EZ-PD™ PAG1S-1P based 65 W ATQ GAN USB PD dual-C charger and adapter solution user guide

About this document

Scope and purpose

This document provides instructions and a quick start guide for EZ-PD™ PAG1S-1P-based 65 W ATQ GAN PD dual-C charger and adapter solution (REF_65W_2C_GAN_PAG1).

Intended audience

This document is primarily intended for EZ-PD™ PAG1S-1P multiport charger and adapter solution developers.

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1 Introduction

As portable electronic devices such as smartphones, tablets, and laptops require faster charging, the Power Delivery (PD) technology is designed to provide the fastest charging possible through a USB Type-C (USB-C) cable. The USB PD Standard Power Range (SPR) standard defines the maximum power to deliver over a USB-C cable up to 100 W. This allows for providing multiple USB-C ports (Figure 1) on universal AC-DC adapters that can charge a wide range of devices such as smartphones, gaming laptops, power tools, and e-bikes.

However, these new requirements for higher power and multi-port have presented challenges for the converter topologies used till now. Considering a few factors such as electromagnetic compatibility, power factor correction, standby power, and average efficiency ensures that the chargers and adapters are effective and efficient. The size (power density), load sharing, and scaling up multiple ports became critical factors for design engineers and end-users. The power efficiency of USB-C chargers and adapters is a crucial role in determining their power density. Therefore, converter topology, usage model, integration, and flexibility of controller functionalities are all key factors to consider when selecting the right adapter architecture for the needs.

Figure 1 shows a typical block diagram of a multi-port adapter. The front-end AC-DC converter produces the requested output voltage. On the other hand, the buck converter (connected at the output of the AC-DC converter) ensures that the defined USB-C PD specifications and performance are achieved for multi-port adapter applications. Figure 1 shows a high-level block diagram of the EZ-PD™ PAG1S-1P based 65 W dual-C adapter and charger solution.

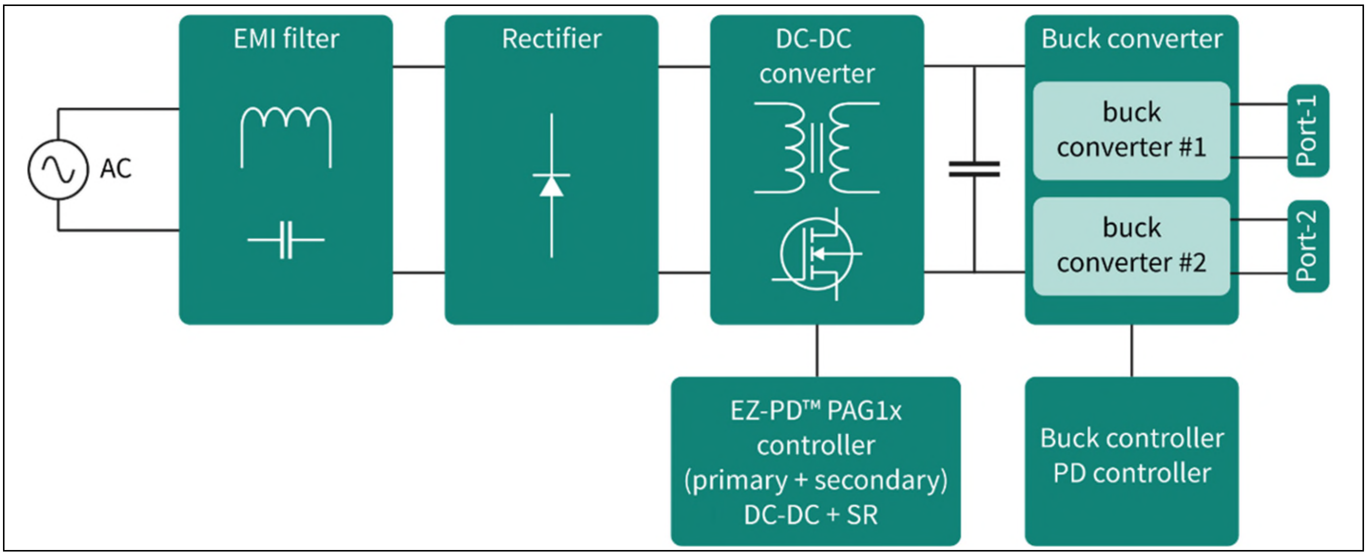

Figure 1 High-level block diagram of a dual-port adapter

Infineon provides a comprehensive solution for both sections of adapters, i.e., AC-DC and buck converters. Specifically, for AC-DC conversion, Infineon's EZ-PD™ PAG1x-based solution, along with the EZ-PD™ CCG7DC-based buck converter, ensure compatibility with USB PD/Programmable Power Supply (PPS) standards. The EZ-PD™ CCG7DC supports a dual PD/PPS port, capable of controlling two buck controllers with integrated drivers, which makes it an ideal choice for dual or multi ports (multiples of 2) applications.

Table 1 Critical components bill of materials (BOM)

Designator	Description	Part number	Manufacturer
U1	EZ-PD™ PAG1S USB PD power adapter secondary side controller	CYPAS111A1-24LQXQ	Infineon Technologies
U2	EZ-PD™ PAG1P primary side startup controller	CYPAP112A3-10SXQ	Infineon Technologies
U3	EZ-PD™ CCG7DC dual-port USB Type-C with PD and buck-boost controller	CYPD7271-68LQXQES	Infineon Technologies
Q4	CoolGaN™ IGLD60R190D1AUMA1 600 V 190 mΩ 10 A thinPAK8x8	IGLD60R190D1AUMA1	Infineon Technologies
Q3	Nmos BSC050N10NS5 100 V 5 mR 16 A PG-TDSON-8 for SR	BSC050N10NS5	Infineon Technologies
Q7, Q8	Nmos BSZ0902NS 30 V 3.5 mΩ 58 A PG-TSDSON-8_3.3*3.3	BSZ0902NS	Infineon Technologies
Q1, Q5, Q6, Q9	Nmos BSZ063N04LS6 40 V 6.3 mΩ 40 A PG-TSDSON-8_3.3*3.3	BSZ063N04LS6	Infineon Technologies
T1	350 uH ATQ power transformer	–	–
T2	Pulse edge transformer	LCL-T6-5138A	JQH Technologies
EC1, EC5, EC6	CAP ALUM 33 uF 20% 400 V	KCXD2402G330MF	Yingming Electronic
EC4	CAP ALUM 22 uF 20% 400 V	KCXD2402G220MF	Yingming Electronic
EC2, EC3	Solid CAP ALUM POLY 680 uF 20% 25 V	NPXC1401E681MJTM	Yingming Electronic
EC4	Solid CAP ALUM POLY 330 uF 20% 25 V	NPXC0901E331MJTM	Yingming Electronic
L2, L3	22 µH ring inductor	TCH040125-W220M	SAYES Technologies

2 Specification

Table 2 Test specifications

Parameter	Value
Input voltage and frequency	90 to 264 V AC, 47 to 63 Hz
Max output power	65 W system power with dual-C and a max load current of 3.25 A 65 W on each port with a max load current of 3.25 A
Output voltage	**Single port:** Fixed PDOs: 5.0 V / 3.0 A, 9.0 V / 3.0 A, 15.0 V / 3.0 A, 20.0 V / 3.25 A PPS: 3.3 V to 21.0 V, 3.25 A with PPS power limit **Dual port:** 20W: 5V/3A, 9V/2.22A, 3.3V-5.9V/3A, 3.3V-11V/2.2A 32.5W: 5V/3A, 9V/3A, 12V/2.7A, 3.3V-11V/3A, 3.3V-16V/2.15A 45W: 5V/3A, 9V/3A, 12V/3A, 15V/3A, 20V/2.25A, 3.3V-16V/3A
Peak efficiency	> 93%
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
Charging standards supported	1. USB-C PD v3.1 including programmable power supply (PPS) mode 2. Apple Charging 2.4 A 3. Qualcomm QC 2.0, 3.0, 4.0, 5.0 4. Samsung AFC 5. USB BC 1.2
EMI/EMC	1. CE, CISPR32 CLASS B 2. ESD, IEC61000-4-2 3. Surge, IEC61000-4-5 4. Harmonics, IEC61000-3-2

3 Board overview

The EZ-PD™ PAG1S-1P based 65 W USB PD dual-C charger and adapter solution (REF_65W_2C_GAN_PAG1 + CCG7DC 65W_2C with ATQ) shown in Figure 2 solution board is designed to meet the specifications shown in Table 2. Baseboard with dual-C operates up to 65 W and each port operates up to 65 W.

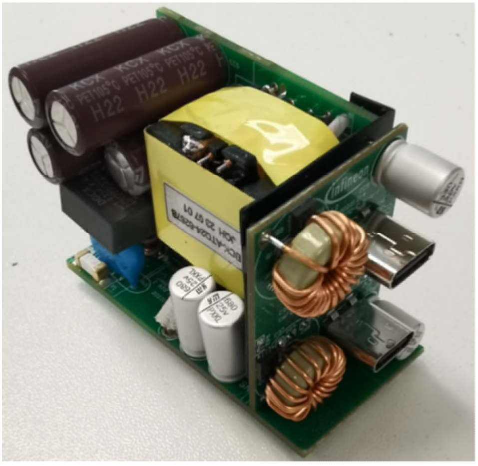

Figure 2 REF_65W_2C_GAN_PAG1 + CCG7DC 65W_2C with ATQ solution board

Figure 3 shows the schematic diagram for the EZ-PD™ PAG1x-based with dual-port output. In this solution, the EZ-PD™ PAG1x operates with about 70-kHz and functions as a secondary-side flyback, and SR controller. Additionally, the EZ-PD™ CCG7DC functions as a buck controller, regulating the output voltage to a lower level than the input voltage, and a PD controller, negotiating with the connected device to provide the required power and voltage levels. The communication link between EZ-PD™ PAG1S and EZ-PD™ CCG7DC ensures optimal operation and efficiency by enabling a seamless optimization of the system's performance.

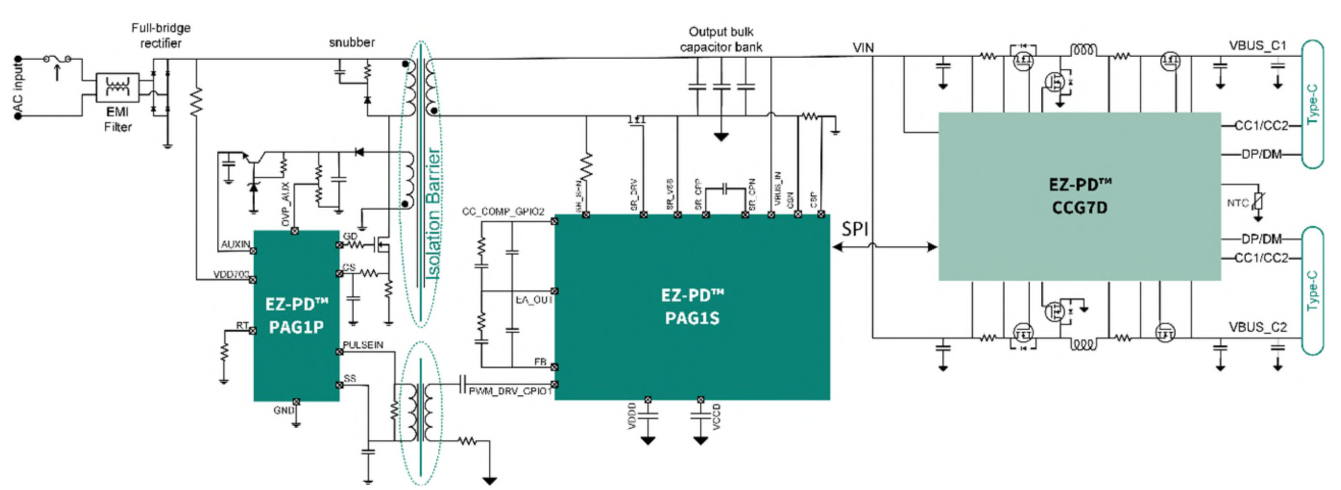

Figure 3 Schematic diagram of EZ-PD™ PAG11P-1S + EZ-PD™ CCG7DC design

4 Procedure to program EZ-PD™ CCG7DC-based daughter board

EZ-PD™ PAG1S and EZ-PD™ CCG7DC support PSoC™ MiniProg4 (CY8CKIT-005) as a programmer to program the EZ-PD™ controllers. The EZ-PD™ PAG1S-based main board and EZ-PD™ CCG7DC-based daughter board can be programmed using a PSoC™ MiniProg4 five-pin connection.

Figure 4 PSoC™ MiniProg4 (CY8CKIT-005) Programmer Kit

Programming interface and settings

The CYPRESS™ Programmer software is used as a programming interface to program the firmware (*.hex* file) in an EZ-PD™ PAG1S-based main board and EZ-PD™ CCG7DC-based daughter board. For programming, select the “CCGx” platform and make other settings, as shown in Figure 5.

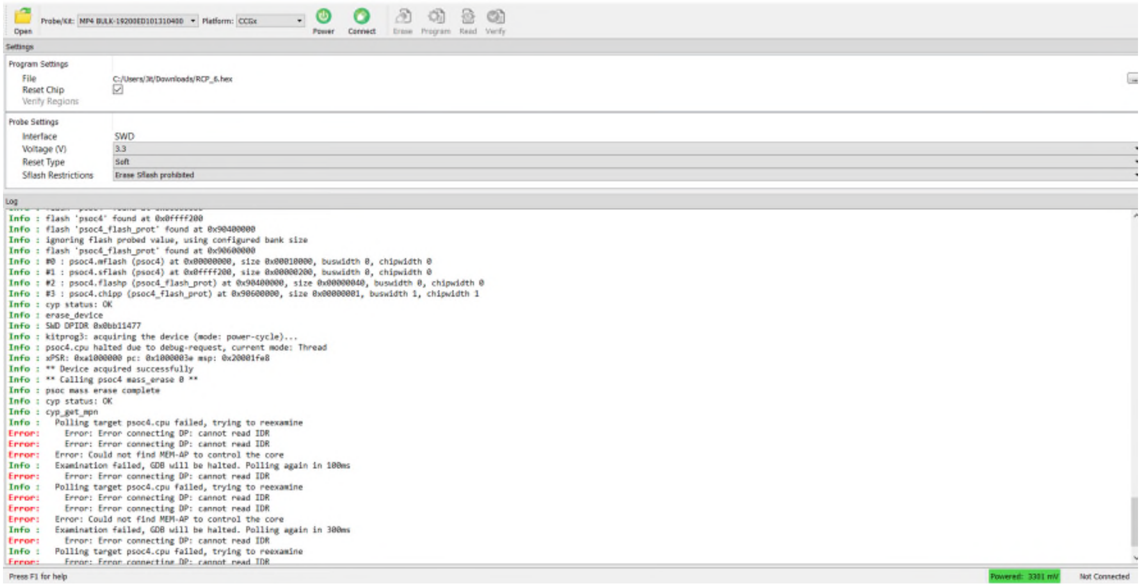

Figure 5 Programming interface to program EZ-PD™ CCG7DC 65-W daughter board

5 Test setup

Figure 6 shows the test setup to capture the electrical data of the DUT. The following setup is the optimal one to capture efficiency by capturing:

- Input power using a power meter
- Output power using high-resolution output multimeters

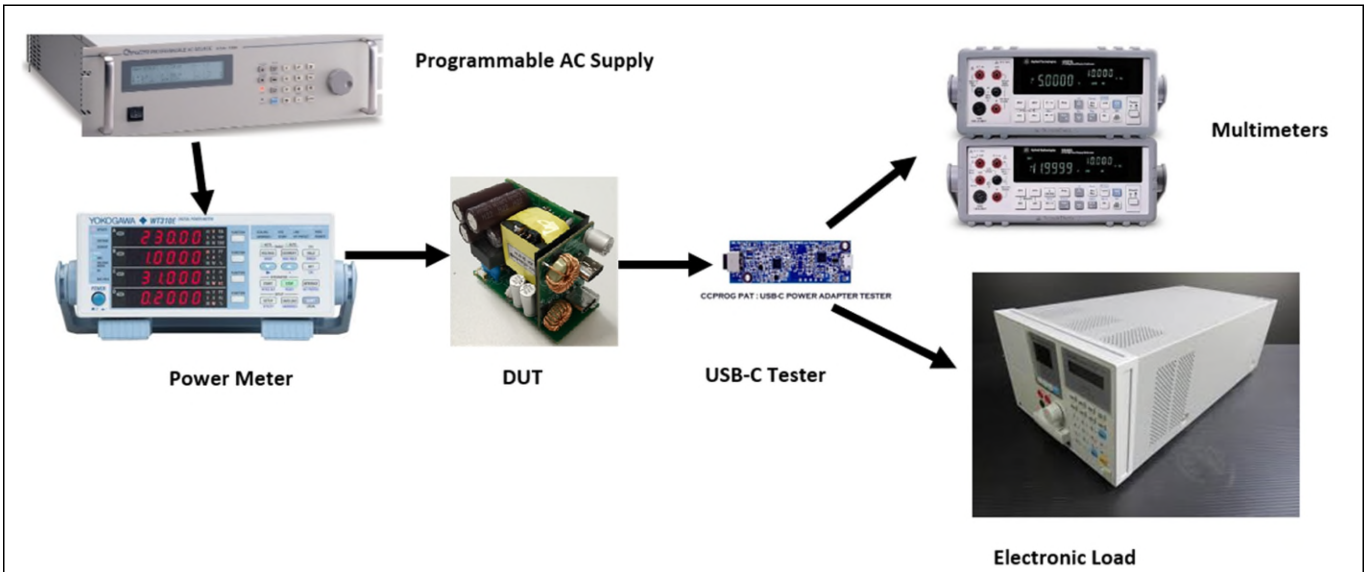

Figure 6 **Test equipment connected to the standalone REF_65W_2C_GAN_PAG1 + CCG7DC 65W_2C with ATQ) board**

5.1 Test equipment

Table 3 shows the test equipment to measure performance parameters such as efficiency, ripple, regulation, and transient response.

Table 3 **Test equipment details**

Test setup	Description
Programmable AC source	Chroma 61501
AC power meter	Yokogawa WT310E
PAT tester	USBCEE PAT
Electronic load	Chroma 63102A
Multimeters	Keysight 34465A

5.2 Power adapter tester (PAT)

Connect the DUT to a USB-C power adapter tester (PAT) using a USB Type-C cable. After the connection is established, the PAT UI does a PDO discovery and displays the results.

The EZ-PD™ EZ-PD™ PAG1S-1P based 65 W USB PD dual-C charger and adapter solution is pre-configured with seven PDOs:

Single output: Port1 or Port2:

- **Fixed PDOs**: 5.0 V / 3.0 A; 9.0 V / 3.0 A; 15.0 V / 3.0 A; 20.0 V / 3.25 A
- **PPS**: 3.3 V to 21.0 V, 3.25 A (PPS power limited)

Dual output: Port1 and Port2:

- **20 W**: 5 V/3 A, 9 V/2.22 A, 3.3 V to 5.9 V/3 A, 3.3 V-11 V/2.2 A
- **32.5 W**: 5 V/3 A, 9 V/3 A, 12 V/2.7 A, 3.3 V to 11 V/3 A, 3.3 V to 16 V/2.15 A
- **45 W**: 5 V/3 A, 9 V/3 A, 12 V/3 A, 15 V/3 A, 20 V/2.25 A, 3.3 V to 16 V/3 A

Choose a 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 the PAT tester, see USBCEE.

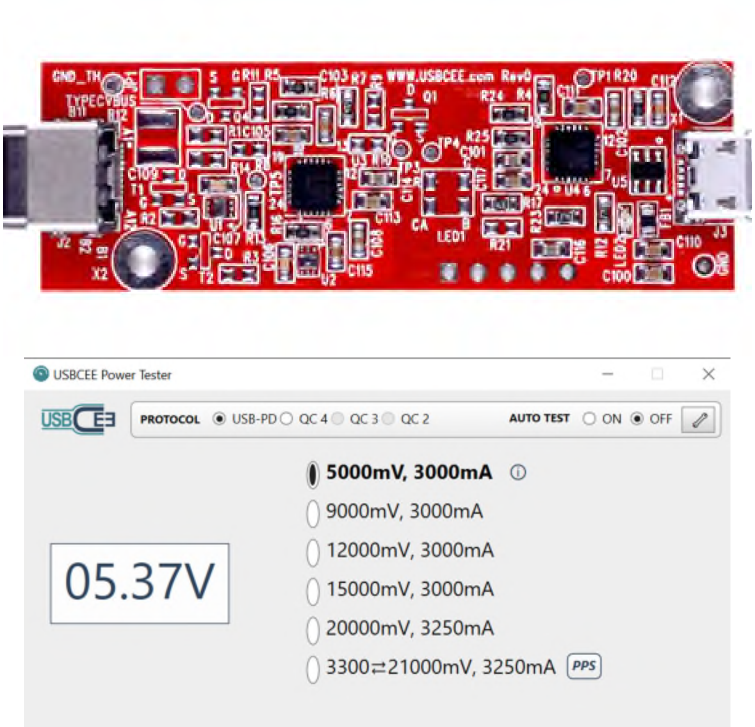

Figure 7 **PAT tester and user interface**

6 Quick steps for demo

1. Connect the 65 W solution board to the power meter AC terminal (which is already connected to the programmable AC supply) as in Figure 6.
2. Connect a USB PD tester or a power adapter tester (PAT) to the port and ensure that the USB PD tester gets into a successful Power Delivery contract as shown in Figure 7.
3. Connect the electronic load at the PAT tester load terminal as in Figure 6.
4. Select the desired voltage on PAT UI and ramp up the load on the electronic load.

References

Datasheets

[1] EZ-PD™ PAG1P, Primary side startup controller

[2] EZ-PD™ PAG1S - CYPAS111, USB PD power adapter secondary side controller

[3] CYPD7271, EZ-PD™ CCG7DC dual-port USB-C Power Delivery and DC-DC controller

Revision history

Document revision	Date	Description of changes
**	2023-04-04	Initial release
*A	2023-04-21	Post to web

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