

Common Mode Chokes and Baluns

Actual Measurements

Mar 2021
9V1KG

Common Mode Chokes and Baluns

- Common mode choke (CMC) = 1:1 Balun
 - 50 Ohm in – 50 Ohm out
 - Balun stands for balanced-unbalanced
 - Unun stands for unbalanced-unbalanced
 - CMC to reduce current on coax shield of coaxial cable
 - CMC to reduce pick-up of noise on coax shield due to imbalances when receiving

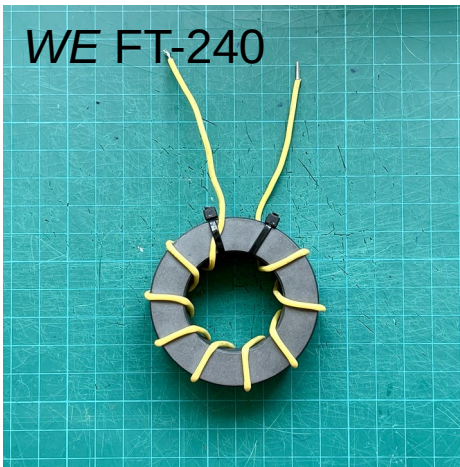
Common Mode Chokes and Baluns

- RF Transformer
 - 50 Ohm in – x Ohm out: to match coax cable to antenna impedance
 - Often: 1:2 (50/100), 1:4 (50/200), 1:9 (50/450), 1:49 (50/2450) for different types of antennas
 - Can be balun (balanced feedline) or unun (endfed)
- Transformer with limited frequency range can be realized by transmission line segments
 - I use a 4:1 transformer (2 RG58 parallel) for my short lin. loaded dipole for 18 and 21 Mhz
- Wideband HF coverage using ferrite cores
 - 1.8 MHz (160 m) to 30 MHz (10 m)

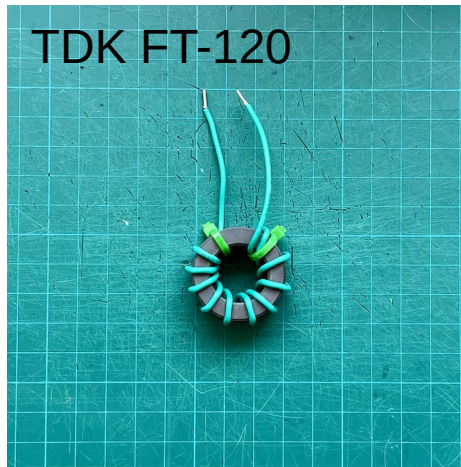
RS FT-140



WE FT-240



TDK FT-120



2 TDK, stacked



DG0SA



WE 1:9

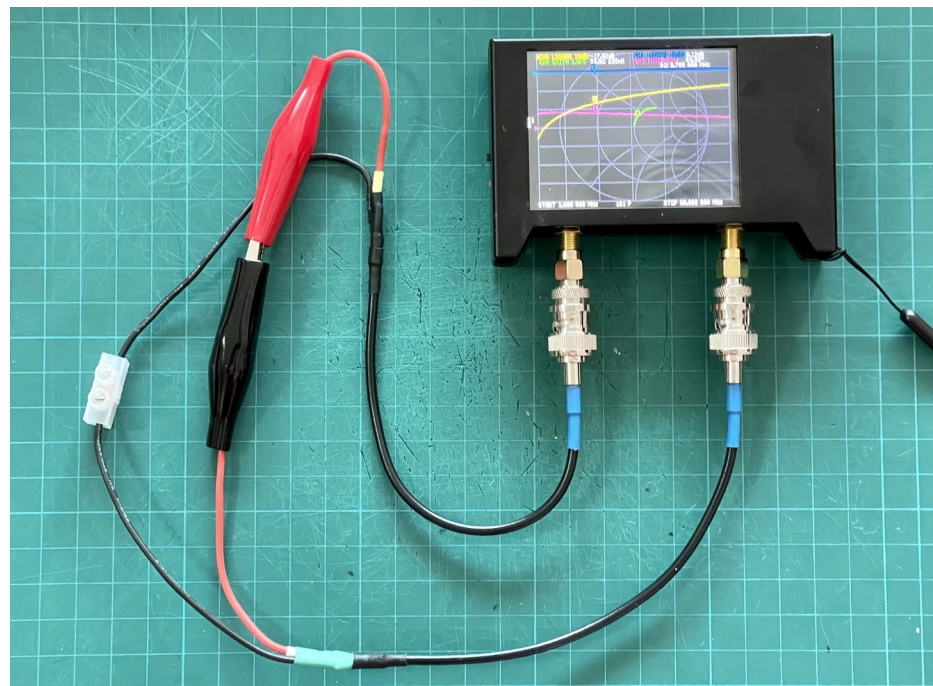


MPAS "Hybrid Micro" 1:5



Measurements

- Nano VNA V2 SAA2
- 201 instead of 101 points, max. 1021 points via USB
- 1 MHz – 30 MHz: 56 kHz/step
- 70 dB dynamic range
- No precise measurement, but sufficient for our purpose
- SW: NanoVNA-saver on Linux/macOS



Measurements

- Common mode chokes
 - C.M. Rejection:
Min.: 20 dB
Target: > 30 dB
- Balun/Unun
 - VSWR:
Max. : 1.5
Target: < 1.3
 - Loss:
tbd.

Sweep control

Start Center
 Stop Span
 Segments 58.00kHz/step

Markers

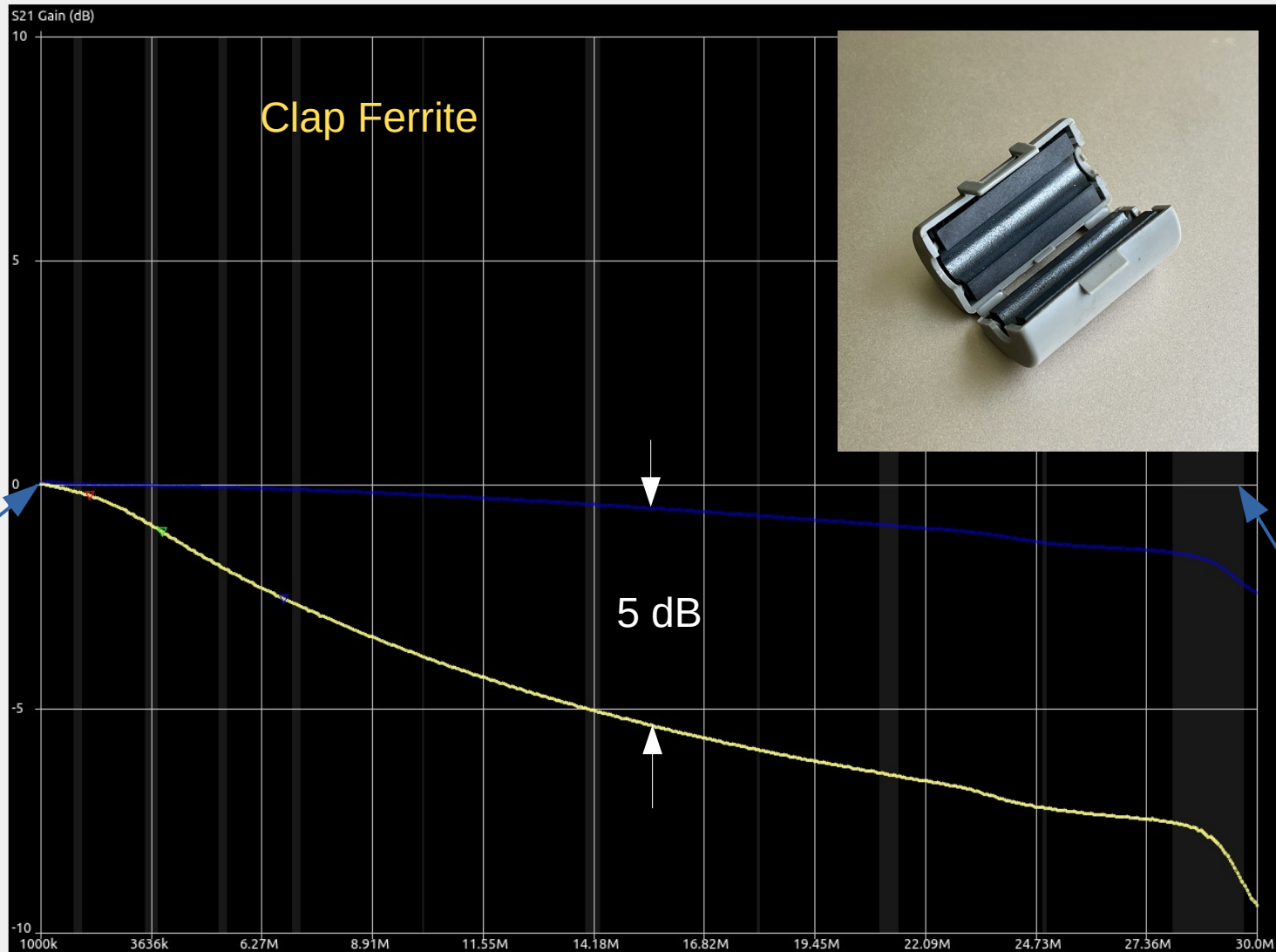
Marker 1 ☒
 Marker 2 ☐
 Marker 3 ☐
☐ Enable Delta Marker
 ☐ Locked

TDR

Estimated cable length: 0.625 m

Reference sweep

Serial port control



- RS Components
 - PN 136-9032
 - 36 x 22 x 16 (FT-140)
 - Material K4000
 - AL 5350 nH
 - Measurement: 8 turn



Sweep control

Start 1000khz Center 15.5MHz
Stop 30MHz Span 29MHz
Segments 1 28.43kHz/step

Sweep settings ...

100%

Sweep

Stop

Markers

Marker 1 1.85293MHz ☒
Marker 2 3.587221MHz ☐
Marker 3 7.112665MHz ☐

☐ Enable Delta MarkerShow data Locked ☐

TDR

Estimated cable length: 0.212 m

Time Domain Reflectometry ...

1 MHz

Reference sweep

Set current as reference

Reset reference

Serial port control

/ttyACM0 (S-A-A-2) v

Rescan

Disconnect

Manage

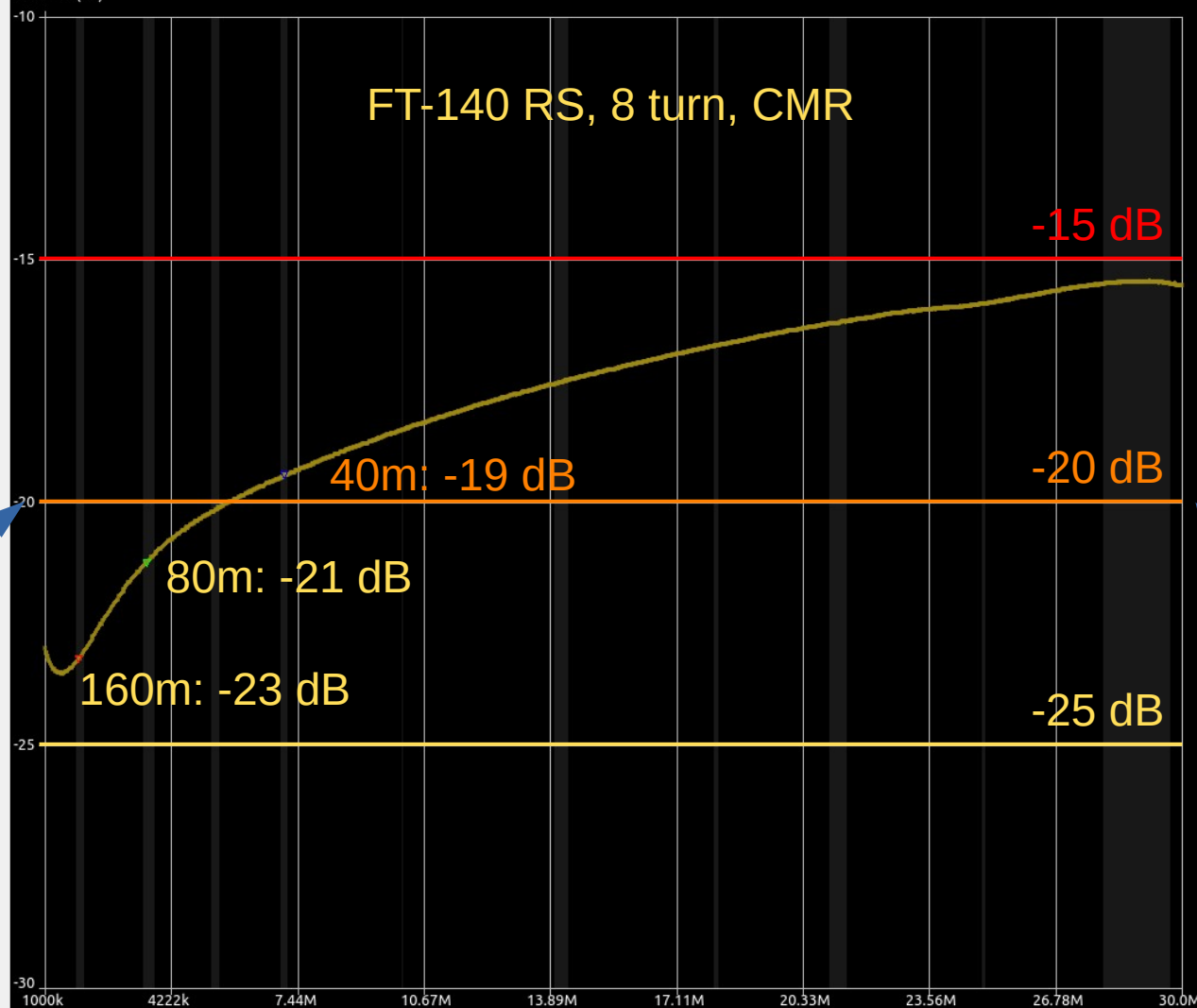
Files ...

Calibration ...

Display setup ...

About ...

S21 Gain (dB)



-15 dB

40m: -19 dB

-20 dB

80m: -21 dB

160m: -23 dB

-25 dB

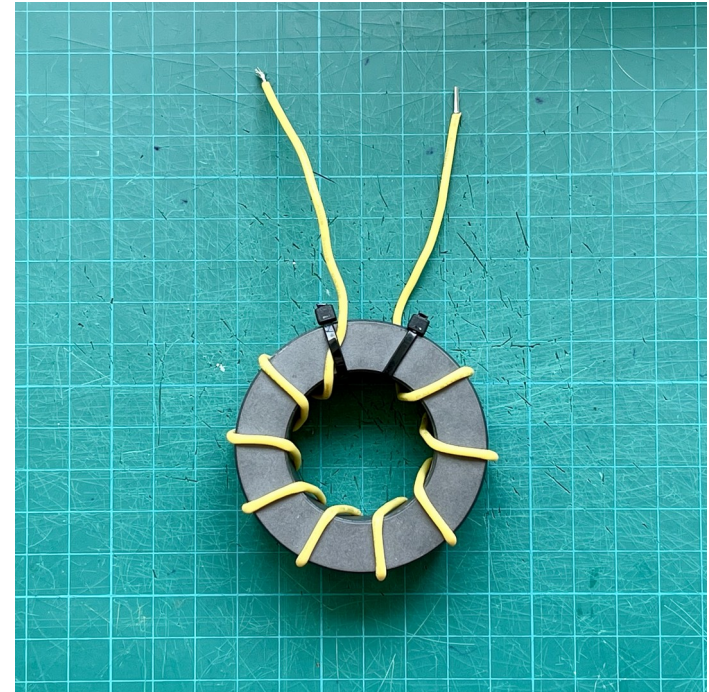
30 MHz

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- Result
 - Best rejection around 1 MHz
 - Not suitable above 7 MHz
 - Does not reach -30 dB



- Wurth Elektronik *WE*
 - PN 74270191
 - 61 x 35 x 20 (FT-240)
 - Material 4W620
 - Measurement: 9 turn



Sweep control

Start 1000khz Center 15.5MHz
Stop 30MHz Span 29MHz
Segments 1 28.43kHz/step

Sweep settings ...

100%

Sweep

Stop

Markers

Marker 1 1.854664MHz ☒ ☒
Marker 2 3.593462MHz ☒ ☐
Marker 3 7.10053MHz ☒ ☐

☐ Enable Delta Marker

Show data

Locked ☐

TDR

Estimated cable length: 0.212 m

Time Domain Reflectometry ...

1 MHz

Reference sweep

Set current as reference

Reset reference

Serial port control

/ttyACM0 (S-A-A-2) v

Rescan

Disconnect

Manage

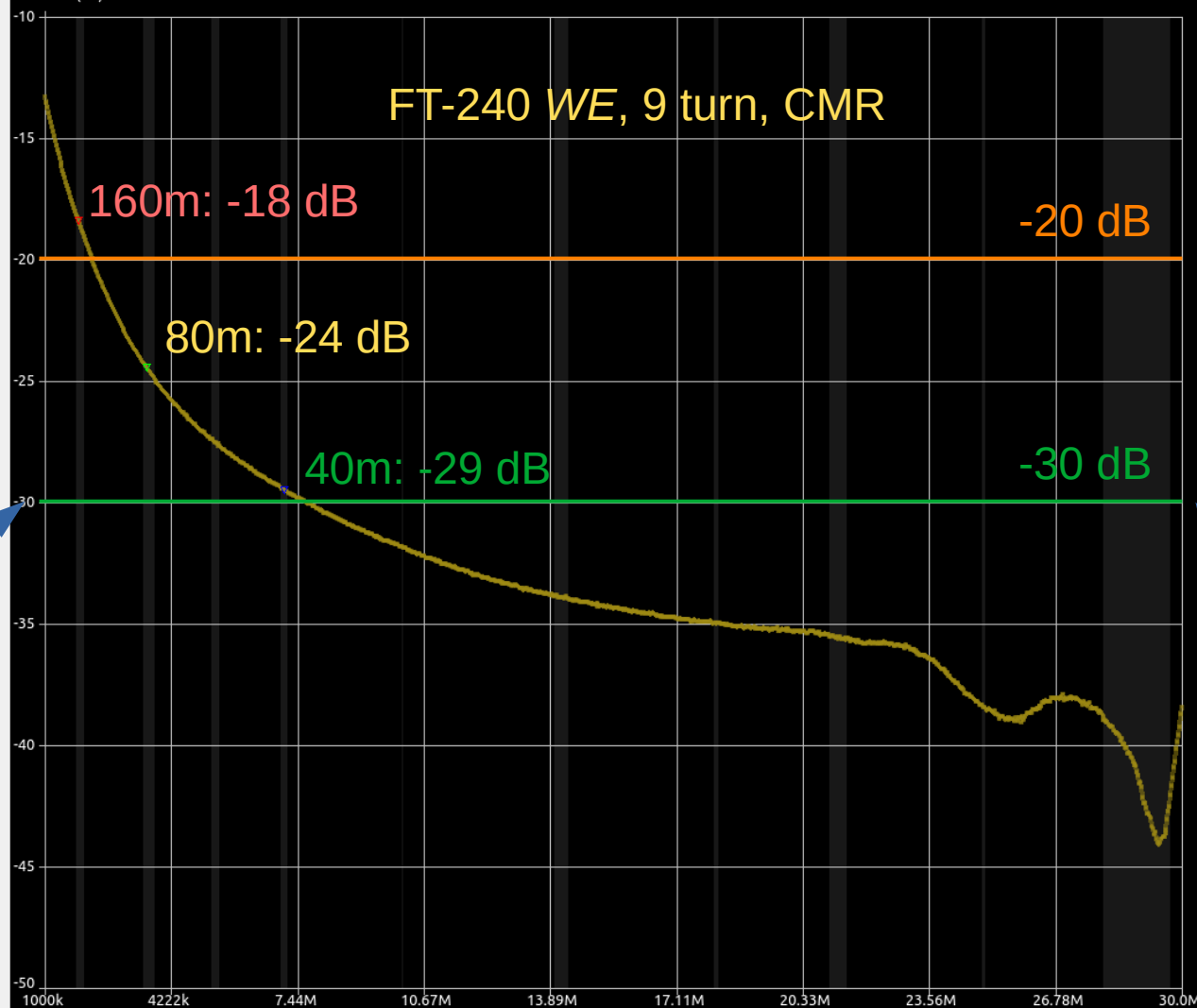
Files ...

Calibration ...

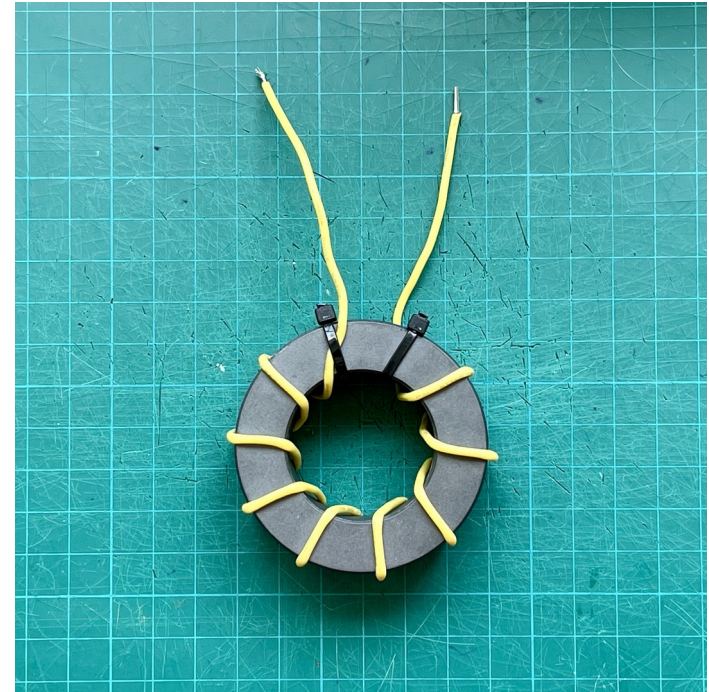
Display setup ...

About ...

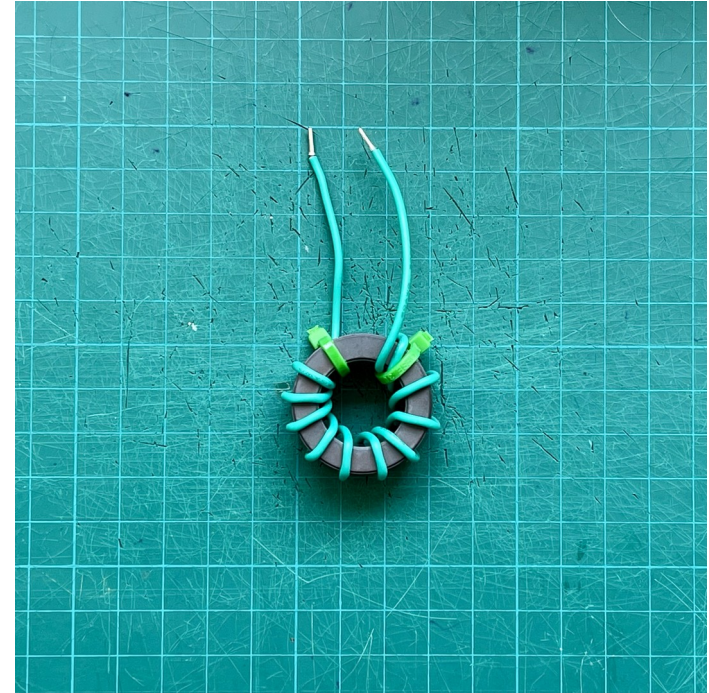
S21 Gain (dB)



- Result
 - 30 dB @ 7 MHz and above
 - Ok (24 dB) for 80 m
 - Suitable for HF 80 m to 10 m
 - Suitable for HF baluns and transformer?



- TDK
 - PN 136-9032
 - 31 x 19 x 13 (FT-140)
 - Material HF70
 - Measurement: 9 turn



Sweep control

Start 500kHz Center 15.25MHz
Stop 30MHz Span 29.5MHz
Segments 1 28.92kHz/step

Sweep settings ...

100%

Sweep

Stop

Markers

Marker 1 1.80149MHz ☒
Marker 2 3.652498MHz ☐
Marker 3 5.329974MHz ☐

☐ Enable Delta Marker

Show data

Locked ☐

TDR

Estimated cable length: 0.209 m

Time Domain Reflectometry ...

0.5 MHz

Reference sweep

Set current as reference

Reset reference

Serial port control

ttyACM0 (S-A-A-2) v

Rescan

Disconnect

Manage

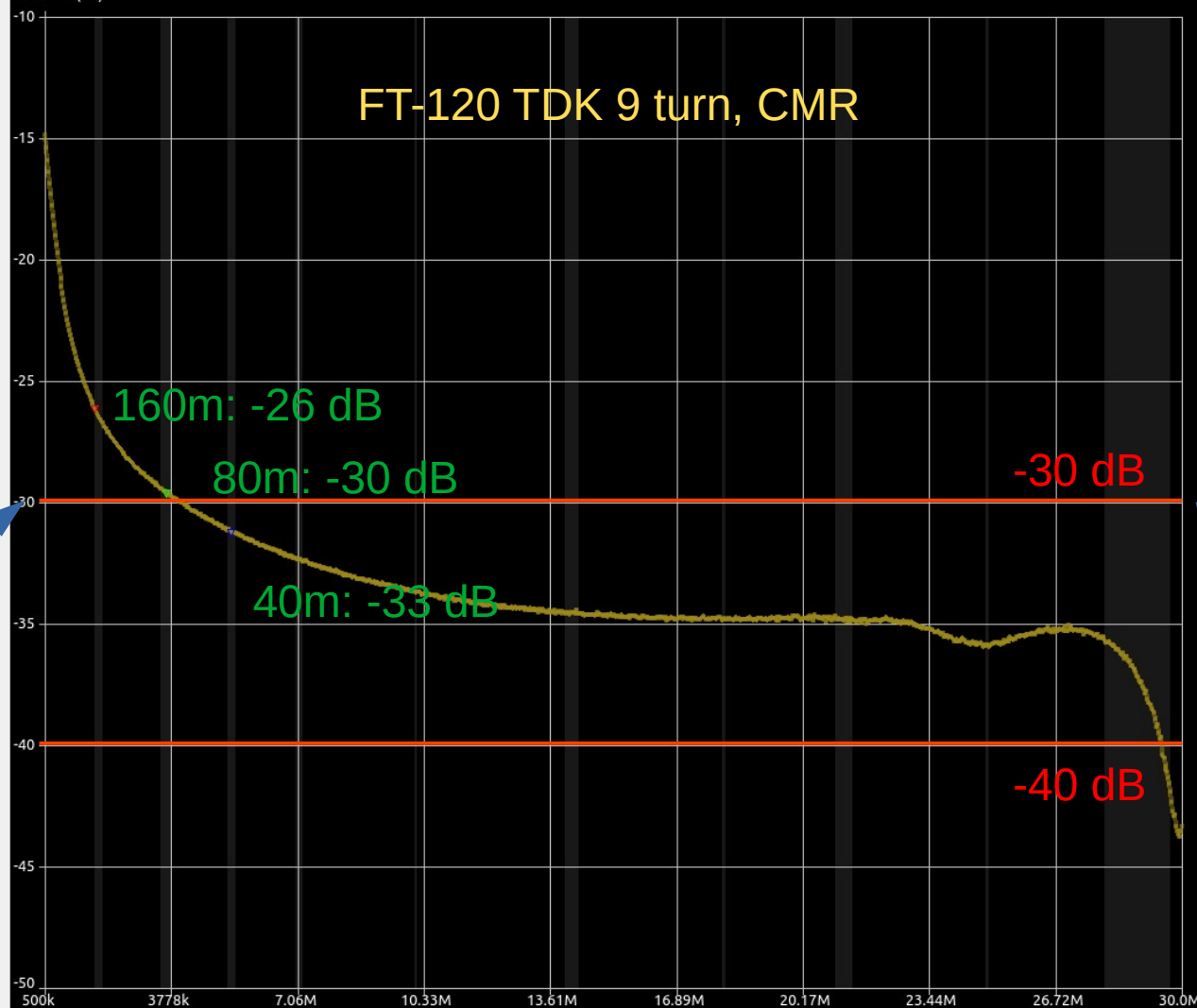
Files ...

Calibration ...

Display setup ...

About ...

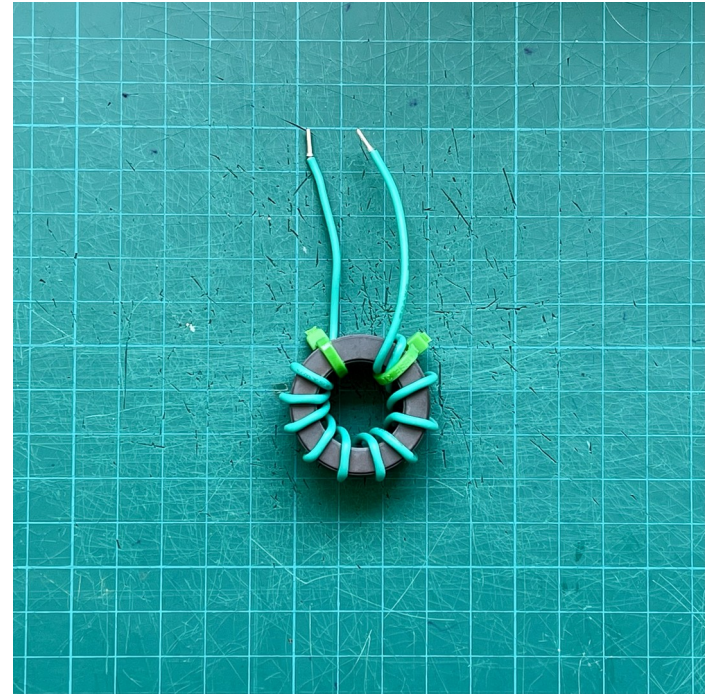
S21 Gain (dB)



30 MHz

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- Result
 - More than 30 dB from 3.5 MHz to 30 MHz
 - 26 dB on 160 m
 - Seems to be the ideal material for common mode rejection chokes



Sweep control

Start Center
 Stop Span
 Segments 28.43kHz/step

Markers

Marker 1 ☐
 Marker 2 ☐
 Marker 3 ☒
☐ Enable Delta Marker
 ☐ Locked

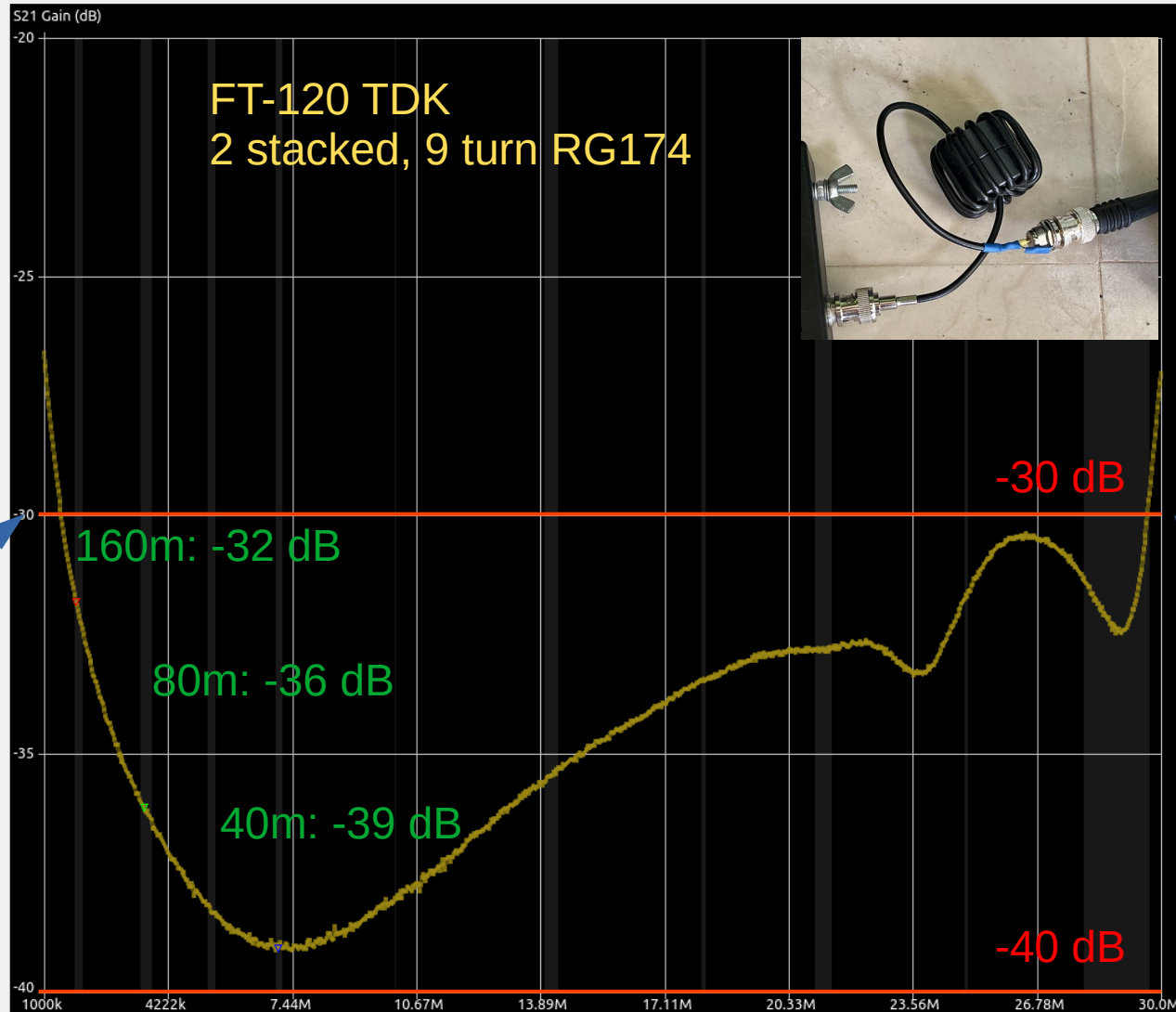
TDR

Estimated cable length: 0.212 m

1 MHz

Reference sweep

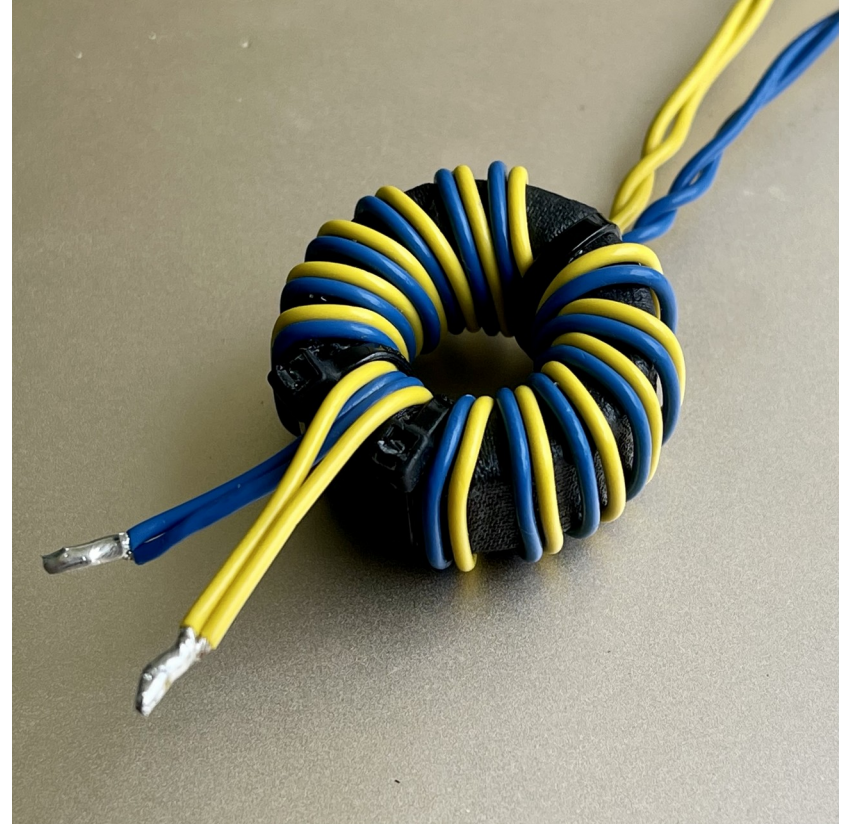
Serial port control



30 MHz

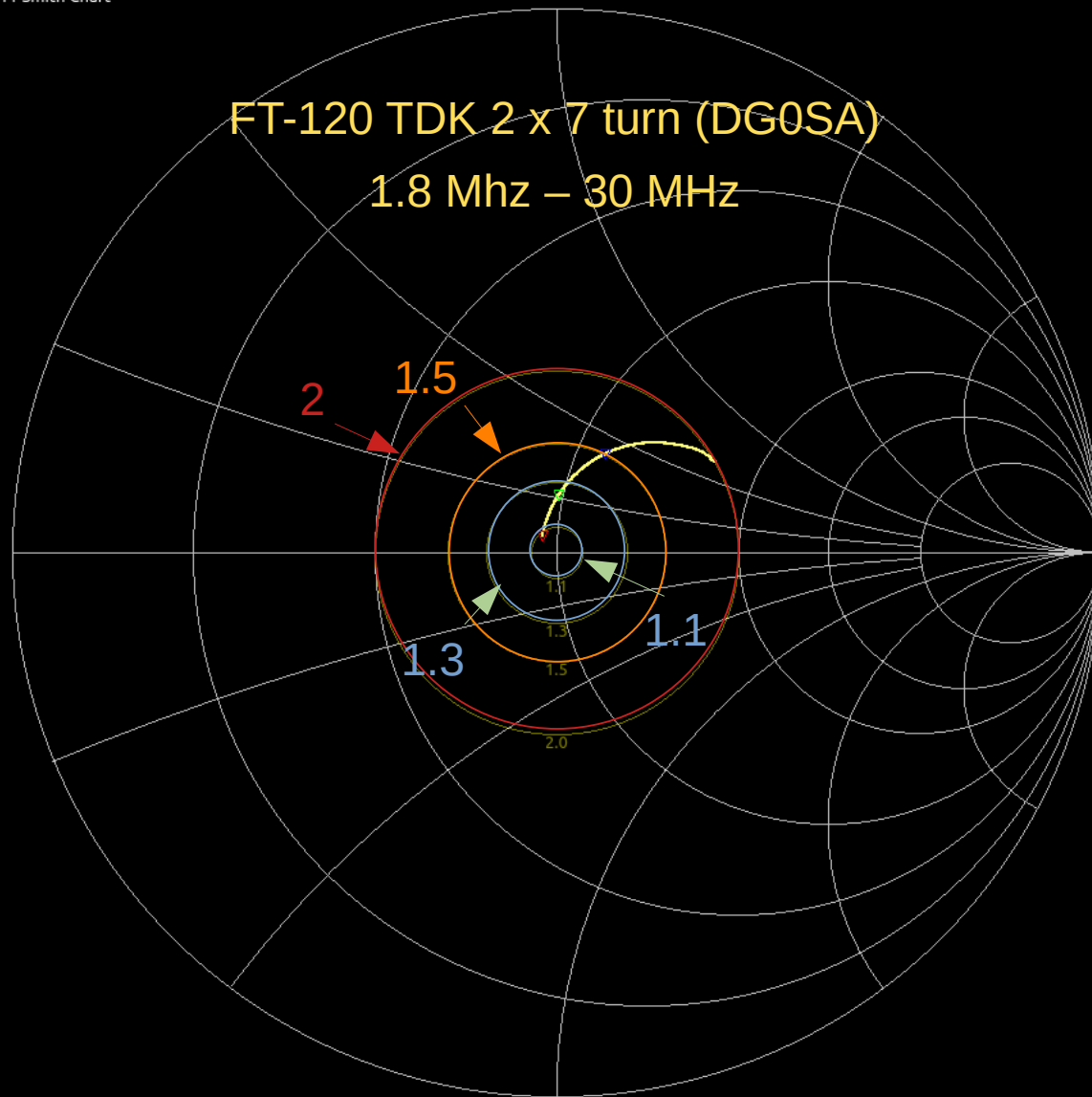
9V1KG

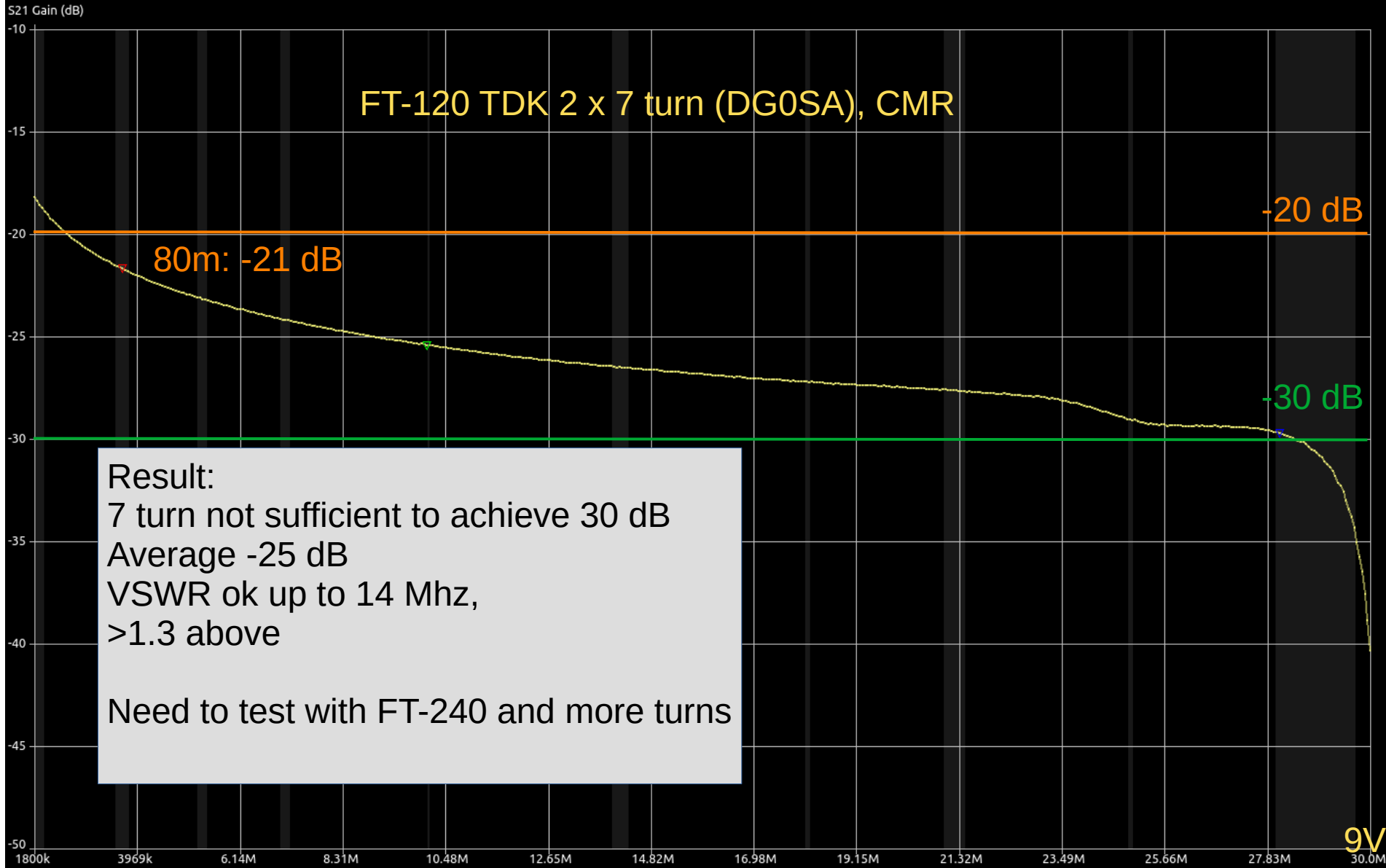
- Design DG0SA
 - 2 x n turn 100 Ohm connected in parallel
 - FT-120 only 2 x 7 turn possible



FT-120 TDK 2 x 7 turn (DG0SA)

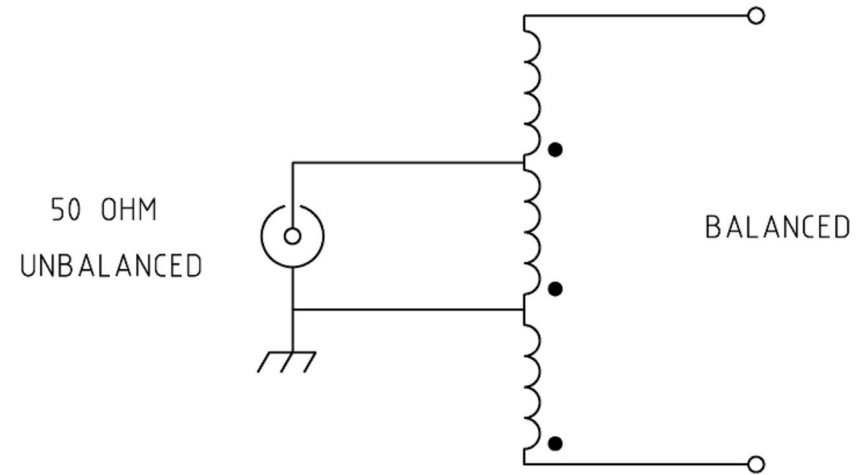
1.8 Mhz – 30 MHz



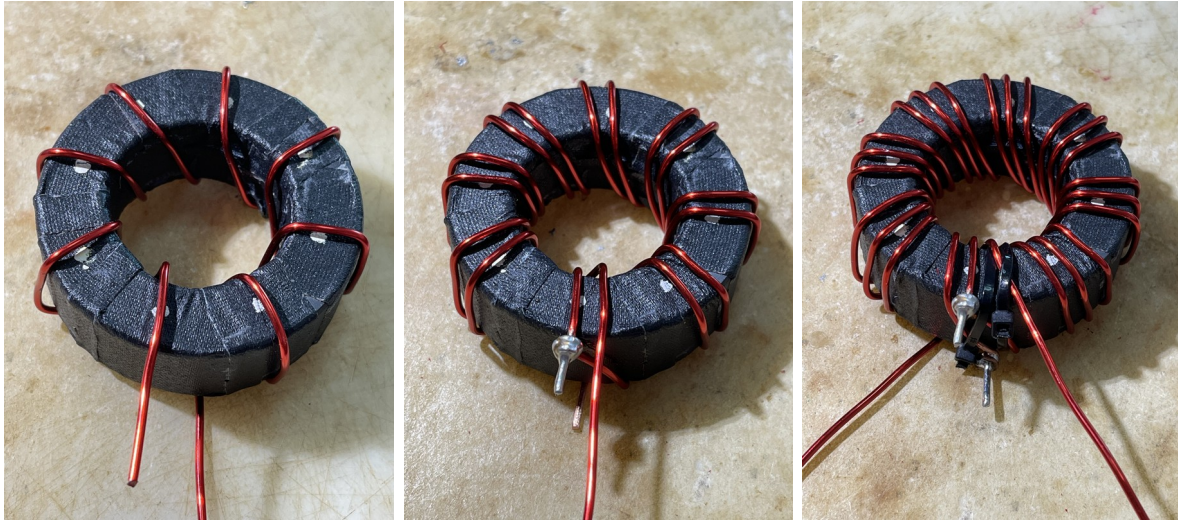


Transformer

- 1:9 Balun
- Trifilar 1.5 mm Cu on FT-240
- Ferrite *WE* 4W620

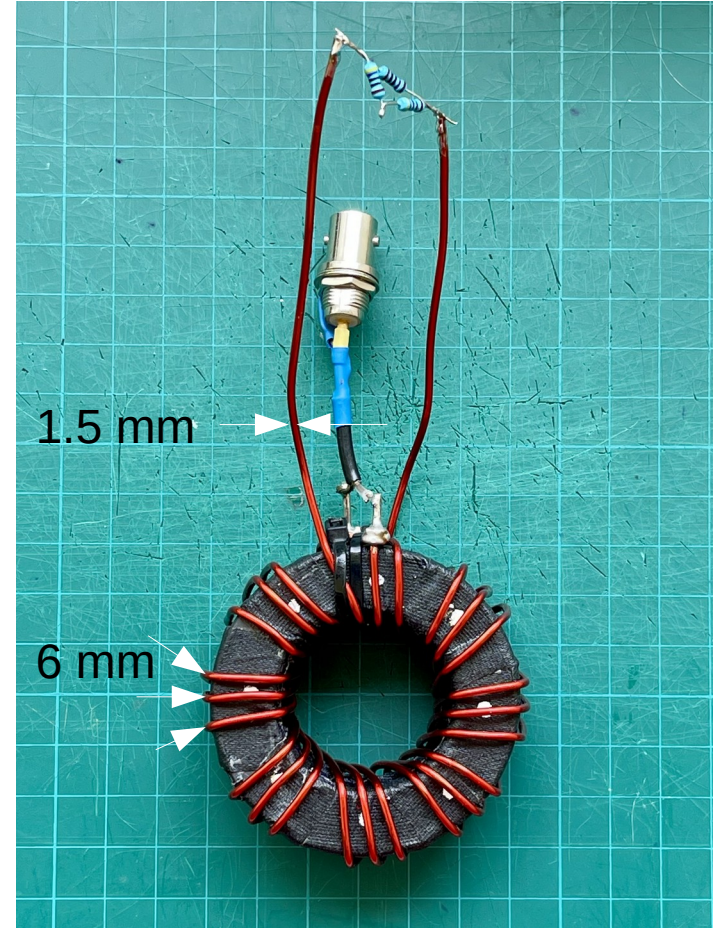


Transformer 1:9

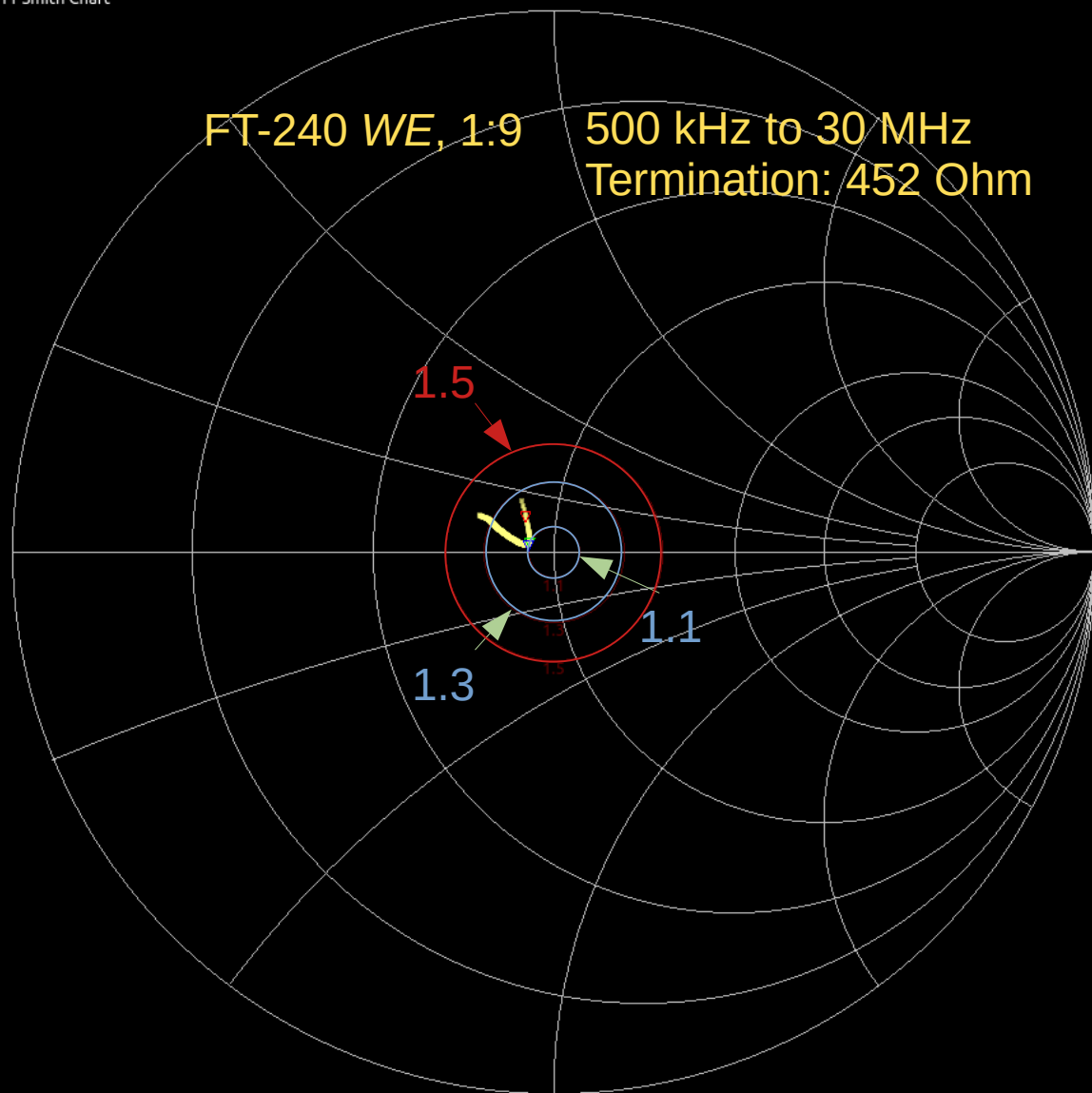


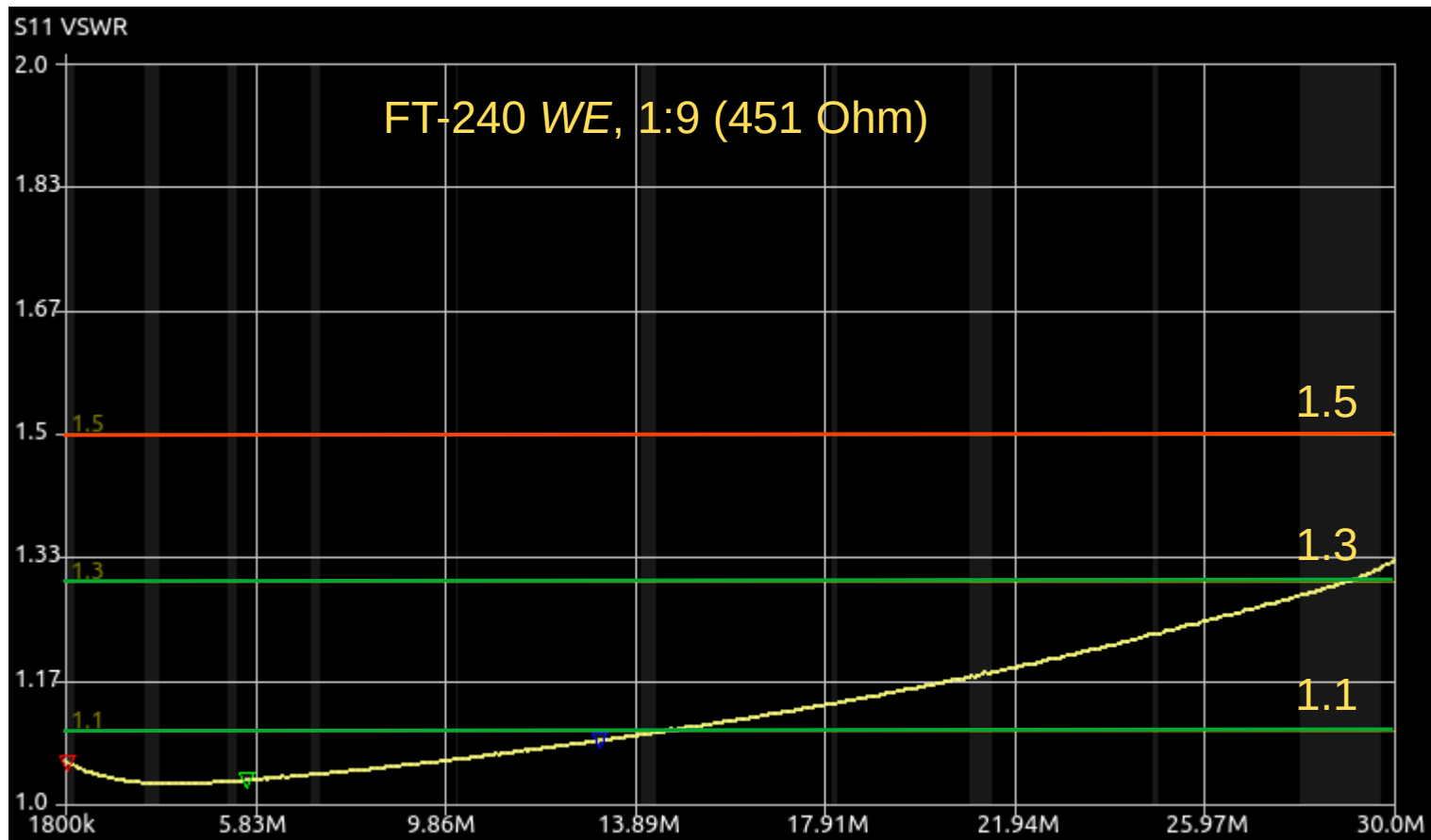
1.5 mm Cu wire trifilar 8 turns on *WE* core
Should work with high power (800 W)

Can be used for “random wire length” antenna



FT-240 WE, 1:9

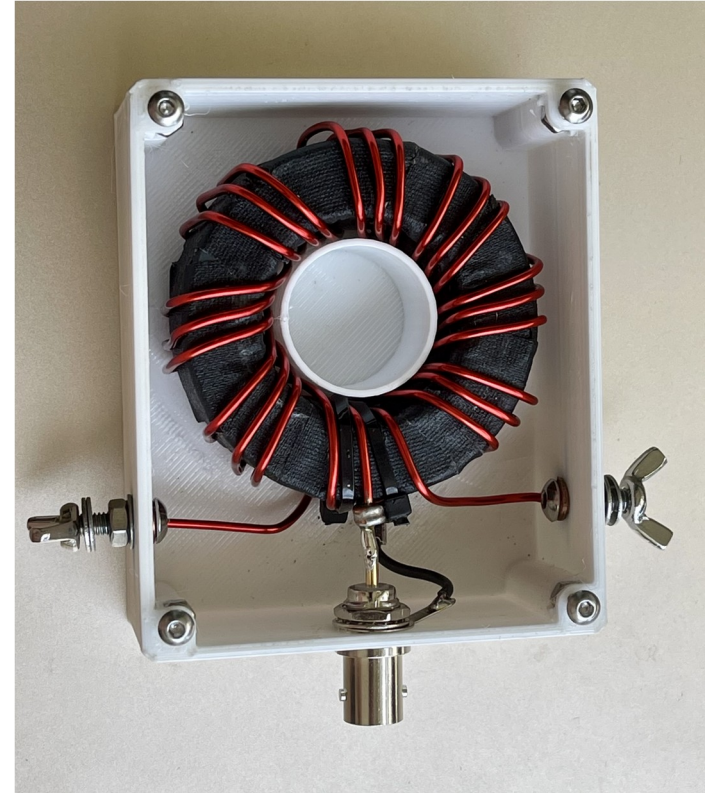
500 kHz to 30 MHz
Termination: 452 Ohm



Transformer 1:9 (Balun)

Result

- Works very well from 1.8 MHz (160 m) to 28 MHz (10 m)
- Ok for 28 MHz (10 m)



Transformer 1:9 (Balun)

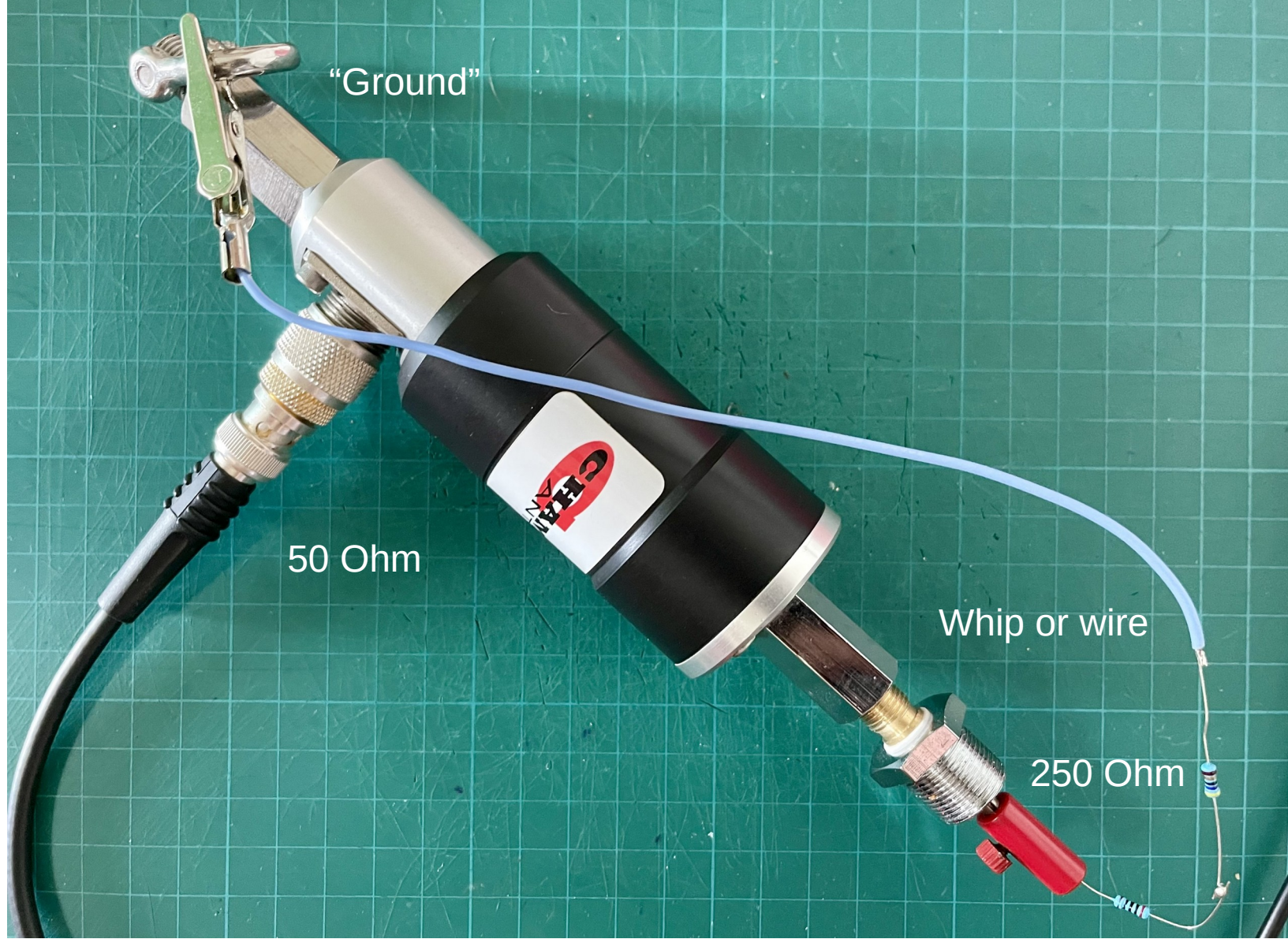
- Usable for symmetrical dipole with 450 Ohm feed line
- With 23 m wire + counterpoise used as “Random wire antenna”
- Works well on all bands 40 m and above with ATU
- Needs additional common mode choke!



Transformer 1:5 (Unun)

- Chameleon MPAS
 - “HYBRID-MICRO Matching unit”
- Specs:
 - 1.8 Mhz to 50 Mhz
 - 100 W SSB, 50 W CW





“Ground”

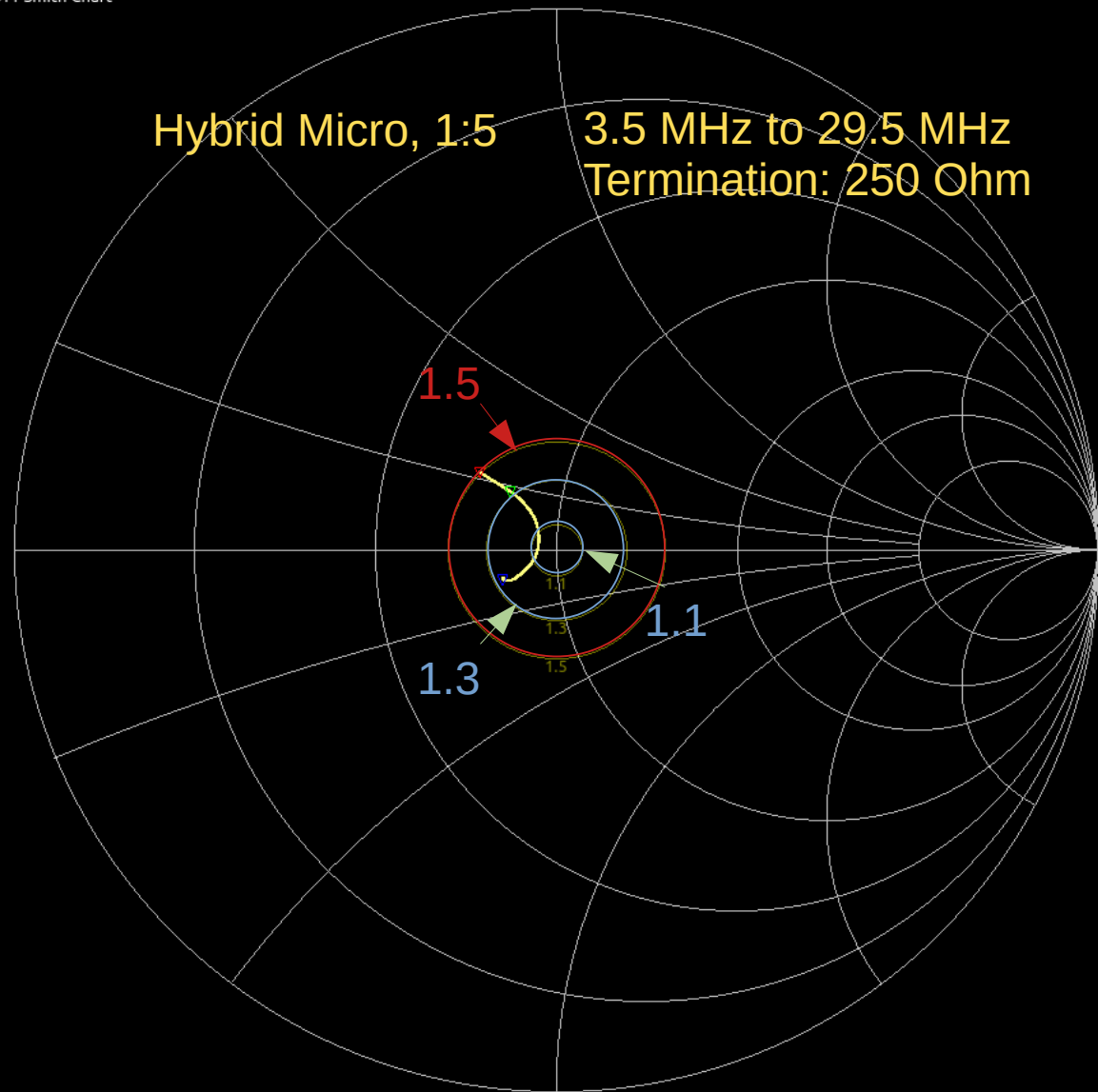
50 Ohm

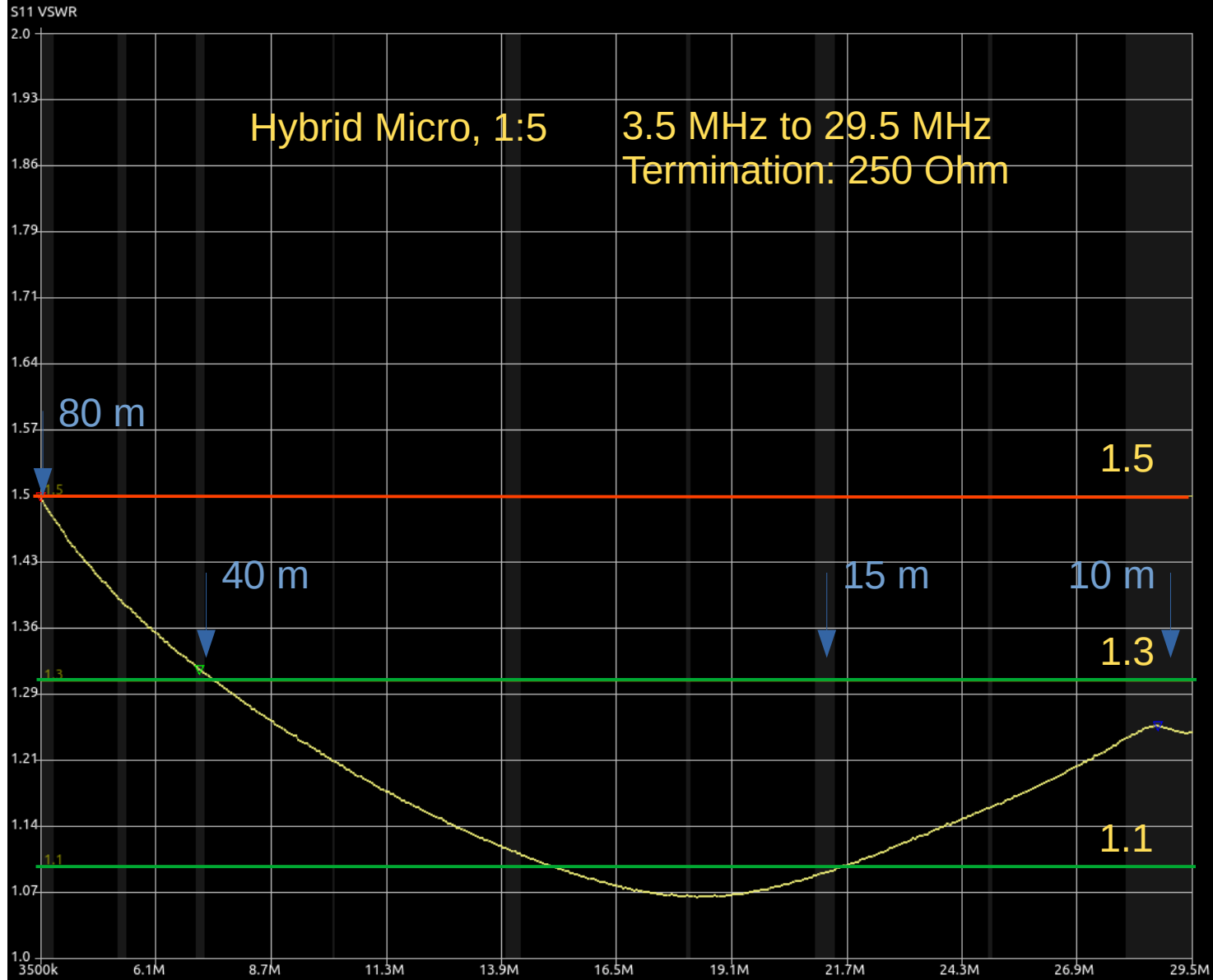
Whip or wire

250 Ohm

9V1KG

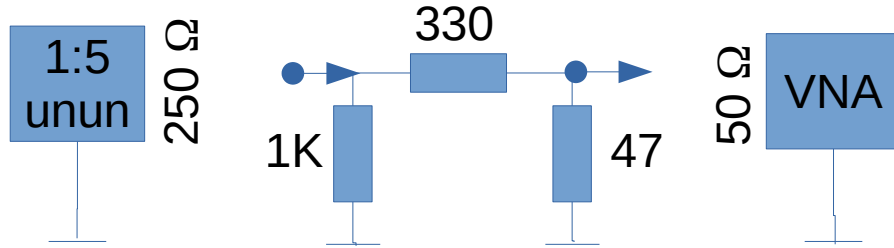
Hybrid Micro, 1:5

3.5 MHz to 29.5 MHz
Termination: 250 Ohm



Measuring losses

Resistive Pi Network for matching



Results

Actual: $R_{in} : 262 \Omega$, $R_{out} : 43 \Omega$

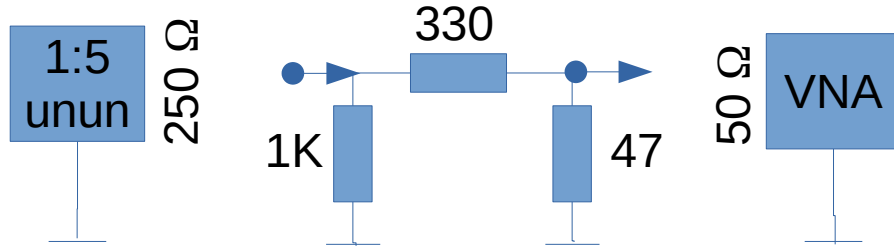
$S_{11} : 33 \text{ dB}$ $S_{22} : 23 \text{ dB}$, $S_{21} : -16 \text{ dB}$

Calibration using two equal Pi NW

Measured $s_{21} : 15.3 \text{ dB}$

Measuring losses

Resistive Pi Network for matching



Actual: R_{in} : 262 Ω , R_{out} : 43 Ω

S_{11} : 33 dB S_{22} : 23 dB, S_{21} : -16 dB

Calibration using two equal Pi NW

Measured s_{21} : 15.3 dB

Results

Frequency	Losses	% Pwr
3.5 MHz	0.6 dB	87%
7.1 MHz	0.9 dB	81%
14.2 MHz	1.4 dB	72%
21.2 MHz	2.0 dB	63%

Summary (1)

- Common mode chokes
 - Optimal solution with 31 x 19 x 13 (FT-140) TDK HF70 and 9 turns RG-174 coaxial cable
 - Even better: 2 pc stacked: > 30 dB from 160 to 10 m
 - Suitable for 100 W!
- Transformer 1:9
 - Excellent performance with WE 61 x 35 x 20 (FT-240) material WE 4W620
 - Should be capable to take much more than 100 W

Summary (2)

- Chameleon Hybrid-Micro 1:5
 - Not usable for 160 m, just ok for 80 m, optimized for 40 m and above
 - Losses ok up to 20 m, > 2 dB for 15 m and above
 - Gets actually quite hot when used with 50 W CW according specs.
 - Yet, a good compromise for fast deployment and fast frequency change, versatile – usable with long wire or whip

Thank You!