



OPEN
Compute Project

Open Rack Standard V0.9

Author: Steve Mills, Mechanical Engineer, Facebook

Style Definition: TOC 1



Contents

| | |
|---|----|
| Contents..... | 2 |
| 1 Introduction | 3 |
| 1.1 Purpose | 3 |
| 1.2 Reference Documents | 3 |
| 2 Overview of Facebook's Open Rack Implementation | 3 |
| 3 Mechanical Requirements..... | 5 |
| 3.1 Rack Columns..... | 5 |
| 3.2 IT Support Shelves | 7 |
| 3.3 Bus bar | 8 |
| 3.4 OpenU Marking..... | 9 |
| 3.5 Marking for Re-Use | 10 |
| 4 Electrical Requirements | 10 |
| 4.1 Bus bar Power Connection..... | 10 |
| 4.2 Bus bar | 10 |
| 5 Revision History..... | 10 |

Deleted: 9

Deleted: 1 → Contents → 2
2 → Introduction → 3
2.1 → Purpose → 3
2.2 → Reference Documents → 3
3 → Overview of Facebook's Open Rack Implementation → 3
4 → Mechanical Requirements → 5
4.1 → Rack Columns → 5
4.2 → IT Support Shelves → 7
4.3 → Busbar → 8
4.4 → Open U Marking → 9
4.5 → Marking for Re-Use → 9
5 → Electrical Requirements → 10
5.1 → Busbar Power Connection → 10
5.2 → Busbar → 10
6 → Revision History → 10

1 Introduction

1.1 Purpose

By adhering to the following principles, the Open Rack fulfills the Open Compute Project goal of maximizing operational efficiency of large-scale deployments;

- Installation and service operations are located in the cold aisle
- Data cables are located on the front of the rack
- Component faults are identifiable from the front of the rack
- Routine service procedures do not require tools
- Non-recyclable components are minimized
- Designs are vanity-free
- Racks are integrated directly into data center air containment solutions

This standard defines the required interfaces between the Open Rack and the equipment it supports. **NOTE:** The standard does not include all of the information necessary to completely define an entire rack.

1.2 Reference Documents

A 3D CAD file of the standard cross-section is provided on GitHub (www.github.com) as a reference to help with the design of the rack:

- <<add http link to CAD file on GITHUB>>
- <<A hyperlink to the chassis design guide on GIT HUB>>

2 Overview of Facebook's Open Rack Implementation

The Open Rack is divided into three zones as shown in Figure 1:

- A Cable zone facing the cold-aisle side of the data center
- An Equipment Bay in the middle for all of the equipment
- A Power and Cooling zone on the hot-aisle side of the data center

Deleted: The

Deleted: is focused on fulfilling

Deleted: large scale

Deleted: by adhering to the following the principles

Deleted: to improve technician access

Deleted: es

Deleted: the use of

Deleted: Vanity

Deleted: designs

Deleted: the

Deleted: will define all of

Deleted: IT gear

Deleted: scope of this

Deleted: cable

Deleted: IT gear

Deleted: Zone

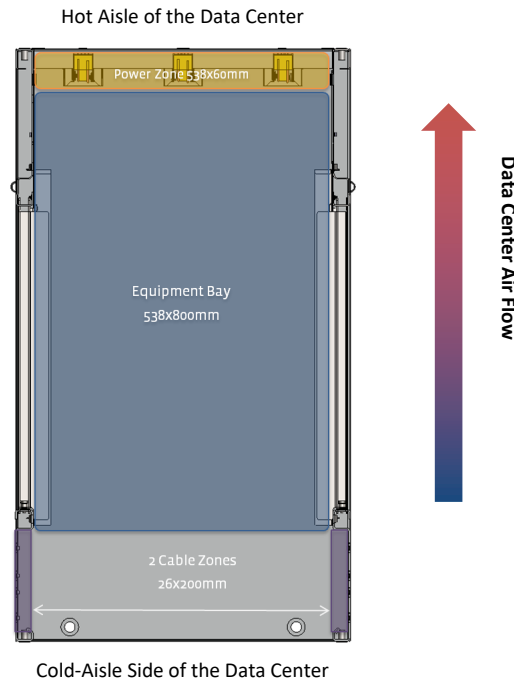


Figure 1: Top View of the Open Rack

The Cable zone, located at the front of the rack, manages and protects the data cables connected to the IT equipment. Technicians can add and remove equipment from the rack without standing in the hot-aisle to perform routine service.

The Equipment Bay is approximately 538mm wide by 800 mm deep. This is the area in which equipment sits (e.g., servers, storage, switches and rack level power shelves). During installation, the equipment slides past the cable zone and rests on a series of horizontal support shelves within the rack. Once on the support shelves, a DC connector in the equipment blind-mates into the 12V bus bars in the Power/Cooling zone.

The Power/Cooling zone in the rack consists of one or more pairs of 12V bus bars that transmit power from a rack level power shelf to the equipment. The vertical bus bars connect the equipment with the rack-level power sub-system located either above or below the Equipment Bay. The system is designed so that equipment in the Equipment Bay can attach to the bus bar continuously along its entire length to accommodate chassis of different sizes over multiple generations. Optionally, this zone could also include rack-level cooling fans, a rack level management system, and PDUs.

Integrated together, these components combine to create a self-contained eco-system optimized for hyper-scale computing.

- Deleted: Zone
- Deleted: provides a volume for the managing and protecting
- Deleted: connecting
- Deleted: gear
- Deleted: It is located in the front of the rack so that IT gear can be ...
- Deleted: ed
- Deleted: removed
- Deleted: requiring technicians to go
- Deleted: to
- Deleted: behind the rack for
- Deleted: provides and area
- Deleted: for the IT gear
- Deleted: such as
- Deleted: IT gear
- Deleted: provided by
- Deleted: IT gear
- Deleted: busbar
- Deleted: Zone
- Deleted: Zone
- Deleted: 1
- Deleted: busbar
- Deleted: all of
- Deleted: IT gear
- Deleted: busbar
- Deleted: IT gear
- Deleted: IT gear
- Deleted: IT Gear
- Deleted: busbar
- Deleted: , which is

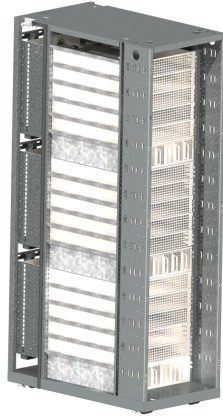


Figure 2: Open Rack Assembly Example

The rack retention features incorporated into the vertical posts repeat every 48mm. This 48mm increment is defined as OpenU.

3 Mechanical Requirements

3.1 Rack Columns

The vertical columns in the rack help retain equipment and also limit its horizontal movement. This enables the chassis to align the bus bar clip to the bus bars.

As the equipment is installed into the rack, it will stop against a series of lances in on the hot-aisle side of the rack frame. The lances keep the equipment from falling out the back of the rack when moving the rack or servicing equipment. The lances also provide several millimeters of air gap between the back of the equipment and the bus bars. This air gap prevents shock loads from damaging the bus bars.

Once the equipment is installed, the rack frame equipment has a series of rectangles along the front vertical frame that can be used to prevent the equipment from moving forward. Equipment designers can use these rectangles when designing retention schemes that help technicians quickly remove equipment. For example, equipment that does not weigh much could use simple metal spring latches to grab into the rectangle. Heavier equipment might use a thick cam lever with a positive latch for retention.

In order to comply to this standard, the vertical columns of the rack shall contain the features defined below and displayed in Figure 3 and Figure 4:

- A series of 14x18mm rectangles on the front column for the equipment in the Equipment Bay. The rectangles must appear at least 15mm deep into the frame.
- A series of lances in the rear column to act as hard stops for the equipment in the Equipment Bay.

Deleted: provide retention features for

Deleted: the IT gear

Deleted: t

Deleted: of the IT Gear so tha

Deleted: t

Deleted: can

Deleted: busbar

Deleted: busbar

Deleted: IT Gear

Deleted: the gear

Deleted: gear

Deleted: during movement and service of the

Deleted: IT gear

Deleted: IT Gear

Deleted: busbar

Deleted: so that

Deleted: do not damage

Deleted: busbar

Deleted: IT gear

Deleted: IT Gear

Deleted: IT Gear

Deleted: during movement

Deleted: These rectangles can be used by IT Gear

Deleted: for a variety of different IT Gear

Deleted: allow

Deleted: for quick removal by a technician for service

Deleted: IT Gear

Deleted: a

Deleted: While h

Deleted: IT Gear

Deleted: claim compliance

Deleted: SHALL

Deleted: following

Deleted: as

Deleted: IT gear

Deleted: IT gear

- Rectangles and lances shall repeat every 48mm along the length of the vertical columns. They may repeat every 24mm (support for 1/2OpenU) if desired.

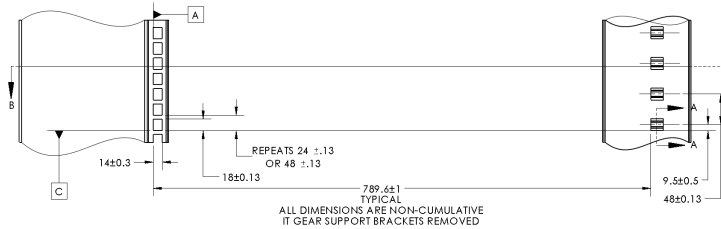


Figure 3: Open Rack Front Detail

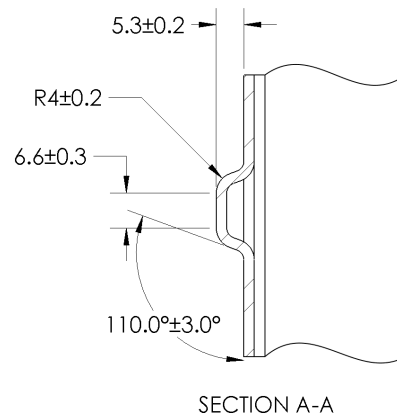


Figure 4: Open Rack Rear Stop Detail

The rack shall also provide the following features (Figure 5):

- Vertical columns 538-540mm apart
- Support for three bus bar cage assemblies

Deleted: The r

Deleted:

Deleted: the

Deleted: SHALL

Deleted: ,

Deleted: but MAY

Deleted: busbar

Deleted:

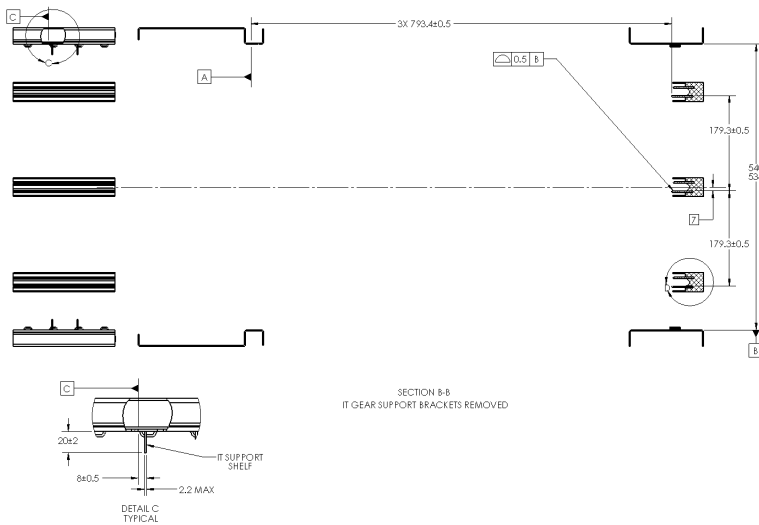


Figure 5: Open Rack Cross-Section

3.2 IT Support Shelves

The IT equipment sits on a series of horizontal support shelves. These shelves could be constructed as individual brackets that are assembled into the rack, or incorporated into the rack structure itself by creating them out of the sides of the rack. The quantity and vertical locations of the shelves are left to the customer to specify.

The IT Support Shelves shall:

- Support [equipment](#) as small as 1 OpenU tall (48mm)
- Conform to the shape shown in Detail B ([Figure 6](#))
- Provide a continuous ground path from the [equipment](#) to the Open Rack frame
- Have a finish that does not encourage the growth of metal whiskers
- Be recessed between the vertical posts so that the 538mm equipment bay width is not reduced

The pair of IT Support brackets should:

- Support a minimum of 70kg under a dynamic load defined by Telcordia GR63 Zone 2
- Have a hot-dip zinc coating conforming to ASTM A653 or JIS 3302 SGOC

Deleted: IT Gear

Deleted: Figure 6Figure 5

Deleted: IT Gear

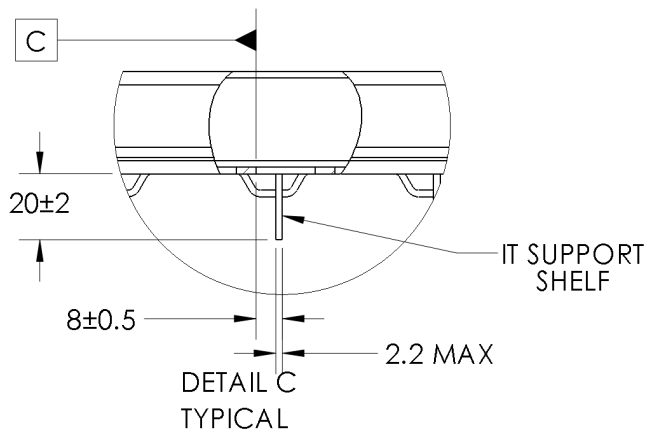


Figure 6: IT Support Bracket Detail

3.3 Bus bar

The **bus bars** are located in the back of the rack and transmit the 12V power from the rack-level power sub-system to the **equipment** in the rack. The bars allow the **equipment** to plug directly into the power so the technician does not need to go to the back of the rack to disconnect power cords prior to servicing **equipment**.

The **bus bar** cover protects the user from the positive 12V **bus bar** when the rack is powered-up. Access to the front of the **bus bar** should be limited by the design of the **equipment** and/or a blank to fill any empty **equipment** location in the rack.

The **Bus bars** shall:

- Be populated with either **one** or **three bus bars** per power zone
- Be located in the center position in the rack if only a single **bus bar** pair is populated
- Be located in the rack per **Figure 5** and comply with Detail D in **Figure 7**
- Be plated with nickel at minimum of 10 microns thick. The nickel plating may be over-plated with silver or gold

The **Bus bars** should be designed so that they can be removed and re-installed by a trained service technician in the field.

Deleted: Busbar

Deleted: busbar

Deleted: power

Deleted: IT Gear

Deleted: IT Gear

Deleted: that

Deleted: the IT Gear

Deleted: busbar

Deleted: is intended to

Deleted: busbar

Deleted: busbar

Deleted: IT Gear

Deleted: IT Gear

Deleted: Busbar

Deleted: 1

Deleted: 3

Deleted: busbar

Deleted: .

Deleted: busbar

Deleted: .

Deleted: Figure 3-2

Deleted: Figure 7Figure 6

Deleted: .

Deleted: .

Deleted: Busbar

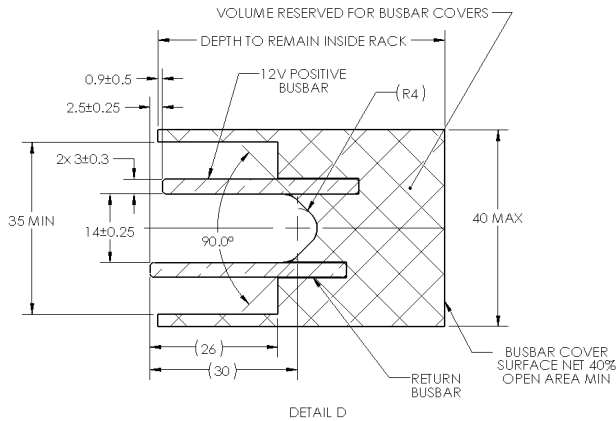


Figure 7: Bus bar Detail

A volume around each [bus bar](#) is reserved for an optional [bus bar](#) cover to protect the user. While protecting the user is not optional, the methodology is. For example, [a single hinged panel could cover the entire back of the rack](#) rather than [using](#) individual covers around each [bus bar](#) set.

The [bus bars](#) shall:

- Have [user](#) access limited by a method that conforms to UL60950.

If individual [bus bar](#) covers are used, the [bus bar](#) covers shall:

- Stay within the zone defined in [Figure 7](#).
- Have a perforated surface behind the [bus bars](#), that has a minimum of 40% opening after any support, insulators, or labels are included ([Figure 7](#)).
- Have perforations and limited access to service panels that conform to UL 60950

3.4 OpenU Marking

Each OpenU on the rack should be numbered so technicians can easily identify the exact location of the [equipment](#).

Each OpenU on the [rack](#) shall be sequentially numbered in a permanent and legible manner starting with the number one ([1](#)) in the bottom of the rack.

[Each](#) OpenU number should be painted using a silkscreen process rather than adhesive labels to improve the long-term reliability.

[Each](#) OpenU number should be located so that cable bundles and [equipment](#) will not hinder [its](#) visibility.

Deleted: Busbar

Deleted: busbar

Deleted: busbar

Deleted: the entire back of the rack could be covered by a single hinged panel...

Deleted: busbar

Deleted: busbar

Deleted: .

Deleted: busbar

Deleted: busbar

Deleted: Figure 7Figure 6

Deleted: busbar

Deleted: (Figure 6)

Deleted: .

Deleted:

Deleted: IT gear

Deleted: R

Deleted: The

Deleted: s

Deleted: The

Deleted: s

Deleted: IT Gear

Deleted: the use's



3.5 Marking for Re-Use

The lifecycle of the rack is normally significantly longer than the [equipment](#) inside it. Ideally the rack would be used for multiple generations of equipment. The [load rating](#) of the [rack](#) frame and the IT Shelves, however, is not controlled by this standard. [Thus](#), when it is time to re-purpose the rack for future equipment, it is necessary to know the limits of the rack.

[The load rating should be located so it is visible from the cold-aisle of the rack.](#)

The rack shall be marked:

- In a permanent and legible manner with the maximum load [\[in kilograms\]](#) that the IT Support shelves and the [rack](#) frame are capable of supporting [\(whichever is less\)](#) under Telcordia GR63 Zone2
- With the latest revision number of the standard for which the rack is compliant in either of the following formats:
 - OPEN RACK SPECIFICATION REVXX.X
 - ORS REVXX.X

Where "XXX" is the alphanumeric version of the specification such as: V1.0 or V2.2

- In a location that is visible to the user without [removing equipment](#)
- In a location that will not be damaged by [equipment](#) sliding in and out of the rack during routine service.

4 Electrical Requirements

4.1 Bus bar Power Connection

The [bus bar](#) connector provides the electrical path from the 12V and ground [bus bars](#) in the back of Open Rack to the IT equipment in the Equipment Bay.

4.2 Bus bar

The [bus bar](#) shall:

- Be made of copper with an IACS near 100%
- Be plated with either [nickel](#) or [silver](#) to protect the surface of the [bus bar](#) during repeated cycling of the [bus bar](#) power connector.
- Have a [bus bar](#) voltage of 12.2+/- 0.4V along the entire length of the bus.

The [rack](#)-level [power system](#) should provide 12.5 +/-0.1V at the connection to the [bus bar](#).

The current density of the [bus bar](#) should be less than 6amp/mm².

5 Revision History

| Revision | Release Date | Change Description |
|-------------|--------------|------------------------|
| Steve Mills | 0.1 | Initial release |
| Steve Mills | 0.9 | Release for OCP review |

Deleted: IT Gear
Deleted: that is
Deleted: of
Deleted: ,
Deleted: so i
Deleted: load-rating
Deleted: Rack
Deleted: So
Deleted: R
Deleted: (whichever is less)

Deleted: the removal of
Deleted: IT Gear
Deleted: IT Gear
Deleted: .

Deleted: The load rating should be located so it is visible from the cold-aisle of the rack. ¶

Deleted: Busbar

Deleted: busbar

Deleted: busbar

Deleted: Busbar

Deleted: busbar

Deleted: .

Deleted: Nickel

Deleted: Silver

Deleted: busbar

Deleted: busbar

Deleted: .

Deleted: busbar

Deleted: . ¶

Deleted: Rack

Deleted: Power

Deleted: System

Deleted: busbar

Deleted: busbar

| | | |
|------------|-------|--------------|
| Jay Hauser | 0.9.1 | General edit |
|------------|-------|--------------|