From Concept to Circuit: Designing Effective PoC Filters

Contribution to 802.3dm Task Force

January 21, 2024

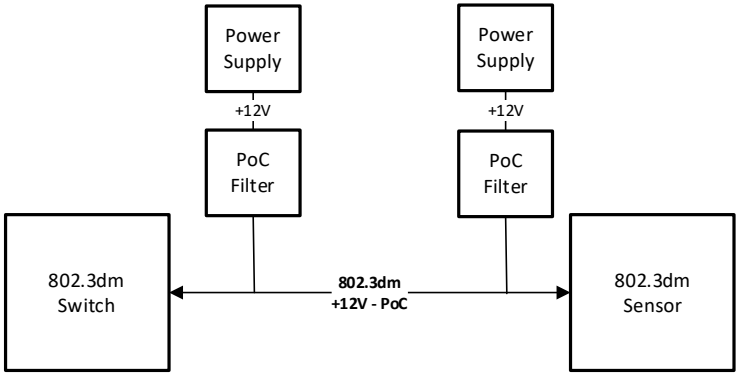
TJ Houck (Marvell)

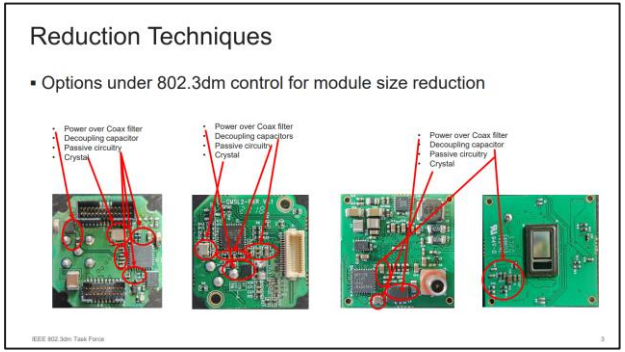
Topics

- Importance of Power over Coax (PoC)
- Requirements for a Filter and component selection
- Can ACT achieve 1 inductor solution?

Importance of Power over Coax (PoC)

- Reduces cable and connector complexity
- Weight Reduction – few cables and connectors
- Cost effective – faster manufacturing and installation
- Fewer points of failure
- PCB spacings – less connectors allows for smaller module design



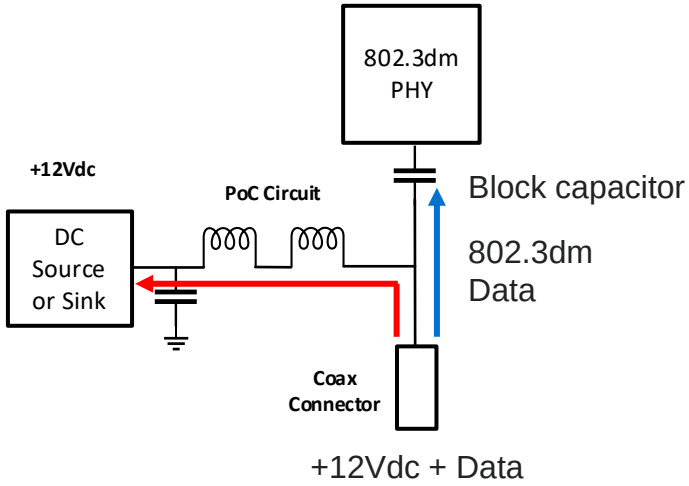


Referenced: https://ieee802.org/3/dm/public/0724/houck_3dm_01_0724.pdf

Requirements for a Filter and Component Selection

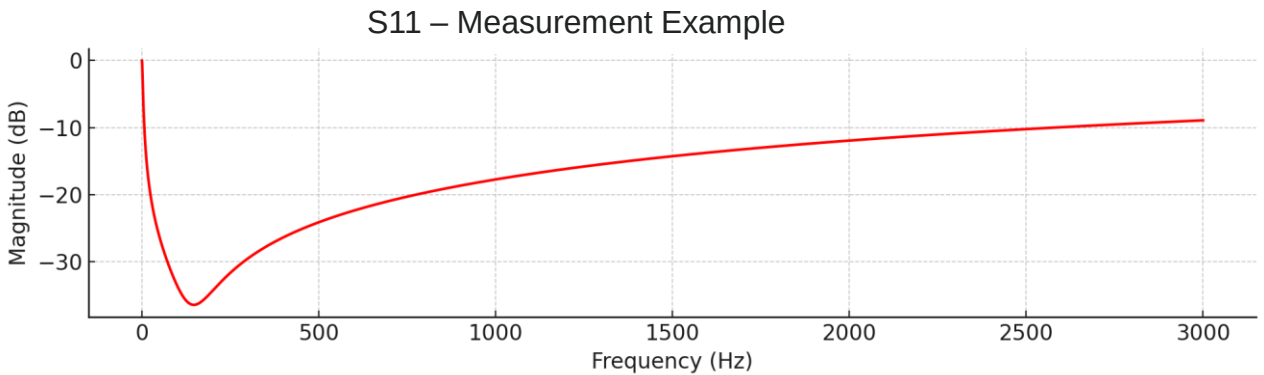
- Why Inductors?
  - Allow DC power to pass through while blocking high frequency signals (data)
  - Suppress Power Line Noise Inductors act as a filters to suppress noise on the power line preventing it from affecting the 802.3dm data
  - Filtering out unwanted noise that is coupled onto the coax cable – EMI
  - Supports Steady Power Delivery – inductors smooth out voltage fluctuations
  - Acts as a low pass filter for Power

- Why not capacitors?
  - Capacitors block DC voltage



Requirements for a Filter and Component Selection

- Why are S-parameters (Return Loss) looked at?
- PoC circuits use return loss to evaluate how well the inductor matches the impedance of the transmission line.
  - A high return loss would indicate minimal reflection meaning the inductor is matching the impedance of the system.
  - When 1 inductor is used it is very simple to meet the RL requirements

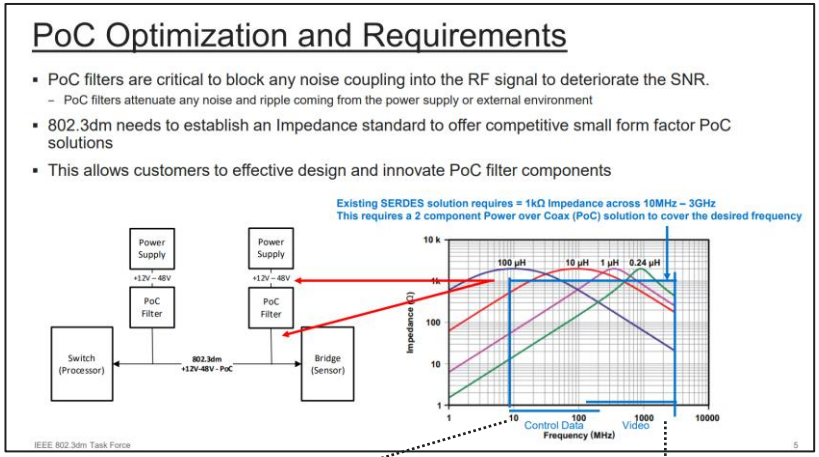


Requirements for a Filter and Component Selection

- What is inductor Impedance?
  - Unlike resistors that offer constant resistance to current flow, the impedance of an inductor varies with frequency of the AC signal passing through it.
  - Inductors combines both resistance (real component) and reactance (imaginary component)

$$Z_L = j\omega L$$

- j is the imaginary unit (j = $\sqrt{-1}$)
- ω is the angular frequency (ω = 2πf)
- L is the inductance in Henries (H)



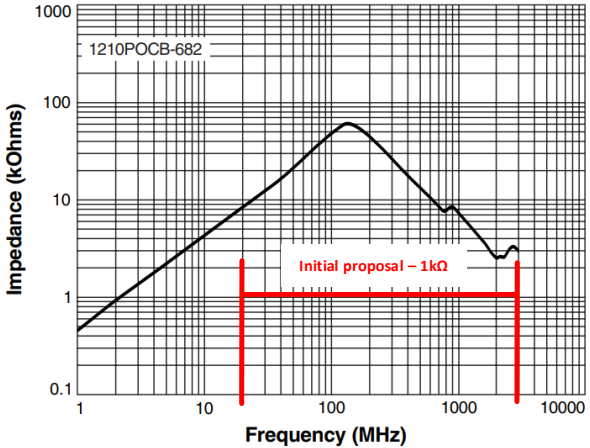
Referenced: https://ieee802.org/3/dm/public/0724/houck_3dm_01_0724.pdf

Requested an Impendence Specification

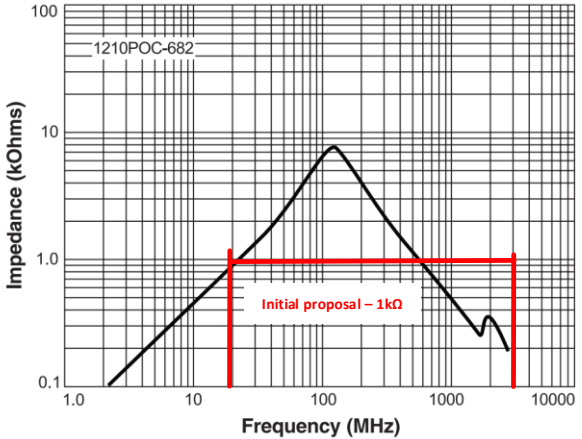
Can ACT Achieve 1 inductor Solution

- Older PoC inductors have issues meeting the broadband noise rejection required for 802.3dm
- New PoC inductors are able cover broadband noise rejection required with broadband impedance response

New PoC Inductor



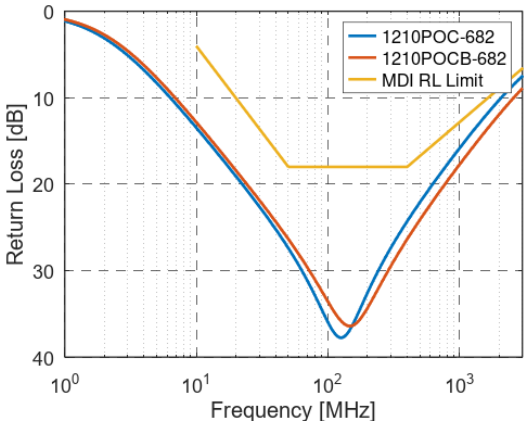
Old PoC Inductor



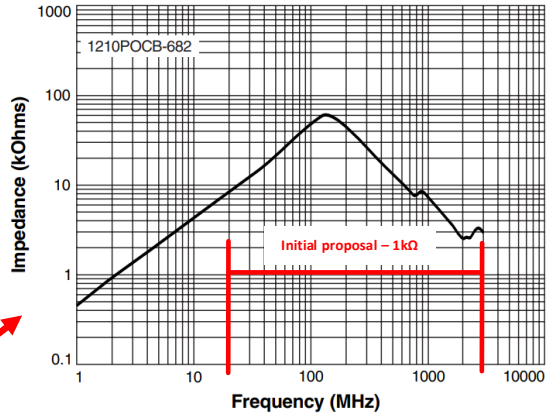
Referenced: https://www.coilcraft.com/getmedia/9804936a-6bb5-49a8-bcd2-09eba1192490/1210pocb.pdf
Referenced: https://www.coilcraft.com/getmedia/5e8de018-68c5-4442-84ce-d5212c44660c/1210poc.pdf

Can ACT Achieve 1 inductor Solution

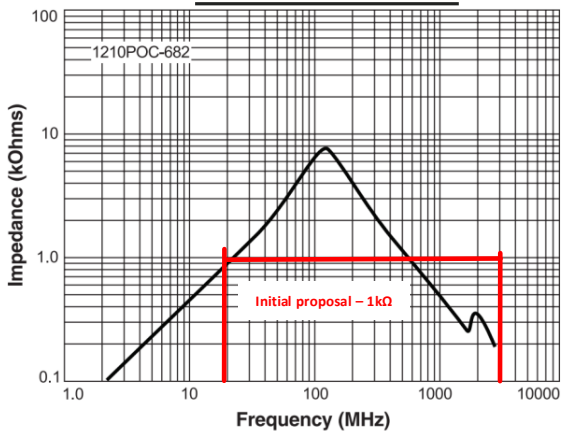
- Looking at purely S-parameters (IL/RL) or Impedance will not create an effective PoC filter solution
- S-parameters – used to evaluate signal integrity and matching of transmission line
- Below are 2 inductors that meet proposed RL limits for 802.3dm
  - Old inductor has “POOR” impedance performance
  - New inductor has “GREAT” impedance performance



New PoC Inductor

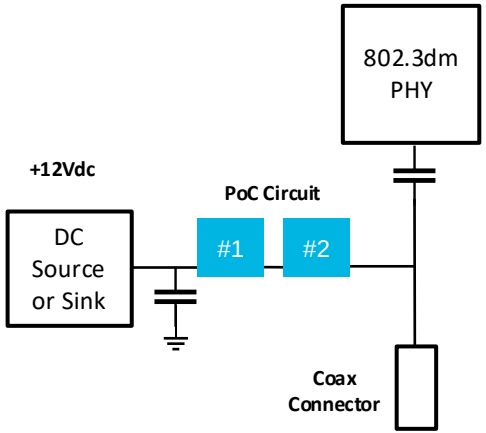


Old PoC Inductor

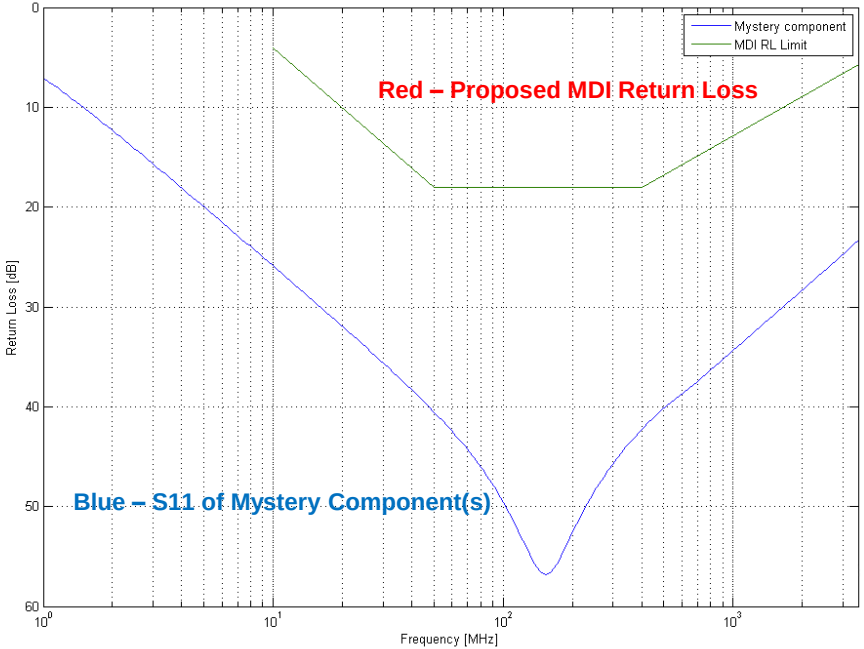


Quiz Time

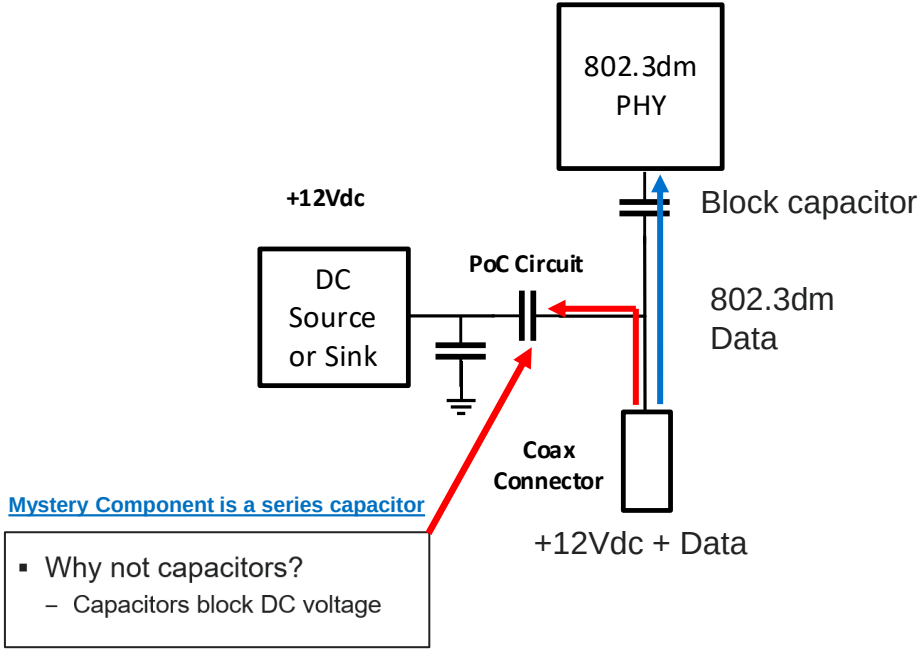
Can this component work for 802.3dm?



S11 Mystery Component(s)



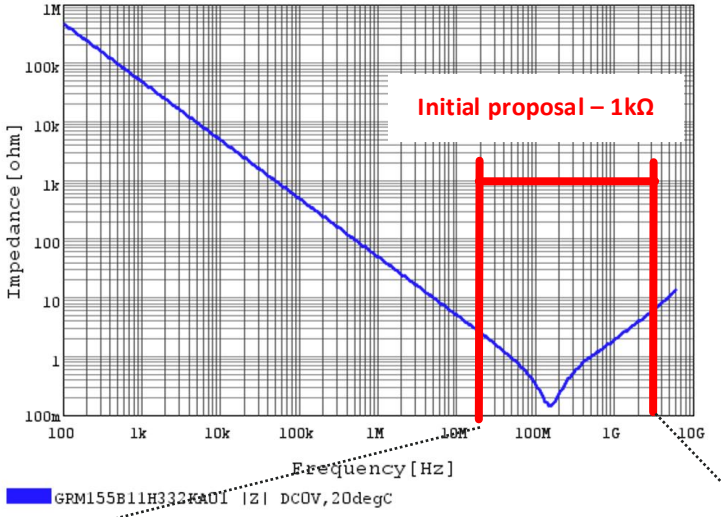
What happens when you DON'T look at Impedance?



- Why not capacitors?
  - Capacitors block DC voltage

$$Z_C = \frac{1}{j\omega C}$$

As frequency increase, ω becomes larger, causing the Z to decrease. This is due to the current through a capacitor increase with frequency for a given voltage.



If 1kΩ impedance proposal was followed – this would've been seen

Summary

1. It is **proposed** to introduce Impedance specifications for PoC implementations
2. Propose **requirements** with coil vendors to achieve a 1 inductor solution
3. **Low DCR** solutions are possible with changes to current inductors
4. **Both Impedance and Return Loss** should be looked at to determine the inductor meets necessary specifications

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