# 4SQ (Four Square) twisted pair  Rx Array revisited

***Plug and play for 160m + 80m in single box***

- Design dedicated to common-noise reduction — interconnected transmission lines are twisted pairs.
  100 Ω baluns with **CMMR suppression >55 dB** (no external ferrite-based common-noise suppressors required).
  Designed for the needs of OM0R superstation; QTH at 1000 m ASL (MW IMD becomes very significant).

- **Eight directions** to fill gaps between diagonal headings: 4 diagonal + 4 perpendicular.
  Ready for 160 m or 80 m reversible BSEF array (ideal for major DX headings: USA, JA, EU). RDF >13 dB using the same controller.

- Embedded phasing arrangement — no external phasing (delay) lines required (plug-and-play).
  Embedded BPF for 160 m and 80 m (reduces massive MW broadcast).
  Embedded 15 dB LNA with OIP3 >50 dBm and NF <3 dB.
-
  **Embedded MicroHAM RS-485** — compatible with MicroHAM ARCO/TRIO;

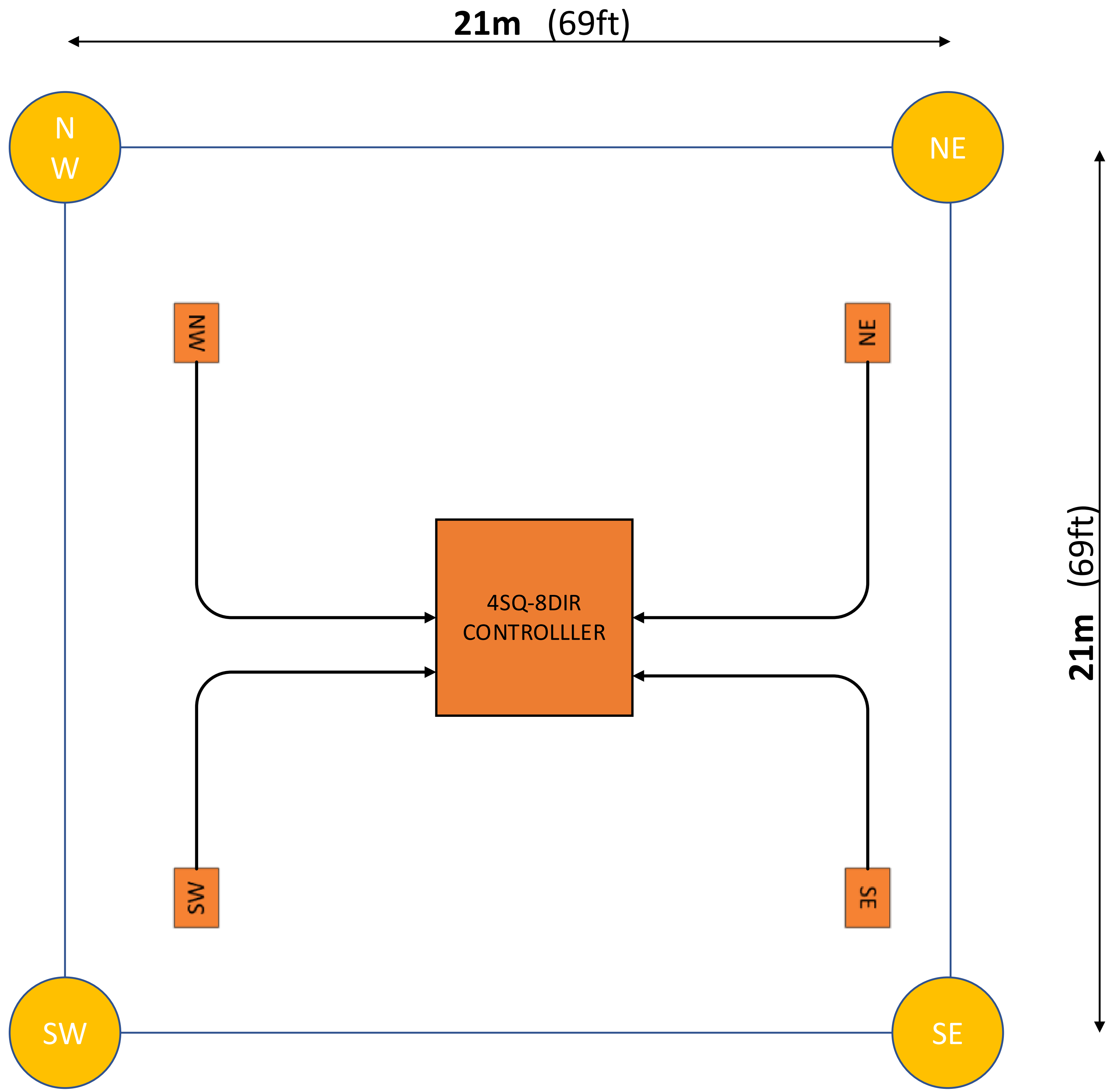
  **Supports remote operation via MicroHAM VNC**.

- Embedded BCD decoder — 3-wire switching-matrix control.
  Embedded RS-485 requires only 2 wires (controls 8 directions and LNA ON/OFF).
  Control wires extensively filtered for optimal CMMR.

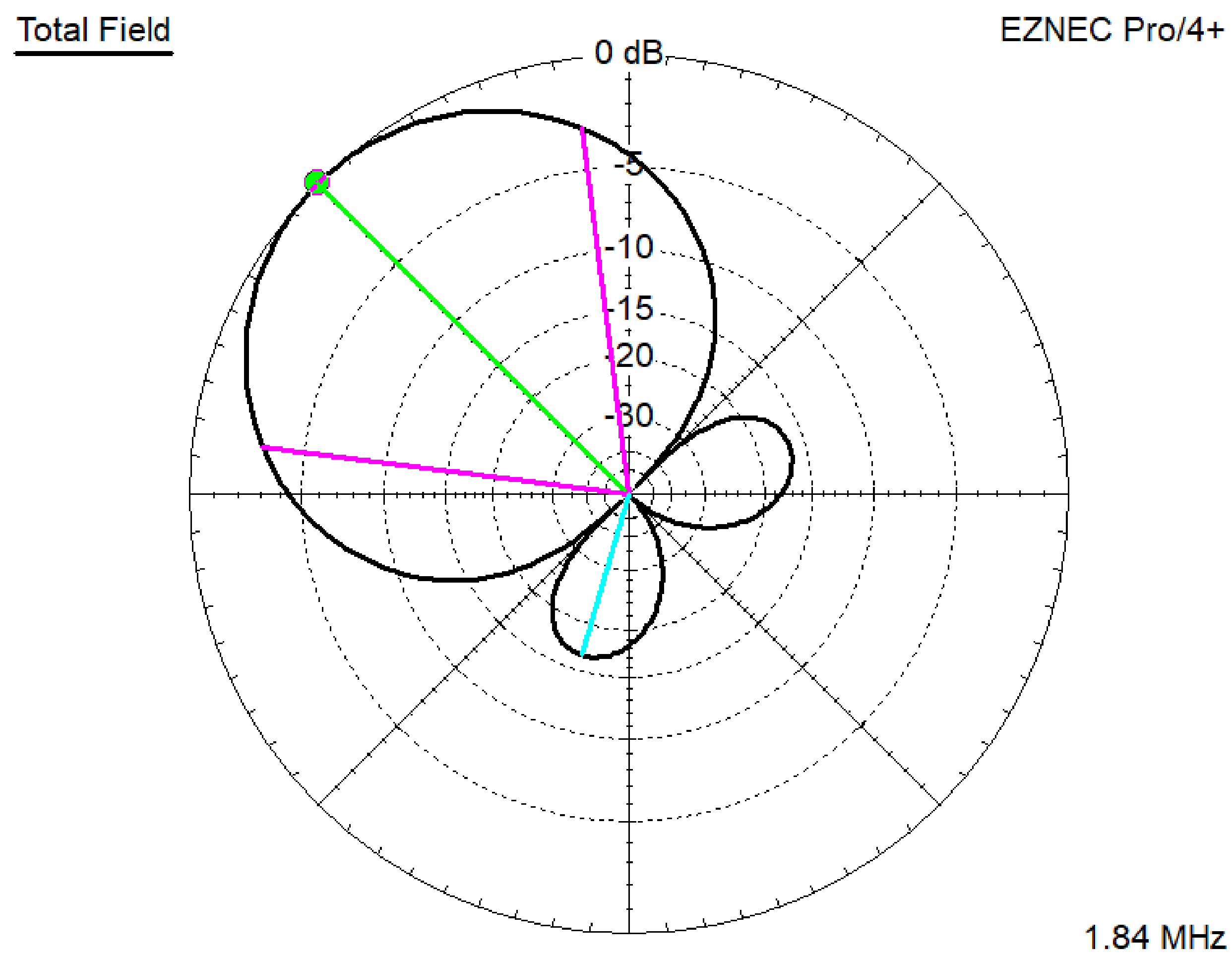
- ABS-insulated enclosure to keep grounds floating.
  High-grade industrial connectors for enhanced reliability.
  Differential transimpedance LNA with 6 m high mini-verticals (no radials needed).
  Transimpedance LNA with separate RX and separate DC paths.

# Optimized differential RX 4SQ array

**21x21m footprint for 160m/80m with RDF 11.95dB**



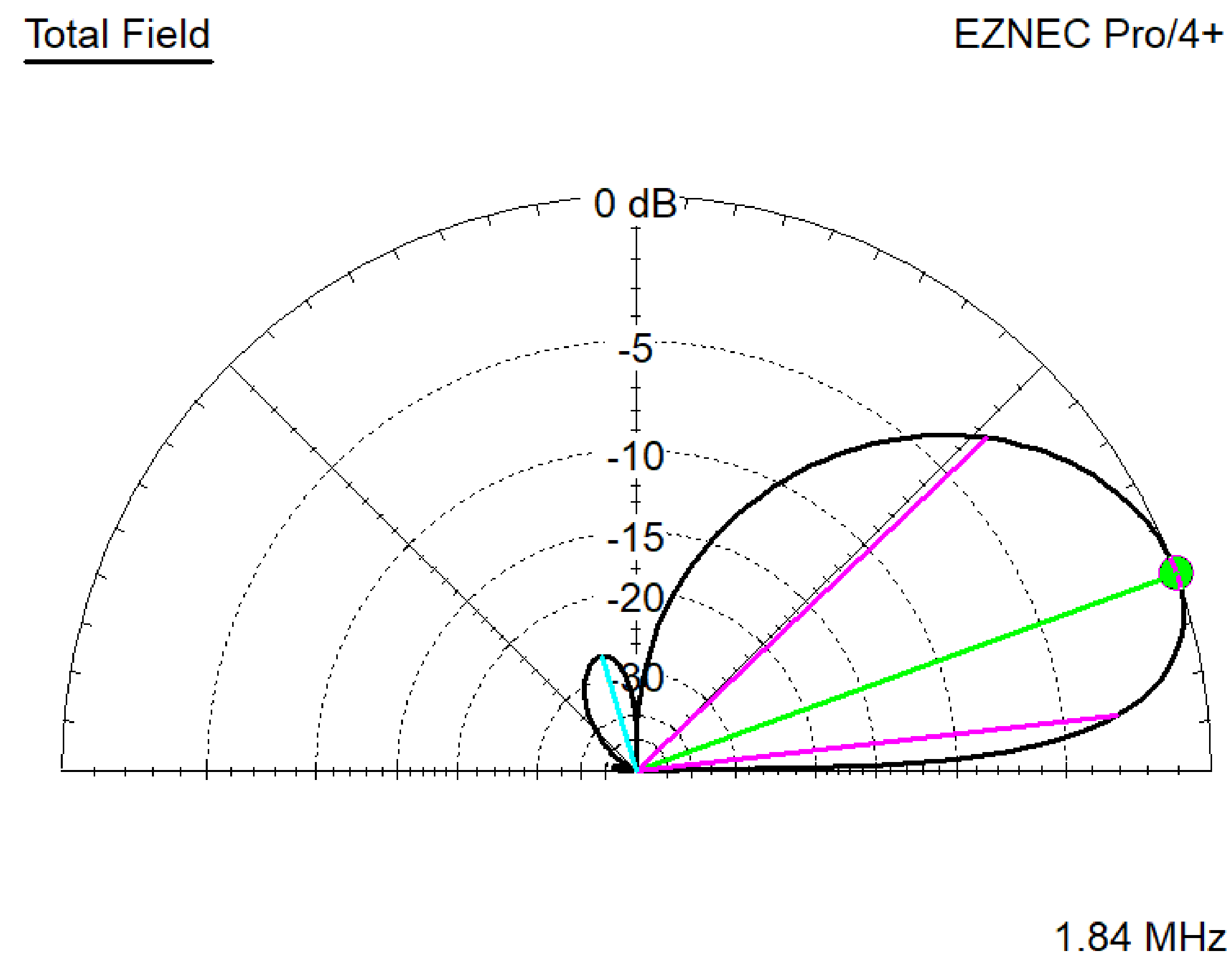
# 21x21m on 160m  RDF  11.95dB




Azimuth Plot
Elevation Angle 20.0 deg.
Outer Ring -11.62 dBi

Slice Max Gain -11.62 dBi @ Az Angle = 135.0 deg.
Front/Back 68.81 dB
Beamwidth 75.4 deg.; -3dB @ 97.3, 172.7 deg.
Sidelobe Gain -28.14 dBi @ Az Angle = 254.0 deg.
Front/Sidelobe 16.52 dB

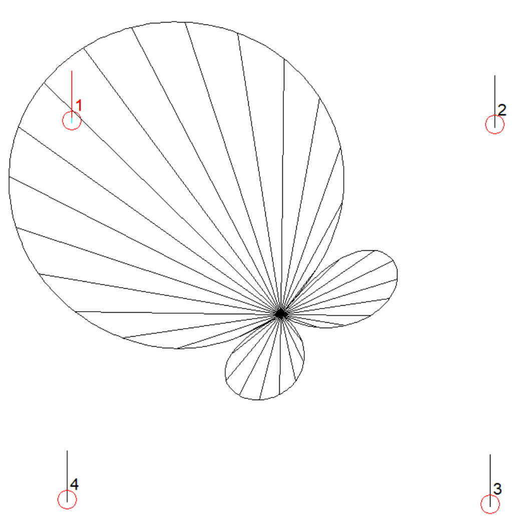
Cursor Az 135.0 deg.
Gain -11.62 dBi
0.0 dBmax




Elevation Plot
Azimuth Angle 135.0 deg.
Outer Ring -11.62 dBi

Slice Max Gain -11.62 dBi @ Elev Angle = 20.0 deg.
Beamwidth 37.1 deg.; -3dB @ 6.5, 43.6 deg.
Sidelobe Gain -38.58 dBi @ Elev Angle = 107.0 deg.
Front/Sidelobe 26.96 dB

Cursor Elev 20.0 deg.
Gain -11.62 dBi
0.0 dBmax

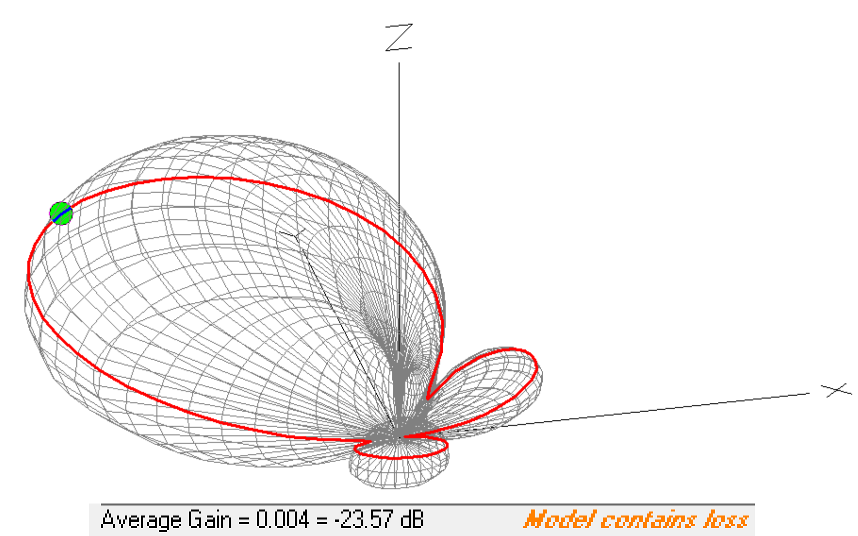



Sources

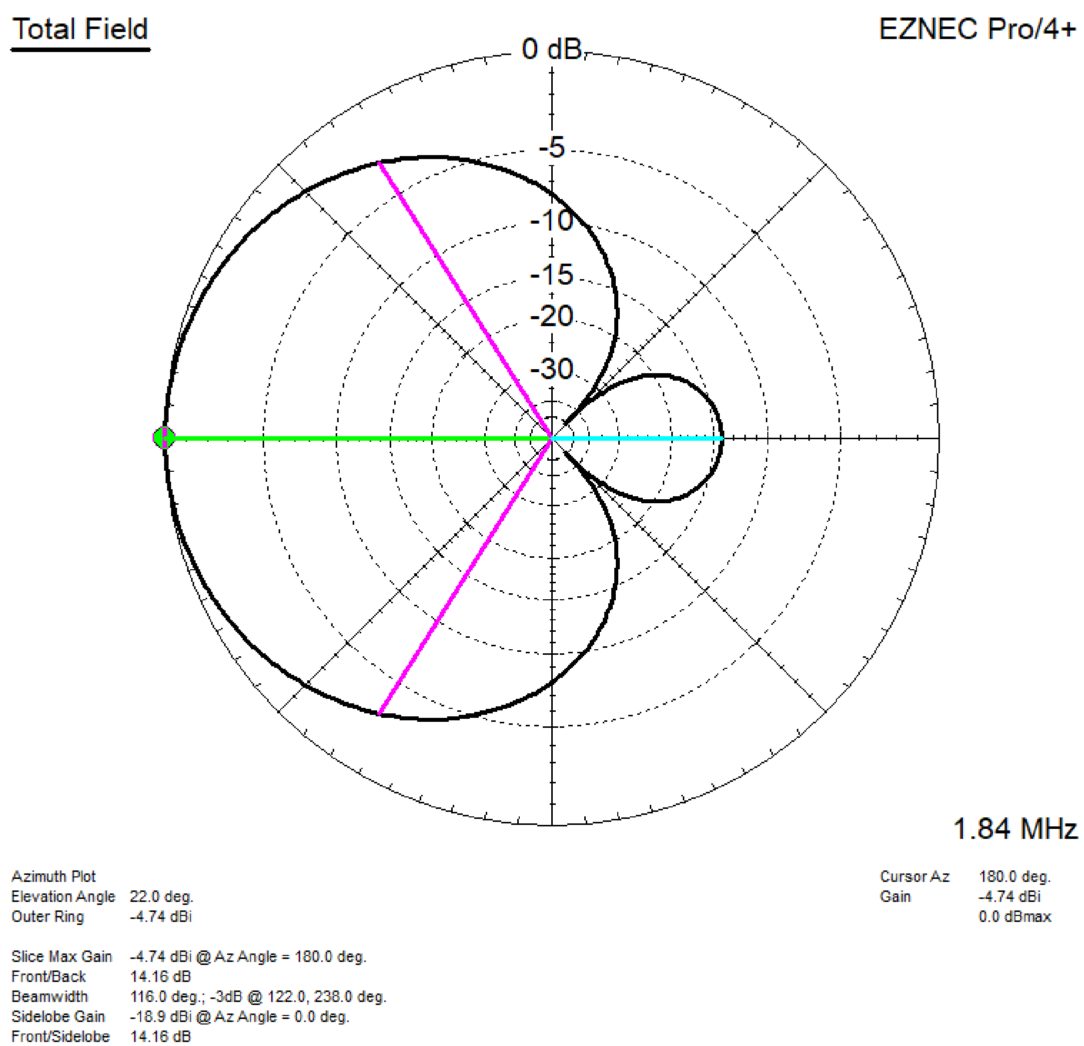
Source Edit Other

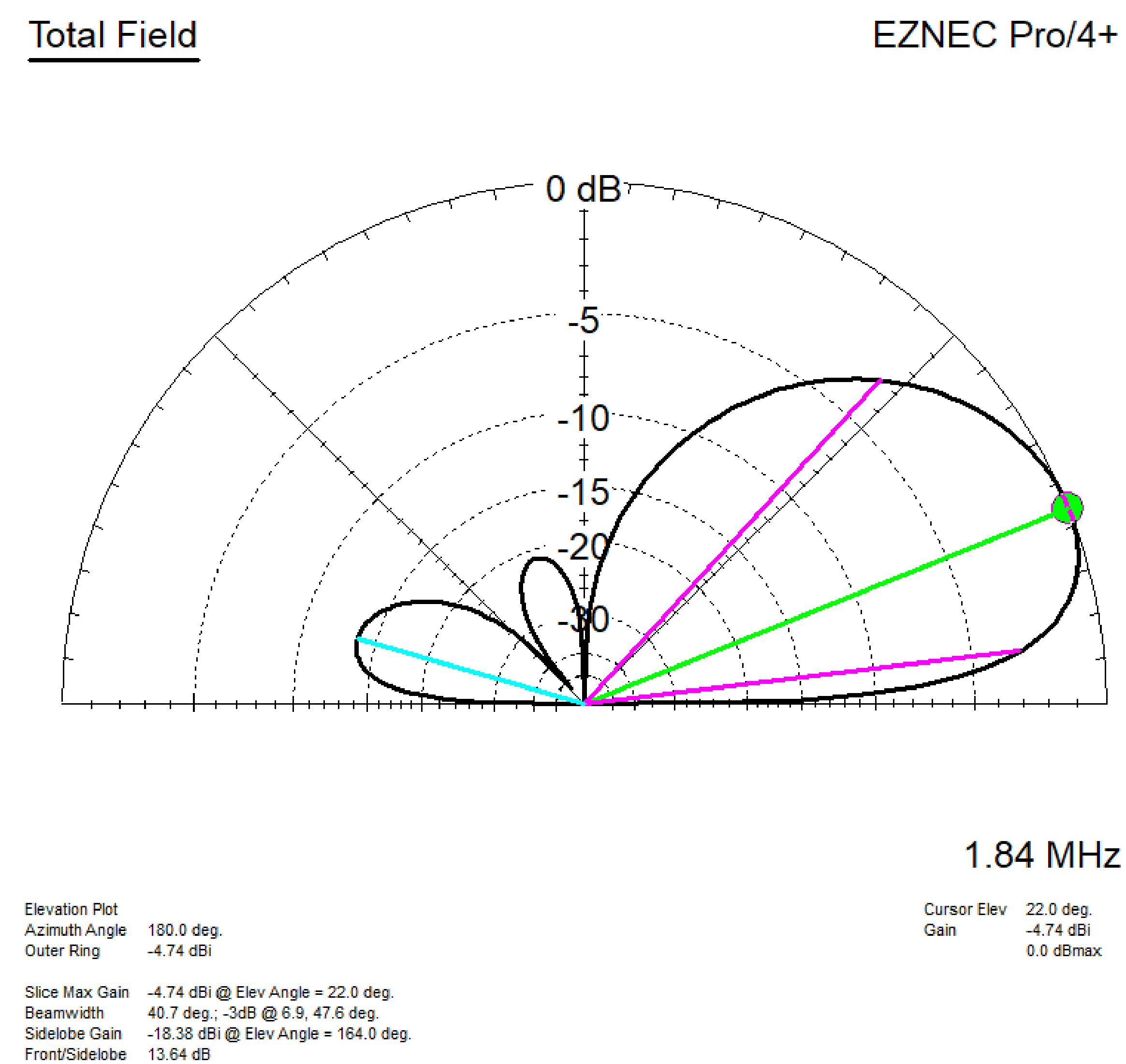
Sources

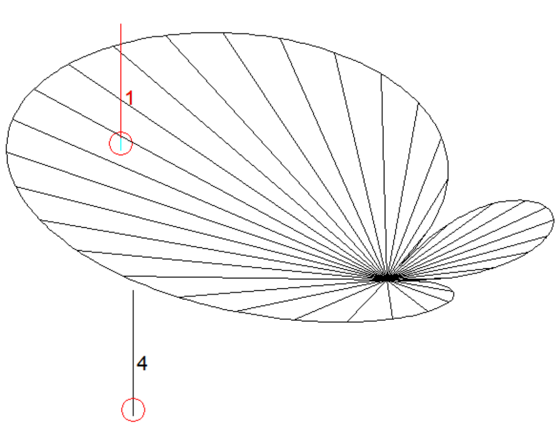
| No. | Specified Pos. Wire # | Specified Pos. % From E1 | Actual Pos. % From E1 | Actual Pos. Seg | Amplitude (V, A) | Phase (deg.) | Type |
|---|---|---|---|---|---|---|---|
| 1 | 2 | 0 | 5 | 1 | 1 | 150 | I |
| 2 | 1 | 0 | 5 | 1 | 1 | 0 | I |
| 3 | 4 | 0 | 5 | 1 | 1 | 150 | I |
| 4 | 3 | 0 | 5 | 1 | 1 | 300 | I |



# 21x21m on 160m  RDF  9.86dB





Sources

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| No. | Specified Pos. Wire # | Specified Pos. % From E1 | Actual Pos. % From E1 | Actual Pos. Seg | Amplitude (V, A) | Phase (deg.) | Type |
|---|---|---|---|---|---|---|---|
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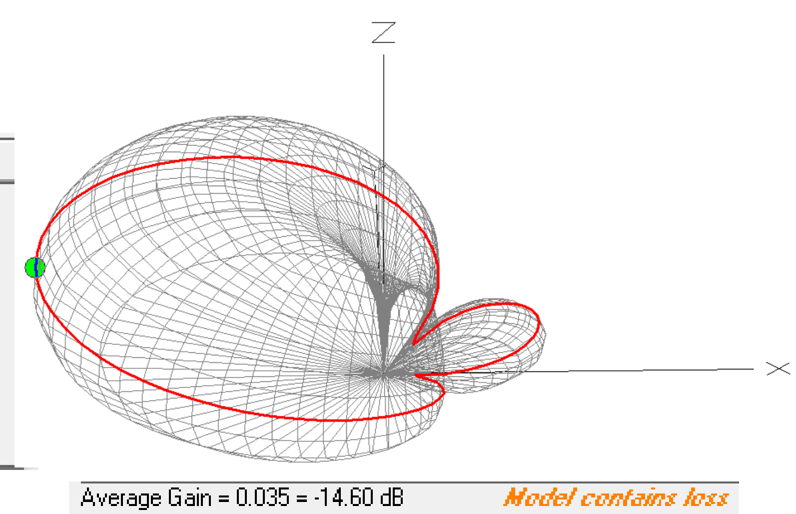
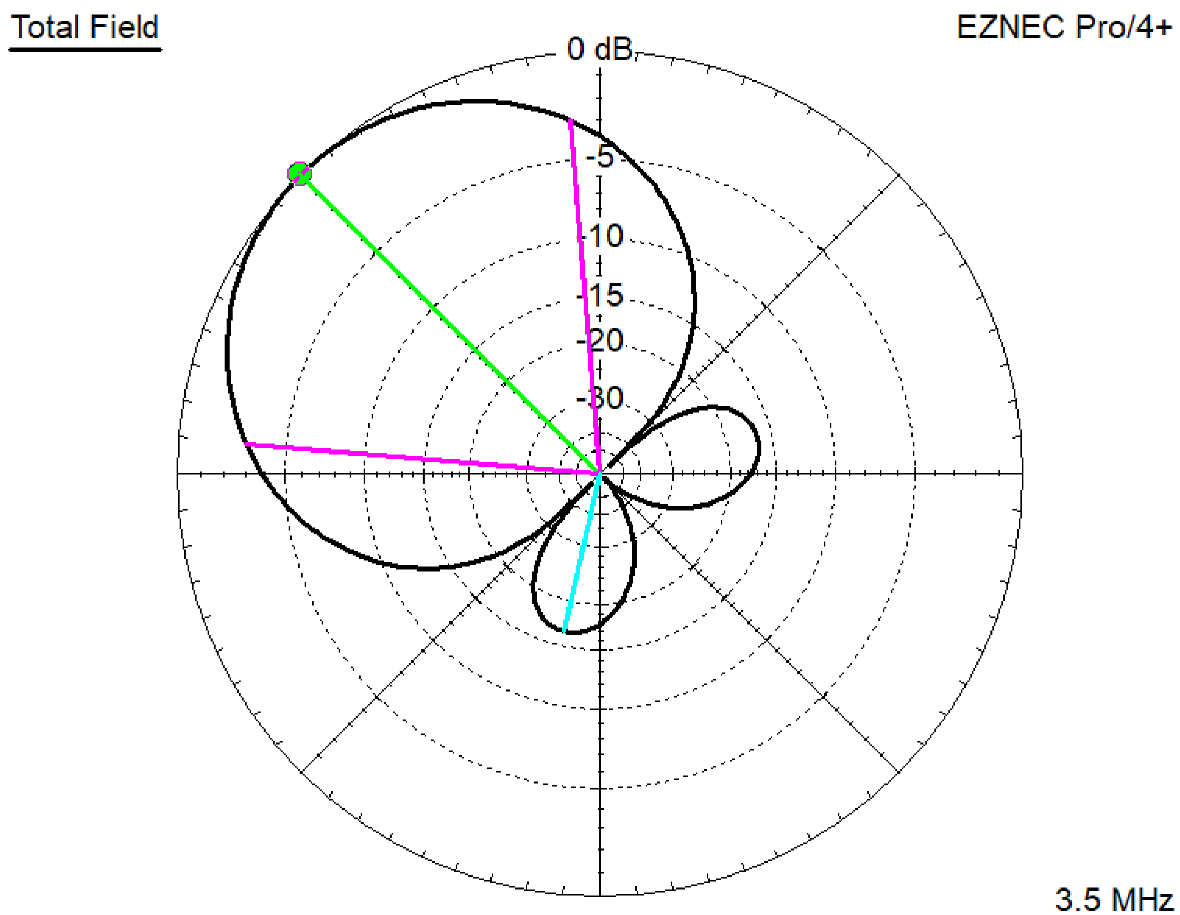
| 2 | 1 | 0 | 5 | 1 | 1 | 0 | I |
| 3 | 4 | 0 | 5 | 1 | 1 | 0 | I |
| 4 | 3 | 0 | 5 | 1 | 1 | 150 | I |



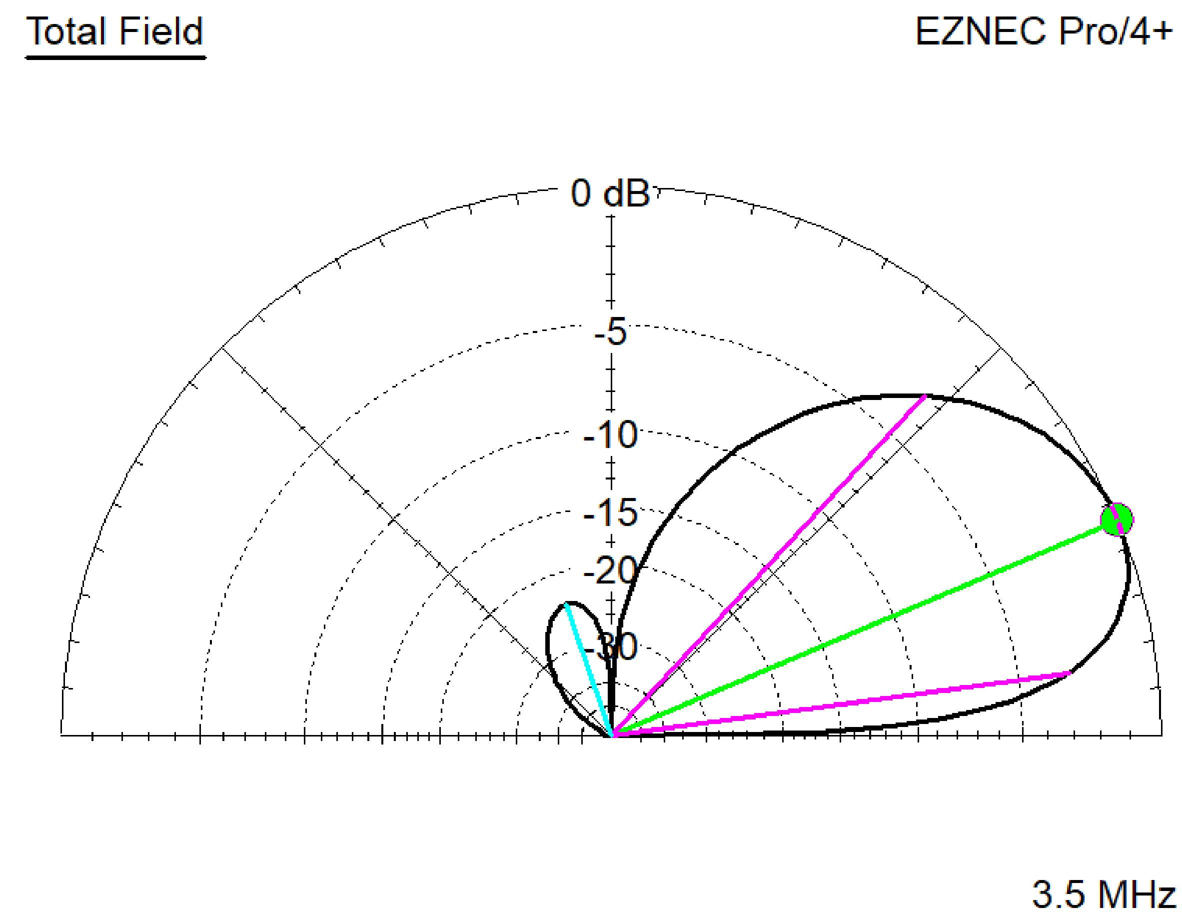
# 21x21m on 80m RDF 11.55dB




Azimuth Plot
Elevation Angle 23.0 deg.
Outer Ring -0.44 dBi

Slice Max Gain -0.44 dBi @ Az Angle = 135.0 deg.
Front/Back 71.93 dB
Beamwidth 80.5 deg.; -3dB @ 94.7, 175.2 deg.
Sidelobe Gain -16.93 dBi @ Az Angle = 257.0 deg.
Front/Sidelobe 16.49 dB

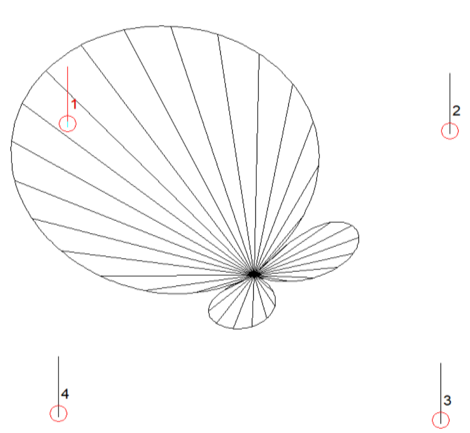
Cursor Az 135.0 deg.
Gain -0.44 dBi
0.0 dBmax




Elevation Plot
Azimuth Angle 135.0 deg.
Outer Ring -0.44 dBi

Slice Max Gain -0.44 dBi @ Elev Angle = 23.0 deg.
Beamwidth 39.6 deg.; -3dB @ 7.8, 47.4 deg.
Sidelobe Gain -24.08 dBi @ Elev Angle = 109.0 deg.
Front/Sidelobe 23.64 dB

Cursor Elev 23.0 deg.
Gain -0.44 dBi
0.0 dBmax




Sources

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| No. | Specified Pos. | | Actual Pos. | | Amplitude | Phase | Type |
|---|---|---|---|---|---|---|---|
| | Wire # | % From E1 | % From E1 | Seg | (V, A) | (deg.) | |
| 1 | 2 | 0 | 5 | 1 | 1 | -240 | I |
| 2 | 1 | 0 | 5 | 1 | 1 | 0 | I |
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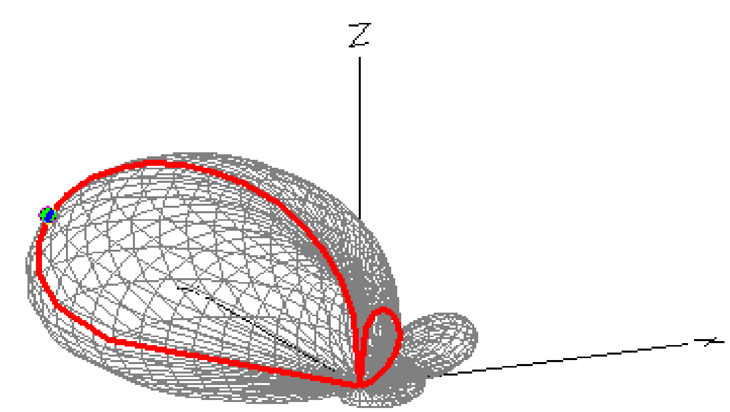
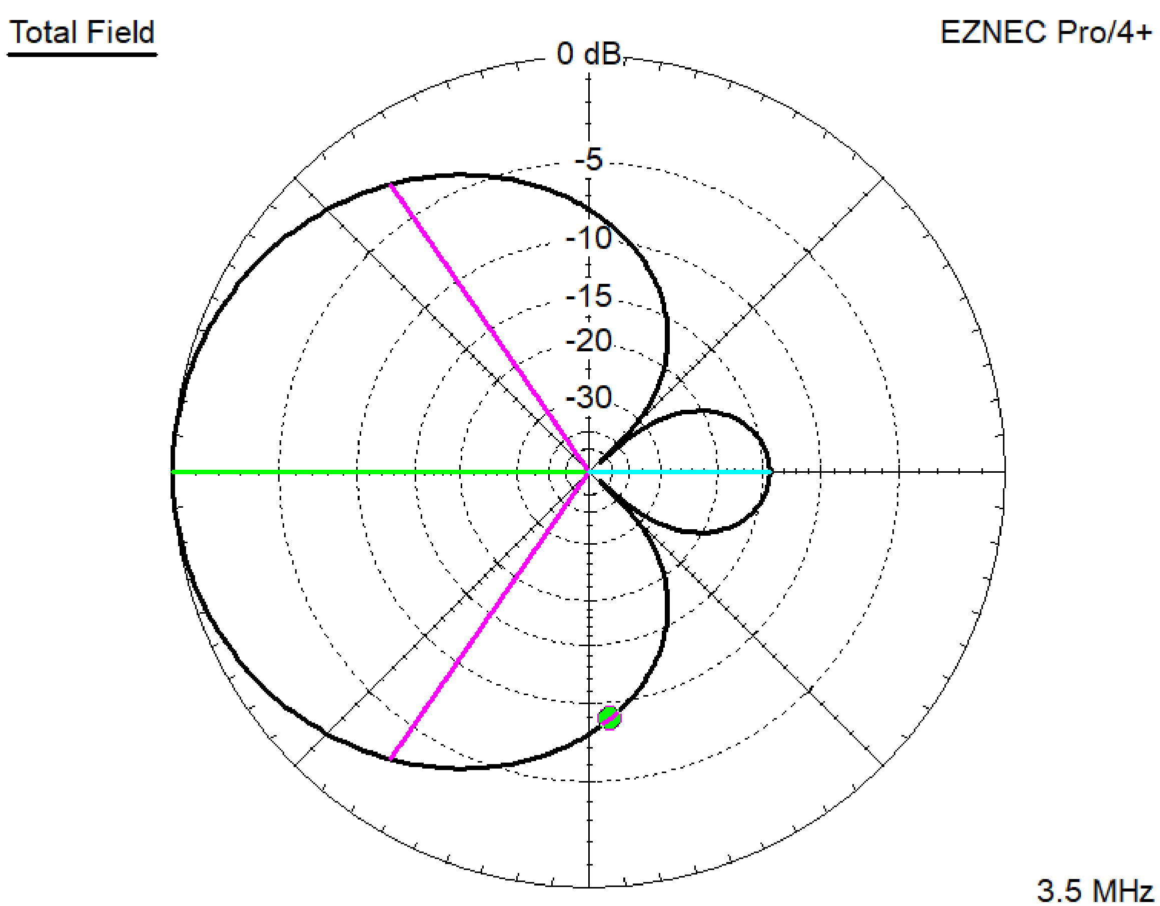
| 4 | 3 | 0 | 5 | 1 | 1 | -120 | I |



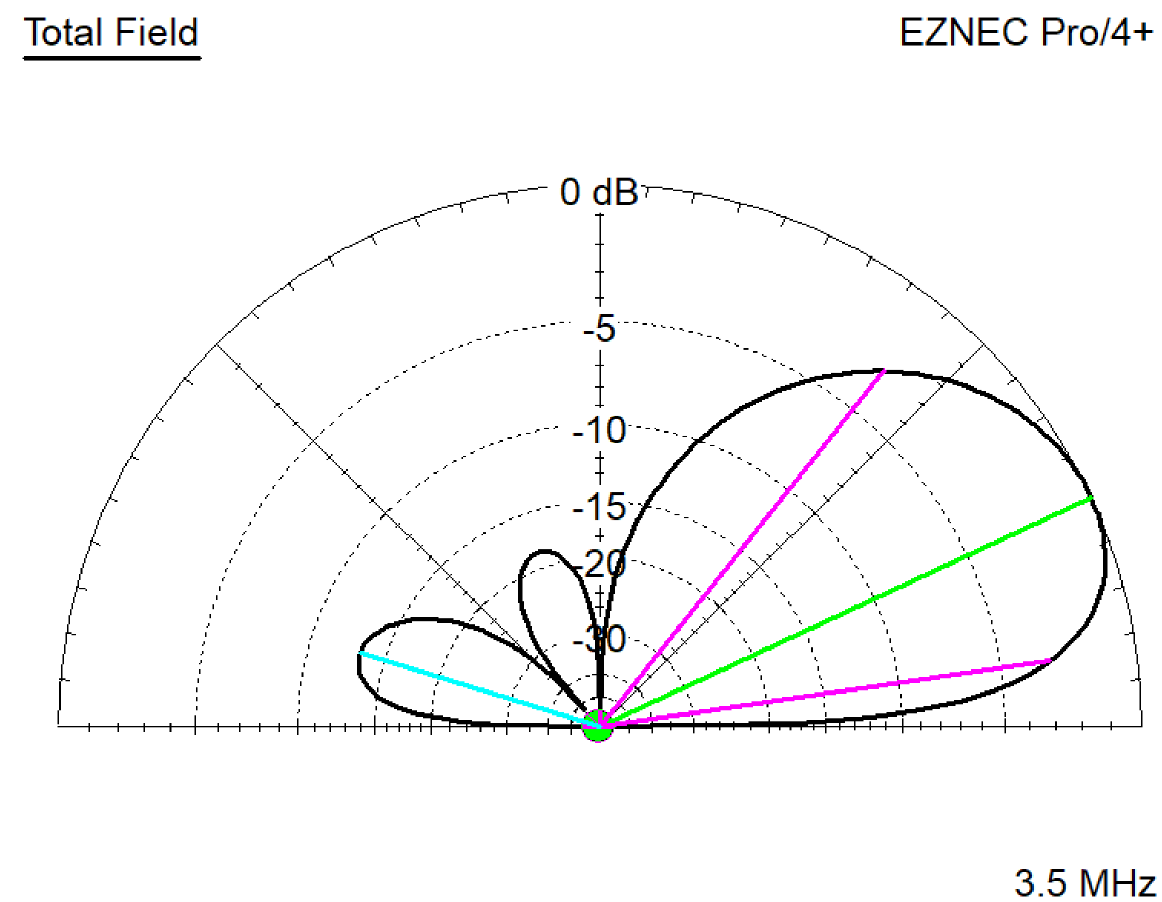
# 21x21m on 80m RDF 9.8dB




Azimuth Plot
Elevation Angle 25.0 deg.
Outer Ring 0.82 dBi

Cursor Az 275.0 deg.
Gain -8.03 dBi
-8.85 dBmax

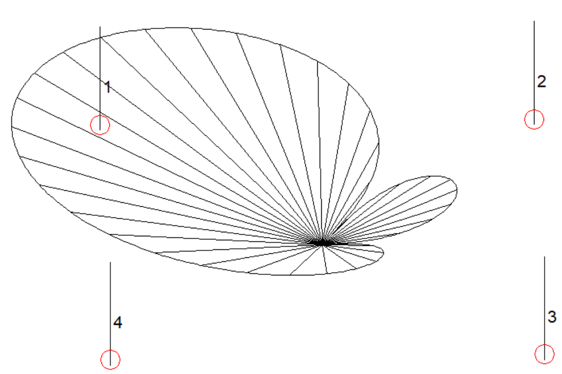
Slice Max Gain 0.82 dBi @ Az Angle = 180.0 deg.
Front/Back 14.31 dB
Beamwidth 111.0 deg.; -3dB @ 124.5, 235.5 deg.
Sidelobe Gain -13.49 dBi @ Az Angle = 0.0 deg.
Front/Sidelobe 14.31 dB




Elevation Plot
Azimuth Angle 180.0 deg.
Outer Ring 0.82 dBi

Cursor Elev 180.0 deg.
Gain -99.99 dBi
-99.99 dBmax

Slice Max Gain 0.82 dBi @ Elev Angle = 25.0 deg.
Beamwidth 43.1 deg.; -3dB @ 8.3, 51.4 deg.
Sidelobe Gain -12.42 dBi @ Elev Angle = 163.0 deg.
Front/Sidelobe 13.24 dB




Sources

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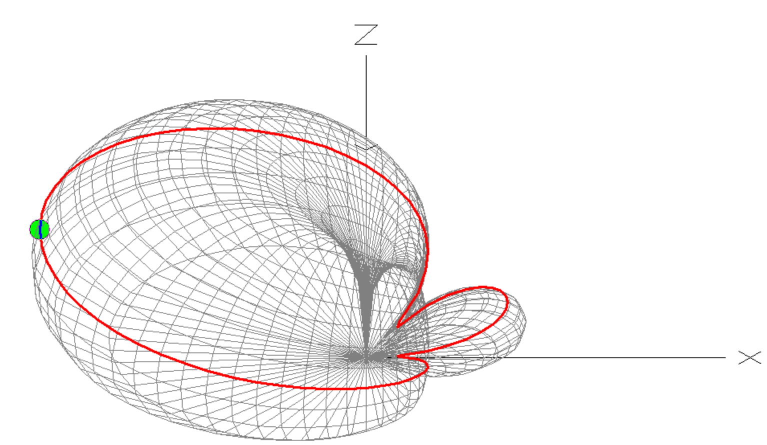
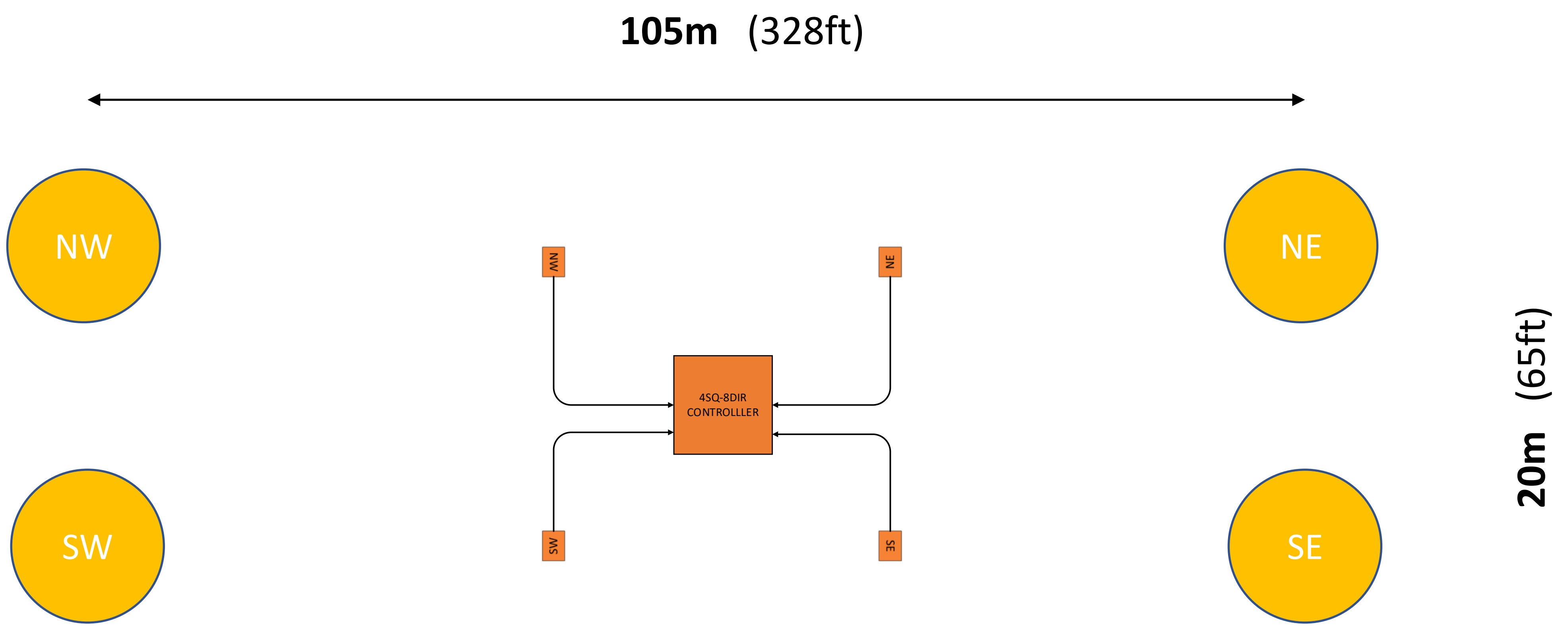
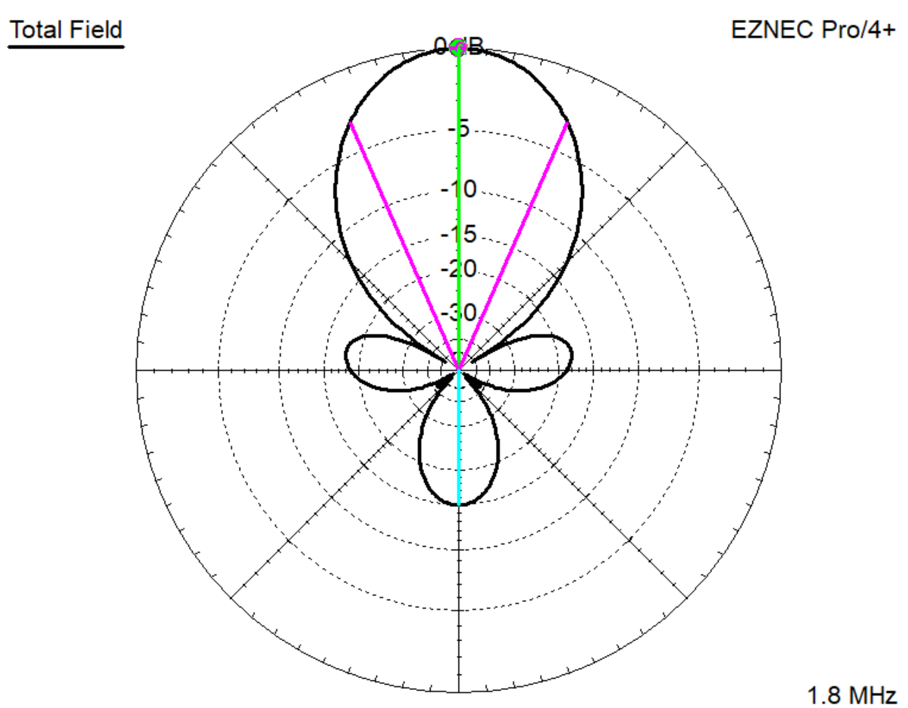
Sources

| No. | Specified Pos. | | Actual Pos. | | Amplitude | Phase | Type |
|---|---|---|---|---|---|---|---|
| | Wire # | % From E1 | % From E1 | Seg | (V, A) | (deg.) | |
| 1 | 2 | 0 | 5 | 1 | 1 | 120 | I |
| 2 | 1 | 0 | 5 | 1 | 1 | 0 | I |
| 3 | 4 | 0 | 5 | 1 | 1 | 0 | I |
| 4 | 3 | 0 | 5 | 1 | 1 | 120 | I |

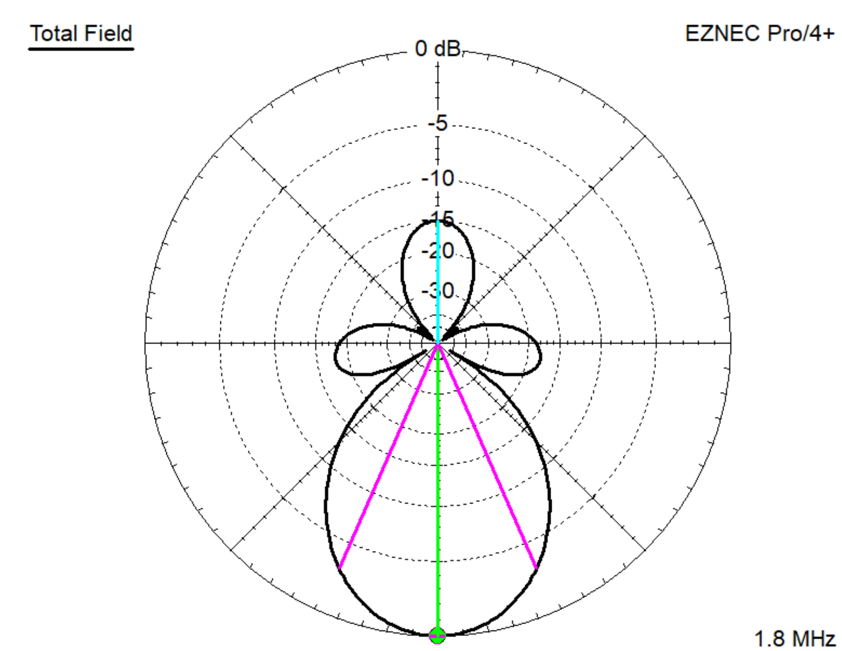


# BSEF (Broad side end fire) 20x105m on 160m RDF 13.22dB

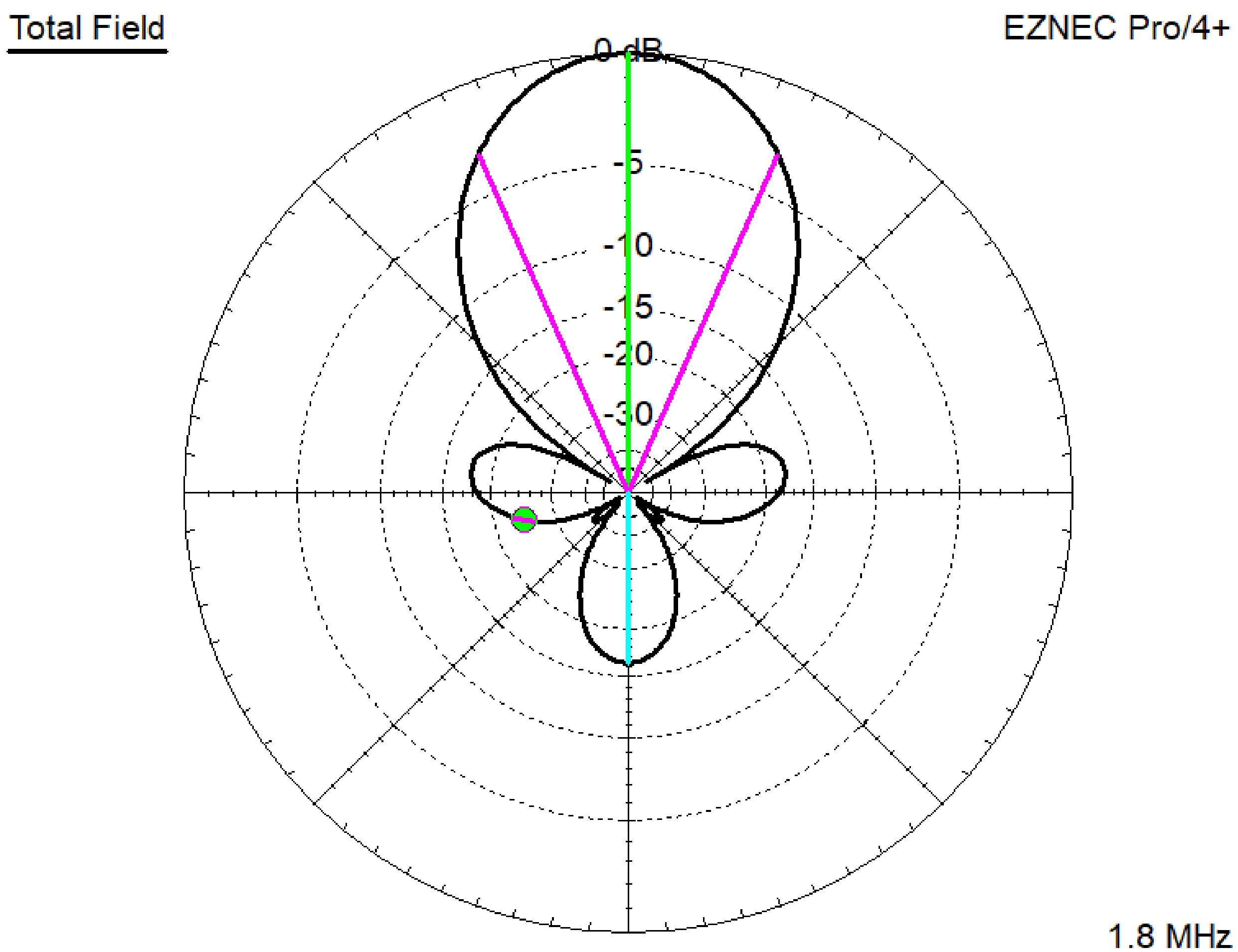



instant reverse



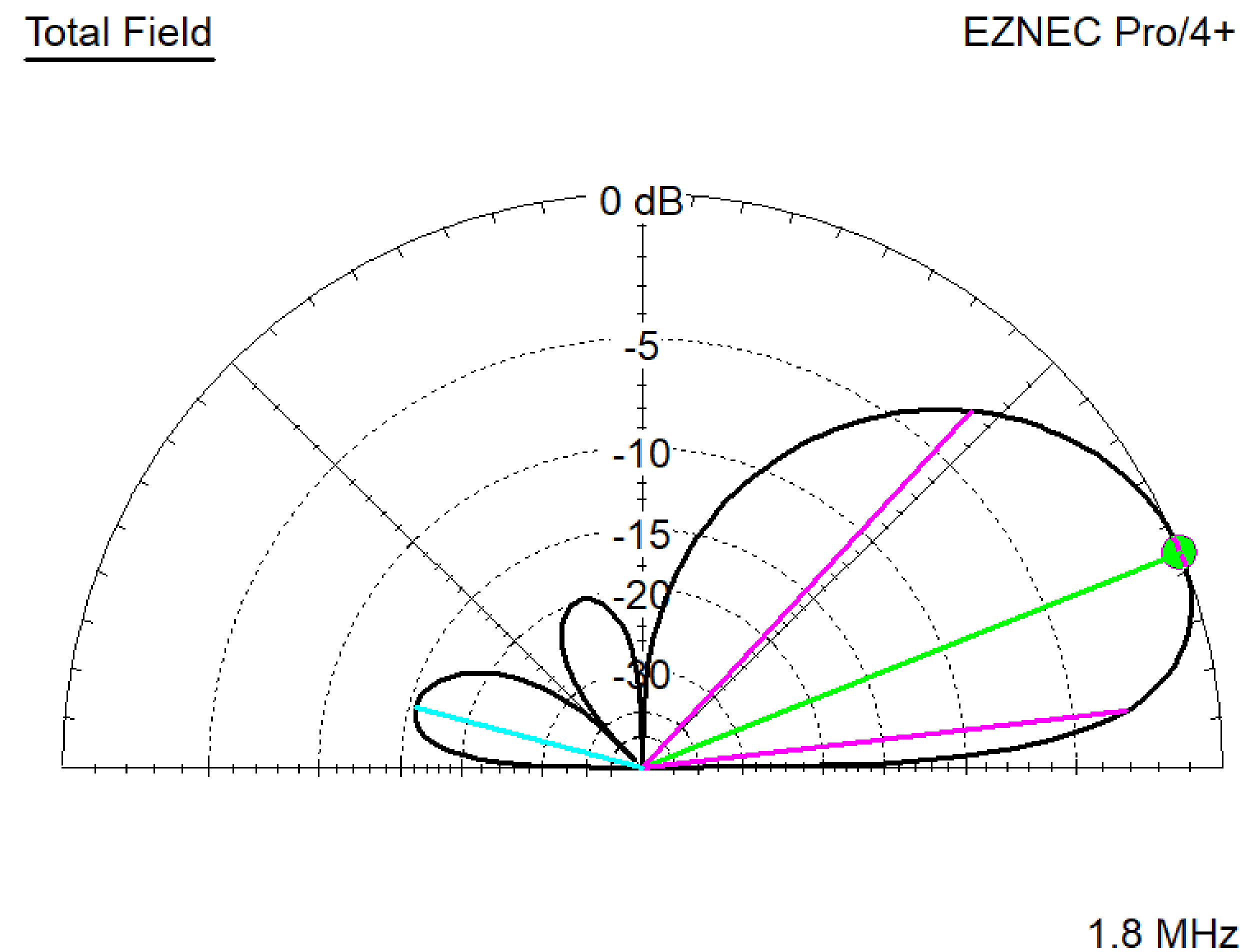
# BSEF (Broad side end fire) 20x105m on 160m RDF 13.22dB




Azimuth Plot
Elevation Angle 22.0 deg.
Outer Ring -8.27 dBi

Slice Max Gain -8.27 dBi @ Az Angle = 90.0 deg.
Front/Back 16.3 dB
Beamwidth 47.4 deg.; -3dB @ 66.3, 113.7 deg.
Sidelobe Gain -24.57 dBi @ Az Angle = 270.0 deg.
Front/Sidelobe 16.3 dB

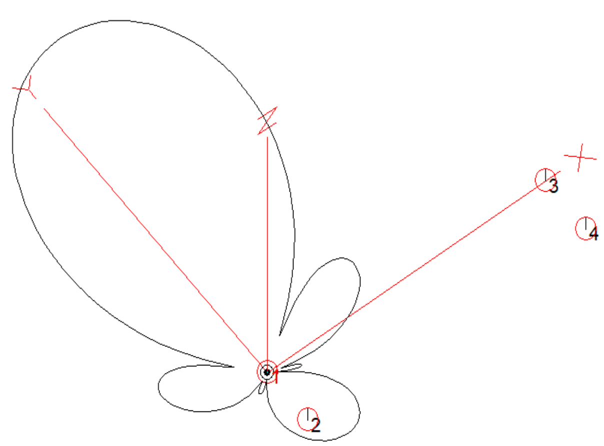
Cursor Az 195.0 deg.
Gain -32.73 dBi
-24.46 dBmax




Elevation Plot
Azimuth Angle 90.0 deg.
Outer Ring -8.27 dBi

Slice Max Gain -8.27 dBi @ Elev Angle = 22.0 deg.
Beamwidth 40.9 deg.; -3dB @ 6.8, 47.7 deg.
Sidelobe Gain -23.81 dBi @ Elev Angle = 165.0 deg.
Front/Sidelobe 15.54 dB

Cursor Elev 22.0 deg.
Gain -8.27 dBi
0.0 dBmax

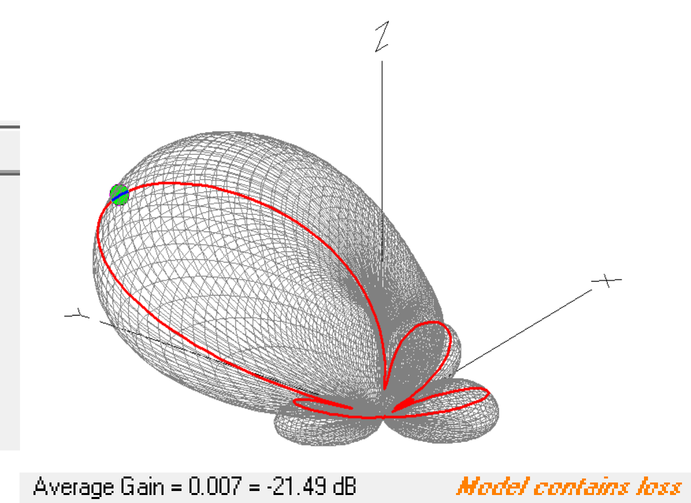



Sources

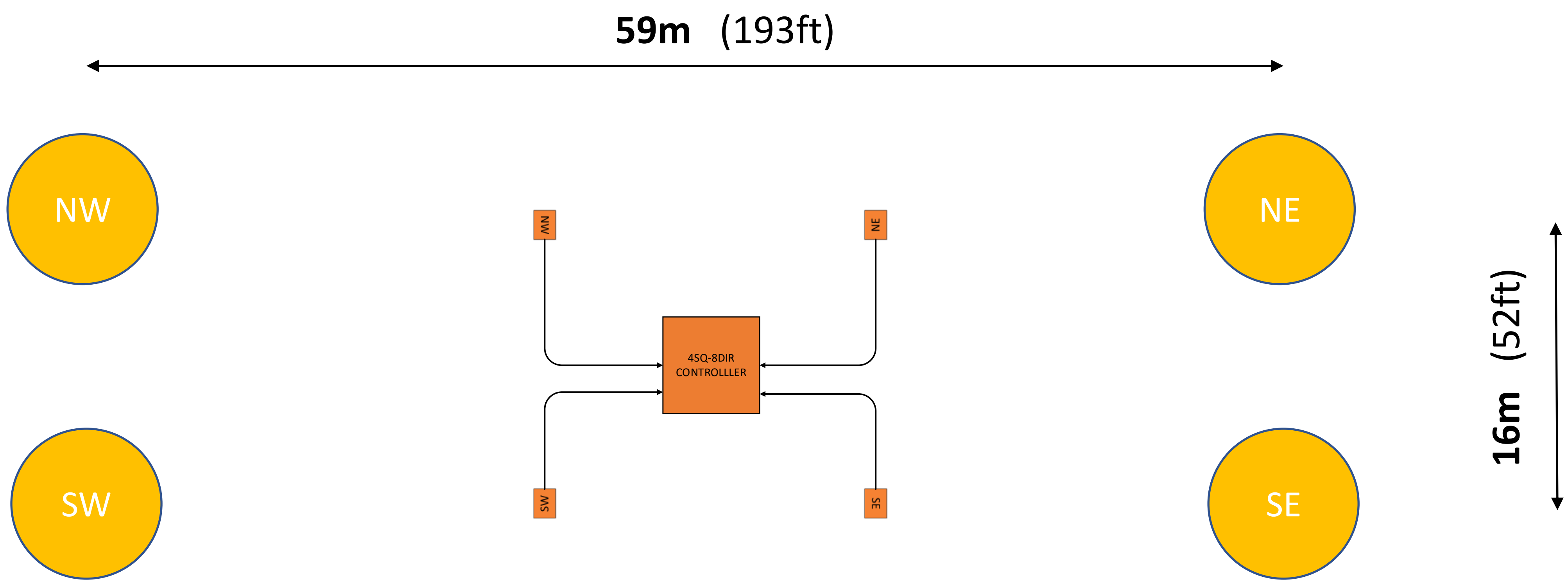
Source Edit Other

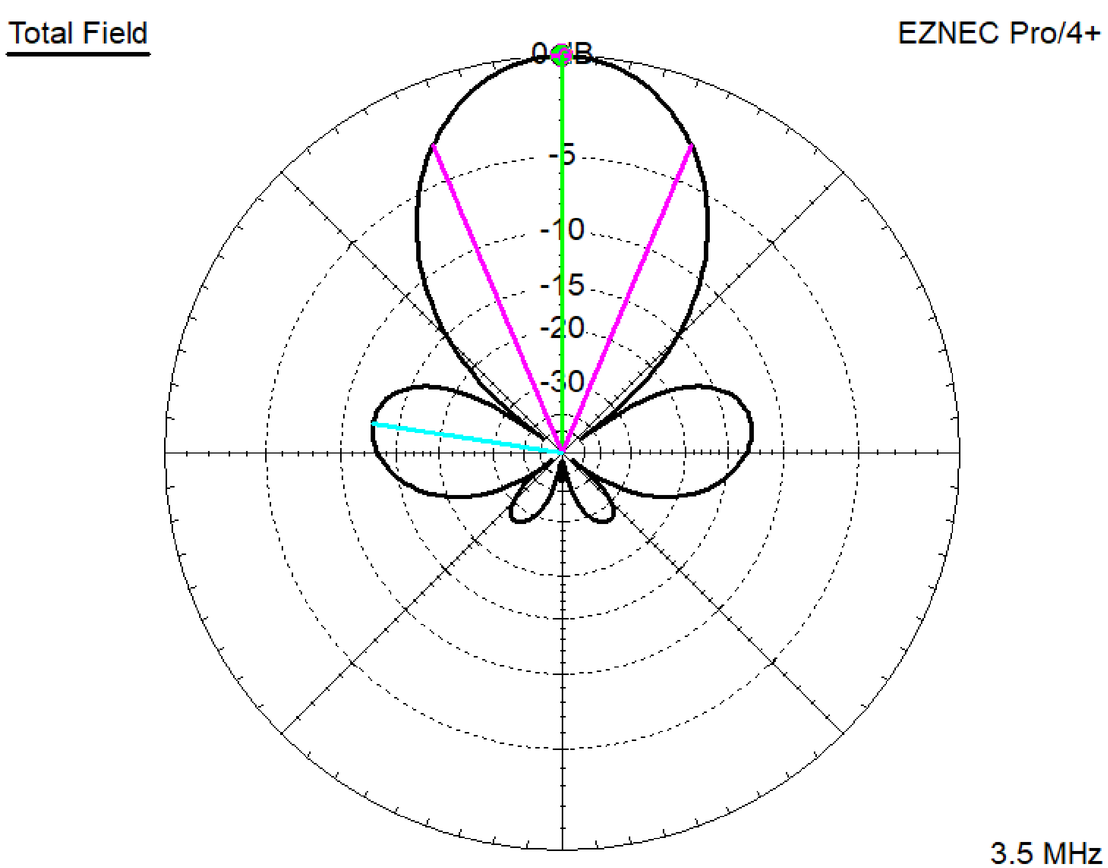
Sources

| No. | Specified Pos. Wire # | Specified Pos. % From E1 | Actual Pos. % From E1 | Actual Pos. Seg | Amplitude (V, A) | Phase (deg.) | Type |
|---|---|---|---|---|---|---|---|
| 1 | 1 | 0 | 8.33333 | 1 | 1 | 0 | I |
| 2 | 2 | 0 | 8.33333 | 1 | 1 | 150 | I |
| 3 | 3 | 0 | 8.33333 | 1 | 1 | 0 | I |
| 4 | 4 | 0 | 8.33333 | 1 | 1 | 150 | I |

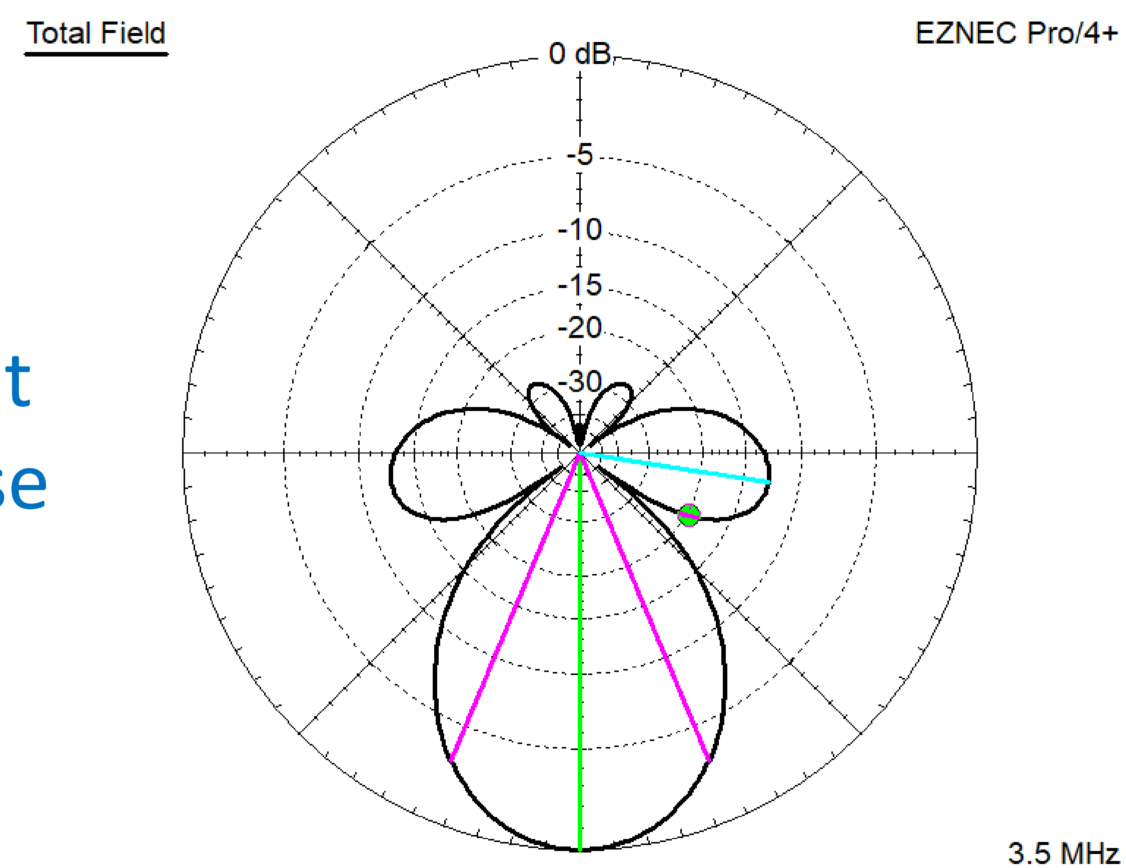


# BSEF (Broad side end fire) 16x59m on 80m RDF 13.06dB

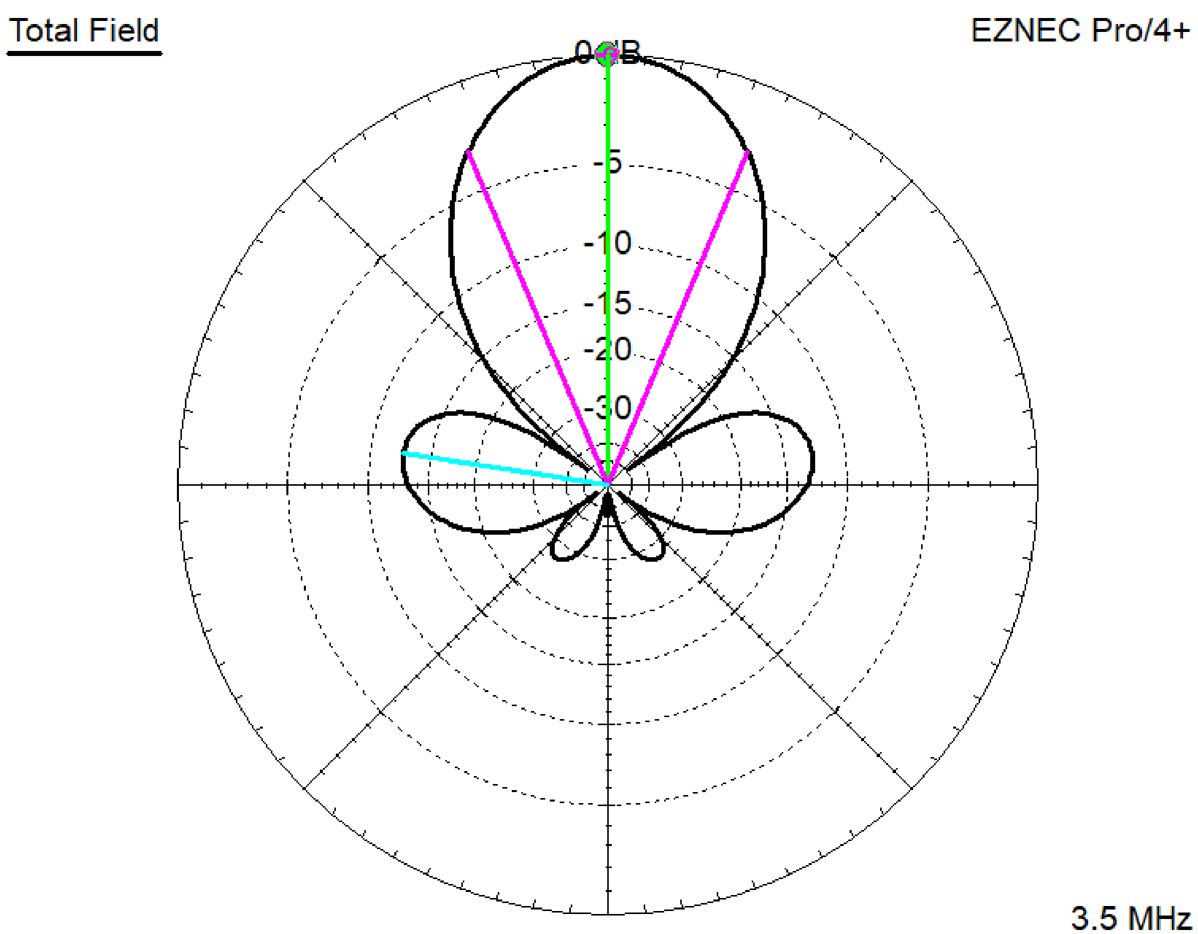



instant reverse



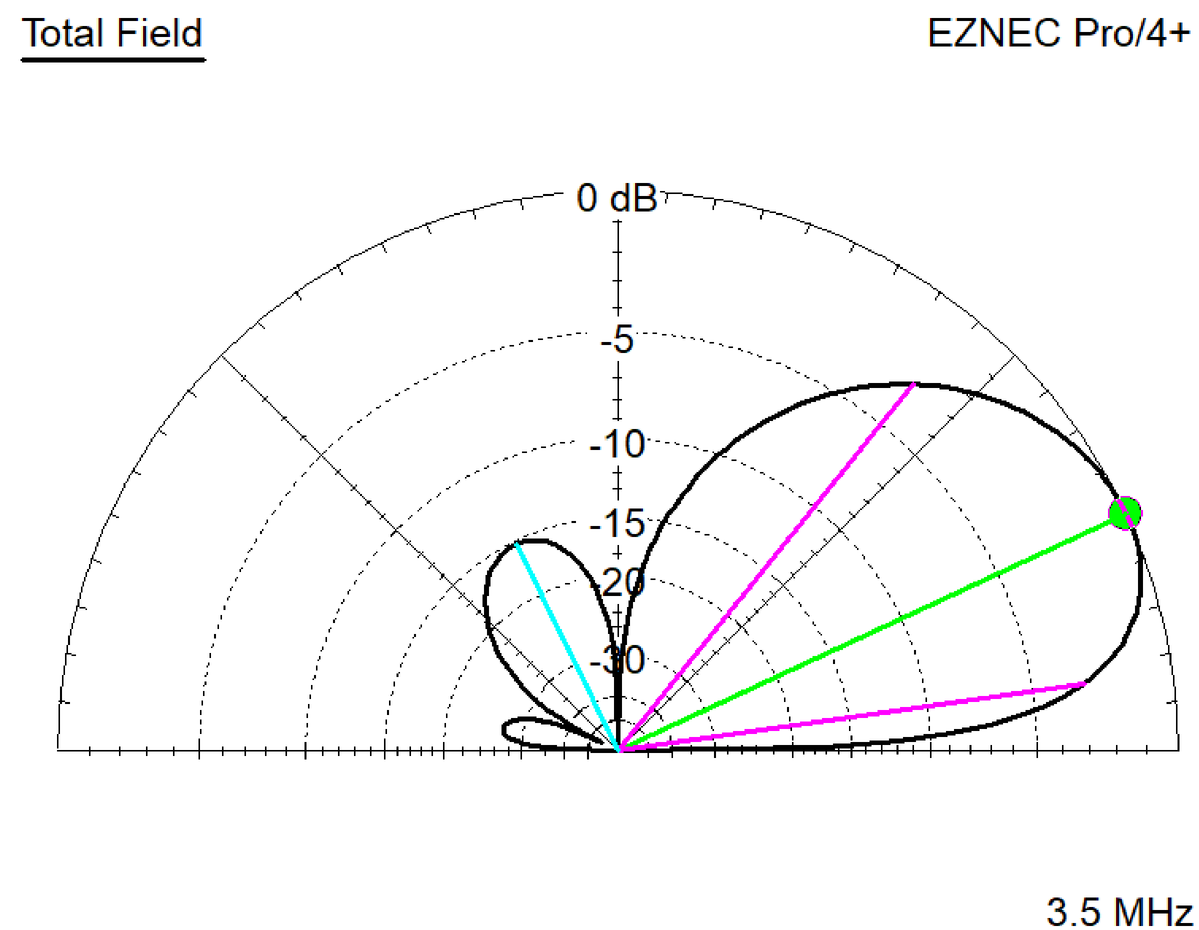
# BSEF (Broad side end fire) 16x59m on 80m RDF 13.06dB




Azimuth Plot
Elevation Angle 25.0 deg.
Outer Ring -0.63 dBi

Slice Max Gain -0.63 dBi @ Az Angle = 90.0 deg.
Front/Back 44.67 dB
Beamwidth 45.6 deg.; -3dB @ 67.2, 112.8 deg.
Sidelobe Gain -13.21 dBi @ Az Angle = 171.0 deg.
Front/Sidelobe 12.58 dB

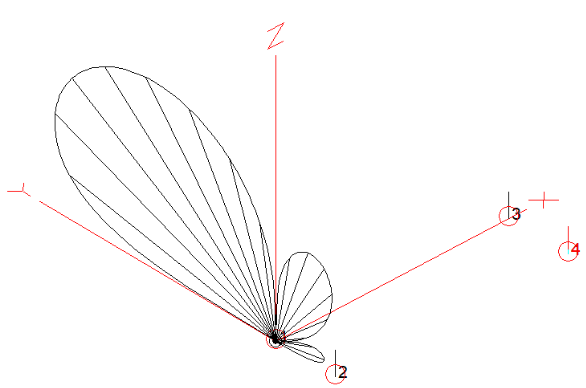
Cursor Az 90.0 deg.
Gain -0.63 dBi
0.0 dBmax




Elevation Plot
Azimuth Angle 90.0 deg.
Outer Ring -0.63 dBi

Slice Max Gain -0.63 dBi @ Elev Angle = 25.0 deg.
Beamwidth 42.9 deg.; -3dB @ 8.2, 51.1 deg.
Sidelobe Gain -15.92 dBi @ Elev Angle = 116.0 deg.
Front/Sidelobe 15.29 dB

Cursor Elev 25.0 deg.
Gain -0.63 dBi
0.0 dBmax

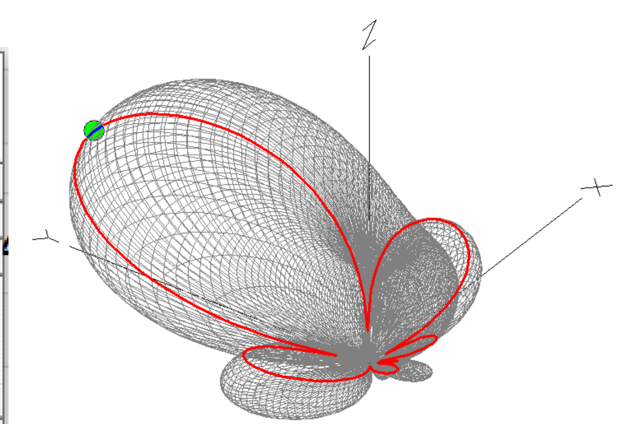



Sources

Source Edit Other

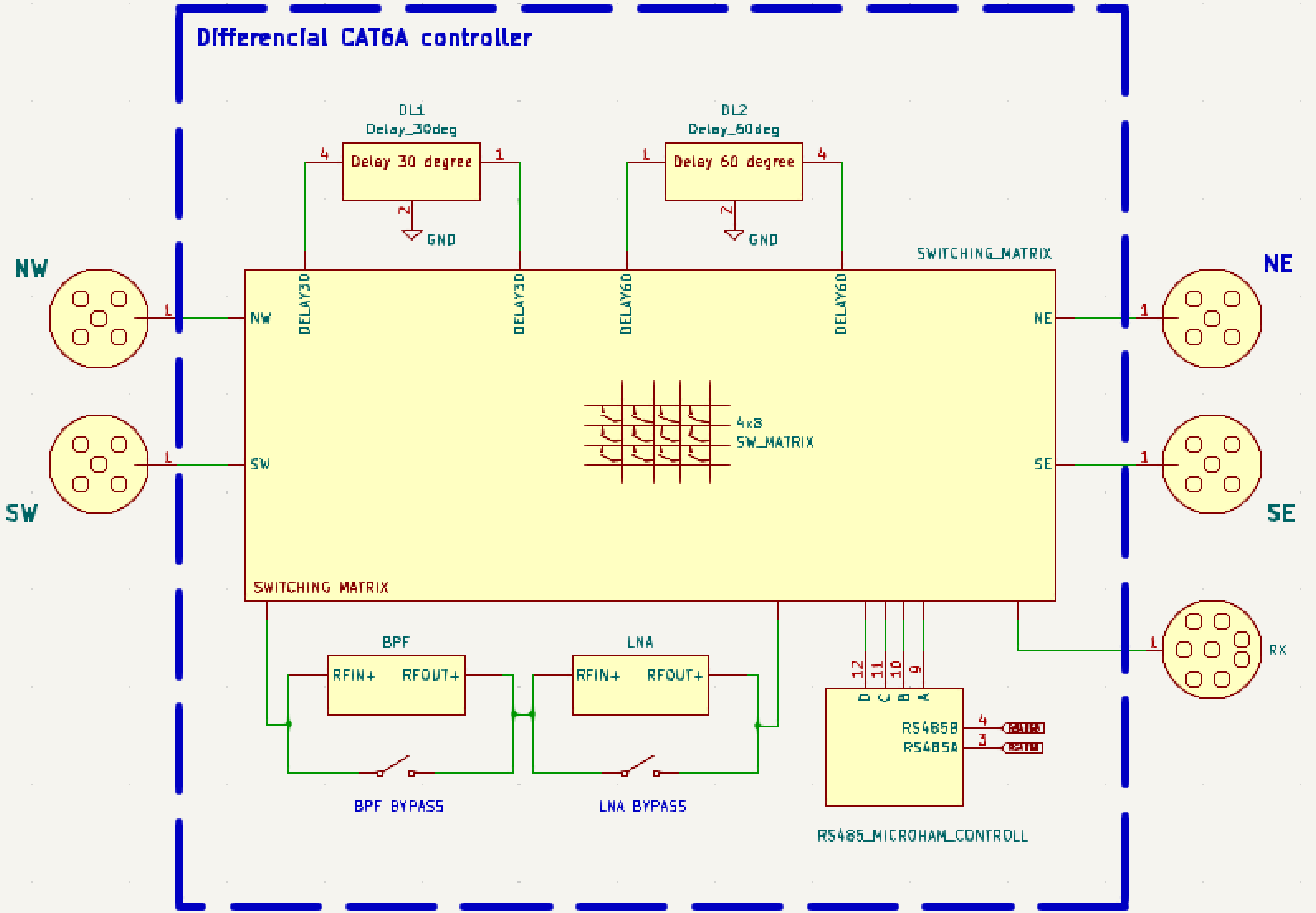
Sources

| No. | Specified Pos. | | Actual Pos. | | Amplitude | Phase | Type |
|---|---|---|---|---|---|---|---|
| | Wire # | % From E1 | % From E1 | Seg | (V, A) | (deg.) | |
| 1 | 1 | 0 | 8.33333 | 1 | 1 | 0 | I |
| 2 | 2 | 0 | 8.33333 | 1 | 1 | 120 | I |
| 3 | 3 | 0 | 8.33333 | 1 | 1 | 0 | I |
| 4 | 4 | 0 | 8.33333 | 1 | 1 | 120 | I |

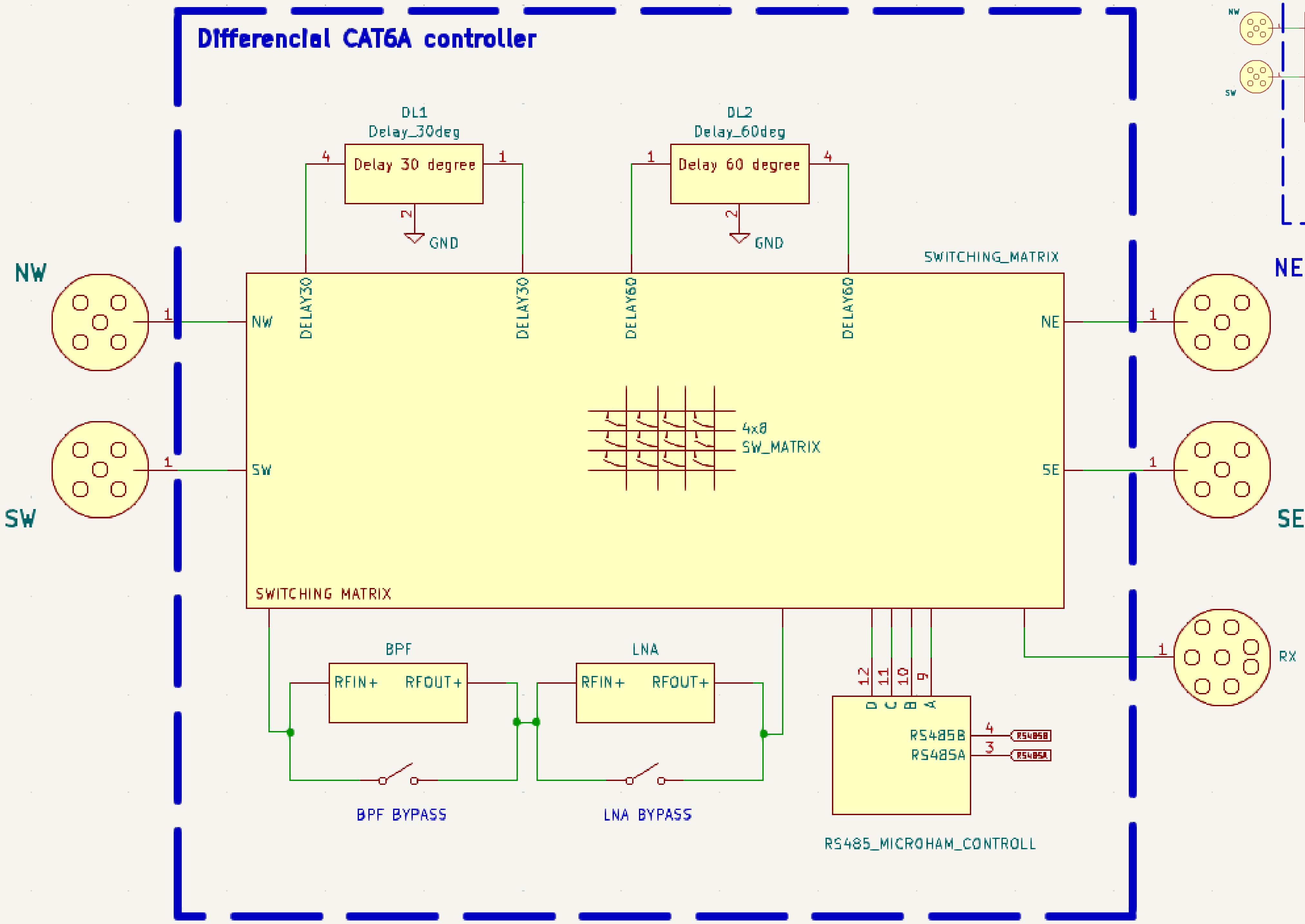



Average Gain = 0.043 = -13.69 dB *Model contains loss*

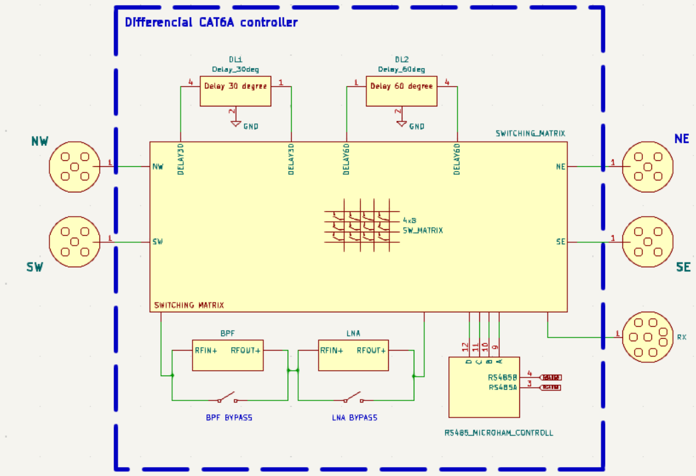
# 4SQ RX ANT – 8 direction



# 4SQ RX ANT – 8 direction




4SQ RX ANT – 8 direction



# Common noise mitigation at RX arrays

## Common-mode noise on coaxial cable

- Definition: **Common-mode (CM) noise on coax is unwanted voltage or current on the cable shield** (and both conductors relative to ground) that appears equally with respect to the system reference. In coax the shield carries most CM currents; the center conductor and shield may both shift relative to ground.

## How CM noise gets onto coax

- Capacitive or inductive coupling from nearby conductors, power lines, RF transmitters, or switching equipment.
- Ground potential differences between equipment at each end (ground loops).
- Lightning/surge or transients induced on long outdoor runs.
- Poor or inconsistent shield termination (loose connectors, low braid coverage).
- Common-mode currents generated by unbalanced antennas or feed systems.

## Why it matters

- CM currents on the shield can radiate, causing EMI/RFI and interfering with nearby systems.
- **CM can convert to differential noise at connectors, discontinuities, or equipment inputs (imperfect shielding, impedance mismatch),**
- producing **false signals in receivers.**

## Mitigation techniques (brief):

- Shielding and grounding
- **Twisted pairs**
- Filters and common-mode chokes
- Surge protectors,
- Proper termination
- Impedance matching
- Shielding connectors

# Common noise mitigation techniques

**Common-mode noise  at twisted pair**

- Noise (voltage or current) that appears identically on two or more conductors with respect to a common reference (usually ground). In a two-conductor pair, both lines carry the same unwanted signal relative to ground.

**Common mitigation techniques**

- Use differential transmission lines with high CMRR.
- Proper grounding and single-point ground or equipotential bonding to avoid loops.
- Cable shielding tied correctly (e.g., one-end or both-end depending on system).
- Common-mode chokes and ferrite beads on cable entries.
- Balanced transmission lines (twisted pair) and proper termination.
- Filtering (common-mode filters) and surge protection.
- Good PCB layout to keep return paths short and symmetric.

# Mass produced Ethernet cables

**CAT5E**


**CAT6A**


**Estimated insertion loss (attenuation) for Cat5e and CAT6A:**

- 1.8 MHz: ≈ 2.46 dB per 100 m (≈ 0.0246 dB/m).
- 3.5 MHz: ≈ 3.57 dB per 100 m (≈ 0.0357 dB/m).
- 7.0 MHz: ≈ 5.11 dB per 100 m (≈ 0.0511 dB/m).
- DC resistance per conductor ≈ 0.0900 Ω/m = 90.0 Ω/km (at 20 °C)
- Loop (two conductors) ≈ 0.1801 Ω/m = 180.1 Ω/km

- 1.8 MHz: ≈ 2.41 dB/100 m
- 3.5 MHz: ≈ 3.32 dB/100 m
- 7.0 MHz: ≈ 4.61 dB/100 m
- DC resistance per conductor ≈ 0.0700 Ω/m = 70.0 Ω/km (at 20 °C)
- Loop (two conductors) ≈ 0.1401 Ω/m = 140.1 Ω/km

**Quick comparison — Cat5e vs Cat6**

Standards & frequency

- Cat5e: TIA/EIA-568-B.2-1 / TIA-568-C.2 — rated to 100 MHz
- Cat6a: TIA/EIA-568-B.2-1 / TIA-568-C.2 — rated to 250 MHz

**Electrical/performance**

- Cat6 has stricter limits for NEXT, PSNEXT, ACR/PSACR, return loss, and delay skew → lower crosstalk and better signal margin.
- Cat6 typically shows lower attenuation and higher signal-to-noise at higher frequencies (up to 250 MHz).

**Construction differences**

- Cat5e: 4 twisted pairs, usually no internal separator. Typical 24 AWG.
- Cat6: 4 twisted pairs with tighter twists; many cables include a central spline/separator or thicker pair separators to reduce intra-pair crosstalk; often specified as 23 AWG or better for some vendors.