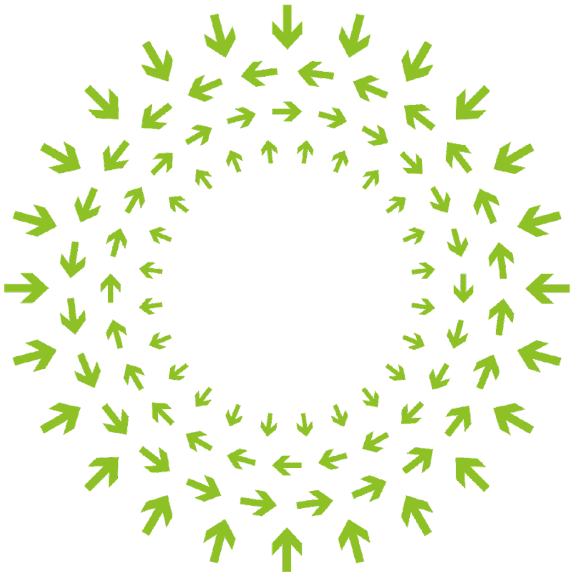


OPEN

Compute Project

CEDaCI Circular Economy-Ready Server Chassis Design

Version 1.0
Revision 0
Base Specification
Effective June 21,
2023

Authors:
Kristina Kerwin
Prof. Deborah Andrews
Silvio Lavandeira

Table of Contents

1. License 2
    1.1. Open Web Foundation (OWF) CLA 2
        London South Bank University 2
        Notes: 2
    1.2 Acknowledgements 3
2. Compliance with OCP Tenets 4
    2.1. Openness 4
    2.2. Efficiency 4
    2.3. Impact 4
    2.4. Scale 5
    2.5. Sustainability 5
3. Change Log 6
4. Scope 7
5. Overview 7
6. Environmental Regulatory Compliance and Requirements 9
7. Physical Specifications 10
    7.1 Mechanical 12
8. Electrical Requirements 12
9. Thermal Design Requirements 12
10. Interfaces (I/O Subsystems) 13
    10.1 Signal List 14
    10.2 Rear Side Power, I/O, Expansion Board and Midplane Subsystems 14
11. Prescribed Materials 14
12. Hardware Management 14
13. Security 14
14. References (recommended) 15
Appendix A - Checklist for IC approval of this Specification (to be completed by contributor(s) of this Spec) 16

1. License

1.1. Open Web Foundation (OWF) CLA

Contributions to this Specification are made under the terms and conditions set forth in Open Web Foundation Modified Contributor License Agreement ("OWF CLA 1.0") ("Contribution License") by:

London South Bank University

Usage of this Specification is governed by the terms and conditions set forth in **Open Web Foundation Modified Final Specification Agreement ("OWFa 1.0") ("Specification License").**

You can review the applicable OWFa1.0 Specification License(s) referenced above by the contributors to this Specification on the OCP website at http://www.opencompute.org/participate/legal-documents/. For actual executed copies of either agreement, please contact OCP directly.

Notes:

1) The above license does not apply to the Appendix or Appendices. The information in the Appendix or Appendices is for reference only and non-normative in nature.

NOTWITHSTANDING THE FOREGOING LICENSES, THIS SPECIFICATION IS PROVIDED BY OCP "AS IS" AND OCP EXPRESSLY DISCLAIMS ANY WARRANTIES (EXPRESS, IMPLIED, OR OTHERWISE), INCLUDING IMPLIED WARRANTIES OF MERCHANTABILITY, NON-INFRINGEMENT, FITNESS FOR A PARTICULAR PURPOSE, OR TITLE, RELATED TO THE SPECIFICATION. NOTICE IS HEREBY GIVEN, THAT OTHER RIGHTS NOT GRANTED AS SET FORTH ABOVE, INCLUDING WITHOUT LIMITATION, RIGHTS OF THIRD PARTIES WHO DID NOT EXECUTE THE ABOVE LICENSES, MAY BE IMPLICATED BY THE IMPLEMENTATION OF OR COMPLIANCE WITH THIS SPECIFICATION. OCP IS NOT RESPONSIBLE FOR IDENTIFYING RIGHTS FOR WHICH A LICENSE MAY BE REQUIRED IN ORDER TO IMPLEMENT THIS SPECIFICATION. THE ENTIRE RISK AS TO IMPLEMENTING OR OTHERWISE USING THE SPECIFICATION IS ASSUMED BY YOU. IN NO EVENT WILL OCP BE LIABLE TO YOU FOR ANY MONETARY DAMAGES WITH RESPECT TO ANY

CLAIMS RELATED TO, OR ARISING OUT OF YOUR USE OF THIS SPECIFICATION, INCLUDING BUT NOT LIMITED TO ANY LIABILITY FOR LOST PROFITS OR ANY CONSEQUENTIAL, INCIDENTAL, INDIRECT, SPECIAL OR PUNITIVE DAMAGES OF ANY CHARACTER FROM ANY CAUSES OF ACTION OF ANY KIND WITH RESPECT TO THIS SPECIFICATION, WHETHER BASED ON BREACH OF CONTRACT, TORT (INCLUDING NEGLIGENCE), OR OTHERWISE, AND EVEN IF OCP HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

1.2 Acknowledgements

The Contributors of this Specification would like to acknowledge the following companies for their feedback:

List all companies or individuals who may have assisted you with the specification by providing feedback and suggestions but did not provide any IP.

2. Compliance with OCP Tenets

2.1. Openness

This device is aimed at use by the server manufacturers as benchmark design to aid the transition to a circular economy. Any third party will be able to build, modify, to improve and/or personalize the device from the contribution, provided the core design principles are met to allow sustainability and extended use of the product. These criteria are embedded in the mechanical design of the hardware and are:

- Design for disassembly
- Part interchangeability and standardization across product models and generations (and brands if applicable).
- Reduced use of plastics.
- Fixed component constraint points and component shape/form factor.

The device is intended to be used in conjunction with open-source firmware and software to increase the life and the use stage of the product. The contributors are open to any suggestions with respect to collaboration, design feedback and contributions from other platform participants provided it is in line with the design principle for circular economy.

2.2. Efficiency

This contribution includes improved product modularity; reduced use of virgin raw materials and raw and critical raw materials, reduced manufacturing costs due to continuous part reuse; reduced product utilization at end-of-life, reduced transportation costs due to re-usability of parts; reduced environmental embodied impacts and embodied carbon due to re-usability of parts, reduced material use and reduced transportation carbon impact.

2.3. Impact

This proposed design is a real-life demonstration of how a resource-efficient product can be created by applying sustainable design thinking and life cycle assessment methods, together with a holistic design approach and the integration of the eco-design policy requirements outlined by the EU Circular Economy Action Plan 2020, and other directives. By designing a standardized sustainable product CEDaCI project future-proofed data center equipment design for the Circular Economy and built a critical foundation for a sustainable methodology for ICT equipment

2.4. Scale

By designing a standardized sustainable product, the CEDaCI project future-proofed data center equipment design for Circular Economy and built a critical foundation for a sustainable hardware design that can be expanded on to achieve the ultimate goal of complete circularity in the future. This practice also established a broader change by offering good practice design methods and recommendations that can be adopted by product designers throughout the design industry leading to a crucial shift in design thinking in the future.

2.5. Sustainability

The CEDaCI proposed server design is a real-life demonstration of how a sustainable product can be created by applying sustainable design thinking and life cycle assessment methods, together with a holistic design approach and the integration of the eco-design policy requirements outlined by the EU Circular Economy Action Plan 2020, and other directives. By designing a standardized resource-efficient server the CEDaCI project future-proofed data center equipment design for Circular Economy and built critical foundation for a sustainable hardware design that can be expanded on to achieve the ultimate goal of complete circularity in the future. This practice also established a broader change by offering good practice design methods and recommendations that can be adopted by product designers throughout the design industry leading to a crucial shift in design thinking in the future.

Considering current eco-design policy requirements outlined in the EU Circular Economy Action Plan 2020 in conjunction with the results from different server model assessments and the consistent design pinch points outlined by The CEDaCI, the project team proposes emphasizing the future enterprise-type server design on standardization of the following features:

1. Creating a set of reusable universal server enclosures for the most commonly used server form factors (sizes), that can be used as stand-alone units or within a rack. The enclosures shall be able to accommodate parts from any server manufacturer, model, or generation in its given product range in the future.
2. Ensure standardized, universal, and simplified design of parts' enclosures on all other levels of assembly (as much as is physically possible) and eradicate any designs that prevent disassembly for repair or recycling.
3. Increase resource efficiency by reducing materials use without compromising performance (dematerialize).
4. Reduce and rationalize the number and type of materials used within the product by eliminating non-recyclable non-durable plastics and reducing Critical Raw Materials (CRM) content in non-electronic components. Aluminum is commonly used in server design, however, since 2020 bauxite (Aluminum ore) has been considered a CRM. It is important to keep Al content to a minimum and to expand the use of recycled sources manufacture and transportation. Reduce the complexity of the design by removing the

unnecessary fastenings, making it easy to disassemble and repair, redesigning fan and hard disk enclosures and creating a standard fit-all power supply module.

5. Make the parts durable. Reduce the need to manufacture new parts by making the design more durable, reduce mean time to failure and increase product life span.
6. Allow open-source firmware for cross-model parts use and to support extended product use after the end of service and end of sale.
7. Modular PCBs. Consider developing modular PCBs and using a biodegradable substrate.
8. Other cooling. Design the chassis, so it can accommodate other cooling options if required.
9. Local manufacturing and logistics. Source locally recovered materials in manufacturing. Consider local businesses for product assembly, re-manufacture, and transportation.

It is important to note that. The CEDaCI proposes best practice methods, any changes to basic constraint points and sizes would void the idea of design for circular economy. All the mechanical components of the server are designed for continuous reuse with standardised component constraint points, form factors, and fastenings while giving the OEMs the benefit of improving the electronics. Any future models can have brackets or further constraint points added, providing the original fix points are left/kept in place – this will allow for novelty and at the same time for continuous part reuse.

This model is a standard 2U rackmount server model, however, the design allows for increasing the form factor to 3U

3. Change Log

Date	Version #	Author	Description
Friday, May 12, 2023	#1	K. Kerwin	Draft 1
Thursday, May 18, 2023	2	B. Nowroozi	Reformatted to Base Specification
Monday, 22MAY23	5	B. Nowroozi	edits
Tuesday, June 13, 2023	6	K. Kerwin	edits
Wednesday, June 21, 2023	7	K. Kerwin	edits

4. Scope

This document defines a Hardware Base Specification.

This document defines the technical details for one of the following types of specifications:

1. base specification for an intended physical The CEDaCI circular economy-ready enterprise rack server

5. Overview

The CEDaCI circular economy-ready enterprise rack server is aimed at use by the server manufacturers as benchmark design to aid the transition to a circular economy. The CEDaCI circular economy-ready enterprise rack server design will future-proof data center equipment design for Circular Economy and build a critical foundation for a sustainable hardware design that can be expanded on to achieve the ultimate goal of complete circularity in the future. The advantage of this design is that it is an enterprise server that fits a standard rack and can be used as a stand-alone machine (i.e., does not require specialist racks). All the mechanical components of the server are designed for continuous reuse with standardized component constraint points and component form factors, reduced number of fastenings and standardized fastenings while still giving the OEMs the benefit of improving the electronics. The plastic content of the server is significantly reduced and kept to a minimum. The continuous reuse of the mechanical components allows for the reduced need to manufacture new components and for a reduced number of components that will have to be transported as well as reduce the need to use raw resources.

The CEDaCI created a benchmark design for a universal server chassis that can hold 2U-3U form factor (FF) compatible components for a standard rack-mounted server. The FF of the server would be determined by the lid height which would depend on the size of the components that are placed inside the base. (There is an option to improve the design by providing a bracket that can hold an all-in-one double socket over the chip liquid cooling assembly with 2x92mm fans and increasing the lid FF to 3U).

For the purpose of design feasibility demonstration, a 2U FF was chosen as a base model as it is the most commonly used enterprise server FF. The design is mainly concentrated on the mechanical parts of the server with a degree of PCB modularity that is physically possible to achieve at present. The design focused on the chassis because current server designs are unique but are regularly updated to increase performance and capacity which is achieved through changes in electronic components (PCB, IC) without consideration of where and how these components are attached to the box/chassis. It is essential to standardize the chassis and the component constraint points and make the design simple by removing any unnecessary fastenings to reduce the manufacturing impact and the number of components to a minimum.

The model is intended to be used as a standardized benchmark design in future server generations and includes the following features:

- Shallow standard reusable tray that fits a standard open rack and can accommodate different FF.
- Simple sliding reusable lid that can be easily manufactured to fit either 2U or 3U FF depending on the components used. (For the CEDaCI model a 2U FF was used as it is the most common size of enterprise rack-mount servers)
- Front HDD caddy and power panel housing enclosure hold up to 3 universal reusable HDD caddies and an easy-access power control board assembly. The HDD caddy is designed to hold either 2.5” or 3.5” storage drives without the need to manufacture different types of chassis. A maximum of 24 SFF or 9 LFF drives can be used.
- The storage drive connector board uses the latest SAS-3/PCIe-3 connector and supports both SATA/SAS & NVMe (PCI-e) drives. Each HDD caddy holds a separate hard drive backplane PCB to ensure ease of disassembly and repair. (N.B> types of connectors are for demonstration purpose only and are not a mandatory requirement).
- A universal reusable fan caddy that holds up to six, 60mm, multi-speed DC fans without the need for the individual casing to hold the fans in place. The fan cage brackets can be adapted to support over-the-chip all-in-one liquid CPU coolers with 92mm fans providing the lid FF is increased to 3U.
- The fan connector board is separated from the mainboard to ensure greater modularity and ease of repair.
- Dual-purpose reusable PCI riser that supports NIC and GPU. Reusable, single-screw, easy-to-remove power monitor panel and PCB.
- Reusable, single-screw front HDD caddy blank cover.
- Zero-screw, slide and lock enclosure design to fit PCBs in place.
- The model uses a maximum of 6 screws (two types: IS 3727 - M3 4mm thumb screw and BS EN ISO 7046-2H M3 4mm Phillips screw) to keep some system components in place, with the Motherboard held by a single thumbscrew and hook brackets.

Each manufacturing process was considered to implement the simplest mode of steel production. Due to the lack of standardization of power supply units (PSU) across the board, the CEDaCI proposes a PSU cage bay designed to hold up to 2 power supply units with the maximum dimensions of 184mm x 68mm x 38mm, as a benchmark. **Future model updates may have dimensions of PSU bays revised to house M-CRPS power supplies.**

6. Environmental Regulatory Compliance and Requirements

Please describe any environmental regulations or requirements for any platform boards and full system, if applicable.

- Designed for optional UL/CE/NRTL/FCC/IEC/EN/etc. compliance certifications.
- Designed to achieve RoHS/WEE directives, REACH regulations.
- Operating temperature/altitude compliance with ASHRAE TC0909 Class A3.
- Shock and vibration requirements to operate within ASHRAE 90429 Structural and Vibration Guidelines for Datacom Equipment Centers

Typical specifications:

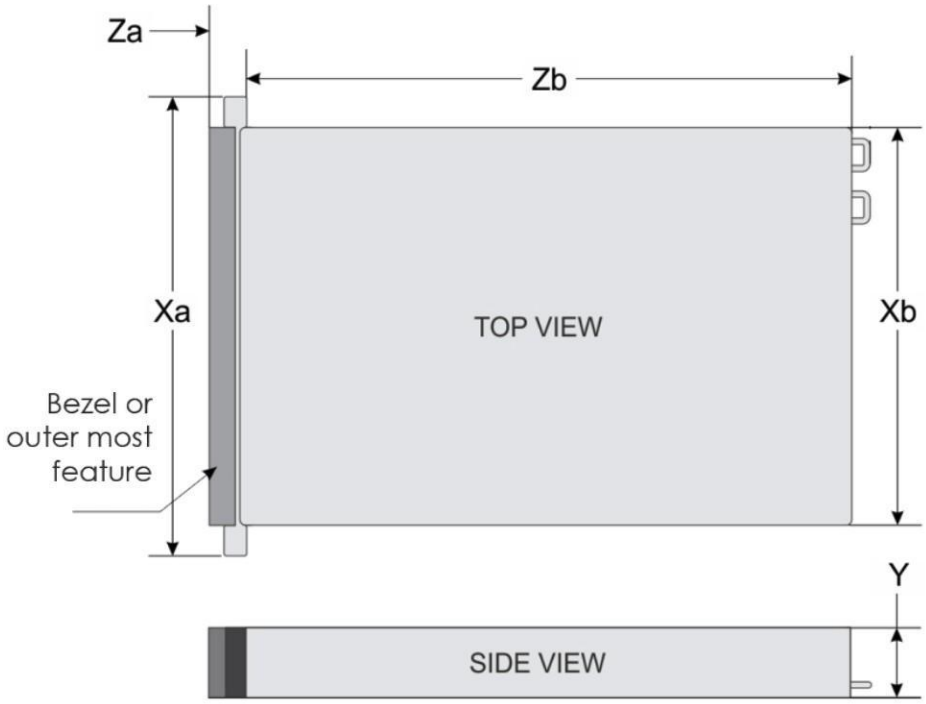
- Altitude:
    - 0 to 914 meters (3000 feet); Operating temperature 0 to 35 degrees Celsius
    - 914 to 2133 meters (7000 feet); Operating temperature 10 to 32 degrees Celsius
- Operating relative humidity: 10%~90% R.H
- Storage relative humidity: 10%~93% R.H.
- Working temperature: 5~35°C (heat dissipation needs to be clear at (35°C /40°C /45°C)
- Storage temperature range: -40~+70°C



7. Physical Specifications

The targets:

- Total mass of the CEDaCI server chassis, a 2U server model (excluding hard disks and memory) is 14 kg.
- A total of 65 main assembly components and fastenings
- Total plastic mass of 85.69 g (air baffle design not included)



System	Xa	Xb	Y	Za (with bezel)	Zb
2U Chassis	483.4mm max	450mm max	87.9mm max	50mm max	848mm max

Requirement	Status
For Za, the bezel, pull handles, or outer most features should not exceed a maximum of 50mm beyond the front mounting flange, which allows for space to the cabinet door and airflow.	Required
The chassis height (Y) should not exceed a maximum of 87.9mm to account for stack-up tolerances, along with chassis sag and bow concerns.	Required
The total chassis length (Za + Zb) should allow space for server cables of about 152mm, and should not exceed a maximum of 748mm for 900mm rack depth, or 848mm for 1000mm rack depth.	Recommended

Dual-Band RRU Block Diagram

7.1 Mechanical

The layout of this design is a 2RU server form factor chassis that fits within a 19” EIA rack, per EIA-310-D specifications. The server has connections in the rear for network, power etc. and access in the front for storage and compute.

- Simple sliding reusable lid that can be easily manufactured to fit either 2U or 3U FF depending on the components used. (For the CEDaCI model a 2U FF was used as it is the most common enterprise rack-mount server size).
- Front HDD caddy and power panel housing enclosure hold up to 3 universal reusable HDD caddies and an easy-access power control board assembly. The HDD caddy is designed to hold either 2.5” or 3.5” storage drives without the need to manufacture different chassis. A maximum of 24 SFF or 9 LFF drives can be used.
- A universal reusable fan caddy that holds up to six, 60mm, multi-speed DC fans without the need for the specialist casing to hold the fans in place. The fan cage brackets can be adapted to support over-the-chip all-in-one liquid CPU coolers with 92mm fans providing the lid FF is increased to 3U.
- Reusable, single-screw front HDD caddy blank cover.
- Zero-screw, slide and lock enclosure design to fit PCBs in place.
- The model uses a maximum of 6 screws (two types: IS 3727 - M3 4mm thumb screw and BS EN ISO 7046-2H M3 4mm Phillips screw) to keep some system components in place, with the Motherboard held by a single thumbscrew and hook brackets.

8. Electrical Requirements

Please describe general electrical power requirements. Example: Power Input envelope +48VDC, 110VAC, peak/average power, etc.…

Designed for a standard 2U rackmount server power supply range in line with COMMISSION REGULATION (EU) 2019/424 of the European Parliament and of the Council.

Note: In this specification, there’s design flexibility for power input

9. Thermal Design Requirements

This server is designed for air cooling with a typical front to back airflow model.

- The universal reusable fan caddy holds up to six, 60mm, multi speed DC fans without the need for the specialist casing to hold the fans in place.

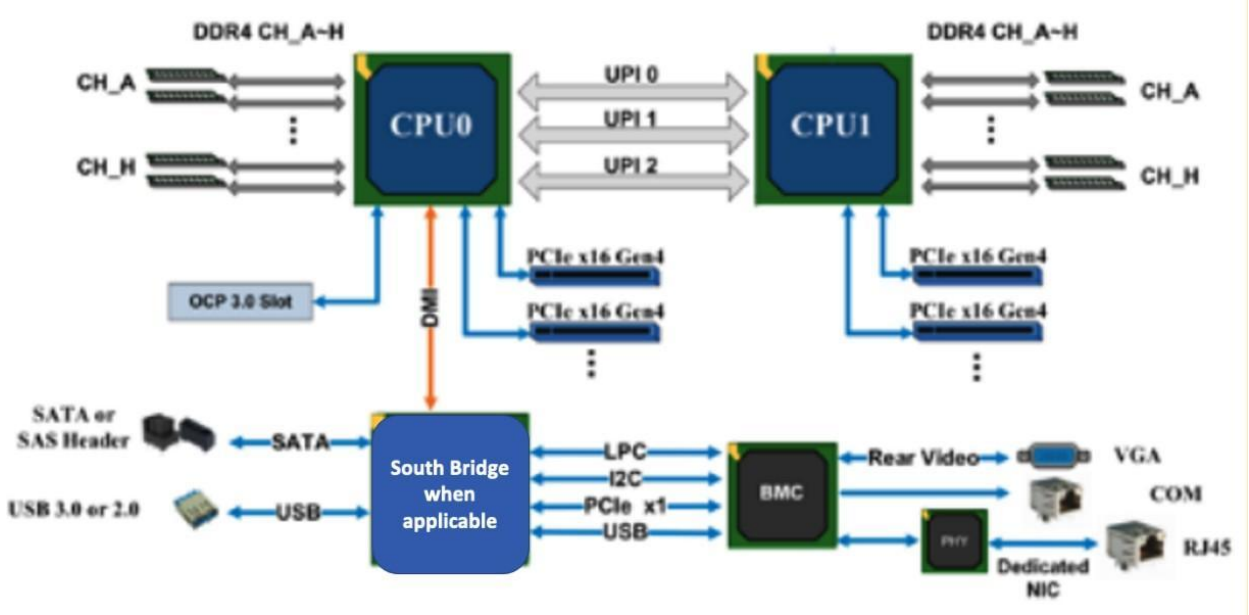
- The fan cage brackets can be adapted to support over-the-chip all-in-one chip liquid cooling assembly with 2x 92mm fans providing the lid FF is increased to

3U.

Any optional liquid cooling would need to comply with OCP Liquid Cooling Requirements.

10. Interfaces (I/O Subsystems)

The server will provide interfaces typical to an enterprise server. The diagram below is representative only.



Representative Block Diagram Above.

Interfaces typical of a 2RU Server (N.B> component types are typical of a 2RU server interface and are intended for representation only):

- The storage drive connector board uses the latest SAS-3/PCIe-3 connector and supports both SATA/SAS & NVMe (PCI-e).) (F) (N.B> component type for demonstration purposes only).
- DDR4 (F) Memory Slots (N.B> component type for demonstration purposes only).
- Power Input Connector (AC/DC depending on the power supply) (F)
- HDMI (F)
- Ethernet RJ-45 (F)
- USB 3.0 (F)

- PCIe Gen4 (F) (N.B> component type for demonstration purposes only).
- Host TPM 2.0
- Fan: 5 pin Du Pont

10.1 Signal List

This list is representative of a typical server. It's not a requirement.

- Power and Ground
- Synchronization/Clocks
- PCIe
- i2C/i3C
- SATA
- USB 3.0
- VGA
- Ethernet 802.3-2018
- TPM 2.0 (FIPS 140-2)

10.2 Rear Side Power, I/O, Expansion Board and Midplane Subsystems

Dual-purpose reusable PCI riser design supports NIC and GPU. Reusable, single-screw, easy-to-remove power monitor panel and PCB.

11. Prescribed Materials

Server primary material is 1mm sheet steel.

12. Hardware Management

Layout support for Optional: Board Management Controller (BMC) typically supporting:

- IPMI 2.0
- Simple network management protocol (SNMP v1/v2c/v3)
- HTML5/Java remote console (keyboard, mouse, and video)
- Remote virtual media
- Web browser login
- Intelligent fault diagnosis system

13. Security

Optional layout support for OCP Datacenter Secure Control Module (DC-SCM) specification.
See https://www.opencompute.org/documents/ocp-dc-scm-spec-rev-1-0-pdf

14. References (recommended)

1. The European Parliament and the Council of the European Union. DIRECTIVE 2011/65/EU of the European Parliament and of the Council.
2. Circular Economy Action Plan For a Cleaner and more competitive Europe (2020), Ec.europa.eu. European Commission.
   Available from:
   https://ec.europa.eu/environment/pdf/circular-economy/new_circular_economy_action_plan.pdf
3. COMMISSION REGULATION (EU) 2019/424 of 15 March 2019 laying down ecodesign requirements for servers and data storage products pursuant to Directive 2009/125/EC of the European Parliament and of the Council and amending Commission Regulation (EU) No 617/2013 (2019), EUR . Official Journal of the European Union. Available from:
   https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32019R0424
4. Materialstoday: PROCEEDINGS Vol 64, part 3, 2022, Pages 1283-1289
   Available from: https://www.sciencedirect.com/science/article/pii/S2214785322022507

Appendix A - Checklist for IC approval of this Specification (to be completed by contributor(s) of this Spec)

Complete all the checklist items in the table with links to the section where it is described in this spec or an external document.

Item	Status	Link to detailed explanation
Has this contribution been presented to an OCP Project group during a project call or engineering workshop?	Yes or No	If “No”, please state the reason.
Approval by Project Leads	Yes or No	If “No”, please state the reason.
Is this contribution entered into the OCP Contribution Portal?	Yes or No	If “No”, please state the reason.
Was it approved in the OCP Contribution Portal?	Yes or No	If “No”, please state the reason.