BELDEN
Let's build the future.

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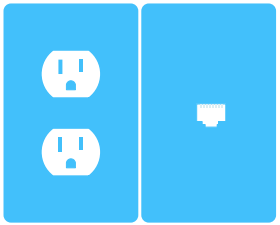
For Billions of NEW IoT Connections …

From Power + Data…



PoE Powering the “Things”

	2003	2009	2018			
Standard	**IEEE 802.3af**	**IEEE 802.3at**	**IEEE 802.3bt**			
Acronym	PoE	PoE+	4pPoE (PoE++)			
			Type 1	Type 2	Type 3 Cisos UPOE	Type 4
			2 pairs	4 pairs	4 pairs	4 pairs
Source Current (max. per pair set)	350 mA	600 mA	350 mA	300 mA	600 mA	960 mA
Source Voltage (min.)	44 V	50 V	44 V	50 V	50 V	52 V
Power Sourcing Equipment PSE (max.)	15.4 W	30 W	15.4 W	30 W	60 W	100 W
Powered Device (PD)	12.95 W	25.5 W	12.95 W	25.5 W	51 W	71 W (95W)

15W

15W

60W

71W

80-100W

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Remote Powering

- POE, Class 2
- Fault Managed Power Systems (FMPS), Class 4

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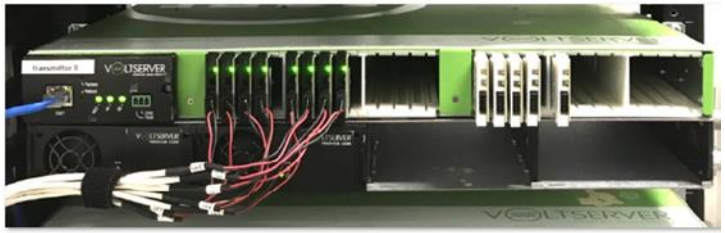
Agenda –

duration 45 min.



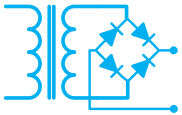
Remote Powering

- Convergence
- Need for speed and … power > POE
- More Power at further distances …
- Class 4, Fault Managed Power Systems (FMPS)
  - What makes Class 4 different from other power distribution options,
  - How does it work,
  - Where does is play,
  - Components and infrastructure review,
  - Use Case,
  - FMPS cable requirements, options,

Circuit Classes – 2023 NEC Definitions

Class 1
The portion of the wiring system between the load side of the Class 1 power source and the connected equipment

Class 2
The portion of the wiring system between the load side of the Class 2 power source and the connected equipment. Due to its power limitation, a Class 2 circuit considers **safety from a fire initiation standpoint and provides acceptable protections from electric shock**



Class 3
The portion of the wiring system between the load side of the Class 3 power source and the connected equipment. Due to its power limitation, a Class 3 circuit considers safety from a fire initiation standpoint. Since higher levels of voltage and current than for Class 2 are permitted, additional safeguards are specified to provide protection from an electric shock hazard that could be encountered

Class 4
The portion of the wiring system between the load side of the Class 4 transmitter and the Class 4 receiver or Class 4 utilization equipment, as appropriate. Due to the active monitoring and control of the voltage and current provided, a Class 4 circuit considers **safety from a fire initiation standpoint and provides acceptable protections from electric shock**

Convergence in the smart building

Current State

Sub-Systems Types

- Networking/ Structured Cabling
- A/V
- Low Voltage
- Wireless Specialists

Applications

- Data
- Voice
- A/V
- Security
- Building
- DAS

Future State

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PartnerAlliance

Single, Unified IP network

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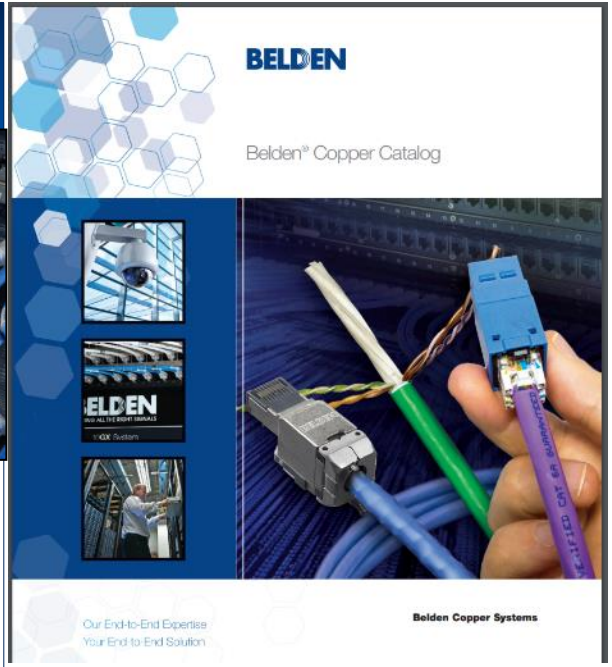
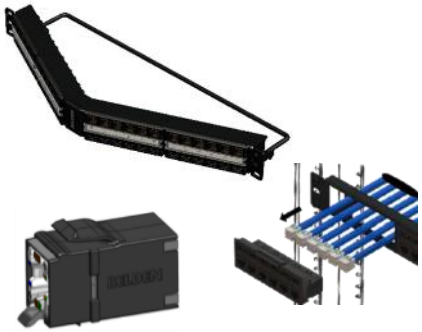
Copper Cable & Connectivity solution

Copper Cable & Connectivity

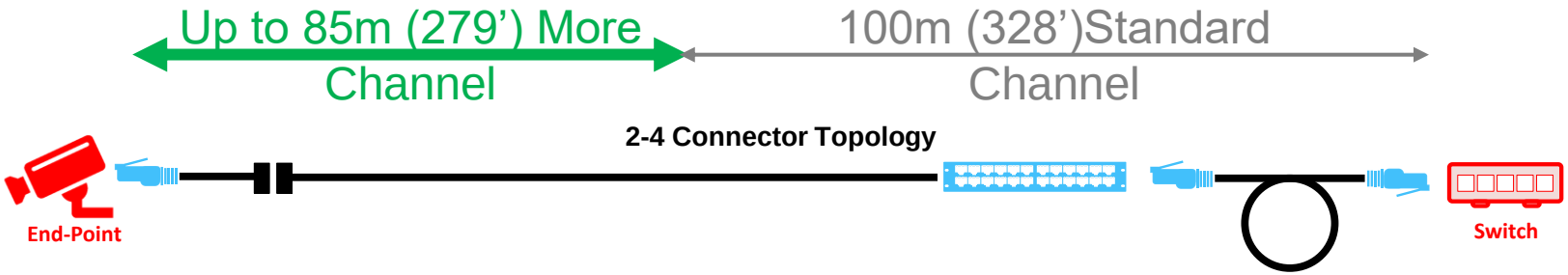
- Category systems for LAN and Data Center
- Access Control Cabling
- Building Automation & Control





REVConnect Coupler

Extended Reach with Belden CAT6a & REVConnect



Channel Reach	PoE	10Base-T	100Base-T	1000Base-T	2.5G/5GBase-T	10GBase-T
10GXS	***15W PoE (Type 1)***	185m (607 ft)	150m (492 ft)	110m (361 ft)	106m (348 ft)	100m (328 ft)
	30W PoE (Type 2)	150m (492 ft)	150m (492 ft)	110m (361 ft)	106m (348 ft)	100m (328 ft)
	60W PoE (Type 3)	150m (492 ft)	150m (492 ft)	110m (361 ft)	106m (348 ft)	100m (328 ft)
	100W PoE (Type 4)	120m (394 ft)	120m (394 ft)	110m (361 ft)	106m (348 ft)	100m (328 ft)
10GXW	***15W PoE (Type 1)***	140m (459 ft)	140m (459 ft)	100m (328 ft)	100m (328 ft)	100m (328 ft)
	30W PoE (Type 2)	130m (426 ft)	130m (426 ft)	100m (328 ft)	100m (328 ft)	100m (328 ft)
	60W PoE (Type 3)	130m (426 ft)	130m (426 ft)	100m (328 ft)	100m (328 ft)	100m (328 ft)
	100W PoE (Type 4)	120m (394 ft)	120m (394 ft)	100m (328 ft)	100m (328 ft)	100m (328 ft)

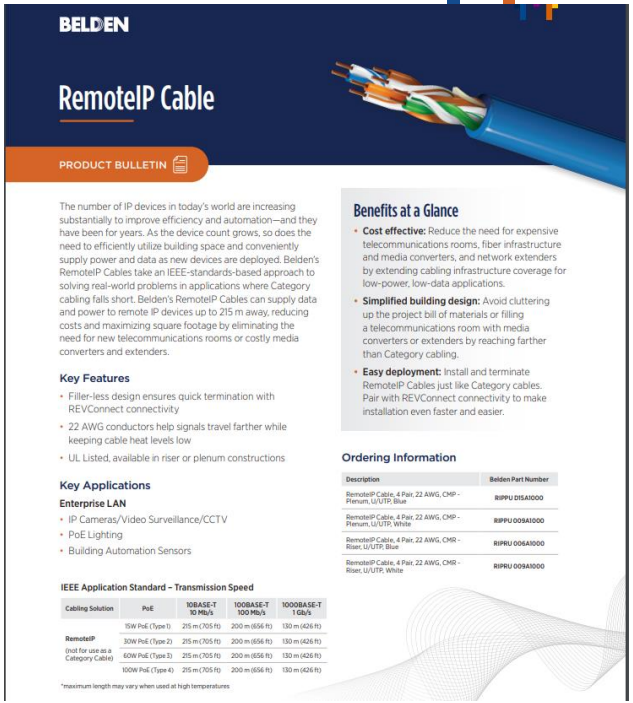
Certified Extended Reach

Extending POE reach: Belden RemoteIP Cable

- Belden's RemoteIP cable is tailored to low bandwidth IP devices requiring remote power at distances beyond 100 meters
  - IEEE application standards-based cabling guarantees success today and in the future
  - Common Applications: IP cameras, PoE lighting, building sensors
- **RIPPU:** Belden RemoteIP Cable, 4 Pair, 22 AWG, U/UTP, CMP – Plenum
- **RIPRU:** Belden RemoteIP Cable, 4 Pair, 22 AWG, U/UTP, CMR – Riser

		IEEE Application Standard – Transmission Speed		
Cabling Solution	**PoE**	**10BASE-T 10 Mbps**	**100BASE-T 100 Mbps**	**1000BASE-T 1 Gbps**
RemoteIP (not for use as a Category Cable)	***15 W PoE (Type 1)***	215 m (705 ft)	200 m (656 ft)	130 m (426 ft)
	30 W PoE (Type 2)	215 m (705 ft)	200 m (656 ft)	130 m (426 ft)
	60 W PoE (Type 3)	215 m (705 ft)	200 m (656 ft)	130 m (426 ft)
	100 W PoE (Type 4)	215 m (705 ft)	200 m (656 ft)	130 m (426 ft)
maximum length may vary when used at high temperatures				

[Don't Over-Engineer IP Camera Systems: RemoteIP vs Category Cable]


BELDEN

RemoteIP Cable

PRODUCT BULLETIN

The number of IP devices in today's world are increasing substantially to improve efficiency and automation—and they have been for years. As the device count grows, so does the need to efficiently utilize building space and conveniently supply power and data as new devices are deployed. Belden's RemoteIP Cables take an IEEE-standards-based approach to solving real-world problems in applications where Category cabling falls short. Belden's RemoteIP Cables can supply data and power to remote IP devices up to 215 m away, reducing costs and maximizing square footage by eliminating the need for new telecommunications rooms or costly media converters and extenders.

Key Features

- Filler-less design ensures quick termination with REVConnect connectivity
- 22 AWG conductors help signals travel farther while keeping cable heat levels low
- UL Listed, available in riser or plenum constructions

Key Applications

Enterprise LAN

- IP Cameras/Video Surveillance/CCTV
- PoE Lighting
- Building Automation Sensors

IEEE Application Standard – Transmission Speed

Cabling Solution	PoE	10BASE-T 10 Mb/s	100BASE-T 100 Mb/s	1000BASE-T 1 Gb/s
RemoteIP (not for use as a Category Cable)	15W PoE (Type 1)	215 m (705 ft)	200 m (656 ft)	130 m (426 ft)
	30W PoE (Type 2)	215 m (705 ft)	200 m (656 ft)	130 m (426 ft)
	60W PoE (Type 3)	215 m (705 ft)	200 m (656 ft)	130 m (426 ft)
	100W PoE (Type 4)	215 m (705 ft)	200 m (656 ft)	130 m (426 ft)

*maximum length may vary when used at high temperatures

Benefits at a Glance

- **Cost effective:** Reduce the need for expensive telecommunications rooms, fiber infrastructure and media converters, and network extenders by extending cabling infrastructure coverage for low-power, low-data applications.
- **Simplified building design:** Avoid cluttering up the project bill of materials or filling a telecommunications room with media converters or extenders by reaching farther than Category cabling.
- **Easy deployment:** Install and terminate RemoteIP Cables just like Category cables. Pair with REVConnect connectivity to make installation even faster and easier.

Ordering Information

Description	Belden Part Number
RemoteIP Cable, 4 Pair, 22 AWG, CMP - Plenum, U/UTP, Blue	RIPPU D15A1000
RemoteIP Cable, 4 Pair, 22 AWG, CMP - Plenum, U/UTP, White	RIPPU 009A1000
RemoteIP Cable, 4 Pair, 22 AWG, CMR - Riser, U/UTP, Blue	RIPRU 006A1000
RemoteIP Cable, 4 Pair, 22 AWG, CMR - Riser, U/UTP, White	RIPRU 009A1000

Typical data speeds for video are also provided in the table below. Reducing factors like frames per second or color depth further reduces bandwidth requirements.

Codec	Uncompressed	H.264	H.265	MJPG2000
Resolution	Required Bandwidth			
720p	829 Mbps	1.9 Mbps	1.3 Mbps	11.1 Mbps
1080p	1866 Mbps	4.3 Mbps	3 Mbps	25.1 Mbps
4K	7465 Mbps	17.3 Mbps	12.1 Mbps	100.2 Mbps

Category 6A, Outside Plant Indoor/Outdoor, CMR and CMP

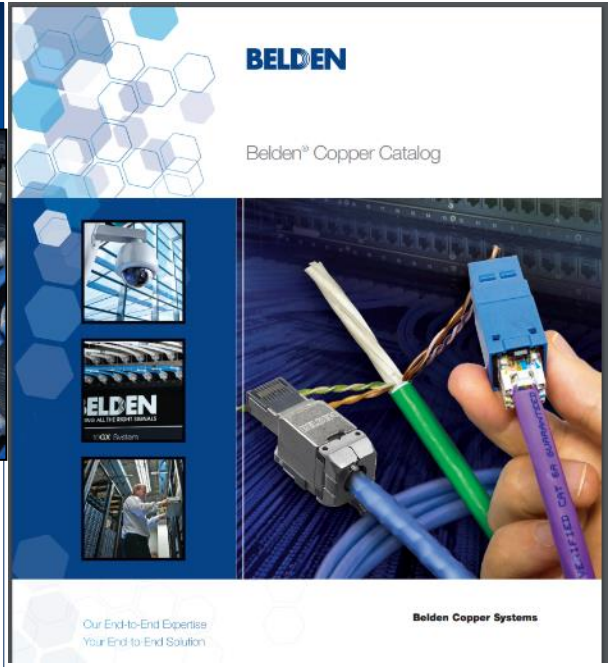
- No need to transition ($$$) from outdoor to indoor rated cables.
- Perfect for slab-on-grade applications
- Available in CMR and CMP rating

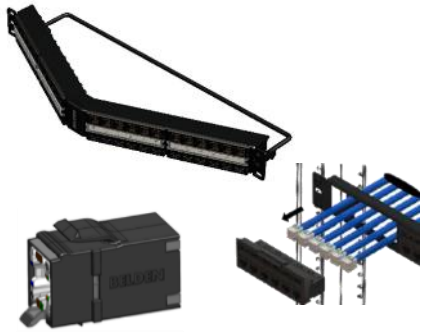
Part #	Description
IOP6AU	Category 6A Indoor/Outdoor Cable, 4 Pair, U/UTP, CMP/CMX, Gel Free

Copper Cable & Connectivity solution

Copper Cable & Connectivity

- Category systems for LAN and Data Center
- Access Control Cabling
- Building Automation & Control





REVConnect Coupler

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Needing More …. Power at greater distance

Notion of “Mission Critical Power”

10 X … POE on steroid

Fault Managed Power Systems FMPS, Class 4

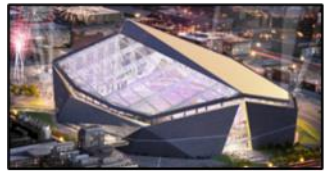
NEC 2023

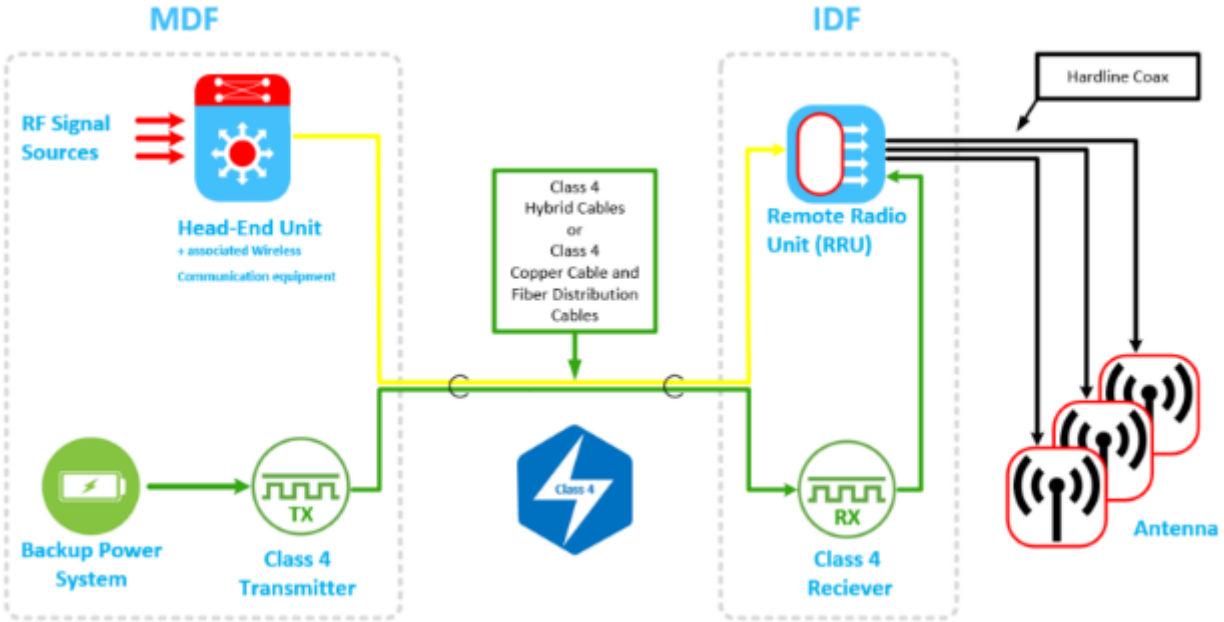
New Articles added for Class 4, Article 726 (System) and Article 722 (Cabling)

- Class 4 is as safe (safer) as Class 2
- Installed in same pathways as Category Cabling
- Installed by same personnel as Category Cabling

Item	Description	Status
2023 NFPA 70 (Article 726)	National Electrical Code	Released
UL 1400-1	Outline of Investigation for Fault-Managed Power **System** Requirements	Released
UL 1400-2	Outline of Investigation for Fault-Managed Power **Cable** Requirements	Released

Class 4, Fault Manages Power Systems
First use case … DAS



- ✓ **Progress- 800+ signature installations**
  - Indoor: DAS, DRAN, small cell, POE, and GPON
  - Outdoor: ODAS, small cell, rooftop macro

WHAT IS DIGITAL ELECTRICITY™ ?

Significant power

at

Significant distance

using

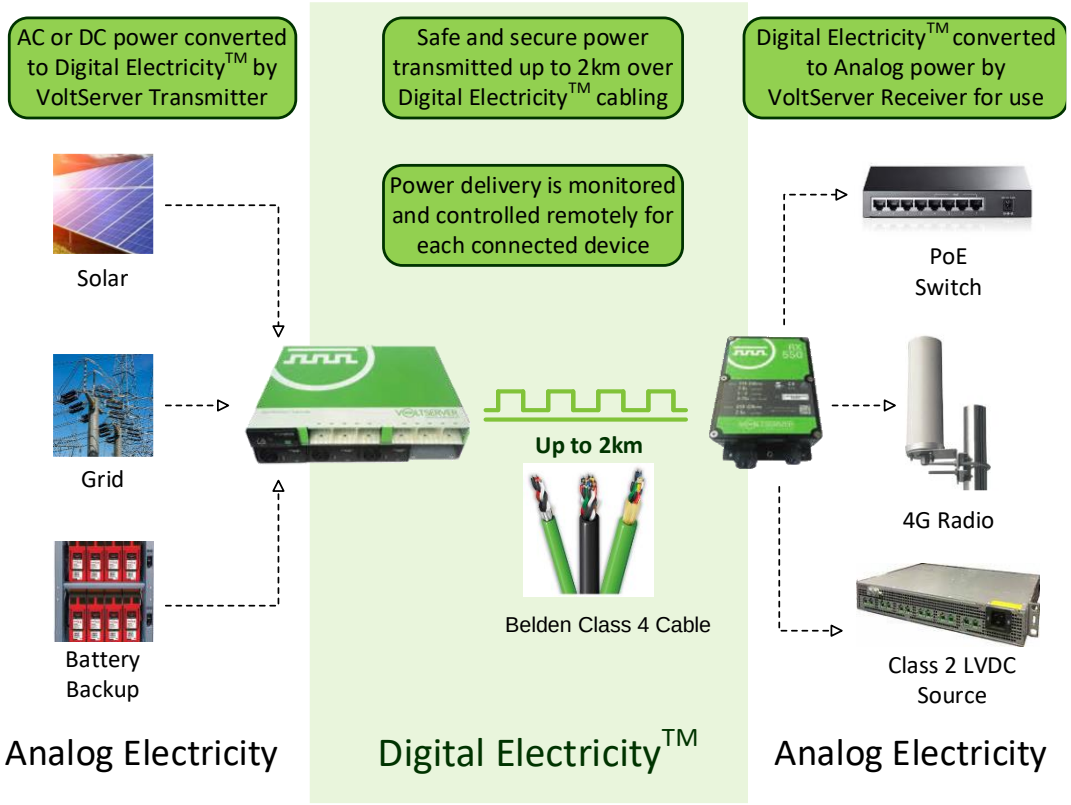
Small conductors

with

Safe delivery

and

Speed of deployment



WHERE - WHY

CLASS 1, 3, POWER

- *AC or 48VDC*
- *Very High-Power Levels*
- *NEC Article 300 Wiring Methods*
  - *Conduit, Permits*
- *Large wire gauge*

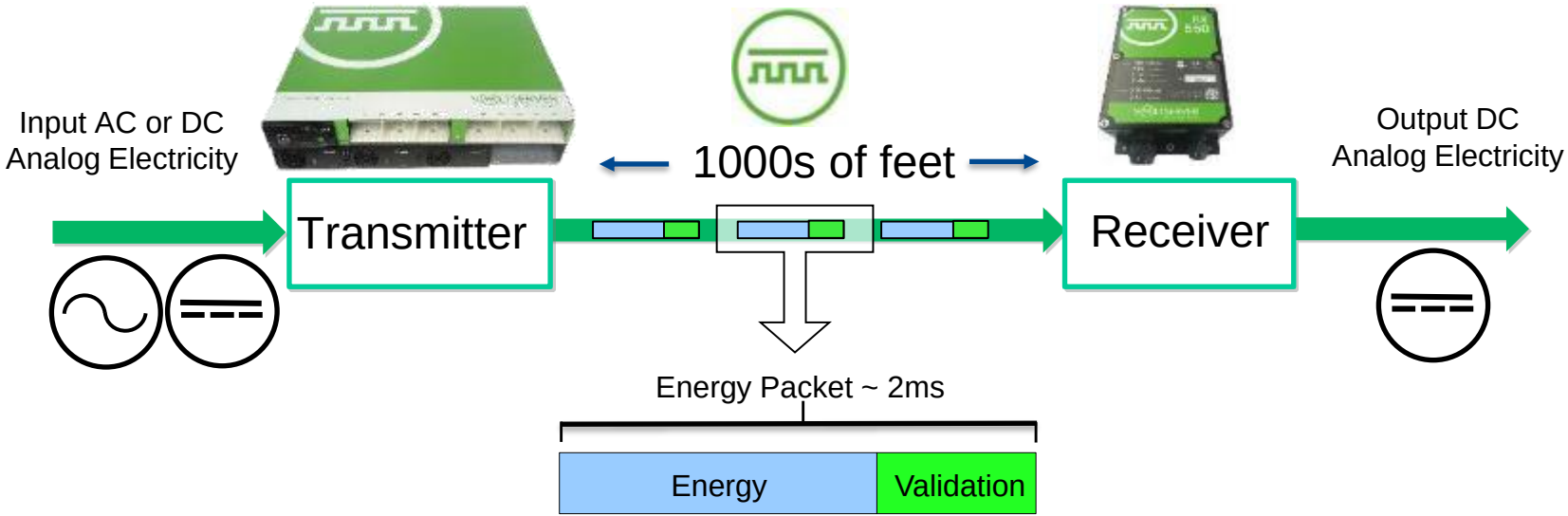
CLASS 4, FMPS POWER

- *Supports powering AC or 48VDC loads*
- *High Power Levels (up to 2KVA)*
- *Class 2 wiring methods, no conduits*
- *Technician labor installations*
- *Minimal wire gauge*
- ***Long range** (up to 2KM)*

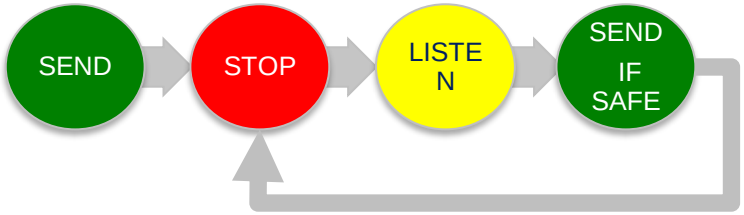
CLASS 2 POWER ex: POE, DC Power

- *Low voltage 100W maximum per pair*
- *Voltage drop limits to short range*
- *Class 2 wiring, no conduits*
- *Technician labor installations*

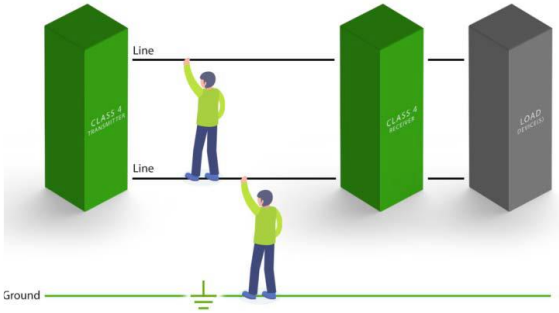
HOW DOES FMPS WORK?



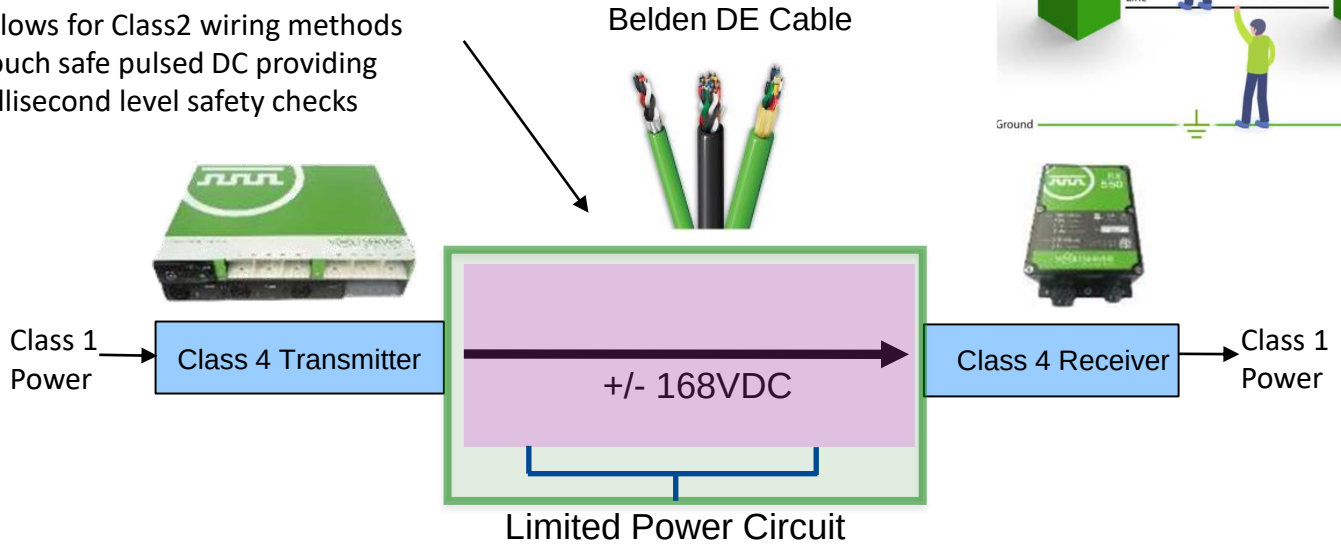
1) Monitor line condition
2) OK? Energize Line and Send Energy Packet, NOT OK STOP
3) De-Energize Line then perform Analog/Digital safety verification
4) OK? send another, otherwise STOP



VOLTSERVER LIMITED POWER SOURCE



Qualified as a Limited Power Circuit
-Allows for Class2 wiring methods
-Touch safe pulsed DC providing millisecond level safety checks



FMPS-Class 4 can be run with:
Power Limited Fire Alarm NEC Art. 760
Fiber Optic NEC Art. 770
Com./Multipurpose Cables NEC Art. 800
Coax NEC Art. 820

Can not be run with:
Power and Lighting (Without Barrier)

LOCATIONS AND APPLICATIONS

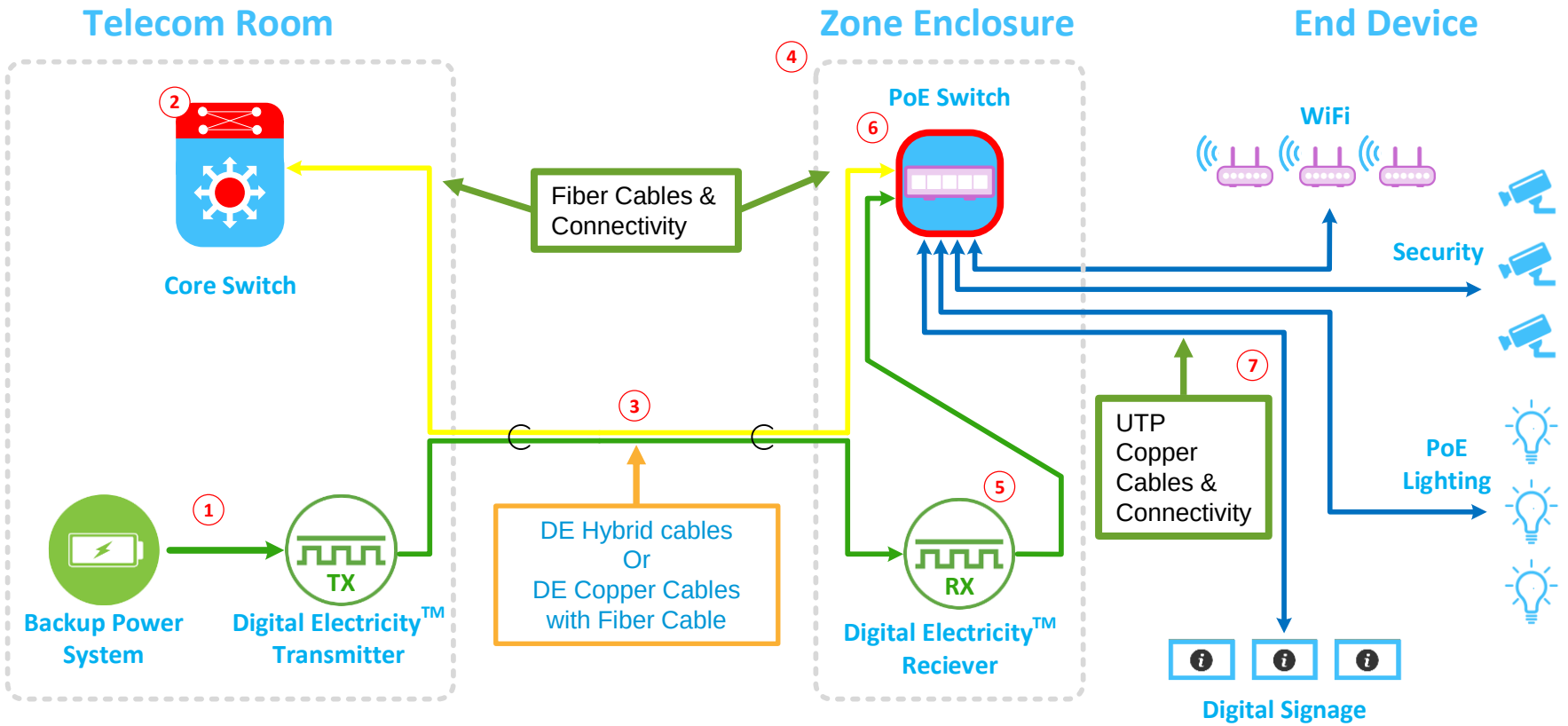
Class 4, FMPS Installed Today In:

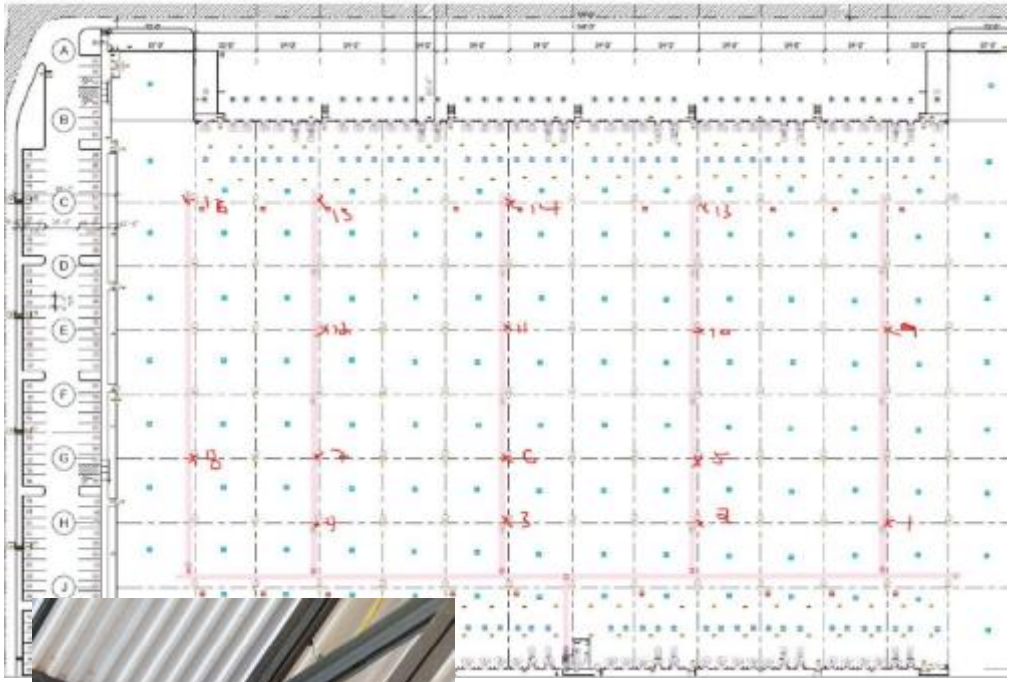
- Large Sports Venues
- Office Towers
- Condominiums
- Medical Buildings
- Hotel Tower
- DC Microgrid
- Airport Terminals
- Hospitals
- Stadiums and Convention Centers

Applications …

- Mobile Radio Power:
  4G LTE, 5G, Carrier WiFi
  DAS, Small Cell, Macro, AP
- Power Over Ethernet Switches:
  Wi-Fi, IoT, Security Cameras
  LED lights, PLC Controllers
- High Speed Communications Power:
  FTTx, GPON, ONT, OLT, xDSL, G-FAST
- Smart LED Lighting Power
- UPS/Centralized Battery Back-Up

Class 4 + PoE Configurations





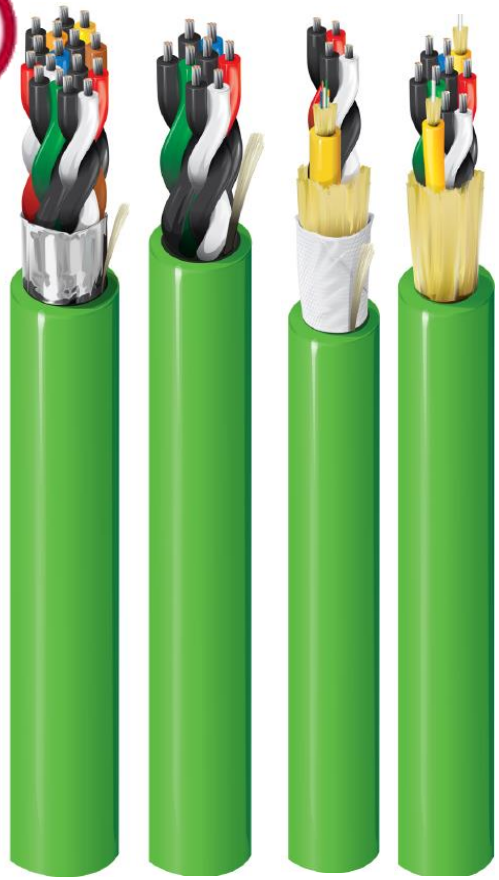
Belden FMPS, Class 4 Cables

FEATURES

- Stranded design maintains cable flexibility
- Conductor sizes: 14, 16, 18 AWG
- Number of pairs: 2, 4 or 8
- 300V rating
- Unshielded or shielded options
- Tinned copper conductors improve cable longevity
- Breakout and distribution fiber constructions
- OM3, OM4 and OS2 type fiber

BENEFITS

- Supports sensing to detect cable problems
- Safe to touch without dangerous electrical shock
- Extended reach (thousands of feet) with mutual capacitance of <35 pF/ft to maintain power-transfer quality
- Ideal for indoor and indoor/outdoor applications
- Hybrid construction means fewer cables to stock and fewer cables to pull



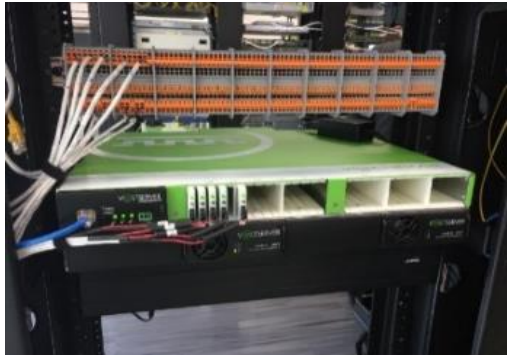
Belden Class 4, FMPS, cables “CL4”

- Supporting ***mission critical power*** delivery between transmitter and receiver

- Improved cable electrical performance to support Class 4
  - Inconsistency in cable or fluctuations in the electrical performance of the cable can cause the fault detection to trip
  - active line monitoring for safety ➤ 500 safety checks per second

- Key attributes;
  - Low conductor to conductor mutual capacitance (<35 pF/ft.)
  - Low resistivity (stranded-tinned copper conductors, 14-16-18 awg.)
  - 300V$_{RMS}$ Rated
  - NEC Article 725 marking
  - Longer reels … 2000 ft. standard, up to 5000 ft.

Fault Managed Power Systems (FMPS) - Reach



14 AWG - Maximum Length (Meters)					
Power (W)	100 W	500 W	1000 W	1500 W	2000 W
2 Pairs	2000	1070	515	330	240
3 Pairs	2000	1605	**775**	495	360
4 Pairs	2000	2000	1035	665	480

18 AWG - Maximum Length (Meters)					
Power (W)	100 W	500 W	1000 W	1500 W	2000 W
2 Pairs	2000	425	205	130	95
3 Pairs	2000	635	**305**	195	140
4 Pairs	2000	850	410	260	190

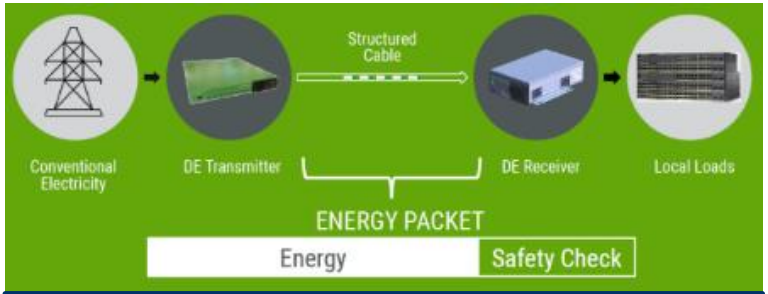
Design Input …

- What power source(s)

- List of equipment to be powered in each remote location
  - Load
  - Power requirement (AC, DC)
  - Equipment spec sheet, model #

- Distance from Telecom Room to remote Zone(s) > TR, IDF, enclosures

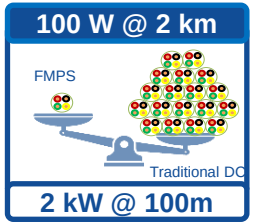
Fault Managed Power (Class 4) Systems Overview



FMPS permits system components to be placed anywhere they are needed

ICT Integrator installing Class 4 cabling in same cable tray as ICT cabling

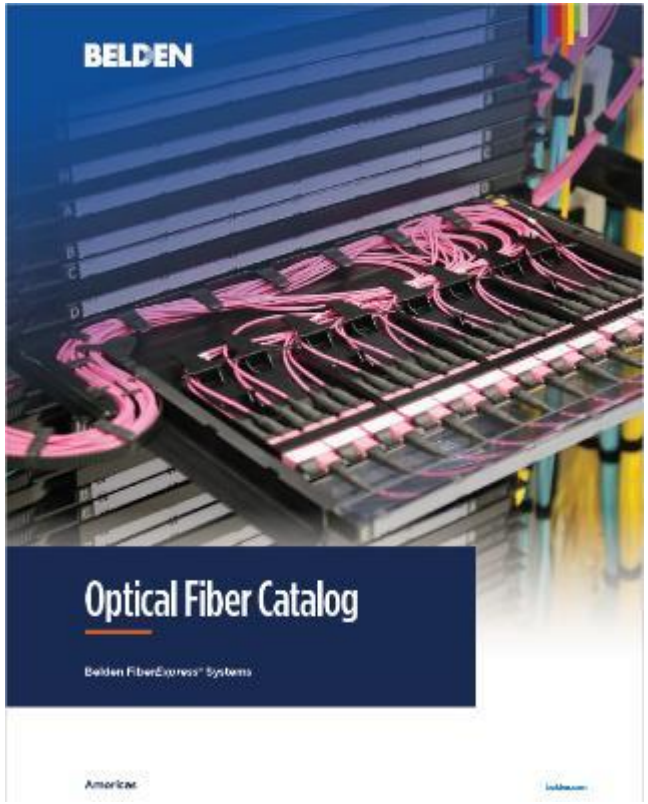
- **Safe Delivery**
- **Significant Power**
- **Significant Distance**
- **Smaller Conductors**
- **Speedy Deployment**

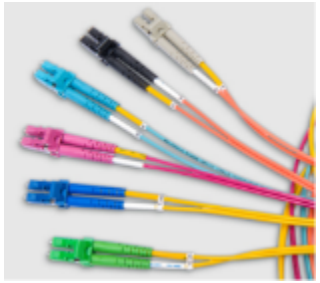


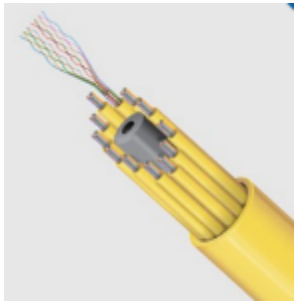
Treated the same as:

- PoE
- Category Cables
- Fiber

Fiber Cable & Connectivity solutions







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Remote IP and Class 4 Power Resources and links;

- Application-Based RemoteIP Cable
- Belden RemoteIP Cable offering

- Class 4 Systems Change How Technology is Powered
- Fault-Managed Power System (FMPS) Cables
- FMPS Cables Product Bulletin
- The Industry's First UL-Certified Class 4
- Here Comes Class 4 Power: Differences Between Circuit Classes
- www.VoltServer.com

Thank You !

BELDEN

Let's build the future.

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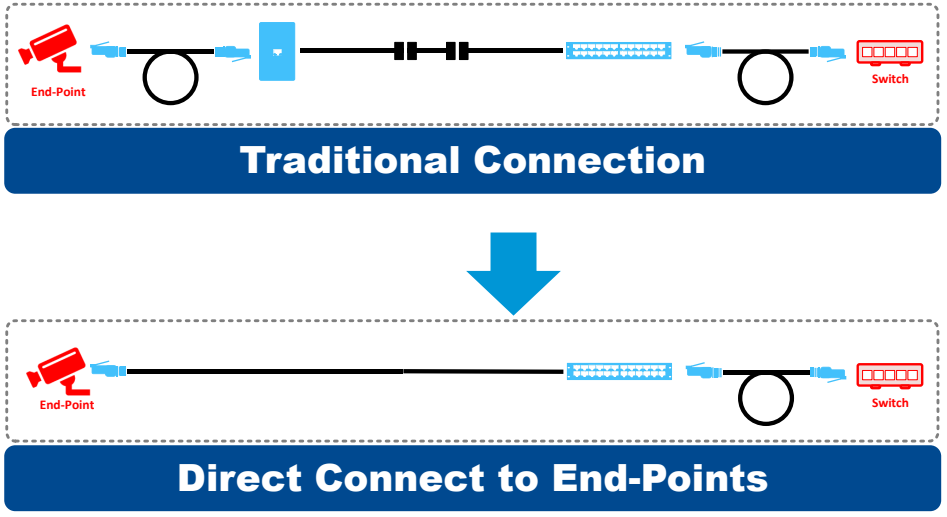
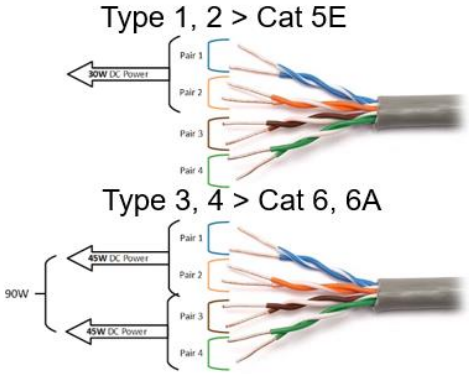
New Approaches: Direct Connect Modular Plug Terminated Link (MPTL)

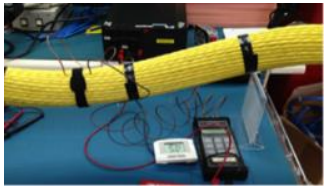
Modular Plug Terminated Link



Included as a normative Annex F in TIA568.2-D

Need for speed (10Gb/s) power (100W)





2020 NEC
LP Ratings
Limited Power

Speed Challenges (10Gb/s):

- 625 MHz bandwidth, attenuation-insertion loss, cable diameter (0.295”>0.250”)
- Noise from neighboring cables (Alien Cross Talk)
- Immunity from surroundings EMI (Cable balance, Cable geometry control)

Power Challenges (100W POE):

- DC loop resistance (< 25 ohms)
- DC unbalance (data signal distortion, bit errors)
- Temperature rise in bundled cables (impact on attenuation-IL and fire risk)
  - Heat dissipation techniques

EquiSpline™ Design

Smaller Diameter 0.265”, 0.250” ✓

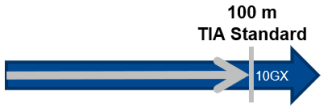
Saves up to 25% on space and weight with small OD

Highest Power Rating ✓

PoE

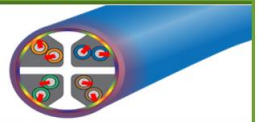
Energy efficient with less risk of system slow down through 100W

Exceeds TIA 100 m ✓



10GXS Cables do not compromise on channel length

Reduces heat transfer ✓



EquiBlock™ Barrier Technology achieves uniform heat flow dissipation while maintaining insertion loss performance

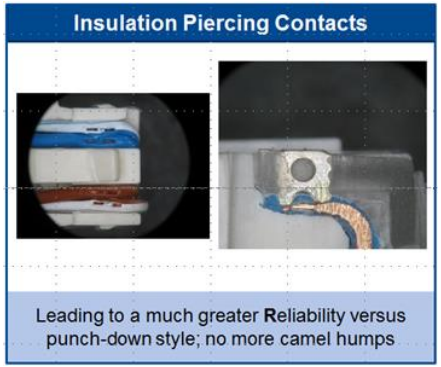
Less Noise ✓

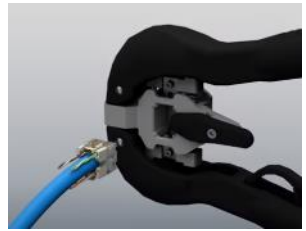
Other Category 6A solutions have an average of 200% more noise coupling than 10GX Cables

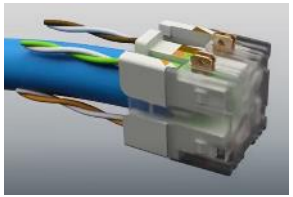
Belden REVConnect connectivity with core technology

Why REVConnect:

- Reliable > Increase first pass yield from 92-95% to 99%
- Easy for Tech's and Quicker to terminate (20%+)
- Versatile > Convert from jack to plug in a snap







The cabling industry was ready for a small **REV**olution!

BELDEN
SENDING ALL THE RIGHT SIGNALS

REVConnect
By the Numbers

RELIABLE

First pass yields with REVConnect to exceed 99% for all styles including 10GX jacks and plugs through insulation piercing contact technology

99% FPY

REVConnect fully supports all performance and reliability requirements required for 100W PoE

100W PoE

EASY

25%

Termination time over 25% faster with REVConnect versus other RJ45 brands

Save up to **60% labor time** when using Belden's patented bonded-pair cable

Speed up installer training and stay on schedule with only one termination method for all RJ45 connectors including 5e, 6+ and 6A jacks and plugs

1

VERSATILE

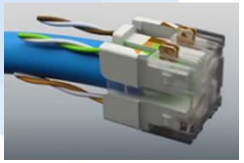
REVConnect FlexPlug provides

100% IoT device compatibilty with devices using standard RJ45 plugs

200+ PRODUCTS

Expand the REVConnect benefits and savings across your entire system with over 200 products that include jacks, plugs, couplers, patch panels, pre-terminated assemblies and wall-mount systems

Stay on budget and on schedule with up to **10% reduced deployment and testing time** by improving project logistics with the system's unique and innovative **cap-and-go flexibility**



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