Basics of “Snow Flaking”

Modifying and Tuning Microstrip Circuits

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Tuning Microwave Circuit Boards

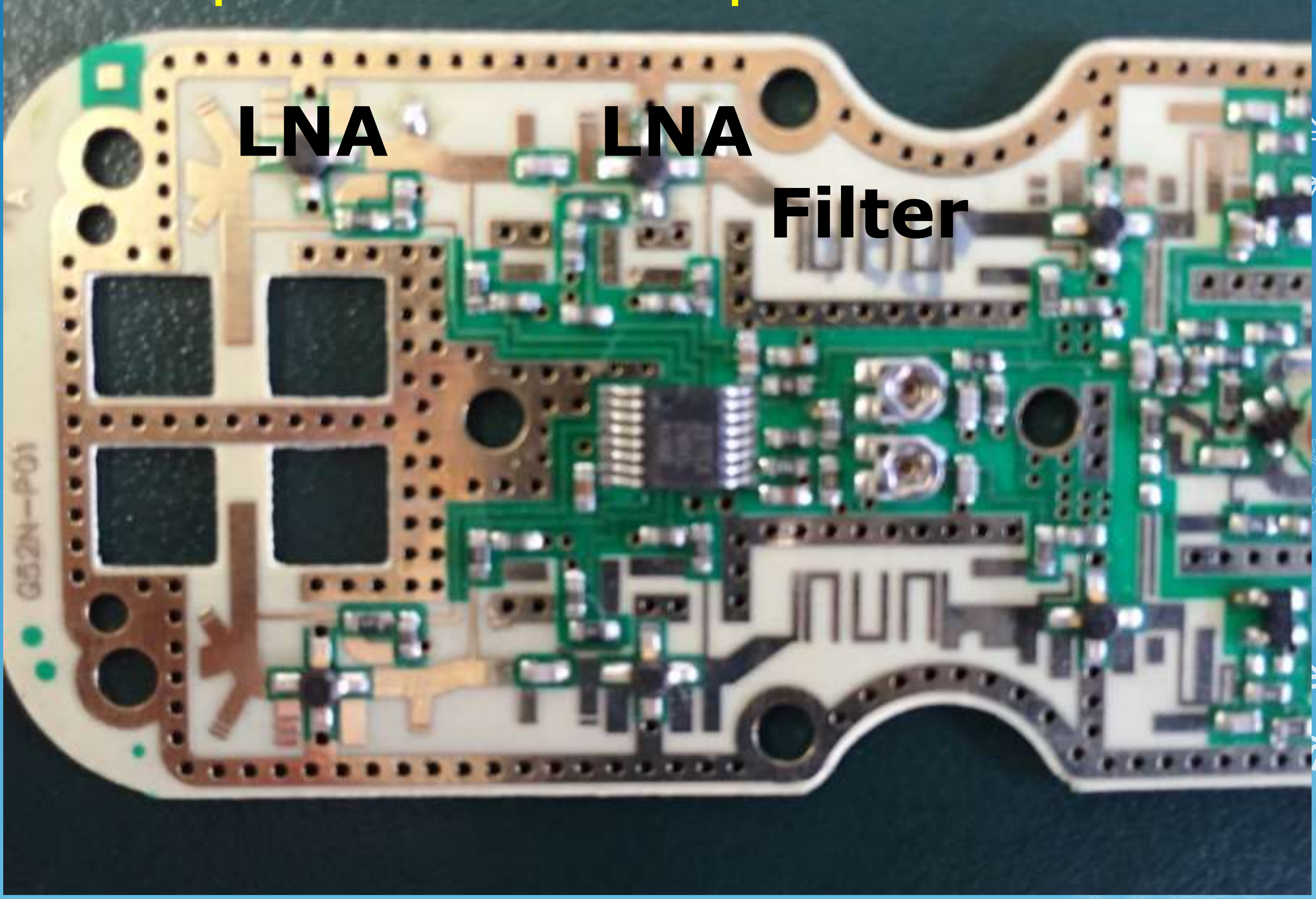
- The physical behavior of electricity changes with frequency.
- At DC and low frequencies, wires are adequate to convey electrical power.
- At radio frequencies, specially designed transmission lines (T/Ls) are necessary.
- At microwave frequencies, more sophisticated T/Ls are required.

A Ku-Band LNB for TV:

Can these be used for Amateur 10 GHz? **Sometimes**

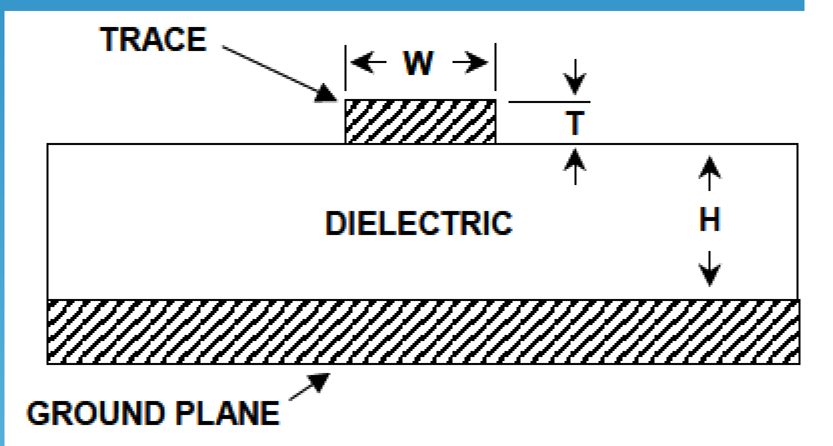
A Ku-Band LNB for Direc-TV:

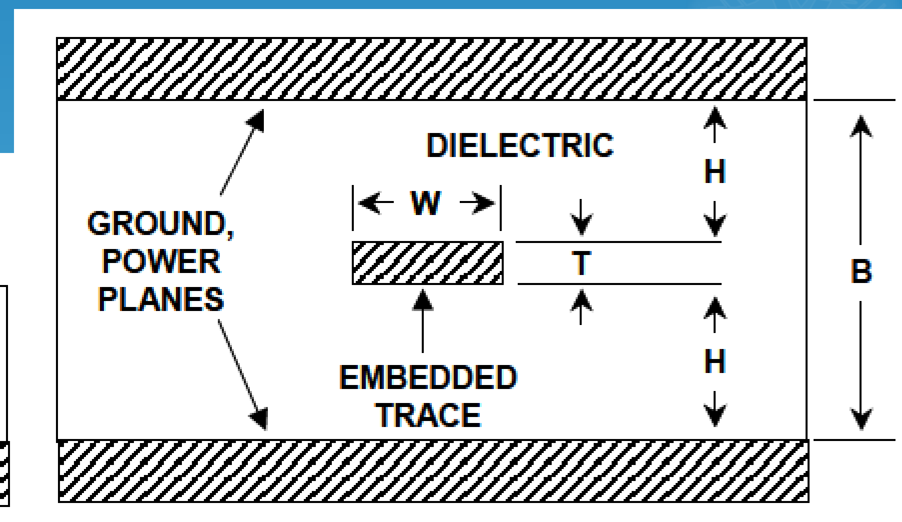
Example of microstrip LNAs & Filter



Microstrip and Stripline

"MICROSTRIP"



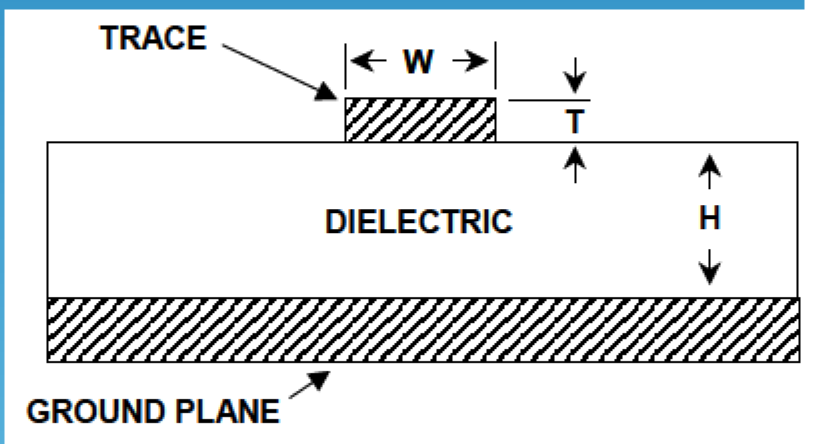


"STRIPLINE"

Microstrip and Stripline

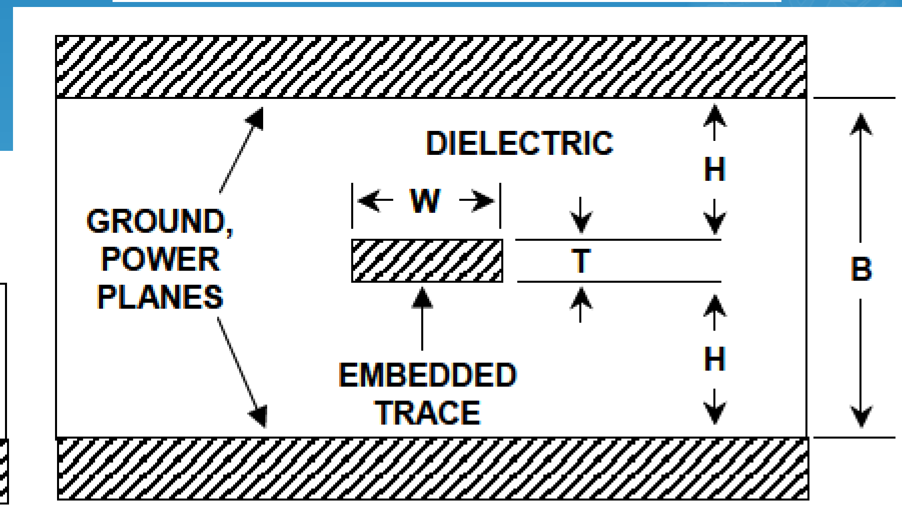
Impedance (Z_o) Calculation

“MICROSTRIP”



$$Z_o(\Omega) = \frac{87}{\sqrt{\varepsilon_r + 1.41}} \ln\left[\frac{5.98H}{(0.8W + T)}\right]$$

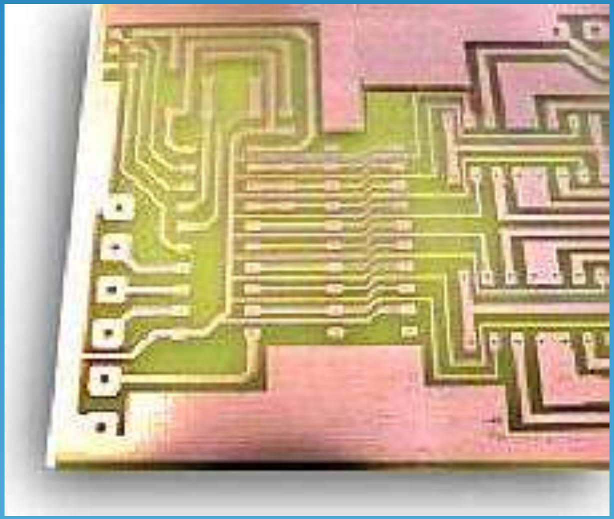
$$Z_o(\Omega) = \frac{60}{\sqrt{\varepsilon_r}} \ln\left[\frac{1.9(B)}{(0.8W + T)}\right].$$



“STRIPLINE”

Microstrip
Typical Circuit Materials

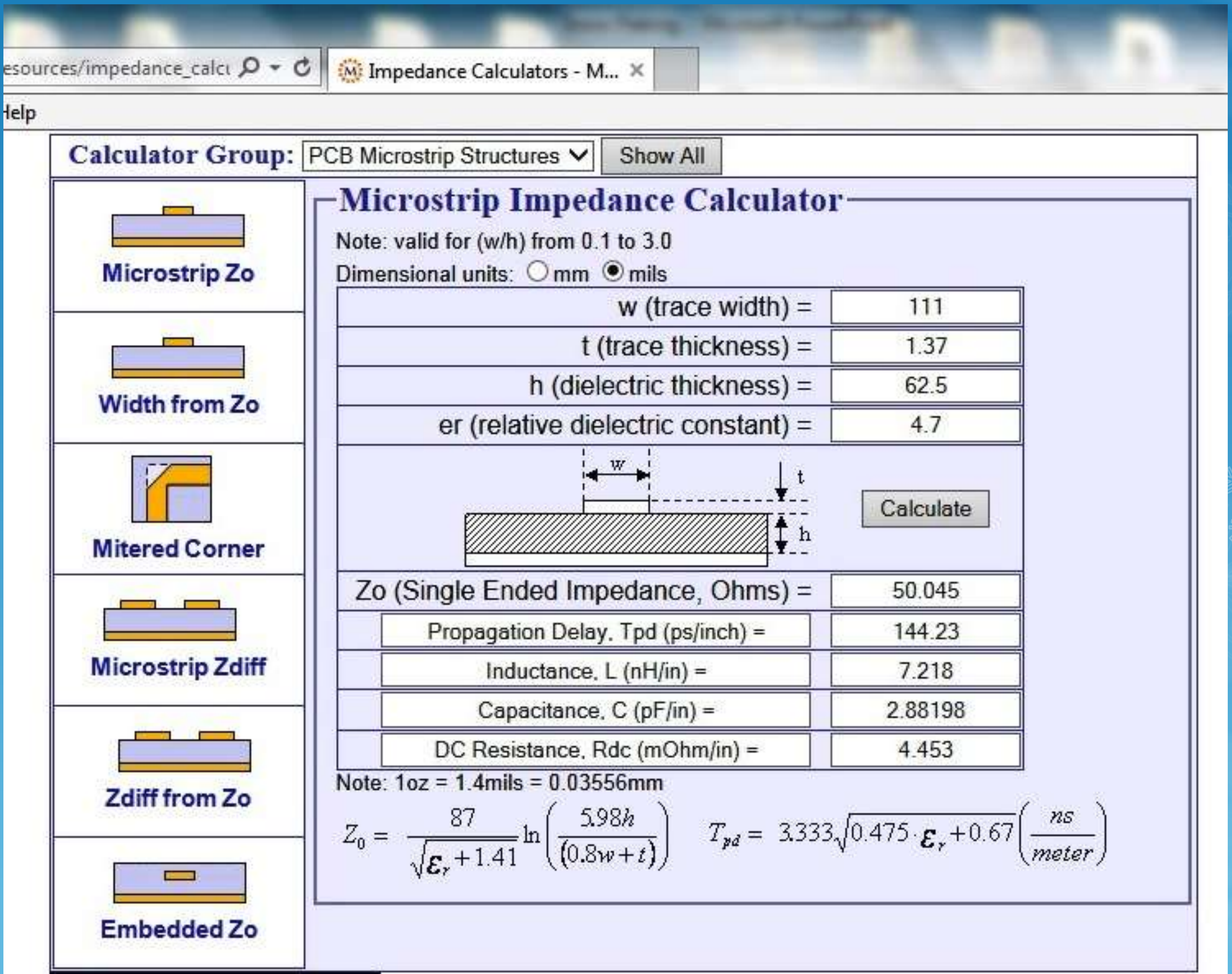
Dielectric Constant (Er)



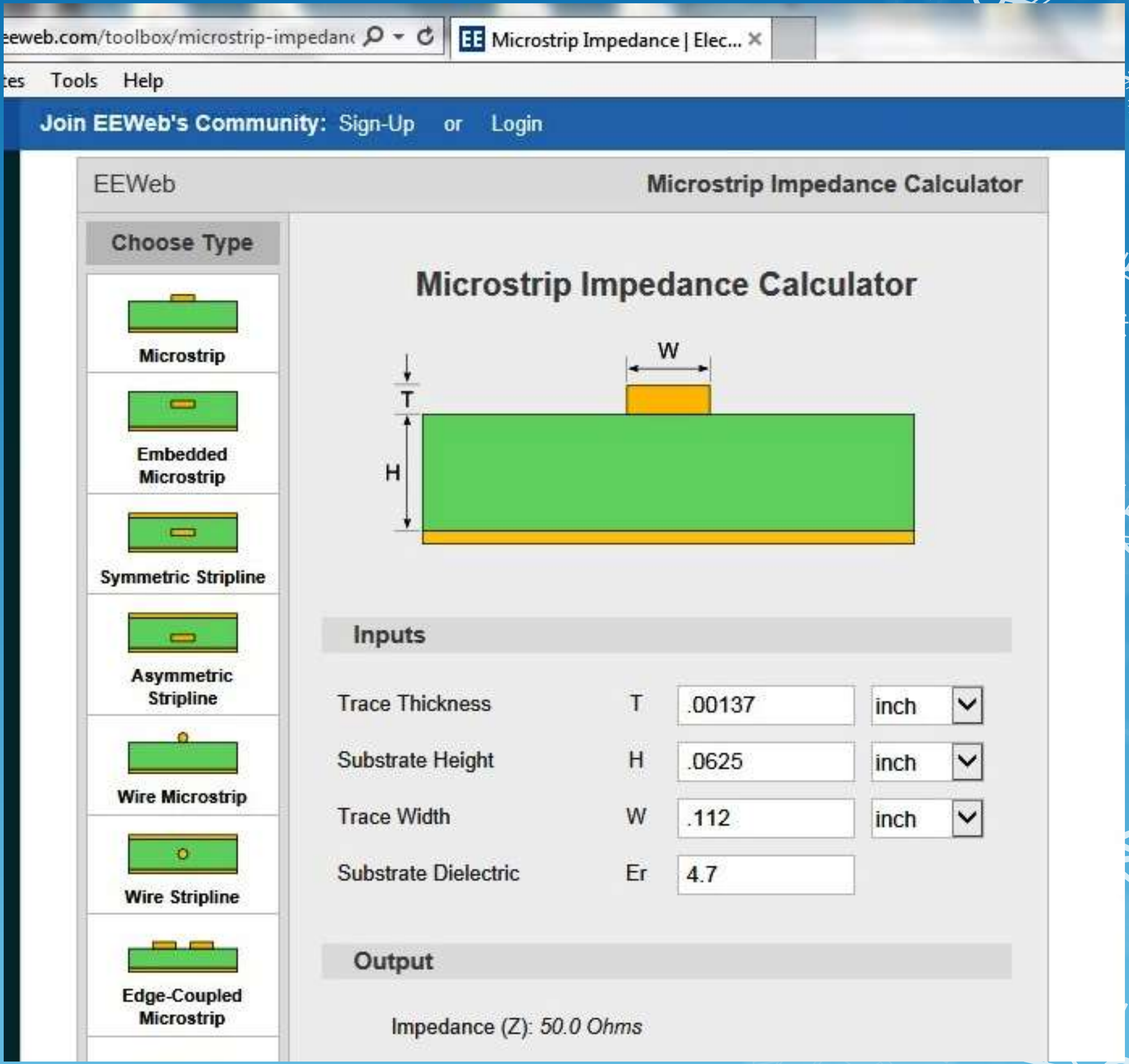
G-10 Fiberglass (Epoxy)
Er – 4.7

RT-Duroid (Teflon)
Er – 2.2

http://www.mantaro.com/resources/impedance_calculator.htm



http://www.eeweb.com/toolbox/microstrip-impedance



Microstrip

Typical 50-Ohm line Width (inches)

PCB Material (1oz. Cu)		**.0625”**		**.03125”**	
G10 Fiberglass		**.112”**		**.056”**	
RT Duroid		**.155”**		**.077”**	

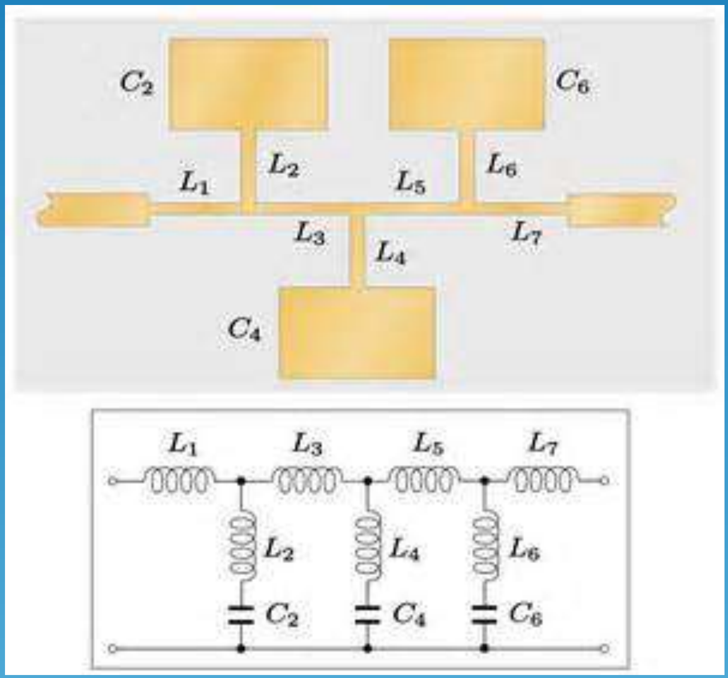
Dielectric Constant (Er)

G-10 Fiberglass
(Epoxy)
Er – 4.7

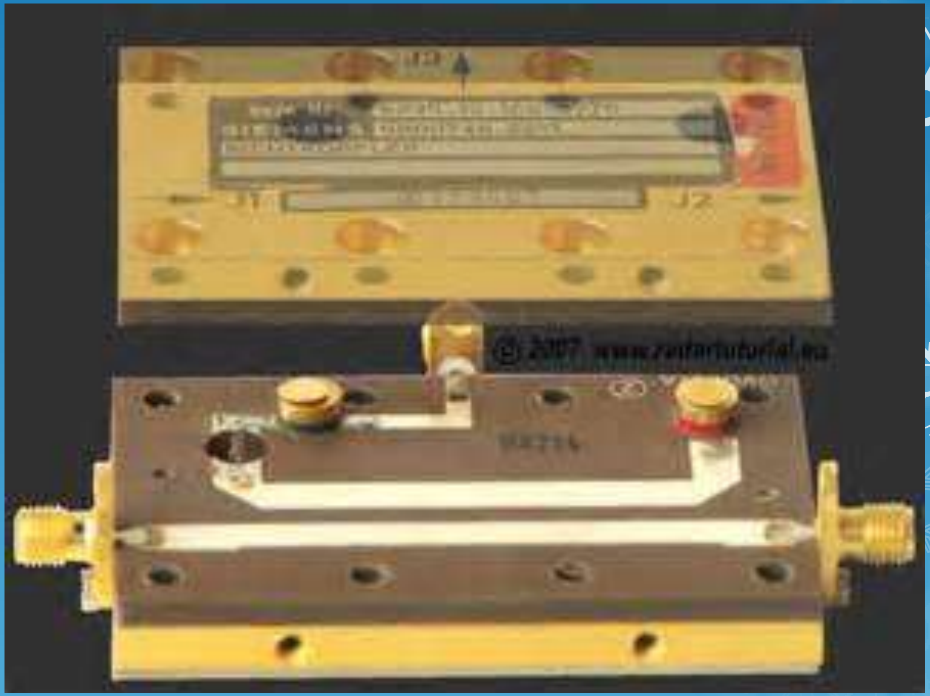
RT Duroid
(Teflon)
Er – 2.2

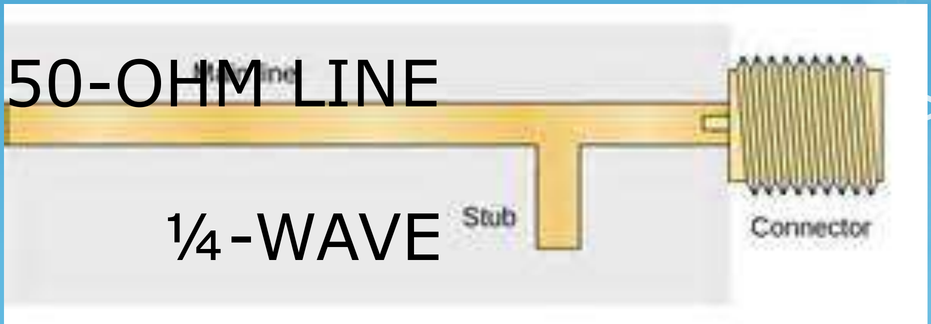
Microstrip Components

CAPACITORS



TRANSFORMER



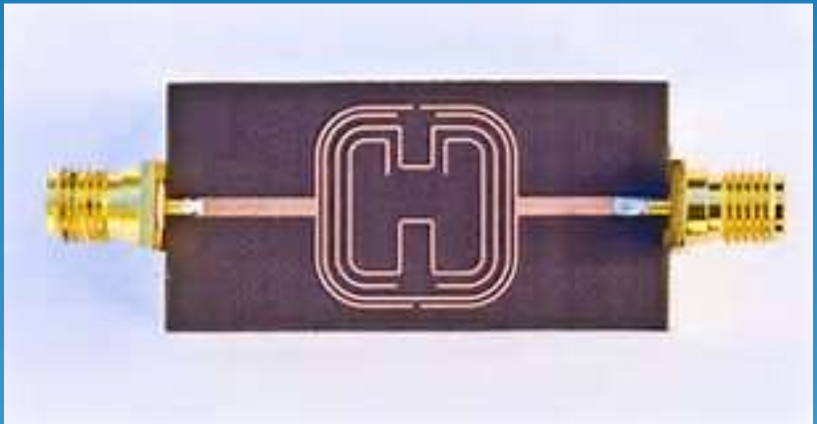


50-OHM LINE

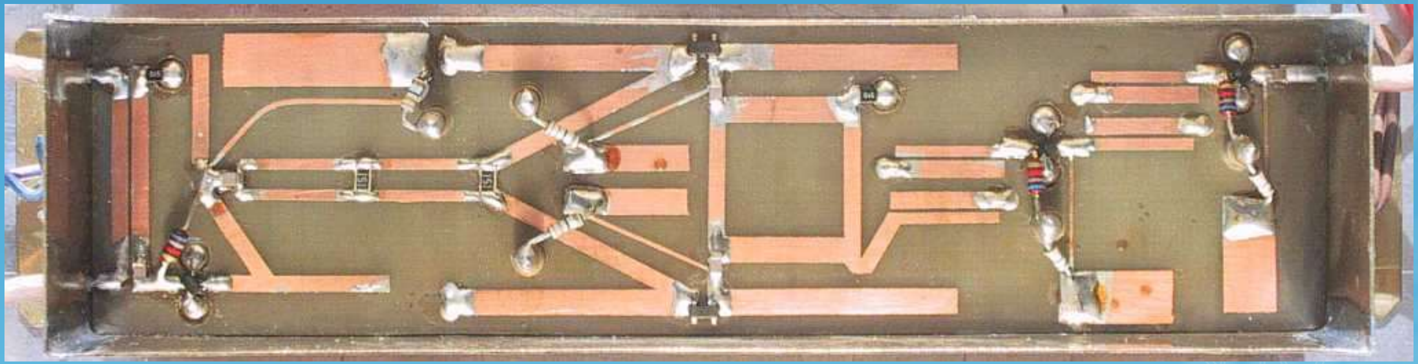
¼-WAVE

Microstrip Components

RESONATOR

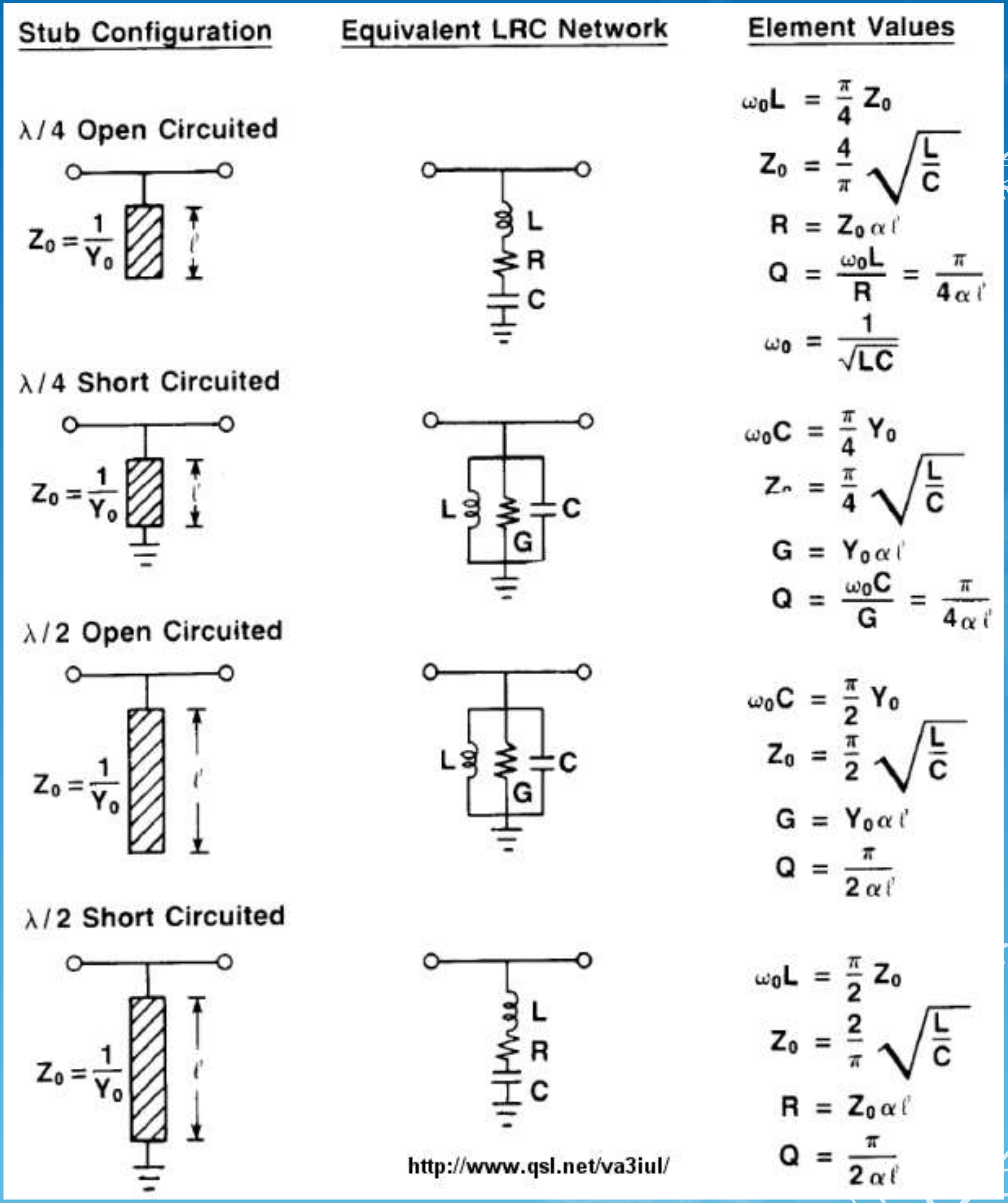


FILTER



MIXER

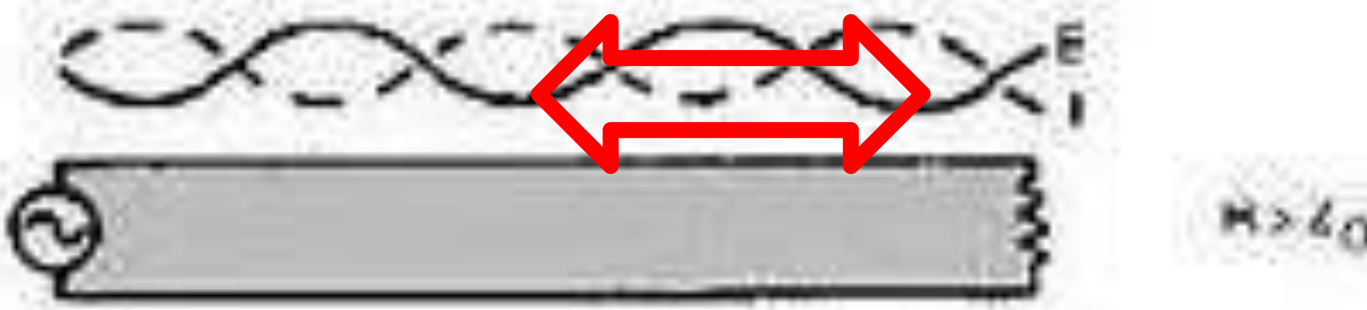
Microstrip Components



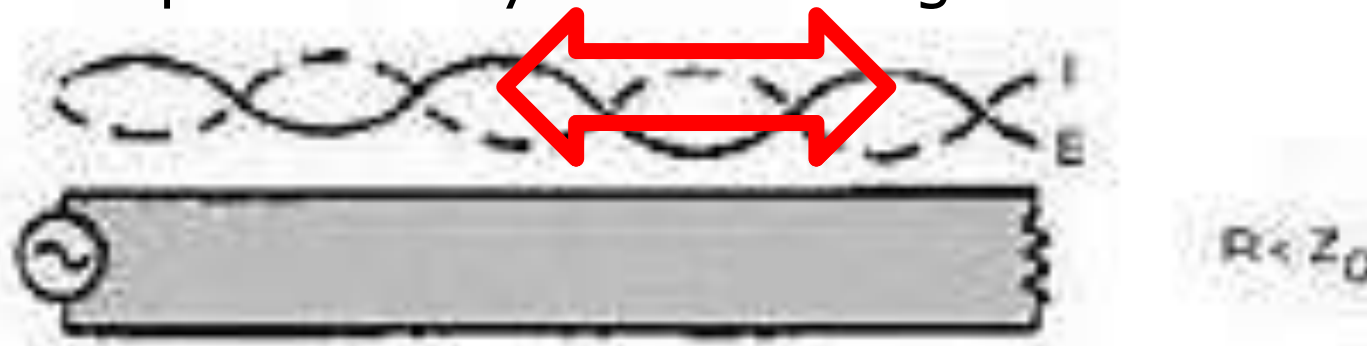
Transmission Line Review

Unequal Load and Line Impedances

Cause a “Standing Wave” to develop



Repeats every ½ Wavelength



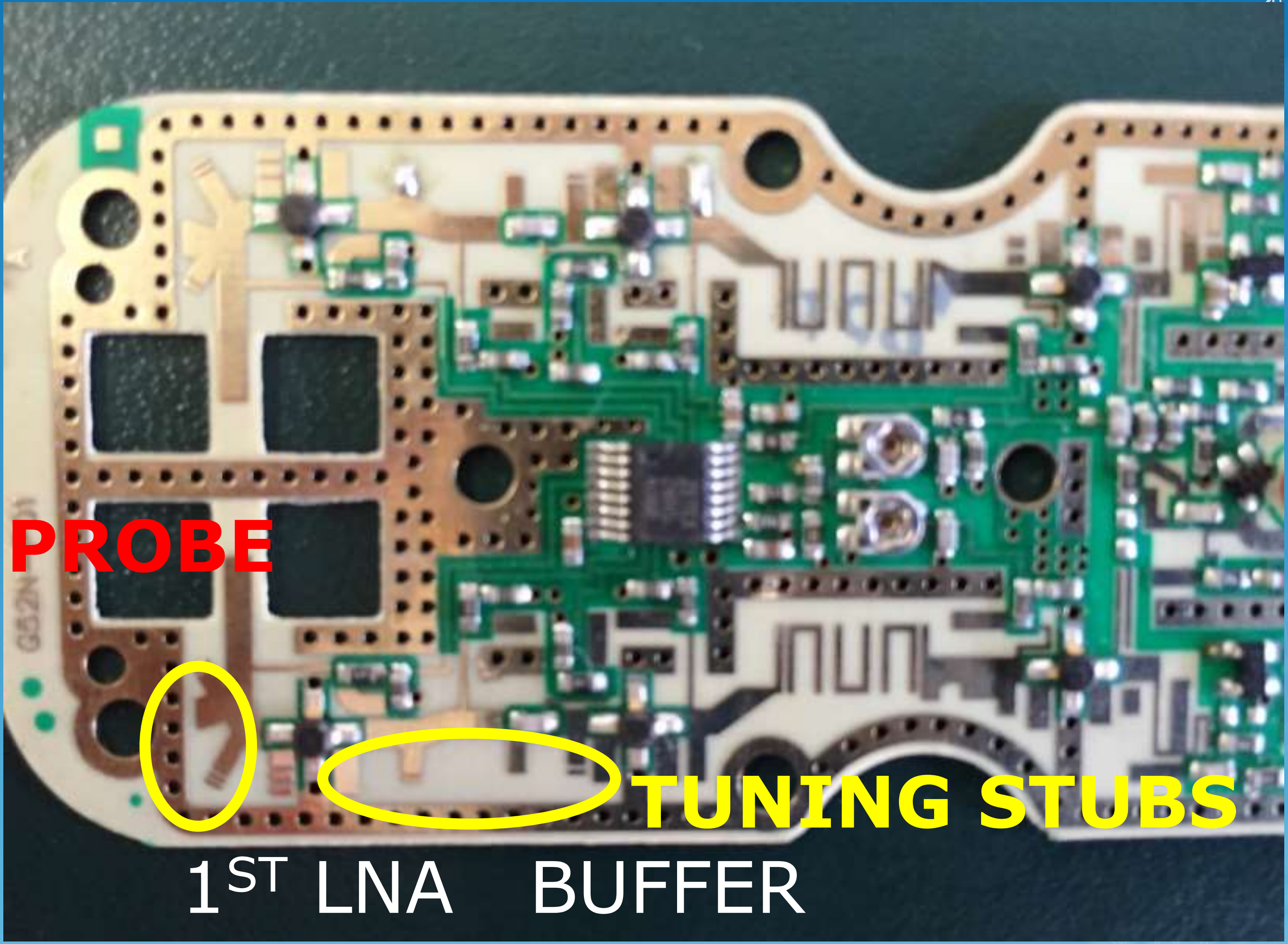
Transmission Line Review

Effects of Inductance and Capacitance

Z_o Means “Characteristic Impedance”

Reactance shifts the standing wave

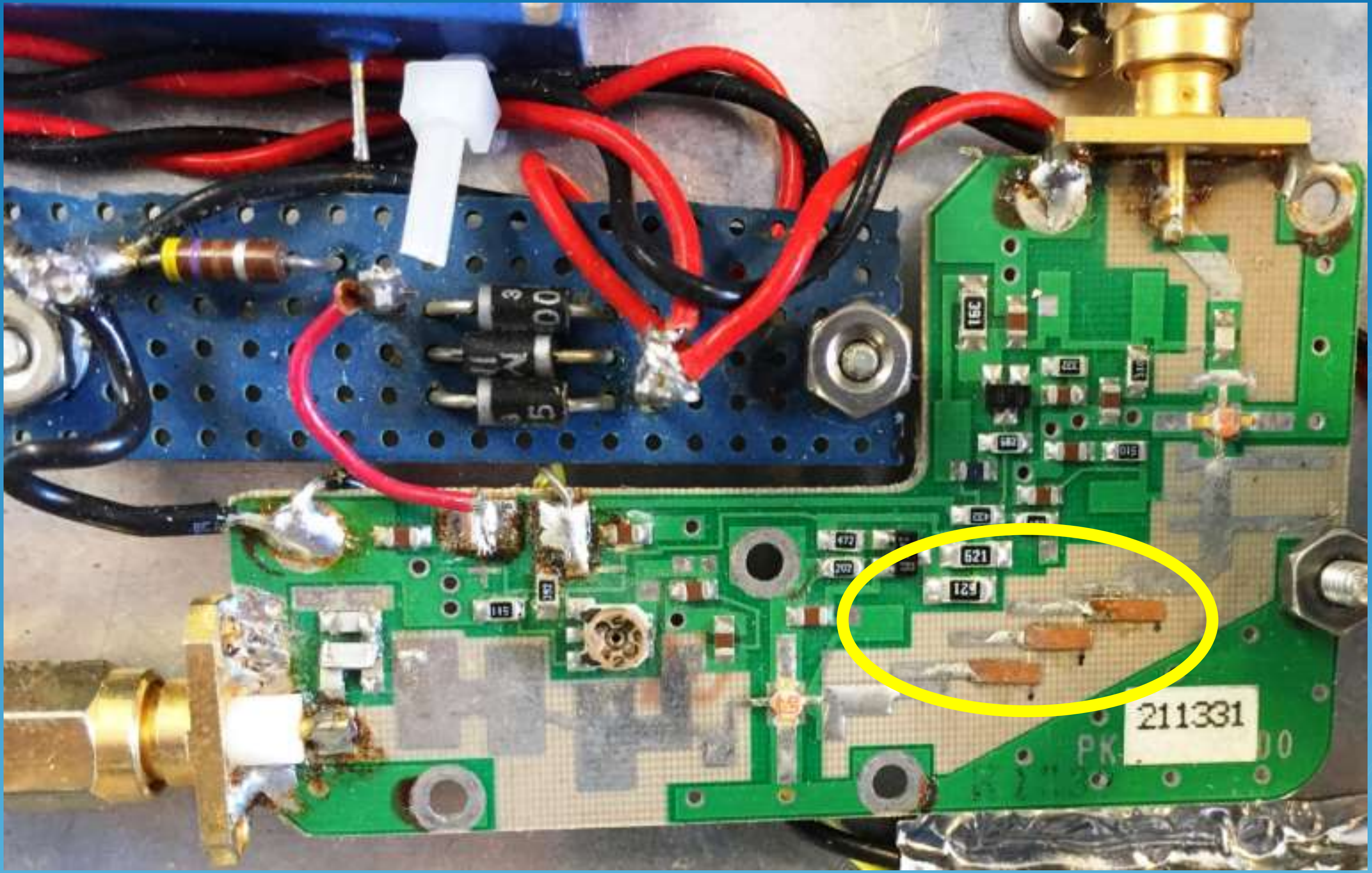
Application of the Theory



Application of the Theory

- Put Dielectric (Kapton)Tape over the filter to broadband it
- Jumper the filter with semi-rigid coax
- Take an output at the input side of the filter via a 1 or 2 pF coupling cap
  – 2 stages of LNA should be enough
- Tune both sides and use the best performer as online unit

Application of the Theory:



2.556 GHz X4 MULT.

10.224 GHz FILTER

Application of the Theory:

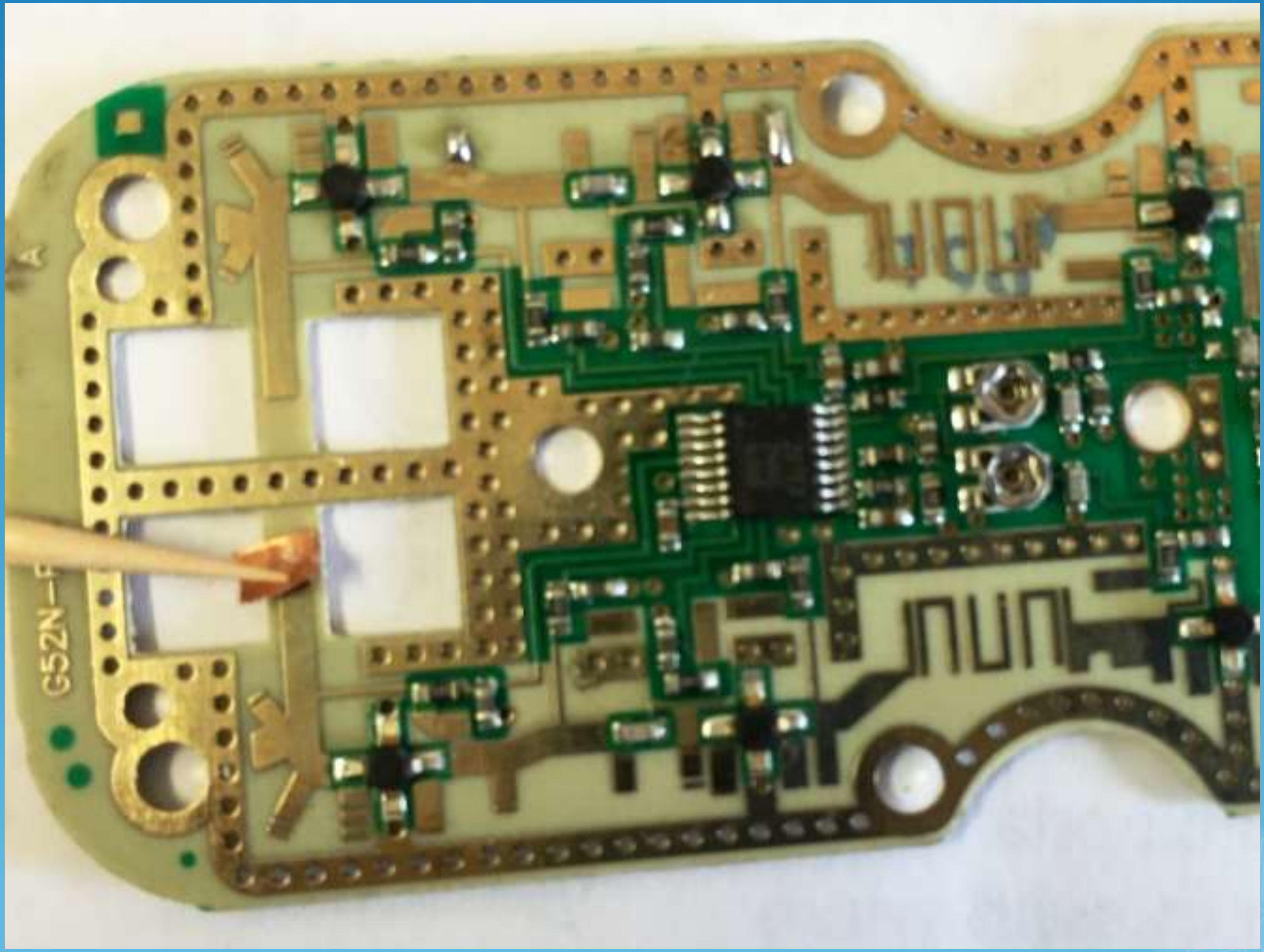
AF6NA MOD.
TO LNB
(Added Copper to Frequency Det. Network)

D.R.O.
FREQ. PULL
10.750 TO 10.400 GHz

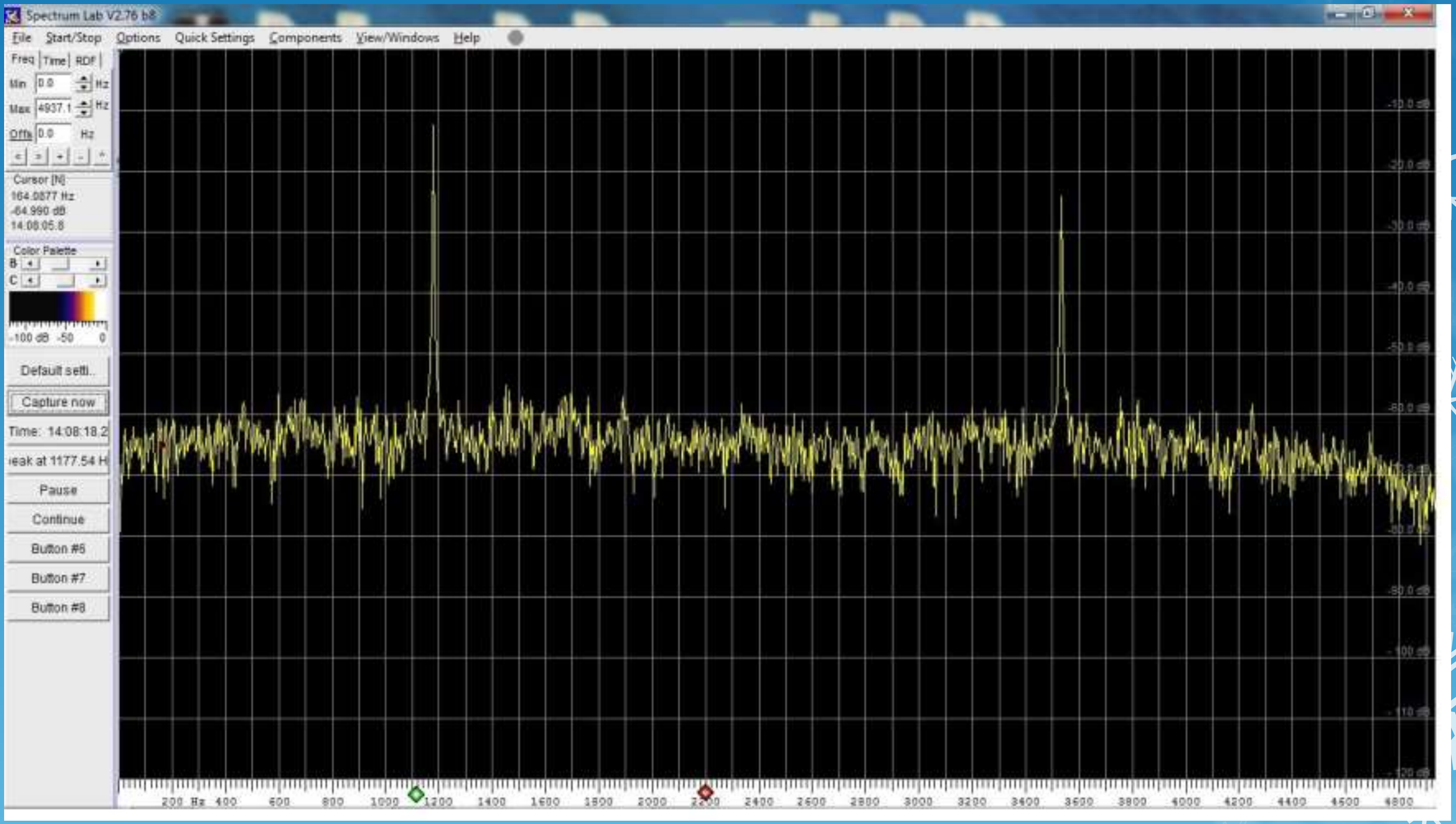
Application of the Theory

- Adding Capacitance is the most common practice in tuning microstrip lines.
- Experimentation is the most common approach.
- An appropriate measurement system is a necessary tool to observe changes.
- Noise Floor
- Gain
- Frequency

Move the copper 'snowflake" around near the microstrip trace – **Avoid touching DC power traces!**



Spectrum Lab Screen
Position the snowflake - Watch the noise



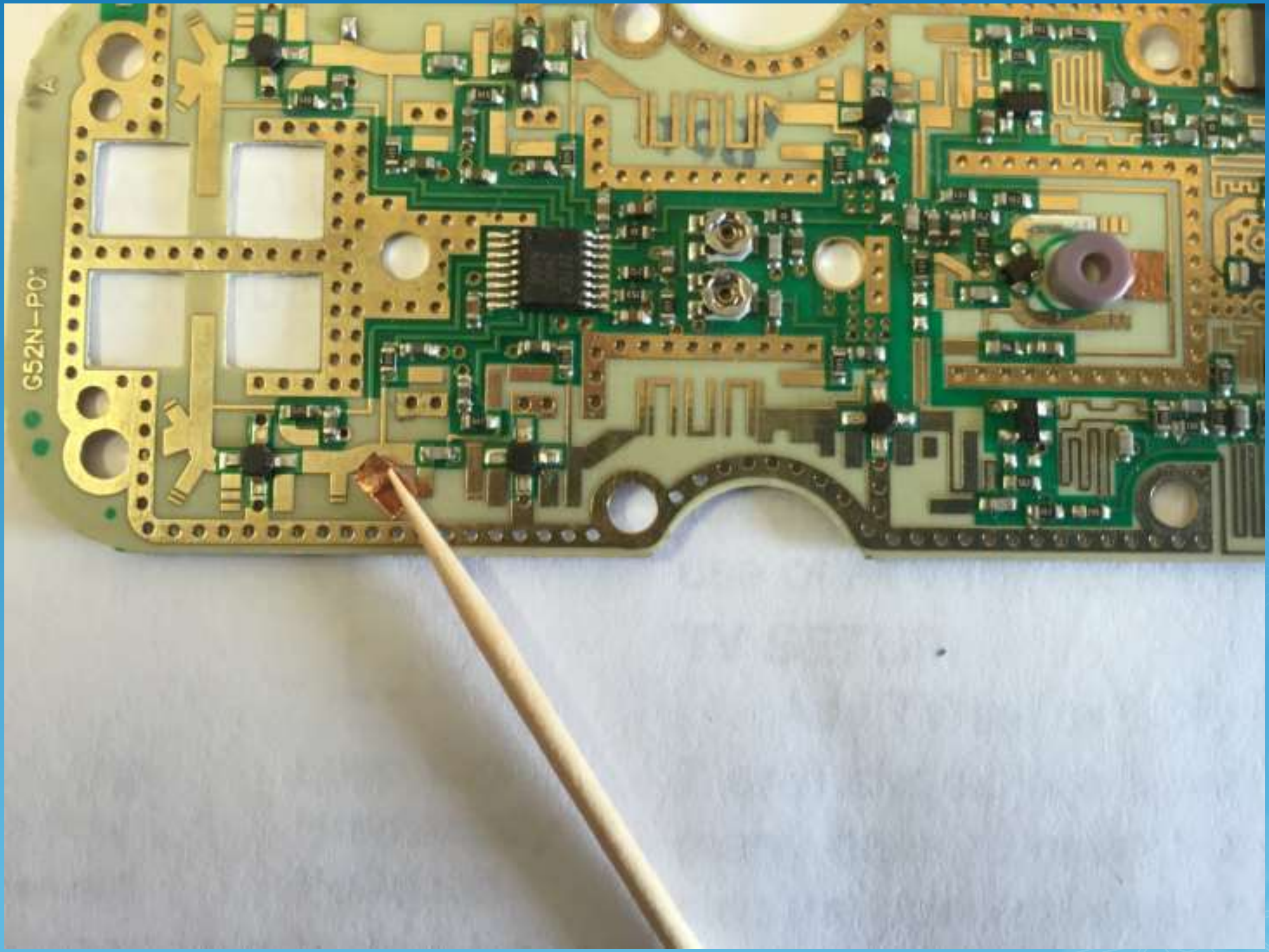
All AGC should be "OFF"

Alternative Monitoring Systems Position the snowflake -

- **Use an audio voltmeter at the audio output – measure the noise***
- **Power meter output to Voltmeter with an audible tone output – listen to the noise***
- **Use a spectrum analyzer and tune for best carrier to noise***
- **An audio meter with "SINAD" function***

*** All AGC should be "OFF"**

Once the input side is optimized – Try the output side – watch noise & gain



Glue the snowflakes down once you find the “optimal” position

QUESTION:

What kind of glue is best?

Solder the snowflake in place