Power Supply efficiency improvements at low load conditions

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Why
do we need or want this?

WHY A HIGH EFFICIENCY?

Rules

Table 2

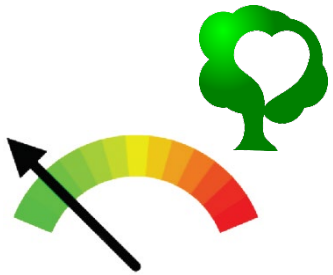
power demand limits other than on-mode, in Watts

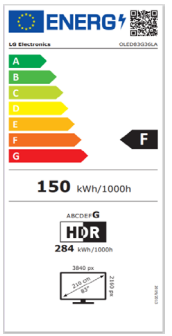
	Off mode	Standby mode	Networked standby mode
Maximum limits	0,30	0,50	2,00

Competition

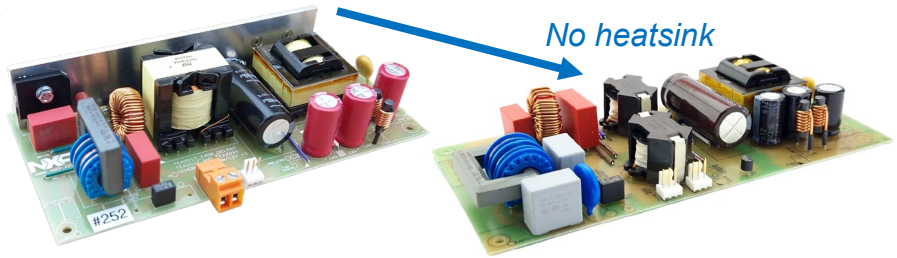
Smaller

Less energy waste





Cheaper



WHY A HIGH EFFICIENCY @ LOW LOAD?

Rules

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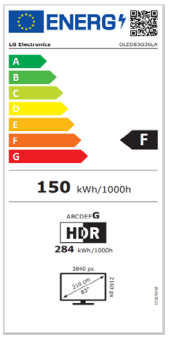
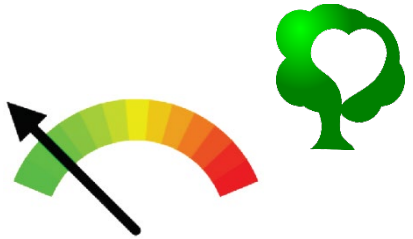




TV

ON

Standby

Smart equipment with several operation conditions at low(er) load

Smart TV

ON

Local dimming

Gallery / Art

Ambilight

Radio only

Recording

Updating

Voice controlled

Standby

ErP Lot-5 requirements

Example requirement for TV (EU)

Table 2

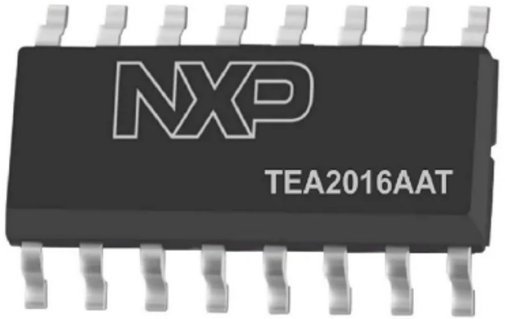
power demand limits other than on-mode, in Watts

	Off mode	Standby mode	Networked standby mode
Maximum limits	0,30	0,50	2,00
Allowances for additional functions when present and enabled			
Status display	0,0	0,20	0,20
Deactivation using room presence detection	0,0	0,50	0,50
Touch functionality, if usable for activation	0,0	1,00	1,00
HiNA function	0,0	0,0	4,00
Total maximum power demand with all additional functions when present and enabled	*0,30*	*2,20*	*7,70*

How
do we achieve this ?

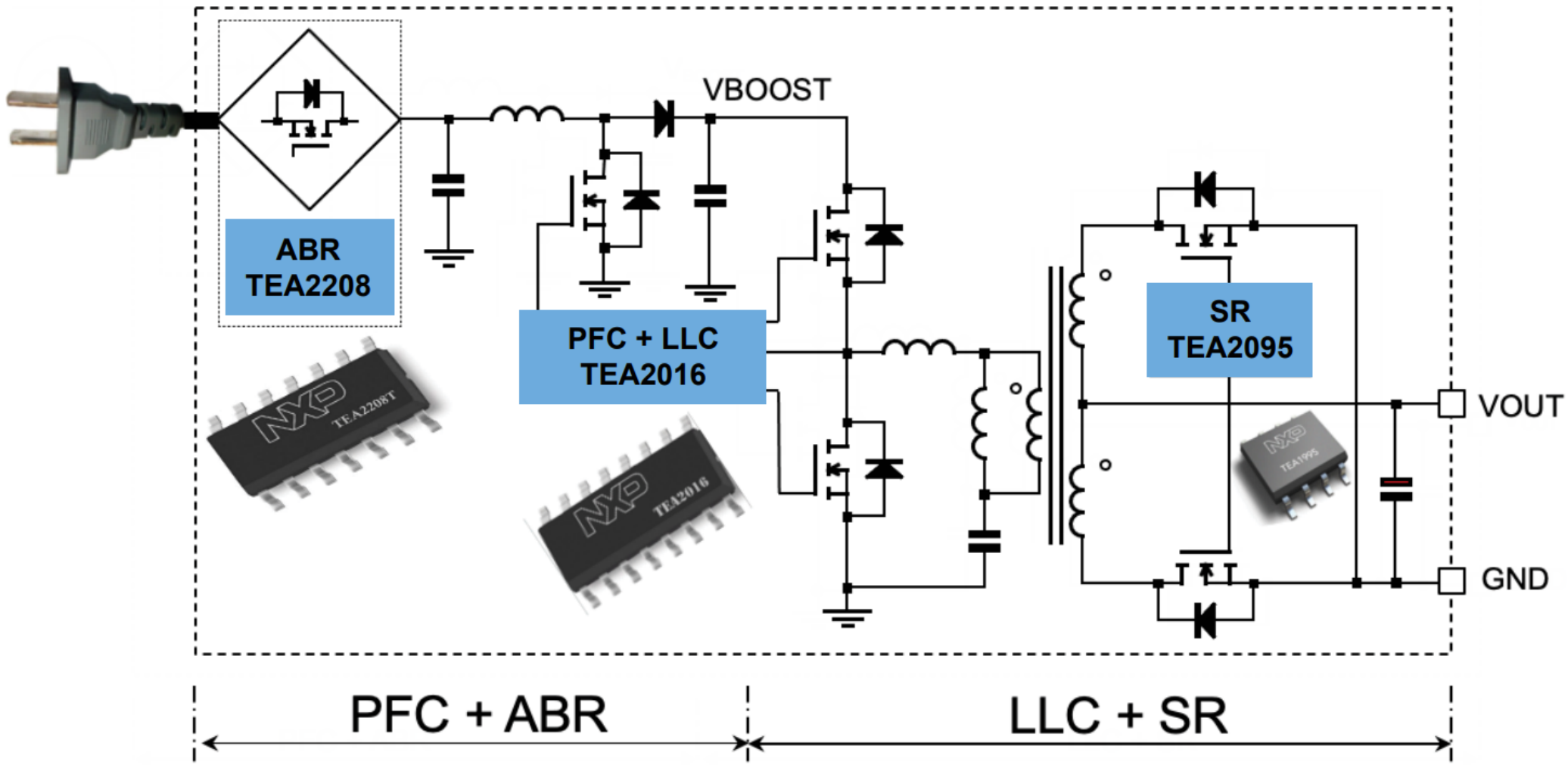
TEA2017DB1580
240W 12V x 20A

Multi mode PFC + LLC
combi controller



DCM PFC + LLC
combi controller

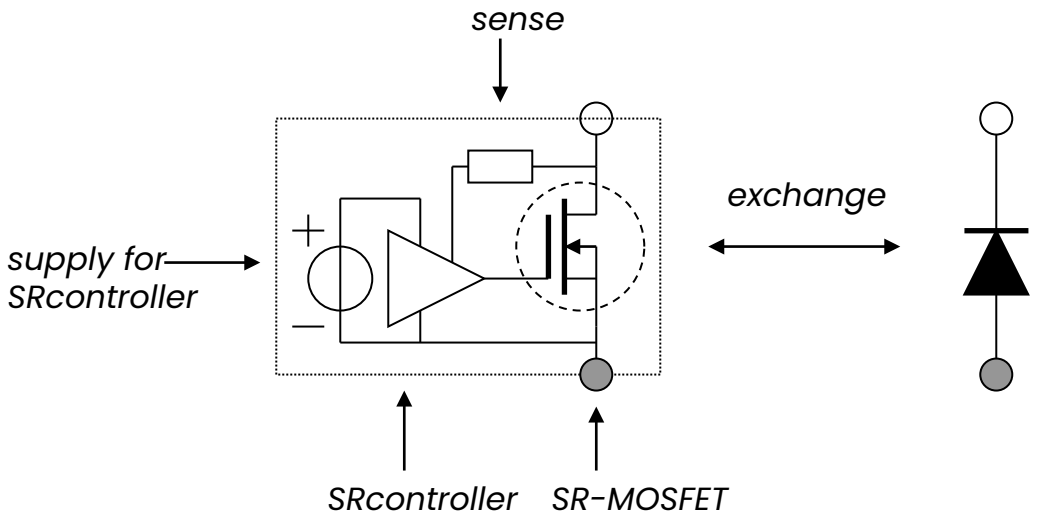
TEA2016DB1519
240W 12V x 20A


VBOOST
ABR
TEA2208
PFC + LLC
TEA2016
SR
TEA2095
VOUT
GND
PFC + ABR
LLC + SR

IMPROVING EFFICIENCY

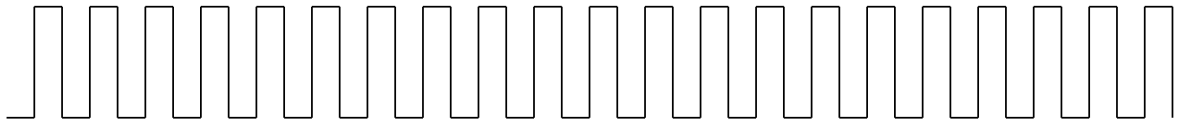
Improving efficiency for high loads

- Active Bridge Rectification
- Synchronous Rectification

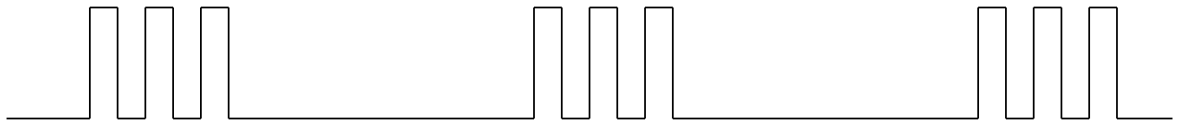


Improving efficiency for low loads

- Burst mode operation

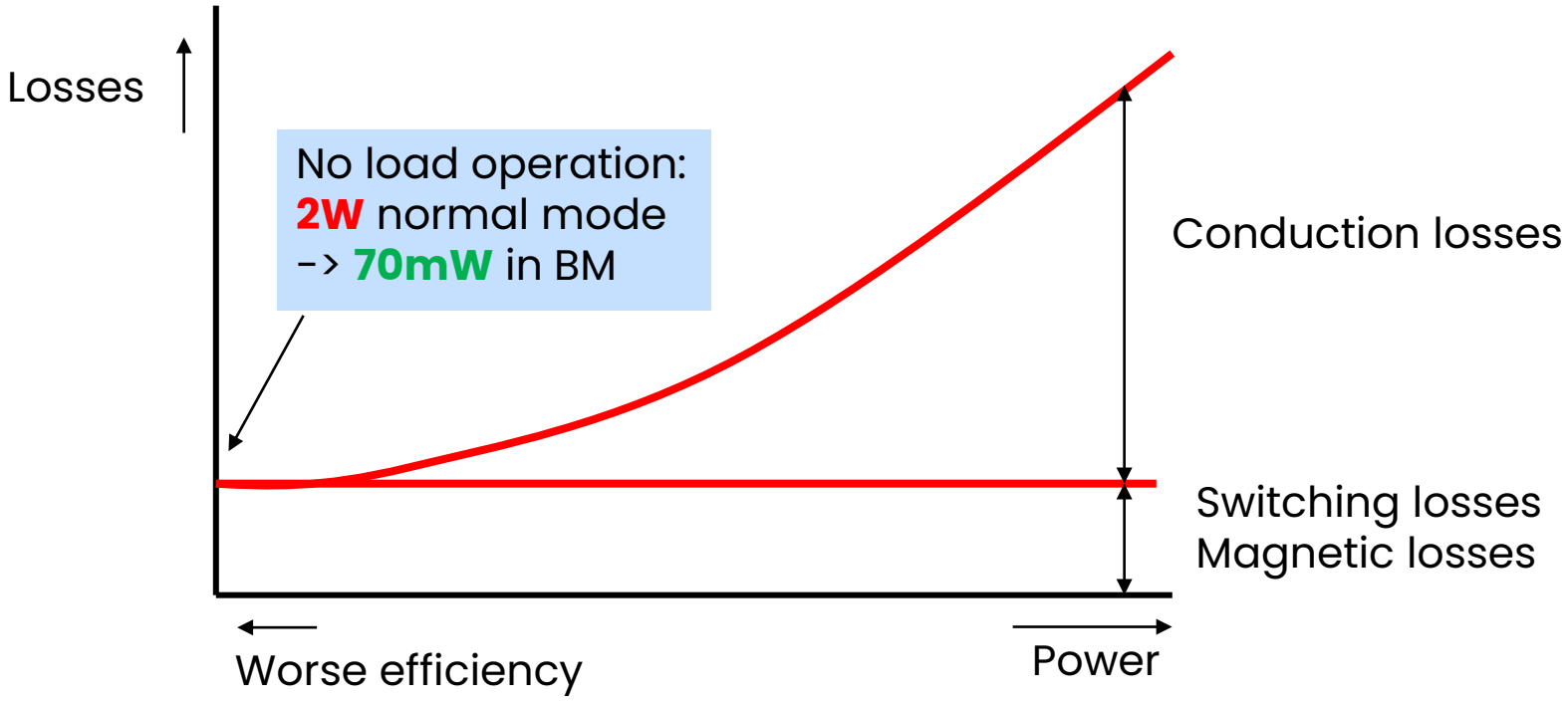


Continuous switching mode



Burst mode switching
(and increase the energy per cycle)

LOSSES RESONANT CONVERTER (LLC)

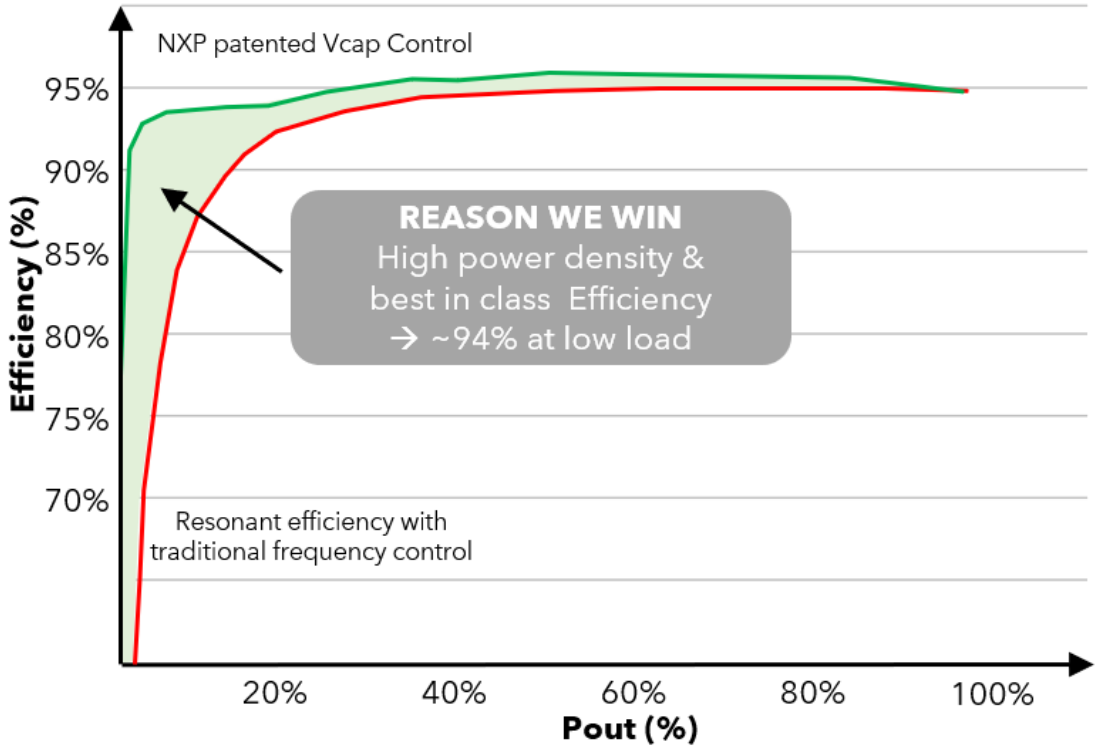


Burst Mode : No switching/magnetic losses when not switching

EFFICIENCY RESONANT CONVERTER (LLC)

NXP Leadership in LLC resonant power conversion through highest and flat efficiency

+



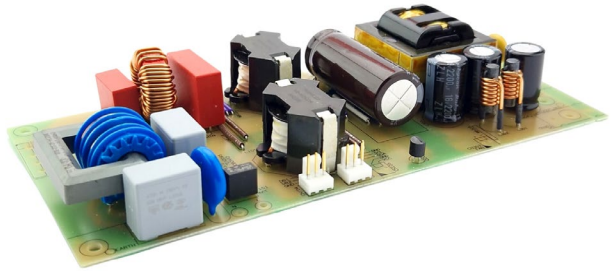
LLC only

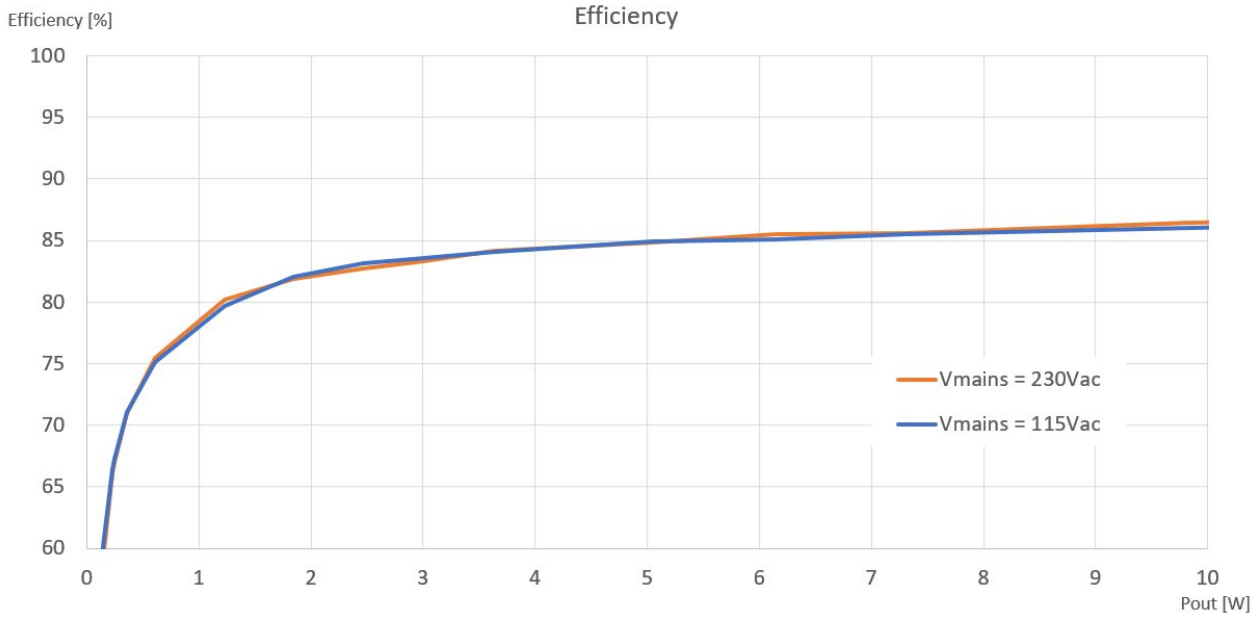
innovation by NXP
GreenChip

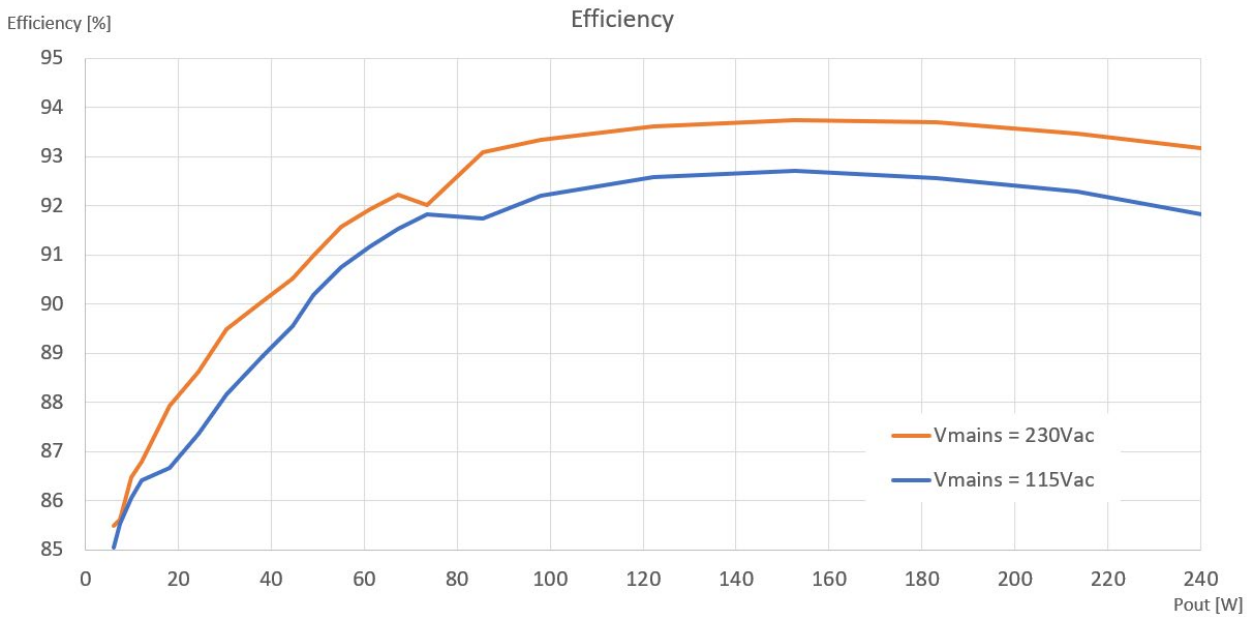
80 PLUS TITANIUM
ENERGY STAR
ENERGY Energy Efficiency & Renewable Energy

EFFICIENCY COMPLETE PFC+LLC POWER SUPPLY

Example:
TEA2376DB1603 240W (12V, 20A) demo board
including active bridge rectifier (mains) and synchronous rectifier (ou



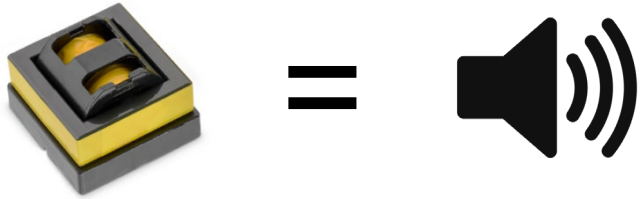


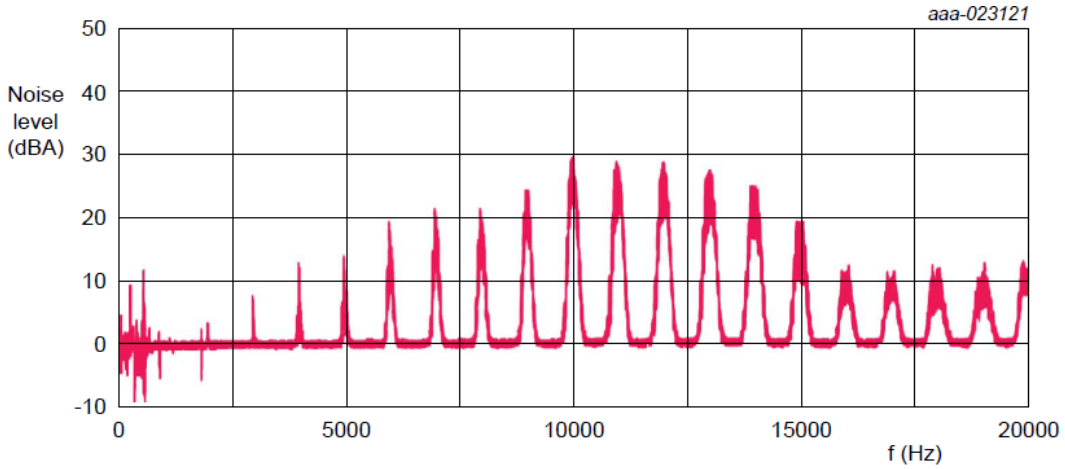


But,
are there side effects ?

UNWANTED SIDE EFFECTS OF BURST MODE OPERATION

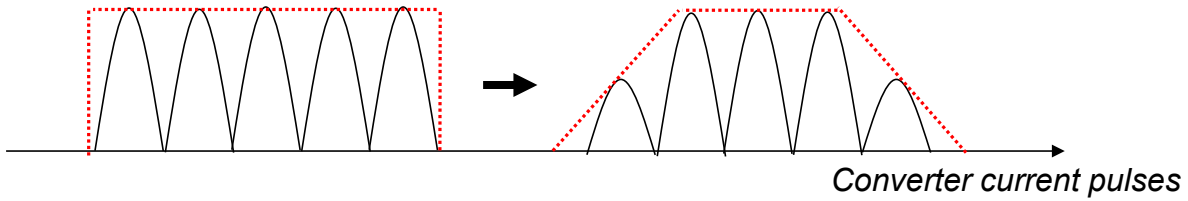
Audible noise





Harmonics of the 1 kHz burst frequency produce most noise at the audio noise resonance frequency of the transformer. For this transformer, the resonance is around 11 kHz.

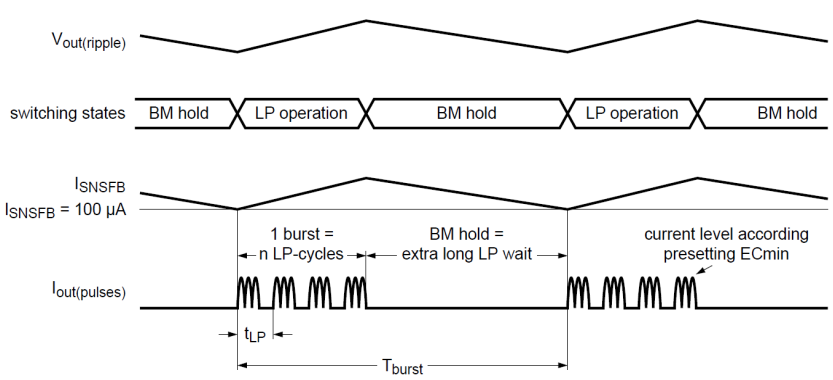
Reduce audible noise by soft start and soft stop:



-> Trade off between the amount of efficiency benefit and unwanted side effects

UNWANTED SIDE EFFECTS OF BURST MODE OPERATION

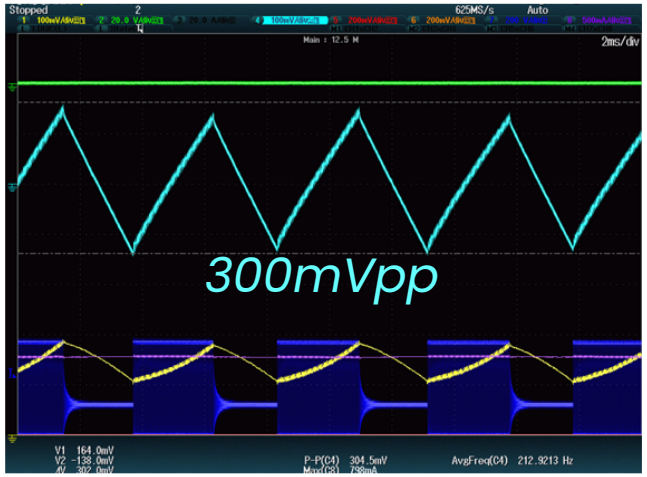
Output voltage ripple



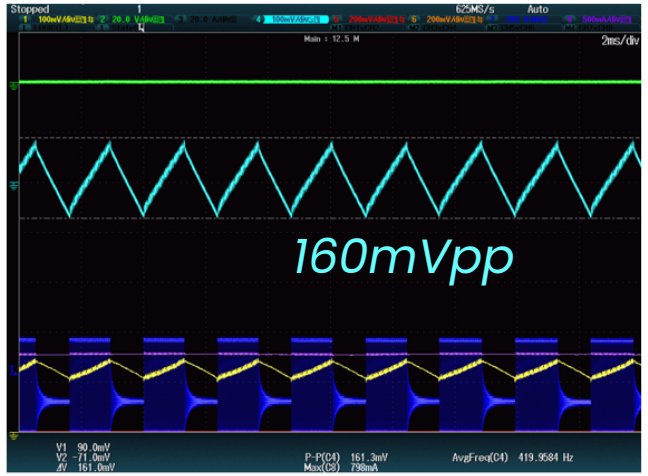
Vout,AC

ISNSFB
IOUT,DC
HB

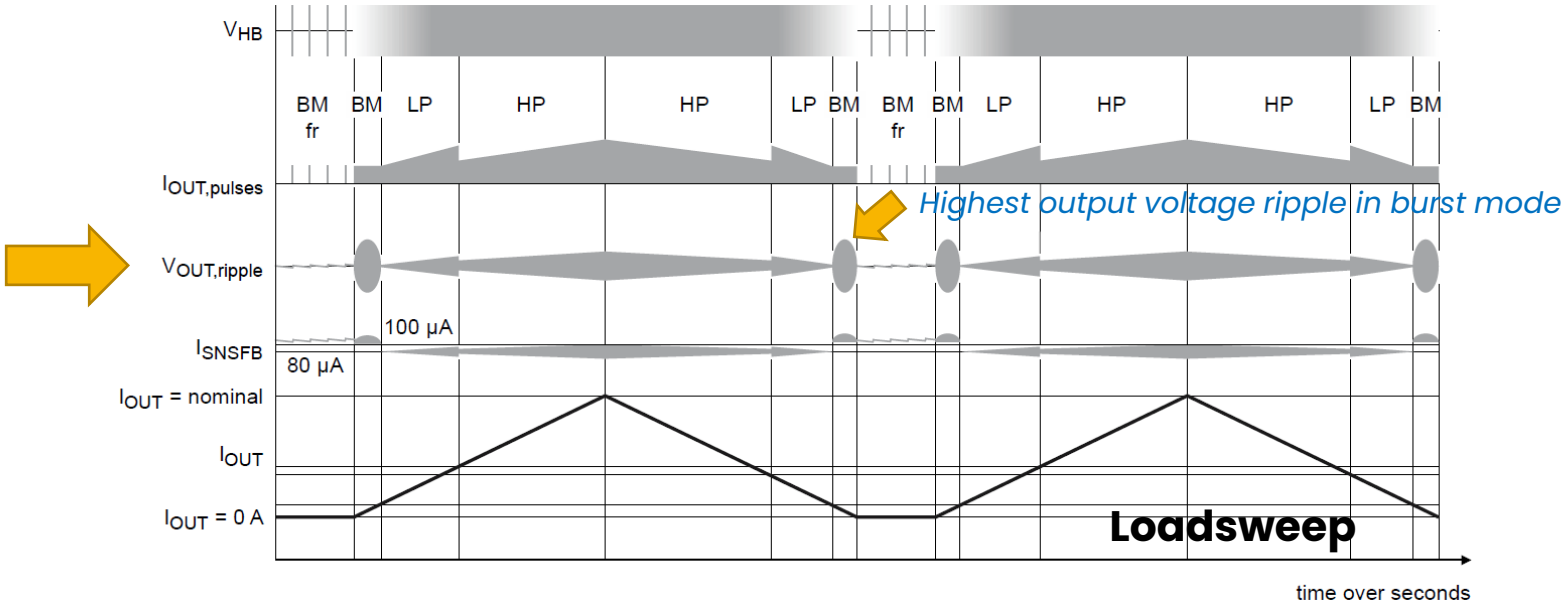
*BM repetition frequency set for **200Hz***



*BM repetition frequency set for **400Hz***



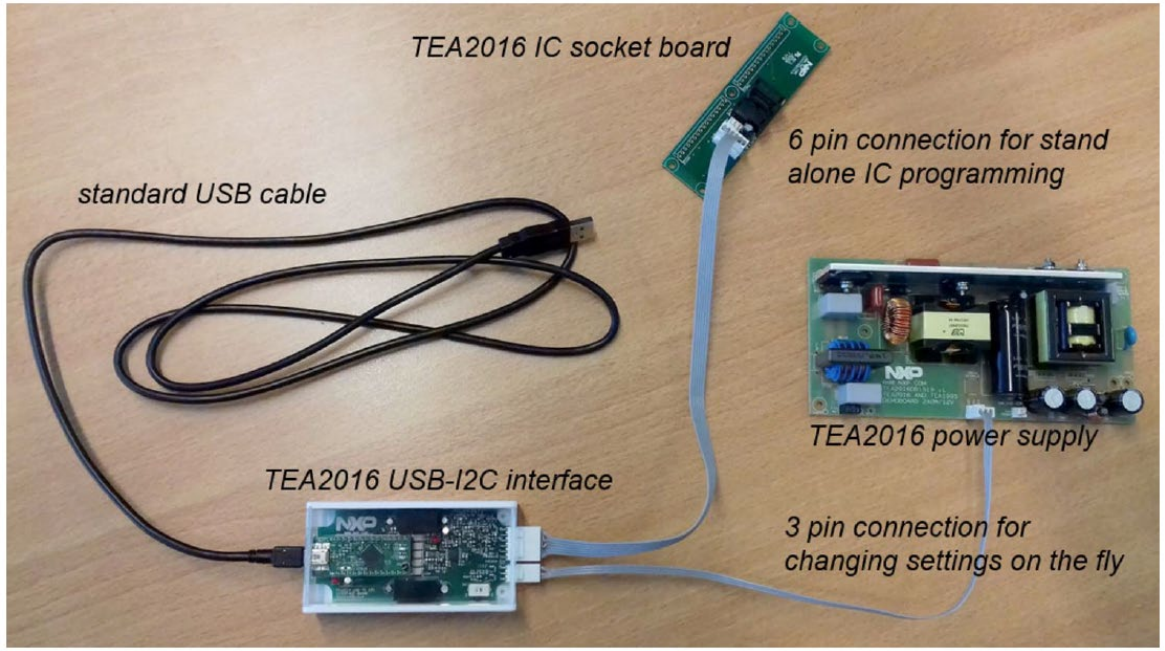
Maximum output voltage ripple at 50% duty cycle BM



-> Trade off between the amount of efficiency benefit and unwanted side effects

SPECIAL FUNCTIONS IN THE TEA2016 TO SUPPORT OPTIMIZING PERFORMANCE IN LOW LOAD CONDITIONS.

BY INTERNAL IC (MTP) SETTINGS.



FUNCTIONS THAT ARE DEMONSTRATED

1. PFC+LLC burst mode operation
2. PFC soft start and soft stop
3. Maximum PFC switching frequency
4. LLC burst mode transition power level (and energy per cycle)
5. Low power mode number of peak (duty cycle and energy per cycle)
6. LLC soft start and soft stop

But there more options in the settings and in circuit design (converter components).

Video: recorded demo on the lab table

(8 minutes)

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