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# Comparison of MLCC and X2Y® Technology for Use in Decoupling Circuits

# OUTLINE

**Goal: To investigate the performance of the X2Y® Technology as a decoupling device.**

1. **What is X2Y® Technology?**
   - **Structure**
   - **Circuit 1 & Circuit 2 Configurations**
2. **Evaluation #1 – Flux Containment**
   - **Performance vs. Spacing Requirements**
3. **Evaluation #2 – X2Y® vs. Low-Inductance Capacitors**
   - **Inductive behavior beyond SRF**
4. **Evaluation #3 – X2Y® Package Size and Inductance Correlation**
   - **Inductive behavior and physical geometry**
5. **Evaluation #4 – X2Y® Circuit 1 vs. Circuit 2**
   - **Utilizing the full potential of the X2Y® Technology**
6. **Conclusion**

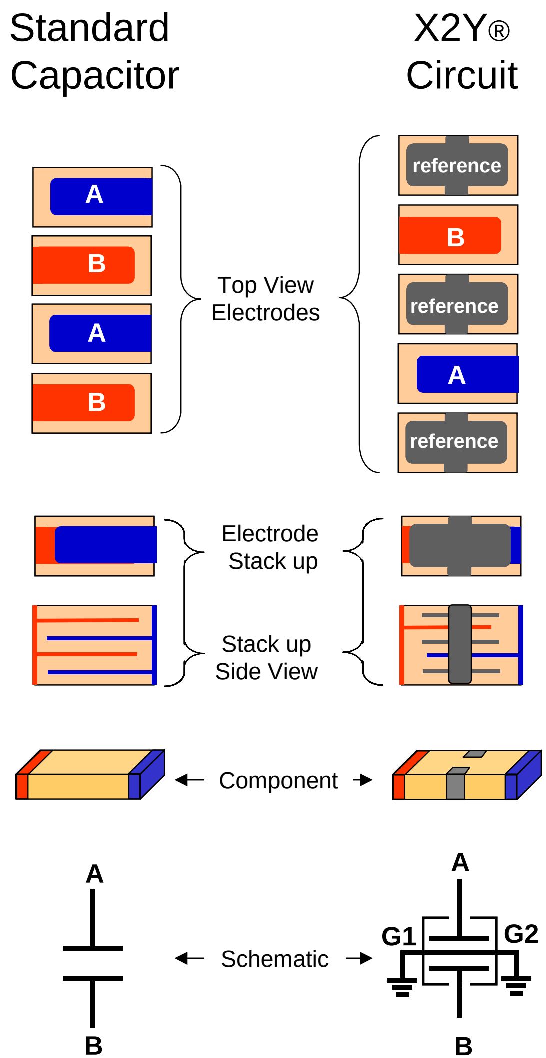
# Internal/external design differences

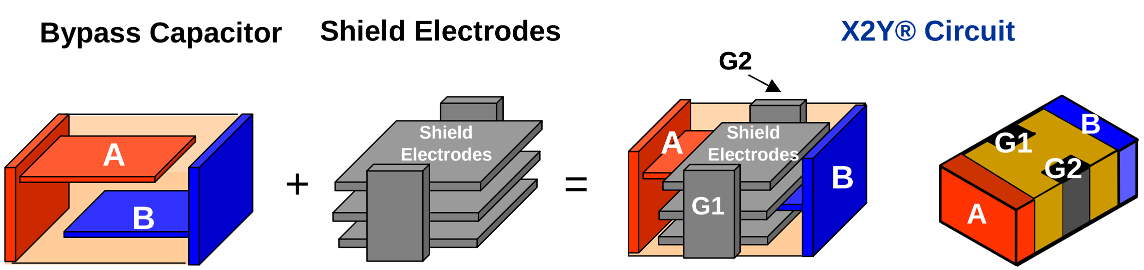
## X2Y vs. Standard Caps :

- Same standard component sizes
- Same standard capacitance values
- Same dielectric materials
- Same electrode materials
- Same termination materials

## <u>Here's what's new</u> :

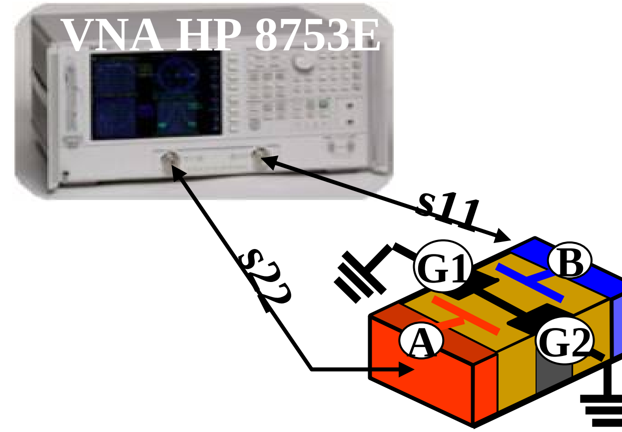
- New internal electrode arrangement
- Two new side terminations (G1 and G2)

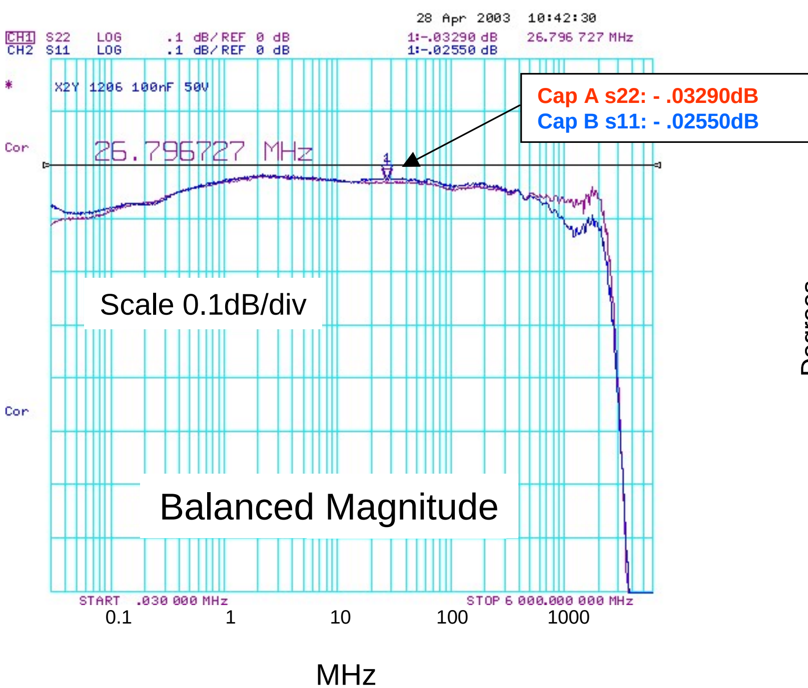


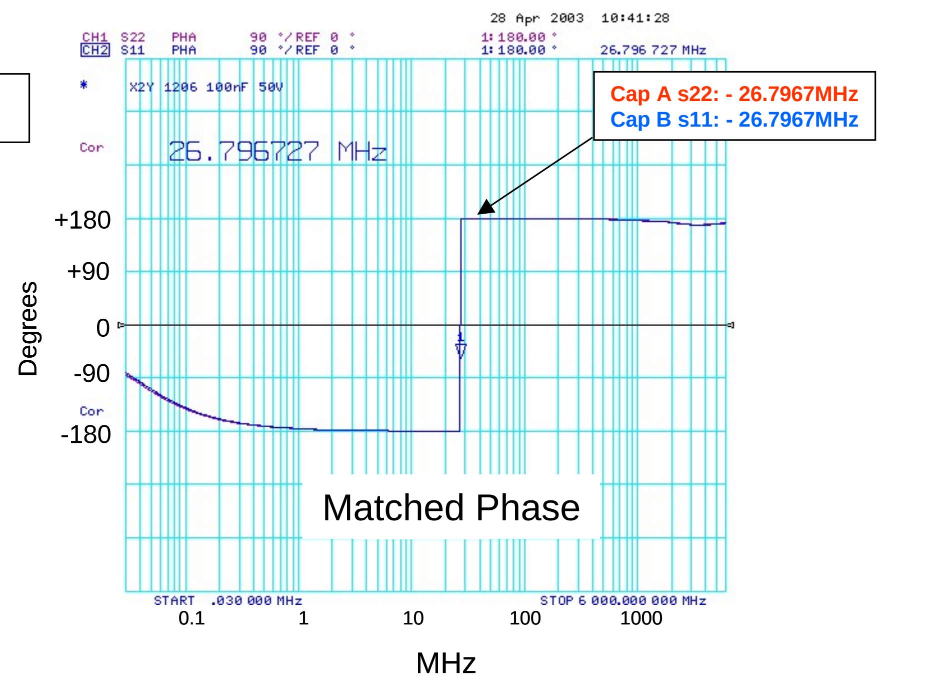



## Symmetrical structure:

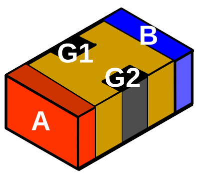
- Matched capacitance (1-2.5%) line-to-gnd
- Effects of temperature variation eliminated
- Effect of voltage variation eliminated
- Effect of aging is equal on both caps

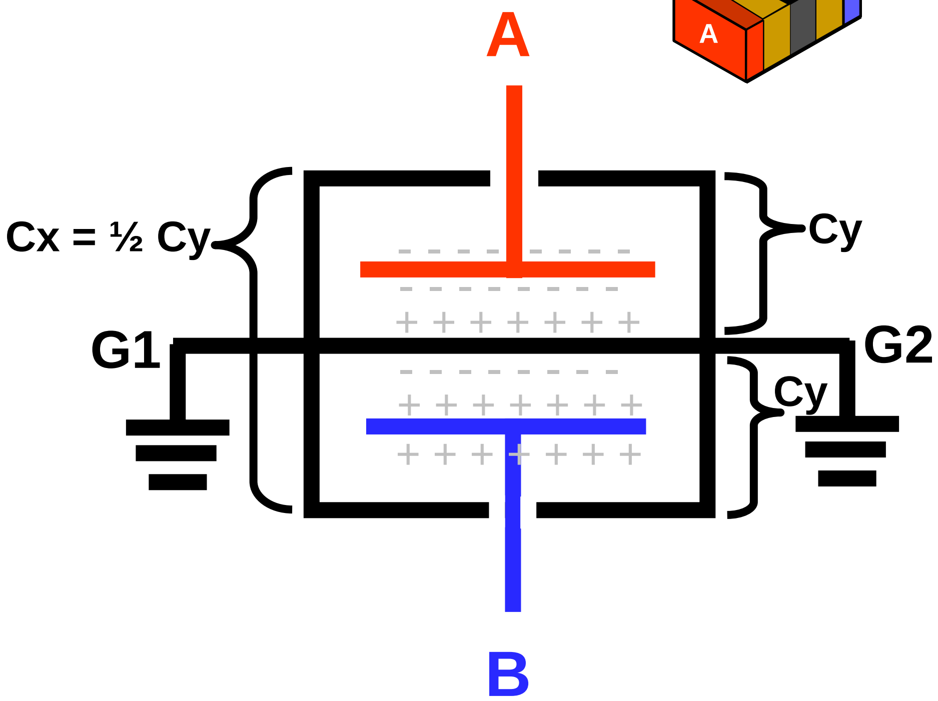


How is the X2Y capacitor specified in data sheets?




## Cap and Voltage rating:

- Capacitance is specified by either single Y capacitor (measured line-to-ground)
- Static measurement of the X capacitor = ½ of the specified Y capacitor

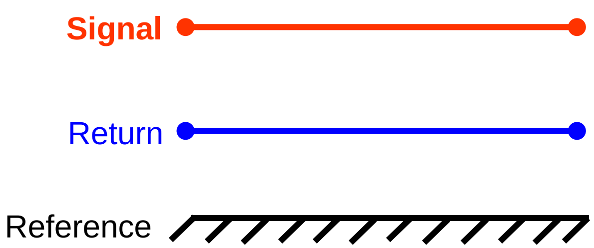
- Voltage rating is specified by either single Y capacitor (measured line-to-ground)
- Voltage rating for the X capacitor = 2x the specified Y capacitor voltage rating

Summary of the main circuit uses for the X2Y component.

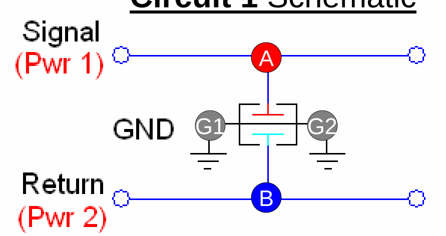
## **Circuit 1** Mode:

- Used for a (3) conductor circuit (signal, return, ground or reference)
- Differential applications

(3) Conductor System



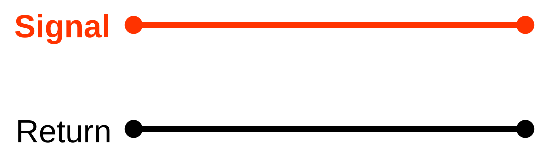

**Circuit 1** Schematic



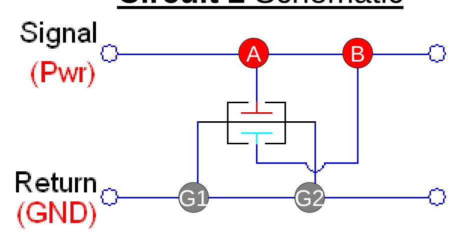

## **Circuit 2** Mode:

- Used for a (2) conductor circuit (signal, return)
- Single ended applications

(2) Conductor System

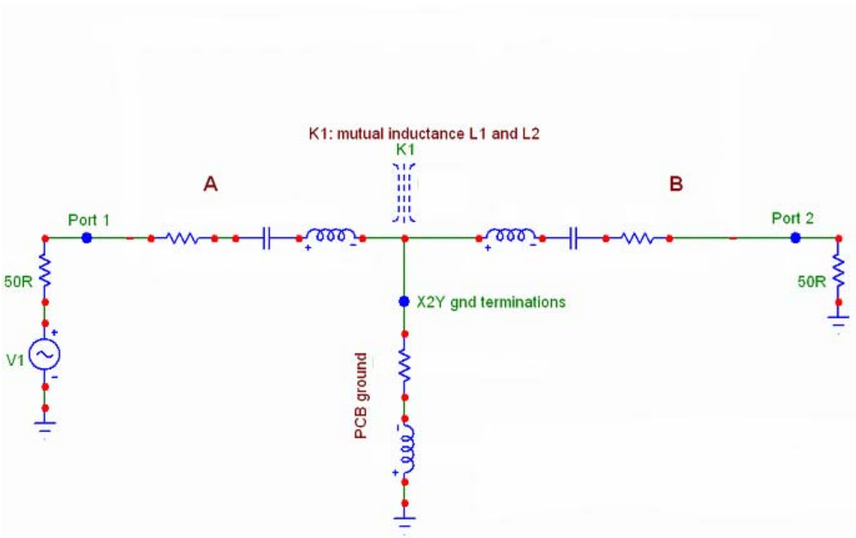



**Circuit 2** Schematic

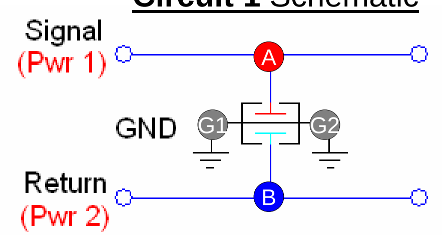


# Available Modeling Information.

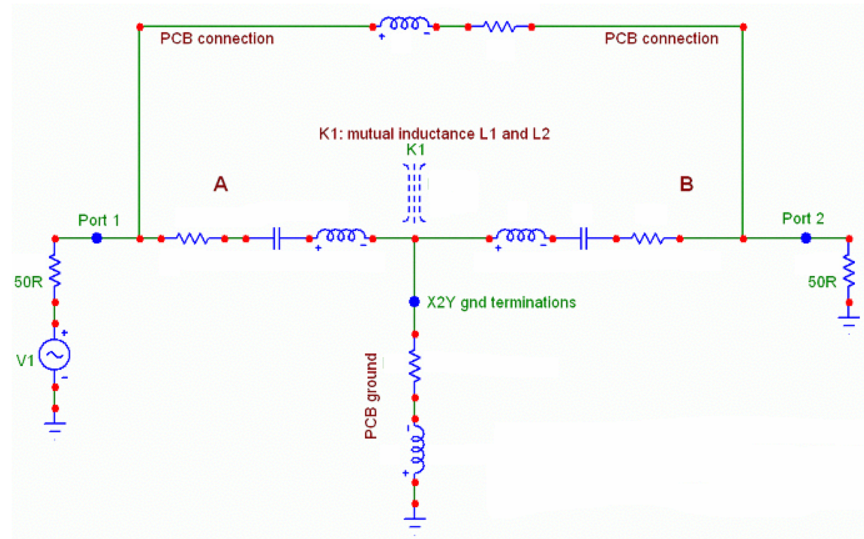
## **Circuit 1** Mode:



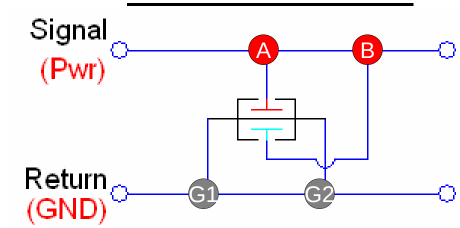

**Circuit 1** Schematic




## **Circuit 2** Mode:



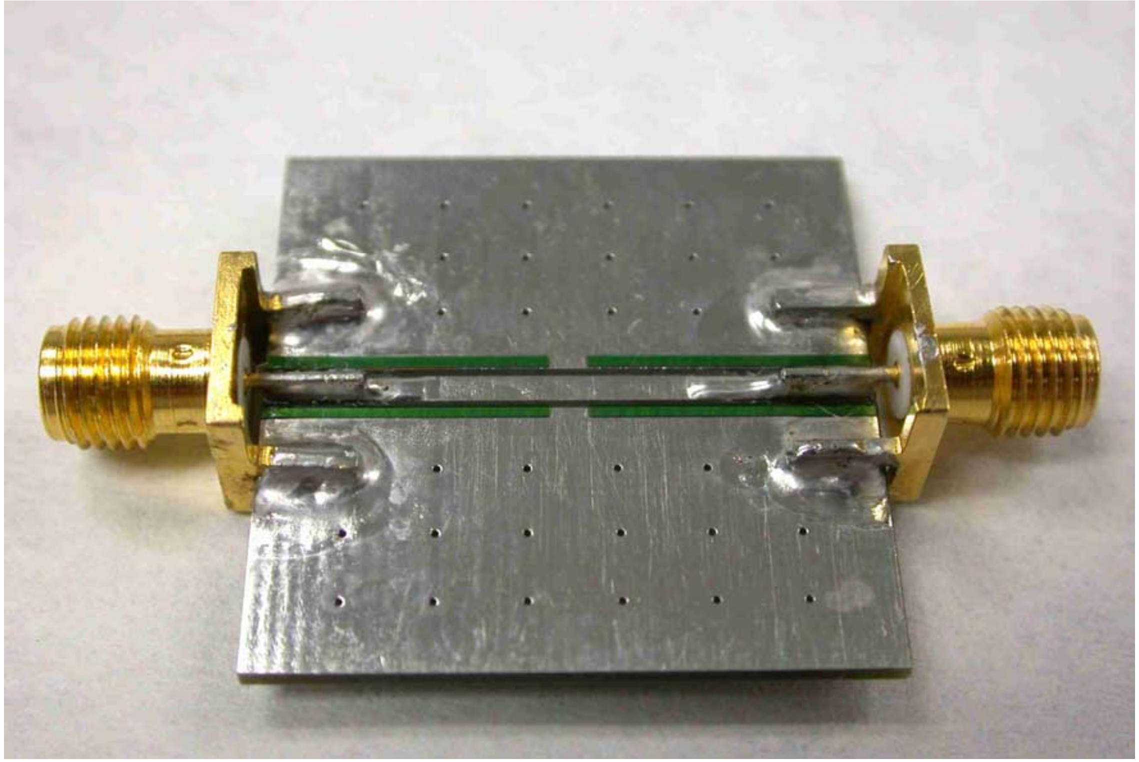

**Circuit 2** Schematic




* Model by Phycomp/Yageo, www.yageo.com

# EVALUATION #1 – FLUX CONTAINMENT

- Overall dimension of 28mm x 28mm
- FR-4 substrate
- Double layered, 1.0688mm thick
- Relative permittivity of 4.6
- Signal trace is 1.345mm
- Ground trace widths are 12.9475mm
- SMA connectors are soldered at each end of the signal trace



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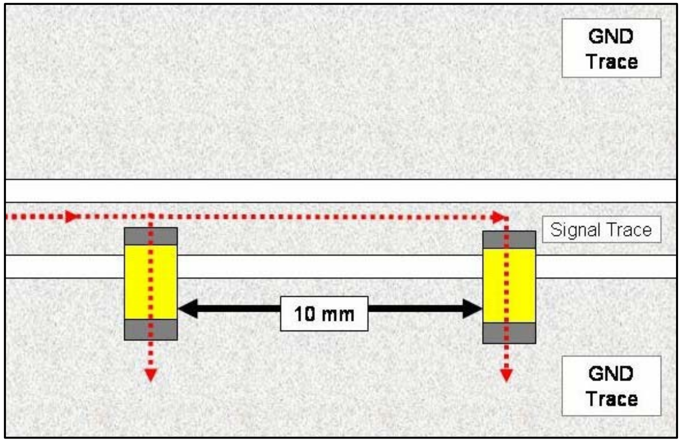
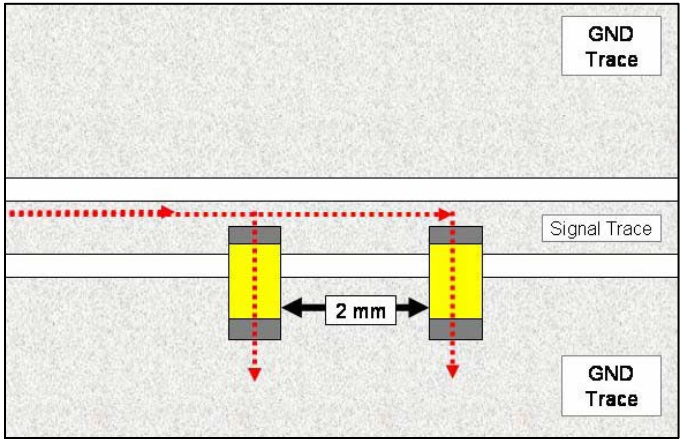
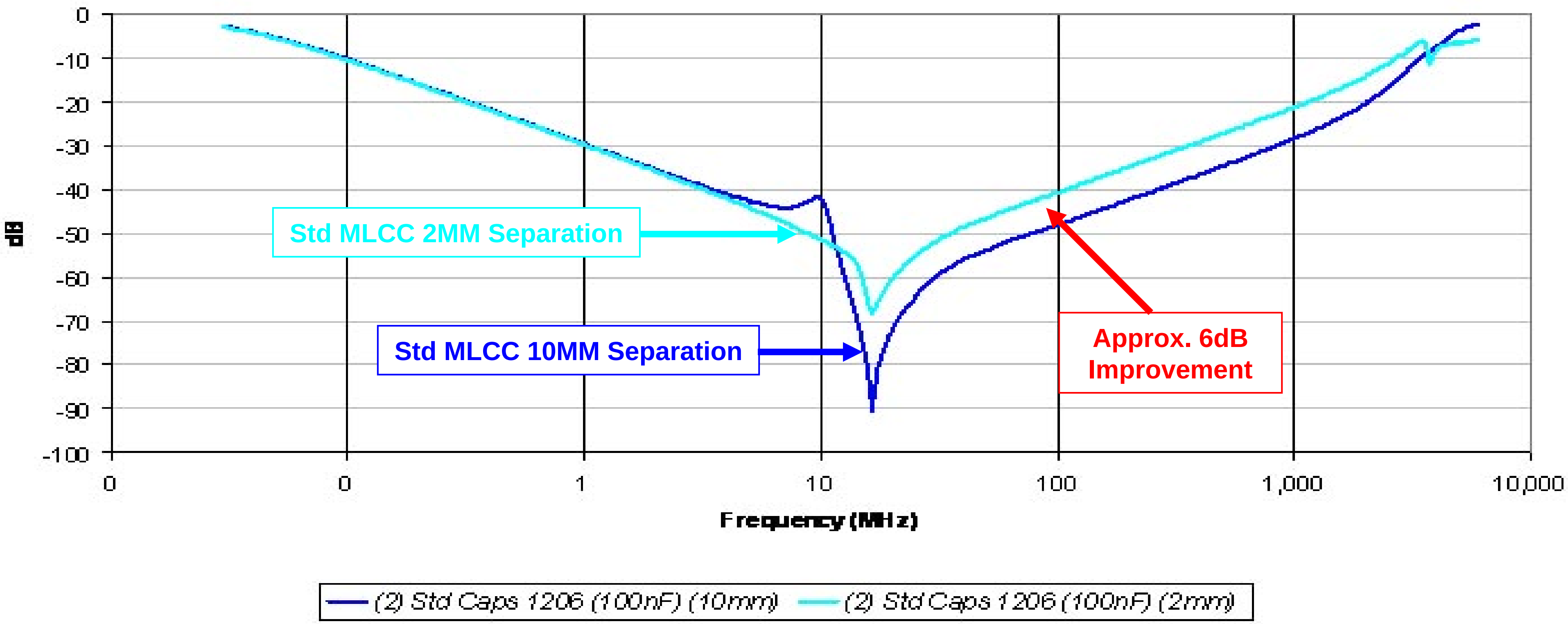
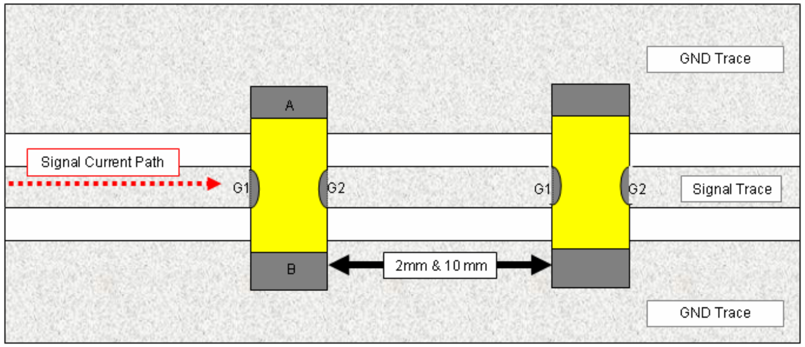
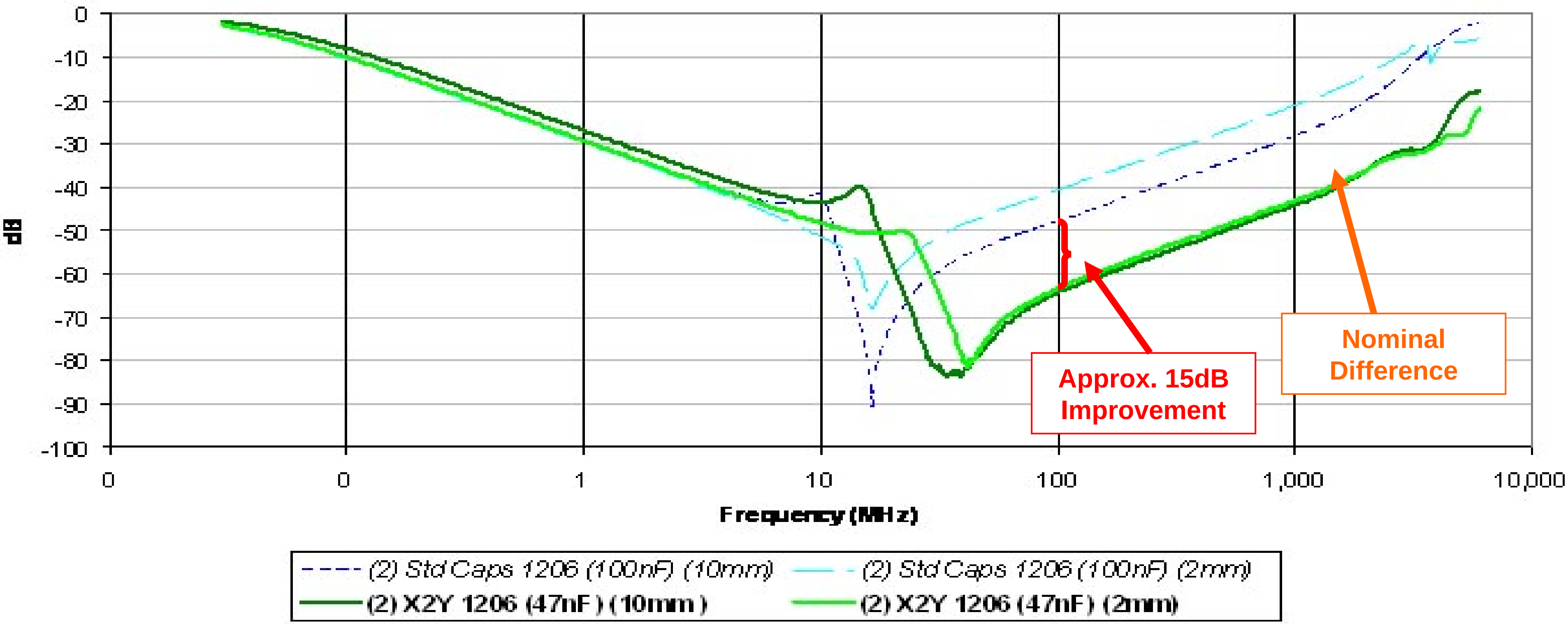


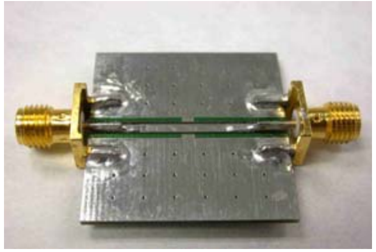
# EVALUATION #1 (continued)



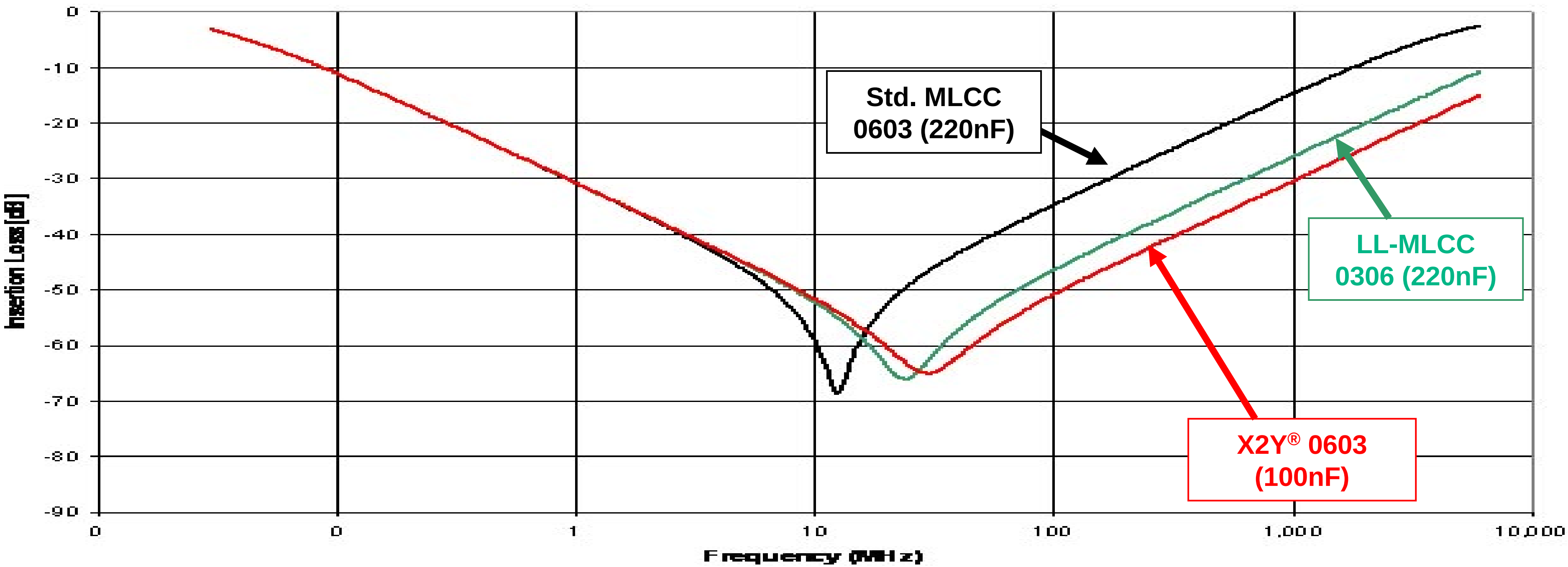
# Summary Evaluation #1

1. Std. MLCC spaced 10mm vs. 2mm apart have a 6dB improvement in inductance beyond SRF.
2. X2Y® components spaced 10mm vs. 2mm apart show nominal differences beyond SRF.
3. Both spacing distances of the X2Y® components had a 15dB improvement over the best case (10mm) Std. MLCC.
4. X2Y® components contain magnetic flux internal to the component which reduces spacing requirements Std.  MLCC have due to mutual inductance between them.



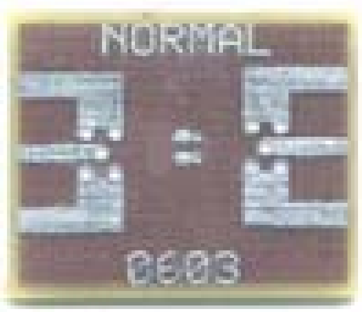
# Inductance beyond SRF

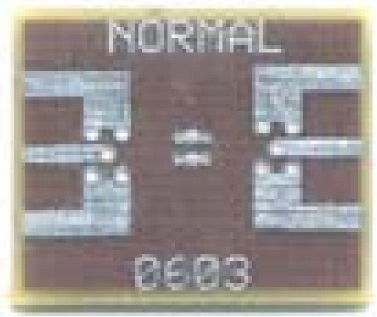
1. X2Y® exhibits a 16dB improvement beyond SRF over a Std. MLCC.
2. X2Y® exhibits a 3dB improvement beyond SRF over a Low-Inductance reverse geometry MLCC.

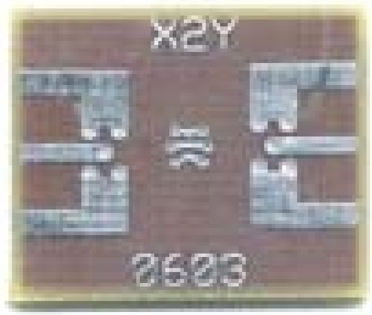


# Evaluation #2 – (using vias)

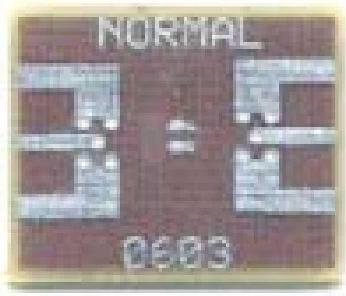
- 4 layer boards
- Overall size of 1.2” by 1.2”
- 0.062” thick
- FR-4 substrate
- Planes are solid copper (1 ounce)
- Planes located 0.012” and 0.05”
- Nominal Er is 4.6 at 1MHz.

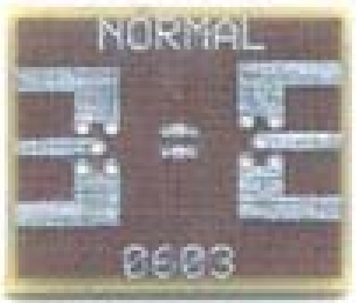


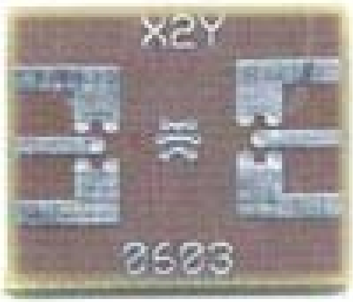



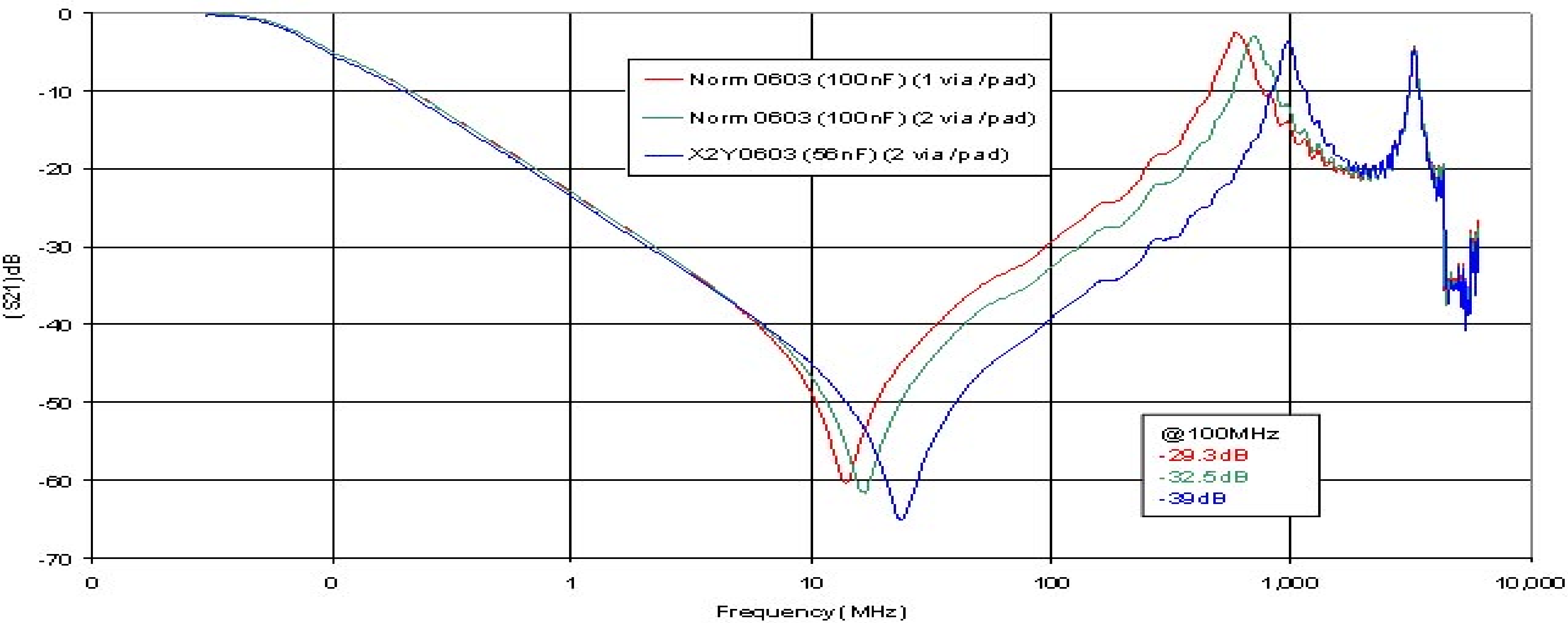



# Evaluation #2 – (using vias)



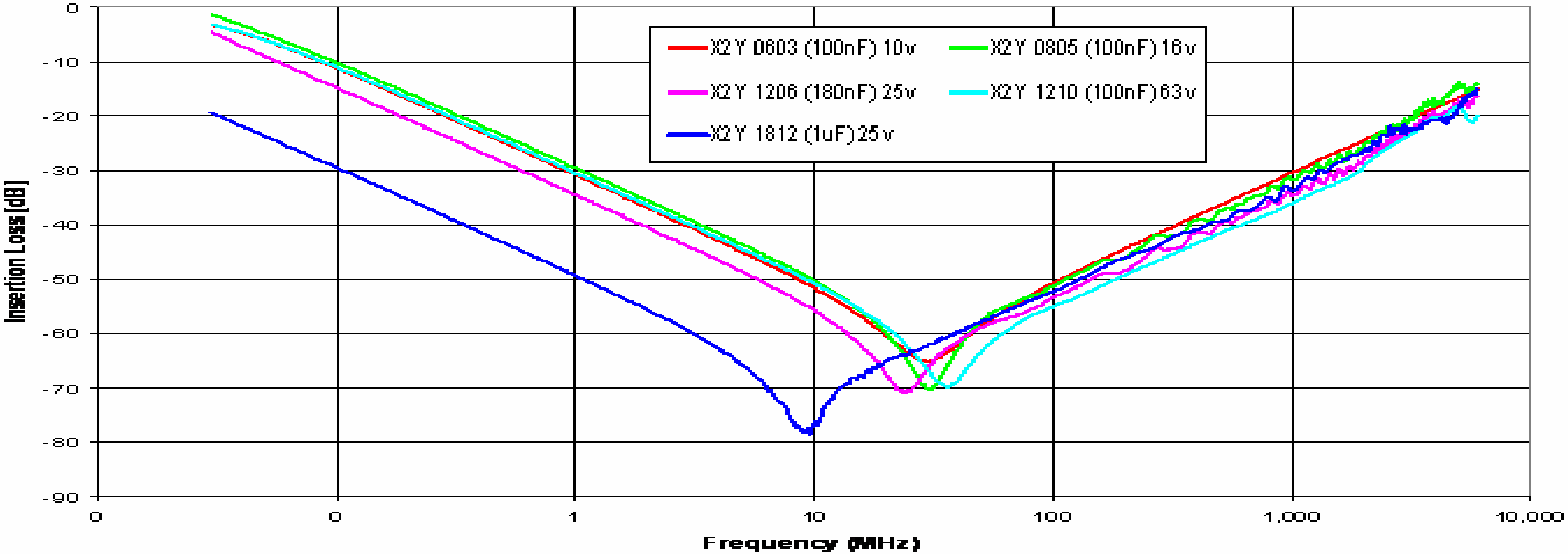



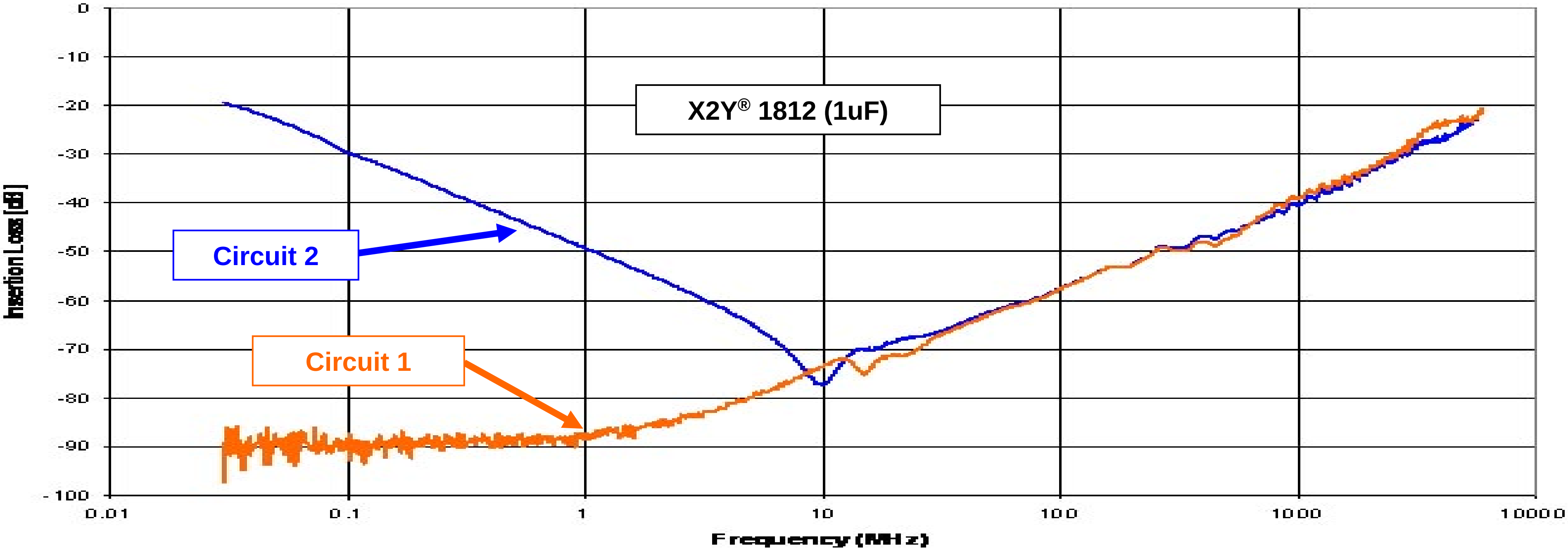
# Inductance and Geometry

1. X2Y® 1812 has a 1 – 2dB improvement over the X2Y® 0603.
2. The larger package size allows for more parallel electrodes, thus more internal cancellation of mutual inductance and larger cap values.
3. Counters the notion of “smaller is better”.



# X2Y® Circuit Configuration Comparisons

1. Circuit 1 & Circuit 2 configurations have the same low-inductive behavior beyond SRF.
2. Circuit 1 improves the low end frequencies before SRF by providing a more efficient means of energy transfer.



# Questions