PRESENTATIONS

2014 CONFERENCE

Interpreting Receiver Performance Data for the Real World

GROKKING RECEIVER PERFORMANCE

Gerald Youngblood, K5SDR
President & CEO
FlexRadio Systems

To Grok

- *Grok: Verb - To understand intuitively or by empathy (Oxford English Dictionary)*

RECEIVER MEASUREMENTS
NOT FOR MERE MORTALS...

Receiver Performance???

RMDR

IMD DR3

PRE On/Off

IP2

BDR

2 & 20 KHz Spacing

MDS

NF

IP3

Survey

- Do You Follow Numbers?
  - QST Reviews
  - Sherwood Enginering
- Which Numbers?
  - MDS
  - Intermodulation Distortion Dynamic Range
  - Reciprocal Mixing Dynamic Range
  - Blocking Dynamic Range
  - IP3

Which numbers really count?

Is Bigger Always Better?

Blocking gain compression dynamic range: Not specified.	Blocking gain compression dynamic range, 500 Hz bandwidth, 500 Hz roofing filter:

	20 kHz offset Preamp off/on	*5/2 kHz offset Preamp off*
3.5 MHz	>139/>149 dB	>139/134 dB
14 MHz	>138/>148 dB	>138/133 dB
50 MHz	>137/141 dB	>137/132 dB

Reciprocal mixing dynamic range: Not specified.	14 MHz, 20/5/2 kHz offset: 117/101/87 dB

ARRL Lab Two-Tone IMD Testing (500 Hz bandwidth, 500 Hz roofing filter)*

Band/Preamp	*Spacing*	*Input Level*	*Measured IMD Level*	*Measured IMD DR*	*Calculated IP3*
3.5 MHz/Off	20 kHz	–25 dBm	–129 dBm	104 dB	+27 dBm
		–6 dBm	–97 dBm		+40 dBm
14 MHz/Off	20 kHz	–16 dBm	–128 dBm	112 dB	+40 dBm
		–3 dBm	–97 dBm		+44 dBm
		0 dBm	–88 dBm		+44 dBm
14 MHz/On	20 kHz	–25 dBm	–138 dBm	113 dB	+32 dBm
		–11 dBm	–97 dBm		+32 dBm
14 MHz/Off	5 kHz	–17 dBm	–128 dBm	111 dB	+39 dBm
		–3 dBm	–97 dBm		+44 dBm
		–0 dBm	–90 dBm		+45 dBm
14 MHz/Off	2 kHz	–27 dBm	–128 dBm	101 dB	+24 dBm
		–9 dBm	–97 dBm		+35 dBm
		0 dBm	–88 dBm		+44 dBm**
50 MHz/Off	20 kHz	–19 dBm	–127 dBm	108 dB	+35 dBm
		–9 dBm	–97 dBm		+35 dBm

Second-order intercept point: Not specified.	Preamp off/on: 14 MHz, +69/+69 dBm; 50 MHz, +57/+57 dBm.

When will I hear interference?

How will it perform on my antenna?

How good is good enough?

Use Cases, Use Cases

- Field Day – May be worst case
- Multi-multi
- Top band neighbor
- 6m Band Opening
- CW DX Pileup
- SSB DX Pileup
- Contest Operation
- Microwave

The Measurement That Counts…

- Strength of interfering signals
- Outside final filter pass band
- Causing interference >= antenna noise
- On my antenna
- At my QTH
- On my mode and band

Question:

- Most commonly quoted receiver benchmark?

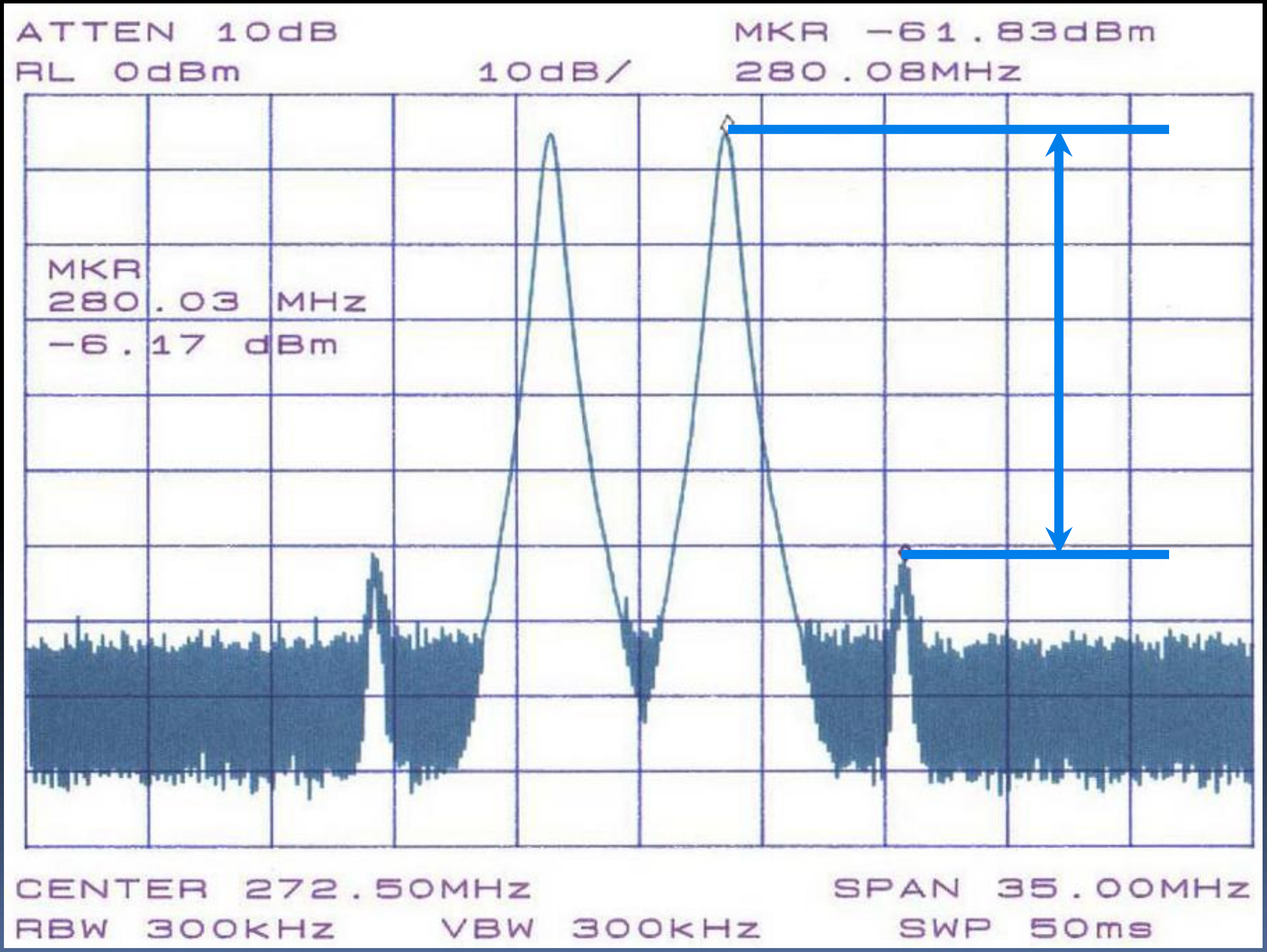
Answer:

- Two Tone 3rd Order Intermodulation Distortion Dynamic Range (IMD DR3)
  - 2 KHz Spacing
  - 500 Hz Bandwidth
  - 20m
  - Preamp Off

Problem

- IMD DR3 MDS Reference is Arbitrary
- IMD DR3 and Blocking Exclude Phase Noise
- IP3 is Meaningless
- None Referenced to Real World

Two Tone 3rd Order Intermodulation Distortion



IP3: None Follow 3rd Order

Radio	IM3 MDS to S5 Slope
Triple Conversion Superhet	1.79
Double Conversion Superhet	1.72
Direct Conversion SDR	1.57
Double Conversion Superhet	2.54 (Almost)
Direct Sampling A	1.61
Direct Sampling B	1.83

IP3 Problem

- Radios Not 3rd Order
- Irrelevant to Real World
- Advertising Mumbo Jumbo
- Useful Only in Pure Analog Engineering

IMD DR Changes with Level

Popular Double Conversion Roofing Filter Transceiver

Band/Preamp	Spacing	Input Level	Measured IMD Level	Measured IMD DR
14 MHz/Off	2 KHz	-27 dBm	-130 dBm	103 dB
		-14 dBm	-97 dBm	83 dB
		0 dBm	-59 dBm	59 dB

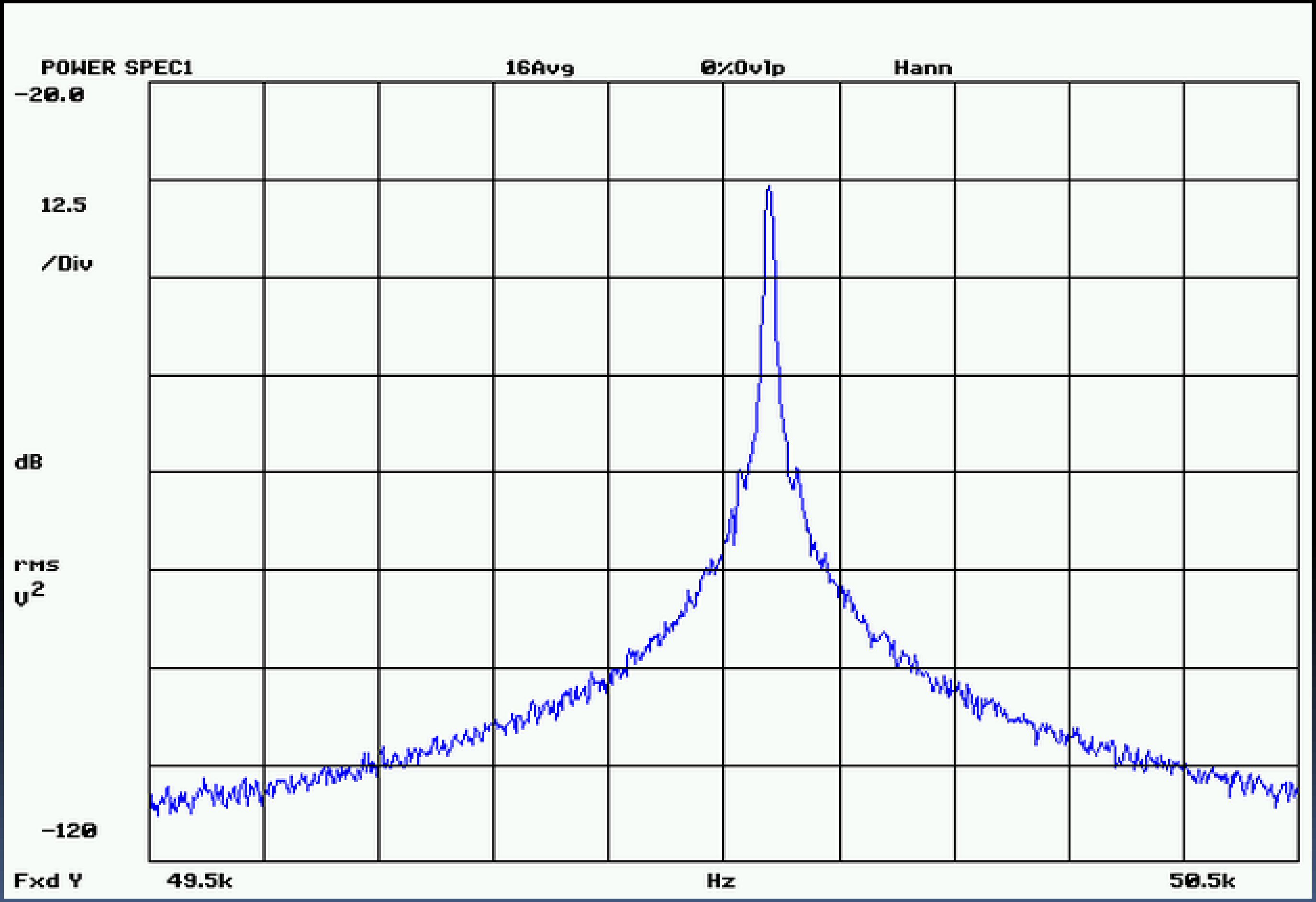
Direct Sampling Transceiver

Band/Preamp	Spacing	Input Level	Measured IMD Level	Measured IMD DR
14 MHz/Off	2 KHz	-14 dBm	-119 dBm	105 dB
		-2 dBm	-97 dBm	95 dB
		0 dBm	-90 dBm	90 dB

IMD DR3 Problem

- Referenced to Arbitrary MDS
- Degrades with Increasing Signal Level
- Ignores Reciprocal Mixing Phase Noise
- No Reference to Band Noise

Reciprocal Mixing Phase Noise May Dominate



Awesome Numbers, Right?

Blocking gain compression: 140 dB typical at 2, 5 and 20 kHz spacing with 400 Hz, 8 pole roofing filter.

Gain compression, 400 Hz bandwidth:**

	20 kHz Offset Preamp Off/On	*5/2 kHz offset Preamp Off*
3.5 MHz	142/137 dB	140/139 dB
14 MHz	142/138 dB	140/140 dB
50 MHz	140/138 dB	128/124 dB

Reciprocal Mixing (500 Hz BW): Not specified. 20/5/2 kHz offset: –112/–100/–86 dBc.

ARRL Lab Two-Tone IMD Testing**

Band/Preamp	*Spacing*	*Input Level*	*Measured IMD Level*	*Measured IMD DR*	*Calculated IP3*
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		–14 dBm	–97 dBm		+28 dBm
		0 dBm	–60 dBm		+30 dBm
14 MHz/Off	20 kHz	–24 dBm	–130 dBm	106 dB	+29 dBm
		–13 dBm	–97 dBm		+29 dBm
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		–21 dBm	–97 dBm		+17 dBm
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		–14 dBm	–97 dBm		+28 dBm
		0 dBm	–59 dBm		+30 dBm
50 MHz/Off	20 kHz	–26 dBm	–131 dBm	105 dB	+27 dBm
		–11 dBm	–97 dBm		+32 dBm

Second-order intercept: Not specified. Preamp off/on: +75/+75 dBm.**

It's Really an 86 dB Radio!

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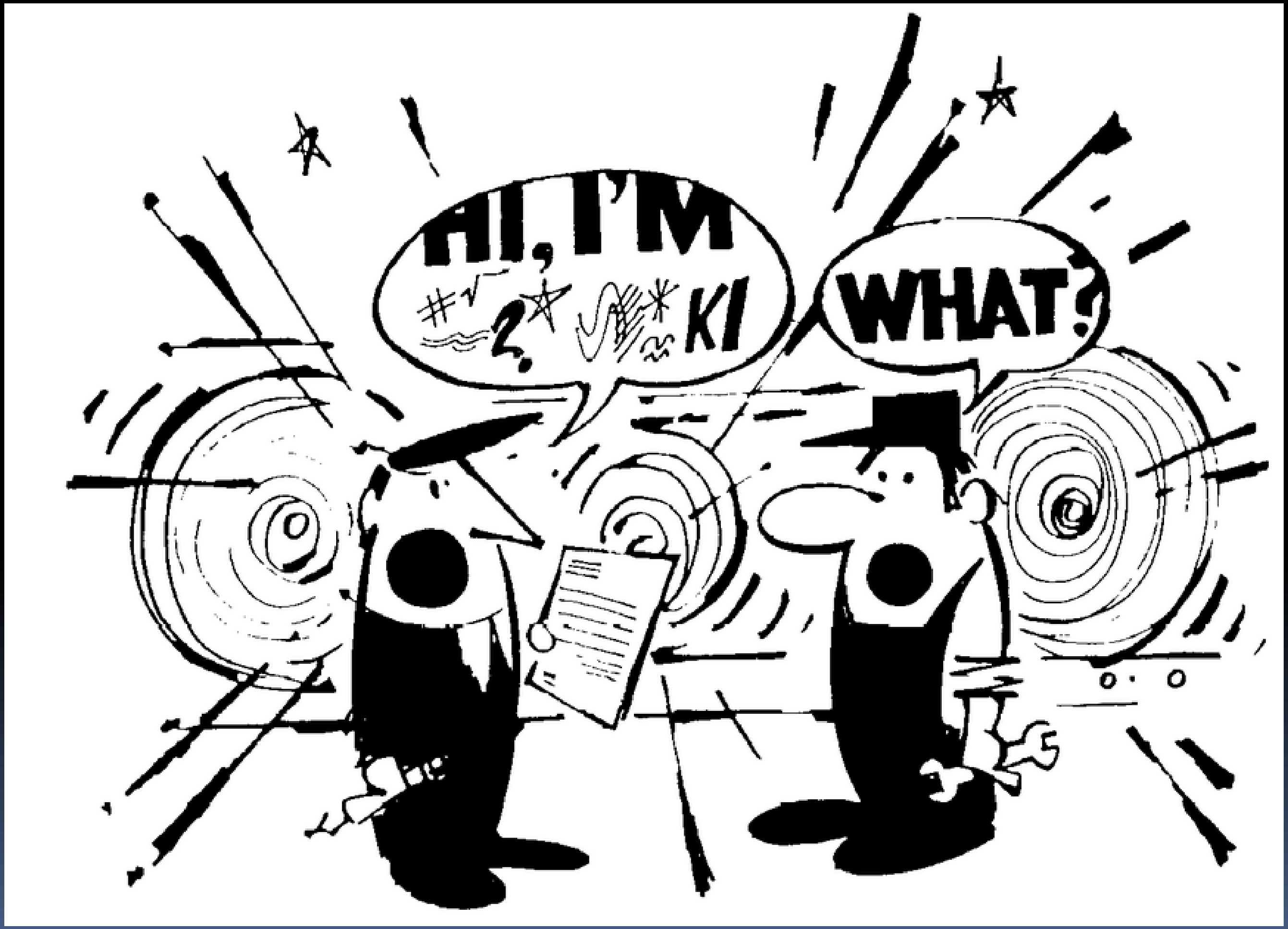
		–14 dBm	–97 dBm		+29 dBm
		0 dBm	–59 dBm		+30 dBm
14 MHz/Off	2 kHz	–27 dBm	–130 dBm	103 dB	+25 dBm
		–14 dBm	–97 dBm		+28 dBm
		0 dBm	–59 dBm		+30 dBm
50 MHz/Off	20 kHz	–26 dBm	–131 dBm	105 dB	+27 dBm
		–11 dBm	–97 dBm		+32 dBm

Second-order intercept: Not specified. Preamp off/on: +75/+75 dBm.**

IF YOU DON'T GROK NOISE, YOU WON'T GROK RADIO.

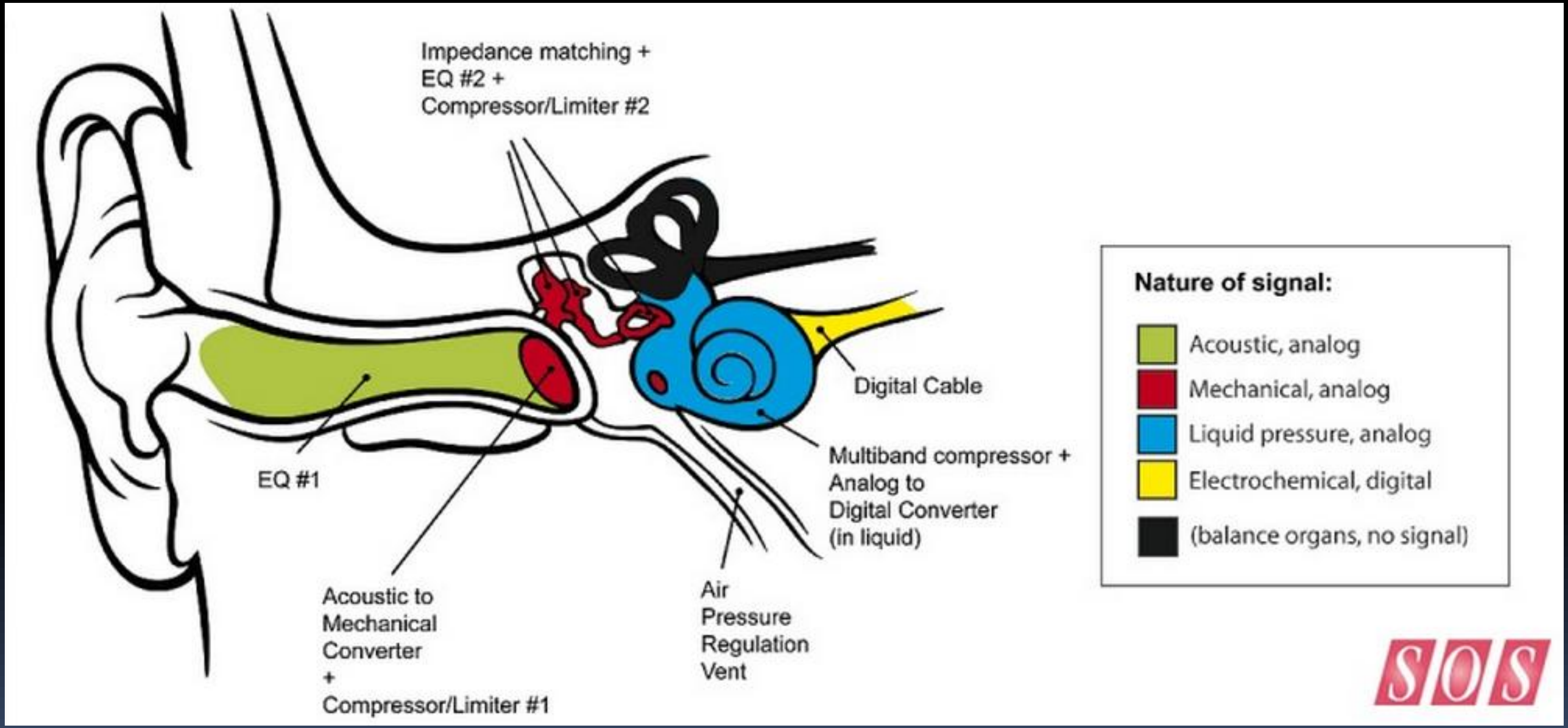
K5SDR Operating W100AW



World Record 137.6 Decibels!

Seattle Seahawk Stadium

Human Ear Signal Processor



Source: How the Ear Works, Sound on Sound

Human Ear

- Total Dynamic Range
  - 140 dB
  - 100 trillion to one
- Instantaneous Dynamic Range
  - Concert Hall – 80 dB
  - Human Speech – 40 dB

Sound Levels

- 110 dB - Pain
- 120 dB – Chainsaw
- 130 dB – Aircraft Carrier
- 137.6 dB – Seahawk Stadium 12/2/2013
- 150 dB – Eardrum Ruptures

Noise Limits Dynamic Range

- 140 – 137.6 = 2.4 dB Instantaneous DR
- Better Engage Attenuator (Ear Plugs)

Average Band Noise in 500 Hz

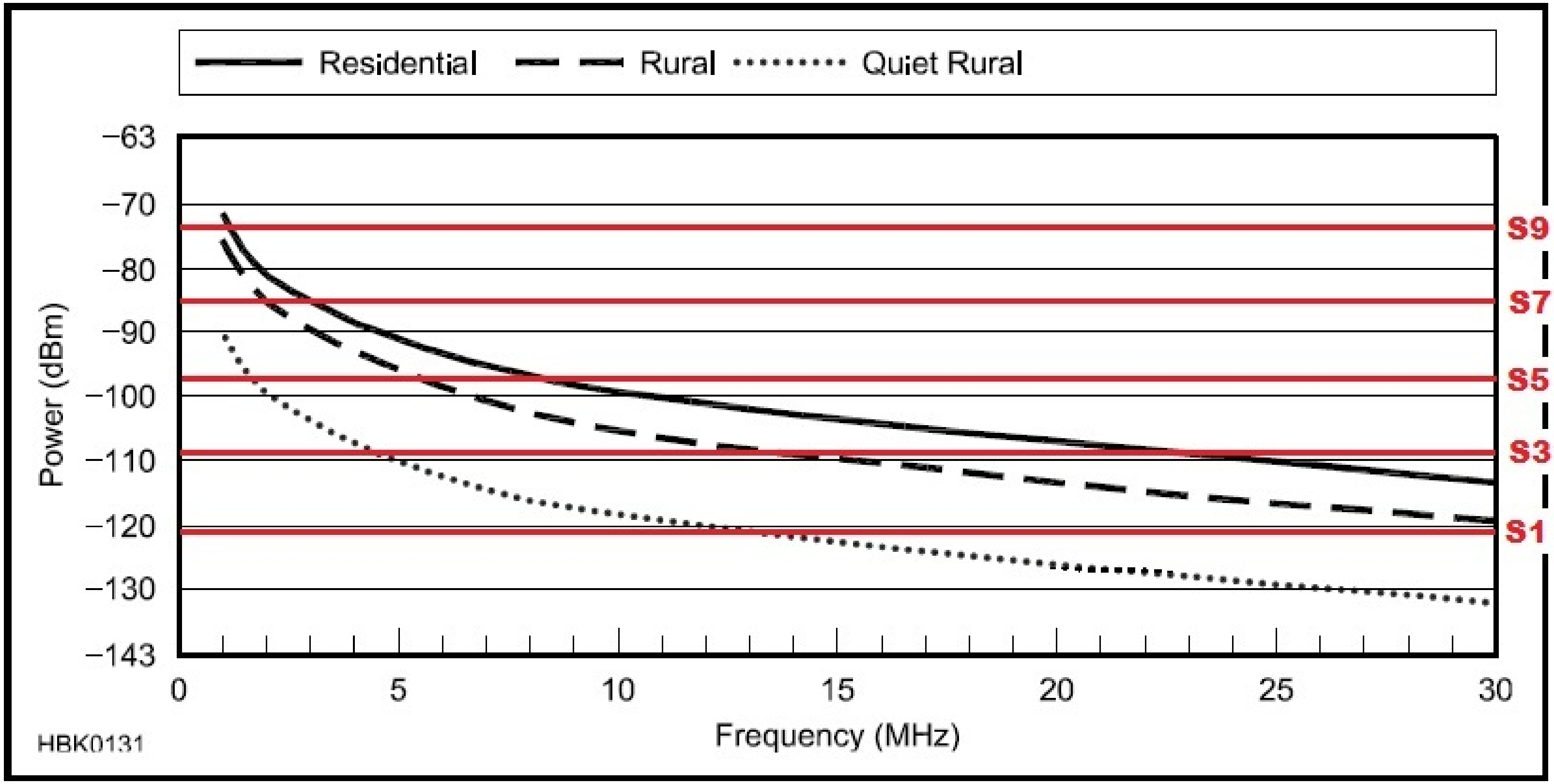


Fig 19.37 — Typical noise levels versus frequency for various environments. (Man-made noise in a 500-Hz bandwidth, from Rec. ITU-R P.372.7, *Radio Noise*)

Noise Figure

- Receiver Noise Compared to:
  - Noise Generated in 50 Ohm Resistor
  - Measured in 1 Hz Bandwidth @ 25C
- 0 dB NF = -174 dBm/Hz
- MDS Specified in 500 Hz
- 0 dB NF MDS: -174 + 27 = -147 dBm

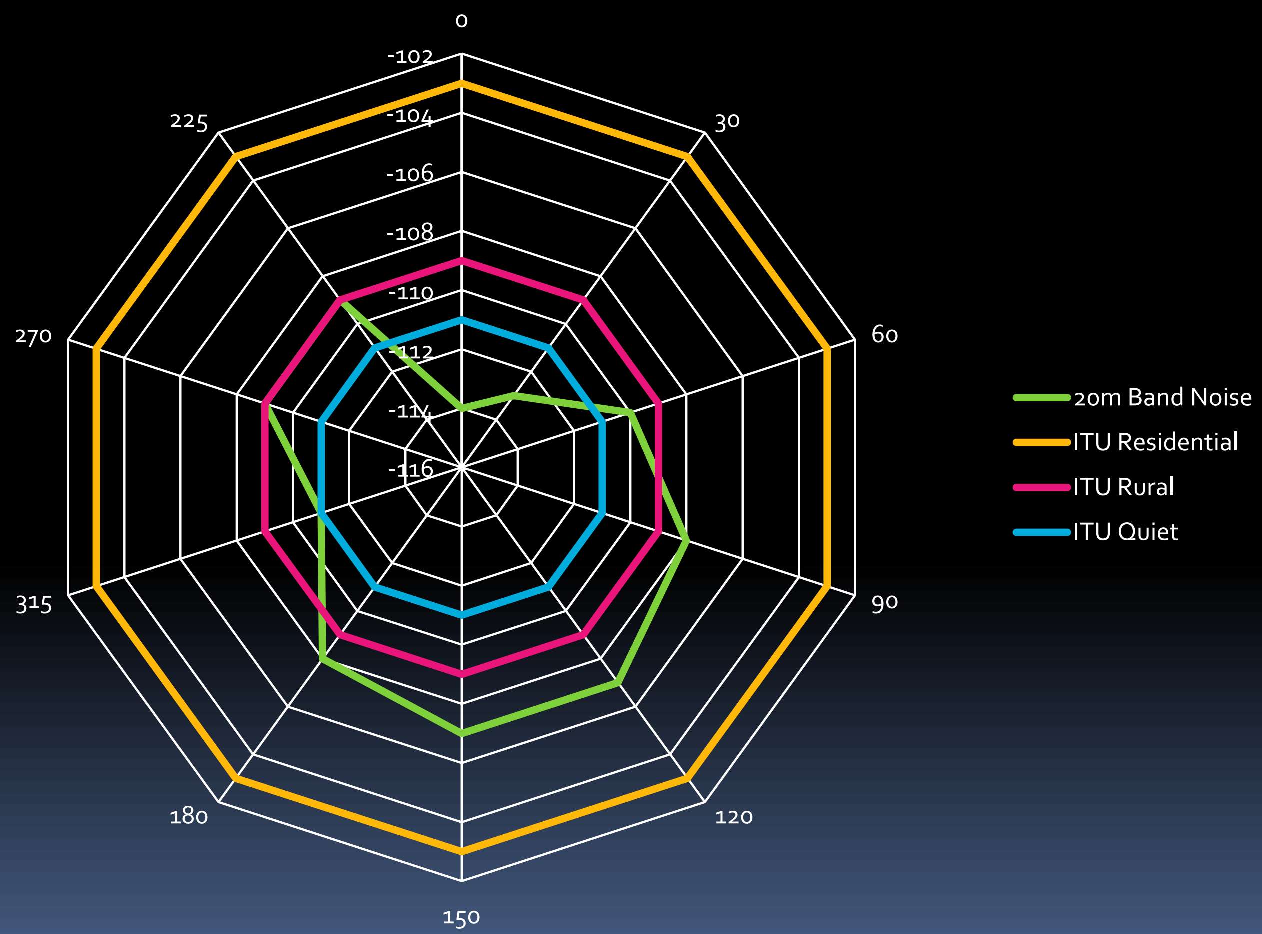
ITU Band Noise NF Equivalent

	Antenna NF Equivalent		
Band	**Quiet Rural**	**Rural**	**Residential**
160	47	60	67
80	40	54	59
40	32	45	52
30	29	42	48
20	25	38	44
17	22	35	40
15	20	33	39
10	16	28	35

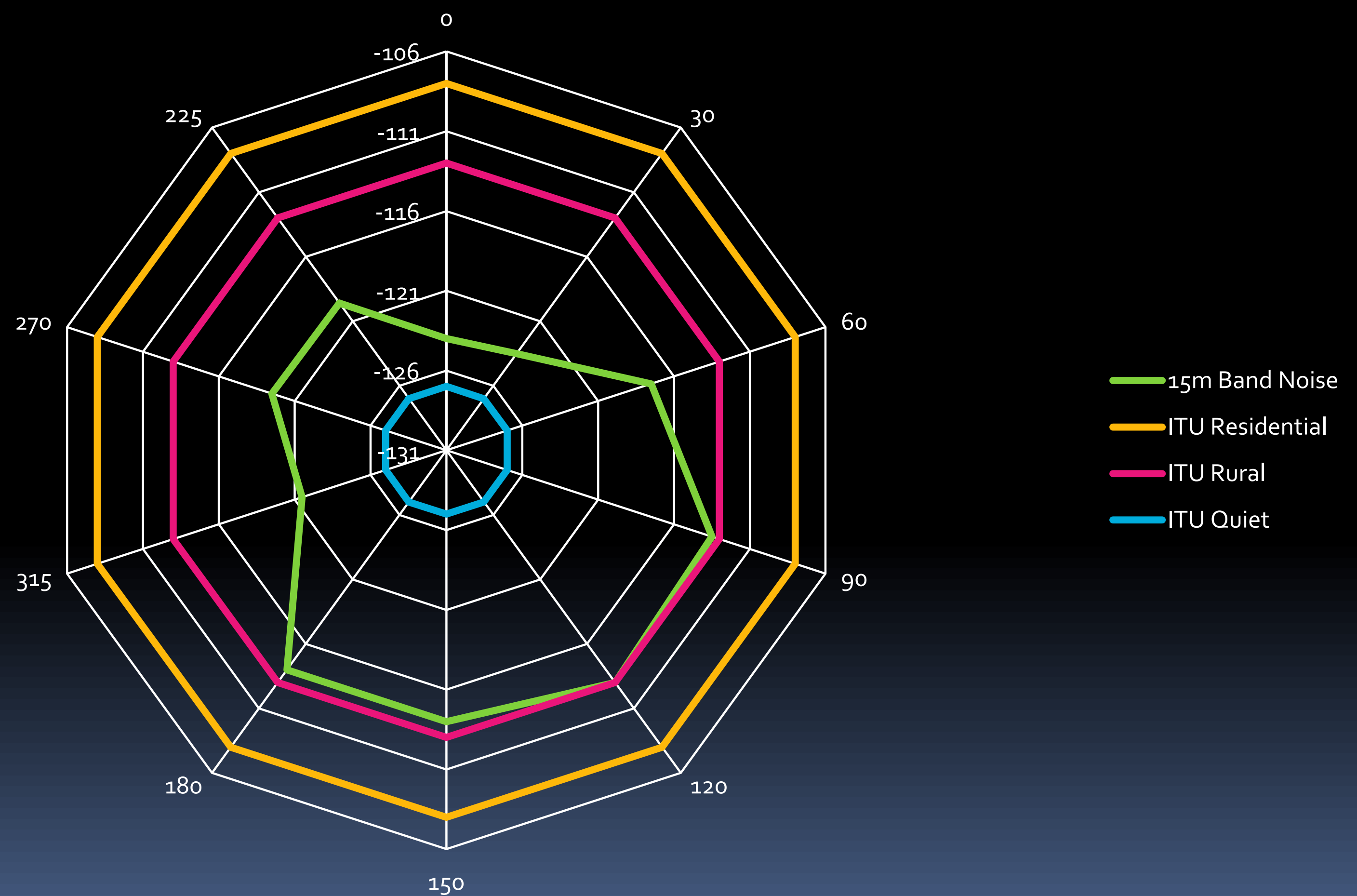
NC0B – Ault, Colorado

NC0B – Ault, Colorado

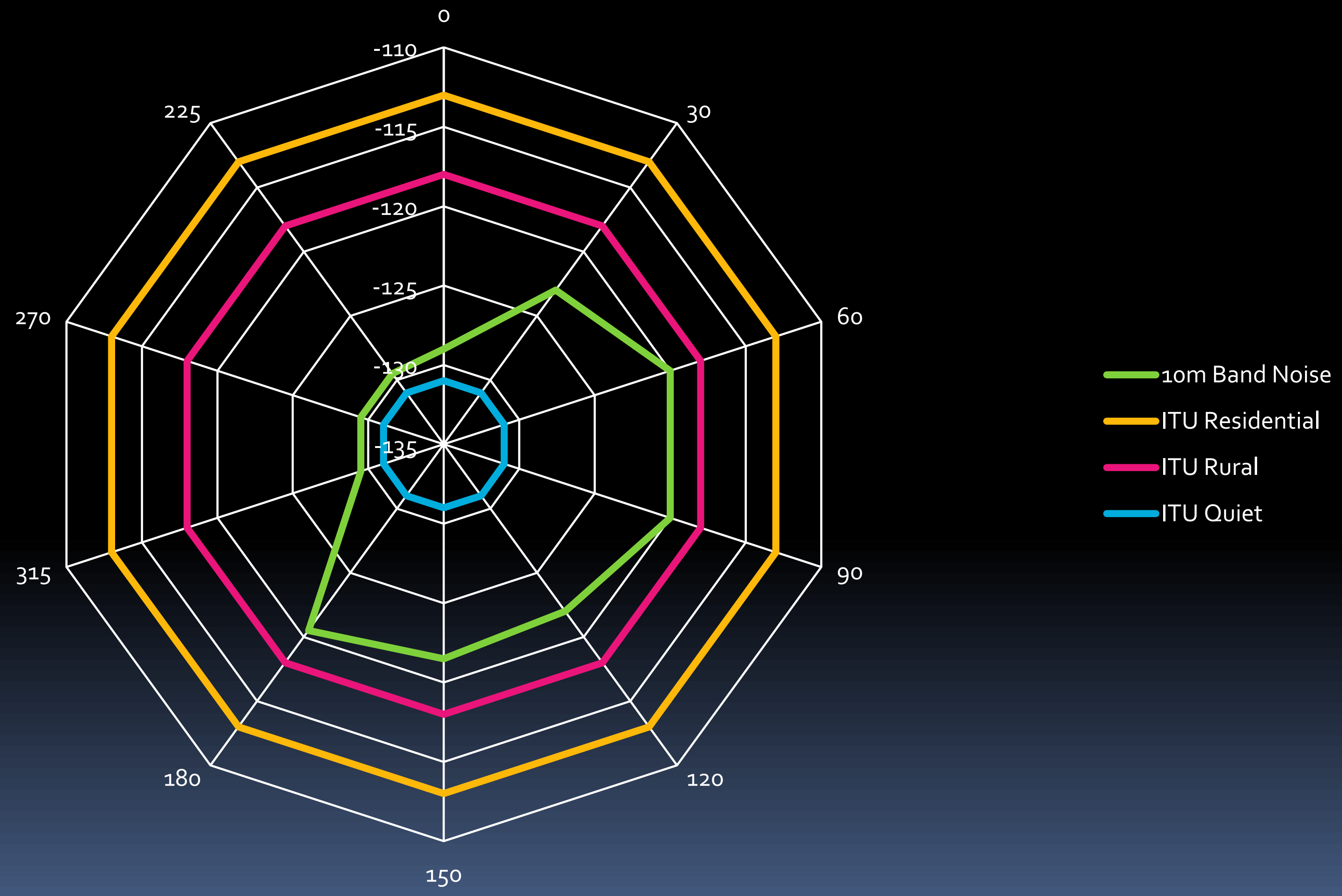
NC0B 20m Noise 10/20/13



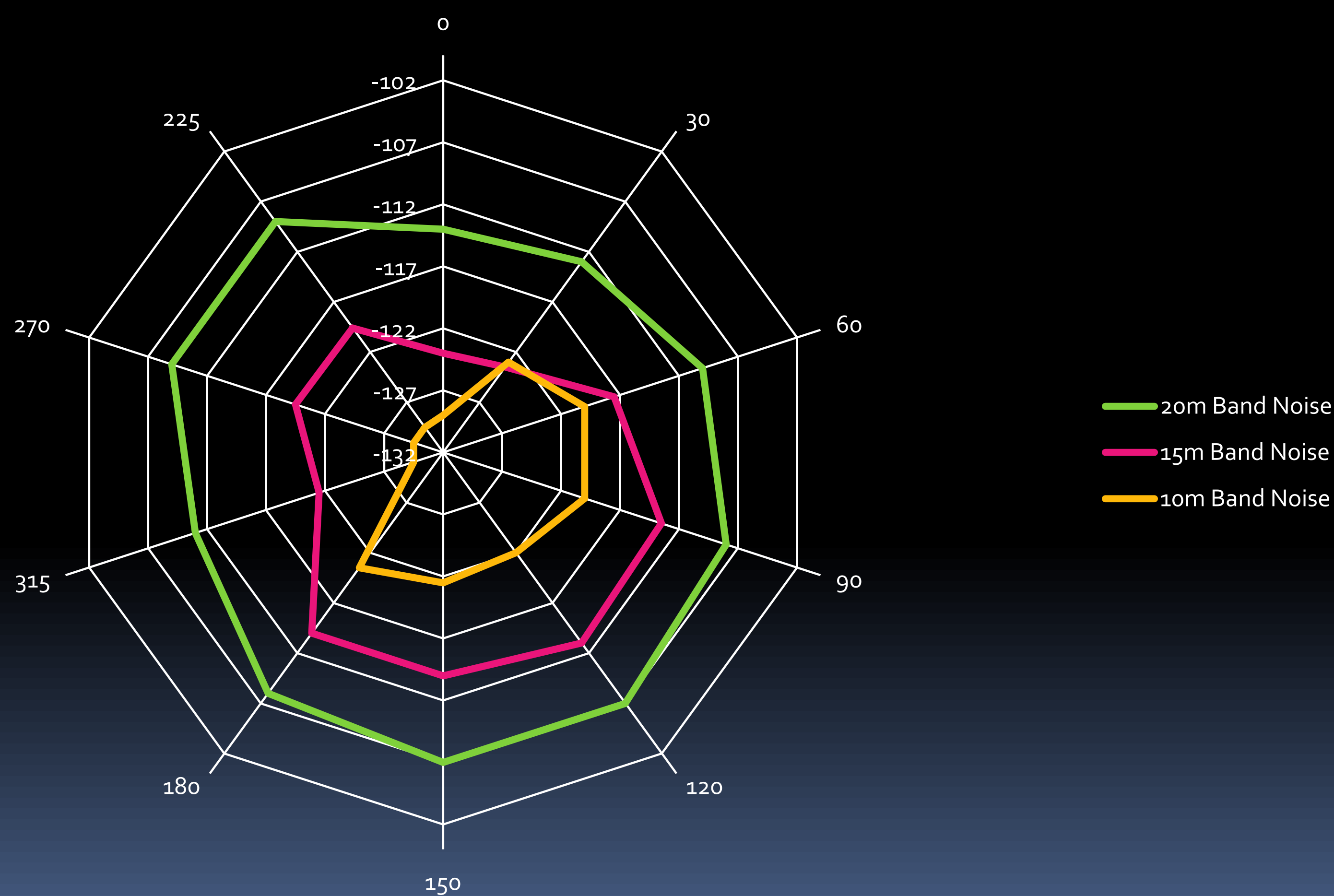
NC0B 15m Noise 10/20/13



NC0B 10m Noise 10/20/13



NC0B Composite Band Noise



INTRODUCING INTERFERENCE FREE SIGNAL STRENGTH (IFSS)

Interference Free Signal Strength (IFSS)

- Max. Signal Strength Without Interference
- At ITU Rural Average Band Noise
- Two Tone: IMD + Phase Noise
- Single Tone: Blocking or Phase Noise

Let's Plot Double Conversion Roofing Filter Receiver

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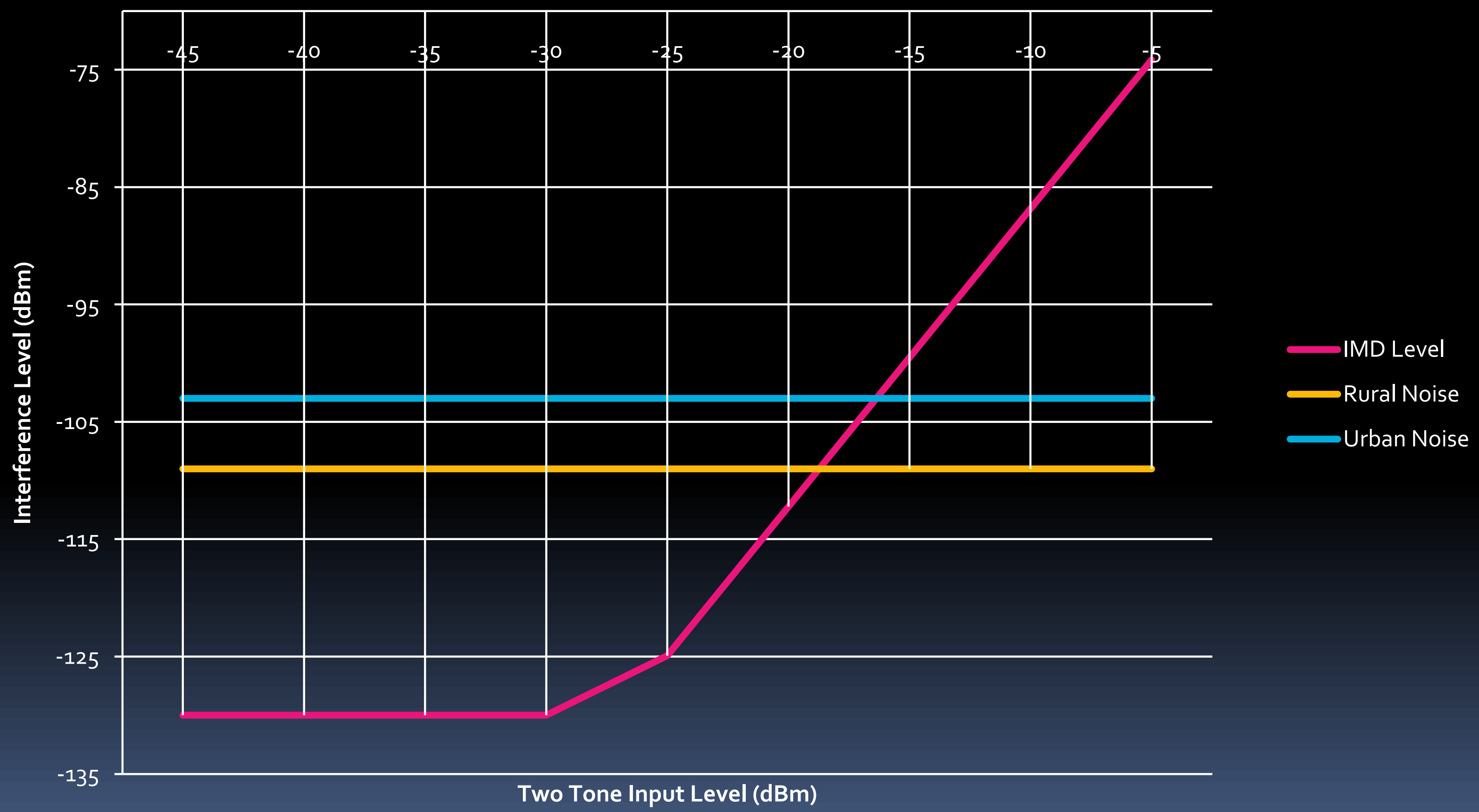
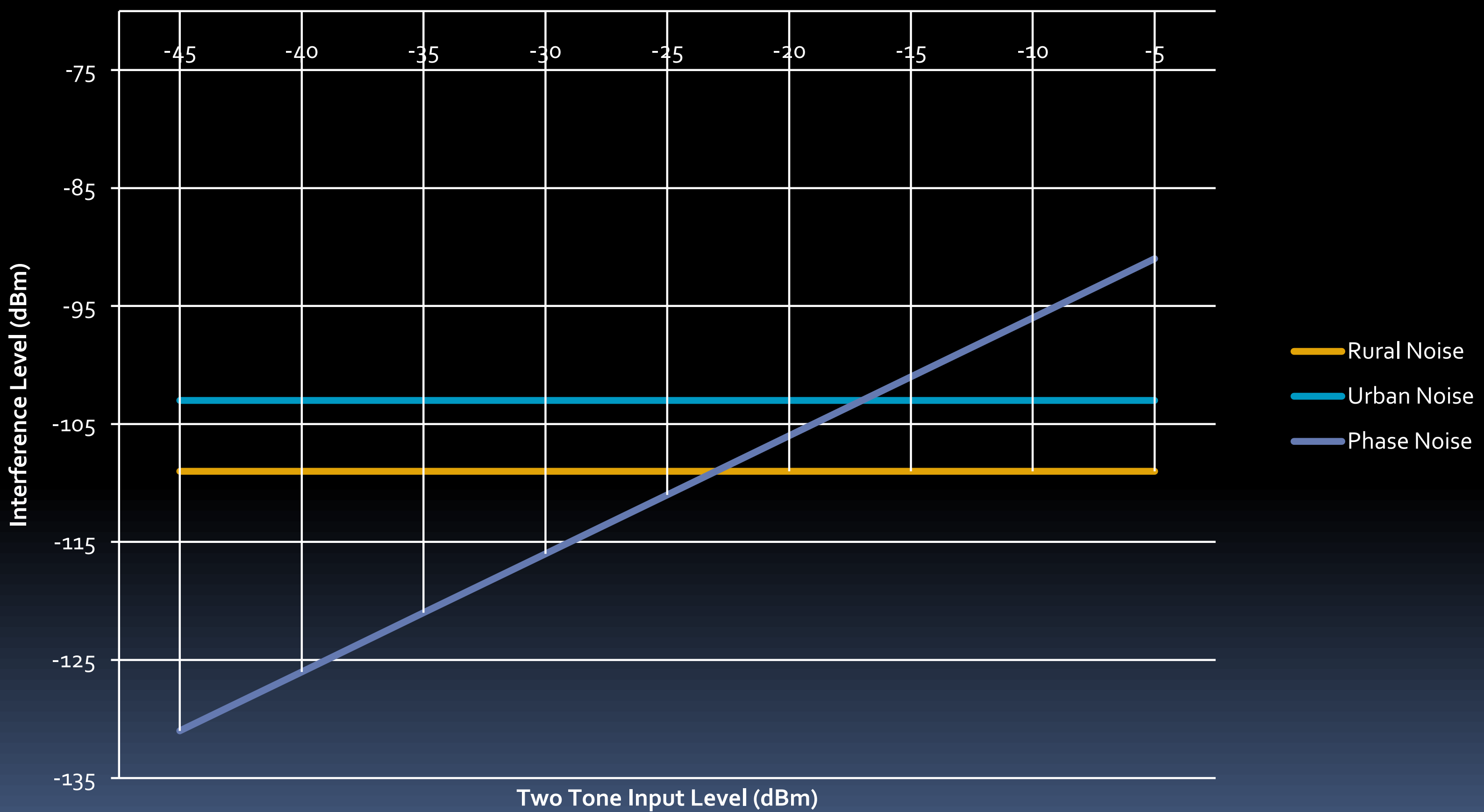
IMD3 vs Band Noise Level Equals Rural:–18 dBm

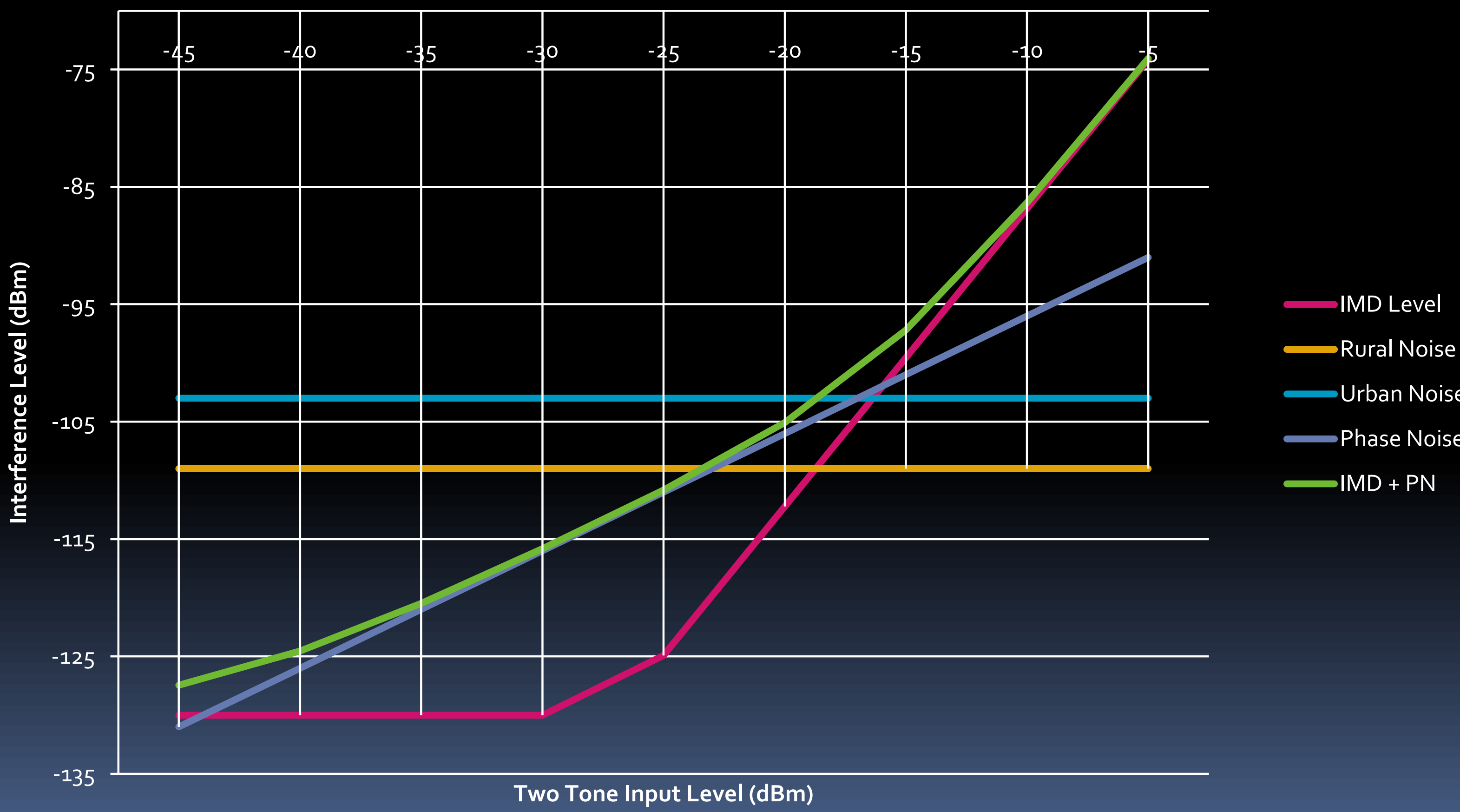


Phase Noise vs Band Noise Equals Rural: -23 dBm

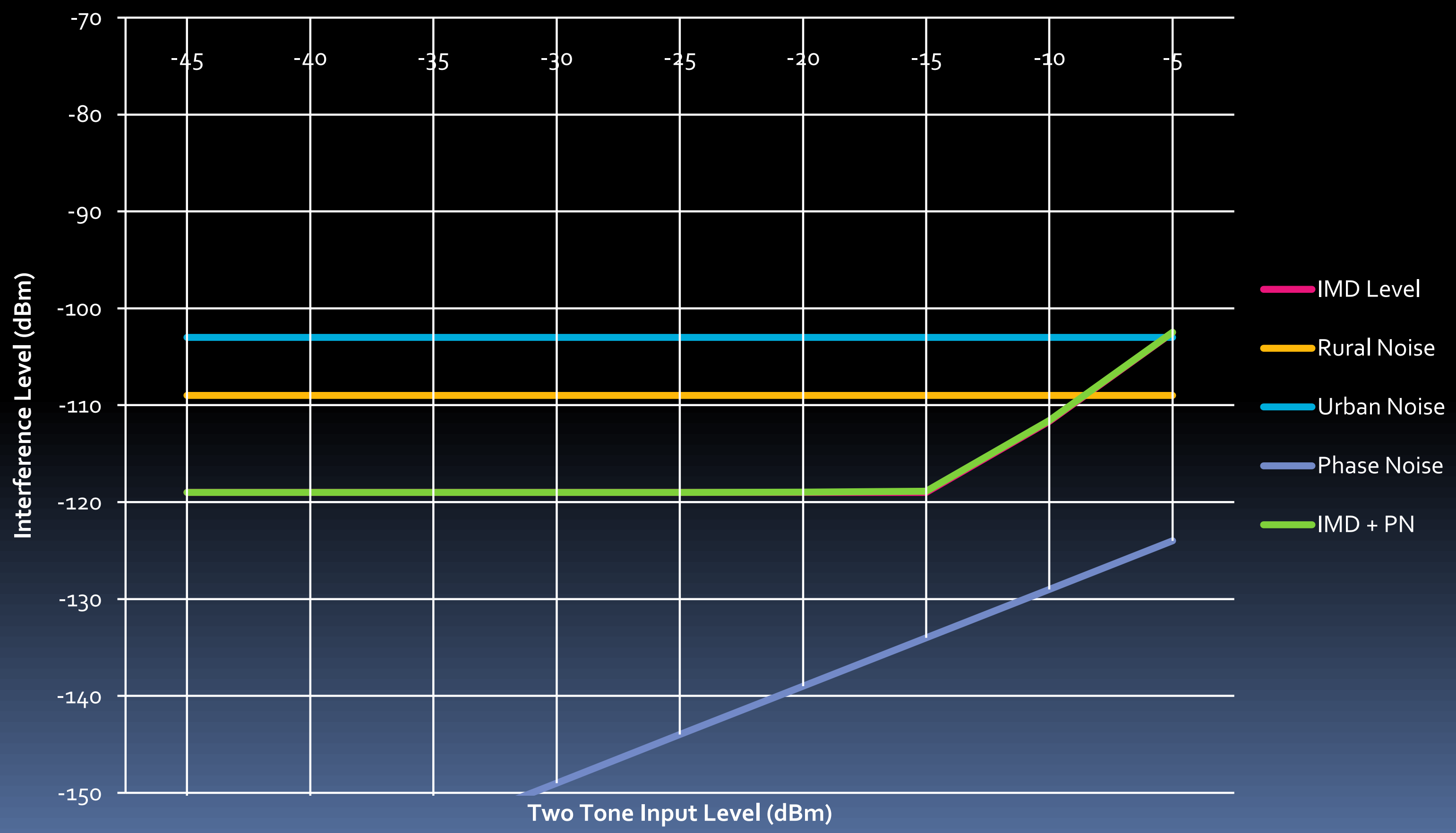


IFSS = -23 dBm (S9 + 50 dB)

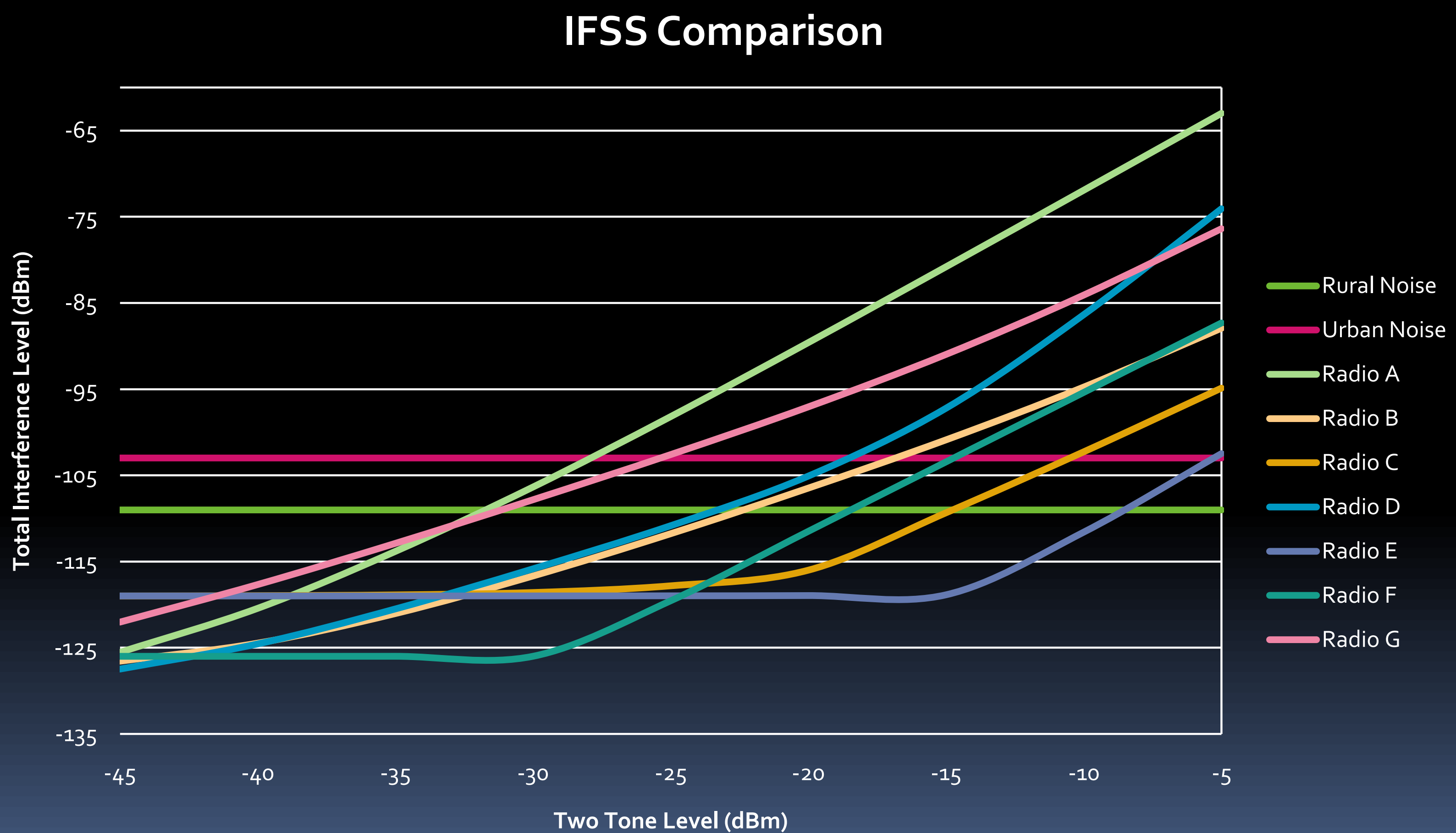
IFSS DR = -23 – (-109) = 86dB



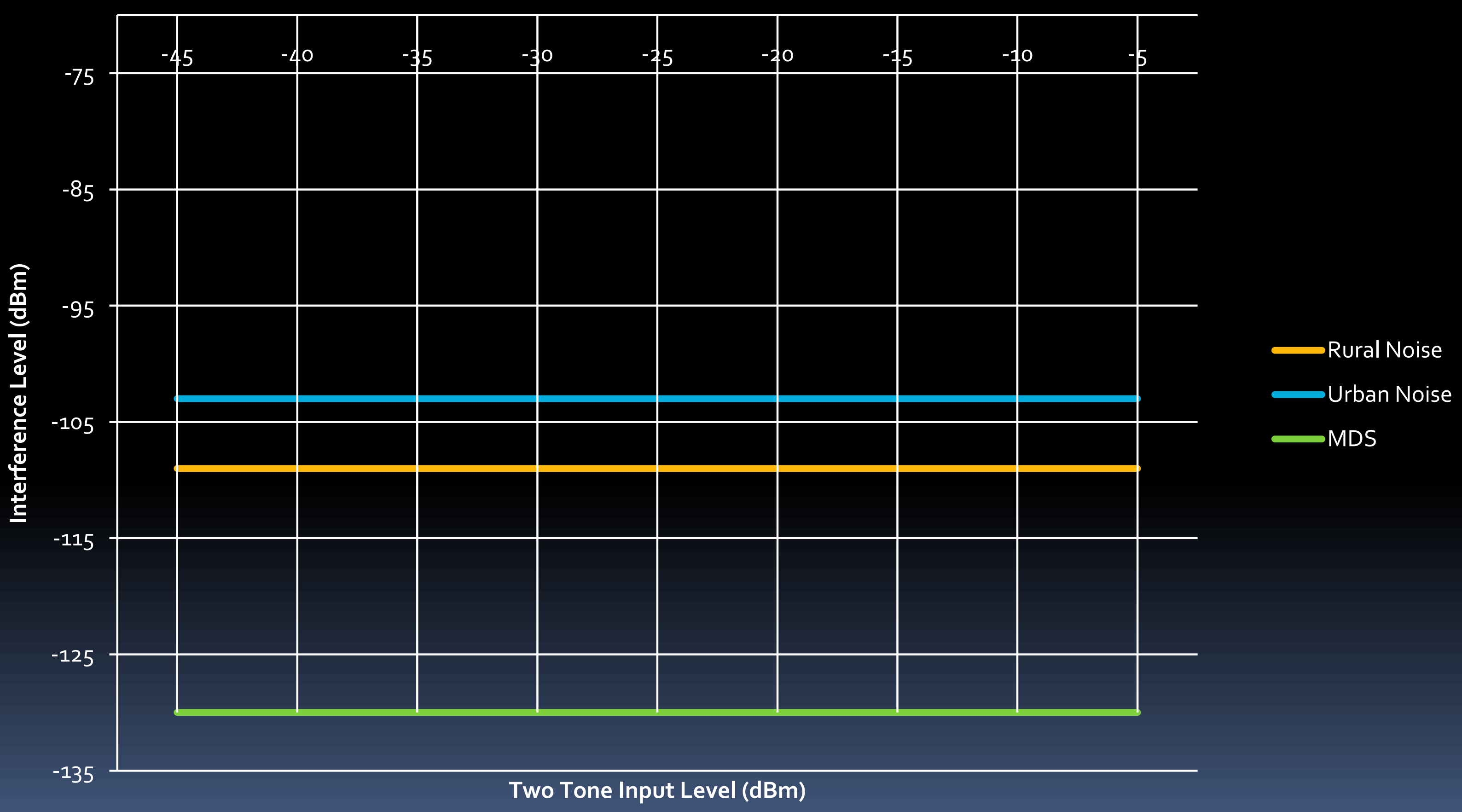
Direct Sampling
IFSS = -8 dBm (S9 + 65 dB)
IFSS DR = -8 – (-109) = 101 dB



High End HF Transceivers



Can Sensitivity be Wasted?



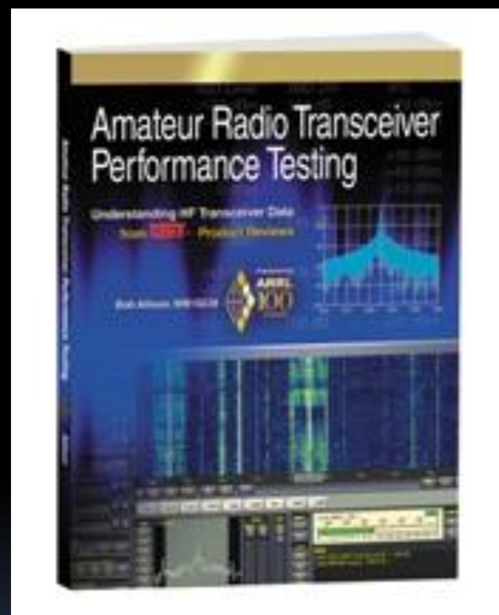
Sensitivity Rule of Thumb

- Antenna noise 8-10 dB > RX noise
- Use attenuator if much greater
- Use preamp if much less

Conclusion

- Understand band noise
- Understand your use case needs
- Relate total receiver performance to noise
- Optimize sensitivity for band noise

ARRL Lab Measurements



Author:	Bob Allison, WB1GCM
ISBN:	978-1-62595-008-6
Order No.:	0086
Price:	$19.95

Interpreting Receiver Performance Data for the Real World

GROKKING RECEIVER PERFORMANCE

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Adding Another Dimension to your Roving Experience

2014 CSVHFS Conference

Jim Froemke

Google: “KØMHC/rover”

New Dimensions in Roving

Introduction – cont.

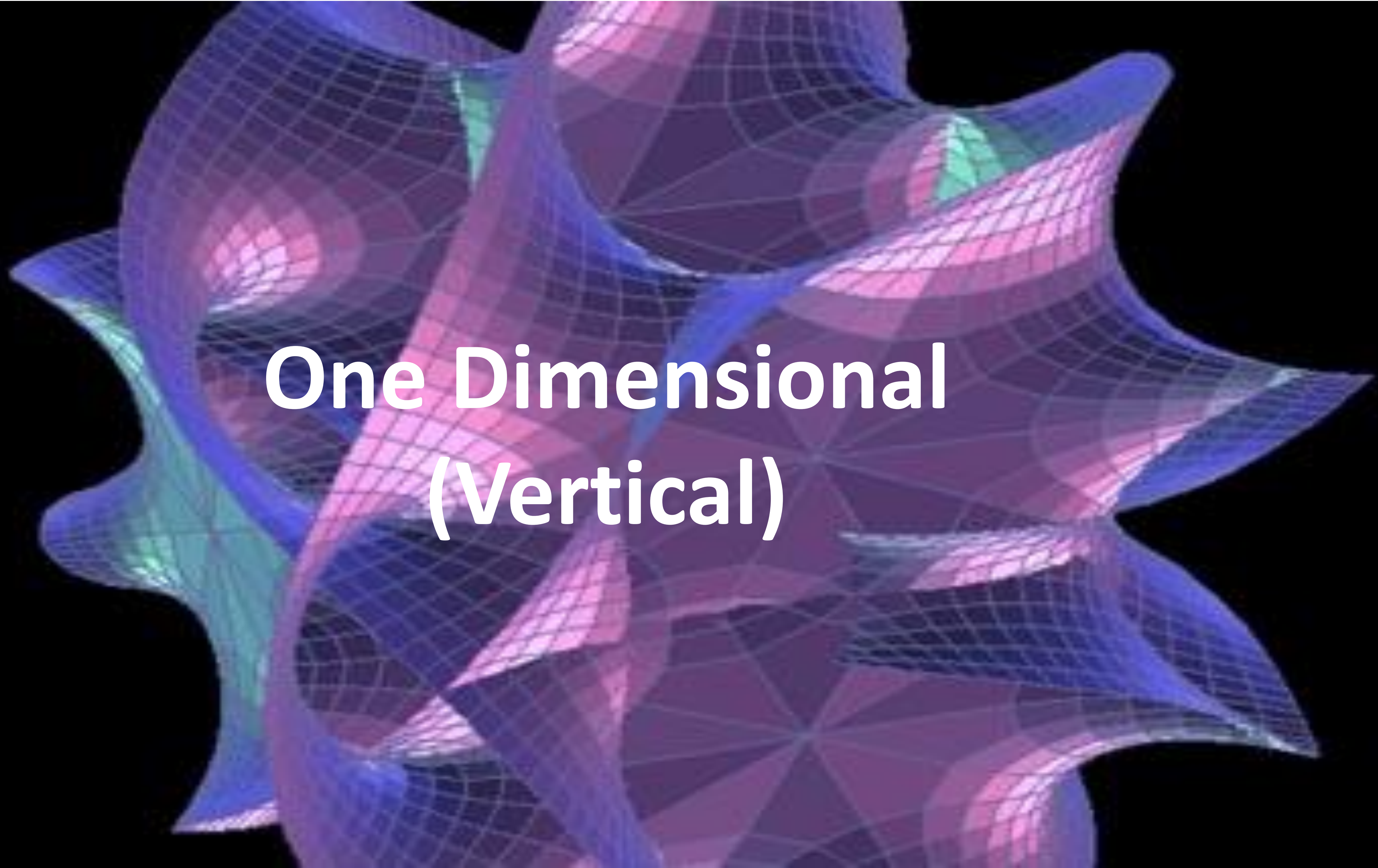
- **In 1963 my first rover tower/mast was welded to the floor board of my 1956 Chevy convertible.**

Introduction – cont.

- **Over time, my rover configurations have continued evolve outside-of-the-box in various dimensions.**

Introduction – cont.

- Many of the mistakes I've made have led to more practical results.
- However, my roving partner still insists on bringing his own fire extinguisher along.


One Dimensional
(Vertical)

VERTICAL Elevation of Mast(s)

Many rover configurations have a short, fixed height mast(s).

- This works great when you’re located at “scenic outlook” sites with distant views of the horizon and minimal blockage from nearby terrain features, foliage or structures.

VERTICAL Elevation of Mast(s)

Many rover configurations have a short, fixed height mast(s).

- However, these “optimum” rover sites can be few and far between. Often it’s necessary to elevate antennas to achieve better results when operating from “average” locations.

VERTICAL Elevation of Mast(s)

Results also vary by band.

- For example, on 6 meters you benefit more from "ground bounce" when you're antenna is above one wavelength.
- On the microwave bands, you benefit when your antennas can see over local obstructions (think of Texas cedar trees and Iowa corn stocks).

Vertical Elevation of Mast(s) - cont.

- ➢ **The obvious advantages are:**
  - ✓ **Better performance when located at "average" locations**
  - ✓ **Lower angle-of-radiation for the "low" bands (6 – 0.7 meters)**
  - ✓ **Less vehicle noise pick-up**

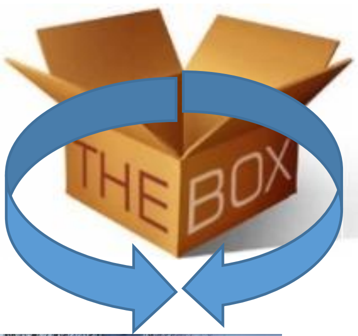
- ➢ **The disadvantages include (but are not limited to):**
  - ✓ **Higher complexity , cost and weight**
  - ✓ **Longer assembly & disassembly time before and after roving**
  - ✓ **Longer set-up and break-down times while roving**
  - ✓ **Opportunities for making more mistakes**


Two Dimensional
(Flat)

Azimuth Rotors

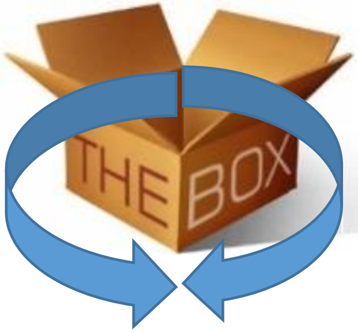
- **While rotors may seem like an obvious choice, many rovers use fixed, forward aimed antennas that are dependent on the vehicle steering wheel for azimuth aiming. This is a very acceptable alternative and has been used very successfully by many well known rovers.**

- **Over time, some rovers chose to add an antenna rotor as an operating convince and/or necessity for cramped operating locations. It allows them to have more accurate and faster changes in azimuth bearings.**



Azimuth Rotors

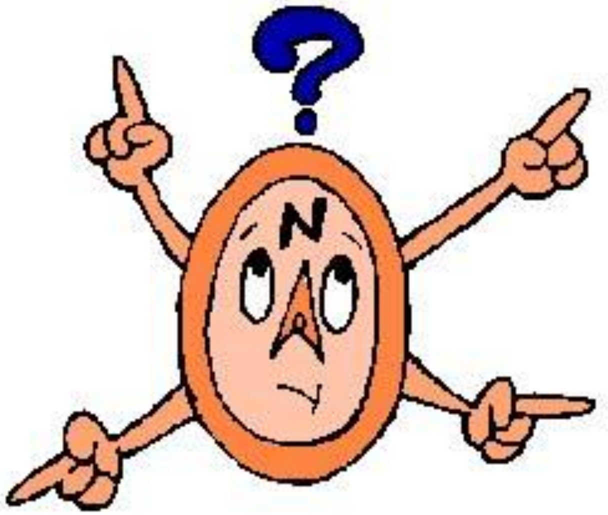
- ➢ **The obvious advantages are:**
  - ✓ **Better azimuth aiming accuracy**
  - ✓ **Faster antenna rotation**
  - ✓ **Access to smaller operating locations**
- ➢ **The disadvantages include (not limited to):**
  - ✓ **Higher complexity , cost and weight**
  - ✓ **Need for 115 VAC power**
  - ✓ **Longer assembly & disassembly time before and after roving**



Azimuth Rotors – cont.

- A major unanticipated consequence is the need for an azimuth bearing "off-set" when using a rotor.

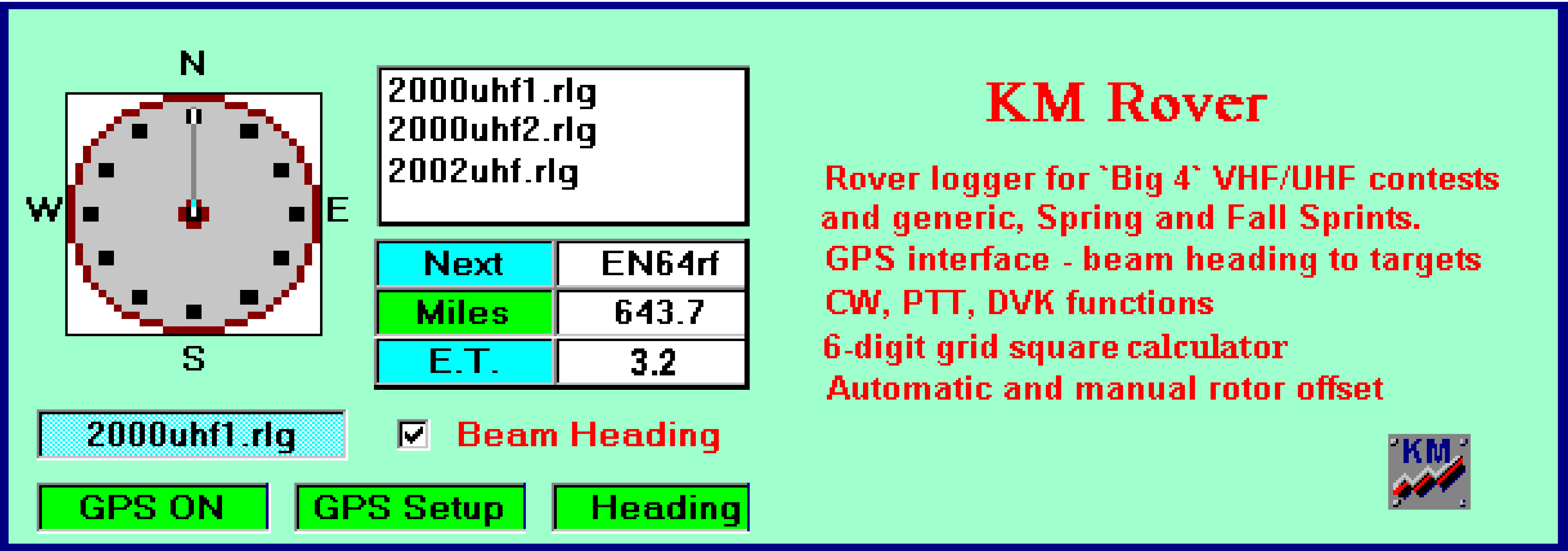
- Often an operating location will not allow your vehicle to park facing North.

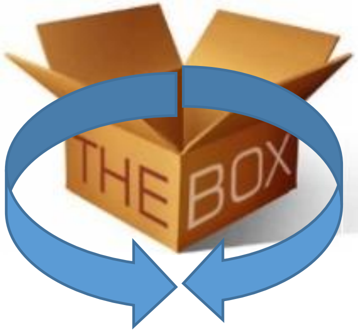


  - Therefore, all of your azimuth bearings will be off-set by a fixed amount making your bearing calculations more difficult.

Azimuth Rotors – cont.

- The use of an azimuth bearing off-set tool such as the KMRover logging program, etc. will help with this chore.



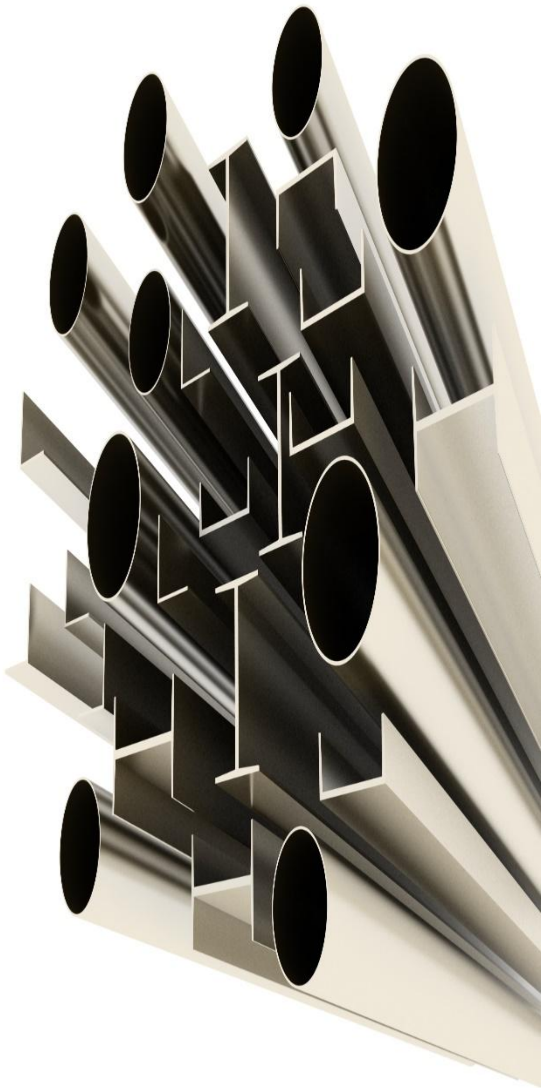


Azimuth Rotors – cont.

- Other rotor related issues include:
  - ✓Local RF interference generated by a DC to AC power inverter
  - ✓Additional coaxial cable distance for an around-the-rotor loop
  - ✓Rotor control cable
  - ✓Rotor base mounting
  - ✓Rotor/mast “strain-relief” bearing (if significant height and/or wind loading)
  - ✓Consideration of radius-of-rotation if operating in-motion and/or on road shoulders


Three Dimensional
(Spherical)

Multi-Dimensional, Collapsible Antenna Array



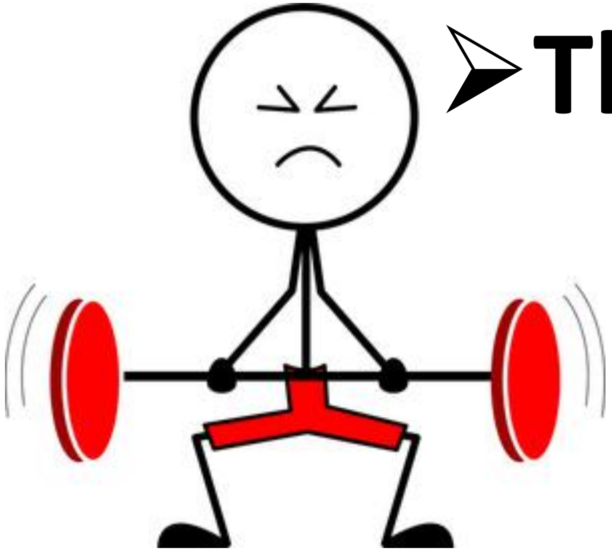
- **Over the last several years I've increased the amount of aluminum mounted on my single, rover mast more than a factor of 4. This includes adding bands, longer booms (within a limited turning radius) and more antennas. Each roving event has resulted in several steps forward and some steps backward as I've learned what works (and doesn't work) in the sometimes harsh, roving environments.**

Multi-Dimensional, Collapsible Antenna Array

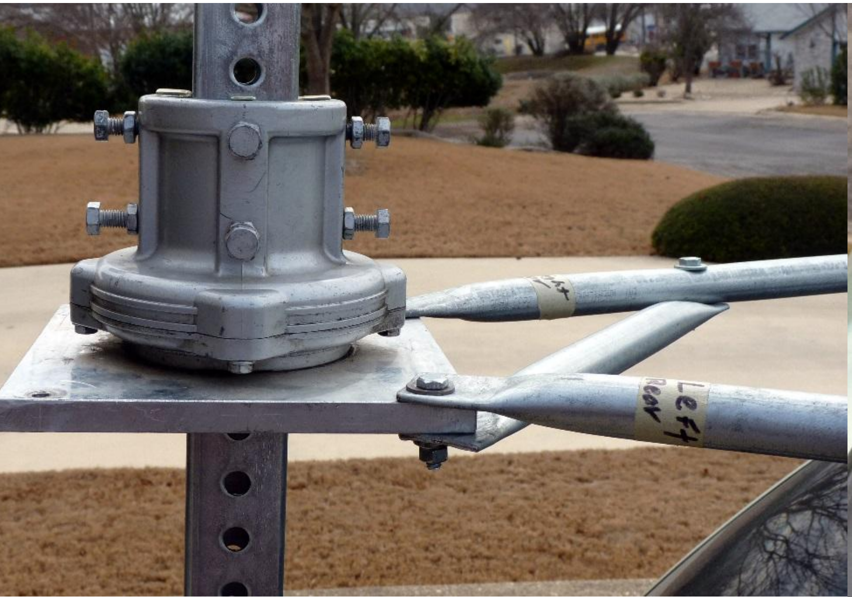
- **One of the major unanticipated consequence is the overall weight "creep". Even additional aluminum antennas can add significant weight to the single, push-up mast configuration when you factor in:**

- **Coax, relays, power-dividers, pre-amps and non-conductive mast materials.**

Multi-Dimensional, Collapsible Antenna Array



- This led to a redesign including:
  - Manual, crank-up "helper"
  - Strengthened thrust bearing to luggage rack brace
  - Stronger luggage rack bolts



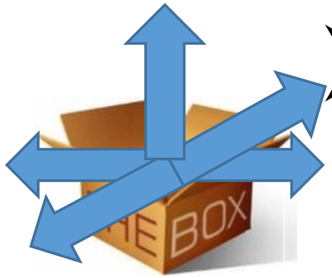
Multi-Dimensional, Collapsible Antenna Array

- **Another unanticipated consequence is the "nesting" difficulty when the entire push-up mast configuration is first elevated and then lowered from it's "operating" height of ~24' to it's "traveling" height of ~12'.**

Multi-Dimensional, Collapsible Antenna Array

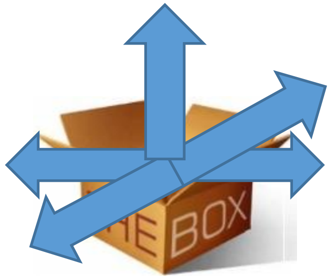
- **This must be accomplished manually within minimum set-up and break-down times so as to minimize the "down" time while roving.**

Multi-Dimensional, Collapsible Antenna Array - cont.



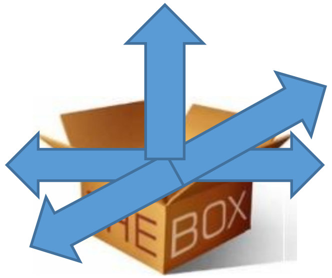
- Multi-Dimensional Antenna Arrays can result in a significant overall improvement in addition to whatever else you may have already tried as you pursue the conquest of working distant, weak signal stations.
- These configurations include:
  - ✓Vertical, 2-D stacking
  - ✓Horizontal, 2-D stacking
  - ✓4-square, 3-D stacking

Multi-Dimensional, Collapsible Antenna Array - cont.



- **Base stations often employ vertically and/or horizontally stacked antennas to improve both transmission and reception results. Using fixed tower(s)/mast(s) these are not too difficult to implement.**

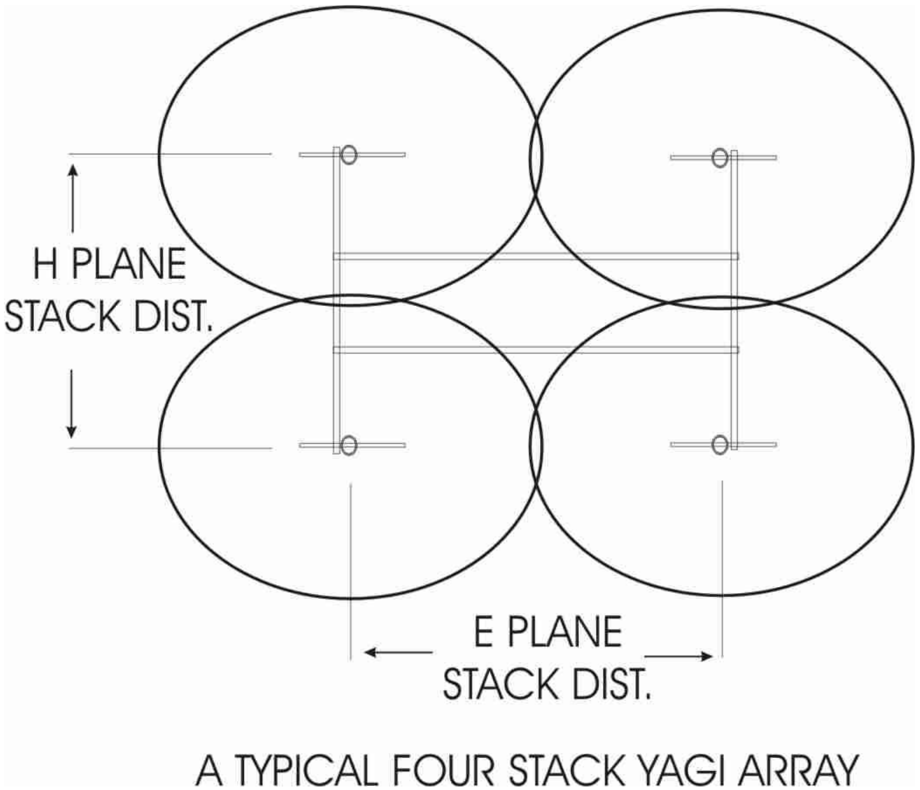
Multi-Dimensional, Collapsible Antenna Array - cont.

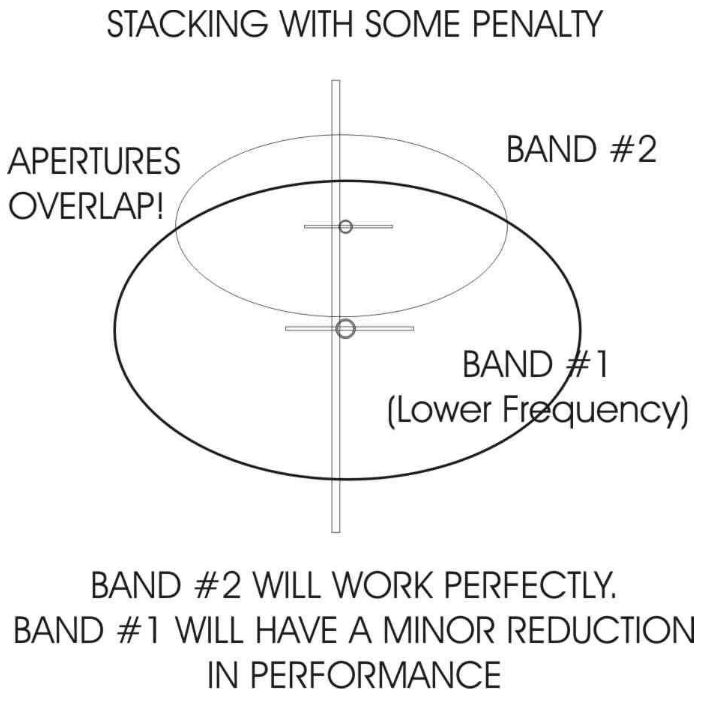


- **Adding 3-dimensional and/or 2-dimensional stacks to an already crowed, multi-band, rover-vehicle tower/mast can be a bit of a challenge.**

Multi-Dimensional, Collapsible Antenna Array - cont.

- **The effectiveness of antennas for more bands and/or higher gain may be compromised if they are just "crammed" onto a single rover antenna mast without consideration of their mutual interaction and cross-talk (think of burned out pre-amps).**





Multi-Dimensional, Collapsible Antenna Array - cont.

- **The use of a rover vehicle as a platform for a mobile tower/mast necessitates meeting various state and federal road restrictions and optimum stacking distances may not meet these requirements:**
  - ✓ **The traveling height (due to bridges and overhanging trees**
  - ✓ **Radius of rotation for operating while in motion and while stopped on road shoulders**
  - ✓ **Overall width while traveling on highways**
  - ✓ **Rear overhang warning flags**

Multi-Dimensional, Collapsible Antenna Array – cont.

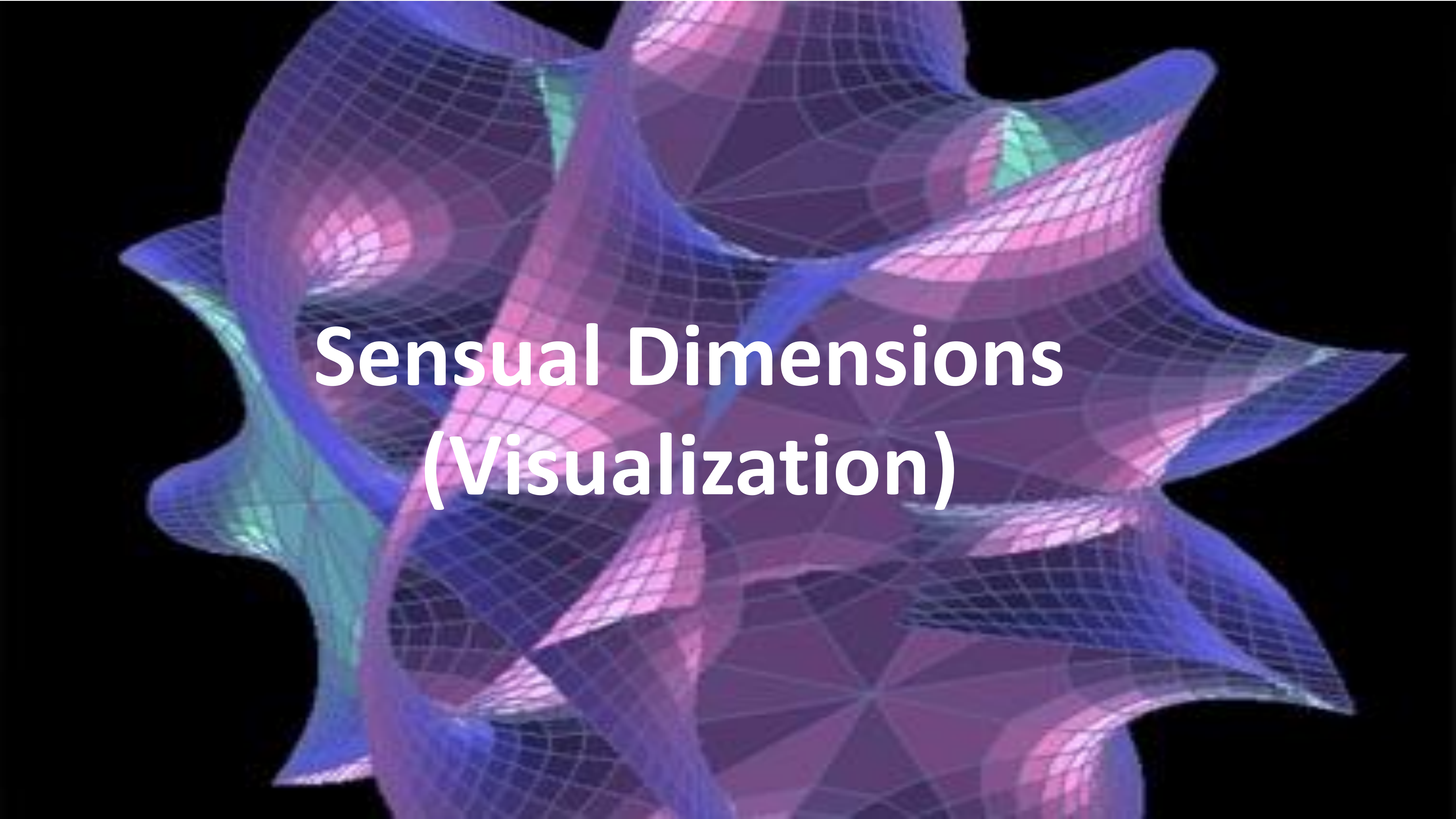
The obvious advantages are:

- ✓ Higher gain within a limited turning radius (overall boom length)
- ✓ Lower angle-of-radiation
- ✓ Higher transmit ERP
- ✓ Improved receive signal strength
- ✓ Ambient noise reduction

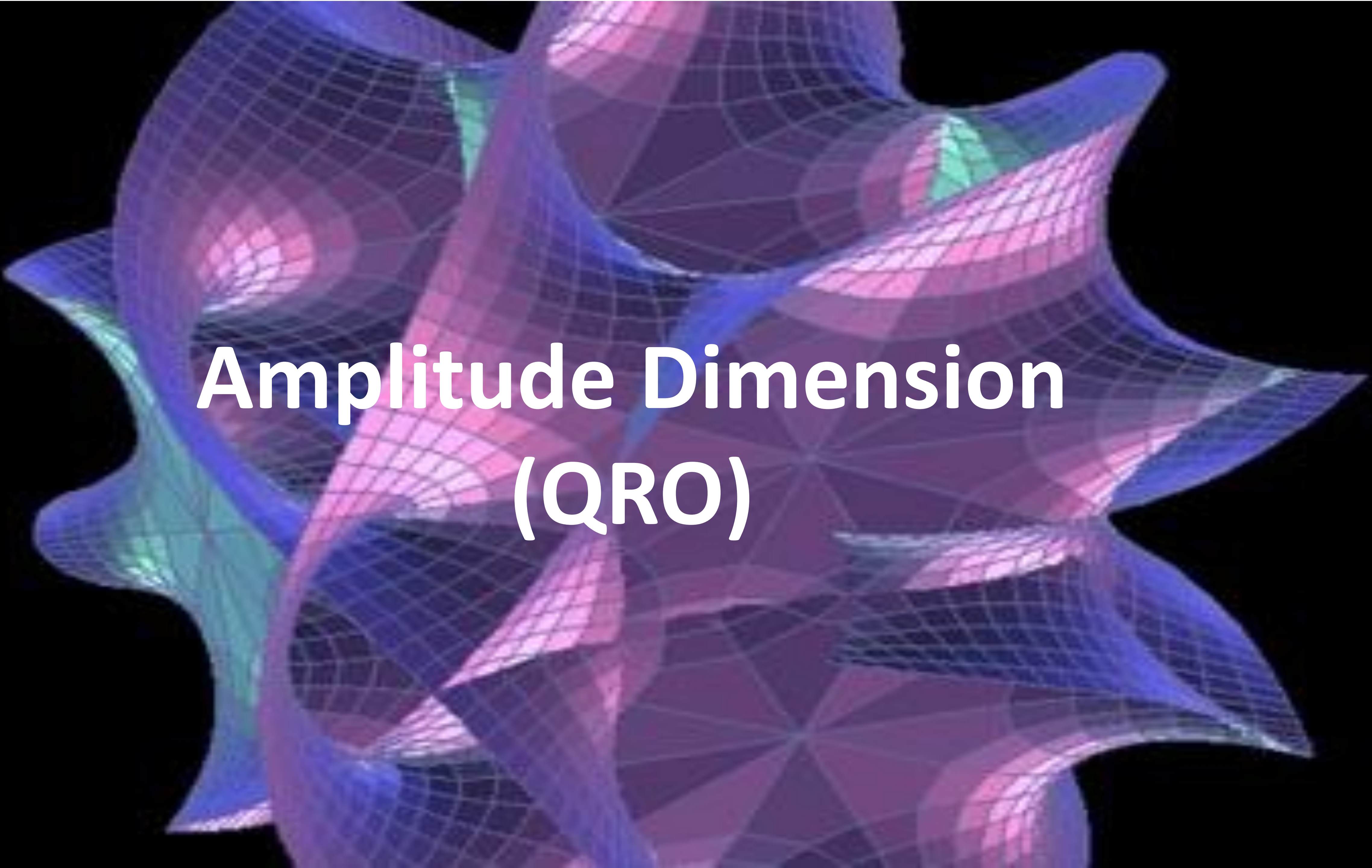
Multi-Dimensional, Collapsible Antenna Array – cont.

The disadvantages include (not limited to):

- ✓Higher complexity (2-4 X antennas, feeds, matching, power-dividers, non-conductive booms, etc.)
- ✓Higher cost and weight
- ✓Longer assembly & disassembly time
- ✓Longer set-up and break-down times
- ✓Higher traveling height
- ✓Tighter azimuth aiming and keeping the vertical mast plumb
- ✓Opportunities for making more mistakes


Sensual Dimensions
(Visualization)


FlexRadio Systems™ PowerSDR™ v2.0.22 FLEX-5000: 3207-5019
Setup Memory Wave Equalizer XVTRs CWX Mixer Antenna Report Bug
START
VFO A
7.150000
40M Ext/Adv SSB
TX
VFO Sync
VFO Lock
Tune Step:
1kHz
7.000000
Save
Restore
VFO B
14.071000
TX
20M RTTY
RX1 Meter
TX Meter
Signal
Fwd Pwr
-77 dBm
MON TUN
MOX
MUT
AF: 50
AGC-T: 90
Drive: 50
AGC
Preamp
Med
On
SQL: -150
RX1: ANT2
TX: ANT2
RX2: ANT1
3/29/2011
LOC 19:13:54
160 80 60
40 30 20
17 15 12
10 6
VHF+ WWV GEN
LSB USB DSB
CWL CWU FMN
AM SAM SPEC
DIGL DIGU DRM
1383.5Hz
-75.1dBm
7.151 383 MHz
Pan:
Center
Zoom:
0.5x 1x 2x 4x
5.0k 4.4k 3.8k
3.3k 2.9k 2.7k
2.4k 2.1k 1.8k
1.0k Var 1 Var 2
Low -2850 High -150
Width:
Shift
Reset
SPLT A > B
0 Beat A < B
IF->V A <> B
XIT 0
RIT 0
CPU %: 9.0
NR ANF
NB NB2
SR BIN
Panadapter
AVG Peak
MultiRX
Swap
Mic 5
DX 5
CPDR 2
VOX 200
DEXP -40
Transmit Profile:
Default DX
Show TX Filter on Display
RX EQ
TX EQ
VAC
RX2
Preamp
RX2 Band:
20m
Pan
VOL
Mute
AGC-T: 90
SQL: -150
AGC:
Med
Waterfall
RX2 Meter
Signal
-68 dBm
Low 150 High 2850


Amplitude Dimension
(QRO)

Higher Power - Roving with Solid State Amplifiers

“Make more noise!” - What’s New?

- ✓ **With the recent VHF+ contesting rules changes, you can now run up to 50 watts on 902 MHz and UP within the SOLP category.**
- ✓ **General rovers can run the authorized maximum power.**
- ✓ **Continuing introduction of higher power and/or lower cost solid state modules suitable for amateur radio use.**
- ✓ **Popularity of digital modes (require higher duty cycles)**

Higher Power - Roving with Solid State Amplifiers

"Make more noise!" - What are the challenges (for rover usage)?

✓Power

- LDMOS (KW) requires 50 VDC @ up to 30 amps within a rover
- XRF-286 (Spectrain-75W) requires 26 VDC @ up to 20 amps
- GaAs FET (Kuhne-50W) requires 13 VDC @ up to 20 amps
- TE Systems-375W requires 13 VDC @ up to 70 amps

✓Power Options:

- Voltage Boosters
  - TGE 13 and 26 VDC models

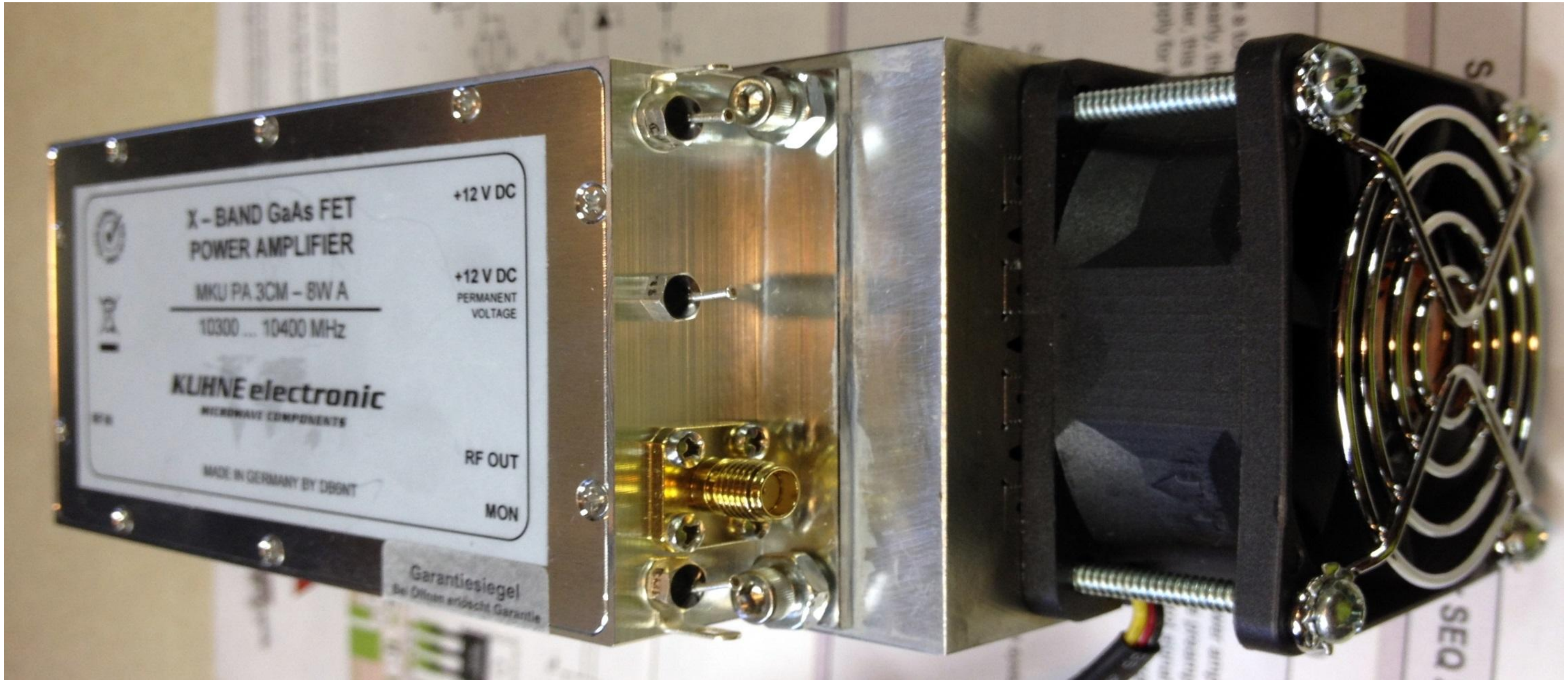
- Generators

Higher Power - Roving with Solid State Amplifiers

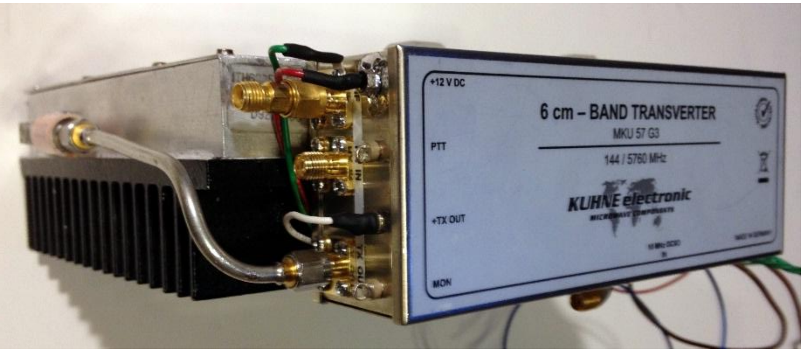
"Make more noise!" - What are the challenges (for rover usage)?

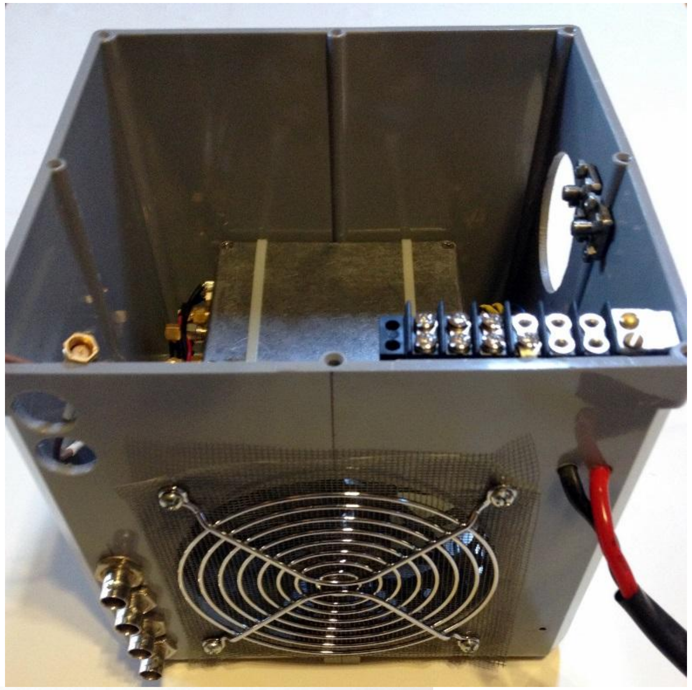
✓**Cooling**

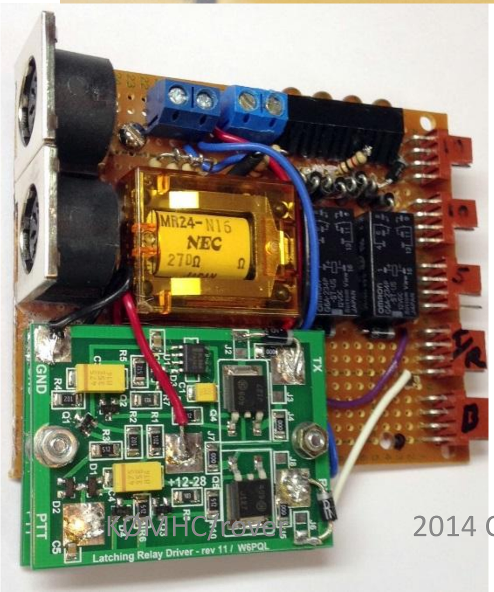
- **Linear classes with continuous dissipation and long duty cycles**
- **Improved heat transfer, spreader and heat sink dissipation**



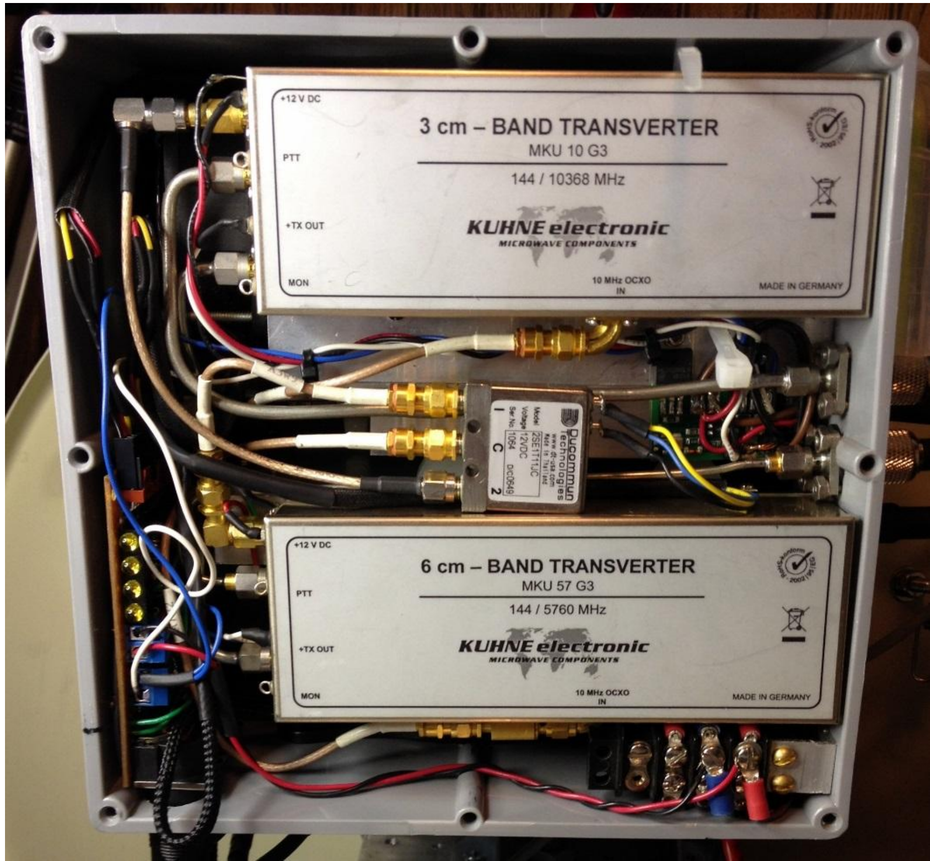
Dish-band Example – Packaging & Cooling





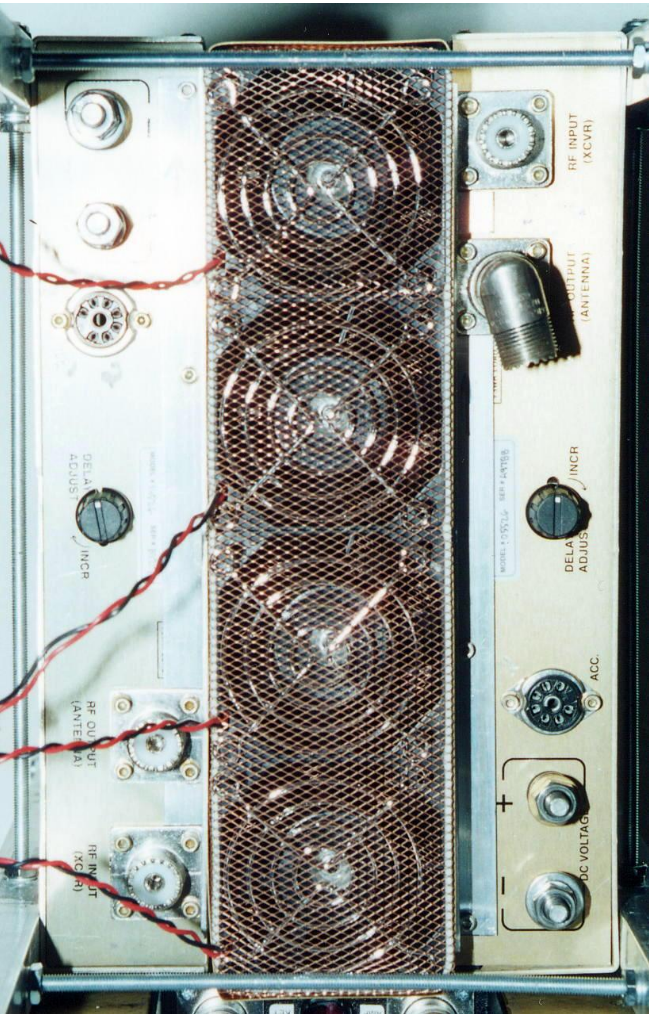


8" x 8" x 7"
microwave "box"

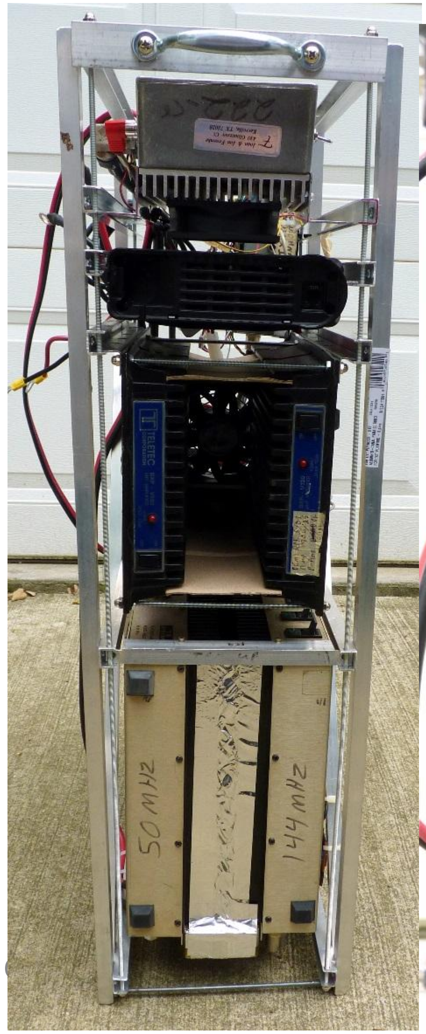


Low-bands Example – Packaging & Cooling

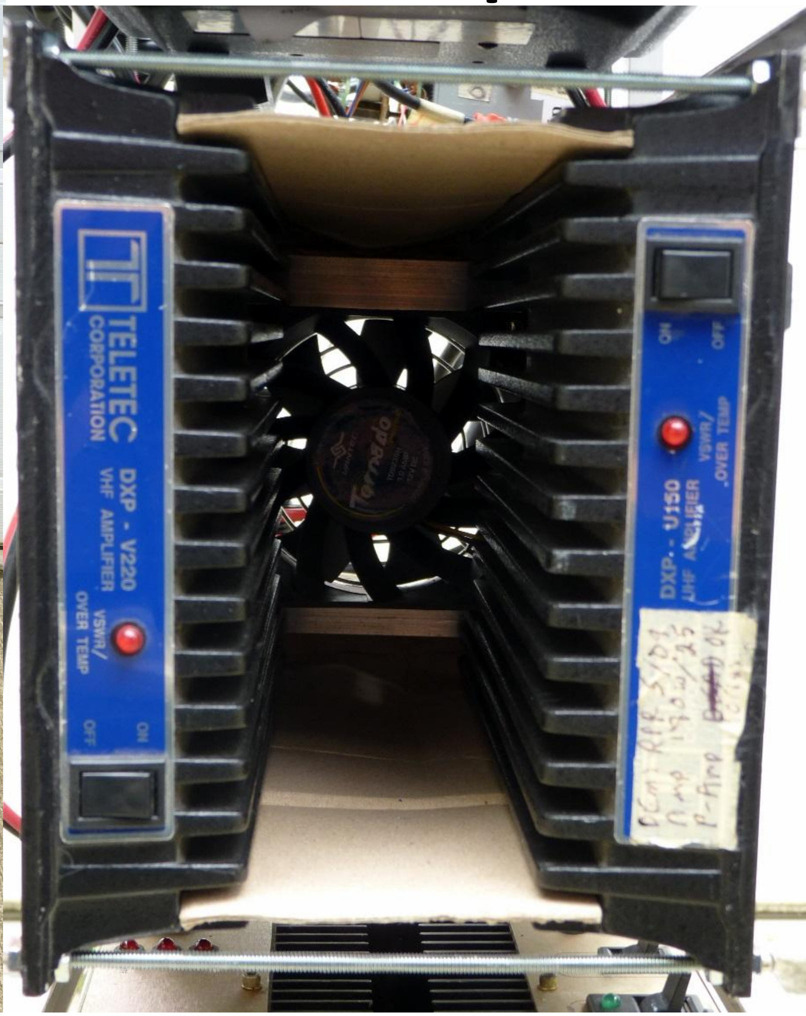
6 & 2 meter TE System amplifiers



8” W x 32” H Rover Rack



1.25 & 0.7 meter TELETEC amplifiers



Higher Power - Roving with Solid State Amplifiers

"Make more noise!" - What are the challenges (for rover usage)?

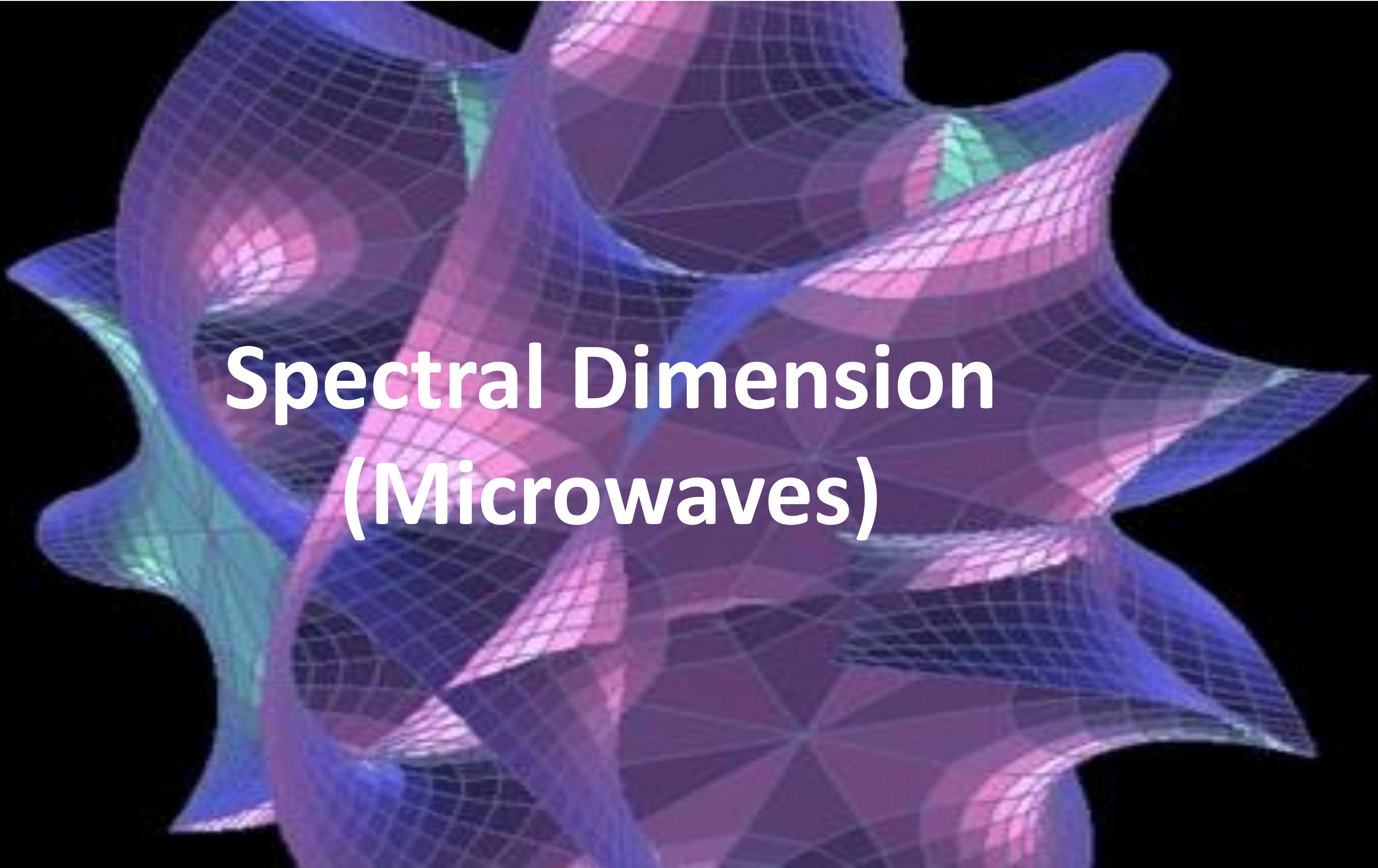
✓ **Protection**

- **Over drive, voltage, SWR and thermal cutouts**
- **RF relay power handling and isolation**
- **Pre-amp sequencing**

✓ **Packaging**

- **Resistance to the diverse, rover operating environments**
- **Tolerance for the rugged, rover transpiration situations**
- **Multi-venue considerations:**
  - ❑ **Portable tripod**
  - ❑ **Mobile (Rover)**
  - ❑ **Fixed (Base)**

Spectral Dimension
(Microwaves)



Higher Frequency - Roving with Dish Bands

"It's where the action is!" - What's new?

- ✓**Frequency stability**
  - **Stable GPS and OCXO frequency sources and lower cost synthesizers**
- ✓**Improved Components**
  - **Dishes, Feeds and Modules**
- ✓**Improved digital modes**
- ✓**Popularity of dish-bands (5 GHz and up) - Particularly 10 GHz**

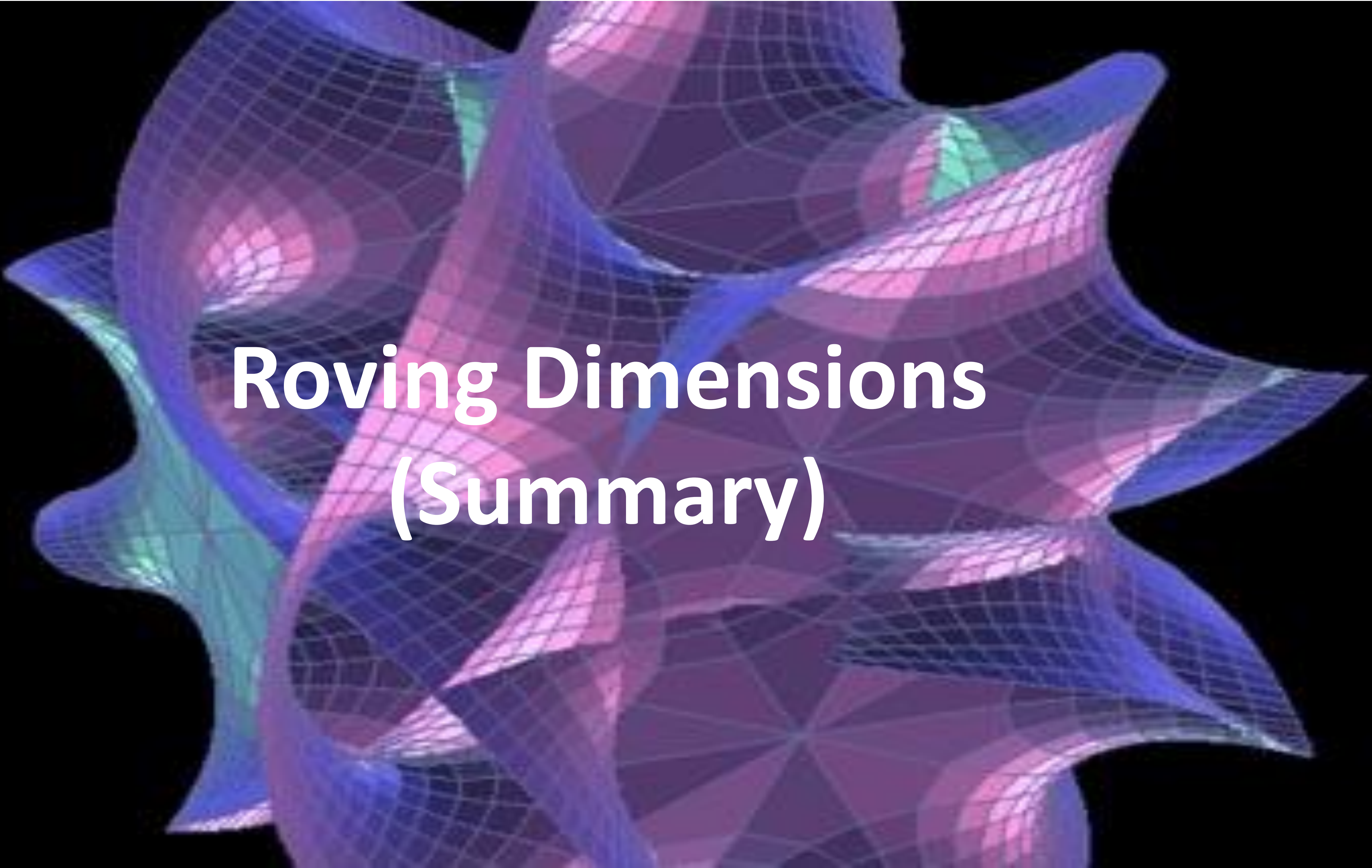
10 GHz; Everyone who's anyone is doing it!

Higher Frequency - Roving with Dish Bands

"It's where the action is!" - What are the challenges?

- ✓ **Station set-up and break-down time at each site**
- ✓ **Storage space (within rover vehicle)**
- ✓ **Accurate azimuth aiming**
- ✓ **Finding operating sites with better line-of-sight**

- Operating new propagation on microwave:
  - ✓ Rain, hail and snow scatter
  - ✓ Airplane reflection
  - ✓ EME



Roving Dimensions
(Summary)

Summary

- **Roving offers many opportunities to explore new dimensions.**
- **One-size-doesn’t-fit-all and everyone has limited resources. So, think about what most meets your needs and go-for-it!**
- **Don’t forget to: “Listen for the Weak Ones”**
  - In memory of Bill Seabreeze, W3IY/rover, SK

Future Roving Dimensions

- Time - Rapid Deployment
- Digital Modes:
  - Installation, setup and settings?
  - Prerequisites:
- Polarization Diversity
- Social - Family Participation

- Expanded Computer Assistance:
  - Visualization
  - Digital Modes
  - Band & Array Switching
  - Navigation
  - Logging
  - Azimuth & Elevation Control
  - Remote Control

References

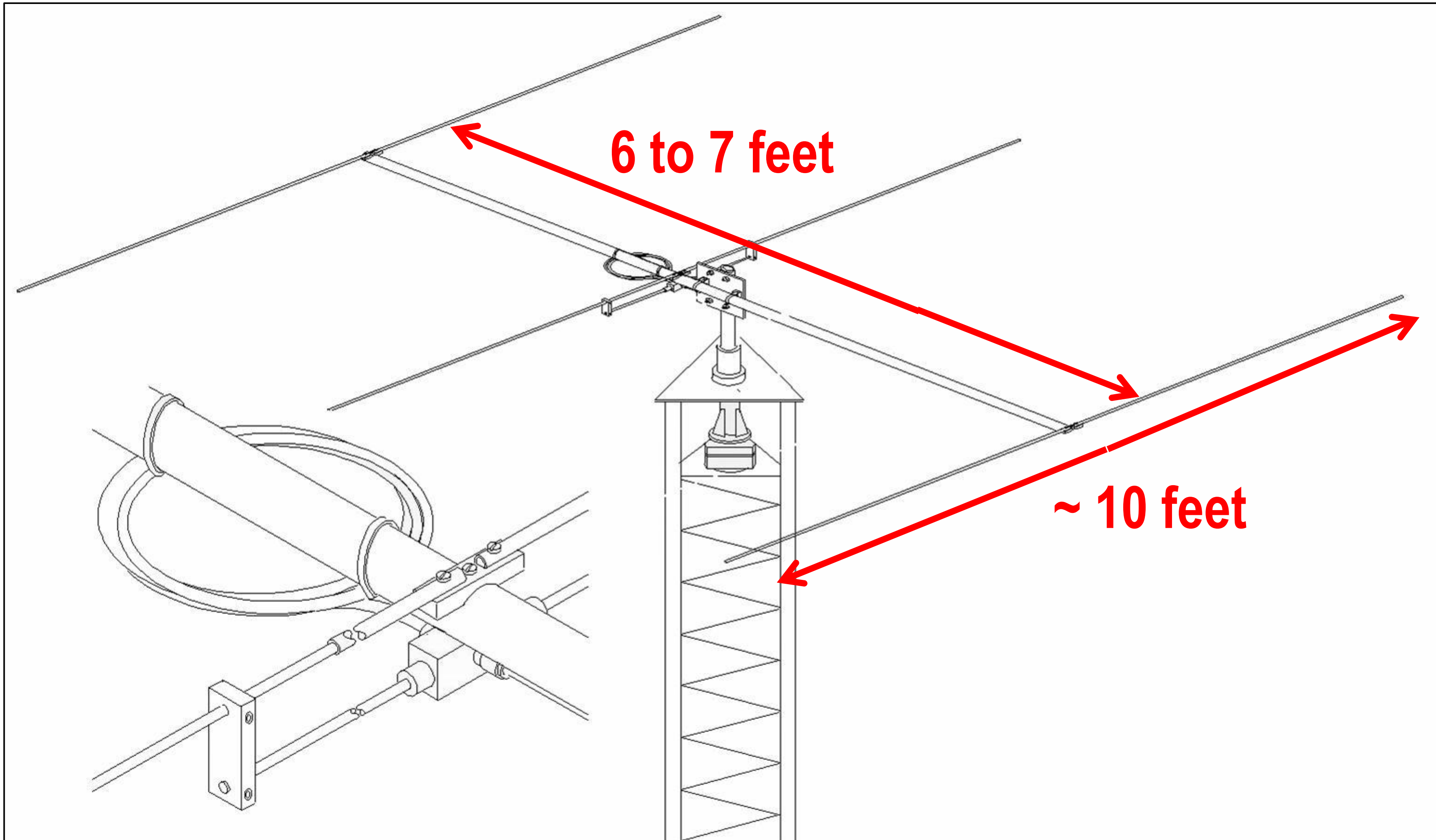
- 2014 CSVHFS Proceedings – text article
- 2006 CSVHFS Presentation – "From Entry to Extreme Roving"
- For access to my blog just Google: "KØMHC/Rover"
- Related Links:
  - Kuhne Electronics - Amplifiers
  - TGE - Voltage Boosters
  - KM Rover - Logger
  - Directive Systems - Antennas
  - PAR Electronics - Antennas
  - McMaster - Square Steel Tubing
  - Max-Gain Systems – Square Fiberglass Tubing


Thanks for your attention

A Reduced Size 6m Moxon For Roving

Jon Platt
W0ZQ/R
EN34

The Rovers 6m Antenna Dilemma #1
<u>They Are BIG</u> !



The Rovers 6m Antenna Dilemma #1

***They Are BIG* !**

The Rovers 6m Antenna Dilemma #2
You Need To Get Them Up "High" !

"Elevation Angles Required for 6m Sporadic E"

Carl Luetzelschwab
K9LA
21 October 2006
[unpublished]

http://k9la.us/

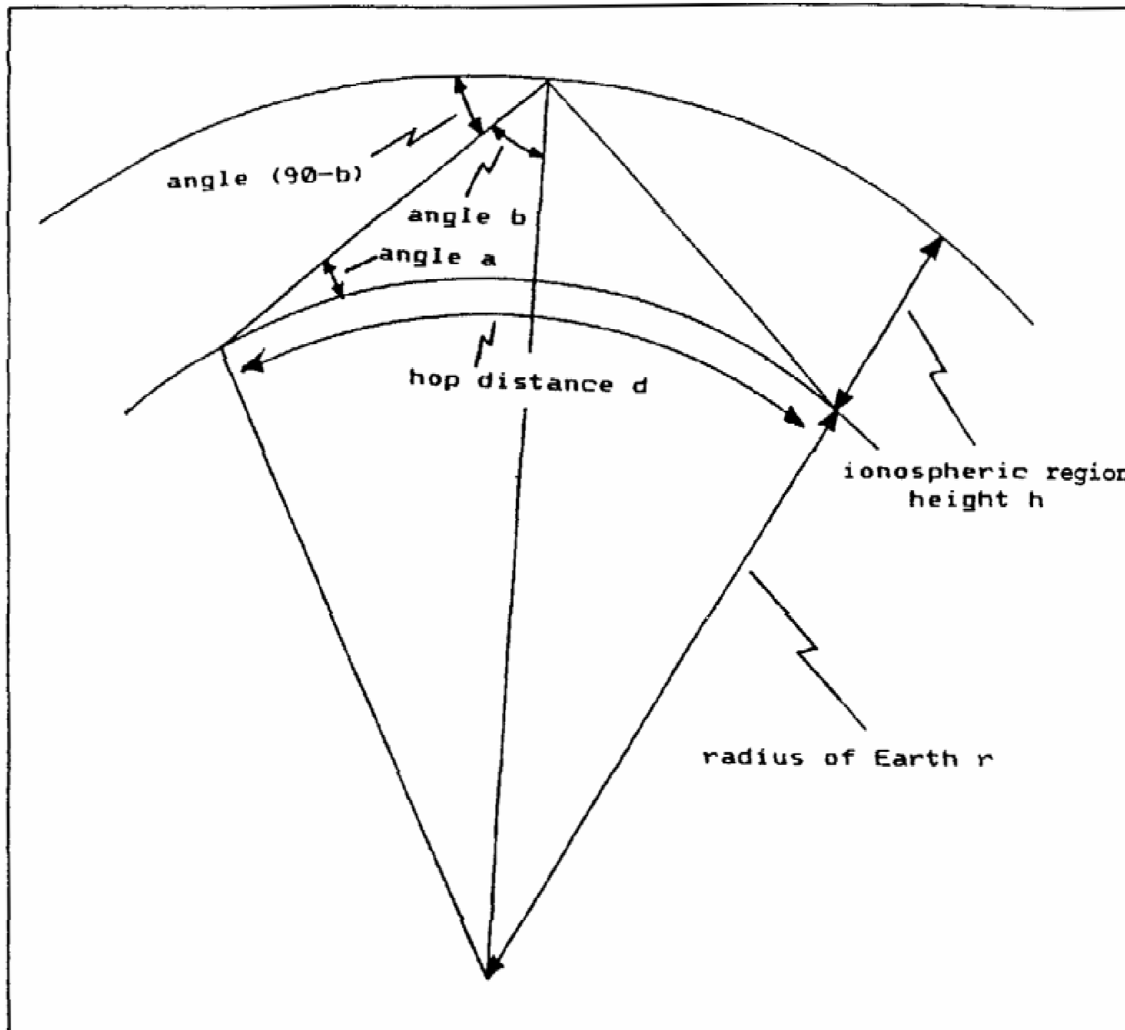


FIGURE 1

The Rovers 6m Antenna Dilemma #2

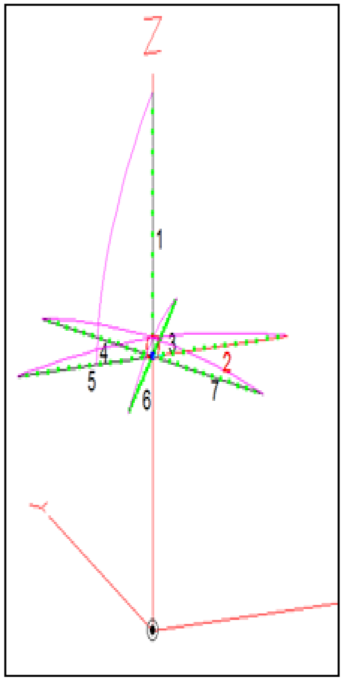
You Need To Get Them Up "High" !

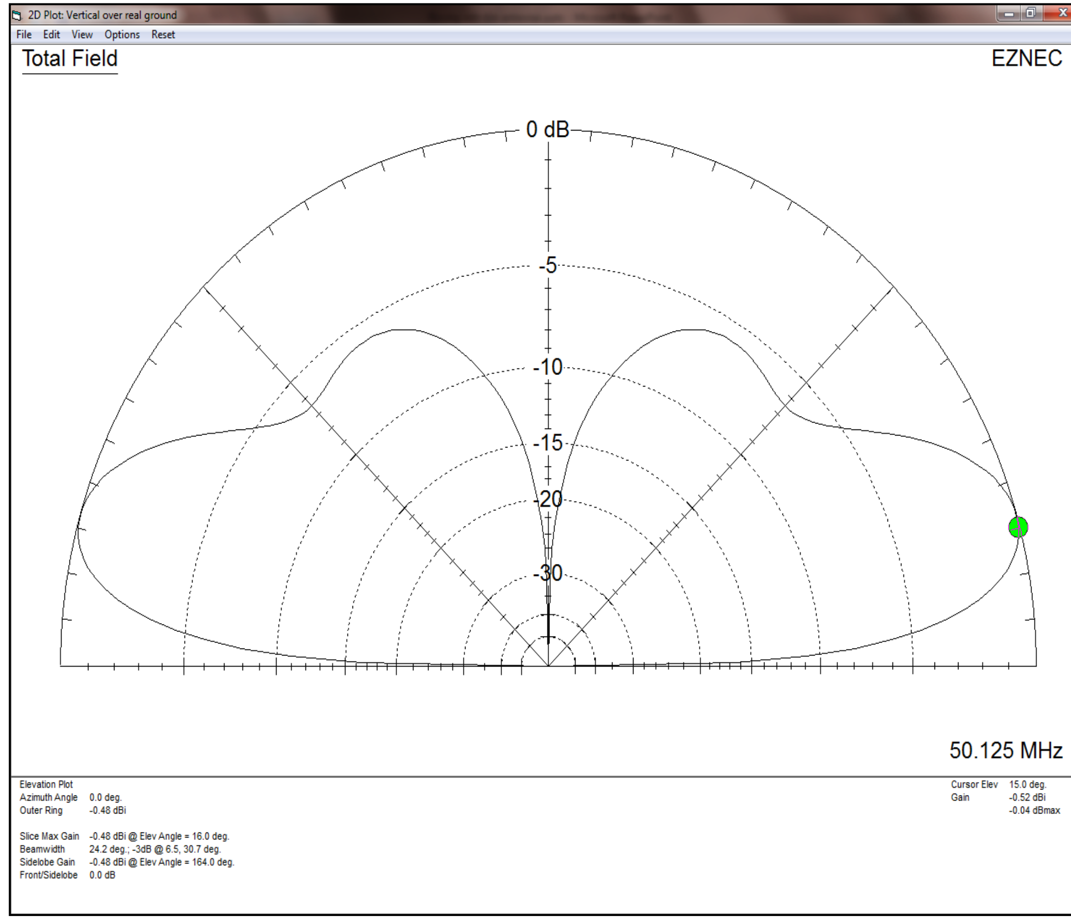
angle a	hop distance d	angle b	M-factor	required foE_s
0°	2297 km	79.67°	5.58	8.98 MHz
5°	1438 km	78.53°	5.03	9.96 MHz
10°	965 km	75.96°	4.04	12.40 MHz
15°	700 km	71.85°	3.21	15.61 MHz
20°	537 km	67.59°	2.62	19.12 MHz
25°	428 km	63.08°	2.21	22.67 MHz
30°	350 km	58.43°	1.91	26.23 MHz

Table 1 – Required Sporadic E Critical Frequencies

- ✓ **There is not enough ionization to refract signals at angles any higher than about 15°.**
- ✓ **All the propagation happens under 15° and especially in the 2° to 10° range.**

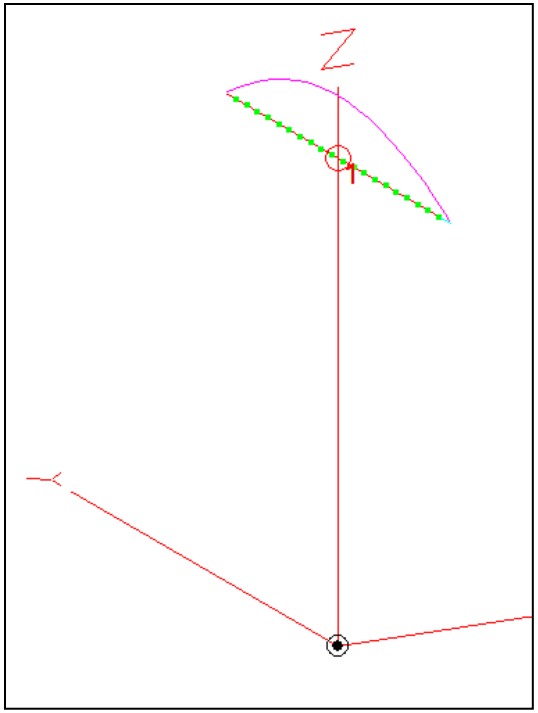
The Rovers 6m Antennas
Solution #1 - How About Verticals ?



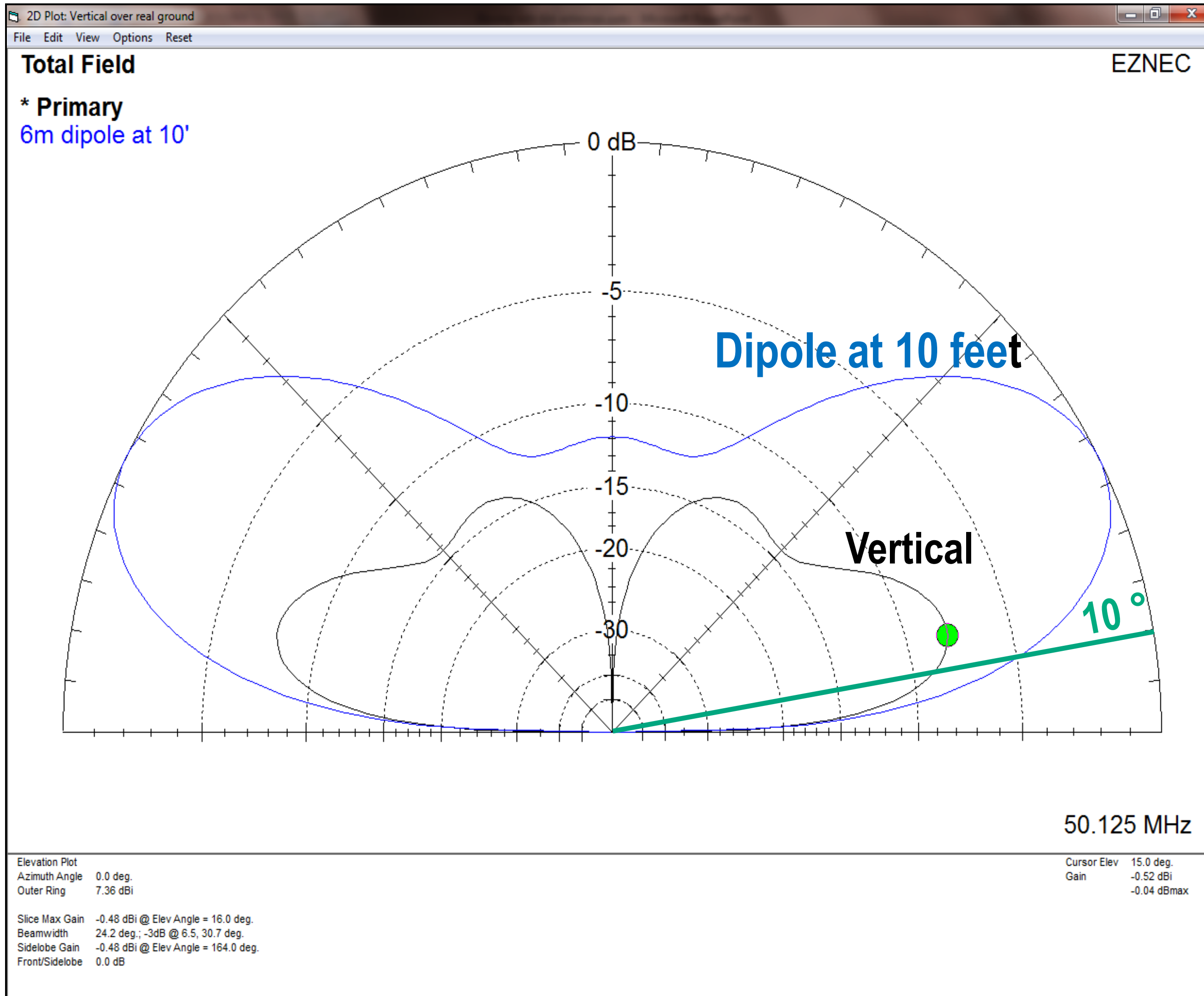


- **Base at 5 ft above ground**
- **Added 10 ohms for "ground loss"**
- **Using High Accuracy ground model**

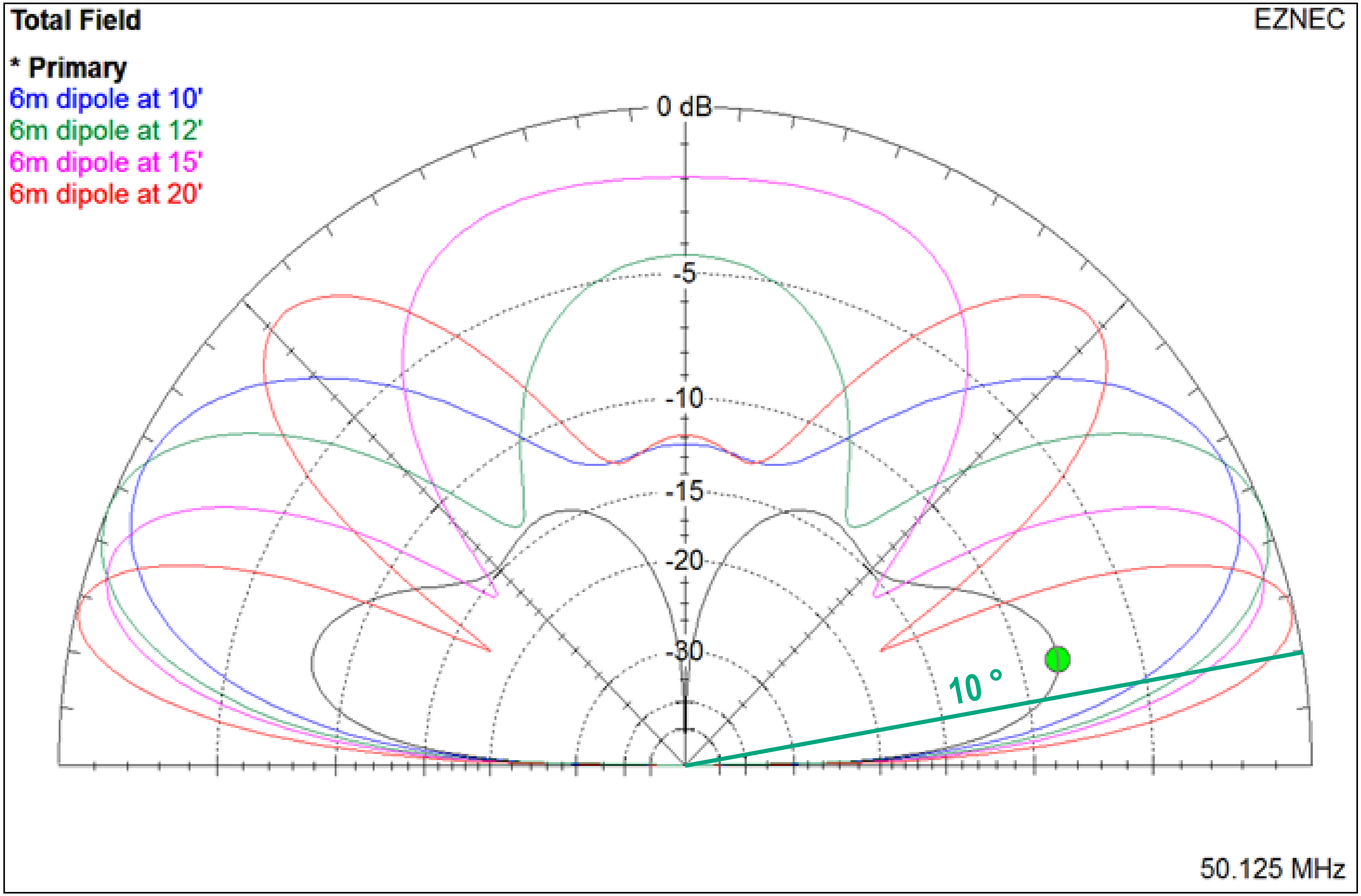
The Rovers 6m Antennas
Solution #1 - How About Verticals ?



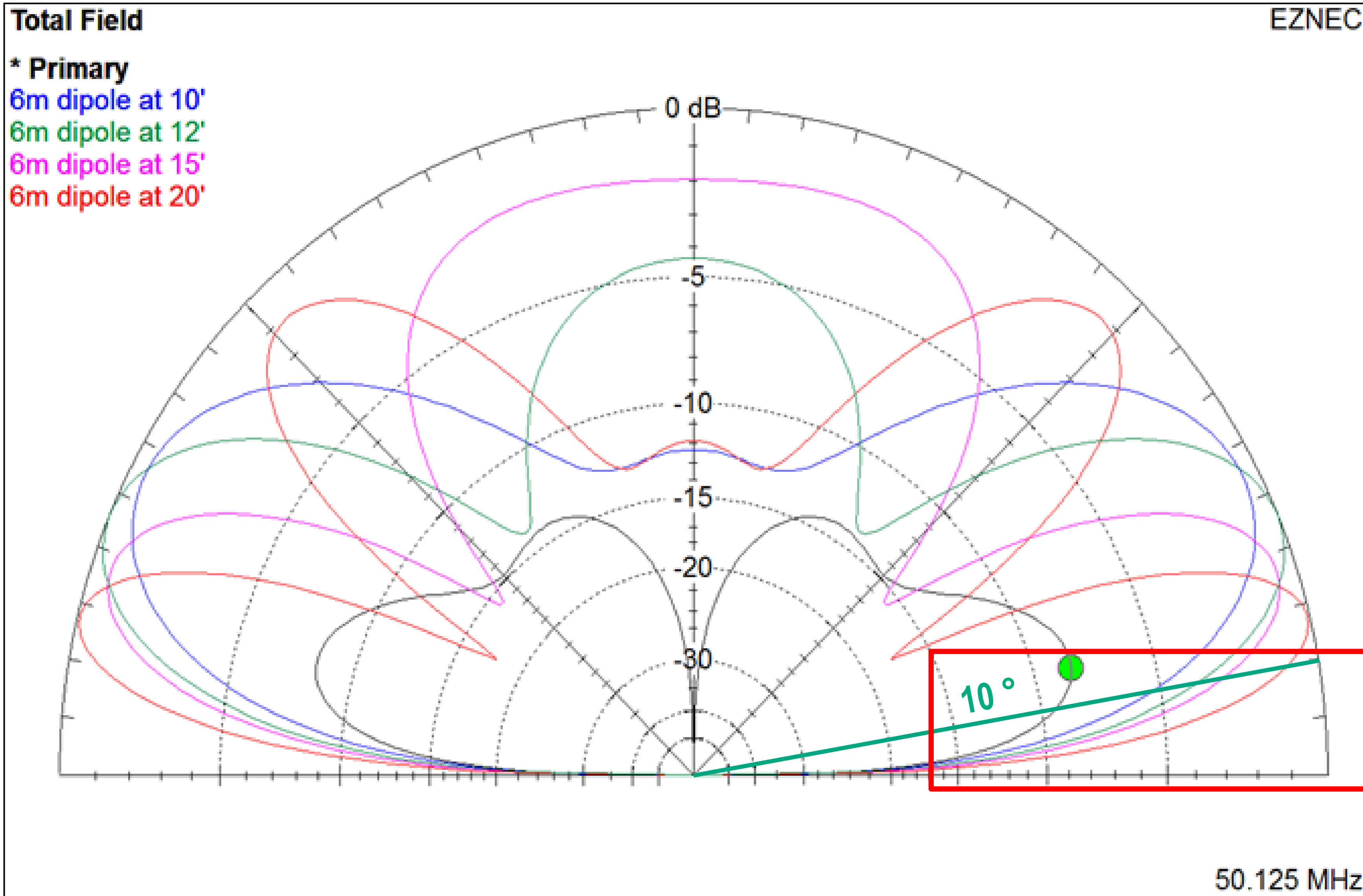
- 10 ft above ground
- Using High Accuracy ground model

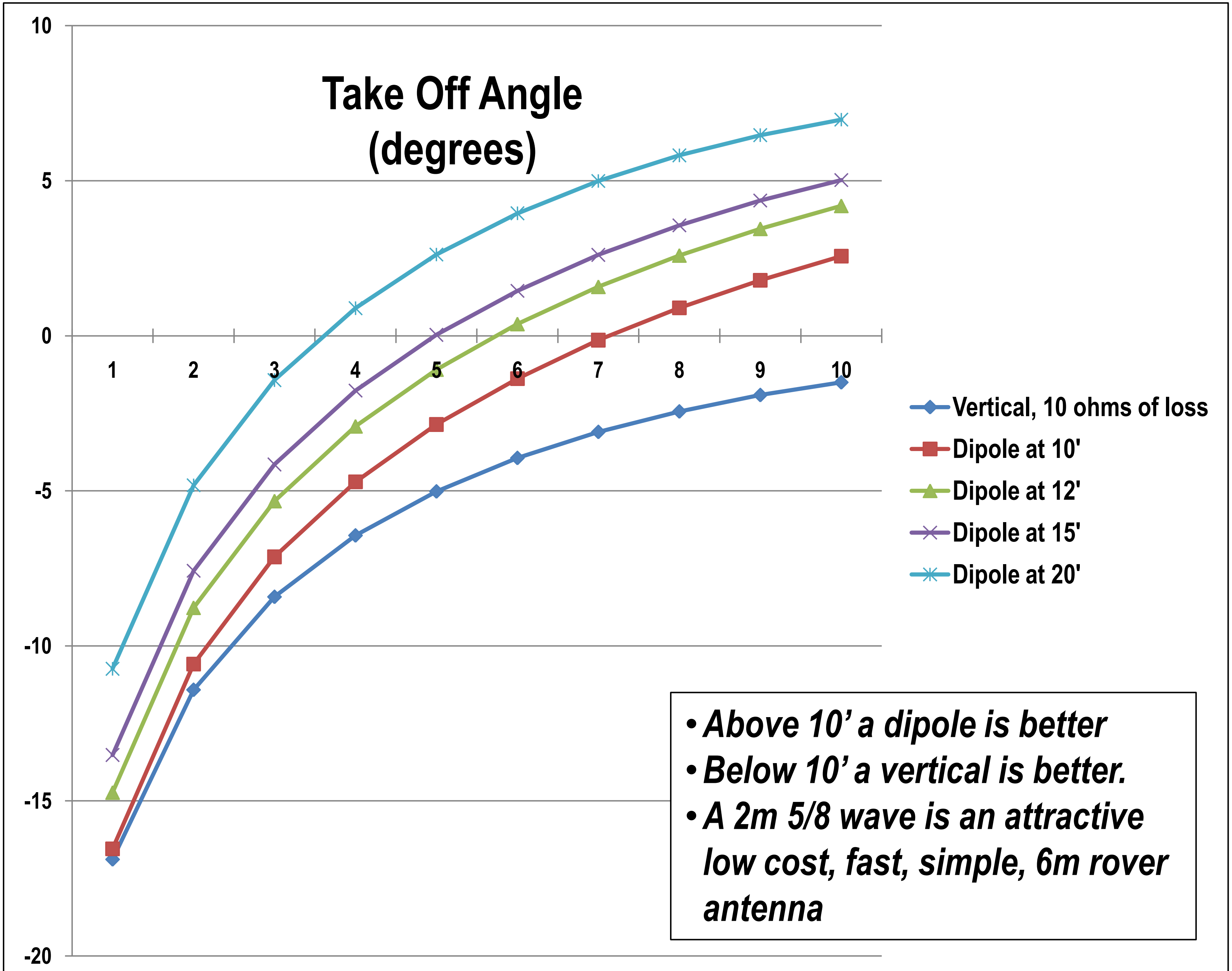


The Rovers 6m Antennas
Solution #2 – Higher Dipoles ?



The Rovers 6m Antennas
Solution #2 – Higher Dipoles ?



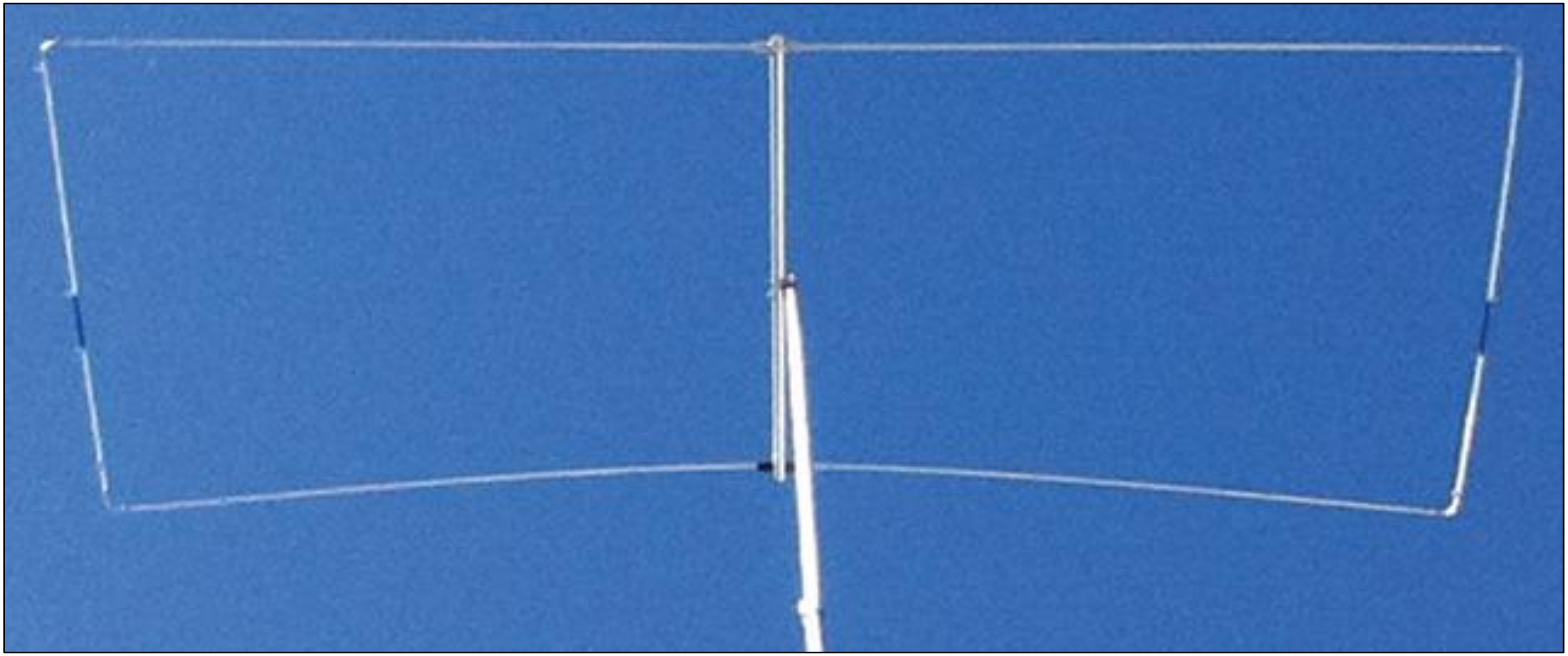


Take Off Angle
(degrees)
dB
10
5
0
-5
-10
-15
-20
1
2
3
4
5
6
7
8
9
10
Vertical, 10 ohms of loss
Dipole at 10'
Dipole at 12'
Dipole at 15'
Dipole at 20'
• Above 10' a dipole is better
• Below 10' a vertical is better.
• A 2m 5/8 wave is an attractive low cost, fast, simple, 6m rover antenna

The Rovers 6m Antennas
Solution #3 – Adding Gain ?

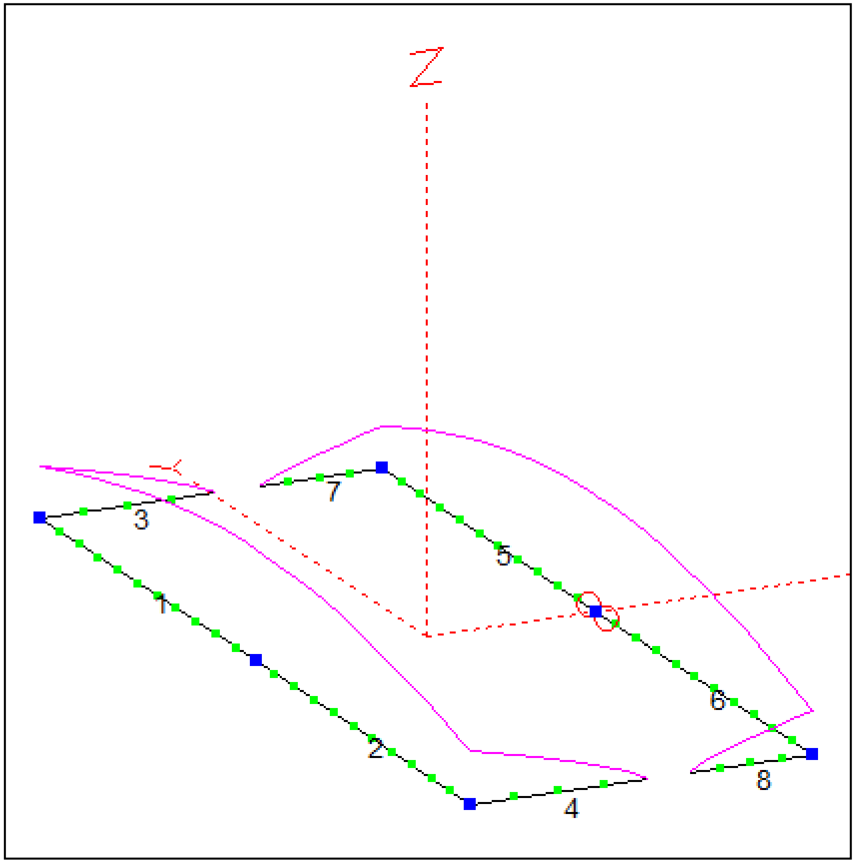
MFJ-1896 6m Moxon

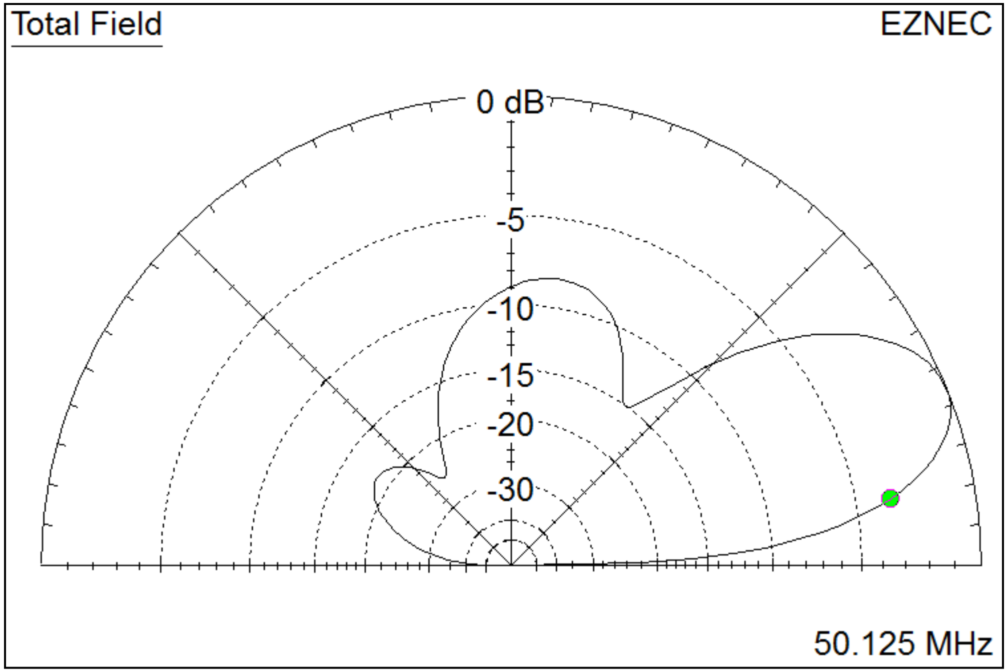
- ✓ **Low cost**
- ✓ **Easy to modify**
- ✓ **Direct coax feed (check the pig tails)**

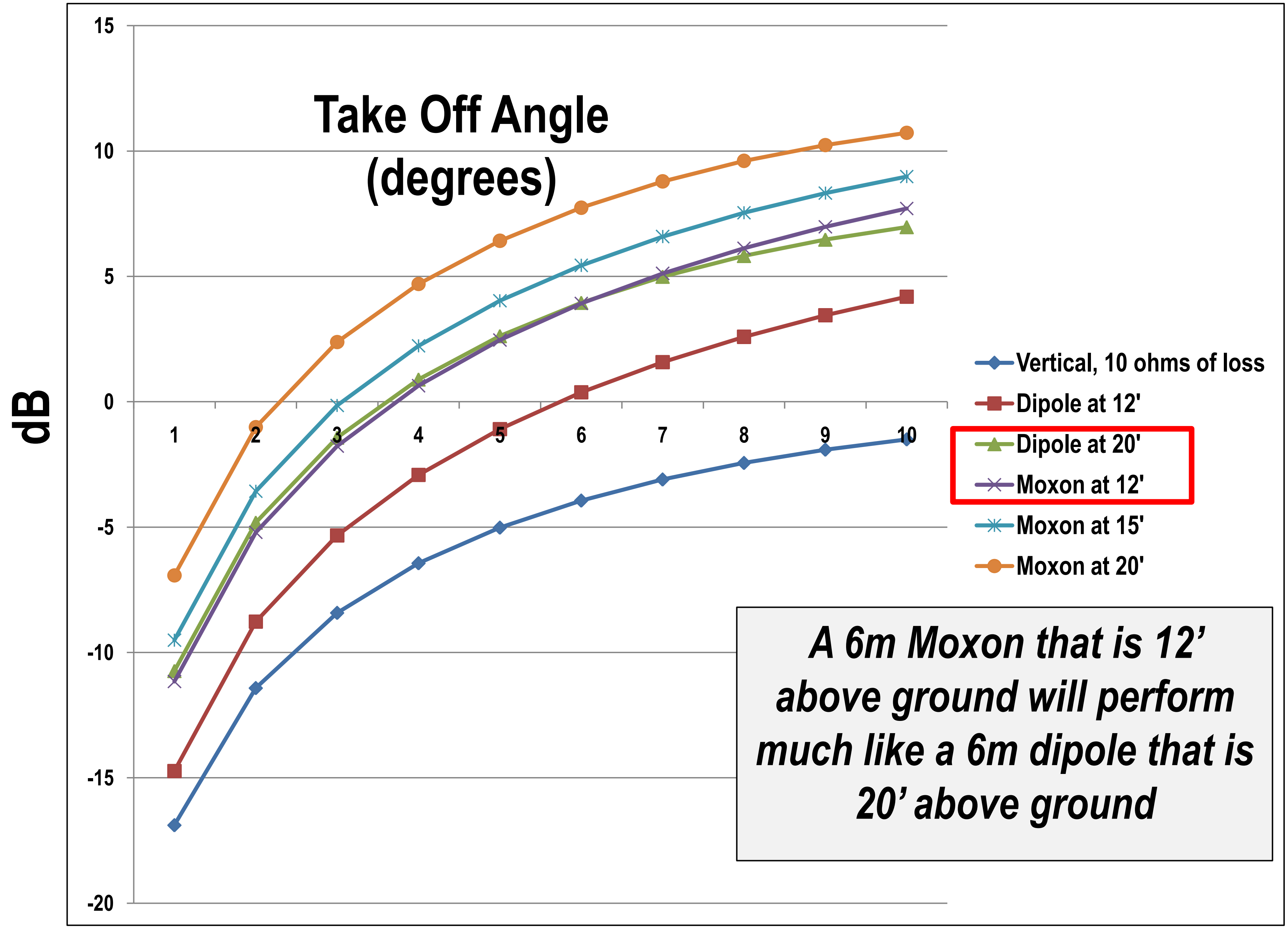


The Rovers 6m Antennas
Solution #3 – <u>Adding Gain</u> ?

MFJ-1896 6m Moxon

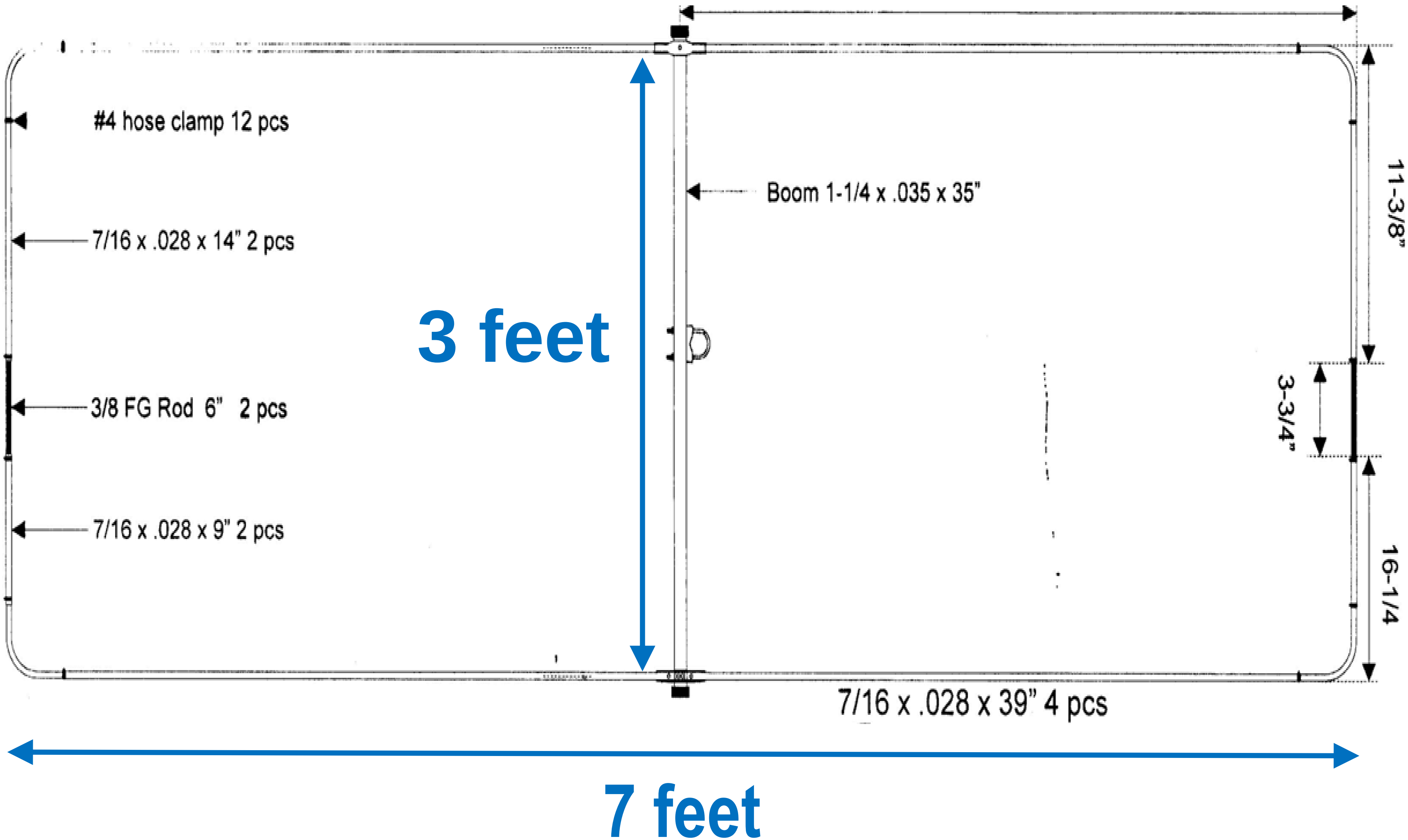




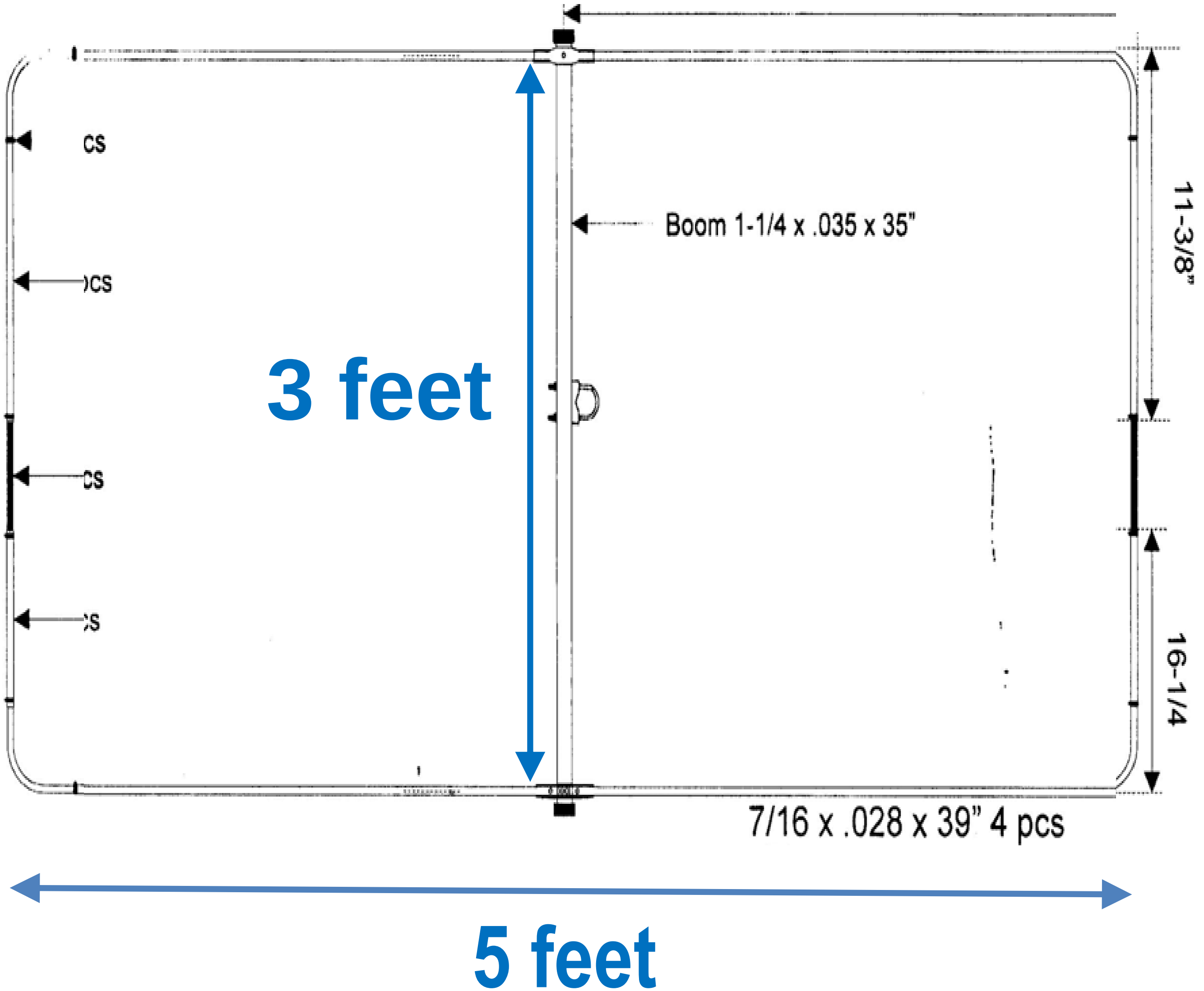


Take Off Angle
(degrees)
dB
15
10
5
0
-5
-10
-15
-20
1
2
3
4
5
6
7
8
9
10
Vertical, 10 ohms of loss
Dipole at 12'
Dipole at 20'
Moxon at 12'
Moxon at 15'
Moxon at 20'
A 6m Moxon that is 12' above ground will perform much like a 6m dipole that is 20' above ground

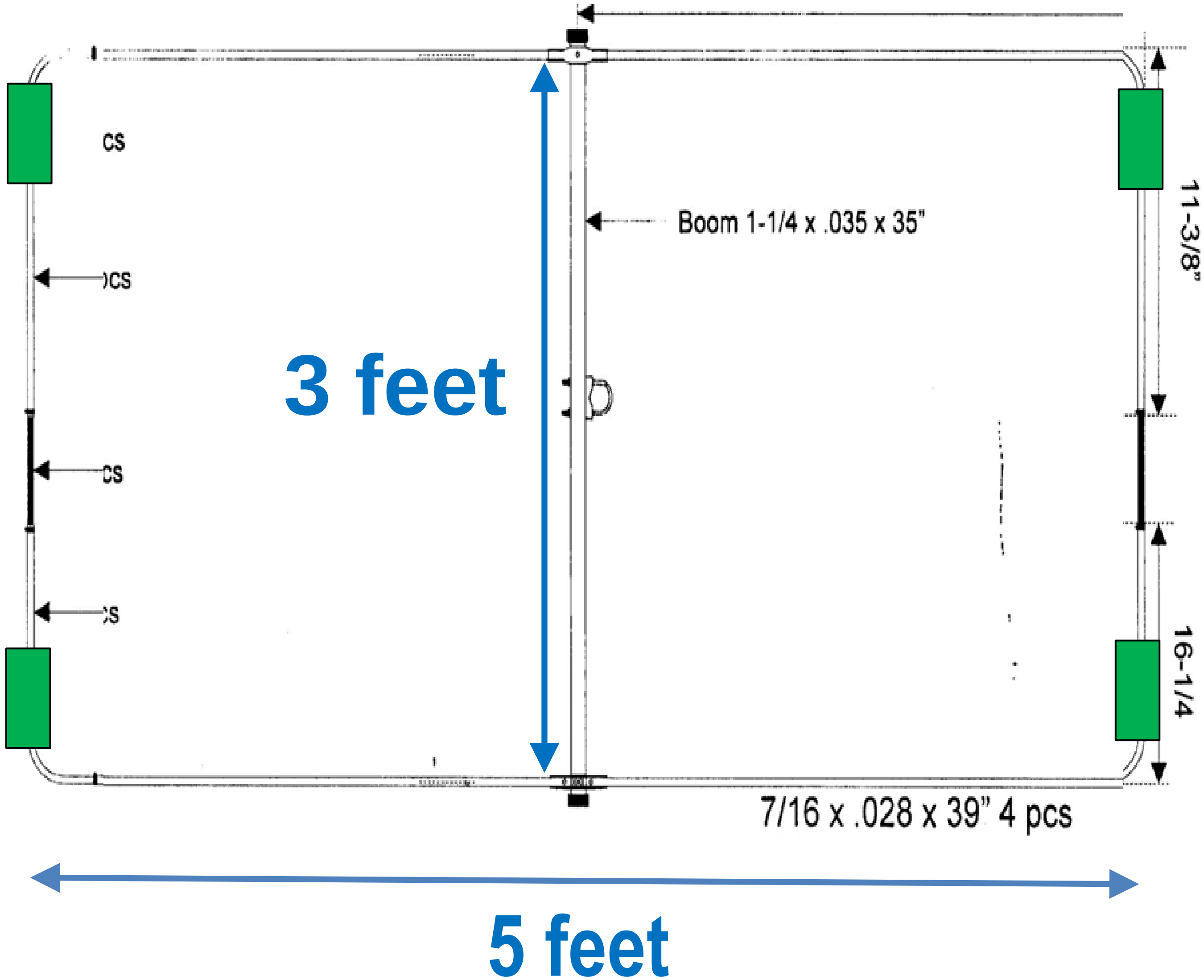
The Rovers 6m Antennas
MFJ-1896 …. But Its *Still* BIG !

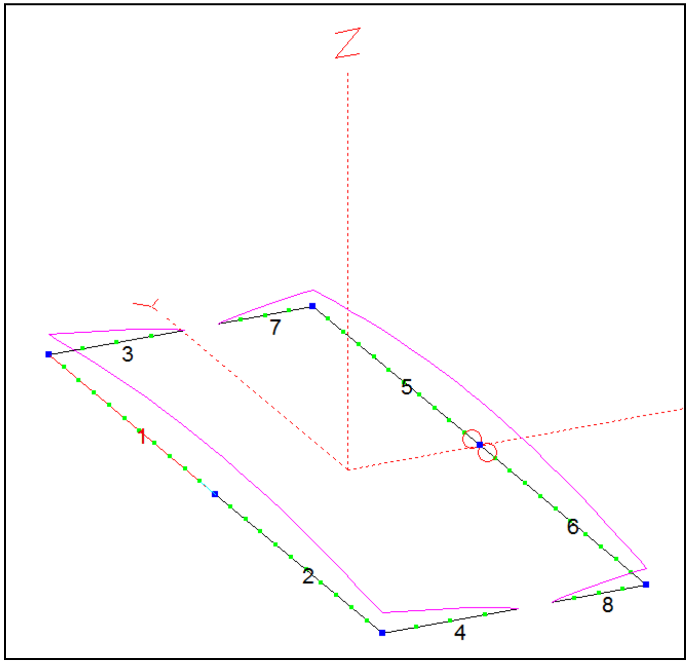


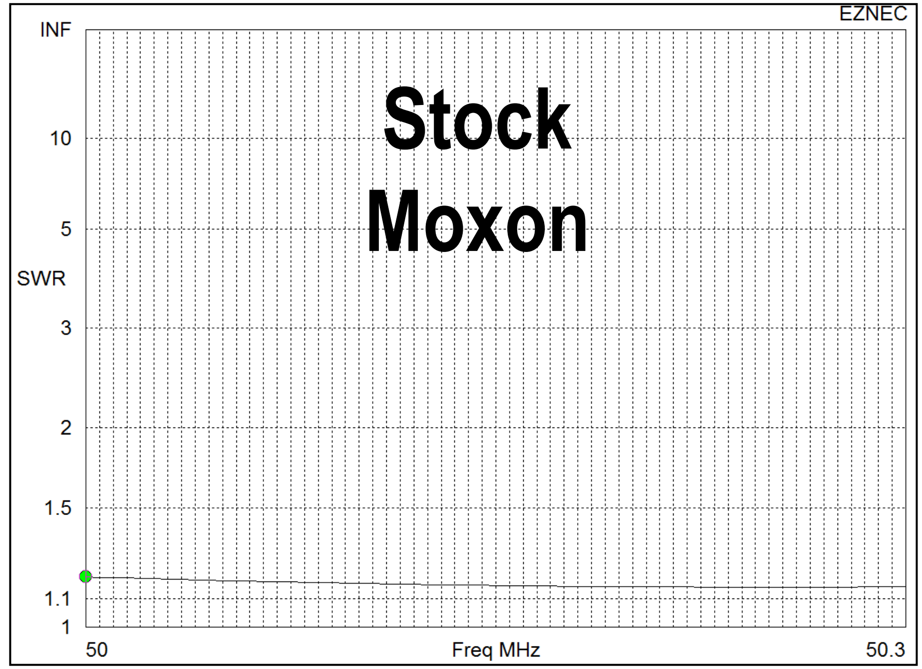
What If We Cut It One Foot On Each Side?

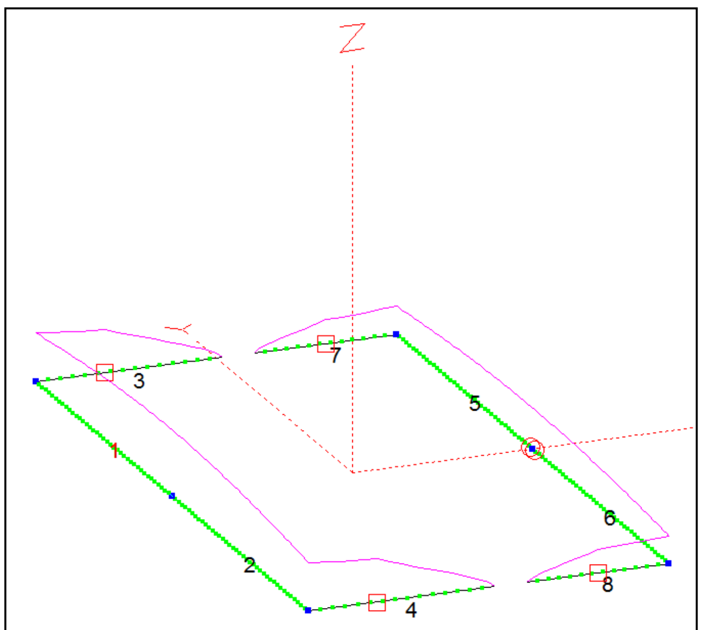


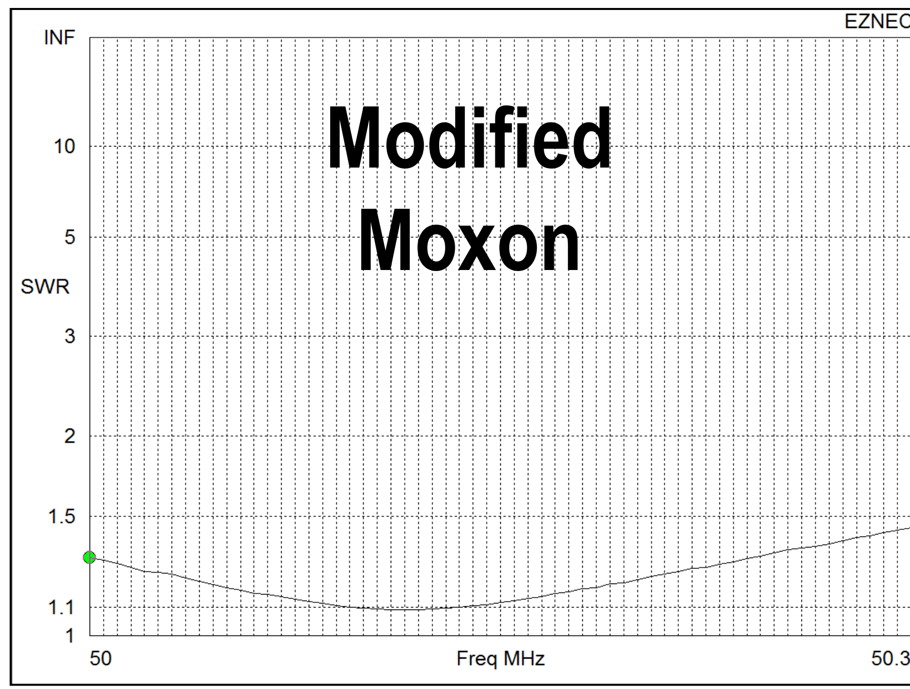
And Then Add Loading Coils ?



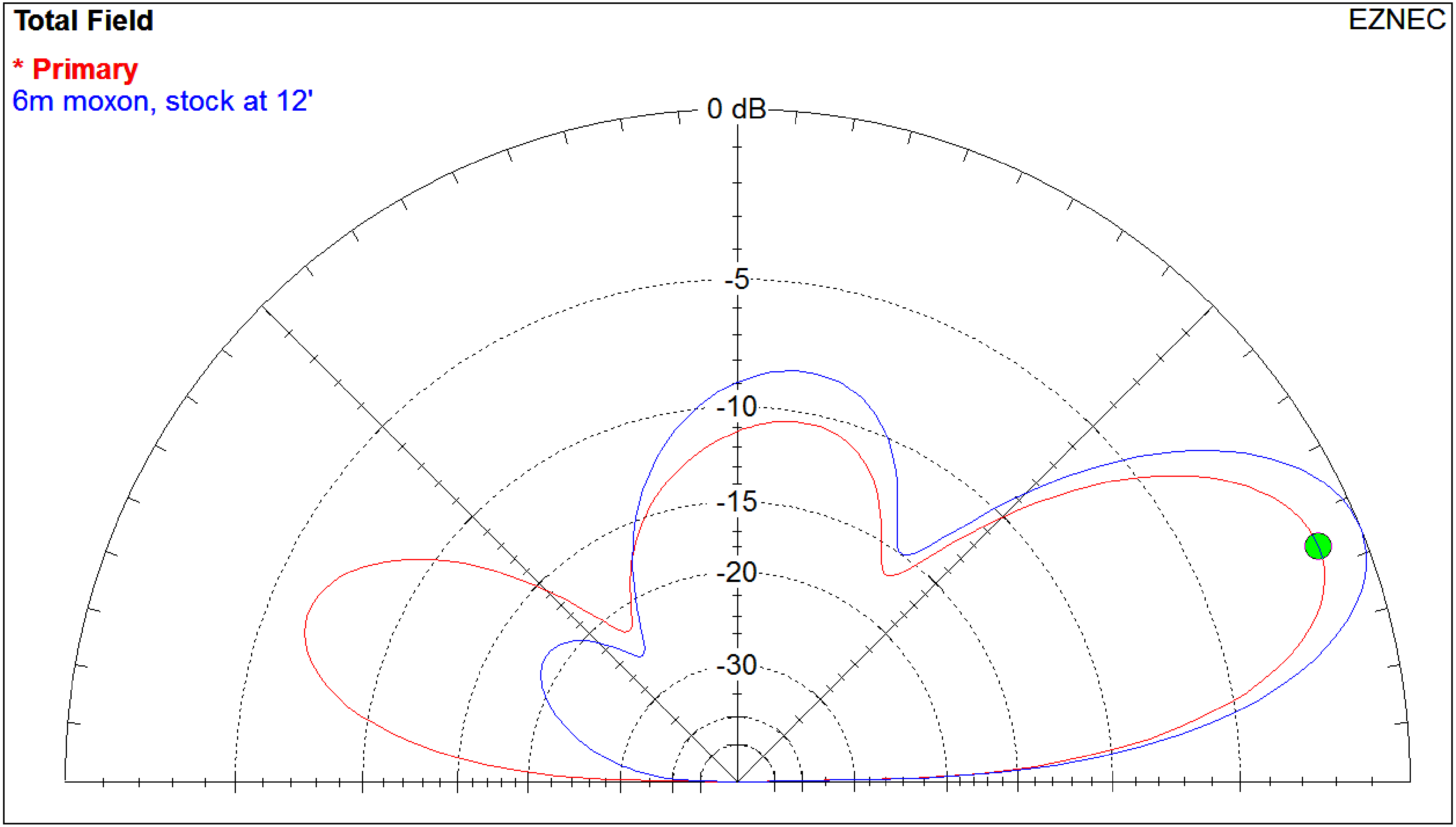

Z
3
7
5
1
6
2
8
4

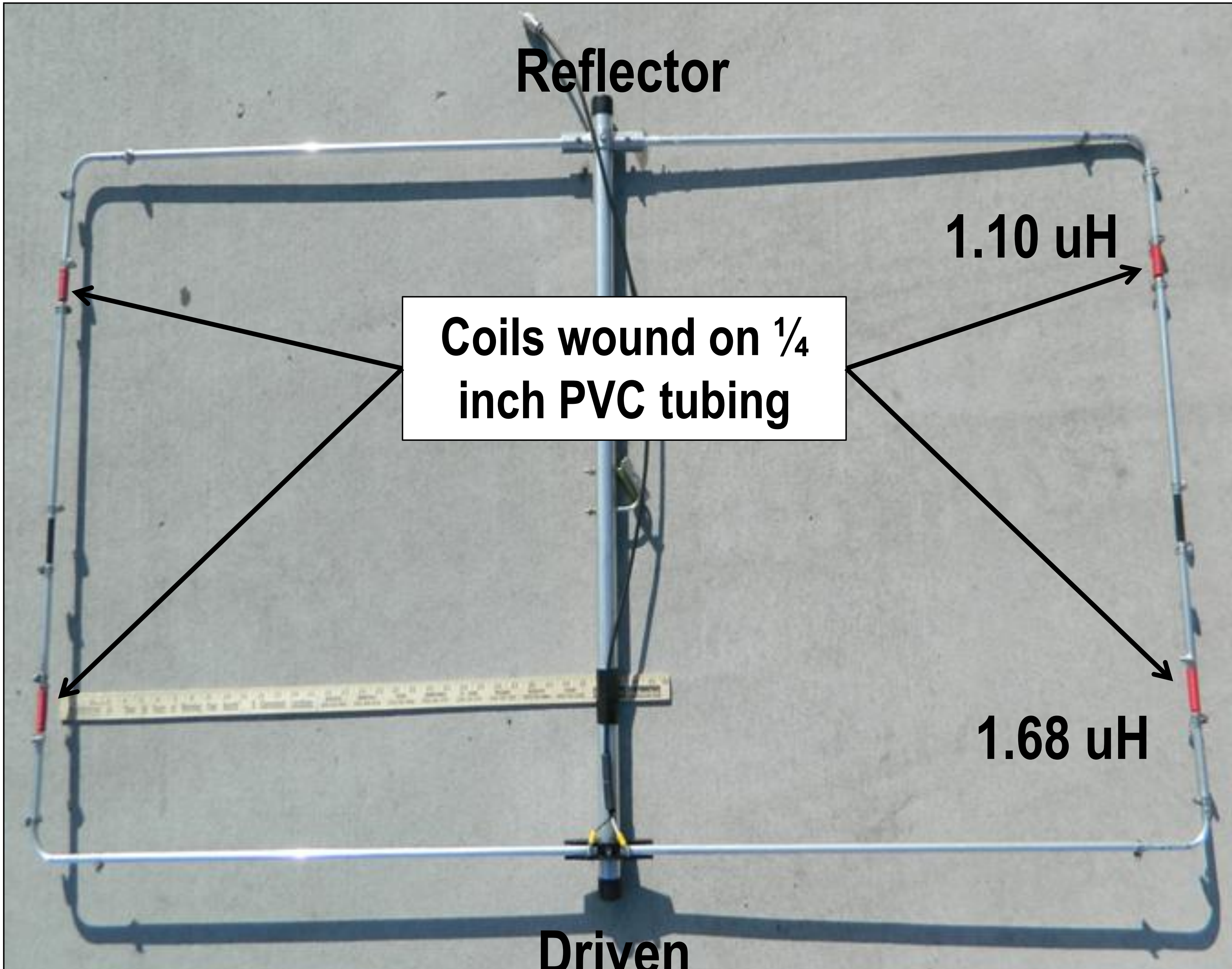

EZNEC
Stock
Moxon
INF
10
5
SWR
3
2
1.5
1.1
1
50
Freq MHz
50.3


Z
3
7
5
1
6
2
8
4

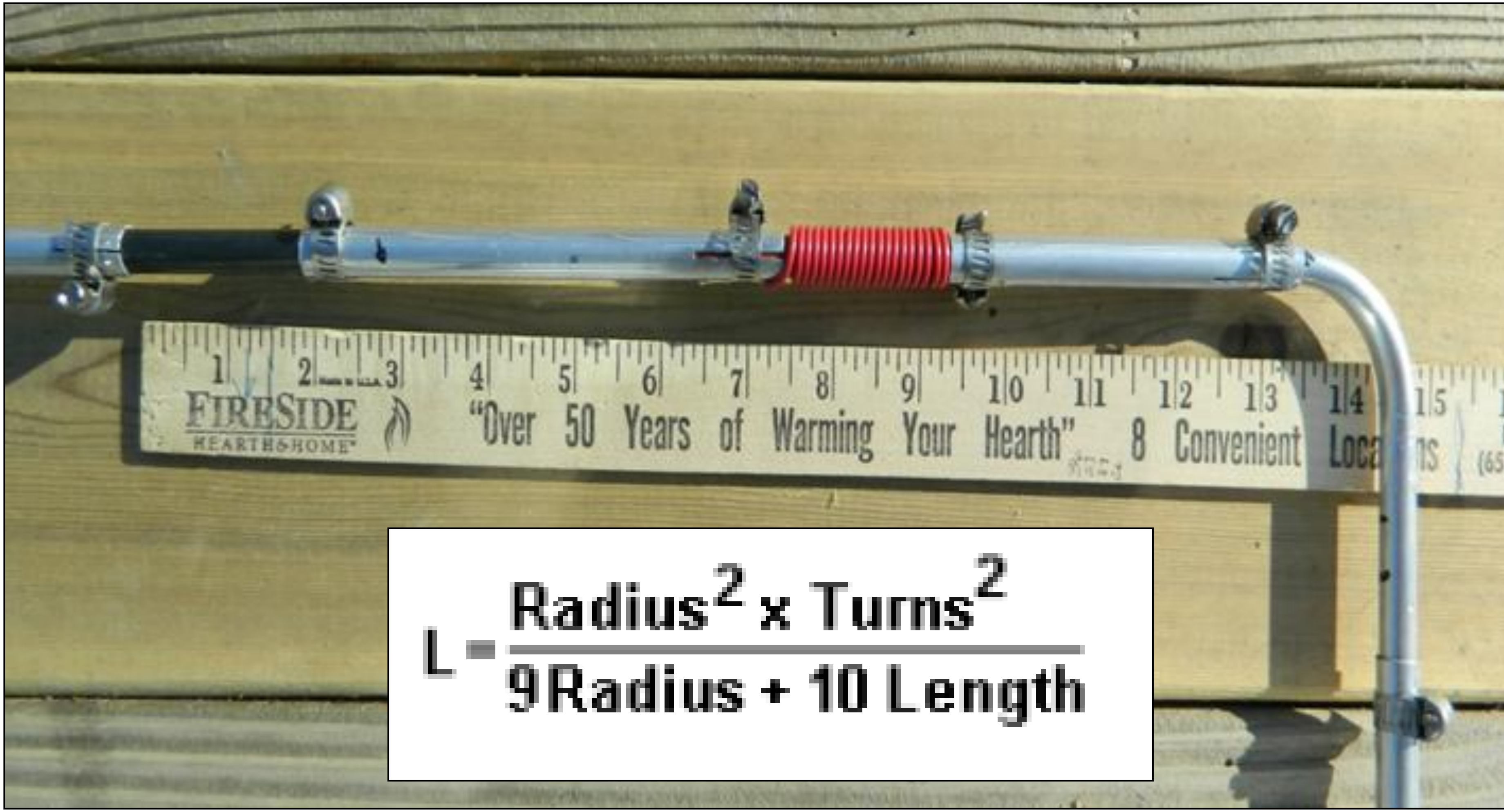

EZNEC
Modified
Moxon
INF
10
5
SWR
3
2
1.5
1.1
1
50
Freq MHz
50.3

Stock Moxon vs Modified Moxon




Reflector
1.10 uH
Coils wound on ¼ inch PVC tubing
1.68 uH
Driven

Coils wound on ¼ inch PVC tubing



$$L = \frac{\text{Radius}^2 \times \text{Turns}^2}{9\,\text{Radius} + 10\,\text{Length}}$$

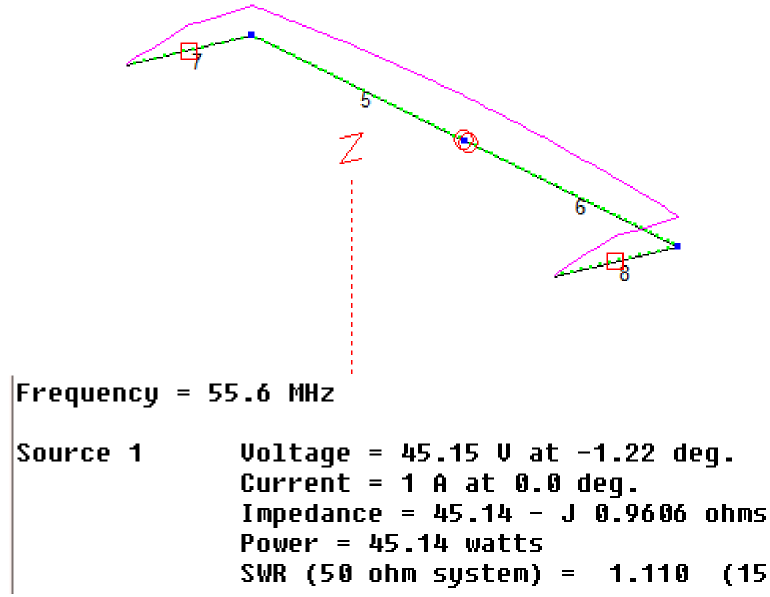
And …… it didn’t work.

Resonated to low, no pattern on 6m.

Most likely culprit was the loading coils were wrong.

Back to EZNEC

1. Eliminated the reflector by raising to 200'. Driven element by itself now resonated at 55.6 MHz.
2. Returned the reflector to 10', moved the feed over to it, and raised the driven element to 200'. Reflector resonated at 52.1 MHz.



Back to my test jig

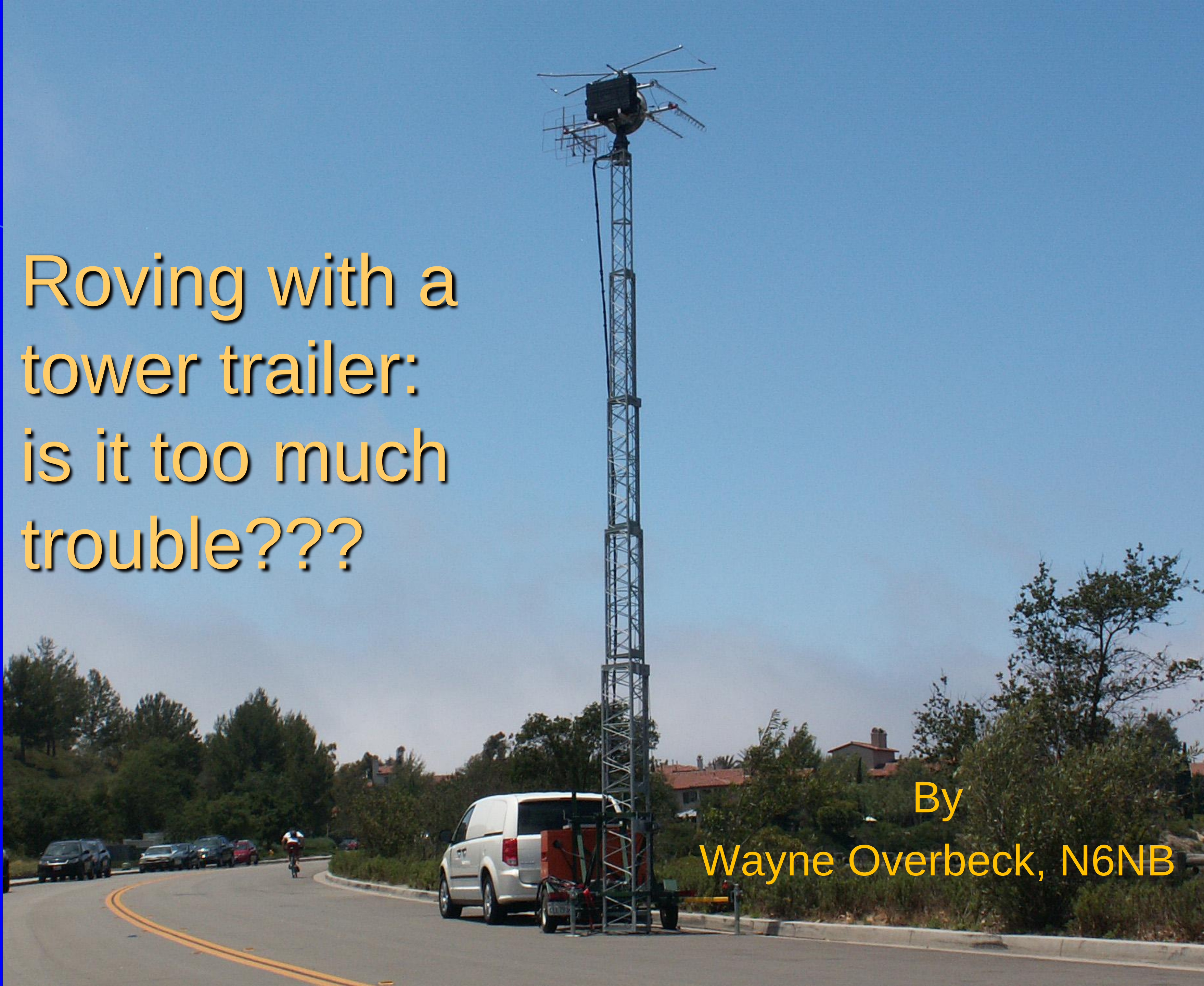
3. Removed the reflector and adjust the driven element loading coils equally to resonate at 55.6 MHz. N = 19 turns.
4. Removed the driven element, mount in its place the reflector elements, and adjust the reflector loading coils equally to resonate it at 52.1 MHz. N = 16 turns.
5. Moved the reflector elements to its correct location and remount the driven element.

Now It Works *AND* It Is Just The Right Size !

What Did I Learn ?

1. A 2m 5/8 wave is a *very* convenient 6m ¼ wave antenna.
2. On 6m, ~ 10’ above ground is the crossover point between using a dipole versus using a vertical.
3. A 6m Moxon 12’ above ground is about the same as a 6m dipole 20’ above ground.
4. Moxons can be reduced in physical size by using loading.
5. Need more work to understand how loading works in modeling versus real life. More of an issue on VHF?
6. For Rev 2.0, make the two elements physically identical and vary only the inductive loading.
7. There is a lot of fun experimentation still ahead !

73   W0ZQ/R


Roving with a tower trailer: is it too much trouble???
By
Wayne Overbeck, N6NB

Tower trailers have pros and cons

- They aren’t very maneuverable
- They slow you down (speed limit = 55 m.p.h. in many states)
- The setup is a lot of trouble
- You can’t operate while in motion, BUT:
- They can get your antennas above local obstructions
- They can lower your takeoff angle

High versus low antennas

An article in QST, March, 1970

High Versus Low Antennas

Performance Tests Using Identical Arrays

BY WAYNE E. OVERBECK,* K6YNB

"THE higher the better" is the traditional rule of thumb for ham radio antennas. Few amateurs would disagree with this axiom, and most experienced antenna builders can recall how much better they "got out" after "raising the beam another 15 feet." However, few empirical studies of the effect of antenna height on signal strength have been published in amateur circles.

This is unfortunate, since several amateurs have studied the question methodically, including Dr. J. E. Lindsay, who has now published his definitive treatise on quads and Yagis[1] but not his excellent work in this area. And while both *The A.R.R.L. Antenna Book* and Orr's *Beam Antenna Handbook*[2] discuss the importance of antenna height in theoretical terms, neither reports the results of practical studies in the field.

With this in mind, the author set out to study the effect of height on signal strength at various distances, on several bands, and with various forms of propagation. Only amateur equipment was available for the study, but in other respects, the author strived to keep the methodology as rigorous as possible.

The Method

The author's approach was to erect identical antennas atop two towers of different heights and obtain comparative signal reports — with some safeguards to minimize reporting errors and to assure proper statistical treatment for the resulting data. For the main tests, one tower was 72 feet high (the practical maximum for the author's residential back yard at the time of the tests), while the other stood 34 feet high (about the minimum usable height for DX work, according to Orr). The two towers were placed as far apart as possible without trespassing — about 50 feet. With this separation, no interaction was evident on any band.

A pair of two-element cubical quads were selected for the 10-, 15-, and 20-meter experiments. Each had an eight-foot boom with all elements mounted concentrically on two sets of spreaders, and each antenna was fed with a single feed line (85 feet of RG-8/U in both cases). This design obviously involves some compromises in element spacing and impedance matching, but both quads developed good SWR curves and front-to-back ratios when tuned. And, more important for our study, whatever compromises existed were essentially the same for both the high and low antennas.

It became apparent during the tests that many amateurs regard cubical quads as exceptional performers at low heights, but (unlike Yagis) not much better if raised higher. This popular impression is contrary to Lindsay's findings, which suggest that quads and Yagis respond quite comparably to changes in their height. Accepting Lindsay's conclusions, we assumed that our findings would be roughly the same if Yagis had been used for the primary experiments.

The author wanted to determine how well high and low antennas would perform not only on DX work, but on "Stateside" *F*-layer communications, ground-wave work, and *E*-skip as well. Thus, separate tabulations were kept for DX reports (i.e., those from stations more than 4000 miles away) and for reports from "Stateside" stations (i.e., *F*-layer reports over 1500–3000-mile paths) on each frequency band.[3] The author was careful to avoid seeking reports

* 11552 Gail Lane, Garden Grove, Calif. 92640.

[1] Lindsay, "Quads and Yagis," *QST*, May, 1968.

[2] Orr, William I., *Beam Antenna Handbook*, 3rd edition,

[3] No 10-meter "Stateside" tests are reported because the muf was too low for reliable *F*-layer work across the U.S. when these tests were run.

Shown here are the two cubical quads used by the author to study the effects of antenna height on performance. The antenna at right is atop a 34-foot tilt-over mast described by the author in June, 1969, QST. The quad at left is on a 72-foot tower.

High antennas = low "takeoff angles"

In a 1968 study of identical antennas at 34' and 70':

- 70' antenna had decisive advantage on F2 propagation
- 70' antenna had decisive advantage on long-haul tropo
- 34' antenna had 1.3 S-unit advantage on E skip!
- E skip: bimodal optimum takeoff angle (5 degrees for long paths, 10 degrees for shorter paths)
- Some contest stations have both high and low antennas on six meters
- Higher antennas are better for most F2 and long-haul tropo

Getting above local obstructions

- Foliage and buildings attenuate signals
- Foliage can devour 1 to 2.5 dB. *per meter*
- Some buildings can absorb even more
- A personal observation: a small antenna high and in the clear is usually better than a big one surrounded by obstacles


Bensalem, PA
October, 2012

Cape Cod, MA
October, 2012

Center, TX, January, 2013


AMATEUR RADIO
K5QE
ROVER VEHICLE
RAM 1500

Newport Beach, CA, June, 2013


Panorama Heights, CA
July, 2013


12682
12682


12592

10 GHz beacon, 110 miles away
(dish at 45’ then descending to 15’)

In wide open terrain…

Building still another tower trailer

- If a tower trailer can improve your signal that much, what about at home?
- N6NB wanted a *backyard* tower trailer.


Harbor Freight item #90153,
1090 lbs. rated payload


4LZ7136


N6NB
4LL7934
4LZ7136


Tower down = out of sight

What about other alternatives?

The “cabover kilowatt,” 1971

I-80 overlook, New Jersey, 2003

Sheep Hill, NJ (FN20), 2003

Is this worth the trouble?

www.n6nb.com

DSES

Deep Space Exploration Society

A Non-Profit Corporation Dedicated to the Excitement of Hands-on Space Exploration

Central States VHF Society 2014 Conference

Presented by:

Myron Babcock, KL7YY

Board member and Treasurer, DSES


Paul Plishner
Radio Astronomy and
Space Sciences Center
This site is owned and operated
by the Deep Space Exploration
Society with offices in Longmont
Colorado. Further information can
be obtained on our website:
http://dses.org or leaving a
message at 719-337-2112
Deep Space
Exploration Society

Returning from CSVHFC in Dallas, July 2011, AA0L and KL7YY stopped by DSES site..

Deep Space Exploration Society

A Non-Profit Corporation Dedicated to the Excitement of Hands-on Space Exploration

Location

5 Mi South of Haswell, CO,
Kiowa County, U.S.A.
Go south on Rd 19 until you see the antenna.
Plishner Dish GPS Location:

Grid Square: DM88kj	**Enter: DSES on Google maps and it will take you there.**
N38° 22′ 51.10″	W103° 9′ 22.96″
N40° 08.900′	W105° 13.922′ (T-22)
38.380796°	-103.156358°
Elevation:	1381m, 4554 ft

History of DSES

T-22 is a building with two 60 foot dish antennas located on the northern most edge of the mesa north of Boulder, CO.

The site is part of the current Department of Commerce, Institute for Telecommunication Services (ITS). In 1990 a group of people received permission, from then the National Bureau of Standards, to work on the facility.

The Deep-Space Exploration Society (DSES) was incorporated in 1991 and was the outgrowth of an effort to return the Table Mountain antenna facility in Boulder County to active use after many years of dormancy.

T-22 site on Table Mountain North of Boulder, CO.

This is a Quiet Zone, where transmission is not authorized. After many years of improvement to both building Infrastructure and to both 60 foot dishes, DSES access to this site was terminated in 2008.

T-22 Projects at the Boulder site.

Falcon Gold with the Air force Academy and Paratrak with CU computer science students

Falcon Gold was the Air force Academy's first student (cadet) designed and built satellite. They realized that they did not have a ground station with sufficient gain to receive the signal from the satellite and came to DSES for help. We provided them with a ground station that tracked the satellite and received its telemetry. This was a multi-month project during which we worked closely with the officers and cadets to help them achieve their goals. It was a great success

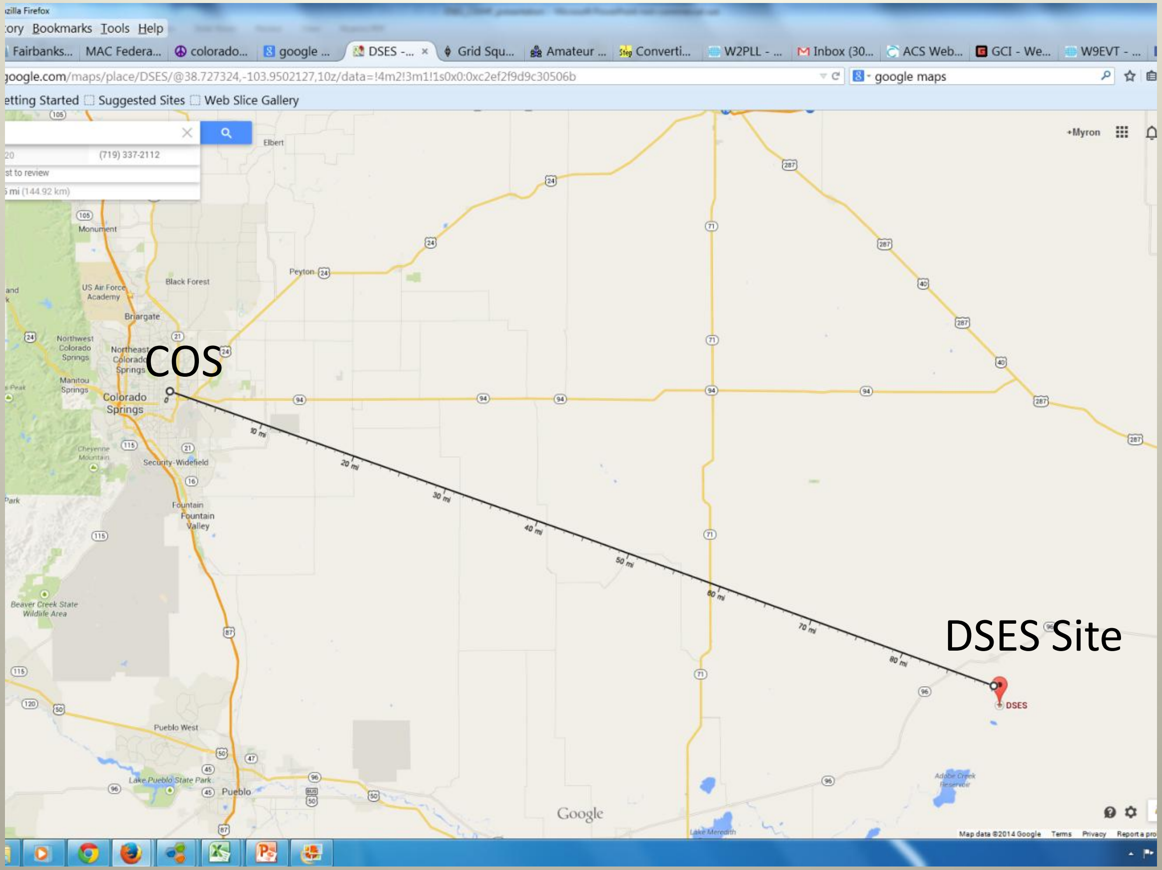
T-22 Projects Cont.

The Paratrak project was a senior project for a group of CU computer science students. DSES built a closed loop controller and provided a software driver for the students to use. They in turn designed the software to drive the dish. The program accepted tracking instructions in several forms including RA and DEC, TLEs (two line elements) as well as a pull down menu of celestial objects.

We have provided a number of school groups with exciting and educational tours. This has encouraged several of them to pursue physics and engineering when then entered college.

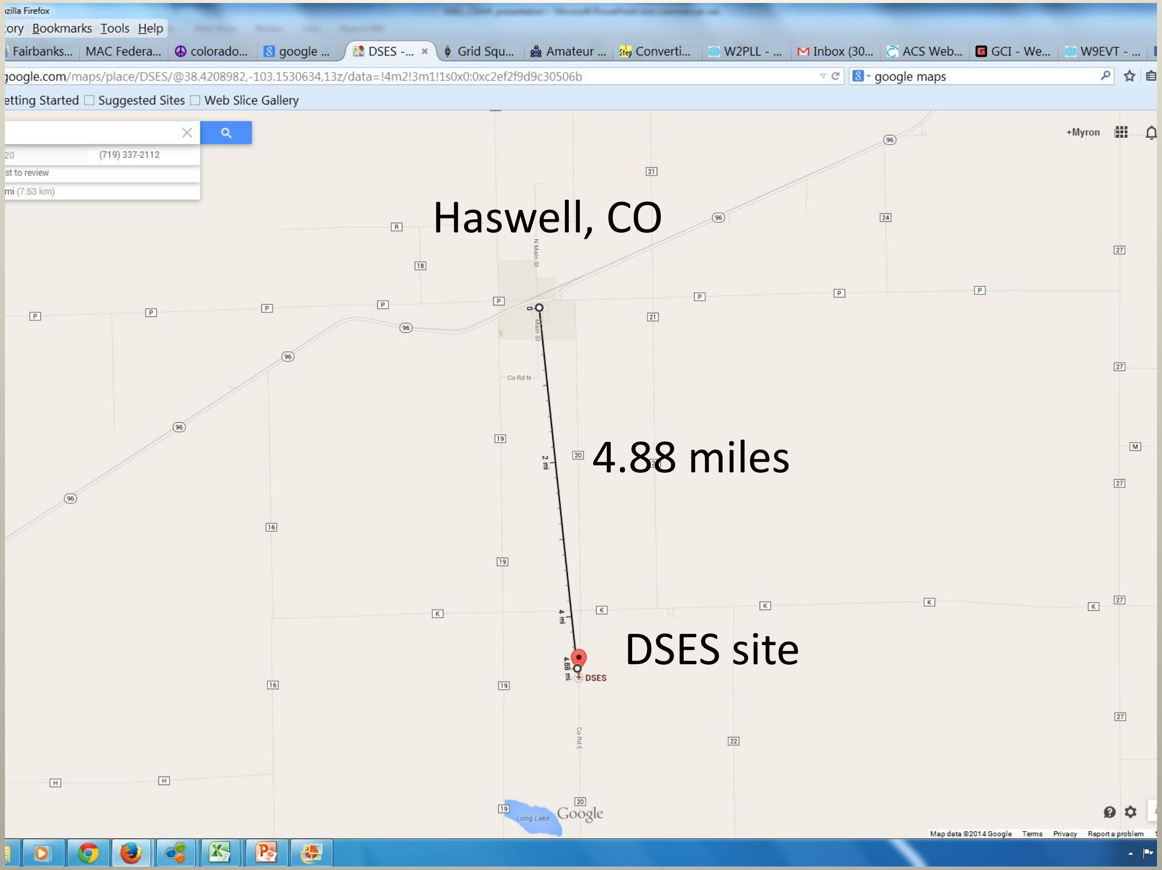
Moving Day for DSES

In 2010, with the acquisition of the Paul Plishner (W2PLL) Radio Astronomy and Space Science Center, we left the Boulder County Table Mesa site with its two 60ft dish antennas. Now, even though we only have one dish antenna, many more opportunities to work with the education and science centers have become possible.



Located 90 airline miles SE of Colorado Springs

Google Maps, insert DSES and it will take you to the site.



4.8 miles south of Haswell, CO; Kiowa County

Paul Plishner DSES Site

- The Beginning: National Bureau of Standards project started in 1957. Operational from 1958 to 1974.
- Used for Tropospheric radio propagation studies for design of communications systems in Northern Latitudes in the construction of the DEW Line from Alaska to Greenland.
- This site was one of several similar sites located from Boulder, CO to Arkansas.

1972 Haswell NBS field site

500 foot tower, 3-phase 900 amp service
no longer at site.

1972 Haswell NBS field site

1972 Haswell NBS field site

Our first vist to DSES in 2014 after a winter of tumbleweeds

April 19, 2014

Cleaning out the ramp entrance to bunker door.

April 19, 2014

Entrance to underground bunker complex.

April 2014

Looking to top of ramp from bunker entrance

April 2014

Looking from bunker entrance to main bunker rooms

Main room inside bunker

Main bunker room looking down entrance hallway

Main bunker room looking west.

Shop area with test equipment and assorted shop tools

Electrical Room with solar charged batteries.

Don Lewis, KE0EE, setting up batteries.

Solar panels for bunker batteries

Installing 25KW propane Generator into shelter

July 20, 2013

Installing 25KW propane Generator into shelter

July 20, 2013

Generator installed but not wired to bunker or dish tower

Antenna Specifications

Frequencies: 400 Mhz to 2 Ghz

Diameter: 60 feet

Antenna Gain: 42.5 dbi at 1 Ghz

Beam Width: 2.6 degree at 400 Mhz
0.8 degree at 1.2 Ghz

Noise Temperature: 1-2db at 400 Mhz total system

Noise Figure: 0.8db at 400 Mhz w/20db LNA

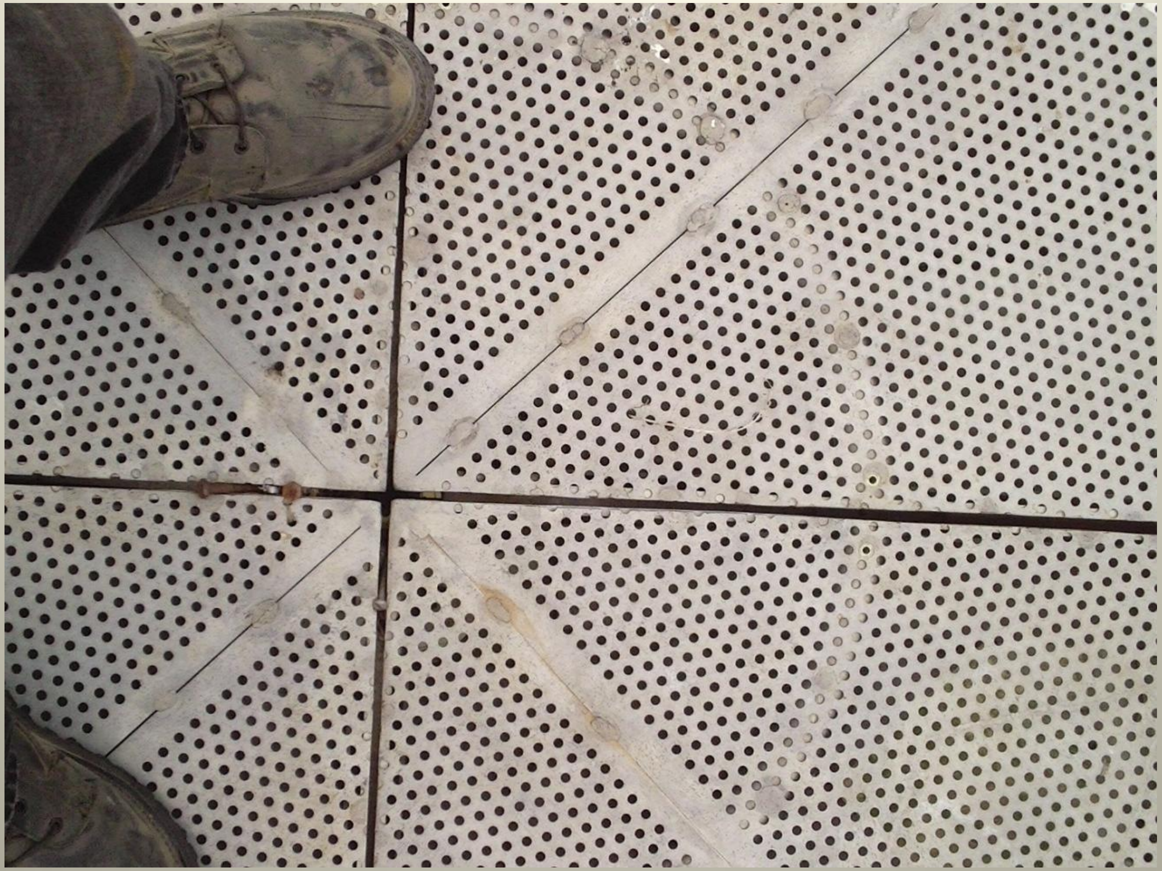
Coverage: Full Hemisphere

Slew Rate Max Az/El: 40/40 deg/min

Inside the dish

Adam Glazier – site project manager (2011-2013)

Paul Berg – K0DJV, Dish maintenance supervisor (2011-2013)



Dish Center

Dish is in excellent condition for being over 56 years old.

Looking straight up at 3 – feed lines/wave guides from the early days

4 inch antenna feed line removed

Moving of dish for installation of 1296 antenna feed

July 20, 2014

Moving of dish for installation of 1296 antenna feed

July 20, 2014

Moving of dish for installation of 1296 antenna feed

July 20, 2014

Moving of dish for installation of 1296 antenna feed

July 20, 2014

Moving of dish for installation of 1296 antenna feed

July 20, 2014

Install of 1296 Mhz antenna feed

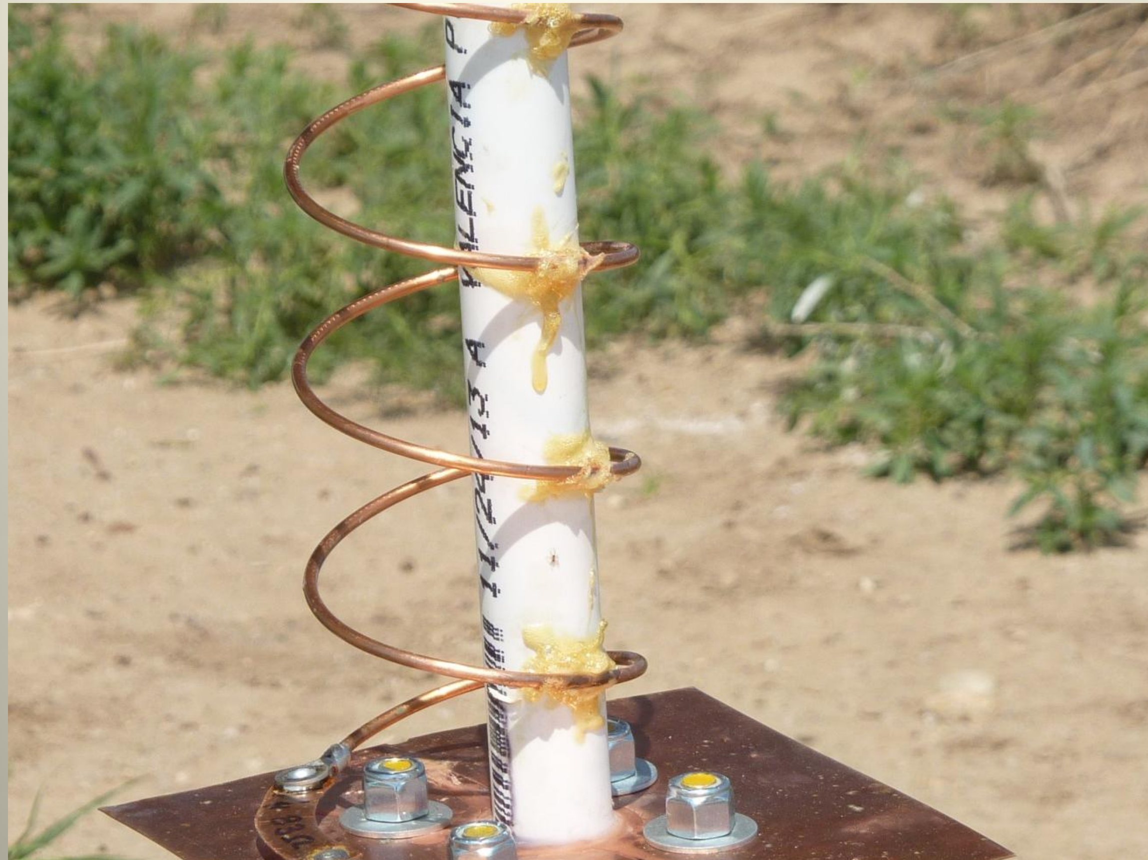
Steve Plock – KL7IZW left

Ray Uberecken – AA0L right

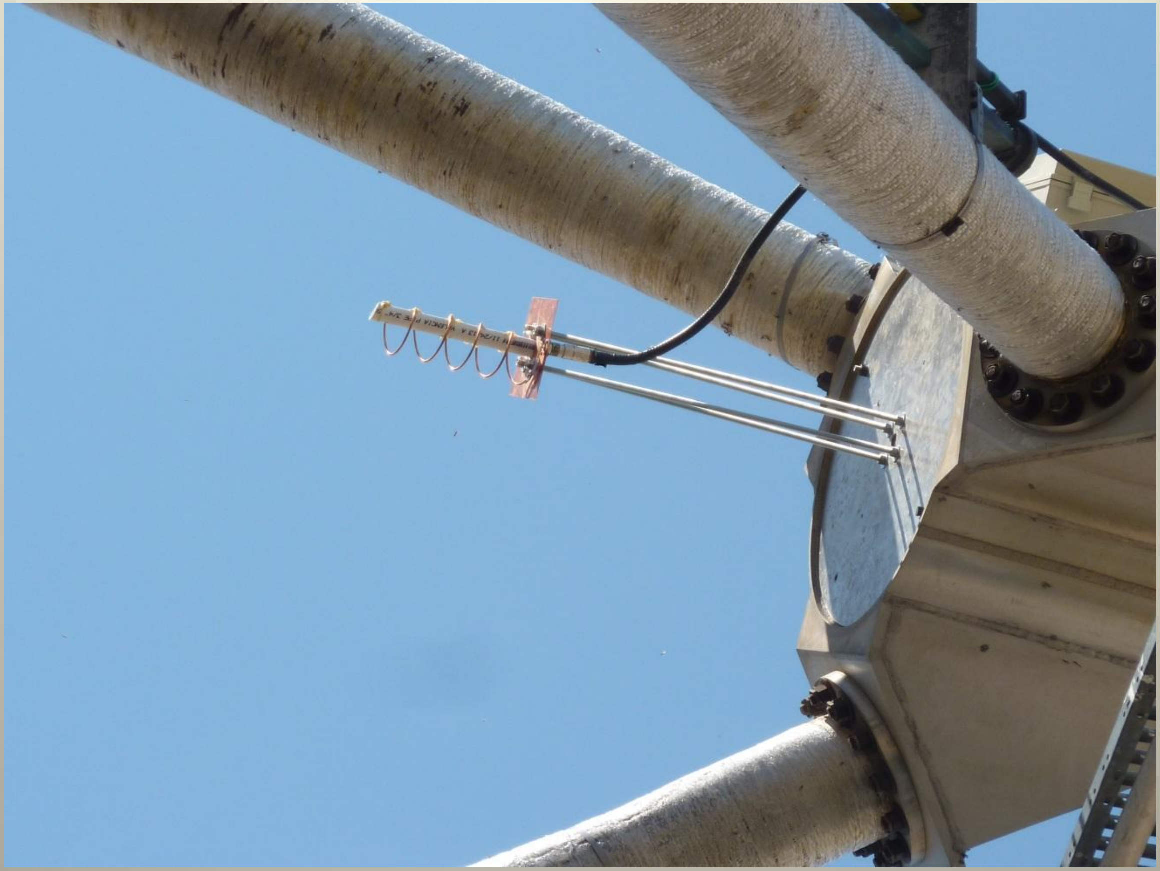
Install of 1296 Mhz antenna feed

Install of 1296 Mhz antenna feed

Ray Uberecken – AA0L



1296 Mhz antenna feed constructed by KL7IZW, Steve Plock.



Antenna feed installed and ready for our first transmission.

July 20, 2014

Antenna pointing East.

July 20, 2014

1.2 Ghz station for first transmission in 40 years

1815Z (12:15MDT) July 20, 2014

Downeast Microwave (1296-28 HP5) transverter

July 20, 2014

ICOM IC-1271A

July 20, 2014

Ray Uberecken – AA0L making contact on coordinating frequency, 7185 Khz.

July 20, 2014

The last time this antenna was used for transmitting was July 1974. This past Sunday, July 20, 2014, the DSES Organization made contact on 1296.1 Mhz with KORZ, Bill Mc Caa, Boulder, CO (155 miles); W6AOL, Dave Clingerman, Parker, CO (110 miles); and KK0Q, Dennis Lessley, Westminster, CO (144 miles). Also heard but not worked was N0POH, Wayne Heinen, Aurora, CO.

We had schedules with 12 other stations but were unable to make contact due to equipment changes and antenna aiming difficulties. Even our 40 meter coordinating frequency failed to provide us any propagation during the latter parts of our proposed schedule.

On site temperatures were 109 degrees outside and over 100 degrees inside the tower pedestal. Not the best conditions for 1.2 Ghz operations.

Deep Space Exploration Society

A Non-Profit Corporation Dedicated to the Excitement of Hands-on Space Exploration

During selected dates in September and the VHF contest, We will operate at 1296.100 Mhz USB with the call sign **K0H**.

Station details are as follows: Primary Operators AA0L, KL7IZW, KL7YY

Antenna 18 meter (60 foot) parabolic dish (DM88KJ)

Transverter 1296-28 HP5 & Icom IC-1271A

We will have an EIRP of approx. +90 dBm and would like to contact as many members as possible. Please email with your callsign if you can get down to the horizon with your antenna on 1296. Thanks KL7IZW
email wohnfeld@aol.com

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DSES membership consists of voting and non-voting members. Voting membership is $50.00 per year and non-voting membership is $20.00 per year.

Current membership roster consist of 29 voting members and 8 non-voting members.

Current DSES Officers and Board Members for 2014

President – Michael Lowe
Vice President- Ray Uberecken, AA0L
Secretary – Gail Lowe
Treasurer – Myron Babcock, KL7YY
Board Member – Steve Plock, KL7IZW
Board Member – Aaron Reid
Board Member – Michael Hoffert

Future Plans

A system for making real time data from the antenna available on the internet and later the capability to allow remote command and control of the antenna from the internet

Capability to allow remote command and control of the antenna from the internet.

Remote control will provide a convenient way for DSES members to monitor their projects remotely and thereby expand the utilization of the facility.

Allow outside researchers and groups to remotely operate the facility as a research tool for their own projects.

Plishner DSES site from 1 mile North

For more information contact us at:
http://www.dses.org,

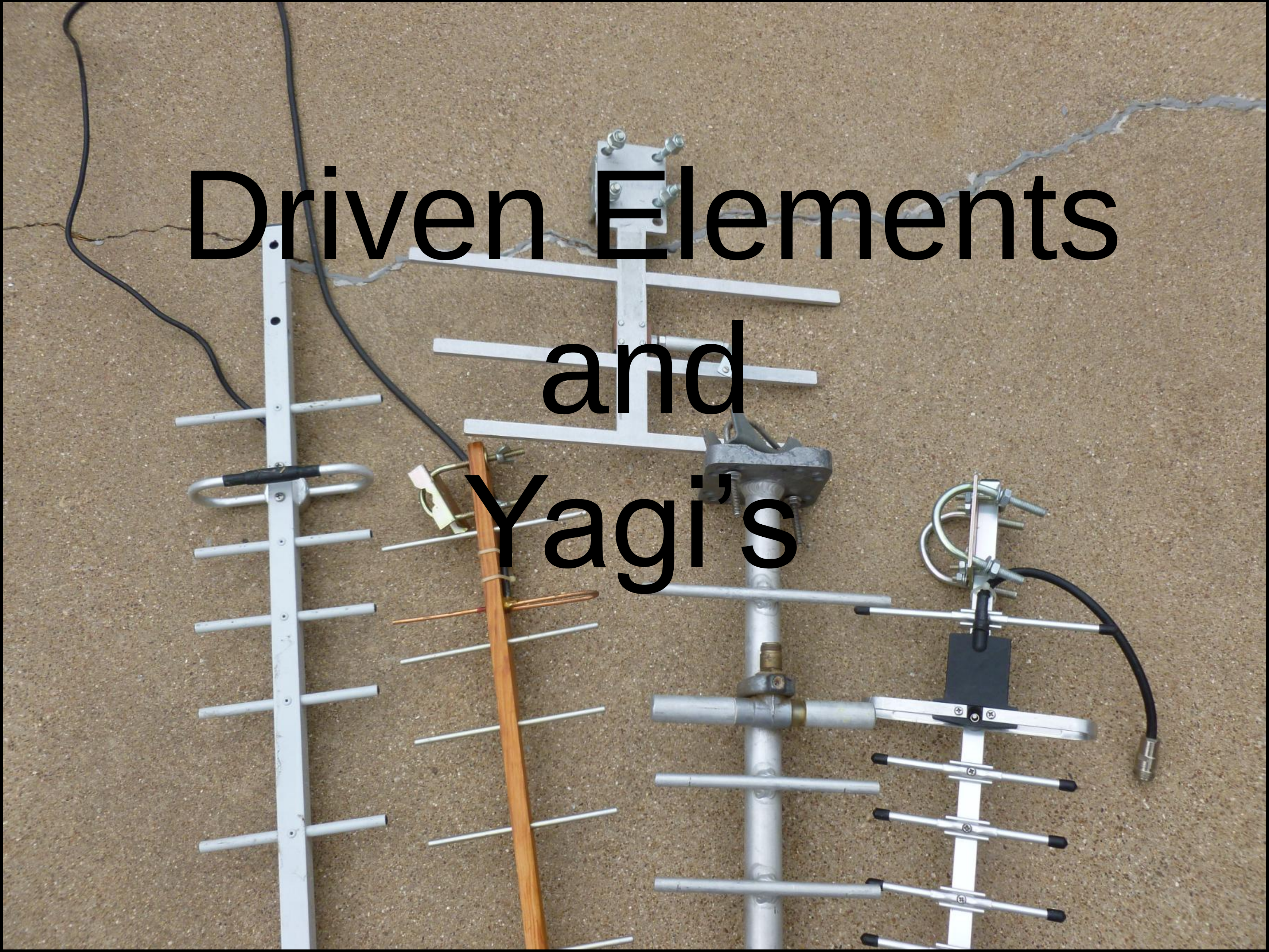
Deep Space Exploration Society

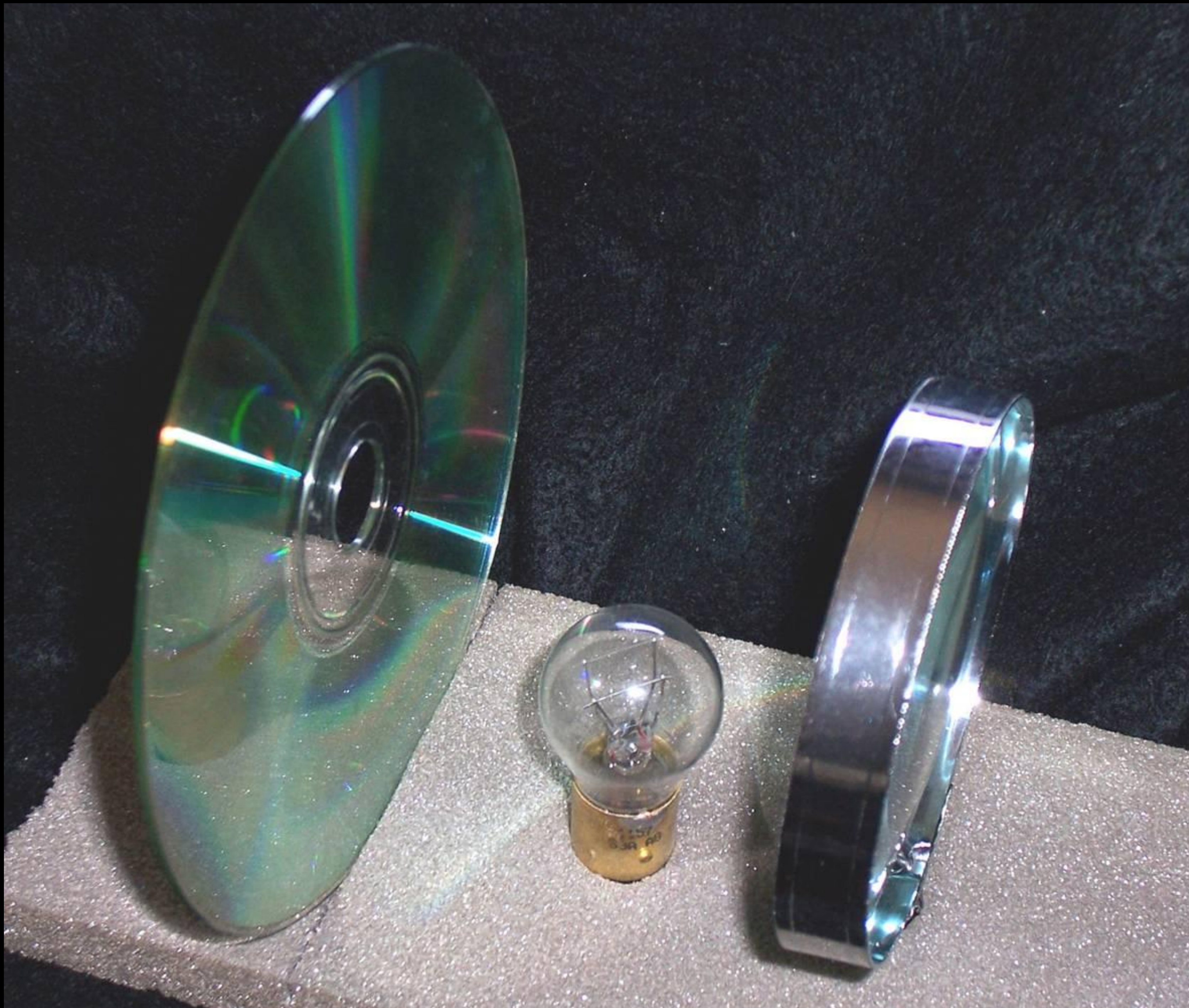
7131 Oriole Lane

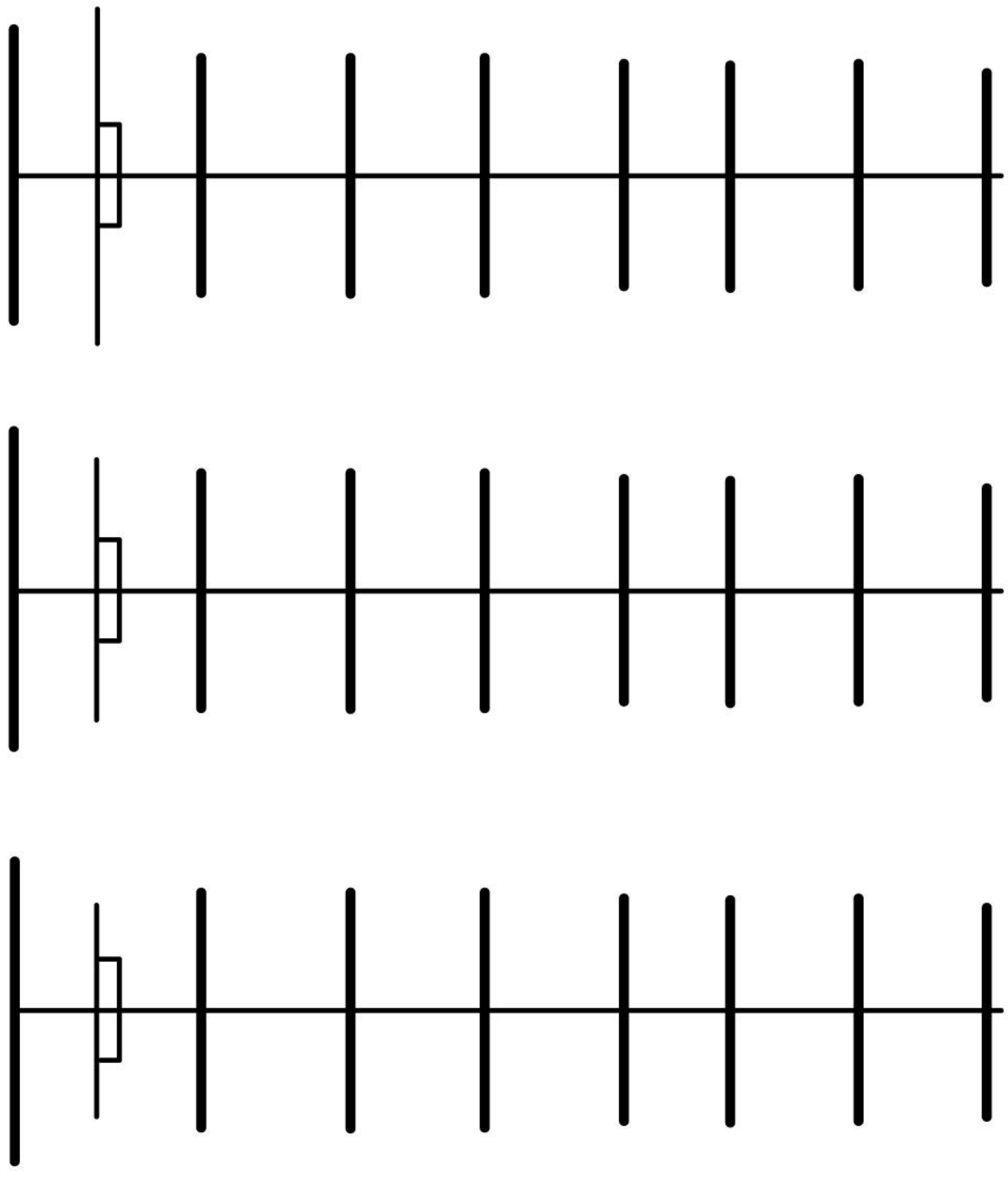
Longmont, CO 80503

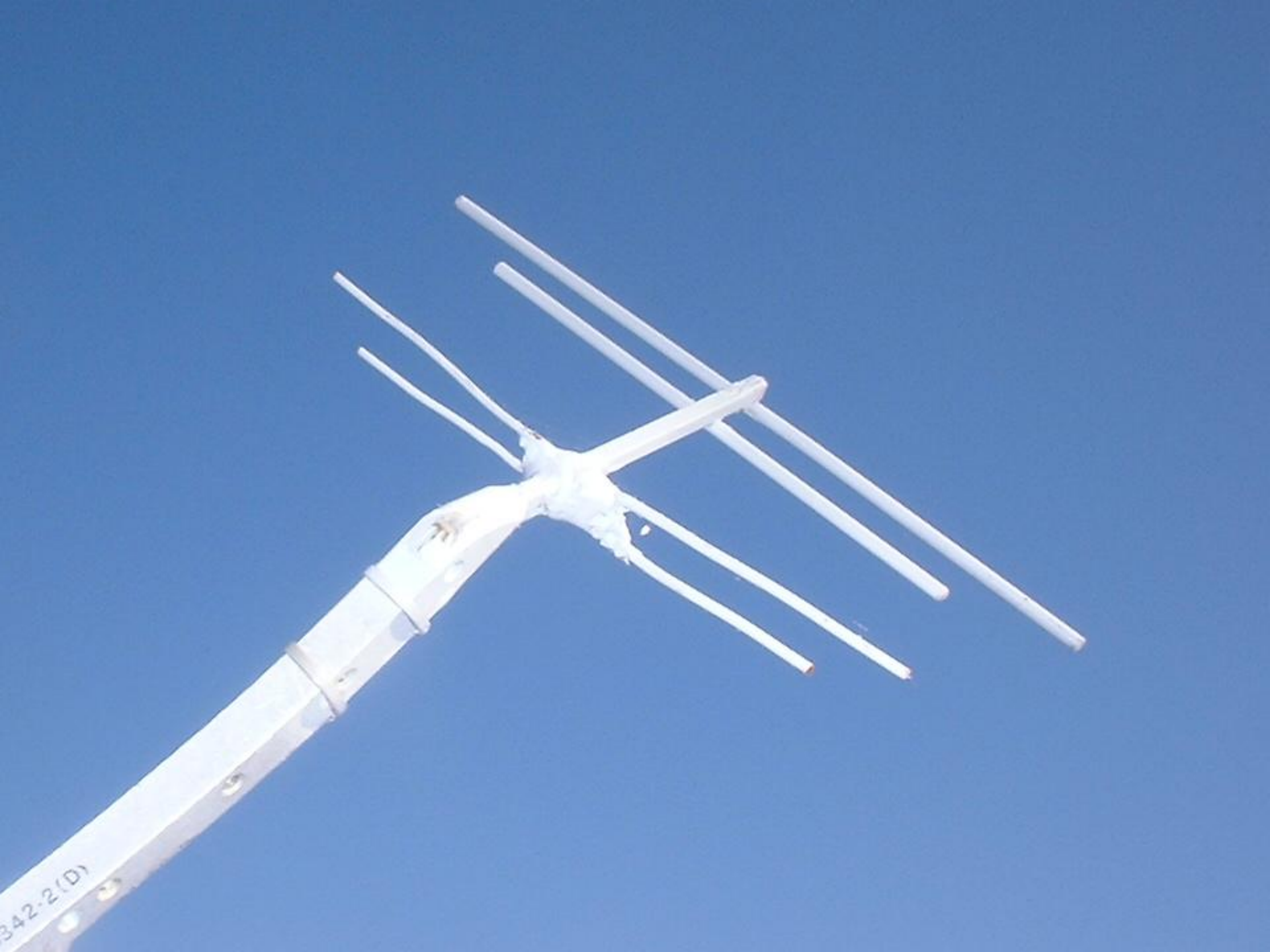
(719) 337-2112 (C)

Driven Elements and Yagi's





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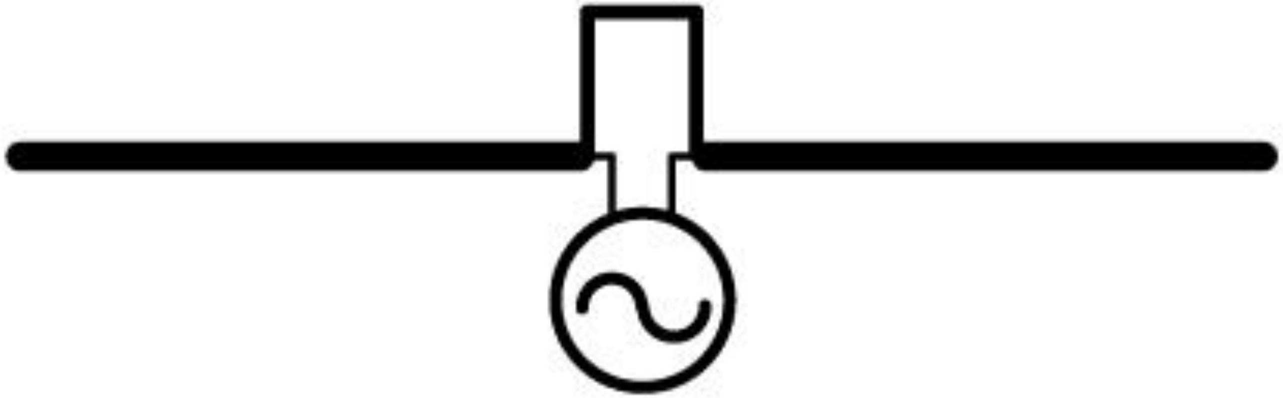
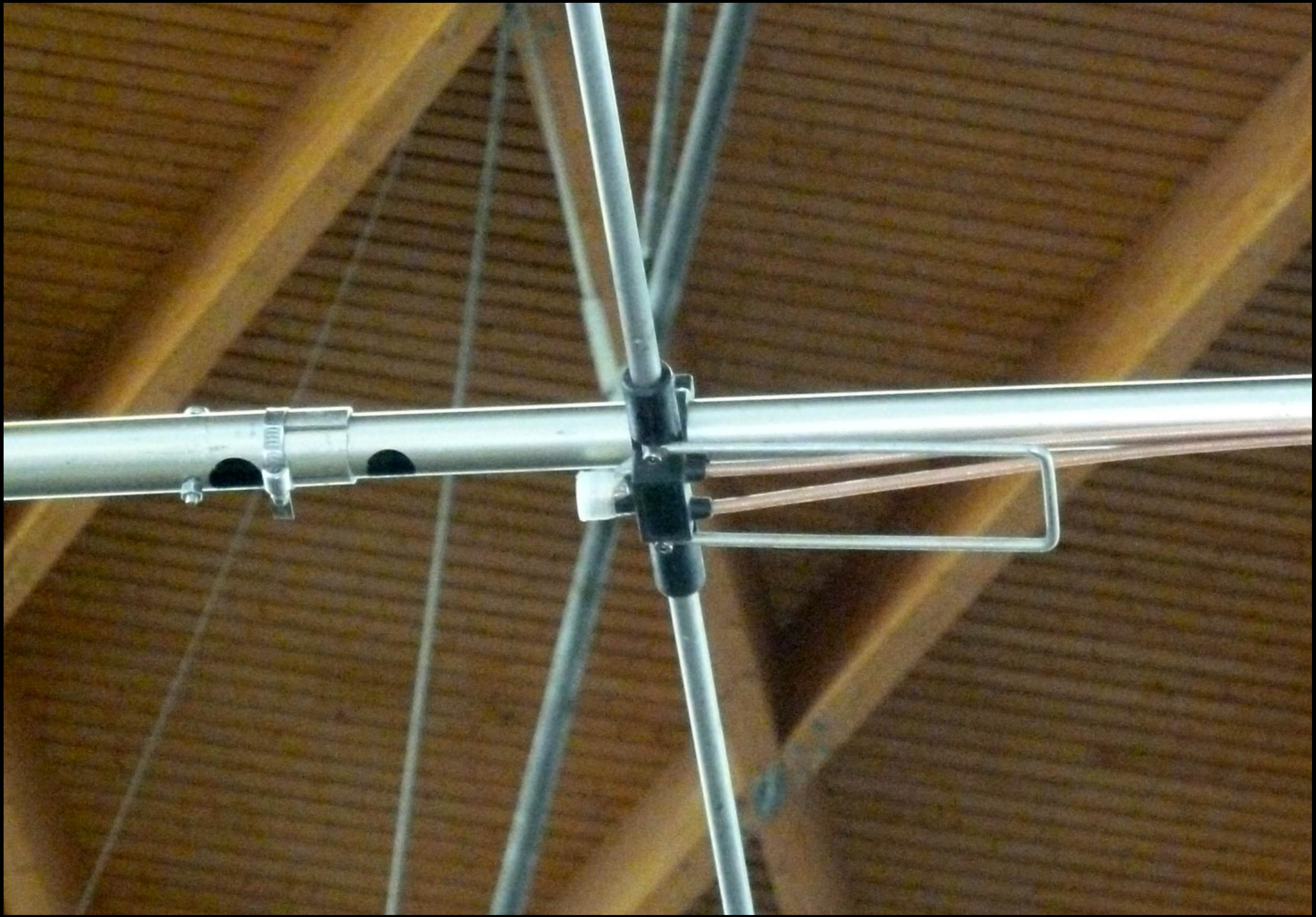
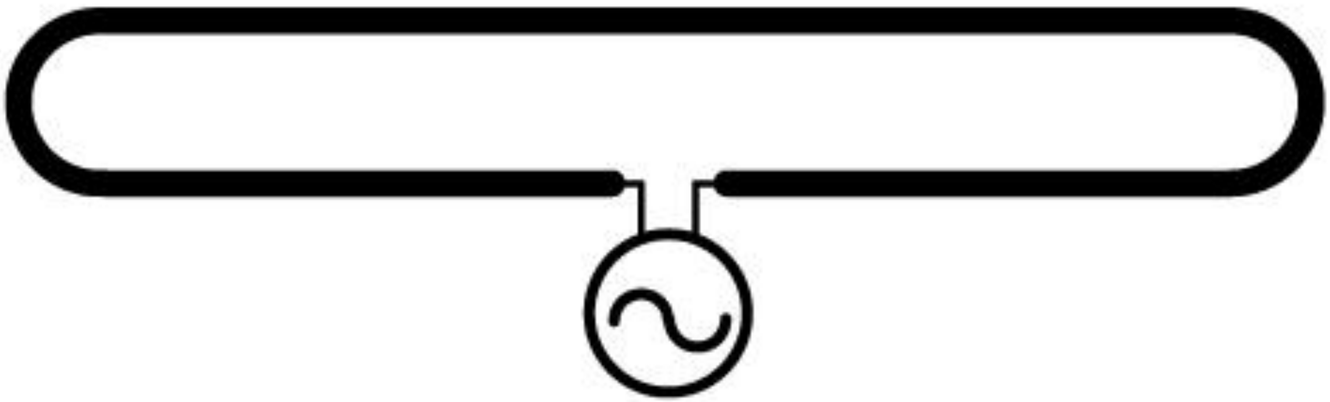
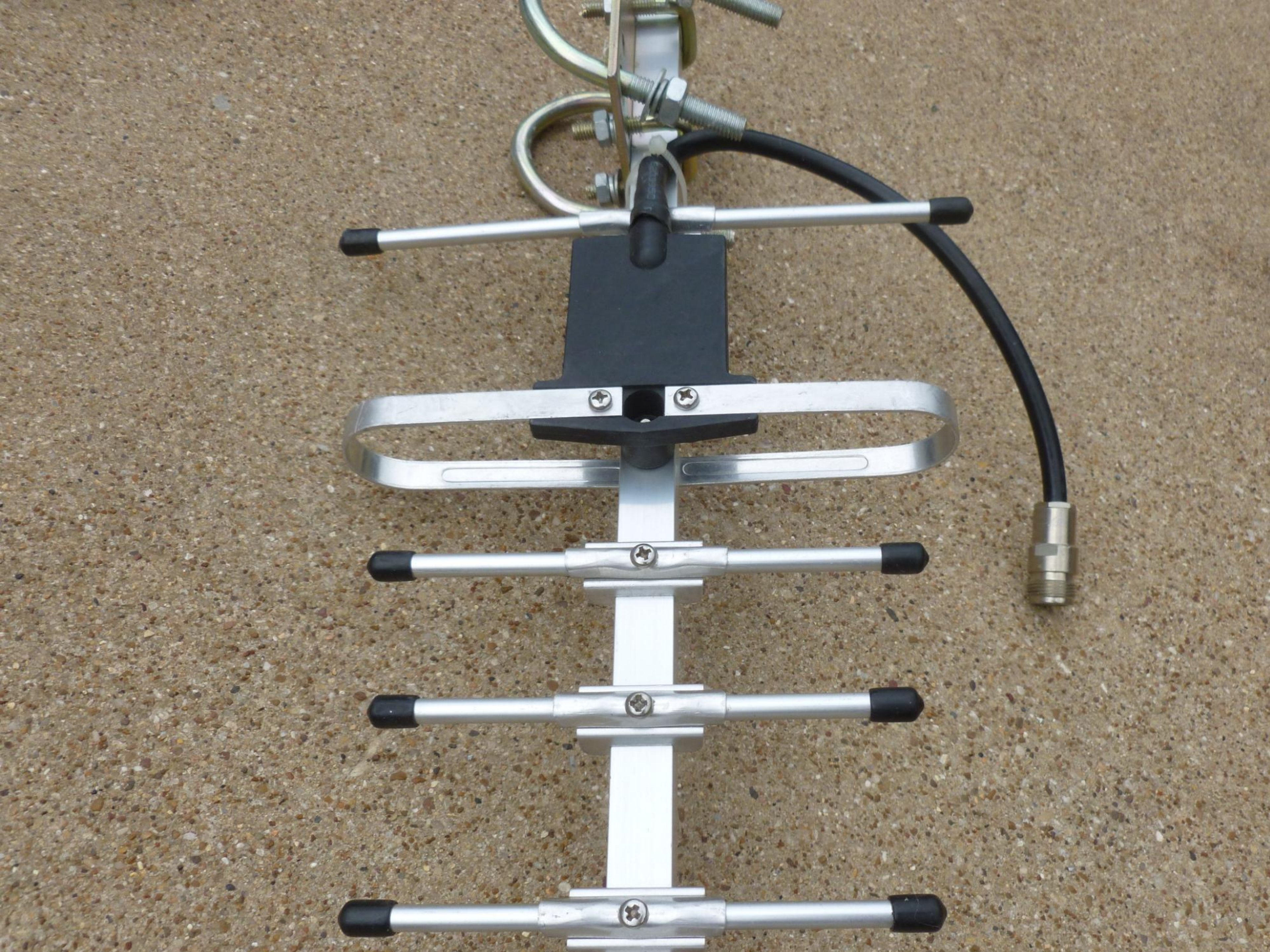
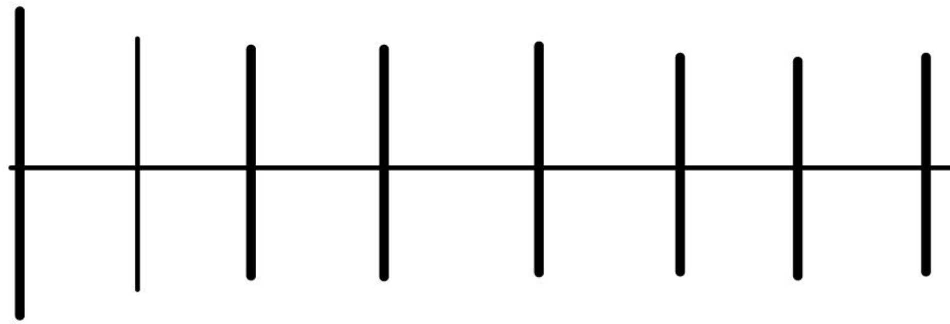




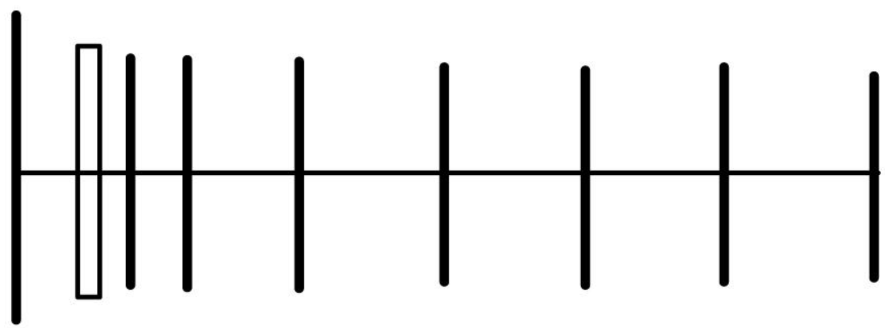




Low Impedance 72 Ohms



High Impedance 300 Ohms



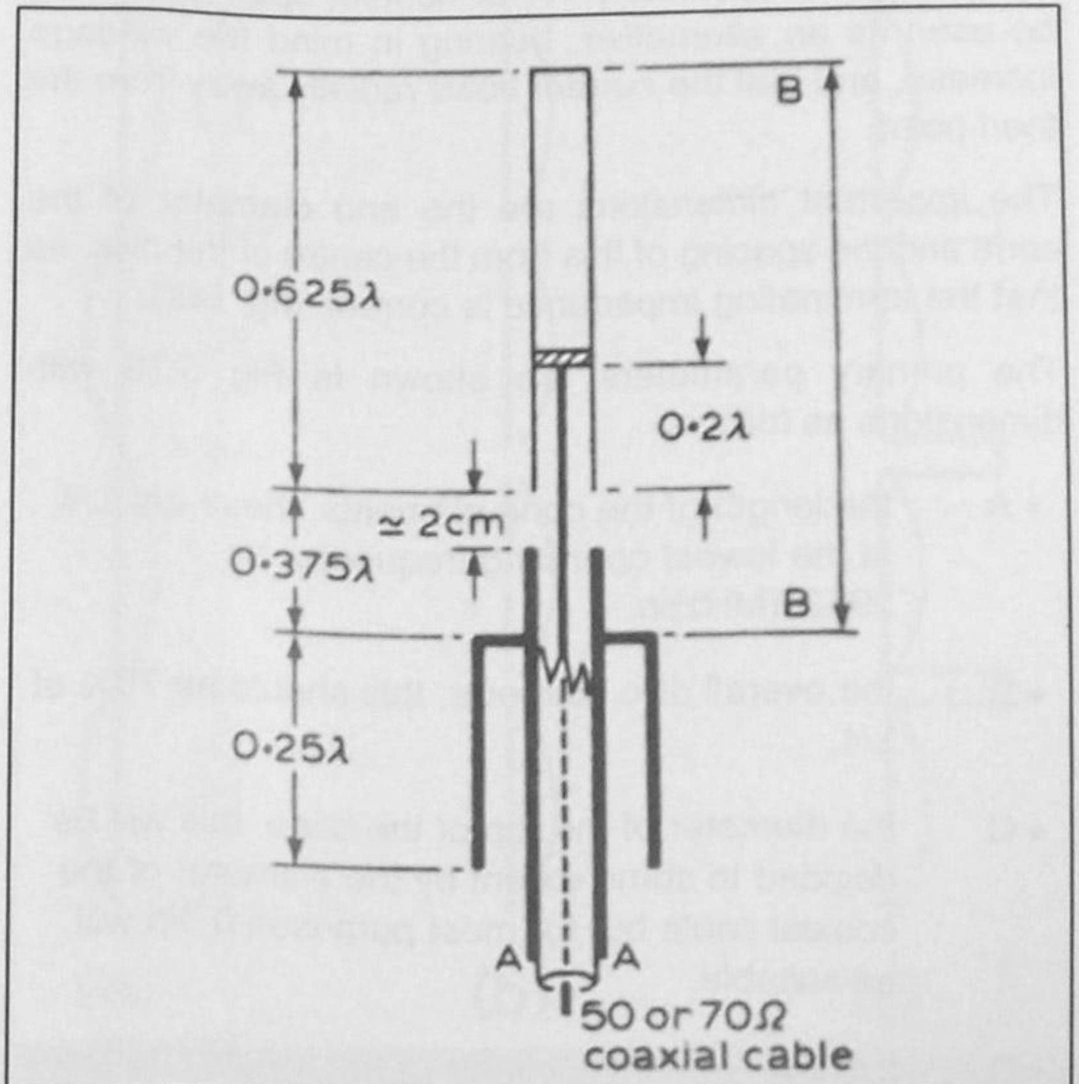
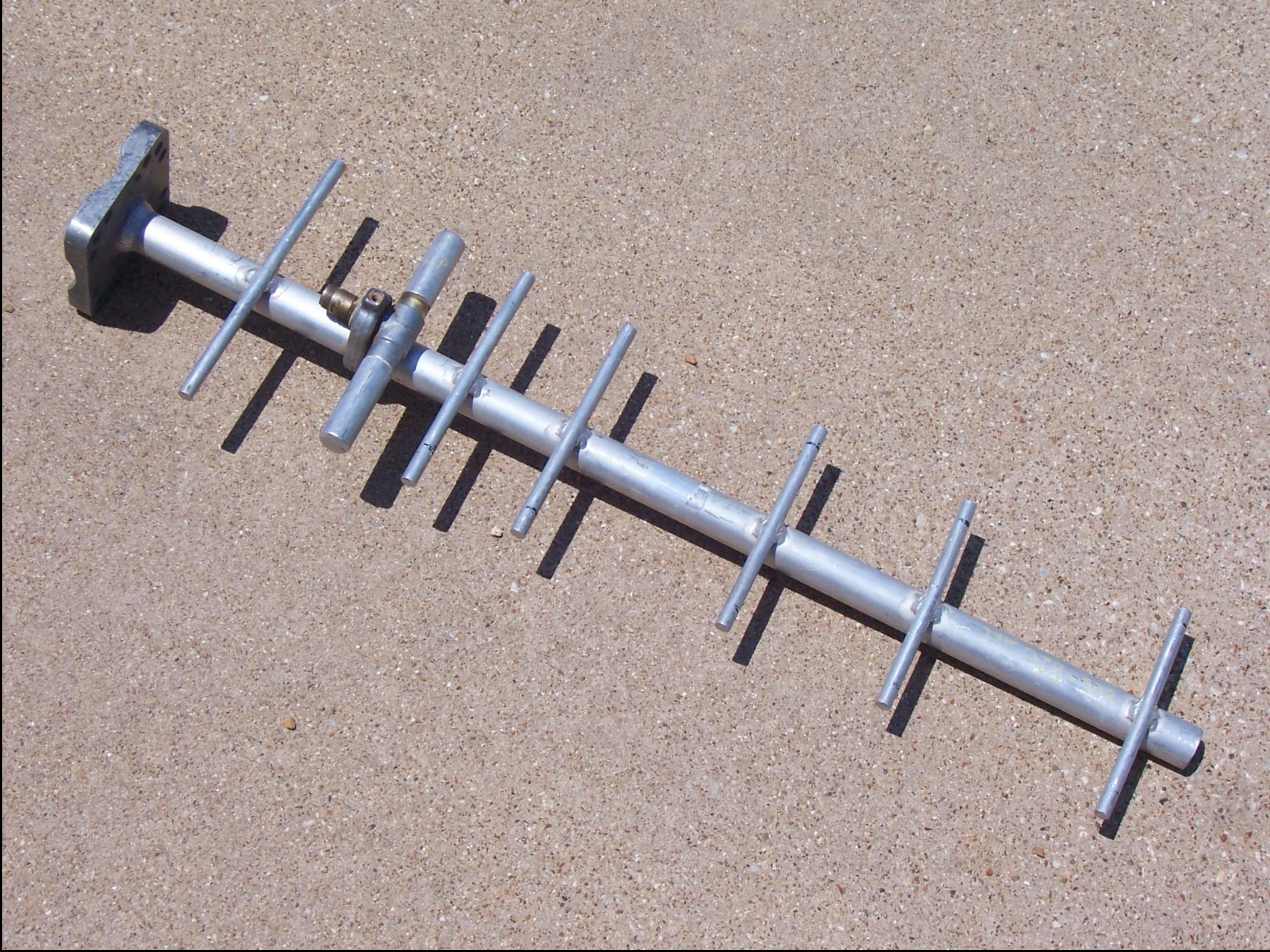
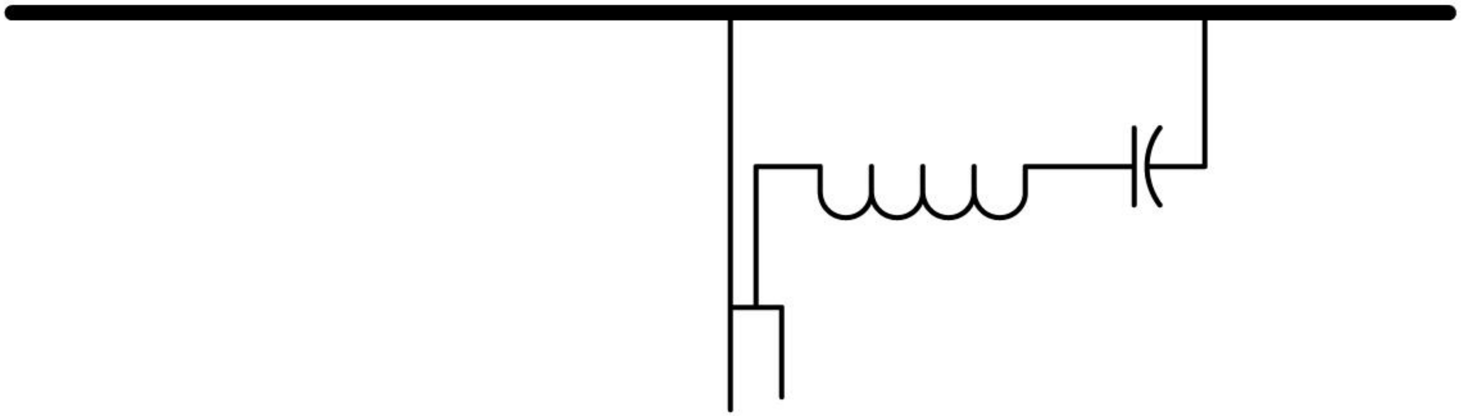
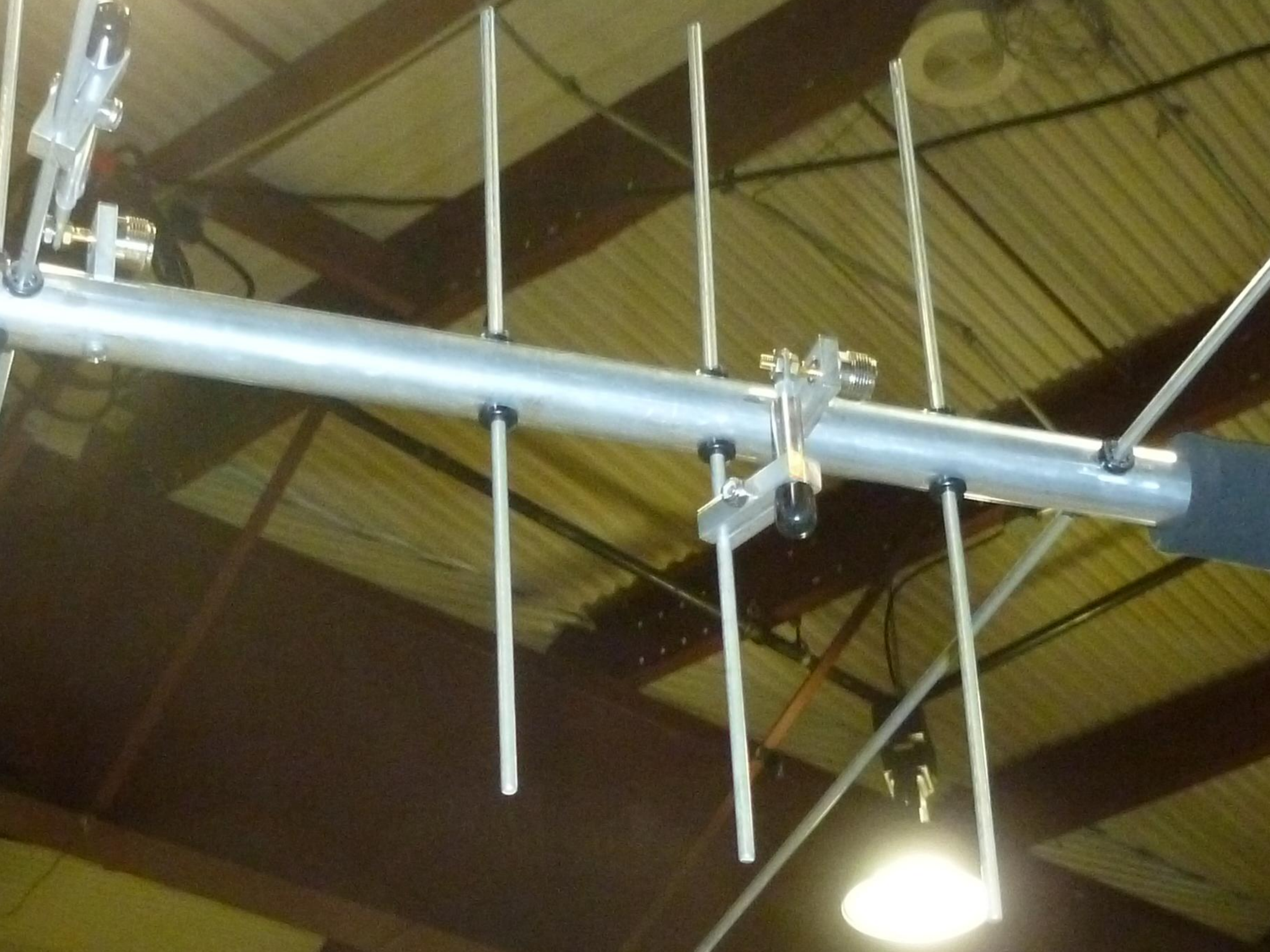
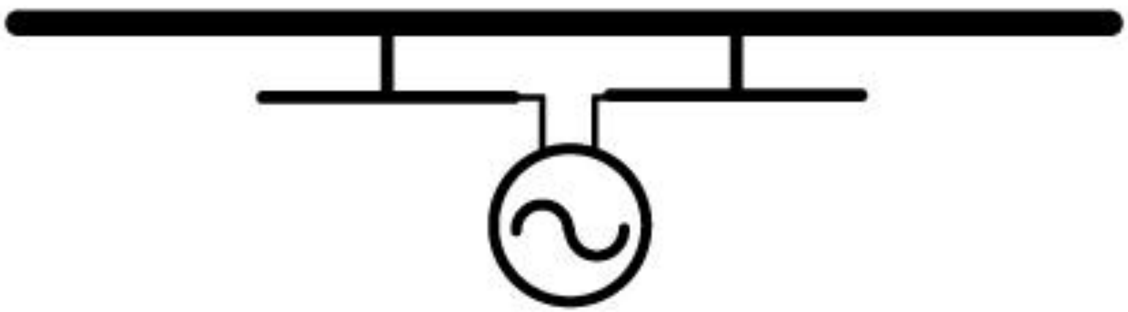


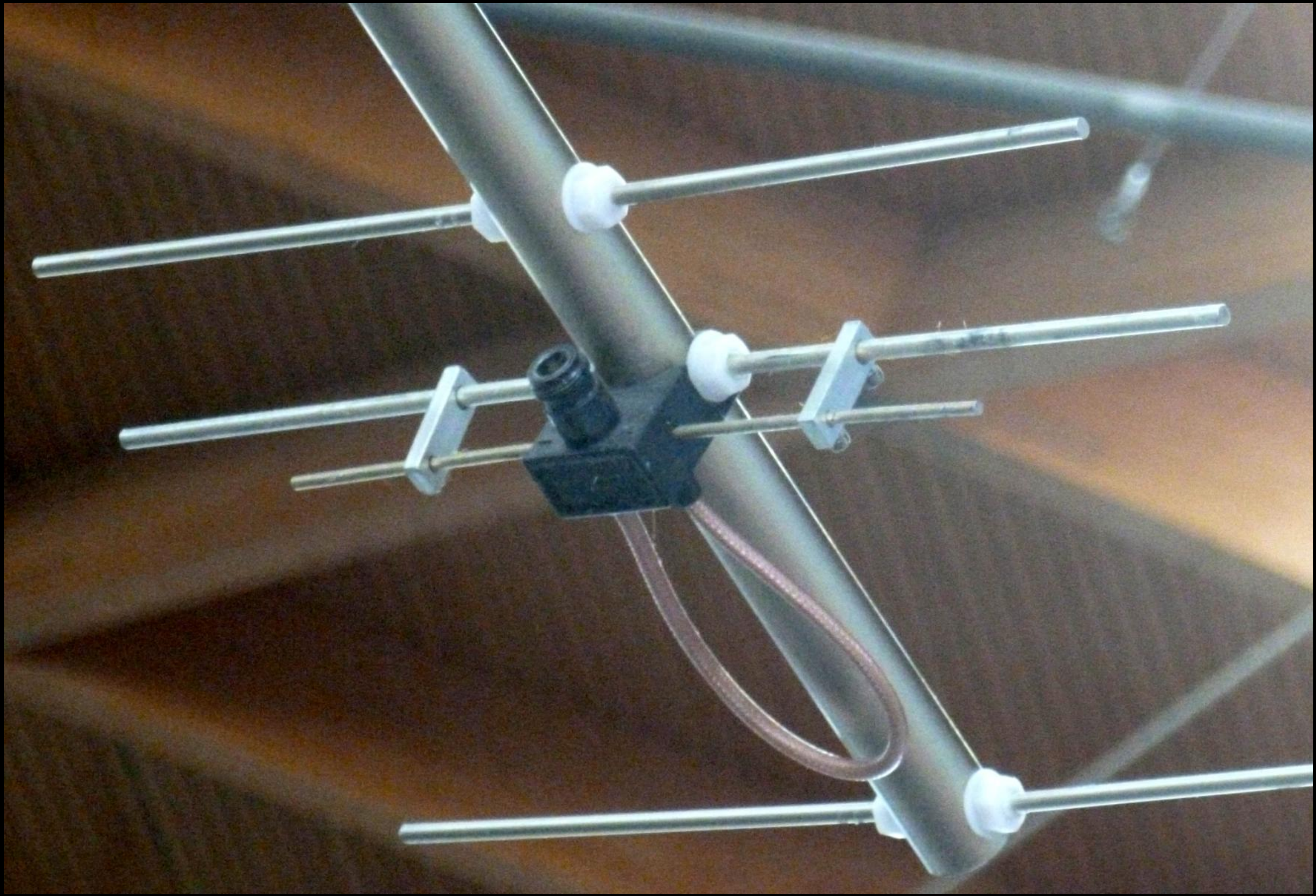
Fig 5.73: Gain sleeve dipole.

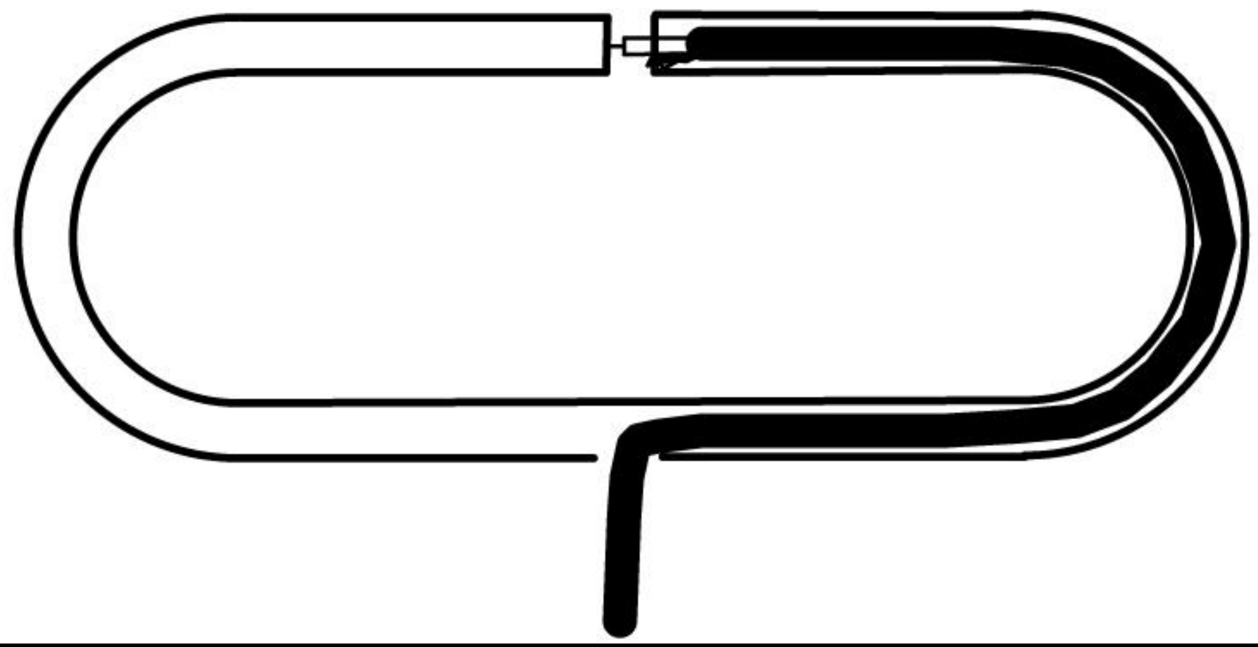


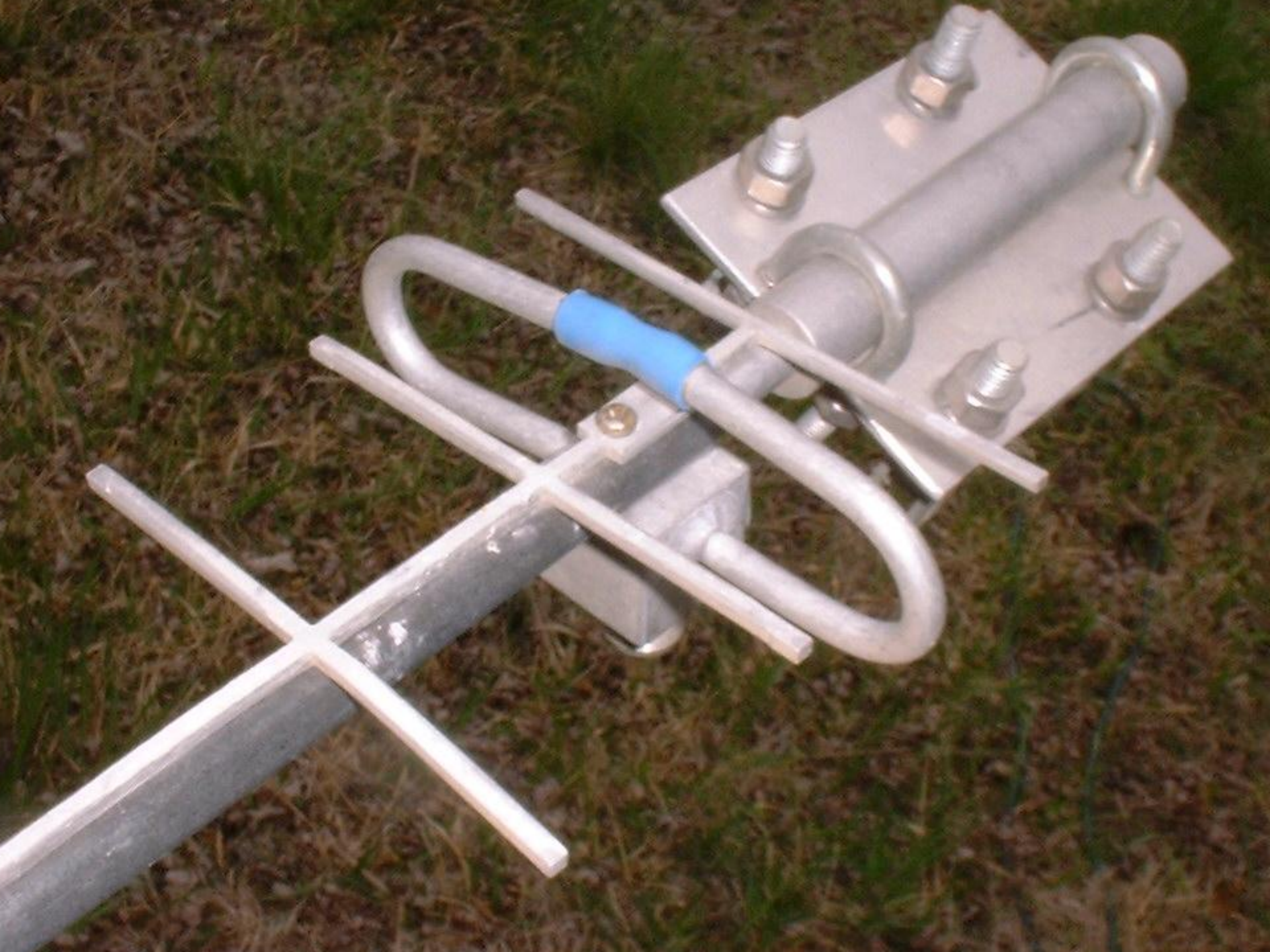


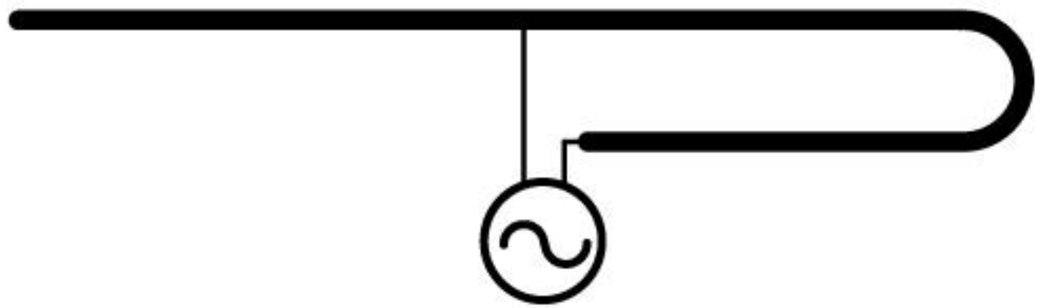


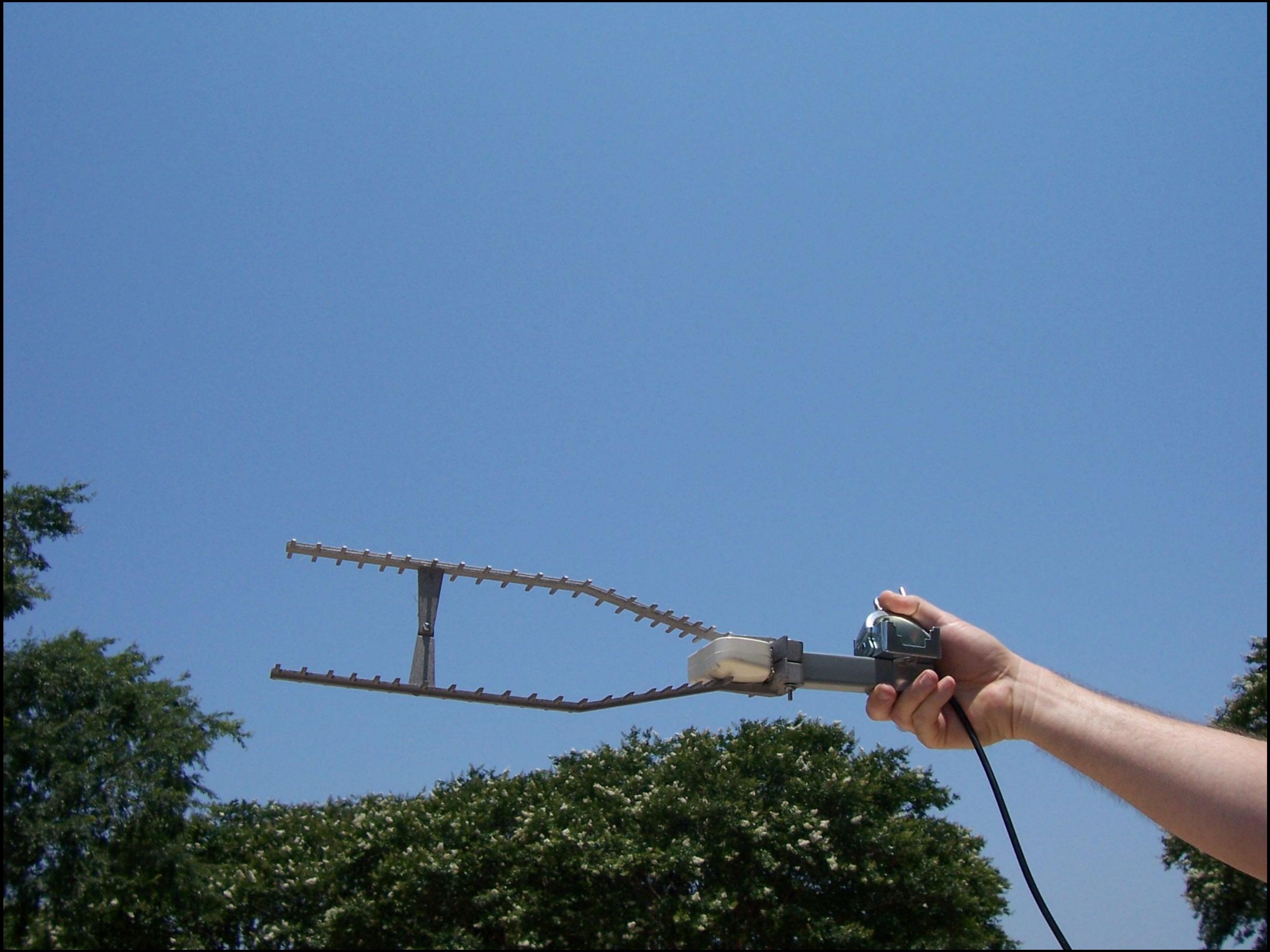


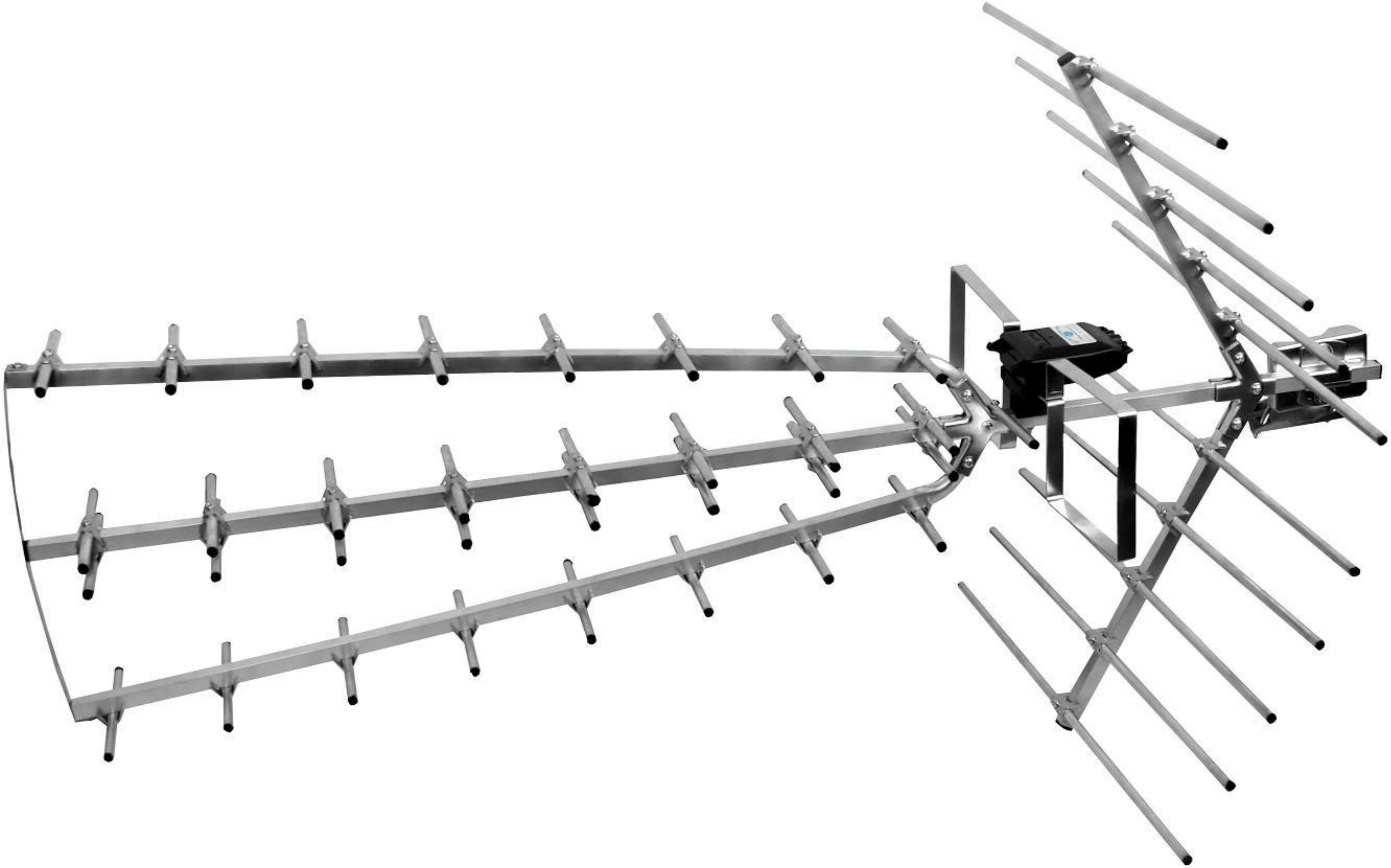




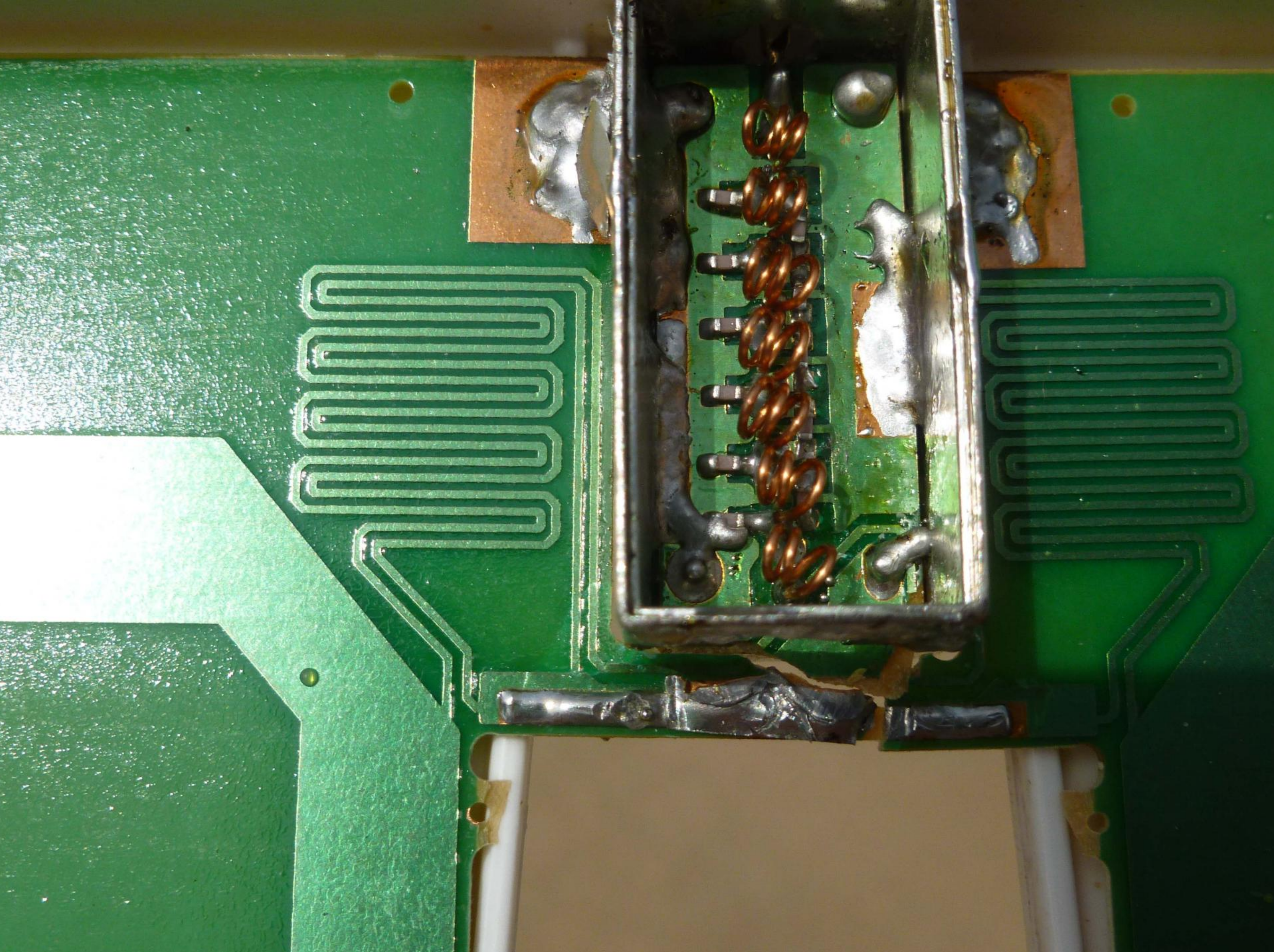


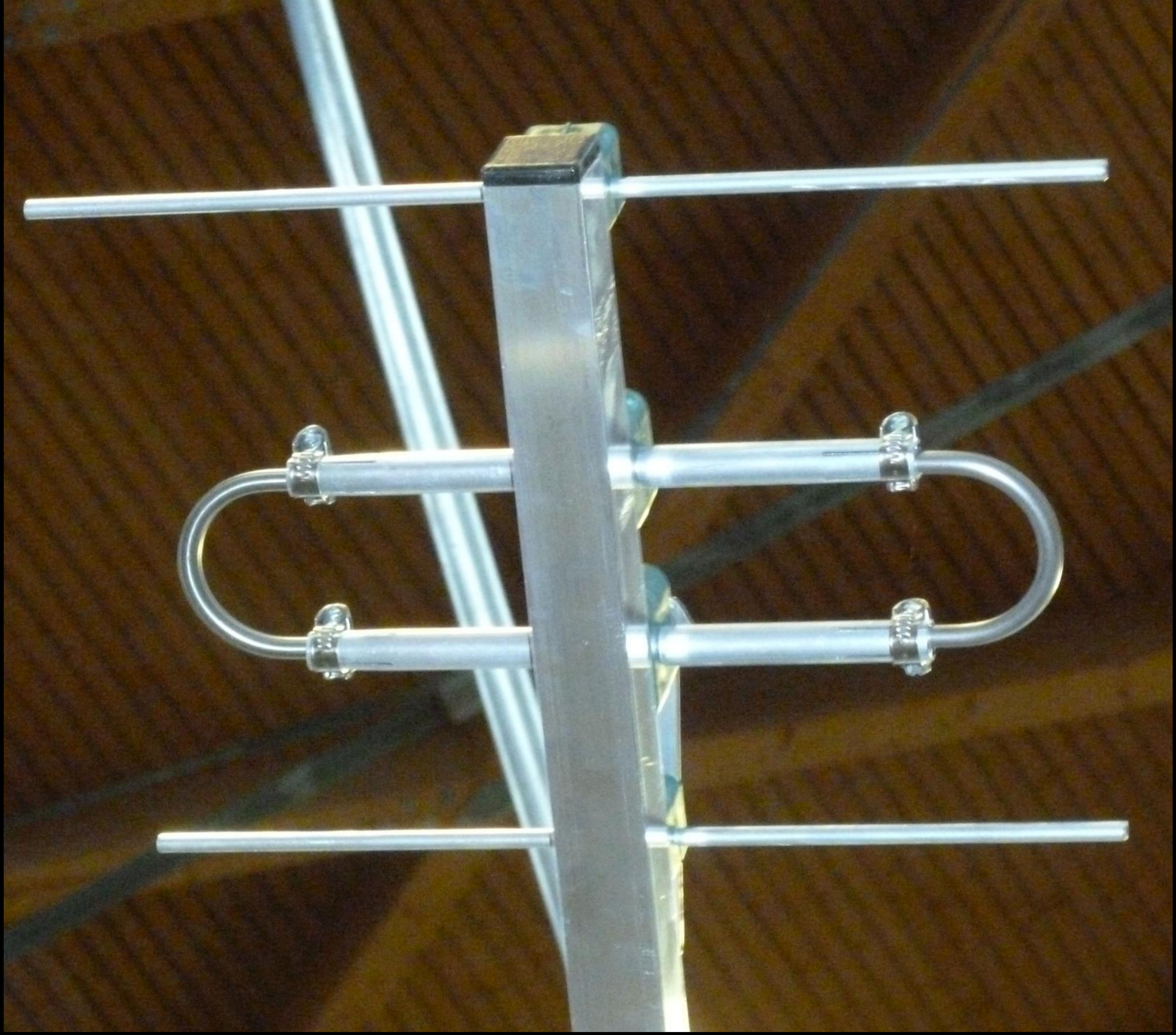


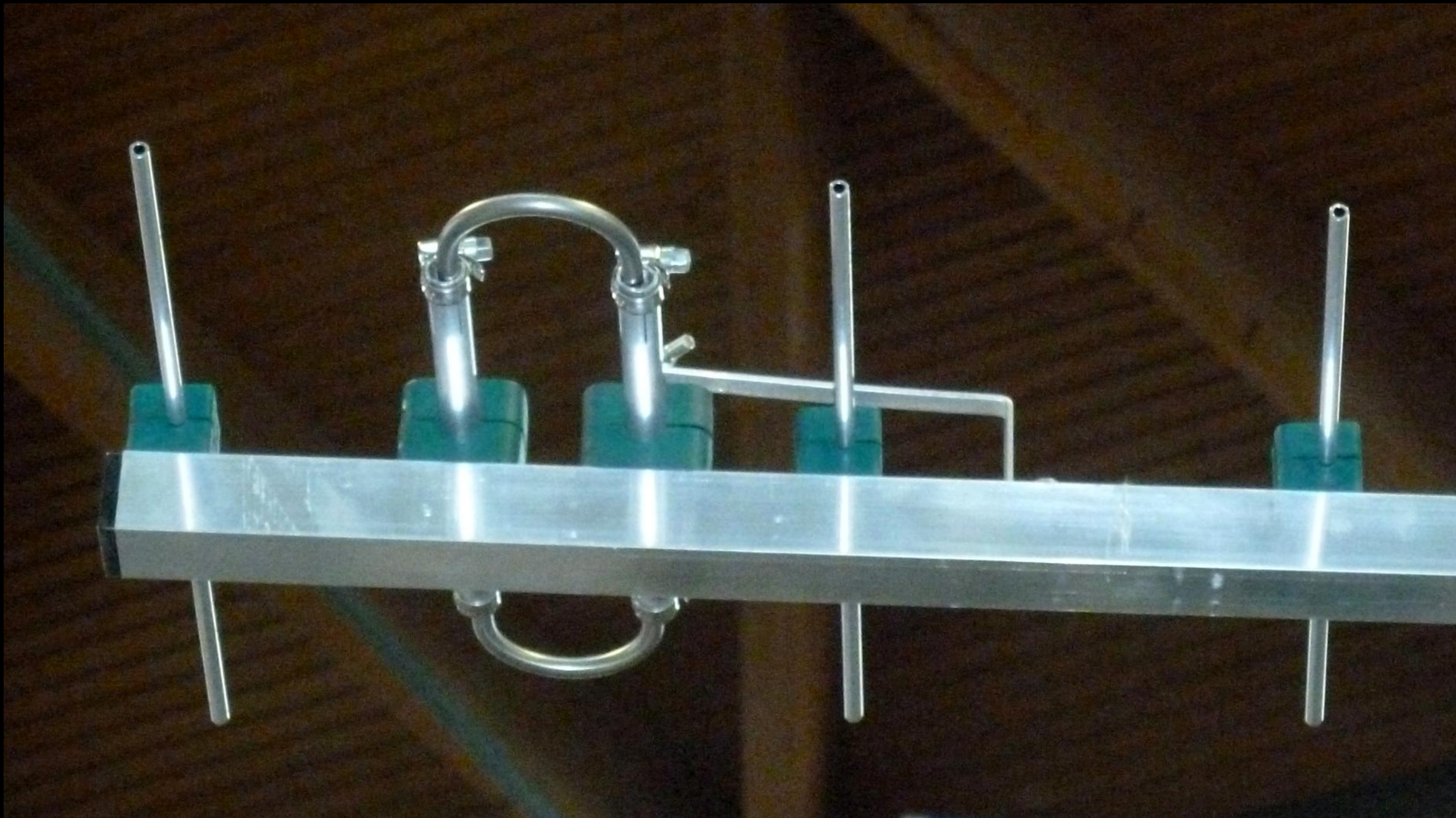


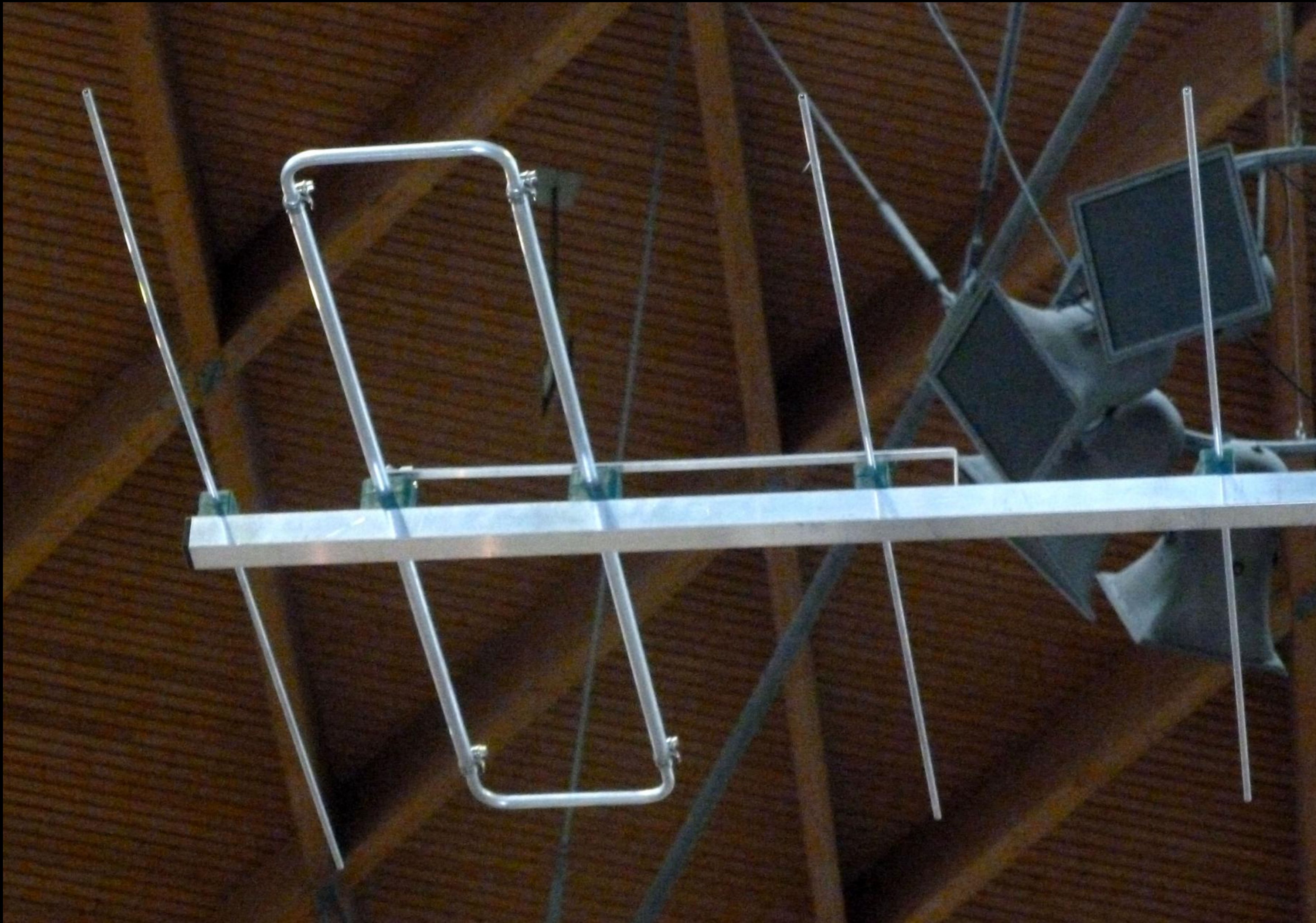


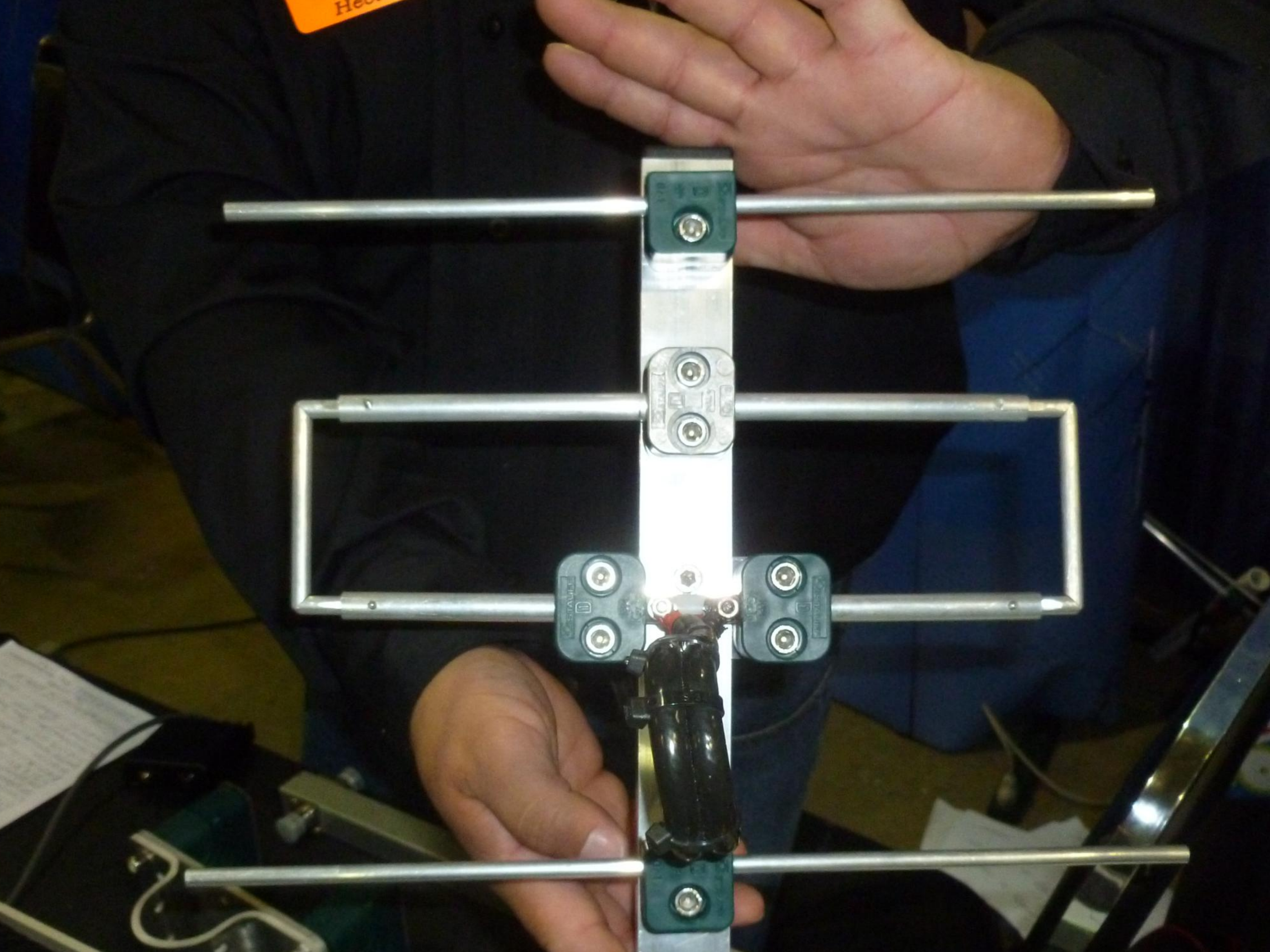

WC

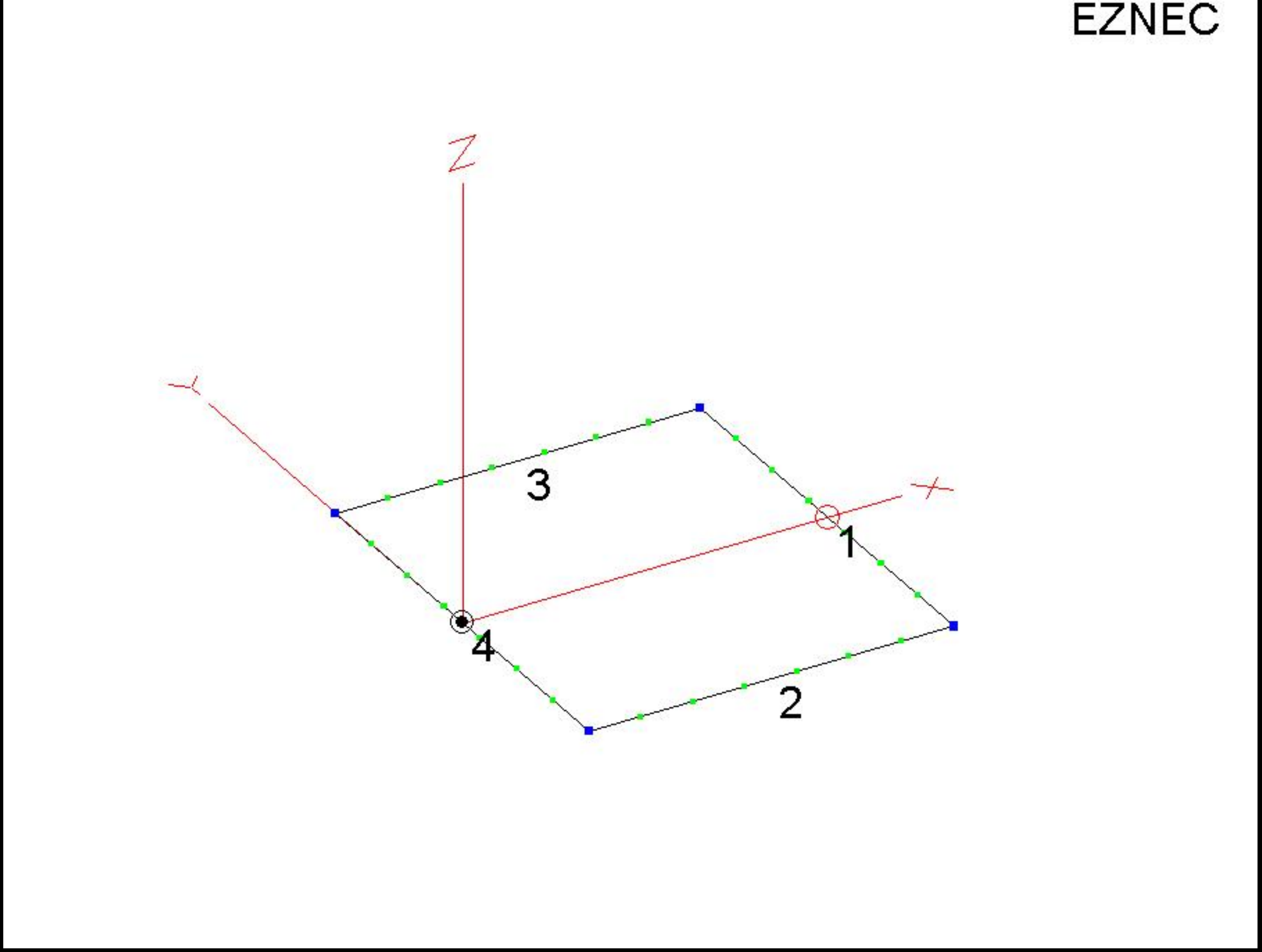




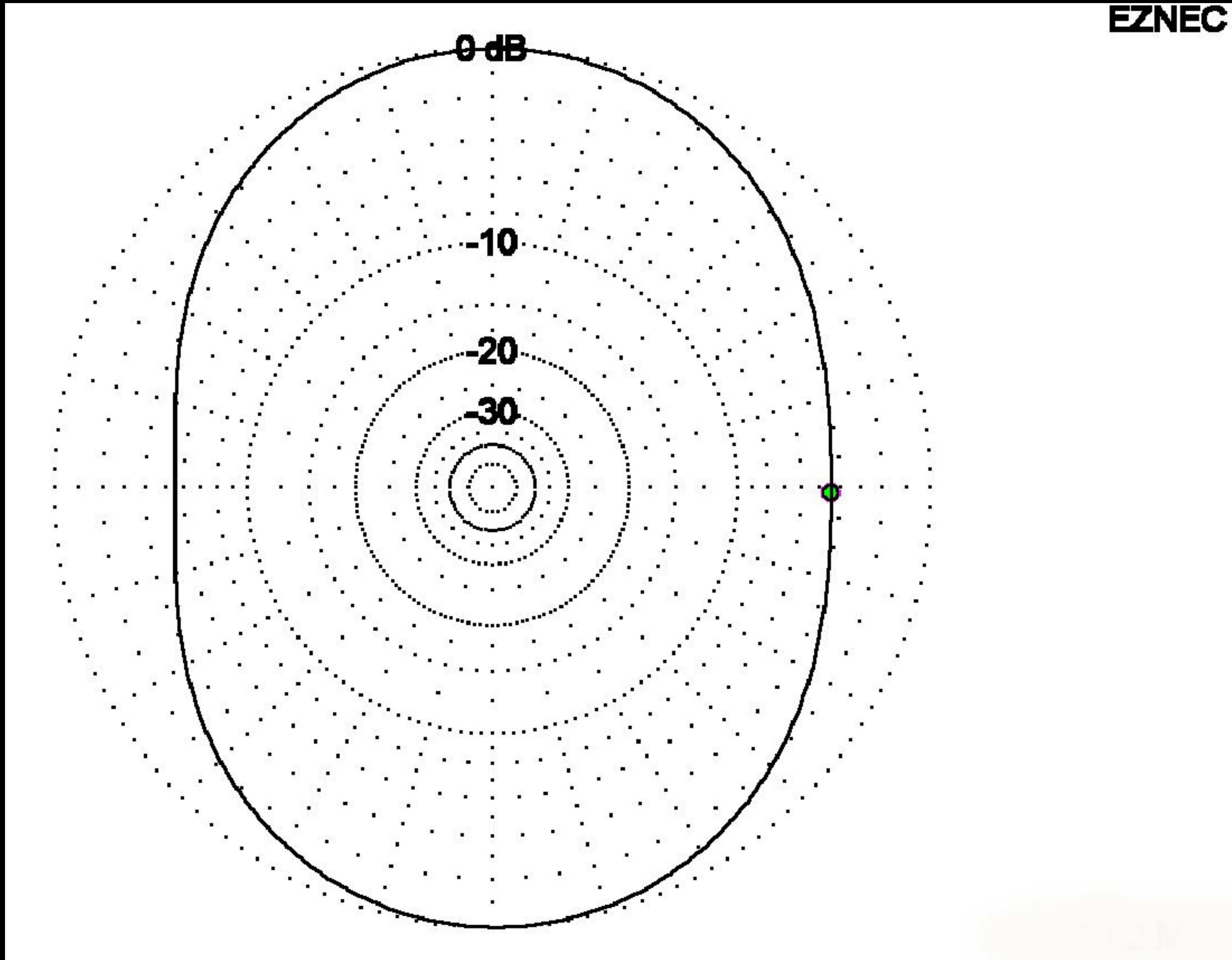


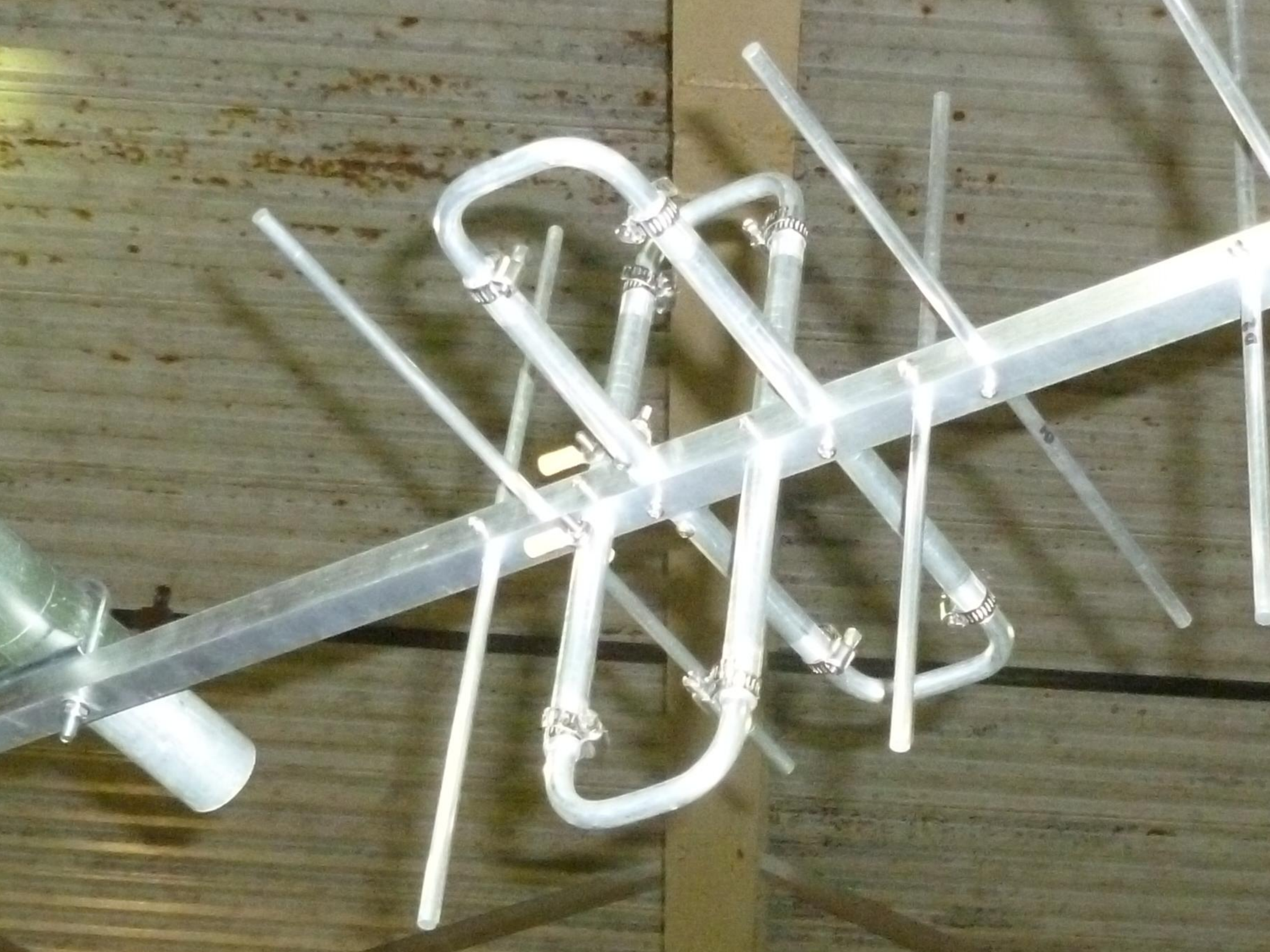


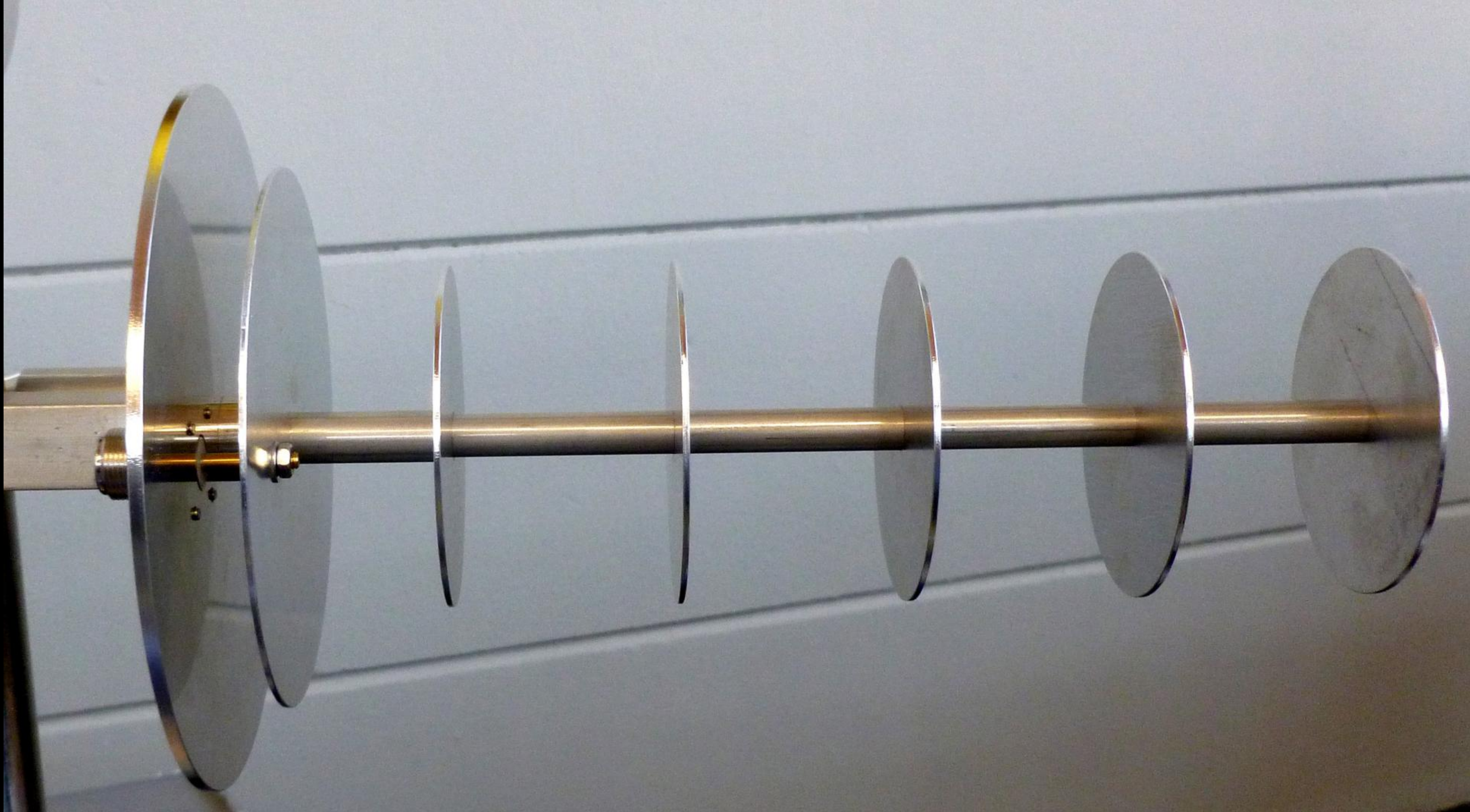


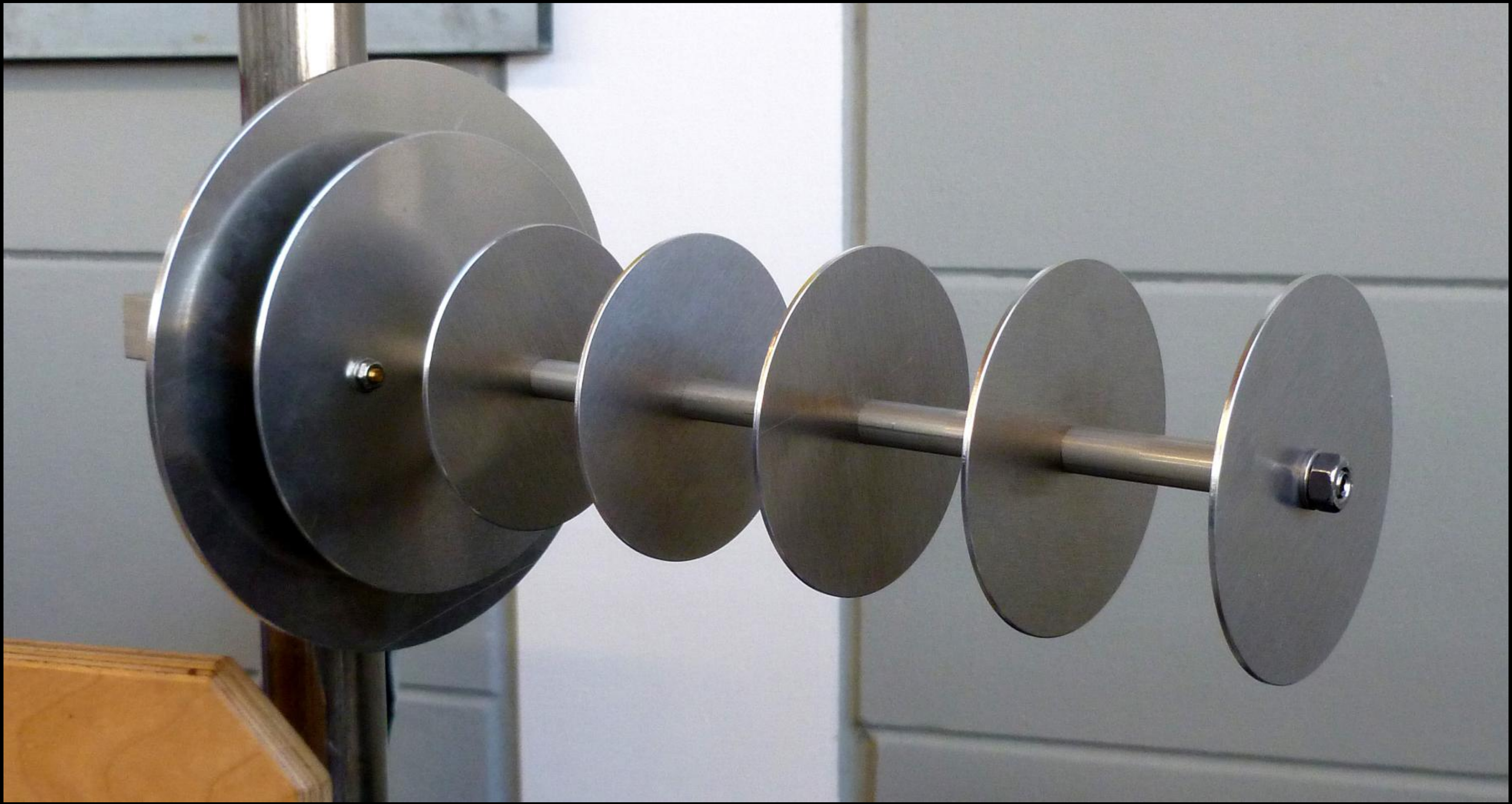


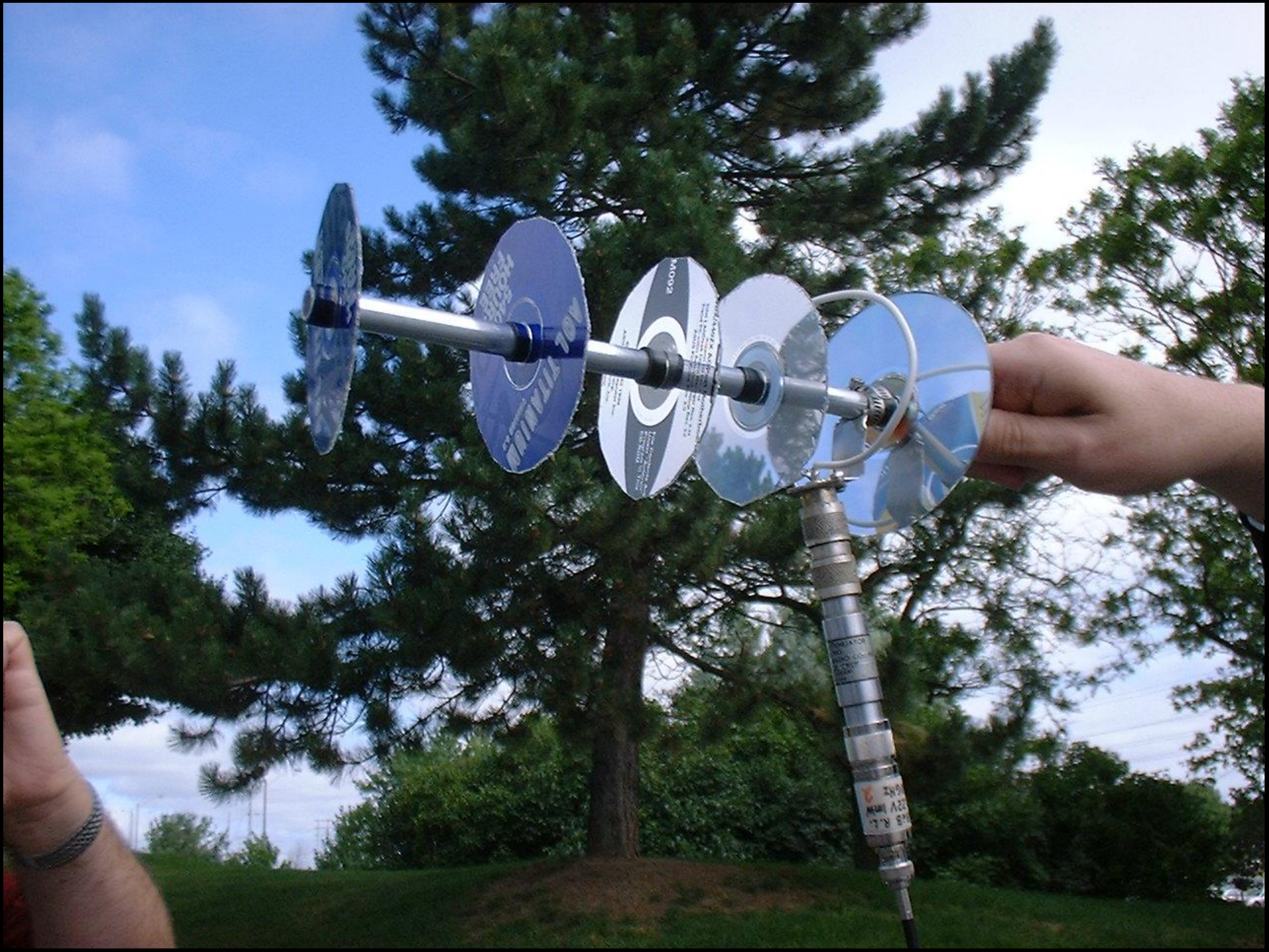
EZNEC
Z
Y
X
3
1
4
2

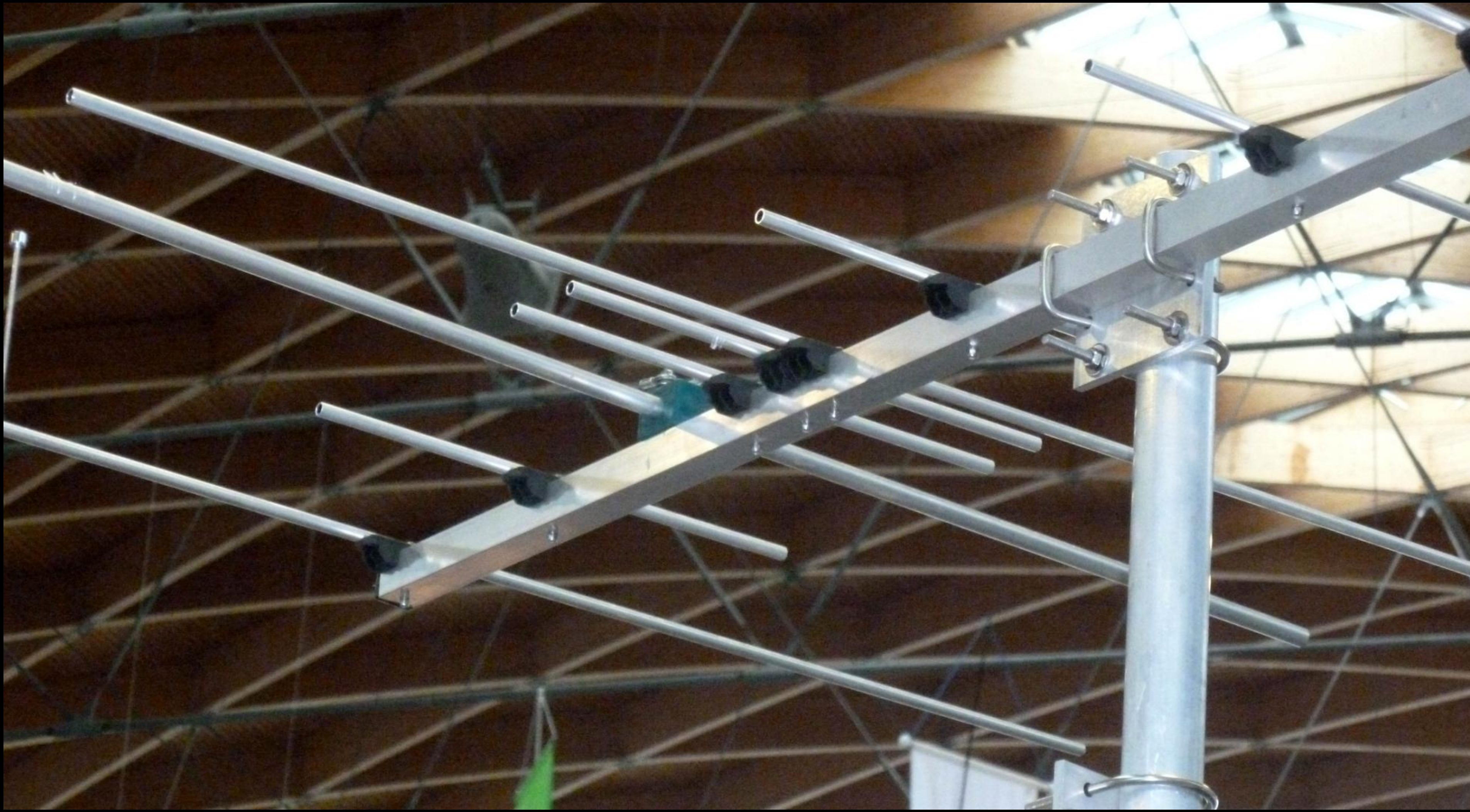

EZNEC
0 dB
-10
-20
-30









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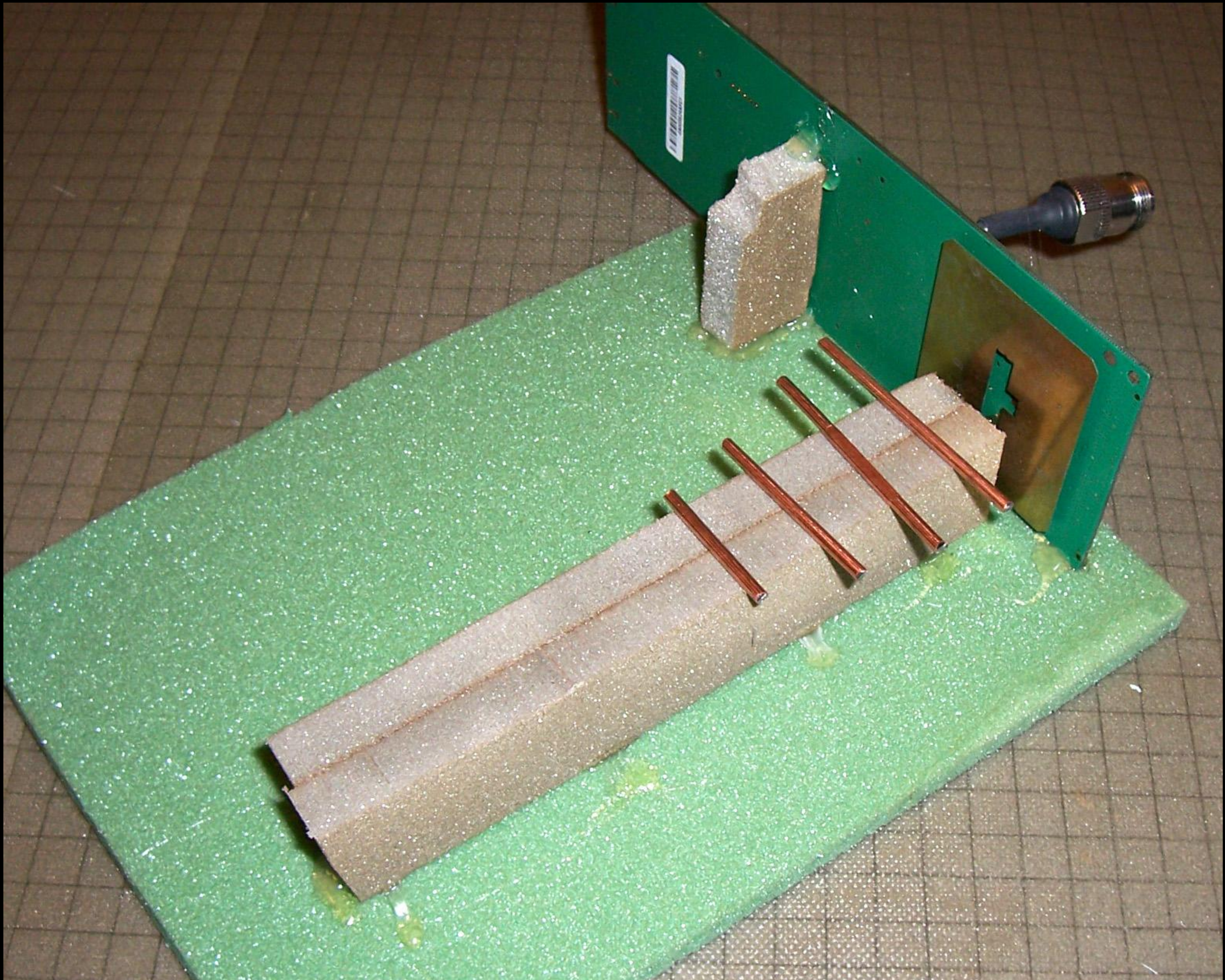
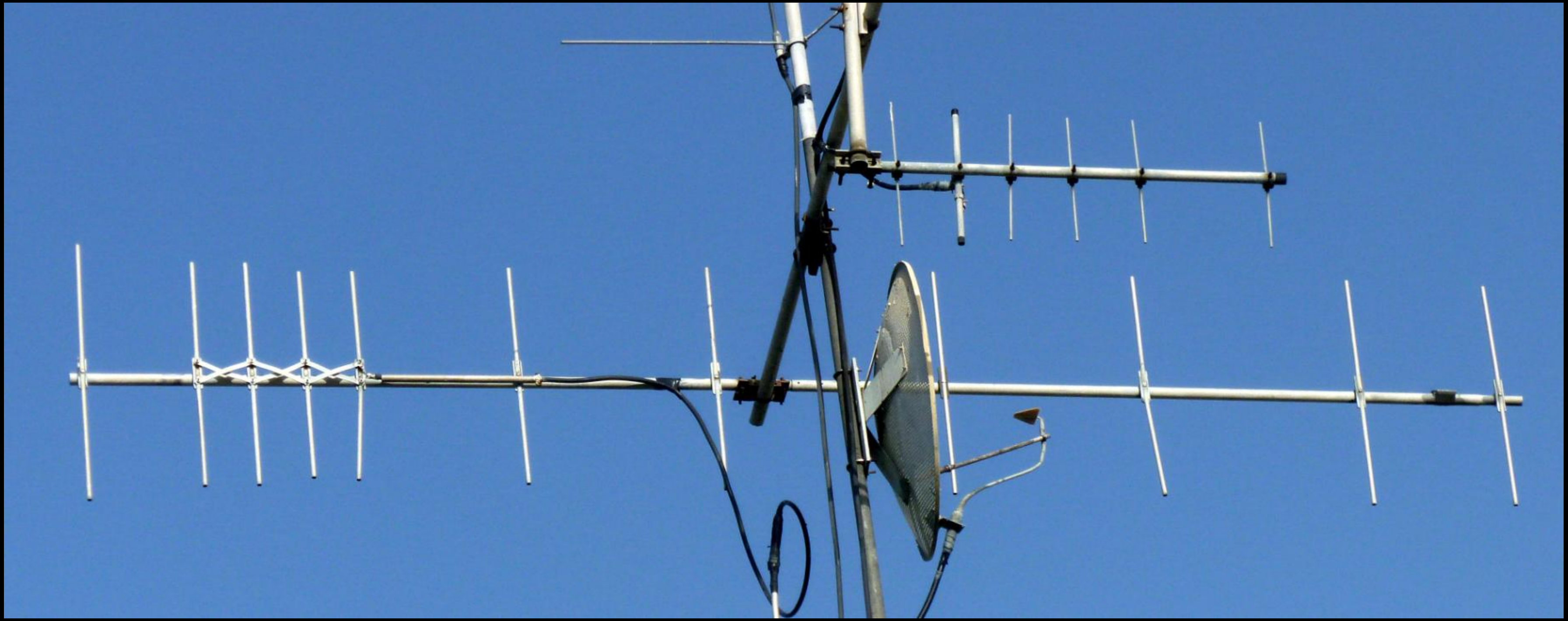
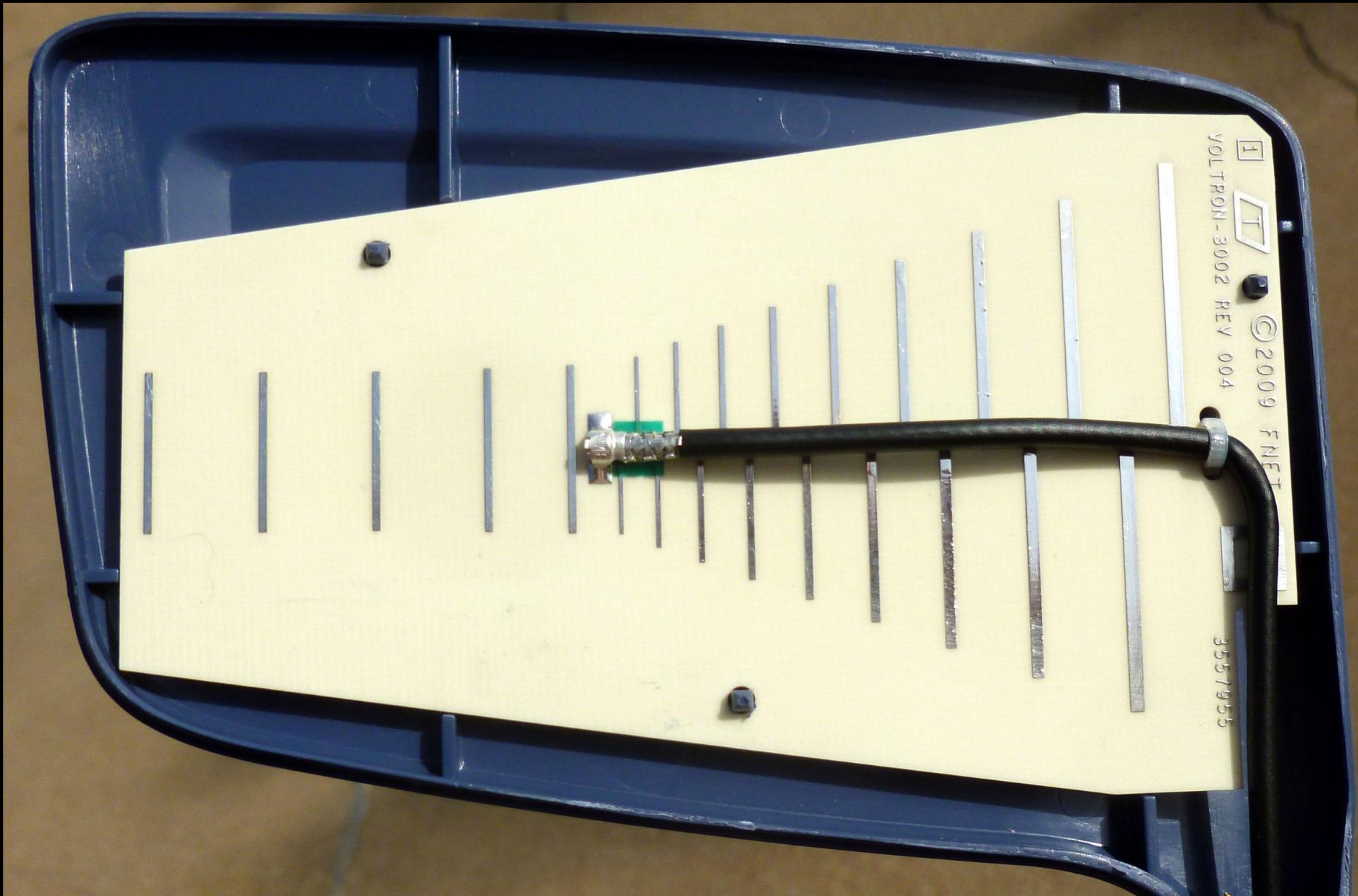



TENNADYNE
T28
50–1300 MHz
TENNADYNE

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VOLTRON-3002 REV 004
©2009 FNET
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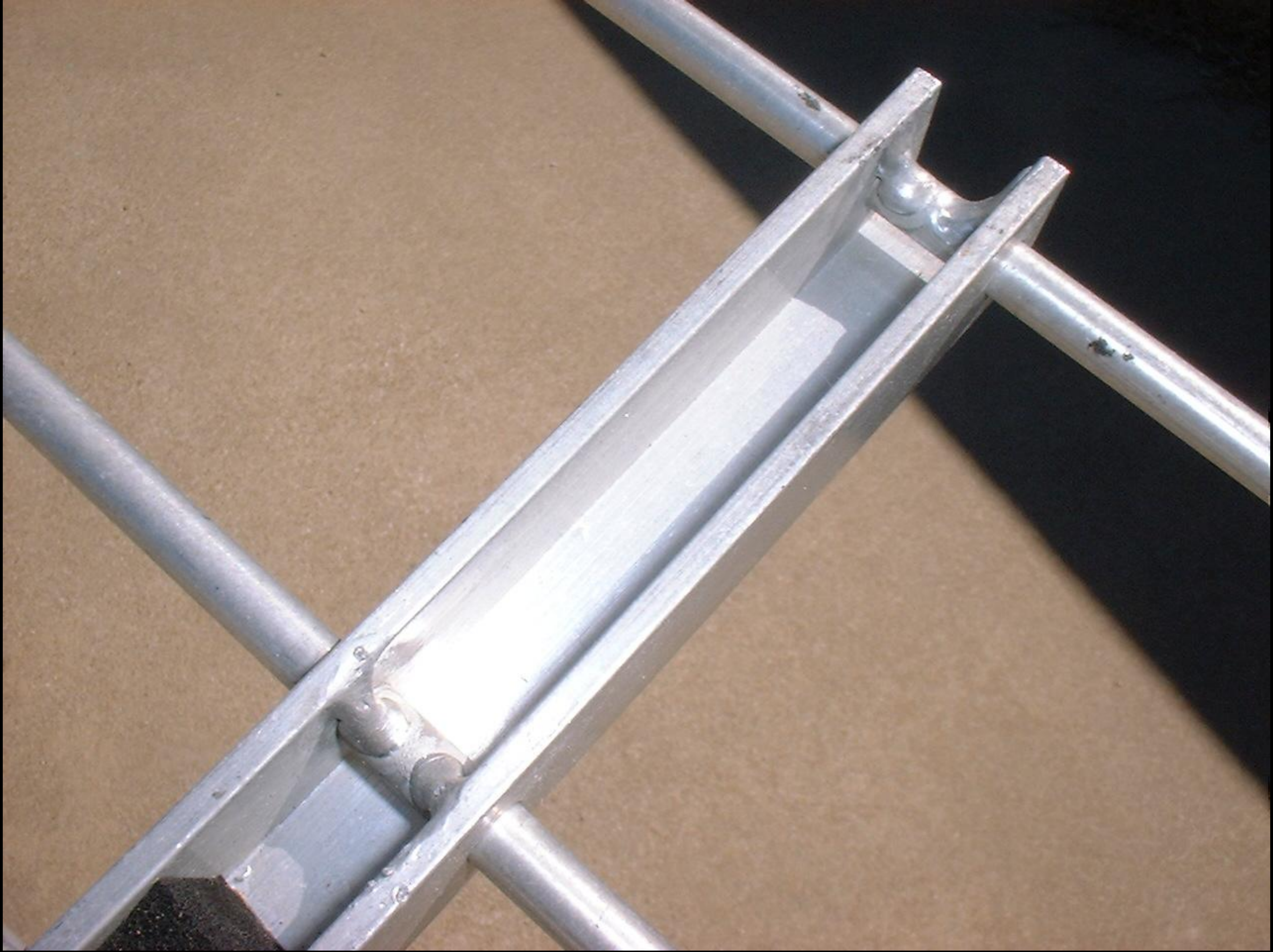

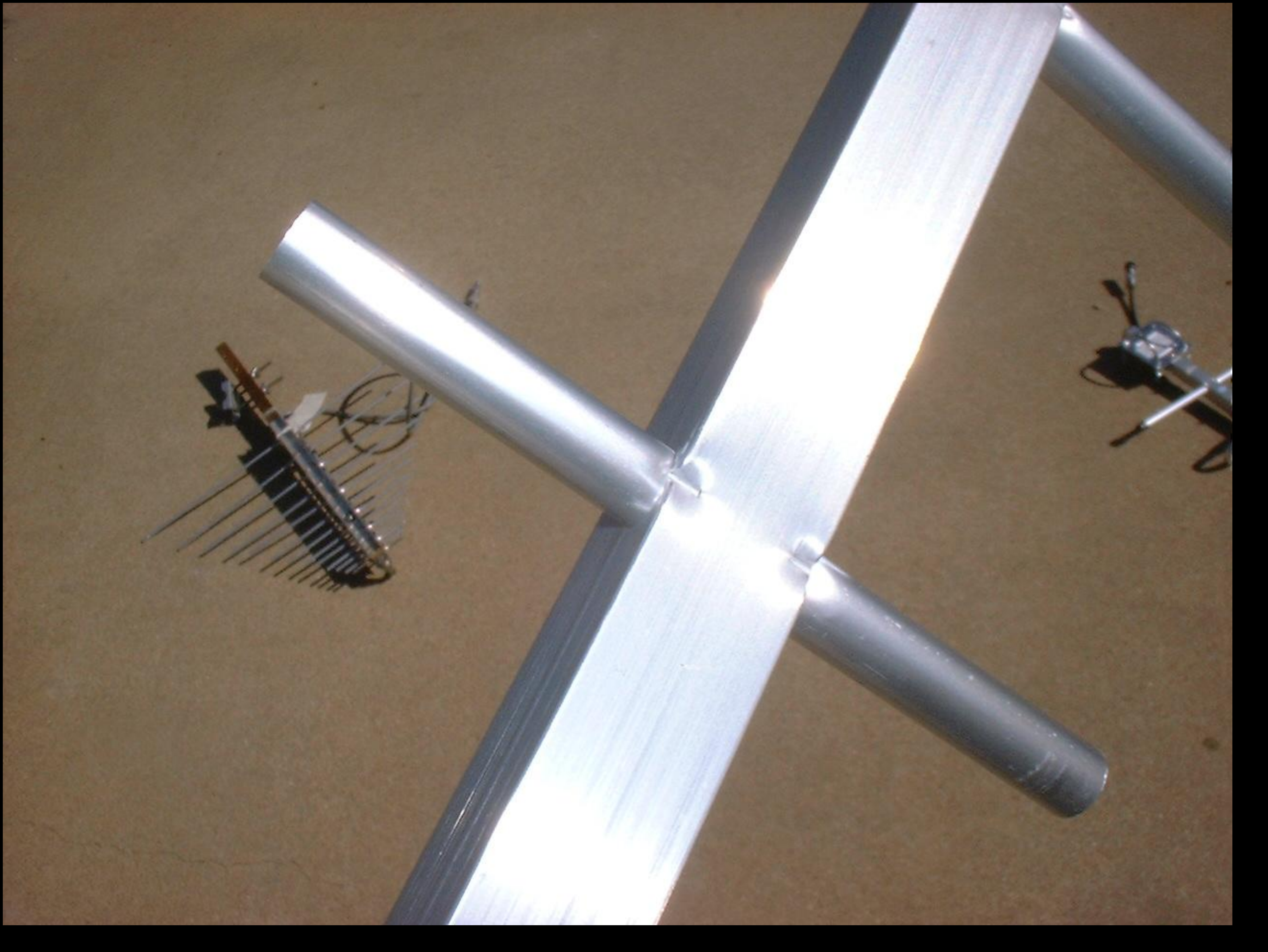

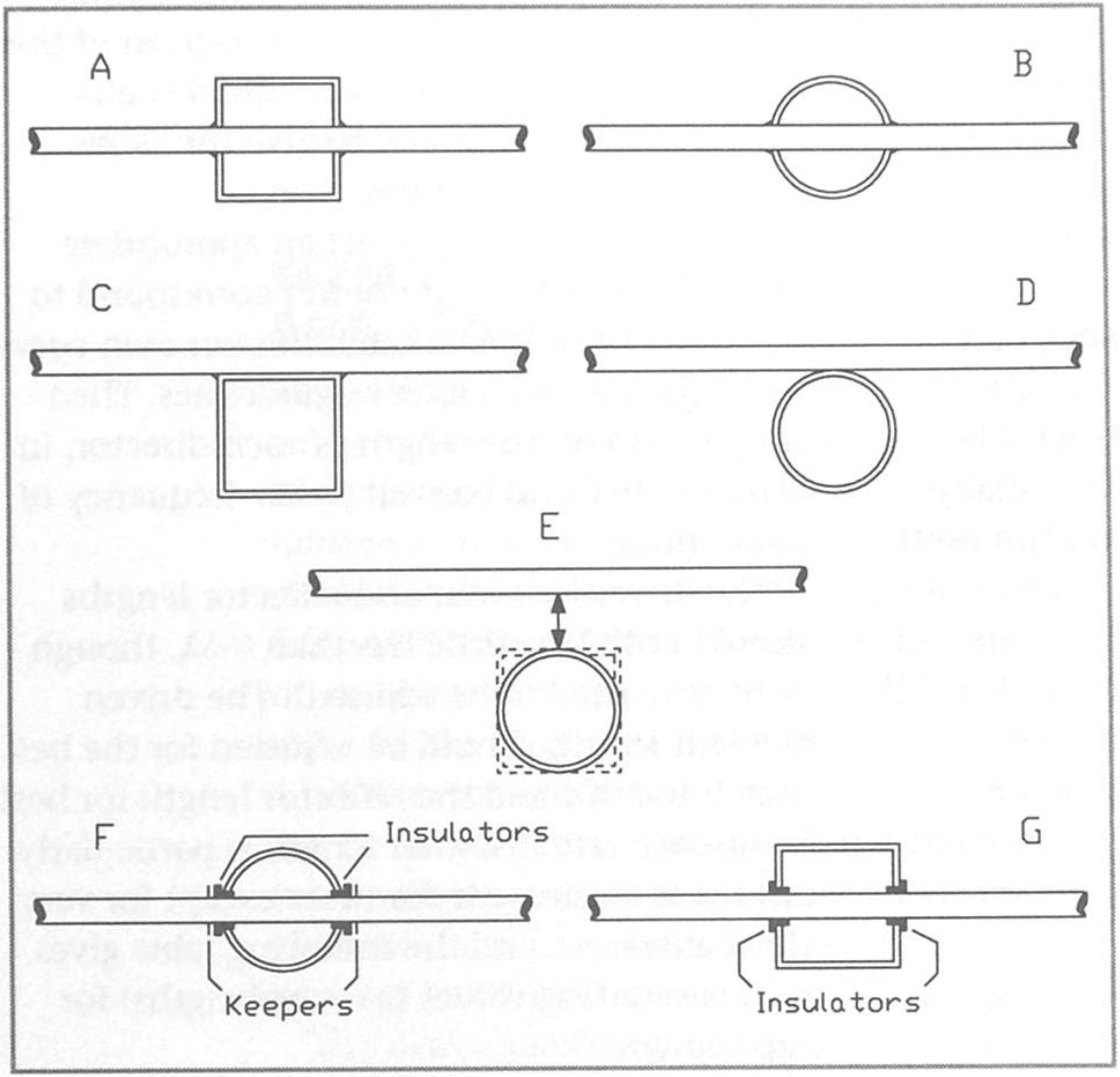

A
B
C
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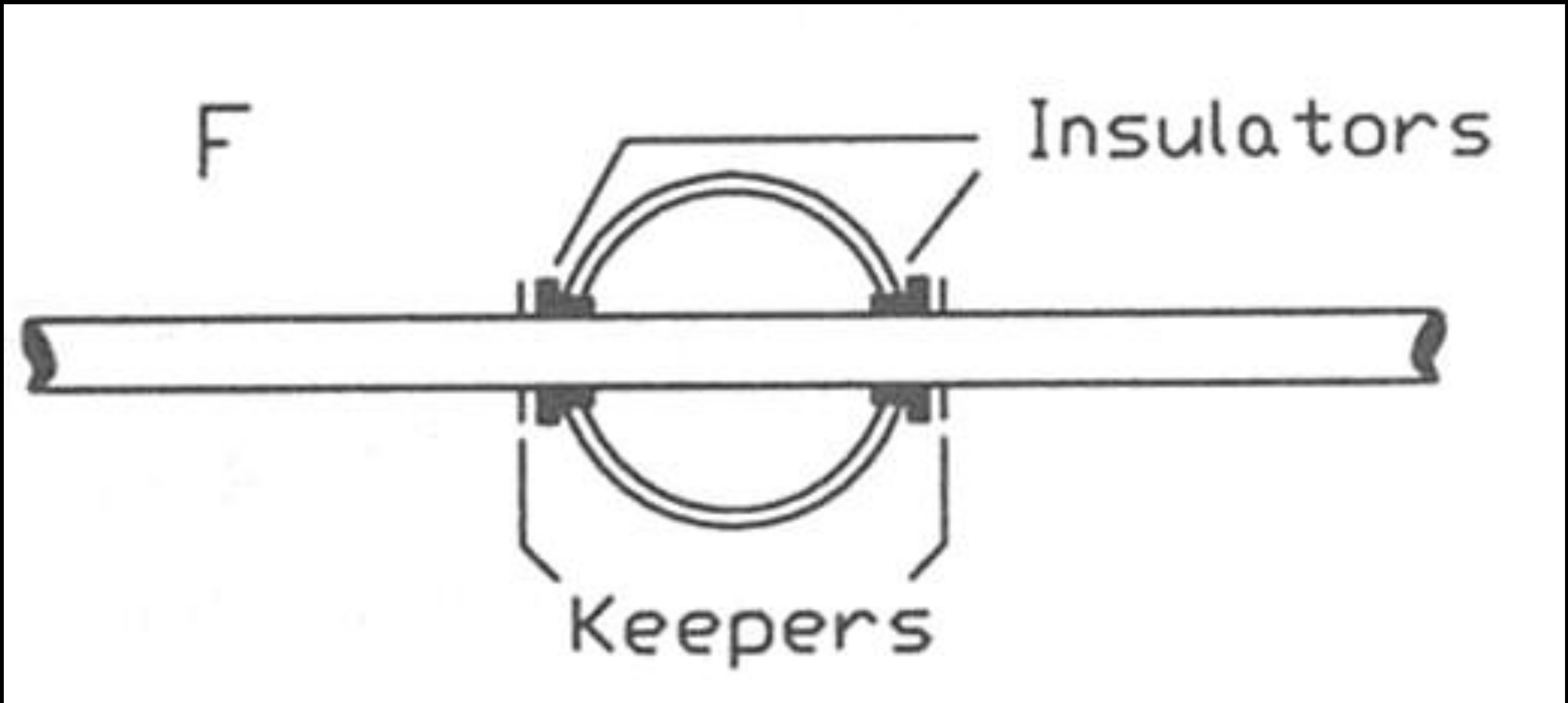
Insulators
Keepers
G
Insulators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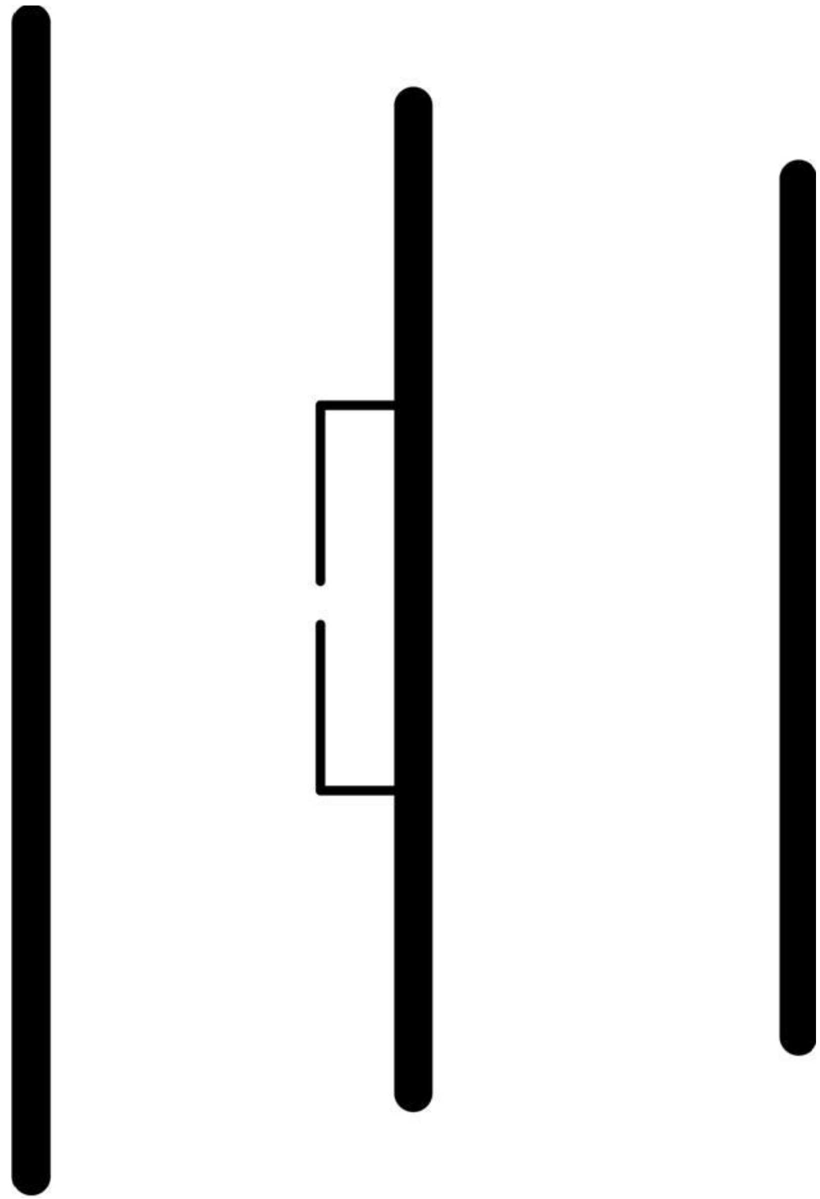
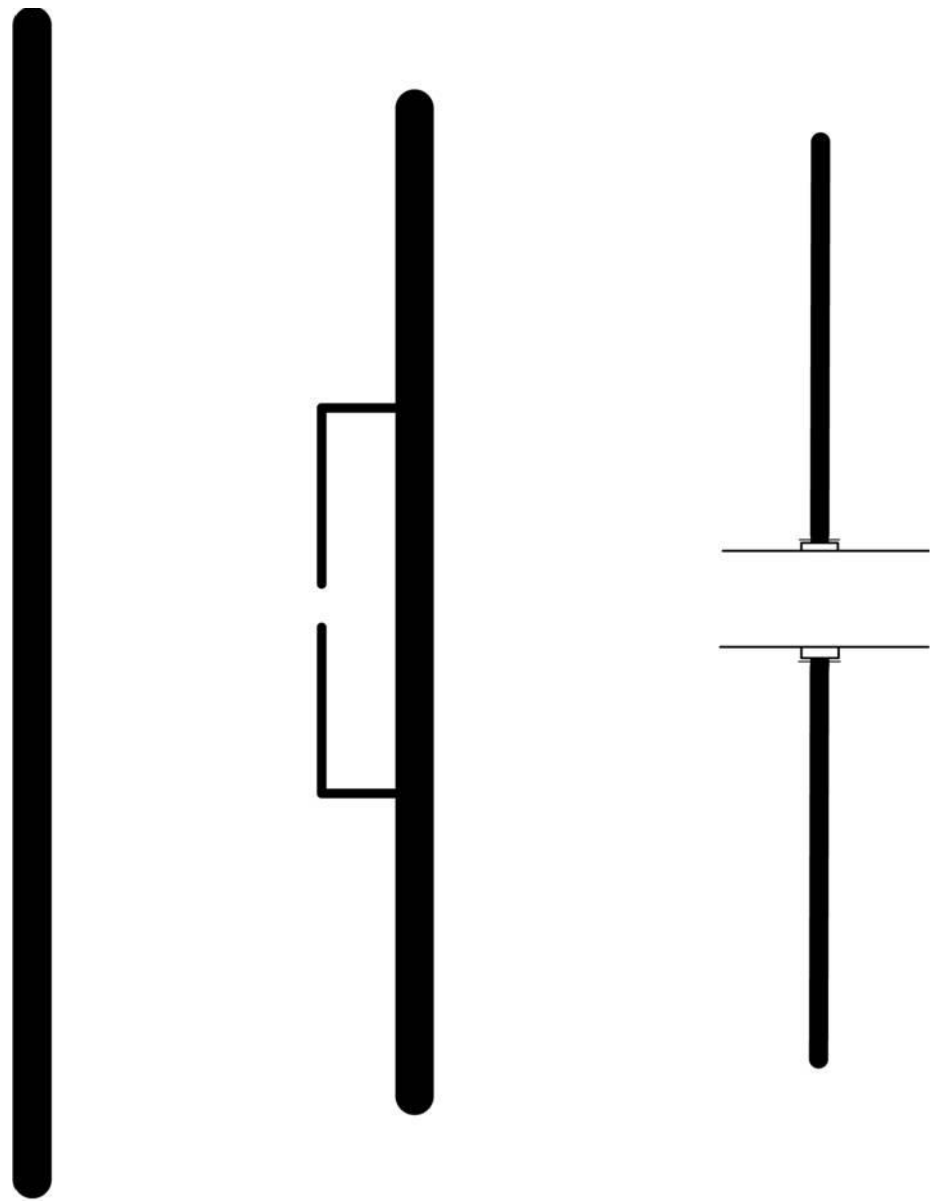
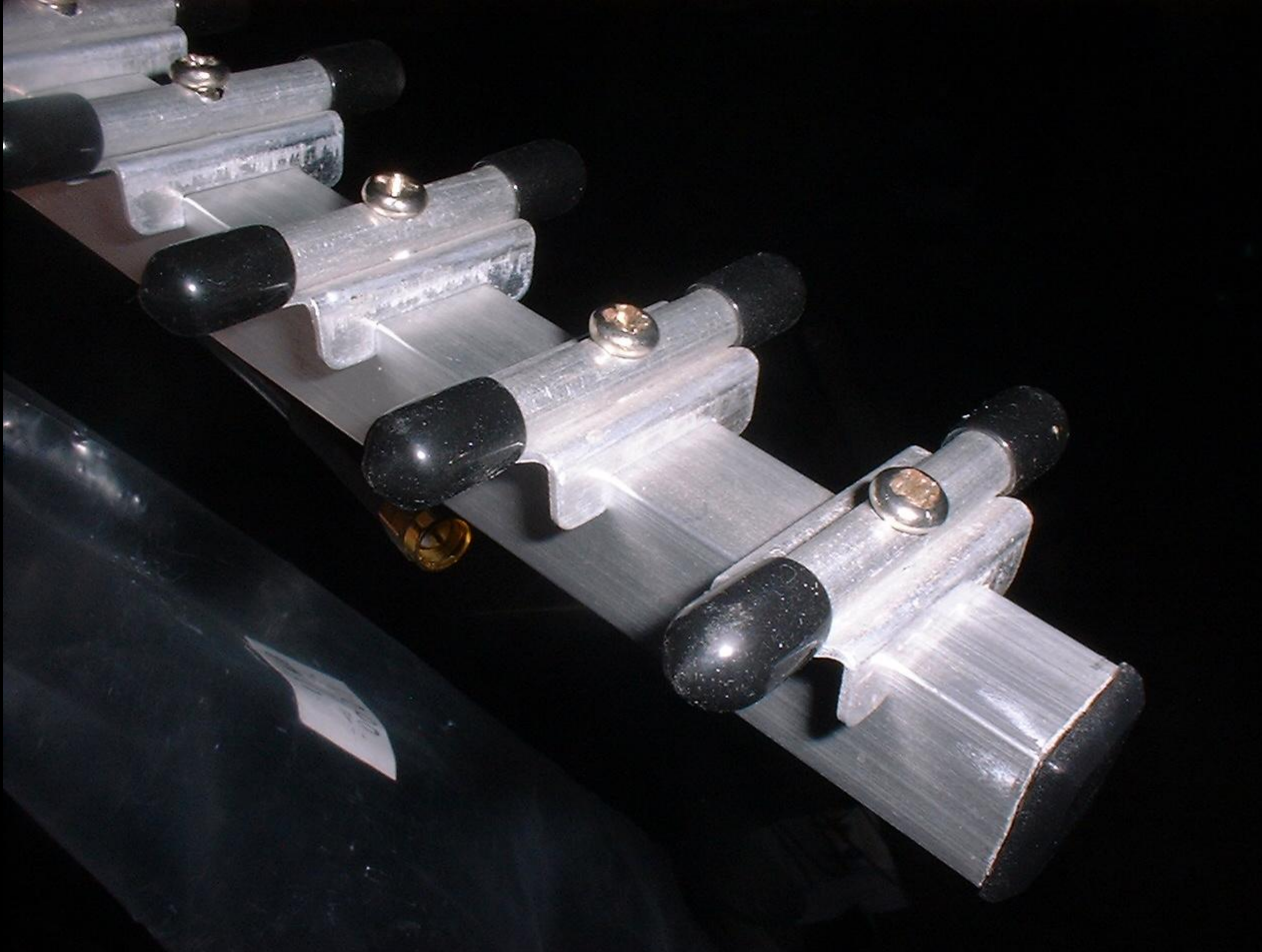
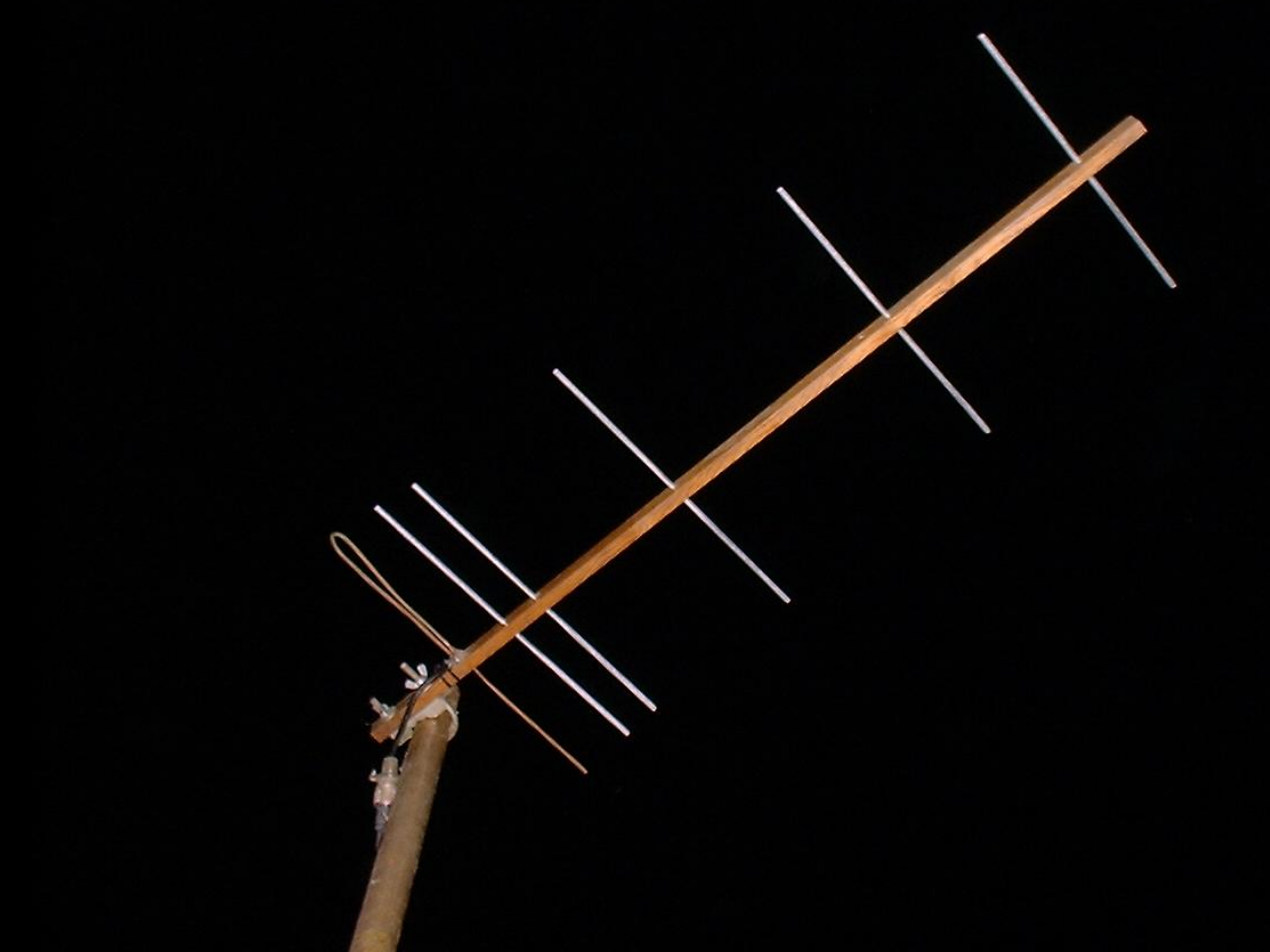
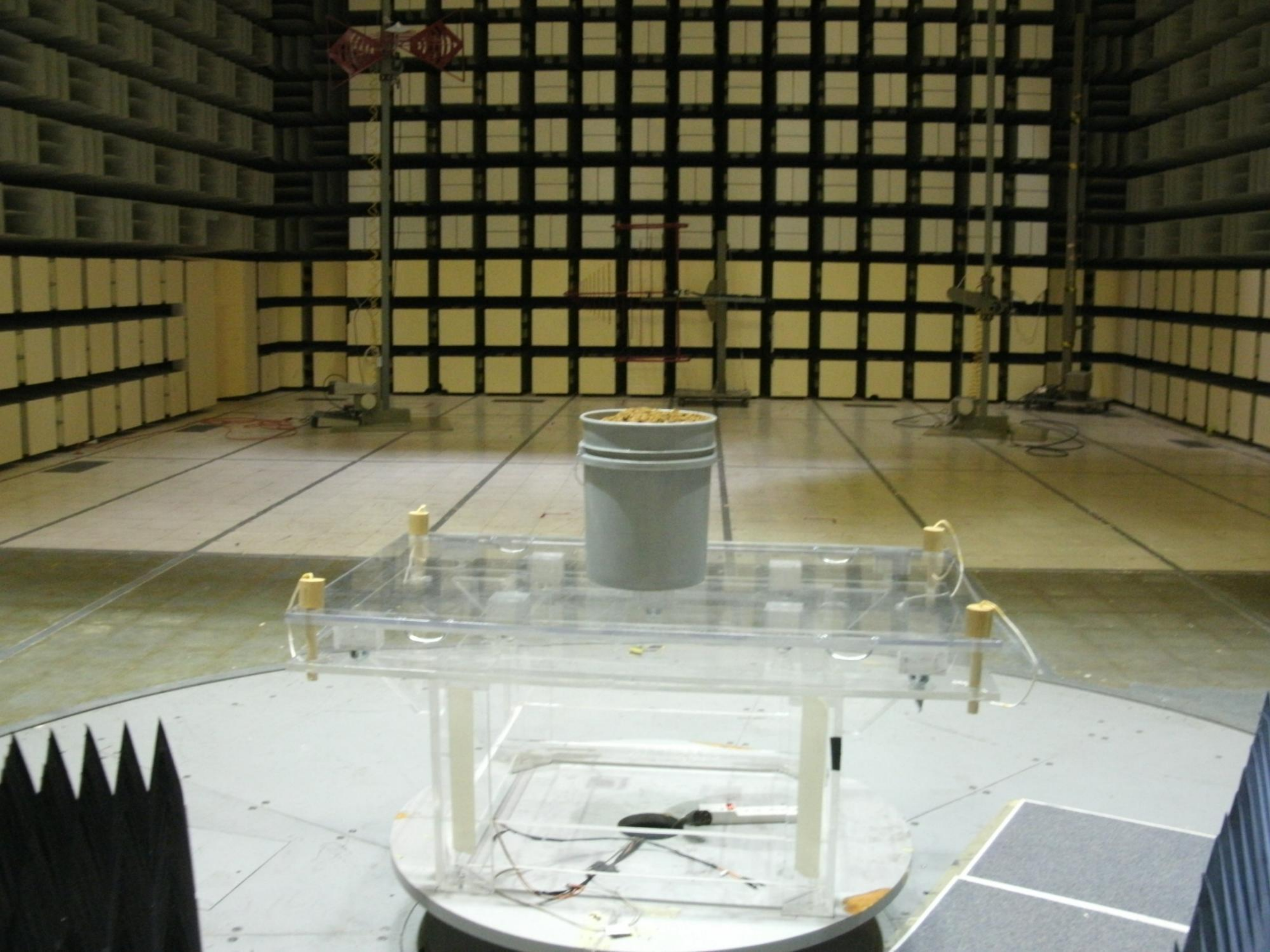
Keepers











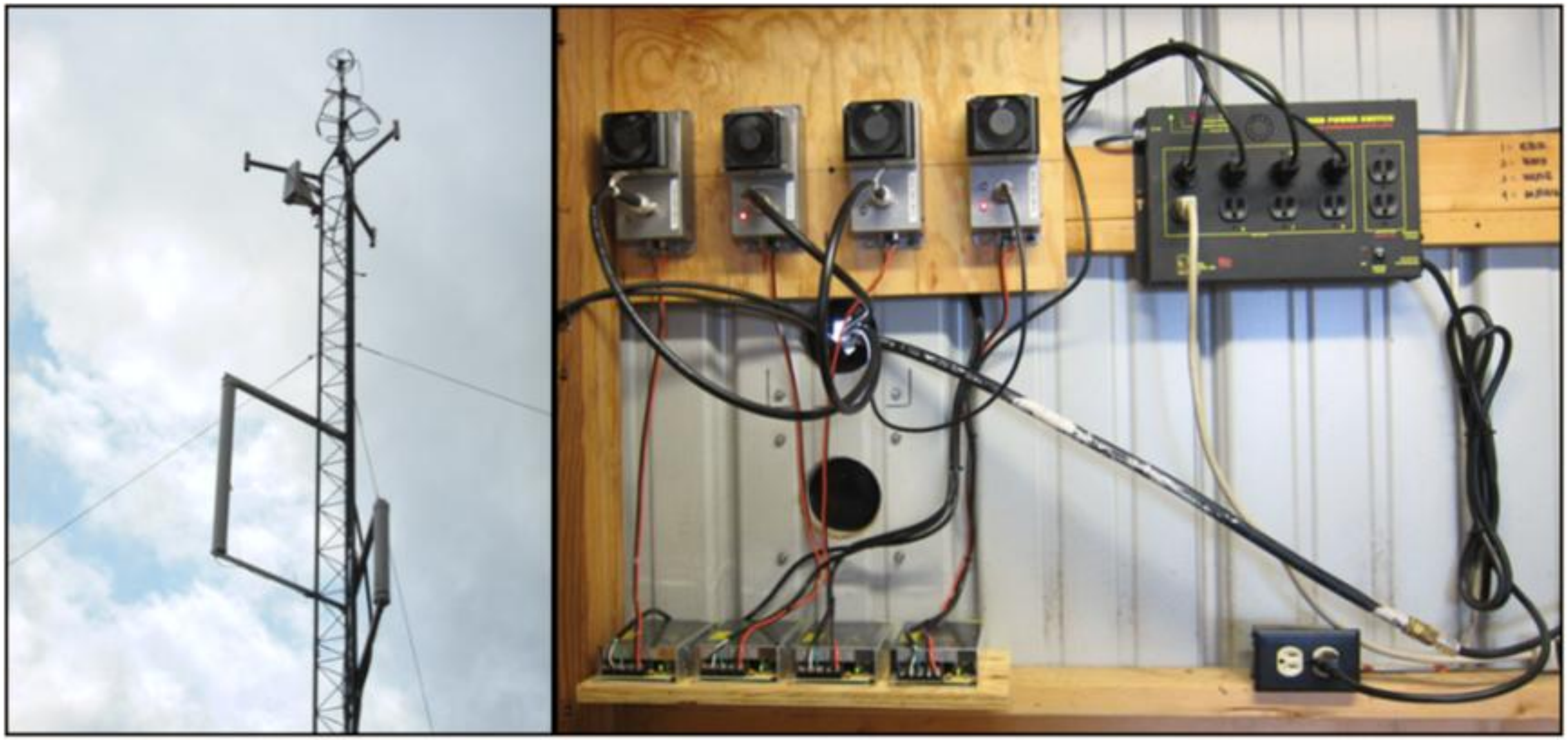
A Common Design for 6M Through 33CM Beacons

Beacon Exterior View

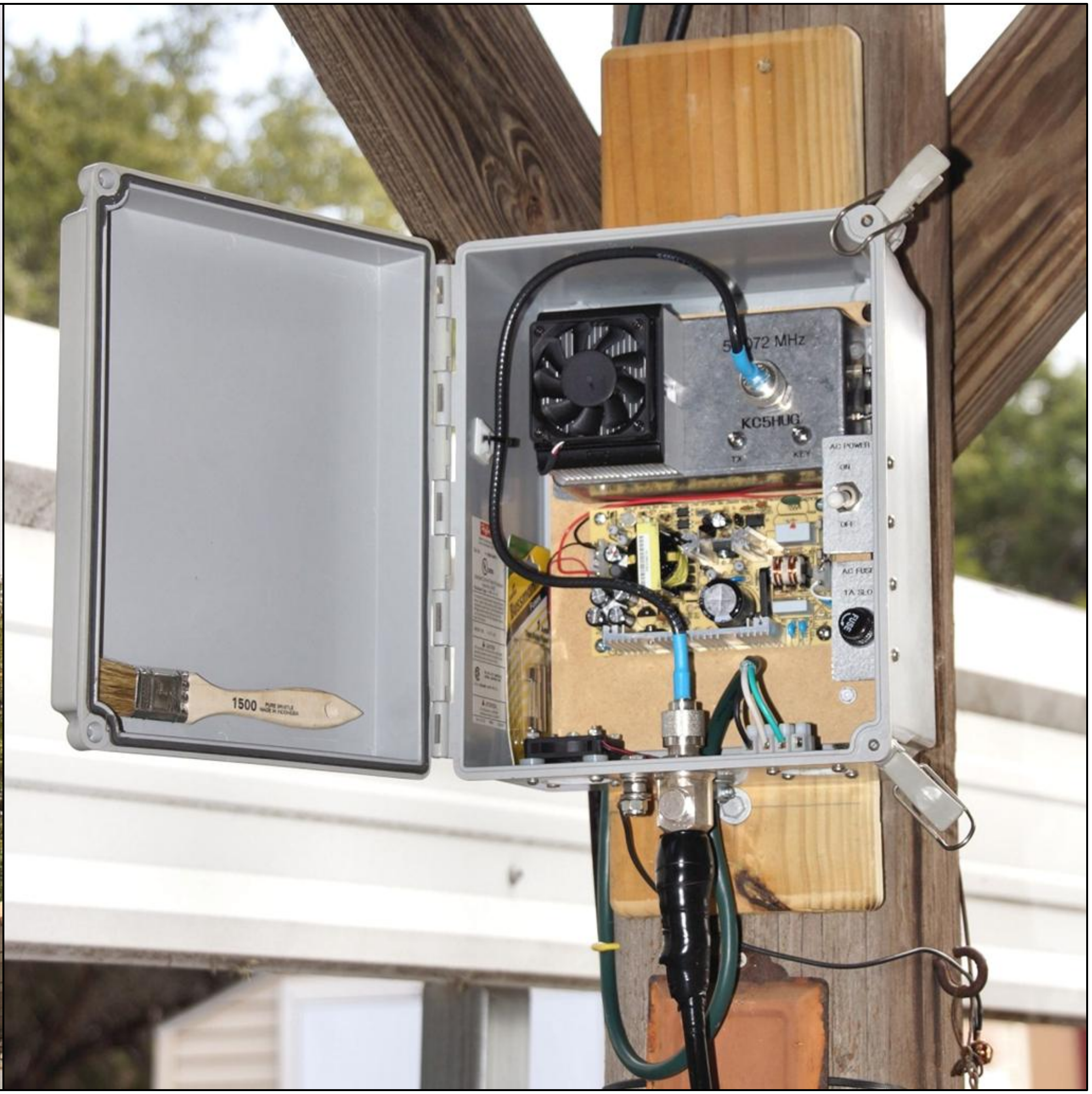
Beacons Parameters

Freq.(MHz) +/- 3KHz	Location	Pwr (W)	Antenna	Elevation Gnd ASL / Ant AGL	Callsign	Status
50.072	EL09uw W Canyon Lake, TX	15, 1.5, 0.15	Par Omniangle	1080' / 27'	KC5HUG	Active
144.295	EM00xh Austin, TX	10, 1, 0.1	Par Omniangle	1240' / 45'	K5RMG	Active
222.060	EM00xh Austin, TX	10, 1, 0.1	Big Wheel (folded dipoles	1240' / 45'	K5TRA	Active
432.345	EM00xh Austin, TX	10, 1, 0.1	Big Wheel (folded dipoles)	1240' / 45'	K5RMG	Active
902.330	EM00xh Austin, TX	15, 1.5, 0.15	Helical Collinear	1240' / 45'	K5RMG	Active

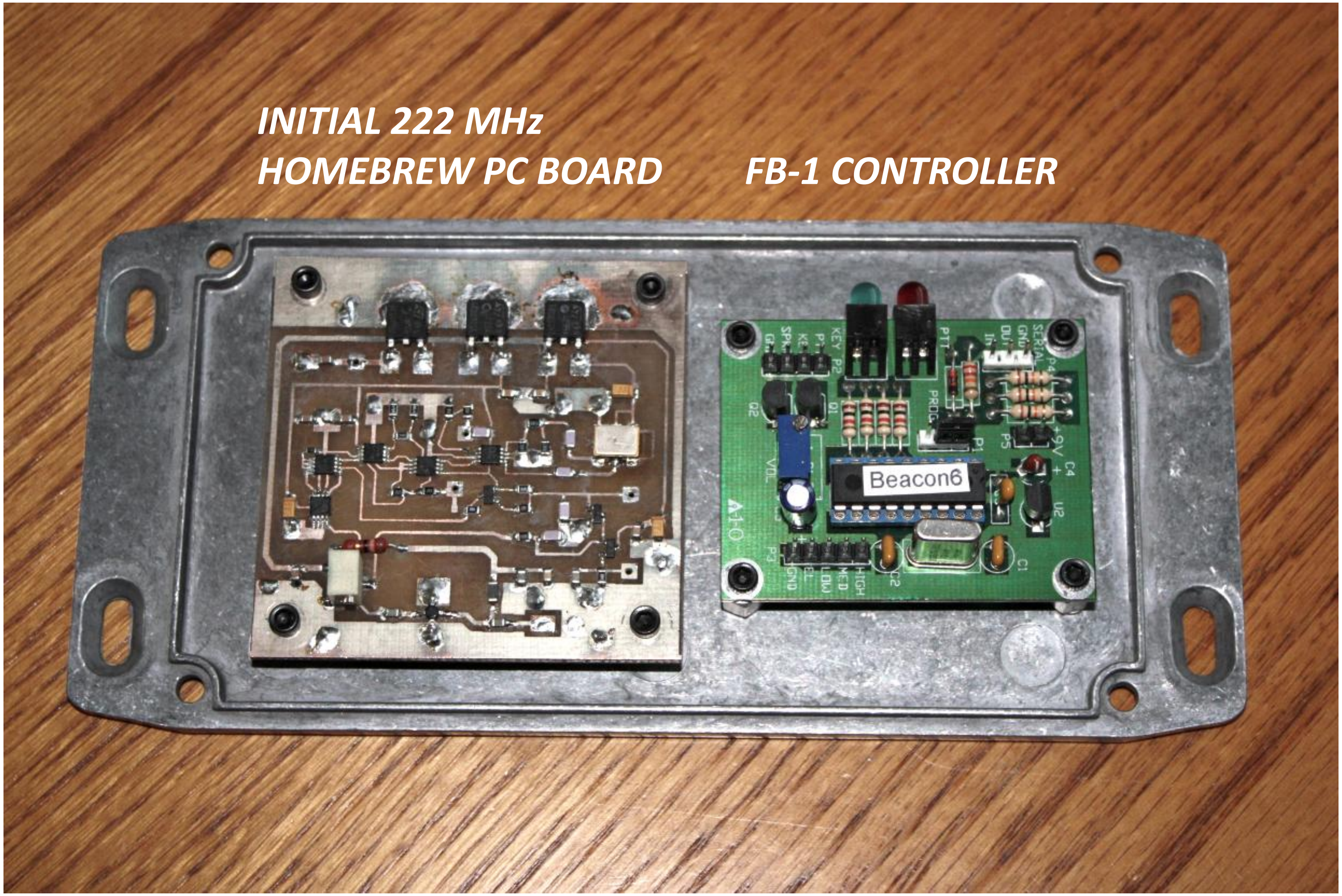
RMG Beacon Site



Canyon Lake 6M Beacon Installation

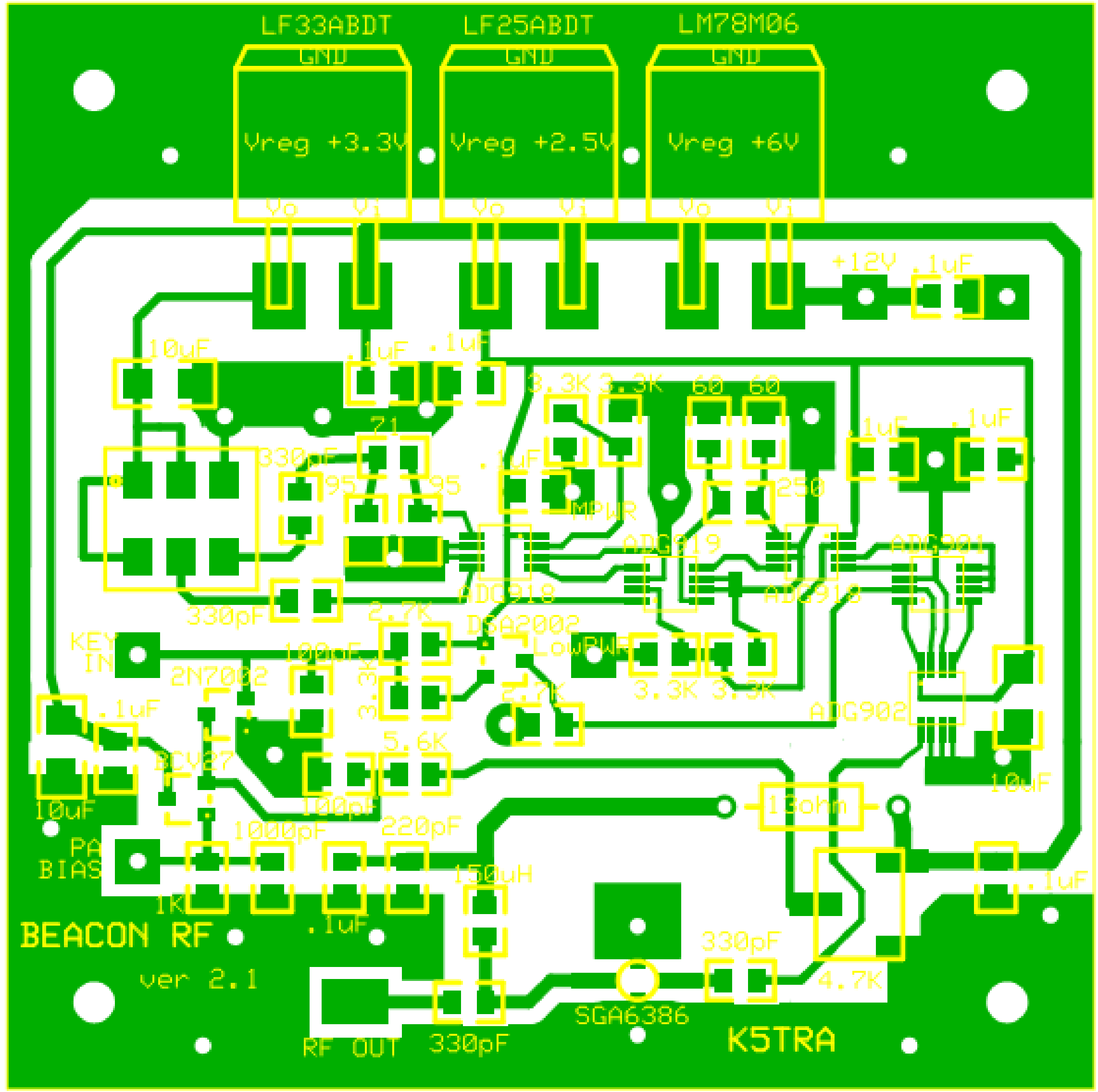


Prototype RF & Control



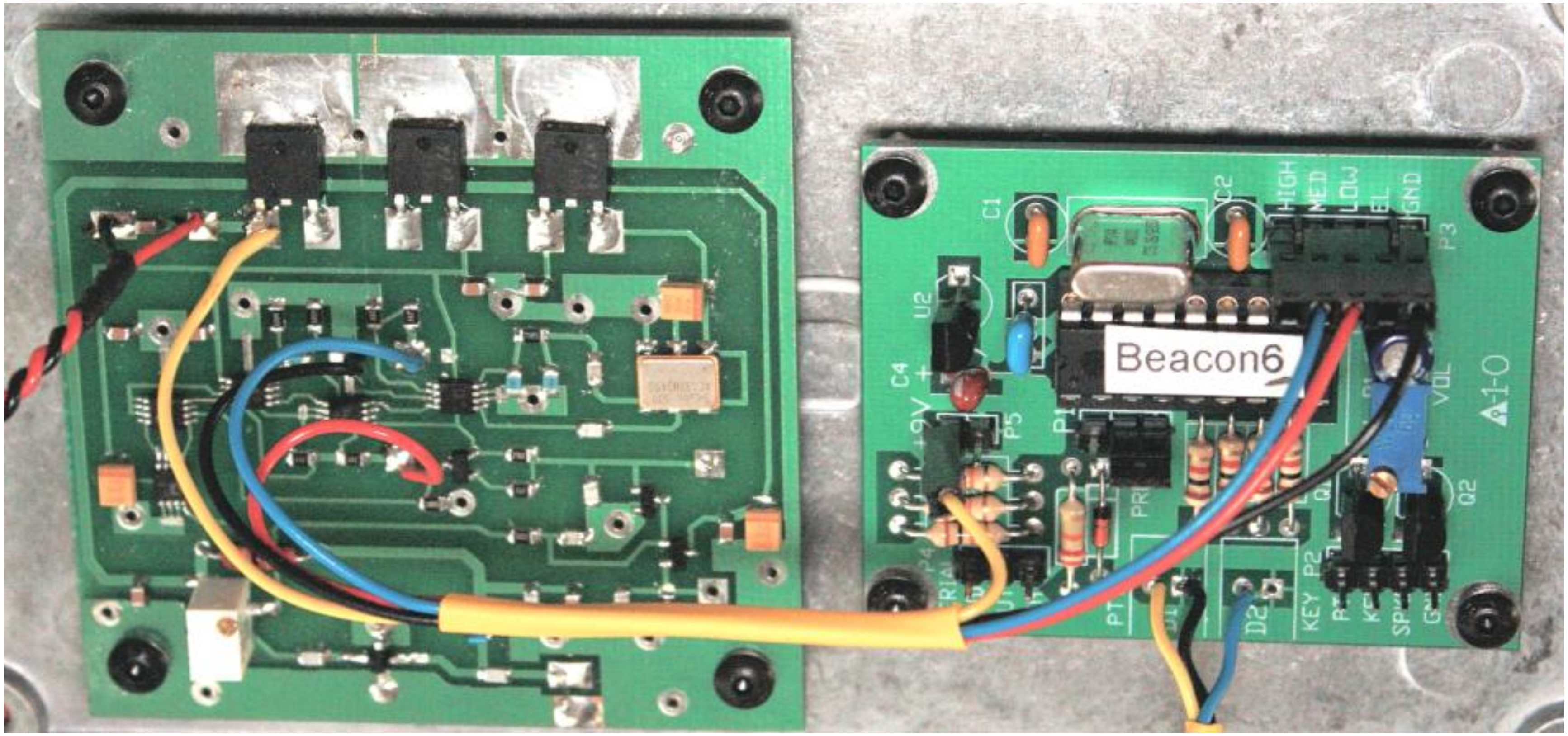
Beacon RF Board Layout

- Prototype fab
  - **“Press-n-Peel” resist**
  - **HB bubble etcher**
- Commercial fab
  - **ExpressPCB**

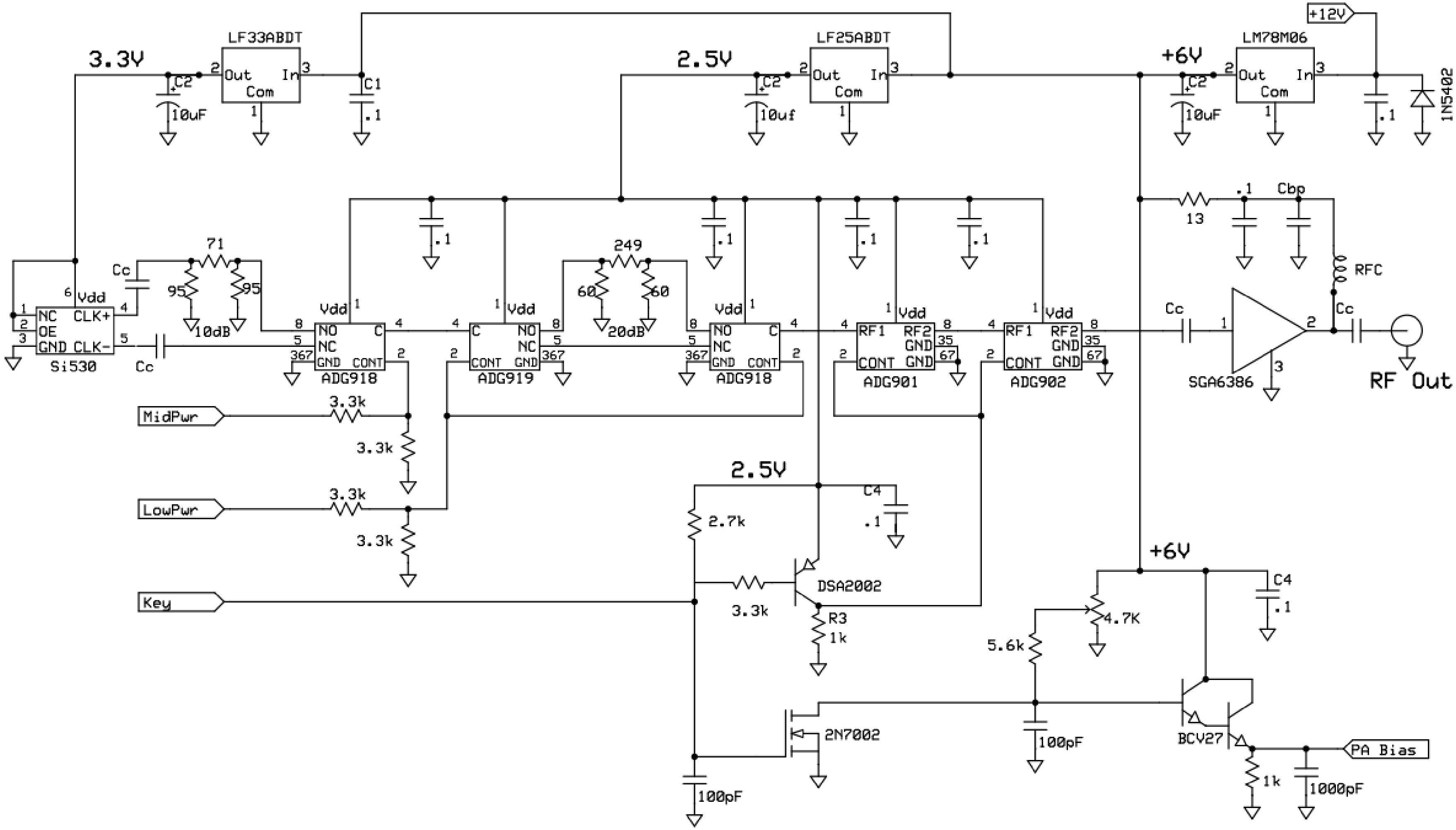


RF Board & FB-1 Controller

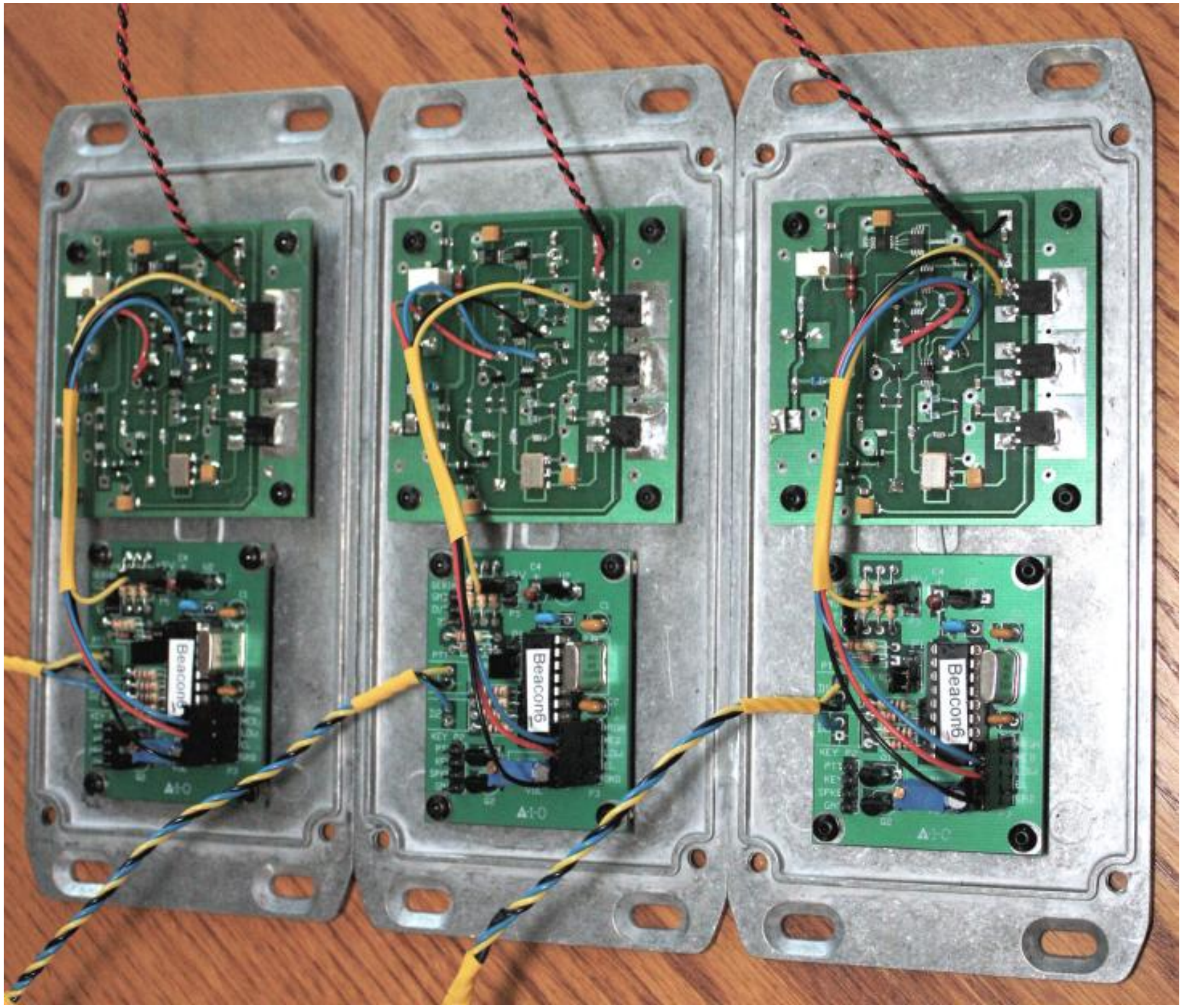
COMMERCIAL RF BOARD (ExpressPCB) ***FB-1 CONTROLLER***



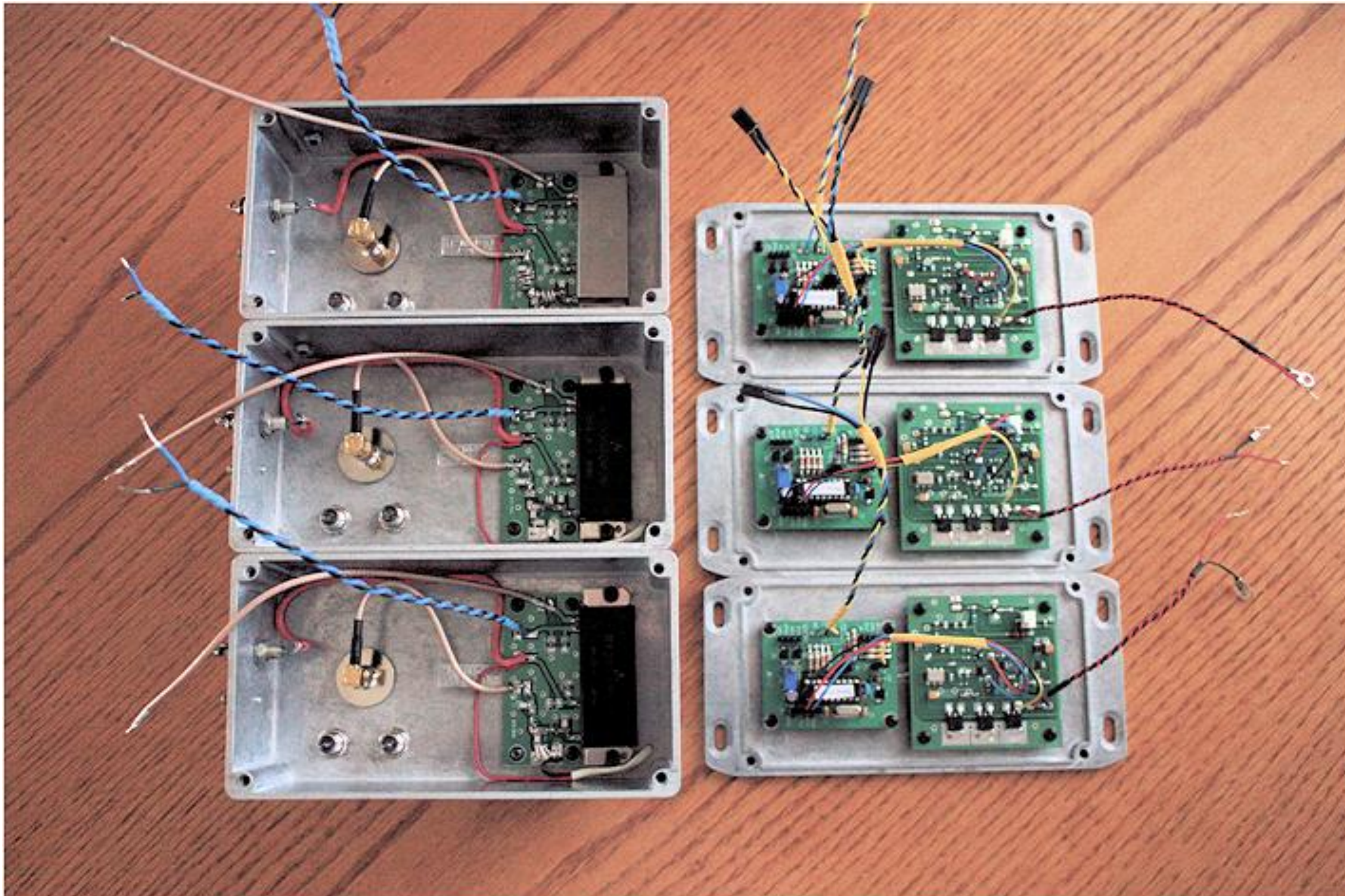
RF Board Schematic



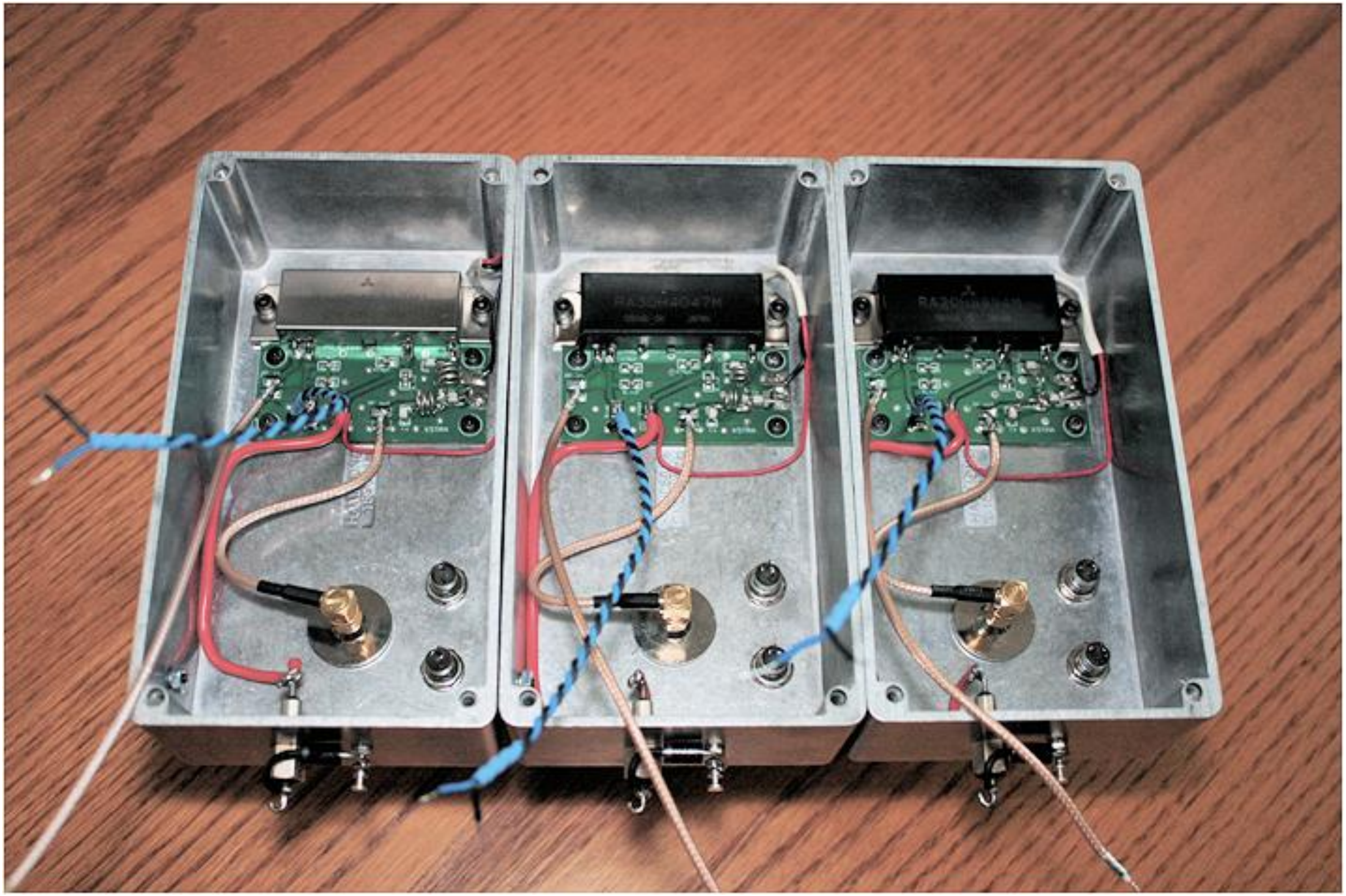
144, 432, and 902 MHz Beacons



Beacon Interior



Beacon PA and LPF Assembly

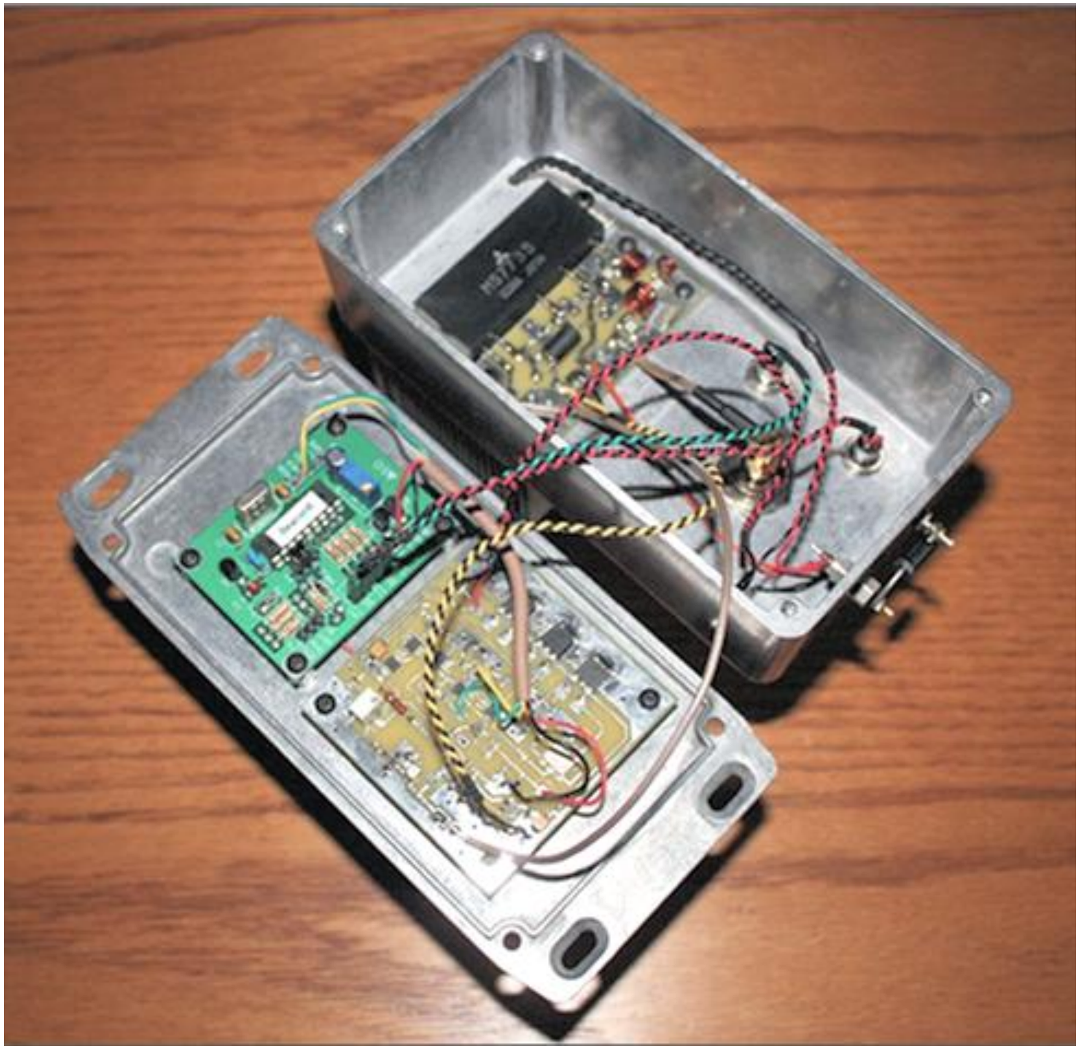


Beacon PA Module Comparison

BAND FREQ	MITSUBISHI MODULE	NOM. GAIN	GATE BIAS	RATED POWER	FLANGE FOOTPRINT	NUMBER IO PINS
50 MHz	M57735	28 dB	9 V	20 W	22x66 mm^2	5
144 MHz	RA30H1317M	33 dB	4.5 V	30 W	21x66 mm^2	4
222 MHz	RA30H2127M	33 dB	4.5 V	30 W	21x66 mm^2	4
432 MHz	RA30H4047M	33 dB	4.5 V	30 W	21x66 mm^2	4
902 MHz	RA20H8994M	33 dB	4.5 V	20 W	21x66 mm^2	4

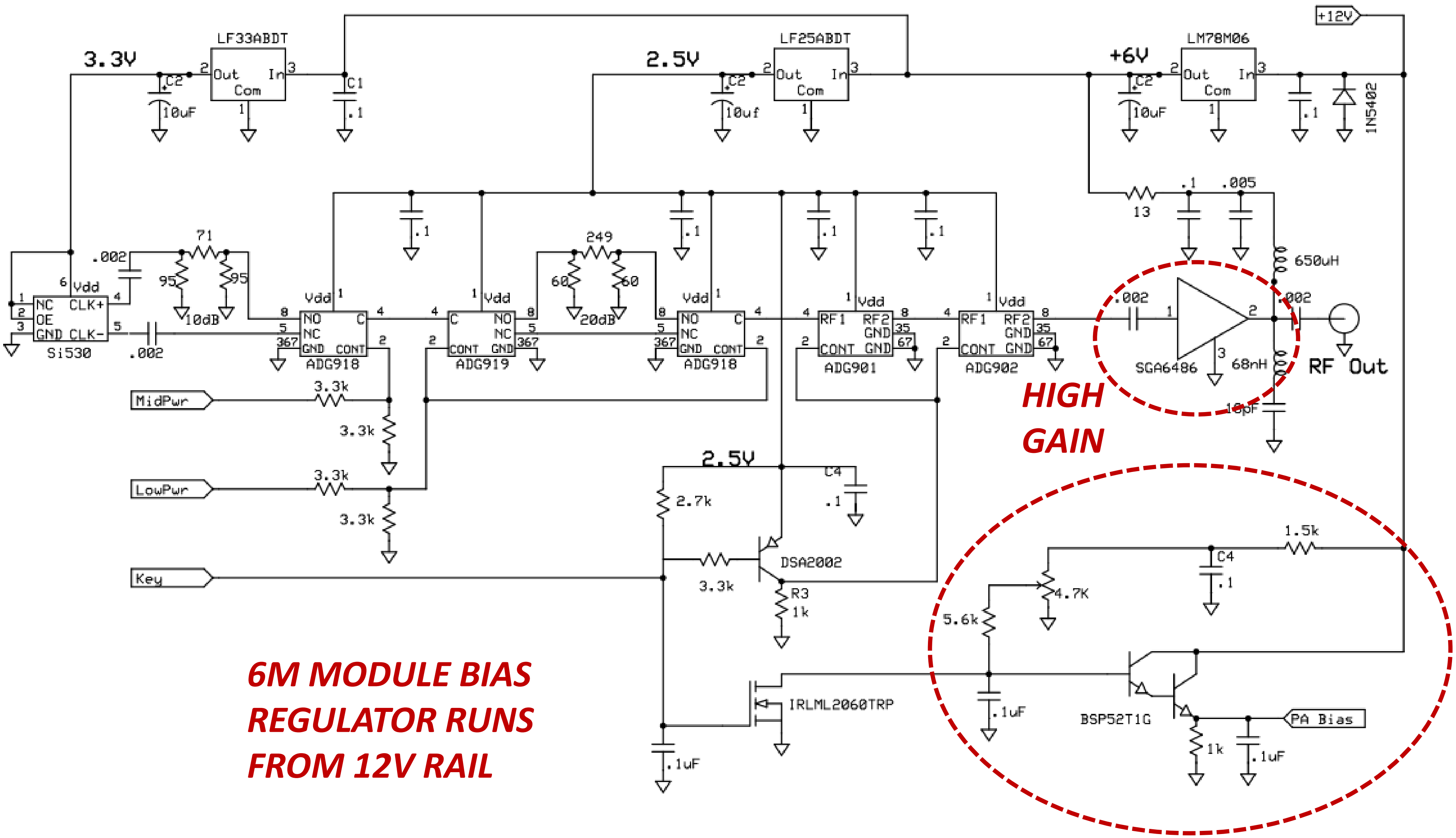
- 50 MHz modules differ from the others
  - **5 dB less gain**
  - **Higher bias voltage**
  - **More IO pins**
- Requires two slightly different board designs

50.072 MHz Beacon



- New RF board
  - **Higher bias voltage out**
- New PA module interface board
  - **More IO pins**

6M RF Board Schematic

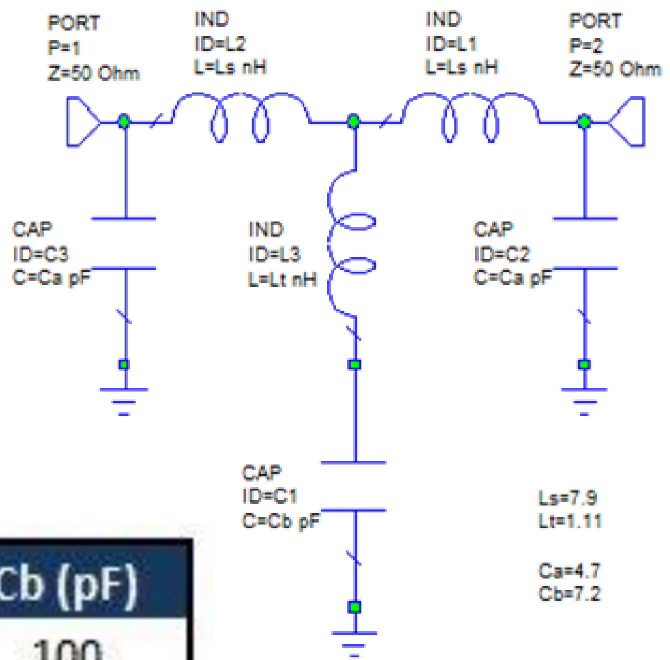


HIGH GAIN

6M MODULE BIAS REGULATOR RUNS FROM 12V RAIL

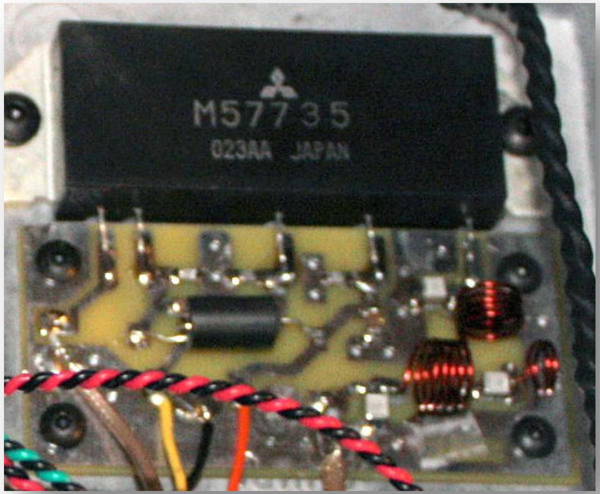
LPF LC Values

- 5th order LPF
- 2nd harmonic traps
- Common board layout

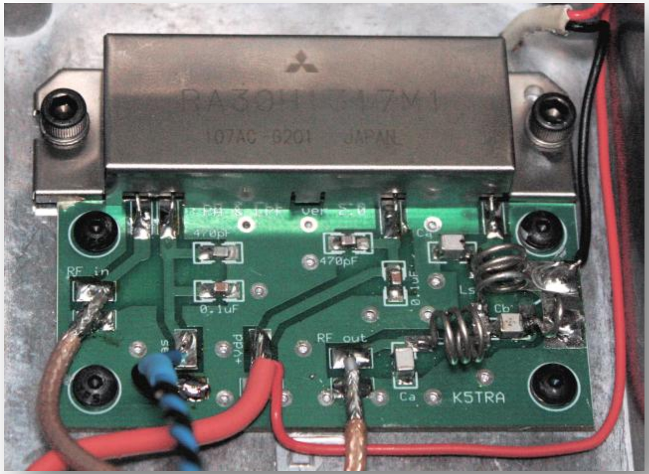


FREQ	Ls (nH)	Lt (nH)	Ca (pF)	Cb (pF)
50 MHz	147	25.3	68	100
144 MHz	54.3	7.9	27	39
222 MHz	37.9	5.4	16	23
432 MHz	19.5	2.8	8.2	12
902 MHz	7.9	1.1	4.7	7.5

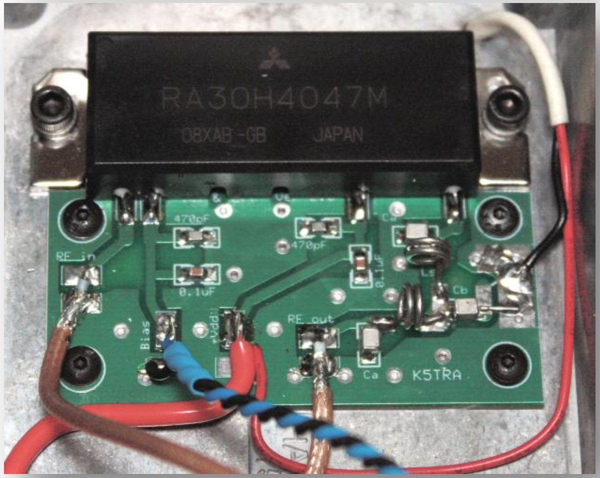
PA & LPF Boards



50 MHz



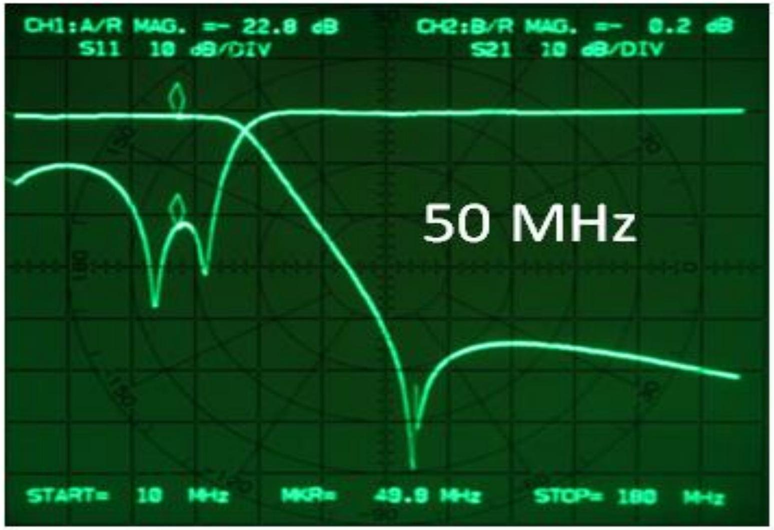
144 MHz



432 MHz

902 MHz

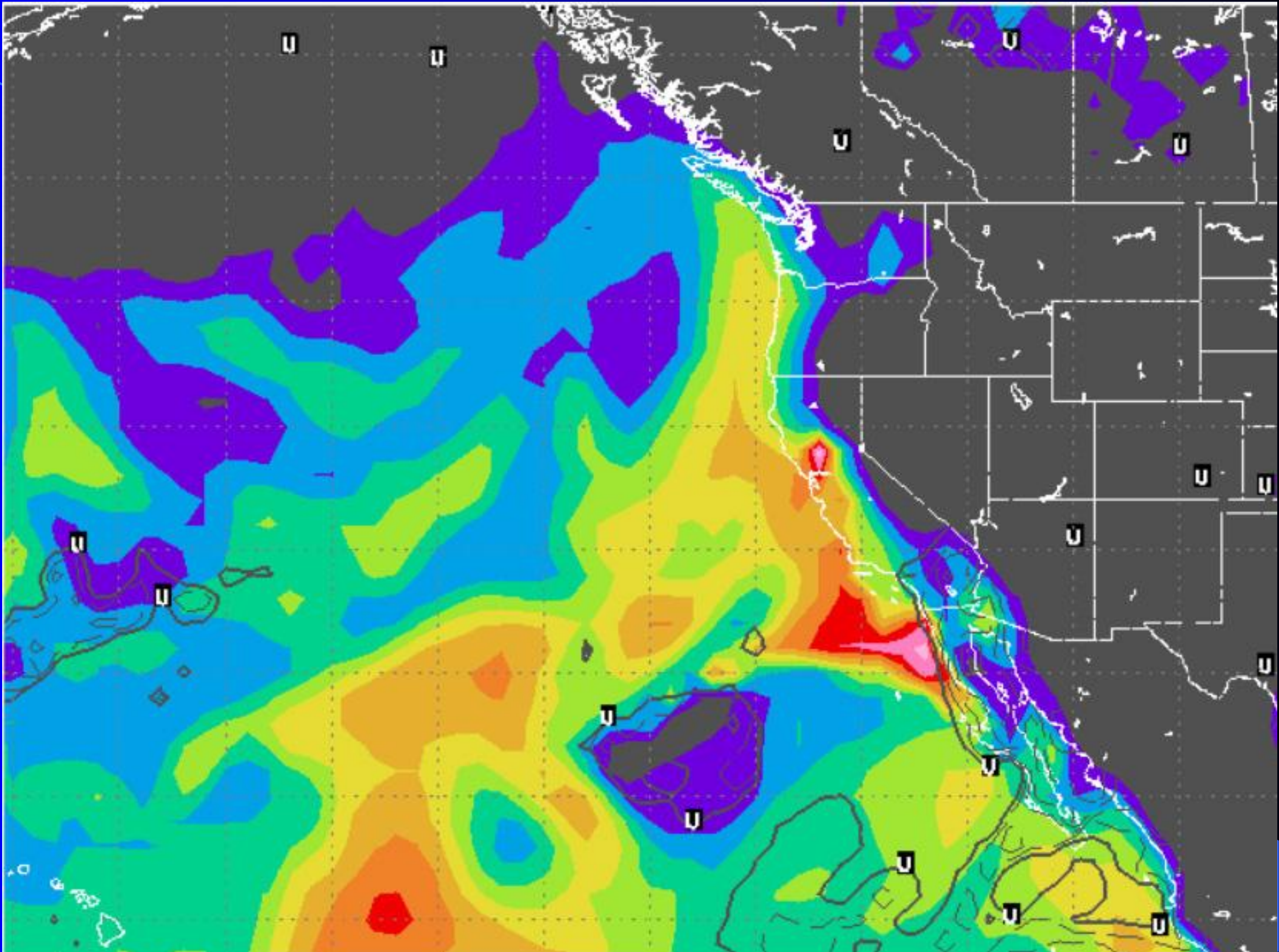
LPF Performance



Summary

- Original/Prototype beacon at K5AND QTH:
  - 222.060 MHz, 10 W, K5TRA, folded dipole big-wheel (K5VH)
- Three RMG beacons at K5AND QTH:
  - 144.295 MHz, 10 W, K5RMG, Omniangle (PAR Electronics)
  - 432.345 MHz, 10 W, K5RMG, folded dipole big-wheel (K5VH)
  - 902.330 MHz , 15 W, K5RMG, helical collinear (K5TRA)
  - *Thanks to K5AND for funding the RMG beacons*
- GVARC beacon at Canyon Lake:
  - 50.072 MHz, 15 W, KC5HUG, Omniangle (PAR Electronics)
  - *Thanks to K5WWQ and GVARC for funding the 6M beacon*
- Common RF and control board design
- Si530 XO used as source in all 5 beacons
- PA interface boards with harmonic filters
- Mitsubishi PA modules

Working Hawaii on VHF, 1957-2014: an eyewitness account

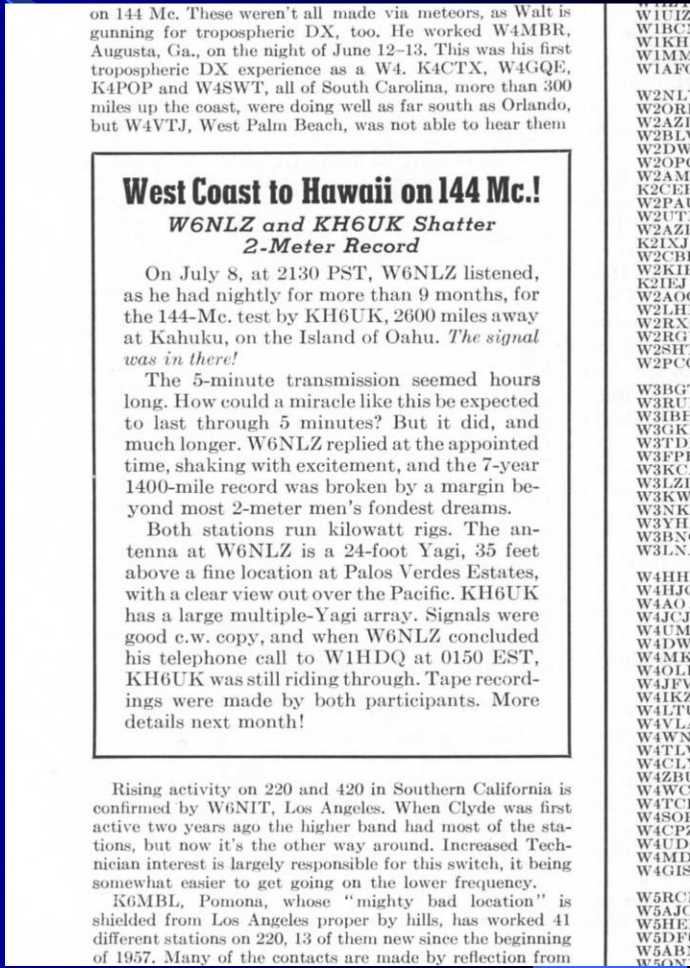


By
Wayne
Overbeck,
N6NB

The breakthrough, July 8, 1957

W6NLZ works KH6UK on 144 MHz:

- Distance – 2,540 miles
- Almost double old DX record
- Success after 9 months of nightly skeds
- W6NLZ wakes W1HDQ, QST vhf editor, at 1:50 a.m. to share the news and says…
- "Stop the presses!"
- QST squeezes item at right into August, 1957 edition (details in September)
- Propagation method uncertain then



on 144 Mc. These weren't all made via meteors, as Walt is gunning for tropospheric DX, too. He worked W4MBR, Augusta, Ga., on the night of June 12–13. This was his first tropospheric DX experience as a W4. K4CTX, W4GQE, K4POP and W4SWT, all of South Carolina, more than 300 miles up the coast, were doing well as far south as Orlando, but W4VTJ, West Palm Beach, was not able to hear them

West Coast to Hawaii on 144 Mc.!

W6NLZ and KH6UK Shatter 2-Meter Record

On July 8, at 2130 PST, W6NLZ listened, as he had nightly for more than 9 months, for the 144-Mc. test by KH6UK, 2600 miles away at Kahuku, on the Island of Oahu. *The signal was in there!*

The 5-minute transmission seemed hours long. How could a miracle like this be expected to last through 5 minutes? But it did, and much longer. W6NLZ replied at the appointed time, shaking with excitement, and the 7-year 1400-mile record was broken by a margin beyond most 2-meter men's fondest dreams.

Both stations run kilowatt rigs. The antenna at W6NLZ is a 24-foot Yagi, 35 feet above a fine location at Palos Verdes Estates, with a clear view out over the Pacific. KH6UK has a large multiple-Yagi array. Signals were good c.w. copy, and when W6NLZ concluded his telephone call to W1HDQ at 0150 EST, KH6UK was still riding through. Tape recordings were made by both participants. More details next month!

Rising activity on 220 and 420 in Southern California is confirmed by W6NIT, Los Angeles. When Clyde was first active two years ago the higher band had most of the stations, but now it's the other way around. Increased Technician interest is largely responsible for this switch, it being somewhat easier to get going on the lower frequency.

K6MBL, Pomona, whose "mighty bad location" is shielded from Los Angeles proper by hills, has worked 41 different stations on 220, 13 of them new since the beginning of 1957. Many of the contacts are made by reflection from

Who were those guys?

Ralph "Tommy" Thomas, KH6UK…

- Prominent New Jersey VHFer as W2UK
- Sent to Hawaii in 1955
- Chief engineer of RCA (Marconi) station, Oahu
- Built first-rate VHF station with almost nobody to work…

Who were those guys?

John T. Chambers, W6NLZ…

- Up and coming 30-something engineer in L.A. aerospace industry
- Builder of an excellent VHF station in Palos Verdes, overlooking L.A. and the Pacific
- Agreed to run skeds with KH6UK in 1956

How did they do it? With patience and perseverance, but HOW?

- Meteor scatter? No. Signal stable for hours.
- F2 propagation? No. MUF not *nearly* high enough.
- E skip? No. No Es noted even on lower frequencies.
- Extreme tropopheric bending? Possibly.
- A previously unknown kind of tropospheric propagation? Well, let’s look into this…

So how did they *really* do it?

"Evidence from the Los Angeles Weather Bureau, and scientific opinion gathered by (W1HDQ) while attending the URSI General Assembly at Boulder, Colo., point definitely to tropospheric propagation. While the 2,540-mile path is some 25 percent longer than any previous proven reception of signals at 100 Mc. or higher, some authorities on tropospheric propagation over ocean paths are of the opinion that the new record is far from unbeatable." - QST, October, 1957, pg. 93

The U.S. Navy weighs in…

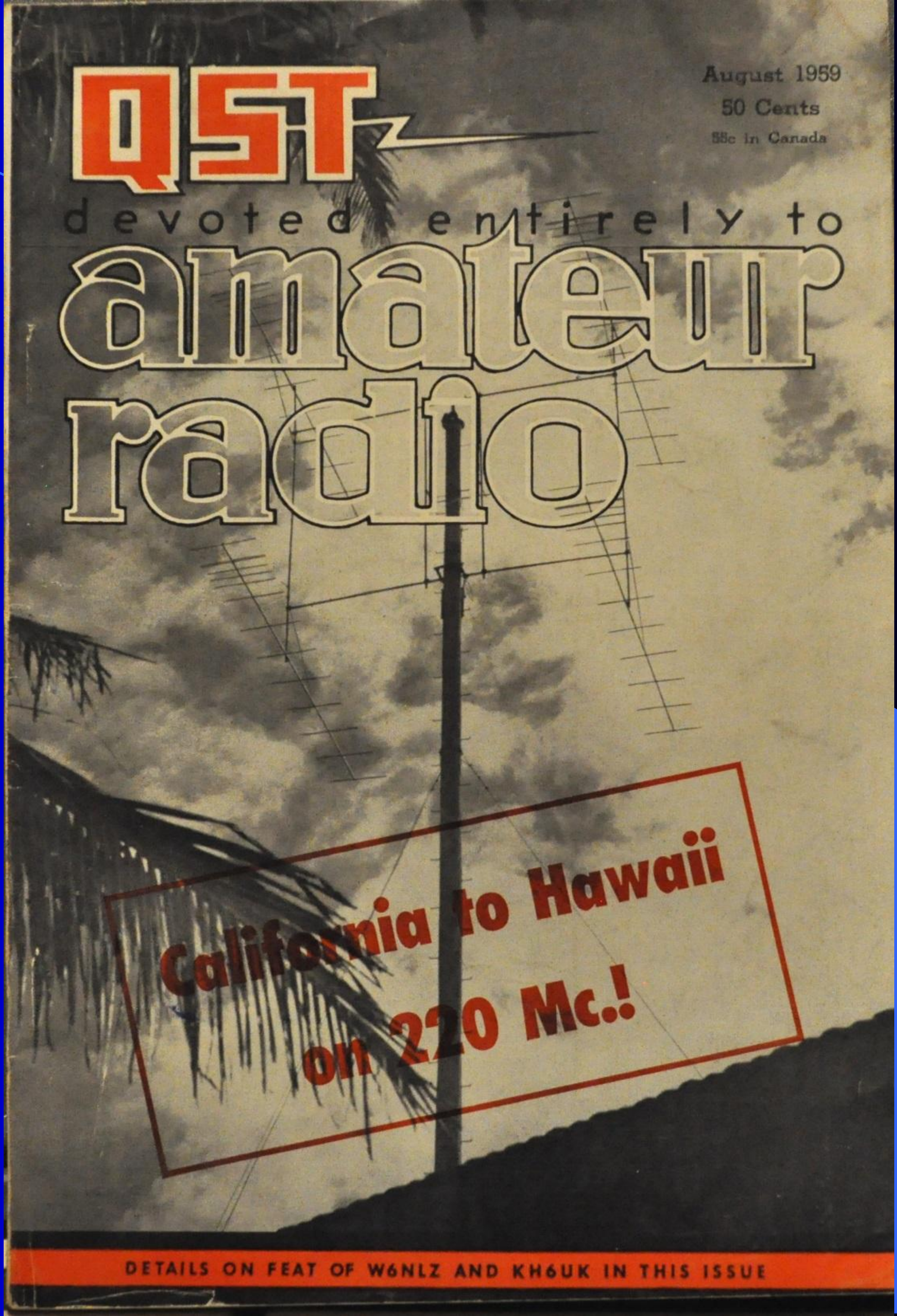
Here's a footnote in large type: If you *Google* Charles G. Purves, author of Naval Research Laboratory Publication No. 7725 (1974), you will find a summary of Navy research in the 1950s and 1960s that documented the existence of <u>elevated ducts</u> in tropical ocean regions. The Navy conducted four "Project Tradewinds" studies of ducting that involved hundreds of long flights at various altitudes.

NRL conclusions of note to hams:

- These ducts are rarely large enough to conduct signals below about 75 MHz.
- 800 feet of duct thickness = waveguide-like signal “trapping” at two meters and higher frequencies
- Ducts rise in elevation at a typical rate of 230 feet per 100 nautical miles up to 5000’, then 100 feet per 100 n.m.

<u>BOTTOM LINE: Ducts start near sea level in California and rise to 5,000-8,000 feet elevation in Hawaii</u>

Enough theory. Check out this 1959 QST cover!



W6NLZ and KH6UK do it again!

- June 22, 1959: they work on 222 MHz.
- It happens on fifth night of schedules!
- QST splashes red box across its cover (very unusual then)
- QST talks about ducting, later reports on Navy's "Tradewinds III" study (41 flights from San Diego to Hawaii)

W6NLZ and KH6UK try 432 in 1960

- July 20, 1960: W6NLZ hears KH6UK on 432 MHz with signals as strong as S8
- KH6UK can't hear W6NLZ – no 2-way contact
- They work crossband, with KH6UK listening on 144
- KH6UK later finds bad 416B tube in his 432 front end
- Too late: the opening is over

The 13-year drought

After the 1960 skeds on 432, no known mainland-to-Hawaii contacts occurred on two meters or higher for 13 years…

John Chambers, 1920-1969

On Oct. 5, 1969, W6NLZ died of an inoperable brain tumor after collapsing at work. He was 49.

Central States VHF Society created its famous John Chambers Memorial Award in 1970.

Tommy Thomas, W2UK/KH6UK won the award in 1973.

N6NB's John Chambers memorabilia: an antenna tuner he built and 1978 Chambers award…

After 13 years, a mega-opening!

- July 28, 1973: California stations starting with K6DYD discover they can key up KH6EQN/R, Mauna Loa.
- K6YNB (now N6NB) in Orange County works over 100 Hawaiians via KH6EQN.
- Several stations work Hawaii on simplex, breaking the W6NLZ-KH6UK distance record.
- Now <u>everyone</u> starts working the duct on FM or SSB.
- The opening lasts five days.

1973 tropo duct hot spots

New kids on the bluff!

WB6ASR (now W6IT, left) and WB6RAL (now W6MT) key up the Mauna Loa repeater from Pt. Sal, Calif. with 10 watts and a quagi antenna at a very low height!

In the fog at Pt. Sal (CM95), K6YNB's "cabover kilowatt" works Hawaii after the opening ends in Southern California, 29 July 1973. This site is 700' asl on a bluff overlooking the Pacific.

Starting in 1976, it happens again, and again, and again and again

California to Hawaii on 2 Meters — 1976 Edition

That radio rainbow has just made its second showing within three years.

By Wayne Overbeck,* K6YNB

Everyone from amateurs to the U.S. military considered it an impossible feat until the late John Chambers, W6NLZ and Ralph Thomas, KH6UK, did it in July, 1957, after some 10 months of daily scheduling. The same pair repeated their incredible accomplishment on 220 MHz in June, 1959. But after that, it was 14 years until the next W6-KH6 QSO above 144 MHz. We recall the spectacular five-day-long 1973 opening and compare it with the shorter but equally dramatic opening this summer.

Ever since those five warm, summer days in late July, 1973, Californian and Hawaiian hams have been waiting, hoping, wishing and praying for more of those thrilling days when vhf signals miraculously span 2500 miles of ocean to make each other sound like locals on 2 meters.[1]

Sure enough, it happened again on another hot, summer day – June 28, 1976. Conditions were the same in many ways, but different in others. For some vhfers the latest opening was better, but frustrating for others because it failed to last as long or travel as far north as the previous spectacular.

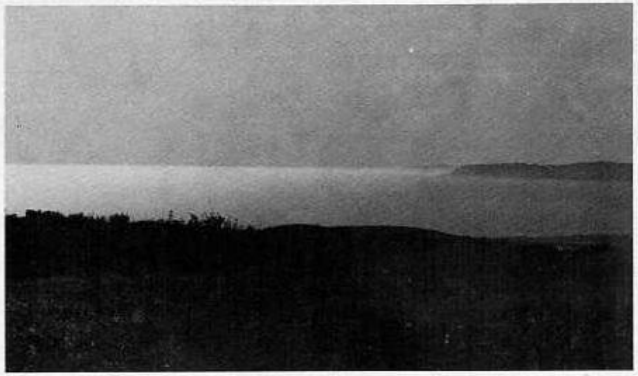
The basic mechanism that makes those line-of-sight signals cross an ocean on such rare occasions is a tropospheric duct. It might be likened to an enormous, flat, elongated pipe conveying vhf signals thousands of miles close to the earth's surface. Unlike typical E- or F-layer ionospheric propagation on lower frequencies, the ducted signal never rises to any great height or bounces back down. Thus, sporadic E and F2 signals can rise over mountains while the tropospheric duct can be blocked by any large terrestrial object along the way.

Usually, the duct is fairly low at the California end, rises as it moves west and ends at both shorelines. The east elevation is less than 1500 feet while the Hawaii side lies between 5000 and 8500 feet above sea level. That means Californian stations with a clear shot to sea at modest heights have a big edge on their side of the path and Hawaiian mountaintoppers, or mountainside repeaters, have the advantage there.

*5113 Whitecap St., Oxnard Shores, CA 93030

[1] References appear on page 48.

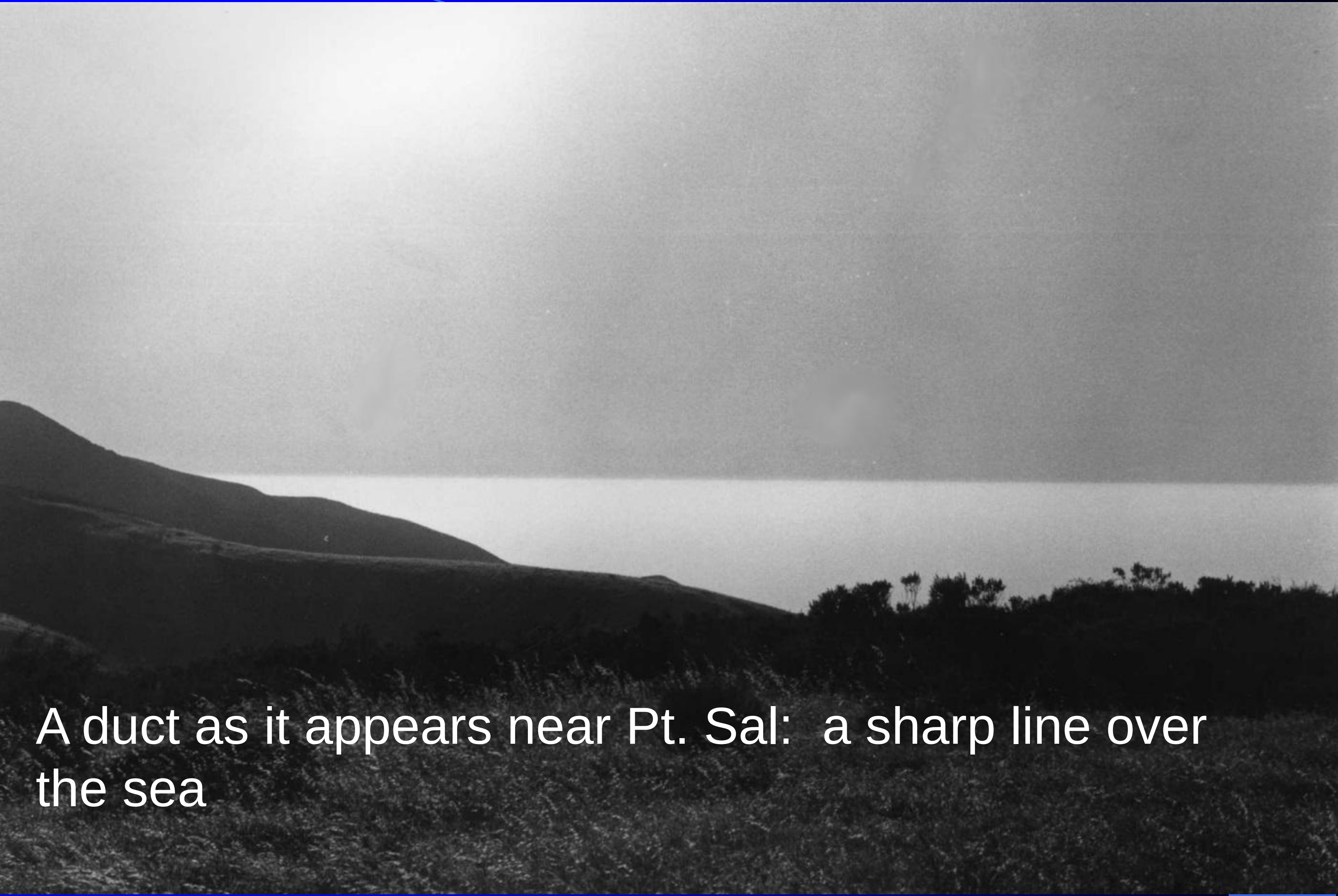
Most temperature inversions have gradual changes with height. However, the one that ducted 2-meter signals 2500 miles across the Pacific Ocean had a very abrupt boundary as seen here on June 29, 1976, near Santa Maria, California.



Characteristics of the Modern Openings

The original mainland-to-Hawaii duct was first worked by Jerry Gastil, K6DYD, on July 28, 1973, when he keyed the 16/76 repeater at the 8300-foot level of Mauna Loa – 13,000 feet high. His kilowatt rig fed an 80-element Yagi array at his home 300 feet above the sea on Point Loma near San Diego. Since that day Jerry has maintained a daily morning ritual of attempting to key it again. Finally, his perseverance was rewarded at 1657 UTC on June 28, 1976, when he hit the Hawaiian repeater and quickly worked nine KH6 stations.

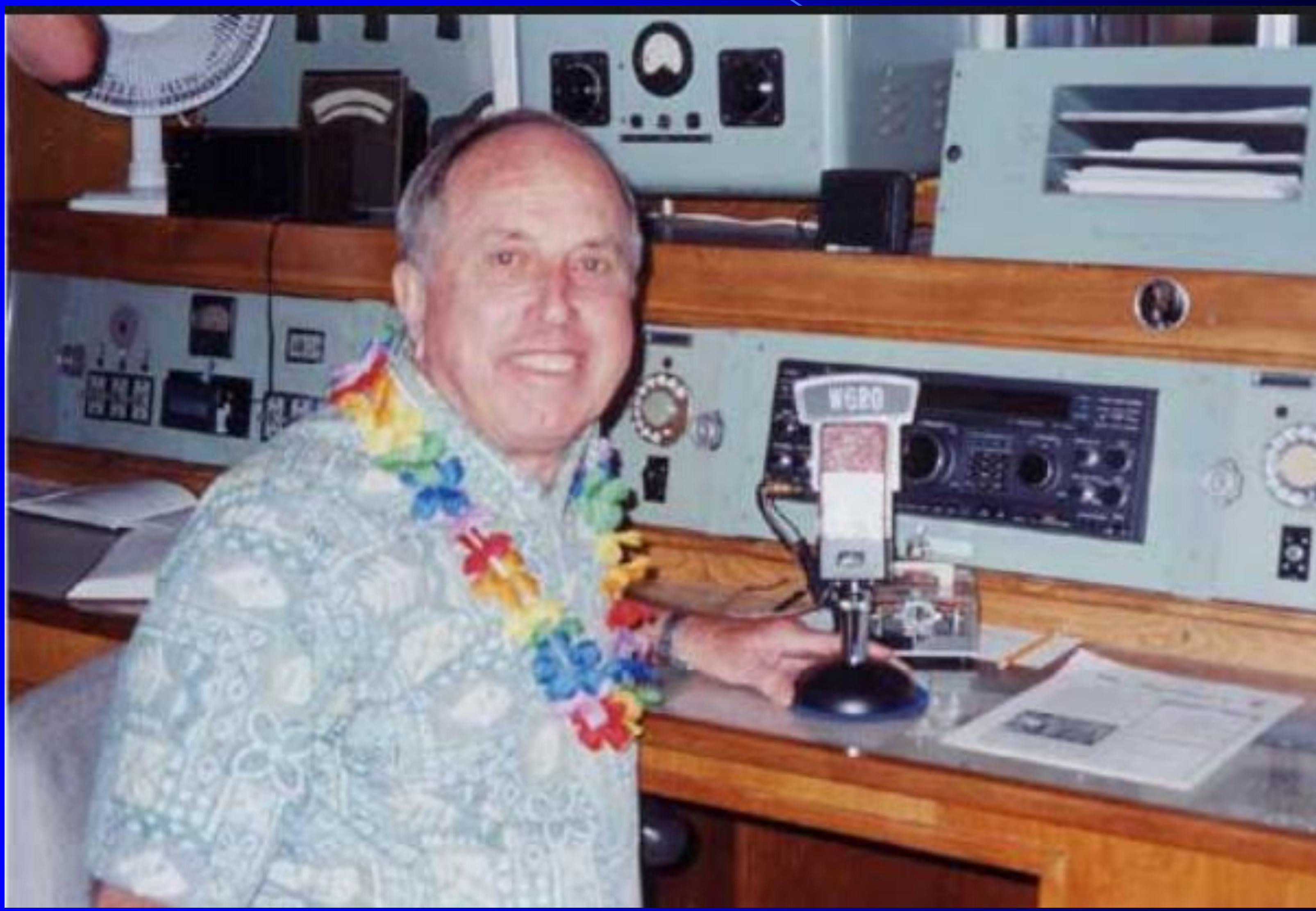
A difference this time was that the Mauna Loa repeater had changed to 22/82, a fact which made it much more difficult for California stations to work through it. There are busy 22/82 repeaters all along the California coast that covered the weaker Hawaiian sig-



A duct as it appears near Pt. Sal: a sharp line over the sea

A portable station works Hawaii, 1976

The KH6HME run begins…



Paul Lieb, KH6HME

In 1979, an extraordinary man named Paul Lieb began setting up beacons at the 8,000-foot level on Mauna Loa, allowing mainland hams to tell exactly when there was a tropo duct that extended all the way to Hawaii. When the band opened, Paul would go to the beacon site and stay for days if necessary to work everyone who wanted to work Hawaii. Over the next 33 years, he was on the Hawaiian end of thousands of trans-Pacific VHF+ QSOs. The era ended with his passing on July 16, 2012.

KH6HME's DX records

After 33 years of VHF+ DXing from Mauna Loa, Paul held ALL of the terrestrial DX records on all bands from two meters through 5.7 GHz. No one has yet worked from Hawaii to the mainland on 10 GHz. Here is a list of the records as compiled by W5LUA and posted on the ARRL website.

W5LUA's current Pacific duct record data

Band	DX(km)	Calls of stations	Date
144	4,754	KH6HME (BK29go) - W1LP/MM (DL51ce)	21-Aug-1999
	4,333	KH6HME (BK29go) - W7FI (CN87ws)	01-Jul-1995
222	4,150	KH6HME (BK29go) - XE2/N6XQ (DL29cx)	15-Jul-1989
432	4,150	KH6HME (BK29go) - XE2/N6XQ (DL29cx)	15-Jul-1989
902	4,064	KH6HME (BK29go) - N6XQ (DM12jr)	13-Jul-1994
1296	4,150	KH6HME (BK29go) - XE2/N6XQ (DL29cx)	15-Jul-1989
2304	3,982	KH6HME (BK29go) - N6CA (DM03tr)	14-Jul-1994
3456	3,982	KH6HME (BK29go) - N6CA (DM03tr)	28-Jul-1991
5760	3,982	KH6HME (BK29go) - N6CA (DM03tr)	29-Jul-1991
10 GHz		A new frontier waiting to be conquered!	

The greatest duct ever?

In 1995 there was an opening from Hawaii to the mainland that extended all the way to the Canadian border and beyond, allowing stations from San Diego to Seattle to work Hawaii on two meters. W7FI set the modern land-to-land record during that opening, but N7MWV and W7YOZ worked KH6HME from sites only a few kilometers closer to Hawaii than W7FI. The duct extended inland from the Bay Area to the river delta region. K7XC, on a mountaintop near Reno, managed to get a signal into the duct and worked KH6HME from Nevada.

One of the longest ducts ever

In early July of 2014 there was an opening to Hawaii that lasted for eight days, one of the longest-lasting ducts yet observed.

KH7Y, signing KH6HME (now a memorial club call sign), went to the Mauna Loa beacon site and worked a number of stations from San Diego to the Bay Area on July 5, the fourth day of the duct.

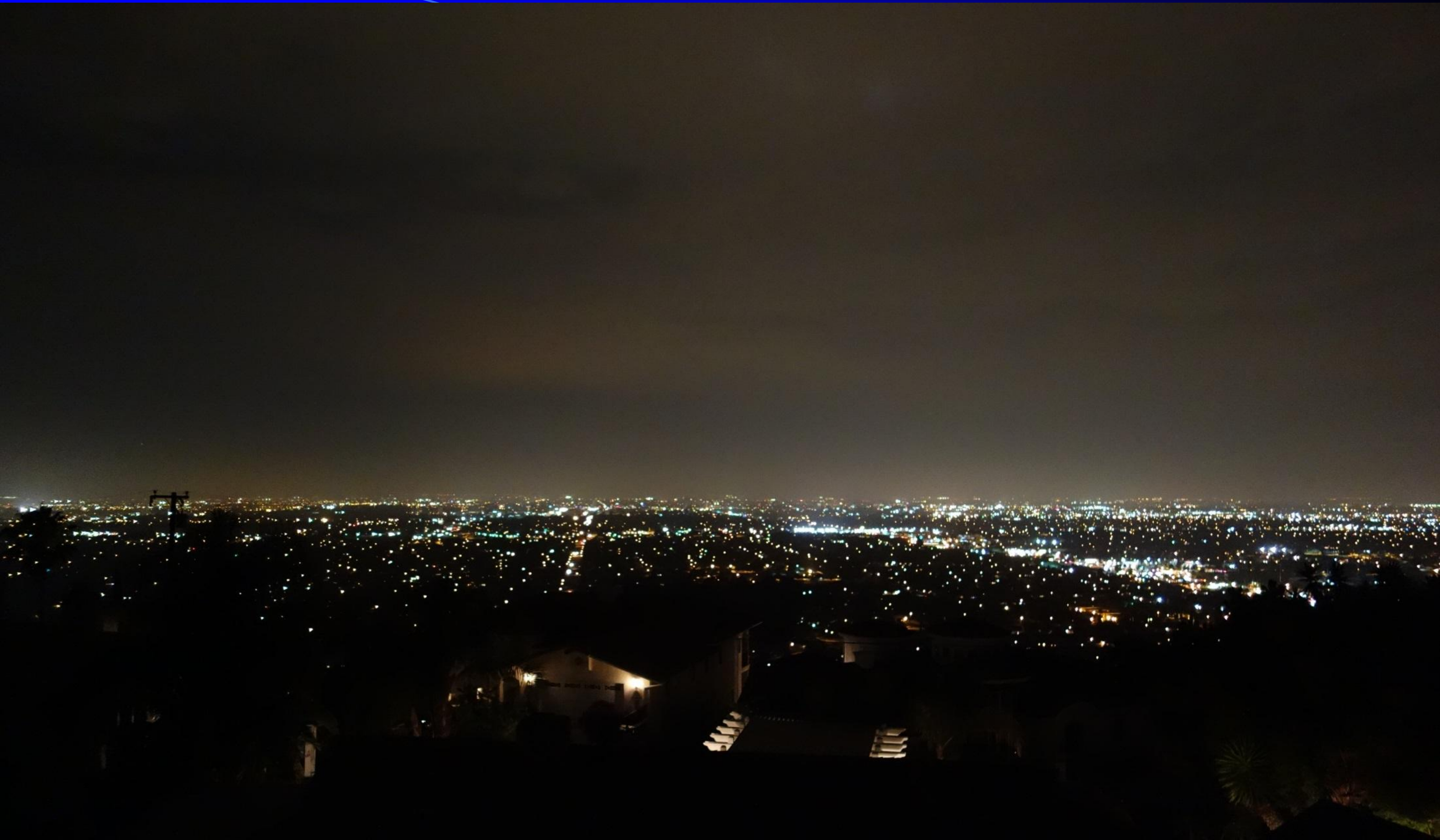
Here is how the beacons sounded at N6NB in Orange County during that opening.

A contact on 223.5 FM

Here is part of a trans-Pacific QSO on 223.5 MHz FM between KH6HME (KH7Y, operator) and N6NB. With only 15 watts of power output, Fred was solid copy on FM at a distance of 2,500 miles.

These videos are on YouTube (search for keywords KH6HME and N6NB).

For comparison, here’s a brief except of a 144 MHz signal from a station at a lower elevation, made at a time when KH6HME/B was S9.



Where these videos were made…


To Hawaii
The duct as it appeared on 5 July 2014

www.n6nb.com

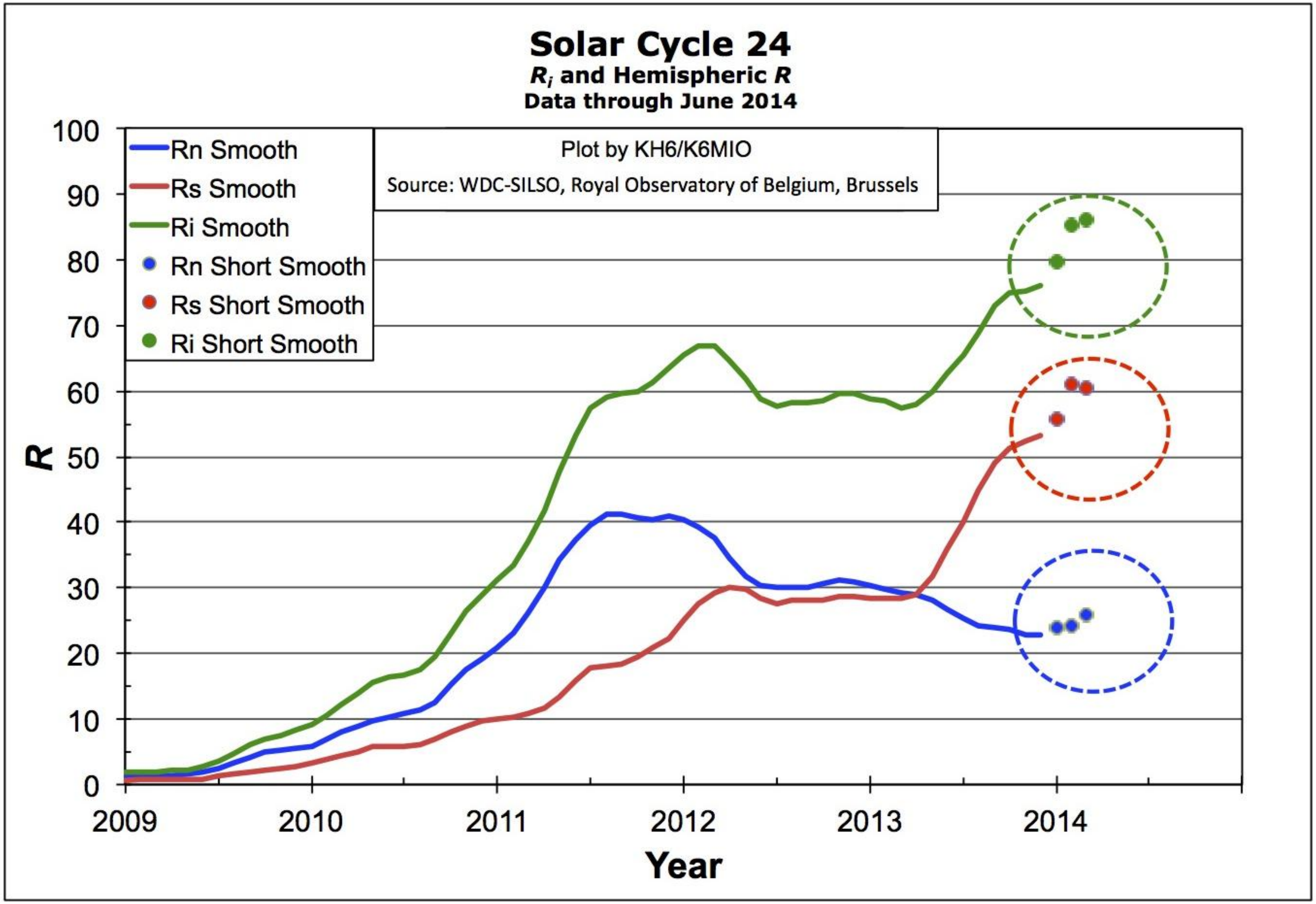
A Quick Look at Cycle 24

KH6/K6MIO

Central States VHF Society Conference

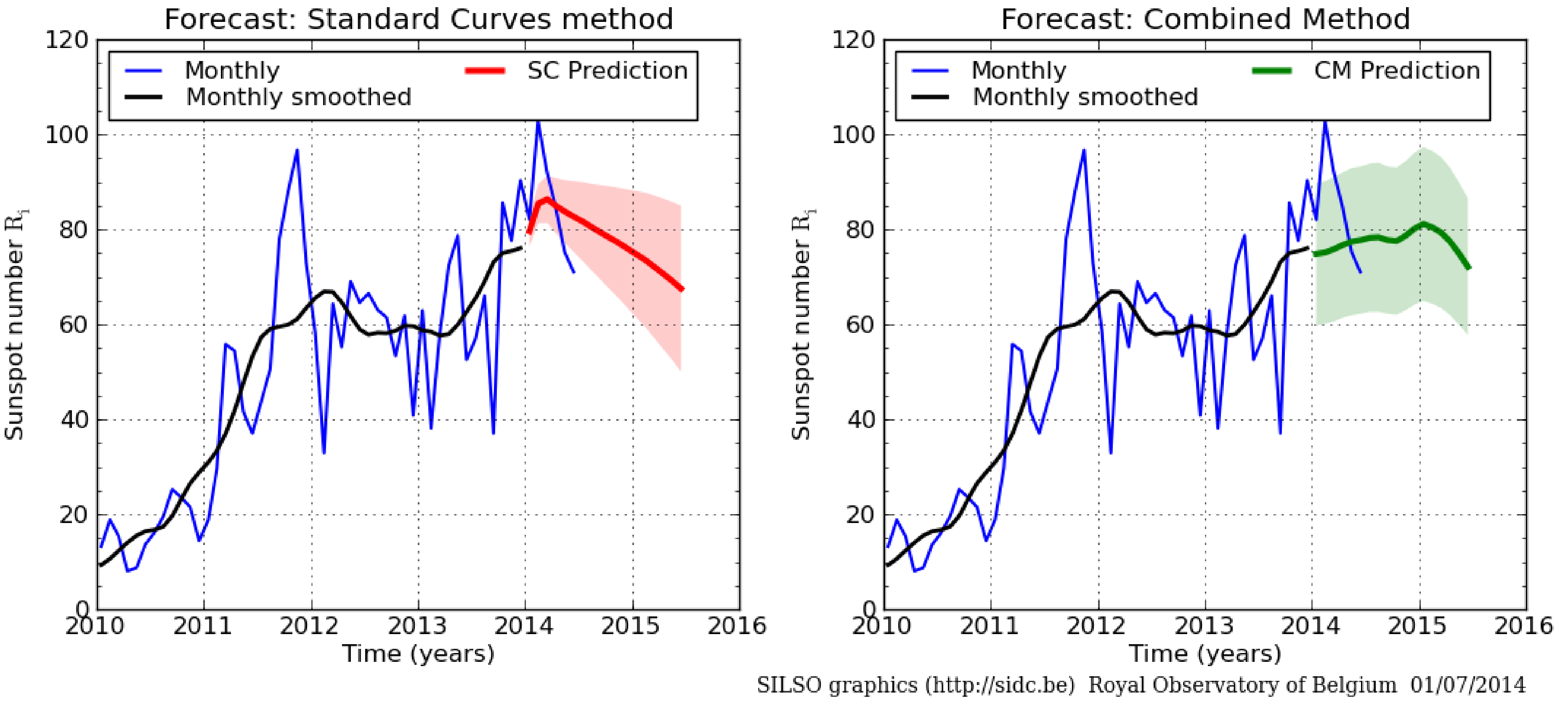
July 26, 2014

Total and Hemispheric R



Predictions A

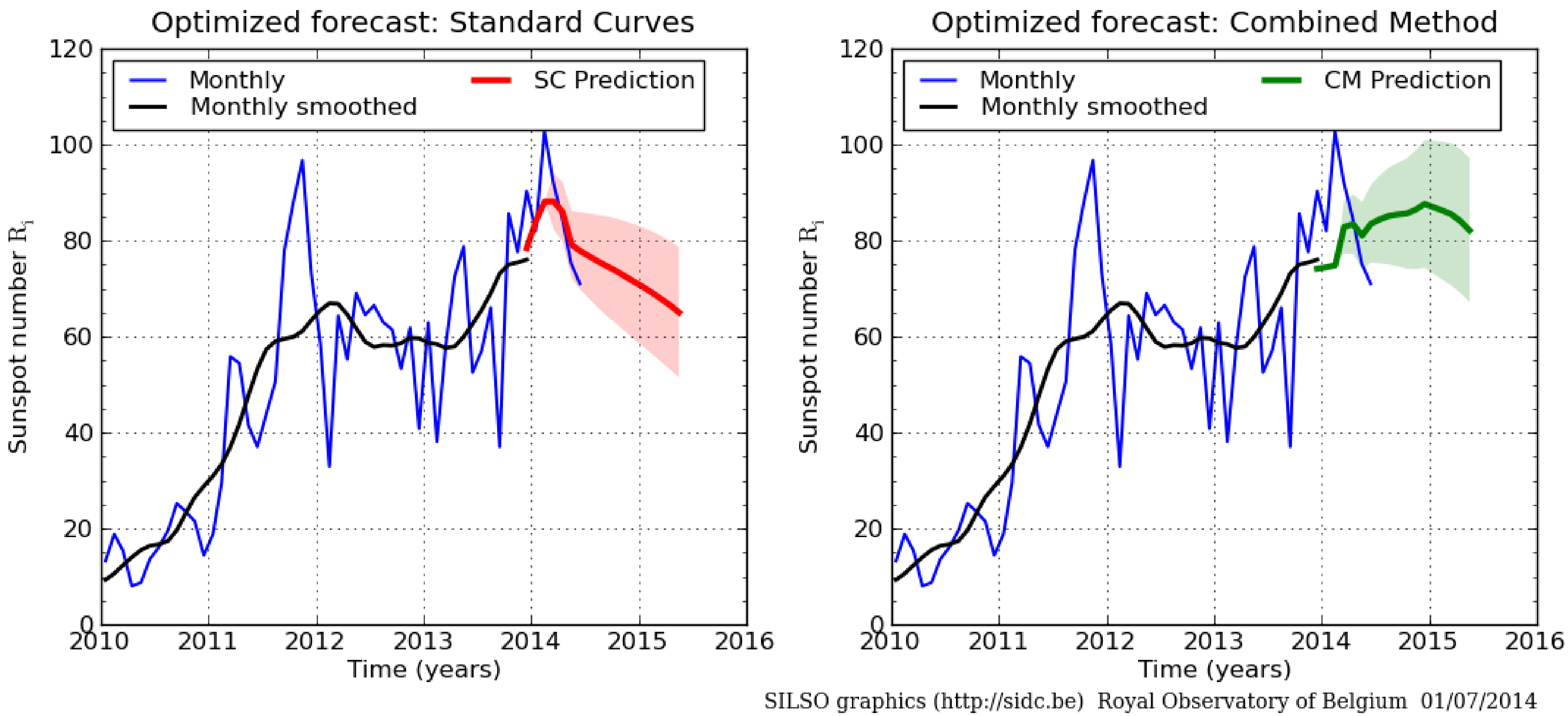
Get (Almost) Any Answer You Want



Source: WDC-SILSO, Royal Observatory of Belgium, Brussels

Predictions B

Get (Almost) Any Answer You Want



Source: WDC-SILSO, Royal Observatory of Belgium, Brussels

Summary of Predictions

Source: WDC-SILSO, Royal Observatory of Belgium, Brussels

Standard Curve

Normal (86 max Mar 2014)

- Oct 2014: 78 ± 22
- Jan 2015: 75 ± 27
- Apr 2015: 71 ± 32

Kalman Filter (88 max Mar 2014)

- Oct 2014: 74 ± 11
- Jan 2015: 70 ± 12
- Apr 2015: 66 ± 13

Combined Method

Normal

- Oct 2014: 78 ± 16
- Jan 2015: 81 ± 16 (maximum)
- Apr 2015: 77 ± 16

Kalman Filter

- Oct 2014: 86 ± 12
- Jan 2015: 87 ± 14 (maximum)
- Apr 2015: 84 ± 15

As Always,
Be Ready for Anything!

Good DX, Aloha

Simple VHF Contesting

OR---

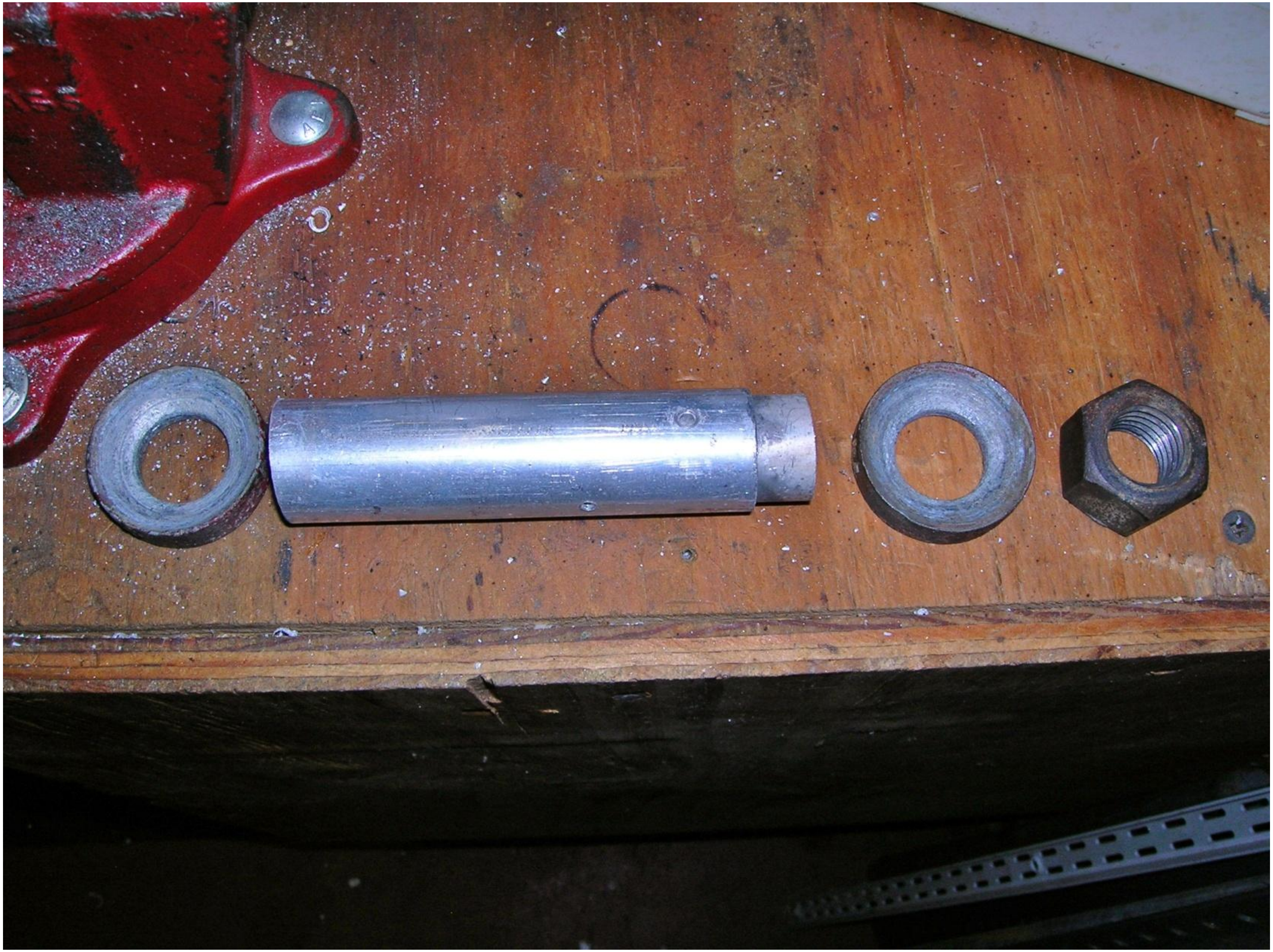
Portable Operation in the South

Staying Cool

And Dry!


FLORIDA
SOCIETY
MICROWAVE

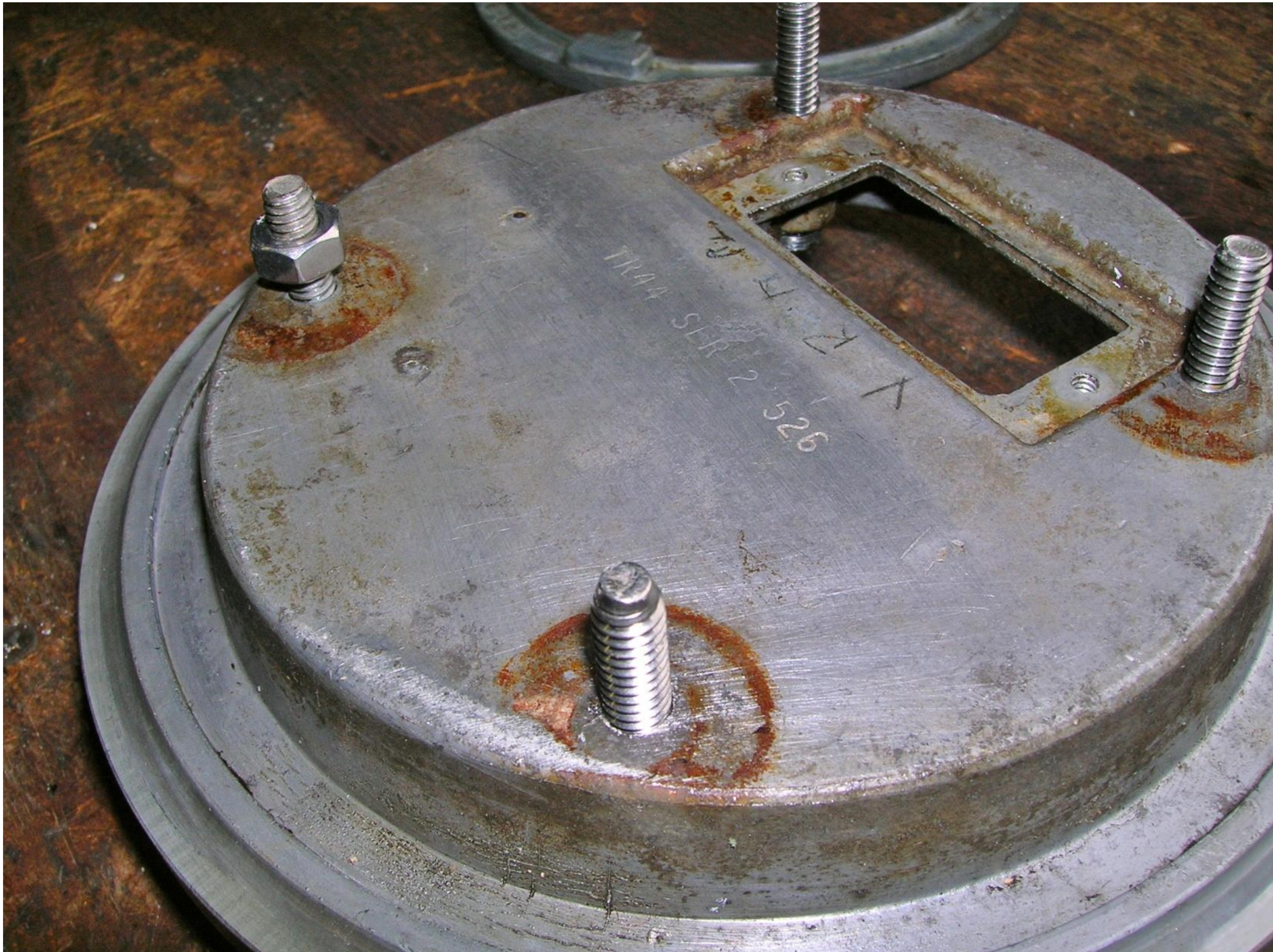

Manufacturing
CURT
www.curtmfg.com
Max Trailer Wt. 6,000 lb.
Max Tongue Wt. 600 lb.
V-5 Rated

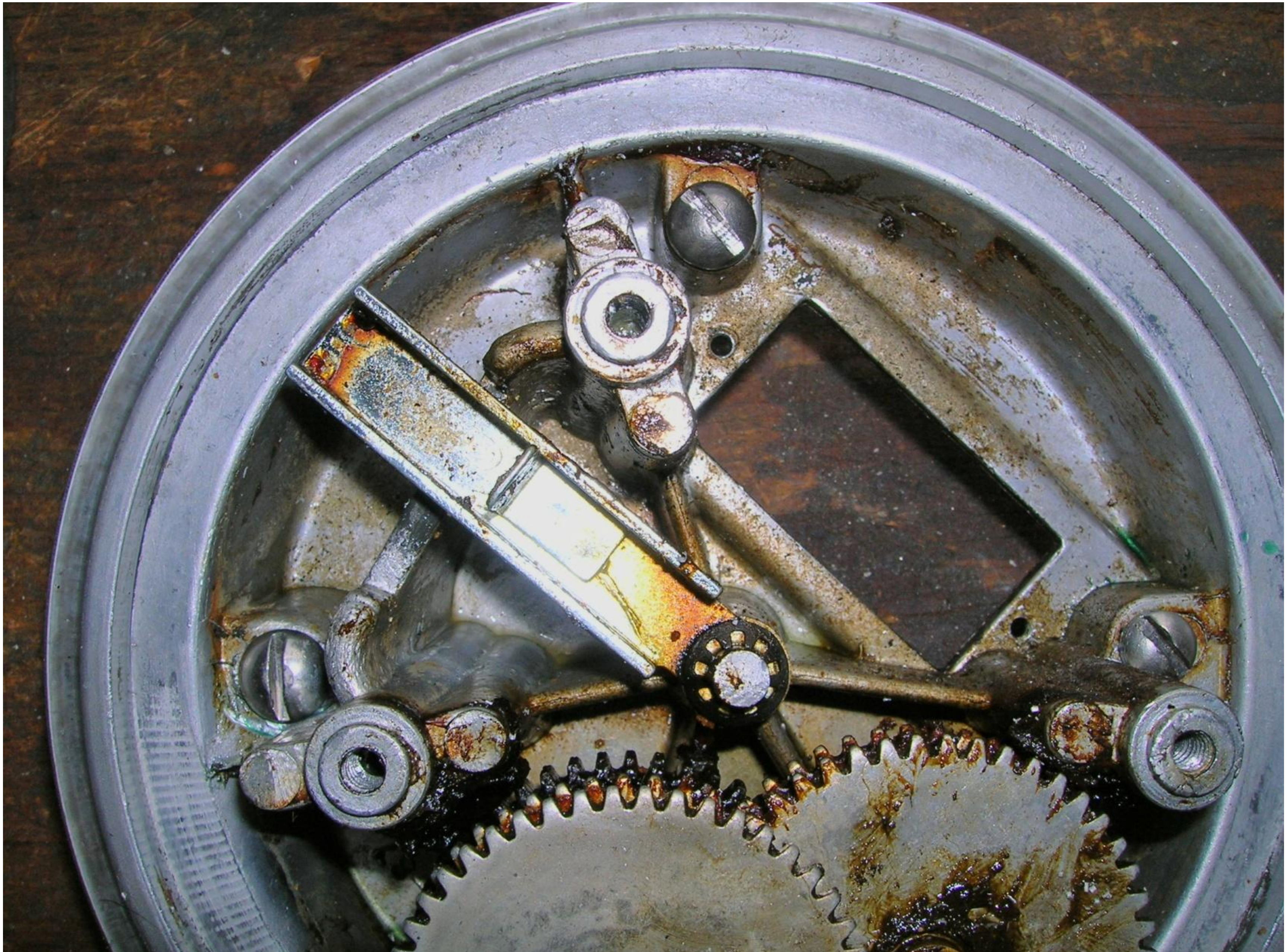


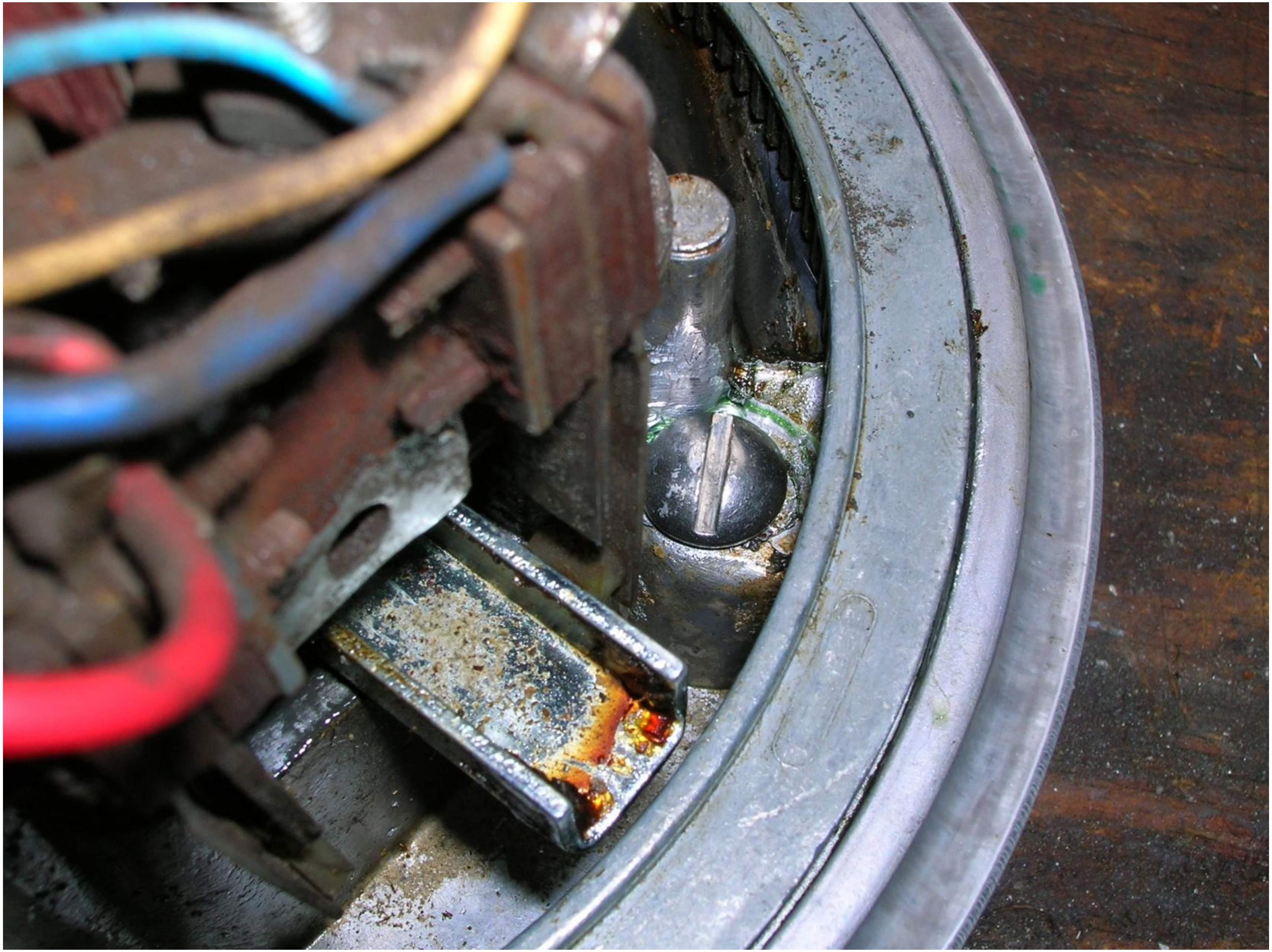

Manufacturing
CURT
www.curtmfg.com
Max Trailer Wt. 6,000 lb.
Max Tongue Wt. 600 lb.
V-5 Rated
Do not overload any part of
your towing system at any time.
Made in
the U.S.A.


www.curtmfg.com
Max Trailer Wt. 6,000 lb.
Max Tongue Wt. 600 lb.
V-5 Rated
Do not overload any part of
your towing system at any time.
Made in
the U.S.A.

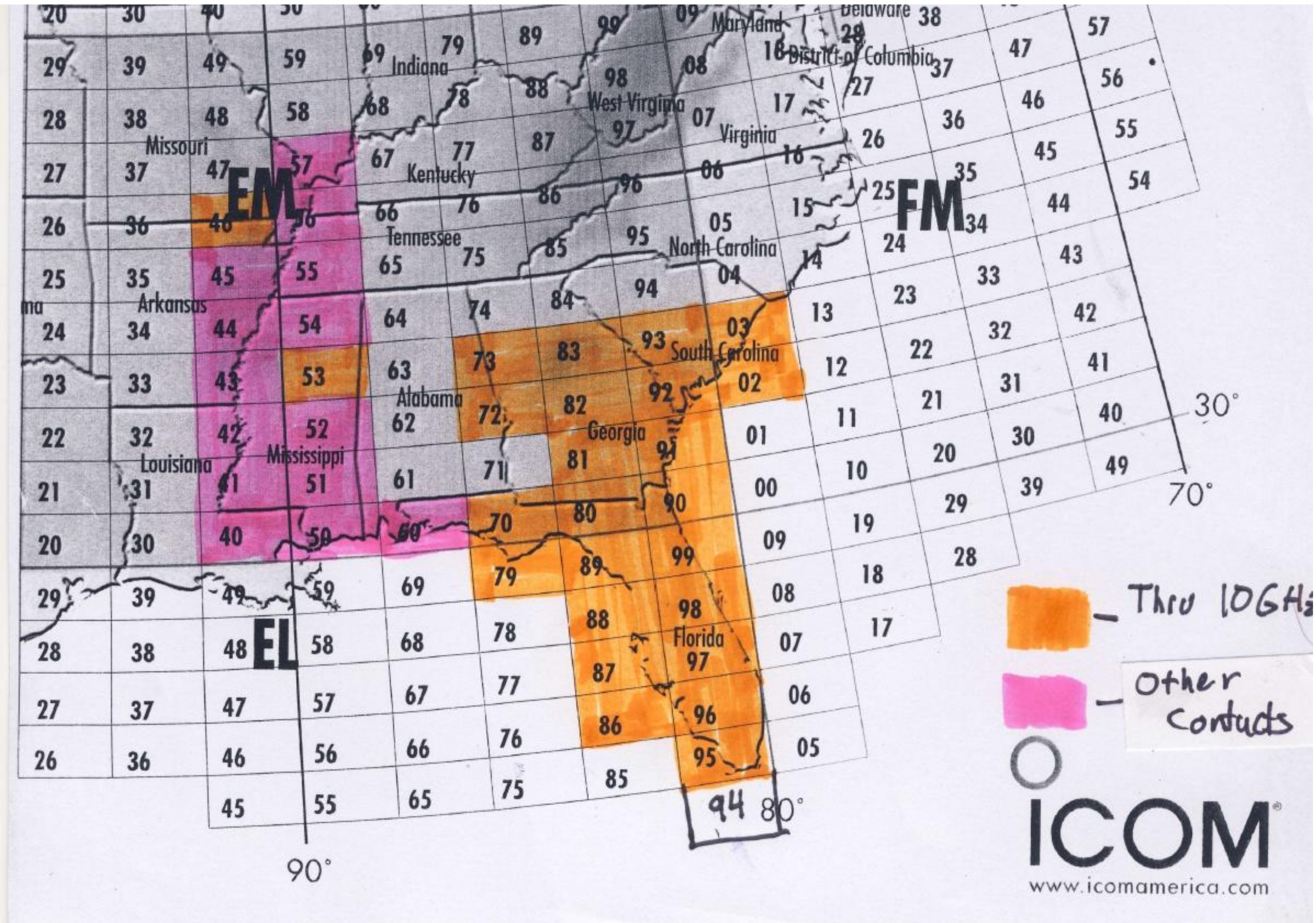

WARNING
2008 36-JL


TR44 SER 2 526






LOCTITE
290
THREADLOCKER
WICKING GRADE



EM
FM
EL
Missouri
Indiana
West Virginia
Maryland
Delaware
District of Columbia
Virginia
Kentucky
Tennessee
North Carolina
South Carolina
Arkansas
Alabama
Georgia
Mississippi
Louisiana
Florida
30°
70°
80°
90°
Thru 10GHz
Other Contacts
ICOM
www.icomamerica.com

EM91gc

Jekell Island

Brunswick, GA


HÖEGH AUTOLINERS


DEMI

ELECRAFT K
RANSCEIVER
20 40 60
RF 50 100
50.116.55
ANT1
AGC- F
PRE
NB
XFIL
FL2
10 W
A
TX
B
CUT — HI
WIDTH
NORM
I/II
PWR


Chien, WI


NO
FISHING
FROM
BRIDGE


NO
FISHING
FROM
BRIDGE

EL79tx

Mashes Sands Beach

Panacea, FL


STOP


STOP


PLEASE DEPOSIT
TRASH IN THIS
CONTAINER


STOP


ICOM

50.094.19
A
TX
B
10
VOX
ANT1
AGC- F
PRE
NB
XFIL
FL3
0.1W
WIDTH
I/II
PWR


STARKE, FLORIDA
029 LJF
TOWN&COUNTRY


E-350


DEMI

So how did we do!

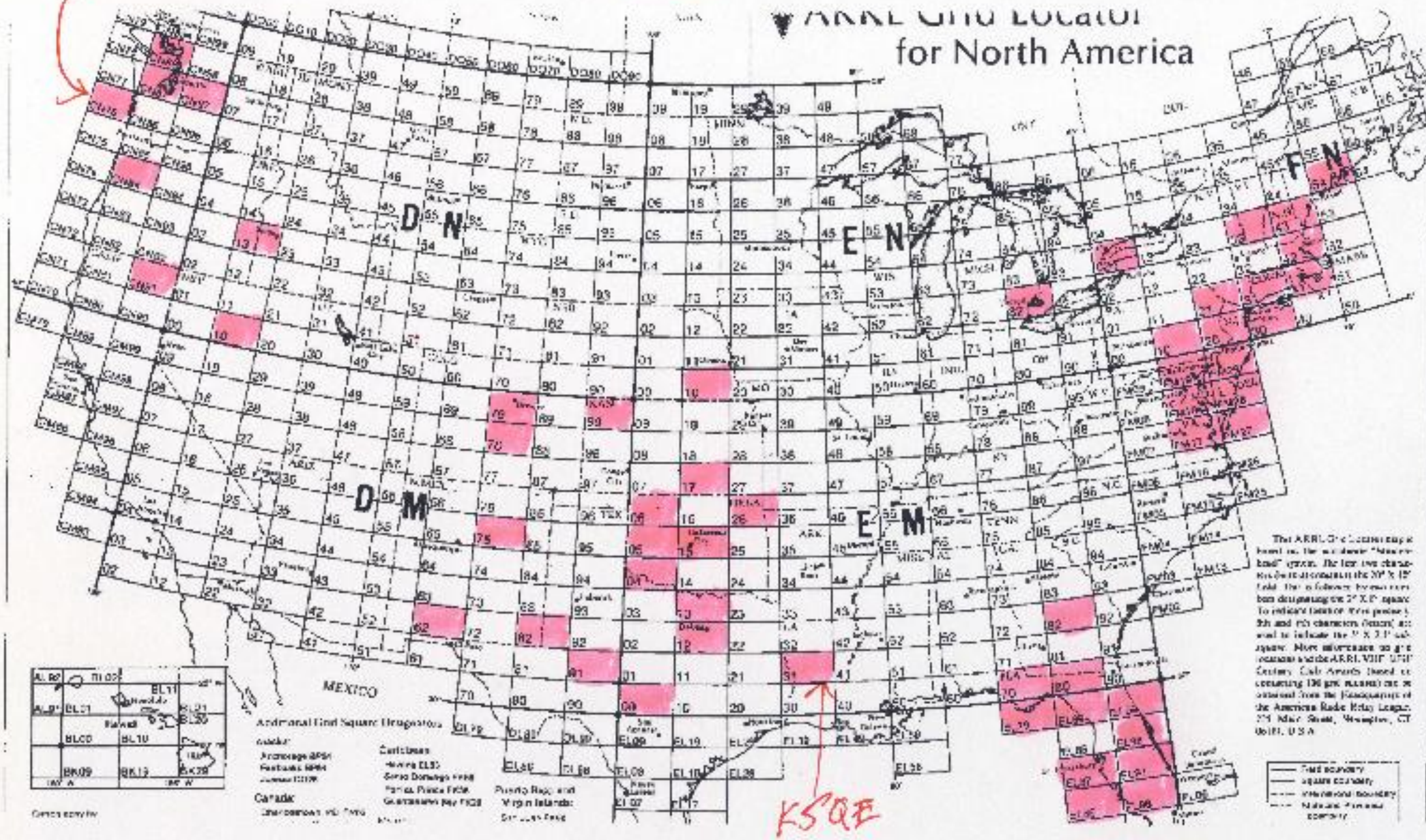
Totals:

EM91	**38 Q's**	**30 GRIDS**
EL79	**157Q's**	**60 GRIDS**

9-5

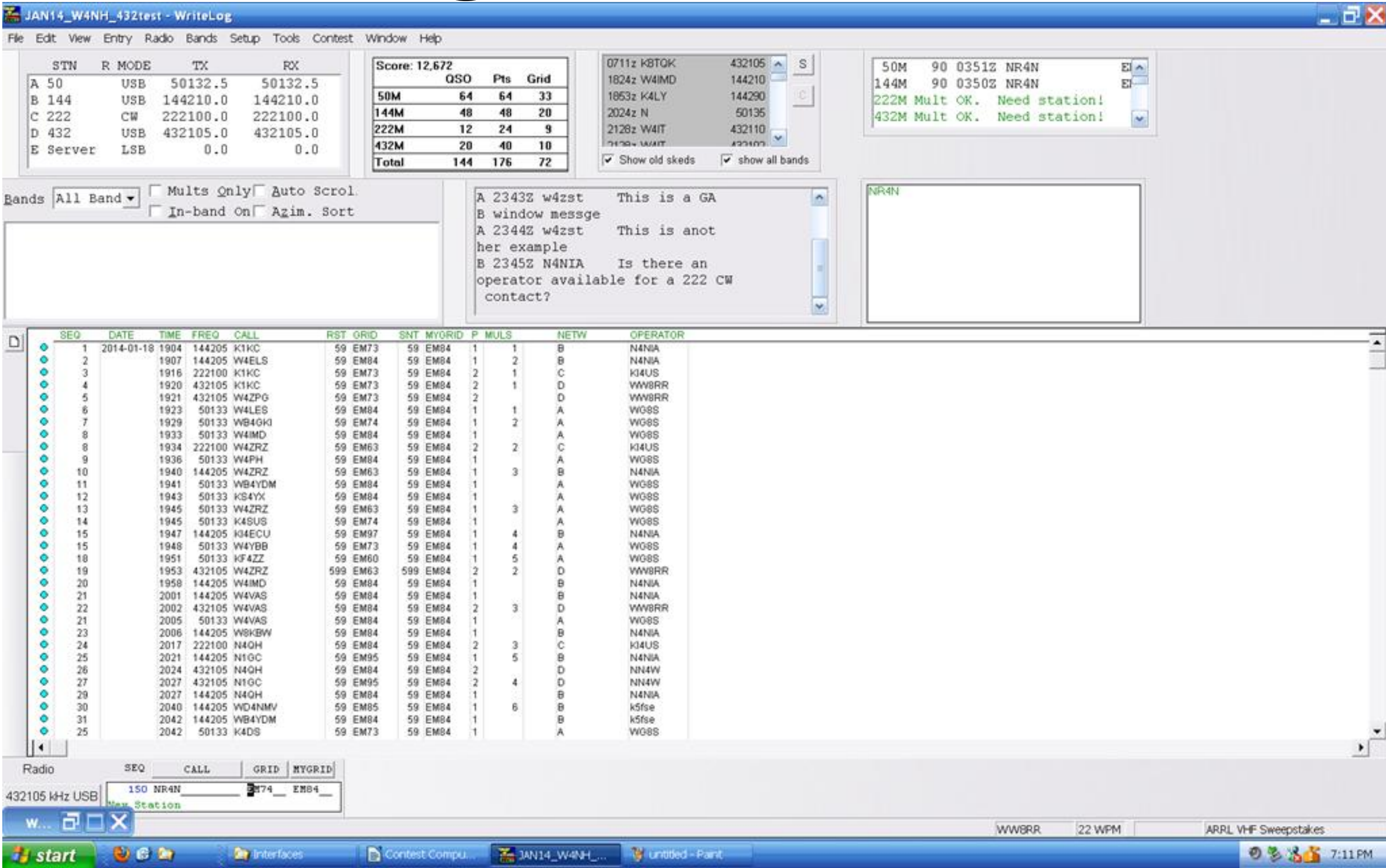
55 Grids

WW7D/R

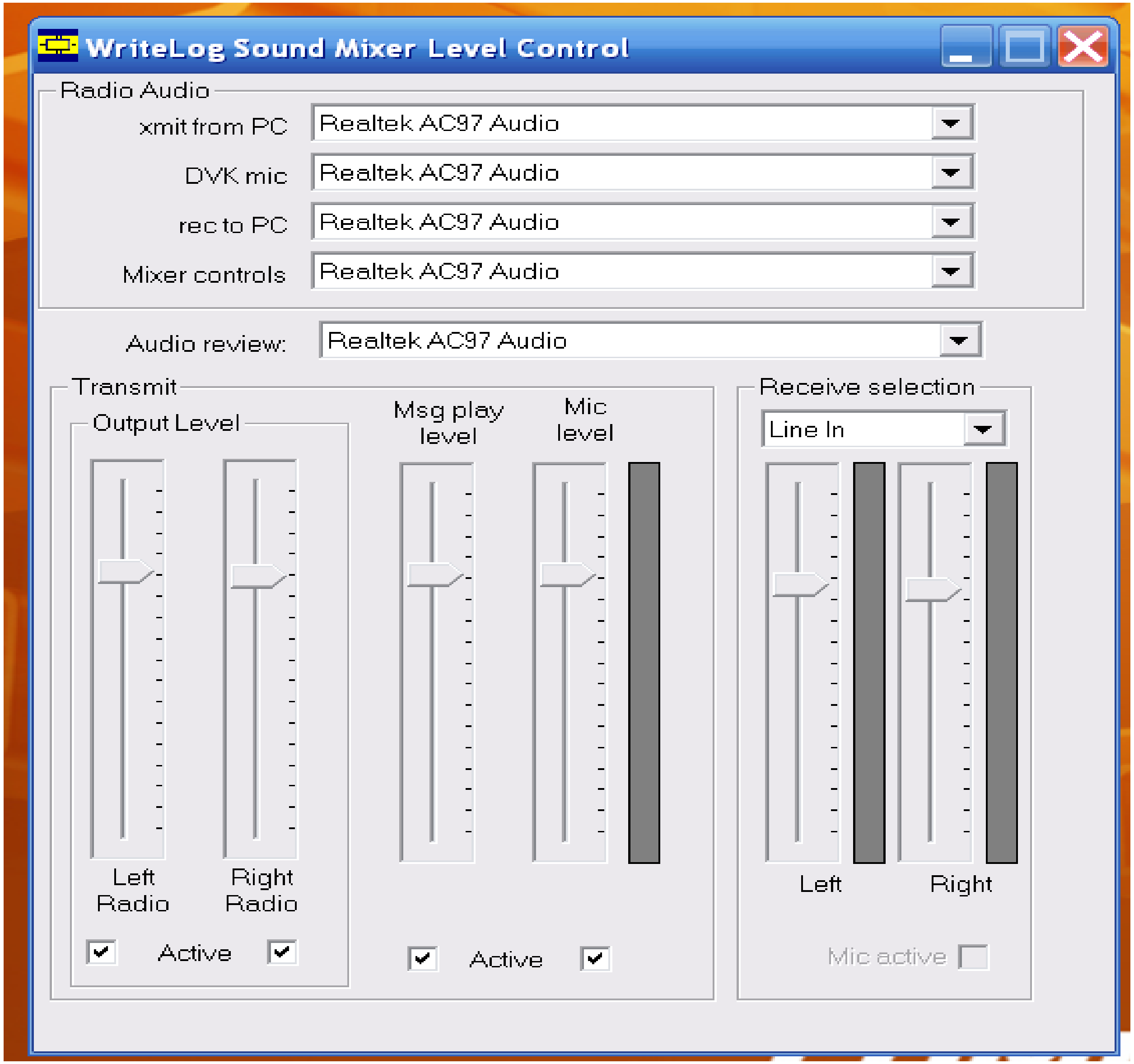


We Had Fun!

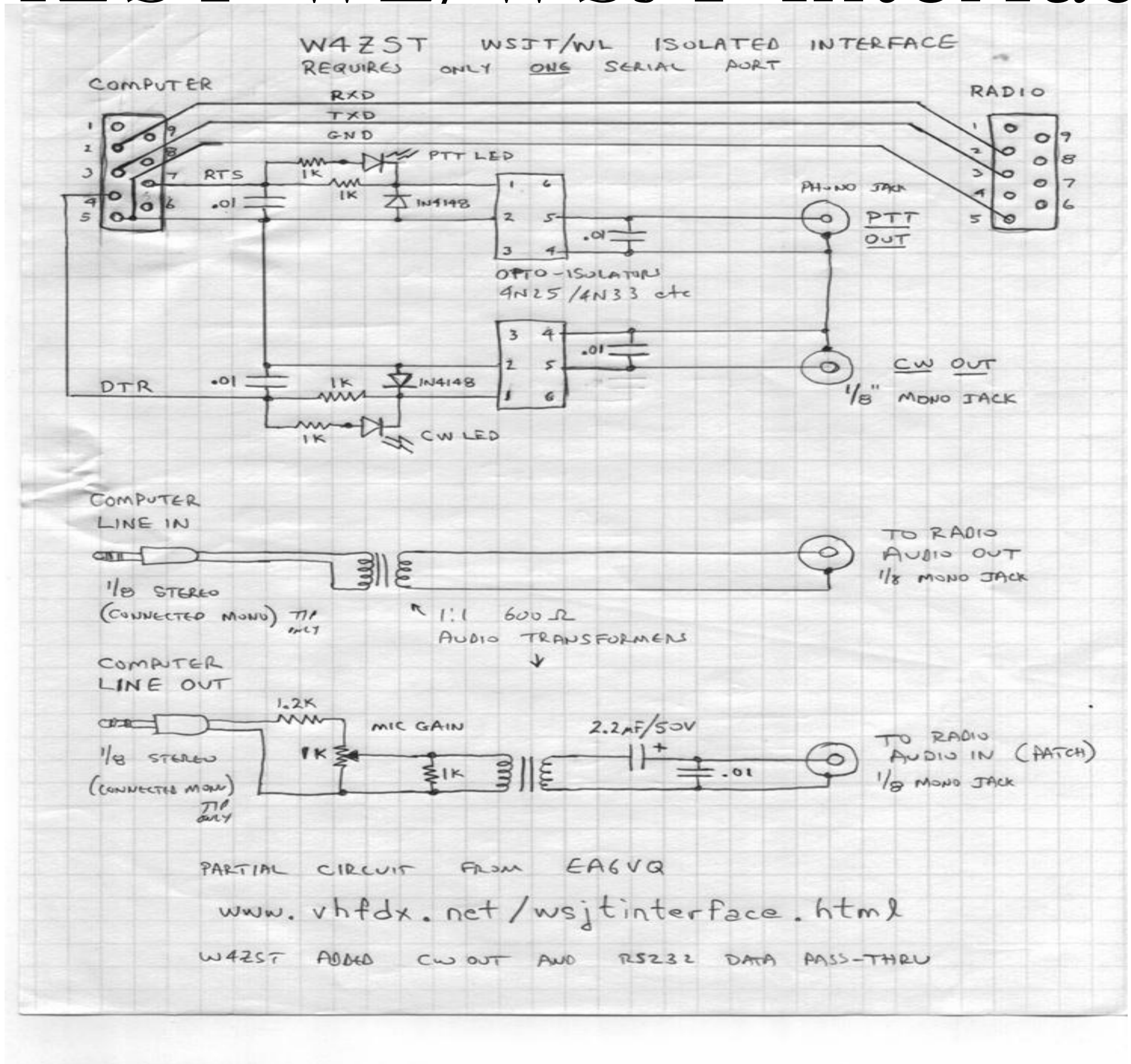
WriteLog Contest Screenshot



WriteLog Sound Card Setup



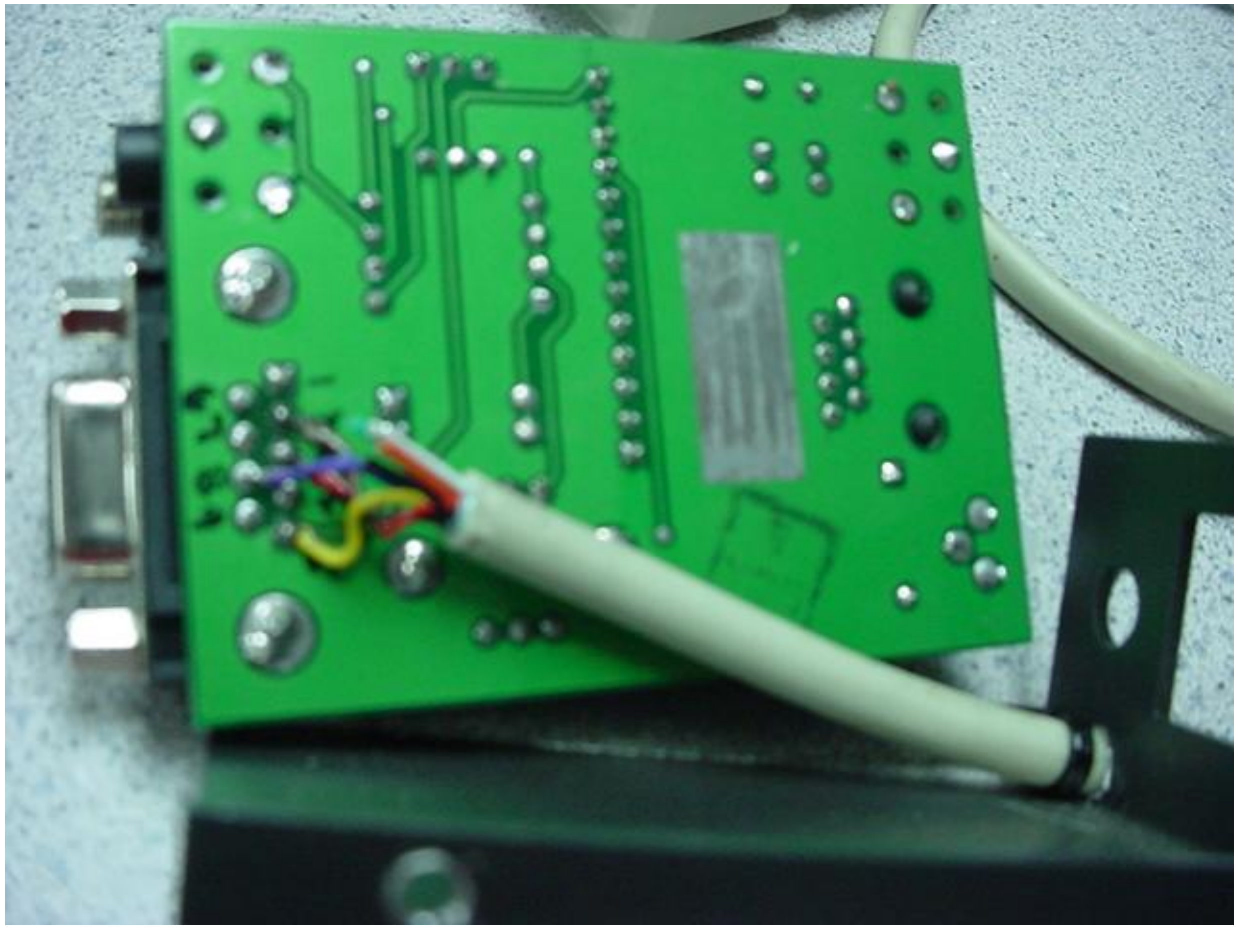
W4ZST WL/WSJT Interface



First Generation Interface

Second generation for K3

RS-232 Pass-thru on RigBlaster NoMic



Showing holes drilled in case

Completed Modified NoMic

Third generation Interface

EZ Bake Oven Project

N5YC Brian Straup

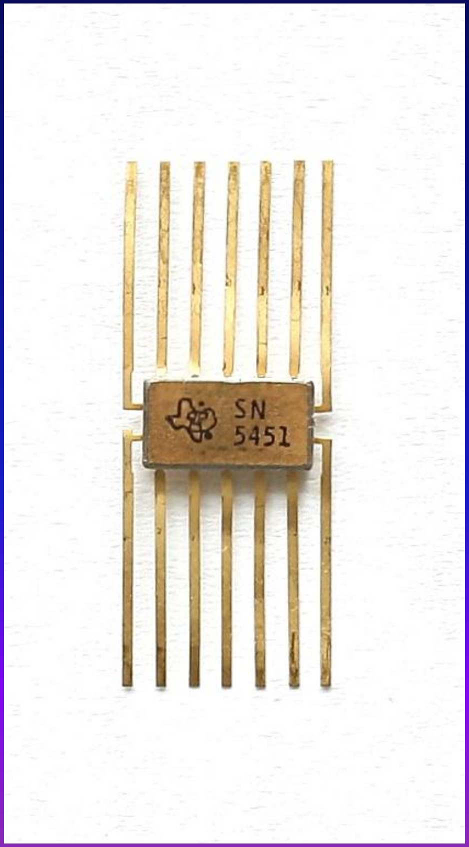
SMD vs Toaster Oven

Introduction / SMD Parts

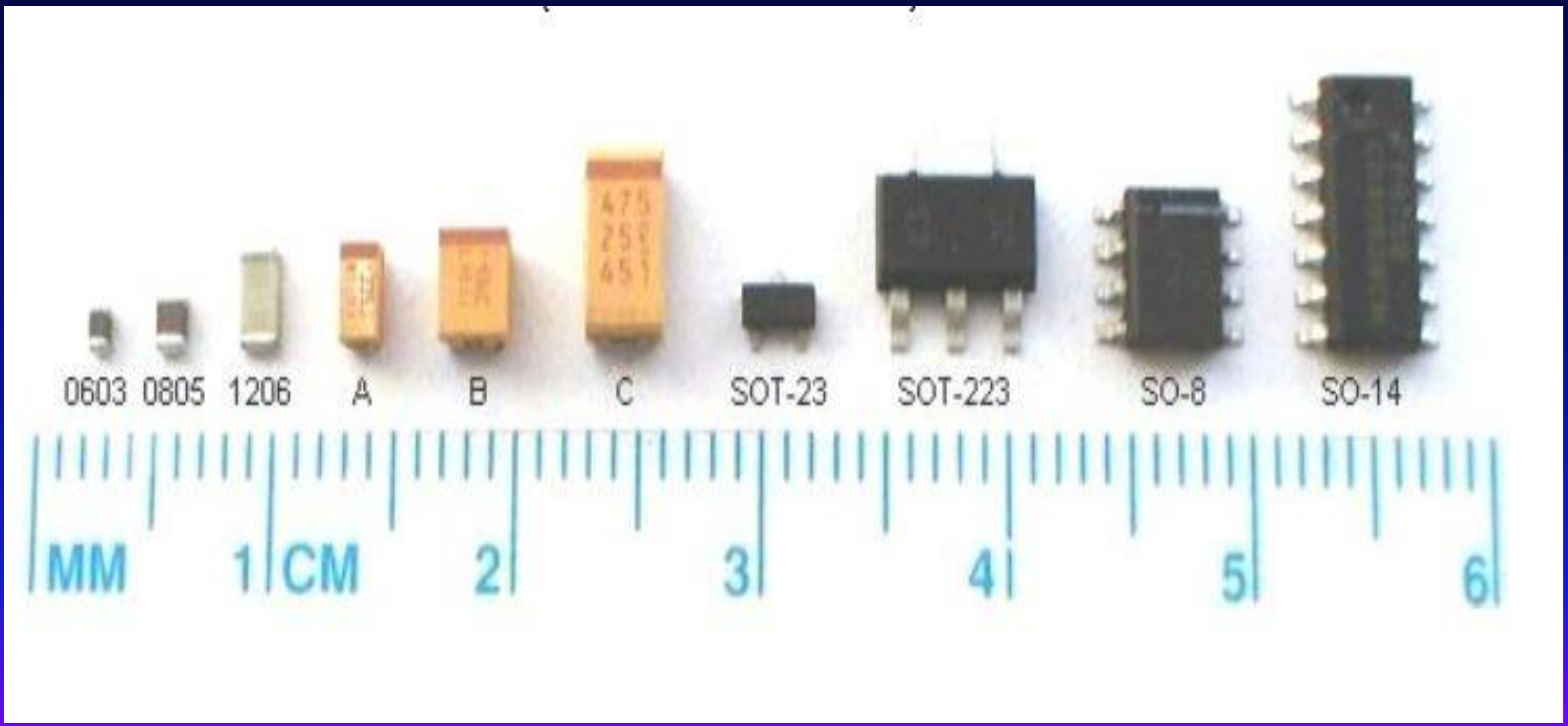
- Overview SMD Assembly Process
- Inside a Commercial Shop
- Lab Workstation for SMD
- Affordable Reflow Oven
- In House Assembly Photo Opportunity

Who was First ?

- Texas Instrument 1962 Flat Package

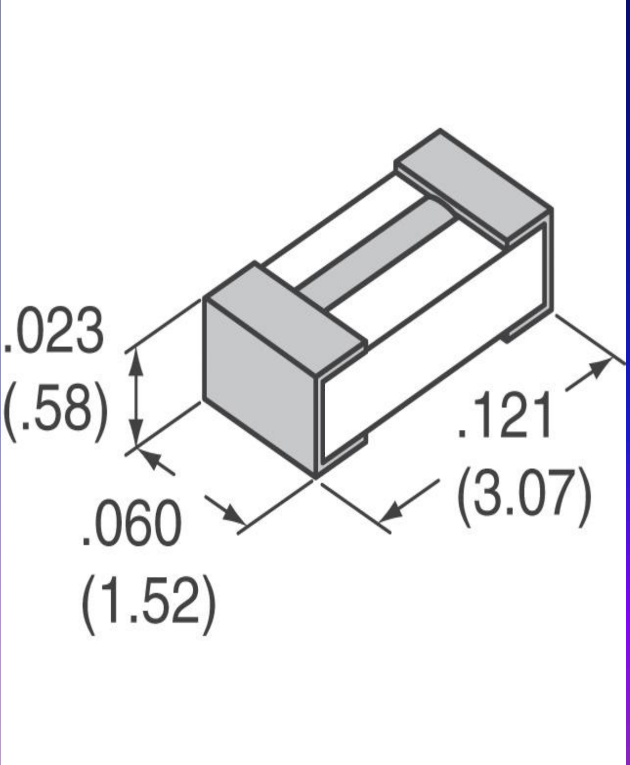


SMD Common Parts

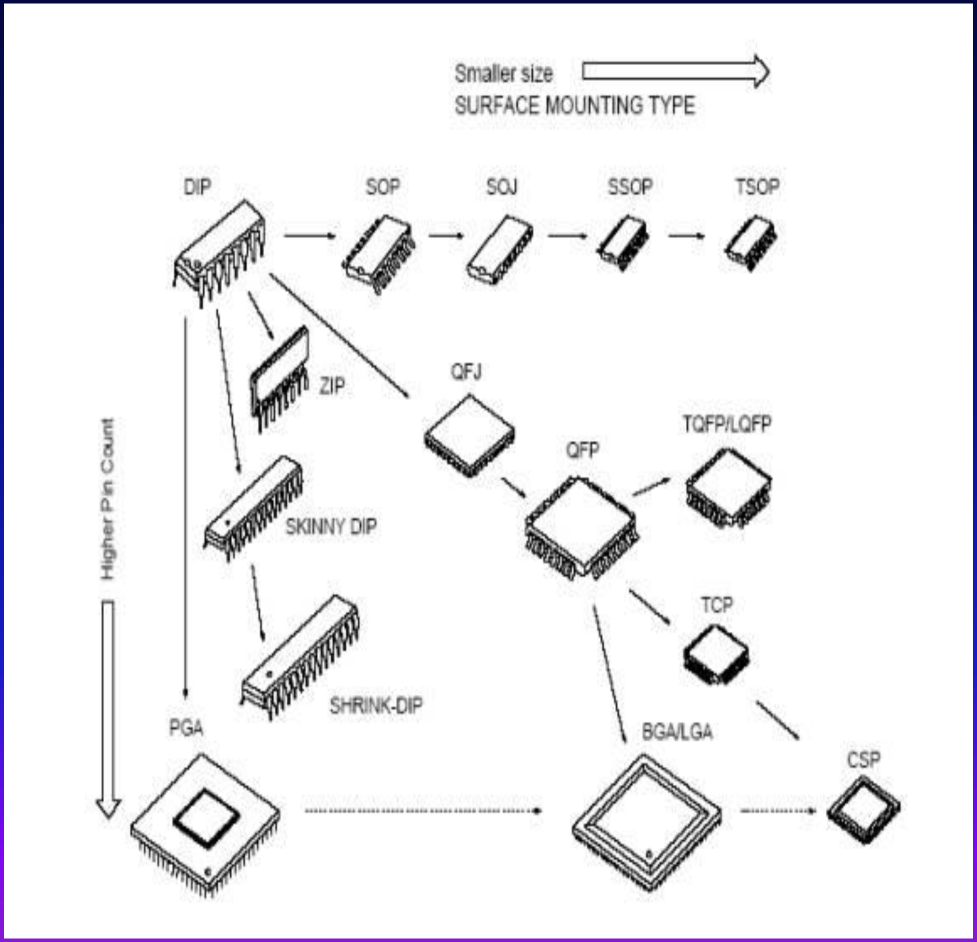


Oh What O What

- 1206   12 * .010   by   06 * .010



Silicon Packages



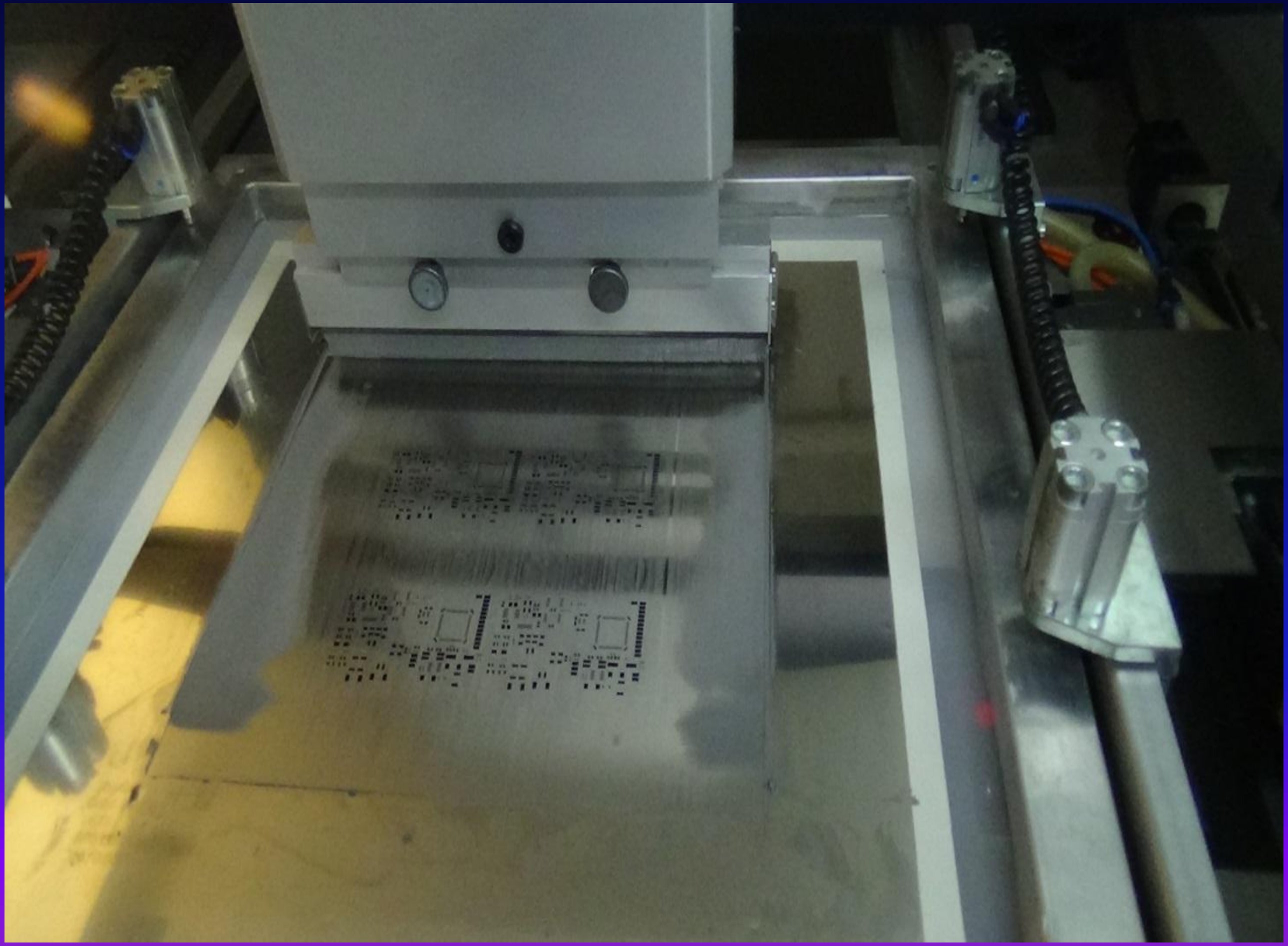
How Boards are Assembled

- Raw PCB
- Screen Solder Paste
- Place Parts
- Reflow Solder
- Repeat
- Machine Wash Air Dry No spin cycle

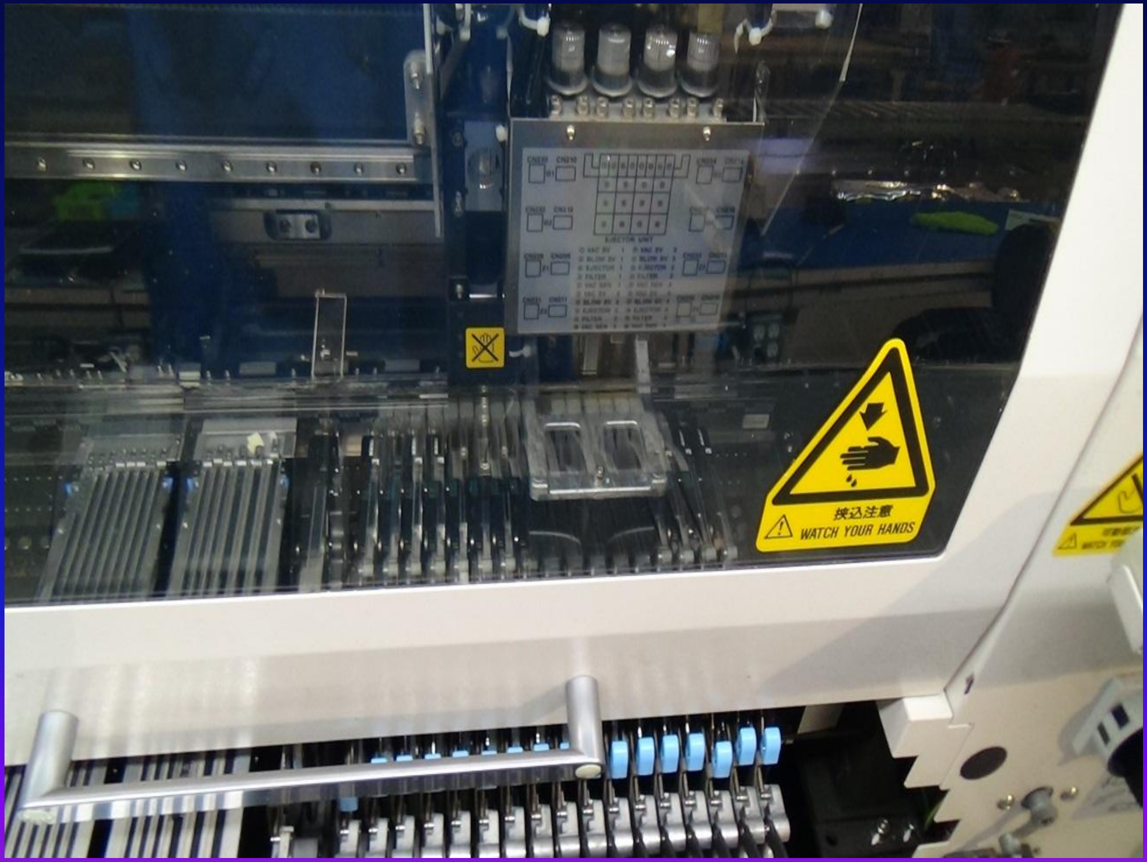
Inside an Assembly House

Special Thanks to US.TX Dripping Springs TX

Solder Screen



Pick and Place

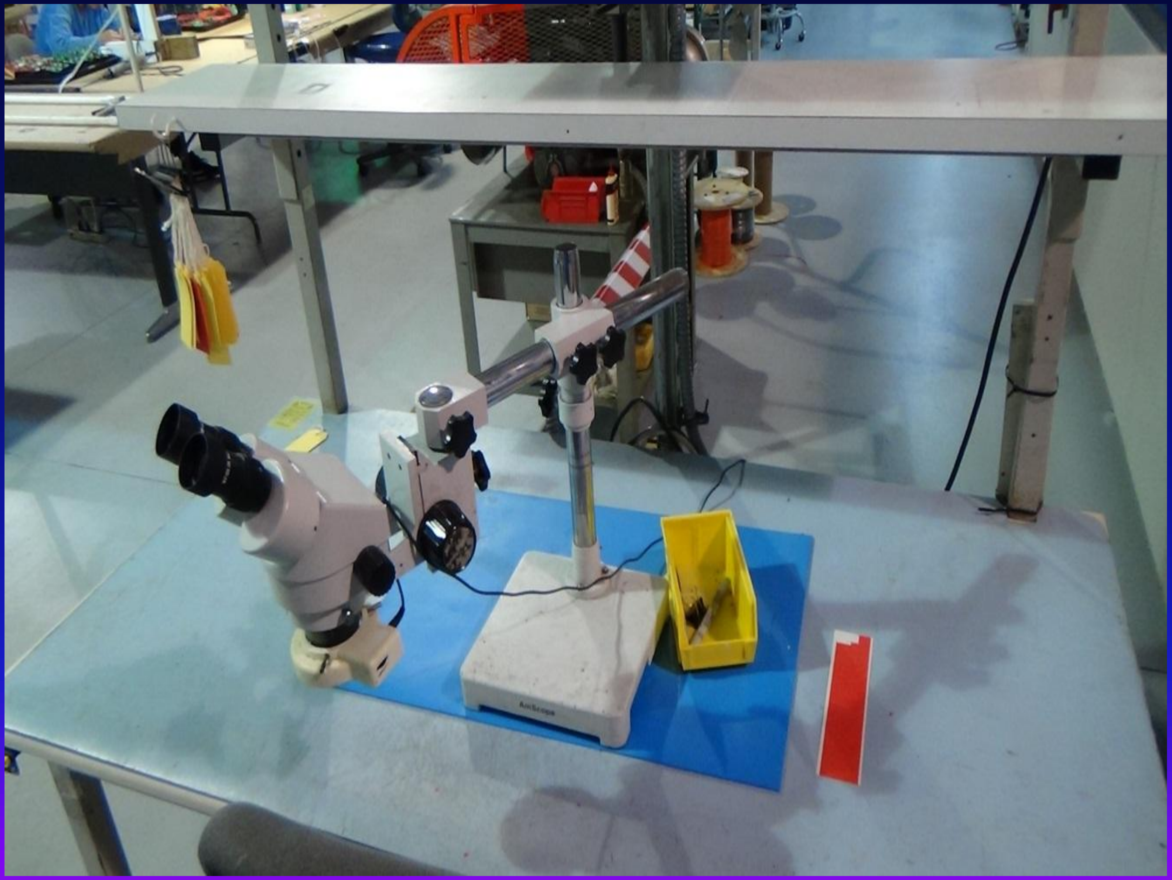


Reflow Oven

How Do I do this at Home ?

- Workstation
- Hot Air Pencil / Soldering Iron
- Medicinal Compounds (Solder + Flux)
- Hand Tools
- Affordable Reflow Oven

Work Station



Microscope

- Binocular Inspection
- Variable Zoom is nice .75 to 3.5X
- 10X Wide Field Eyepieces 1X Objective
- .5X Barlow Lens
- Ring Light
- Single Most Expensive Item

Barlow Lens

Anti Static Mat

- Grounded Pad
- Wrist Strap
- Bright Color for Locating flipped Parts

Hot Air Pencil

- Temperature and airflow regulated
- Single unit with Soldering iron
- Various tips
- Combined unit is more cost effective
- NO PAINT STRIPPERS

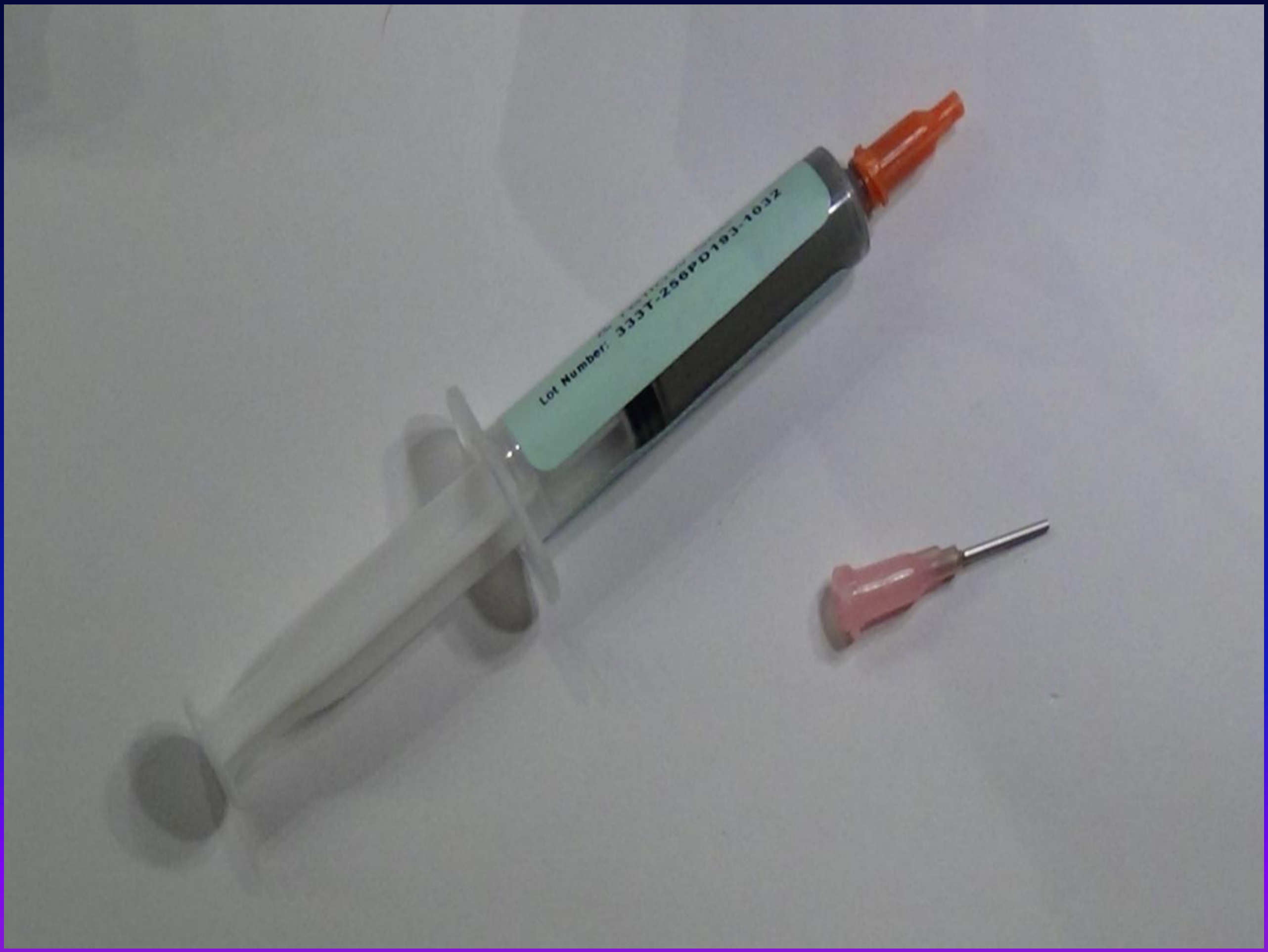
Hot Air Station

Hot Air Nozzle

New Chemicals / Old Friends

- Gel Flux / Liquid Flux
- SMD Paste Solder
- Dri-Wick (Small)
- Denatured Alcohol / Acetone

SMD Solder Paste



Solvent / Cleaner

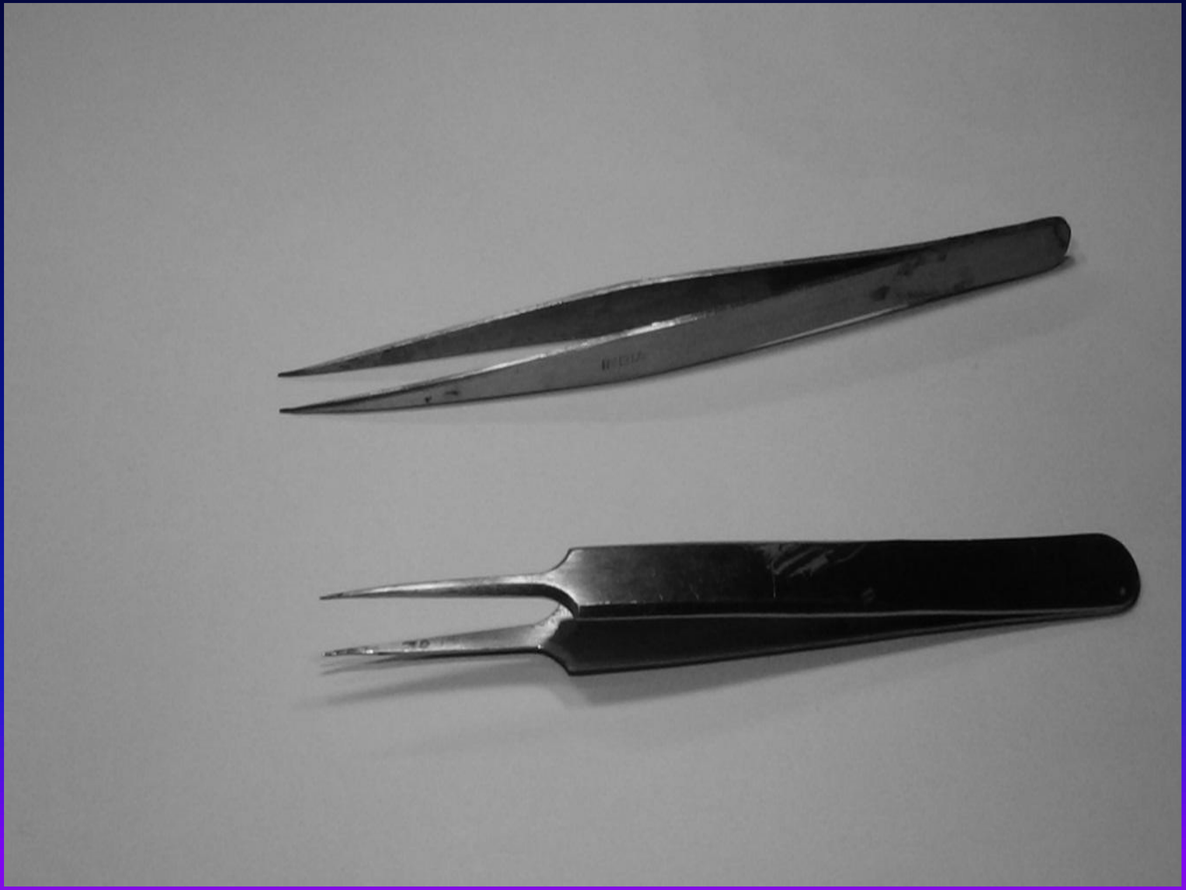
Gel Flux

Why Hot Air is preferred Choice

Hand Tools

- Stainless Steel Pointed Tweezers
- Sharp Exact Knife
- Dental Pick
- Vacuum pencil

Tweezers



Vacuum Pencil

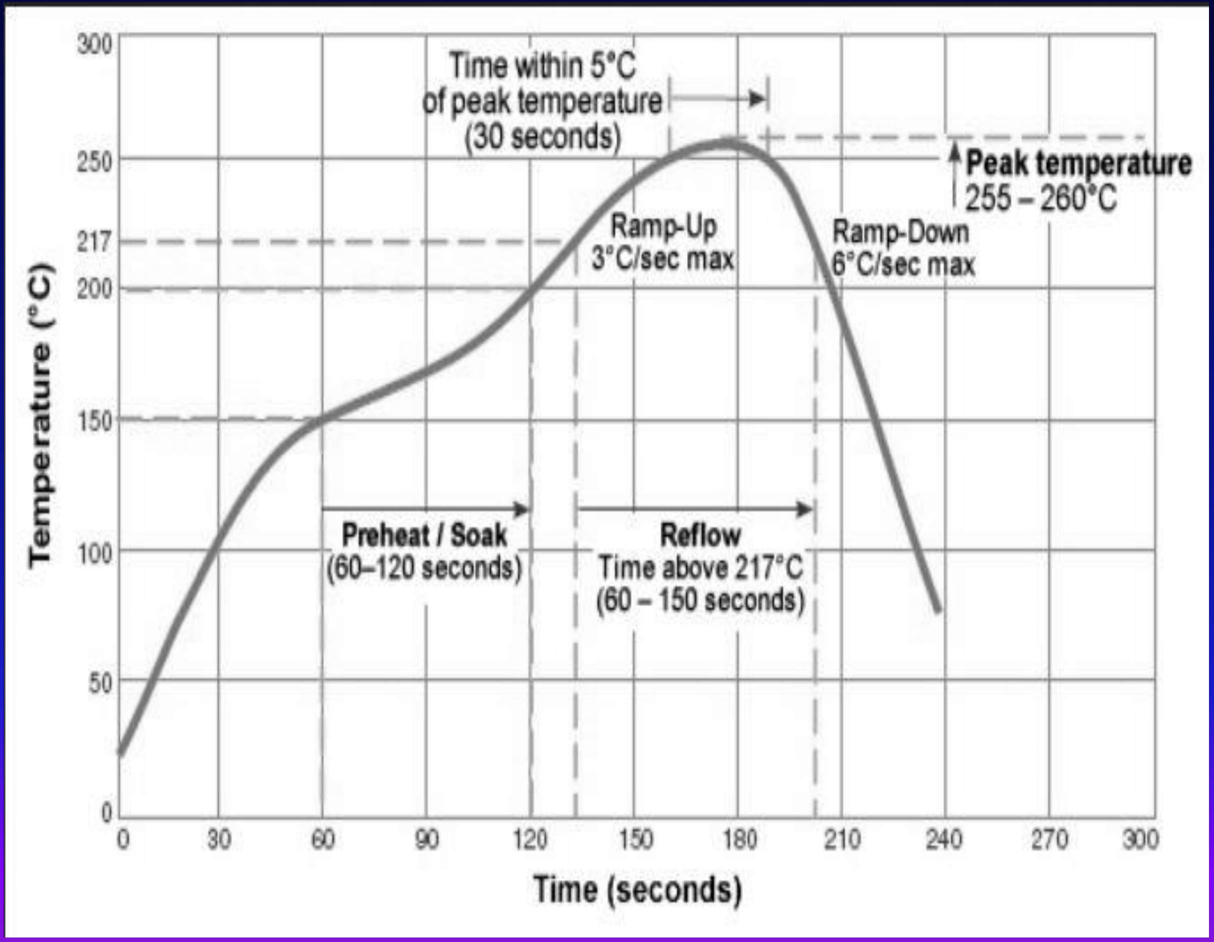
Reflow Heat Source

- Its ALL about the Curves
- What not to use
- Reflow Toaster Oven

Its All About the Curves

- Phases of SMD Reflow
- Phase I 25 to 150C   3C /second MAX
- Phase II 150 to 200C Presoak Activates Flux
- Phase III 200C to 245C Reflow 15 to 30 Sec
- Phase IV Peak to 200C 6C /second MAX

NO-LEAD Typical Process



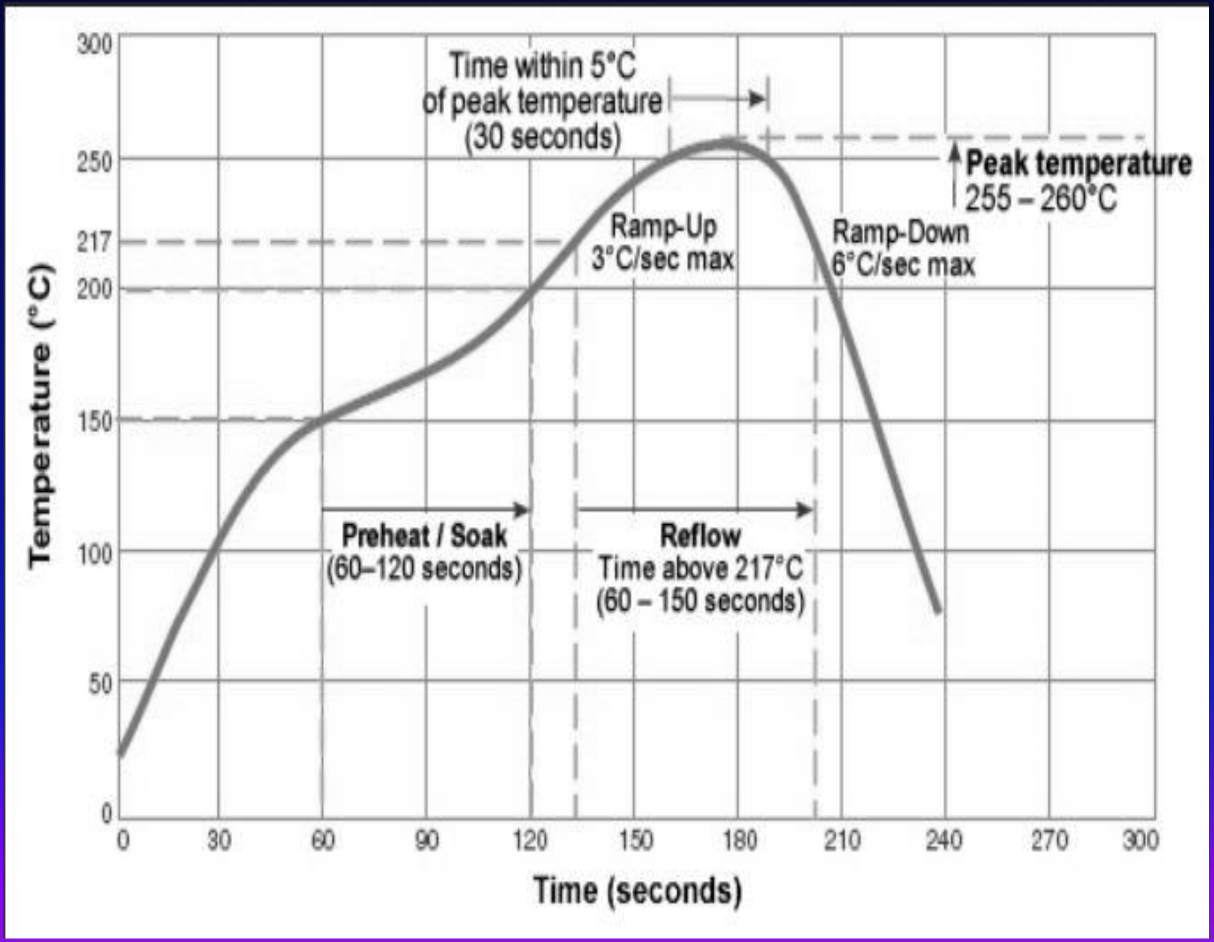
What Not To Use

- Hotplate Heats and cools too slow
- Frying Pan Once Hot exceeds heating profile
- Paint Stripper Burn board and parts
- Toaster Oven Without Controller
- ROHS temperature is close to part damage

Toaster Oven ?

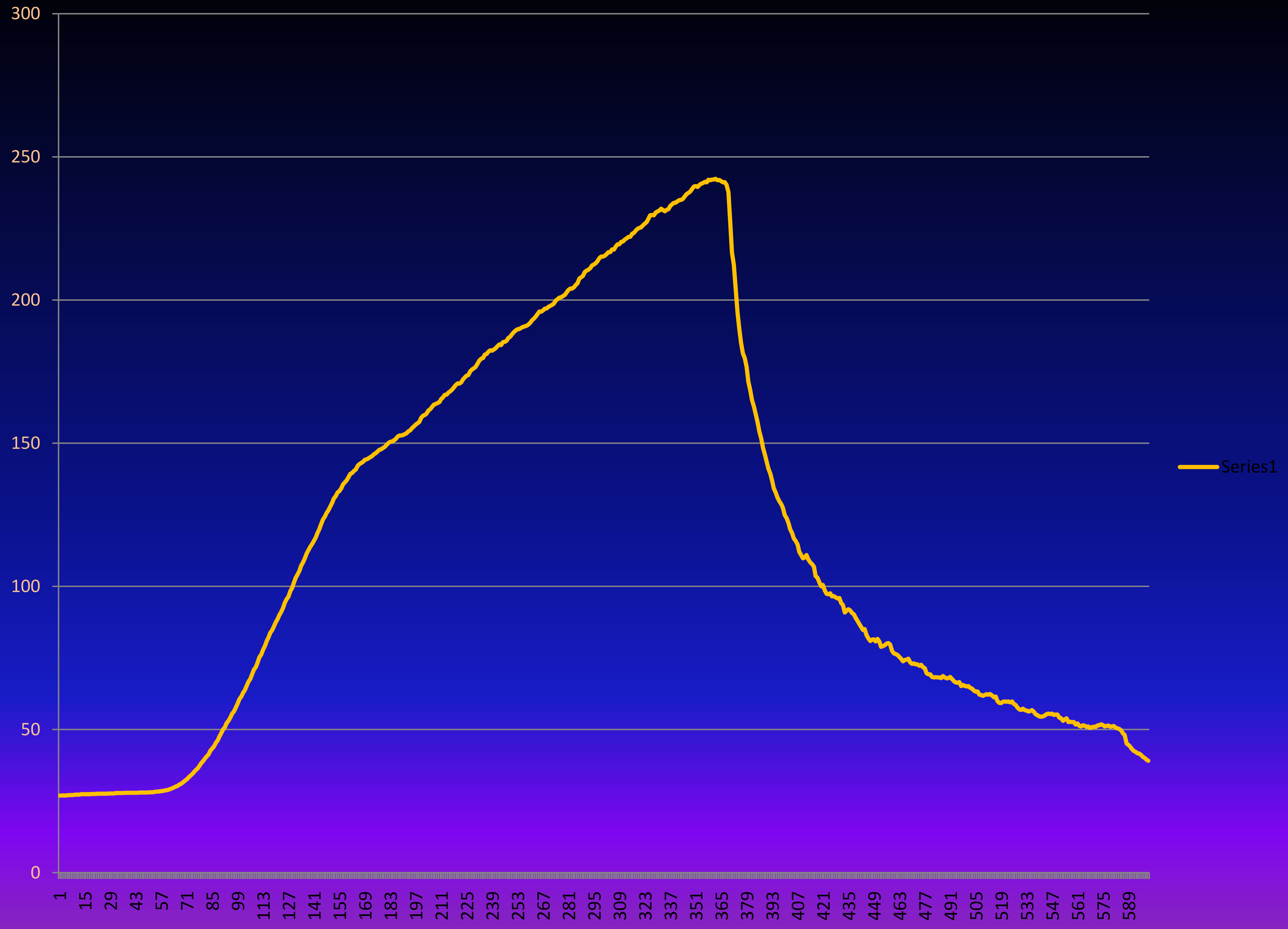
- 1400W recommended Small oven size
- Easily Modified for Solid State Relay
- Inexpensive controller
- Half the Cost of Low End China PCB Oven

NO-LEAD Typical Process



Why 1400W ?

- Heater operating near Maximum at 200C
- Lower Power will eventually get hot but will expose the parts to much longer heating times
- Inexpensive controller
- Half the Cost of Low End China PCB Oven


300
250
200
150
100
50
0
1
15
29
43
57
71
85
99
113
127
141
155
169
183
197
211
225
239
253
267
281
295
309
323
337
351
365
379
393
407
421
435
449
463
477
491
505
519
533
547
561
575
589
Series1

Oven Modifications

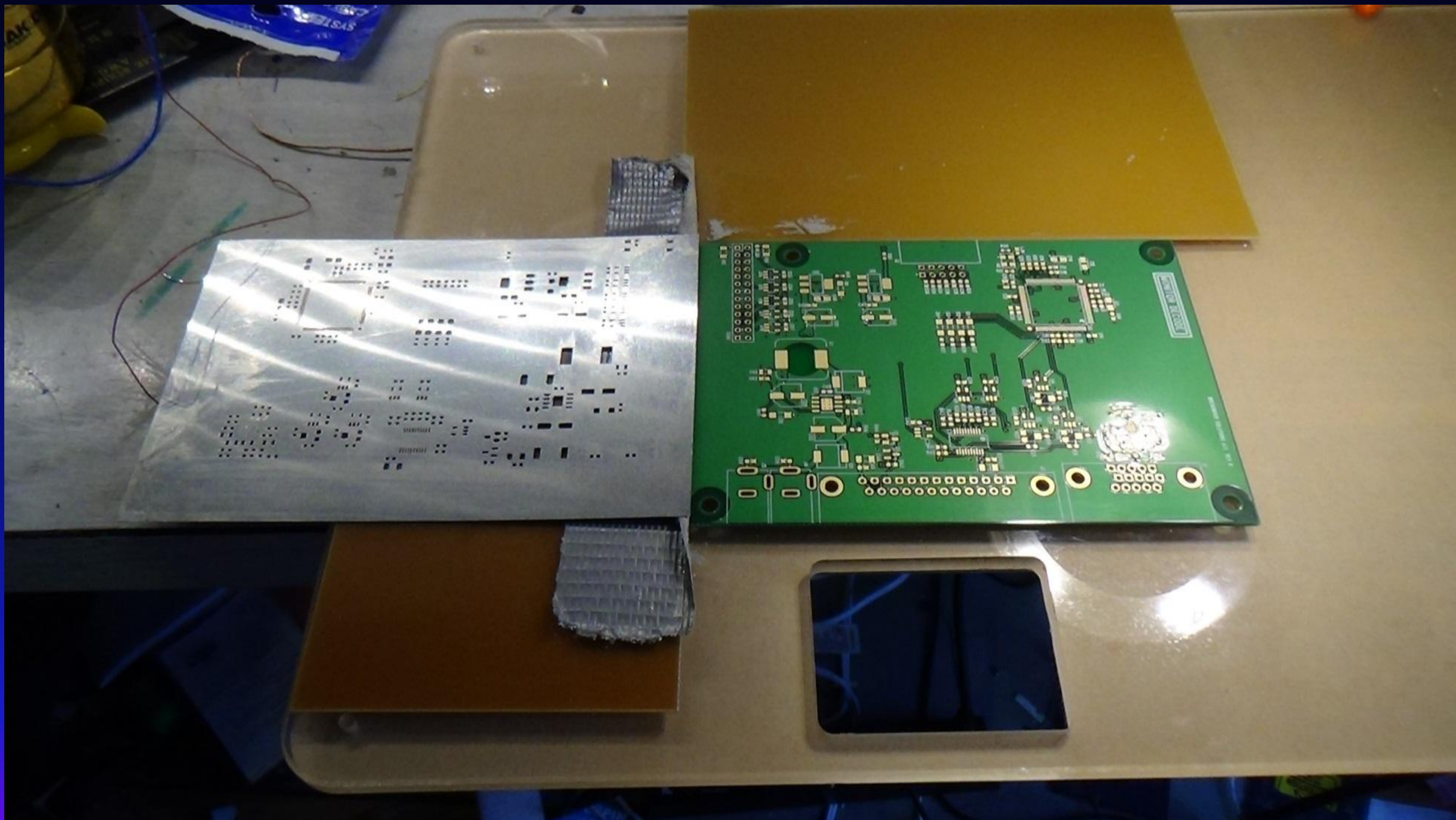
- Heavy Foil Wrapped Fiberglass Bats reduces Volume and keeps IR inside the box.
- Solid State Relay
- External Controller
- Type K Thermocouple (Fiberglass casing)

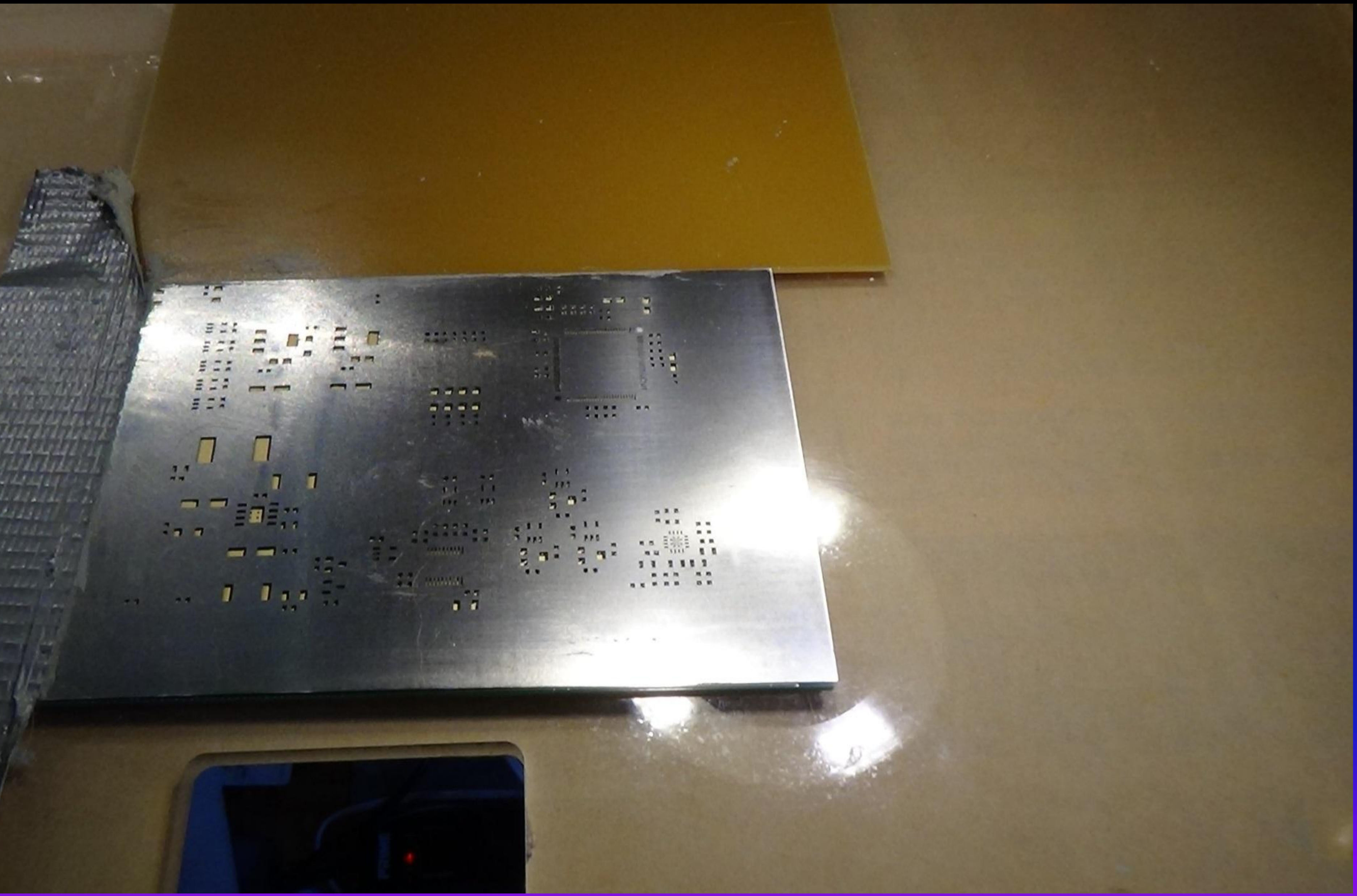
My Little Oven

Reflow on the Go

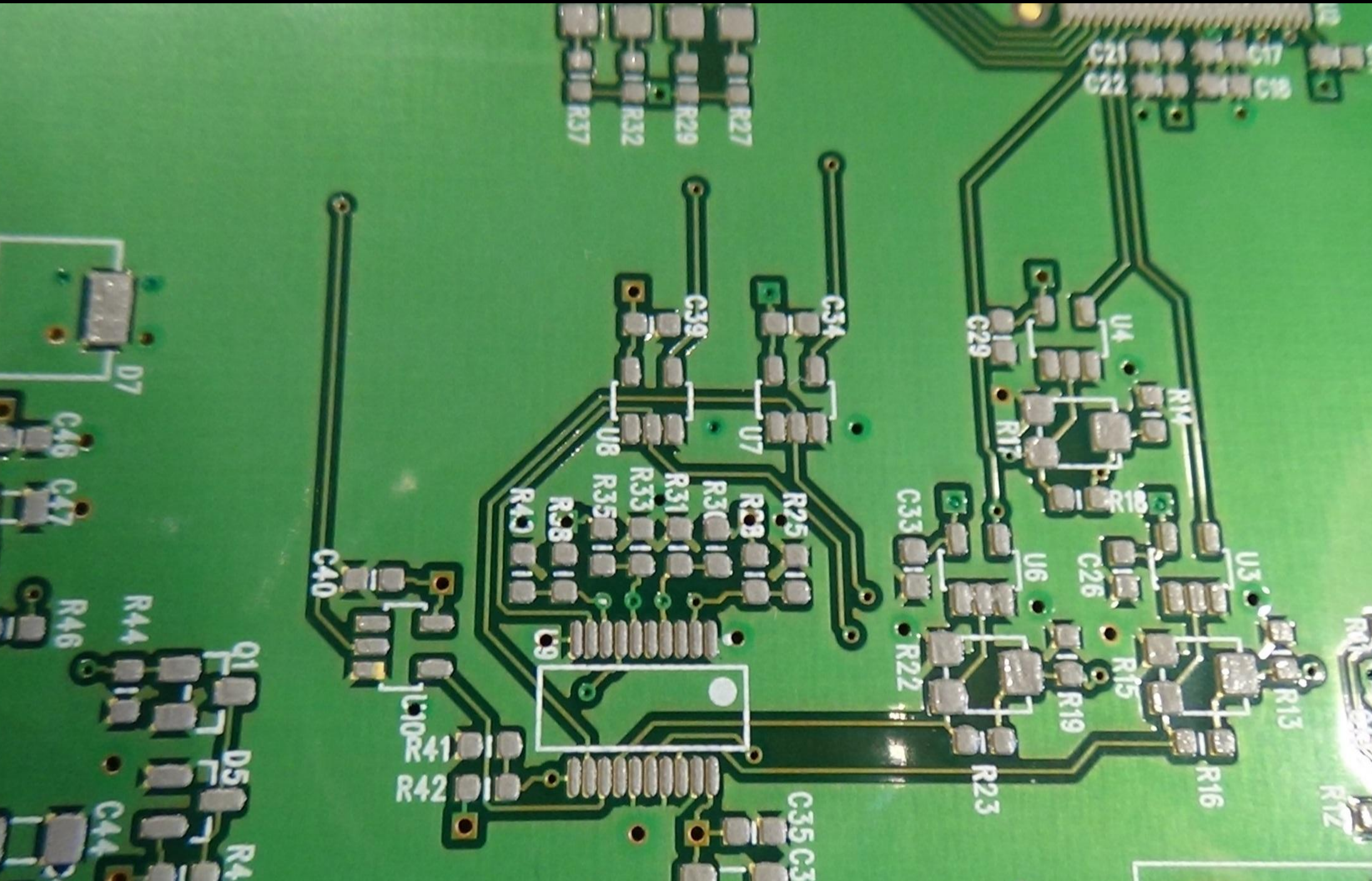
Shop PCB Assembly

- Short Sequence of a customer board build

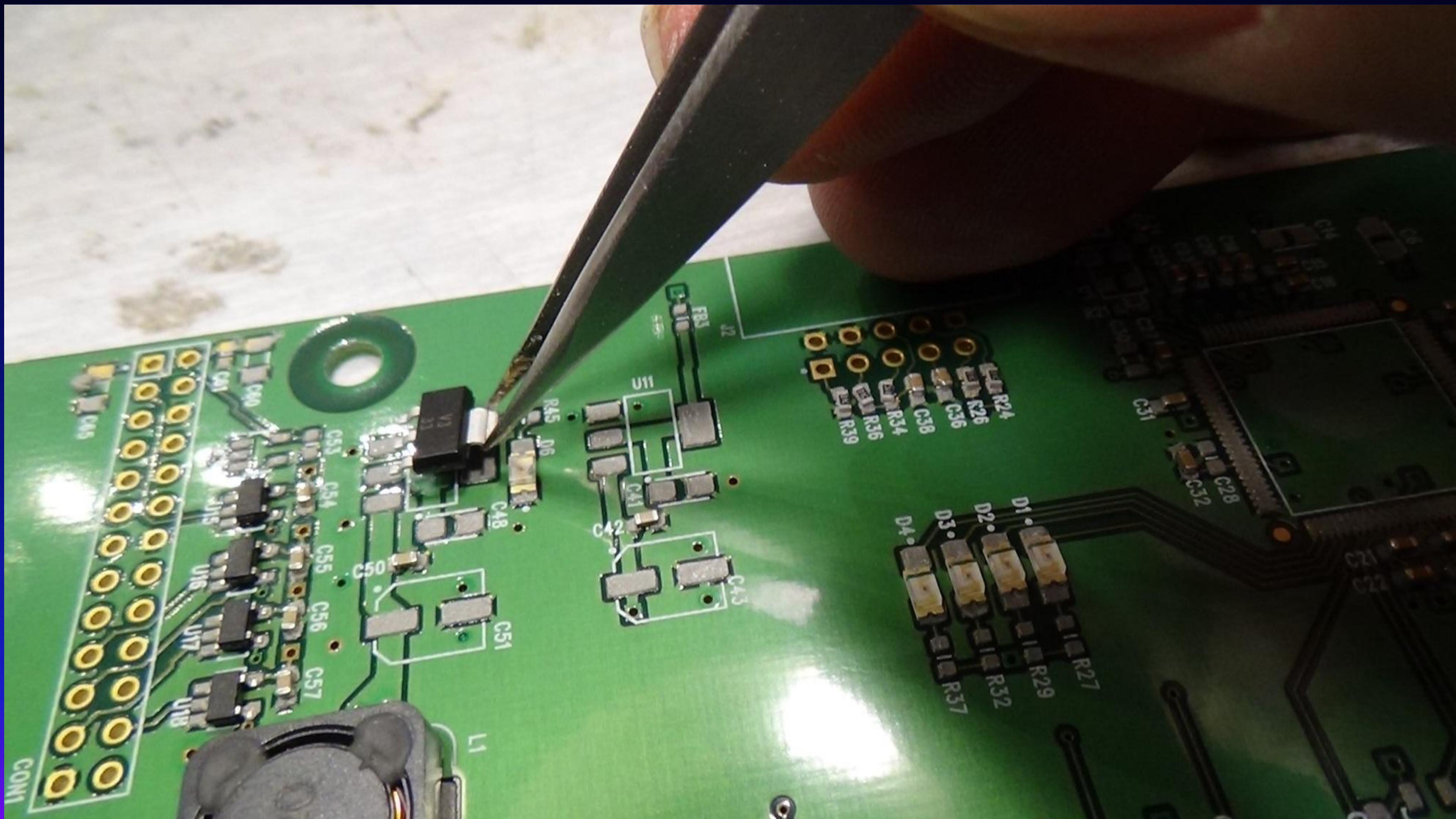





D2AUDIO
DIGITAL AMPLIFIERS



R37
R32
R29
R27
C21
C22
C17
C18
C39
C34
C29
U4
U8
U7
D7
C46
C47
R46
R44
Q1
C40
R41
R42
D5
C44
C33
U6
U3
C26
R22
R19
R15
R13
R23
R16
R12
R18
C35


U11
R45
D6
C48
C50
C51
C42
C41
C43
L1
CON1
C53
C54
C55
C56
C57
U16
U17
U18
R39
R36
R34
C38
C36
R26
R24
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C28
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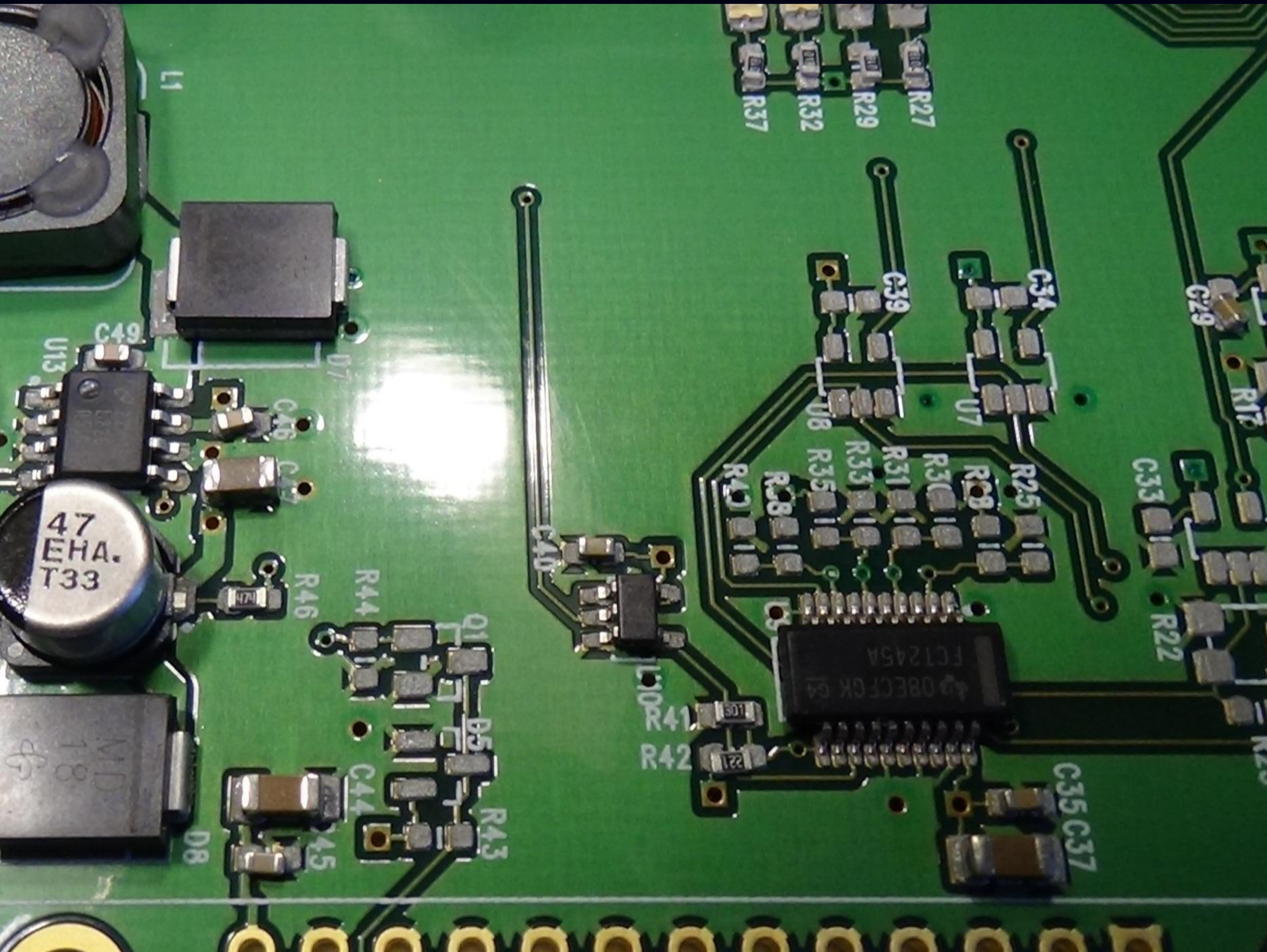
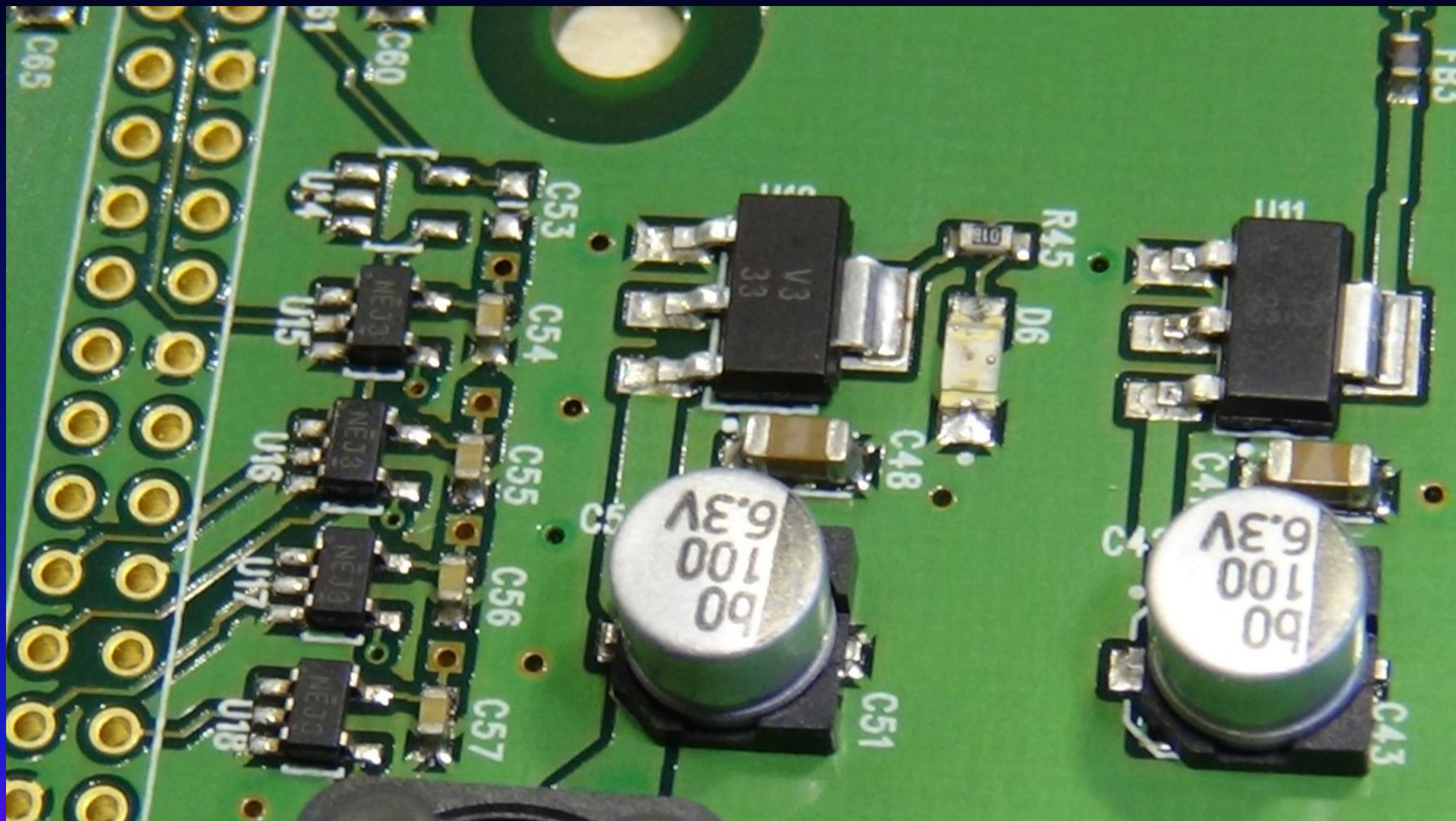
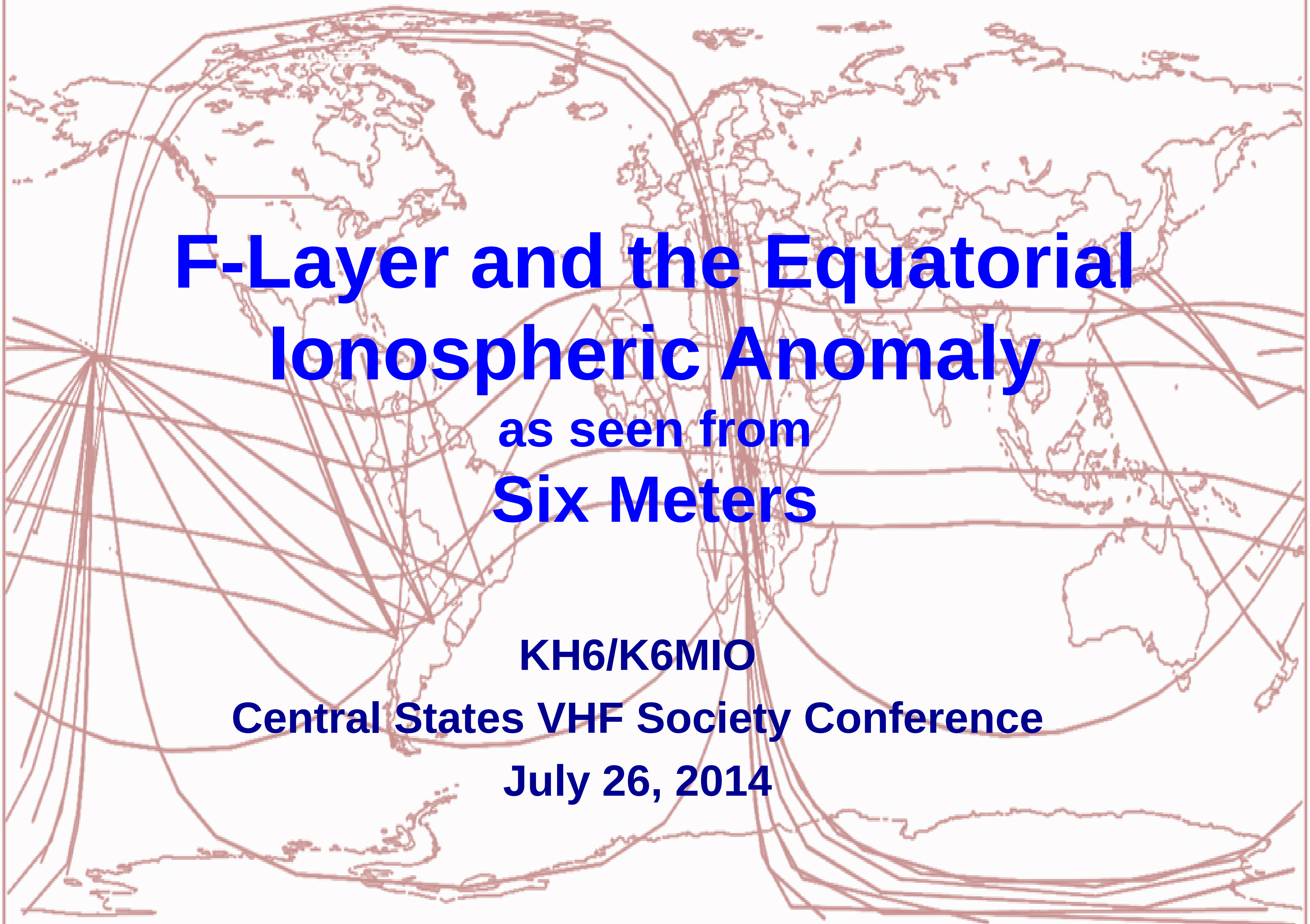
D3
D4
R37
R32
R29
R27
C21
C22


L1
R37
R32
R29
R27
C39
C34
C29
C49
U13
D7
U8
U7
C33
47
EHA.
T33
R46
R44
Q1
C40
R41
R42
FCT245A
R22
D5
C44
R43
D8
C35
C37


C65
C60
C53
U15
C54
U16
C55
U17
C56
U18
C57
R45
D6
C48
C51
C43
FB3
V3
33
6.3V
100
b0
6.3V
100
b0

Wrapping up the QSO

- SMD parts can easily be reworked with a little practice
- Entire PCB can be soldered at one time
- Safe reflow temperatures can be obtained
- The new expresso machine was in the same isle as the toaster ovens



F-Layer and the Equatorial Ionospheric Anomaly

as seen from

Six Meters

KH6/K6MIO

Central States VHF Society Conference

July 26, 2014

Overview

- Basic Propagation Review
  - Radio ray-path angles with the E and F layers
  - Geomagnetic field and the Dip Equator
- Equatorial ElectroJet (EEJ) and Two “Fountains”
  - Daytime Fountain: Pushes E and F1 electrons to F2
  - Evening Fountain: Pushes thin electron *bubbles* to F2
- Various F-region Propagation Forms
  - Perhaps, more than you might have thought (7!)

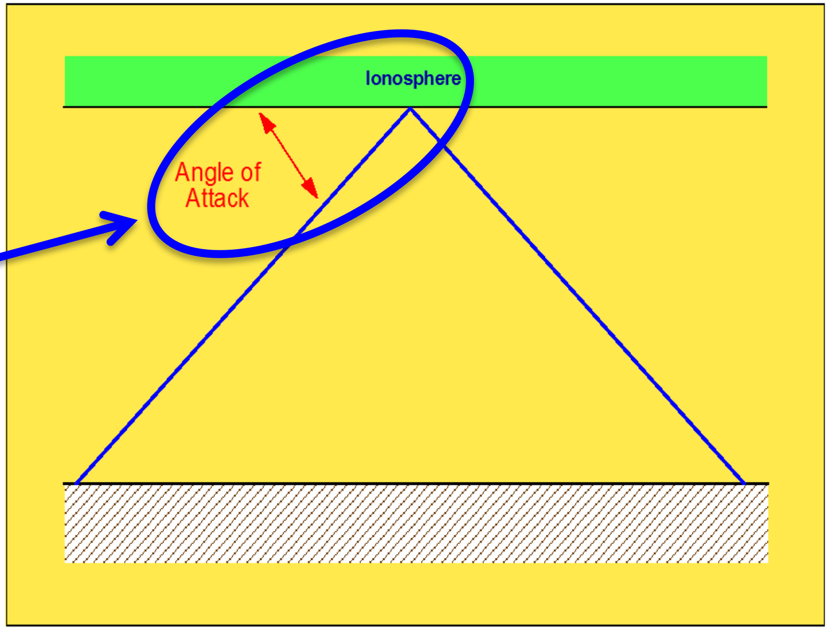
Some Propagation Physics

- "Critical frequency" f_0 is the ***vertical*** **MUF**
  - Vertical incidence ionosondes

$$f_0 = \sqrt{N_e} \times (9\times10^{-6}) \text{ MHz (mks)}$$

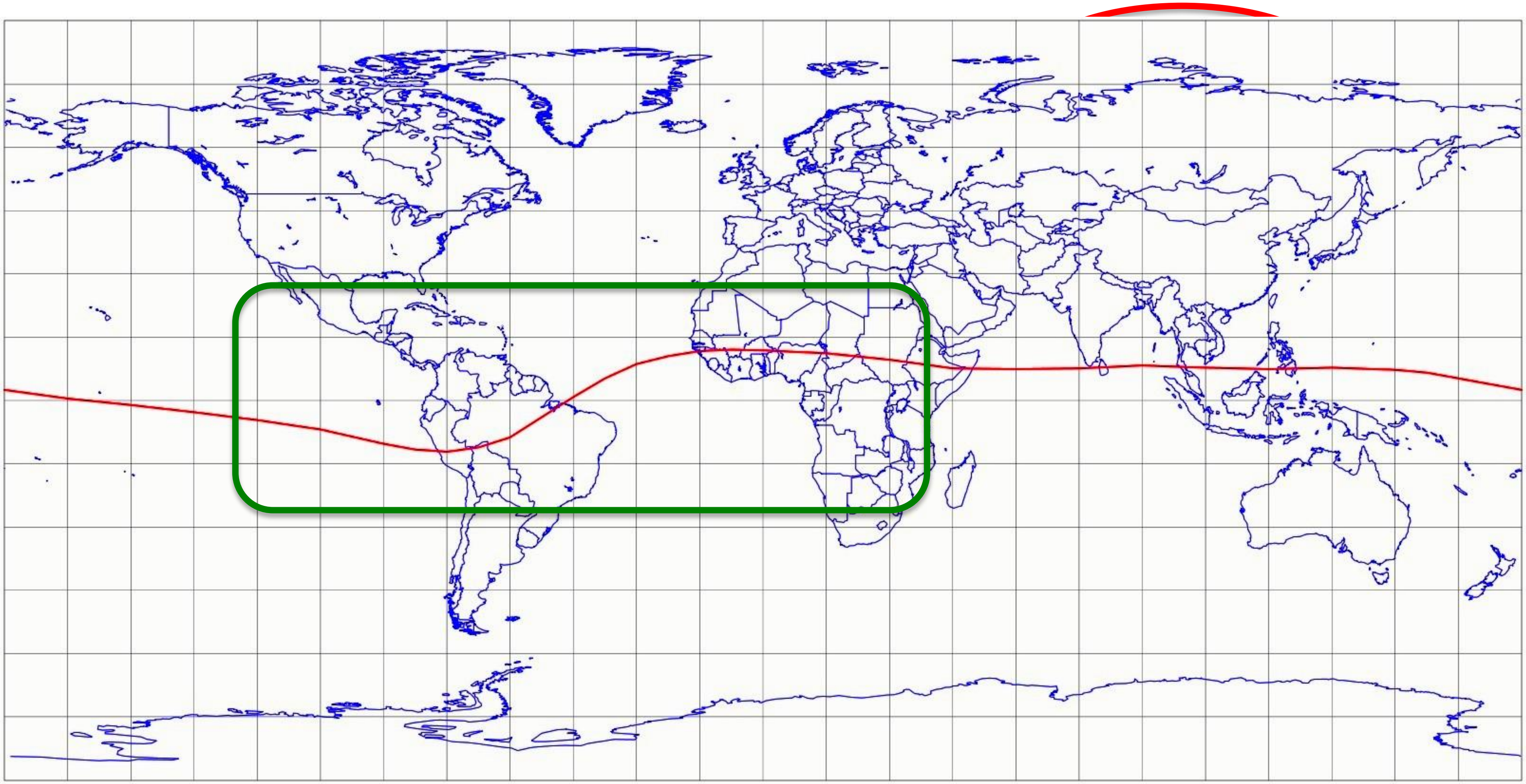
  - "Skip" MUF (oblique incidence)

$$f_{MUF} = M f_0 = \text{cosec}(\alpha) f_0$$



- α is the angle of *attack*
  - Cosec(α) is the ***M*** Factor
  - **Skip** MUF also depends on the signal-path ***geometry***
  - ***Smaller*** α = ***Higher*** MUF, with ***same*** electron density

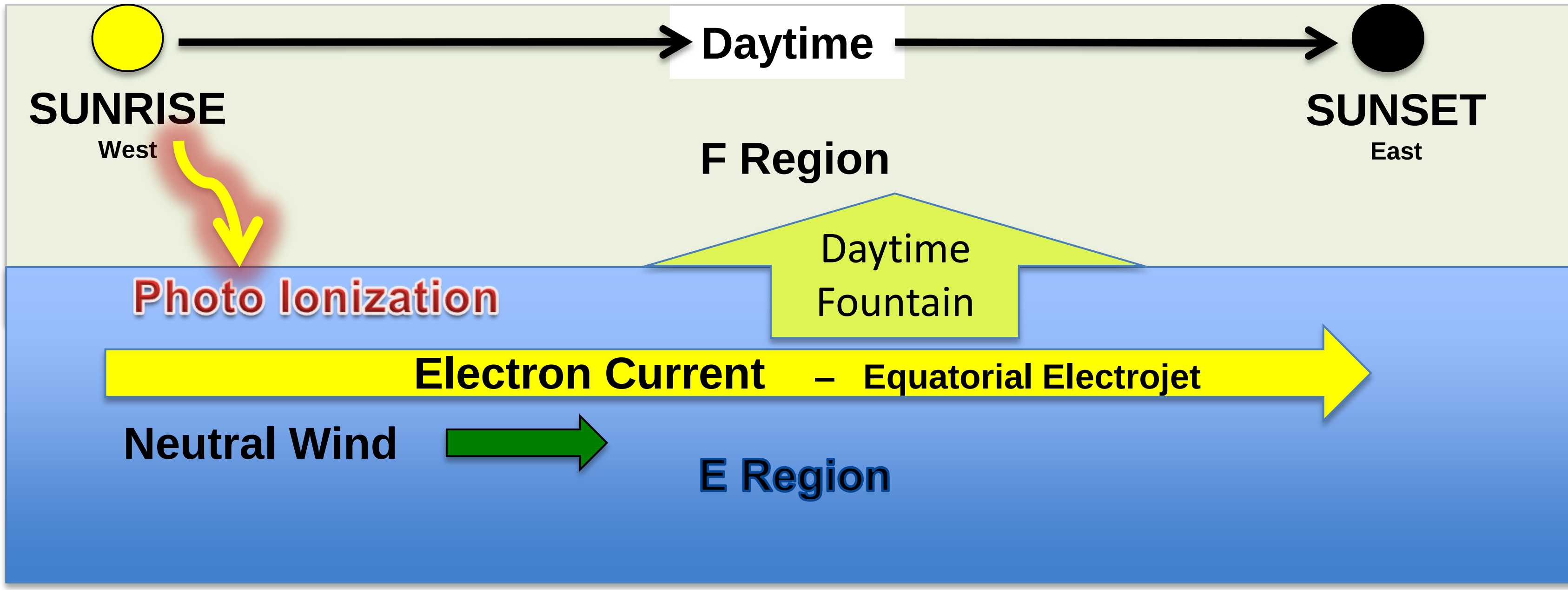
Geomagnetic Field



- Over the Magnetic Dip Equator:
  - ***All*** field lines are ***parallel*** to the ***Earth's Surface***

Daytime E and F Layers

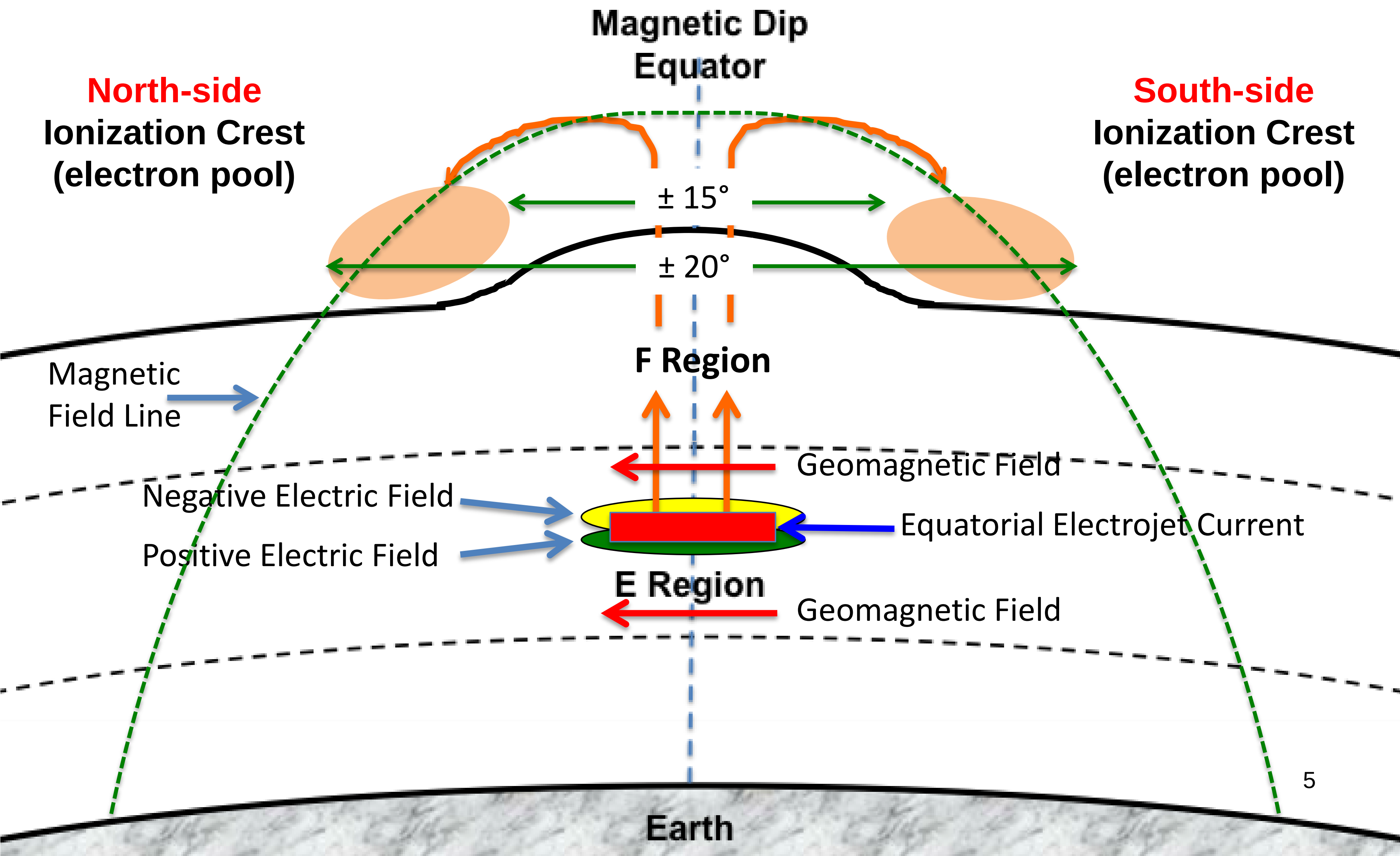
Along the *Dip Equator*



- Daytime sun comes up and solar radiation creates:
  - Ionization in the E, F1, and F2 layers, *and*
  - Heating => **Neutral** wind drags E-layer electrons eastward
  - Creates intense *current* ribbon along the dip equator
  - With the magnetic field causes the ***Daytime Fountain***

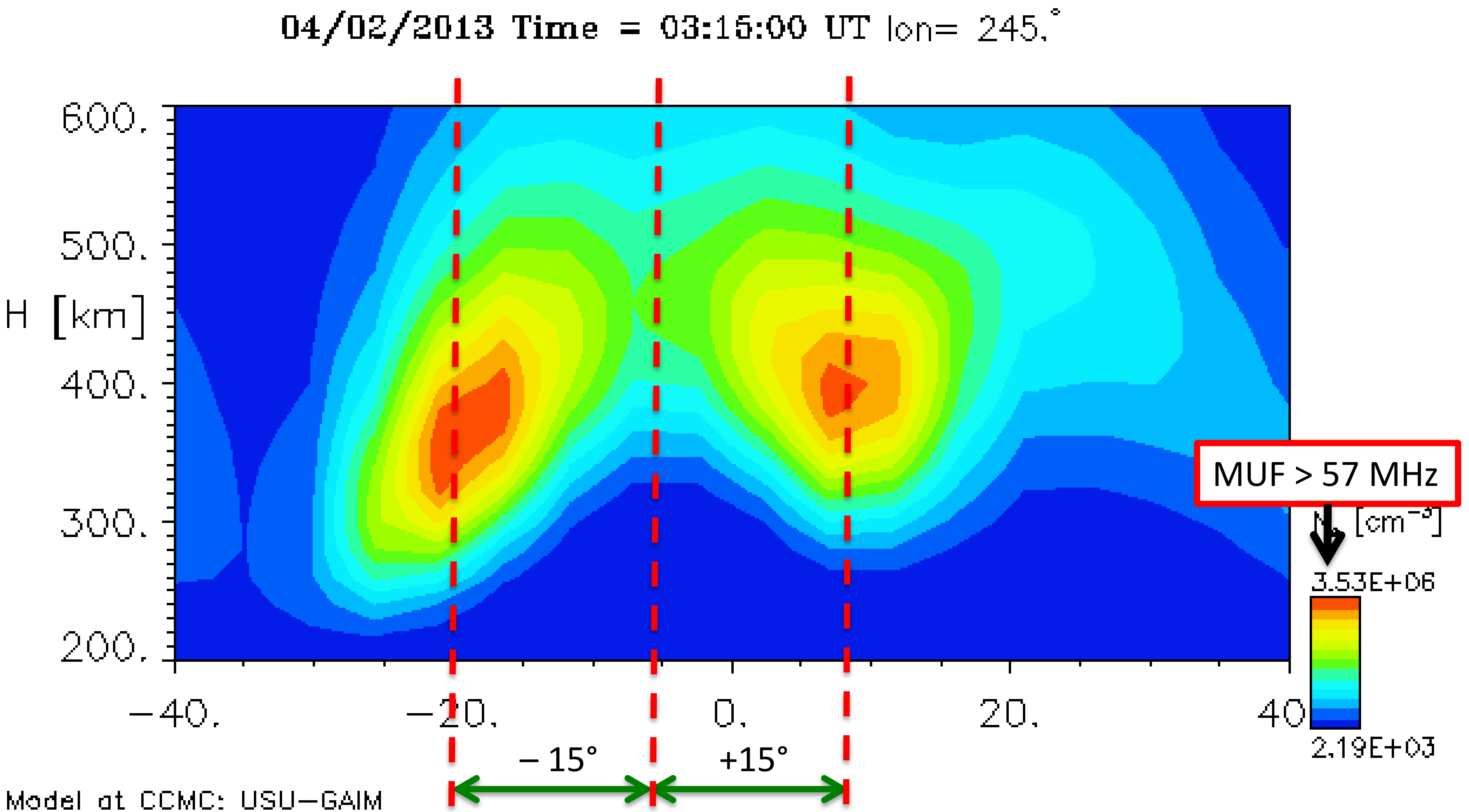
Daytime Fountain Effect

Looking Eastward Straight Down the Electrojet



USU-GAIM Model Electron Density

Peak MUF > 57 MHz

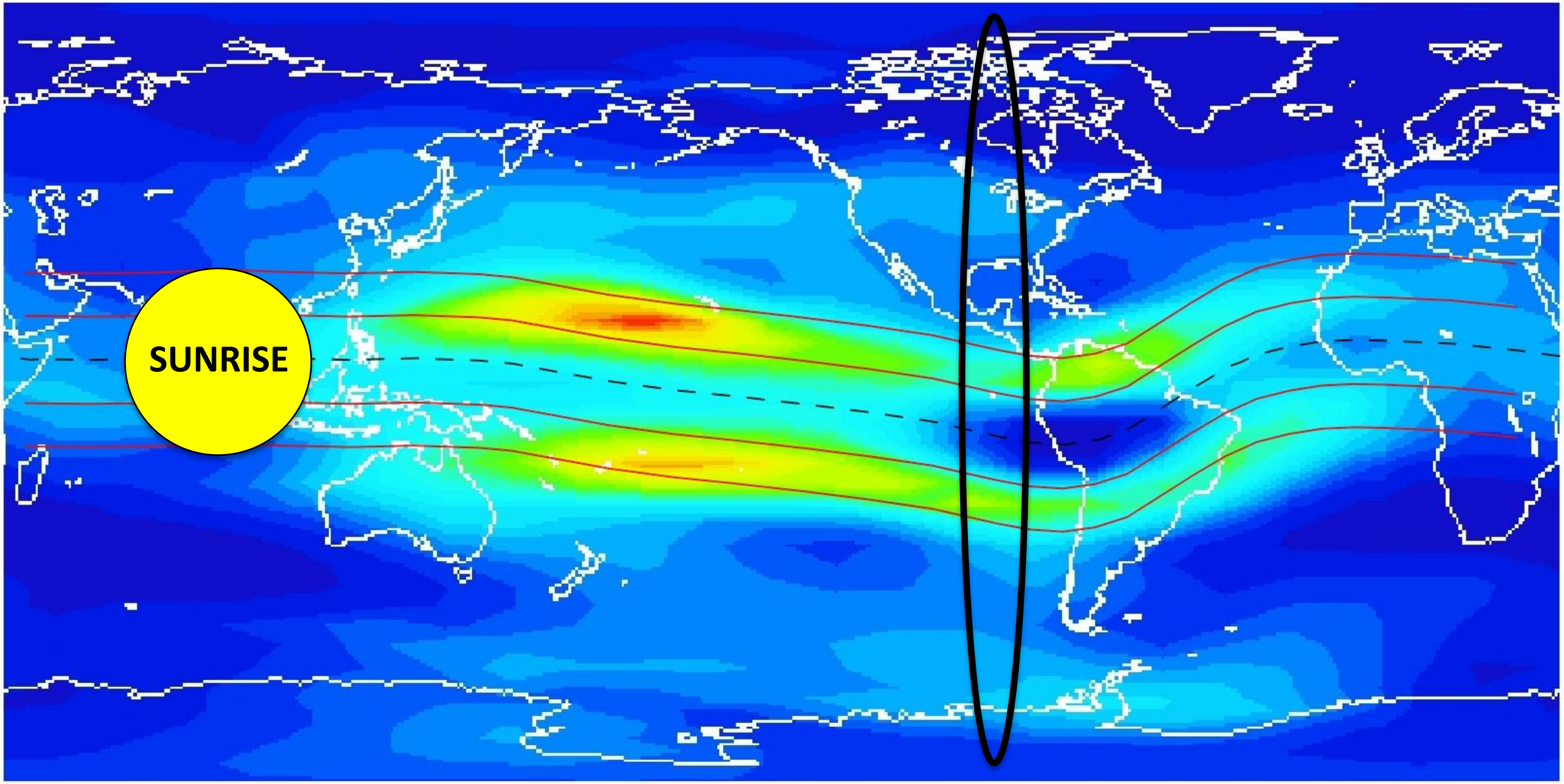


Sun "Pulls" Ionization Crests Westward

Along the North and South Ionization Lanes

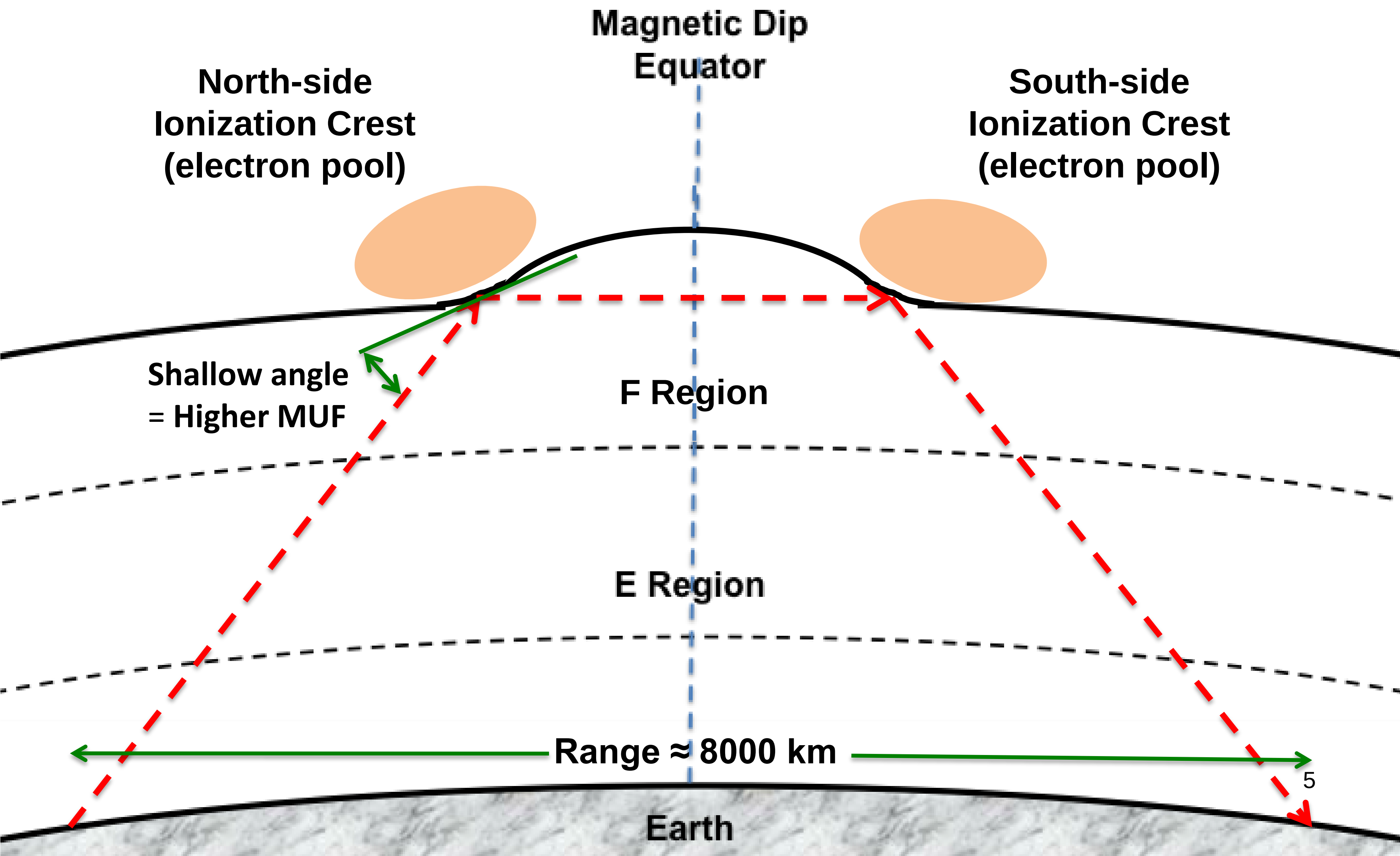
It takes a few hours to build up the ionization

So, what *can* happen in the afternoon?



USU-GAIM ionization model courtesy of GAIM Team Utah State University

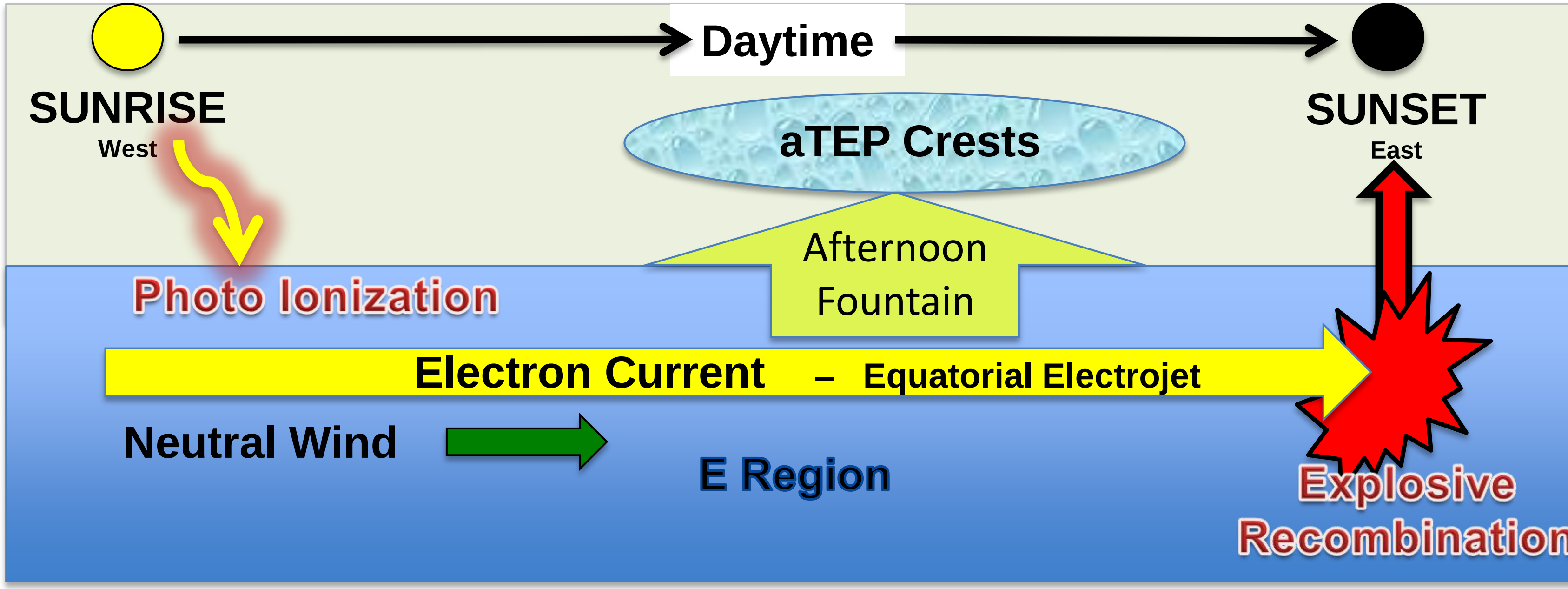
Daytime Fountain
Afternoon TEP (aTEP)



aTEP Basic Characteristics

- Seasons: Spring and Fall ***Equinoxes***
  - – Need equal ionization of both north and south crests
    - Sun is near the Dip Equator
- Crest Locations: ~ 17° north and 17 south (mag)
- Best Station Location: ≤ 2200 km of nearest crest
  - – Looking *toward* the dip equator
- Best Times of Day: ≈ 1200 – 1700 LST

What About Sunset?



- Daytime Sun creates:
  - Ionization, wind, electrojet, and the afternoon fountain crests
- BUT, when the Sun stops: Raging current hits brick wall
  - ***Explosive Recombination*** at the sunset terminator
  - Huge upward shockwaves – Pre Reversal Enhancement (PRE)
  - Evening Bubble Fountain

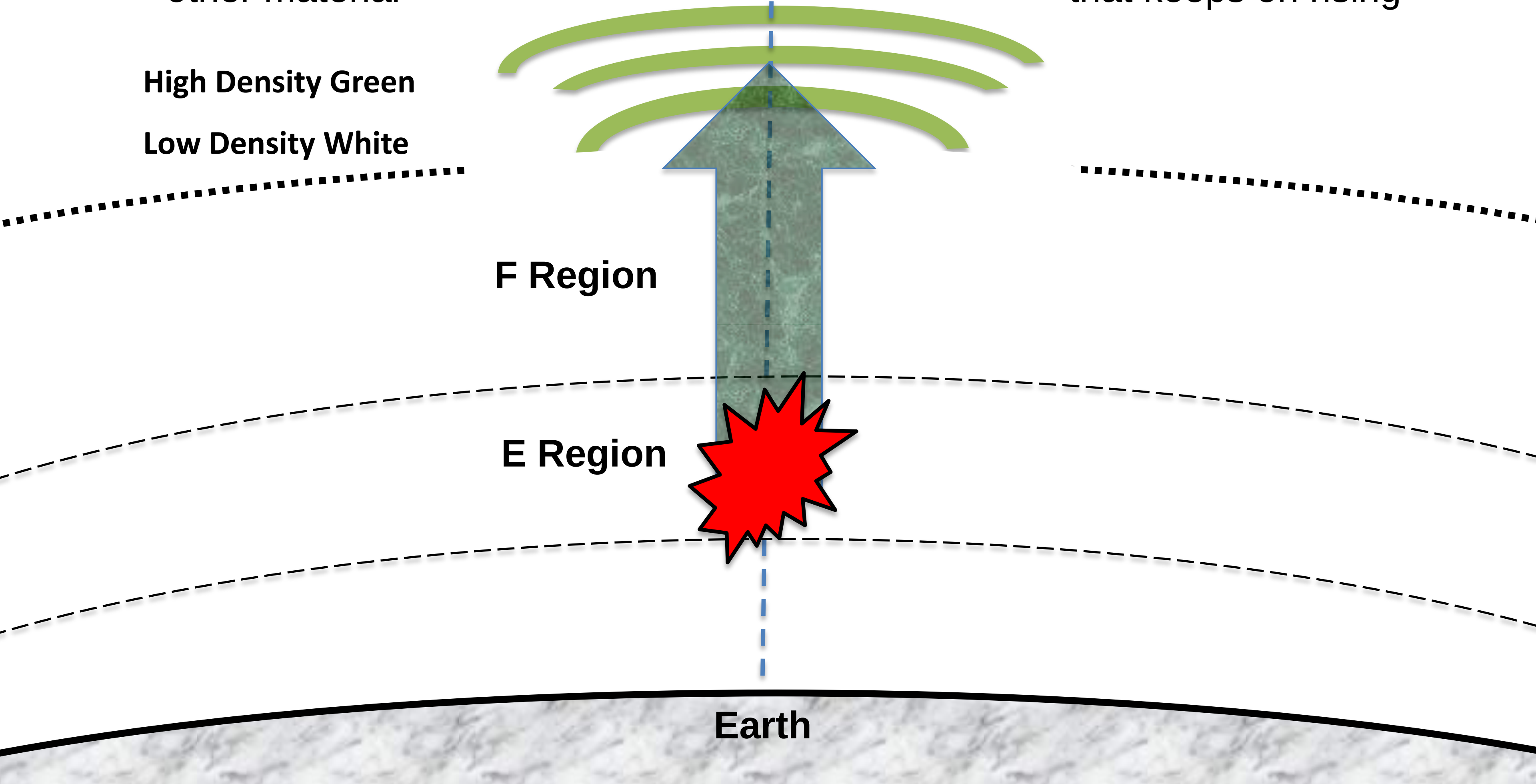
Evening *Bubble* Fountain

Shock-Induced Gravity Waves

Daytime Fountain
Column starts full of electrons, ions, and other material

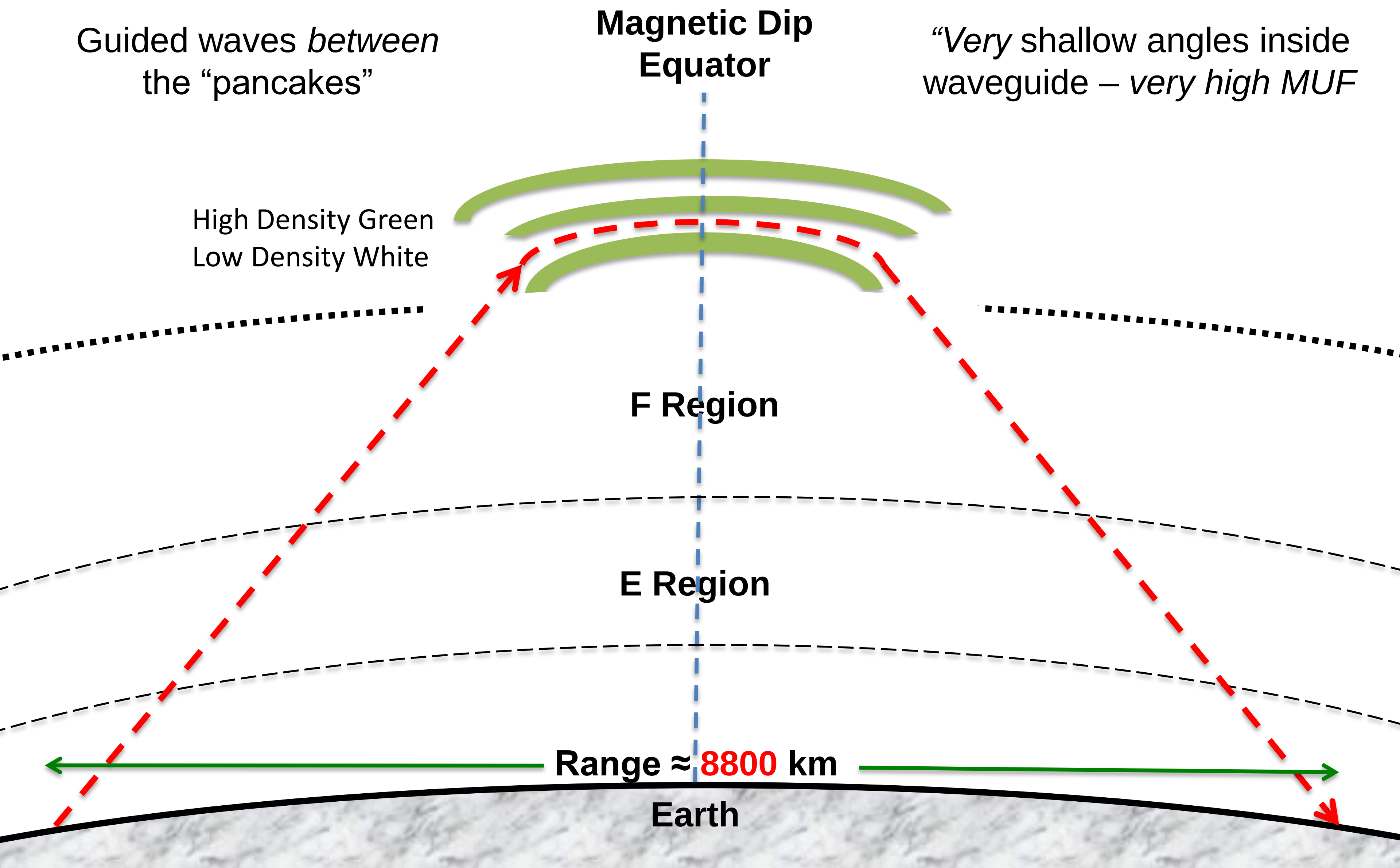
Magnetic Dip Equator

Shock waves break up column into a stream of “Bubbles” that keeps on rising



Bubble Fountain

Evening *TEP (eTEP)*



eTEP Basic Characteristics

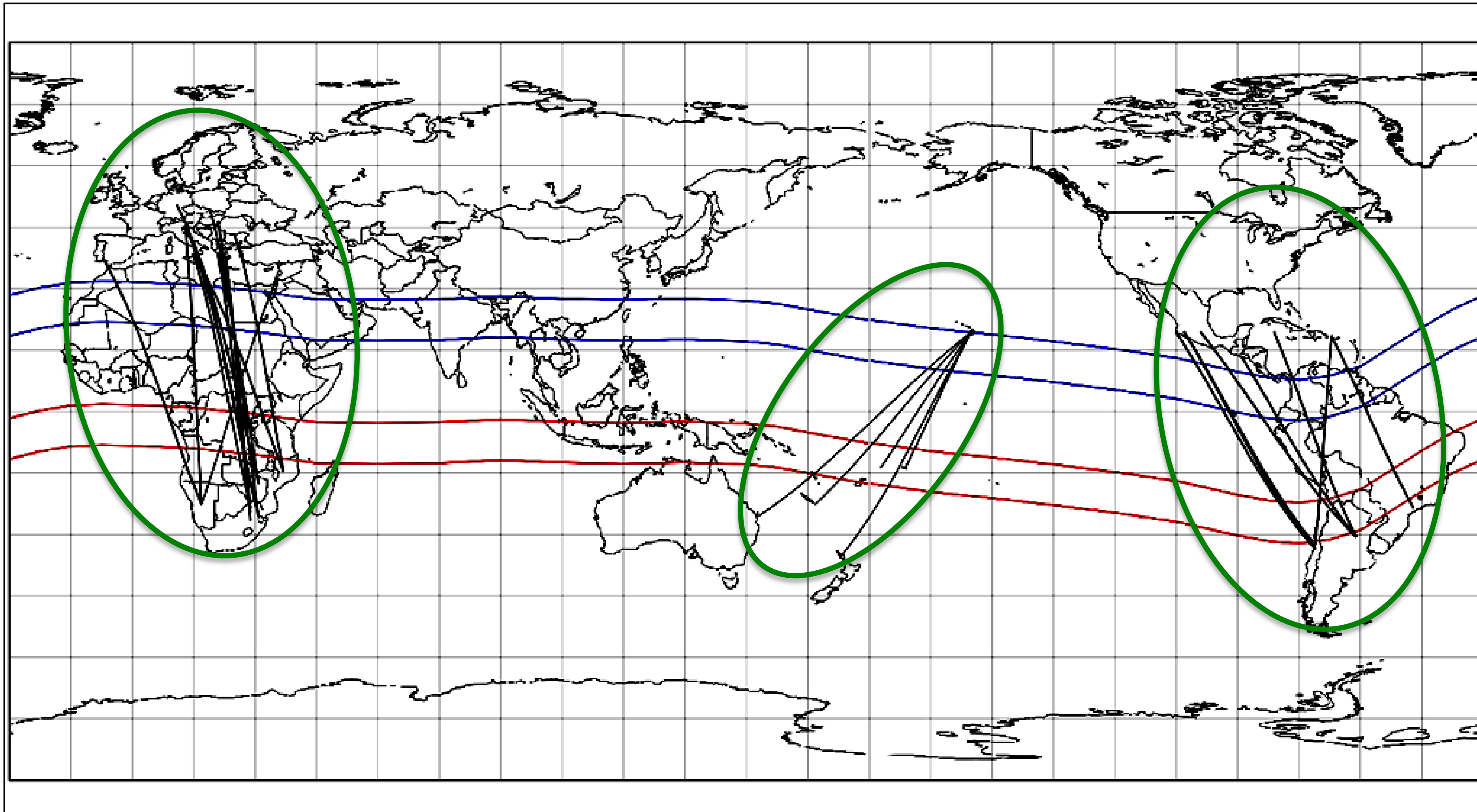
- Seasons: Spring and Fall ***Equinoxes***
  - Need equal ionization of both north and south lanes
    - Sun is near the Dip Equator
- Best Station Location: ≤ 2200 km of nearest lane
  - Looking *toward* the dip equator
- Best Times of Day: ≈ 1900 – 0000 LST
- Ranges out to about 8800 km
- ***Low Obliquity*** (more north-south than east-west)

Many Flavors of *Equatorial Anomaly* F-Region Propagation

- Afternoon TEP (aTEP)
  - More or less North-South
- Evening TEP (eTEP)
  - More or less North-South
- *Very* Oblique TEP
  - North-South with Lots of East-West
- Single Lane F2
  - Not Transequatorial at all!!
- Skewed Paths (Not Great Circle)
  - Two Great Circles are better than one?
- TransPolar Long-path (TPL)
  - Transequatorial double time
- Es Link to TEP
  - More inclusive

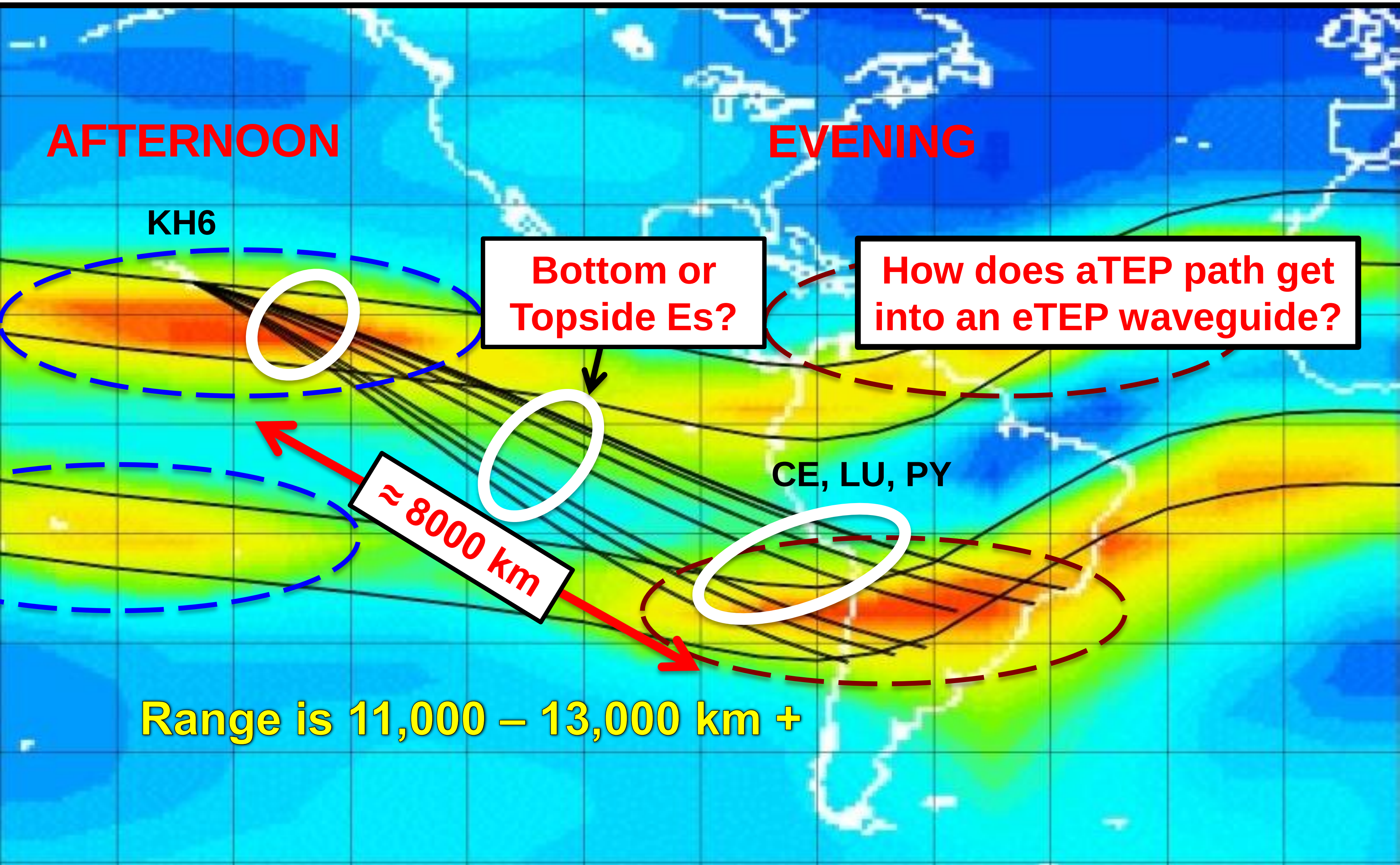
North-South TEP

Both aTEP and eTEP (But, Different Times of Day)



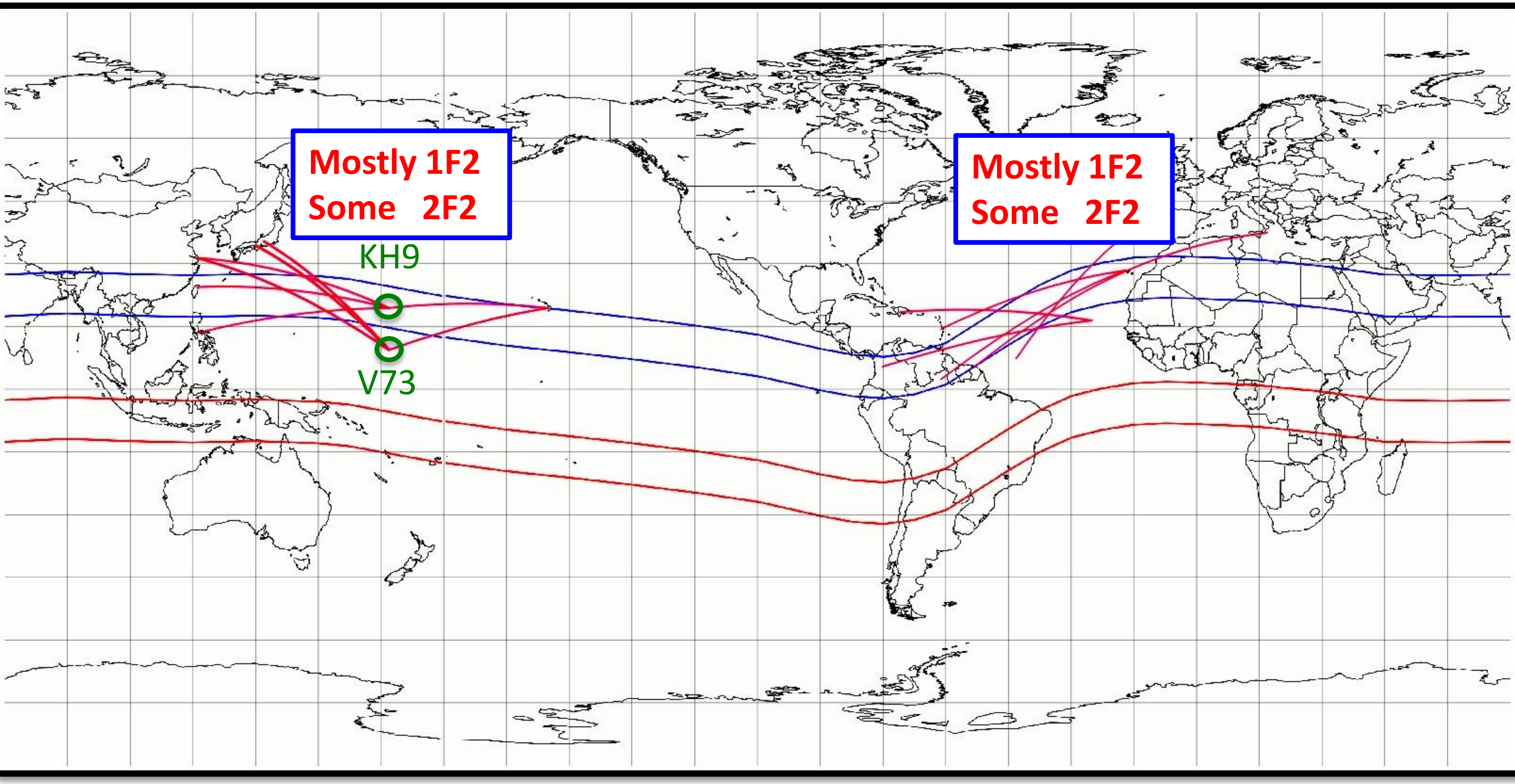
Very Oblique TEP

A *Common* Path, but Hard to Explain



Single-Lane Equatorial F2

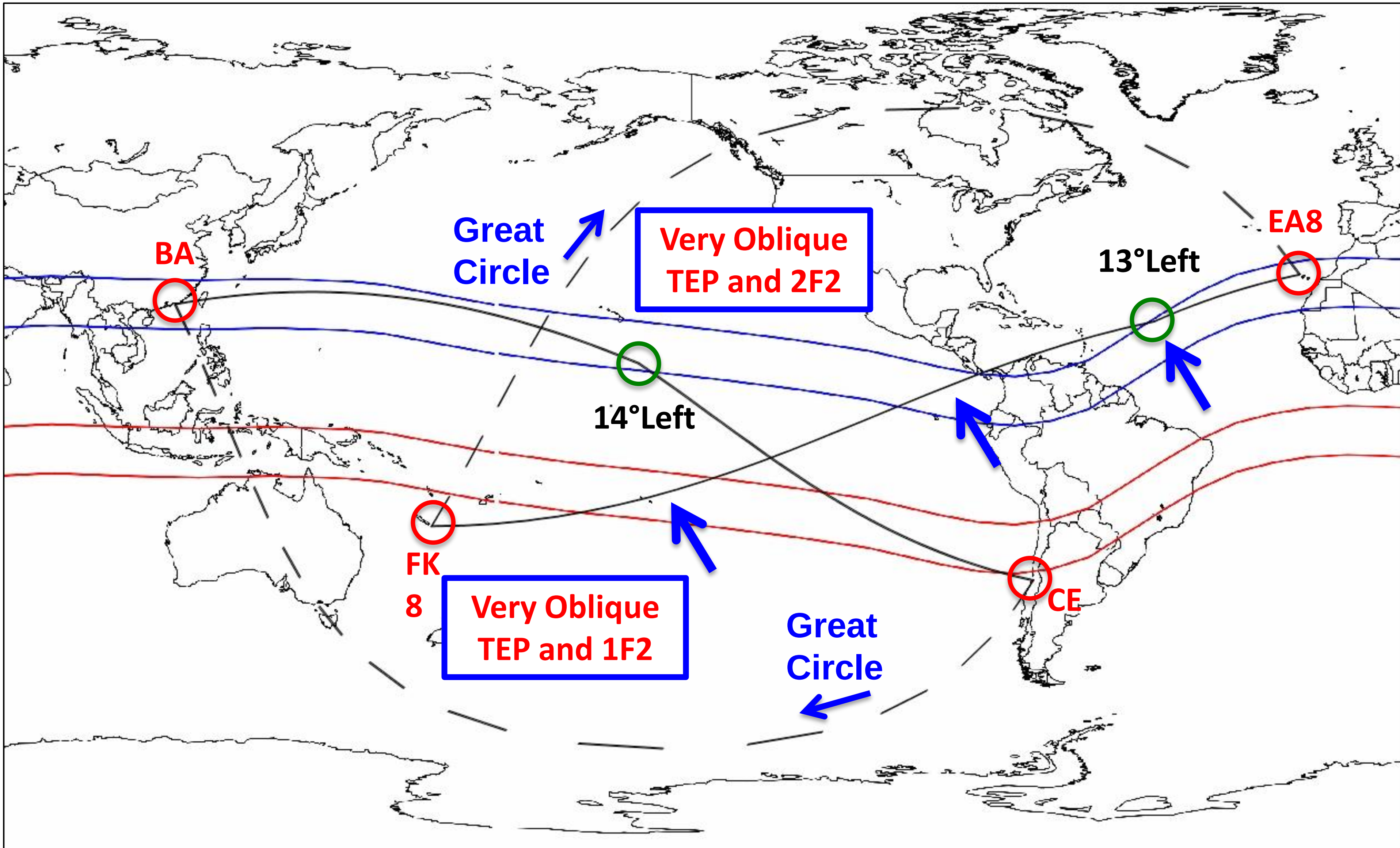
Propagation *Along*, and *Across, One Lane Only*



Skew Paths

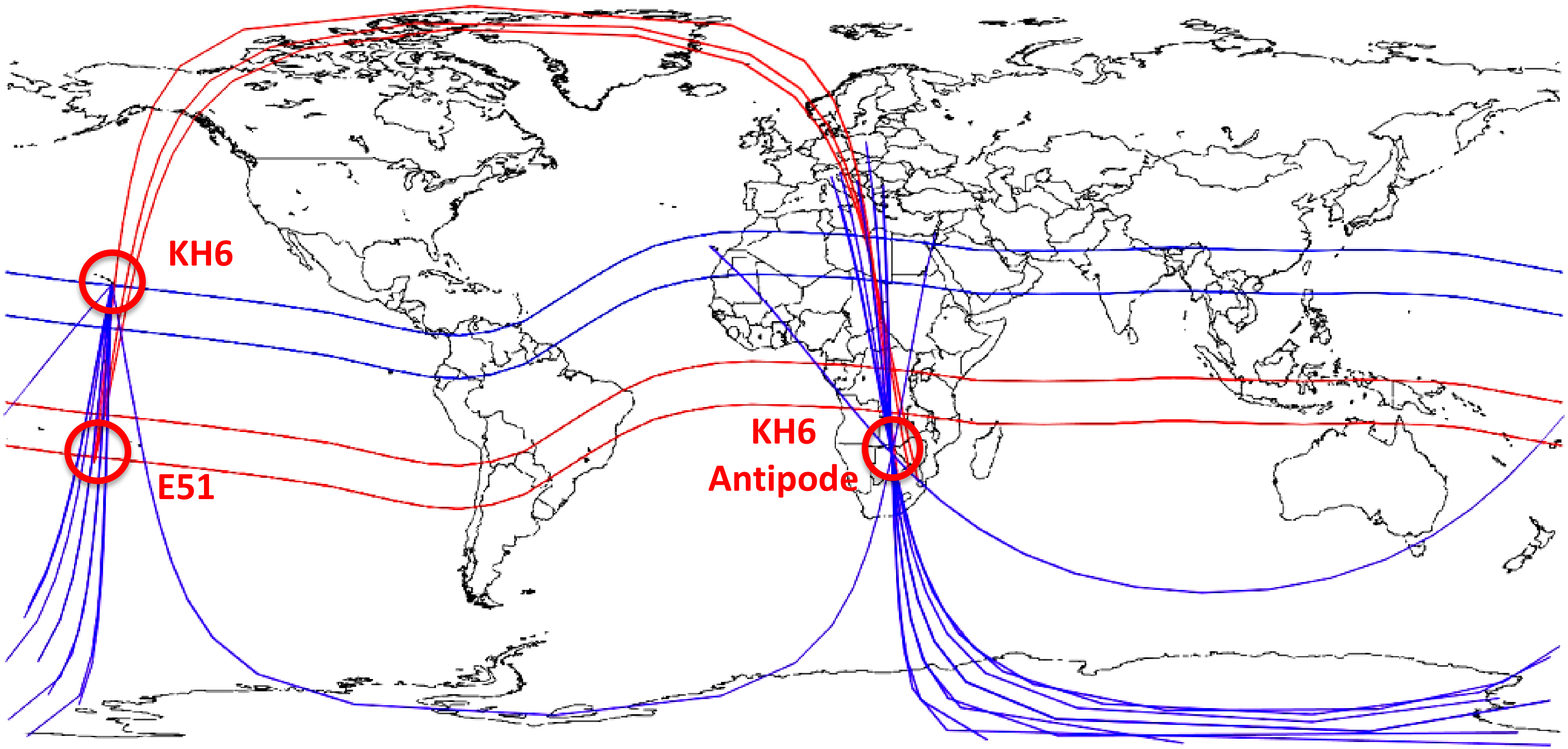
Are Two Great Circles Better Than One?

A *Little* Bend Makes *Big* Difference

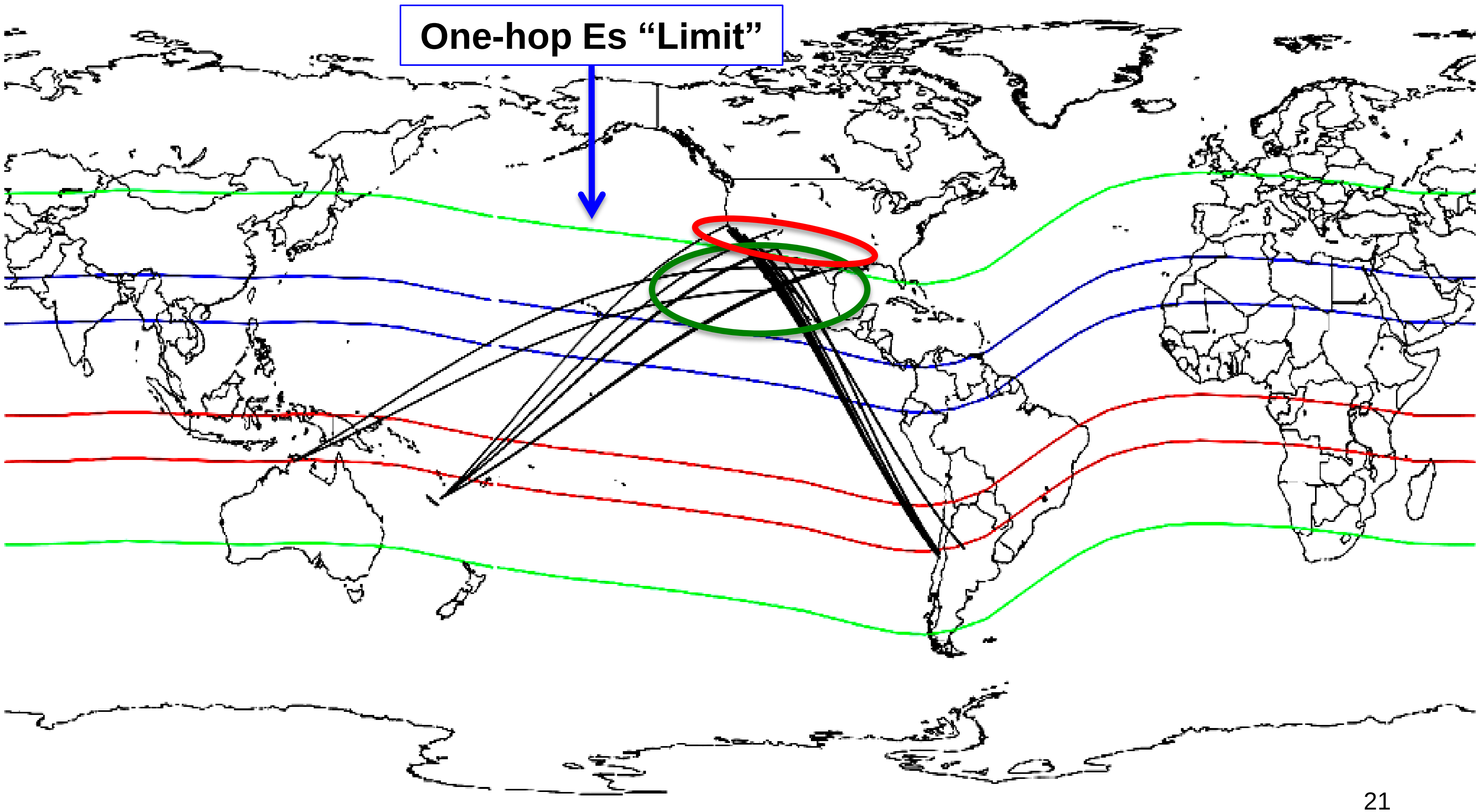


TransPolar Long-path KH6 and E51

2200-0130 East End to 0900-1100 West End

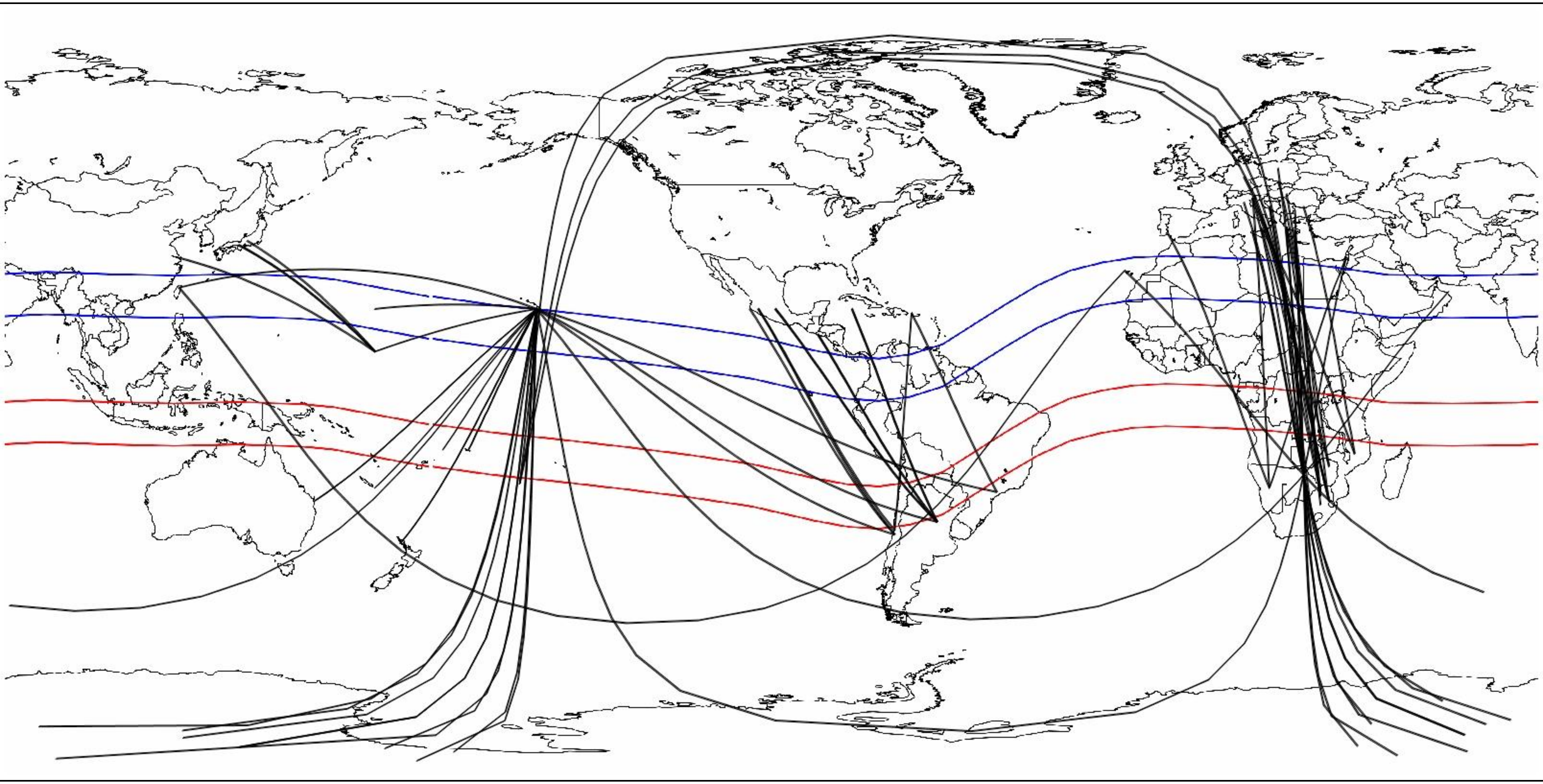


Sporadic E *Links* to TEP



So, If Cycle 25 is Really a Bust...

15-m May Still Be Up and Running, Six-Meter Style



We'll See...

BTW, the Daytime Fountain ALSO is a *very major player* in Midlatitude Es.

Maybe we'll talk about that next year.

Mahalo
and
Good DX

Acknowledgments

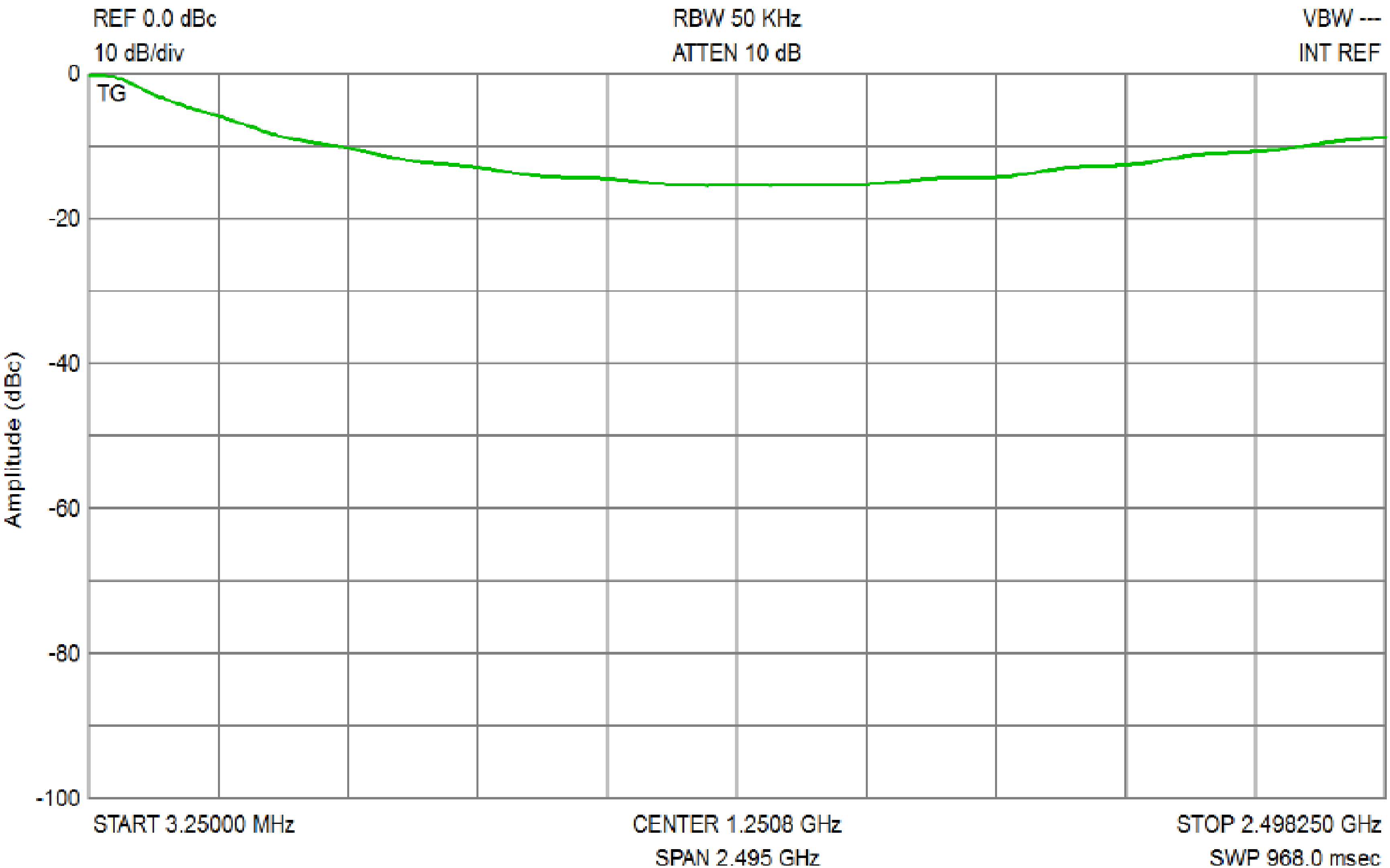
- **Gabriel Sampol, EA6VQ**, for his dxmaps.com database.
- **Javi Gaggero, LU5FF**, **Haroldo “DJ” Bradaschia, PY7DJ**, **Remi Touzard, FK8CP**, and **Jon Jones, N0JK**, for their propagation observations, and **Linda Kennedy, WH6ECQ**, who is a killer proofreader.
- **Robert B. Schmunk**, NASA Goddard Institute for Space Studies, for writing and supporting the **G.Projector** mapping program.
- The **USU-GAIM team** and the **NASA Goddard Community Co-ordinated Modeling Center group** for their valuable and gracious assistance.
  - The USU-GAIM Model was developed and made available by the GAIM team **(R.W. Schunk, L. Scherliess, J.J. Sojka, D.C. Thompson, L. Zhu**) at Utah State University.
  - The Community Coordinated Modeling Center group at the NASA Goddard Space Flight Center ran the computer models for the selected dates and times.

How to make use of that expensive analyzer you just bought

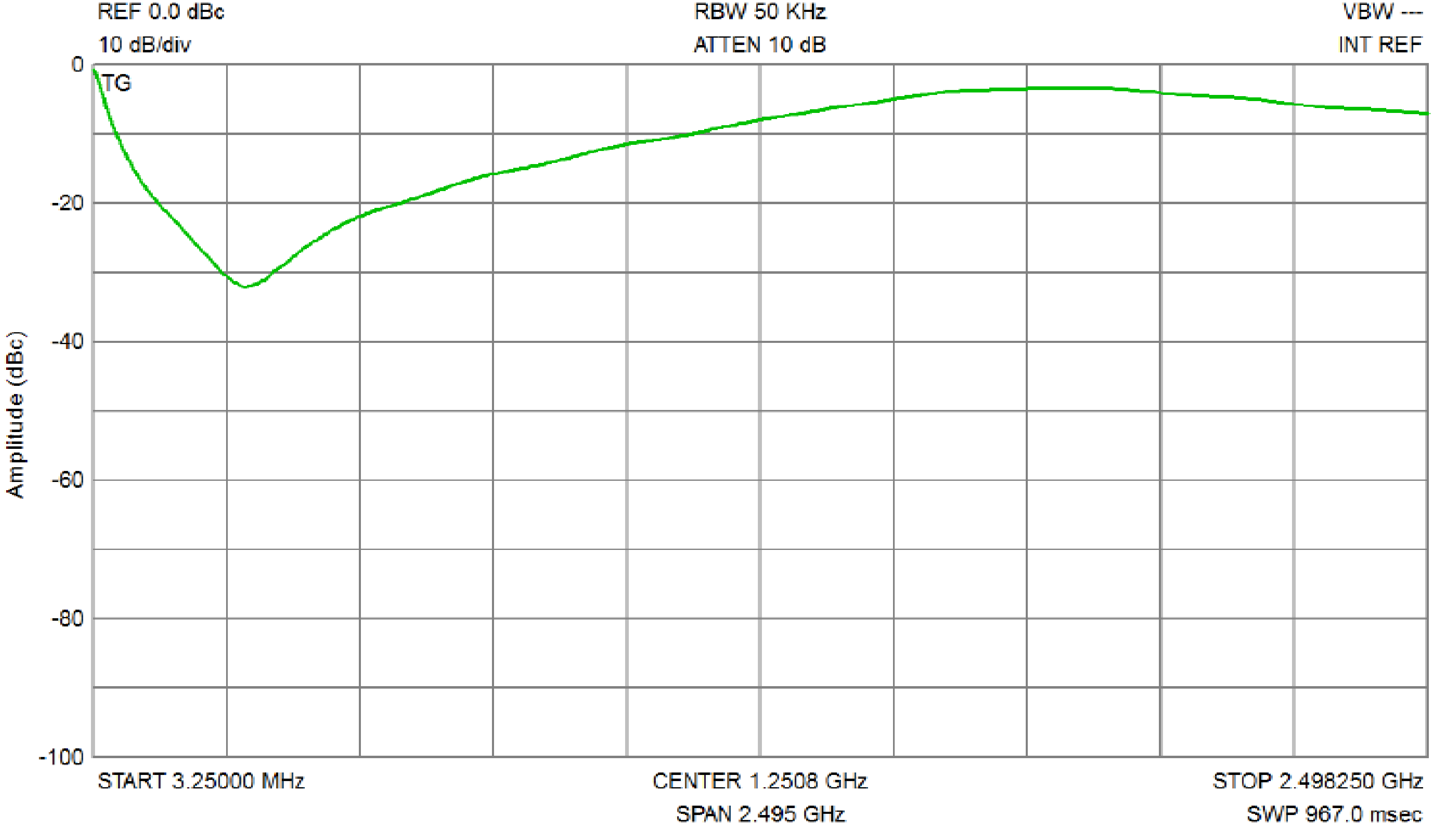
Jim Klitzing - W6PQL

Effective RF Suppressors

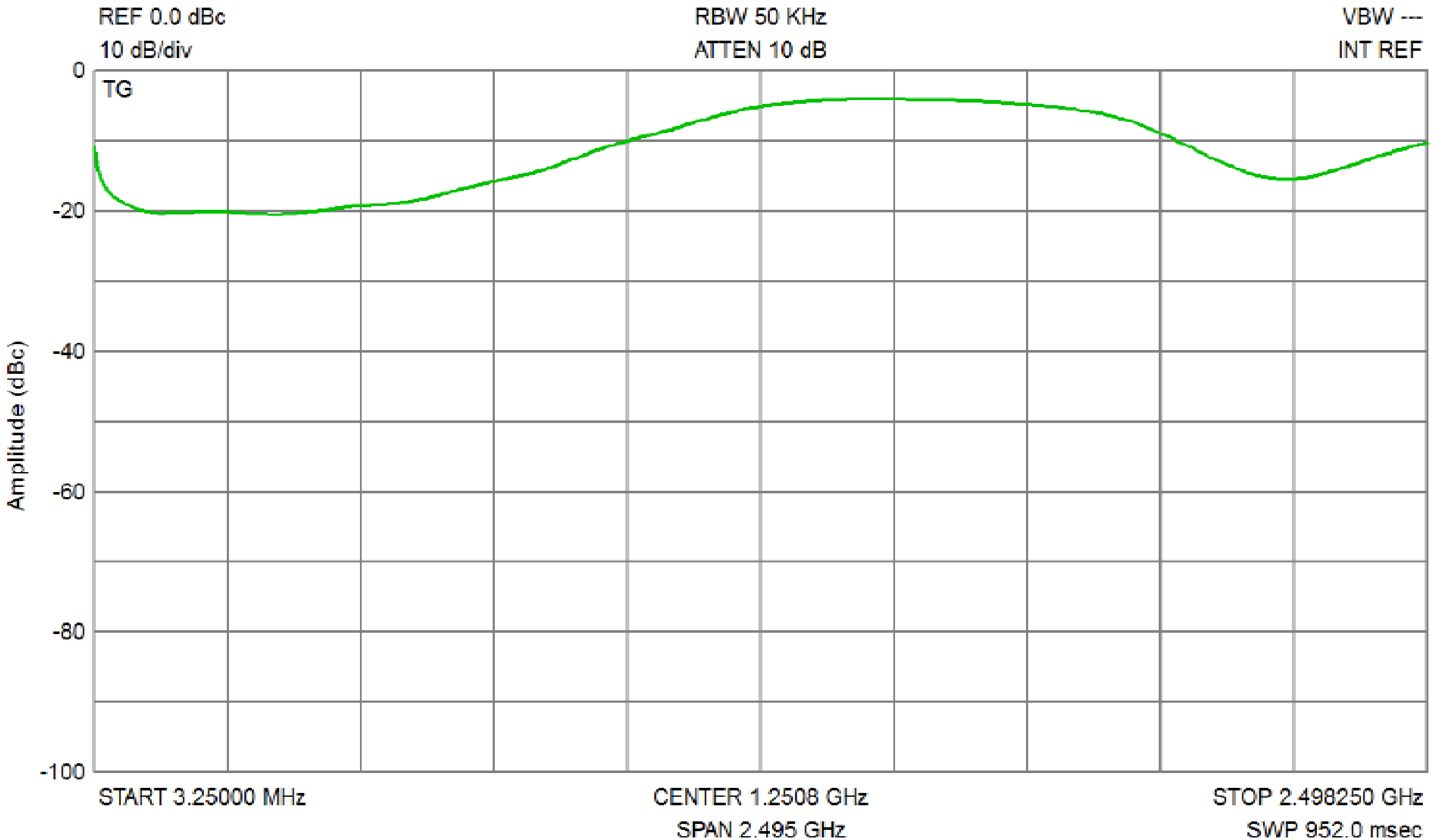
100nh moulded inductor



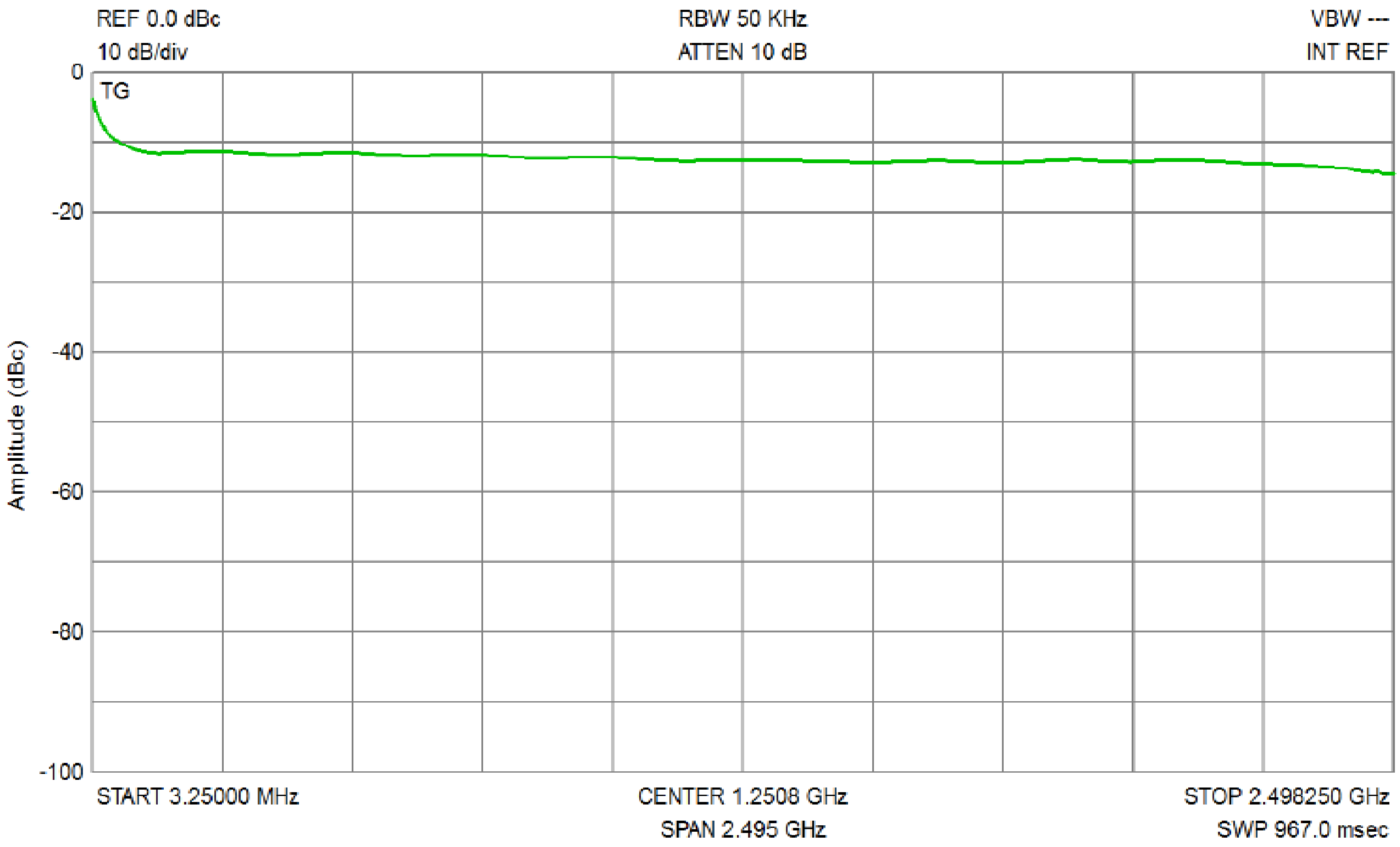
1 uh moulded inductor



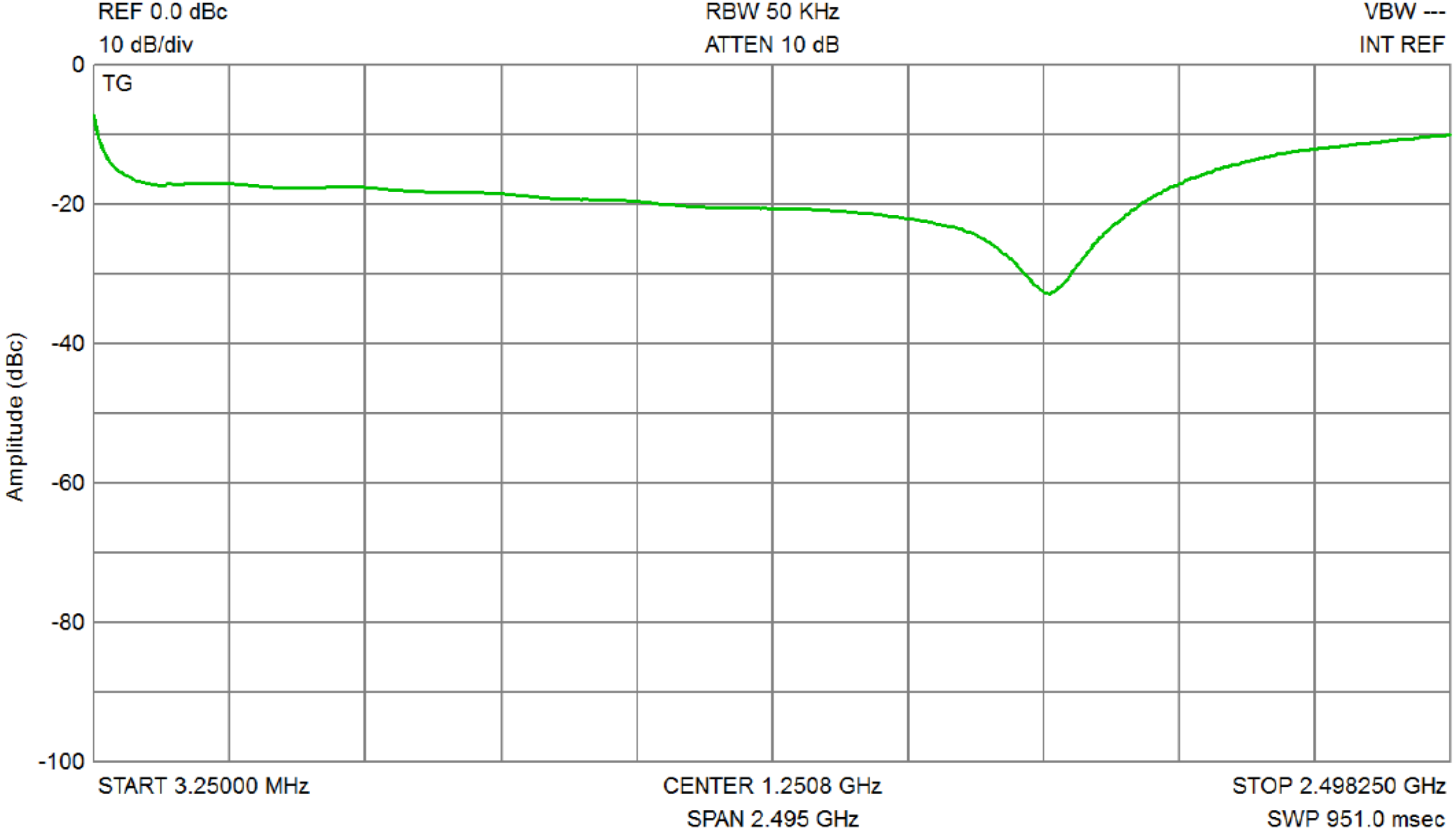
43 Material Ferrite bead 2643250402 (3 turns)



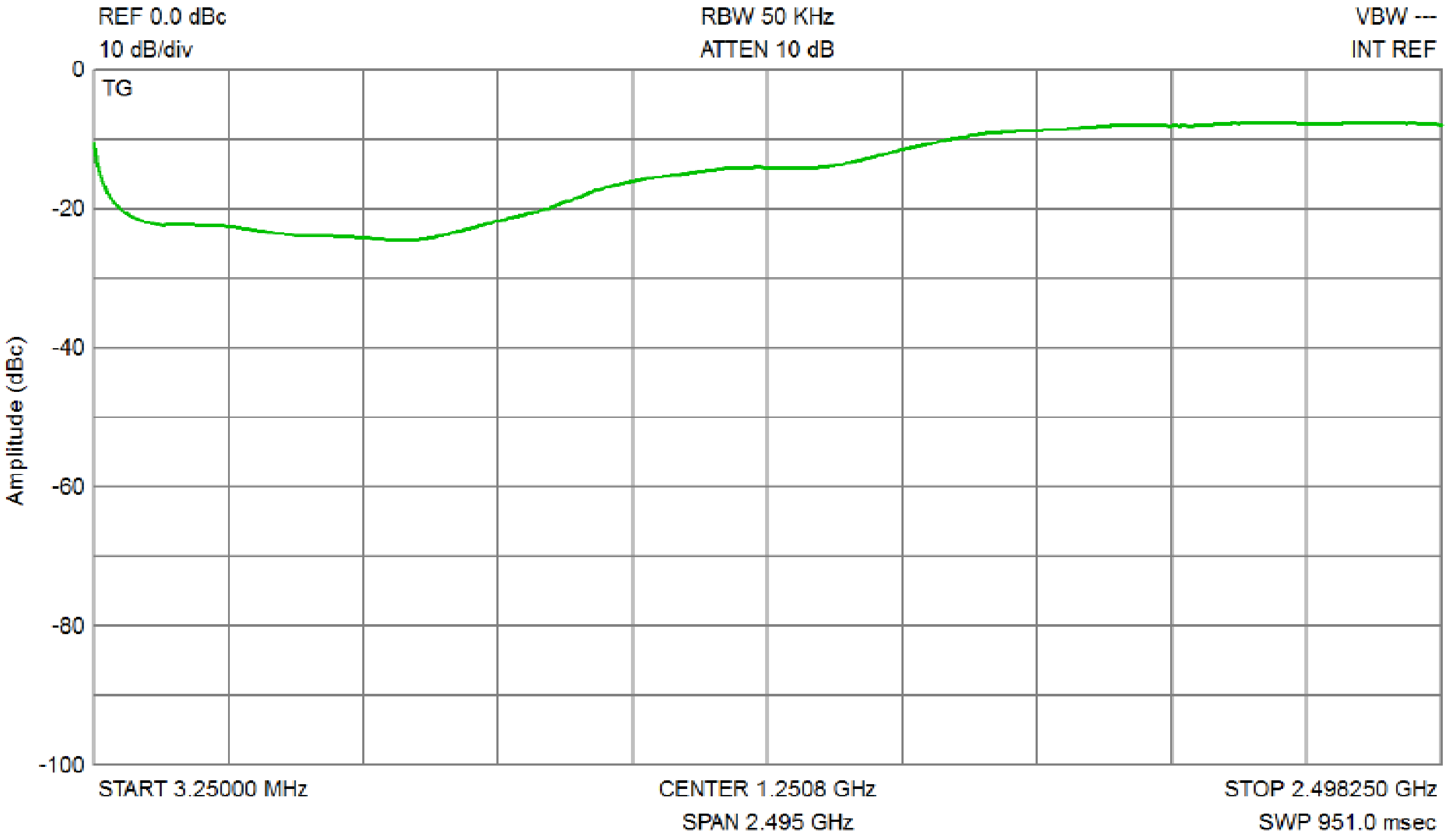
Laird Ferrite Core 28b0375000 (2 turns)



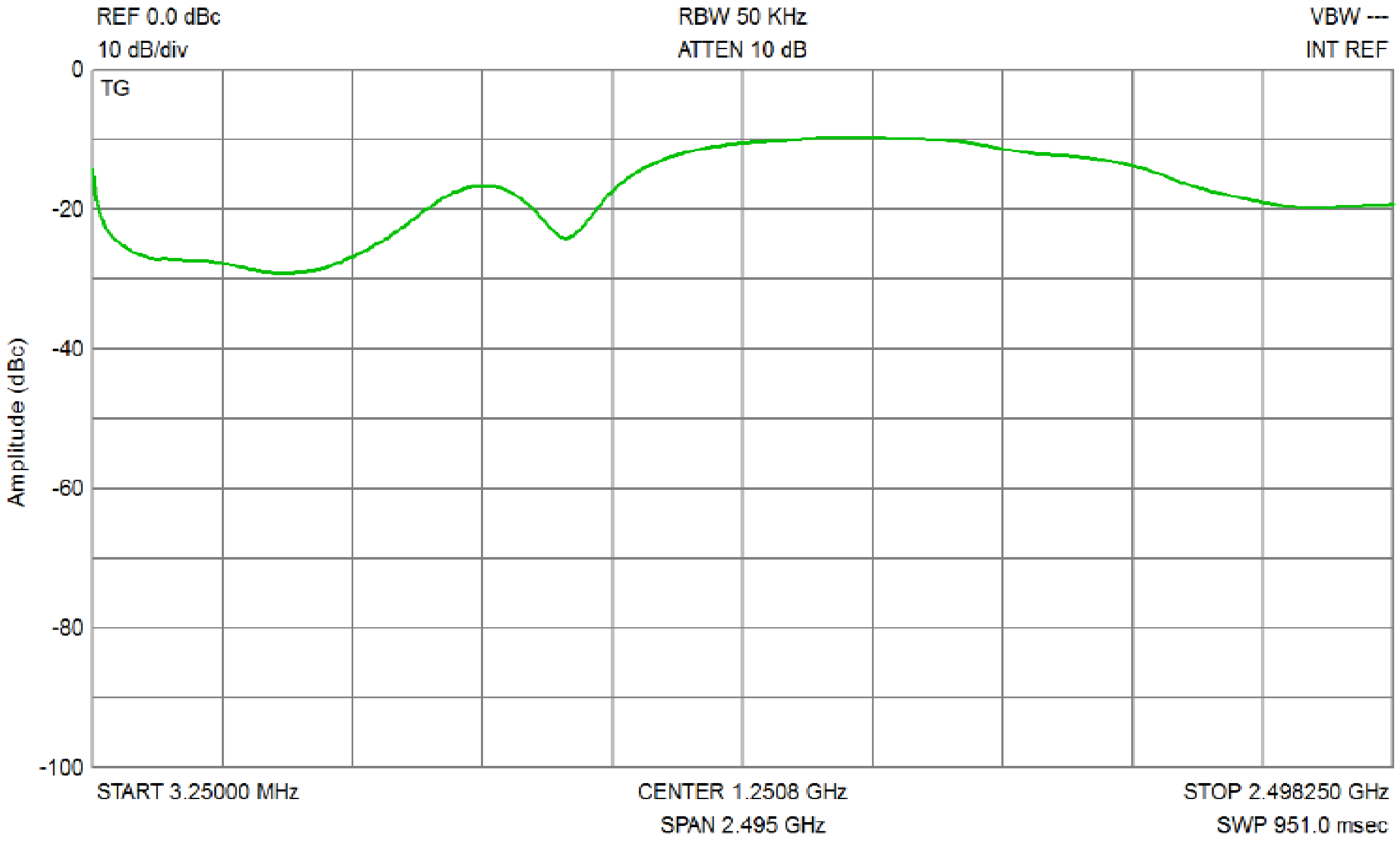
Laird Ferrite Core 28b0375000 (3 turns)



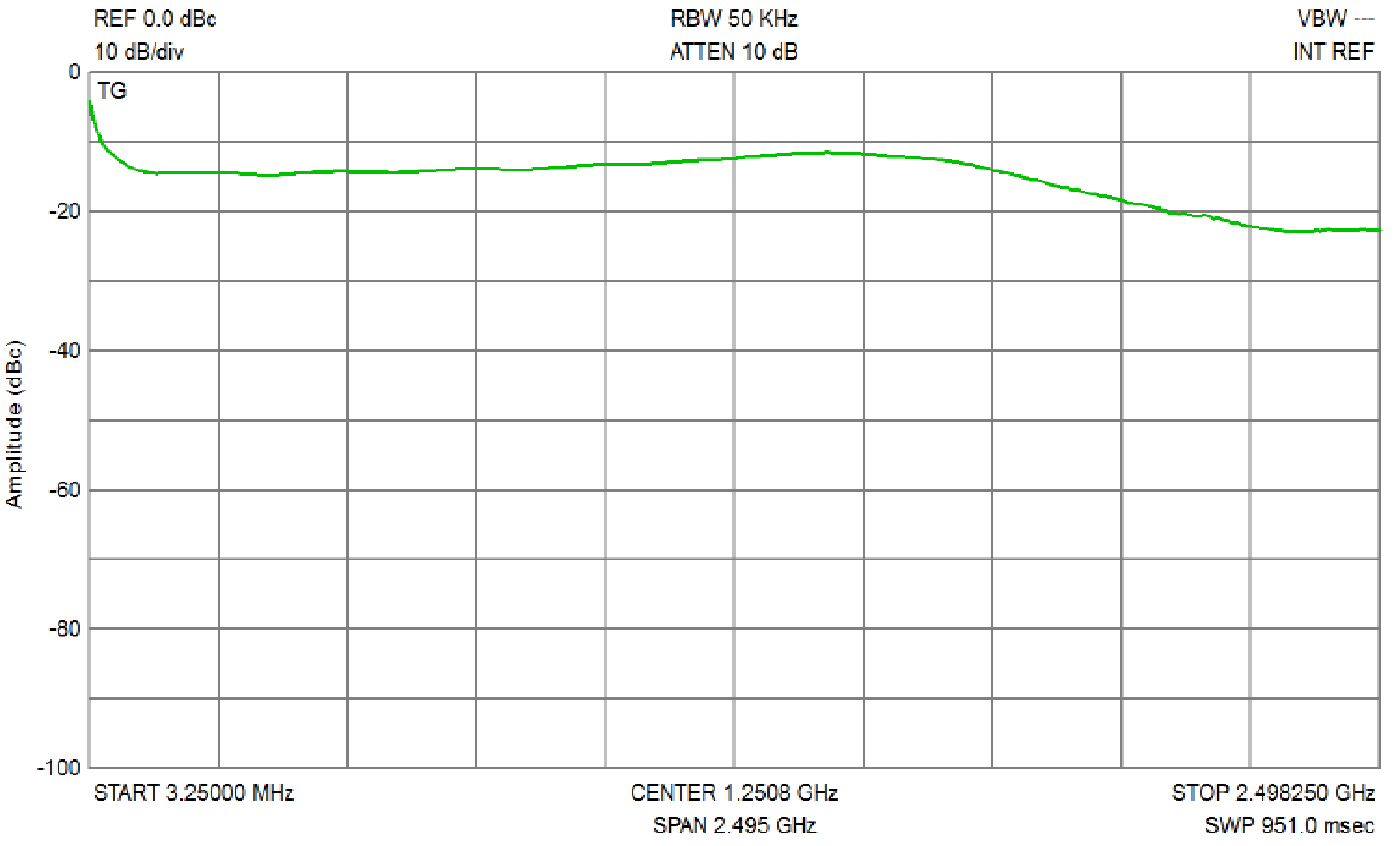
Laird Ferrite Core 28b0375000 (4 turns)



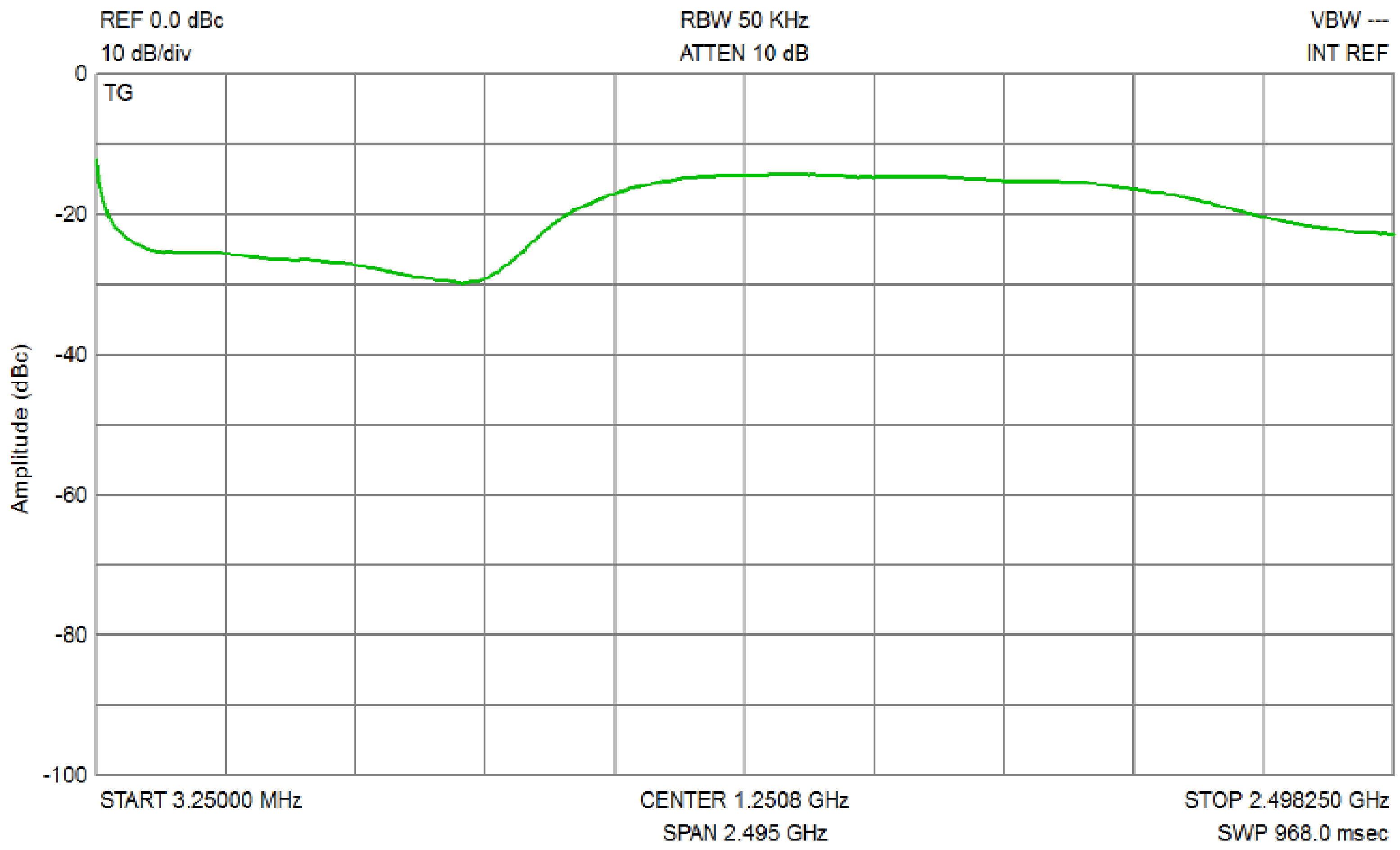
Laird Ferrite Core 28b0375-300 (4 turns)



Laird Ferrite Core 28b0562-100 (2 turns)



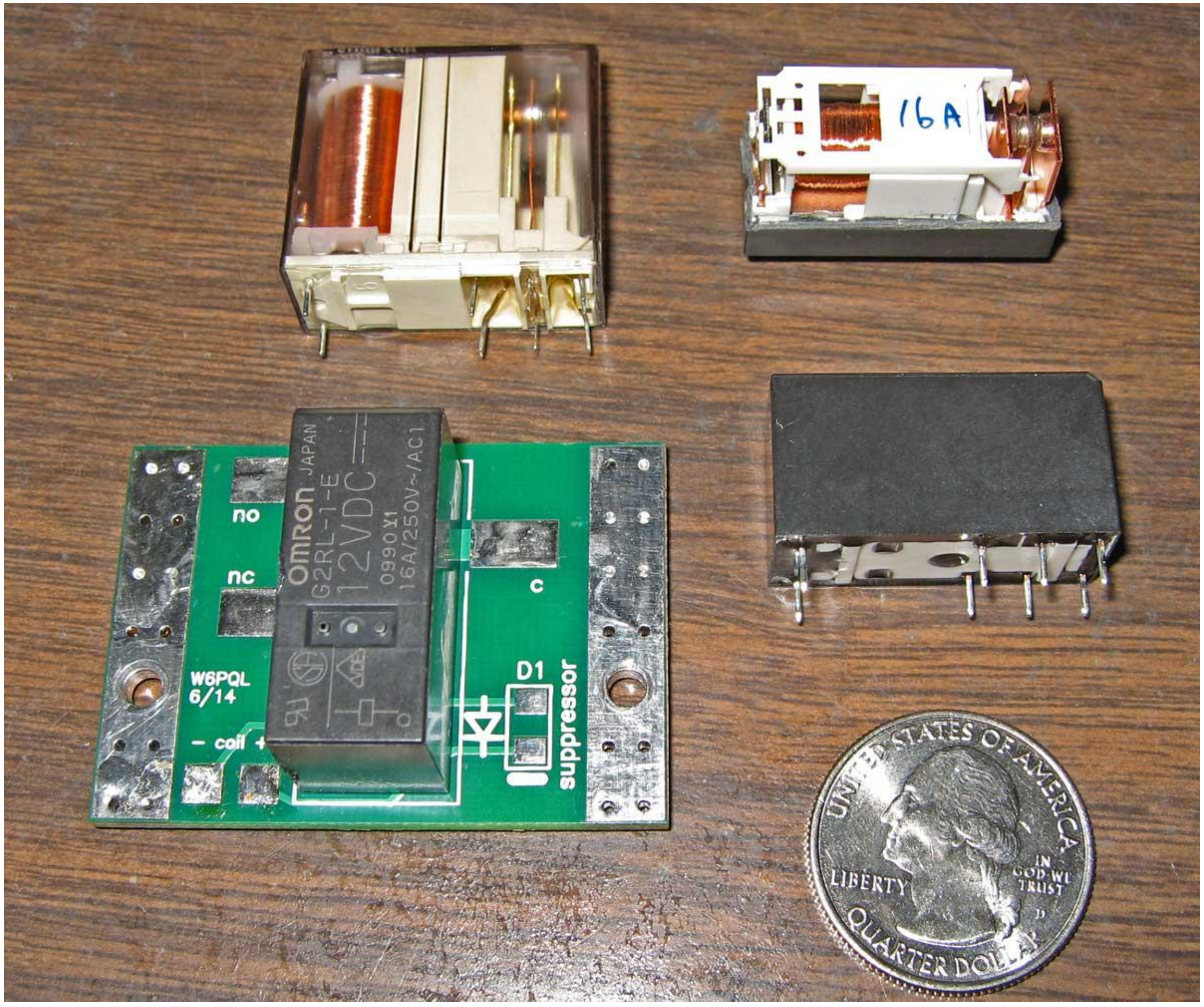
Laird Ferrite Core 28b0562-100 (4 turns)

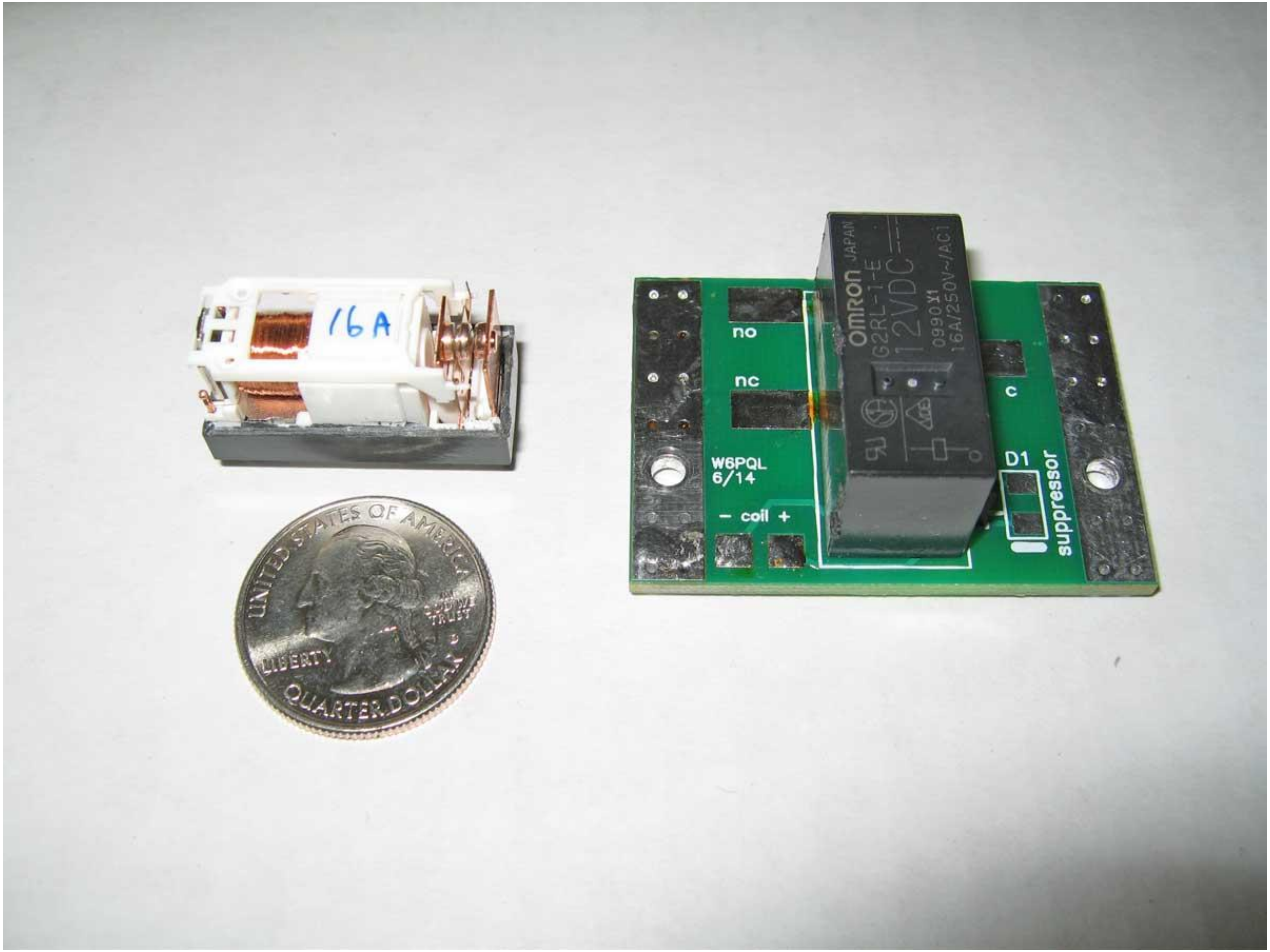


Antenna Relays

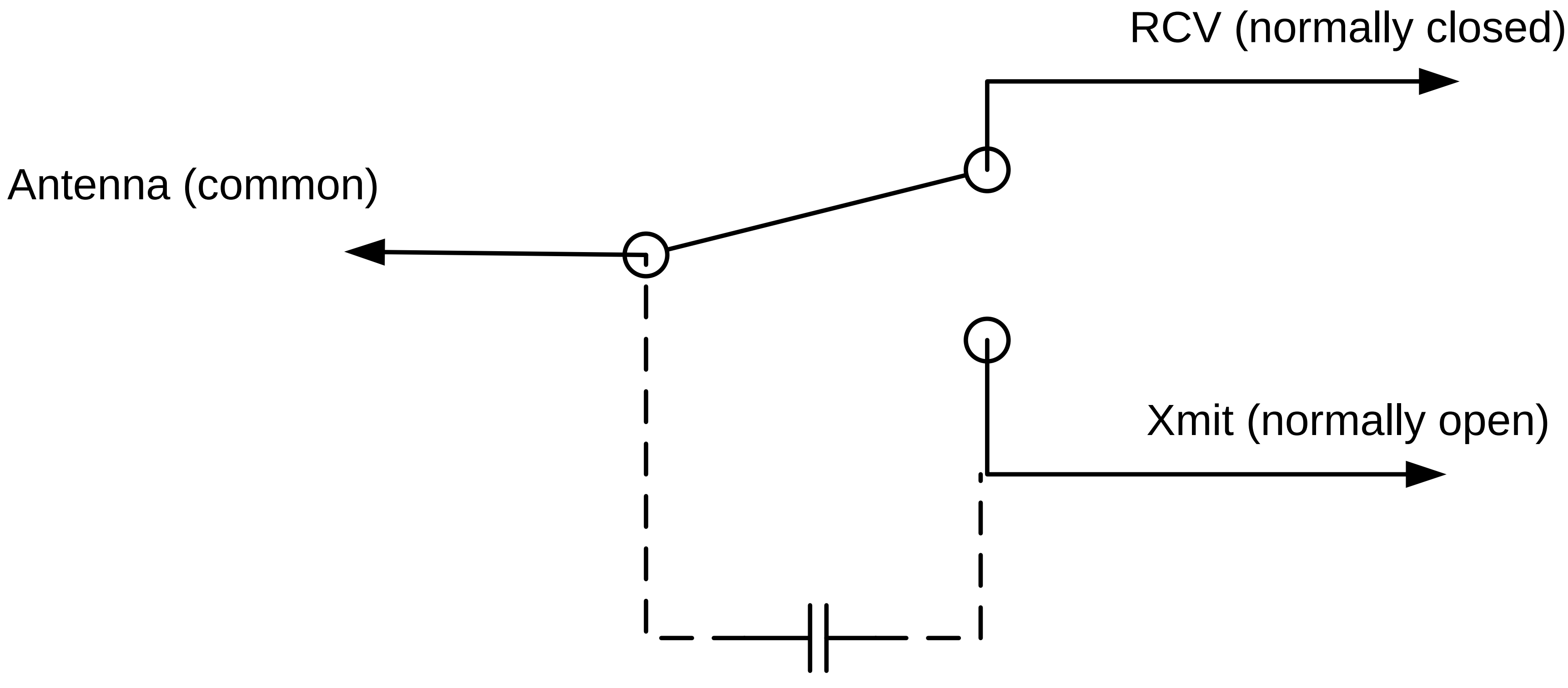
These are great relays to use if you have the budget for them

OK but I like to save $. I want to use one of these relays

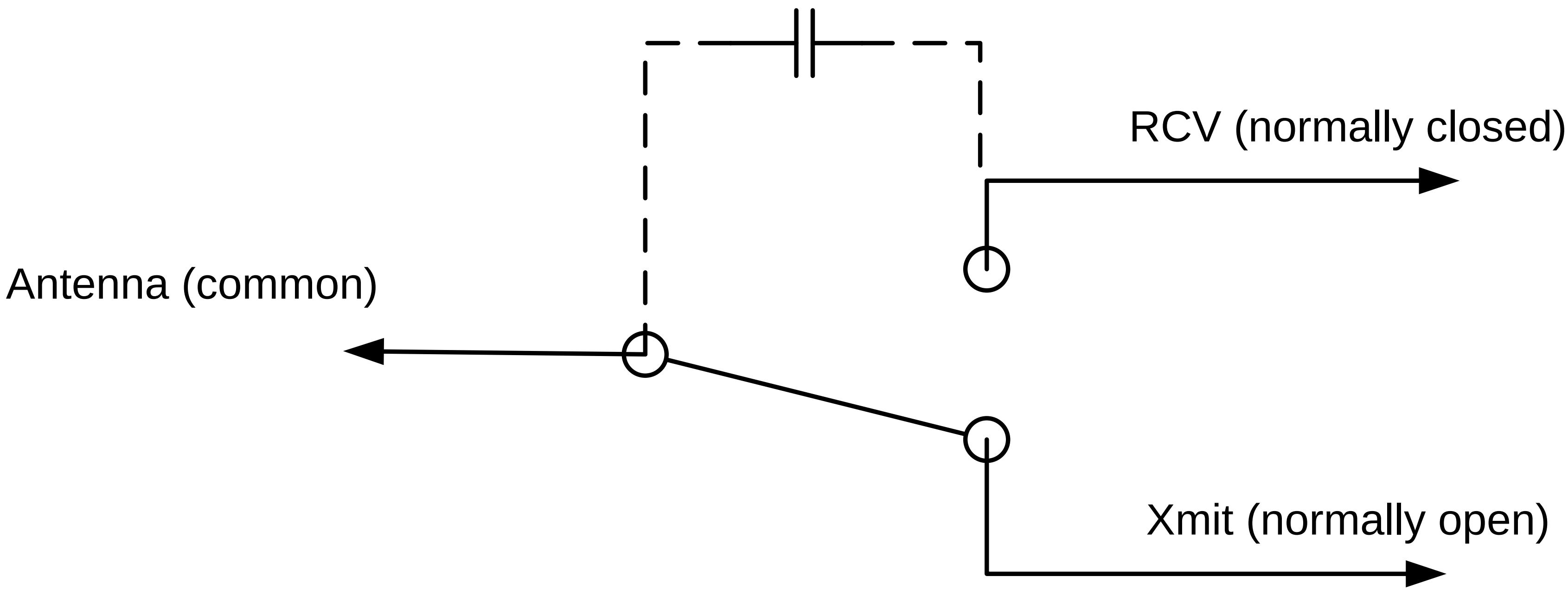



16A
UNITED STATES OF AMERICA
LIBERTY
QUARTER DOLLAR
omron JAPAN
G2RL-1-E
12VDC
16A/250V~/AC1
no
nc
c
W6PQL
6/14
— coil +
D1
suppressor

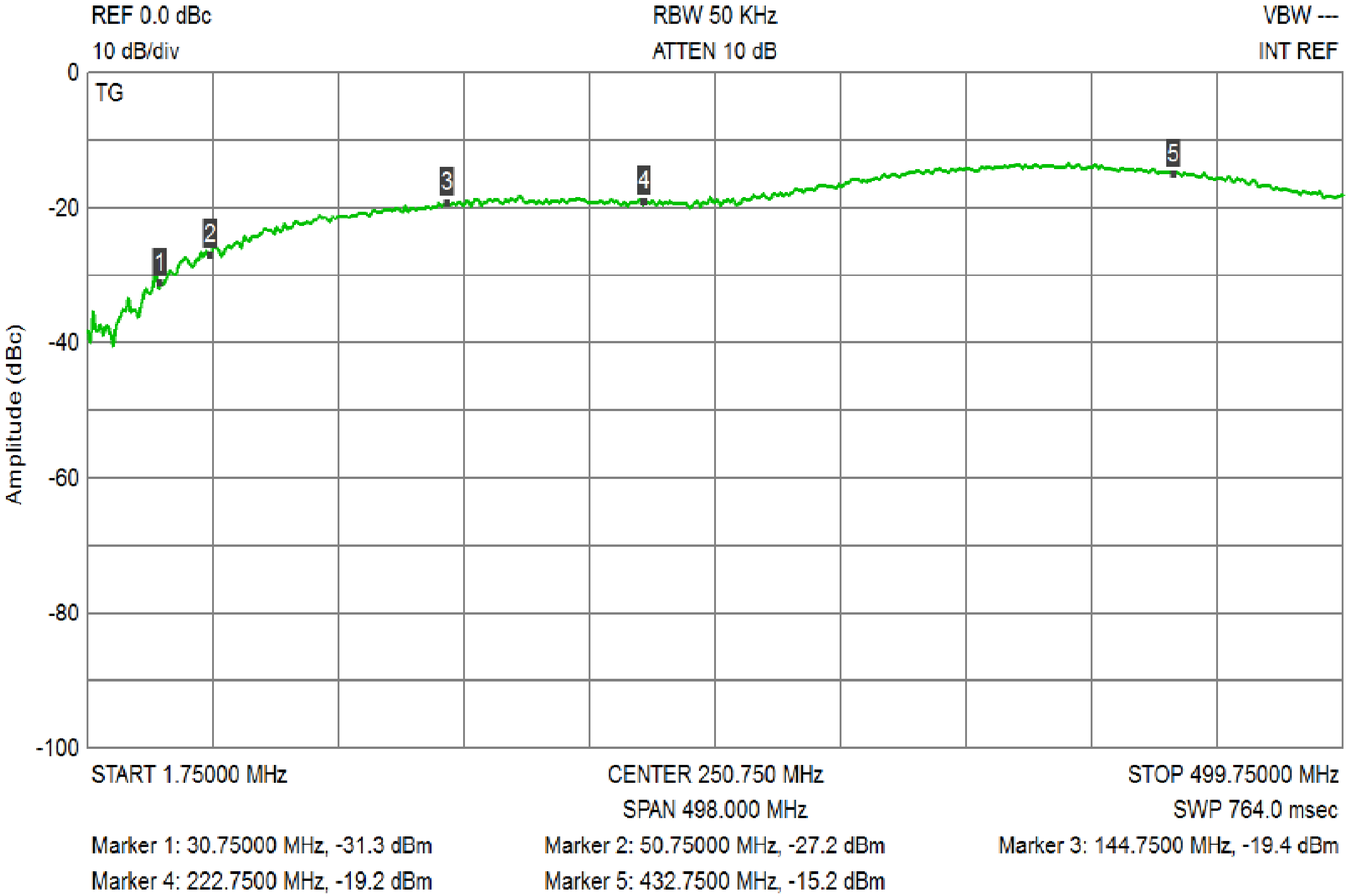
Receive configuration



Transmit configuration

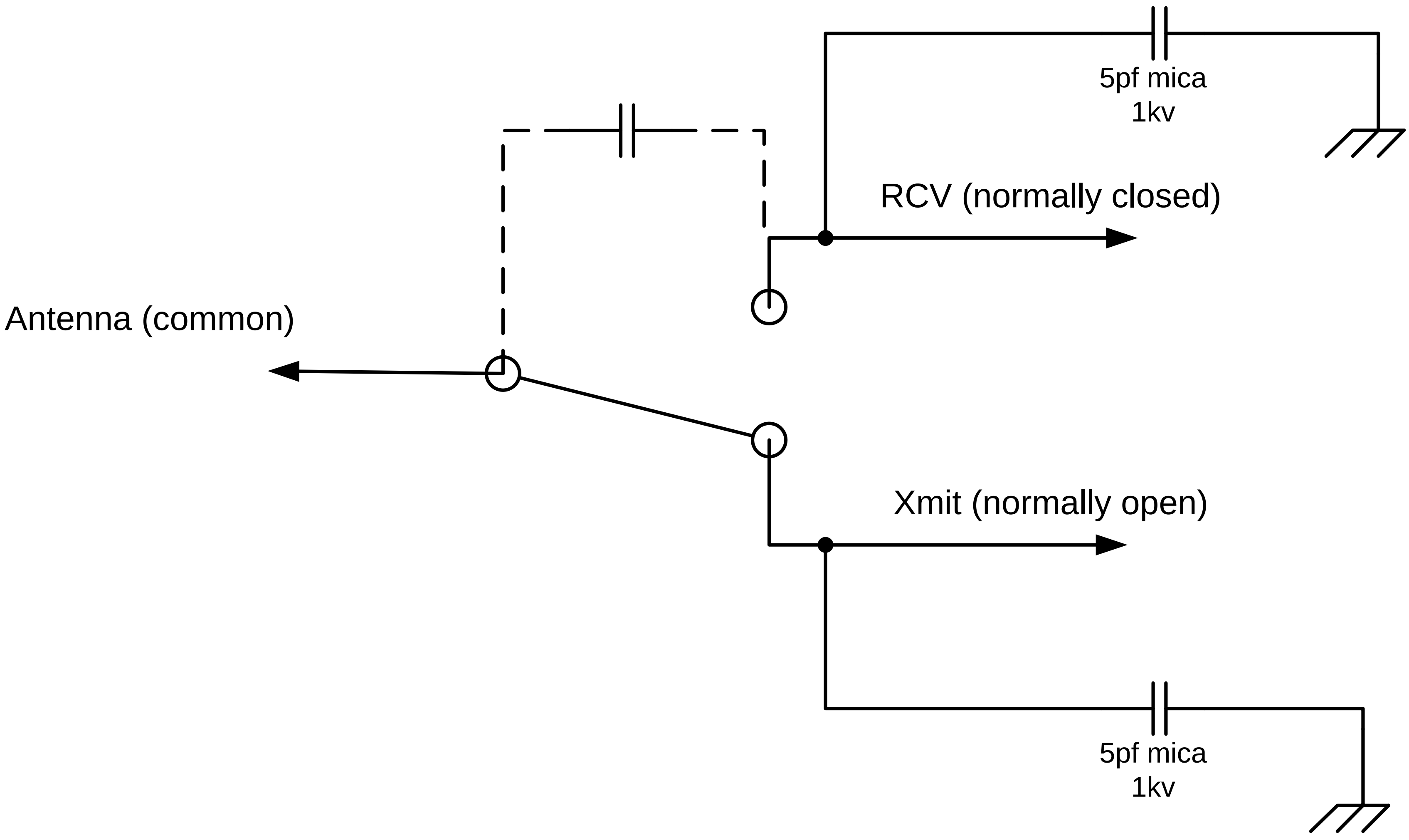


Return loss (SWR)

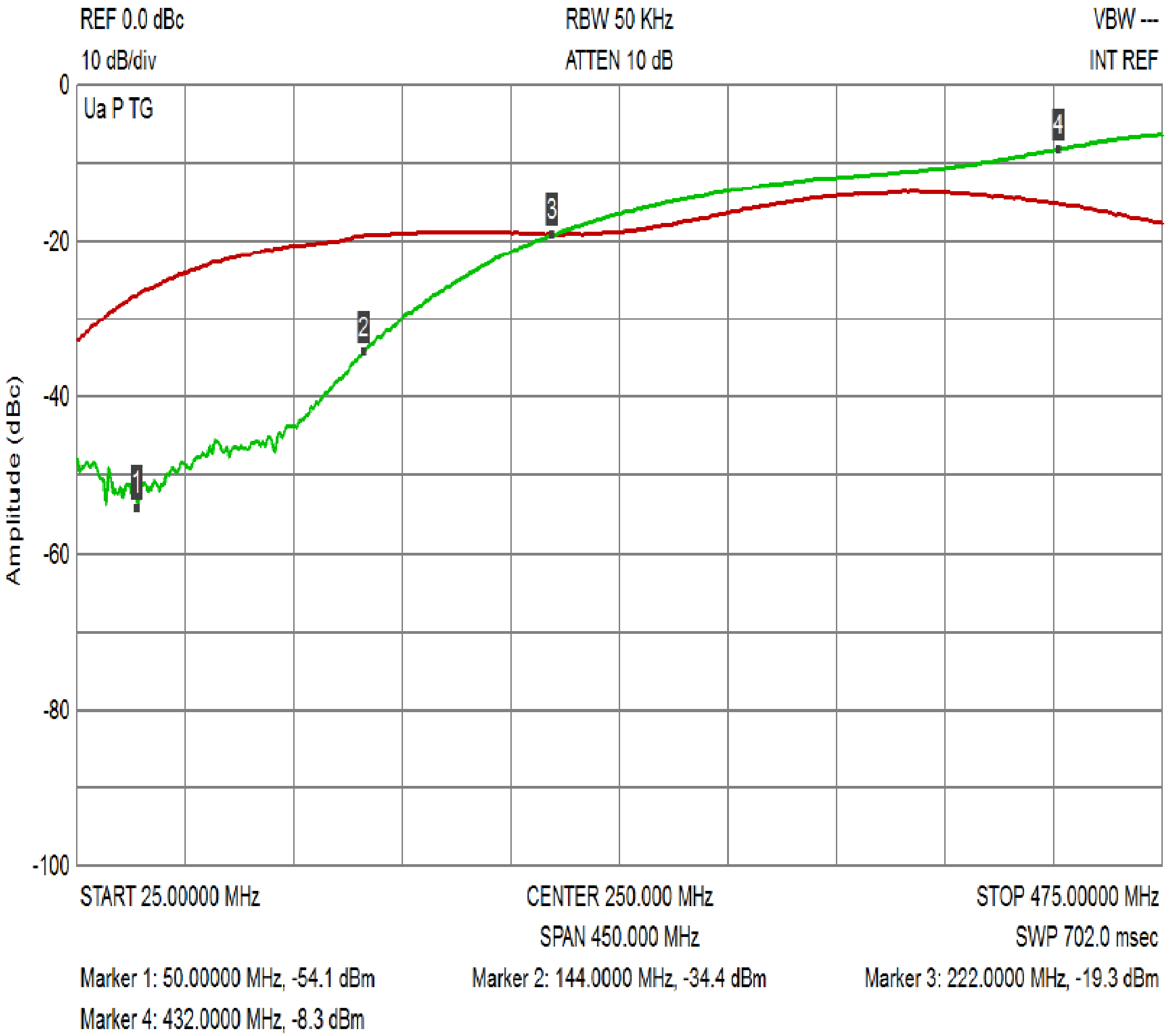


Compensation for VSWR

(2 meters and below)



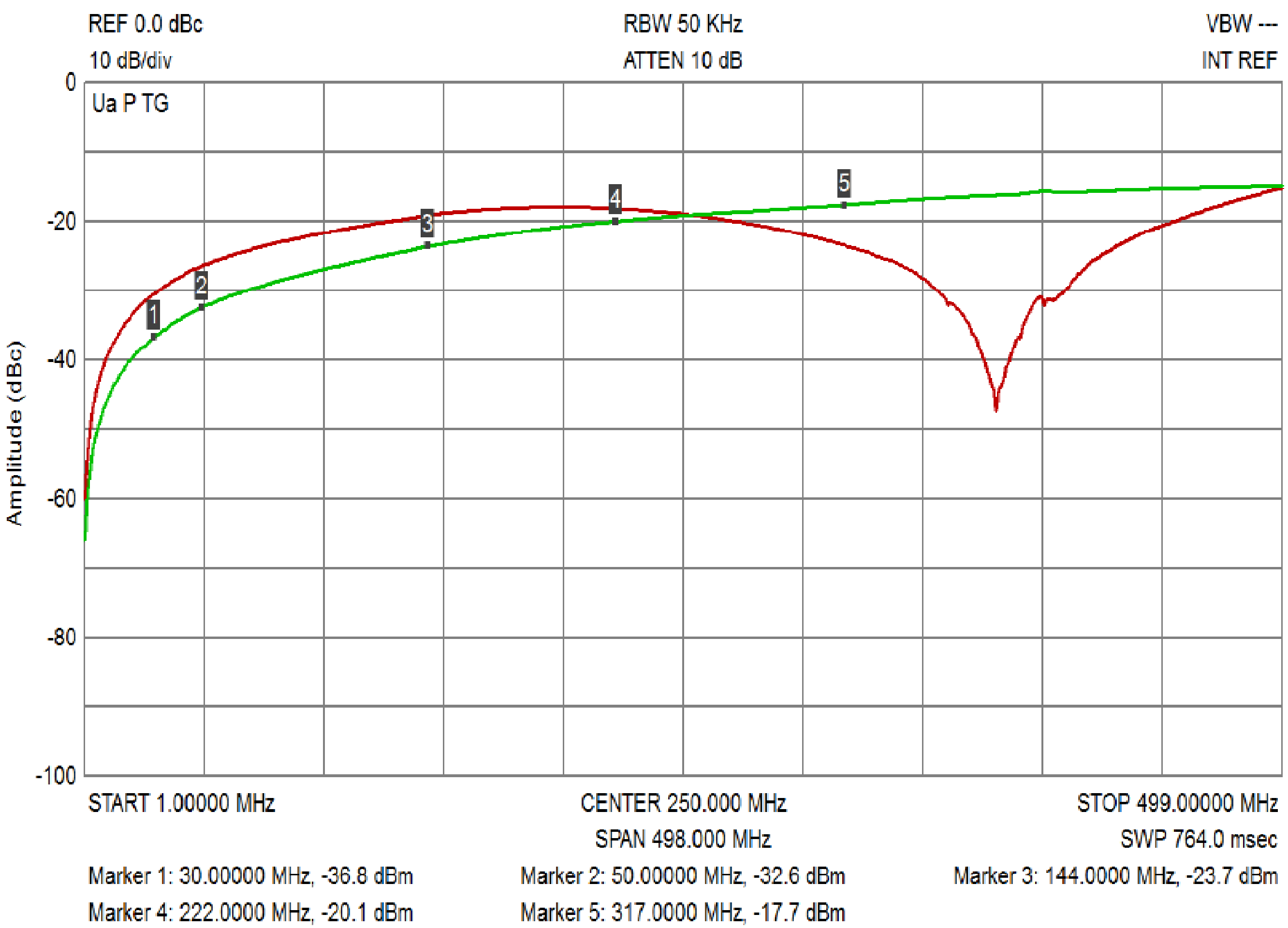
Return loss (SWR)



VSWR (return loss) is another problem that gets worse as the frequency increases

- Uncompensated
- 5pf added across NO and NC contacts

Isolation

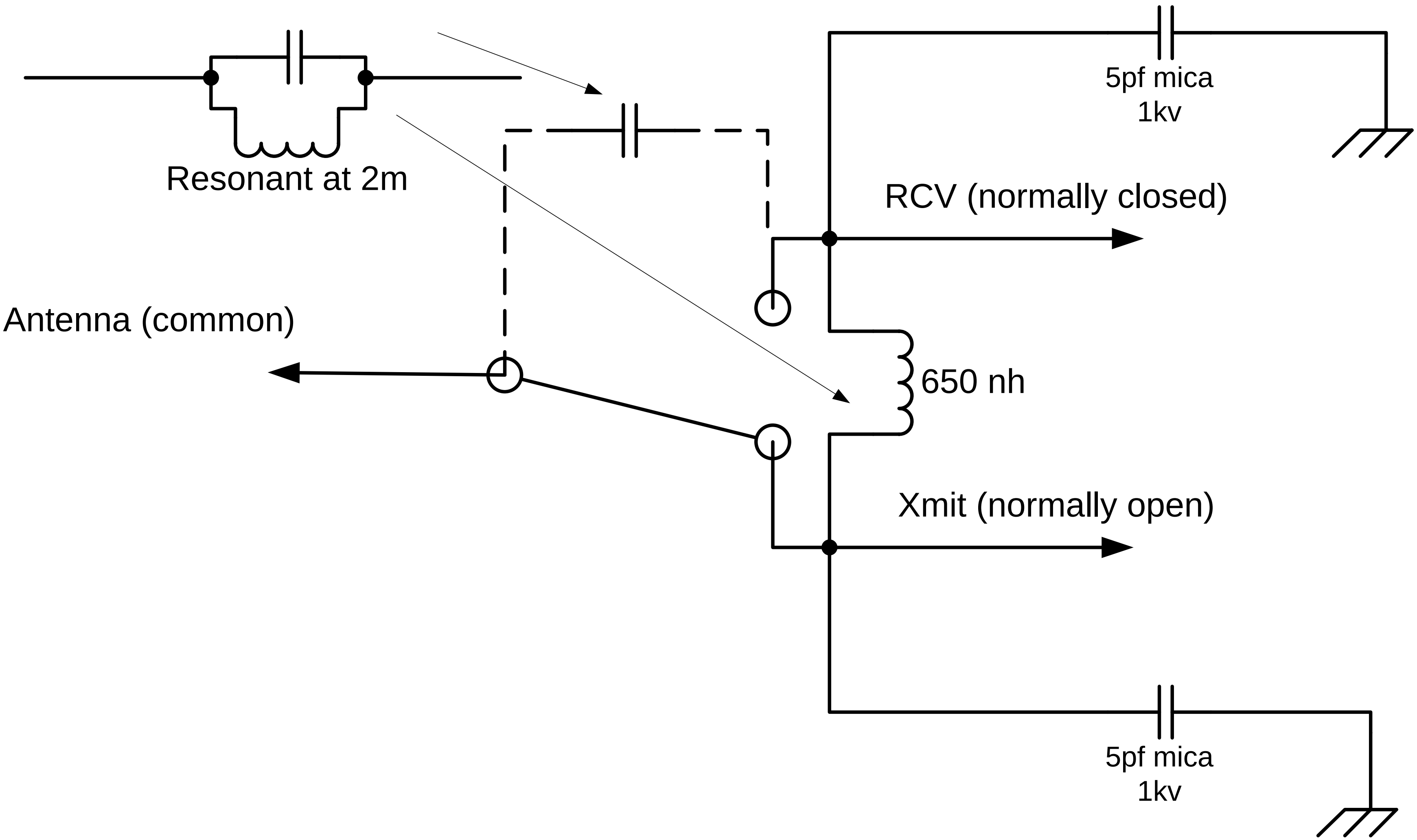


- Common port terminated in 50z
- Common port open

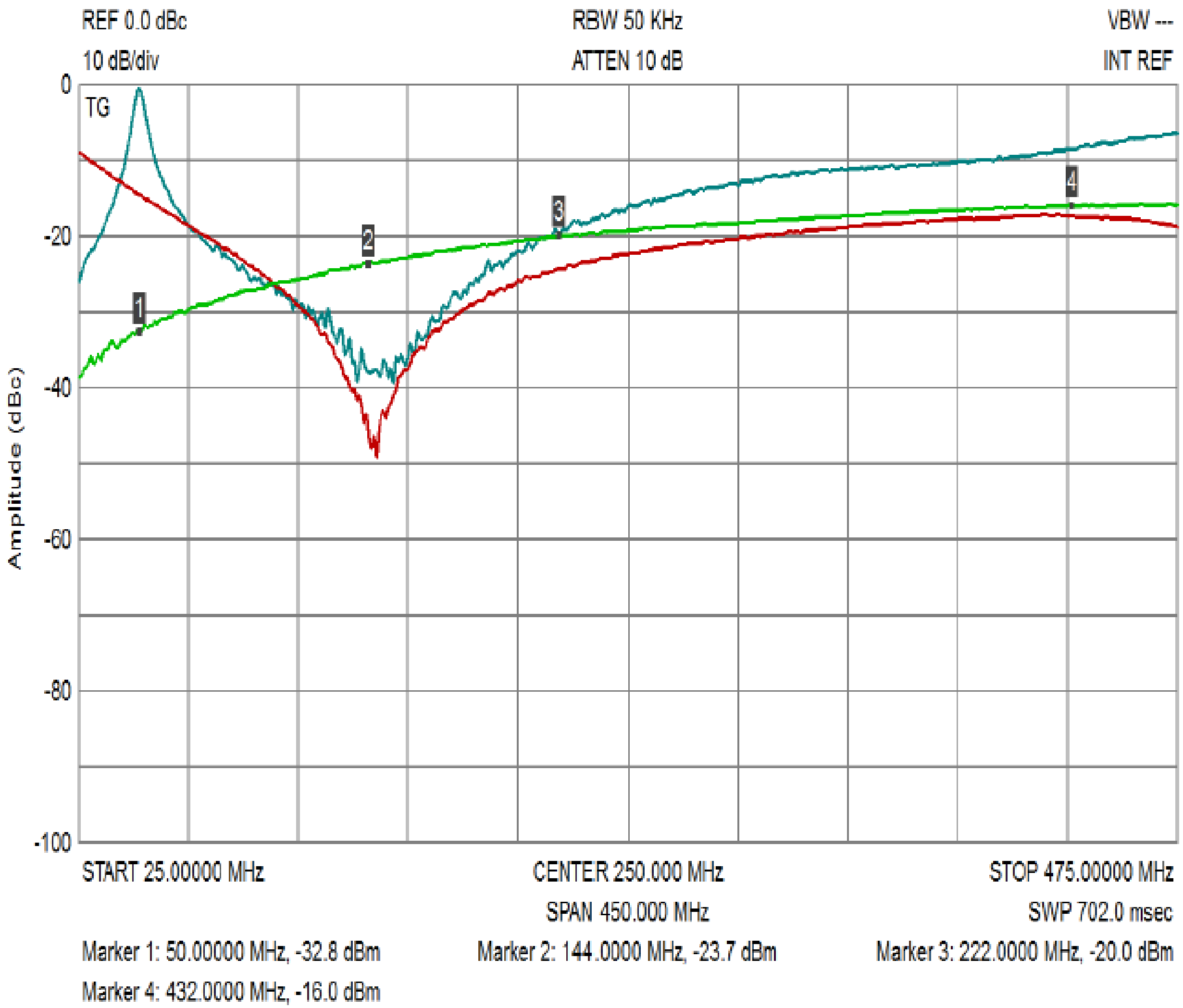
One of the biggest issues with these relays at VHF is isolation

The highest useful band appears to be 6 meters

Compensation for poor isolation



Compensation



Compensation allows us to use this relay at 2 meters

- Isolation (uncompensated)
- Isolation (compensated with 650 nh)
- Return loss (compensated with 5pf shunt)

WW SIX METER BBQ

AUSTIN, TX

SEPTEMBER 26-27

dick@dkhanson.com

BUILDING
A
VHF/UHF STATION

K5AND

When we lived in Atlanta from 1980-2006, my antennas were never higher than the surrounding trees!

Being at lake level on Lanier was fun for watersports, but <u>terrible</u> for radio!

Tower base
Base in EM73
(Cumming) was
20' above lake.

Top of 100'
tower was still
10' below big
hardwoods.

☹

Moving to Austin, TX, in EM00 changed everything. Hilltop (1240') with 360 degree view.

Our last QTH before going to the 'home'.....


40m 120'
near = 7mi
far = 40mi
20m 105'


Looking North
6 & 2m tower
uWave tower

20 & 10m stacks

(added 12m 3 el)

40m & 15m stack

(added 17m 3 el with 2el 30m coming)

80 & 160m vertical with elevated radials

8-circle array for receive only

VHF-UHF Station

ELECRAFT K3 (RX/TX IF)

TRANSVERTERS:
ELECRAFT 2m, 1.25m & 70cm

DEMI 33, 23 & 13cm; with ApolLo synthesizer and external 10MHz Rubidium standard

MY STATION LAYOUT IS SUCH THAT THE 50-432 GEAR IS IN MY 'SHACK'. THE 902-2304 GEAR IS REMOTED IN MY ATTIC, SO, MUST CONTROL ALL THE ATTIC GEAR FROM THE SHACK: TURN GEAR (POWER SUPPLIES ETC) IN ATTIC OFF/ON, SWITCH PTT LINES (NOT SO EASY WITH K3), AND SWITCH ANTENNA RELAYS.

WHAT WAS NEEDED WAS A K3 "INTERFACE" WITH REMOTE (ATTIC) SWITCH TO ACCOMPLISH THESE TASKS.

TOM APEL, K5TRA, DESIGNED TWO DIGITAL INTERFACES TO DO THIS.

1) PROVIDE PROPER IF FREQUENCY TO THE TRANSVERTERS (28 OR 144 MHZ)
2) SWITCH PTT LINE TO THE SELECTED BAND
3) PROVIDE FOR PTT FUNCTION FOR AMPS
4) PROVIDE FOR ANTENNA RELAY SWITCHING ON 33-13cm AMPS

CHANGING BANDS FROM HF THRU UHF WOULD NOW BE A SINGLE BUTTON-PUSH ON THE K3


magic box
PRIME MERIDIAN OF THE WORLD
EAST
WEST
ELECRAFT K3 TRANSCEIVER
ELECRAFT P3
50.125.06
ELECRAFT XV SERIES TRANSVERTER
ELECRAFT XV SERIES TRANSVERTER
POWER OUTPUT (W)
K5AND
PWR 144 222 432 902 1296 2304
SONY

K3 DIGITAL INTERFACE

(it *is* magic)


222,432
REMOTE
K3
222,432 TX
902,1296 TX
902,1296 RX
2M PA
K3
2304 IF

DEMI INTERFACE in ATTIC

AMP WALL

144 222 432

HF Remote 50


Six News G5KW Trophy
UKSMG
UKSMG Jersey Trophy
QST
QEX
LIFE MEMBER
K5AND
FOURTEENTH ANNUAL
K4UHF AWARD
VHF
Presented To
DICK HANSON
K5AND
For Outstanding Contributions
And Service To The
VHF/UHF
Weak-Signal Community
Over Many Years
2010
YOKOHAMA


ST. VINCENT'S
ANTIGUA
JAMAICA
VP5/W6JKV VP5/W4HM
VP5H
Turks & Caicos
ANGUILLA
MONTSERRAT
BELIZE
VRØN
J3/K5AND
VP2V/W7XU
CYØX
k5d
DELL

AMPLIFIERS

KLITZING VHF2000 6m....1.5KW **

KLITZING 2m/1.25m/70cm....1KW

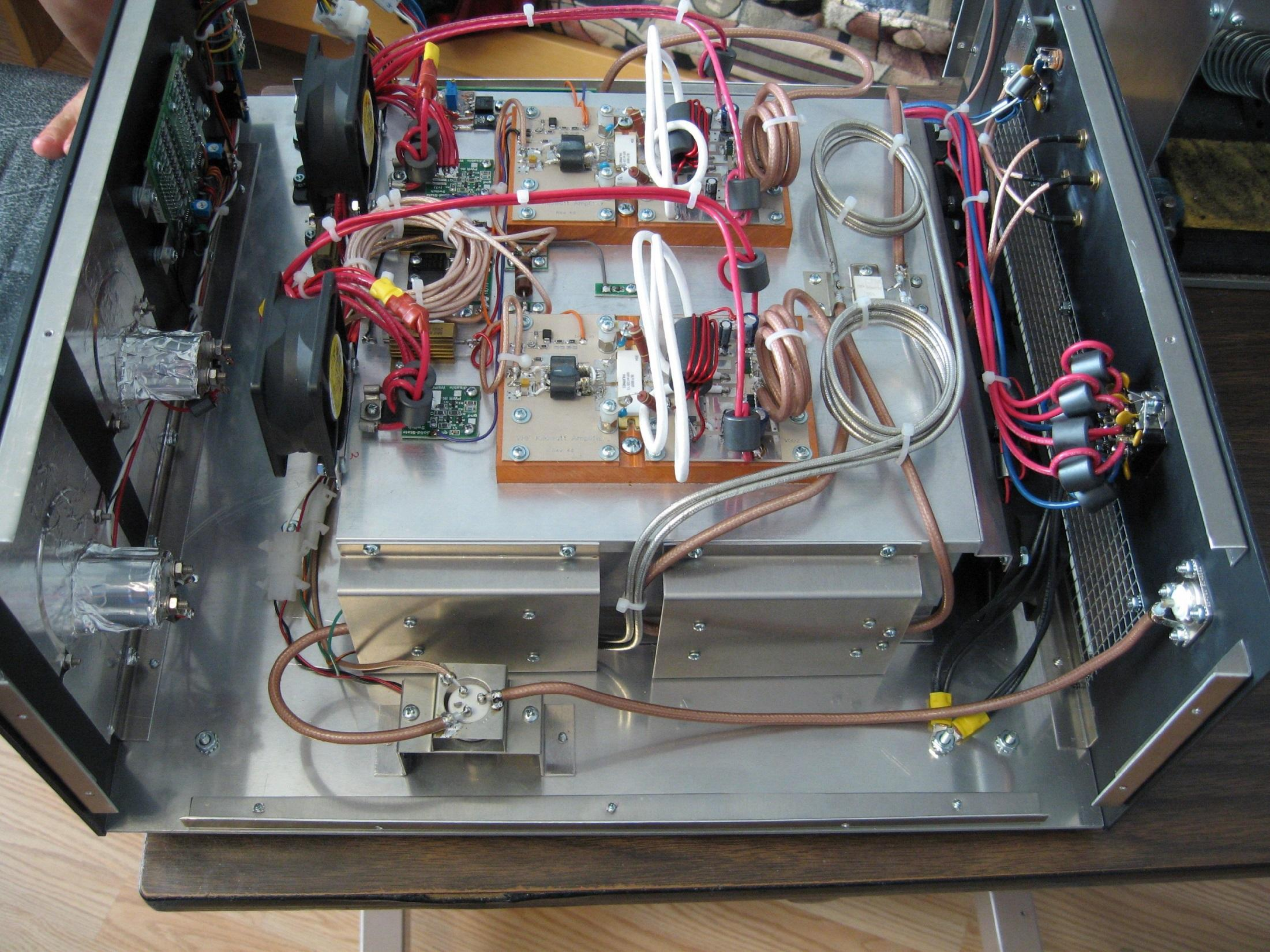
PAIR MOTOROLA 33cm....400W

KLITZING 23cm....250W

SPECTRIAN 13cm....150W

KLITZING 6M2000


Input Attenuator
ALC
ALC Set
Driver
PTT
Input switch
Input 5w Max
Power Supply
Antenna



Power supplies are two each Meanwell 2000-48, in parallel, supplying 80 amps @ 50VDC; mains are 240VAC

6 & 2m ANTENNA SWITCHING:
via K3 INTERFACE

ANTENNA CHOICES:

- 6m YAGIS
  - 2m YAGIS
    - 2m K5DDD LOOPS


105'
2m = 9 el LFAs
95'
85'
6m = 8 el LFAs
95' 25G rotating tower
60'

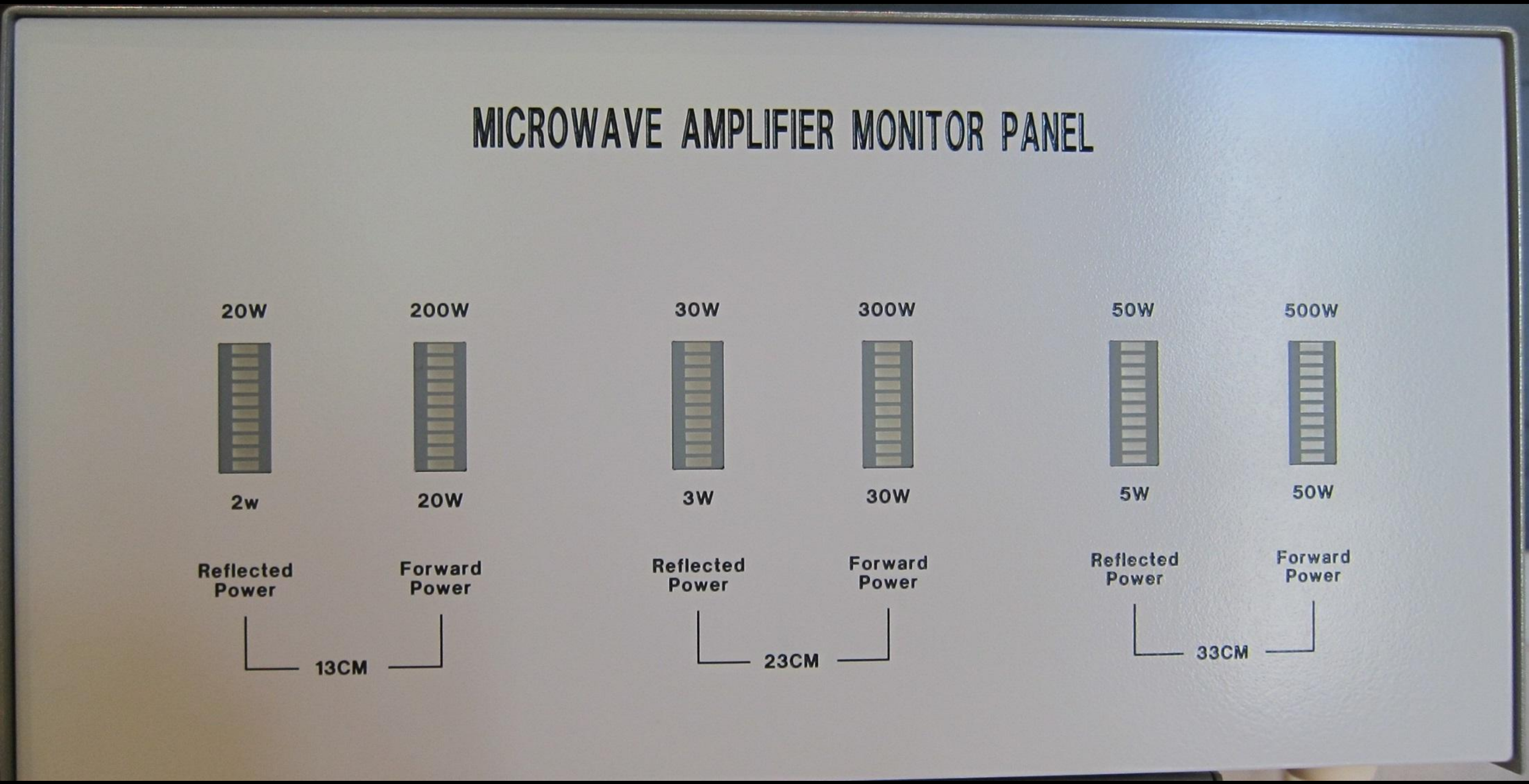

33cm
23cm
13cm
1.25m
10 el LFAs
70cm
12 el LFA
Rohn 25G…50'

OOPS!!

EASY ENUFF TO 'WATCH' THE 6M THRU 70CM AMPS; BUT WHAT ABOUT THE 13-23CM AMPS UP IN THE ATTIC??

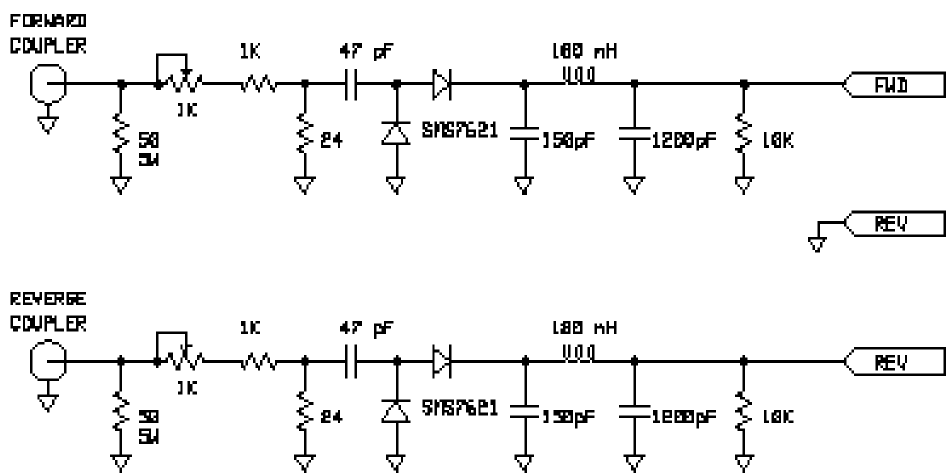
WOULD NEED SOME SORT OF REMOTE READOUT CAPABILITY

KLITZING MONITOR PANEL



KLITZING 902 HYBRID COUPLERS

COUPLER REAR VIEW



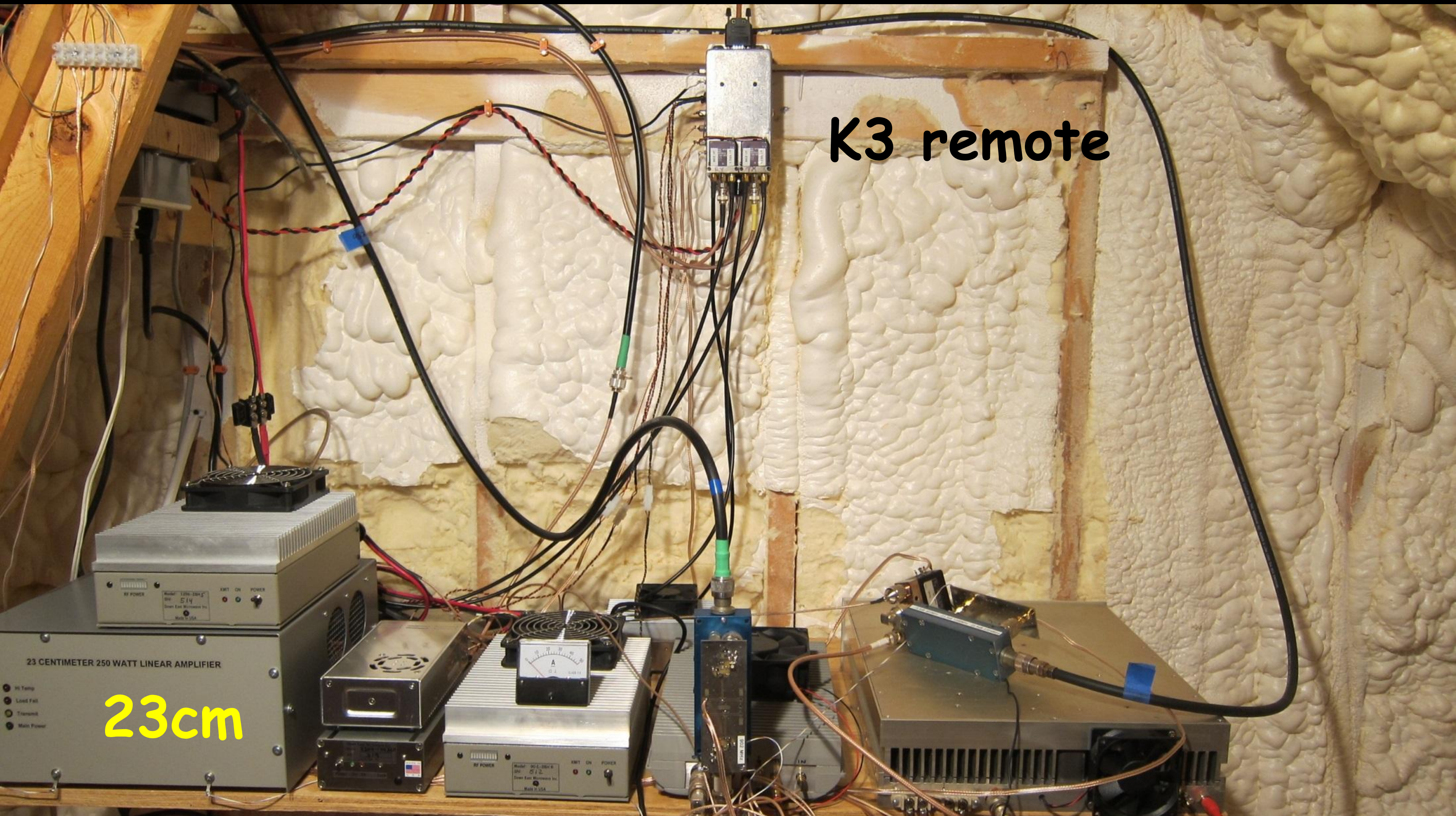
Dual Detector		
- For MECA Dual Coupler -		
K5TRA	Rev 1.1 7/20/2013	

K5TRA DETECTORS FOR 902/2304

THESE DRIVE THE REMOTE MONITOR PANEL LED READOUTS

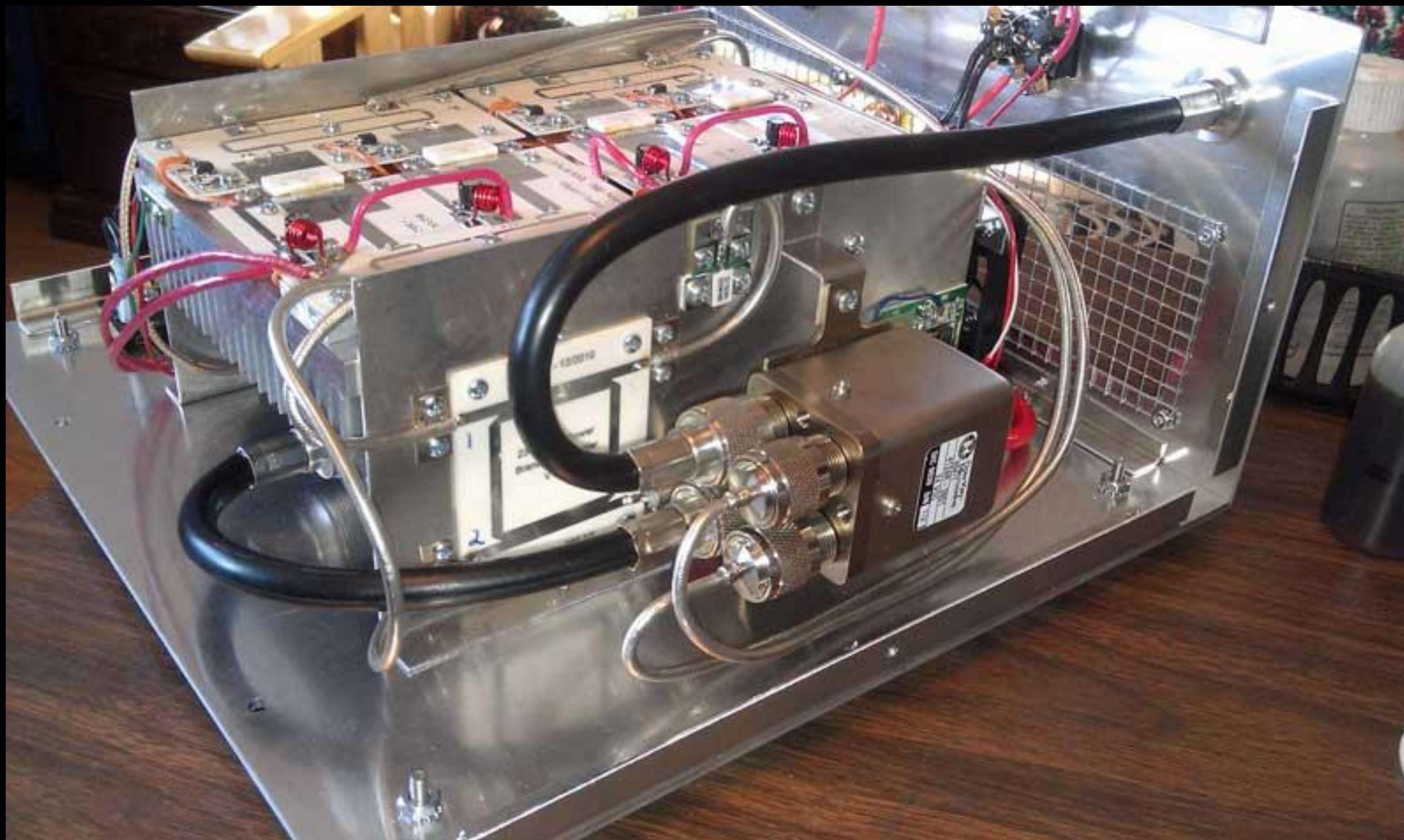
902-2304 AMPS & 28VDC
60A POWER SUPPLY
LIVE IN CONDITIONED
ATTIC SPACE (80F max)

FEEDLINES FROM
AMPS TO ANTENNAS
ARE 20' LONG

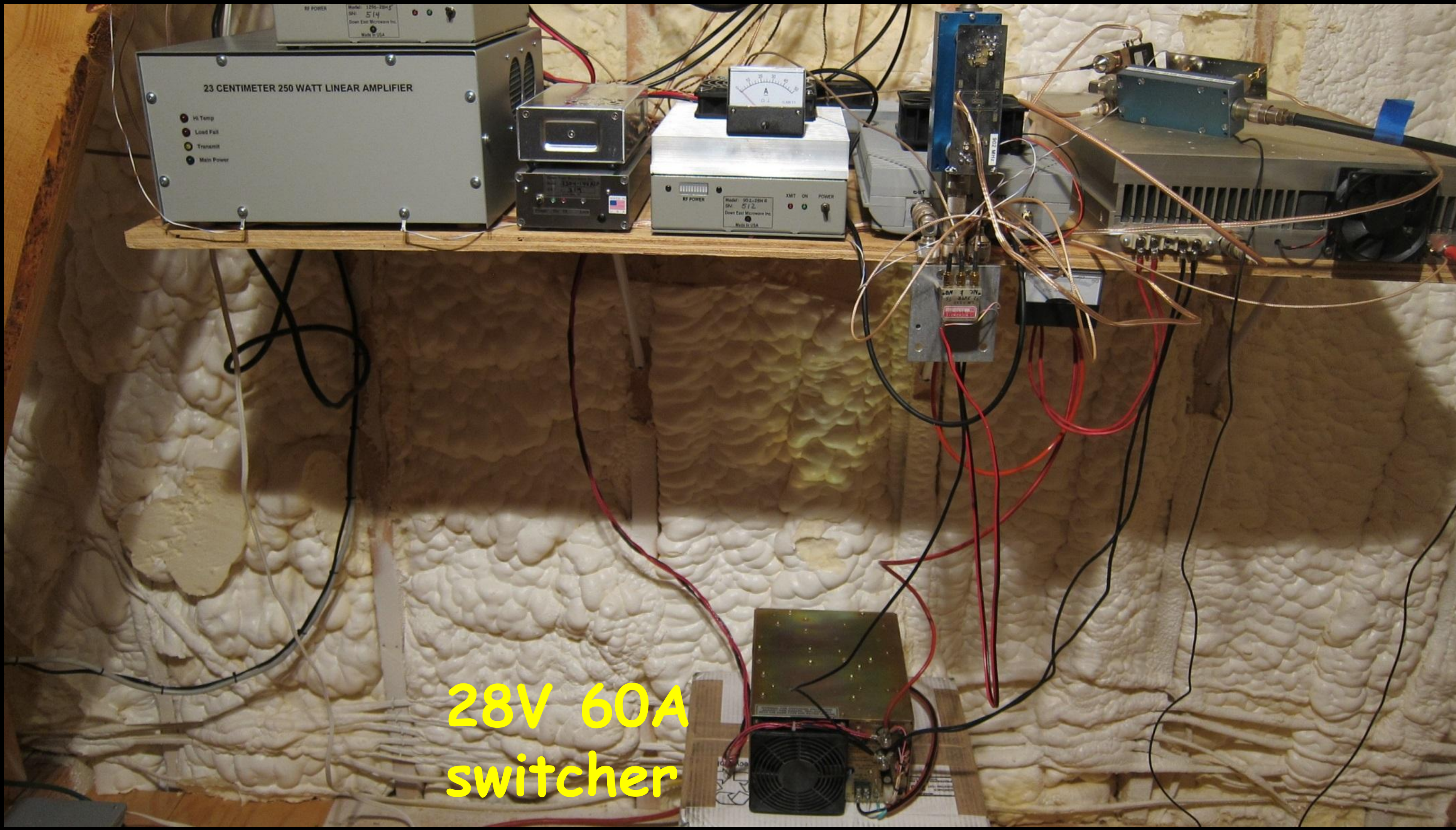


13cm 33cm 13cm

INTERIOR OF 23 CM AMP



DEVICES ARE MRF-286


23 CENTIMETER 250 WATT LINEAR AMPLIFIER
Hi Temp
Load Fail
Transmit
Main Power
RF POWER
XMIT
ON
POWER
Made In USA
28V 60A
switcher

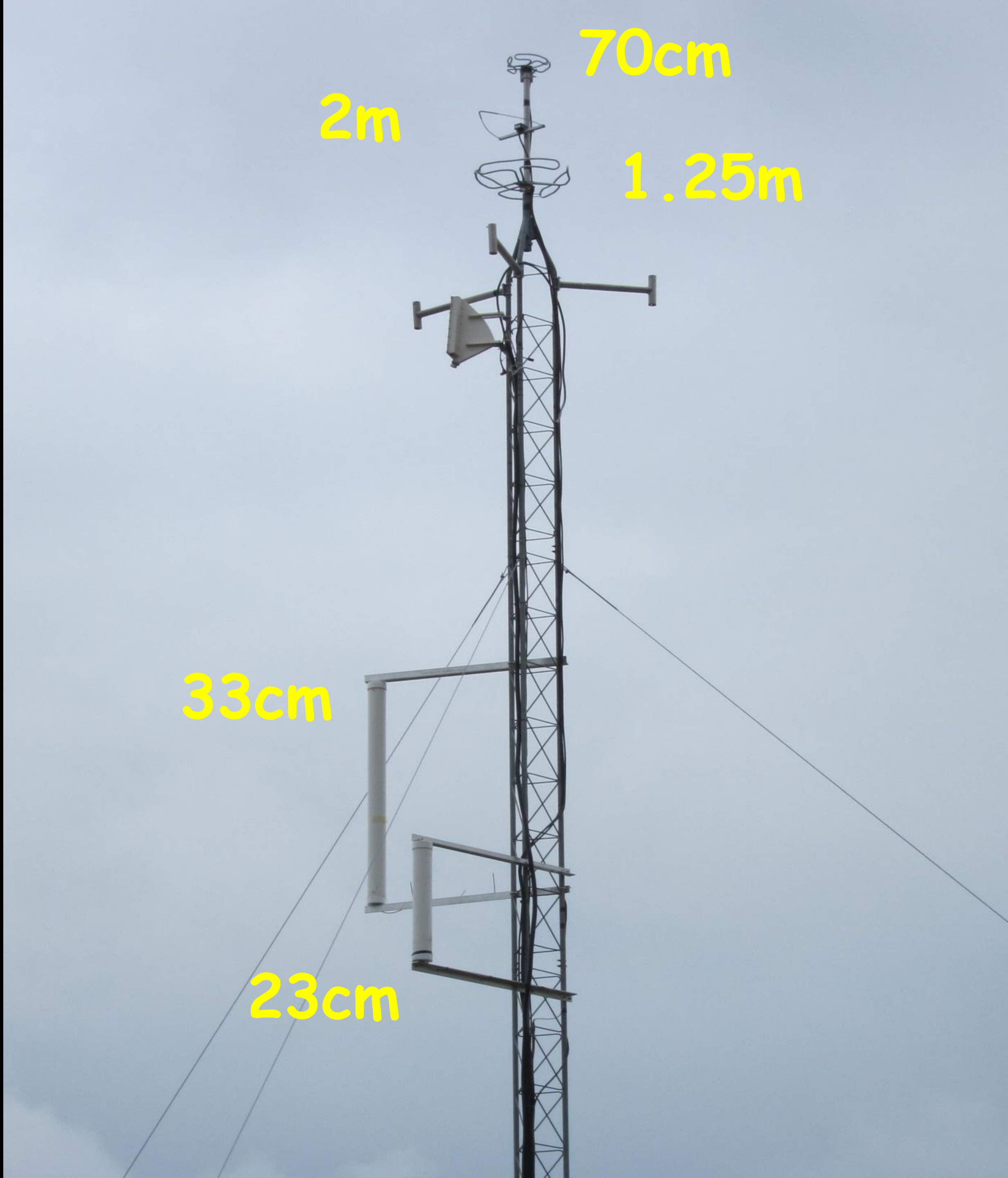

10G……soon!
W8ZN
Directive Systems

K5RMG BEACONS

AT K5AND QTH

AVG ASL = 1300'

(400' from my Station; remote power on/off via Internet)



LOTS OF 'ELMERING' FROM:

STEVE:	N5AC	STEVE:	K4RF
STEVE:	N2CEI	CHARLES:	K4CSO
TOM:	K5TRA	GEORGE:	K5TR
AL:	W5LUA	TERRY:	AB5K
LARRY:	K5OT	*KATHIE HANSON*	

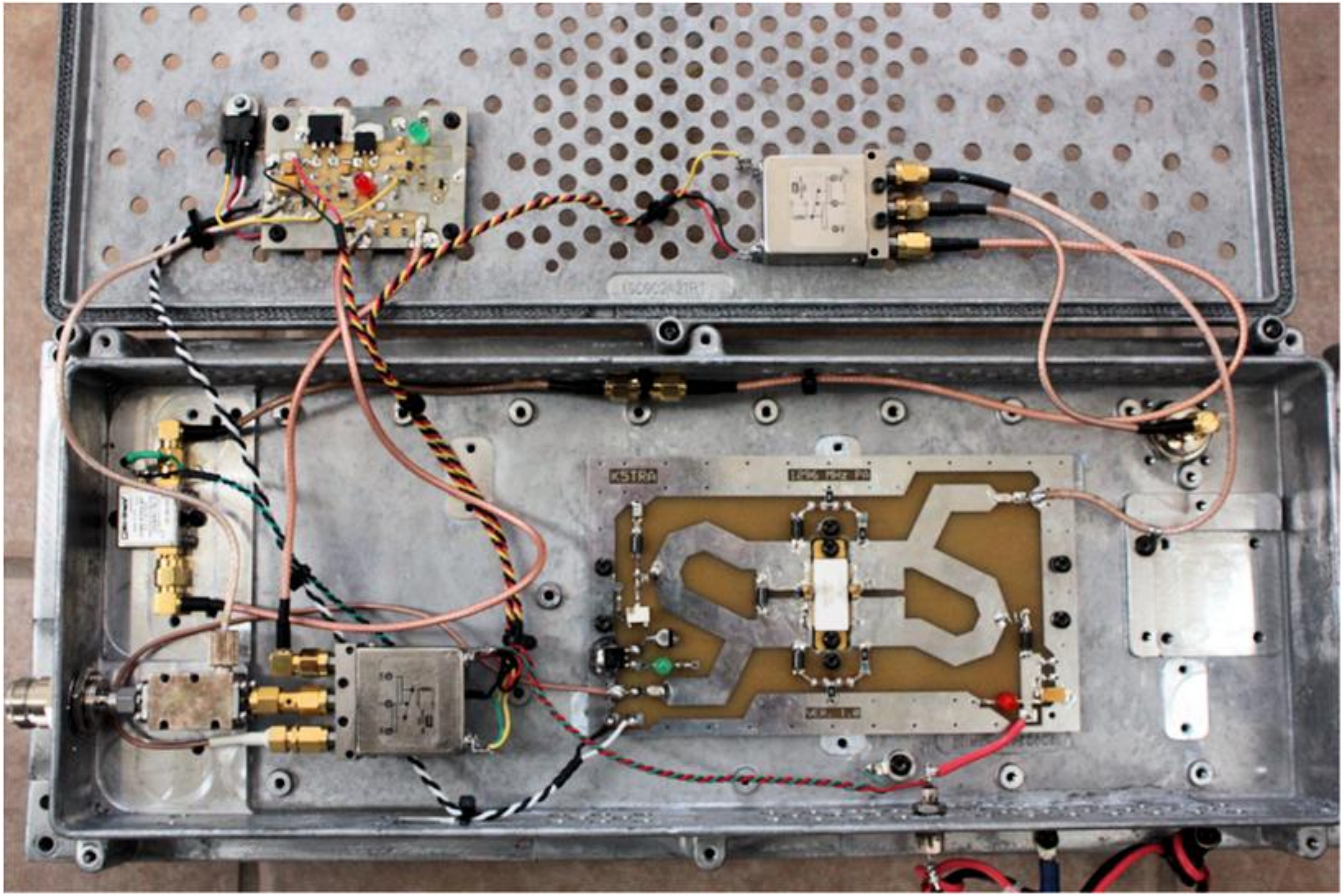
THANKS SO MUCH!!

THAT'S

ALL

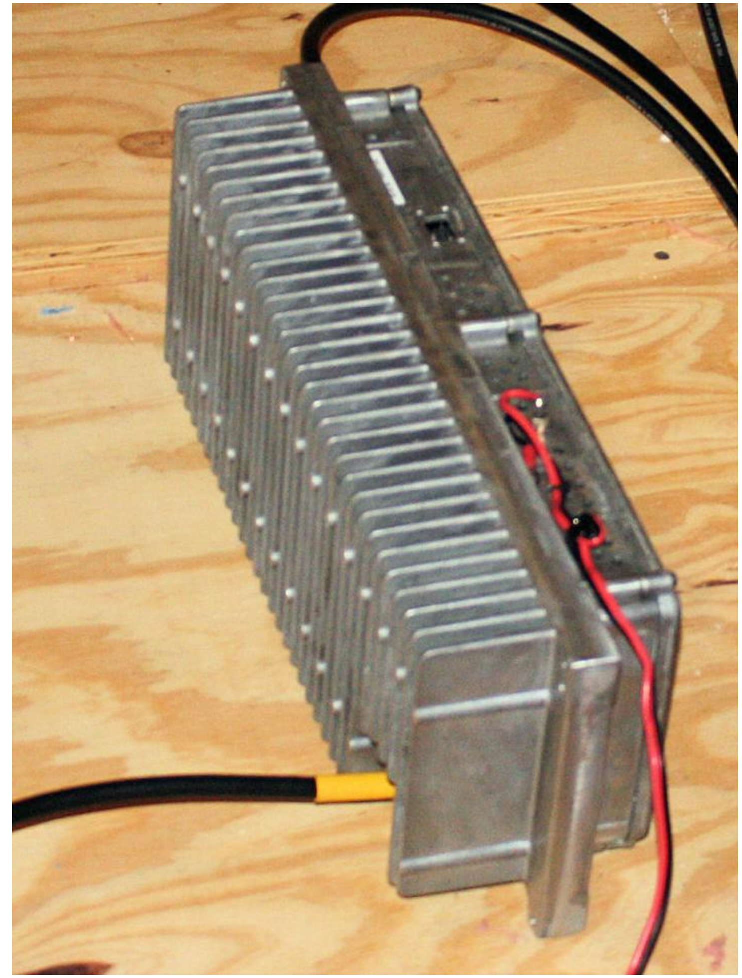
FOLKS!

1296 MHz Remote 100W PA and LNA



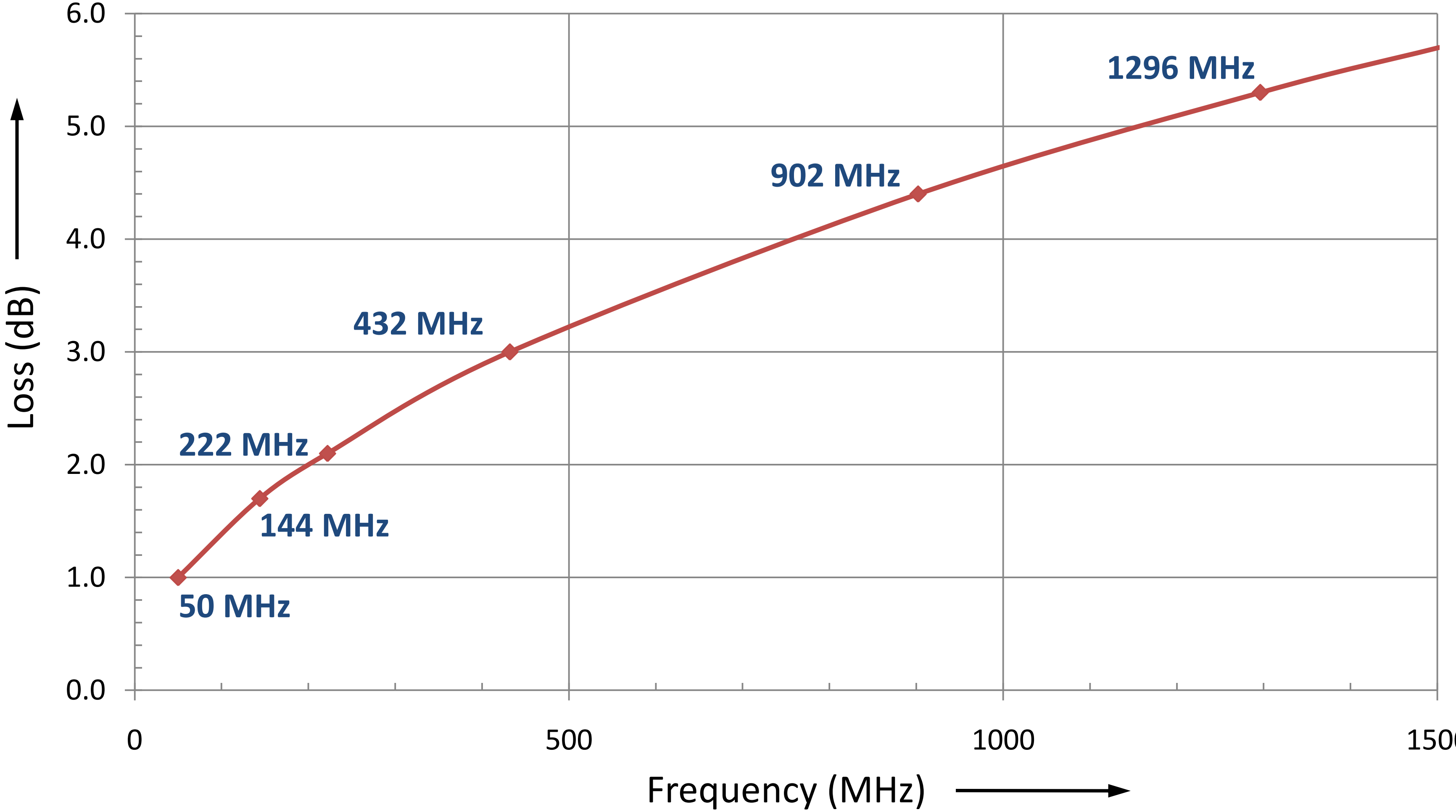
Remote Amplifiers - Why ??

- Greater ERP
  - Feedline loss eliminated
- Improved receiver sensitivity
  - In shack LNA limited by feedline loss
  - NF established at the antenna with remote LNA

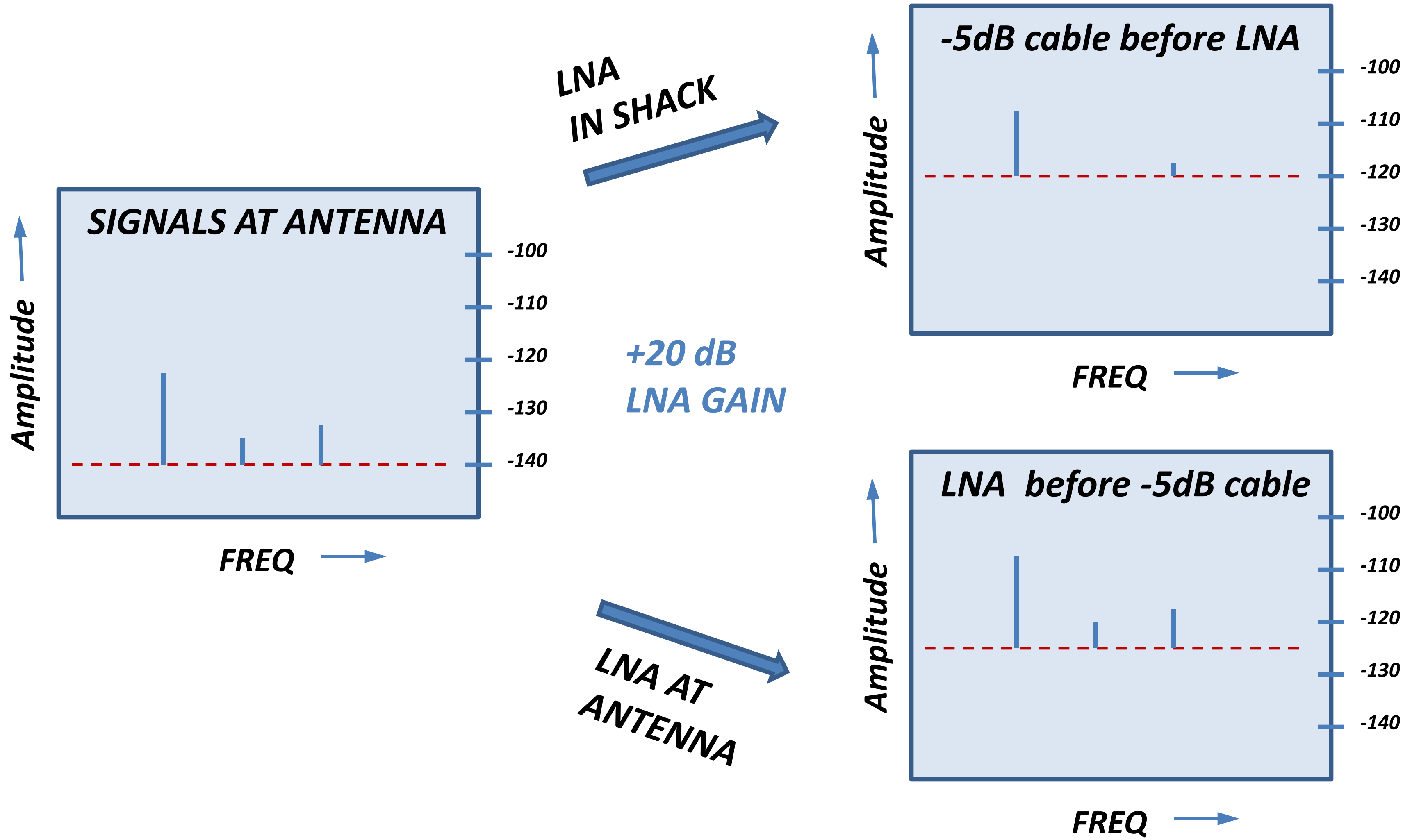


Loss of LMR-400

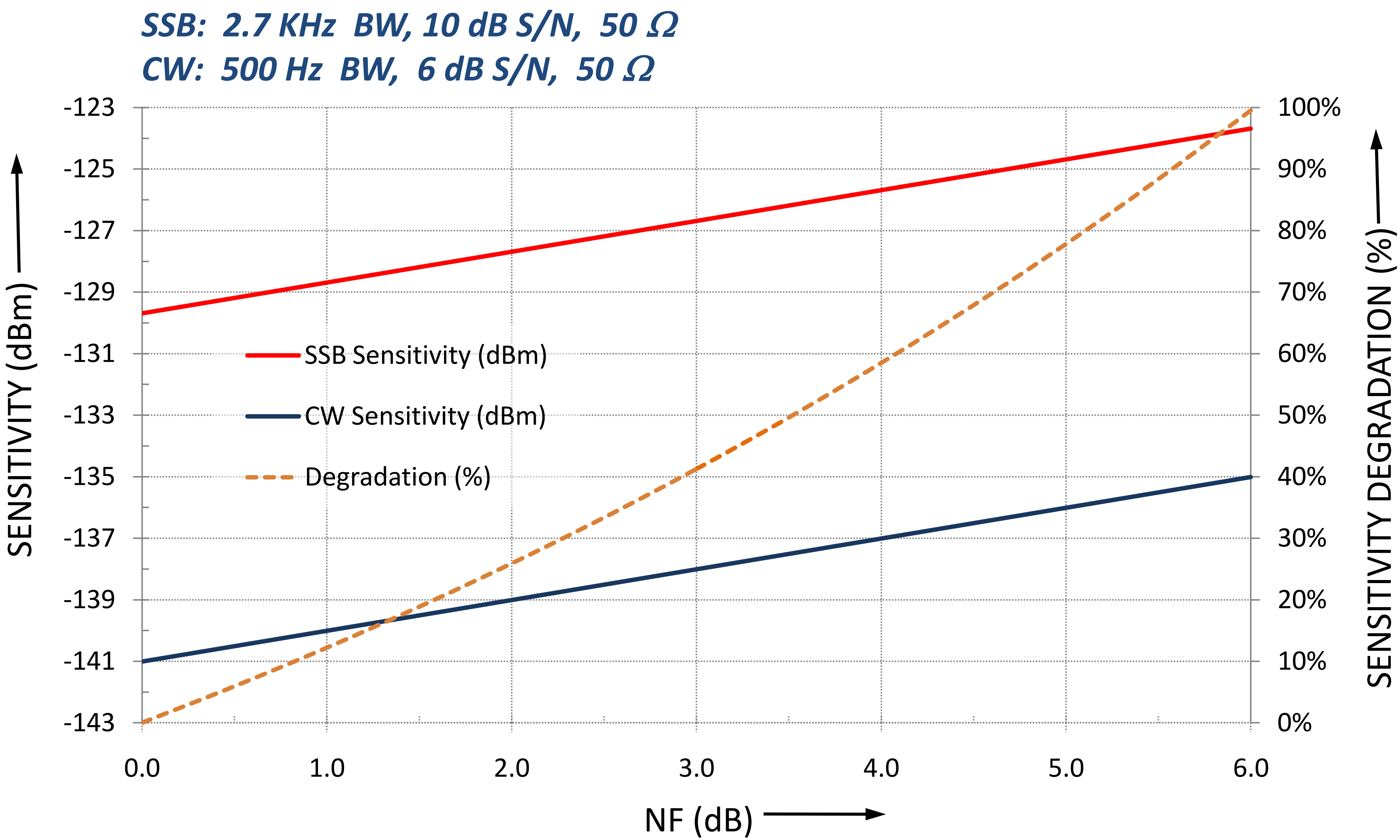
(100 ft, with connectors)



NF Performance is Set by 1st "Stage"

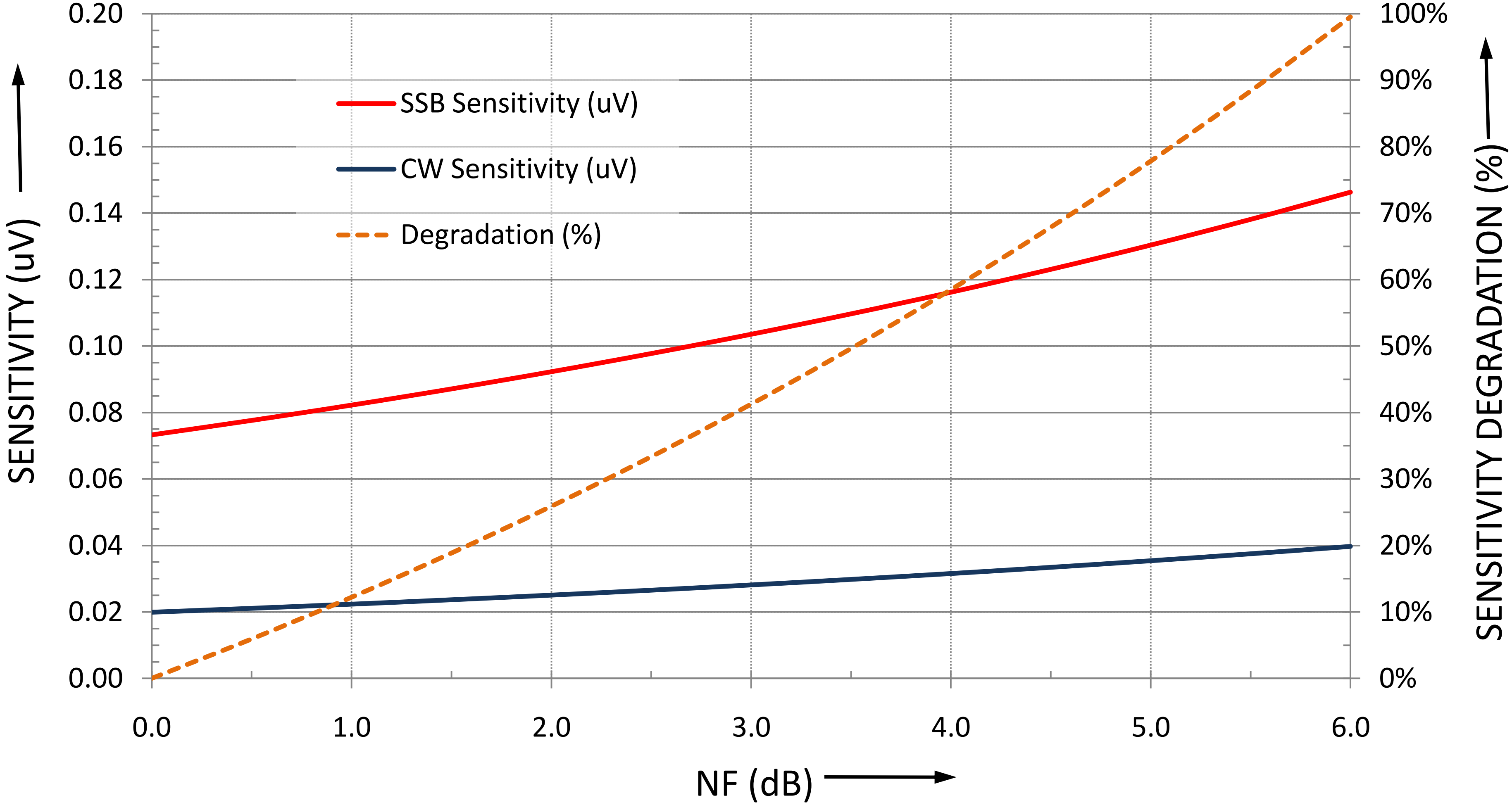


Sensitivity vs NF



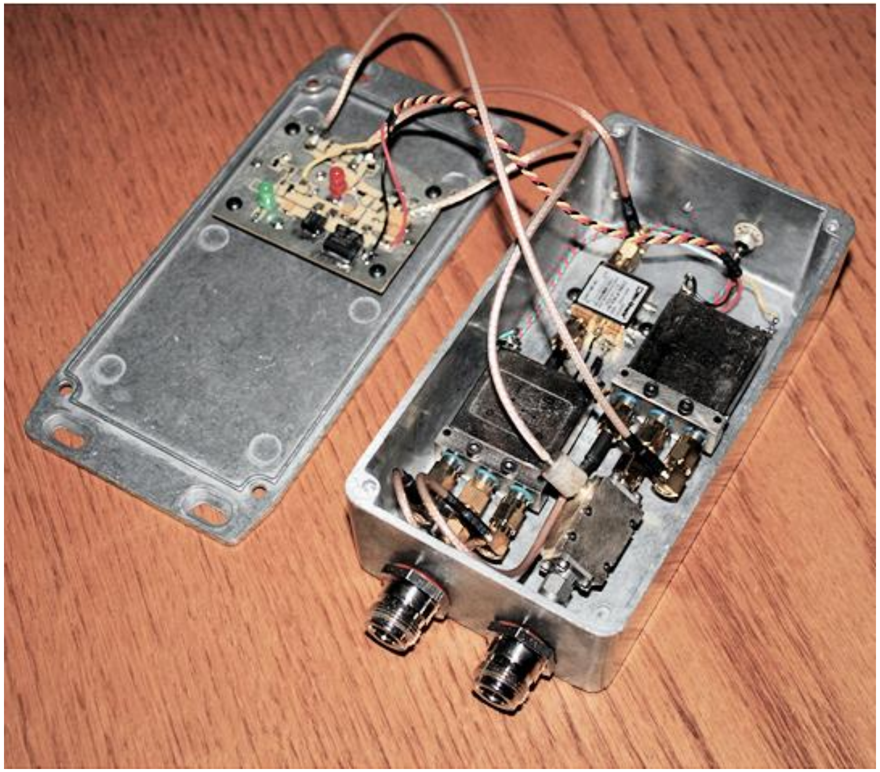
Sensitivity vs NF

SSB: 2.7 KHz BW, 10 dB S/N, 50 Ω
CW: 500 Hz BW, 6 dB S/N, 50 Ω



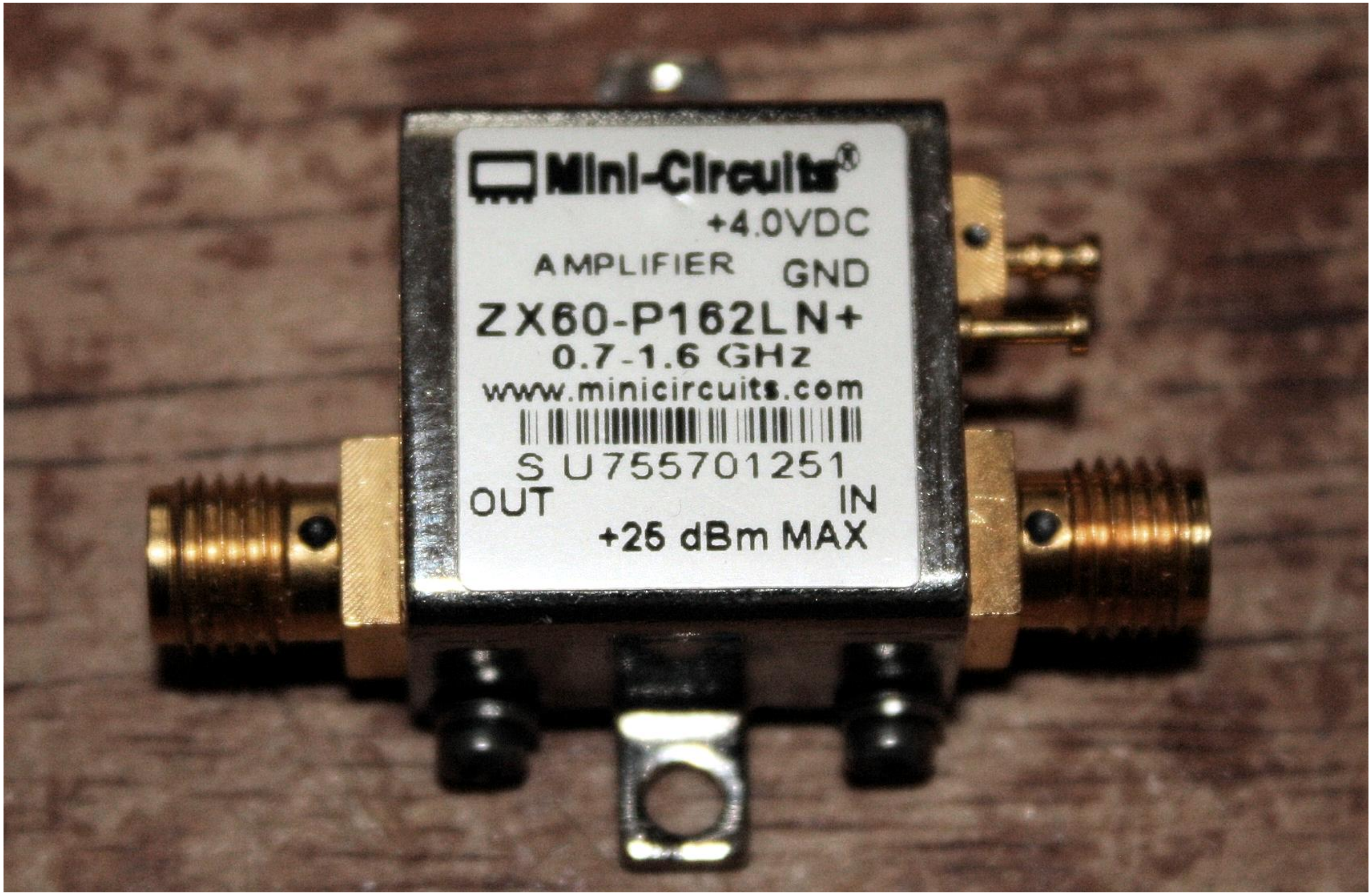
Remote 1296 MHz LNA

- Initial remote project was LNA
  - RF sensed switching
  - Minicircuits: ZX60-P162LN
  - 0.5 dB NF
  - +21 dB gain
  - BPF was not needed for 1296



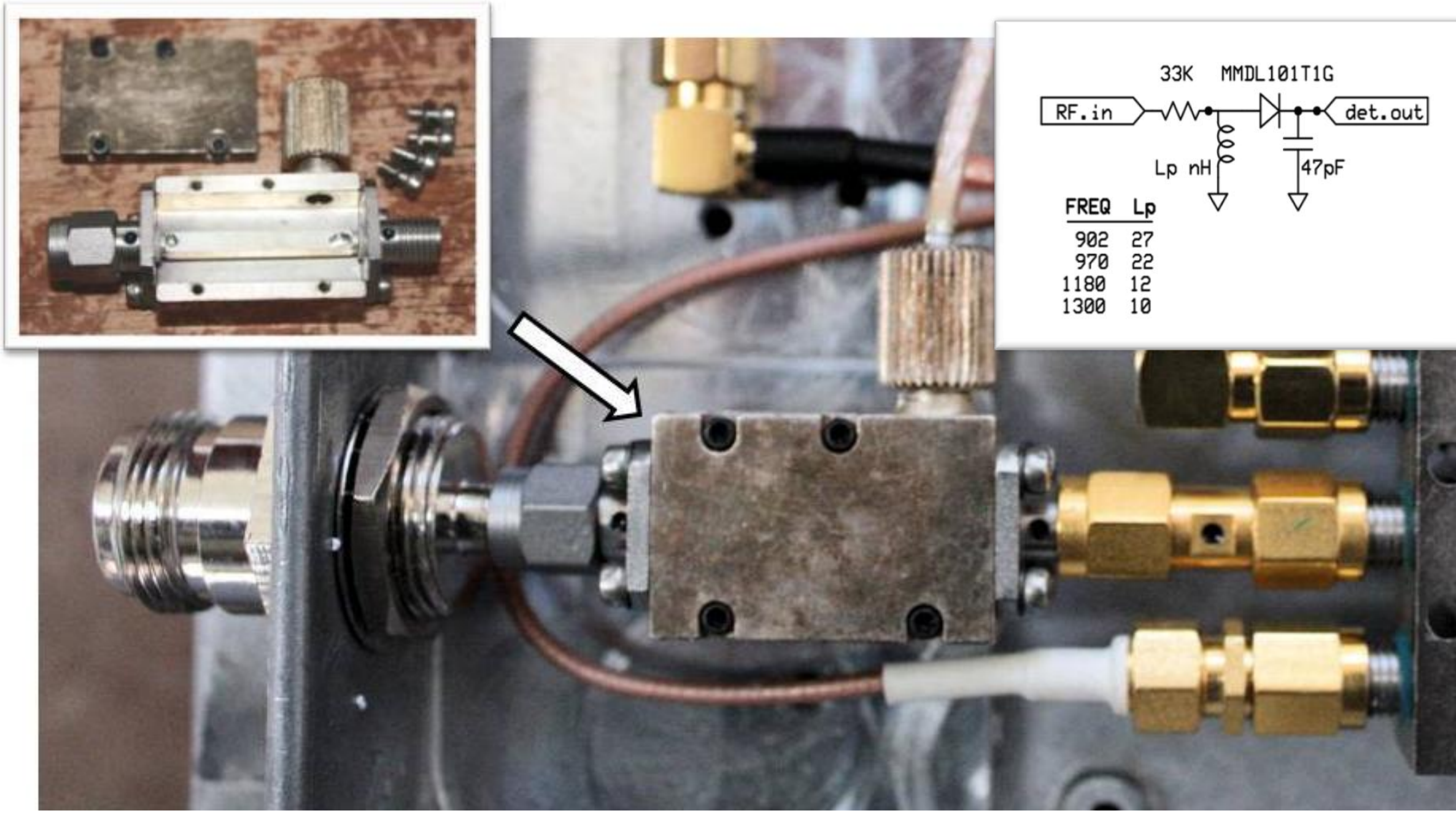
- Worked extremely well
  - Basis for receive side of LNA/PA unit presented here

LNA (NF ≤ 0.5 dB, G ≈ 21 dB)



Schottky Detector

CONTROL SENSITIVITY DOWN TO +13 dBm



Control Circuit

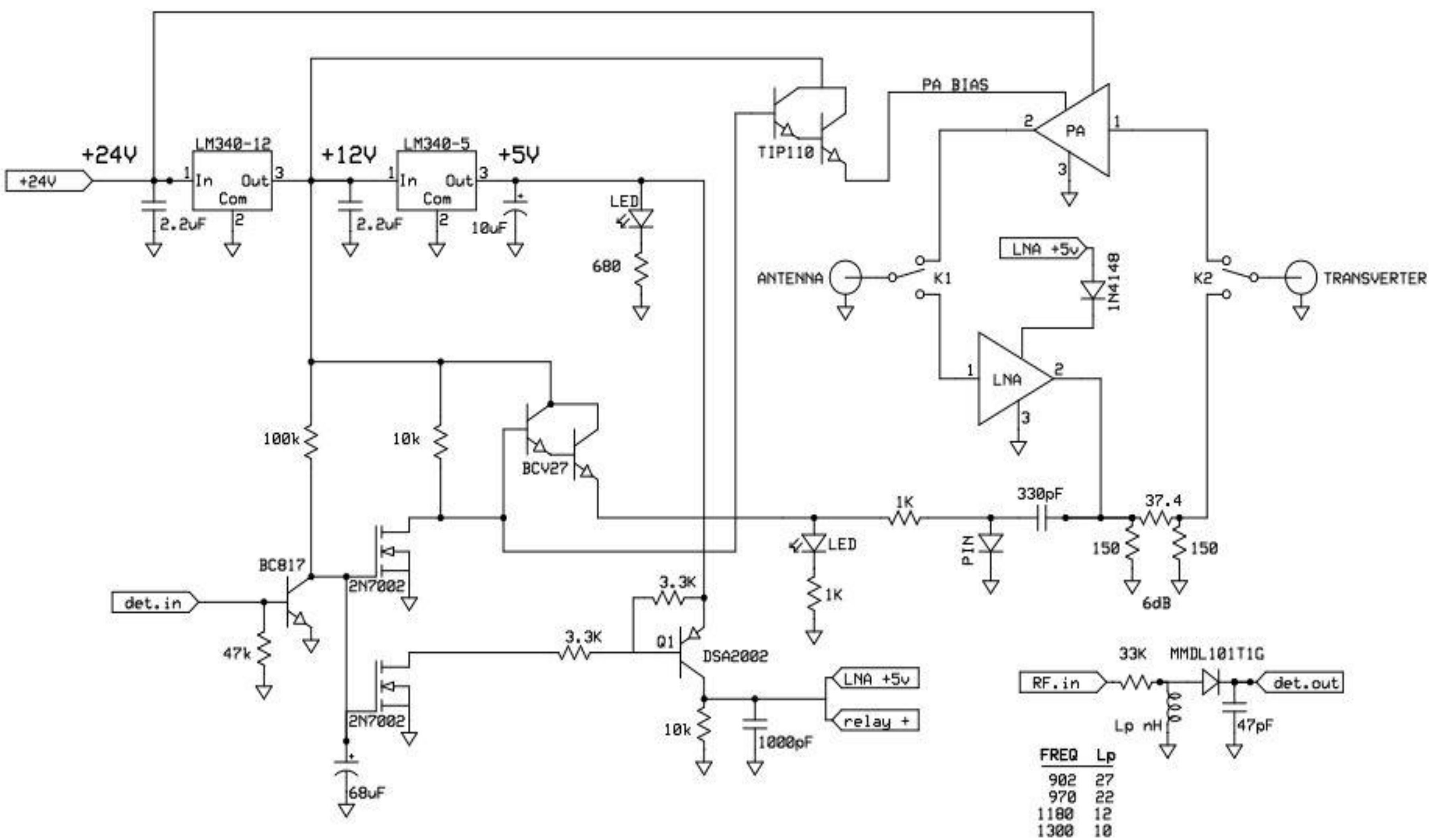
- RF sensed switching

- Protect the LNA in the unpowered state
- Switch the LNA on when in powered state

- When RF is detected:
  - PIN protect the LNA
  - Switch coaxial relays to TX state
  - Power off LNA
  - Apply gate bias to PA

- When RF is removed:
  - Delay switching to receive state (1 second)

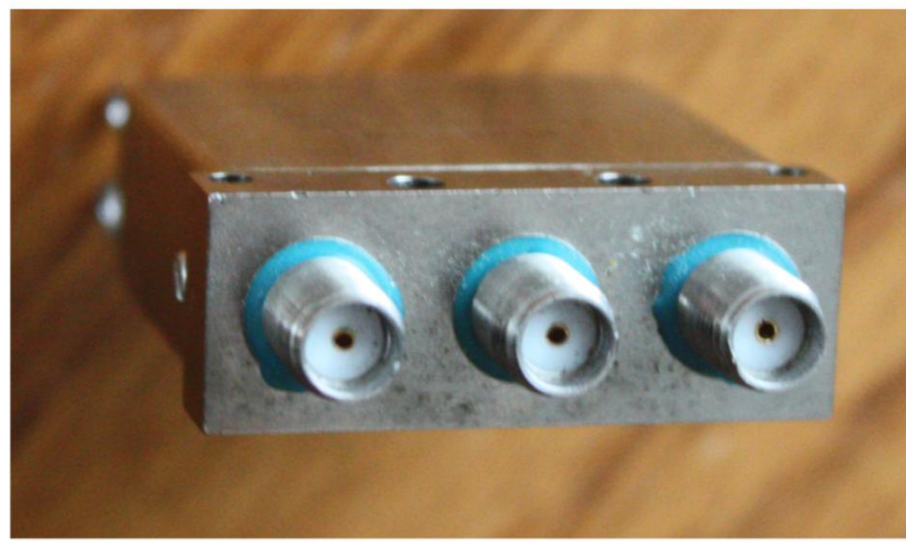
Remote Amplifier - Control Schematic



Coaxial Relays

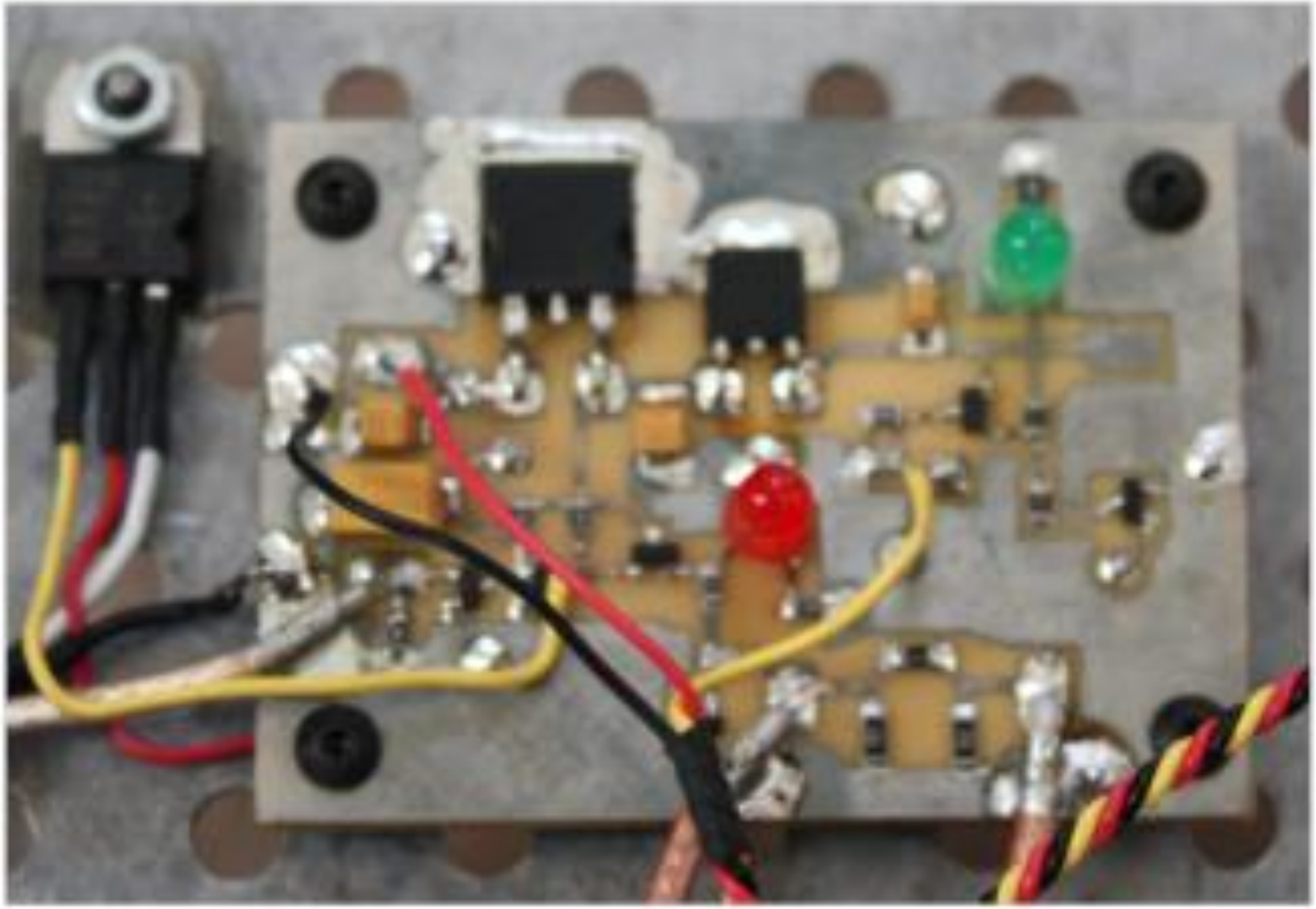
K&L Microwave

- 0.08 dB loss
- 33 dB return loss
- 90 dB isolation



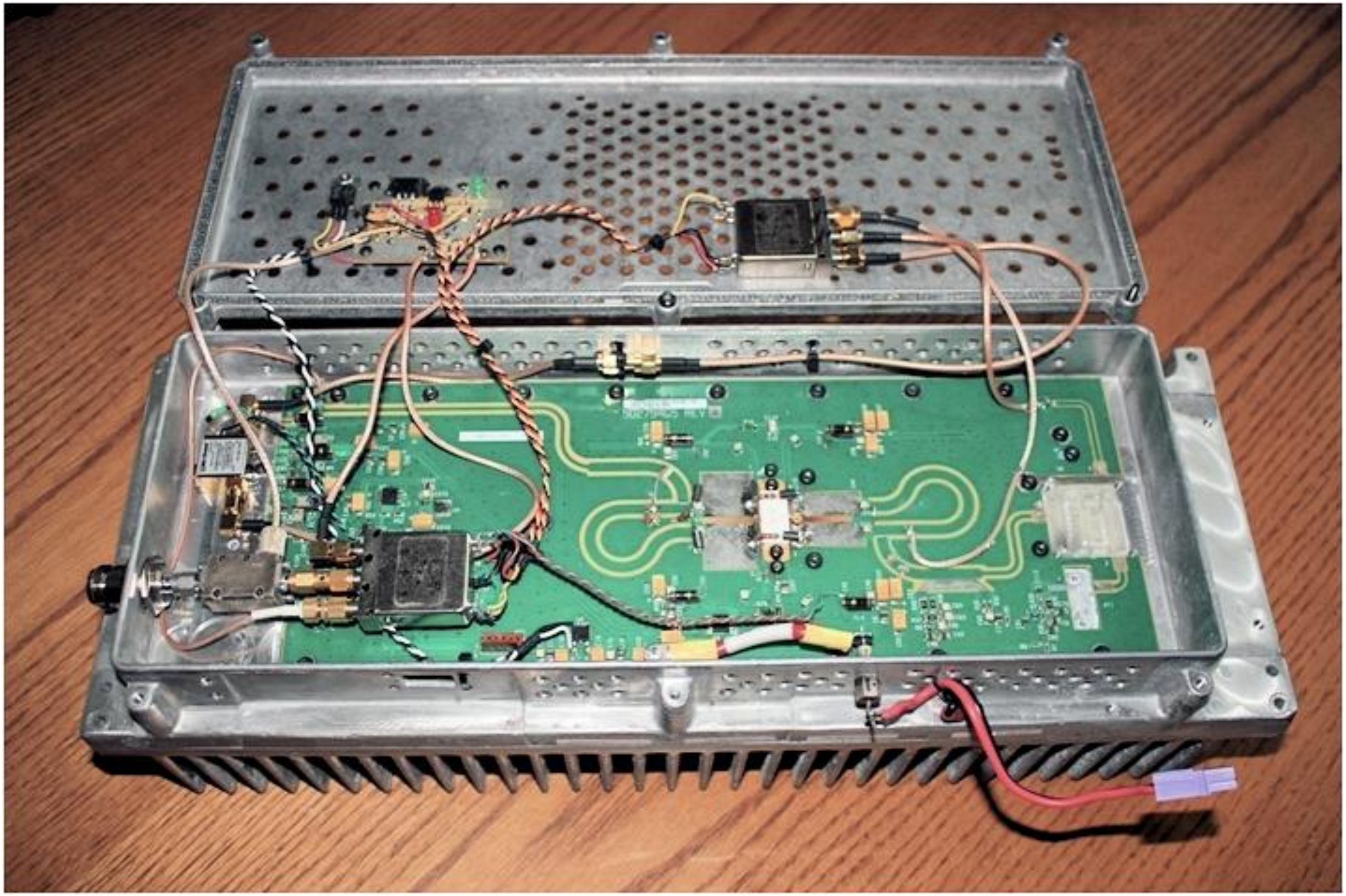
- SMA SPDT
- +28V powered
- +5V logic

Control Board

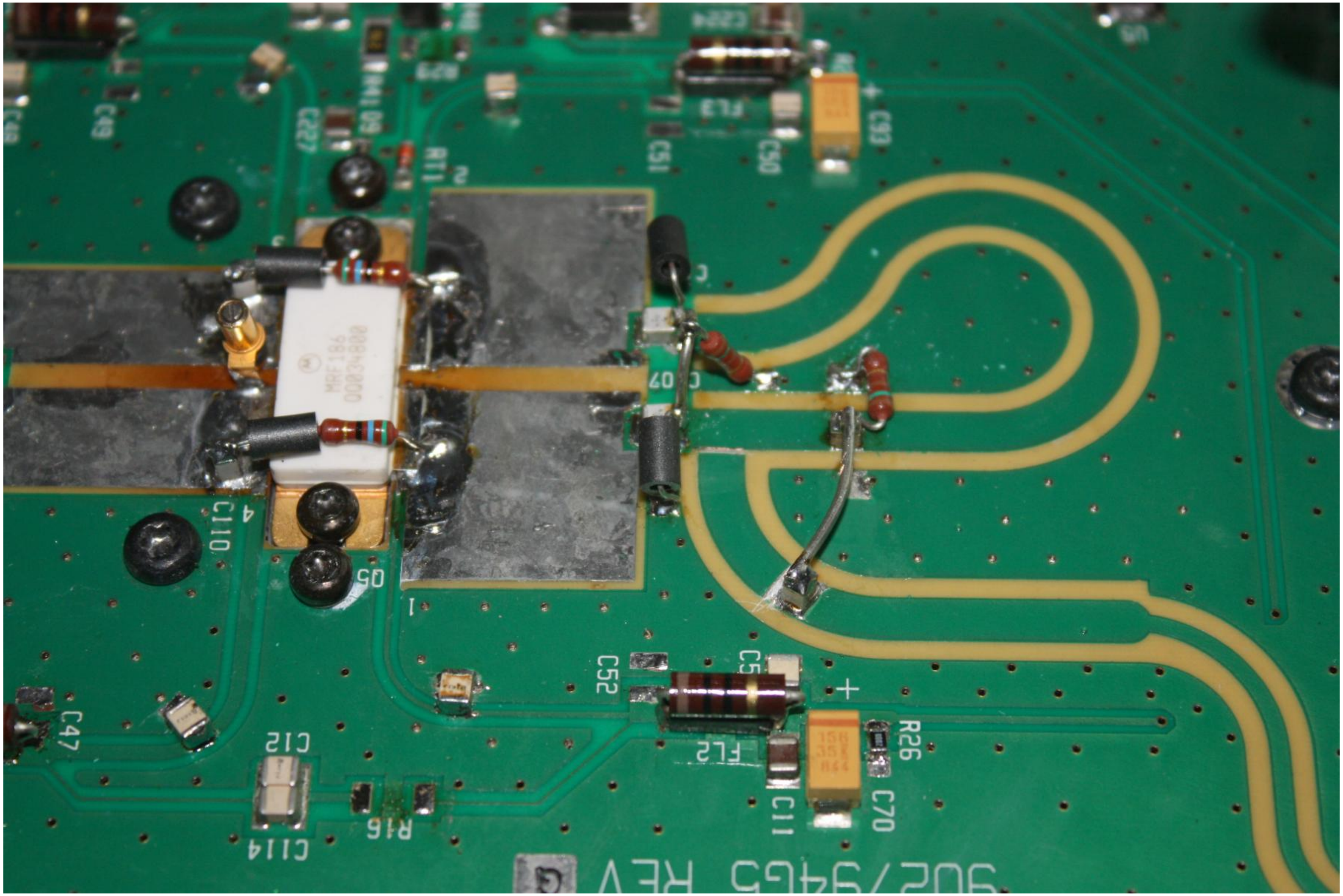


902 MHz and 1296 MHz Remote PA & LNA

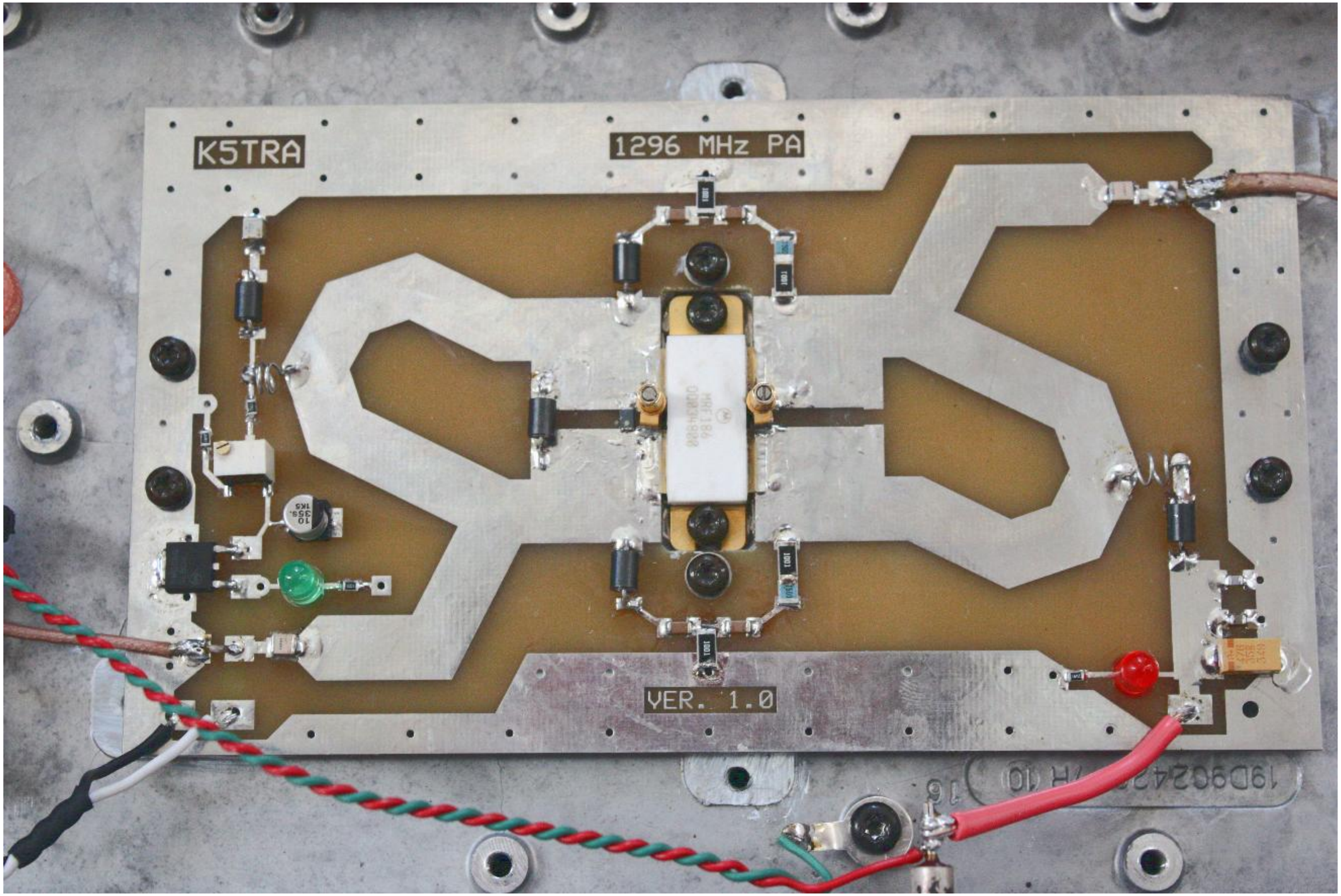
Initial 1296 MHz Remote PA & LNA



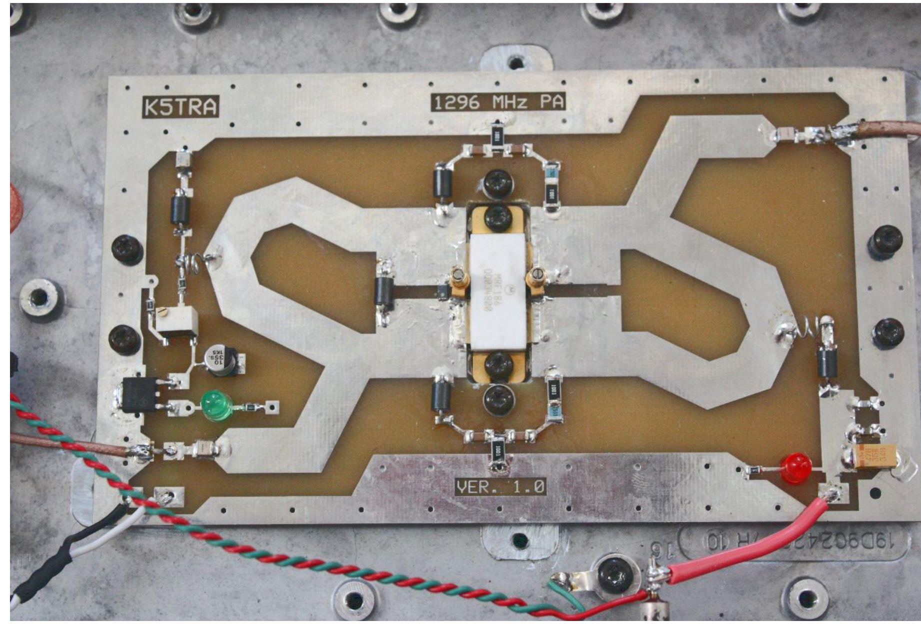
Initial Modified MASTR-III 860 MHz PA



Pushpull 100 W PA Board



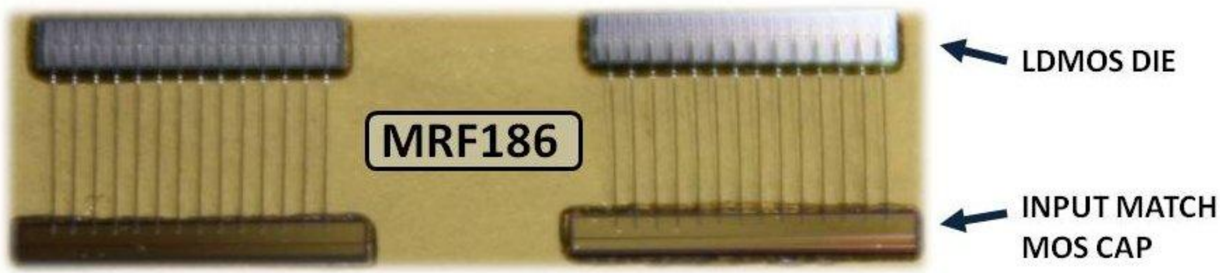
PA Details



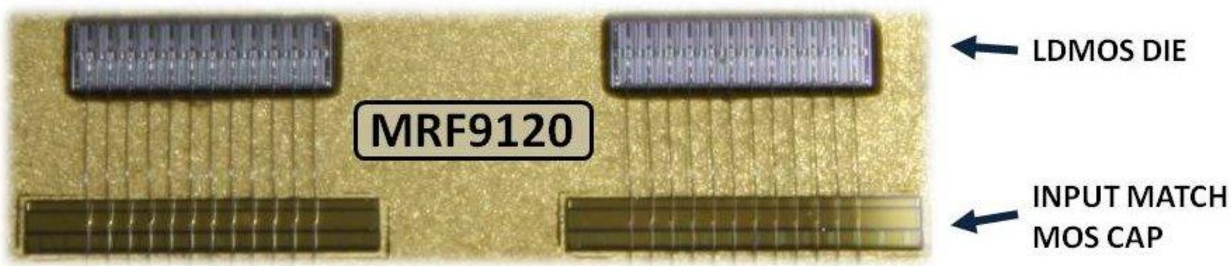
- Pushpull operation
- LDMOS MRF-186
- Low frequency negative FB for stability
- Dedicated bias regulator
- Inexpensive 0.062” FR4 - ExpressPCB

Remote 1296 MHz LNA

- MRF186
  - 5:1 rugged
  - 120W CW
  - θ = 0.80 °C/W
  - 1 GHz nominal

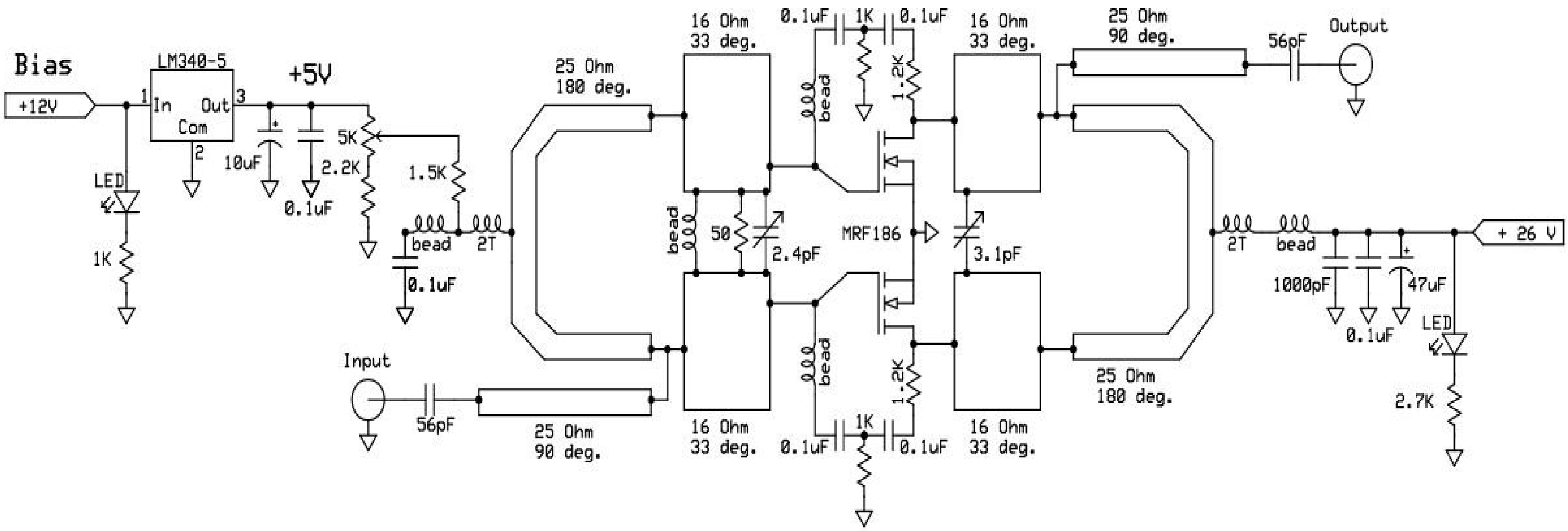


- MRF9120
  - 10:1 rugged
  - 120W CW
  - θ = 0.45 °C/W
  - 880 MHz nominal



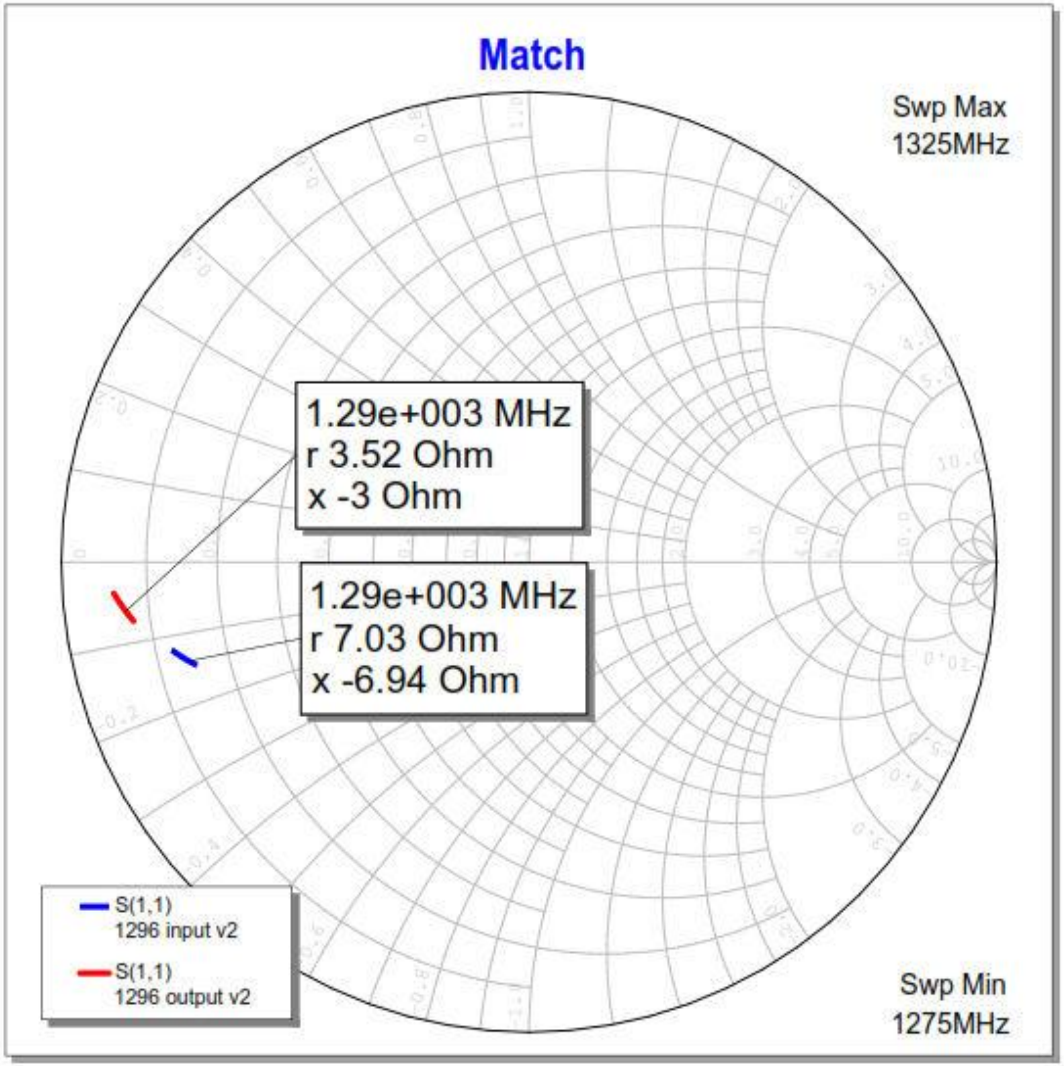
- **MRF186 selected** *despite thermal / ruggedness trafeoff*
  - Input internal matching of MRF9120 spoils 1296 MHz performance
    - Very hard to match MRF9120 at 1296 MHz
    - MRF9120 stability is challenged at 1296 MHz when matched

1296 PA Board Schematic

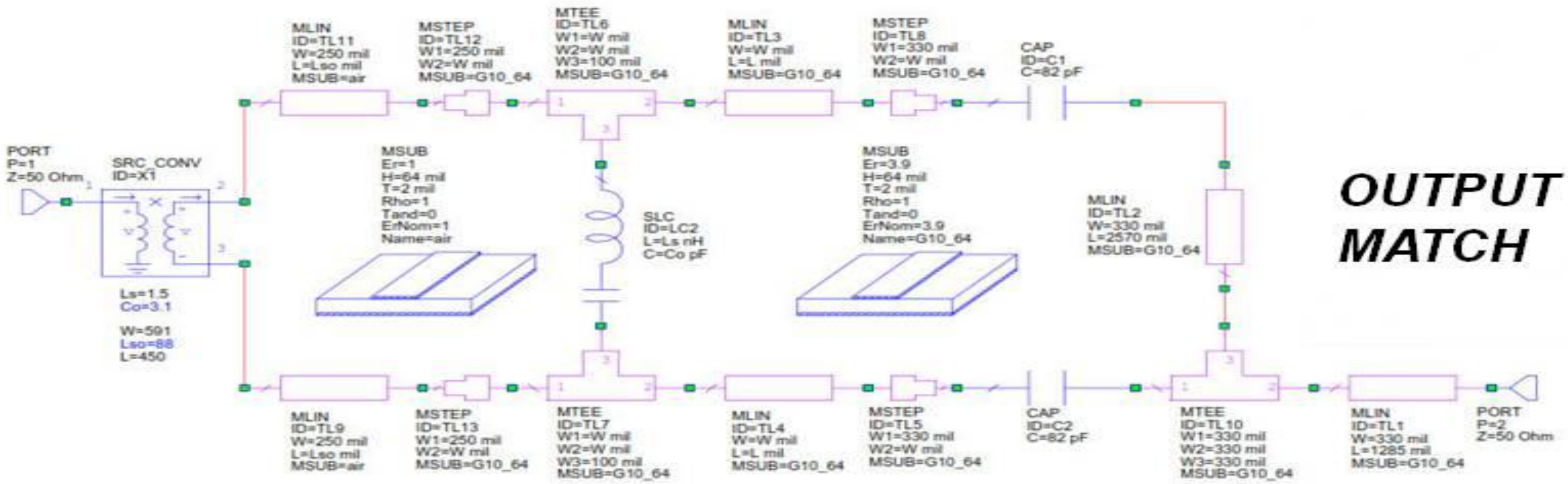


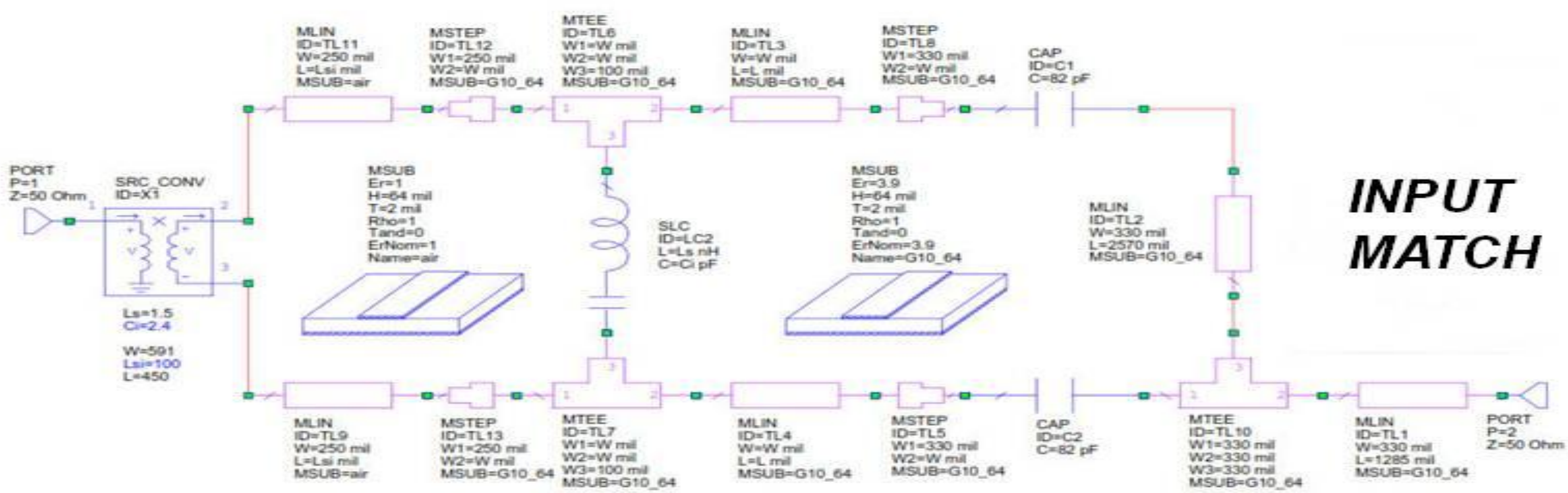
- Negative FB for low frequency stability
- $\frac{1}{2}\lambda$ delay line 4:1 balun to 25Ω ports
- $\frac{1}{4}\lambda$ line provides impedance transformation 50Ω to 12.5Ω

LDMOS PA Match Simulation

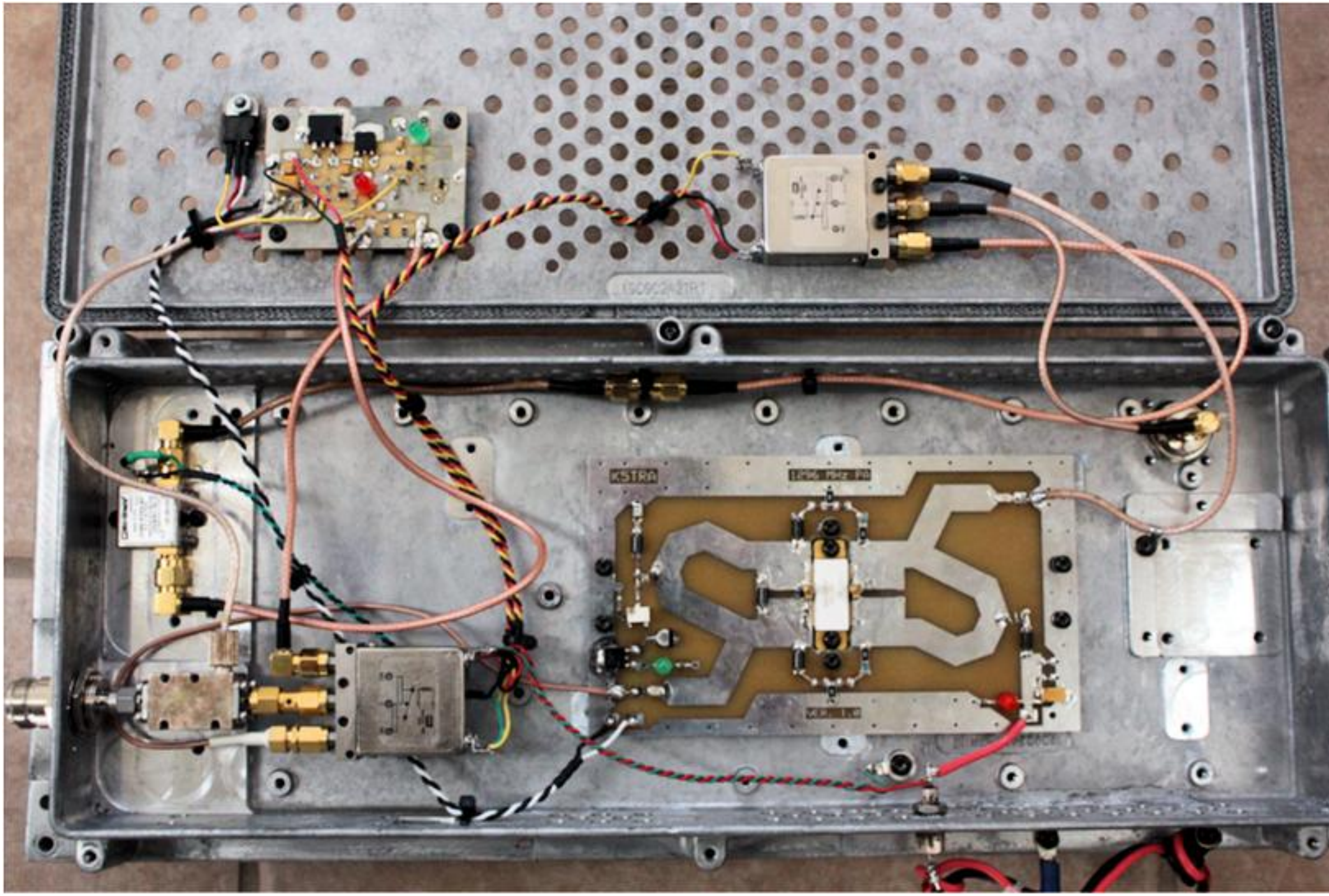


Matching Networks





1296 MHz Remote 100W PA and LNA

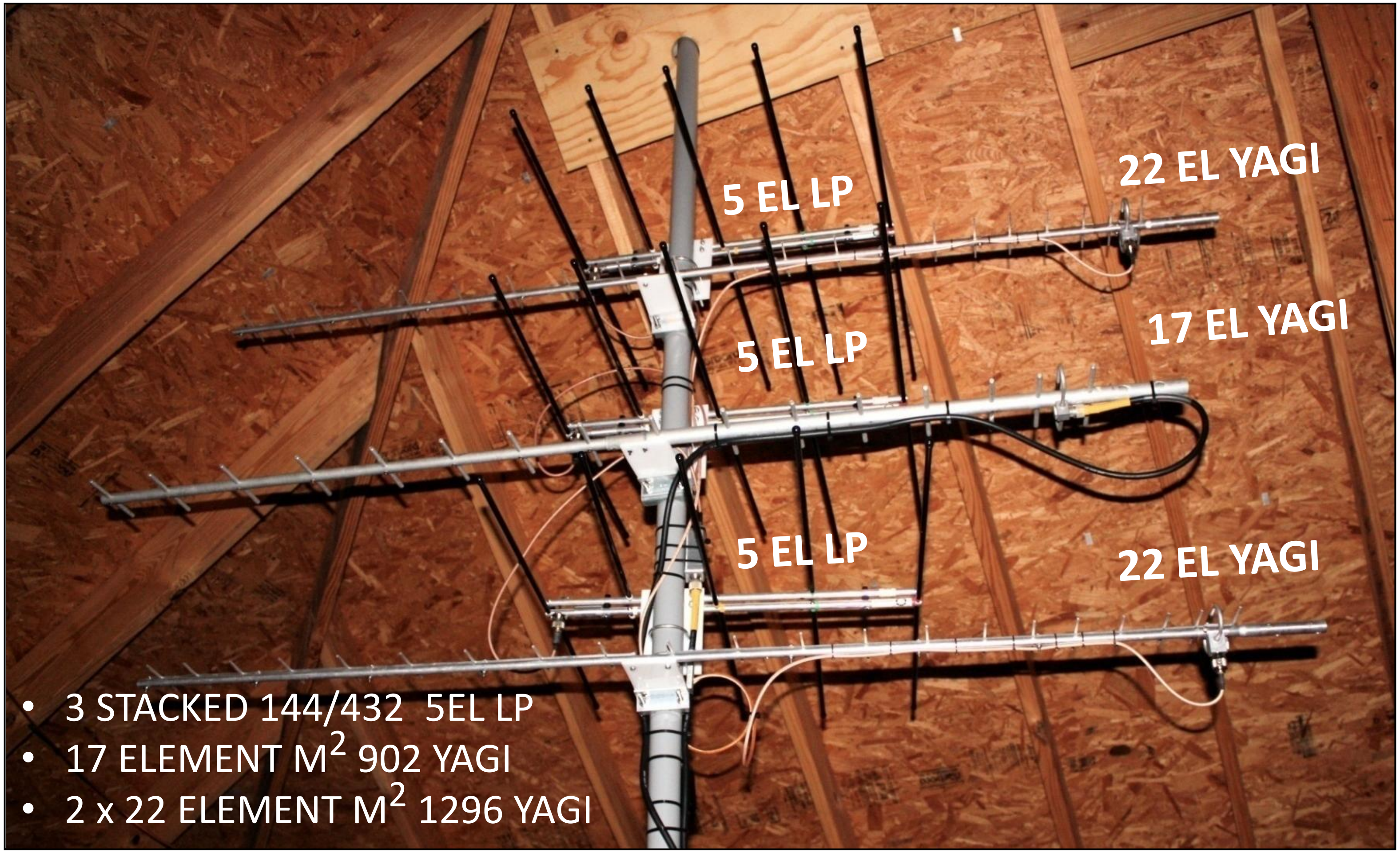


902 MHz and 1296 MHz Remote PA & LNA

Network IP Controlled Power-Strip

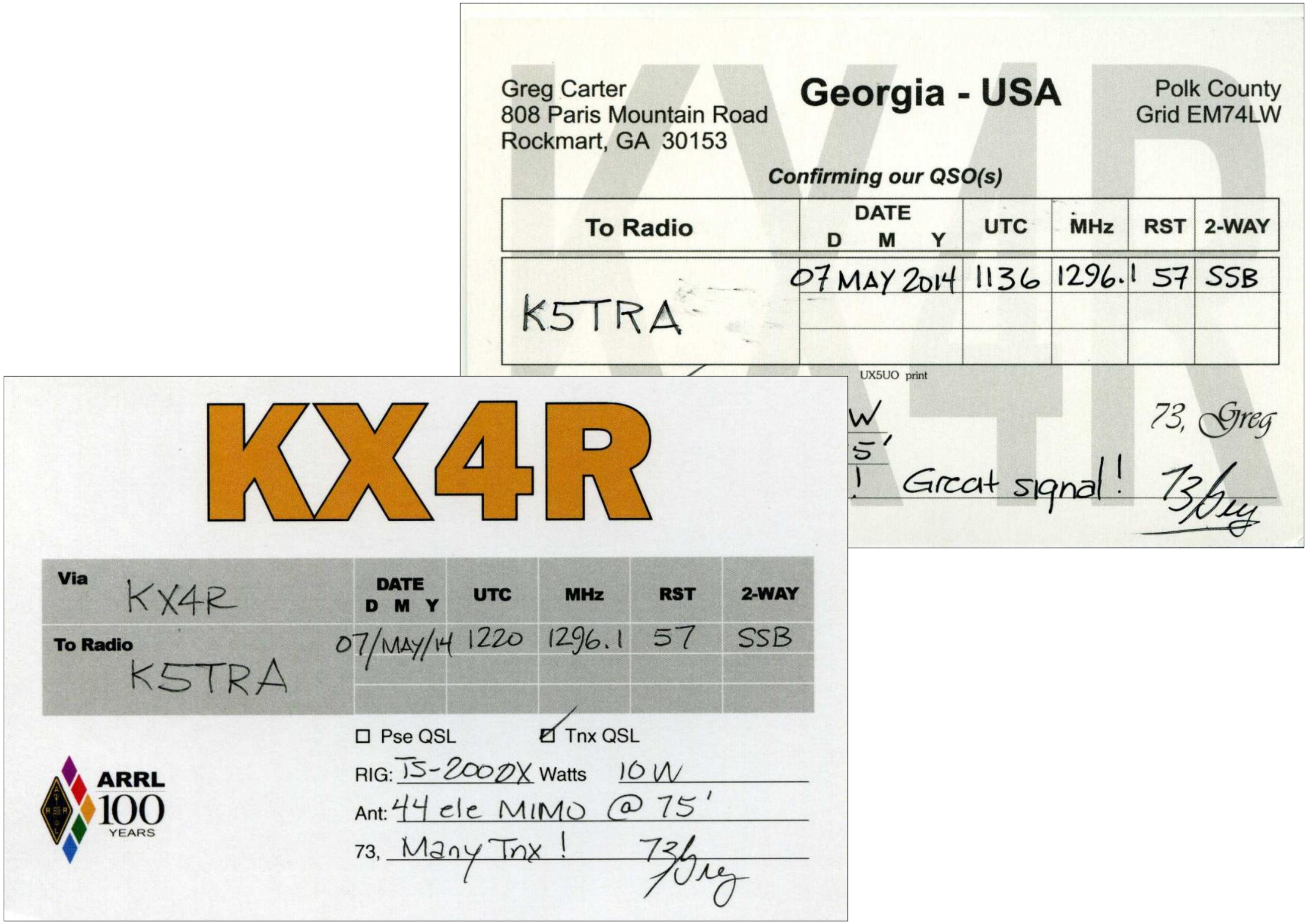
Remote PA and LNA power supply on-off control

Antennas



- 3 STACKED 144/432 5EL LP
- 17 ELEMENT M^2 902 YAGI
- 2 x 22 ELEMENT M^2 1296 YAGI

On Air Results



Summary

- Remote operation is key to performance:
  - Remote LAN : establish NF at antenna !
  - Remote PA : greater ERP (100’ LMR400 = 5 dB) !
- RF sensed keying can work very well if the detector is sensitive (tuned). +10 dBm to +13 dBm should key TX
- Control circuit must protect the LNA
- *Minicircuits* ZX60-P162LN LNA is a great value
- 100 W to 120W from MRF-186
- *ExpressPCB* board process: 0.062” FR-4
- On-Air results have been very good

Solid State Kilowatt Amplifiers

A tutorial on how to annoy your neighbors with modern LDMOS transistors

Which bands will we explore here?

- 6m, 2m, 222MHz and 70cm
(I'll sneak in a little 23cm also)

- 1.8 – 30MHz (fall 2014)

Can You Build One of These?

Sure, why not?

Another version

OK, so this isn't a VHF KW

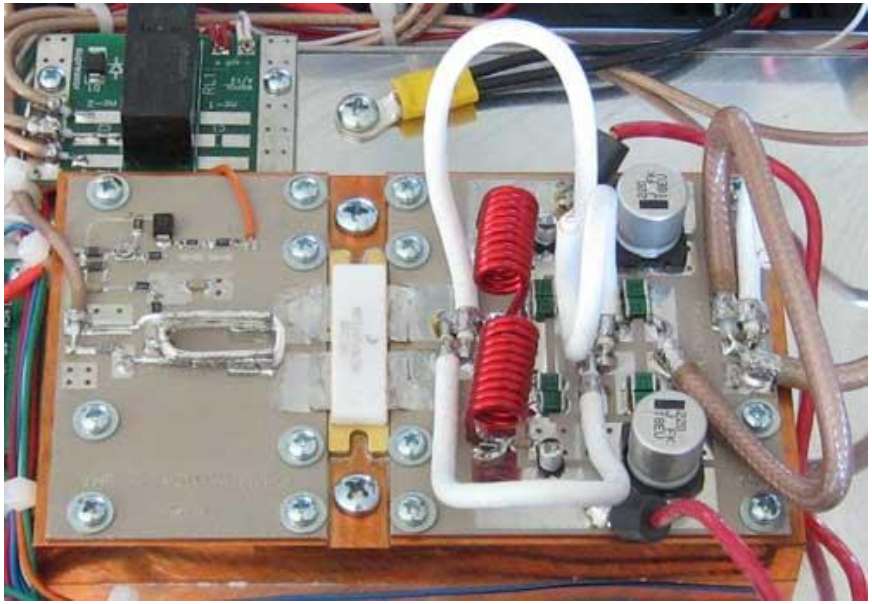
And this one is even smaller

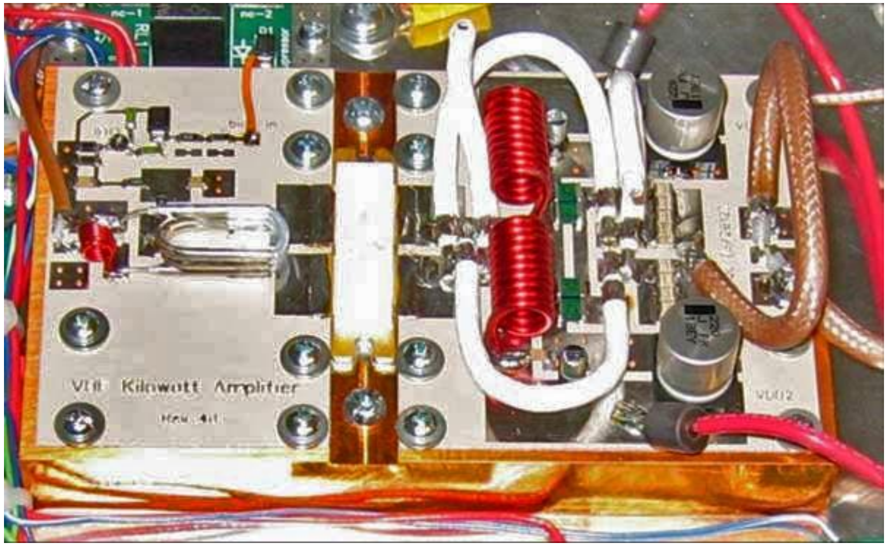
BIG LDMOS devices are available

At “reasonable” cost

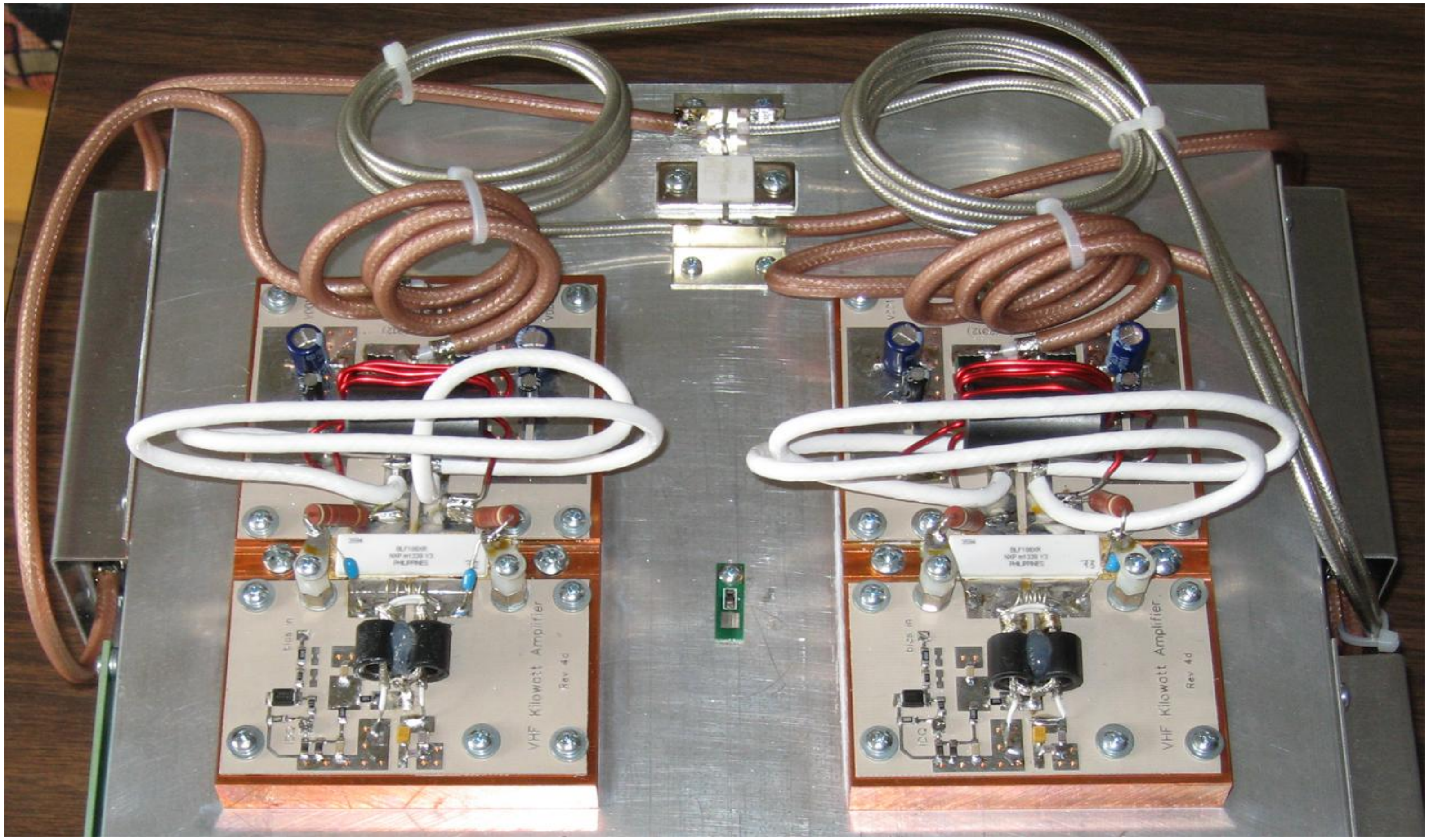
- **Freescale and NXP (Phillips)**
  - **MRFE6VP1K25H - 1.25kw (Freescale) HF to ~300MHz**
  - **MRFE6VP5600H – 600w (Freescale) HF to 450 MHz**
  - **BLF188XR -1.4KW (NXP) HF to ~300MHz**
  - **BLF184XR – 600w (NXP) HF to 450MHz**

VHF RF Decks





A Legal-Limit Version
(this one is a prototype for 6m)

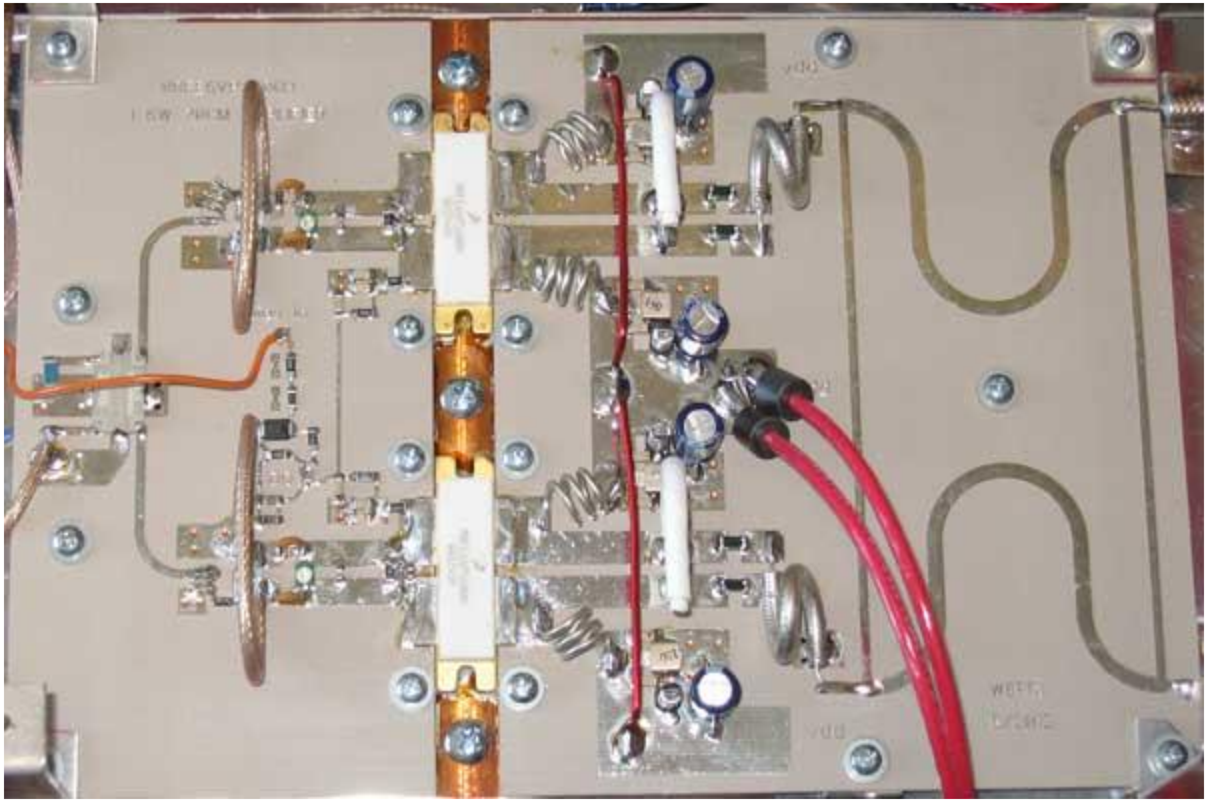


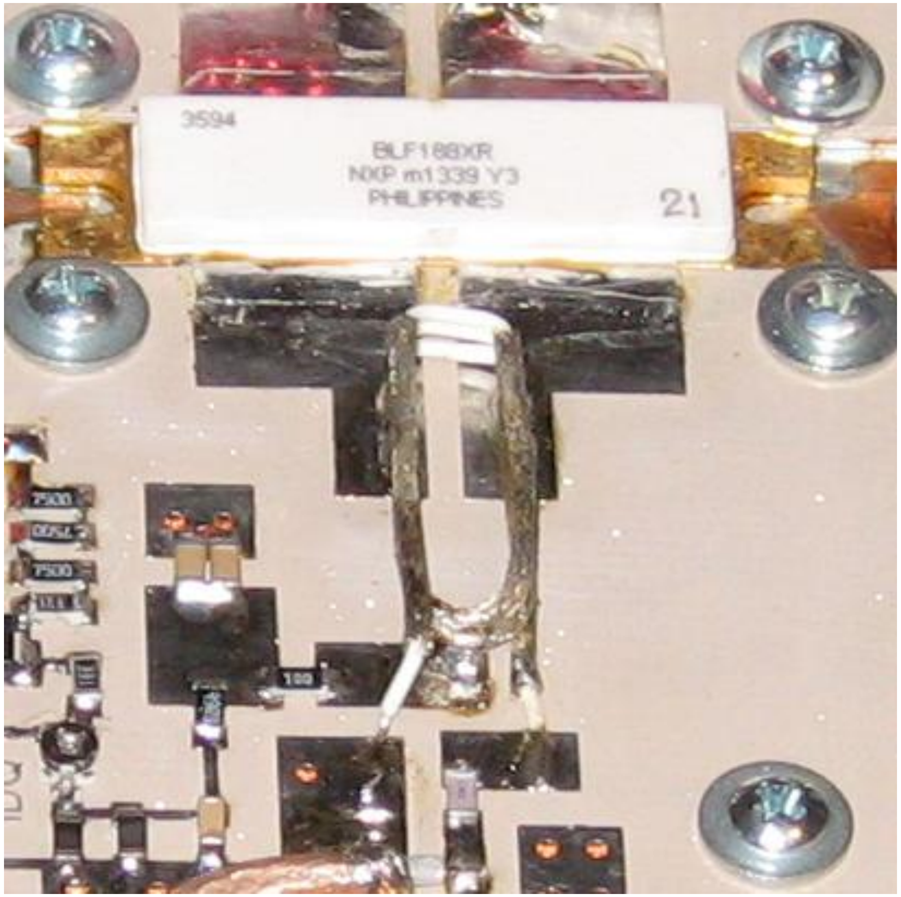
The Completed Legal-Limit 6 Meter Amplifier

70 CM is a different animal

70cm

- 1.25kw part produces ~350w with low efficiency
  - 600w part produces 500w at P1db with 53% efficiency
  - Two of the 600w parts produce 1kw at P1db with 53% efficiency



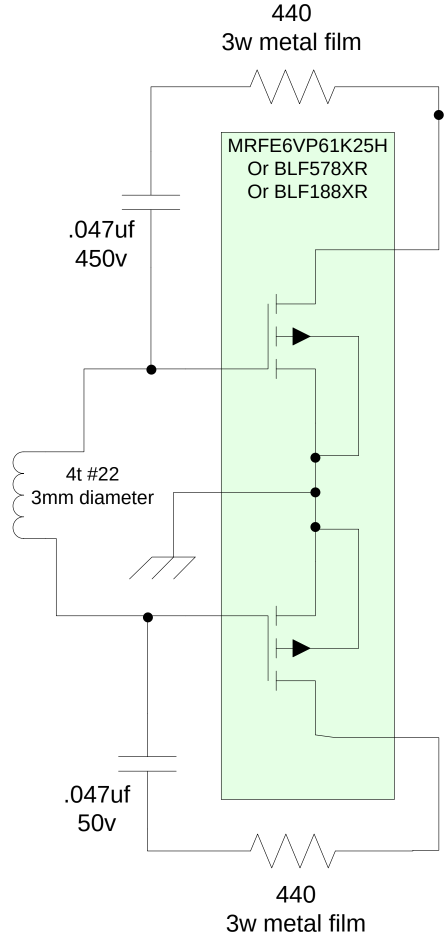


We must kill all of that extra low frequency gain. This design used for 2m and 222 has an ally in that battle, the input transformer. It’s nature at lower frequencies is to short the gates together

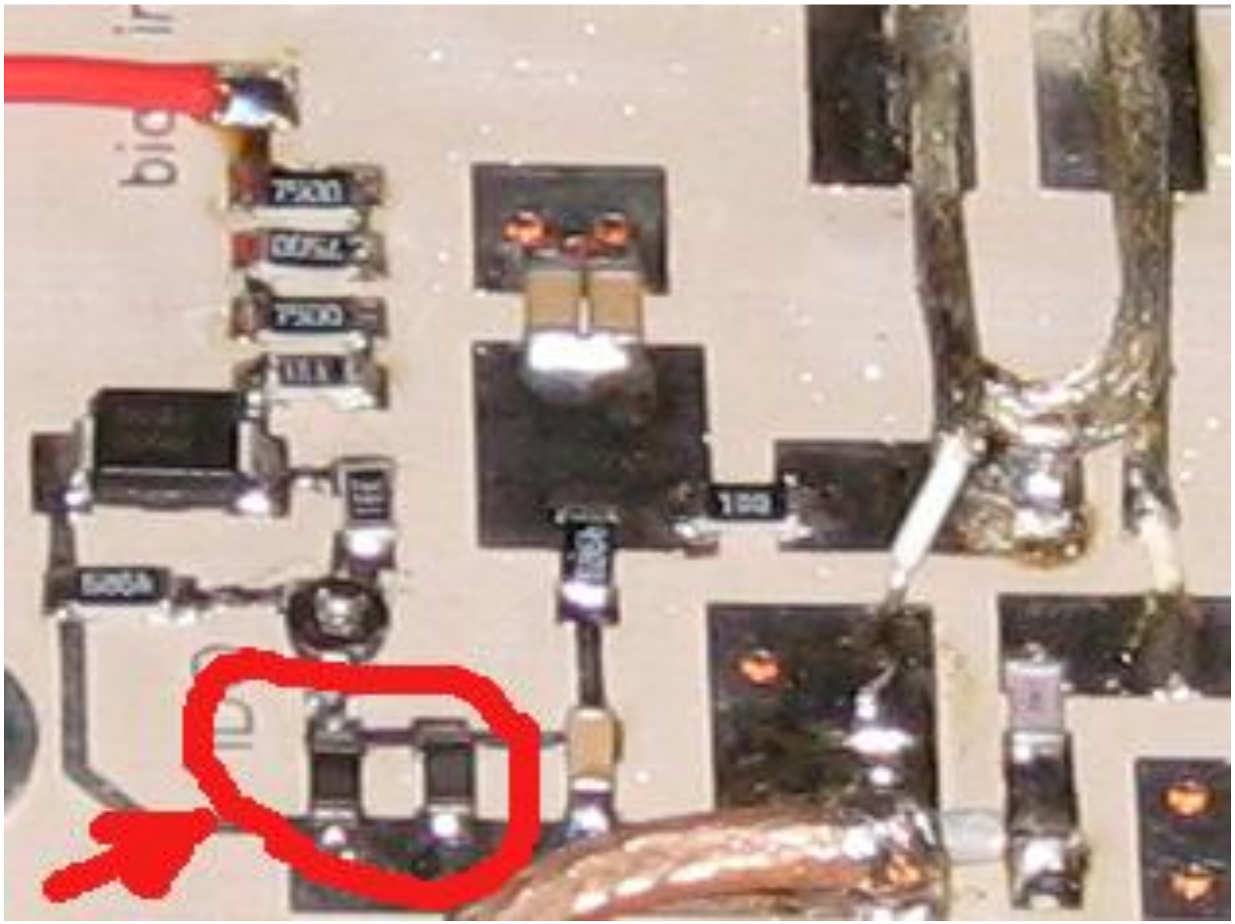
Design Cautions

1. All bands
   - Use good quality PC board substrate
   - Matching components (capacitors)
     - Best capacitor for matching is coaxial
   - Instability due to low frequency gain
     - Gate components
     - Degenertative feedback (res/cap in series drain to gate)

2. Bias stability (thermal drift)
   - LDMOS IDQ thermal drift
     - Use of thermistors for stabilization



Thermistor Location



Mounting of Degenerative Feedback Components on 70cm KW board

Where to Find Design Info

- Manufacturer reference designs
- Dubus magazine
- QST and QEX magazine
- Web sites
  - www.w6pql.com
  - F1JRD
  - Many others

Critical Parts

1. LDMOS distributors
   - Newark Electronics www.newark.com (Freescale)
   - RFMW Limited http://www.rfmw.com/ (NXP)
   - Digikey www.digikey.com
   - Mouser www.mouser.com
   - Richardson RFPD www.richardsonrfpd.com (Freescale)

Critical Parts

High power RF capacitors

- Metal Micas
  - Mouser
  - Digikey
  - Communication Concepts www.communication-concepts.com/
- SMT micas (CDE MC series)
  - Mouser
- Coaxial matching capacitors
  - Self-made

More Critical Parts

Inductors and transformers

- Communication Concepts
- Mouser
- Self-wound RF chokes and transformers

Coax (special stuff, 10, 12, and 25 ohm)

- Communication Concepts
- RF Elettronica www.rfmicrowave.it
- EBay (50 Ohm RG401,RG402, RG316, RG142)

More Critical Parts

Terminations

- Richardson RFPD
- RFMW Limited (Florida RF labs terminations)
- EBay

High power RF resistors and attenuators

- Richardson RFPD (ATC attenuators)
- Newark (Johanson attenuators)
- Mouser (high power resistors for attenuators)

More Critical Parts

Relays and transfer switches

- RFPARTS (www.rfparts.com) - Tohtsu, Dow Key
- Surplus Sales of Nebraska - Tohtsu, Dow Key
- EBay
- WWW.W6PQL.COM (input relay board)

PC boards

- Communications Concepts
- RFHAM
- WWW.W6PQL.COM

More Critical Parts

Copper spreaders

- RFHAM
- WWW.W6PQL.COM

Aluminum heat sinks

- www.heatsinkusa.com
- WWW.W6PQL.COM (fully machined to accept spreaders)

Cabinets and panels

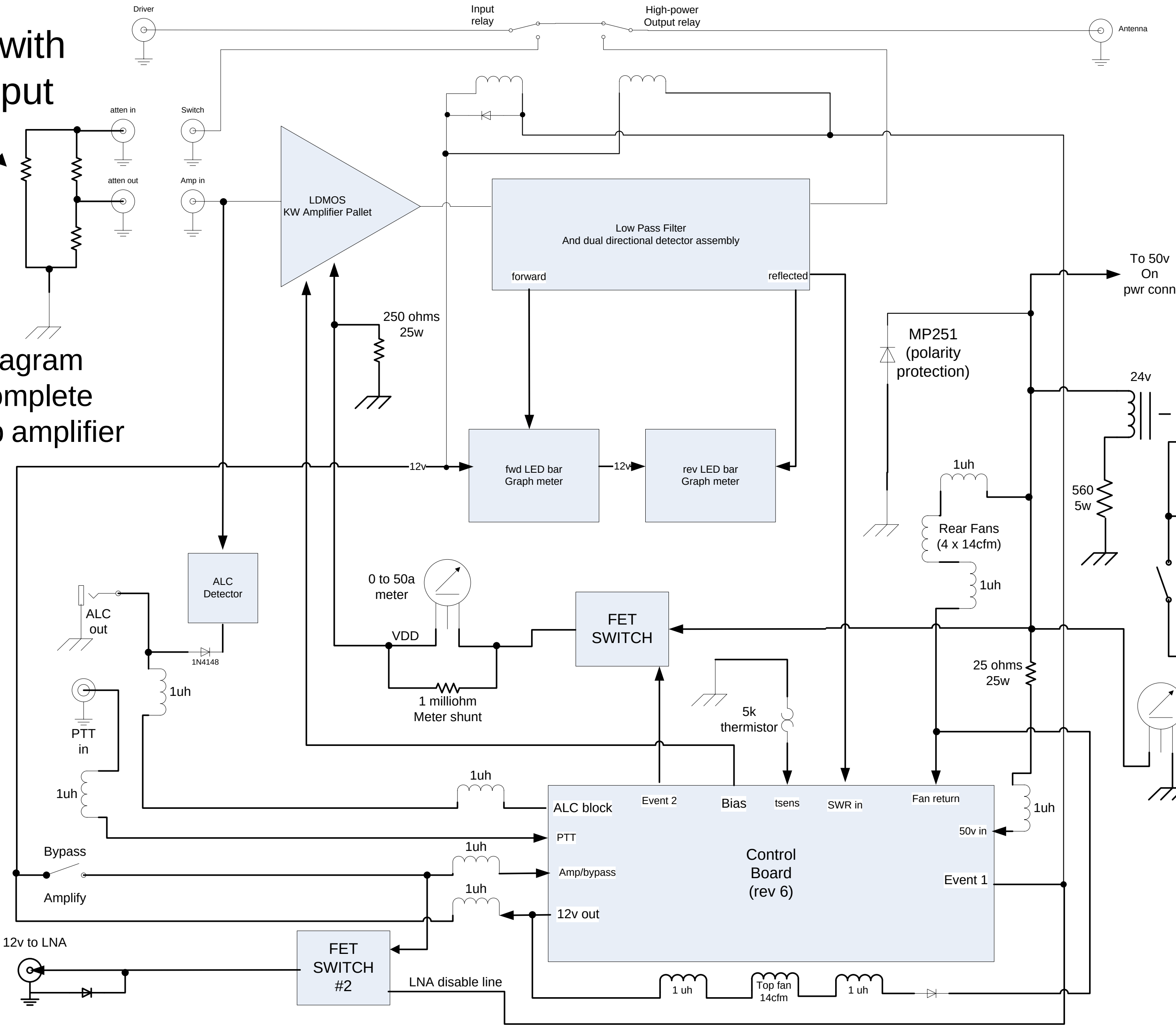
- www.frontpanelexpress.com

OK, you have an RF Deck

Now what?

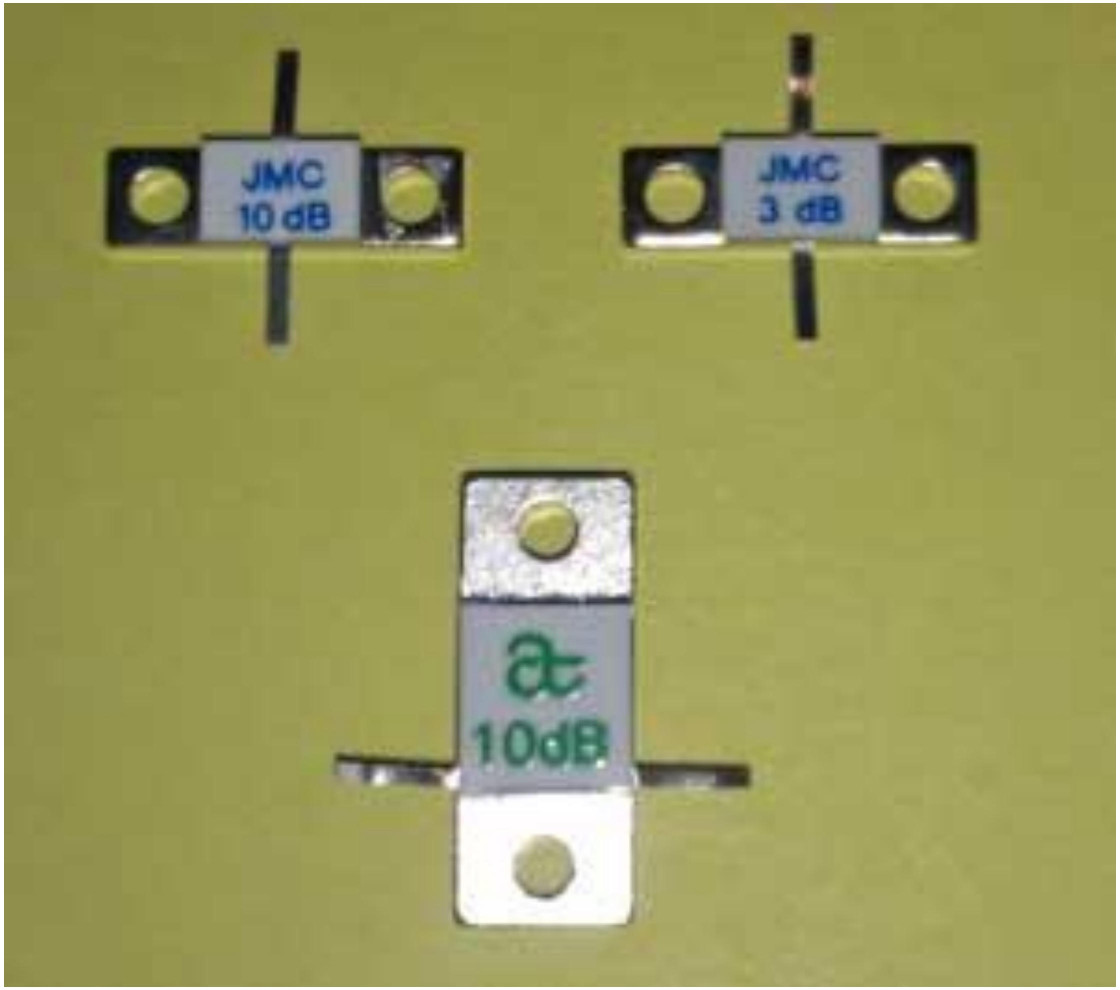
Start with the input

Block diagram
For a complete
Desktop amplifier

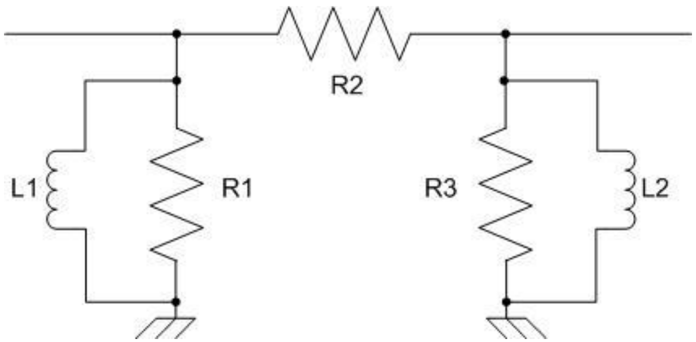


Flange-Mount Attenuators

- Available in 3,6,10,20 and 30 db packages (availability varies)
- Made by ATC and Johanson
- 100 watt package
- Requires transistion boards



A more flexible option



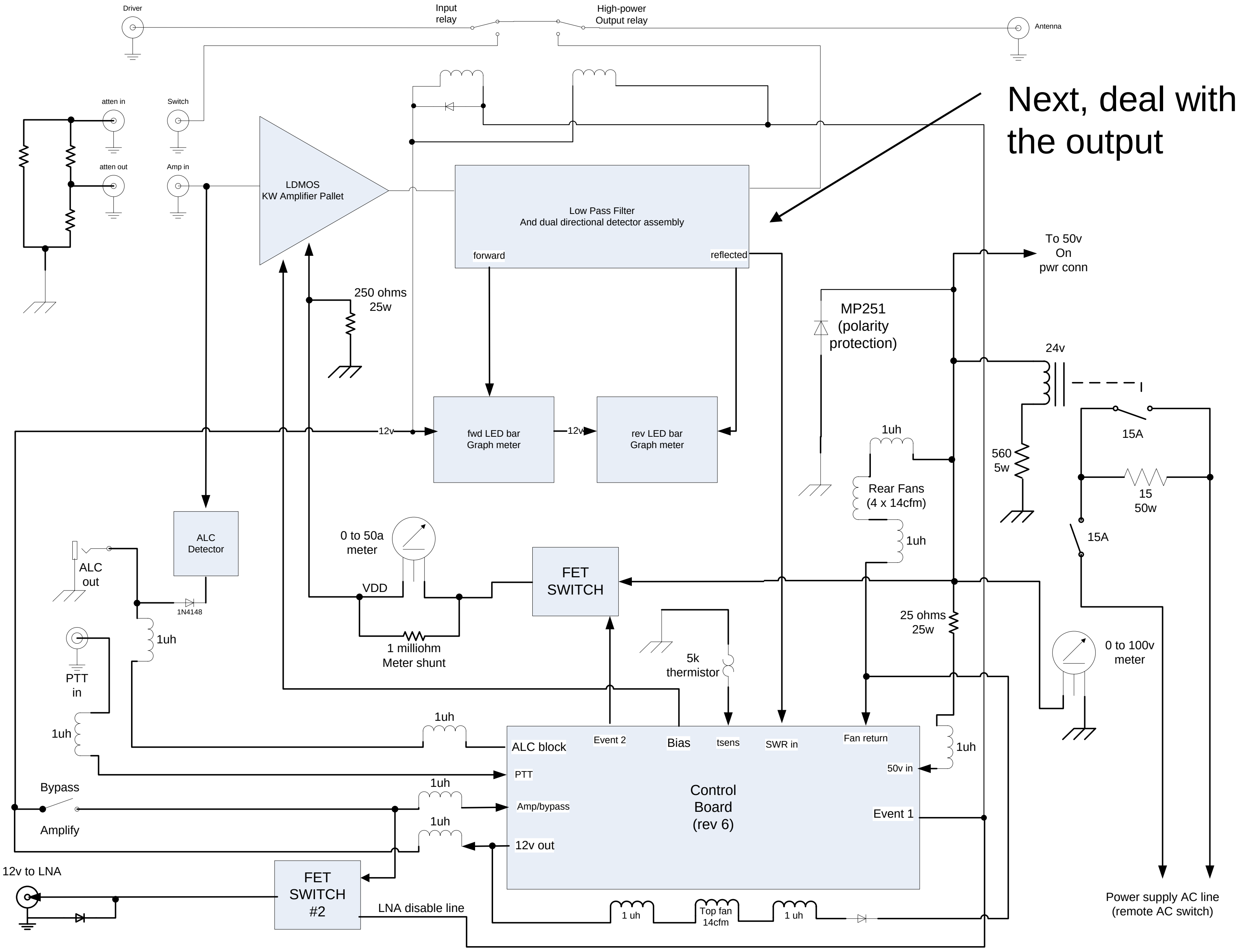
Attenuator setup

432 MHz	3db	6db	10db	13db	16db
R1	300 – 15w	100 - 15w	100 – 30w	75 -30w	
R2	15 -15w	50 – 15w	75 – 15w	100 – 15w	
R3	300 -15w	Not used	100 – 15w	75 – 15w	
L1	27nh	3 turns #22 3mm dia, space-wound input inductor; position across R1 terminals near body	8.5nh inductor 3 turns #22, 3mm id, 8mm long; position across R1 terminals near body	8.5nh inductor 3 turns #22, 3mm id, 8mm long; position across R1 terminals near body	
L2	27nh	33nh	27nh	27nh	

222 MHz	3db	6db	10db	13db	16db
R1		100 – 15w			
R2		50 -15w			
R3		Not used			
L1		120nh			
L2		220nh			

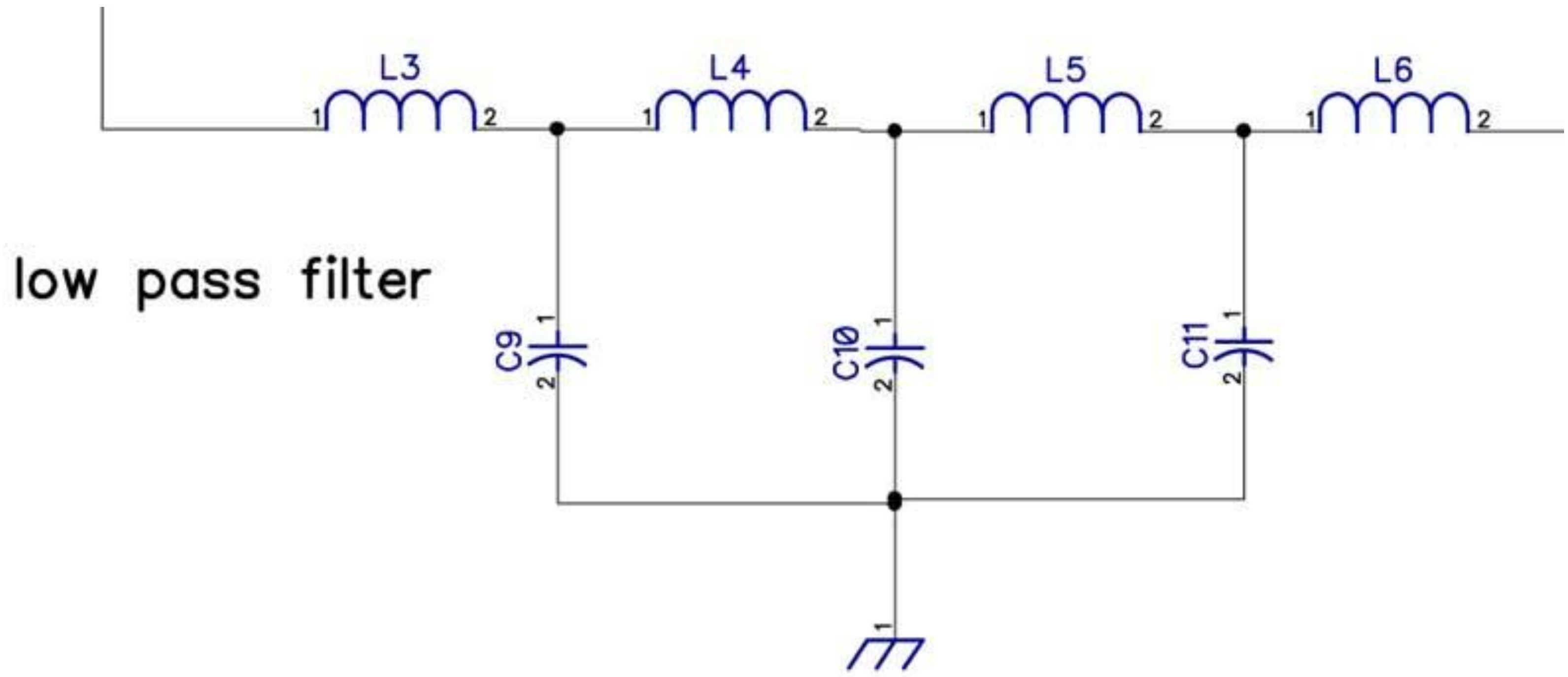
144 MHz	3db	6db	10db	13db	16db
R1	300 – 15w	100 – 15w	100 – 30w	75 -30w	75 – 100w
R2	15 -15w	50 -15w	75 – 15w	100 – 15w	150 – 30w
R3	300 -15w	Not used	100 – 15w	75 – 15w	75 – 15w
L1	330nh	270nh	220nh	220nh	120nh
L2	330nh	560nh	330nh	330nh	270nh

50 MHz	3db	6db	10db	13db	16db
R1	300 – 15w	100 – 15w	100 – 30w	75 -30w	75 – 100w
R2	15 -15w	50 -15w	75 – 15w	100 – 15w	150 – 30w
R3	300 -15w	Not used	100 – 15w	75 – 15w	75 – 15w
L1	Not used	Not used	Not used	Not used	Not used
L2	Not used	Not used	Not used	Not used	Not used



Next, deal with the output
Driver
Input relay
High-power Output relay
Antenna
atten in
Switch
atten out
Amp in
LDMOS KW Amplifier Pallet
Low Pass Filter And dual directional detector assembly
forward
reflected
To 50v On pwr conn
MP251 (polarity protection)
24v
250 ohms 25w
12v
fwd LED bar Graph meter
12v
rev LED bar Graph meter
1uh
560 5w
15A
Rear Fans (4 x 14cfm)
15 50w
1uh
15A
ALC Detector
ALC out
1N4148
0 to 50a meter
VDD
FET SWITCH
1uh
1 milliohm Meter shunt
25 ohms 25w
0 to 100v meter
5k thermistor
PTT in
1uh
1uh
ALC block
Event 2
Bias
tsens
SWR in
Fan return
1uh
50v in
PTT
Bypass
1uh
Amp/bypass
Control Board (rev 6)
Event 1
Amplify
1uh
12v out
12v to LNA
FET SWITCH #2
LNA disable line
1 uh
Top fan 14cfm
1 uh
Power supply AC line (remote AC switch)

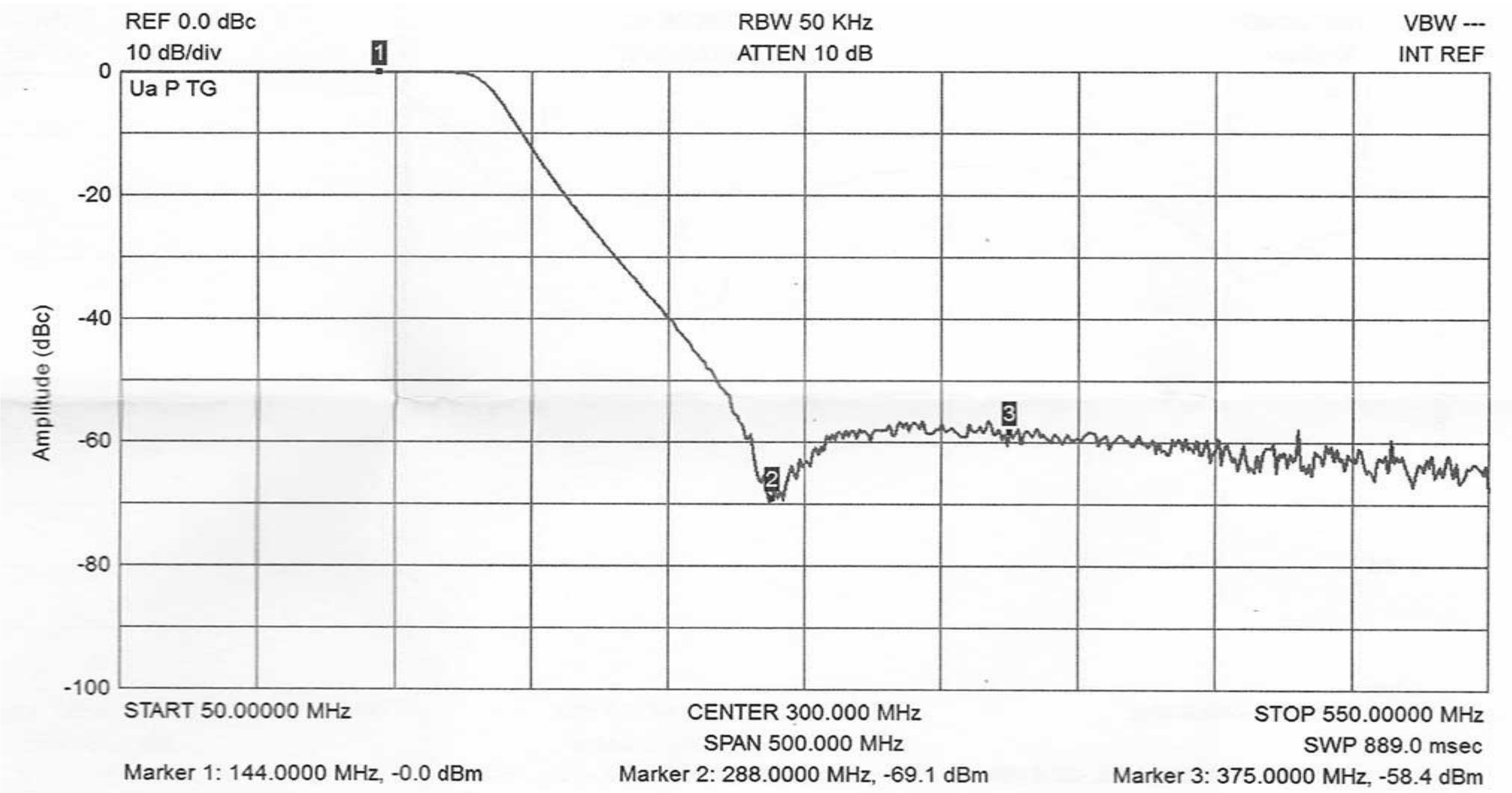
Low Pass Filter



Low Pass Filter

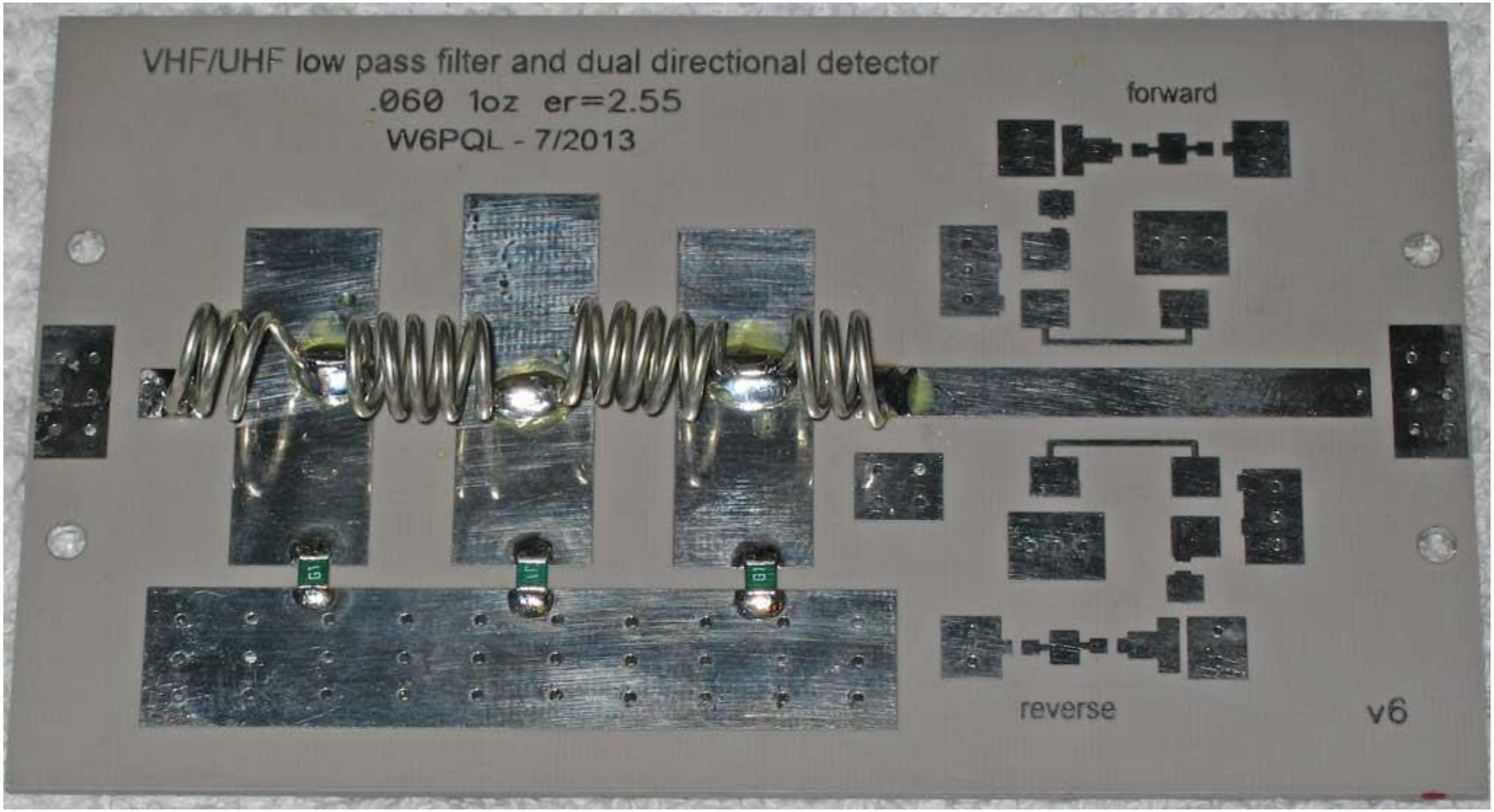
Filter Passband

2m setup

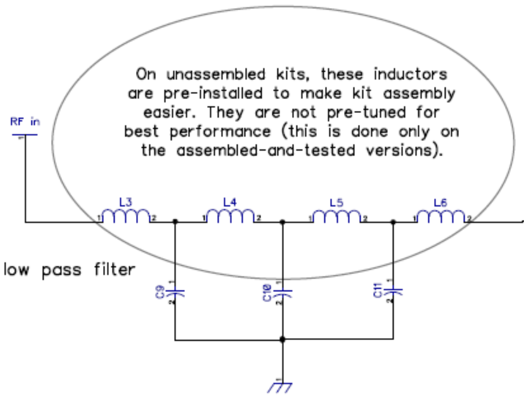


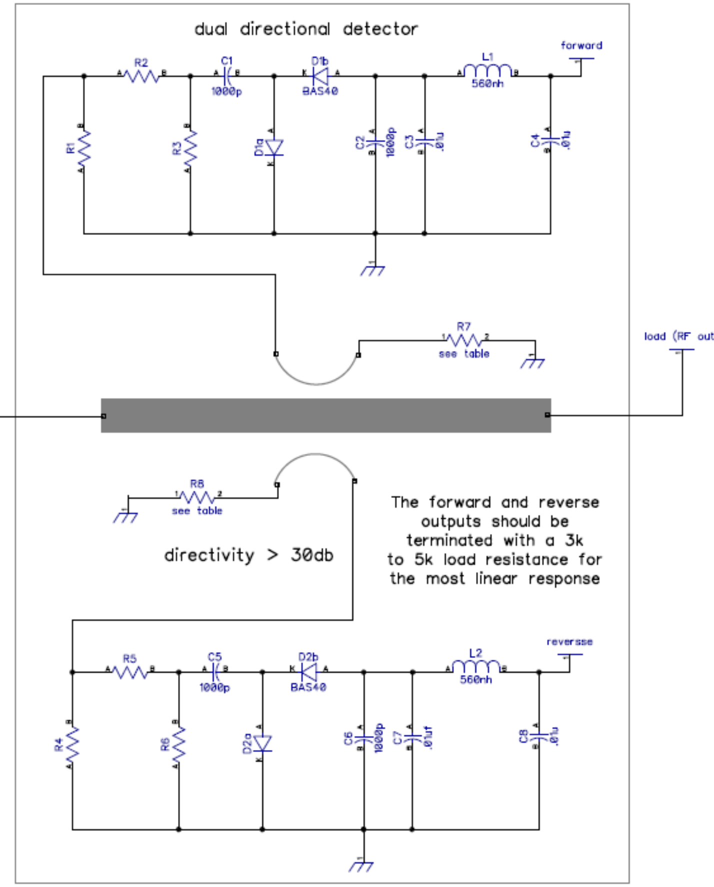
Low Pass Filter

with dual directional detector



1 KW LPF and dual directional detector assembly
total insertion loss is < 1/10 db (7-2013 version)





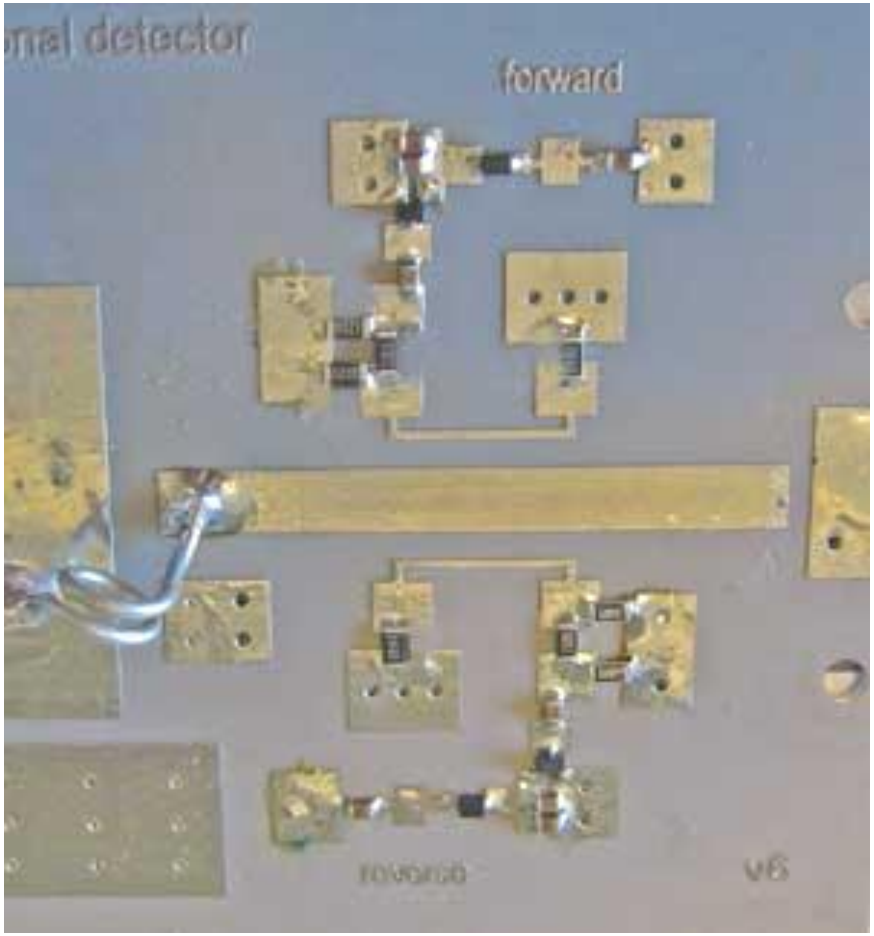
coupling is very loose at 50 MHz, so the sensitivity of the SWR trip on the control board, and the sensitivity of the bar graph display amplifier must be increased for this band. R2 on the control board should be changed to 100k. R21 on the REV power display board should be changed to 22k

50 MHz	70 MHz	144 MHz	222 MHz	432 MHz	component
-53db	-50db	-43db	-40db	-34db	coupler forward sample level
4 turns #16 .25 ID, .310 long	4 turns #16 .25 ID, .5 long	3 turns #16 .25 ID, .375 long	2 turns #16 .195 ID, .187 long	2 turns #16 .165 ID, .250 long	L3, L6
10 turns #16 .25 ID, .75 long	7 turns #16 .25 ID, .70 long	5 turns #16 .25 ID, .500 long	4 turns #16 .195 ID, .375 long	4 turns #16 .165 ID, .375 long	L4, L5
60pf metal mica	50pf metal mica	18pf metal mica	10pf metal mica	pcb only	C9, C11
75pf metal mica	60pf metal mica	22pf metal mica	13.5pf metal mica	pcb only	C10
3 db	6 db	13 db	16 db	20 db	forward attenuator
0 db	0 db	3 db	6 db	10 db	reverse attenuator
120 ohms	120 ohms	100 ohms	100 ohms	75 ohms	R7, R8

Attenuation	R1, R3 or R4, R6	R2 or R5
0 db	not used	jumper (zero)
3 db	300	17
6 db	150	33
10 db	100	69
13 db	82	100
16 db	69	150
20 db	62	250

The values in the table above have been optimized for best performance, and are different than the ones shown in the online web article

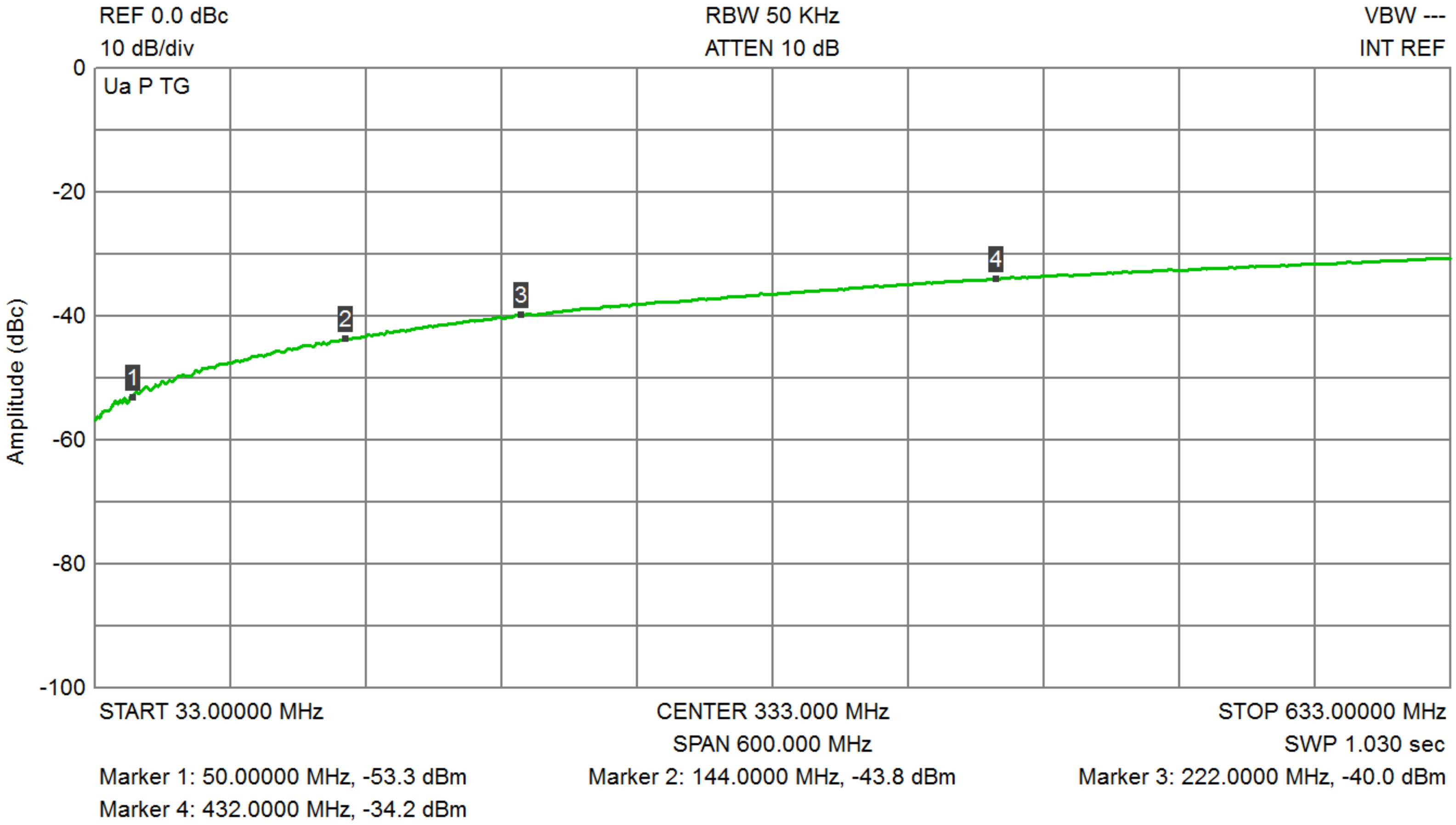
Low Pass Filter
with dual directional detector

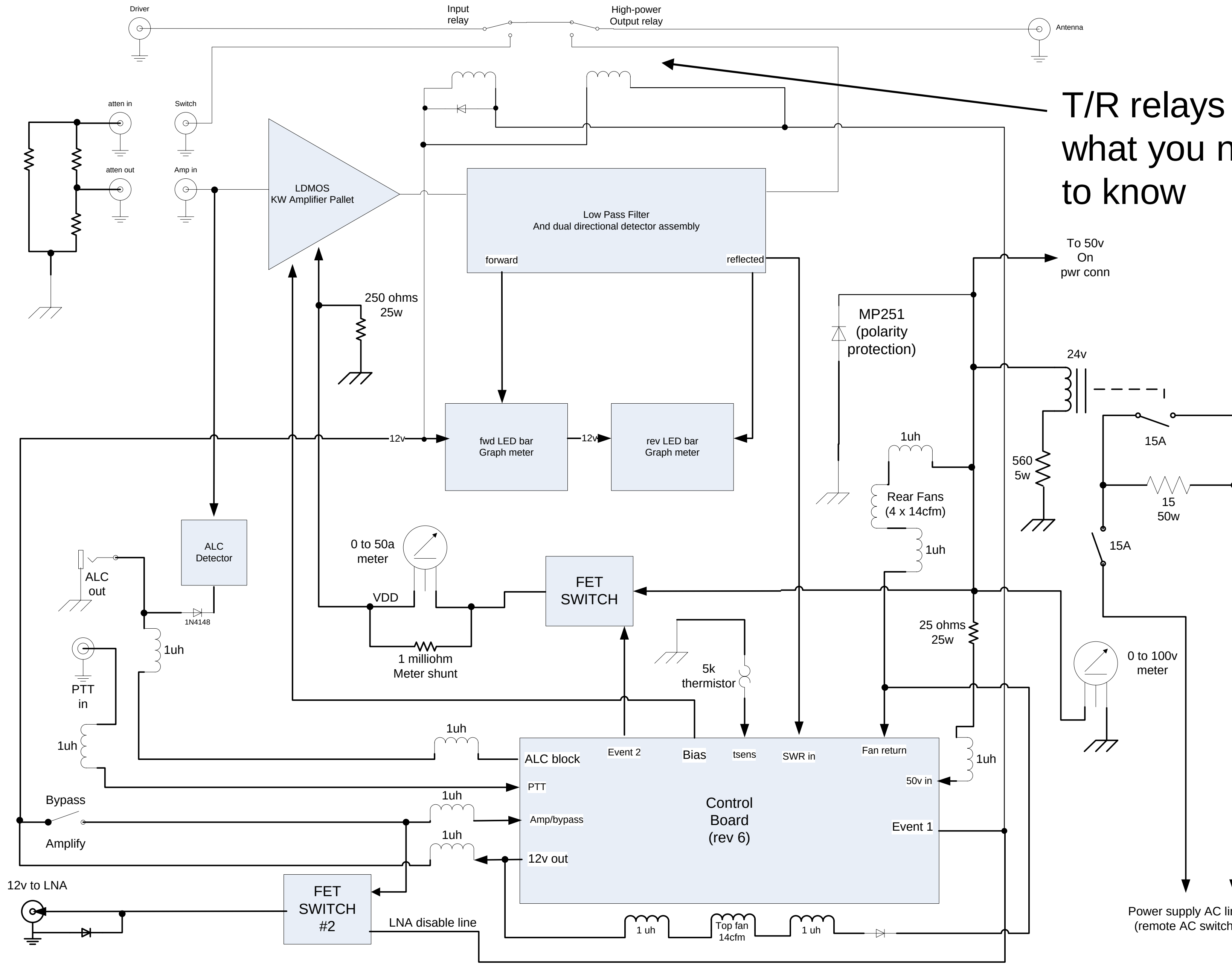


1. Coupler will sample both forward and reflected power levels
2. Each band can be configured for correct signal levels
   - On-board attenuators set the correct signal levels for the detector diodes

Coupler Response

coupling across VHF/UHF bands





T/R relays – what you need to know

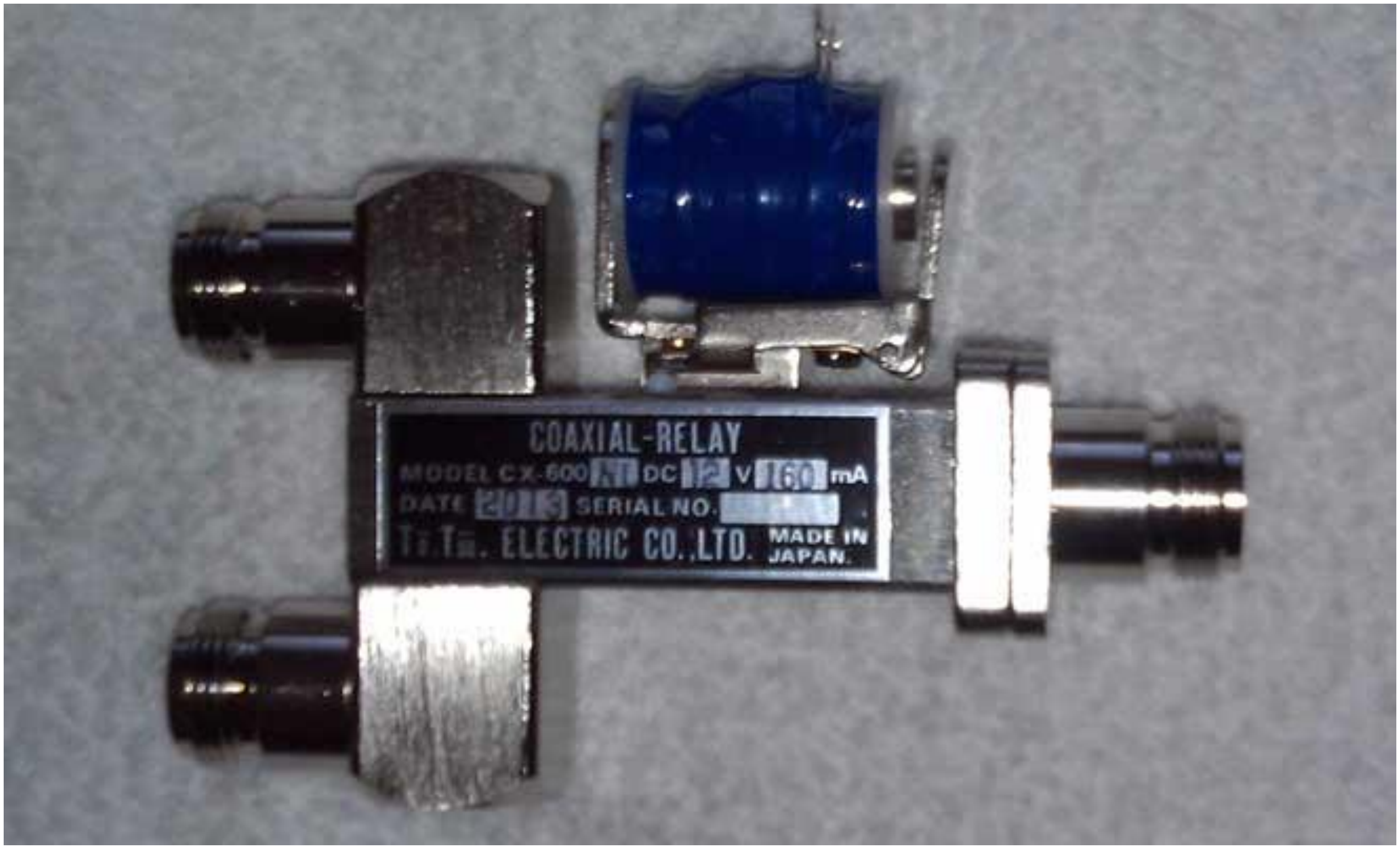
Antenna Relays (output)

Transfer switch
Dow Key model 412

SPDT model 402

Antenna Relays (output)

SPDT – Tohtsu model CX600NL

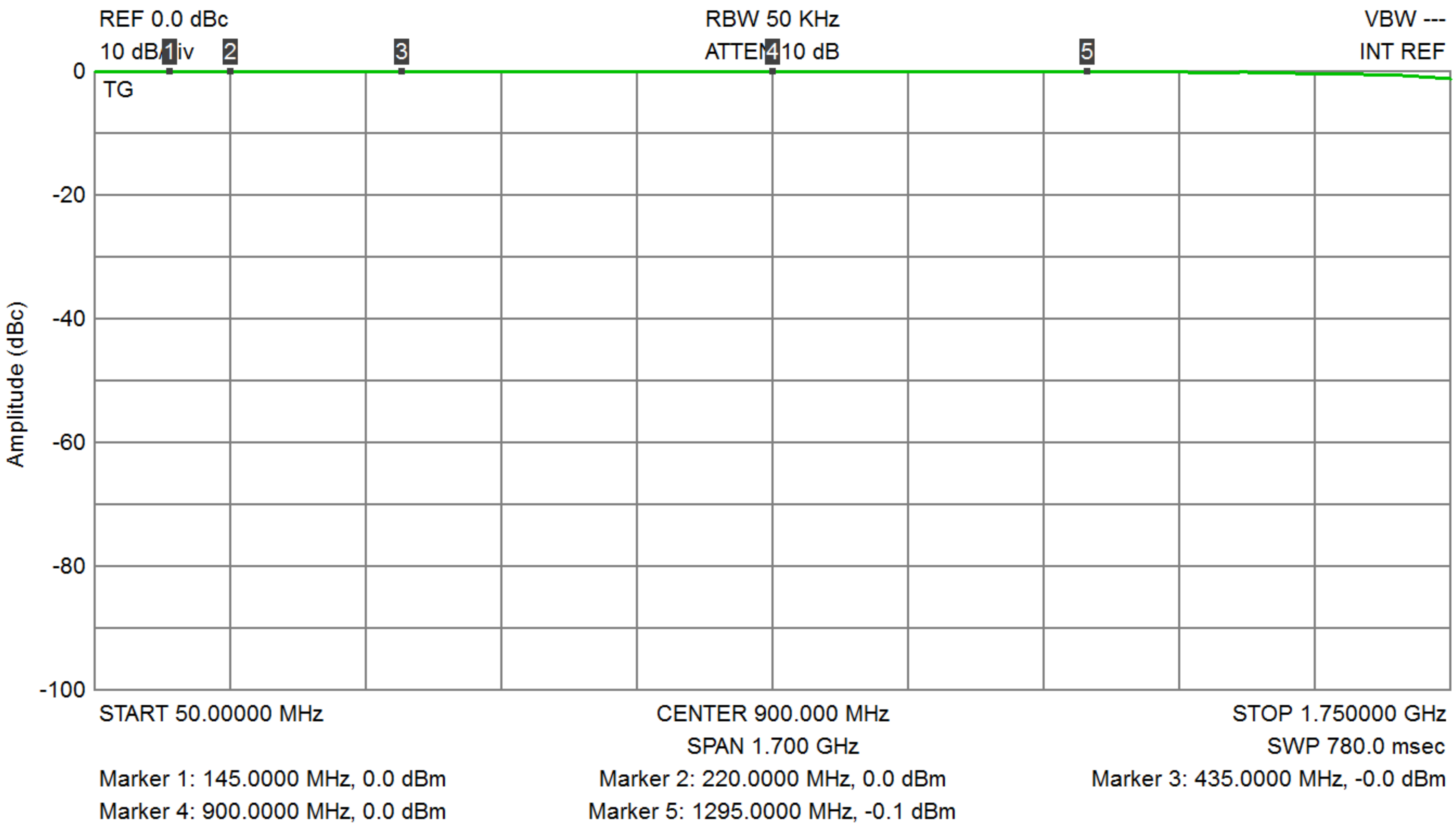


Antenna Relays (output)

SPDT – Gigavac type vacuum relay

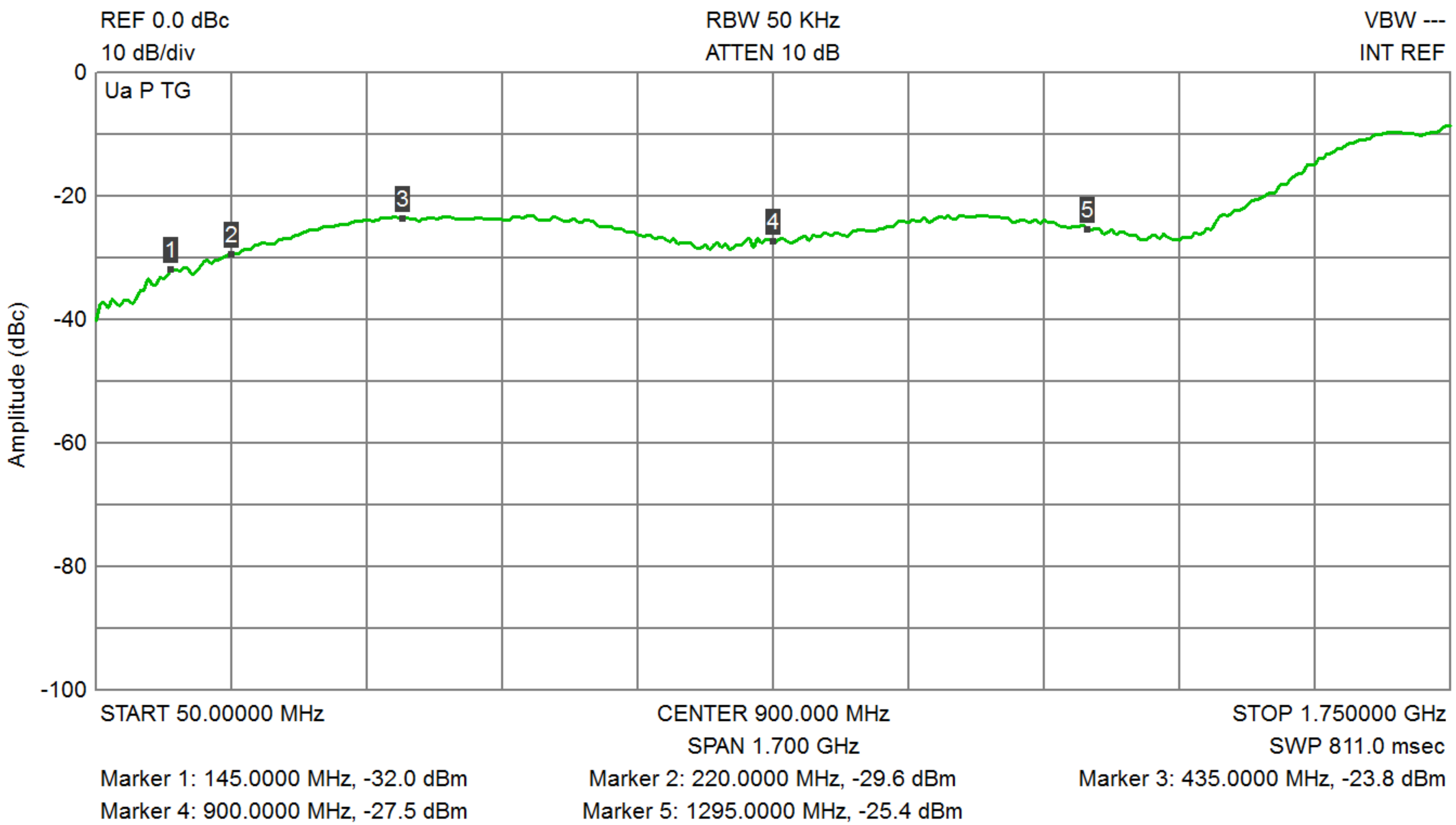
Relay Measurements (CX600NL)

insertion loss



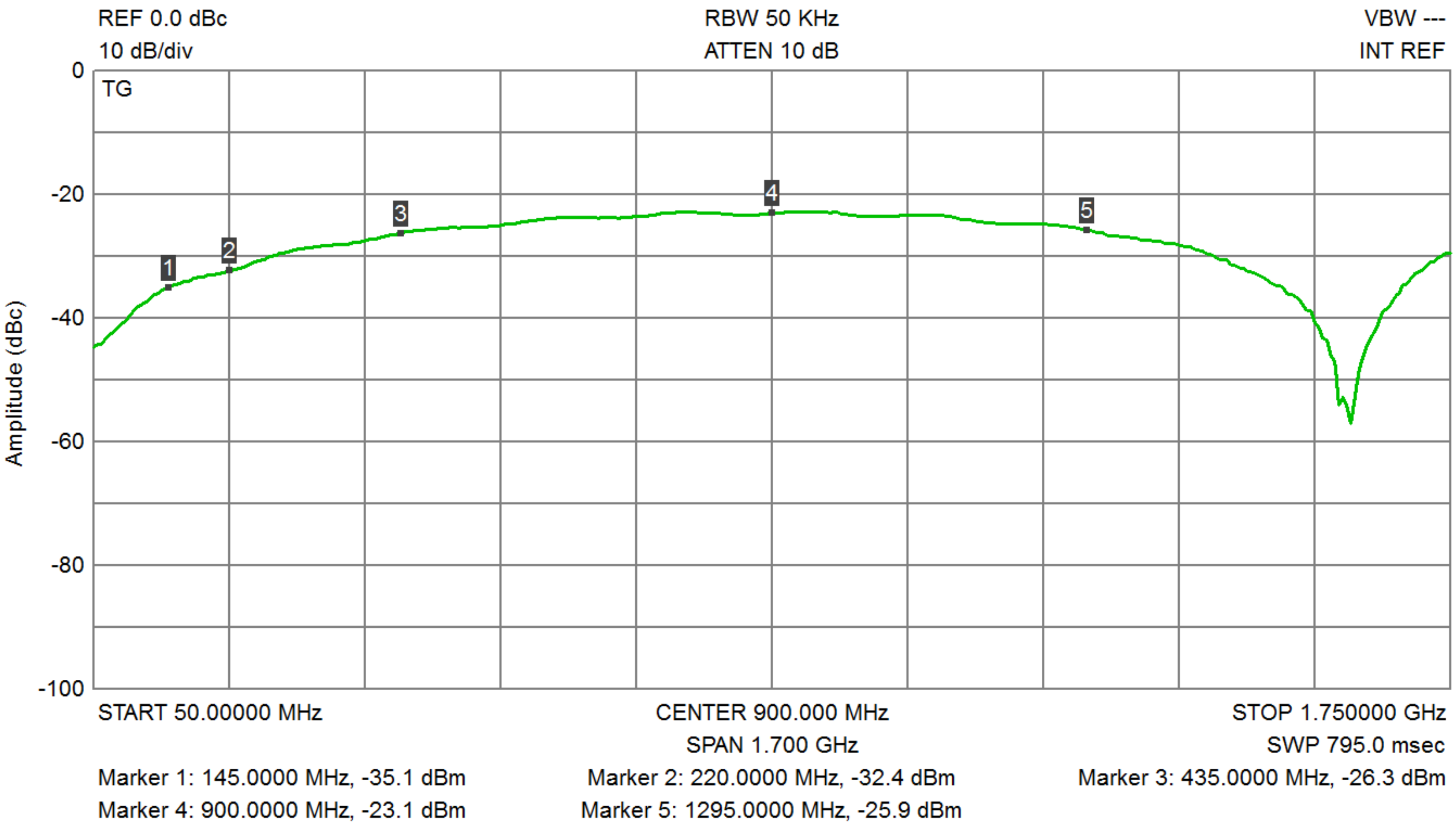
Relay Measurements (CX600NL)

return loss



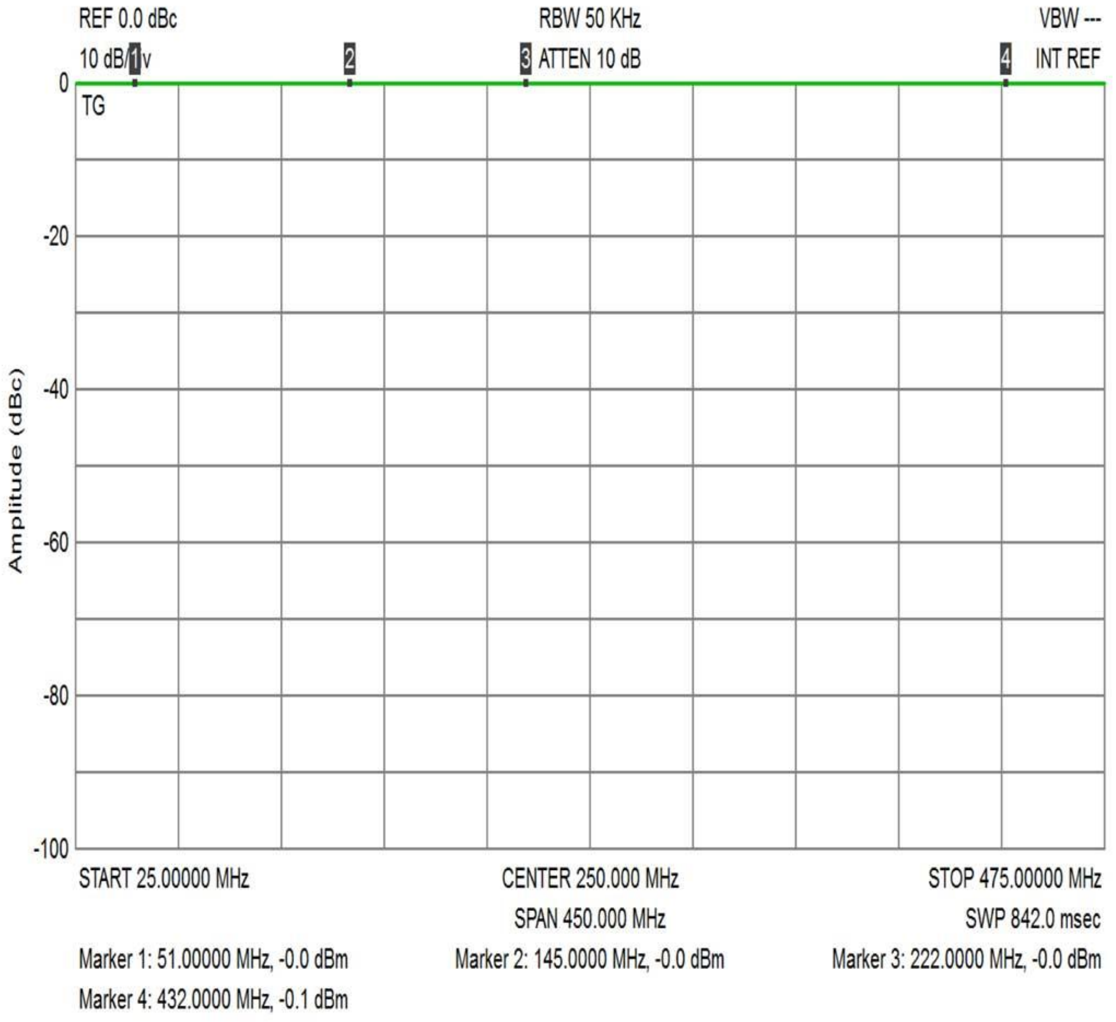
Relay Measurements (CX600NL)

isolation



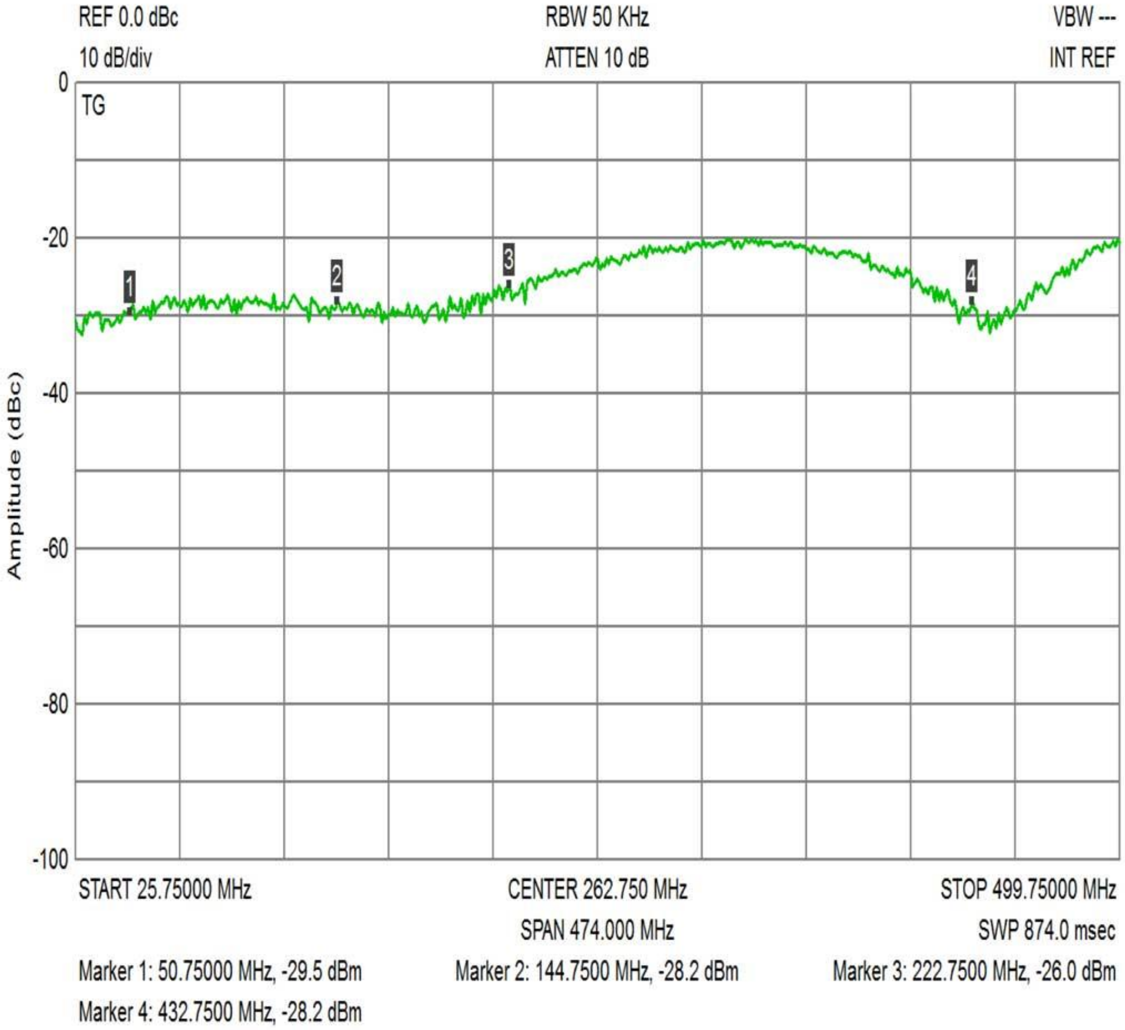
Relay Measurements VHC1

insertion loss (Vacuum)



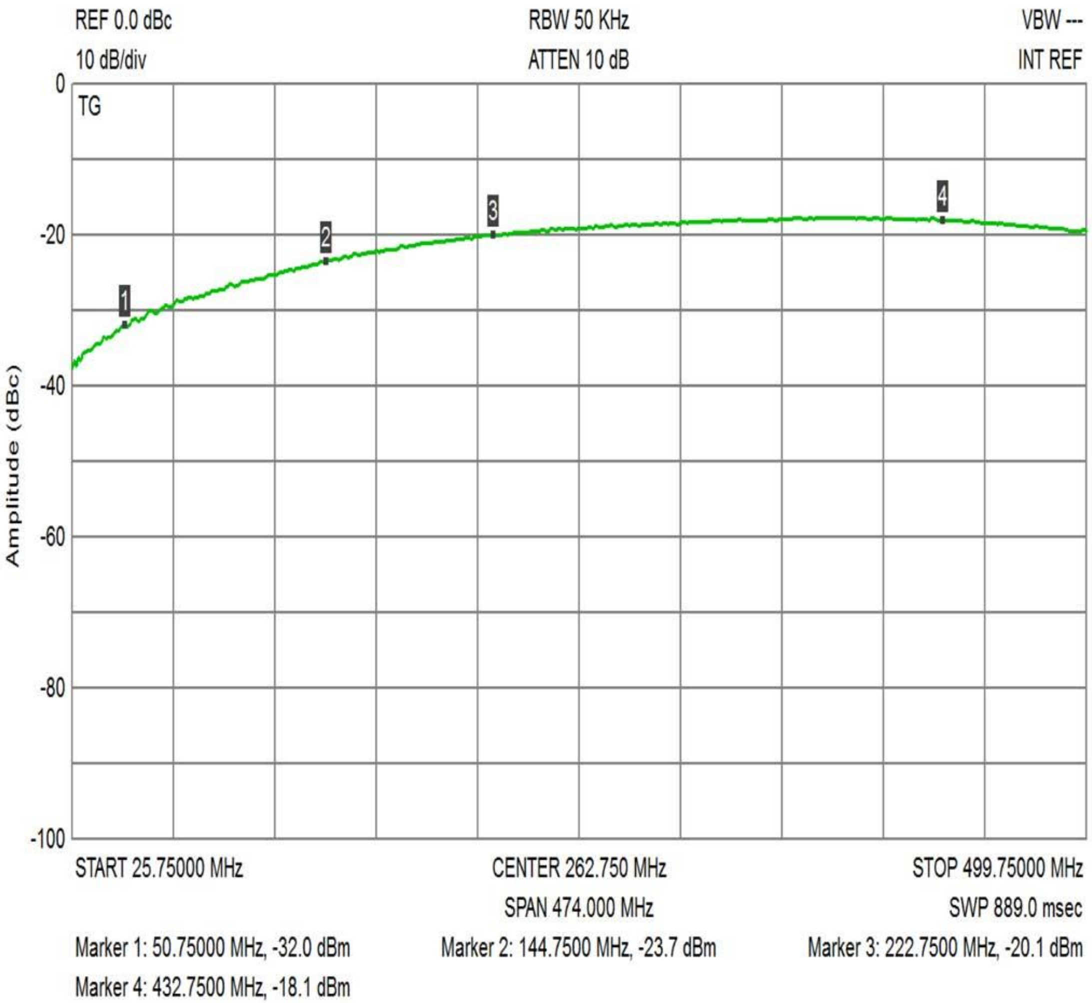
Relay Measurements VHC1

return loss (Vacuum)

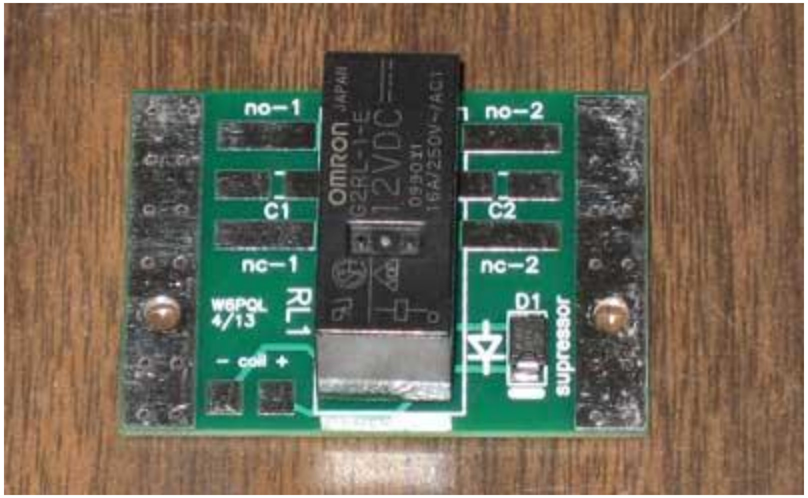


Relay Measurements VHC1

isolation (Vacuum)

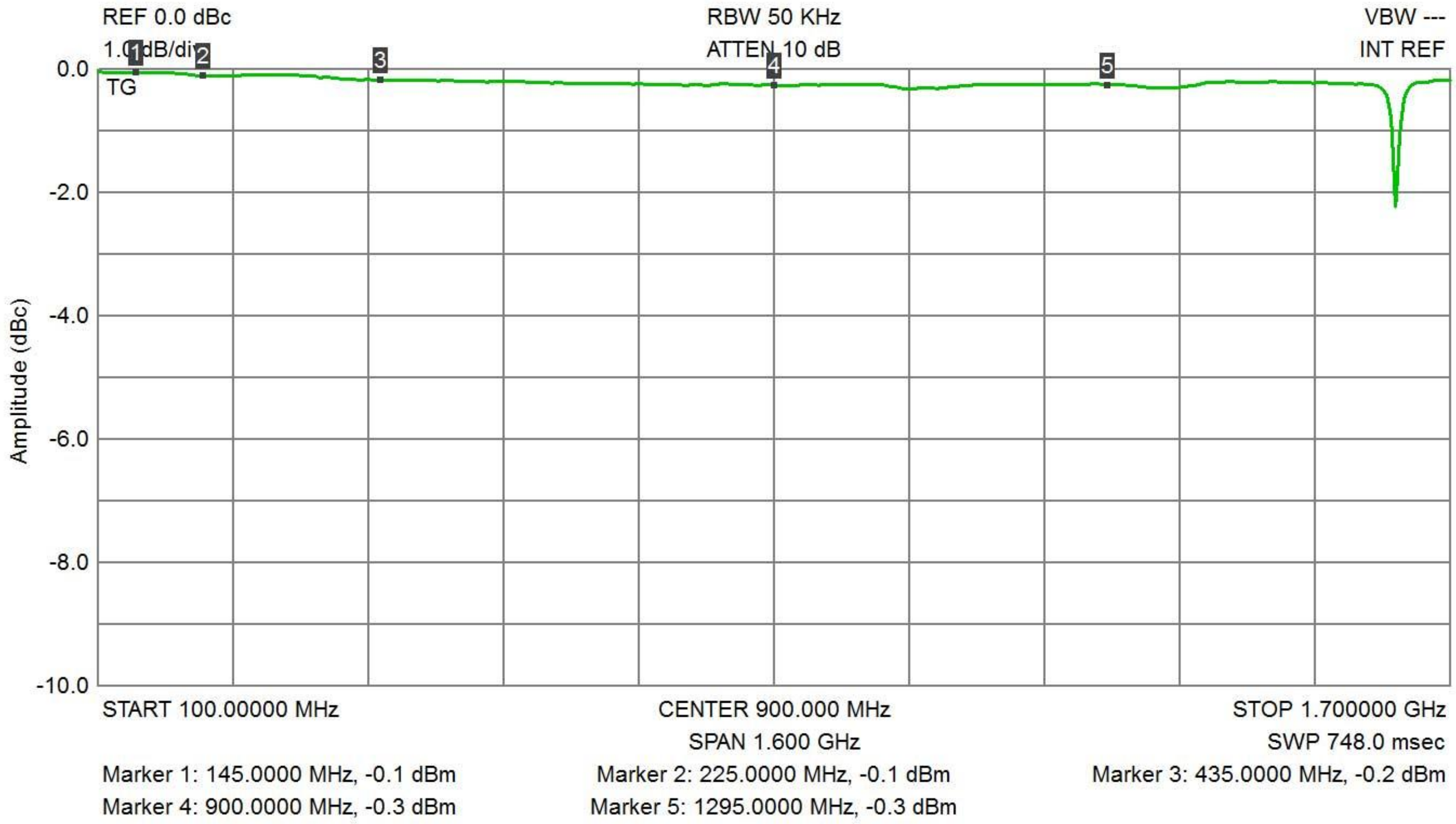


Antenna Relays (input)



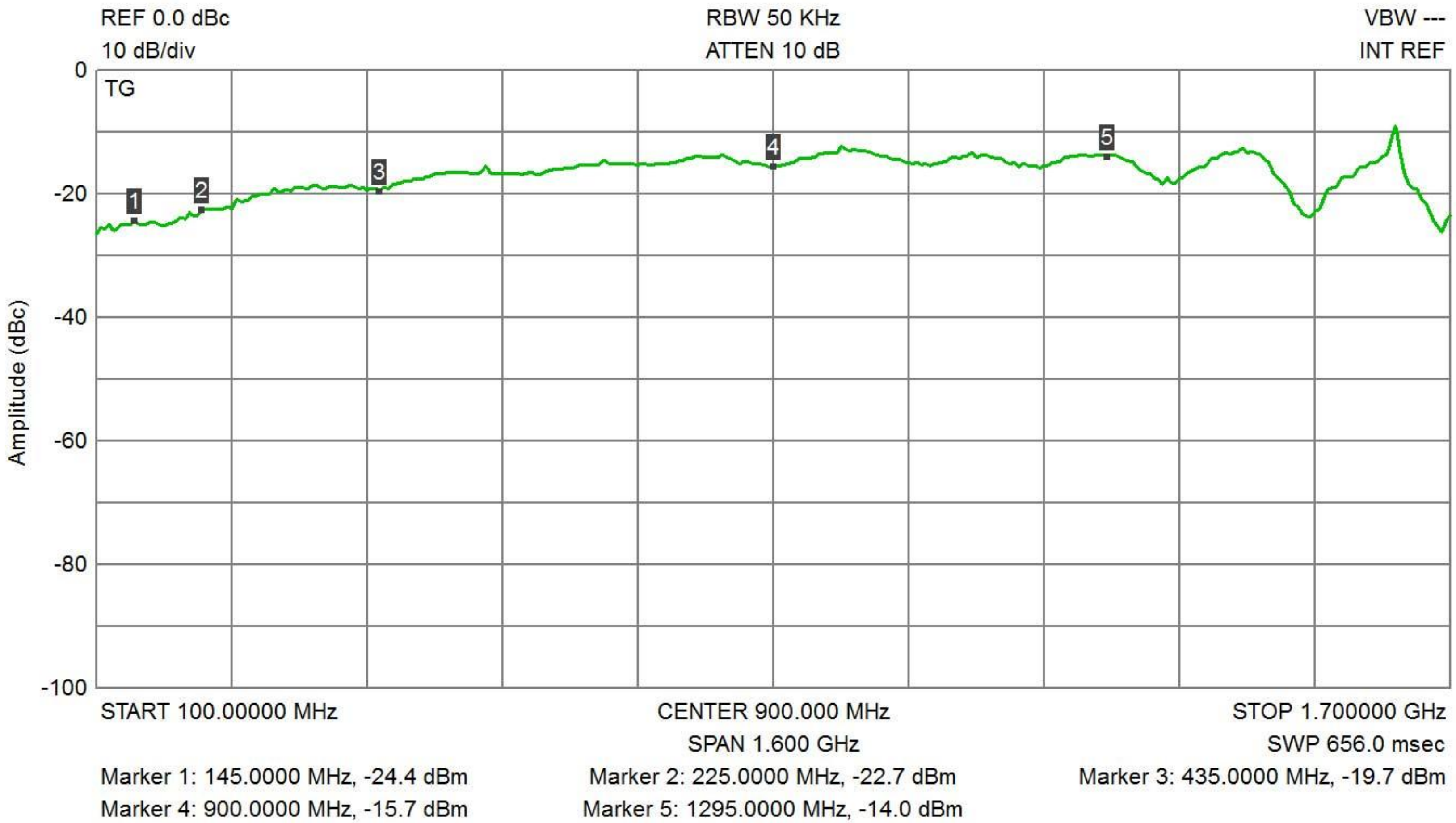
Relay Specs (CX120A)

insertion loss



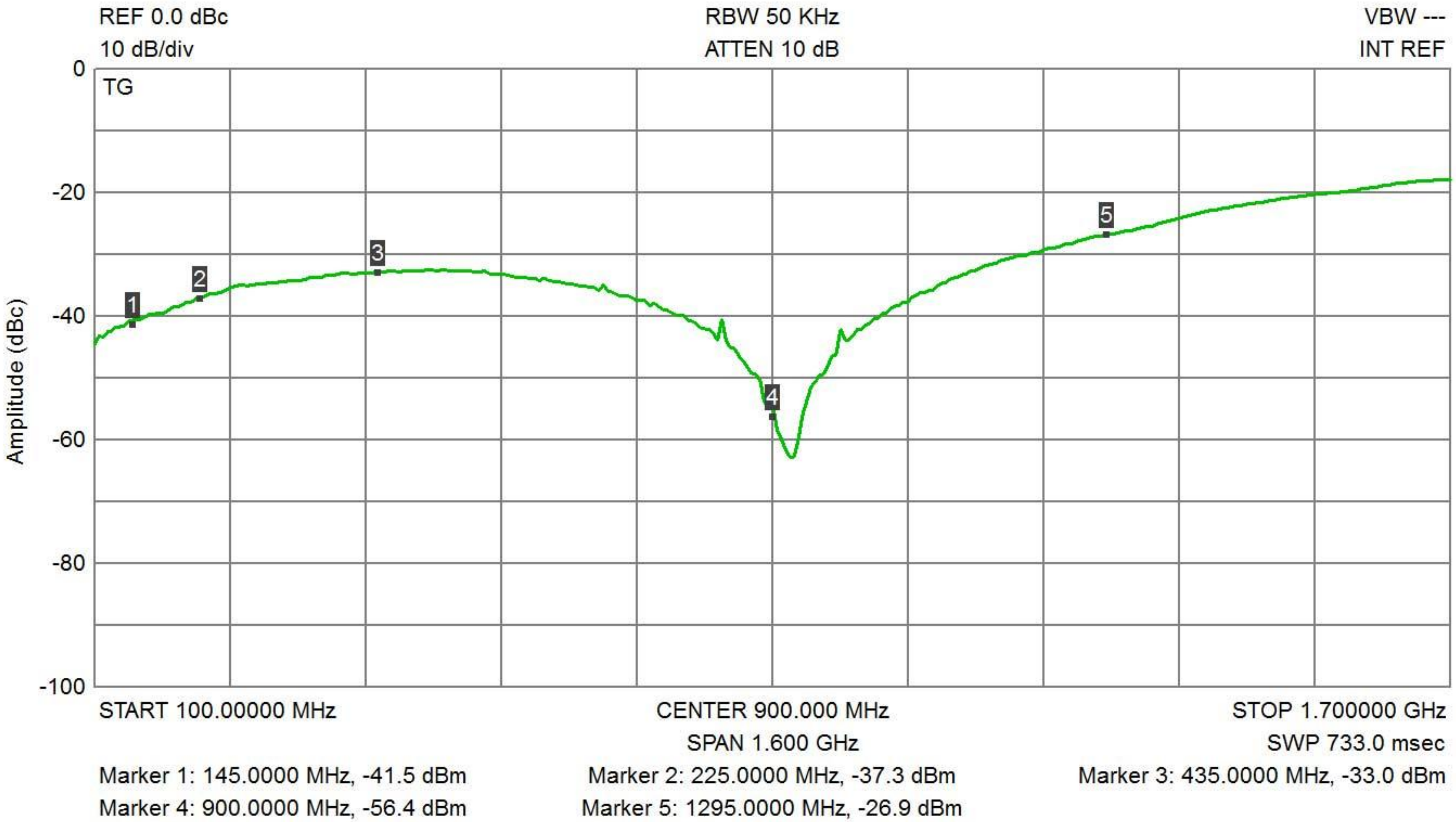
Relay Specs (CX120A)

return loss



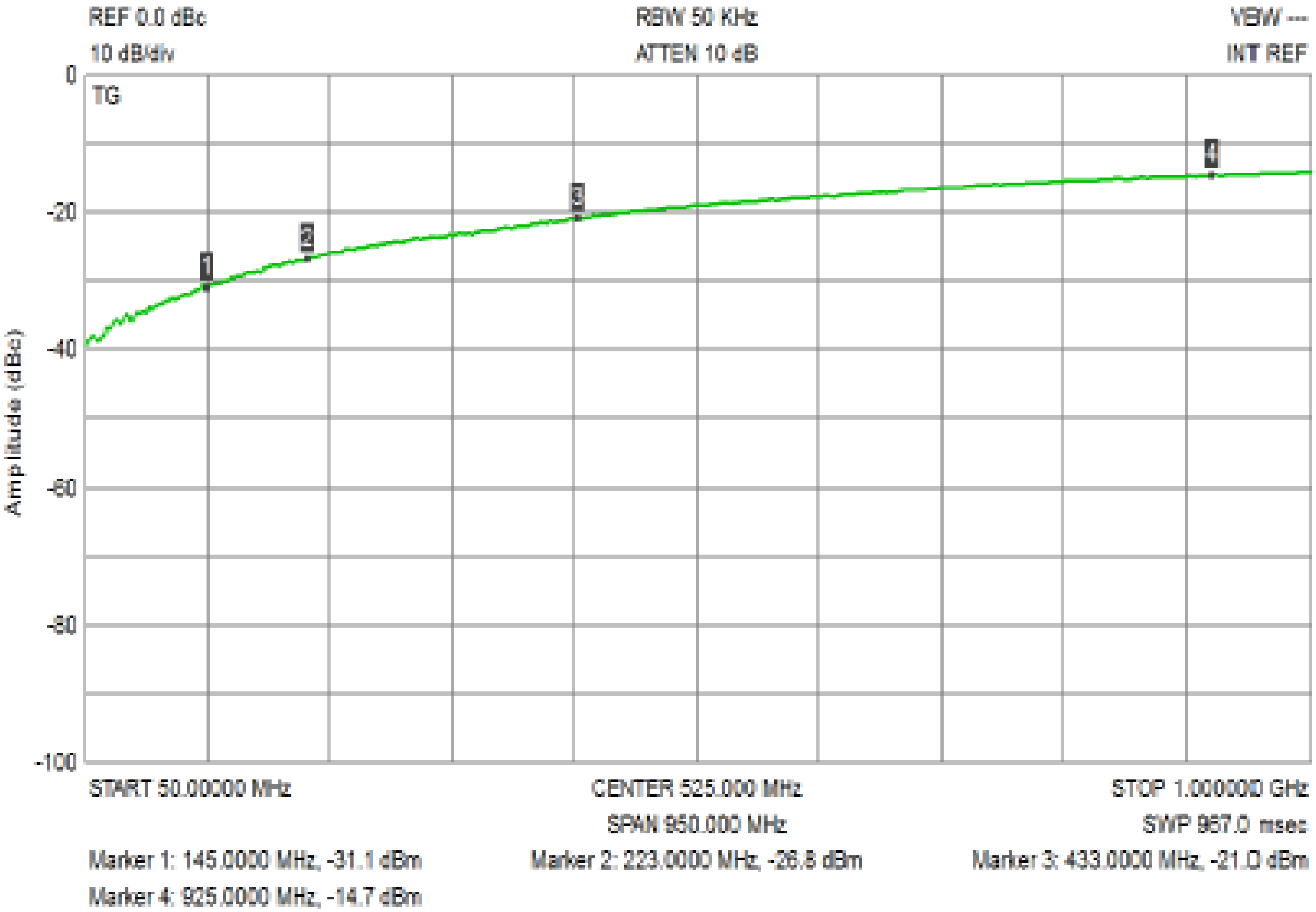
Relay Specs (CX120A)

isolation

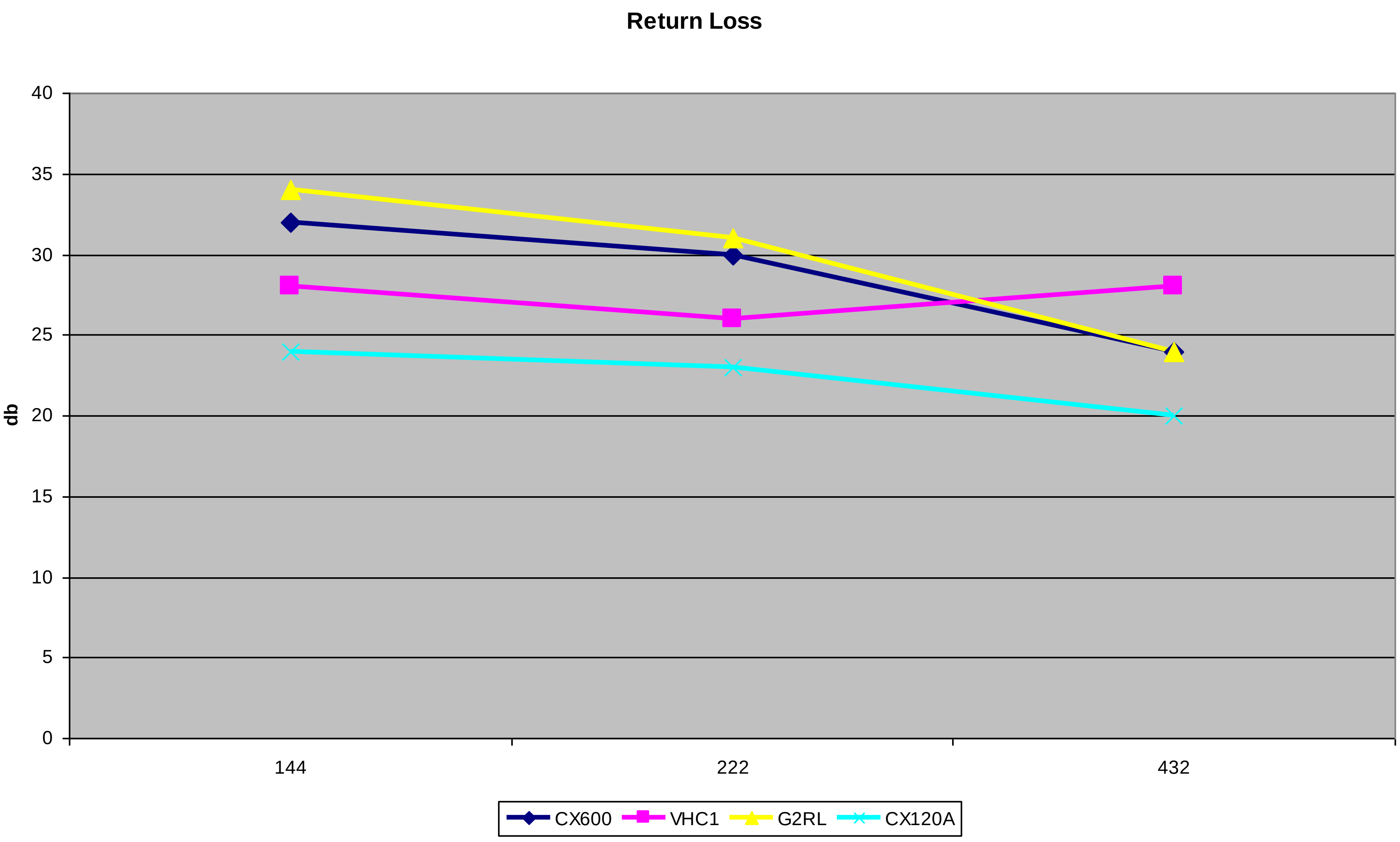


Relay Specs

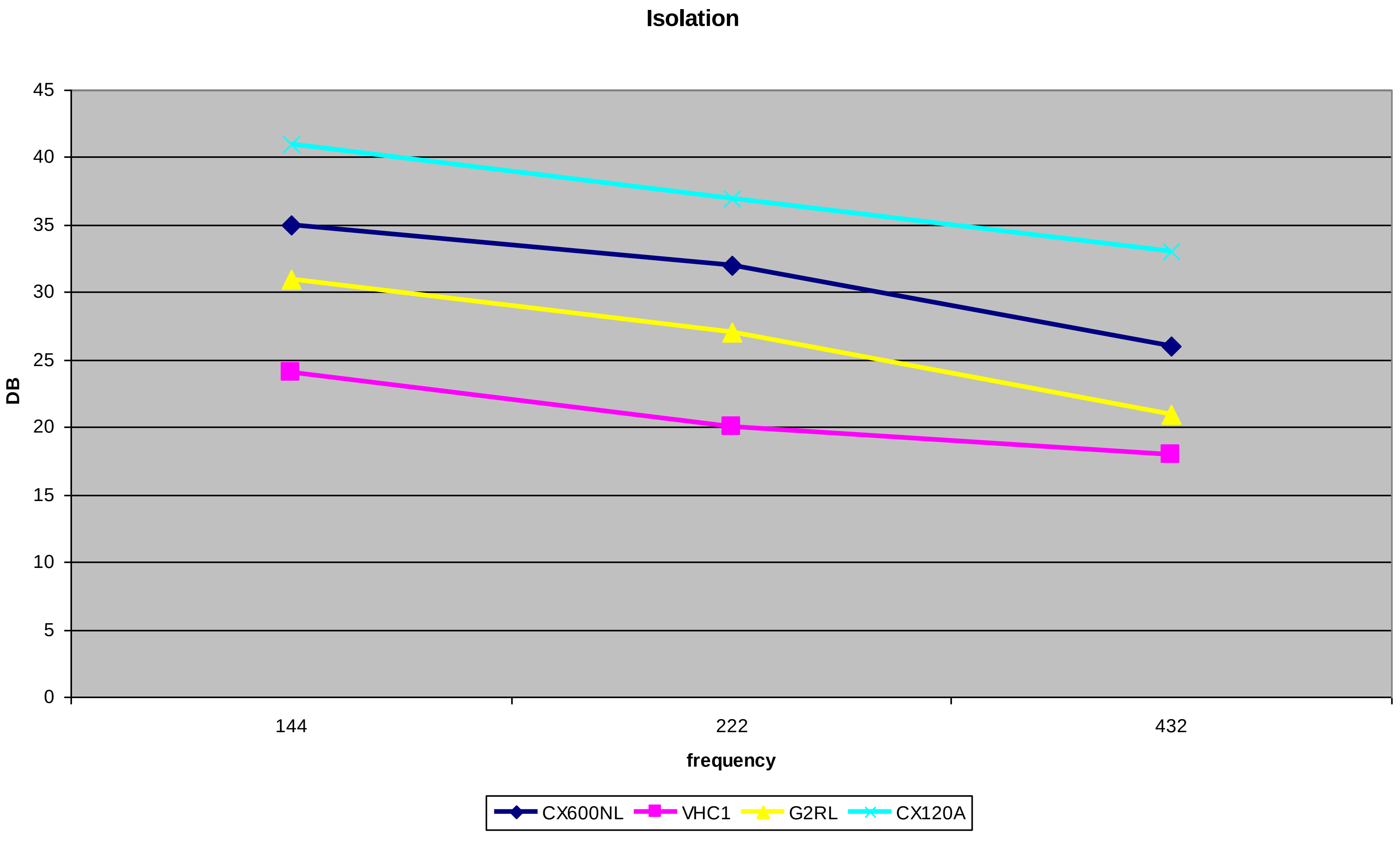
isolation (G2RL series)

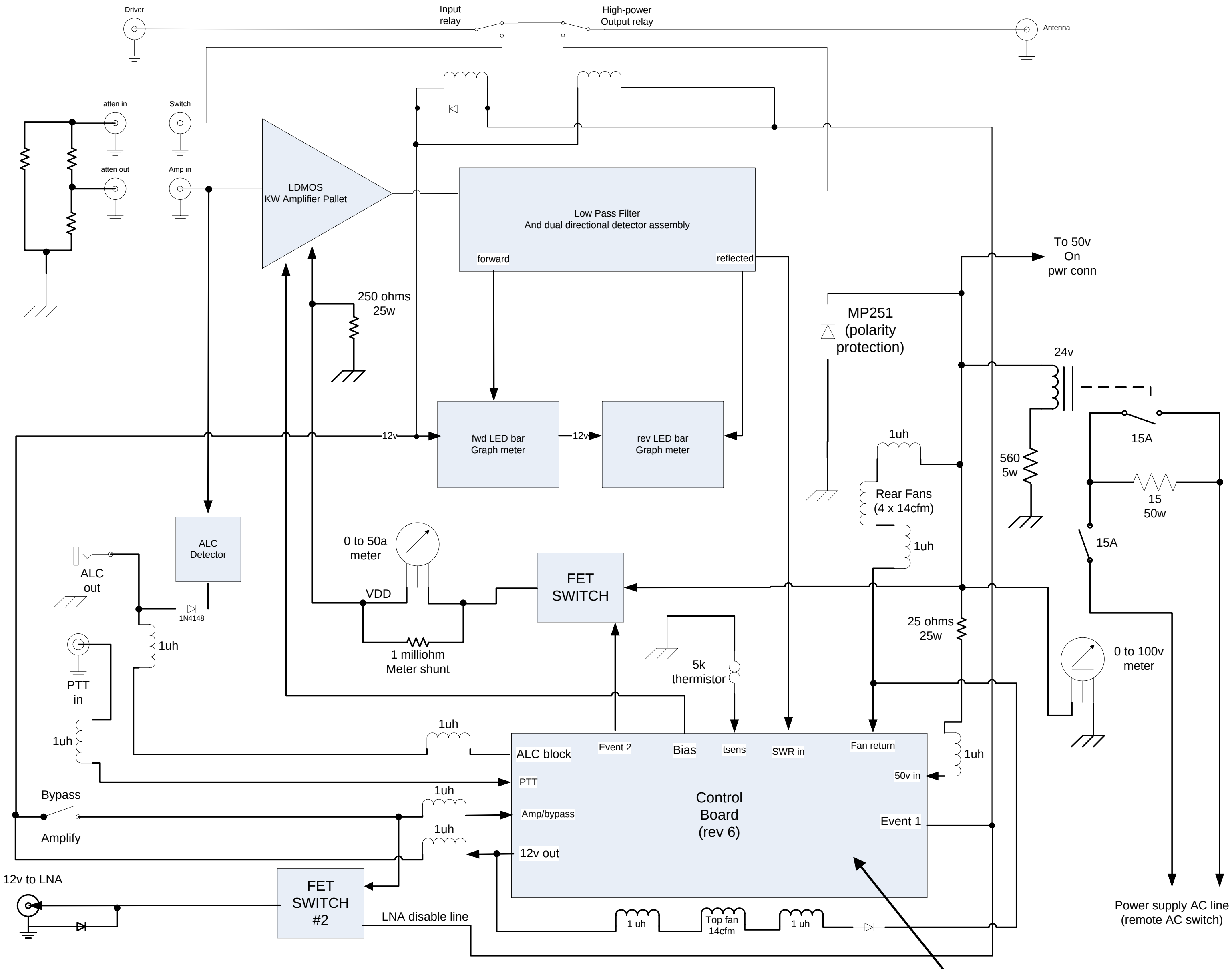


Relay Comparison



Relay Comparison





Get Smart –

Chaos vs Control

Control Board Functions

- Sequencer
  - Prevents hot-switching the antenna output relay
- DC power gate
  - VDD and bias (event 2)
- Fan control
- Reverse power lockout (high VSWR)
- Over-temp lockout
- Sequenced LNA power feed and drive power gating if required (event 3)

Coming soon to a band near you

- K2OP – 160 thru 6m
  - 1kw+ on 160m thru 10m
  - 850w on 6m
  - Broadband transformer design

Very complex switching and filtering, as you can imagine

- Harmonic content is as high as -9dbc on some bands
  - Thus, a complex output filter is required…the prototype is working well now
    - Combination LPF and diplexer

6 Meter Expeditions Are Great

- Take your family, it is almost never open all day
- Your spouse can carry an amplifier
- There are a lot of rare countries unlike hf
- Remember-mostly good dx is weak signal
- Take big antenna, amplifier, and good location really matters

58 Expeditions on Six, 21 on Two Meter EME

- Visiting different cultures
- Making friends
- Learning about propagation
- Helping others feel the excitement of dx and succeed in DXCC (K5FF & W5UN)
- Seeing ruins you would not imagine

Cook Islands News

Telephone 2065 Ext.460 | RAROTONGA, FRIDAY 28 NOVEMBER 1980. | 15 Cents

Marine Conservation Measures Already Under way

Restrictions on Littering, Gill netting, Fish poisoning, Scuba diving

Information has been received from the Minister of Internal Affairs, Mr I. Short, that regulations are already underway to strengthen certain conservation measures.

The Minister said that the whole aim of these regulations is to give some 'teeth' to the act which has largely been ignored.

BEACHES

Persons taking sand from the beaches within a chain from the water's edge could be fined up to $500.

To prevent littering on the beaches and public areas, heavy fines will be imposed on anybody caught littering; the litter could be as small as a cigarette butt.

Internal Affairs hopes to set up more rubbish bins around the main public areas, and already an order has been made for proper rubbish stands – anti-dog stands. The Minister said that once these have been installed, the anti-litter regulations will come into force.

FISHING

"Fishing is a serious area," said the Minister, "and I think a lot has been said about it in the past, but very little action has been taken. Everyone on Rarotonga, and particularly those

● Turn to page 5

Room 329 of the Rarotongan Hotel--for a while it was the headquarters of a small amateur radio operation.

Russian Spies??? Naw, just a Texan

The Hotel Management was in an uproar. There were two Russian spies in Room 329, transmitting secret messages. An antenna was on the roof of their unit – yes they've got to be Russian spies!!

So armed with a female reporter, a camera and a notebook, hotel manager Mr Sheedy rushes up to Room 329 to confront the spies. And meets two bewhiskered rather bewildered Texas gentlemen.

They're really all old friends with one love in common – radio operating.

Jim Treybig and Dave Meekrs are touring several Pacific islands, and operating their radio set from where they can.

"One has to get a licence first," said Jim," before one operates his set."

Both are from San Francisco, and have been amateur radio operators for several years. They thought of touring some of the South Pacific islands to give isolated areas a chance to talk to other parts of the world.

● Turn to back page

ZK1XE

F2 from Gambia

10TH ANNUAL
BBQ & BS
9-11-93
TANDEM'S
COOKIN'
W6JKV JR
W6JKV

WITH THANKS TO JIMMY TREYBIG

W 6 J K V

FOR THE FOLLOWING 50 MHz CONTACTS, ACCEPTED TOWARD

DXCC #1 (K5FF) & DXCC #2 (W5FF)

COUNTRY	CALLSIGN	DATE	QSL	MODE
GAMBIA	C5AEH	11/13/81	X	SSB
FIJI ISLANDS	3D2JT	04/03/82	X	CW
TONGA	A35JT	04/11/82	X	SSB
RIV. GIGEDO	XE1JJU/XF4	06/13/82	X	SSB
CAYMAN ISL.	ZF2DN	07/25/82	X	SSB
MARIANA ISLANDS	W6JKV/KH0	11/23/82	X	SSB
ANGUILLA	VP2EME	06/04/84	X	SSB
GREENLAND	W6JKV/OX	06/30/84	X	CW
DESECHEO	W6JKV/KP5	06/06/85	X	SSB
ST. VINCENT	W6JKV/J8	06/10/86	X	SSB
AZORES	W6JKV/CU2	07/05/86	X	SSB
ANTIGUA	W6JKV/V2A	06/12/87	X	SSB
ARUBA	P40JT	06/09/88	X	CW
KIRIBATI WEST	T30DJ	03/31/89	X	CW
FED.S. MICRONESIA	V63JT	10/31/89	X	CW
MADEIRA	W6JKV/CT3	11/19/89	X	CW

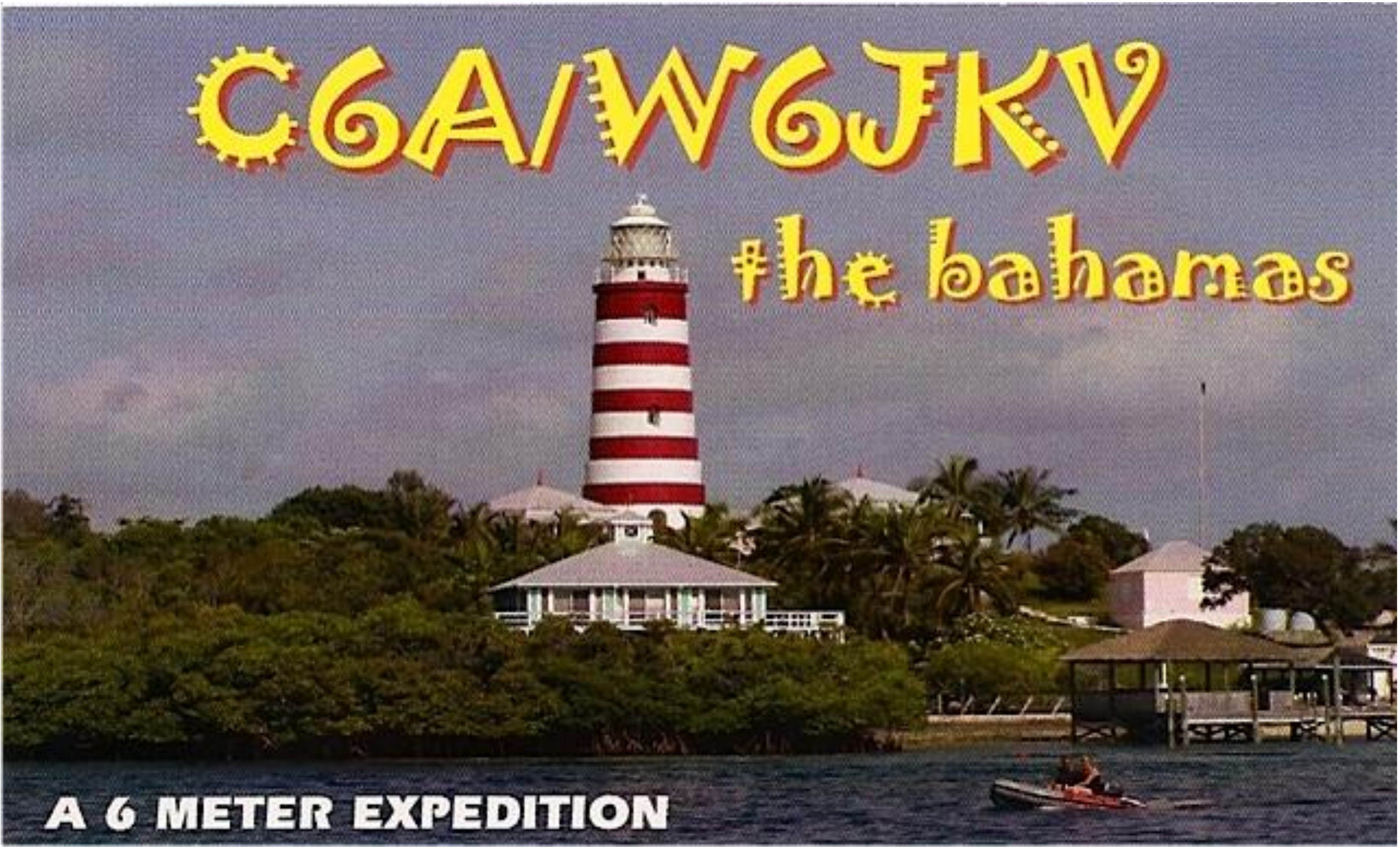
Lee Fish - K5FF

Fred Fish - W5FF

Villa in J6 Looking at Ocean

CARIBBEAN DELUX FAMILY ADVENTURES


GCat


C6A/W6JKV
the bahamas
A 6 METER EXPEDITION

Summary Results from West Indies E Prop.

Date	Country	Call Sign	QSOs	# Countries
2012	St. Barts	FJ/W6JKV	1179	57
2011	St. Maarten (new)	PJ76	1670	72
2010	St. Martin	FS/W6JKV	1501	56
2009	Antigua	V29JKV	1840	
2008	Alaska	KL7/W6JKV	Not west Indies	
2007	St. Vincent	J8/W6JKV	938	58
2006	Belize	V31IV		
2005	Dominica	J79KV	941	57
2004	Bahamas	C6/W6JKV	1131	51
2003	Grenada	J3/W6JKV	in F2 Time	
2002	St. Martin	FS/W6JKV	422	33
2001	British Vir. Is.	VP2V/W6JKV	644	24
2000	Monteserrat	VP2MJJ		
1999	Anguilla	VP2E/W6JKV	815	32
1999	St. Lucia	J68CB		
1998	Dominica	J79KV	355	4
1997	St. Lucia	J6/W6JKV	143	14

At The Limit, Receiving

• Antenna (50 foot boom vs 15)	5 db
• 1 degree main lobe	3 db
• Ground gain	6 db
• Antenna pattern, beach location	no noise
• Difference and no noise	17 db

- Most African stations run 10 watts & dipole

At the Limit- Transmitting

- 50 ft boom vs 15 ft….. 5 db
- Ground gain…salt water 6 db
- 1000 versus 100 watts 9 db
- Main lobe at 1 versus 2 or 3 degrees 3 db*
- No obstruction to water +
- total 23 db *not possible K6QXY


On-Stage Stands

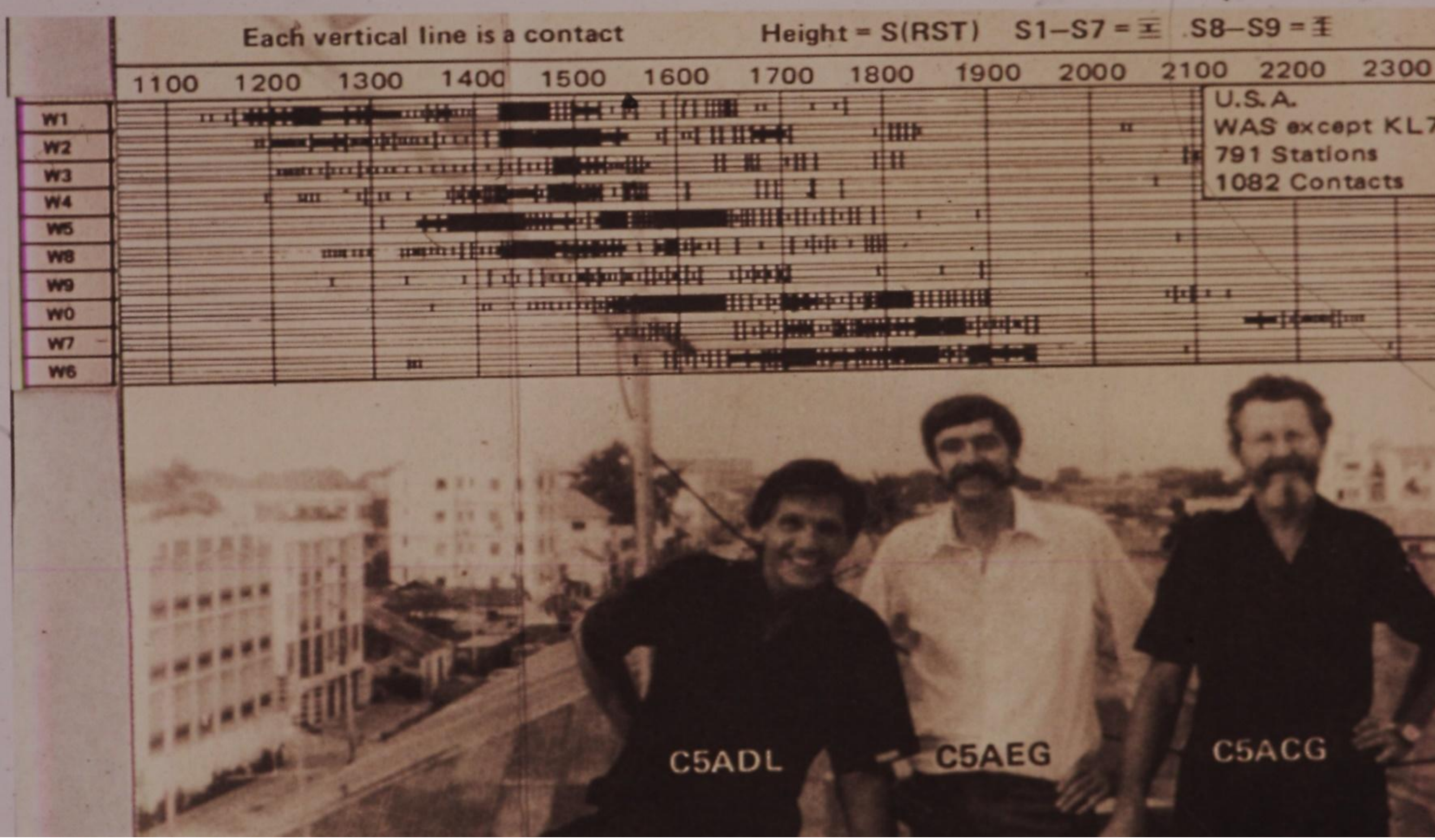
Value of Antenna and Ground Gain

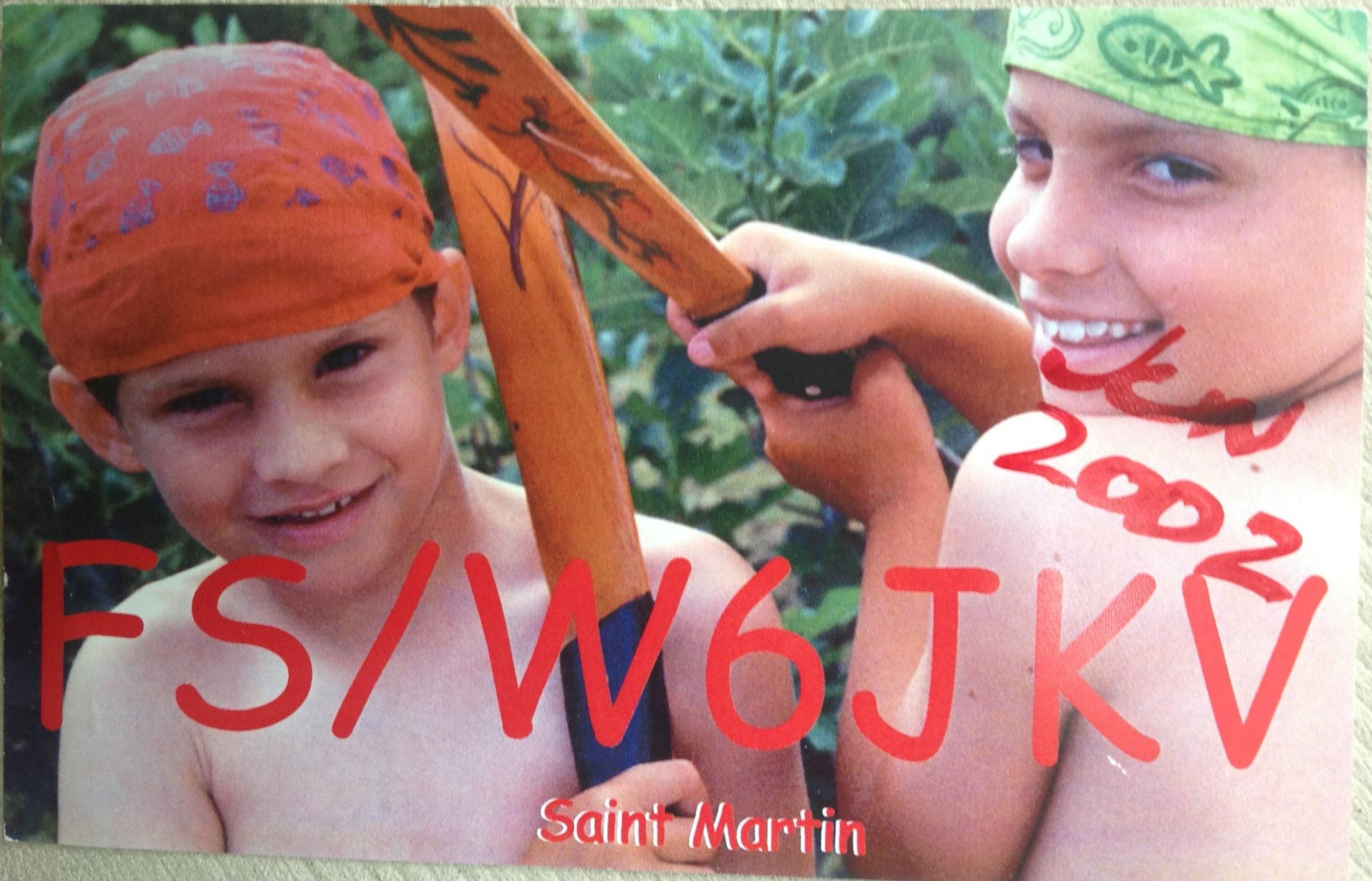
- Eme is true test of antenna & ground gain
- Single 2 meter yagi on horizon at moon rise
- Tip over ocean water
- Signals just come out of noise, s3, s4
- Signals go away…tilt antenna up and sigs are barely readable
- Listen on moon set over land, they are weak

Noise Is A Killer

- Cable in Mexico, copy it here on E openings at 59 Mhz
- Electrical in VP2E, 30 over S9 even laying antenna on group
- Take big antenna with clean pattern (eme)
- Take TVI and phone filters, and grounding wire (Belize)

Time of Openings-C5AEH



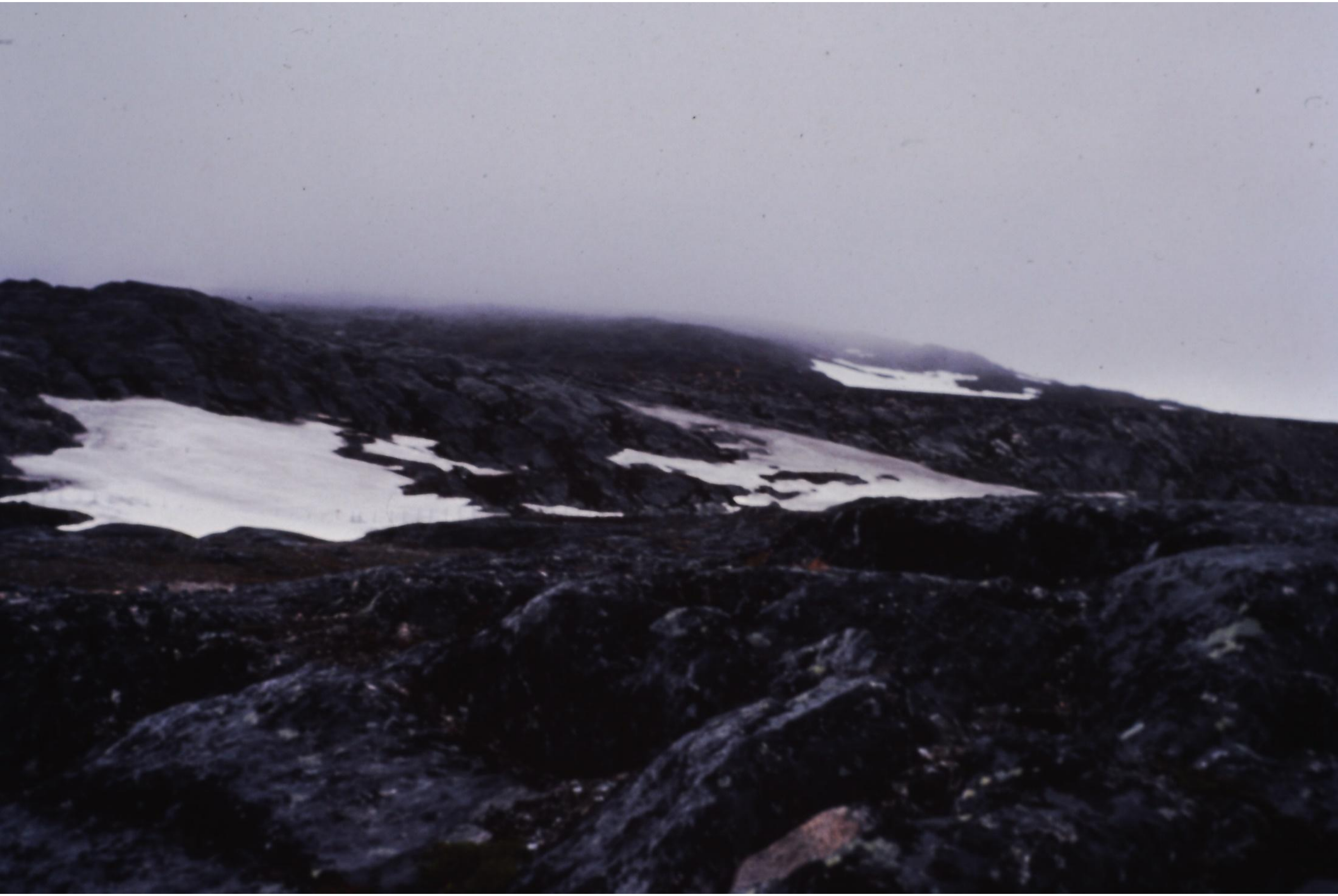

FS/W6JKV
Saint Martin
2002

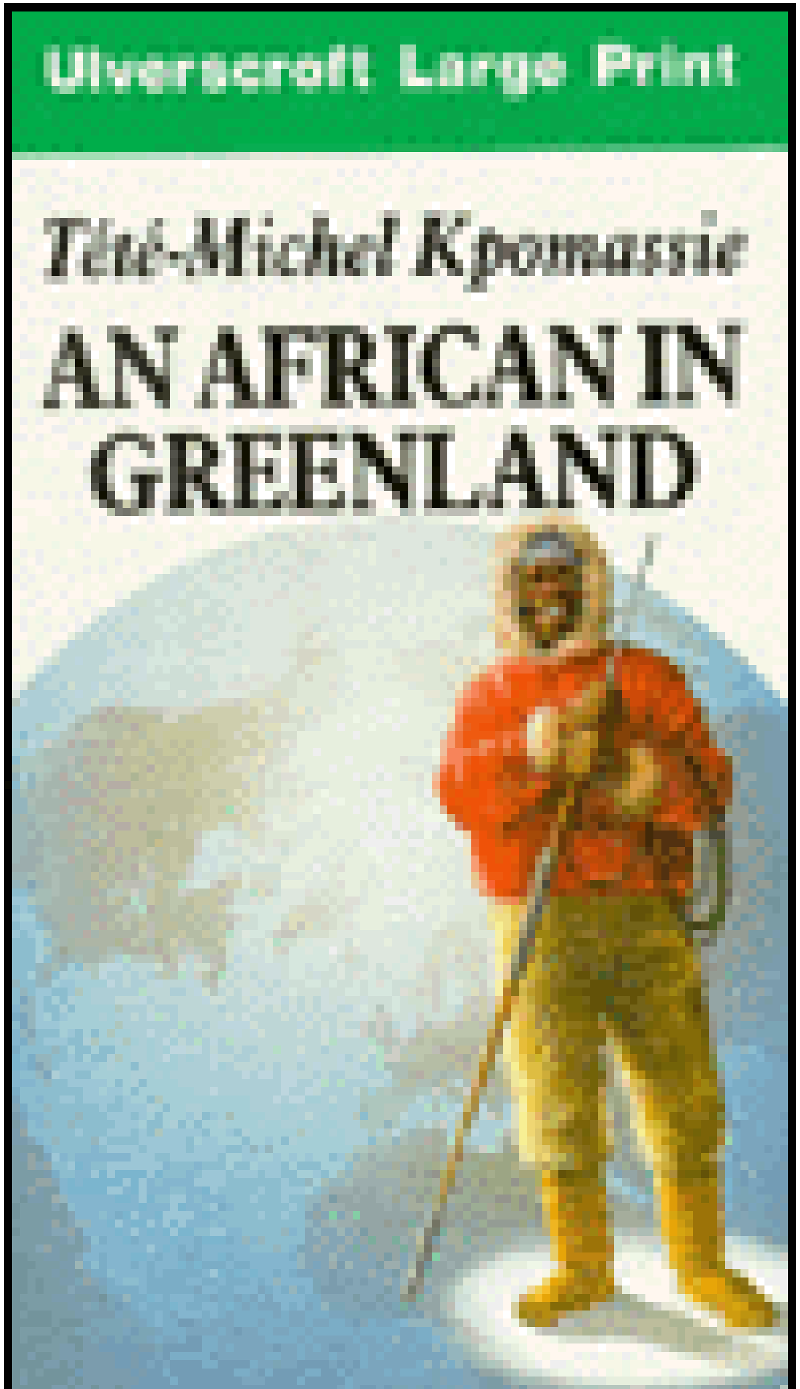

SEA·DOO
2
SEA·DOO


SPALDING
NBA

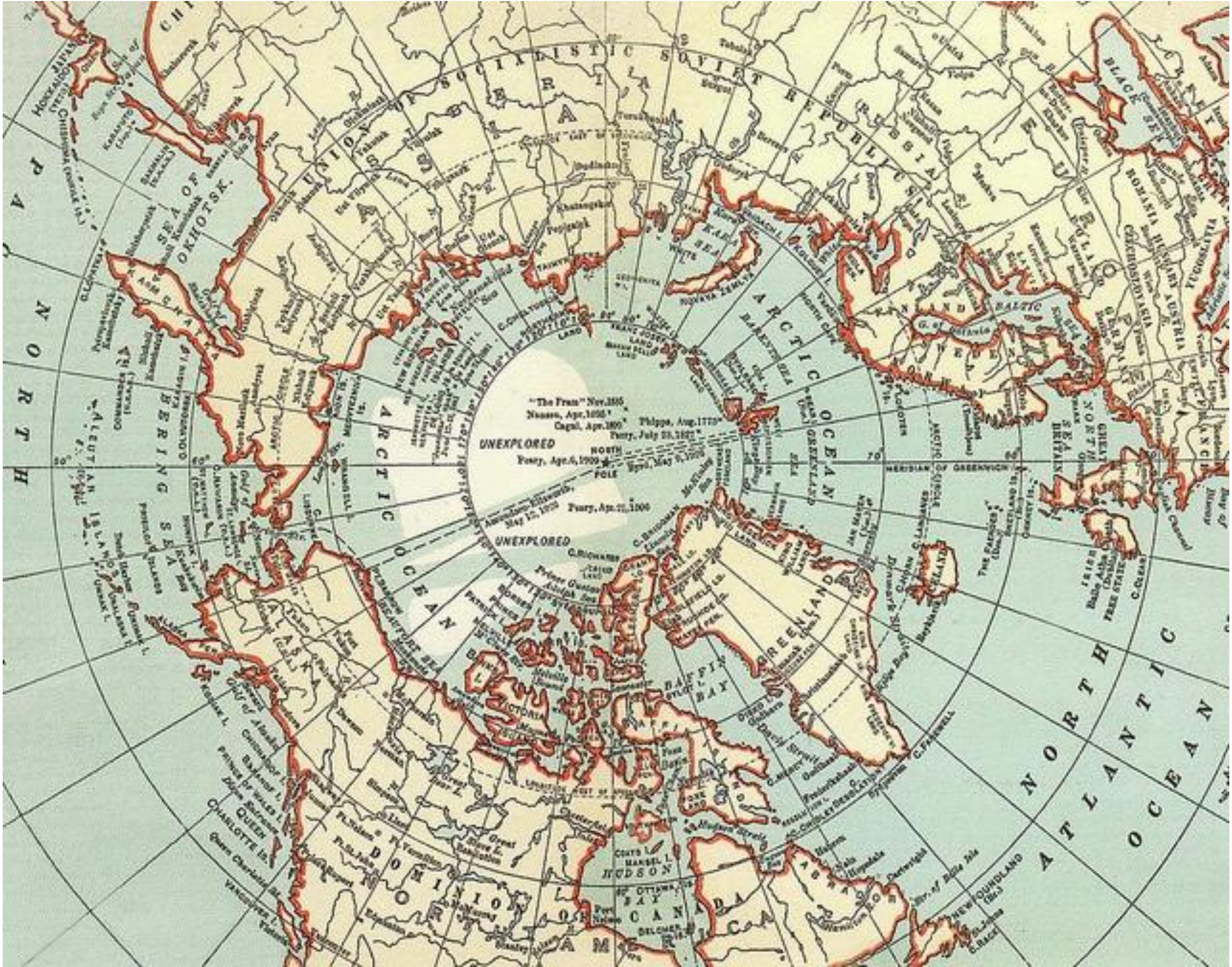
FAMILY WINTER WONDER LAND ADVENTURES


Nuuk, Greenland




Ulverscroft Large Print
Tété-Michel Kpomassie
AN AFRICAN IN GREENLAND

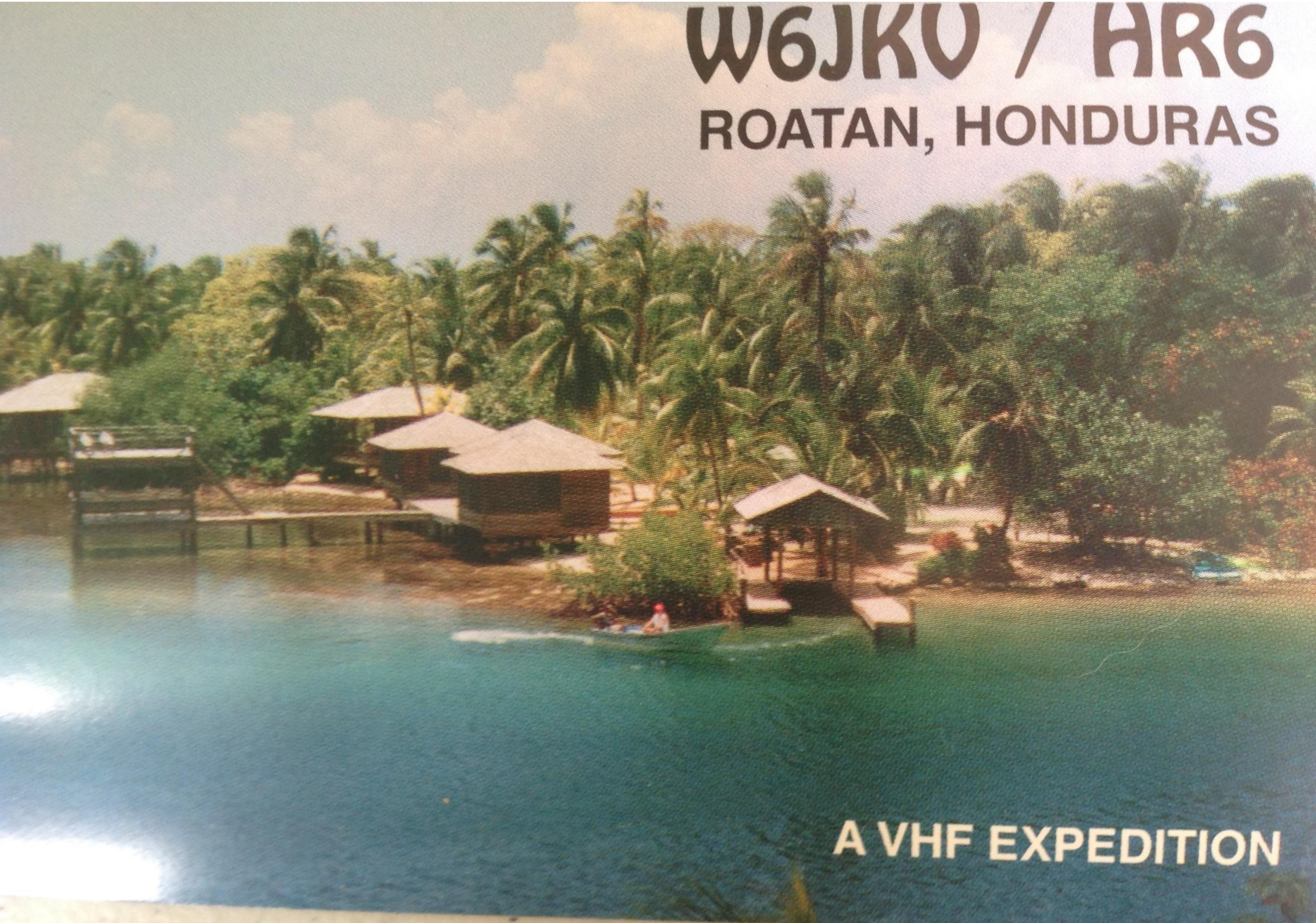
ALASKA KL7/W6JKV JUNE, 2008



UNION OF SOCIALISTIC SOVIET REPUBLICS
SIBERIA
RUSSIA
SEA OF OKHOTSK
BERING SEA
ALEUTIAN ISLANDS
ALASKA
ARCTIC OCEAN
UNEXPLORED
NORTH POLE
KARA SEA
BARENTS SEA
GREENLAND SEA
GREENLAND
BAFFIN BAY
HUDSON BAY
DOMINION OF CANADA
NORTH ATLANTIC OCEAN
BLACK SEA
BALTIC
NORTH SEA
MERIDIAN OF GREENWICH
NOVAYA ZEMLYA
FRANZ JOSEF LAND
VICTORIA
"The Fram" Nov. 1895
Peary, Apr. 6, 1909
Byrd, May 9, 1926
UNEXPLORED

CENTRAL AMERICAN HOT SPOT ADVENTURES


V31iV
Belize
50 mhz by W6JKV


W6JKV / HR6
ROATAN, HONDURAS
A VHF EXPEDITION

TE with Side Scatter

FAMILY ADVENTURES TO WEST AFRICA AND NEAR BY ISLANDS

F2 from Gambia


STRUCTOR
C F A O GAMBIA LTD
STRUCTOR

MADERIA
CT3/W6JKV

1989


25 11 88'

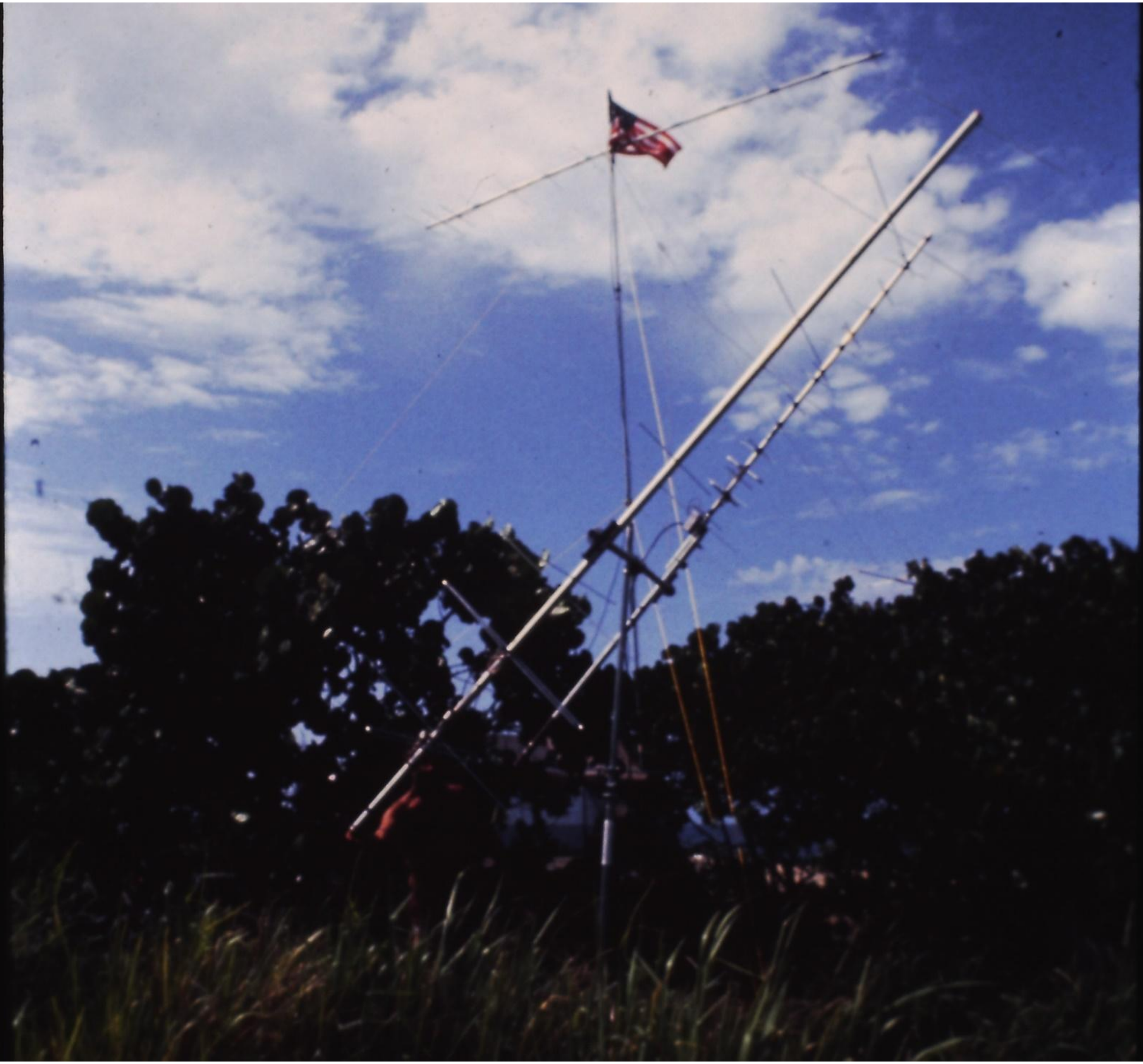

25 11 88'


W6JKV/CT2
A 50 MHZ EXPEDITION
BY W6JKV,K6MYC,K6HCP

TENT ADVENTURES

(NO CHILDREN)

ISLA DESECHEO KP5/W6JKV



ISLA DE AVES…
THE ISLAND OF A MILLION BIRDS

YV0/W6JKV

ISLA DE COCOS (TREASURE IS.) TI9/W6JKV

The Hotel on TI9


Islas Revillagigedo
XE1JJU/XF4
A 50 MHZ EXPEDITION

XF4- Land of Scorpions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matthewmeierphoto.com

PACIFIC PARADISE FAMILY ADVENTURES


sla de Pascua
K6MYC/CE0
W6JKV/CE0
A VHF EXPEDITIO


WELCOME TO POHNPEI
Keep Pohnpei Clean & Free From Litter
"Fight Pollution"
$20.00 FINE FOR FIRST CONVICTION AND UP TO $500.00 FOR SUBSEQUENT CONVICTION - BY STATE LAW !!!
'89 10 29


'89 10 31


1 11 '88

TE or Trans Equatorial

- Relates to magnetic equator- G same as W5
- Centered around Mar/Apr and Oct/Nov
- South USA and Caribbean to S. America
- 3 to 8 PM normal but earlier and later especially in Pacific and Caribbean
- Around the world from near equator
- Can happen at low sun spots

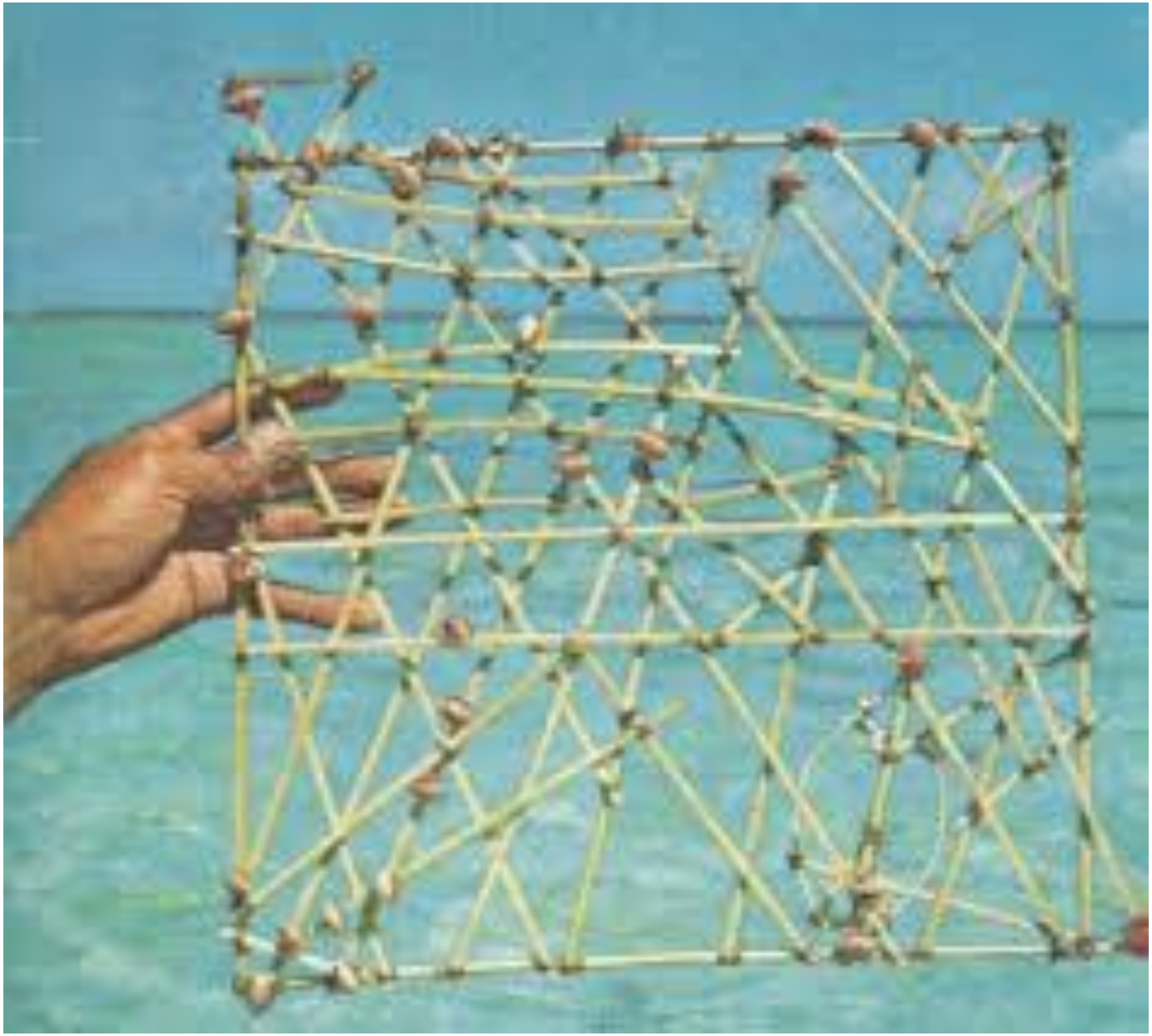

Tarawa, Kiribati
T30DJ

TECHNOLLOGY OF PALM TREE

TUVALU, KIRIBAS T20JT

T20JT to 8P6 Long Path


CLIMATE
CHANGE IN TUVALU
IS GETTING VERY
SERIOUS



Nuku'Alofa
Kingdom of Tonga
A35JT
A 50 MHZ EXPEDITION

SAIPAN KH0/W6JKV

WALLIS ISLAND FW/W6JKV (PICTURE FROM FW5JJ)

FIJI 3D2JT 1982


FJ/W6JKV
ST. BARTHELEMY
"oh no, another
family RADIO vacation"