EZ-PD™ CCG7SAF automotive rear-seat charger solution demo kit (REF_CCG7SAF_45W_RSC) user guide

About this document

Scope and purpose

This document provides solution demo and features of the single-port EZ-PD™ CCG7SAF automotive USB Type-C Power Delivery (PD) and buck-boost controller in the automotive rear-seat charger (RSC) solution demo kit (REF_CCG7SAF_45W_RSC).

Intended audience

This document is primarily intended for the automotive rear-seat charger (RSC) solution designers using the EZ-PD™ CCG7SAF automotive USB Type-C PD and buck-boost controller.

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1 Introduction

The USB Power Delivery (USB PD) automotive rear-seat charger must deliver a wide range of configured positive output voltage and power from an automotive battery input ranging from 5.5 V – 18 V. A four-switch buck-boost converter (FSBBC) is a suitable topology that supports variable input voltages and configurable-output-voltage applications such as USB PD where high efficiency and high power-density is required. The FSBBC configuration can act as a buck, a boost, or a buck-boost converter to provide an output voltage with the same polarity as the input voltage. Improved efficiency of the FSBBC is observed due to synchronous rectification. On similar lines, buck-only and boost-only operations can be achieved.

Constant-frequency peak current mode control (PCMC) is a popular control technique for a switched-mode power converter. PCMC offers built-in overcurrent protection, robust dynamic responses, simplified voltage-loop compensator design, and rejection of the input voltage disturbances.

EZ-PD™ CCG7SAF automotive, single-port USB Type-C PD controller with integrated buck-boost DC-DC controller with two buck MOSFETs is a single-chip controller used for the automotive rear-seat charger solution demo kit.

EZ-PD™ CCG7SAF automotive controller is a highly integrated, single-port USB Type-C PD solution with an integrated buck-boost controller and two buck MOSFETs in a single chip. It complies with the latest USB Type-C and PD specifications and is intended for automotive rear-seat charger applications. Integrations offered by EZ-PD™ CCG7SAF not only reduce the bill of materials (BOM) but also provide a footprint-optimized solution for power adapter charging needs. EZ-PD™ CCG7SAF has integrated gate drivers for VBUS NFET on the provider path. It also includes hardware-controlled protection features on the VBUS. EZ-PD™ CCG7SAF supports a wide input voltage range (4 V-24 V with 40 V tolerance) and programmable switching frequency (150 kHz – 600 kHz) in an integrated PD solution. EZ-PD™ CCG7SAF has the capability of in-system firmware upgrade through the Type-C interface.

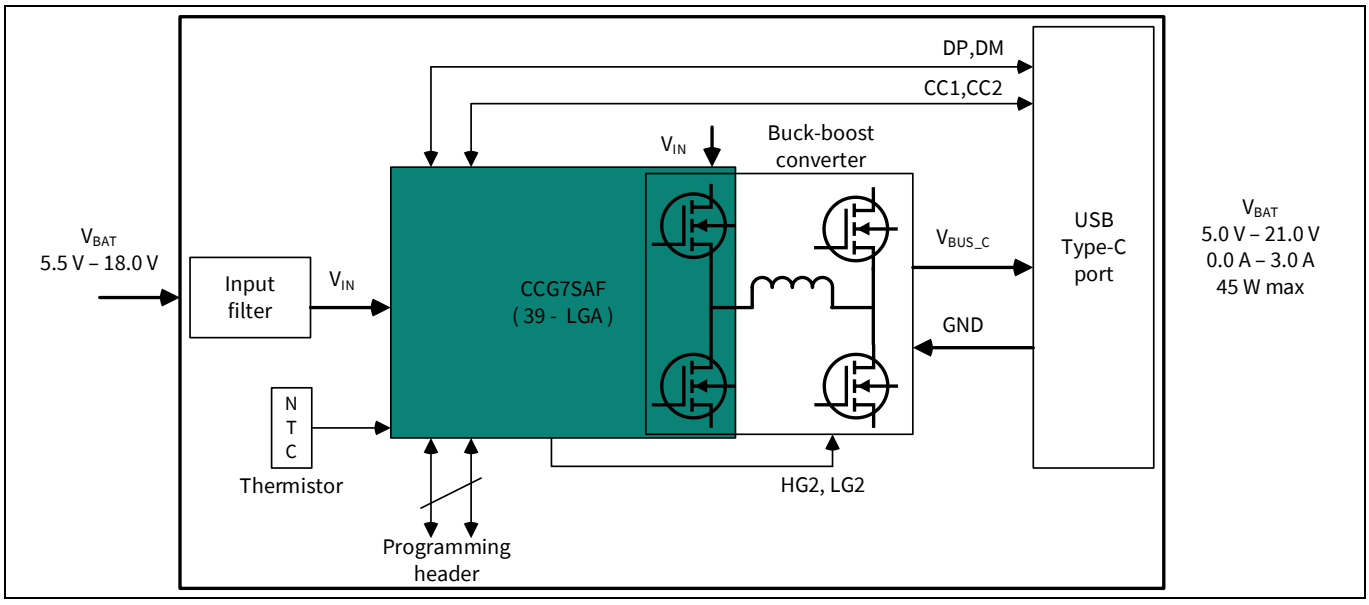


Figure 1 EZ-PD™ CCG7SAF automotive-based single output USB PD rear-seat charger

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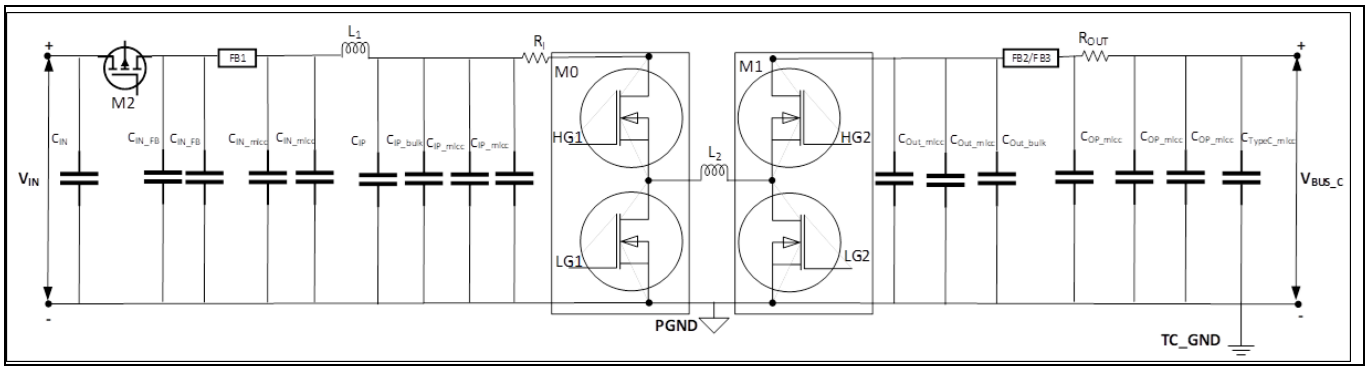


Figure 2 High-level block diagram of REF_CCG7SAF_45W_RSC Kit power stage

Table 1 Critical components BOM

Designator	Description	Part number	Manufacturer
U1	EZ-PD™ CCG7SAF automotive single-port USB Type-C with PD and buck-boost controller (M0 is internal to the CCG7SAF controller)	CYPD7192-39BFXS	Infineon Technologies AG
M1	MOSFET 2N-CH 40 V, 45 A, 8TDSON	IAUC45N04S6L063H	Infineon Technologies AG
M2	MOSFET 1N-CH 60 V, 1.2 mΩ, 287 A	NVMFS5C604NL	Onsemi
FB1	Powerline ferrite bead 1206, 12 A, 1.6 mΩ	BLM31SN500SH1	Murata Electronics
FB2, FB3	Powerline ferrite bead 0805, 06 A, 4.0 mΩ	BLM21SN300SH1	Murata Electronics
L1	200 nH shielded molded inductor, 22.4 A, 3.5 mΩ	XGL3530-201	CoilCraft
L2	6.8 µH shielded molded inductor, 11.5 A, 14 mΩ	XGL6060-682	CoilCraft
C_{IP_BULK}	CAP ALUM HYB 100 µF, 20%, 35 V SMD	EEH-ZK1V101XP	Panasonic
C_{OUT_BULK}	CAP ALUM POLY 220 µF, 20%, 25 V	GYC1E221MCQ1GS	Nichicon

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2 EZ-PD™ CCG7SAF automotive RSC solution demo kit (REF_CCG7SAF_45W_RSC) specifications

Table 2 Kit specifications

Parameter	Value
Input voltage	5.5 V_{DC} – 18 V_{DC}
Maximum output power	45 W on port with a maximum load current of 3 A
Output voltage	Fixed PDOs: 5 V/3 A, 9 V/3 A, 15 V/3 A, 20 V/2.25 A PPS: 5.0 V – 11 V, 3 A; 5.0 V – 16 V, 3 A; 5.0 V – 21 V, 2.25 A; PPS power limit of 45 W
Peak efficiency	97%
Protections	• Input overvoltage protection • Input undervoltage protection • V_{BUS_C} overvoltage protection (OVP) • V_{BUS_C} undervoltage protection (UVP) • Overcurrent protection (OCP) • Short-circuit protection (SCP) • Overtemperature protection (OTP) • V_{BUS_C} to CC short protection
Power throttling	• Programmable input voltage throttling: a) 18 $V_{DC} \geq V_{IN} \geq 11\ V_{DC}$ 45 W b) 11 $V_{DC} > V_{IN} \geq 09\ V_{DC}$ 33.75 W c) 09 $V_{DC} > V_{IN} \geq 5.5\ V_{DC}$ 22.5 W • Programmable thermal throttling: a) -40°C ≤ T < 90°C 45 W b) +90°C ≤ T < 105°C 22.5 W
Charging standards supported	1. USB-C PD 3.2 v1.0 including programmable power supply (PPS) mode 2. Apple Charging 2.4 A/3.0 A 3. Qualcomm QC 2.0, 3.0, 4.0,5.0 4. Samsung adaptive fast charging (AFC) 5. USB BC 1.2

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3 Overview

The EZ-PD™ CCG7SAF automotive RSC solution demo kit (REF_CCG7SAF_45W_RSC) (shown in Figure 3) is designed to meet the specifications shown in Table 2.

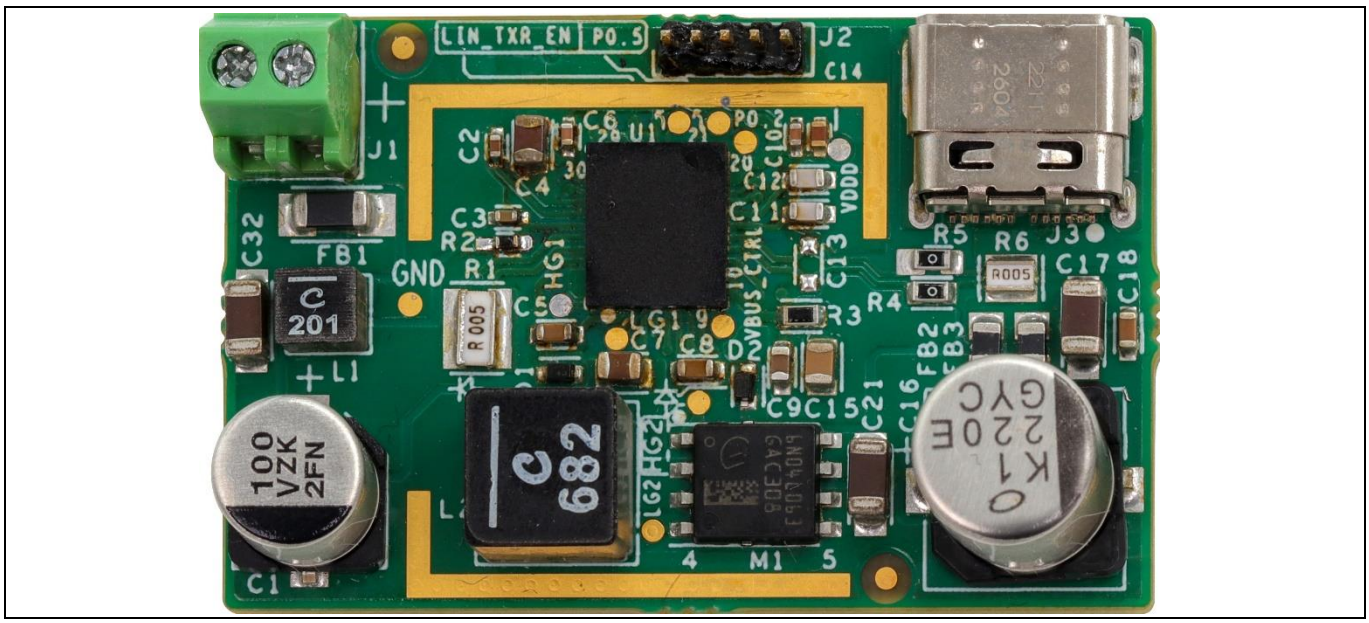


Figure 3 CCG7SAF automotive rear-seat charger solution demo kit

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4 Test setup

Figure 4 shows the measurement equipment connections.

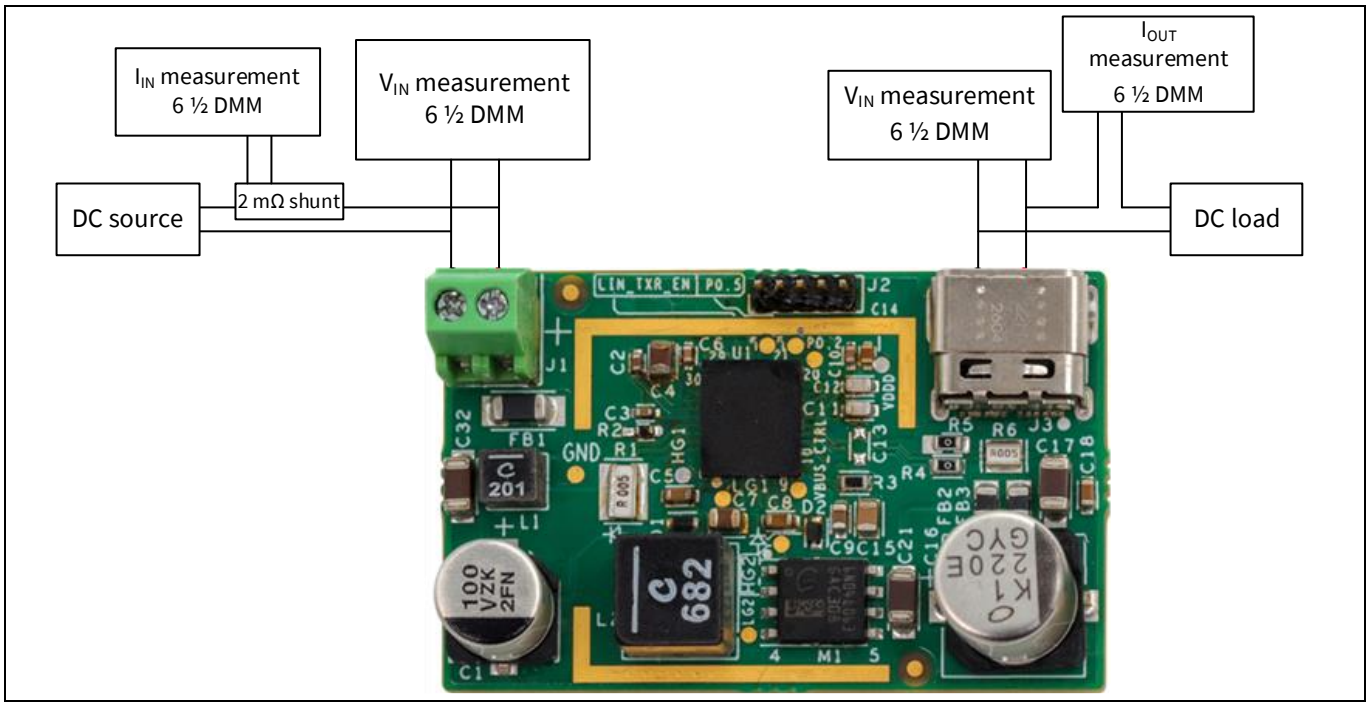


Figure 4 Test equipment connected to RSC solution demo kit (REF_CCG7SAF_45W_RSC)

4.1 Test equipment

The test equipment details shown in Table 3 can be used to measure the performance parameters such as efficiency, ripple, regulation, and transient response.

Table 3 Test equipment details

Test setup	Description
Programmable DC source	Chroma 62024P-80-60
Oscilloscope	Tektronix MDO 3034
Digital multimeter (I_{OUT})	Keysight 34465A
Data logger (V_{BUS_C}, $I_{IN,}$ V_{IN})	Keysight 34970 A
Electronic load	Chroma 63102A
Input current (I_{IN}) measurement shunt	Y14880R00200D5W

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4.2 Power adapter tester (PAT)

The DUT is connected to a power adapter tester (PAT) (CCPROG PAT) using a USB Type-C cable. Once a successful connection is established, the PAT UI does a PDO discovery and displays the results. The RSC solution demo kit is preconfigured with seven PDOs:

Fixed PDOs: 5 V/3 A; 9 V/3 A; 15 V/3 A; 20 V/2.25 A

PPS: 5.0 V – 11 V, 3 A; 5.0 V – 16 V, 3 A; 5.0 V – 21 V, 2.25 A (PPS power limits)

You can either choose the suitable preconfigured PDO or configure a new one using the EZ-PD™ Configuration Utility. Tests in the following sections use preconfigured PDOs.

To know more about the PAT tester, visit the USBCEE webpage.

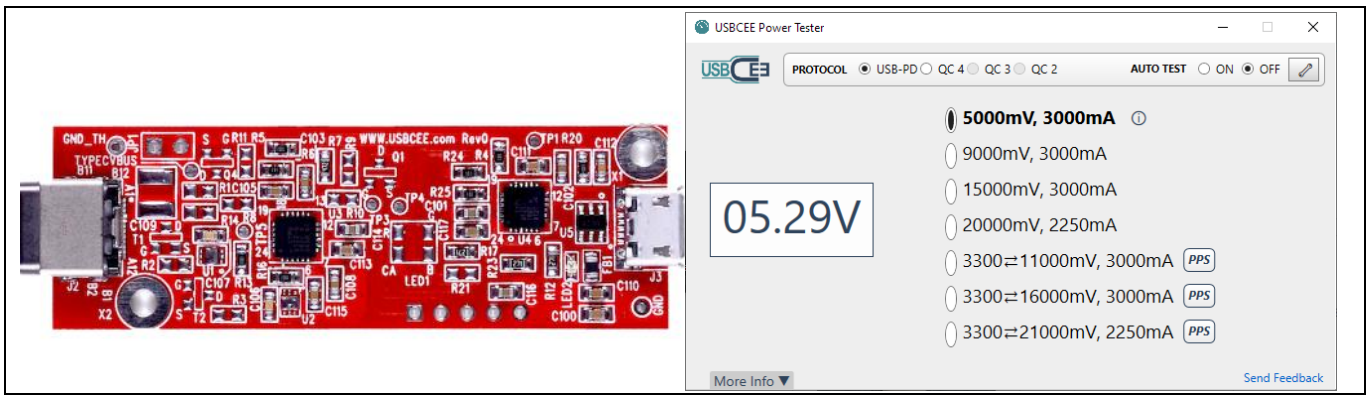


Figure 5 PAT tester and user interface

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5 Quick steps for demo

1. Connect the 12 V input supply at the J1 connector as shown in the Test setup section
2. Connect a USB PD tester or a power adapter tester (PAT) to the port and make sure that the USB PD tester gets into a successful Power Delivery contract as shown in the Power adapter tester (PAT) section

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References

[1] EZ-PD™ CCG7SAF automotive single-port USB Type-C with PD and buck-boost controller; Available online

[2] EZ-PD™ CCG7SAF controller based rear-seat charger power stage design calculator; Available online

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Revision history

Document revision	Date	Description of changes
**	2024-01-09	Initial release
*A	2025-05-27	Released to Web

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