*Application Note*

# *Retrofit UCC28750 EVM to Support Aux Power Application*

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**ABSTRACT**

Flyback topology is major used in the low power PSU (<100W), because it is easy to design and cost effective. Most of high power PSU also need the Auxpower to support the Vdd and fan power supply, and the power rating is also under 100W, so flyback topology is used at every PSU.

UCC28750 is a highly-integrated current-mode, continuous-conduction-capable, PWM controller optimized for high performance, low standby power, and cost effective offline flyback converter applications using an opto-coupler.

This application note introduces how to retrofit the UCC28750 EVM to fit the Aux power and also explain the benefit for this application.

## Table of Contents



## Trademarks

# 1 Introduction

The UCC28750EVM-071 is a 60-W evaluation module (EVM) for evaluating an off-line power AC to DC flyback converter. The UCC28750EVM-071 converters 85-VRMS to 265-VRMS input voltage down to 24-VDC, capable of delivering 60W of output power. The schematic is shown in Figure 1-1.

However, the PFC stage is in the front end, and the PFC converts the universal AC input voltage to 400Vdc, and the output voltage is 12V for fan power supply, so this application note introduces how to retrofit the UCC28750EVM-071 to support the Aux power application.

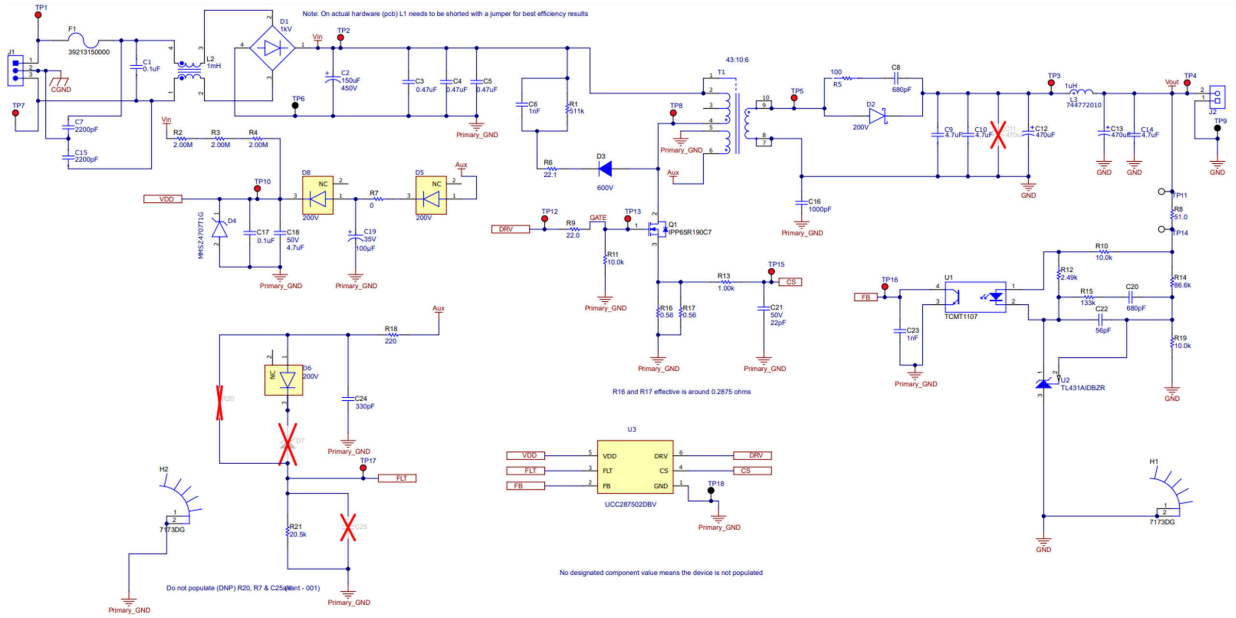


**Figure 1-1. Original EVM Schematic**

## 2 Retrofit Items

The Auxwinding voltage reflects the VDS waveform, so the VDS voltage spike also impacts the VDD voltage. The VDS voltage spike is increased when output loading increased too, so the VDD voltage is charged higher at full load.

That is why the RCD snubber is increased and also adds additional snubber at Auxwinding, so the snubber can avoid IC to trigger VDD OVP at heavy load.

TI also published the Power Tips training video to explain how to fine tune RC snubber.

The Figure 2-2 and Figure 2-3 shows VDS (Ch1) and Vaux(Ch2) and VDD(Ch3) waveform at different loading, and the VDD is increased at higher loading.

The change is listed in the following:

- Transformer changed to RM10 Bobbin.
- Lm : 660uH ; Lr : 11uH
- Np : Ns : Na = 39 : 5 : 6
- C6 : 10nF
- R1 : 80KΩ
- R7 : 10Ω
- R19 : 23.4KΩ
- R10 : 5KΩ
- add additional RC filter at Auxwinding
- R22 : 10Ω
- C27 : 470pF

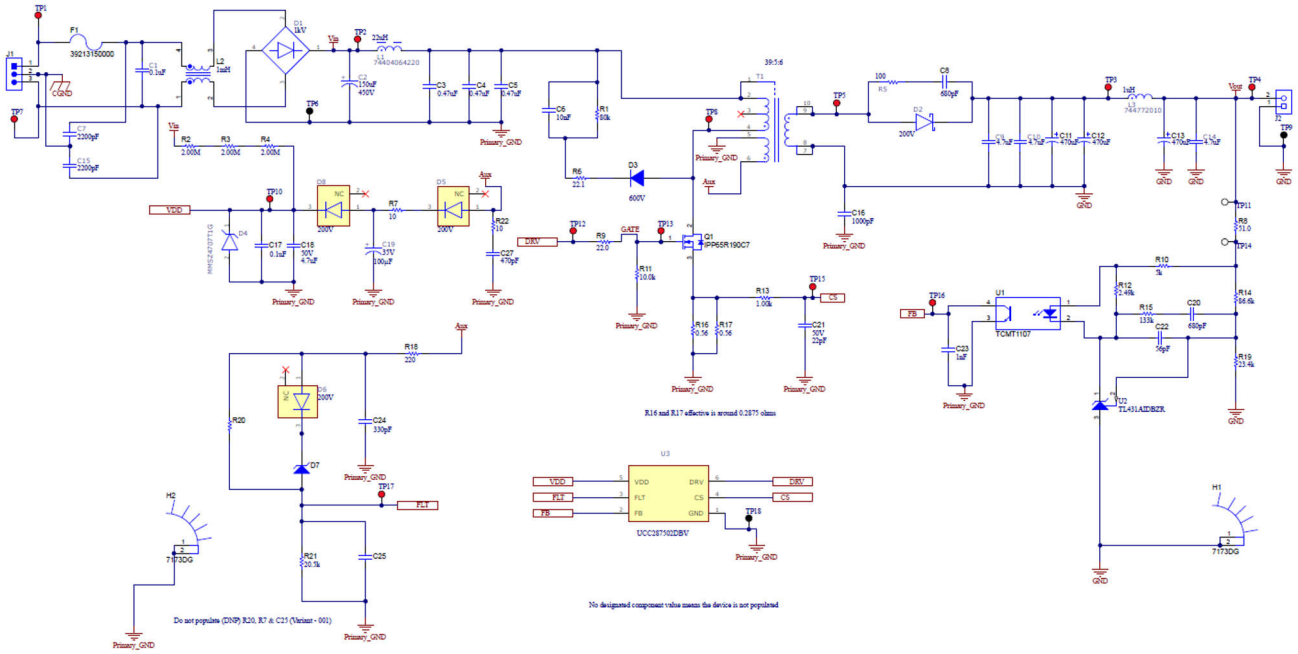

**Figure 2-1. Updated Schematic**

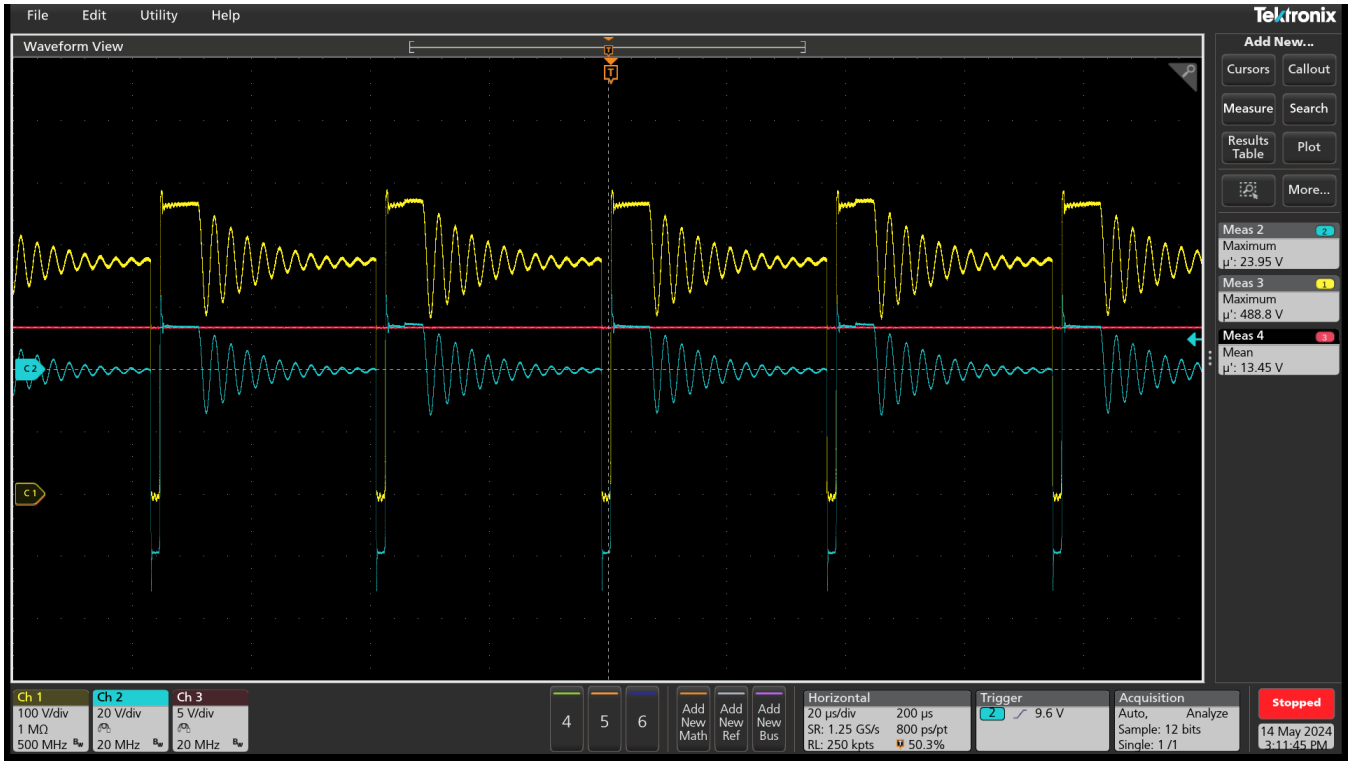


**Figure 2-2. Output Load at 0.5A; VDD 13.45V**

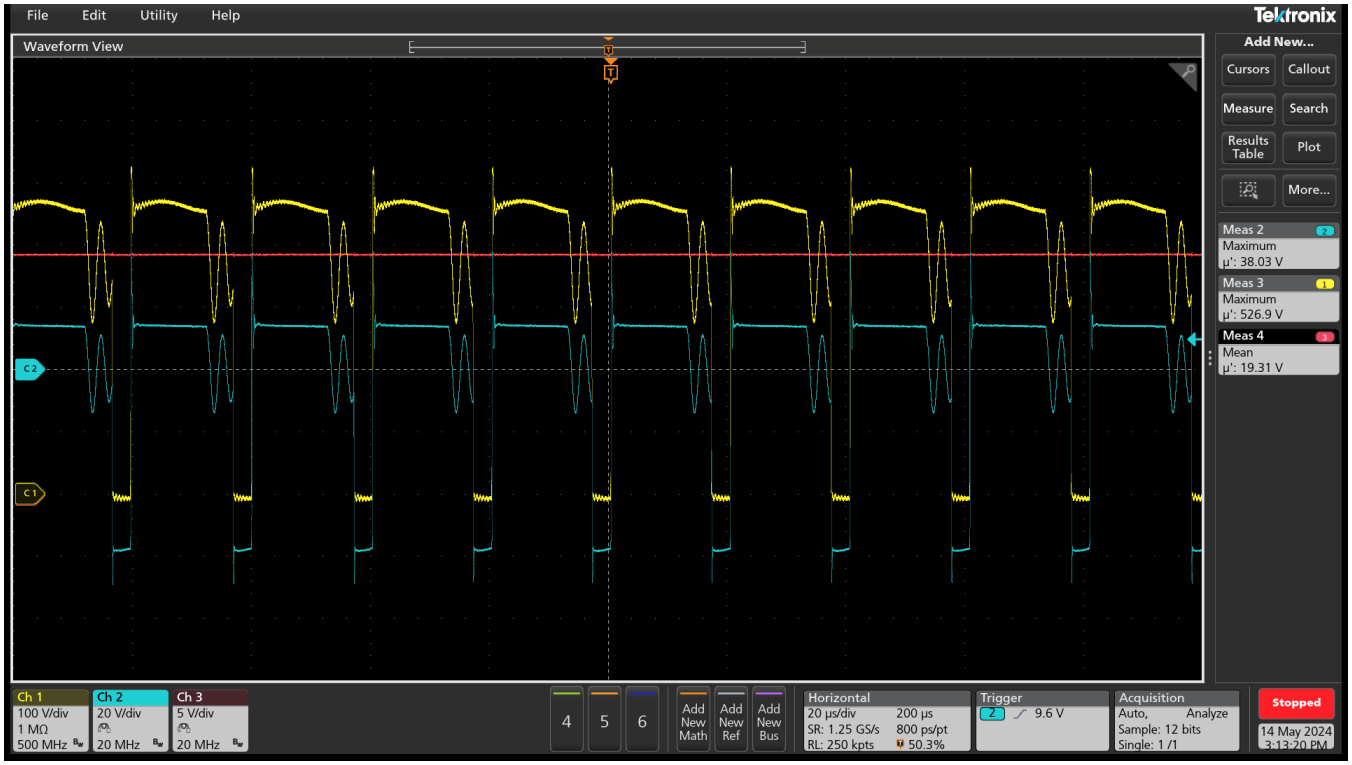


**Figure 2-3. Output Loading at 4A; VDD 19.31V**

# 3 Implement SR with UCC24612-1EVM

The UCC24612-1EVM evaluation module (EVM) is used to convert the output rectifier of a flyback converter from a diode to a synchronous rectifier (SR) FET to investigate and evaluate the efficiency benefits of using an SR over a rectifier diode. The EVM comes with the UCC24612-1 SR controller installed. This controller was optimized to work with secondary side output regulated flyback converters.

The UCC28750 EVM can retrofit with UCC24612-1 EVM to improve the efficiency, and the changed items and efficiency improvement as the following shows.

**Changed items**

- D2 changed to UCC24612-1 EVM
- Connect the UCC24612-1 EVM TP1 to UCC28750 EVM TP5
- Connect the UCC24612-1 EVM TP2 to UCC28750 EVM TP3
- Connect the UCC24612-1 EVM TP3 to UCC28750 EVM TP4
- Change the Q1 FET to CSD19502 (100V FET)
- JP1 connected

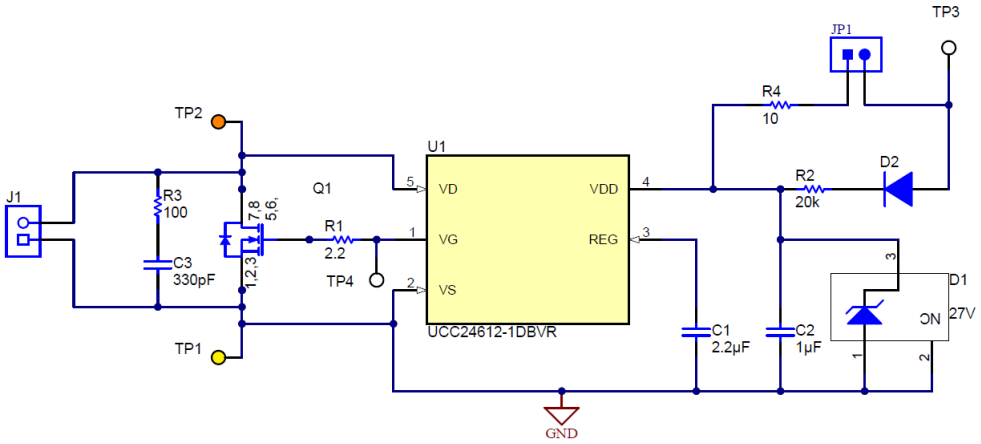


**Figure 3-1. UCC24612 EVM Schematic**

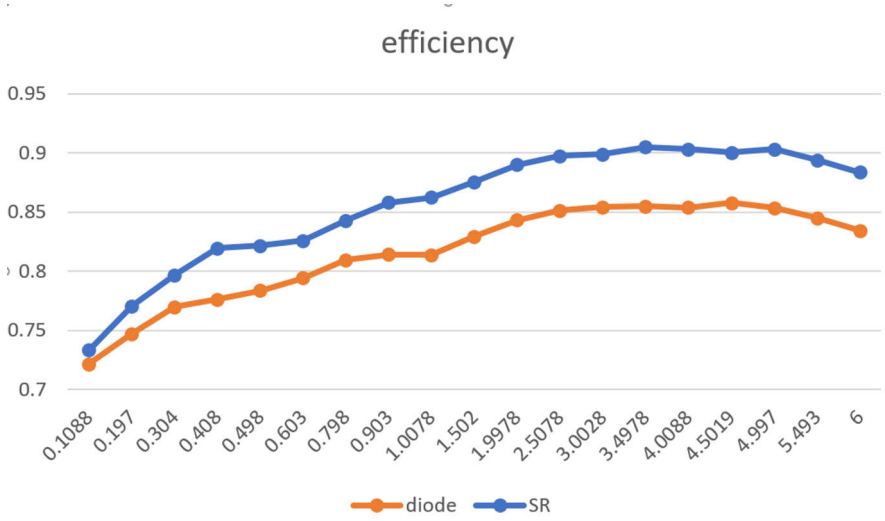


**Figure 3-2. Efficiency Curve**

**Table 3-1. Efficiency Improvement**

| Io (A) | Pin (Original EVM) | Pin (D2 use SR) | Efficiency (Original EVM) | Efficiency (D2 use SR) | Efficiency Improvement |
|---|---|---|---|---|---|
| 0.1 | 1.8 | 1.77 | 72.19% | 73.33% | 1.14% |
| 0.2 | 3.15 | 3.05 | 74.73% | 77.06% | 2.32% |
| 0.3 | 4.7 | 4.55 | 77% | 79.7% | 2.71% |
| 0.4 | 6.3 | 5.94 | 77.63% | 81.9% | 4.31% |
| 0.5 | 7.6 | 7.23 | 78.34% | 82.17% | 3.79% |
| 0.6 | 9 | 8.7 | 79.44% | 82.6% | 3.14% |
| 0.8 | 11.8 | 11.3 | 80.95% | 84.32% | 3.37% |
| 0.9 | 13.23 | 12.55 | 81.4% | 85.84% | 4.41% |
| 1 | 14.8 | 13.94 | 81.4% | 86.25% | 4.85% |
| 1.5 | 21.6 | 20.46 | 83% | 87.6% | 4.62% |
| 2 | 28.3 | 26.77 | 84.34% | 89.03% | 4.69% |
| 2.5 | 35.1 | 33.33 | 85.16% | 89.76% | 4.6% |
| 3 | 41.9 | 39.85 | 85.46% | 89.9% | 4.34% |
| 3.5 | 48.8 | 46.1 | 85.5% | 90.52% | 5.01% |
| 4 | 56 | 52.94 | 85.4% | 90.34% | 4.94% |
| 4.5 | 62.6 | 59.64 | 85.8% | 90.05% | 4.26% |
| 5 | 69.8 | 65.98 | 85.37% | 90.35% | 4.98% |
| 5.5 | 77.5 | 73.3 | 84.54% | 89.4% | 4.87% |
| 6 | 85.77 | 80.99 | 83.46% | 88.38% | 4.93% |

# 4 UCC28750 Benefits in Aux Power

1. UCC28750 has dedicated fault pin to disable IC by external signal.
   In high power application, the main power stage controller uses MCU or has house keeping IC, so customer can disable Aux power when the PSU triggers the protection or the sequence requirement.
   Customer can short FLT pin to GND to disable IC easily by MCU GPIO signal.
2. The main power stage like PFC and LLC or PSFB is very noisy and Auxpower can be modular at daughter card then closes to the main power stage components.
   UCC28750 is CCM controller, and is less sensitive than QR flyback controller, because QR flyback controller needs to sense the Auxwinding voltage to achieve the valley switching and input and output voltage detection.
3. IC supports the power boost mode to increase the switching frequency up to two times so IC can avoid the transformer saturation during peak load, and the IC control law as Figure 4-1.
   In Auxpowr application, the main output loading is bias power for Fan, and has peak load requirement to speed up the thermal dissipation.
4. UCC28750 is the economical flyback controller in TI.

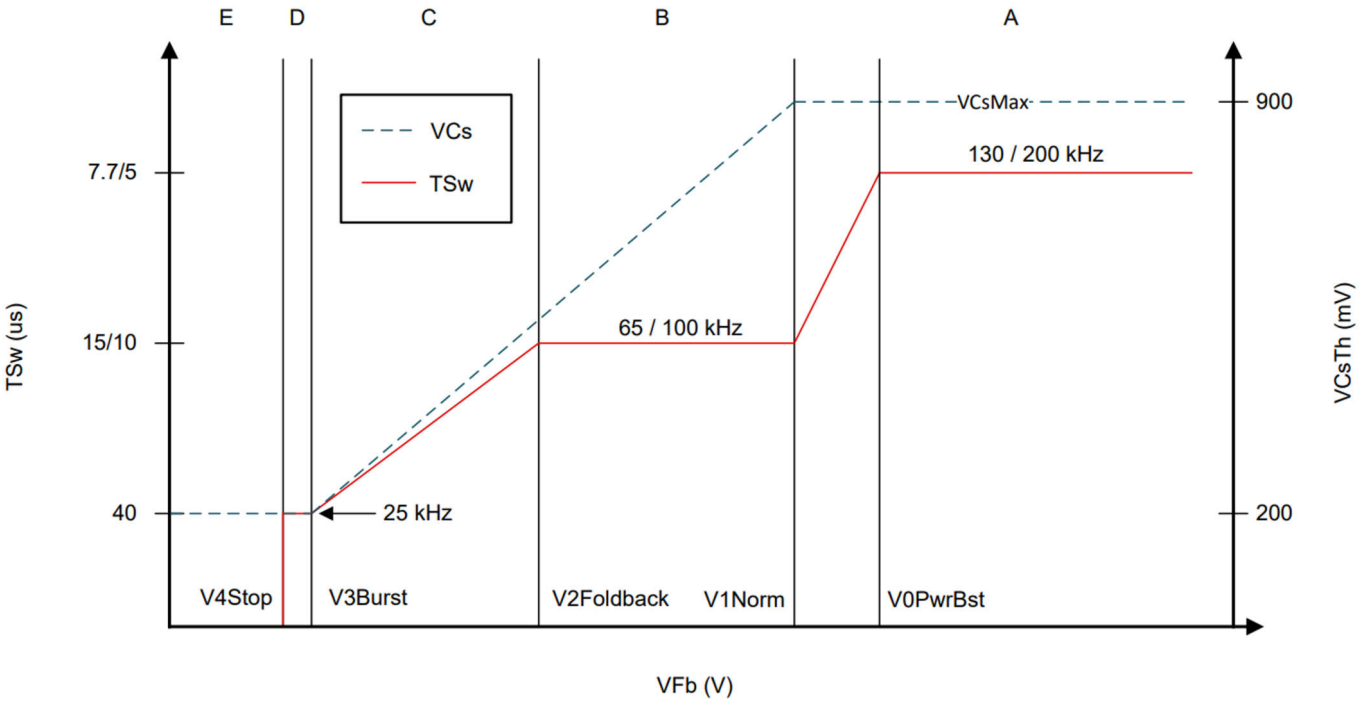


**Figure 4-1. IC Control Law**

# 5 Common Issues

The *Flyback Aux Winding OVP and UVLO Fault Sensing Design and Troubleshooting Tips*, application note introduces several common issues and troubleshooting tips, and this section also adds some issues.

1. The VDD pin is typically powered through a resistor network connected to the rectified bulk voltage and later an auxiliary winding in an AC/DC flyback application, and the charging path as Figure 5-1 showing. However, the resistor brings extra power consumption then impacts the no load power consumption, so the resistance is up to MΩ, but the side effect is that the charger current is smaller then impacts the startup time. The diode at auxiliary power path has reverse current, and the reverse current increased up to 1000 times at high ambient temperature as Figure 5-2 showing, and the reverse current can also limit the charge current from resistor power path, so customer sometimes faces that the VDD can't be charged up to startup point during burn in testing, then controller can't start switching.
2. In the Auxpower application, the flyback has multi-output for different loading, so the cross regulation is important, TI also published the *Adding a single capacitor to improve cross-regulation in dual-output flyback power supplies*, technical article and also Multiple Output Flybacks: How to Improve Cross Regulation training video to guide.
3. Customers can mention that the power consumption is too high during no load testing. However, the EVM test result is around 100mW. Customers measured higher power consumption because the dummy loading still present even the main power off. As Figure 5-3 showing VDD for OPA and MCU or other analog IC and gate driver bias power, so these extra loading still needs to be considered.
   Customers can remove the output loading by disconnecting the diode at output winding, besides the main output with regulation feedback loop.

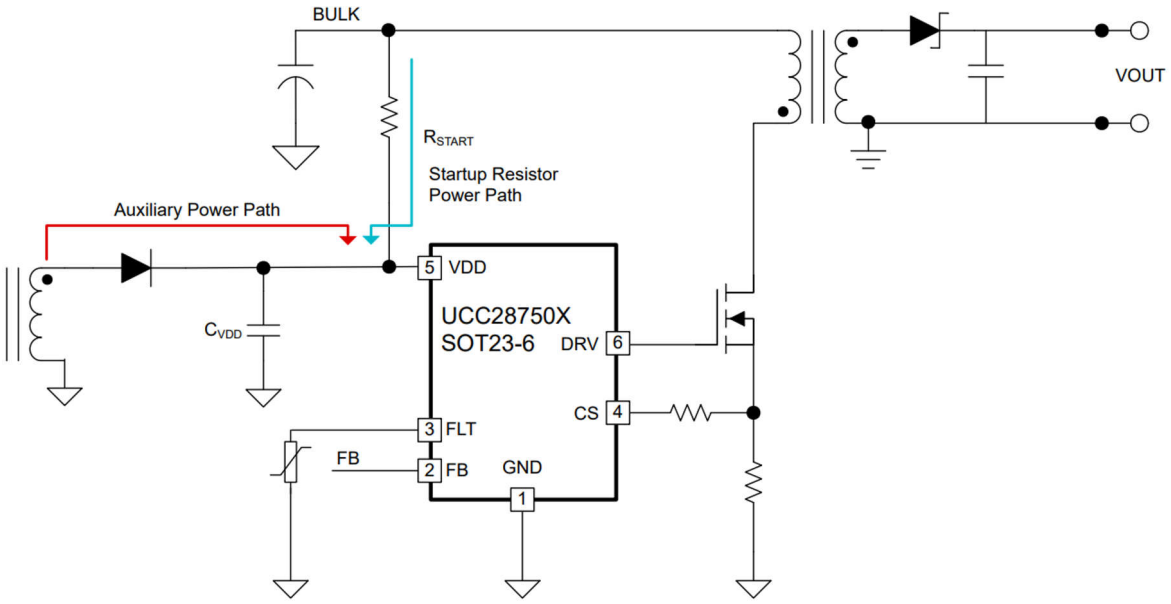


**Figure 5-1. VDD Charging Path**

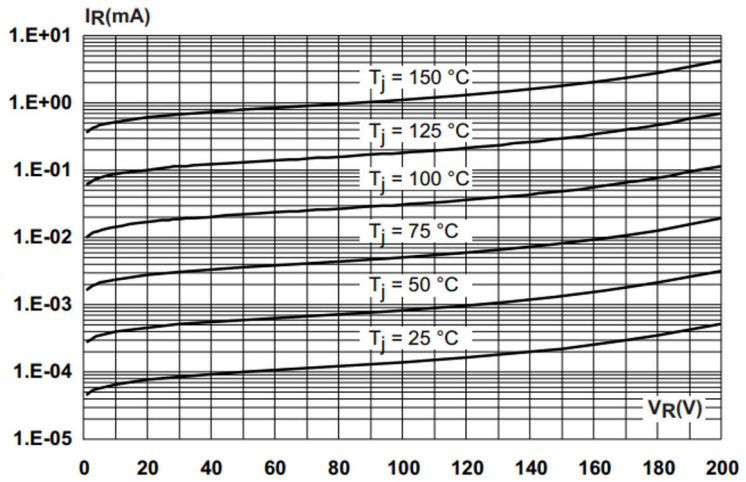


**Figure 5-2. Diode Reverse Current**

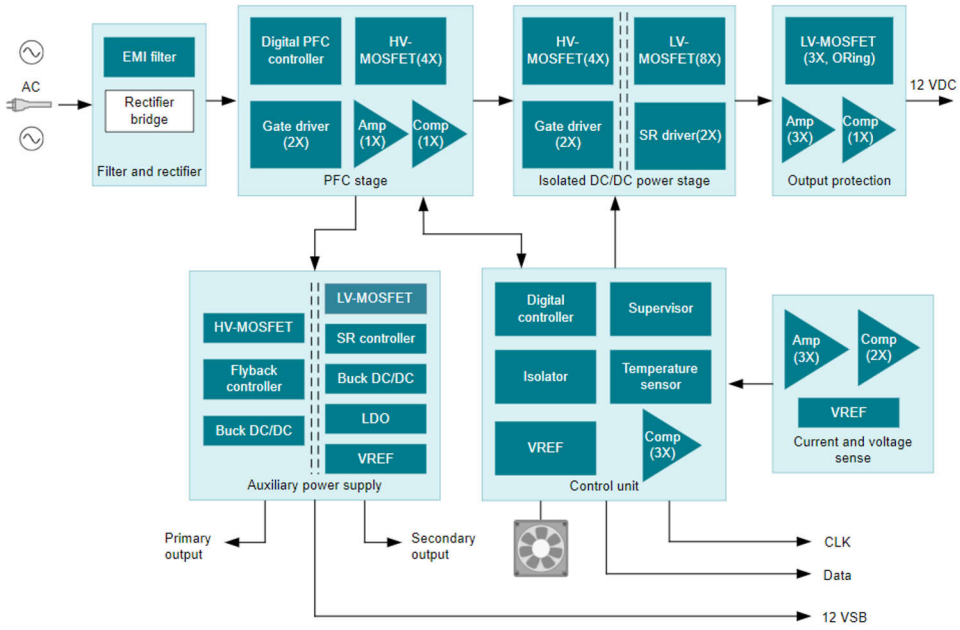


**Figure 5-3. Server Block Diagram**

## 6 Summary

If this device is a good design for your projects, do not hesitate to contact with a TI FAE. TI has several useful materials available, such as *Using the UCC28750EVM-071 60-W AC to DC Converter* EVM, *Calculator*, and *7.8W Wide AC Input Non-Isolated High-Side Buck Reference Design*.

## 7 References


- Texas Instruments, *UCC28750 Current-Mode Flyback Controller with Secondary-Side Regulation (SSR) for Off-Line Applications*, data sheet.
- Texas Instruments, *Using the UCC28750EVM-071 60-W AC to DC Converter*, user's guide.
- Texas Instruments, *Using the UCC24612-1EVM Secondary -Side Synchronous Rectifier Controller Diode Replacement Board*, user's guide.
- Texas Instruments, *Snubbing the flyback converter*, training video.
- Texas Instruments, *Flyback Aux Winding OVP and UVLO Fault Sensing Design and Troubleshooting Tips*, application note.
- Texas Instruments, *Adding a single capacitor to improve cross-regulation in dual-output flyback power supplies*, application note.
- Texas Instruments, *Multiple Output Flybacks: How to Improve Cross Regulation*, training video.

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