Field Day Antennas and Setup for ARA

2020

The Context for ARA Field Day Antennas

- The ARA club operates with up to 10 simultaneous rigs
  - 4 or 5 HF phone rigs
  - Digital rig (all 5 FD HF bands)
  - CW rig (all 5 FD HF bands)
  - 6 and 2 meters VHF rigs
  - GOTA rig
- The ARA FD site in Leitersburg Park
  - Maximum antenna spacing is in the 800 to 1000 feet range, but useful spacing is less due to sloping ground and concentration of rigs at the pavilion
  - Width of site is limited by construction in 2020 and by large new building in the future
- Inter-station interference has been significant in past years
  - CW interference into digital and phone operations has dominated problems due to full 100 watts of TX power with ON/OFF operation and due to activity
  - Interference has been an issue even between different operating bands
  - Other types of interference are believed to also be significant

Solutions for 2020 Field Day for Interference

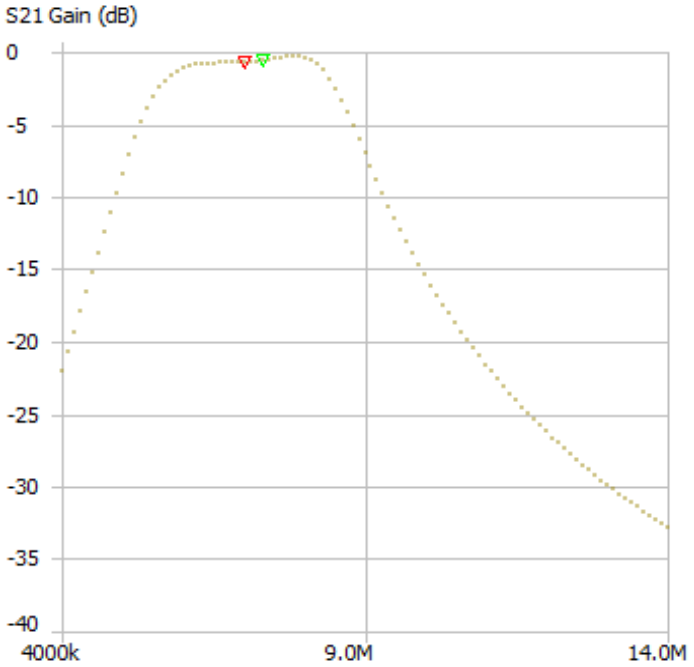
- Bandpass filters for each HF band
  - Needs to be applied to all HF operations
  - Address TX inter-band emissions (noise, harmonics…)
  - Address RX front end overload
  - 3x 80/40/20/15/10 meters bandpass filters now built/tuned/tested (15 total)
- Use 3 polarities to null antenna coupling between phone, digital and CW antenna clusters
  - East-west inverted vees for phone 80/40/20 meters
  - North-south trap dipole for digital 80/40/20/15/10 meters
  - Verticals for CW- 20/15/10 R5 and 33’ fiberglass ship for 80/40
- Use high performance Triplexer and Bandpass filters to support simultaneous operations on 80/40/20 meters phone with a shared inverted vee
- Test and adjust/tune antennas prior to Field Day
  - Tune for resonance on all bands
  - Adjust inverted vees ends and trap dipole alignment to minimize coupling to the CW verticals
- Plan power distribution and grounding to minimize RF coupling
  - CW station will have independent power (small generator) and grounds
  - Use RF chokes and coils of power cable to mitigate coupling for phone and digital
- Log interference on FD for all setups – Time, band, interference type

Other Rigs and Setups

- Phone for 15 and 10 meters and GOTA
  - Use bandpass filters
  - Use antennas near the pavilion & rigs
  - Verticals like buddipoles but preferably rotatable dipoles or loop antennas to null interference
- 6 meters and 2 meters
  - Rely on rigs internal filters
  - Use horizontal beams near pavilion or near the basketball court

Bandpass Filters

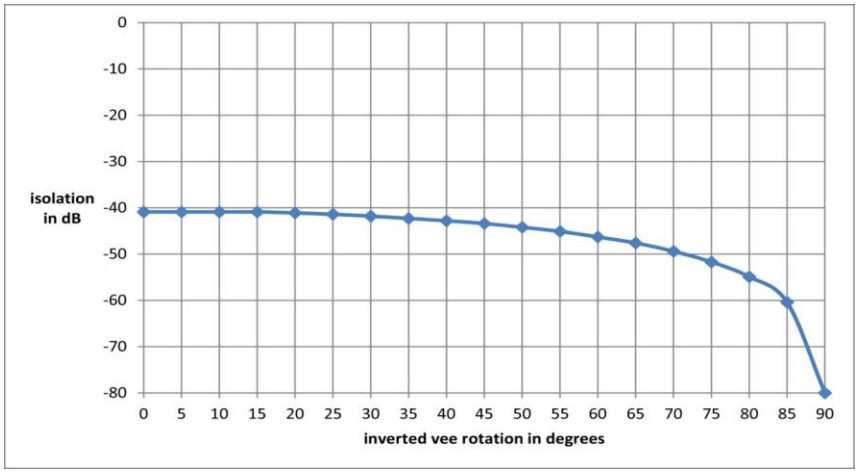
3 section bandpass filter



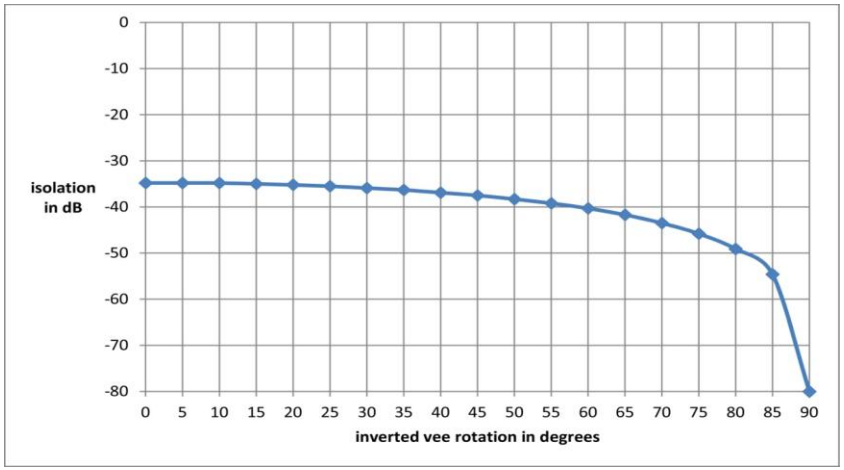
40 meters filter response

- Filters measured/tuned with a NanoVNA
- About 0.5 dB loss in the operating band
- About 30 dB of rejection of adjacent bands for 80/40/20 meters
- About 15 dB of rejection of adjacent bands for 20/15/10 meters

Antenna Orientation for Isolation



Inverted Vee to Inverted Vee (similar for dipoles) on 40 meters spaced 300 feet EZNEC simulation

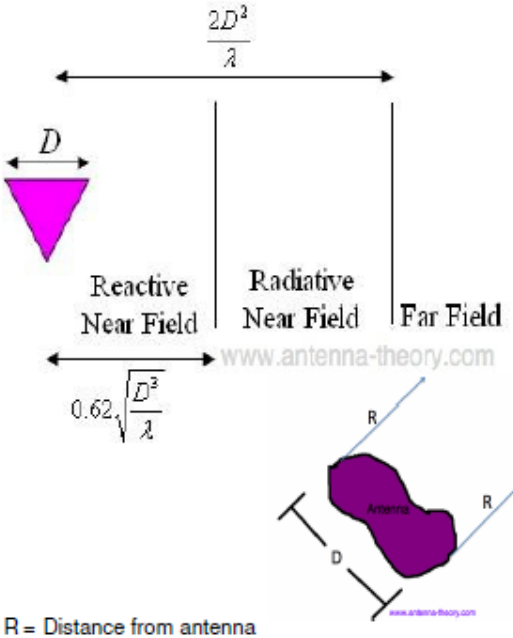


Vertical to Inverted Vee on 40 meters spaced 300 feet EZNEC simulation

- Possible to achieve isolation for 3 clusters using polarization
- 50 to 70 dB of isolation is practical
    - Open field or nearly open is necessary
    - Adjustments are needed due to uneven ground and reflections
- Dipole tilting can cancel ground path reflection coupling for the vertical to dipole or inverted vee that is oriented off the end

Near/Far Field Distances

Antenna clusters should be in each other's far field to have well formed radiative patterns and negligible induction field coupling



Field Strength Calcs

f	λ	RNF a	(D≤ λ/2) a	FF b
MHz	m	ft	ft	ft
3.5	85.7	61.6	44.7	140.6
7	42.9	30.8	22.4	70.3
14	21.4	15.4	11.2	35.2
21	14.3	10.3	7.5	23.4
28	10.7	7.7	5.6	17.6
50	6.0	4.3	3.1	9.8
144	2.1	1.5	1.1	3.4

Reactive Near Field (0<R<a):
Non-Radiating Induction fields dominate

Radiating Near Field (Fresnel Zone) (a<R<b):
Induction fields die off; Radiating Fields begin to emerge
Radiation pattern shape may vary appreciably w/ distance

Far Field (Fraunhofer Zone) (b<R):
Dominated by Radiating Fields
Final radiation pattern is formed & does not change shape with distance.
Fields die off as 1/R; power density dies off as 1/R^2

R = Distance from antenna
D = Largest antenna dimension

APPROXIMATIONS:

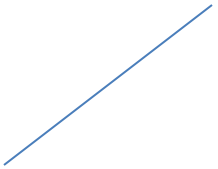
a = Distance to Reactive / Radiating Near Field transition. a = 0.62 (D^3)/λ
For "short" antennas (D≤ λ/2), a = λ/2π = 0.159λ
b = Distance to Radiating Near Field / Far Field Transition. b = 2(D^2)/λ

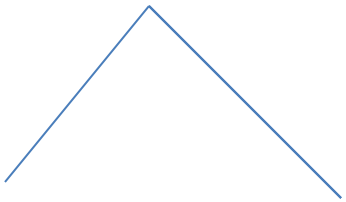
REFERENCES:

http://www.antenna-theory.com/basics/fieldRegions.php
https://en.wikipedia.org/wiki/Near_and_far_field

Three Antenna Clusters for HF Bands with Polarization Isolation

Digital 80/40/20/15/10
Trap dipole





80/40/20 fan
Phone inverted vee

80/40 33’ whip
20/15/10 R5
Verticals for **CW**

ARA FD antenna
2020 FD

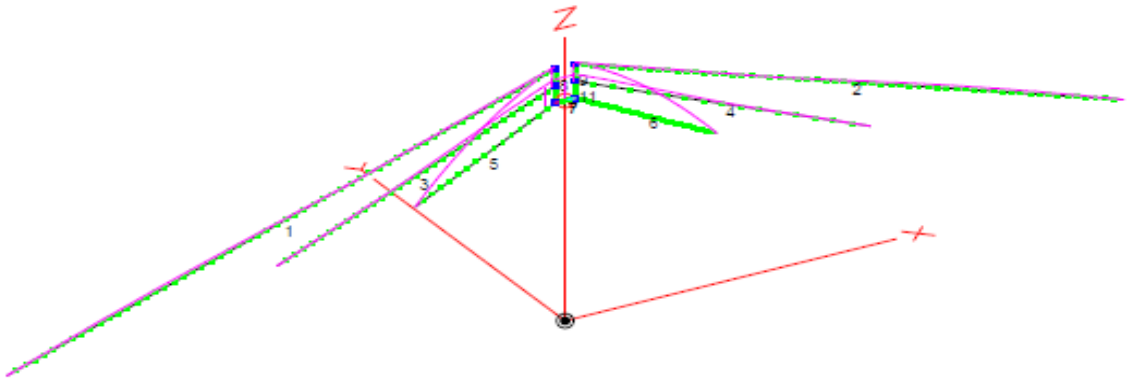
Antenna Layout for Field Day

Span of about 500 feet over the 3 antenna clusters ensures that far fields dominate

Trap Dipole 80/40/20/15/10

Inverted Vee 80/40/20

EZNEC



80 40 20 Fan Inverted Vee

Inverted Vee Collapsed

R5 Vertical For 20/15/10

80/40 Meters Vertical with 33 Foot Fiberglass Pole & Impedance Match Box

Pre-Field Day Measurements and Findings

- The 3 Antenna Clusters were setup in a 500 feet line in a farm field in April 2020
- Isolations of about 60 dB from the verticals to the trap dipole on 80/40 and near 70 dB on 20/15/10 were measured
- Isolations of 52 to 55 dB from the verticals to the inverted vees which was improved to near 70 dB for 80/40/20 by adjusting inverted vee end points
- Isolations of about 55 dB from the trap dipole to the inverted vees
- 100 watt CW interference was imperceptible with around 70 dB of isolation and > 50 KHz offset in frequency – limited by TX broadband amplifier noise
- For isolations near 60 dB, disabling RX preamps reduces 100 watt CW interference to nearly imperceptible
- Digital and phone interference is expected to be less problematic than CW interference due to average lower power and lack of sharp ON/OFF transitions
- Expect negligible interference issues between bands assuming bandpass filters and the isolation provided by polarized antennas
- Expect limited problems with interference when operating in the same bands, but disabling preamps, adding front end attenuation or reducing TX power may be used to help if significant interference happens

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