

# Tower and Station Grounding

**Southwest Dallas County Amateur Radio Club**

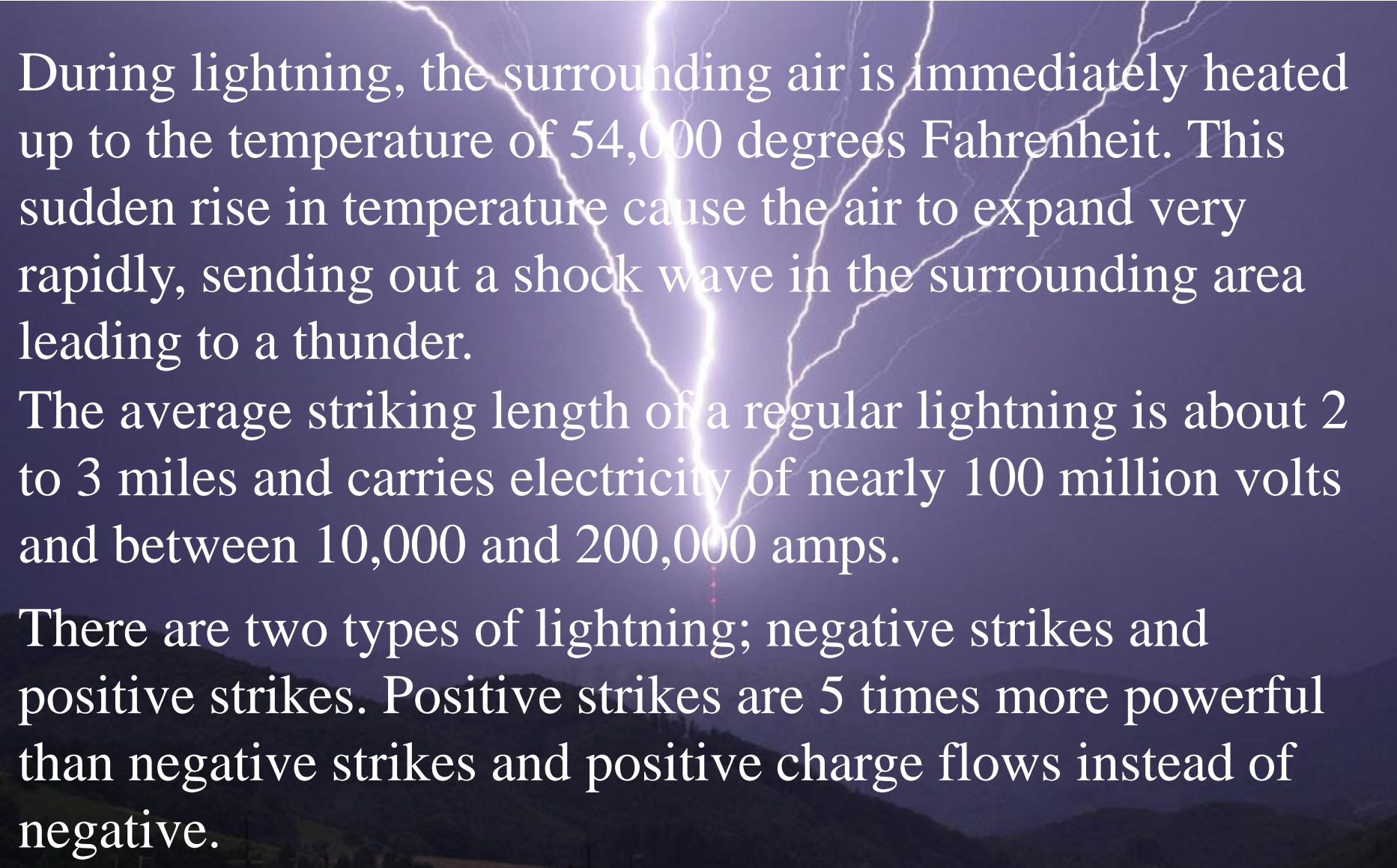
1/17/2017

Presented By Maurice Martin KM5RF

# Why Ground ?



# What You Don't Want !

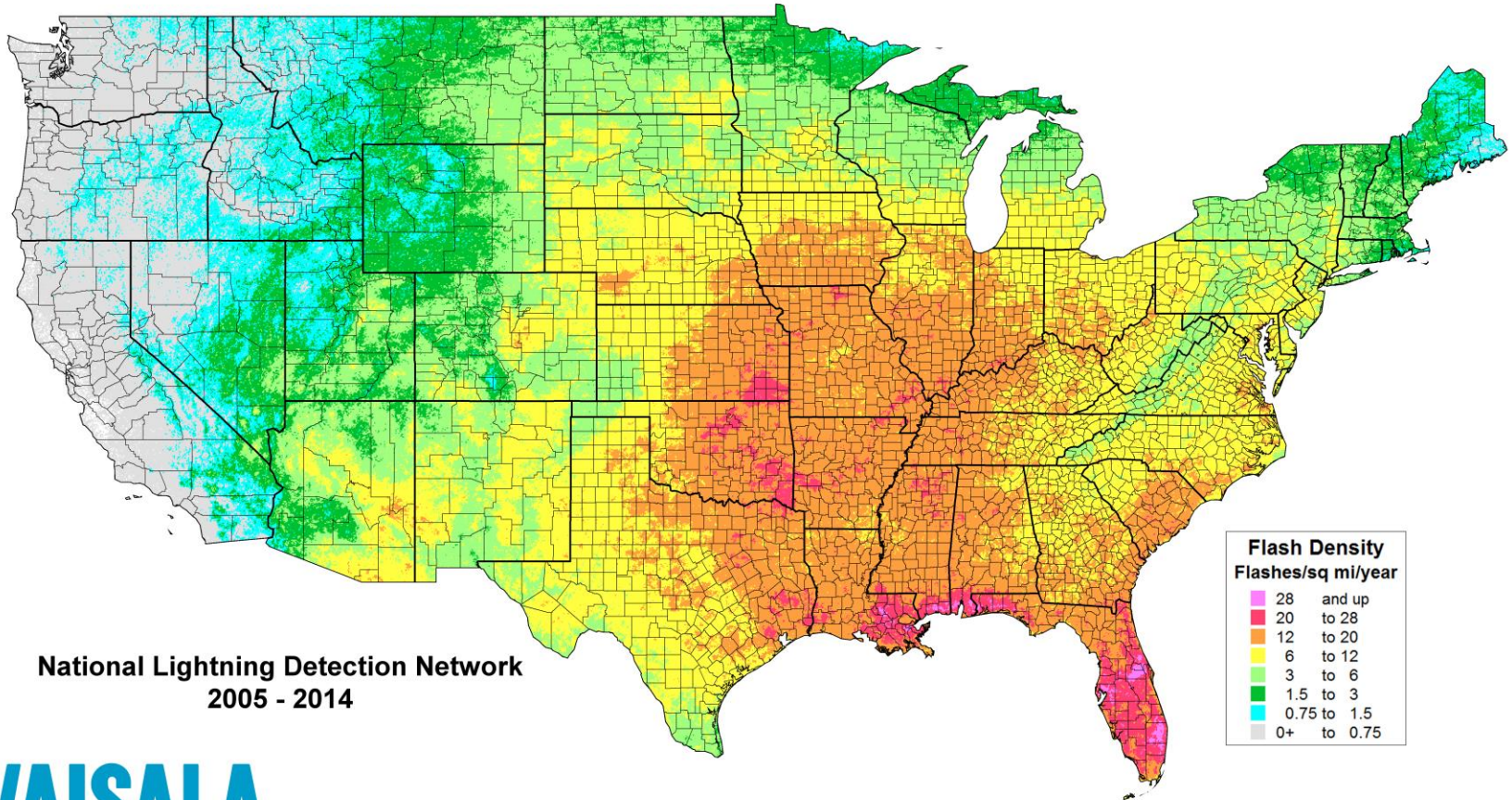


During lightning, the surrounding air is immediately heated up to the temperature of 54,000 degrees Fahrenheit. This sudden rise in temperature cause the air to expand very rapidly, sending out a shock wave in the surrounding area leading to a thunder.

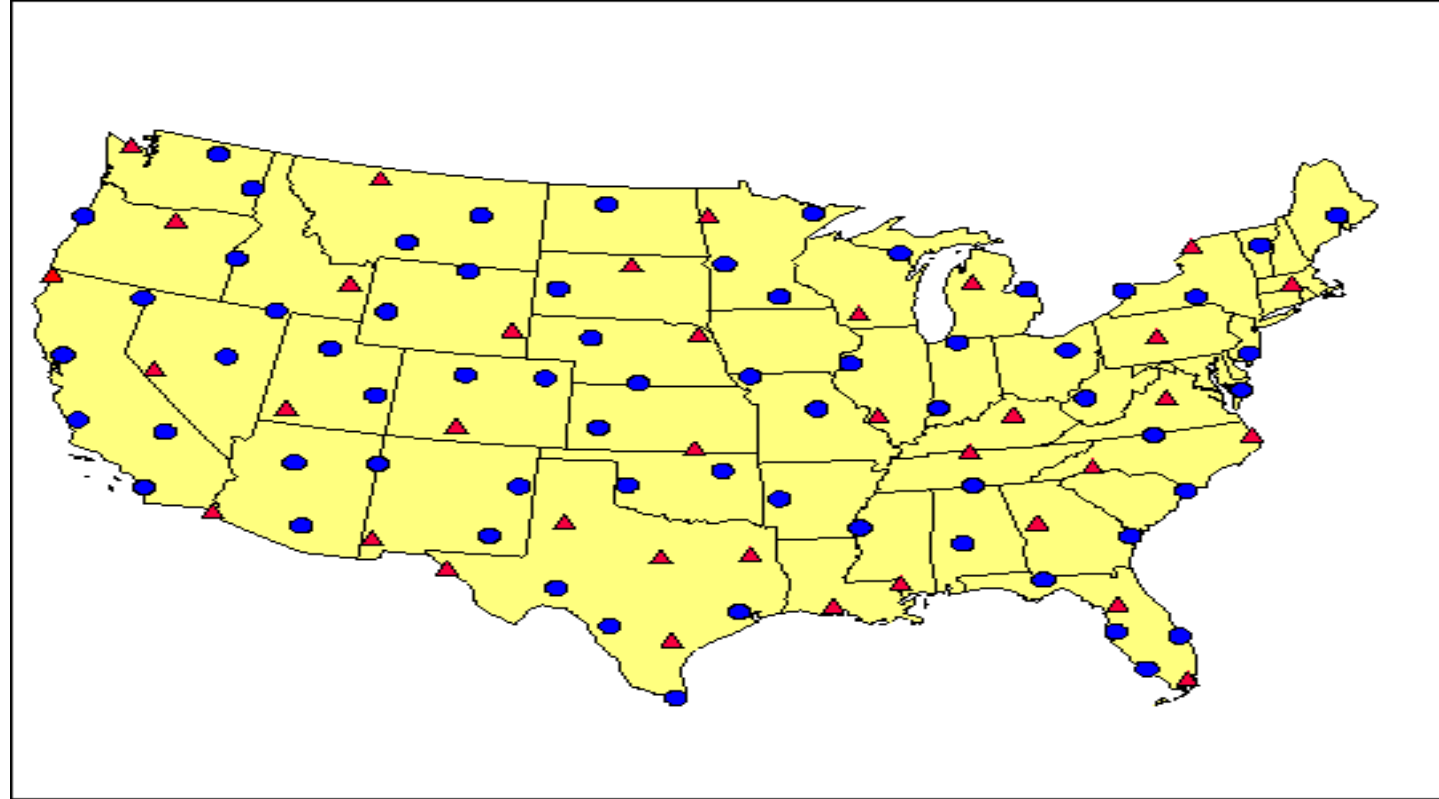
The average striking length of a regular lightning is about 2 to 3 miles and carries electricity of nearly 100 million volts and between 10,000 and 200,000 amps.

There are two types of lightning; negative strikes and positive strikes. Positive strikes are 5 times more powerful than negative strikes and positive charge flows instead of negative.

# National Lightning Detection.



**VAISALA**



**Location of the lightning sensors comprising the NLDN.** The red triangles are impact sites; blue circles are TOA sites.

### **Summary**

1. Lightning detection is based on the concept that a magnetic wave in the form of concentric circles is generated and propagated outward from the return stroke.
2. Lightning detection equipment detects mainly cloud-to-ground lightning activity.
3. The current lightning detection network in the United States uses the wide band magnetic Direction Finding (DF) or IMPACT and time-of-arrival (TOA) sensors.
4. The ground stroke lightning data includes information on latitude and longitude, date and time, polarity, and amplitude.

# LightningMaps.org 1/15/17

## With 1 hour settings.

The screenshot displays the LightningMaps.org website interface. At the top, the URL is <https://www.lightningmaps.org/#y=32.5701;x=-97.7074;z=3;m=sat;r=0;s=0;o=0>. The page title is "Real-Time Lightning Map". The main content is a satellite map of Texas with numerous orange lightning strikes and grey circular radar-like overlays. The map is centered on the Dallas-Fort Worth area. On the left side, there is a sidebar with navigation links: "Maps and statistics", "Real Time", "Europe", "Oceania", "America", "Information", "Extras", "Apps", "About", "For Participants", "Login", and "MyBlitzortung PHP". Below these is a "Lightning in USA" map showing a heatmap of lightning activity across the United States. At the bottom left, there is a search box for "Enter Zip Code or City". The top right corner features social media icons for Facebook, Google+, and Twitter, along with a "GET WEATHER FORECAST" button. The bottom of the page contains a footer with the text: "Lightning data by [Blitzortung.org](#) and contributors • Blitzortung.org is a free community project • [Contact](#)". The system tray at the very bottom shows the time as 4:29 PM on 1/15/2017.

# LightningMaps.org 1/15/17

## With 1 minute settings.

The screenshot displays the LightningMaps.org website interface. At the top, the URL is <https://www.lightningmaps.org/#y=32.5701;x=-97.7074;z=9;t=3;m=sat;r=0;s=0;o=0,l>. The page features a dark purple header with the site logo and navigation icons for Facebook, Google+, and Twitter. The main content area is a satellite map of Texas, centered on the Dallas-Fort Worth area, showing numerous lightning strikes represented by yellow and orange dots with white circular ripples. The map includes various UI elements: a left sidebar with 'Maps and statistics' (Real Time, Europe, Oceania, America), 'Information' (Extras, Apps, About), 'For Participants' (Login, MyBlitzortung PHP), and a 'Lightning in USA' overview map; a top navigation bar with zoom, info, and settings icons; and a right sidebar with a 'GET WEATHER FORECAST' button, a form to 'Enter Zip Code or City', and a 'Get Local Weather Radar & Forecasts.' button. The bottom of the page contains a footer with 'Lightning data by Blitzortung.org and contributors' and a system tray at the very bottom showing the time as 4:30 PM on 1/15/2017.

# What is lightning protection ?

- A complete system of air terminals, conductors, ground terminals, interconnecting conductors, surge suppression devices, and other connectors to complete the system.



# Potential Difference

- Occurs when an object has two or more references to ground and these different references have different ground resistance measurements. The different ground potentials are equalized in the system resulting in damage.

# Single Point of Ground

- A system that ties the equipment in a building such as racks ,cable trays, radios, amplifiers and towers and connects them into one single point of ground. This method is designed to eliminate problems with differences in potential.

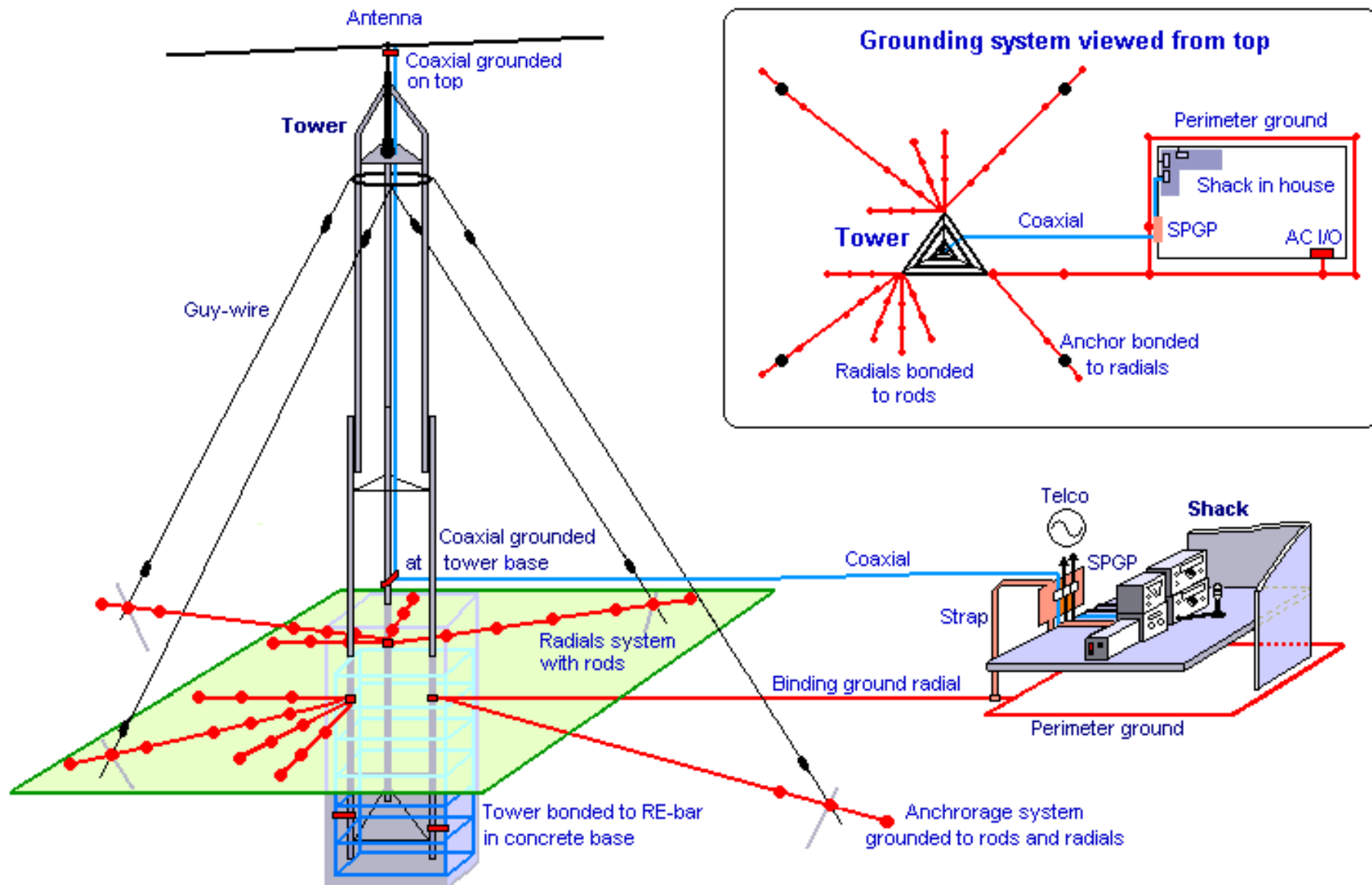
# Ufer Grounding

- During World War II, the U.S. Army required a grounding system for bomb storage vaults near Tucson and Flagstaff, Arizona. Conventional grounding systems did not work well in this location since the desert terrain had no water table and very little rainfall. The extremely dry soil conditions would have required hundreds of feet of copper rods to be inserted into the ground in order to create a low enough impedance ground to protect the buildings from lightning strikes.

# Herbert G Ufer

- In 1942, Herbert G. Ufer was a consultant working for the U.S. Army. Ufer was given the task of finding a lower cost and more practical alternative to traditional copper rod grounds for these dry locations. Ufer discovered that concrete had better conductivity than most types of soil. Ufer then developed a grounding scheme based on encasing the grounding conductors in concrete. This method proved to be very effective, and was implemented throughout the Arizona test site

# Ufer Ground in Tower System



# Tower Base Ufer Cage ½ Rebar

Use A706 Weldable rebar (Grade W) if rebar ties are not used .



# The Tower Base



# Ground Rods

- If Ufer grounding alone was enough, the manufacturers of ground rods would go out of business. But a Ufer ground alone it is not adequate.
- Remember, the best day a ground rod will normally see (resistivity) is the day it is installed. Corrosion, glazing, etc., all are factors that lessen the effectiveness of ground rods.



# Ground Rods Continued

- The effectiveness of a 1" ground rod over the 1/2" ground rod is minimal when resistance readings are taken. The larger rods are chosen for more difficult soil conditions.
- A 1" copper clad rod when compared to a 1/2" copper clad rod in the same soil conditions will yield about a 23% improvement in performance.

# Ground Rods Continued

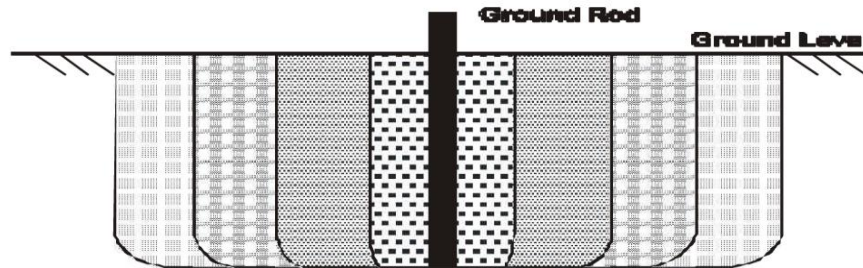
- When dissimilar materials are joined, galvanic corrosion occurs.
- 8 foot ground rods should have a 16 foot separation between them.
- Proper wire to rod connection.
- You do not want coupling between the rods.
- Ground rods can be driven at a 45 degree angle or placed horizontal.

Removed from test site after 12 years.  
Top rod is galvanized bottom is copper  
plated.

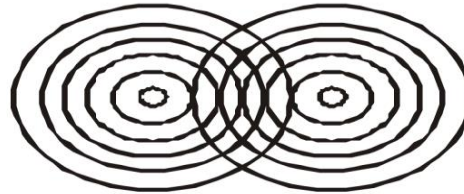


# Example of Ground Rod Spacing

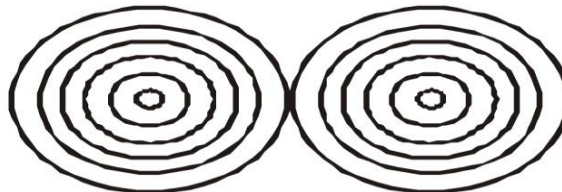
## GROUND ROD SPHERE OF INFLUENCE



### Incorrect Spacing

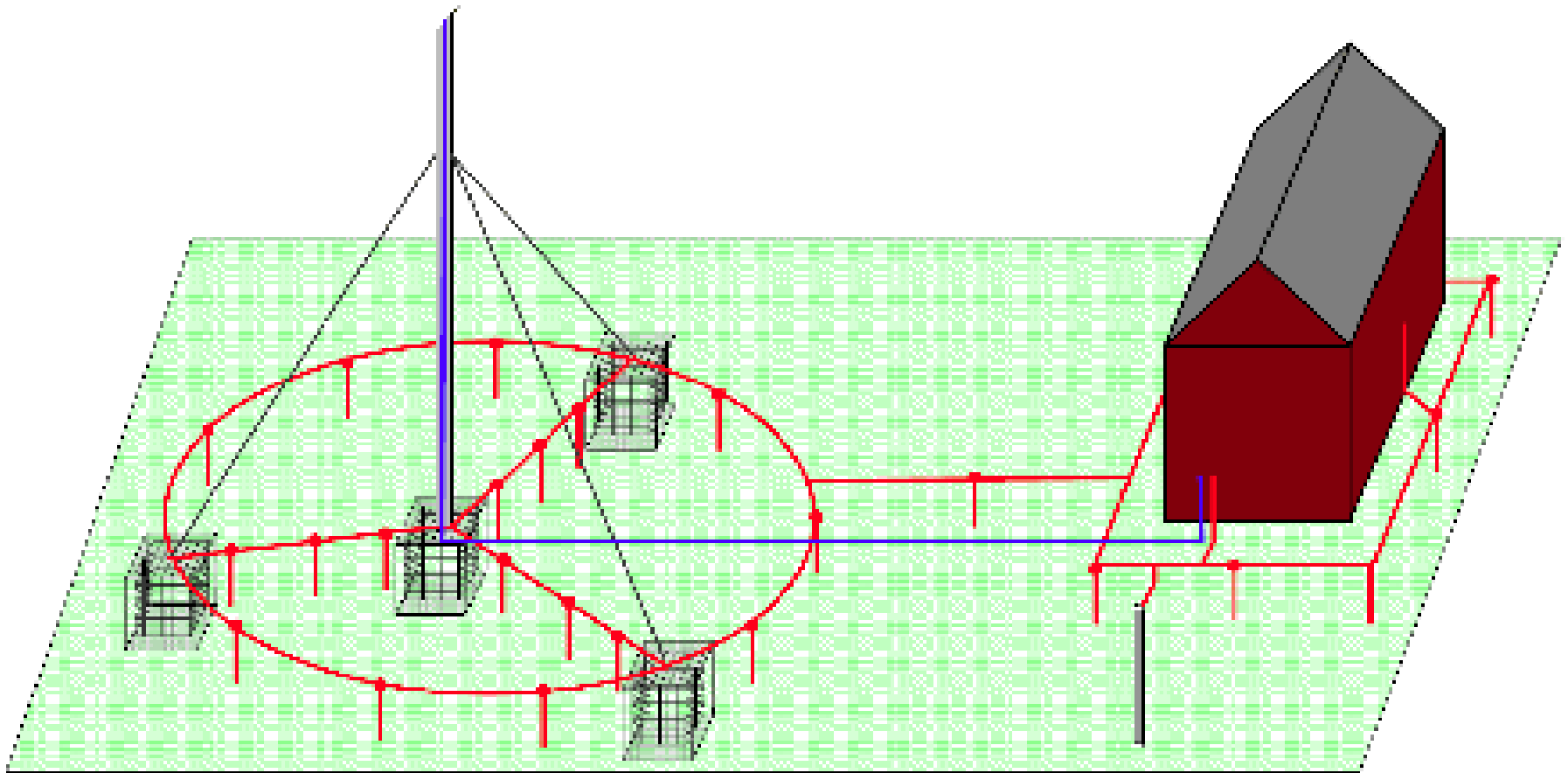


### Correct Spacing

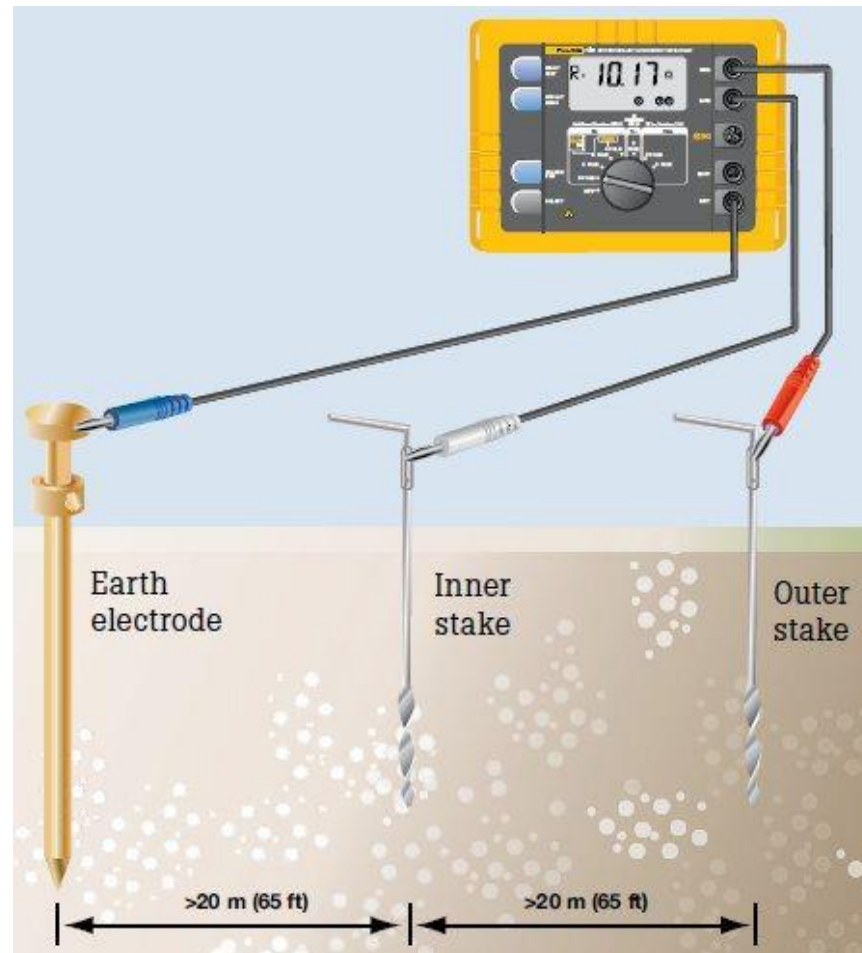


8Ft. Rod - 8Ft. Radius Influence  
10Ft. Rod - 10Ft. Radius Influence

Ufer Ground and Rods in Place.  
Radials also work as counterpoise for antenna system



# Testing of Ground Rods is Performed with a Megger



# Connecting The Ground Rod Eritech 1500 for 5/8 rod #4 bare wire



# DGI Hammer on 5/8 #4 wire





# Cable Tray Also Grounded



# PolyPhaser Surge Protector

DC Block , Frequency Range 1.5 MHz to 700 MHz, Turn On Voltage 600 Vdc  $\pm$  20 %

**RF Power HF 2kW, VHF 375W, UHF 125W** VSWR  $\leq$  1.1 to 1 over frequency range Insertion Loss  $\leq$  0.1dB over frequency range

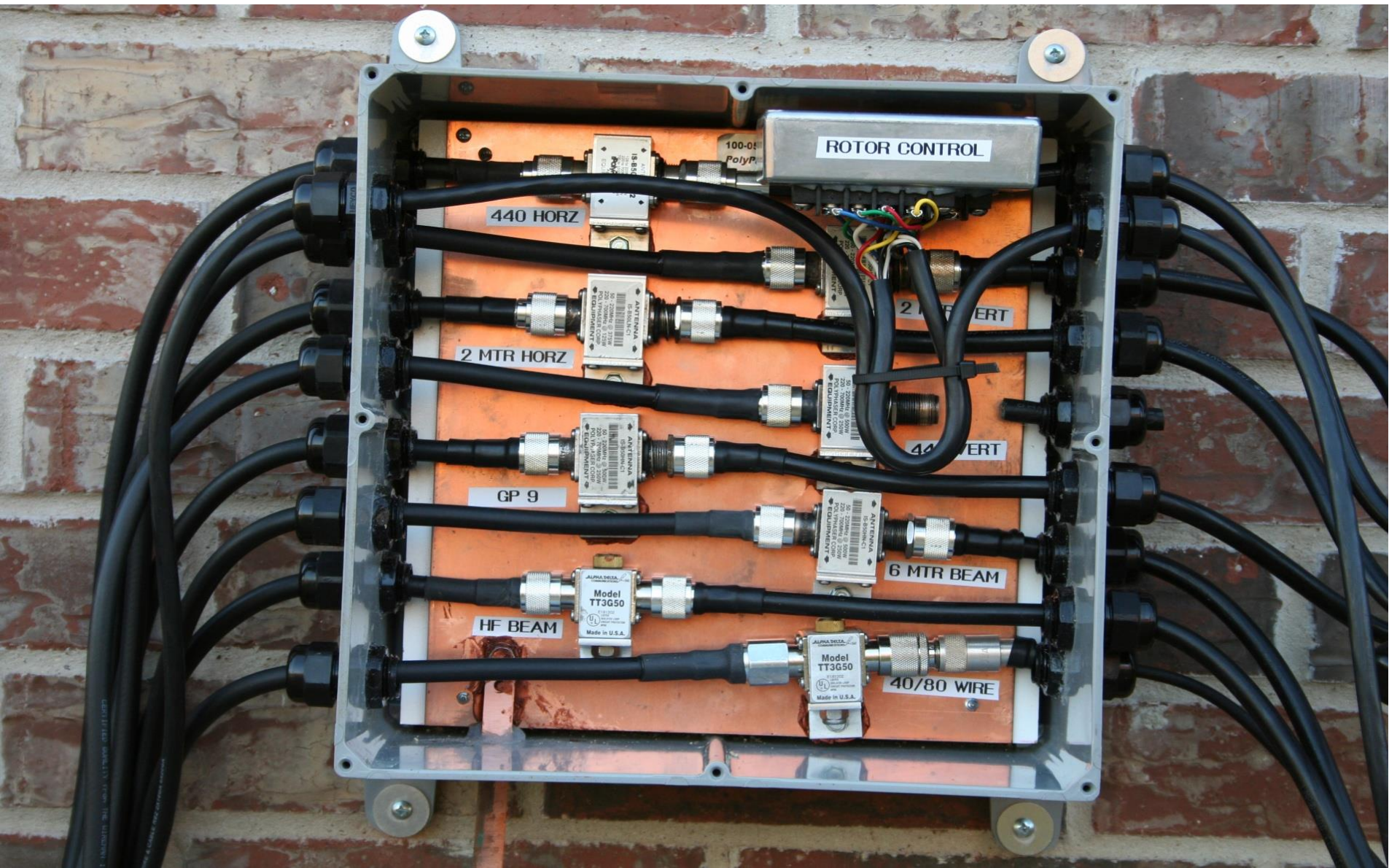


## Alpha Delta Surge Protector

Alpha Delta N Connector Coaxial Surge Protectors are rated for 200 or 2,000 watts at frequencies up to 3 GHz. They are not DC-blocked, so they will pass control voltages in applications requiring the coaxial cable to carry both RF and DC voltage. The Arc Plug is replaceable and comes in 200 watt and 2Kilowatt versions.



# Surge Protector Box before Strike





# Coax Entry Box



# Alpha Delta Switch

Switch Insertion Loss: Less than 0.10 dB

Switch Isolation: More than 50 dB

Power Rating (0 to 30 MHz): 1,500W PEP/1,500  
CW

Arc Plug is Replaceable



# Alpha Delta Switches grounded to Equipment Bar





# Equipment Ground Bar Connected to Surge Protection Ground Rod



# Why Go To All The Trouble ?



# Why I go to the Trouble !



# On a high Spot in Ellis County



# What is left of GP-9 07/04/2016



GP-9 07/04/2016



Any Questions or Comments ?

