



Engineering Real-Time Class 4 Fault-Managed Power Systems (FMPS)

High-Power DC Distribution and Emerging Global Standards

CEANCE

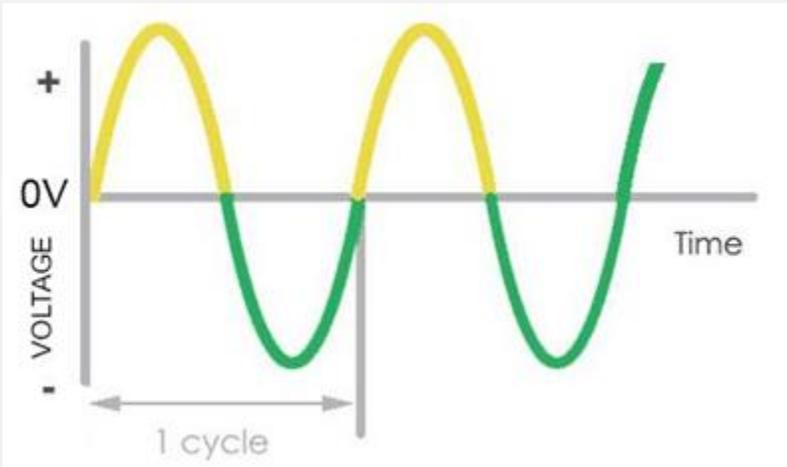
APEG PROTECTION
ENGINEERS
GROUP



Cence Power

- DC power R&D lab - established in 2014 (Argentum Electronics)
 - Working with MEP firms on R&D initiatives for DC power distribution
- Launched first product in 2024 (3kW LV Hub)
- Over 1.5MW of DC power distribution deployed since launch
- Our R&D focus
 - Class 2 Low-Voltage Systems
 - Class 4 Fault-Managed Power Systems

AC vs. DC Power



Alternating Current (AC) Power

AC power changes its polarity (or direction of current flow) typically 50 or 60 times per second, giving it a frequency of either 50 or 60 hertz, or Hz for short.

vs.



Direct Current (DC) Power

Direct current (DC) power doesn't have a frequency. This is because its current flows directly through cables without changing its polarity.



Today, over 32% of power consumption in buildings is DC.

This is expected to grow to over 74% by 2030

Highest Growth DC Applications



LED Lighting Systems (Class 2 and 4)



Telecom-Wireless Densification (Class 4)



DC Motors (HVAC) (Class 2 and 4)



EV Charging (Class 4)



Renewables and Microgrids (Class 2 and 4)

A new class of power

is redefining the future of power delivery.

In 2023, the NEC introduced Class 4 Power.

A change this significant hasn't happened in 45 years—since 1978, when Class 3 was introduced.

Also known as Fault Managed Power (FMP), the new Class 4 rating enables power to be distributed at levels we're used to with AC branch circuits, but with the safety profile of Class 2 power limited circuits.

Class 1 and Branch Circuits

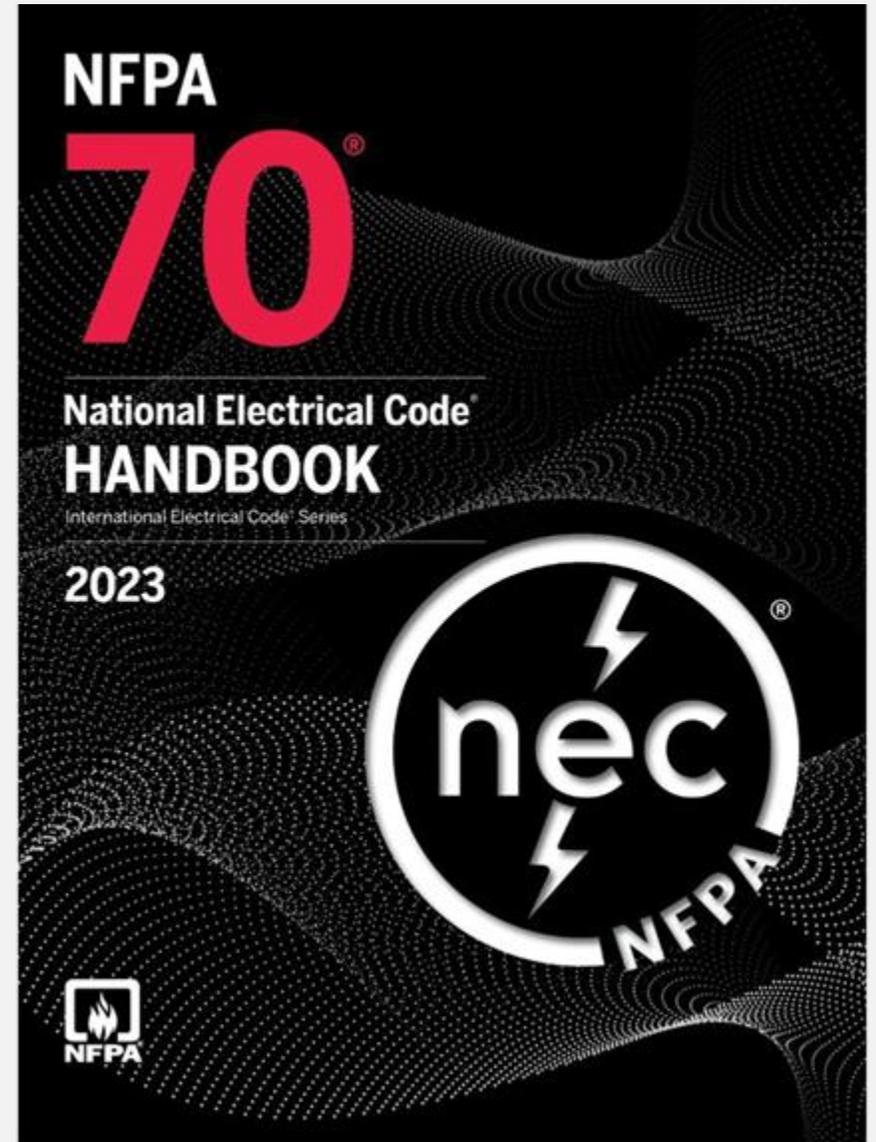
Mechanically
protected wires

Class 2 & 3

Power Limited, low
power

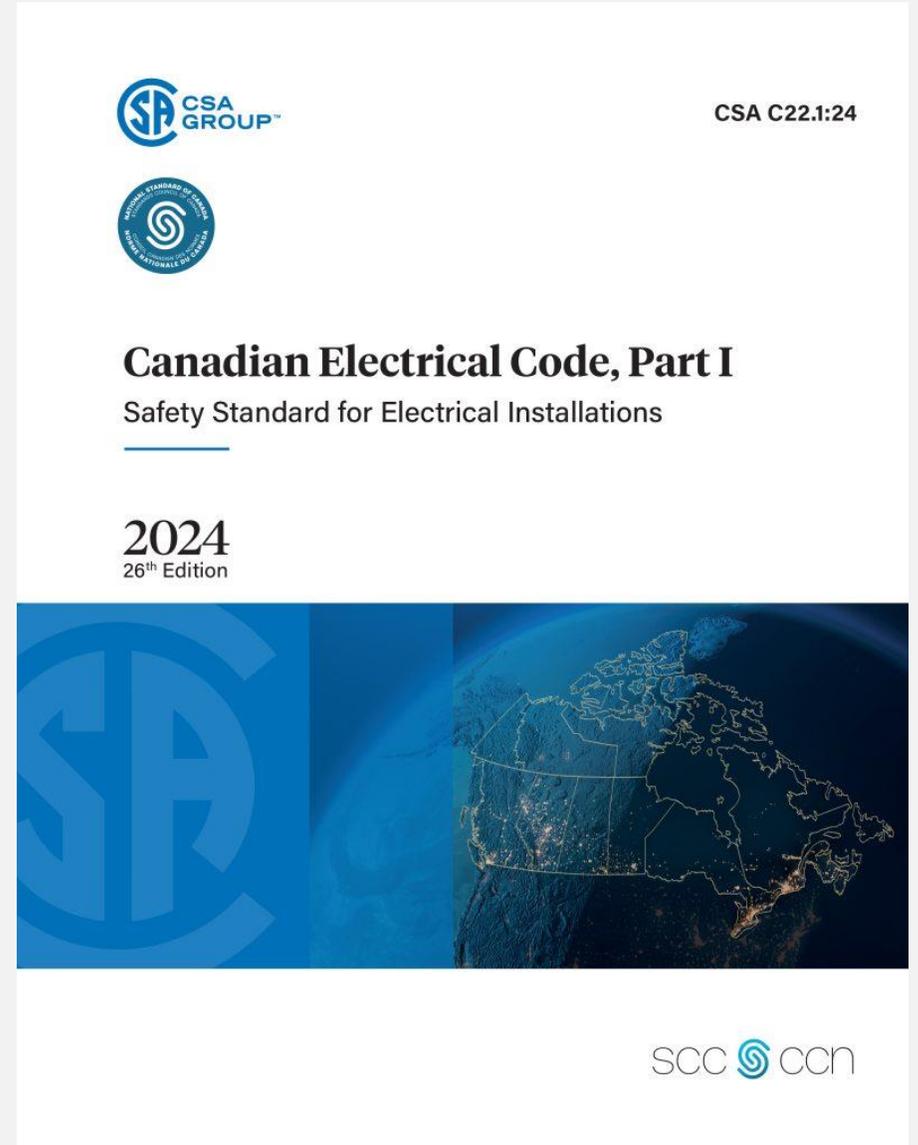
Class 4

DC
Fault Managed
Power



Standards and Codes activity

- ATIS-0600040 Technical Report
 - November 24, 2021 & July 2, 2024
- UL 1400-1 & -2 (Outline of investigation)
 - December 19, 2022 & July 13, 2023
- NEC Article 726 (2023)
 - 2026 - unified "Limited-Energy" framework (Articles 720–750)
- Canada (in development)
 - CSA C22.2 No. 0.24 - FMPS
 - CSA C22.2 No. 356 – FMP Cables
 - FMP integration into Section 16 of the 2027 Canadian Electrical Code (CEC)
- NEMA - Limited Energy Systems Section (2024)
- IEC? IEC TS 63444 (*Industrial networks*)?
- Others?

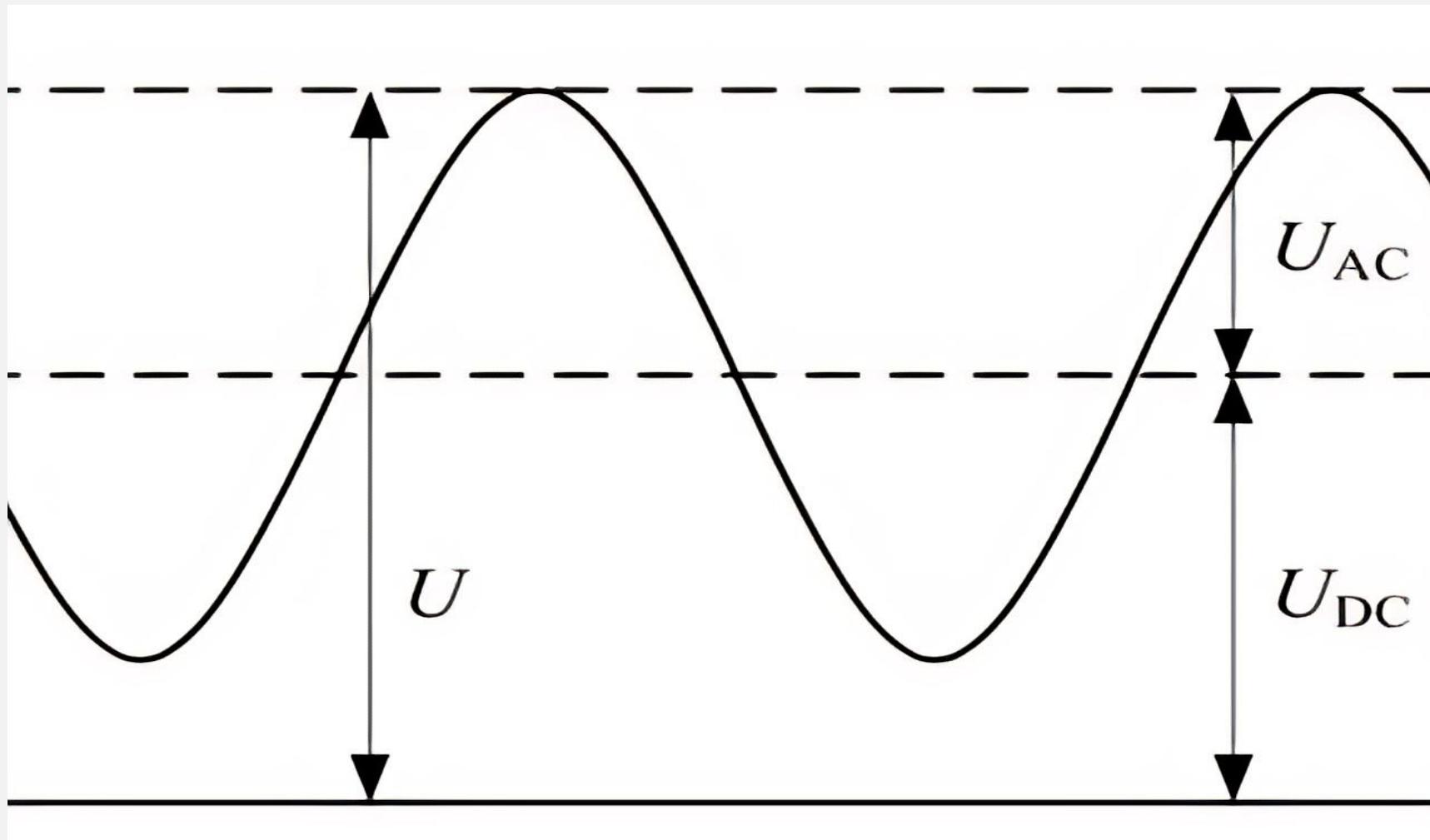


Flexible Installation

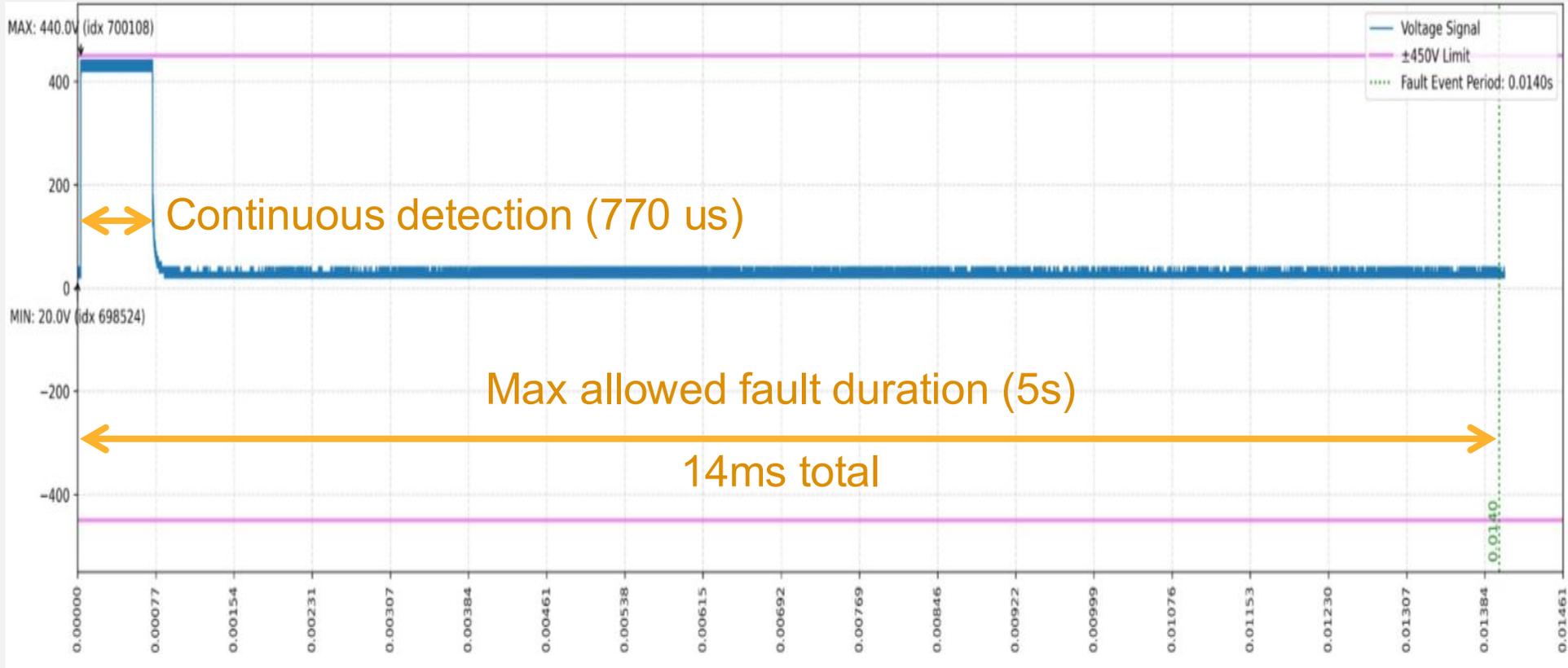
- Can be mounted anywhere
 - No clearance required from a code perspective
- Class 2 low-voltage wiring rules apply
 - Free air cable installation



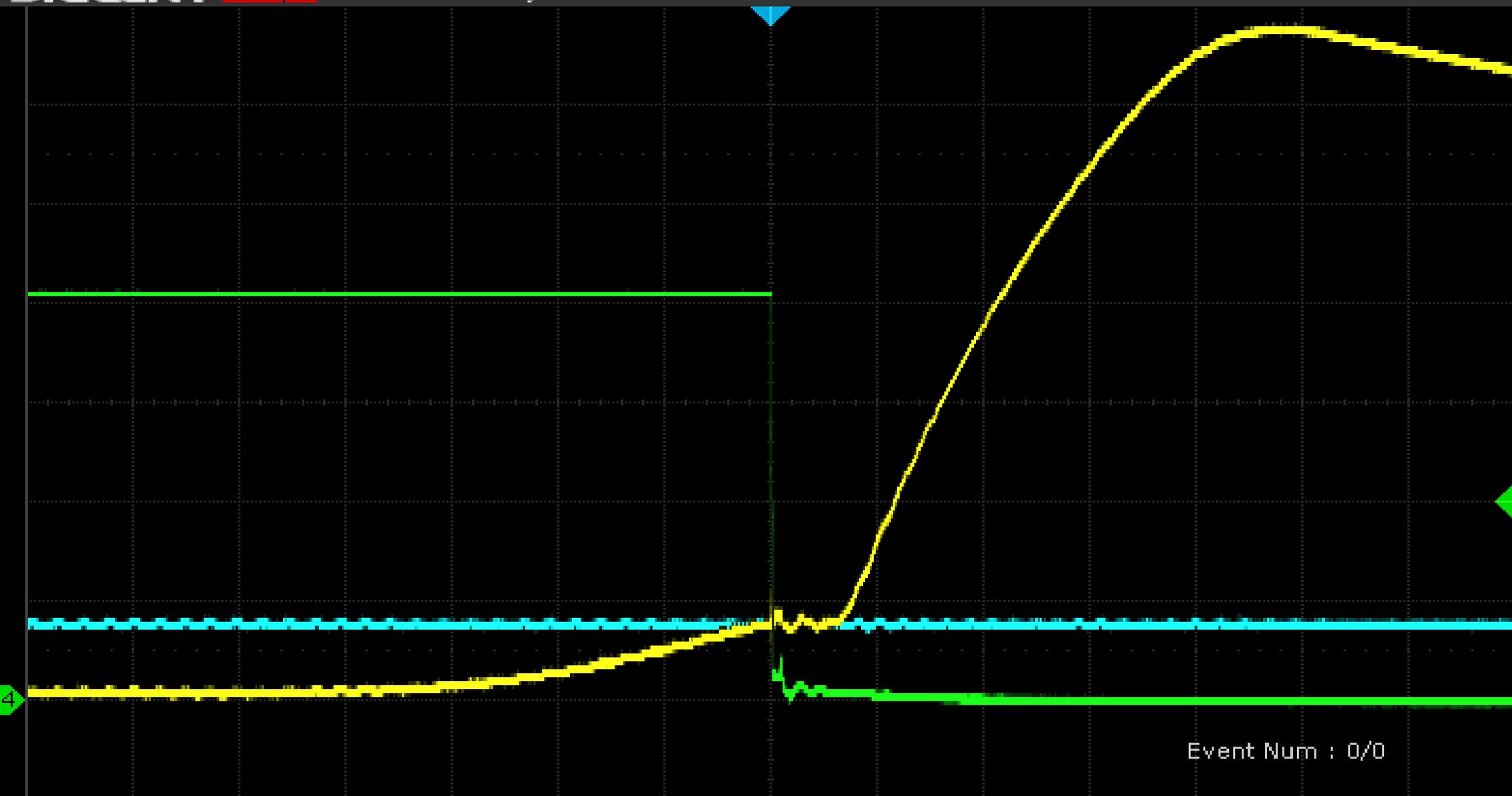
Continuous Power – Superimposed AC signal (PLC)



Sample fault detection timing – continuous detection



Fault waveform (high-impedance fault, injected at cable mid-point) – 400V input
– 3kW - Maximum cable length (attenuation)



Sa 500MSa/s

Curr 350kpts

Edge CH4

DC

L 200V

1 DC1M

1X 1.00V/
-3.00V

3 DC1M

1X 1.00V/
-3.00V

4 DC1M

10X 100V/
-300V

Event Num : 0/0

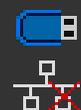
CH4

Freq[2]=****

Mean[4]=203.91V

Mean[1]=2.54V

Mean[3]=744.88mV

Coupling
DCBW Limit
FullAdjust
CoarseProbe
10XNext Page
Page 1/3

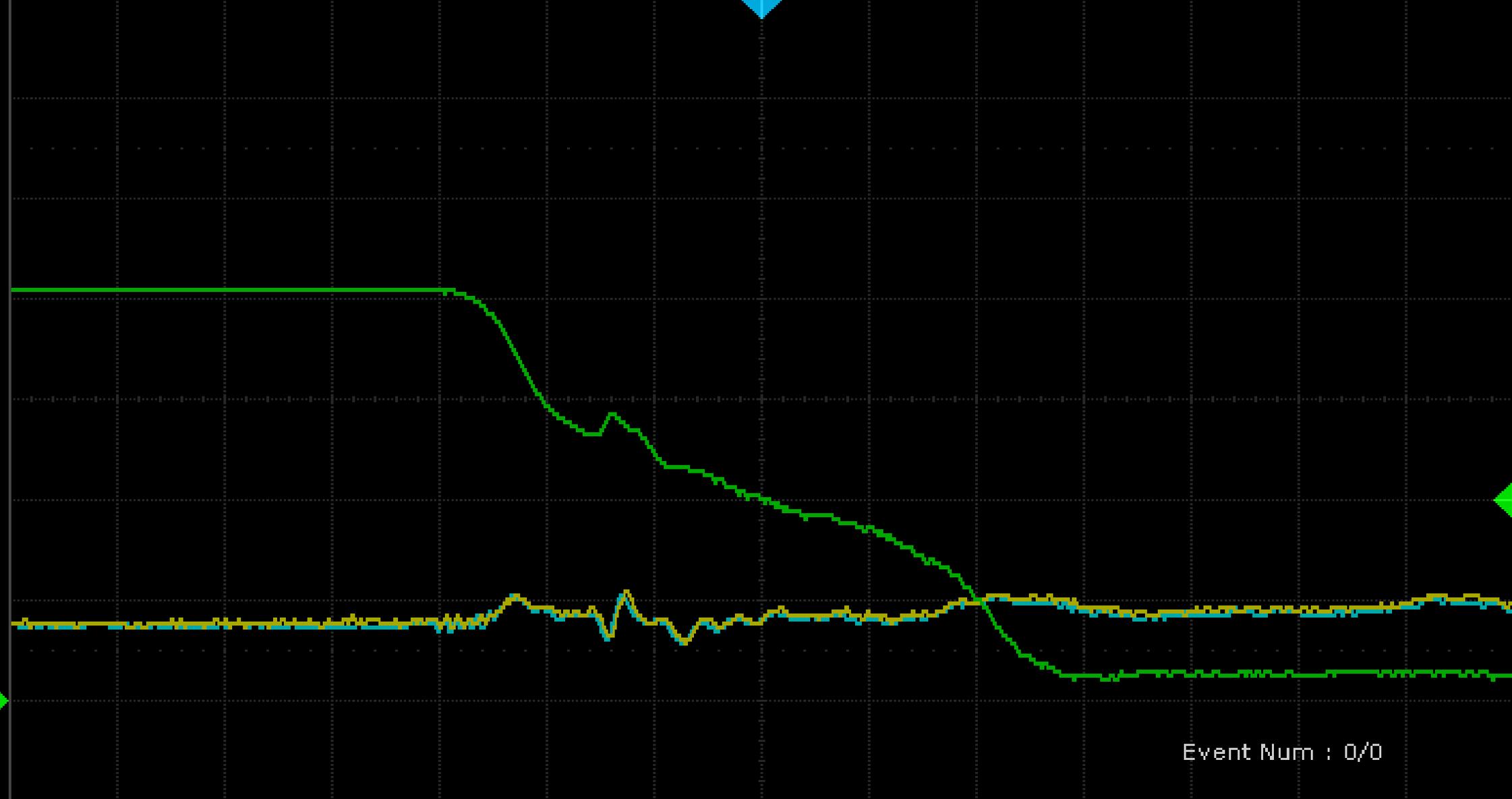
Sa 500MSa/s
Curr 350kpts

Edge CH4
DC
L 200V

1 DC1M
1X 1.00V/-3.00V

3 DC1M
1X 1.00V/-3.00V

4 DC1M
10X 100V/-300V



Event Num : 0/0

CH4 Freq[2]=**** Mean[4]=211.58V Mean[1]=853.89mV Mean[3]=821.83mV

Coupling DC

BW Limit Full

Adjust Coarse

Probe 10X

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Power Loss (400V at Tx output)

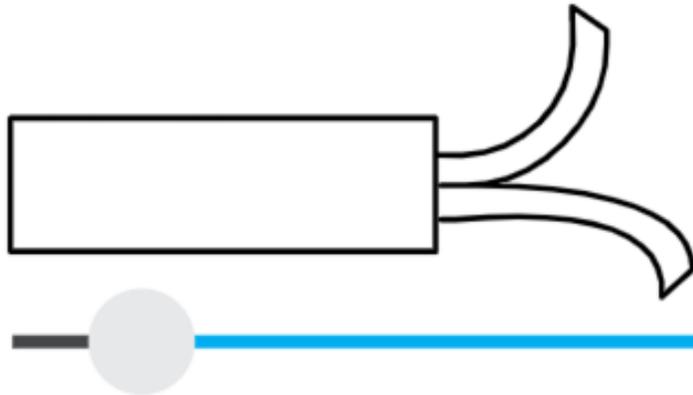
Power transmitted (W)	1,000						12,000					
	100	200	400	600	800	1000	100	200	400	600	800	1000
Distance (m)	100	200	400	600	800	1000	100	200	400	600	800	1000
AWG	18	18	16	16	14	12	18	18	16	14	12	12
Power Received (W)	928	927	925	882	866	913	11,119	11,078	10,978	10,851	10,680	10,557
Pairs	1	1	1	1	1	1	4	4	4	4	4	4
System Efficiency	93%											

<https://www.cencepower.com/calculators/voltage-drop-calculator>

Telecom Applications

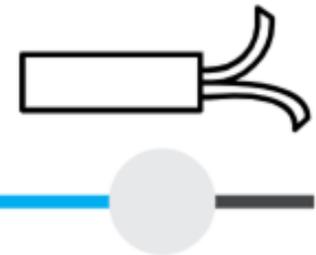


Reduce telecom project capital costs associated with cabling. Class 4 power systems provide higher voltages (up to 450V DC).



48V DC cable

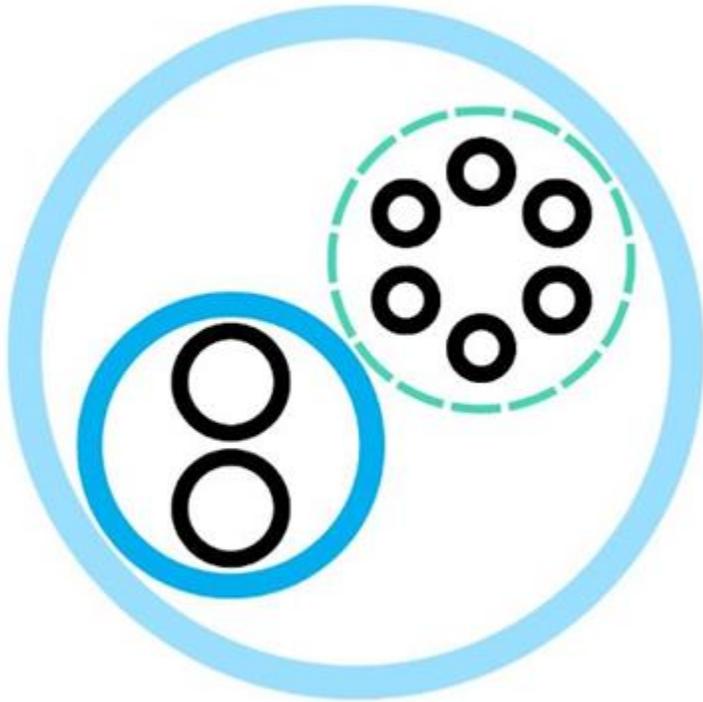
Cables in low voltage, high power, applications (such as traditional telecom rectifiers) require larger cable gauges to support the current needed.



450V DC cable

Cables in Class 4 systems have a gauge that is about 10x smaller than the gauge of a cable with 48V DC running through it, carrying the same amount of power

Telecom Applications



Optical Fibres for data transmission

Copper Wire for Class 4 DC power transmission

Other Applications

- *Some* Types of Data Centers
 - Power density 6kW/1U on Tx
 - 6kW/1U on Rx (@48V) and 12kW/1U on Rx (@400V)
- Outdoor pole lighting
- Indoor lighting
- Enterprise networks (powering PoE switches)

Next up: 3kW Bus

Up to 3.2kW
Up to 400V DC



Tx (single pair)



Rx



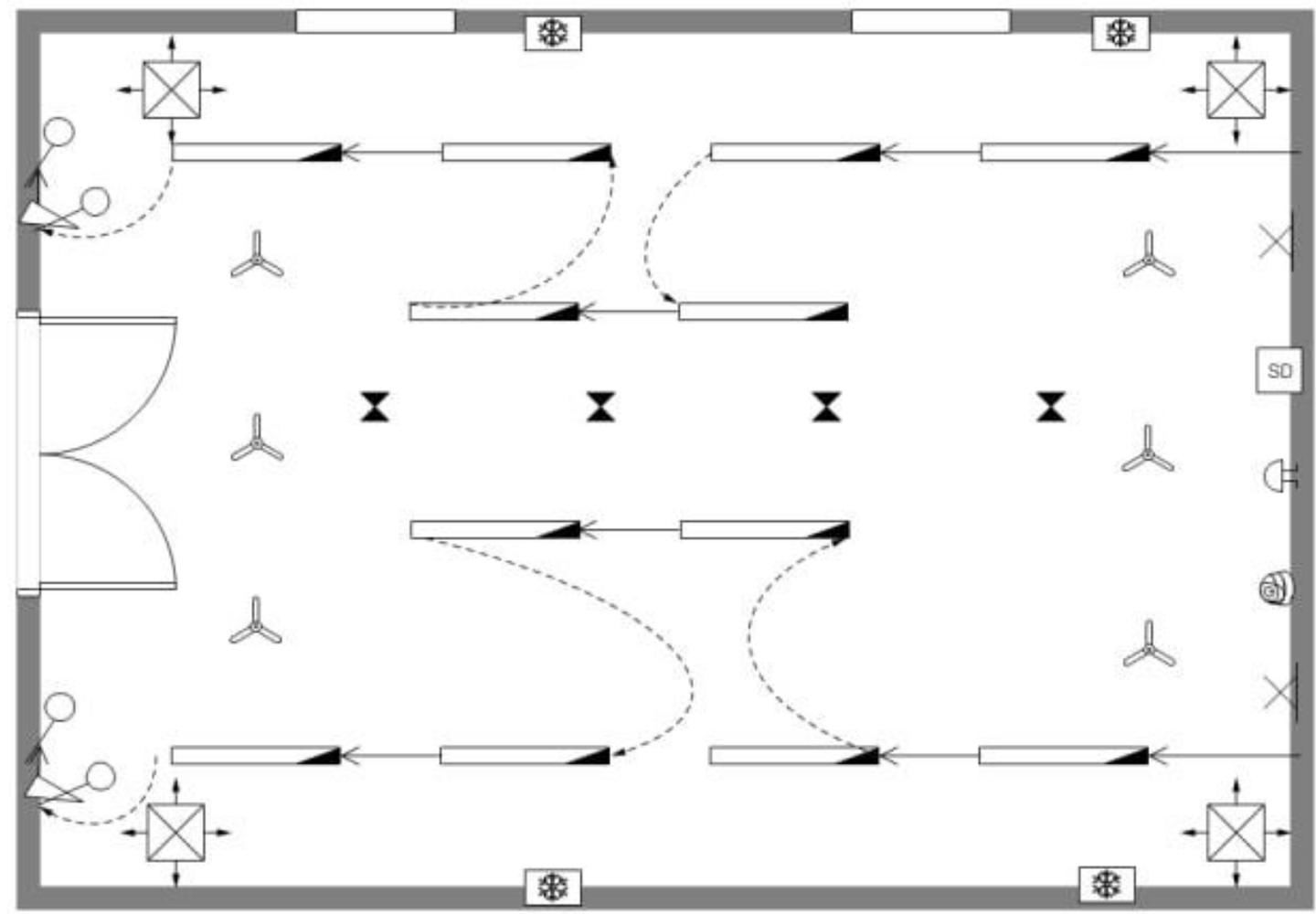
Rx



Rx



Bus architecture enables 3kW branch circuits, using Class 2 (low-voltage) wiring practices



Significant Greenhouse Gas Reductions (Embodied)

Impact on a 100,000 ft² (9,290 m²) Commercial Building

Metric	Baseline	Class 4 Power (50% Reduction in Cable)
Total Copper Wire Mass	114,345 kg	57,173 kg
Total Copper Wire Length	46,482 m	23,241 m
Embodied Carbon (Product Stage)	864,537 kg CO ₂ e	432,272 kg CO ₂ e
Total Embodied Carbon (Whole-Life)	1,760,448 kg CO ₂ e	880,231 kg CO ₂ e
Whole Building Carbon Intensity	384.88 kg CO ₂ e/m ²	354.39 kg CO ₂ e/m ²
Overall Embodied Carbon Reduction	-	880,216 kg CO₂e (7.9% reduction)

- **7.9% reduction** in total embodied carbon.
- **Can cut copper usage by half**, reducing extraction and manufacturing emissions.
- **Improves efficiency** while maintaining **safety** and performance.



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Thank You

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