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Implementing Inside Plant Network Platform Hot Standby Powering

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Note: Standards that are released multiple times in the same year use: a, b, c, etc. to indicate normative balloted updates and/or r1, r2, r3, etc. to indicate editorial changes to a released document after the year.

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1. Introduction

1.1. Executive Summary

Hot standby is the practice of reducing the locations of transformation of electricity from multiple power supplies to a single, or group of power supplies, thus increasing efficiency and decreasing energy lost to transformation at multiple points. This standard defines how an operator can effectively leverage hot standby to reduce energy consumption. Also in this standard, the parameters for equipment manufacturers are defined.

1.2. Scope

This standard defines the implementation of hot standby power supply unit (PSU) deployments of equipment contained inside operator critical facilities to optimize energy usage as opposed to using dual-redundant platform powering. This standard covers any active device (server, switch, router, laser chassis, etc.) which requires electricity to operate via installed PSUs and can be operated in a hot standby configuration. It also includes alerting, alarming, settings, and controls for hot standby enabled platforms.

1.3. Intended Audience

- Cable operator critical facility, deployment, and procurement teams
- Platform and power supply manufacturers

1.4. Benefits

This document provides operators guidance in deployment of hot standby which will allow energy savings through software-controlled power supply monitoring and staging. It also provides deployment schemas to aid in balancing load on AC and DC plants as well as monitoring and alerting profile adjustments.

1.5. Areas for Further Investigation or to be Added in Future Versions

Additional original equipment manufacturer (OEM) engagement for platform controls to allow PSU switching frequency to be set in operating systems and automated.

2. Normative References

The following documents contain provisions which, through reference in this text, constitute provisions of this document. The editions indicated were valid at the time of subcommittee approval. All documents are subject to revision and, while parties to any agreement based on this document are encouraged to investigate the possibility of applying the most recent editions of the documents listed below, they are reminded that newer editions of those documents might not be compatible with the referenced version.

2.1. SCTE References

No normative references are applicable.

2.2. Standards from Other Organizations

No normative references are applicable.

2.3. Other Published Materials

No normative references are applicable.

3. Informative References

The following documents might provide valuable information to the reader but are not required when complying with this document.

3.1. SCTE References

[SCTE 270] SCTE 270 2021r1, Mathematics of Cable

3.2. Standards from Other Organizations

No informative references are applicable.

3.3. Other Published Materials

No informative references are applicable.

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shall not	This phrase means that the item is an absolute prohibition of this document.
forbidden	This word means the value specified ***shall*** never be used.
should	This word or the adjective "*recommended*" means that there *may* exist valid reasons in particular circumstances to ignore this item, but the full implications *should* be understood, and the case carefully weighed before choosing a different course.
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5. Abbreviations and Definitions

5.1. Abbreviations

AC	alternating current
DC	direct current
OCP	overcurrent protection
OEM	original equipment manufacturer
PSU	power supply unit

5.2. Definitions

Definitions of terms used in this document are provided in this section. Defined terms that have specific meanings are capitalized. When the capitalized term is used in this document, the term has the specific meaning as defined in this section.

efficiency	quantifies losses at the PSU as voltage is transformed from input voltage to platform voltage
efficiency curve	the operational curve for a given PSU denoting the changes in efficient transformation based on output load
hot standby	a platform's ability to have one or more PSUs go dormant to shift the primary PSU into a more efficient operational range and decrease the number of locations in which voltage is transformed
input voltage	voltage which is supplied by the distribution equipment in the site and is the required input voltage of the PSU
inside plant	equipment contained inside operator critical facilities
Platform	when capitalized in this document, represents any active device (server, switch, router, laser chassis, etc.) which requires electricity to operate via installed PSU(s) and can be operated in a hot standby configuration
platform voltage	the required voltage of the platform post transformation through the PSU
power supply unit	the platform power supply which transforms input voltage to platform required voltage

6. Operationalizing Hot Standby

An operator must plan for hot standby deployments as it is a fundamental change from current dual-redundant deployment practices. Circuit level monitoring and preventive maintenance practices may need to be adjusted to accommodate this new powering schema.

6.1. Implementing Hot Standby

Operators should engage original equipment manufacturers (OEMs) that offer this option embedded in the platform operating system. Even if hot standby is not utilized at initial deployment, the flexibility to realize energy savings through software features allows scalability in the future.

6.2. Hot Standby Monitoring Practices

Operators might need to adjust alerting and alarming thresholds for any circuit-level power distribution telemetry because transitions into hot standby mode shift the load of the Platform to one PSU or cluster of PSUs.

6.3. Hot Standby Deployment Schemas

Operators will need to determine which deployment schema works best for their network; this standard covers different schemas to aid in deployments.

7. Primary/Hot Standby PSU Modes and Methods

7.1. Deploying Hot Standby, Power Distribution Schemas

There are two primary configuration options when an operator is considering hot standby: odd/even and auto.

The following options *may* subsequently be applied in various distribution panel scenarios furthering resiliency in the deployment.

Operators might find a combination of the following modes and methods work best for their specific deployments.

7.1.1. Odd or Even Mode

System configuration of odd or even wherein the supply to be placed in standby is either the odd or the even numbered supply.

This configuration allows operators to control the primary and hot standby power supply for each deployed device.

7.1.2. Automatic Mode

System configuration of automatic mode wherein the Platform uses a semi-random distribution within a group of like Platforms.

This allows for less developed configuration (all Platforms in auto) across larger device populations but might not balance as desired over smaller populations of devices.

7.1.3. Odd/Even Mixed Method

In this power-deployment schema example the odd numbered Platforms will have PSU0 set as primary while the even numbered Platforms will have PSU1 as primary. This allows a no-touch balance of load on the distribution panels or plug strips. Alternating in the odd/even profile keeps balance between A and B sides of the panel (see Figure 1), yellow indicates the active PSU.

DC Distribution Panel 1										
A Side	Platform 1	Platform 2	Platform 3	Platform 4	Platform 5	Platform 6	Platform 7	Platform 8	Platform 9	Platform 10
B Side	Platform 1	Platform 2	Platform 3	Platform 4	Platform 5	Platform 6	Platform 7	Platform 8	Platform 9	Platform 10
Circuit #	1	2	3	4	5	6	7	8	9	10

Figure 1 DC Distribution Panel Example

7.1.4. Two-Panel, Odd/Even Method

In this power-deployment schema example, an operator would be deploying two panels for redundancy and in doing so, splitting the A and B of each circuit across those deployed panels. Settings of each Platform remain the same as in 7.1.3 utilizing odd/even mode, but the load is distributed across panels for an added layer of resiliency (see Figure 2), yellow indicates the active PSU.

DC Distribution Panel 1										
A Panel	Platform 1	Platform 3	Platform 5	Platform 7	Platform 9	Platform 11	Platform 13	Platform 15	Platform 17	Platform 19
	Platform 2	Platform 4	Platform 6	Platform 8	Platform 10	Platform 12	Platform 14	Platform 16	Platform 18	Platform 20
Circuit #	1↑ 2↓	3↑ 4↓	5↑ 6↓	7↑ 8↓	9↑ 10↓	11↑ 12↓	13↑ 14↓	15↑ 16↓	17↑ 18↓	19↑ 20↓

DC Distribution Panel 2										
B Panel	Platform 1	Platform 3	Platform 5	Platform 7	Platform 9	Platform 11	Platform 13	Platform 15	Platform 17	Platform 19
	Platform 2	Platform 4	Platform 6	Platform 8	Platform 10	Platform 12	Platform 14	Platform 16	Platform 18	Platform 20
Circuit #	1↑ 2↓	3↑ 4↓	5↑ 6↓	7↑ 8↓	9↑ 10↓	11↑ 12↓	13↑ 14↓	15↑ 16↓	17↑ 18↓	19↑ 20↓

Figure 2 Two-Panel, Distributed Odd/Even Mode Example

7.1.5. Dual Panel, Mixed Odd/Even, Distributed A/B Method

In this power deployment schema example, an operator would be deploying two panels for redundancy, splitting the A and B of each circuit across the deployed panels, while also deploying mixed odd/even mode to provide balanced load across redundant circuits (see Figure 3), yellow indicates the active PSU.

DC Distribution Panel 1										
A Side	Platform 1	Platform 3	Platform 5	Platform 7	Platform 9	Platform 11	Platform 13	Platform 15	Platform 17	Platform 19
B Side	Platform 2	Platform 4	Platform 6	Platform 8	Platform 10	Platform 12	Platform 14	Platform 16	Platform 18	Platform 20
Circuit #	1	2	3	4	5	6	7	8	9	10

DC Distribution Panel 2										
A Side	Platform 2	Platform 4	Platform 6	Platform 8	Platform 10	Platform 12	Platform 14	Platform 16	Platform 18	Platform 20
B Side	Platform 1	Platform 3	Platform 5	Platform 7	Platform 9	Platform 11	Platform 13	Platform 15	Platform 17	Platform 19
Circuit #	1	2	3	4	5	6	7	8	9	10

Figure 3 Dual Panel, Mixed Odd/Even, Distributed A/B Example

8. Circuit Distribution Monitoring and Alerting with Hot Standby Deployed

Operators ***shall*** consider total platform load, rather than per-circuit alerting, for capacity and overcurrent alert profiles.

8.1. Circuit Distribution Monitoring

8.1.1. Traditional Alerting Profile

With dual-redundant powering schemas, the individual circuit is typically monitored for approximately half of the Platform power needs. If minor thresholds are at 60%, major thresholds at 70%, and critical thresholds at 80%, the dual-redundant equivalent is half of the threshold (see Table 1).

Thresholds and alerts ***shall*** be updated to allow for hot standby operation without causing erroneous alerts or dispatching of resources.

Note: All threshold values represented are for example purposes only and not an indication of suggested operator threshold settings. Each operator will need to determine the best thresholds for their network and equipment.

Table 1 Traditional Dual-Redundant Alert Profiles

Alert	Minor	Major	Critical
Total Load	60%	70%	80%
A Circuit Load	30%	35%	40%
B Circuit Load	30%	35%	40%

8.1.2. Hot Standby Alerting Profile

With hot standby deployments, operators ***shall*** care for the Platforms' need at the circuit level, in aggregate. Where monitoring 50% of the total circuit capacity was allowable in dual-redundant alert profiles, the A and B sides of the circuit ***shall*** now be aggregated in order to alert and alarm.

Circuit loads ***shall*** be summed (see Table 2):

A Circuit Load + B Circuit Load = Total Load of Device.

To alert or alarm with this value:

Total Load of Device/Overcurrent Protection Device Rating = % of Threshold

Table 2 Hot Standby Alert Profiles

Alert	Minor	Major	Critical
Total Load	60%	70%	80%
A + B Circuit Load	60%	70%	80%

The overcurrent protection device (OCP) rating ***shall*** only be used once in the calculation.

- If A Circuit Load + B Circuit Load = Total Load of Device, then Total Load of Device ***shall*** be divided by the OCP rating of only Circuit A or Circuit B.
- If BMS/DCIM tools ***shall*** utilize both readings, then the operator ***shall*** sum OCP values for the affected circuits and halve them prior to calculating.

8.1.3. Dual-Redundant or Single-Ended Devices with Hot Standby Monitoring Enabled

Dual-redundant type circuits will alert as expected when hot standby alert profiles are used for a distribution panel with both types of deployments connected. Operators ***shall not*** install single-ended devices in redundant circuit positions.

Examples of both dual-redundant and single-ended devices are shown in Table 3. Circuits A1, B1, A2, and B2 are all connected and monitored correctly allowing for both dual-redundant and single-ended devices to alert from a distribution panel with a hot-standby profile enabled.

Circuits A3 and B3 are incorrectly connected as the hot standby profile would sum the loads of single-ended Platforms 3 and 4 (Circuits A3 and B3) leading to an alert for 100% load.

Table 3 Examples of Dual-Redundant and Single-Ended Device Monitoring

Load Side Circuit	Device	OCP	Load	Total Load	Percentage of OCP
Circuit A1	Platform 1	20	7.5	15	75%
Circuit B1	Platform 1	20	7.5		
Circuit A2	Platform 2	10	5	5	50%
Circuit B2	OPEN				
Circuit A3	Platform 3	10	5	10	100%
Circuit B3	Platform 4	10	5		

9. Preventive Maintenance with Hot Standby Enabled Circuit Migration or Maintenance

9.1. Pre-Maintenance Steps

An operator *should* amend scheduled maintenance standard operating procedures to limit potential impact.

9.1.1. Dual-Redundant Implementation

When hot standby is enabled, an operator *may* script all Platforms to dual-redundant operation prior to the preventive maintenance work beginning.

9.1.2. Primary/Hot Standby PSU Forceover

When hot standby is enabled, an operator *may* script primary PSU to the dedicated circuit(s) that will be uninterrupted during the preventive maintenance.

9.1.3. Hot Standby Configuration

When hot standby is enabled, an operator *may* consider preventive maintenance be allowed with no change to configuration which could potentially cause migration from primary to hot standby PSUs multiple times during the maintenance period.

9.2. Post-Maintenance Steps

An operator *should* migrate back to the chosen power distribution schema post-preventive maintenance work.

9.3. PSU Mode-Change Frequency

Operators could consider changing primary and hot standby PSUs, at the platform level, on some established cadence.

PSU mode-change frequency *should* be integrated into the hot standby operating system settings in future iterations of the operator's procedures.

10. Original Equipment Manufacturer Configuration

10.1. Hot Standby and Platform Reliability

Original equipment manufacturers ***shall*** provide for instantaneous switching between primary and hot standby power supplies when a platform-level PSU failure or need exists.

OEMs *should* consider allowing hot standby setting changes while Platforms are in production.

10.1.1. Platform Response Time

Any Platform which allows for hot standby configuration ***shall*** support instantaneous switching between primary and hot standby PSUs with no downtime to services.

10.1.2. Power Supply Response Time

Any PSU deployed in a Platform which allows hot standby configuration ***shall*** support instantaneous switching, at the platform level, between primary and hot standby PSUs with no downtime to services.

10.1.3. Primary PSU Visual Indication

The primary and hot standby PSUs *should* be identifiable upon visual inspection of the Platform and installed PSUs. Indicator LEDs, or similar visual confirmation *should* be available at the PSU or platform level to inform operational teams.

10.2. Hot Standby Thresholds

As hot standby is applied to reduce electricity consumption, standard thresholds for staging the standby PSU on or off ***shall*** be aligned with the efficiency of the Platform and PSU.

10.2.1. Platform Hot Standby System Configuration

When enabled, the PSU in hot standby ***shall not*** be brought into service unless one or more of the following are true:

1. Primary power supply has failed
2. Impending impact to reliability (pre-failure to primary PSU)
3. Primary PSU has reached 80% capacity
4. Platform's efficiency would be negatively impacted by remaining on a single PSU
5. Requirement due to hard/soft power cycling of the Platform or OS upgrade/restart

10.2.1.1. Platform Level Thresholds

If a Platform can be fully supported by a single PSU, the Platform's hot standby, primary PSU settings ***shall*** allow configuration to sustain the Platform to its maximum efficiency, or full load, as determined by the operators' engineering and deployment teams.

If a particular PSU reaches maximum efficiency at 70% load, the platform setting ***shall*** allow for an operator to configure the primary PSU to remain as the only active PSU up to this threshold (see Table 4).

Table 4 Hypothetical Load & Efficiency Curve

Percentage of Load	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
PSU Efficiency	60%	65%	70%	75%	80%	85%	90%	90%	90%	90%

10.2.2. Platform Return to Hot Standby

If the PSU in hot standby has been brought into service for any of the scenarios in 10.2.1, the Platform ***shall*** revert to hot standby on the designated PSU once these criteria have been met:

1. Primary power supply has been replaced, post failure
2. Impact to primary power supply has been resolved
3. Primary PSU has returned to ≤80% capacity
    a. Hot standby PSU ***shall*** return to hot standby state after primary PSU reaches one of two criteria:
        i. Achieved ≤80% capacity for >30 minutes
        ii. Achieved ≤65% capacity after >10 minutes
4. Platform's efficiency would be negatively impacted remaining on two PSUs without breaching 80% rule
5. Hard/soft restart or OS upgrade is complete

11. Hot Standby PSU Power Profile

11.1. Maximum Threshold for Telemetry of Hot Standby PSU

As the primary driver of utilizing hot standby is to drive energy efficiency into operators' inside plant spaces, a maximum power draw for the PSU in hot standby ***shall*** be set.

Platforms ***shall*** maintain a power profile for the PSU in hot standby of ≤18 watts per PSU.

11.2. Hot Standby PSU Telemetry

The power supply in hot standby ***shall*** maintain telemetry to report status to ensure redundant availability.

11.3. Hot Standby PSU Testing Interval

The Platform ***shall***, at designated intervals (OS upgrades, configuration changes, biannual scheduled test, etc.), stage both PSUs "on" to ensure function prior to reengaging hot standby functionality.