# Grounding Your Station

## And Saving Your Equipment (Hopefully)

By: W5IM

# Types of Ground Systems

Usually Found At A Ham Station

- R.F. Operating Ground
- EMP Protection Ground
- Electrical Safety Ground

# R.F. Operating Ground

- An R.F. Operating Ground is generally considered to be a ground connection in which some R.F. current flows as a normal function of the installation.
  - Through experiment it has been found that 120 radials spaced every 3 degrees at about a half wavelength long works best for vertical radiator.
  - The Ground (earth) appears as a series resistance in the antenna equivalent circuit.
  - Therefore, without radials, ground mounted vertical antennas are not much more than dummy loads that radiate a little.
- Most Ham Stations will have balanced antenna's (dipole, beam, etc.), or a raised vertical with radials and will not need an R.F. Operating Ground.
  - But, all antenna systems will benefit from an R.F. Operating Ground.

# EMP Protection Ground

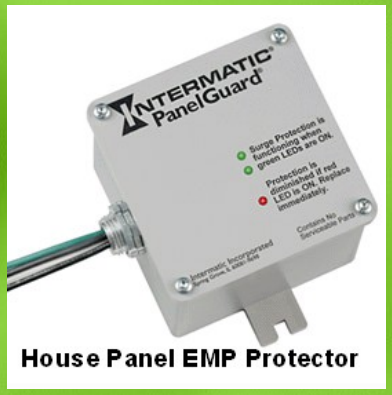
- Stands for **E**lectro**M**agnetic **P**ulse
  - Nuclear Explosions
  - Lightning
  - Occasionally From Power Company Switching Transient or Accident

# Some EMP Protection Devices

Metal Oxide Varistors (MOV)

Gas Tube Arrestor

EMP Protection Strip




House Panel EMP Protector

Coax EMP Protector

# Electrical Safety Ground

Can Be Divided Into Two Types

- Ground Electrode
  - Provides Path For Lightning
- Equipment Ground
  - Provides Path For Fault Current

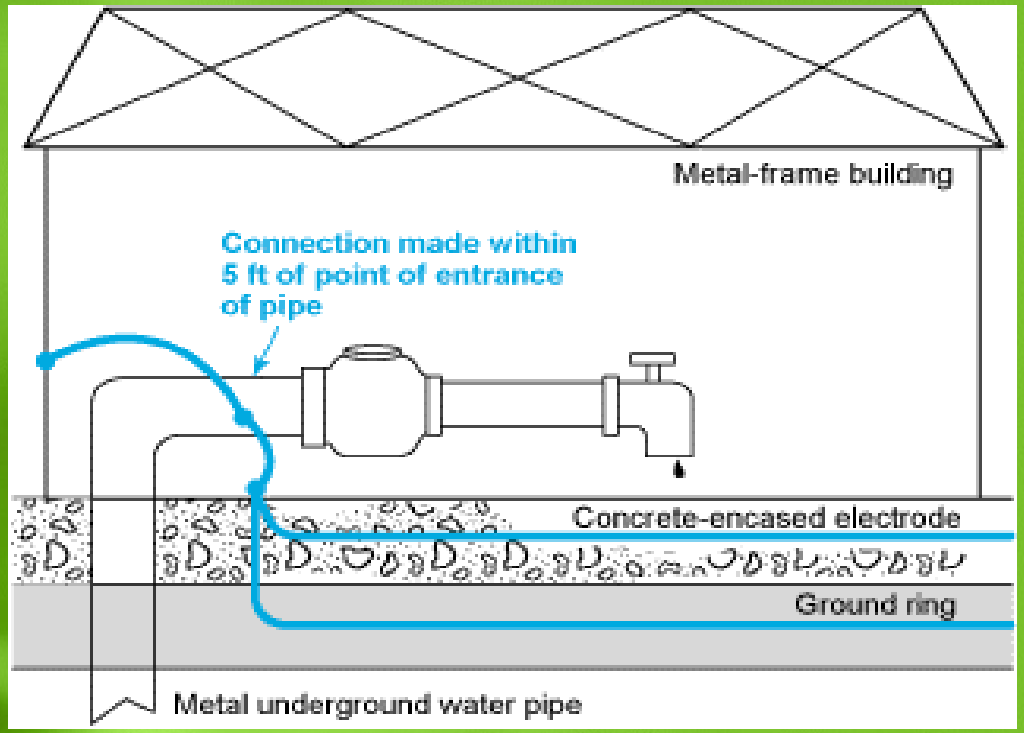
# Ground Electrode

Since we are interested in Lightning Protection we will only consider the Ground Electrode

- **NEC Requires a Minimum of Two Per Installation**
  - **Can be any two of the following (one of each)**
    - Ground Rod (minimum 8' in length)
    - Ufer Ground (concrete incased re-bar or ground rod)
    - Ground Ring (consisting of at least 20' of minimum #2bare copper encircling the structure buried a minimum of 21/2')
    - Metal Water Pipe (within 5 feet of building entrance)
    - Frame of Metal Building (support encased in concrete)
  - **All available grounds must be connected together by un-spliced ground electrode conductor sized according to NEC requirement and be at or below 25 ohms to earth.**

# Ground Electrode Example

Notice All Available Ground Electrodes Must Be Used



# Tower Base As Ground Electrode

☜Ufer Ground

Ground Rod☞

# Ground Rod Materials Are Important

Examples: Two Rods Dug Up After 10 Years

- 3/4" Galvanized Rod
- 5/8" Copper Clad Rod

A Check With An Earth Resistance Tester Reveals A Ground Resistance of 13 Ohms For This Installation And Is Well Below The Minimum 25 Ohms Required By The National Electrical Code.

# Let's Do The Math

Average Current In Lighting Strike = 100,000 Amps for .05ms

Measured Ground Resistance = 13 Ohms

Ohm's Law: E(voltage)=I(current) X R(resistance)

100,000amps X 13ohms = 1300kilovolts to ground

This voltage appears on every device connected to the ground electrode.

# The 1300KV Problem

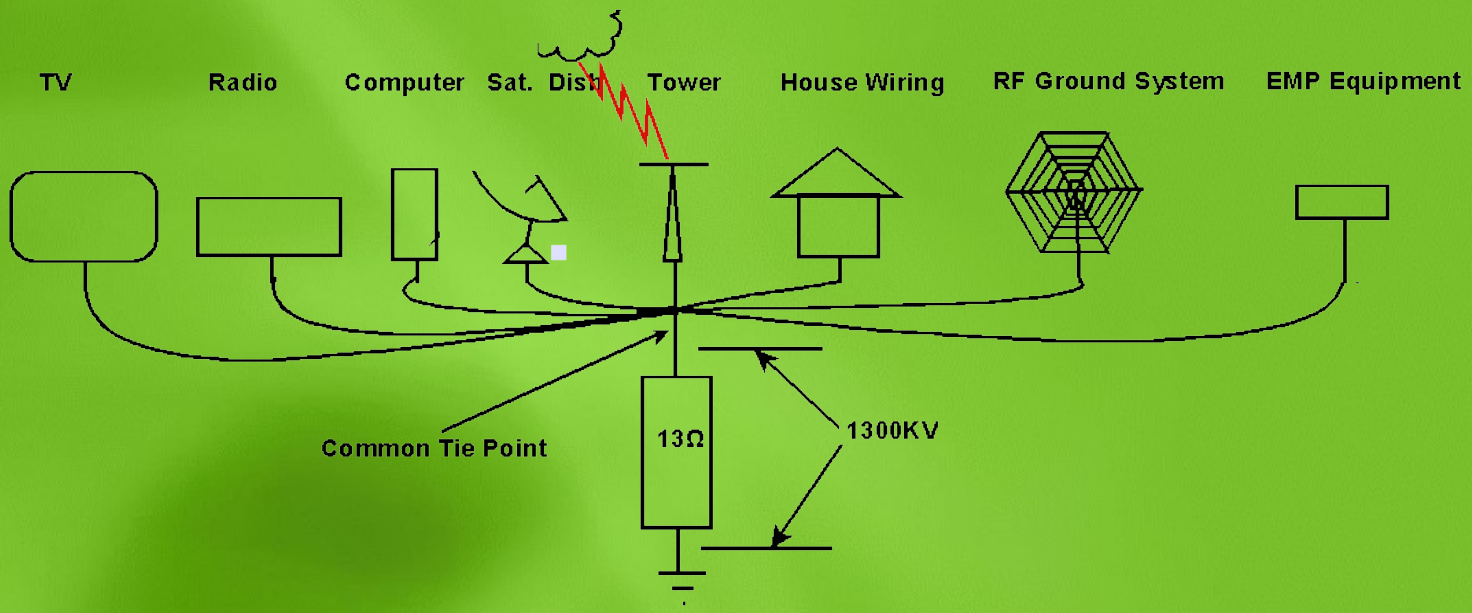
There is nothing you can do about the fact that 1300KV to ground will appear on all your equipment for .05 ms.

But maybe we can keep some if not most damage from occurring.

But how?

# By making sure all equipment is tied to the same ground point!

Let's see what that would do.




Potential between each device is small or zero

**But, This Is Not A Perfect World So EMP Protection Is Necessary**

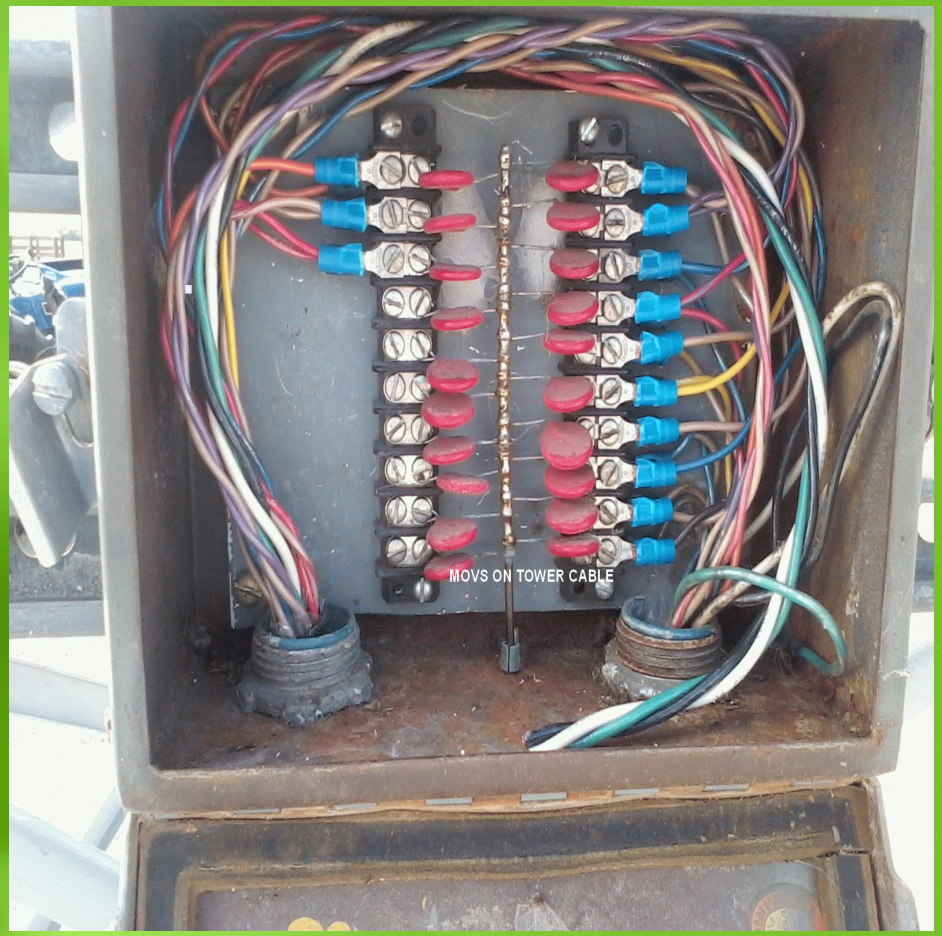
# EMP Protection.

Since it's not a perfect world. There may still be some potential difference develop between the conductors coming into the shack, the individual devices, and the elevated ground conductor.

The EMP equipment will be able to clamp that voltage easily and keep the voltage between the conductors and equipment below a point where damage can occur.

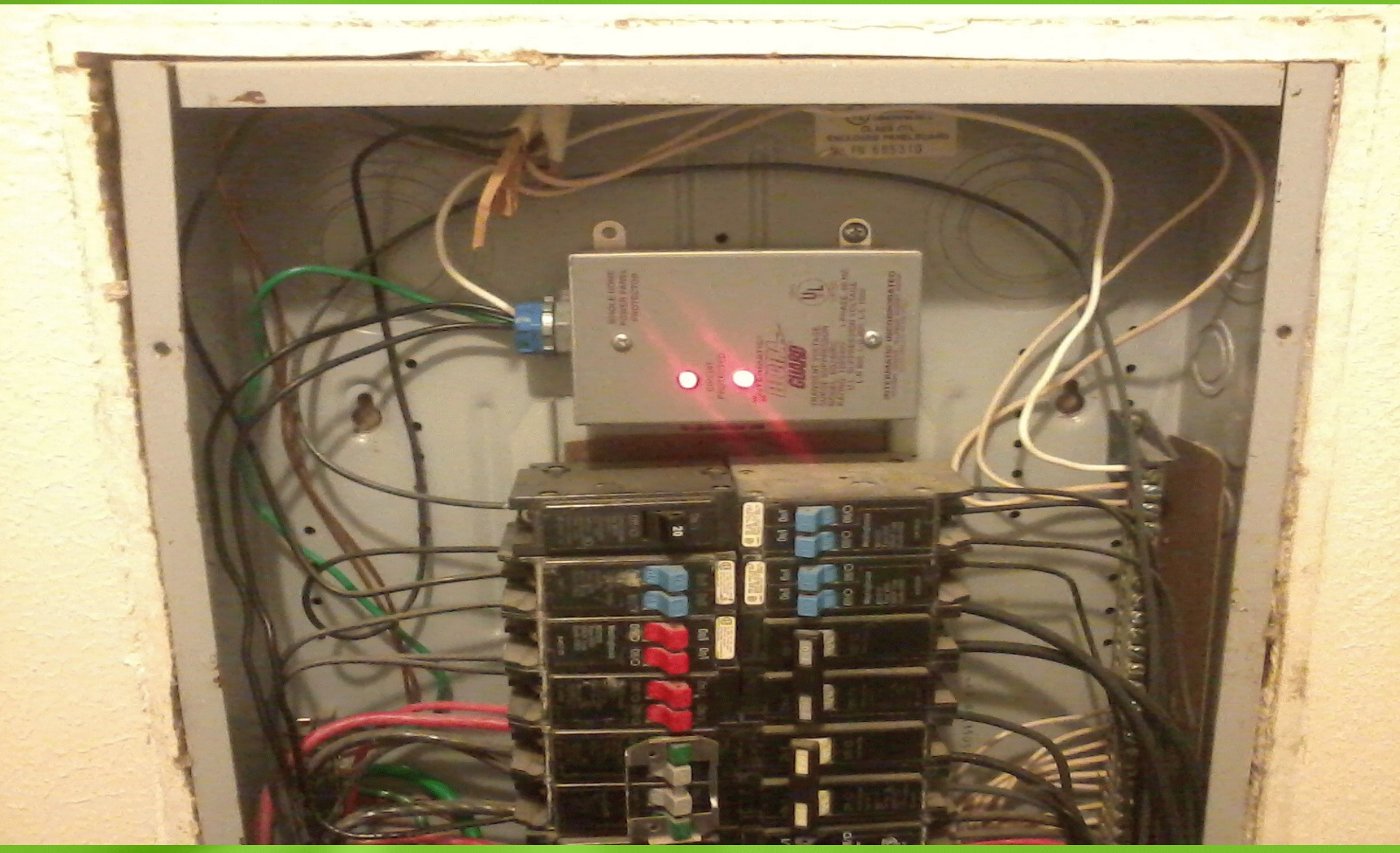
# EMP Protection at Tower

## MOV'S On Control Cable



# EMP Protection Entering Shack

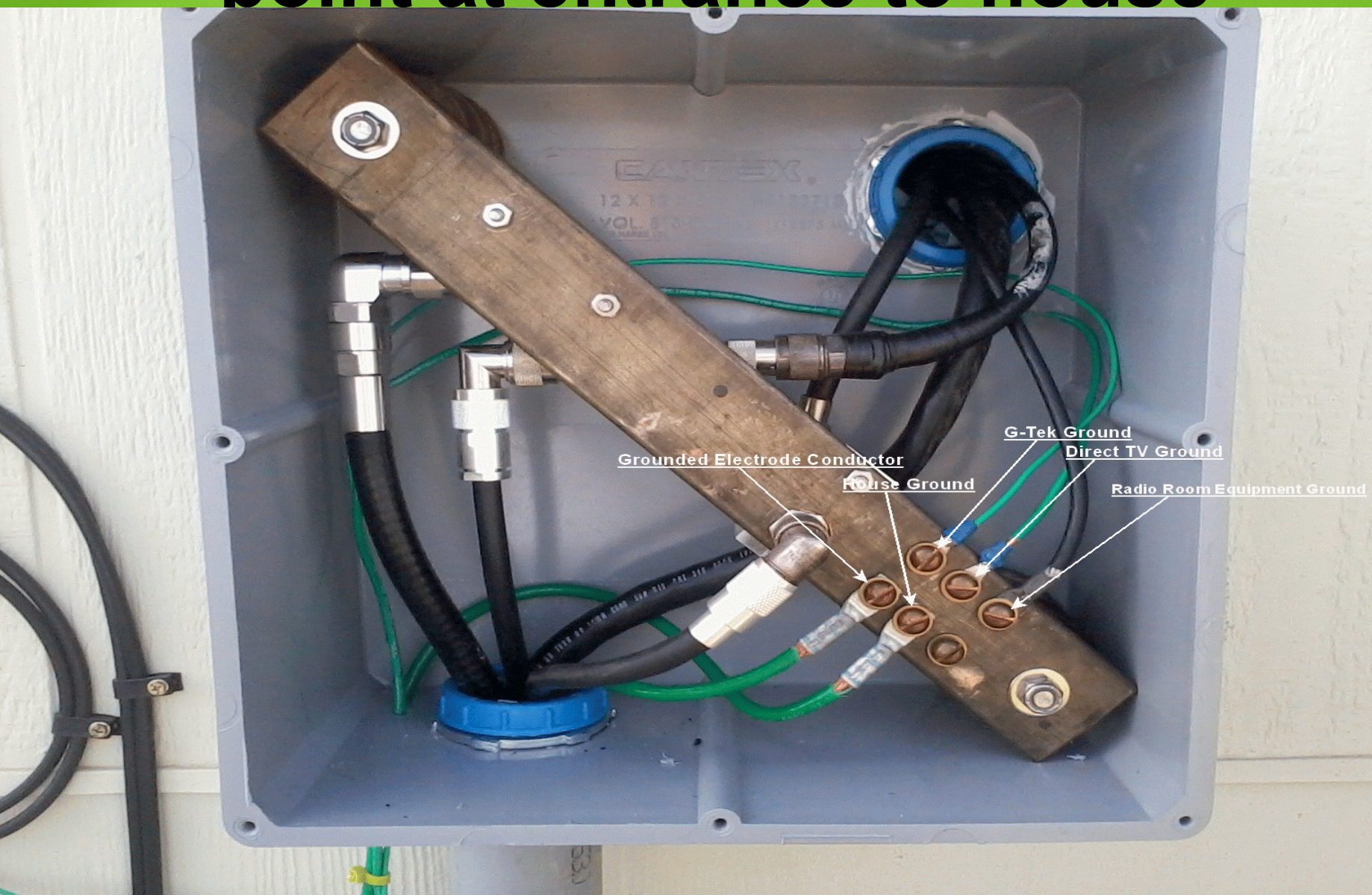
# EMP Protection in Breaker Panel



# EMP Protection At Station

# Tie all station equipment to common ground

# Tie all grounds to same ground point at entrance to house



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## The End

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