EMBARCADOS WEBINAR

Patrocinado por MOUSER ELECTRONICS

Do básico ao avançado,

como ter uma solução AC/DC otimizada para nossa realidade.

Michael Guarizo

Engenheiro de Aplicações

power integrations™

EMBARCADOS

Patrocinado por

MOUSER ELECTRONICS

BP&M REPRESENTAÇÕES

Embarcados Webinar

Do básico ao avançado

Como ter uma solução AC/DC Otimizada para nossa realidade

BP&M SALES REP

MICHAEL GUARIZO

Professional

Current: FAE at BP&M

Past: Engineer at IBRAMED

Academic

Electrical Engineer from Universidade Federal de Itajubá (UNIFEI)

Personal:

Current City: Amparo

Team: Corinthians

Wife and daughter

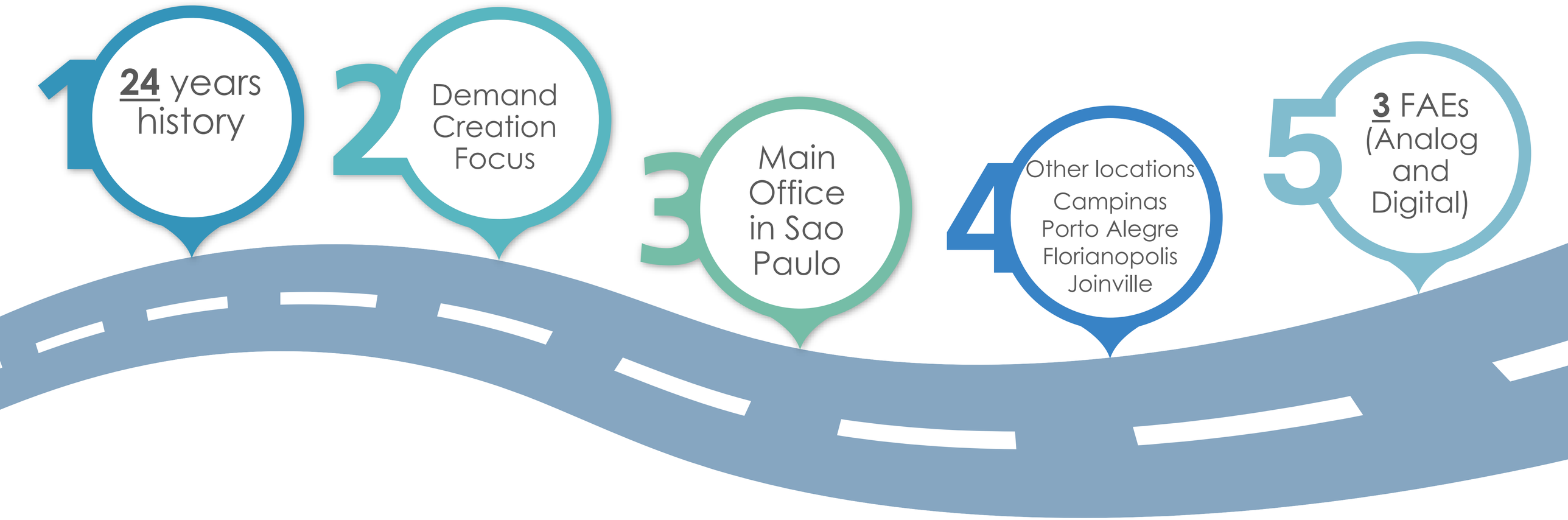
Hobbies: Sports, cooking, games

LinkedIn: https://www.linkedin.com/in/michael-felipe-guarizo/

E-mail: guarizo@bpmrep.com.br

BP&M SALES REP

BP&M SNAPSHOT



BP&M SALES REP

LINECARD

ANALOG DEVICES

BROADCOM

COHERENT

FCL COMPONENTS

Littelfuse

Micron

NORDIC SEMICONDUCTOR

power integrations

SANYO DENKI

SAMSUNG

SAMSUNG LED

ublox

YAGEO Group

YAGEO KEMET Pulse

ZETTLER electronics

BASIC STEPS OF THE AC/DC SOLUTION

1 - DETERMINE THE INPUT PARAMETERS

2 – CALCULATE THE TRANSFORMER PARAMETERS

3 – CALCULATE THE MOSFET PARAMETERS

4 – CALCULATE THE RECTIFIER DIODE PARAMETERS

5 – CALCULATE THE OUTPUT CAPACITOR PARAMETERS

6 – CALCULATE THE SNUBBER PARAMETERS

1 – INPUT PARAMETERS

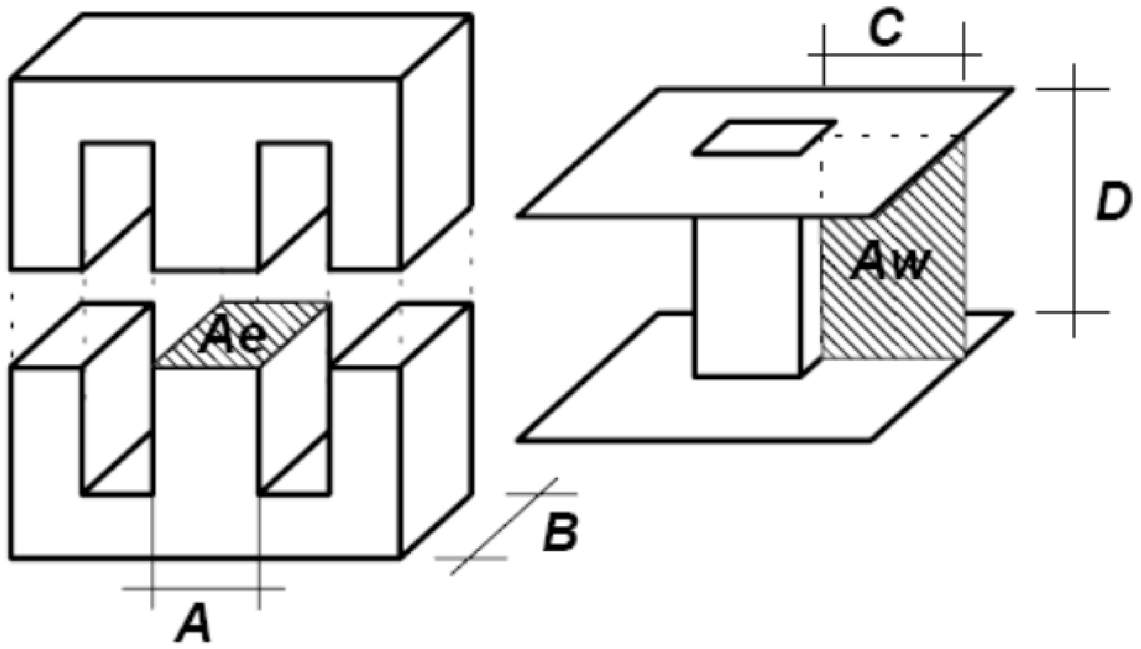
PARAMETERS	VALUES
INPUT RANGE (VAC)	85-265VAC
OUTPUT VOLTAGE (VDC)	12VDC
OUTPUT CURRENT (A)	2A
OUTPUT POWER (W)	24W
OUTPUT TOLERANCE (%)	10%
TOPOLOGY	FLYBACK
EFFICIENCY (%)	85%
OUTPUT RIPPLE (V)	120mV
EXTRAS	FILTER EMC, OUTPUT FILTER, TEMPERATURE, SIZE

2 – TRANSFORMER PARAMETERS

A – CORE DETERMINATION

$$AeAw = \frac{1{,}1 * P_{OUT} * 10^4}{K_P * K_W * f_s * J * \Delta B}$$

Pout – Output power (W)
Kp - Primary utilization fator (0,4 – 0,6)
Kw - Winding area utilization fator (0,3 – 0,45)
fs – Switching frequency (Hz)
J – Current density (300 – 550 A/cm2)
ΔB – Variation of magnetic flux (0,2 – 0,4 T)



ZETTLER electronics

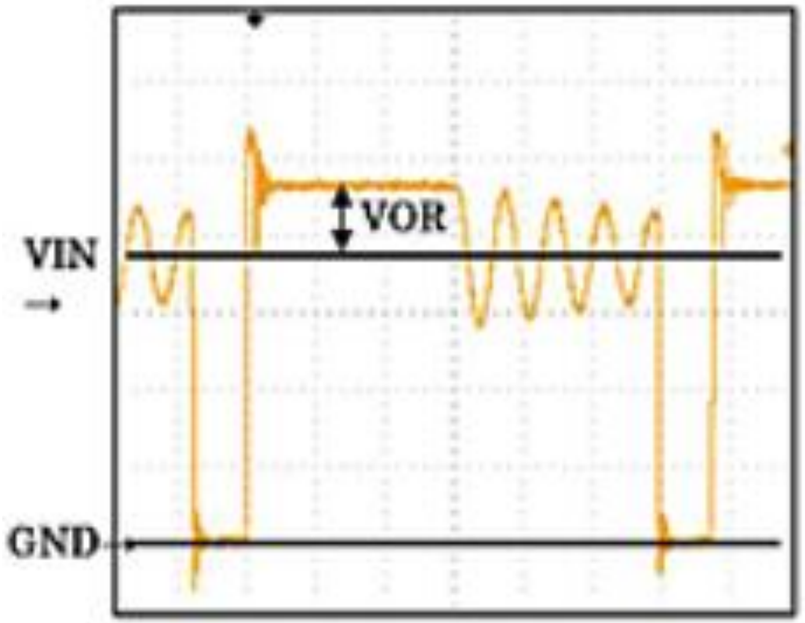
Pulse a YAGEO company

2 – TRANSFORMER PARAMETERS

B – TURNS RATIO

$$D_{MAX} = \frac{V_{OR}}{VIN_{min} + V_{OR}}$$

$$\frac{N_p}{N_s} = \frac{V_{OR}}{V_O} = n$$



MOSFET Vds

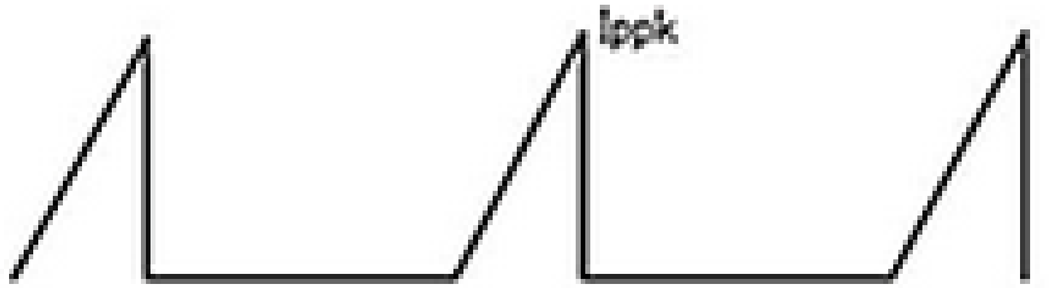
Dmax – Maximum Duty cicle of the IC (0,5 – 0,6)
VOR – Reflected output voltage (VDC)
VINmin – Minimum input voltage (VDC)
VO – Output voltage (VDC)
n – Turns ratio

2 – TRANSFORMER PARAMETERS

C – PRIMARY INDUCTANCE

$$L_p = \frac{(V_O + V_F) * (1 - D_{max})^2}{2 * Io_{max} * f_s} * n^2$$

$$I_{ppk} = \frac{2 * Io_{max}}{1 - D_{max}} * n^2$$



Lp – Primary inductance (H)
VF – Forward voltage of the rectifier diode (V)
Iomax – Maximum current output (A)
Ippk – Primary peak current (A)

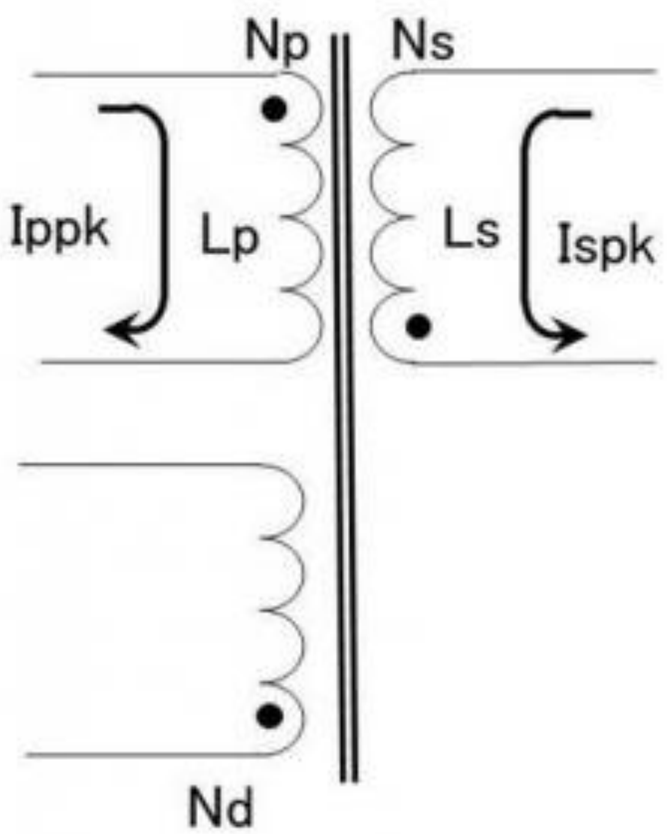
2 – TRANSFORMER PARAMETERS

D – PRIMARY, SECONDARY AND BIAS WINDING TURNS

$$N_p > \frac{L_p * I_{ppk}}{A_e * \triangle B}$$

$$N_s = \frac{N_p}{n}$$

$$N_d = N_s * \frac{Vcc_{IC} + VF_{IC}}{V_O + V_F}$$



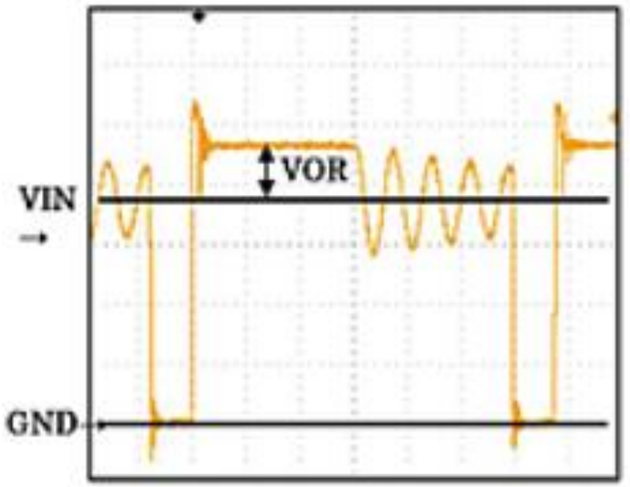
Vcc_ic – IC voltage (V)
VF_ic – Forward voltage of the IC rectifier diode

3 - MOSFET PARAMETERS

$$P_{sw} = V_{DS} * I_{ppk} * f_s * \frac{(Q_{GS2} + Q_{GD})}{I_G}$$

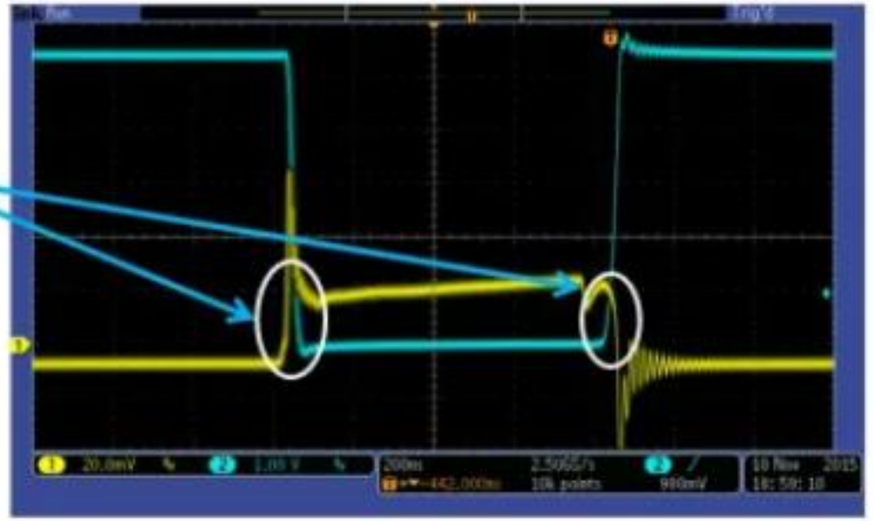
$$V_{DS} = VIN_{max} + V_{OR} + V_{spike}$$

$$I_{DS} > I_{ppk}$$



MOSFET Vds

Regions of power loss



power integrations™

IXYS
A Littelfuse Technology

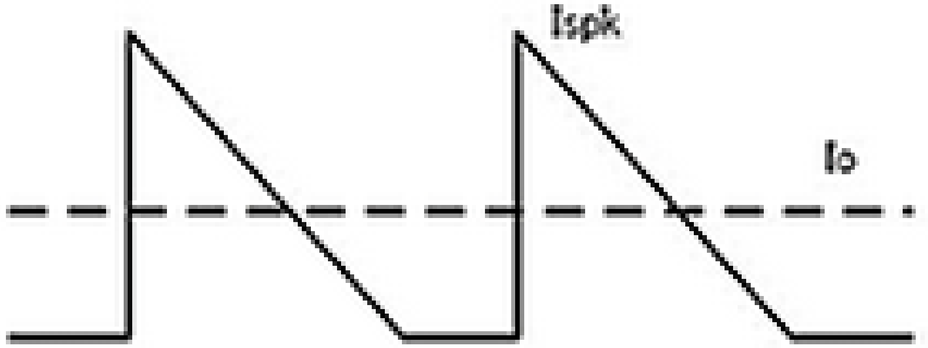
4 - RECTIFIER DIODE PARAMETERS

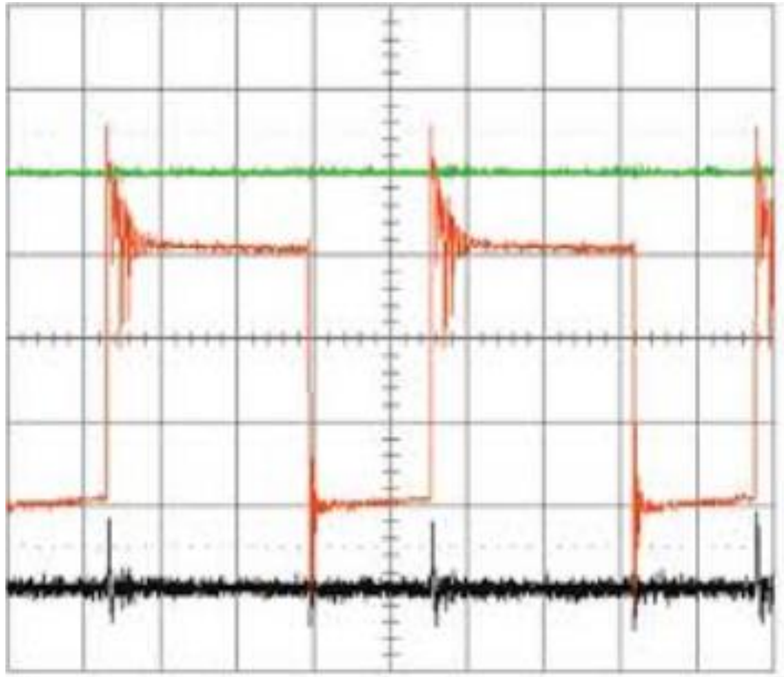
$$I_{spk} = \frac{2 * Io_{max}}{1 - D_{max}}$$

$$P_D = V_F * I_{spk}$$

$$I_D > I_{spk}$$

$$V_D > V_{OR} + V_{spike}$$





5 – OUTPUT CAPACITOR PARAMETERS

$$Co_{min} = \frac{D_{max} * Io_{max}}{f_s * \triangle Vo}$$

$$ESR < \frac{\triangle Vo}{I_{spk}}$$

$$I_{co} = I_{spk} * \sqrt{\frac{1 - D_{max}}{3}}$$

$$V_{co} > 1{,}5 * V_O$$

Co_min – Minimum output capacitance (F)
ESR – Equivalent series resistence (Ohm)
Ico – Output capacitor ripple current (A)
Vco – Output capacitor voltage (V)
ΔVo – Output ripple voltage (V)

KEMET
a YAGEO company

6 – SNUBBER PARAMETERS

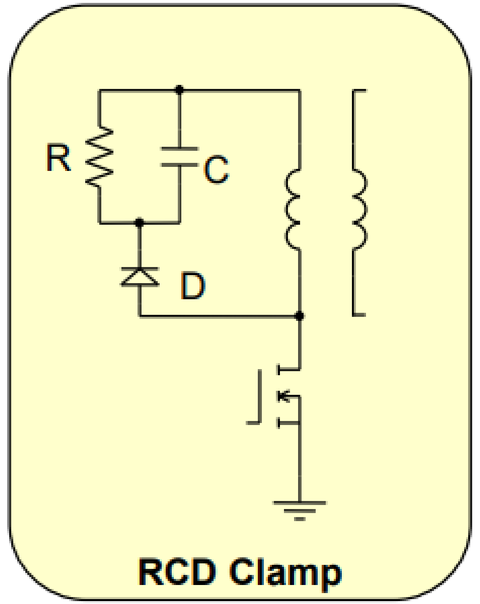
$$V_{clamp} = V_{max} - V_{IN}$$

$$R_{clamp} = \frac{2 * V_{clamp} * (V_{clamp} - n * V_O)}{f_s * L_{leakage} * I_{ppk}^2}$$

$$C_{clamp} = \frac{5}{f_s * R_{clamp}}$$

$$P_{clamp} = \frac{1}{2} * L_{leakage} * I_{ppk}^2 * f_s \left(\frac{V_{clamp}}{V_{clamp} - n * V_O} \right)$$

Vclamp – Voltage drop in the Snubber (V)
Vmax – Maximum voltage in the switch (V)
Rclamp – Snubber resistor (Ohm)
Lleakage – Transformer leakage inductance (H)
Cclamp – Snubber capacitor (F)
Pclamp – Snubber resistor power (W)



ADVANCED STEPS OF THE AC/DC SOLUTION

1 – EMC/EMI FILTER

2 – PROTECTIONS

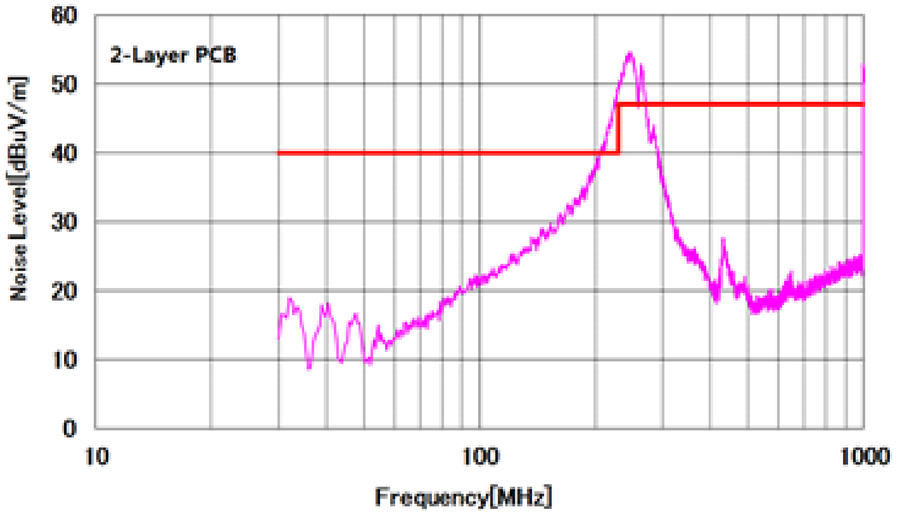
3 – TRANSFORMER GOOD PRACTICES

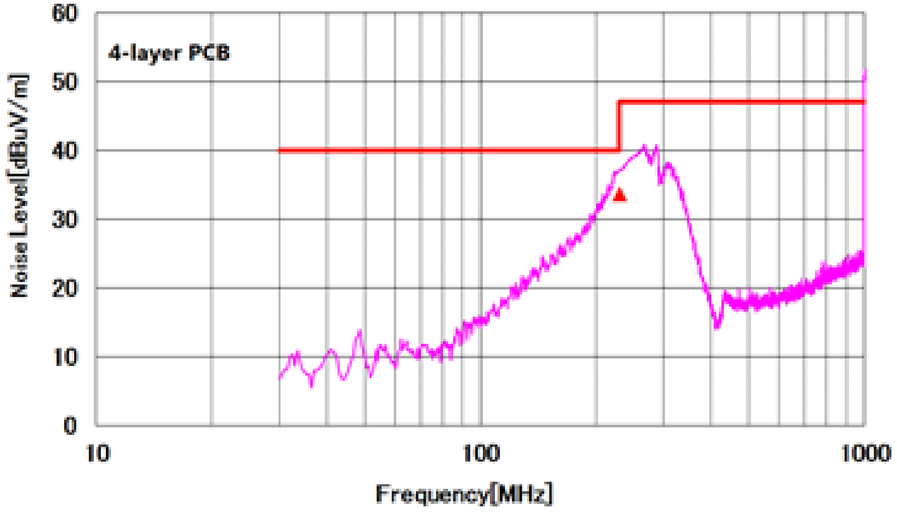
4 – OUTPUT FILTER

5 – SNUBBER OPTIMIZATION

6 – ADVANTAGES OF POWER INTEGRATIONS IC

1 – EMC/EMI FILTER





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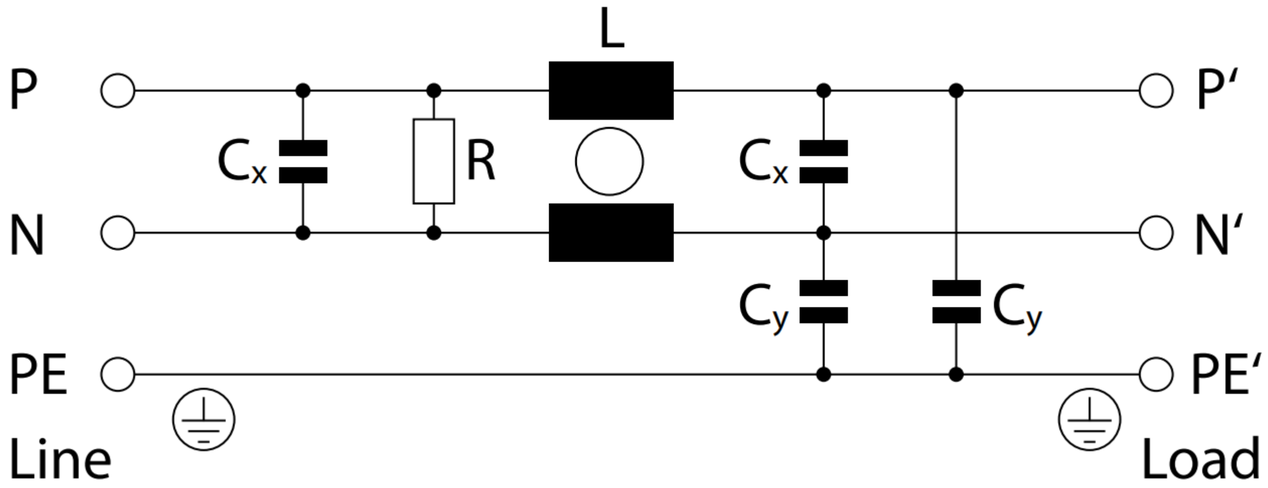
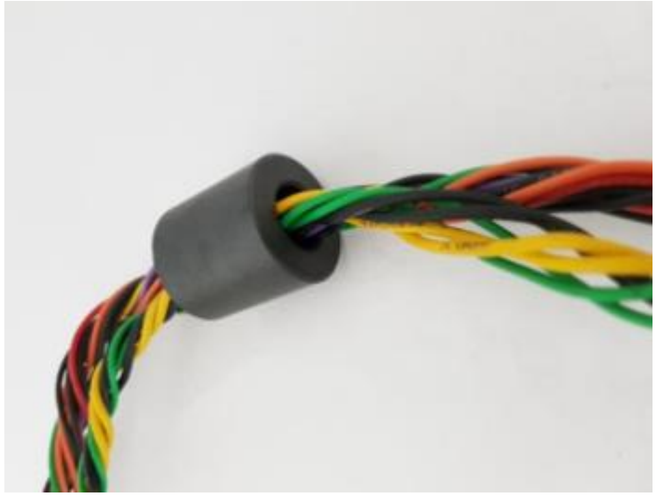
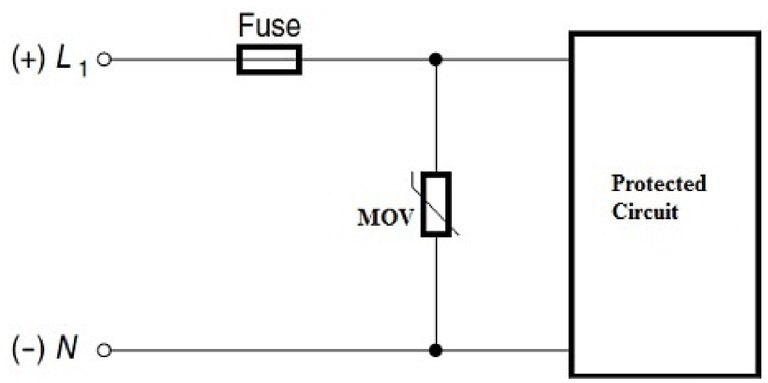
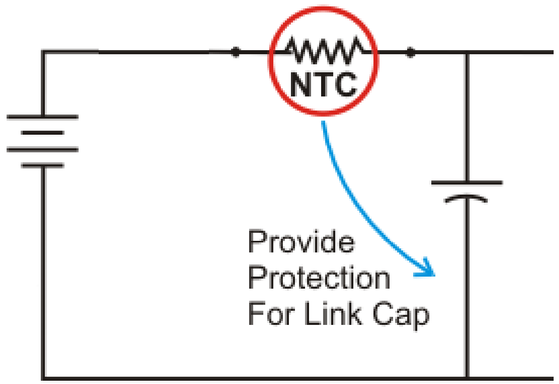
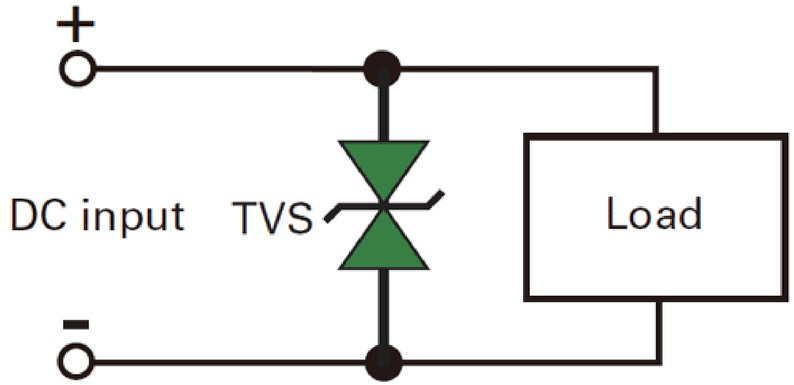


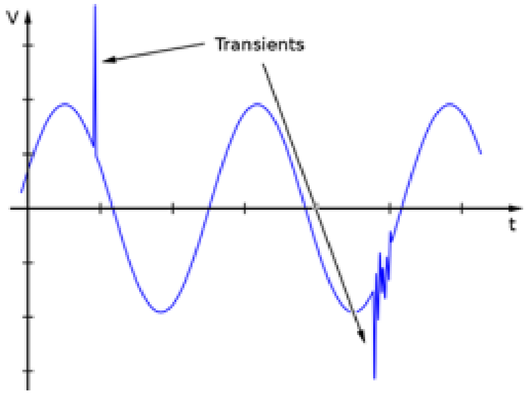


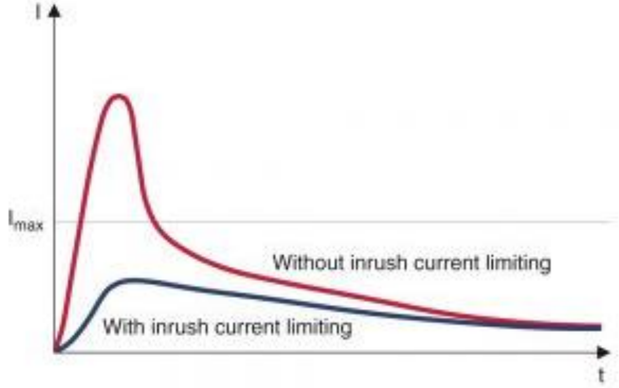
2 - PROTECTIONS

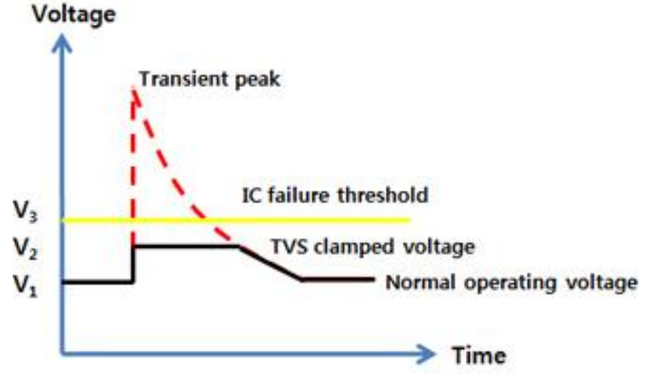












$$VAC_{MOV} > VIN_{max}$$

$$I_{NTC} > I_{ppk}$$

$$Vclamp_{TVS} > V_O$$

$$I_{MOV} > Surge$$

3 – TRANSFORMER GOOD PRACTICES

Eletromagnetic shield connected to primary GND

Split the primary into two windings

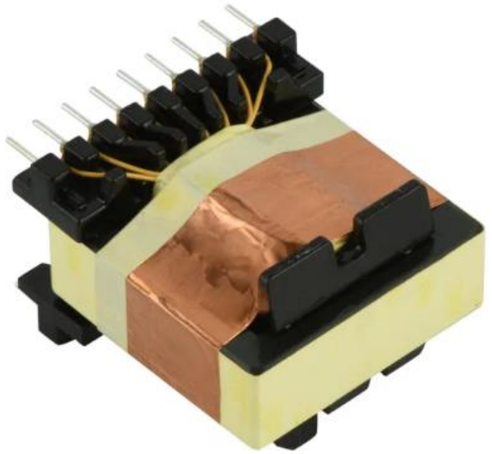
Evenly use the entire window area of the bobbin

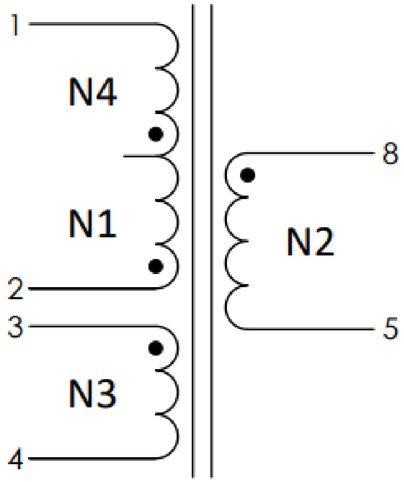
L_leakage < 3% * L_primary

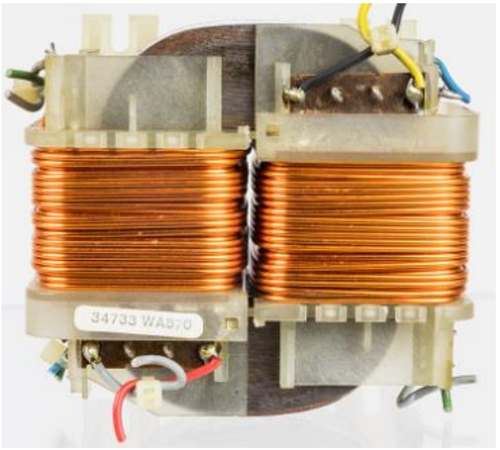
Use AWG compatible with the switching frequency to reduce the skin effect

LITZ wire reduces losses and leakage inductance

Central GAP improves magnetic flux uniformity







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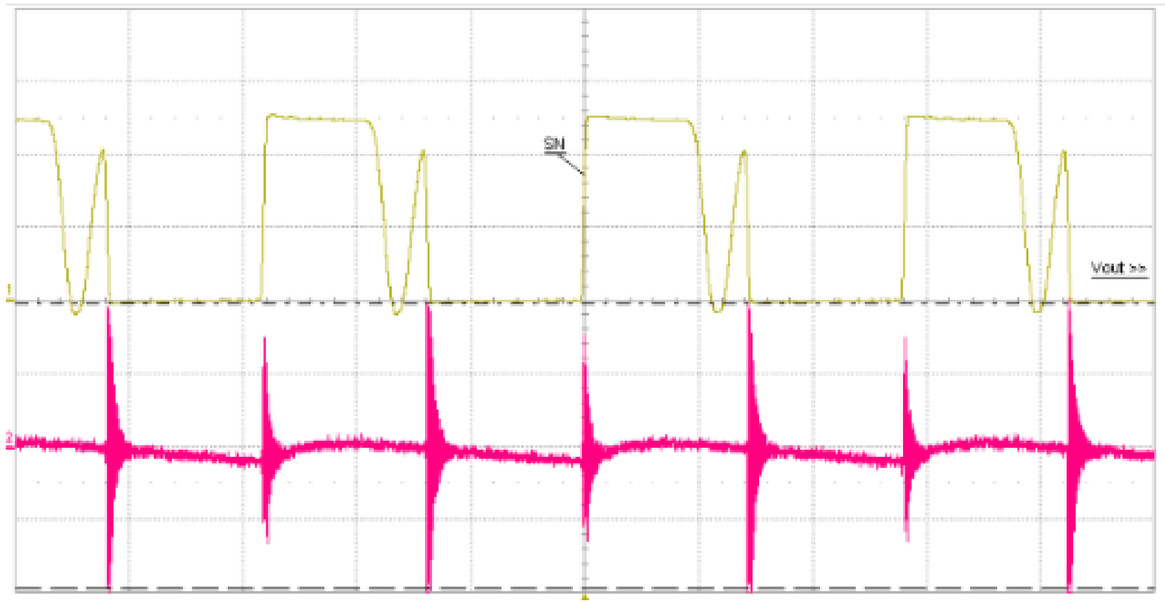
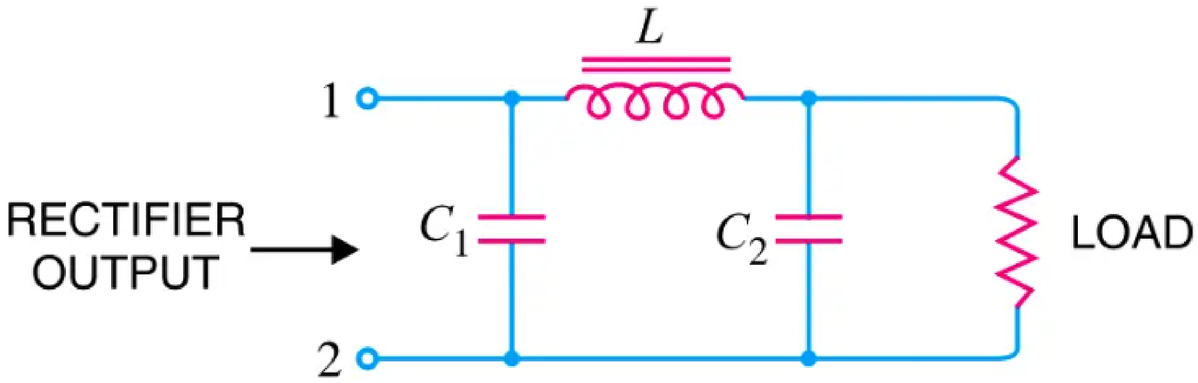
Pulse a YAGEO company

4 – OUTPUT FILTER





$$f_s = \frac{1}{2 * \pi * \sqrt{L * C_2}}$$

$$I_{L\_sat} > I_{spk}$$

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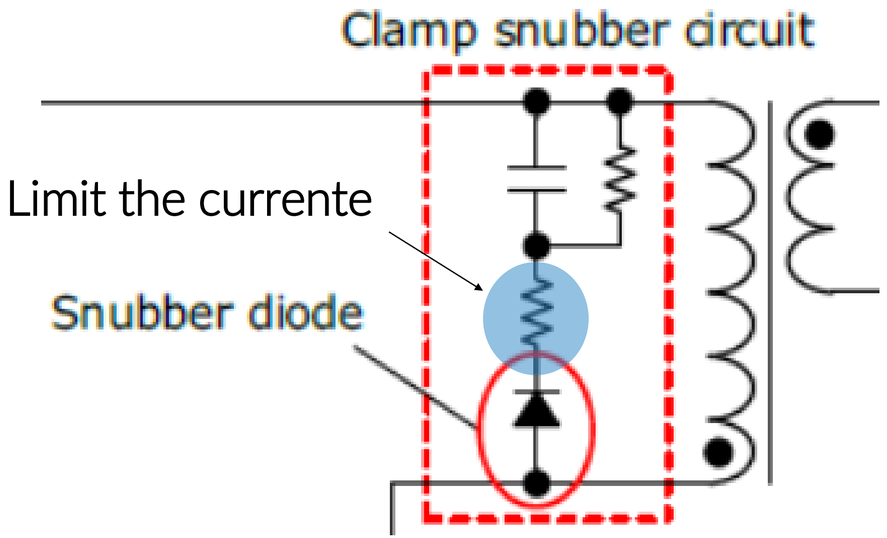
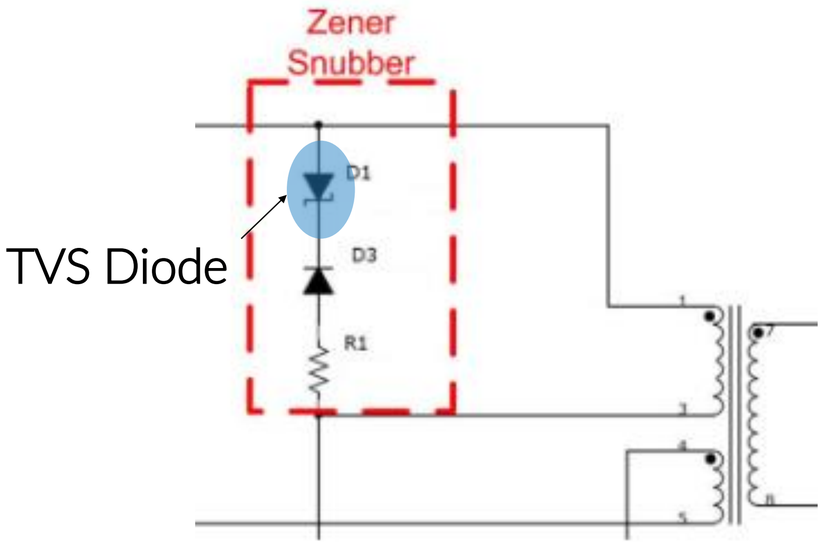
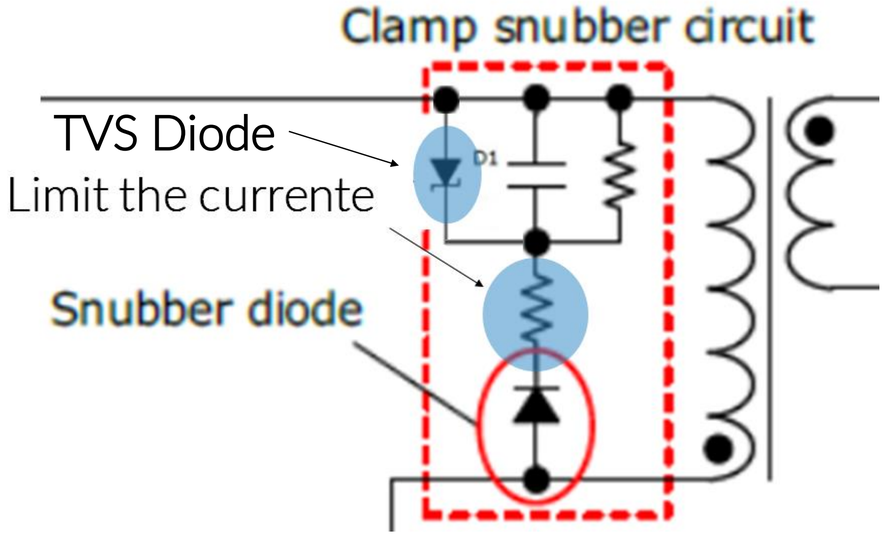
KEMET a YAGEO company

5 – SNUBBER OPTIMIZATION





YAGEO Group



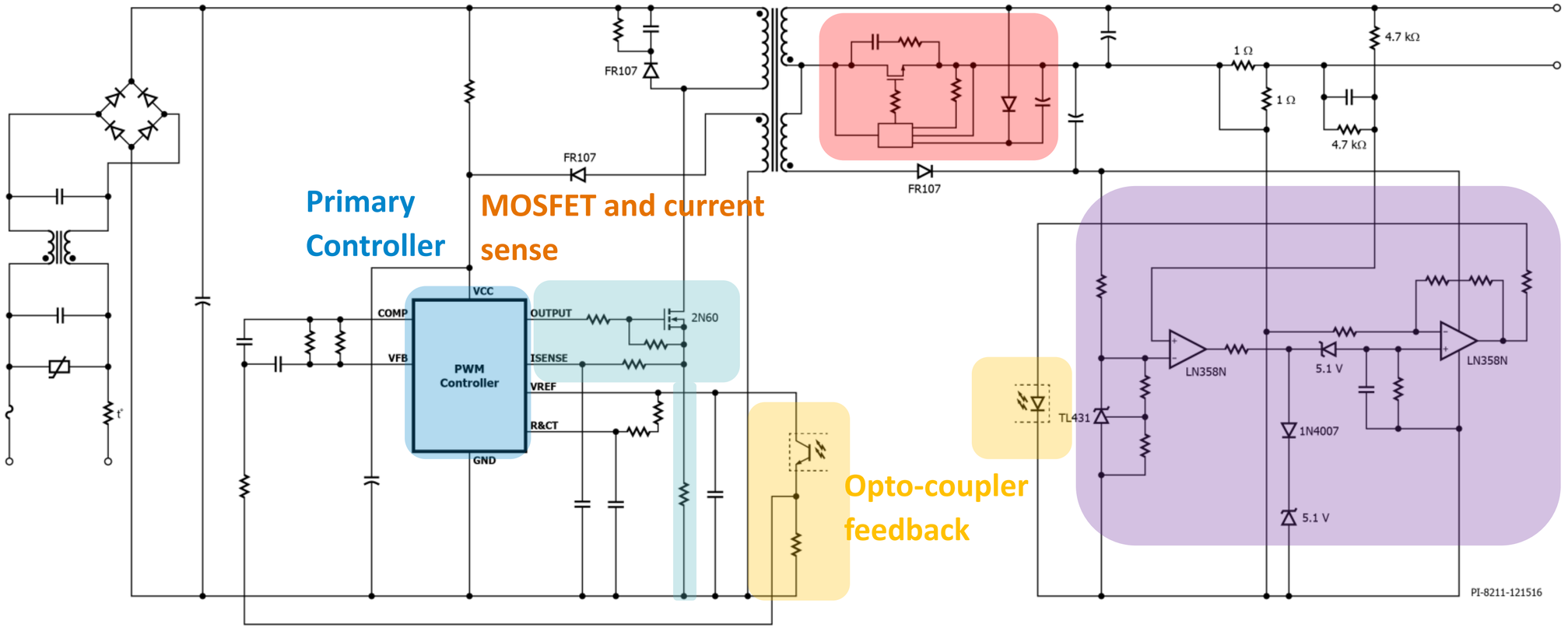
Littelfuse®

TYPICAL FLYBACK CIRCUIT

EMI filter and bridge rectifier

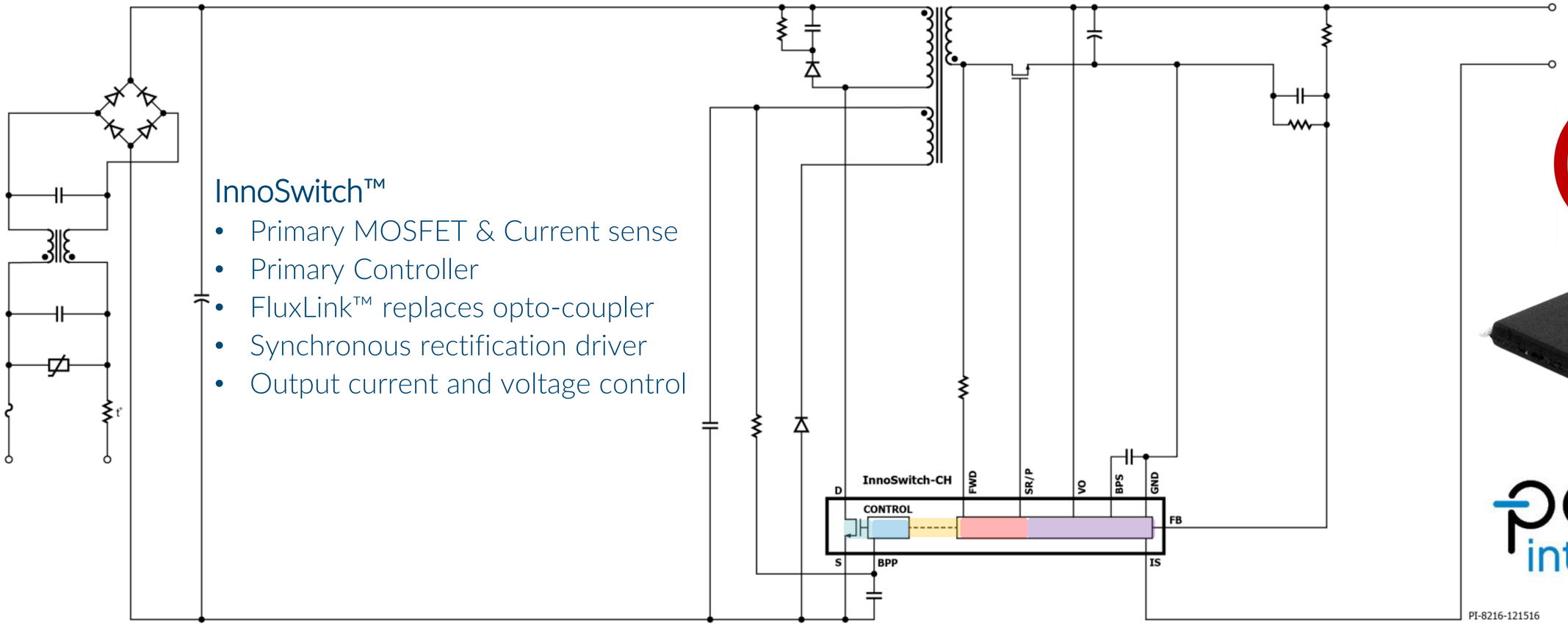
Isolation transformer

Synchronous rectification



Conventional PSU - Typically **around 60 + Components**

6 – ADVANTAGES OF POWER INTEGRATIONS

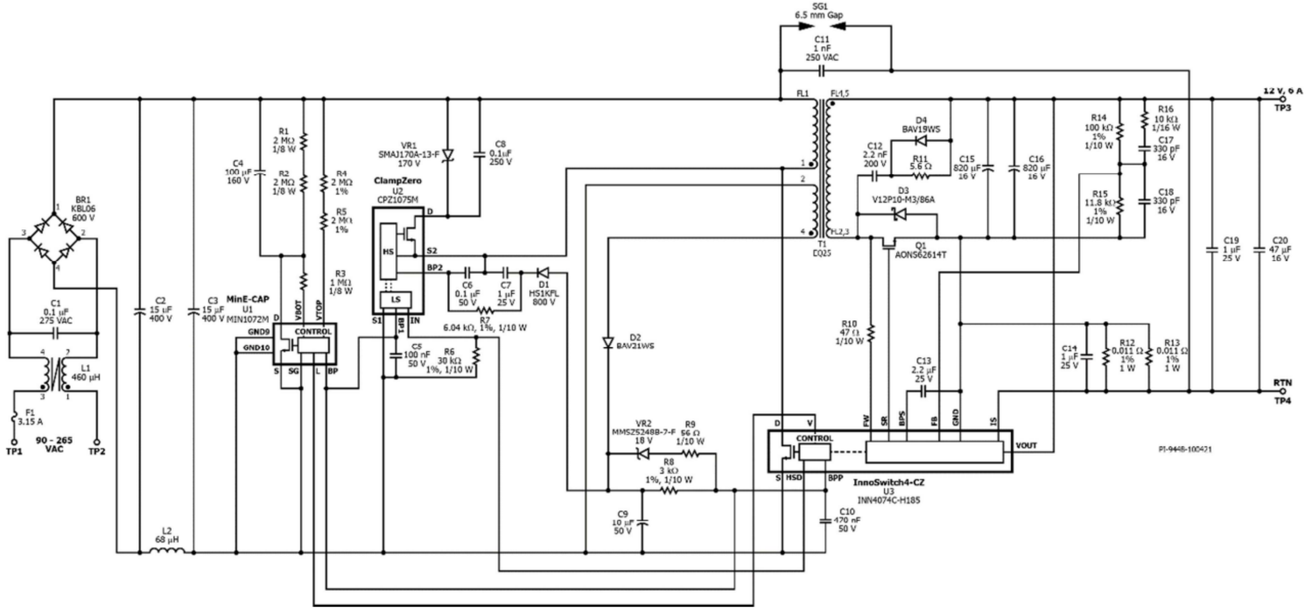


InnoSwitch™
- Primary MOSFET & Current sense
- Primary Controller
- FluxLink™ replaces opto-coupler
- Synchronous rectification driver
- Output current and voltage control

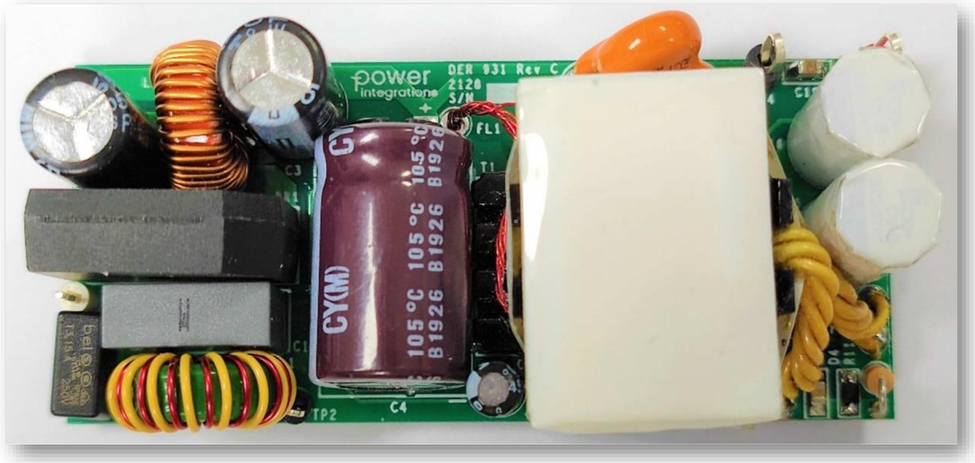
power integrations™

PSU using InnoSwitch - Typically <30 Components

DER-931: 72W SUPER COMPACT INDUSTRIAL POWER SUPPLY



- MinE-CAP enables 130uF input capacitance
- >100W peak power capability from 90-265Vac



DER-931 board size compared to a credit card

https://www.power.com/design-support/ac-dc-conversion/design-kits

REFERENCE DESIGN KITS (RDK)

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Select	Image	Part #	Mfr.	Description	Datasheet	Availability	Pricing (USD) Price by Qty.		
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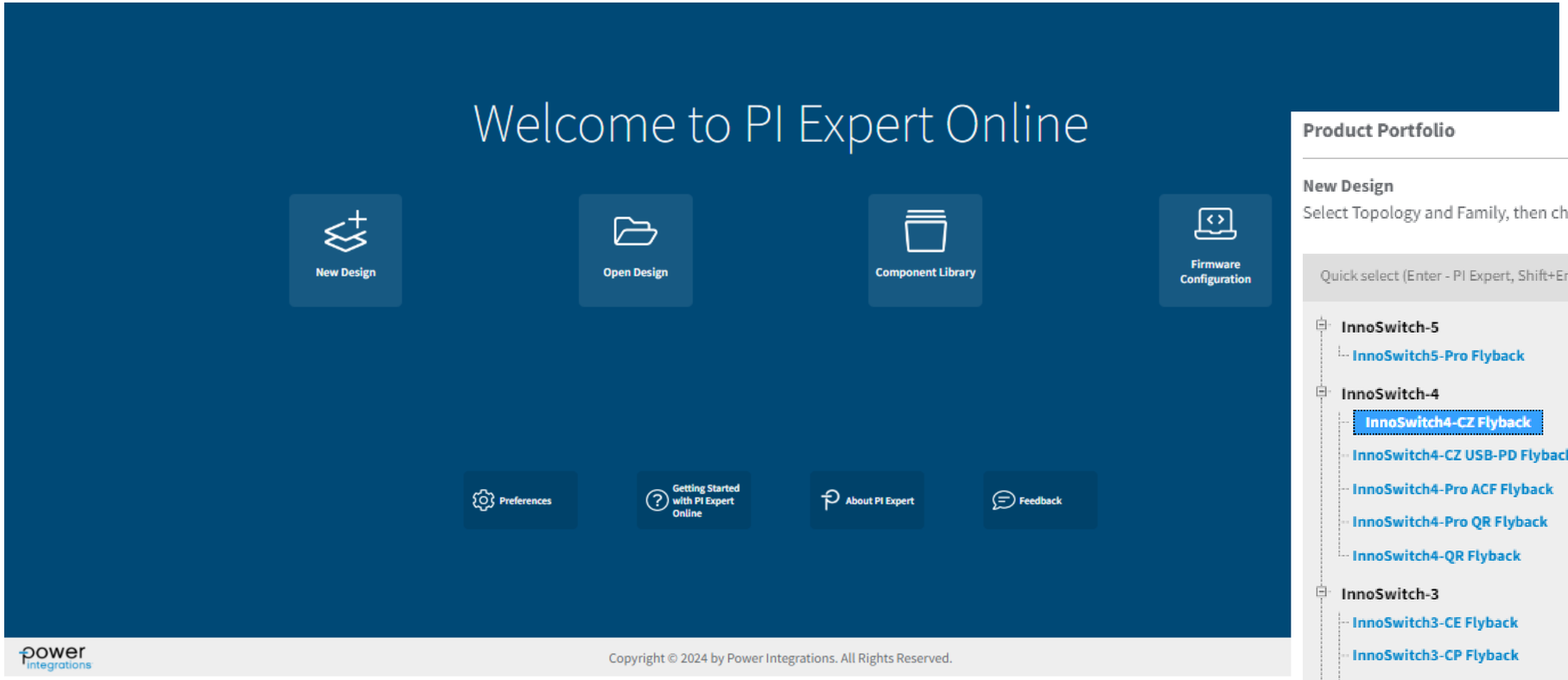
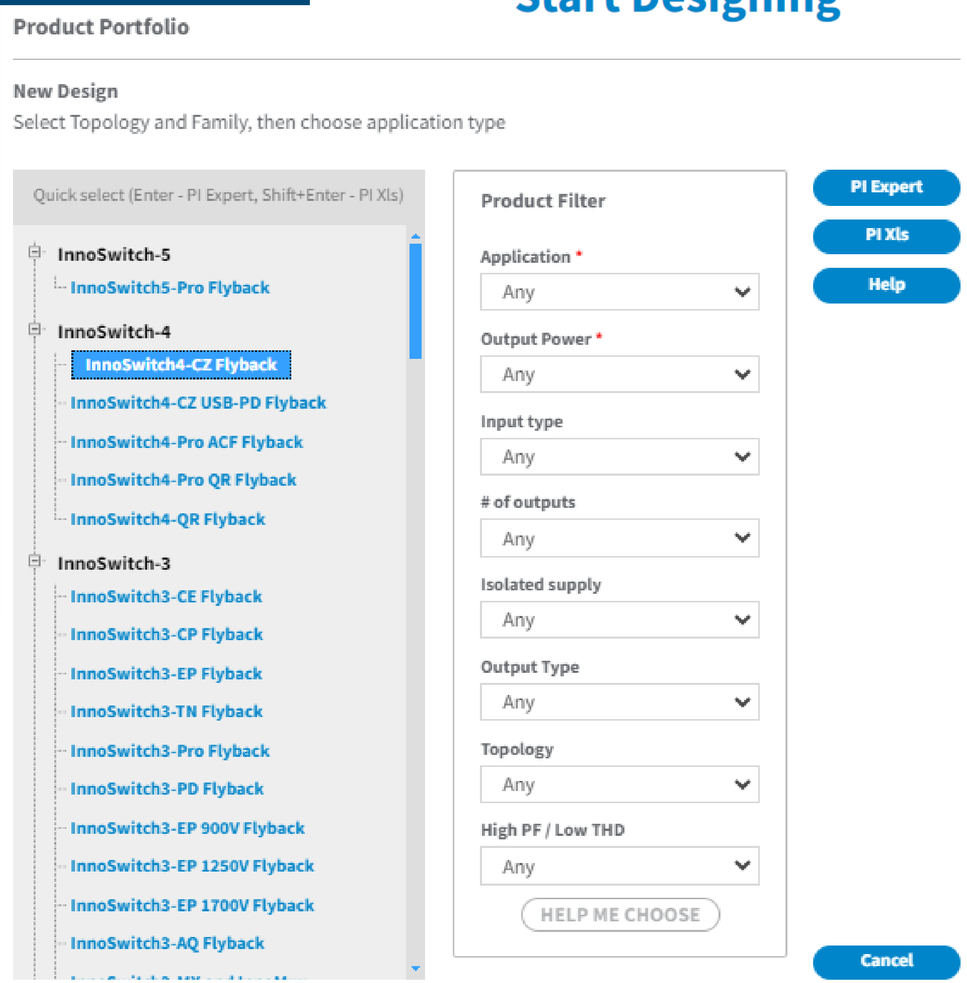


Expert

Start Designing



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NEED HELP FOR A PSU DESIGN?

Please contact guarizo@bpmrep.com.br for support.

Project Request Table	To be completed
Company Name	
Design Engineer (contact information)	
Project Name	
Project Stage (R&D / Concept / Design / Prototype)	
Current solution (Do you use STM, On-semi, NXP, etc)	
Application (Appliances, Lighting controls…)	
Estimated Annual Usage (Kpcs./year)	
Schedule Production Release	
Build Location & Contract Manufacturer's Name	
Preferred Authorized Distributor:	
PI Solution - Part Number (PI will recommend)	
Input Voltage Range	**VAC**
Output power level range	**W**
Output Voltage Required	**V**
Output Current Required	**Amps**
Constant Voltage or Constant Current performance required (CV or CC)	
Output tolerance (%)	**%**
Isolated (Yes or No) (What topology? Flyback, Buck, buck-boost…)	
Target Efficiency (%)	**%**
Ambient Temperature (°C)	**°C**

THANK YOU

Any
Questions ?

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