

POE供电解决方案

王鑫诚/Seazen Wang

2020/09/10

□ Part 1. POE Overview

- I. Application
- II. POE Connection
- III. POE Protocol

□ Part 2. DCDC Converter

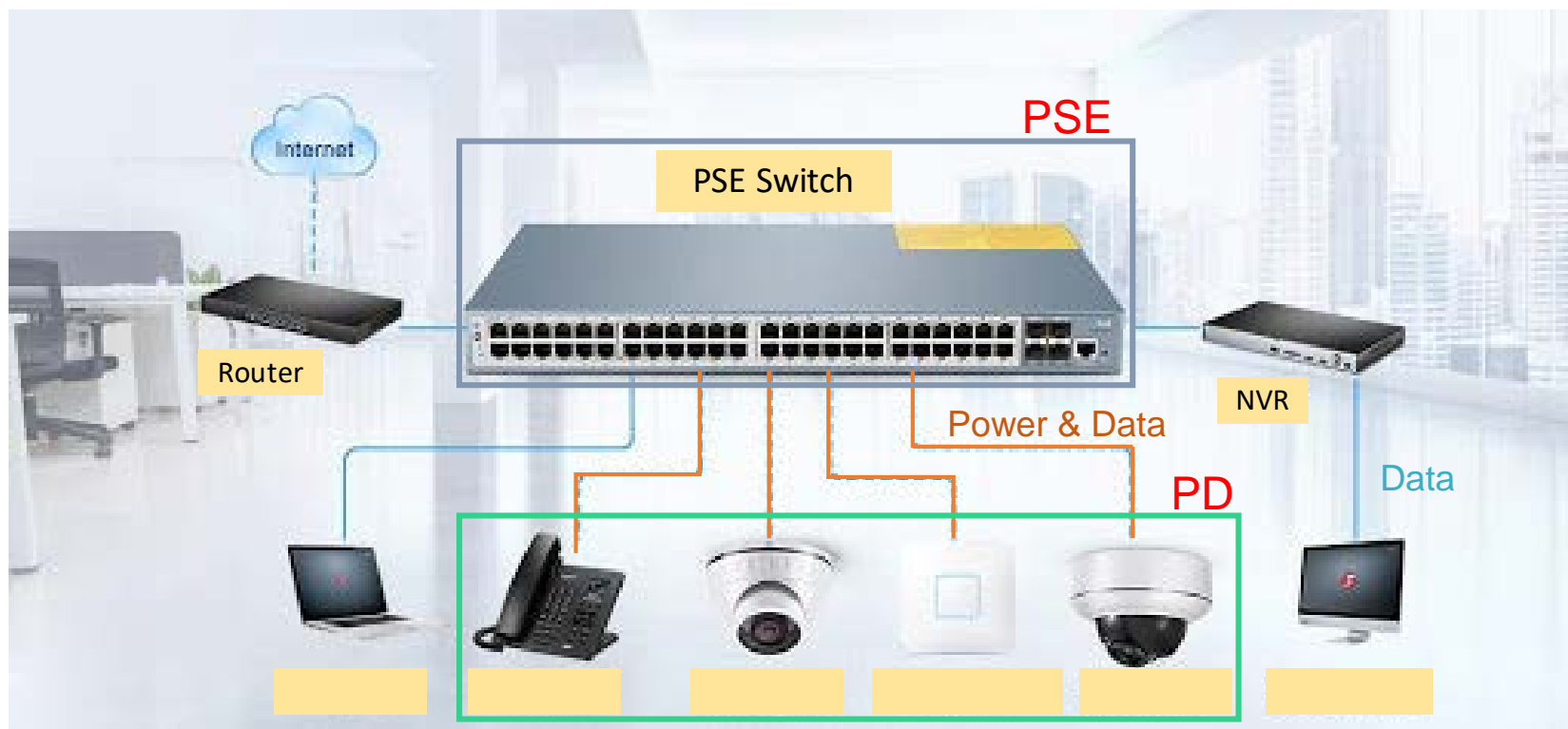
- I. Topology Selection
- II. Pain points of design
- III. Adaptor O-Ring

□ Part 3. MPS POE Solutions

- I. MPS PD af Solutions
- II. MPS PD at Solutions
- III. MPS PD bt Solutions

POE Application

Power Over Ethernet : PSE (Power Sourcing Equipment) provide power to PD (Power Device) over LAN cabling



✓ Low cost

✓ Easy to install and expand

✓ Remote management

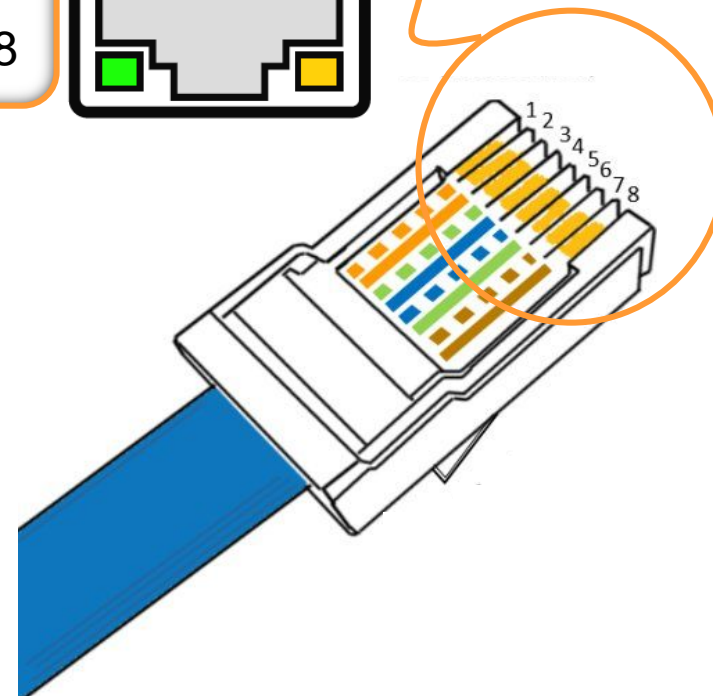
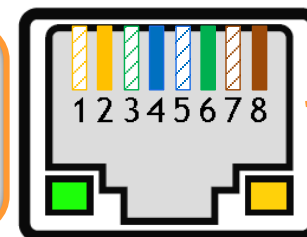
✓ Good compatibility

POE Connection



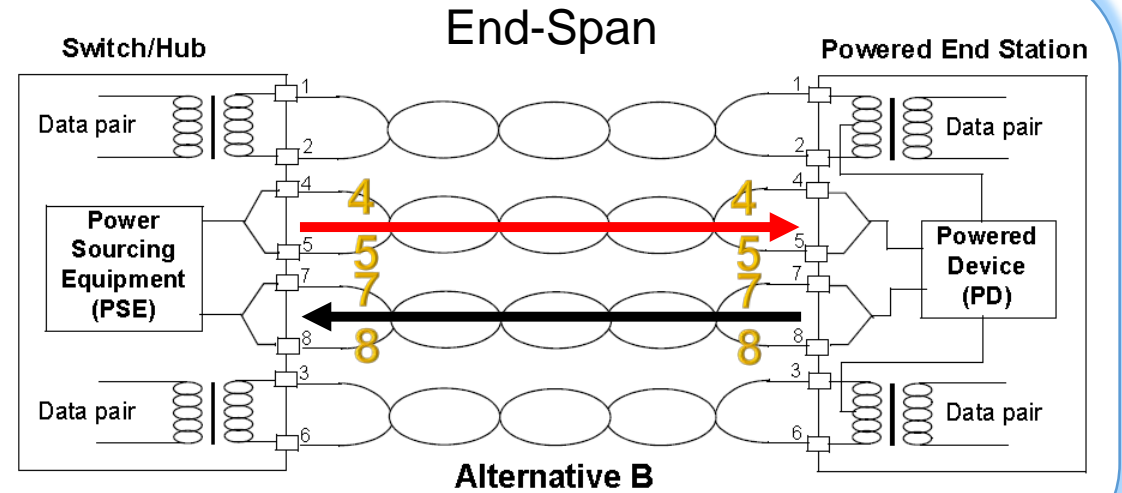
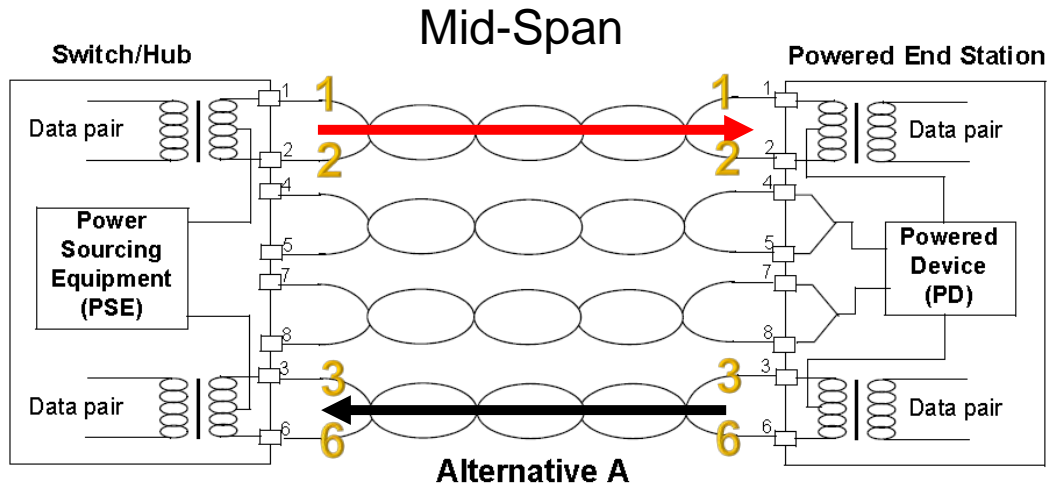
信号对: 橘 & 绿 -> 1,2 & 3,6
备用对: 蓝 & 棕 -> 4,5 & 7,8

PSE / PD port

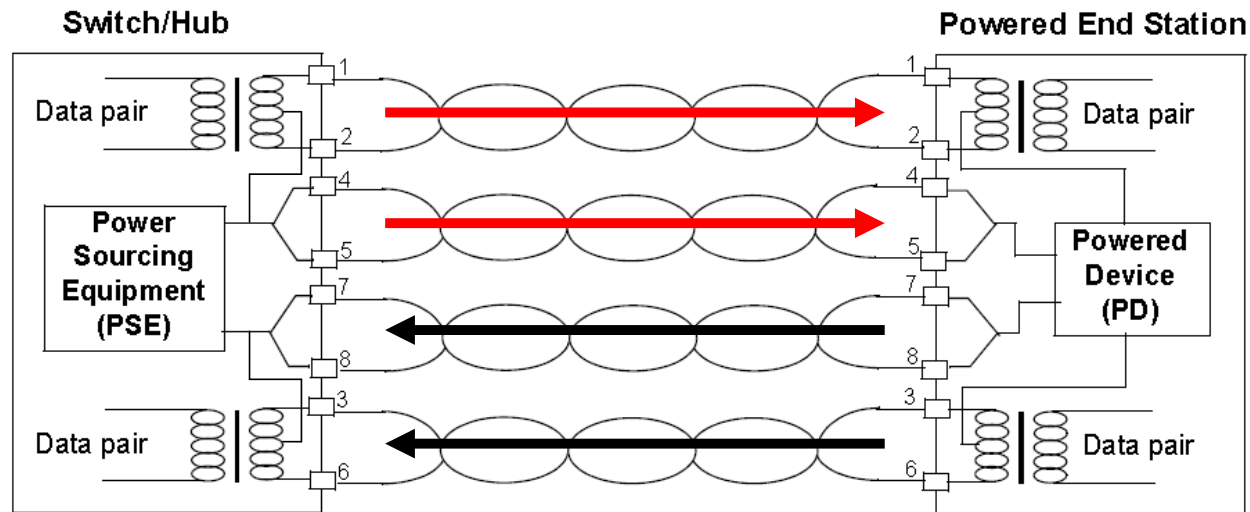


POE Connection

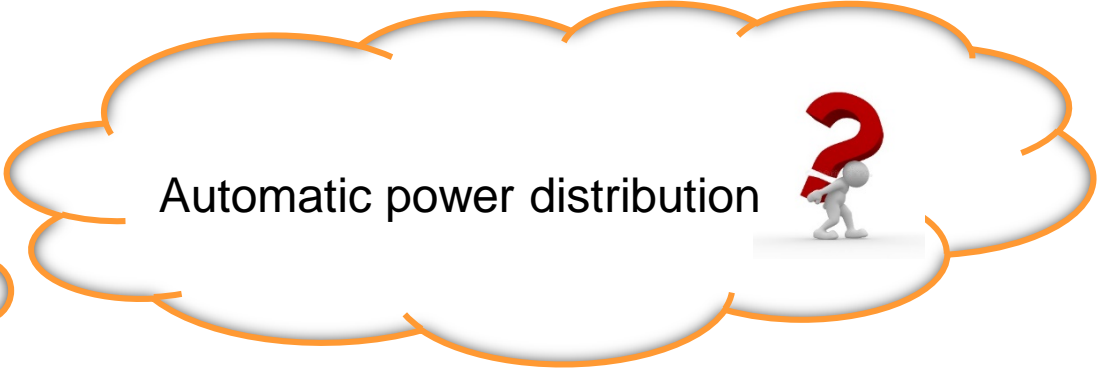
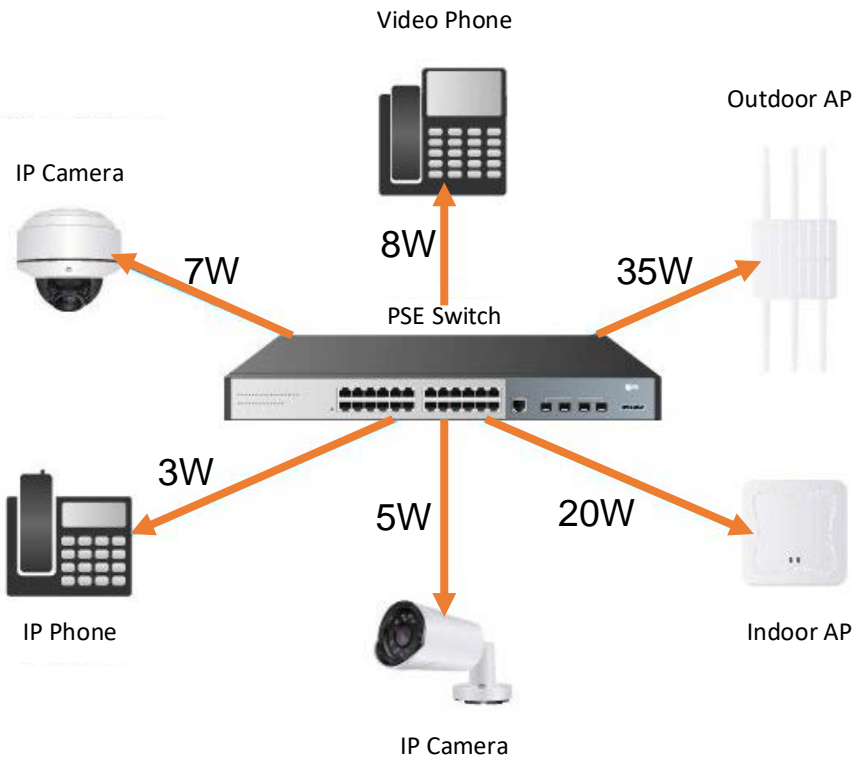
<30W



>30W



POE Power Classification

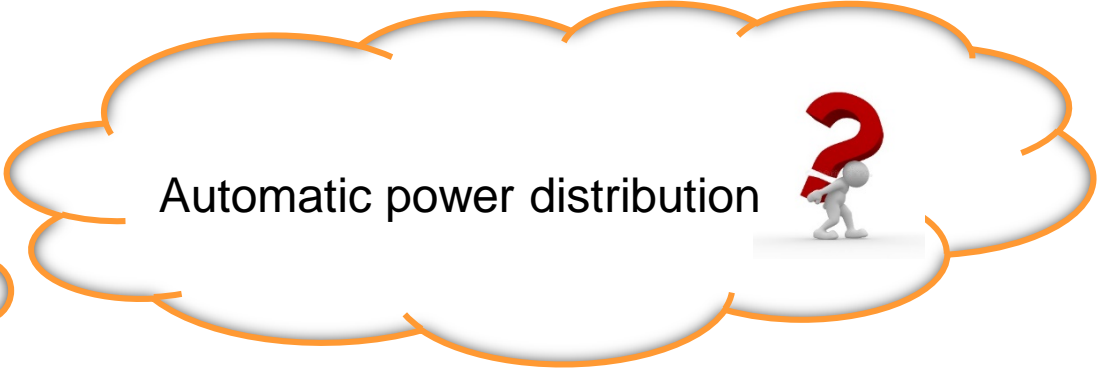
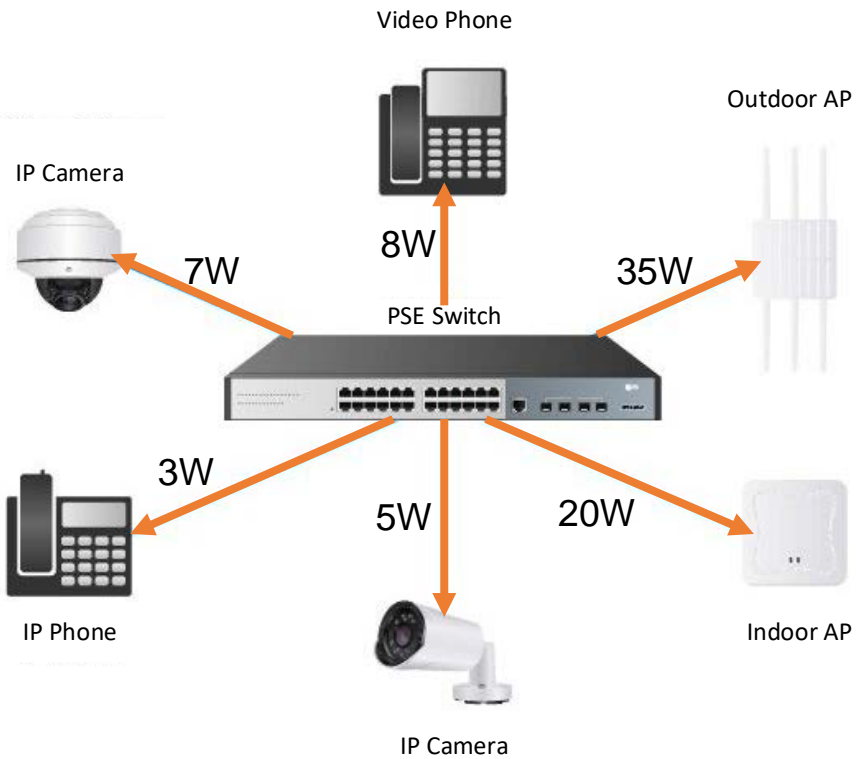


Type 3 (802.3bt)				Type 4 (802.3bt)			
Type 1 (802.3af)		Type 2 (802.3at)					
Class 1 4 W	Class 2 7 W	Class 3 15.4 W	Class 4 30 W	Class 5 45 W	Class 6 60 W	Class 7 75 W	Class 8 90 W
2-pair only (Type 1 & 2) 2-pair or 4-pair power (Type 3 & 4)				always 4-pair power			
Class 1 3.84 W	Class 2 6.49 W	Class 3 13 W	Class 4 25.5 W	Class 5 40 W	Class 6 51 W	Class 7 62 W	Class 8 71.3 W

Four Type

Eight Class

POE Power Classification

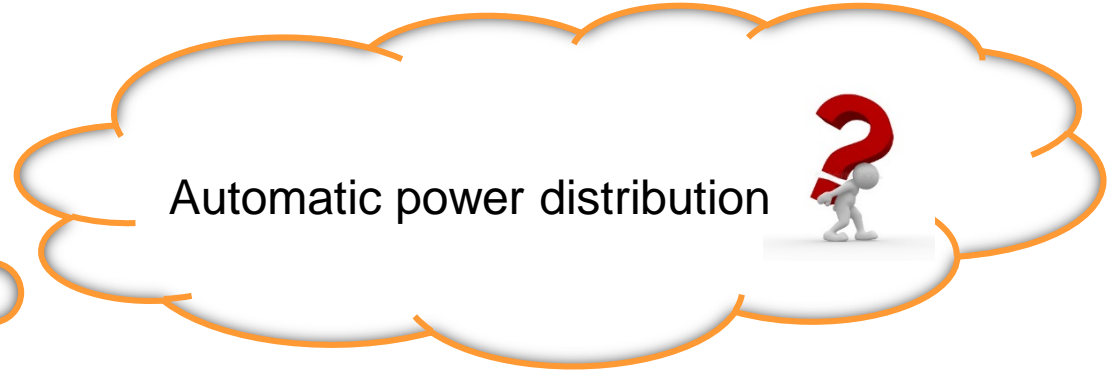
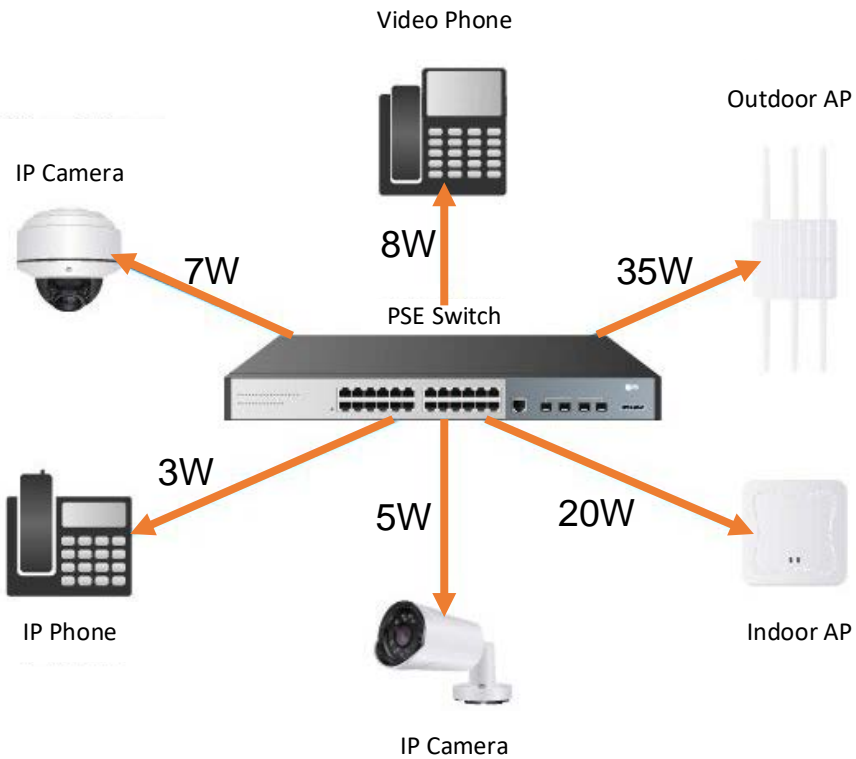


PSE	Type 3 (802.3bt)				Type 4 (802.3bt)			
	Type 1 (802.3af)	Type 2 (802.3at)						
Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8	
4 W	7 W	15.4 W	30 W	45 W	60 W	75 W	90 W	
2-pair only (Type 1 & 2) 2-pair or 4-pair power (Type 3 & 4)				always 4-pair power				
Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8	
3.84 W	6.49 W	13 W	25.5 W	40 W	51 W	62 W	71.3 W	
PD								

Four Type

Eight Class

POE Power Classification

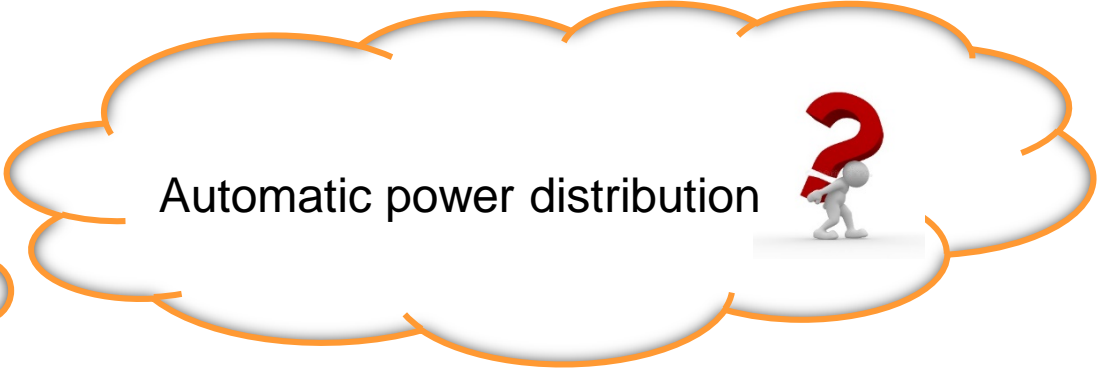
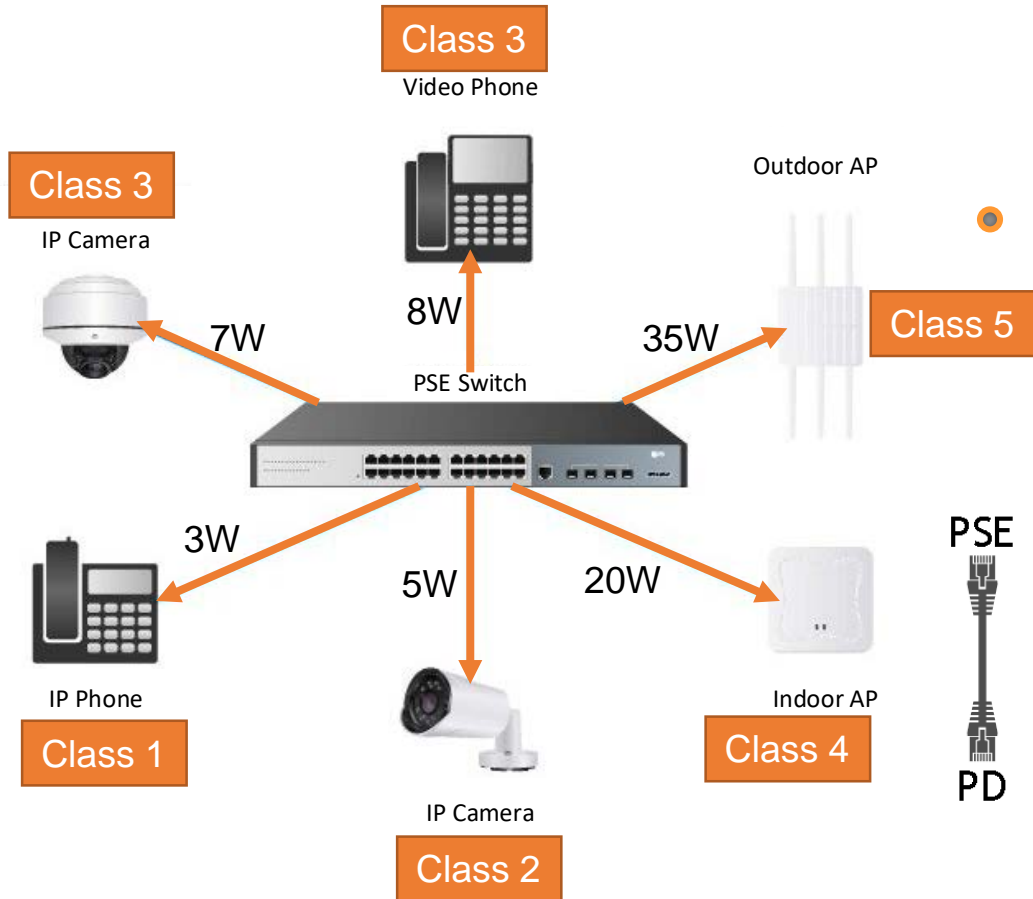


Type 3 (802.3bt)				Type 4 (802.3bt)			
Type 1 (802.3af)		Type 2 (802.3at)		Type 3 (802.3bt)		Type 4 (802.3bt)	
Class 1 4 W	Class 2 7 W	Class 3 15.4 W	Class 4 30 W	Class 5 45 W	Class 6 60 W	Class 7 75 W	Class 8 90 W
2-pair only (Type 1 & 2) 2-pair or 4-pair power (Type 3 & 4)				always 4-pair power			
Class 1 3.84 W	Class 2 6.49 W	Class 3 13 W	Class 4 25.5 W	Class 5 40 W	Class 6 51 W	Class 7 62 W	Class 8 71.3 W

Four Type

Eight Class

POE Power Classification

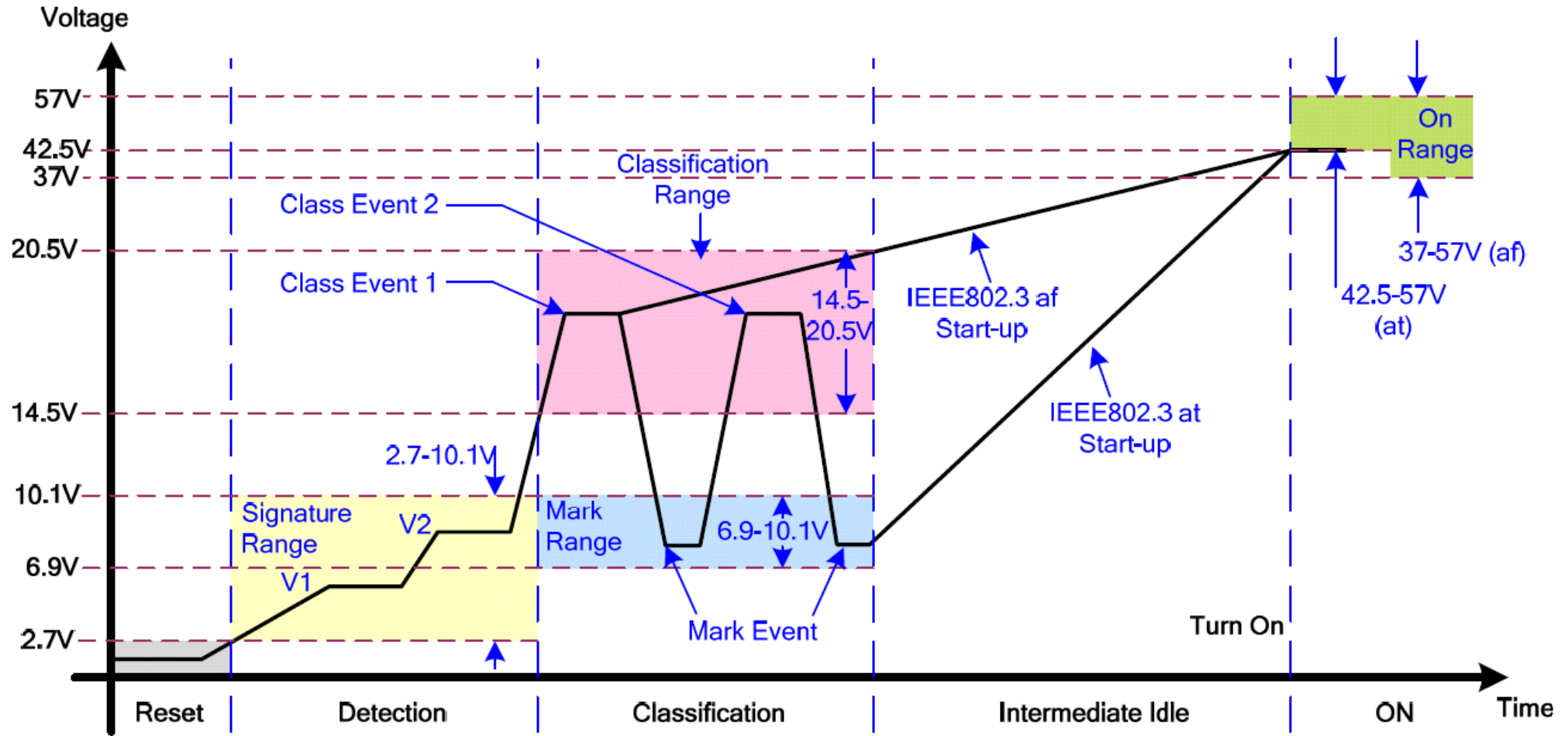


Type 3 (802.3bt)				Type 4 (802.3bt)			
Type 1 (802.3af)		Type 2 (802.3at)					
Class 1 4 W	Class 2 7 W	Class 3 15.4 W	Class 4 30 W	Class 5 45 W	Class 6 60 W	Class 7 75 W	Class 8 90 W
2-pair only (Type 1 & 2) 2-pair or 4-pair power (Type 3 & 4)				always 4-pair power			
Class 1 3.84 W	Class 2 6.49 W	Class 3 13 W	Class 4 25.5 W	Class 5 40 W	Class 6 51 W	Class 7 62 W	Class 8 71.3 W

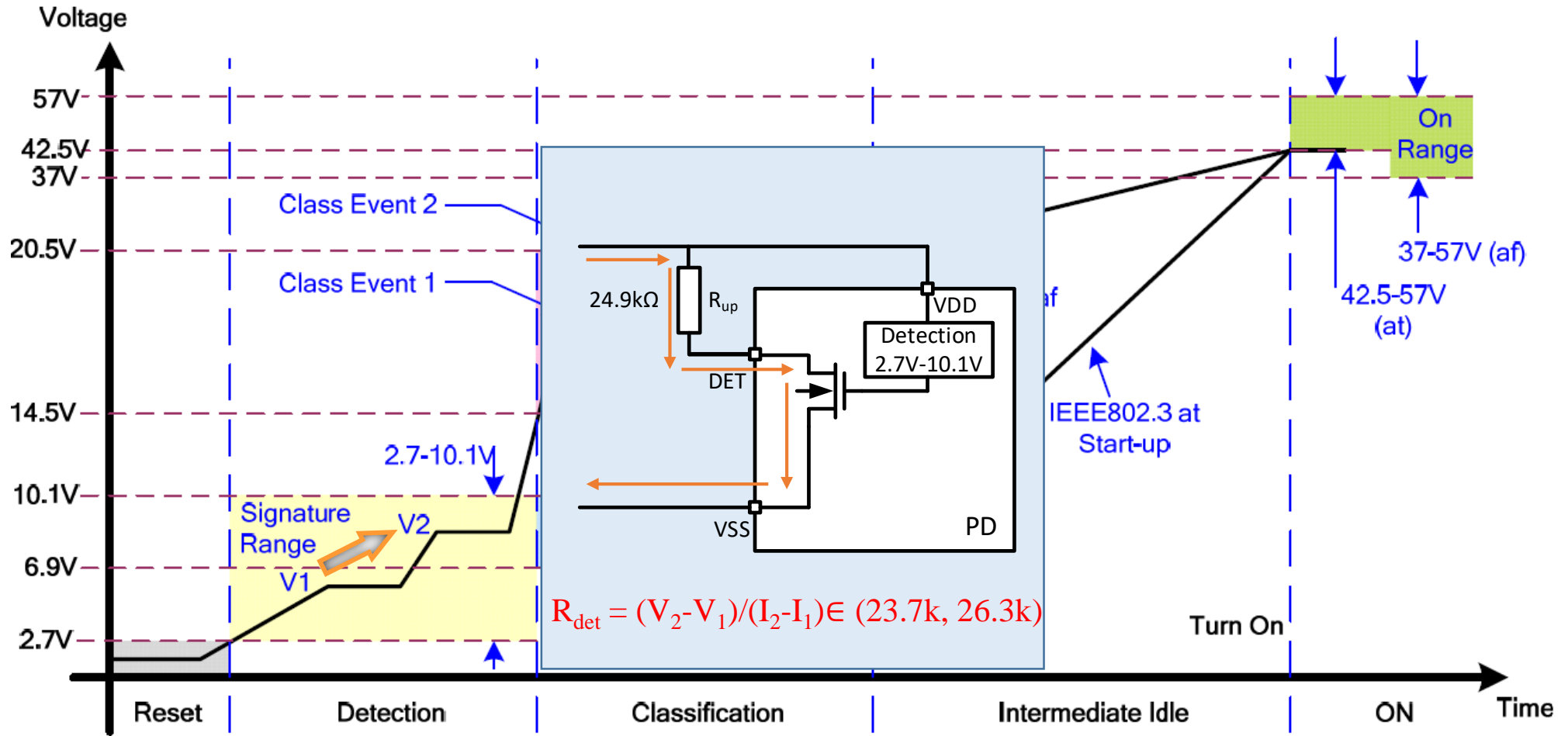
Four Type

Eight Class

POE Protocol – IEEE 802.3af/at



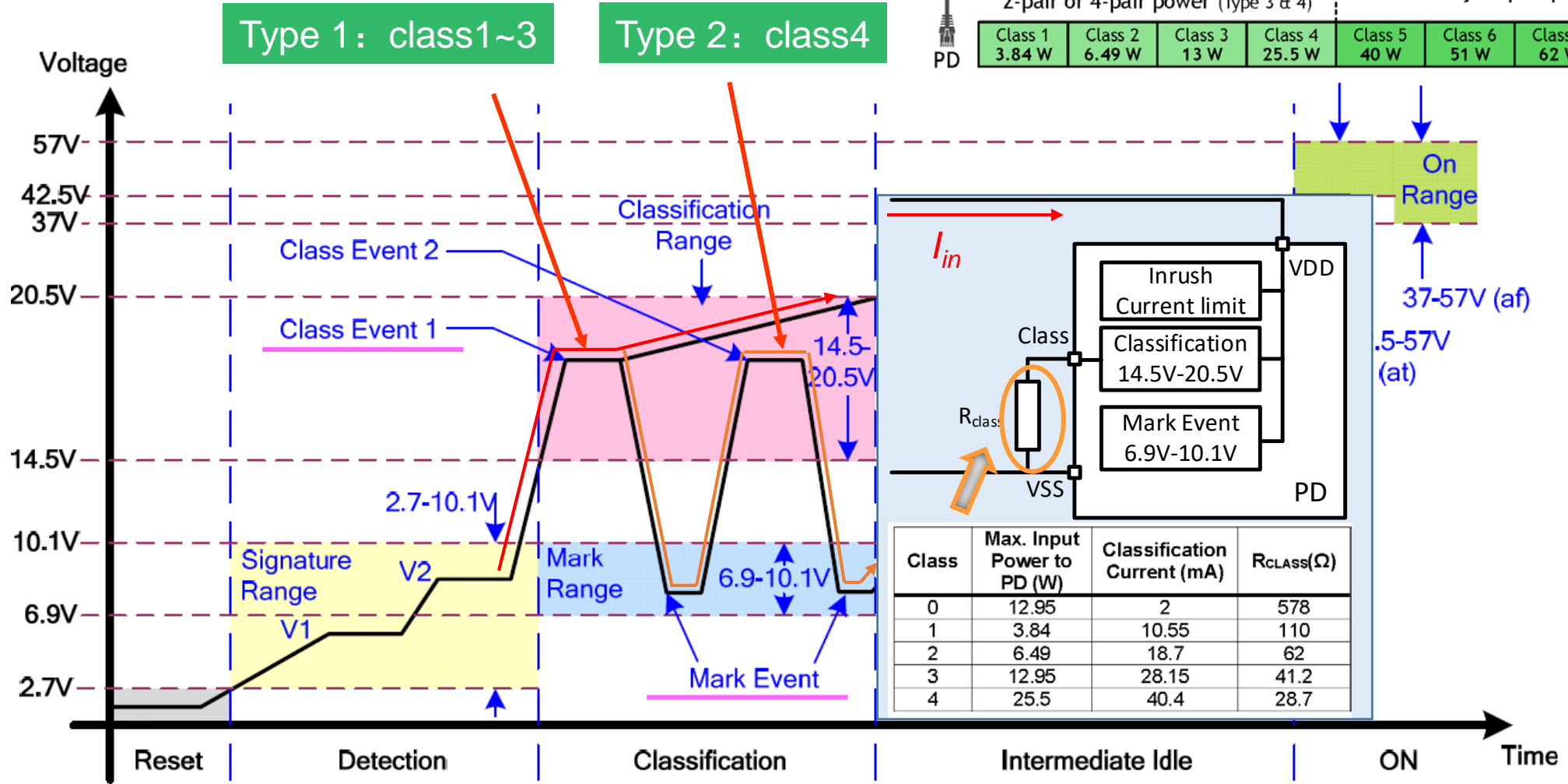
POE Protocol – IEEE 802.3af/at



Judge PD by R_{det} and Low detection voltage can protect the wrongly connected IP equipment

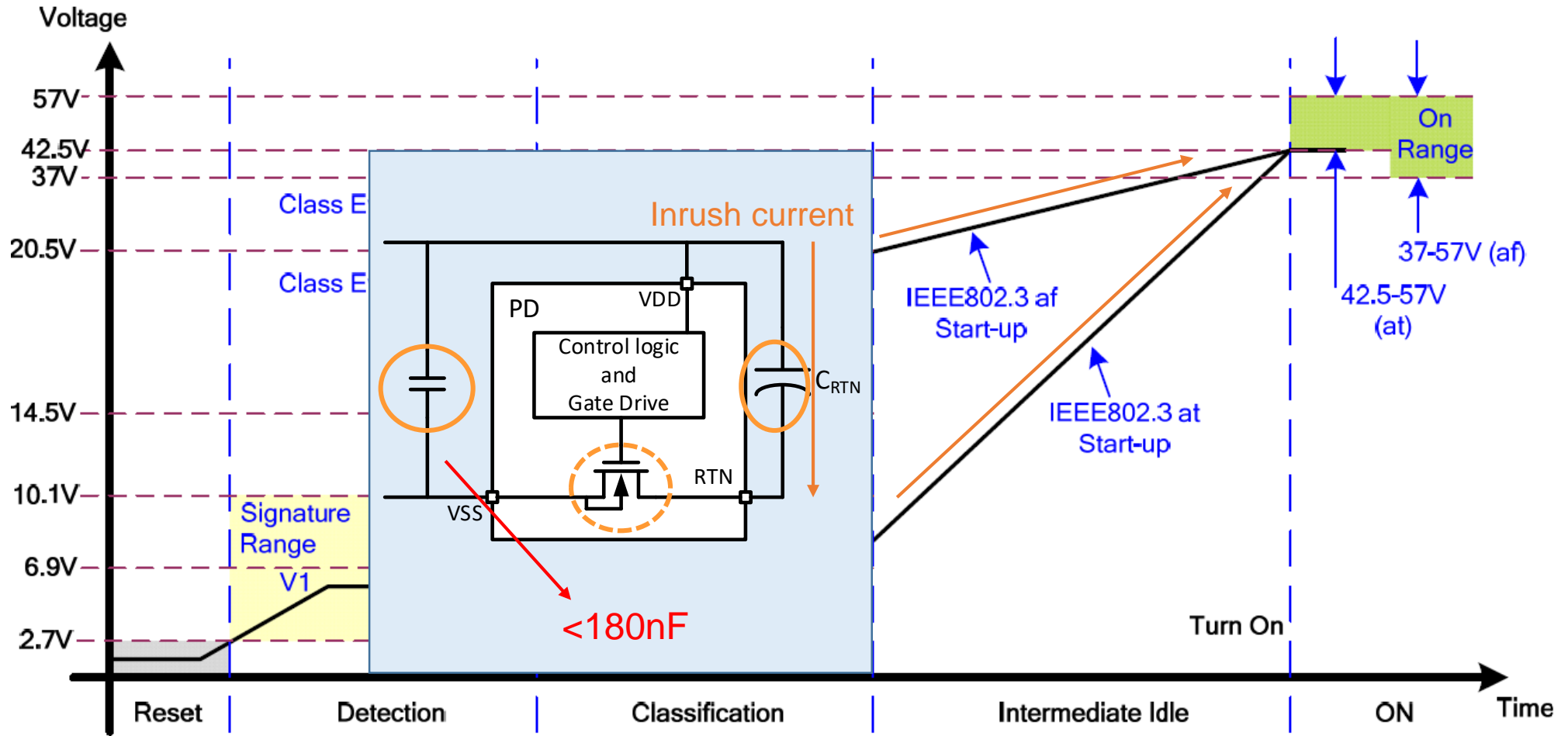
POE Protocol – IEEE 802.3af/at

PSE	Type 3 (802.3bt)				Type 4 (802.3bt)			
	Type 1 (802.3af)		Type 2 (802.3at)		Type 3 (802.3bt)		Type 4 (802.3bt)	
PD	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8
	4 W	7 W	15.4 W	30 W	45 W	60 W	75 W	90 W
	2-pair only (Type 1 & 2)				always 4-pair power			
	2-pair or 4-pair power (Type 3 & 4)							
	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8
	3.84 W	6.49 W	13 W	25.5 W	40 W	51 W	62 W	71.3 W



Class Type1->Type2->Type3->Type4 in turn by monitoring PD input

POE Protocol – IEEE 802.3af/at



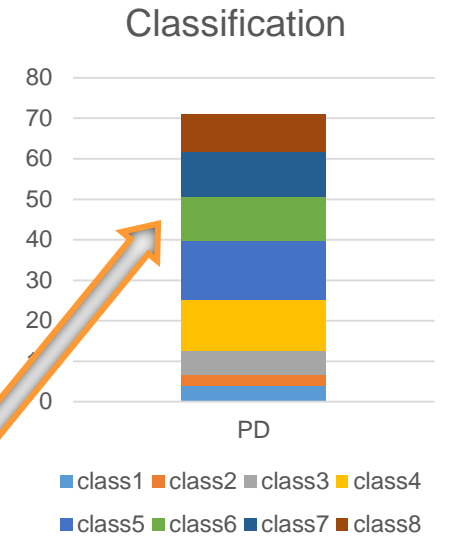
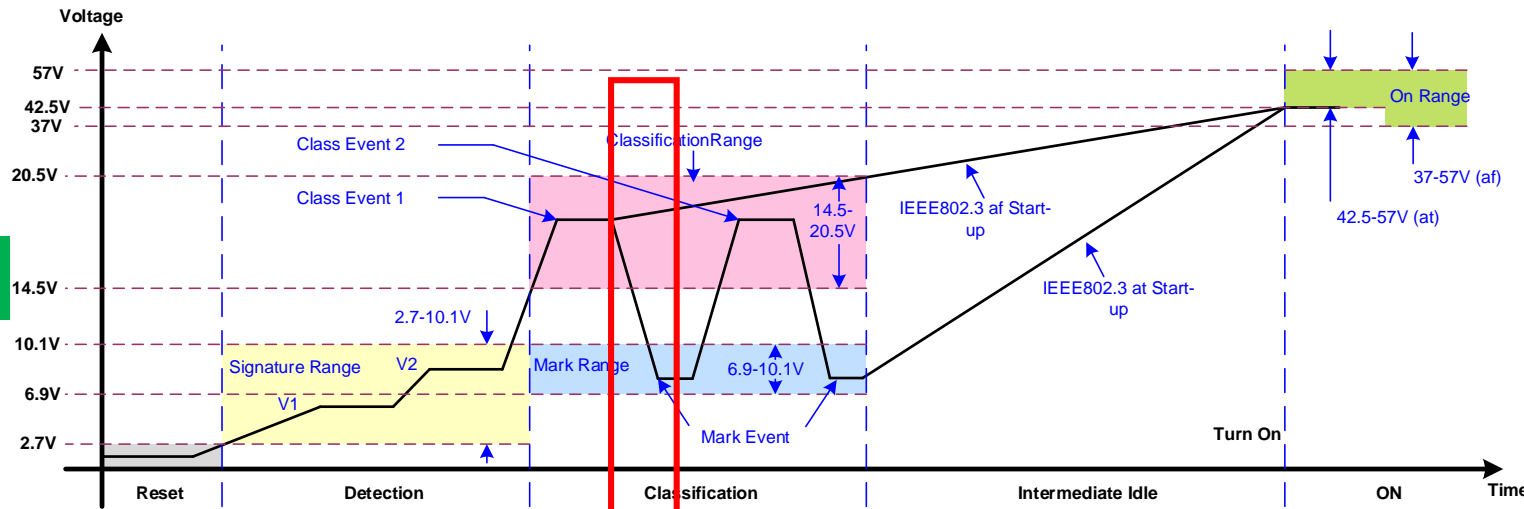
PD Bypass MOS limits the inrush current during power on

POE Protocol – IEEE 802.3 bt



POE Protocol – IEEE 802.3 bt

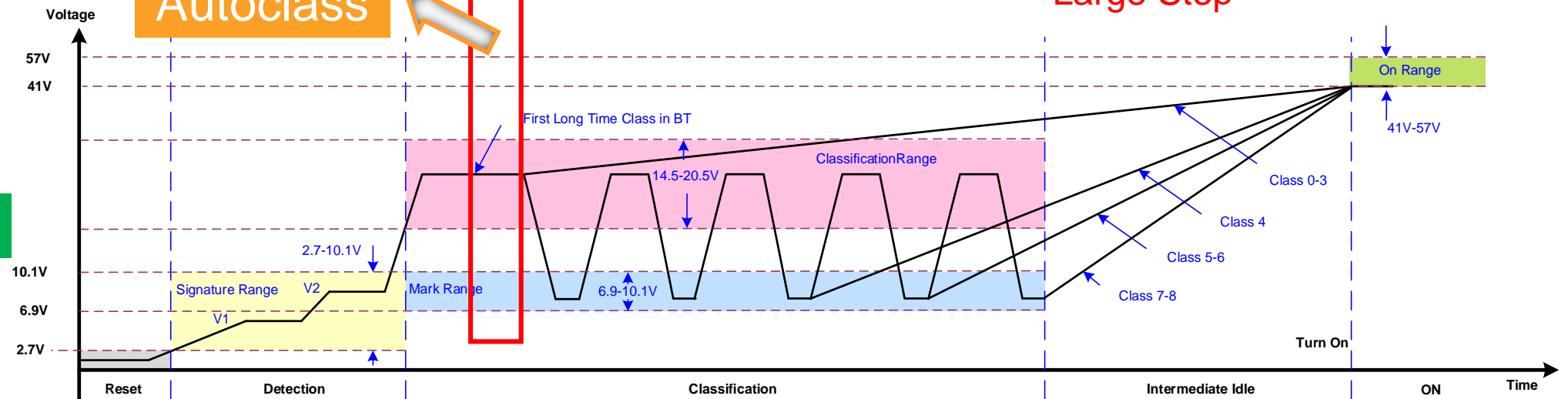
802.3af/at



Autoclass

Large Step

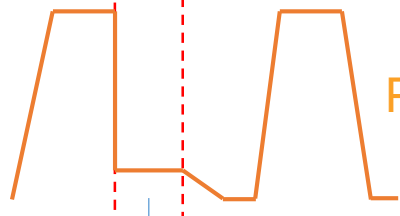
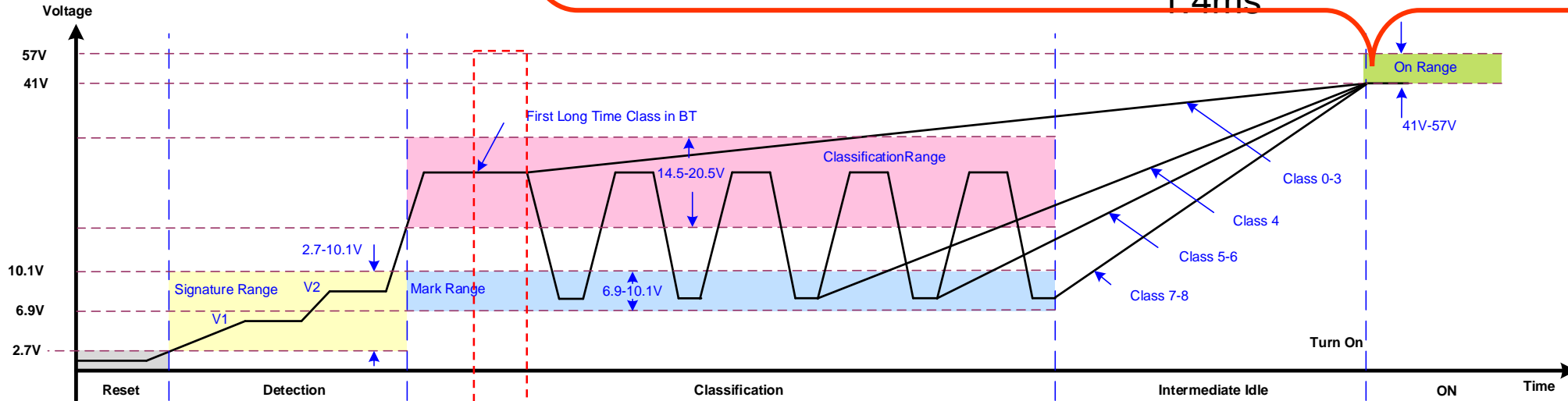
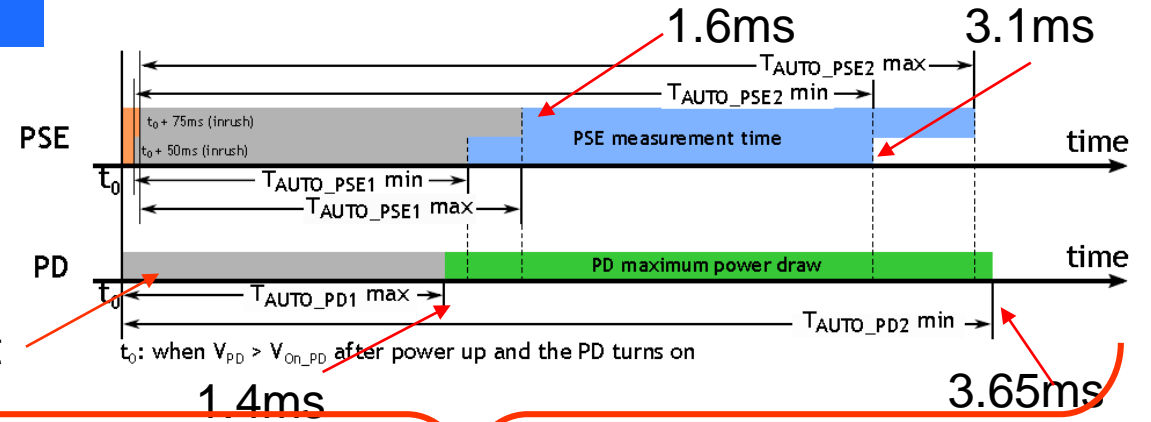
802.3bt



POE Protocol – Autoclass Function

Auto class requirements:

Inrush and soft start

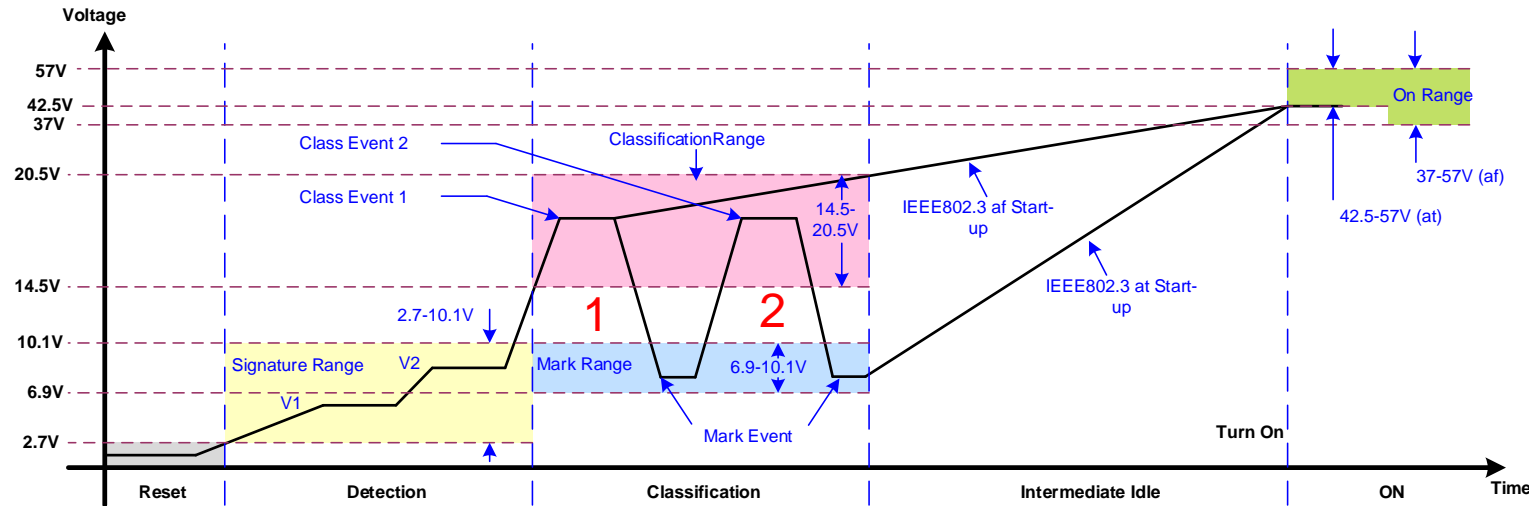


PSE monitor output current

PD change the class level to class 0

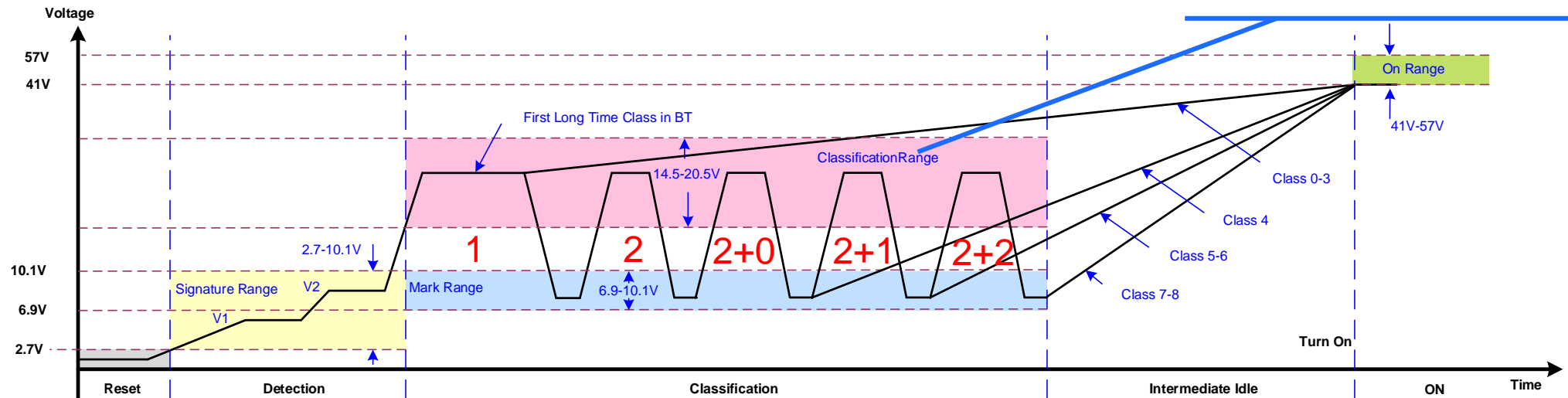
POE Protocol – IEEE 802.3 bt

802.3af/at



Requested Class	Number of class events				
	1	2	3	4	5
Class 1	Class 1	×	×	×	×
Class 2	Class 2	×	×	×	×
Class 3	Class 3	×	×	×	×
Class 4	Class 3	Class 4	Class 4	×	×
Class 5	Class 3	Class 4	Class 4	Class 5	×
Class 6	Class 3	Class 4	Class 4	Class 6	×
Class 7	Class 3	Class 4	Class 4	Class 6	Class 7
Class 8	Class 3	Class 4	Class 4	Class 6	Class 8

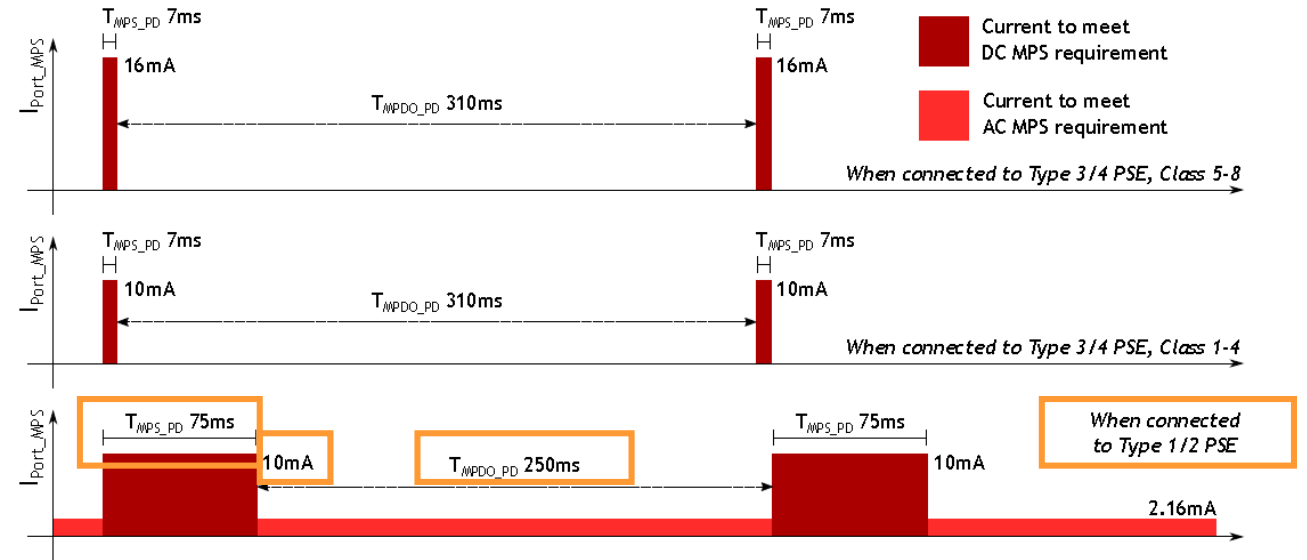
802.3bt



More classification times for Type2 POE in IEEE 802.3bt standard



POE Protocol-Maintain Power Signature



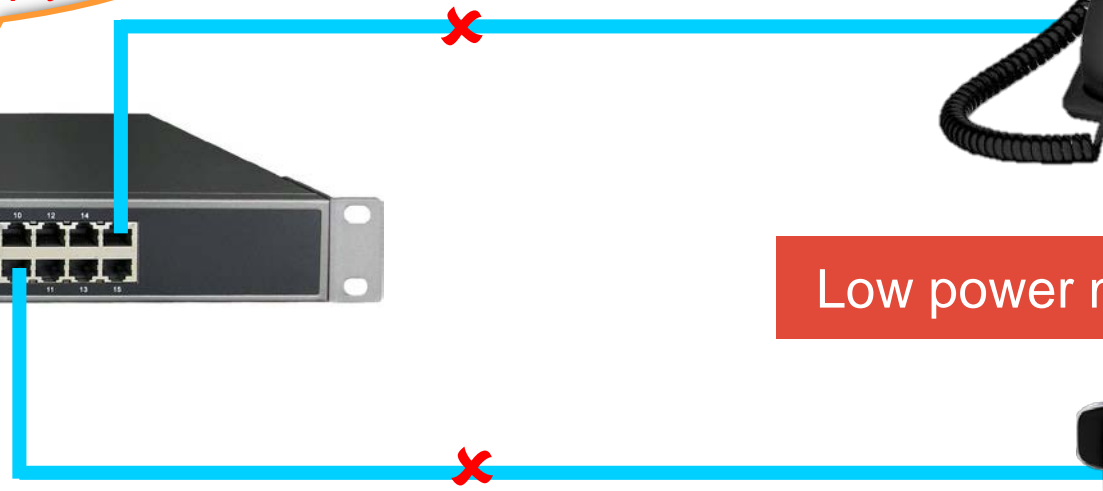
PD Type	Assigned Class	PSE Type	Minimum current I_{port_MPS}	Minimum on time T_{MPS_PD}	Maximum off time T_{MPDO_PD}
1,2	all	all	10mA	75ms	250ms
3,4	1 to 4	1,2	10mA	75ms	250ms
	1 to 4	3,4	10mA	7ms	310ms
	5 to 8	3,4	16mA	7ms	310ms

POE Protocol-Maintain Power Signature

Output current smaller than Maintain Power Signature.
Cut off power supply!



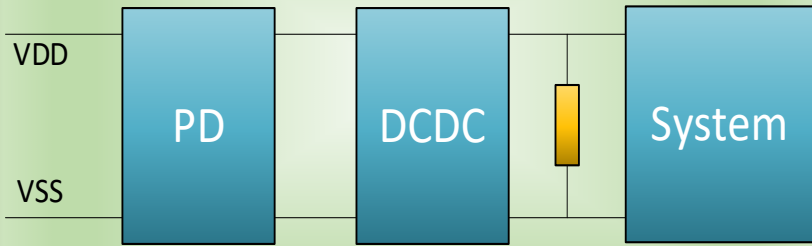
Low power mode in standby mode



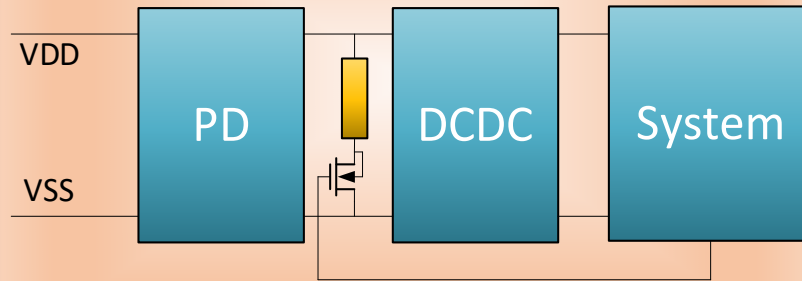
How to avoid this mistake?

POE Protocol-Maintain Power Signature

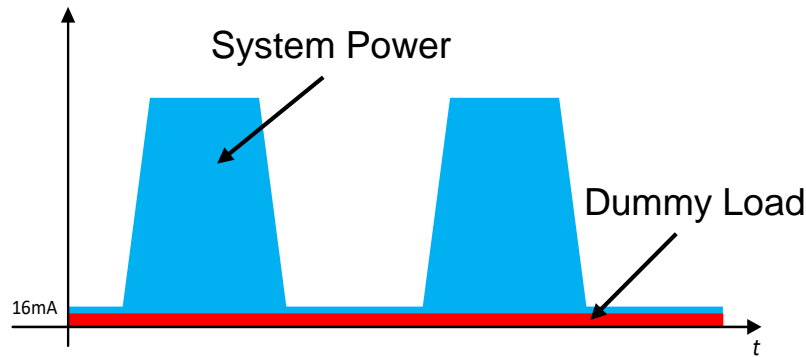
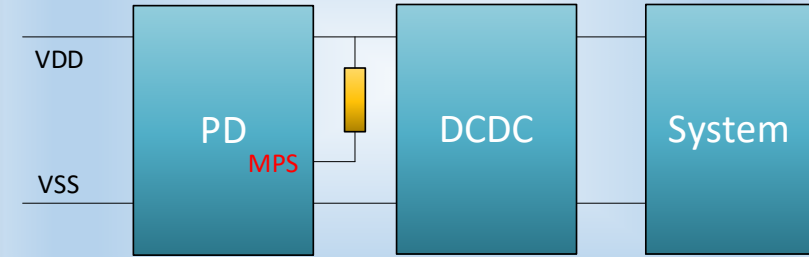
Dummy load



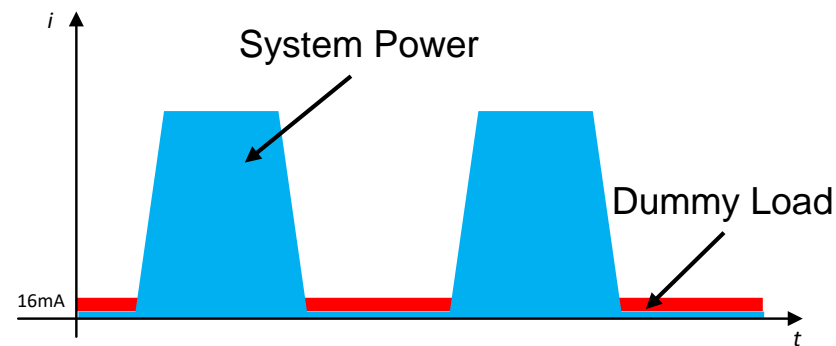
Dummy load + MOS



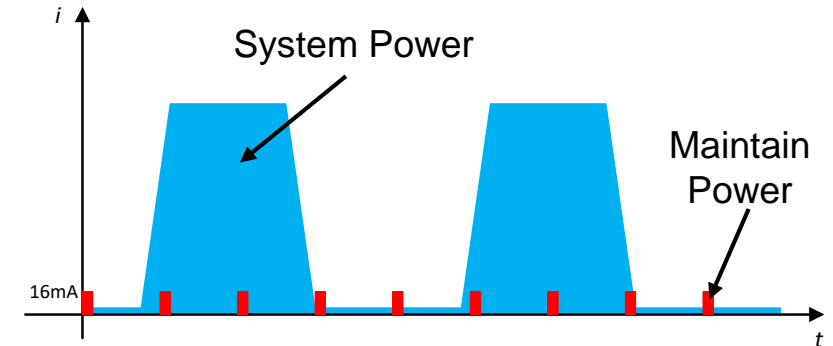
Maintain Power Signature



✓ Sample ✗ Low efficiency



✓ High efficiency ✗ Complicated



✓ Sample ✓ High efficiency



Outline

□ Part 1. POE Overview

- I. Application
- II. POE Connection
- III. POE Protocol

□ Part 2. PD DCDC Converter

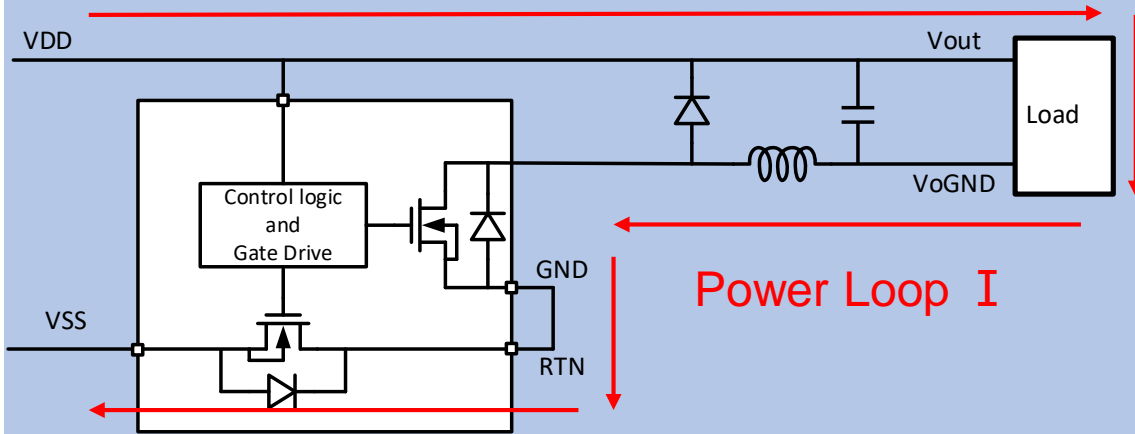
- I. Topology Selection
- II. Pain points of design
- III. Adaptor O-Ring

□ Part 3. MPS POE Solutions

- I. MPS PD af Solutions
- II. MPS PD at Solutions
- III. MPS PD bt Solutions

DCDC Topology Choose – Non-isolated

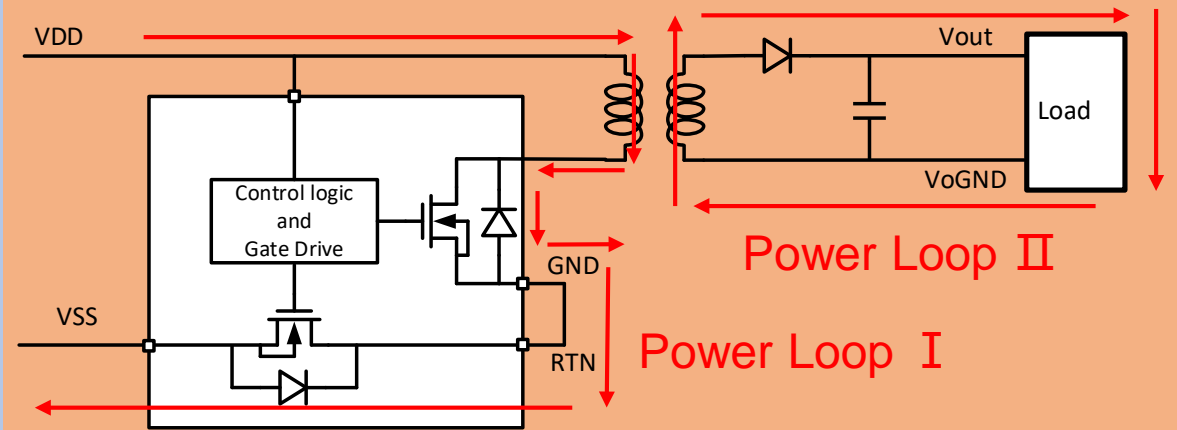
Non-isolated Converter



Power Loop I

- ✓ Easy design
- ✓ Sample BOM
- ✓ Low cost and small size

Isolated Converter

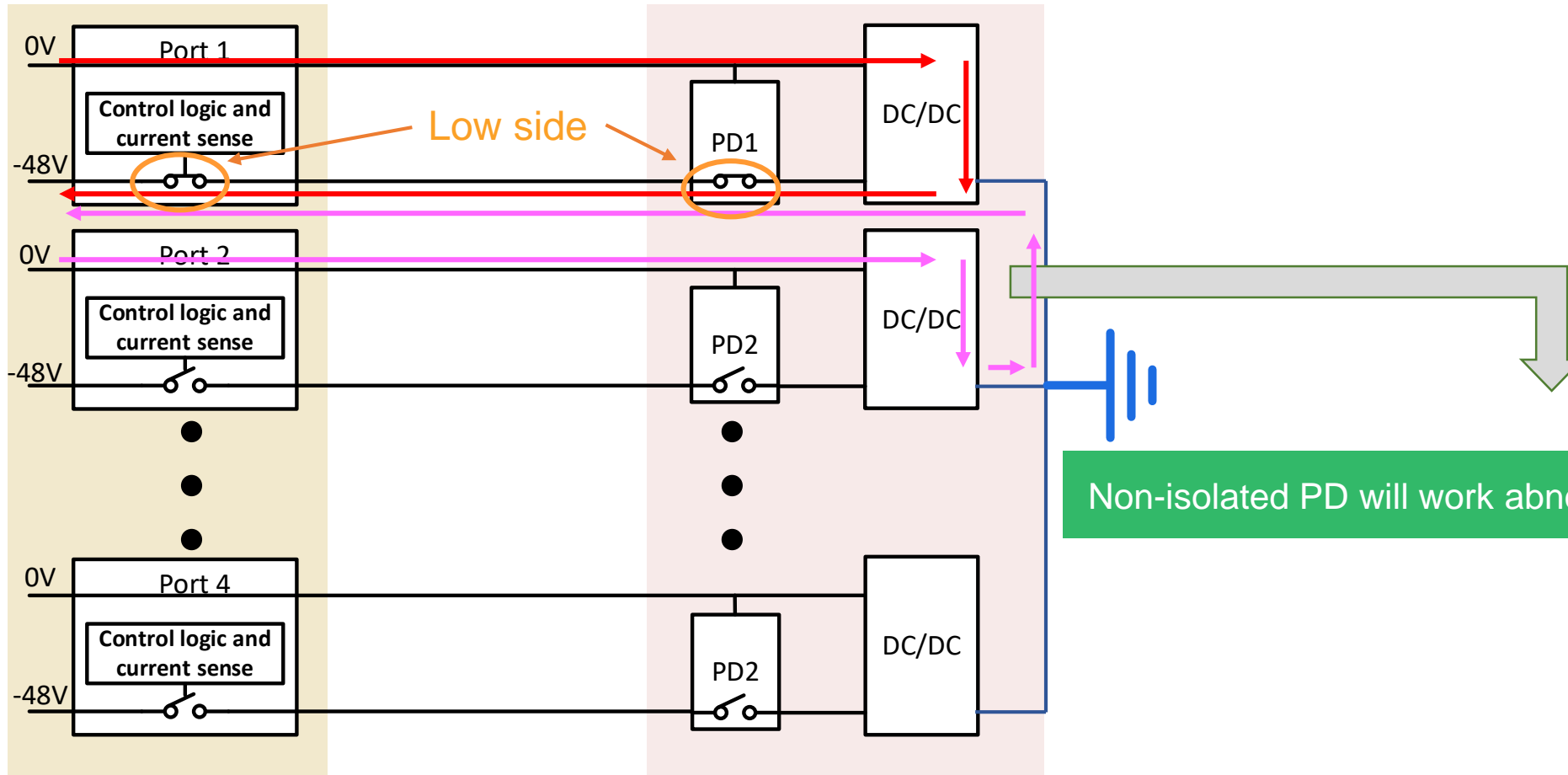


Power Loop II

Power Loop I

- ✓ High security
- ✓ Wide output range
- ✓ Support common GND

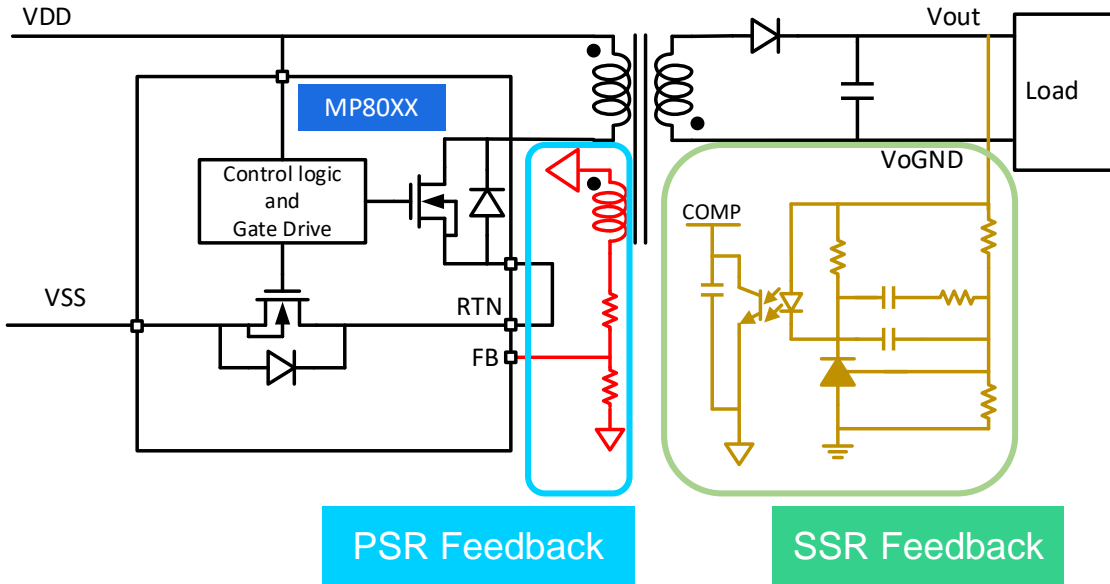
DCDC Topology Choose – Non-isolated



Non-isolated PD will work abnormally after connecting to PSE

DCDC Topology Choice - Isolated

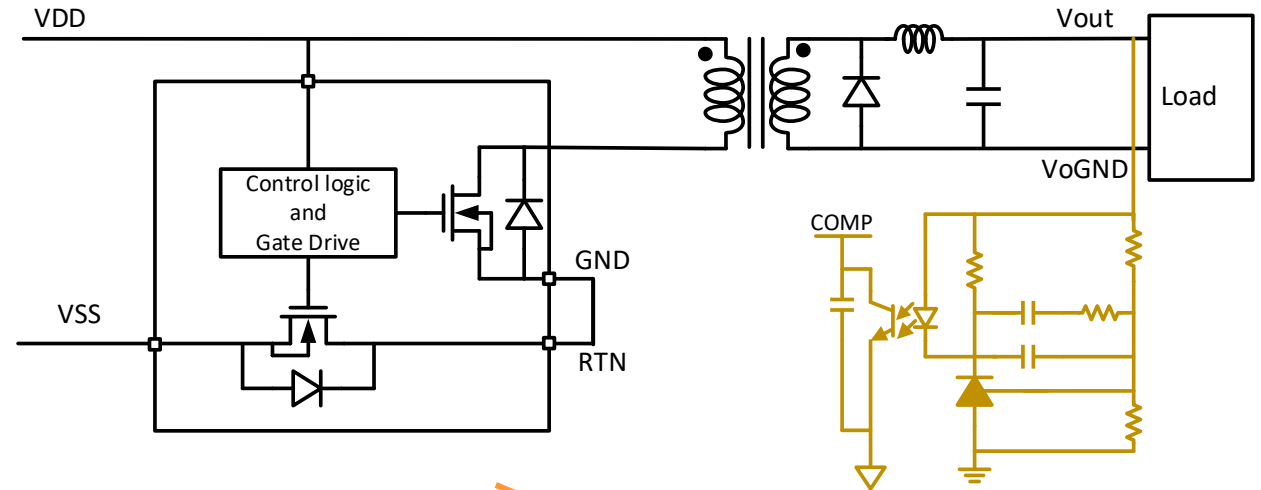
Flyback



- ✓ Sample BOM
- ✓ Low Cost
- ✓ Debug Easily

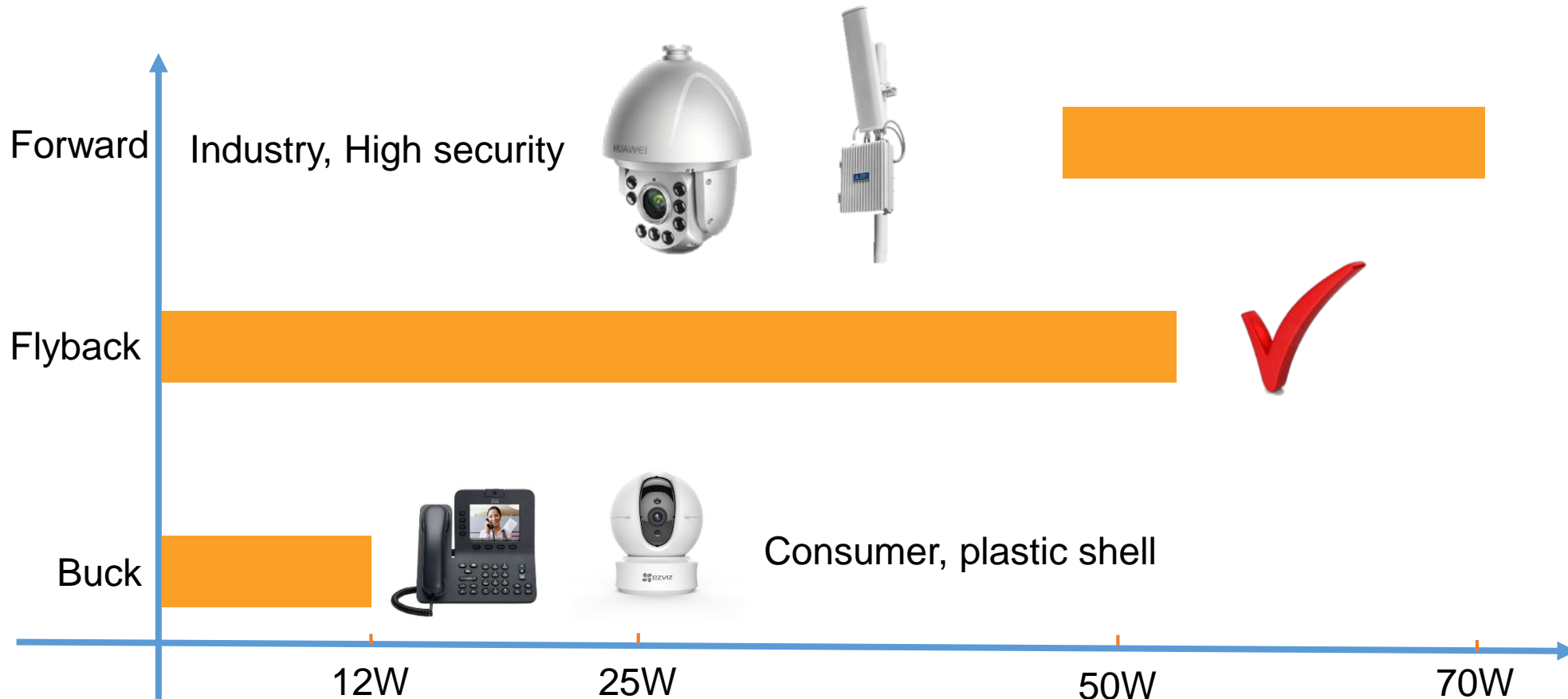
- ✓ Good Regulation
- ✓ Good Transient

Forward



- ✓ High Efficiency
- ✓ Smaller Vout Ripple
- ✗ High Voltage Stress
- ✗ High Cost

DCDC Topology Choice



Pain Points of design – PD Converter



mEVS84802

Key Points of design - Size

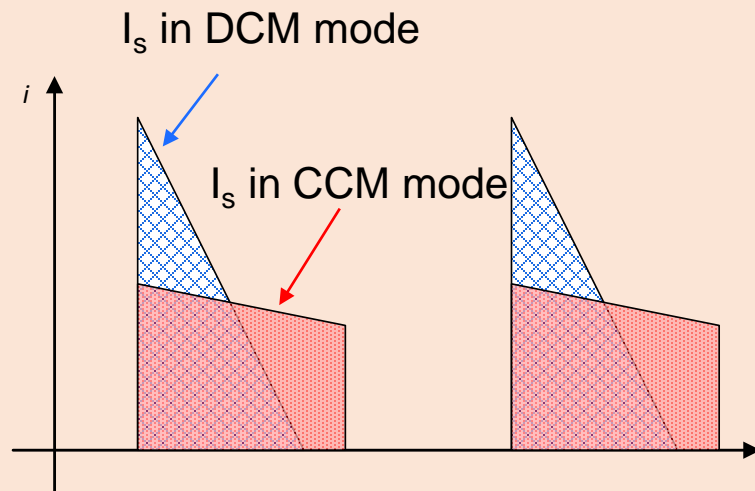
High Frequency

200kHz -> 300kHz -> 500kHz

$$AP = AwAc \frac{(1 + \eta)Po}{4\eta K_W k_f J B_{AC} f} \times 10^4 (cm^4)$$

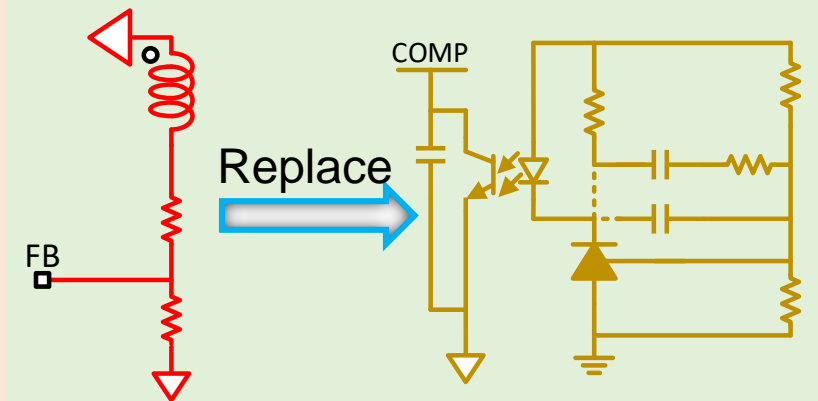
CCM

Peak current -> B_{AC}



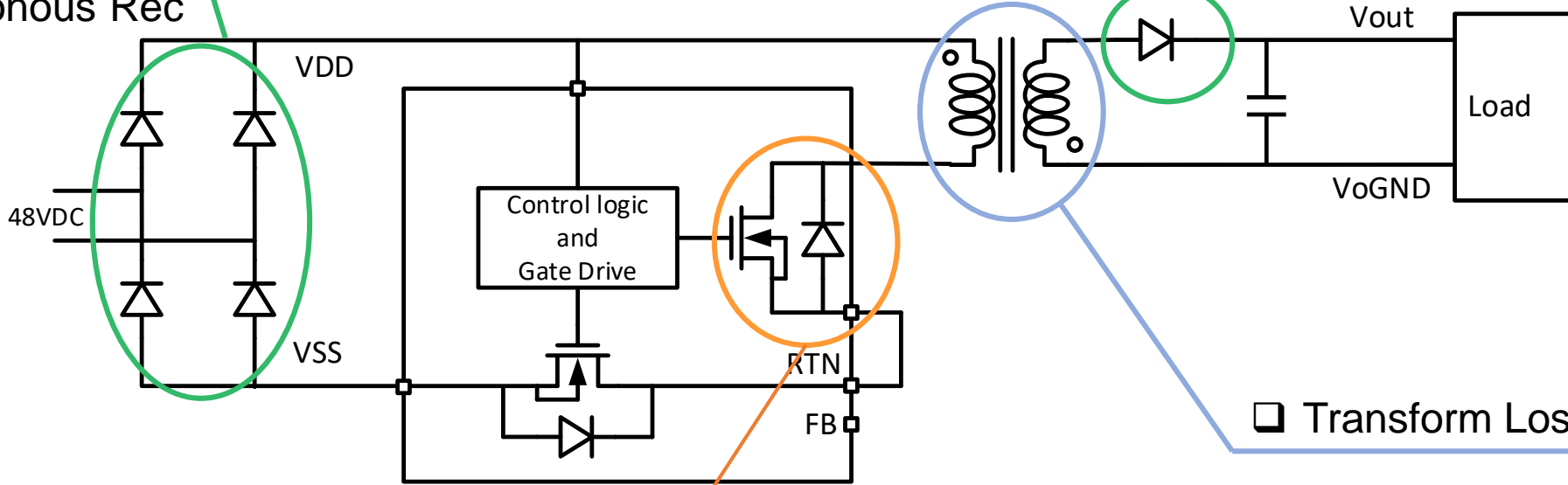
PSR Mode

BOM Sample



Key Points of design - Efficiency

- Input Rec-
- Low V_F , Schottky
- Synchronous Rec



Switch Loss

- Low C_{ds}
- Strong driver
- Frequency decrease with Load

Conduction Loss

- Low R_{dson}
- Low current peak

Diode Loss

- Low V_F , Short recover time
- Synchronous Rectification

Transform Loss

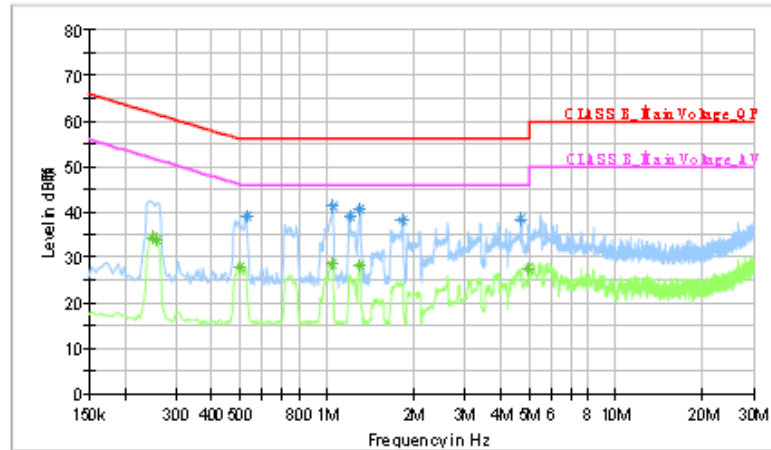
- Good coupling
- Small loop
- Low current density

Key Points of design - EMC



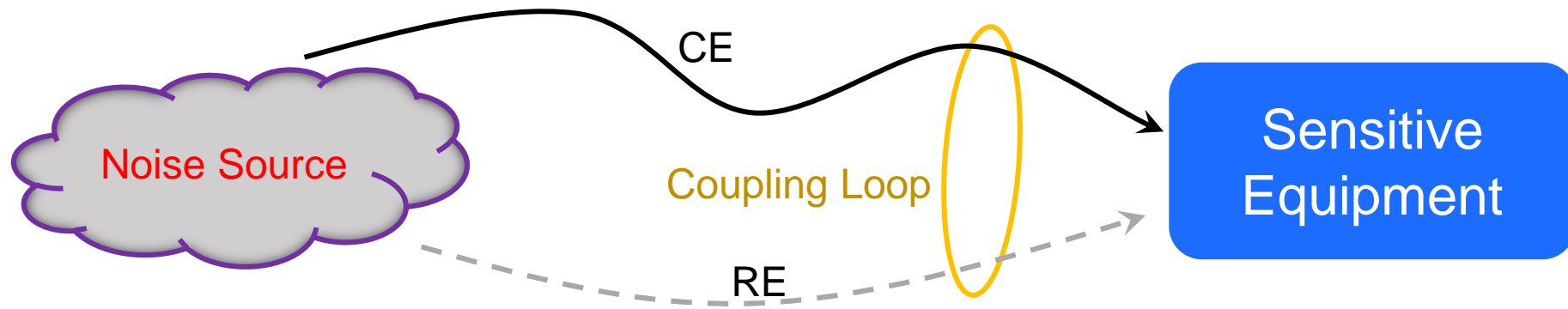
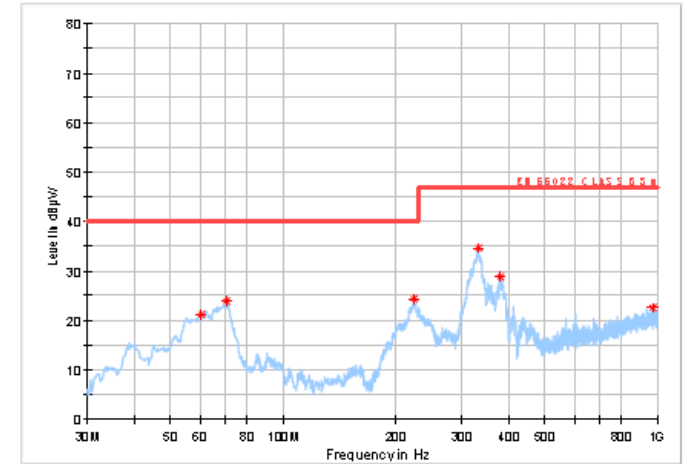
CE

$V_{in}=48V$, $V_o=12V$, $I_{out}=2A$

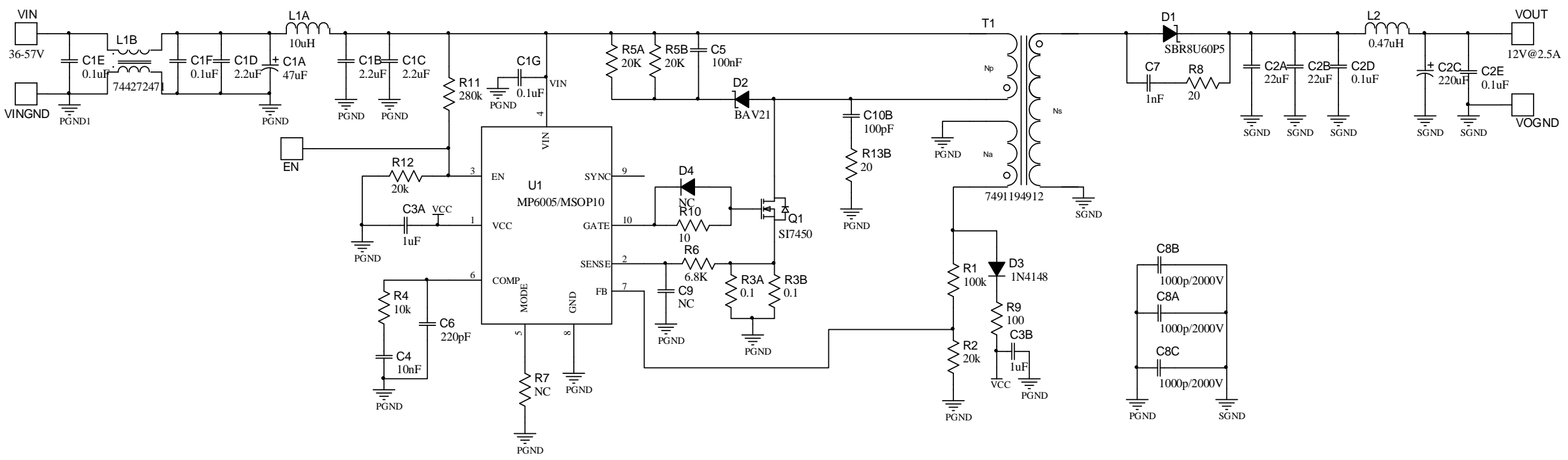


RE

$V_{in}=48V$, $V_o=12V$, $I_{out}=2A$



Key Points of design – EMC: Noise Source



Noise Source

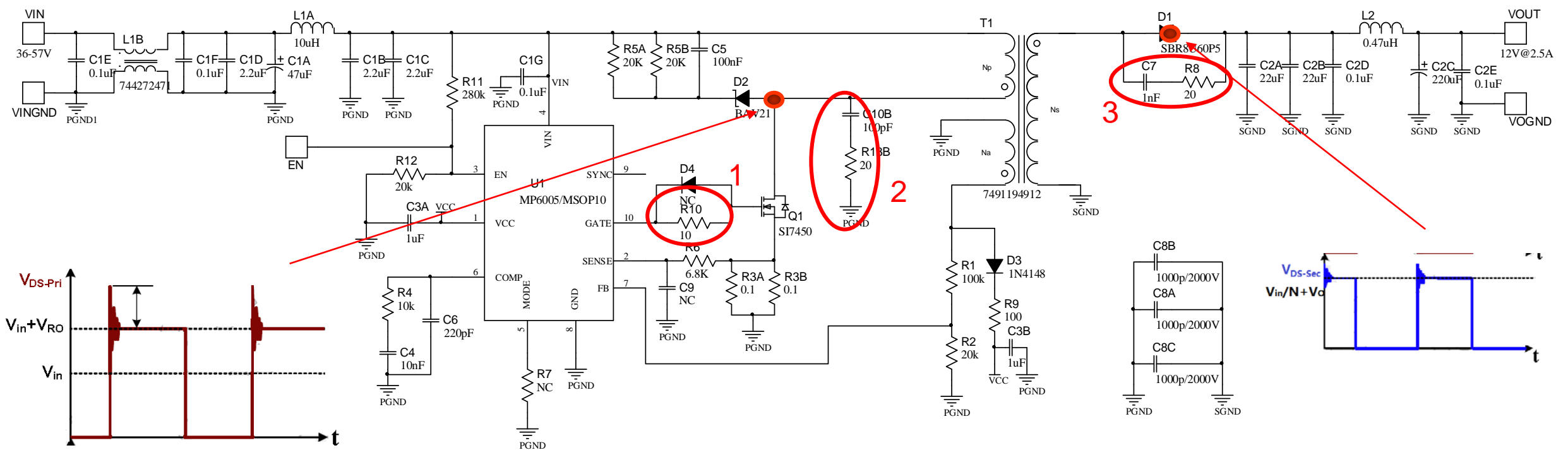
CE

dv/dt

RE

di/dt

Key Points of design – EMC: Noise Source



Noise Source

CE

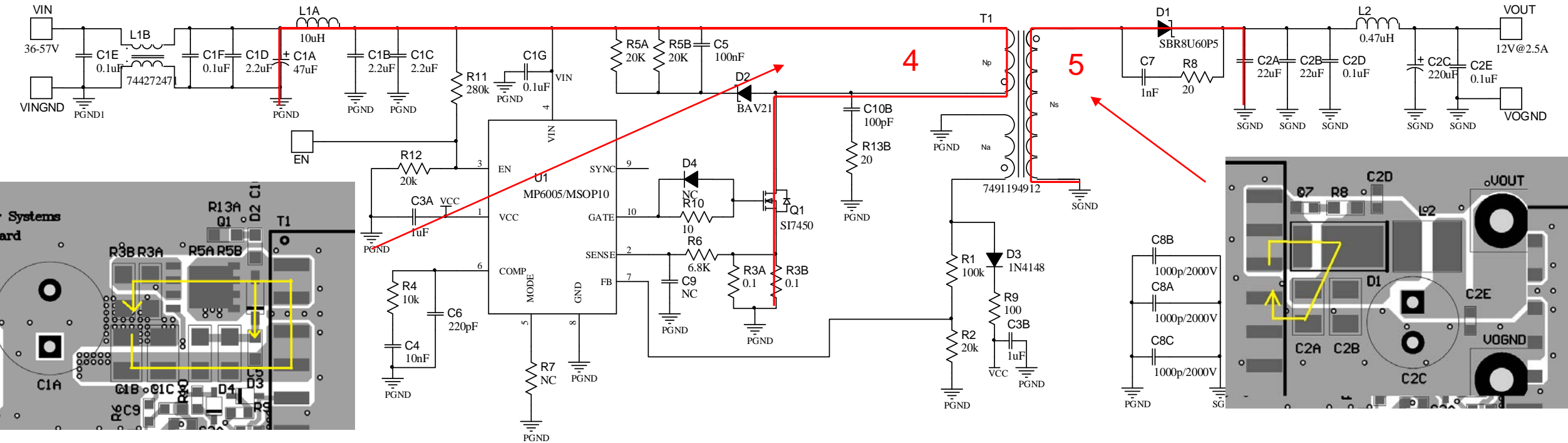
dv/dt

- Slower Drive speed
- Add Snabber

RE

di/dt

Key Points of design – EMC: Noise Source



Noise Source

CE

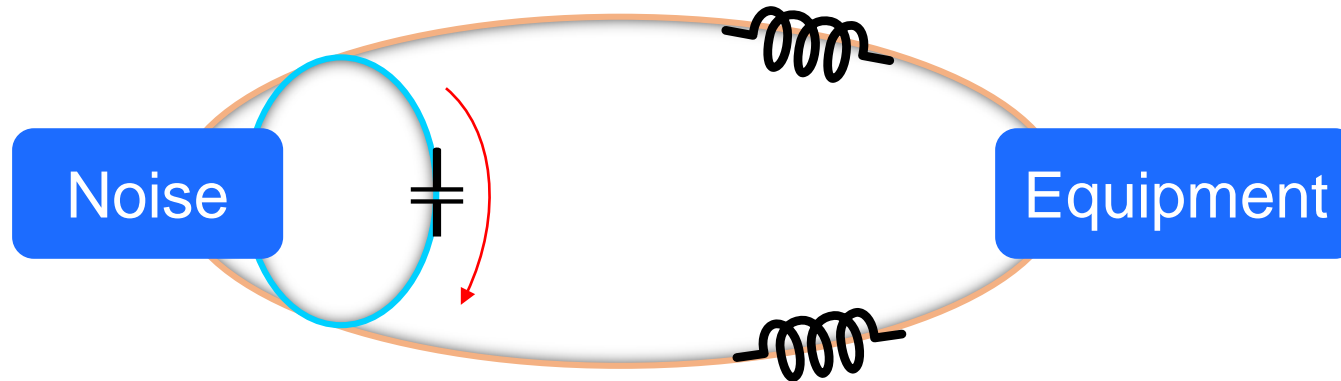
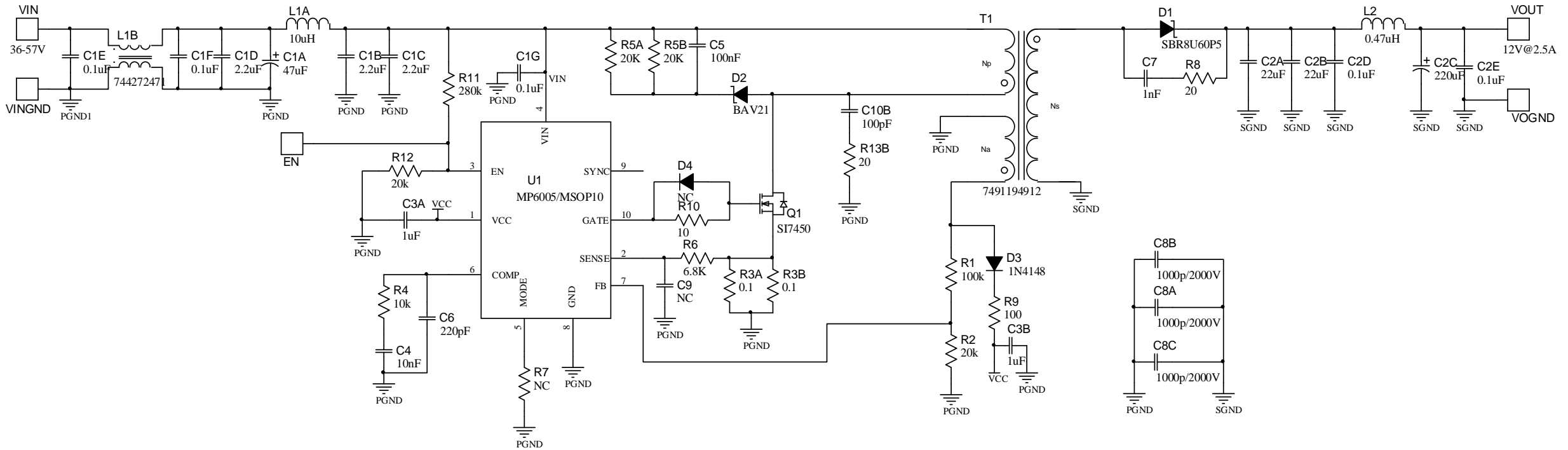
dv/dt

RE

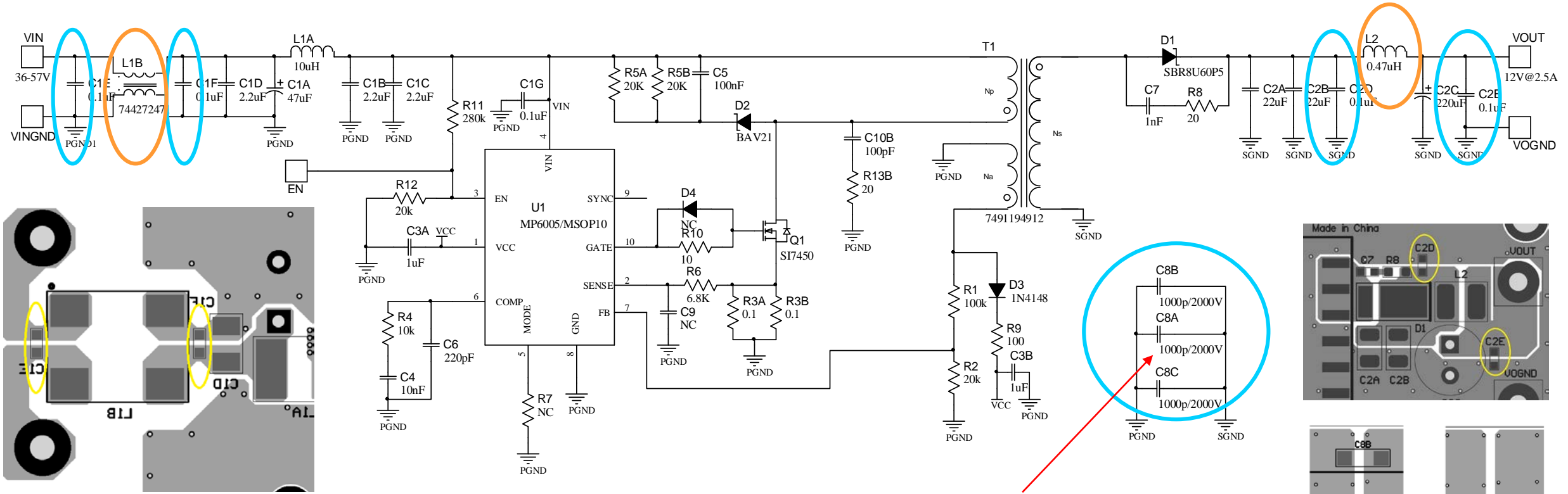
di/dt

- Smaller high-frequency Loop

Key Points of design – EMC: Coupling Loop



Key Points of design – EMC: Coupling Loop

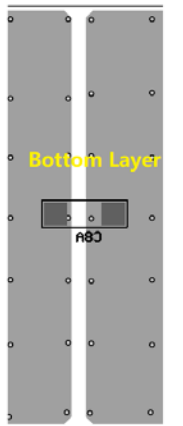
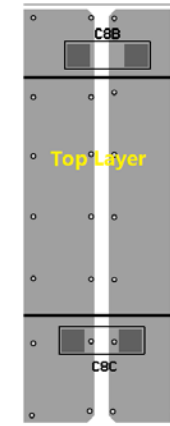
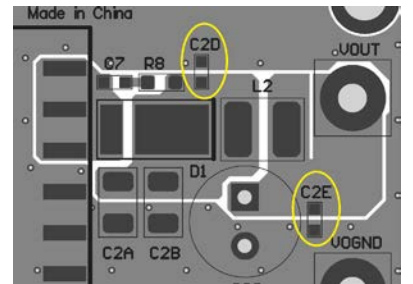


6. More X Capacitor

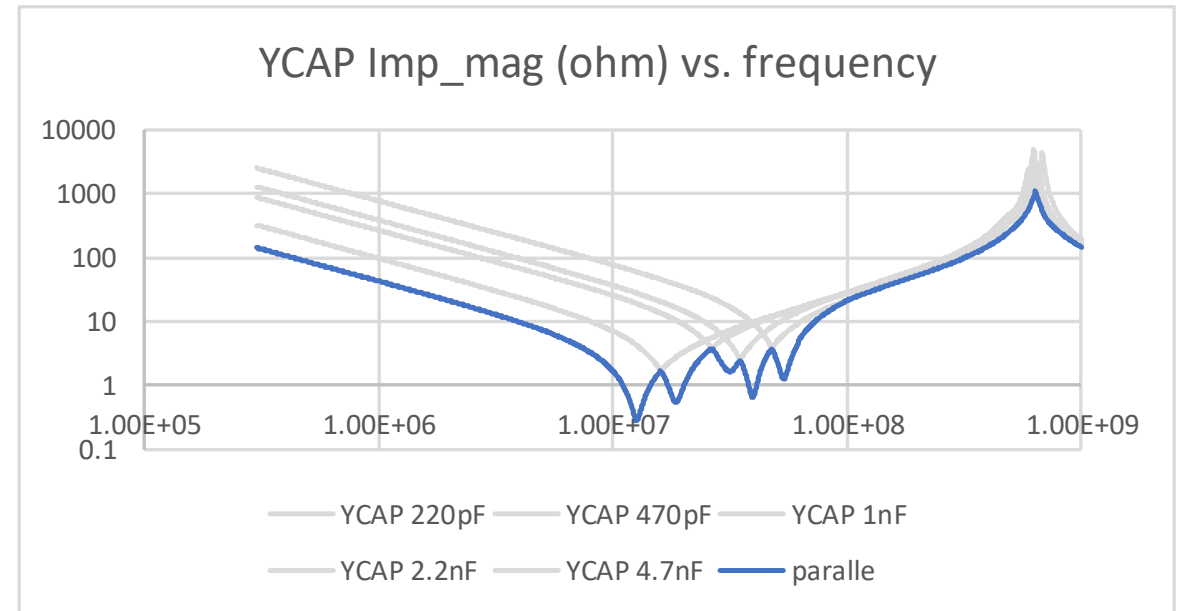
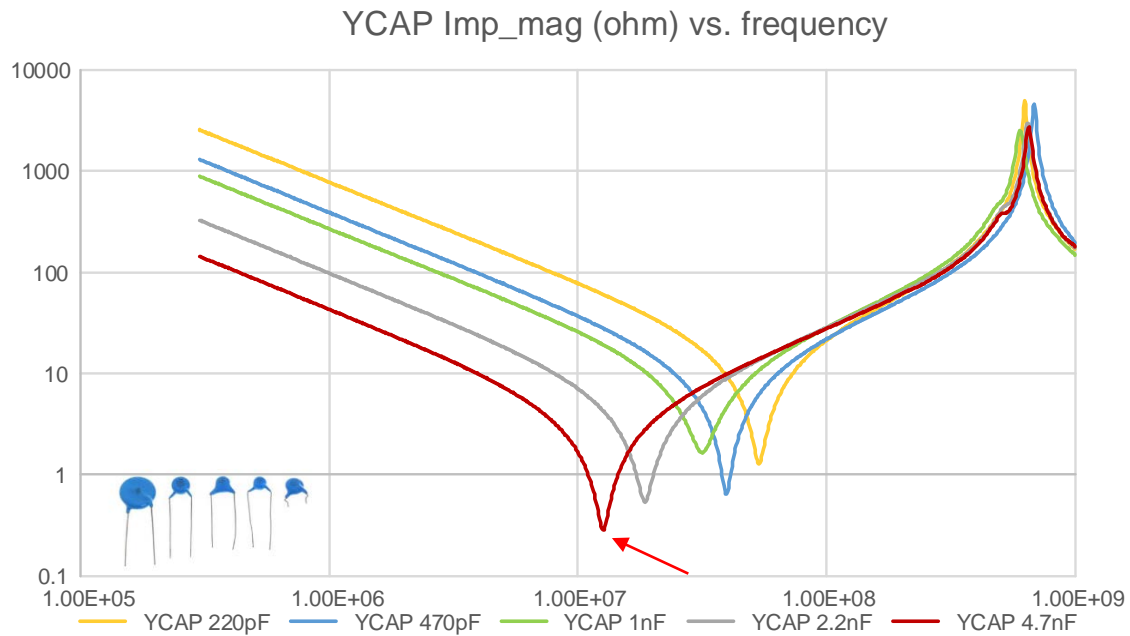
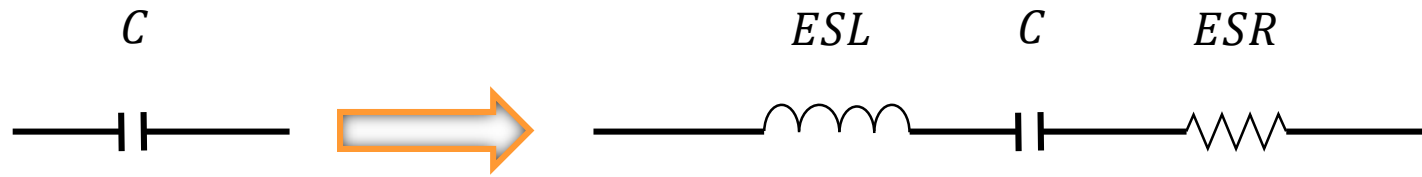
8. Add DM Inductor

7. More Y Capacitor

9. Add CM Inductor

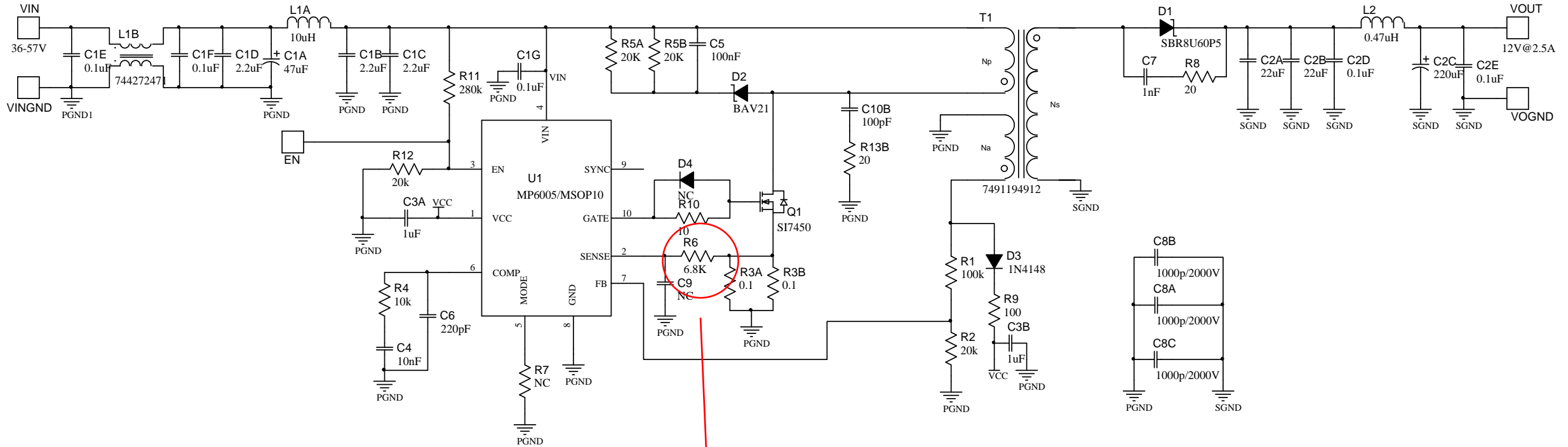


Key Points of design – EMC: Coupling Loop



Using with multiple capacitance values is better for EMC

Key Points of design – EMC: Frequency Dither

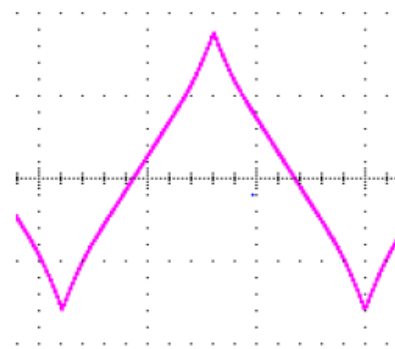


10. Frequency Dither

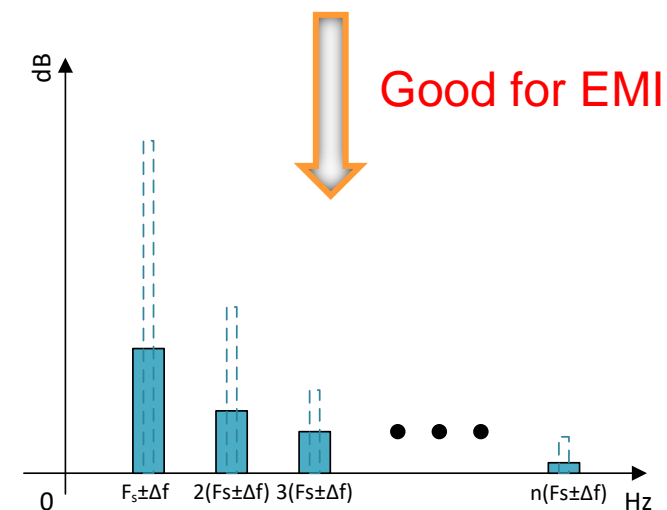
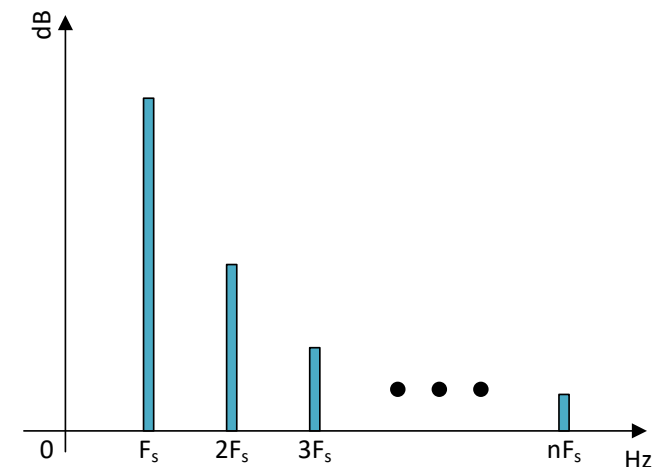
Key Points of design – EMC: Frequency Dither

Table 3, SENSE Pin Program Options

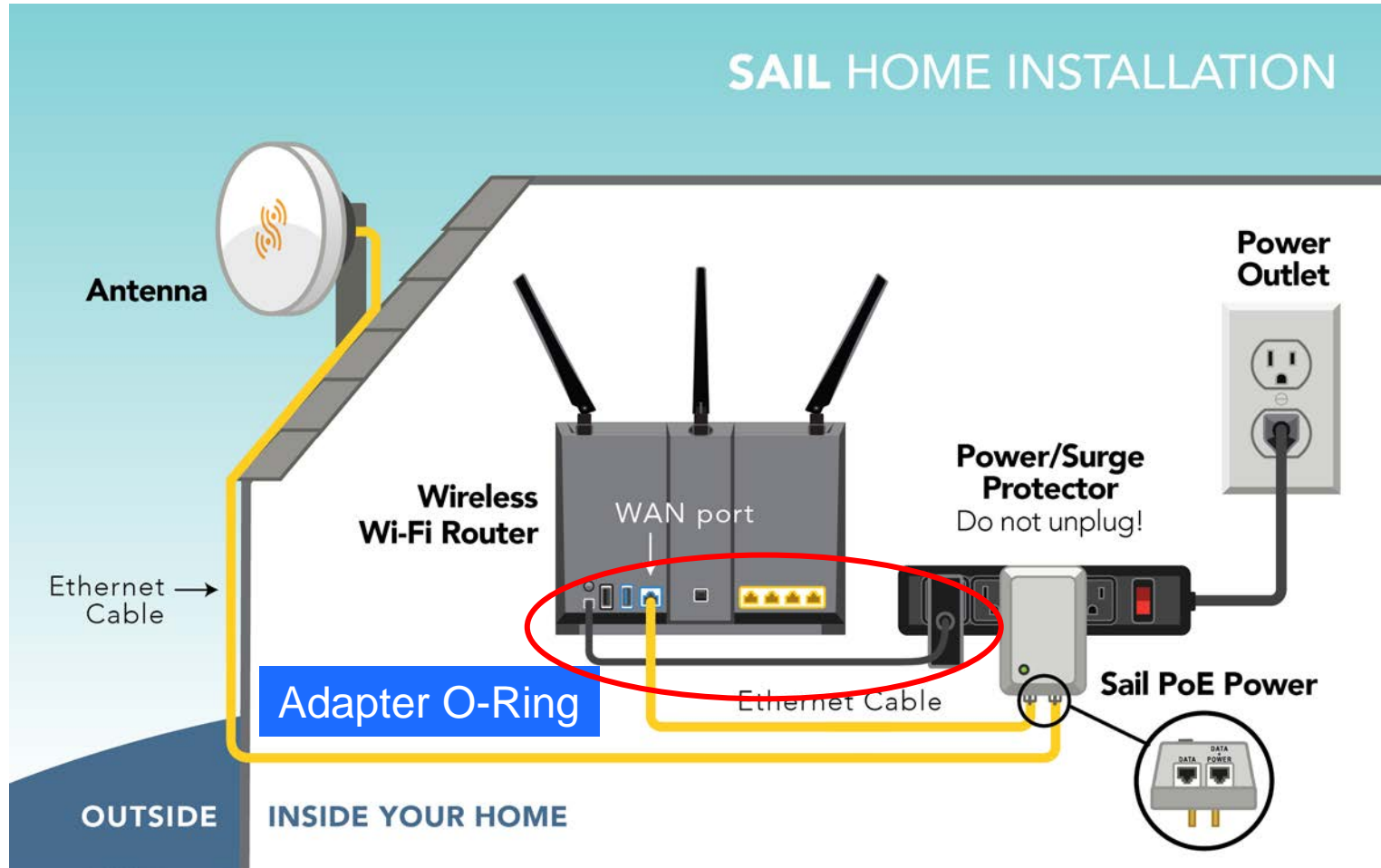
SENSE to GND Resistance ($k\Omega$) ⁽¹⁴⁾			PSR Mode		SSR Mode
MIN	TYP. (1%)	MAX	Dither Range (kHz)	I_{FB} / V_{SENSE} Ratio ($\mu A/mV$)	Dither Range (kHz)
0	0	1.3	0	0	0
3	3.3	3.6	± 15	0.054	± 7.5
6.2	6.8	7.5	± 15	0.108	± 15
12.7	12.7	13	± 15	0.216	± 22.5
24.9	25.5	28	± 15	0	± 22.5



Spread Spectrum technology



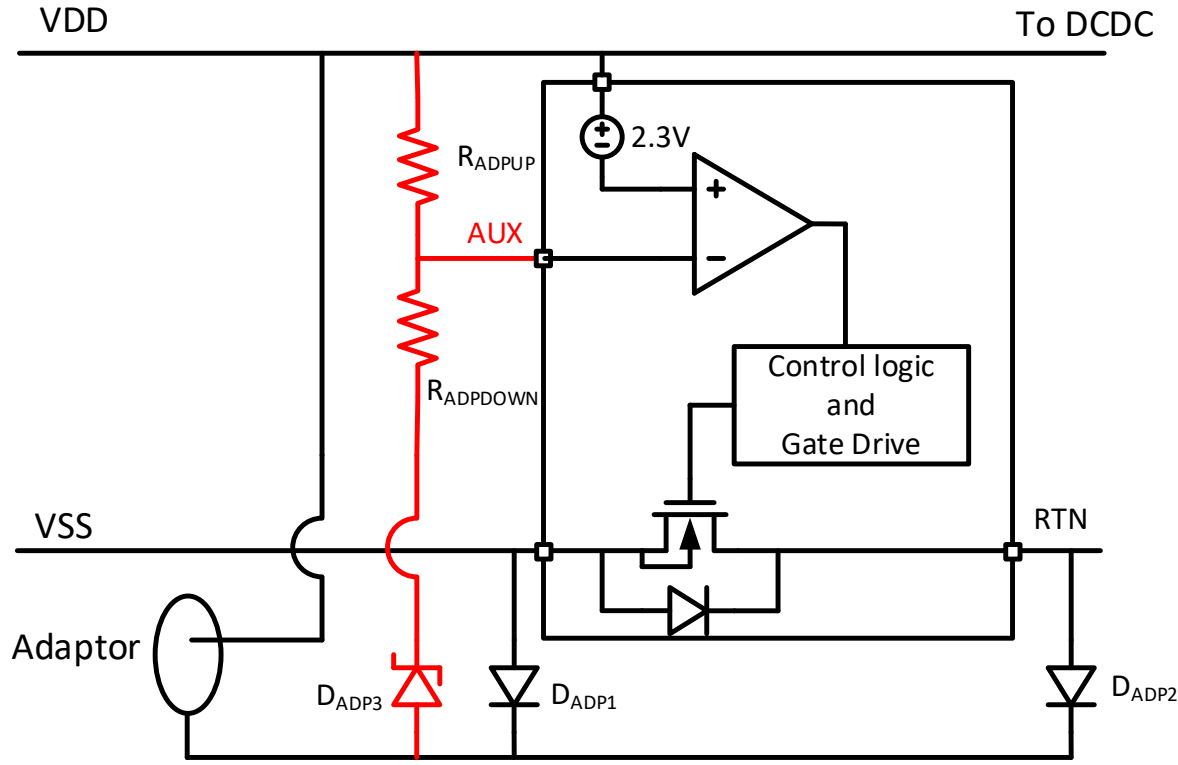
Adaptor O-Ring



Adaptor O-Ring is very popular in some household products

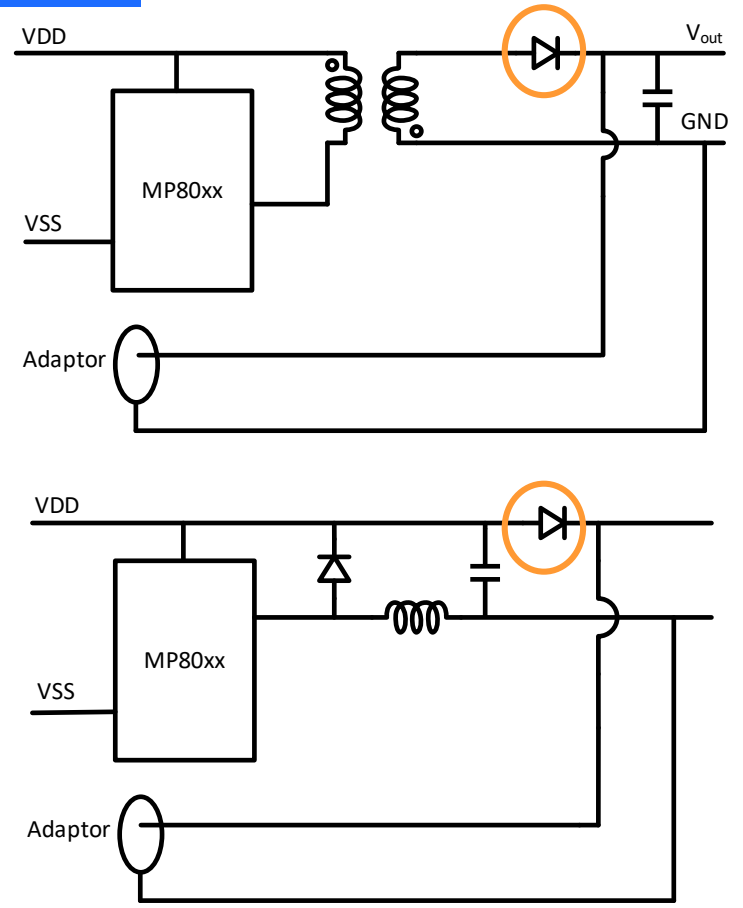
Adaptor O-Ring

MODE I :



In terms of power supply, the adaptor has priority

MODE II :



Priority is determined by diode and output voltage

Outline

□ Part 1. POE Overview

- I. Application
- II. POE Connection
- III. POE Protocol

□ Part 2. PD DCDC Converter

- I. Topology Selection
- II. Pain points of design
- III. Adaptor O-Ring

□ Part 3. MPS POE Solutions

- I. MPS PD af Solutions
- II. MPS PD at Solutions
- III. MPS PD bt Solutions

MPS POE Roadmap – PD Solutions

Cover IEEE802.3af/at/bt requirements

High Efficiency, Low Temperature

Small Solution Size, Simple BOM

Low Cost

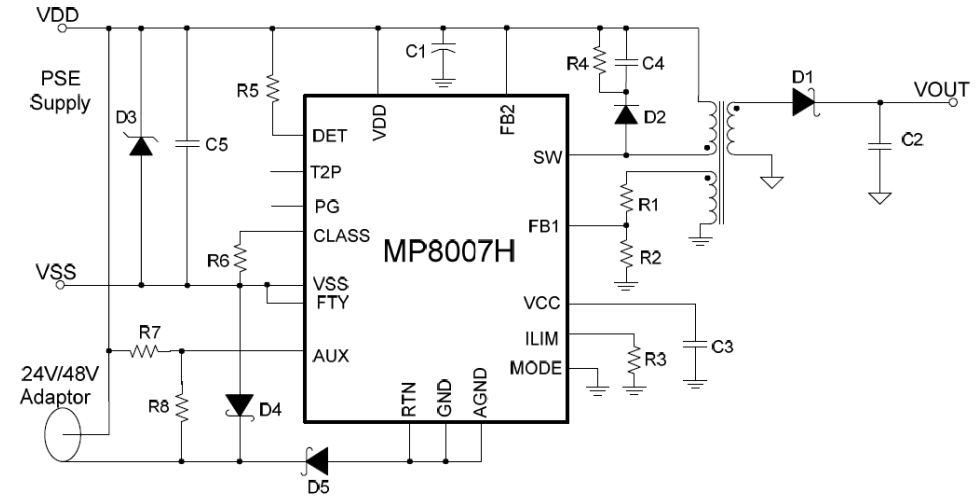
Easy Design

802.3af PD Solution——MP8007H

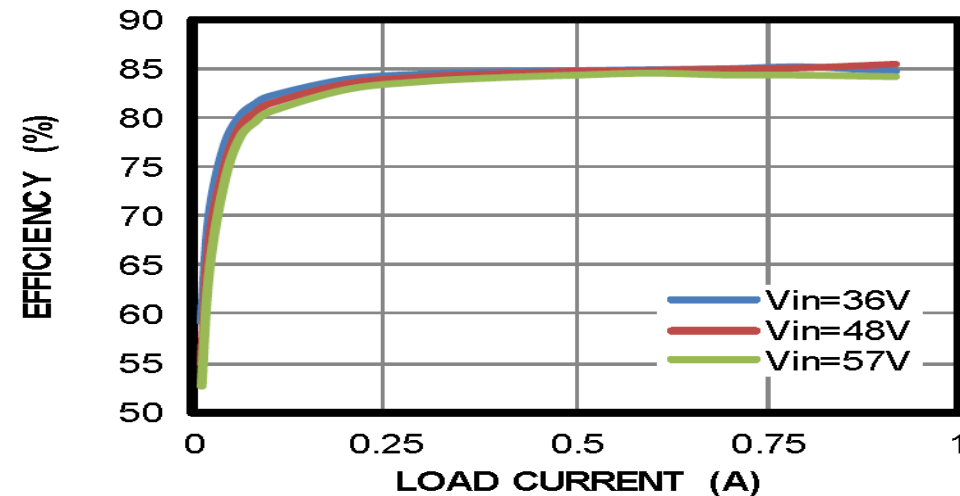
FEATURES

- Compatible with **802.3af** Specification
- 100V **0.48Ω** PD Integrated Pass Switch
- Support **PSR** and SSR Flybuck and **Buck**
- **300KHz** Maximum Switching Frequency
- **Adaptor O-Ring Power Option**
- **QFN-28 4mmX5mm**

Application Circuit



Efficiency vs. Load Current

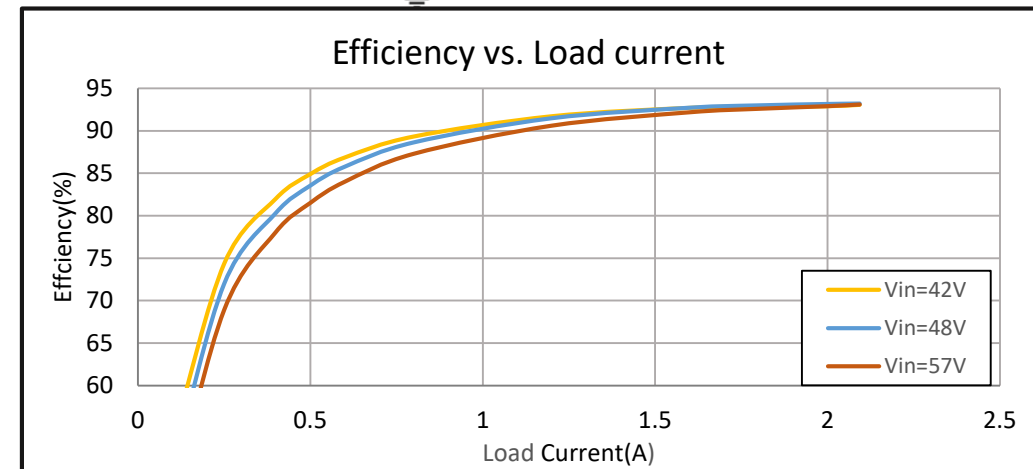
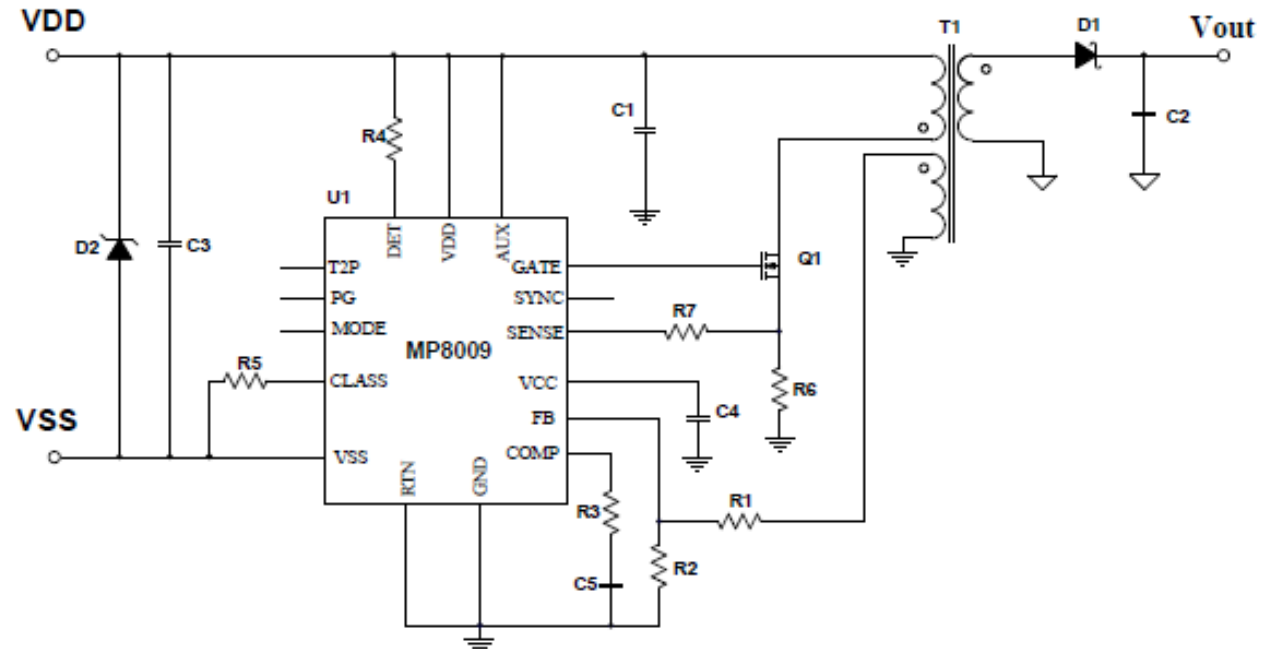


802.3at PD Solution——MP8009

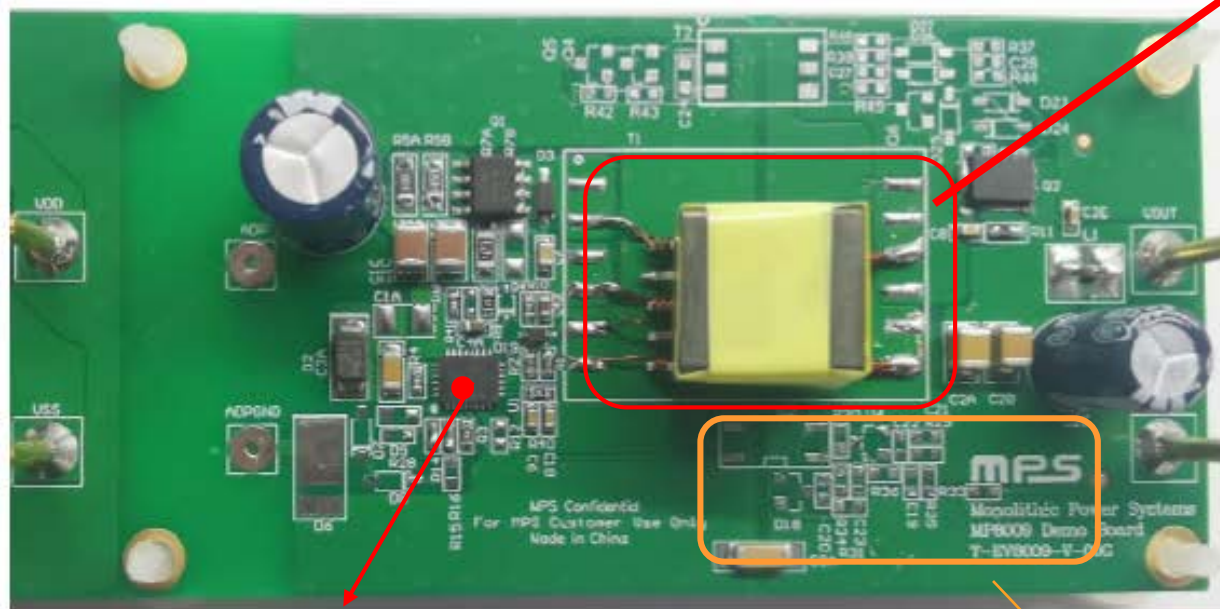
FEATURES

- Compatible with 802.3af/at Specifications
- 100V 0.48Ω PD Integrated Pass Switch
- Support PSR and SSR Flyback and Forward
- 2A GATE and 0.8A SYNC Drivers
- Auxiliary Adaptor O-Ring Power Supply
- Light Load 30kHz Frequency Limit
- Frequency Dithering
- QFN-28 4mmX5mm

Application Circuit



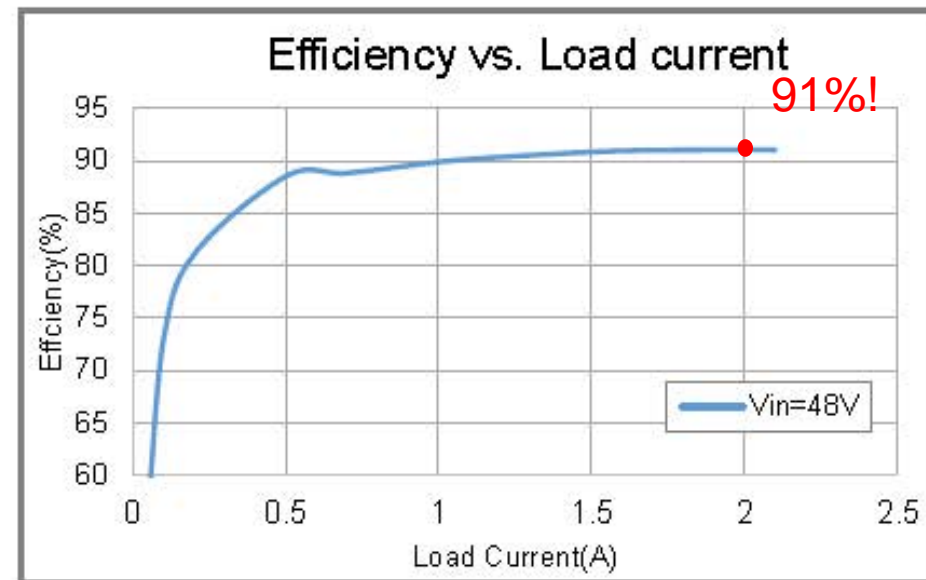
802.3at PD Solution——MP8009



MP8009

SSR

EP13 / Save more than 30% Size



802.3at PD Solution——MP8009 Module

FEATURES

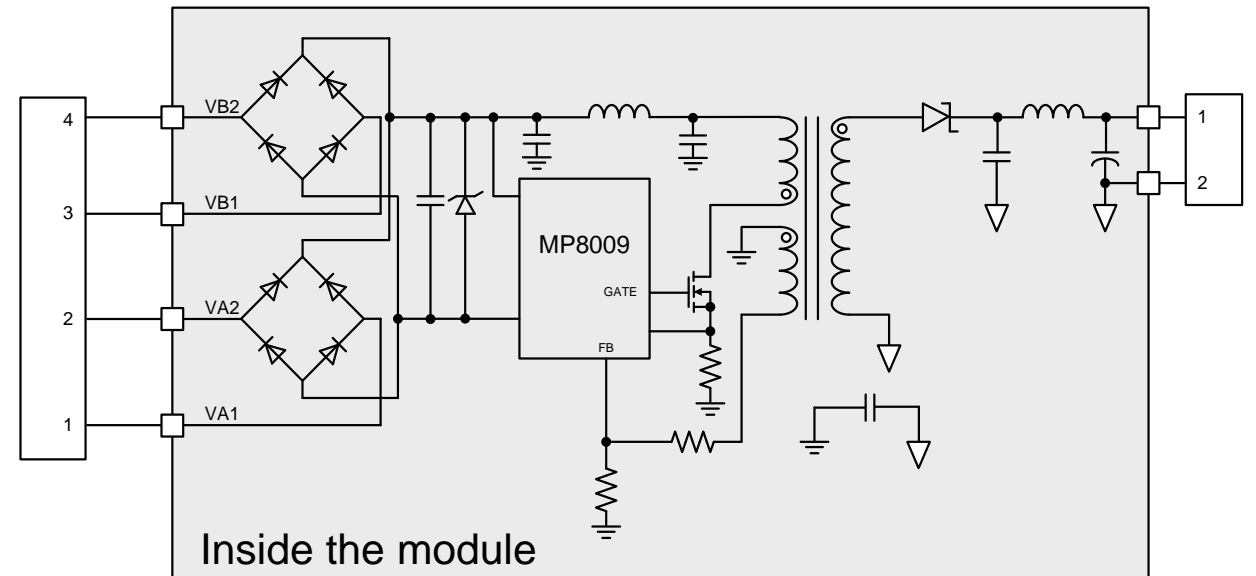
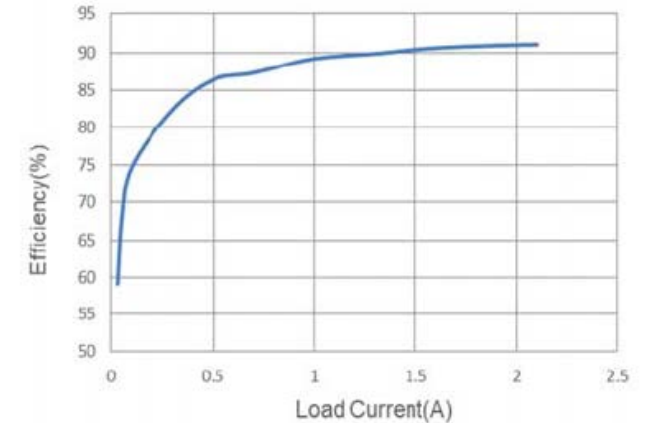
- Compatible with 802.3af/at Specifications
- VIN Range: 42V to 53V
- **Up to 25W Output Power with 12V Output**
- SIP Package 56mm(L)x22mm(H)
- High Efficiency: **5% higher than competitor**
 - 91% @ 24W, 89% @ 12W
- Minimum external components needed
- **1500V Isolation**
- Hiccup Protection for OLP, SCP, OVP and thermal shut down
- **Meet EN55022 Class B EMI standard**
- Featured by MP8009
 - Fully-Integrated 802.3at/at Compliant PoE PD Interface with Flyback/Forward Controller
- Pin Compatible with PD-1002



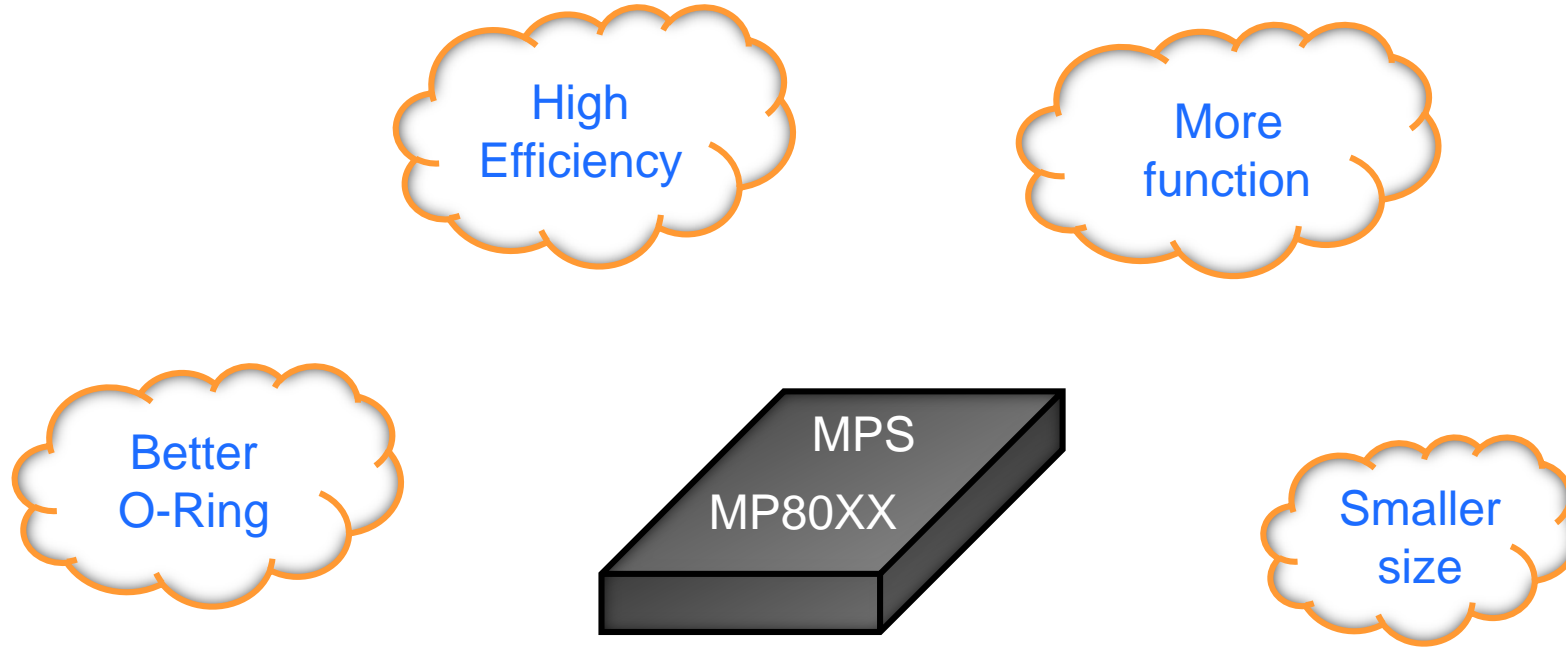
Samples available now

Efficiency

$V_{IN} = 48V, V_{OUT} = 12V$



802.3bt PD Solution——MP80xx



Contact us for more details~

Thanks!