

New Product Update

High frequency wide input/wide output LLC controller - UCC25660

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Product marketing engineer

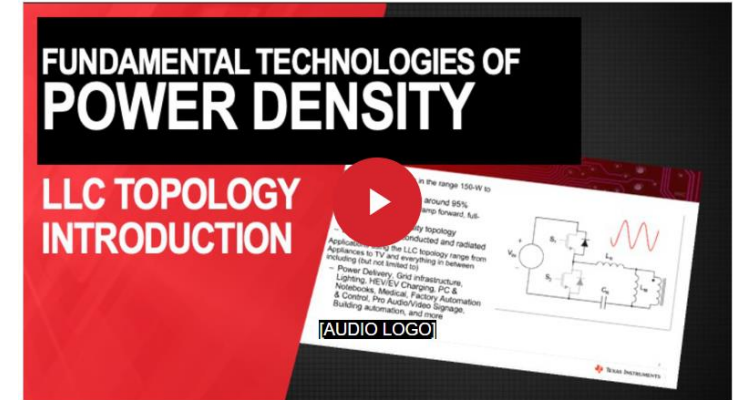
LLC topology overview

What is an LLC?

LLC stands for inductor, inductor, capacitor

- The LLC is a resonant zero-voltage switching (ZVS) topology that can achieve efficiencies more than 96% achieving high power densities
 - To maintain resonance, the LLC must work at a 50% duty cycle
 - The LLC varies the switching frequency (F_{SW}) to control power delivered
 - ZVS operation means that the LLC has a low EMI footprint
- The LLC is typically used in 150-1000W applications

Common challenges with designing an LLC are managing burst mode, over-load power thresholds, and sensitivity to layout



For more details see [LLC topology overview](https://www.ti.com/llc-topology-overview) on ti.com

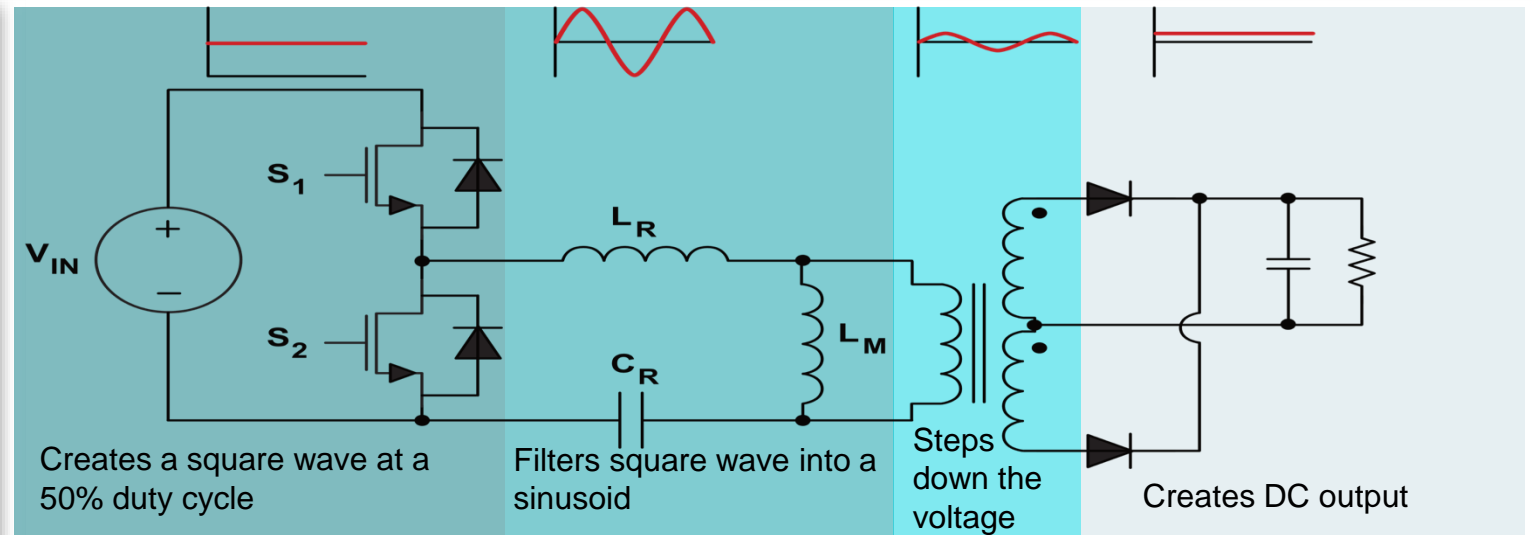
An LLC consists of four sections:

Switch network

Resonant tank

Transformer stage

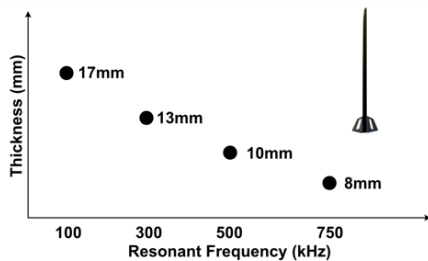
Rectification



UCC25660 Key advantage + system benefits

Key advantages

- ✓ High power density.
- ✓ Wide V_{IN}/V_{OUT} support.
- ✓ Optimized light load efficiency.
- ✓ Enhanced power stage reliability.
- ✓ Fast load transient response.
- ✓ Ease of design



Features	Application impact	System benefits
High switching frequency & optimization for GaN	<ul style="list-style-type: none">• >20% thinner design (300kHz to 750kHz)	<ul style="list-style-type: none">• High power density
Input power proportional control (IPPC)	<ul style="list-style-type: none">• Wide V_{IN}/V_{OUT} avoids unwanted burst mode and overload power protection• Can work without PFC front-end for non-universal VAC applications	<ul style="list-style-type: none">• Ease of design• Wide V_{IN}/V_{OUT} support• Fast load transient response
Self adaptive soft start	<ul style="list-style-type: none">• Less sensitive to layout• Enhanced power stage reliability	<ul style="list-style-type: none">• Ease of design
Audible frequency skip burst mode	<ul style="list-style-type: none">• Increased efficiency – 5 to 10% at 5-20% load• Minimized audible noise (e.g. <18db in adapter)	<ul style="list-style-type: none">• Optimized light load efficiency
Cycle-by-cycle current limit	<ul style="list-style-type: none">• Enhanced system reliability – reduced peak current stress for power switches	<ul style="list-style-type: none">• Enhanced power stage reliability
Capacitive region avoidance	<ul style="list-style-type: none">• Eliminates reverse recovery in the MOSFET	<ul style="list-style-type: none">• Enhanced power stage reliability
Integrated PFC on/off	<ul style="list-style-type: none">• Reduced BoM count	<ul style="list-style-type: none">• Ease of design• Optimized light load efficiency

Applications + system benefits

TV



- ✓ 750kHz switching frequency enables slim SMPS
- ✓ New adaptive burst mode improves light load efficiency.

LED lighting



- ✓ IPPC enables wider output operating (2:1) range to support dimming without entering burst mode

Battery charger



- ✓ IPPC supports a wider charging voltage range
- ✓ No hardswitching during pre-biased startup

Notebook adapter



- ✓ 750kHz enables >20% higher power density
- ✓ PFC On/Off control reduces standby power

Bold indicates leading competition

UCC25660 Key features

750kHz resonance

Wide V_{IN} support

Wide V_{OUT} support

Light load efficiency

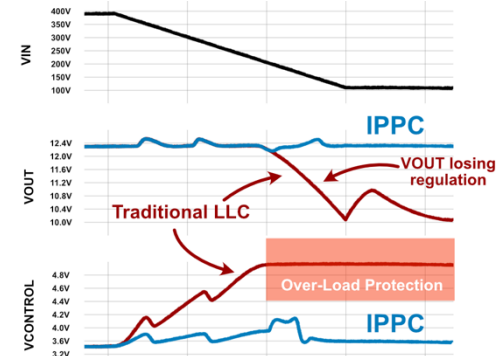
Low audible noise

Controlled soft-start

Capacitive region avoidance

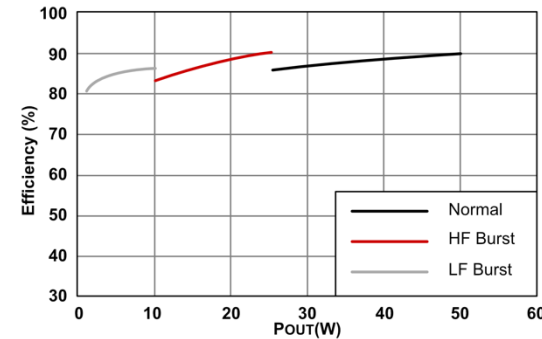
PFC on/off control

Wide input support



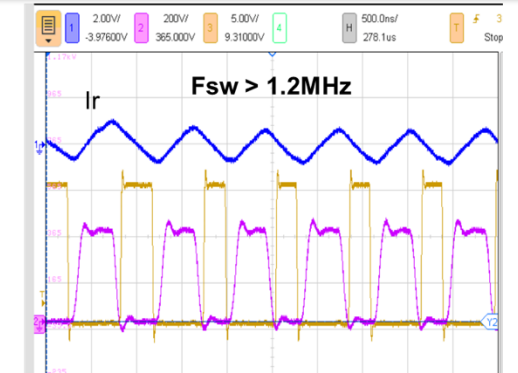
Avoids unwanted over-load protection

Light load efficiency



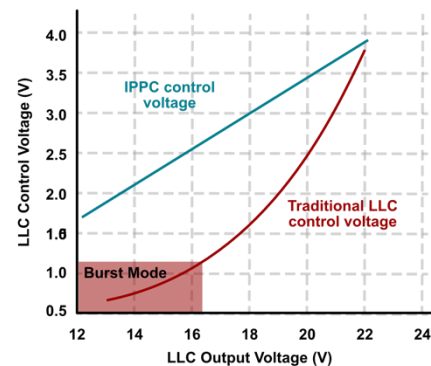
>5-20% efficiency improvement at light load

High frequency operation



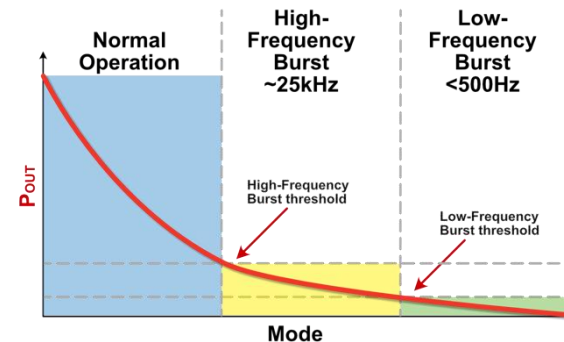
High frequency startup to get into resonance

Wide output support



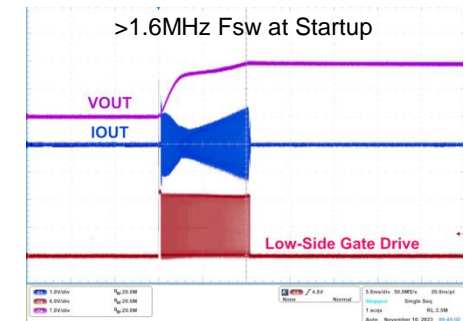
Avoids unwanted burst mode

Low audible noise



Minimizes audible noise <20dBc

Controlled soft-start



High Frequency Startup lowers peak currents

UCC25660x

50-kHz to 750-kHz wide V_{IN}/V_{OUT} range LLC controller optimized for light load efficiency

Features

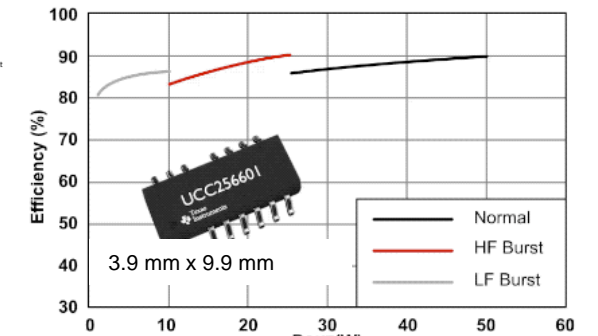
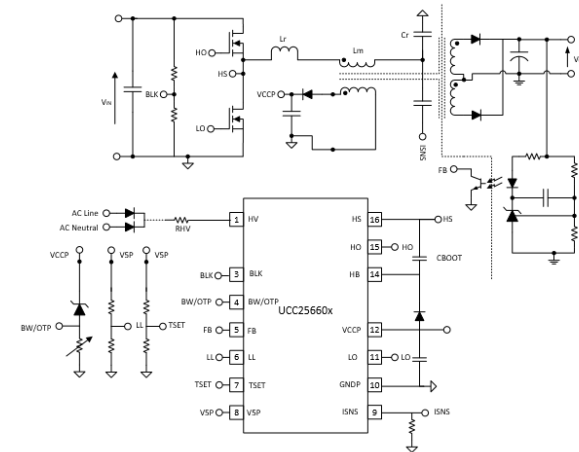
- Wide input & output LLC (WLLC) operation enabled by IPPC
- Enhanced light load operation enabled by mixed burst mode:
 - Audible frequency (1kHz to 20kHz) range skip
 - Integrated PFC on/off control signal
- Up to 750-kHz resonant frequency
- Automatic capacitive region avoidance and recovery
- Adaptive soft start control with minimized inrush current
- Complete sets of protections including OCP, OLP, OVP & OTP
- X-Cap discharge (UCC256601 & UCC26604)

	UCC256601	UCC256602	UCC256603	UCC256604
Typical Applications*	Generic, AIO, PC, Gaming adapter	Lighting, Broad Industrial, Battery Charger	Industrial, OLED TV	LED TV
Application Needs	High power density, ultra-low standby power	DC Input	System with existing aux supply	High power density, ultra-low standby power, Extended power range for IoT support
High Voltage Startup	●	●		●
Extended Gain Range (Universal V_{AC} PFC OFF)				●
PFC ON/OFF	●	●		●
X-Cap Discharge	●			●

* Note: All options can be used in any application.

Benefits

- Supports wider power range with PFC disabled as well as wider output range
- Improved efficiency at light loads.
 - Minimizes audible noise (<20dBc) & exceeds DoE level VI, EU regulations
 - Further reduces standby power (<75mW)
- Best in class power density enabled by reduced magnetics
- Eliminates body diode reverse recovery, prevents shoot-through & reduced EMI
- Minimizes stress on components and supports a pre-biased startup
- Improve overall power stage reliability & robustness
- Higher efficiency and lower standby power compared to bleed resistors



Light load efficiency for 500-W Supply



UCC25660x selection guide

	UCC256601	UCC256602	UCC256603	UCC256604
Typical Applications*	Generic, AIO, PC, Gaming adapter	Lighting, Broad Industrial, Battery Charger	Industrial, OLED TV	LED TV
Application Needs	High power density, ultra-low standby power	DC Input	System with existing aux supply	High power density, ultra-low standby power, Extended power range for IoT support
High Voltage Startup	●	●		●
Extended Gain Range (Universal V _{AC} PFC OFF)				●
PFC ON/OFF	●	●		●
X-Cap Discharge	●			●

• Note: All options can be used in any application.



UCC25660 collateral

Reference designs and EVM's



UCC25660EVM-20



PFCLCCSREVM



10mm max Z-height 400-W
TV SMPS reference design
PMP23463



Multi-bay power tool battery
charger



High power density adapter
featuring GaN

More reference designs coming!

Getting started

- UCC25660 [Selection Guide](#)
- App note on Wide Vin capability(Dec 2023)
- Planned IEEE paper on IPPC Control for LLC
- UCC25660 EVM [User guide](#)
- PFCLLCSEVM User guide

10mm z-height TV
SMPS

Coming Soon!



Simplis model & Excel
based design calculator

Training

- [LLC Introduction Video](#)
- Sales webinar introduction.
- Sales deep dive. May 24th
- Videos: 6x minute-to-win-it describing the features. 2Q 2024
- 6 blogs for the different features.



LED
Driver



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