RF Common Mode Choke Performance

How to select/construct efficient RF common mode chokes that eliminate RF ground loops, and RF in the Shack, that impact amateur radio station performance.

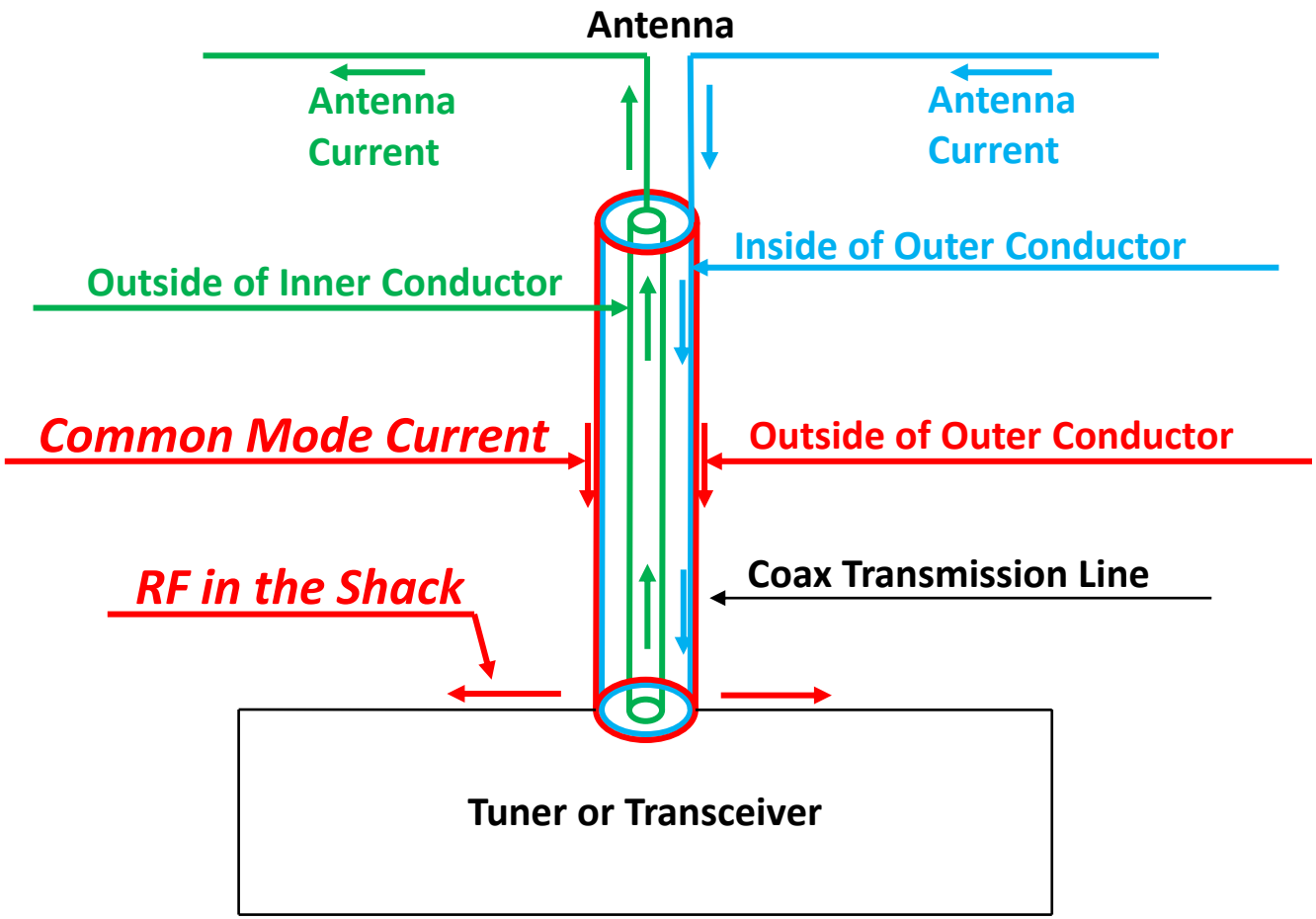
www.carshamradio.org/index.php/resources

Paul Krahmer KA4IOX

December 4, 2025

What is a Common Mode Choke?

- A Common Mode Choke provides high impedance to common mode current to reduce RF in the Shack.



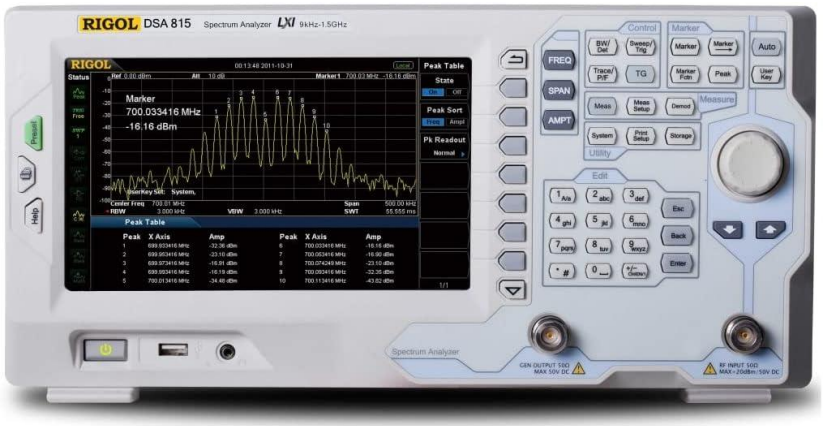
Coiled Coax Common Mode (CM) Choke Performance

- Grid or Gate Dip meter can be used to find Common Mode self resonant frequency (SRF) of coiled coax chokes.
- Use CM chokes below their SRF, where they are inductive.

Amateur Band	Coil	Coax Turn	RG-8X Turns per Choke
	Diameter	Spacing	
80	6 inches	Close/Random	18
75	6 inches	Close/Random	16
60	6 inches	Close/Random	12
40	6 inches	Close/Random	9
30	6 inches	Close/Random	5
20	6 inches	Close/Random	4
17	6 inches	Close/Random	3
15	6 inches	Close/Random	3
12	6 inches	Close/Random	3
10	6 inches	Close/Random	2

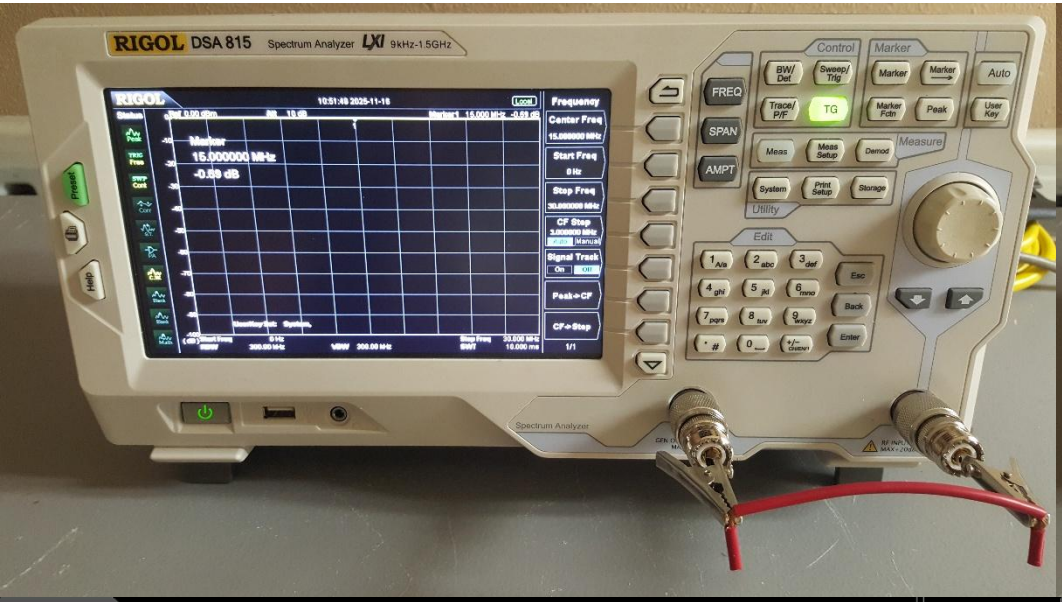
Spectrum Analyzer or Vector Network Analyzer with Tracking Generator

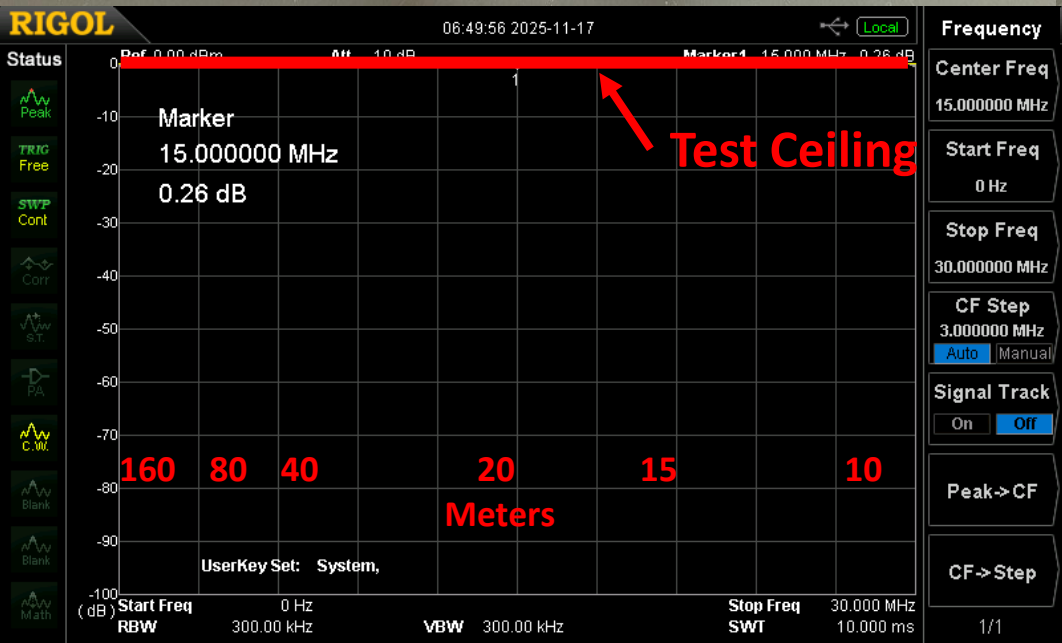
- **Rigol DSA 815-TG Spectrum Analyzer with Tacking Generator, 9KHz – 1.5 GHz, 8 inch screen. Measures AM/FM demodulation, S parameters, Duplexer VSWR, Phase, Delay.**
- Aursinc Nano VNA SAA-2N V2.2, 1.6KHz – 3GHz, 4 inch touch screen. Measures S parameters, Duplexer, VSWR, Phase, Delay.



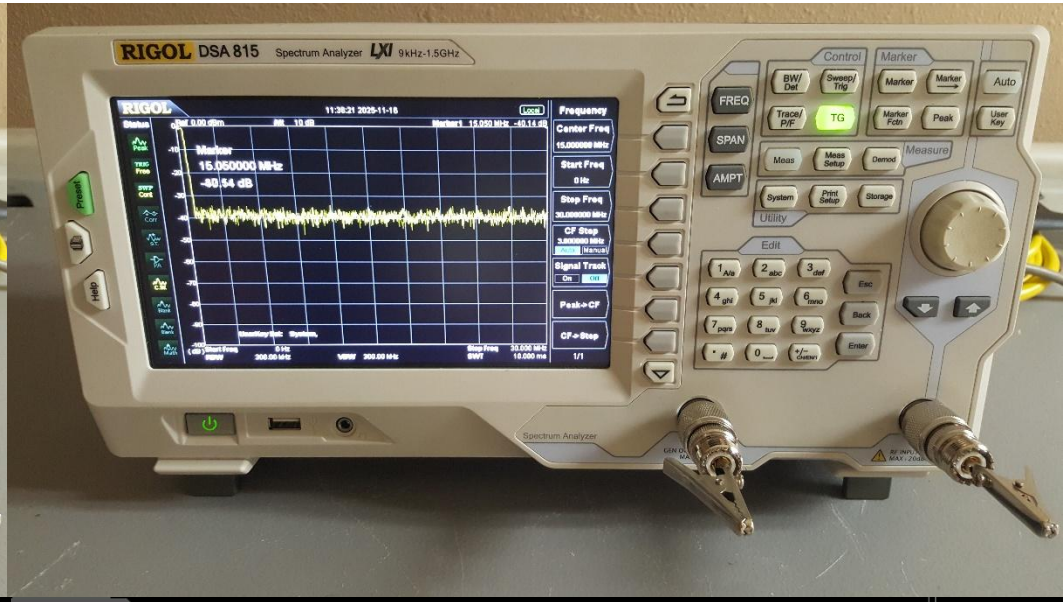
Spectrum Analyzer test setup 1 and normalization, 0 to 30MHz

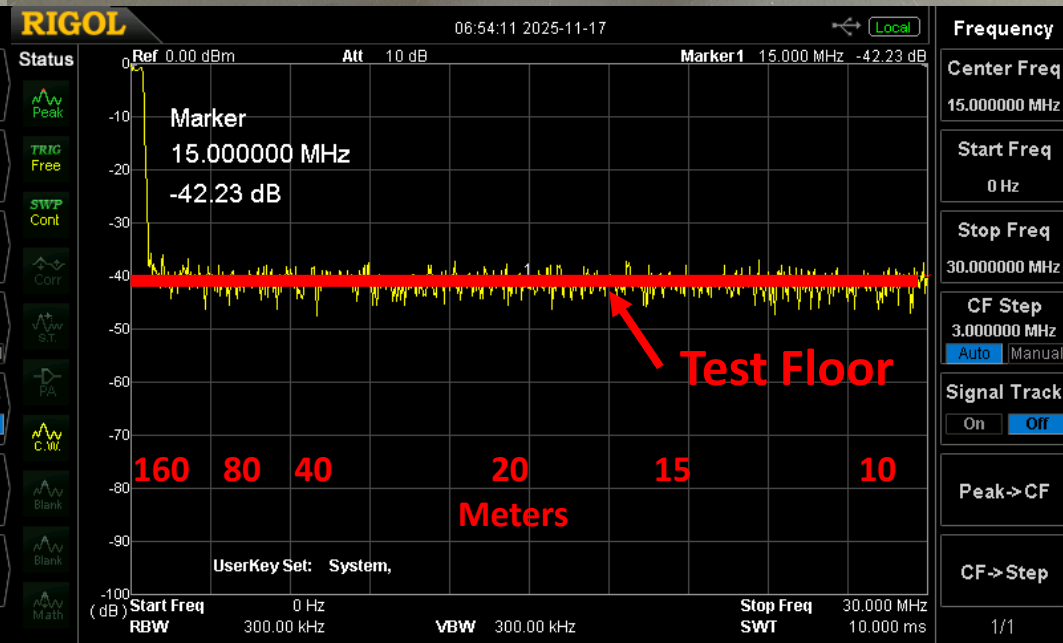
Closed Loop





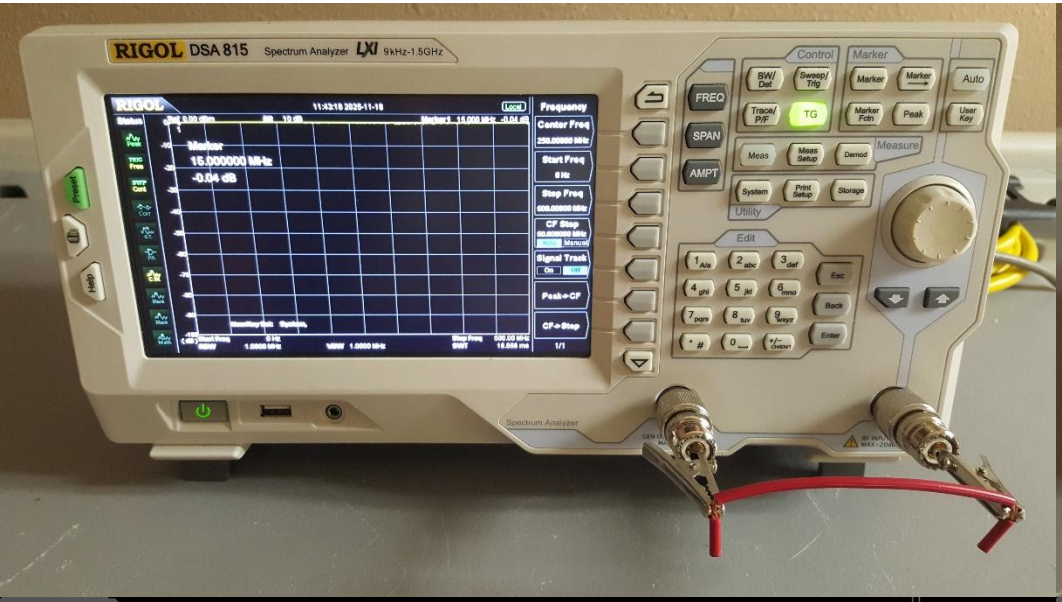
Open Loop

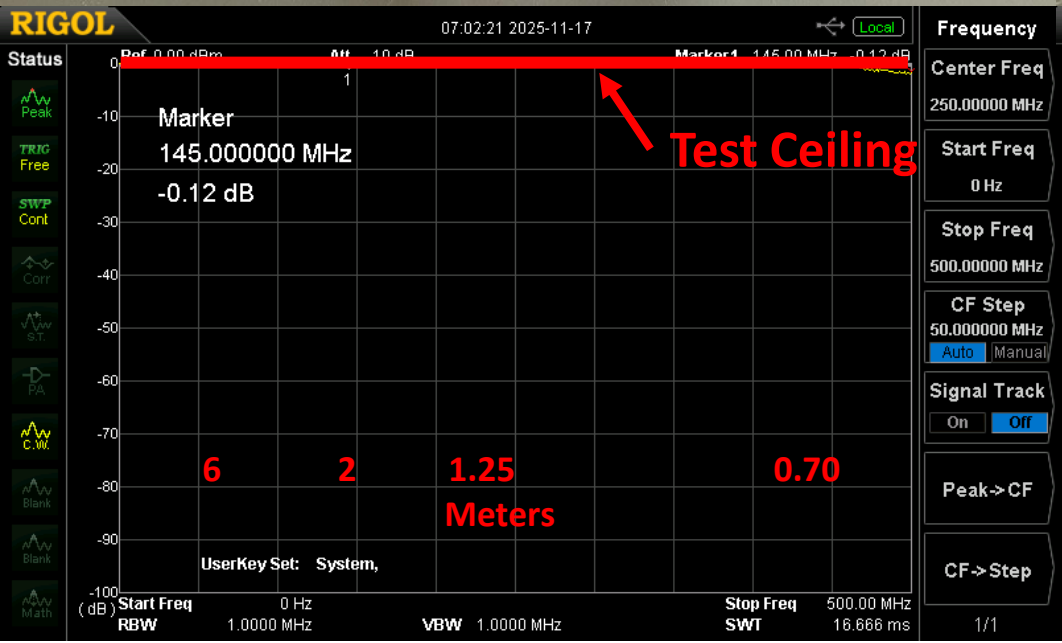




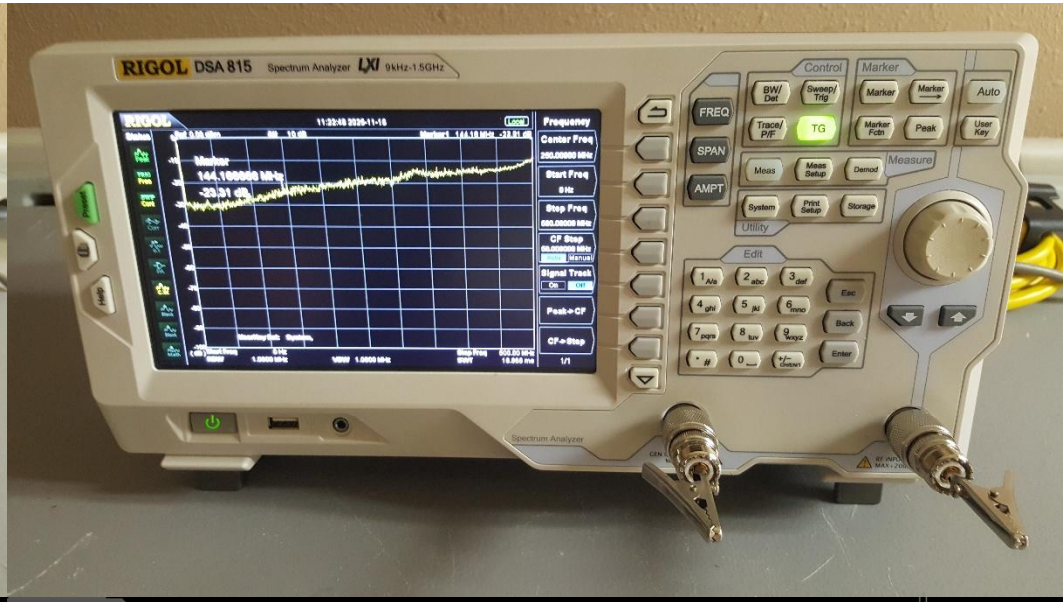
Spectrum Analyzer test setup 1 and normalization, 0 to 500MHz

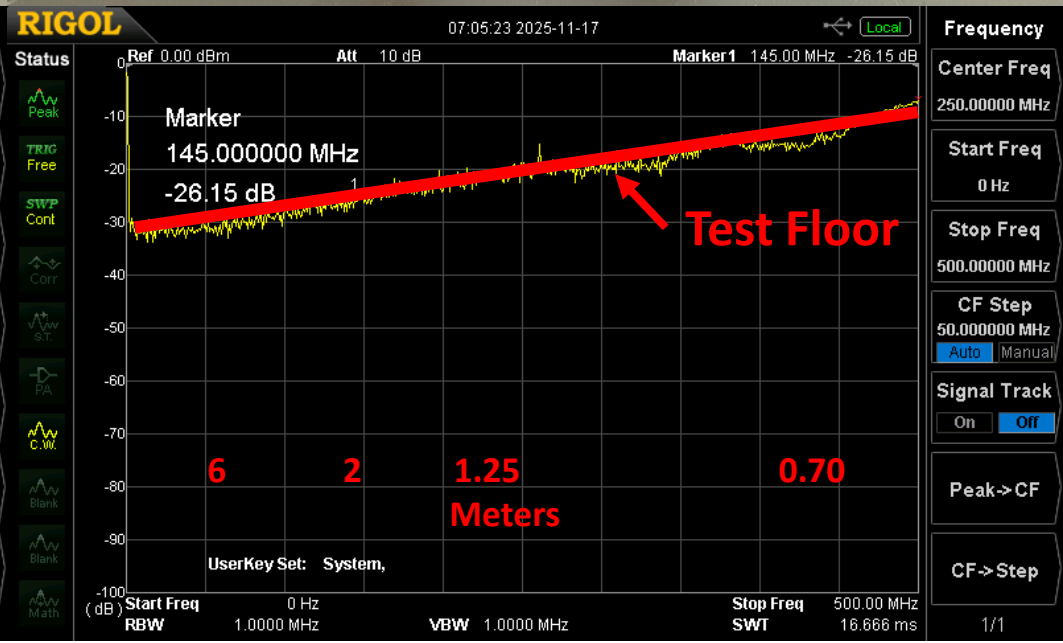
Closed Loop





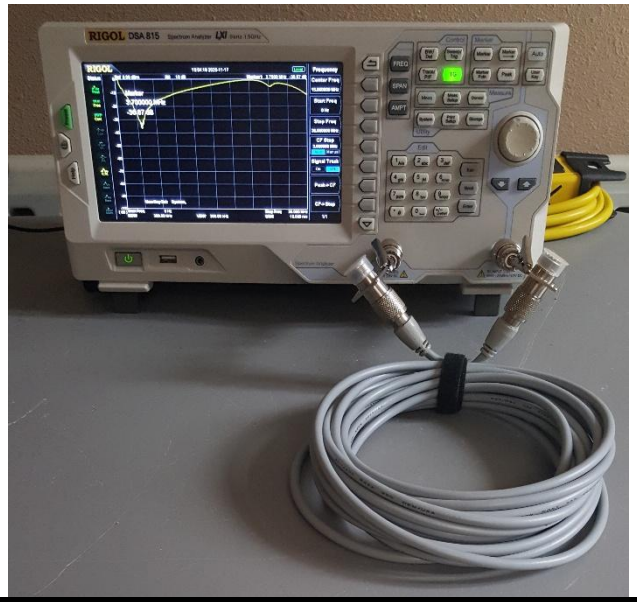
Open Loop

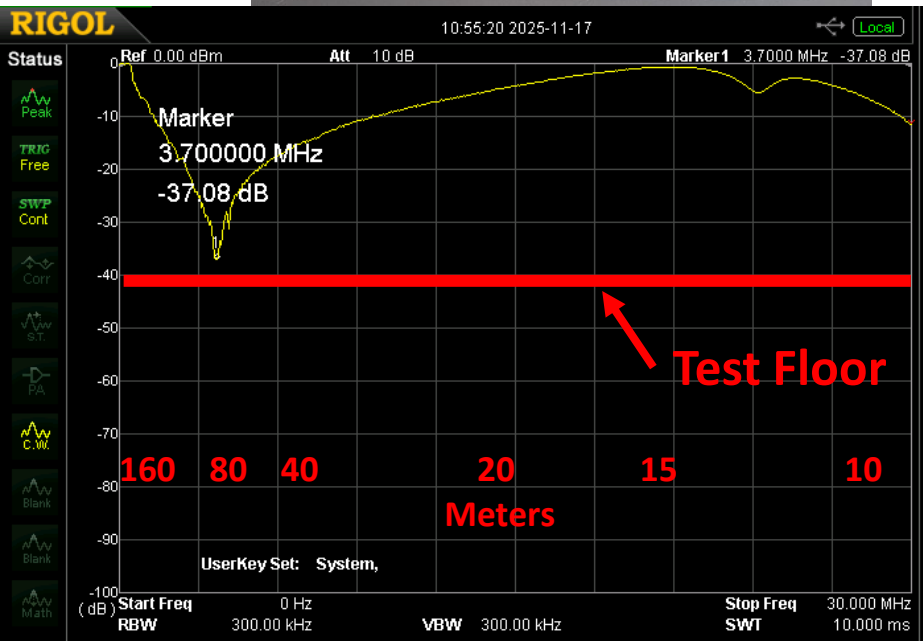




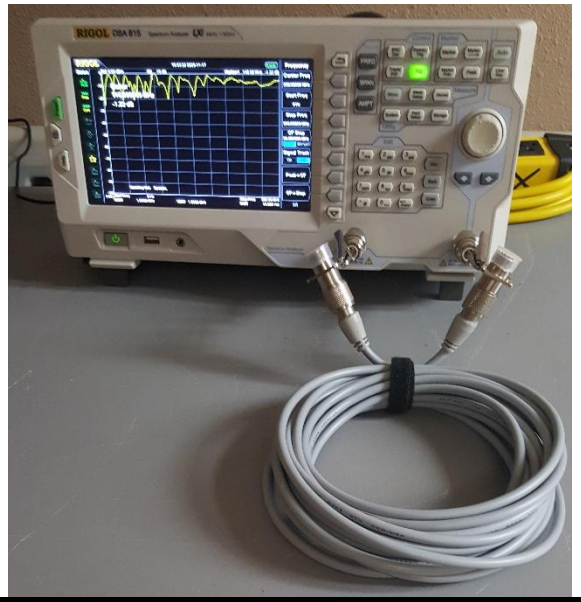
15 turns RG-8X, Open cell (FPE) gas-injected foam polyethylene dielectric

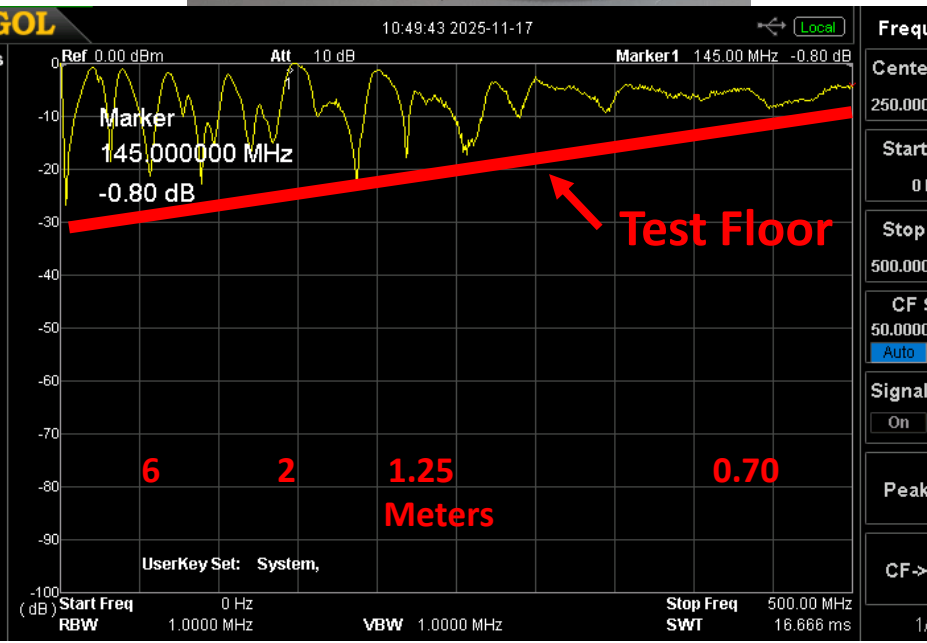
0 to 30MHz





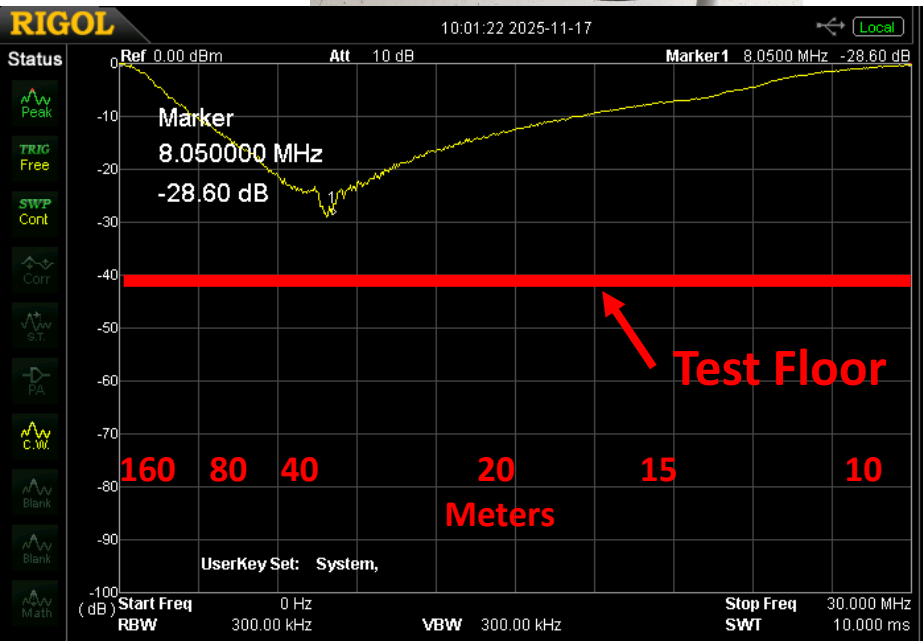
0 to 500MHz



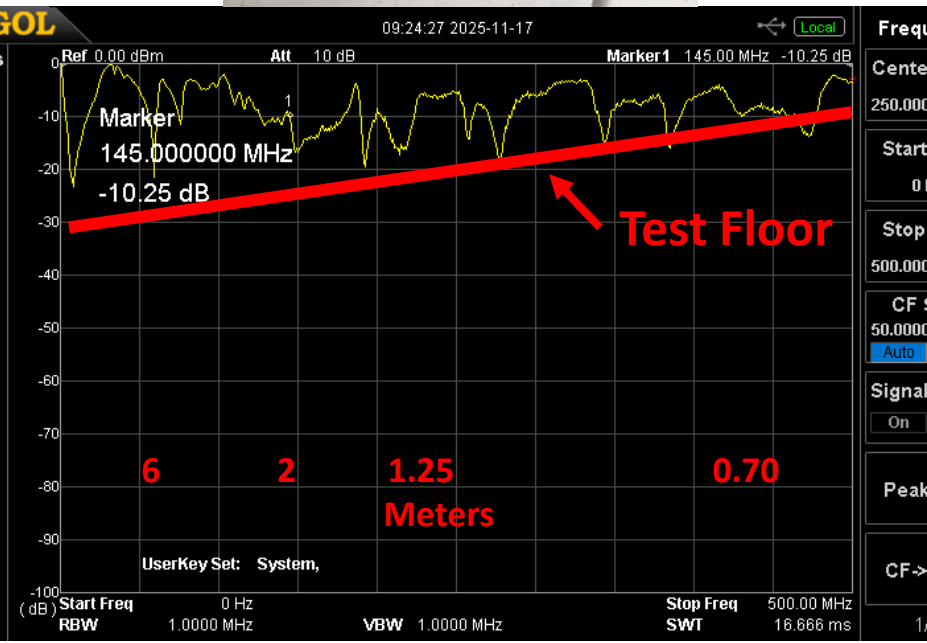


6 turns, 8 in diameter, RG-213, (PTFE) polytetrafluoroethylene (Teflon) dielectric

0 to 30MHz

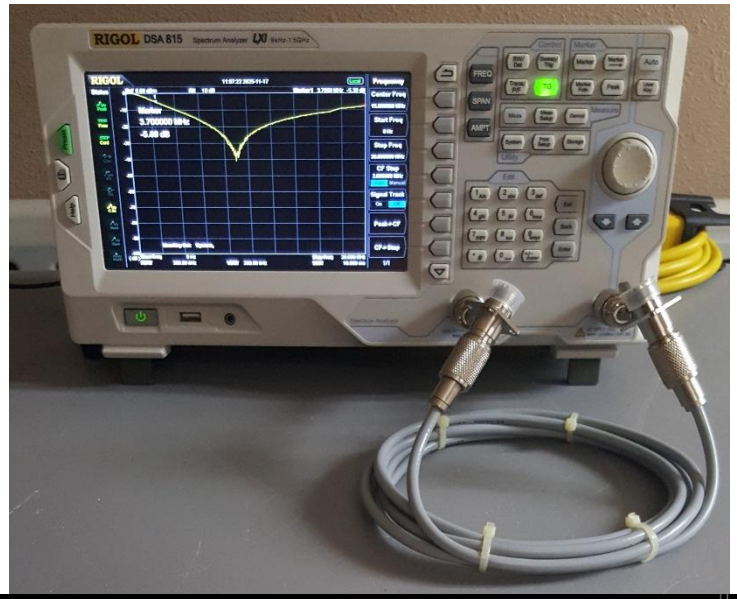


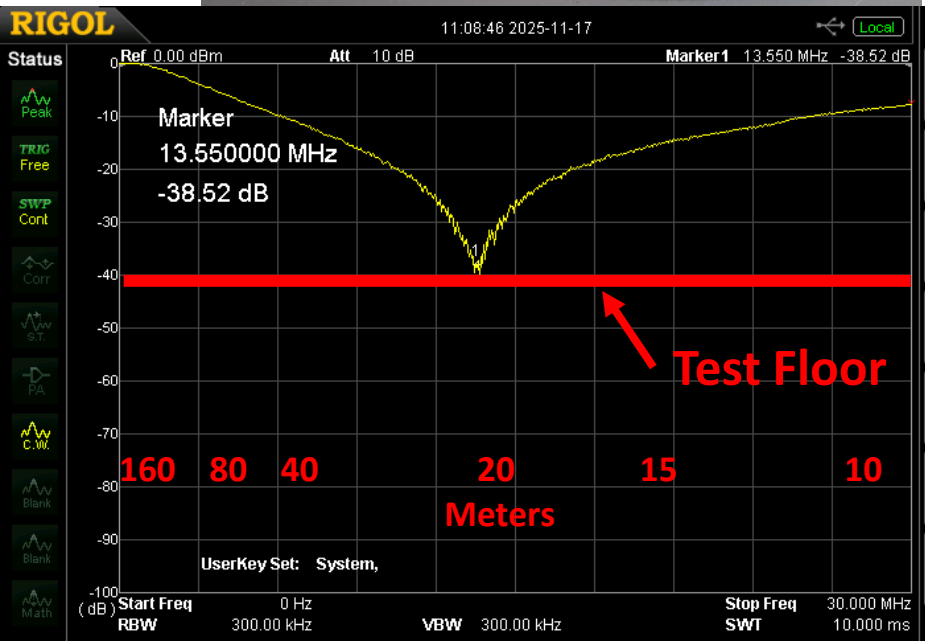
0 to 500MHz



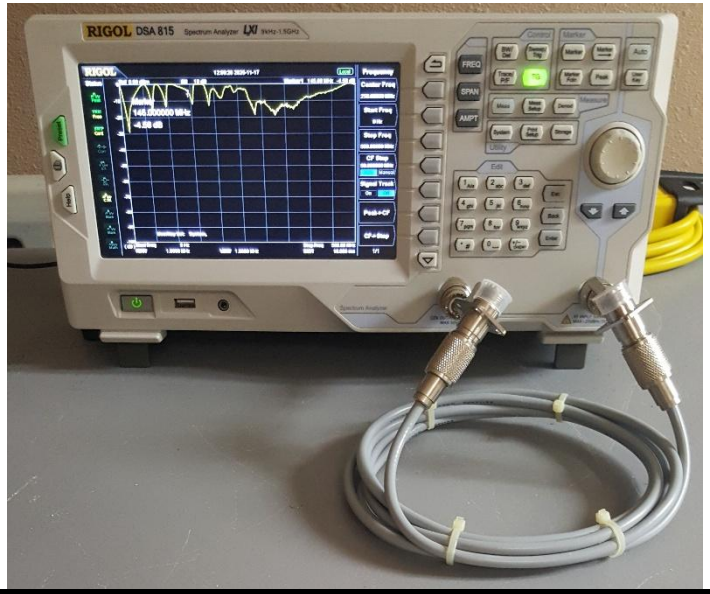
6 turns RG-8X, Open cell (FPE) gas-injected foam polyethylene dielectric

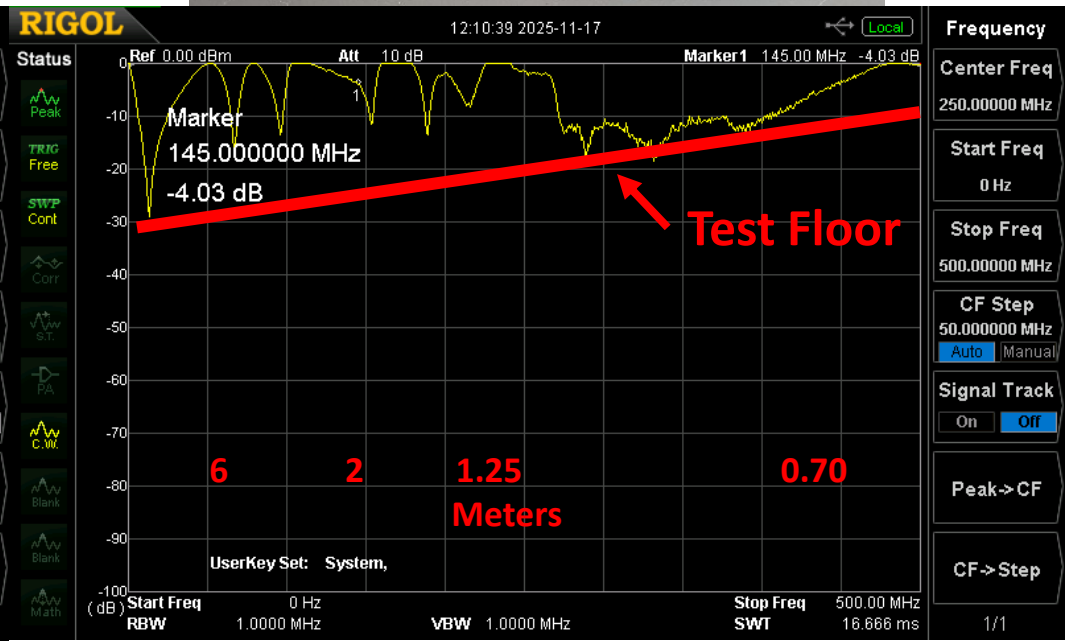
0 to 30MHz





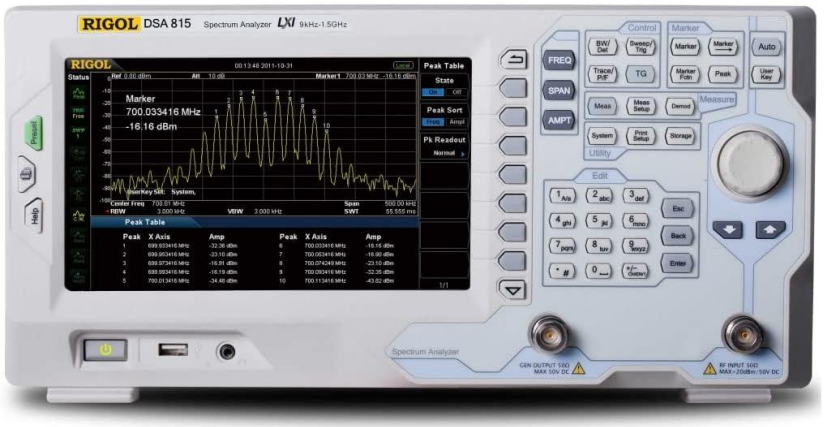
0 to 500MHz





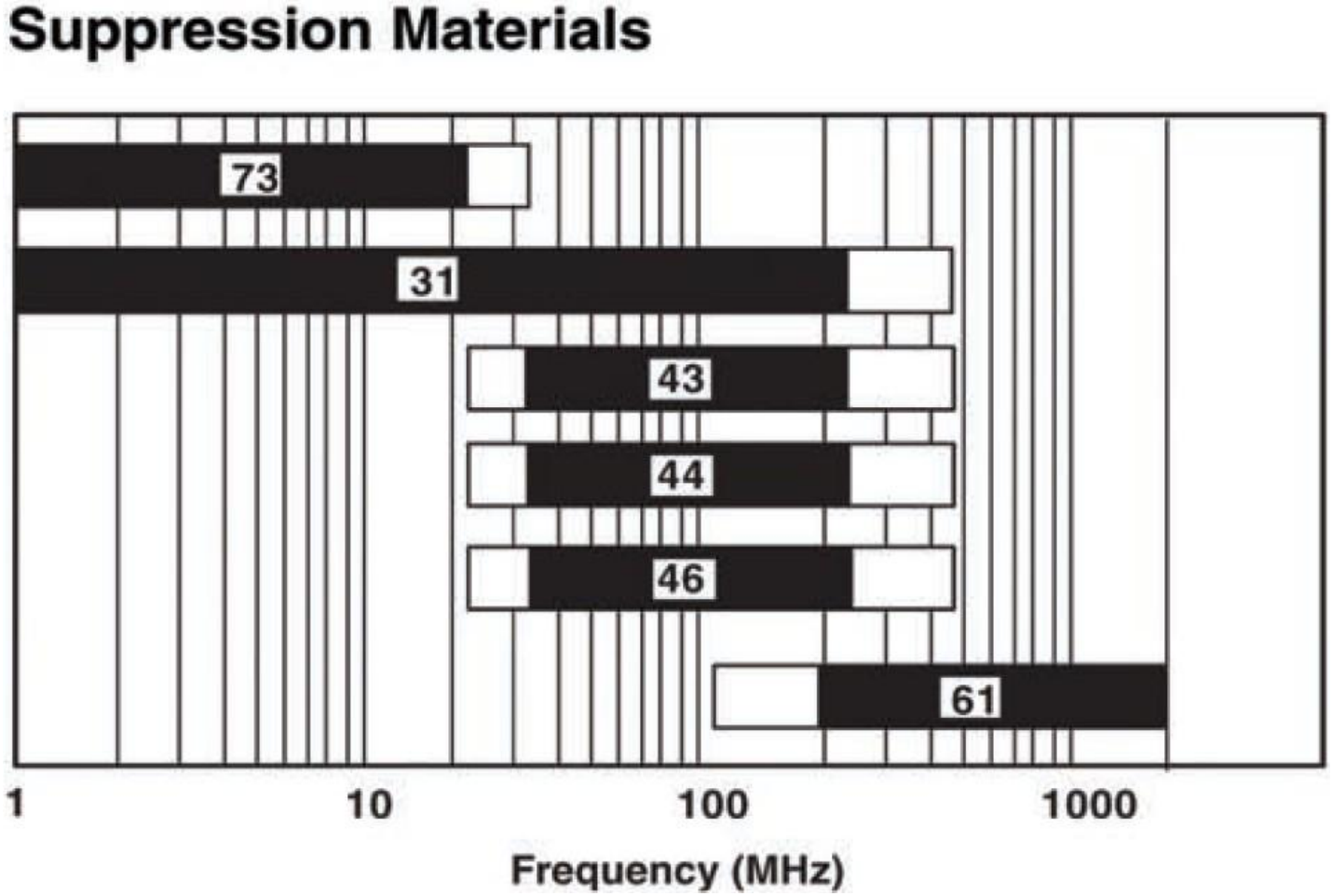
Coiled Coax CM Choke with Ferrite(s) Performance

- Grid Dip meter cannot be used to find Common Mode resonant frequency of coiled coax choke when ferrites are added.
- Ferrites flatten, and widen Common Mode response.
- A Spectrum Analyzer or Vector Network Analyzer with Tacking Generator can be used.



Ferrite Frequency Performance

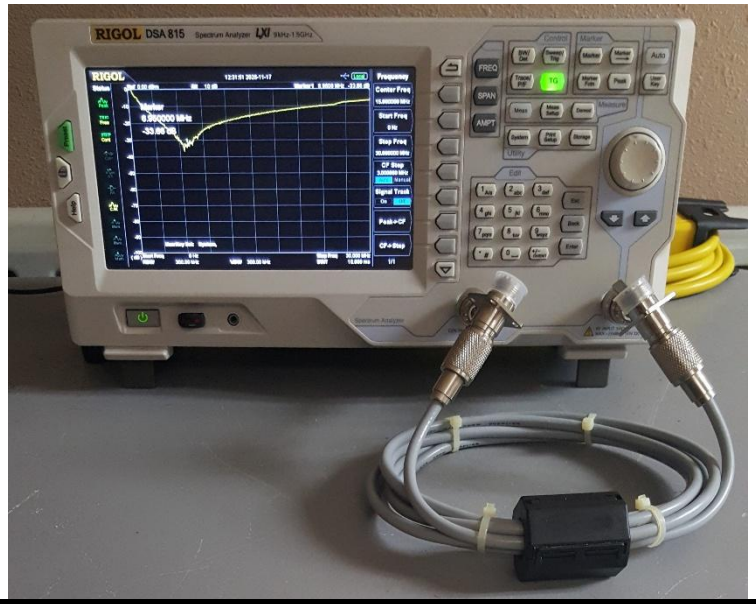
- Type 31 ferrite material recommended frequency range covers the entire HF spectrum, including 2 and 1.25 meters.
- Type 61 ferrite material recommended frequency range covers 1.25 meters to 2GHz.

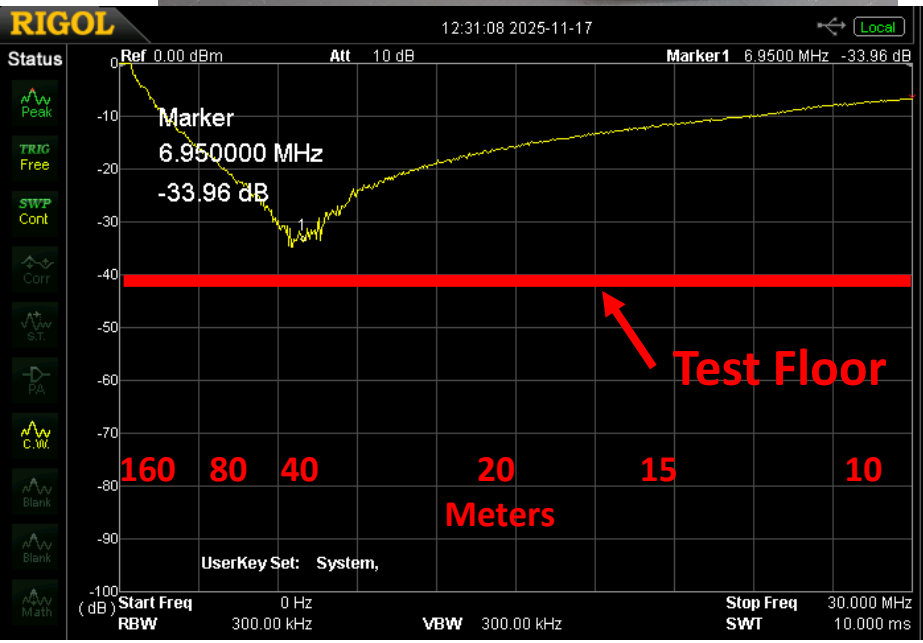


Fair-Rite Products Corporation

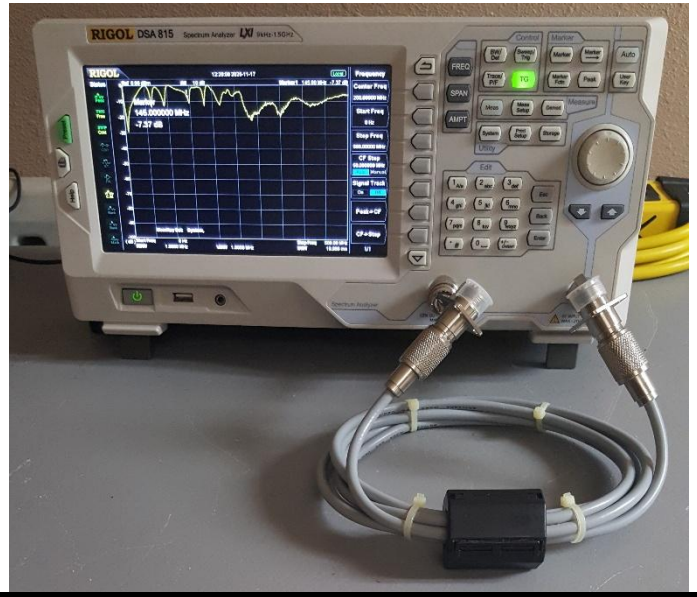
6 turns RG-8X, with 1 type 31? clamp on ferrite, Open cell (FPE) gas-injected foam polyethylene dielectric

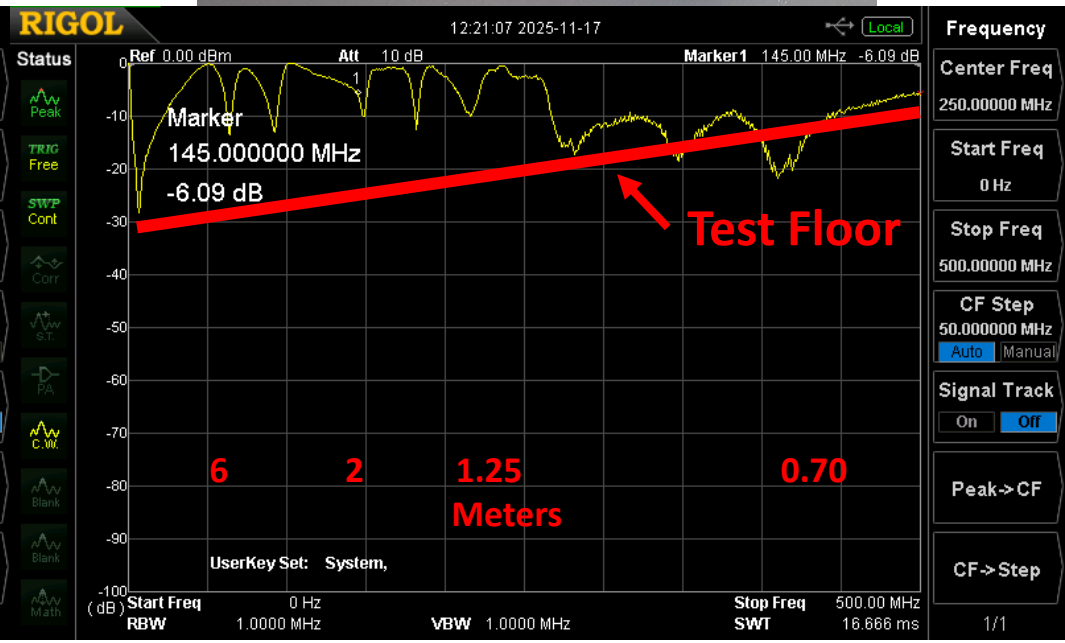
0 to 30MHz





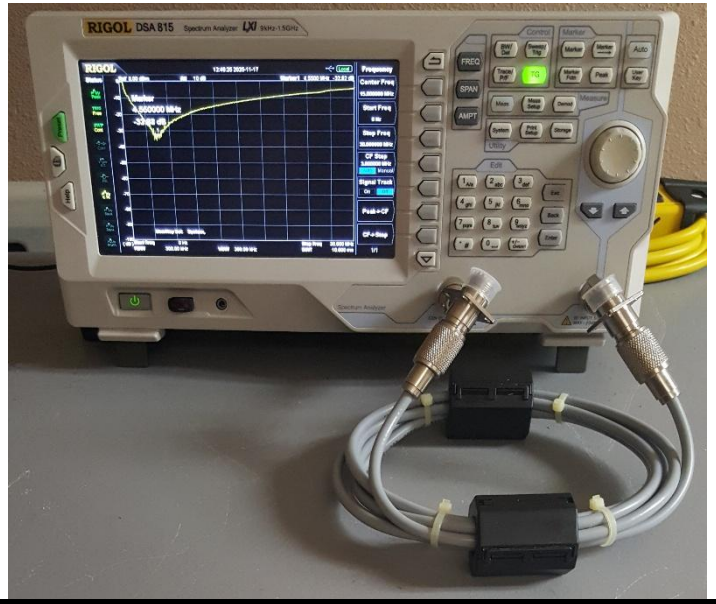
0 to 500MHz

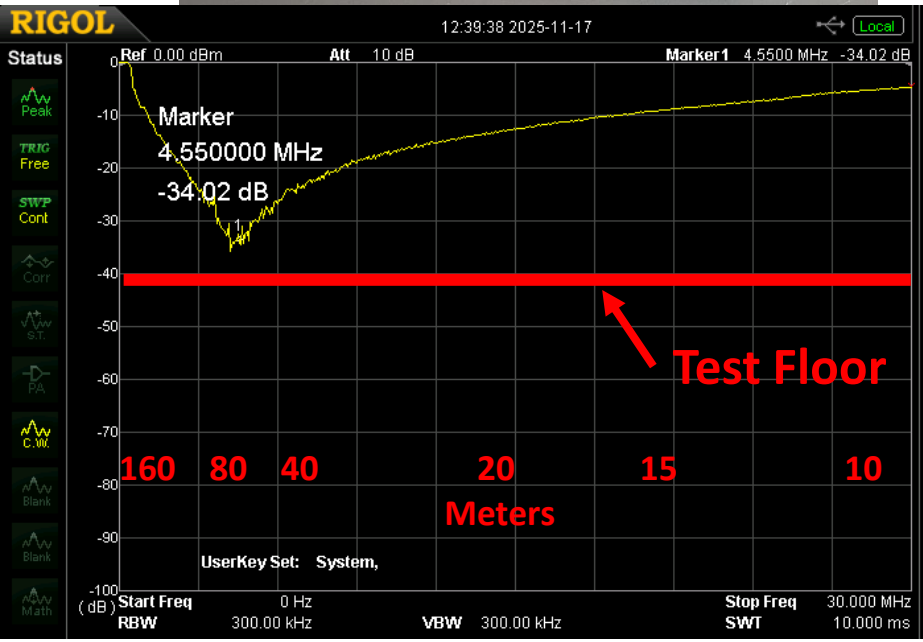




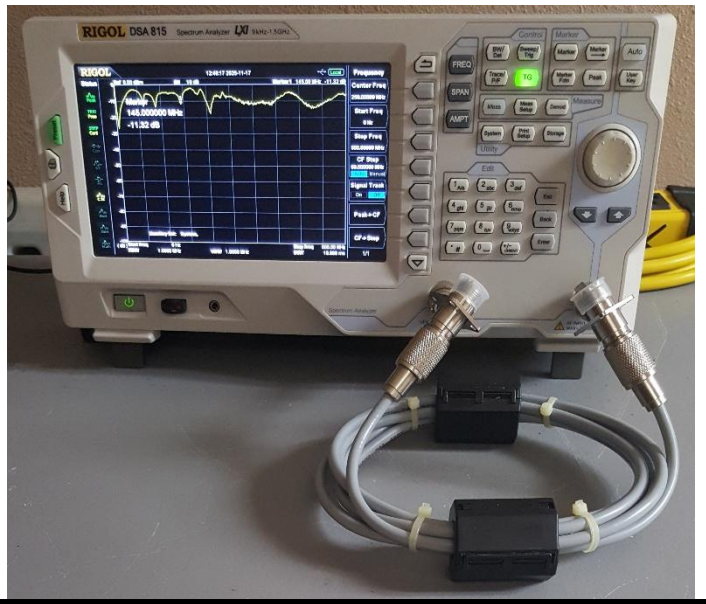
6 turns RG-8X, with 2 type 31? clamp on ferrites, Open cell (FPE) gas-injected foam polyethylene dielectric

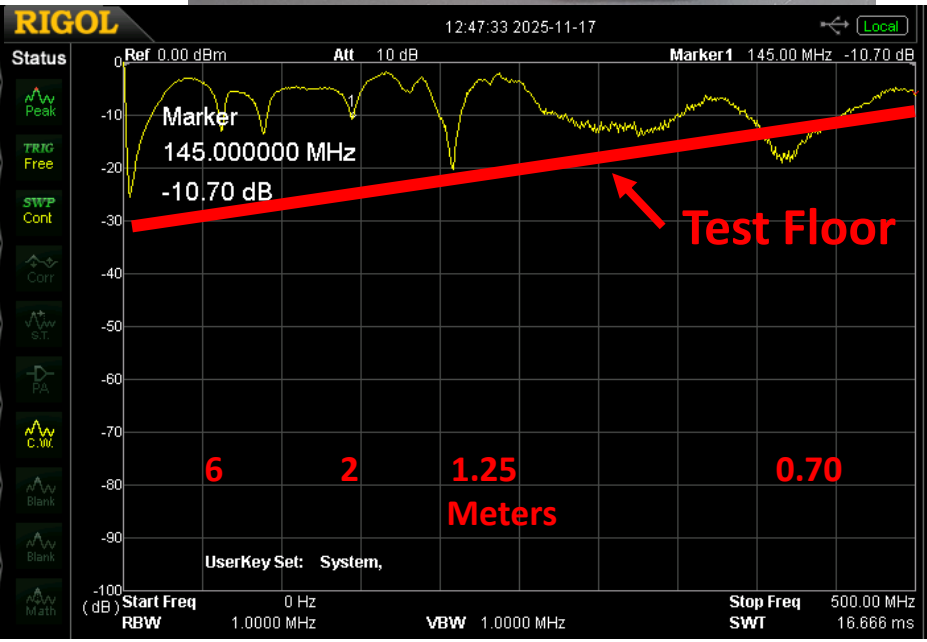
0 to 30MHz





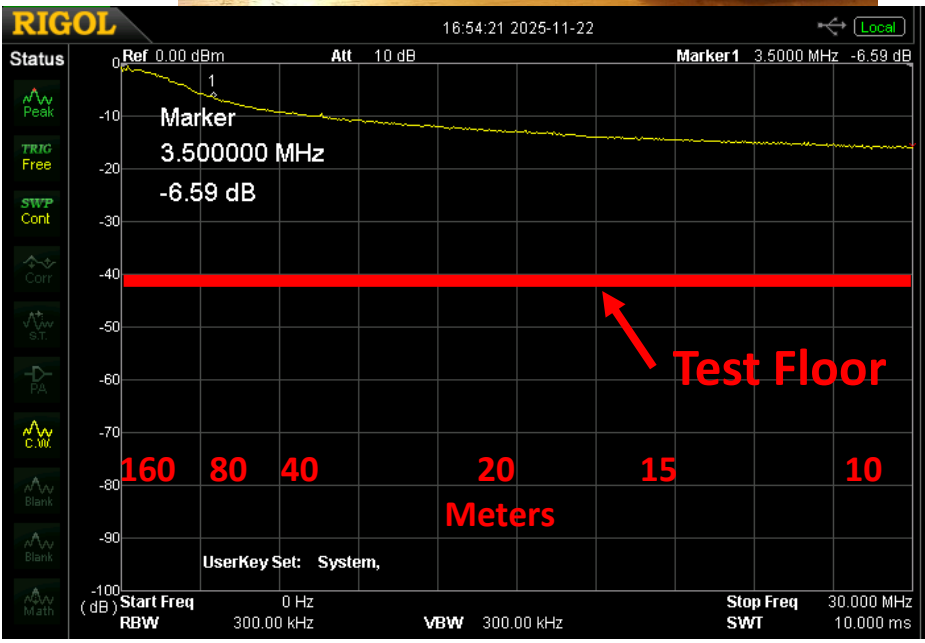
0 to 500MHz



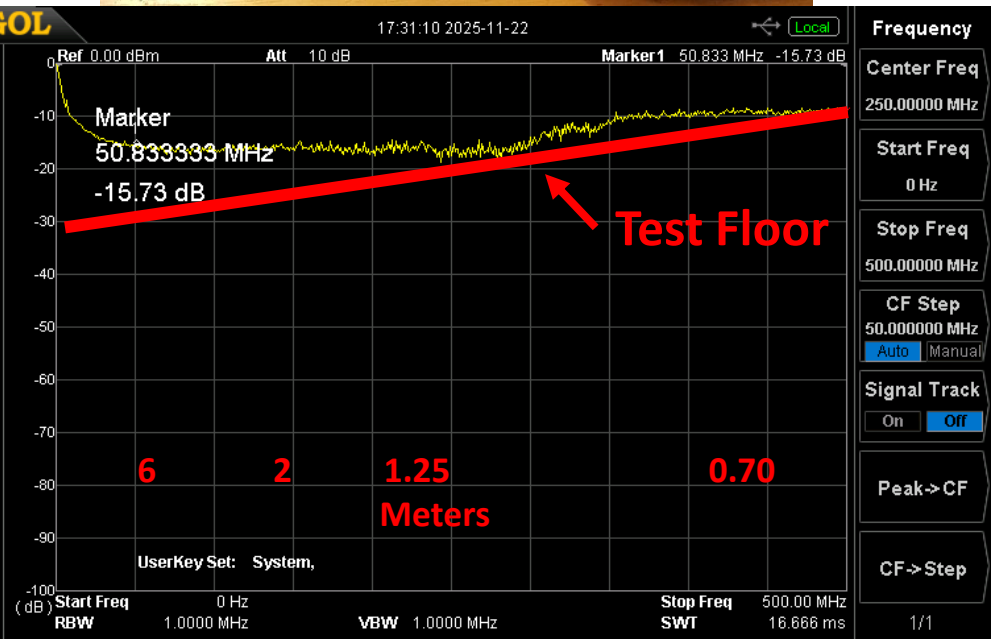


6 Sizhongda Ferrites, type 31 clamp on, RG-213, (PTFE) polytetrafluoroethylene (Teflon) dielectric

0 to 30MHz



0 to 500MHz

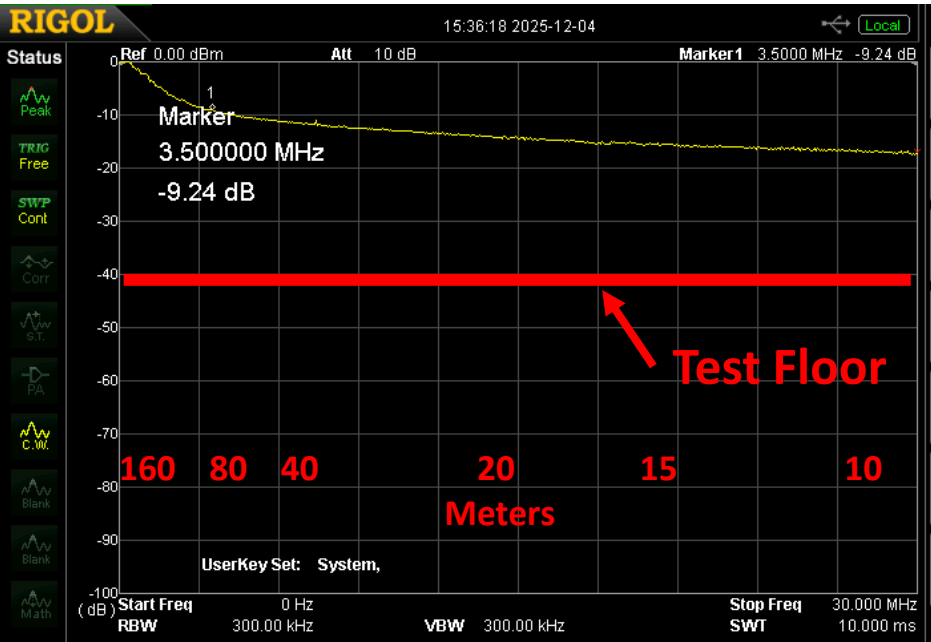


5 Palomar Engineers Ferrites, type 31, RG-213, (PTFE) polytetrafluoroethylene (Teflon) dielectric

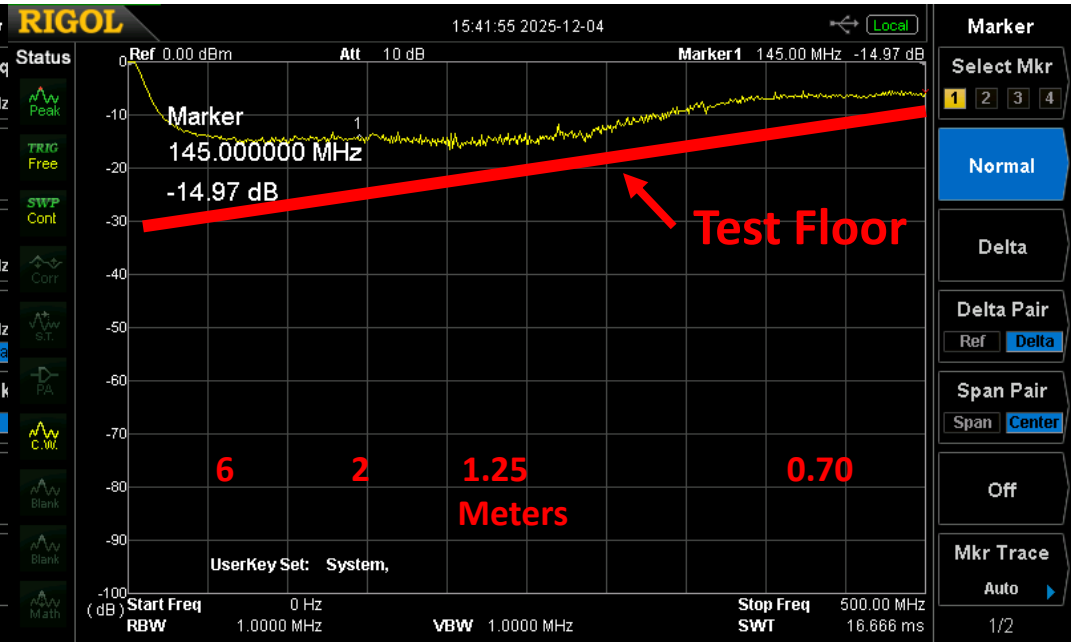
Single turn w/ single ferrite spec:

- RFI range: 1 - 300 MHz
- 5 MHz / 71 ohm
- 10 MHz / 100 ohm
- 25 MHz / 156 ohm
- 100 MHz / 260 ohm
- 250 MHz / 260 ohm

0 to 30MHz



0 to 500MHz



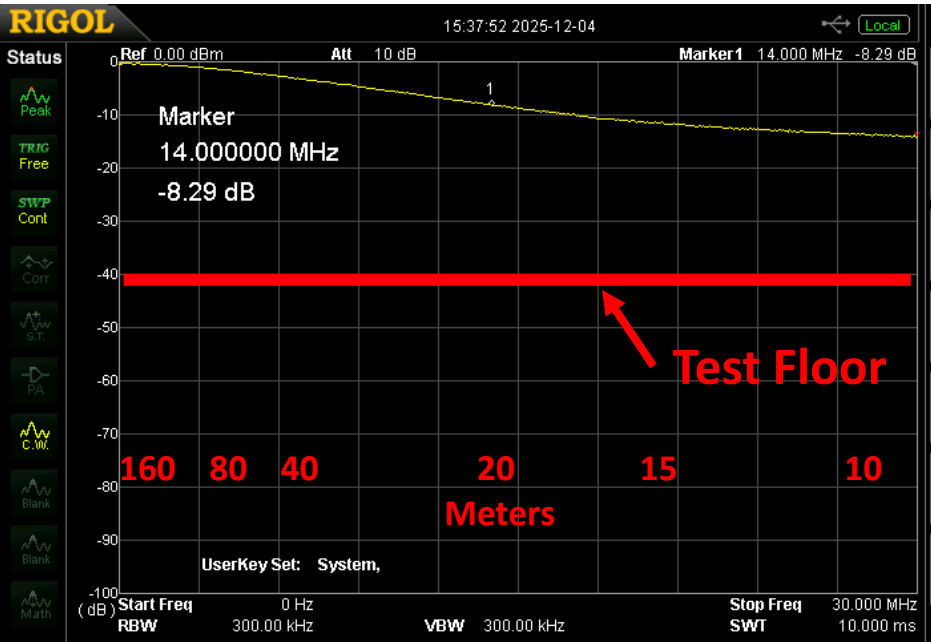
5 Palomar Engineers Ferrites, type 61, RG-213, (PTFE) polytetrafluoroethylene (Teflon) dielectric

Single turn w/ single ferrite spec:

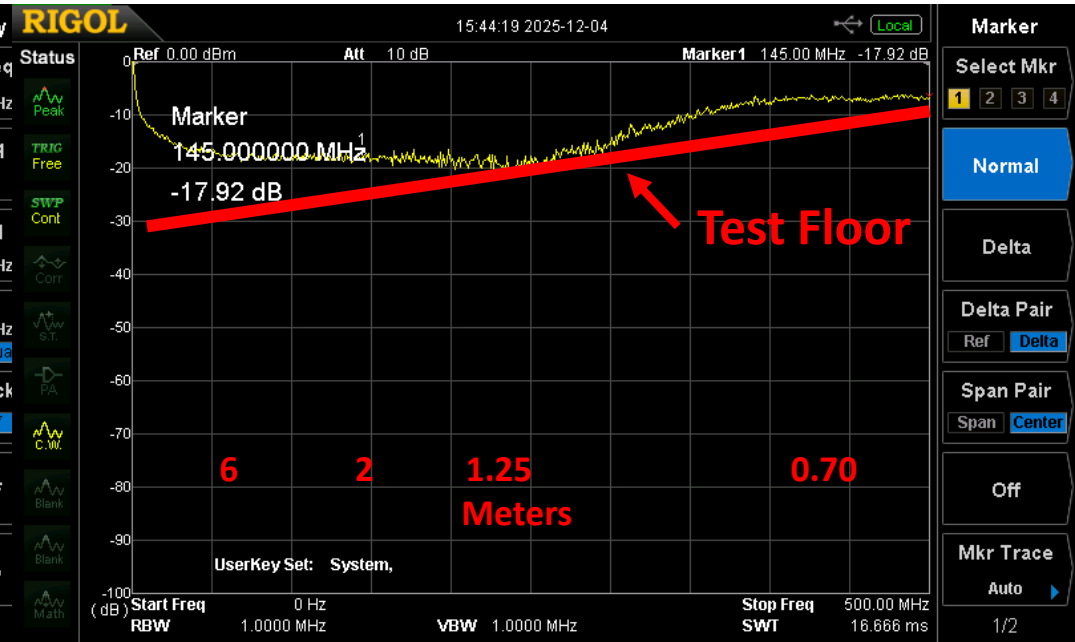
- RFI range: 200 - 2000 MHz
- 100 MHz / 205 ohm
- 250 MHz / 285 ohm
- 500 MHz / 435 ohm
- 1000 MHz / 457 ohm

2turns-4XΩ, 3turns-9XΩ, 4turns-16XΩ

0 to 30MHz

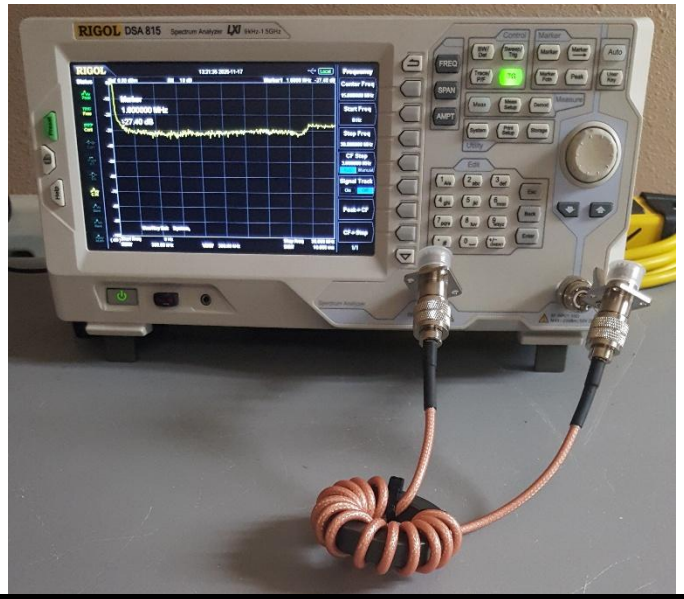


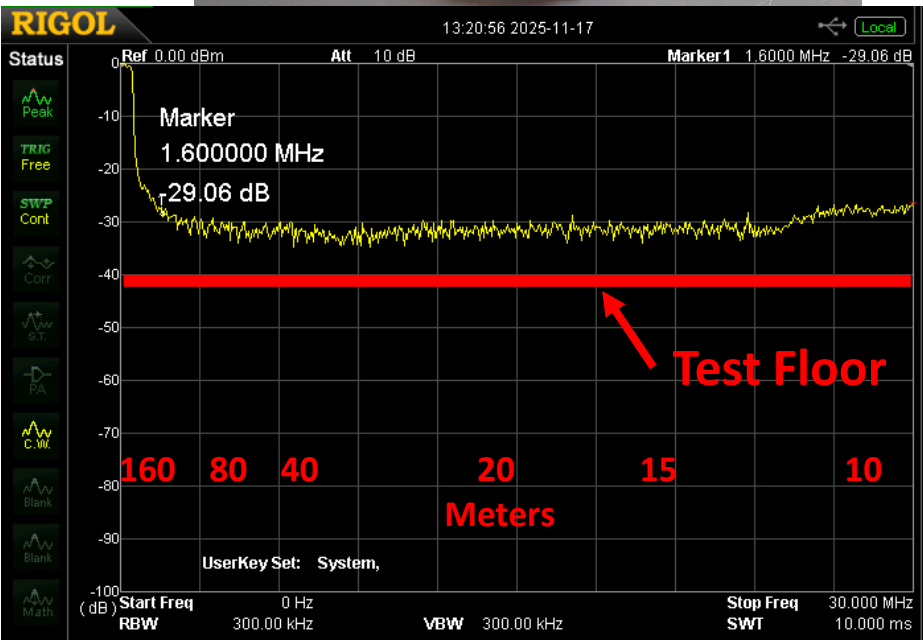
0 to 500MHz



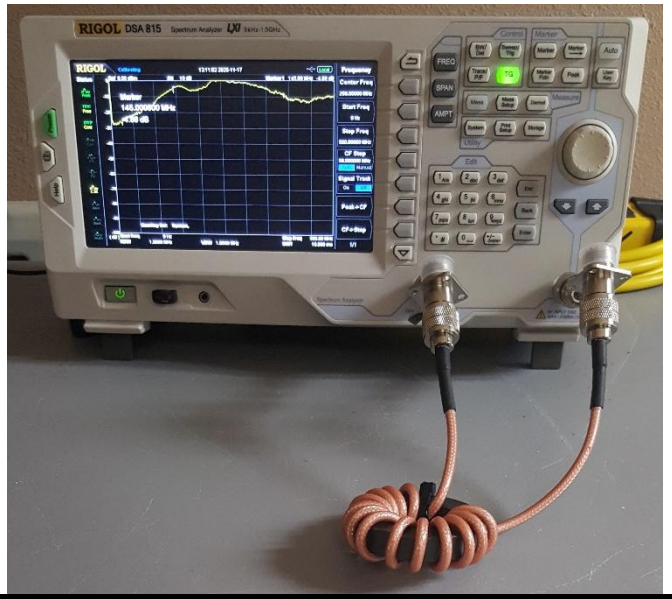
13 turns RG-400, on type 31 toroid ferrite, (PTFE) polytetrafluoroethylene (Teflon) dielectric

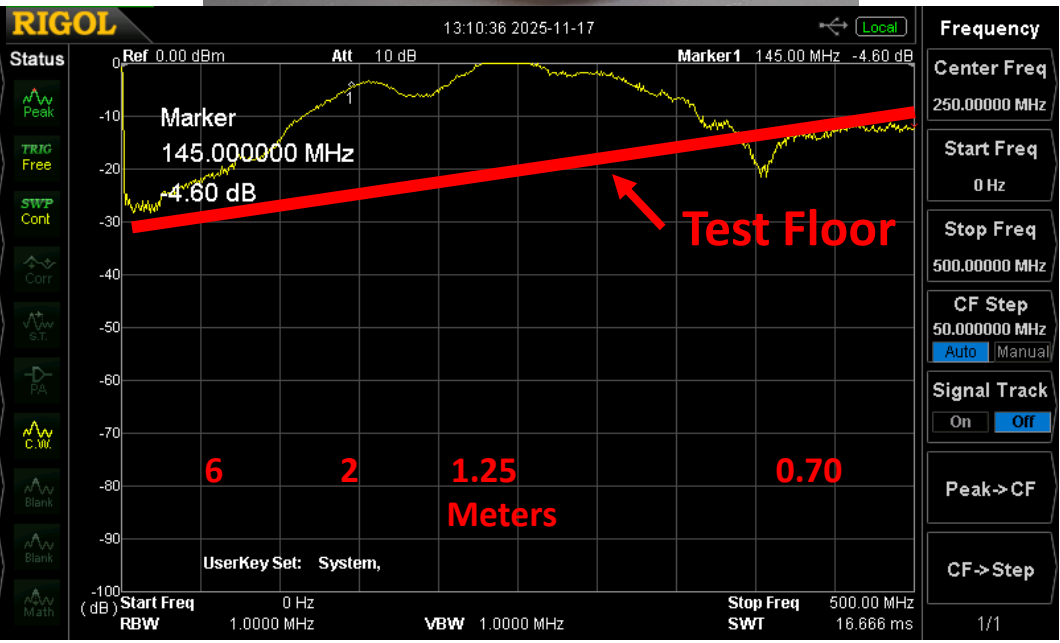
0 to 30MHz





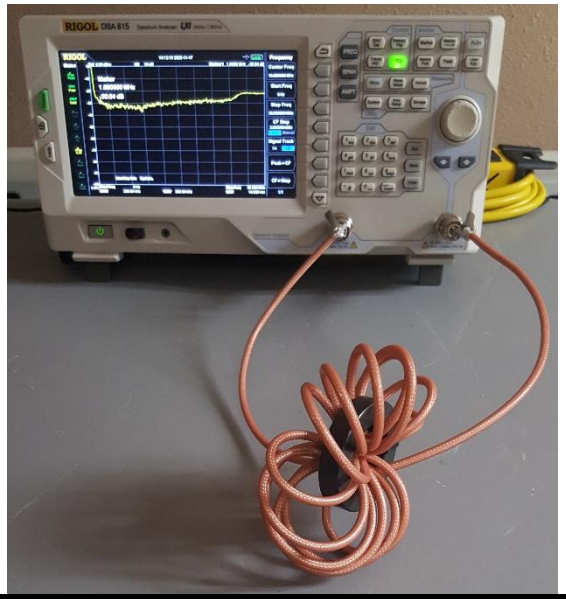
0 to 500MHz

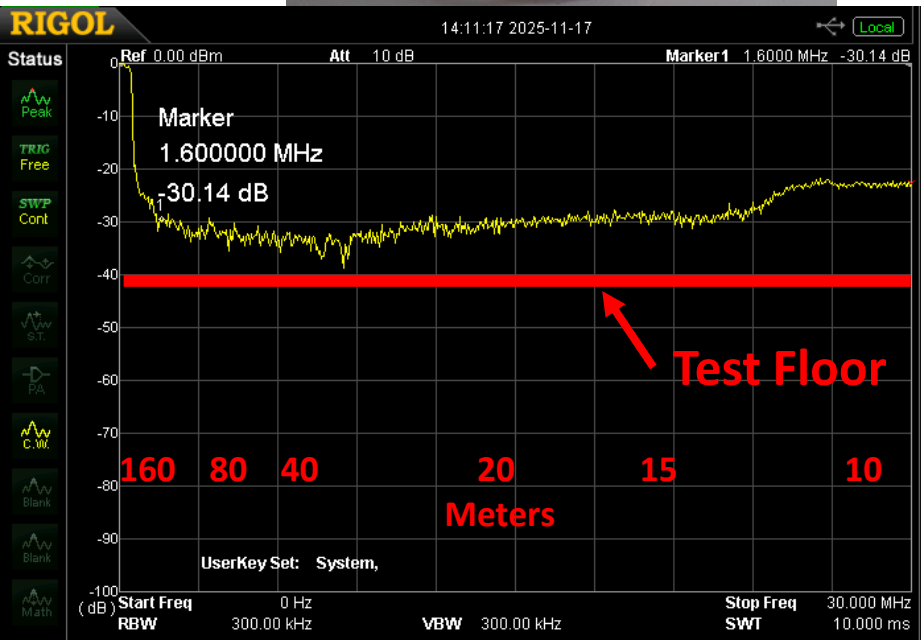




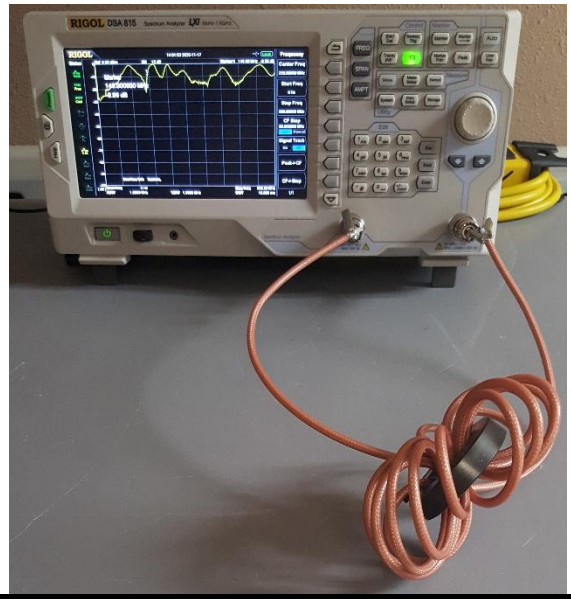
13 turns large loop RG-400, on type 31 toroid ferrite, (PTFE) polytetrafluoroethylene (Teflon) dielectric

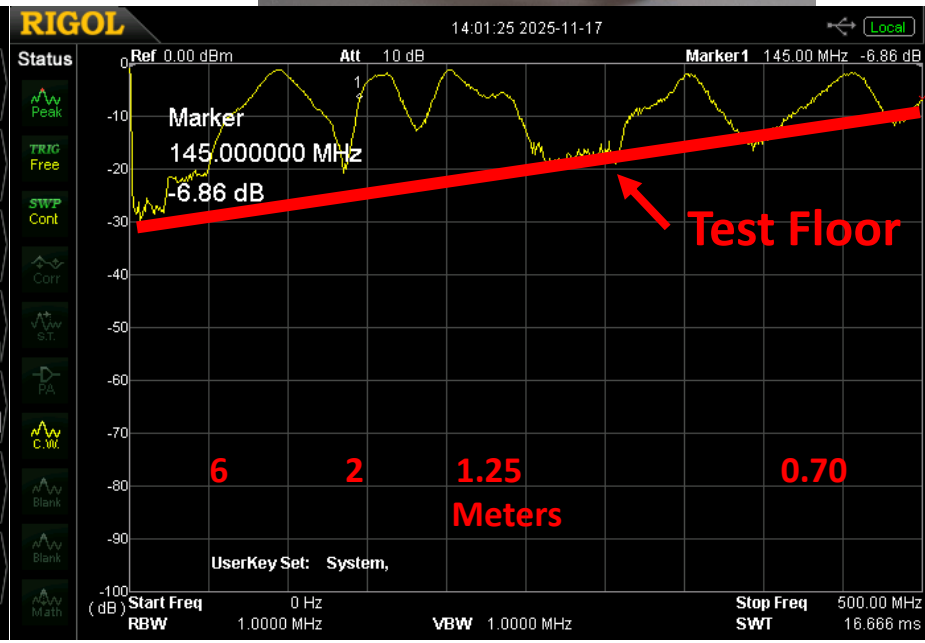
0 to 30MHz





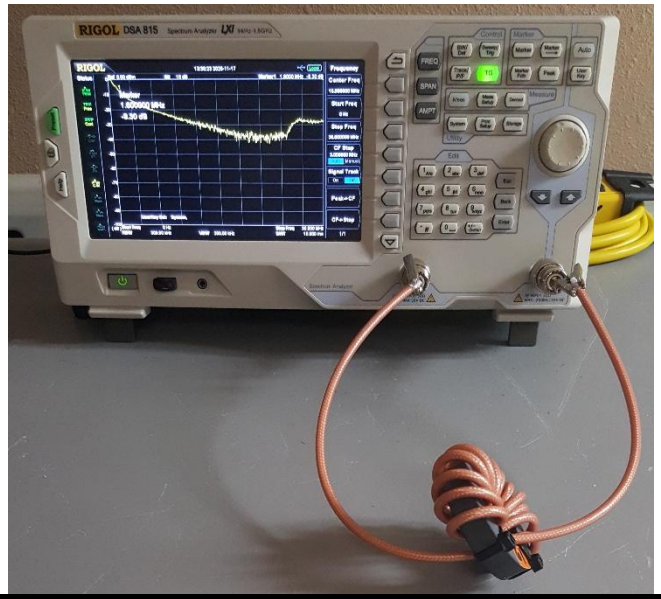
0 to 500MHz

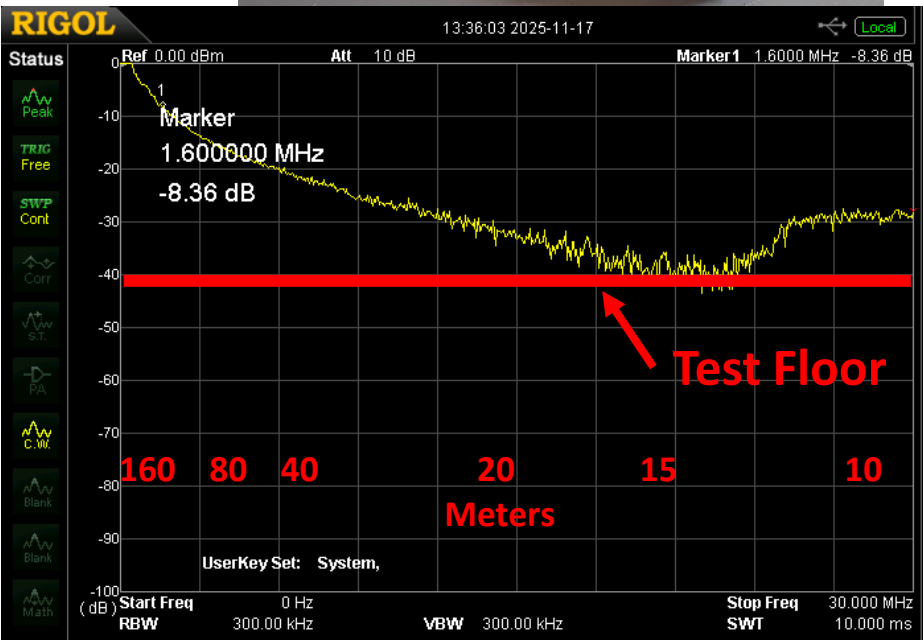




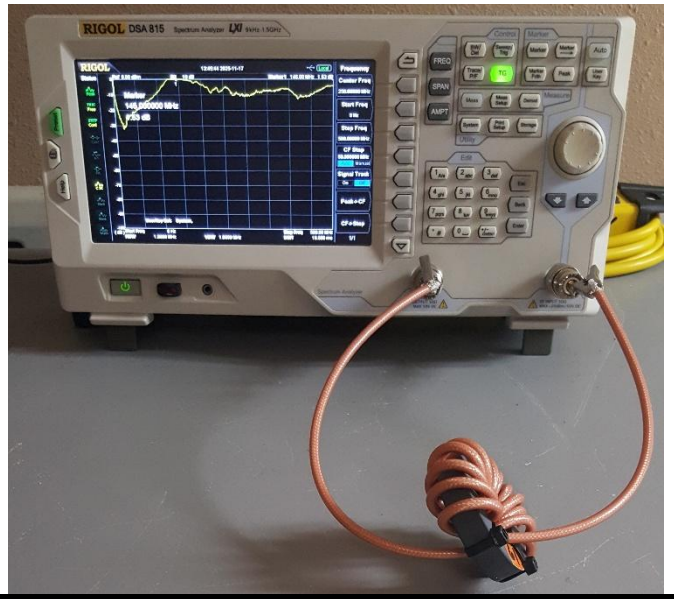
13 turns RG-400, on type 61 toroid ferrite, (PTFE) polytetrafluoroethylene (Teflon) dielectric

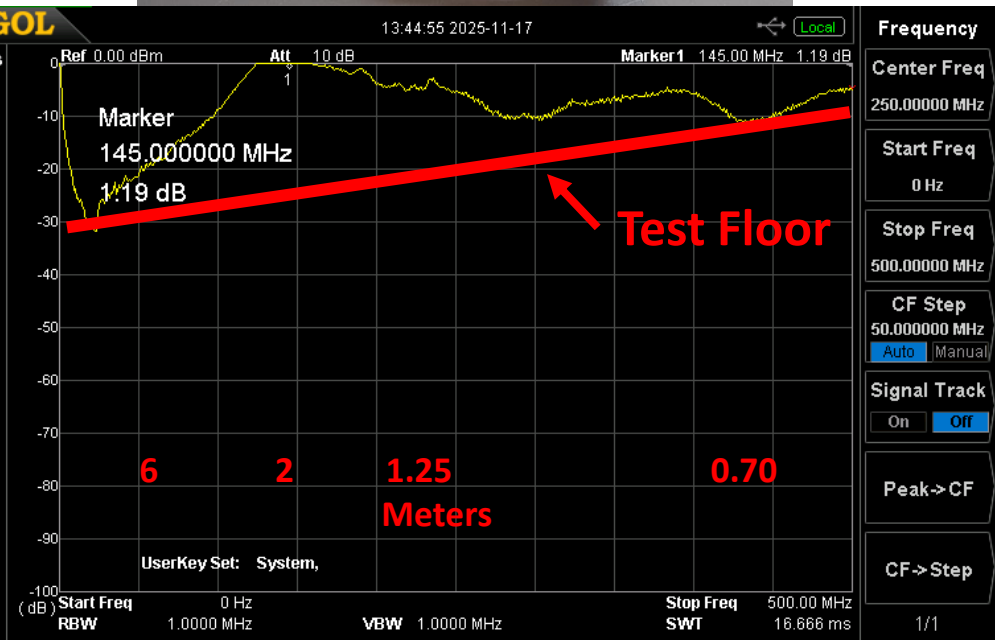
0 to 30MHz





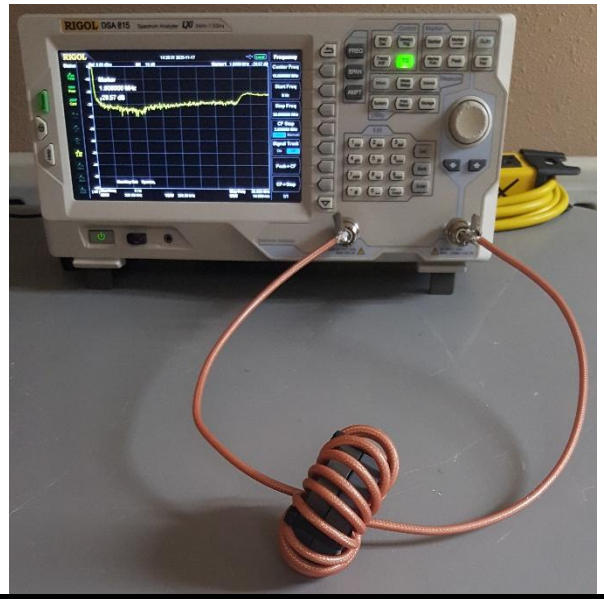
0 to 500MHz

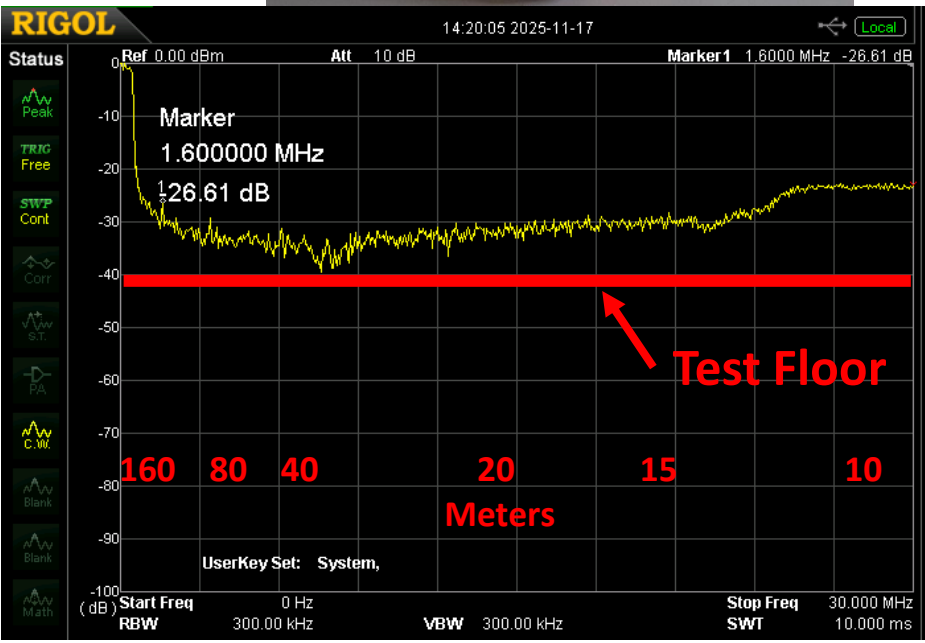




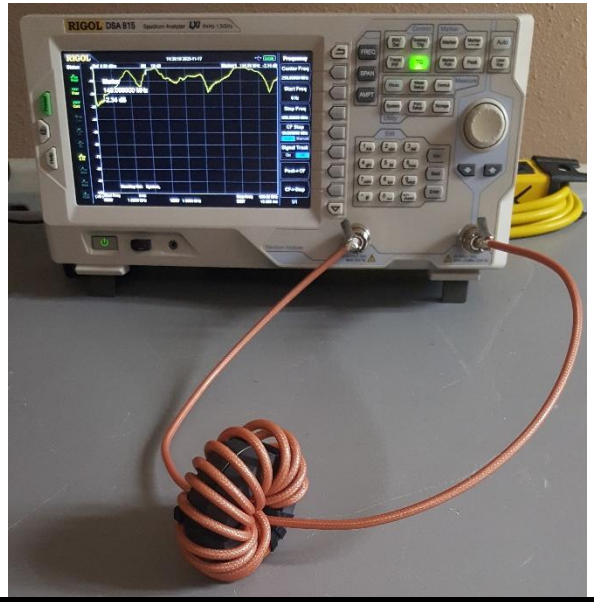
13 turns RG-400, on type 31 and type 61 toroid ferrite, (PTFE) polytetrafluoroethylene (Teflon) dielectric

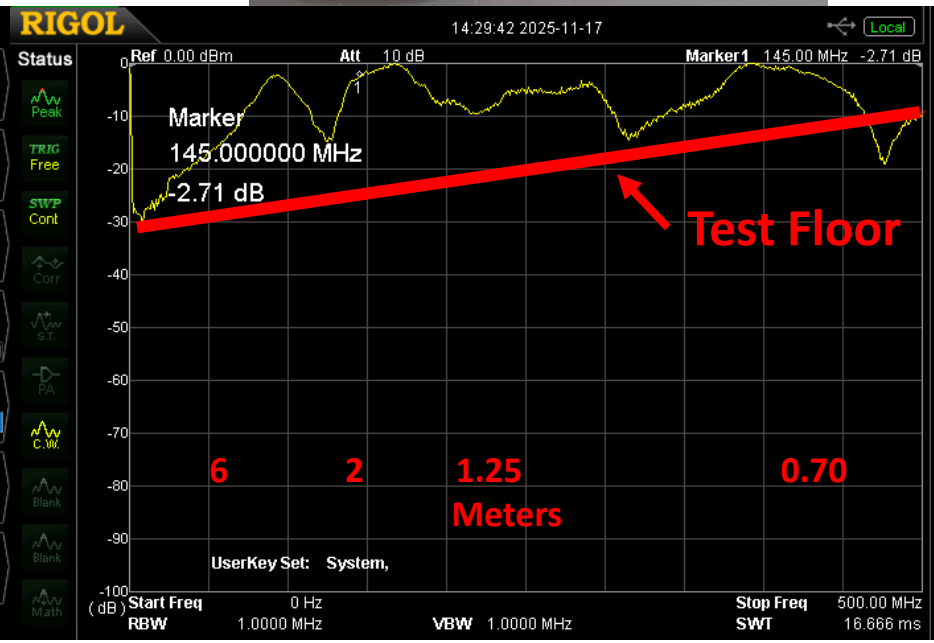
0 to 30MHz





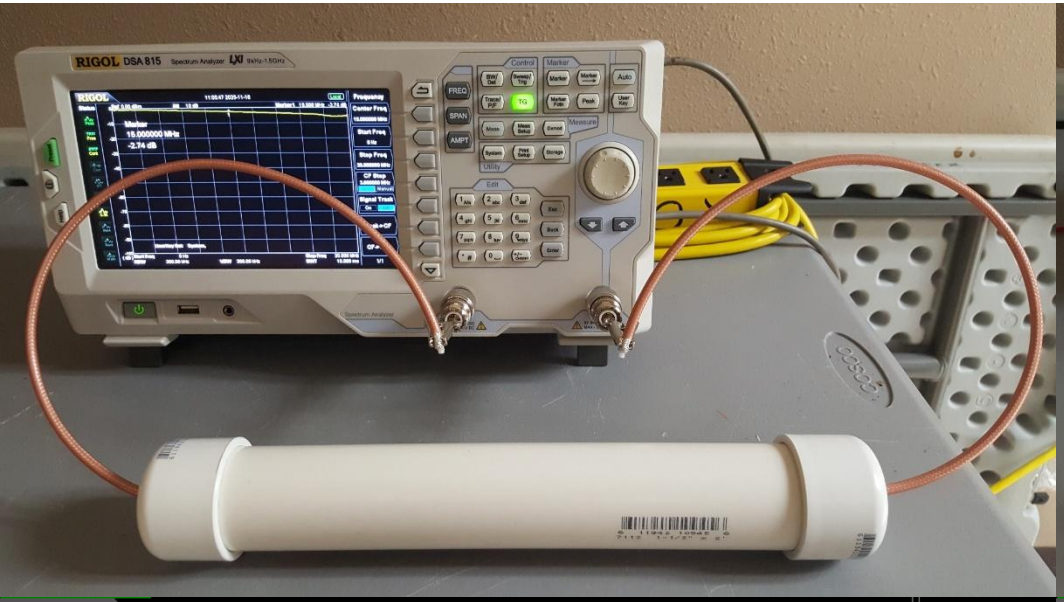
0 to 500MHz

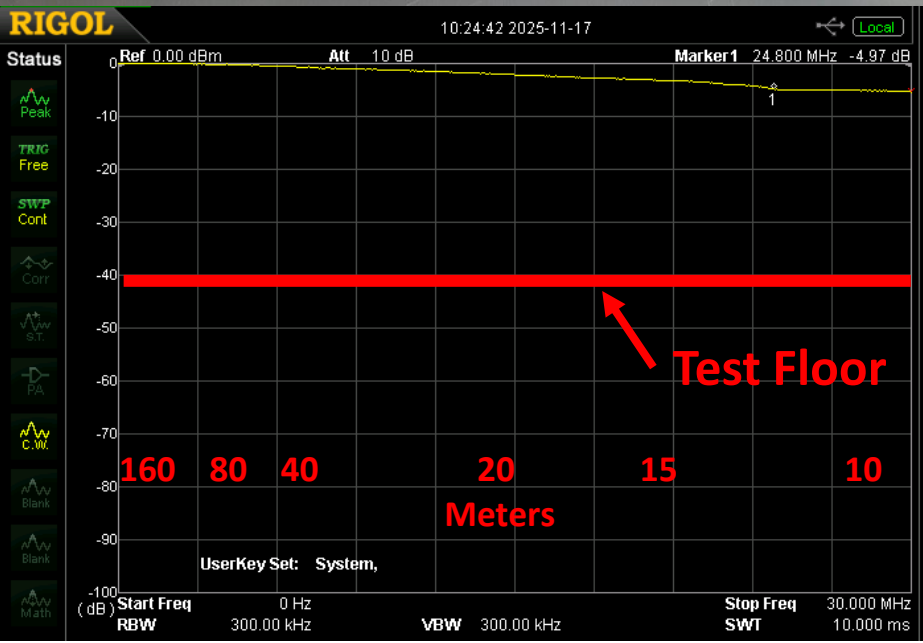




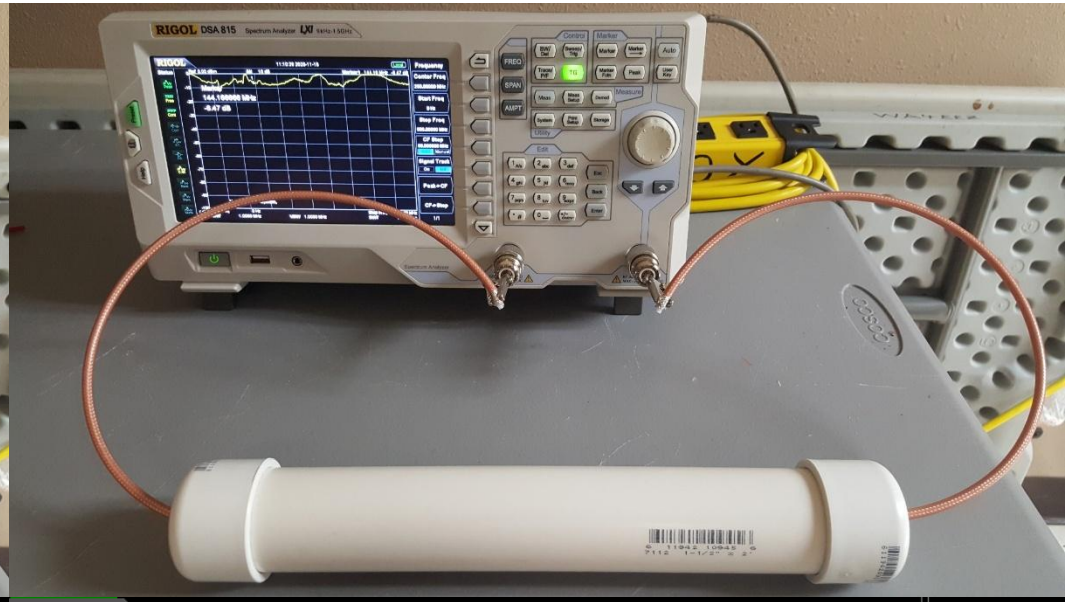
Single line of RG-400 through 1 foot 1.5 inch diameter of 0000 Steel Wool

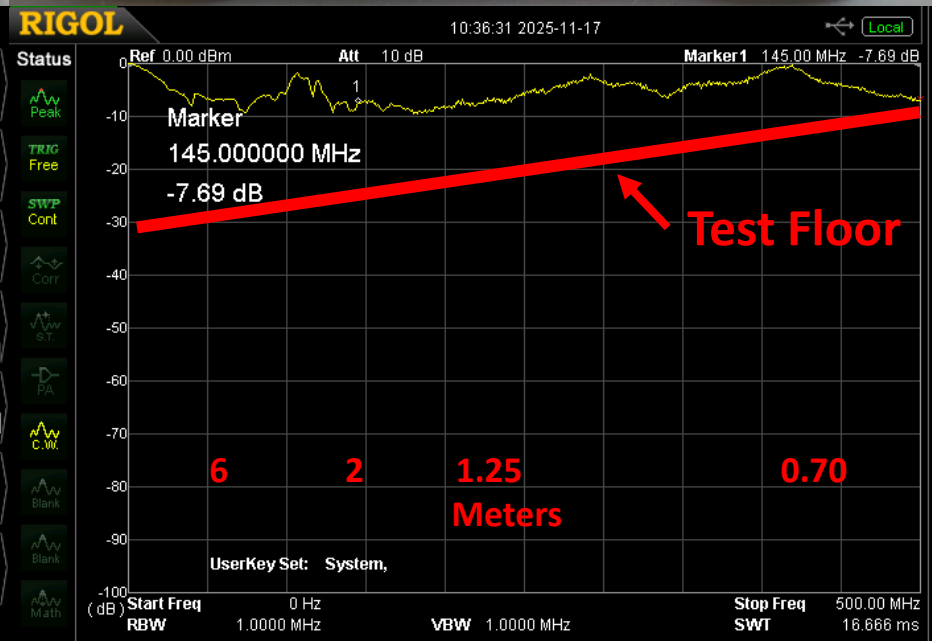
0 to 30MHz





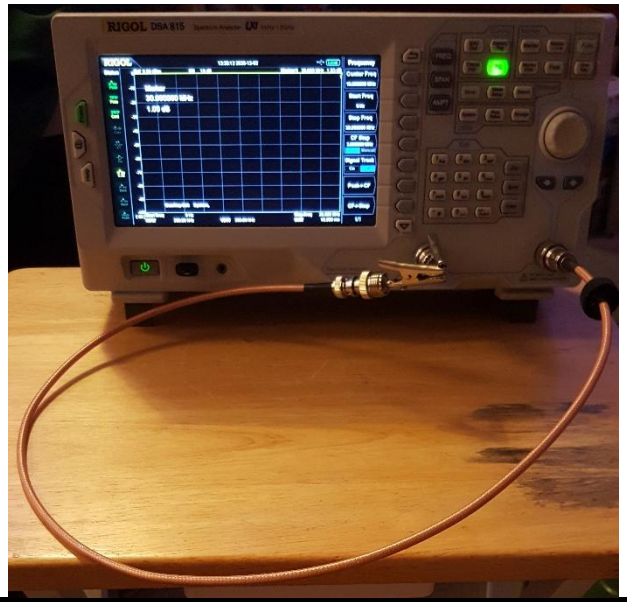
0 to 500MHz



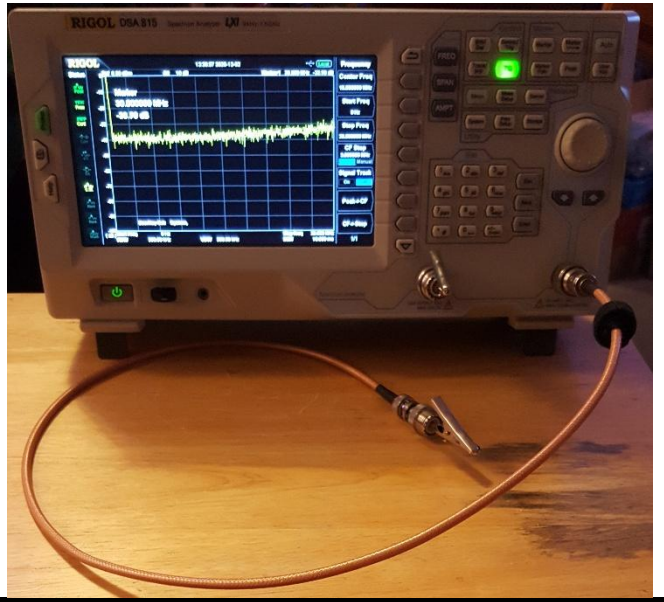


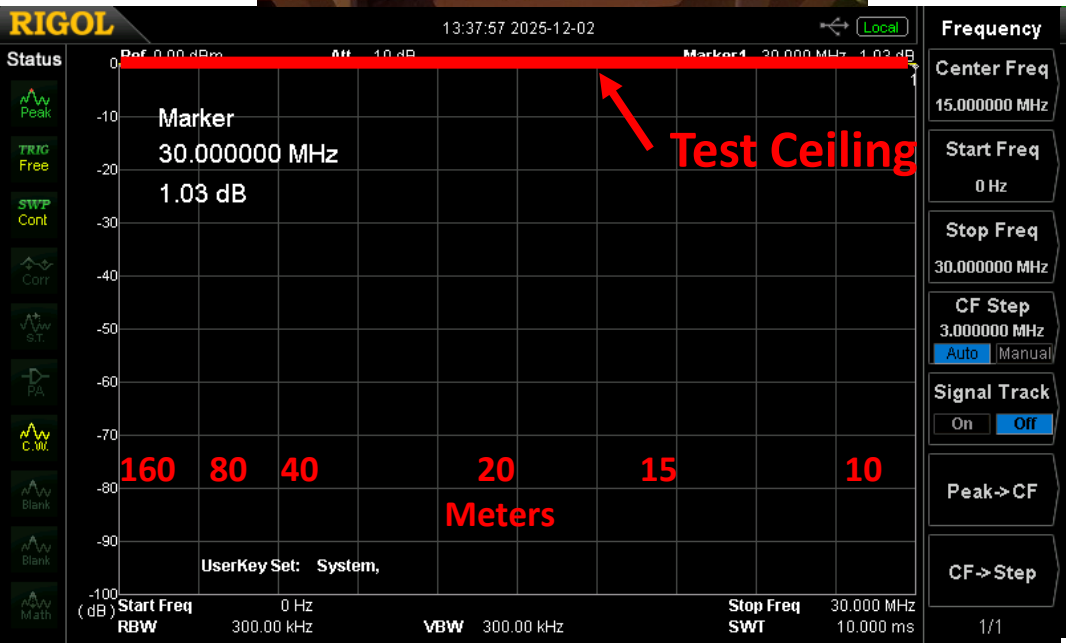
Spectrum Analyzer test setup 2 and normalization, 0 to 30MHz

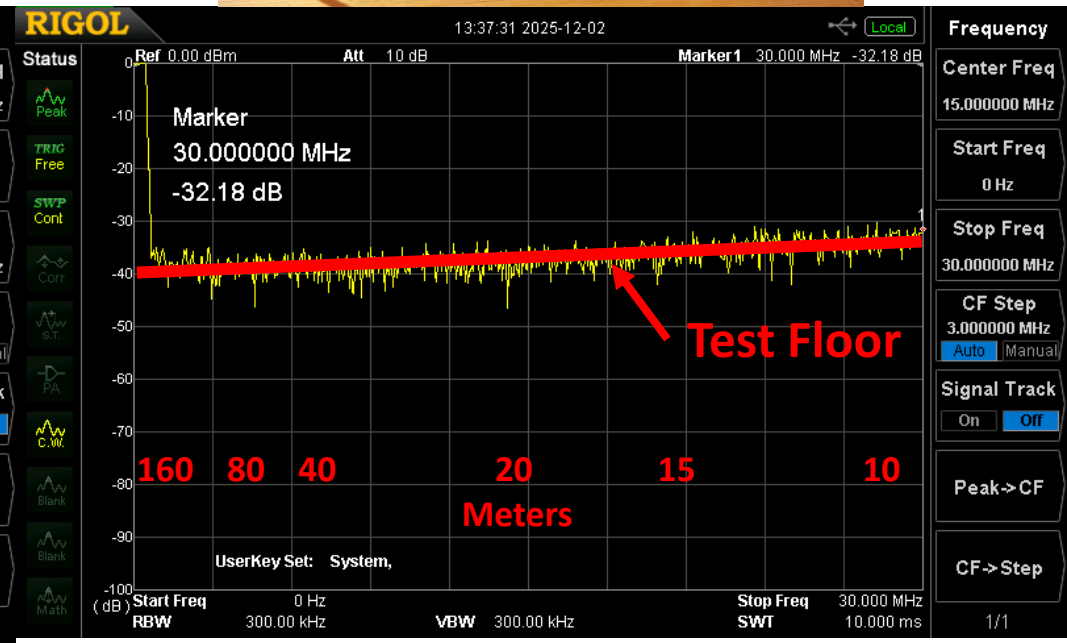
Closed Loop



Open Loop

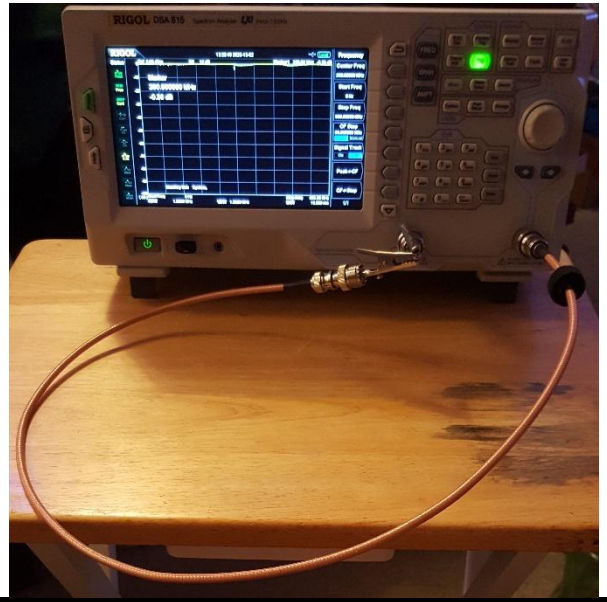




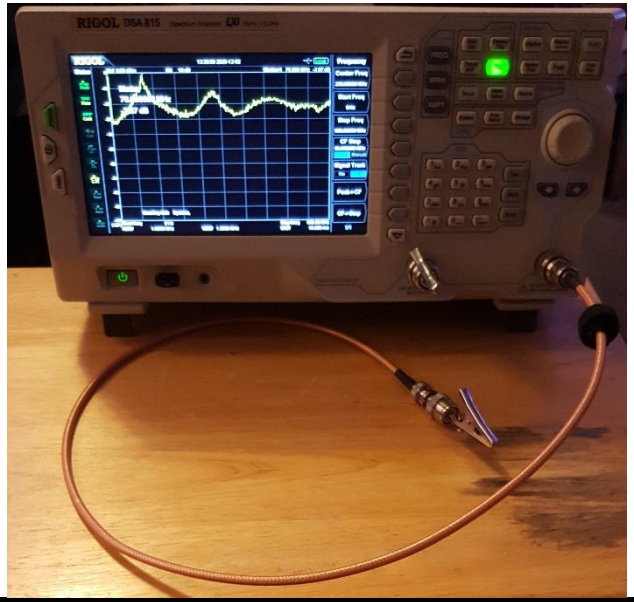


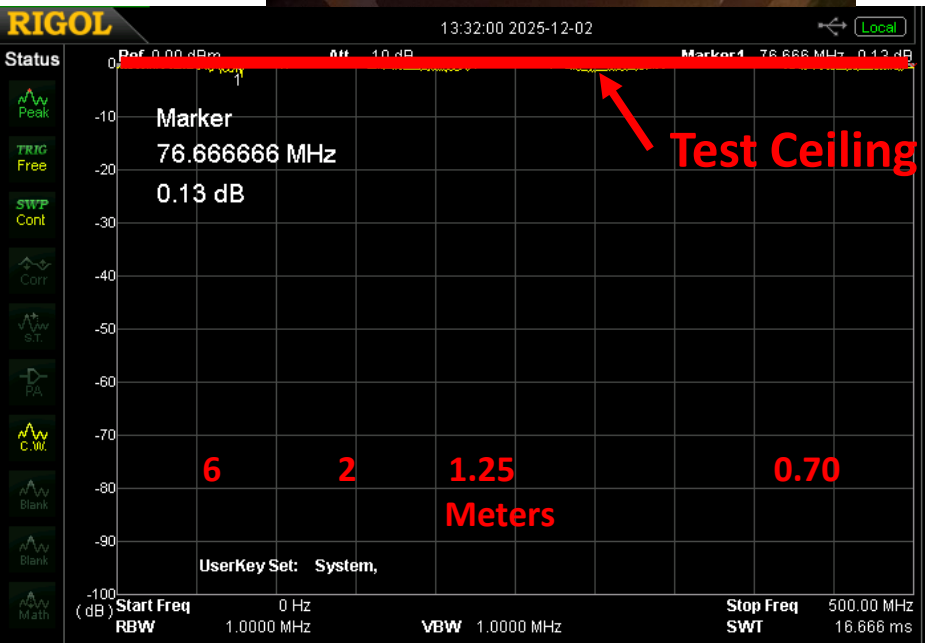
Spectrum Analyzer test setup 2 and normalization, 0 to 500MHz

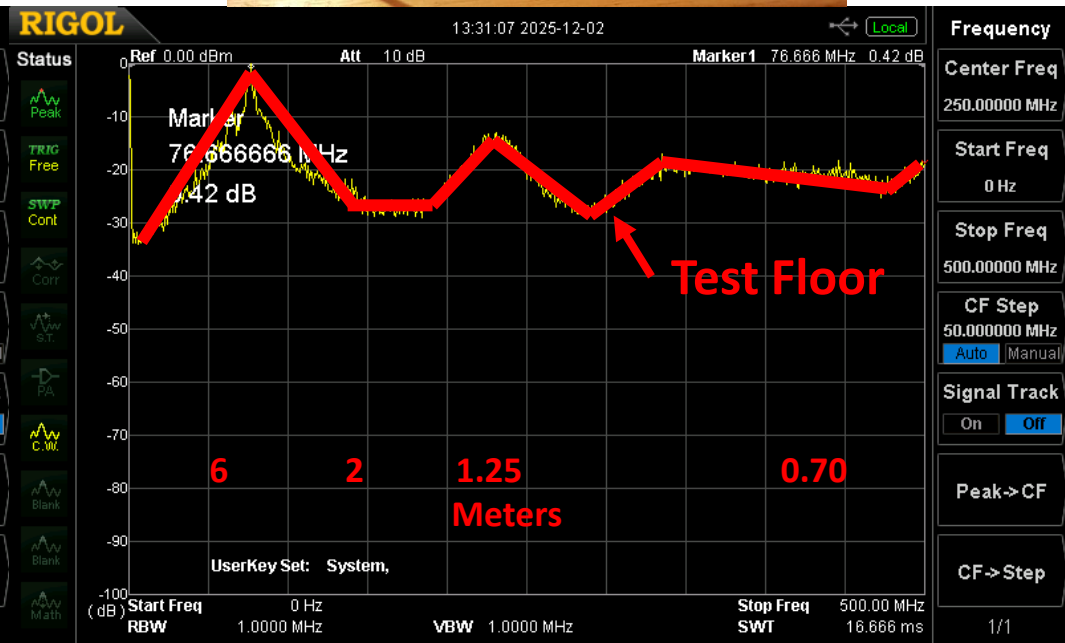
Closed Loop



Open Loop



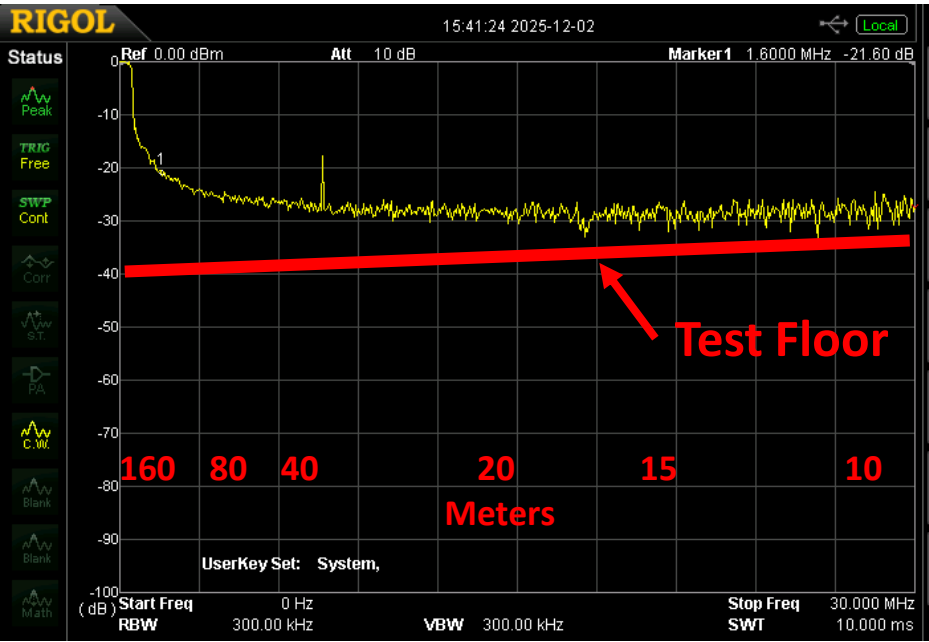




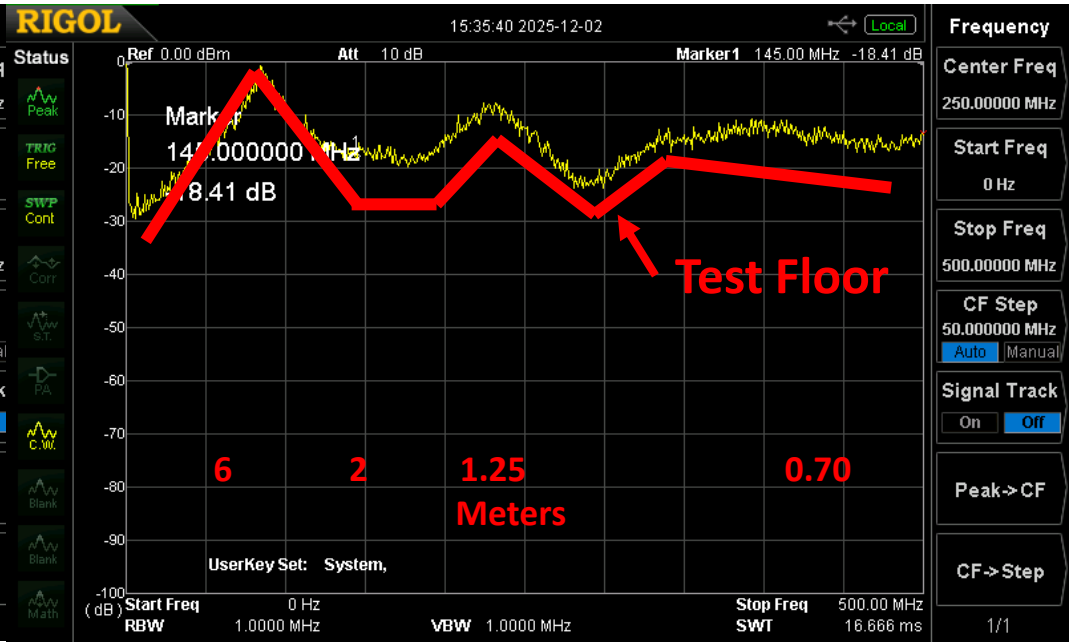
CMC-154-3K, made using trade secrets in a PVC tube

- Rated 1MHz – 54MHz, 3KW
- For 1MHz -54MHz, up to -39 db common mode attenuation claimed.

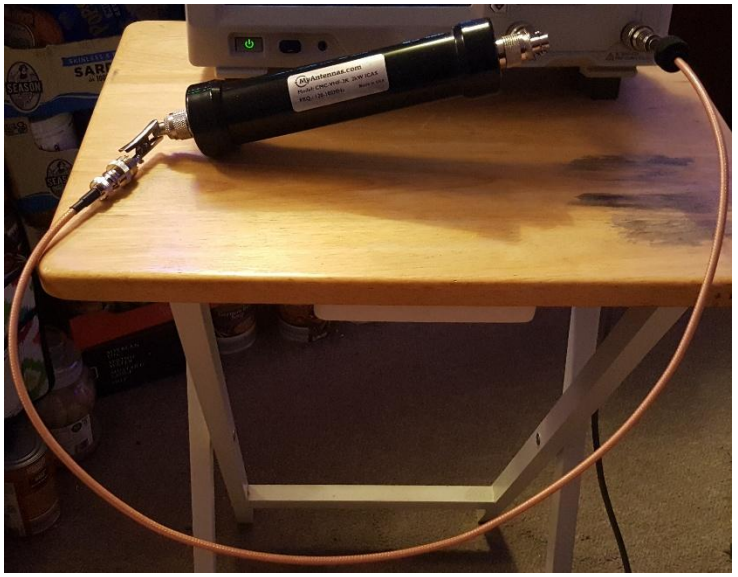
0 to 30MHz



0 to 500MHz

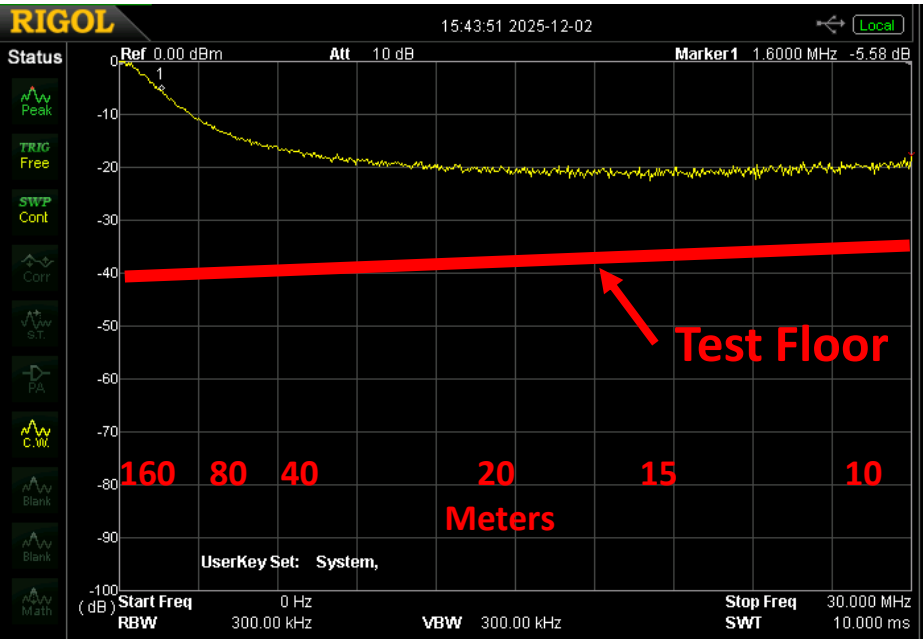


CMC-VHF-2K, made using trade secrets in a PVC tube

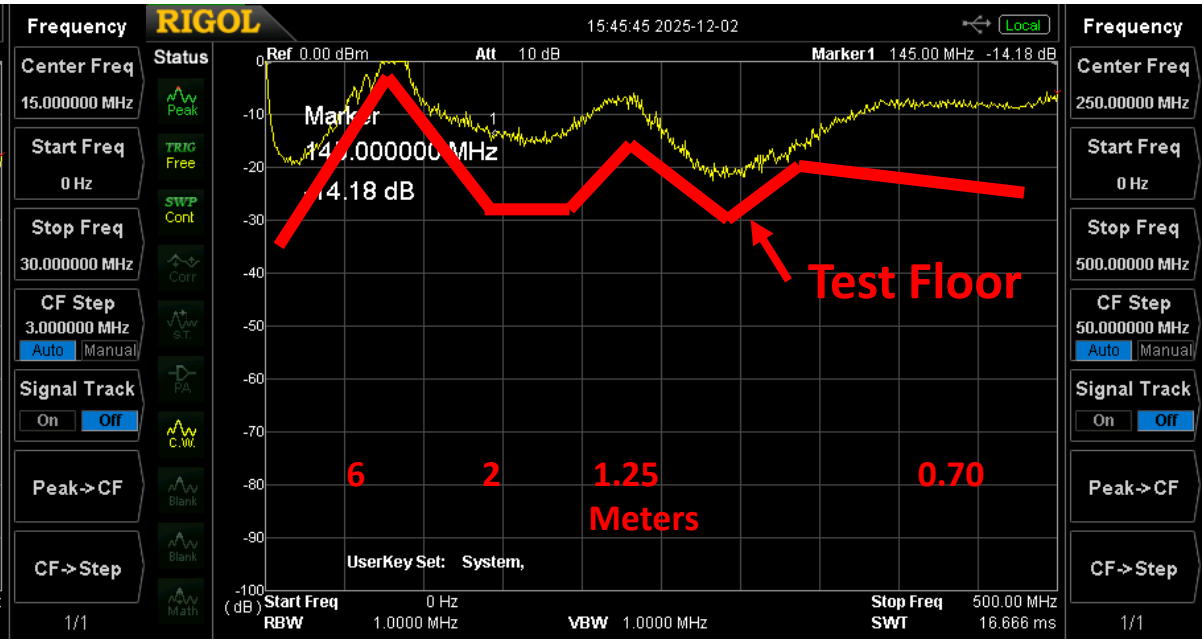


- Rated 120MHz – 180MHz, 2KW
- For VHF frequencies, up to -37 db common mode attenuation claimed.

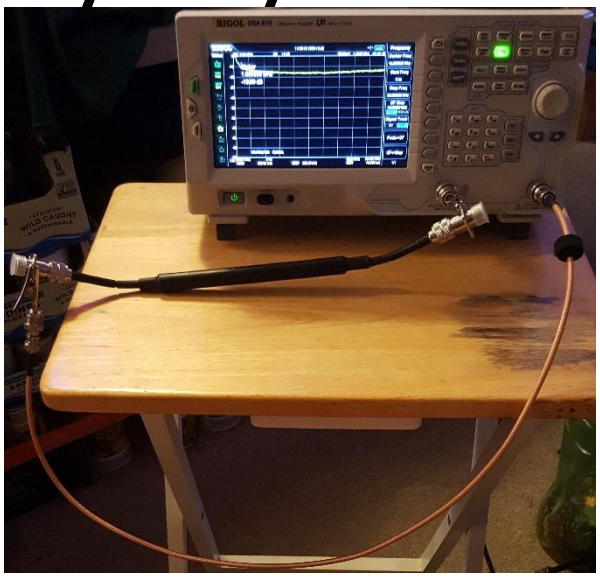
0 to 30MHz



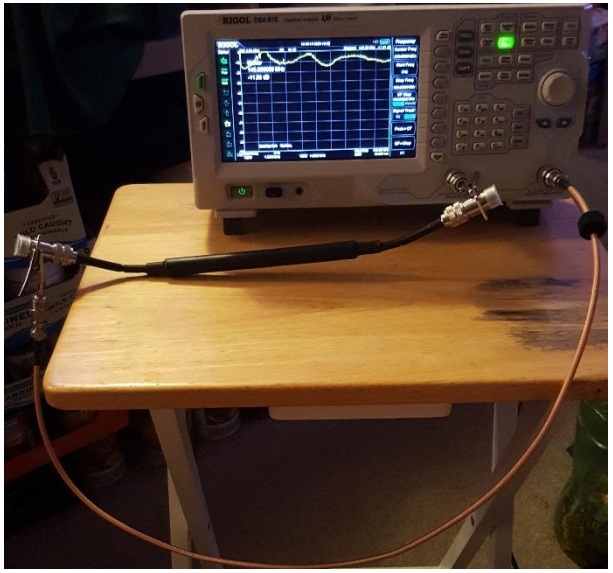
0 to 500MHz



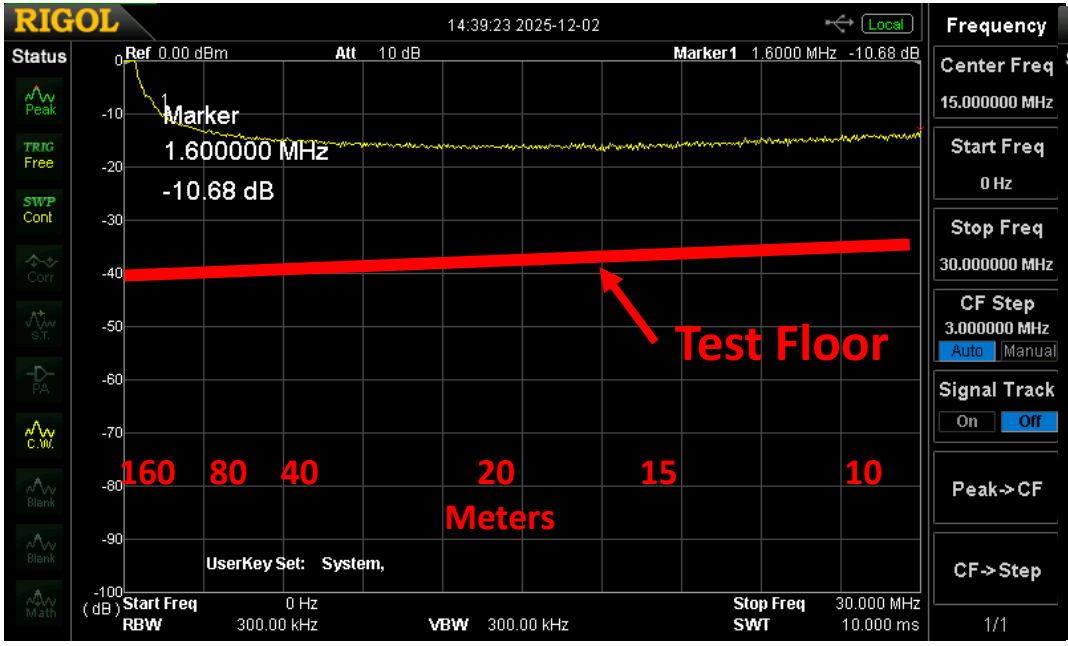
1 line ABR-240 (LMR-240), with 6 type 31 ring ferrites, (GIFP) Closed cell gas-injected foam polyethylene dielectric

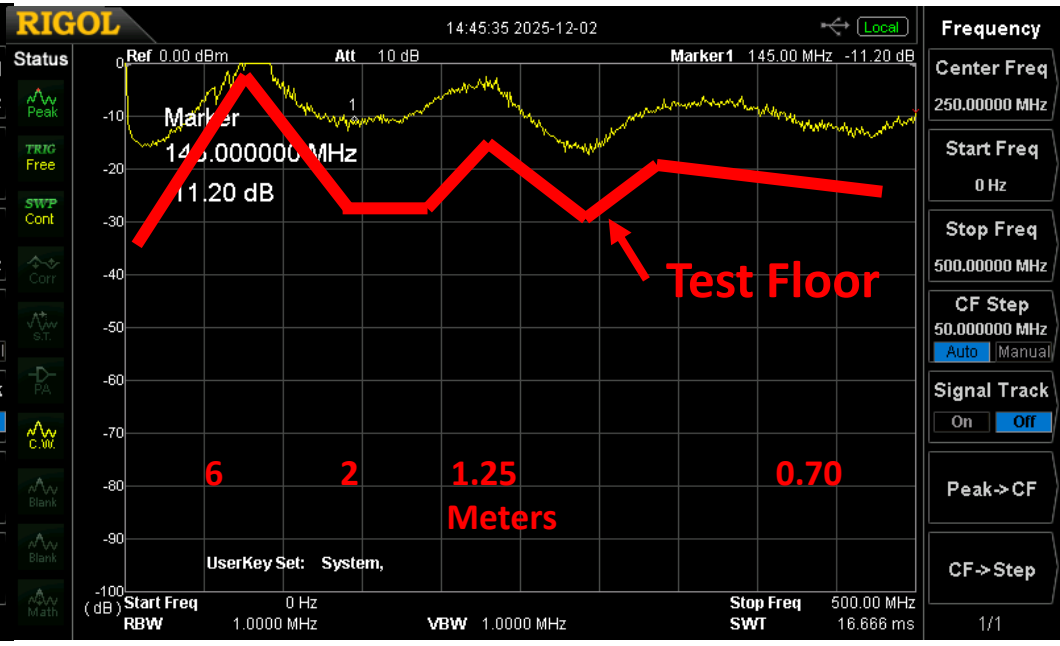


0 to 30MHz



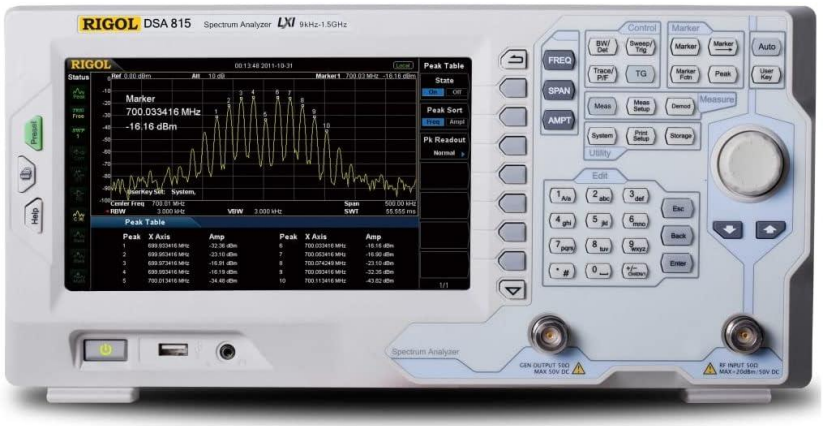
0 to 500MHz



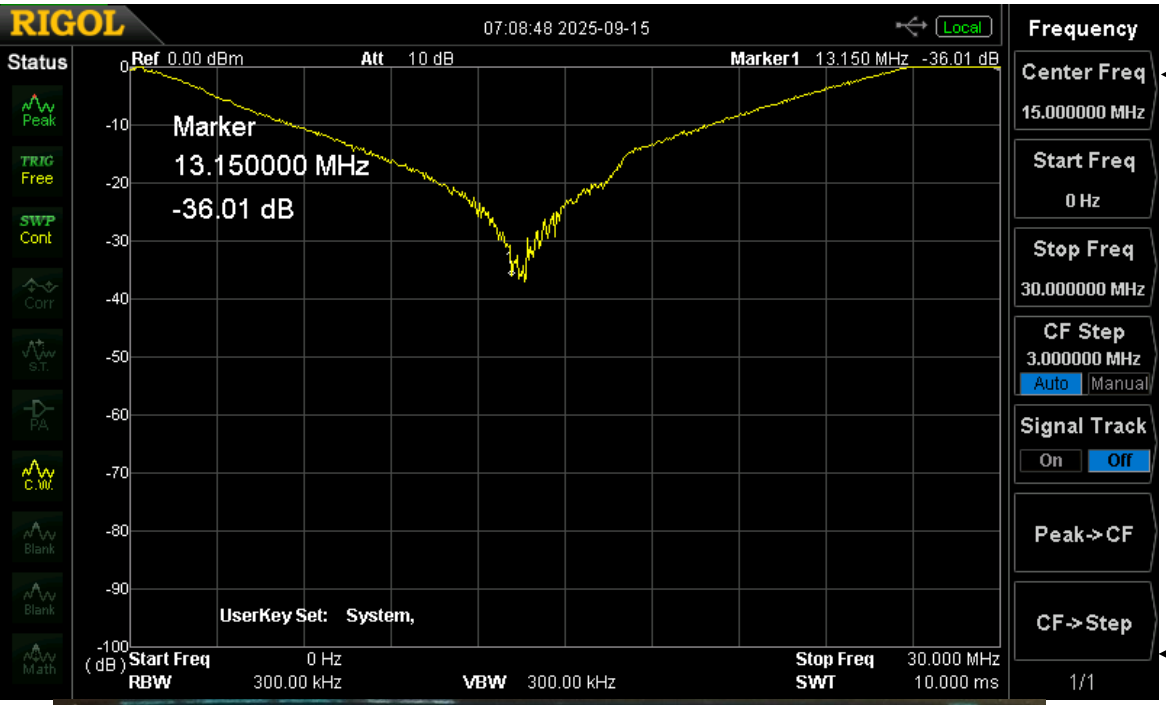


Comparison of Spectrum Analyzer and Vector Network Analyzer with Tracking Generator

- Rigol DSA 815-TG Spectrum Analyzer with Tacking Generator, 9KHz – 1.5 GHz, 8 inch screen. Measures AM/FM demodulation, S parameters, Duplexer VSWR, Phase, Delay.
- Aursinc Nano VNA SAA-2N V2.2, 1.6KHz – 3GHz, 4 inch touch screen. Measures S parameters, Duplexer, VSWR, Phase, Delay.



6 turns RG-8X, 0Hz/100KHz to 30MHz, Open cell (FPE) gas-injected foam polyethylene dielectric



0db

-100db

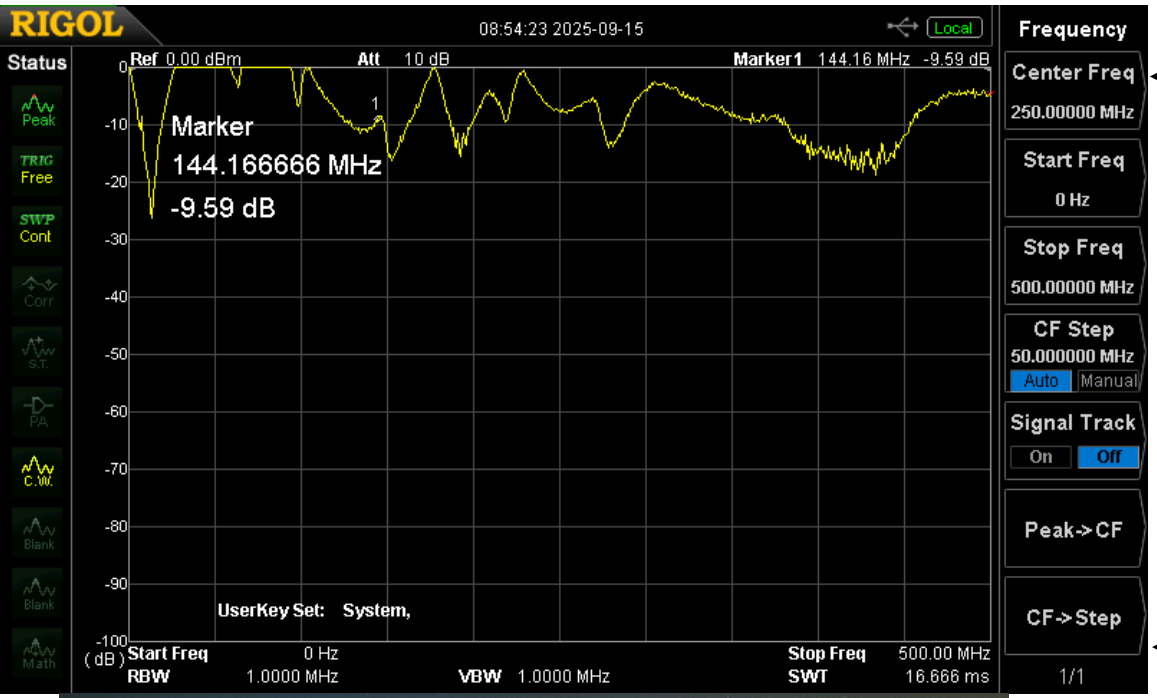
Rigol

0db

-70db

Nano VNA

6 turns RG-8X, 0Hz/100KHz to 500MHz, Open cell (FPE) gas-injected foam polyethylene dielectric



← 0db

← -100db

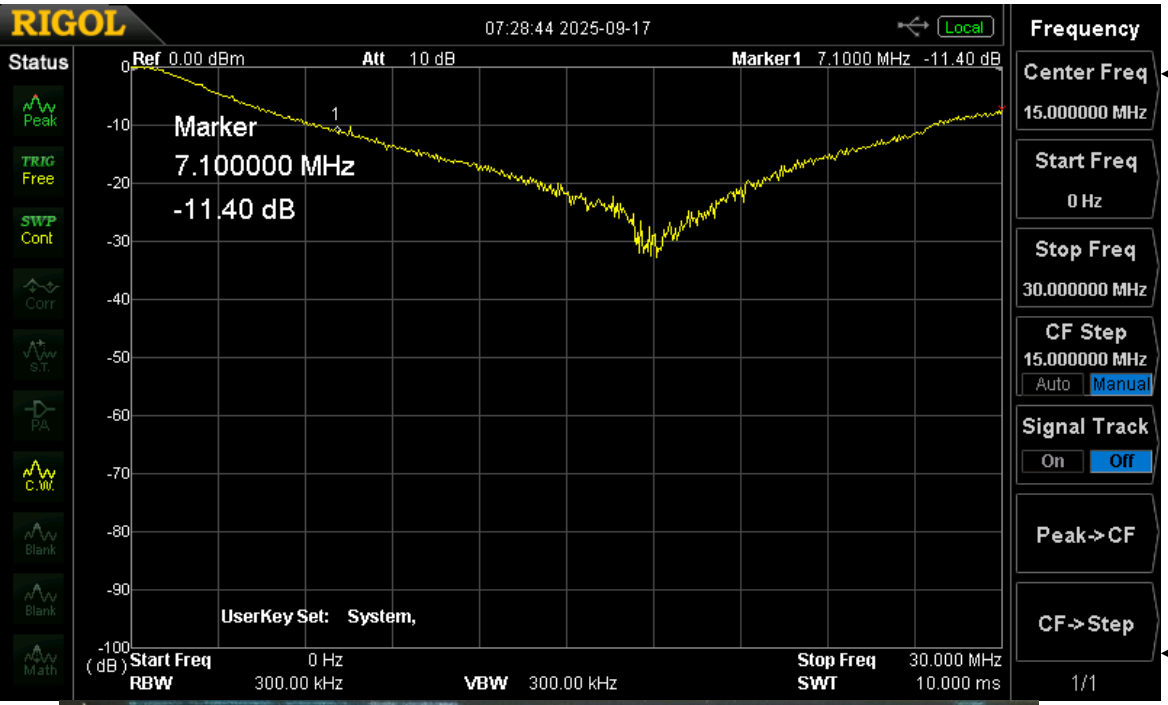
Rigol

← 0db

← -70db

Nano VNA

6 turns RG-400, 0Hz/100KHz to 30MHz, (PTFE) polytetrafluoroethylene (Teflon) dielectric



0db

-100db

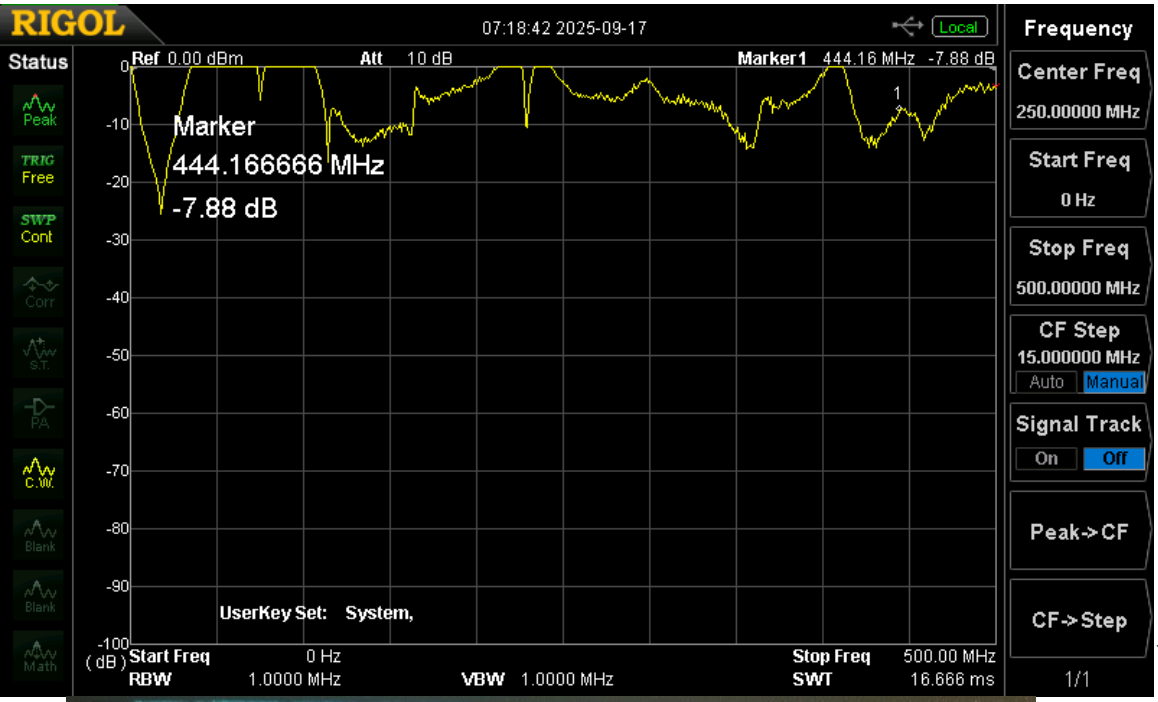
Rigol

0db

-70db

Nano VNA

6 turns RG-400, 0Hz/100KHz to 500MHz, (PTFE) polytetrafluoroethylene (Teflon) dielectric



← 0db

Rigol

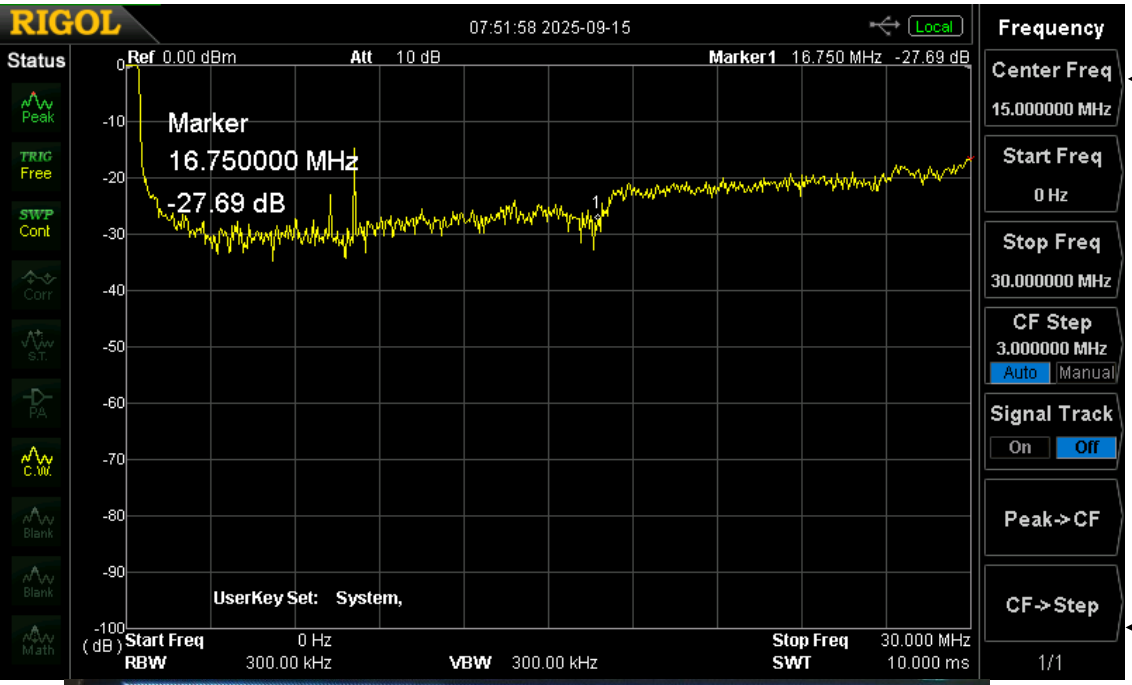
← -100db

← 0db

Nano VNA

← -70db

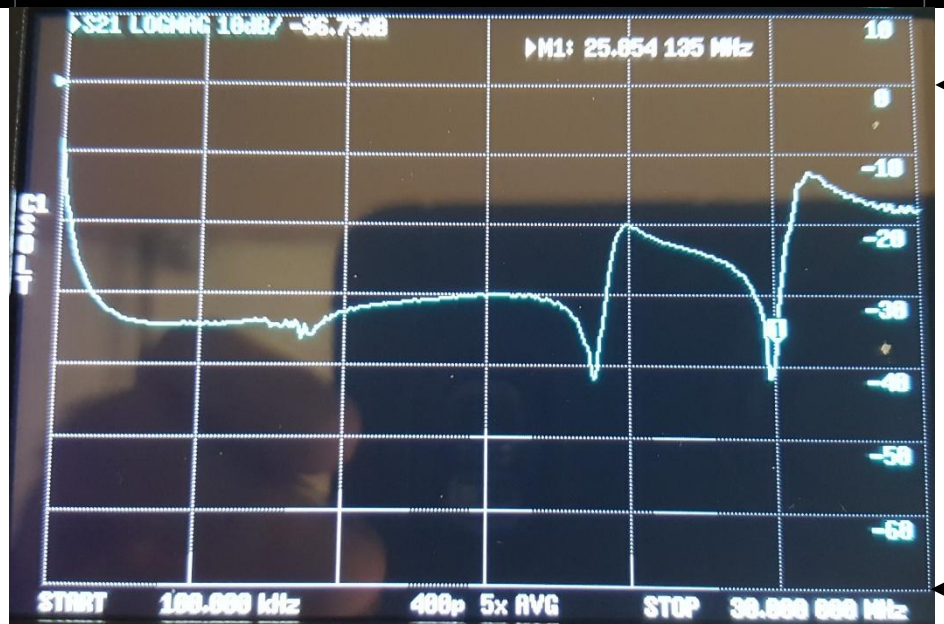
13 turns RG-400, 0Hz/100KHz to 30MHz, on type 31 toroid ferrite, (PTFE) polytetrafluoroethylene (Teflon) dielectric



0db

-100db

Rigol

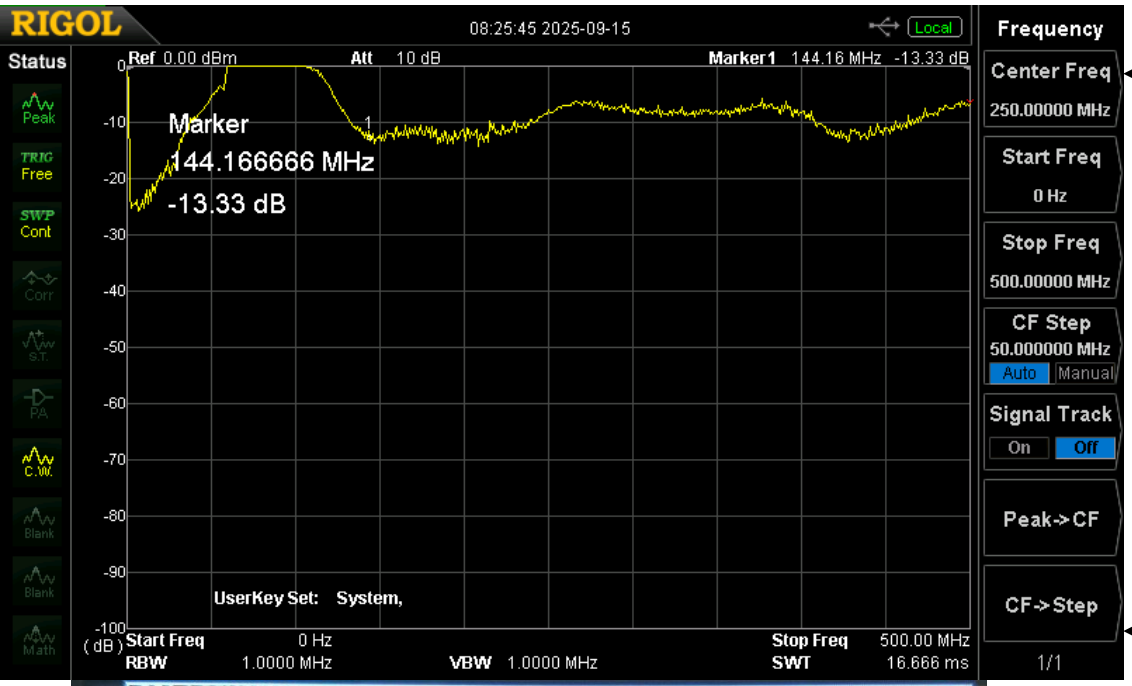


0db

-70db

Nano VNA

13 turns RG-400, 0Hz/100KHz to 500MHz, on type 31 toroid ferrite, (PTFE) polytetrafluoroethylene (Teflon) dielectric



0db

-100db

Rigol

0db

-70db

Nano VNA

References

- ARRL Handbook
- ARRL Antenna Book
- ARRL Grounding and Bonding book, Second Edition
- www.fair-rite.com/wpapers_anotes/how-to-choose-ferrite-components-for-emi-suppression/
- fair-rite.com/materials/
- k9yc.com/2018Cookbook-Pacificon2021.pdf
- k9yc.com/2018Cookbook.pdf
- k9yc.com/RFI-Ham.pdf
- www.carshamradio.org/index.php/resources

Summary of take-aways

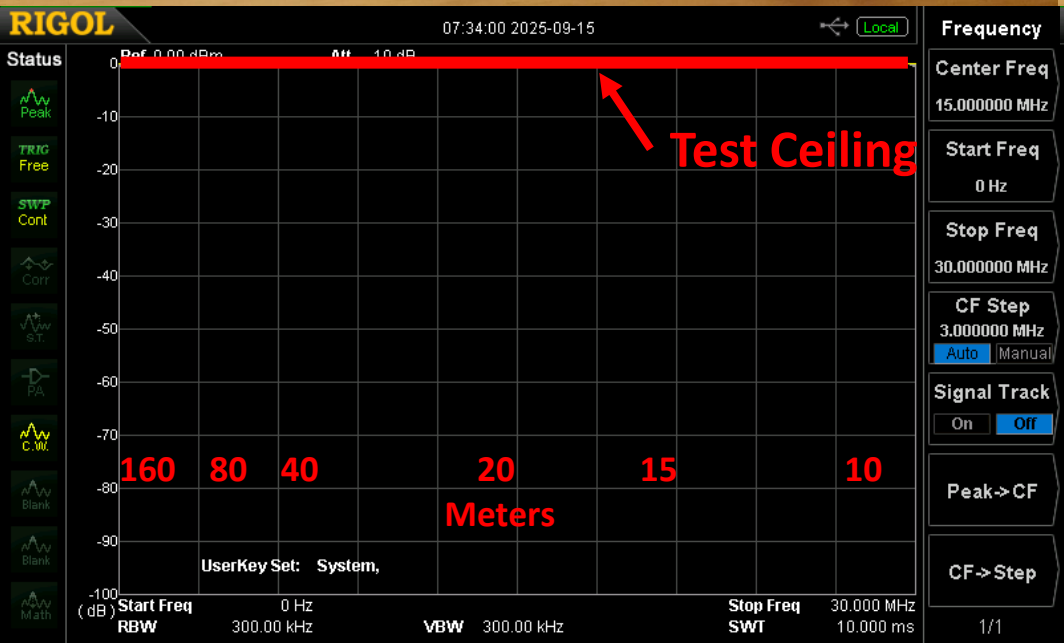
- Coiled coax common mode choke
  - DIP the coil after installation
  - Operate below the DIP frequency.
- Best multiband HF common mode choke
  - 240 size type 31 toroid ferrite
  - 13 turns of ¼ inch diameter closed cell or Teflon dielectric coax
    - Like RG-400 or LMR-240
- Best 2m / 70cm common mode choke
  - 12 **Sizhongda** type 31 clamp-on ferrites (no loops)
    - Found on Amazon
- Aursinc Nano VNA SAA-2N with tracking generator
  - Useful to test common mode choke performance

Appendix

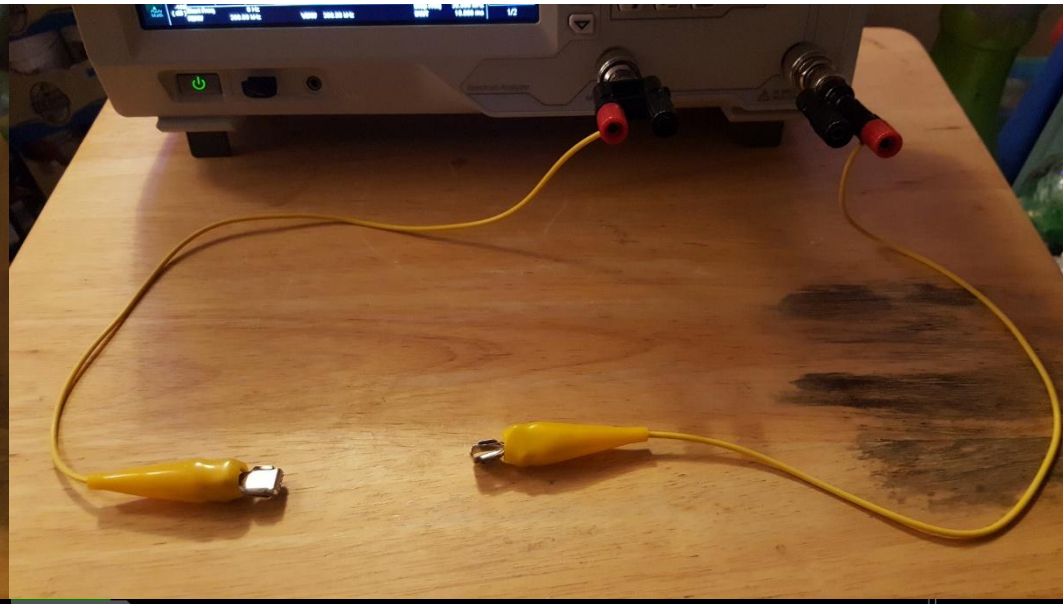
- Additional test data with the Rigol spectrum analyzer
- Test data using Aursinc Nano VNA SAA-2N V2.2

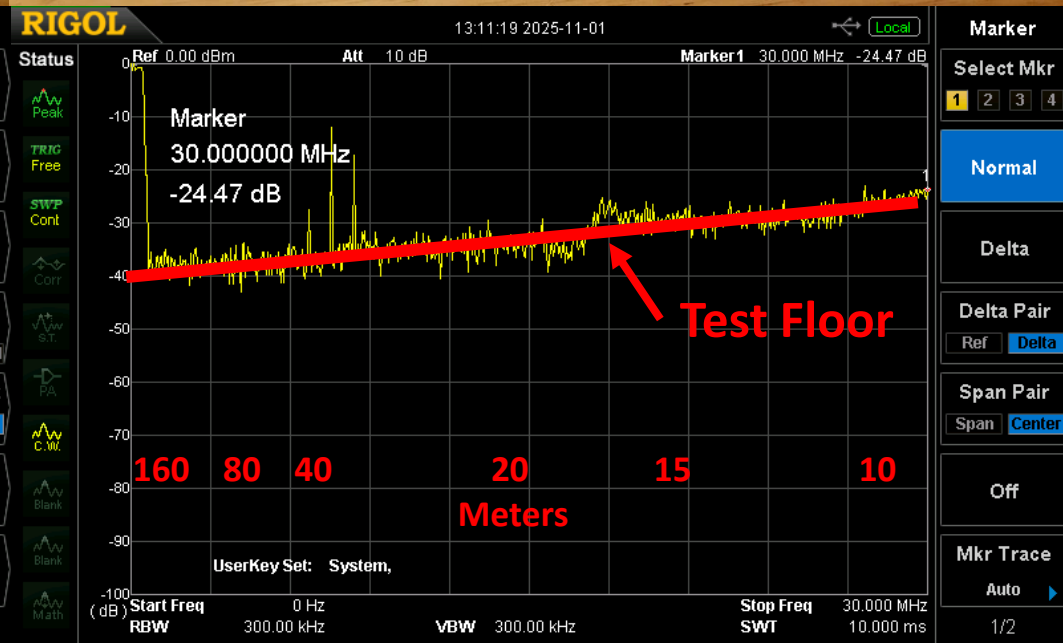
Spectrum Analyzer test setup and normalization, 0 to 30MHz

Closed Loop



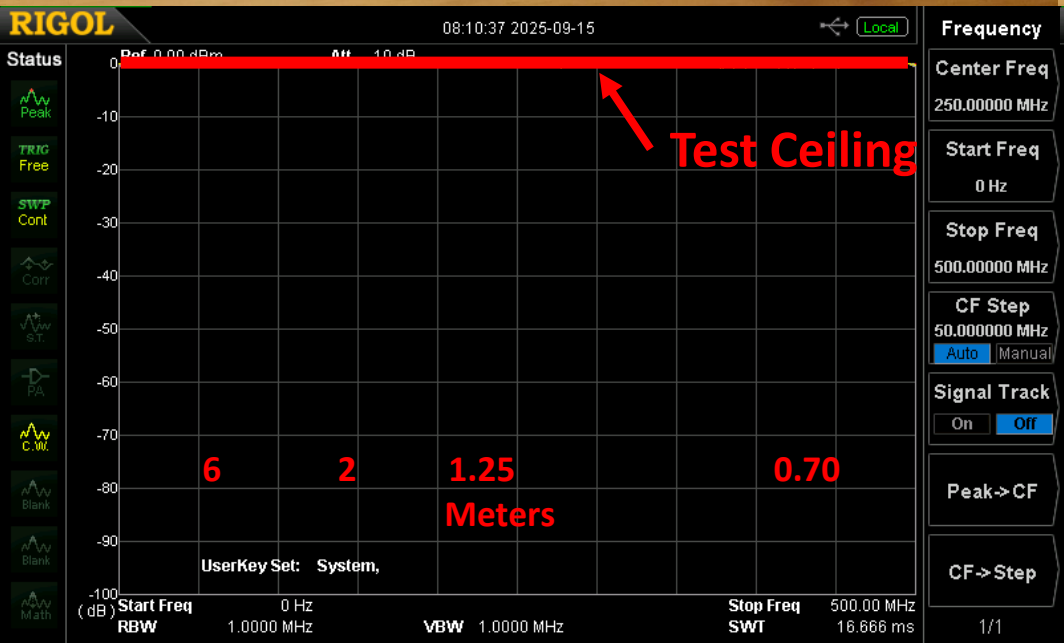
Open Loop



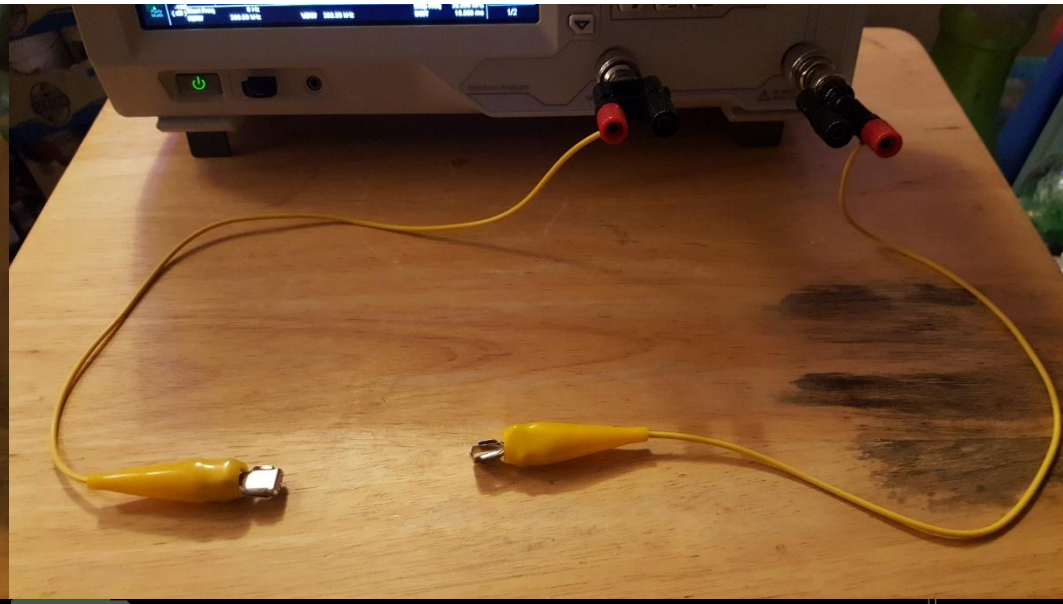


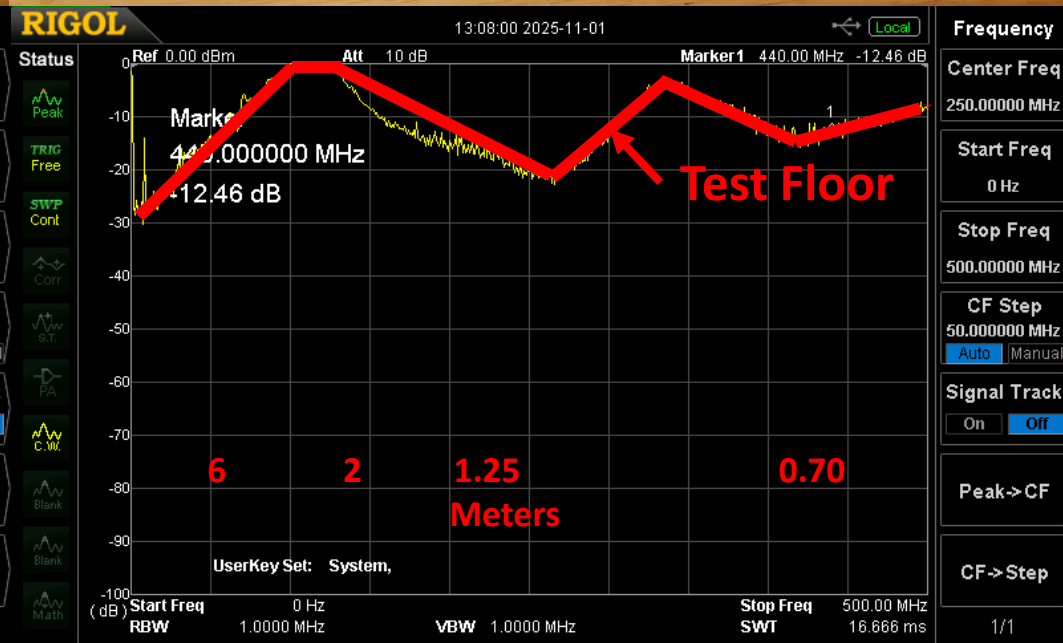
Spectrum Analyzer test setup and normalization, 0 to 500MHz

Closed Loop

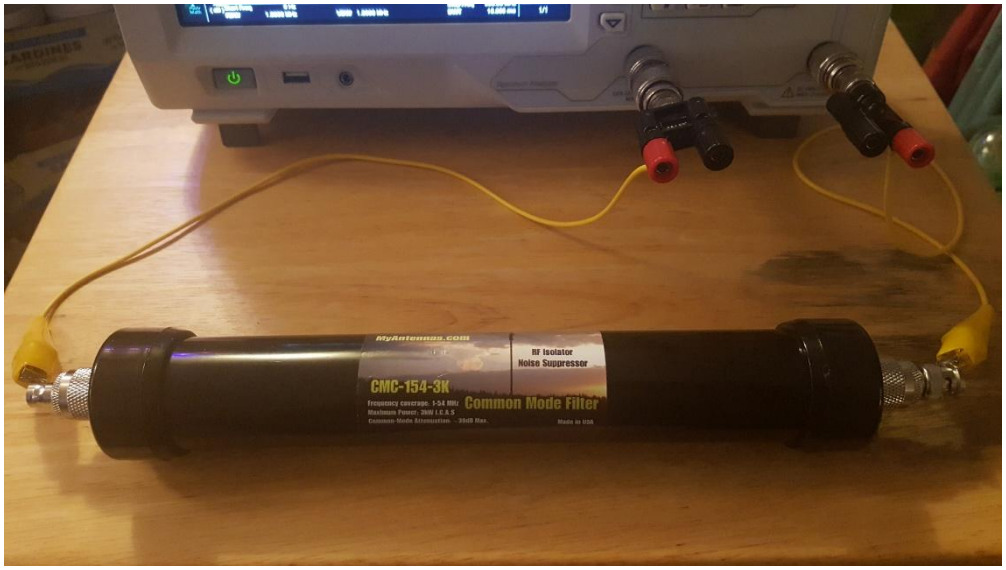


Open Loop



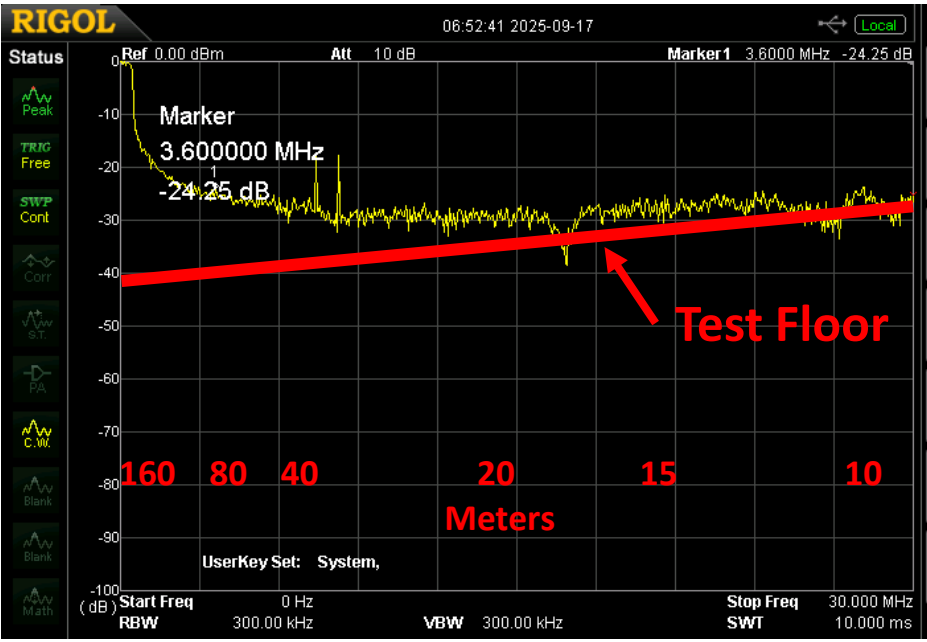


CMC-154-3K, made using type trade secrets in a PVC tube

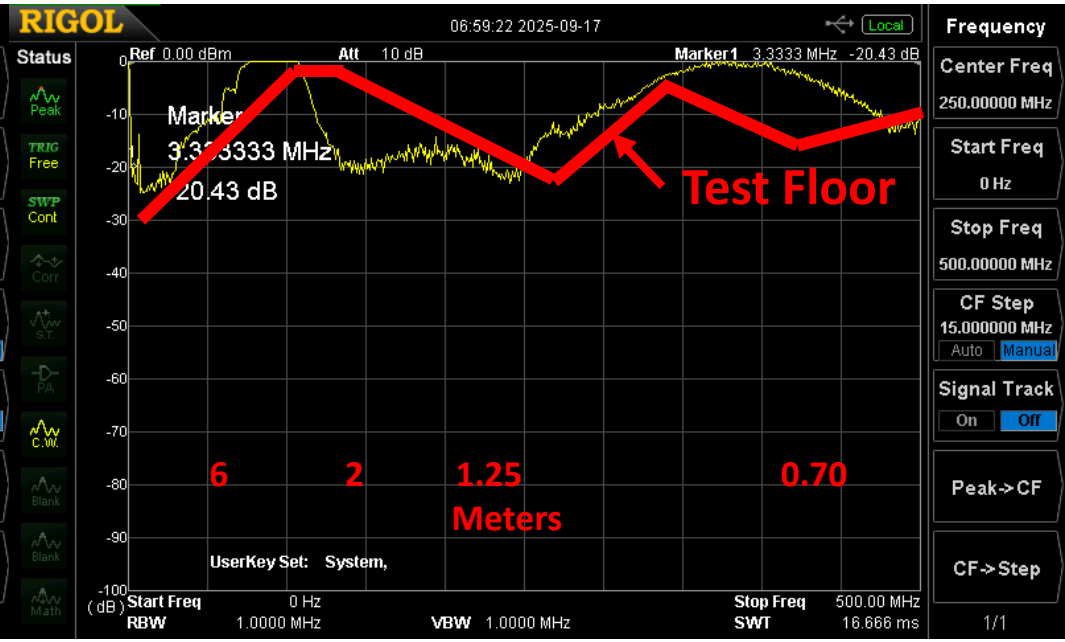


- Rated 1MHz – 54MHz, 3KW
- For 1MHz -54MHz, up to -39 db common mode attenuation claimed.

0 to 30MHz



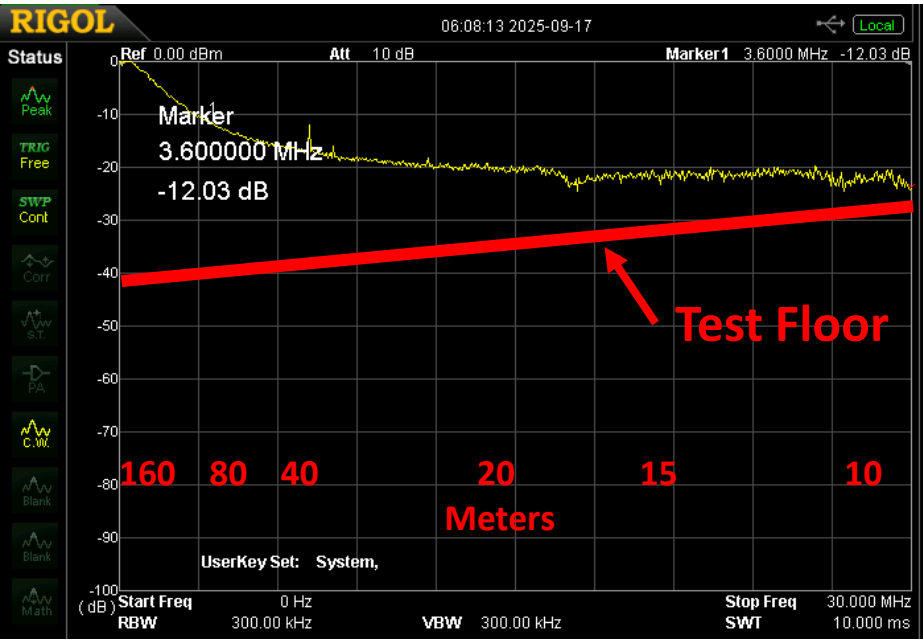
0 to 500MHz



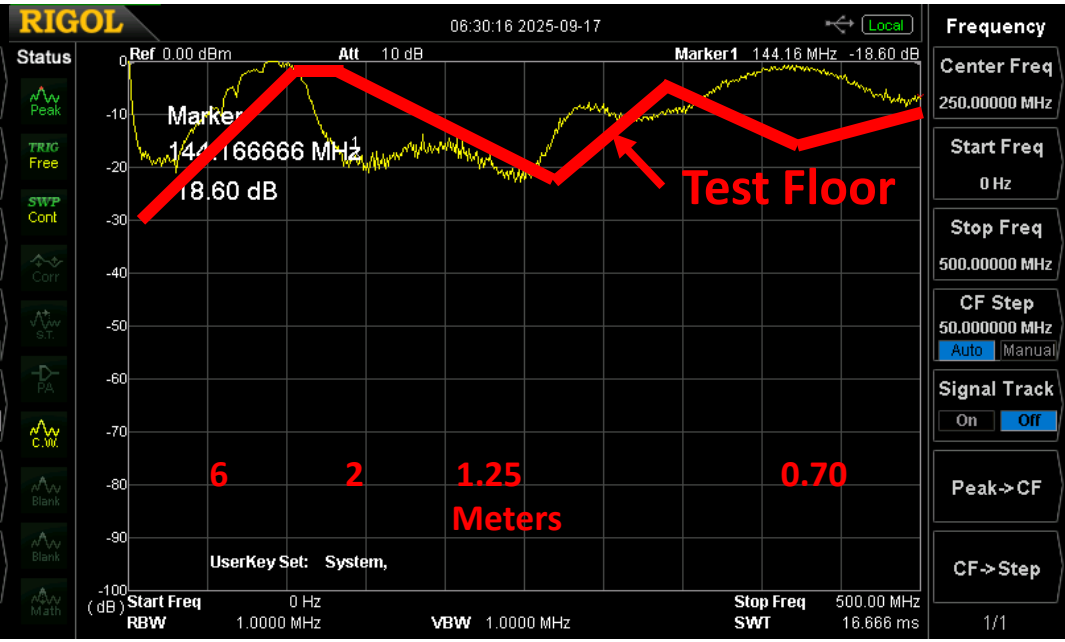
CMC-VHF-2K, made using trade secrets in a PVC tube

- Rated 120MHz – 180MHz, 2KW
- For VHF frequencies, up to -37 db common mode attenuation claimed.

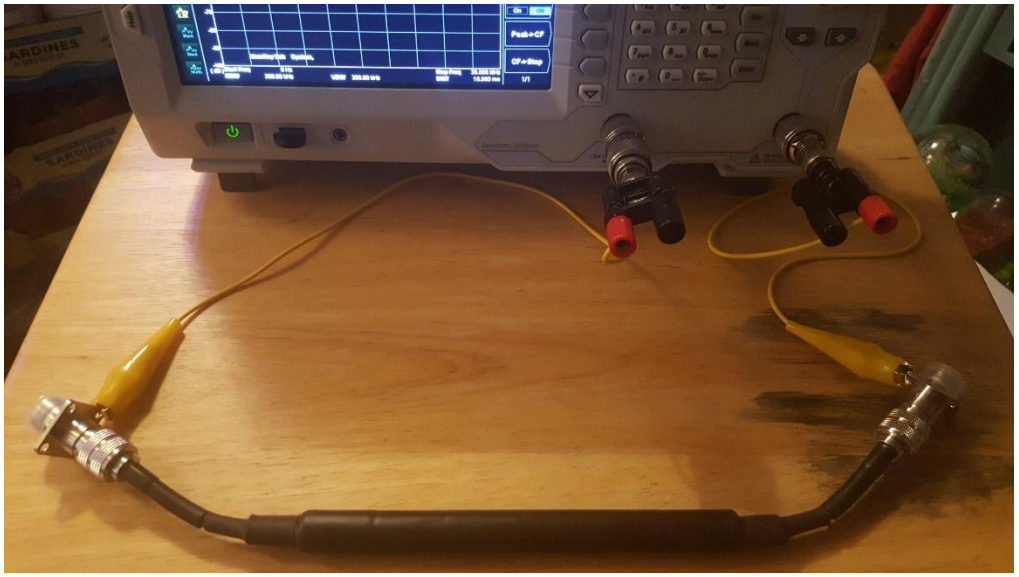
0 to 30MHz



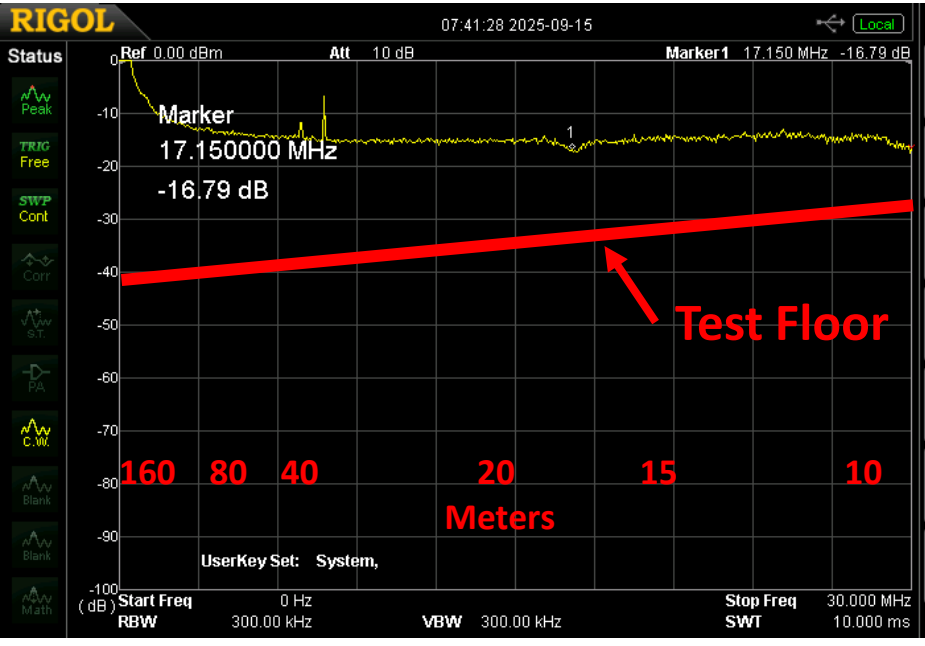
0 to 500MHz



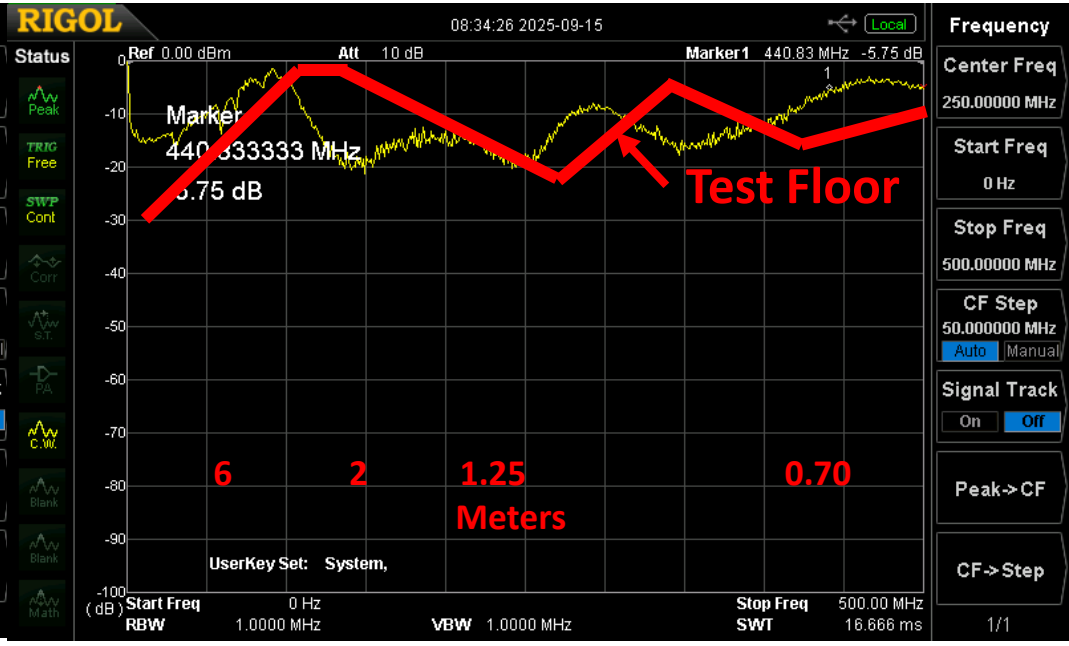
1 line ABR-240 (LMR-240), with 6 type 31 ring ferrites, (GIFP) Closed cell gas-injected foam polyethylene dielectric



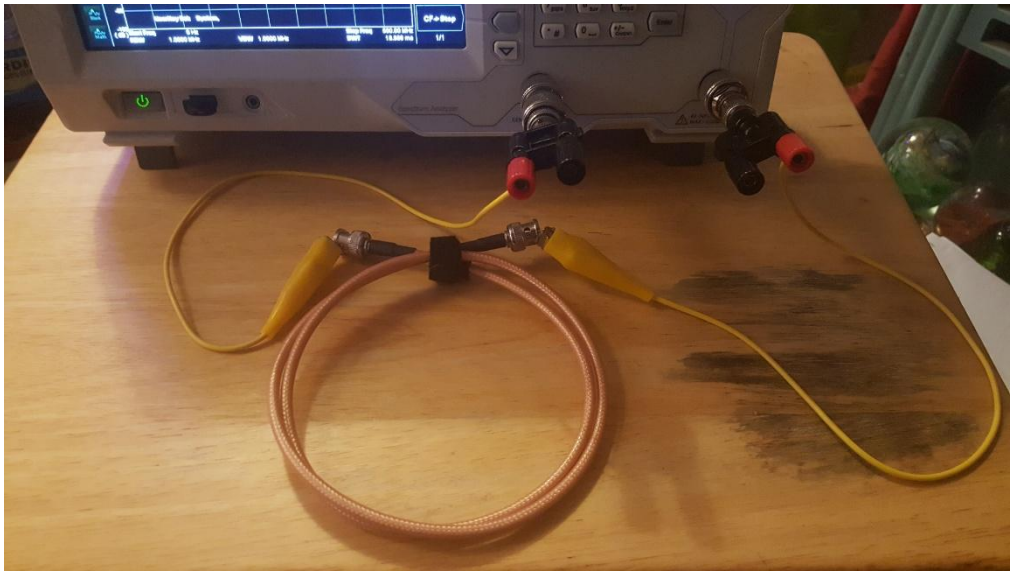
0 to 30MHz



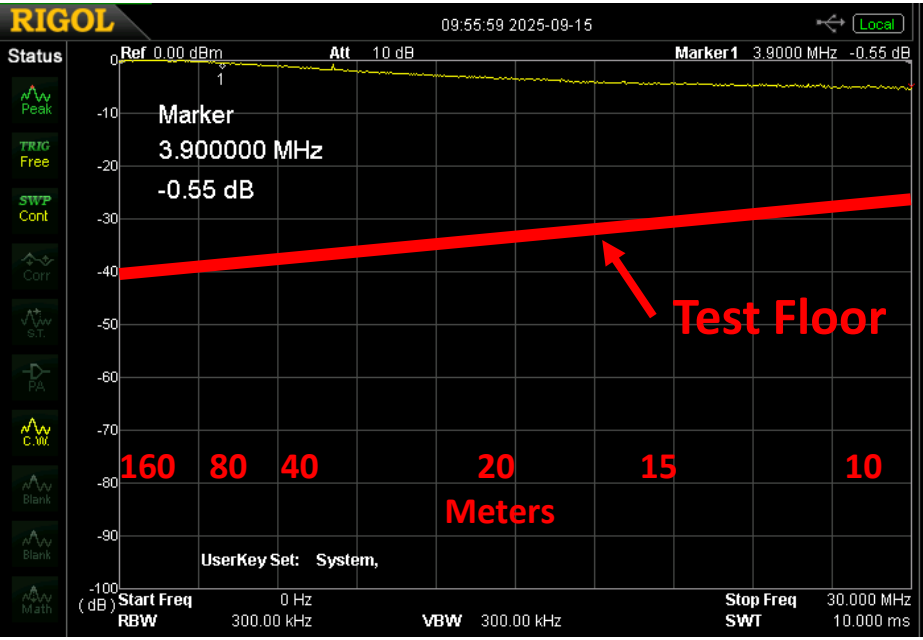
0 to 500MHz



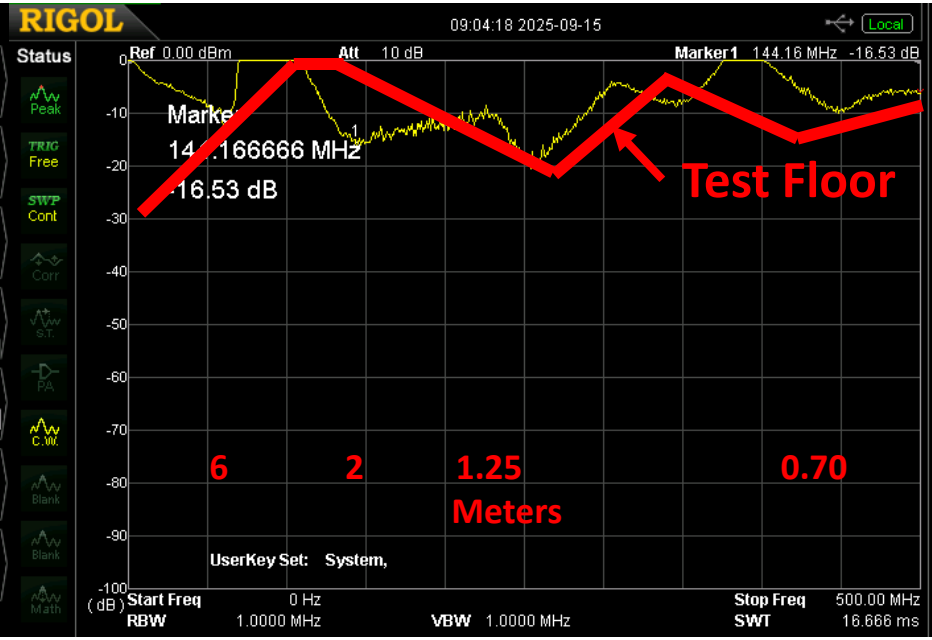
2 turns RG-400, (PTFE) polytetrafluoroethylene (Teflon) dielectric



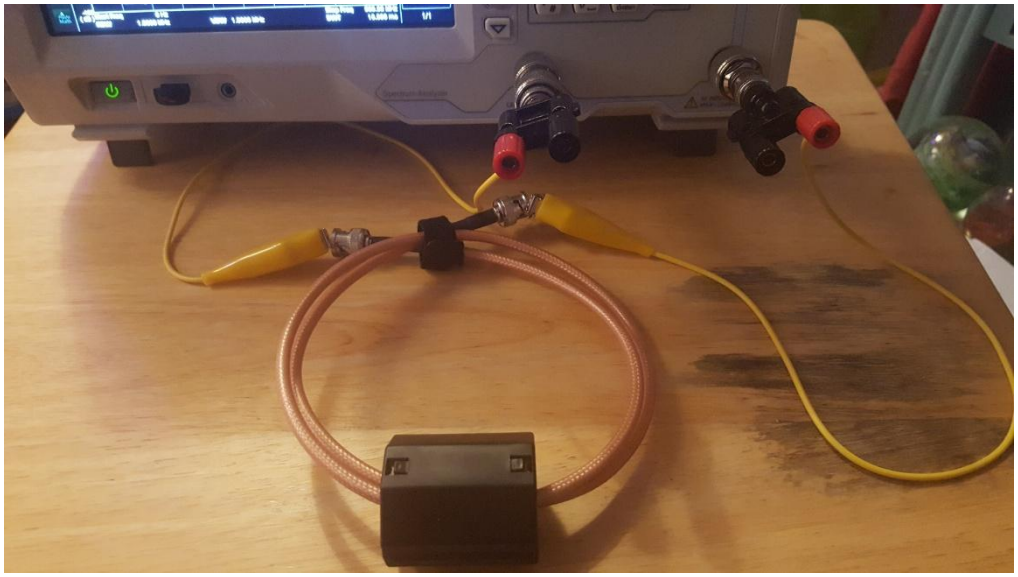
0 to 30MHz



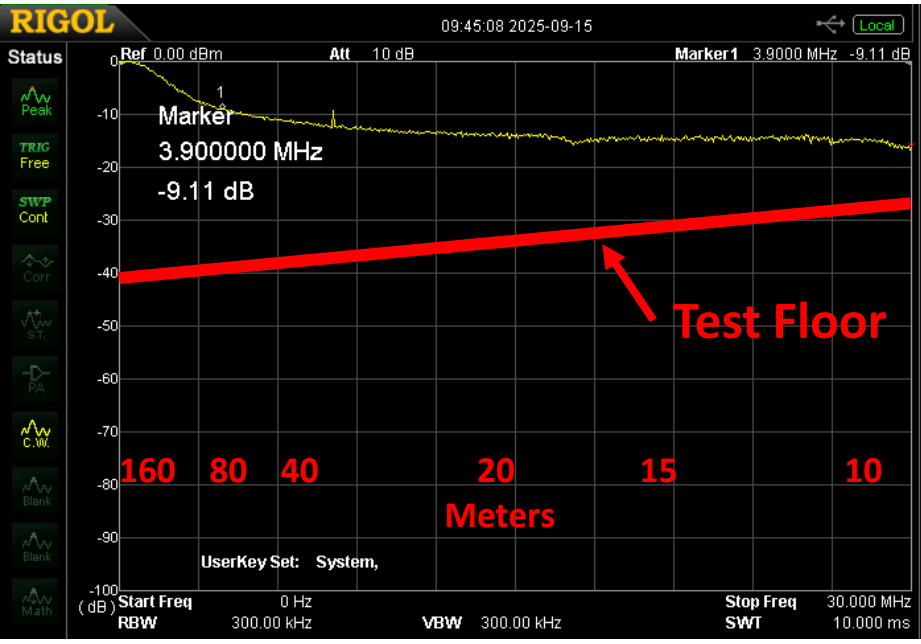
0 to 500MHz



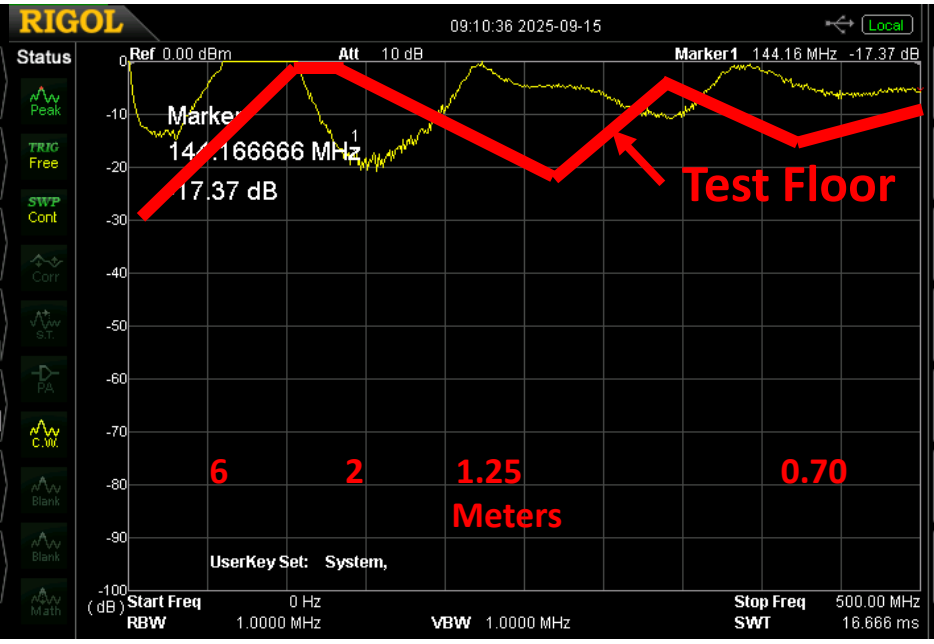
2 turns RG-400, with 1 type 31? clamp on ferrite, (PTFE) polytetrafluoroethylene (Teflon) dielectric



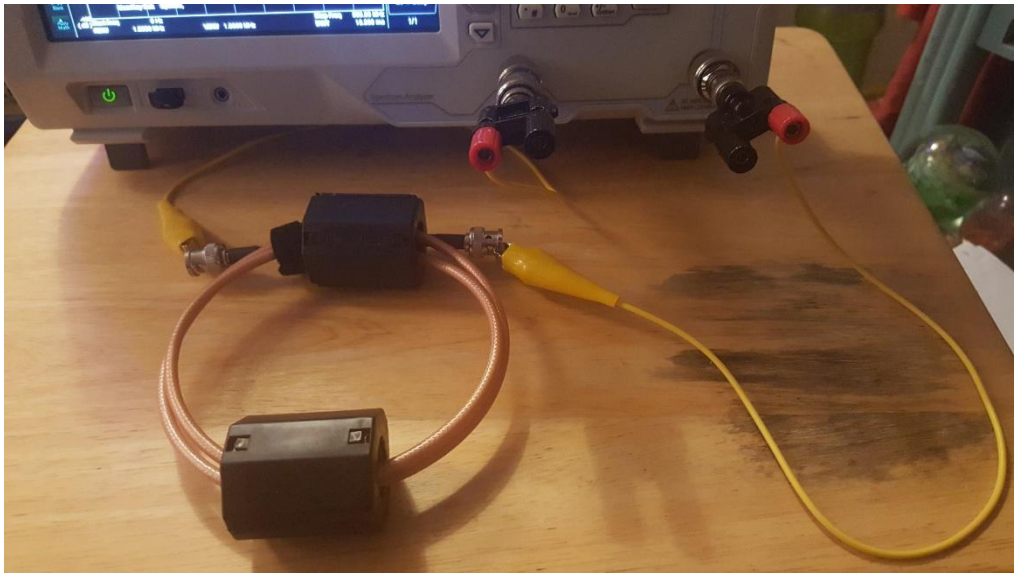
0 to 30MHz



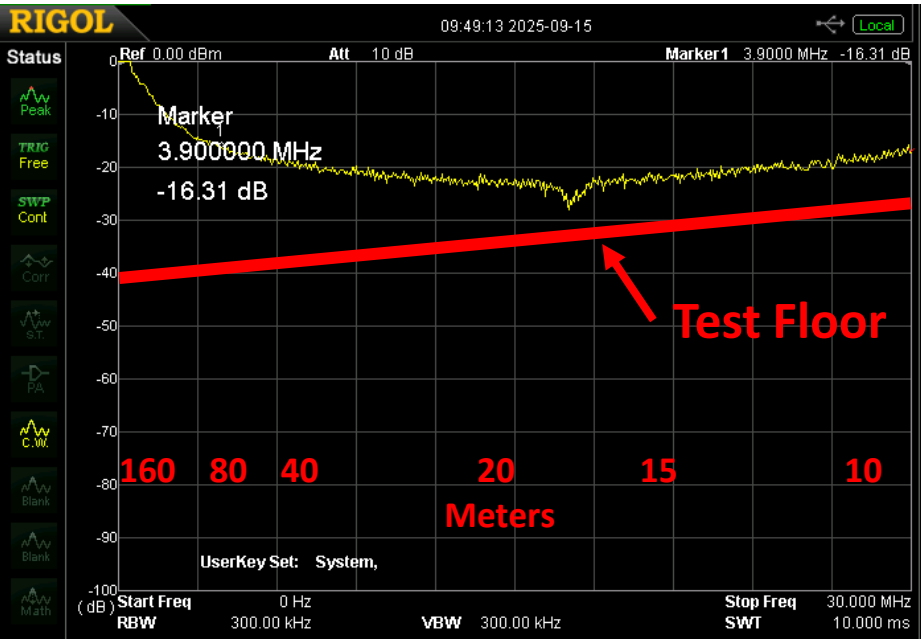
0 to 500MHz



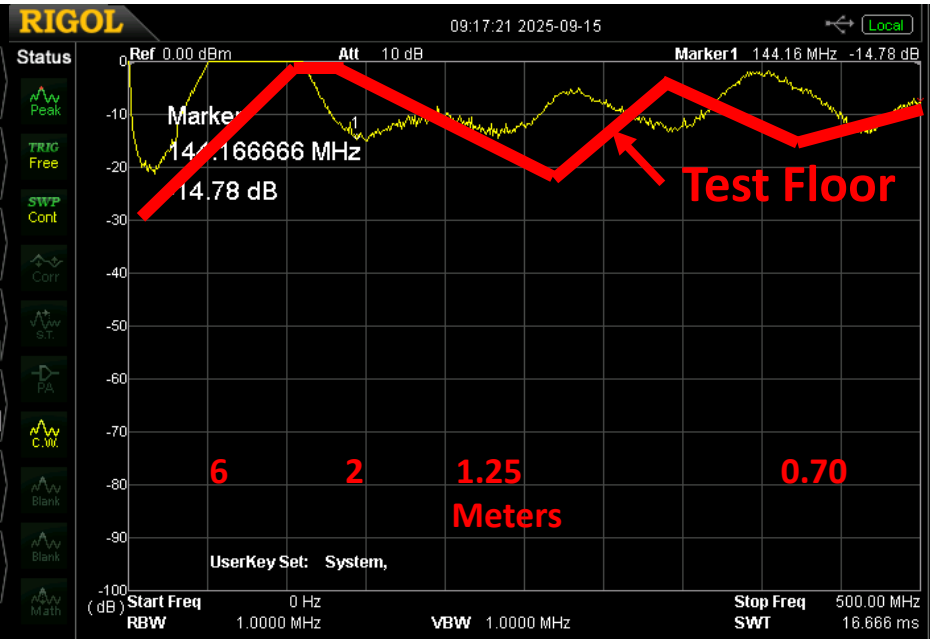
2 turns RG-400, with 2 type 31? clamp on ferrites, (PTFE) polytetrafluoroethylene (Teflon) dielectric



0 to 30MHz

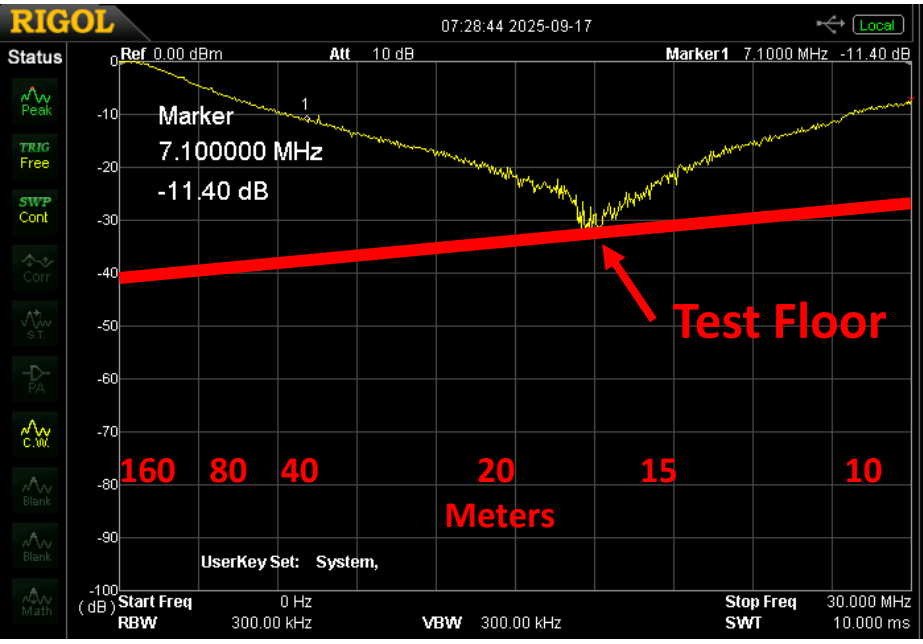


0 to 500MHz

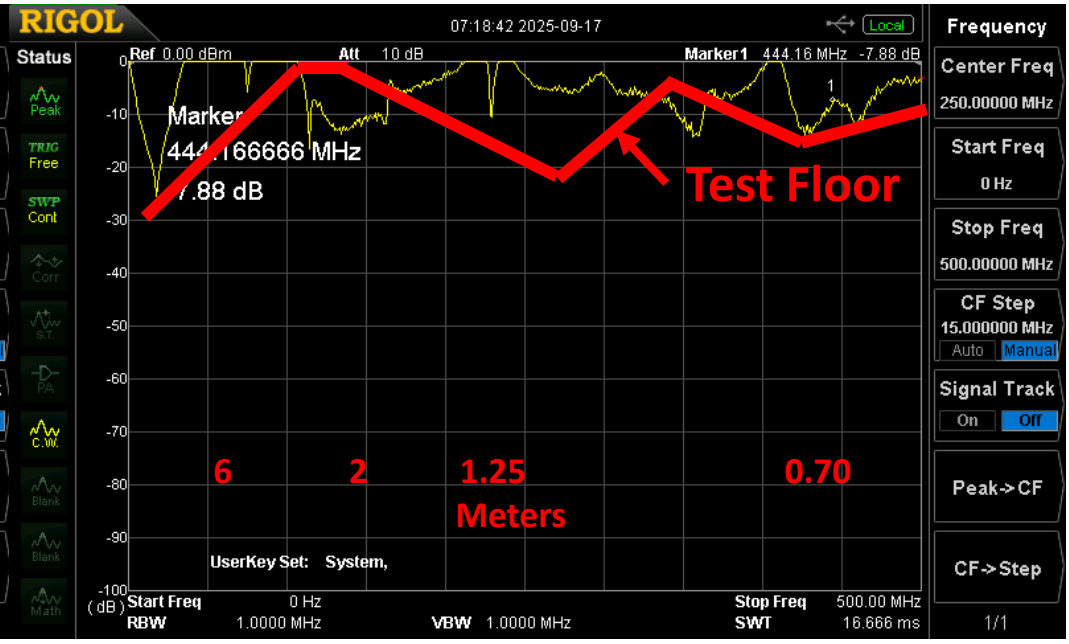


6 turns RG-400, (PTFE) polytetrafluoroethylene (Teflon) dielectric

0 to 30MHz

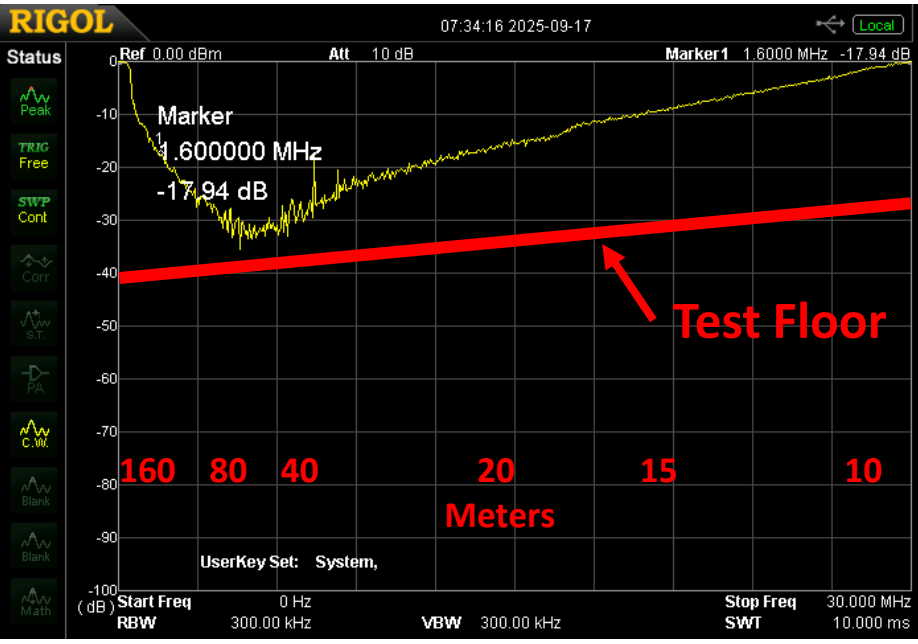


0 to 500MHz

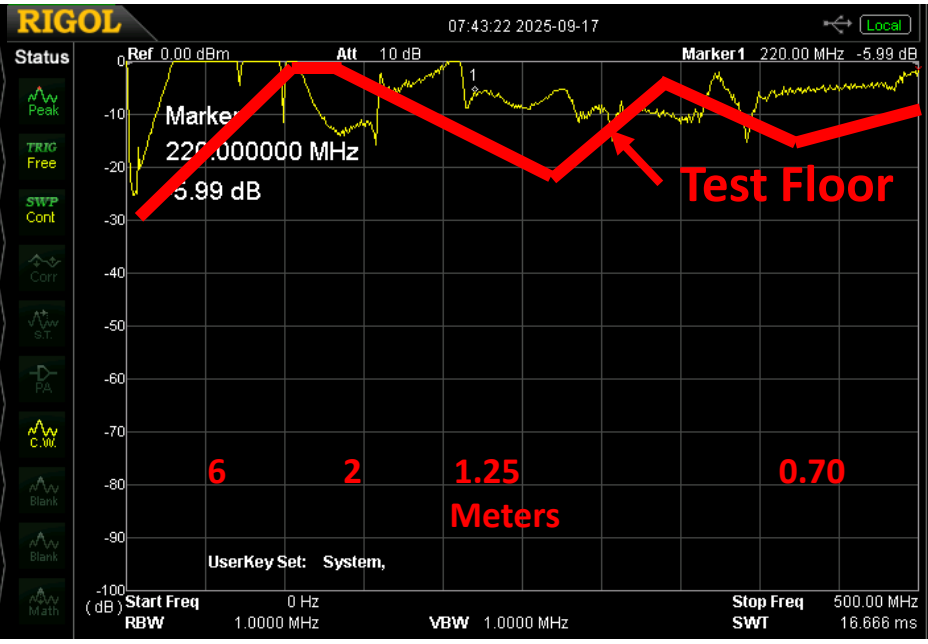


6 turns RG-400, with 1 type 31? clamp on ferrite, (PTFE) polytetrafluoroethylene (Teflon) dielectric

0 to 30MHz

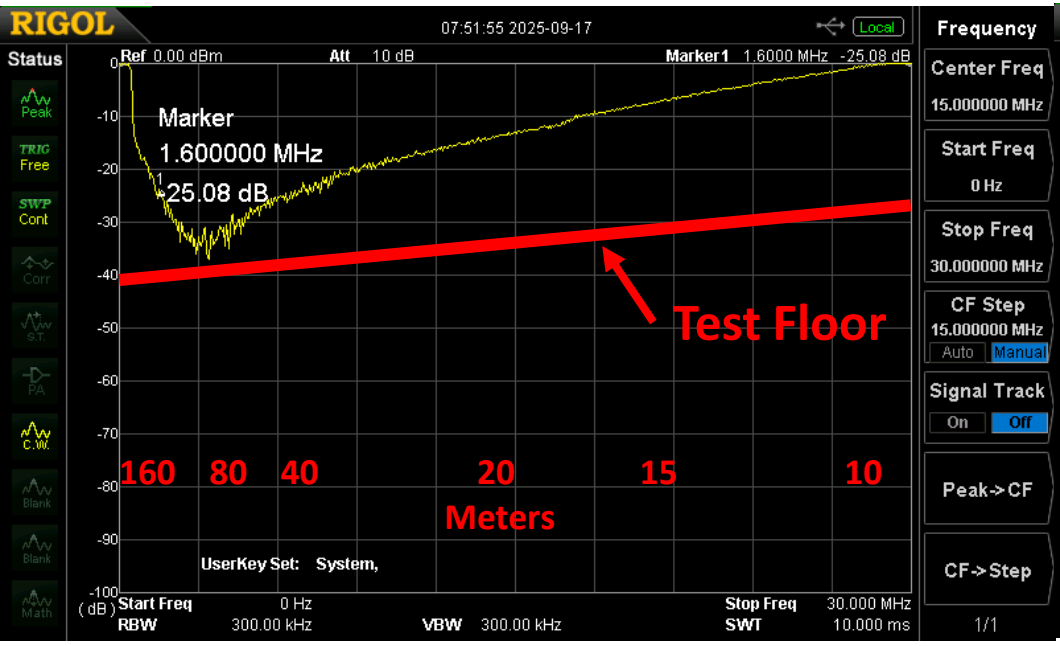


0 to 500MHz

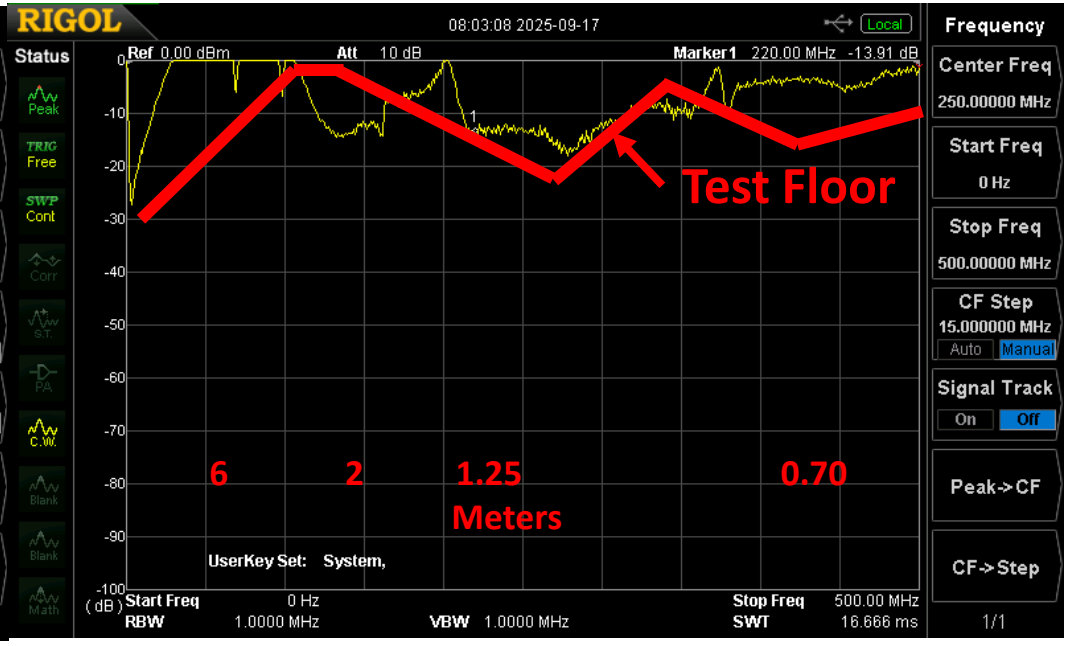


6 turns RG-400, with 2 type 31? clamp on ferrites, (PTFE) polytetrafluoroethylene (Teflon) dielectric

0 to 30MHz

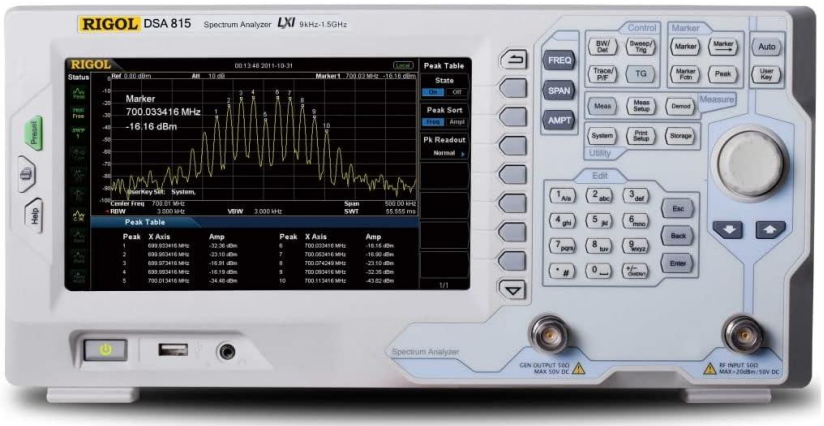


0 to 500MHz



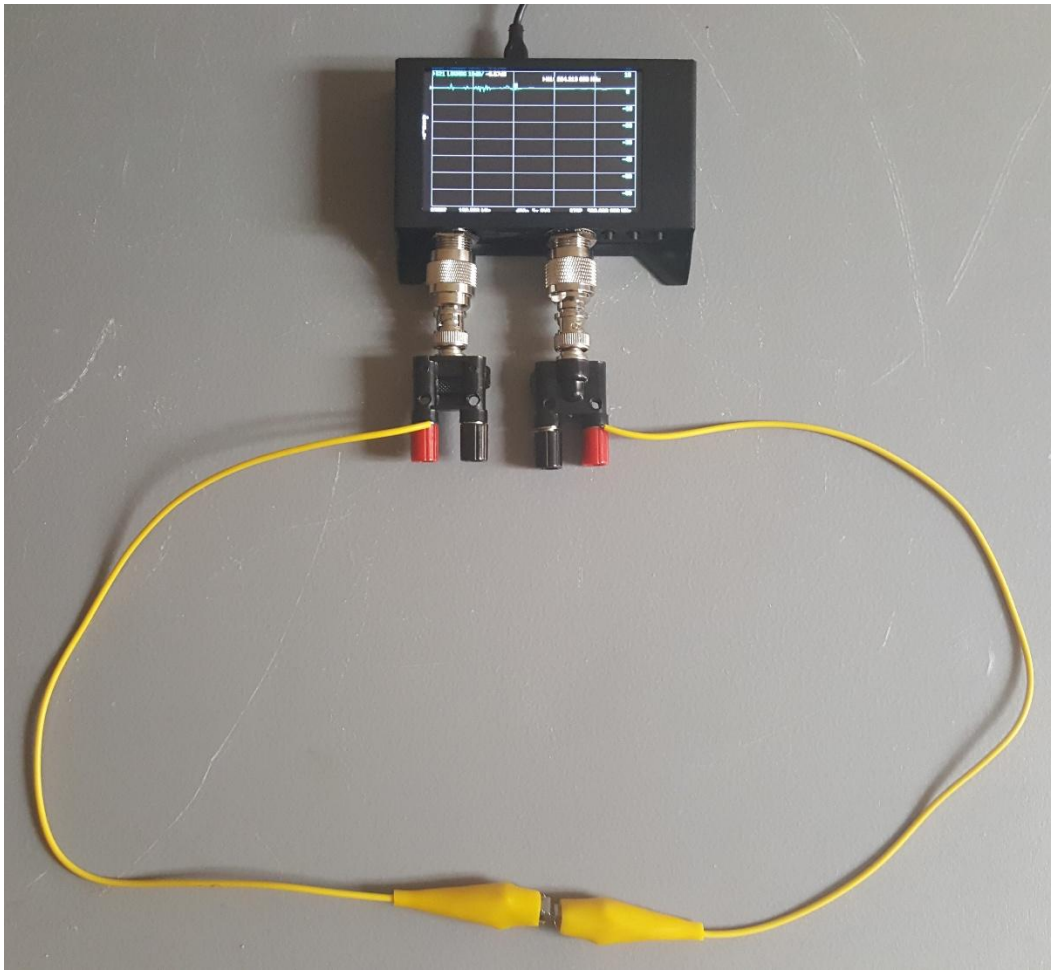
Spectrum Analyzer or Vector Network Analyzer with Tracking Generator

- Rigol DSA 815-TG Spectrum Analyzer with Tacking Generator, 9KHz – 1.5 GHz, 8 inch screen. Measures AM/FM demodulation, S parameters, Duplexer VSWR, Phase, Delay.
- **Aursinc Nano VNA SAA-2N V2.2, 1.6KHz – 3GHz, 4 inch touch screen. Measures S parameters, Duplexer, VSWR, Phase, Delay.**

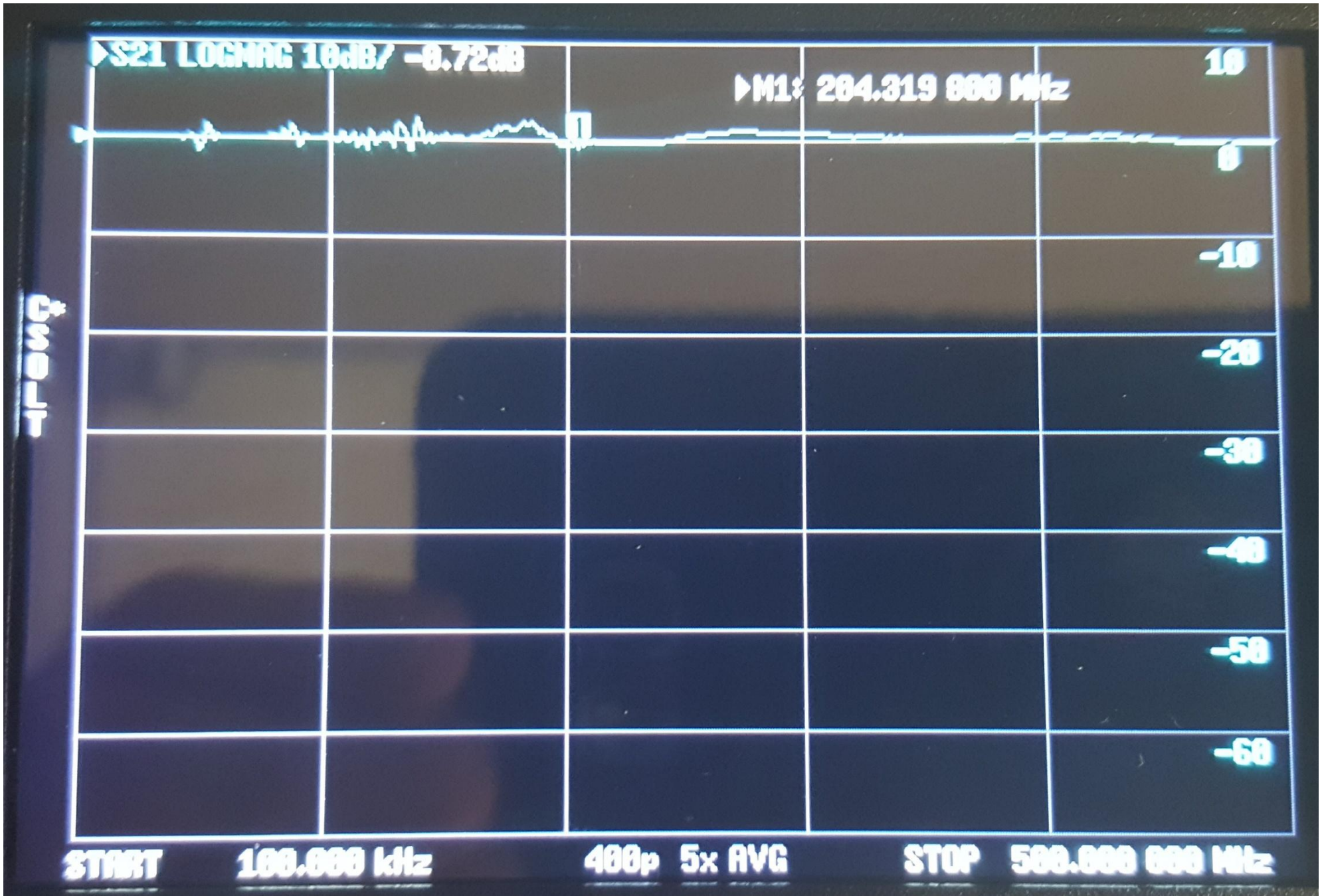


Nano VNA test setup and normalization

- A Nano VNA with Tacking Generator can also be used to plot Common Mode frequency performance of coiled coax chokes.

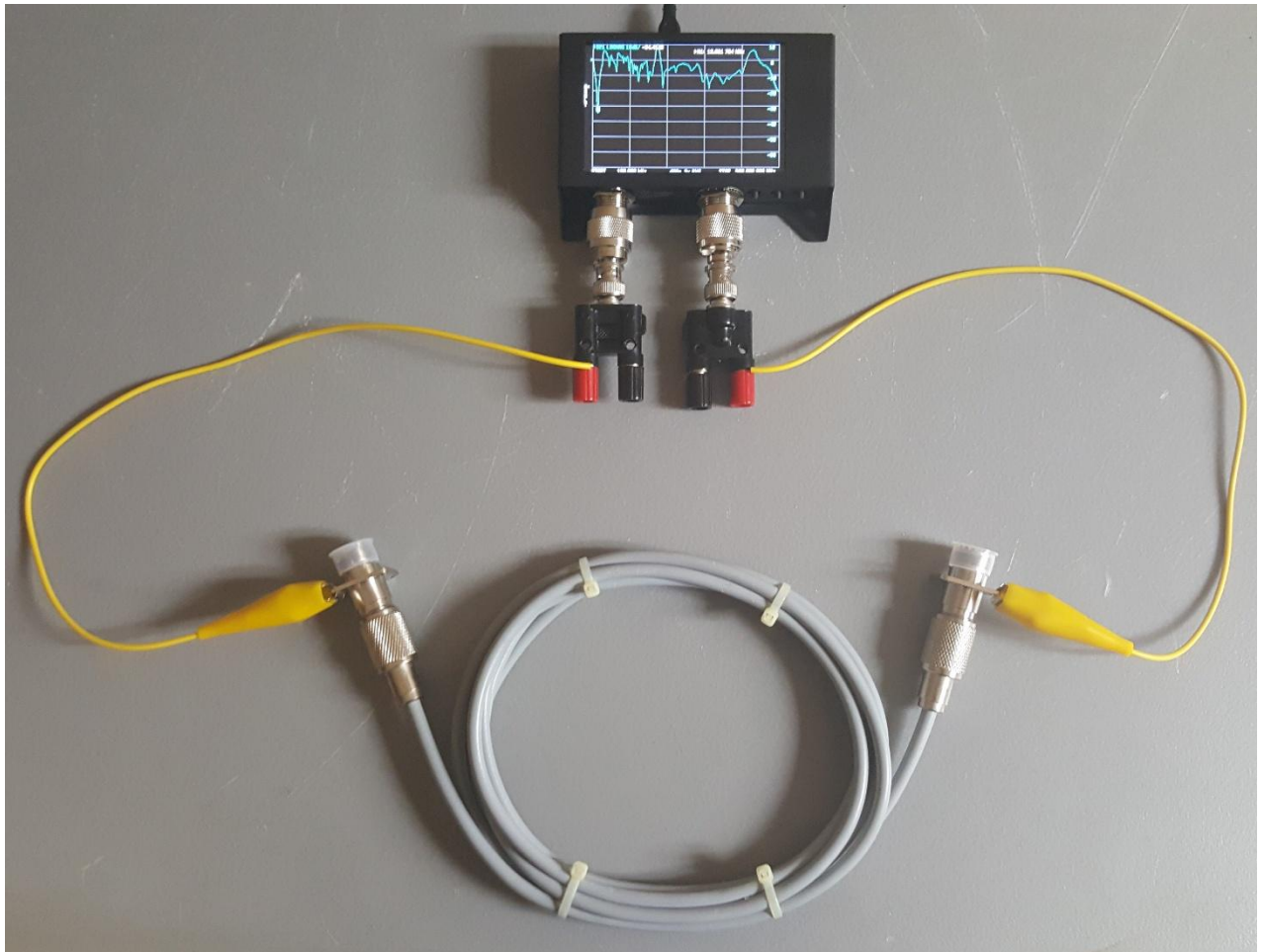


Nano VNA Normalized Test Setup
100KHz to 500MHz



Coiled Coax Common Mode (CM) Choke Performance, 6 turns.

- A Nano VNA with Tacking Generator can be used to plot Common Mode frequency performance of coiled coax chokes.

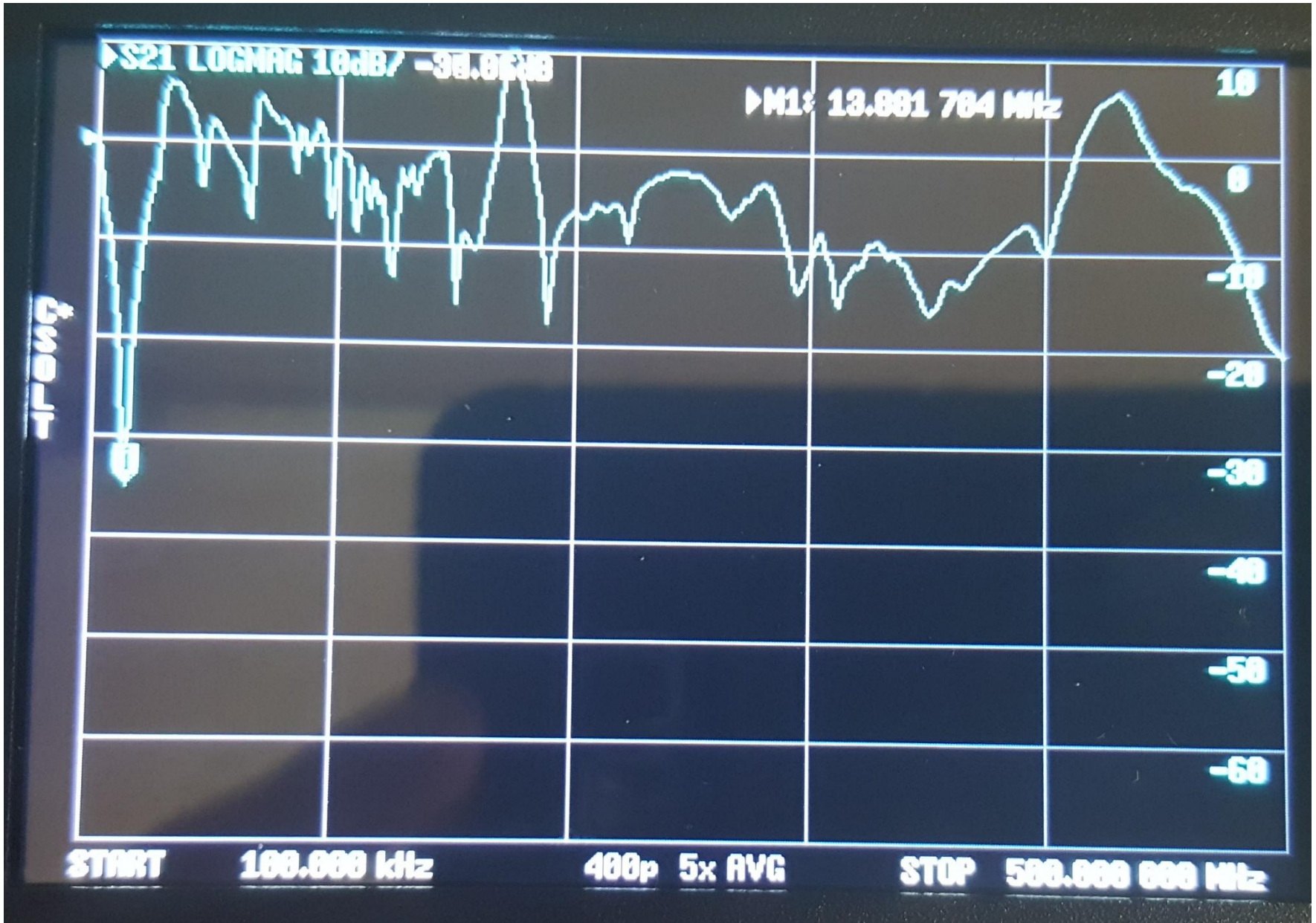


6 turns RG-8X, 100KHz to 30MHz, Open cell (FPE) gas-injected foam polyethylene dielectric

- Nano VNA

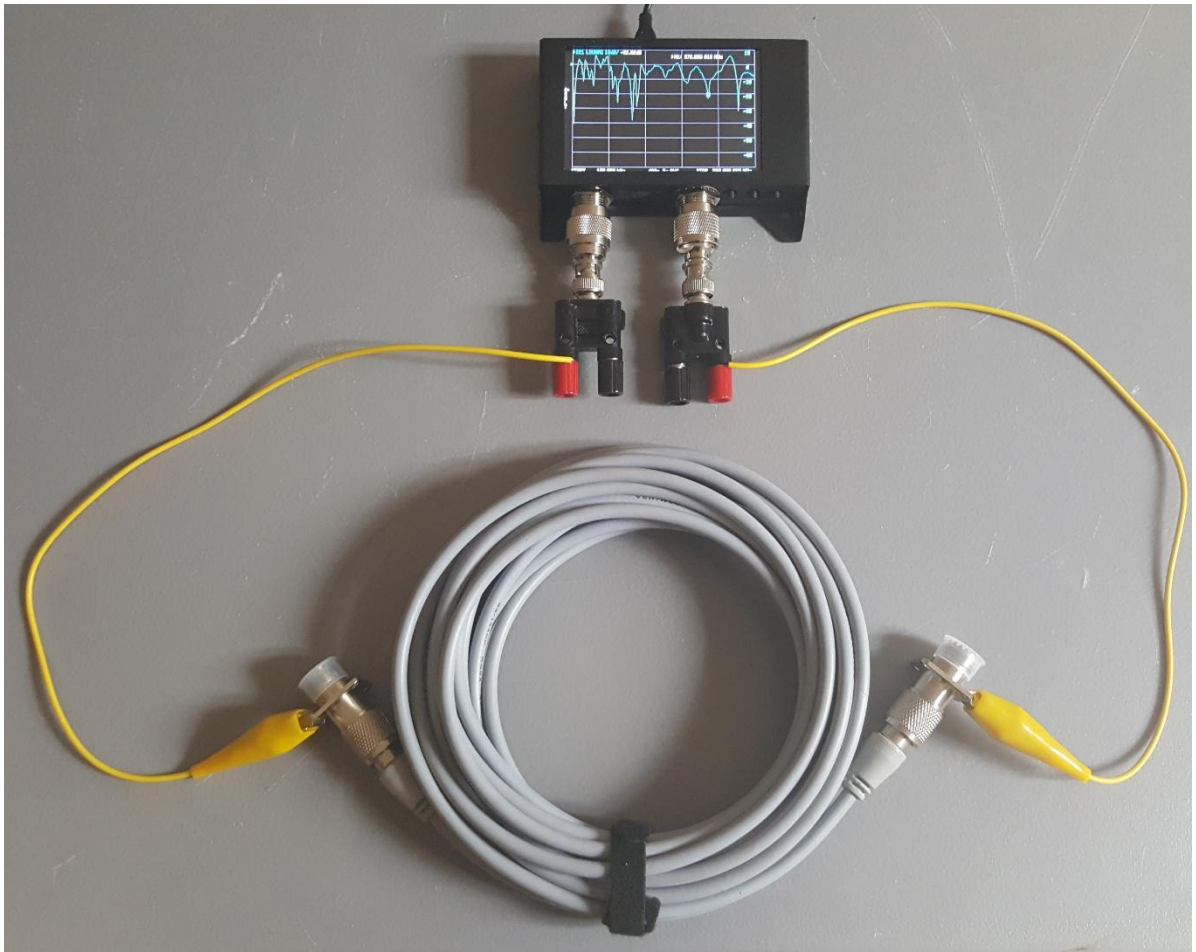
6 turns RG-8X, 100KHz to 500MHz, Open cell (FPE) gas-injected foam polyethylene dielectric

- Nano VNA



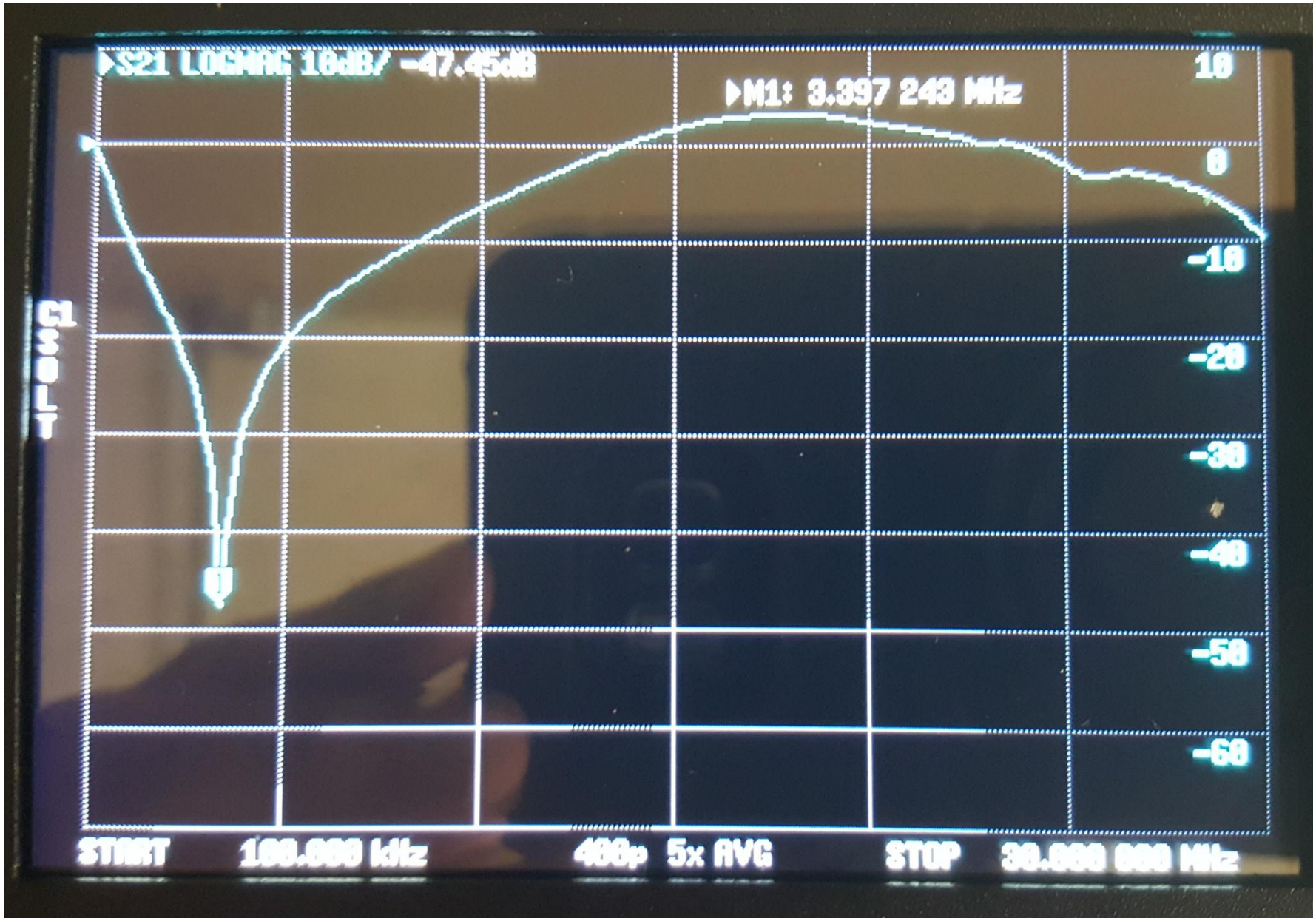
Coiled Coax Common Mode (CM) Choke Performance, 15 turns.

- A Nano VNA with Tacking Generator can be used to plot Common Mode frequency performance of coiled coax chokes.



15 turns RG-8X, 100KHz to 30MHz, Open cell (FPE) gas-injected foam polyethylene dielectric

- Nano VNA

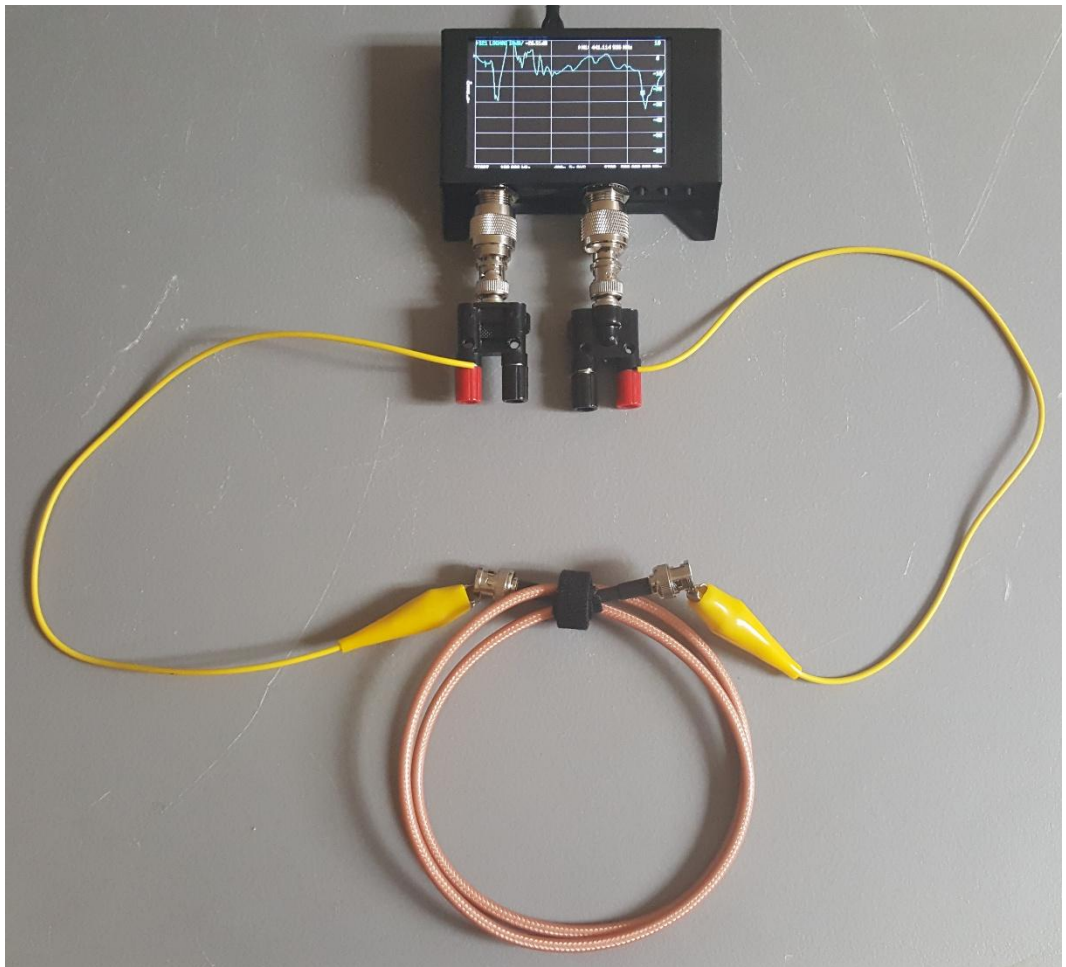


15 turns RG-8X, 100KHz to 500MHz, Open cell (FPE) gas-injected foam polyethylene dielectric

- Nano VNA

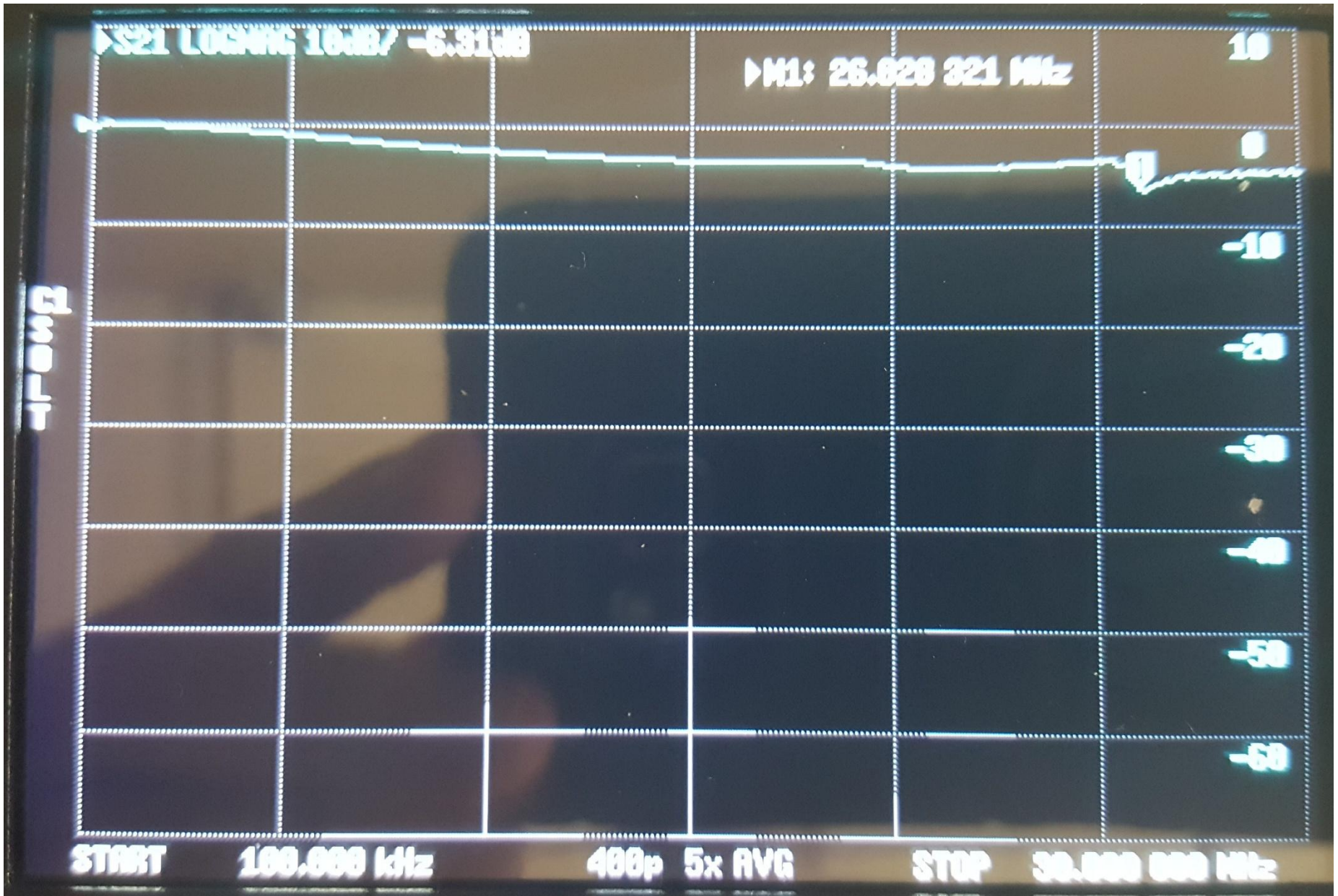
Coiled Coax Common Mode (CM) Choke Performance, 2 turns.

- A Nano VNA with Tacking Generator can be used to plot Common Mode frequency performance of coiled coax chokes.



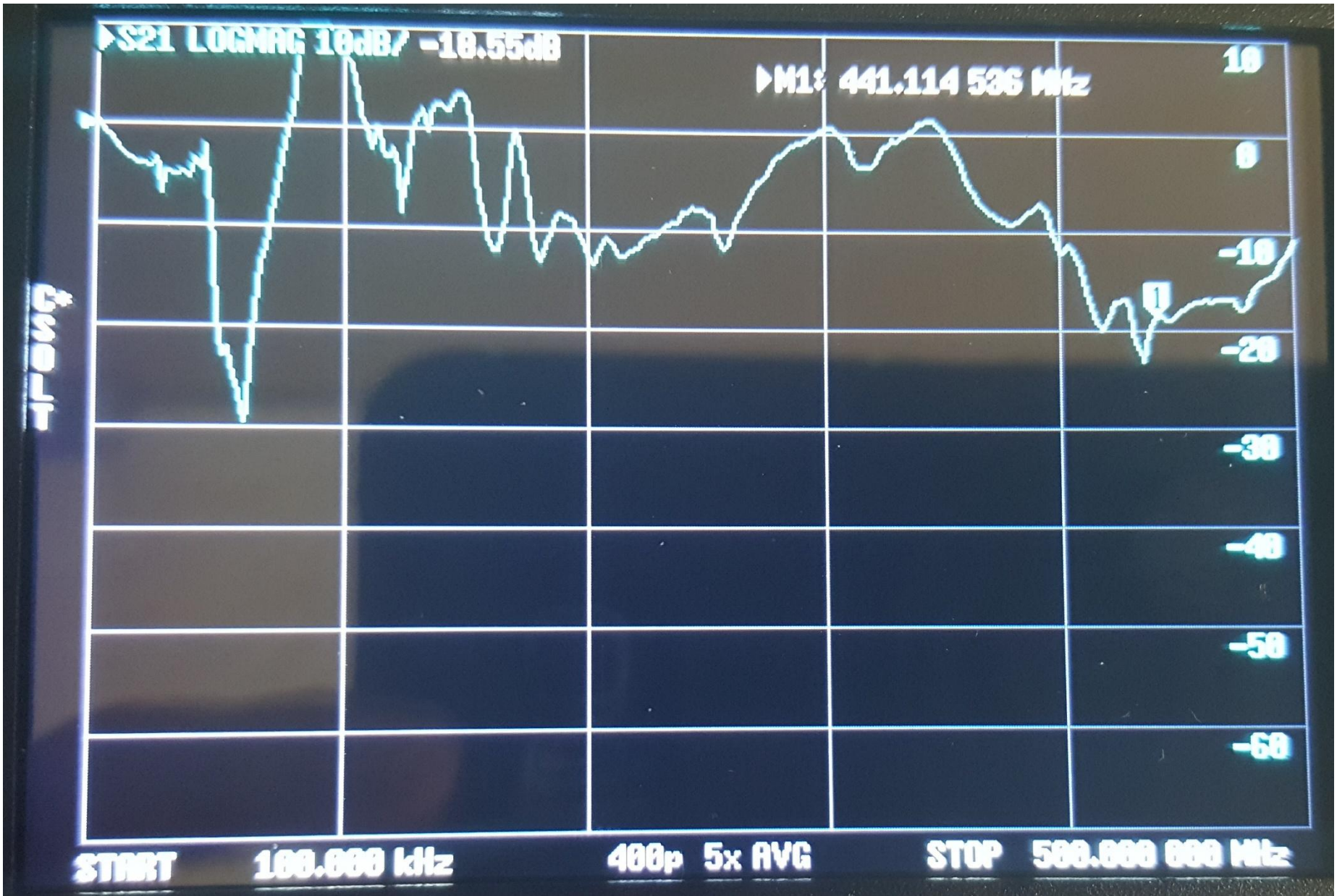
2 turns RG-400, 100KHz to 30MHz, (PTFE) polytetrafluoroethylene (Teflon) dielectric

- Nano VNA



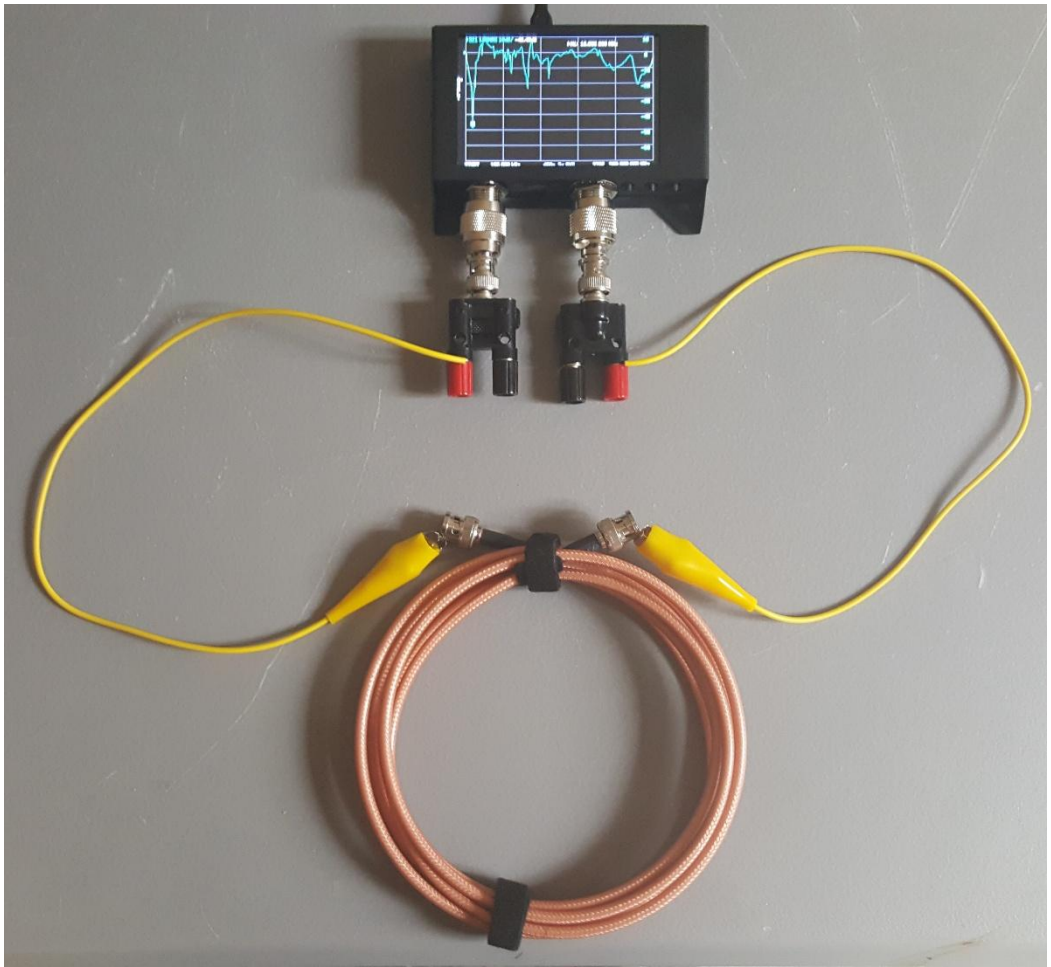
2 turns RG-400, 100KHz to 500MHz, (PTFE) polytetrafluoroethylene (Teflon) dielectric

- Nano VNA



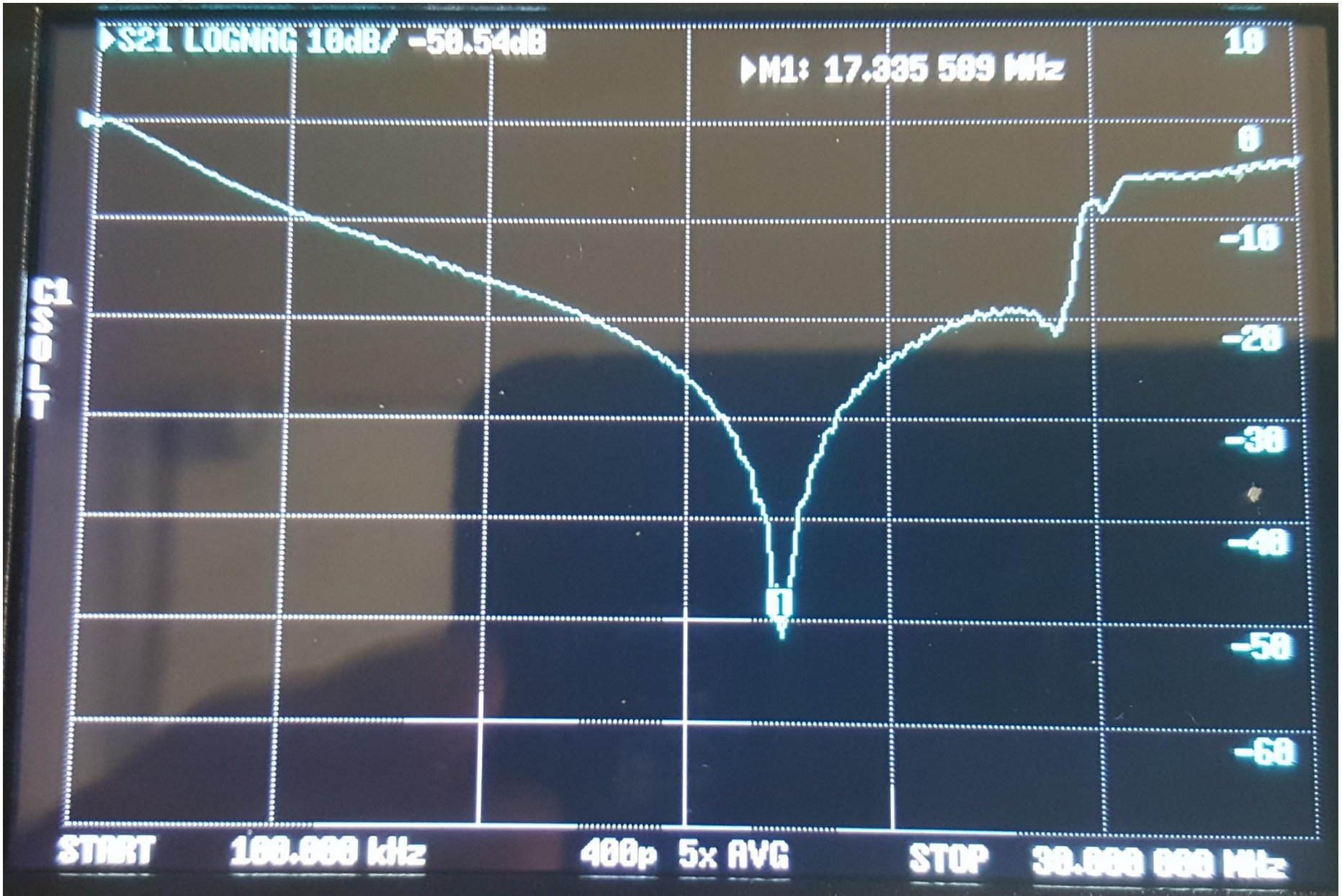
Coiled Coax Common Mode (CM) Choke Performance, 6 turns.

- A Nano VNA with Tacking Generator can be used to plot Common Mode frequency performance of coiled coax chokes.



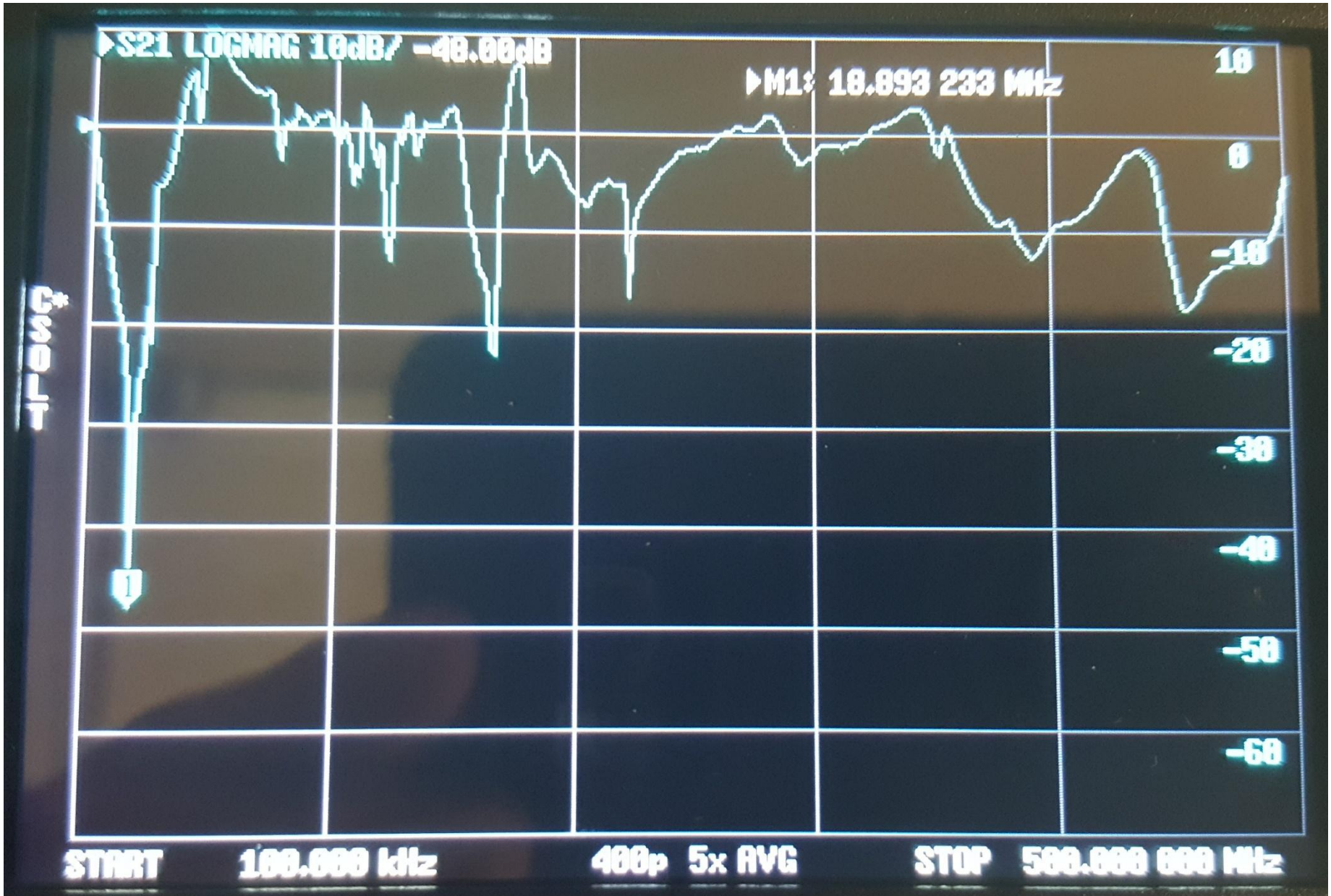
6 turns RG-400, 100KHz to 30MHz, (PTFE) polytetrafluoroethylene (Teflon) dielectric

- Nano VNA



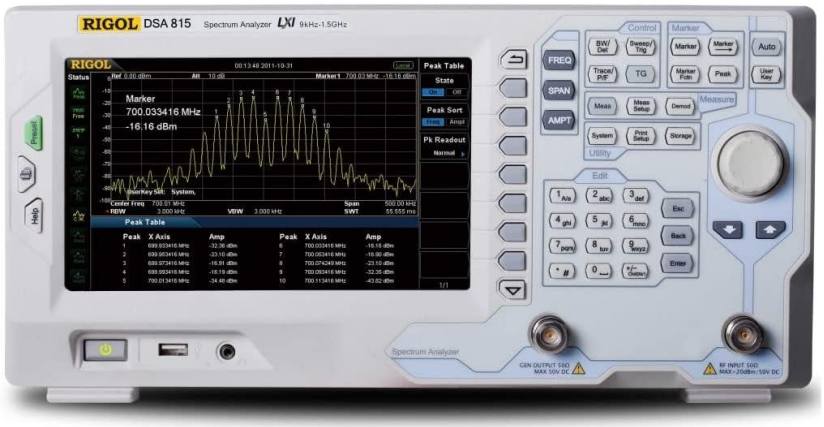
6 turns RG-400, 100KHz to 500MHz, (PTFE) polytetrafluoroethylene (Teflon) dielectric

- Nano VNA



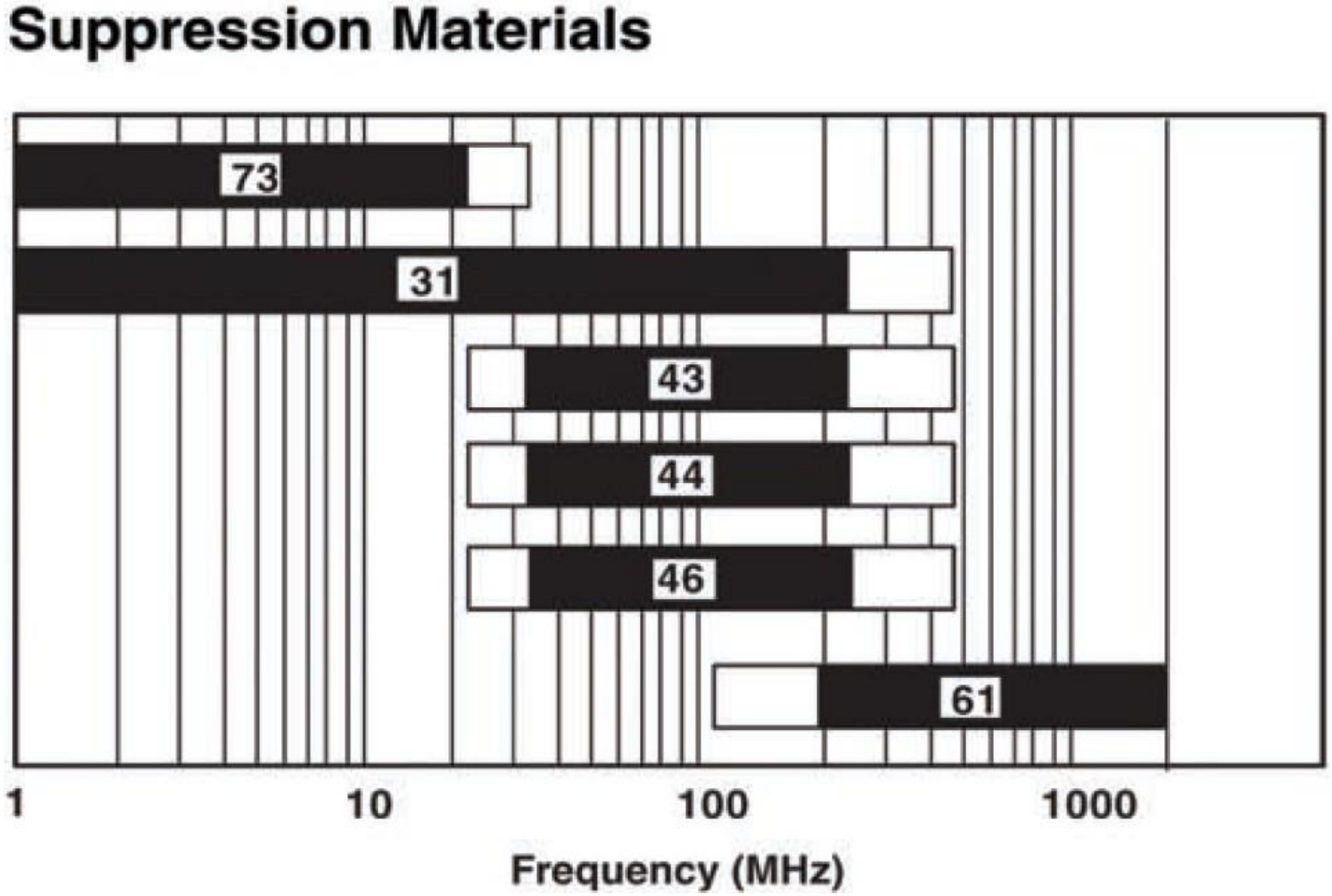
Coiled Coax CM Choke with Ferrite(s) Performance

- Grid Dip meter cannot be used to find Common Mode resonant frequency of coiled coax choke when ferrites are added.
- Ferrites flatten, and widen Common Mode response.
- A Spectrum Analyzer or Vector Network Analyzer with Tacking Generator can be used.



Ferrite Frequency Performance

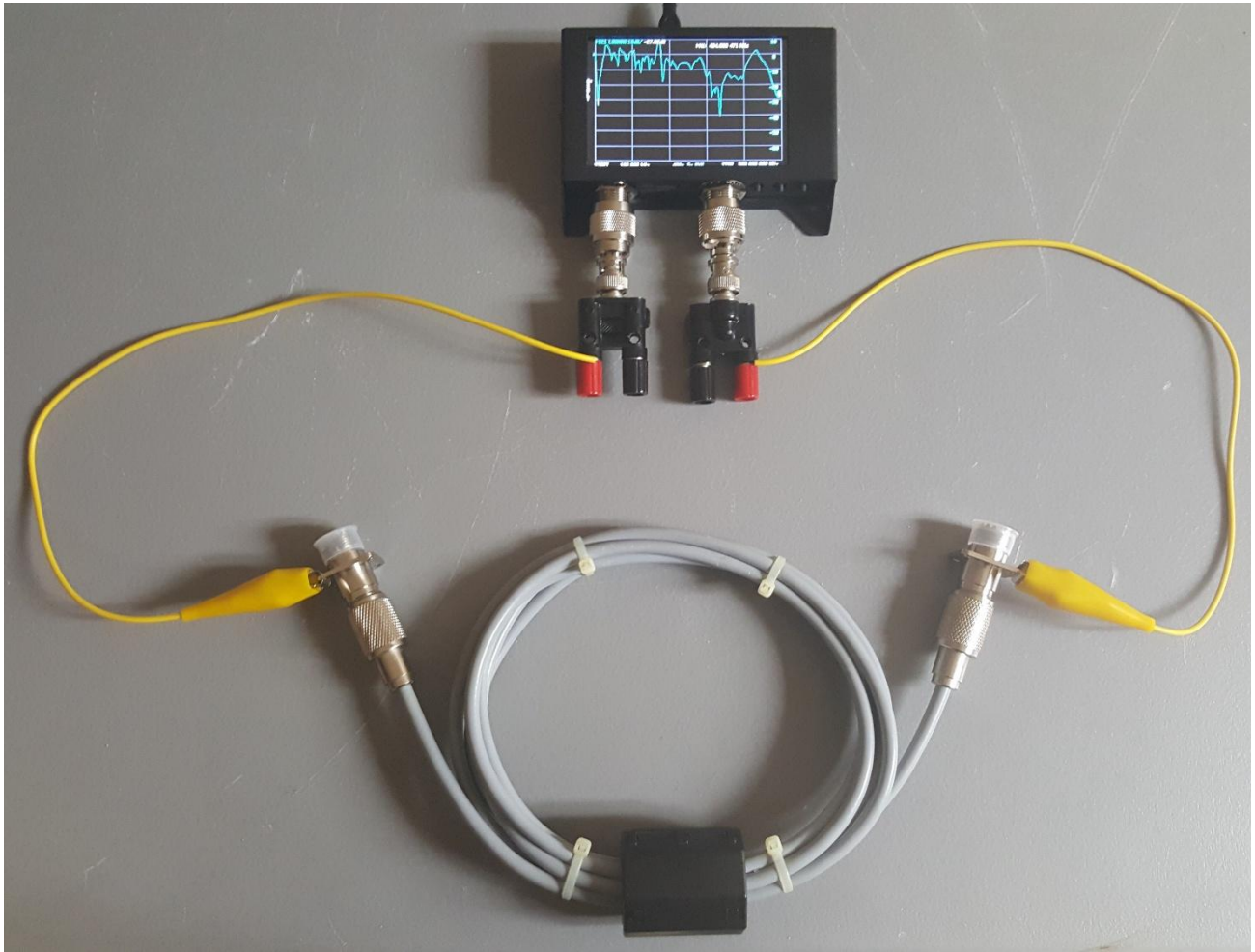
- Type 31 ferrite material recommended frequency range covers the entire HF spectrum, including 2 and 1.25 meters.
- Type 61 ferrite material recommended frequency range covers 1.25 meters to 2GHz.



Fair-Rite Products Corporation

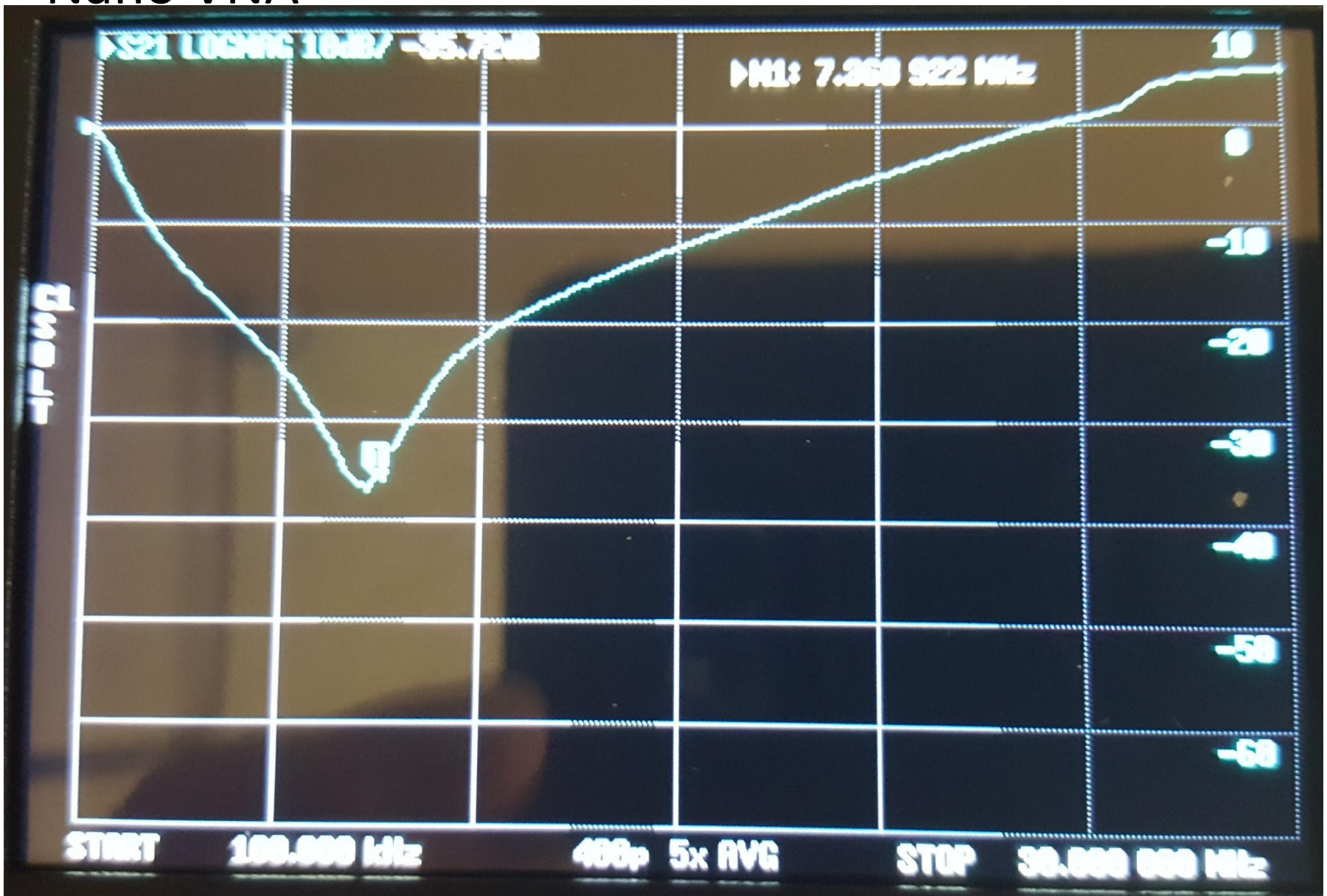
Coiled Coax Common Mode (CM) Choke Performance, 6 turns, 1 ferrite.

- A Nano VNA with Tacking Generator can be used to plot Common Mode frequency performance of chokes made with coiled coax and ferrite.



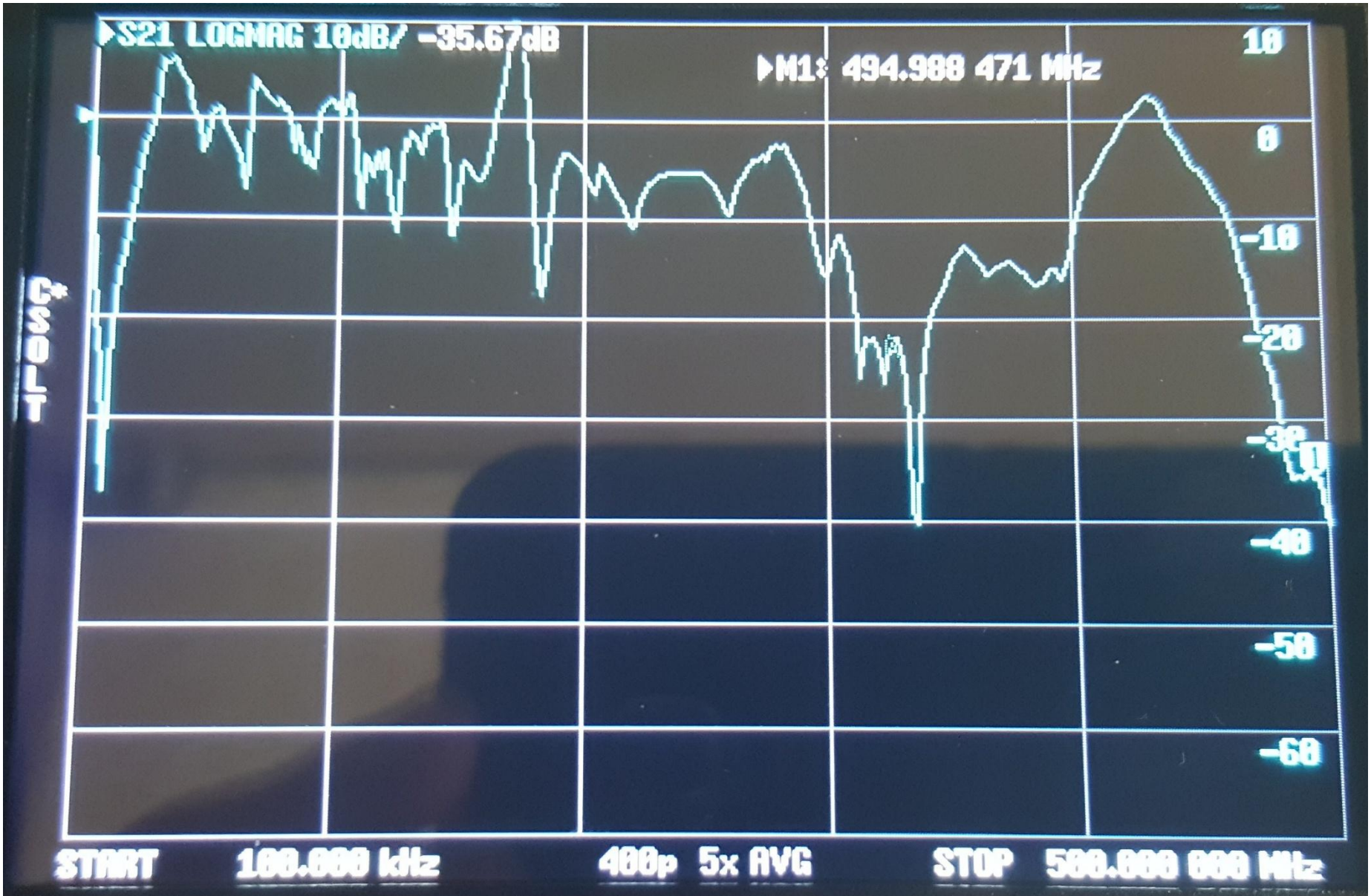
6 turns RG-8X, 100KHz to 30MHz,
with 1 type 31 clamp on ferrite, Open cell (FPE) gas-injected foam polyethylene dielectric

- Nano VNA



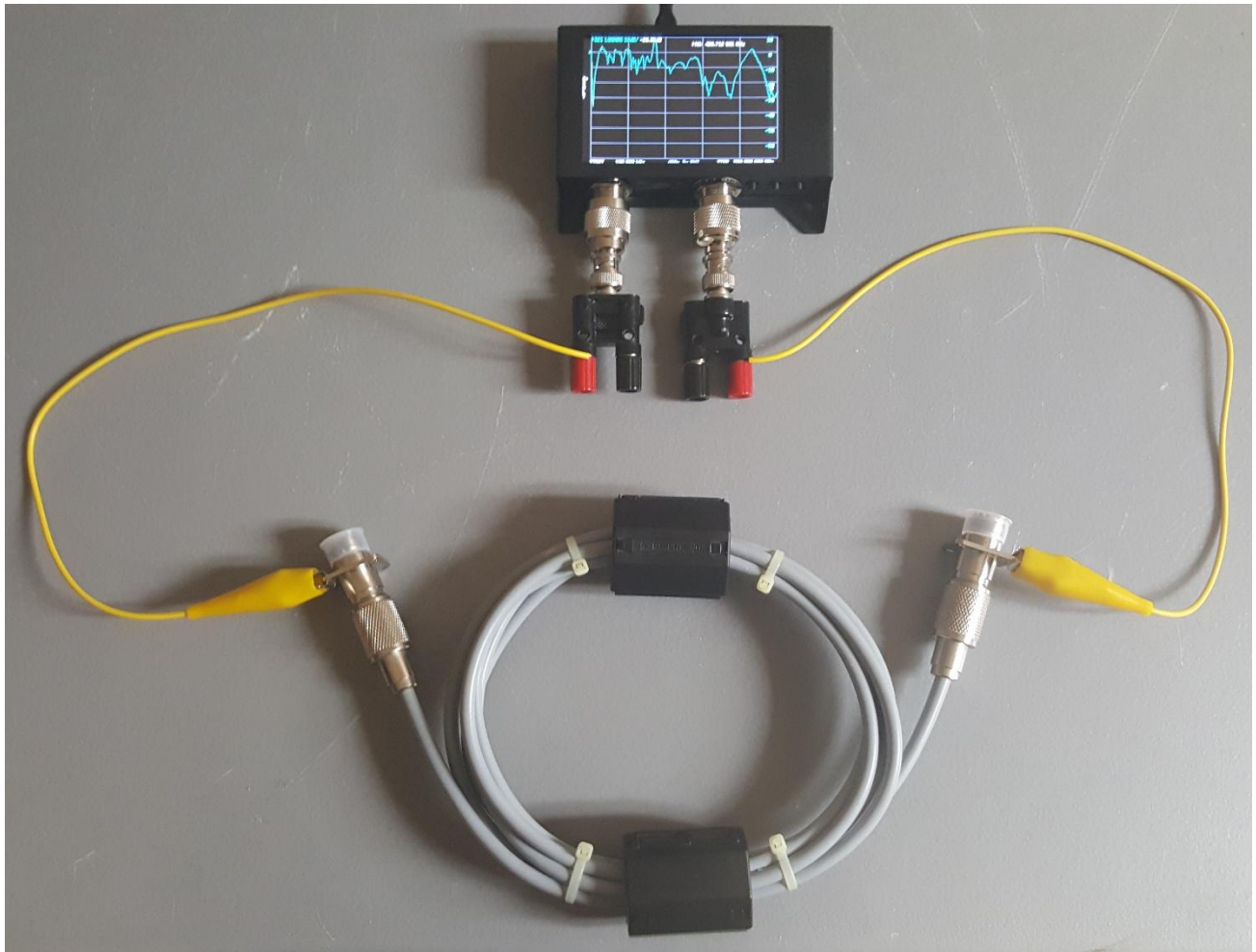
6 turns RG-8X, 100KHz to 500MHz,
with 1 type 31 clamp on ferrite, Open cell (FPE) gas-injected foam polyethylene dielectric

- Nano VNA



Coiled Coax Common Mode (CM) Choke Performance, 6 turns, 2 ferrites.

- A Nano VNA with Tacking Generator can be used to plot Common Mode frequency performance of chokes made with coiled coax and ferrites.

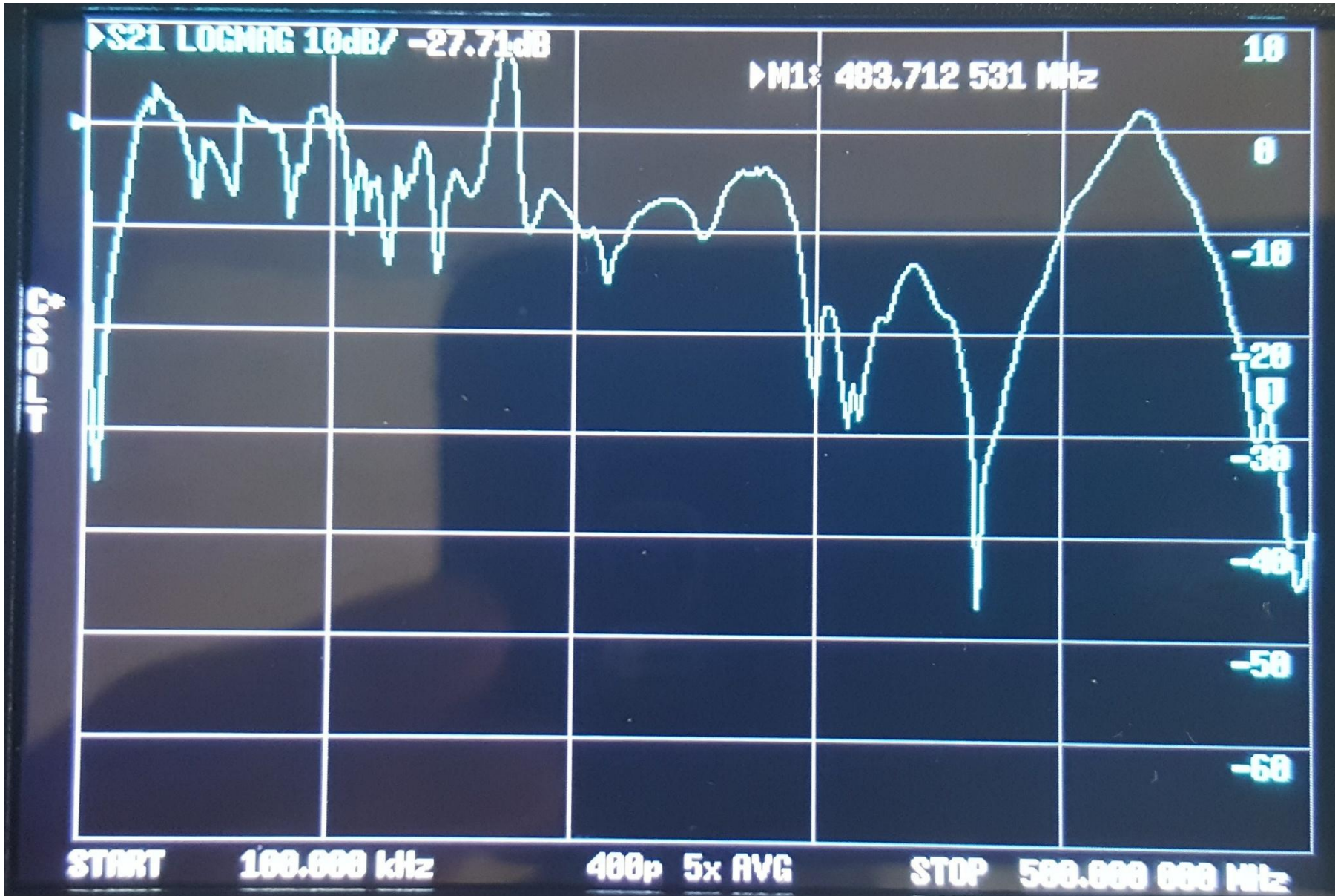


6 turns RG-8X, 100KHz to 30MHz, with 2 type 31 clamp on ferrites, Open cell (FPE) gas-injected foam polyethylene dielectric

- Nano VNA

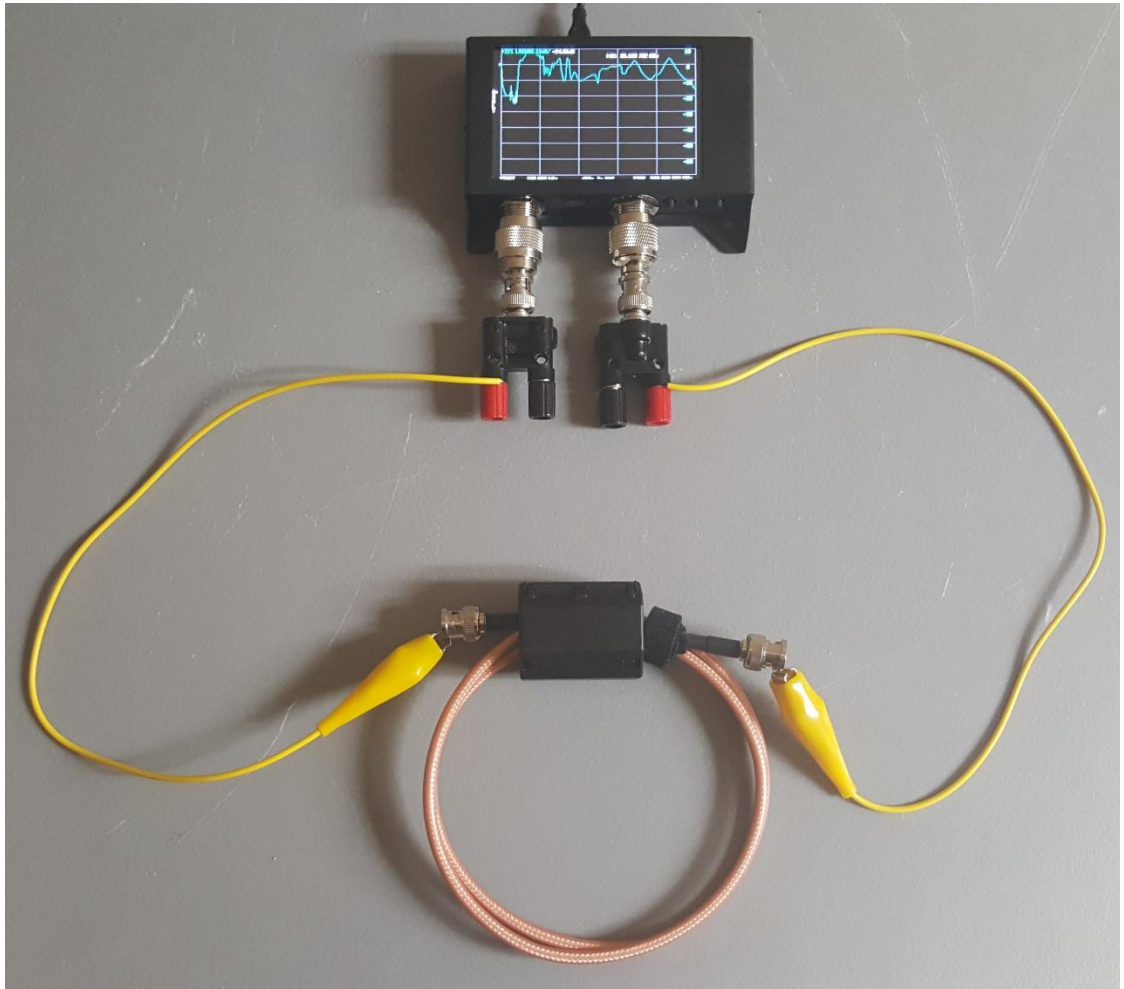
6 turns RG-8X, 100KHz to 500MHz,
with 2 type 31 clamp on ferrites, Open cell (FPE) gas-injected foam polyethylene dielectric

- Nano VNA



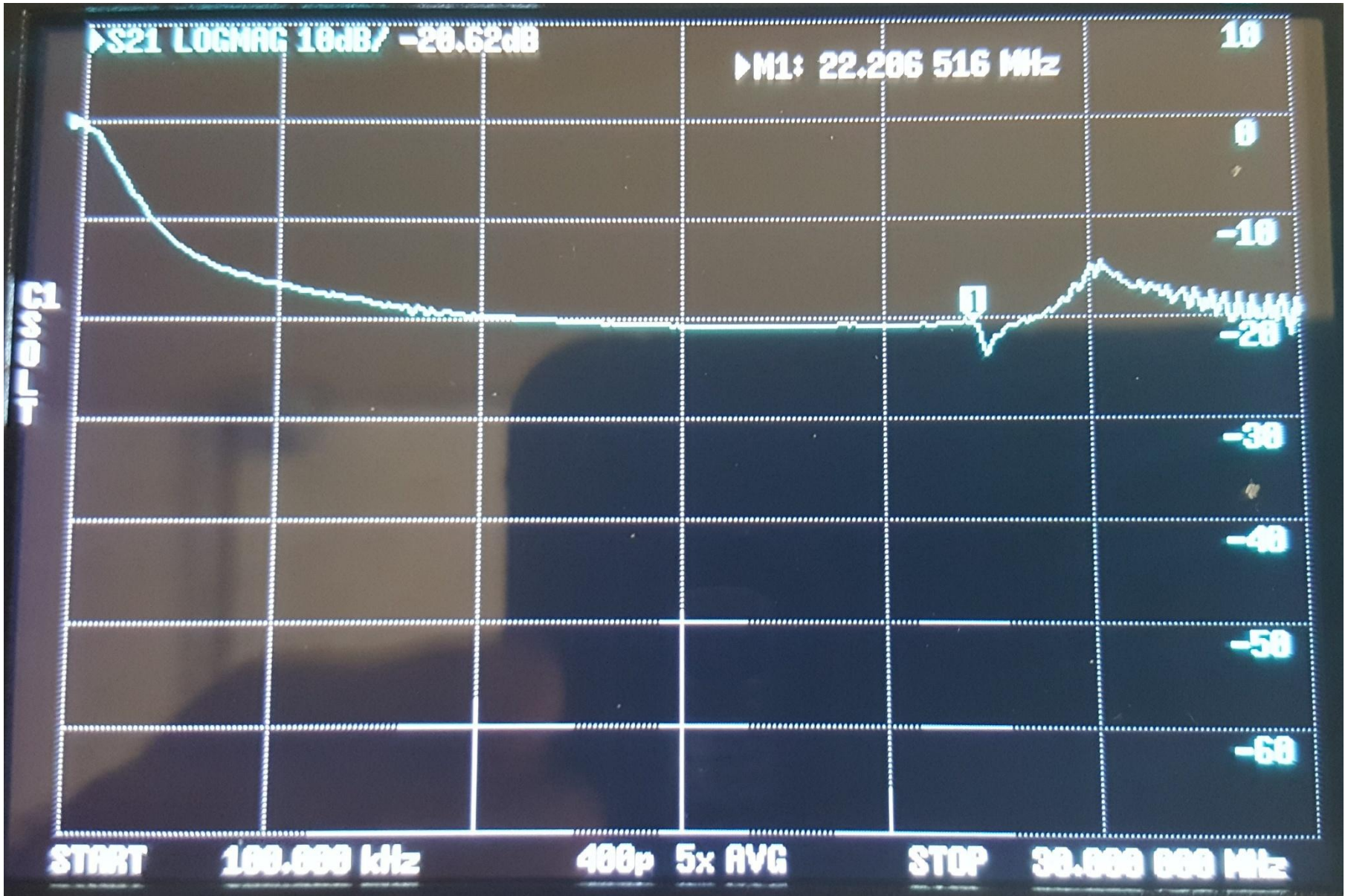
Coiled Coax Common Mode (CM) Choke Performance, 2 turns, 1 ferrite.

- A Nano VNA with Tacking Generator can be used to plot Common Mode frequency performance of chokes made with coiled coax and ferrite.



2 turns RG-400, 100KHz to 30MHz, with 1 type 31 clamp on ferrite, (PTFE) polytetrafluoroethylene (Teflon) dielectric

- Nano VNA

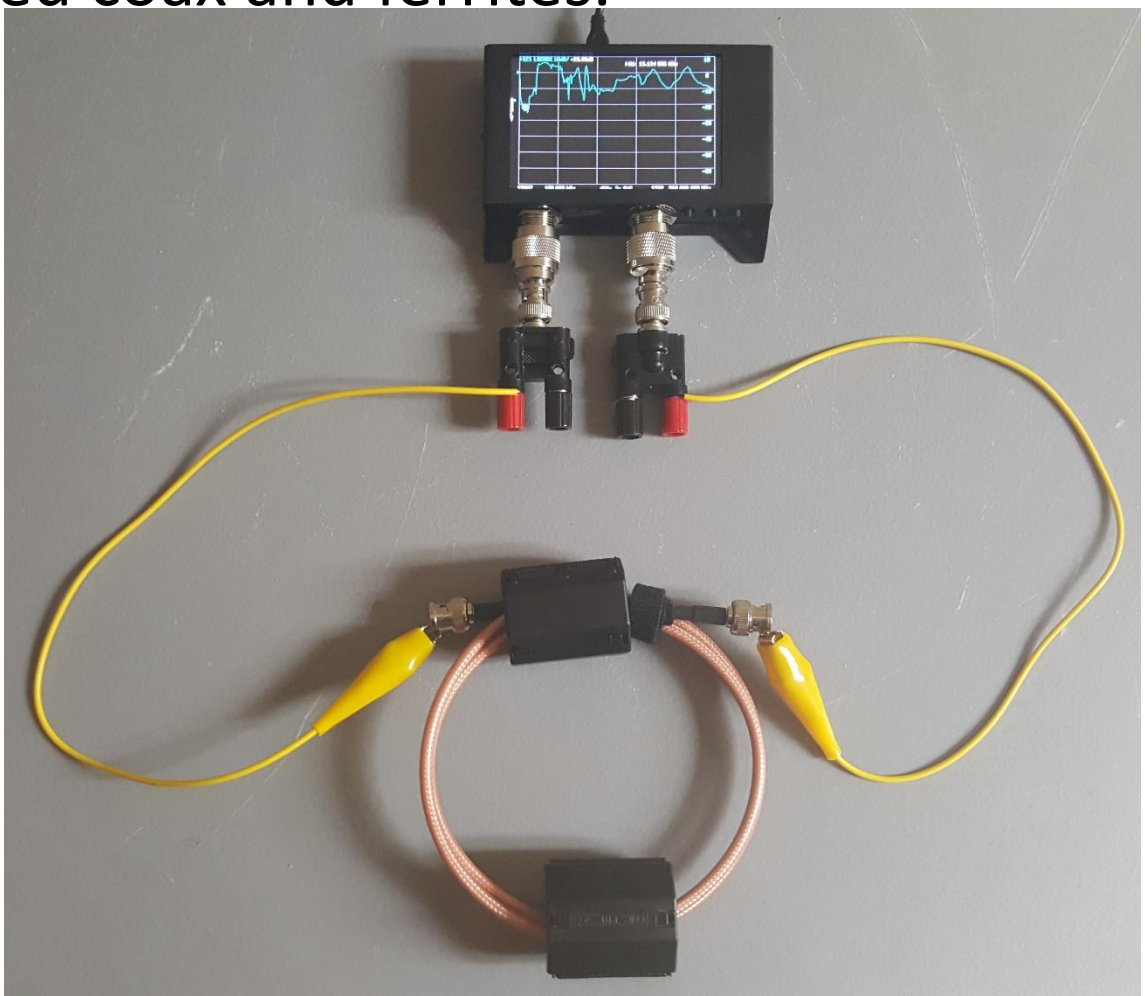


2 turns RG-400, 100KHz to 500MHz, with 1 type 31 clamp on ferrite, (PTFE) polytetrafluoroethylene (Teflon) dielectric

- Nano VNA

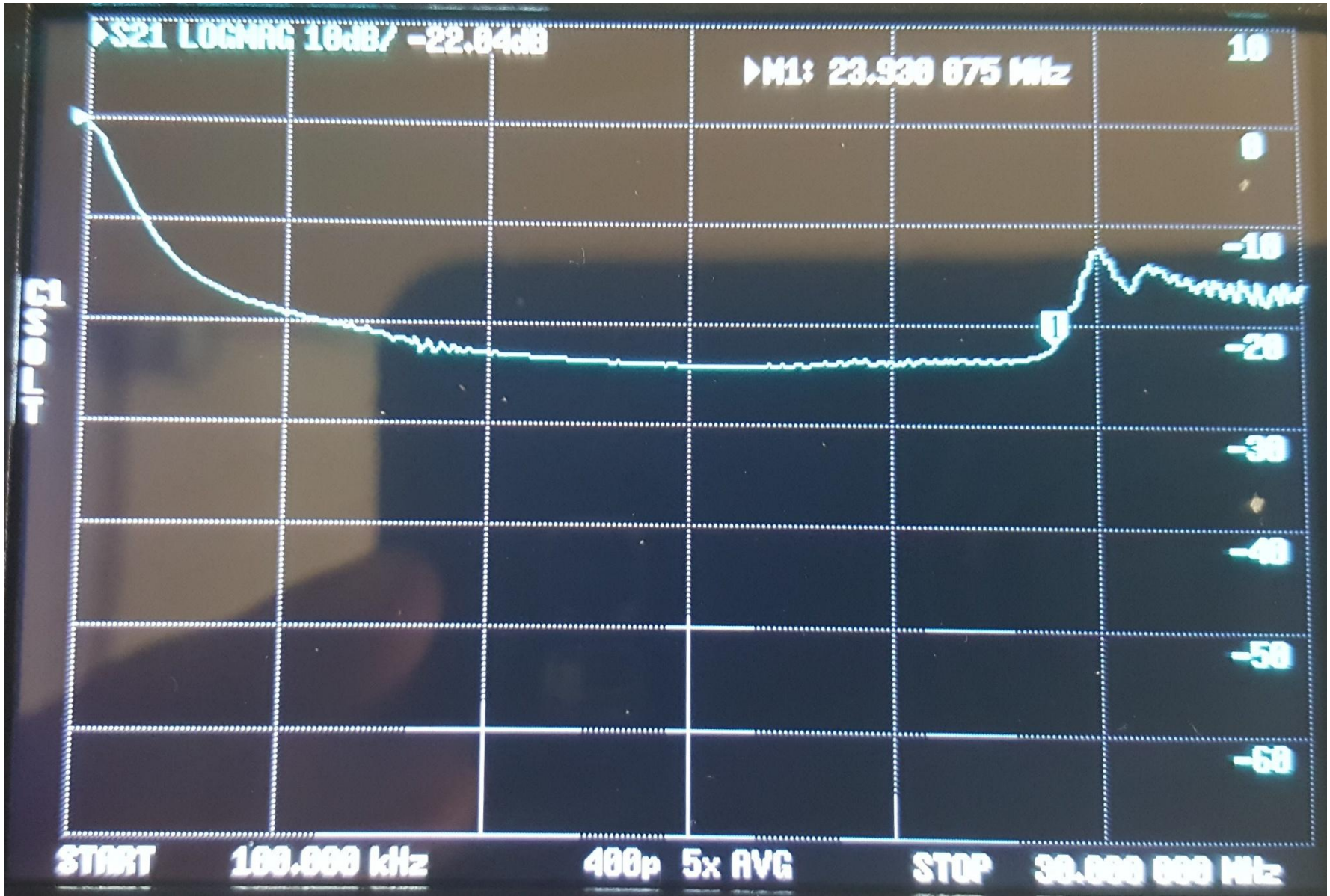
Coiled Coax Common Mode (CM) Choke Performance, 2 turns, 2 ferrites.

- A Nano VNA with Tacking Generator can be used to plot Common Mode frequency performance of chokes made with coiled coax and ferrites.



2 turns RG-400, 100KHz to 30MHz, with 2 type 31 clamp on ferrites, (PTFE) polytetrafluoroethylene (Teflon) dielectric

- Nano VNA

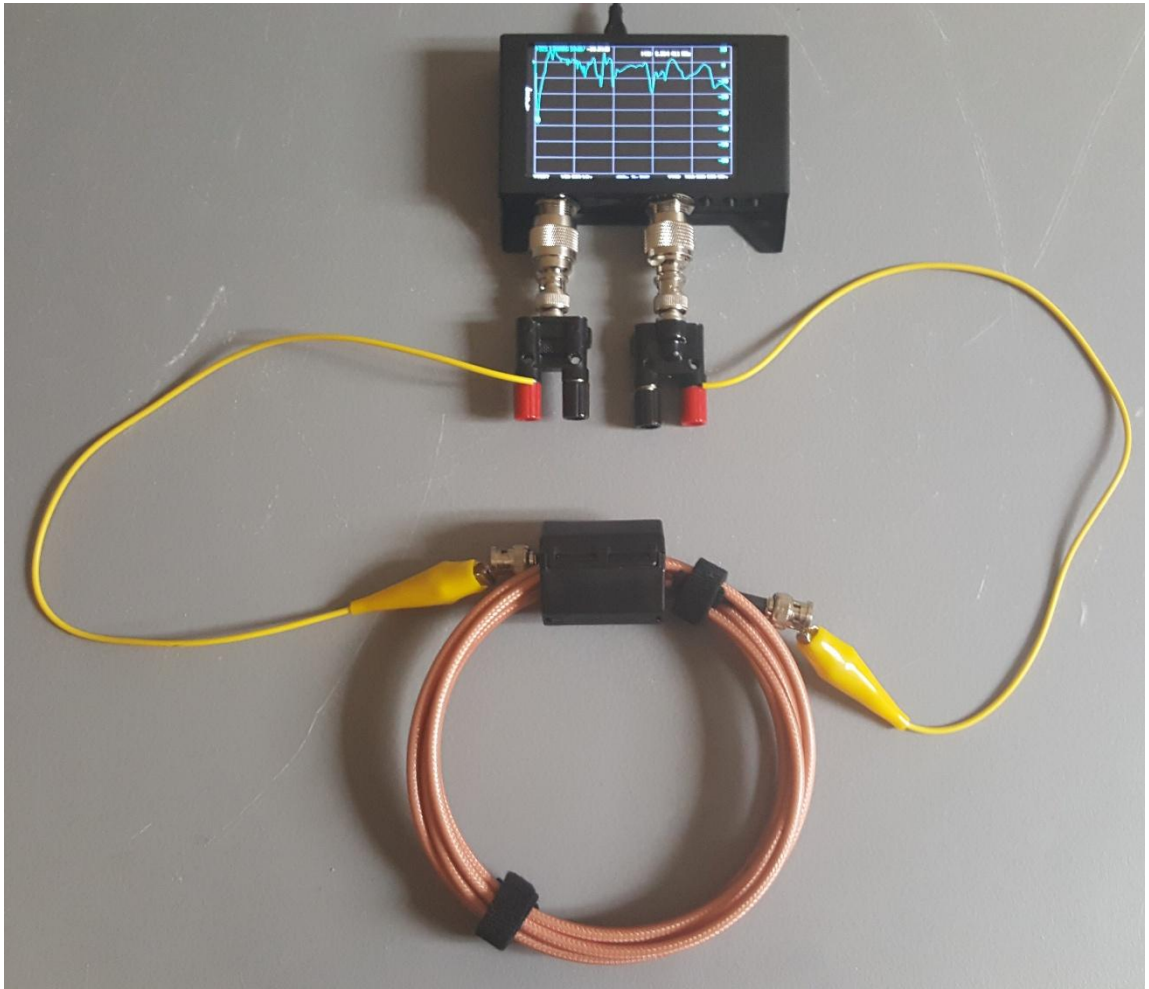


2 turns RG-400, 100KHz to 500MHz, with 2 type 31 clamp on ferrites, (PTFE) polytetrafluoroethylene (Teflon) dielectric

- Nano VNA

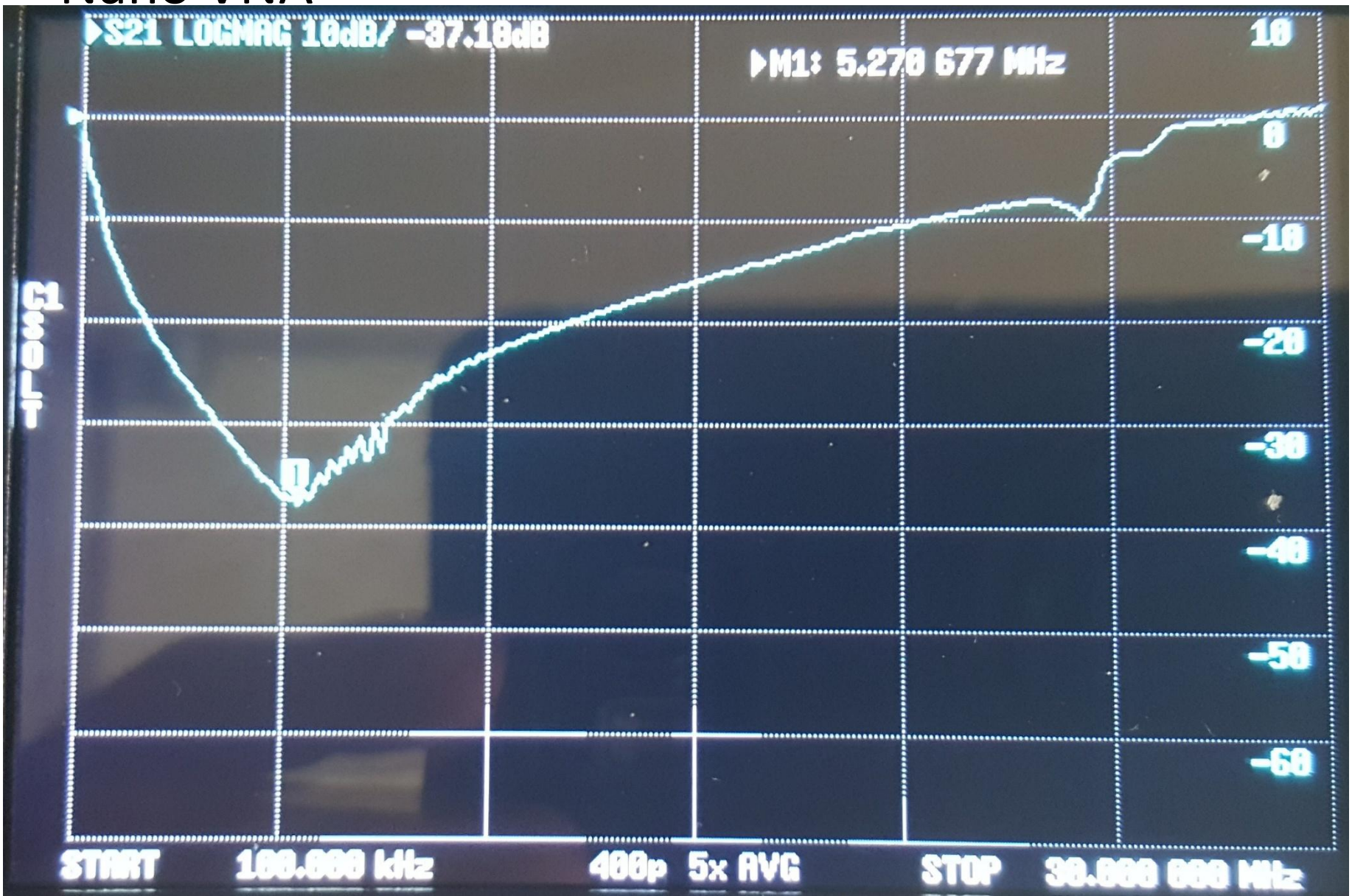
Coiled Coax Common Mode (CM) Choke Performance, 6 turns, 1 ferrite.

- A Nano VNA with Tacking Generator can be used to plot Common Mode frequency performance of chokes made with coiled coax and ferrite.



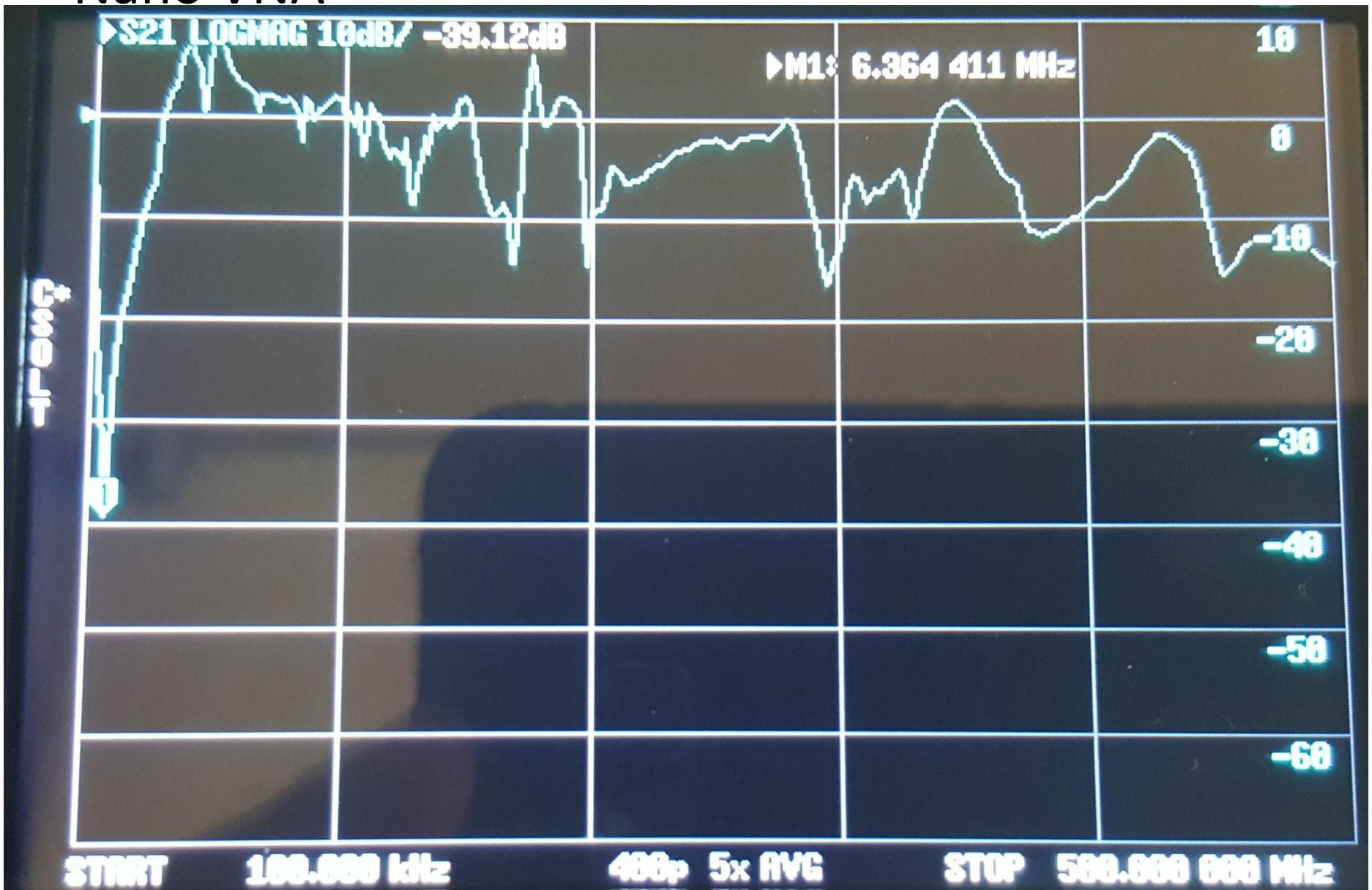
6 turns RG-400, 100KHz to 30MHz, with 1 type 31 clamp on ferrite, (PTFE) polytetrafluoroethylene (Teflon) dielectric

- Nano VNA



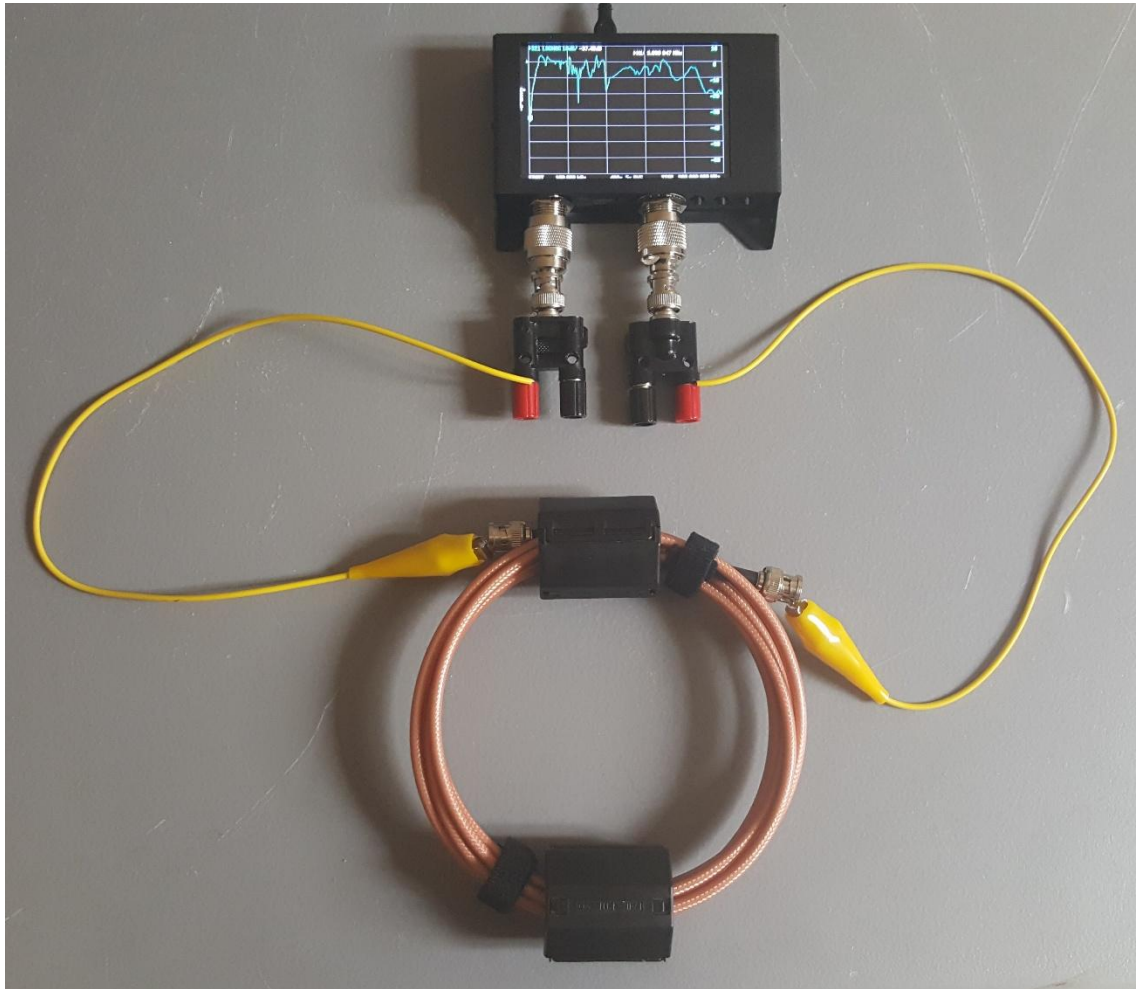
6 turns RG-400, 100KHz to 500MHz, with 1 type 31 clamp on ferrite, (PTFE) polytetrafluoroethylene (Teflon) dielectric

- Nano VNA



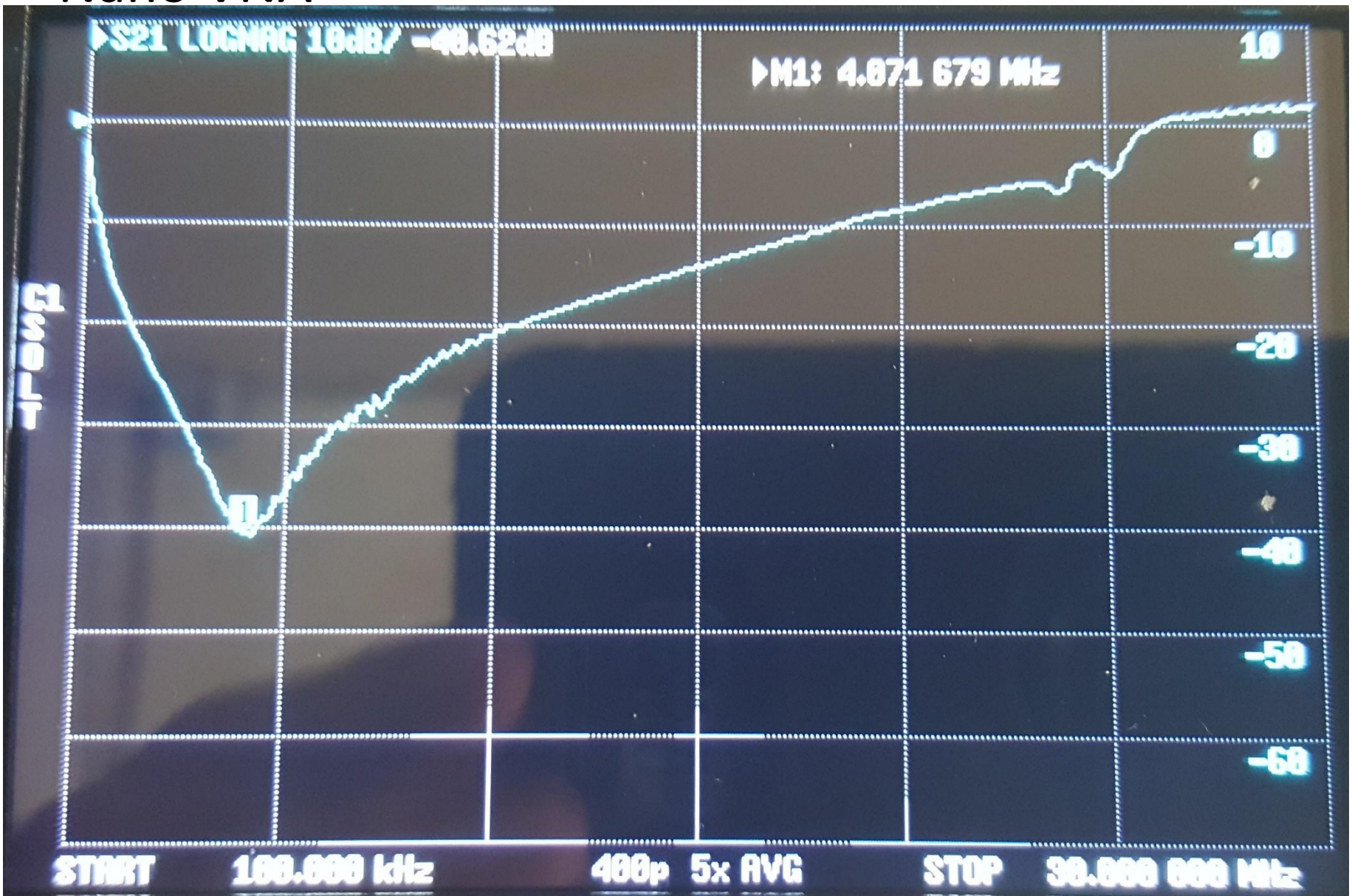
Coiled Coax Common Mode (CM) Choke Performance, 6 turns, 2 ferrites.

- A Nano VNA with Tacking Generator can be used to plot Common Mode frequency performance of chokes made with coiled coax and ferrites.



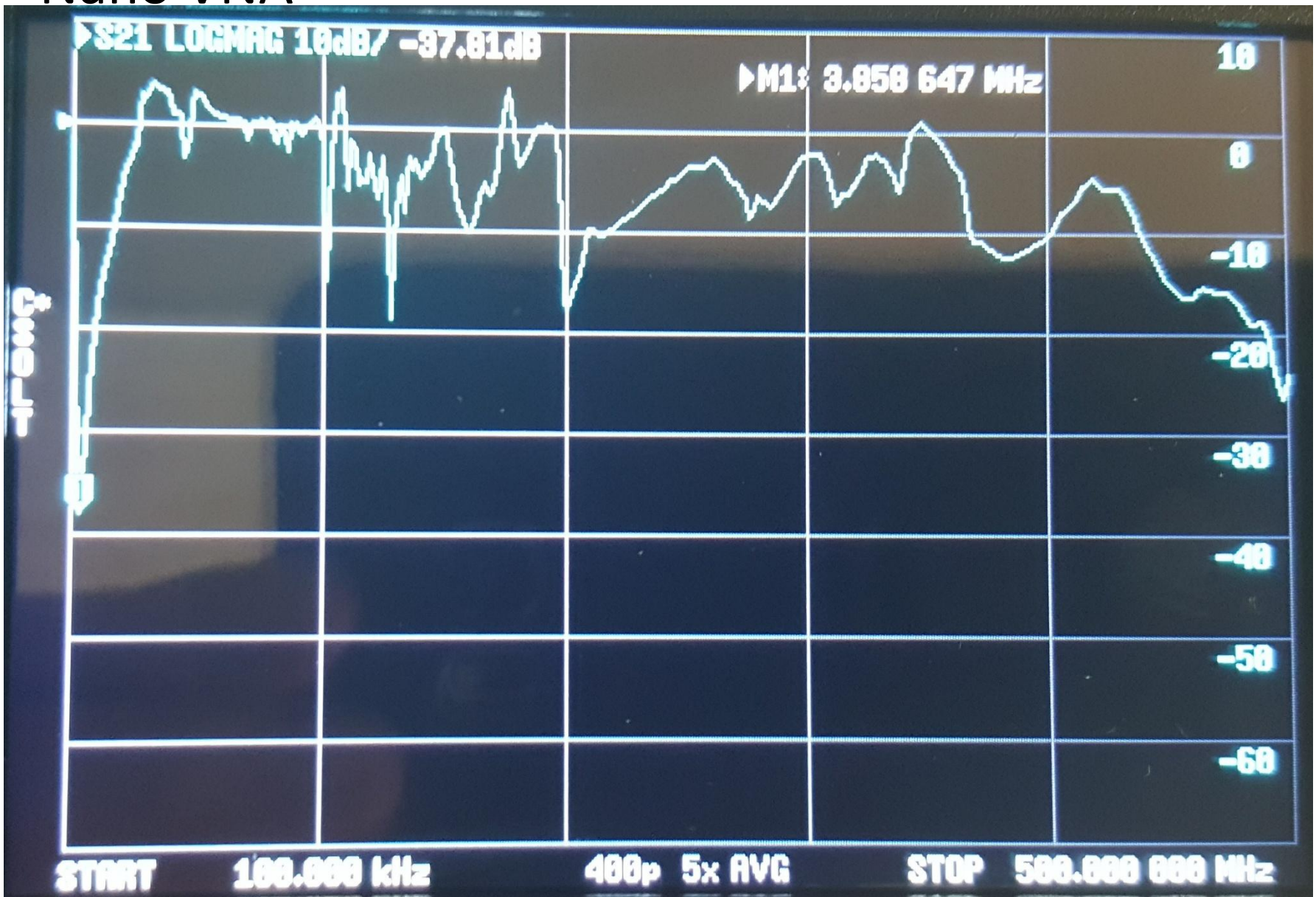
6 turns RG-400, 100KHz to 30MHz, with 2 type 31 clamp on ferrites, (PTFE) polytetrafluoroethylene (Teflon) dielectric

- Nano VNA



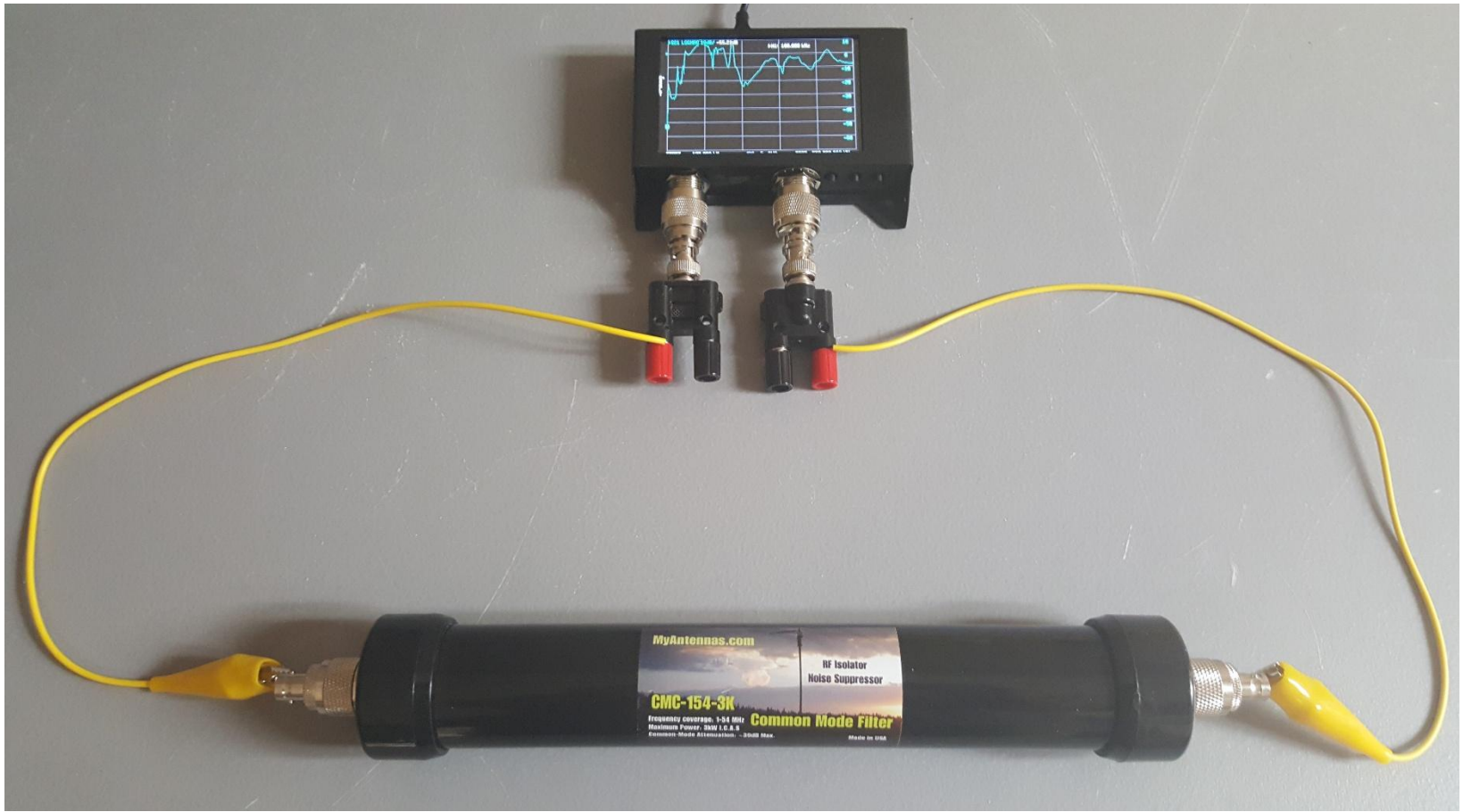
6 turns RG-400, 100KHz to 500MHz,
with 2 type 31 clamp on ferrites, (PTFE)
polytetrafluoroethylene (Teflon) dielectric

- Nano VNA



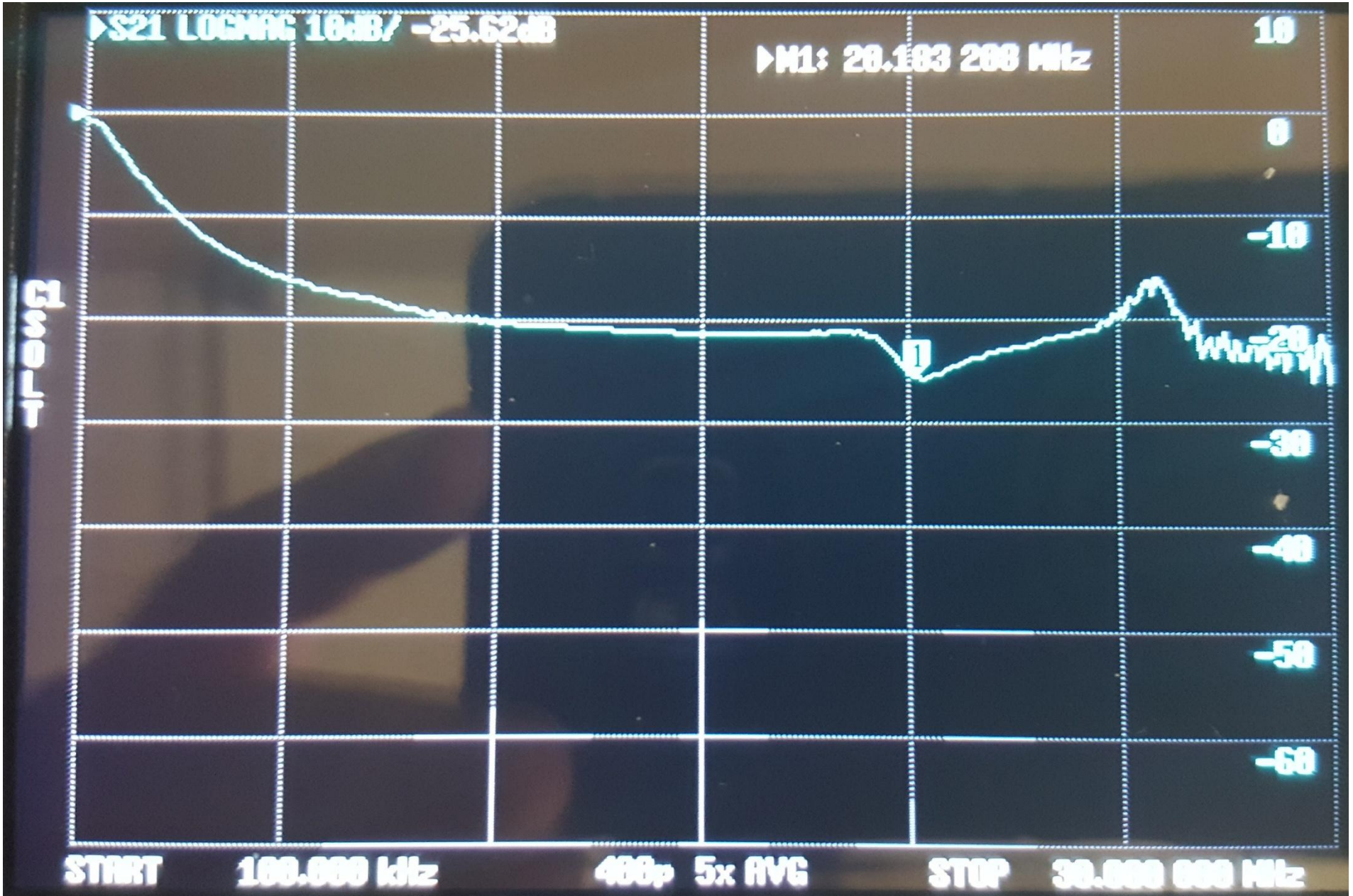
Commercial Common Mode (CM) Choke Performance, ferrites in tube.

- Rated 1MHz – 54MHz, 3KW
- For 1MHz -54MHz, up to -39 db common mode attenuation claimed.
- Nano VNA



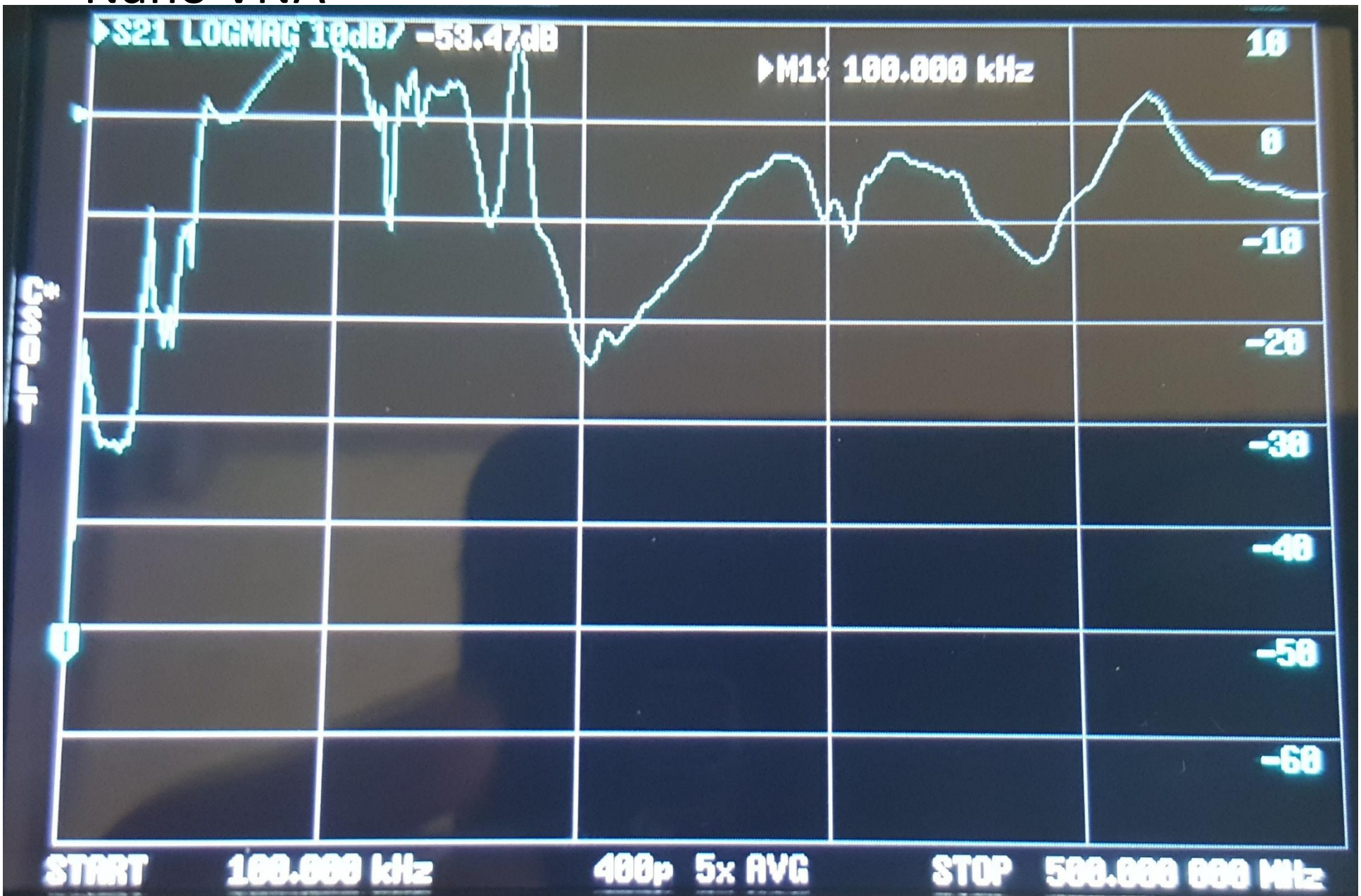
CMC-154-3K, 100KHz to 30MHz, made using type 31 ferrites in PVC tube

- Nano VNA



CMC-154-3K, 100KHz to 500MHz, made using type 31 ferrites in PVC tube

- Nano VNA

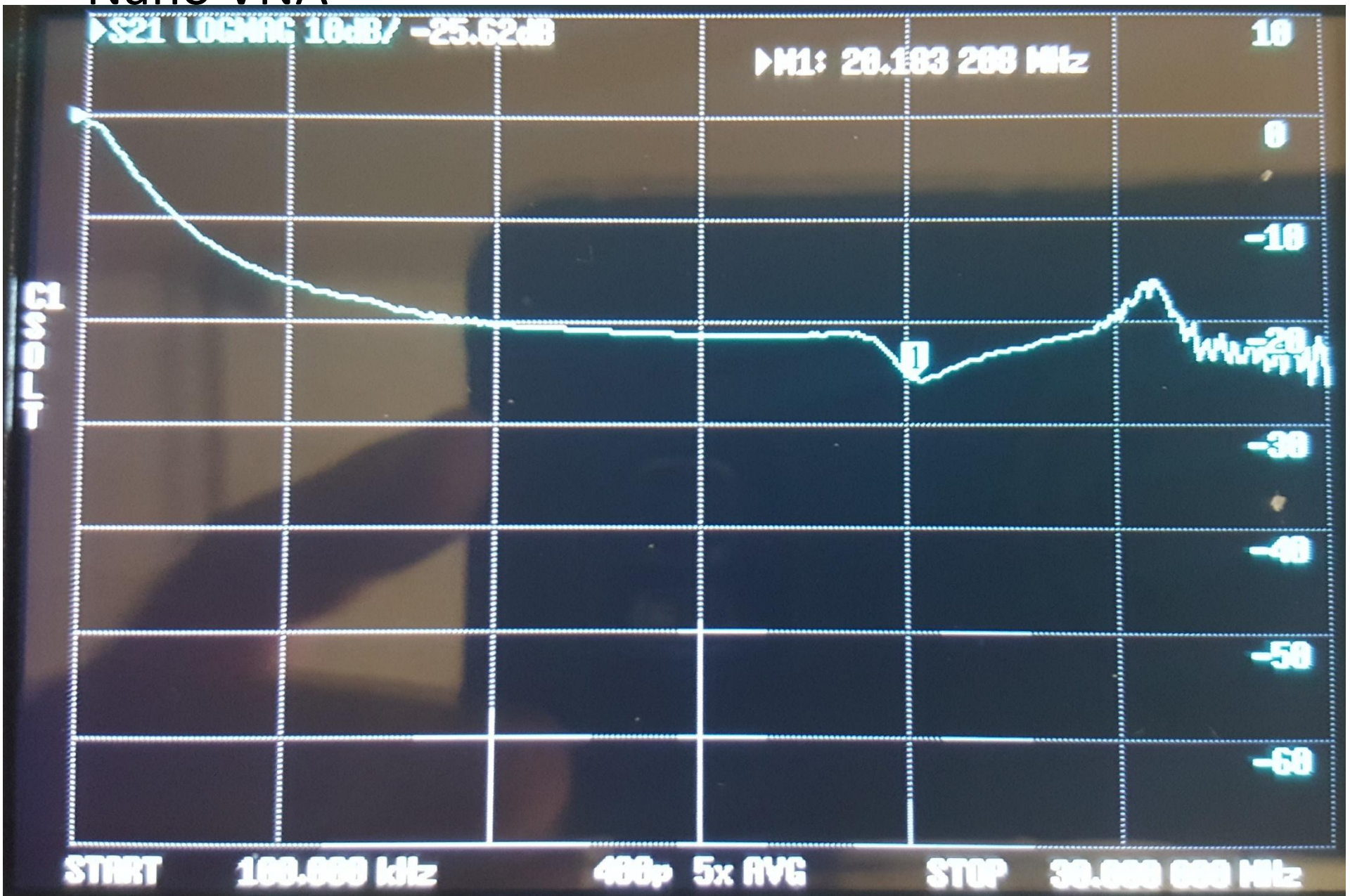


Commercial Common Mode (CM) Choke Performance, ferrites in tube.

- Rated 120MHz – 180MHz, 2KW
- For VHF frequencies, up to -37 db common mode attenuation claimed.
- Nano VNA

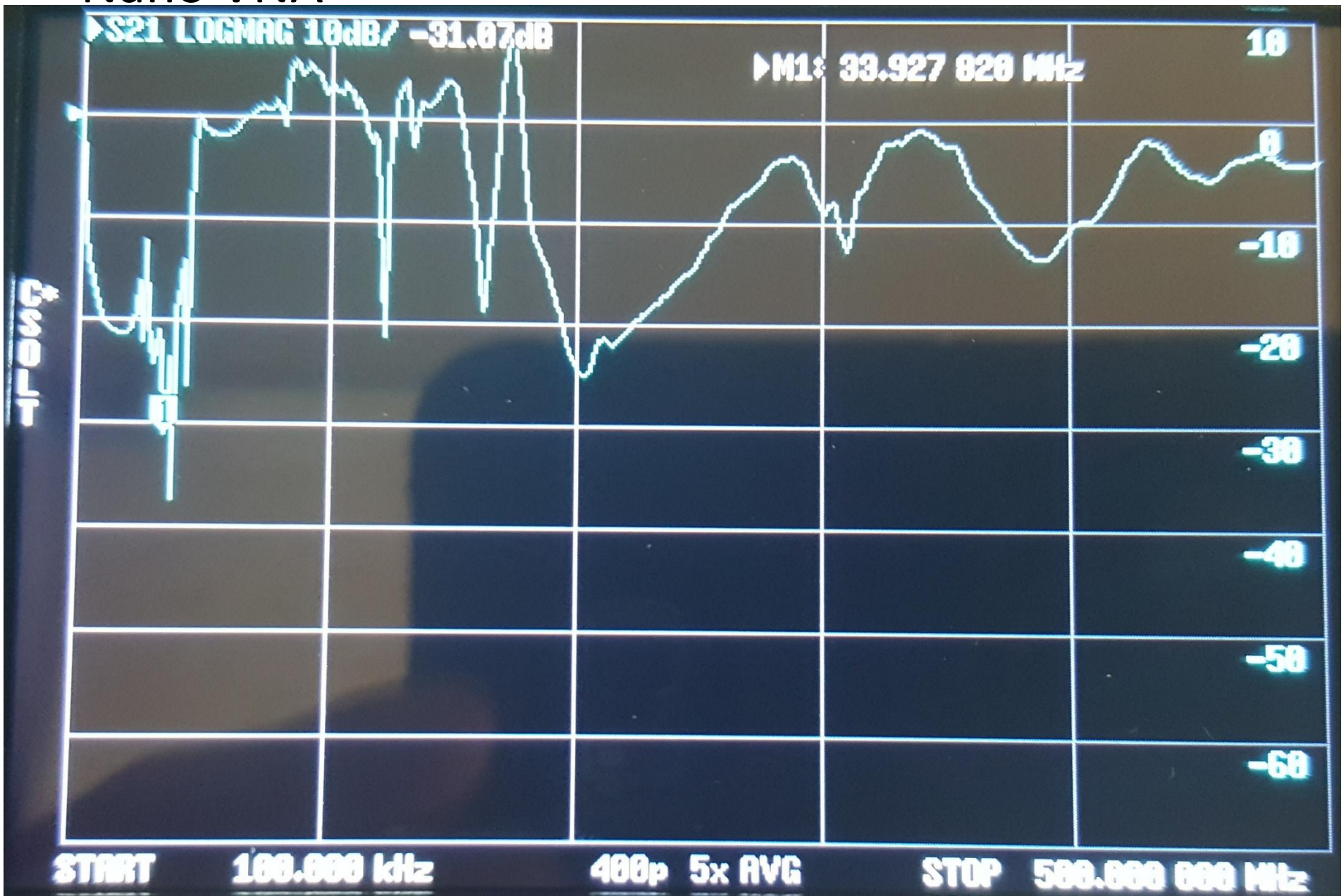
CMC-VHF-2K, 100KHz to 30MHz, made using ferrites in PVC tube

- Nano VNA



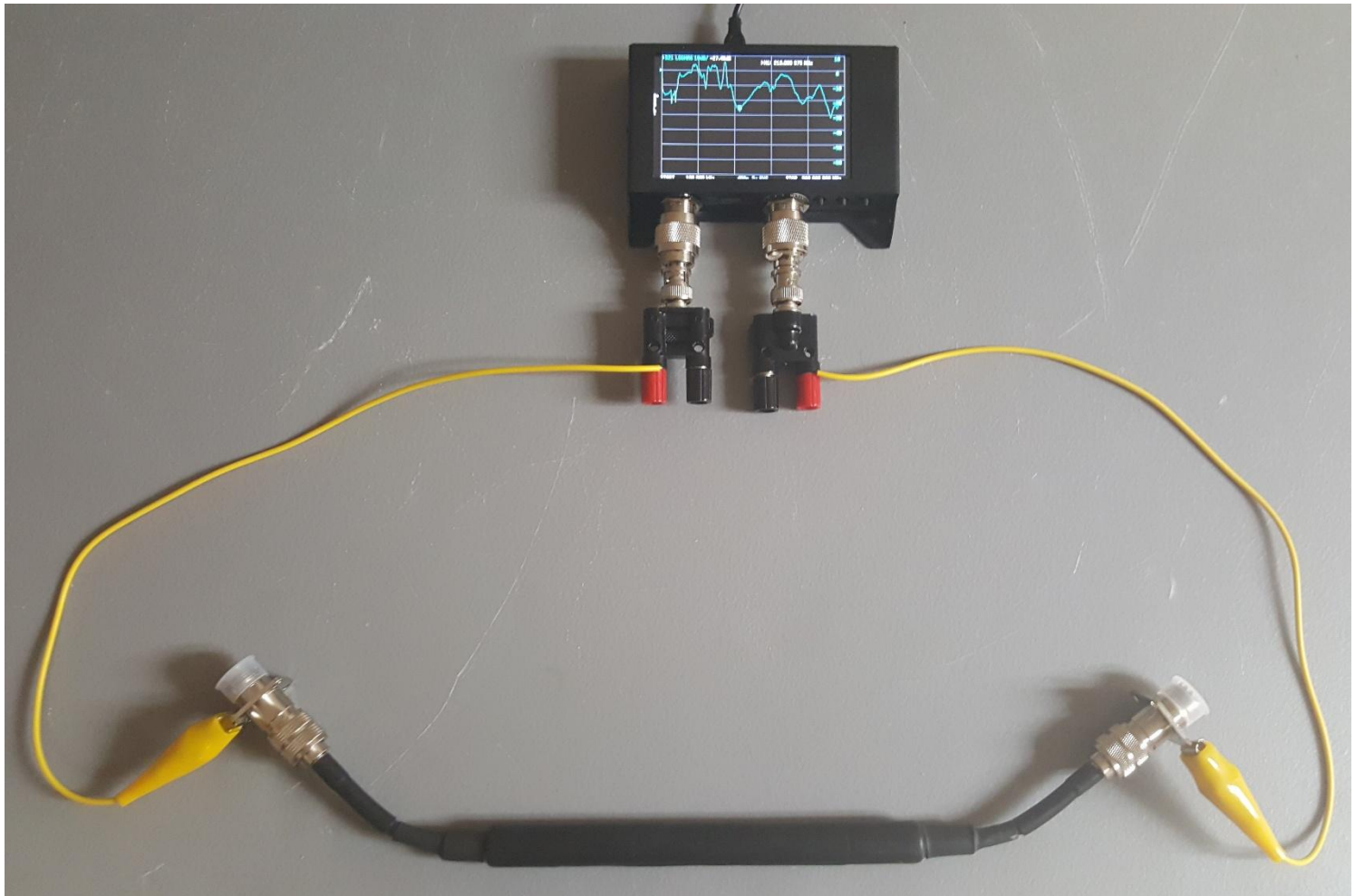
CMC-VHF-2K, 100KHz to 500MHz, made using ferrites in PVC tube

- Nano VNA



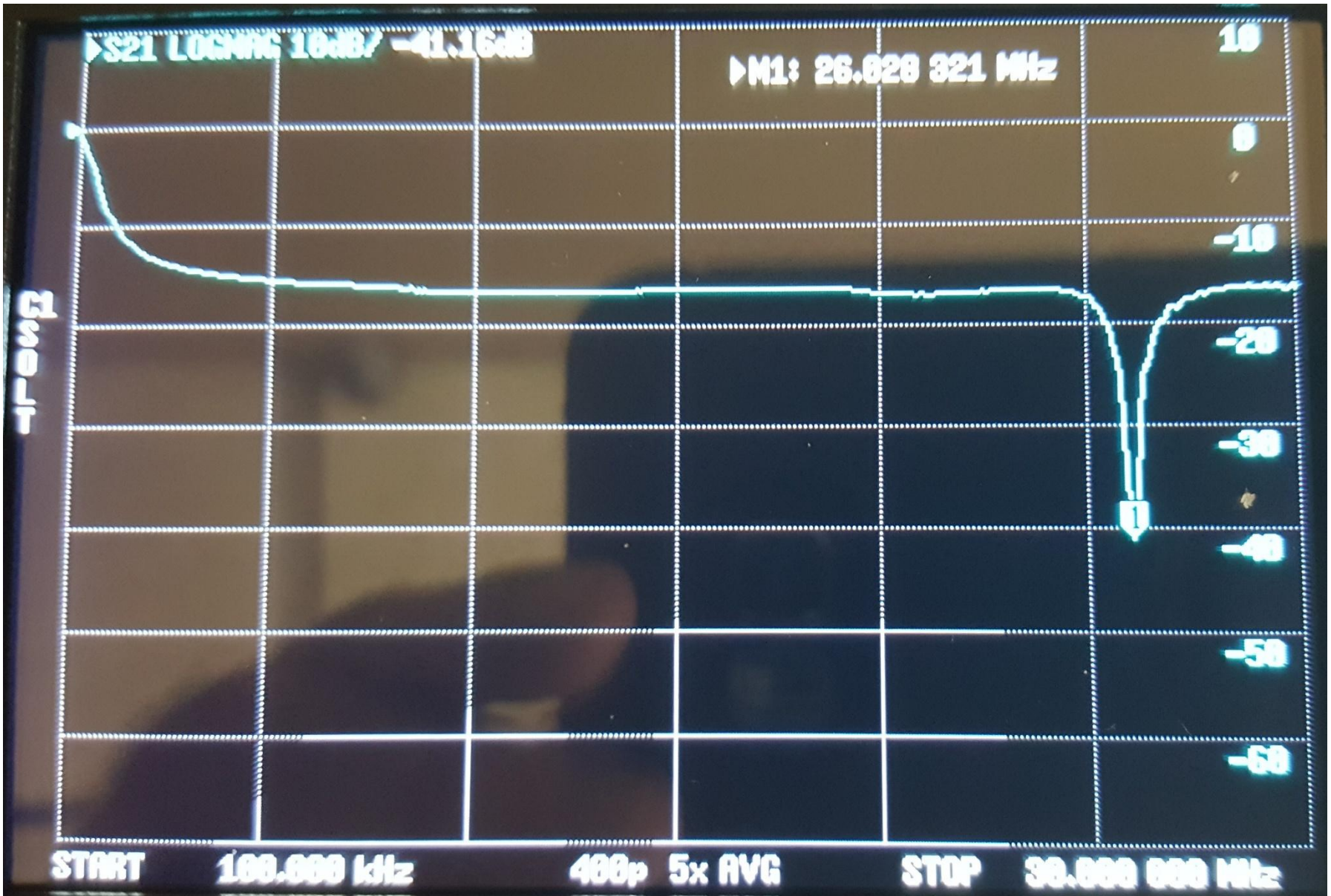
Coiled Coax Common Mode (CM) Choke Performance, 6 ring ferrites.

- A Nano VNA with Tacking Generator can be used to plot Common Mode frequency performance of chokes made with ferrites on coax.



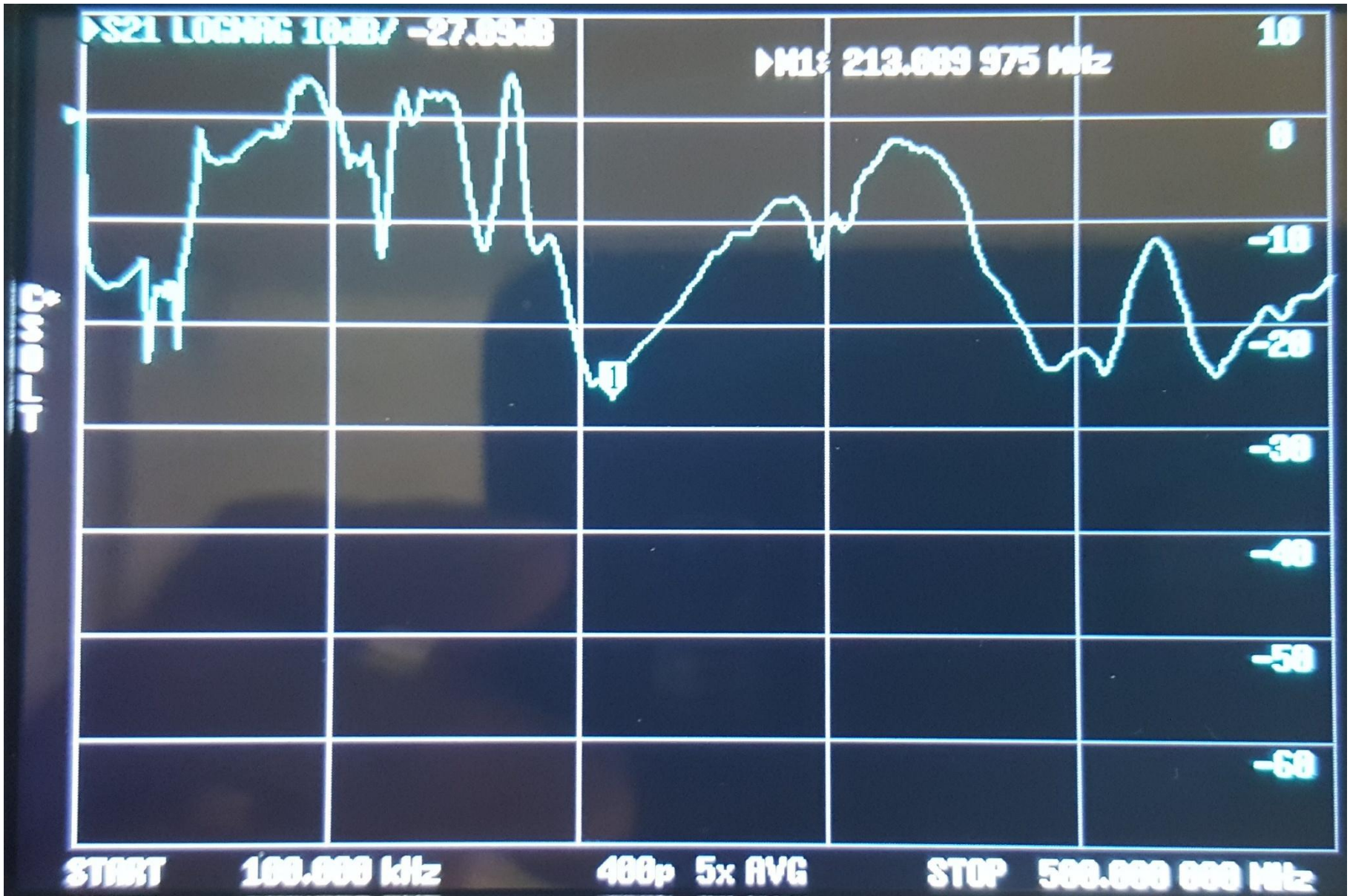
0 turns ABR-240 (LMR-240), 100KHz to 30MHz, with 6 type 31 ring ferrites, (GIFP) Closed cell gas-injected foam polyethylene dielectric

- Nano VNA



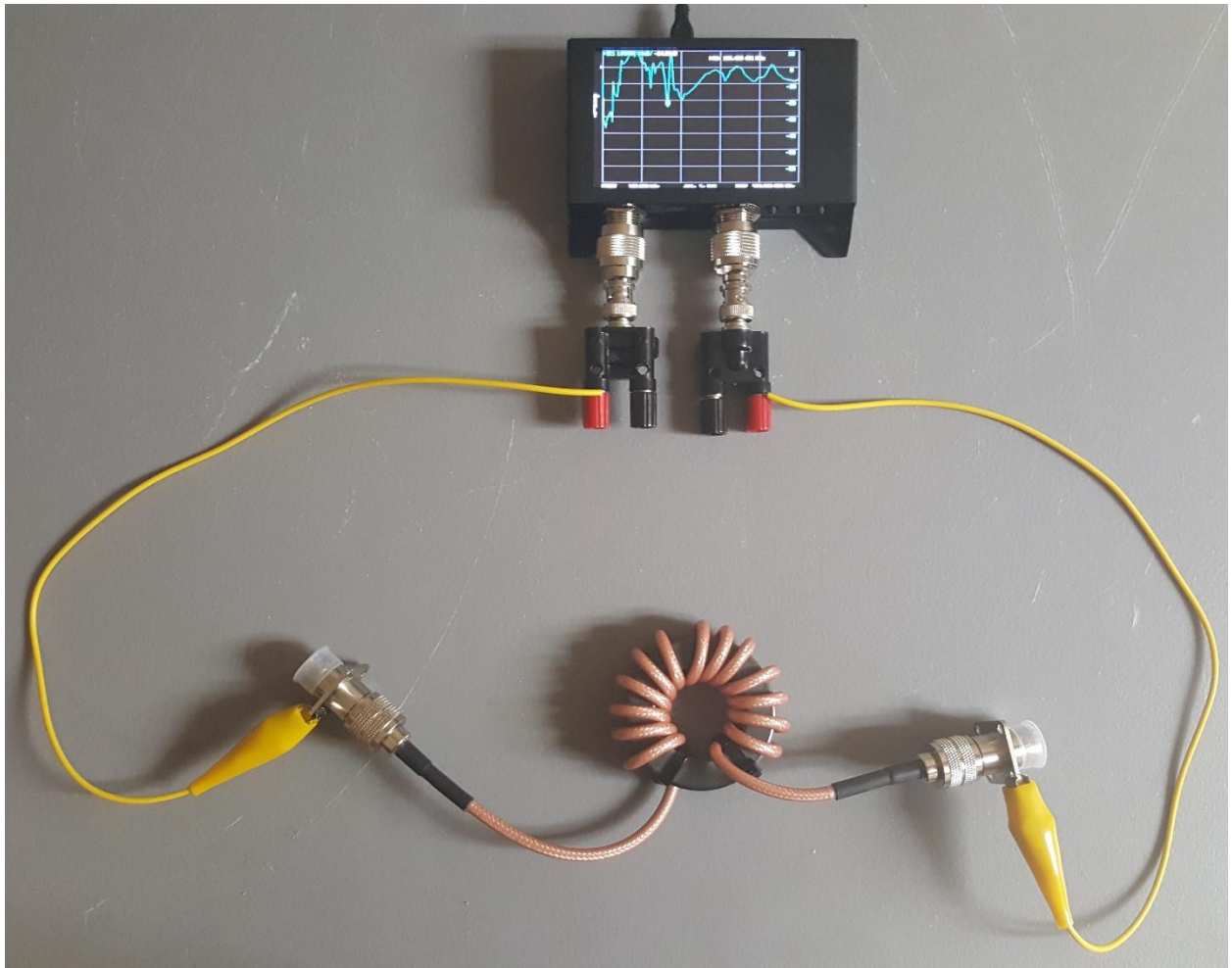
0 turns ABR-240 (LMR-240), 100KHz to 500MHz, with 6 type 31 ring ferrites, (GIFP) Closed cell gas-injected foam polyethylene dielectric

- Nano VNA



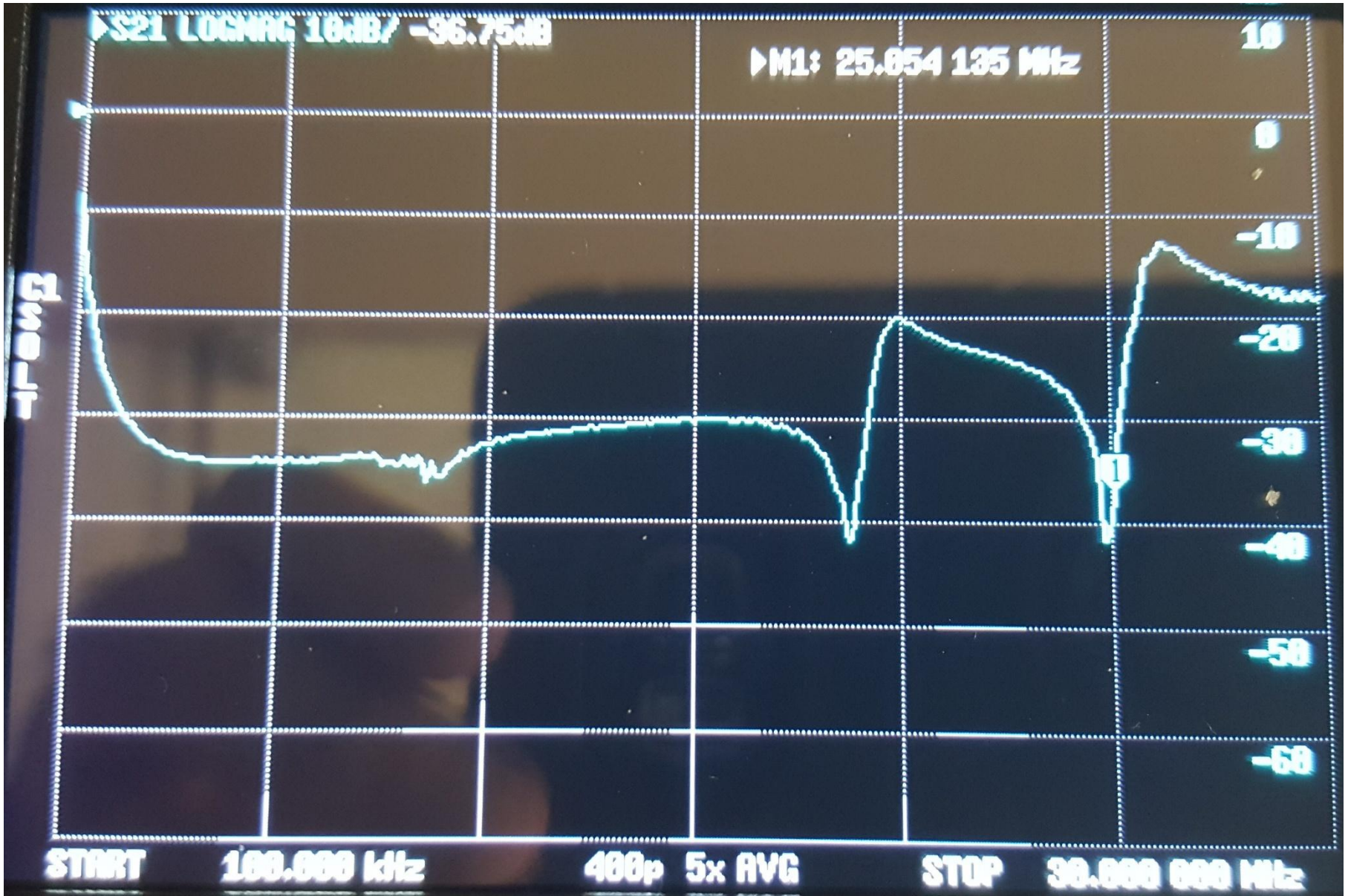
Coiled Coax Common Mode (CM) Choke Performance, 13 turns on ferrite.

- A Nano VNA with Tacking Generator can be used to plot Common Mode frequency performance of chokes made with coiled coax on a toroidal ferrite.



13 turns RG-400, 100KHz to 30MHz, on type 31 toroid ferrite, (PTFE) polytetrafluoroethylene (Teflon) dielectric

- Nano VNA



13 turns RG-400, 100KHz to 500MHz,
on type 31 toroid ferrite, (PTFE)
polytetrafluoroethylene (Teflon) dielectric

- Nano VNA