

HF Wire Antennas, EMI Contest Stations

WCARC November 2016
VE3KL

Introduction

A Top Down View of a Radio Station(s)

1. Wire Antenna Design...**Ideas needed..**
2. Dipoles and Unwanted Radiation (EMI)
3. A Radio Station and Its Problems
4. Some Basics and Baluns
5. Designing a Contest Station (Field Day...

Wire Antenna Design

Ideas(back of the envelope)

1. Tools well established

Simulators, Analyzers, Vector Z meters

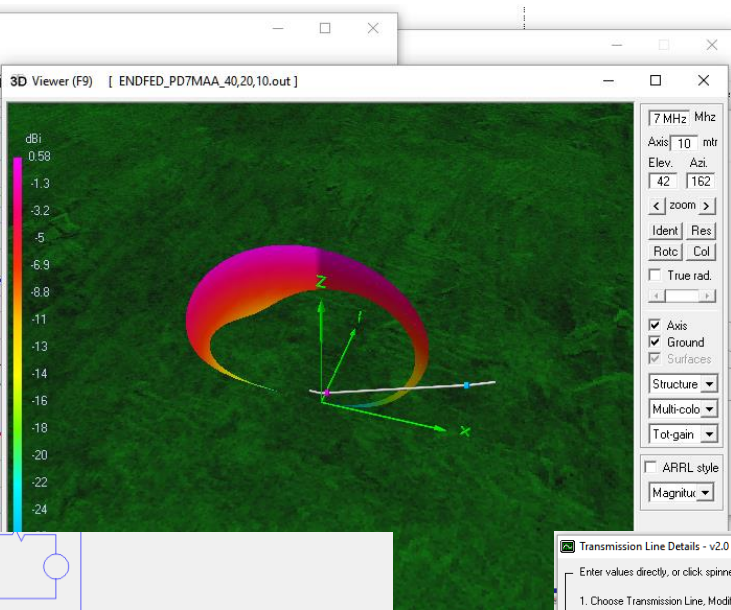
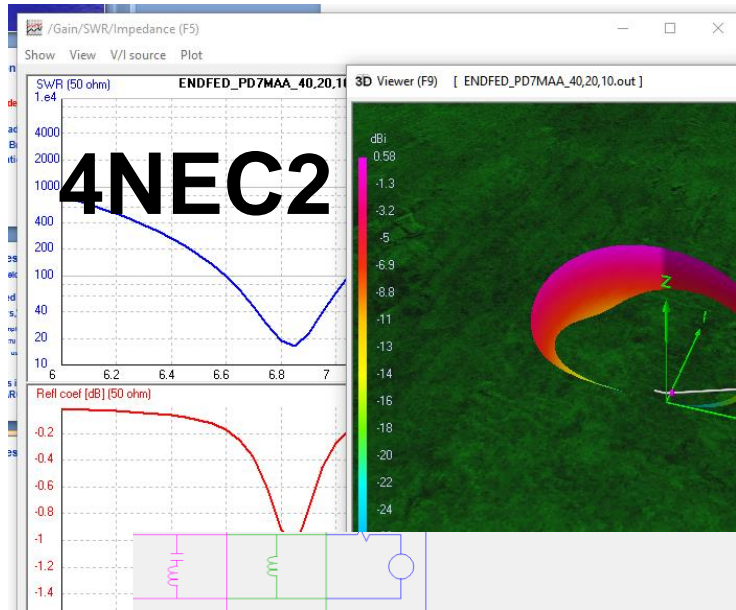
4nec2 (includes a very simple optimizer)

TL Details, SimSmith, AIM4170 connects to SimSmith

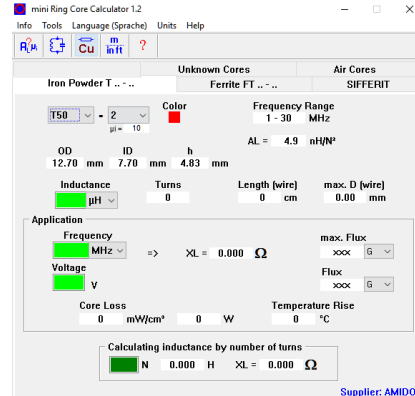
2. **Missing:** Advanced Optimizers

Wire Antenna Design Tools

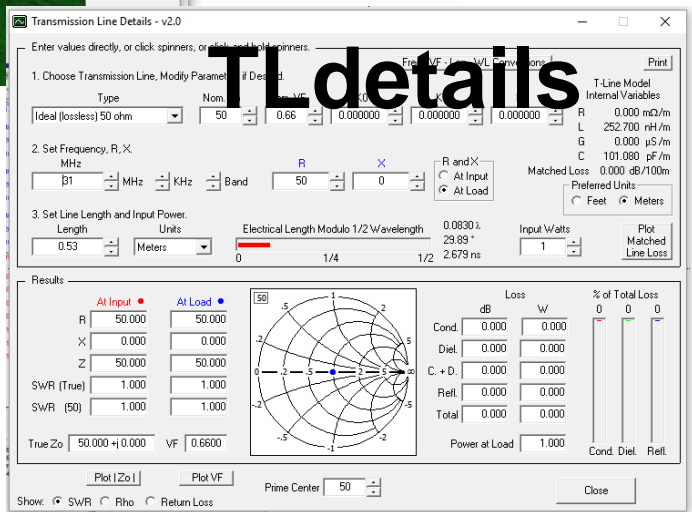
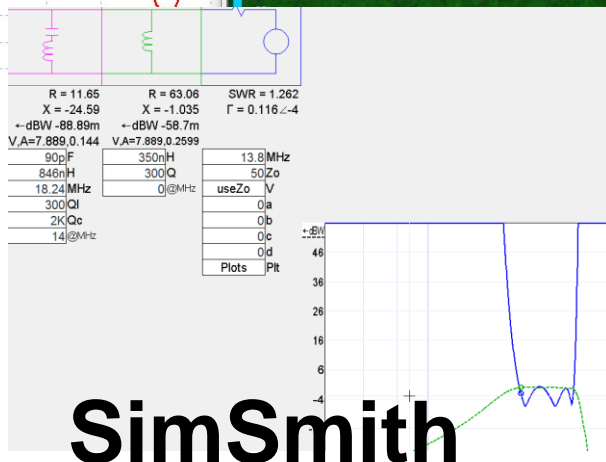
Many Tools Available



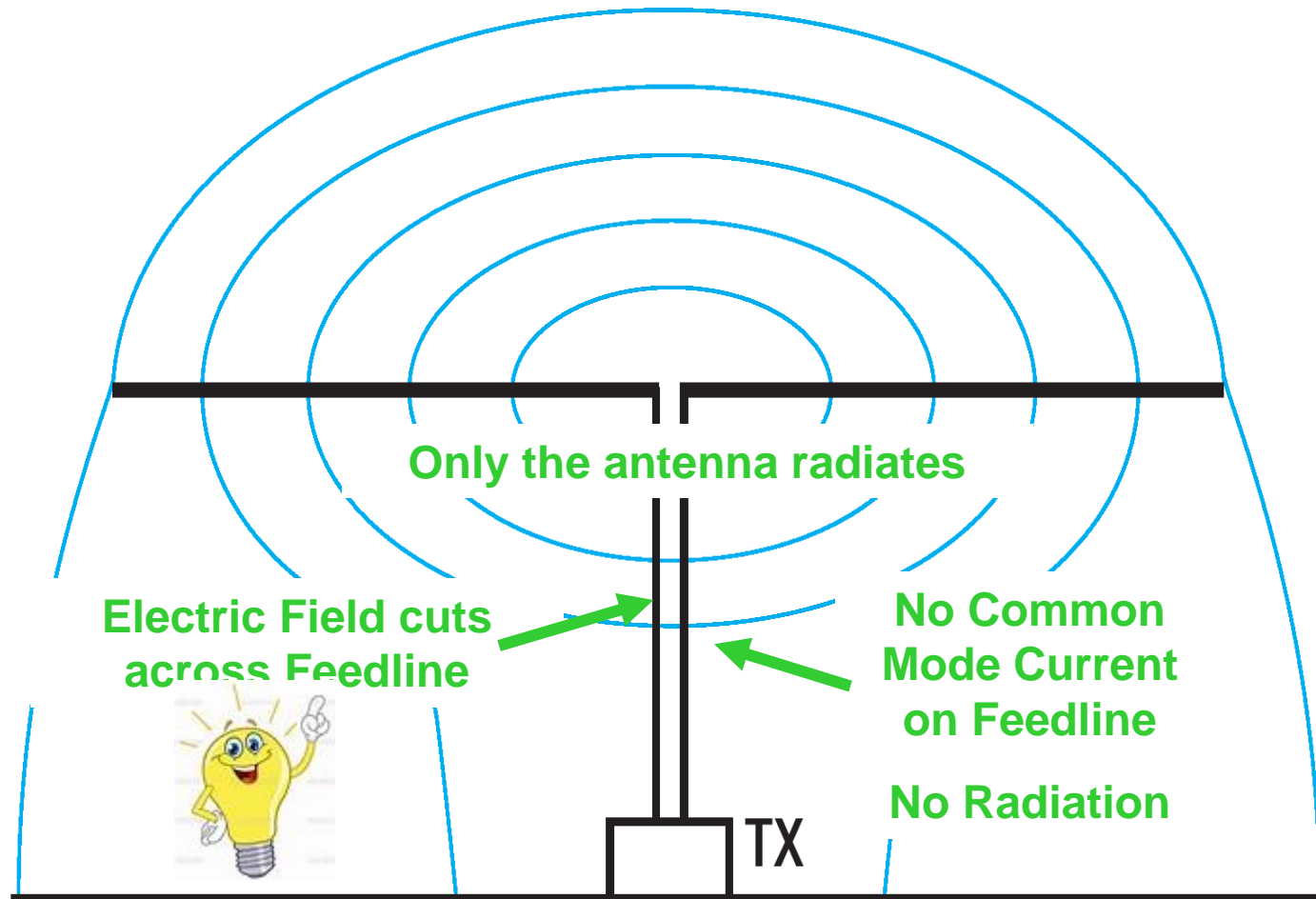
GROUND PLANE SPECIFIED WHERE WIRE ENDS TOUCH INFINITE GROUND. SOMMERFELT RELATIVE DIELECTRIC CONST CONDUCTIVITY=3.000E-03 M COMPLEX DIELECTRIC CONST



TOROIDs



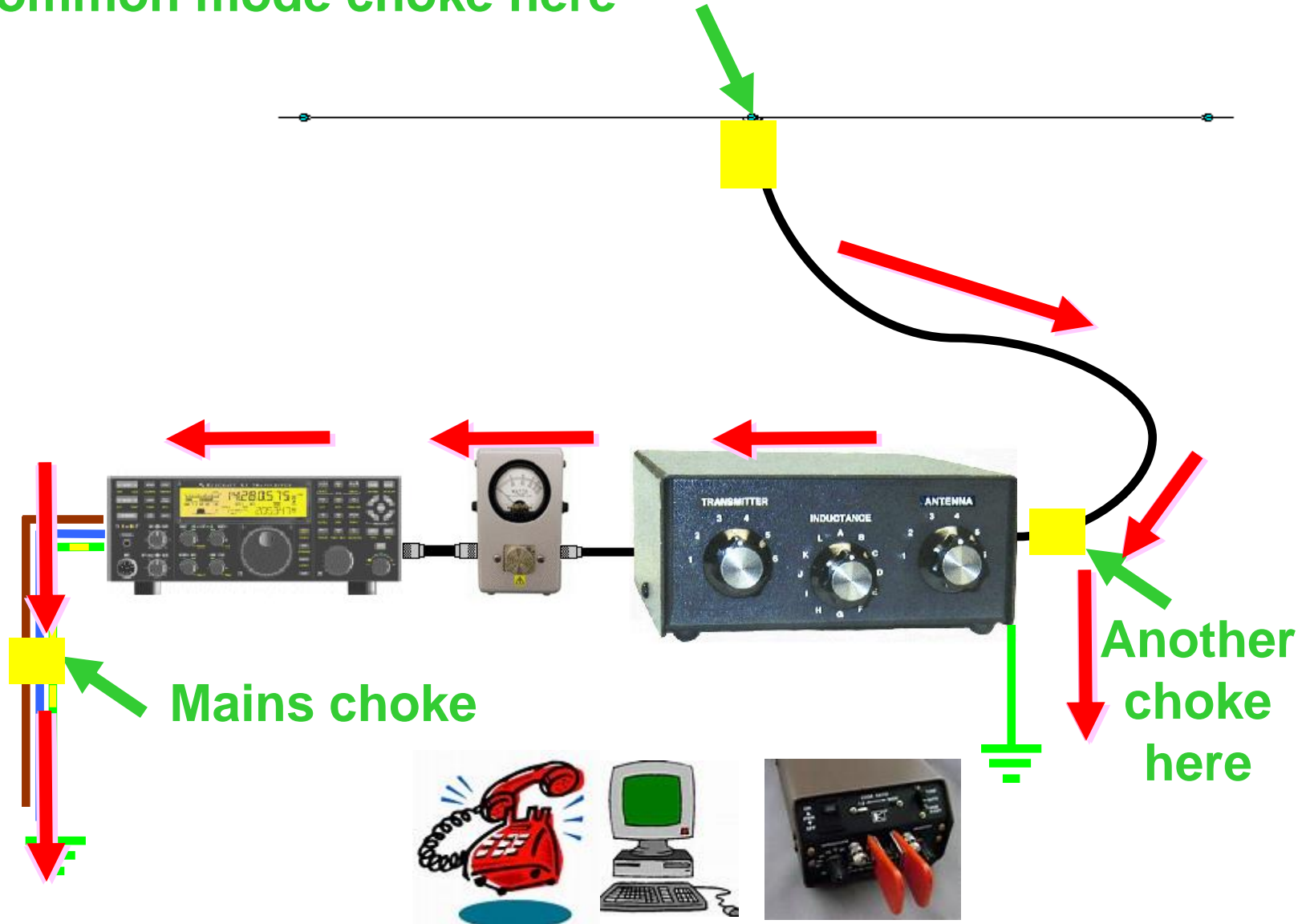
The Ideal Fictitious Antenna



Common Mode Currents.....Currents that Radiate

A Basic Radio System

Common mode choke here

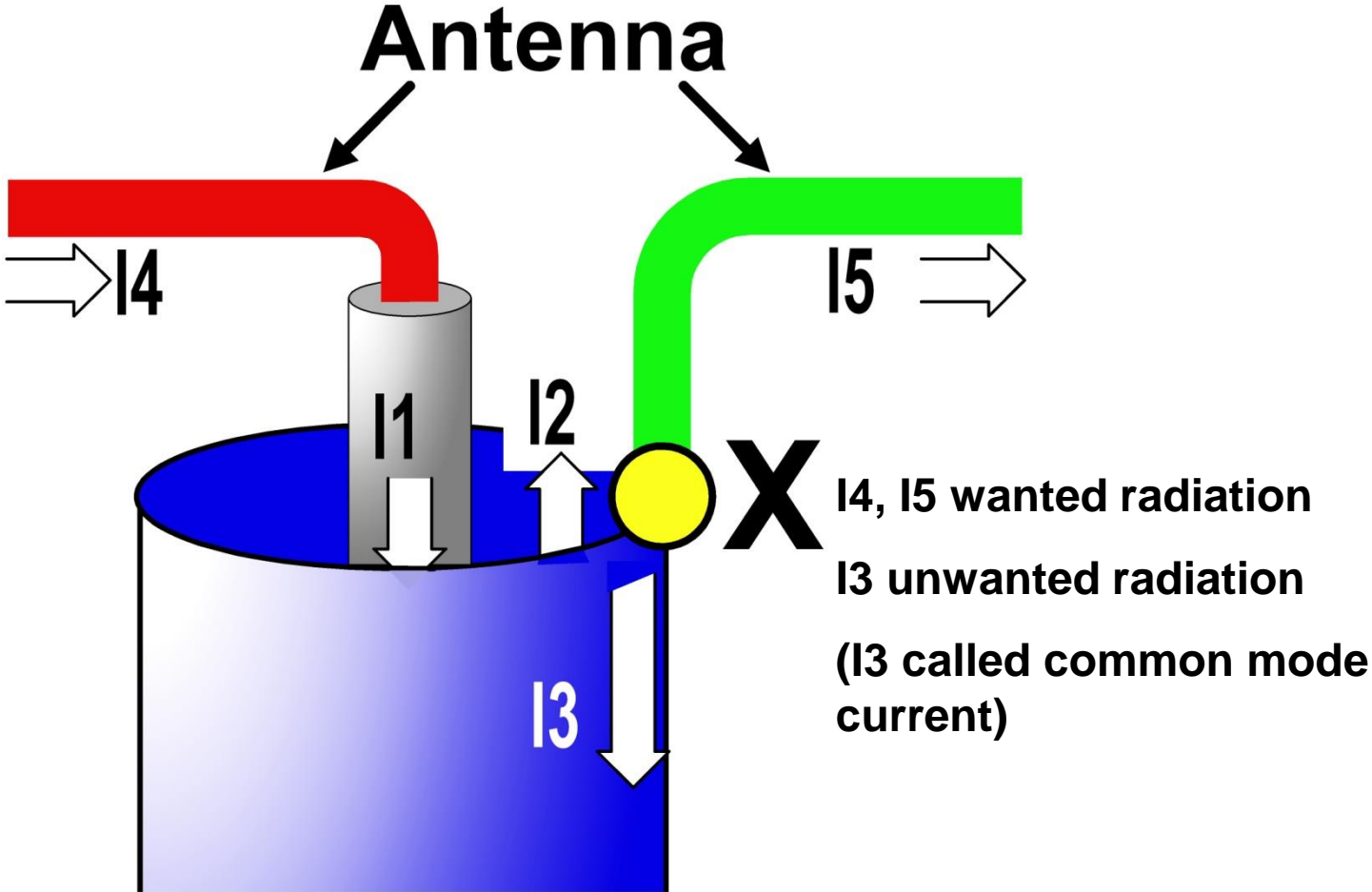


Unwanted Common Mode Currents

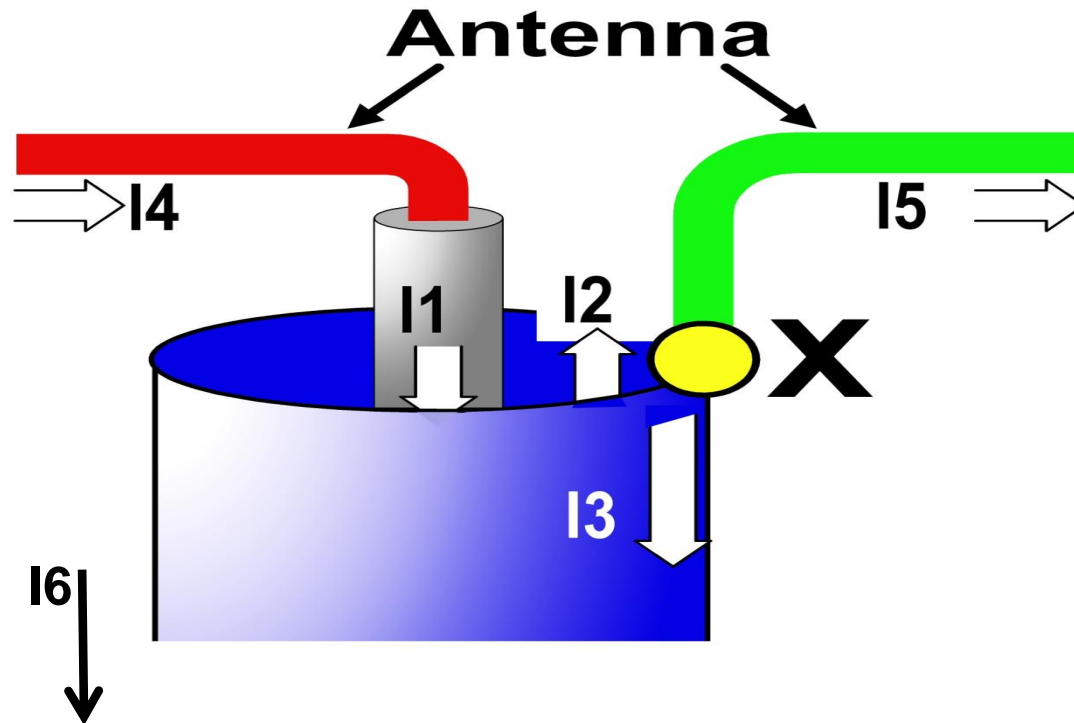
Currents On the Outside of Coax

- **Causes Coax to radiate...poor SWR and distorted antenna patterns**
- **Current gets into keyers, microphones, computers, routers and the radio**
- **Reduce with line isolators/chokes/baluns**

Coax Basics



Coax Basics



Two Sources of Unwanted Common Mode Radiating Current

I_3 Right at the antenna/coax junction

I_6 Direct radiation from antenna

What is a Choke

(Also called a 1:1 Balun, Line Isolator)



ZIP Cord 100 Ohm
Good for 4:1 Balun's

A short section of
Transmission line: 50 Ohm
Wind it on a Ferrite Core
= A 1:1 Balun/Choke



What does “high performance” mean?

Generally,

high performance = high CM impedance

For tough EMI problems, that means...

several thousand ohms

wide bandwidth

mainly resistive (why?)



Contest Stations

Field Day

OARC Corkery June 2016



Antenna Summary

1. Most Antennas worked as expected (Individually)
2. Strong EMI between the End Fed and Windom..We worked around this problem with our 40m Vertical thanks to Mike's suggestion (VE3FFK)
3. Some EMI was experienced on the **6m** station! Maybe Phase Noise from an HF Transmitter.

EMI Solutions ?

Causes of Interference (EMI)

1. Co-Resonant antennas closely spaced...Mutual Coupling

Co-Resonant: Antennas resonant on same frequency

2. Received Transmitter Phase Noise and Harmonics

3. Currents flowing on outside of coax: Called Common Mode

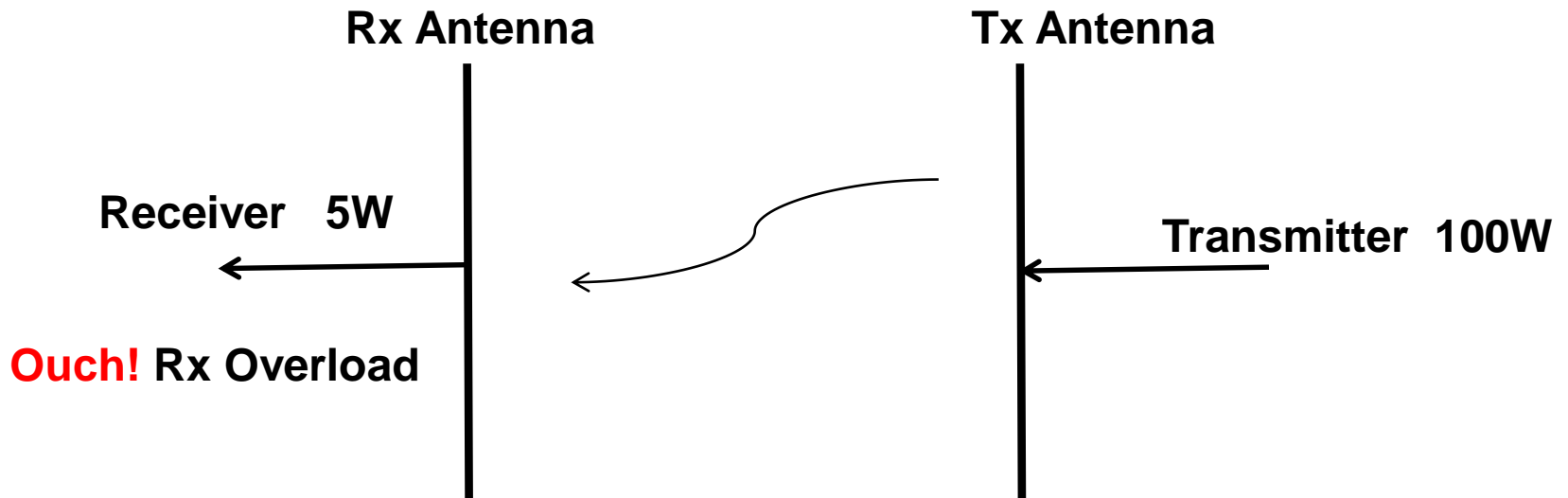
All of the Above can be addressed

Let's See How

Mutual Coupling

(Remember the Yagi?)

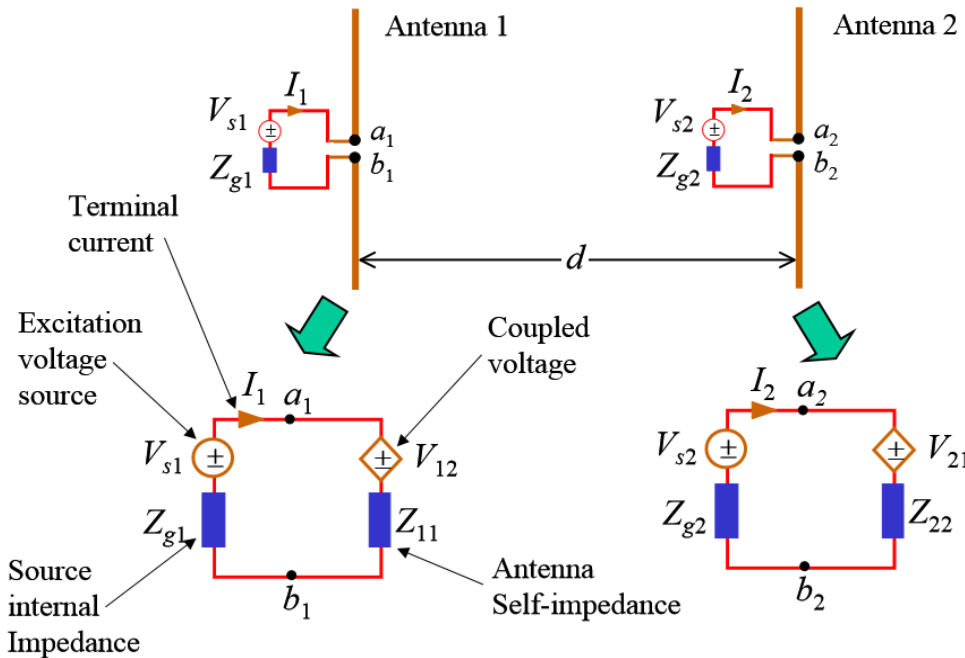
Tx antenna couples a strong signal into **nearby** receiving antennas.... Z_m [Ohm]



Mutual Coupling Basics..Zm.

Transmitting

Receiving



$$V_{21} = I_1 * Z_m$$

$$\text{Power}_r / \text{Power}_t = [Z_m / Z_{11}]^2 / 4$$

$$\text{For } Z_g = Z_{11} = Z_{22}$$

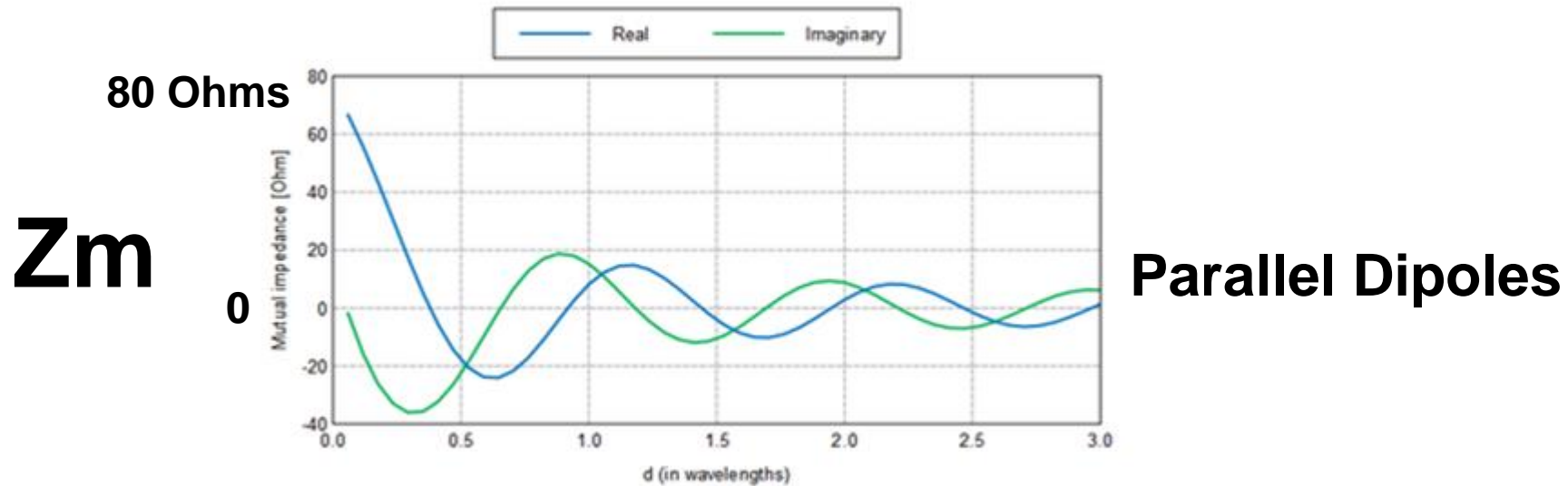
$$\text{If } Z_m = Z_g = 50$$

Power received only **6 dB** below power transmitted

Mutual Coupling

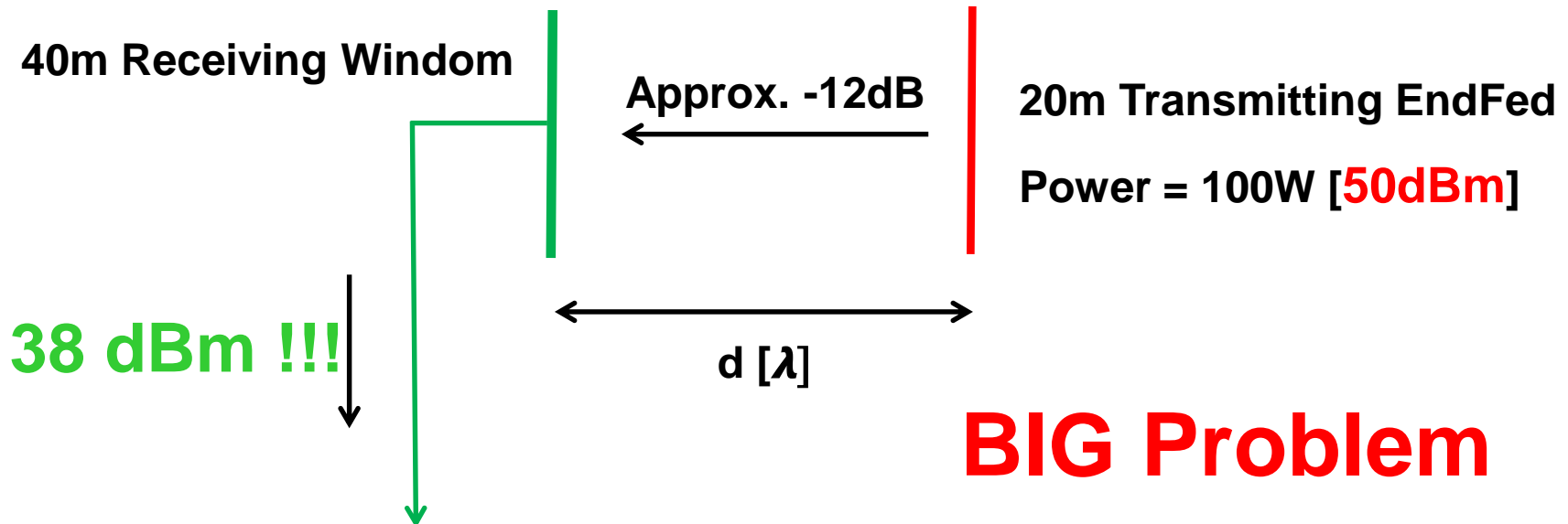
If antenna spacing = 0.25λ

Power Received = **12** dB below Power Transmitted



Spacing in Wavelengths

Mutual Coupling Co-Resonant (End Fed and Windom)



Yaesu FT-1000D (40m)

Out of Band De-sensing Occurs at approximately 5 dBm

RF Amplifier turned off

Add a Bandpass Filter at Receiver Helps Mutual Coupling

Broad Band Receiving
Antenna 40m radio

Approx. -12dB

20 m Transmitting Antenna

Power = 100W [50dBm]

38 dBm

$d [\lambda]$

BandPass Filter
45 dB Rejection

Problem Nearly Solved

-7 dBm

Yaesu FT-1000D (40m)

Out of Band Blocking Occurs at approximately -5 dBm

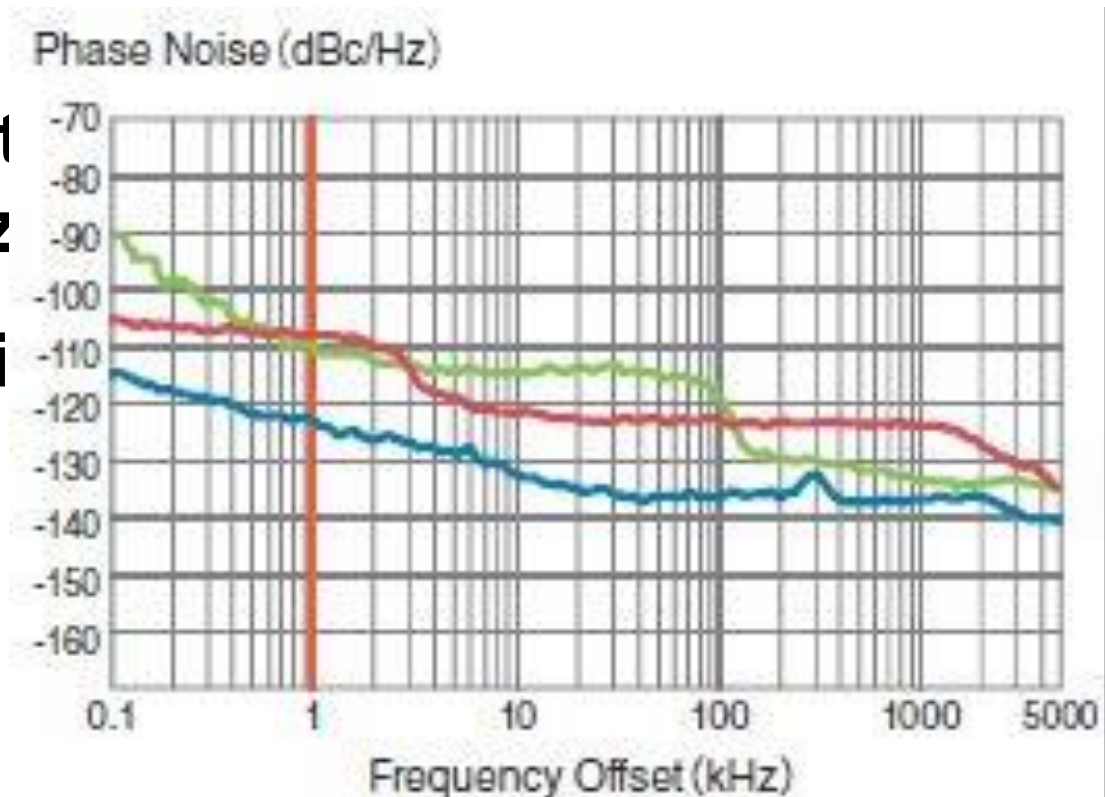
RF Amplifier turned off...*turn on rx attenuator*

Phase Noise

Transmitter Phase Noise What is it?

1. All Oscillators have a small amount of non-wanted Phase Variation with time. Digital Engineers call this Clock Jitter

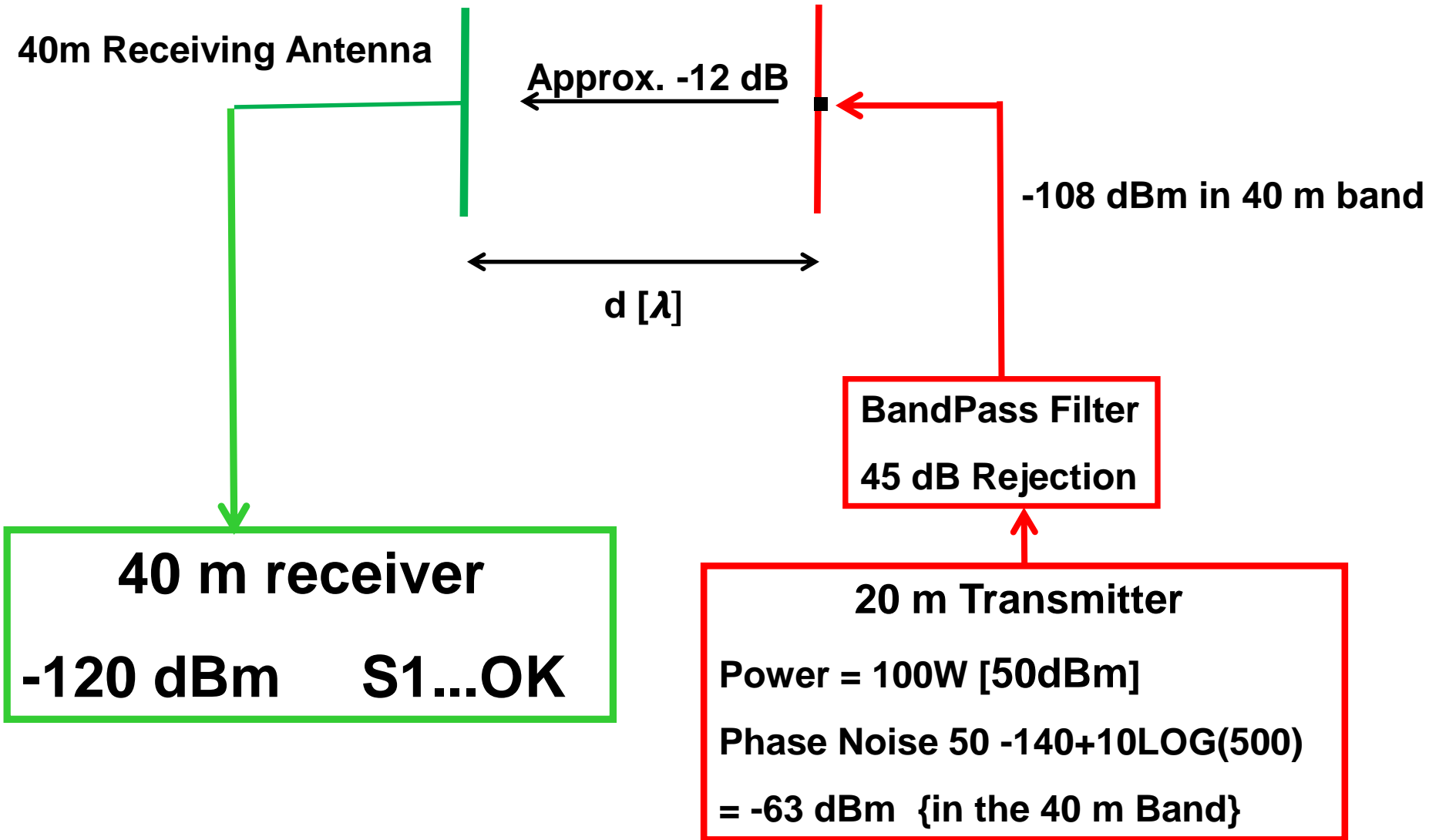
2. ICOM and of power (dBc/Hz)
Noise Transmi



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/)

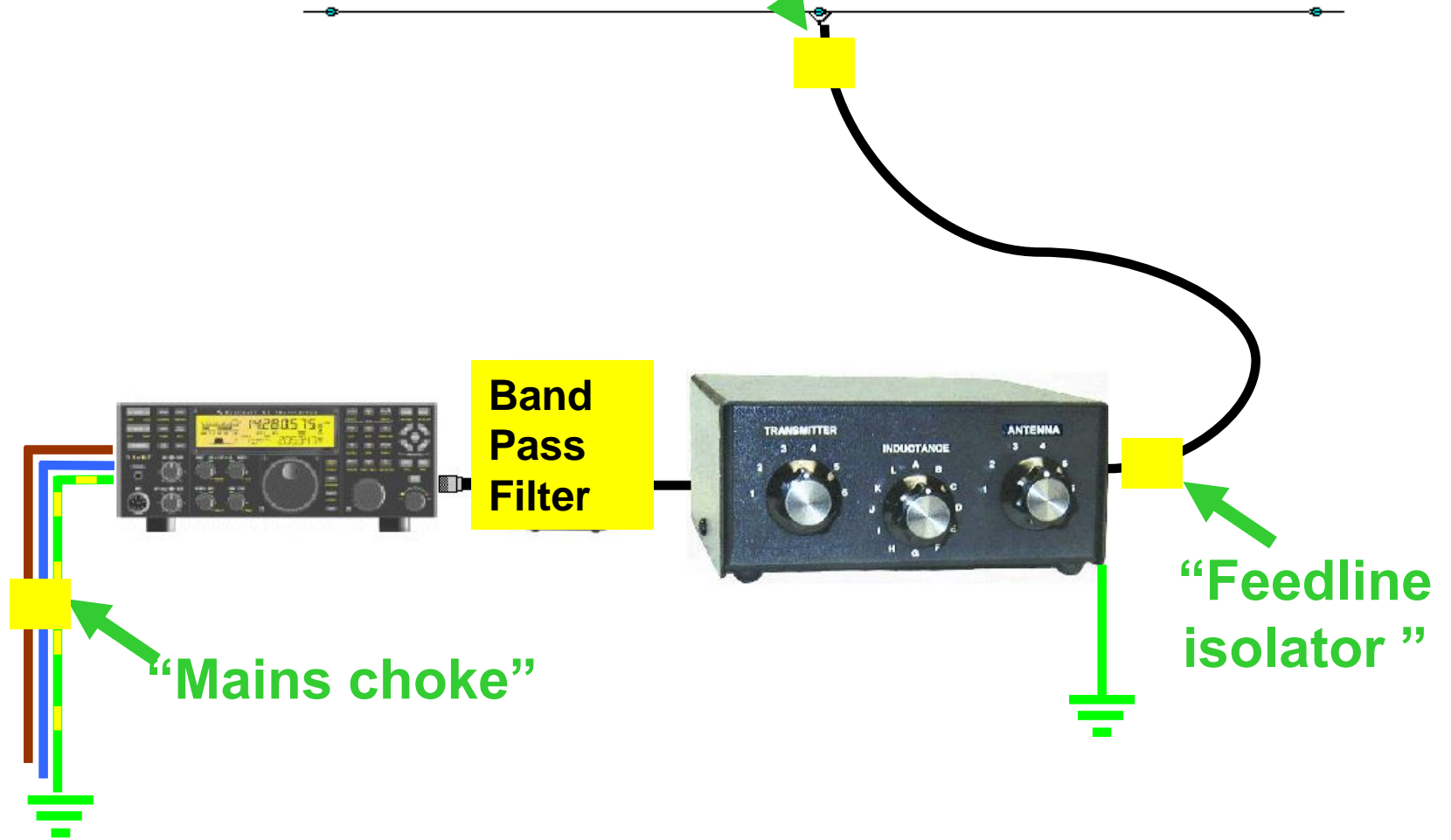
Phase Noise

Transmitter Phase Noise

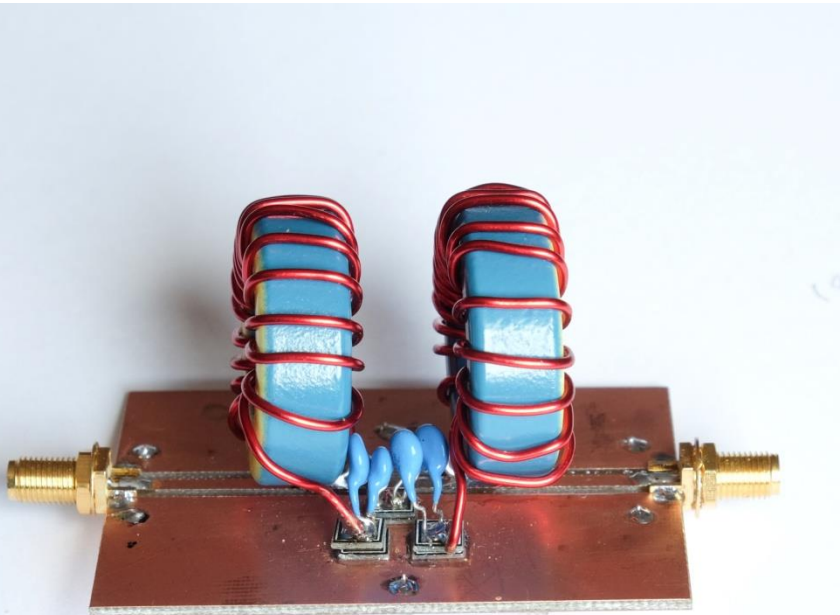


Set-Up for All Stations

Line Isolator here = "balun"



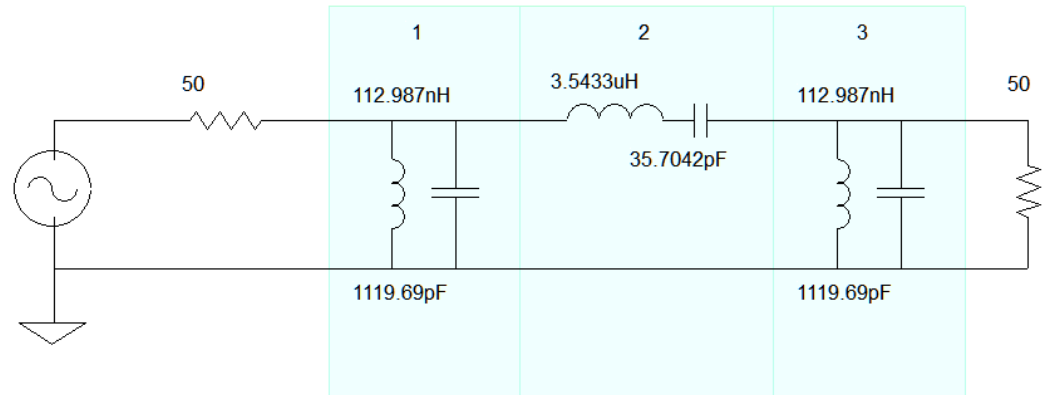
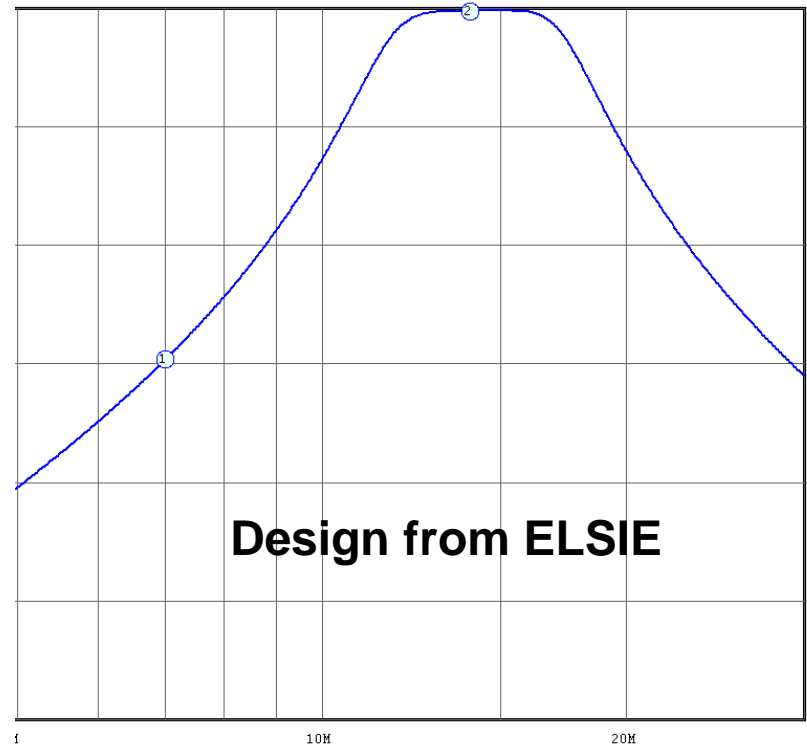
Filter Implementation...Prototype



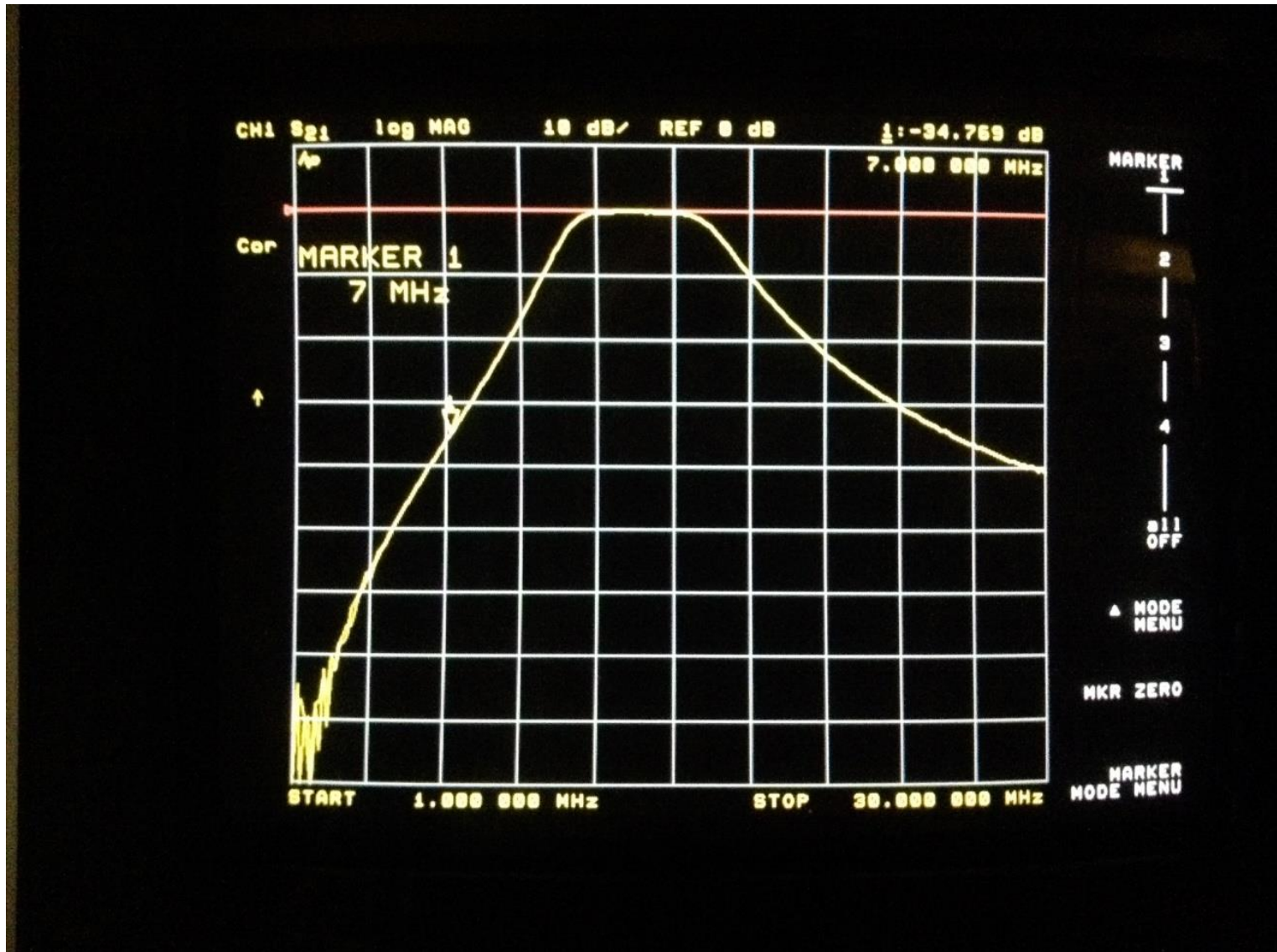
6 KV Capacitors

Big Toroids

100 W



20m BandPass Filter..Three Pole Butterworth Measurements.....Complements VE3ZRK



20m BandStop Filter..Three Pole Butterworth Measurements



Summary

- Chokes are easy to make...use three
might need small chokes at keyers,
computers...
- A ground stake is useful...lightning
- Filters are essential for contest stations
- Some EMI problems quite elusive

References/Acknowledgements

- GM2SEK [web](#) site and drawings
- ON9CVD..a comprehensive [web](#) site on Ferrites and HF applications.
- Parts and Kits...Toroid [Supplier](#)

A background image of a blue sky with light, wispy clouds over a blue ocean. A bright reflection of the sun is visible on the left side of the water.

73 Dave VE3KL