Introduction to the EMC CX High Density Rack Featuring CX4 UltraFlex Technology

A Detailed Review

Abstract

This white paper introduces the EMC® CLARiiON® CX High Density Rack, which is available for CX4-480 and CX4-960 storage systems with UltraFlex™ technology. This paper describes the hardware differences between standard and high-density racks, the benefits of high-density racks, and the cases in which high-density racks provide optimal benefits.

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Introduction to the EMC CLARiiON CX High Density Rack Featuring CX4 UltraFlex Technology
A Detailed Review
Executive summary
The EMC® CLARiiON® CX High Density Rack provides increased storage density to the midtier storage customer while leveraging the unique highly available and highly flexible storage system components of the CLARiiON CX4 UltraFlex™ product line.

The CX High Density Rack improves space utilization and provides power preservation. The rack is physically larger than and visibly distinct to the standard CX 40U rack, and accommodates up to twice the number of drives. This rack is available with the CX4-960 and CX4-480 CLARiiON array platforms; it can also be purchased as an expansion rack for existing CX4 storage systems. The CX High Density Rack has similar agency compliance to the standard CX 40U rack, and it is a cost-effective solution for data centers that have limited space availability, very high capacity requirements, and predictable I/O load characteristics. There are restrictions that are unique to the CX High Density Rack; only SATA and Enterprise Flash Drives are supported within the rack. The best use cases for CX4 arrays in a CX High Density Rack are backup to disk, data archiving, and video storage.

Introduction
This white paper describes the architecture of the CX High Density Rack for CX4 storage systems. It compares the features and capabilities of the CX High Density Rack with the standard CX 40U rack. It also outlines the unique benefits that the CX High Density Rack provides to customers.

Audience
This white paper is intended for EMC employees, partners, IT planners, storage architects, administrators, and any others involved in evaluating, acquiring, managing, operating, or designing an EMC networked storage environment.

Overview
The CX High Density Rack has several major characteristics that are discussed in this white paper including:

• The 42U rack is taller and deeper than the 40U rack.
• Up to 26 DAEs can be housed in one CX High Density Rack; this is double the density of a CX 40U rack.
• With its SATA and Flash drives, the CX High Density Rack draws less power than typical tiered storage systems with 10k and 15k Fibre Channel drives.
• The CX High Density Rack is different from both the Atmos™ hardware rack and the CX 40U rack. The most visible differences are the 42U height and the tandem DAE rail mounts.
• The CX High Density Rack has three major restrictions:
  ▪ All drives in the rack (with the exception of Bus 0 Enclosure 0 slots 0 - 5) must be either SATA or Flash drives. (In CX4 systems, SATA and Flash drives cannot share a DAE.)
  ▪ Both enclosures mounted in a tandem rail row must be configured to run on the same back-end bus.
  ▪ All back-end bus components must be connected with specifically qualified copper Fibre Channel cables.

CX High Density Rack architecture
The CX High Density Rack (HDR) builds on the industry experience EMC has acquired through its varied, highly acclaimed, and successful product designs. The CX HDR was designed to support 10 drives per 1U of rack space, compared to five drives per 1U of rack space in the standard CLARiiON rack. This is
achieved through the use of newly designed and tested components, as well as leveraging existing EMC designs from other product lines. The major new components of the CX HDR solution are:

- 42U rack with single-phase PDUs
- Stabilization brackets
- Tandem rail assembly
- EMI shielding
- Cable track assembly (CTA)
- Full-height front door

The CX HDR utilizes tandem disk array enclosure (DAE) mounting within the rack. As a result, the existing CX HDR utilizes the same proven DAE4P and provides double the storage density of the standard CX rack, with no impact to performance or availability. The DAEs are mounted two to a row, with one situated in front of another. Cool air enters the front DAE, exhausts through the rear, into the front of the second DAE, and finally exhausts through the rear into the back of the 42U rack. The easiest way to visualize this is to imagine one shortened CX rack immediately in front of another.

To allow for servicing of the drives in the rear DAE, sliding drawer functionality is implemented. The front DAE slides out and locks in a safe position to allow for servicing of any of the drives in the rear DAE, as well as any of the rear-facing components of the front DAE. Rear-facing components of the rear DAE can be accessed from the rear of the rack. The tandem DAE tray also slides out the rear of the rack for rear DAE installation or removal.

### 42U rack

The CX HDR is an evolution of the Atmos hardware rack, which is obvious upon physical comparison. There are some key differences in the design of the rack, which are shown in the Table 1. The Atmos hardware rack was designed specifically for Atmos hardware. Similarly, the CX HDR was designed specifically for CLARiiON CX4 systems. As a result, the two racks are not interchangeable. The CX HDR is 42U, which allows it to fit through industry-standard data center doorways. Due to the additional space requirements of the dual enclosure rail assembly, the 42U rack is deeper than the standard CX 40U rack. The CX HDR, like the Atmos hardware rack, ships with both front and rear lockable doors. All three racks are compared in Table 1.

<table>
<thead>
<tr>
<th>Rack</th>
<th>CX High Density Rack</th>
<th>Atmos hardware rack</th>
<th>CX 40U rack</th>
</tr>
</thead>
<tbody>
<tr>
<td>Components height</td>
<td>42U</td>
<td>44U</td>
<td>40U</td>
</tr>
<tr>
<td>Total dimensions</td>
<td>78.5&quot; H (1.96 m) x 43.3&quot; D (1.1 m) x 24.0&quot; W (.60 m)</td>
<td>82&quot; H (2.08 m) x 43.3&quot; D (1.1 m) x 24.0&quot; W (.60 m)</td>
<td>75&quot; H (1.90 m) x 39.4&quot; D (1.0 m) x 24.0&quot; W (.60 m)</td>
</tr>
<tr>
<td>Power cord connector</td>
<td>Qty 4: NEMA L6-30p, or IEC-309-332P6, or 56PA332 Right Angle</td>
<td>Qty 3: NEMA L6-30p</td>
<td>Qty 4: NEMA L6-30p, or IEC-309-332P6, or 56PA332 Right Angle</td>
</tr>
<tr>
<td>Maximum total system weight*</td>
<td>2,598 lb</td>
<td>2,548 lb</td>
<td>2,100 lb</td>
</tr>
<tr>
<td>Operating voltage and frequency</td>
<td>200-240 V AC 50/60 Hz</td>
<td>200-240 V AC 50/60 Hz</td>
<td>200-240 V AC 50/60 Hz</td>
</tr>
</tbody>
</table>

* Maximum total system weight = the weight of the rack + the weight of the maximum amount of hardware the rack can accommodate in an EMC-supported configuration.
Stabilization bracket

The CX HDR includes unique mount points for a floor stabilization bracket. The floor stabilization brackets improve rack stability; they attach the rack to floor tiles or the sub-flooring to prevent the cabinet from moving. The brackets optionally mount to both the front and rear of the 42U rack, details of which are in the Site Preparation Guide for the 42U Dense Storage Cabinet and the 42U Dense Storage Cabinet Unpacking and Setup Guide.

Rail assembly

The CX HDR contains a newly designed tandem rail assembly that includes the three major components detailed in Table 2. The rail assembly provides mechanical support and access to both the front and rear DAEs in a given row. The rail assembly is designed so that access to rear DAEs is provided from the front of the rack via a sliding mechanism that slides a complete DAE pair to the front. This mechanism has physical restrictions so that only one DAE pair can be accessed at a time to ensure that stability is maintained throughout the procedure.

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tandem rail</td>
<td>Used to house both the front and rear DAEs in a particular enclosure row</td>
</tr>
<tr>
<td>DAE plates</td>
<td>Left and right plates mount onto DAEs that then sit on tandem rails</td>
</tr>
<tr>
<td>Cable track assembly (CTA)</td>
<td>See the “Cable track assembly” section next for CTA detail</td>
</tr>
</tbody>
</table>

Figure 1. Fully extended rail assembly

EMI shielding

The CX HDR implements equivalent EMI shielding levels of the standard CX 40U rack through a different methodology. When housed in the CX 40U rack, DAEs and drives in the rack are protected from EMI by the front bezels. The CX HDR uses a black mesh EMI shield to protect individual DAEs in place of the front bezels.

Cable track assembly

The CX HDR has a high level of active component density that requires that the cables routed to the components be properly and safely routed and stored. The two DAEs per row form factor require a new solution for routing power and HSSDC2 cables from the front DAE. This is accomplished with the cable track assembly, which contains several components listed in Table 3. The complete cable track assembly creates a virtual 30-drive disk enclosure. The cable track assembly is completely installed in the CX HDR from EMC, which means that cable routing is already complete for the maximum supported number of DAEs for that rack model, even if a lesser number of DAEs is ordered and configured with the rack.
Table 3. Components in the cable track assembly

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IGUS cable track</td>
<td>Flexible sleeve used for routing cables from the front DAE to the rear DAE or rear of the rack</td>
</tr>
<tr>
<td>Cable Management Arm (CMA)</td>
<td>Articulating arm in the rear of the rack that manages cable bundle extension and reflection</td>
</tr>
<tr>
<td>Y power cords</td>
<td>Y cord that gangs front and rear power to a single plug-in rack PDU</td>
</tr>
<tr>
<td>2.1 m HSSDC2 cables</td>
<td>HSSDC2 cable from front DAE expansion ports to the HSSDC2 coupler in CMA. Used to add DAEs on a bus using 5-meter extension cables. This cable has 100 ohm resistance, which is different from a standard CX back-end cable that has 150 ohm resistance.</td>
</tr>
<tr>
<td>1.5 m HSSDC2 cables</td>
<td>HSSDC2 cable from the rear DAE expansion port to the front DAE primary port. This is a standard CX back-end cable with 150 ohm resistance.</td>
</tr>
<tr>
<td>HSSDC2 coupler</td>
<td>HSSDC2 female-to-female coupler</td>
</tr>
</tbody>
</table>

Additional components

When ordered with a CX4-960 or CX4-480 storage system model, the CX HDR will include a ship-kit. When ordered as an expansion rack, there are no additional components supplied. Items in the ship-kit include:

- Spare 8-meter HSSDC2 cable for troubleshooting purposes
- Extra system labeling kit with:
  - HSSDC2 FC coupler bus labels
  - DAE flange enclosure ID labels
  - HSSDC2 wrap-around cable labels
- Illustrated label placement guide
- “As-Built” back-end bus diagram

**CX High Density Rack restrictions**

**Drive restrictions**

The restrictions for CX HDR drives vary according to enclosure location. The disk array enclosure that houses the operating system disks (DAE-OS Bus 0 Enclosure 0) is the only DAE that can house Fibre Channel (FC) drives. So, FC drives are allowed in slots 0-5, which allows the system drives to be FC, and allows one FC hot spare. Additionally, the DAE-OS must be situated in the bottom row, in the front position. This ensures that the thermal and air flow requirements for FC drives are met, which cannot be guaranteed in other positions in the CX HDR. All other DAEs may only contain 5,400-rpm SATA, 7,200-rpm SATA, or Flash drives. As of December 2009, 1 TB SATA (7,200 and 5,400 rpm), 2 TB SATA (5,400 rpm), 73 GB Flash, and 400 GB Flash drives are offered with the CX HDR. To determine what additional drives may be offered, please contact your qualified sales associate.

**Back-end bus restrictions**

Due to the tandem rail design that supports two enclosures per row, there is a physical requirement that both enclosures in the same row reside on the same bus. The implications of this requirement are that when using the CX HDR as an expansion rack, care must be used when laying out the design to ensure that appropriate cabling is used and that buses are not overallocated. The CX4 limit of eight physical enclosures per back-end bus does not change with the CX HDR. This restriction allows the HSSDC2 cable...
length requirements to be met while allowing the cables to be routed in a reasonable manner so it is possible to service them. When ordered with a CX4-960 or CX4-480 storage system, all the back-end bus cabling will be applied according to all restrictions. Typically, this will result in an interleaved physical configuration where the first enclosure of every bus is in the first rack. This "as shipped" configuration will be documented and supplied with the system.

Data-in-place upgrade restrictions
CX4-480c systems in a CX High Density Rack cannot undergo a data-in-place upgrade to a CX4-960 for two major reasons. The back-end bus restrictions require that the first enclosure of every bus be in the first rack. A CX4-480 has only four back-end buses, and a CX4-960 has eight back-end buses; consequently there is no space in rack one to add four additional enclosures. Also, there is no additional space when a CX4-480 is installed in a CX HDR, which is required to upgrade to a physically larger CX4-960 xPE.

Cable restrictions
Due to signal strength considerations, the CX HDR requires qualified back-end bus cables when interfacing with the FC coupler due to signal strength considerations. All HSSDC2-to-HSSDC2 back-end bus cables that are connected to the FC coupler must be 100 ohm resistance. The SFP-to-SSDC2 back-end bus cable that connects to the storage processor and the FC coupler must be the 2.1-meter length 150 ohm resistance part. All HSSDC2-to-HSSDC2 cables that connect from one back-end component to another, without interfacing with the FC couple, can be either 150 ohm or 100 ohm resistance. The maximum combined cable length for any runs that interface with the FC couple must be less than or equal to 7 meters. The part numbers of the currently qualified 100 ohm cables are listed in Table 4.

Table 4. Qualified 100 ohm cables to interface with FC coupler

<table>
<thead>
<tr>
<th>Part number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>038-003-596</td>
<td>HSSDC2 to HSSDC2 cable with 100 ohm resistance in 2-meter length</td>
</tr>
<tr>
<td>038-003-573</td>
<td>HSSDC2 to HSSDC2 cable with 100 ohm resistance in 5-meter length</td>
</tr>
</tbody>
</table>

Where the CX HDR series fits into the CLARiiON rack family
The CX High Density Rack is EMC’s second rack offering for CLARiiON storage hardware. The other rack is the standard CX 40U rack. The CX 40U rack provides a single component in each row, with industry-standard 19-inch NEMA mounting brackets. The 40U rack allows up to 13 3U disk array enclosures per expansion rack; or, if a CX4-960 xPE and SPS are installed, then 13 3U disk array enclosures can also be installed. When this maximum capacity is compared to the 26 3U disk array enclosures per expansion rack for the CX HDR, the double density concept becomes clear. The CX HDR can be combined with the CX 40U rack to house the same storage system. For example, a CX4-960 can be purchased in the CX HDR, and a CX 40U expansion cabinet can be added at a later date for moderate expansion, or expansion that requires Fibre Channel drives. If there is a need for very large expansion with only SATA drives, then the CX HDR is the logical choice.

CX High Density Rack benefits
The CX High Density Rack was designed to provide increased utilization of floor space in a data center, primarily by increasing the number of supported drives per cabinet. This allows for a tangential benefit in power savings due to the SATA-only drive restriction. Major customer benefits include:

- Doubles the density of the EMC 3U FC DAE offering for customers with computer room space constraints.
  - Increases the current five drives per U (15 disks in 3U) to 10 drives per U
  - Increases the total drives per rack
• Allows 26 3U DAEs per rack; up to 390 SATA drives per rack
• Provides an industry-leading 20 terabytes of raw capacity per U when combined with the newly introduced 2 TB SATA drives
• As a SATA- and EFD-only device, CX High Density Rack configurations will draw less power than standard tiered storage offerings with 10k and 15k drives
• Requires fewer 30-ampere power drops than two fully configured CX 40U racks (4 vs. 8)

**CX High Density Rack data center applications**
The CX High Density Rack was designed to increase data center space utilization with CX4 systems. The CX4 system in a CX HDR should provide identical performance to a CX4 system in a CX 40U rack. The major difference is the limitation requiring EFD and SATA drives only. Since FC drives are only allowed in the DAE OS, Bus 0 Enclosure 0, applications that depend on the capacity and performance of FC drives may not be good candidates for a CX HDR-based CX4 system.

The general recommendation is to size the CX4 solution for performance, as outlined in the *EMC CLARiiON Best Practices for Performance and Availability* white paper, and then determine if the CX HDR is capable of housing your system. EMC expects that the most popular applications that will run on CX4 systems housed in a CX HDR are:
- Backup to disk
- Block-based data archiving
- Streaming video
- Mass image storage

**Conclusion**
The CX High Density Rack provides double the data center space utilization and less power utilization than similarly configured CX 40U racks. The CX HDR was designed to incorporate EMC’s experience with both standard configuration 40U NEMA racks and the tandem DAE mounting of the Atmos hardware rack into a new 42U rack with tandem DAE mounting. The CX HDR will fit in the majority of data centers and utilize the proven technology of the CLARiiON CX4 product line. There are several noticeable differences from the CX 40U rack: front and rear doors, 42U height, and tandem DAE mounting on sliding rails. The CX HDR also allows for improved power utilization, requiring half the L6-30 power drops and less power consumption than a similar drive count in CX 40U racks.