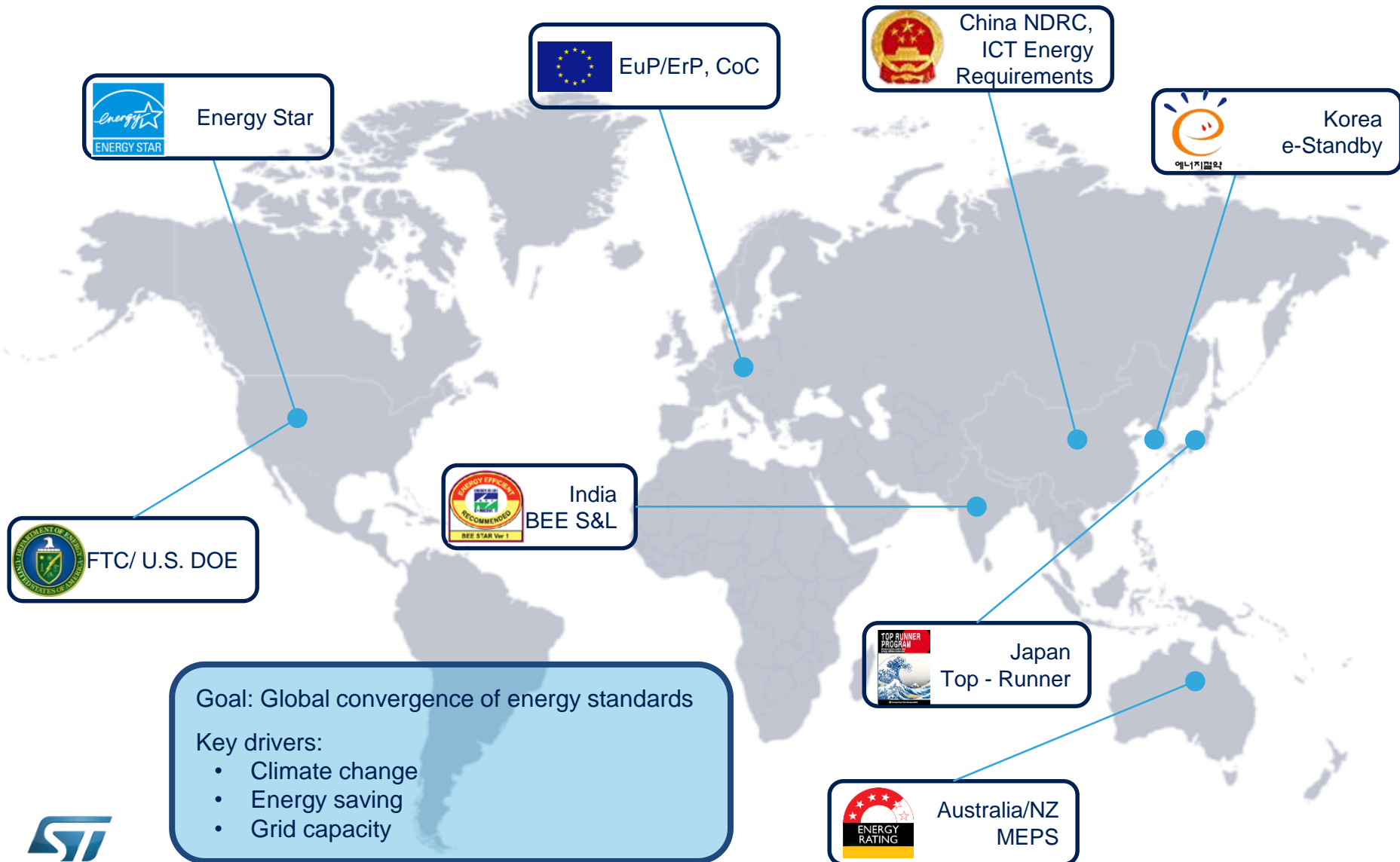




# EuP Lot 6 Tier2 Ecodesign requirements for Standby: ST's Readiness

# Power supply energy regulations landscape

2



# ST's commitment in reducing standby power consumption

3

2000

2005

2010

2015

2020

## Standby power reduction IC technology

- VIPer0P unveiled in 2015
- IR & RF remotely-controlled Zero Standby

## Smart power ICs

### IC leakage current reduction & HV Start-up technology

- Reaching  $< 0.5 \text{ mW}$  IC consumption
- Integrated HV start-up: from 200 mW with ext. resistor to  $0.05 \text{ mW}$  consumption

Today ST has reached the lowest power consumption in the market during no load

## Power discretes

### Low-loss switching high-efficiency device technology

- Latest MOSFET tech.: +0.45% efficiency at light load vs. previous technology

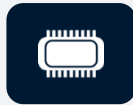
## Leveraging breadth and depth of dedicated SMPS product portfolio



HV converters



PFC ICs



LLC controllers



Digital controllers



SR controllers



HV & LV Power MOSFETs



Schottky and ultrafast diodes



Protections

Smart power ICs

Power discretes

# Understanding EuP Lot 6 Tier2: Standby is a Deep Sleep Mode

4

- **Standby defined by LoT 6:** “A condition where the equipment is connected to the mains power source, depends on energy input from the mains power source to work as intended, and provides only the following functions, which may persist for an indefinite time:
  - Reactivation function, or reactivation function and only an indication of enabled reactivation function, and/or
  - Information or status display”

## Energy-using products



Household appliances



Information technology equipment



Consumer equipment



Toys, leisure and sports equipment

January 2010

Tier1

January 2013

Tier2



Power consumption in Off-mode<sup>(\*)</sup>  $< 0.5 \text{ W}$

Power consumption in Standby mode with reactivation function only  $< 0.5 \text{ W}$

Power consumption in Standby mode with reactivation function and status display  $< 1.0 \text{ W}$

(\*) “Off-mode” is a condition in which the equipment is connected to the mains power source and is not providing any function.

# State-of-the-art controllers effectively help meet EuP Lot 6 Tier2

- Stringent energy regulations require **IC's dedicated features** to improve the SMPS standby consumption in systems that do not include an auxiliary power supply



Primary side



## L6563H

HV start-up  
TM PFC

## L4984D

CCM PFC – Line-  
modulated FOT

## L6699

Enhanced HV  
resonant controller



PFC Standby improvement

- Integrated 700 V start-up source
- Burst mode operation / Idle state driven by DC-DC converter's IC through dedicated interface
- Typical IC consumption in Burst mode: 2.2 mA

- Synchronized burst-mode operation with D2D converter controller.
- Typ. idle state quiescent current: 200  $\mu$ A

LLC Standby improvement

- Improved burst mode operation at light load or no load
- Self-adaptive deadtime
- IC quiescent current in Burst mode: 1 mA

## SRK2001

Adaptive synch.  
rect. controller

SR Standby improvement

- Intelligent automatic sleep mode, reducing also IC's quiescent consumption
- Typ. IC quiescent current for low consumption mode operation: 50  $\mu$ A



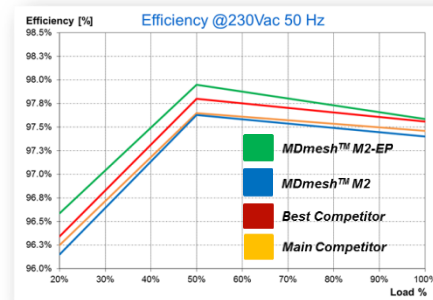
Secondary side



# Efficient power MOSFETs enhance the ecodesign performance

6

- **Continuous improvement** of HV and LV MOSFET technologies to answer the world's need for more efficient power supplies



## MDmesh M2 EP

**STP25N60M2-EP**  
M2-enhanced  
performance  
for 200W PFC

PFC Efficiency improvement

- Suitable for hard & soft-switching topologies
- Improved efficiency at light load
- Higher efficiency at whole load range
- Lower temperature

**STF15N60M2-EP**  
M2-enhanced  
performance  
for 150W LLC

LLC Light load efficiency  
improvement

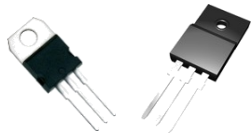
- Extremely low gate charge
- Optimized Vth and Rg values for soft switching
- Reduced switching losses for wide range of load and input voltage

## H7 – F7 technology

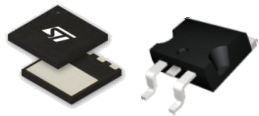
**STLD220N3LLH7**  
**STL220N6F7**  
**STLD130N8F7**

Synchronous Rectification  
efficiency improvement

- Extremely low on-resistance
- Dual side cooling package to increase efficiency and to improve current handling capability
- Lower temperature

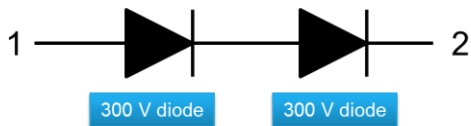


Primary  
side



Secondary  
side

# Latest rectifier technologies add value to the ecodesign



## Tandem G2

**STTH8T06DI**  
**STTH8ST06DI**  
**STTH12T06DI**  
 Housed inside  
 insulated package

PFC Efficiency improvement

- Very low reverse recovery charges (QRR)
- Very low switching losses
- Insulated package with internal ceramic
- Very good thermal behaviors.

## SiC\* diodes

**STPSC8C065D**  
**STPSC806D**  
**STPSC12C065D**  
**STPSC1206D**

PFC Efficiency improvement

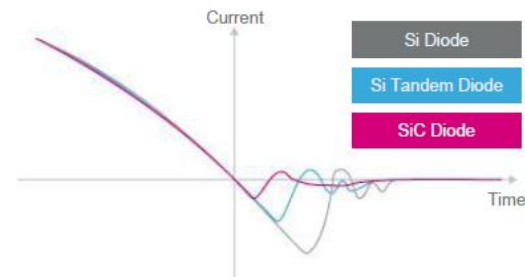
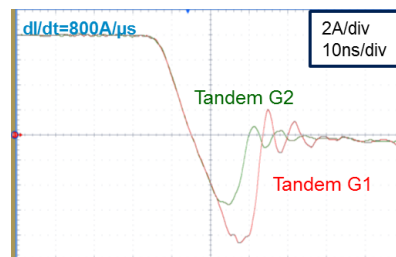
- Low forward conduction losses
- Negligible switching losses
- Extremely low reverse recovery charges (QRR)
- $V_{RRM}$  600 V, 650 V, 1200 V guaranteed @ -40 °C.
- Low EMC, simplifying certification and speeding TTM
- High  $T_j$ , 175 °C ensuring high reliability

## FERD\* technology

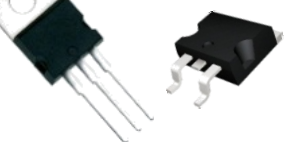
**FERD20U50DJF**  
**FERD40U45CG**

DC/DC Efficiency improvement

- Ultra-low VF technology
- Higher current density (A/mm<sup>2</sup>)
- Lower leakage current ratio typ. & max
- Lower dependency of IR versus  $T_j$  → Lower thermal runaway risk



Primary side  
(PFC)



Secondary  
Side

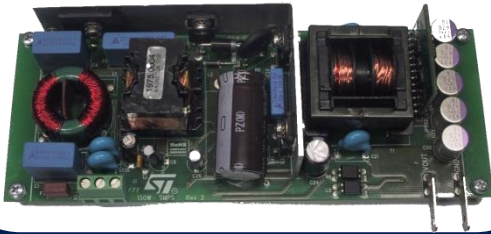
# System solutions compliant with EuP Lot 6 Tier2

8



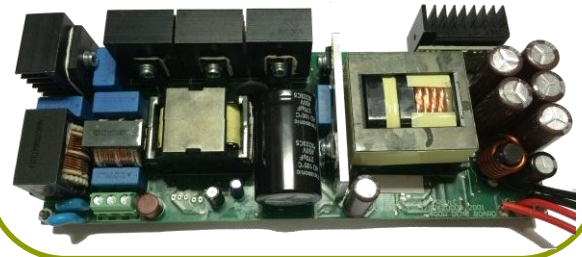
## STEVAL-ISA170V1

12V - 150 W resonant converter with synchronous rectification based on L6563H, L6699 and SRK2001



## EVL400W-ADP/ATX

12V - 400W SMPS for adapter, desktop and AIO using L4984D, L6699 and SRK2000A





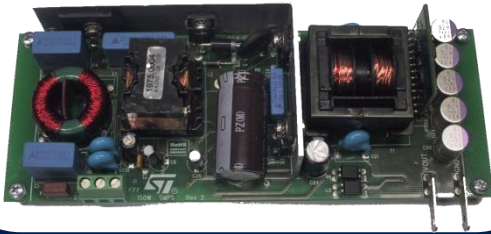
# System solutions compliant with EuP Lot 6 Tier2

9



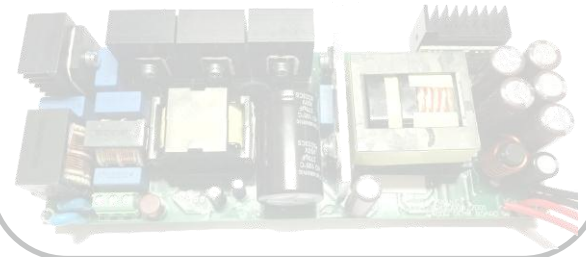
## STEVAL-ISA170V1(\*)

12V - 150 W resonant converter with synchronous rectification based on L6563H, L6699 and SRK2001



## EVL400W-ADP/ATX

12V - 400W SMPS for adapter, desktop and AIO using L4984D, L6699 and SRK2000A

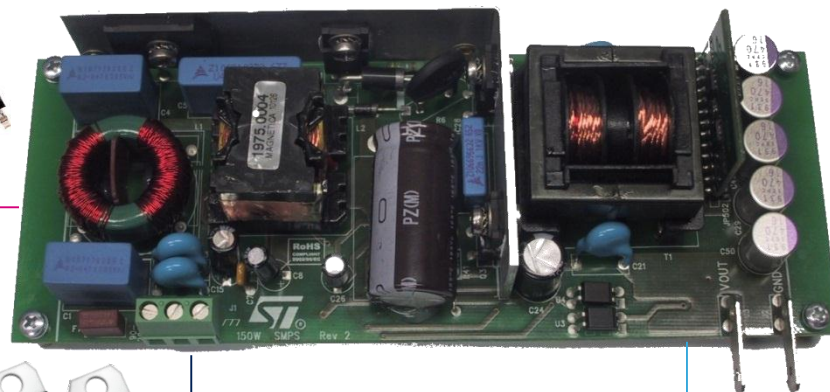


# STEVAL-ISA170V1: 12 V - 150 W resonant converter with synchronous rectification

10



Based on state-of-the-art PFC and LLC controllers, **L6563H** and **L6699**



## Advanced power stage

- Based on **MDmesh™ M2** technology of power MOSFETs

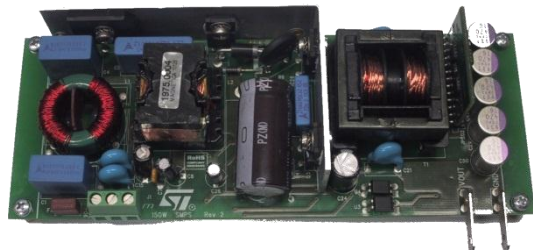


Uses latest synchronous rectification controller **SRK2001**, to boost efficiency in all load conditions



## Outstanding performance vs. Ecodesign requirements

- Compliant with **ENERGY STAR®** requirements or computers ver. 6.1
- Compliant with **EuP Lot 6 Tier2** requirements for household and office equipment
- Compliant with European **CoC ver. 5 Tier 2** requirements for external power supplies



# STEVAL-ISA170V1

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## Main features and target applications

### Main features

- Input mains range: 90-264 V<sub>AC</sub>, frequency 45-65 Hz
- Output voltage: 12 V at 12.5 A continuous operation
- Mains harmonics: According to EN61000-3-2 Class-D or JEITA-MITI Class-D
- No-load mains consumption: < 0.15 W at 230 V<sub>AC</sub>, according to **European CoC ver. 5 Tier 2** requirements for external power supplies
- Avg. efficiency > 91% at 115 V<sub>AC</sub>, according to **ENERGY STAR® 6.1** for external power supplies
- Light load efficiency: According to **EuP Lot 6 Tier2** requirements
- EMI: According to EN55022 Class-B
- Safety: According to EN60950
- Protections: PFC brownout protection, LLC anti-capacitive protection, output overcurrent and short-circuit protection

### Target applications



All-in-one  
computer PSU



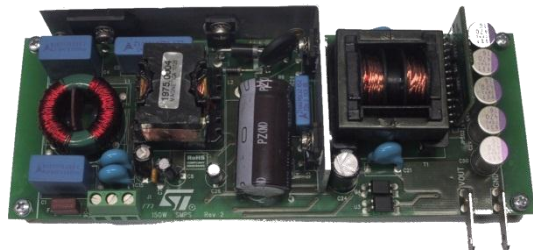
ATX desktop  
PSU



High power  
adapters



Game consoles



# STEVAL-ISA170V1

12

## Block diagram

Power stage: key technologies

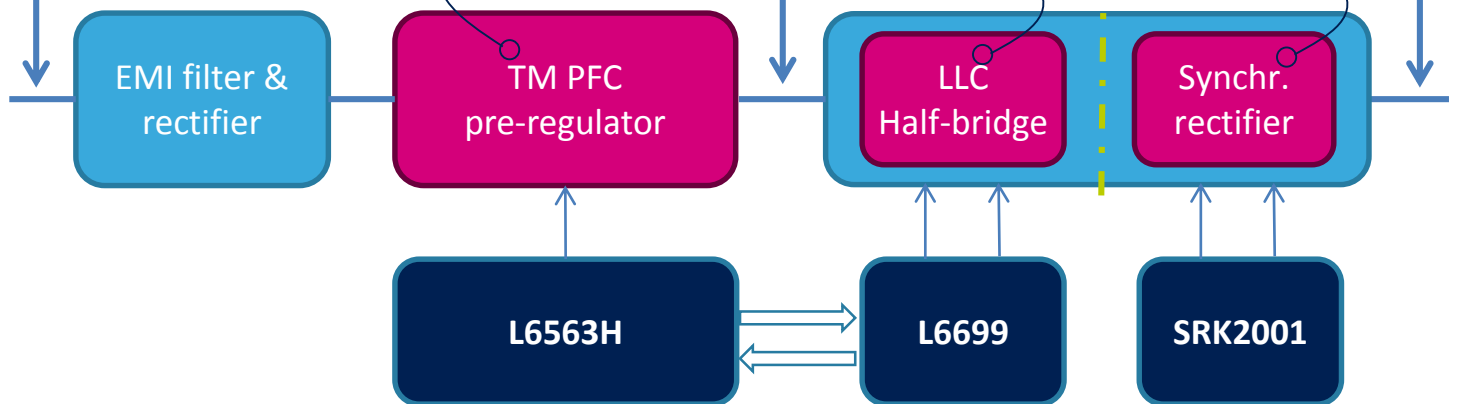
MDmesh™ M2  
Power MOSFETs  
**STF24N60M2**

Turbo 2 Ultrafast  
Diode  
**STTH5L06 or  
STTH5R06**

MDmesh™ M2  
Power MOSFETs  
**STF9N60M2**

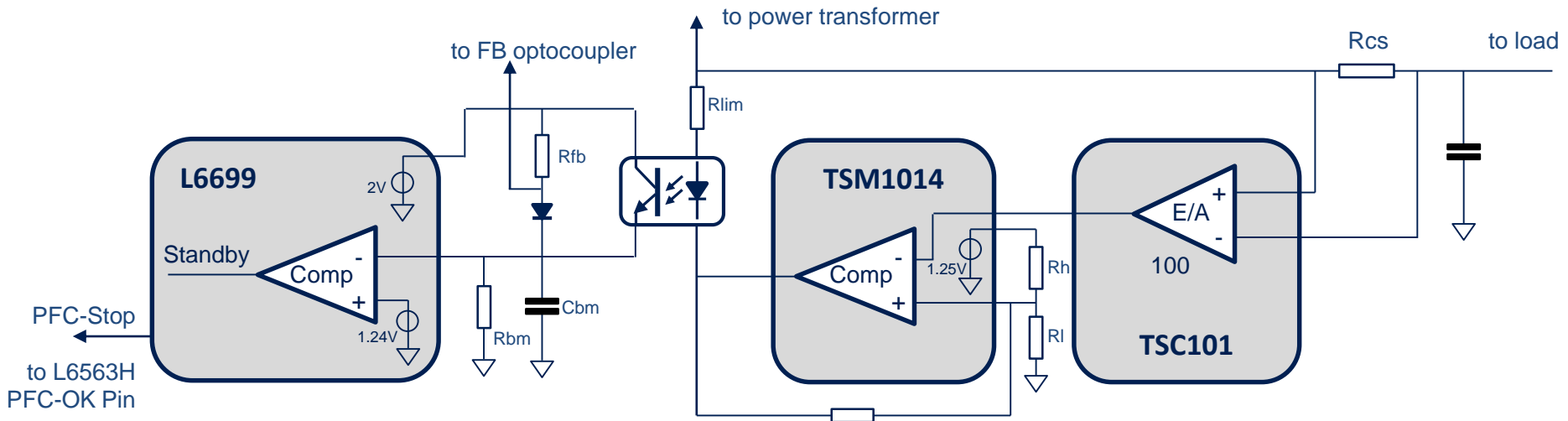
STripFET™ V  
Power MOSFETs  
**STL140N4LLF5**

Input voltage  
90 to 264 V<sub>AC</sub>, 45/65 Hz



- TSM1014 (CC-CV controller) and TSC101 (amp. for current detector) are used for Burst mode

## Standby power-saving through reliable Burst mode



Burst mode operation heavily influences converter efficiency at light loads

→ Burst mode threshold must be properly set

Burst mode threshold set by sensing directly the output load

→ Standby consumption independent of production spread

L6699 enables also the PFC burst mode and the L6563H idle state

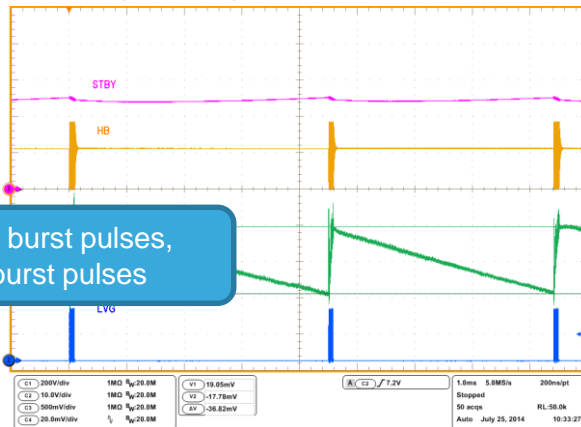
→ Power supply overall standby consumption improved

# STEVAL-ISA170V1:

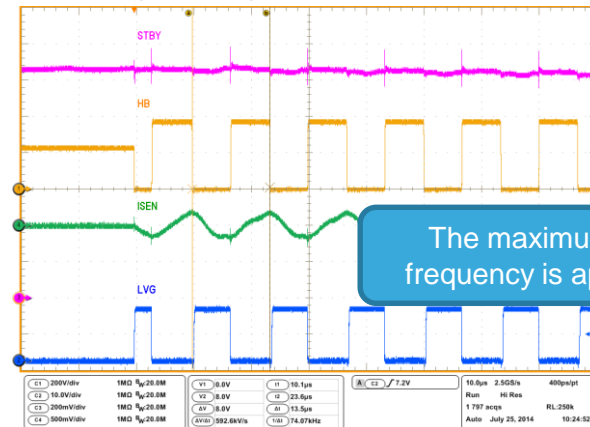
## Burst mode operation at light loads

14

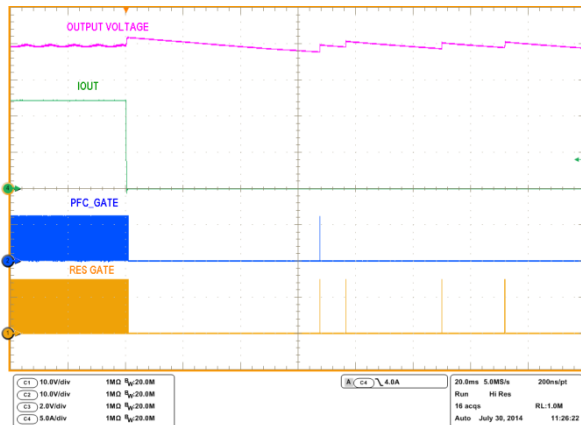
**Pout = 250 mW operation**  
STBY Pin (purple), output voltage (green),  
Half-bridge (orange) and low-side GD (blue)



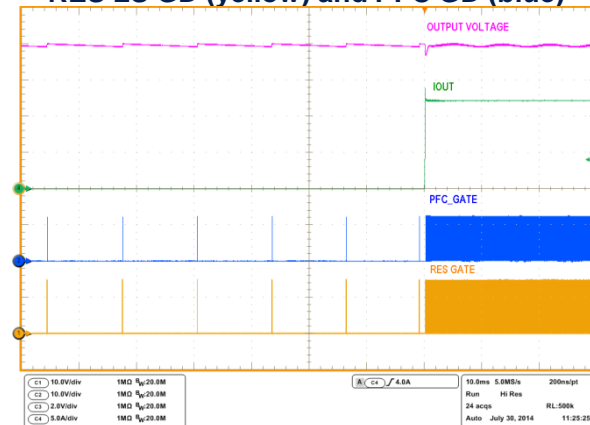
**Pout = 250 mW operation – detail**  
STBY Pin (purple), ISEN pin (green),  
Half-bridge (orange) and low-side GD (blue)



**Transition full load to no load at 115 Vac - 60 Hz**  
Output voltage (purple), output current (green),  
RES LS GD (yellow) and PFC GD (blue)



**Transition no load to full load at 115 Vac - 60 Hz**  
Output voltage (purple), output current (green),  
RES LS GD (yellow) and PFC GD (blue)



# STEVAL-ISA170V1:

## Verification of Ecodesign requirements

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**ENERGY STAR® requirements for computers ver. 6.1: PASS**

	Test results		Limits
	115 Vac - 60 Hz	230 Vac - 50 Hz	
Efficiency @ 20 % load	84.2%	86.63%	>82%
Efficiency @ 50 % load	91.24%	92.90%	>85%
Efficiency @ 100 % load	90.96%	93.16%	>82%
Power factor	0.9897	0.9521	>0.9

Test results		Limits	
115 Vac - 60 Hz	230 Vac - 50 Hz		
90.6%	92.20%	>87%	Avg. efficiency measured at 25%, 50%, 75%, 100% (*)
52.04%	54.63%	>50%	Efficiency @ 250 mW load
35.06%	35.65%	>33%	Efficiency @ 100 mW load (*)

**EuP Lot 6 Tier2 requirements: PASS**

(\*) Source of requirement: ST's customers

**European CoC ver. 5 Tier2 requirements for external power supplies: PASS**

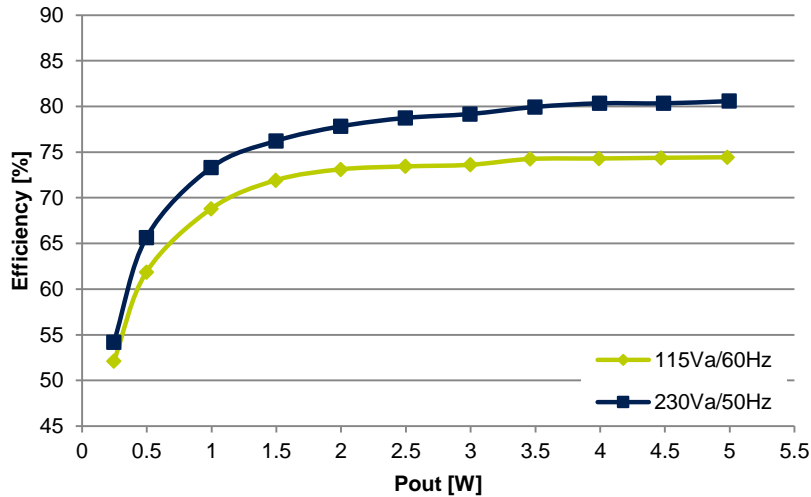
	Test results		Limits
	115 Vac - 60 Hz	230 Vac - 50 Hz	
Avg. efficiency measured at 25%, 50%, 75%, 100%	90.6%	92.20%	>89%
Efficiency @ 10% load	81.27%	85.21%	>79%
No-load input power [W]	0.140 W	0.145 W	< 0.15 W

# STEVAL-ISA170V1: Efficiency measurements

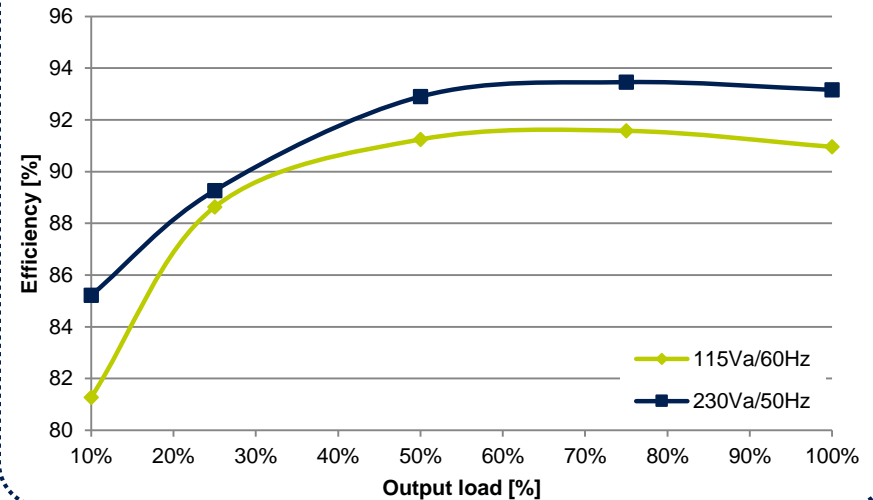
16

- Light load efficiency improved by **synchronized Burst mode** function of both L6563H and L6699 and by **self-adaptive deadtime** of L6699

Light load efficiency



Full range load efficiency





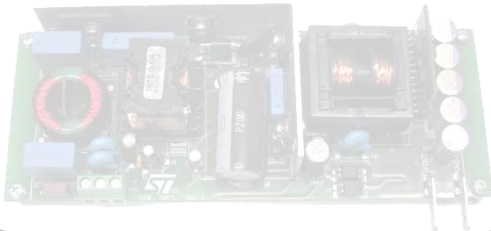
# System solutions compliant with EuP Lot 6 Tier2

17



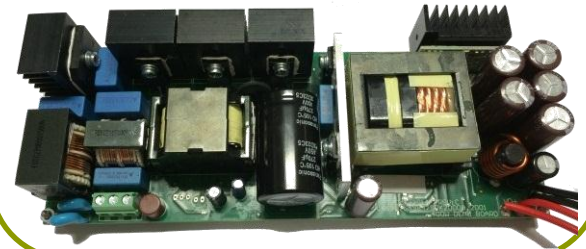
## STEVAL-ISA170V1(\*)

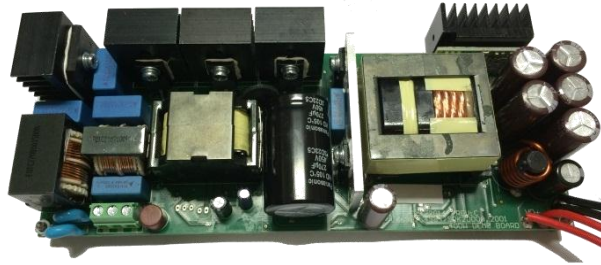
12V - 150 W resonant converter with synchronous rectification based on L6563H, L6699 and SRK2001



## EVL400W-ADP/ATX

12 V – 400 W SMPS for adapter, desktop and AIO using L4984D, L6699 and SRK2000A





# EVL400W – ADP/ATX

## Main features and target applications

### Main features

- Wide input voltage range: 90 to 264 V<sub>AC</sub> (45 ÷ 65 Hz)
- Output voltage: 12V ± 2 % at 33 A continuous operation
- Overall efficiency at full load: above 87% according to **ENERGY STAR® 6.1** for computers and compliant with **80Plus GOLD** level
- Avg. efficiency: > 89%, according to **European CoC ver. 5 Tier2** for external power supplies
- No load mains consumption: < 0.15 W at 230 V<sub>AC</sub>, according to **European CoC ver. 5 Tier 2** for external power supplies
- Light load efficiency: **European CoC ver. 5 Tier2** requirements for external power supplies and **EuP Lot 6 Tier2** for office equipment (Pin < 500 mW for Pout = 250 mW @ 115 V<sub>AC</sub> and 230 V<sub>AC</sub>)
- Mains harmonics: According to EN61000-3-2 Class-D or JEITA-MITI Class-D
- EMI: According to EN55022 Class-B

### Target applications



All-in-one  
computer PSU



ATX desktop  
PSU



High power  
adapters



# EVL400W – ADP/ATX

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## Block diagram

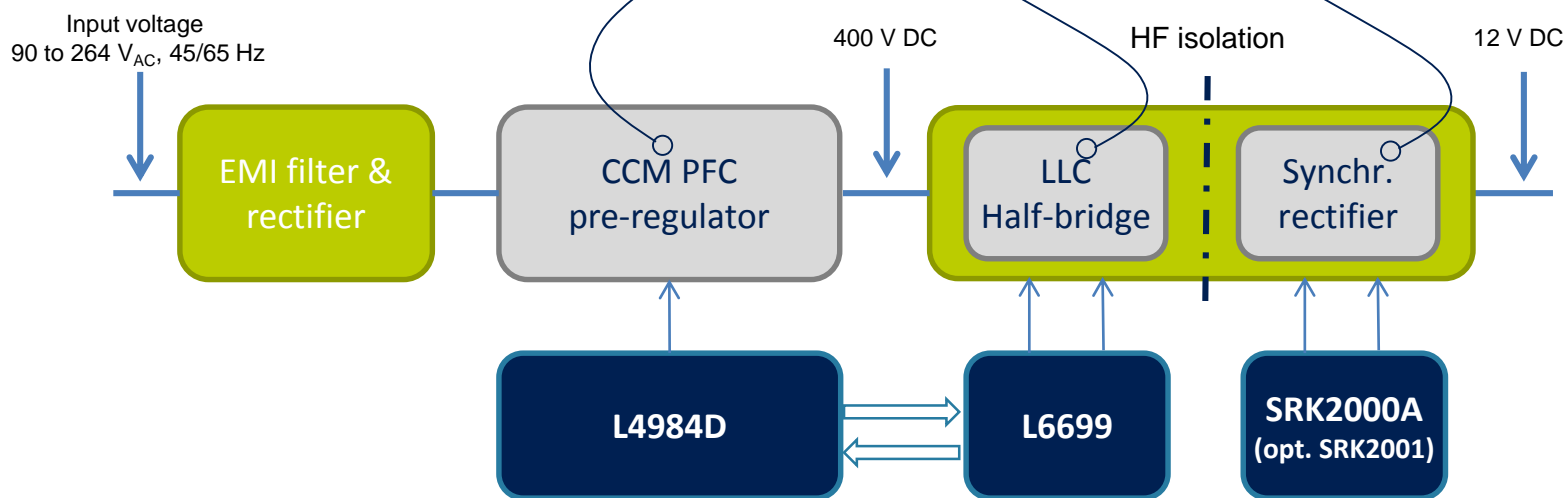
Power stage: key technologies

MDmesh™ M2 EP  
Power MOSFETs  
**STF25N60M2-EP(\*) (x2)**

Turbo 2 Ultrafast / Tandem  
Diode  
**STTH8S06FP or  
STTH8T06DI**

MDmesh™ M2 EP  
Power MOSFETs  
**STF20N60M2-EP(\*\*)**

STripFET™ V  
Power MOSFETs  
**STL140N4LLF5 (x2)**



- TSM1014 (CCCV controller) and TSC888 (amp. for current detector) are used for Burst mode

## light-load power consumption and efficiency

- Light-load efficiency improved by **synchronized Burst mode** function of both L4984D and L6699 and by **self-adaptive deadtime** of L6699

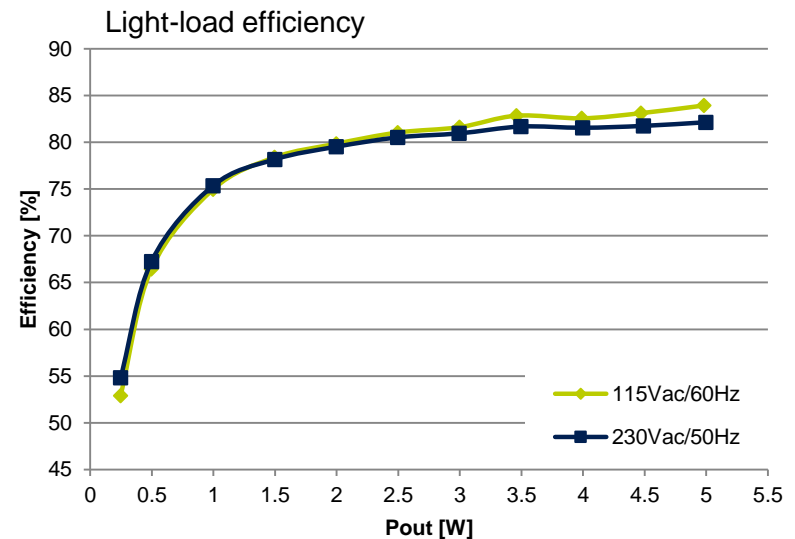
### Power losses calculation with 250 mW load

Input signal divider of PFC	45.4 mW
PFC IC – L4984D	39 mW
LLC IC – L6699	16.9 mW
SR IC – SRK200A	6 mW (*)
Feedback loop	3.6 mW
Current detector	3.6 mW

Total power consumption 364.5 mW (\*\*)

(\*) <1 mW with SRK2001 option

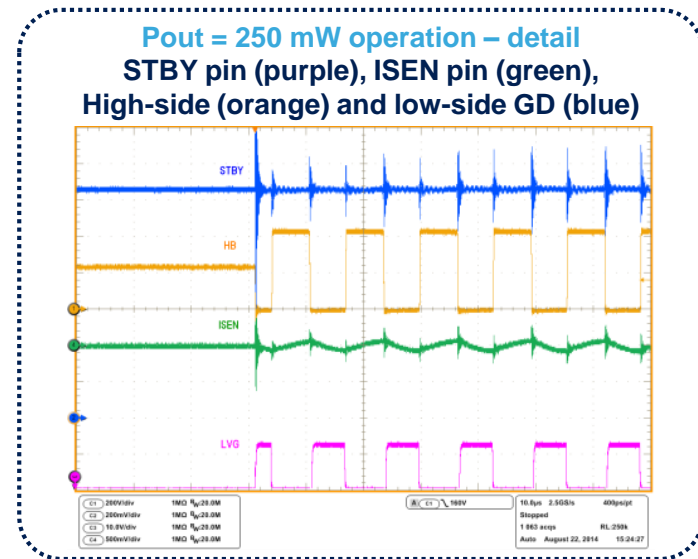
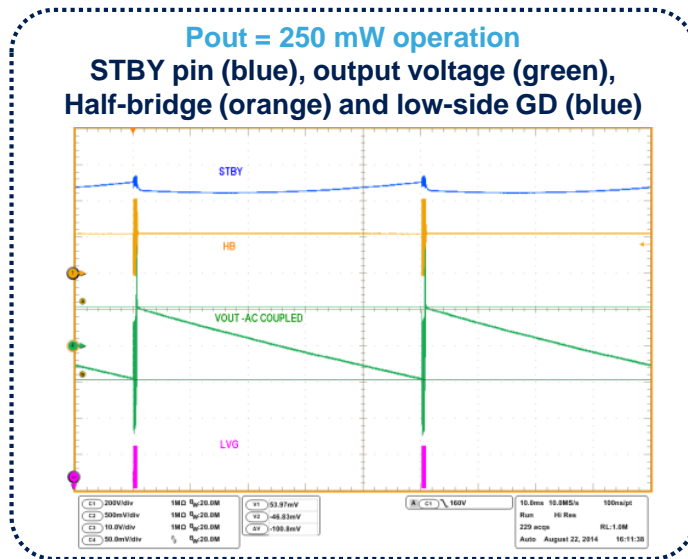
(\*\*) Not including switching and magnetic losses, input rect. and filter losses



# EVL400W – ADP/ATX

## Burst mode operation at light load

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The burst pulses are very narrow and their period is quite long

The resulting equivalent switching frequency is very low, approximately 80 kHz, ensuring high efficiency

The first initial pulse is shorter than the others

No high current peak at half bridge operation restarting

# EVL400W – ADP/ATX: Verification of Ecodesign requirements

22

**ENERGY STAR® requirements for computers ver. 6.1: PASS**

	Test results		Limits
	115 Vac - 60 Hz	230 Vac - 50 Hz	
Efficiency @ 20 % load	92.10%	92.85%	>82%
Efficiency @ 50 % load	91.01%	94.06%	>85%
Efficiency at 100 % load	88.22%	91.06%	>82%
Power factor	0.9963	0.9794	>0.9

Test results		Limits	
115 Vac - 60 Hz	230 Vac - 50 Hz		
90.67%	92.86%	>87%	Avg. efficiency measured at 25%, 50%, 75%, 100% (*)
52.90%	54.80%	>50%	Efficiency @ 250 mW load
35.00%	36.00%	>33%	Efficiency @ 100 mW load (*)

**EuP Lot 6 Tier2 requirements: PASS**

(\*) Source of requirement: ST's customers

**European CoC ver. 5 Tier2 requirements for external power supplies: PASS**

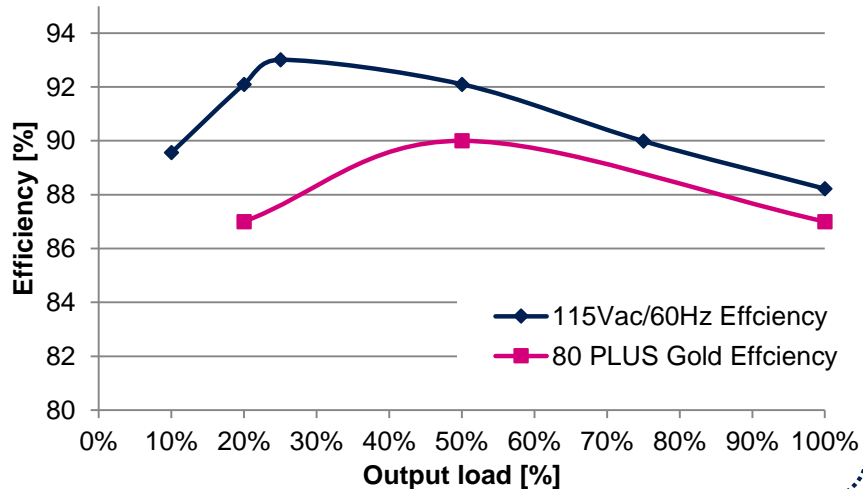
	Test results		Limits
	115 Vac - 60 Hz	230 Vac - 50 Hz	
Avg. Efficiency measured at 25%, 50%, 75%, 100%	90.67%	92.86%	>89%
Efficiency @ 10% load	89.56%	90.56%	>79%
No Load Input Power [W]	0.129 W	0.143 W	< 0.15 W

# EVL400W – ADP/ATX: Efficiency measurements

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80 Plus-GOLD requirements: **PASS**

115 V<sub>AC</sub> / 60 Hz efficiency



230 V<sub>AC</sub> / 50 Hz efficiency

