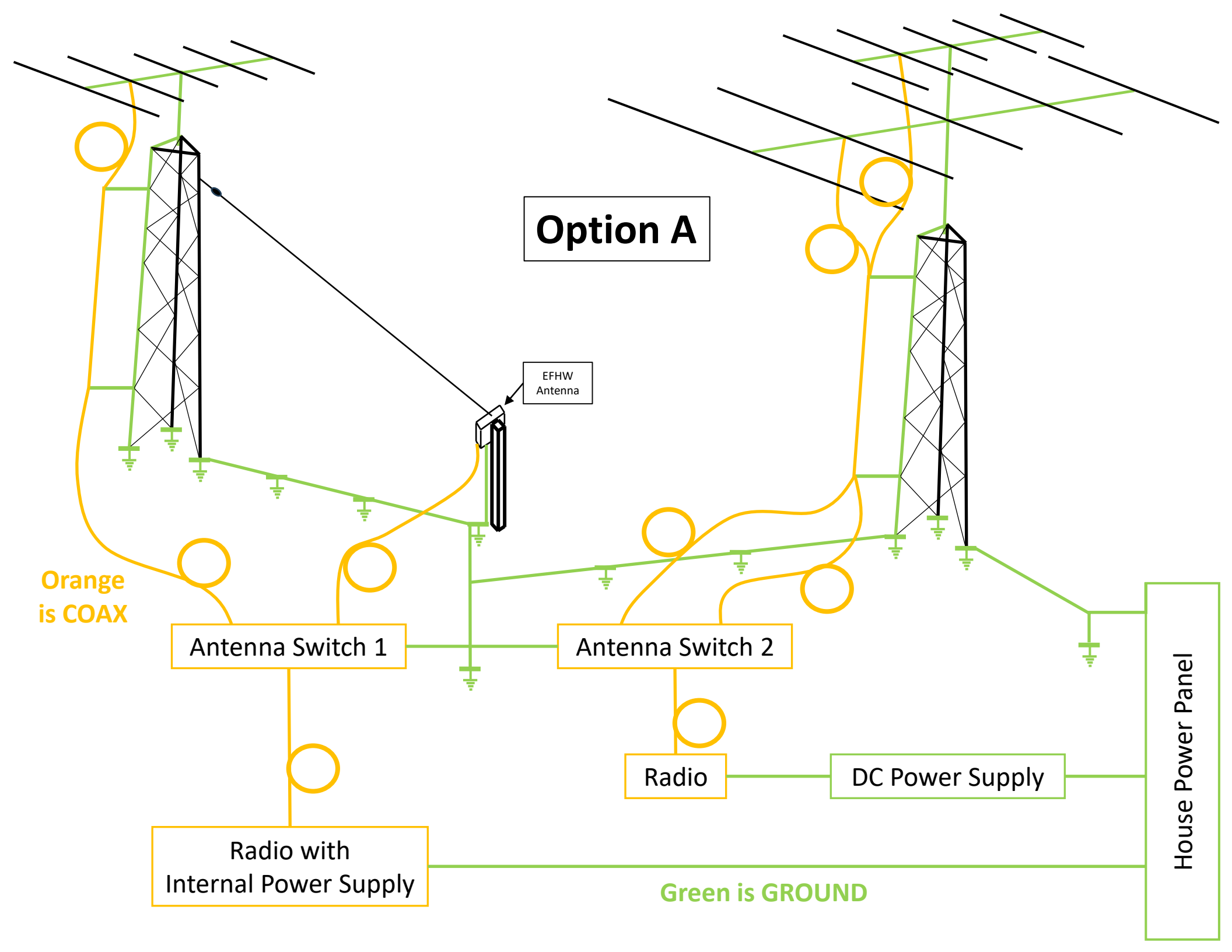
# The Ground Loop Solution (cont’)

- Total number of common mode RF chokes required for our station analysis are shown on the next page.
- First slide is Option A, which may be easier to implement.
- Second slide is Option B, incorporating common mode RF chokes on the power supplies.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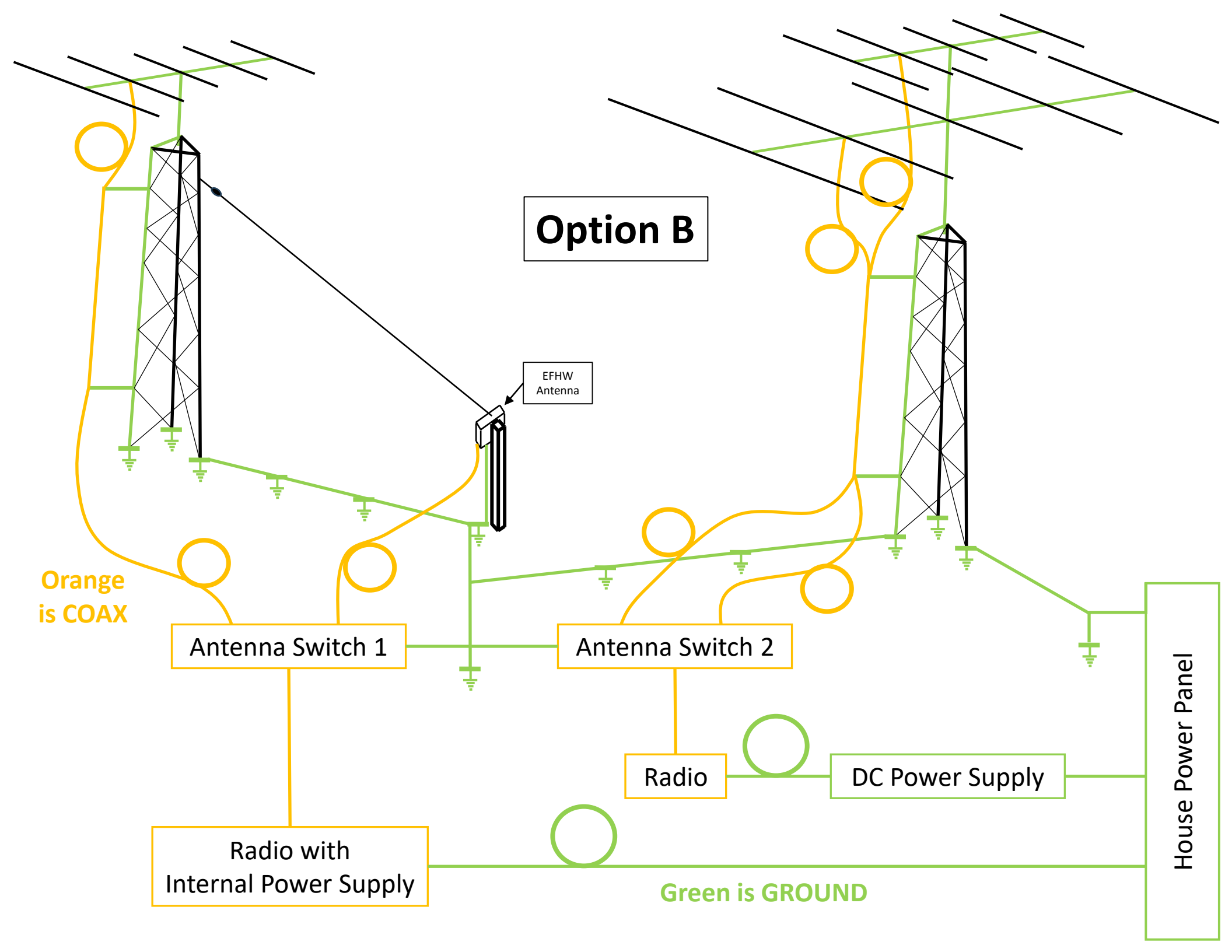
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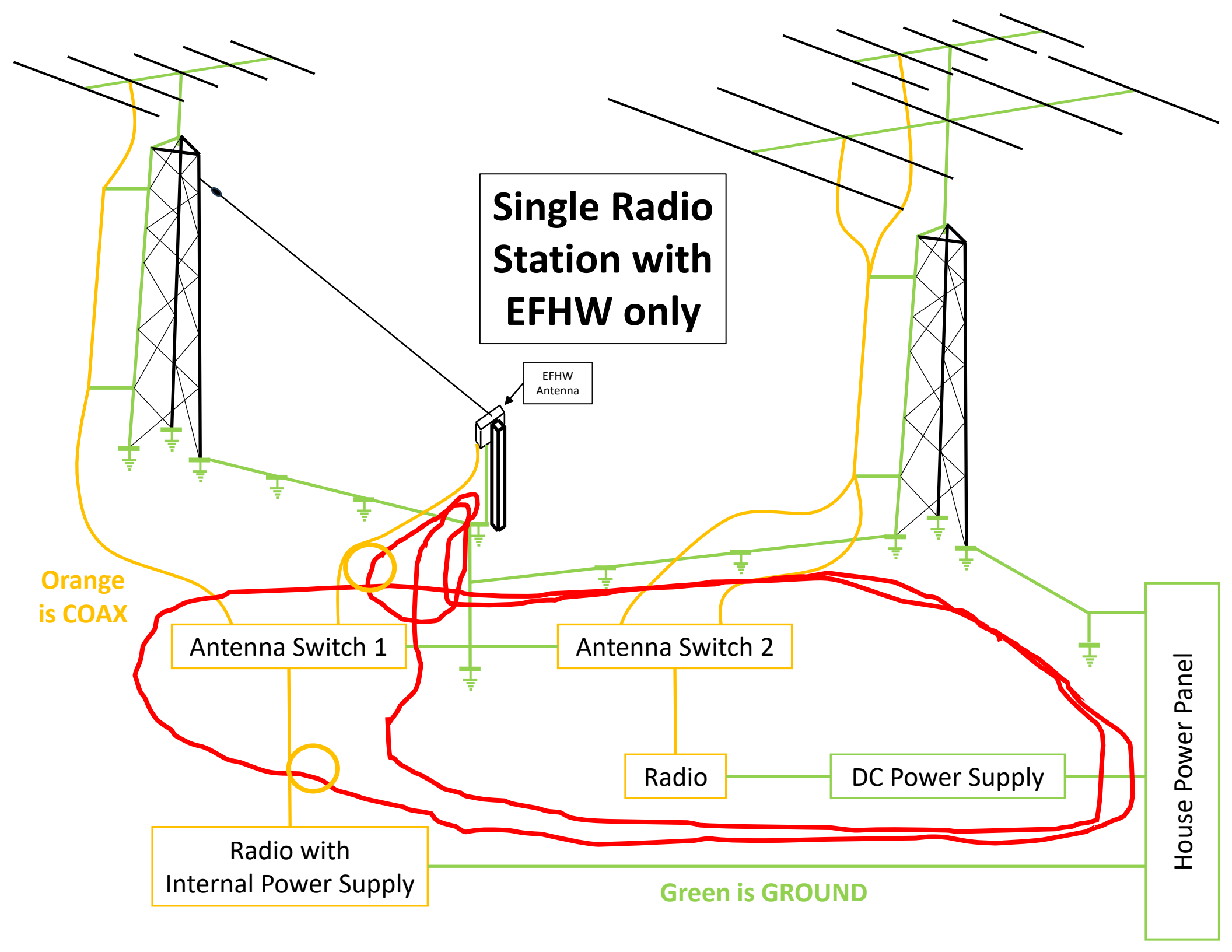
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