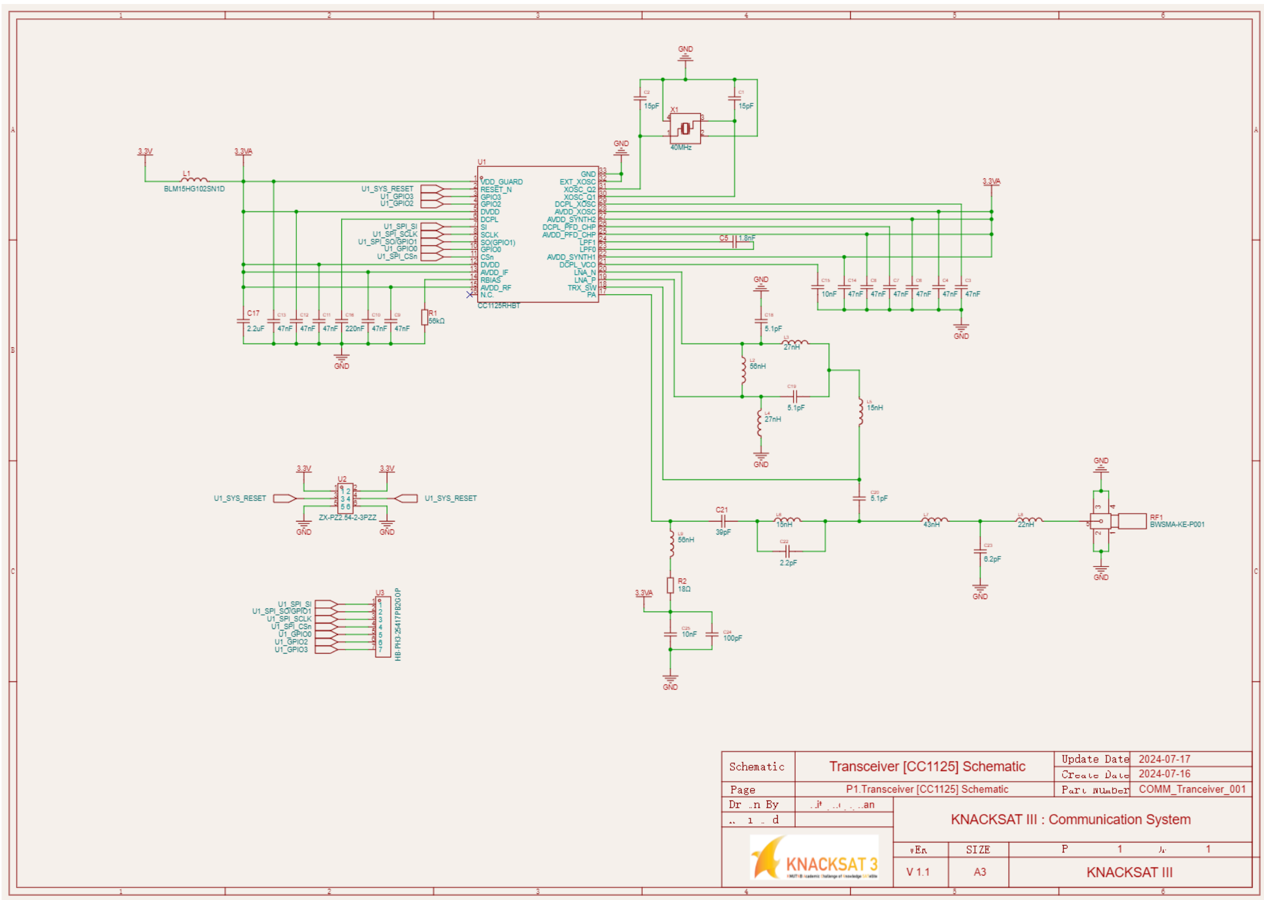
Transceiver Design Documentation

Transceiver [CC1125] Schematic Design



Detail

Transceiver chip :

[CC1125 Ultra-High Performance RF Narrowband Transceiver]()

Communication Interface :

[Serial Peripheral Interface (SPI)]()

Transceiver User's Guide :

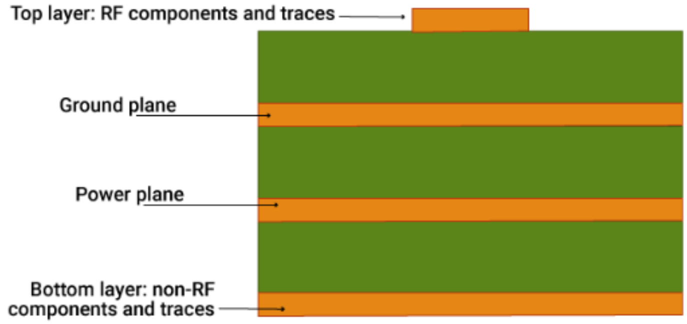
[User's Guide [SWRU295E] CC112X CC1175 Low Power High Performance]()

Application Report :

[Achieving Optimum Radio Range]()

PCB Design

Layer



Dielectric constant for FR4-grade : 4.5

Transmission line (Microstrip trace)

Transmission line effects

There is no straightforward answer to the question "when do I have to start considering transmission line properties?" The best response is, when the effects become important to you. One of the simplest electrical laws is that which relates frequency, wavelength and the speed of light:

$$\lambda \quad = \quad 3 \cdot 10^8 / f$$

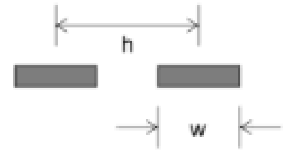
which is modified because of the reduction in velocity of propagation when a (lossless) dielectric medium is involved by the relative permittivity or dielectric constant of the medium,

$$\lambda_d \quad = \quad \lambda / \sqrt{\varepsilon_r}$$

One rule of thumb is that a cable should be considered as a transmission line when the wavelength of the highest frequency carried is less than ten times its length. You may be embarrassed by transmission line effects at lengths of one fortieth the wavelength or

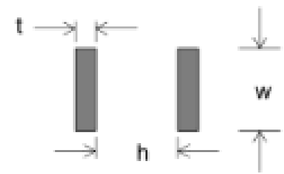
1. Side-by-side parallel strip

$$Z_o = 120/\sqrt{\varepsilon_r} \cdot \ln\{h/w + \sqrt{[(h/w)^2 - 1]}\}$$



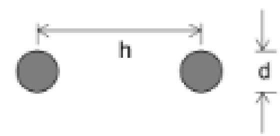
2. Face-to-face parallel strip

$$Z_o = 377/\sqrt{\varepsilon_r} \cdot h/w \quad \text{if } h > 3t,\ w >> h$$
$$120/\sqrt{\varepsilon_r} \cdot \ln 4h/w \quad \text{if } h >> w$$



3. Parallel wire

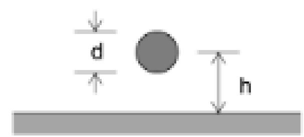
$$Z_o = 120/\sqrt{\varepsilon_r} \cdot \ln\{h/d + \sqrt{[(h/d)^2 - 1]}\}$$
$$120/\sqrt{\varepsilon_r} \cdot \ln 2h/d \quad \text{if } d << h$$



(Z_o of typical pvc-insulated pairs and twisted pairs is around 100Ω)

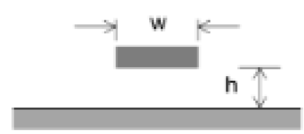
4. Wire parallel to infinite plate

$$Z_o = 60/\sqrt{\varepsilon_r} \cdot \ln\{2h/d + \sqrt{[(2h/d)^2 - 1]}\}$$
$$60/\sqrt{\varepsilon_r} \cdot \ln 4h/d \quad \text{if } d << h$$



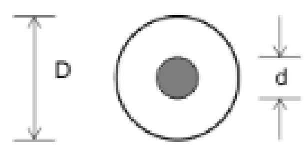
5. Strip parallel to infinite plate

$$Z_o = 377/\sqrt{\varepsilon_r} \cdot h/w \quad \text{if } w > 3h$$
$$60/\sqrt{\varepsilon_r} \cdot \ln 8h/w \quad \text{if } h > 3w$$



6. Coaxial

$$Z_o = 60/\sqrt{\varepsilon_r} \cdot \ln(D/d)$$



Dielectric constants of various materials	ε_r	Velocity factor ($1/\sqrt{\varepsilon_r}$)
Air	1.0	1.0
Polythene/Polyethylene	2.3	0.66
PTFE	2.1	0.69
Silicone Rubber	3.1	0.57
FR4 Fibreglass PCB	4.5 (typ)	0.47
PVC	5.0	0.45

Table 1.9 Characteristic impedance, geometry and dielectric constants

Passive Component for RF circuit

SRF (Self Resonance Frequency) : Maximum Frequency that can use before the component transform to Invalid behavior

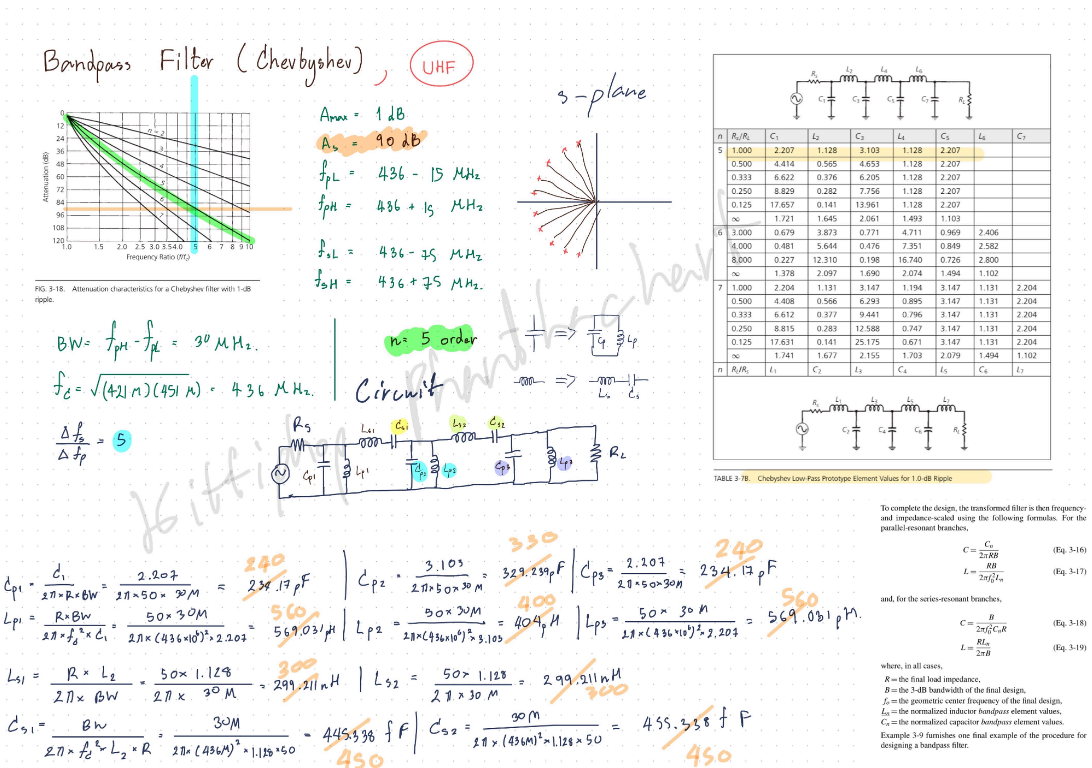
Recommended Maximum Frequencies for Capacitors

TYPE	MAX FREQUENCY
Aluminum Electrolytic	100 kHz
Tantalum Electrolytic	1 MHz
Mica	500 MHz
Ceramic	1 GHz

LC Ladder Bandpass Filter (@436MHz)

LC Ladder Bandpass Filter Design

Type of Filter : 5'th order Chebyshev filter with 1-dB Ripple



Reference Filter Design :

RF Circuit Design - 2nd Edition.pdf / Chapter 3 FILTER Design

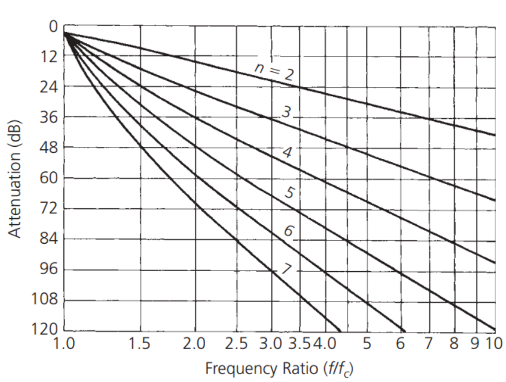
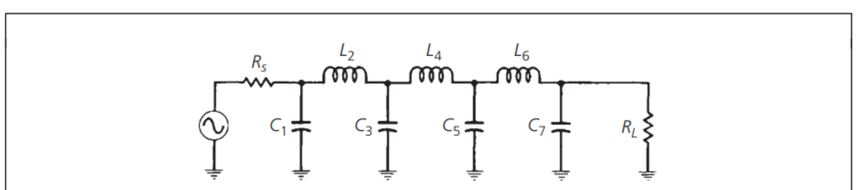


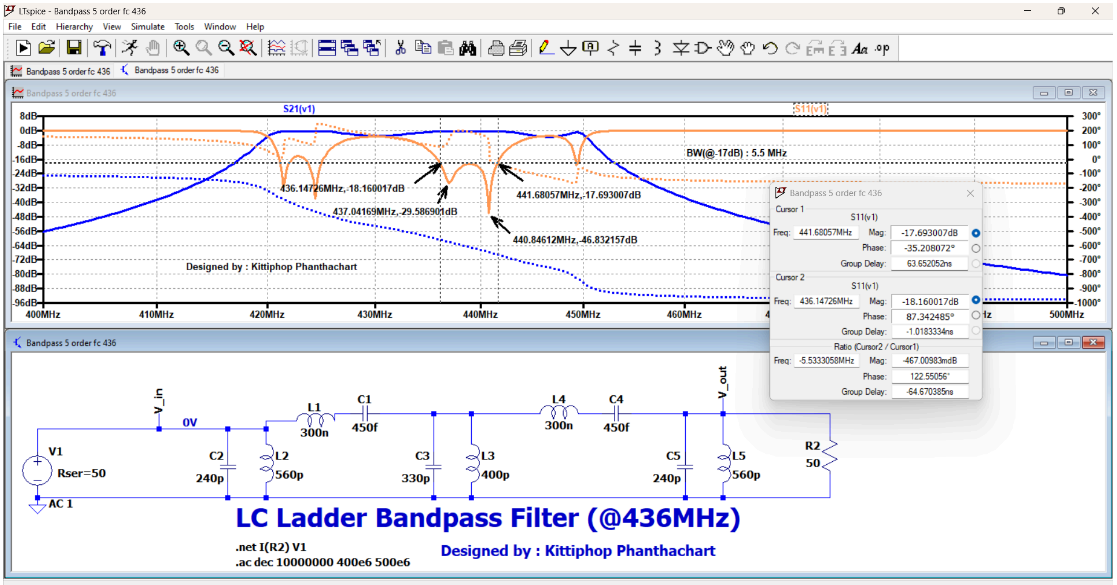
FIG. 3-18. Attenuation characteristics for a Chebyshev filter with 1-dB ripple.



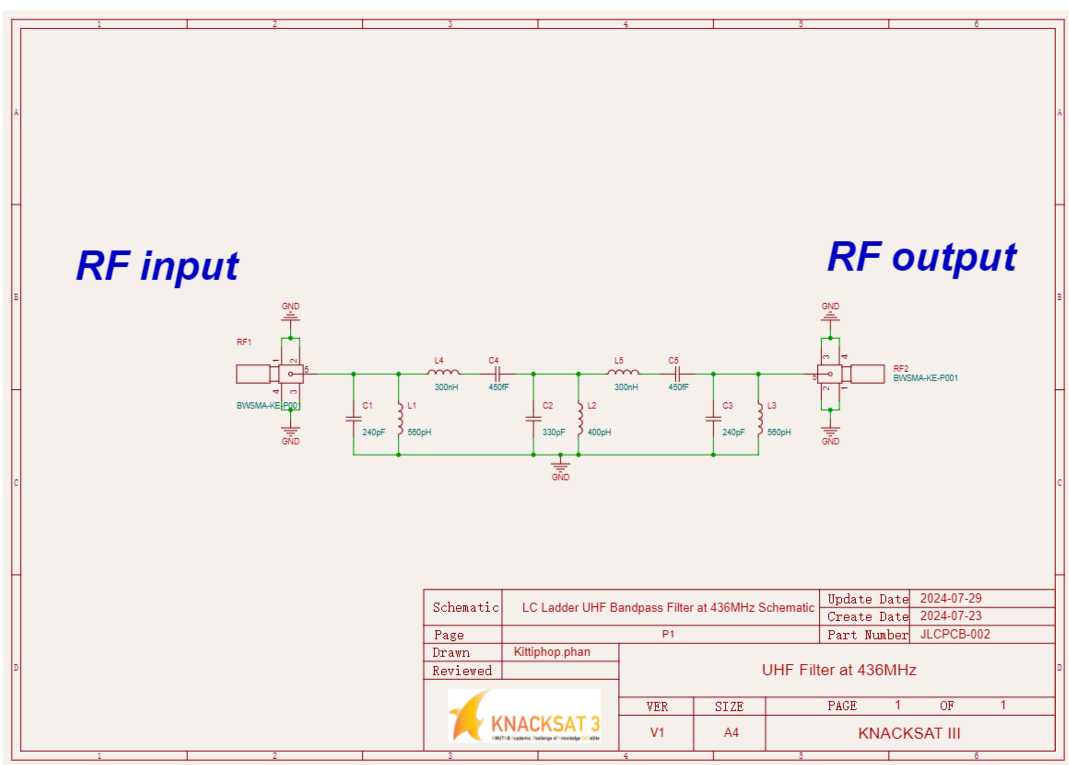
n	R_s/R_L	C_1	L_2	C_3	L_4	C_5	L_6	C_7
5	1.000	2.207	1.128	3.103	1.128	2.207		
	0.500	4.414	0.565	4.653	1.128	2.207		
	0.333	6.622	0.376	6.205	1.128	2.207		
	0.250	8.829	0.282	7.756	1.128	2.207		
	0.125	17.657	0.141	13.961	1.128	2.207		
	∞	1.721	1.645	2.061	1.493	1.103		

LC Ladder Bandpass Filter Simulation

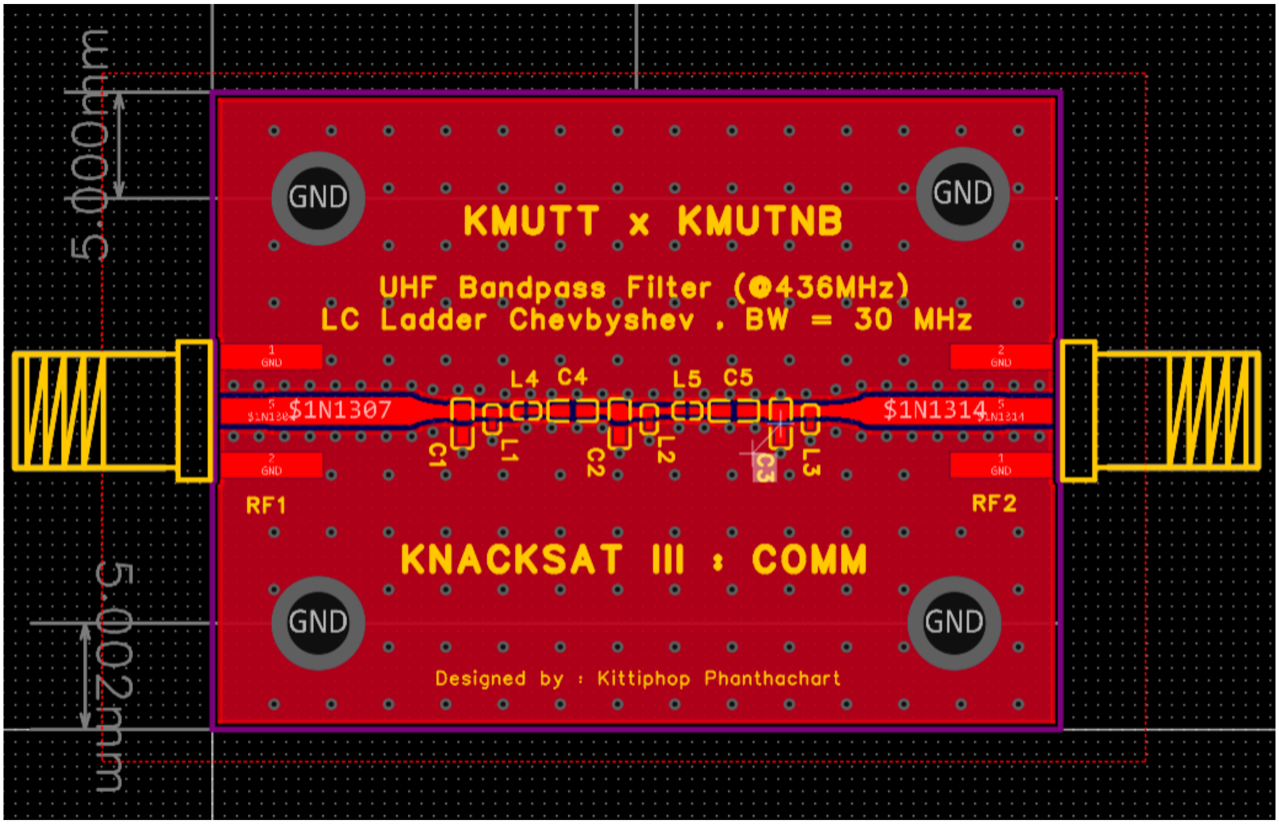
By LTspice : [Bandpass 5 order fc 436MHz.asc]

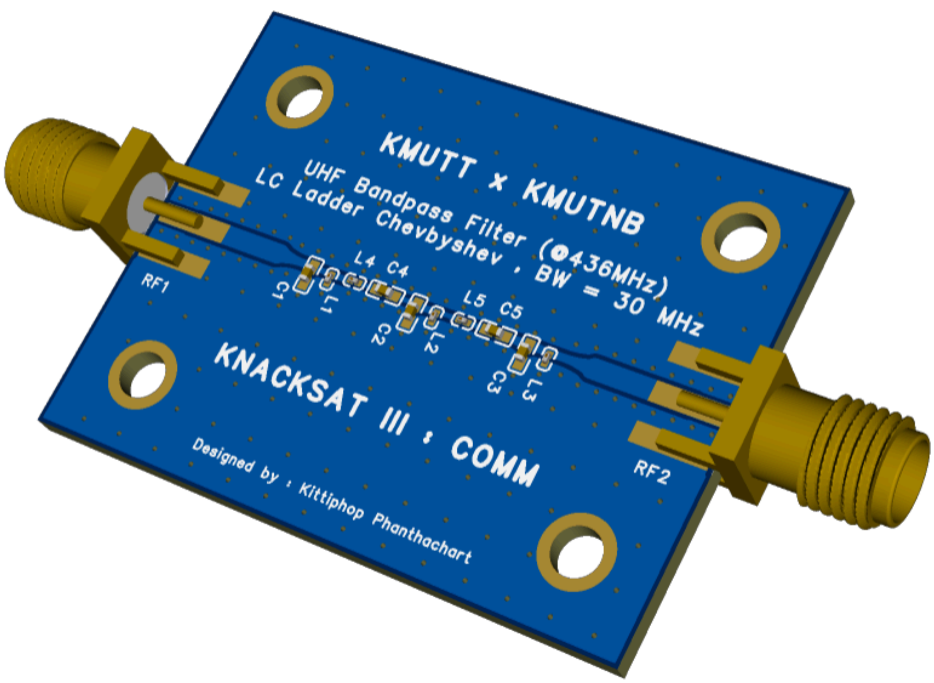


LC Ladder Bandpass Filter Schematic

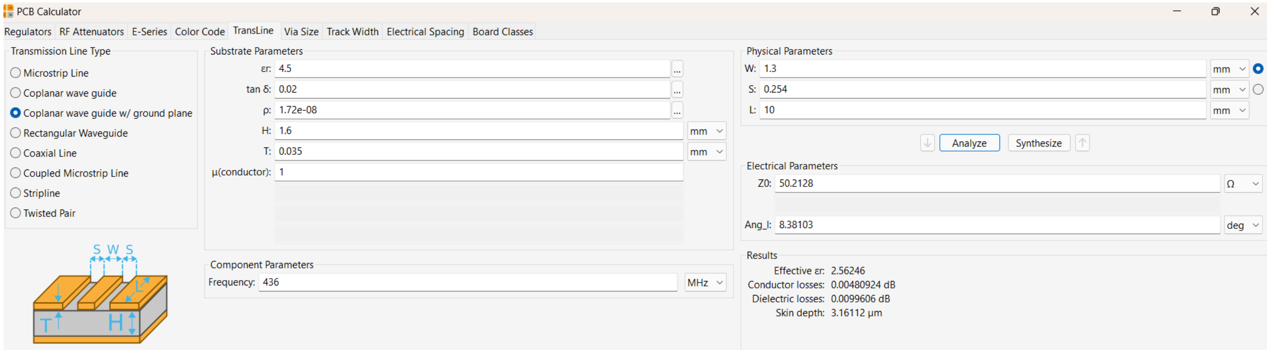


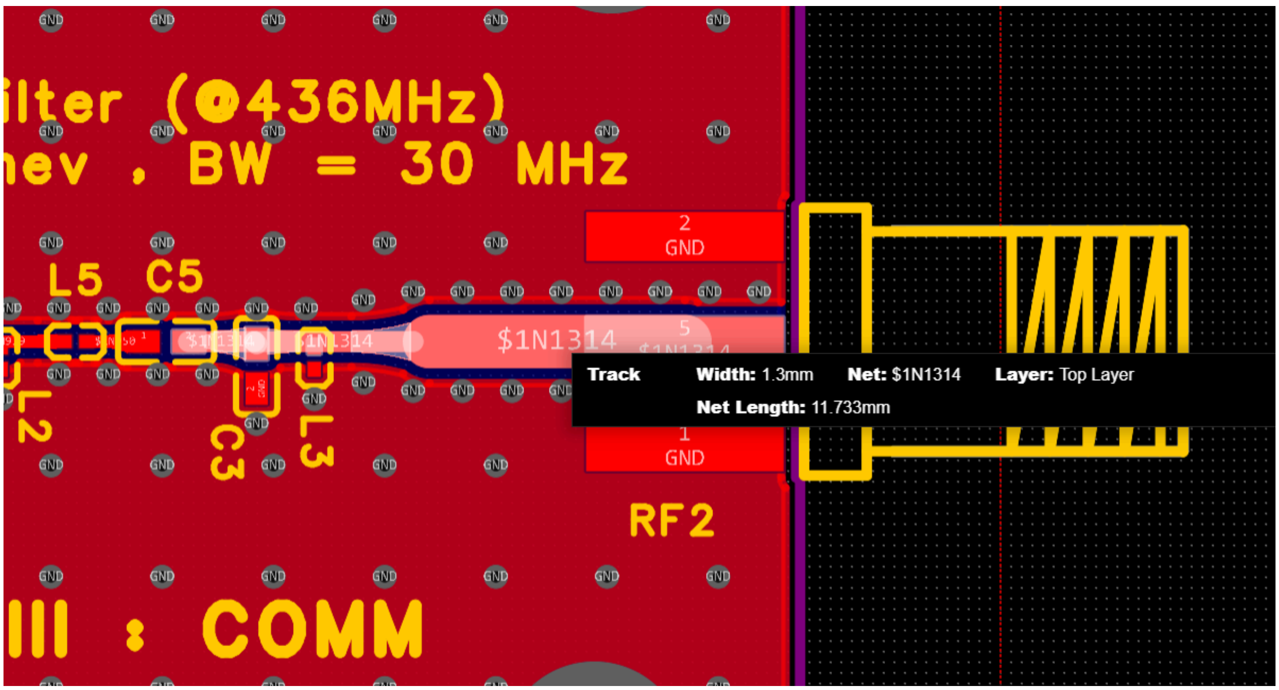
LC Ladder Bandpass Filter PCB Design





Microstrip Transmission Line Calculated





Zo = 50.2128 Ohms