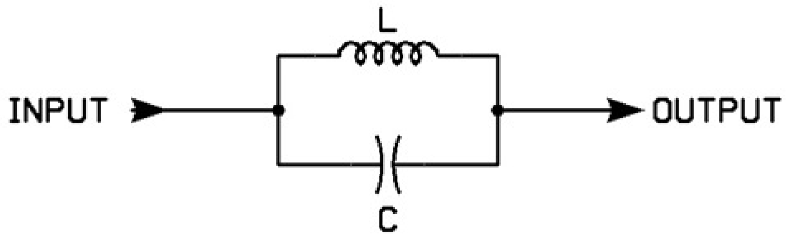
THE ART OF MAKING TRAPS

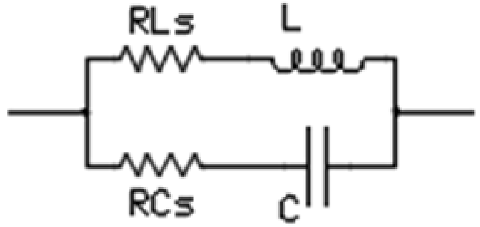
By iw2fnd Lucio

The Ideal Trap



$$f_0 = \frac{1}{2\pi\sqrt{LC}} \;\; [Hz]$$

The Real Trap



$$f_0 = \frac{1}{2\pi\sqrt{LC}} \sqrt{\frac{\frac{L}{C} - R_{Ls}^2}{\frac{L}{C} - R_{Cs}^2}} \;\; [Hz]$$

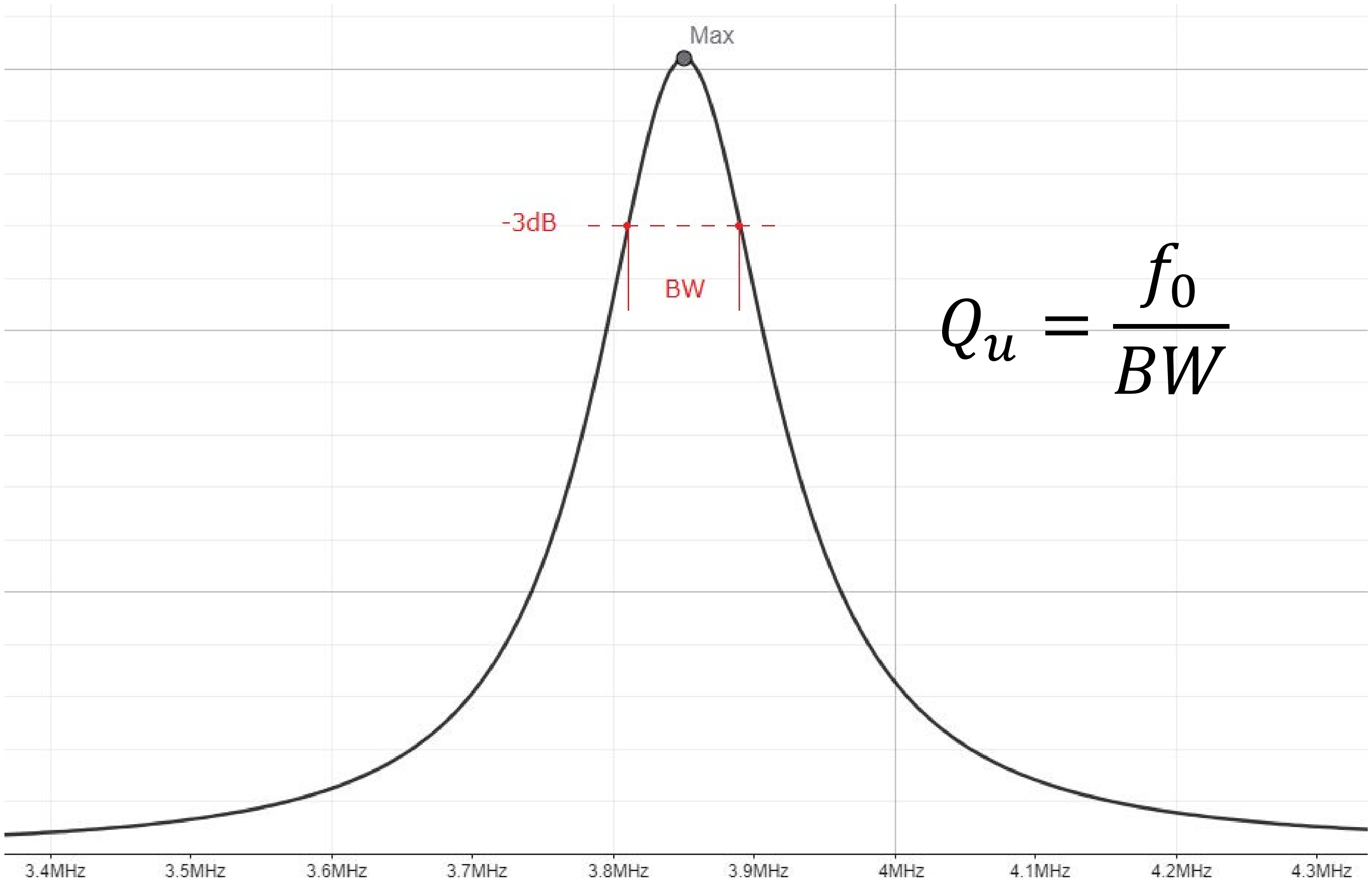
The Real Trap

DYNAMIC RESISTANCE

$$R_{p0} = \frac{R_{Ls}R_{Cs} + \frac{L}{C}}{R_{Ls} + R_{Cs}} \quad [\Omega]$$

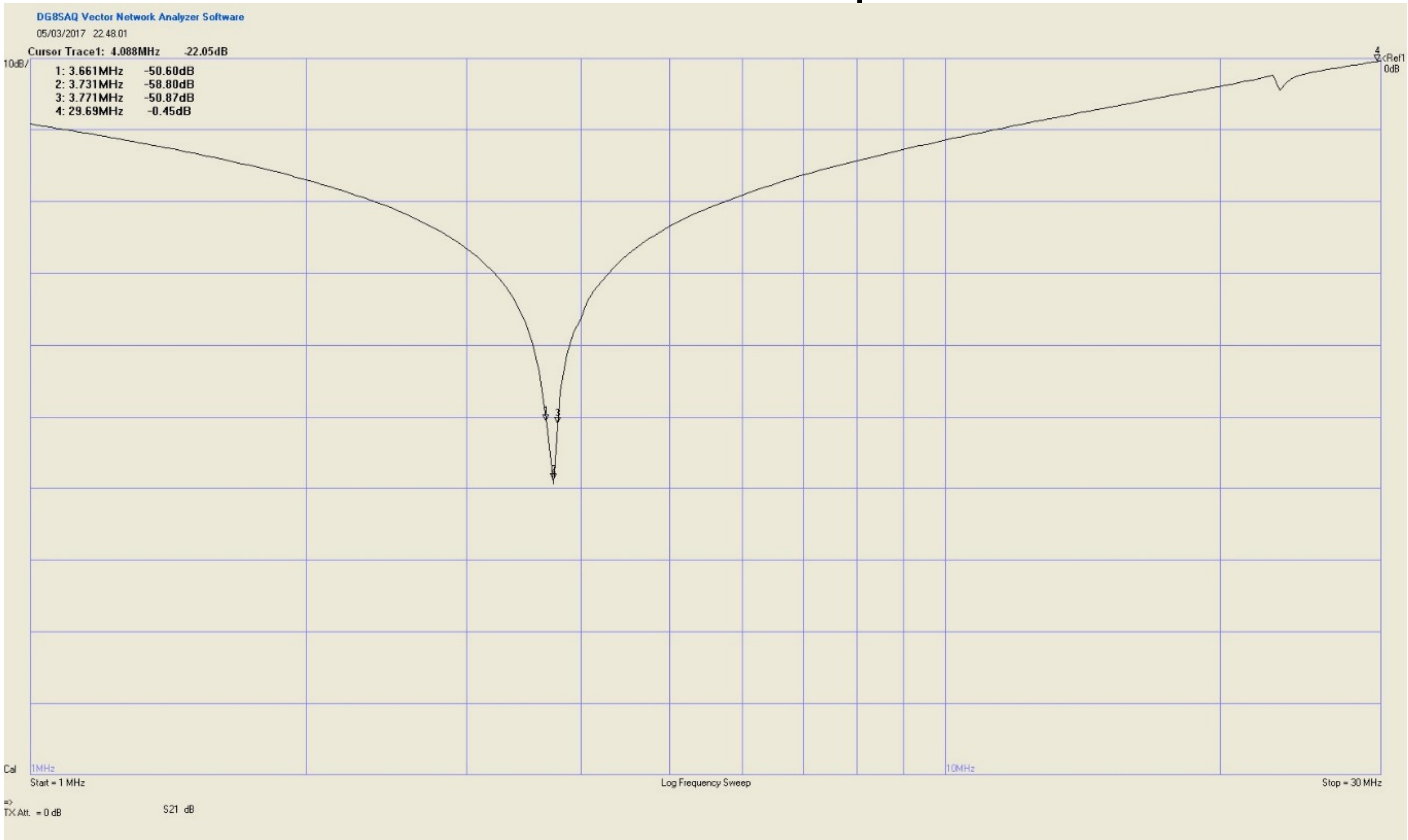
PARASITIC ELEMENTS	
INDUCTOR	**CAPACITOR**
$R_{Ls} = \frac{2\pi f L}{Q_L}$	$R_{Cs} = \frac{1}{2\pi f C Q_C}$

The Real Trap



$$Q_u = \frac{f_0}{BW}$$

The Real Trap



Design Phases

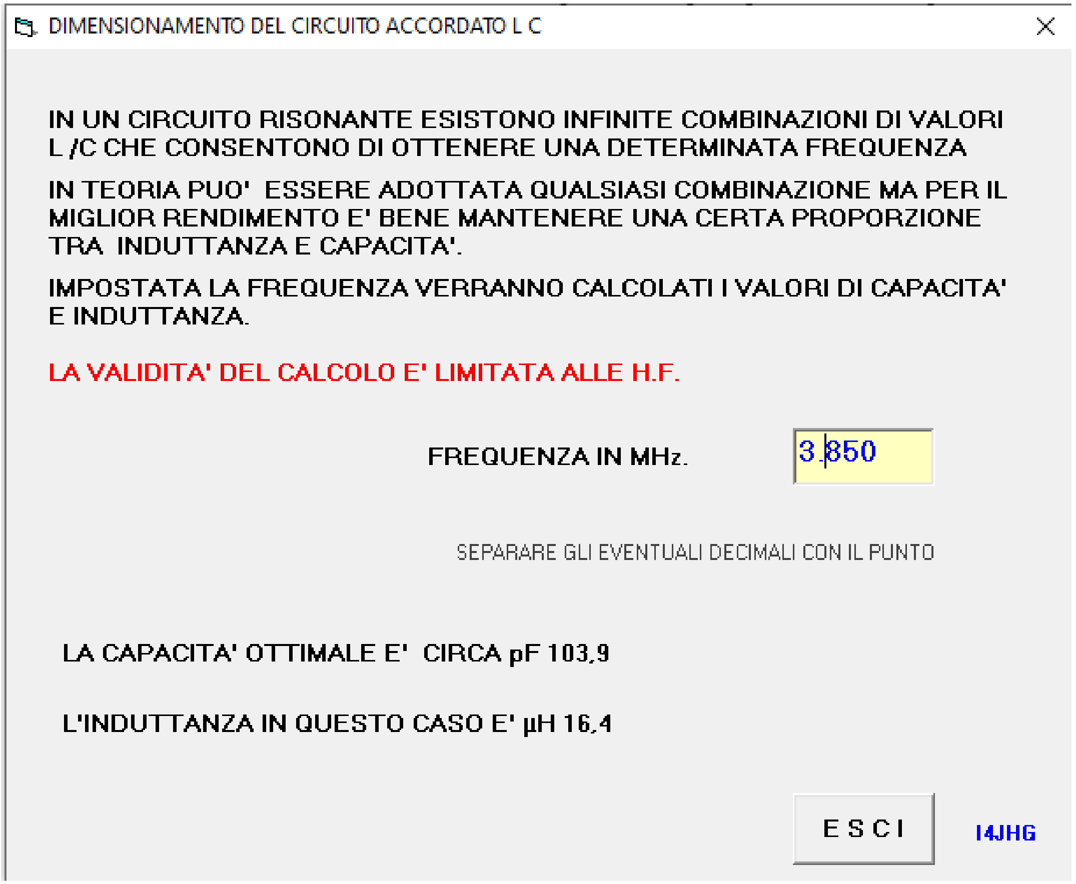
1. Selection of the Center Frequency and Capacitor;
2. Choice of Materials;
3. Inductor Design Calculation;
4. Practical Construction of the Inductor;
5. Assembly and Bench Tuning of the Trap.

Selection of the Capacitor

https://www.ari-scandiano.org/

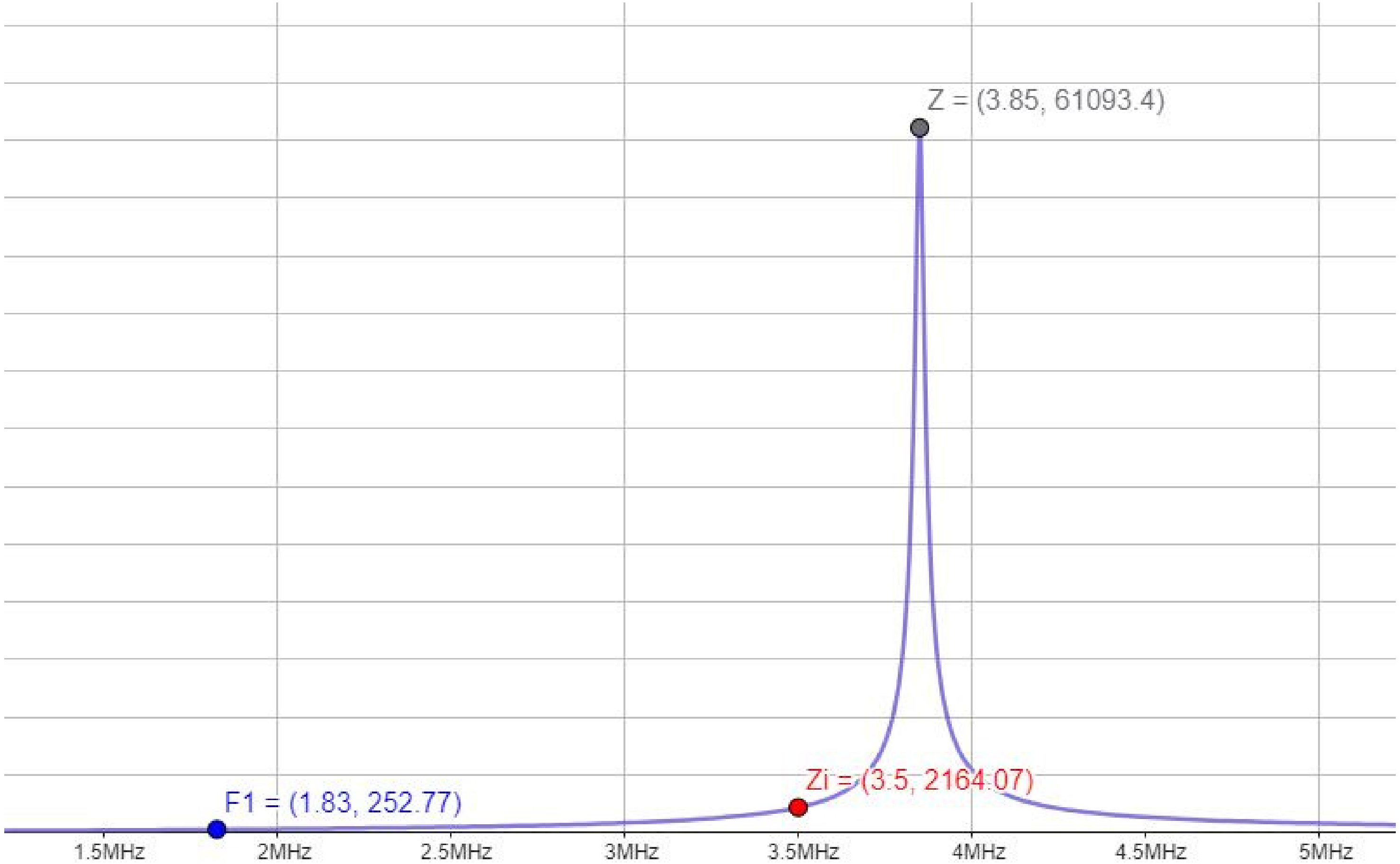
Selection of the Capacitor

Selection of the Capacitor



Inductor Dimensioning

Selection of the Center Frequency



Choice of the Coil Former

C. Plastics

Material	Dielectric Type	Freq / Hz	εr'	Tanδ	Dielectric strength / kV/mm	resistivity, ρ / Ωm
ABS (acrylonitrile-butadiene-styrene)	Polar	60	2.4 - 5.0	0.003 - 0.008	-	10^{14}
		1k	2.5 - 3.0	-		
		1M	2.4 - 3.8	0.007 - 0.015		
Acrylic (polymethyl-methacrylate, Perspex, Lucite, Plexiglass) 20°C	Polar	60	3.5 - 4.5	0.04 - 0.06	40	$>10^{15}$
		1k	3.5 - 4.0	0.040		
		1M	3.0 - 3.3	0.02 - 0.030		
		100M	2.6	0.036		
		1G	2.58	0.009		
ETFE (ethylene-tetrafluoroethylene copolymer, Tefzel)	slightly polar	1k	2.6	<0.0006	200 (1 mil) 160 (5 mil)	10^{16}
		1M	2.6	0.005		
		1G	2.4	0.0055		
Nylon-66 (ordinary, typical) 20°C	Polar	60	4.0 - 4.6	0.014 - 0.04	–	10^{12}-10^{13} dry (10^{10} @ 50%RH)
		1M	3.4 - 3.6	0.04		
		100M	3	0.02		
PET (polyethylene-terephthalate, polyester, Mylar), 20°C	Polar	50	3.2	0.002	300 (1mil) 134 (5mil)	10^{16} - 10^{17}
		1k	3.2	0.005		
		1M	3.0	0.016		
		100M	2.9	0.013		
		1G	2.8	0.003 - 0.008		
PEEK (polyether ether ketone)	Polar	100	3.2	0.001	24 (? mm)	$>10^{16}$
		1 M	3.2	0.002		
Polycarbonate (PC, Lexan, Merlon, Tuffak) typical 20°C	Polar	60	3.17	0.0009	250 (1 mil) 80 (5 mil)	2×10^{14}
		1k	2.99	0.0015		
		1M	2.93 - 2.96	0.010		
		1G	2.89	0.012		
Polyethylene (Polythene, PE) 20°C	non-polar	50 - 1G	2.2 - 2.35 typ 2.3	< 0.0003	200 (1 mil) 120 (5 mil)	10^{14} - 10^{18}
Polypropylene (PP) 20°C	non-polar	50 - 1G	2.2 - 2.6 typ 2.2	<0.0005 typ 0.0003	100 (5 mil)	10^{13} - 10^{16}
Polystyrene (PS, Distrene, Vitron, Trolitul) 20°C	non-polar	50 - 1G	2.4 - 2.7	0.0002 - 0.0005	200 (1 mil)	10^{17} - 10^{19}
		1M	2.56	0.00007		
		100M	2.55	0.0001		
		10G	2.54	0.00043		
PTFE (poly-tetrafluoroethylene, Teflon), 20°C	non-polar	50 - 3G	2.0 - 2.1	≤0.0002	50-80 (1 mil) 40 (5 mil)	10^{17} - 10^{19}
PVC, plasticised (polyvinylchloride) 20°C	Polar	1k	4.0 - 8.0	0.07 - 0.16	60 (5 mil)	5×10^{9} - 5×10^{12}
		1M	3.3 - 4.5	0.04 - 0.14		
		10M	4	0.06		
PVC-U (unplasticised) 20°C	Polar	50	3.2	0.02	55 (5 mil)	5×10^{12} - 10^{16}
		1k	3.0 - 3.3	0.009 - 0.017		
		1M	2.7 - 3.1	0.006 - 0.017		
		100M	2.8	0.01		
		1G	2.8	0.019		

Choice of the Coil Former

E. Material selection by loss tangent.

Lossy Tanδ ≥ 0.01 (δ ≥ 0.57°)	Good 0.01 > Tanδ ≥ 0.001 (0.57° > δ ≥ 0.057°)	Excellent Tanδ < 0.001 (δ < 0.057°)
Fibreglass (GRP) Nylon PVC Phenolic (SRBF, SRBP) Rubber Neoprene Wood	ABS* Acrylics (Perspex, Plexiglass)* Glass, Porcelain PET (Mylar, polyester) Polycarbonate (Lexan) Silicone rubber ETFE (Tefzel)	Vacuum Air Mica Polyethylene (PE) Polypropylene (PP) Polystyrene (PS) PTFE (Teflon)

* Borderline performance. Tail-end of low-frequency dispersion occurs in HF range.

F. Weathering and high-temperature limits of plastics and rubbers.

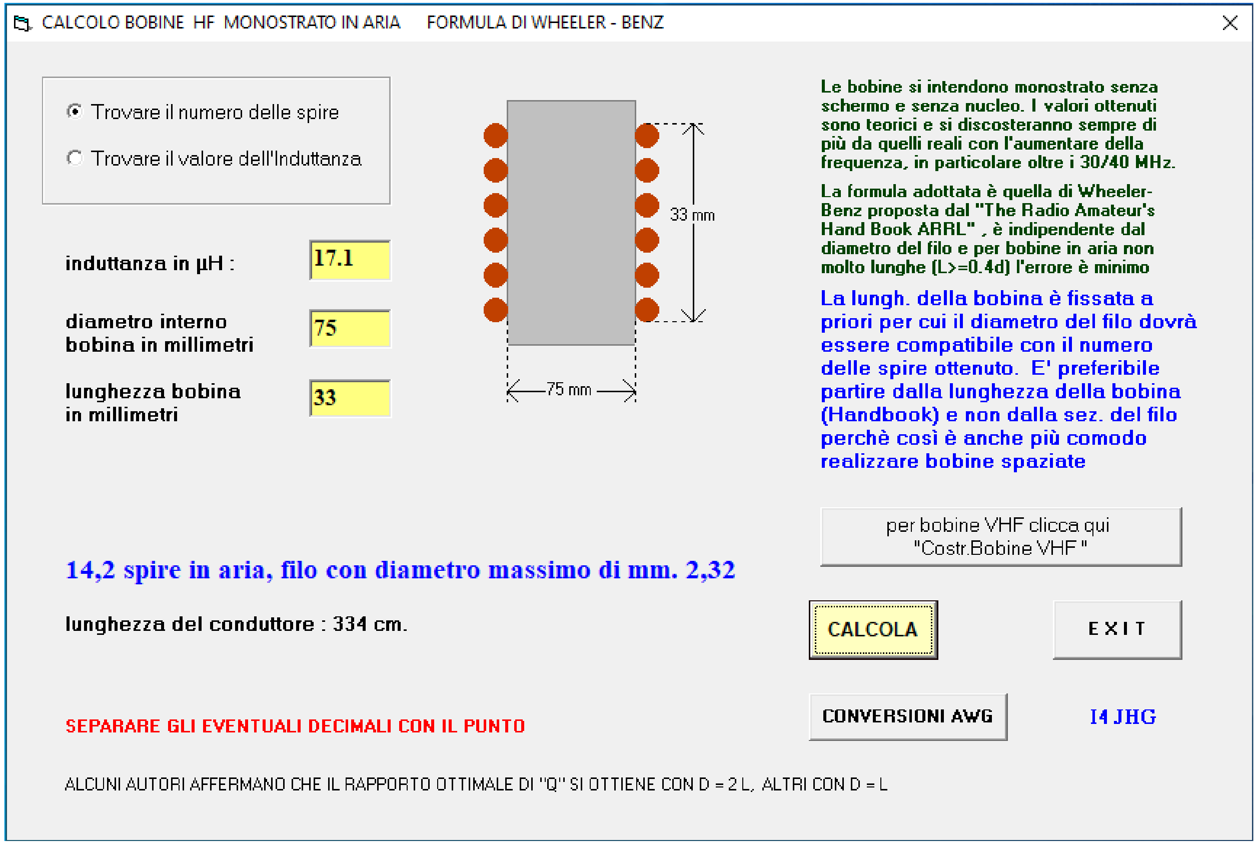
Material	Water absorption (Saturated)	Melting or softening temp. / °C	UV Resistance
ABS	0.6 - 1%	Softens >77	Fair
Acrylic	0.3 - 0.4%	Softens 180	Good
ETFE	< 0.02%	Melts 270	Fair - Good
Nylon 66	8.5% saturated (2.5% @ 50% RH)	Melts 218	Fair
Polycarbonate	0.35 %	Softens 132	Fair
Polyethylene	< 0.01%	Melts ~133	Poor* - Fair
Polypropylene	< 0.03%	Melts 168	Poor* - Fair
Polystyrene	0.04 - 0.1%	Softens ~98	Poor - Fair
PTFE	0	Melts 327	Very Good
PVC (plasticised)	Negligible		Fair
PVC-U	Negligible	Softens ~80	Fair - Good
Rubber (Natural)		Decomposes	Very poor
Neoprene		Decomposes	Poor
Silicone Rubber	~0	Thermoset	Good

Sources for table F: Refs [40], [8] + practical experience. UV Resistance: Good = no significant change in properties on prolonged exposure. Fair = changes in surface properties or transparency, but maintains structural integrity. Poor = becomes brittle and disintegrates.
* Basic UV resistance may be improved by additives. Addition of carbon black gives UV resistance by preventing light penetration but increases Tanδ.

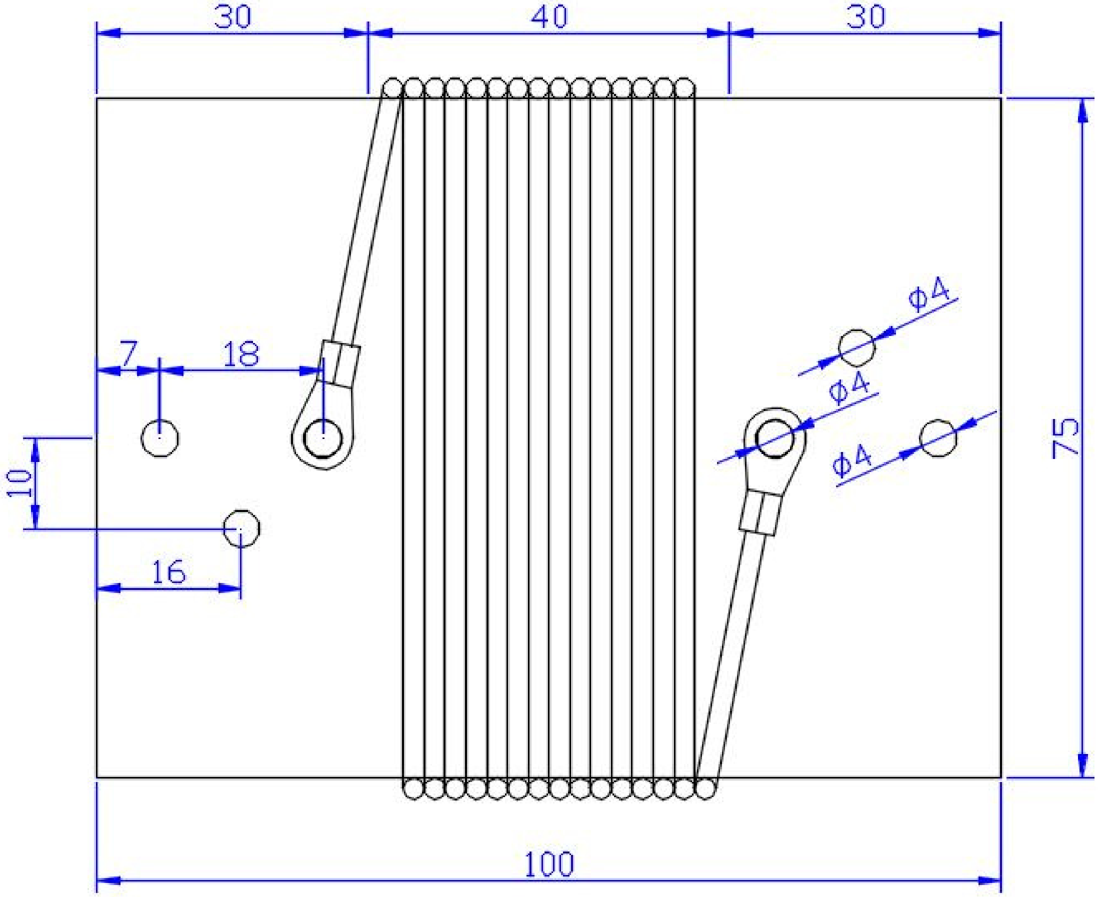
MATERIALE	g/cm^3
PolyEtylene (PE)	0,94 – 0,96
PolyPropilene (PP)	0,90 – 0,96
Teflon (PTFE)	2,18 - 2,20
PolyVinilCloruro (PVC)	1,35 – 1,45

Inductor Design Calculation

$$L = \mu_0 \mu_r \, N^2 \, \frac{A}{l} \;\; [H]$$



Coil Former Preparation



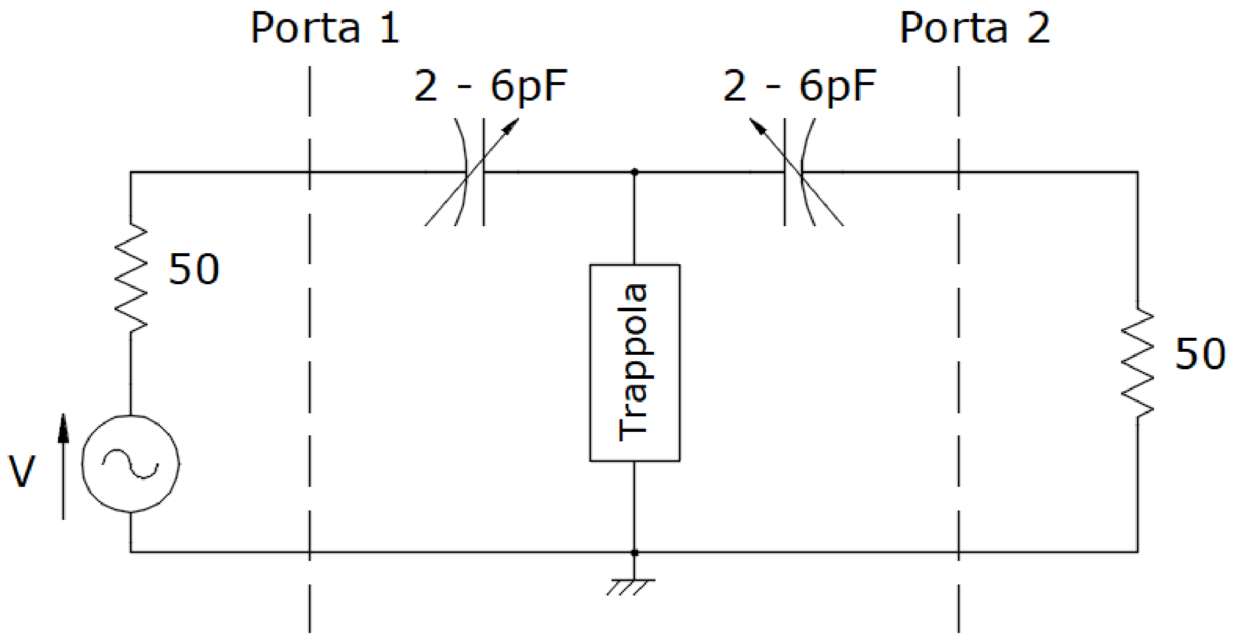
Sezione Cavo FS17	Diametro Esterno [mm]
1x1,5	3,0
1x2,5	3,6
1x4	4,1
1x6	4,6

Calculation of the Unloaded Q of the Trap

$$Q_u = \frac{Q_L Q_C}{Q_L + Q_C} = \frac{237 \cdot 16271}{237 + 16271} = 233$$

$$\mathrm{BW} = \frac{f_0}{Q_u} = \frac{3850}{233} = 16{,}5\ kHz$$

Measurement of the Unloaded Q of the Trap



Attenuazione almeno -30bB

$$Q_u = \frac{f_0}{BW}$$

Trap Impedances at 3810 kHz