EZ-PD™ CCG7D automotive dual-port USB-PD rear seat charger (RSC) solution user guide

About this document

Scope and purpose

This document provides a solution demo features of dual-port EZ-PD™ CCG7D automotive USB Type-C power delivery (PD) and buck-boost controller in the automotive rear seat charger (RSC) solution demo kit (REF_CCG7D_120W).

Intended audience

This document is primarily intended for automotive rear seat charger (RSC) solution designers using EZ-PD™ CCG7D 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 needs to deliver a wide range of configured positive output voltage and power from a 5.5 V–18 V automotive battery input. A four-switch buck boost converter (FSBBC) is the suitable topology, which can support variable input voltages and configurable output voltage applications such as USB PD where high efficiency and power density are also required. The FSBBC configuration can act as buck, boost, or buck-boost converter to provide an output voltage with the same polarity of the input voltage. Improved efficiency of the FSBBC is observed due to synchronous rectification. In similar lines, buck only, and boost-only operations can be achieved.

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

EZ-PD™ CCG7D automotive dual- port USB Type-C Power Delivery controller with integrated buck-boost DC-DC controller is a single-chip controller used for the automotive rear seat charger solution demo board.

EZ-PD™ CCG7D automotive controller is a highly integrated dual-port USB Type-C PD solution with integrated buck-boost controllers. It complies with the latest USB Type-C and PD specifications, and is targeted for automotive rear seat charger applications. Integration offered by EZ-PD™ CCG7D not only reduces the bill of materials (BOM) but also provides a footprint-optimized solution for power adapter charging needs. EZ-PD™ CCG7D has integrated gate drivers for VBUS NFET on the provider path. It also includes hardware-controlled protection features on VBUS. EZ-PD™ CCG7D supports a wide input voltage range (4 V–24 V with 40-V tolerance) and programmable switching frequency (150–600 kHz) in an integrated PD solution. EZ-PD™ CCG7D automotive has the capability of in-system firmware upgrade through the Type-C interface.

A high-level block diagram of the EZ-PD™ automotive-based dual-output USB PD rear seat charger solution is shown in Figure 1.

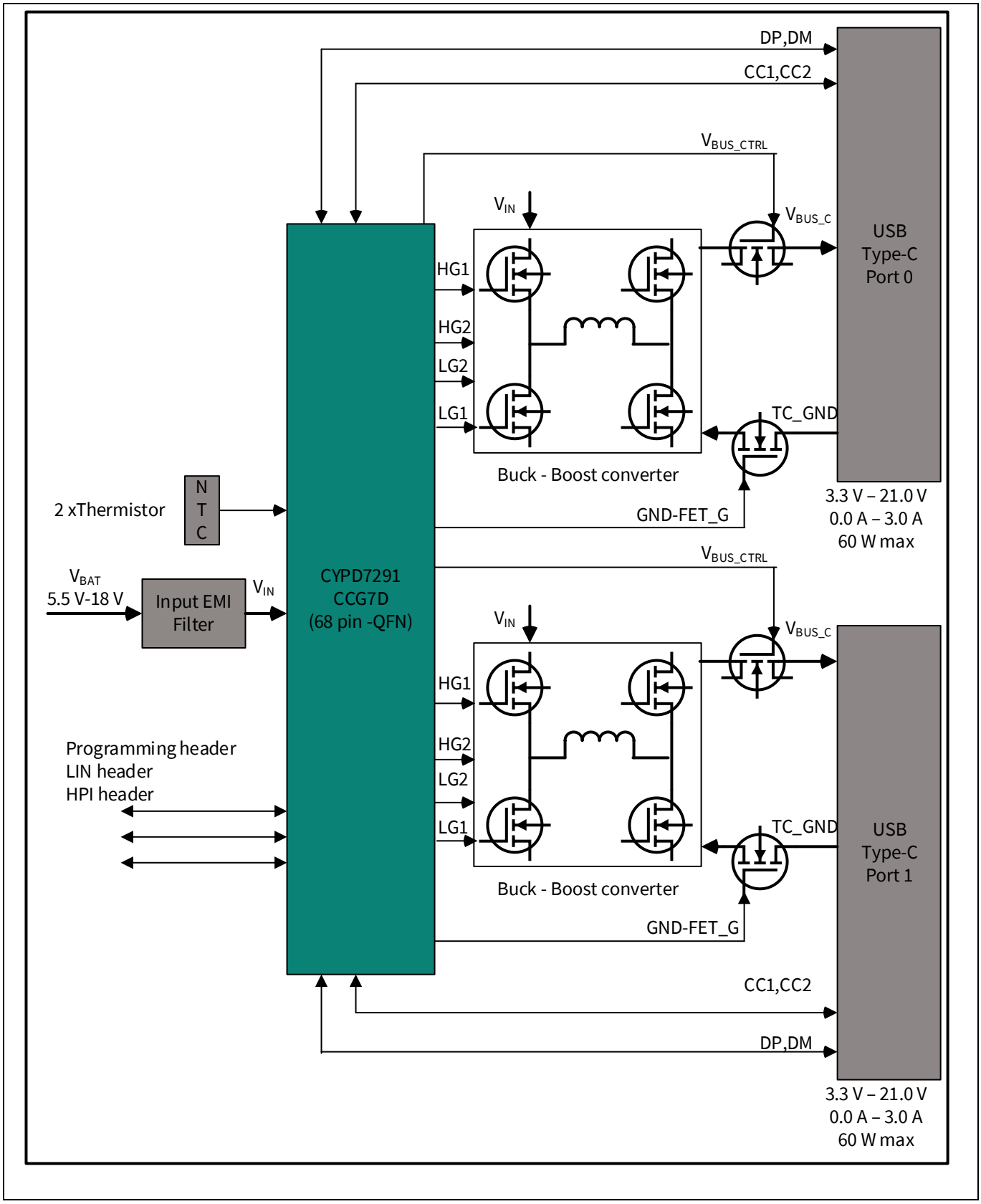

Figure 1 EZ-PD™ CCG7D automotive-based dual-output USB PD rear seat charger

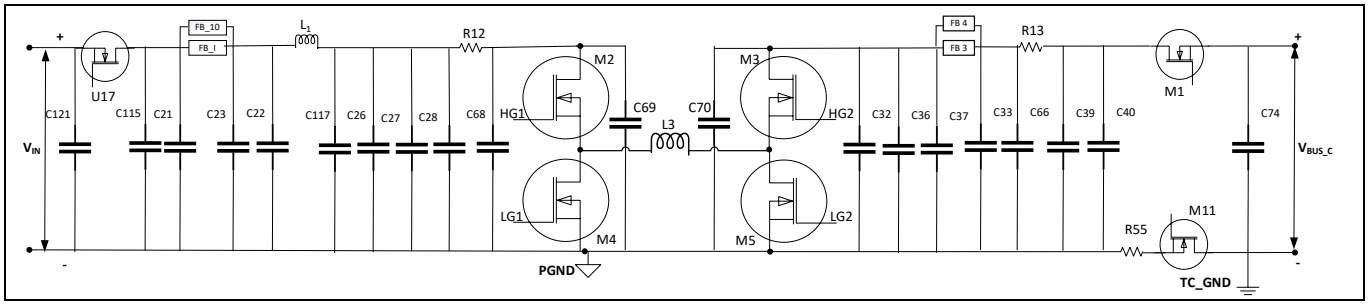

Figure 2 High-level block diagram of RSC solution board power stage

Table 1 Critical components BOM

Designator	Description	Part number	Manufacturer
U1	EZ-PD™ CCG7D automotive dual-port USB Type-C PD and buck-boost controller 68-pin QFN	CYPD7291-68LDXS	Infineon Technologies
U17	MOSFET N-CH 60 V 120 A TDSON-8-43	IAUC120N06S5N017	Infineon Technologies
M2, M3, M4, M5	MOSFET N-CH 40 V 40 A 8TSDSON	IPZ40N04S5L4R8ATMA1	Infineon Technologies
M1	MOSFET N-CH 40 V 40 A 8TSDSON	IPZ40N04S53R1 ATMA1	Infineon Technologies
M11	MOSFET N-CH 40 V 40 A 8TSDSON	IPZ40N04S5L2R8ATMA1	Infineon Technologies
FB1, FB10	Powerline ferrite bead 1206, 12 A 1.6 mΩ	BLM31SN500SH1	Murata Electronics
FB3, FB4	Powerline ferrite bead 0805, 06 A 4.0 mΩ	BLM21SN300SH1	Murata Electronics
L1	Fixed inductors 220 nH Shld 20% 28.5 A 1.3 mΩ	XGL6060-221MEC	CoilCraft
L3	Fixed inductors 6.8 µH 20% 18.5 A 8.9 mΩ	XAL1010-682	CoilCraft
C121	CAP CER 10 µF 50 V X7S 1210	GCM32EC71H106KA03K	Murata Electronics
C66, C115	CAP CER 10000 pF 50 V X7R 0603	GCD188R71H103KA01D	Murata Electronics
C21, C22, C23, C28, C32, C33, C36	CAP CER 10 µF 50 V X7R 1206	CGA5L1X7R1H106K160 AC	TDK Corporation
C117	CAP CER 1 µF 50 V X7R 0805	GCM21BR71H105KA03K	Murata Electronics
C26	CAP ALUM POLY 56 µF 20% 50 V SMD	GYC1J560MCQ1GS	Nichicon
C27	CAP CER 1 µF 50 V X7R 0805	GCM21BR71H105KA03K	Murata Electronics
C37	CAP ALUM POLY 220 µF 20% 25 V SMD	GYC1E221MCQ1GS	Nichicon
C68, C69, C70	CAP CER 4.7 µF 50 V X7R 0805	CGA4J1X7R1H475K125AE	TDK Corporation
C39	CAP CER 0.1 µF 50 V X7R 0603	GCM188R71H104KA57J	Murata Electronics
C40	CAP CER 1 µF 50 V X7R 0805	GCM21BR71H105KA03L	Murata Electronics
C74	CAP CER 4.7 µF 50 V X7R 1210	C1210C475K5RACAUTO	Kemet

2 REF_CCG7D_120W kit specifications

Table 2 Test specifications

Parameter	Value
Input voltage	5.5 V_{DC} – 18 V_{DC}
Max output power	60 W on each port with a max load current of 3 A
Output voltage	Fixed PDOs: 5 V / 3 A, 9 V / 3 A, 15 V / 3 A, 20 V / 3 A PPS: 3.3 V – 11 V, 3 A; 3.3 V – 16 V, 3 A; 3.3 V – 21 V, 3 A with PPS power limit
Peak efficiency	97%
Protections	1. Input overvoltage protection 2. Input undervoltage protection 3. V_{BUS_C} overvoltage protection (OVP) 4. V_{BUS_C} undervoltage protection (UVP) 5. Overcurrent protection (OCP) 6. Short-circuit protection (SCP) 7. Over-temperature protection (OTP) 8. V_{BUS_C} to CC short protection 9. V_{BAT} to GND short protection
Power throttling	1. Programmable input voltage throttling per port: a) 18 $V_{DC} \geq V_{IN} \geq 11$ V_{DC} 60 W b) 11 $V_{DC} > V_{IN} \geq 09$ V_{DC} 45 W c) 09 $V_{DC} > V_{IN} \geq 5.5$ V_{DC} 30 W 2. Programmable thermal throttling: a) -40°C ≤ T < 90°C 60 W b) +90°C ≤ T < 105°C 30 W
Charging standards supported	1. USB-C PD v2.0 including programmable power supply (PPS) mode 2. Apple Charging 2.4 A 3. Qualcomm QC 2.0, 3.0, 4.0 4. Samsung AFC 5. USB BC 1.2

3 RSC solution demo (REF_CCG7D_120W) kit board overview

The EZ-PD™ CCG7D automotive RSC solution demo (REF_CCG7D_120W) kit is shown in Figure 3. This solution board is designed to meet the specifications shown in Table 2.

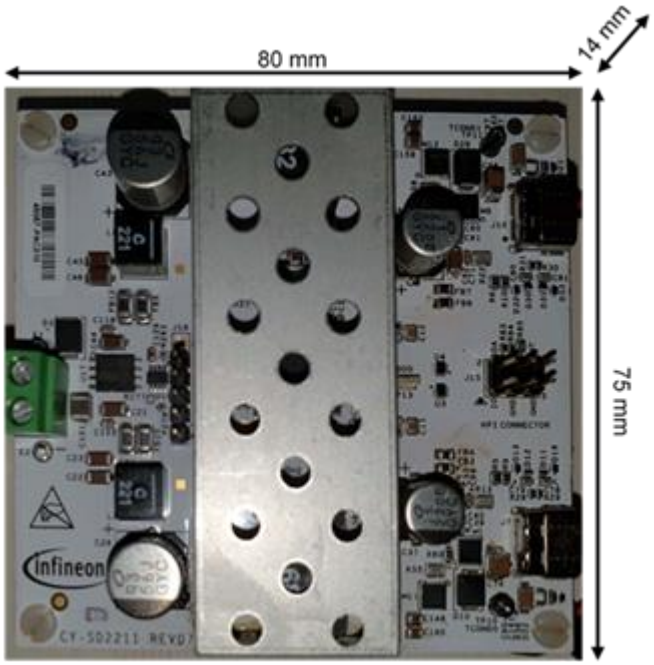

Figure 3 EZ-PD™ CCG7D automotive rear seat charger solution board

4 Test setup

Measurement equipment connectivity is shown in Figure 4.

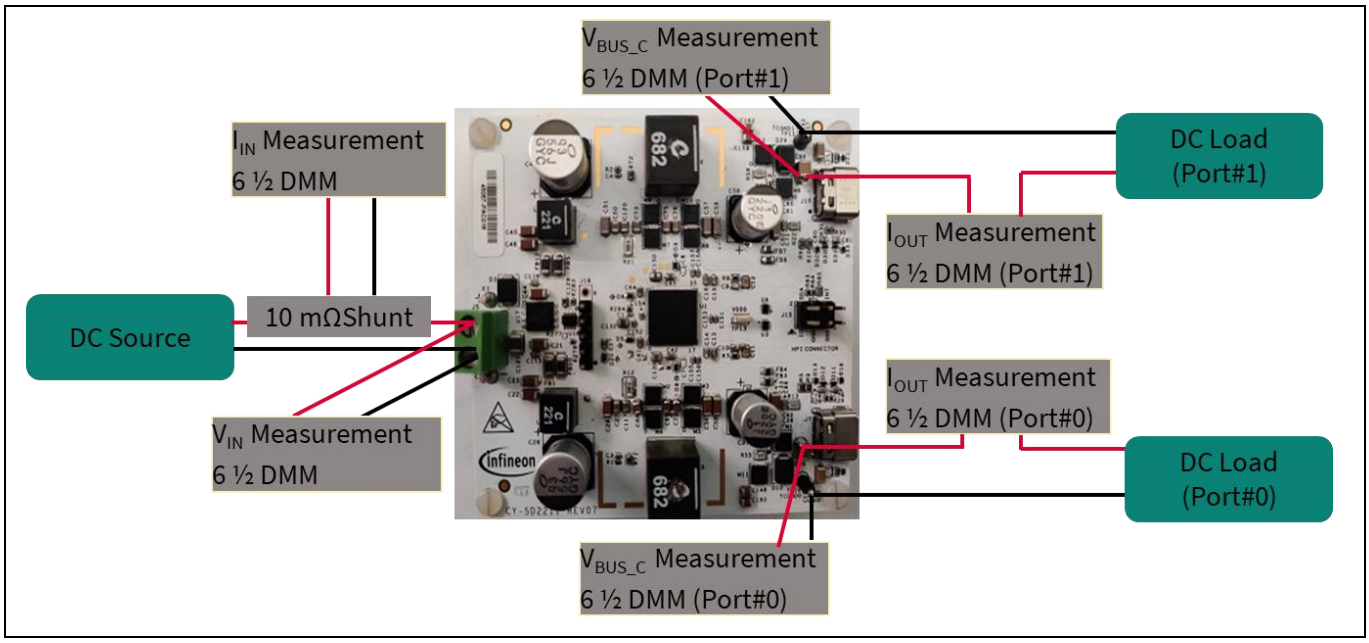

Figure 4 Test equipment connected to the RSC solution demo (REF_CCG7D_120W) board

4.1 Test equipment

The test equipment shown in the Table 3 can be used to measure the performance parameters like 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 (port #0 I_{OUT}, port #1 I_{OUT})	Keysight 34465A
Data logger (port #0 V_{BUS_C}, port #1 V_{BUS_C}, I_{IN}, V_{IN})	Keysight 34970 A
Electronic load	Chroma 63102A
Input current (I_{IN}) measurement shunt	Y14880R01000D5W

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 pre-configured with 7 PDOs:

Fixed PDOs: 5 V / 3 A, 9 V / 3 A, 15 V / 3 A, 20 V / 3 A

PPS: 3.3 V – 11 V, 3 A; 3.3 V – 16 V, 3 A; 3.3 V – 21 V, 3 A (PPS power limited)

Test setup

You can either choose the suitable pre-configured PDO or configure a new one using the EZ-PD™ configuration utility. Tests in the following sections use pre-configured PDOs.

To know more about PAT tester, see USBCEE.

Figure 5 PAT tester and user interface

5 Quick steps for demo

1. Connect the 12-V input supply at J5 as shown in Test setup.
2. Connect a USB PD tester or a power adapter tester (PAT) to Port 0 and make sure that the USB PD tester gets into a successful Power Delivery contract as shown in Power adapter tester (PAT).
3. Repeat steps 1 and 2 on Port 1.
4. To test load sharing, connect a USB PD tester to one of the Type-C ports and USB PD phone to the other Type-C port. Monitor how the negotiated power levels change when both the Type-C ports are active.

References

Contact Infineon Support to obtain these documents.

[1] Infineon Technologies AG: *002-28172: EZ-PD™ CCG7D automotive datasheet*

[2] Infineon Technologies AG: *002-34168: EZ-PD™ CCG7x RSC power stage design calculator*

[3] Infineon Technologies AG: *002-32985: Hardware design guidelines for EZ-PD™ CCG7D in automotive applications*

[4] Infineon Technologies AG: *002-33172: EZ-PD™ CCG7D automotive rear seat charger (RSC) solution demo (SD2211) kit ISO 7637-2 and ISO 16750-2 test report*

[5] Infineon Technologies AG: *002-32948: EZ-PD™ CCG7D RSC solution board CISPR 25 Class 5 Conducted and Radiated Emission Results*

[6] Infineon Technologies AG: *002-32949: CCG7D automotive rear seat charger (RSC) solution demo (SD2211) kit test report*

Revision history

Document revision	Date	Description of changes
**	2022-01-04	Initial release
*A	2024-09-18	Model number changed from SD2211 to REF_CCG7D_120W

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