User's Guide

Low-Cost, High-Performance Auxiliary Power Supply Solution for 11KW OBC

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ABSTRACT

On-board charge (OBC) is one of the key components in new energy vehicles. The auxiliary power supply is used to provide stable power to gate drivers, voltage and current sampling, MCU, and so forth. This document first introduces the two main architectures commonly used for OBC auxiliary power supplies. Based on the power requirements of the auxiliary power supply of the mainstream 11KW OBC on the market, using a low-voltage 12V battery as the input of the auxiliary power supply. Low-cost, high-performance auxiliary power solutions are introduced, and the system block diagram, system BOM cost, Pros and Cons of the solutions are analyzed in detail.

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1 Introduction

OBC is the main component of new energy vehicles. According to the power level, OBC mainly has single-phase 3.3KW, 6.6KW, and three-phase 11KW, 22KW. Different types of OBC have different topological structures and different number of switch transistors, resulting in different bias power supply solutions. Commonly used auxiliary power types include Flyback, Push-Pull, LLC and DC-DC module. When selecting an auxiliary power topology, a comprehensive trade-off must be made based on system cost, design complexity, efficiency, system EMI and other aspects.

2 Main Architecture of OBC Auxiliary Power Supply

2.1 Flyback Architecture

Flyback architecture is one of the most widely used auxiliary power architectures. It usually supports a wide input voltage range. By adding a secondary winding on the secondary side of the transformer, it can easily support multiple outputs. LLC, Push-Pull, DC-DC module and other converters can also be added to the rear stage of Flyback. The Flyback architecture is shown in Figure 2-1.

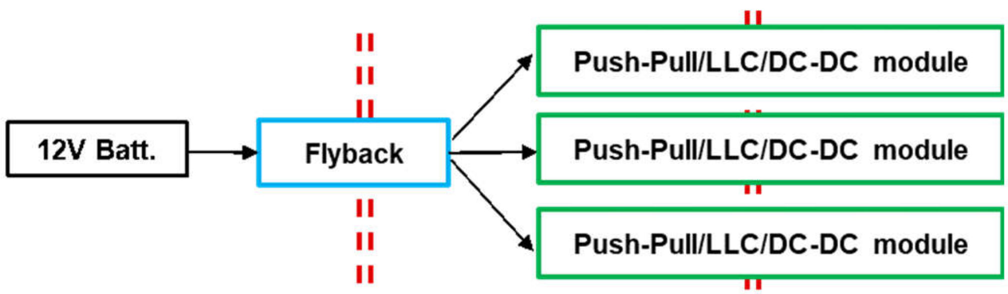

Figure 2-1. Flyback Architecture

2.2 Boost/Sepic Architecture

In the Boost/Sepic architecture, Boost/Sepic is usually used as a front-stage voltage pre-regulator to convert the 12V voltage of the low-voltage battery into a stable input voltage. LLC, DC-DC module and other converters can be added to the rear stage. The Boost/Sepic architecture is shown in Figure 2-2.

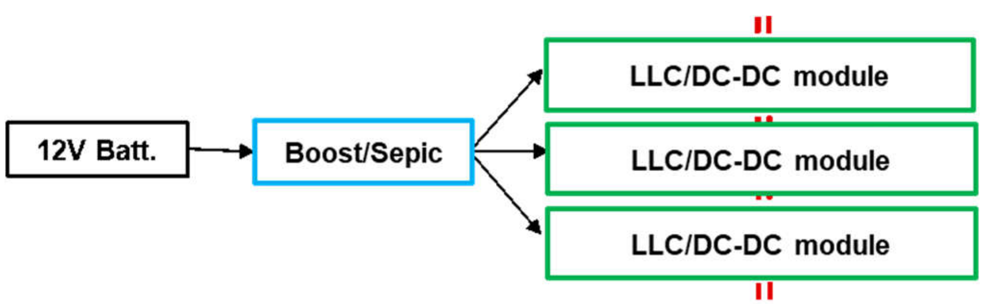

Figure 2-2. Boost/Sepic Architecture

3 11KW OBC Auxiliary Power Supply Power Requirement

At present, OBC is developing in the direction of high power. 11KW OBC is the current mainstream power range. It is of great significance to design a low-cost, high-performance OBC auxiliary power supply. Figure 3-1 shows the architecture of a three-phase 11KW OBC.

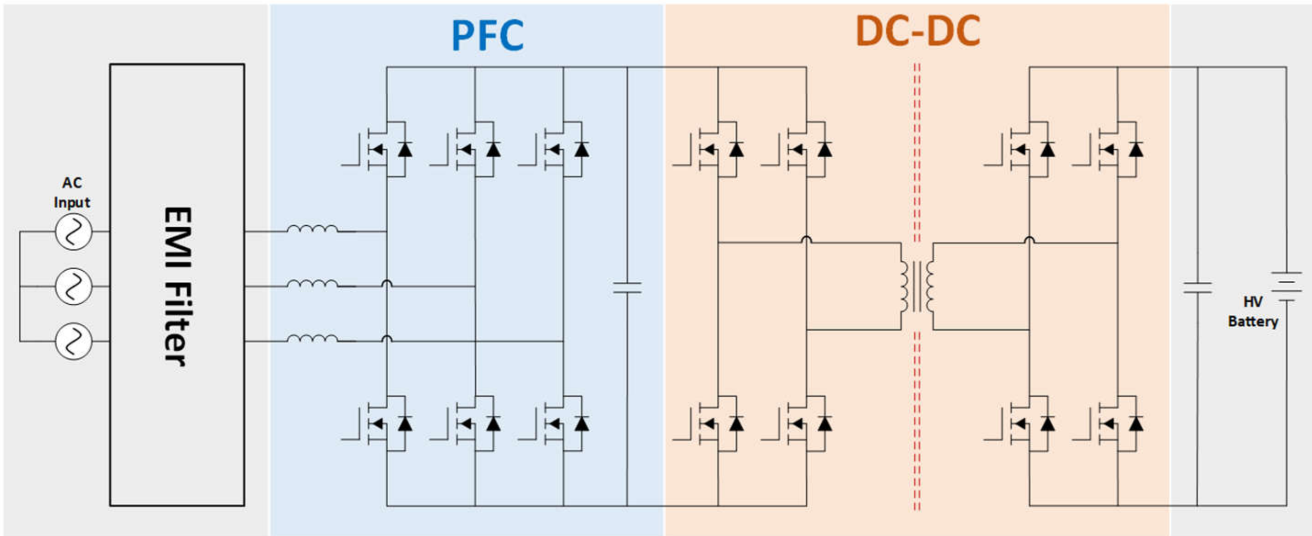

Figure 3-1. Three-Phase 11KW OBC Architecture

For the PFC side, assume that the driving power required by each SiC is Pbias=0.8W,For the DC-DC side, assume that the driving power required by each SiC is Pbias=1.4W. Table 3-1 shows the power requirements of the three-phase 11KW OBC. (The data are only estimated data based on the general OBC architecture, and designers can adjust them according to their actual needs.)

Table 3-1. Three-Phase 11KW OBC Power Requirement

Item	Quantity	Power (W)
PFC driving power (SiC)	6	0.8*6 = 4.8
AC Voltage Sensing	4	0.05*4 = 0.2
AC Current Sensing	4	0.05*4 = 0.2
DC-DC driving power (SiC)	8	1.4*8 = 11.2
DC Voltage Sensing	1	0.05*1 = 0.05
DC Current Sensing	2	0.05*2 = 0.1
MCU	1	1
Total power		17.55(W)

4 Low-Cost, High-Performance Auxiliary Power Solution

The LLC converter has high efficiency. TI's UCC25800-Q1 transformer driver is open-loop control, so it is necessary to add a pre-voltage pre-regulator between the low-voltage 12V battery and the auxiliary power circuit to make the UCC25800-Q1 work at a fixed input voltage, commonly used pre-voltage pre-regulator circuits are Boost or Sepic circuits. The research scope of this article is to use a low-voltage 12V battery as the input. Considering the fluctuation of the input voltage range, the input voltage range is generally 6-18V. The Sepic circuit is suitable for occasions where there is a need for Boost and Buck. Compared with the Boost converter, the Sepic converter has an additional energy storage inductor and a DC blocking capacitor. The system BOM cost is higher and the design is more complex. The input voltage range of UCC25800-Q1 is 9-34V. Under the condition of 34V input voltage, the power of UCC25800-Q1 can up to 9W. This solution selects UCC2803-Q1 as the Boost converter to increase the 12V voltage of the low-voltage battery to 34V as the front-stage voltage pre-regulator.

The block diagram of this solution is shown in Figure 4-1. The peripheral circuit design of this solution is simple, the efficiency can reach 85%-90%, and the output voltage adjustment accuracy can reach ±5%.

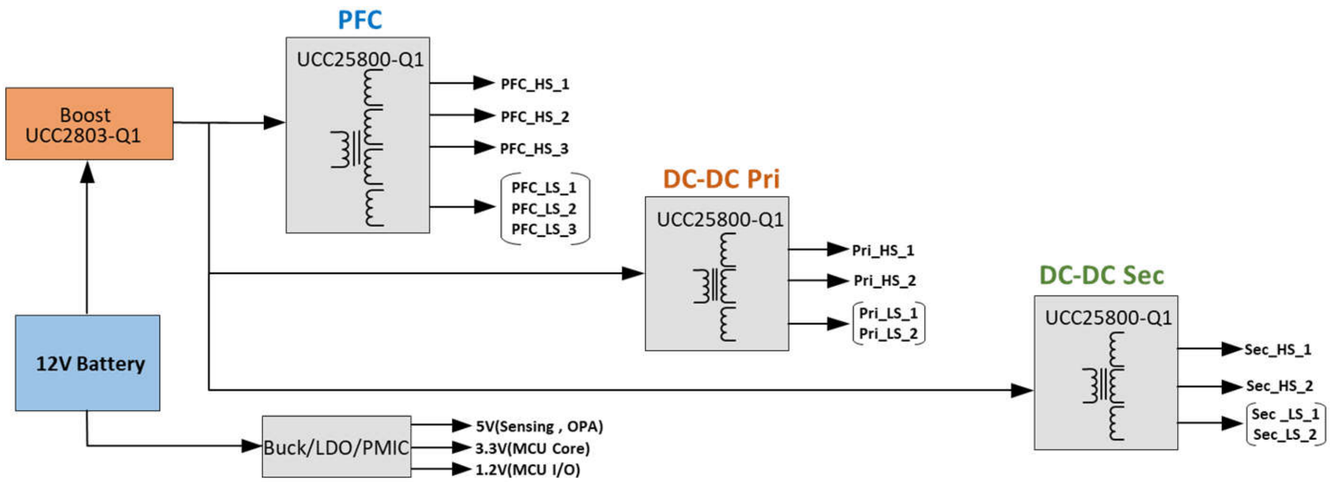

Figure 4-1. Boost+LLC Block Diagram

The system BOM cost of this solution is shown in Table 4-1.

Table 4-1. Boost+LLC System BOM Cost

Part Group	Description	Qty	Device Cost [$]	Cost [$]
LLC	UCC25800-Q1	3	0.28	0.84
Boost	UCC2803-Q1	1	0.18	0.18
Buck/LDO/PMIC				1
Capacitor large	1206	5	0.05	0.25
Capacitor medium	805	36	0.03	1.08
Capacitor small	603	6	0.01	0.06
Resistor	603	21	0.002	0.042
Mosfet		1	0.5	0.5
Diode		28	0.03	0.84
Transformer		3	0.5	1.5
		104		6.29

The pros and cons of this solution are shown in Table 4-2.

Table 4-2. Pros and Cons

Item	Performance
Total system cost	Low
Efficiency	High
Component count	Medium
EMI	High
Regulation accuracy	Low
Power density	Medium

The radar chart is shown in Figure 4-2.

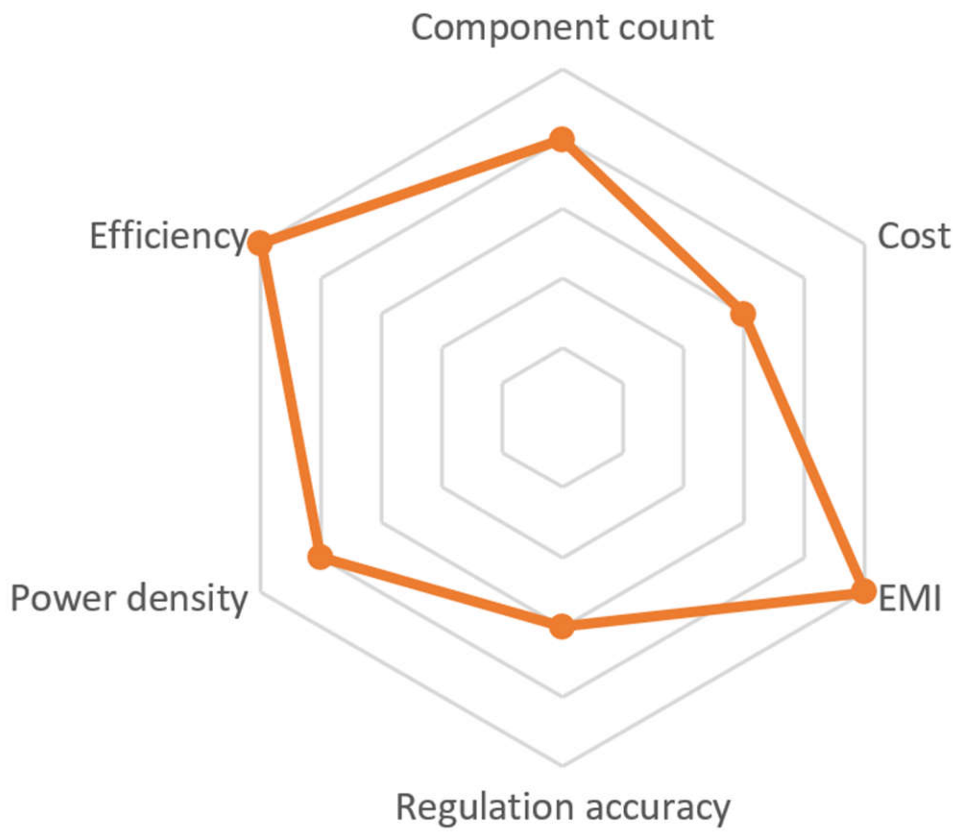

Figure 4-2. Boost+LLC Radar Diagram

5 Summary

This document introduces the auxiliary power architecture commonly used in OBC, and introduces low-cost, high-performance auxiliary power solutions based on the power requirements of 11KW OBC for auxiliary power.

6 References

- Texas Instruments: *UCC25800-Q1 Ultra-low EMI Transformer Driver for Isolated Bias Supplies Data Sheet*
- Texas Instruments: *UCC280x-Q1 Low-Power BiCMOS Current-Mode PWM Controllers Data Sheet*

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