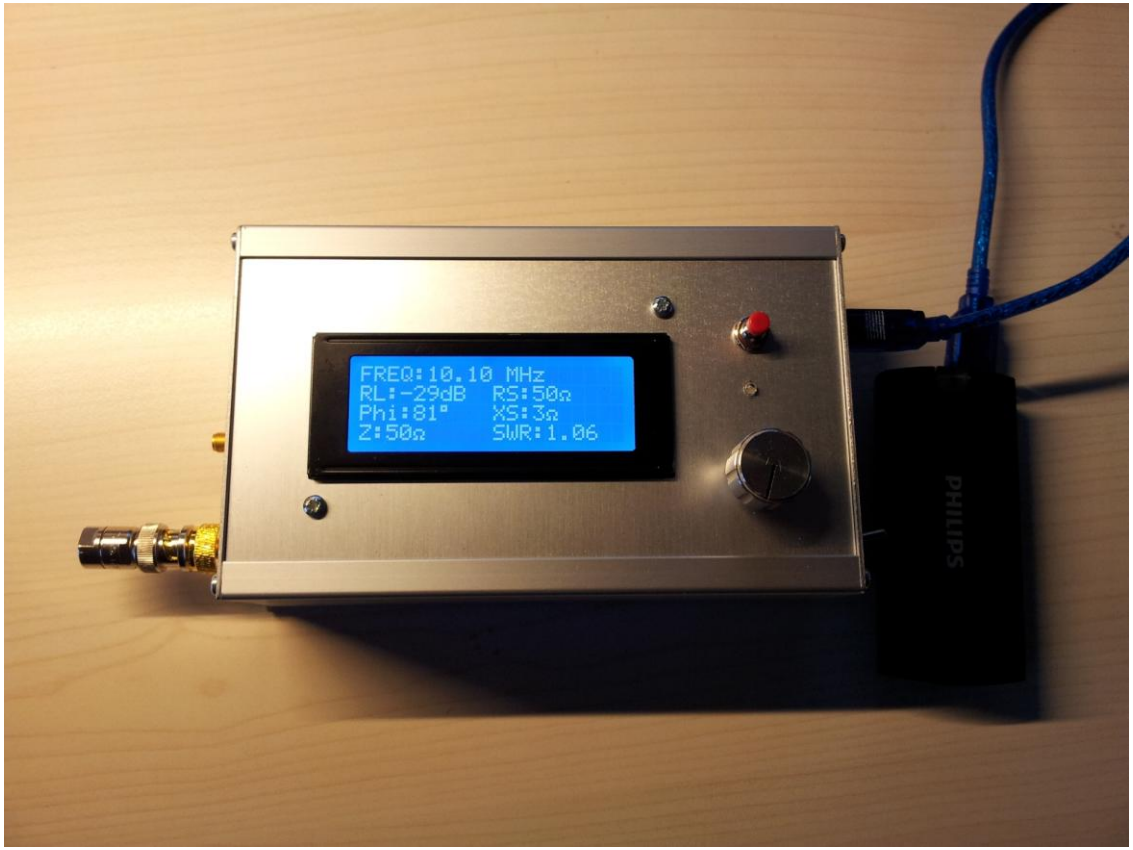
EEN ANTENNE – ANALYZER ZELF BOUWEN MET ARDUINO



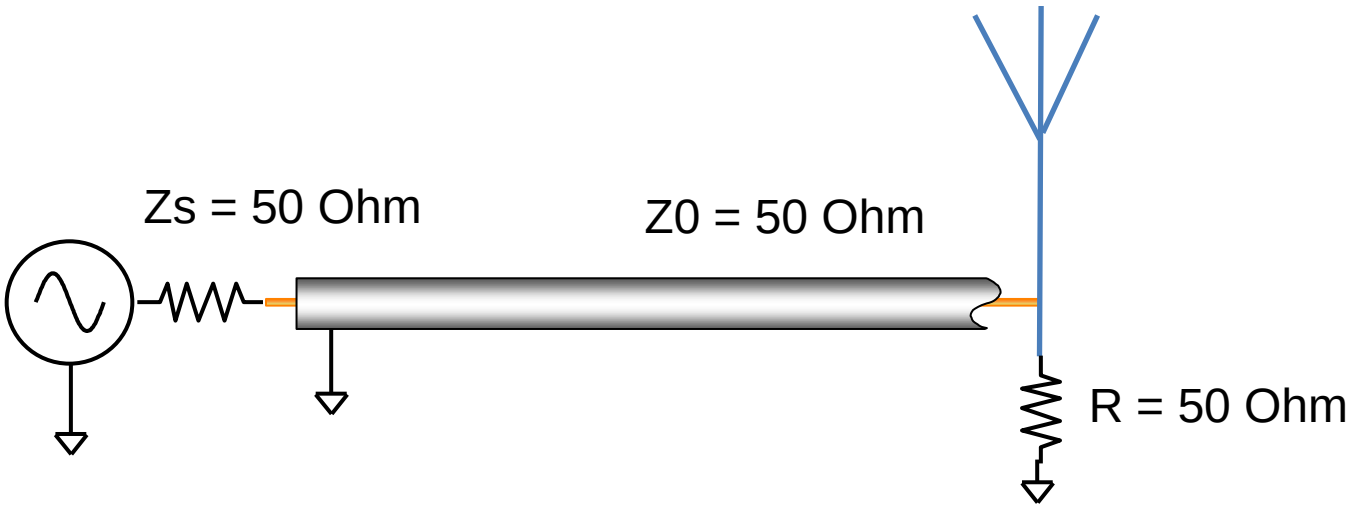
ON7UF

23/09/2016

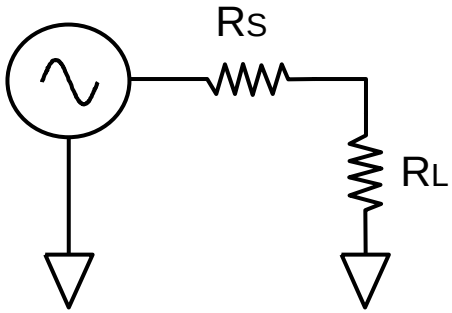
AGENDA

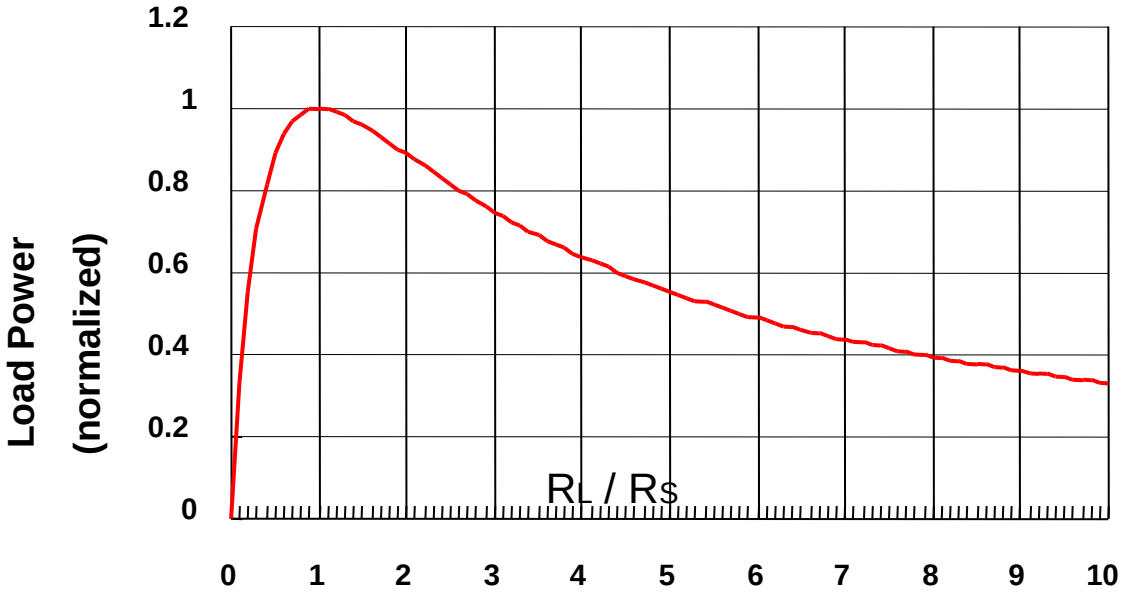
- Deel 1
  - Introductie
  - Wat meet een antenne analyzer ?
  - Hoe meet hij dat ?
- Pauze
- Deel 2
  - Praktische realisatie
  - Arduino
  - Software
  - Enkele toepassingen

WAT MEET EEN ANTENNEANALYZER



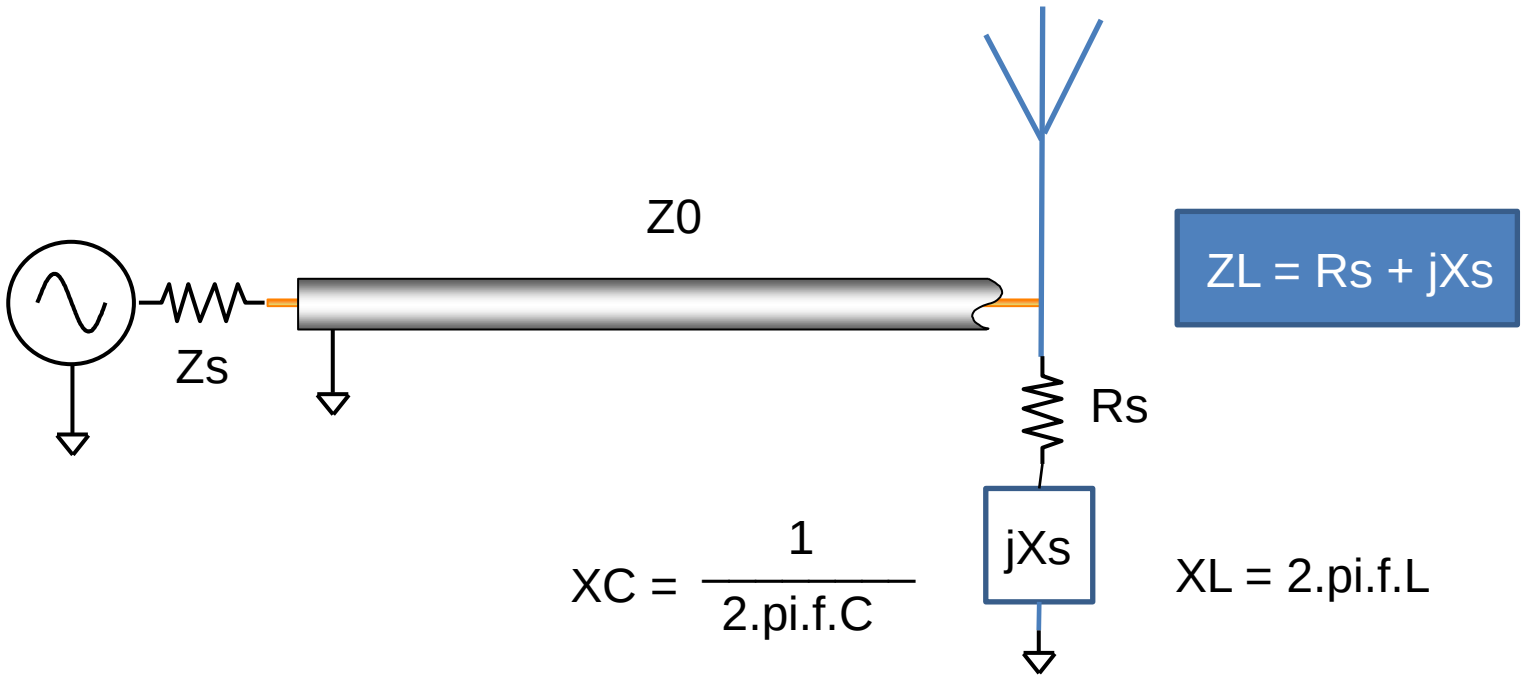
IMPEDANTIE AANPASSING



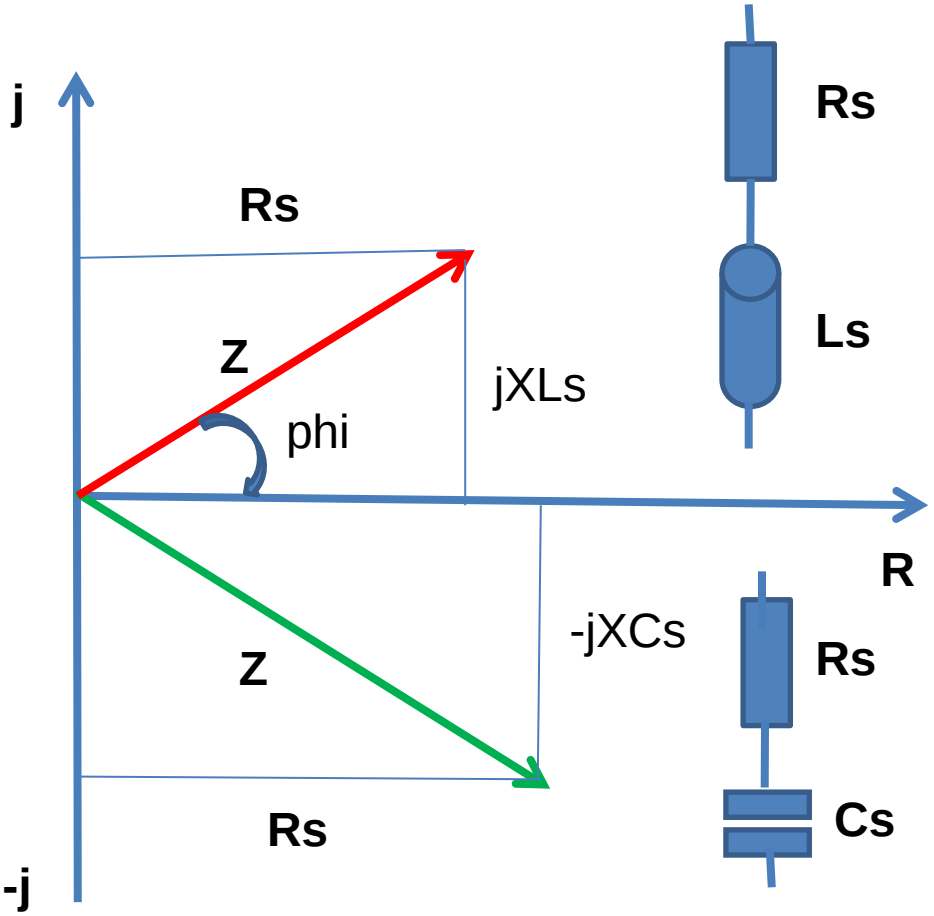


Maximum power is transferred when RL = RS

WAT MEET EEN ANTENNEANALYZER



IMPEDANTIE



$Z = Rs + jXLs$

$XL = 2.pi.f.L$

$$|Z| = \sqrt{Rs^2 + Xs^2}$$

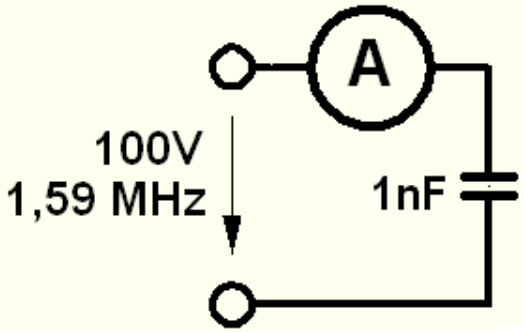
$$phi = bgtg \frac{Xs}{Rs}$$

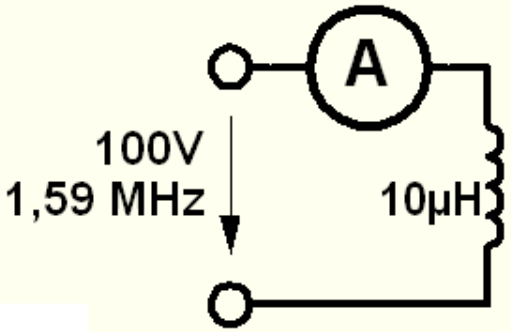
$Z = Rs - jXCs$

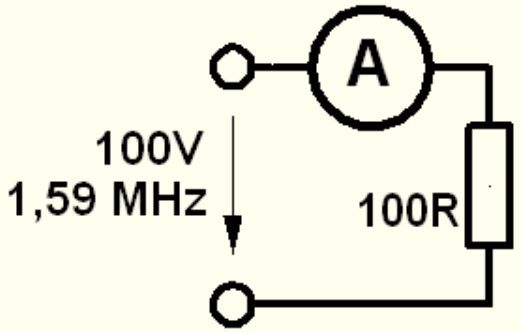
$$XC = \frac{-1}{2.pi.f.C}$$

$COS\ phi = R / Z$

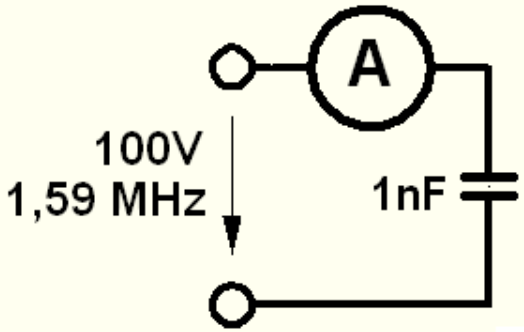
Wisselstroomweerstand

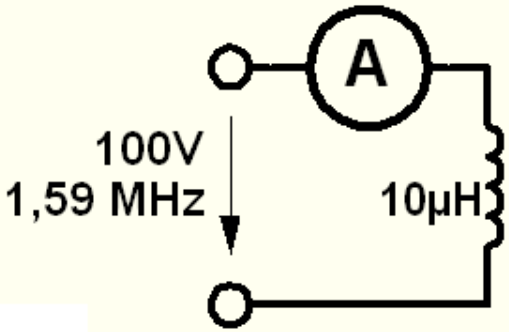


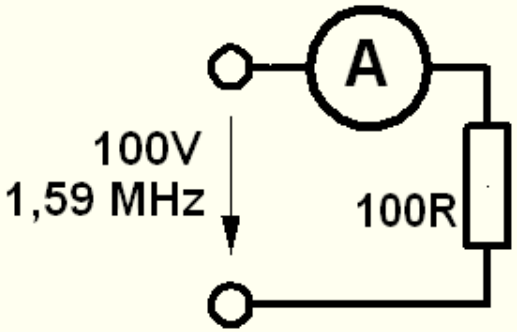


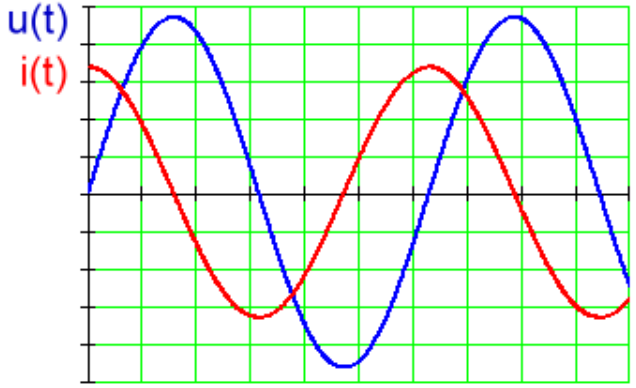


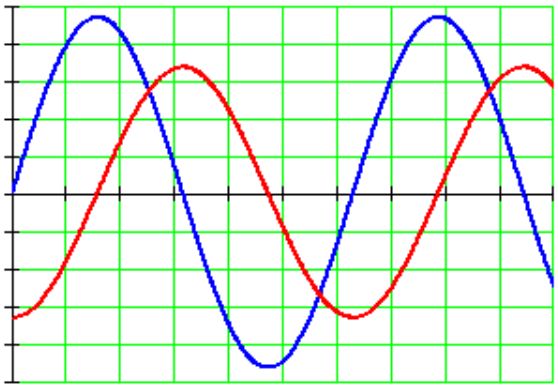
Wisselstroomweerstand

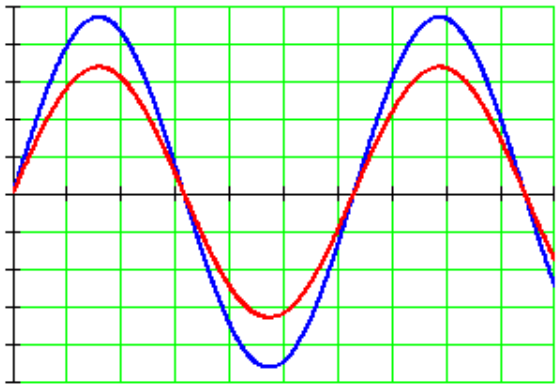




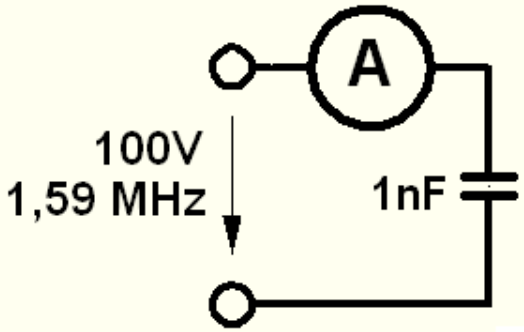


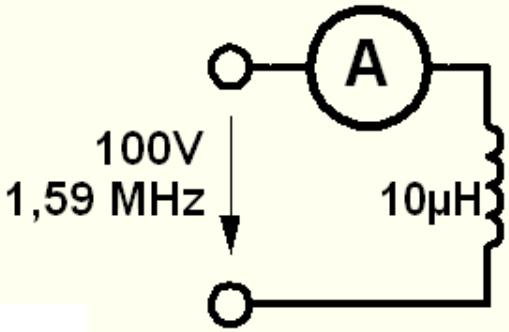


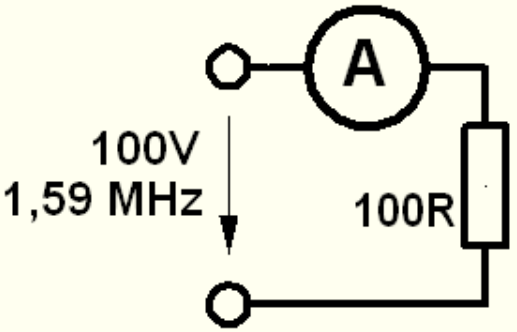


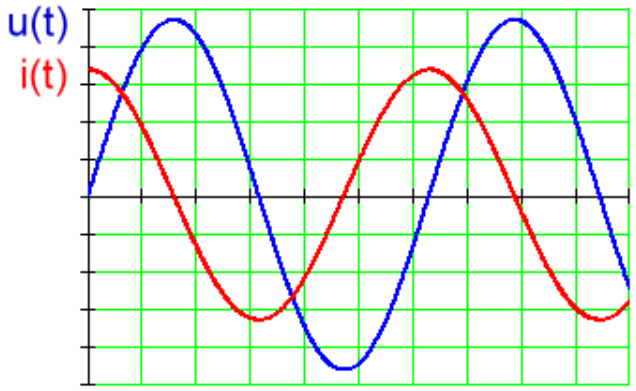


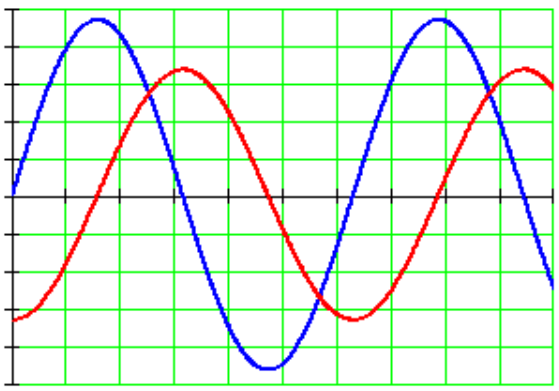
Wisselstroomweerstand

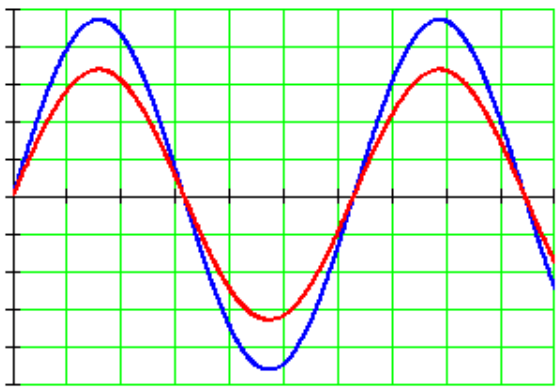


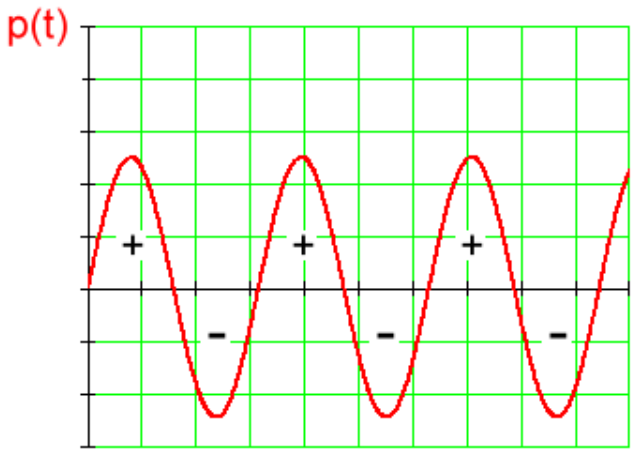


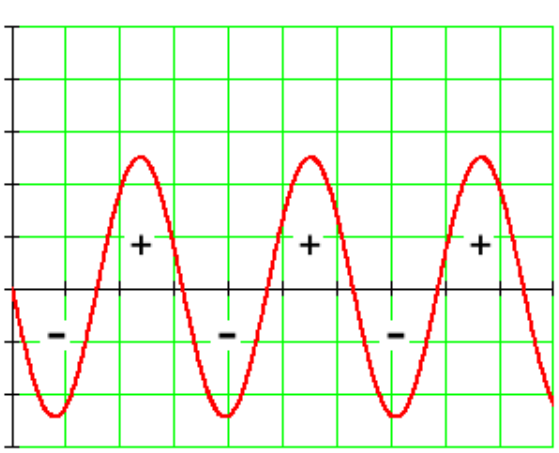


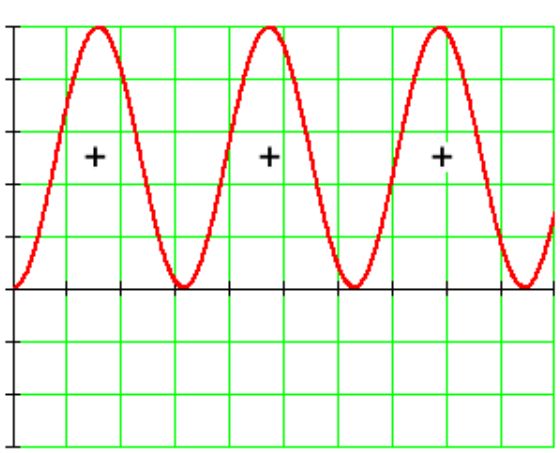




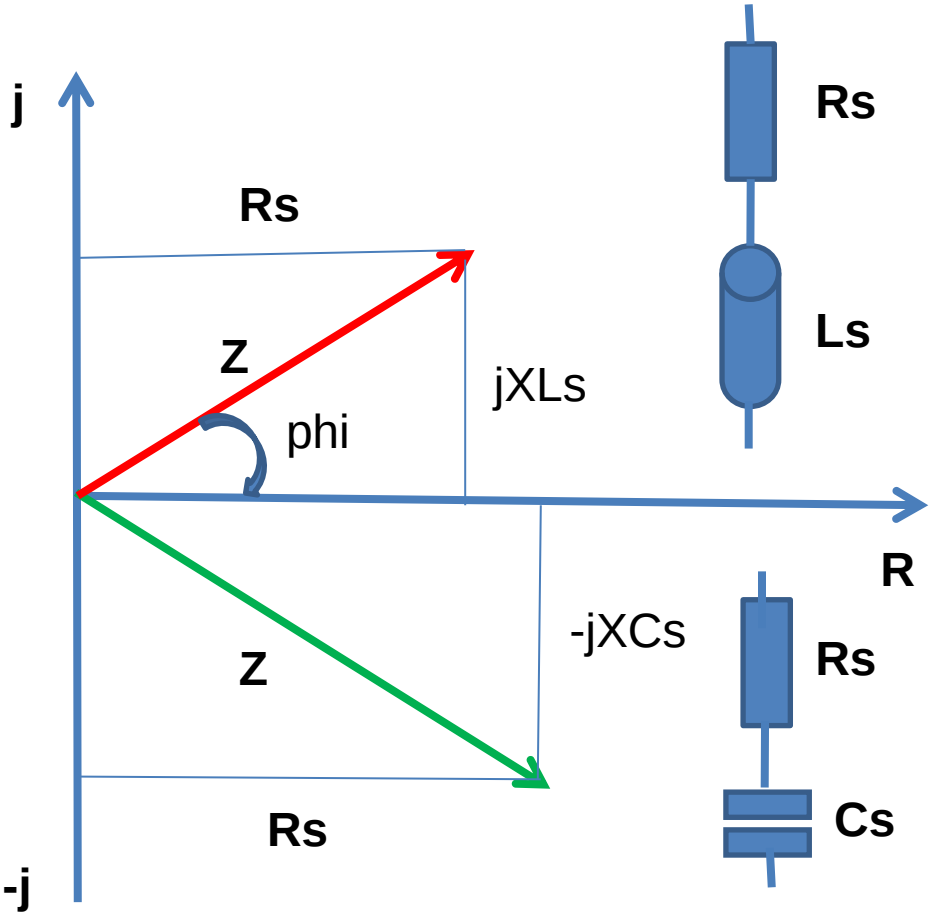








IMPEDANTIE



$Z = Rs + jXLs$

$XL = 2.pi.f.L$

$$|Z| = \sqrt{Rs^2 + Xs^2}$$

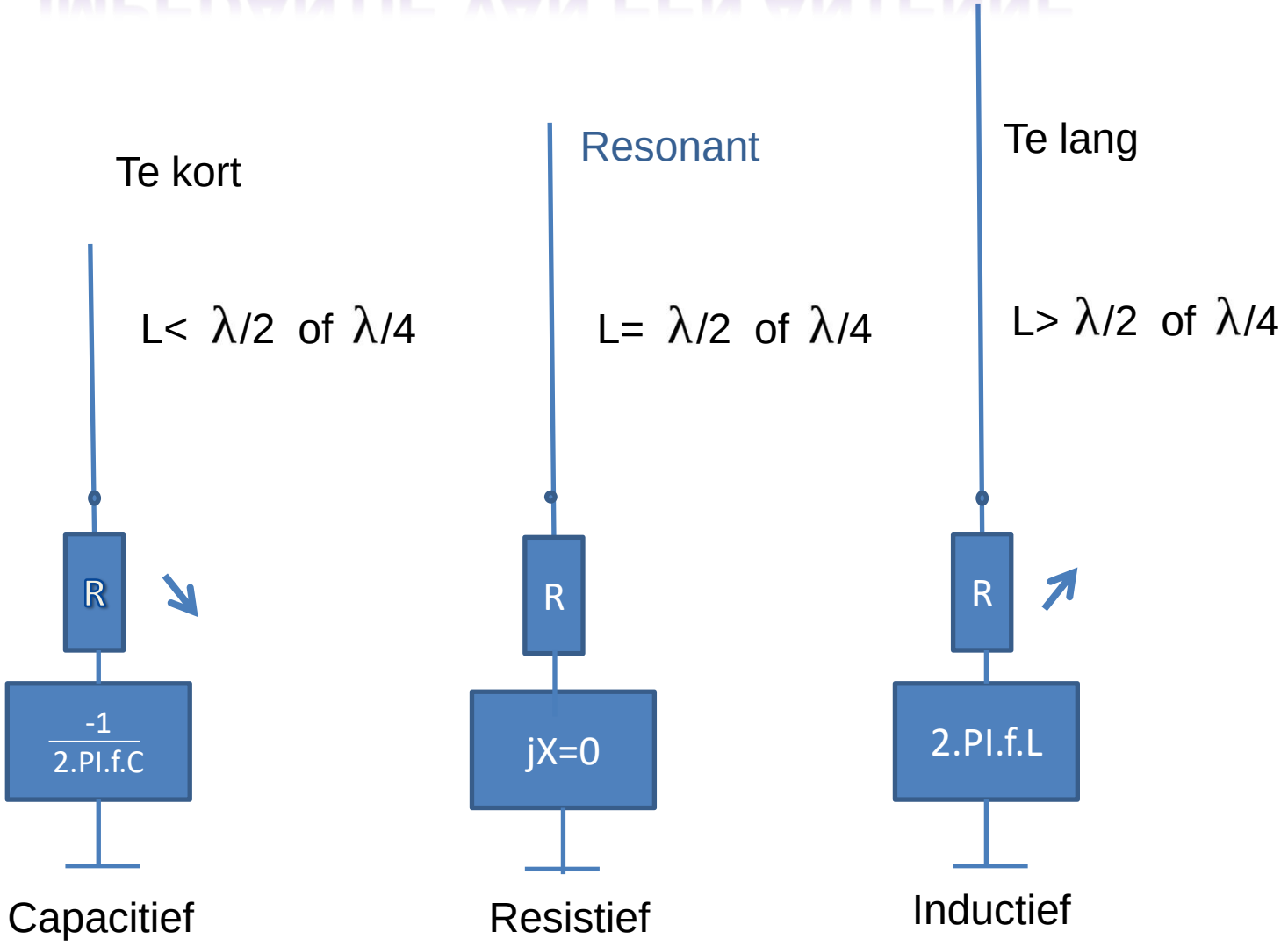
$$phi = bgtg \frac{Xs}{Rs}$$

$Z = Rs - jXCs$

$$XC = \frac{-1}{2.pi.f.C}$$

$COS\ phi = R / Z$

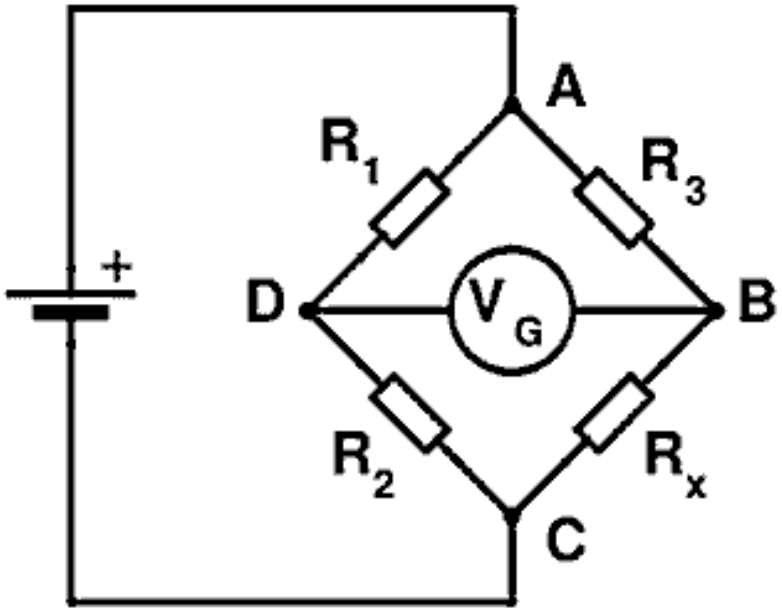
IMPEDANTIE VAN EEN ANTENNE



IMPEDANTIEMETING

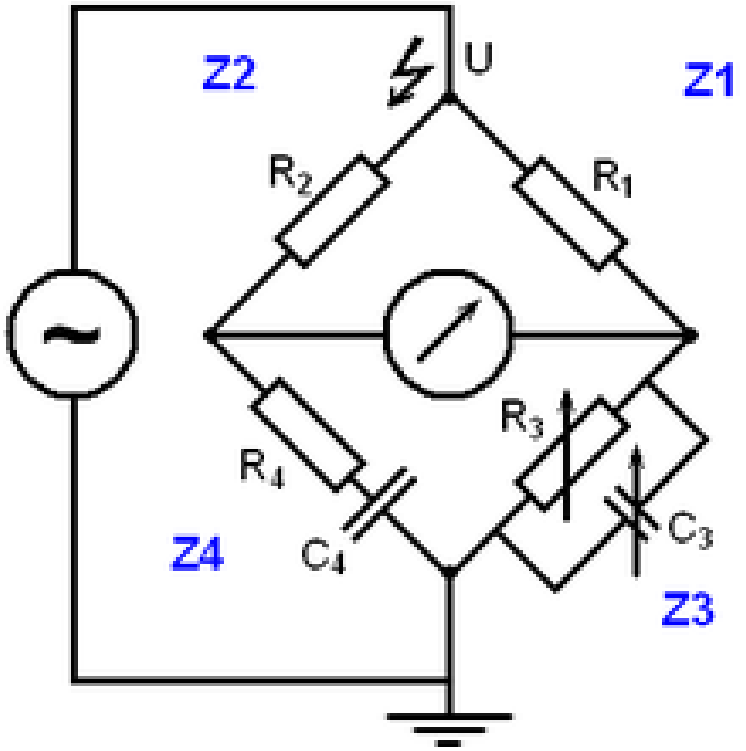
Brug van Sir Charles Wheatstone

1843 Royal Society

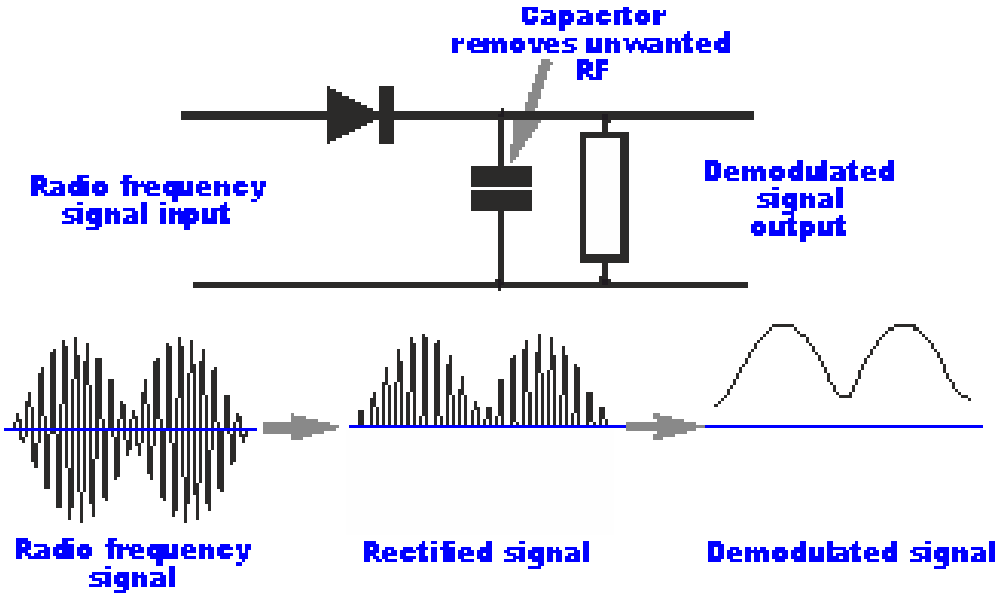


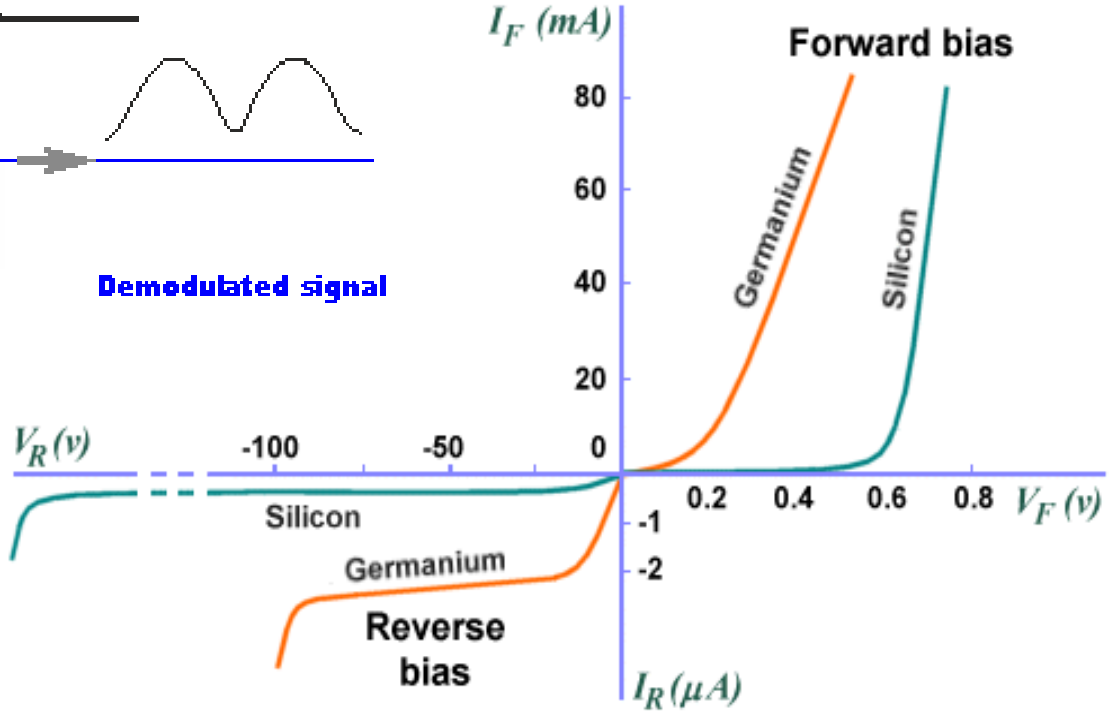
$$R_x = \frac{R_3 \cdot R_2}{R_1}$$

Brug van Wien

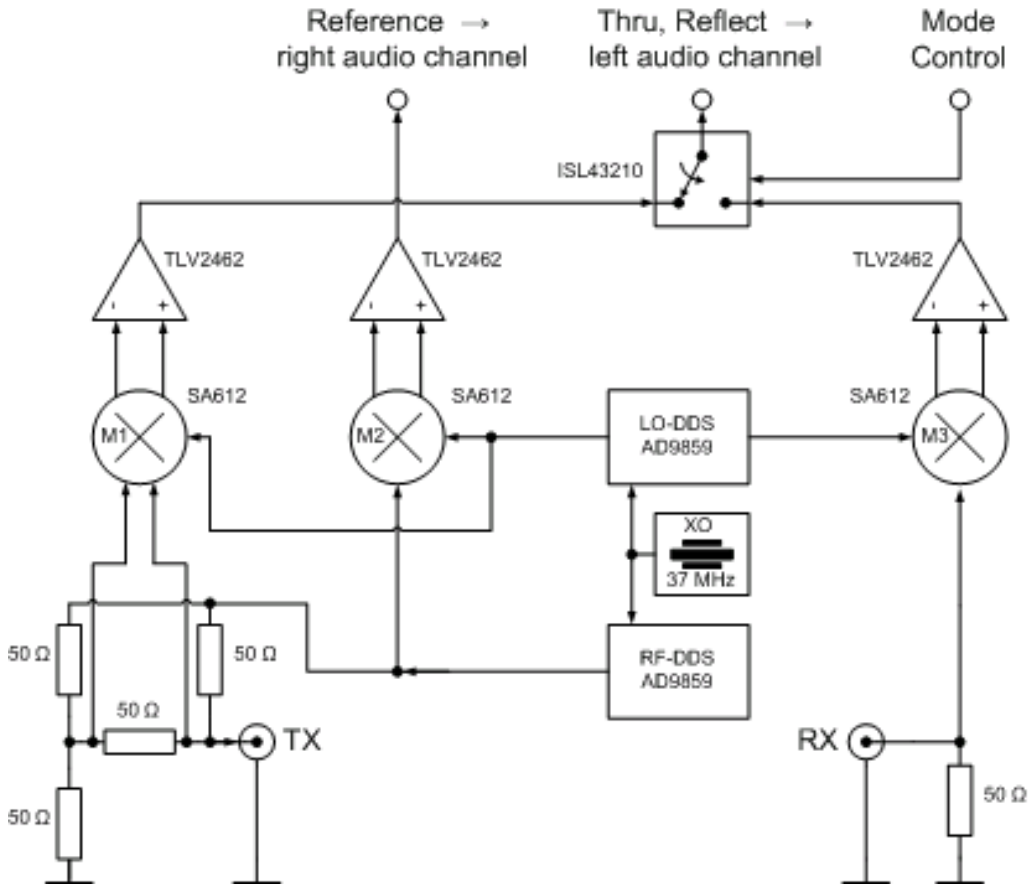


AMPLITUDE DETECTIE

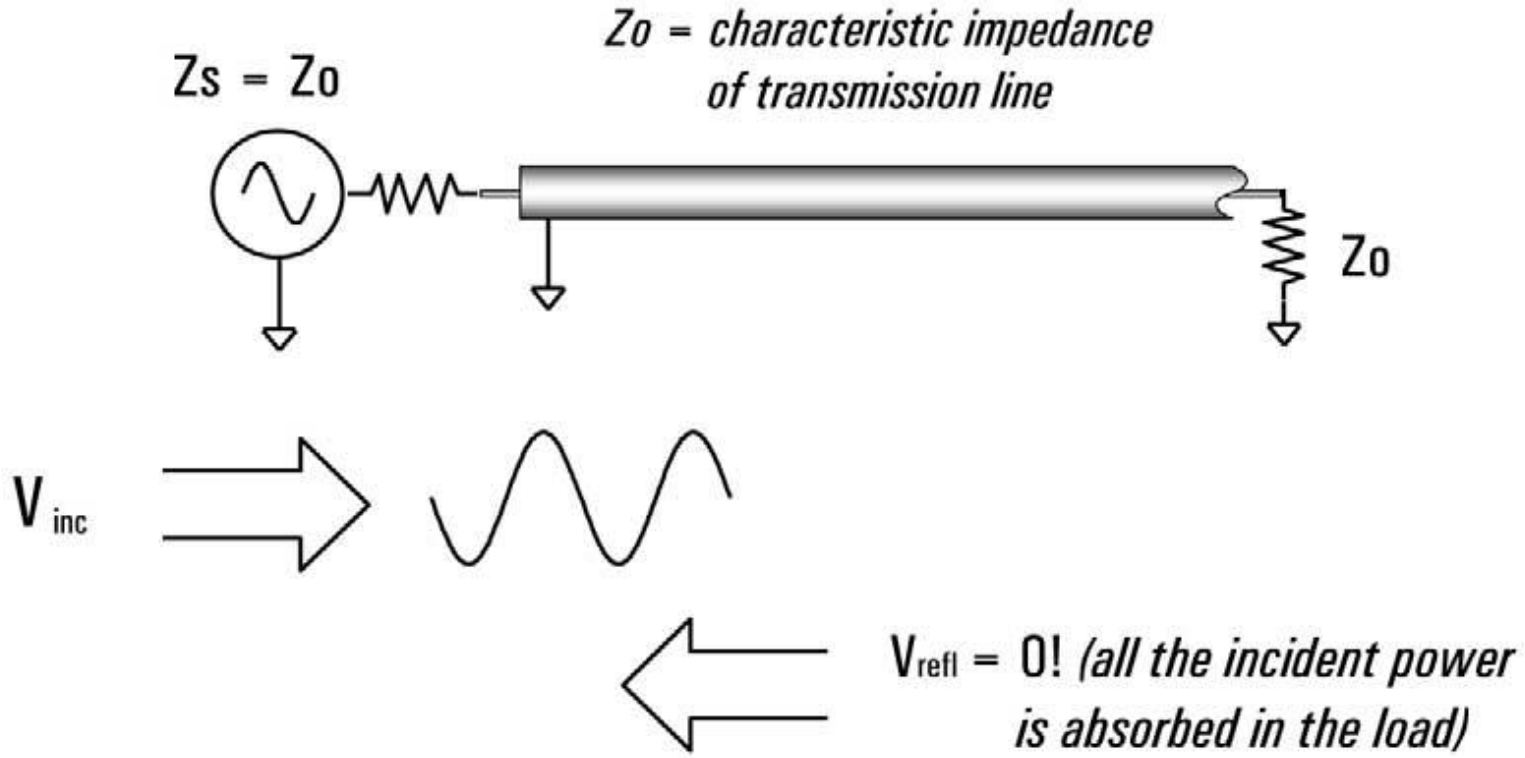




N2PK EN DG8SAQ
VNA ONTWERP VOOR GEVORDERDEN

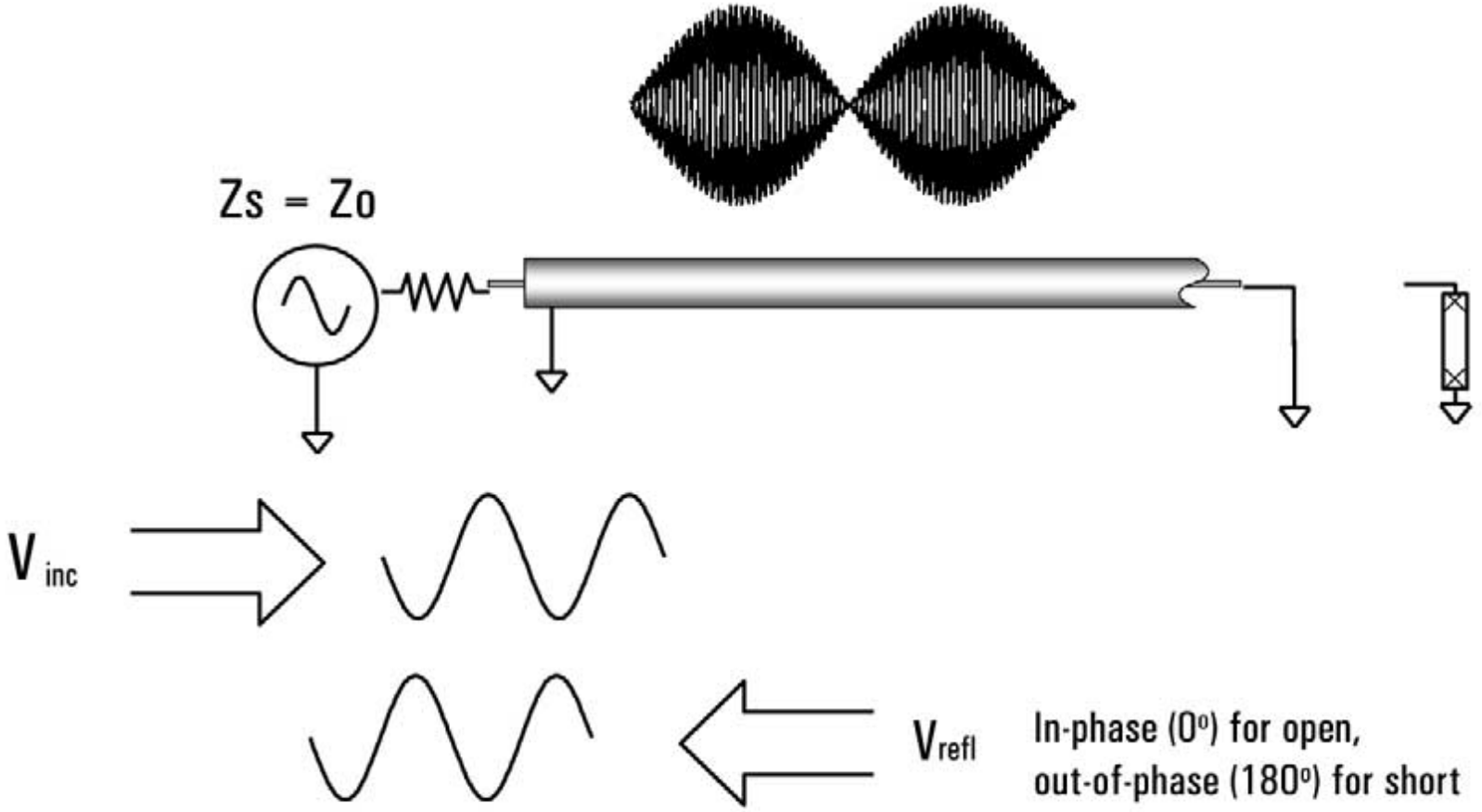


GEDRAG TRANSMISSIELIJN



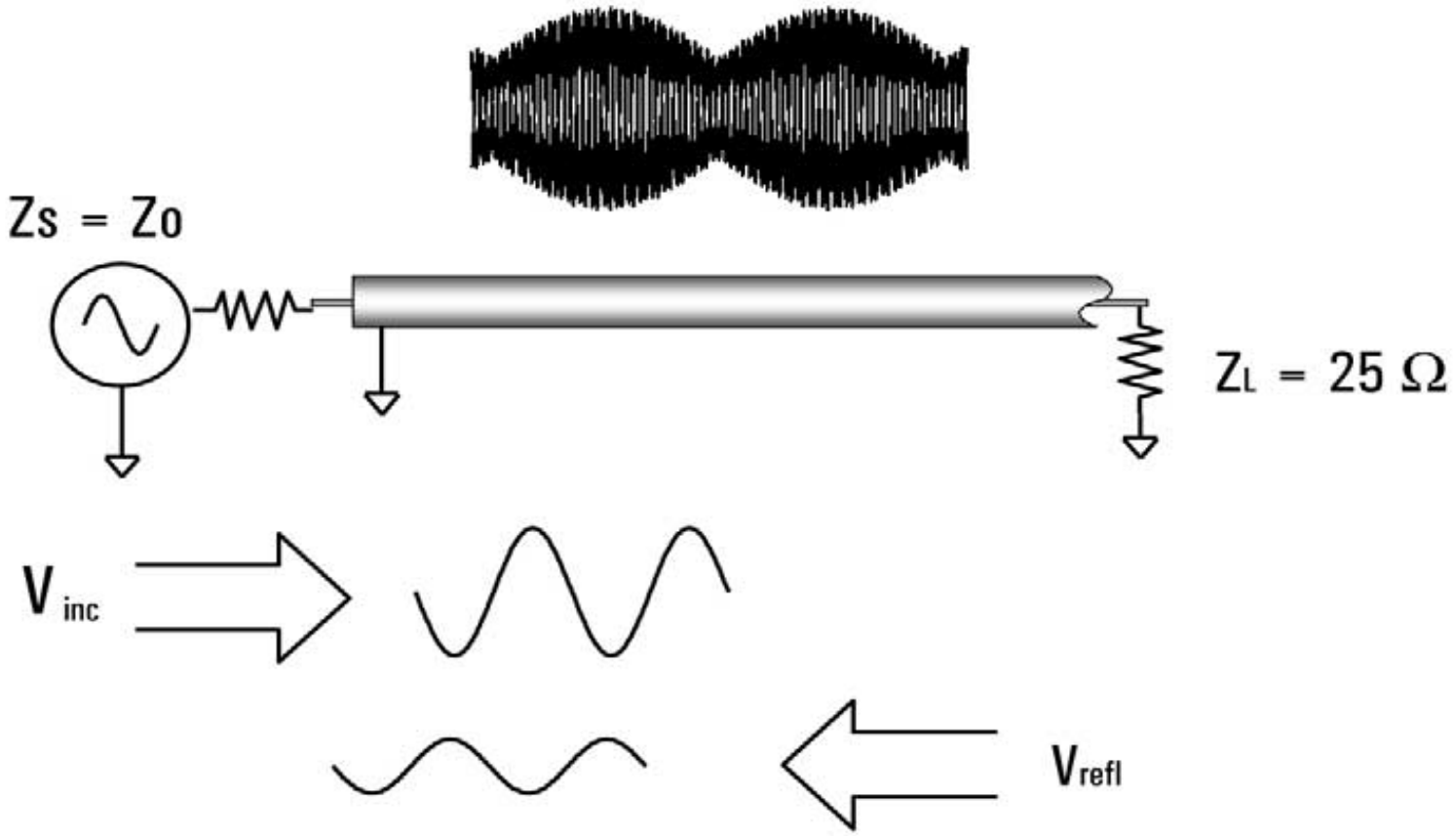
For reflection, a transmission line terminated in Zo behaves like an infinitely long transmission line

GEDRAG TRANSMISSIELIJN



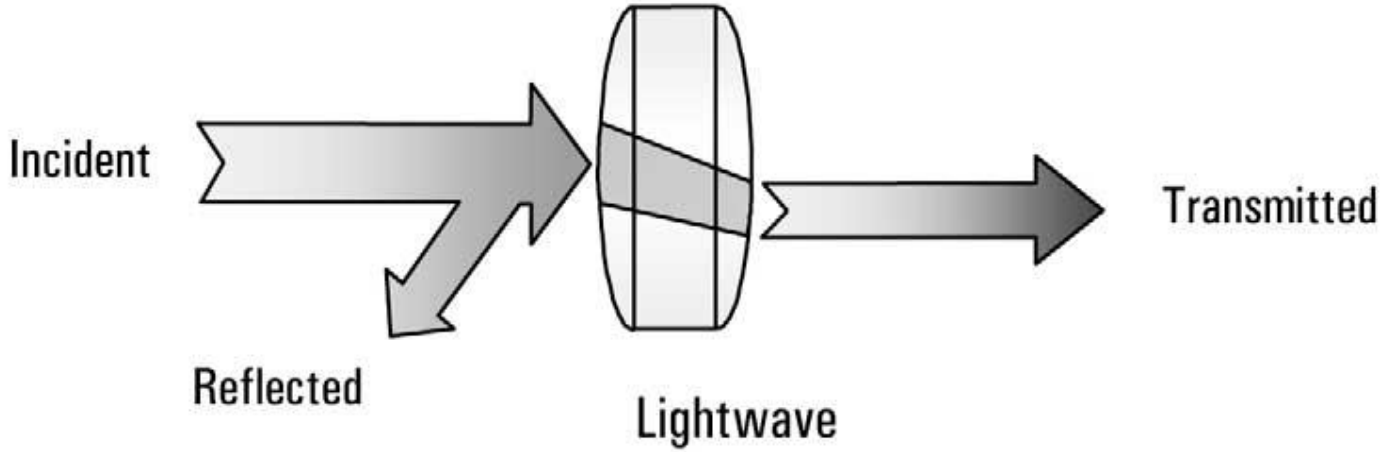
For reflection, a transmission line terminated in a short or open reflects all power back to source

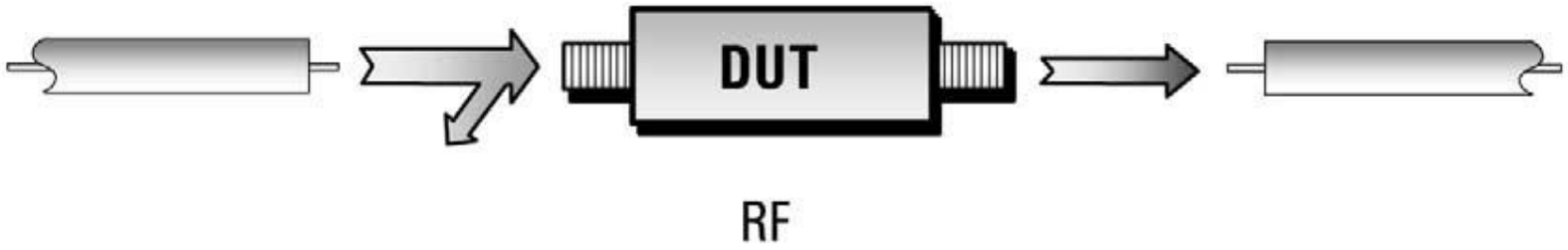
GEDRAG TRANSMISSIELIJN



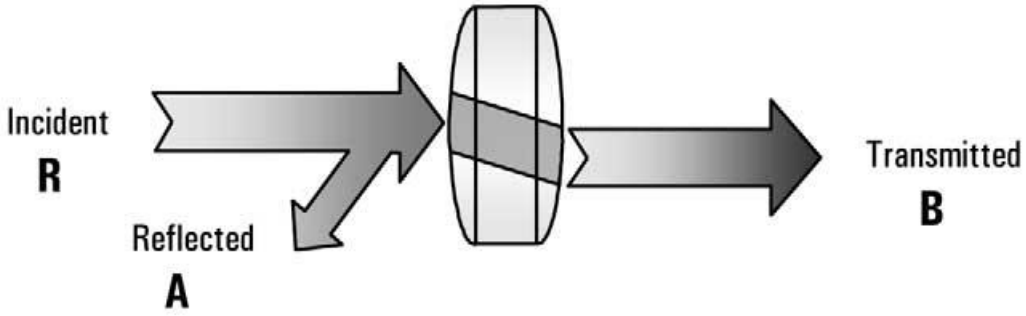
Standing wave pattern does not go to zero as with short or open

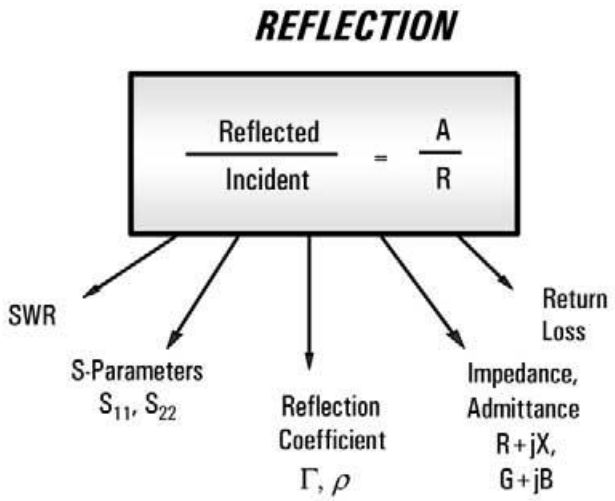
NETWERK ANALYZE

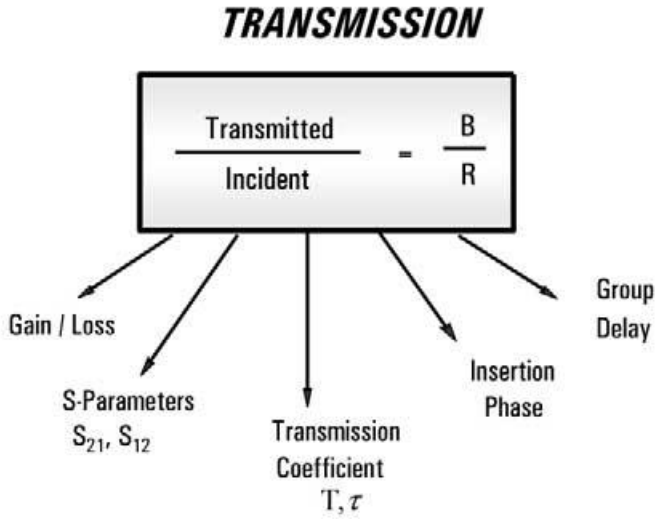




REFLECTIE / TRANSMISSIE MODE







DE REFLECTIE MODE

Reflection Coefficient

$$\Gamma = \frac{V_{reflected}}{V_{incident}} = \rho \angle \Phi = \frac{Z_L - Z_0}{Z_L + Z_0}$$

Return loss = -20 log(ρ), $\rho = |\Gamma|$

Voltage Standing Wave Ratio

$$\text{VSWR} = \frac{E_{max}}{E_{min}} = \frac{1 + \rho}{1 - \rho}$$

No reflection
($Z_L = Z_o$)

Full reflection
(Z_L = open, short)

0	ρ	1
∞ dB	RL	0 dB
1	VSWR	∞

RETURN LOSS REFERENCE

RETURN LOSS AND RELATED QUANTITIES

Return Loss	Reflect Co. Mag.	SWR	% Power Reflected	R>50 ohms	R<50 ohms
0	1.00	INF	100.0	INF	0.0
0.25	0.97	69.5	94.4	3475	0.7
0.5	0.94	34.8	89.1	1738	1.4
1	0.89	17.4	79.4	870	2.9
2	0.79	8.7	63.1	436	5.7
3	0.71	5.8	50.1	292	8.5
4	0.63	4.4	39.8	221	11.3
5	0.56	3.6	31.6	178	14.0
6	0.50	3.0	25.1	150	16.6
7	0.45	2.6	20.0	131	19.1
8	0.40	2.3	15.8	116	21.5
9	0.35	2.1	12.6	105	23.8
10	0.32	1.9	10.0	96.2	26.0
15	0.18	1.4	3.2	71.6	34.9
20	0.10	1.2	1.00	61.1	40.9
25	0.056	1.12	0.32	56.0	44.7
30	0.032	1.07	0.10	53.3	46.9
35	0.018	1.04	0.03	51.8	48.3
40	0.010	1.02	0.01	51.0	49.0
50	0.003	1.01	0.001	50.3	49.7
60	0.0010	1.002	0.0001	50.1	49.9
70	0.0003	1.001	0.00001	50.03	49.97

DE TRANSMISSIE MODE

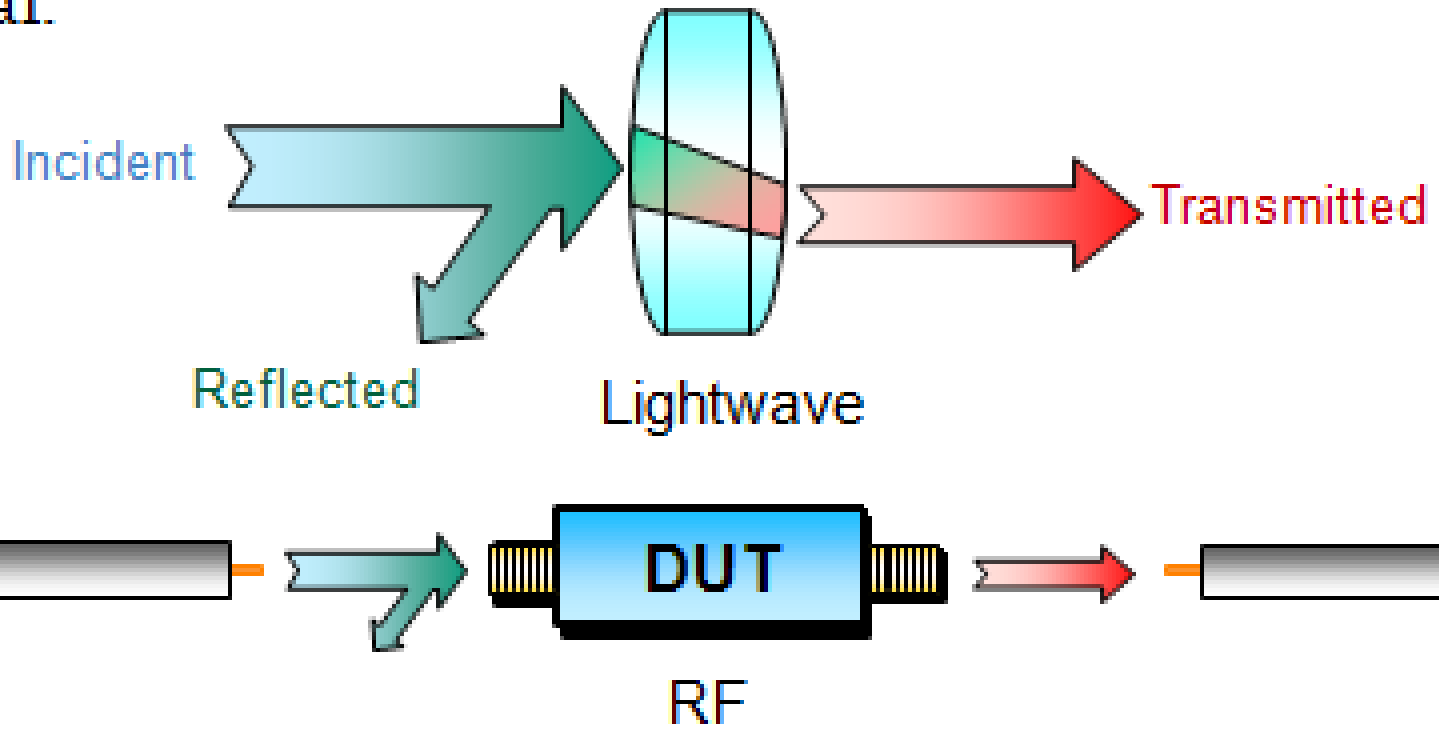
$$\text{Transmission Coefficient} = T = \frac{V_{\text{Transmitted}}}{V_{\text{Incident}}} = \tau \angle \phi$$

$$\text{Insertion Loss (dB)} = -20 \log \left| \frac{V_{\text{Trans}}}{V_{\text{Inc}}} \right| = -20 \log \tau$$

$$\text{Gain (dB)} = 20 \log \left| \frac{V_{\text{Trans}}}{V_{\text{Inc}}} \right| = 20 \log \tau$$

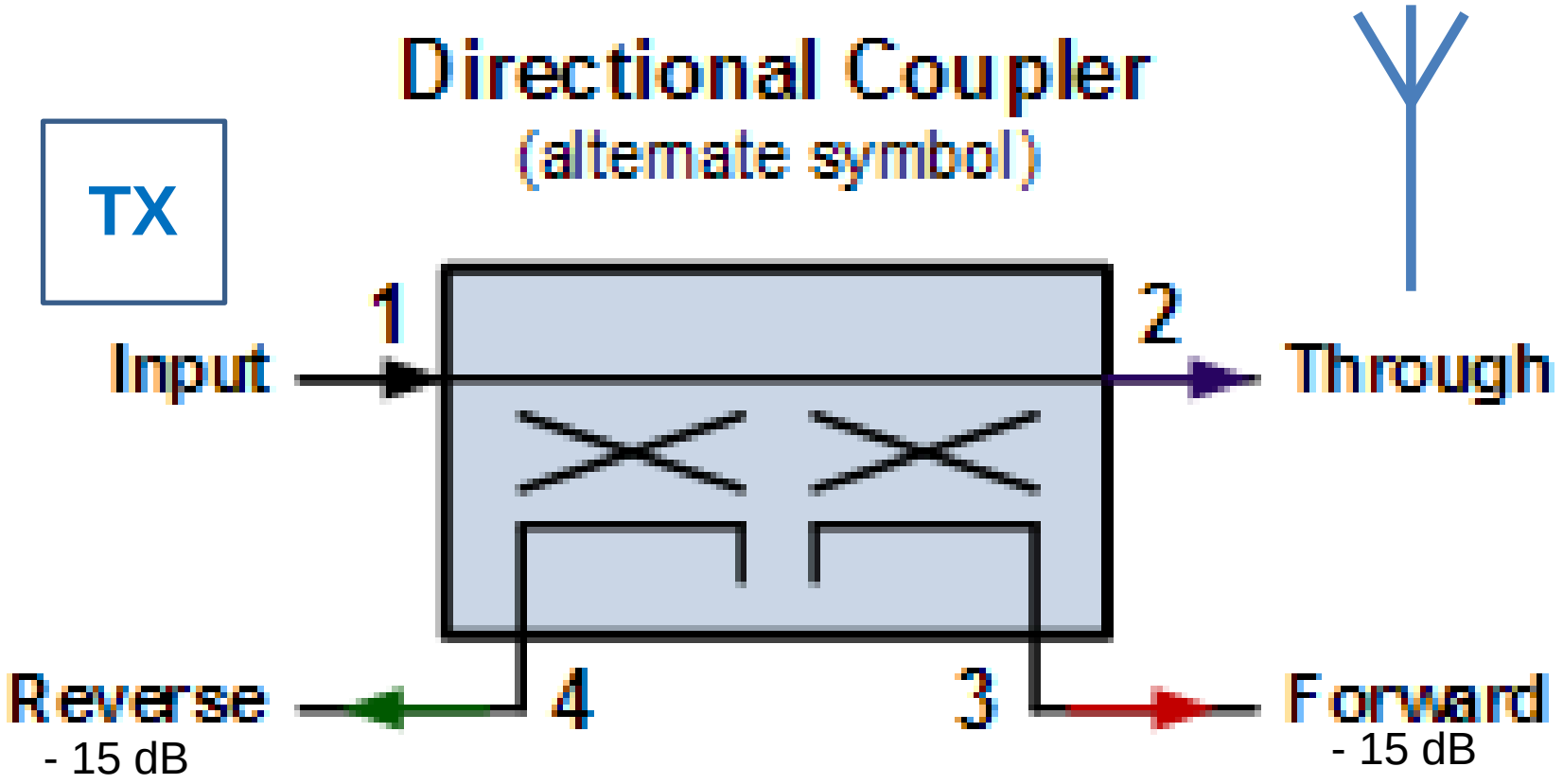
Lightwave Analogy to RF Energy

• Network analysis is concerned with the accurate measurement of the *ratios* of the reflected signal to the incident signal, and the transmitted signal to the incident signal.

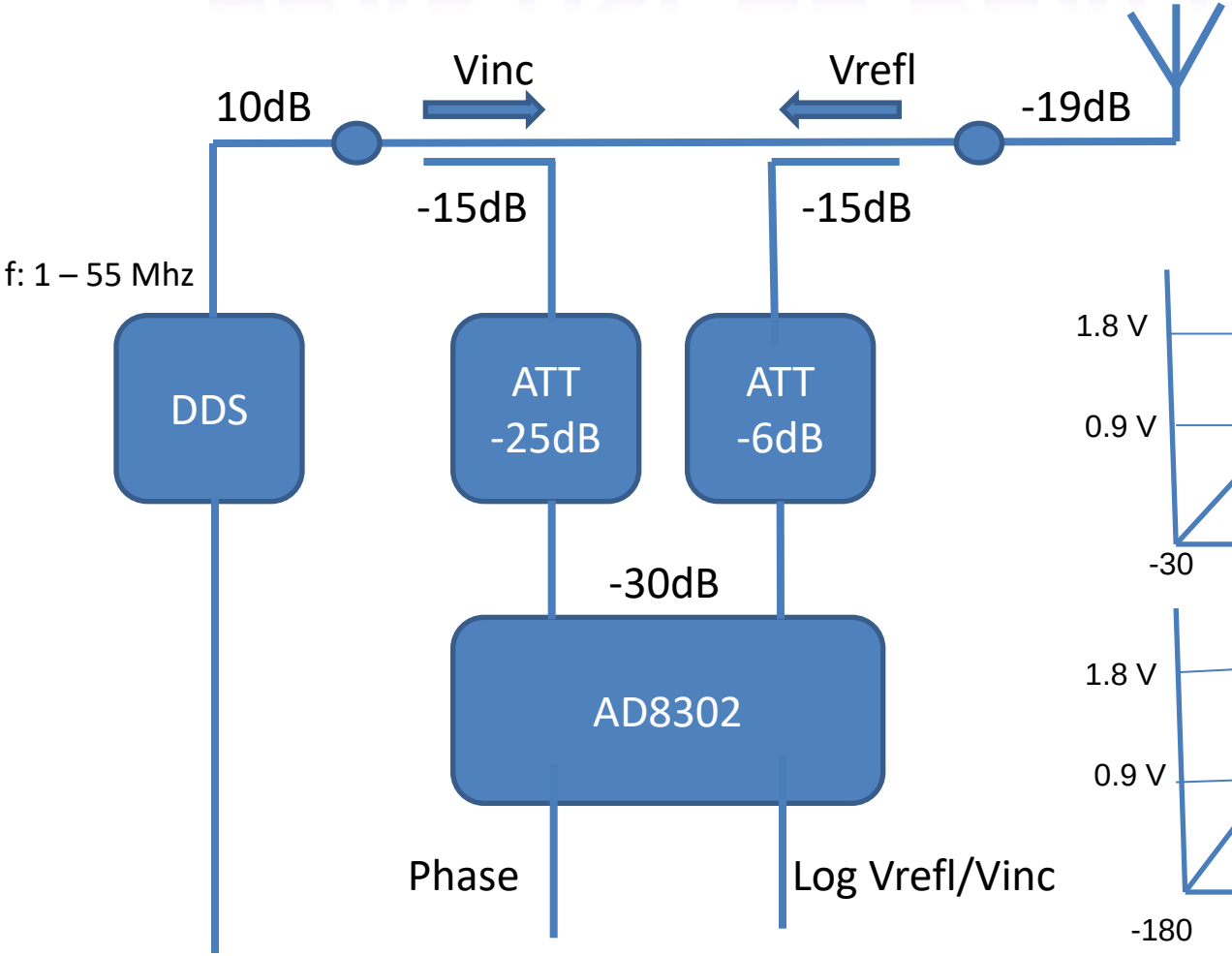


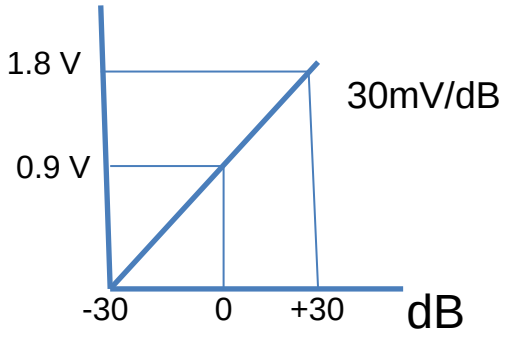
PAUZE

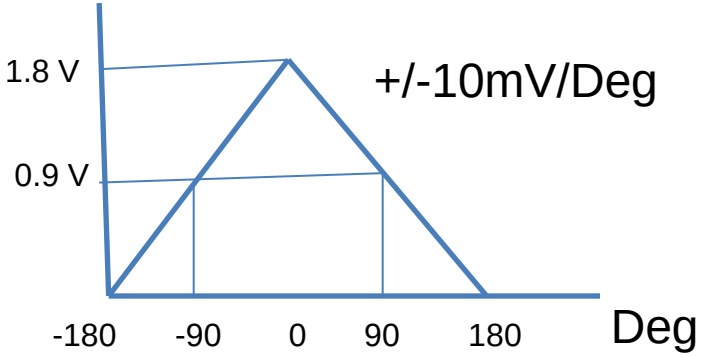
DE BI - DIRECTIONELE COUPLER



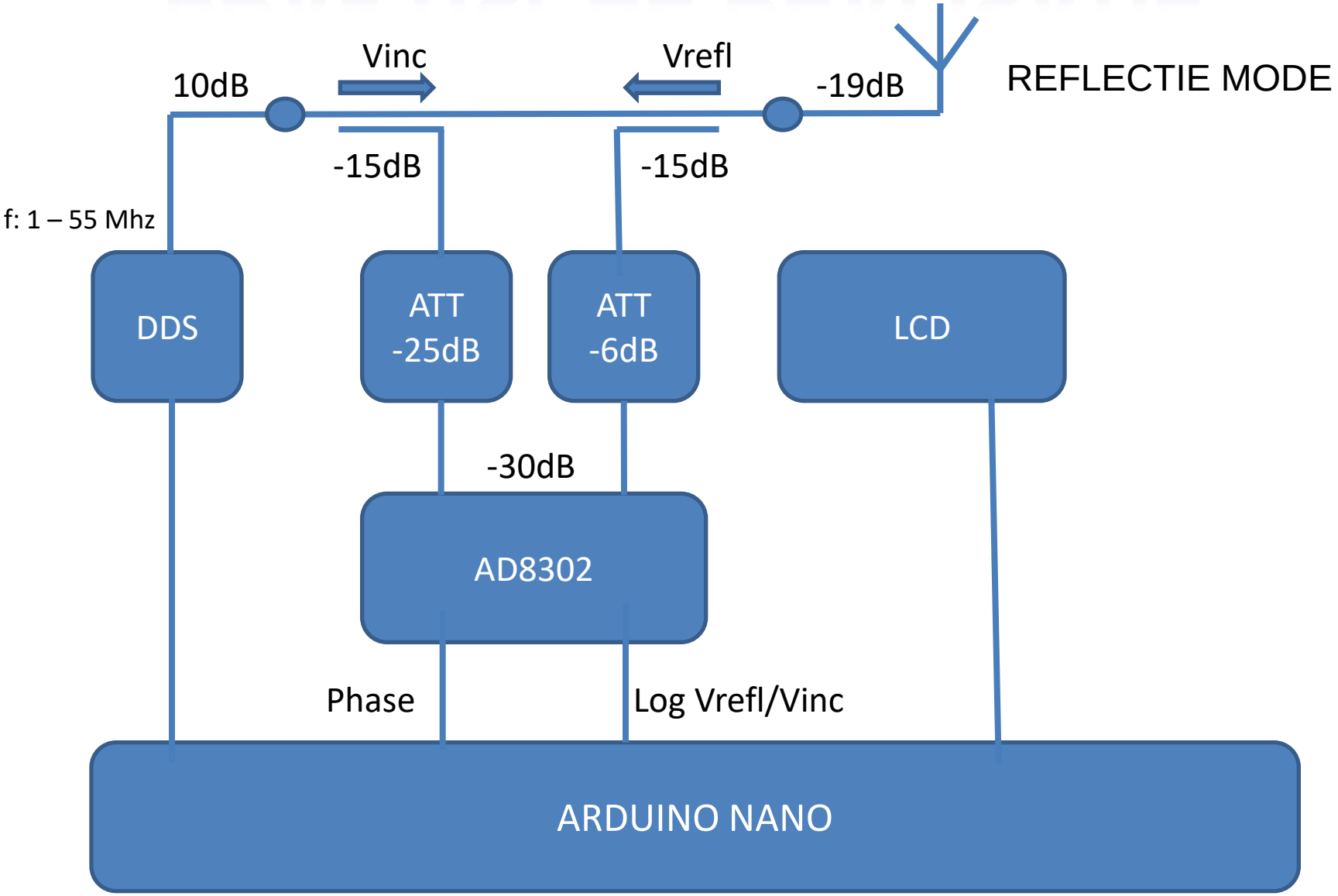
PRAKTISCHE REALISATIE



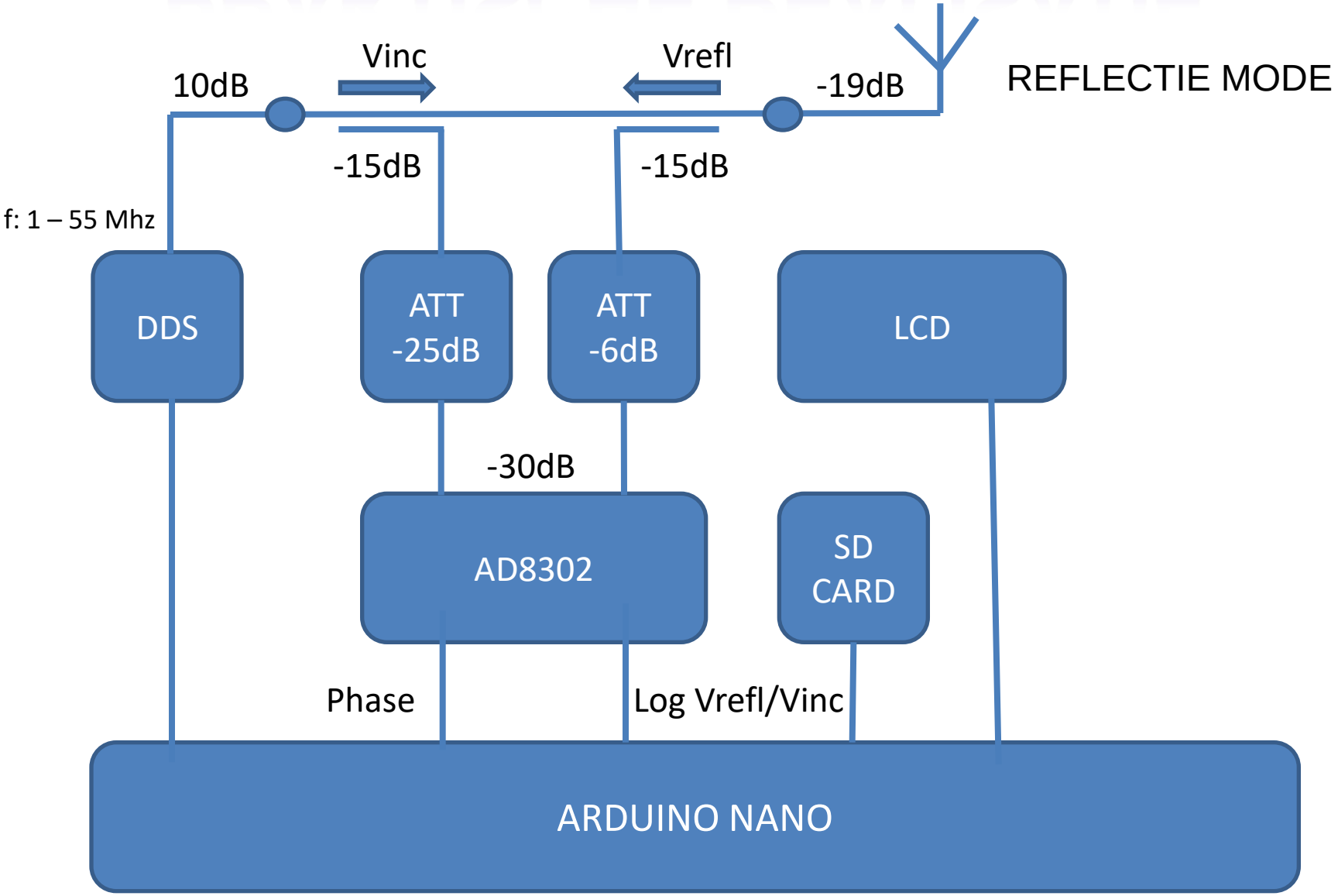




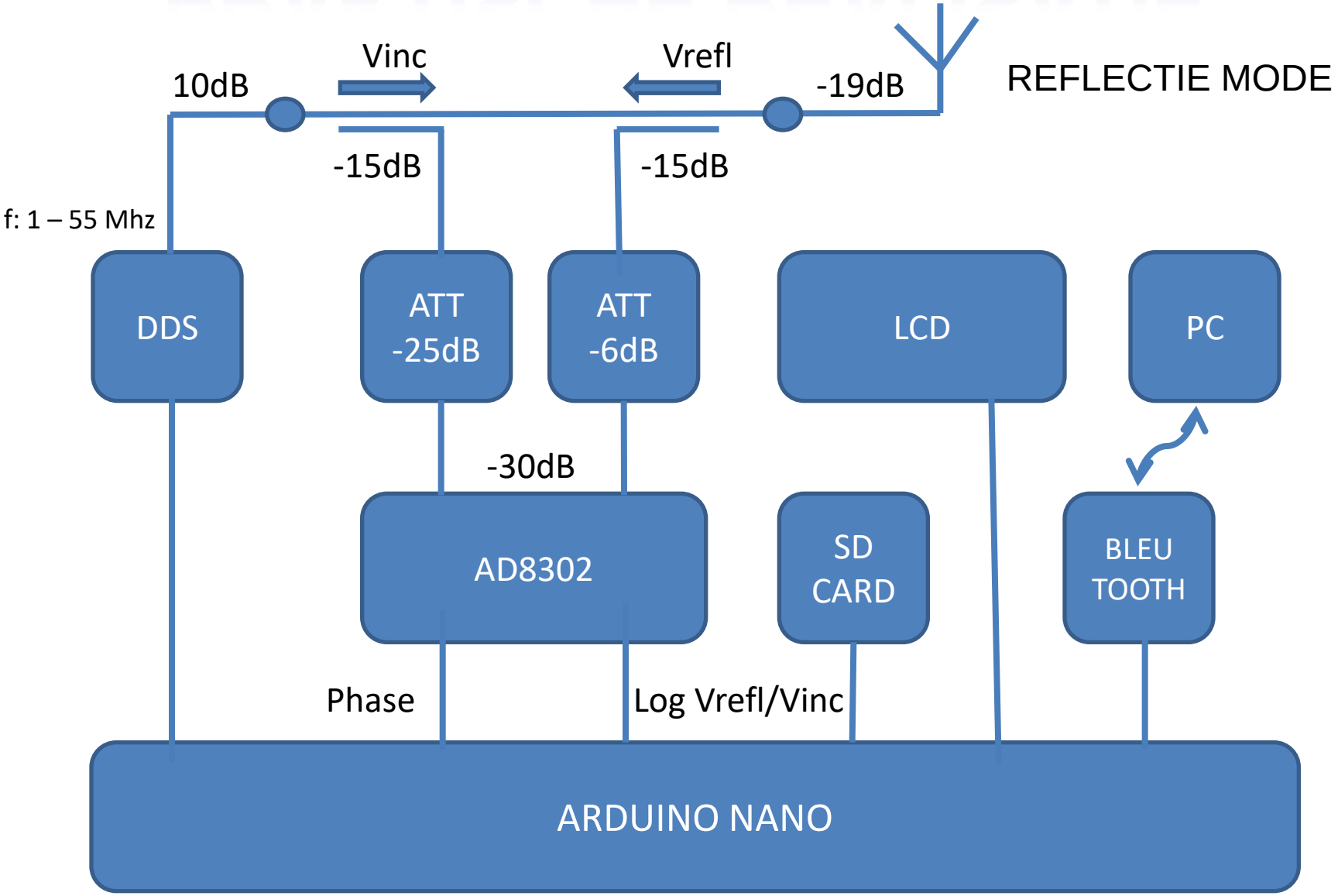
PRAKTISCHE REALISATIE



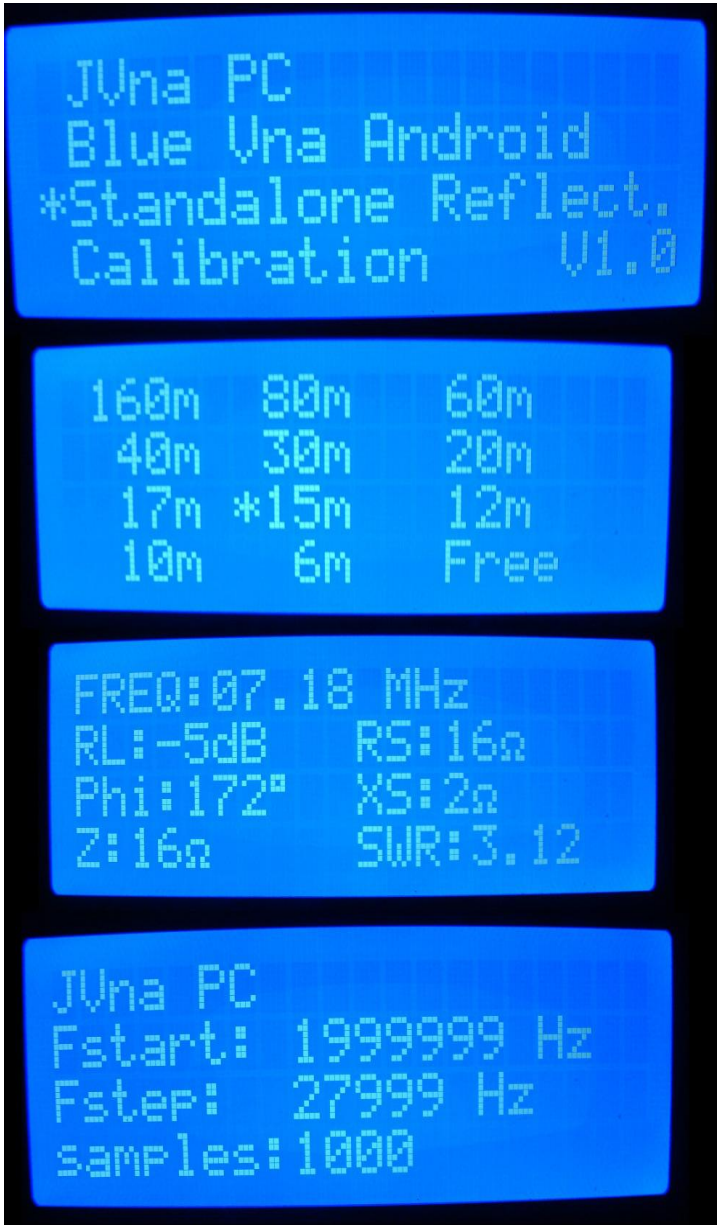
PRAKTISCHE REALISATIE

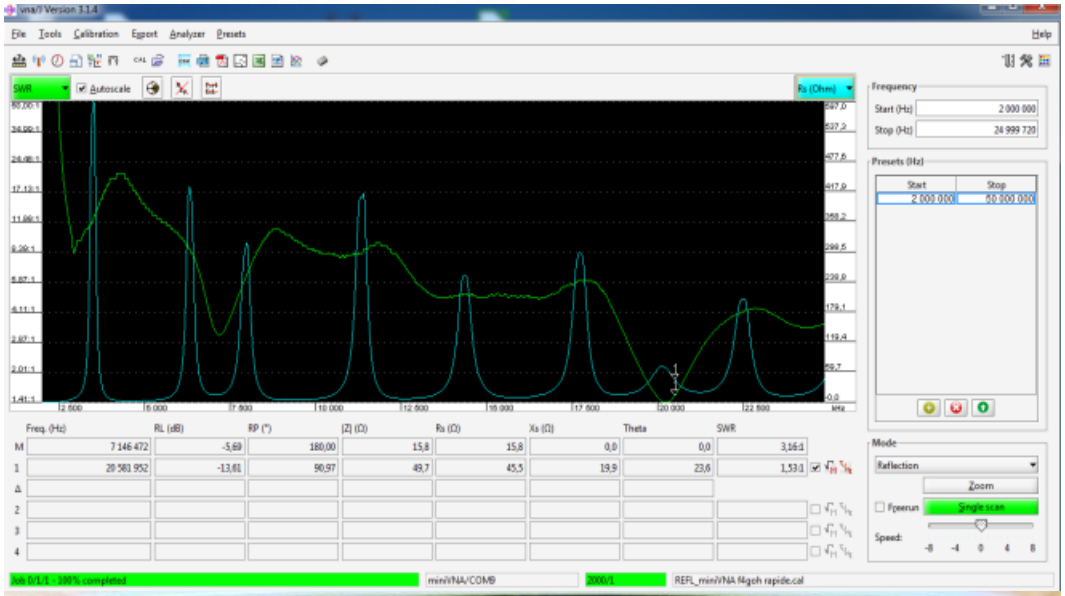


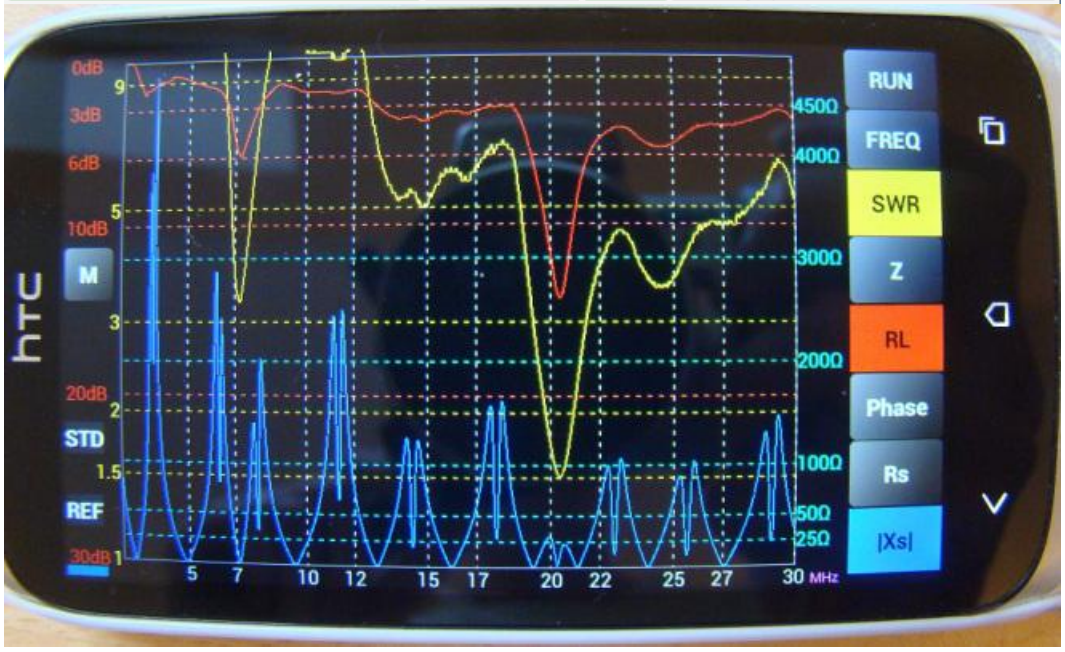
PRAKTISCHE REALISATIE



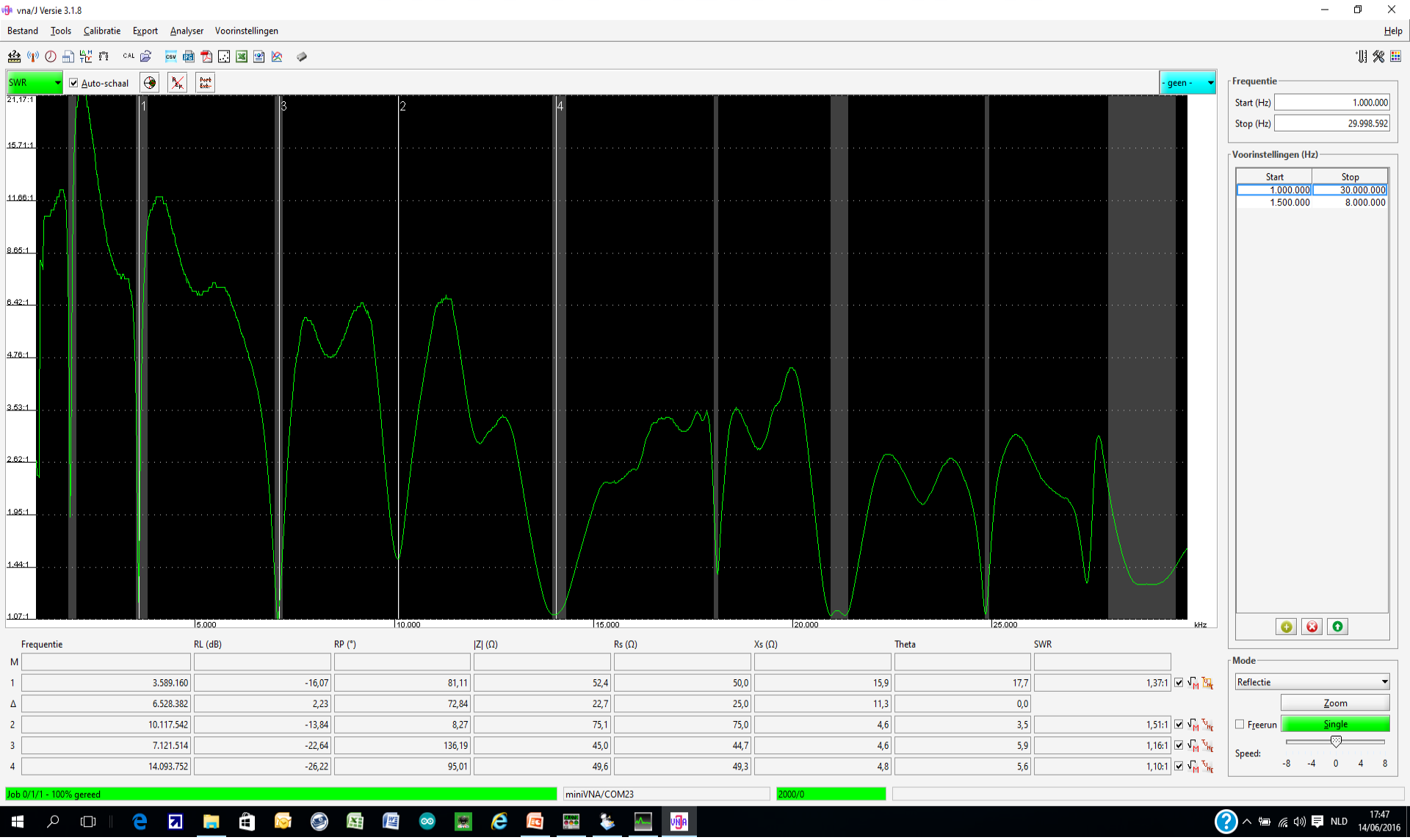
DE SOFTWARE


JVna PC
Blue Vna Android
*Standalone Reflect.
Calibration V1.0
160m 80m 60m
40m 30m 20m
17m *15m 12m
10m 6m Free
FREQ:07.18 MHz
RL:-5dB RS:16Ω
Phi:172° XS:2Ω
Z:16Ω SWR:3.12
JVna PC
Fstart: 1999999 Hz
Fstep: 27999 Hz
samples:1000

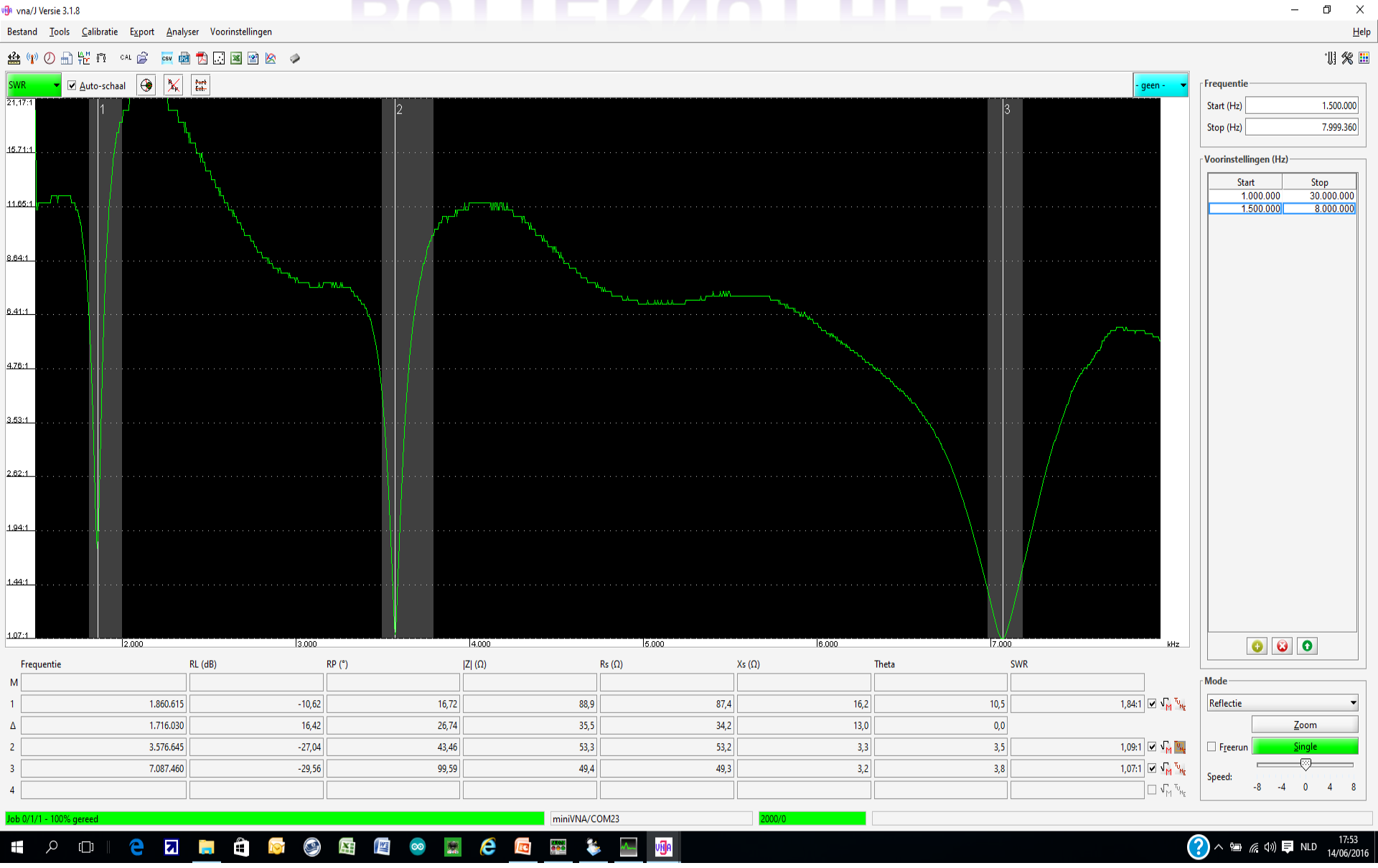

File Tools Calibration Export Analyzer Presets Help
SWR
Autoscale
Rs (Ohm)
Frequency
Start (Hz) 2 000 000
Stop (Hz) 24 999 720
Presets (Hz)
Start Stop
Freq. (Hz) RL (dB) RP (°) |Z| (Ω) Rs (Ω) Xs (Ω) Theta SWR
M 7 146 472 -5,69 180,00 15,8 15,8 0,0 0,0 3,16:1
1 28 581 952 -13,81 90,97 49,7 45,5 19,9 23,6 1,53:1
Mode
Reflection
Zoom
Freerun
Single scan
Speed:
Job 0/1/1 - 100% completed
miniVNA/COM9
REFL_miniVNA f4gch rapide.cal


htc
0dB
3dB
6dB
10dB
20dB
STD
REF
30dB
M
9
5
3
2
1.5
1
4500Ω
4000Ω
3000Ω
2000Ω
1000Ω
500Ω
250Ω
5 7 10 12 15 17 20 22 25 27 30 MHz
RUN
FREQ
SWR
Z
RL
Phase
Rs
|Xs|

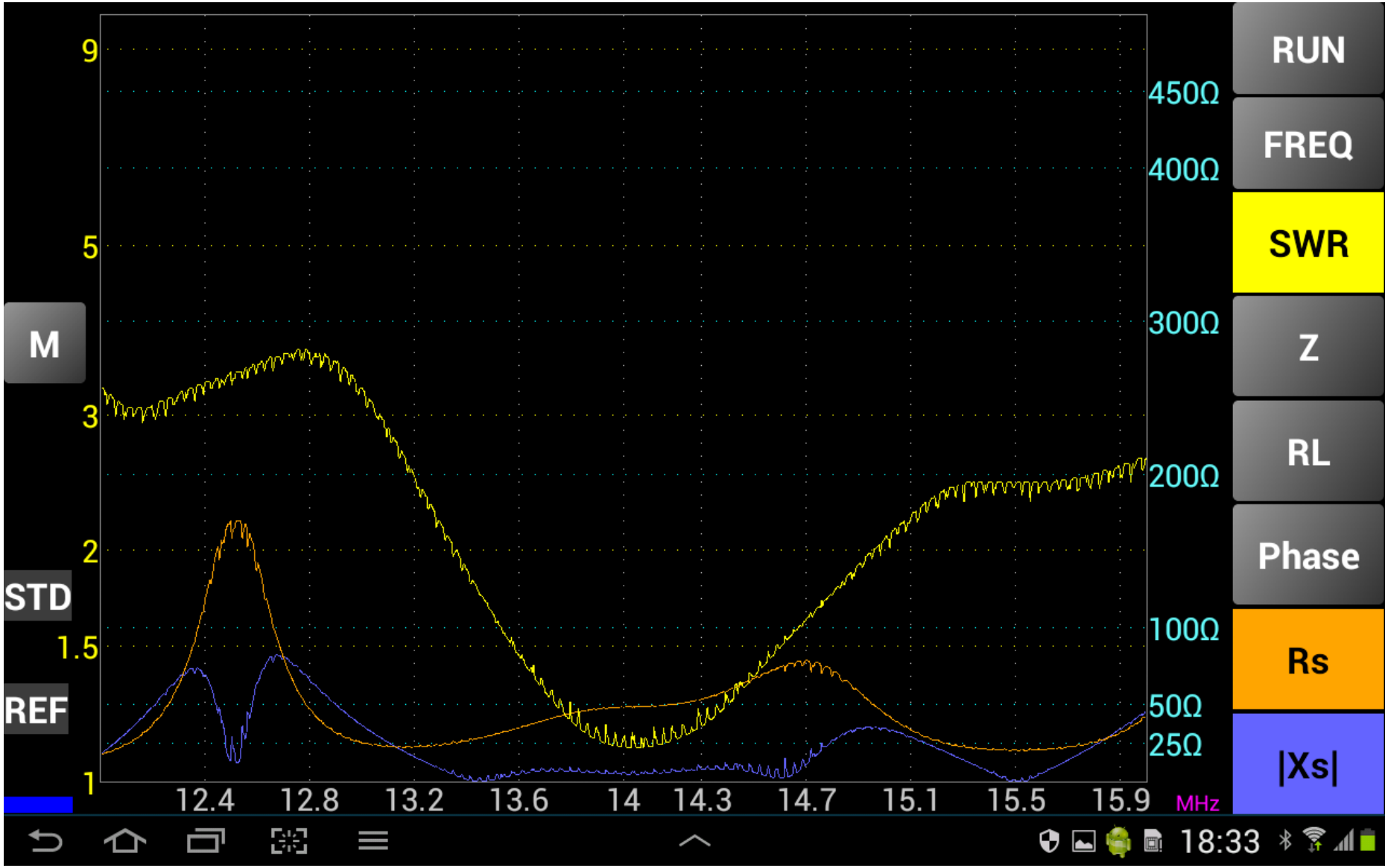
BUTTERNUT HF-9



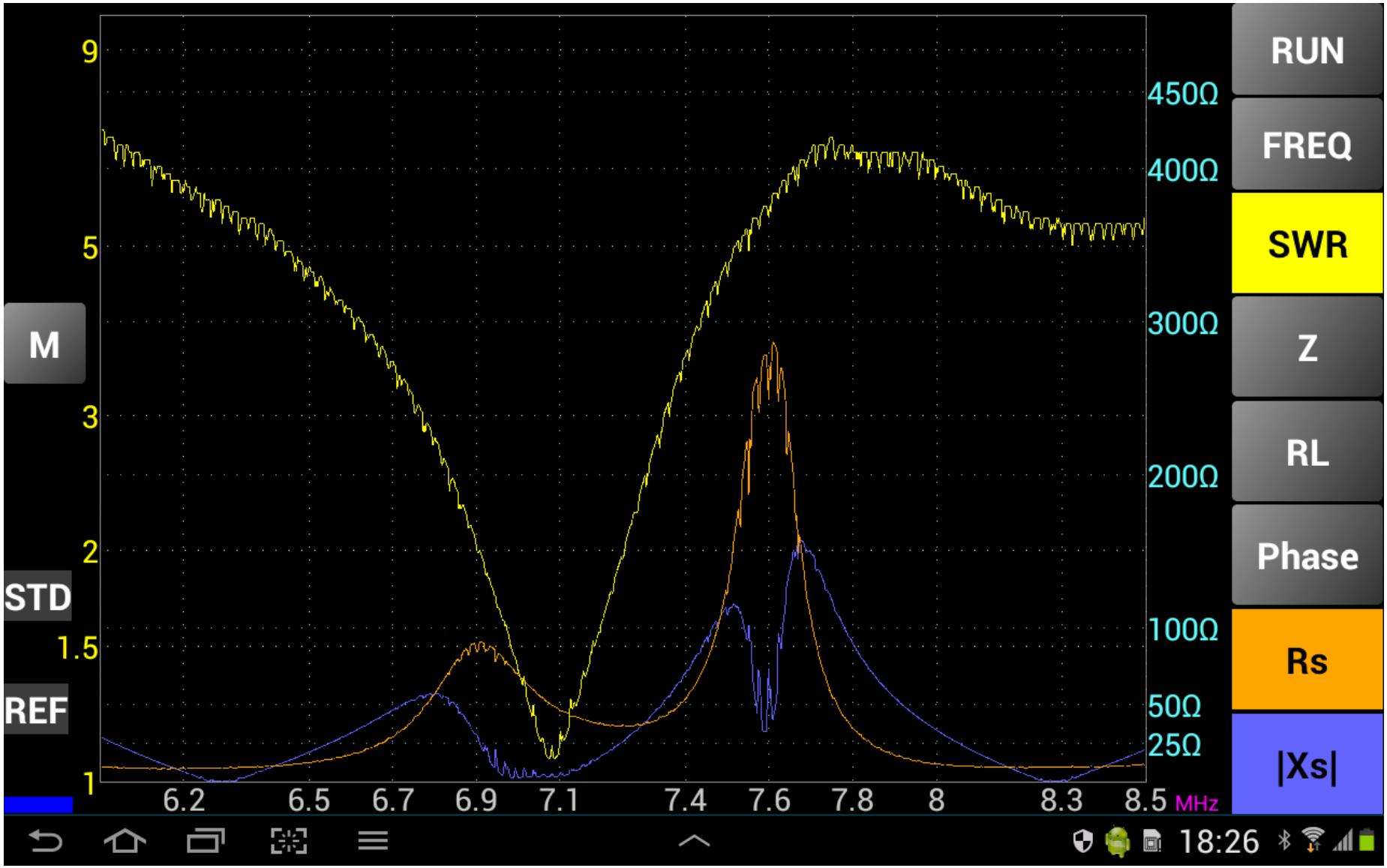
BUTTERNUT HF- 9



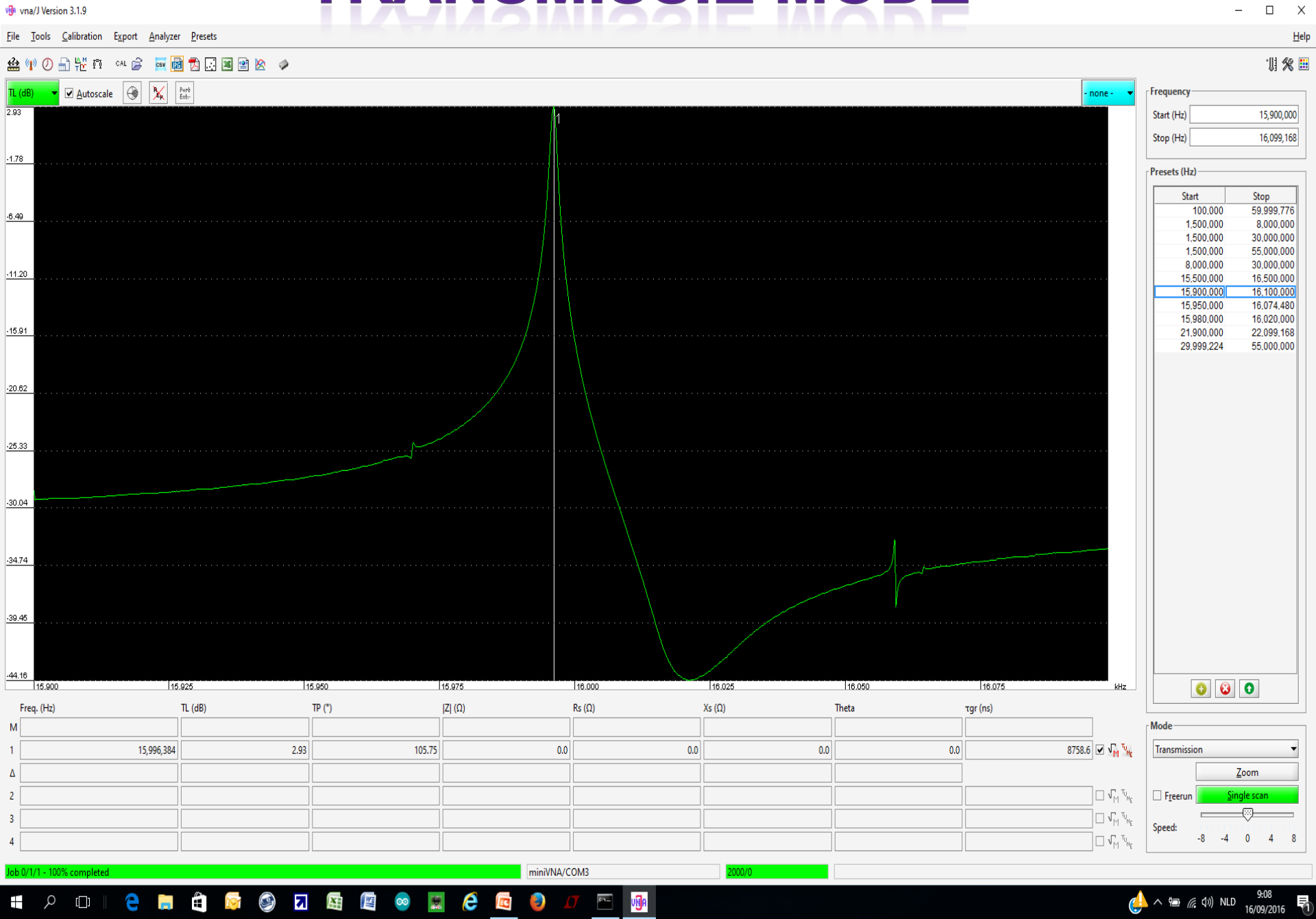
OP ANDROID TABLET

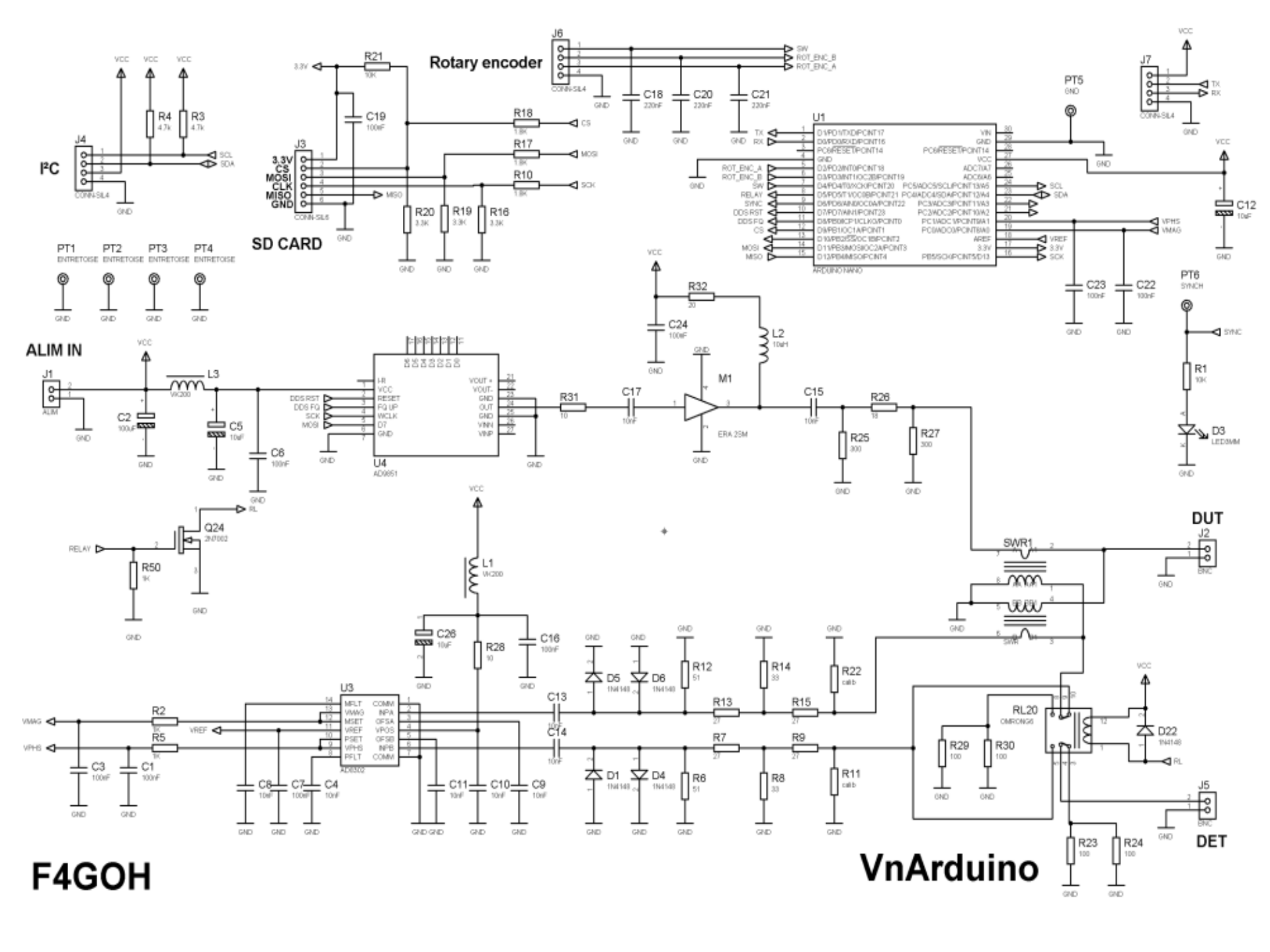


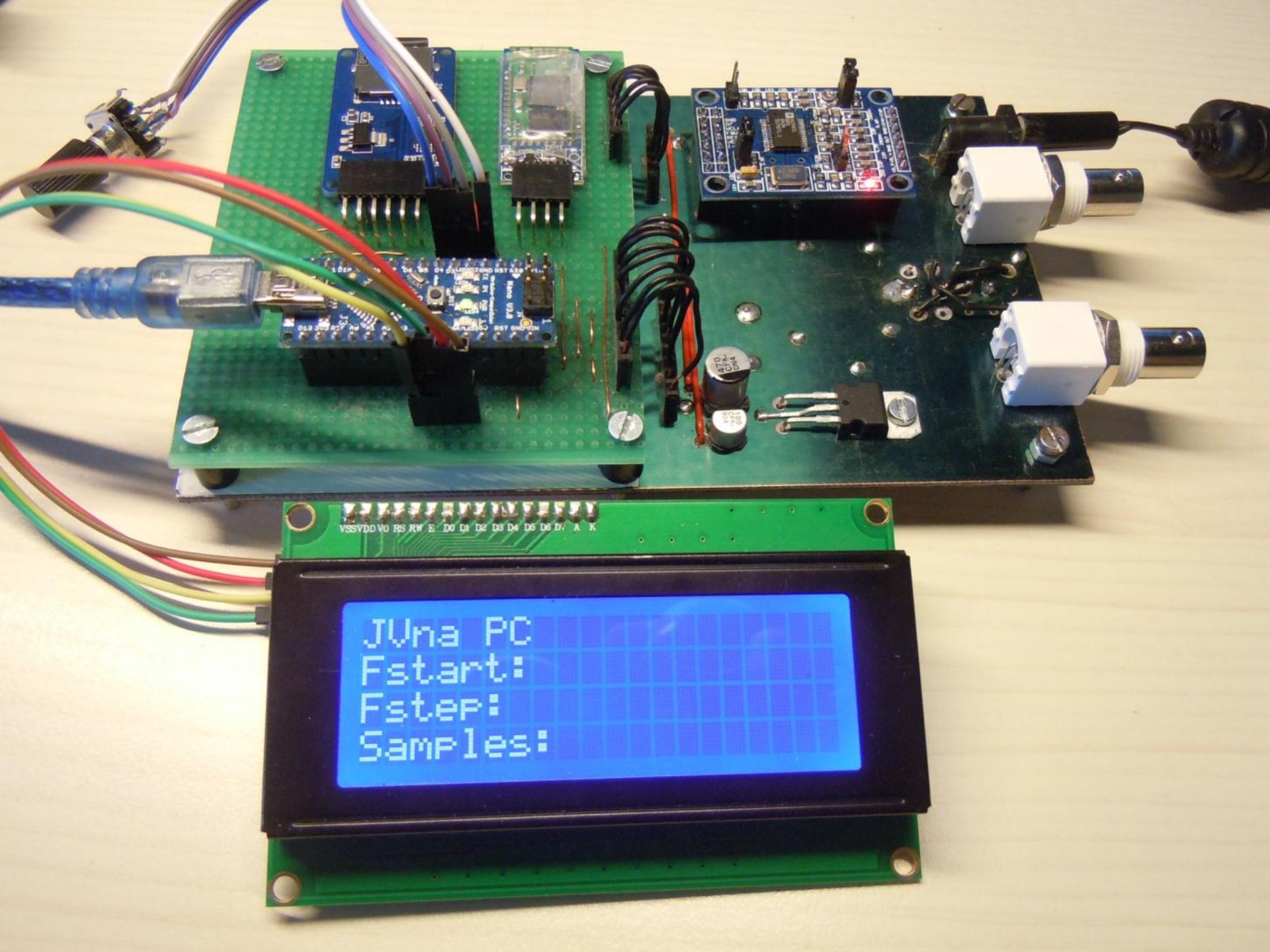
OP ANDROID TABLET

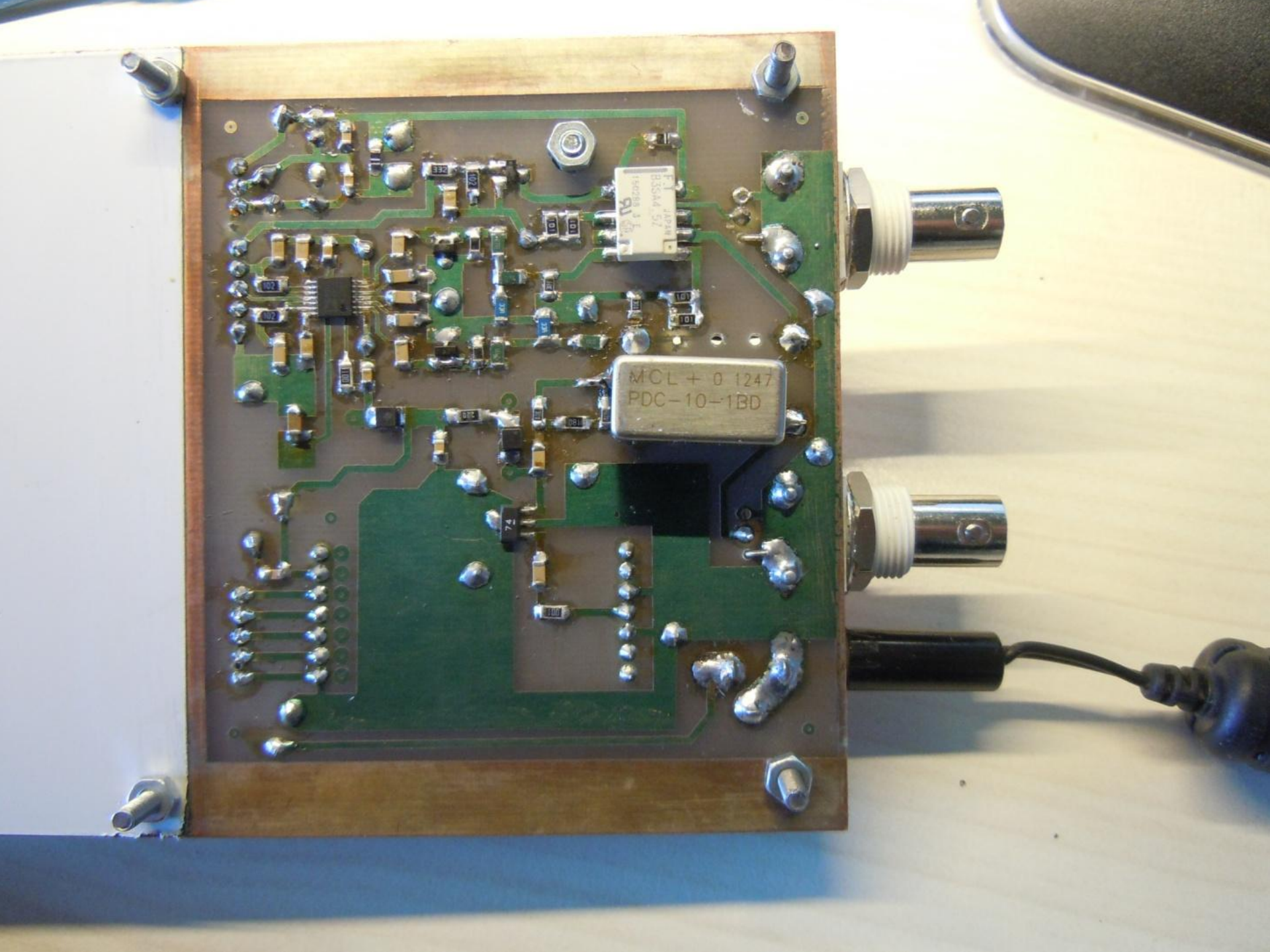


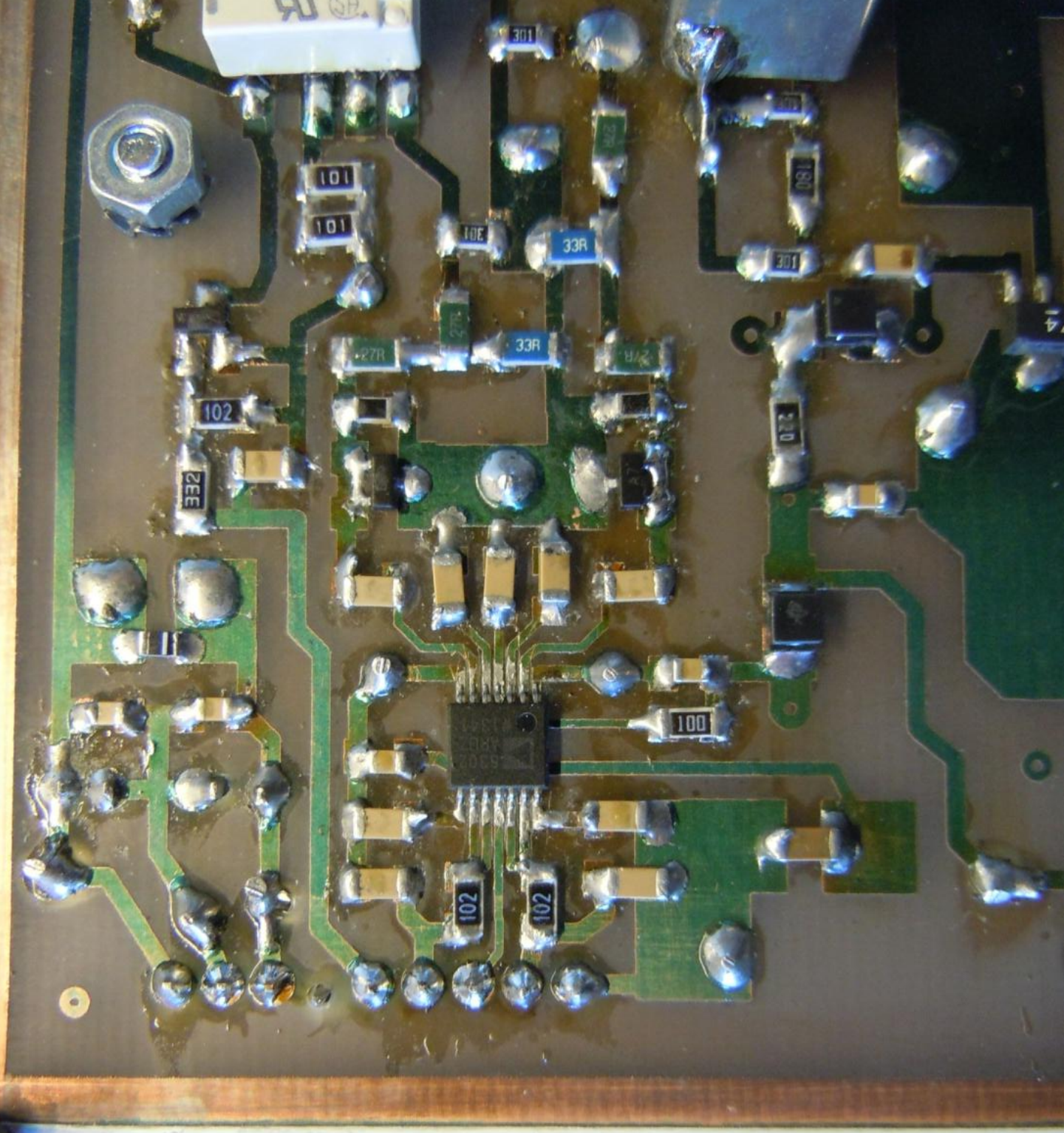
TRANSMISSIE MODE



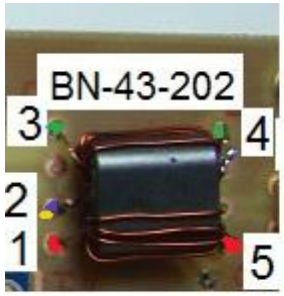

I²C
SD CARD
Rotary encoder
ALIM IN
DUT
DET
F4GOH
VnArduino

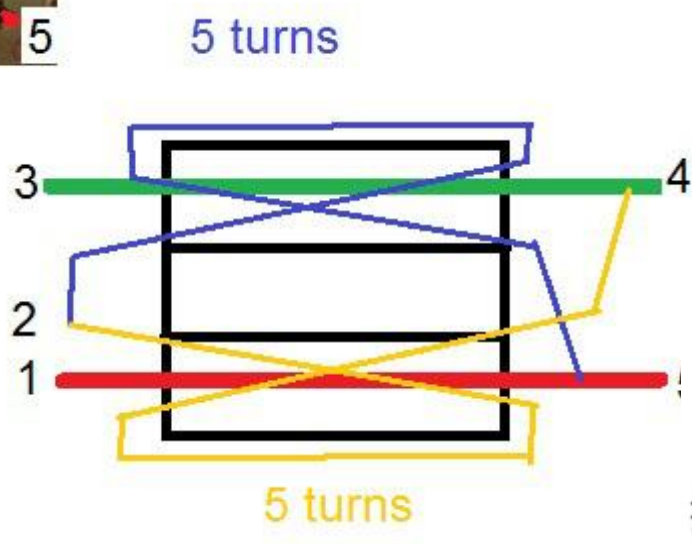

VSS VDD VO RS RW E D0 D1 D2 D3 D4 D5 D6 D7 A K
JVna PC
Fstart:
Fstep:
Samples:

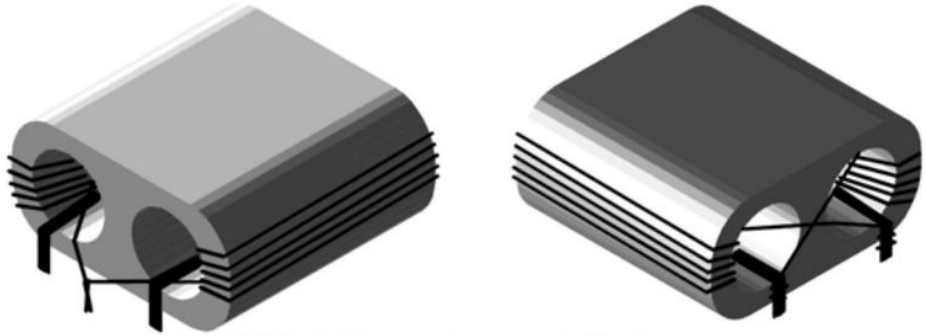

MCL + 0 1247
PDC-10-1BD


301
101
101
10E
33R
180
301
27R
33R
102
332
330
100
102
102

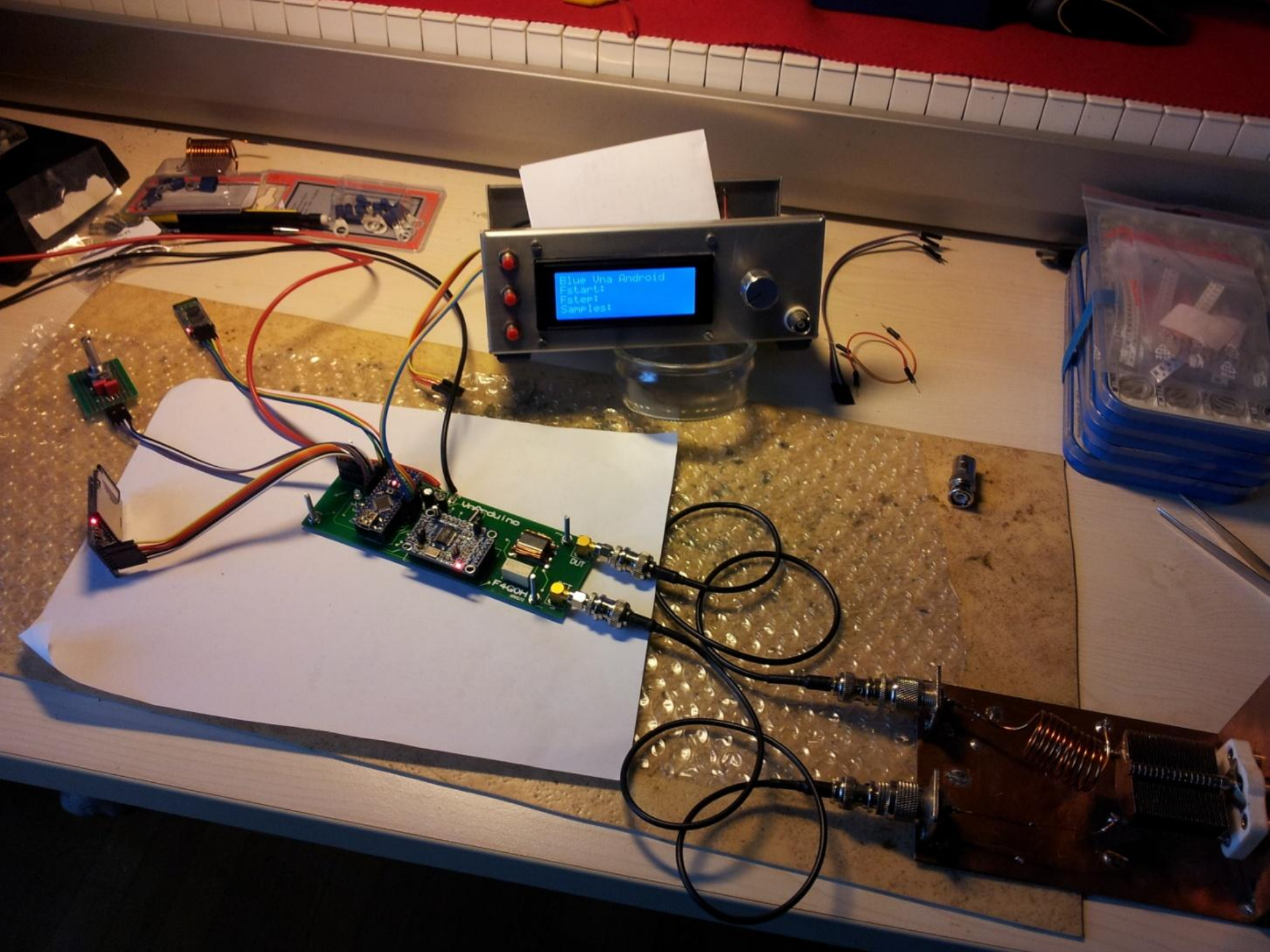
BIDIRECTIONELE COUPLER







BN-43-202 Tandem coupler 2x5 turns 0.5mm


Blue Una Android
Fstart:
Fstep:
Samples:
DUT


FREQ:10.10 MHz
RL:-29dB RS:50Ω
Phi:81° XS:3Ω
Z:50Ω SWR:1.06
PHILIPS

INFORMATIE

- https://hamprojects.wordpress.com/2015/06/21/hf-arduino-vna/#more-180 (F4GOH)
- Yahoo group: The Poor Ham's SNA
- Google naar
  - Antenne – analyzer (+ arduino)
  - Vector Network Analyzer (VNA)
  - Scalar Network Analyzer (SNA)
  - N2PK en DG8SAQ