

System Power Supply: One task – Three solutions

Configurable, Unit Type or Distributed Power Architecture (DPA)

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MEDISCHE ELEKTRONICA
Ontwikkelingen, normen en toepassingen

6 februari 2024 | Van der Valk Vianen

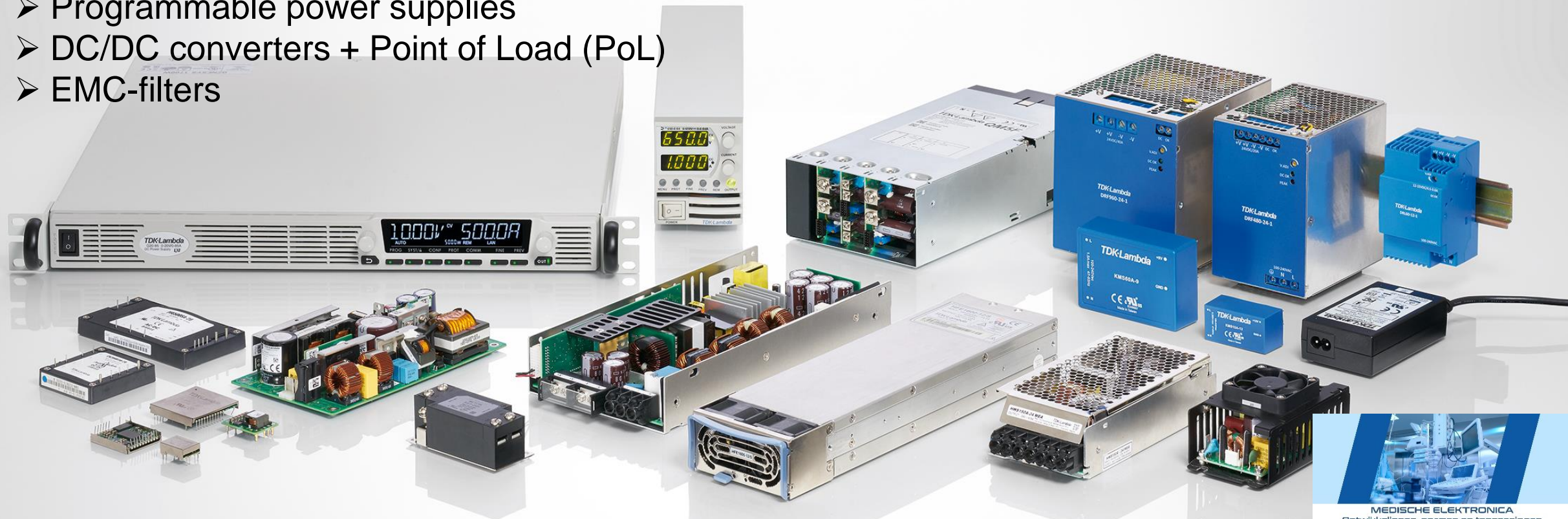
Company profile

Attracting Tomorrow



TDK Lambda is a global manufacturer of power supplies for industrial and medical applications.

- Focus on reliability, lifetime and quality
- Wide product portfolio covering
 - Unit type power supplies
 - Configurable power supplies
 - Programmable power supplies
 - DC/DC converters + Point of Load (PoL)
 - EMC-filters



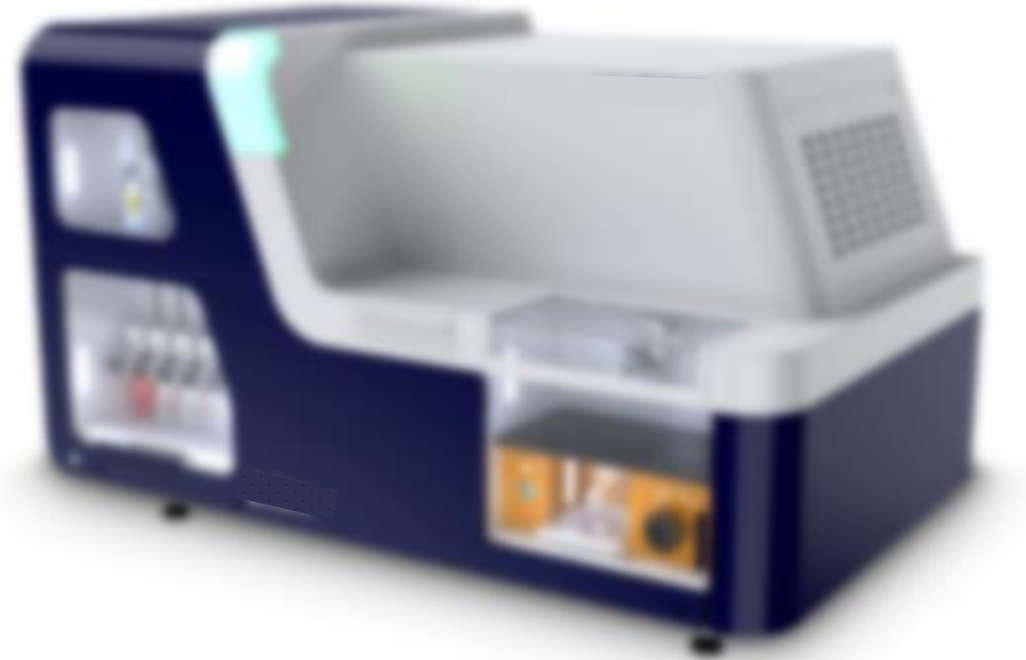
The virtual “task”= Application to compare our three solutions

Analytical Equipment

- EN60601 safety approvals
- For patient contact: 2MOPP
- Input: 85-265VAC single-phase

- Power requirement:

Logic PCB + Display	12V	20A
Pump	36V	8A
Automation	24V	3/10A
<u>Standby-Power</u>	<u>5V</u>	<u>1A</u>
Total Power:	773 Watt max.	



Three fundamental concepts

A:

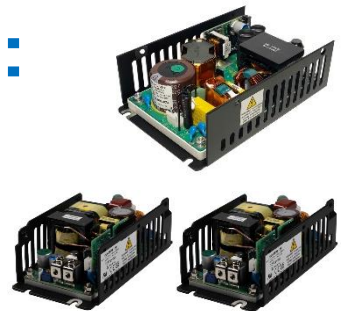


Configurable Power Supply

= Modular system based on a standard case and a primary converter with a huge range of output modules with different voltages and output power to be factory configured for individual solutions

Example: MU4 with 12V@20A, 24V@10A, 36V@10A, 5V@1A Standby

B:



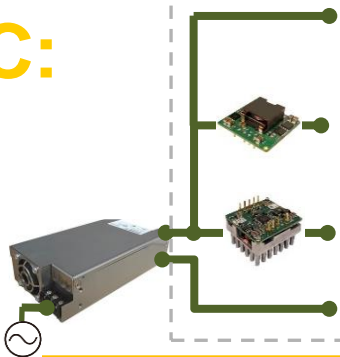
Unit Type Power Supply

= Separate standard power supply for each required output.

„Easy“ to select and purchase (from web shop)

Example: CUS-Series 400W unit @36V and 5V Standby, 250W unit @24V, 250W unit @12V

C:



Distributed Power Architecture (DPA)

= Front-End power supply to support main load and a DC-Bus with additional DC/DC or Point of Load (without galvanic isolation)

Example: CUS-Series unit @36V and 5V Standby,
PoL i7A @12V, i7A @24V



Size



Configurable

Dimensions

257.5 x 89 x 41 mm

Volume

~940 cm³



Unit Type

400W unit
250W unit (2x)

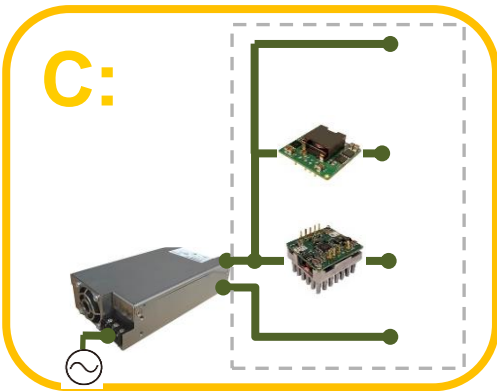
142 x 90 x 41.0 mm

119 x 64 x 39.5 mm

~524 cm³

2x ~300 cm³

~1124 cm³



DPA

Frontend (AC/DC)
PoL i7A
PoL i7A

171 x 85 x 42.5 mm

37 x 34 x 12.7 mm

37 x 34 x 12.7 mm

~618 cm³

~16 cm³

~16 cm³

~ 650 cm³



Size and required space/spacings

A:

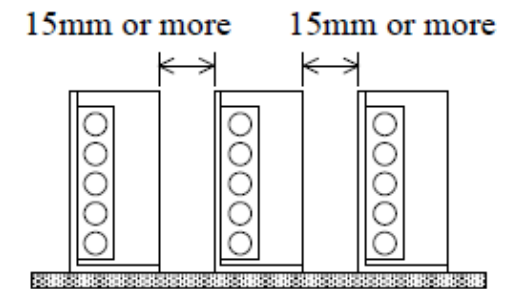


- Unit is ready to use
- Requires some space for fan-cooling and wiring.
- **Just one single part to mount and connect**

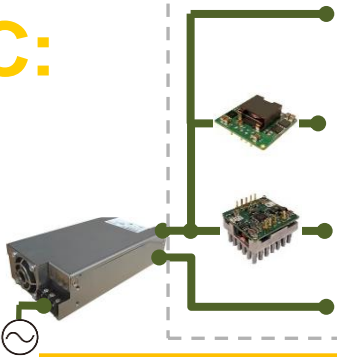
B:



- The set of Unit Type power supplies require spacings between the units for proper cooling.
- Higher system temperatures could require additional space for system cooling (fan).
- “AC-distribution” requires space.



C:



- Frontend requires space for fan-cooling and wiring.
- In the DPA the DC/DC's require PCB-space on the application-board (for themselves and external components)
- Additional heatsinks or fans for cooling could be required.



Power Loss / Efficiency



Configurable

Power loss

Efficiency

~86W

<90%



Unit Type

400W unit 36V

~18W

<94%

250W unit 24V/12V (2x)

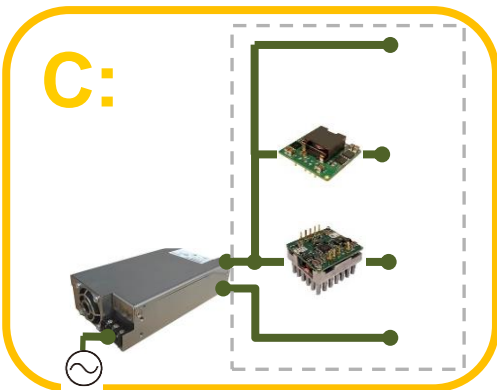
~18W

<93%

Total:

~54W

<93,1%



DPA

AC/DC 36V

~42W

<95%

PoL 24V

~7W

<97%

PoL 12V

~12W

<95%

Total:

~61W

<92,1%



Power Loss requires Cooling

A:



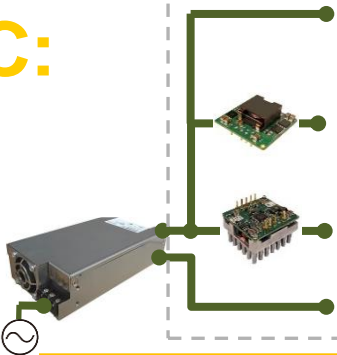
- Internal temperature-controlled fan
silent fan with 36dBA@80% load
- Reliable cooling is guaranteed by the unit itself

B:



- Every unit has it's individual cooling requirements. Do they harmonize?
- Thermal evaluation in the final equipment - especially for convection cooled units
- Additional cooling efforts in the final equipment (fans/airflow)

C:

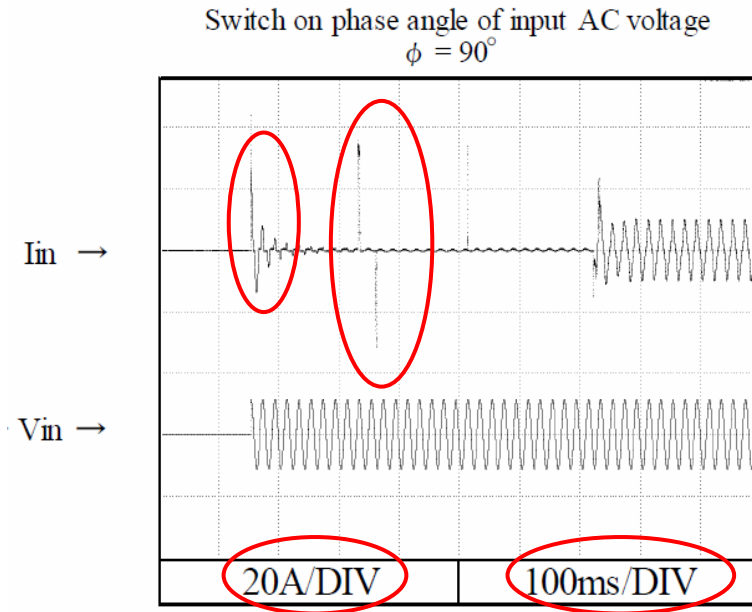


- Front-end power supply with internal temperature-controlled fan
- DC/DC's require cooling – by airflow or by conduction (heatsink)
- High flexibility to distribute the heat sources (DC/DC's) throughout the complete system.
- Thermal evaluation necessary



Inrush Current

The input capacity inside a power supply causes a (very short; <20msec.) peak-current at switch ON. This inrush current need to be limited by a resistor to avoid fuse/MCB tripping.

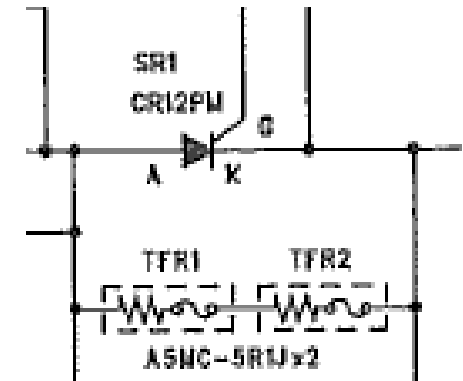


Bigger (> 300W) power supplies short the resistor after startup.

Use of higher resistance-value
= lower inrush current peak

Smaller power supplies just contain a NTC
(always „active“).

Use of lower resistance-value
= higher inrush current peak



Consequence: The inrush current of small (100W) power supply could become as high or even bigger as the inrush current of a big (1000W) unit.

Inrush Current

A:



The Configurable power supply contain an optimised circuit for best **active** inrush current limitation.

< 45A

B:



Sum of 3 individual inrush current peaks results in critical high value.

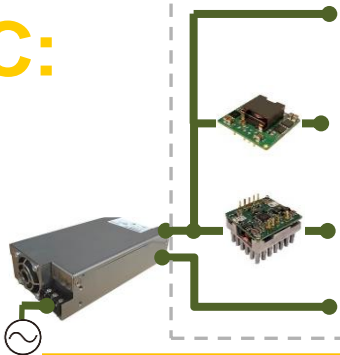
CUS400M active inrush limit < 40A

CUS250M passive inrush limit (2x) < 75A

<75. Note: the inrush I²t is significantly below the rating of the internal 5A fast acting fuse, or an external circuit breaker

Consider switching capability of relays, switches etc. ! **total < 190A**

C:



The Frontend power supply contain an optimised circuit for best **active** inrush current limitation.

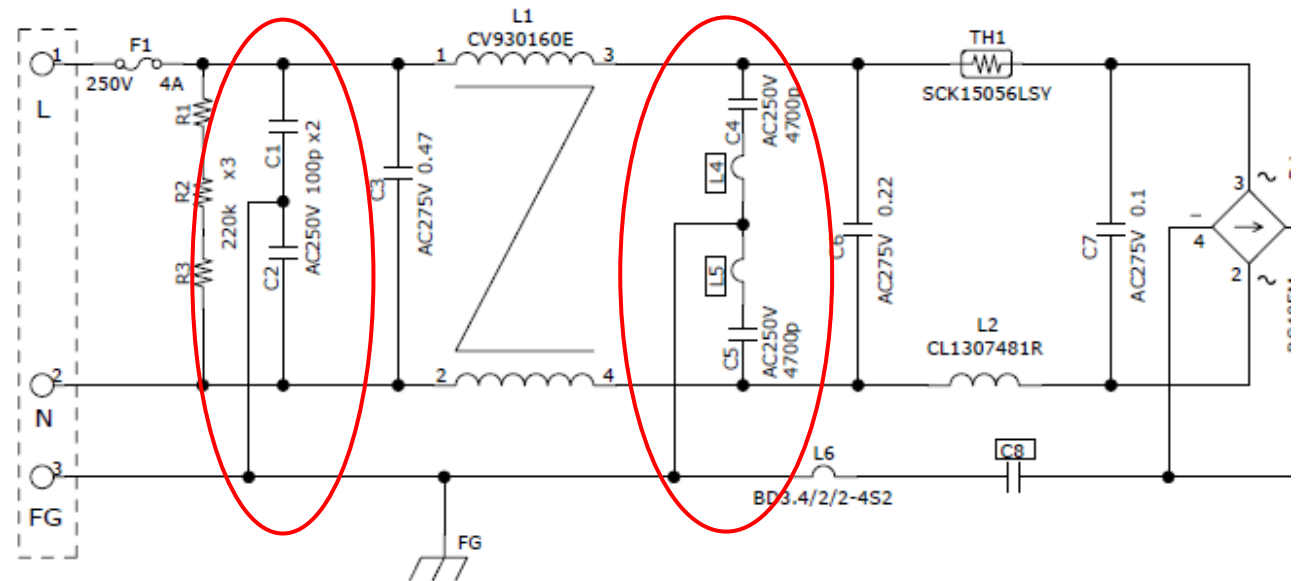
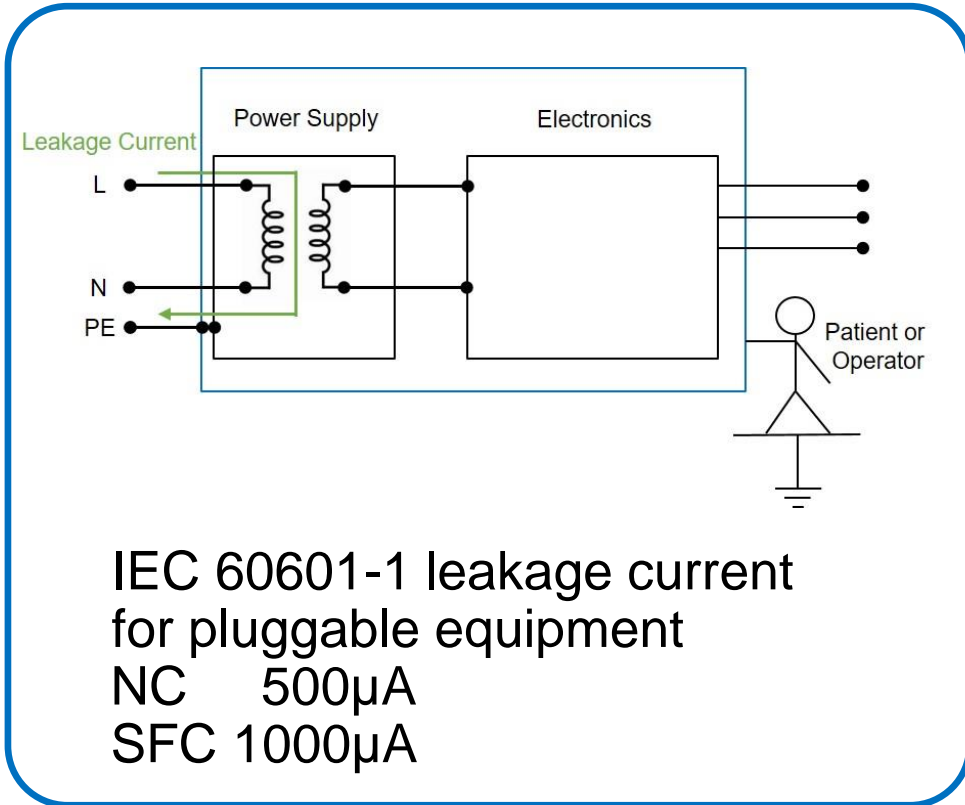
< 50A

The DC/DC-converters are powered from the secondary output of the frontend and have no influence on the mains input.



Earth Leakage current

The internal EMC-filter in the power supply contains Y-capacitors to short high-frequency interference to ground. This result in a permanent current on the ground/earth.
For medical equipment, the limits for earth leakage current are very low.



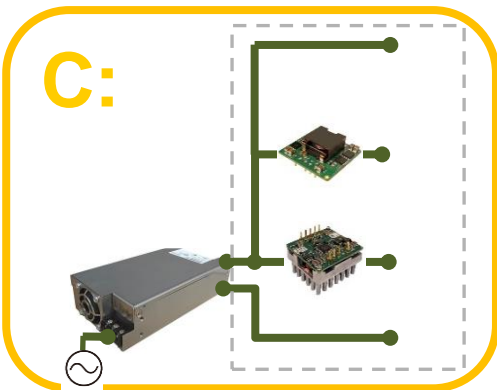
Earth Leakage current



- Designed for booth:
- Good EMC performance - radiated and conducted emission class B
- Very low leakage current <300 μ A



- Three separate Unit Type power supplies
- 3x EMC-filter = 3x leakage current
 - CUS400M <250 μ A
 - CUS250M <150 μ A
 - CUS250M <150 μ A
- Max. leakage current for pluggable device NC 500 μ A: **<550 μ A**



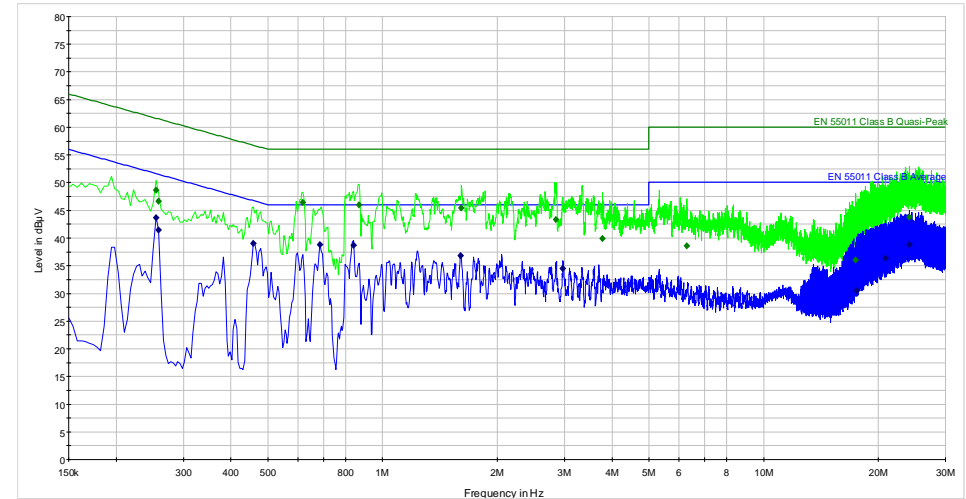
- Only AC/DC Frontend generates leakage current
- Radiated/conducted emission class B
- Very low leakage current <250 μ A
- DC/DC's are located on the output of the power supply
- No (tiny) effect on total leakage current



EMC / EMI

Conducted and Radiated Emission

- A switch-mode power supply contain up to three switching-stages
 - PFC = Power Factor Correction; typ. 65 – 100kHz
 - Main-converter pri./sec.; typ. 55 – 500kHz
 - Auxiliary voltage for standby; typ. 66 – 100kHz



- Each switching frequency is visible as a peak in the conducted emission spectrum. To comply with the regulatory limits, every power supply contain internal filter-circuits.

But...

- The individual assemblies within equipment, their arrangement, cable routing and cable lengths have a considerable influence on conducted and radiated emission.
- Even if every component used inside the equipment comply with the emission-limits, it is not guaranteed that the complete equipment will fulfil this limits as well.
- As more active switching stages are present inside equipment, as higher the risk for resonance, coupling ore interference and associated „badly surprises“ peaks in the emission spectrum.



EMC / EMI

A:



Configurable power supply

- 2 (3) Switching frequencies (PWM)
- Tuned filter integrated in the power supply
- Only one AC-inlet

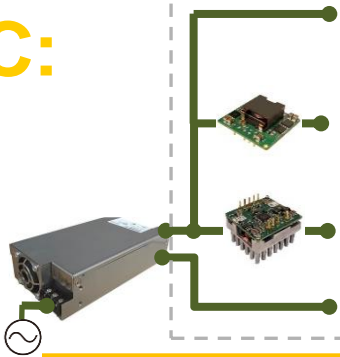
B:



3 individual power supplies, each with 2 (3) Switching frequencies (PWM)
= different topology and switching frequency

- AC-Inlet for 3 units = long cable-loom for distribution
- Many different switching frequencies – risk for „bad surprises“

C:



DPA with Frontend power supply

- 2 (3) Switching frequencies (PWM) in the Frontend
- 2 units of DC/DC-converter with individual switching-regulator
- Possibility to separate the DC/DC´s from each other inside the equipment.
- Possibility so synchronise the switching stage of the DC/DC´s



System Integration

A:



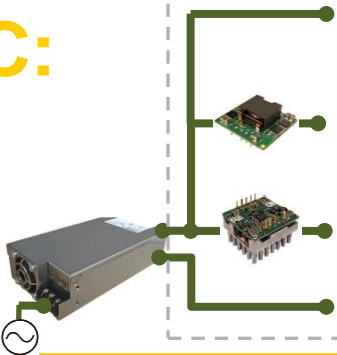
- A configurable unit is not a “click and buy” webshop product.
- It need to be configured with a web-tool or together with a specialist.
- It is not available from stock; it will be built with modules on order.
- **It is a single unit, fitting perfect to the individual system requirements**
- **It offers high technical performance – easy to install.**

B:



- **Unit Type power supplies are available next day from a webshop.**
- Even when the specification of each unit look very well. – there are some pitfalls to overcome as more units are combined together.
- **Inrush current, earth leakage current, conducted/radiated emission**

C:



- The DPA is the „**highest value**“ solution.
- It requires engineering skills for PCB-design and thermal evaluation.
- It gives highest flexibility to distribute “power sources” in the system.
- PS keeps always a single frontend unit, any further voltage is in the responsibility of the board-designer.



■ Questions?

■ **Meet us (with a demo) at our stand 22.**

- Telerex Team: - Carlo Mathijssen, Ruud Rijkers
- TDK: - Udo Schweizer



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