SYSTEMIZED CROSS-CONNECTION TESTING ABOARD DP VESSELS

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Power 2 Session
Dynamic Positioning Conference 2022

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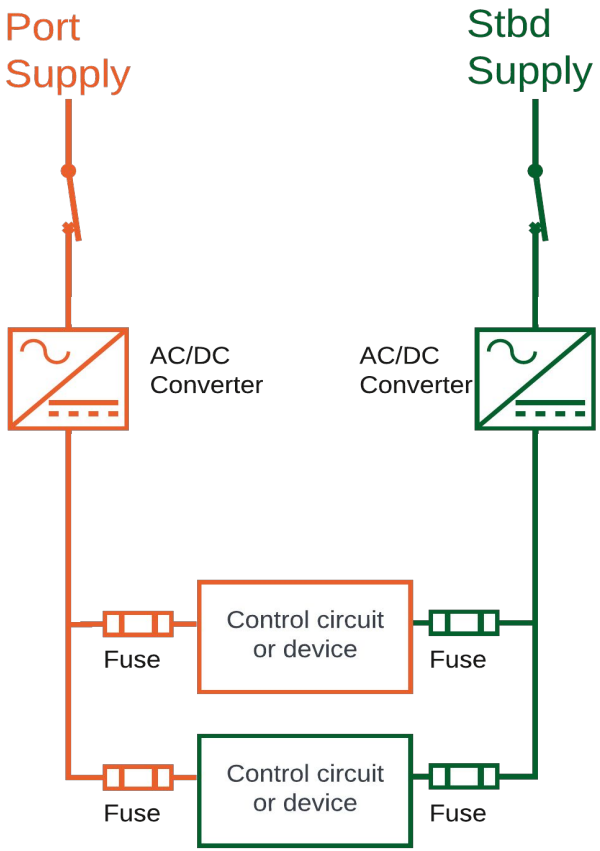
LV CROSS-CONNECTIONS

Cross-connection: A power distribution architecture with a common point of intersection between two power sources from redundant groups.



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THE RISKS

TECHOP D-01

Table 6-1 Guide to Categorisation of Cross-connections

Mitigation of Fault Propagation in control power			Risks associated with common points formed by various type of components				
	Has been isolated or validated by analysis and testing	F					Stop at the first True Statement
Increasing levels of protective functions	Has not been validated by analysis and testing	E					
	No alarms for detection of hidden failures	D			HIGH RISK		
	No resolution of overvoltage concerns	C					
	No current limiting and / or Batteries for ride through capability (Interlocks for Auto changeovers)	B		HIGHER RISK			
	No overcurrent & Ground Fault Protection or reverse current blocking	A	HIGHEST RISK				
Nature of the Common Point			1	2	3	4	5
			Hardwired	Diodes	Auto changeover	dc to dc SMP QUINT etc.	Isolated or Manual Changeover

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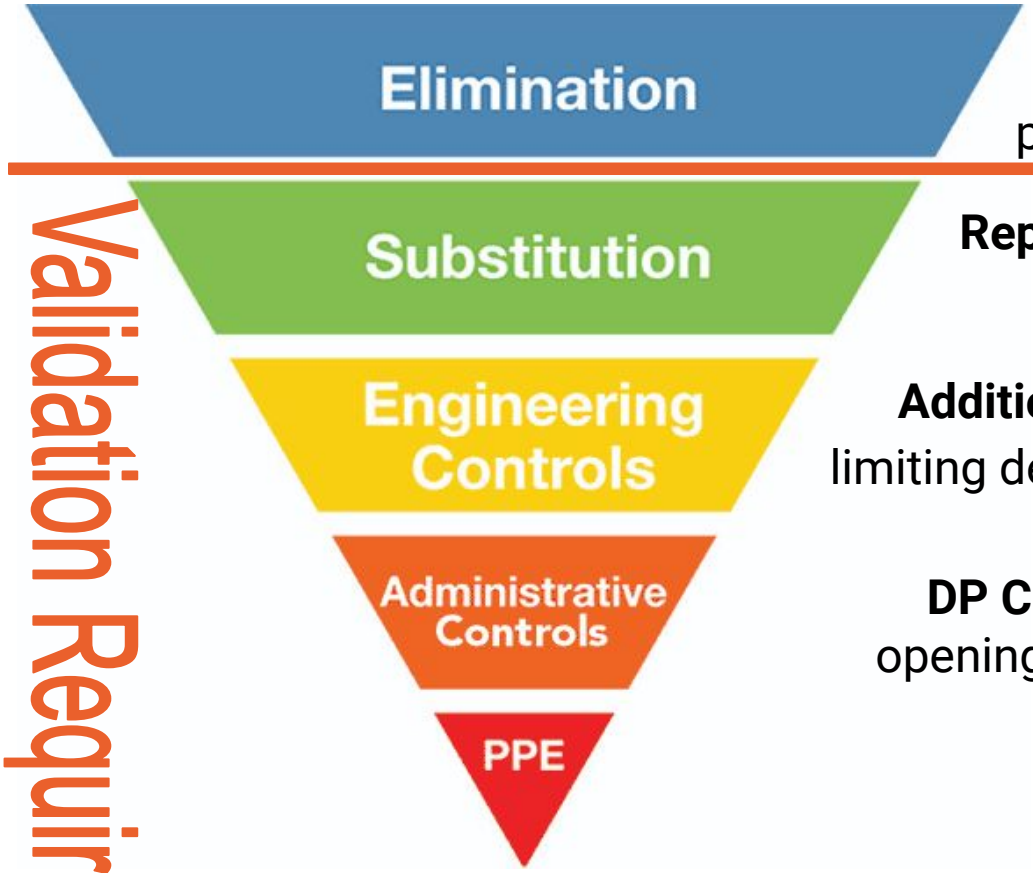
ISOLATION: Complete removal of the secondary supply

VALIDATION: Activities undertaken to ensure the barriers to prevent fault propagation beyond system architecture meet the design philosophy.

Source: https://www.safetyandhealthmagazine.com/articles/16790-the-hierarchy-of-controls

Validation Required



Removal of secondary power supply

Replacement of breaker type

Addition of current limiting devices in line

DP Checklists for opening of breakers

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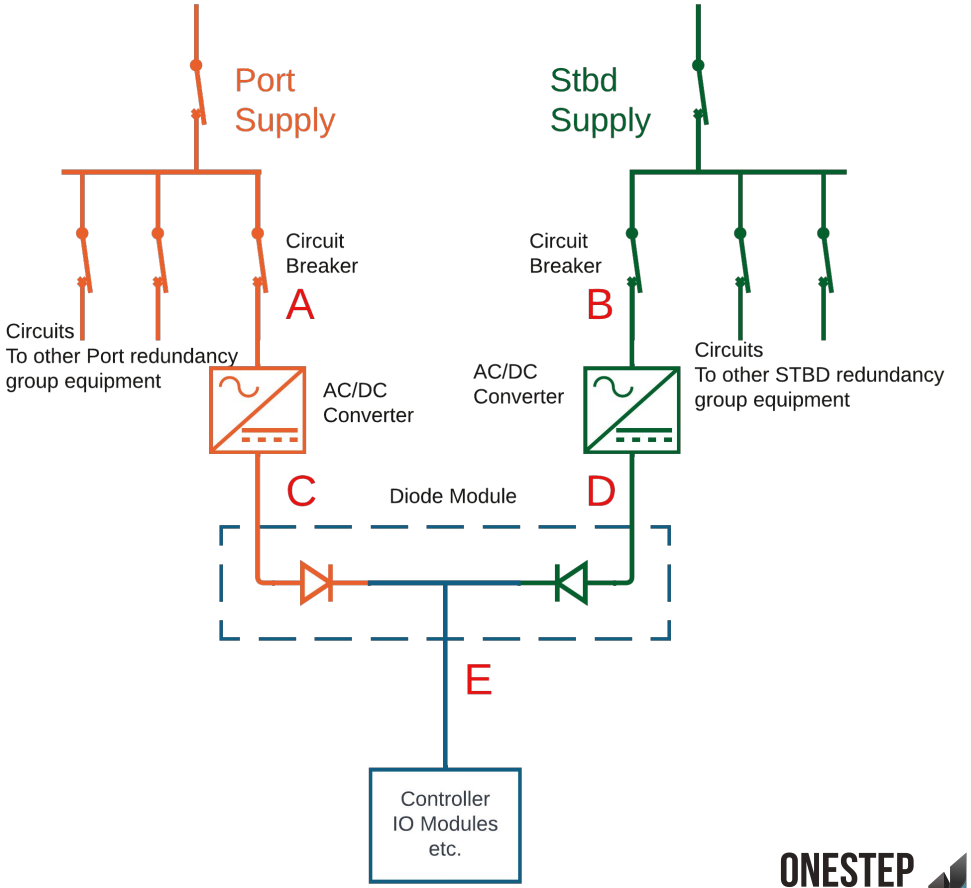
CROSS-CONNECTION - VALIDATION LOCATIONS

DCShortCUT Failure Mode Matrix	Downstream of Power Supply 1	Downstream of Power Supply 2	Downstream of Power Supplies 1 & 2 simultaneously	Between protections & load
Load Increase	✓	✓		✓
Overload	✓	✓		✓
Short Circuit	✓	✓	✓	✓
Short to Ground / Earth Fault	✓	✓	✓	✓
Variable over-voltage (max 120%)	✓	✓		✓
Loss of Power Supply	✓	✓		

EXAMPLE CROSS-CONNECTION

Voltage and current measurement nodes for collection of evidence of validation



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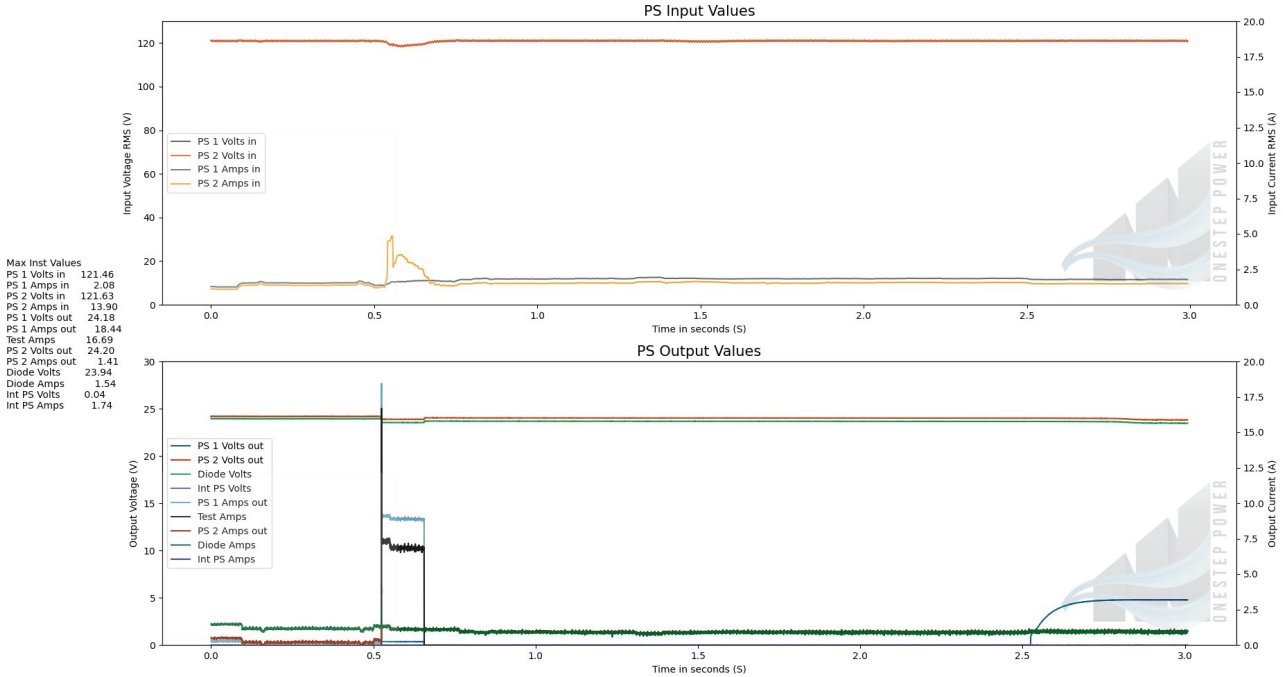
SIMPLIFIED VALIDATION MATRIX

Test	Node	A		B		C		D		E	
		Volts	Amps	Volts	Amps	Volts	Amps	Volts	Amps	Volts	Amps
Overload	C	≈	⇧	≈	≈	⇩	⇧	≈	≈	≈	≈
	D	≈	≈	≈	⇧	≈	≈	⇩	⇧	≈	≈
	E	≈	⇧	≈	⇧	⇩	⇧	⇩	⇧	⇩	⇧
Short-Circuit	C	≈	⇧	≈	≈	⇩	⇧	≈	≈	≈	≈
	D	≈	≈	≈	⇧	≈	≈	⇩	⇧	≈	≈
	E	≈	⇧	≈	⇧	⇩	⇧	⇩	⇧	⇩	⇧
Earth Fault (Floating System)	C	≈	≈	≈	≈	≈	≈	≈	≈	≈	≈
	D	≈	≈	≈	≈	≈	≈	≈	≈	≈	≈
	E	≈	≈	≈	≈	≈	≈	≈	≈	≈	≈
Earth Fault (Bonded System)	C	≈	⇧	≈	≈	⇩	⇧	≈	≈	≈	≈
	D	≈	≈	≈	⇧	≈	≈	⇩	⇧	≈	≈
	E	≈	⇧	≈	⇧	⇩	⇧	⇩	⇧	⇩	⇧
Over-Voltage	C	≈	⇩	≈	⇩	⇧	⇧	≈	⇩	⇧	⇧
	D	≈	⇩	≈	⇩	≈	⇩	⇧	⇧	⇧	⇧
	E	≈	⇩	≈	⇩	≈	⇩	≈	⇩	⇧	⇧

EXAMPLE VALIDATION EVIDENCE: SHORT-CIRCUIT

Short Circuit Pos to Neg PS 1 QUI-120-24-QUI-120-24-QUI-U.json 14:52:46 22 09 12



Max Inst Values

PS 1 Volts in	121.46
PS 1 Amps in	2.08
PS 2 Volts in	121.63
PS 2 Amps in	13.90
PS 1 Volts out	24.18
PS 1 Amps out	18.44
Test Amps	16.69
PS 2 Volts out	24.20
PS 2 Amps out	1.41
Diode Volts	23.94
Diode Amps	1.54
Int PS Volts	0.04
Int PS Amps	1.74

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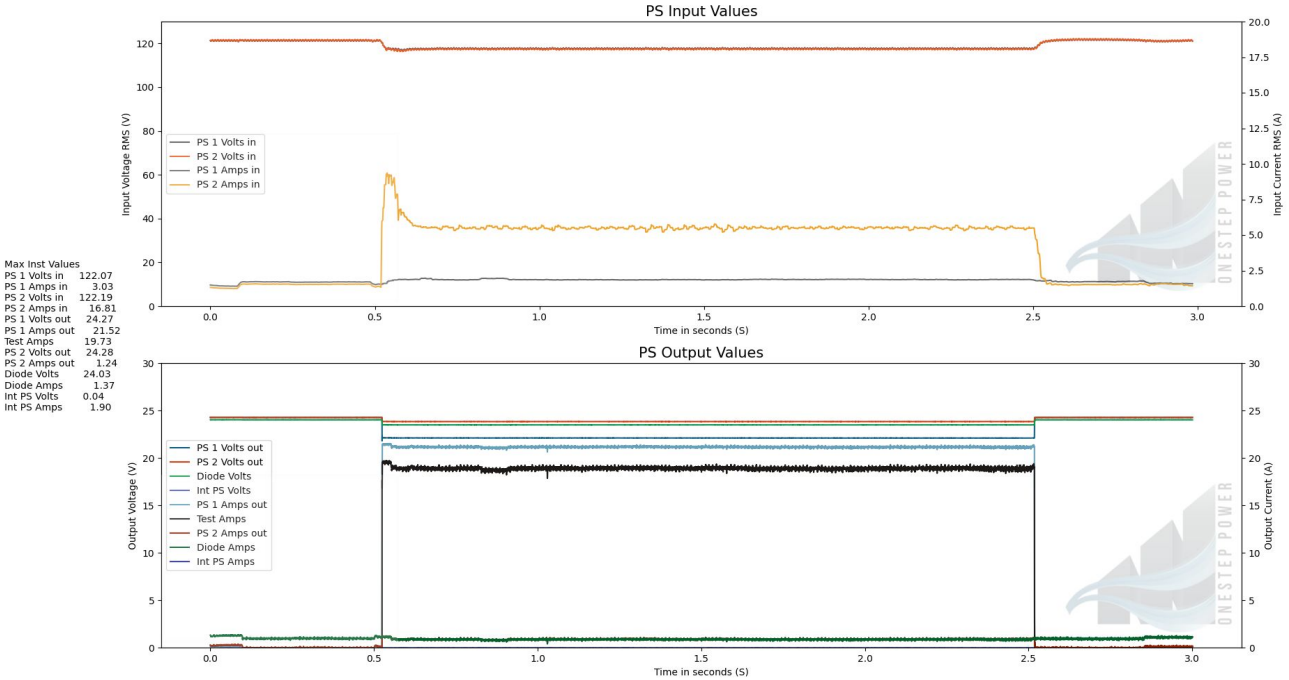
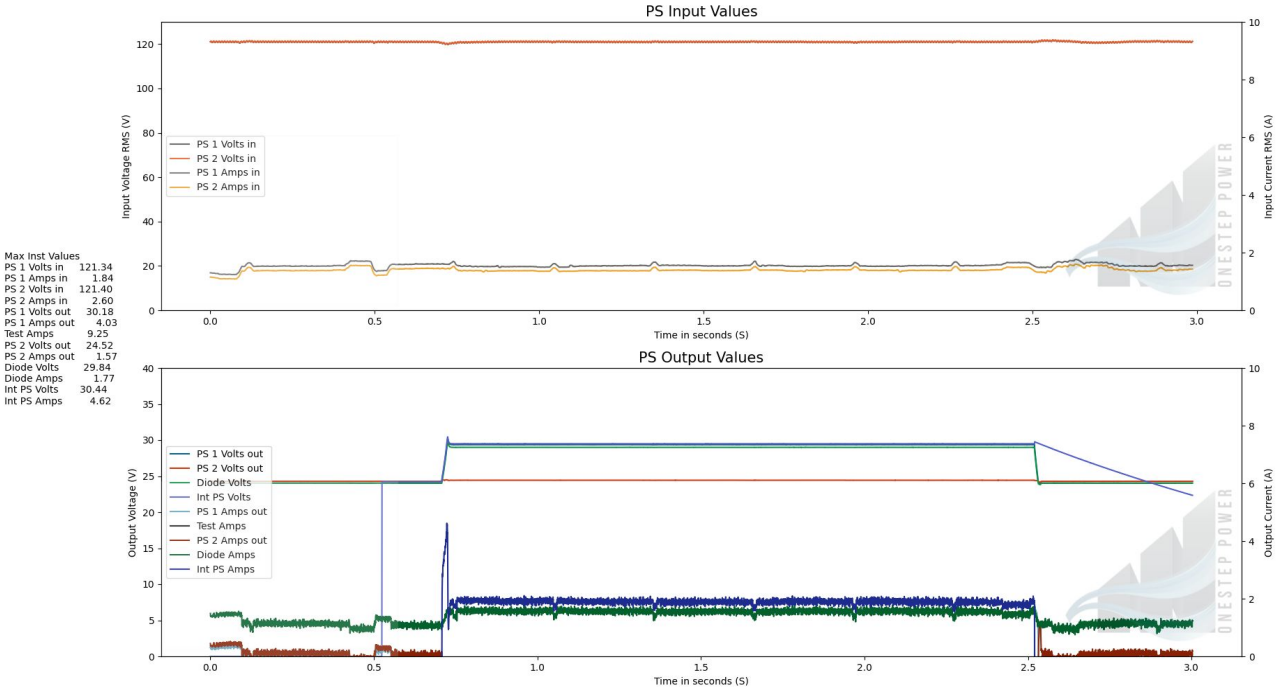
EXAMPLE VALIDATION EVIDENCE: FULL LOAD TEST

Load Test at 26 A PS 1 QUI-120-24-QUI-120-24-QUI-U.json 14:48:49 22 09 12



EXAMPLE VALIDATION EVIDENCE: OVER-VOLTAGE

Over Voltage PS 1 QUI-120-24-QUI-120-24-QUI-U.json 14:51:39 22 09 12



GENERALIZED ARCHITECTURES

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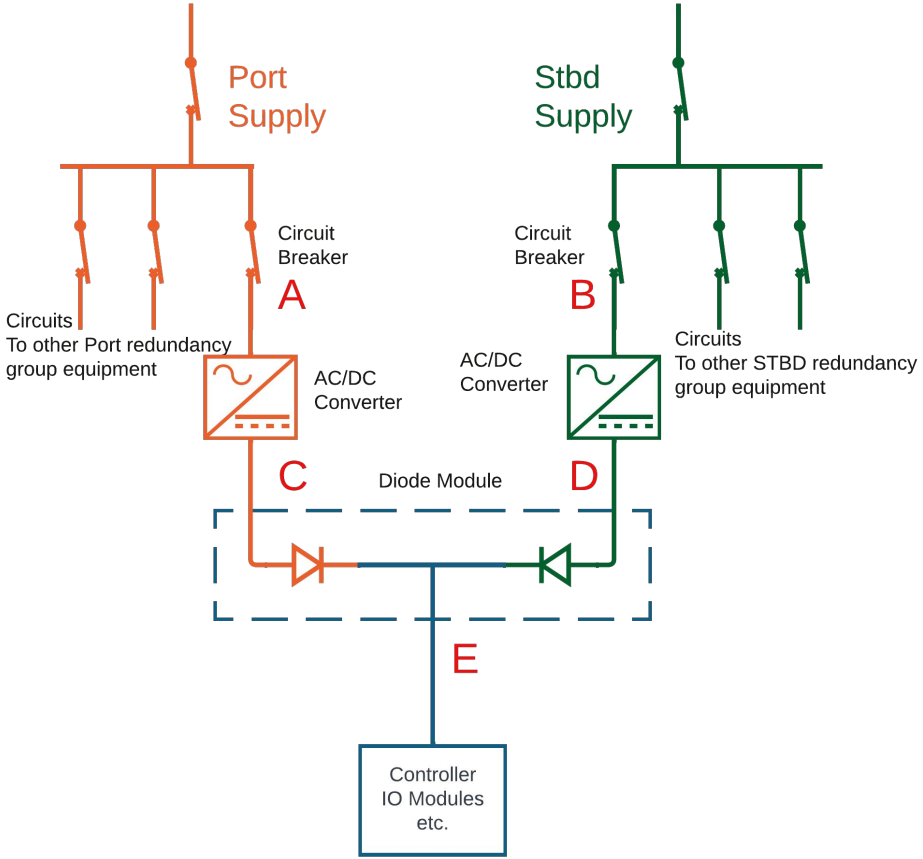

TWO SWITCH MODE POWER SUPPLIES FEEDING A SINGLE CABINET

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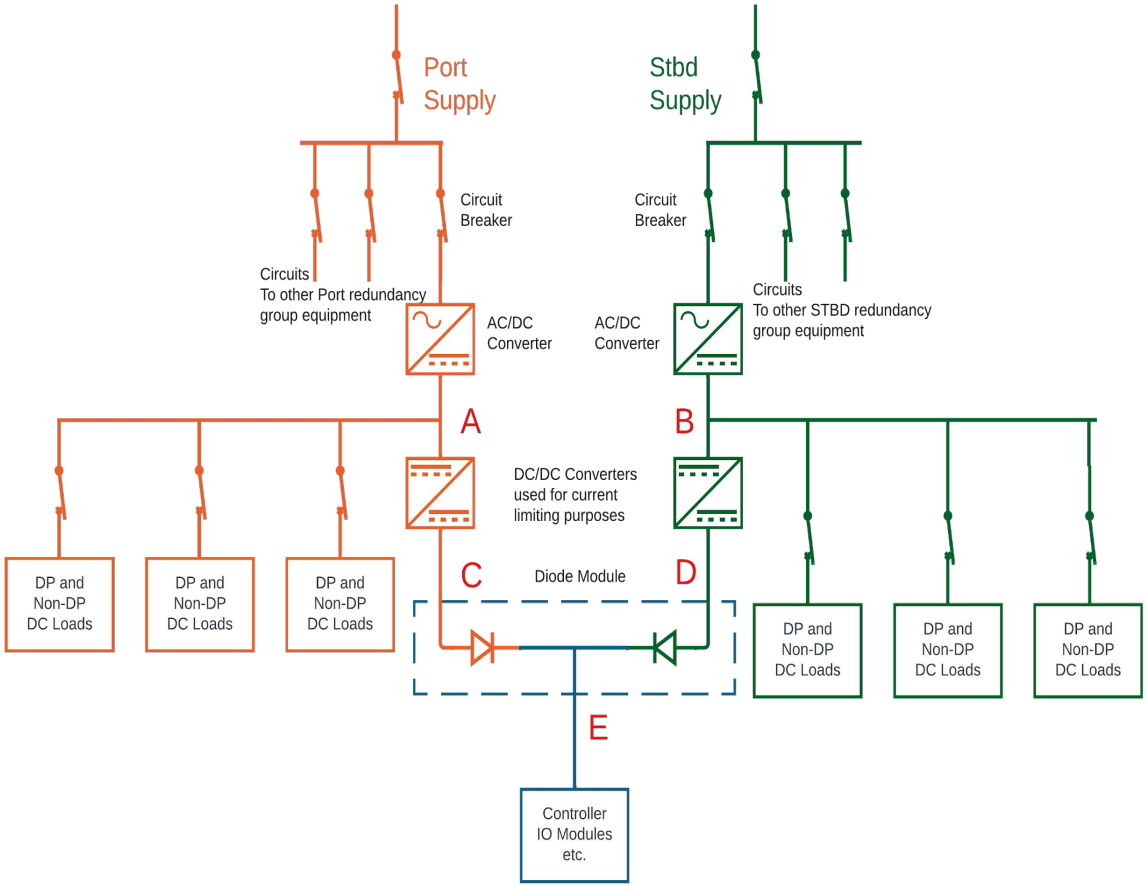

TWO SMPSS FEEDING MULTIPLE CONSUMERS ON MULTIPLE GROUPS WITH CURRENT LIMITING DC/DC CONVERTERS

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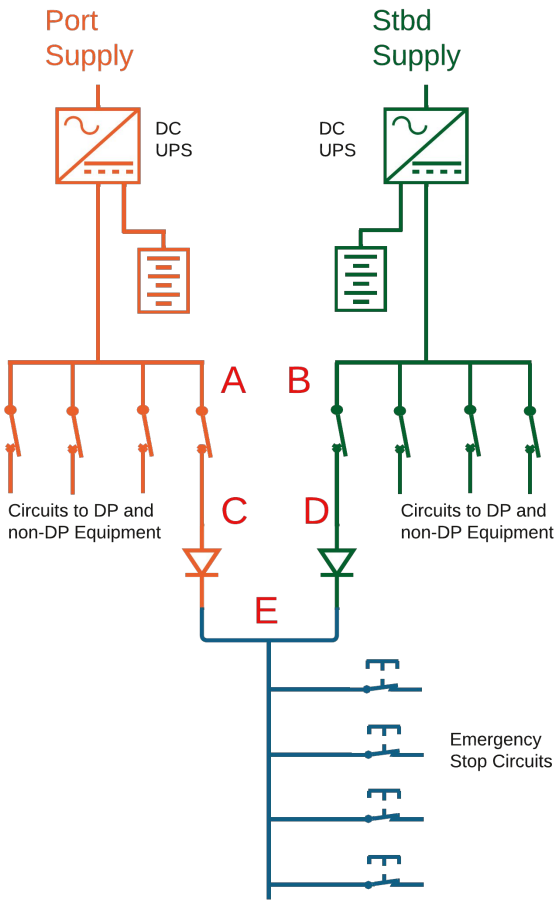

DC UPS SYSTEMS FEEDING DP AND NON-DP SYSTEMS ON MULTIPLE GROUPS

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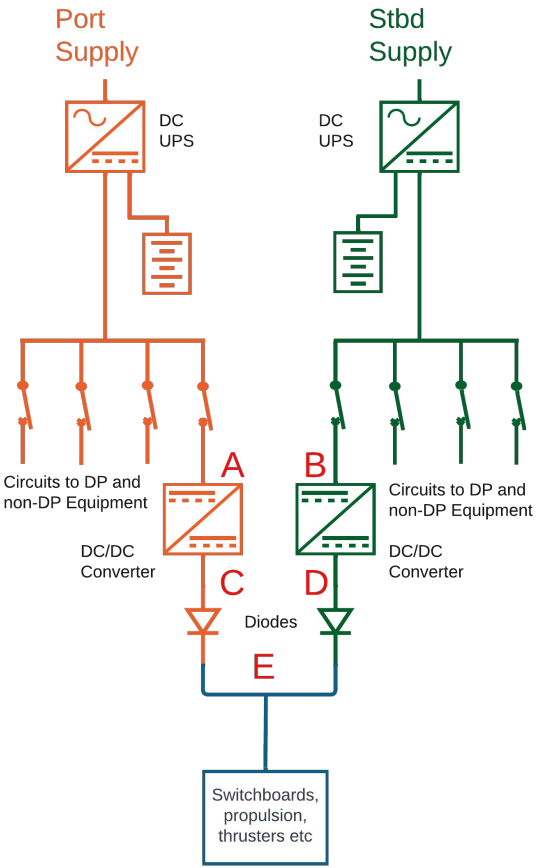
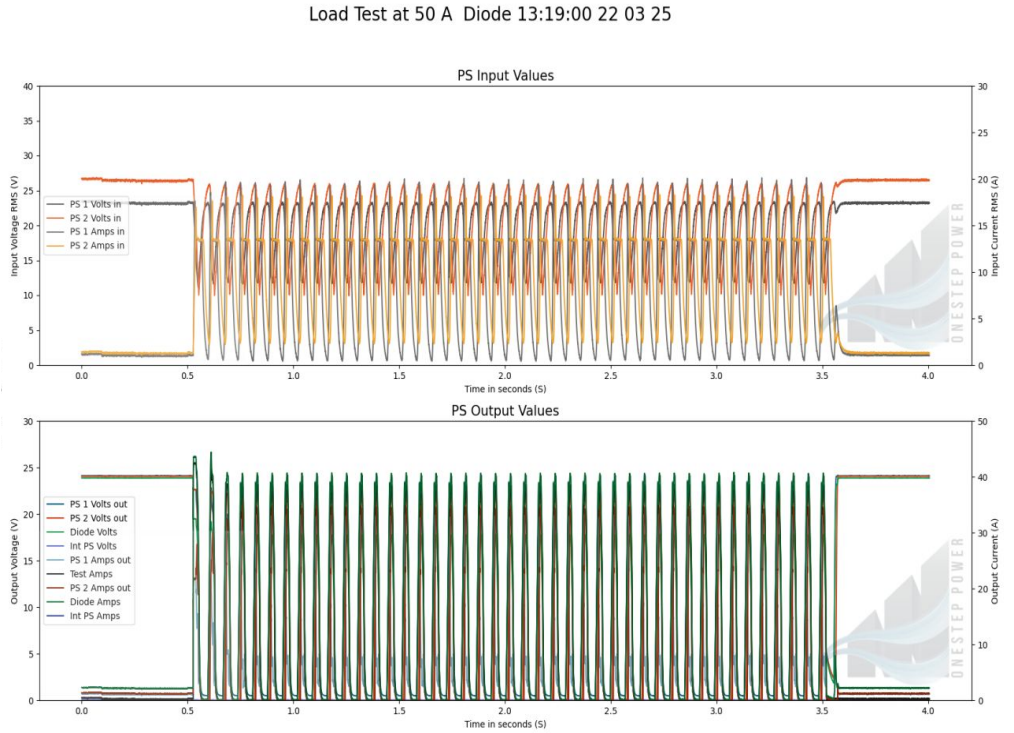


DC UPS WITH CURRENT LIMIT DEVICES

EXAMPLES OF FAILED BARRIERS

During testing programs, while not common, there have been some similar barrier failures on different systems



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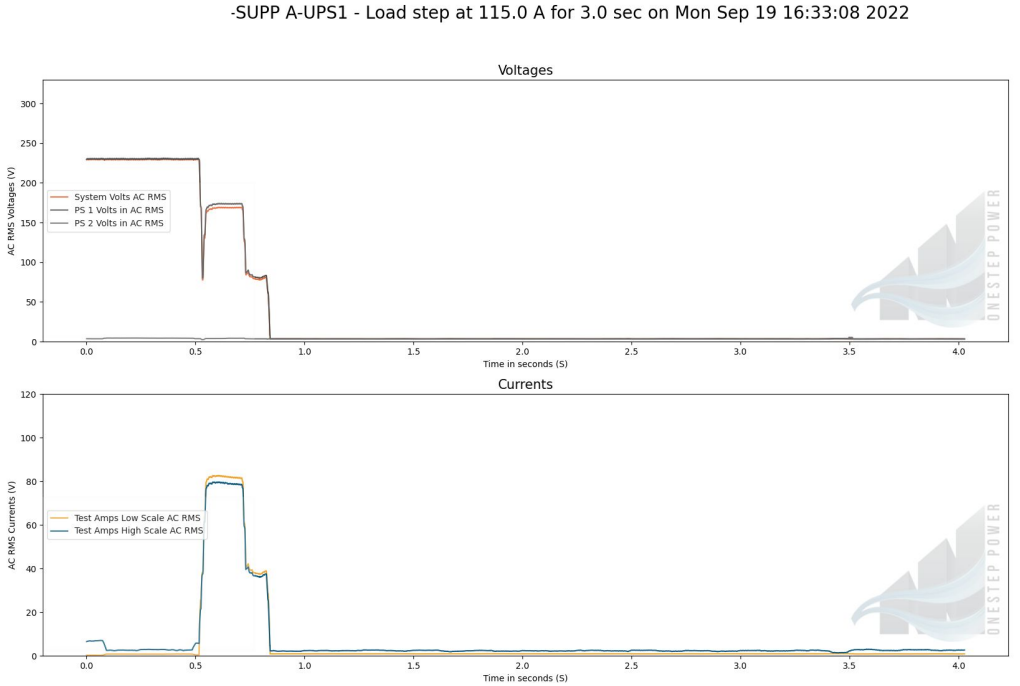

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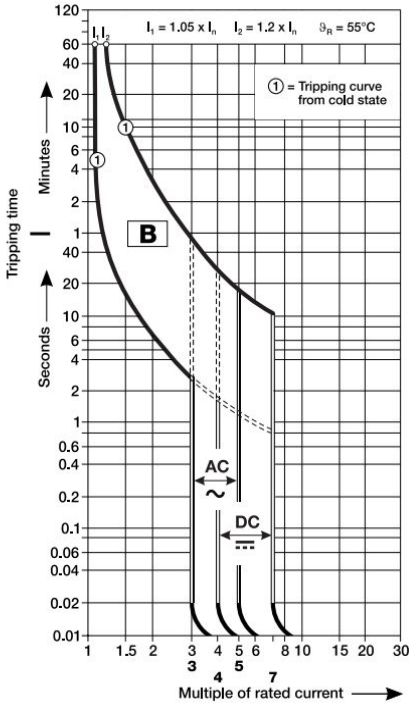
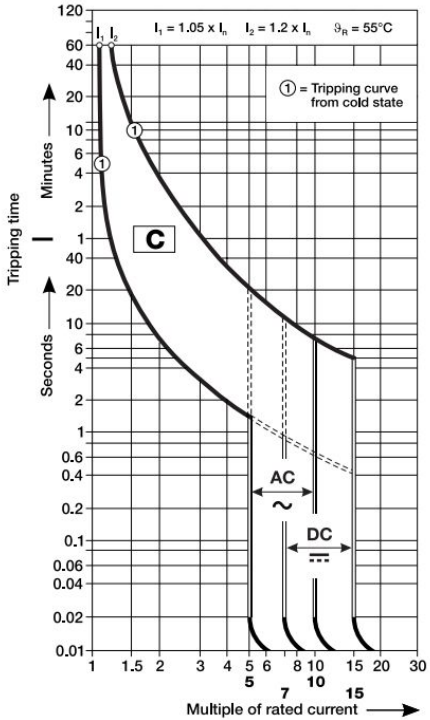
B characteristic



C characteristic



Z characteristic

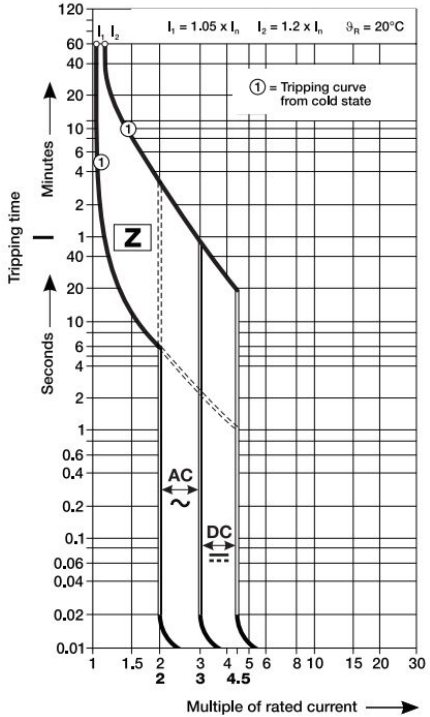


ABB 2015 System pro M compact® Miniature Circuit Breaker S 200 M UC for DC and AC applications Accessed 22 Sept 2022
https://search.abb.com/library/Download.aspx?DocumentID=2CDC002142D0207&LanguageCode=en&DocumentPartId=&Action=Launch

THANK YOU

Come see a ShortCUT Demo at Booth #4

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