

100~1400瓦全数字设定PFC + LLC整合型电源控制IC: TEA2017

邓平飞
恩智浦应用工程师
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SECURE CONNECTIONS
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PUBLIC

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AGENDA

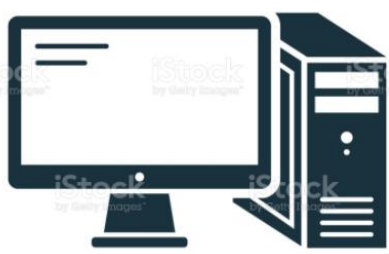
Marketing Session

- The developing story of TEA1916, 2016 to 2017
- Key unique features of TEA2017 & key performance; also using our 600W demo board as examples.
- Energy saving regulation
- Use cases TEA2017
- NXP LLC Product Portfolio
- Web address of related documents of TEA2017 on NXP web.

Technical Application Session

- Power Factor and THD Improvement
- Mixed Mode PFC: “CCM”+ “QR”+ “DCM with valley detection”
- PFC frequency decrement
- PFC frequency jitter
- PFC improved soft-start
- MTP setting & Programming
- Introduction to TEA2017 600W demo board

Q&A



Regular:300W
Peak Power:500W



Indoor
Display
Power
5V/40A~80A



NEW GENERATION

DIGITAL & PROGRAMMABLE

RESONANT POWER PLATFORM

**Industrial
Power**

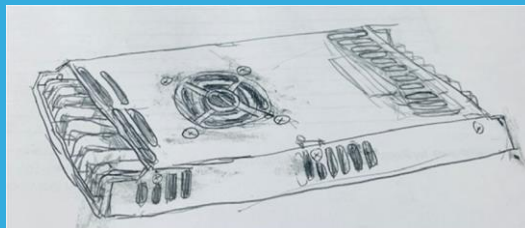
600W



80" TV or
65" OLED TV



12V/33A



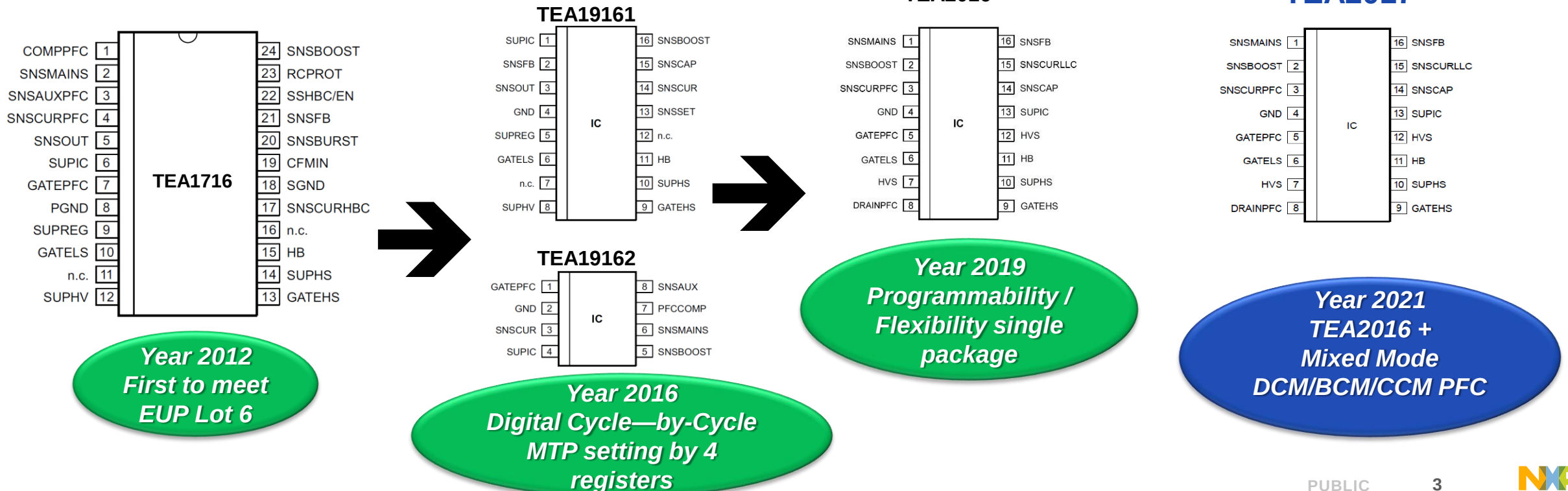
300W

**10~20 USB Ports
Charger**

300~400W

NEXT GENERATION: DIGITAL PROGRAMMABLE PFC + LLC: TEA2017

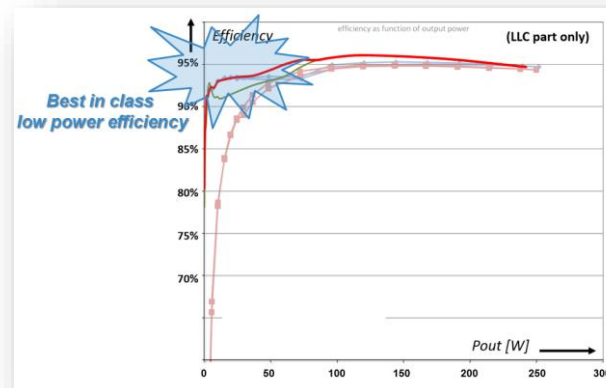
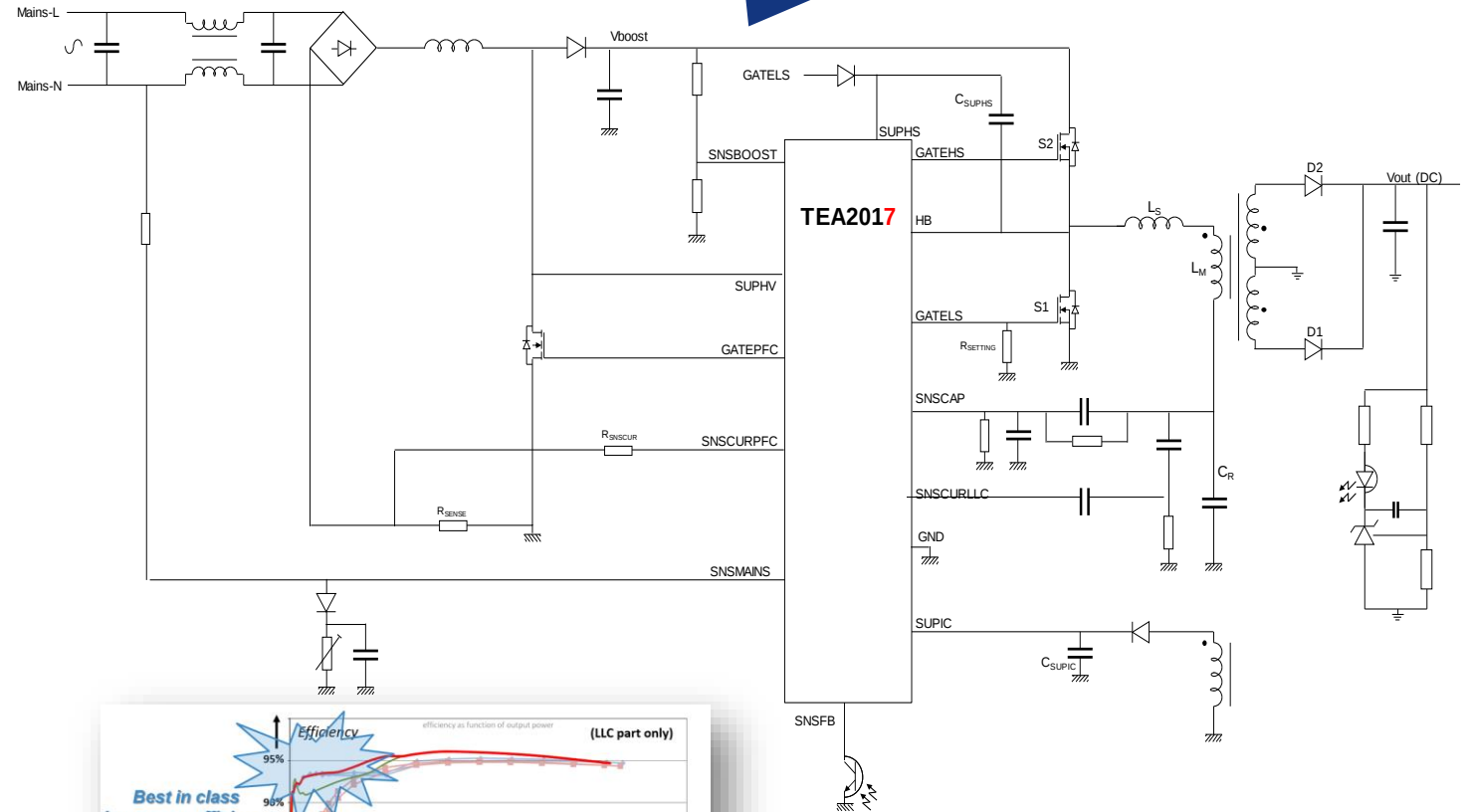
- DCM/QR/CCM Mixed Mode PFC
- Up to 1,400W
- Power Factor, THD and EMI improvement
- High amount of protections, including second independent OVP & inrush current
- High configurability via MTP
- Digital state-machine. **NO FIRMWARE !!**



Additional Advantages of TEA2017

- Very high efficacy a light load
- Very low component count
- Fast Dynamic load response ($\leq \pm 5V$ when the load increased from 0% to 100%)
- Very low power consumption @no load ($< 70mW$ @ no load for 300W/20V)
- Accurate burst-mode level
- Low audible noise
- Many protections
- Short development time needed
- Mature platform (very high volume of TEA2016 & TEA1916 in Market)

Pin compatible
with TEA2016



Test Results for 600W Demo (185mmx 73.5mm x 39mm; 18.5W/In³) with TEA2017AAT, TEA2209T & TEA2095T

Symbol	Parameter	Value	Condition
Input			
V_{mains}	AC mains voltage	90 V to 265 V	AC
f_{mains}	mains frequency	47 Hz to 63 Hz	
$P_{\text{i(noload)}}$	no-load input power	< 150 mW	at 230 V / 50 Hz
$P_{\text{i(lightload)}}$	light load input power	Refer standby power section	
PF	power factor	> 0.99 > 0.95	At 90 VAC ~ 264 VAC, 600 W Pout At 90 VAC ~ 264 VAC, 300 W Pout
Output			
V_{out}	nominal output voltage	12 V	Constant voltage regulation, 0 A to 50 A
I_{out}	maximum nominal output current	50 A	At 90 V to 265 V
$V_{\text{out(pk-pk)}}$	output voltage peak to peak level during dynamic load	< $\pm 5\%$	50 Hz and 1000 Hz dynamic load at the PCB end
$V_{\text{out_ripple}}$	output voltage ripple	< 500 mV	Oscilloscope bandwidth 20MHz
$t_{\text{hold_up}}$	hold-up time	> 15 ms	600 W Pout
$t_{\text{start-up}}$	start-up time	< 1 s	600 W Pout
t_{rise}	output voltage rising time	< 20 ms	5% to 95 % at 600 W Pout
$\eta_{100\%}$	max load efficiency	> 94 %	600 W Pout
η	max, 50% and 20% load efficiency	80 Plus Platinum	
EMC and Safety			
CE	conduction EMI	> 3dB	at 600 W Pout
T_{comp}	components temperature	Refer temp section	at room temp

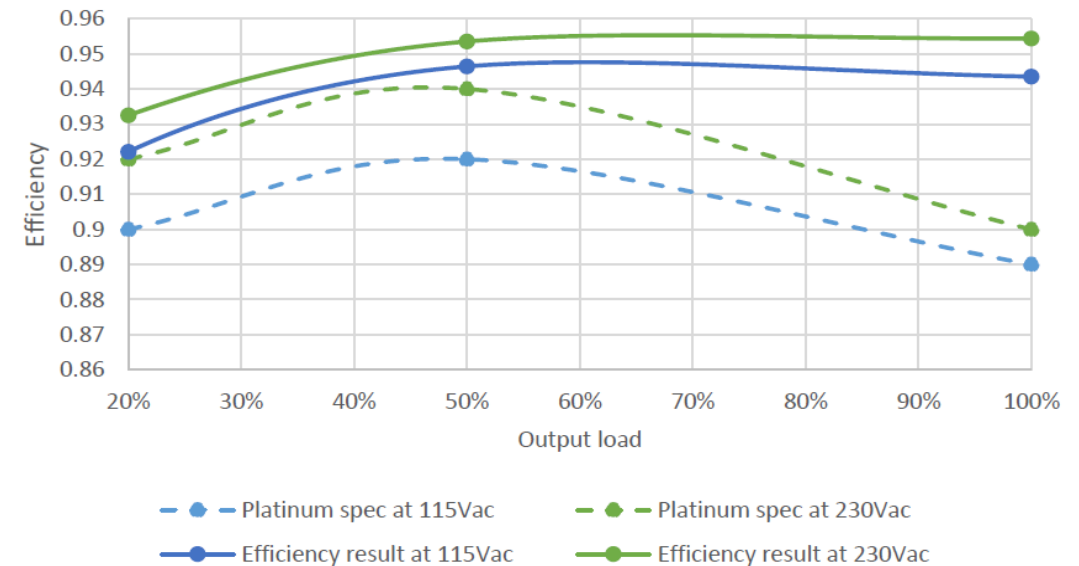
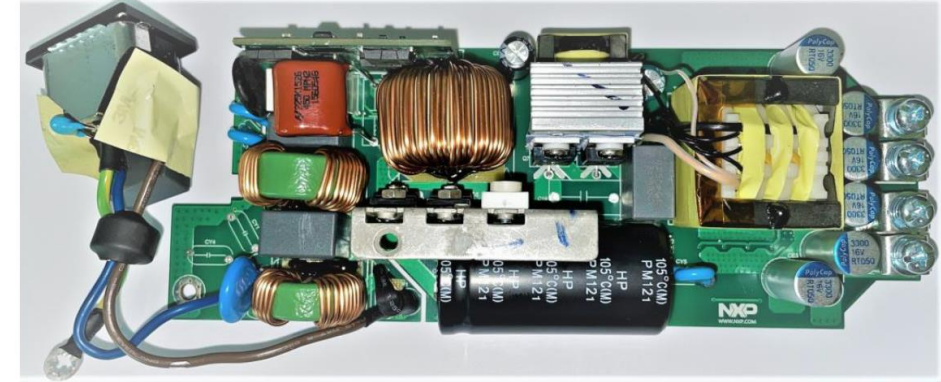


Figure 18. Efficiency test result comparison with 80 plus platinum efficiency standard

能源法规与市场趋势

能源法规——刚刚发布或即将发布

- 加州新能源法规: >80% 从~3W到以上 (何时?)
- 电视电源: <0.3W@待机模式(e.g. 12V/10mA) (某些品牌目前标准)
- EPA能源之星 7.0
 - ✓希望将最低计算 IPS 效率从 80Plus Bronze 提高到 80Plus Silver 效率等级 (自2019年11月生效)
 - ✓**完整网络连接能力**- 已经修改完整网络连接能力的定义, 以适应业界正在开发的全新极低功率模式。这些新模式可让网络持续处于连线状态, 但功耗低于2瓦。
- EUP/ERP Lot 7: <0.2W@待机模式/无负载 (何时?)
- **UL62368 (2019上半年)**
- ...

大尺寸电视机电源的改变 (55/65 & OLED)

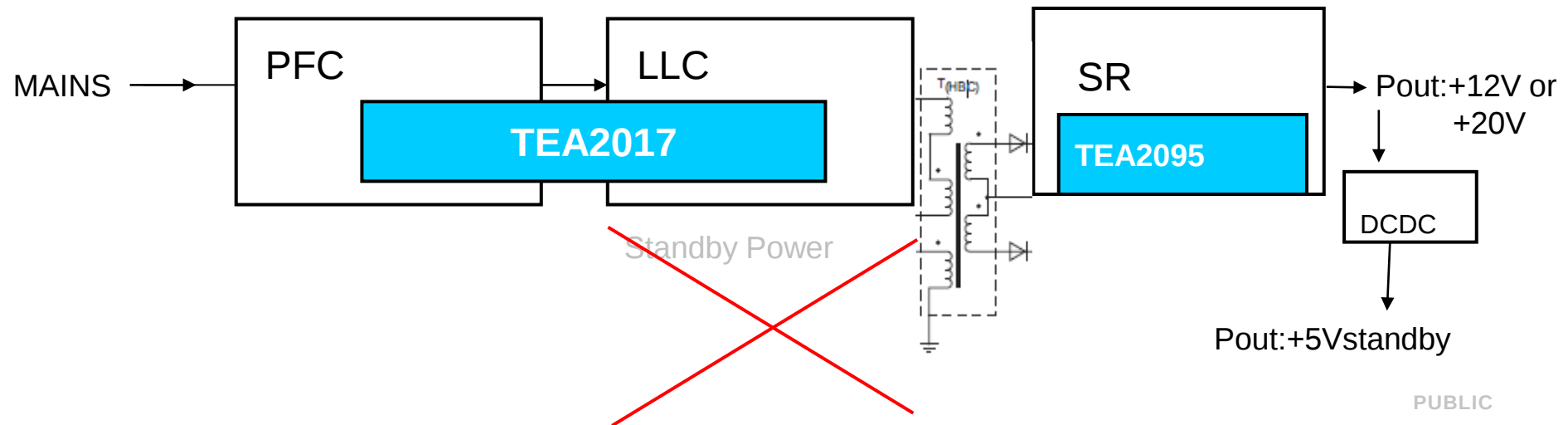
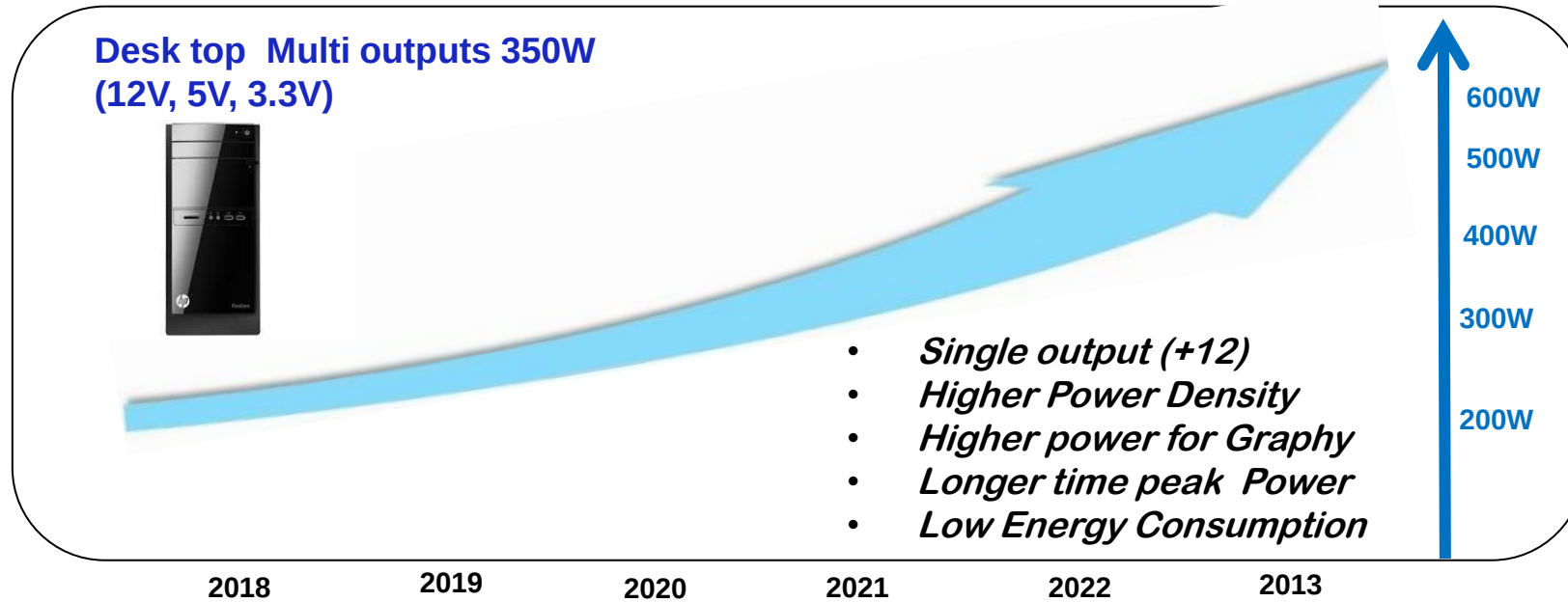
尺寸	W/O Type Port & Edge LEDs	W/O Type C port & Direct Bakclight	With 2 Type C Ports & Direct Backlight	2 Type C ports & OLED Light Source
55"	Vout <=24V: 50W Vout >50V: 80W Sub-TTL: 130W	Vout <=24V: 50W Vout > 50V: 100W Sub-TTL: 150W	Vout <24V: 150W Vout >50V: 100W Sub-TTL: 250W	Vout <24V 150W Vout 30~48V: 250W Sub-TTL: 400W
65"	Vout <=24V: 50W Vout >50V: 120W Sub-TTL: 170W	Vout <=24V: 50W Vout > 50V: 150W Sub-TTL: 250W	Vout <24V: 150W Vout >50V: 150W Sub-TTL: 300W	Vout <24V 150W Vout 30~48V: 350W Sub-TTL: 500W

不再使用 Flyback
(反激), 改用
PFC+LLC (諧振)

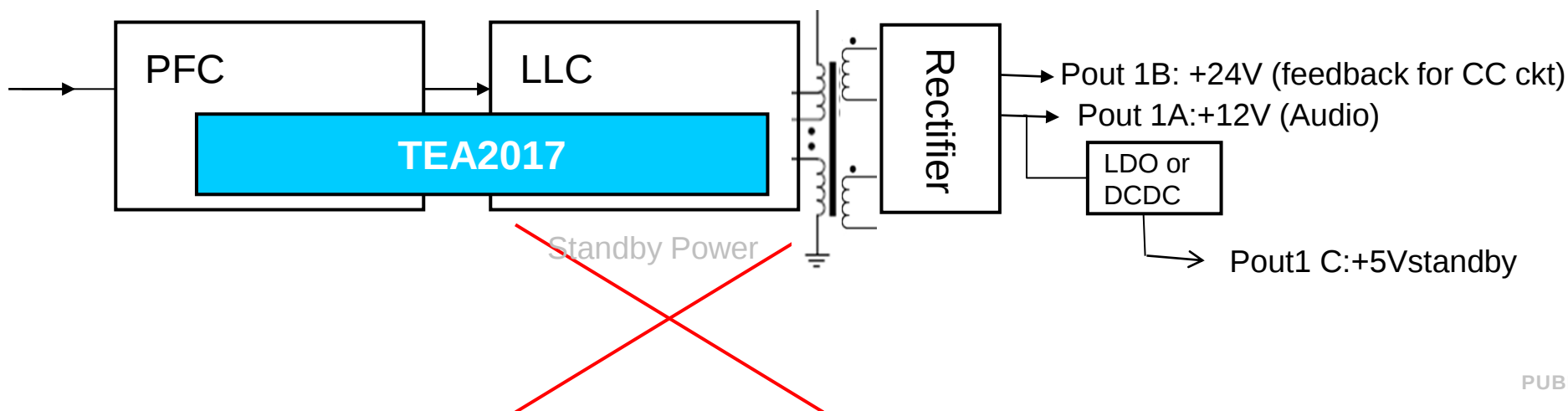
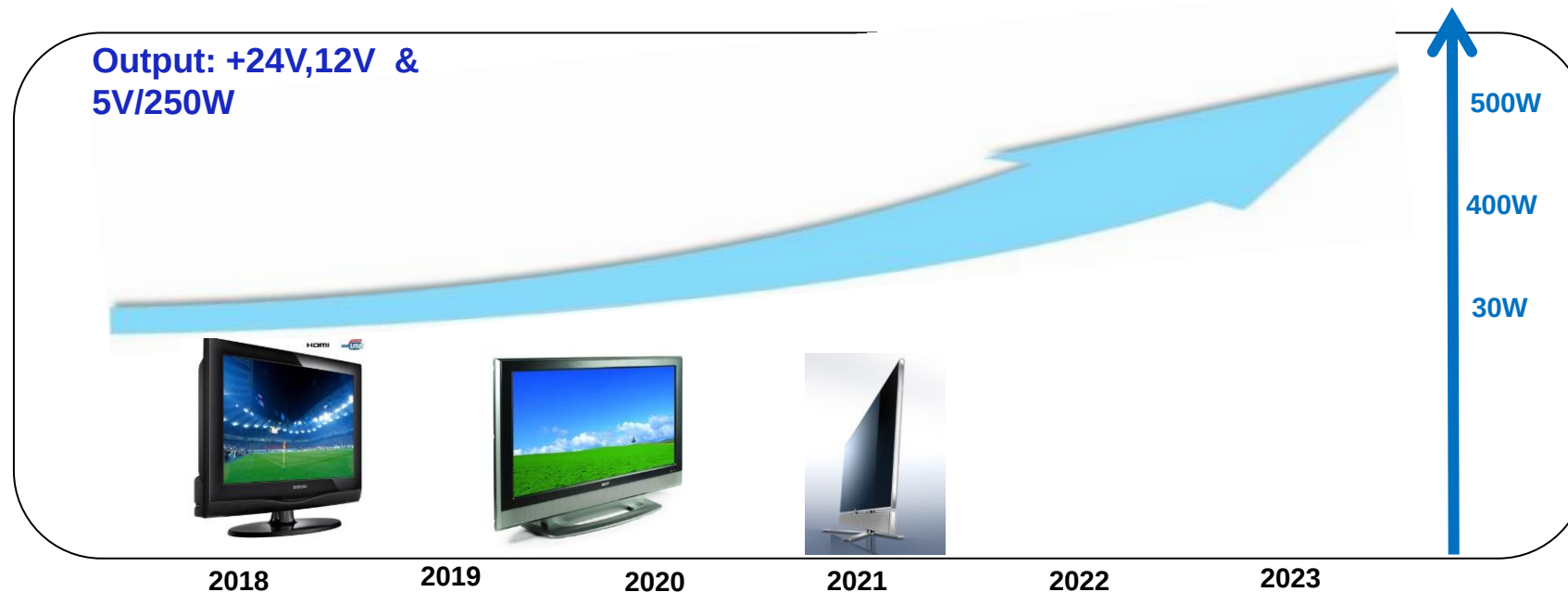
- 總功率大增
- 輸出電壓變小
- 同步整流使用機率大增 (TEA2095T)

PC电源的主要市场趋势（桌面） 多输出→单输出

Single Peak output: 12V/500W



多输出电视趋势 → 2个输出, 例如 $\geq 300\text{W}$ LED with Type Ports or OLED 电视电源



为什么AIO和台式电脑为单输出功率

- 设计更简单;
- 更容易通过法规要求;
- 减少组件数量;
- 更坚固/可靠, 更长的产品寿命;
- 更容易获得EnergyStar法规认证;
- LDO或DC / DC级的效率更高, 成本更低。

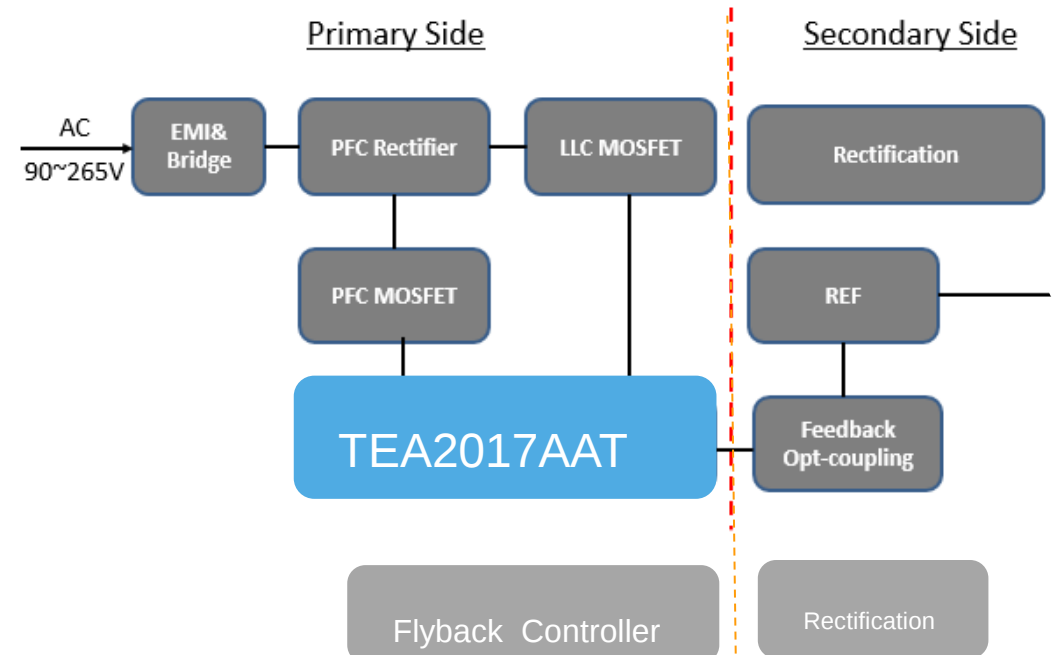
TEA2017 成功应用案例



USE CASE: 400~600W TV POWER

Customer	TV Power Maker
BL-SIP Part No. (Sockets)	TEA2017AAT
End Application	>70" TV Set platform
Why TEA2017 chosen	- Easier to use & debug than the other combo IC - PCB size smaller & less compony count than old projects - Better Power saving
Use Experience	- Direct support from NXP FAE at begging stage - Disti FAE support from PCB layout to debug

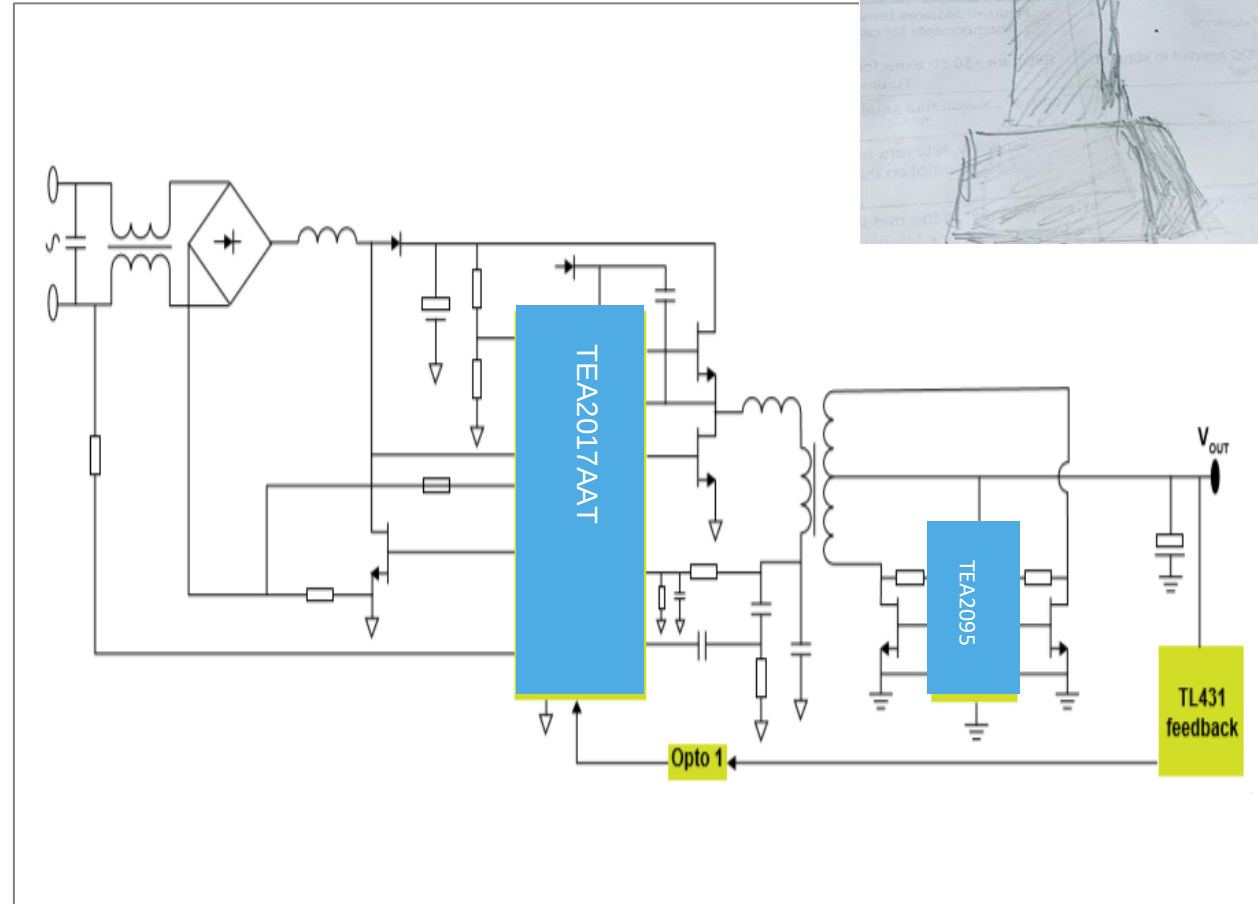
End Product: TV SET



USE CASE: 300W OUTDOOR DISPLAY POWER

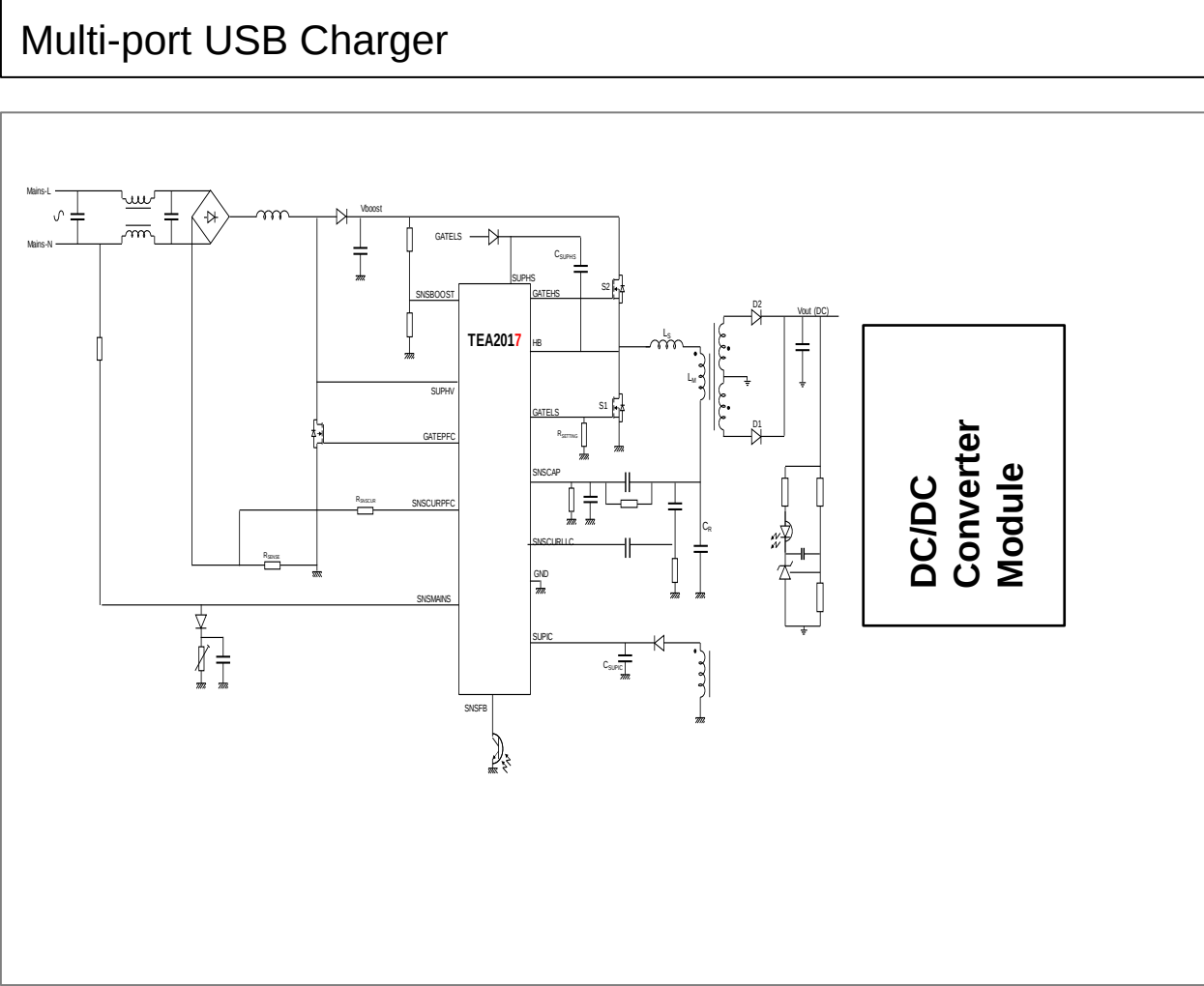
Customer	Out Door Display Makers
BL AA Device	TEA2017AAT+ TEA2095
End Application	China local brands outdoor display Power with 5Vout
Why TEA2017AAT Chosen	Product features highly match customer requirements Good relationship with customer High Efficiency at light and high load Low component count
Use Experience	• Direct support from NXP FAE at begging stage • Disti FAE support from PCB layout to debug • Short development time

Outdoor Display Power



USE CASE: 300W MULTI-PORT USB PD CHARGER

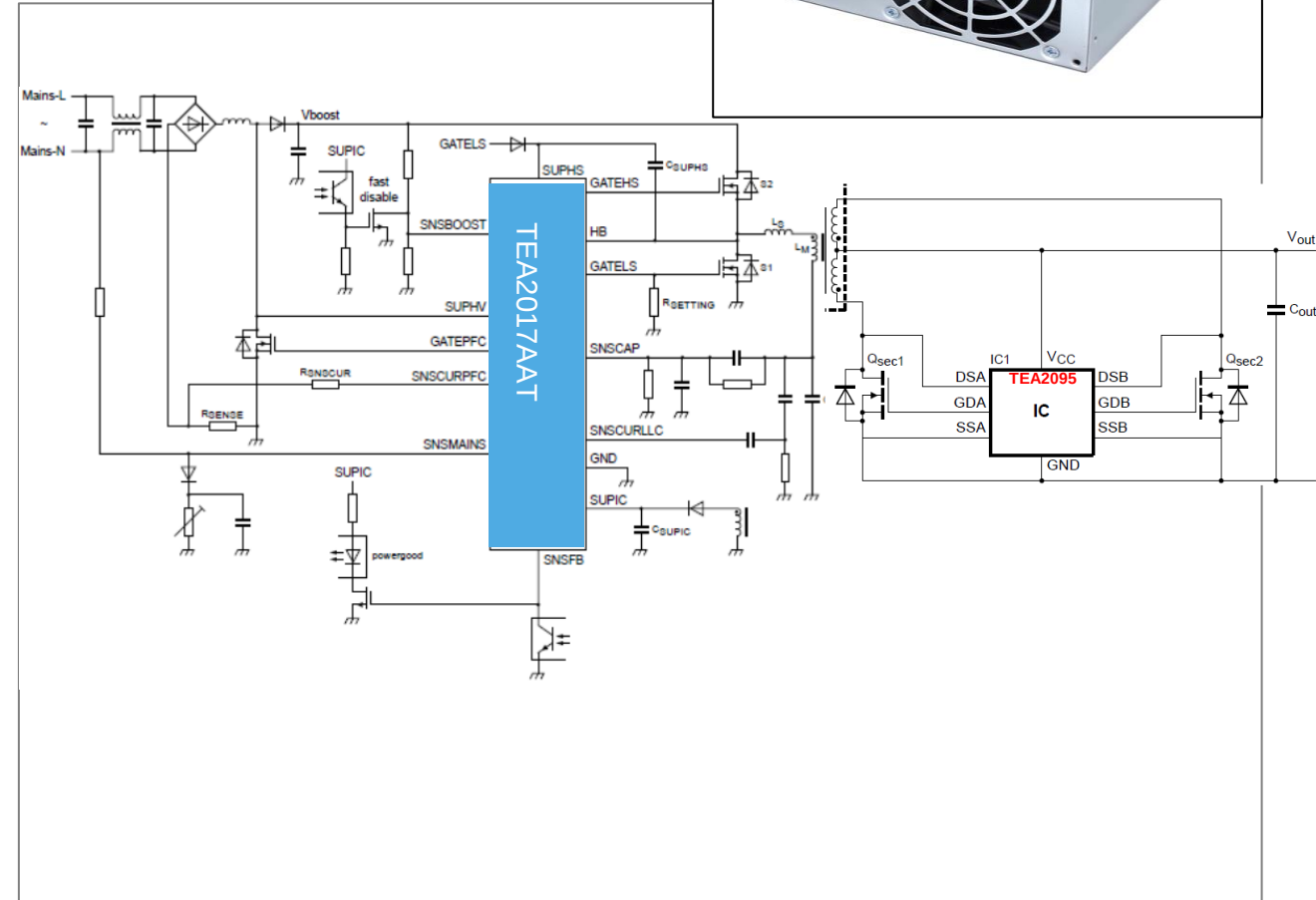
Customer	USB Multi Port charger makers
BL AA Device	TEA2017AAT+ TEA2095
End Application	More than-10-Ports USB Chargers
Why TEA2017AAT Chosen	• Low power consumption at no load, tiny load & standby Power • Very low component count • Mature & high share in the market
Use Experience	• Direct support from NXP FAE at begging stage • Disti FAE support from PCB layout to debug • Short development time



USE Case: 500W Peak Power for Desktop PC

Customer	PC Power Maker
BL AA Device	TEA2017AAT+ TEA2095ET
Application	Desktop PC Power with 2- time peak power
Why TEA2017AAT Chosen	• Low power consumption at no load, tiny load & standby Power • Easy to pass Energy Star • Meet 2 time-peak power requirement • Very low component count • Mature & high share in the market
Use Experience	• Direct support from NXP FAE at begging stage • Disti FAE support from PCB layout to debug • Short development time

PC Power



最新恩智浦电源IC产品组合



LLC拓扑的推力产品ACDC电源控制器

Application	Description	Part Number	USP	Status & Remarks
>75W Adapters, Lighting but no THD requirement, NB PC, Desktop PC, AIO PC, TV, out/in door display. Medical Power, Multi-Port USB Charger & etc. (<=300W)	LLC digital controller+ DCM PFC Controller	TEA19161 (SO16)+ TEA19162 (SO8)	- Parameters can be set by 4 registers <70mW@no load for 240W/12V 2~15% higher at load <10%; <+/-5% voltage regulation for 0% to 100% load - Meets Platinum standard	TEA19161+TEA19162: MP Q1'16 Design tool of TEA1916 released April'20
SR IC for LLC power supply (<1000W)	LLC Synchronous Rectifier IC	TEA1995T (SO8) or TEA2095T(SO8) /TEA2095TE(HSO8)	2~7% High efficiency at middle load via adaptive driving capability by loading - TEA2095 for higher power (over 300W) & lower Vds MOSFET	TEA1995: MP Q3'15 TEA2095: Released Nov'19 TEA2095T(E)/1 with copper wire: released Q3'20
>75W Adapters, Lighting but no THD requirement, NB PC, Desktop PC, AIO PC, TV, out/in door display. Medical Power, Multi-Port USB Charger with GAN Transistor & etc. (<=300W)	Combo Controller with LLC digital control+ DCM PFC Control	TEA2016 (SO16) + (TEA1995 or TEA2095)	- Parameters can be set for >80 parameters 30~50 components reduced vs TEA1916 generation - Meets Platinum standard - Advantage of TEA19161+ TEA19162	TEA2016 released June'19
200~ few KWs for any power which needs higher efficiency on Bridge stage	Active Bridge Rectifier Controller can work under any topology(e.g. LLC, & Forward, Fullbridge & etc.)	TEA2208 (SO14): replace 4 diodes TEA2206 (SO8) : replace 2 Diodes TEA2209 (SO16): replace 4 Diodes, much lower power @no/tiny load	- Forward conduction losses of the diode rectifier bridge are eliminated - Very low IC power consumption (2 mW) with X-capacitor discharge - Very low external part count	TEA2208: released Nov'19 TEA2206: Released Dec'20 TEA2209: Released Jan'21
Up to 1,400W: Adapters, Lighting , NB PC, Desktop PC, AIO PC, TV, out/in door display. Medical Power, Multi-Port USB Charger with GAN Transistor & etc.	Combo Controller with LLC digital control+ DCM/QR/CCM Mixed Mode PFC	TEA2017 (SO16) + (TEA2095)	- Advantages of TEA2016 - Low THD, high PF value & easier to handle EMI - DCM/QR/CCM Mixed Mode PFC	TEA2017: released June'21 Design tool of TEA2017: Released July'21

TEA2017官方网站

- <https://www.nxp.com.cn/products/power-management/ac-dc-solutions/ac-dc-controllers-with-integrated-pfc/digital-configurable-llc-and-multimode-pfc-controller:TEA2017AAT>



产品应用设计技术支持公司

搜索

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语言

主页 / 能源管理 / AC-DC Solutions / 集成PFC的AC-DC控制器 / TEA2017AAT/2 Digital Configurable LLC and Multimode PFC Controller

TEA2017AAT: Digital Configurable LLC and Multimode PFC Controller

NEW

概述

文档

工具 & 软件

购买/参数

封装/质量

跳转至

概述与特性

开发板和设计

目标应用

相似产品

概述

PREPRODUCTION

The TEA2017AAT is a digital configurable LLC and PFC combo controller for high-efficiency resonant power supplies. It includes both the LLC controller and PFC controller functionality. The PFC can be configured to operate in DCM/QR, CCM fixed frequency, or multimode which supports all operation modes to optimize the PFC efficiency. The TEA2017AAT enables building a complete

特征

> Distinctive features

> Green features

> Protection features

PUBLIC 19



TEA2017 : Digital configurable LLC and multimode PFC controller promotion



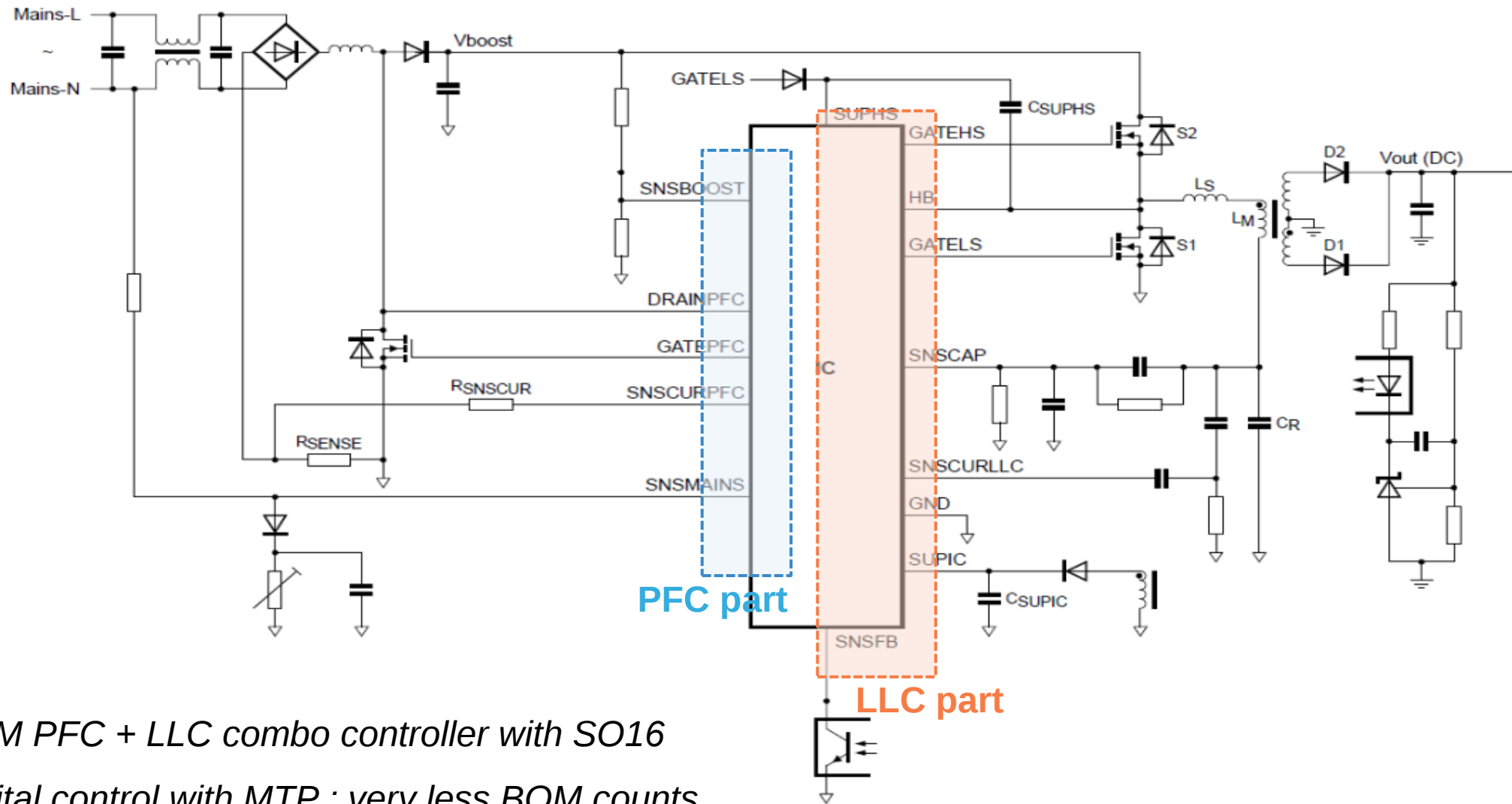
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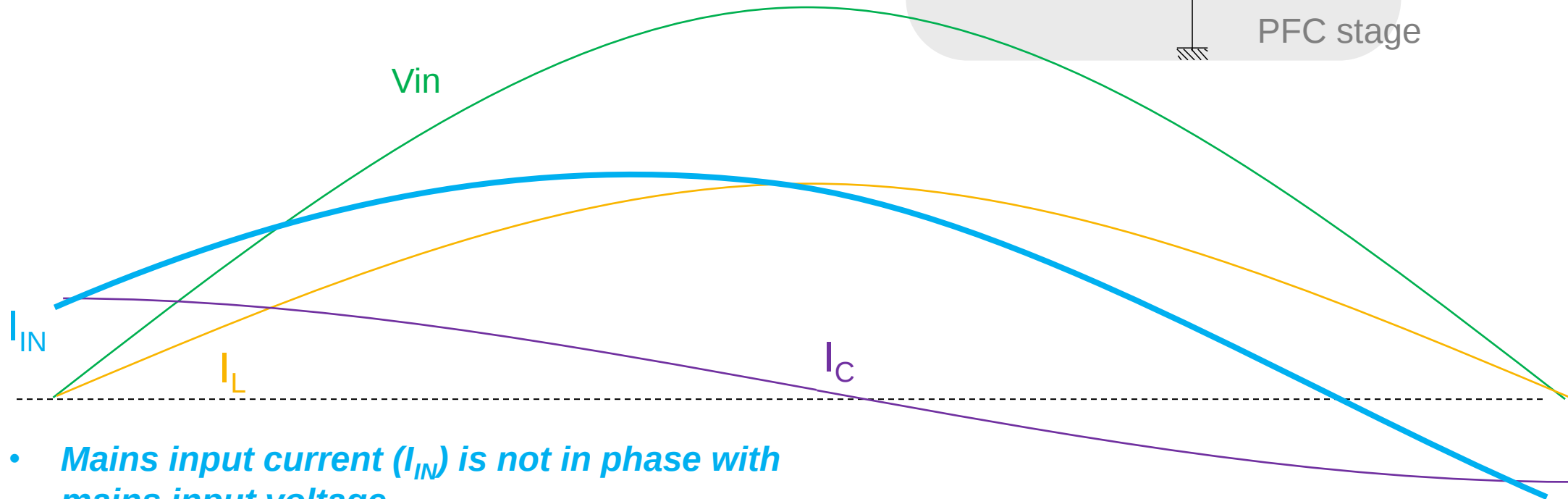
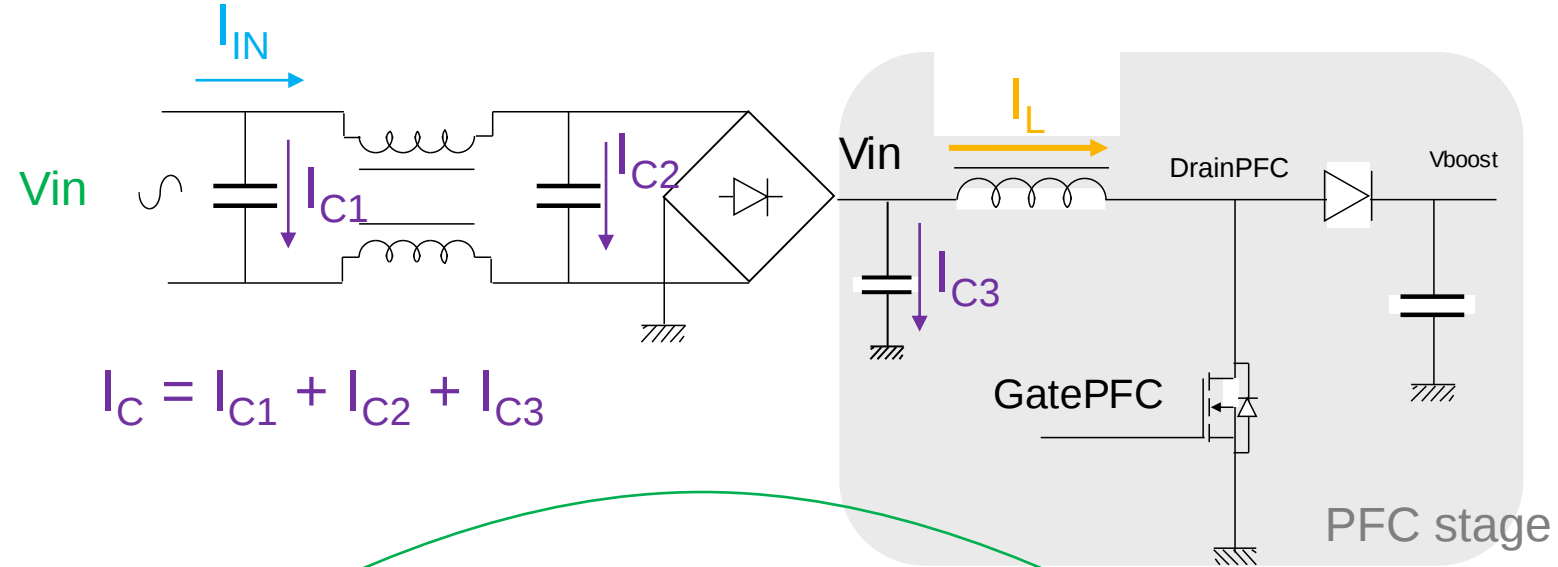
TEA2017 Application schematic



- ✓ CCM PFC + LLC combo controller with SO16
- ✓ Digital control with MTP ; very less BOM counts

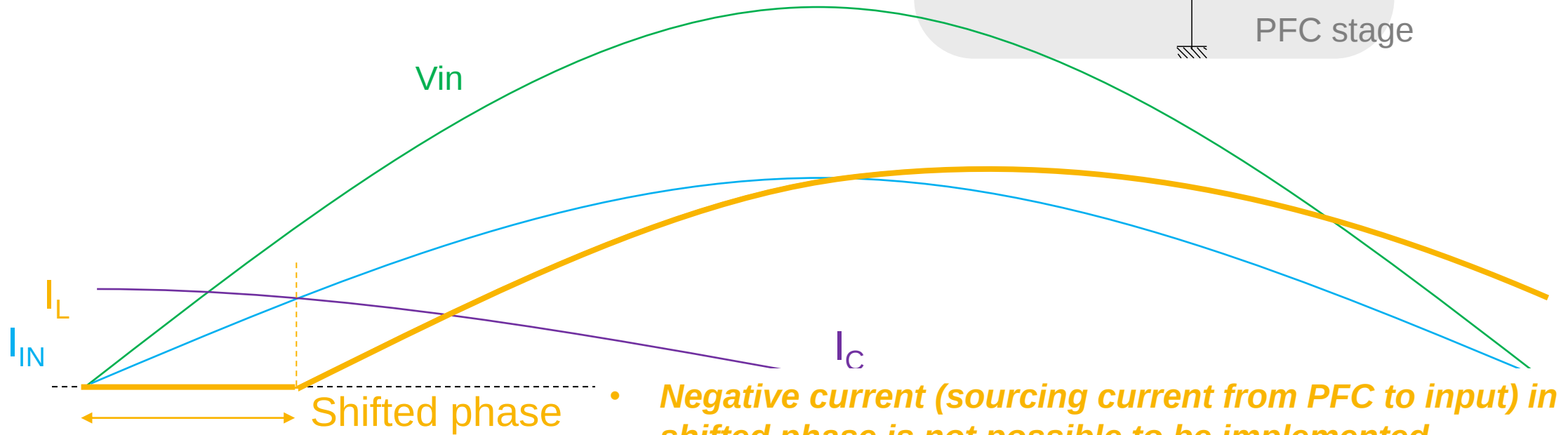
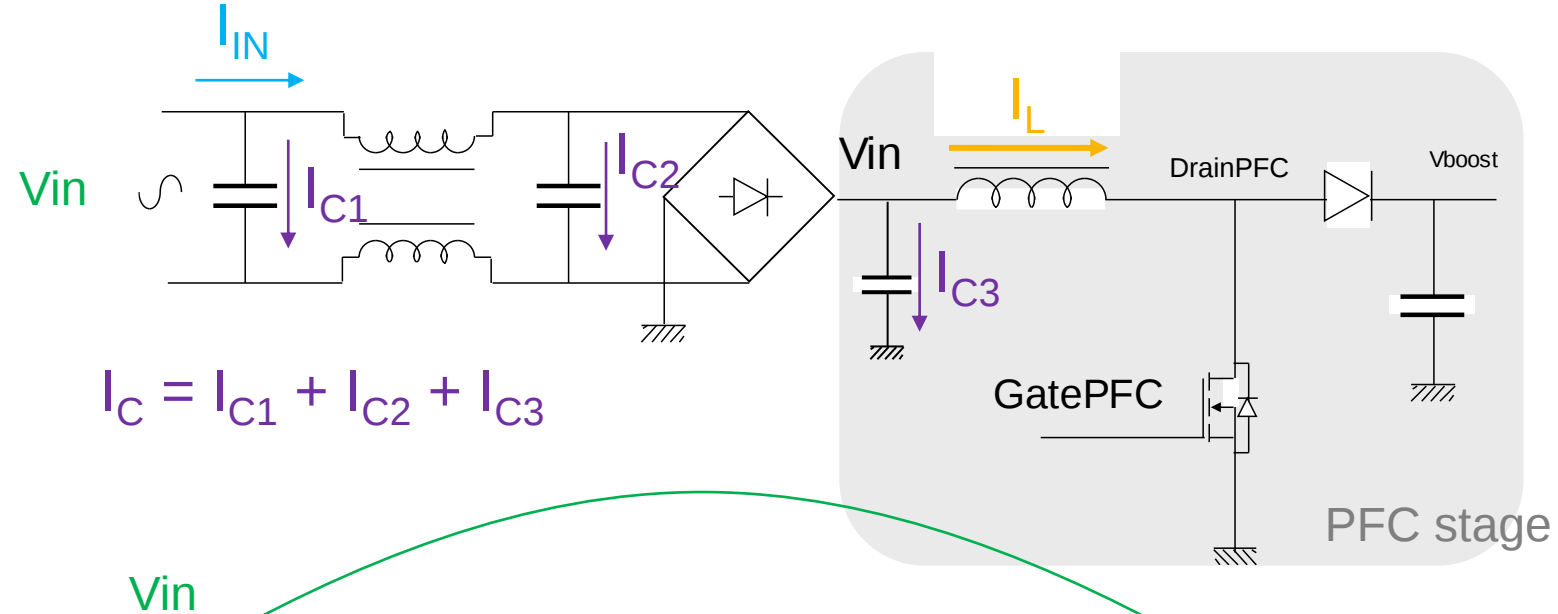
- *Power Factor and THD improvement*
- *Mixed mode PFC ; “CCM” + “QR” + “DCM with valley detection”*
- *PFC frequency decrement*
- *PFC frequency jitter*
- *PFC improved soft-start*
- *MTP setting and programming*
- *Introduction to TEA2017 600W demo board*

Pure sinewave on average inductor current does NOT mean good PF/THD



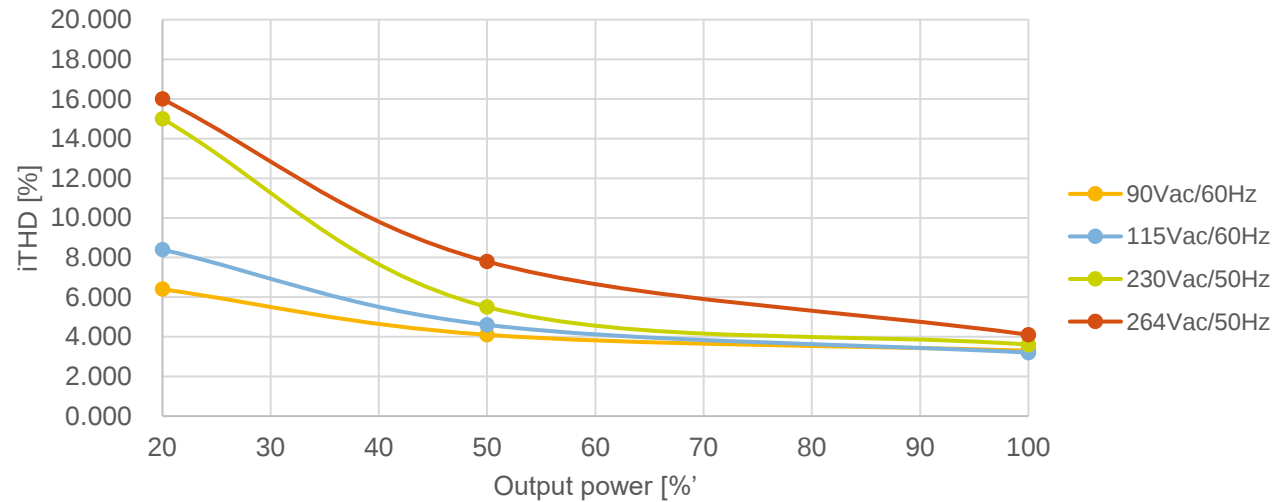
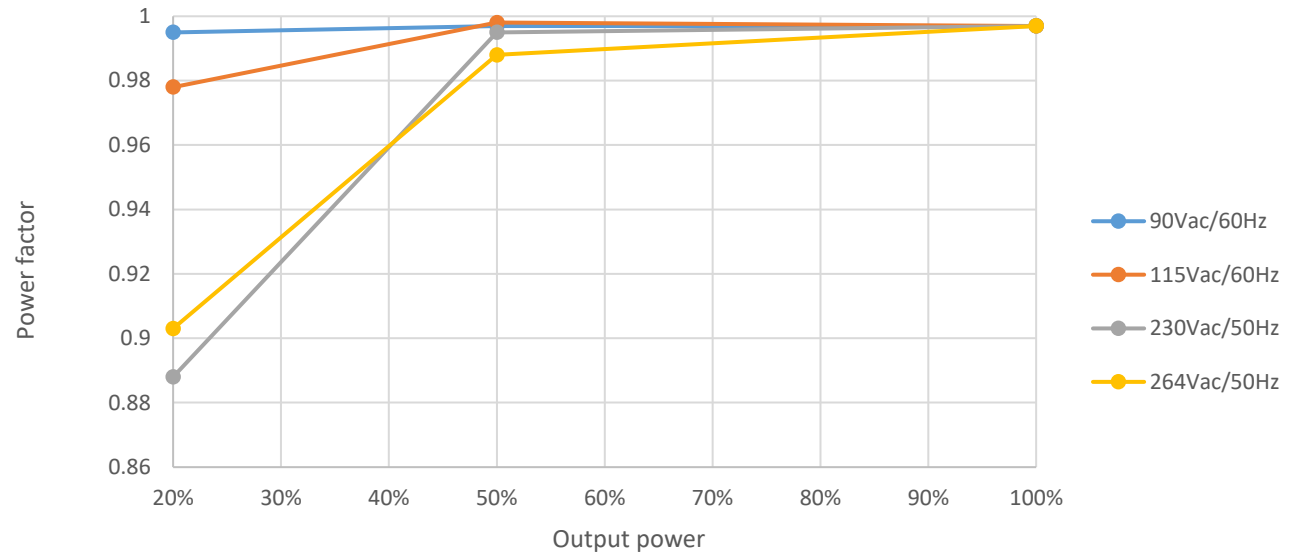
- Mains input current (I_{IN}) is not in phase with mains input voltage

How to achieve better PF and THD ?



- Negative current (sourcing current from PFC to input) in shifted phase is not possible to be implemented.
- Therefore, no switching operation during shifted phase.

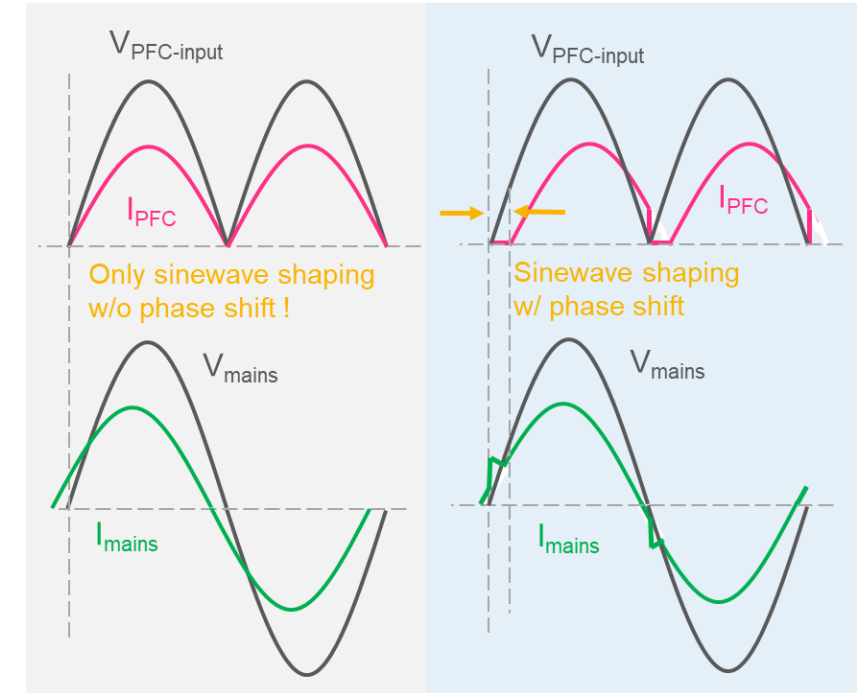
Power factor and THD test result



- Power factor > 0.99, iTHD < 10% at 100% load
- Power factor > 0.88, iTHD < 20% at 20% load

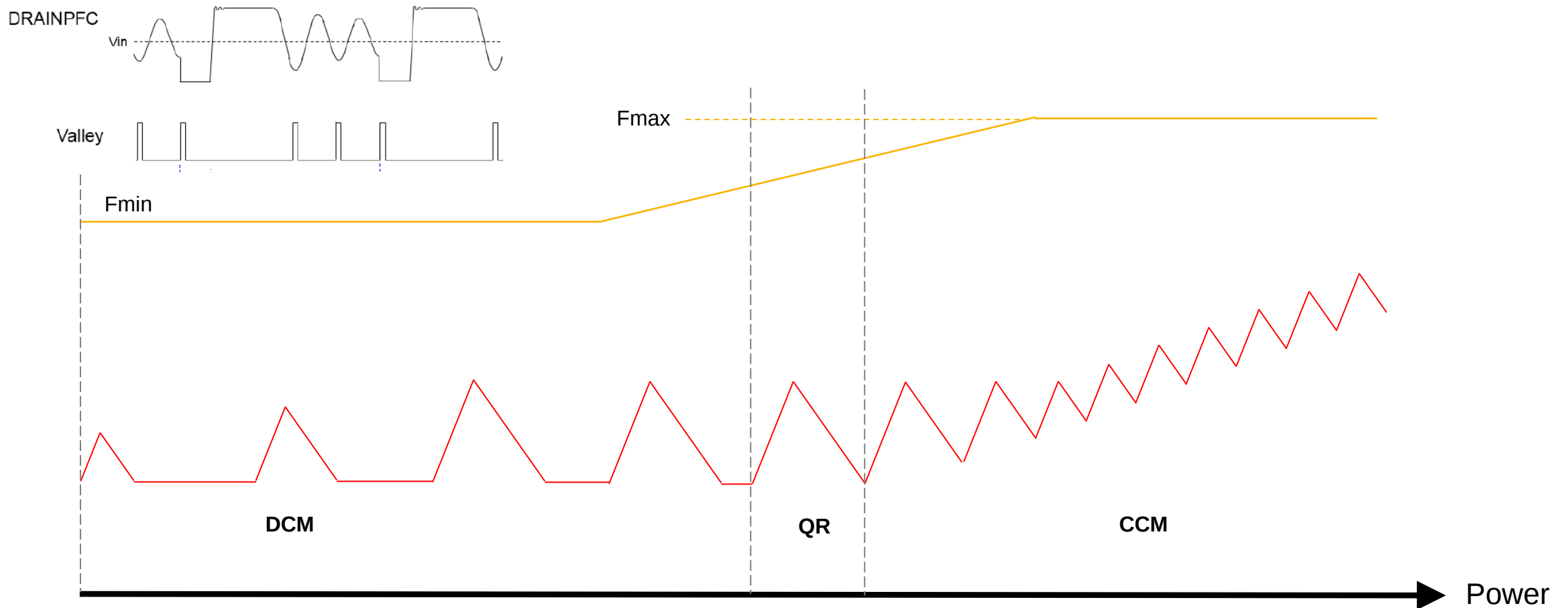
Sinewave shaping with phase shift

[average current mode control]



- *Power Factor and THD improvement*
- ***Mixed mode PFC ; “CCM” + “QR” + “DCM with valley detection”***
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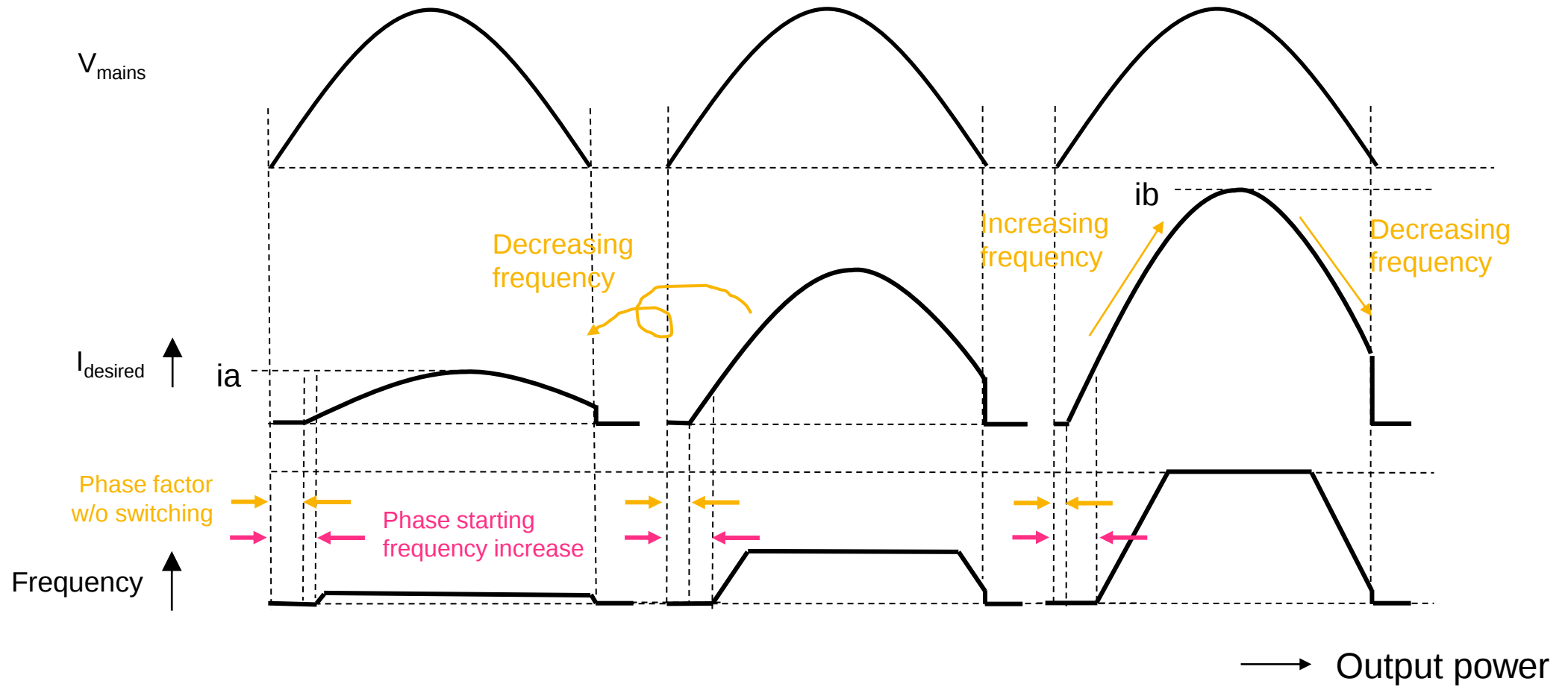
TEA2017 _ Mixed mode PFC control ; CCM/DCM/QR



- ✓ Typical design for high power application
- ✓ Even though frequency control intends to increase frequency at higher power range, the practical frequency is decreased for QR operation.

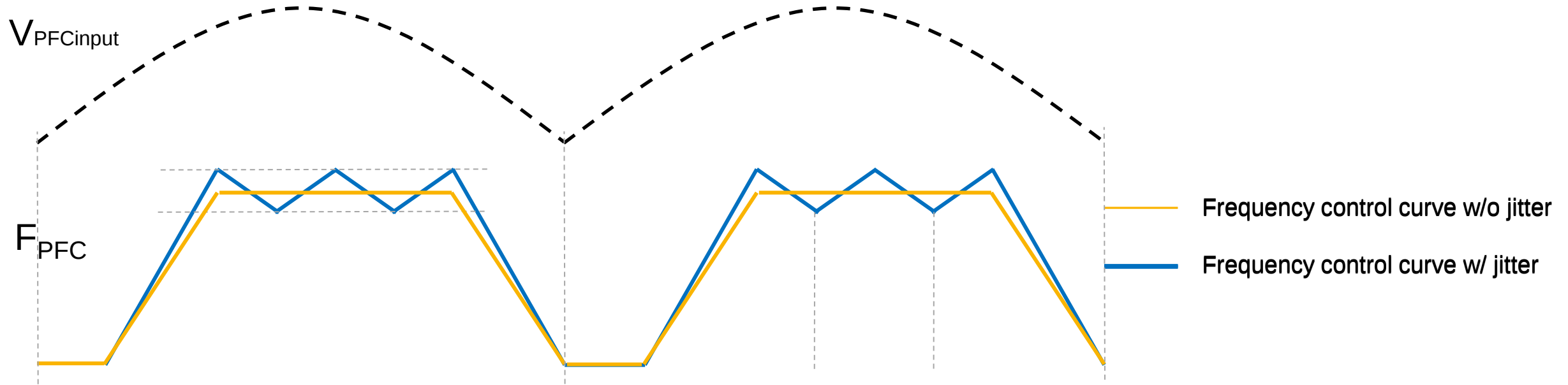
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- ***PFC frequency decrement***
- *PFC frequency jitter*
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TEA2017 _ Frequency by output power

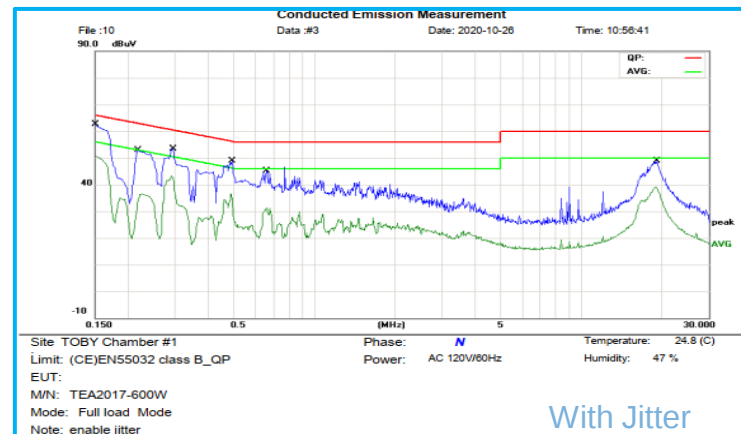
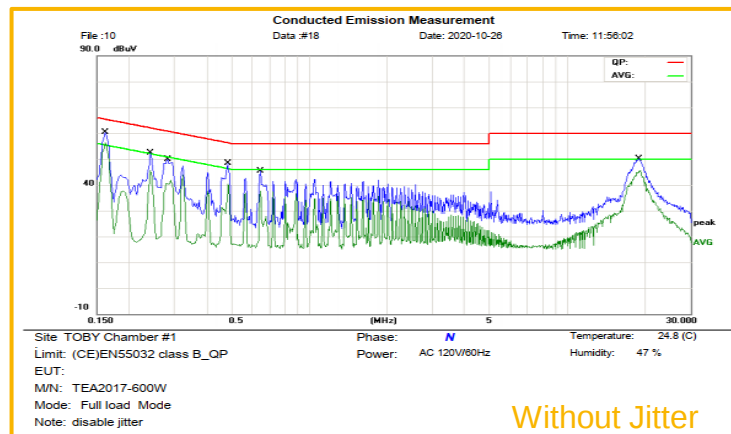


- *Power Factor and THD improvement*
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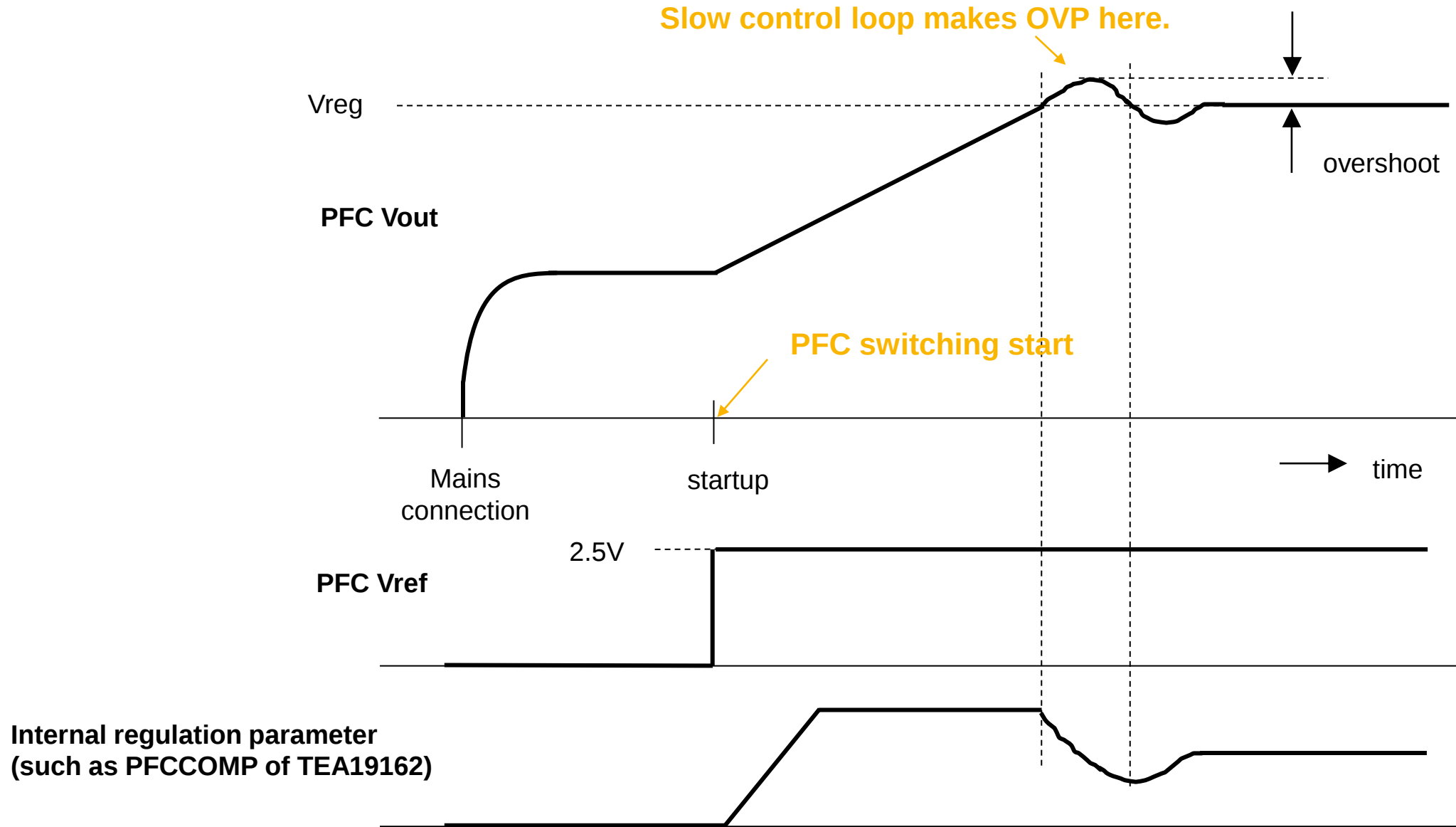
TEA2017 _ PFC jitter function

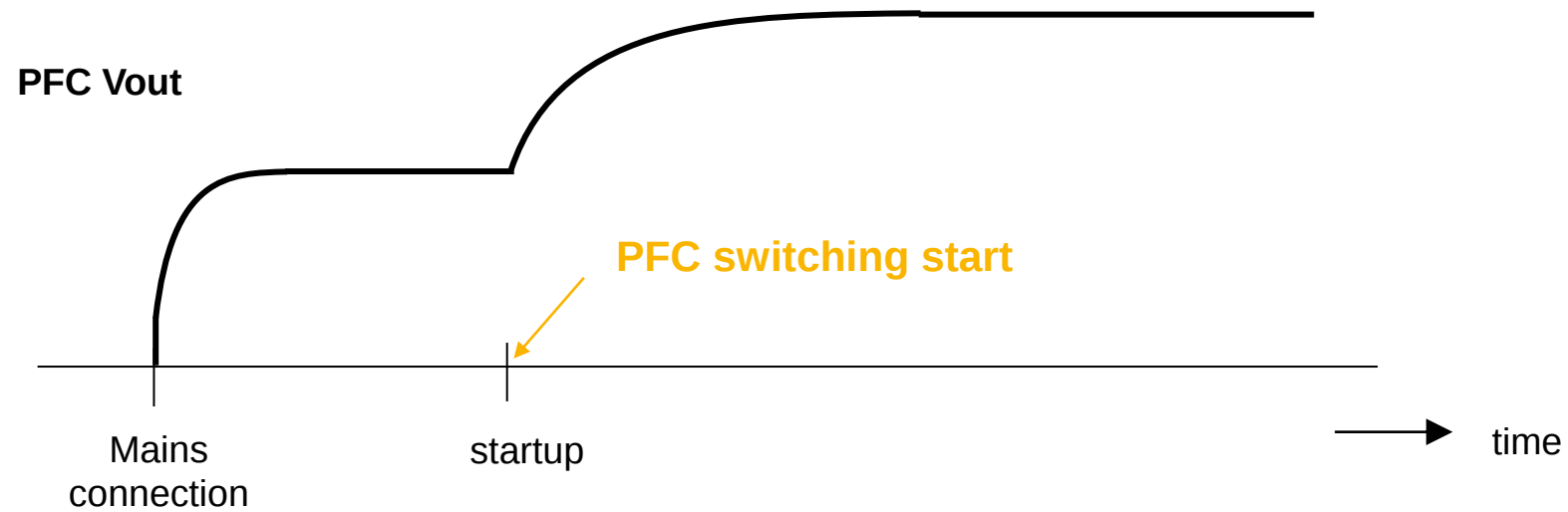


Jitter frequency change amplitude
- Average frequency w/ jitter is same as frequency control value.

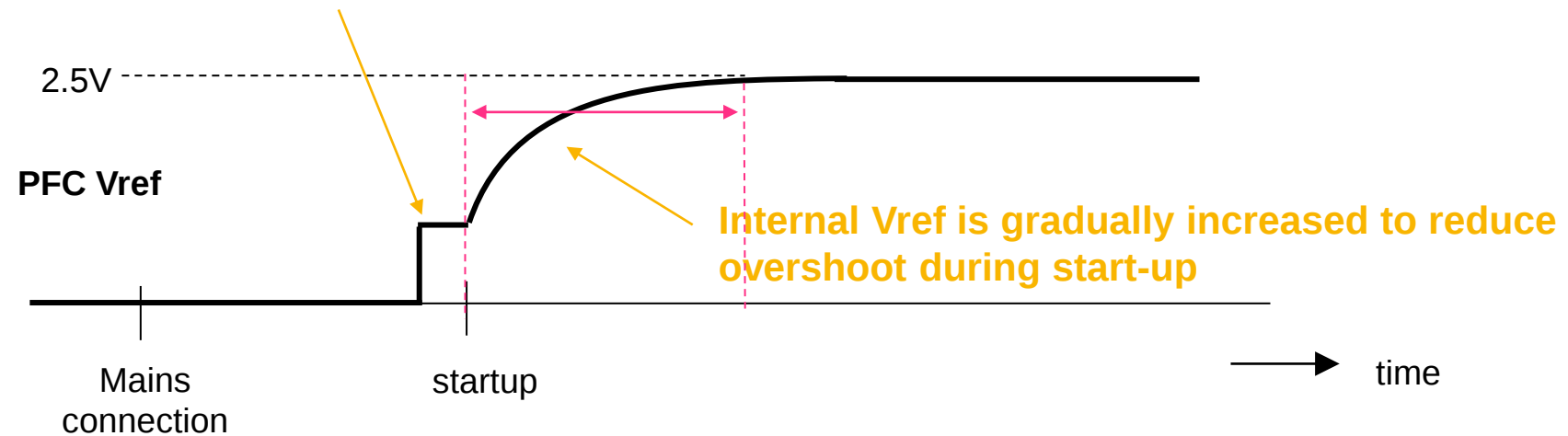


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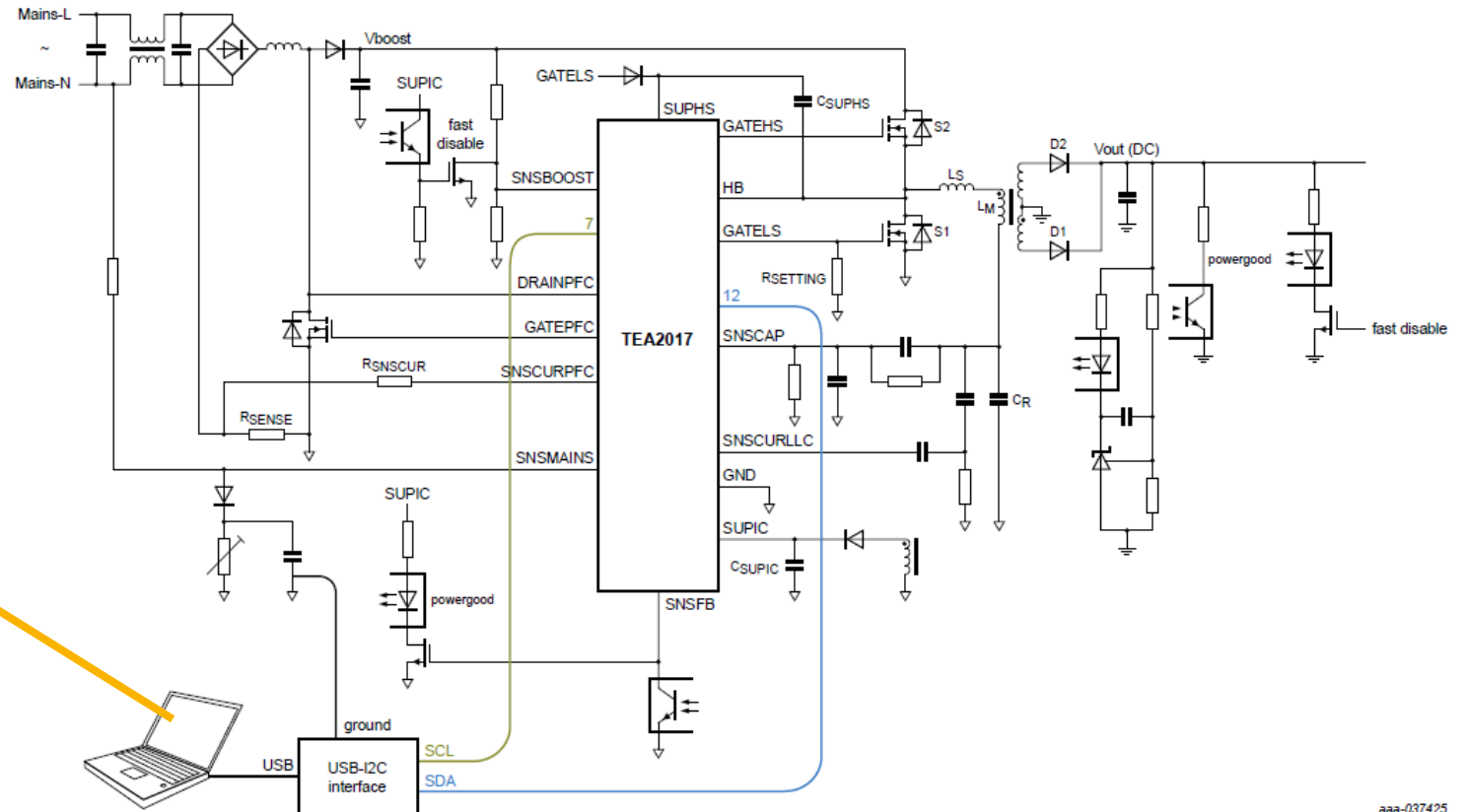
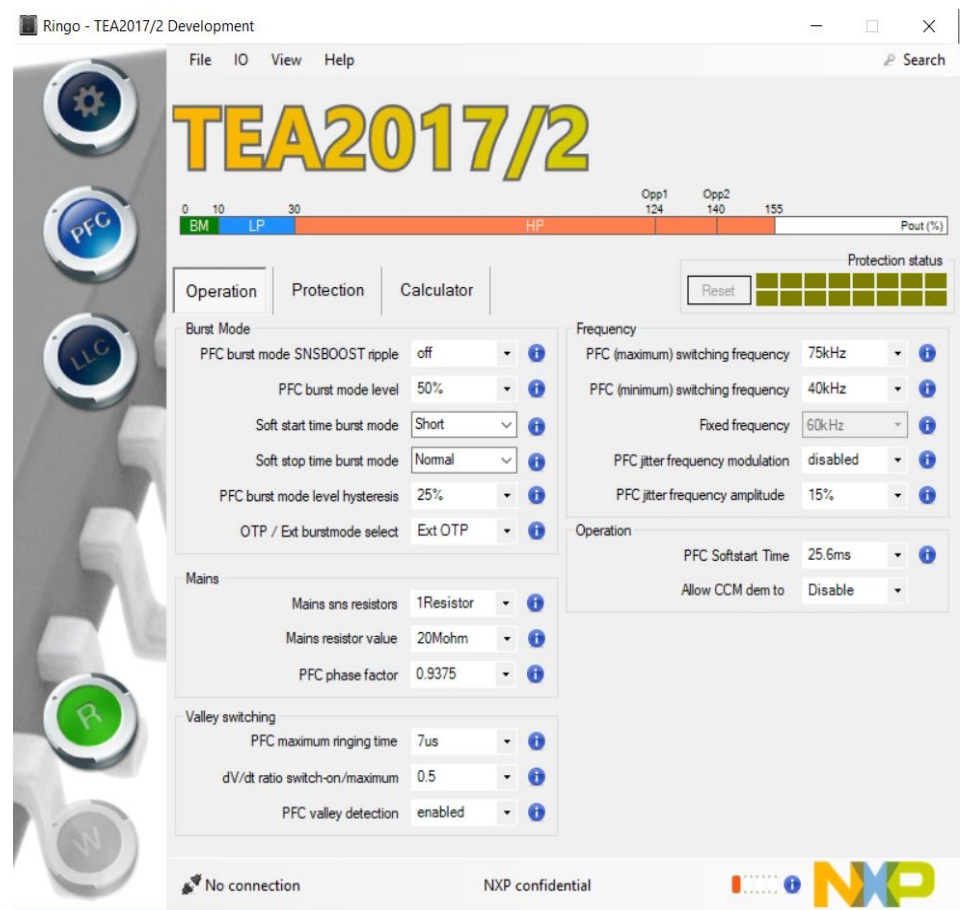


SNSBOOST pin detected mains peak level here.



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TEA2017_ MTP setting and programming

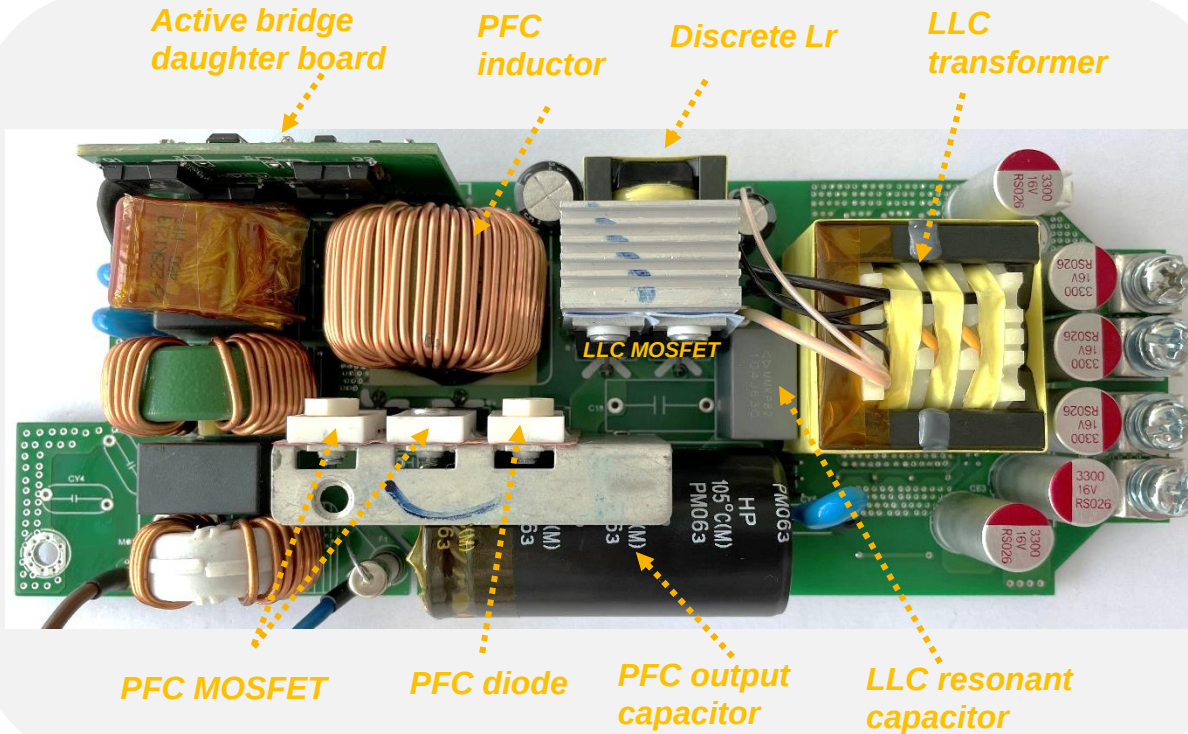


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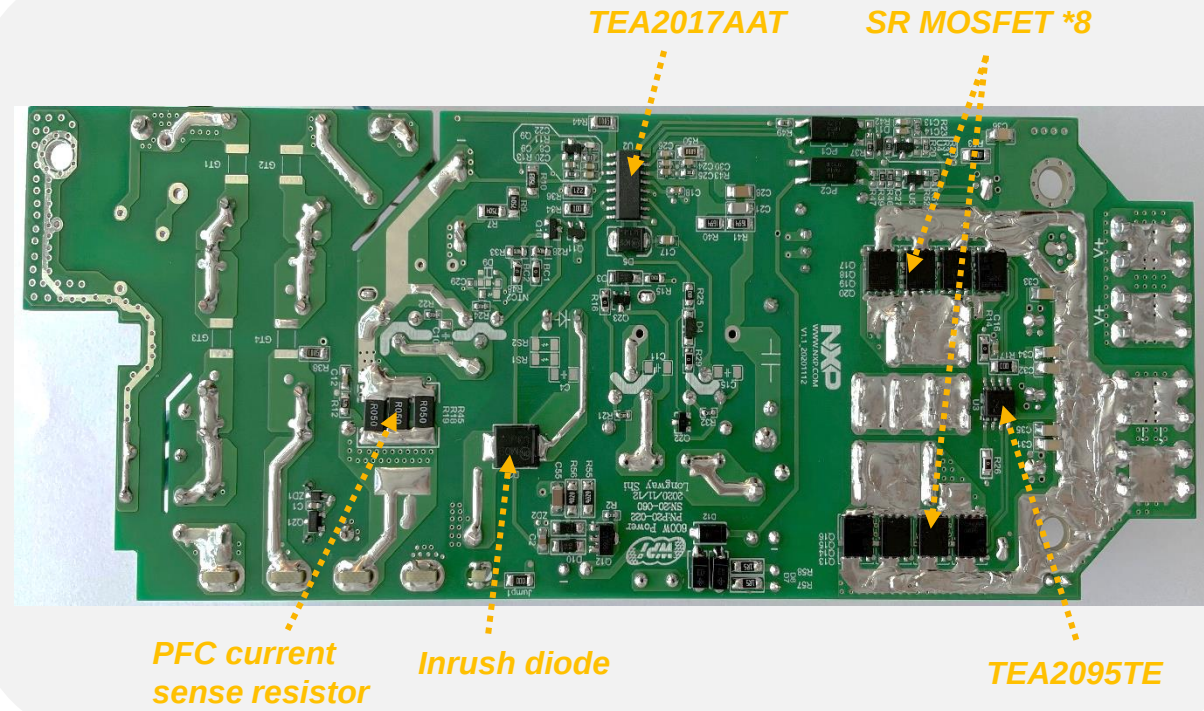
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- ***Introduction to TEA2017 600W demo board***

Demo board photo

Top side



Bottom side

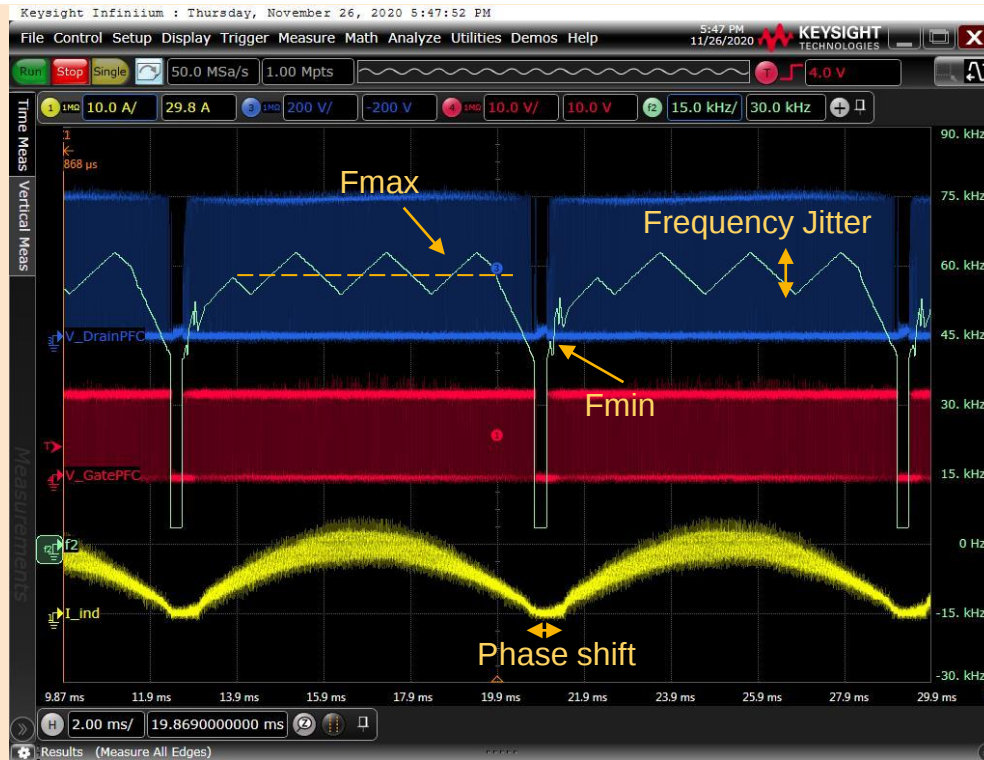


PFC normal operation

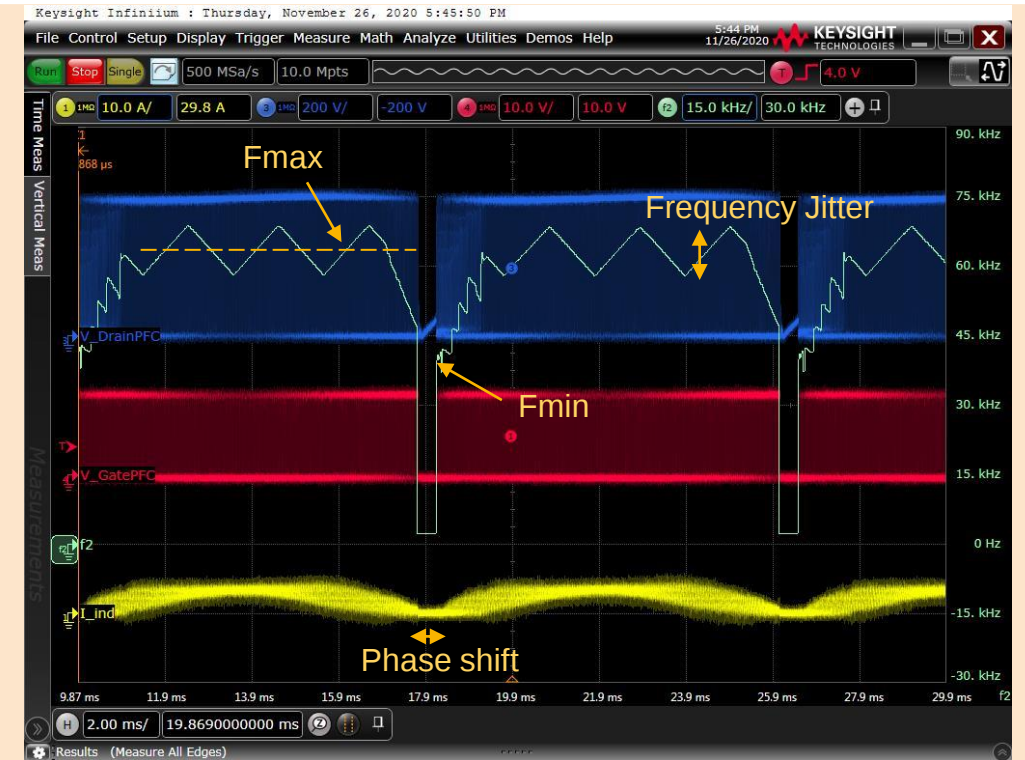
90Vac & 12V/50A

Waveform

CH1 : Ipfc_inductor
CH2 : DrainPFC
CH3 : GatePFC
F2 : PFC frequency

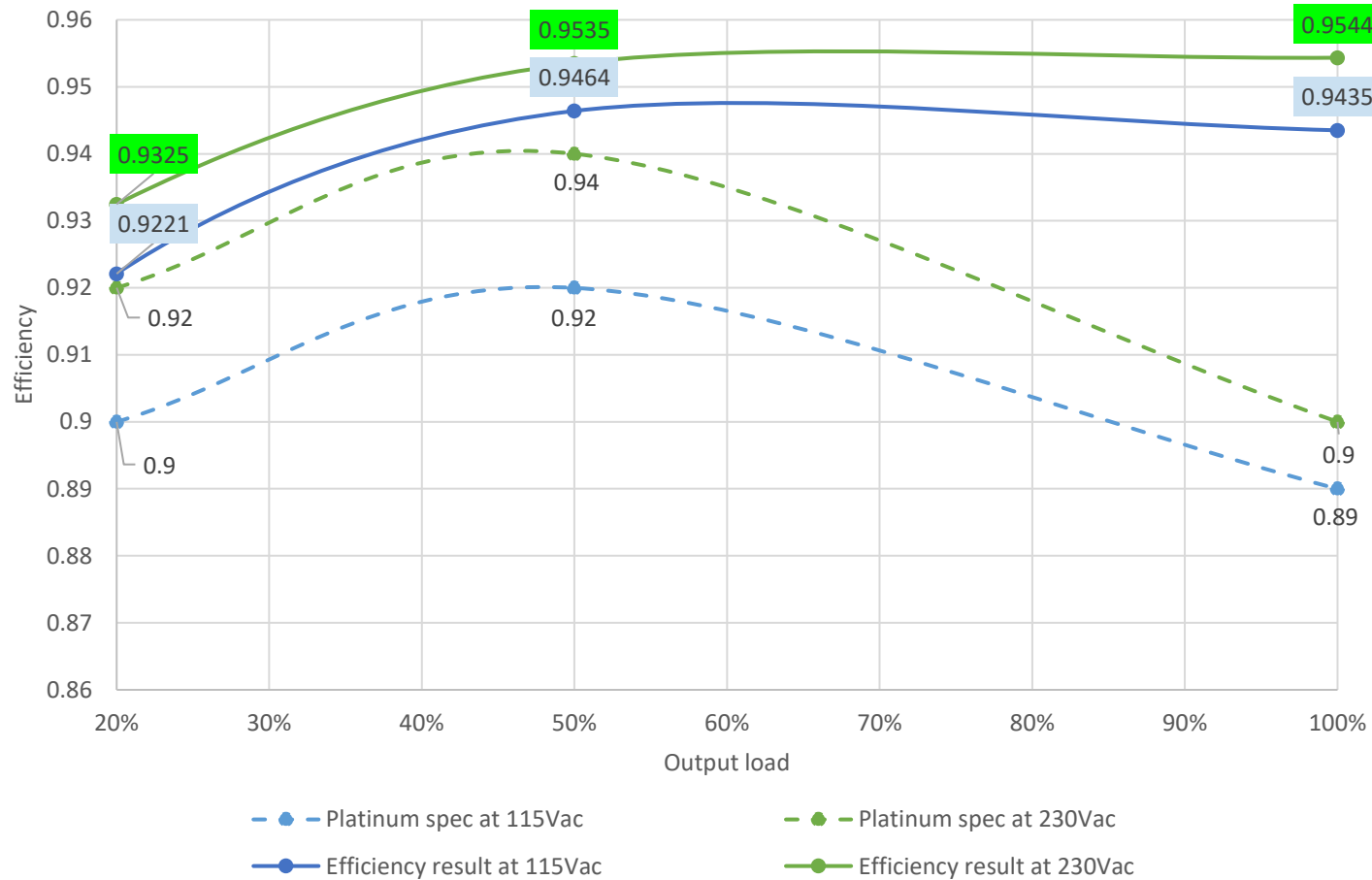


264Vac & 12V/50A



- PFC phase shift operates well for good power factor
- PFC frequency is min value nearby zero-crossing. As Ipfc_inductor average is increased, frequency is increased to max value.
- After PFC frequency increased to max value, frequency jitter operates for better EMI

Efficiency test result



□ Efficiency achievement key points

- At heavy load condition
 - Active bridge
 - PFC frequency control
 - SR performance
- At light load condition
 - PFC frequency control
 - PFC valley detection
 - LLC Low power mode operation

- Test condition : without 2W Fan

Standby power consumption

Input power test result, 115Vac	Input power test result, 230Vac	Output load condition	Specification
<u>0.082 W</u>	<u>0.110 W</u>	<u>No load</u>	<u>0.15 W</u>
0.263 W	0.277 W	0.0125 A	0.5 W
1.628 W	1.579 W	0.104 A	2 W
3.807 W	3.671 W	0.25 A	4 W
6.226 W	6.017 W	0.417 A	6.25 W

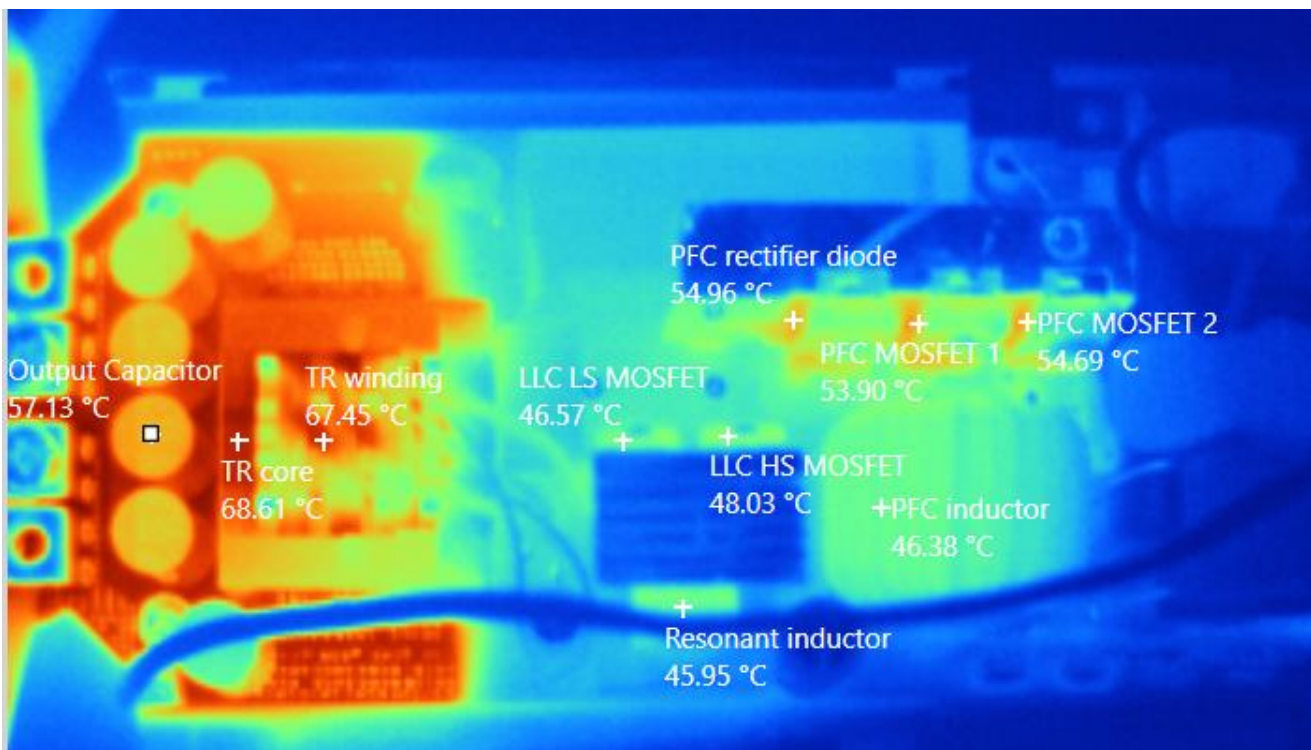
Test equipment ; WT210 with 300s integration time

Additional power loss breakdown at no load condition

1. Compact TEA2017 design (e.g. TEA2017 240W demo) : 70 mW
2. Active bridge : 8 mW
3. 1uF input capacitor: 15 mW
4. LDO and others : 7 mW

Components temperature

- 90Vac input, 600W load, aging 1hr with FAN with thermal camera
- Max temp is <70deg at room temp



Components	Part name	Test result	Test equipment
PFC inductor	L1	46.4 °C	Thermal camera
PFC MOSFET 1	Q5	54.6 °C	Thermal camera
PFC MOSFET 2	Q6	53.9 °C	Thermal camera
PFC rectifier diode	D1	54.9 °C	Thermal camera
LLC HS MOSFET	Q7	48.0 °C	Thermal camera
LLC LS MOSFET	Q8	46.5 °C	Thermal camera
Transformer winding	T1	67.4 °C	Thermal camera
Transformer core	T1	68.6 °C	Thermal camera
Resonant inductor winding	Lr1	45.9 °C	Thermal camera
Output capacitor	CE5	57.1 °C	Thermal camera
SR MOSFET	Q13	61.0 °C	Thermocouple thermometer
	Q20	55.0 °C	Thermocouple thermometer
TEA2017T	U2	42.0 °C	Thermocouple thermometer
TEA2095TE	U3	59.0 °C	Thermocouple thermometer
Ambient		25 °C	



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