Analyzing an Antenna

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Prepared for WCARA/VOA August 4th 2022

Analyzing an Antenna - What is an Antenna ?

- History
- Theory
- Practice
- Analysis

What is an Antenna ? - History

- 1830 Faraday connected Magmatism & Electricity
- 1865 Maxwells Equations
- 1880s Hertz Developed Dipole Antenna with a Spark Gap
- 1880s Hertz developed Loop Antenna to receive
- 1901 Marconi transmitted across Atlantic. 200 meter Long Wire
- 1905 Phased Array Marconi & Braun. 1990s Patriot Missile
- 1906 Columbia University antenna experiments
- 1920s Yagi, 1939 Horn, 1940s Parabolic, 1970s Patch, 1980s PIFA
- To Present Day many more

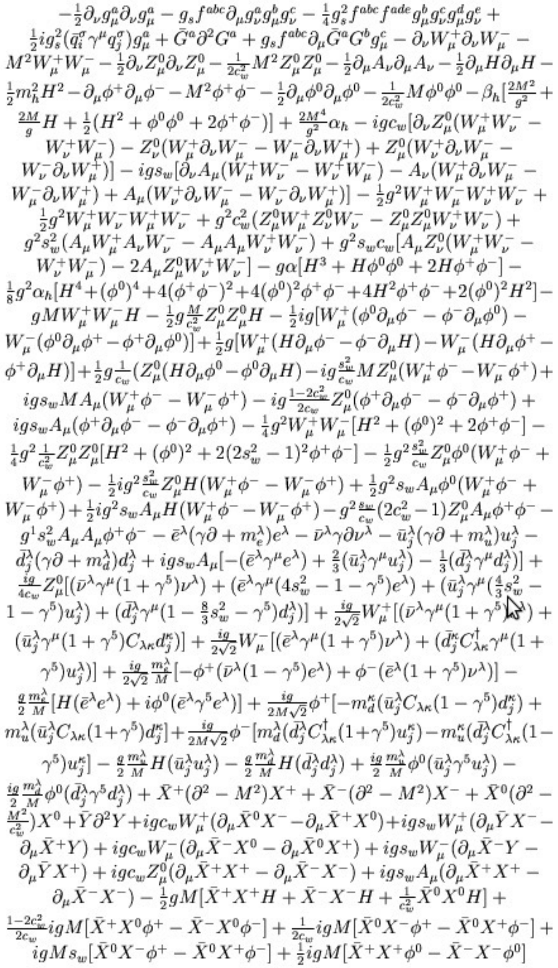
What is an Antenna ? - Theory

- Some Math -> Let there be Light ->

- Then Maxwell Said in 1865 or So

Gausss' Law	$\nabla \cdot \mathbf{D} = \rho_V$
Gausss' Magnetism Law	$\nabla \cdot \mathbf{B} = 0$
Faradays Law	$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$
Ampere's Law	$\nabla \times \mathbf{H} = \frac{\partial \mathbf{D}}{\partial t} + \mathbf{J}$

=



≈ Let There be Light

What is an Antenna ? In Practice – More Math!

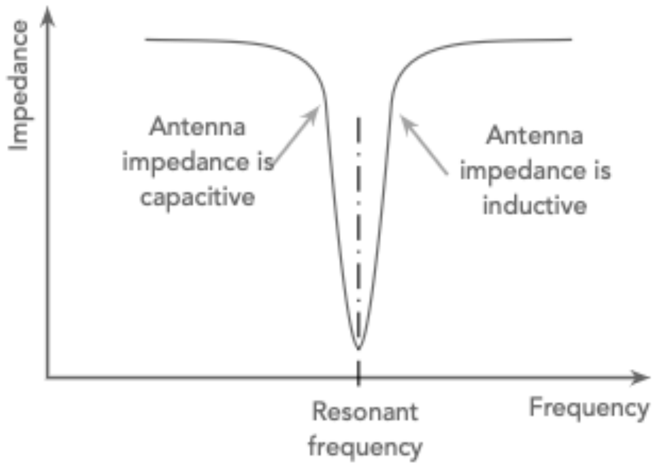
- VSWR Antenna System Match = VSWR = $|V^{MAX}|/|V^{MIN}|$ Reflected Wave or Impedance / Resistance
- A Dipole ½ λ at Resonance has an Impedance 73 Ω purely Resistive

  SWR for a Resonant Dipole = 73/50 = 1.46
- Antenna Resonance f = 1 / (2 x π x √(L x C)) , $X_c = 1/2\pi fc$ $X_L = 2\pi fL$
- Wavelength ¼ λ = 984 x .25 x .95 / 146.52 = 1.6 ft or 19.1” or 48.6 cm
- Length of Coax RG400 ¼ λ at 146.52 Mhz in feet is =

  984 x .25 x .695 / 146.52 = 1.167 feet or 14.00” or 35.56 cm

What is an Antenna ? In Practice

- An Ideal Dipole will have an Impedance of ~ 73 Ω
- An Ideal Vertical will have an impedance of ~ 36 Ω
- Baluns are widely used to get to 50 Ω at feed point.
- VSWR Minimum is for the Transceivers benefit.
- VSWR =1 is not necessarily the most efficient.
- Resonance is the most efficient place to operate.

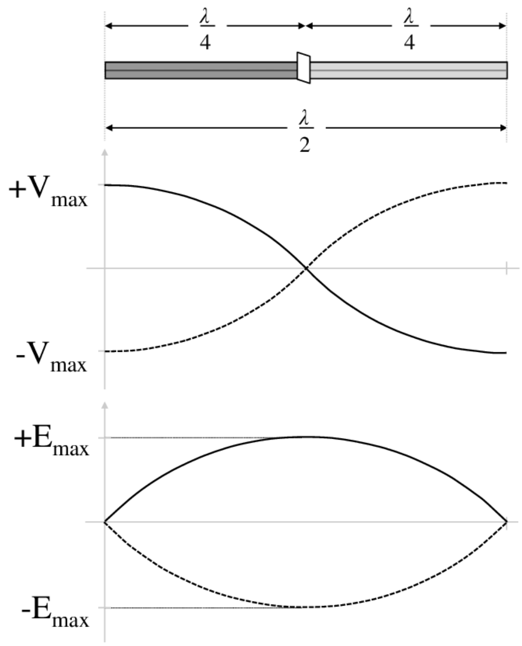


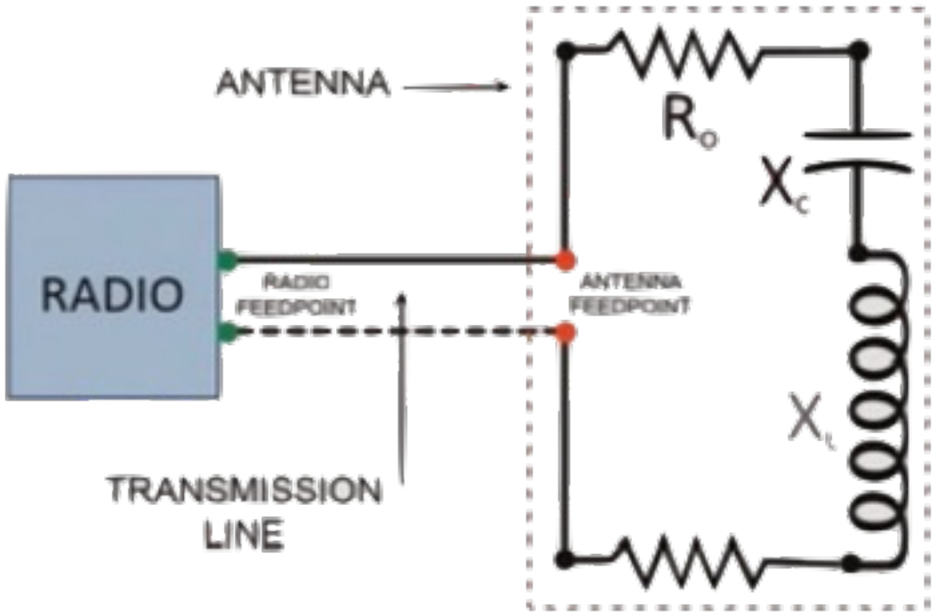
Variation of impedance of antenna

What is an Antenna ? In Practice

- Antennas are used to transmit and receive electromagnetic energy.

Current Voltage Distribution





What is an Antenna ? – Analysis

- VSWR
- Time Domain Refractometry
- Resonance at Frequency
- Impudence er Impedance
- Length of Feed Line Coax
- Efficiency
- Phase
- Polarization

What is an Antenna? – Analysis – Our Tools

- RigExpert AA-55 Zoom – Walter W8LTR
- RigExpert 230 – Stephen KE8TEY

What is an Antenna? – Analyze – AA55 Zoom

Frequency range: 0.06 to 55 MHz
Frequency entry: 1 Hz resolution
Measurement for 25, 50, 75 and 100-Ohm systems
SWR measurement range: 1 to 100 in numerical modes,
1 to 10 in chart modes
SWR display: numerical or analog indicator
R and X range: 0…10000, -10000…10000 in numerical modes,
0…1000, -1000…1000 in chart modes
Display modes:
– SWR at single or multiple frequencies
– SWR, return loss, R, X, Z, L, C and phase angle at single frequency
– SWR chart, 100 points
– R, X chart, 100 points
– Smith chart, 100 points
– Return loss chart, 100 points
– Cable tools (loss and characteristic impedance)
Optional open-short-load calibration.
Non Volatile memory:
– 10 slots to save measurement results
RF output:
– Connector type: UHF (SO-239)
– Output signal shape: square, 0.06 to 55 MHz
– Output power: +13 dBm (at 50 Ohm load)

Power:
– Two 1.5V alkaline batteries, type AA
– Two 1.2V Ni-MH batteries, type AA *
– Max. 4 hours of continuous measurement, max. 2 days in stand-by mode when fully charged batteries are used
– When the analyzer is connected to a PC or a DC adapter with USB socket, it takes power from these sources
Interface:
– 320×240 color TFT display
– 6×3 keys on the water-proof keypad
– Multilingual menus and help screens
– USB connection to a personal computer
Dimensions: 103 mm x 207 mm x 37 mm (4.1 in x 8.1 in x 1.4 in)
Operating temperature: 0…40 °C (32…104 °F)
Weight: 310 g (10.9 Oz) w/o batteries
Warranty: 2 years
GTIN-13: 4820185420099
RigExpert AA-55 ZOOM is made in Ukraine.
Specifications are subject to change without notice.
* Batteries are not included with the analyzer.

What is an Antenna – Analyze Walter W8LTR

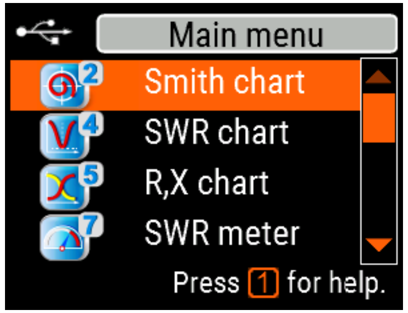
- The following tasks are easily accomplished by using this analyzer:

- Rapid check-out of an antenna
- Tuning an antenna to resonance
- Comparing characteristics of an antenna before and after specific event (rain, hurricane, etc.)
- Making coaxial stubs or measuring their parameters
- Cable testing, measuring cable loss and characteristic impedance
- Measuring capacitance or inductance of reactive loads

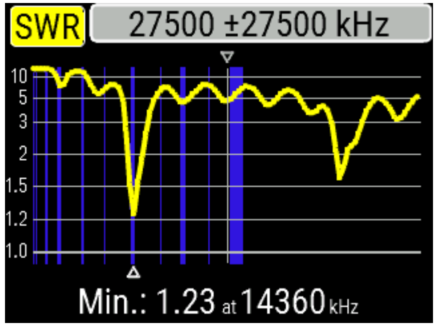
1. Antenna connector
2. Liquid crystal display
3. Keypad
4. USB connector

What is an Antenna – Analyze with the AA-55 Zoom

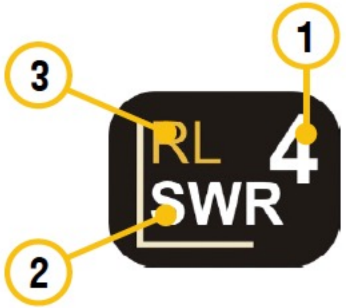
- Main Menu



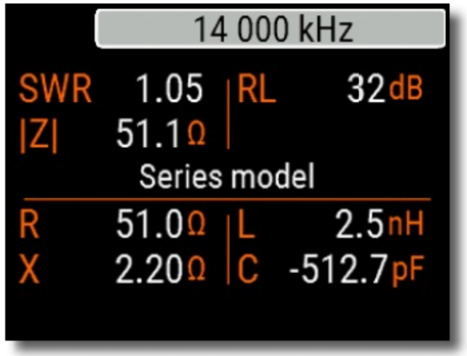
SWR Chart



- Multifunctional Keys



Data Screen

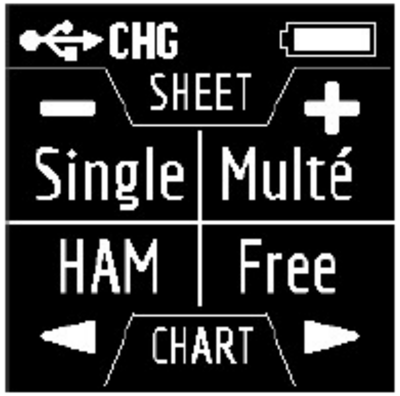


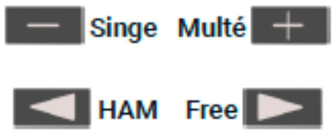
R,X Chart

What is an Antenna? – Analyze – RigExpert230

Operating frequency: 100 kHz – 230 MHz
Size: 185 * 40 * 33 mm (7,3 in x 1,6 in x 1,3 in)
Weight: 185 grams (6.5 Oz) (unpacked, with battery installed)
Type of antenna connector: SO-239
Number of Enter Keys: 6
Display: monochrome e-paper, 200 * 200 pixels.
Type of battery used: Li-ion 18650 (included)
PC Connector Type: USB 2.0 Type-C
Charging Port Type: USB Type-C
Bluetooth Availability: Yes, Bluetooth ver. 4.2 BLE Single-mode, Class B
Battery Charge Time: 3 hours.
RF Power: -10 dBm (at 50 Ohm load)
Minimum frequency step: 1 kHz
Operating temperature: 0…40 °C (32…104 °F)

Main Screen



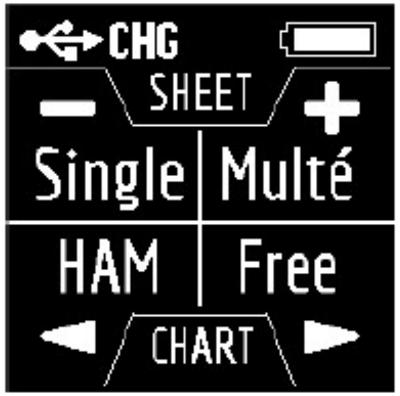


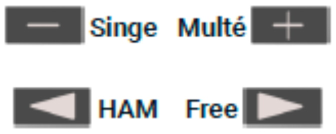
What is an Antenna? – Analyze – RigExpert230

- 6 Buttons to Press

  The Singe and Multé functions display the measurement result as numbers, while the HAM and Free functions display the measurement results as numbers and charts. When you press ▷ in the Main Menu, 5 information screens will be available.

Main Screen

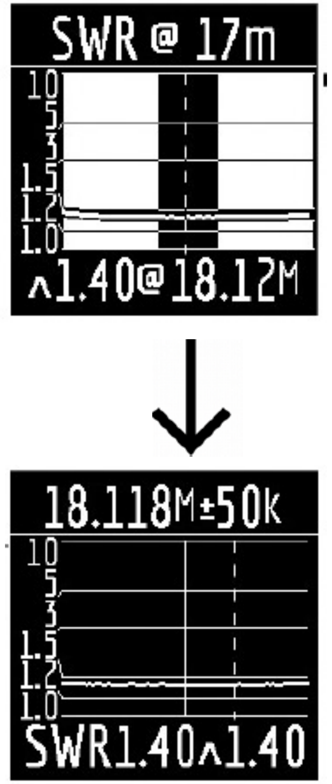




What is an Antenna? – Analyze – RigExpert230

- **Single** is a measurement of all parameters. The mode started is started by pressing the Single button
- **Multé** is a new mode, in which you can quickly assess how well your antenna works on different HAM bands. The result is displayed as stars.
- **HAM** mode, the SWR icon and the range over which the measurement is carried out are displayed at the top of the screen.
- **Free** mode is useful for survey measurement of the antenna in a wide frequency range or for measuring the SWR in a very narrow predetermined area.

Switch From SWR to Free Mode by Pressing – or + Key



What is an Antenna? – Analyze – RigExpert230

- Set the Center Frequency. A long Press of the ▷ While in Free Mode

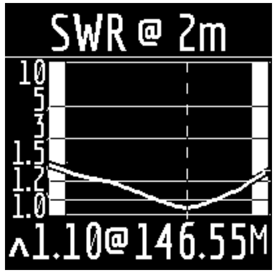
- Settings Menu in the Main Menu press

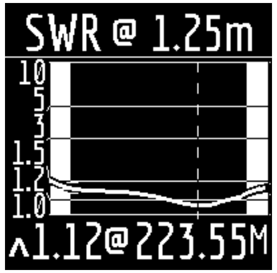
- Press ▷ Adjust User Settings ▷
- Then cycle thru
  - Turn on/off Bluetooth, Enable screen inversion, Analyzer automatic shutdown time. Choosing ITU region, Band Search Normal / Deep , Calibration On / Off, System Z0 50, Factory Reset, Clear Slots

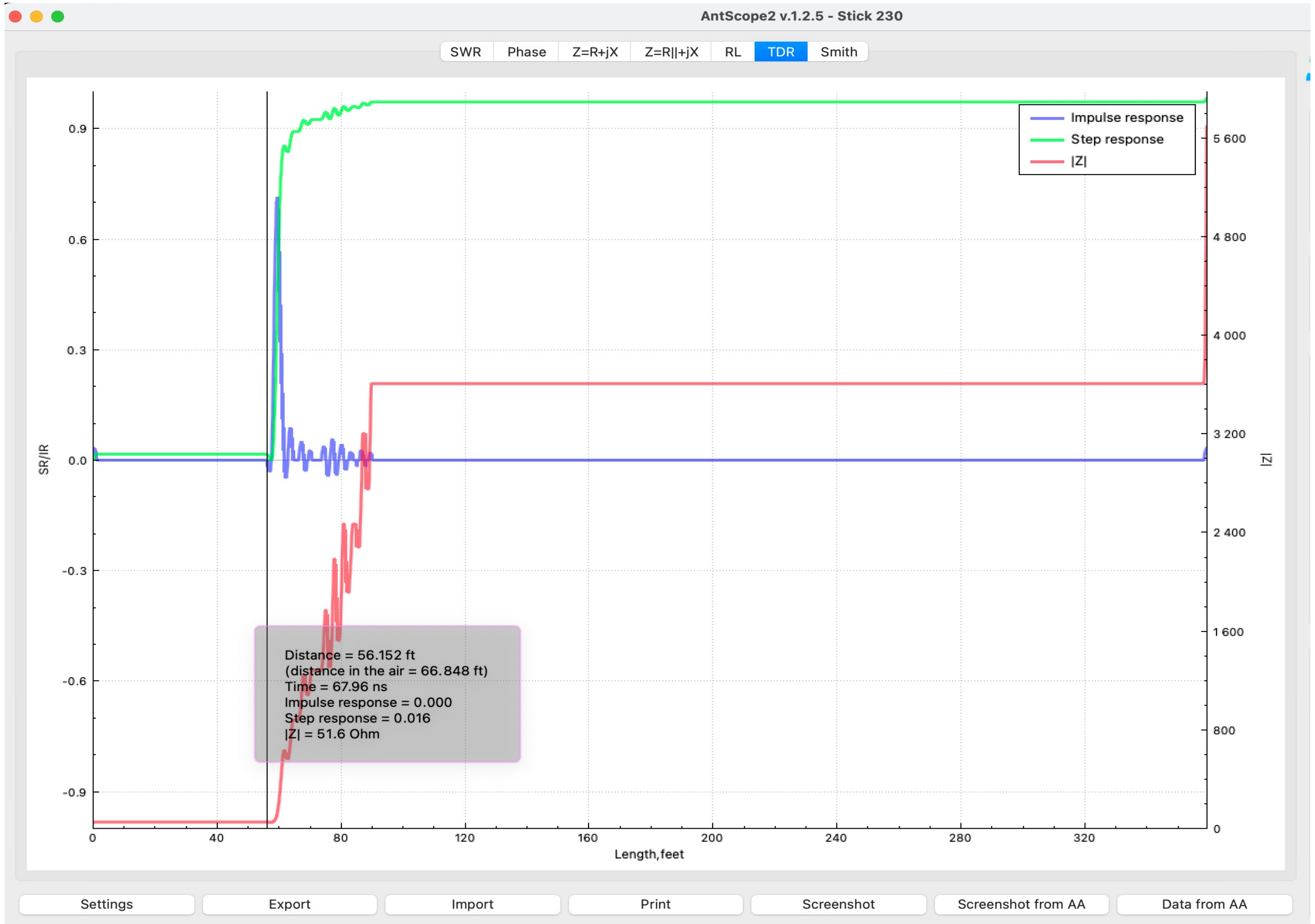
What is an Antenna? – Analyze – Software

KE8TEY C*met 2m / 1.25m /70cm Tri-Band TDR Thru Bulkhead

- AntScope2

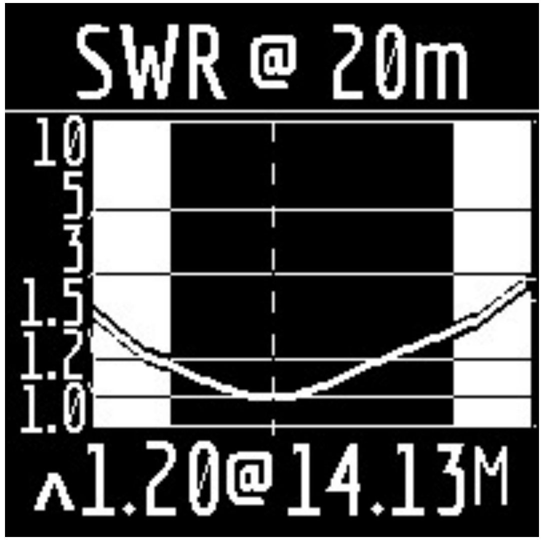


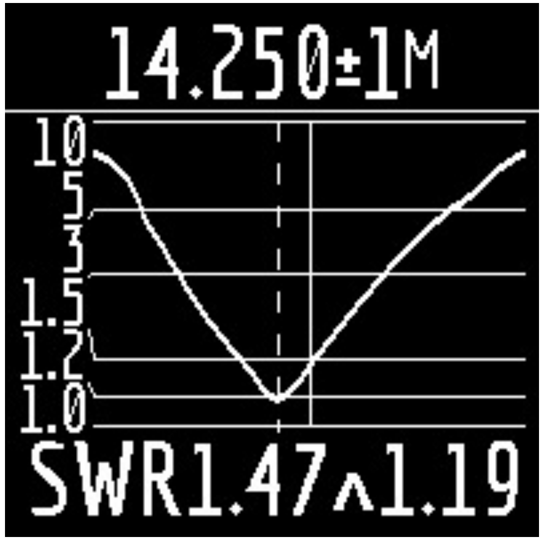


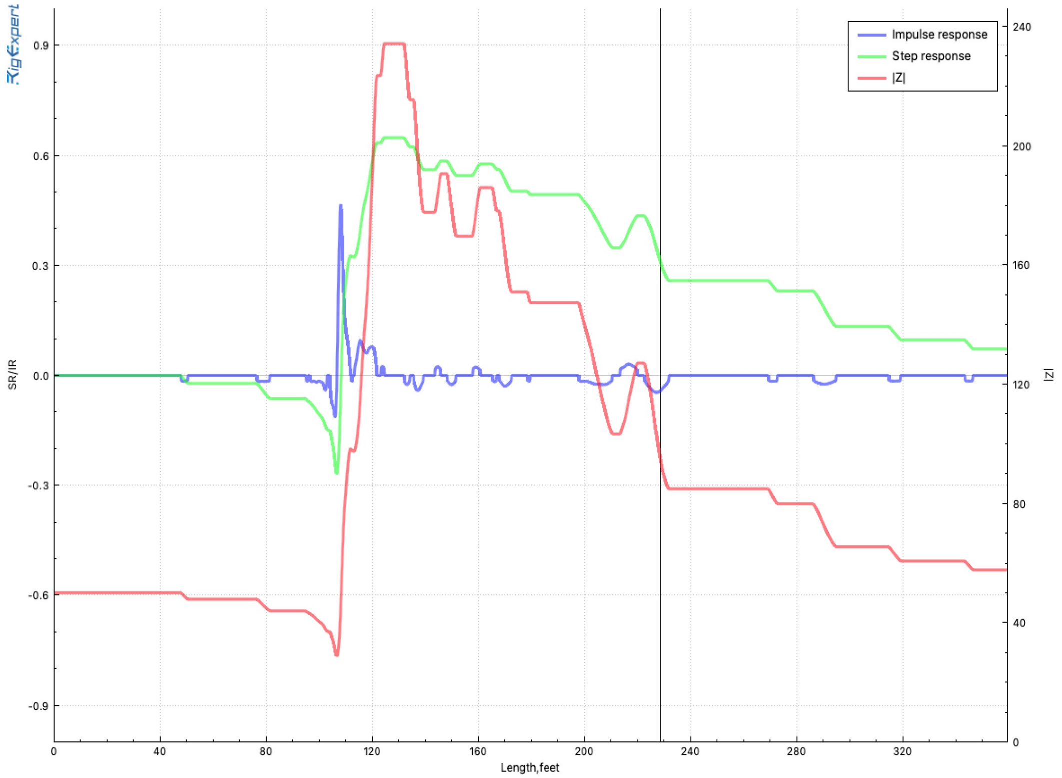


What is an Antenna - Why Analyze?

- Youth On The Air 2022 Holiday Inn Hex Beam 20 Meters



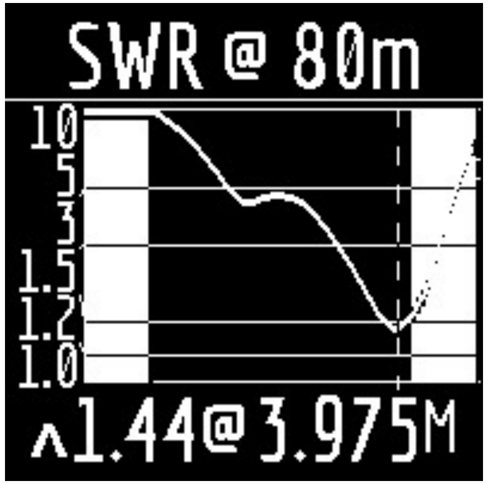


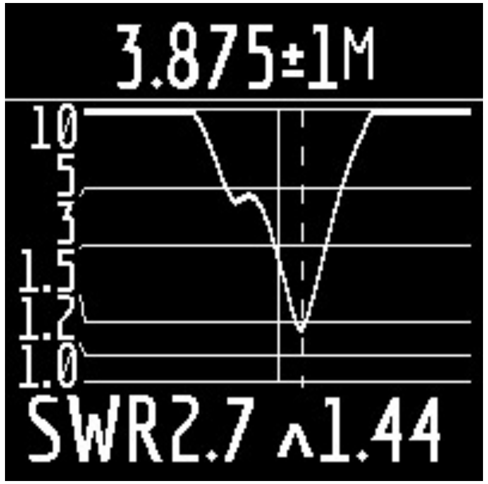


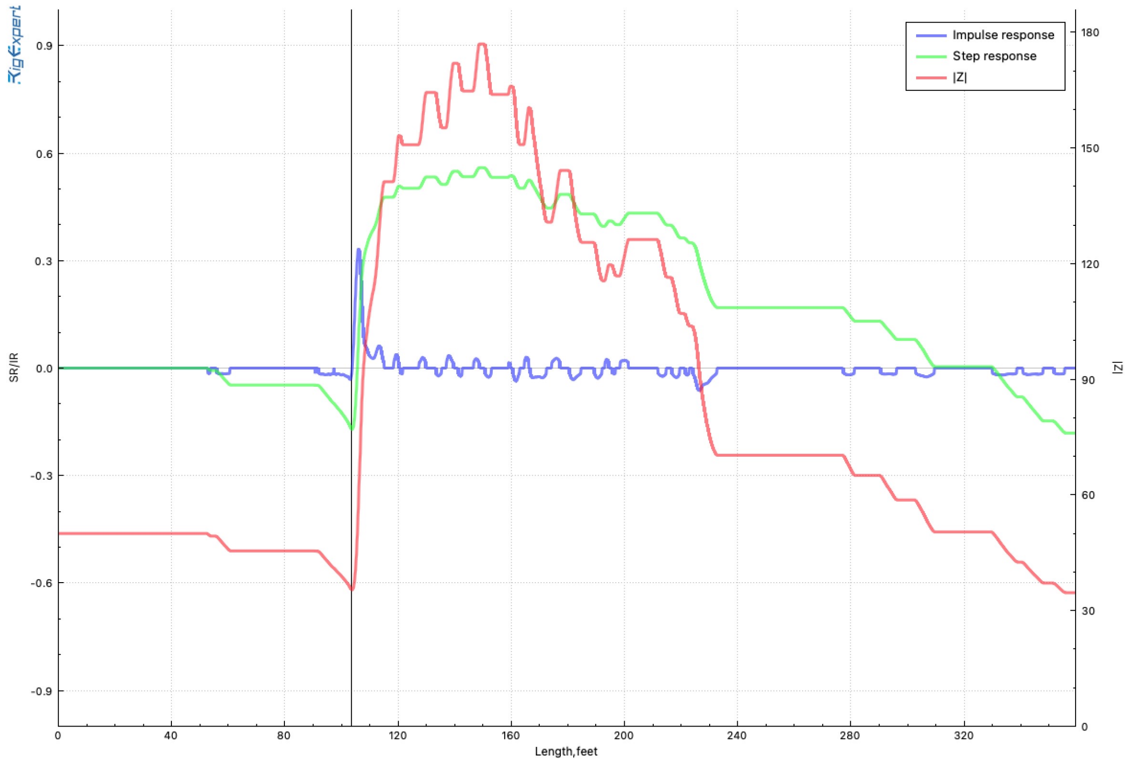
- Along with 17,15, 12, 10 meters

What is an Antenna - Why Analyze?

- Youth On The Air 2022 Holiday Inn Vertical





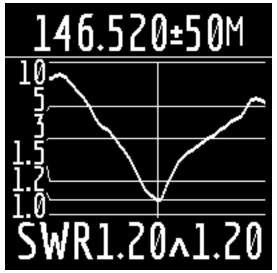


Make Informed Decisions!

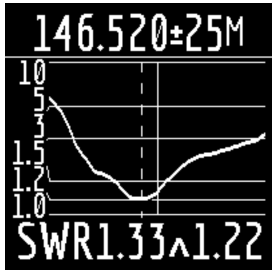
What is an Antenna - Why Analyze?

- 2 Meter Antenna Various Cable Lengths

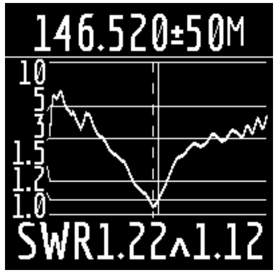
146.52Mhz ABR 6ft



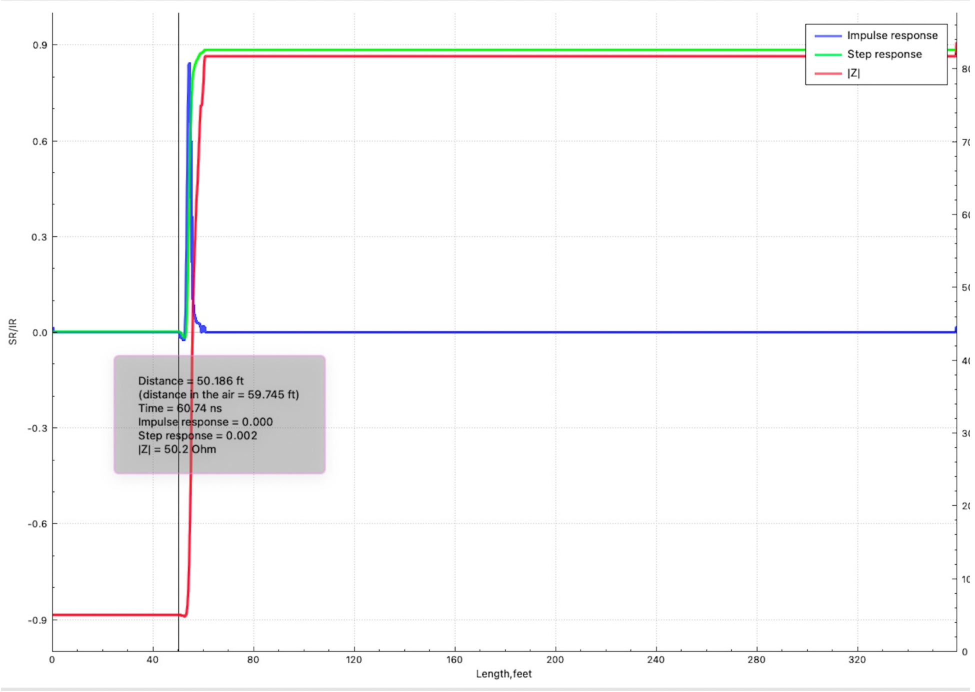
146.52 RG400 ≈ 1 λ



146.52 LMR 400 50ft



TDR LMR 400 50ft



Make Informed Decisions!

Analyzing an Antenna – Some Observations

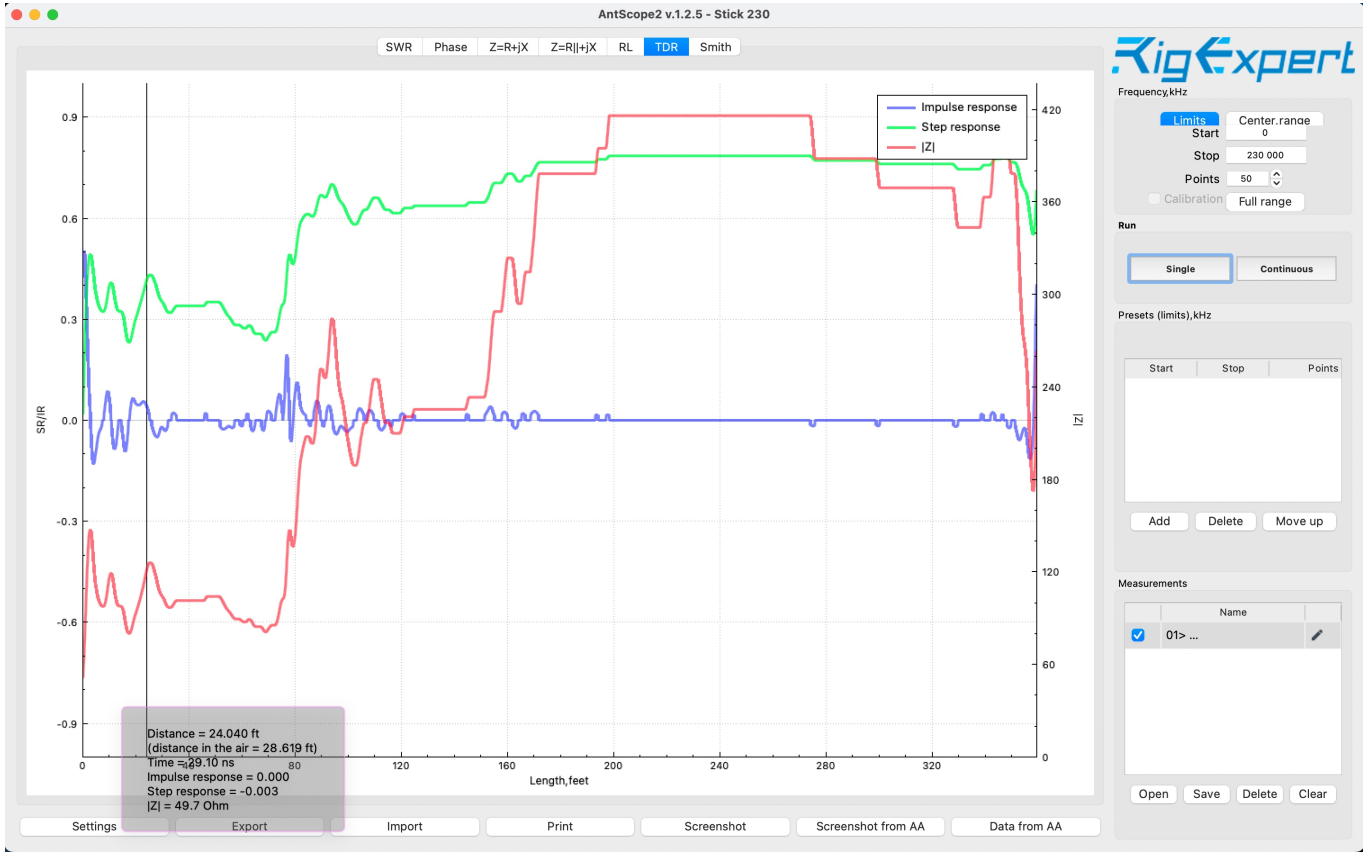
- VSWR is for the health of the Transmitter.
- VSWR is close but not Exactly Resonance in all cases.
- Resonance is good
- All Antennas can send and Receive
- All Antennas have Resistance, Inductance & Capacitance
- Antennas can bite at their ends.
- The Average person uses over 10 Antennas / Day
- Maxwell was a cool dude right there with Einstein, Newton….
  - Unified Faraday, Gauss, Ampere, Ohm
  - Alternating Electric Fields create Alternating Magnetic Fields
  - There is no Magnetic Monopole

Questions & Comments

- Thank you for your Time!
- Walt thank you!
- WCARA thank you!

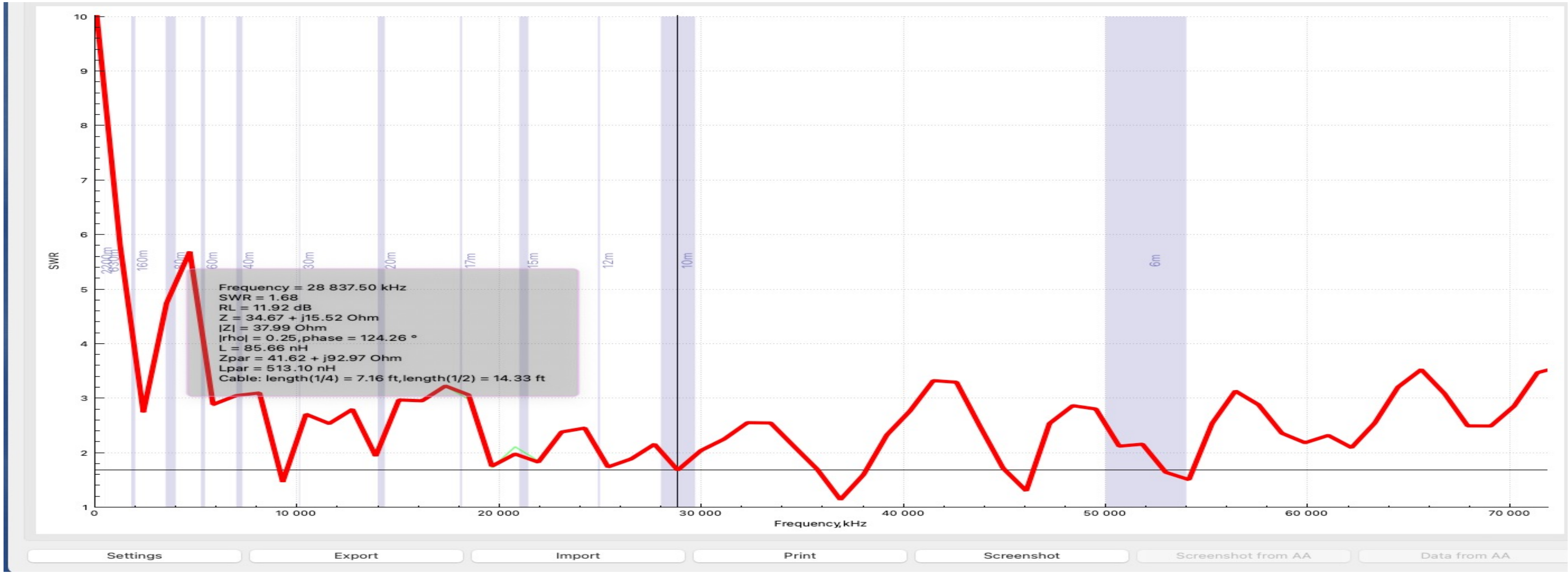
Additional Scans

- Walt's Defective Cable



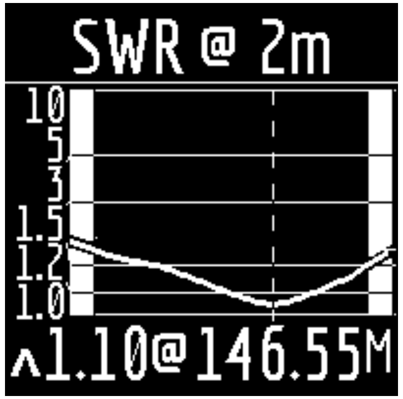
Additional Scans

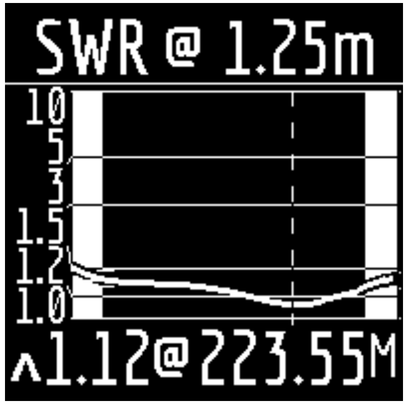
- Stephens EMCOMM II



Additional Scans

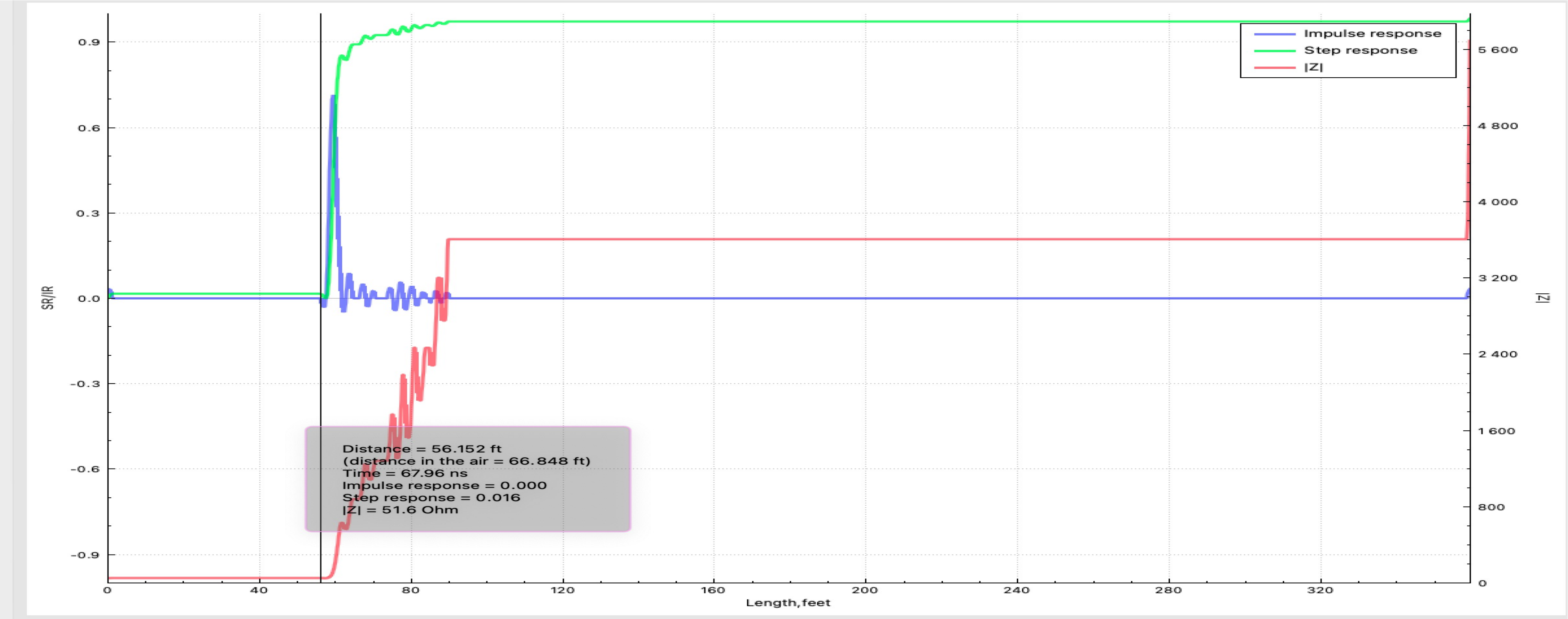
- KE8TEY C*met 2m / 1.25m /70cm Tri-Band





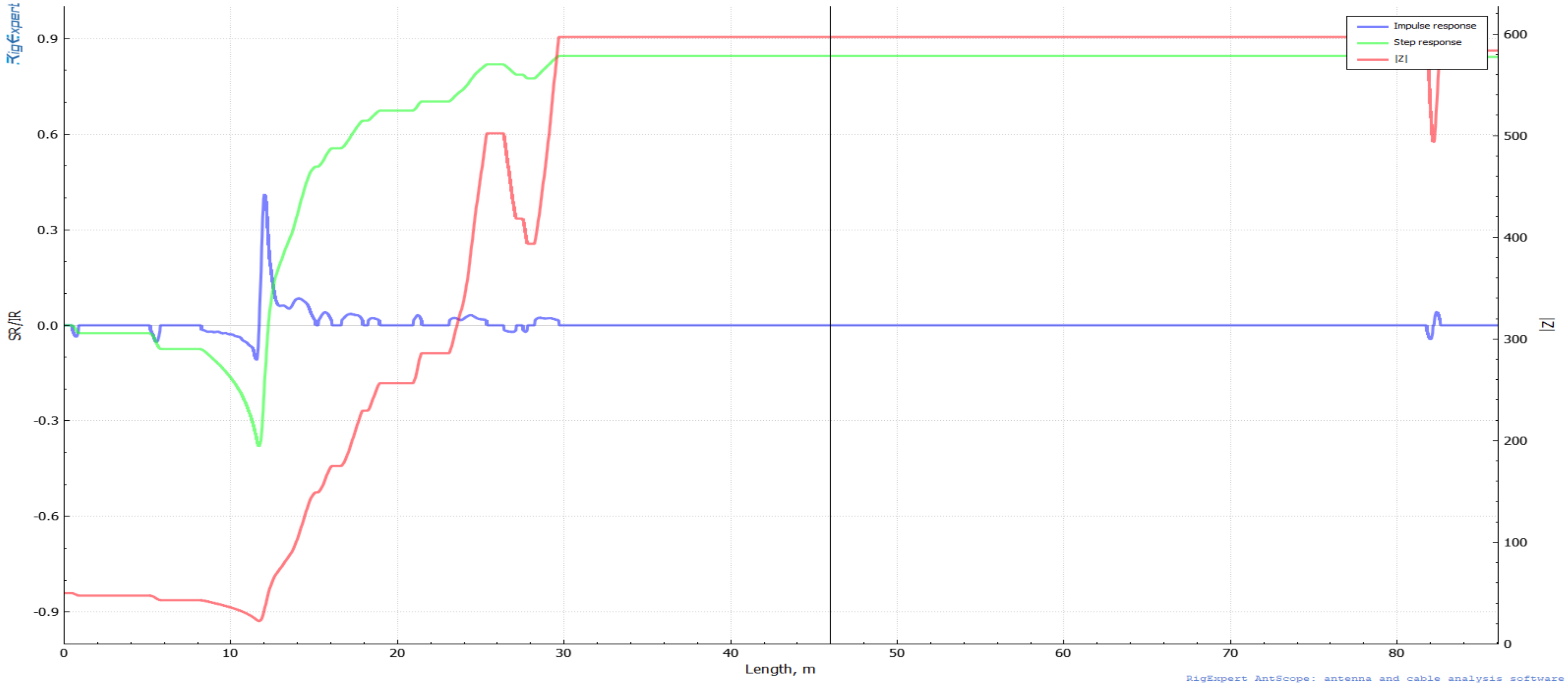
Additional Scans

KE8TEY C*met 2m / 1.25m /70cm Tri-Band TDR Thru Bulkhead



Additional Scans

WC8VOA North Beam Cable Splices



Additional Scans

WC8VOA West Beam