

Willkommen

Latest trends in Device connectivity Vikas Grover P.Eng


Technologies
Experience future-oriented solutions and products.

Latest Trends in device connectivity

Agenda

1. DC Grids & Higher Voltage
2. DIN Rail to PCB
3. Hybrid connectivity & IEC Standardization
4. Improving Production efficiencies
5. Advanced Shielding Technology
6. Optimum heat management
7. Single Pair Ethernet

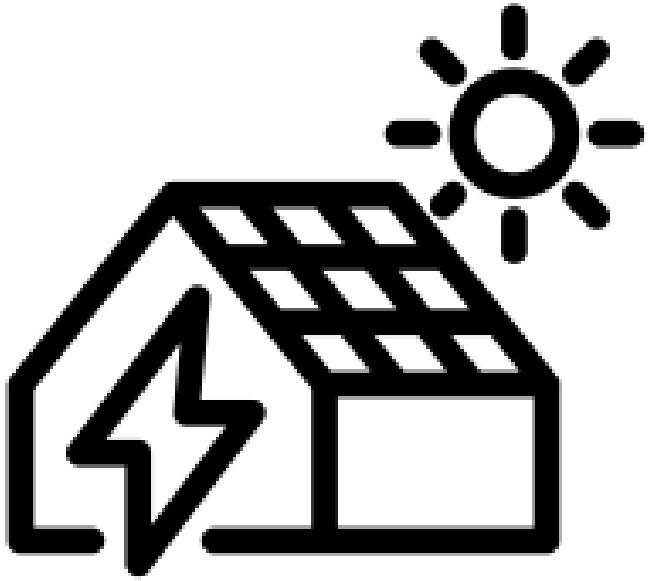
1. DC Grids & Higher voltage

Motivation for DC Grids

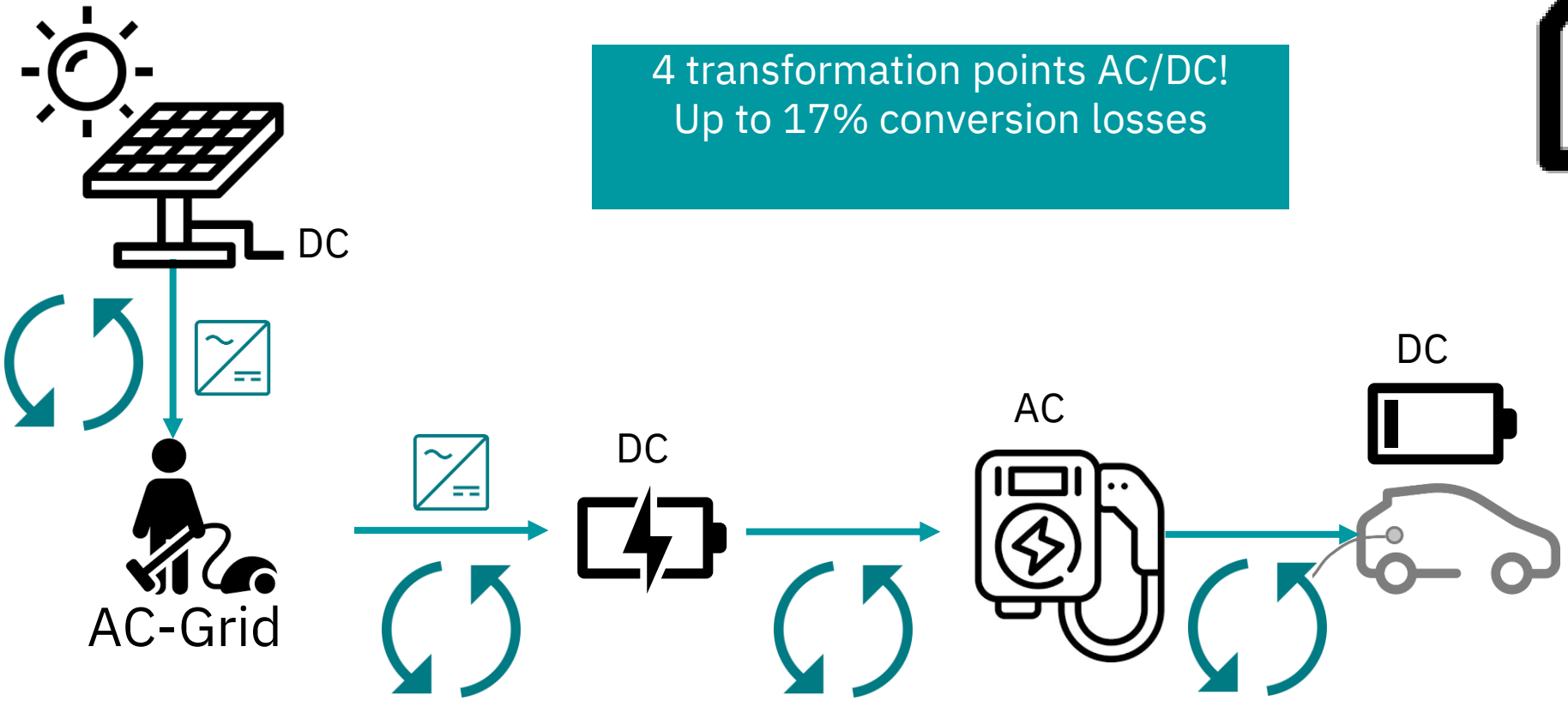
Our World is Electric



Energy conversion losses (AC/DC)

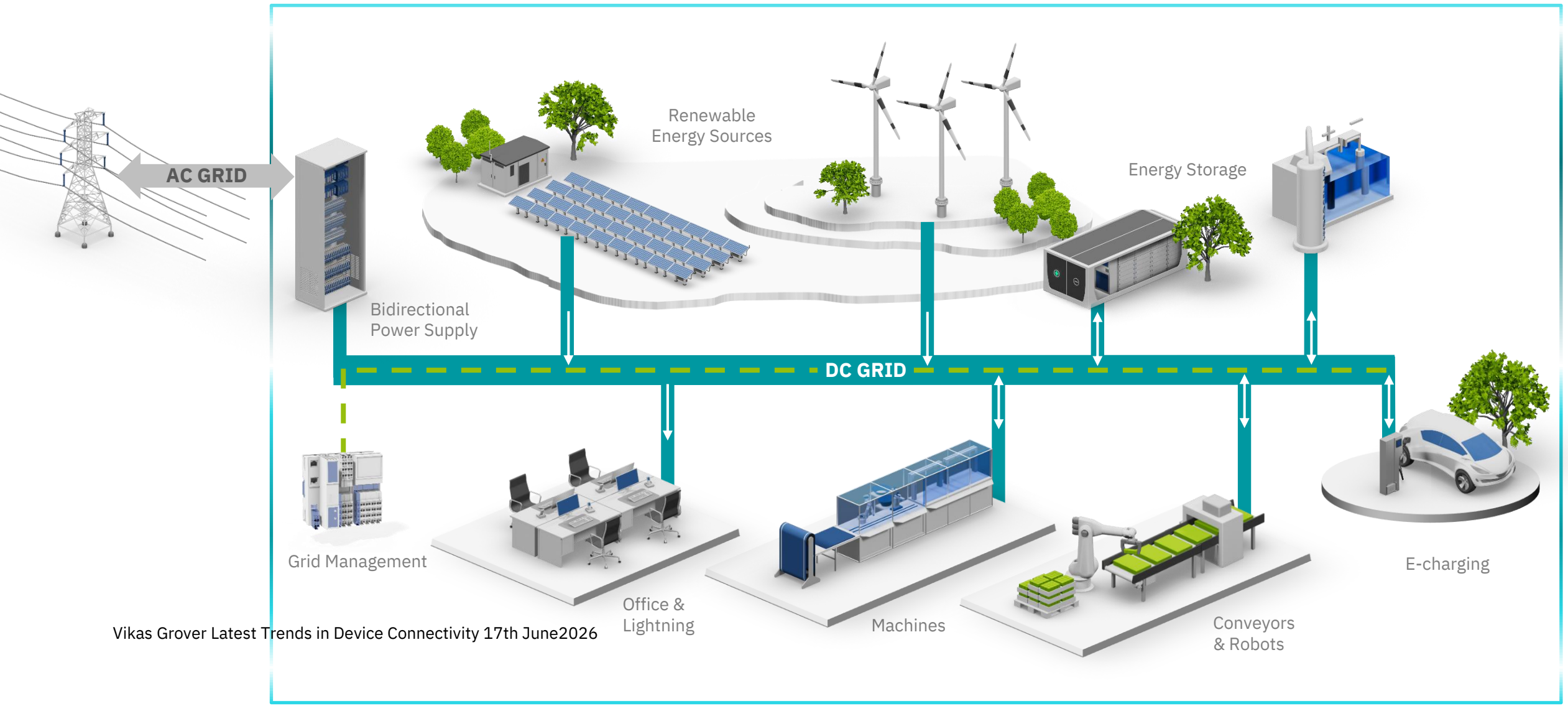


4 transformation points AC/DC!
Up to 17% conversion losses



Overview

DC-Microgrid in Industry



Terminal blocks up to 1500 V

General

- Demand for products with higher voltages is increasing consistently, especially in the following sectors:
  - Renewable energies
  - Charging infrastructure
  - Battery storage systems
  - Power supplies

- Advantages
  - Higher electric voltages = Lower power losses
  - Reduced use of copper materials = cost saving





Terminal blocks up to 1500 V

General

- Most of the transmission losses are due to resistance loss.
- By doubling voltage, the current and therefore conductor cross section can be reduced while having the same power output.
  - $P = U * I$

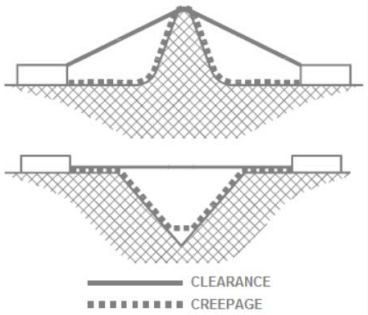
- Why 1500 V?
  - The Low Voltage Directive 2014/35/EU covers health and safety risk on a wide range of electrical equipment for voltages of:
    - 50 – 1000 V AC
    - 75 – 1500 V DC



Terminal blocks up to 1500 V

Requirements

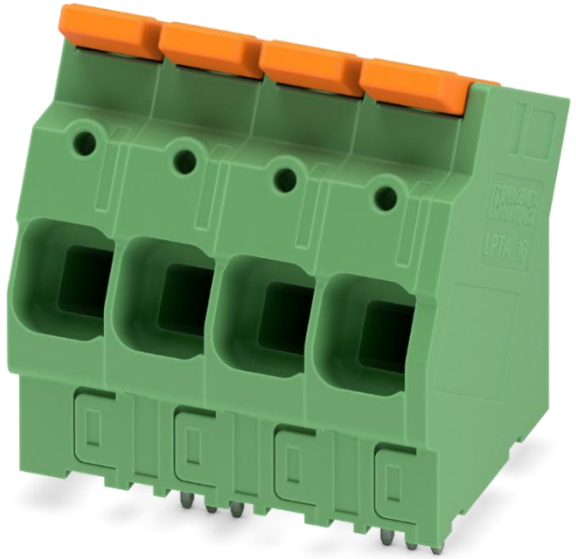
- Clearance and creepage distances
  - UL1059 Usegroup E:
    - Through air = 17.8mm, over surface = 30.5mm
  - UL 840 / IEC 60947-7-4 (Usegroup F)
    - Through air = 14mm, over surface = 20mm
- Approved materials
  - Materials with Voltages > 600 V the Inclined Plane Tracking (IPT) applies and has to be 1,5 kV for 1500 V
  - In addition, UL 1059 requires a minimum wallthickness of 0,38 mm



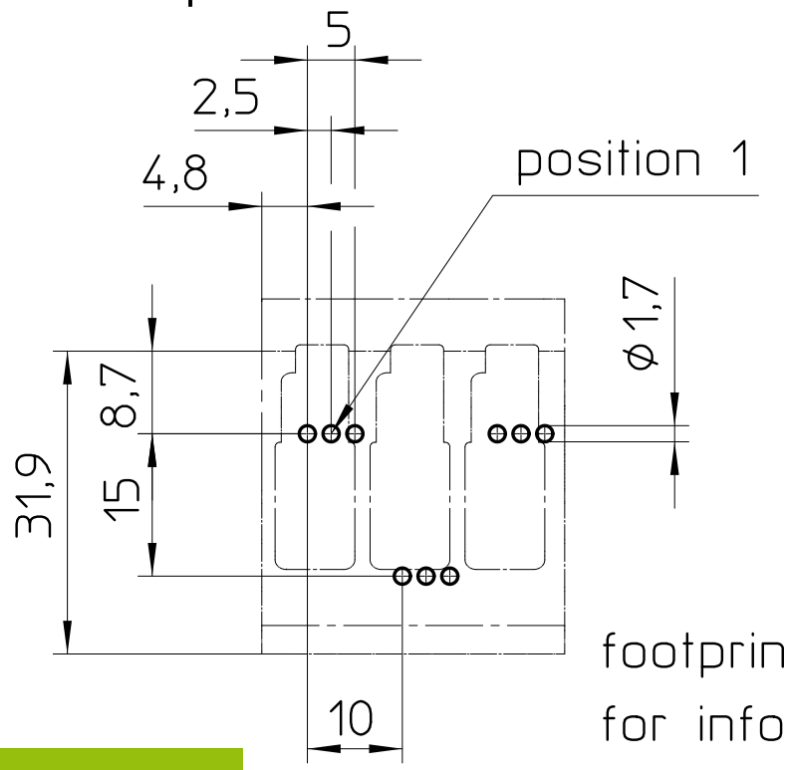
	Application	Potential involved in volts
A.	Service – including dead-front switchboards, panelboards, service equipment, and the like	51 – 150
		151 – 300
		301 – 600
B.	Commercial appliances, including business equipment, electronic data processing equipment, and the like	51 – 150
		151 – 300
		301 – 600
C.	Industrial, general	51 – 150
		151 – 300
		301 – 600
D.	Industrial, devices having limited ratings[b]	51 – 300
		301 – 600
E.	Terminal blocks rated 601 – 1500 V[c]	601 – 1000
		1001 – 1500
F.	Industrial, devices using the alternative approach to spacings[d]	51 – 1500
G.	LED lighting equipment[b]	51 – 300
		301 – 600

UL COPYRIGHTE

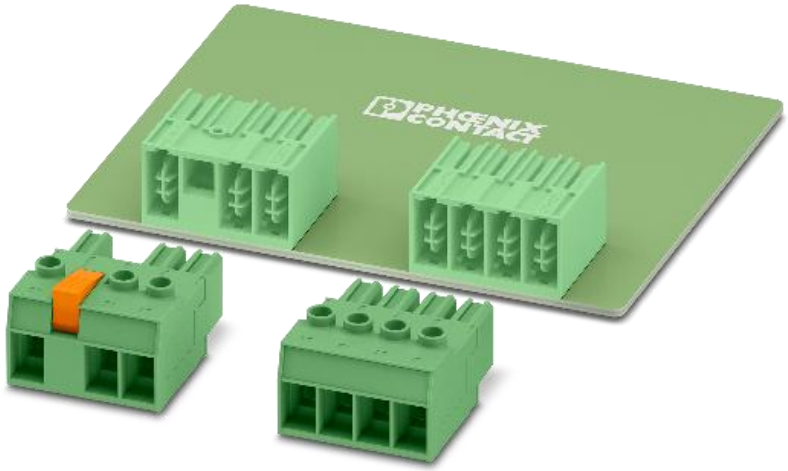
Terminal blocks up to 600V/1000 V

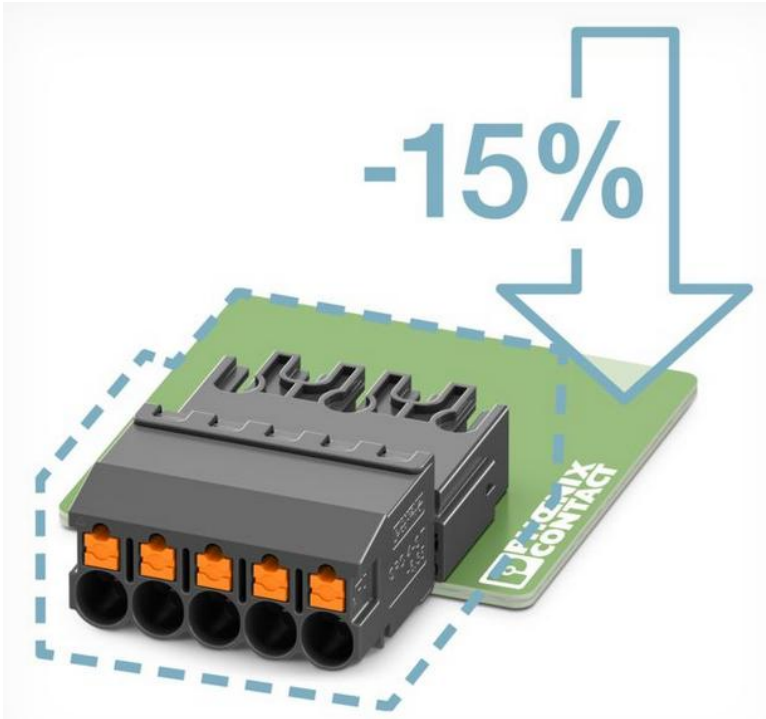


Footprint:



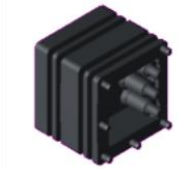
Zig-zag pinning allows 1000 V



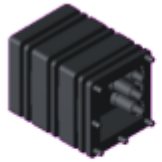


Terminal blocks up to 1500 V

- SPT Modular
- Cross sections:
  - 1,5 – 35 mm²
- Connection direction:
  - vertical
- Different spacer for different cross section + voltages
- UL + VDE Approval for up to 1500V DC
-



SPT 1,5/2,5 Spacer 1000V



SPT 1,5/2,5 Spacer 1500V



SPT MODULAR - PCB terminal block

1237697

PCB terminal block, modular, Push-in spring-cage connection, 3.5 mm ... 15 mm pitch, rated current up to 125 A, rated voltage up to 1500 V depending on the selected spacer, rated cross-section of 1.5 mm² ... 35 mm², individual configuration

Made to order
Product is made for you and cannot be returned.

Customizable Item

Why can't I see prices?

CONFIGURE

Piece 10

Minimum order quantity: 10 piece
Packing unit: 10 piece
Break packing: not allowed

ADD TO CART

Where Can I Buy This Item?
Ask a Question
Show product details (PDF)
Product Help

Product details

Expand all

Technical data

Commercial data

Downloads

Classifications

Approvals

Environmental product compliance

Battery pole connectors

Safe connections for energy storage systems

NEW

Main features

- Rated current: up to 400 A
- Rated voltage: 1,500 V
- Conductor cross-section:
  16 mm² ... 120 mm²
- Pollution degree 2
- Degree of protection: IP65, IP67
- >100 insertion cycles
- Mechanical and color coding



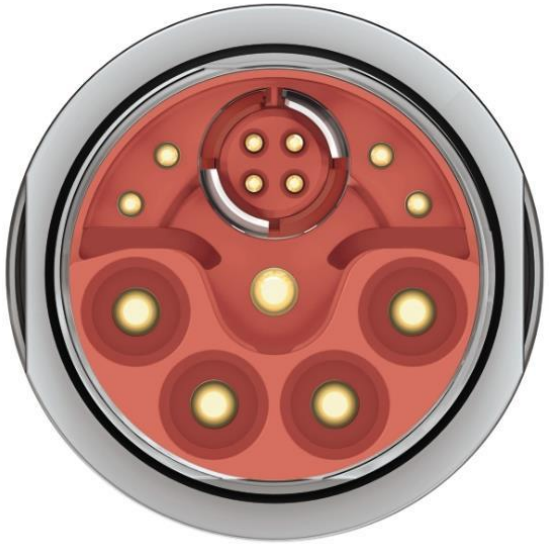
Gain info

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2. Hybrid Connectivity & IEC Standardization

Why Hybrid connectors?

Ethernet	Profinet	Ethercat	Sercos	Powerlink	Endat2.2	SPE



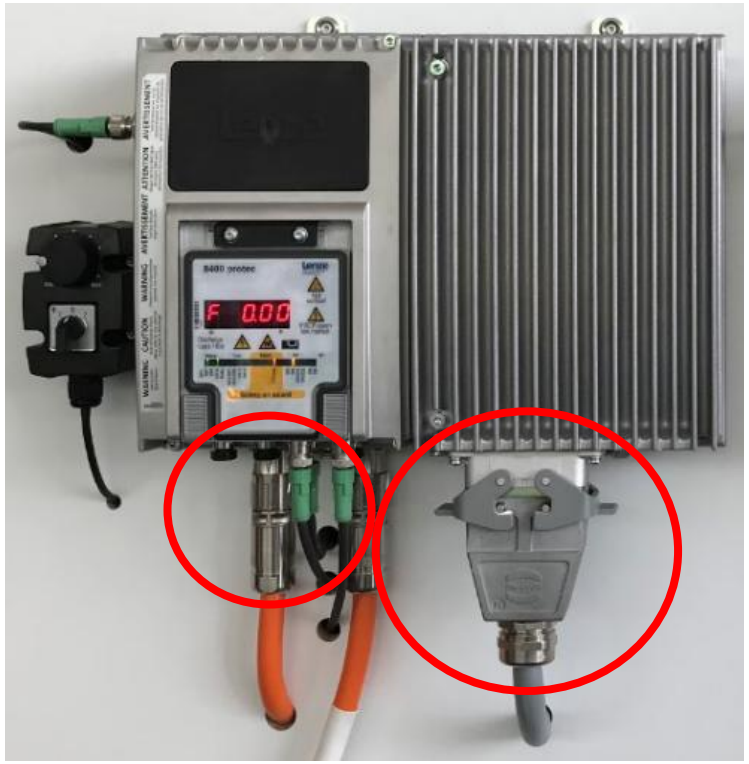
Ready for Industry 4.0 !

- **Degree of automation** in the industry increase constantly
- **Data rates** increase for "intelligent" motors / actuators
- growing communication **down to the field level**
- **EMI requirements** increase
- One cable solution reduces the **number of connection points**
- **cable trays** become smaller
- **DaisyChain** motor applications are simple to implement
- **Weight reduction** of devices

Confidential – For internal use only

Cobots - collaborative robots in industrial production

Advantages of Hybrid connectors





- Hybrid connector for „ 3 in 1“ wiring
- Space saving installation

Hybrid connectors with different manufacturers





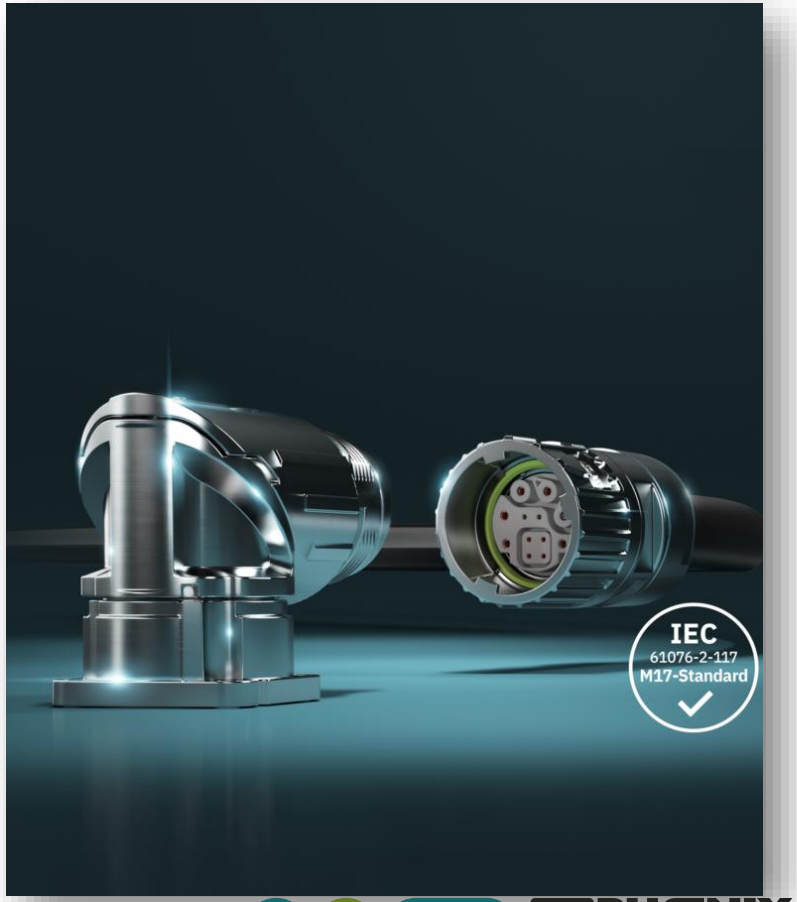




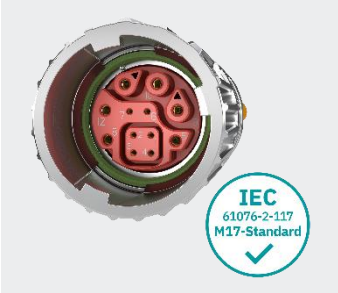
Hybrid connector

Perfect combination of 3-in-1 and standardization

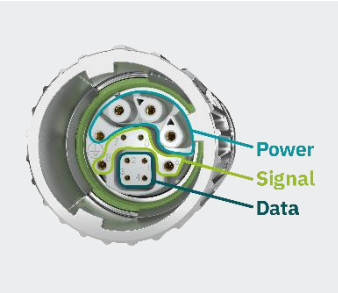




Your added value in the application



Pin assignments based on the IEC 61076-2-117 standard



Compact devices, with a space-saving 3-in-1 solution



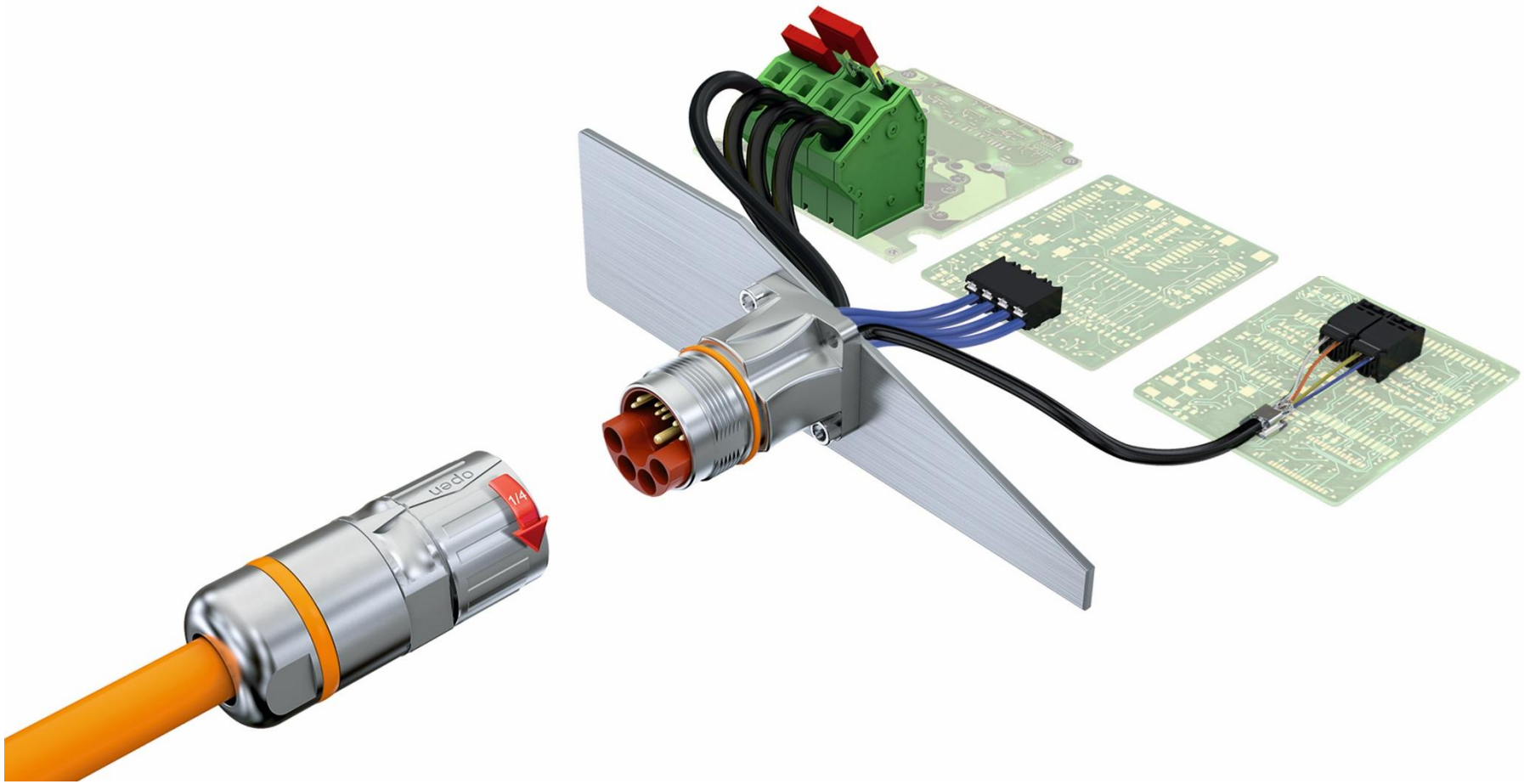
Time savings with fast and easy installation

HIGHLIGHT

PHOENIX CONTACT

Cobots - collaborative robots in industrial production

Hybrid, 3 in 1 - signal, data and power



M17 PRO Hybrid and M23 Hybrid PCB Mount Connectors

Space-saving 3-in-1 solution

Your advantages

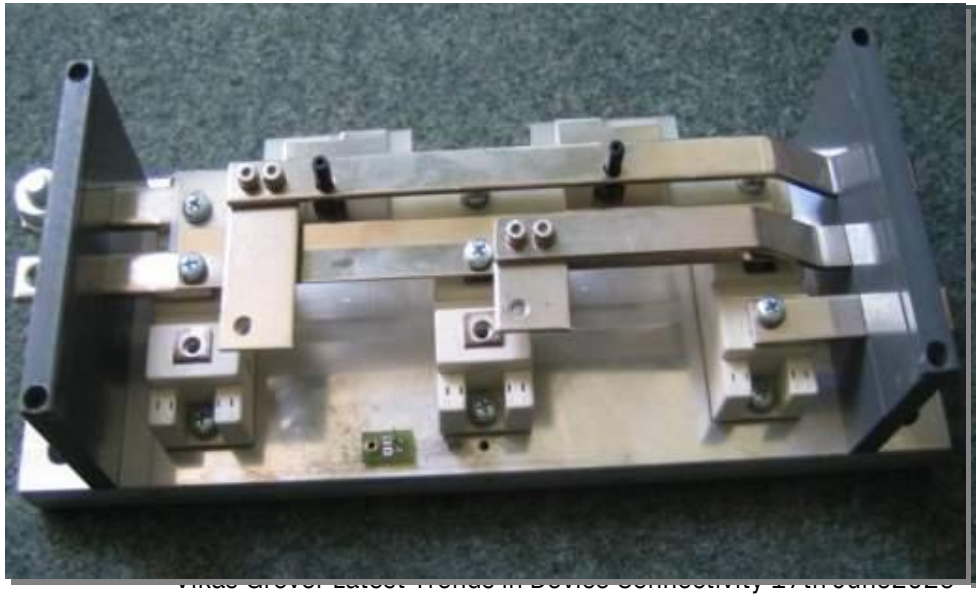
- Reliable transmission of signals, data, and power in a single connector
- 80% faster mounting and 60% less installation space compared to litz wire assemblies
- Cost reduction due to the elimination of additional PCB connectors
- Reduction of PCB complexity and EMC risks
- Elimination of work steps containing high error potentials



3. DIN Rail to PCB

Invertors changing from using Bus Bar to PCB

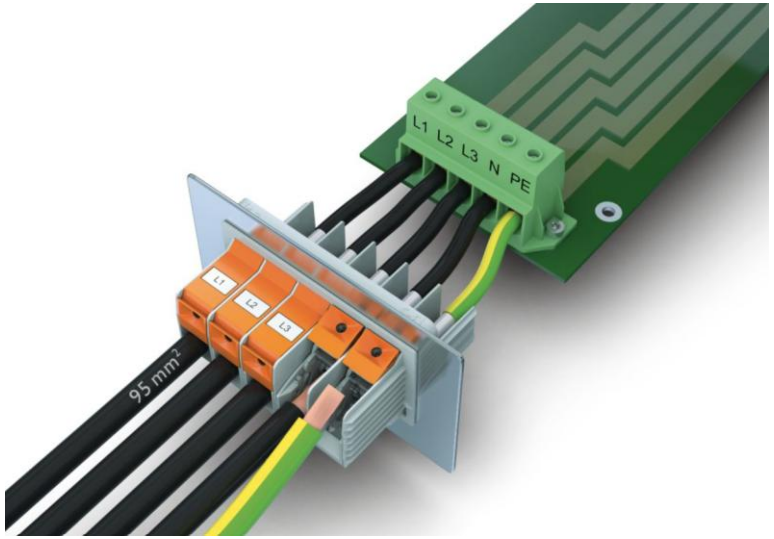
Conventional technology / power separated from control:



High-current PCB technology / integrating the power and control unit on one PCB:



200A for panel & terminal block on PCB

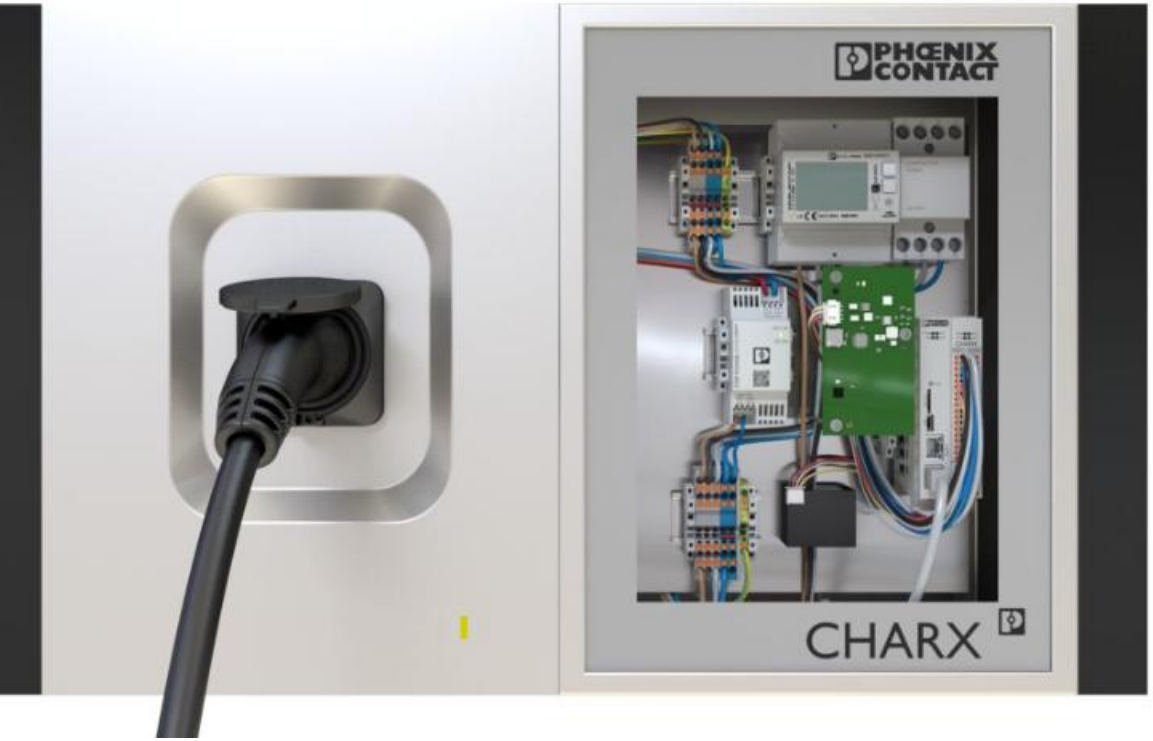


EV Charging Infrastructure

AC Charger changing from using DIN rail to PCB

DIN rail mounting

EV Charger 1



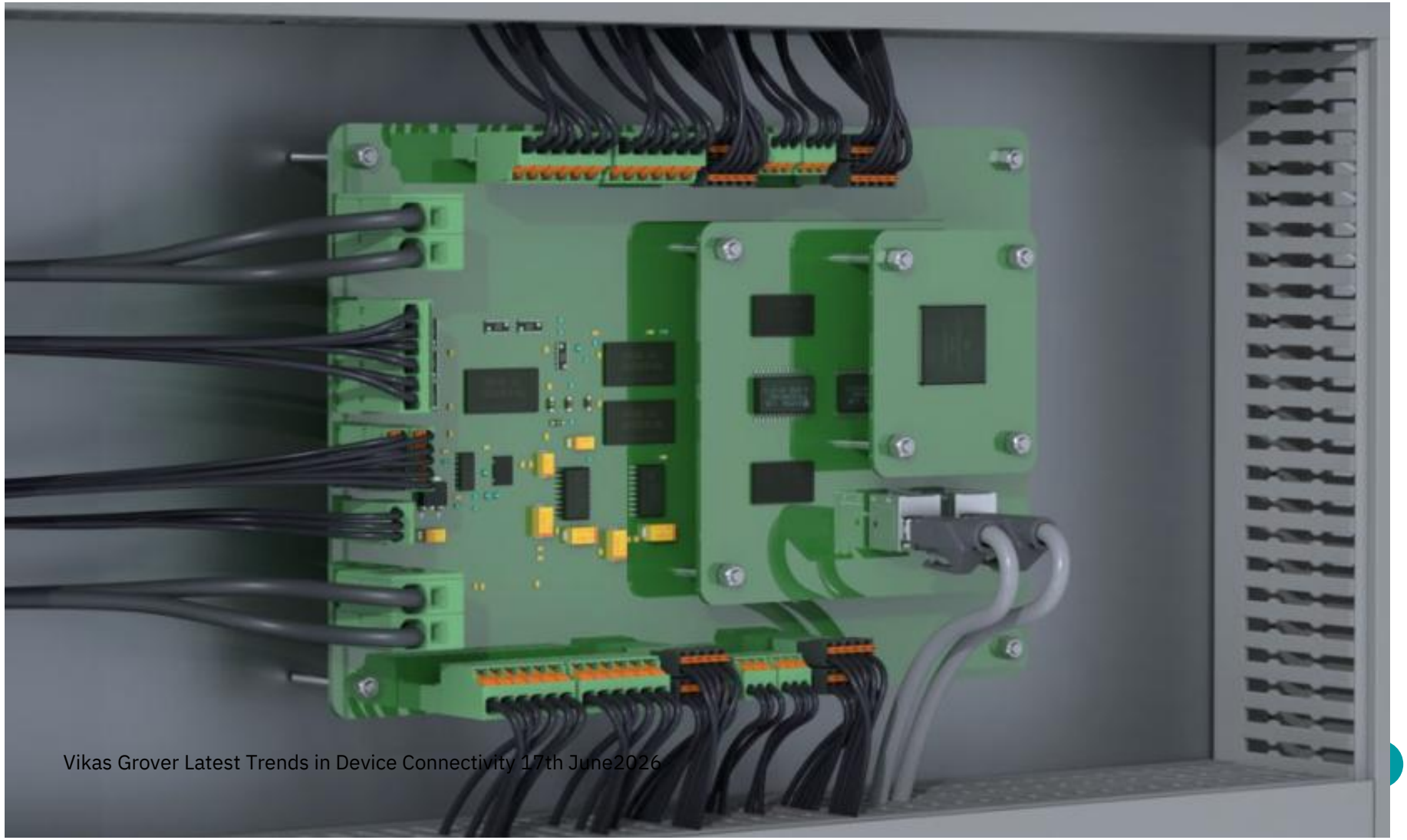
PCB mounting

EV Charger 2



EV Charging Infrastructure

PCB-based DC charging station: Controller detail



4. Improving Production efficiencies - THR connectors

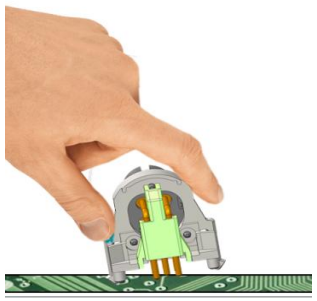
M12 THR right-angle connector for automated production

New design for Robotic Assly



40 sec.





-95 %

2 sec.

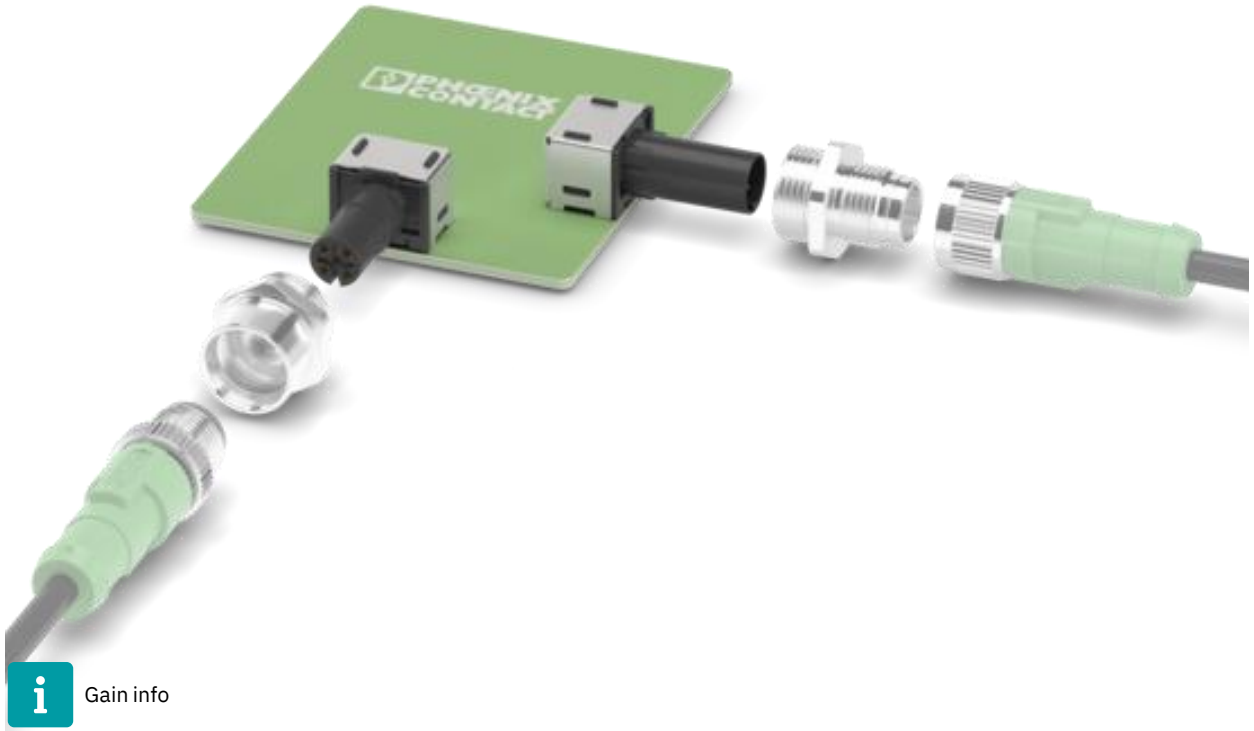




Angled M12 device connector for THR

NEW

Increases efficiency in production



Gain info

Your advantages

- Suitable for pick-and-place: automated assembly on the PCB helps to increase efficiency in production
- Optimized design: shifted center of gravity, thereby “effortless” standing on the PCB without locking clips
- Flexible: easy positioning and alignment on the PCB even in confined spaces
- Modular: compatible with the available THR housings

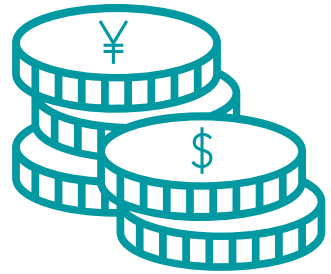
4. Improving Production Efficiencies

- New Technologies for faster connectivity

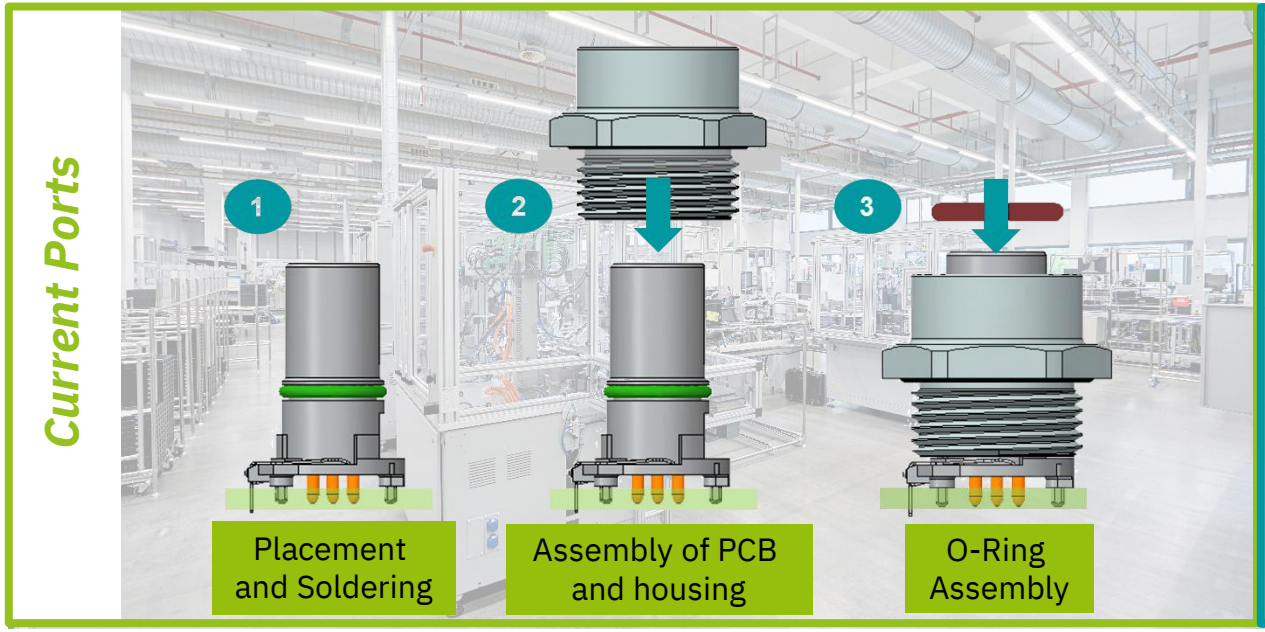
Push-Pull technology

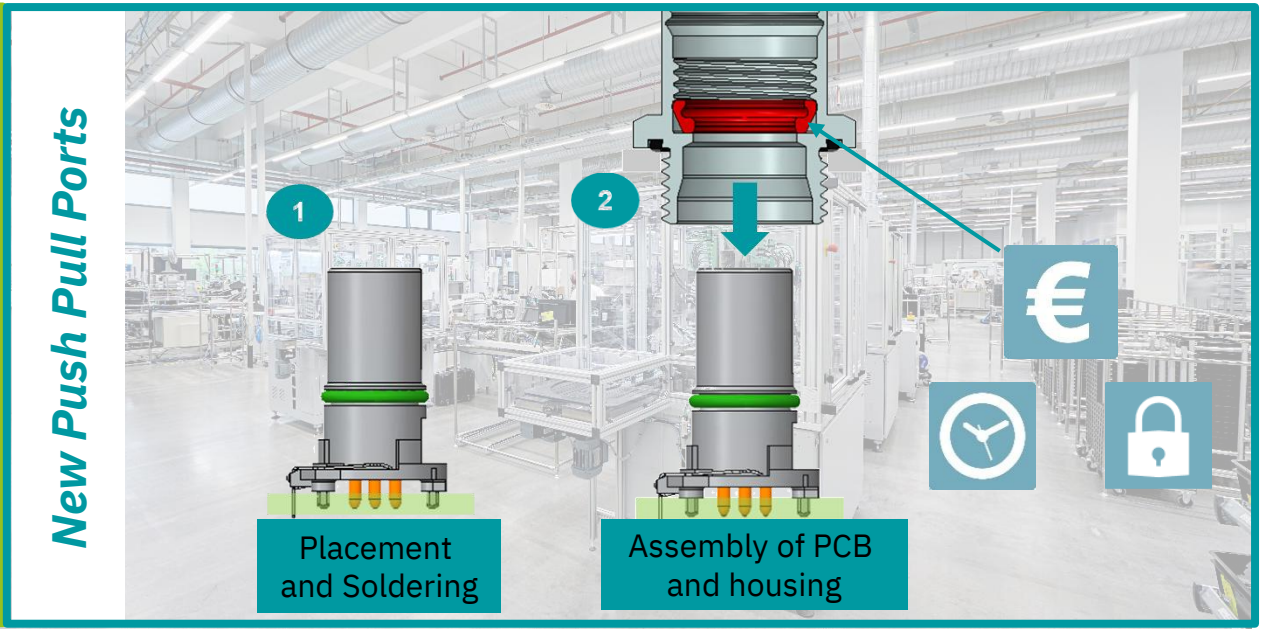
Technology update

- O-Ring Assembly
- Time & handling cost reduction
- Failure prevention



Time saving in the production (~10s)





Focus on push-pull technology

Installation today ... screw... screw... screw...



8 x screw

ca. 75 sec x 50,- € / h = 1.04 €



Installation tomorrow ... push... push... push...



ca. 22 sec x 50,- € / h = 0.30 €

Assumption: 10,000 boxes with 8 ports/year

Savings: 10,400€ - 3,000 € = 7,400 € / year



M12 push-pull power device connectors

High Power transmission in M12

NEW

Main features

- M12 push-pull internal and external locking
- One M12 device connection for screw and push-pull connectors
- Different housing versions for different installation conditions
- Voltages up to 600 V
  Currents up to 16 A



SACC-FP-FPF-M12/M16 THR PW PPI

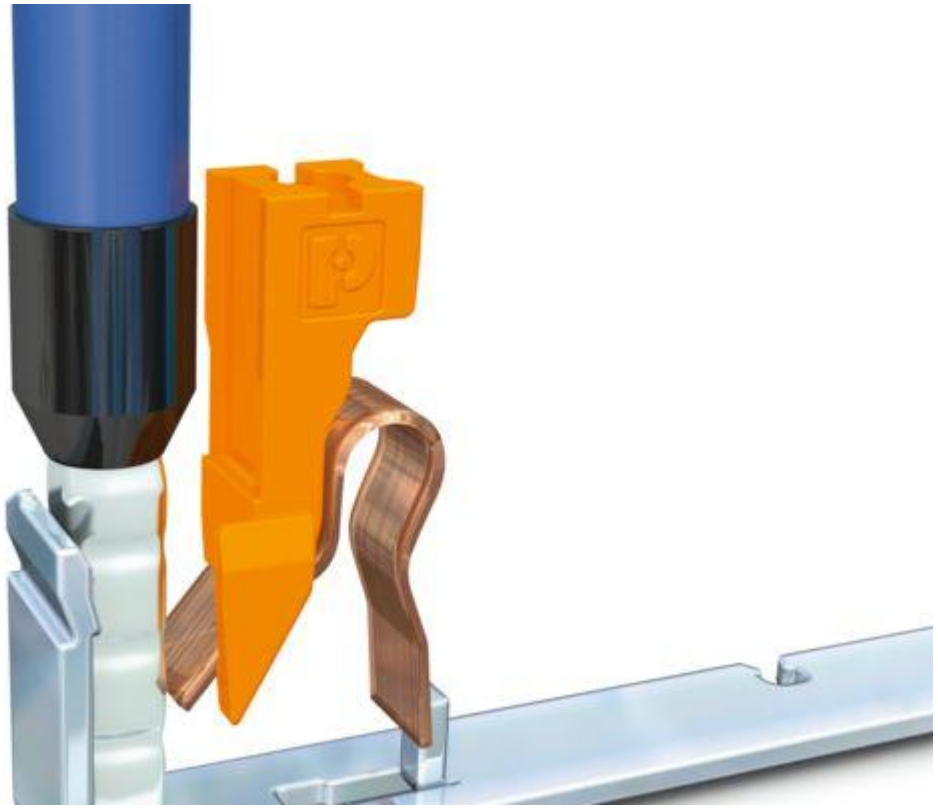
Your advantages

- Quick and reliable connection even in confined spaces
- Time savings of 80% during installation compared to screw connection
- Easy design-in: countersunk M12 ports for compact device concepts

Gain info

Push-in connection





High Current Heavy duty connector also available with Push-In



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Push-X technology

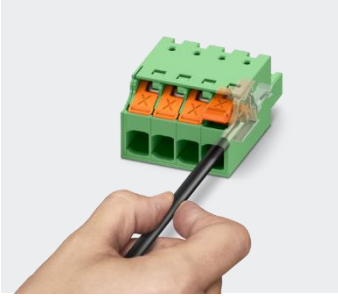
Push-X technology enables direct conductor connection of flexible and rigid conductors with or without ferrules.

ORDER FREE SAMPLES

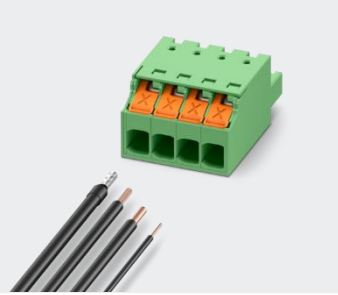


PHOENIX CONTACT

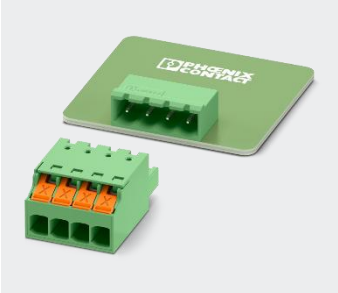
Push-X Technology



Highly convenient operation thanks to effortless and tool-free conductor connection



Quick installation of all types of conductors with and without ferrule



Compatibility with existing COMBICON portfolio connectors

Push-X Technology

Designed by Phoenix Contact

HIGHLIGHT

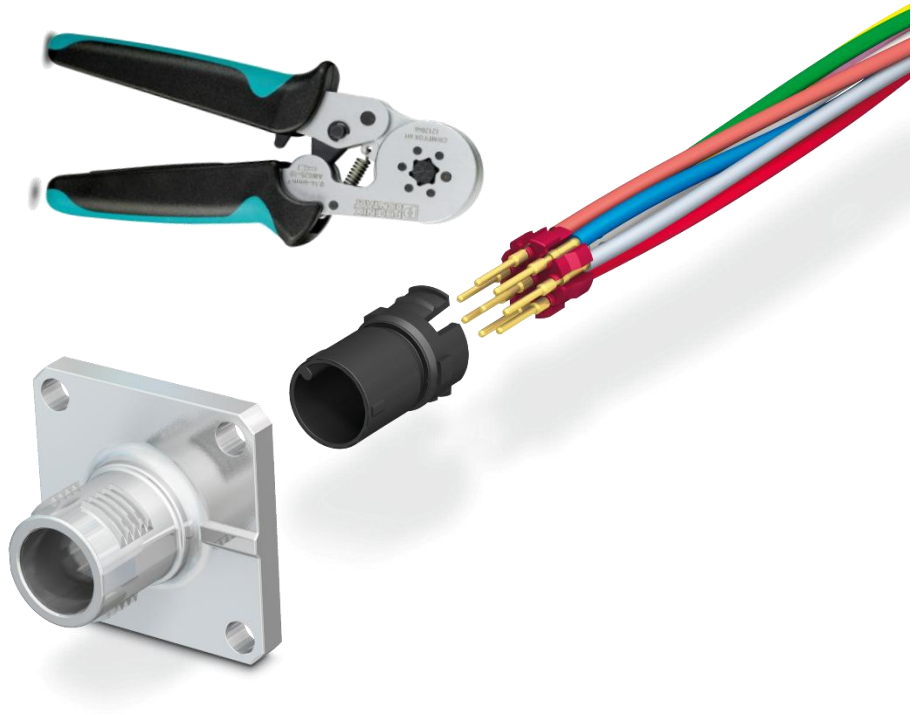
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M12 Panel Feed-Through Solutions / Push Lock

Connect toolless in the field

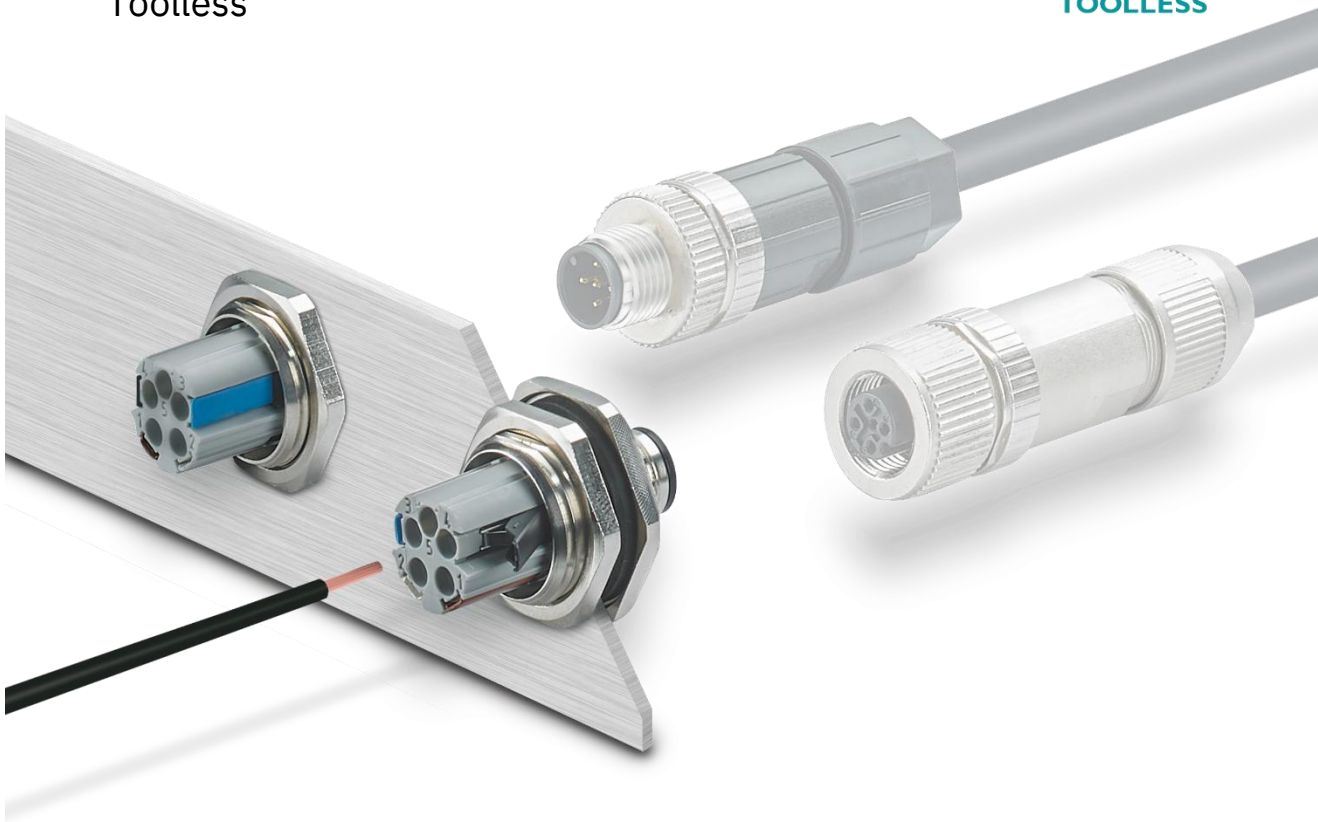
Crimp connection

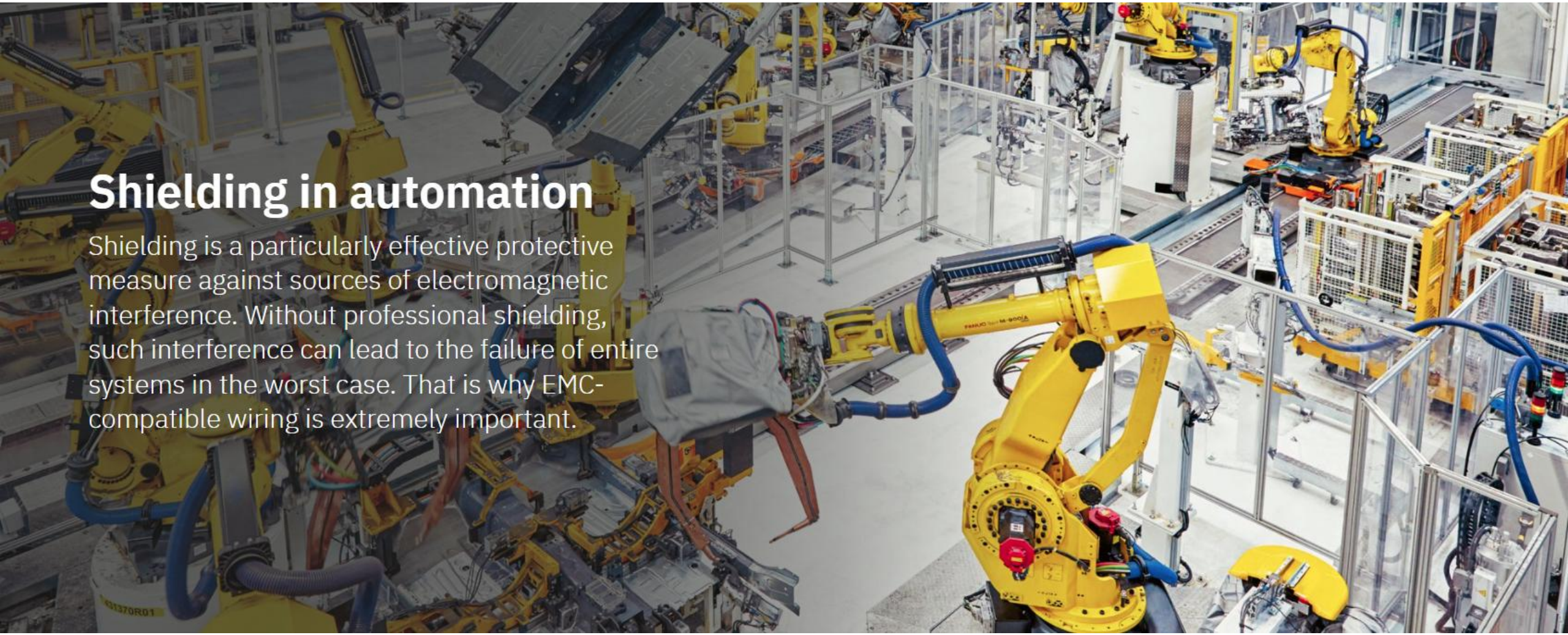
Special tools needed



Push-Lock connection

Toolless



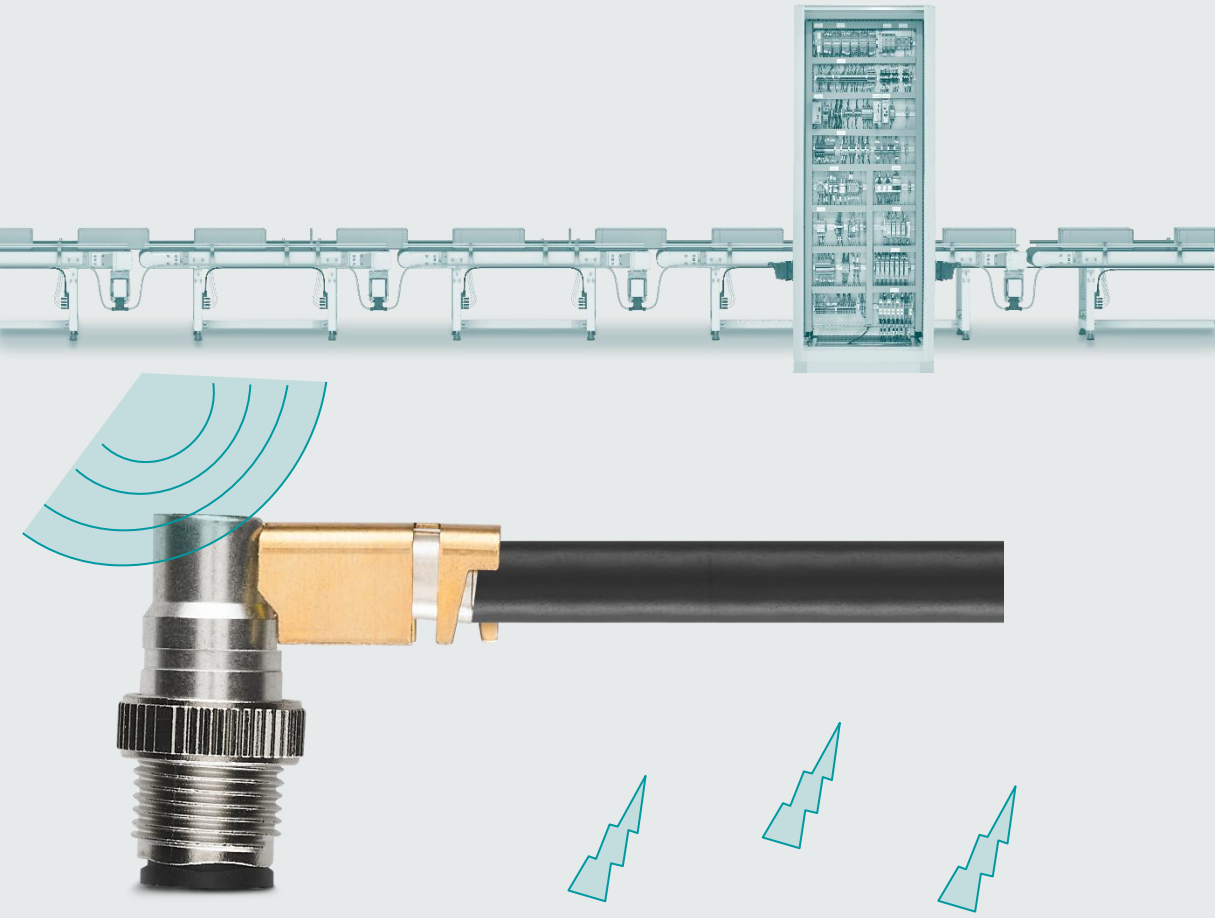


Shielding in automation

Shielding is a particularly effective protective measure against sources of electromagnetic interference. Without professional shielding, such interference can lead to the failure of entire systems in the worst case. That is why EMC-compatible wiring is extremely important.

Overmolded Cables with AST

Shielding purpose in general



EMI in the field, e.g. caused by

- Drives
- Frequency converters
- Welding equipment
- Power cables
- Lightning strikes

Advantages of shielding in the field

- ✓ Shielding (braid or foil) diverts interference signals to the ground → protection of conductors
- ✓ Protection against electromagnetic interferences (EMI) in the field
- ✓ Protection against radiation → Field devices protected against interferences
- ✓ Ensuring error-free communication and signal transmission
- ✓ Compliance with EMC regulations (electromagnetic compatibility), e.g. CE declarations

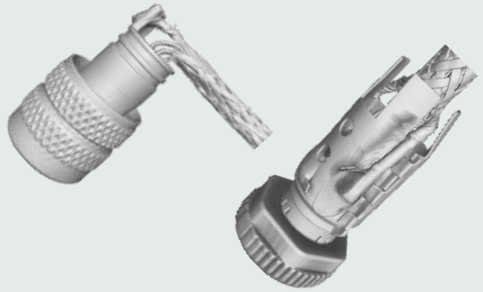
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Overmolded Cables with AST

Types of shielding

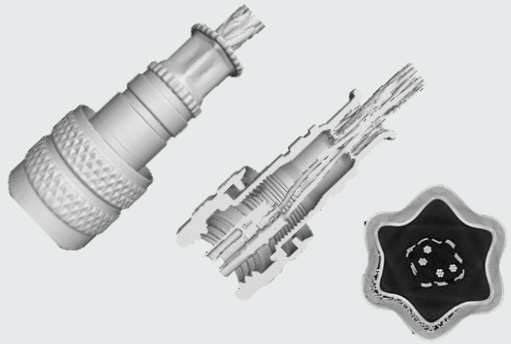
- **Applicable**
- Partly applicable
- Not applicable

01 Soldering



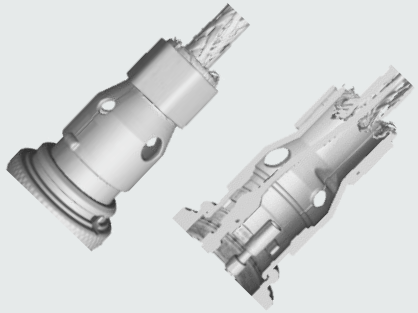
- **stable shield connection to cable and connector**
- Preferably 360° contact
- Closed shield housing from cable to connector
- **High flexibility**
- Low assembly & logistics effort
- Full automatability
- High flexibility
- **Maximum scalability**

02 Single sleeve



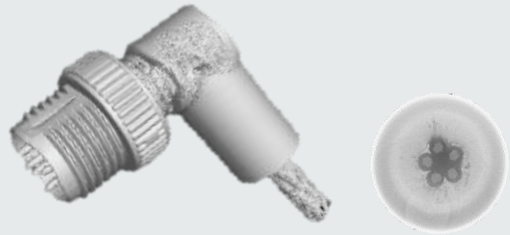
- stable shield connection to cable and connector
- **Preferably 360° contact**
- Closed shield housing from cable to connector
- High process capability
- Low assembly & logistics effort
- Full automatability
- High flexibility
- Maximum scalability

03 Multi sleeve



- **stable shield connection to cable and connector**
- **Preferably 360° contact**
- Closed shield housing from cable to connector
- High process capability
- Low assembly & logistics effort
- Full automatability
- High flexibility
- Maximum scalability

04 Metal-mold



- **stable shield connection to cable and connector**
- **Preferably 360° contact**
- **Closed shield housing from cable to connector**
- **High process capability**
- **Low assembly & logistics effort**
- **Full automatability**
- **High flexibility**
- **Maximum scalability**

Overmolded Cables with AST

Production steps of AST

01 Crimping



Crimping of standard contacts to stripped conductor ends

02 Assembly



Assembling of the M12 head by pressing in the contacts into the conatct carrier

03 Pre-mold



Preparation of the M12 head and conductors with special **”pre-mold”** made by PP for mechanical robustness and first sealing

04 Metal-mold



Preparation of the M12 head and cableshield with special **”metal-mold”** for 360° shield connection, mechanical robustness and sealing

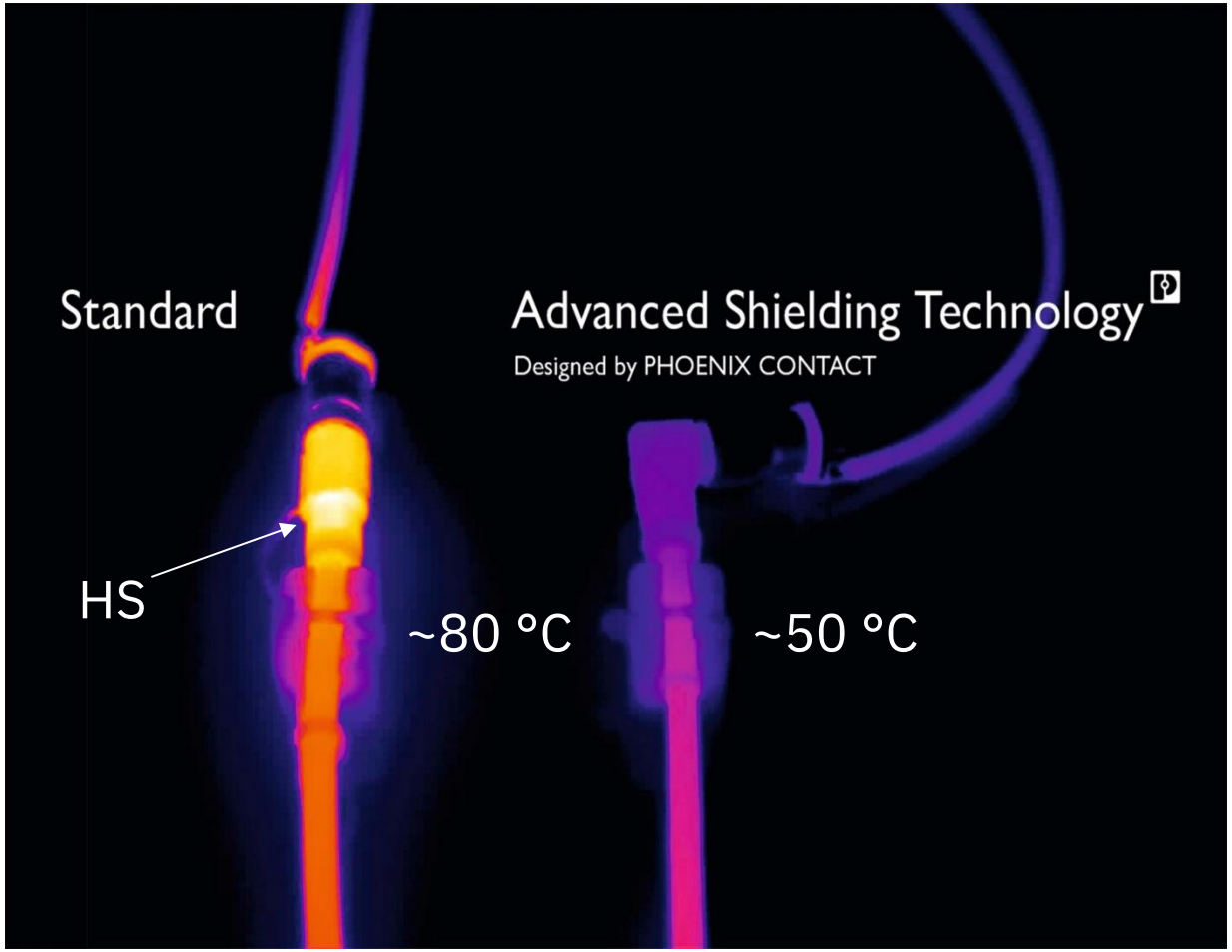
05 Standard mold



Preparation of the M12 grip body with **common overmold**

Overmolded Cables with AST

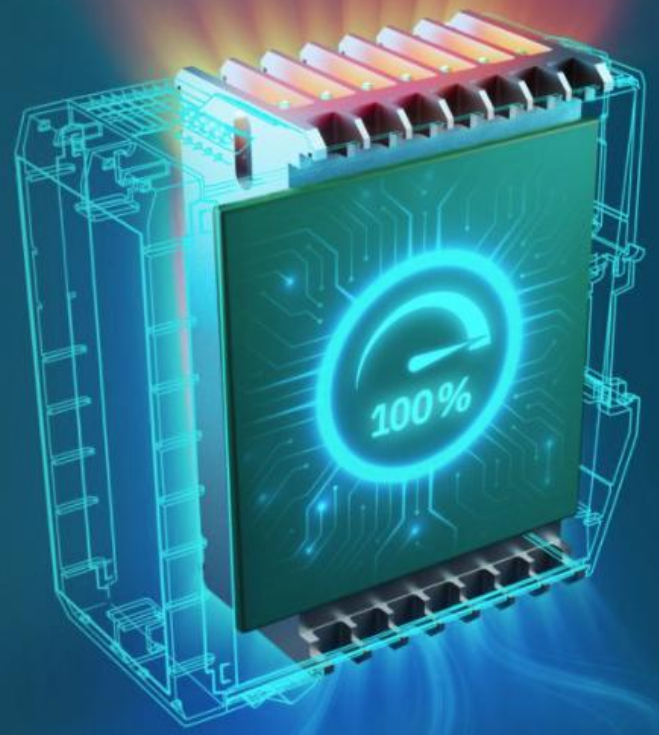
Temperature during short circuit



Heat out. Power in.

Maximize power density in your electronics housings with passive cooling solutions and thermally optimized PCB layouts: from configuration and comprehensive thermal simulations to implementation – ideal for powerful and miniaturized applications.

REQUEST A CONSULTATION



PHOENIX CONTACT

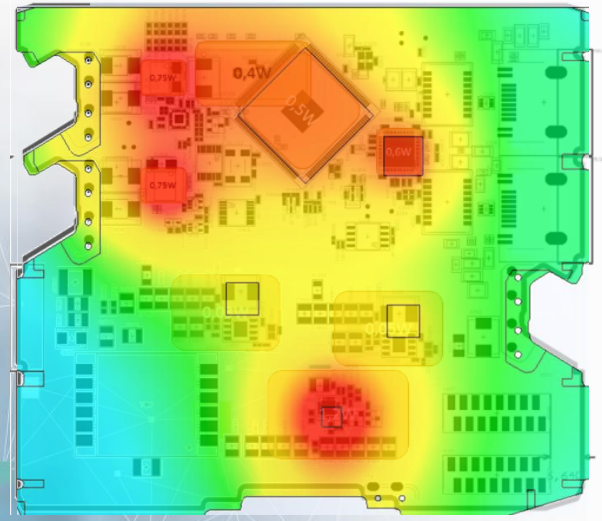
Confidential (II)

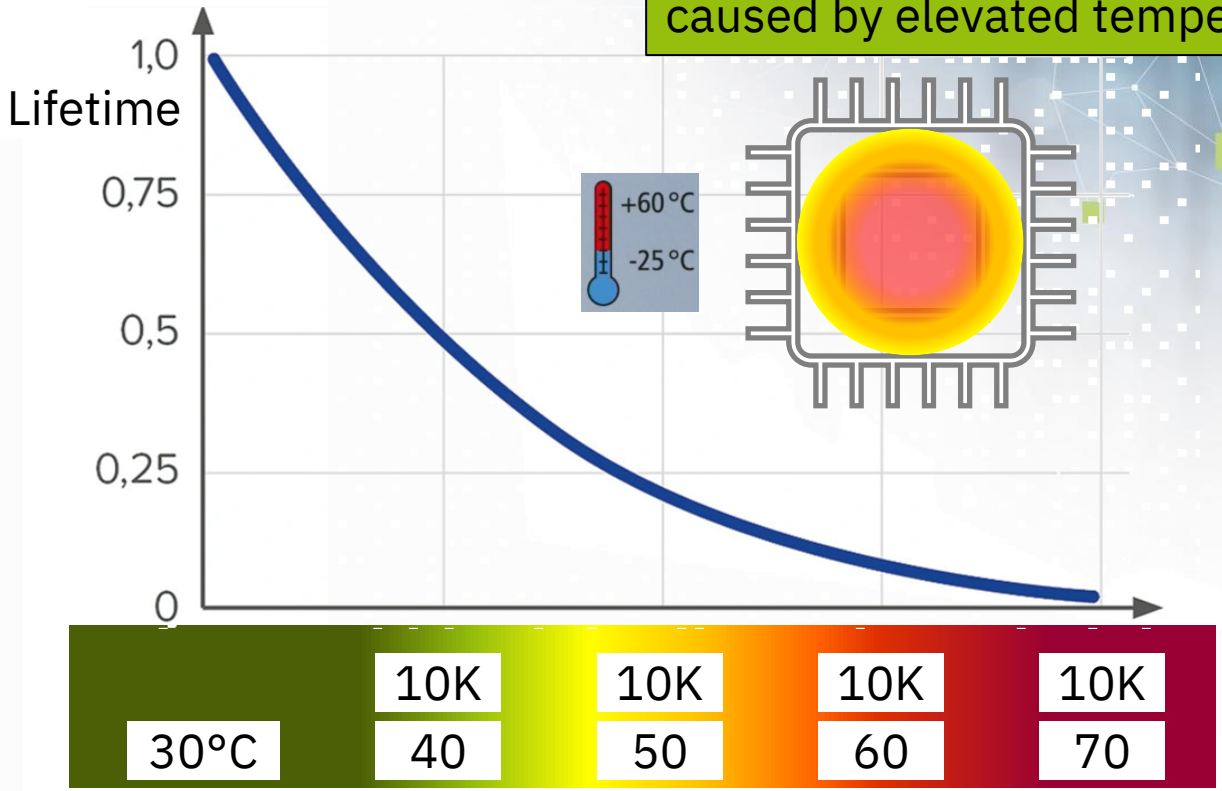
Rising Thermal Stress in Modern Electronics

Most electronics failures are caused by elevated temperatures

Influencers of higher temperatures in electronic housings:

- **Higher data requirements**
- Smaller components
- Insufficient ventilation
- Dust

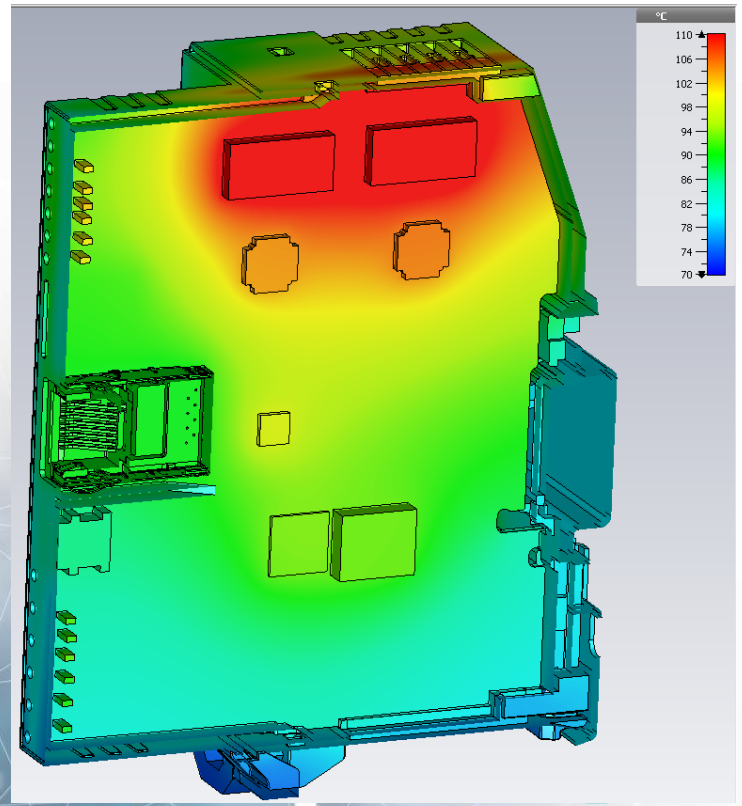




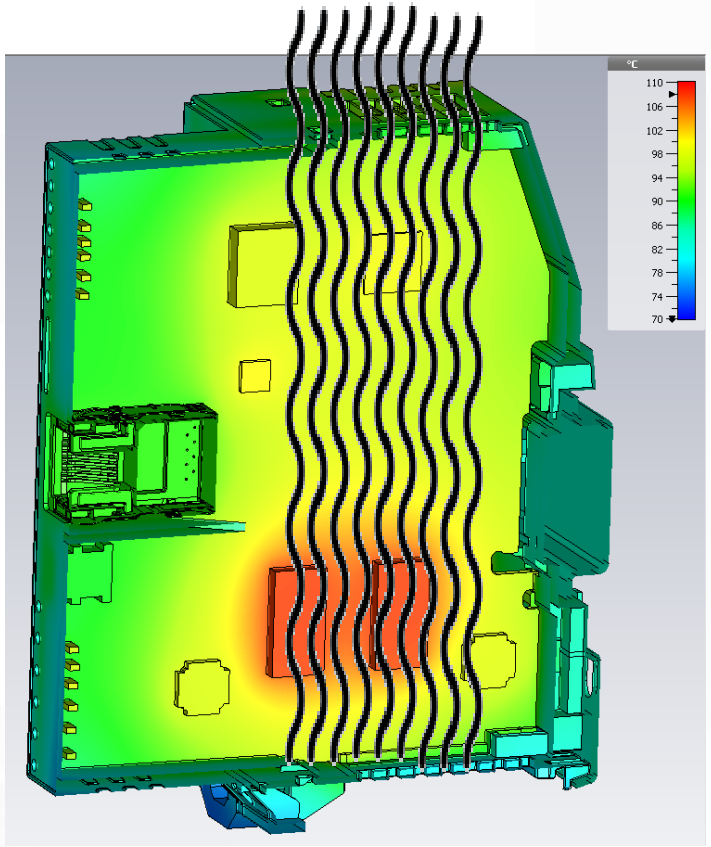
- Requirement: ϑ ambient> 60 °C + sunlight
- Aging: Reduce of Lifetime ½; by rise Δϑ = 10 K
- Doubling of complexity every 2 years

Confidential (II)

Rising Thermal Stress in Modern Electronics



Initial PCB Layout



Optimized Layout

Increasing Thermal Challenges

Power density and miniaturization increase heat generation, making dissipation difficult in compact electronics.

Reliability Risks of Heat

Higher junction temperatures sharply reduce semiconductor lifetime, threatening device reliability and performance.

Environmental and Design Factors

Ambient heat, dust, and poor airflow worsen thermal conditions, demanding better cooling strategies.

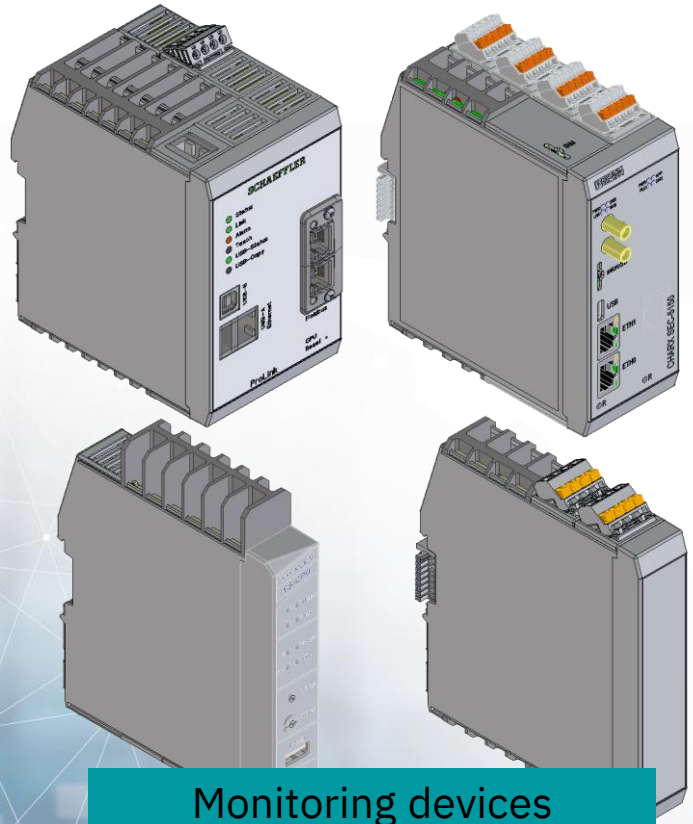
Importance of Thermal Management

Proactive thermal design and simulation help reduce failures, improve reliability, and lower costs.

Our goal is to help customers optimize their design for thermal management solution (Solution over Cost)

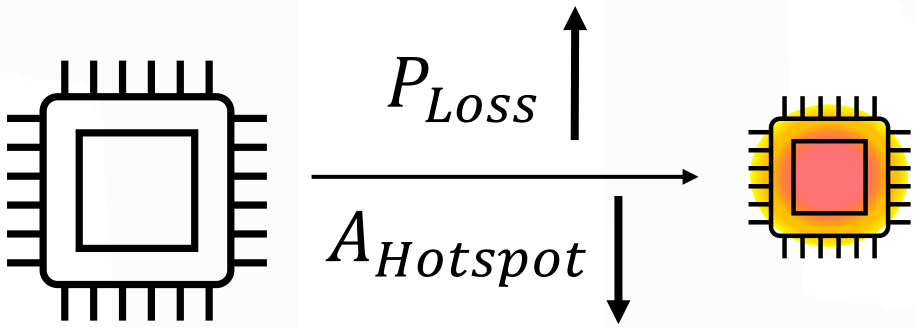
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Target applications



Monitoring devices
Converters
Controllers
etc.

Higher data rates, increasing miniturization and power density



CPUs
GPUs
DCDC Converters
MOSFETs
Etc.

Critical Electronic Applications
CPUs, GPUs, DC-DC converters, and edge devices require effective thermal management due to rising power density.

Market Trends Driving Demand
Industrial digitalization, IIoT expansion, and electrification increase the need for advanced thermal solutions.

Thermal Management Importance
Conduction, convection, and radiation techniques are essential to dissipate heat in constrained installations.

Strategic Market Position
Providing holistic thermal system designs positions companies to meet thermal challenges across industries.

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Thermal management solution process

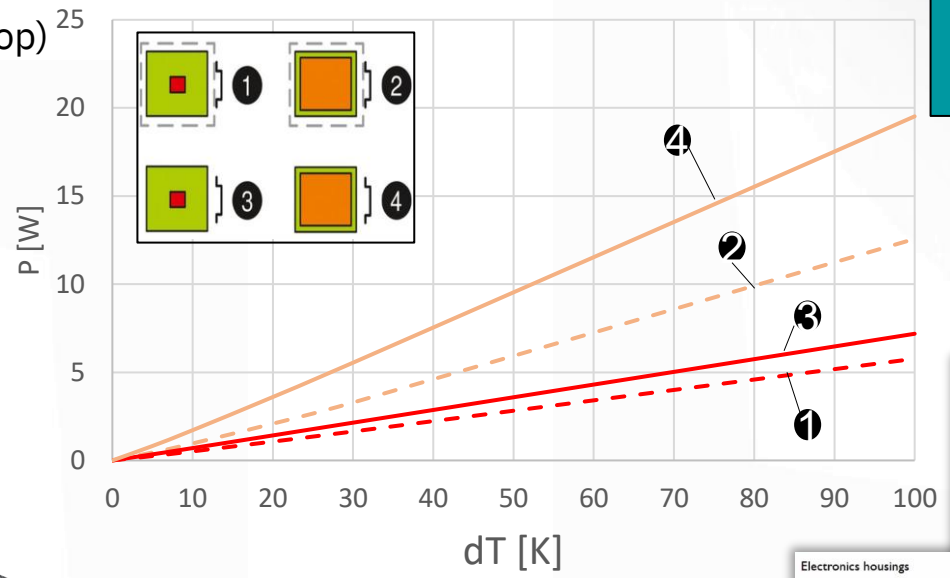
1

Customer Driven Activities

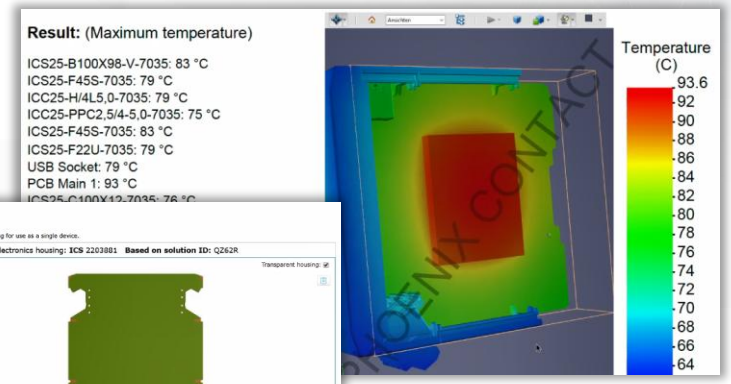
- Catalog values (PxC Webshop)
- Online simulation

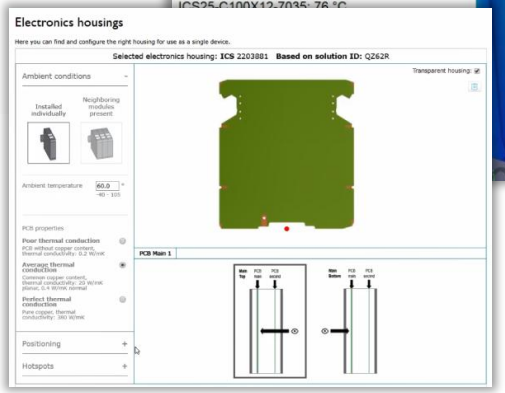
(Configurators for electronics housings | Phoenix Contact)





Each housing / heatsink has its own derating diagram!





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Thermal management solution process

1

Customer Driven Activities
- Catalog values
- Online simulation



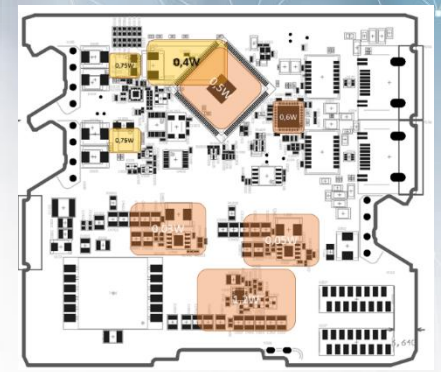


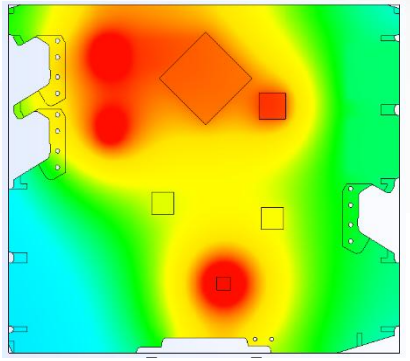
Free thermal management consultation and modeling for your customer application (Teams call)

What we need:

- housing type (Solution ID)
- ambient conditions
  - Mounting conditions
  - ΔT hotspots
- technical data hot spots
  - Size
  - Power loss[W] / Tmax [°C]
- PCB layout (ODB++ file)

- → Fill in sheet available





2

Thermal Management Team
- Free thermal management simulation & consulting

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Thermal management solution process

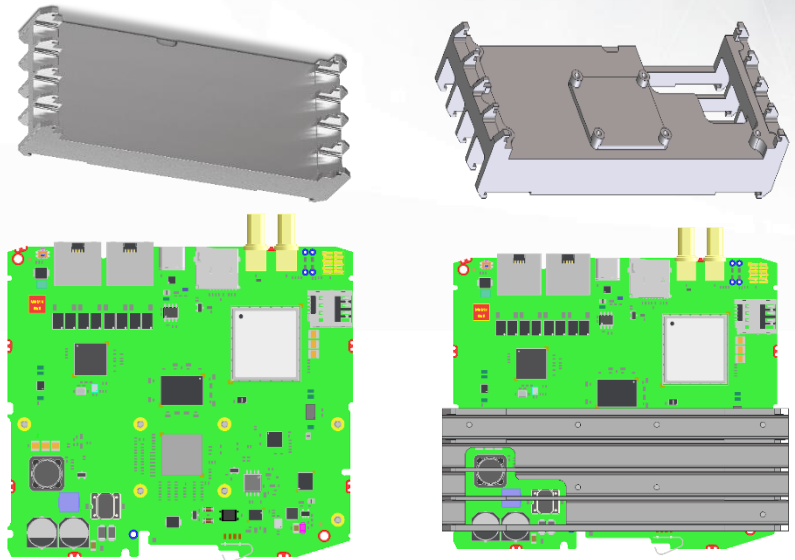


1

Customer Driven Activities
- Catalog values
- Online simulation

3

Thermal Management Report
- Detailed reports
- Multiple options demonstrated
- Includes options for heat sinks, heat spreaders and/or component changes



2

Thermal Management Team
- Free thermal management simulation

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Thermal management solution process

1

Customer Driven Activities
- Catalog values
- Online simulation

2

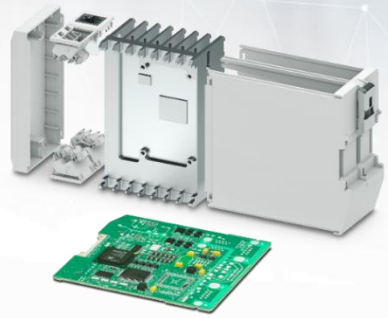
Thermal Management Team
- Free thermal management simulation

3

Thermal Management Report
- Detailed reports
- Multiple options demonstrated
- Includes options for heat sinks, heat spreaders and/or component changes

4

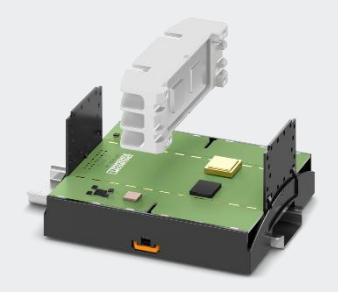
Quote/Drawings
- Lead times and pricing
- Heat sink drawing for customization



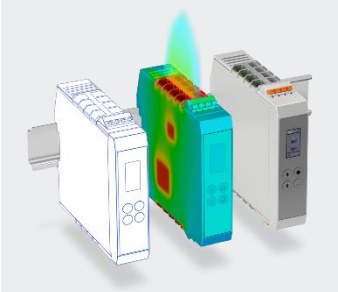
Thermal Management



Hybrid systems made from aluminum heatsinks and plastic housings



Passive cooling solutions – optimized for individual requirements



Personal advice throughout the entire development process

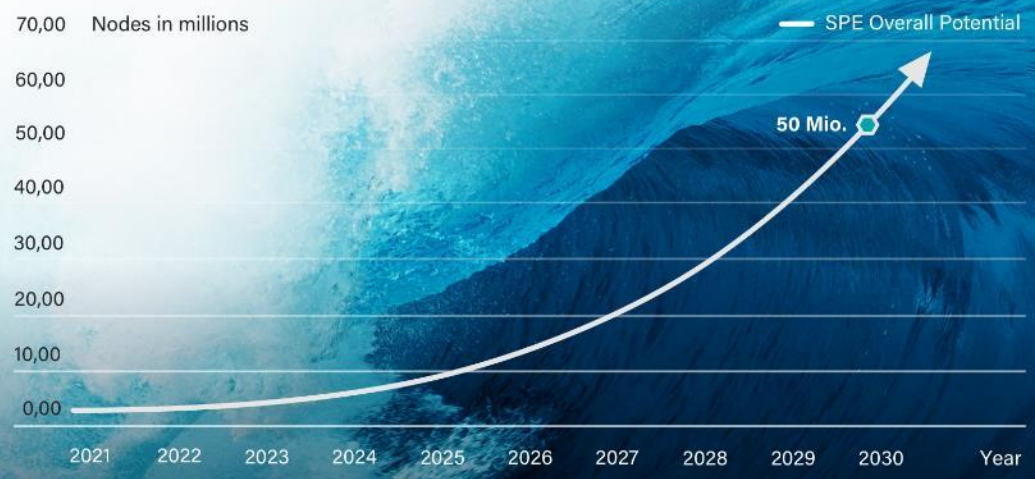


Single Pair Ethernet



UNSTOPPABLE

We are on the way to 50 million SPE nodes by 2030.
Be part of it!



Vikas Grover Latest Trends in Device Connectivity 17th June2026

Single Pair Ethernet
System Alliance

Single Pair Ethernet @ PHOENIX CONTACT

Target markets, Applications & Demands of SPE Technology







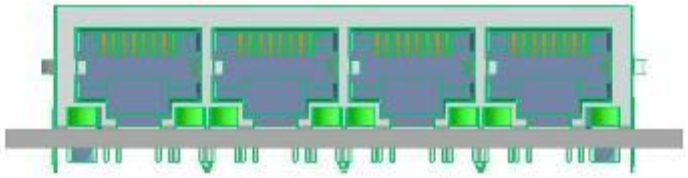
	Factory automation	Building automation	Process automation
Priorities of applications	Ind. Cabling of electrical cabinets Field cabling (e.g. PROFINET) Field cabling of sensors	Cabling of electrical cabinets Field cabling (e.g. KNX)	Field cabling of sensors
Transfer rate	10 MBit/s - 1 GBit/s	10 MBit/s - 1 GBit/s	10 MBit/s
Link-Segment length	≤ 100 m	< 1000 m	< 1000 m
Conductor cross-section	AWG 26-22	AWG 26-22	AWG 22-18
Protection classes	IP20 - IP6x	IP20 - IP6x	IP6x
Mech. / el. Robustness	medium – high	low – medium	high (+Ex field)
Current Plug connectors	RJ45, Individual wiring, Clip, M8/12	Individual wiring, Clip, EIB, RJ45	Clip, Plug connector, M12
Relevant SPE Standards	**IEEE 802.3cg 10BASE-T1** **IEEE 802.3bp 1000BASE-T1**	**IEEE 802.3cg 10BASE-T1** **IEEE 802.3bp 1000BASE-T1**	**IEEE 802.3cg 10BASE-T1L** **+ APL Extension**

Single Pair Ethernet @ PHOENIX CONTACT

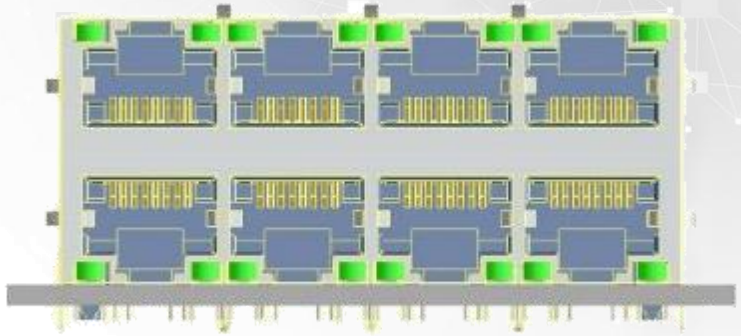
IEC 63171: RJ45 vs SPE

Space:
Packing density

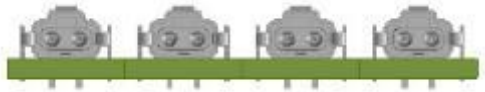
RJ 45



59,8mm



IEC 63171-6



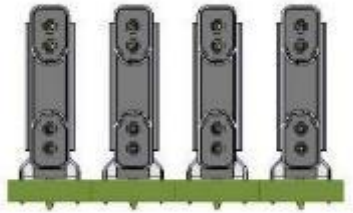
~ 45mm



IEC 63171-2



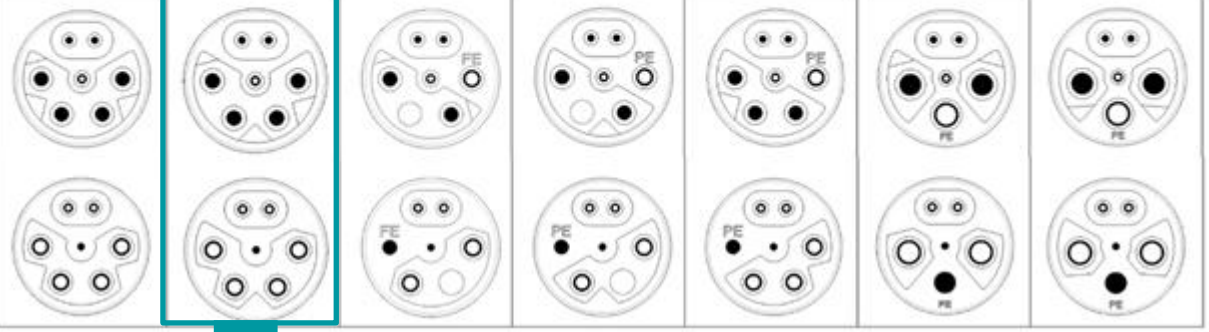
~ 28mm



Single Pair Ethernet

M12 Hybrid Connector interfaces IEC 63171-7

- IEC 63171-7

POWER	2-Phase				3-Phase	2-Phase	
		50V AC Max.		690V AC Max.	480V AC Max.	50V AC Max.	690V AC Max.
	1x 12A Max.	2x 8A Max.	1x 8A Max.	1x 8A Max.	1x 8A Max.	1x 16A Max.	1x 16A Max.
	Code 1	Code 2*	Code 3	Code 4	Code 5	Code 6	Code 7
MALE							
FEMALE							

New





Single Pair Ethernet has a new face

Phoenix Contact is driving the universal SPE standard forward



PHOENIX CONTACT

Single Pair Ethernet

Uniform SPE mating face for PROFINET

Basis
SPE M12 Hybrid
(IEC 63171-7)



PROFINET Working Group Cabling (CB/PG1)

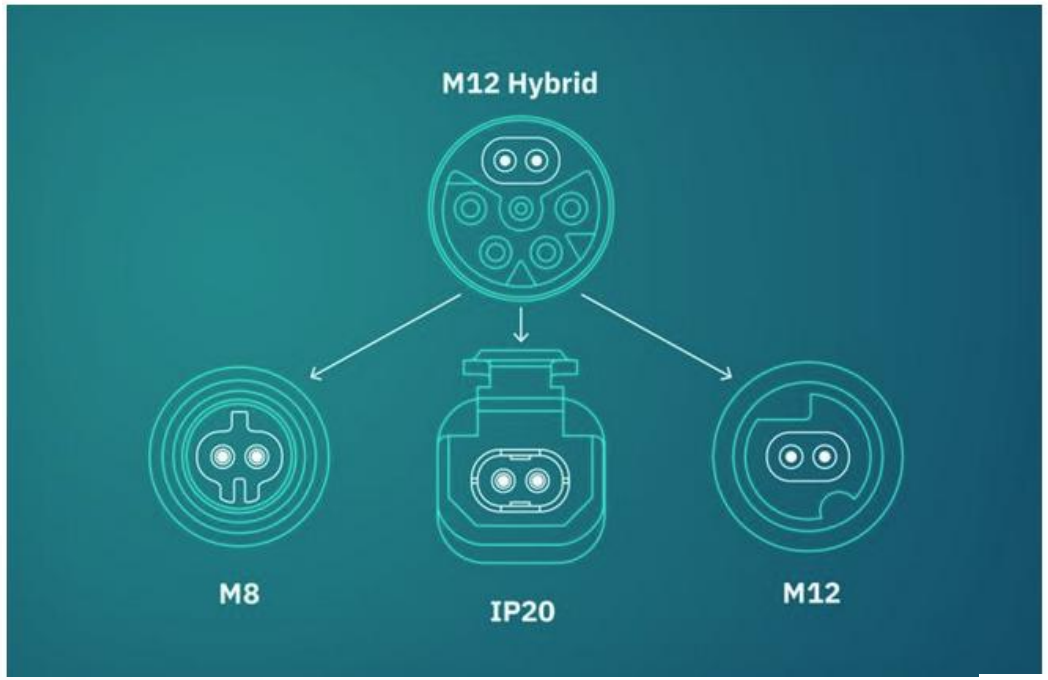
PHOENIX CONTACT · Weidmüller · Rosenberger · WAGO · HARTING · TE connectivity · MURR ELEKTRONIK · YAMAICHI ELECTRONICS · SIEMENS · BELDEN · Telegärtner · Amphenol · ESCHA · molex

PROFINET has developed a consensus for uniform SPE mating faces:

- IP20
- M8
- M12 (incl. M12 Hybrid)

➢ Result: Official press release on SPS24 on the uniform connector

A Standardized Plug System for PROFINET over SPE - www.profibus.com



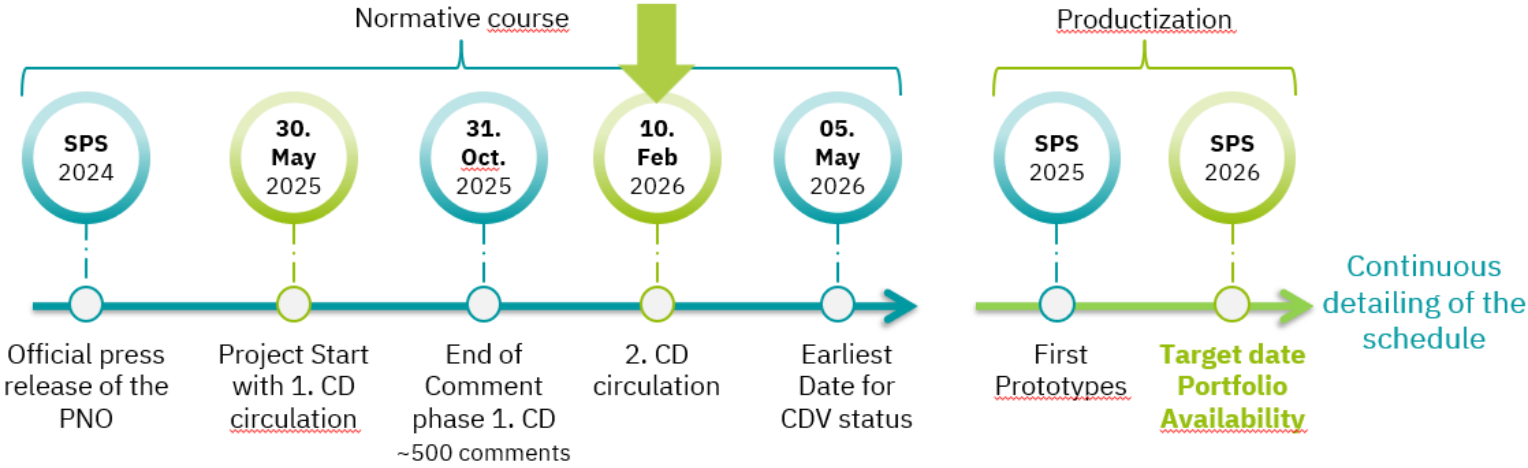
A standard for factory automation

Finally, there is an end to uncertainty and competing standards in factory automation. Whether IP20, M8, M12, or M12 Hybrid – with the standardized SPE pin connector pattern in accordance with IEC 63171-7 ED2 (in progress), you will soon benefit from all the advantages of the Single Pair Ethernet connection for your devices. Making this technology interoperable and future-proof across manufacturers. Various mechanical codings enable new flexibility for different IEEE standards and applications – perfect for modern factory automation. Start planning now, with Phoenix Contact as your strong partner at your side.

> Watch the SPE webinar

Single Pair Ethernet

Rough schedule for the uniform mating face



Thank you

