

The danger of underdamped filters!

OMICRON 11th Power Analysis & Design Symposium



Prof. Arturo Mediano
I3A, University of Zaragoza (SPAIN)
amediano@unizar.es

Organized by,



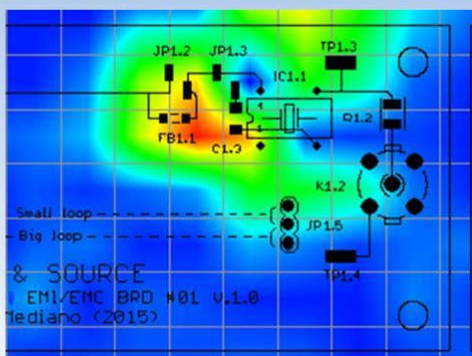
2022

March 9th, 2022



A High Frequency Lab for

design, diagnostic, troubleshooting and training



Interferences (EMI)
Electromagnetic Compatibility (EMC)
Signal Integrity (SI)
Radiofrequency (RF)

Contact: Arturo Mediano
amediano@unizar.es
www.cartoontronics.com

About the speaker ...

Prof. **Arturo Mediano**

Teaching Professor in EMI/EMC/RF/SI

I3A, University of Zaragoza (SPAIN)

Arturo Mediano is the founder of The HF-Magic Lab®, a specialized laboratory for design, diagnostic, troubleshooting, and training in the EMI/EMC, Signal Integrity, and RF fields at I3A (University of Zaragoza).

He received his M.Sc. (1990) and his Ph. D. (1997) in Electrical Engineering from the University of Zaragoza (Spain), where he has held a teaching professorship in EMI/EMC/RF/SI since 1992.

For more than 30 years Arturo has been involved in R&D projects with many companies in the EMI/EMC, Signal Integrity and RF fields for communications, industry, medical, and scientific applications. He regularly shares his knowledge and expertise with students and engineers in teaching courses and seminars.



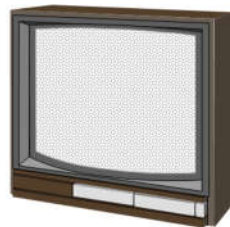
Email: amediano@unizar.es

LinkedIn: www.linkedin.com/in/amediano



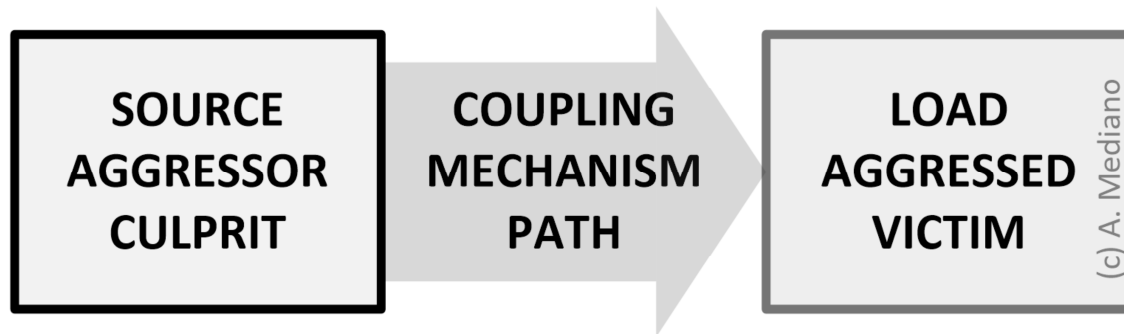
© A. Mediano University of Zaragoza (SPAIN) · amediano@unizar.es

Introduction: EMI picture (2)



© A. Mediano University of Zaragoza (SPAIN) · amediano@unizar.es

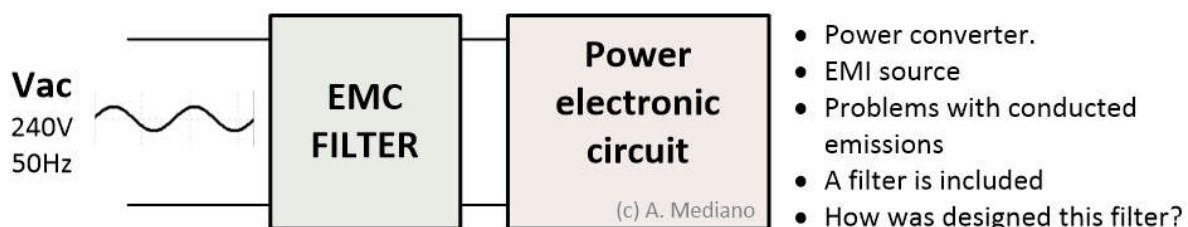
Introduction: EMI general picture



© A. Mediano University of Zaragoza (SPAIN) · amediano@unizar.es

The product: description

- 1.- Your product is a power electronic converter.
- 2.- Connected to mains network (i.e. 240V/50Hz)
- 3.- The product needs an EMC filter to comply with conducted emissions regulations.



© A. Mediano University of Zaragoza (SPAIN) · amediano@unizar.es

About the filter: how it was designed

How the filter was designed (possibilities):

- Option 1: same filter as from previous model (or custom tuned).
- Option 2: designed by trial and error → **dangerous**
- Option 3: direct replica from a competitor → **honest?**
- Option 4: commercial filter → **expensive? (not always)**
- Option 5: designed correctly from scratch → **you need time**

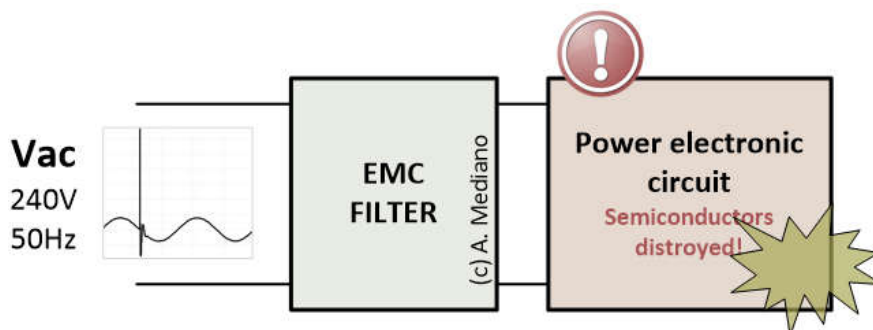
Additionally:

- designed only with emissions in mind (not immunity)
- not usually considering radiated emissions
- trying to use low cost components → **be careful!**



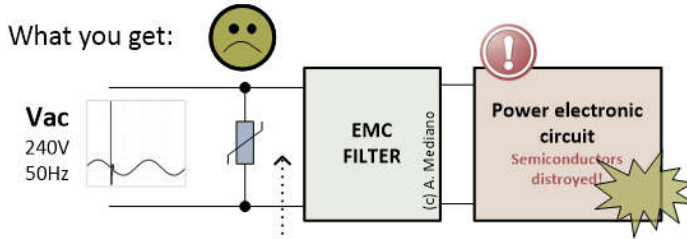
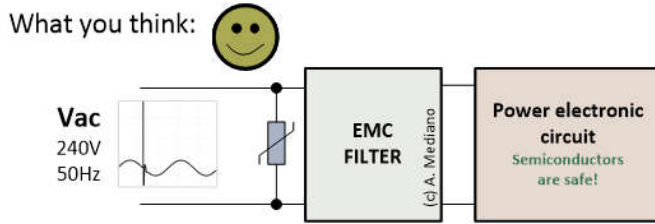
© A. Mediano University of Zaragoza (SPAIN) · amediano@unizar.es

The product: trying to pass immunity



© A. Mediano University of Zaragoza (SPAIN) · amediano@unizar.es

Fail in immunity: varistor?



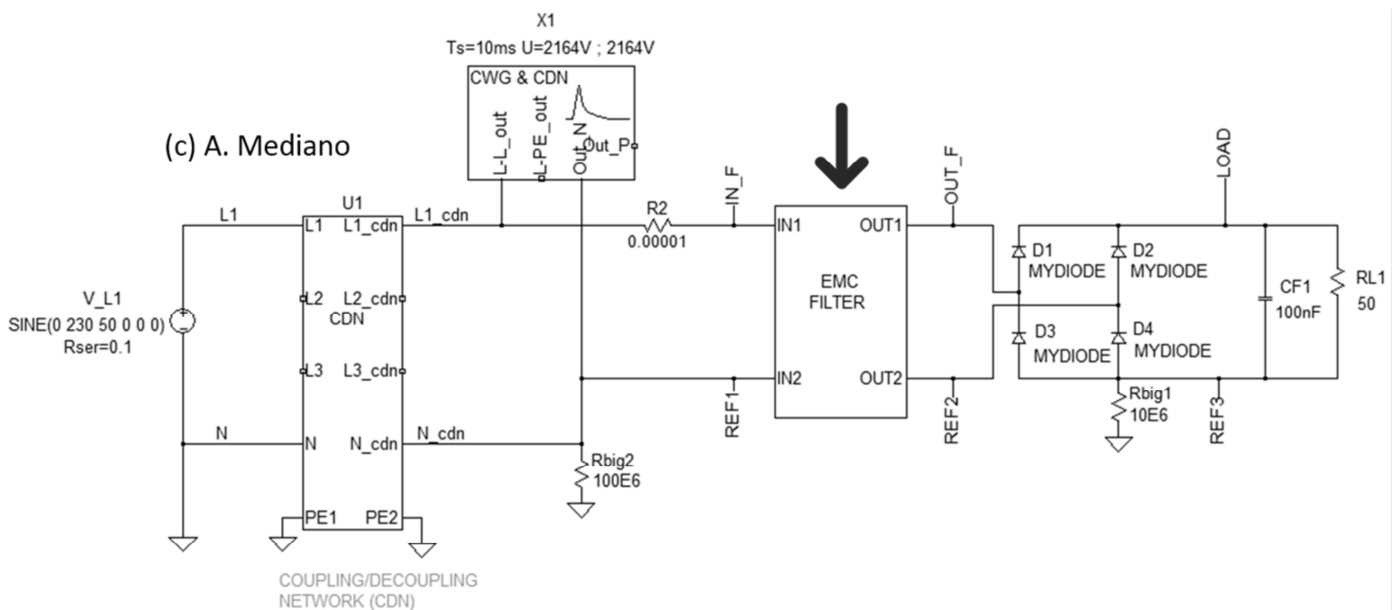
How is this possible??

... and you can see varistor is clamping input transient!!!!



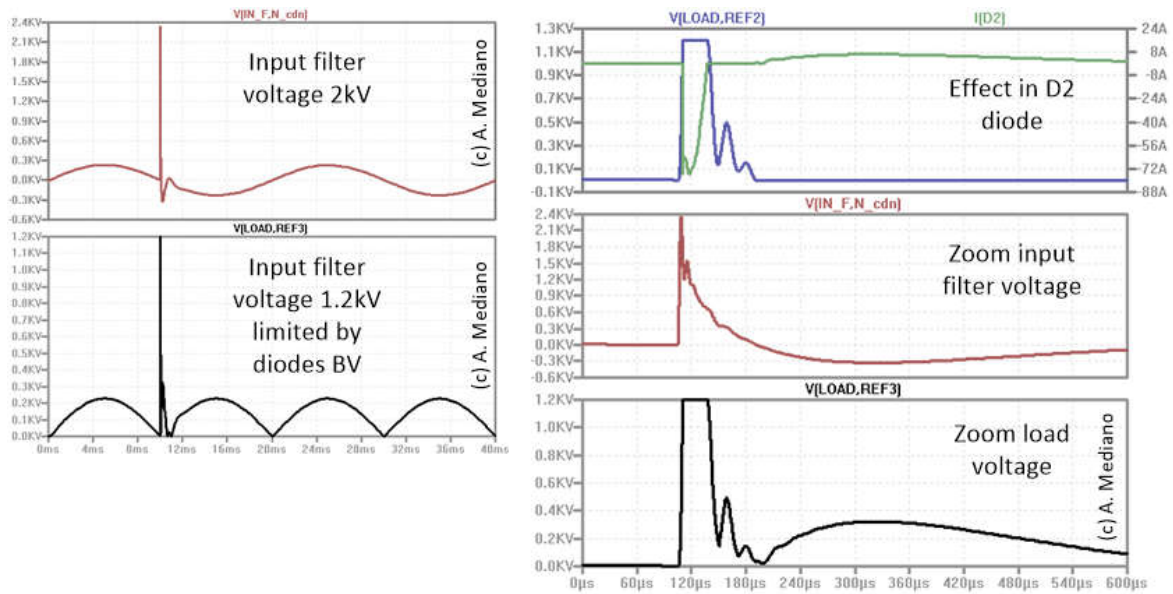
© A. Mediano University of Zaragoza (SPAIN) · amediano@unizar.es

Design example: with LTSPICE



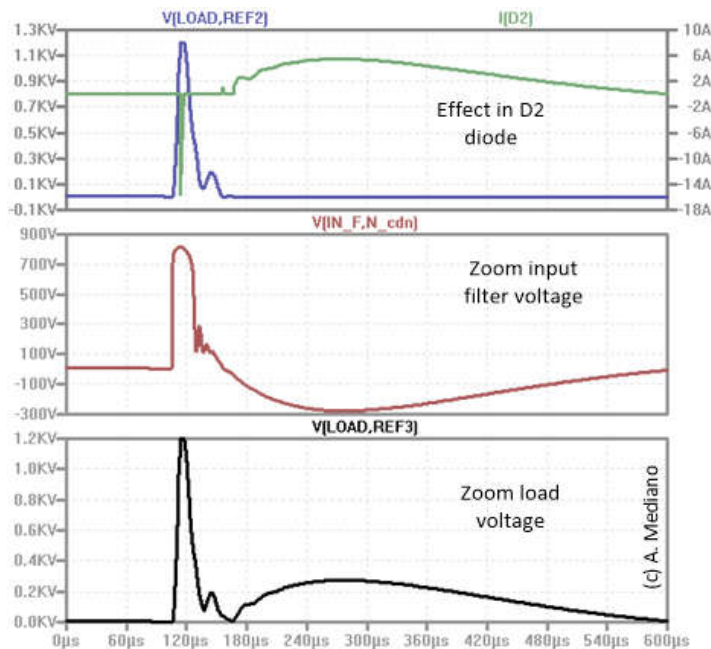
© A. Mediano University of Zaragoza (SPAIN) · amediano@unizar.es

Design example: with LTSPICE



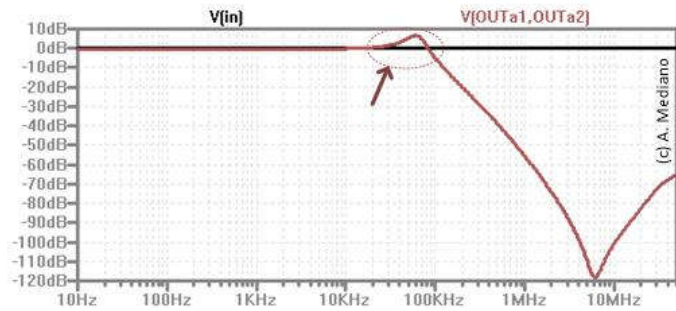
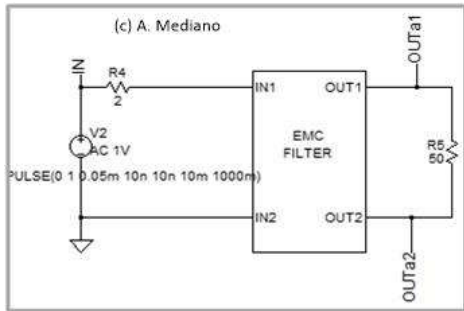
© A. Mediano University of Zaragoza (SPAIN) · amediano@unizar.es

Design example: adding input varistor

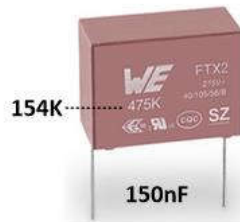
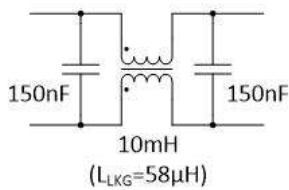


© A. Mediano University of Zaragoza (SPAIN) · amediano@unizar.es

Design example: filter review

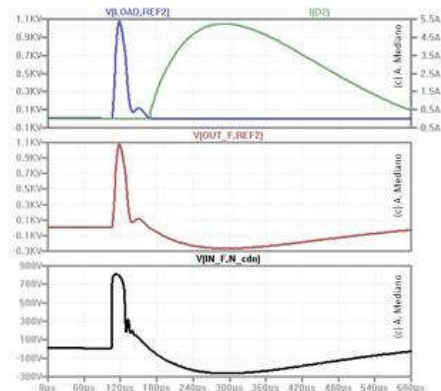
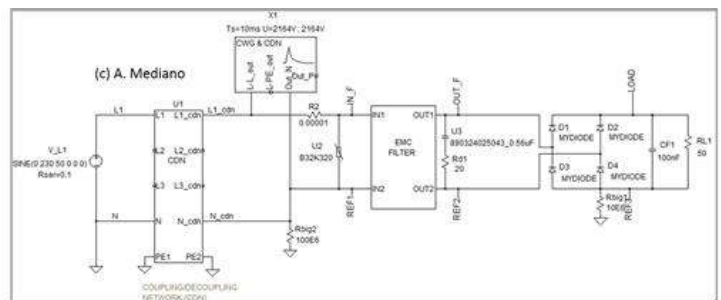
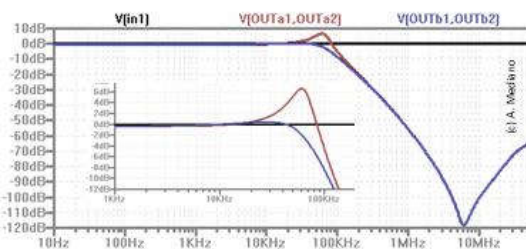
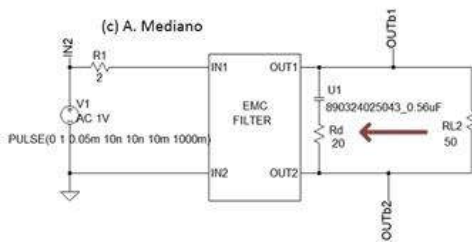


Basic schematic



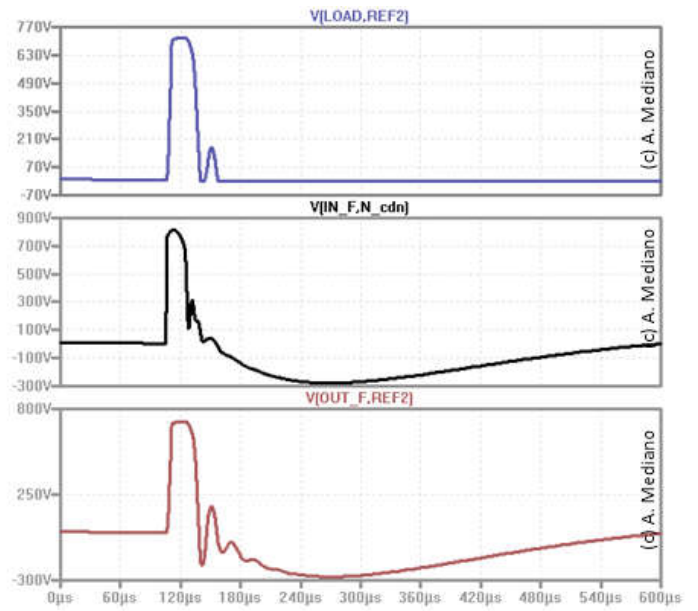
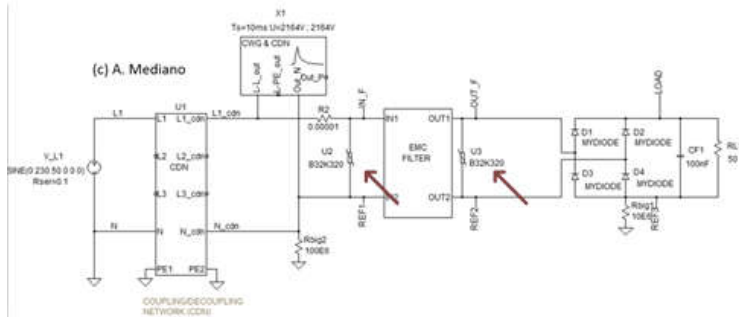
© A. Mediano University of Zaragoza (SPAIN) · amediano@unizar.es

Design example: filter damping



© A. Mediano University of Zaragoza (SPAIN) · amediano@unizar.es

Design example: using two varistors



© A. Mediano University of Zaragoza (SPAIN) · amediano@unizar.es

Demo



© A. Mediano University of Zaragoza (SPAIN) · amediano@unizar.es

THANK YOU!



Prof. **Arturo Mediano**
University of Zaragoza (SPAIN)
amediano@unizar.es