

EMC CLARiiON CX4 Series DC Power Systems

A Detailed Review

Abstract

This white paper introduces the full architecture and functionality of the EMC® CLARiiON® CX4 UltraFlex™ series DC-powered systems, including the CX4-120 DC, CX4-240 DC, and CX4-480 DC.

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Executive summary

EMC® CLARiiON® CX4 DC-powered storage systems are based on the same breakthrough architecture and extensive technological innovation as their AC counterparts and the CX3 DC-powered storage systems that preceded them. The DC-powered product line delivers the same industry-leading performance that customers have come to expect from EMC products.

DC-powered systems work in harsh and demanding environments, and are designed to be NEBS level 3 compliant. NEBS level 3 is an especially demanding certification. Although it is not legally mandated, EMC has had each of the DC systems independently tested and awarded a certificate of compliance with NEBS level 3 requirements to ensure that systems deployed in harsh environments perform consistently and reliably.

Introduction

This white paper introduces the CLARiiON CX4 DC power storage systems. It describes the hardware associated with the CX4 DC systems, and the differences between AC- and DC-powered systems. The powerup and powerdown sequences for these systems are also discussed.

This paper also highlights the operating conditions of each piece of DC hardware. Finally, this paper examines the levels of certification that the CX4 DC systems have obtained.

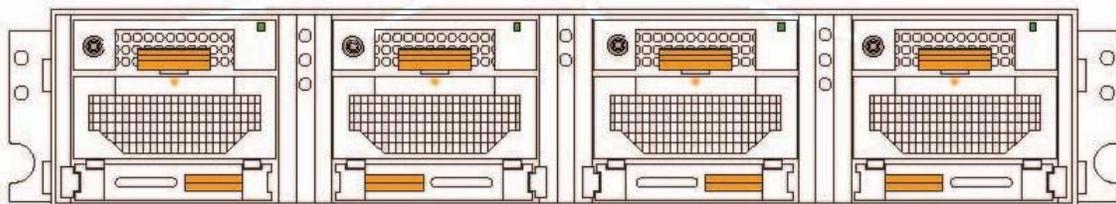
Audience

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.

DC system overview

The DC CX4 series storage systems are made up of the following modular components:

- A CX4 storage processor enclosure (SPE) houses the two storage processors (SPs).
- A 4 Gb/s UltraPoint™ DC-powered disk-array enclosure (DAE) houses up to 15 drives. Additional DAEs can be added for a maximum of 120 drives for the Model 120 DC, 240 drives for the Model 240 DC, and 480 drives for the Model 480 DC¹.



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Figure 1. CX4 DC power supplies, cooling, and SPs

All CX4 DC models utilize the SPE shown in Figure 1. Each SPE includes four power supplies, two per SP. Both SPs are configured with N+1 power and cooling. The power supplies contain thermal sensors for ambient temperature monitoring. High speed blowers are attached to each power supply for cooling. A single power supply can power a single SP and a single blower can cool a single SP. Each SP can have a

¹ DC-powered arrays do not use a standby power supply (SPS).

single fault and still maintain write caching. The CX4 DC systems can run (and maintain high availability) indefinitely with one power supply/blower module faulted or removed on each SP. Write cache is handled the same way in a CX4 DC as it is in the AC models. For example, write cache can still be enabled with just a single functioning power supply/ blower module.

Like their AC counterparts, the DC systems utilize the enhancements in the UltraPoint DAEs. These enhancements include increased fault isolation, link testing, and 2 Gb/s versus 4 Gb/s *auto-sense*. UltraPoint's auto-sense speed setting allows the enclosure to run drives at the highest supported speed, and provides the CX4 the flexibility to simultaneously use a combination of 2 and 4 Gb/s back-end buses. For additional details about the functionality of the CX4 series disk storage arrays, see the [*Introduction to the EMC CLARiiON CX4 Series Featuring UltraFlex Technology*](#) white paper available on Powerlink® and EMC.com.

Where the DC-powered CX4 fits into CLARiiON storage

For environments where AC power is not an option, EMC has introduced three DC models. The CX4-120, CX4-240, and CX4-480 are now available in AC *and* DC configurations. Like their AC-powered counterparts, CX4 DC systems are dual protocol, with both Fibre Channel and iSCSI connectivity. DC-powered systems are often used in telecommunications, gas, oil, and federal applications. These DC units are ideally suited to unique environments. Occasionally, these unique deployments face harsh environmental conditions. For this reason, the new DC-powered systems are ETSI- and NEBS-compliant.

The CX4 DC-powered systems are NEBS level 3 compliant. This certification is used to ensure that systems deployed in harsh environments perform consistently and reliably. Temperature, humidity, fire, earthquake, vibration, acoustic, air quality, and electrical safety testing are just a few of the rigors that systems must endure to be fully NEBS compliant. These tests are exceptionally important for systems operating in unique environments, but their benefits extend to all deployments.

Table 1 on page 6 compares the three DC CX4 models.

Table 1. Comparison of the CX4 UltraScale series DC power systems

| Components/Connectivity | CX4-120 | CX4-240 | CX4-480 |
|----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|------------------------|------------------------|
| Processor architecture per SP ² | 1 dual core 1.2 GHz | 1 dual core 1.6 GHz | 1 dual core 2.2 GHz |
| Physical memory per SP | 3 GB | 4 GB | 8 GB |
| Max system cache | 600 MB | 1,264 MB | 4,500 MB |
| Max write cache per system | 600 MB | 1,264 MB | 4,500 MB |
| Max front-end FC ports per SP ³ | 6 | 8 | 12 |
| Max front-end iSCSI ports per SP | 4 | 6 | 8 |
| Back-end 4 Gb/s FC ports per SP ⁴ | 1 | 2 | 4 |
| Max drives per storage system | 120 | 240 | 480 |
| Min drives per storage system | 5 | 5 | 5 |
| Max initiators per storage system | 256 | 512 | 512 |
| Max H/A hosts per storage system | 128 | 256 | 256 |
| Max LUNs per storage system | 1024 | 1024 | 4096 |
| Max RAID groups per storage system | 60 | 120 | 240 |
| Max drives per RAID group | 16 | 16 | 16 |
| Max LUNs per RAID group | 256 | 256 | 256 |
| Max Storage Groups per system | 128 | 256 | 512 |
| SPE form factor | 2 U | 2 U | 2 U |
| Minimum configuration form factor | 5U | 5U | 5U |
| Drives available | All CX4 DC systems are offered with 146 GB and 300 GB 15k, and 400 GB 10k Fibre Channel drives that are 4 Gb/s capable and NEBS-compliant | | |

CX4-480 DC system

The minimum CX4-480 DC assembly consists of a single 2U SPE and a 3U 4 Gb/s UltraPoint DAE, for a total of 5U. A fully configured CX4-480 DC consists of the SPE plus 32 3U DAEs, for a total of 98U, and requires two additional cabinets.

The SPE and DAE assemblies are rackmounted for efficiency, and provide the user with many configuration options. The CX4-480 DC system can be mounted in one of three ways. Customers can utilize EMC's 40U Titan cabinet, a Telco rail self-supporting rack, or a third-party rack.

² All models in the CX4 series have two SPs.

³ Front-end ports connect the storage system to the SAN or direct-attach host.

⁴ Back-end ports connect the storage system to other DAEs.

Storage processor

Each CX4-480 DC SP contains one dual-core 2.2 GHz Intel processor. This dual-SP architecture provides the power for enhanced performance, stability, and reliability in the CX4-480 DC storage system. Each CX4-480 DC SP has 8 GB of system memory. A PCI Express-x4 CMI channel between the SPs is used for communication and messaging between the SPs and to mirror data that is written to the storage system's write cache.

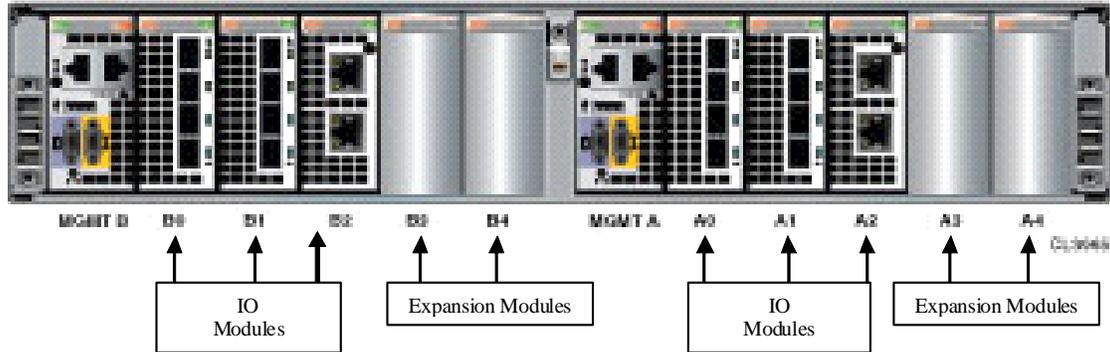


Figure 2. Rear view of the CX4-480 DC SPE

Figure 2 shows the rear of the storage processor enclosure for a CX4-480 DC storage processor. Each CX4-480 DC SP (base configuration) has four Fibre Channel front-end (FE) ports, and two iSCSI FE ports, as well as two additional I/O Module slots that allow for expanded front-end connectivity. By default, the speed of the FE ports is set to **auto-negotiate**. Navisphere Manager or CLI allows the user to select a specific speed. These ports are customer-replaceable small-form-factor pluggable optical transceivers inserted into field-replaceable Fibre Channel I/O Modules. Each SP also has four 4 Gb/s Fibre Channel back-end ports, which, along with the peer SP, form four redundant FC back-end loops for disk connectivity and capacity expansion.

LEDs provide indications of LAN connectivity, SP power, boot progress, and fault status, as well as power supply and blower status. The LEDs also indicate the speed at which the front- and back-end ports are running – green indicates 2 Gb/s and blue indicates 4 Gb/s.

Table 2. CX4-480 SPE DC ratings

| CX4-480 DC SPE3 | Rating |
|---------------------|------------------------------------------------------------------|
| DC line voltage | -36 V to -72 Vdc (Nominal -48 V or -60 V power systems) |
| DC line current | 8.6 A max. at -36 Vdc, 6.5 A typical at -48 Vdc |
| Power consumption | 310 W max. |
| Heat dissipation | 1.12×10^6 J/hr (1,060 BTU/hr) max. |
| Inrush current | 18 A peak, per requirements in EN300 132-2 Sect. 4.7 limit curve |
| DC protection | 20 A fuse on each power supply, 20 A fuse in inlet cable |
| DC inlet type | Molex Incorporated 46394-0001 |
| Mating DC connector | Molex Incorporated 46396-1000 |
| Ride-through time | 10 ms min. at -48 V input |
| Current sharing | 10% max., 10% min. between power supplies |

CX4-240 DC system

The minimum CX4-240 DC assembly consists of a single 2U SPE and a 3U 4 Gb/s UltraPoint DAE, for a total of 5U. A fully configured CX4-240 DC consists of the SPE plus 16 3U DAEs, for a total of 50U, and requires one additional cabinet.

The SPE and DAE assemblies are rackmounted for efficiency, and provide many configuration options. The CX4-240 DC system can be mounted in one of three ways. Customers can utilize an EMC 40U Titan cabinet, a Telco rail self-supporting rack, or a third-party rack.

Storage processor

Each CX4-240 DC SP contains one dual-core 1.6 GHz, Intel processor. This dual-storage processor architecture provides the power for enhanced performance, stability, and reliability in the CX4-240 DC storage system. Each CX4-240 DC SP has 4 GB of system memory. There is a PCI Express-x4 CMI channel between the SPs that is used for communication and messaging between the SPs and to mirror data that is written to storage system's write cache.

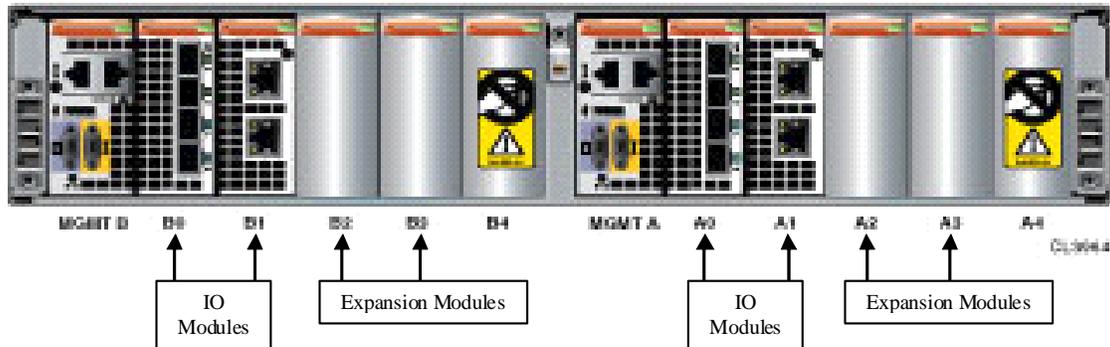


Figure 3. Rear view of the CX4-240 SPE

Figure 3 shows the rear of the storage processor enclosure for a CX4-240 DC storage processor. Each CX4-240 DC SP (base configuration) has two Fibre Channel FE ports, and two iSCSI FE ports, as well as two additional I/O Module slots that allow for expanded FE connectivity. By default, the Fibre Channel FE ports are set to **auto-negotiate**. The user can change the settings from auto-negotiate to 1, 2, or 4 Gb/s using Navisphere Manager or CLI. These ports are customer-replaceable small-form-factor pluggable optical transceivers inserted into field replaceable Fibre Channel I/O modules. Each SP also has two 4 Gb/s Fibre Channel back-end ports, which, along with the peer SP, form two redundant FC back-end loops for disk connectivity and capacity expansion.

LEDs provide indications of LAN connectivity, SP power, boot progress, and fault status, as well as power supply and blower status. The LEDs also indicate the speed at which the front- and back-end ports are running – green indicates 2 Gb/s and blue indicates 4 Gb/s.

Table 3. CX4-240 SPE DC ratings

| CX4-240 DC SPE3 | Rating |
|-------------------|------------------------------------------------------------------|
| DC line voltage | -36 V to -72 Vdc (Nominal -48 V or -60 V power systems) |
| DC line current | 7.5 A max. at -36 Vdc, 5.6 A typical at -48 Vdc |
| Power consumption | 270 W max. |
| Heat dissipation | 0.972×10^6 J/hr (930 BTU/hr) max. |
| Inrush current | 18 A peak, per requirements in EN300 132-2 Sect. 4.7 limit curve |

| | |
|---------------------|----------------------------------------------------------|
| DC protection | 20 A fuse on each power supply, 20 A fuse in inlet cable |
| DC inlet type | Molex Incorporated 46394-0001 |
| Mating DC connector | Molex Incorporated 46396-1000 |
| Ride-through time | 10 ms min. at -48 V input |
| Current sharing | 10% max., 10% min. between power supplies |

CX4-120 DC system

The minimum CX4-120 DC assembly consists of a single 2U SPE and a 3U 4 Gb/s UltraPoint DAE, for a total of 5U. A fully configured CX4-120 DC consists of the SPE plus eight 3U DAEs, for a total of 26U (which will all fit in a single 40U cabinet.)

The SPE and DAE assemblies are rackmounted for efficiency, and provide the user with many configuration options. The CX4-120 DC system can be mounted in one of three ways. Customers can utilize EMC's 40U Titan cabinet, a Telco rail self-supporting rack, or a third-party rack.

Storage processor

Each CX4-120 DC SP contains one dual-core 1.2 GHz, Intel processor. This dual-storage processor architecture provides the power for enhanced performance, stability, and reliability in the CX4-120 DC storage system. Each CX4-120 DC SP has 3 GB of system memory. There is a PCI Express-x4 CMI channel between the storage processors that is used for communication and messaging between the SPs and to mirror data that is written to the storage system's write cache.

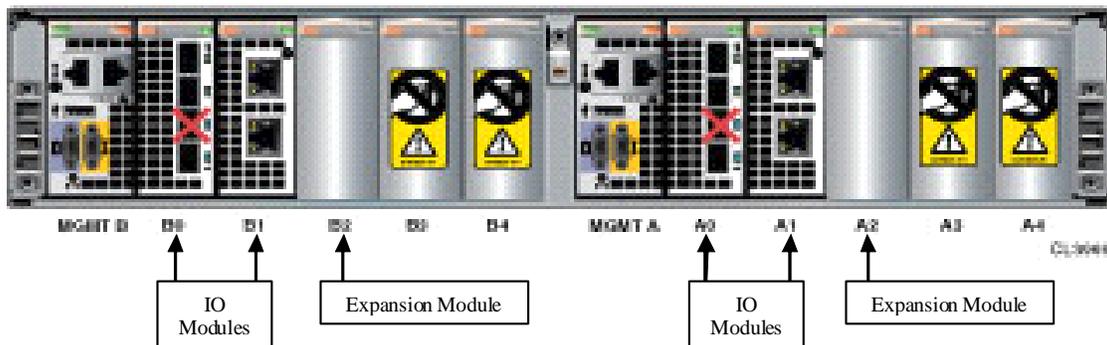


Figure 4. Rear view of the CX4-120 SPE

Each CX4-120 DC SP (base configuration) has two 4 Gb/s Fibre Channel FE ports, and two iSCSI FE ports, as well as one additional I/O Module slot that allows for expanded FE connectivity. By default, the FE ports are set to **auto-negotiate**. The user can change the settings from auto-negotiate to a specific supported speed using Navisphere Manager or CLI. These ports are customer-replaceable small-form-factor pluggable (SFP) optical transceivers inserted into field replaceable Fibre Channel I/O Modules. Each SP also has one 4 Gb/s Fibre Channel back-end port, which, along with the peer SP, forms a redundant FC back-end loop for disk connectivity and capacity expansion.

LEDs provide indications of LAN connectivity, SP power, boot progress, and fault status, as well as power supply and blower status. The LEDs also indicate the speed at which the front- and back-end ports are running – green indicates 2 Gb/s and blue indicates 4 Gb/s.

Table 4. CX4-120 SPE DC ratings

| CX4-120 DC SPE3 | Rating |
|---------------------|------------------------------------------------------------------|
| DC line voltage | -36 V to -72 Vdc (Nominal -48V or -60V power systems) |
| DC line current | 7.2 A max. at -36 Vdc, 5.4 A typical at -48 Vdc |
| Power consumption | 260 W max. |
| Heat dissipation | 0.936 x 10 ⁶ J/hr (890 BTU/hr) max. |
| Inrush current | 24 A peak, per requirements in EN300 132-2 Sect. 4.7 limit curve |
| DC protection | 10 A fuse on each power supply |
| DC inlet type | Molex Incorporated 46394-0001 |
| Mating DC connector | Molex Incorporated 46396-1000 |
| Ride-through time | 10 ms min. at -48 V input |
| Current sharing | 10% max., 10% min. between power supplies |

CX4 UltraScale DC-powered 4 Gb/s UltraPoint DAE

The physical disk drives are stored in DAEs, which are separate from the storage processors. Each DAE measures 3U in height and has room for up to fifteen 2 or 4 Gb/s drives. When looking at the front of the DAE, the drive numbering increases from 0, located at the left, to 14, located at the far right of the enclosure. The 4 Gb/s UltraPoint DAE has two link control cards (LCCs) that are capable of running at 2 or 4 Gb/s.

A DAE4P has two LEDs on the front face in addition to the LEDs present on any inserted drives. The user can determine what speed the enclosure is operating at by looking at the LED on the front of the enclosure. The LED on the left-front of the enclosure indicates fault status. The LED on the right-front of the enclosure has three states of operation: **Green**, **Blue**, and **Off**. **Green** or **Blue** indicates that the enclosure is powered, and that the drives are operating at 2 or 4 Gb/s, respectively. The unit is not powered on when the LED is **Off**.

Table 5. 4 Gb/s UltraPoint DAE DC ratings

| 4 Gb/s UltraPoint DAE | Rating |
|-----------------------|------------------------------------------------------------------|
| DC line voltage | -36 V to -72 Vdc (Nominal -48V or -60V power systems) |
| DC line current | 11.0 A max. at -36 Vdc, 8.3 A max at -48 Vdc |
| Power consumption | 396 W max. |
| Heat dissipation | 1.43 x 10 ⁶ J/hr (1,350 BTU/hr) max. |
| Inrush current | 20 A peak, per requirements in EN300 132-2 Sect. 4.7 limit curve |
| DC protection | 20 A fuse on each power supply |
| DC inlet type | Positronic Industries PLB3W3M1000 |
| Mating DC connector | Positronic Industries PLB3W3F7100A1 |
| Ride-through Time | 10 ms min. at -48 V input |
| Current Sharing | 60% max., 40% min. between power supplies |

Powering sequences

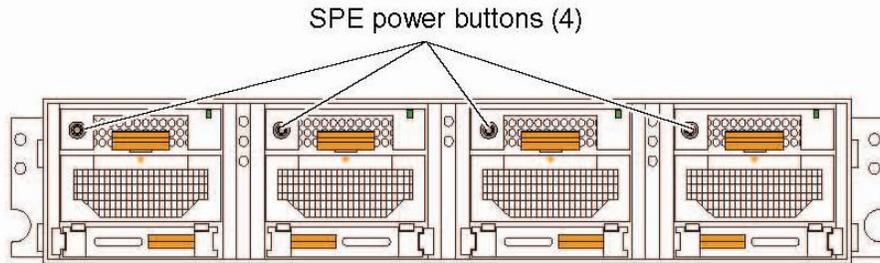
The DAE4P must be powered on to set the enclosure address. However, it cannot be part of a back-end bus. The enclosure address cannot be changed while the back end is connected. Therefore, the storage system should be powered up and the DAE4P enclosure addresses set *before* connecting back-end (disk

I/O) cables. For details on how to change the enclosure address, please see the latest version of the CLARiiON Procedure Generator.

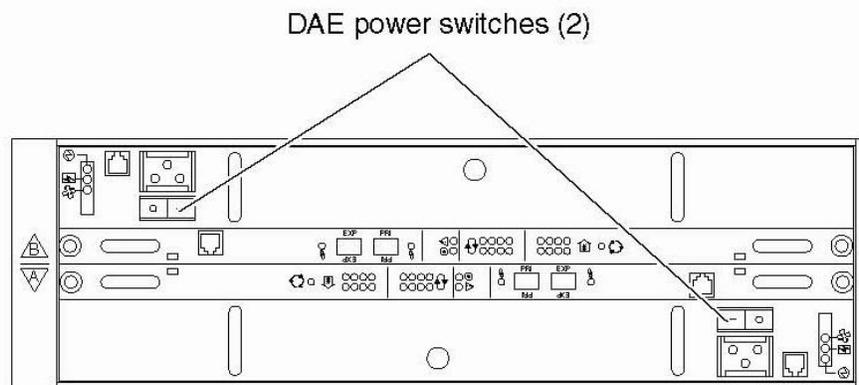
Powerup sequence

Follow these instructions to power up any of the CX4 DC-powered storage systems.

1. Press the power buttons on the SPE power supplies⁵.



2. Toggle the DAE4P power switches to the **ON (-)** position.



Powerdown sequence

Follow these four steps to power down any of the CX4 DC-powered storage systems.

Note: Before a CX4 DC-powered storage system is powered down, it is imperative that all data in the write cache be written to disk. There are three different ways to ensure that this has taken place; these are enumerated in steps 1-3. Best practice is to perform all four steps in the shutdown procedure in order, but any of steps 1-3 will safely destage data in the write cache to disk.

1. Stop all I/O activity to the CX4 from any attached servers.

Stopping the I/O allows the storage processor to destage the cache data more quickly, and permits the servers attached to the storage system to shut down properly.

If any of the servers connected to the storage system is running a UNIX operating system, you must unmount the file systems.

⁵ The Off position for the SPE power button is OUT, level with the protective cover.

-
2. In the Navisphere Secure Command Line Interface (CLI):

Perform this step on either SP A or SP B. Issue the following Navisphere command to disable the write cache and to complete the write of cache data to disk:

```
naviseccli -h <sp_IP_address> setcache -wc 0
```

Issue the following Navisphere command to determine when the write cache is empty. (On a large configuration, this can take several minutes):

```
naviseccli -h <sp_IP_address> getcache
```

Examine the Cache state and unassigned cache pages fields in the Navisphere display.

Do not continue unless the number of unassigned cache pages is 0.

The display will look like this:

```
SP Read Cache State Disabled
SPA Write Cache State Disabled
SPB Write Cache State Disabled
Cache Page size: 2
Write Cache Mirrored: YES
Low Watermark: 60
High Watermark: 80
SPA Cache pages: 604415
SPB Cache pages: 604416
Unassigned Cache Pages: 0
Read Hit Ratio: N/A
```

3. Toggle each power supply's switch to the off position.
 - a. On the storage processor enclosure, press the power button on each power supply and hold the button in for two seconds.

Blinking power supply LEDs indicate that the shutdown sequence is in progress. An orderly shutdown that flushes all cache can take up to two minutes before the storage processor sends a STOP to the power supply.
 - b. Allow the power supply to complete its shutdown sequence before removing the power source.
4. Power down power sources A and B. If it is necessary to retain power to other systems in a rack/cabinet, leave the power sources powered up. If necessary, toggle the DAE4P power switches to the off position.

Standards certification and compliance

Stand-alone CX4 series enclosures (CX4-120, CX4-240, CX4-480, and DAE4P) with DC power have been tested and are compliant with the international environmental and safety specifications listed in Table 6. Each enclosure is marked to indicate compliance and certification. All products designed, manufactured, or sold by EMC and its subsidiaries comply with the worldwide IT standards (applicable to the product type) that are published and accepted in the countries of intended sale.

Table 6. Quality and safety standards for CX4 UltraScale series DC power systems

| Quality and safety standards | Description |
|-------------------------------------------------|------------------------------------------------------------------------------------|
| GR-63-CORE | Telcordia Technologies Generic Requirements |
| GR-1089 | |
| ETS 300 019 | European Telecom Standard Institute |
| ETS 300 132-2 | |
| ETS EN 300 386 (2001) | |
| NEBS Level III | Network Equipment Building System |
| Underwriters Laboratories Listing: UL 60950-1 | Safety of Information Technology Equipment including Electrical Business Equipment |
| CSA 22.2 No. 60950-1-03 | |
| TUV Certification: European Norm EN60950-1:2001 | |
| CB Scheme Report: IEC 60950 | |
| CCC Certification CNCA-01C-020:2001 GB 4943 | |
| GOST Certification | |
| Resolution 92/98 Phase III IRAM certification | |
| EN55024:1998 | |
| RoHS | Reduction of Hazardous Substances |
| FCC Class A | Class A, Radio Frequency Device Requirements |

Conclusion

The CLARiiON CX4 series DC power systems eliminate many of the typical limitations of AC power. The addition of the DC line allows incredible flexibility in deployment options. DC-powered arrays are an elegant solution when AC power is unavailable, for example in remote or harsh environments. For that reason, EMC's DC-powered systems are designed and built to high standards, including NEBS level 3 compliance.

References

The following can provide more information:

- *EMC CLARiiON CX4-Series DC-Powered Enclosures Installation and Operation Guide*
- *EMC CLARiiON DC Power CX4 Model 120 Networked Storage System specification sheet*
- *EMC CLARiiON DC Power CX4 Model 240 Networked Storage System specification sheet*
- *EMC CLARiiON DC Power CX4 Model 480 Networked Storage System specification sheet*
- *EMC Rails and Enclosures (CX4 Series Storage Systems) Field Installation Guide*
- *EMC CLARiiON CX4 Series Hardware in NEBS-Compliant Environments Installation Guidelines*