DC Low Voltage Lighting & Power Controls

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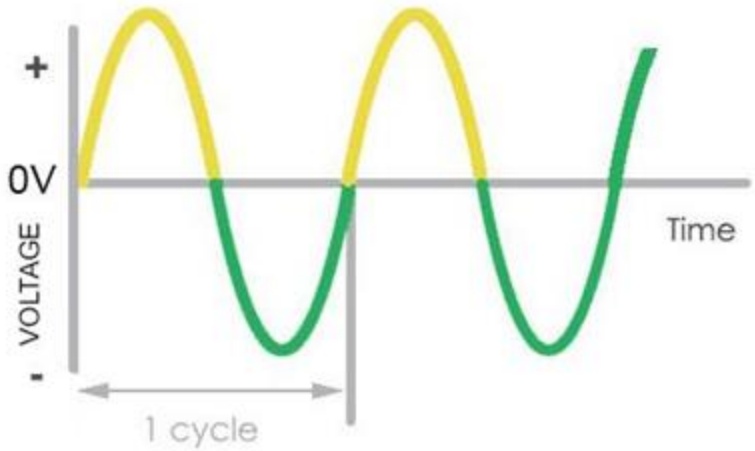
AC vs. DC Power



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.

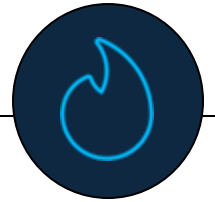
Direct Current (DC) Power

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

Converting from AC to DC is inefficient

The Grid is AC, but our usage is DC

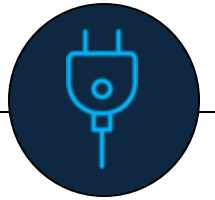
Utilities supply AC power and buildings today require DC distribution.



Micro-conversions waste energy.

Converting from AC to DC at the device is inefficient.

The process loses, on average 20% of the energy to heat.



Conversion efficiencies <45W ar[illegible]ed.

California has T20

An[illegible]e is >45W, efficiency is only regulated to 85%.

So, manufacturers tend to reduce cost and size by sacrificing efficiency.

DC will DOMINATE Building Power in 5 years

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

This is expected to grow to over 74% by 2030

High Growth DC Applications


LED Lighting Systems (LVDC)


Telecom Wireless Densification (HVDC)


DC Motors (HVAC), (LVDC/HVDC)


EV and Fast Charging (HVDC)


Renewables and Microgrids (LVDC/HVDC)

Standard PoE Buzzwords and Selling Points

No electrical contractor needed!!!

PoE means two-way communication

No conduit!

Future alterations without rewiring.

Each fixture node has advanced control and data analytics.

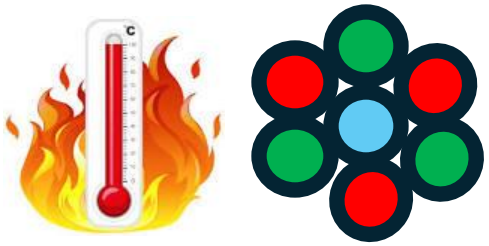
More wattage means more devices and applications!

Global open standard on connectivity and compatibility.

POE is easier and cheaper!

Common PoE Pitfalls

Cable Bundle Heating Reduces Transmission Efficiency



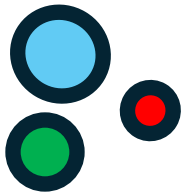
802.3bt Type 4 100W power derated to 71W at PD due to heat loss (23AWG creates more heat and more resistance)

- >30% of global fixtures exceed 71W maximum PoE size
- >60% of global fixtures do not carry UL2108/ETL listings
- 802.3bt uses 4P power and suffers from both current imbalance and current unbalance

Additional Cooling required for IDF Closets

Cable Specification for Max LP Rating for PoE is 0.5A (needs higher temp rating because carrying power)

Cable Manufacturing Selection accounts for up to 4% additional power loss to PD

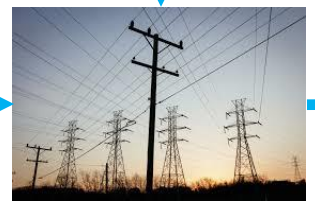


PoE Range Limitations

MAX 100M but degrades severely after 50M so that's the true limit

Today's AC World is Built on Loss

Utility Scale Battery Farms use Rectifiers to convert AC to DC Power for Storage **(+20% loss)**
These Batteries use Inverters to convert DC stored power back to AC Power for Transmission **(+20% Loss)**



PV generates DC Power and uses Inverter to convert to AC for Building **(+20% Loss)**

Utility Scale Generation Creates DC Power and Uses Inverters to AC Power for Transmission **(+20% Loss Minimum)**

Level 2 AC and DC Fast Chargers require Rectifiers to convert from AC to DC **(+20% loss)**

BESS Batteries use Rectifiers to convert AC to DC Power for Storage **(+20% loss)**
The BESS Battery uses Inverter to convert DC stored power back to AC Power for Building **(+20% Loss)**

Extremely Simplified Example of Cascading Losses

Produce 100W DC

80W

Stores 64W DC

51W

Delivers 48W DC

48W

PV Inverter Converts DC to AC for transmission – 20% loss

BESS Rectifier Converts AC to DC for storage – 20% loss and another 20% loss back to AC for transmission

480V to 277V Transformer is 93% efficient

Deliver 48W AC

We can do better!

Tomorrow's DC-Coupled Answers

Utility Scale Battery Farms use Rectifiers to convert AC to DC Power for Storage **(+20% loss)**
These Batteries use Inverters to convert DC stored power back to AC Power for Transmission **(+20% Loss)**

Utility Scale Generation Creates DC Power and Uses Inverters to AC Power for Transmission **(+20% Loss Minimum)**

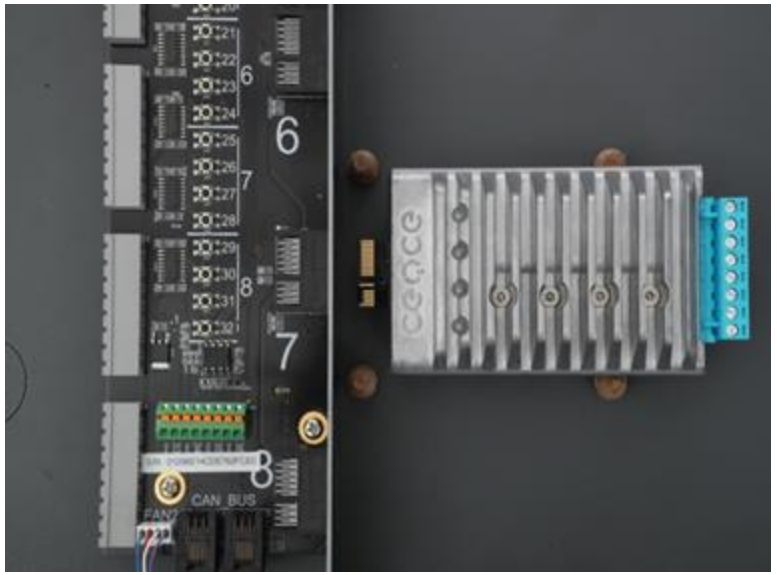
DC Coupled Barrier

Maximizing local PV generates DC Power for Building Loads **(No Loss)**

DC EV Charger **(No loss)**

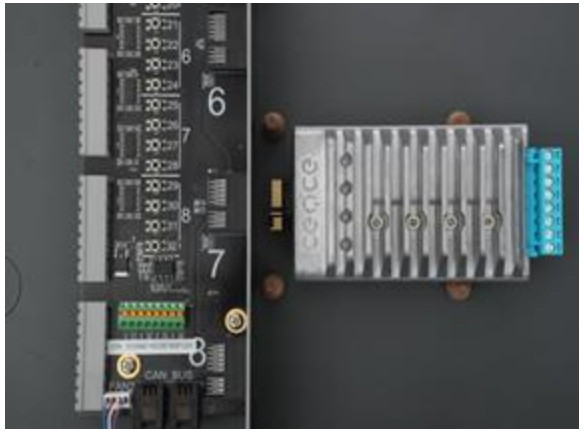
BESS Batteries use DC Power for Storage **(No loss)**
BESS Battery uses DC Power for Building **(No Loss)**

State of technology of low voltage lighting



- Low Voltage Lighting (LVDC) are gaining popularity in certain verticals driven by flexible installation requirements.
- Hot, swappable driver modules vs. an enclosure full of remote mounted drivers or PoE.
- Cence has 1.7 Million Square Feet of Active 2025 Projects, Powering More Than 1 Megawatt of Clean, Efficient DC Demand.

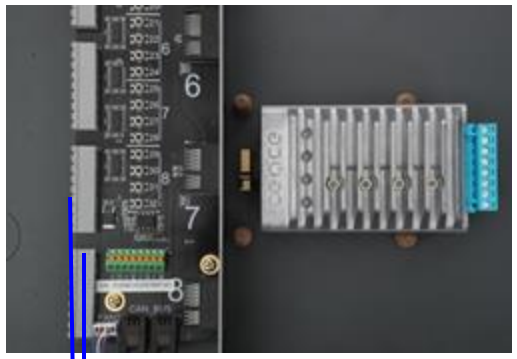
Direct Current Cence Low Voltage Lighting Hub



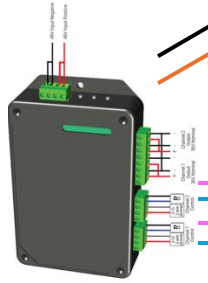
- 8 modules, 400W each
- 4 channels per module 100W
- Remote Node allows additional zoning and controls
- 32 channels total, 100W each
- 3kW total peak power

Cence Direct Current Lighting Control System

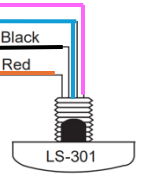
Each hot, swappable driver has **4** 100W DC outputs; each 100W DC output can have a remote I/O node that further splits the zone into **2** 36W zones.



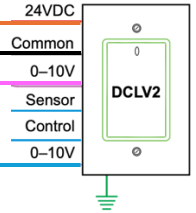
Control Zone



Remote Node



30mA



16mA

16mA

120V Line

120V Load

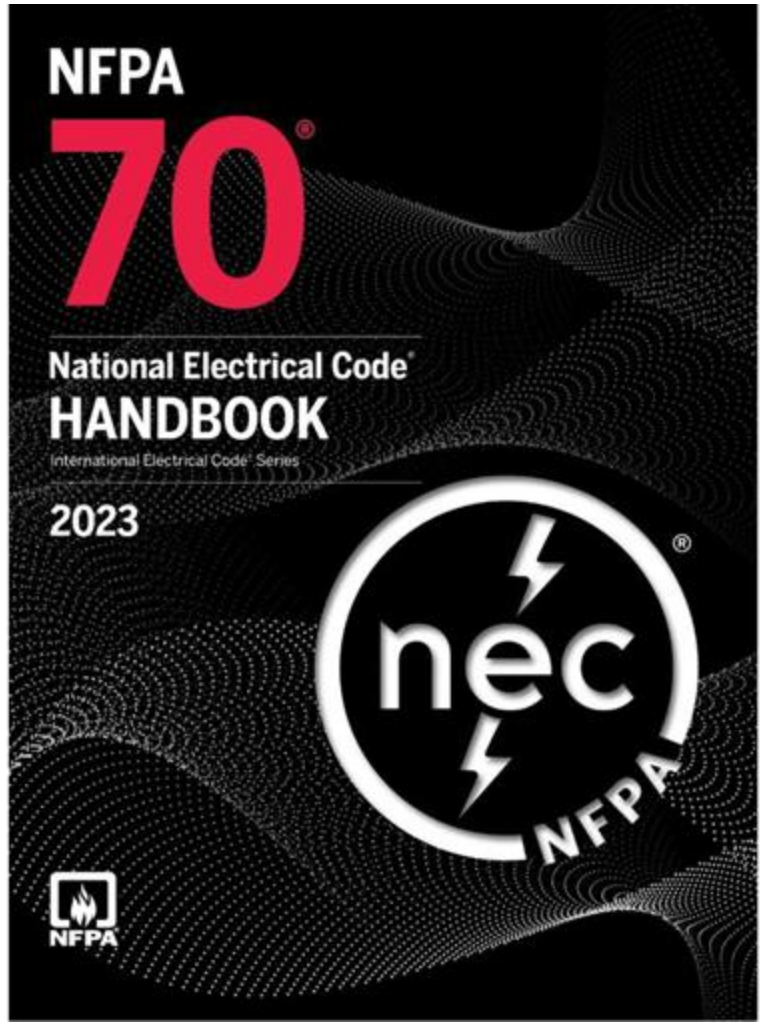
A new class of power
is redefining the future of electricity.

In 2023, the NEC introduced Class 4 Power.

A change this significant to the NEC hasn't happened in 45 years—since 1978, with the addition of Class 3.

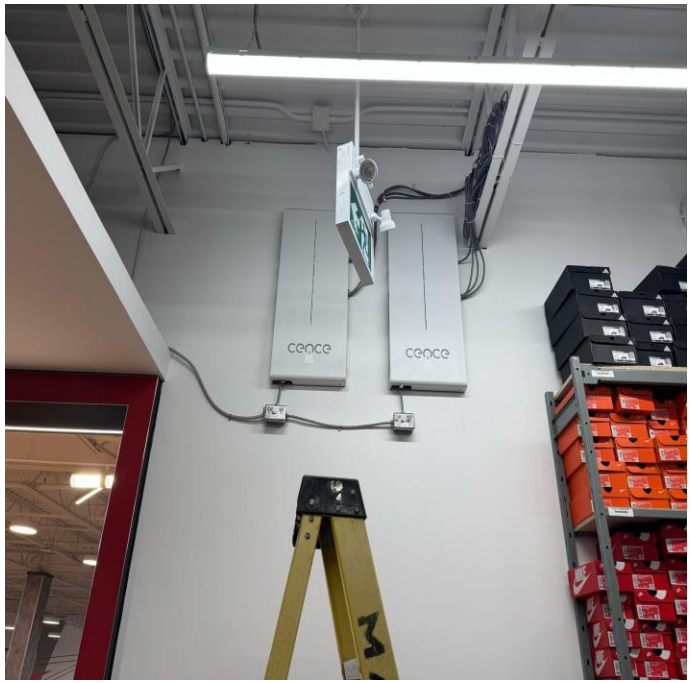
Also known as Fault Managed Power (FMP), the new Class 4 rating enables power to be distributed at 10x lower cost, 10x higher power, and 100x increased safety and efficiency.

Class 1	Class 2 & 3	Class 4
AC Mechanically protected wires	DC Lower wattage restrictions to ensure safety	DC/HVDC Fault Managed Power



NEC 2023 Expected to be Adopted 1 January 2026

- Adopts Class 4 Fault Managed Power Systems Article 726
- Updates Article 250 grounding and bonding requirements for DC lighting systems
- Class 4 and Class 2 can be run in same conduit
- Class 4 FMPS will help California rewrite the Title 24 Part 6, Part 11, and Title 20 standards.



Class IV: a new class of power redefines the future of electricity

A class 4 power system monitors for the following fault conditions:

- An abnormal condition such as abnormal voltage, current, waveform, or load condition is identified in the system
- A short circuit
- Human skin contact on energized parts
- A ground-fault condition
- An overcurrent condition
- Intentional shorting of the line at the receiving or transmitting end to force de-energization for purposes of maintenance or repair

High Voltage Direct Current

HVDC

UL Certifications

UL Certifications for a Class 4 Power System (Ex. Cence HVDC)

- UL 1400-1
- UL 1400-2

- CSA and IEC Certifications in progress

Electric Shock Protection

Duration of current in milliseconds	DC RMS current magnitude (mA)
0.100	3,975
0.200	2,447
0.50	1,288
1.00	793
2.00	488
4.00	300
5.00	300
10.0	300

Figure 5.3

Fault Current Limit Curve (mA)

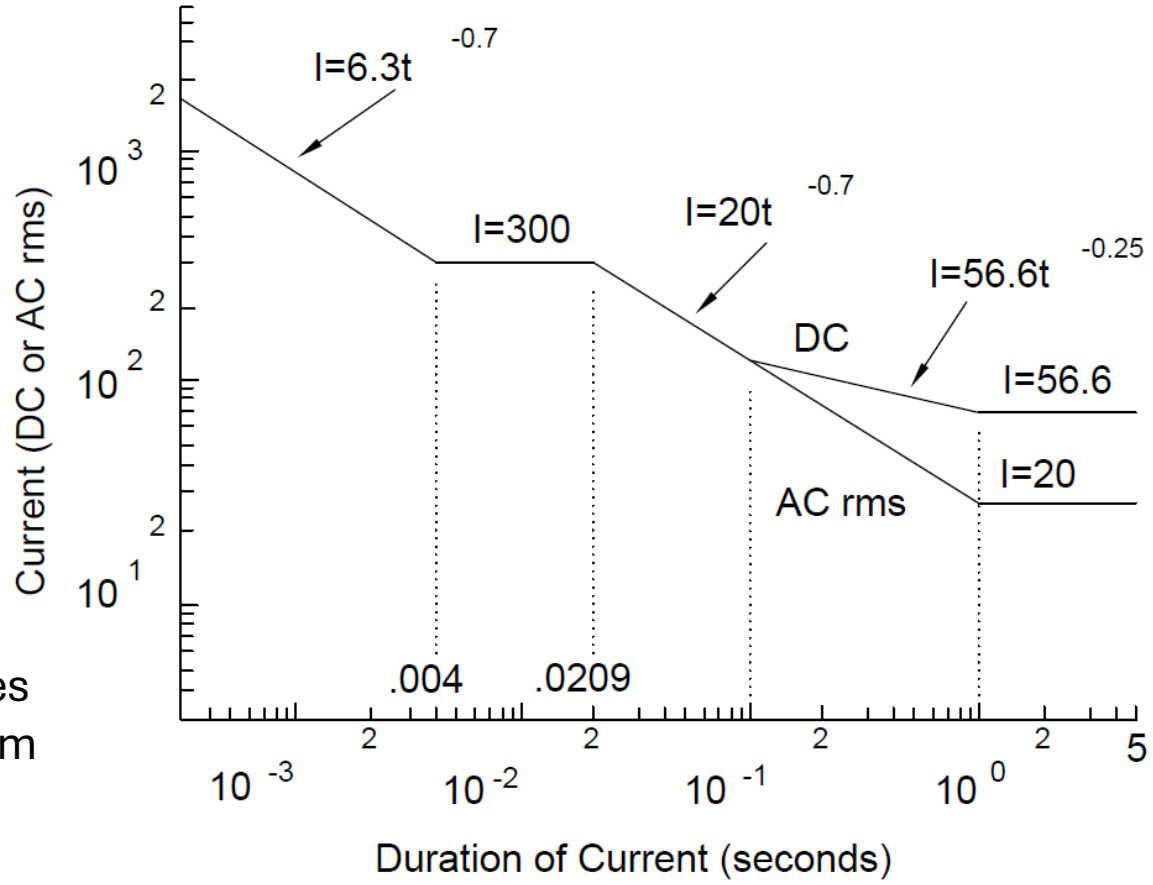


Figure 5.3 sets the fault current/time safety curve. It ensures that in the event of human contact with live parts, the system limits current below levels that could cause ventricular fibrillation or prevent a person from letting go (otherwise leading to possible death or injury).

Arc Fault Fire Protection

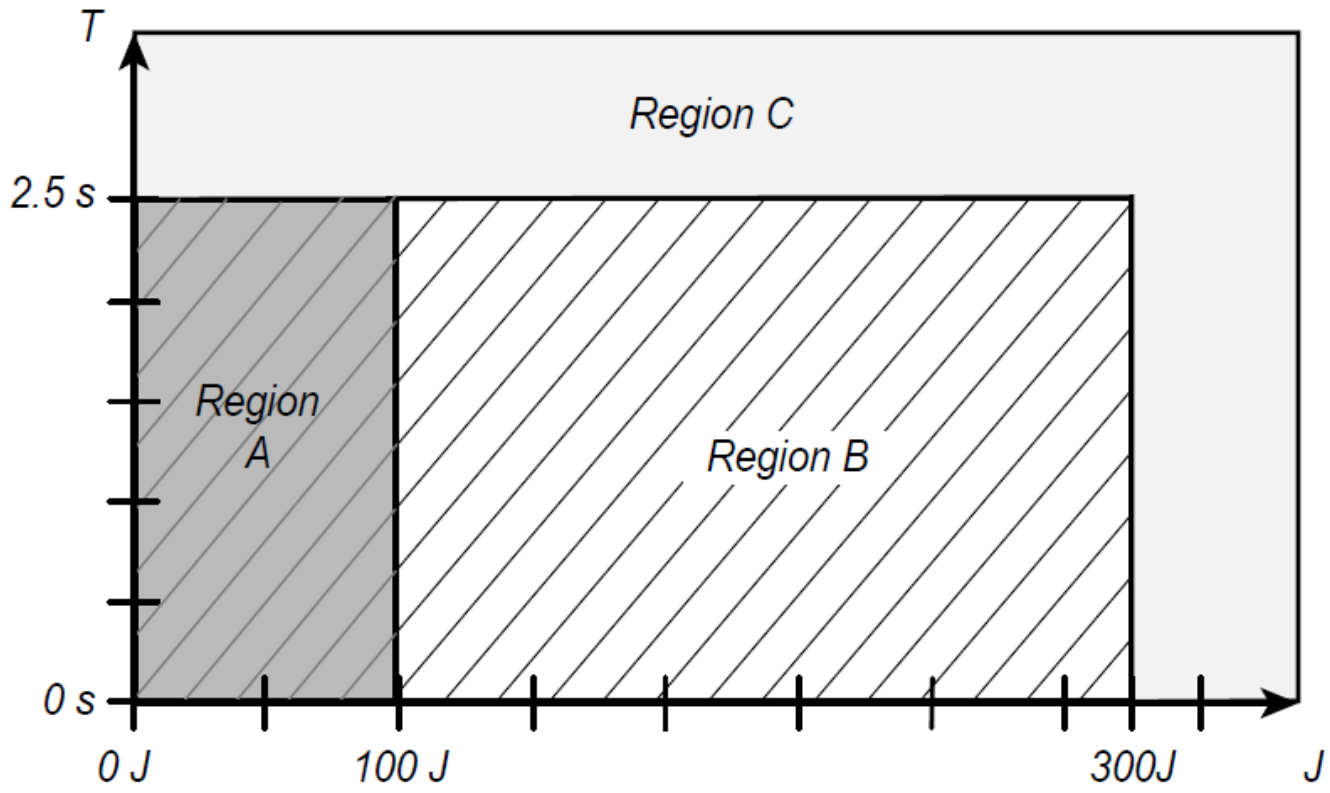
1. Capacitor Discharge (15 J)
2. Series Arc
3. Parallel Arc

•**Fault detection:** ≤ **200 µs**, within the **first quadrant of Region A** on the protection curve.

•**Response:** The system trips and isolates the circuit immediately.

•**Let-through energy:** Limited to **≤ 10 J**; the product will not permit energy above 10 J to be delivered under a fault.

Figure 7.1 sets arc-energy/time limits. It requires the system to extinguish arcs quickly enough that they cannot ignite insulation or other materials.




cence
2LNL1
2LNL2

Cence is one of 4 FMPS manufacturers

"Semiconductors have fundamentally altered the way we distribute and consume goods and information. Through FMP, they could disrupt the way we distribute and consume electricity, making it safer, smarter and more efficient for everyone."

Andrew Lu, Director Product Management
Cisco

"As buildings become more intelligent and need more devices, power, and connectivity, Class 4 (FMP) will be a viable option in venues like airports, Class-A offices, stadiums and arenas, and industrial plants to support mission-critical systems like 5G radios and small cells, power distribution infrastructure, distributed antenna systems (DASs), passive optical networks (PONs), and systems that use PoE switches."

Ron Tellas ,Sr Solution Architect
Belden

Digital Current™| Cence FMP – Transmitters and Receivers

- 4 channels, 3.2kW peak
- 12.8kW peak power per transmitter
- 400V peak

Datacenter and 48V Telecom Applications for DC Power Electronics Infrastructure

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.

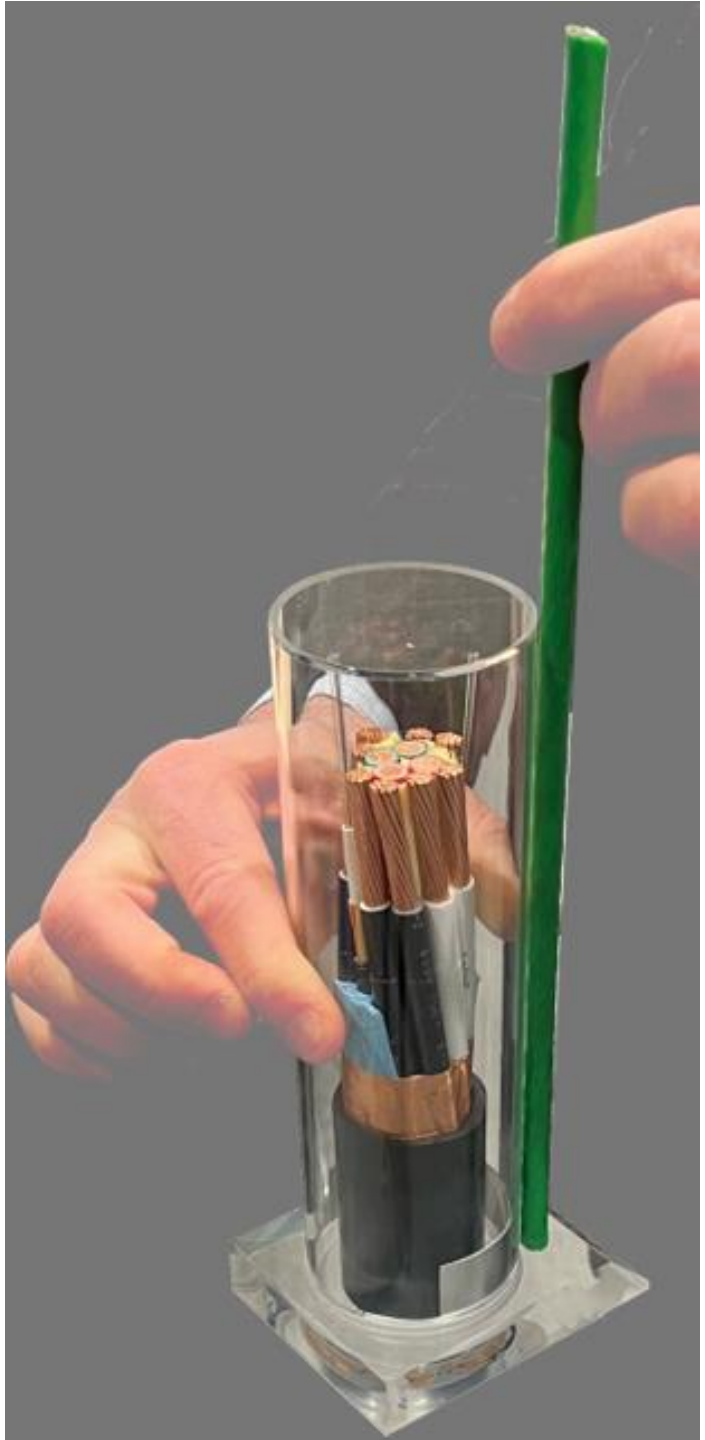
450V DC cable

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

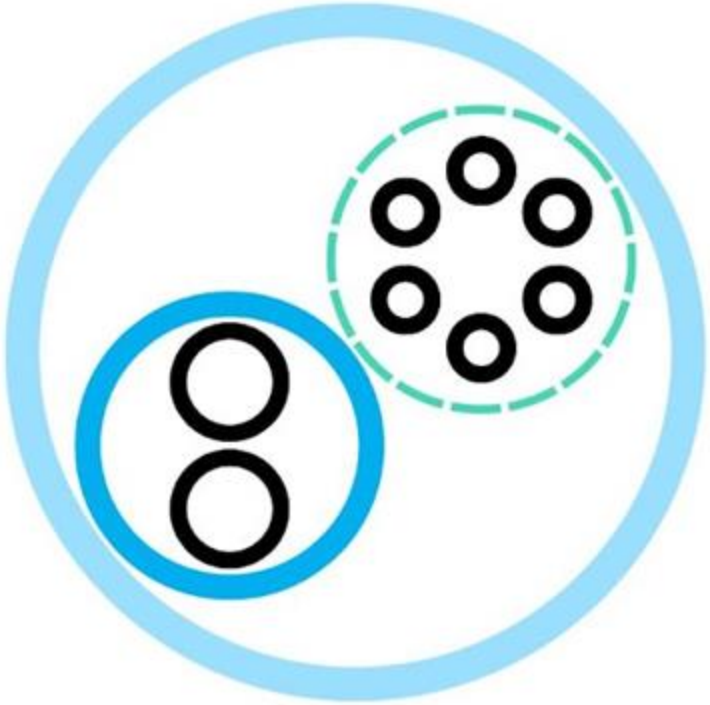
Class 4 Telecom Applications

48V telecom cable (left)
vs
400V Class 4 telecom cable (right)

Massive Savings Throughout Datacenter Projects Just on Embodied Copper



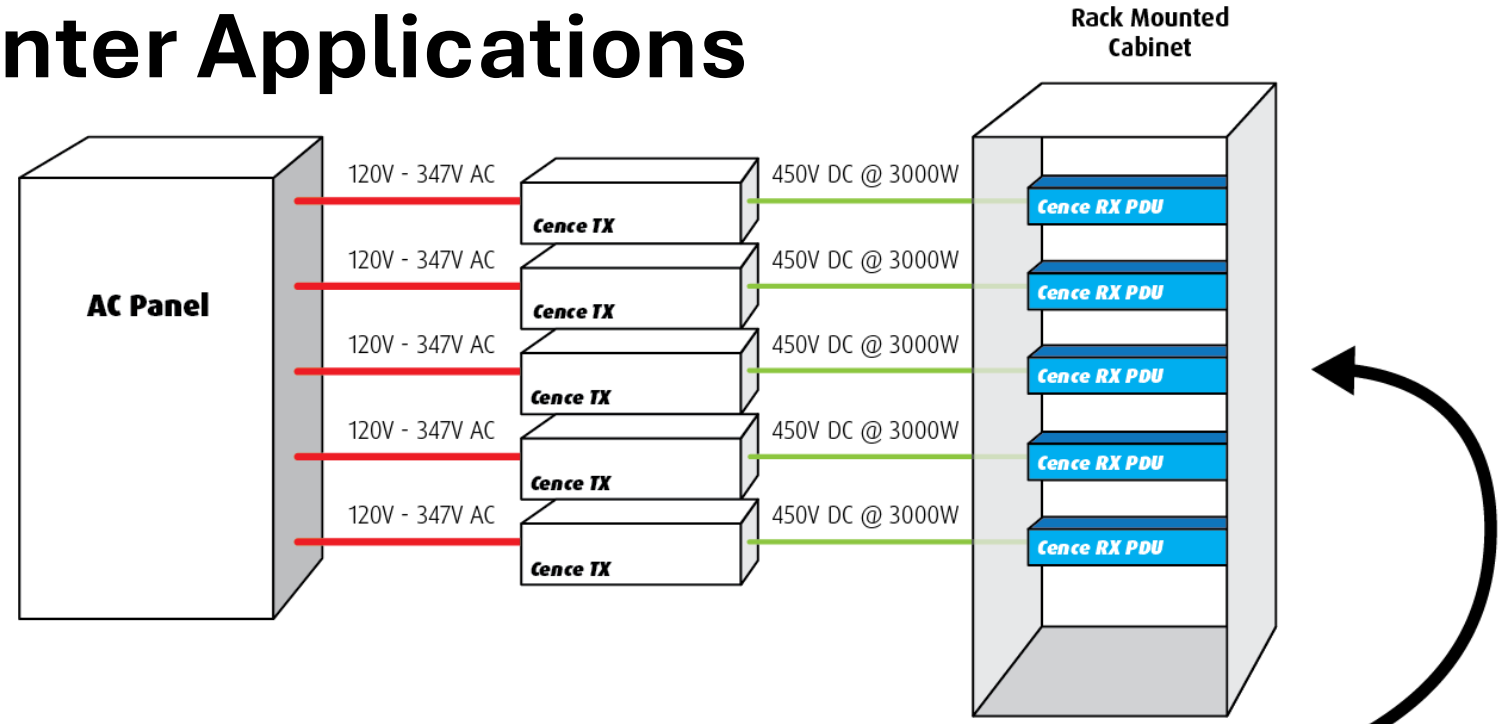
Class 4 Telecom Applications

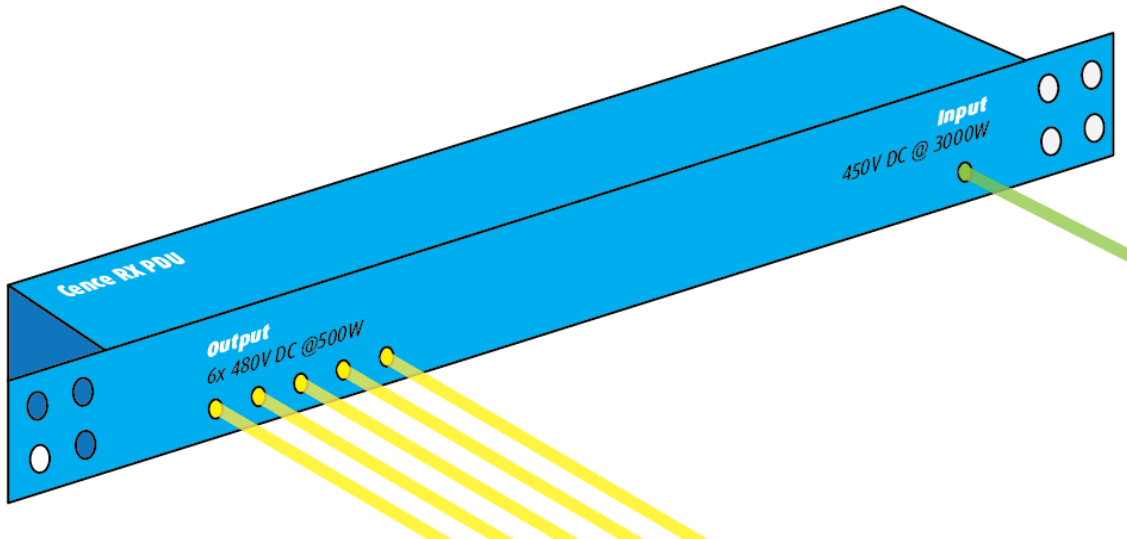


Optical Fibres for data transmission

Copper Wire for Class 4 DC power transmission

Datacenter Applications





Datacenter Applications – 95% System Efficiency

Power transmitted (W)	1000						6400						12800					
Distance (m)	100	200	400	600	800	1000	100	200	400	600	800	1000	100	200	400	600	800	1000
CSA (mm2)	1	1	1.5	2.5	2.5	4	1	2.5	4	4	6	6	1	2.5	4	4	6	6
Power Received (W)	929.1	909.15	894.9	900.6	884.45	899	5660.1	5743.7	5660.1	5451.1	5521.4	5382.7	11320.2	11487.4	11320.2	10902.2	11042.8	10765.4
Power Supplies / Transmitters needed (qty#)	1	1	1	1	1	1	2	2	2	2	2	2	4	4	4	4	4	4
Recievers needed (qty#)	1	1	1	1	1	1	2	2	2	2	2	2	4	4	4	4	4	4

System Efficiency	95%

Implied Transition Tasks for Class 4 Growth

Architects on how DC Lighting & Class 4 FMPS Power LEAD Sustainability and Net-Zero

Code writers on the cost and energy savings database of installation and O&M costs.

EDUCATE

Electrical engineers on Class 4 FMPS structural wiring to support DC lighting

Mechanical manufacturers on Class 4 FMPS to create disruptive, new products

Mechanical specifiers on Class 4 FMPS capabilities

AHJs and Inspectors on proper DC and Class 4 inspection standards

Significant Greenhouse Gas Reductions (Operational)

- **Energy Savings : (Estimated up to 40%):**
  - 20% from AC/DC conversion efficiency increase,
  - Additional 20% energy savings from interactive sensors (occupancy / daylight harvesting)
  - Baseline: LED with no controls other than wall switches

- **For every 1 kWh conserved, 0.85 Pounds of CO2 emissions are diverted from the atmosphere**
  Baseline case: 3,750 W of lighting required for 5,000 sq.ft 9’ ceiling commercial office (assuming 45 footcandles required)
  - 16,425 kWh used annually (assuming lights are on for 12 hrs/day)
  - 3.285 kWh / sq.ft annually

- **With 40% savings: 1.314 kWh/sq.ft annually is saved**
  - 1.12 pounds of CO2 emissions are diverted per square foot per year using the Cence LV system

Significant Greenhouse Gas Reductions (Embodied)

Impact on a 100,000 ft^2 (9,290 m^2) Commercial Building

Metric	Baseline	Cence 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_2e	432,272 kg CO_2e
Total Embodied Carbon (Whole-Life)	1,760,448 kg CO_2e	880,231 kg CO_2e
Whole Building Carbon Intensity	384.88 kg CO_2e/m^2	354.39 kg CO_2e/m^2
Overall Embodied Carbon Reduction	-	**880,216 kg CO_2e (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.

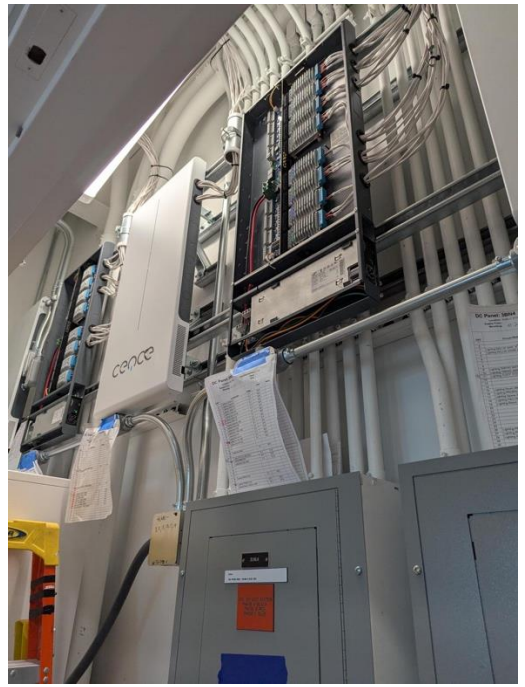
FAQs

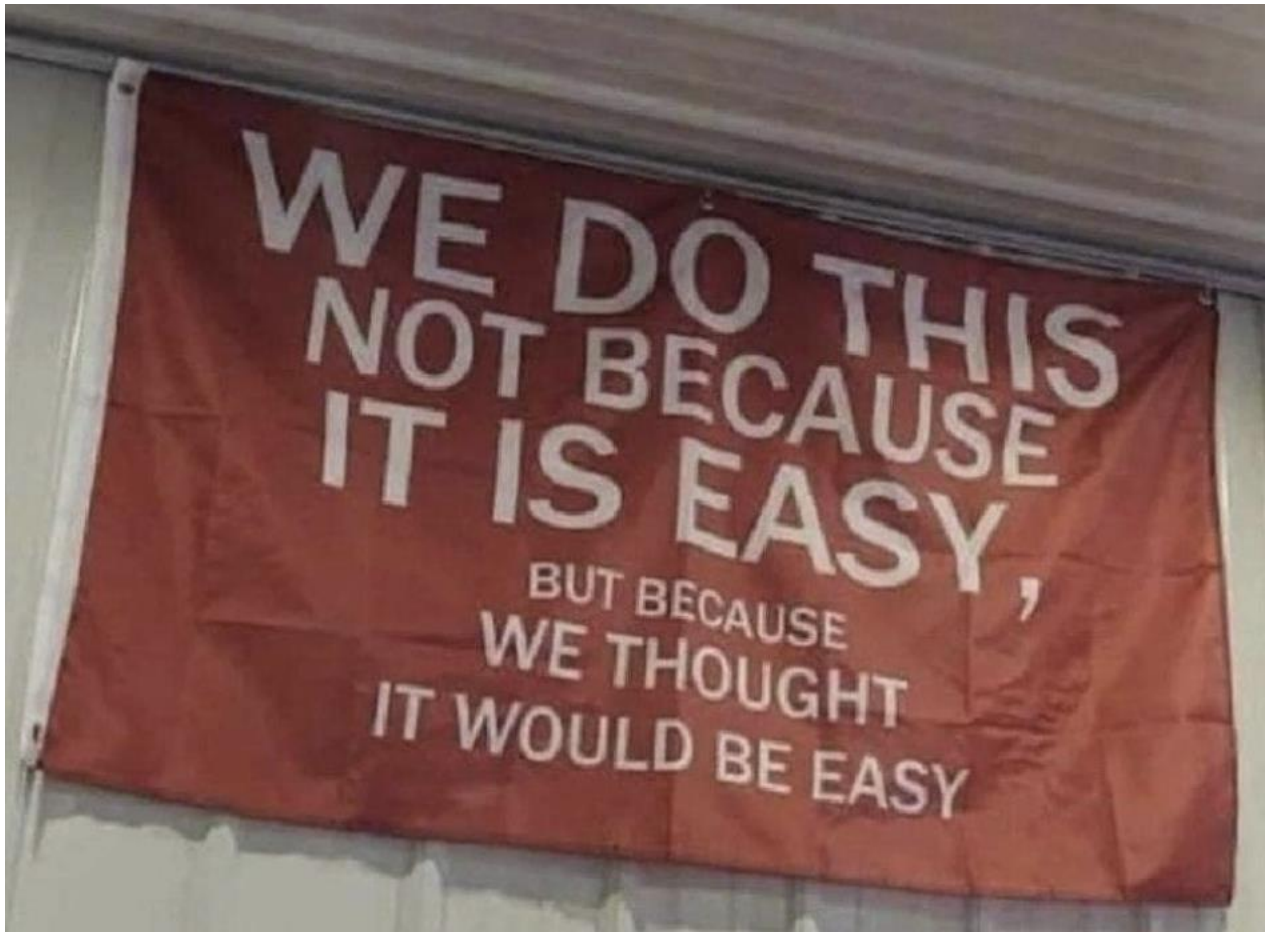
- No software licensing issues.

- DC Low Voltage teams within EC clients can best evaluate what applications are the best fit for low voltage lighting.

- Californian Specifiers and AHJs to document the installation, inspection, and licensing requirements for electrical contractor proficiency.

- California adheres to NEC but also has Title 24 energy requirements. Cence meets or exceeds these energy standards and is UL certified.




WE DO THIS
NOT BECAUSE
IT IS EASY,
BUT BECAUSE
WE THOUGHT
IT WOULD BE EASY

Questions?