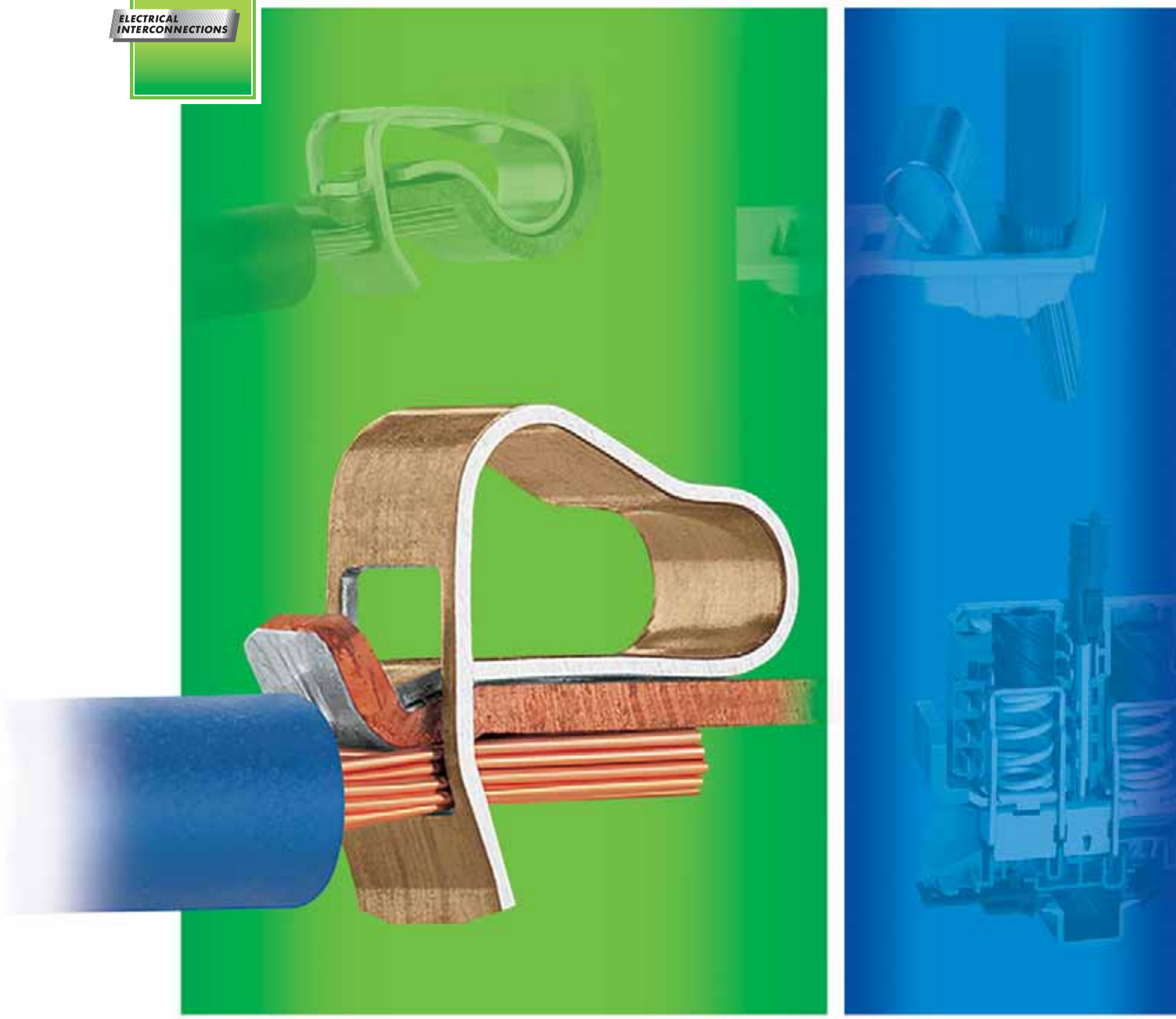
ELECTRICAL INTERCONNECTIONS



The WAGO CAGE CLAMP® Technology

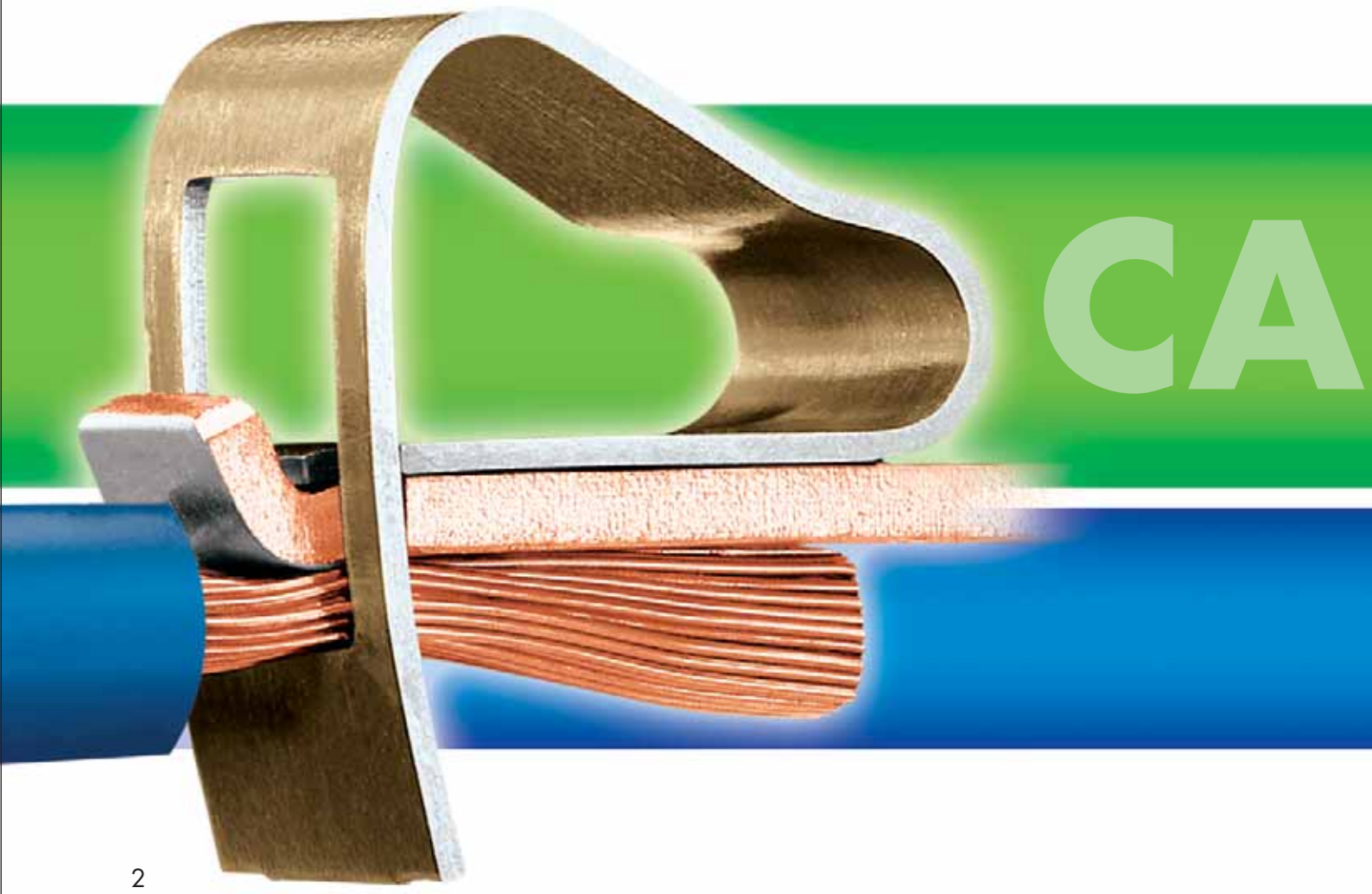
Vibration-proof – fast – maintenance-free!

WAGO®
INNOVATIVE CONNECTIONS

The WAGO CAGE CLAMP® Technology

For nearly 30 years, WAGO CAGE CLAMP® technology has provided vibration-proof and maintenance-free clamping connections, resulting in improved availability of installations and devices – to the profit of WAGO customers in global competition.

Vibration-proof – fast – maintenance-free!



Contents

GE CLAMP®

CLAMP types

1977 The original WAGO CAGE CLAMP®

For solid, stranded and flexible conductors. The birth of a new industry standard in electrical connection technology worldwide.

Patent No. 270 6482

1996 CAGE CLAMP® Compact

The compact version of the original CAGE CLAMP® connection. The foundation of ultra-small rail-mounted terminal blocks up to 4mm².

Patent No. 196 41206

1998 POWER CLAMP

For rail-mounted terminal blocks for conductors from 25mm² up to 95mm². WAGO redefines the limits of spring terminal technology.

Patent No. 198 17924

2003 CAGE CLAMP®S

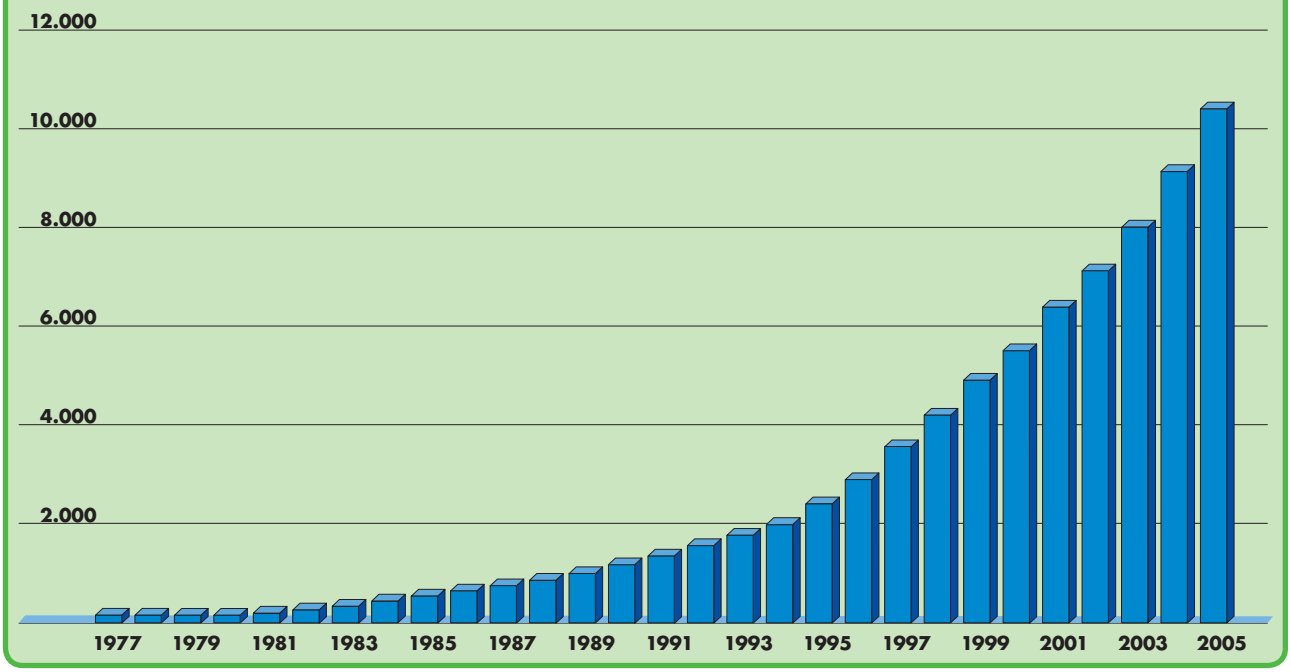
A new quantum leap. A universal connection for all copper conductors, like the original CAGE CLAMP®. Additional benefit: direct connection of stripped solid conductors and flexible conductors with ferrule.

Patent No. DE-A 102 39273, DE-A 102 60545, EP-A 1 391 965

System features and benefits

- WAGO provides the most comprehensive product range using the universal CAGE CLAMP® connection technology
- Wire range 0.08 mm^2 to 95 mm^2
- All important approvals assure worldwide acceptance
- Space saving: terminals with CAGE CLAMP® connection are up to 30% smaller than comparable products in the market
- Damage-free conductor clamping due to pre-programmed clamping force, dependant on conductor diameter
- Safe and clear handling
- Unlimited range of applications
- Worldwide industry standard
- Time and cost effective, because it is
  - **vibration-proof**
  - **fast**
  - **maintenance-free**

Number of CAGE CLAMP® springs produced up to the present time (in millions)

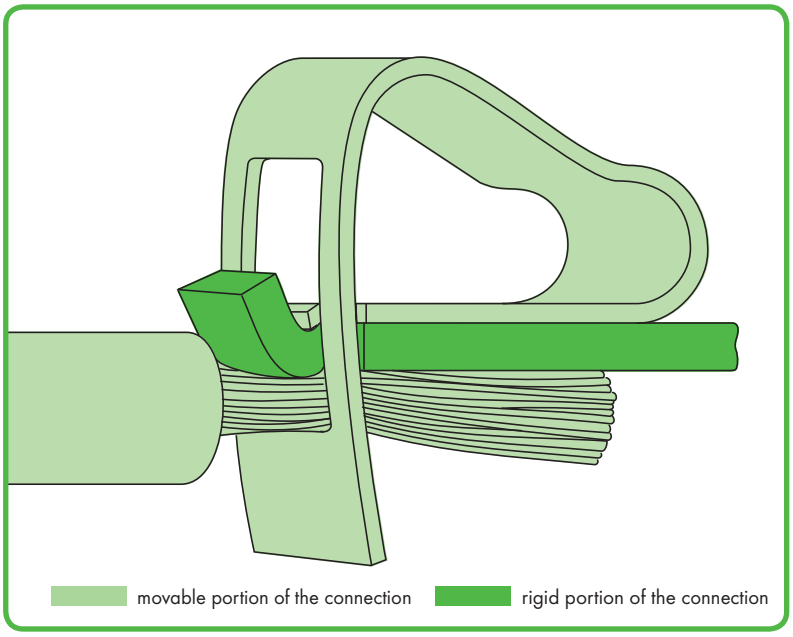


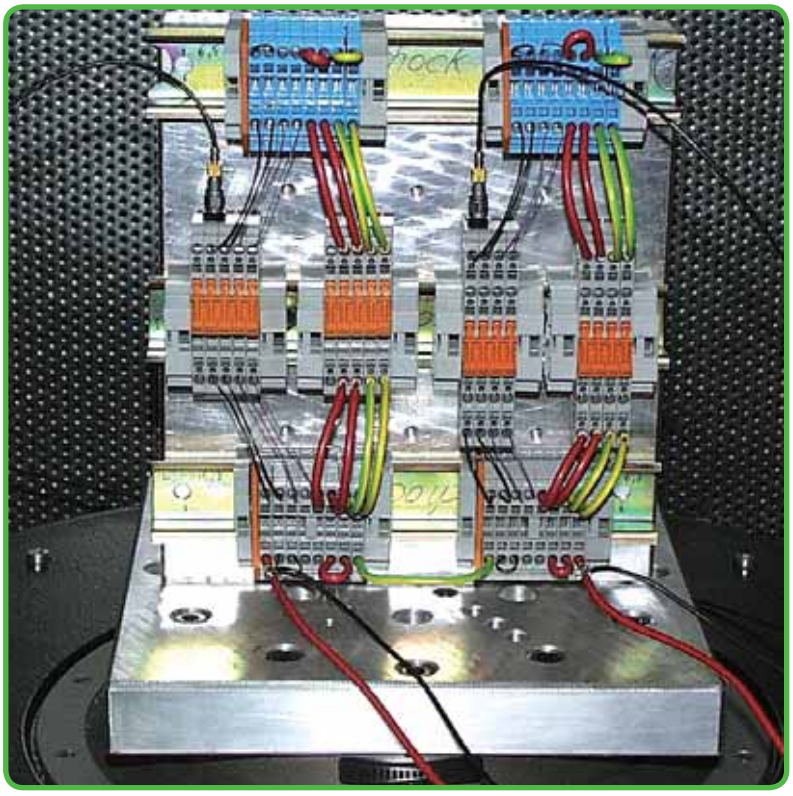
Vibration- and shock-proof – maintenance-free

The **vibration-proof** properties of CAGE CLAMP® connections were tested and verified in a vibration test to IEC/EN 60068-2-6. In this test, a variable frequency band up to 2000 Hz, at different accelerations up to 20 G and different amplitudes up to 20 mm, was passed in three axes. Extremely demanding test requirements for electrical installations in rolling stock (IEC/EN 61373) are prescribed by railway authorities or the testing agencies for marine approvals, such as GL, LR and DNV. These rigorous tests were also passed.

In the **impact test** to IEC/EN 60068-2-27 or for railway applications to IEC/EN 61373, the test samples were exposed to instant shock stresses, instead of permanent vibrations. Stresses up to 100 G on the x, y, and z-axis were passed without any problems.

The **maintenance-free** feature results from the excellent long term consistency of the electrical and mechanical properties of the clamping connection – more accurately, the clamping point. The voltage drop test serves in the evaluation of the clamping point quality under stresses such as vibrations, temperature changes and corrosive influences, in order to verify the gastightness of the contact point. The CAGE CLAMP® technology has proven its long term consistency in laboratory tests by international approval authorities as well as in worldwide applications. The result is a maintenance-free guarantee, reducing service costs and increasing the availability and reliability of installations and devices.

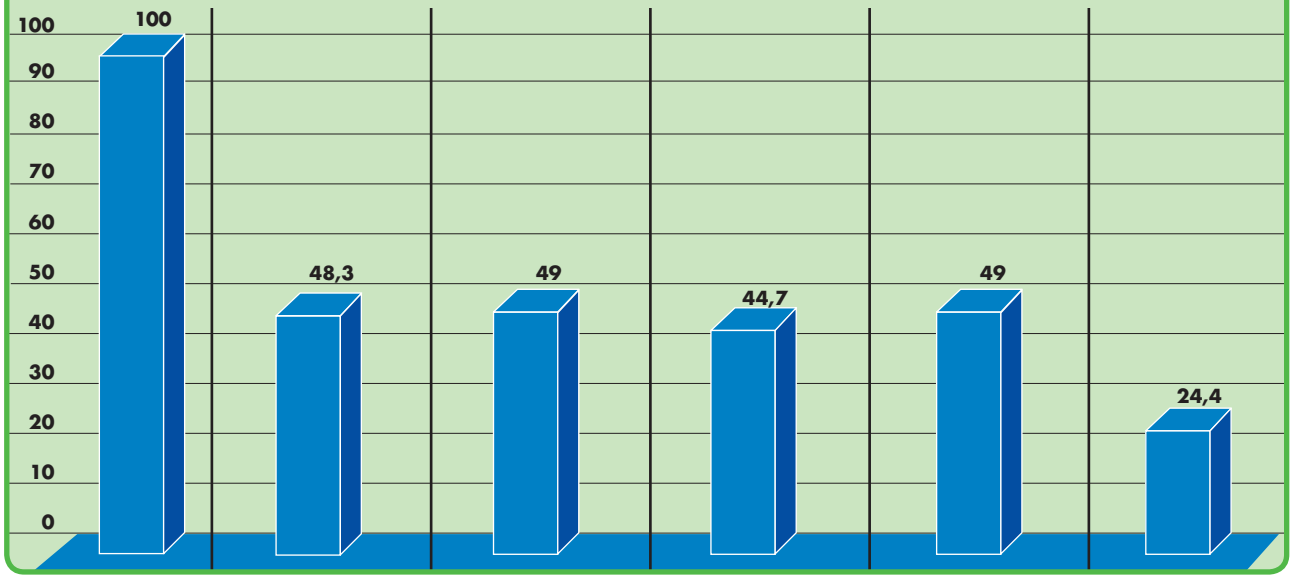




Time saving

- CAGE CLAMP® technology reduces labour charges due to significantly reduced wiring times
- Faster commissioning and elimination of service costs due to the maintenance-free condition provide additional savings
- Material and labour costs can also be reduced, when the conductors are used without prior preparation, i.e. crimping of ferrules or pin terminals. The front-entry wiring provides the ideal prerequisite. Well respected users expressly indicate this fact in their specifications.

Average manual wiring times in a percentage comparison (per MTM)

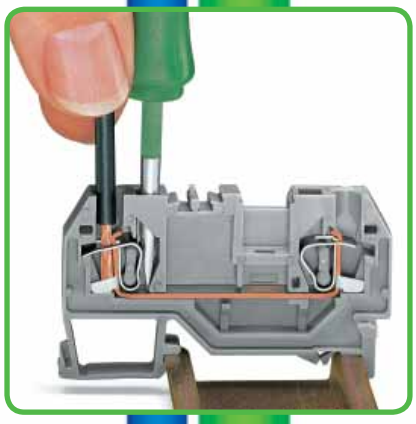


Screw connection	CAGE CLAMP® connection, side-entry wiring solid conductors without ferrule, flexible conductors with ferrule	CAGE CLAMP® connection, front-entry wiring, flexible conductors without ferrule	CAGE CLAMP® connection, front-entry wiring, solid conductors, flexible conductors with ferrule	CAGE CLAMP®S connection, front-entry wiring, flexible conductors without ferrule	CAGE CLAMP®S connection, front-entry wiring, **direct connection** of solid conductors and flexible conductors with ferrule

Simple and clear handling

Front-entry wiring:
CAGE CLAMP®S connection

Front-entry wiring:
CAGE CLAMP®S connection, **direct connection** of solid conductors and flexible conductors with ferrule



Front-entry wiring:
CAGE CLAMP® connection

Side-entry wiring:
CAGE CLAMP® connection

One conductor per clamping point – clamps all copper conductors, free of damage

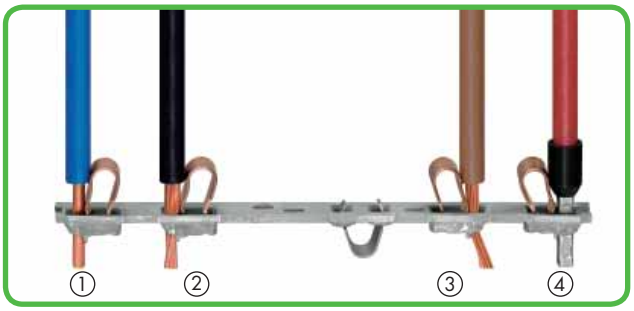
A number of VDE directives prescribe or recommend, respectively, that only one conductor should or must be connected per clamping point, e.g., DIN VDE 0611 Part 4, 02.91, section 3.1.9. WAGO complies with this safety requirement expressed in the corresponding directives.

The following technical and economical benefits are thus realised for the user:

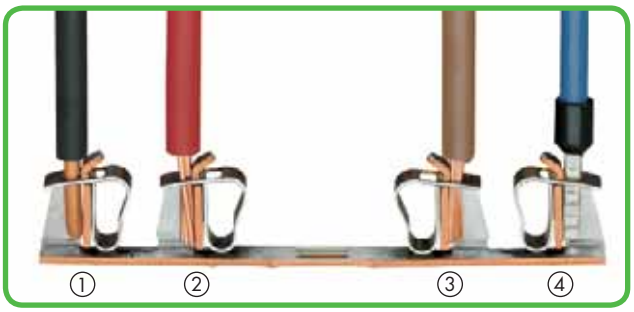
- Each conductor is clamped independently from others
- Any wire size combination per potential can be safely connected
- Where re-wiring is required, only the conductor to be changed is removed from the clamping point, all other conductors remain safely clamped
- The arrangement of more than two clamping points on one current bar permits the multiplication of potentials, without jumpers or additional terminal blocks

CAGE CLAMP® and CAGE CLAMP®S connections clamp CU conductors from 0.08 mm^2 to 35 mm^2 (95 mm^2), or from 0.25 mm^2 to 25 mm^2, respectively. Splice protection is not required – but can be used.

The conductor is pressed against the current bar in the **predefined contact area**, without damaging it. The clamping force automatically adjusts to the wire size. Possible conductor deformation is balanced, an accidental loosening is safely prevented.

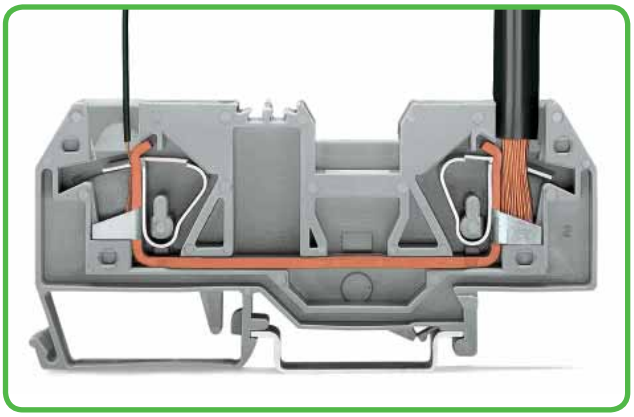


CAGE CLAMP®S connection: one conductor per clamping point



CAGE CLAMP® connection: one conductor per clamping point

① solid
② stranded
③ flexible
④ flexible with ferrule (gastight crimped)



A connection usually not seen in the field: A 0.2 mm^2 conductor (left) and nominal diameter 16 mm^2 (right) in one 16 mm^2 terminal block

Gastight clamping point – measurable contact quality

Frequently occurring industrial atmospheres capable of influencing the long term consistency of clamping points, are simulated in the thermal chamber for climatic tests. All WAGO products comply with the requirements of the following climatic tests:

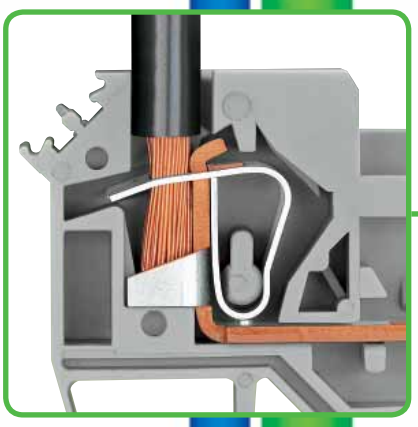
- Temperature change stresses to IEC/EN 60947-7-1, IEC/EN 60998-2-2
- Industrial atmosphere to EN ISO 6988, IEC/EN 60068-2-42, IEC/EN 60068-2-60
- Salt spray to IEC/EN 60068-2-11, marine applications GL, LR, DNV
- Quick temperature changes to IEC/EN 60068-2-14 Relative humidity, cyclical (12 + 12 hours) to IEC/EN 600689-2-30, marine applications GL, LR, DNV

The long term consistency of the low contact resistance of CAGE CLAMP® and CAGE CLAMP®S connections is the result of the **gastightness** at the clamping points. The connected conductor is pressed against the current bar (electrolyte copper with lead-free block tin surface coating) within the defined contact zone, by the spring clamp (acid and saltwater proof CrNi spring steel). The conductor is embedded into the soft tin layer at a high specific contact pressure and hence immune against corrosive creeping.

The contact pressure

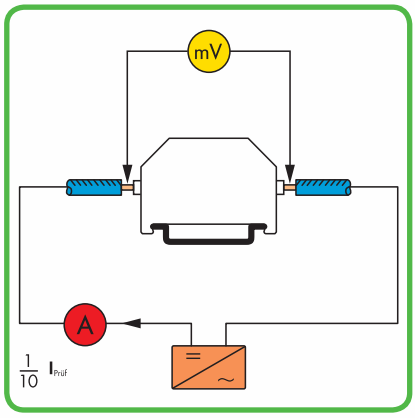
$$P\left[\frac{N}{mm^2}\right] = \frac{Force\ F\,[N]}{Area\ A\ [mm^2]}$$

has the same level in CAGE CLAMP® as in screw terminals.



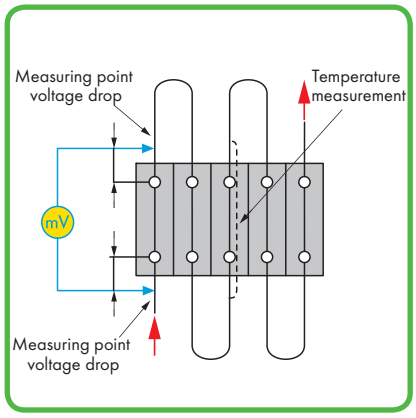
The quality of a clamping point can best be evaluated, using the following test procedures:

The **voltage drop test** is used to evaluate the quality of the clamping point under stresses such as vibration, temperature changes and industrial atmospheres.



Test arrangement "voltage drop test"

The **temperature-rise test** is required for examination of the clamping point, including the surrounding insulating enclosure, at rated current, overcurrent and short-circuit current levels.



Test arrangement "temperature-rise test"

High current-carrying capacity

The **short time withstand capacity** is defined in standards such as IEC/EN 60947-7-1 for through rail-mounted terminal blocks, as a **current-carrying capacity of 120 A per mm² nominal diameter** for the duration of 1 second. **In the case of a 95 mm² high-current terminal block** of the WAGO Series 285, **this translates to 11,440 A!**

Ground (earth) conductor terminal blocks to be tested are submitted to 120 A per mm² for 3 x one second. The pass criterion for the test is the voltage drop (limit value and constancy).
CAGE CLAMP® and CAGE CLAMP®S connections pass this test without damage and impairment of the functionalities.

Test arrangement "short time withstand current test"

Unrealistic test of a CAGE CLAMP® rail-mounted terminal block, 4 mm²: **Increase of current without time limit.** In such an extreme test – fuse devices would have interrupted the current –, **the terminal block is undamaged.**

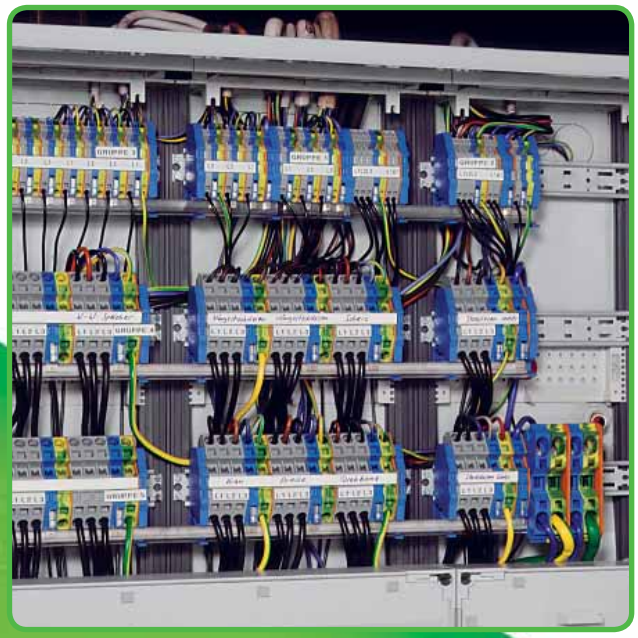
Global acceptance

As inventors and pioneers for spring clamp terminals, WAGO had an idea in 1951, when founding the company: to clamp electrical conductors via spring force, instead of a screw mechanism. Today, more than 50 years later, WAGO is the globally recognized leader in spring clamp technology.

WAGO products with CAGE CLAMP® connecting technologies have proven themselves since their market introduction in 1977 in all application conditions in electrical and electronic engineering, having obtained all important international approvals.

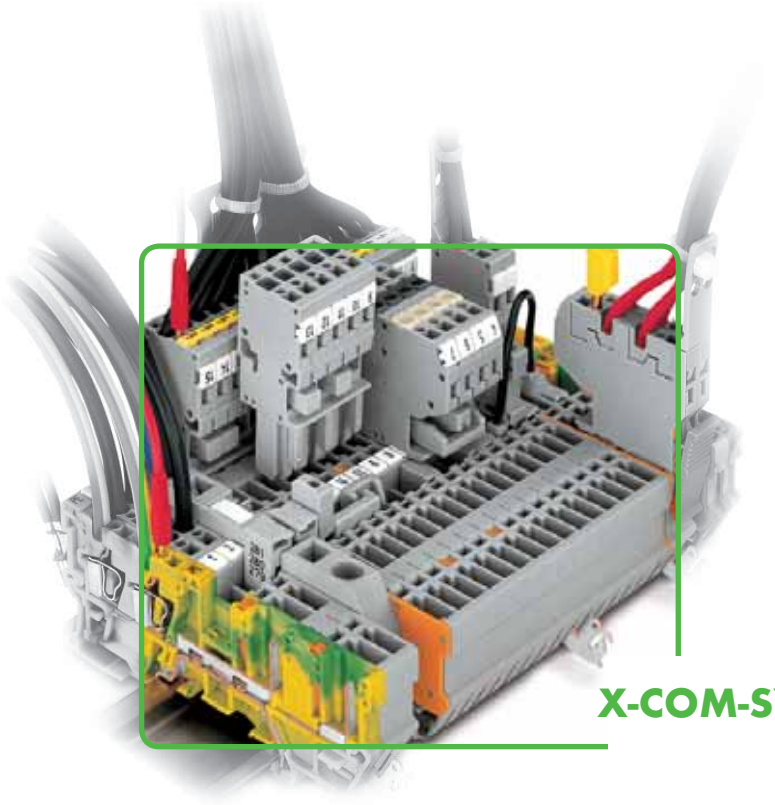
In installation and machine engineering, plant automation, automotive sector, rail and marine applications, as well as in the on-/offshore sector, ...

Global acceptance



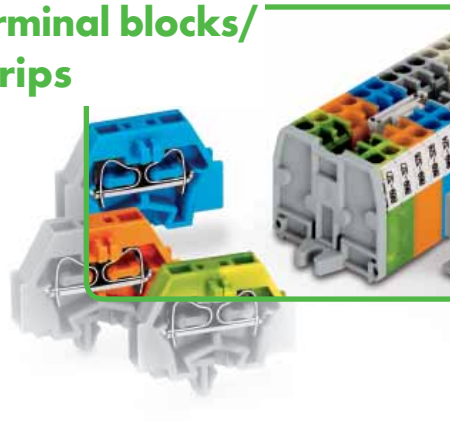
... in the chemical and petrochemical industry, in switch-gear engineering, food processing, printing and postprint processing machinery, in power stations of any energy sector, elevators and escalators, in building installation and automation, instrument engineering and industrial electronics, etc.

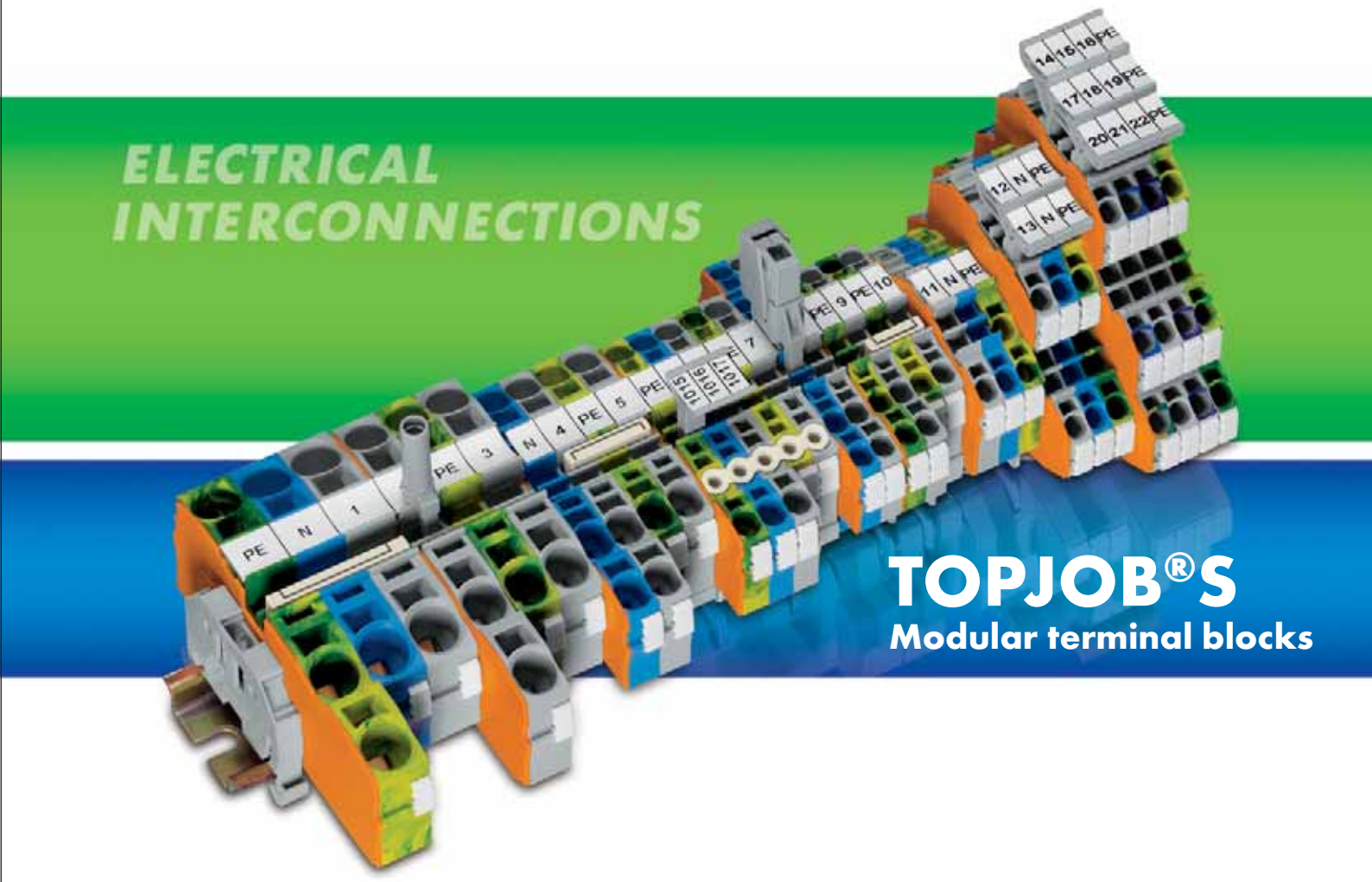
Examples of products with CAGE CLAMP® tec



X-COM-SYSTEM

Modular terminal blocks/ terminal strips





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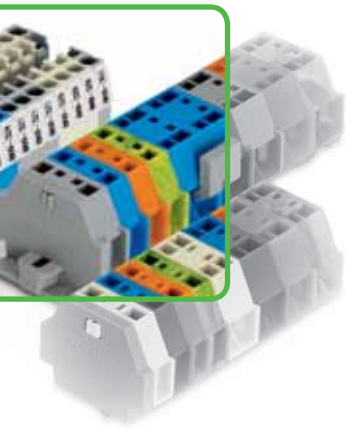
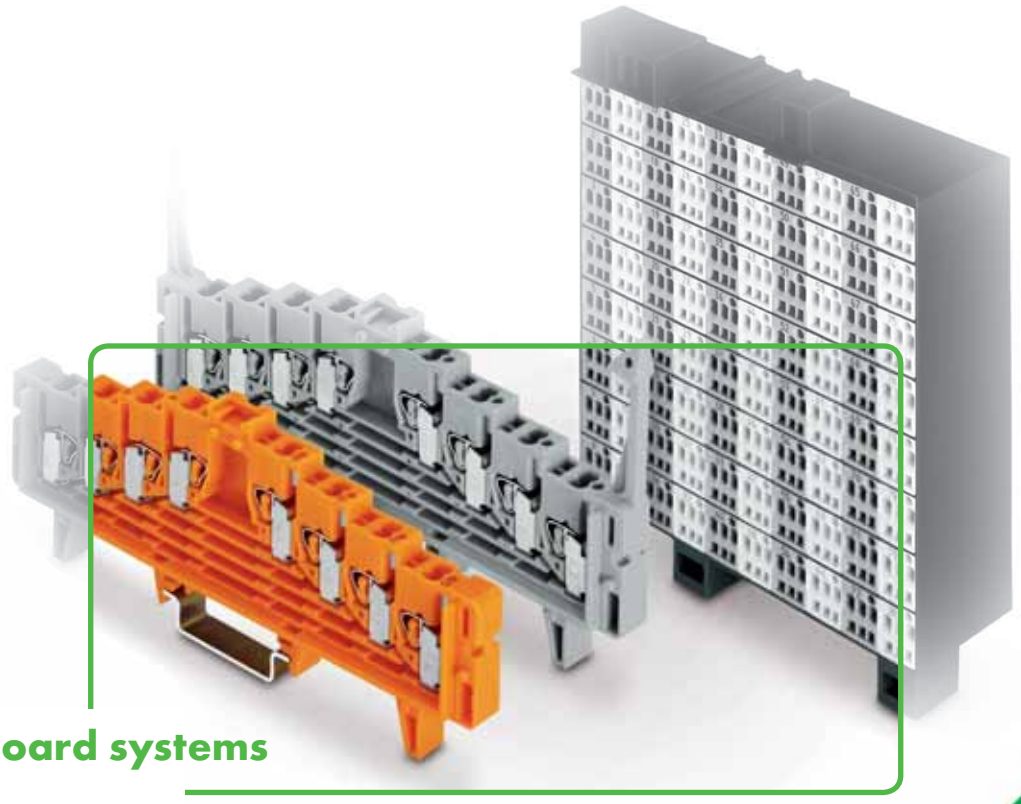
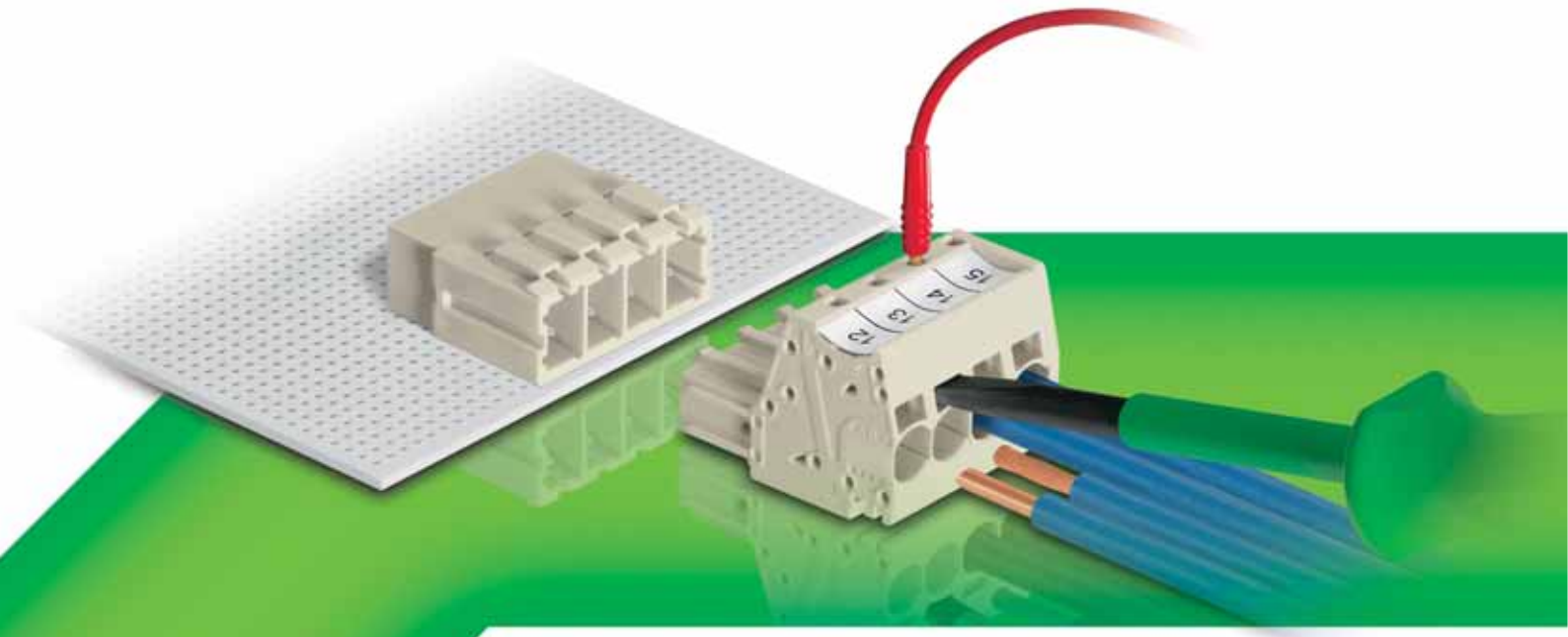




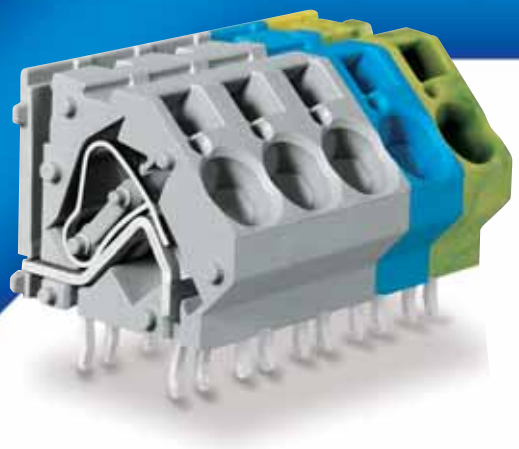
Patchboard systems

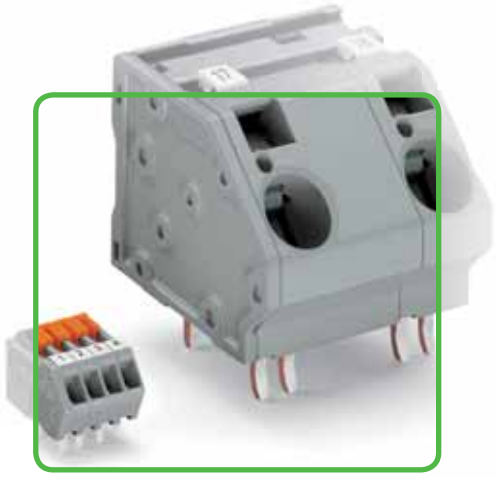
WINSTA®

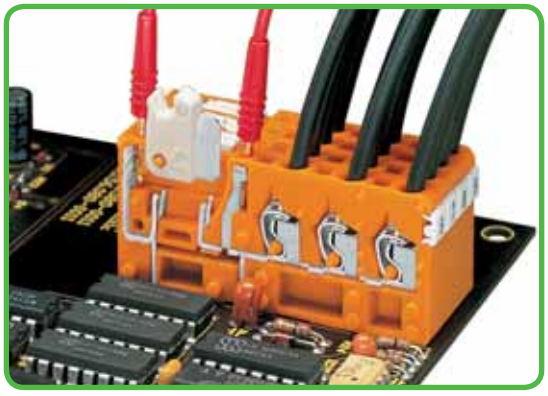
Plug-in connector system



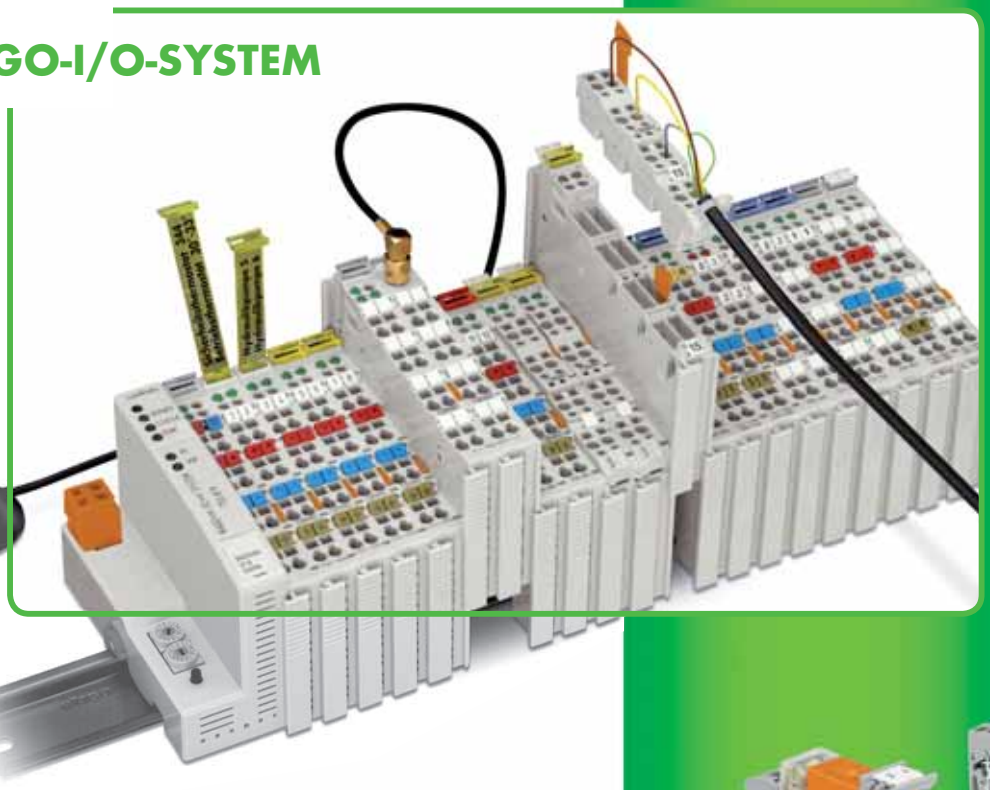
Connectors and PCB terminal blocks



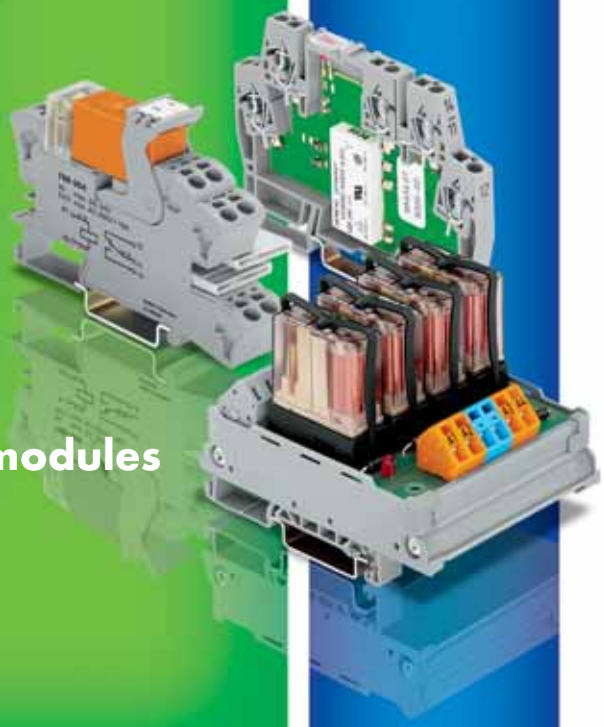




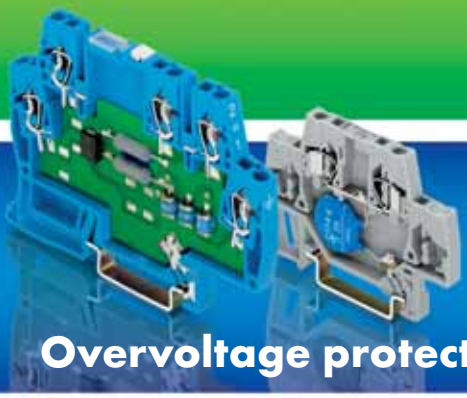
WAGO-I/O-SYSTEM



Transducers



Relay modules



Overvoltage protection

ELECTRONIC

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