DIGITAL WE DAYS 2023

THINK OUTSIDE THE BOX, POE FLYBACK WITH A TWIST!

WÜRTH ELEKTRONIK MORE THAN YOU EXPECT

TODAY'S SPEAKERS

PRESENTATION
Mohamed Al-Alami
Senior Field Applications Engineer

MODERATION
Silas Zorn
Marketing Department

INFORMATION ABOUT THE WEBINAR

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However, you can ask us questions using the chat function.

Duration of the presentation	30 Min
Q&A:	10 – 15 Min

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And on	Digital WE Days 2023 YouTube Playlist

AGENDA

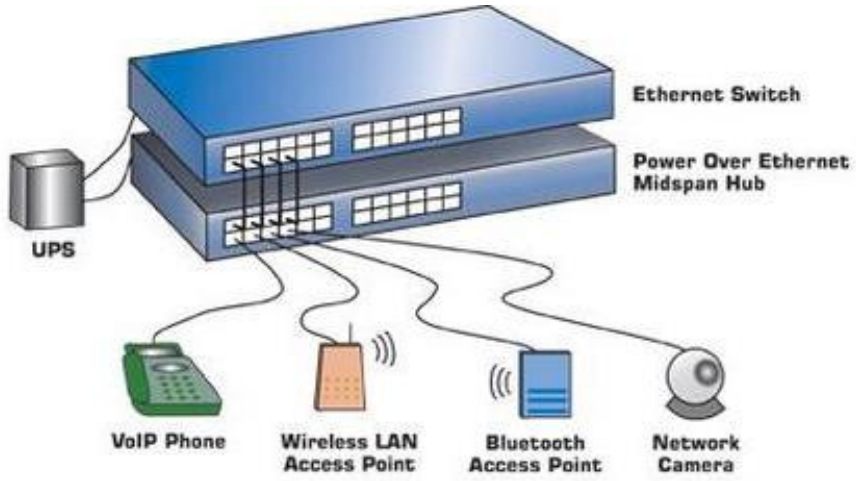
- Concept and Architecture
  - Concept
  - Architecture
    - Signal and Power Flow
- PoE Options and Solutions
- Practical Example 1– PoE PSE
  - Flyback Parasitic Elements
- Practical Example 2– PoE Type 2 PD
  - Layout and Tracking

CONCEPT AND ARCHITECTURE

CONCEPT

Power over Ethernet

Technology for passing electrical power along data lines of wired Ethernet LANs (up to 100m cable)
Applicable Standard IEEE 802.3



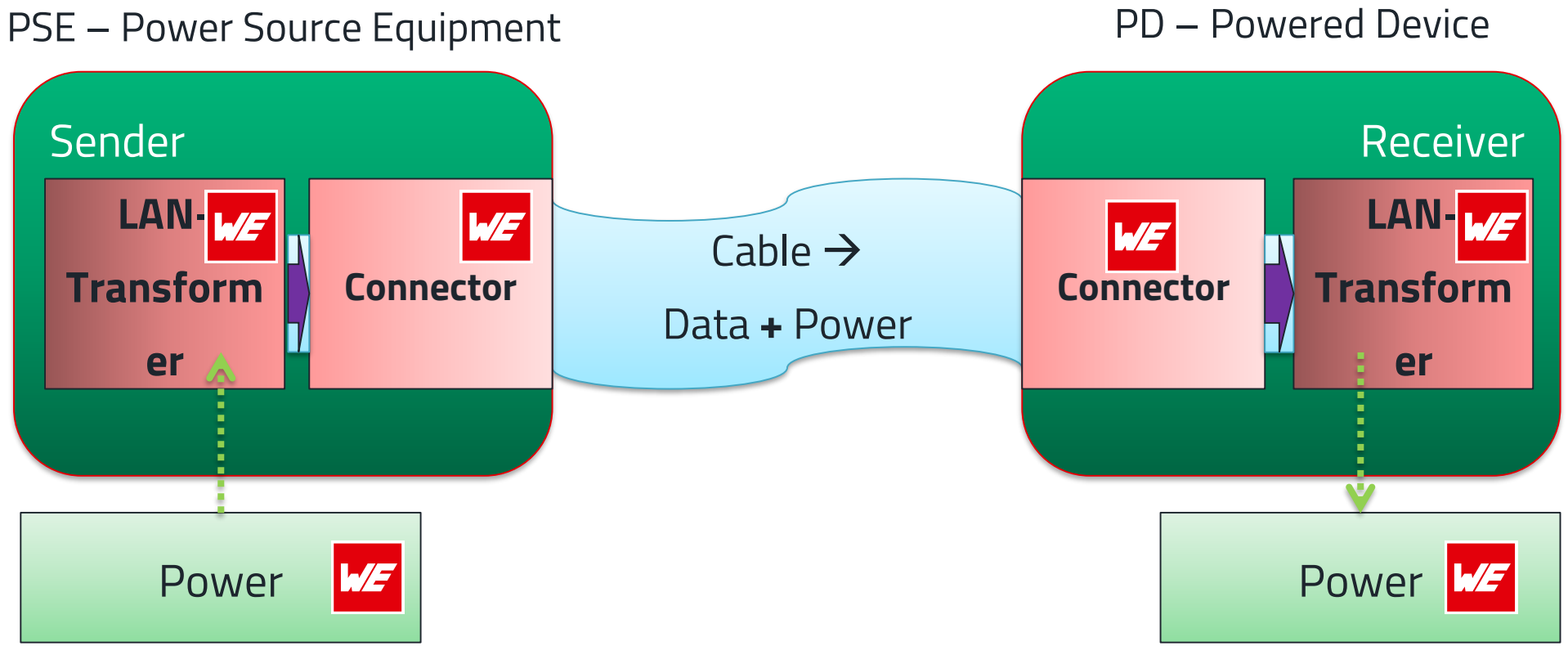
CONCEPT

Types

PoE Standard	IEEE 802.3af Type 1	IEEE 802.3at Type 2	IEEE 802.3bt Type 3	IEEE 802.3bt Type 4
Max Power Delivered by PSE	15.4W	30W	60W	100W
Power Available at PD	12.95W	25.5W	51W	71W
Max Current	350mA	600mA	600mA	960mA
Twisted-pair used	2-Pair	2-Pair	4-Pair	4-Pair

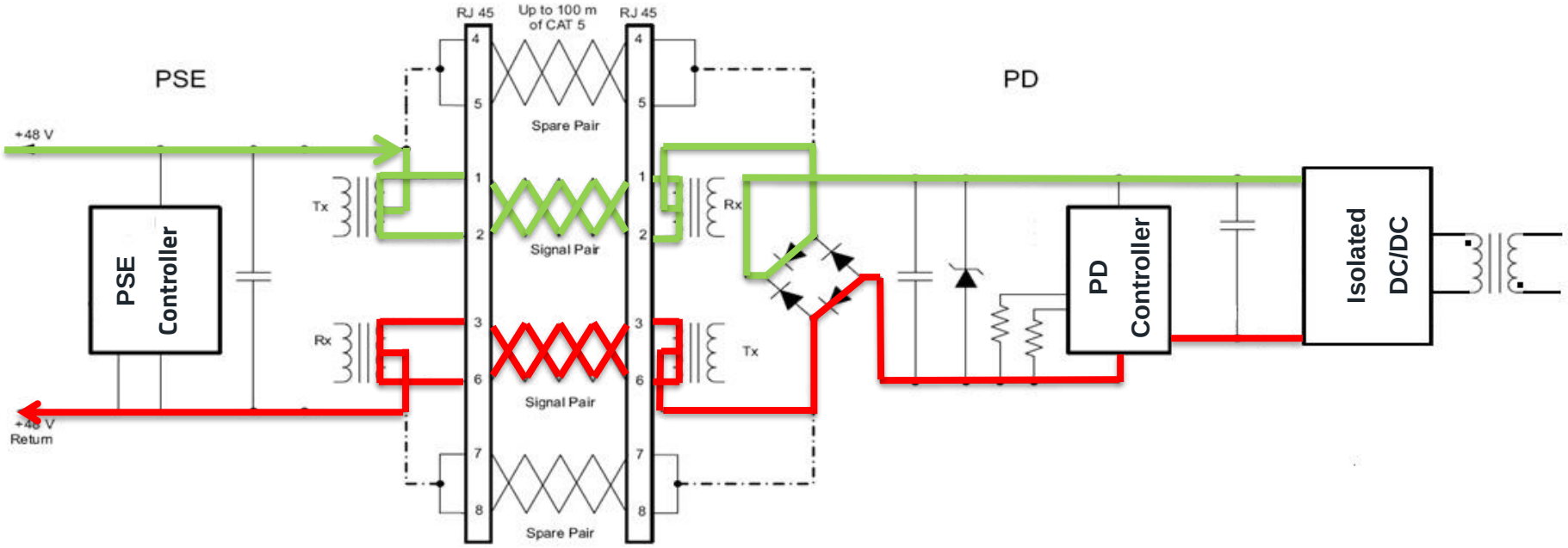
ARCHITECTURE

System



ARCHITECTURE

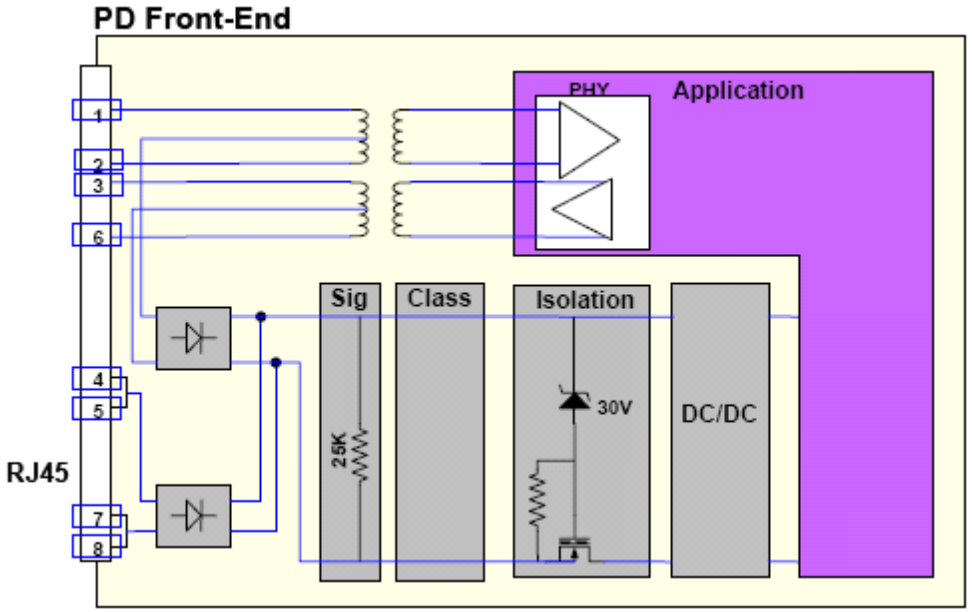
Power Flow PSE -> PD

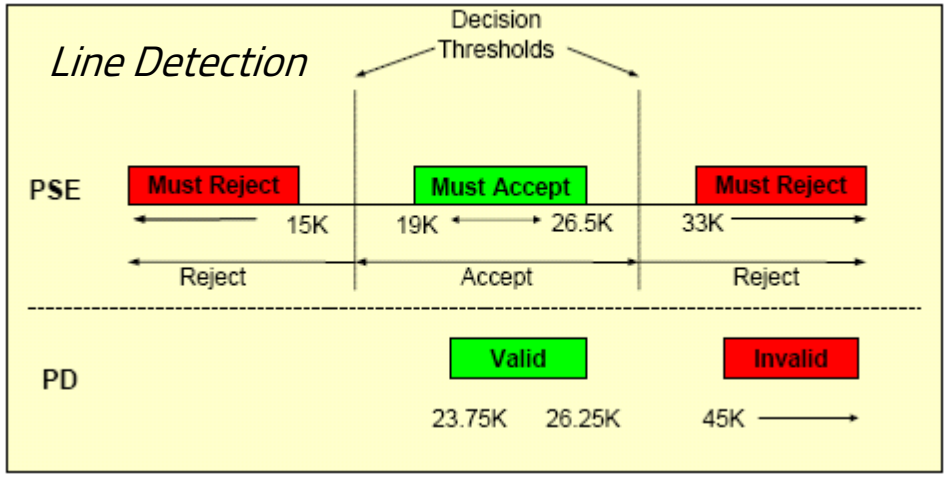


ARCHITECTURE

Power Flow PSE -> PD

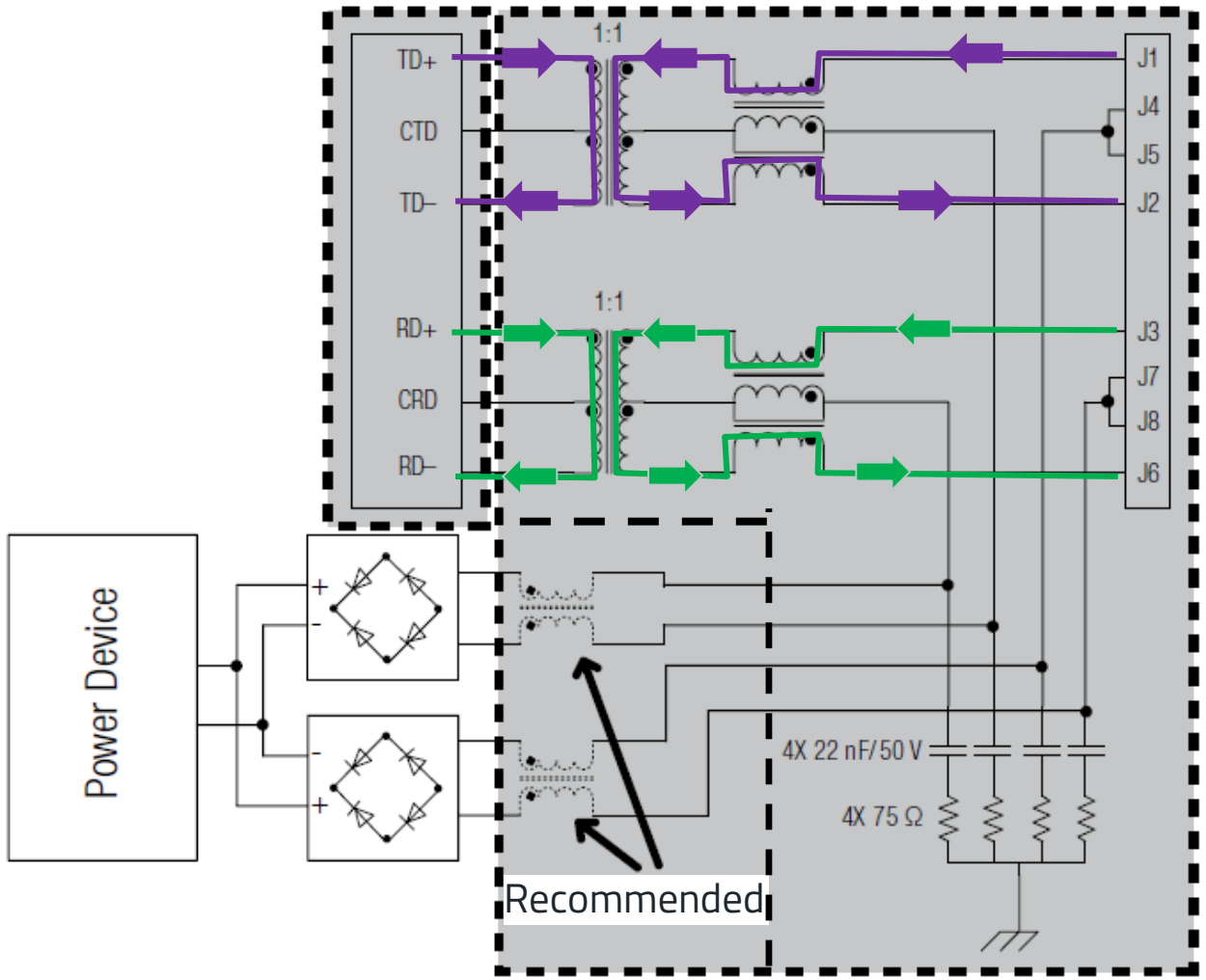
- **Diode Bridges:** The PD must be able to accept power from either data or spare pairs and it should be insensitive to the power's polarity.
- **Signature:** Presents a resistor with standard-defined value. The PSE utilizes it by inducing low probing voltages, allowing the PSE to verify the existence of a valid PD. Should the PSE identify anything other than a valid PD, it will not inject power to the line.
- **Classification:** This block reacts to the PSE's classification probing with a proper current value, defining the power class of the PD.
- **Isolation:** FET switch is responsible for letting the PSE power go through the application only after detection and classification processes have successfully ended.
- **DC/DC:** Following the PoE interface is a DC/DC converter block, converting the 36 to 57 Vdc input to the application's voltage.





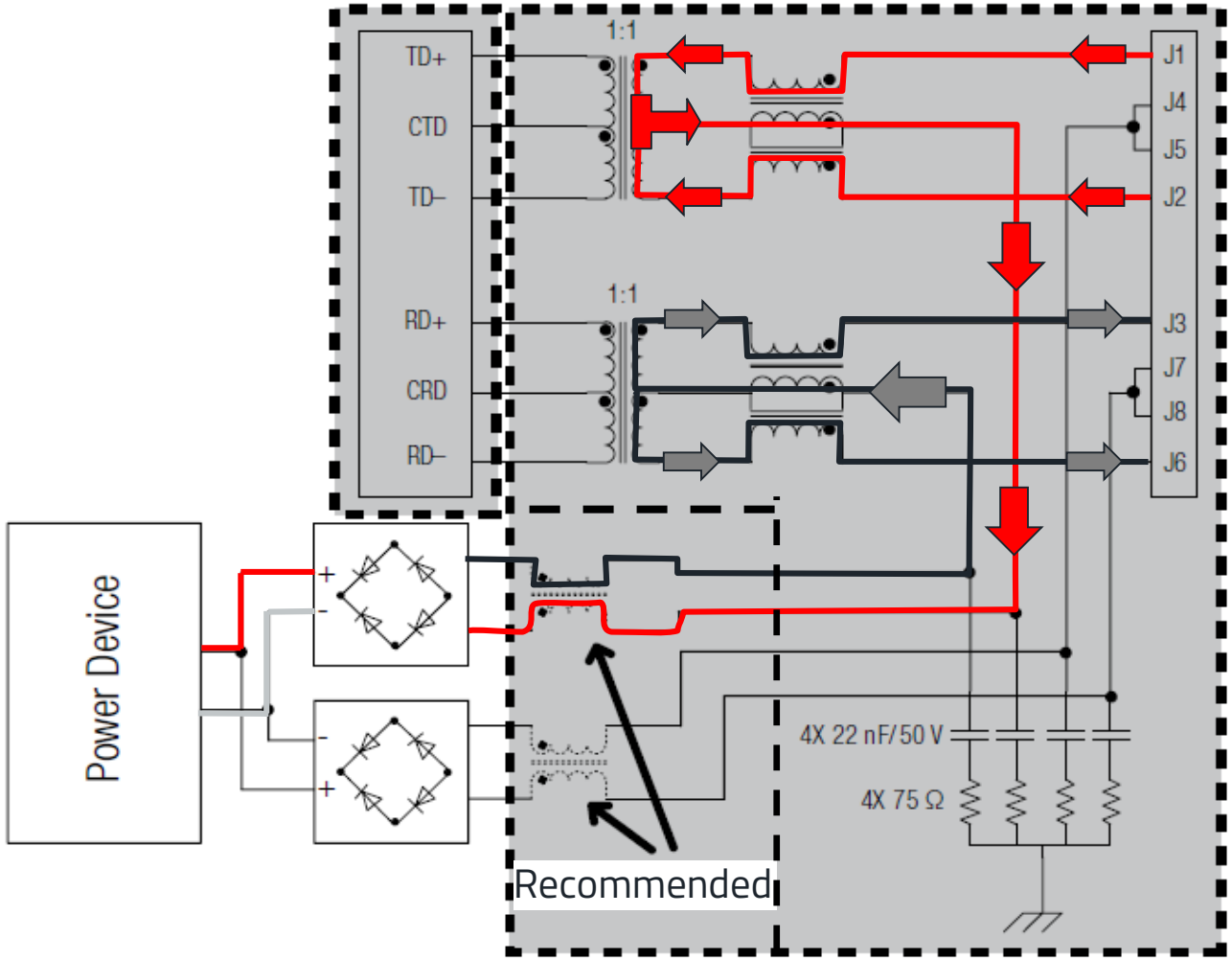
ARCHITECTURE

Data Path



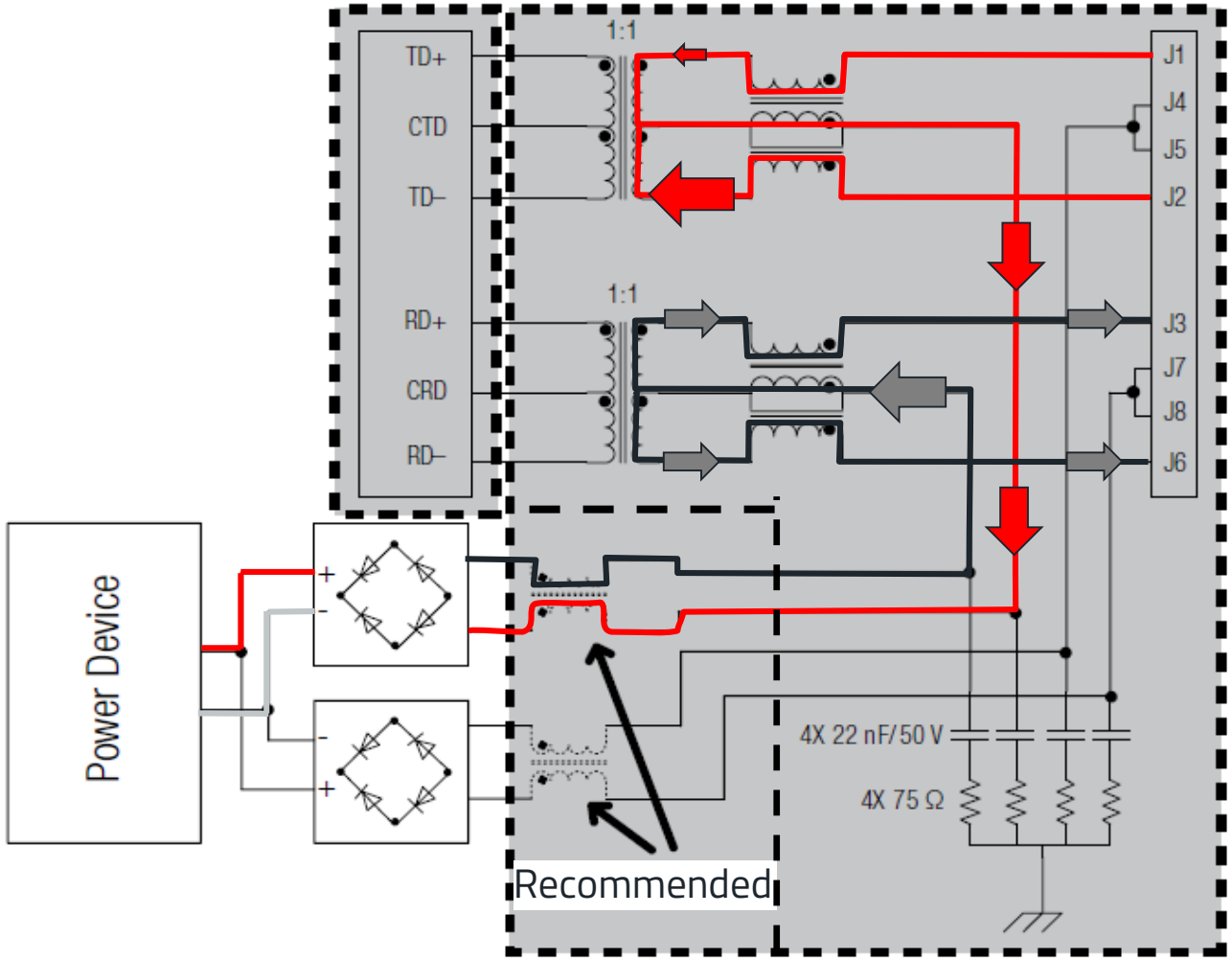
ARCHITECTURE

Power Path 1



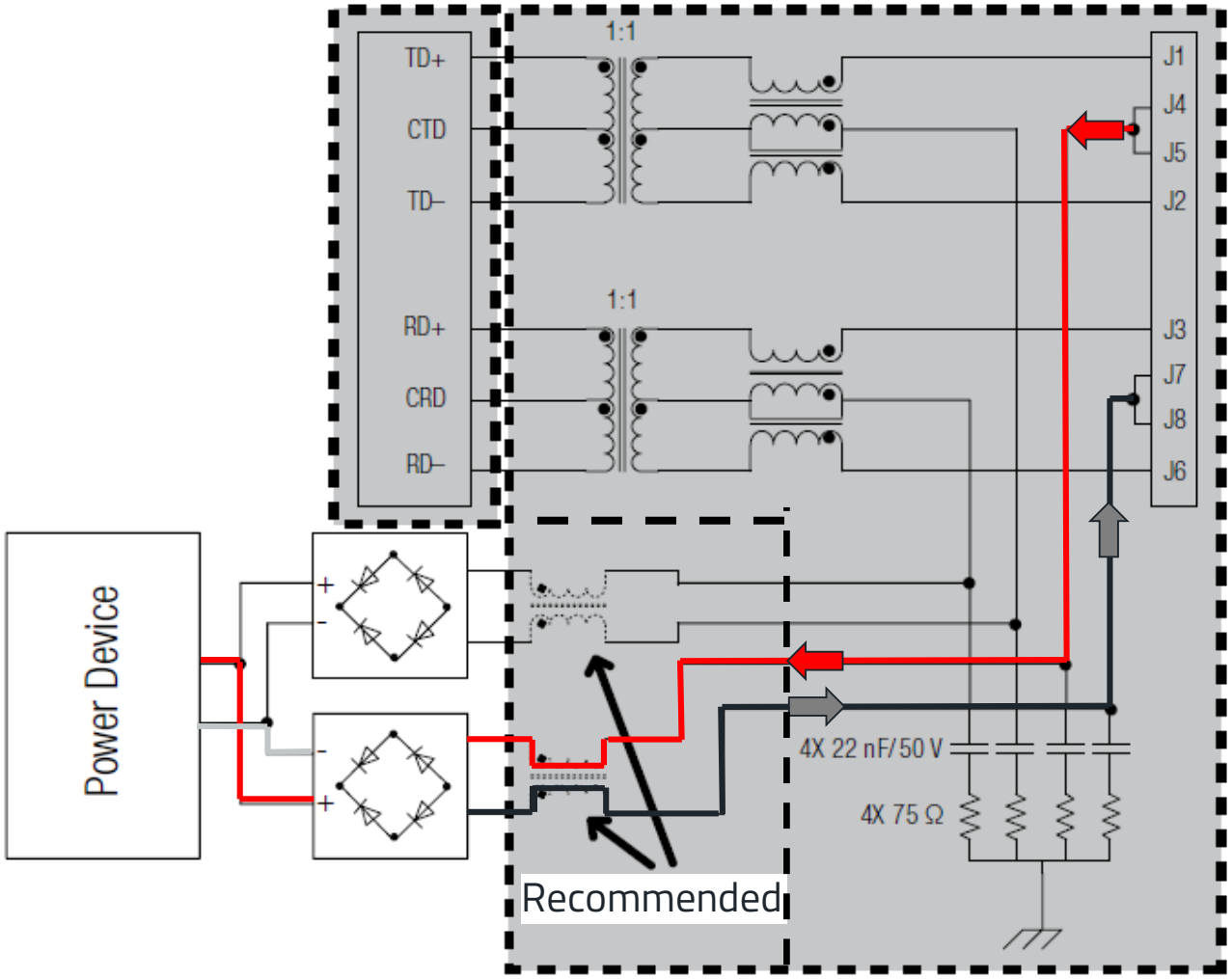
ARCHITECTURE

Power Path Imbalance



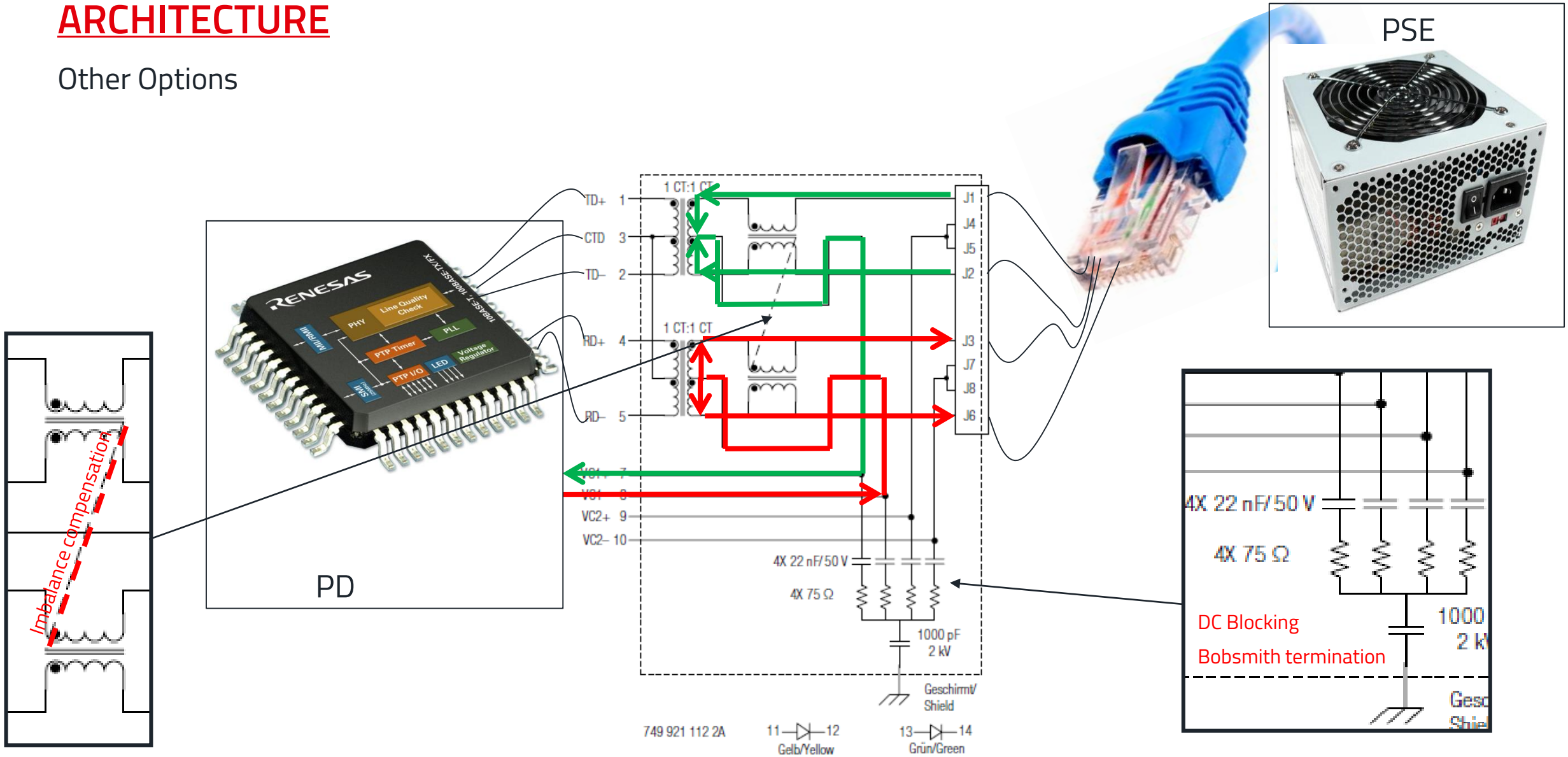
ARCHITECTURE

Power Path 2



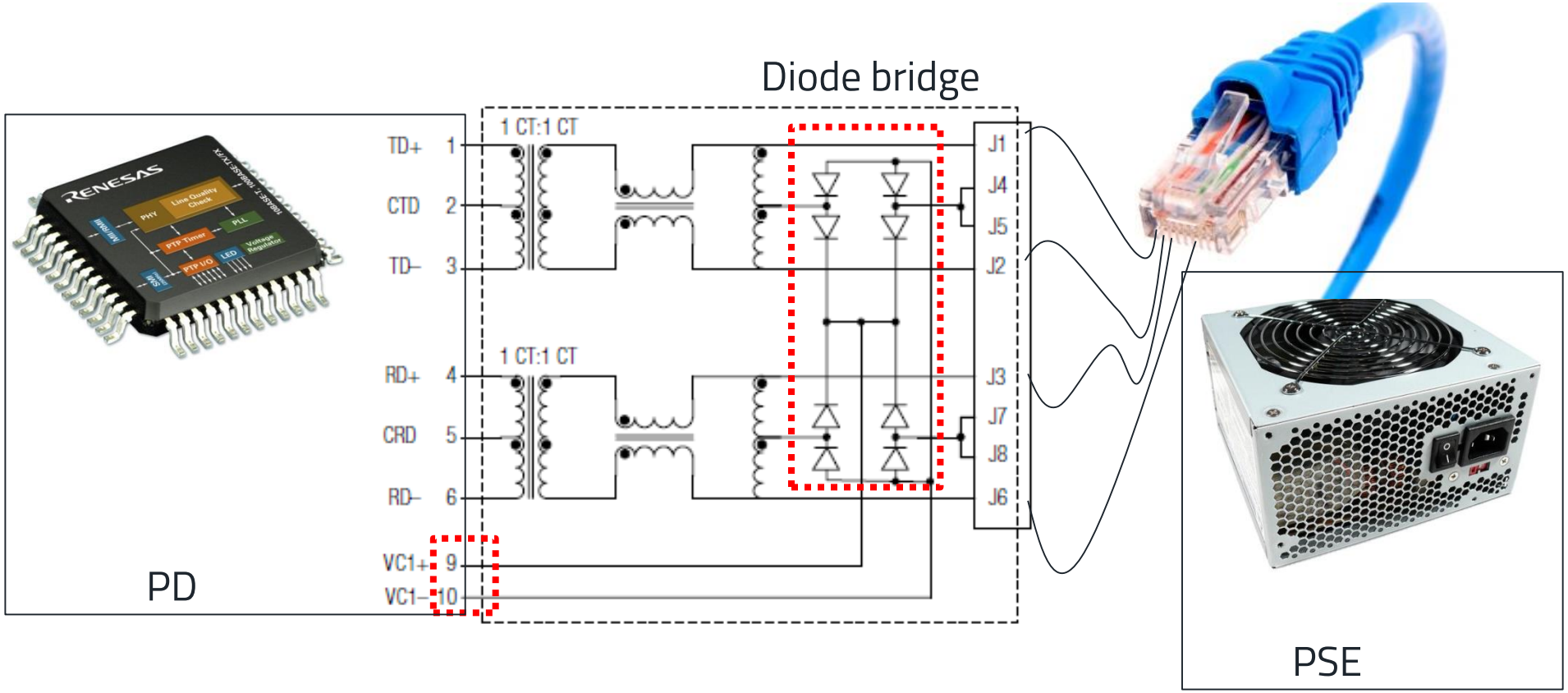
ARCHITECTURE

Other Options



ARCHITECTURE

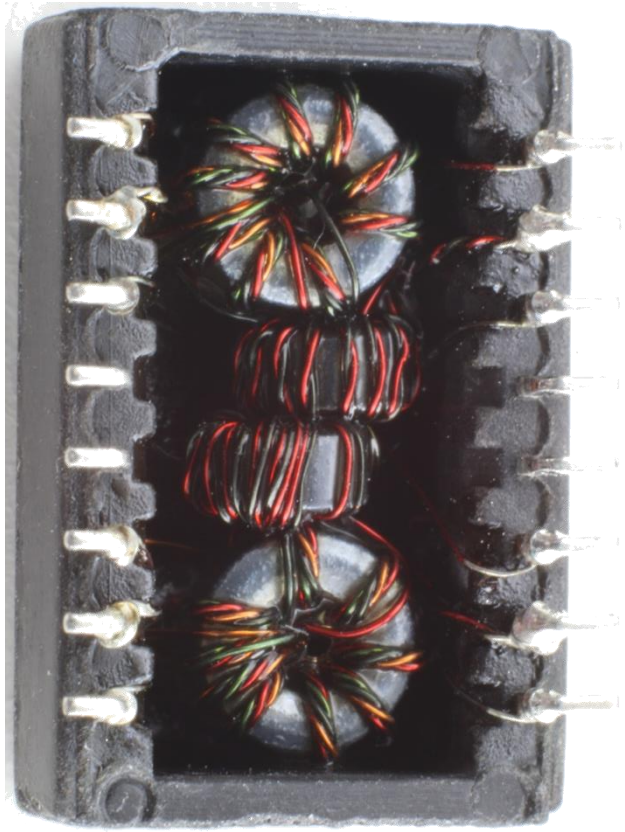
Other Options



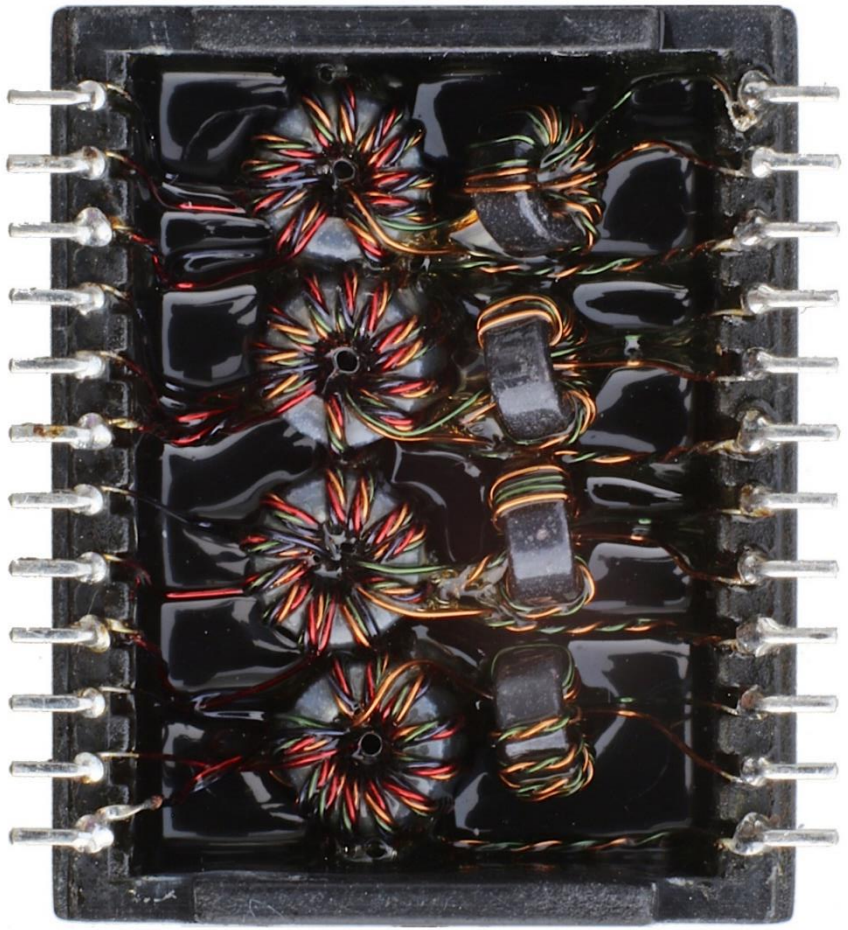
ARCHITECTURE

Discrete ***WE-LAN*** Two Pair / Four Pair

10/100BT



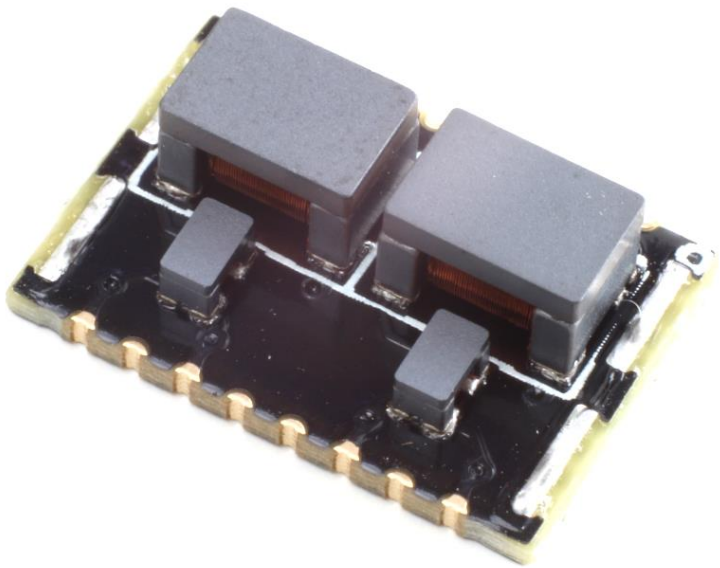
1GBT / 10GBT



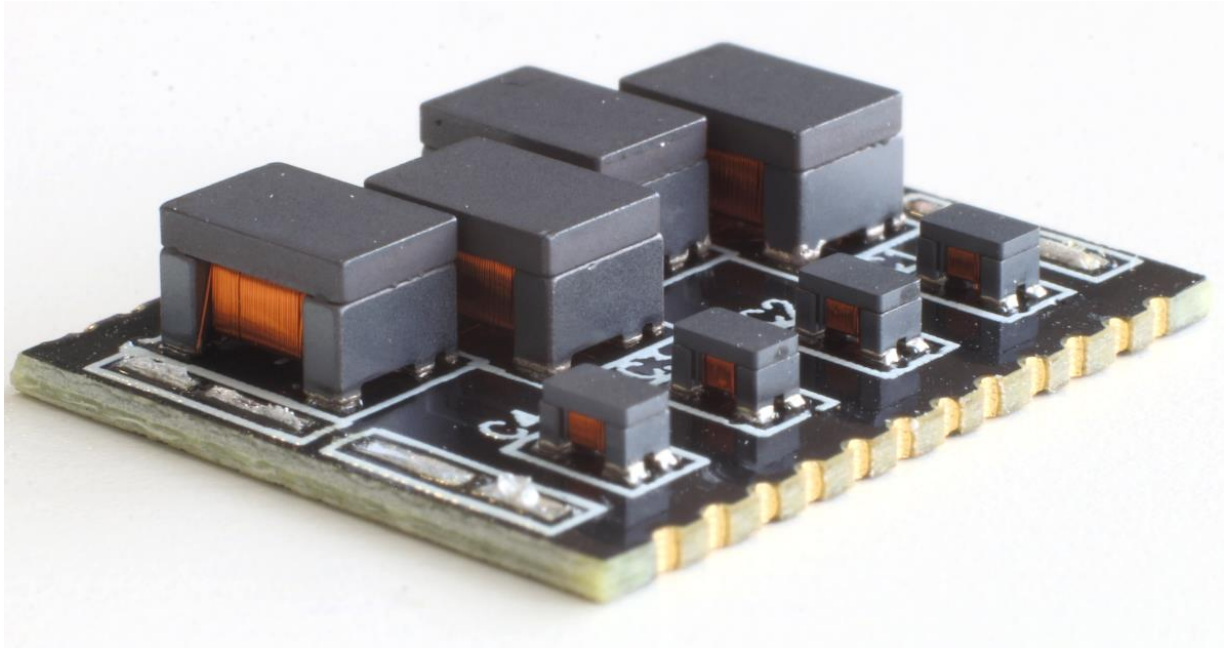
ARCHITECTURE

Discrete ***WE-LAN AQ*** Two Pair Vs Four Pair

10/100BT

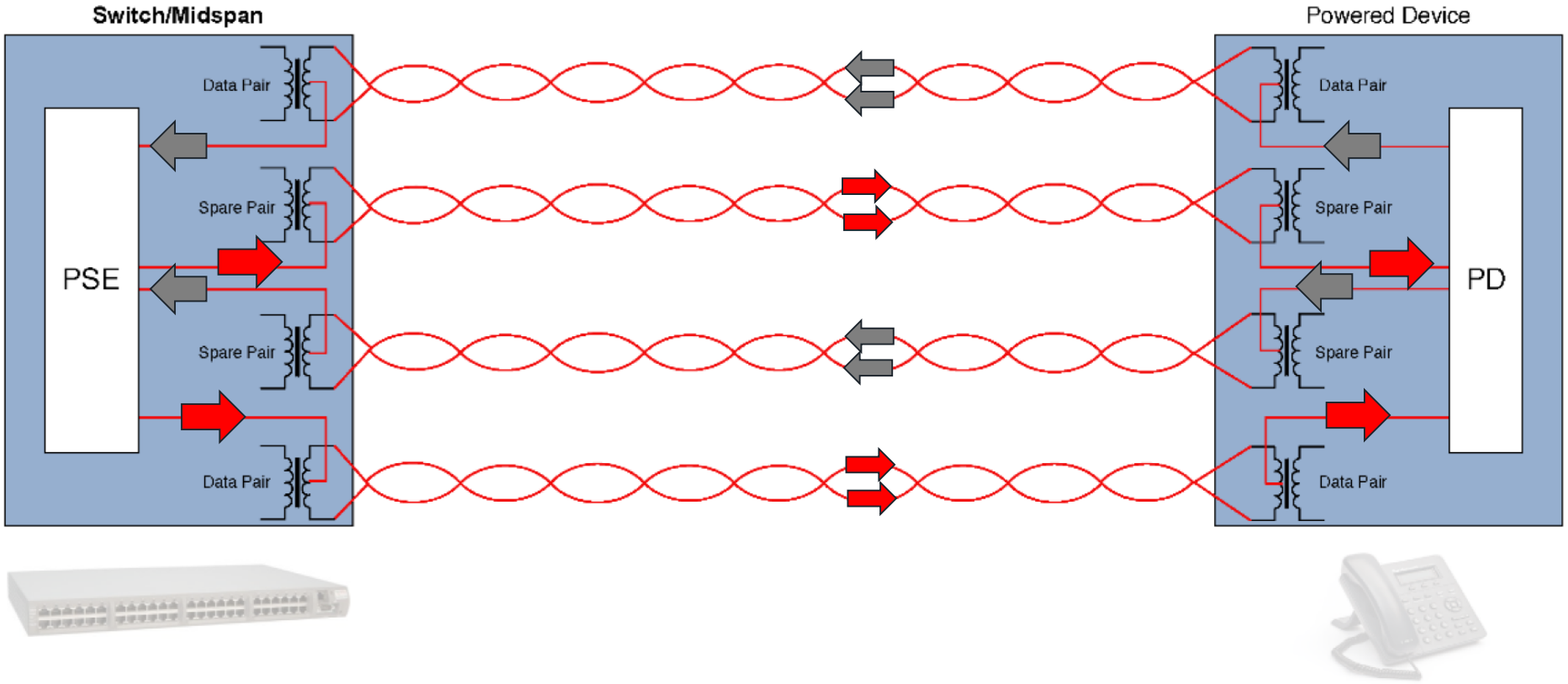


1GBT



ARCHITECTURE IEEE802.3.BT

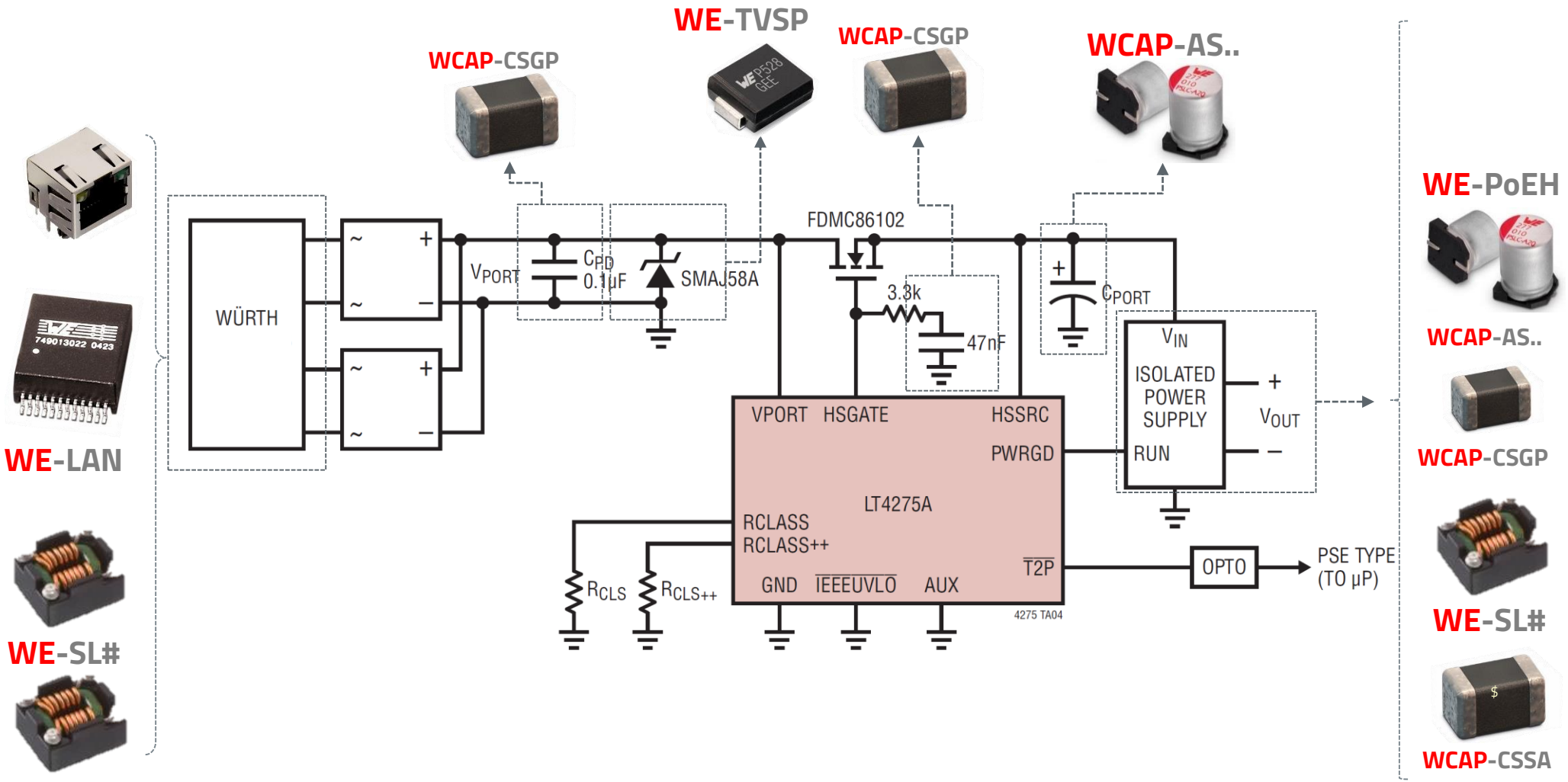
2 Power Paths



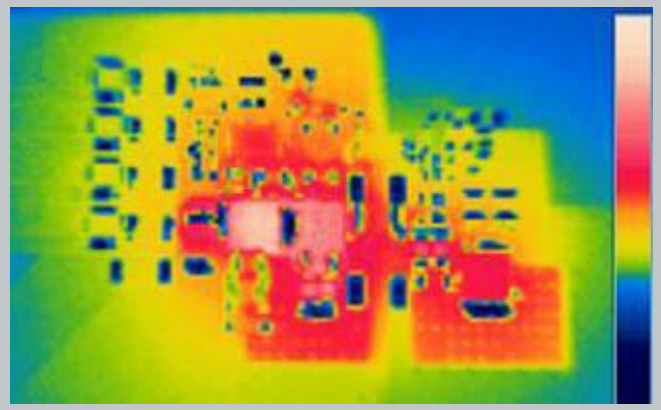
Source Microsemi

ARCHITECTURE

Powered Device



POE
OPTIONS & SOLUTIONS



TYPES AND CLASSIFICATION

Class Number	PSE Output Power [W]	PD Input Power [W]	PD Type	Notes
0	15.4	12.95	1	IEEE802.3af
1	4	3.84	1	
2	7	6.49	1	
3	15.4	12.95	1	
4	30	25.5	2	IEEE802.3at
5	45	40	3	IEEE802.3bt
6	60	51	3	
7	75	62	4	
8	90	73	4	

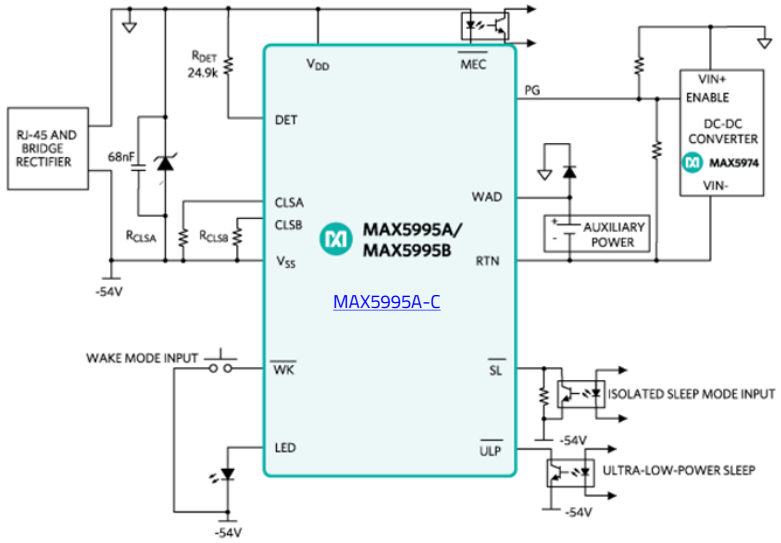
TYPES AND CLASSIFICATION

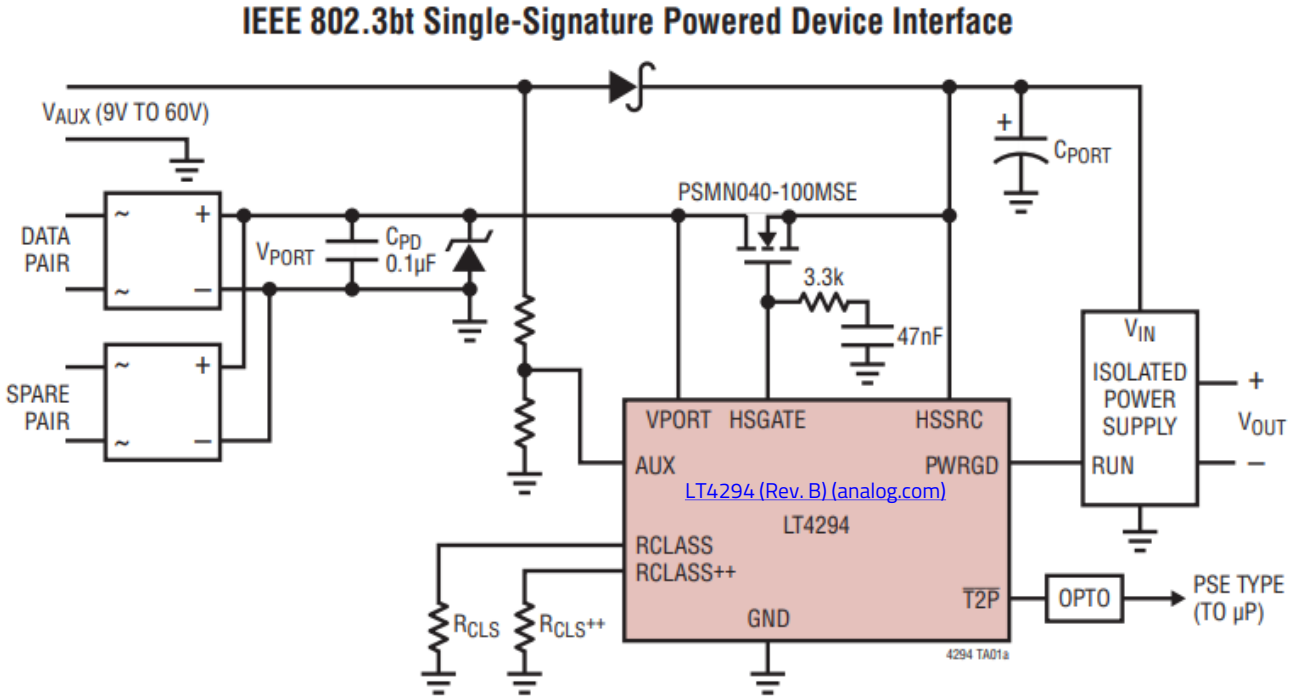
PD REQUESTED CLASS	PD REQUESTED POWER	PD TYPE	NOMINAL CLASS CURRENT	RESISTOR (1%)	
				R_{CLS}	R_{CLS}++
0	13W	Type 1	2.5mA	1.00kΩ	Open
1	3.84W	Type 1 or 3	10.5mA	150Ω	Open
2	6.49W	Type 1 or 3	18.5mA	80.6Ω	Open
3	13W	Type 1 or 3	28mA	52.3Ω	Open
4	25.5W	Type 2 or 3	40mA	35.7Ω	Open
5	40W	Type 3	40mA/2.5mA	1.00kΩ	37.4Ω
6	51W	Type 3	40mA/10.5mA	150Ω	47.5Ω
7	62W	Type 4	40mA/18.5mA	80.6Ω	64.9Ω
8	71.3W	Type 4	40mA/28mA	52.3Ω	118Ω

DISCRETE SOLUTION

Example

- Two ICs
  - One for the PSE<->PD hand shake (interface controller)
  - Second for control of isolated DC/DC converter.
- Gives more flexibility for future re-design in case of obsolescence/EoL.
- Gives more options / alternatives for either IC.



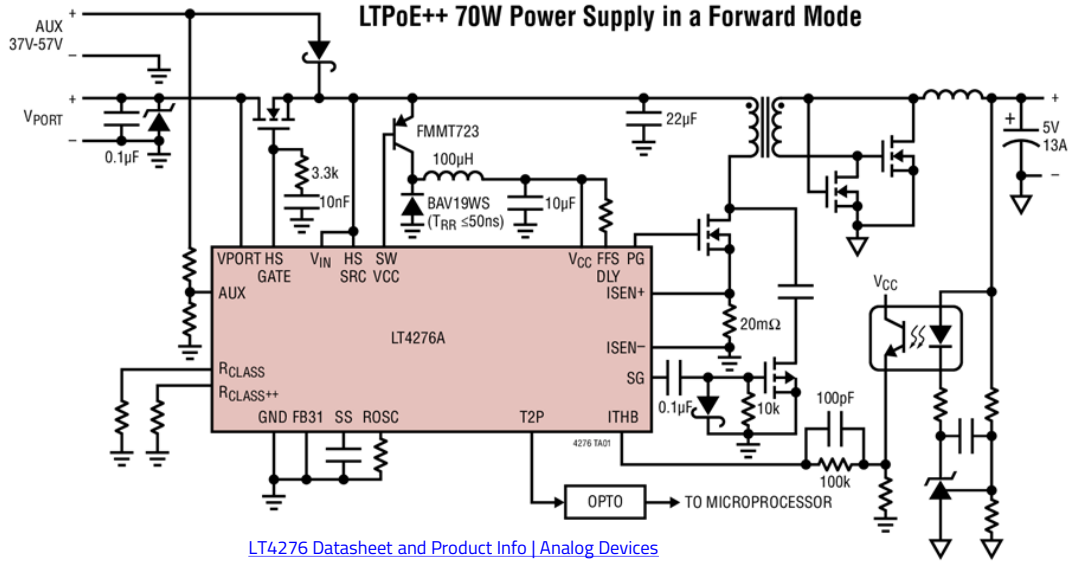


DC2911A (Rev. 0) (analog.com)

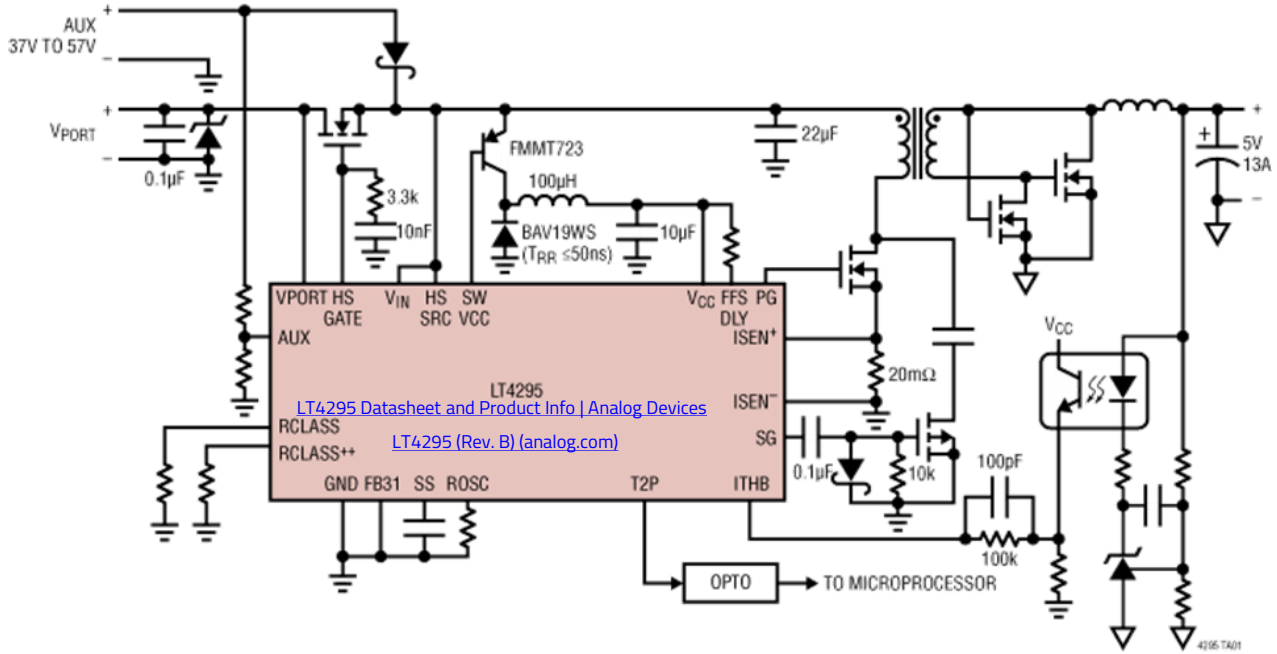
INTEGRATED SOLUTION

Example

- One IC including both functionality:
  - PSE<->PD hand shake (interface controller)
  - DC/DC converter controller
- Less parts. Smaller pcb area
- Easier/better layout and tracking
- Ability to add extra filtering

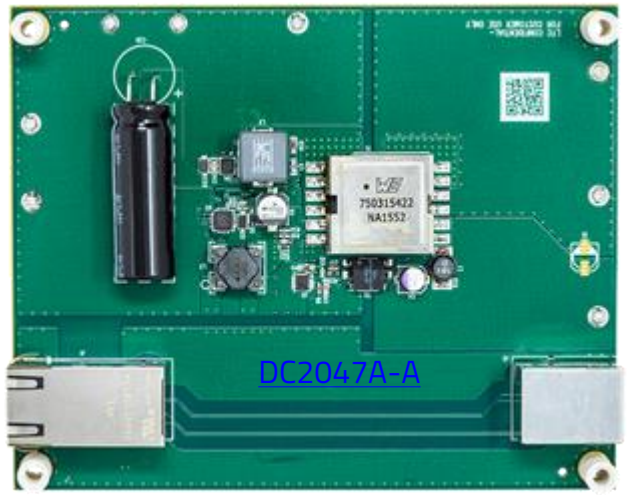


LT4276 Datasheet and Product Info | Analog Devices



LT4295 Datasheet and Product Info | Analog Devices

LT4295 (Rev. B) (analog.com)

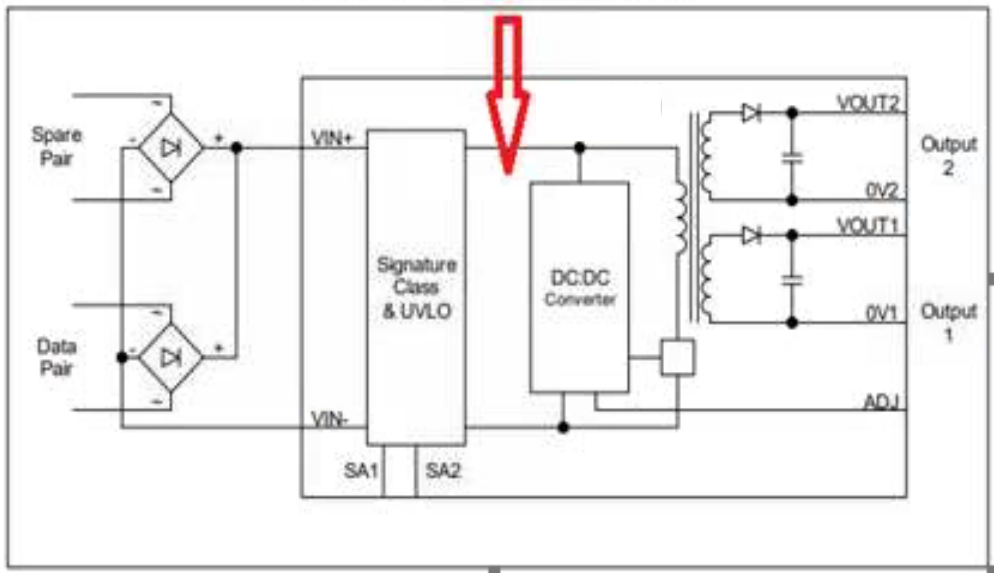


DC2047A-A

MODULE SOLUTION

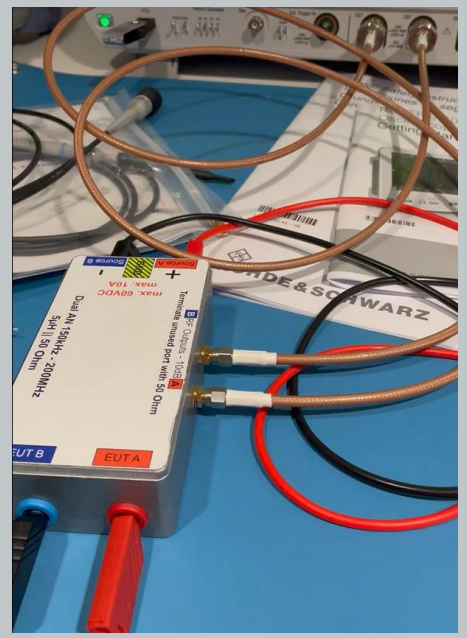
Example

- Module Includes:
  - PSE<->PD hand shake (interface controller)
  - DC/DC converter controller
  - DC/DC isolated converter
- Less parts. Smaller pcb area
- Easier/better layout and tracking
- Faster time to market.
- However:
  - No access to the Power Converter Input to introduce the filtering after the PoE Signature/Class communications.
  - The filter capacitance is the issue here as indicated in the 2012 revision of the IEEE 802.3 standard.
  - This limits C to 150nF.
  - No guarantee of using up to 10uF (may accept or reject). Ref sections 33.2.5.3 & 33.2.5.4 on PD detection and rejection criteria.



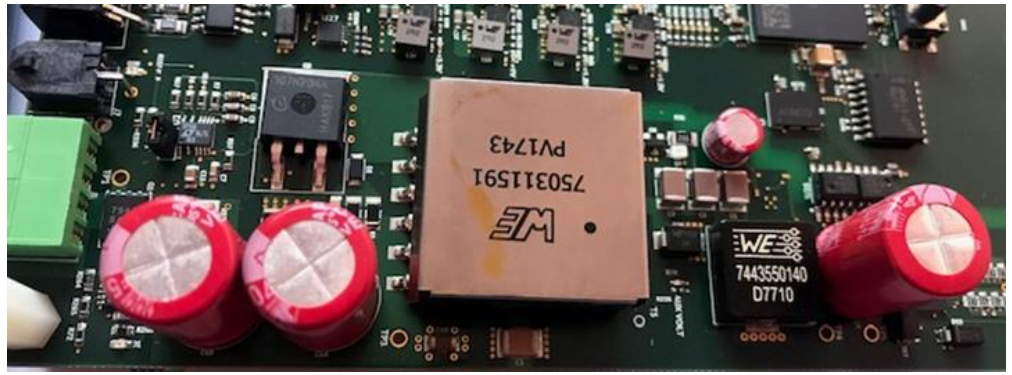
PRACTICAL EXAMPLE 1

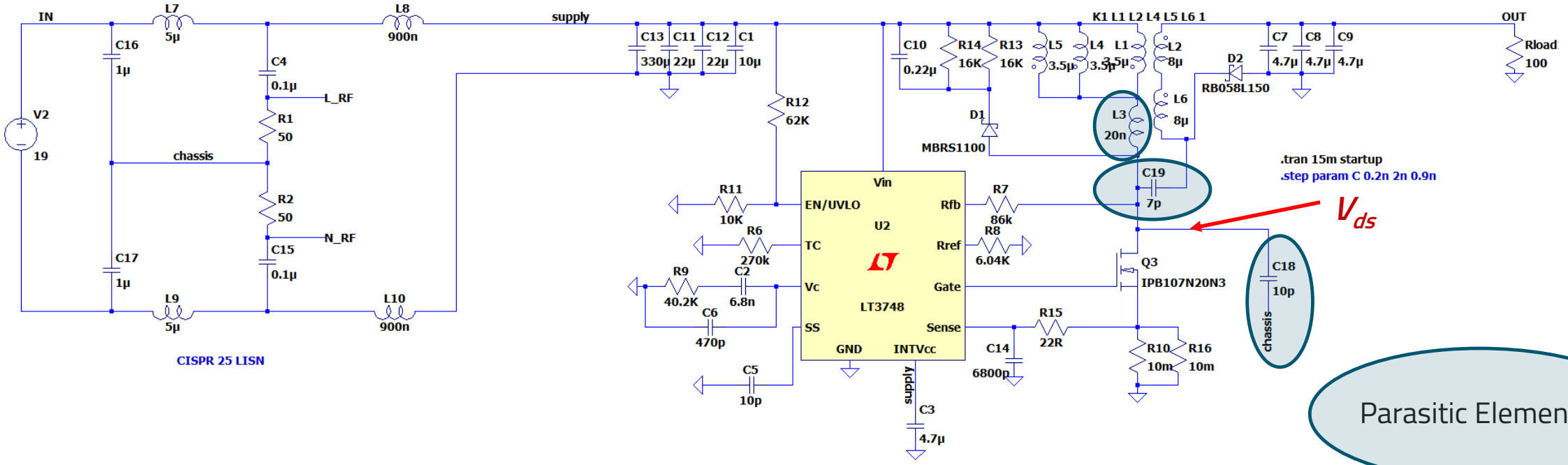
POE PSE



POE PSE FLYBACK CONVERTER (LT3748)

- **Design Requirements:**
  - Vin= 9V-20V
  - Vout = -56V
  - Iout = 0.7A (tested up to 1A)
  - Max Efficiency 80%

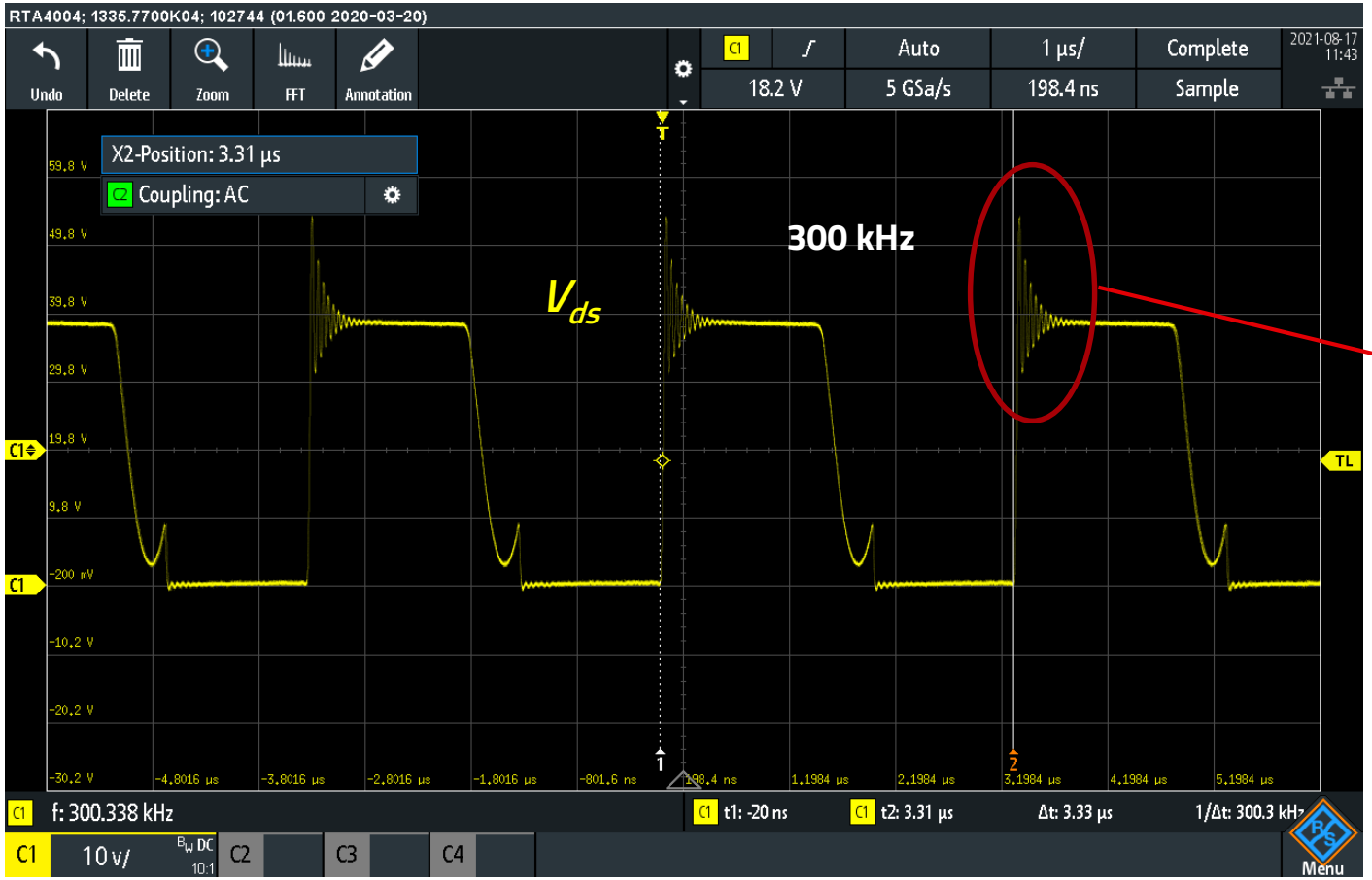




Parasitic Elements

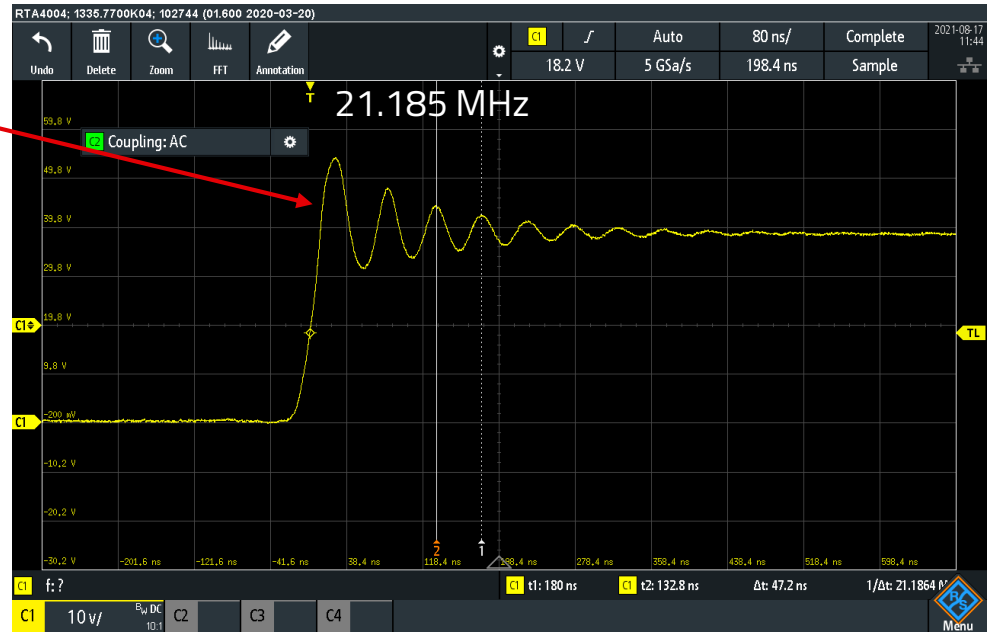
POE PSE FLYBACK CONVERTER

Test and Measurement: R&S RTA4004 – Time Domain Measurement

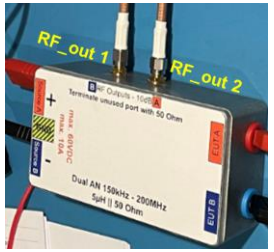


Ringing (Llk & Cout)

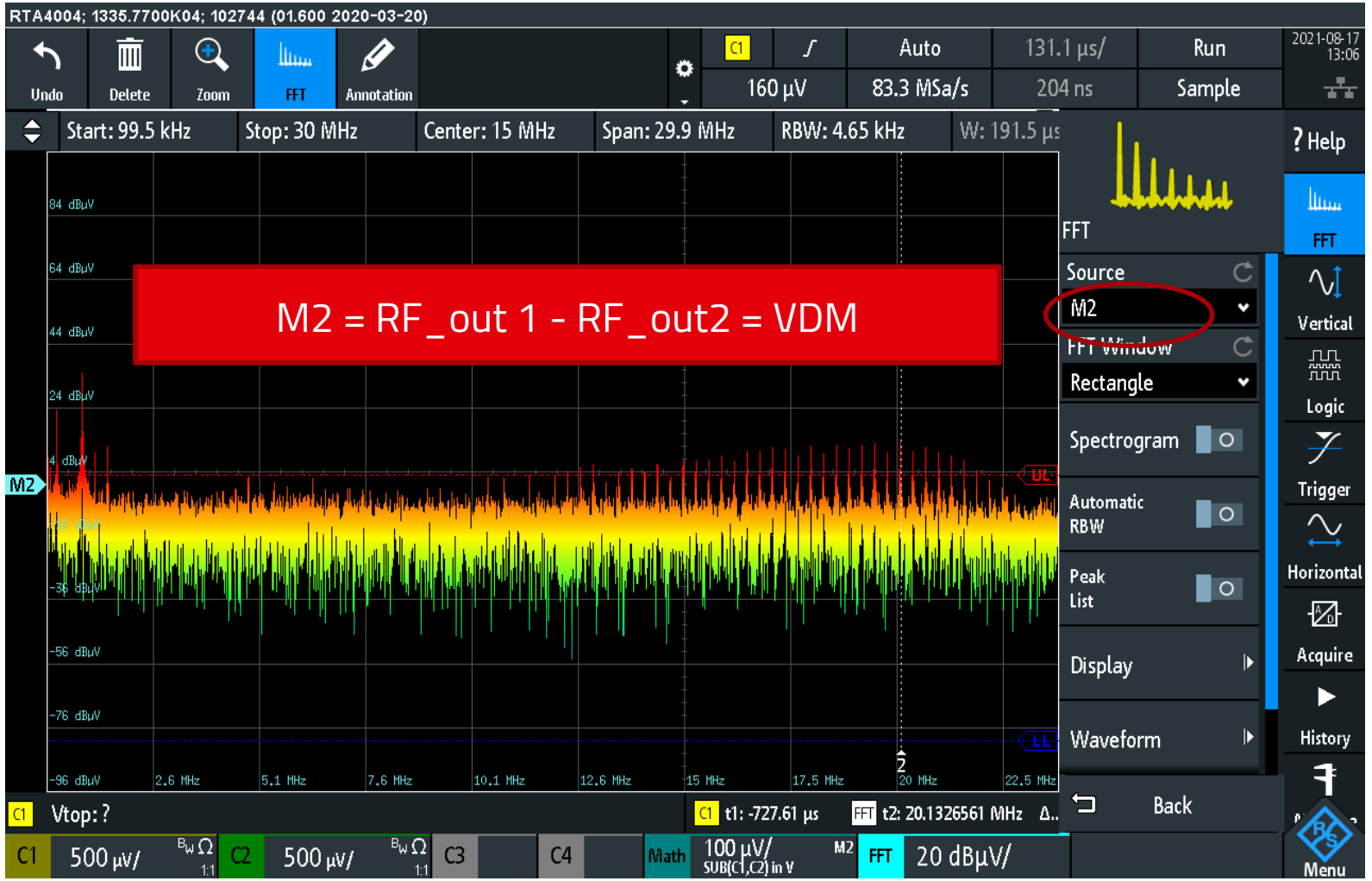
Vin = 20V; Vo = -56V; Po = 29W



POE PSE FLYBACK CONVERTER

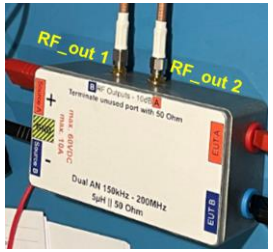


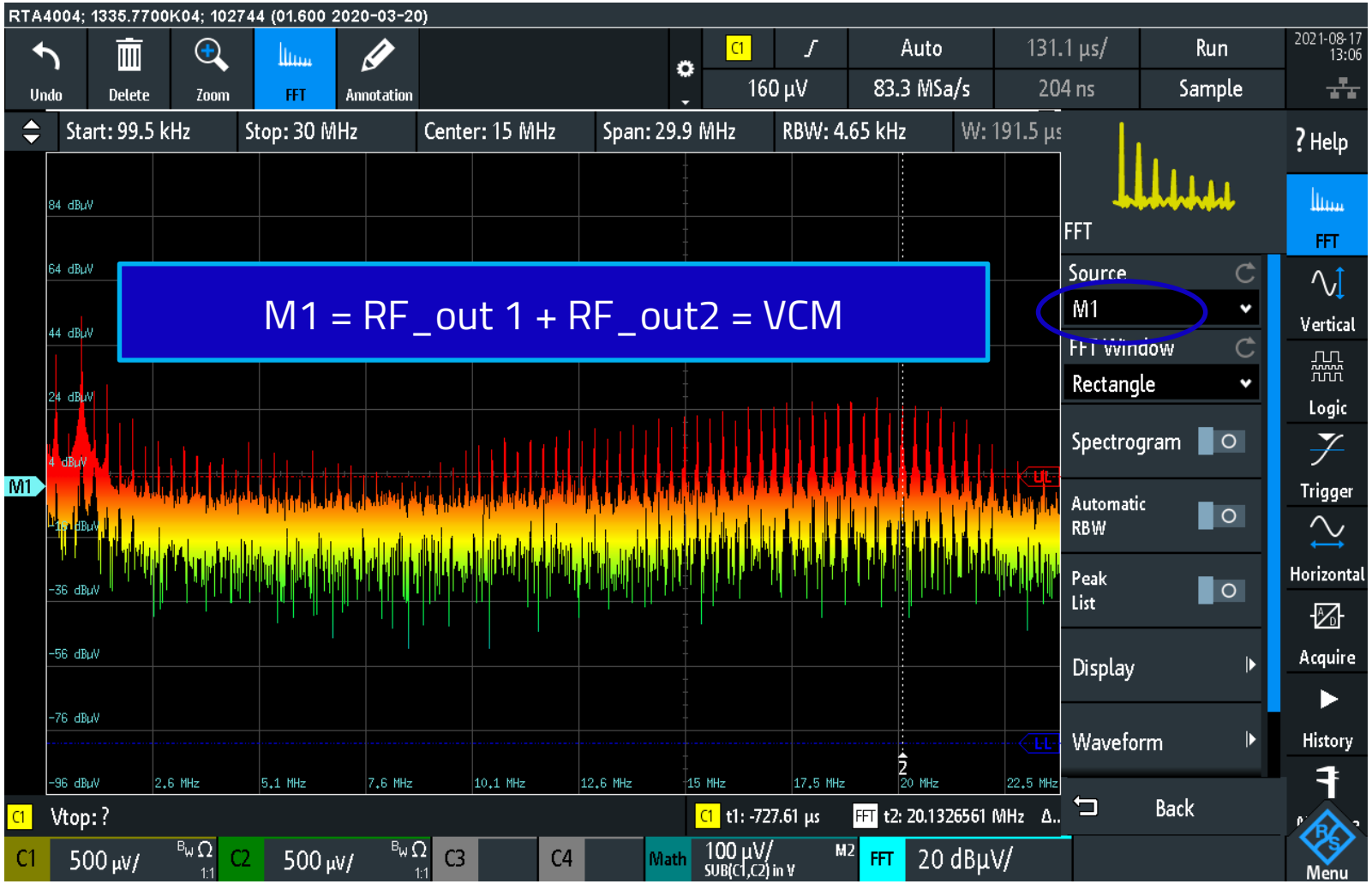
Conducted Emissions Performance - Differential Mode



POE PSE FLYBACK CONVERTER

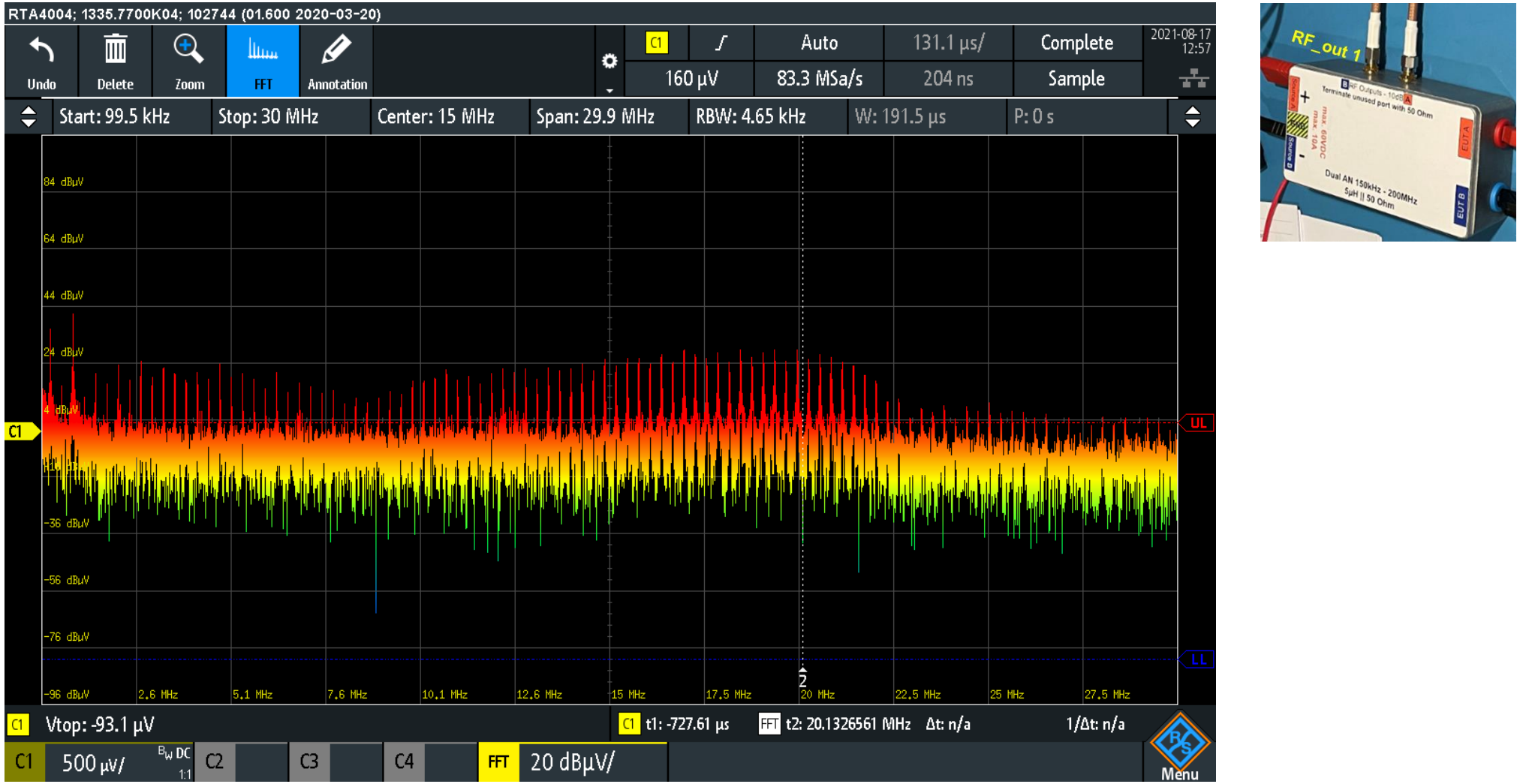
Conducted Emissions Performance - Common Mode





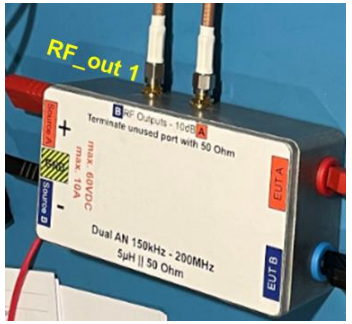
POE PSE FLYBACK CONVERTER

Test and Measurement: NO Filtering Solutions



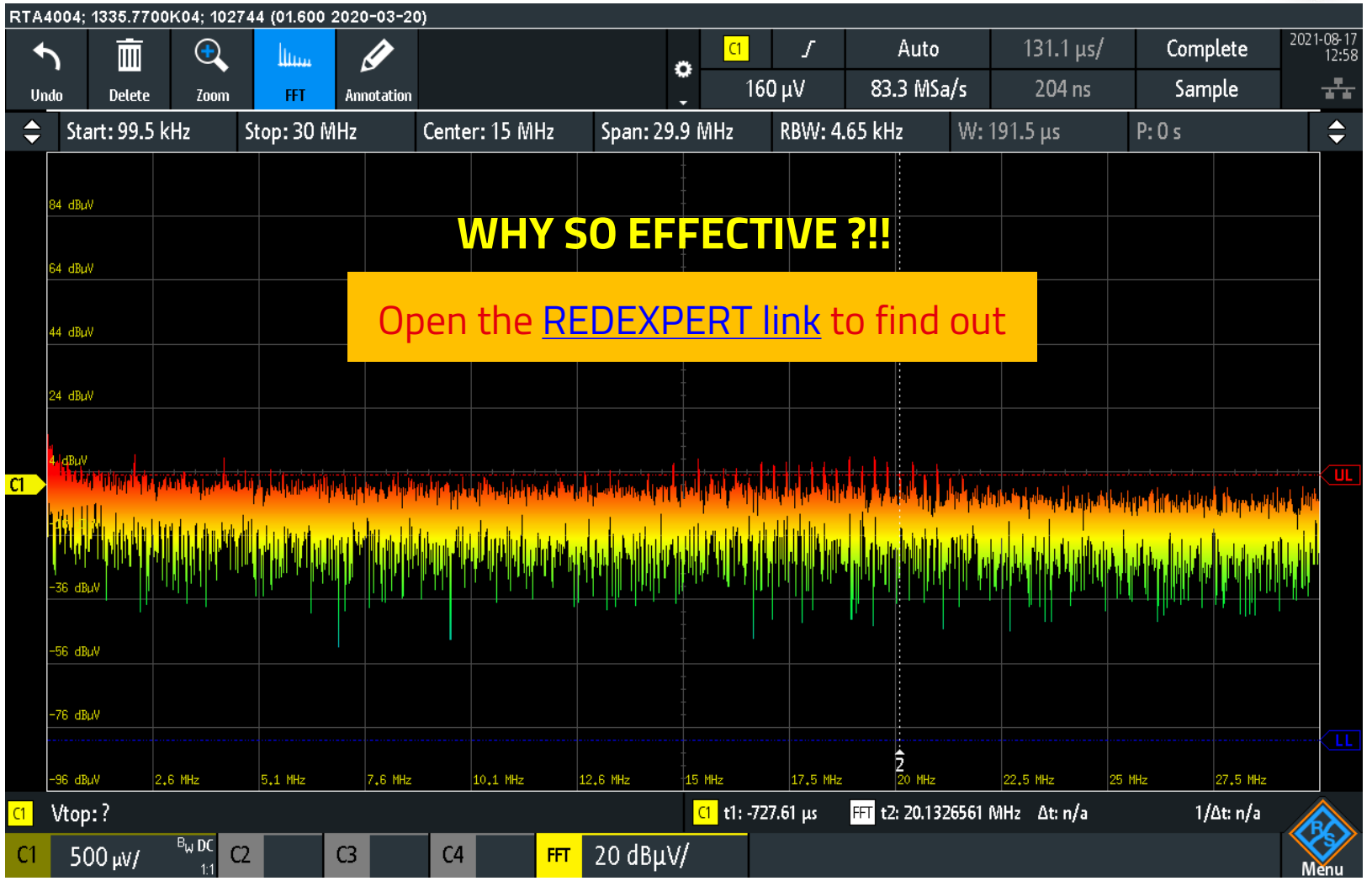
POE PSE FLYBACK CONVERTER

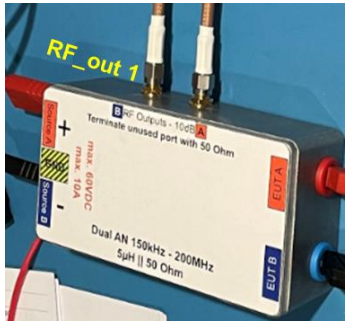
Test and Measurement: With Differential Inductor (WE-PD 77447709470 [47uh])



POE PSE FLYBACK CONVERTER

Test and Measurement: With Common Mode Choke (WE-FC 7448640407 [1.5mh])

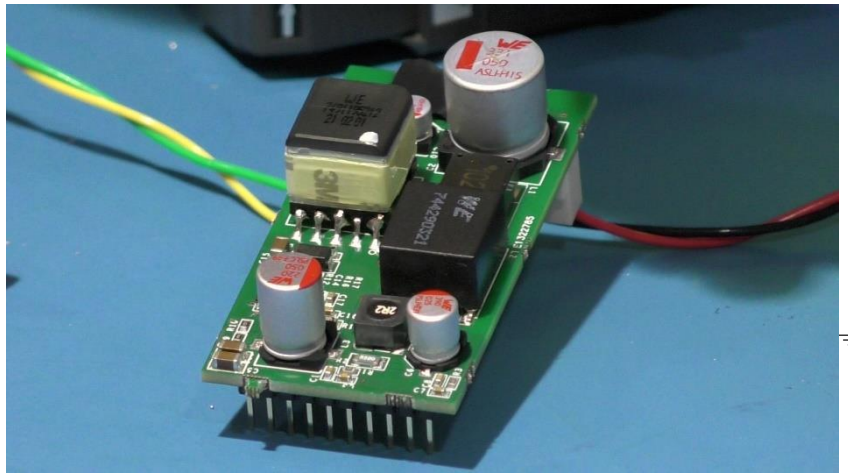


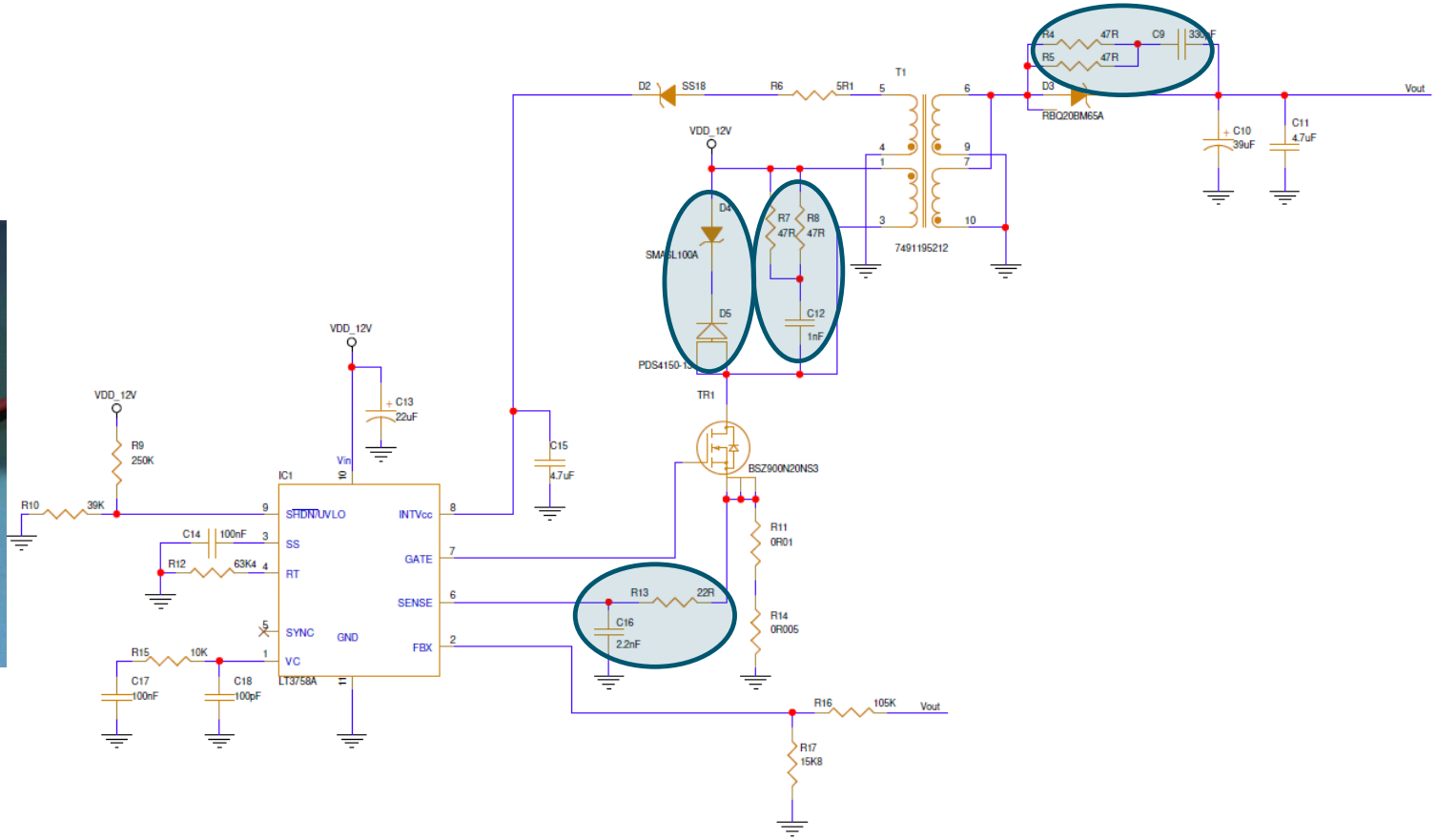


PRACTICAL EXAMPLE 2 POE TYPE 2 PD LAYOUT & TRACKING

TYPE 2 POE FLYBACK CONVERTER (LT3758A)

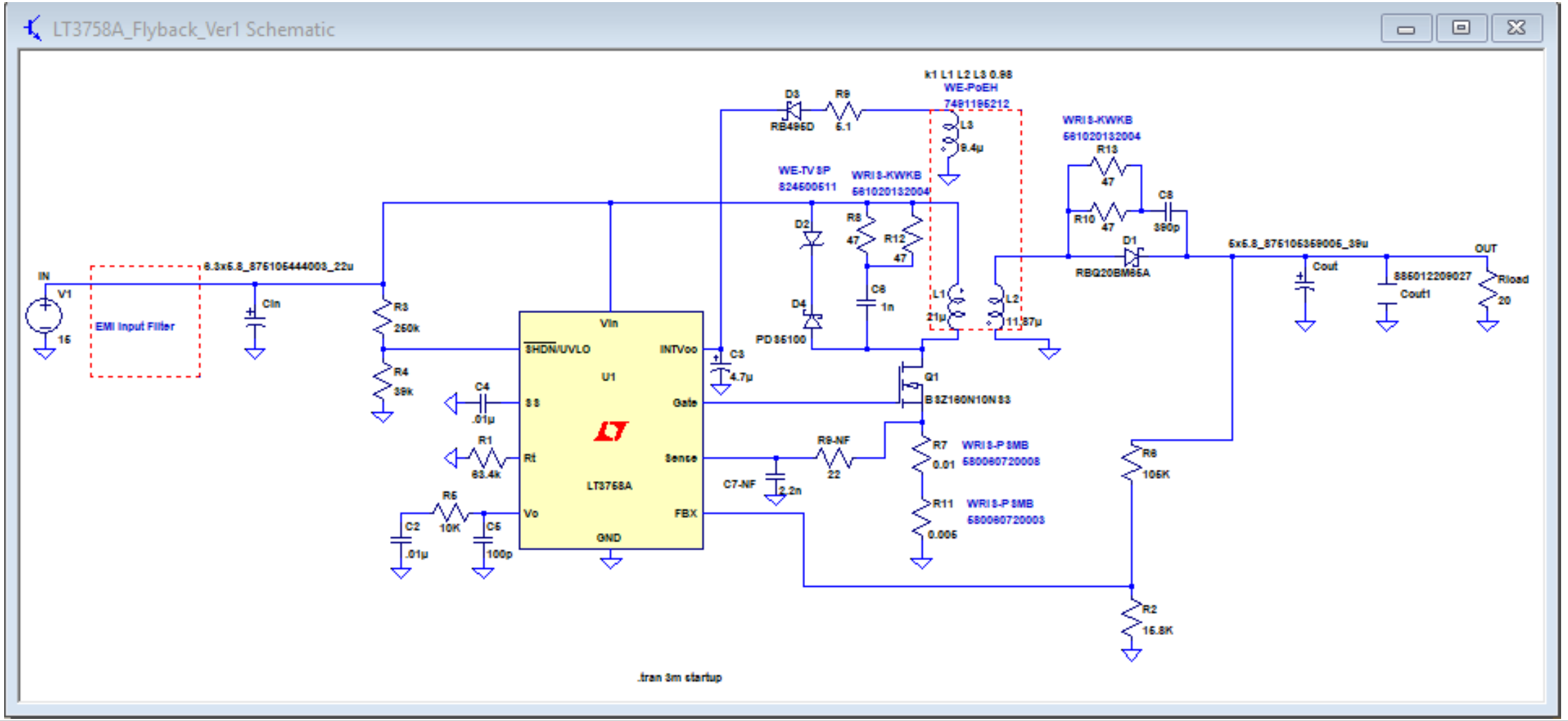
- **Design Requirements:**
  - Vin= 9V-30V
  - Vout = 12V
  - Iout = 1.5A (up to 2.5A)
  - Max Efficiency 90%





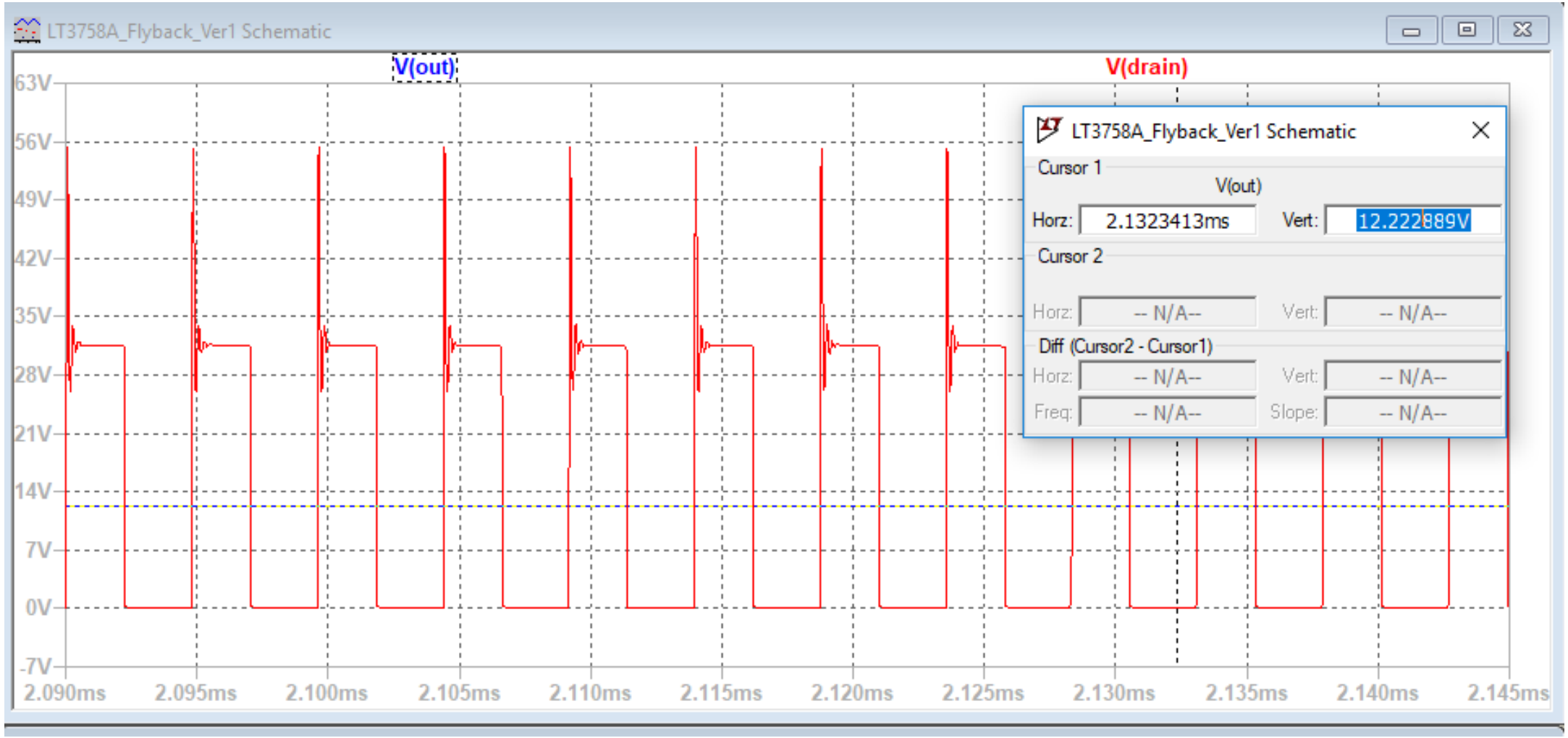
TYPE 2 POE FLYBACK CONVERTER (LT3758A)

Design Simulation: Power Circuit



TYPE 2 POE FLYBACK CONVERTER (LT3758A)

Design Simulation: Power Circuit



TYPE 2 POE FLYBACK CONVERTER (LT3758A)

Design Simulation: Filter Circuit

List of Parts

D1: WE-TVSP
824501141
https://www.we-online.com/catalog/datasheet/824501141.pdf

FB1/FB2: WE-MPSB
74279224551
https://www.we-online.com/catalog/datasheet/74279224551.pdf

C0: WCAP-PSLC
875075661010
330uF / 35V
https://www.we-online.com/catalog/en/datasheet/875075661010.pdf

C1 / C2: WCAP-CSGP
88501220907
4.7uF / 25V
https://www.we-online.com/catalog/en/datasheet/885012209027.pdf

CY1 / CY2: WCAP-CSGP
885012006069
47nF / 25V
https://www.we-online.com/catalog/en/datasheet/885012206069.pdf

CdY1/CdY2: WCAP-CSGP
100nF/50V
https://www.we-online.com/catalog/en/datasheet/885012206095.pdf

Cd: WCAP-ASLI
47uF/35V
https://www.we-online.com/catalog/en/datasheet/865080543009.pdf

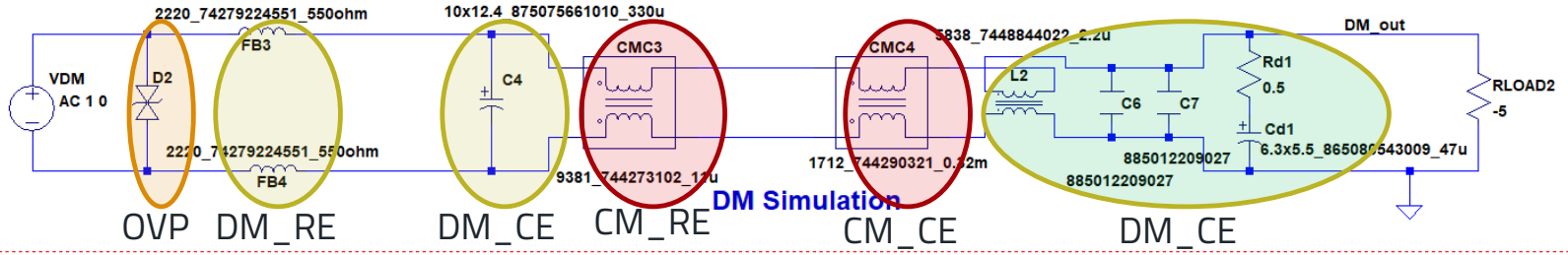
Cout: WCAP-PSHP
875115452003
100uF / 20V
https://www.we-online.com/catalog/en/datasheet/875115452003.pdf

CMC1: WE-SL5 HC
744273102
https://www.we-online.com/catalog/en/datasheet/744273102.pdf

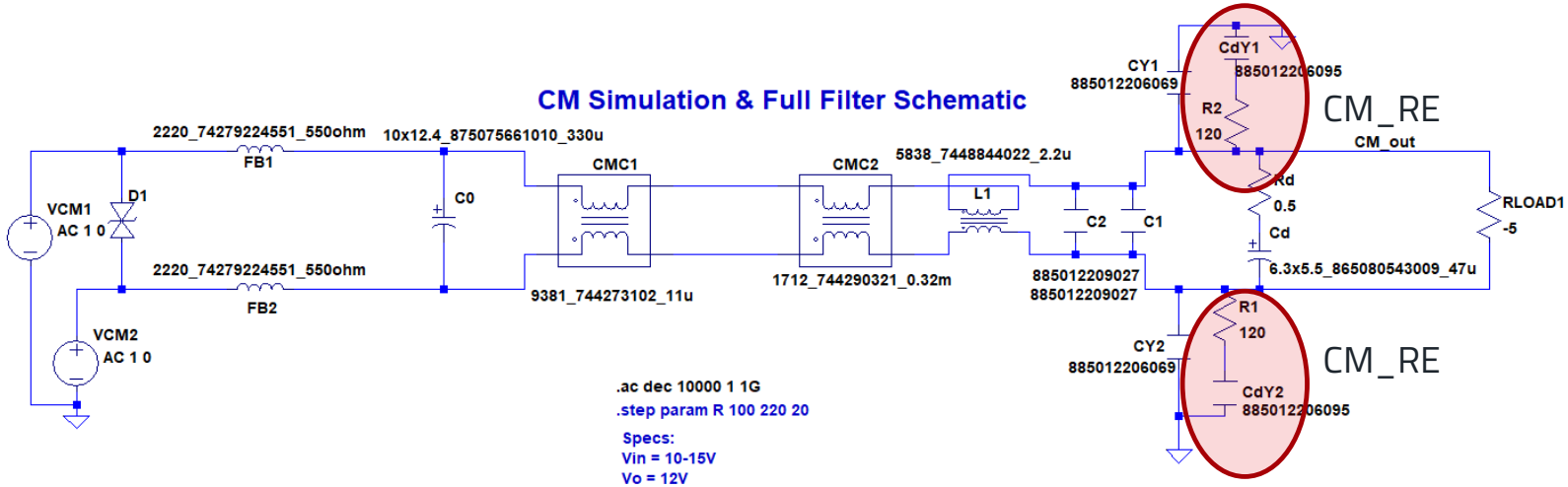
CMC2: WE-UCF
744290321
https://www.we-online.com/catalog/en/datasheet/744290321.pdf

L1: WE-DPV
7448844022
https://www.we-online.com/catalog/en/datasheet/7448844022.pdf

12V DC Supply Input
Optimised Filter

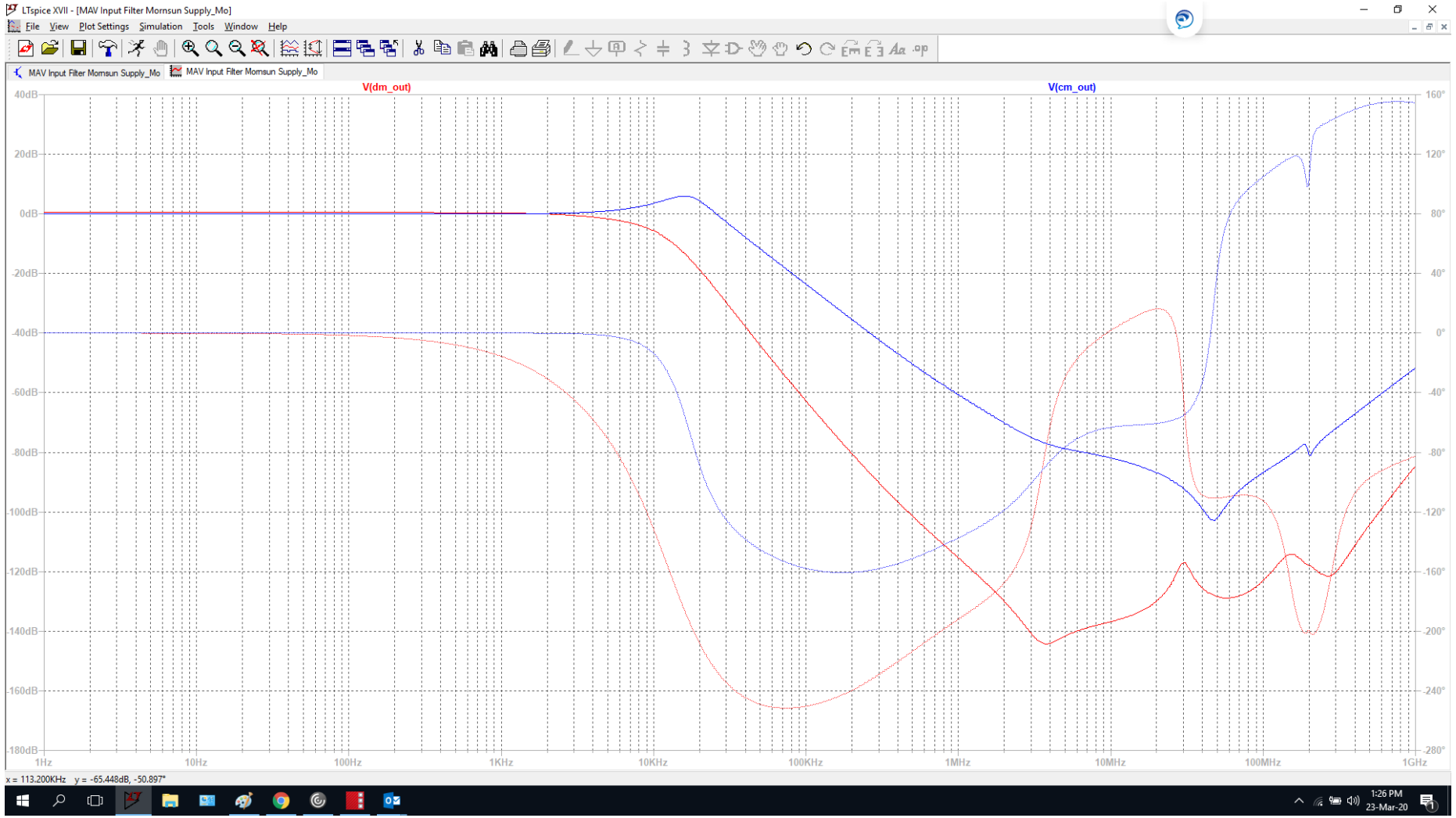


CM Simulation & Full Filter Schematic



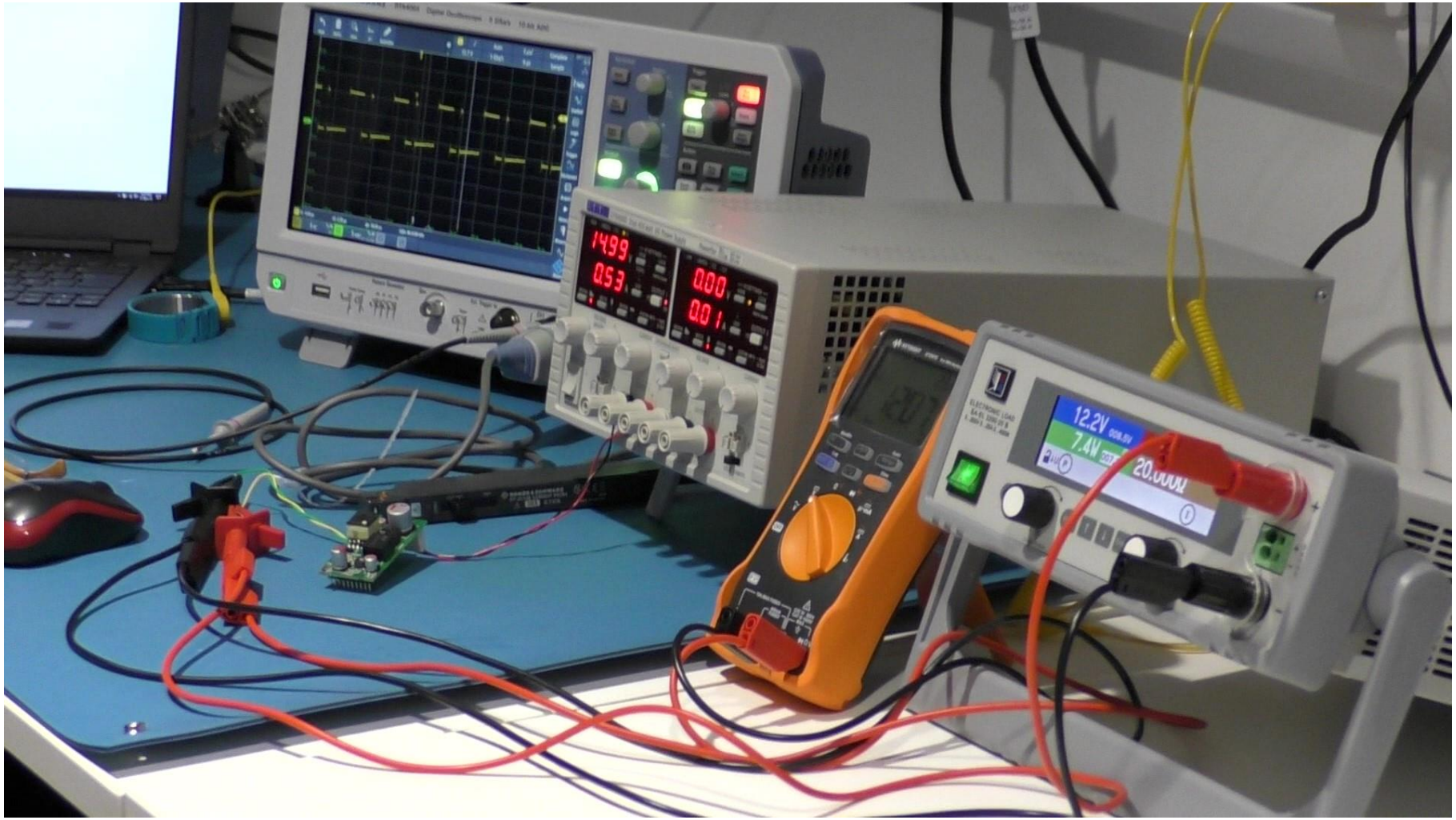
TYPE 2 POE FLYBACK CONVERTER (LT3758A)

Design Simulation: Filter Circuit



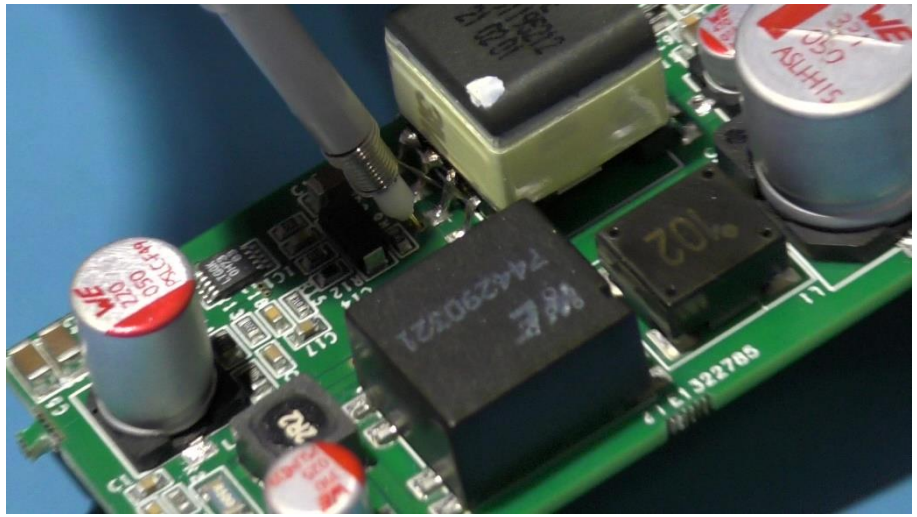
TYPE 2 POE FLYBACK CONVERTER (LT3758A)

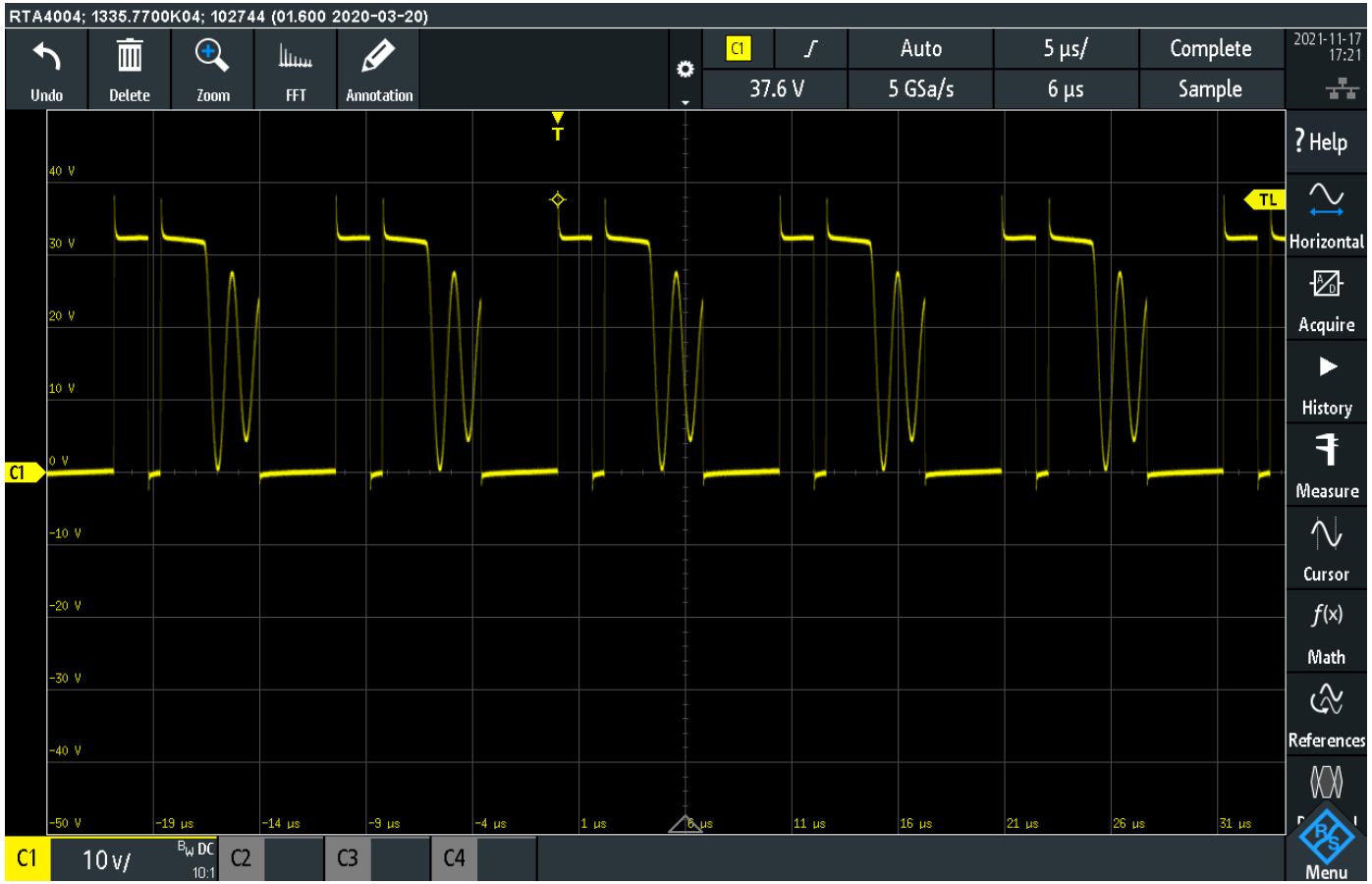
Test and Measurement: Signal Integrity



TYPE 2 POE FLYBACK CONVERTER (LT3758A)

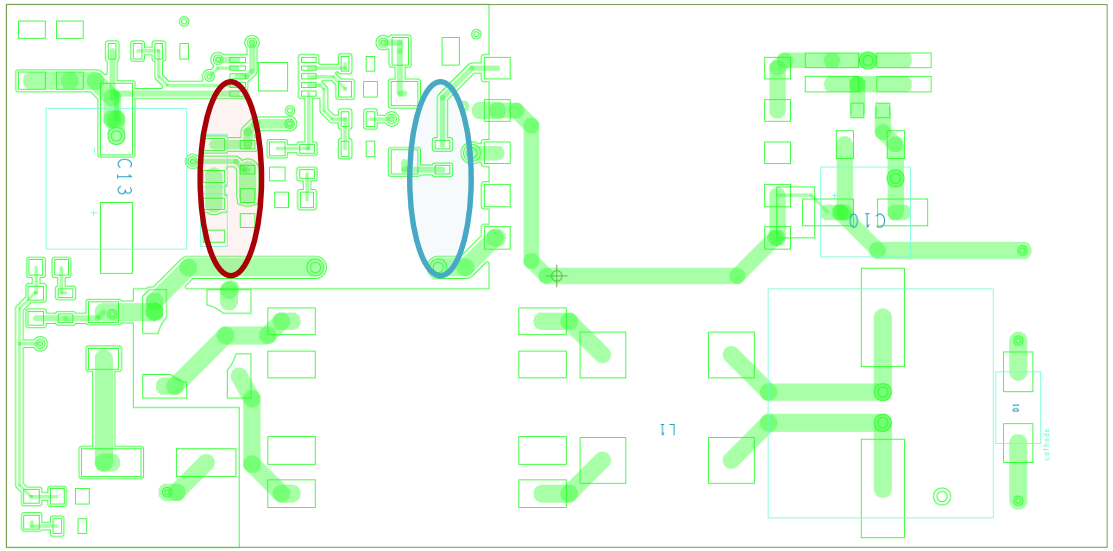
Test and Measurement: Signal Integrity

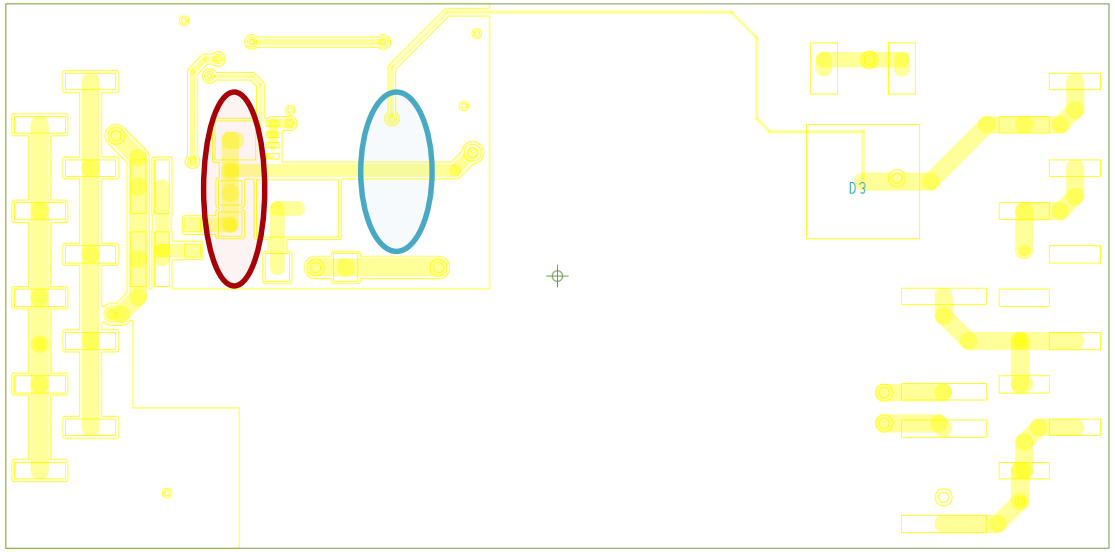




TYPE 2 POE FLYBACK CONVERTER (LT3758A)

Layout and Tracking Review



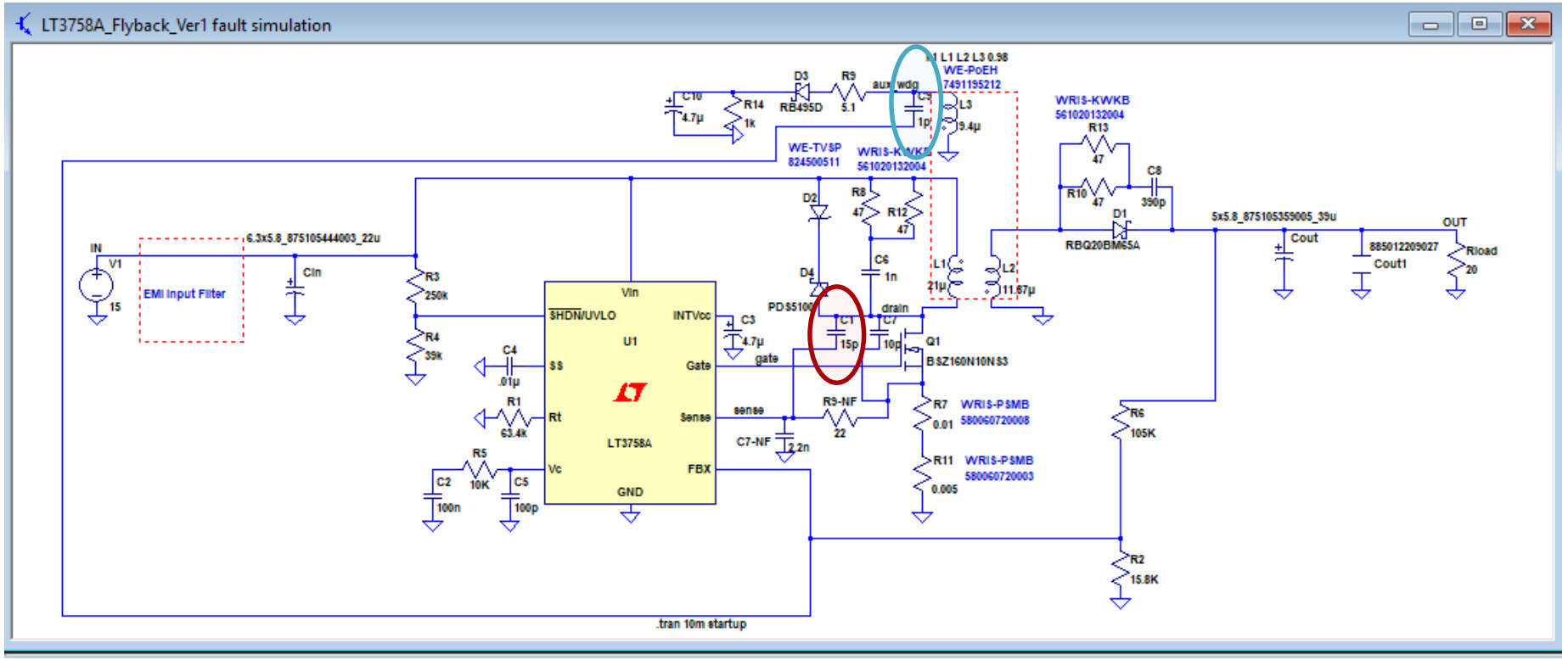


- **Several issues identified:**
  - Ground connection far from the input/output capacitors, Mosfet Source / Rsens and IC Power GND
  - AGND and PGND not separated
  - Track to gate of mosfet to small
  - Critical: Feedback signal shadows the auxiliary winding switching signal.
  - Critical: Current sense signal overlaps the FET Drain signal.

TYPE 2 POE FLYBACK CONVERTER (LT3758A)

Signal Integrity Simulation: Power Circuit

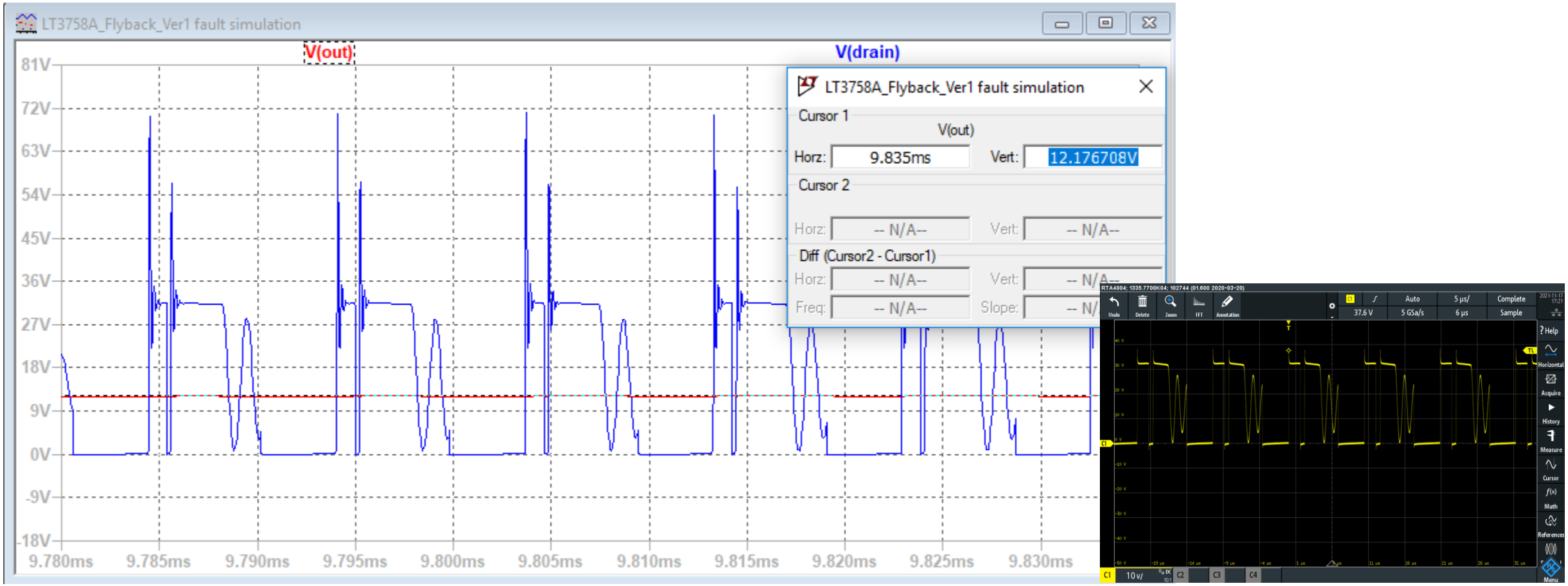
- **Parasitic coupling capacitance estimated based on pcb and track parameters**
  - **https://www.emisoftware.com/calculator/biplanar-capacitance/**
- **Modelled in LT Spice and simulated**



TYPE 2 POE FLYBACK CONVERTER (LT3758A)

Signal Integrity Simulation: Power Circuit

- **Results consistent with the measurements**



TYPE 2 POE FLYBACK CONVERTER (LT3758A)

Summary and Conclusions

- Regulation is fine across the load and line spec conditions
- Efficiency is good at around 87%
- Thermal performance is very good (max board temperature 42.4DegC).
- EMC Conducted emissions performance is also very good.
- However, layout and tracking has resulted in an issue with signal integrity.
- In General, Layout and Tracking issues:
  - Can be difficult to identify
  - May not result in an immediate failure
  - Or may result in a complete failure of the converter
- A good layout and tracking is essential along with filtering to achieve EMC and good functional performance.

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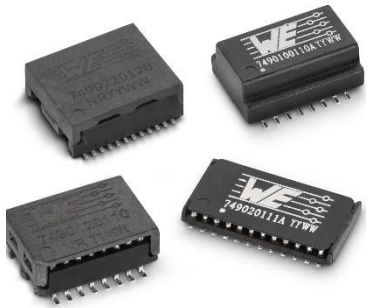
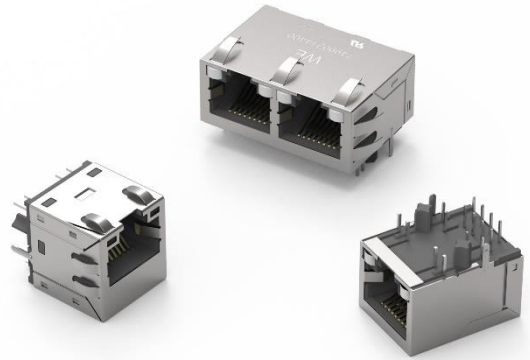
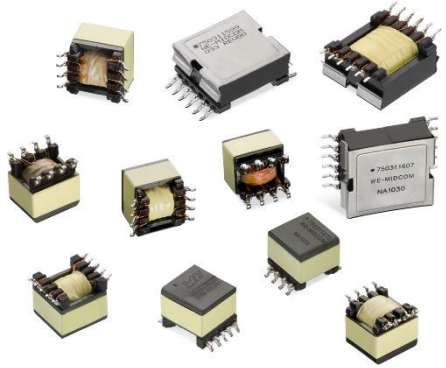
Signal & Communications | Passive Components | Würth Elektronik Product Catalog (We-online.Com)







Questions

& Answers

We are here for you now!
Ask us directly via our chat or via E-Mail.

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