**Interoperability of Mixed Supplier PSUs in An Open Rack Power Shelf**

1. Scope
2. Technical Considerations

**Scope**

At power shelf level, PSU models from multiple suppliers need to operate seamlessly in any mixed configurations. PSUs from different suppliers can be treated and used as one part bearing the same part number. The interoperability of PSUs brings great benefits to field serviceability, inventory management, and PSU supply chain management.

This document outlines technical considerations for the interoperability of PSUs from different suppliers. The interoperability requirements, including design and verification testing, should be incorporated into PRD (product requirement document) at an early stage.

This document is not necessarily a comprehensive list of PSU functional requirements that are defined in PSU specification.

**Technical Considerations**

The following functions are some of the ones related to interoperability that need to be considered during design and testing.

1. Mechanical Compatibility

The following mechanical items are generally related to interoperability: critical dimensions and tolerances, connectors, pin type/length/assignments, ejector/latch, guide pin, EMI gasket, LED identification/color, etc. They should be clearly defined in PSU specification to ensure compatibility between different suppliers. Any discrepancies shall be reviewed on a case by case basis.

1. Fan, Fan Speed Control Compatibility

In case of forced air cooling with multiple PSUs side by side, fan performance and fan speed control algorithm from different PSU suppliers shall be tuned to avoid excessive back pressure or back flow to each other.

Suppliers must share the airflow impedance curve of the PSU and the shelf.

1. Electrical Compatibility
	1. Current Sharing Control Method

PSU suppliers shall use a similar non-proprietary current sharing control method (e.g. single wire democratic active current sharing control, droop sharing control, etc.). The detailed parameters of the corresponding sharing control method shall be defined in the PSU specification (e.g. current sharing bus voltage versus current formula, adjustment range, etc.). Suppliers shall exchange their current sharing circuits.

* 1. Voltage Loop Bandwidth

PSUs from different suppliers shall have a similar voltage loop bandwidth.

* 1. Current Sharing Loop Bandwidth

PSUs from different suppliers shall have a similar current loop bandwidth.

* 1. Power up, Recovery from AC Loss, and OCP Recovery of Mixed PSUs in Parallel Mode

When the system load is higher than the single PSU maximum rating, which is the case for open rack power shelves, design considerations shall be taken to avoid startup failure, including synchronized turn-on of PSUs, a similar output rise time, and/or delayed OCP shut-down during startup with constant current or constant power control.

If the OCP is in auto-recovery mode, then the OCP recovery delay time and rise time should also be considered to avoid recovery failure.

* 1. PSU input and output interface signals shall share the same logic and interface circuit (e.g. pull-up/pull-down resistors, capacitors and/or protection diodes).
1. Firmware Compatibility for Monitoring, Control, and Communication

Suppliers shall use the same firmware communication protocol for PSU monitoring and control, such as in-system programming (boot-loading), the event log (black box), AC dropout recovery timing, BBU functions, etc. PSU sensors’ accuracy and alert/protection thresholds need to be defined for compatibility.

1. Interoperability Verification Test
	1. Supplier shall exchange samples for the interoperability test. The samples shall include normal setting output voltage PSUs as well as corner case voltage setting PSUs.
	2. Dynamic Load Response

The power shelf level dynamic load test should be performed with normal setting PSUs as well as mismatched voltage setting PSUs. Watch for ringing as an indicator of instability and an excessive peak current that may trip OCP.

* 1. Fault Injection

Test with minimum two PSUs working in parallel. Inject SPOF (single-point-of-failure), including short circuit, under voltage, and over voltage(both slow and fast) inside ORing device of a PSU. The paralleled PSU(s) and output bus voltage shall stay uninterrupted during the test.

* 1. Hot Swap

Test insertion/removal and on/off with normal setting PSUs as well as mismatched PSUs. Output bus voltage deviations shall stay in regulation.

* 1. Current Loop Bandwidth and Phase Margin Test
	2. FW Test

The FW test shall cover all communication interfaces for monitoring and control (e.g. power and status monitoring, boot loading, event log, LED behavior, BBU functions, etc.).

* 1. Mechanical Inspections and Test

Check mechanical form fit functions for compatibility.

* 1. Airflow and Thermal Test

When necessary, check the airflow back pressures of mixed PSUs with different configurations and load conditions to ensure optimal thermal performance.

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