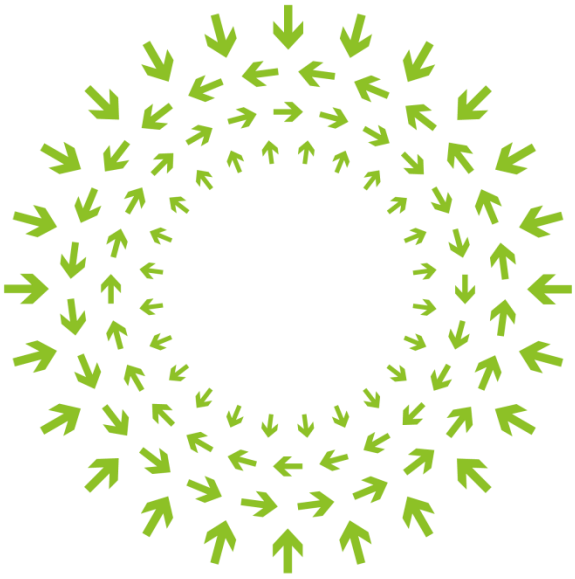

OPEN
Compute Project

Data Center - Design Guide
Direct Current v0.3

Author: John Meinecke, Direct current system architect

Draft: September 23, 2013

Version: 0.3

1 Revision History

Date	Name	Description
9/23/2013	John M.	Draft for review. v0.3

2 Scope

This document describes the mechanical and electrical specifications used as guide in the design of an innovative direct current energy-efficient data center. As a baseline this guide uses V1.0 of the Open Compute Project Data Center specification.

3 Contents

4 Overview

When data center design and hardware design move in concert, they can improve efficiency and reduce power consumption. To this end, the Open Compute Project is a set of technologies that reduces energy consumption and cost, increases reliability and choice in the marketplace, and simplifies operations and maintenance. One key objective is openness—the project is starting with the opening of the specifications

and mechanical designs for the major components of a data center, and the efficiency results achieved at facilities using Open Compute technologies.

Two components of this project are the data center electrical and mechanical elements. This specification focuses on the electrical configuration specifically a non-redundant direct current distribution system. The mechanical elements are incorporated by reference from the Data Center 1.0 specification.

5 License

As of April 7, 2011, the following persons or entities have made this Specification available under the Open Web Foundation Final Specification Agreement (OWFa 1.0), which is available at:

http://www.openwebfoundation.org/legal/the-owf-1-0-agreements/owfa-1-0

Edison DC Systems Inc.

You can review the signed copies of the Open Web Foundation Agreement Version 1.0 for this Specification at http://opencompute.org, which may also include additional parties to those listed above.

Your use of this Specification may be subject to other third party rights. THIS

SPECIFICATION IS PROVIDED "AS IS." The contributors expressly disclaim any warranties (express, implied, or otherwise), including implied warranties of merchantability, non-infringement, fitness for a particular purpose, or title, related to the Specification. The entire risk as to implementing or otherwise using the Specification is assumed by the Specification implementer and user. IN NO EVENT WILL ANY PARTY BE LIABLE TO ANY OTHER PARTY FOR LOST PROFITS OR ANY FORM OF INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES OF ANY CHARACTER FROM ANY CAUSES OF ACTION OF ANY KIND WITH RESPECT TO THIS SPECIFICATION OR ITS GOVERNING AGREEMENT, WHETHER BASED ON BREACH OF CONTRACT, TORT (INCLUDING NEGLIGENCE), OR OTHERWISE, AND WHETHER OR NOT THE OTHER PARTY HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

6 Electrical Design

The electrical system uses a standard 480/277Vac distribution system to +/-190Vdc direct current UPS systems (DC UPS). The direct current output from the DC UPS is controlled by the output switchboard and delivered to an overhead bus system. This overhead bus system will deliver power to the Open Rack DC system that natively uses (+/-190Vdc) in the Rack system specification.

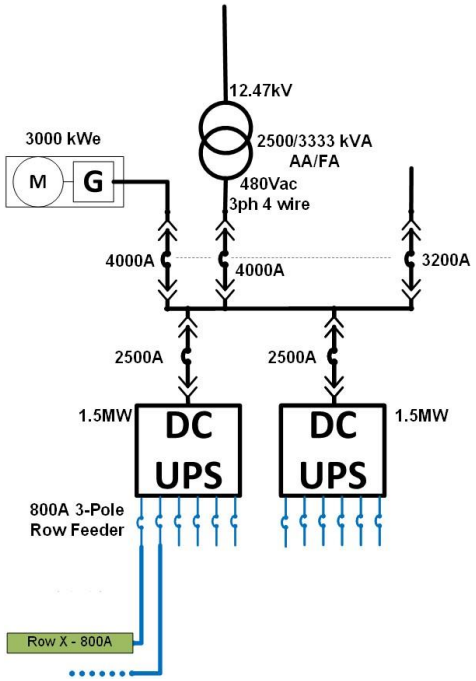

Figure 1: Typical Electrical Overview

Some of the benefits of this direct current distribution system are:

- International voltage and line frequency independent power system
- Eliminates the 48Vdc battery system from data center floor area
- Eliminates the need to manage short circuit currents at row level
- Removes the need for active phase balancing of the Open Rack power supplies that are in the V1.0 specifications
- Allows the switches in the V1.0 system to be self-powering at the rack level

6.1 Codes, Guidelines and Standards

The systems are designed to meet or exceed these standards.

- NEC: National Electrical Code with Local Amendments
- NFPA: National Fire Protection Association

- ANSI: American National Standards Institute
- SFM: State and Local Fire Marshal
- IEEE: Institute of Electrical and Electronics Engineers
- NEMA: National Electrical Manufacturers Association
- UL: Underwriters' Laboratories, Inc. or equivalent testing lab
- IES: Illuminating Engineering Society
- Local and State Building Code

6.2 Featured Electrical Systems

In addition to standard data center electrical design elements (from grounding to MV Switchgear), this design features these electrical and related systems:

- MV – LV Transformers
- AC Main switchboards (MSB)
- DC UPS
- Open Rack DC Electrical Interface
- DC Power bus duct system

6.3 MV – LV Transformers

In an effort to maximize the efficiency of the electrical system an oil filled, pad mounted, power transformer is utilized. This transformer shall:

- 12.47kV – 480/277Vac 2500/3333 kVA OA/FA/FA 65º oil filled power transformer that is pad mounted transformer, utilizing high efficiency core materials to minimize core losses
- Efficiency of the transformer shall be greater than:
    - 99.5% from 10% – 60% load factor

6.4 AC Main Switchboards (MSB)

See MSB board breaker definition in Data Center V1.0 specification. Highlighted here are any changes from that basic design guideline:

- DC UPS feeder breakers: segmented 2500A busses
- Protective device AIC rating is 125 kAIC with pad-mounted transformer impedance specified accordingly to limit the fault current.
- Power quality meter (PQM):
  - Incorporated into each MSB to monitor the normal and standby sources

6.5 Direct Current UPS

The DC UPS can be divided into three major sub elements the AC interface, Energy Storage System, DC Output interface. Additionally the overall system environmental conditions are defined.

6.5.1 Overall AC – DC System

- AC – DC conversion efficiency of greater than 97%
- Inlet air temperature range: (Minimum +5ºC) and (Maximum +40ºC)
- Forced air cooling
- Humidity range (Minimum 5%) and (Maximum 95%) non condensing
- Indoor rated equipment: IP21
- Elevation < 5000′
- Sound pressure level Maximum 80dBa at 1M distance
- System L_{10} life: 90K hrs design minimum

6.5.2 AC Interface

The AC interface shall be:

- Power configuration:
  - 480 / 277 Vac – 3ph, 4 Wire (+10%/-10% voltage range) (50/60 Hz)
  - 2500 Amp - Protective input breaker AIC rating is at least 125 kAIC
  - Breaker shall be UL 1066 type
  - Power factor shall be: >0.97 at greater than 5% load factor
  - IEEE 519 Compliant interface

6.5.3 Energy Storage System

The energy storage system is designed to support AC main input interruptions from impacting the compute loads downstream from DC UPS. This is a non-comprehensive list of possible energy storage systems that can be utilized:

- Traditional wet cell lead-acid, or VRLA battery systems
- LiOn batteries
- Direct current output flywheels
- Others …

6.5.4 DC Output Interface

The direct current output interface shall be:

- +/- 190Vdc, (+ ,N , -)
- Adjustable voltage nominal set point (+3%), and (-5%)
- 1% Voltage ripple (5% - 90% load)

6.5.5 DC Output Switchgear System

The output direct current switchgear shall:

- 800 Amp, UL 489 MCSB
- Load terminations are 2-hole compression type

6.6 Overhead busway interface

The overhead busway interface allows the interconnection of the Rack to the distributed +/-190Vdc power system. This busway interface shall:

- Transmission of+/-190Vdc (+,N, -)
- Interface with rack system via cord drop

6.7 Open Rack DC Electrical Interface

The Open Rack DC interface that is defined below is based on the Open Rack Hardware V1.0 specification converted to a direct current interface.

- +/-190Vdc (+,N, -)
- Anderson Power Products Connector - PowerPole 75 (PP75)
    - Panel mount receptacle interface in top of cabinet

- Rack power distribution +/-190Vdc and 48Vdc that is internally derived (See Open Rack DC for Power Shelf description)

7 Mechanical Design

The goal of the mechanical design is a system with very low operating cost and a relatively low installed cost when compared to a conventional data center.

See Open Compute Project, **Data Center v1.0** specification Section 5

8 Appendix A: Psychometric Sequence of Operations

See Open Compute Project, **Data Center v1.0** specification Appendix A.

9 Appendix B: Indirect Cooling

See Open Compute Project, **Data Center v1.0** specification Appendix B.