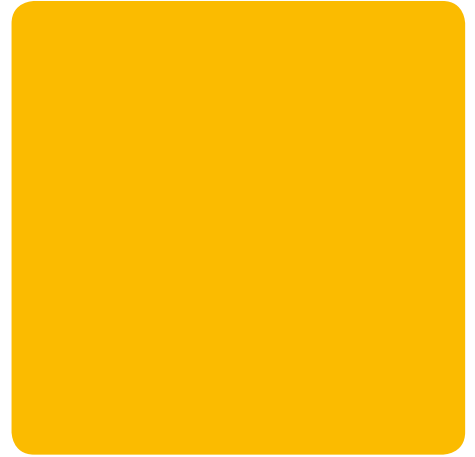


# CMP Cable Cleats





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CMP PRODUCTS

# The CMP Promise to You

## What we promise for your business

CMP Products is a leading designer, manufacturer, and supplier of cable glands, cable connectors, cable cleats and cable accessories for customers around the globe.

Striving to be the best at what we do, delivering the standard of excellence that customers come to expect from us, and retaining our number one supplier status are key objectives of CMP. This means we are committed to continual improvements in our business processes and related activities.

The end result? We can offer unrivalled customer service to our clients - wherever they may be in the world.

## Our commitments and objectives

Innovative design and continual research and development are at the heart of what we do.

As a market leader in cable gland, cable connector and cable cleat technology, we invest heavily in advanced manufacturing techniques, modern IT systems and effective training to offer you unparalleled levels of quality and customer service.

We are also able to develop alliances with distributors and end-users internationally, which is key to our strategy of bringing products to a worldwide audience via a strategic global distribution network.

CMP Products is committed to employing the best people. Those who have the experience, responsibility, skills and passion required to meet our objectives in a safe and healthy manner, and who cause no harm to themselves, others or the environment.

## Our vision of customer care

Putting the customer at the centre of what we do and ensuring a positive experience for everyone we work with is a vital part of our vision.



# CMP Cable Cleats

CMP Products offers a comprehensive range of cable cleats that support cables and conductors, retaining the mechanical load of the cable itself and reducing the mechanical stress placed on any cable termination.

## Rigorous Testing

All of our range is designed, constructed, tested and third party certified in accordance with IEC 61914:2009 to ensure the safety of personnel, the protection of the cable management system and the operating environment.

This testing ensures that the cable cleats are capable of providing the necessary resistance to electromechanical forces, can retain the mechanical load that the cables and conductors are subjected to when under fault conditions, and will safely maintain the integrity of the cable.

We also offer project-specific testing to ensure customer needs are met in full.

## Expertise and Experience

At CMP Products, we can design and manufacture cable cleats for all applications, including single, trefoil, quad and matrix applications, and the expertise offered by our technical department means we can assist with detailed technical queries and design bespoke applications to suit the specialist needs of our clients.

Alongside this expertise comes experience. Our cable cleat range has been created and developed with a comprehensive understanding of the site installation requirements and issues faced by engineering design contractors and installers alike. Lessons learned over many years of supplying other cable related solutions are factored into our products and can be seen in a raft of unique new design features.

These include the capability to accommodate a wide range of fluctuating cable diameters and detailing that adds to the general ease of installation.

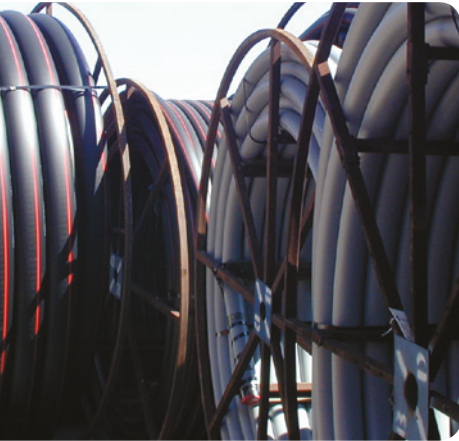
## A comprehensive and diverse range

CMP cable cleats are designed for use within heavy industrial applications and hazardous locations, as well as the arduous conditions and harsh environments encountered by operators in the railways, tunnels and underground, oil and gas and petrochemical industry sectors.

We can offer a cable cleat to suit a variety of support structures including, cable ladder, cable tray, basket, channel, masonry or concrete, and can manufacture in a variety of materials to suit the environmental conditions they may be subjected to.

**Safety is the CMP priority - all CMP cable cleat products are third party tested and certified to IEC 61914:2009 prior to being released on to the market.**

## Product range overview



### Sabre – (1BC)

- Third party certification to IEC 61914:2009
- Available in three different materials:
  - Nylon
  - Low Smoke & Fume (LSF), Zero Halogen (LSOH), Phosphorus Free and VO Nylon
  - LUL approved polymer
- Sunlight (UV) & weather resistant
- Operating temperature -40°C to +60°C
- 10 - 57mm in 10 sizes
- Excellent axial & lateral load retention
- Single bolt fixing design

Page 26



### Falcon – (2BC)

- Third party certification to IEC 61914:2009
- Available in three different materials:
  - Nylon
  - Low Smoke & Fume (LSF), Zero Halogen (LSOH), Phosphorus Free and VO Nylon
  - LUL approved polymer
- Sunlight (UV) & weather resistant
- Operating temperature -40°C to +60°C
- Can be double stacked
- 38 - 135mm in 8 sizes
- Excellent axial & lateral load retention
- Two bolt fixing design

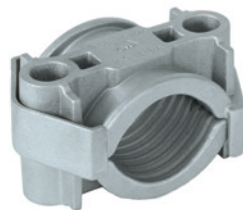
Page 27



### Valiant – (1BCAL)

- Third party certification to IEC 61914:2009
- Available in high pressure die cast aluminium
- Sunlight (UV) resistant
- Operating temperature -60°C to +150°C
- Can be double stacked
- 10 - 71mm in 12 sizes
- Excellent axial & lateral load retention
- Single bolt fixing design

Page 28



### Zenith – (2BCAL)

- Third party certification to IEC 61914:2009
- Available in high pressure die cast aluminium
- Sunlight (UV) & weather resistant
- Operating temperature -60°C to 150°C
- Can be double stacked
- 38 - 151mm in 9 sizes
- Excellent axial & lateral load retention
- Two bolt fixing design

Page 29



### Sapphire – (SHDSS Single cable cleat)

- Third party certification to IEC 61914:2009
- 316L stainless steel
- 26 to 150 mm in 12 sizes for single / parallel formation
- Operating temperature -50°C to +60°C
- Standard Liners which are classified as Low Smoke & Fume (LSF), Zero Halogen (LSOH) and Phosphorus Free
- Combined single (M12) and two bolt (M10) fixing design

Page 30-31

## Product range overview



### Cyclone I (LDSTR 2 Loop cable cleat)

- Third party certification to IEC 61914:2009
- Lightweight aluminium base with 316L stainless steel strap
- 24 - 145mm in 15 sizes for trefoil formation / application
- 36 - 118mm in 8 sizes for multicore cables or single core parallel formations
- 21 - 68mm in 8 sizes for quad formations
- Operating temperature -50°C to +60°C
- Standard Liners which are classified as Low Smoke & Fume (LSF), Zero Halogen (LSOH) and Phosphorus Free

Page 32-33



### Cyclone II (SDSTR 2 Loop cable cleat)

- Third party certification to IEC 61914:2009
- 316L stainless steel base with stainless steel strap
- 24 - 145mm in 15 sizes for trefoil formation / application
- 36 - 118mm in 8 sizes for multicore cables or single core parallel formations
- 21 - 68mm in 8 sizes for quad formations
- Operating temperature -50°C to +60°C
- Standard Liners which are classified as Low Smoke & Fume (LSF), Zero Halogen (LSOH) and Phosphorus Free

Page 34-35



### Cyclone III (HDSTR 3 Loop cable cleat)

- Third party certification to IEC 61914:2009
- 316L stainless steel base with stainless steel strap
- 24 - 145mm in 15 sizes for trefoil formation / application
- 36 - 118mm in 8 sizes for multicore cables or single core parallel formations
- 21 - 68mm in 8 sizes for quad formations
- Operating temperature -50°C to +60°C
- Standard Liners which are classified as Low Smoke & Fume (LSF), Zero Halogen (LSOH) and Phosphorus Free

Page 34-35



### Cyclone Strap – (Intermediate restraint)

- Reduces installation cost
- Reduces installation time
- For multicore, parallel, trefoil and quad installations
- Third party certification to IEC 61914:2009
- Lightweight 316L stainless steel strap

Page 36-37

## Product range overview



### Huron (LDAL cable cleat)

- Third party certification to IEC 61914:2009
- 5000 series aluminium
- 19 - 128mm in 23 sizes for trefoil formation / application
- Operating temperature -50°C to +60°C
- Standard Liners which are classified as Low Smoke & Fume (LSF), Zero Halogen (LS0H) and Phosphorus Free
- Combined single (M10) or two bolt (M10) fixing design

Page 38-39



### Patriot (SDSS cable cleat)

- Third party certification to IEC 61914:2009
- 316L stainless steel
- 19 - 128mm in 23 sizes for trefoil formation / application
- Operating temperature -50°C to +60°C
- Standard Liners which are classified as Low Smoke & Fume (LSF), Zero Halogen (LS0H) and Phosphorus Free
- Combined single (M10) or two bolt (M10) fixing design

Page 40-41



### Sovereign (HDSS cable cleat)

- Third party certification to IEC 61914:2009
- 316L stainless steel
- 19 - 128mm in 23 sizes for trefoil formation / application
- Operating temperature -50°C to +60°C
- Standard Liners which are classified as Low Smoke & Fume (LSF), Zero Halogen (LS0H) and Phosphorus Free
- Combined single (M12) and two bolt (M10) fixing design

Page 42-43



### Conqueror (RTSS cable cleat)

- Third party certification to IEC 61914:2009
- 316L stainless steel
- 19 - 130mm in 16 sizes for trefoil formation / application
- Operating temperature -50°C to +60°C
- Standard Liners which are classified as Low Smoke & Fume (LSF), Zero Halogen (LS0H) and Phosphorus Free
- Combined single (M12) and two bolt (M10) fixing design

Page 44-45



## Product range overview



### Insulation / Separation Pad

- Prevents corrosion between cable cleat and mounting surface
- Low Smoke & Fume (LSF), Zero Halogen (LSOH) and Phosphorus Free as standard
- Preformed knockout positions to suit all CMP cable cleats

Page 57



### C-Clamp

- For use with un-slotted rung / strut
- 316L Stainless Steel construction (other materials available on request)
- Combined single (M12) and two (M10) bolt fixing design
- Tested with CMP cable cleats during short circuit conditions as specified in IEC 61914

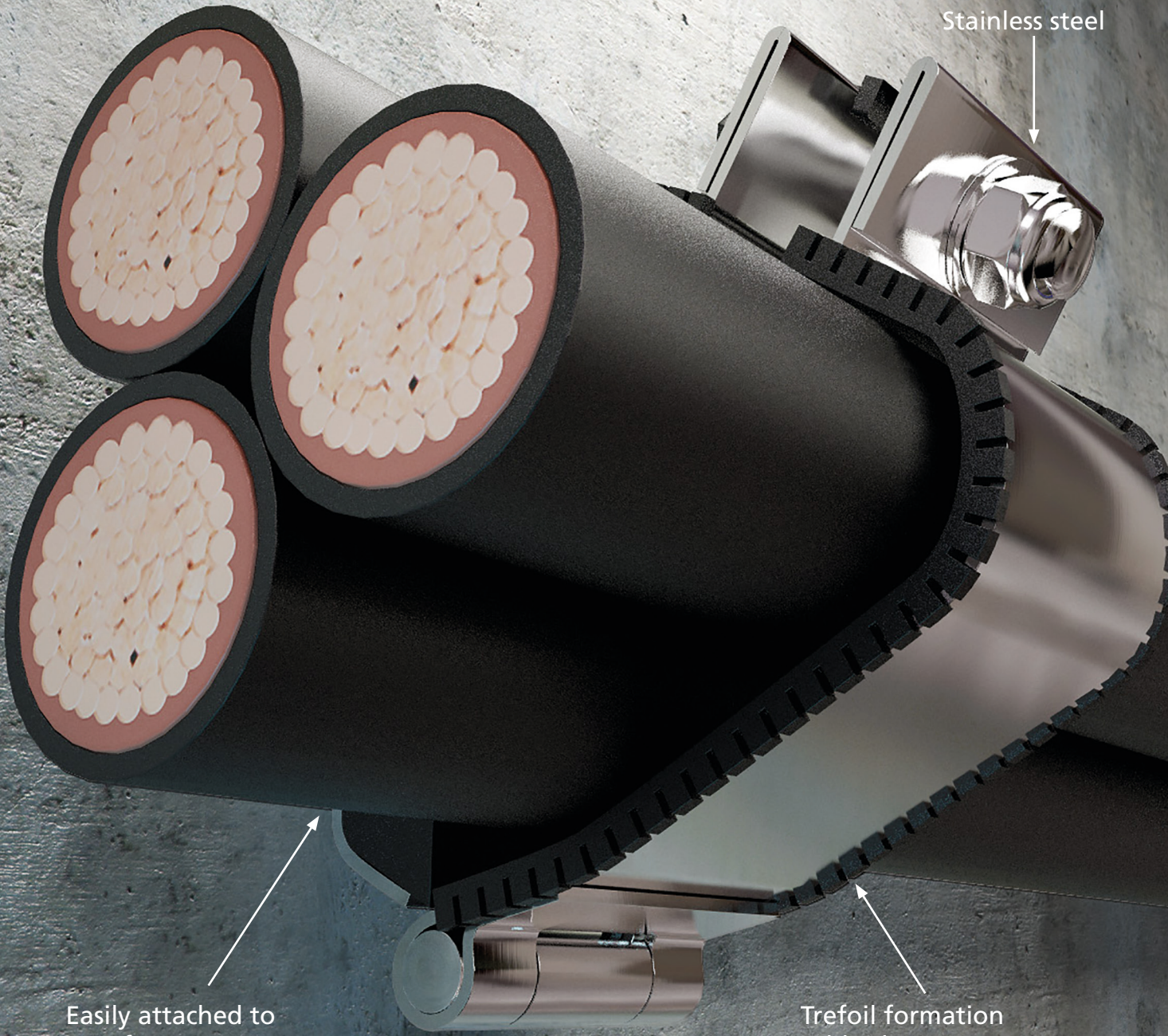
Page 57



### Wire Mesh Cable Tray / Basket Clips

- For use with cable wire basket
- 316L Stainless Steel construction (other materials available on request)
- Combined single (M12) and two (M10) bolt fixing design
- Tested with CMP cable cleats during short circuit conditions as specified in IEC 61914

Page 57



Stainless steel

Easily attached to a surface

Trefoil formation cable cleat

## What is a cable cleat?

Cable cleats are devices designed and tested to ensure the retention and support of cables, and have been used for many years all over the world. However, it was not until 2003 with the emergence of the standard EN 50368 being released, that any standard for cable cleats existed. This standard not only highlighted the retention and support that cable cleats provided to cables, but more importantly it highlighted the protection of the cable management system and the potential risk to human life without the use of cable cleats. Prior to EN 50368 both cable and cable cleat manufacturers provided their own testing to their own standards.

This was then followed up with the publication of IEC 61914 in 2009 which further highlighted the importance of cable cleat products, and correct cable cleating.

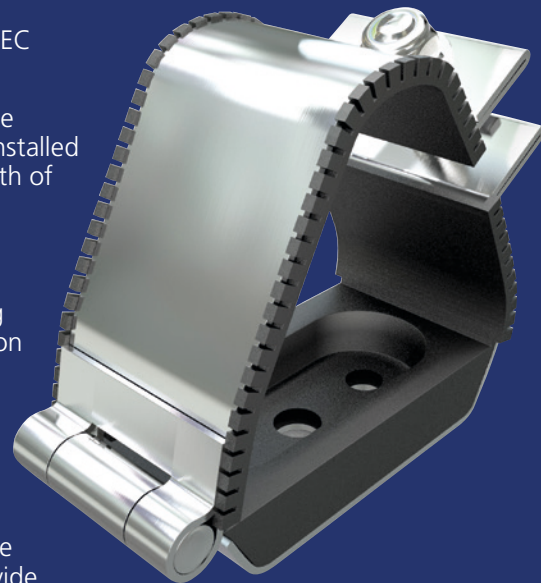
### IEC 61914:2009

#### Cable cleat

'cable cleat' according to IEC 61914:2009 defined as a:

'device designed to provide securing of cables when installed at intervals along the length of cables.'

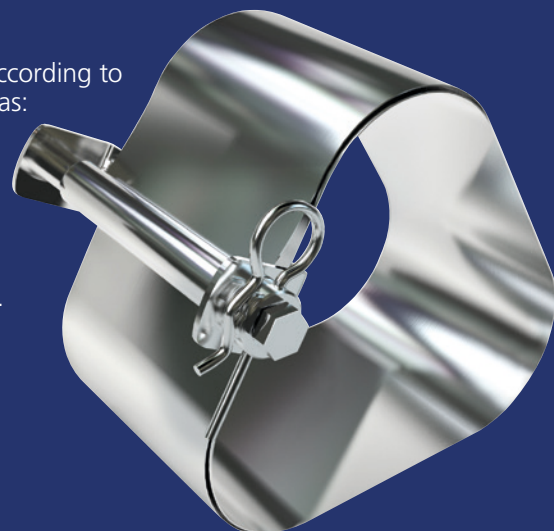
'Note: A cable cleat is provided with a means of attachment to a mounting surface but does not rely on an unspecified mounting surface for the retention of the cables. Examples of mounting surfaces that may be specified are ladder, tray, strut, or rail, wire and beam. Where declared, cable cleats provide resistances to electromechanical forces.'



#### Intermediate restraint

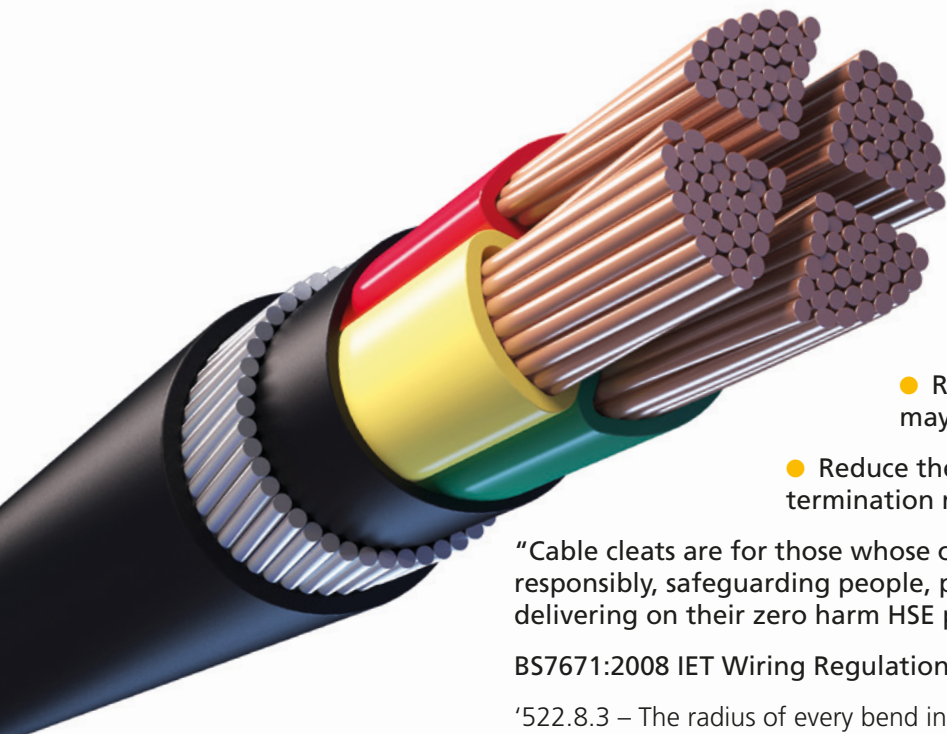
'intermediate restraint' according to IEC 61914:2009 defined as:

'cable retaining device to be used with cable cleats to hold the cables together in order to provide resistance to electromechanical forces. Intermediate restraints are not attached to the mounting surface.'



## Why use a cable cleat?

CMP cable cleats are designed to ensure the retention and support of cables and conductors, reducing the load that the cable may be exposed to under its own weight. By ensuring the cables are fixed, retained and supported correctly this also protects all of the cable terminations by reducing the mechanical load exerted on them. CMP cable cleats are also designed and tested so that in the event of short circuit fault conditions, they will contain the cables without causing damage; enabling the circuit to be restored once the fault has been rectified.



The latest standard IEC61914:2009 specifies requirements and tests for cable cleats and intermediate restraints, used for securing cable in electrical installations. CMP cable cleats provide the necessary levels of resistance to electromechanical forces, where declared, and in addition achieve the following safety measures:

- Support cables and conductors.
- Reduce the mechanical load the cable may be exposed to under its own weight.
- Reduce the mechanical load the cable termination may be exposed to.

“Cable cleats are for those whose core values include operating responsibly, safeguarding people, protecting the environment, and delivering on their zero harm HSE policies” (from IEC61914:2009).

**BS7671:2008 IET Wiring Regulations Seventeenth Edition:**

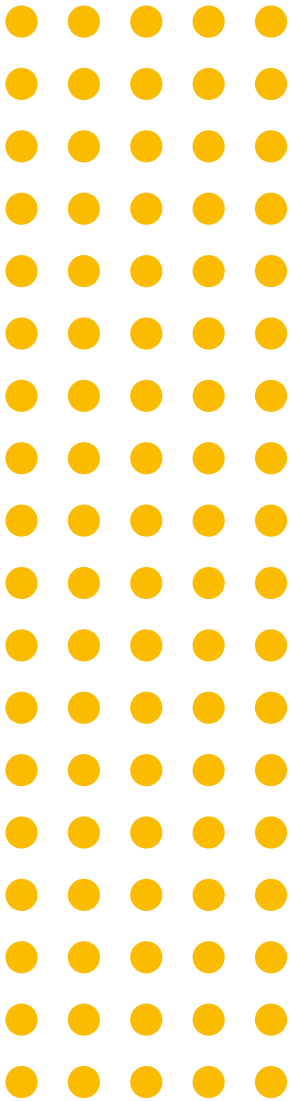
‘522.8.3 – The radius of every bend in a wiring system shall be such that conductors or cables do not suffer damage and terminations are not stressed.’

‘522.8.4 – Where the conductors or cables are not supported continuously due to the method of installation, they shall be supported by suitable means at appropriate intervals in such a manner that the conductors or cables do not suffer damage by their own weight.’

‘522.8.5 – Every cable or conductor shall be supported in such a way that it is not exposed to undue mechanical strain and so that there is no appreciable mechanical strain on the terminations of the conductors, account being taken of mechanical strain imposed by the supported weight of the cable or conductor itself.’



- Reduce the mechanical load a cable may be exposed to due to electrical fault conditions.



**Can I use a circuit breaker instead of cable cleats?**

Although circuit breakers are capable of instantaneous protection, damage to the cables under fault conditions occurs within the first quarter cycle of the fault. Within this period of time the circuit breaker cannot open to suspend the fault, resulting in cable management system damage. A typical circuit breaker interrupts the fault after three cycles. Whilst this may protect the equipment, the cables however may have already been damaged within this short duration and depending on the size of the short circuit, need replacing.

The replacement of any cables comes at a high price as this not only includes the expensive cable costs themselves, but the labour time of decommissioning, the reinstallation of the cable management system. Not only this but the downtime of the operation must also be considered.

The latest standard for cable cleats IEC 61914:2009 lays down the standardised method for testing and certification of cable cleats to prove they can withstand one or more short circuit tests: 6.4.3 resistant to electromechanical forces, withstanding one short circuit, 6.4.4 resistant to electromechanical forces, withstanding more than one short circuit.





## Cable cleat selection

Cable cleat selection takes into account numerous factors listed below, and ideally if CMP Products can be supplied with the following: cable construction – type, ratings and diameter, system design, support structure and environment; it will then be possible to assist you with further advice on the correct type of cable cleat, and also the cable cleat spacing requirements for your specific application.

### Cable – What type of cable is being used?

**Diameter** – The overall diameter of the cable will allow CMP Products to not only size the correct cable cleat, but it will also be required for calculating the short circuit forces the cable cleat maybe subjected to under fault conditions.

**Performance** – Does the cable have any fire performance (FR), or Low Smoke & Fume or Zero Halogen (LSF / LSOH / LSZH) requirements that the cable cleat would also have to adhere to?

**Cable type** – Is the cable a single core or multicore cable? What voltage is the cable? Low voltage (LV), Medium voltage (MV), or High voltage (HV).

### Design - Overview of the cable management system

#### Mechanical load – what will the cable cleat have to support?

All CMP cable cleats having been tested for both axial and lateral loads, this will ensure they will be capable of supporting the weight of the cables(s).

#### Short circuit rating – What kA peak fault or RMS?

What is the maximum peak fault (kA) the cable may be subjected to under short circuit conditions? Based upon the specified cable the short circuit rating can be calculated with use of the standard IEC 61914:2009 to give the maximum forces the cable cleat will need to be able to withstand during a short circuit fault.

#### Cable configuration - Flat form / parallel or trefoil formation?

The cable configuration of the system will define the type of cable cleat required; either a single cable cleat, a trefoil cable cleat, a quad cable cleat, or this may even indicate that a bespoke cable cleat may be required which CMP Products will design, test, and certify to suit the cable management system requirements of its client.

#### Cable run length – How many cable cleats are required?

Whilst the spacing requirements for cable cleats will be subject to cable formation, cable diameter, and short circuit rating, the overall cable run length will give the correct number of cable cleats required for the installation. Cable runs that turn through 90° must also be noted as the cable cleat spacing will be reduced throughout these bends.

#### Expansion

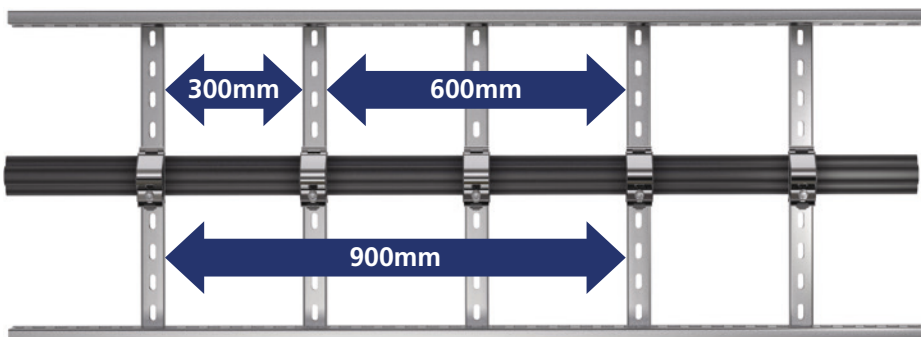
Single core cables expand and contract more due to temperature changes than multicore cables. If the cable is constrained, considerable forces can be transferred to the supporting structure. To allow for this, single core cables are generally “snaked” making slight loops to take up the expansion and contraction. It is also usual to allow some of the cable cleats to move freely and not restrain all cable cleats.



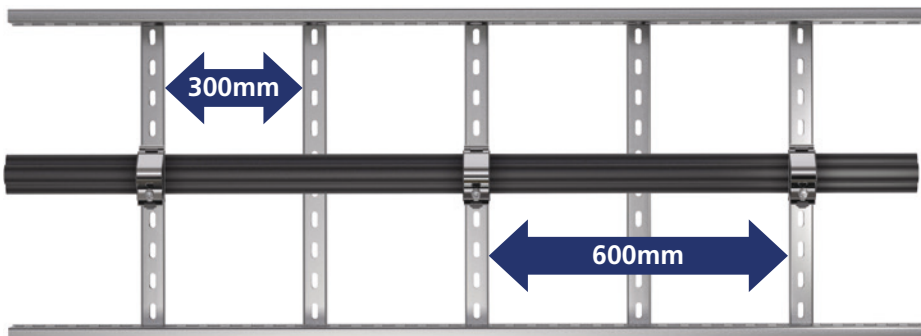
# Cable cleat spacing

The following illustration shows the tensile strength required by each cable cleat dependent upon fixing centres / intervals.

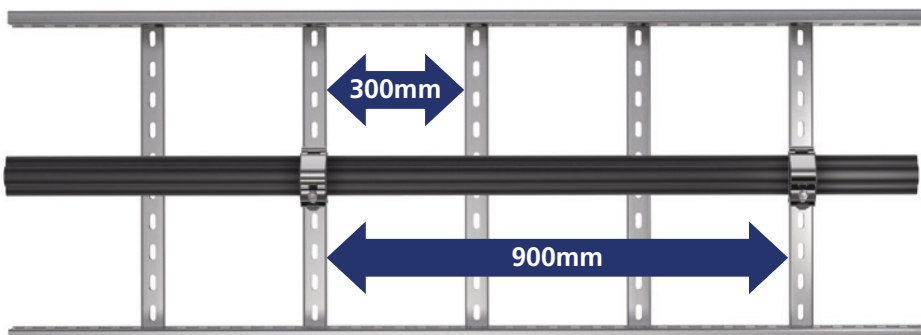
$F_t = 0.17 \dot{i}p^2 / S$   
 **$F_t$  = maximum force on the cable conductor (N/m)**



$0.17 (190 \times 190) / (36 / 1000) = 170,477.22 \text{ N/m}$   
 Cable  $\varnothing = 36\text{mm}$   $\dot{i}p = 190\text{kA}$   
 mounting intervals: 300mm (x 0.3) = 51,141.67N per cable cleat

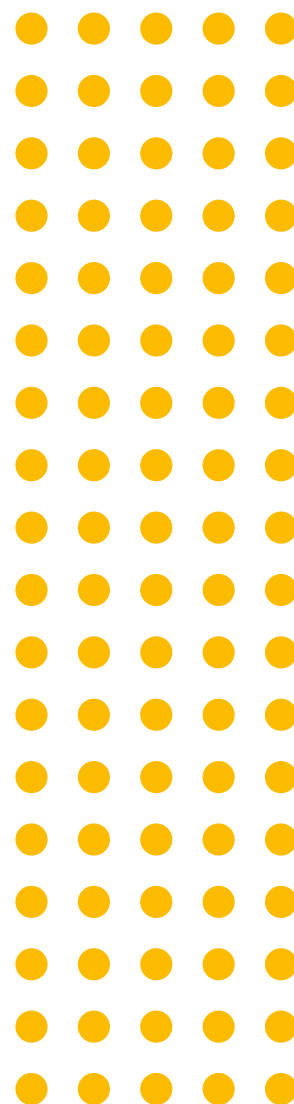


$0.17 (190 \times 190) / (36 / 1000) = 170,477.22 \text{ N/m}$   
 Cable  $\varnothing = 36\text{mm}$   $\dot{i}p = 190\text{kA}$   
 mounting intervals: 600mm (x 0.6) = 102,283.33N per cable cleat.  
 Therefore each cable cleat in this configuration must restrain two times the force of those in the above configuration (300mm).



$0.17 (190 \times 190) / (36 / 1000) = 170,477.22 \text{ N/m}$   
 Cable  $\varnothing = 36\text{mm}$   $\dot{i}p = 190\text{kA}$   
 mounting intervals: 900mm (x 0.9) = 153,424.00N per cable cleat.  
 Therefore each cable cleat in this configuration must restrain one-and-a-half times the force of those in the above configuration (600mm), or three times the force of those in the first configuration (300mm).

For further reference a peak fault versus cable cleat spacing intervals guide can be found on pages 58-59.



## What is a short circuit?

A short circuit is an electrical circuit that allows a current to travel along an unintended path, often where essentially no (or a very low) electrical impedance is encountered. This unintended or abnormal path of negligible impedance can be between live conductors, or between a live conductor and an earth, which have a difference in potential under normal operating conditions.

When electric current flows in a conductor, it creates a magnetic field. In the case of alternating current the magnetic field varies with that current. This magnetic field affects adjacent conductors in two ways: the first is to induce eddy currents, and the second is to induce an electromagnetic field.

Under Short circuit conditions the magnetic fields around the conductors will generate mechanical forces between those conductors. These forces may be considerable and will be greater the closer together the conductors are.

Whilst direct current creates a field, this field is steady and its main effect is to magnetise nearby susceptible objects.

### Eddy Currents (Foucault)

Eddy currents are electric currents induced in conductors when a conductor is exposed to a changing magnetic field.

Eddy currents are induced circumferentially around the current carrying conductors. For this reason, the use of steel wire or steel tape armour is not permitted in single core cables used in A.C. circuits. Similarly it is strongly recommended that cast iron or ferromagnetic cable cleats are not used in conjunction with individual single core cables deployed in A.C. circuits.





## Types of short circuit faults

The most common type of short circuit in a three phase system is a single conductor to earth fault. This is when one of the conductors in a circuit comes into contact with an earth.

The next most common type of short circuit is a phase to phase or conductor to conductor fault - when two of the conductors in a circuit come into contact with each other.

Next is a double phase or double conductor to earth fault - two of the two conductors in a circuit each simultaneously come into contact with an earth.

And lastly, the least common type of short circuit is a balanced three phase or three conductor fault - when all three conductors come into contact with an earth. Whilst this is uncommon, it can happen, and design engineers must go to considerable lengths to guard against the consequences of such an event.

In all cases these faults are short circuits - the path of least resistance is through a fault, and not through the equipment you are attempting to power.

## Short circuit forces

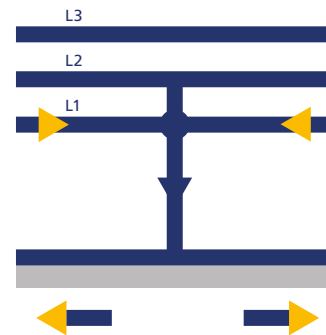
The forces of repulsion between the individual phases of a three phase system cables under fault conditions can be considerable. The cable cleats selected must be capable of withstanding these repulsive forces, which are exacerbated when the cables involved are single core cables.

The short circuit forces generated during fault conditions will be governed by a number of factors, and not just by the type of short circuit. CMP Products cable cleats have been tested and certified in accordance with IEC 61914:2009 for the worst case scenario, a three phase short circuit. The effects of other types of short circuits will create considerably less forces on the cables, nevertheless any short circuit has the potential to develop into a three phase short circuit.

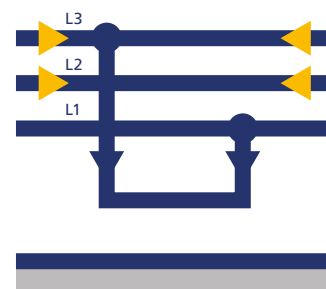
## Short circuit testing

CMP Products has carried out over 300 short circuit tests in accordance with the IEC 61914:2009 standard 'cable cleats for electrical installations'. These tests include various peak faults, cable cleat spacing intervals, and cable formations to conclusively prove the cable cleats' ability to withstand and resist a range of electromechanical forces according to IEC 61914. CMP Products has the technical resources, capabilities and capacity to engage with its clients and deliver bespoke solutions to suit new or unusual situations. The company is able to conduct physical short circuit tests on any of its cable cleats for project specific applications including: specific cable size / type, fault current, cable cleat, and fixing centre / spacing interval configurations.

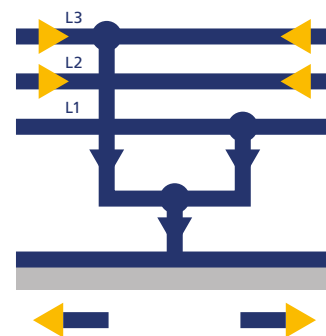
Phase-to-earth short circuit



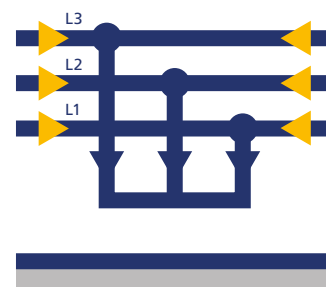
Phase-phase short circuit clear of earth



Phase-phase-to-earth short circuit



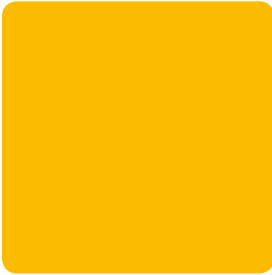
Three-phase short circuit





# Multiphysics cable cleat simulation

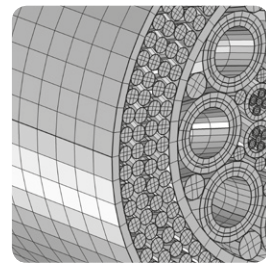
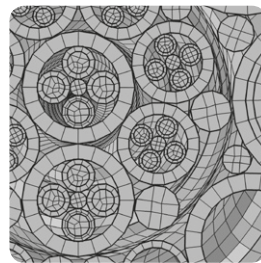
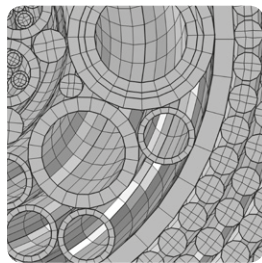
To ensure our customers are able to benefit from the advantages that are possible with the use of advanced simulation technologies, we work closely with Comsol-certified company, Continuum Blue



Continuum Blue's strength lies in its ability to help customers develop, assess, quantify and optimise new innovative technologies and existing products where coupled physical phenomena play a strong part in the development process.

Virtual prototyping and real world simulation helps to:

- understand and quantify a design's performance more accurately
- compare a design with a competitors products before the process of prototyping, production and testing
- reduce development cycles and costs
- eliminate redundant designs at an early stage
- ultimately produce a better product.



**CONTINUUMBLUE**  
technology development

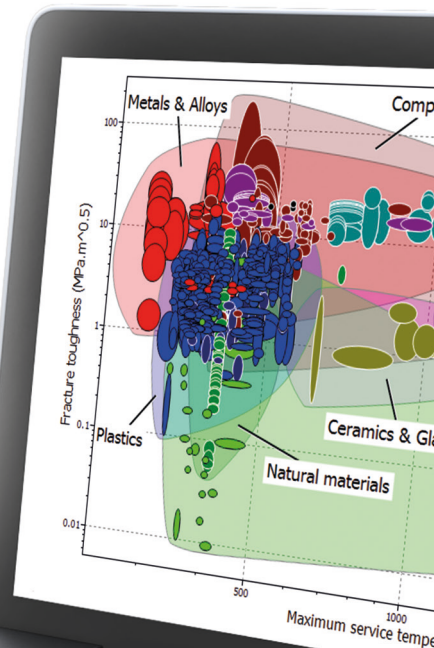
**COMSOL**  
certified consultant

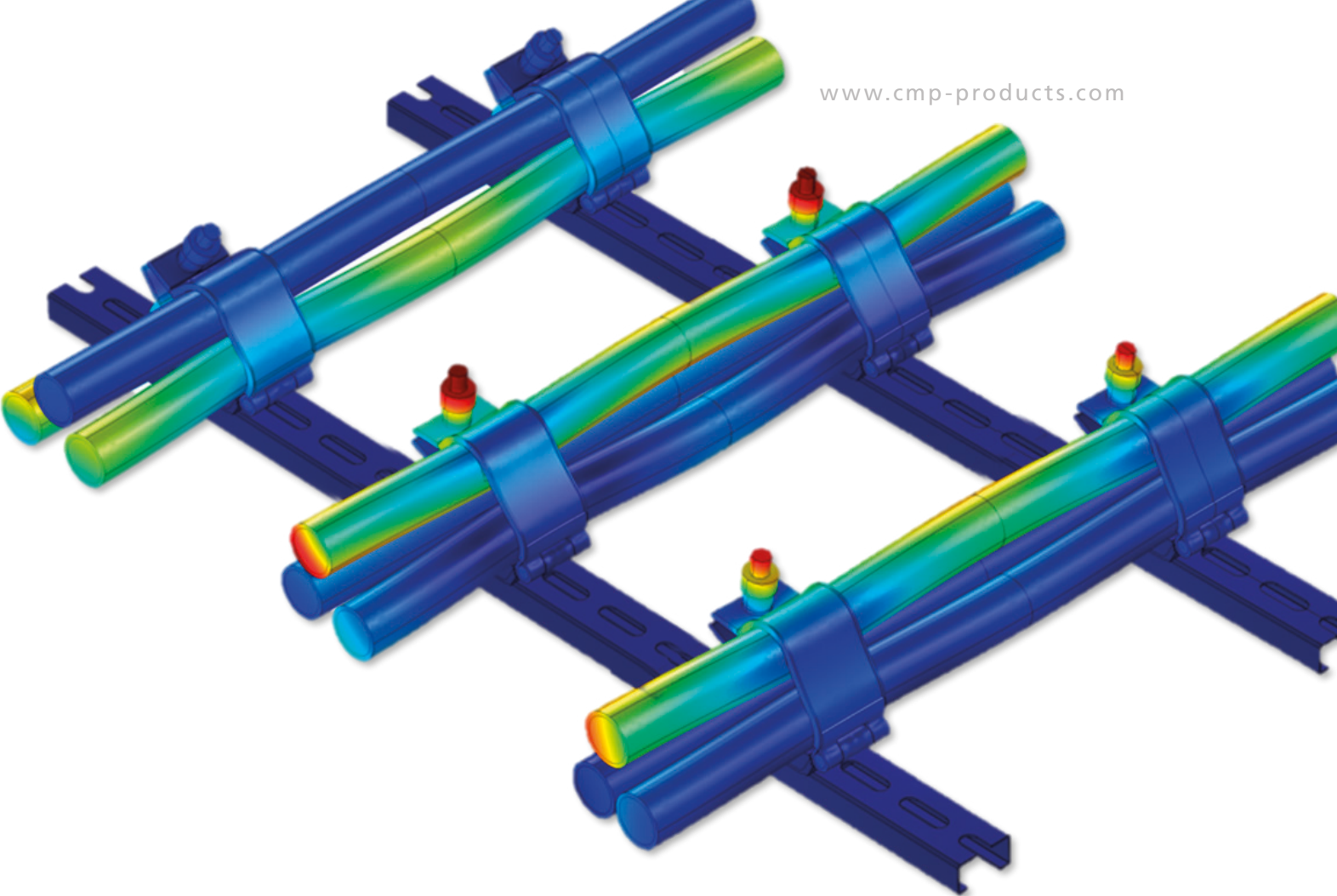
We are able to call on the Continuum Blue's experience in a range of advanced simulation services that includes finite element analysis (FEA), computational fluid dynamics (CFD) and multi-body dynamics. From complex multiphase fluid flow, conjugate heat transfer and electrical and electromagnetic problems to highly nonlinear structural simulations, Continuum Blue's expertise has been used to endorse the extensive CMP cable cleat development programme.

## CMP trefoil cable cleat model

CMP selected Continuum Blue to develop the trefoil cable cleat short circuit simulation models for its range of products because of its exceptional modelling capabilities and ability to accurately predict electromagnetic and mechanical effects during short circuiting of power cables.

MATERIAL SELECTION & OPTIMISATION:  
FRACTURE TOUGHNESS  
VS. TEMPERATURE



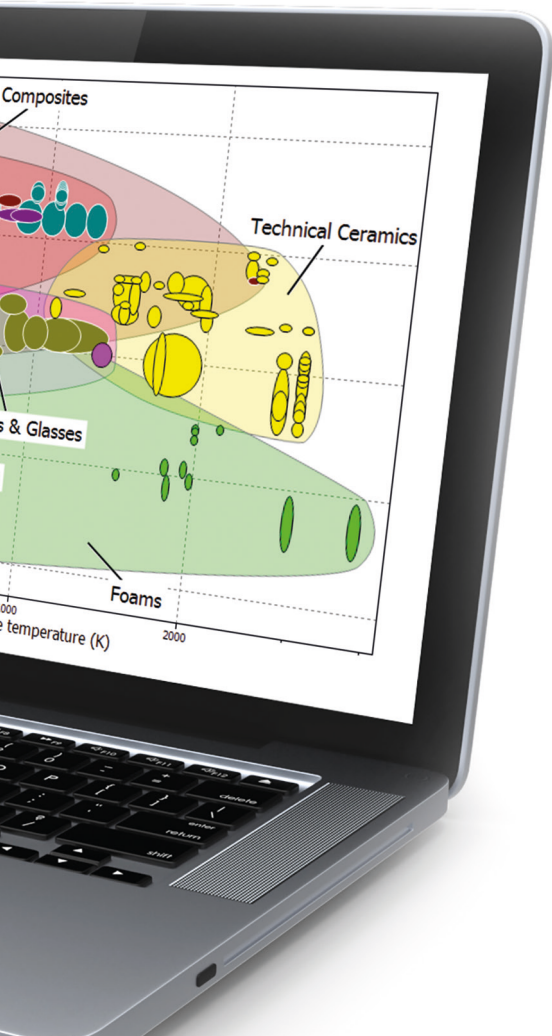


This technology enables a better understanding of the forces acting on various trefoil cable cleat designs, the stresses and deformations observed and the subtle changes in cable cleat design or materials which result in dramatic changes in performance.

Under its founder, Dr Mark Yeoman, who has worked in the oil & gas, aerospace, automotive, chemical and biomedical industries, Continuum Blue offers over 15 years' experience in multiphysics modelling.

The company's full range of services includes:

- Multiphysics simulations (Advanced FEA & CFD)
- Materials selection, assessment & optimisation
- Advanced materials testing & failure analysis
- Contract research





## Simulations of trefoil cable cleats during short circuit

Trefoil cable formation is used where three phases are carried by three single core power cables, rather than a single multicore cable. The advantage of installing three single core cables in such a configuration is that it minimises the induction of eddy currents, therefore reducing the effect of localised heating, whilst maintaining the current carrying capacity of the circuit.



Trefoil cable cleats are devices used to hold the three single core power cables in a triangular touching (trefoil) formation, along the length of the laid cables.

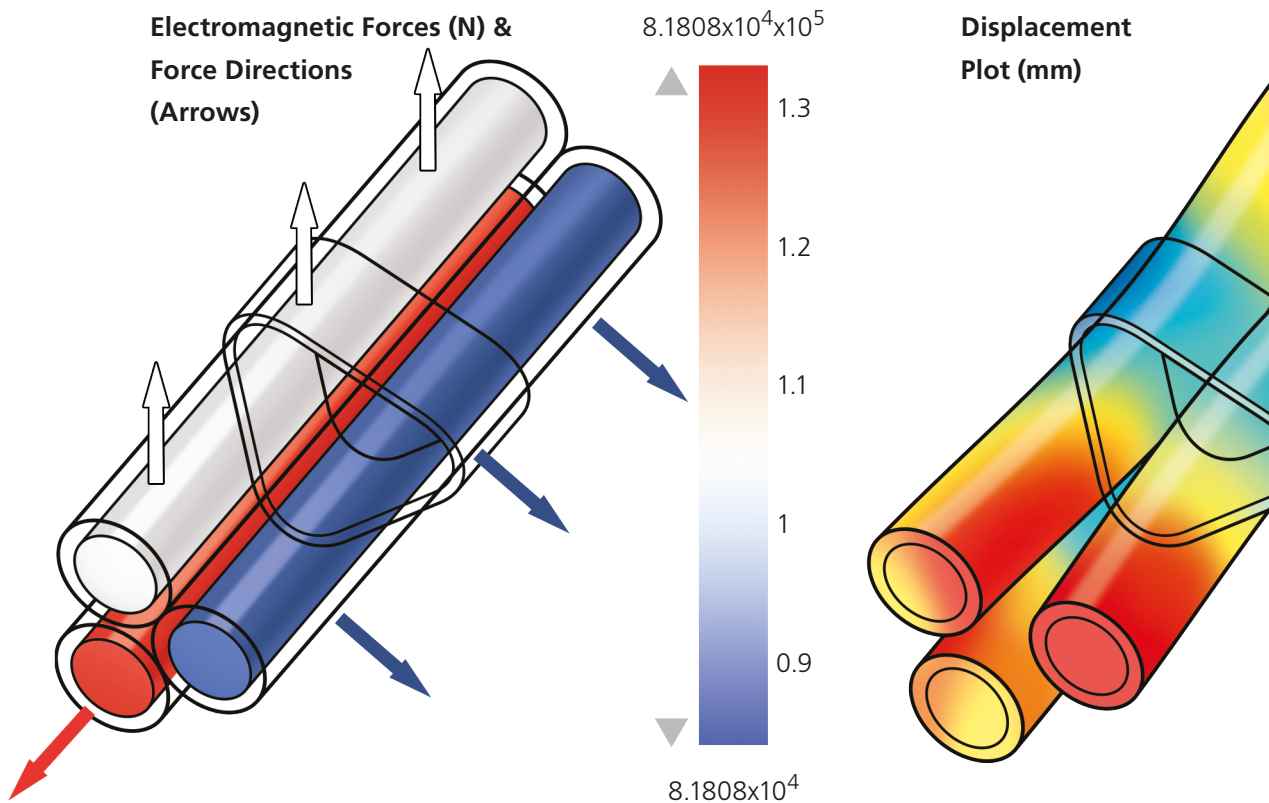
Short circuit fault conditions of single core cables in trefoil formation result in high dynamic electromagnetic forces; these forces need to be restrained correctly in order to prevent extensive damage to the cable management system, and more importantly potential loss of human life.



Manufacturers of trefoil cable cleats are required to physically test their designs in an applied test, where a section of three single core power cables are held with the cable cleats and then exposed to a three phase short circuit.

Each assembly of cable cleat, cable and applied current will yield a different result, so in theory an infinite number of tests are required. These physical tests can be costly in terms of both expense and time.

### Cable Cleat von Mises Stress (MPa) Cable Displacement (mm) Cable Forces (N) Electromagnetic force (Vector Directions)



To avoid the inevitable delays in testing all of the possible permutations that may arise, a time-dependent multiphysics model including currents, induced electromagnetic forces, material plasticity and contact analysis has been set up. This can fully describe and simulate the dynamic load conditions on the cables and cable cleats during a short circuit fault condition.

This multiphysics model can be used to test and assess various cable cleat designs during a short circuit, in a fraction of the time taken to set up and carry out a physical short circuit test.

Every parameter is taken into consideration in the model such as peak fault current, cable diameter, conductor size and type, insulation thickness, cable cleat and liner material properties, cable cleat spacing etc.

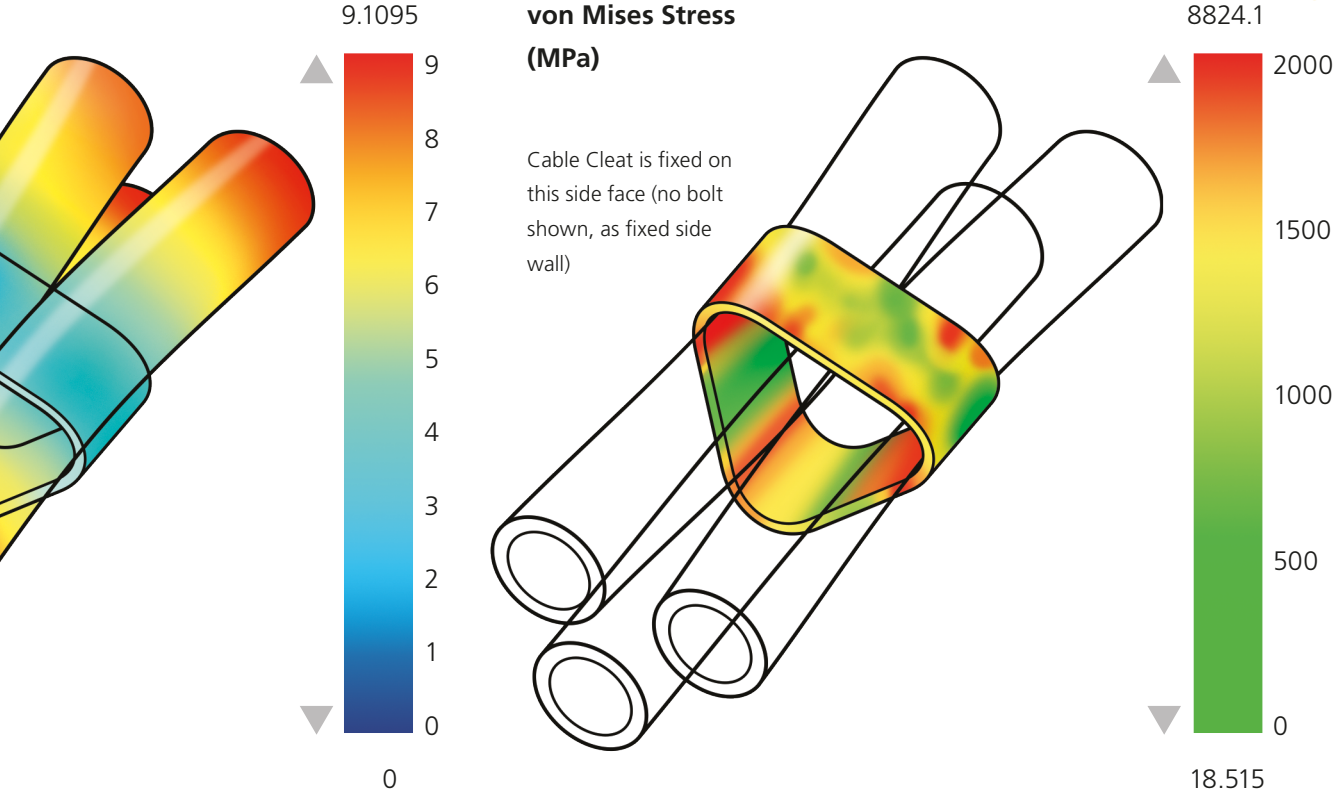
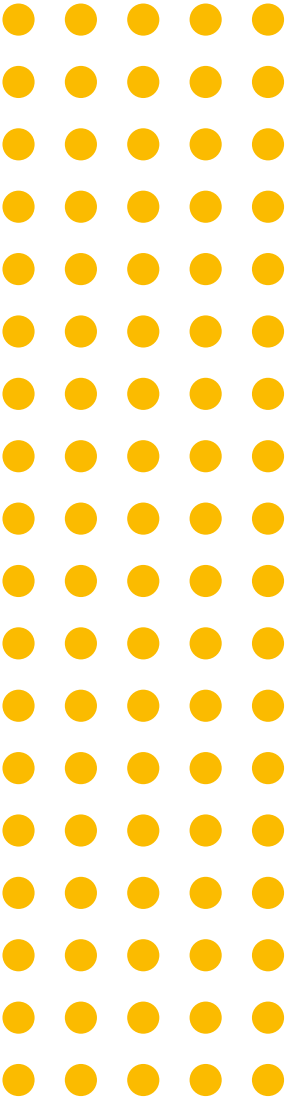
Example outputs of the model are shown below:

The electromechanical forces in Newtons, coupled with arrows showing the vector direction of forces acting upon each cable conductor at a specified point in time during the short circuit.

The displacement magnitude in mm of the cables caused by the electromagnetic forces acting upon them.

The von Mises stress in MPa of the cable cleat material caused by the cable displacement and dynamic load.

Comparisons between the model outputs, physical test data, and calculations given in the test standard, show an excellent correlation. Once the user inputs their defined parameters, the model calculates and displays the outputs which quickly indicate whether or not the selected cable cleat is safe enough to use in that particular application.

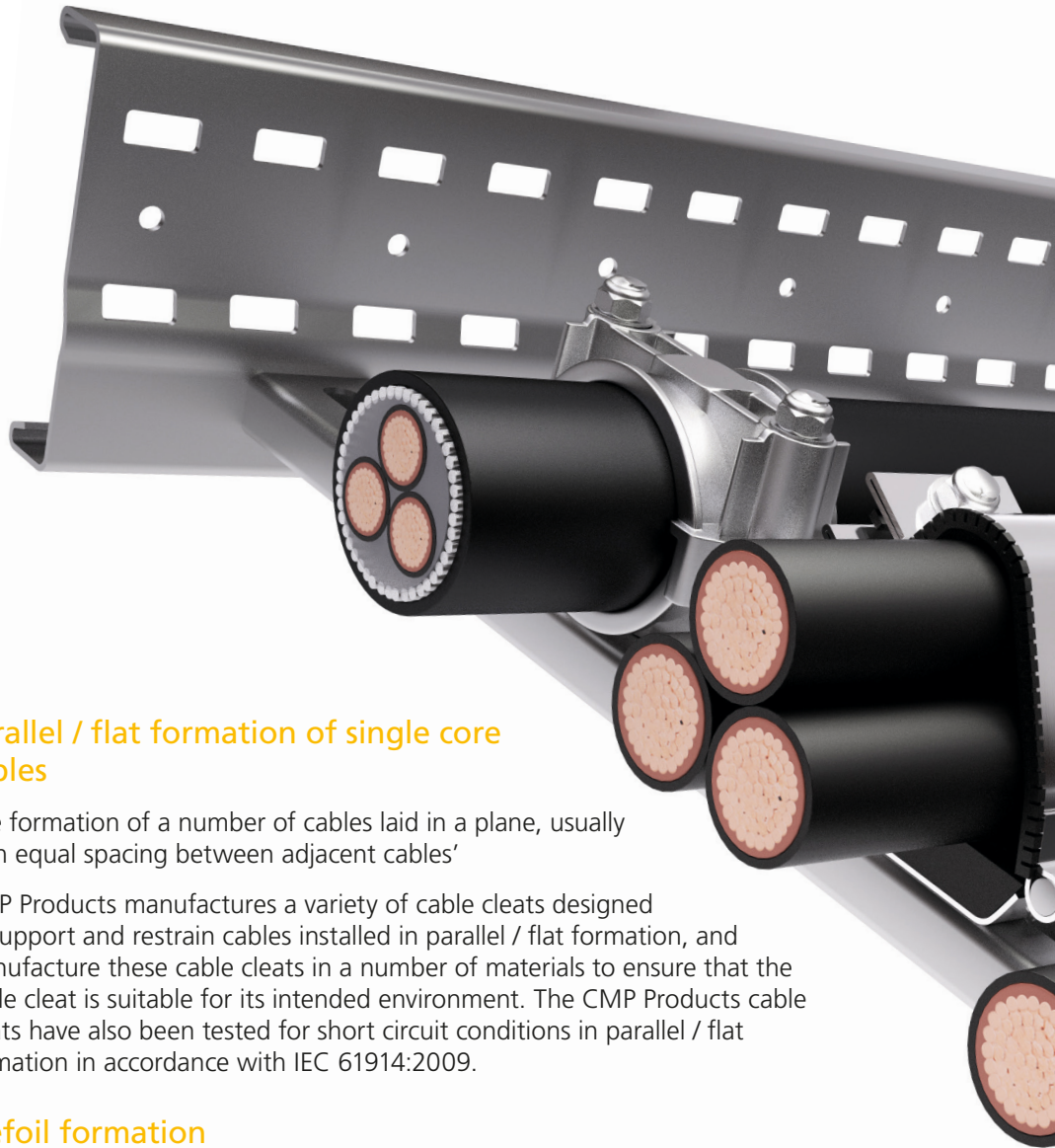


Please refer to page 46 for further information on short circuits.



## Cable formations

All cable installations vary in design from one installation to the next. CMP cable cleats have been designed and tested in accordance with IEC 61914:2009 to ensure that regardless of the cable formation used on the installation, there is a suitable cable cleat available for selection.



### Parallel / flat formation of single core cables

'the formation of a number of cables laid in a plane, usually with equal spacing between adjacent cables'

CMP Products manufactures a variety of cable cleats designed to support and restrain cables installed in parallel / flat formation, and manufacture these cable cleats in a number of materials to ensure that the cable cleat is suitable for its intended environment. The CMP Products cable cleats have also been tested for short circuit conditions in parallel / flat formation in accordance with IEC 61914:2009.

### Trefoil formation

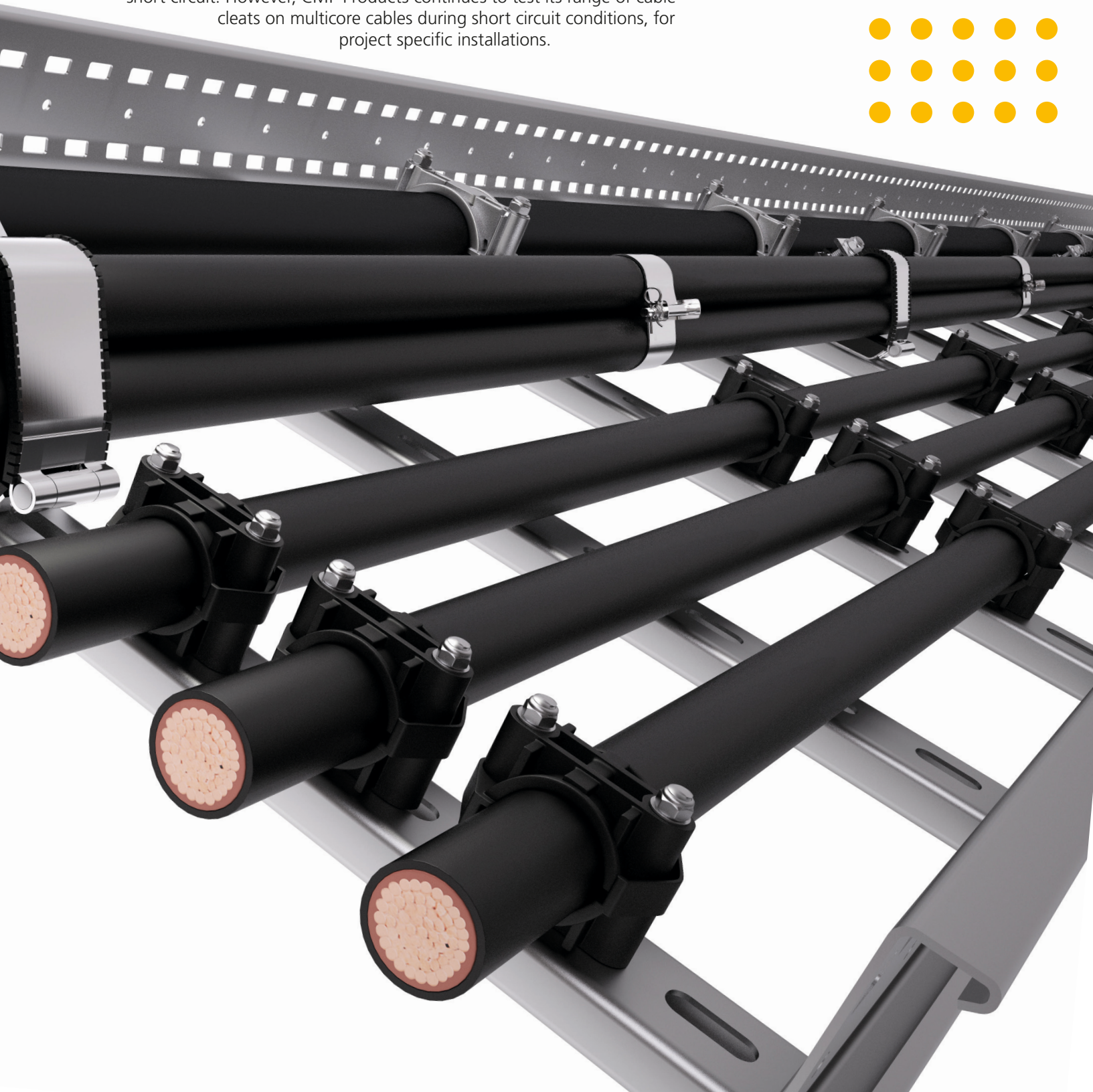
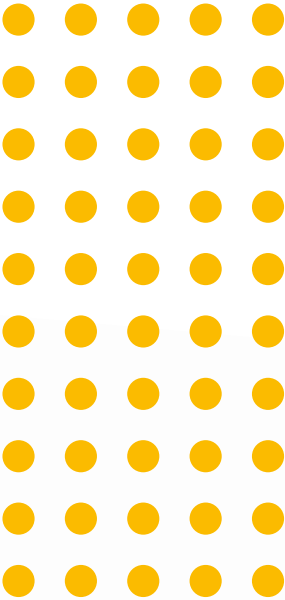
'the formation of three cables so laid to be mutually equidistant. Viewed in cross-section, the lines joining the cable centres form an equilateral triangle'

CMP Products manufactures several cable cleats designed and tested specifically for cables laid in trefoil formation. This range of cable cleats has been successfully tested and certified in accordance with IEC 61914:2009, and these tests include some of the most extreme short circuit conditions ever tested, and greatest electromechanical forces on the cable ever experienced, by any cable cleat for the relevant cable diameters.

**Multicore cable**

‘a cable consisting of multiple conductors, with a common overall covering’

There are currently no standards for the testing of cable cleats during short circuit conditions, when used with multicore cable. Nevertheless there is also a need to restrain, keep safe, and preserve the integrity of multicore cables, whether or not they are equipped with some form of mechanical protection or armour. Multicore cables by their very nature have additional layers of insulation and / or fillers as well as an outer jacket or sheath that are intended to keep them intact during their service life. It is a common assumption that the multicore cables which are equipped with armour and an outer jacket or sheath would contain the forces experienced during a short circuit. However, CMP Products continues to test its range of cable cleats on multicore cables during short circuit conditions, for project specific installations.



## Materials



CMP Products manufactures cable cleats from high quality materials, with excellent flame retardant properties, some of which have been approved to London Underground (LUL) Standard 1-085. All of the CMP polymeric CMP cable cleats have been tested in accordance with various standards that relate to flame propagation, vertical burning, flammability (oxygen index), halogen gas, toxic fume, and smoke emissions tests.

### Polymer:

#### Nylon

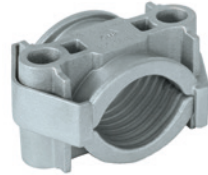
Standard nylon is tough, high tensile, and resistant to abrasion. This material is typically used for industrial applications where less harsh conditions exist.

#### Low Smoke & Fume (LSF), Zero Halogen (LS0H) and Phosphorus Free, V0 Nylon

Nylon polymer, free of halogens and elemental phosphorus, providing a Low Smoke & Fume (LSF) solution. Rated V-0 to UL94 V-0, with very good flame retardant properties.

#### LUL

Flame retardant polymer, free of halogens and elemental phosphorus. It has excellent flame retardant properties and passes the most stringent tests for smoke and toxic fume emissions, making it compliant with the requirements of London Underground Standard 1-085.



### Metallic:

#### Aluminium

Aluminium is remarkable for the metal's low density and for its ability to resist corrosion due to the phenomenon of passivation. Corrosion resistance can be excellent due to a thin surface layer of aluminium oxide that forms when the metal is exposed to air, effectively preventing further oxidation.

The yield strength of pure aluminium is 7–11 MPa, whilst aluminium alloys have yield strengths ranging from 200 MPa to 600 MPa.

Aluminium is nonmagnetic, making it suitable for use with single core cables, and does not easily ignite, ensuring that it does not contribute to the burning process in the event of a fire.

CMP Products utilises 5000 series copper free aluminium for its all-round performance characteristics including mechanical strength, durability, corrosion resistance and flame retardancy.



#### Epoxy coating

Epoxy coating is available for our aluminium products. This 75 to 125 microns layer of epoxy coating is applied to the product for the use in corrosive outdoor applications or where the potential of galvanic corrosion exists between the cable cleat and the support structure. This protective layer has excellent adhesion, and chip and chemical resistance.



#### Stainless Steel

The CMP Stainless Steel ranges of cable cleats are manufactured with type 316L Stainless Steel. Type 316L is more resistant to corrosion and pitting than more conventional Stainless Steels, and it also exhibits higher creep resistance as well as excellent tensile strength and rupture resistance at high temperatures.

#### Fasteners

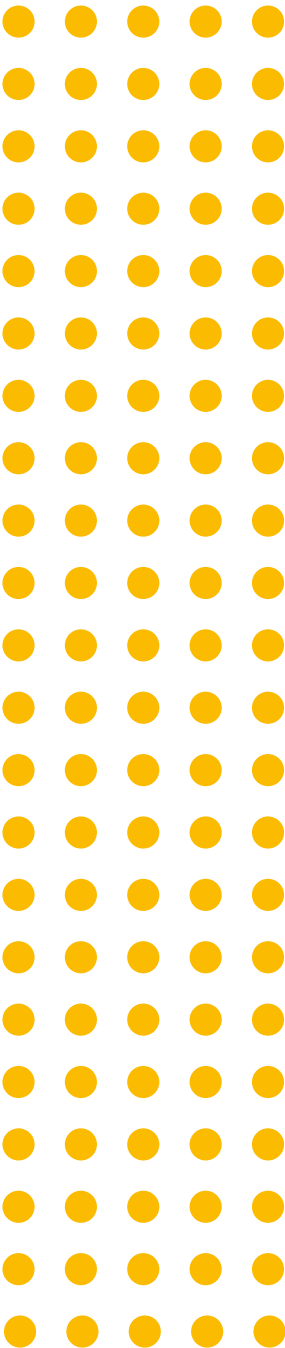
The fasteners shown from pages 30 to 45 form an integral part of the cable cleat design and certification, and are included with the ordering references shown in the selection table. They must not be substituted, or removed and replaced, with a different set of fasteners as this will inevitably change the performance of the installed cable cleat.

Additional fasteners required to secure the cable cleat to the support structure are not included with the ordering references shown in the selection table but can be supplied on request. If in doubt please consult CMP Products for further information.



**Liners (or pads)**

All CMP Products cable cleats and intermediate restraints are supplied with liners. The standard liners are Low Smoke & Fume (LSF) , Zero Halogen (LSOH) and Phosphorus free. The Liners ensure the cable(s) do not have direct contact with the metallic cable cleat or intermediate restraint. Under short circuit conditions, these liners help to cushion the cables from the cable cleats and intermediate restraints during any such fault conditions. They also protect the cables from chafing, particularly in offshore / marine applications where movement between two modules or structures is common. Liners also assist with the restraining of cables when used in vertical cable run applications, where thermal elongation and axial movement occur.



# Classifications

**Flammability classes**

The classification of the ignition and burning resistance characteristics of materials other than metal or ceramic:

Classification	V-0	V-1	V-2
Number of flame applications per sample	2 x 10	2 x 10	2 x 10
Maximum burning time of one sample	≤ 10	≤ 30	≤ 30
Maximum burning time of five samples	≤ 50	≤ 250	≤ 250
Allowable dripping and subsequent ignition of cotton below	No	No	Yes
Allowable afterglow remaining for:	≤ 30	≤ 60	≤ 60

**HB** - Slow burning on a horizontal specimen; burning rate < 76 mm/min for thickness < 3 mm.

**Impact classification**

Classification	Impact energy (J)	Equivalent mass (kg)	Height mm (± 1%)
Very light	0.5	0.25	200
Light	1.0	0.25	400
Medium	2.0	0.5	400
Heavy	5.0	1.7	300
Very heavy	20.0	5.0	400

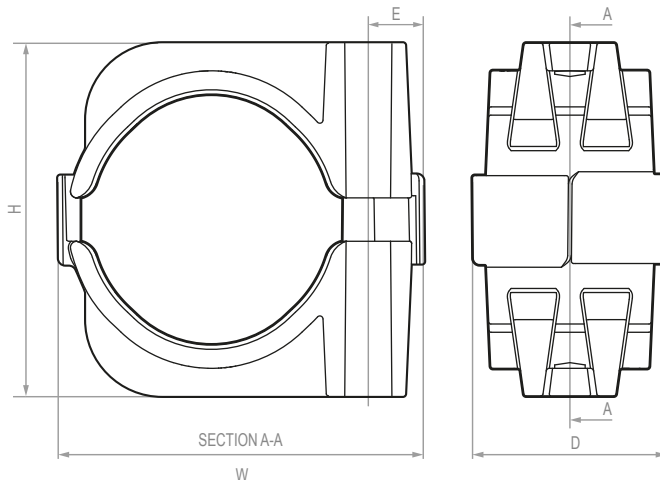
**Corrosion resistance**

Classification	Typical usage	Mean zinc layer thickness (µm)	Minimum zinc layer thickness (µm)	Salt spray duration (h)
Low	Indoor, dry locations	5	3.5	24
High	Outdoor, wet locations	25	18	192

**11.2 Resistance to corrosion (IEC 61914)**

'Stainless Steel containing at least 16% chromium need not be tested and are assumed to meet the classification for high resistance to corrosion.'

# Sabre (1BC Plastic)



The CMP Products Sabre One Bolt single cable cleat is a non-metallic cable cleat which has been designed, constructed, and tested in accordance with the International Standard 'cable cleats for Electrical Installations' (IEC 61914:2009). It ensures the retention and securing of single cables, without damaging or deforming the cable. The cable cleat is manufactured from various materials making it suitable for both indoor and outdoor applications. Due to its unique twin arc internal patent pending design profile it exhibits excellent retention, limiting both the axial and lateral cable movement. The Sabre One Bolt cable cleat is available in ten sizes suitable for cable diameters of 10mm up to 57mm. This cable cleat has an M10 clearance hole for securing it to a mounting surface.

Technical Data & Classification	
Type	Type 6.1.2. Non Metallic 1BC - One Bolt Cable Cleat
Design Specification	IEC 61914:2009
Temperature for permanent application	-40°C to +60°C IEC 61914:2009 clause / part 6.2
Needle Flame Test	Pass - 120 second flame application time IEC 61914:2009 clause 10.0, 10.1, IEC 60695-11-5
Lateral Load Test	1kN - 1.25kN IEC 61914:2009 clause 9.3
Axial Load Test	0.5kN-1kN IEC61914:2009 clause 9.4
Impact Resistance	Pass - Very Heavy IEC 61914:2009 clause 6.3, 6.3.5, 9.2
UV Resistance	Pass IEC 61914:2009 clause 6.5.1.2, 11.1
Material	Standard Nylon, UL94 V0 Nylon or LUL Approved Polymer** <i>Note: V0 Nylon &amp; LUL Polymer are Low Smoke &amp; Fume (LSF), Zero Halogen (LS0H) and Phosphorus Free</i>
Material Colour	Black

Short Circuit Testing to IEC 61914:2009 - Clause 9.5		
Multicore Formation		Parallel Formation
One short circuit (6.4.3) 600mm fixed cleat centres	Two short circuits (6.4.4) 600mm fixed cleat centres	One short circuit (6.4.3) 600mm fixed cleat centres 105mm cable centres
0.1 sec	0.1 sec	0.1 sec
113kA Peak	99kA Peak	68kA Peak
51.3kA RMS	47.1kA RMS	32.3kA RMS

## Features

- Third party certification to IEC 61914:2009
- Available in three different materials:
  - Nylon
  - Low Smoke & Fume (LSF), Zero Halogen (LS0H), Phosphorus Free and V0 Nylon
  - LUL approved polymer
- Sunlight (UV) & weather resistant
- Operating temperature -40°C to +60°C
- 10 - 57mm in 10 sizes
- Excellent axial & lateral load retention
- Single bolt fixing design

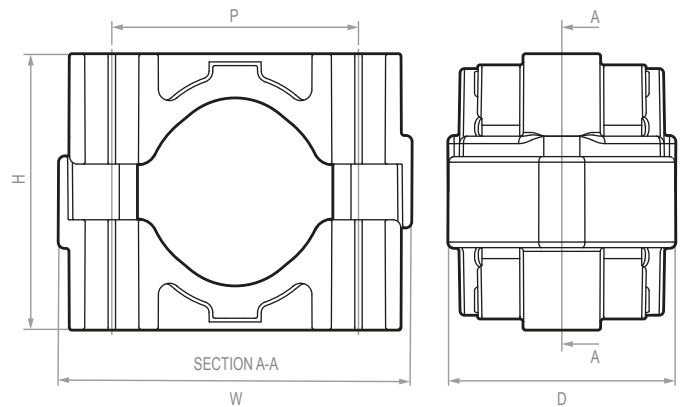
## Cable cleat selection table

Sabre Part No.	Cable Ø range take (mm)	Dimensions mm					Fixing Hole Ø	Weight *(LUL +5%)
		W	H	D	E			
1BC1013	10 - 13	41	34	46	13	1 x M10	23	
1BC1316	13 - 16	44	37	46	13	1 x M10	26	
1BC1619	16 - 19	47	40	46	13	1 x M10	30	
1BC1923	19 - 23	51	44	46	13	1 x M10	34	
1BC2327	23 - 27	54	48	46	13	1 x M10	38	
1BC2732	27 - 32	61	56	46	13	1 x M10	47	
1BC3238	32 - 38	67	62	46	13	1 x M10	53	
1BC3846	38 - 46	75	73	46	13	1 x M10	68	
1BC4651	46 - 51	81	77	46	13	1 x M10	79	
1BC5157	51 - 57	86	83	46	13	1 x M10	88	

Order reference examples: for standard nylon 1BC1013, for LSF suffix Z (1BC1013Z), for LUL approved polymer suffix LUL (1BC1013LUL). \* LUL products are 5% heavier than the weights shown in table. Fasteners required to secure the cable cleat to the support structure are not included with the ordering references shown in the selection table but can be supplied on request.

\*\*For lateral and axial load ratings or Short circuit ratings of LUL polymer products, please contact CMP.

# Falcon (2BC Plastic)



The CMP Products Falcon Two Bolt single cable cleat is a non-metallic cable cleat which has been designed, constructed, and tested in accordance with the International Standard 'cable cleats for Electrical Installations' (IEC 61914:2009). It ensures the retention and securing of single cables, without damaging or deforming the cable. The cable cleat is manufactured from various materials making it suitable for both indoor and outdoor applications. Due to its unique twin arc internal patent pending design profile it exhibits excellent retention, limiting both the axial and lateral movement. The Falcon Two Bolt cable cleats have an excellent range take and are suitable for cable diameters of 38mm up to 135mm in only eight sizes. This cable cleat has two M12 clearance holes for securing it to a mounting surface, which allows for either M10 or M12 fasteners to be used.

Technical Data & Classification	
Type	Type 6.1.2. Non Metallic 2BC - Two Bolt Cable Cleat
Design Specification	IEC 61914:2009
Temperature for permanent application	-40°C to +60°C IEC 61914:2009 clause / part 6.2
Needle Flame Test	Pass - 120 second flame application time IEC 61914:2009 clause 10.0, 10.1, IEC 60695-11-5
Lateral Load Test	16kN - 26kN, IEC 61914:2009 clause 9.3
Axial Load Test	2.75kN - 5kN, IEC 61914:2009 clause 9.4
Impact Resistance	Pass - Very Heavy IEC 61914:2009 clause 6.3, 6.3.5, 9.2
UV Resistance	Pass - IEC 61914:2009 clause 6.5.1.2, 11.1
Material	Standard Nylon, UL94 V0 Nylon or LUL Approved Polymer Note: V0 Nylon & LUL Polymer are Low Smoke & Fume (LSF), Zero Halogen (LSOH) and Phosphorus Free
Material Colour	Black

Short Circuit Testing to IEC 61914:2009 - Clause 9.5		
Multicore Formation	Parallel Formation	
Two short circuits (6.4.4) 600mm fixed cleat centres	One short circuit (6.4.3) 600mm fixed cleat centres 105mm cable centres	Two short circuits (6.4.4) 600mm fixed cleat centres 105mm cable centres
0.1 sec	0.1 sec	0.1 sec
76kA Peak	110kA Peak	86kA Peak
36.2kA RMS	50.0kA RMS	40.9kA RMS

## Features

- Third party certification to IEC 61914:2009
- Available in three different materials:
  - Nylon
  - Low Smoke & Fume (LSF), Zero Halogen (LSOH), Phosphorus Free and V0 Nylon
  - LUL approved polymer
- Sunlight (UV) & weather resistant
- Operating temperature -40°C to +60°C
- Can be double stacked
- 38 - 135mm in 8 sizes
- Excellent axial & lateral load retention
- Two bolt fixing design

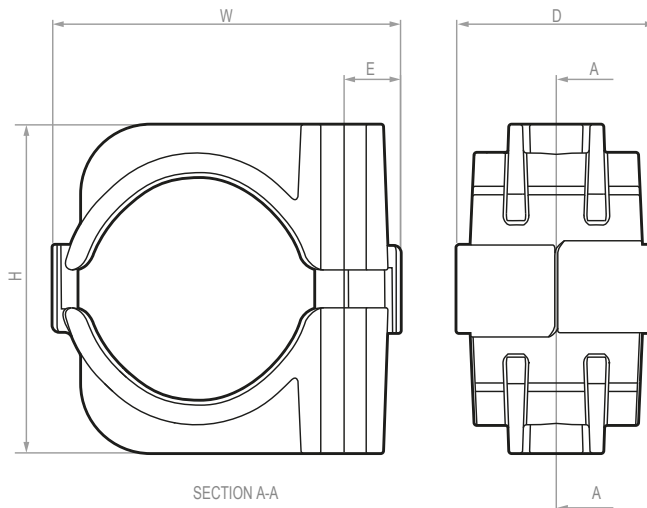
## Cable cleat selection table

Falcon Part No.	Cable Ø range take (mm)	Dimensions mm					Fixing Hole Ø	Weight *(LUL +5%)
		W	H	D	P			
2BC038048	38 - 48	96	74	61	65 - 69	2 x M10 / M12	124	
2BC048058	48 - 58	107	84	61	76 - 80	2 x M10 / M12	146	
2BC058070	58 - 70	119	97	61	88 - 92	2 x M10 / M12	176	
2BC070083	70 - 83	133	110	61	102 - 106	2 x M10 / M12	211	
2BC083097	83 - 97	147	124	61	116 - 120	2 x M10 / M12	242	
2BC096109	96 - 109	160	136	61	129 - 133	2 x M10 / M12	276	
2BC106120	106 - 120	172	148	61	141 - 145	2 x M10 / M12	310	
2BC120135	120 - 135	187	163	61	156 - 160	2 x M10 / M12	349	

Order reference examples: for standard nylon 2BC038048, for LSF suffix Z (2BC038048Z), for LUL approved polymer suffix LUL (2BC038048LUL). \* LUL products are 5% heavier than the weights shown in table. Fasteners required to secure the cable cleat to the support structure are not included with the ordering references shown in the selection table but can be supplied on request.

\*\*For lateral and axial load ratings or Short circuit ratings of LUL polymer products, please contact CMP.

# Valiant (1BCAL)



The CMP Products Valiant One Bolt Aluminium single cable cleat is a metallic cleat which has been designed, constructed, and tested in accordance with the International Standard 'cable cleats for Electrical Installations' (IEC 61914:2009). It ensures the retention and securing of single cables, without damaging or deforming the cable. The cable cleat is manufactured from high pressure die cast aluminium (LM20) making it suitable for both indoor and outdoor applications. Due to its unique twin arc internal patent pending design profile it exhibits excellent retention, limiting both the axial and lateral movement. The Valiant One Bolt cable cleat is available in twelve sizes suitable for cable diameters of 10mm up to 71mm. The cable cleat has an M10 clearance hole for securing it to a mounting surface.

Technical Data & Classification	
Type	6.1.1 Metallic 1BCAL - One Bolt Aluminium Cable Cleat
Design Specification	IEC 61914:2009
Temperature for permanent application	-60°C to +150°C IEC 61914:2009 clause / part 6.2
Needle Flame Test	Pass IEC 61914:2009 clause 10.0, 10.1, IEC 60695-11-5
Lateral Load Test	5kN - 6kN IEC 61914:2009 clause 9.3
Axial Load Test	1.5kN IEC 61914:2009 clause 9.4
Impact Resistance	Pass - Very Heavy IEC 61914:2009 clause 6.3, 6.3.5, 9.2
Material	High pressure die cast aluminium
Material Colour	Silver / grey

Short Circuit Testing to IEC 61914:2009 - Clause 9.5			
Multicore Formation		Parallel Formation	
One short circuit (6.4.3) 600mm fixed cleat centres	Two short circuits (6.4.4) 600mm fixed cleat centres	One short circuit (6.4.3) 600mm fixed cleat centres 105mm cable centres	Two short circuits (6.4.4) 600mm fixed cleat centres 105mm cable centres
0.1 sec	0.1 sec	0.1 sec	0.1 sec
118kA Peak	89kA Peak	90kA Peak	76kA Peak
53.6kA RMS	42.3kA RMS	42.8kA RMS	36.1kA RMS

## Features

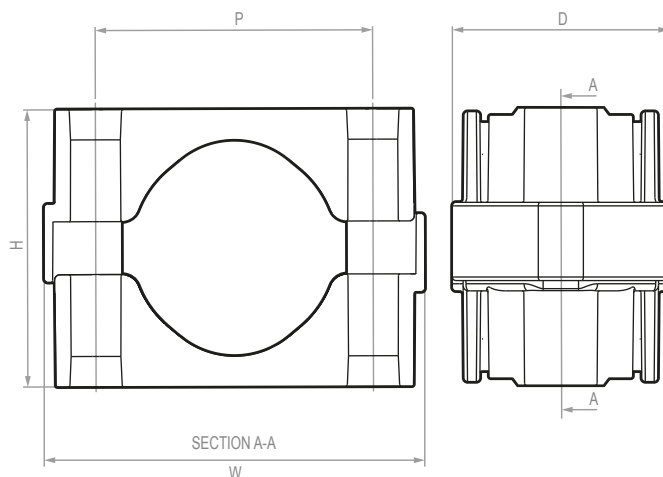
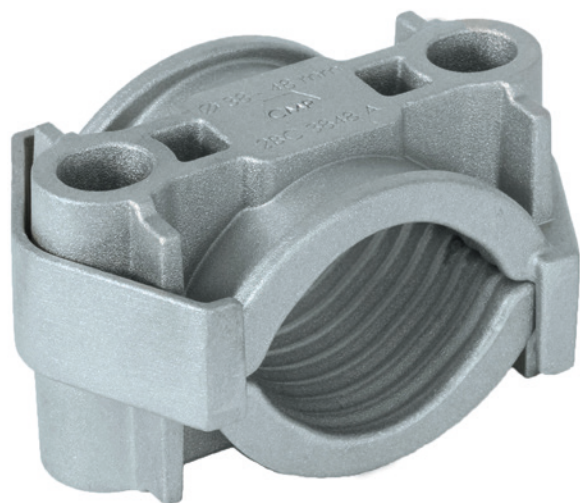
- Third party certification to IEC 61914:2009
- Available in high pressure die cast aluminium
- Sunlight (UV) resistant
- Operating temperature -60°C to +150°C
- Can be double stacked
- 10 - 71mm in 12 sizes
- Excellent axial & lateral load retention
- Single bolt fixing design

## Cable cleat selection table

Valiant Part No.	Cable Ø range take (mm)	Dimensions mm					Weight (g)
		W	H	D	E	Fixing Hole Ø	
1BC1013A	10 - 13	41	34	46	13	1 x M10	57
1BC1316A	13 - 16	44	37	46	13	1 x M10	66
1BC1619A	16 - 19	47	40	46	13	1 x M10	74
1BC1923A	19 - 23	51	44	46	13	1 x M10	83
1BC2327A	23 - 27	55	48	46	13	1 x M10	93
1BC2732A	27 - 32	61	56	46	13	1 x M10	114
1BC3238A	32 - 38	67	62	46	13	1 x M10	130
1BC3845A	38 - 45	75	73	46	13	1 x M10	162
1BC4551A	45 - 51	81	76	46	13	1 x M10	181
1BC5158A	51 - 58	86	83	46	13	1 x M10	199
1BC5865A	58 - 65	94	90	46	13	1 x M10	222
1BC6571A	65 - 71	101	97	46	13	1 x M10	240

Order reference example for epoxy coating suffix EC (1BC1013AEC)  
Fasteners required to secure the cable cleat to the support structure are not included with the ordering references shown in the selection table but can be supplied on request.

# Zenith (2BCAL)



The CMP Products Zenith Two Bolt single cable cleat is a metallic cable cleat which has been designed, constructed, and tested in accordance with the International Standard 'cable cleats for Electrical Installations' (IEC 61914:2009). It ensures the retention and securing of single cables, without damaging or deforming the cable. The cable cleat is manufactured from high pressure die cast aluminium (LM20) making it suitable for both indoor and outdoor applications. Due to its unique twin arc internal patent pending design profile it exhibits excellent retention, limiting both the axial and lateral movement. The Zenith Two Bolt cable cleats have an excellent range take and are suitable for cable diameters of 38mm up to 151mm in only nine sizes. This cable cleat has two M12 clearance holes for securing it to a mounting surface, which allows for either M10 or M12 fasteners to be used.

## Features

- Third party certification to IEC 61914:2009
- Available in high pressure die cast aluminium
- Sunlight (UV) & weather resistant
- Operating temperature -60°C to 150°C
- Can be double stacked
- 38 - 151mm in 9 sizes
- Excellent axial & lateral load retention
- Two bolt fixing design

Technical Data & Classification	
Type	6.1.1 Metallic 2BCAL - Two Bolt Aluminium Cable Cleat
Design Specification	IEC 61914:2009
Temperature for permanent application	-60°C to 150°C IEC 61914:2009 clause / part 6.2
Needle Flame Test	Pass IEC 61914:2009 clause 10.0, 10.1, IEC 60695-11-5
Lateral Load Test	18kN - 32kN, IEC 61914:2009 clause 9.3
Axial Load Test	8kN, IEC 61914:2009 clause 9.4
Impact Resistance	Pass - Very heavy IEC 61914:2009 clause 6.3, 6.3.5, 9.2
Material	High pressure die cast aluminium
Material Colour	Silver / grey

Short Circuit Testing to IEC 61914:2009 - Clause 9.5					
Multicore Formation		Parallel Formation			
One short circuit (6.4.3) 600mm fixed cleat centres	Two short circuits (6.4.4) 600mm fixed cleat centres	One short circuit (6.4.3) 600mm fixed cleat centres 105mm cable centres	Two short circuits (6.4.4) 600mm fixed cleat centres 105mm cable centres	One short circuit (6.4.3) 600mm fixed cleat centres 105mm cable centres	Two short circuits (6.4.4) 600mm fixed cleat centres 105mm cable centres
0.1 sec	0.1 sec	0.1 sec	0.1 sec	1 sec	1 sec
102kA Peak	102kA Peak	130kA Peak	120kA Peak	81kA Peak	71kA Peak
48.6kA RMS	48.6kA RMS	59.0kA RMS	54.5kA RMS	36.8kA RMS	32.2kA RMS

## Cable cleat selection table

Zenith Part No.	Cable Ø range take (mm)	Dimensions mm					Weight (g)
		W	H	D	P	Fixing Hole Ø	
2BC038048A	38 - 48	96	68	61	67	2 x M10 / M12	250
2BC048058A	48 - 58	107	78	61	78	2 x M10 / M12	297
2BC058070A	58 - 70	119	91	61	90	2 x M10 / M12	357
2BC070083A	70 - 83	133	104	61	104	2 x M10 / M12	420
2BC083097A	83 - 97	147	118	61	118	2 x M10 / M12	484
2BC096109A	96 - 109	160	130	61	131	2 x M10 / M12	549
2BC106120A	106 - 120	172	142	61	143	2 x M10 / M12	616
2BC120135A	120 - 135	187	157	61	158	2 x M10 / M12	693
2BC135151A	135 - 151	201	174	61	172	2 x M10 / M12	768

Order reference example for epoxy coating suffix EC (2BC038048AEC)  
Fasteners required to secure the cable cleat to the support structure are not included with the ordering references shown in the selection table but can be supplied on request.

## Sapphire (SHDSS cable cleat)



### Features

- Third party certification to IEC 61914:2009
- 316L stainless steel
- 26 to 150mm in 12 sizes for single / parallel formation
- Operating temperature -50°C to +60°C
- Standard liners which are classified as Low Smoke & Fume (LSF), Zero Halogen (LSOH) and Phosphorus Free
- Combined single (M12) and two bolt (M10) fixing design

The CMP Products SHDSS cable cleat range consists of metallic cable cleats which have been designed, constructed, and tested in accordance with the International Standard 'cable cleats for Electrical Installations' IEC 61914:2009. The SHDSS cable cleat has been designed and tested for high short circuit conditions on cables held in single, parallel / flat formation, to ensure the securing and retention of cables without damage.

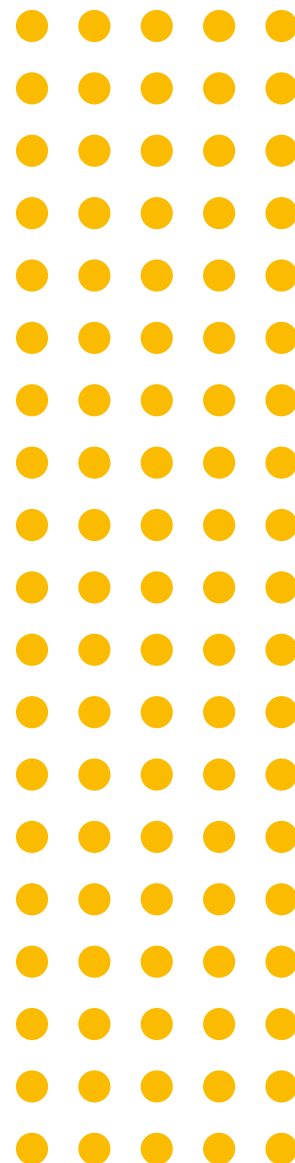
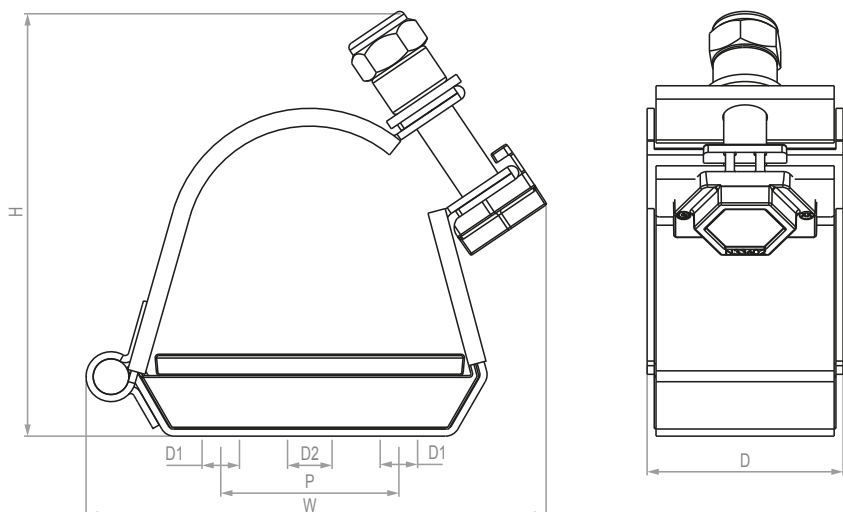
The Sapphire cable cleat is available for single parallel formation for diameters of 26 to 150mm in 12 sizes. The cable cleat is fabricated from 316L stainless steel, giving it high creep strength whilst providing excellent corrosion resistance in the harshest of environments.

The Sapphire cable cleat has one M12 and two M10 fixing clearance holes within its base, allowing versatility to the installer during installation, and is designed to enable the product to be secured to a variety of mounting surfaces. The Sapphire cable cleat hinge opens fully, allowing the cables to be easily placed within the cable cleat, to aid the installer before closing and securing via the mouth piece bolt.

The Sapphire cable cleats come with liners as standard, helping to restrain the cables within vertical applications, providing a layer of protection between the cable sheath and the cable cleat during normal operation, where thermal elongation of cable occurs, protecting the cable from chafing on any mounting surface due to differential movements such as those found in marine and offshore applications. The liners also assist in the extra protection of cables in the event of short circuit fault conditions. The standard liners supplied are classified as Low Smoke & Fume (LSF), Zero Halogen (LSOH) and Phosphorus Free.



## Technical Data



Technical Data & Classification	
Type	6.1.3 Composite SHDSS - Single Heavy Duty Stainless Steel
Design Specification	IEC 61914:2009
Temperature for permanent application	-50°C to +60°C IEC 61914:2009 clause 6.2
Needle Flame Test	Pass - 120 second flame application time IEC 61914:2009 clause 10.0, 10.1, IEC 60695-11-5
Lateral Load Test	3.5kN - 14.5kN, IEC 61914:2009 clause 9.3
Axial Load Test	0.2kN - 0.9kN, IEC 61914:2009 clause 9.4
Impact Resistance	Pass - Very heavy IEC 61914:2009 clause 6.3, 6.3.5, 9.2
Material	316L Stainless Steel with Standard Liner <i>Standard liners are classified as Low Smoke &amp; Fume (LSF), Zero Halogen (LSOH) and Phosphorus Free</i>

Short Circuit Testing to IEC 61914:2009 - Clause 9.5			
Multicore Formation		Parallel Formation	
One short circuit (6.4.3) 600mm fixed cleat centres	Two short circuits (6.4.4) 600mm fixed cleat centres	One short circuit (6.4.3) 600mm fixed cleat centres 105mm cable centres	Two short circuits (6.4.4) 600mm fixed cleat centres 105mm cable centres
0.1 sec	0.1 sec	0.1 sec	0.1 sec
105kA Peak	105kA Peak	110kA Peak	109kA Peak
50.0kA RMS	50.0kA RMS	50.0kA RMS	50.0kA RMS

### Cable cleat selection table

Part No.	Cable Ø range take (mm)	Dimensions mm						Weight (g)
		W	H	D	P	Fixing Hole Ø		
						D1	D2	
SHDSS026032	26-32	95	88	54	25	2 x M10	1 x M12	402
SHDSS032038	32-38	96	93	54	25	2 x M10	1 x M12	431
SHDSS038046	38-46	100	100	54	25	2 x M10	1 x M12	446
SHDSS046051	46-51	104	103	54	25	2 x M10	1 x M12	456
SHDSS051058	51-58	108	107	54	25	2 x M10	1 x M12	472
SHDSS058070	58-70	129	119	54	50	2 x M10	1 x M12	554
SHDSS070083	70-83	137	120	54	50	2 x M10	1 x M12	581
SHDSS083097	83-97	157	137	54	75	2 x M10	1 x M12	665
SHDSS096109	96-109	165	133	54	75	2 x M10	1 x M12	688
SHDSS106120	106-120	170	142	54	75	2 x M10	1 x M12	713
SHDSS120135	120-135	197	157	54	75	2 x M10	1 x M12	814
SHDSS135150	135-150	205	172	54	75	2 x M10	1 x M12	847

Fasteners required to secure the cable cleat to the support structure are not included with the ordering references shown in the selection table but can be supplied on request.

## Cyclone I (LDSTR 2 Loop cable cleat)



### Features

- Third party certification to IEC 61914:2009
- Lightweight aluminium base with 316L stainless steel strap
- 24 - 145mm in 15 sizes for trefoil formation / application
- 36 - 118mm in 8 sizes for multicore cables or single core parallel formations
- 21 - 68mm in 8 sizes for quad formations
- Short circuit rating of 124kA peak fault
- Operating temperature -50°C to +60°C
- Standard liners which are classified as Low Smoke & Fume (LSF), Zero Halogen (LS0H) and Phosphorus Free
- Combined single (M12) and two bolt (M10) base fixing design

The CMP Products Cyclone I Strap cable cleat is a metallic cable cleat consisting of a fabricated lightweight aluminium base and a stainless steel strap which have been designed, constructed, and tested in accordance with the International Standard 'cable cleats for Electrical Installations' IEC 61914:2009. The Cyclone I Strap cable cleat ensures the retention and securing of cables, whilst preventing damage to the cable when in normal operation, or in the event of a short circuit.

The cable cleats allow a wide range of applications including miscellaneous formations. They have an exceptional overlapping range and give the end user more flexibility when compared to more rigid cable cleats on the market. Each cleat is capable of securing various cable formations, such as single cable (multicore) or single cable in parallel formation, trefoil formation, and quad formation. Suitable for single cable applications in diameters of 36mm to 118mm in 8 sizes, in trefoil formation from diameters of 24mm to 145mm in 15 sizes and quad formation from 21mm to 68mm in 8 sizes.

The Cyclone I bases are manufactured from 5000 series aluminium, making the base lightweight, easy to handle and corrosion resistant. The Cyclone straps are manufactured in 316L stainless steel, providing excellent corrosion resistance, and the tensioned straps act as a coil during short circuit conditions to restrain the cable. The Cyclone strap wraps around the angled Cyclone I aluminium base ensuring the cables are always kept central. The strap is fastened to a stainless steel pin with a hexagon shaped head at one end allowing fast, easy installation via the use of a ratchet, power tool or other suitable mechanical device.

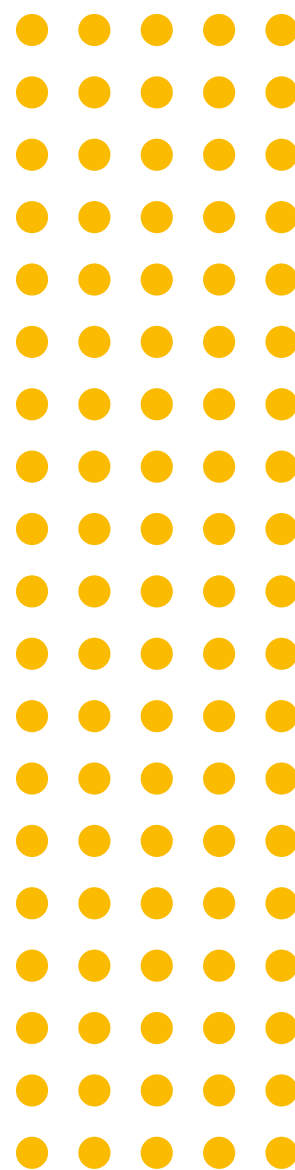
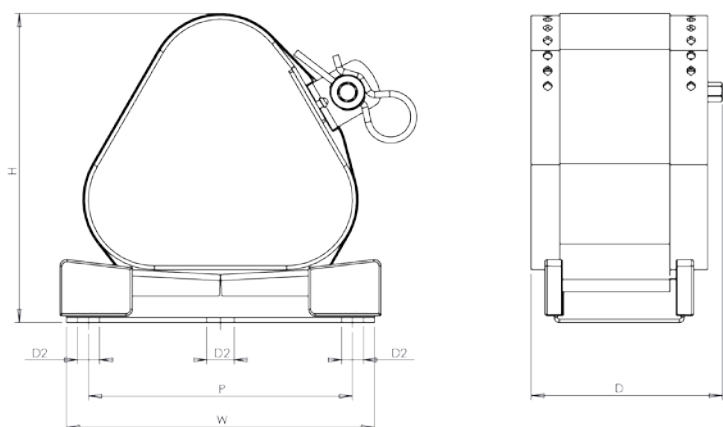
The Cyclone I Aluminium Strap cable cleat has one M12 and two M10 fixing clearance holes within each base, allowing versatile installation and enabling the product to be secured to a variety of mounting surfaces. Due to the design of the Cyclone, the cables do not need to be lifted and placed in to the cable cleat, instead the cables are placed on to the Cyclone bases and the Cyclone straps then wrap around the cables securing them to the mounting surface of the Cyclone base.

The Cyclone I Cable Cleats and Cyclone intermediate straps come with standard liners, which are classified as Low Smoke & Fume (LSF), Zero Halogen (LS0H) and Phosphorus Free. The liners help to restrain the cables within vertical applications, providing a layer of protection between the cable sheath and the Cyclone stainless steel strap and base during normal operation where thermal elongation of cables occurs. The liners also prevent the cable from chafing on any mounting surface due to differential movements such as those found in marine and offshore applications, and protect the cable during short circuit conditions.

The Cyclone Strap is designed to be used as an intermediate restraint (where applicable) between two Cyclone cable cleats to bind cables together giving a cost effective, easy application fixing system. Using the Cyclone I Strap cable cleat and the Cyclone Intermediate Restraint alternatively will dramatically reduce installation time and cost, when compared to alternative cable cleat only solutions.



# Technical Data



Technical Data & Classification	
Type	6.1.3 Composite Strap Cable Cleat - 2 Loop Cyclone I
Design Specification	IEC 61914:2009
Temperature for permanent application	-50 to +60°C
Needle Flame Test	IEC 61914:2009 clause / part 6.2 Pass - 120 second flame application time IEC 61914:2009 clause 10.0, 10.1, IEC 60695-11-5
Lateral Load Test	Single and Trefoil, Refer to CMP Products, IEC 61914:2009 clause 9.3
Axial Load Test	Single and Trefoil, Refer to CMP Products, IEC 61914:2009 clause 9.4
Impact Resistance	Very Heavy IEC 61914:2009 clause 6.3, 6.3.5, 9.2
Material	5000 Series Aluminium, 316L Stainless Steel Strap with Standard Liner <i>Standard liners are classified as Low Smoke &amp; Fume (LSF), Zero Halogen (LSOH) and Phosphorus Free</i>

300mm CAT 1 Cyclone I (0.1 sec)	
Cable OD (mm)	Peak kA
36	124.0
38	127.4
43	135.5
59	158.7
65	166.6

Short Circuit Testing to IEC 61914:2009 - Clause 9.5		
Trefoil Formation		
One short circuit (6.4.3) 300mm fixed cleat centres	Two short circuits (6.4.4) 300mm fixed cleat centres	Two short circuits (6.4.4) 300mm fixed cleat centres
0.1 sec	0.1 sec	3 sec
124kA Peak	116kA Peak	61kA Peak
56.3kA RMS	52.7kA RMS	29.0kA RMS

## Cable cleat selection table

Cyclone I Part No.	Intermediate Restraint Part No.	Cable Ø Range Take (mm)			Dimensions (mm)					Weight (g)	
		Single	Trefoil	Quad	W	H	D	P	Fixing Hole Ø		
									D1		D2
1CYC024034	2STR024034	36-50	24-34	21-29	108	96	89	80	2 x M10	1 x M12	347
1CYC030041	2STR030041	45-60	30-41	26-35	108	109	89	80	2 x M10	1 x M12	358
1CYC037047	2STR037047	55-69	37-47	32-40	128	120	89	100	2 x M10	1 x M12	393
1CYC043054	2STR043054	64-80	43-54	37-46	128	134	89	100	2 x M10	1 x M12	406
1CYC050060	2STR050060	75-88	50-60	43-51	148	145	89	120	2 x M10	1 x M12	465
1CYC056067	2STR056067	83-99	56-67	49-57	148	158	89	120	2 x M10	1 x M12	478
1CYC063073	2STR063073	94-108	63-73	55-62	168	170	89	140	2 x M10	1 x M12	514
1CYC069080	2STR069080	103-118	69-80	60-68	168	183	89	140	2 x M10	1 x M12	527
1CYC072085	2STR072085		72-85		188	193	89	160	2 x M10	1 x M12	596
1CYC082095	2STR082095		82-95		188	212	89	160	2 x M10	1 x M12	615
1CYC092105	2STR092105		92-105		210	231	89	100	2 x M10	1 x M12	653
1CYC102115	2STR102115		102-115		210	250	89	100	2 x M10	1 x M12	672
1CYC112125	2STR112125		112-125		235	269	89	100	2 x M10	1 x M12	751
1CYC122135	2STR122135		122-135		235	288	89	100	2 x M10	1 x M12	771
1CYC132145	2STR132145		132-145		250	307	89	120	2 x M10	1 x M12	808

Note: Cyclone I cable cleat consists of one base and one strap, additional Cyclone cable straps (restraints) ordered separately.  
Order reference example for epoxy coating of cable cleat base suffix EC (1CYC024034EC).  
Fasteners required to secure the cable cleat to the support structure are not included with the ordering references shown in the selection table but can be supplied on request.

## Cyclone II / III (SDSTR 2 Loop cable cleat / HDSTR 3 loop cable cleat)



The CMP Products Cyclone **II** and **III** Strap cable cleats are metallic cable cleats consisting of a fabricated 316L stainless steel base and a stainless steel strap which have been designed, constructed, and tested in accordance with the International Standard 'cable cleats for Electrical Installations' IEC 61914:2009. The Cyclone **II** and **III** Strap cable cleats ensure the retention and securing of cables, whilst preventing damage to the cable when in normal operation or in the event a short circuit fault condition.

The Cyclone **II** Strap cable cleat is designed and tested to restrain cables securely during moderate short circuit forces, whilst the Cyclone **III** Strap cable cleat is designed for high short circuit forces. Cyclone **II** straps are designed to wrap around the cables twice, whilst the Cyclone **III** straps are designed to wrap around the cables three times to provide the resistance needed during high fault short circuit conditions.

The cable cleats allow a wide range of applications including miscellaneous formations. They have an exceptional overlapping range and give the end user more flexibility when compared to more rigid cable cleats on the market. Each cable cleat is capable of securing various cable formations, such as single cable (multicore) or single cable in parallel formation, trefoil formation, and quad formation. Suitable for single cable applications diameters from 36mm to 118mm in 8 sizes, in trefoil formation from diameters of 24mm to 145mm in 15 sizes and quad formation from 21mm to 68mm in 8 sizes.

The Cyclone **II** and **III** bases are manufactured from 316L stainless steel, giving the cable cleats high creep strength and excellent corrosion resistance. The Cyclone straps are manufactured in 316L stainless steel providing excellent corrosion resistance, and the tensioned straps act as a coil during short circuit conditions to restrain the cable. The

### Features

- Third party certification to IEC 61914:2009
- 316L stainless steel base with stainless steel strap
- 24 - 145mm in 15 sizes for trefoil formation / application
- 36 - 118mm in 8 sizes for multicore cables or single core parallel formations
- 21 - 68mm in 8 sizes for quad formations
- Cyclone **II** short circuit rating of 151kA peak fault
- Cyclone **III** short circuit rating of 180kA peak fault
- Operating temperature -50°C to +60°C
- Standard liners which are classified as Low Smoke & Fume (LSF), Zero Halogen (LS0H) and Phosphorus Free
- Combined single (M12) and two bolt (M10) base fixing design

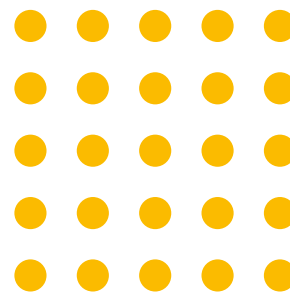
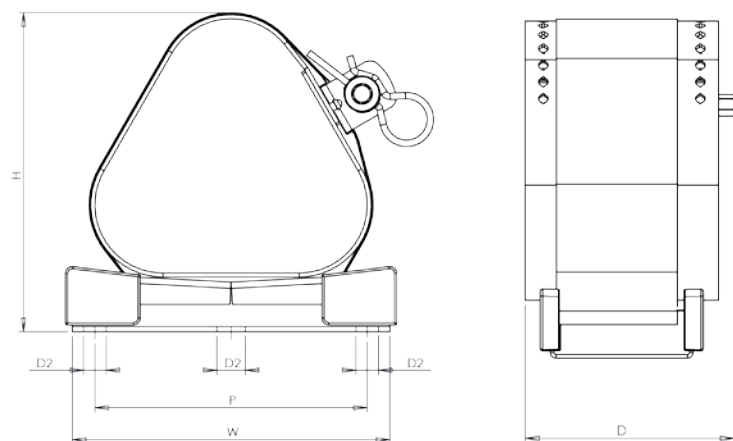
Cyclone strap wraps around the angled Cyclone **II** or **III** stainless steel base ensuring the cables are always kept central, the strap is fastened to a stainless steel pin with a hexagon shaped head at one end allowing fast, easy installation via the use of a ratchet, power tool or other suitable mechanical device.

The Cyclone **II** and **III** Strap cable cleats have one M12 and two M10 fixing clearance holes within each base, allowing versatile installation, and enabling the product to be secured to a variety of mounting surfaces. Due to the design of the Cyclone, the cables do not need to be lifted and placed in to the cable cleat, instead the cables are placed on to the bases and the Cyclone straps then wrap around the cables securing them to the mounting surface of the base.

The Cyclone **II** and **III** cable cleats and Cyclone intermediate straps come with standard liners, which are classified as Low Smoke & Fume (LSF), Zero Halogen (LS0H) and Phosphorus free. The liners help to restrain the cables within vertical applications, providing a layer of protection between the cable sheath and the Cyclone stainless steel strap and base during normal operation where thermal elongation of cables occurs. The liners also prevent the cable from chafing on any mounting surface due to differential movements such as those found in marine and offshore applications, and protect the cable during short circuit conditions.

The Cyclone Straps are designed to be used as an intermediate restraint (where applicable) between two Cyclone cable cleats to bind cables together giving a cost effective, easy application fixing system. Using the Cyclone **II** or **III** Strap cable cleat and the Cyclone Intermediate Restraints alternatively will dramatically reduce installation time and cost, when compared to alternative cable cleat only solutions.

# Technical Data



300mm CAT 1 Cyclone II (0.1 sec)	
Cable OD (mm)	Peak kA
36	151.0
38	155.1
43	165.0
59	193.3
65	202.9

300mm CAT 1 Cyclone III (0.1 sec)	
Cable OD (mm)	Peak kA
36	180.0
38	184.9
43	196.7
59	230.4
65	241.9

Technical Data & Classification	
Type	6.1.3 Composite Strap Cable Cleat - 2 Loop Cyclone II / 3 Loop Cyclone III
Design Specification	IEC 61914:2009
Temperature for permanent application	-50 to +60°C IEC 61914:2009 clause / part 6.2
Needle Flame Test	Pass - 120 second flame application time, IEC 61914:2009 clause 10.0, 10.1, IEC 60695-11-5
Lateral Load Test	Single - 5.5kN - 20kN Cyclone II and 6.5kN - 22kN Cyclone III, IEC 61914:2009 clause 9.3 Trefoil - Refer to CMP Products, Cyclone II and Cyclone III, IEC 61914:2009 clause 9.3
Axial Load Test	IEC 61914:2009 clause 9.4, Single - 0.4kN - 0.6kN Cyclone II and 0.4kN Cyclone III IEC 61914:2009 clause 9.4, Trefoil - 0.4kN Cyclone II and 0.4kN Cyclone III
Impact Resistance	Very Heavy, IEC 61914:2009 clause 6.3, 6.3.5, 9.2
Material	316L Stainless Steel Strap with Standard Liner Standard liners are classified as Low Smoke & Fume (LSF), Zero Halogen (LS0H) and Phosphorus Free

Cyclone II Short Circuit Testing to IEC 61914:2009 - Clause 9.5						
Trefoil Formation						
One short circuit (6.4.3)			One short circuit (6.4.3) w/ Cyclone strap	Two short circuits (6.4.4)		Two short circuits (6.4.4) w/ Cyclone strap
fixed cleat centres 300mm	300mm	600mm	1200mm	600mm	600mm	1200mm
0.1 sec	1 sec	1 sec	0.1 sec	0.1 sec	1 sec	0.1 sec
151kA Peak	80kA Peak	75kA Peak	125kA Peak	120kA Peak	70kA Peak	114kA Peak
68.6kA RMS	35.6kA RMS	34.8kA RMS	56.8kA RMS	54.5kA RMS	32.8kA RMS	51.8kA RMS

Cyclone III Short Circuit Testing to IEC 61914:2009 - Clause 9.5						
Trefoil Formation						
One short circuit (6.4.3)			One short circuit (6.4.3) w/ Cyclone strap	Two short circuits (6.4.4)		Two short circuits (6.4.4) w/ Cyclone strap
fixed cleat centres 300mm	300mm	600mm	1200mm	600mm	600mm	1200mm
0.1 sec	1 sec	1 sec	0.1 sec	0.1 sec	1 sec	0.1 sec
180kA Peak	90kA Peak	80kA Peak	137kA Peak	135kA Peak	75kA Peak	130kA Peak
81.8kA RMS	41.7kA RMS	36.9kA RMS	62.2kA RMS	61.4kA RMS	34.7kA RMS	60kA RMS

## Cable cleat selection table

Cyclone II Part No.	Cyclone III Part No.	Cable Ø Range Take (mm)			Dimensions mm						Weight (g)
		Single	Trefoil	Quad	W	H	D	P	Fixing Hole Ø		
									D1	D2	
2CYC024034	3CYC024034	36-50	24-34	21-29	108	96	89	80	2 x M10	1 x M12	519
2CYC030041	3CYC030041	45-60	30-41	26-35	108	109	89	80	2 x M10	1 x M12	538
2CYC037047	3CYC037047	55-69	37-47	32-40	128	120	89	100	2 x M10	1 x M12	612
2CYC043054	3CYC043054	64-80	43-54	37-46	128	134	89	100	2 x M10	1 x M12	634
2CYC050060	3CYC050060	75-88	50-60	43-51	148	145	89	120	2 x M10	1 x M12	729
2CYC056067	3CYC056067	83-99	56-67	49-57	148	158	89	120	2 x M10	1 x M12	747
2CYC063073	3CYC063073	94-108	63-73	55-62	168	170	89	140	2 x M10	1 x M12	822
2CYC069080	3CYC069080	103-118	69-80	60-68	168	183	89	140	2 x M10	1 x M12	841
2CYC072085	3CYC072085		72-85		188	193	89	160	2 x M10	1 x M12	951
2CYC082095	3CYC082095		82-95		188	212	89	160	2 x M10	1 x M12	978
2CYC092105	3CYC092105		92-105		210	231	89	100	2 x M10	1 x M12	1051
2CYC102115	3CYC102115		102-115		210	250	89	100	2 x M10	1 x M12	1080
2CYC112125	3CYC112125		112-125		235	269	89	100	2 x M10	1 x M12	1210
2CYC122135	3CYC122135		122-135		235	288	89	100	2 x M10	1 x M12	1239
2CYC132145	3CYC132145		132-145		250	307	89	120	2 x M10	1 x M12	1314

Note: Both Cyclone II and Cyclone III cable cleat consists of one base and one strap, additional cable straps (restraints) ordered separately. Fasteners required to secure the cable cleat to the support structure are not included with the ordering references shown in the selection table but can be supplied on request.

## Cyclone Strap (Intermediate restraint)



### Features

- Reduces installation cost
- Reduces installation time
- For trefoil and quad installations
- Third party certification to IEC 61914:2009
- Lightweight 316L stainless steel strap
- Sunlight (UV) resistant
- Operating temperature -50°C to +60°C
- 24 - 145mm in 15 sizes for trefoil formation
- 21 - 68mm in 8 sizes for quad formations
- Standard liners which are classified as Low Smoke & Fume (LSF), Zero Halogen (LSOH) and Phosphorus Free

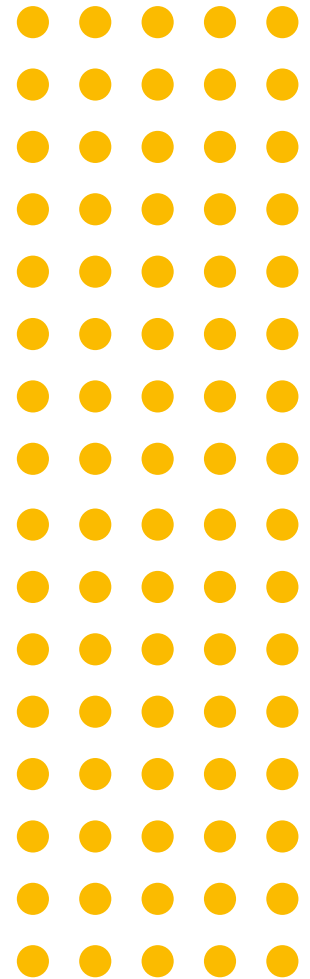
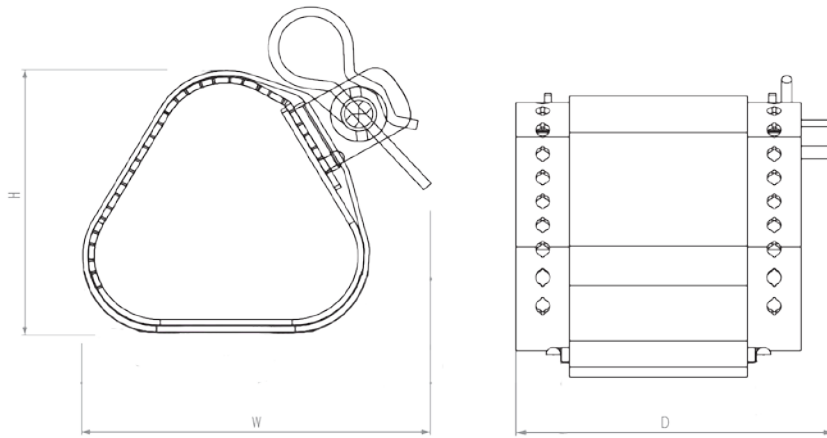
Cyclone Straps are metallic intermediate restraints consisting of a 316L stainless steel strap complete with standard liners which have been designed, constructed, and tested in accordance with the International Standard 'cable cleats for Electrical Installations' IEC 61914:2009. The standard liners supplied are classified as Low Smoke & Fume (LSF), Zero Halogen (LSOH) and Phosphorus Free.

Intermediate restraints are cable retaining devices that can be used in conjunction with cable cleats to hold the cables together in order to provide resistance to electromechanical forces.

Intermediate restraints 2STR are designed to wrap around the cables twice to provide resistance required for moderate short circuit faults, whilst the Cyclone III intermediate restraints 3STR are designed to wrap around the cables three times to provide the resistance needed during high fault short circuit conditions.

Using intermediate restraints between each cable cleat reduces installation time and cost when compared to alternative cleat only systems for use in trefoil or quad formations. CMP Products have tested the Cyclone strap range in accordance to IEC 61914:2009 and are certified to offer these for use with any trefoil cable cleats.





**Technical Data & Classification**

Type	6.1.3 Composite Strap
Design Specification	IEC 61914:2009
Temperature for permanent application	-50°C to +60°C IEC 61914:2009 clause / part 6.2
Needle Flame Test	Pass - 120 second flame application time, IEC 61914:2009 clause 10.0, 10.1, IEC 60695-11-5
Lateral Load Test	Single - 5.5kN - 20kN 2STR and 6.5kN - 22kN 3STR, IEC 61914:2009 clause 9.3  Trefoil - Refer to CMP Products, 2STR and 3STR IEC 61914:2009 clause 9.3
Axial Load Test	IEC 61914:2009 clause 9.4, Single - 0.4kN - 0.6kN 2STR and 0.4kN 3STR  IEC 61914:2009 clause 9.4, Trefoil - 0.4kN 2STR and 0.4kN 3STR
Impact Resistance	Pass - Very Heavy IEC 61914:2009 clause 6.3, 6.3.5, 9.2
Material	316L Stainless Steel Strap with Standard Liner <i>Standard liners are classified as Low Smoke &amp; Fume (LSF), Zero Halogen (LSOH) and Phosphorus Free</i>
Material Colour	Silver / Grey

**Short Circuit Testing to IEC 61914:2009 - Clause 9.5**

Short circuit tested and certified for use with all CMP cable cleats.  
Refer to CMP Products for further information

Cyclone II Strap Part No.	Cyclone III Strap Part No.	Cable Ø Range Take (mm)			Dimensions (mm)			II Strap Weight (g)	III Strap Weight (g)
		Single	Trefoil	Quad	W	H	D		
2STR024034	3STR024034	36-50	24-34	21-29	73	67	80	211	254
2STR030041	3STR030041	45-60	30-41	26-35	87	81	80	230	267
2STR037047	3STR037047	55-69	37-47	32-40	97	93	80	247	301
2STR043054	3STR043054	64-80	43-54	37-46	113	106	80	265	320
2STR050060	3STR050060	75-88	50-60	43-51	125	118	80	280	336
2STR056067	3STR056067	83-99	56-67	49-57	139	131	80	300	377
2STR063073	3STR063073	94-108	63-73	55-62	151	142	80	316	385
2STR069080	3STR069080	103-118	69-80	60-68	165	156	80	334	421
2STR072085	3STR072085		72-85		175	165	80	348	429
2STR082095	3STR082095		82-95		195	185	80	375	465
2STR092105	3STR092105		92-105		215	204	80	402	502
2STR102115	3STR102115		102-115		235	223	80	429	549
2STR112125	3STR112125		112-125		255	243	80	456	588
2STR122135	3STR122135		122-135		275	262	80	483	619
2STR132145	3STR132145		132-145		295	281.5	80	510	657

## Huron (LDAL cable cleat)



### Features

- Third party certification to IEC 61914:2009
- 5000 series aluminium
- 19 - 128mm in 23 sizes for trefoil formation / application
- Short circuit rating of 84kA peak fault
- Operating temperature -50°C to +60°C
- Standard liners which are classified as Low Smoke & Fume (LSF), Zero Halogen (LSOH) and Phosphorus Free
- Combined single (M10) or two bolt (M10) fixing design

CMP Huron cable cleats are metallic cable cleats which have been designed, constructed, and tested in accordance with the International Standard 'cable cleats for Electrical Installations' IEC 61914:2009 to ensure the securing and retention of cables, without sustaining damage to the cable(s).

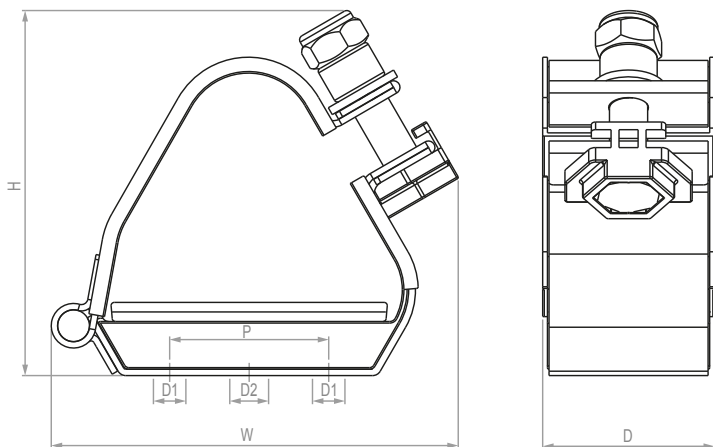
The Huron range of cable cleats are fabricated from 5000 series aluminium and are available in 23 sizes to suit cable diameters 19mm to 128mm.

The Huron cable cleat has three M10 fixing clearance holes within one base, allowing versatility to the installer during installation to use either one M10 bolt or two M10 bolts, and is designed to enable the product to be secured to a variety of mounting surfaces. The Huron cable cleats hinge opens fully allowing the cables to be easily placed within the cable cleat to aid the installer before closing and securing via the mouth piece bolt.

The Huron cable cleats come with standard liners, helping to restrain the cable(s) within vertical applications, This provides a layer of protection between the cable sheath and the cable cleat during normal operation, where thermal elongation of cables occur, protecting the cable from chafing on any mounting surface due to differential movements such as those found in marine and offshore applications. The liners also assist in the extra protection of cable(s) in the event of short circuit fault conditions. The standard liners supplied are classified as Low Smoke & Fume (LFS), Zero Halogen (LSOH) and Phosphorus Free.



## Technical Data



Technical Data & Classification	
Type	6.1.3 Composite LDAL - Aluminium
Design Specification	IEC 61914:2009
Temperature for permanent application	-50°C to +60°C IEC 61914:2009 clause 6.2
Needle Flame Test	Pass - 120 second flame application time IEC 61914:2009 clause 10.0, 10.1, IEC 60695-11-5
Lateral Load Test	Refer to CMP Products, IEC 61914:2009 clause 9.3
Axial Load Test	Refer to CMP Products, IEC 61914:2009 clause 9.4
Impact Resistance	Pass - Very heavy IEC 61914:2009 clause 6.3, 6.3.5, 9.2
Material	5000 Series Aluminium with Standard Liner <i>Standard liners are classified as Low Smoke &amp; Fume (LSF), Zero Halogen (LSOH) and Phosphorus Free</i>

300mm CAT 1 Huron LDAL (0.1 sec)	
Cable OD (mm)	Peak kA
36	84.0
38	86.3
43	91.8
59	107.5
65	112.9

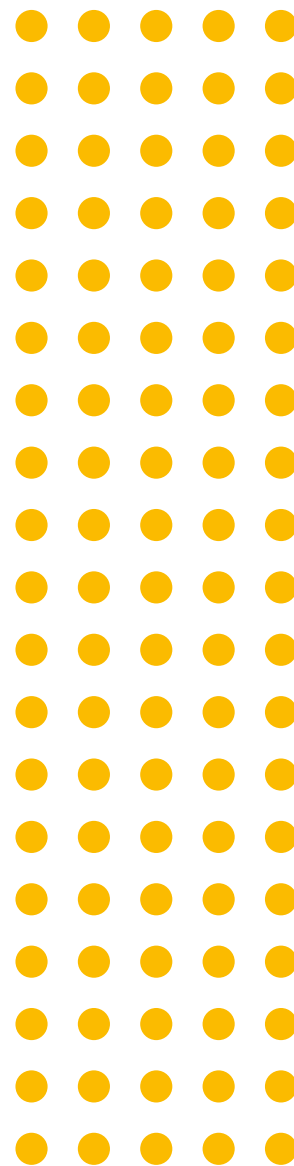
Short Circuit Testing to IEC 61914:2009 - Clause 9.5	
Trefoil Formation	
One short circuit (6.4.3) 300mm fixed cleat centres	Two short circuits (6.4.4) 300mm fixed cleat centres
0.1 sec	0.1 sec
84kA Peak	84kA Peak
40.5kA RMS	40.5kA RMS

### Cable cleat selection table

Huron Part No.	Cable Ø Range Take (mm)	Dimensions (mm)						Weight (g)
		W	H	D	P	Fixing Hole Ø		
						D1	D2	
LDAL019023	19-23	100	87	54	25	2 x M10	1 x M10	213
LDAL023028	23-28	104	88	54	25	2 x M10	1 x M10	235
LDAL027032	27-32	106	97	54	25	2 x M10	1 x M10	242
LDAL030035	30-35	108	103	54	25	2 x M10	1 x M10	248
LDAL033038	33-38	110	107	54	25	2 x M10	1 x M10	251
LDAL036042	36-42	132	108	54	50	2 x M10	1 x M10	295
LDAL040046	40-46	134	113	54	50	2 x M10	1 x M10	302
LDAL044050	44-50	136	121	54	50	2 x M10	1 x M10	309
LDAL048055	48-55	138	127	54	50	2 x M10	1 x M10	320
LDAL051058	51-58	140	130	54	50	2 x M10	1 x M10	326
LDAL055062	55-62	157	138	54	75	2 x M10	1 x M10	363
LDAL059066	59-66	157	145	54	75	2 x M10	1 x M10	371
LDAL063070	63-70	160	152	54	75	2 x M10	1 x M10	378
LDAL067074	67-74	163	160	54	75	2 x M10	1 x M10	386
LDAL071078	71-78	168	167	54	75	2 x M10	1 x M10	395
LDAL074082	74-82	190	175	54	75	2 x M10	1 x M10	444
LDAL077085	77-85	192	180	54	75	2 x M10	1 x M10	450
LDAL082088	82-88	193	186	54	75	2 x M10	1 x M10	455
LDAL088096	88-96	202	201	54	75	2 x M10	1 x M10	472
LDAL096103	96-103	214	215	54	75	2 x M10	1 x M10	486
LDAL103111	103-111	237	229	54	75	2 x M10	1 x M10	545
LDAL111119	111-119	248	244	54	75	2 x M10	1 x M10	561
LDAL119128	119-128	265	260	54	75	2 x M10	1 x M10	591

Order reference example for epoxy coating suffix EC (LDAL019023EC)

Fasteners required to secure the cable cleat to the support structure are not included with the ordering references shown in the selection table but can be supplied on request.



## Patriot (SDSS cable cleat)



### Features

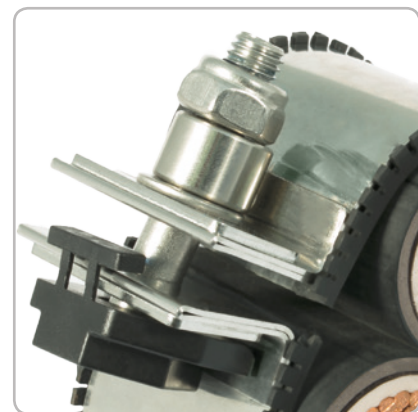
- Third party certification to IEC 61914:2009
- 316L stainless steel
- 19 - 128mm in 23 sizes for trefoil formation / application
- Short circuit rating of 135kA peak fault
- Operating temperature -50°C to +60°C
- Standard liners which are classified as Low Smoke & Fume (LSF), Zero Halogen (LSOH) and Phosphorus Free
- Combined single (M10) or two bolt (M10) fixing design

CMP Patriot cable cleats are metallic cable cleats which have been designed, constructed, and tested in accordance with the International Standard 'cable cleats for Electrical Installations' IEC 61914:2009 to ensure the securing and retention of cables, without sustaining damage to the cable(s).

The cable cleat has been designed and tested for short circuit conditions, within harsh environments. The Patriot cable cleats are available for trefoil application/formation for diameters of 19mm to 128mm in 23 sizes. The Patriot cable cleat is fabricated from 316L stainless steel, giving it high creep strength whilst providing excellent corrosion resistance in the harshest of environments.

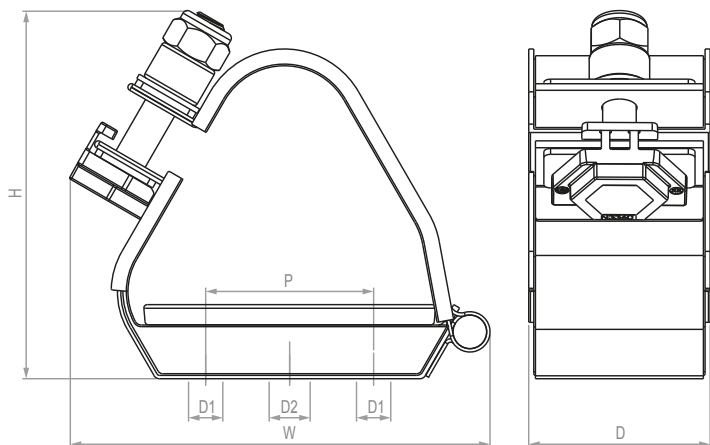
The Patriot cable cleat has three M10 fixing clearance holes within one base allowing versatility to the installer during installation, and is designed to enable the product to be secured to a variety of mounting surfaces. The Patriot cable cleats hinge opens fully allowing the cables to be easily placed within the cable cleat to aid the installer before closing and securing via the mouth piece bolt.

The Patriot cable cleats come with liners as standard, helping to restrain the cable(s) within vertical applications, providing a layer of protection between the cable sheath and the cable cleat during normal operation, where thermal elongation of cables occur, protecting the cable from chafing on any mounting surface due to differential movements such as those found in marine and offshore applications. The liners also assist in the extra protection of cable(s) in the event of short circuit fault conditions. The standard liners supplied are classified as Low Smoke & Fume (LSF), Zero Halogen (LSOH) and Phosphorus Free.





## Technical Data



Technical Data & Classification	
Type	6.1.3 Composite SDSS - Standard Duty Stainless Steel
Design Specification	IEC 61914:2009
Temperature for permanent application	-50°C to +60°C IEC 61914:2009 clause 6.2
Needle Flame Test	Pass - 120 second flame application time IEC 61914:2009 clause 10.0, 10.1, IEC 60695-11-5
Lateral Load Test	Refer to CMP Products, IEC 61914:2009 clause 9.3
Axial Load Test	0.6kN, IEC 61914:2009 clause 9.4
Impact Resistance	Pass - Very heavy IEC 61914:2009 clause 6.3, 6.3.5, 9.2
Material	316L Stainless Steel with Standard Liner Standard liners are classified as Low Smoke & Fume (LSF), Zero Halogen (LSOH) and Phosphorus Free

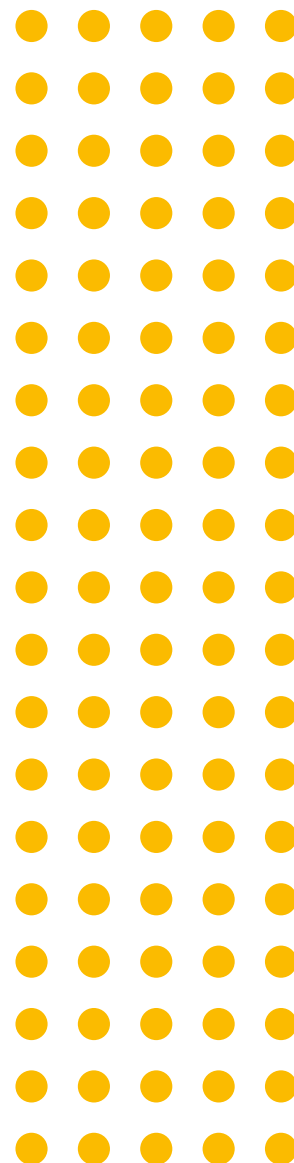
300mm CAT 1 Patriot SDSS (0.1 sec)	
Cable OD (mm)	Peak kA
36	135.0
38	138.7
43	147.5
59	172.8
65	181.4

Short Circuit Testing to IEC 61914:2009 - Clause 9.5			
Trefoil Formation			
One short circuit (6.4.3) 300mm fixed cleat centres	Two short circuits (6.4.4) 300mm fixed cleat centres	Two short circuits (6.4.4) 600mm fixed cleat centres	Two short circuits (6.4.4) 600mm fixed cleat centres
0.1 sec	1 sec	0.1 sec	1 sec
135kA Peak	80kA Peak	108kA Peak	75kA Peak
58.8kA RMS	38.3kA RMS	49.1kA RMS	35.7kA RMS

## Cable cleat selection table

Patriot Part No.	Cable Ø Range Take (mm)	Dimensions (mm)						Weight (g)
		W	H	D	P	Fixing Hole Ø		
						D1	D2	
SDSS019024	19-24	97	87	54	25	2 x M10	1 x M10	312
SDSS023028	23-28	99	92	54	25	2 x M10	1 x M10	318
SDSS027032	27-32	102	97	54	25	2 x M10	1 x M10	324
SDSS030035	30-35	104	101	54	25	2 x M10	1 x M10	329
SDSS033038	33-38	106	104	54	25	2 x M10	1 x M10	336
SDSS036042	36-42	125	109	54	50	2 x M10	1 x M10	395
SDSS040046	40-46	128	114	54	50	2 x M10	1 x M10	403
SDSS044050	44-50	132	116	54	50	2 x M10	1 x M10	409
SDSS048055	48-55	136	123	54	50	2 x M10	1 x M10	420
SDSS051058	51-58	138	129	54	50	2 x M10	1 x M10	426
SDSS055062	55-62	158	136	54	75	2 x M10	1 x M10	482
SDSS059066	59-66	158	144	54	75	2 x M10	1 x M10	489
SDSS063070	63-70	159	151	54	75	2 x M10	1 x M10	496
SDSS067074	67-74	165	159	54	75	2 x M10	1 x M10	504
SDSS071078	71-78	172	166	54	75	2 x M10	1 x M10	513
SDSS074082	74-82	188	174	54	75	2 x M10	1 x M10	588
SDSS077085	77-85	189	179	54	75	2 x M10	1 x M10	593
SDSS082088	82-88	190	185	54	75	2 x M10	1 x M10	598
SDSS088096	88-96	202	200	54	75	2 x M10	1 x M10	614
SDSS096103	96-103	215	213	54	75	2 x M10	1 x M10	628
SDSS103111	103-111	234	228	54	75	2 x M10	1 x M10	710
SDSS111119	111-119	248	243	54	75	2 x M10	1 x M10	726
SDSS119128	119-128	265	259	54	75	2 x M10	1 x M10	744

Fasteners required to secure the cable cleat to the support structure are not included with the ordering references shown in the selection table but can be supplied on request.



## Sovereign (HDSS cable cleat)



### Features

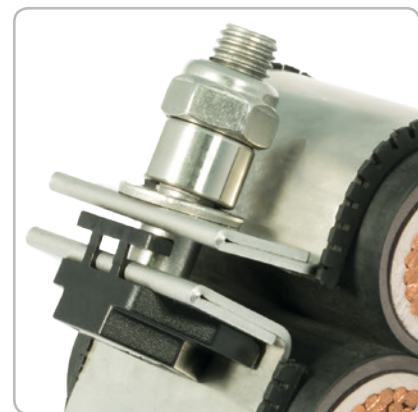
- Third party certification to IEC 61914:2009
- 316L stainless steel
- 19 - 128mm in 23 sizes for trefoil formation / application
- Short circuit rating of 190kA peak fault
- Operating temperature -50°C to +60°C
- Standard liners which are classified as Low Smoke & Fume (LSF), Zero Halogen (LS0H) and Phosphorus Free
- Combined single (M12) and two bolt (M10) fixing design

The CMP Products Sovereign cable cleat range consists of metallic cable cleats which have been designed, constructed, and tested in accordance with the International Standard 'cable cleats for Electrical Installations' IEC 61914:2009. The Sovereign cable cleat has been designed and tested for high short circuit conditions on cables held in trefoil application / formation, to ensure the securing and retention of cables without damage.

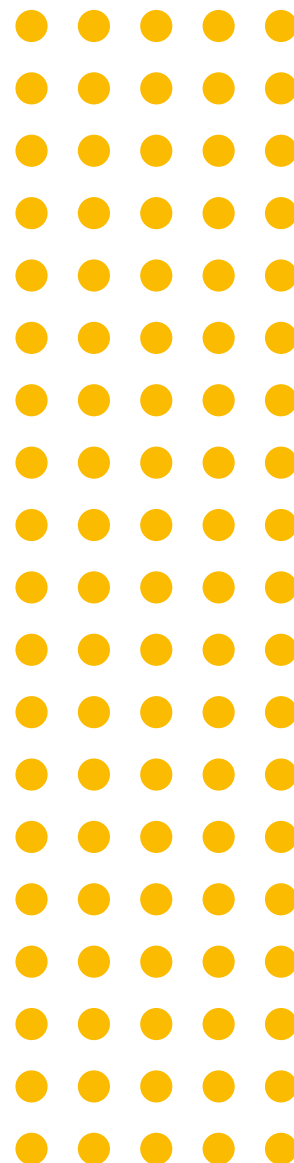
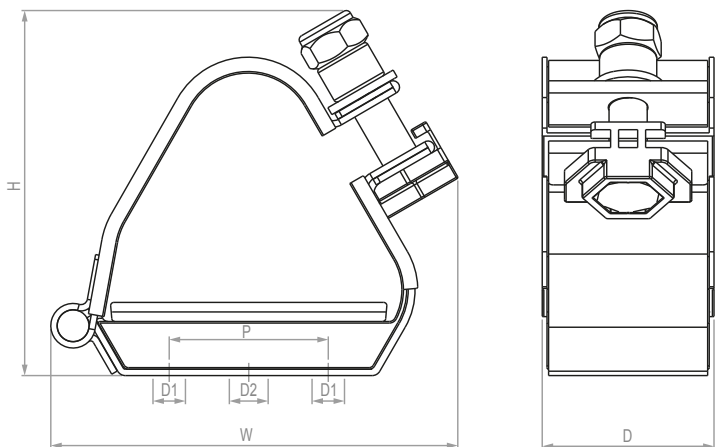
The Sovereign cable cleat is available for trefoil application / formation for diameters of 19mm to 128mm in 23 sizes. The cable cleat is fabricated from 316L stainless steel, giving it high creep strength whilst providing excellent corrosion resistance in the harshest of environments.

The Sovereign cable cleat has one M12 and two M10 fixing clearance holes within its base, allowing versatility to the installer during installation, and is designed to enable the product to be secured to a variety of mounting surfaces. The Sovereign cable cleat hinge opens fully, allowing the cables to be easily placed within the cable cleat, to aid the installer before closing and securing via the mouth piece bolt.

The standard liners help to restrain the cables within vertical applications, providing a layer of protection between the cable sheath and the cable cleat during normal operation, where thermal elongation of cable occurs, protecting the cable from chafing on any mounting surface due to differential movements such as those found in marine and offshore applications. The standard liners also assist in the extra protection of cables in the event of short circuit fault conditions and are classified as Low Smoke & Fume (LSF), Zero Halogen (LS0H) and Phosphorus Free.



## Technical Data



Technical Data & Classification	
Type	6.1.3 Composite HDSS - Heavy Duty Stainless Steel
Design Specification	IEC 61914:2009
Temperature for permanent application	-50°C to +60°C IEC 61914:2009 clause 6.2
Needle Flame Test	Pass - 120 second flame application time IEC 61914:2009 clause 10.0, 10.1, IEC 60695-11-5
Lateral Load Test	Refer to CMP Products, IEC 61914:2009 clause 9.3
Axial Load Test	0.7kN, IEC 61914:2009 clause 9.4
Impact Resistance	Pass - Very heavy IEC 61914:2009 clause 6.3, 6.3.5, 9.2
Material	316L Stainless Steel with Standard Liner <i>Standard liners are classified as Low Smoke &amp; Fume (LSF), Zero Halogen (LSOH) and Phosphorus Free</i>

300mm CAT 1 Sovereign HDSS (0.1 sec)	
Cable OD (mm)	Peak kA
36	190.0
38	195.2
43	207.7
59	243.2
65	255.3

Short Circuit Testing to IEC 61914:2009 - Clause 9.5			
Trefoil Formation			
One short circuit (6.4.3) 300mm fixed cleat centres	One short circuit (6.4.3) 300mm fixed cleat centres	Two short circuits (6.4.4) 600mm fixed cleat centres	Two short circuits (6.4.4) 600mm fixed cleat centres
0.1 sec	1 sec	0.1 sec	1 sec
190kA Peak	96kA Peak	150kA Peak	80kA Peak
87.7kA RMS	46.1kA RMS	68.2kA RMS	38.1kA RMS

### Cable cleat selection table

Sovereign Part No.	Cable Ø Range Take (mm)	Dimensions (mm)						Weight (g)
		W	H	D	P	Fixing Hole Ø		
						D1	D2	
HDSS019023	19-23	100	87	54	25	2 x M10	1 x M12	417
HDSS023028	23-28	104	88	54	25	2 x M10	1 x M12	450
HDSS027032	27-32	106	97	54	25	2 x M10	1 x M12	465
HDSS030035	30-35	108	103	54	25	2 x M10	1 x M12	473
HDSS033038	33-38	110	107	54	25	2 x M10	1 x M12	485
HDSS036042	36-42	132	108	54	50	2 x M10	1 x M12	570
HDSS040046	40-46	134	113	54	50	2 x M10	1 x M12	581
HDSS044050	44-50	136	121	54	50	2 x M10	1 x M12	594
HDSS048055	48-55	138	127	54	50	2 x M10	1 x M12	616
HDSS051058	51-58	140	130	54	50	2 x M10	1 x M12	627
HDSS055062	55-62	157	138	54	75	2 x M10	1 x M12	704
HDSS059066	59-66	157	145	54	75	2 x M10	1 x M12	718
HDSS063070	63-70	160	152	54	75	2 x M10	1 x M12	733
HDSS067074	67-74	163	160	54	75	2 x M10	1 x M12	748
HDSS071078	71-78	168	167	54	75	2 x M10	1 x M12	764
HDSS074082	74-82	190	175	54	75	2 x M10	1 x M12	863
HDSS077085	77-85	192	180	54	75	2 x M10	1 x M12	873
HDSS082088	82-88	193	186	54	75	2 x M10	1 x M12	883
HDSS088096	88-96	202	201	54	75	2 x M10	1 x M12	914
HDSS096103	96-103	214	215	54	75	2 x M10	1 x M12	942
HDSS103111	103-111	237	229	54	75	2 x M10	1 x M12	1055
HDSS111119	111-119	248	244	54	75	2 x M10	1 x M12	1086
HDSS119128	119-128	265	260	54	75	2 x M10	1 x M12	1122

Fasteners required to secure the cable cleat to the support structure are not included with the ordering references shown in the selection table but can be supplied on request.

## Conqueror (RTSS cable cleat)



### Features

- Third party certification to IEC 61914:2009
- 316L stainless steel
- 19 - 130mm in 16 sizes for trefoil formation / application
- Short circuit rating of 170kA peak fault
- Operating temperature -50°C to +60°C
- Standard liners which are classified as Low Smoke & Fume (LSF), Zero Halogen (LSOH) and Phosphorus Free
- Combined single (M12) and two bolt (M10) fixing design

CMP Products Conqueror cable cleats are metallic cable cleats which have been designed, constructed, and tested in accordance with the International Standard 'cable cleats for Electrical Installations' IEC 61914:2009. The Conqueror cable cleat has been designed to restrain a large cable range take, and tested for exceptionally high short circuit conditions on cables held in trefoil application / formation, to ensure the securing and retention of cables without damage.

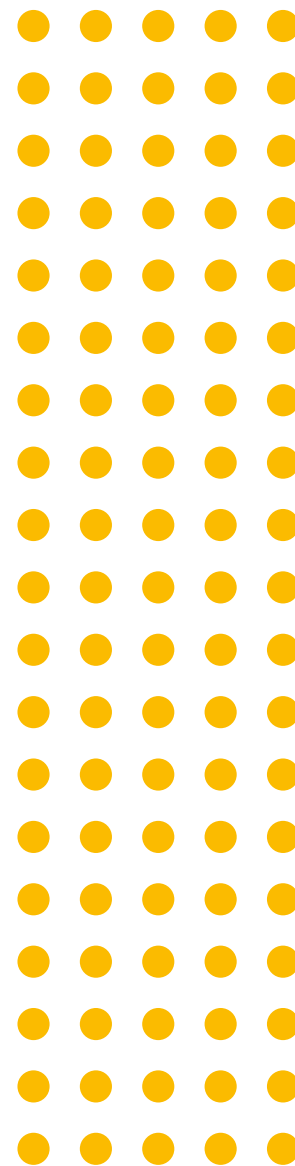
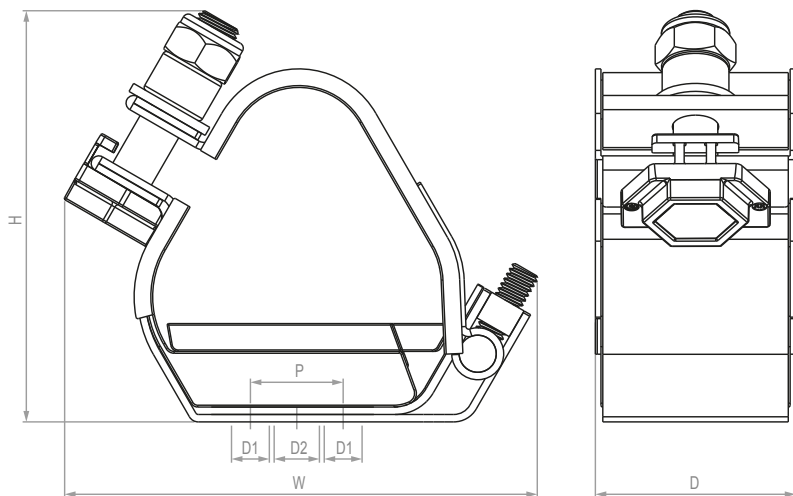
Conqueror is unique with its patent pending adjustable hinge. The movement of this hinge virtually doubles the range take adjustment when compared to other fixed hinged products on the market. Conqueror covers a range of cable diameters from 19mm up to 130mm in only 16 sizes. The cable cleat is fabricated from 316L stainless steel, giving it high creep strength whilst providing excellent corrosion resistance in the harshest of environments.

The Conqueror cable cleat has one M12 and two M10 fixing clearance holes within its base, allowing versatility to the installer during installation, and is designed to enable the product to be secured to a variety of mounting surfaces. The cable cleat hinge opens fully, allowing the cables to be easily placed within the cable cleat, to aid the installer before closing and securing via the mouth piece bolt.

The standard liners help to restrain the cables within vertical applications, providing a layer of protection between the cable sheath and the cable cleat during normal operation, where thermal elongation of cable occurs, protecting the cable from chafing on any mounting surface due to differential movements such as those found in marine and offshore applications. The standard liners also assist in the extra protection of cables in the event of short circuit fault conditions and are classified as Low Smoke & Fume (LSF), Zero Halogen (LSOH) and Phosphorus Free.



## Technical Data



Technical Data & Classification	
Type	6.1.3 Composite RTSS - Range Taking Stainless Steel
Design Specification	IEC 61914:2009
Temperature for permanent application	-50°C to +60°C IEC 61914:2009 clause 6.2
Needle Flame Test	Pass - 120 second flame application time IEC 61914:2009 clause 10.0, 10.1, IEC 60695-11-5
Lateral Load Test	Refer to CMP Products, IEC 61914:2009 clause 9.3
Axial Load Test	0.9kN - 1.1kN, IEC 61914:2009 clause 9.4
Impact Resistance	Pass - Very heavy IEC 61914:2009 clause 6.3, 6.3.5, 9.2
Material	316L Stainless Steel with Standard Liner Standard liners are classified as Low Smoke & Fume (LSF), Zero Halogen (LSOH) and Phosphorus Free

300mm CAT 1 Conqueror RTSS (0.1 sec)	
Cable OD (mm)	Peak kA
36	170.0
38	174.6
43	185.7
59	217.6
65	228.4

Short Circuit Testing to IEC 61914:2009 - Clause 9.5				
Trefoil Formation				
One short circuit (6.4.3) 300mm fixed cleat centres	One short circuit (6.4.3) 300mm fixed cleat centres	Two short circuits (6.4.4) 600mm fixed cleat centres	One short circuit (6.4.3) 600mm fixed cleat centres	Two short circuits (6.4.4) 600mm fixed cleat centres
0.1 sec	1 sec	0.1 sec	3 sec	1 sec
170kA Peak	90kA Peak	131kA Peak	61kA Peak	80kA Peak
77.3kA RMS	43.2kA RMS	59.6kA RMS	29.1kA RMS	38.1kA RMS

## Cable cleat selection table

Conqueror Part No.	Cable Ø Range Take (mm)	Dimensions (mm)						Weight (g)
		W	H	D	P	Fixing Hole Ø		
						D1	D2	
RTSS019023	19-23	99	84	54	25	2 x M10	1 x M12	420
RTSS023032	23-32	122	99	54	25	2 x M10	1 x M12	509
RTSS030039	30-39	126	111	54	25	2 x M10	1 x M12	534
RTSS037046	37-46	132	117	54	25	2 x M10	1 x M12	557
RTSS044053	44-53	151	128	54	50	2 x M10	1 x M12	676
RTSS051060	51-60	154	139	54	50	2 x M10	1 x M12	694
RTSS058067	58-67	157	151	54	50	2 x M10	1 x M12	727
RTSS065074	65-74	176	163	54	75	2 x M10	1 x M12	839
RTSS072081	72-81	182	175	54	75	2 x M10	1 x M12	866
RTSS079088	79-88	191	190	54	75	2 x M10	1 x M12	900
RTSS086095	86-95	216	202	54	75	2 x M10	1 x M12	1023
RTSS093102	93-102	222	215	54	75	2 x M10	1 x M12	1050
RTSS100109	100-109	228	228	54	75	2 x M10	1 x M12	1079
RTSS107116	107-116	254	241	54	75	2 x M10	1 x M12	1199
RTSS114123	114-123	257	254	54	75	2 x M10	1 x M12	1228
RTSS121130	121-130	268	267	54	75	2 x M10	1 x M12	1255

Fasteners required to secure the cable cleat to the support structure are not included with the ordering references shown in the selection table but can be supplied on request.

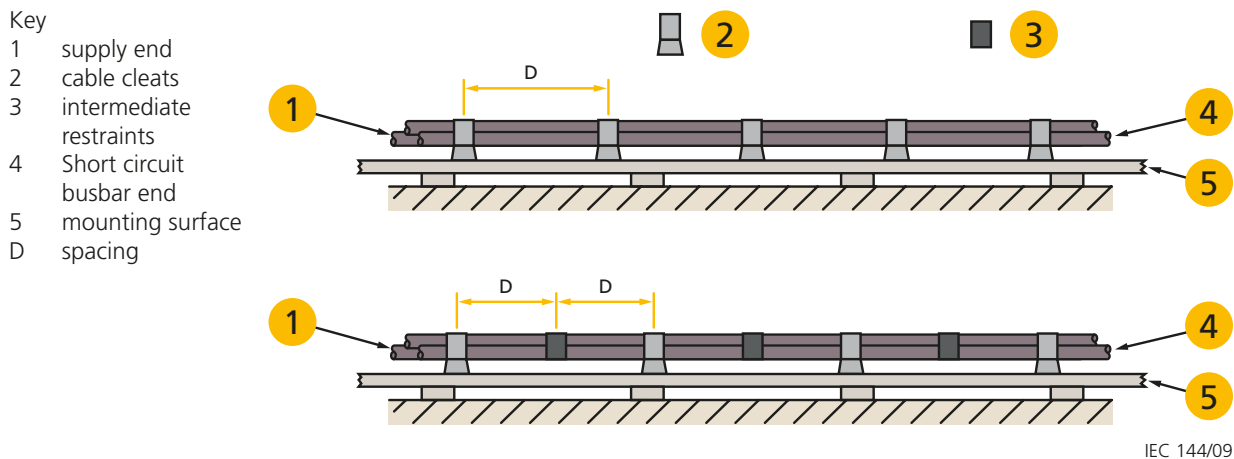
## Short circuit testing

Test for resistance to electromechanical force according to IEC 61914:2009

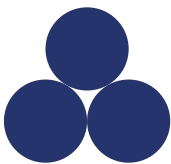
A short circuit test is carried out as follows, using the manufacturer's or responsible vendor's declared values of peak short circuit current ( $i_p$ ) and initial r.m.s. symmetrical short circuit current ( $I''_k$ ). Where there are a number of cable cleats in the range, one or more classes are defined (see 5.1). This test is performed on the most critical size in each class.

The test is carried out at ambient temperature, considered to be the defined temperature for permanent application, using unarmoured single core 600 V / 1,000 V cable with stranded copper conductor. A test rig is assembled using the selected cables and cable cleats, being the equipment under test, with the equipment and cables used being fully documented. The test is then carried out on the declared arrangement at the declared short circuit level. Typical test rig layouts are shown in the illustrations below.

Typical layout for testing for the resistance to electromechanical forces during short circuit:



**Figure 1.**  
Typical arrangement of three cables in close trefoil formation



**Figure 2.**  
Typical arrangement of cables in flat formation



For the purpose of testing, the arrangement of the cables may be as shown in Figure 1, Figure 2 or any other configuration as declared by the manufacturer or responsible vendor.

One end of the test set-up is connected to a three phase supply and the other end to a short circuiting busbar, with all three phases connected. The cable is restrained at a minimum of 5 positions along the length of the cable run. Where intermediate restraints are used, at least 4 cable cleats and at least 3 intermediate restraints shall be used. Cable cleats and intermediate restraints, where used, shall be equally spaced. The cable cleats are fixed to a mounting surface defined by the manufacturer (e.g. cable ladder) which shall be suitably selected taking into account the electromechanical forces likely to occur during the test.

Care is taken to ensure that the cross-sectional area of the cable is adequate for the magnitude and duration of the test current.

The manufacturer's or responsible vendor's catalogue references of the cable cleats and intermediate restraint (where used), the assembly details showing the spacing intervals and the external cable diameter used in the test shall be recorded.

The test set-up is subjected to a three phase short circuit for a duration of not less than 0.1 s. The duration of the test is recorded along with any other relevant data.

**9.5.2 for cable cleats and intermediate restraints classified in 6.4.3**

(6.4.3 Resistant to electromechanical forces, withstanding one short circuit)

Cable cleats and intermediate restraints classified under 6.4.3 shall comply with the following requirements:

- there shall be no failure that will affect the intended function of holding the cables in place;
- the cable cleats and the intermediate restraints, if used, shall be intact with no missing parts (minor deformation is acceptable);
- there shall be no cuts or damage visible to normal or corrected vision to the outer sheath of the cable caused by the cable cleats or by the intermediate restraints, if used.

**9.5.3 for cable cleats and intermediate restraints classified in 6.4.4**

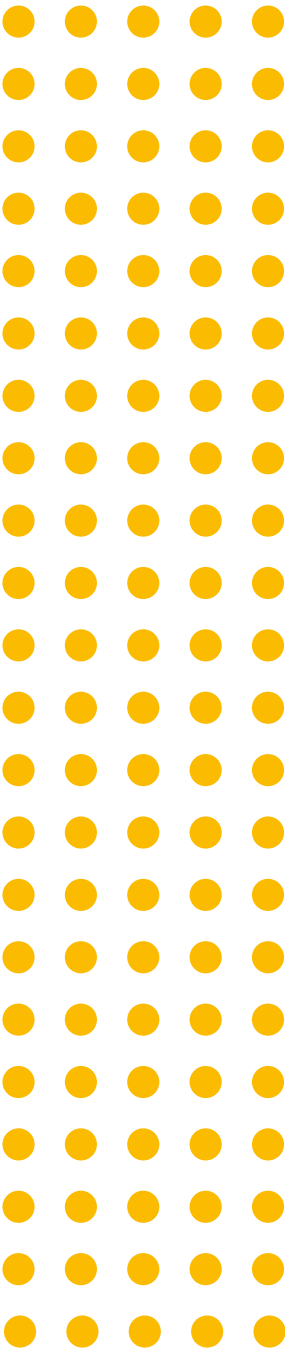
(6.4.4 Resistant to electromechanical forces, withstanding more than one short circuit)

Cable cleats and intermediate restraints classified under 6.4.4 shall comply with 9.5.2. After a second short circuit application, a voltage withstand test is performed by applying a minimum test voltage of 2.8 kV d.c. for a period of  $(60_{-0}^{+5})$  seconds according to the provisions of IEC 60060-1:1989, 'High-voltage test techniques - Part 1: General definitions and test requirements', 13.1, 'Requirements for the test voltage', and 14.1, 'Withstand voltage tests'. The voltage withstand test shall be administered between the cable cores and the mounting frame. The mounting frame shall be bonded to the earthing system. Where the cables incorporate screening or shielding, the screens and shields shall be bonded together and also bonded to the mounting frame. Where the cables do not incorporate screening or shielding, the cable jackets or sheaths and mounting frames shall be pre-wetted with sufficient water to facilitate a current leakage path along the outer jackets or sheaths. The cable jackets or sheaths and mounting frames shall be pre-wetted for  $(2_{-0}^{+1})$  minutes before the test begins using water with a resistivity of  $(100_{-15}^{+15})\Omega.m$ , which shall be measured immediately before starting the test.

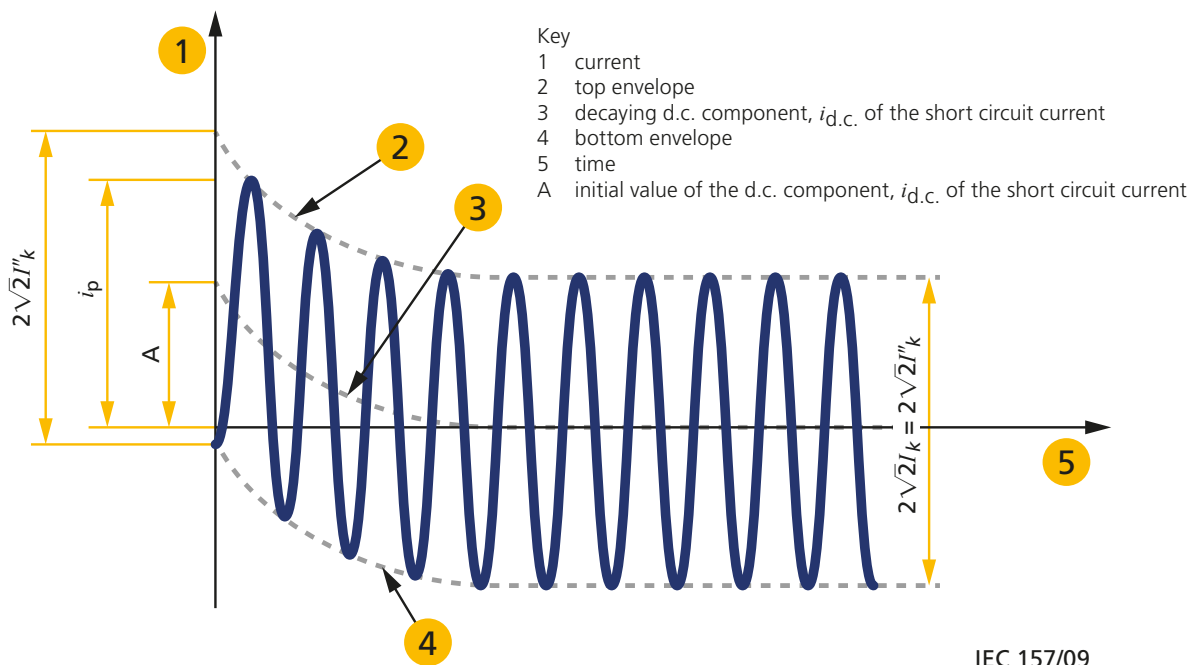
The cables shall meet the requirements of the voltage withstand test without failure of the insulation.

**Calculation of forces caused by short circuit currents (IEC 61914:2009)**

The characteristics of the current during a short circuit depend on a number of factors, including the electrical separation from the generator. The figure below shows a current vs. time characteristic typical of a far-from-generator short circuit. The a.c. component in this case has a constant amplitude ( $I''_k = I_k$ ) and is superimposed on a decaying d.c. component,  $id.c.$  This falls from an initial value, A, to zero.

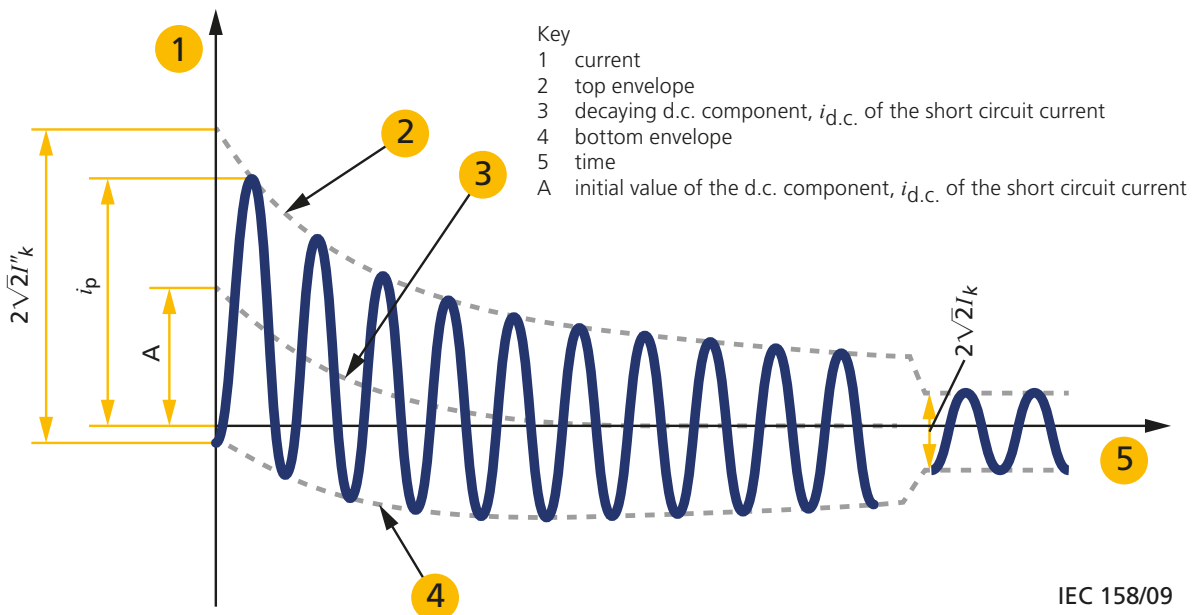


Short circuit current of a far-from-generator short circuit with constant a.c. component



For near-to-generator short circuits, the a.c. component has a decaying amplitude ( $I''_k > I_k$ ) and is also superimposed on a decaying d.c. component,  $i_{d.c.}$  that falls from an initial value, A, to zero. The figure below shows a typical current vs. time characteristic for a near-to-generator short circuit.

Short circuit current of a near-to-generator short circuit with decaying a.c. component





### Specification of the test current

A complete specification of short circuit currents should give the currents as a function of time at the short circuit location from the initiation of the short circuit up to its end. In most practical cases, this is not necessary. It is usually sufficient to know the peak current,  $i_p$ , and the values of the initial r.m.s. symmetrical,  $I''_k$ , and steady state,  $I_k$ , currents.

In order to specify the current used in a short circuit test the following are quoted:

- the peak current,  $i_p$ ;
- the initial r.m.s. symmetrical short circuit current,  $I''_k$ ;
- the short circuit duration,  $t$ .

### Calculation of the mechanical forces between conductors

The electromagnetic force acting on a conductor is determined by the current in the conductor and the magnetic field from the neighbouring conductors. In cable installations, the distances between the conductors are normally small and hence the forces may be considerable.

In the case of two parallel conductors, the electromagnetic force on a conductor can be derived from Equation B1:

$$F(t) = B(t) \cdot i(t) \cdot l$$

- $l$  is the length;
- $F(t)$  is the momentary electromagnetic force on a conductor;
- $B(t)$  is the momentary magnetic field from the neighbouring conductor;
- $i(t)$  is the momentary current in the neighbouring conductor.

If the d.c. component of the short circuit current is disregarded, the momentary force has a sinusoidal variation with a frequency twice the frequency of the currents (Equation B.1). The d.c. component gives a decaying force-component with a frequency the same as the system frequency.

### Two parallel conductors



For the two parallel conductors in figure above., the magnetic field from current  $i_1$ , at the location of the other conductor is:

$$B = \mu_0 \cdot H = \mu_0 \cdot i_1 / 2 \cdot \pi \cdot S \quad (B.2)$$

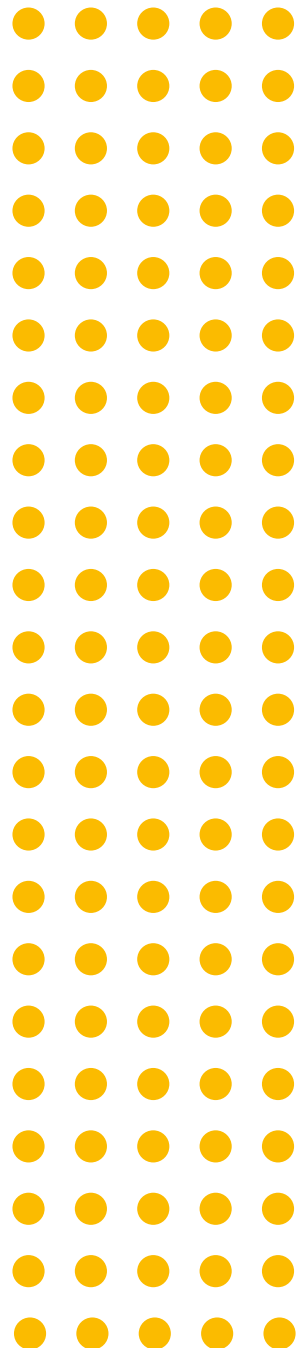
where  $\mu_0 = 4 \cdot \pi \cdot 10^{-7}$  (H/m)

and the mechanical force is:

$$F = i_2 \times B = i_2 \cdot \mu_0 \cdot i_1 / 2 \cdot \pi \cdot S \quad (B.3)$$

This equation is usually written as:

$$Fs = 0.2 \cdot i_1 \cdot i_2 / S \quad (B.4)$$





In this equation, the force is given in N/m,  $i$  in kA and  $S$  in metres. The evaluation of Equation B.4 requires  $S \gg d$  but gives an acceptable accuracy when the current distribution is uniform (or symmetrical) within the conductors.

The vector Equation B.3 confirms that two parallel conductors are repelled if the two currents have a difference in phase angle of  $180^\circ$  and that the force is directed towards the other conductor for currents that have the same phase angle.



In a three phase system, the magnetic field in Equation B.2 is the resulting momentary vector value from the other two phases.

For a three phase short circuit with the conductors in flat configuration, the forces on the two outer conductors are always directed outwards from the central conductor. The force on the central conductor is oscillating. The maximum force on the outer conductors in flat formation can be calculated by:

$$F_{fo} = 0.16 ip^2 / S \text{ (B.5)}$$

The maximum force on the middle conductor in flat formation can be calculated by:

$$F_{fm} = 0.17 ip^2 / S \text{ (B.6)}$$

For a three phase short circuit with the cables in a trefoil configuration the maximum force on the conductor is:

$$F_t = 0.17 ip^2 / S \text{ (B.7)}$$

where:

- $F_s$**  is the maximum force on the cable conductor in flat formation for a single phase short circuit [N/m];
- $F_{fo}$**  is the maximum force on the outer cable conductors in flat formation for a three phase short circuit [N/m];
- $F_{fm}$**  is the maximum force on the centre cable conductor in flat formation for a three phase short circuit [N/m];
- $F_t$**  is the maximum force on the cable conductor in a trefoil configuration for a three phase short circuit [N/m];
- $ip$**  is the peak short circuit current [kA];
- $d$**  is the external diameter of the conductor [m];
- $S$**  is the centre to centre distance between two neighbouring conductors [m].



Peak fault & RMS

A three phase short circuit fault can be split into two states, an asymmetrical state and a symmetrical state. The Peak fault occurs first during the asymmetrical state and is the maximum possible instantaneous value of the short circuit current. The RMS fault occurs after the Peak fault and is the latter more symmetrical state of the short circuit. RMS is the square root of the mean of the squares of the values of these two states.

Peak short circuit - ip

'maximum possible instantaneous value of the short circuit current'

Initial RMS symmetrical short circuit current - I''k

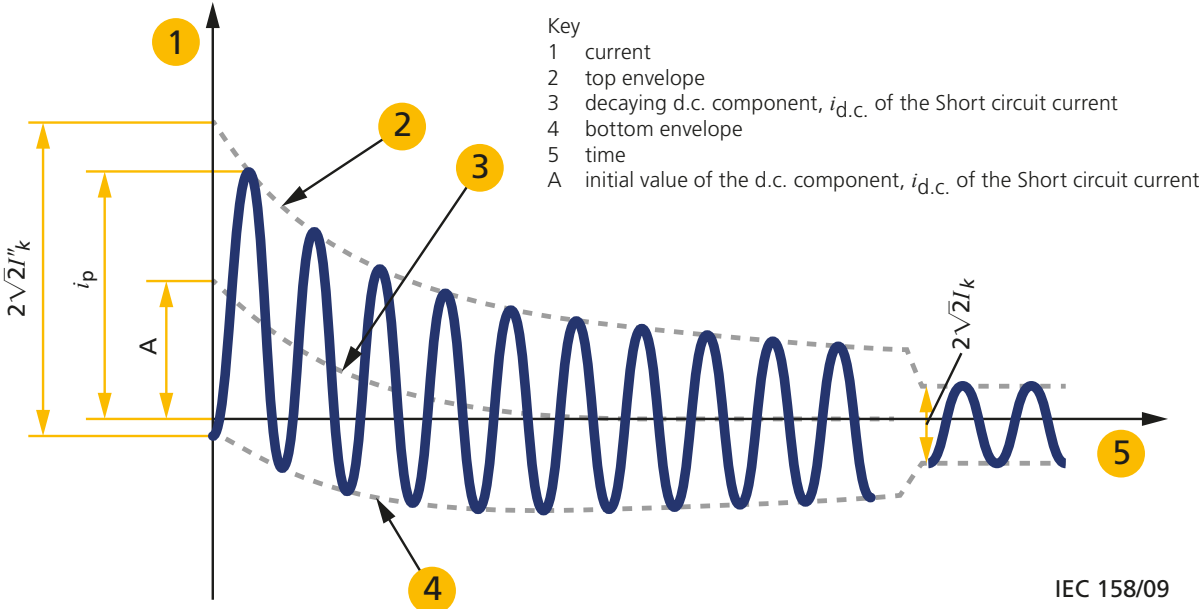
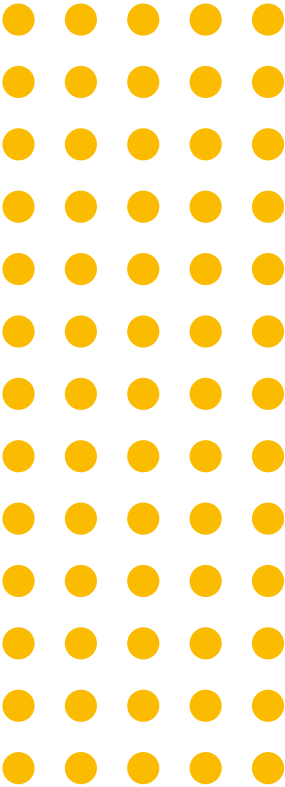
'RMS value of the a.c. symmetrical component of a short circuit current, applicable at the instant of the short circuit if the impedance remains at the zero-time value'

Decaying (aperiodic) component of short circuit current - id.c

'mean value between the top and bottom envelope of a Short circuit current decaying from an initial value to zero'

Steady-state short circuit current - Ik

'RMS value of the Short circuit current which remains after the decay of the transient phenomena'

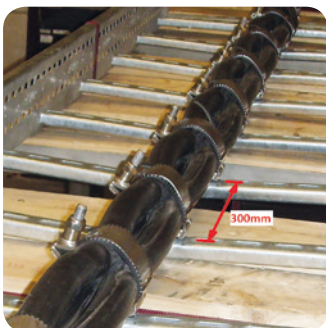


CMP short circuit testing

All CMP Products cable cleats have been tested and certified according to the latest IEC 61914:2009 standard before their release to the market.



Before short circuit test



After short circuit test

# Projecting peak faults and mechanical forces

## Cable cleats - Short Circuit Calculations

Below is an explanation of how CMP Products calculates Peak kA current short circuit current ratings for each specific customer application and installation.

CMP Products has carried out over 300 short circuit tests, however it is not viable to test for every fault current, cable cleat, cable size/type and fixing centre configuration.

CMP Products is continuously developing software to replicate these tests and can undertake project specific testing on the cable cleat, cable and cable tray or ladder intended to be used on the installation.

CMP also has the experience to reliably calculate what the Peak kA short circuit rating will be, based upon the expansive test data it holds following the comprehensive testing programme it has undertaken.

### Testing

Beginning with a short circuit test at 300mm fixing centres, the maximum safe Peak current in kA that the cable cleat under test can restrain is established and achieved.

In the example below the cable cleat successfully passed the tests in the IEC 61914:2009 standard at 190kA on Ø36mm cable @ 300mm fixing centres.

### Calculating the max force per cable cleat tested

From that test result the calculation from the cable cleat standard IEC 61914:2009 is used to work out the force restrained by the cable cleat under test:

- Ft** is the maximum force on the cable (N/m)
- ip** is the peak short circuit current (kA)
- S** is the centre to centre distance between two neighbouring conductors i.e. for trefoil formation this is the cable outside diameter (m)

**In this example the Ft equals 170,472.22 N/m**

Ft is a force in Newtons per metre so to calculate the maximum force which each cable cleat restrained, this must be multiplied by the cable cleat fixing centres:

Max force per cable cleat = Ft (N/m) x fixing centres (m)

Max force per cable cleat in this example (0.3m fixing centres) = 51,141.67 N

### Calculating the Ft for a new application

Now that the maximum force per cable cleat has been established, the formula is transposed to calculate the maximum peak fault current for different fixing centres, cable diameters etc.

To calculate the ip if the fixing centres were to be increased 600mm then Ft would first need to be calculated:

- Ft** is the maximum force on the cable (N/m)
- ip** is the peak short circuit current (kA)
- S** is the centre to centre distance between two neighbouring conductors i.e. the cable outside diameter (m)

**Ft in this new example = 85,236.11 (N/m)**

Now that the Ft for this application has been established, the ip can be calculated.

$$Ft = \frac{0.17 \times ip^2}{S}$$

$$Ft = \frac{0.17 \times 190^2 \text{ (kA)}}{0.036 \text{ (m)}}$$

$$Ft = \frac{\text{max force per cable cleat (N)}}{\text{fixing centres (m)}}$$

$$Ft = \frac{51,141.67 \text{ (N)}}{0.6 \text{ (m)}}$$

## Calculating the $i_p$ for a new application

**$F_t$**  is the maximum force on the cable (N/m)

**$i_p$**  is the peak Short circuit current (kA)

**$S$**  is the centre to centre distance between two neighbouring conductors  
i.e. the cable outside diameter (m)

$i_p$  in this example = 134.35kA

Experience shows that this value is always lower than can be achieved in a physical test. This confirms that there is a safety factor element included in the IEC 61914:2009 calculation; this is a good thing as it means that calculated values are always on the conservative side.

However it also means that the  $F_t$  or maximum force per cable cleat ratings taken from test results should only be used on fixing centre intervals which are shorter than those actually tested, as a basis for any calculated  $i_p$ 's. Calculating the opposite way is not recommended as it contradicts the safety factor employed in the standard and gives unrealistic and unachievable  $i_p$ 's.

### For example

On the same cable cleat and cable the cable cleat successfully passed the tests in the 61914:2009 standard at 150kA @ 600mm fixing centres (calculated  $i_p$  was only 134.35kA so in practice ~12% more was achieved)

From this new  $i_p$  an  $F_t$  is calculated:

**$F_t$**  is the maximum force on the cable (N/m)

**$i_p$**  is the peak short circuit current (kA)

**$S$**  is the centre to centre distance between two neighbouring conductors  
i.e. the cable outside diameter (m)

In this example the  $F_t = 106,250$  N/m

Max force per cable cleat in this example (0.6m fixing centres) = 63,750 N

If this maximum force per cable cleat value was to be used as a basis to calculate the  $i_p$  for fixing centres of 0.3m, then the  $F_t$  would = 212,500 N/m

This gives a calculated  $i_p$  of 212.13kA – THIS IS DANGEROUSLY HIGH!  
Only 190kA was achieved @ 300mm fixing centres under physical test and that showed that the cable cleat was very close to its maximum strength capabilities.

### To re-confirm:

Only use the  $F_t$  or max force per cleat ratings from CMP test results on shorter fixing centres than those intended to be used, as a basis for any calculated  $i_p$ 's. Calculating the opposite way is dangerous, as it contradicts the included safety factor in the standard calculation which gives unrealistic and unachievable  $i_p$ 's.

For the most accurate calculation and safest installation, CMP recommends that the data from the CMP test result of cable cleats fixed closest (but still shorter) to the target fixing centres is used to calculate the  $i_p$ , for example:

If 500mm fixing centres are required, use the 300mm centres force per cleat CMP test data as a basis for the  $i_p$  calculation.

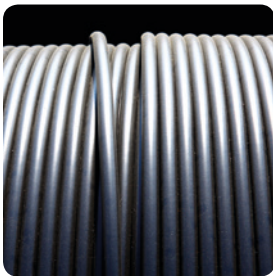
If 900mm fixing centres are required, use the 600mm centres force per cleat CMP test data as a basis for the  $i_p$  calculation.

$$i_p = \sqrt{\left(\frac{F_t \times S}{0.17}\right)}$$

$$i_p = \sqrt{\left(\frac{85,236.11 \text{ (N/m)} \times 0.036 \text{ (m)}}{0.17}\right)}$$

$$F_t = \frac{0.17 \times i_p^2}{S}$$

$$F_t = \frac{0.17 \times 150^2 \text{ (kA)}}{0.036 \text{ (m)}}$$



## Twin arc profiles

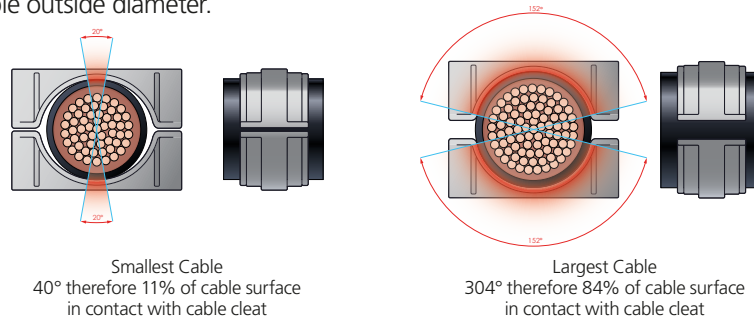
### Disadvantages of standard prior art cable cleat profiles

With prior art products many cable cleats had a simple circular internal profile; this gives excellent surface contact on the maximum size of cable in the clamping range (~84% of the cable in contact with the cable cleat) which in turn gives an excellent level of axial restraint.

However, on the minimum size of cable in the clamping range, little more than a point contact between the top and bottom of the cable and the cable cleat (~11% of the cable in contact with the cable cleat) is achieved which gives a very poor level of axial restraint.

Also, due to the poor surface contact (only in the centres at the top and bottom of the cable) on the smaller sizes of cable in the range, it is easy to over-tighten the fixing bolts. This not only crushes the cable out of shape, it also deforms the cable cleat around the cable therefore stressing the cable cleat material. It is not possible to have the same bolt torque settings for every size of cable, since the smaller cables allow the cable cleat to deform (closing the gaps either side of the cable to cable cleat contact areas in the centre) and the torque level will be reached later, so installation procedures can be ambiguous.

Typical range taking capabilities of prior art cable cleats vary from ~5-8mm on cable outside diameter.



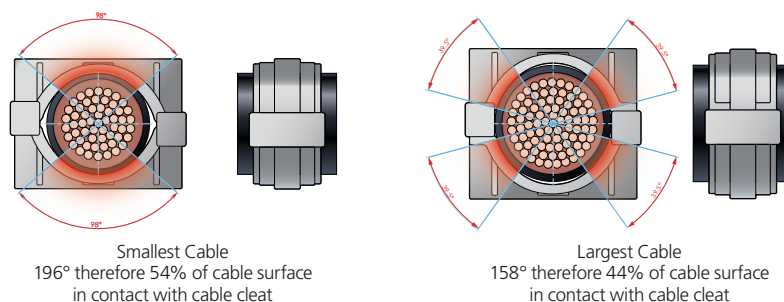
### Benefits of CMP twin arc cable cleat profiles

Analysing the new design CMP single bolt Sabre and Valiant, and two bolt Falcon and Zenith cable cleat internal profile, there are two separate arcs joined tangentially; one arc suited to the minimum sized cable and the other arc suited to the maximum sized cable in the clamping range. The tangential join means that all cable sizes in-between are clamped just as effectively.

This gives an almost uniform level of surface contact throughout the clamping range (~44% on the minimum and ~54% on the maximum sized cables) meaning axial restraint is just as good on the smaller sizes of cable in the range as it is for the largest.

The better comparative surface area contact throughout the clamping range also means that the same torque settings can be used, no matter what size of cable is fitted; removing any uncertainty during installation.

By using the new twin arc design, CMP has also dramatically increased the range taking capability of these types of cable cleat, which varies from 10-15mm on cable outside diameter.



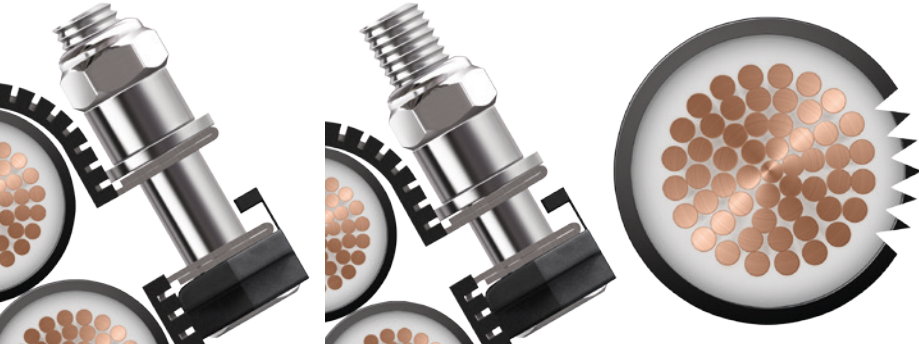
# Cable cleat nut spacer

Industry-wide, a fully threaded bolt is used as standard to ensure that the cable cleat can accept a range of cable diameters. However, the use of a fully threaded bolt can lead to damage to the cables during high short circuit fault conditions.

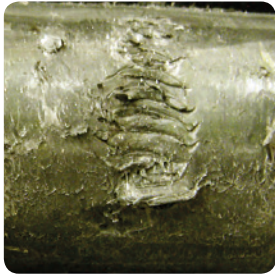
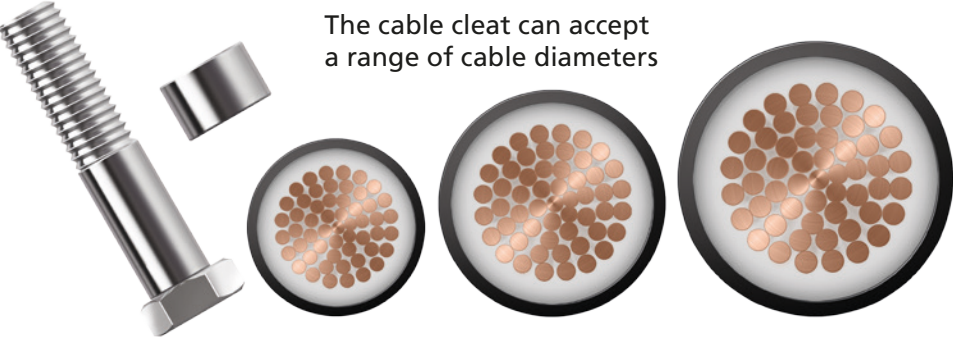
The cable cleat nut spacer from CMP Products (Patent Pending), comes as standard with all of our hinged type cable cleats, regardless of the size of cable cleat or diameter of cable needing to be restrained, and is designed to ensure the cable never comes into contact with the threaded portion of the cable cleat closure bolt.

In over 300 short circuit tests which CMP Products has conducted on our cable cleat range, tremendous forces were generated by the cables during high short circuit conditions. It is during this stage that cables can expel away from each other and try to break the cable cleat restraining them. If any sharp edges, such as threads are exposed to the cables, there may be damage to the cable insulation and, depending on the peak fault, this can be catastrophic. Where the cable insulation is sufficiently damaged, earth shortages will occur, leading to a life-threatening environment for any personnel in the vicinity.

The CMP spacer and bolt combination - one size fits all



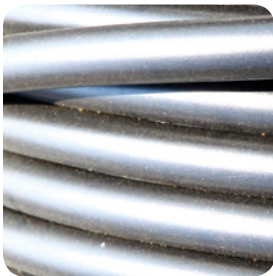
CMP Products' cable cleats use a partially threaded bolt in conjunction with the nut spacer, never allowing the cables to be exposed to the thread of the bolt. The use of these, along with cable cleat liners as standard, means the cables can only ever come into contact with smooth or flat surfaces.



Minor cable damage caused by thread contact



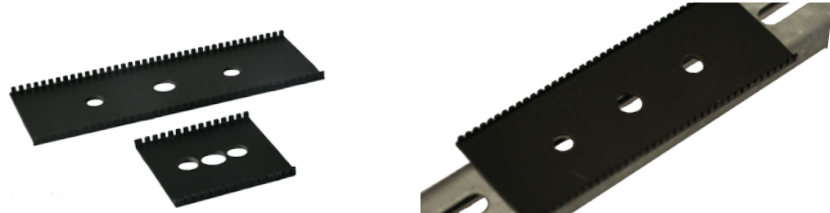
Major cable damage caused by thread contact



## Cable cleat accessories

### Isolation / Separation Pad

The CMP cable cleat isolation / separation pad is designed to prevent corrosion between two dissimilar metals, by ensuring that the cable cleat avoids direct contact with the supporting structure. The pad is manufactured from a Low Smoke & Fume (LSF), Zero Halogen (LS0H) and Phosphorus free material as standard, with predefined knock-out positions. These knock-out positions allow the isolation pad to be used with any CMP Products cable cleat. Once the knock-outs have simply been punched through to suit the bolt fixing centres of the cable cleat, the isolation pad is then cut to suit the cable cleat base size. Once installed the isolation pad will help to prevent galvanic corrosion should the material of the cable management system be different from that of the cable cleat.



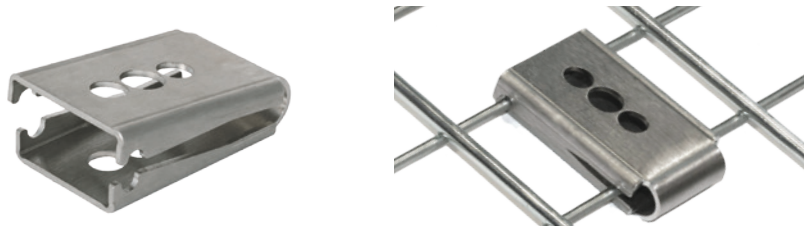
### C-Clamp

The CMP C-clamp is designed to be used with plain or continuous ladder rungs, struts, or channel mounting frame which have no mounting slots or holes provided, to allow for ease of cable cleat mounting. The CMP C-Clamp is manufactured from 316L Stainless Steel, and is supplied in various sizes to suit all CMP cable cleats as well as a wide variety of ladder rungs, struts and channel mounting frames. The design incorporates one M12 and two M10 clearance holes to allow for the flexibility of optional fixing positions to be used. The CMP C-clamps have been utilised and extensively tested during short circuit conditions as specified in IEC 61914 'cable cleats for electrical installations'.



### Wire Mesh Cable Tray / Basket Clips

The CMP Wire Mesh Cable Tray / Basket Clips are manufactured from 316L Stainless Steel and are designed to allow cable cleats to be safely installed onto wire mesh cable tray and / or basket. The CMP basket clip has one M12 and two M10 clearance holes, and slides over the mesh wires of the tray or basket to provide a secure fixing surface for the cable cleat to be attached to. The CMP wire mesh cable tray / basket clips have been utilised and tested during short circuit conditions as specified in IEC 61914 'cable cleats for electrical installations'.





# Galvanic corrosion (Bi-Metallic Corrosion)

Galvanic corrosion (bi-metallic corrosion) is the corrosion that occurs when dissimilar metals are in contact in the presence of an electrolyte. Dissimilar metals and alloys have different electrode potentials, and when two or more come into contact with an electrolyte, one metal acts as anode and the other as cathode. The electrolyte acts as a path for ion migration between the two metals, and the electropotential difference between the dissimilar metals causes the anode metal to dissolve in to the electrolyte, and deposits collect on the cathode metal.

CMP advises the cable cleat and support structure combinations shown in the following tables.

Generic Corrosion Data Table

Galvanic Corrosion Table						
Direct Connection of Metal to Metal Surface Contact Without Intervention or Isolation	Aluminium	Cast Iron	Galvanised Steel	Mild Steel	Stainless Steel	Zinc
Aluminium	Grey	Yellow	Yellow	Yellow	Yellow	Yellow
Cast Iron	Yellow	Grey	Red	Green	Yellow	Red
Galvanised Steel	Yellow	Red	Grey	Red	Yellow	Green
Mild Steel	Yellow	Green	Red	Grey	Yellow	Red
Stainless Steel	Red	Yellow	Yellow	Yellow	Grey	Yellow
Zinc	Yellow	Red	Green	Red	Yellow	Grey

Galvanic corrosion will not occur

Galvanic corrosion insignificant

Galvanic corrosion may occur

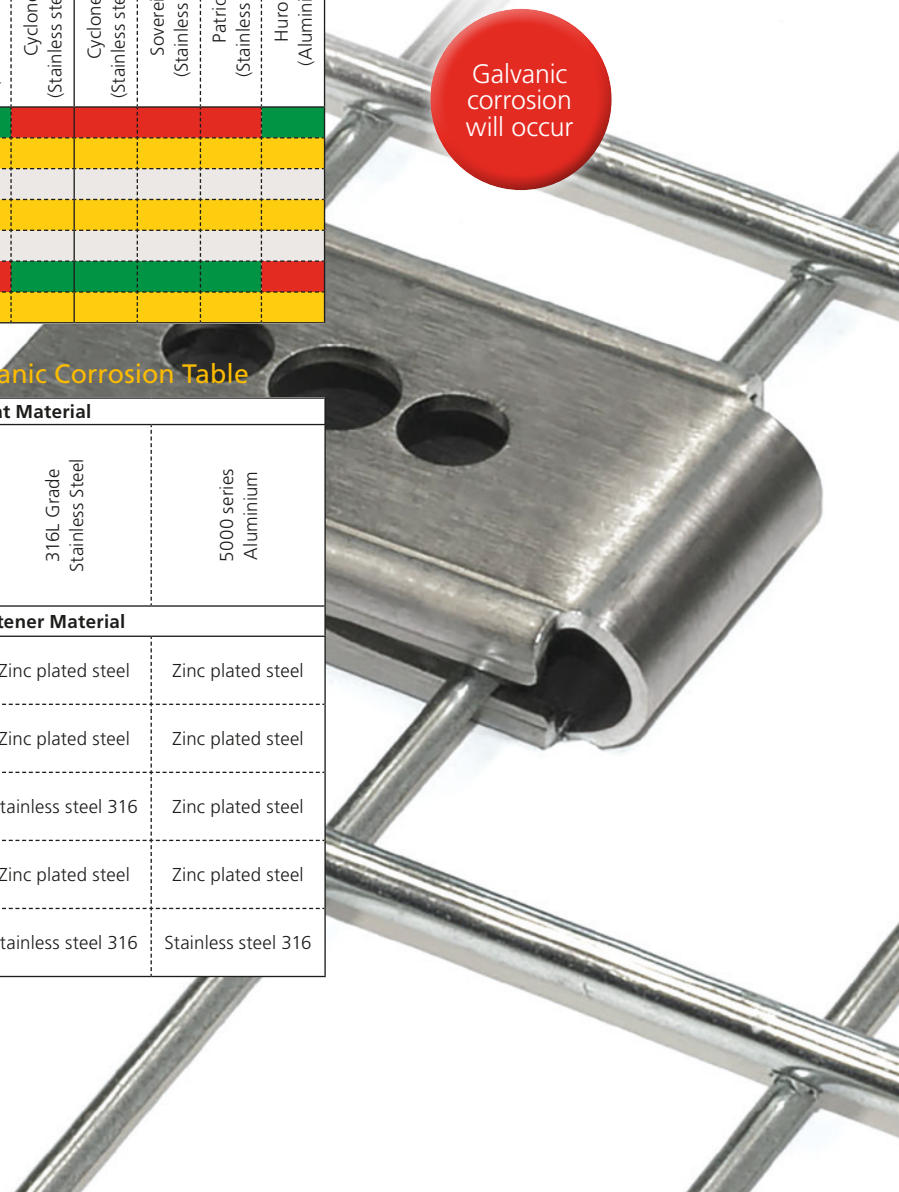
Galvanic corrosion will occur

Cable Cleat / Support Structure Galvanic Corrosion Table

Material of Cable Management / Support Structure	Galvanic Corrosion Table									
	Sabre (polymeric)	Falcon (polymeric)	Valiant (Aluminium)	Zenith (Aluminium)	Cyclone I (Aluminium base)	Cyclone II (Stainless steel base)	Cyclone III (Stainless steel base)	Sovereign (Stainless steel)	Patriot (Stainless steel)	Huron (Aluminium)
Aluminium	Grey	Grey	Green	Green	Green	Red	Red	Red	Red	Green
Galvanised Steel	Grey	Grey	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
GRP	Grey	Grey	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
Mild Steel	Grey	Grey	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
Powder Coated	Grey	Grey	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
Stainless Steel	Grey	Grey	Red	Red	Red	Green	Green	Green	Green	Red
Zinc Plated	Grey	Grey	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow

Cable Cleat Fixings / Support Structure Galvanic Corrosion Table

Material of Cable Management / Support Structure	CMP Cable Cleat Material			
	Single bolt and two bolt clamp Nylon	Single bolt and two bolt clamp Aluminium	316L Grade Stainless Steel	5000 series Aluminium
Recommended Fastener Material				
Aluminium	Zinc plated steel	Zinc plated steel	Zinc plated steel	Zinc plated steel
Galvanised Steel	Zinc plated steel	Zinc plated steel	Zinc plated steel	Zinc plated steel
GRP	Zinc plated steel	Zinc plated steel	Stainless steel 316	Zinc plated steel
Mild Steel	Zinc plated steel	Zinc plated steel	Zinc plated steel	Zinc plated steel
Stainless Steel	Stainless steel 316	Stainless steel 316	Stainless steel 316	Stainless steel 316



## Overview of Peak Fault Current Withstand Capabilities of CMP Trefoil Cable Cleats at Various Mounting Intervals

Cable od (mm)	Cable Cleat Peak Fault Level (kA)							Cable Cleat Spacing (mm) Cat 1(1)
	Conqueror	Cyclone I	Cyclone II	Cyclone III	Huron	Patriot	Sovereign	
24	138.80	101.25	123.29	146.97	68.59	110.23	155.13	300
	106.96	71.59	97.98	110.23	48.50	88.18	122.47	600
	87.33	58.45	80.00	90.00	39.60	72.00	100.00	900
	75.63	50.62	69.27	77.94	34.29	50.91	86.60	1200(2)
26	144.70	105.38	128.33	152.97	71.39	114.73	161.47	300
	111.33	74.51	101.98	114.73	50.48	91.78	127.48	600
	90.90	60.84	83.27	93.68	41.22	74.94	104.08	900
	78.72	52.69	72.10	81.13	35.69	52.99	90.13	1200(2)
28	149.93	109.36	133.17	158.75	74.08	119.06	167.56	300
	115.53	77.33	105.83	119.06	52.39	95.25	132.29	600
	94.33	63.14	86.41	97.21	42.77	77.77	108.01	900
	81.69	54.68	74.82	84.19	37.04	54.99	93.54	1200(2)
30	155.19	113.20	137.84	164.32	76.68	123.24	173.45	300
	119.59	80.04	109.54	123.24	54.22	98.59	136.93	600
	97.74	65.35	89.44	100.63	44.27	80.50	111.80	900
	84.56	56.60	77.45	87.14	38.34	56.92	96.82	1200(2)
32	160.28	116.91	142.36	169.71	79.20	127.28	179.13	300
	123.51	82.67	113.14	127.28	56.00	101.82	141.42	600
	100.84	67.50	92.38	103.93	45.73	83.14	115.47	900
	87.33	58.45	79.99	90.00	39.60	58.78	99.99	1200(2)
34	165.21	120.51	146.75	174.93	81.63	131.20	184.65	300
	127.31	85.21	116.62	131.20	57.73	104.96	145.77	600
	103.95	69.57	95.22	107.12	47.13	85.70	119.02	900
	90.02	60.25	82.45	92.77	40.82	60.59	103.07	1200(2)
36	170.00	124.00	151.00	180.00	84.00	135.00	190.00	300
	131.00	87.68	120.00	135.00	59.40	108.00	150.00	600
	106.96	71.59	97.98	110.23	48.50	88.18	122.47	900
	92.63	62.00	84.84	95.46	42.00	62.35	106.06	1200(2)
38	174.66	127.40	155.14	184.93	86.30	138.70	195.21	300
	134.59	90.08	123.29	138.70	61.03	110.96	154.11	600
	109.89	73.55	100.66	113.25	49.83	90.60	125.83	900
	95.17	63.70	87.16	98.08	43.15	64.06	108.97	1200(2)
40	179.20	130.71	159.17	189.74	88.54	142.30	200.28	300
	138.09	92.42	126.49	142.30	62.61	113.84	158.11	600
	112.75	75.46	103.28	116.19	51.12	92.95	129.09	900
	97.64	65.35	89.43	100.62	44.27	65.72	111.80	1200(2)
42	183.62	133.94	163.10	194.42	90.73	145.82	205.22	300
	141.50	94.71	129.61	145.82	64.16	116.65	162.02	600
	115.53	77.33	105.83	119.06	52.39	95.25	132.28	900
	100.05	66.97	91.64	103.11	45.37	67.35	114.56	1200(2)
44	187.94	137.09	166.94	199.00	92.87	149.25	210.05	300
	144.83	96.93	132.66	149.25	65.67	119.40	165.83	600
	118.25	79.15	108.32	121.86	53.62	97.49	135.40	900
	102.41	68.54	93.79	105.54	46.43	68.93	117.25	1200(2)
46	192.17	140.17	170.69	203.47	94.95	152.60	214.77	300
	148.08	99.11	135.65	152.60	67.15	122.08	169.56	600
	120.91	80.92	110.76	124.60	54.82	99.68	138.44	900
	104.71	70.08	95.90	107.91	47.48	70.48	119.89	1200(2)
48	196.30	143.18	174.36	207.85	96.99	155.88	219.39	300
	151.27	101.24	138.56	155.88	68.59	124.71	173.21	600
	123.51	82.67	113.14	127.28	56.00	101.82	141.42	900
	106.96	71.59	97.96	110.23	48.50	72.00	122.47	1200(2)
50	200.35	146.14	177.96	212.13	98.99	159.10	223.92	300
	154.38	103.33	141.42	159.10	70.00	127.28	176.78	600
	126.05	84.37	115.47	129.91	57.16	103.92	144.33	900
	109.17	73.07	99.98	112.50	49.50	73.48	124.99	1200(2)

(1) CMP recommends that all fixed cleat centres are reduced to 300mm at and near to cable bends, in order to provide better restraint in these important areas.

(2) 1200mm fault levels are shown are for installations that do not include intermediate restraints. Although cables would be safely restrained with fixed cleats mounted at 1200mm intervals, CMP recommends spacing fixed cleats at a maximum of 900mm; this avoids long distances between fixed cleat centres which would allow large 'arches' of cables between each fixed cleat in the event of a Short circuit. With longer fixed cleat mounting intervals, these large 'arches' could damage the cable ladder or interfere with neighbouring components, and damage the cable insulation in the process. Alternatively, the addition of intermediate restraints fitted midway between two fixed cable cleats will prevent large cable 'arches' and also increase the maximum fault current capability of the circuit – please contact CMP for further details.

## Overview of Peak Fault Current Withstand Capabilities of CMP Trefoil Cable Cleats at Various Mounting Intervals

Cable od (mm)	Cable Cleat Peak Fault Level (kA)							Cable Cleat Spacing (mm) Cat 1(1)
	Conqueror	Cyclone I	Cyclone II	Cyclone III	Huron	Patriot	Sovereign	
52	204.31	149.03	181.48	216.33	100.96	162.25	228.35	300
	157.44	105.38	144.22	162.25	71.39	129.80	180.28	600
	128.55	86.04	117.76	132.48	58.29	105.98	147.19	900
	111.33	74.51	101.96	114.73	50.48	74.94	127.47	1200(2)
54	208.21	151.87	184.94	220.45	102.88	165.34	232.70	300
	160.44	107.39	146.97	165.34	72.75	132.27	183.71	600
	131.00	87.68	120.00	135.00	59.40	108.00	149.99	900
	113.45	75.93	103.91	116.91	51.44	76.36	129.90	1200(2)
56	212.03	154.66	188.33	224.50	104.77	168.37	236.97	300
	163.39	109.36	149.67	168.37	74.08	134.70	187.08	600
	133.40	89.29	122.20	137.48	60.49	109.98	152.75	900
	115.53	77.33	105.81	119.06	52.38	77.76	132.28	1200(2)
58	215.78	157.39	191.66	228.47	106.62	171.35	241.17	300
	166.28	111.29	152.32	171.35	75.40	137.08	190.39	600
	135.76	90.87	124.37	139.91	61.56	111.93	155.45	900
	117.57	78.70	107.69	121.17	53.31	79.14	134.62	1200(2)
60	219.47	160.08	194.94	232.38	108.44	174.28	245.29	300
	169.12	113.19	154.92	174.28	76.69	139.43	193.65	600
	138.08	92.42	126.49	142.31	62.61	113.84	158.11	900
	119.58	80.04	109.53	123.24	54.22	80.49	136.92	1200(2)
62	223.10	162.73	198.16	236.22	110.24	177.17	249.34	300
	171.92	115.07	157.48	177.17	77.95	141.73	196.85	600
	140.37	93.95	128.58	144.66	63.65	115.72	160.72	900
	121.56	81.36	111.34	125.28	55.12	81.82	139.19	1200(2)
64	226.67	165.33	201.33	240.00	112.00	180.00	253.33	300
	174.67	116.91	160.00	180.00	79.20	144.00	200.00	600
	142.61	95.45	130.64	146.97	64.67	117.57	163.29	900
	123.51	82.67	113.12	127.28	56.00	83.13	141.41	1200(2)
66	230.18	167.90	204.45	243.72	113.74	182.79	257.26	300
	177.37	118.72	162.48	182.79	80.43	146.23	203.10	600
	144.82	96.93	132.67	149.25	65.67	119.40	165.83	900
	125.42	83.95	114.87	129.25	56.87	84.42	143.61	1200(2)
68	233.64	170.42	207.53	247.39	115.45	185.54	261.13	300
	180.04	120.50	164.92	185.54	81.64	148.43	206.16	600
	147.00	98.39	134.66	151.50	66.66	121.19	168.32	900
	127.31	85.21	116.60	131.20	57.72	85.69	145.77	1200(2)
70	237.05	172.91	210.56	251.00	117.13	188.25	264.94	300
	182.67	122.26	167.33	188.25	82.83	150.60	209.17	600
	149.15	99.83	136.63	153.71	67.63	122.96	170.78	900
	129.17	86.45	118.30	133.11	58.57	86.94	147.89	1200(2)
72	240.42	175.36	213.55	254.56	118.79	190.92	268.70	300
	185.26	124.00	169.71	190.92	84.00	152.74	212.13	600
	151.26	101.24	138.56	155.89	68.59	124.71	173.20	900
	131.00	87.68	119.98	135.00	59.40	88.18	149.99	1200(2)
74	243.73	177.78	216.49	258.07	120.43	193.55	272.41	300
	187.82	125.71	172.05	193.55	90.73	154.84	215.06	600
	153.35	102.64	140.48	158.04	69.54	126.43	175.59	900
	132.81	88.89	121.64	136.86	60.22	89.39	152.06	1200(2)
76	247.00	180.17	219.40	261.53	122.05	196.15	276.06	300
	190.34	127.40	174.36	196.15	86.31	156.92	217.94	600
	155.41	104.02	142.36	160.16	70.47	128.12	177.94	900
	134.59	90.08	123.27	138.70	61.02	90.59	154.10	1200(2)
78	250.23	182.52	222.27	264.95	123.64	198.71	279.67	300
	192.83	129.06	176.64	198.71	87.43	158.97	220.79	600
	157.44	105.38	144.22	162.25	71.39	129.80	180.27	900
	136.35	91.26	124.88	140.51	61.82	91.78	156.12	1200(2)
80	253.42	184.85	225.10	268.33	125.22	201.25	283.24	300
	195.28	130.71	178.89	201.25	88.55	161.00	223.61	600
	159.45	106.72	146.06	164.32	72.30	131.45	182.57	900
	138.08	92.42	126.47	142.30	62.61	92.95	158.10	1200(2)

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