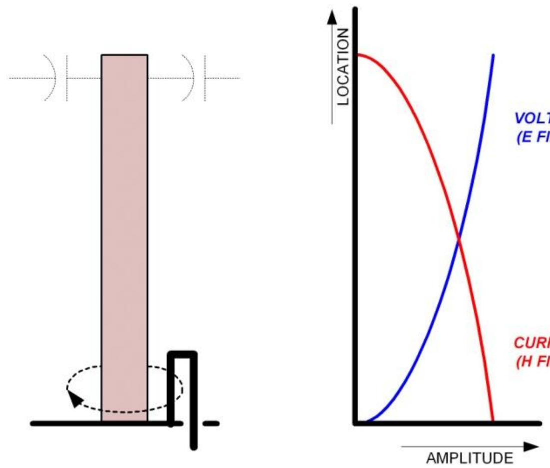
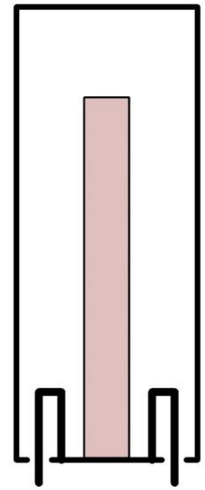
CAVITY and COMBLINE FILTERS, COMBINERS and DUPLEXERS

K5TRA

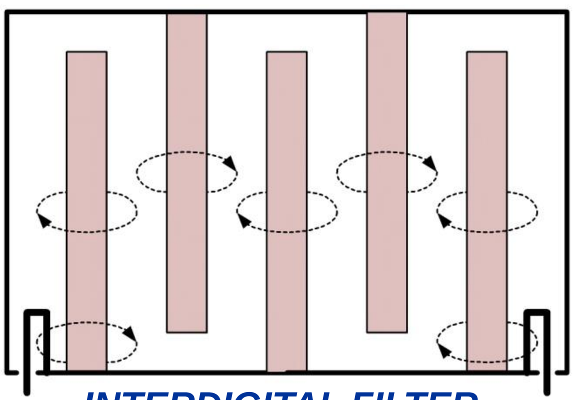
COUPLED QUARTER WAVE RESONATORS



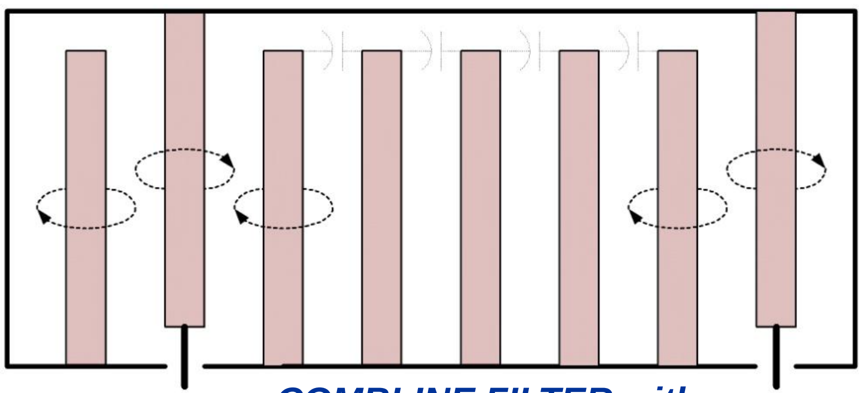
$\lambda/4$ RESONATOR



LOOP COUPLED $\lambda/4$ CAVITY

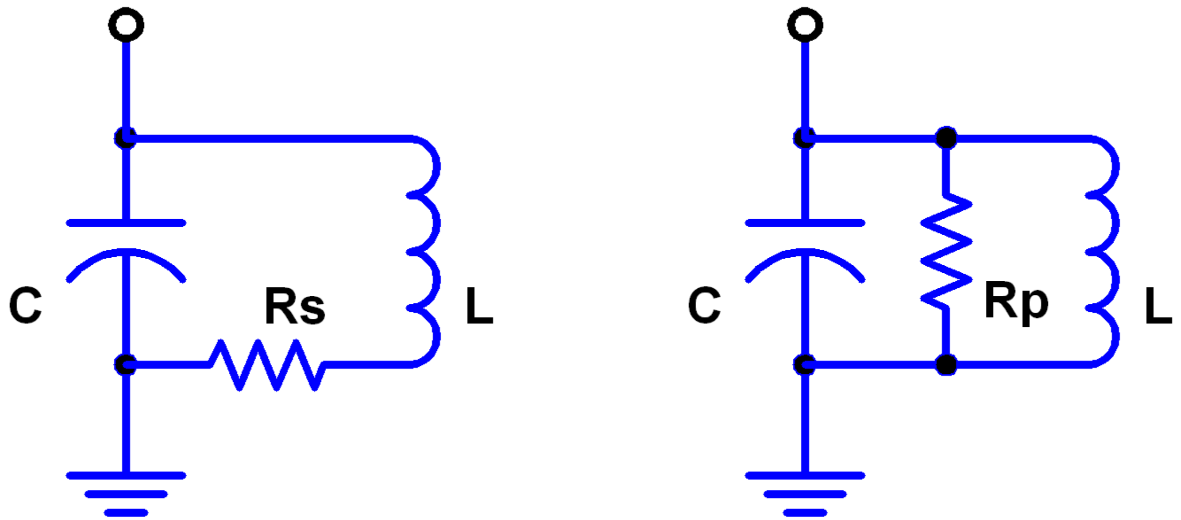


INTERDIGITAL FILTER



COMBLINE FILTER with
INTERDIGITAL PORT COUPLING

PARALLEL RESONATORS

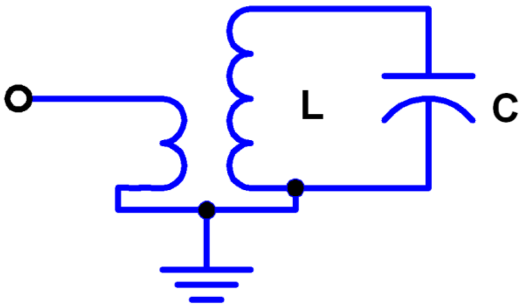


$$Rp = (Qu^2 + 1)\ Rs$$

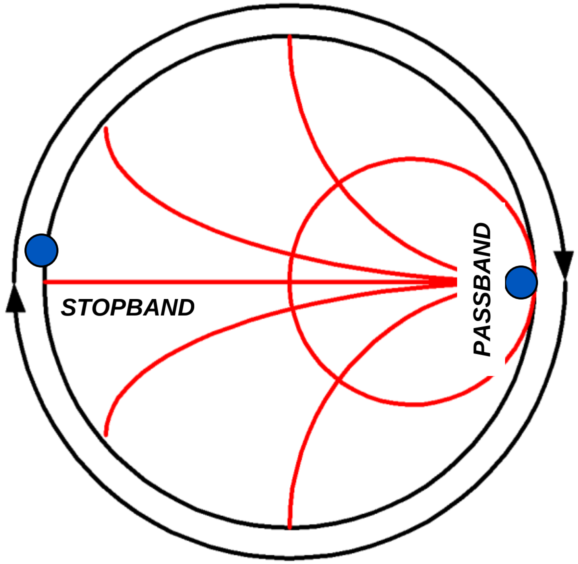
$$Qu = 5000\ \text{(typical)}$$

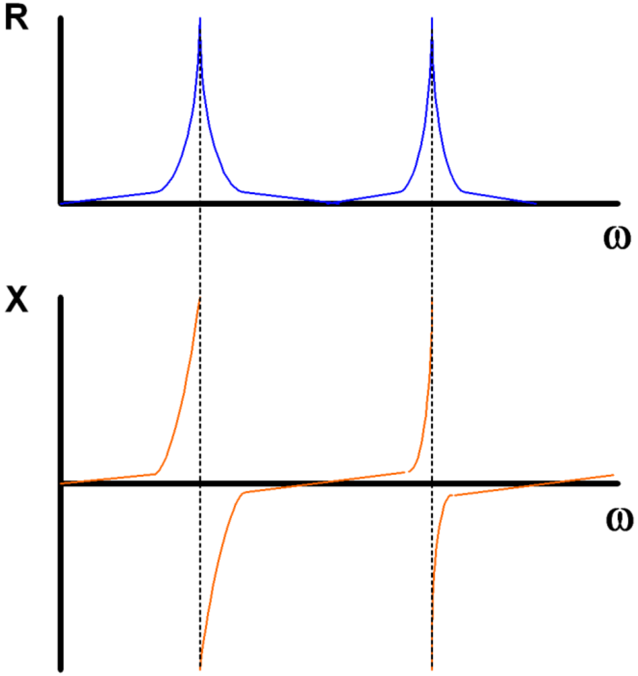
THIS IS A GOOD LUMPED REPRESENTATION OF A λ/4 RESONATOR

CAVITY RESONATOR with LOOP COUPLING



- Parallel LC model
- High Z at resonance
- Low Z (slightly inductive) in stopband
- Resonance at $\lambda/4$ and $3\lambda/4$
- 70% more Qu typical at $3\lambda/4$





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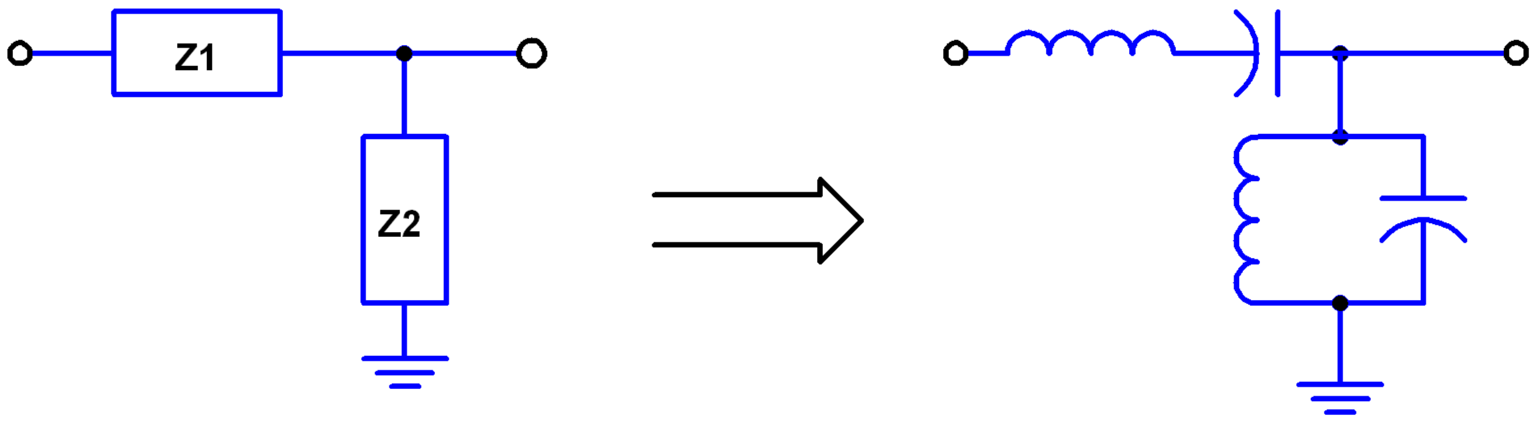
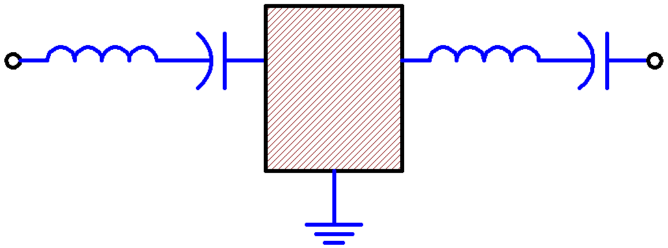
LADDER FILTER BASIC BUILDING BLOCK



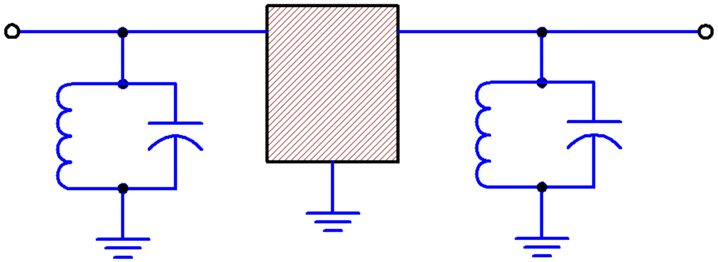
- Passband: Z1 ⇨ *short* and Z2 ⇨ *open*
- Stopband: Z1 ⇨ *open* and Z2 ⇨ *short*

IMPEDANCE INVERTERS PROVIDE REUSE OF RESONATOR TYPE

Z INVERTER



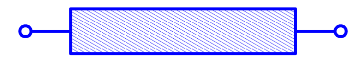
Y INVERTER



- Impedance inverter interface between similar resonators provides maximum stopband attenuation
- Most common impedance inverter is transmission line that is an odd multiples of $\lambda/4$

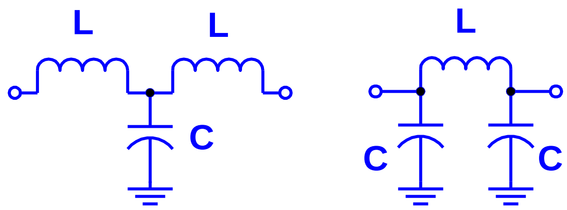
IMPEDANCE INVERTERS

- Impedance (or admitance) inverters can be used to convert parallel resonance to a series resonance characteristic.
- The canonic impedance inverter is the λ/4 line.
- LC forms provide moderate bandwidth Z inversion.
- Capacitive T and π sections are for narrow band applications. Negative C is absorbed into resonator (cancels some positive C).

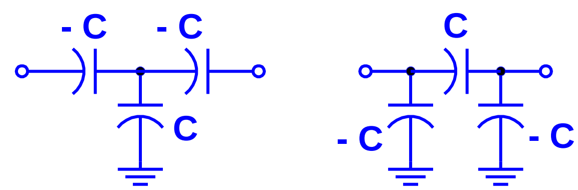


Transmission Line
J (or K) Inverter

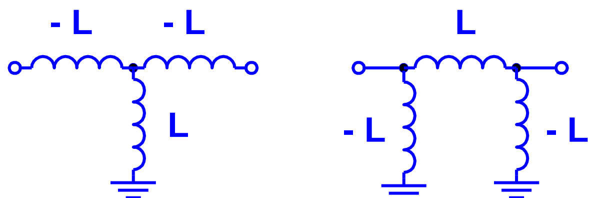
$$Z_0, \quad \theta = \frac{\lambda}{4}$$



$$Z_0 = \sqrt{\frac{L}{C}}, \quad \omega_0 = \frac{1}{\sqrt{LC}}$$

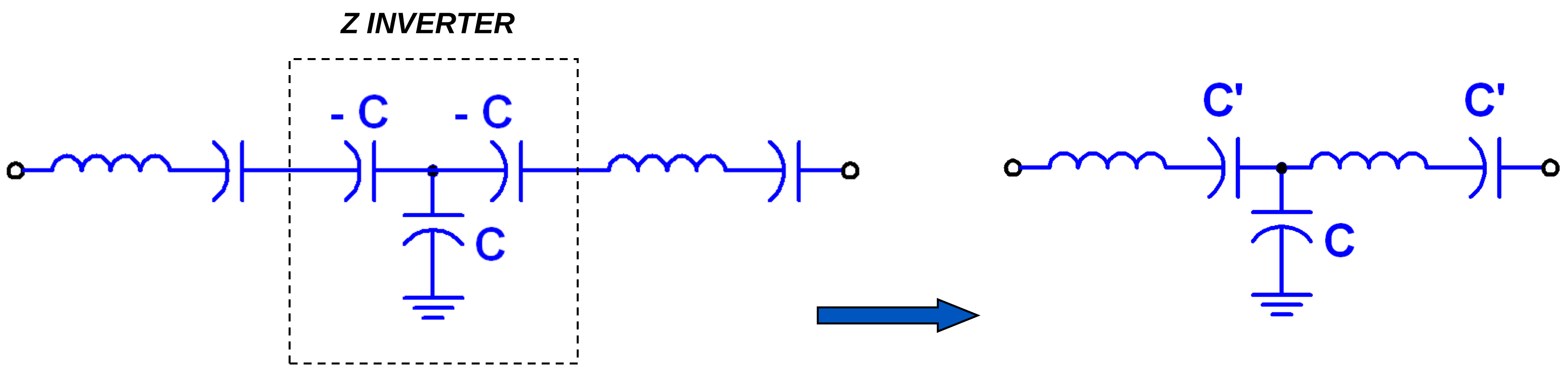


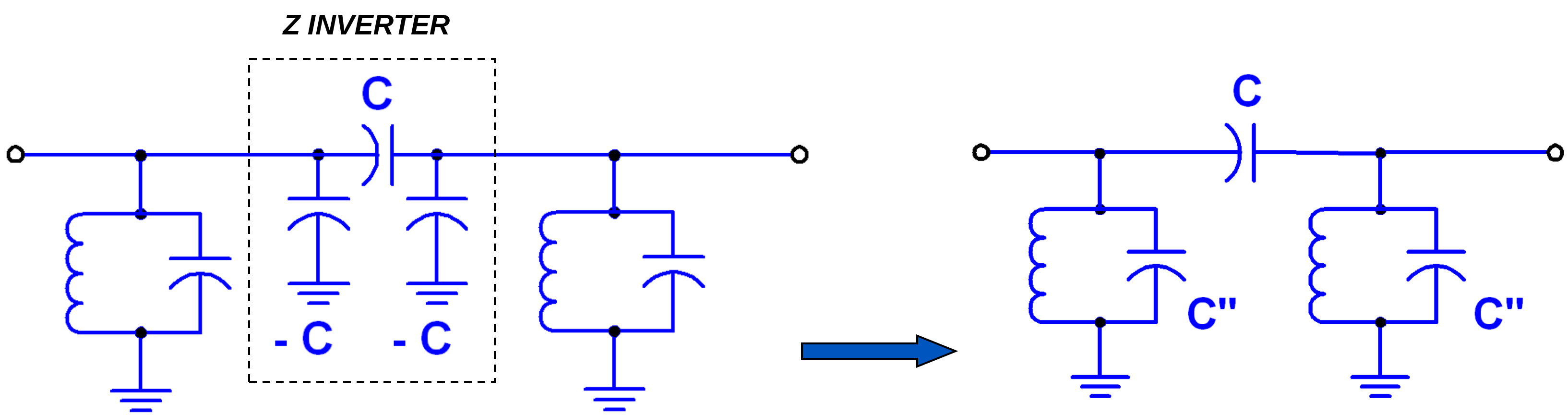
$$Z_0 = \frac{1}{\omega_0 C}$$



$$Z_0 = \omega_0 L$$

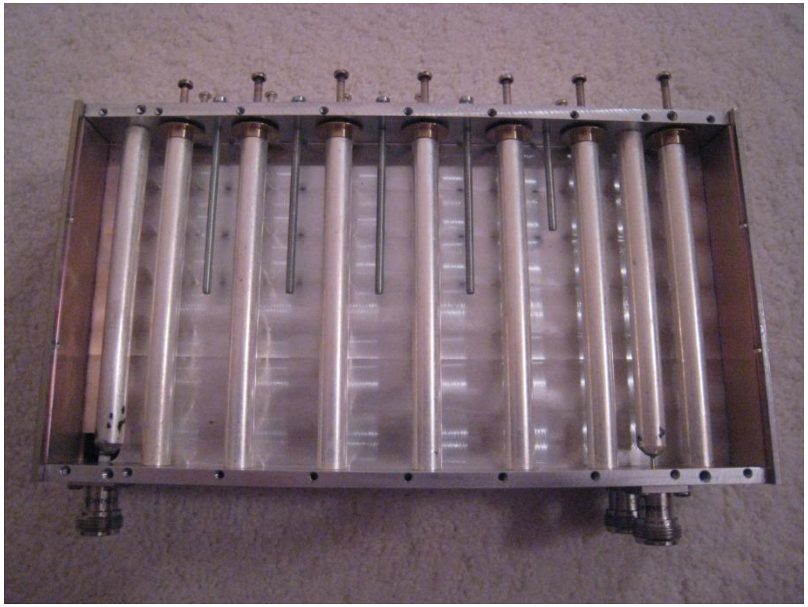
NARROW FILTERS WITH CAPACITIVE Z INVERTER

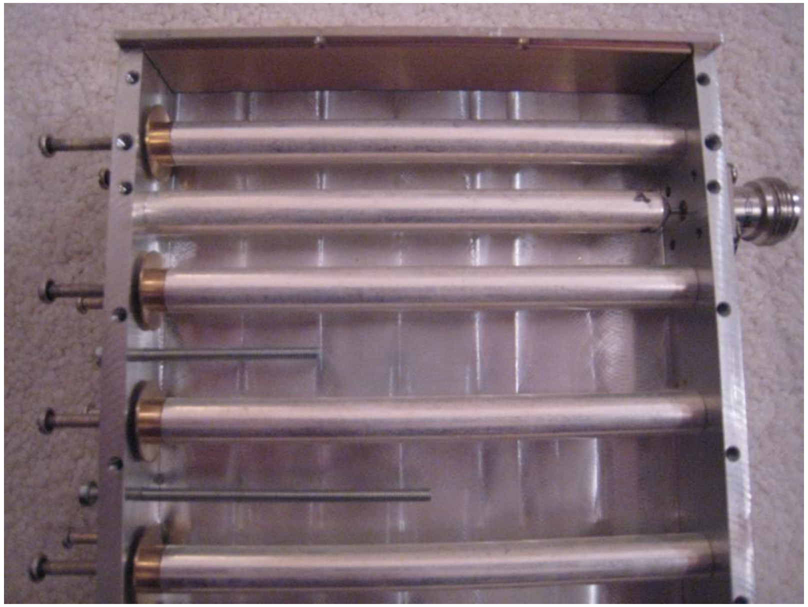




COMBLINE REPRESENTATION

COMBLINE FILTERS in UHF DUPLEXER





- Combline filter formed by capacitive coupled (E field) $\lambda/4$ resonators.
- Resonator tuning with capacitive probe into open end.
- Inverter coupling capacitance tuned with grounded screw between resonators.
- Port coupling resonators are interdigital inductive coupled (H field).
- Outer port reflective resonator sets near stopband rejection.

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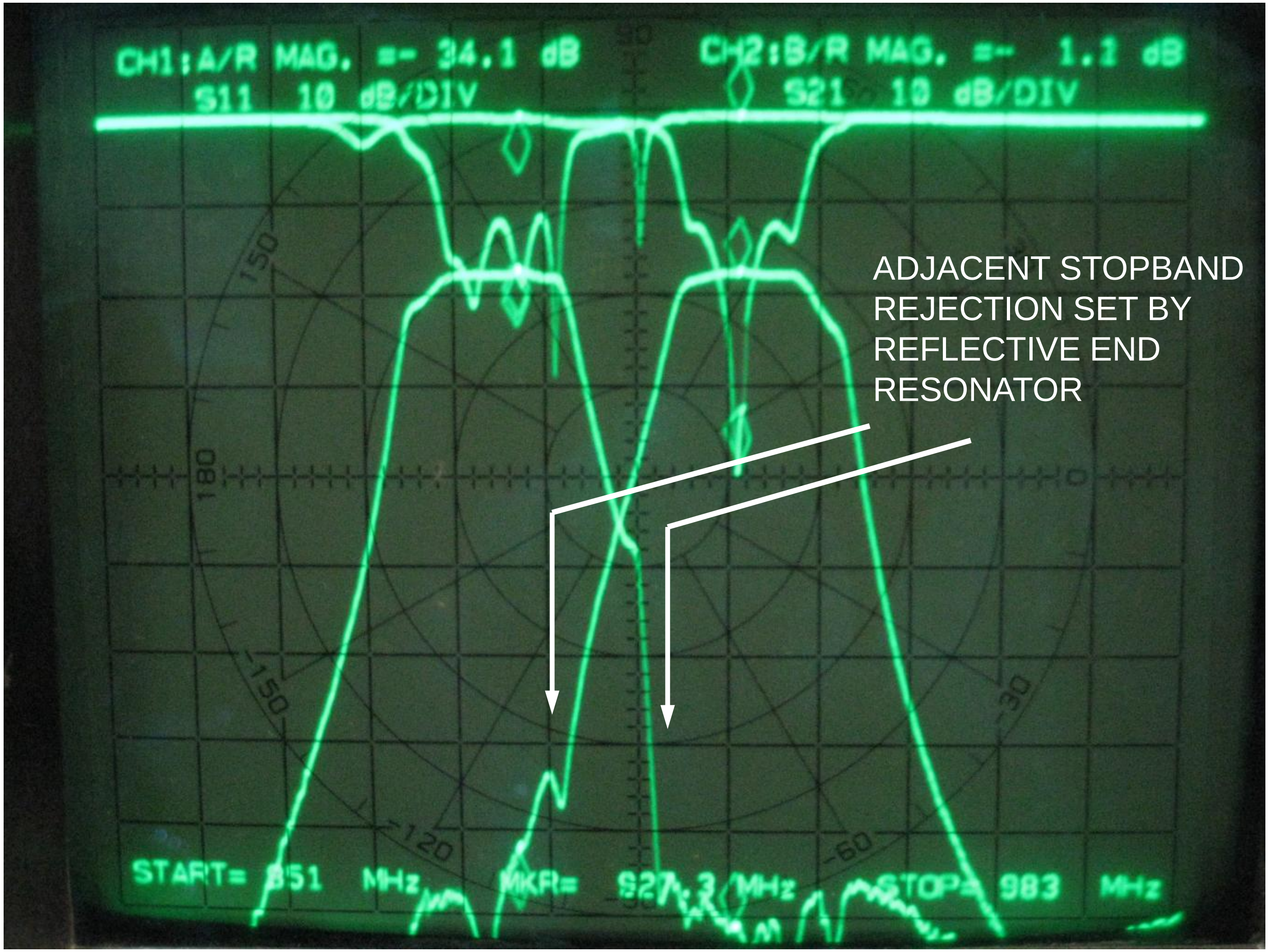
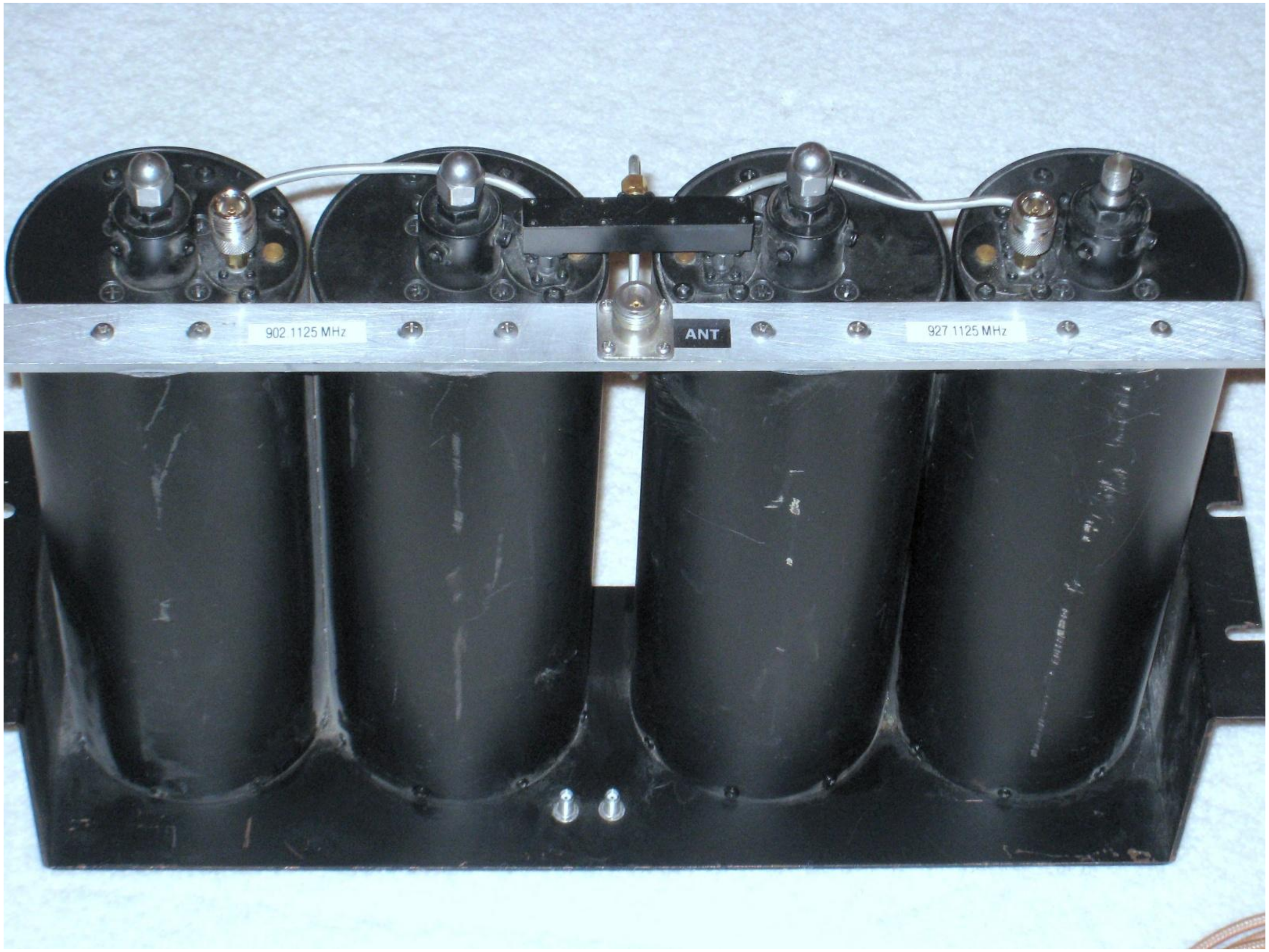
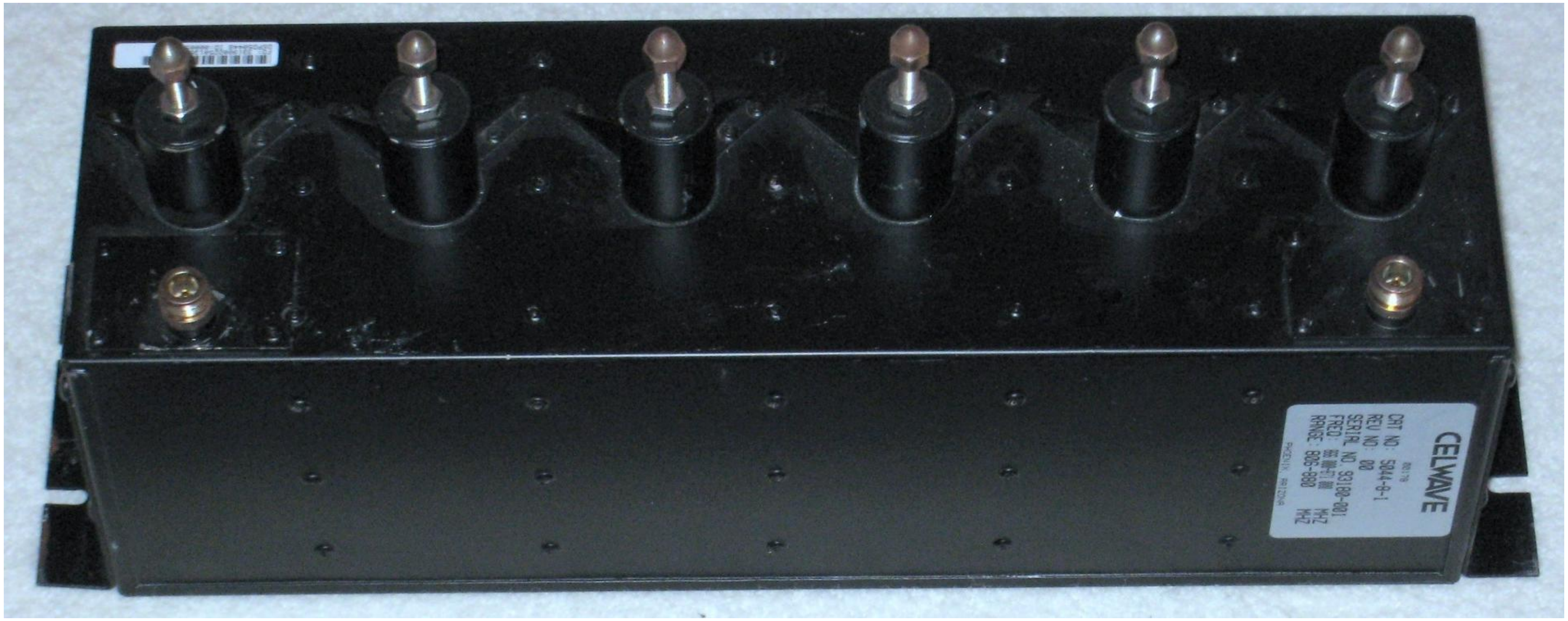
900 MHz COMBLINE DUPLEXER



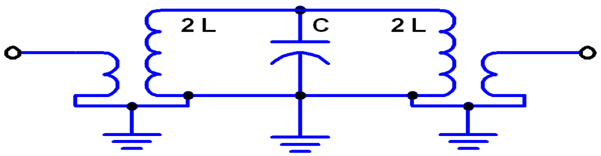
900 MHz DUPLEXER with 3λ/4 CAVITIES



SIX λ/4 CAVITY FILTER

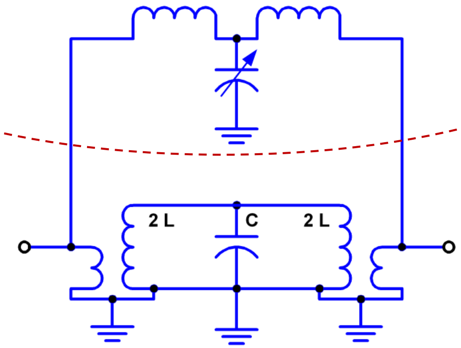


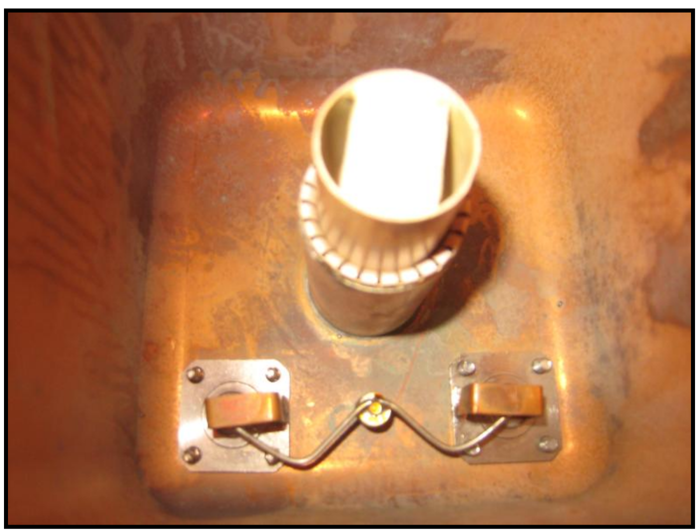
λ/4 CAVITIES



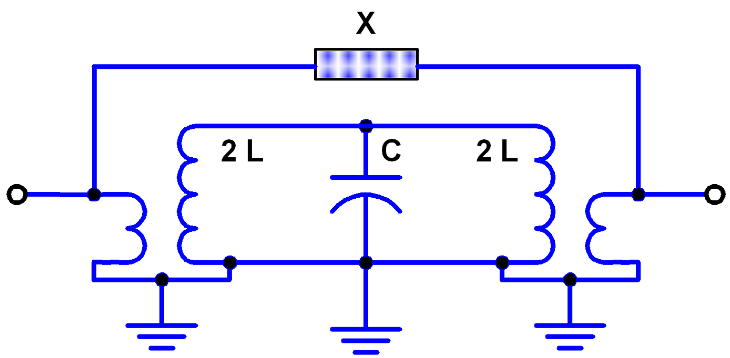
LOOP COUPLED PASS CAVITY

with added
REJECTION ENHANCEMENT NOTCH

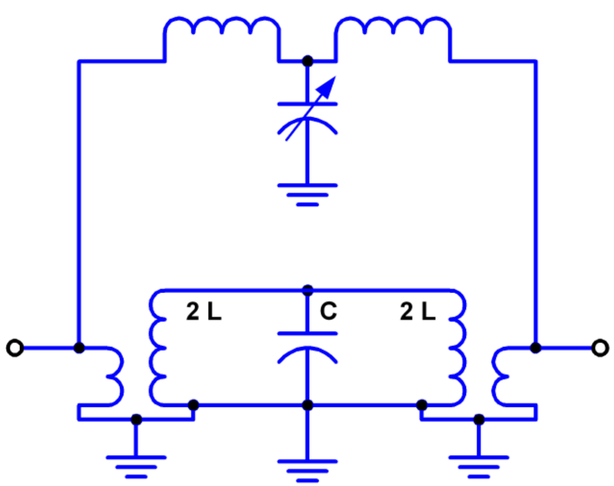


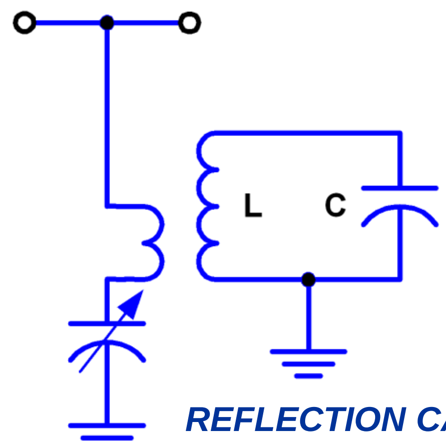


REJECTION ENHANCEMENT ADDED TO PASS CAVITY



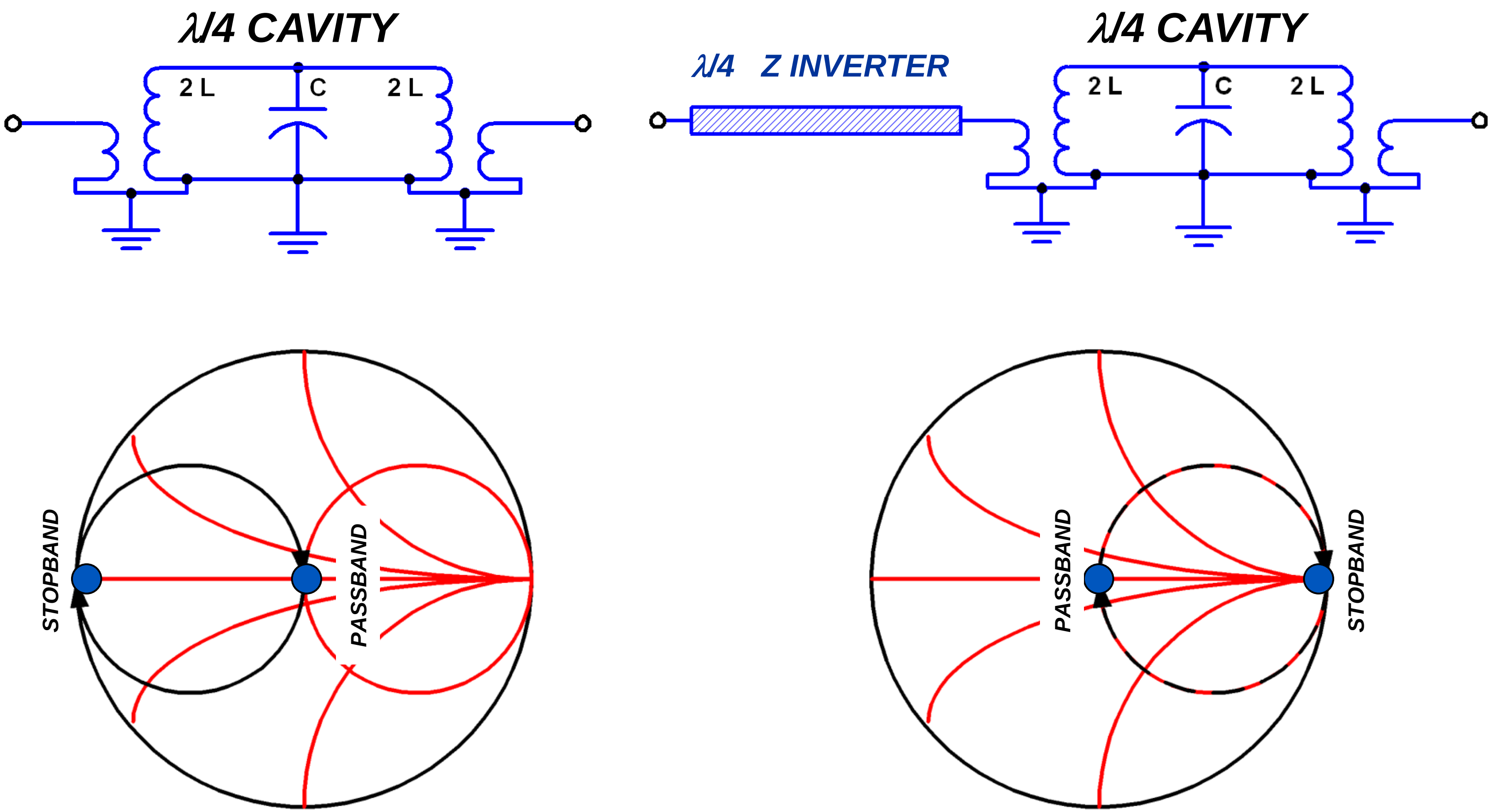
- X can be an inductor for a notch above the pass frequency
- X can be a capacitor for a notch below the pass frequency
- X can be an LC network to provide adjustable rejection above or below the pass frequency



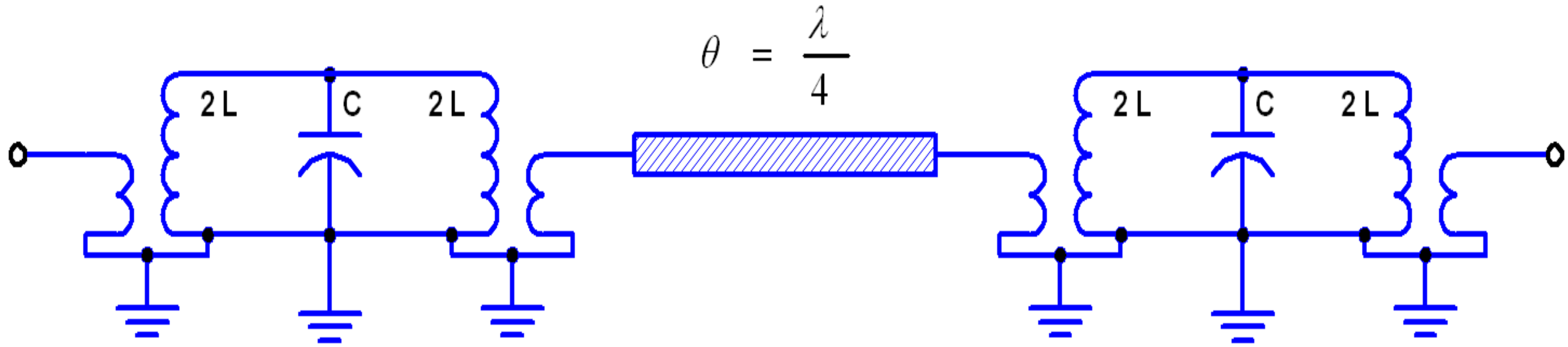


REFLECTION CAVITY WITH SHUNT NOTCH

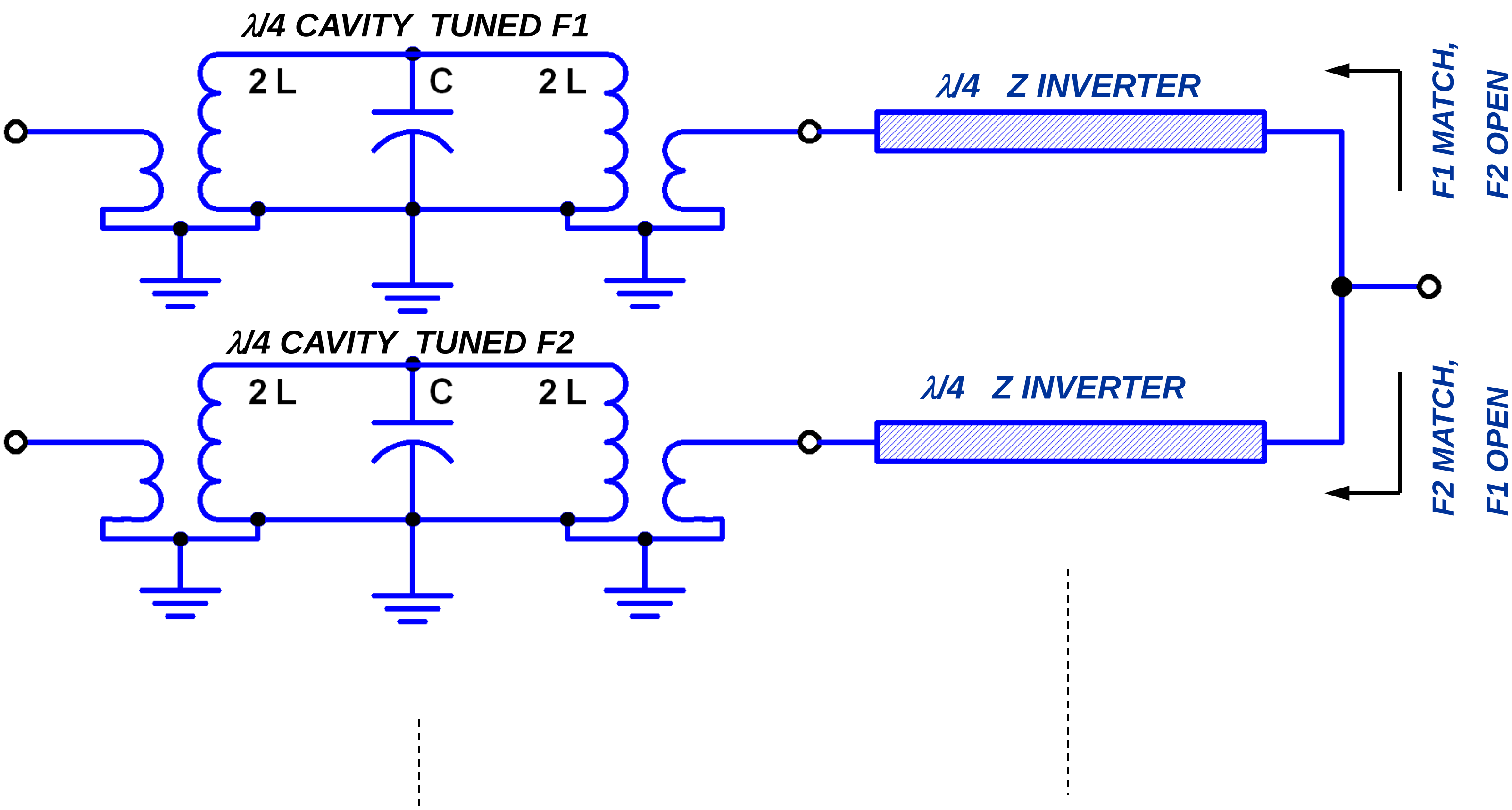
Z INVERTER 'FLIPS' TERMINAL CHARACTERISTIC



TWO CAVITY CASCADE FILTER with λ/4 Z-INVERTER

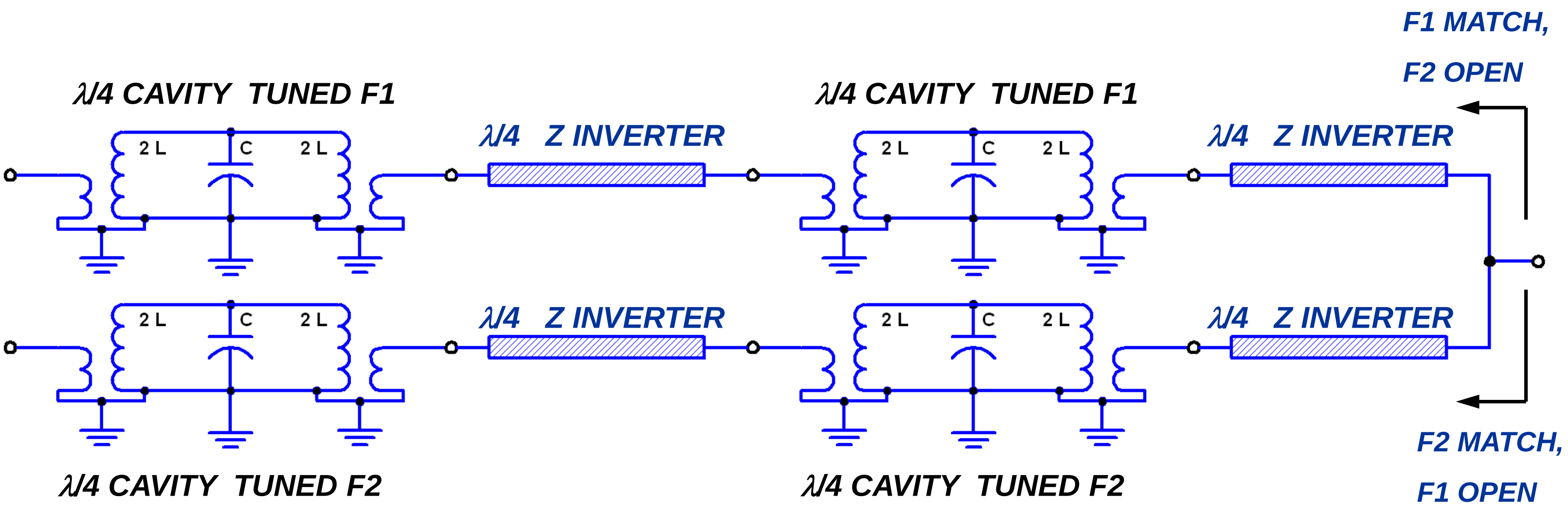


CAVITY TRANSMITTER COMBINER



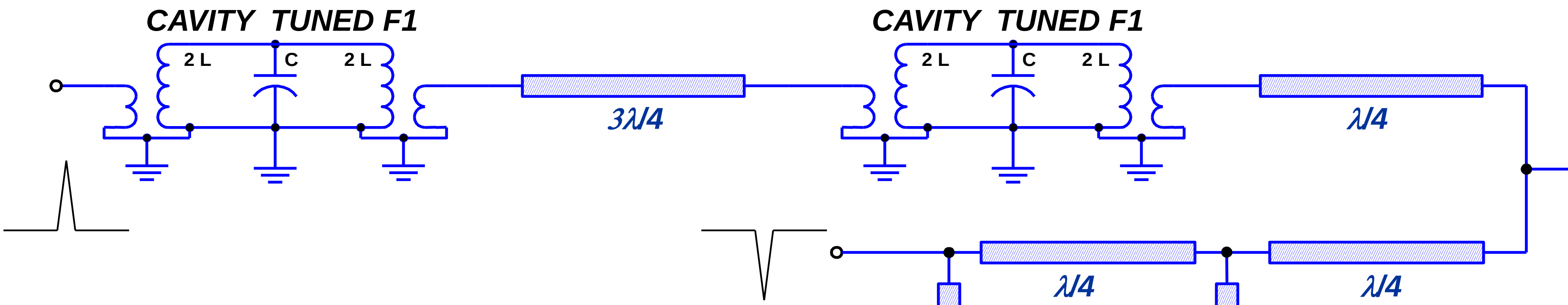
CAN BE EXTENDED TO MORE PORTS AS A 'STAR' COMBINER

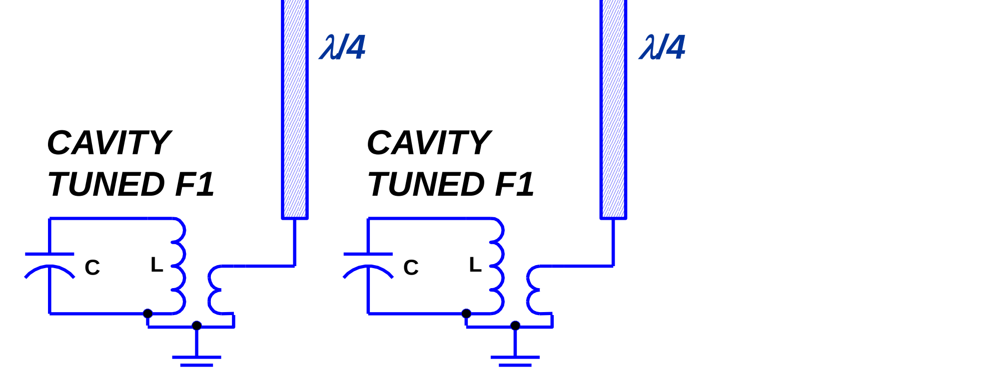
FOUR CAVITY DUPLEXER



- Duplexer operation is the same as with cavity transmitter combiner
- Duplexer performance requires better rejection of other cavity channel frequency. (Isolation of transmitter from receiver in repeater)
- Additional rejection of alternate channel can be added to cavity response.

DUPLEX NARROW AND WIDE BAND PORTS





- Notch filter formed by BP cavities offset by λ/4
- Narrow and wide band duplexer formed by combined pass and notch filters