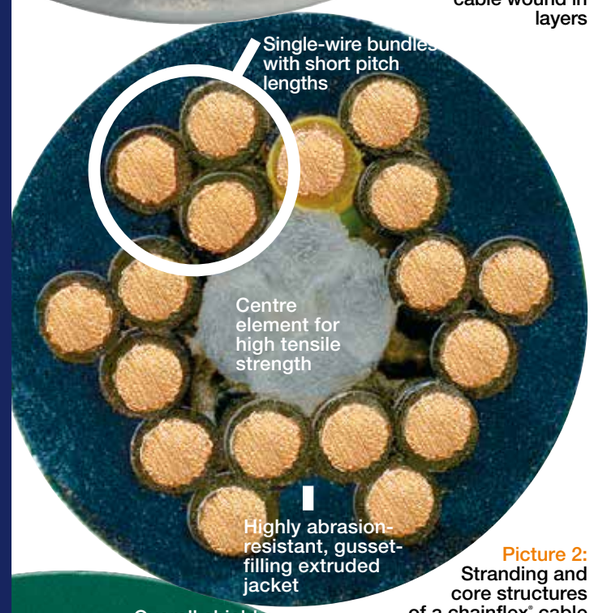
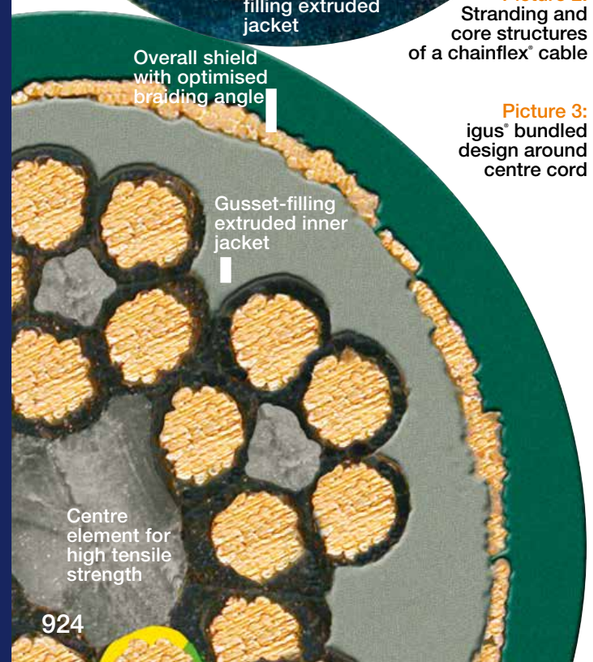
Page

Technical appendix

Picture 1: **Chain-suitable cable wound in layers**



Picture 2: **Stranding and core structures of a chainflex® cable**



Picture 3: **igus® bundled design around centre cord**

chainflex®...

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From the customer's point of view, a flexible energy supply system needs to function properly. However, this demand assumes the perfect operation of all components, including the cables being used in this system. And this is exactly where problems came up in the early 1980s. Due to constantly increasing loads resulting from the constant movement, guided cables often failed even though the energy supply system itself was functioning perfectly. In extreme cases, failures caused by "corkscrews" and core ruptures brought the entire production process to a standstill and resulted in high costs.

In order to find a solution to this problem for its customers, igus® decided to take the initiative. As the first worldwide company to do so, igus® began to develop complete energy chain systems. chainflex® cables and energy chains are now being offered from one source and with a system guarantee depending on the individual application. Based on the increasing know-how gained since 1989 and on the very sophisticated series of tests that have been conducted since then, design principles were, and still are, being developed that help prevent machine downtime in factories throughout the world today.

How can "corkscrews" be prevented?

Here, the term "corkscrew" does not refer to a useful instrument for wine connoisseurs. Instead, it refers to the permanent deformation of guided, moving cables caused by excessive strain - which, in most cases, results in core rupture almost immediately afterwards. How does this happen? How can "corkscrews" be prevented? An important factor here - in addition to a sensible design of the total energy chain system - is the construction of the cables. Simply speaking, a clear distinction can be made between cables braided in bundles and cables wound in layers ▶ see pictures 1 and 2.

Properties of winding in layers

Winding in layers is significantly easier to produce and is therefore offered on the market in so-called "chain-suitable" cables at low cost. But what appears to be tempting at first glance can quickly turn into an expensive mistake when a "corkscrew" immobilises the system being operated with these cables. How do these problems arise? Looking at the cable structure can be quite helpful ▶ see picture 1.
In the case of winding in layers, the cable cores are mostly wound more or less firmly and relatively long in several layers around a centre and are then provided with a jacket extruded to the form of a tube. In the case of shielded cables, the cores are wrapped up with fleece or foils. But what happens to a similarly structured 12-core cable, for example, during normal operation?

The bending process compresses the inner radius of the cable and stretches the outer radius. Initially, this works quite well because the elasticity of the material is sufficient. But very soon, material fatigue causes permanent deformations, and then, due to excursion from the specified paths, the cores make their own compression and tension zones: The corkscrew is created, often followed rather quickly by core ruptures.

... lasts or your money back!

...the chainflex® design and why we feel so confident about this design

Bundled design tried and tested millions of times since 1989

The bundled design eliminates these problems by means of its very sophisticated, internal structure. Here, the core wires are wound with a special pitch length first and then the resulting cores are bundled. For large cross sections, this is done around a strain relief element. The next step is the winding of these bundles around a tension-proof centre cord ▶ see picture 2.

Due to this multiple winding of the cores, all cores move through the inner radius and the outer radius of the cable several times at identical spacing distances. Tensile and compressive forces balance one another around the high-tensile centre cord giving the structure its stability. In this way, the structure remains stable even under maximum bending stress ▶ see picture 3.

Picture 4: **Shielded "chain-suitable" control cable after only 400,000 double strokes with a bending factor of 10 x d**

What are EMC problems and shield wire breakage?

In principle, cable shields must fulfill two tasks:
- Preventing interference getting into the cable
- Preventing interference being transmitted out of the cable

Both tasks are equally important because faulty signals can cause considerable consequential damage in the system itself as well as to any external systems. Furthermore, this is especially problematic due to the fact that incorrect shielding usually cannot be detected from outside, and this is something that makes the trouble-shooting procedure extremely difficult.
How do these kinds of problems arise in the first place?
Once again, the answer is to be found in the internal structure of the cable itself: Is the shielding designed for the movements of the cable? Although it may be very easy to shield a fixed cable, it is much more difficult to guarantee the permanent shielding of a moving cable.

In the case of so-called "chain-suitable" cables, for example, an intermediate layer is formed with foils or fleeces. This layer is supposed to guarantee the separation between the cores and the shield braid. But something that functions quite well for the fixed installation of cables is quite insufficient for moving cables. This has to do with the fact that the foils and fleeces do not stay put between the cores, shield and jacket and may fall apart under stress. Consequently, the metallic shield then rubs on the insulation of the cores - short circuits can then be expected.

Dictionary of defects

Broken wires

Failure of electric conductivity due to broken copper wires as a result of subjecting the individual cores to mechanical load under constant bending stress. In most cases, the causes are incorrect strand wires and/or incorrect stranding pitch directions and lengths.

Insulation damage

Short circuits due to damage to the insulation around the conductor. The cause can be material fatigue under constant bending stress or material abrasion within the core structure. Single wire breakage of the conductor or the shield braid result in perforation of the insulation.

Corkscrew

An externally detectable corkscrew-like deformation of the entire cable due to broken copper wires as the result of subjecting the individual cores to mechanical load during the bending process. In most cases, the causes are poor structure (winding in layers, missing centre, loose jackets extruded to the form of a "tube") and subjecting the cables to high bending stress.

Jacket abrasion

The jacket is abraded down to the cores or to the shield. In most cases, the causes are incorrect selection of materials and/or unfavourable extrusion processes resulting in poor surface properties such that abrasion is an unavoidable effect.

Jacket swelling/jacket breakage

Jacket becomes soft and deformed or breaks until the cores/shield can be seen. The cause can be the incorrect selection of materials with respect to the oils or other chemical substances being used.

Shielding losses/EMC problems

Electromagnetic interferences inside or outside an electric cable. In most cases, the cause is shield wire breakage due to mechanical overload with incorrect shield braid angles. Other causes include loose braids over foils without supporting effects or very open coverings.

Jacket breakage of (36x0.14mm²) after only 900,000 double strokes with a bend radius factor of 7.8 x d

Picture 1: **Optimised shield braiding angle over gusset-filling extruded inner jacket**

chainflex®...

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The production of the shield itself is very time-consuming and cost-intensive and may have been the reason for the use of open braid shields or even simple wire wrappings. The disadvantages are obvious: open shields only possess a limited shielding effect when moving - motion reduces this effect even further. The type of shield is therefore an important point that is not even mentioned in some catalogues.

In its approx. 70% linear and approx. 90% optical coverage cables, igus® eliminates these weaknesses by means of an optimised internal structure. In virtually all shielded chainflex® cables, a gusset-filling extruded inner jacket over the core structure is used. This "second jacket" fulfils two tasks:

- It holds the core structure together and guides the individual cores as in a channel.
- It serves as a firm, round base for a very tight-fitting shield. ▶ see picture 1.

Shield wire breakage - and how this can be prevented

Even during the production of the shield, there are many things that can be done correctly - or incorrectly. Here, an important parameter is the braiding angle.
In the case of "chain-suitable" cables, tensile load on the shield wires in the outer radius of the cable must be taken into account. If an unfavourable braiding angle is used, the tensile load increases even further and shield wire breakage is the result. The consequences range from reduced shielding effects right up to short circuits whenever the sharp wire ends penetrate through the fleeces or foils into the cores. Here is a useful tip: If, after the insulation has been stripped off, the shield can be easily pushed back over the jacket, the shield is then usually unsuitable for use in moving energy supply systems! This is a problem that igus® has now solved with its novel approach:

- The shield braiding angle determined in long-term tests efficiently neutralises the tensile strengths and is therefore highly suitable for energy chains.
- Due to the stable inner jacket, the shield cannot become uncontrolled.
- The shield itself has a torsion protection effect on the wound structure.

Jacket abrasion/jacket breakage

Whilst defects in the internal structure are hardly detectable on the outside, jacket problems are immediately obvious. The jacket is the first protection for the complicated internal structure. This is why broken, worn and swollen jackets are a serious quality defect. To prevent this problem, the igus® customer can select from 7 jacket materials to adapt their energy chain cables to suit the conditions of the respective environment.

... lasts or your money back!

...the chainflex® design and why we feel so confident about this design

Gusset-filling extruded jacket

Here, not only is the material an important factor but also the production process. In the case of the so-called "chain-suitable" cables, the jackets are usually produced extruded to the form of a tube and therefore do not provide the structure with the necessary support for constant bending. The wound structure can fall apart.

Therefore, igus® is the first manufacturer of energy chain systems to offer the so-called the "gusset-filling extruded" jacket.

Here, the jacket material is injected between the core structure powdered with talc and ensures that the core structure does not open up and also makes sure that the cores are guided as in a channel. The special characteristic of this type of production is that the intermediate spaces created between the cores during the winding process, are completely filled with jacket material by the high extrusion pressure. As a result, the jacket material creates a channel-like guide which ensures the cores have a defined longitudinal movement. The jacket also provides a supporting function for the structure. ▶ see picture 2.

The quality bundles of igus® chainflex® cables

- Strain-relieving centre
- Cores in bundles
- Gusset-filling extruded inner jacket in shielded cables
- Enclosed shield braid
- Optimised shield braiding angle
- Gusset-filling extruded jacket

Picture 2: **Gusset-filling extruded jacket**

7 basic rules for a good cable

1. Strain-relieving centre

Clear space is created in the centre of a cable according to the number of cores and the cross section of each cable. This centre should be filled, as far as possible, with a genuine centre cord (and not, as frequently the case, with fillers or dummy cores consisting of waste materials). These measures will then efficiently protect the structure and prevent it from wandering into the middle of the cable.

2. Stranded core

With respect to the selection of core strand wires, the maximum flexibility has proved to be the best solution. Although very flexible conductors can be made using very thin individual wires, these conductors can allow formation of kinks. Long-term testing provided the result of a combination of strand wire diameter, pitch length and pitch direction as the best overall bending-resistant solution.

3. Core insulation

The insulation materials must be made so that they do not stick to one another within the cable. Furthermore, the insulation is also required to support the stranded individual wires of the conductor. Accordingly, only the highest-quality, high-pressure-extruded PVC or TPE materials that have proved their tested reliability in millions of core kilometres are then used in energy chain applications.

4. Structure

The structure must be wound around a stable, tension-proof centre with an optimised short pitch length. However, due to the insulating materials being used, this wound structure should still used. Starting from a quantity of 12 cores, a bundled design should be used.

5. Inner jacket

A gusset-filling extruded inner jacket must be used instead of inexpensive fleeces, fillers or accessory fillers. This measure ensures that the core structure is efficiently guided in longitudinal direction. Moreover, the wound structure cannot fall apart or wander off.

6. Shielding

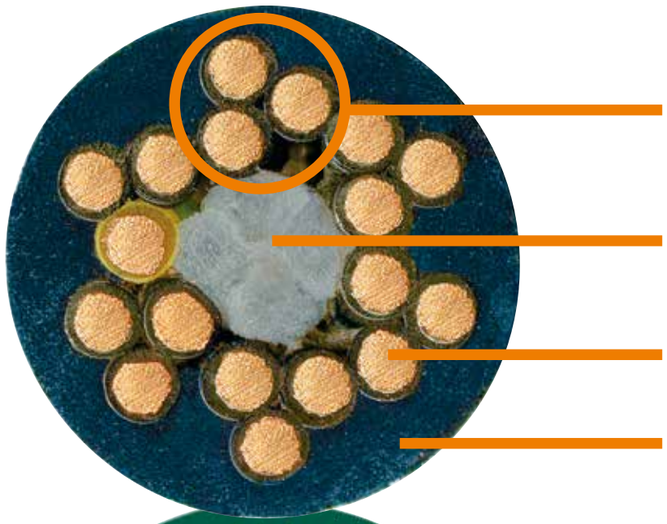
The overall shield should be made tight using an optimised shield braiding angle over an extruded inner jacket. Loose open braids or wrapped stranding reduce the EMC protection considerably and can fail very quickly due to shield wire breakage. A tight total braid shield also has a torsion protection effect on the wound structure.

7. Outer jacket

The material-optimised outer jacket can fulfil many different requirements: from UV-resistant to low-temperature-flexible, and from oil-resistant to cost-optimised. But these outer jackets must have one thing in common: A jacket material must be highly abrasion-resistant but not be allowed to stick to anything. It must be flexible but also provide a supporting function. In any case, the jacket should also be extruded under pressure (gusset-filling).

Sectional views through the igus® chainflex® cable types

Detailed structure of igus® control, data, servo and motor cables



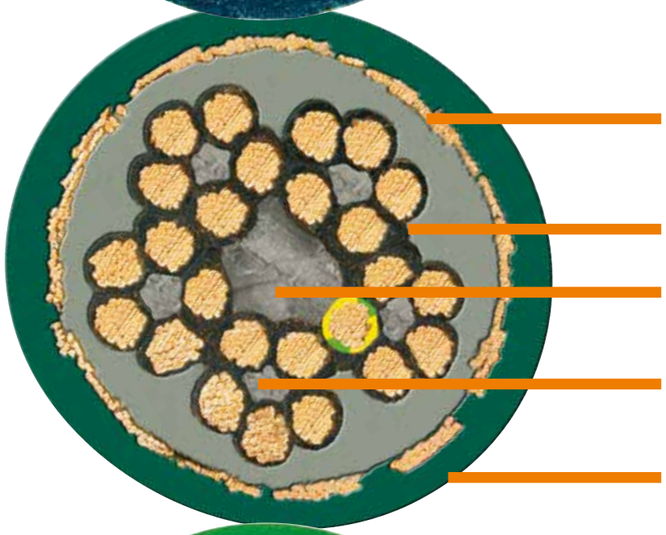
chainflex® control cable, unshielded

Individual bundles with optimised pitch length and pitch direction

Centre element for high tensile strength

Strand wire diameter optimised for energy chains

Highly abrasion-resistant, gusset-filling extruded jacket



chainflex® control cable, shielded

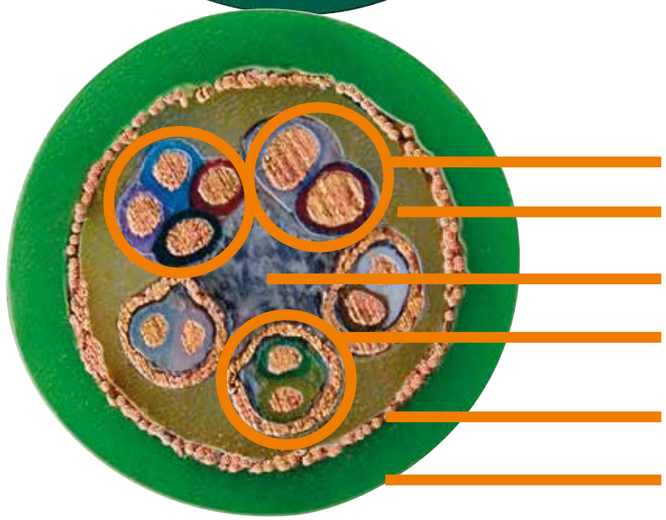
Overall shield with optimised braiding angle (approx. 70% linear, approx. 90% optical coverage)

Gusset-filling extruded inner jacket supports bundles

Centre element for high tensile strength

Centre element for high tensile strength in the individual bundles

Pressure-extruded outer jacket



chainflex® data/sensor cable, shielded

Stranded elements with optimised pitch length and pitch direction

Gusset-filling extruded inner jacket supports bundles

Centre element for high tensile strength

Pair braided shield

Overall shield with optimised braiding angle (approx. 70% linear, approx. 90% optical coverage)

Pressure-extruded outer jacket

chainflex® FOC graded index glass-fibre cable

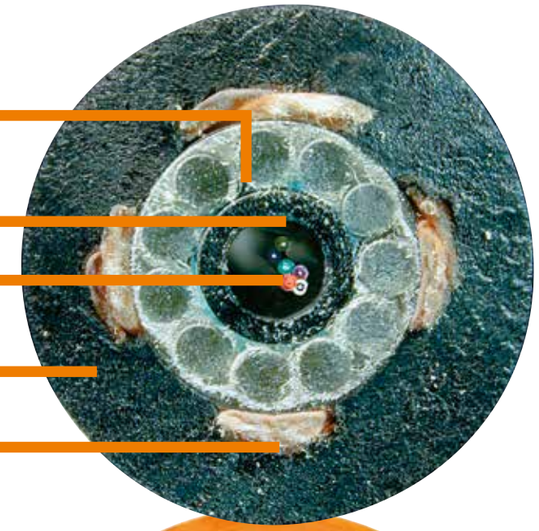
Supporting braid made of glass-yarn GRP rods

Gel-filled fibre tube

FOC fibres

Highly abrasion-resistant TPE jacket

Integrated torsion protection



chainflex® servo cable, shielded

Overall shield with optimised braiding angle (approx. 70% linear, approx. 90% optical coverage)

Optimised strand-wire diameter

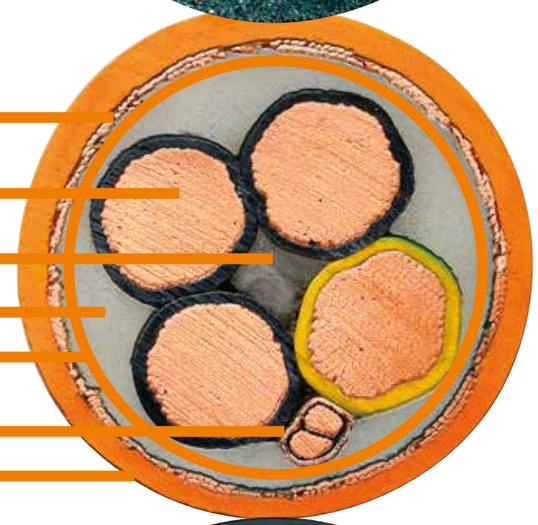
Centre element for high tensile strength

Gusset-filling extruded inner jacket

Cores wound with optimised pitch length and pitch direction

Pair braid shield over optimised wound pair

Highly abrasion-resistant pressure extruded jacket



chainflex® motor cable, shielded

Overall shield with optimised braiding angle (approx. 70% linear, approx. 90% optical coverage)

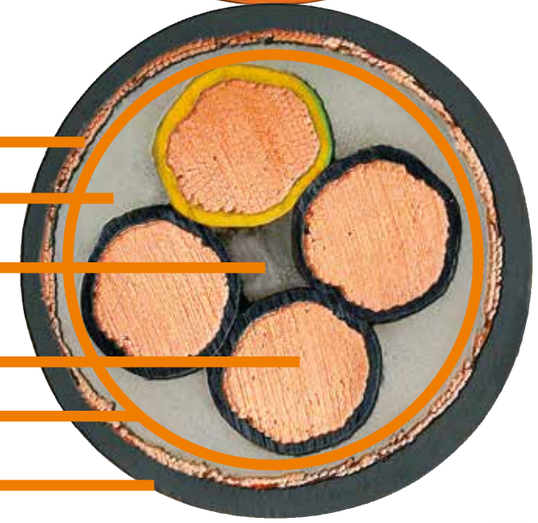
Gusset-filling extruded inner jacket

Centre element for high tensile strength

Optimised strand-wire diameter

Cores wound with optimised pitch length and pitch direction

Highly abrasion-resistant pressure extruded jacket



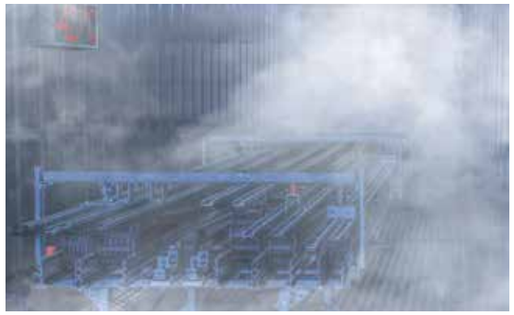
Example: Test 4876 Tested at -40°C

Bending tests in cold conditions in e-chains® with amazing results.

25 years of tests in the igus® in-house chainflex® test lab have clearly shown that international standards for the testing of cables are quite useful, but do not meet the special requirements for continuous movement in e-chains®. Thus we have the standard ratings for "*Mechanical tests - Low temperature bending tests for insulating sheaths and jackets*" according to IEC 60811-504.

According to this international standard, cables, according to the outer diameter, are wound around a mandrel and cooled down for a certain time to the temperature to be tested.
After the removal, a visual inspection is carried out. For the material tested, the test is deemed to have been passed if the material (in this case outer jacket) does not show damage, e.g. cracks.
Based on this standard, all cables for movement are tested in this way and the limit temperature is specified in catalogues as the lowest temperature for a moving application.
Thanks to many different series of tests, igus® has shown that these values are in accordance with the standards, but in continuous movement in e-chains® the materials tested in this way do not withstand the temperature.

Example: igus® test 4876. Here, the so-called chain-compatible PUR cables were tested in comparison with those with chainflex® TPE jacket material.
The cables to be tested were moved in continuous motion in the igus® 40-foot cooling container in an e-chain® at -40°C with a bend radius factor of 6.5 x d and a travel of 5m.



Media and cold tests **of chainflex® cables and e-chains® in the 40-foot climatic container**

The results of this experiment make for interesting reading:
Cables, which are available on the market as cold-flexible down to -40°C with a PUR outer jacket and are marketed as having a service life of 10 million cycles in the catalogue, fail in a real test in an e-chain® at -40°C with a massive jacket break after less than 41,000 strokes!

Jacket damage **after 41,000 strokes ...**

The parallel test of the CF9.15.18, however, was discontinued after more than 520,000 double strokes since no change could be detected at all.
On the basis of this and many other test series, igus® is the only supplier on the market that is able to list three different temperature ranges in its catalogue:
For fixed installation, flexible movement according to DIN EN 60811-504, as well as for continuously moving applications in e-chains®.

A test result from the igus® database	
Test no.	4876
Bend radius factor in e-chain®	6.5 x d
Test temperature	-40°C
Result PUR jacket	Breaks after 41,000 strokes
Result chainflex® TPE jacket	520,000 strokes without any damage

Details of the test online:
www.igus.eu/test4876

Calculate service life online:
www.igus.eu/chainflexlife

40-foot climatic container **for cable tests in continuous motion at -40°C**

520,000 strokes without any damage, **which the CF9.15.18 achieved in this test**

Result PUR jacket: **Broken after 41,000 strokes**

Result chainflex® TPE jacket: **Cable after the 520,000 strokes test**

Example: Test 4866
9 year continuous test
chainflex® Profinet

Bending tests in e-chain® with chainflex®: Profinet bus cable lasts for more than 65 million double strokes.

Due to its extensive equipment, the igus® laboratory with a floor area of 3,800m² offers the necessary environment to carry out continuous flexing tests under real-world conditions, even over many years. Only these real long-term tests lead to the necessary understanding of the behaviour of cable design and materials.

These long-term studies are used to equip the chainflex® **online service life calculator** with its data.

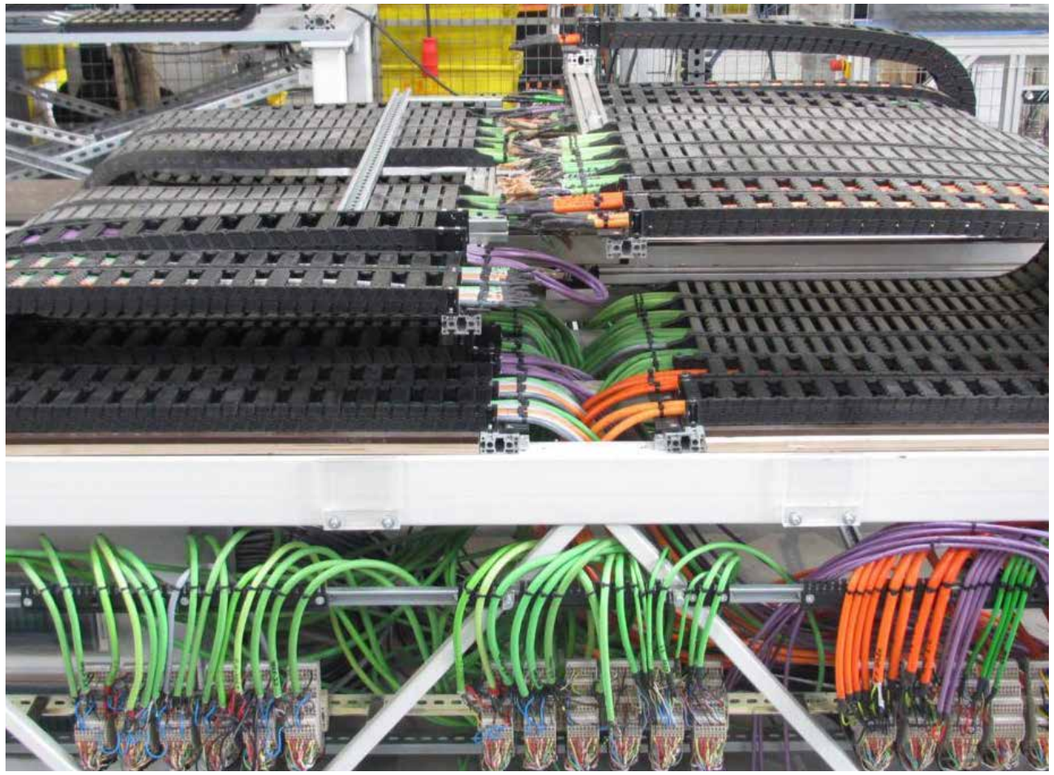
The chainflex® **online service life calculator** offers the user the great advantage of being able to determine the expected service life in advance so as not to be surprised by unscheduled breakdowns due to the cable.

In test 4866, the following question was posed:

To what extent is the continuous bending of the Profinet bus cable of the chainflex® CFBUS.060 type affecting the electrical transmission quality.

Or, in other words, if a chainflex® bus cable is moved in an e-chain® for years, can secure data transmission still be expected?

The CFBUS.060 Profinet cable has been in the long-term test since 2013 and has covered over 65 million double strokes without a measurable change in the electrical properties.



Linear chain tests with continuous monitoring of the electrical cable parameters

LINKWARE™PC
CABLE TEST MANAGEMENT SOFTWARE

Kabelkennung: 4866-1.1
Datum/Uhrzeit: 03/08/2017 11:24:16 AM
Reserve 15.9 dB (NEXT 12-36)
Grenzwert: Profinet
Kabeltyp: Cat 5e F/UTP
NVP: 66.0%

Bediener: A.FINKE
Software-Version: 2.7800
Grenzwerte Version: 1.9500
Kalibrierungsdatum:
Hauptgerät (Tester): 03/03/2017
Remote (Tester): 03/03/2017

Testzusammenfassung: PASS
Modell: DTX-ELT
Hauptgerät S/N: 9751011
Remote S/N: 9751012
Adapter Hauptgerät: DTX-CHA002
Adapter Remote: DTX-CHA002

Länge (ft)	[Paar 12]	34
Laufzeit (ns), Grnz. 555	[Paar 12]	52
Abweichung (ns), Grnz. 20	[Paar 12]	0
Widerstand (Ohm), Grnz. 25.0	[Paar 12]	1.3
Einfüg.-Dämpf. Reserve (dB)	[Paar 12]	20.5
Frequenz (MHz)	[Paar 12]	100.0
Grenzwert (dB)	[Paar 12]	24.0

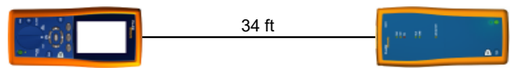
	Min. Abstand		Min. Wert	
N.A.	MAIN	SR	MAIN	SR
Schlechtest Paar	12-36	12-36	12-36	12-36
NEXT (dB)	15.9	16.4	20.8	19.7
Freq. (MHz)	11.9	11.0	86.0	90.0
Grenzwert (dB)	45.8	46.3	31.2	30.9
Schlechtest Paar	12	12	12	12
PS NEXT (dB)	18.9	19.4	23.8	22.7
Freq. (MHz)	11.9	11.0	86.0	90.0
Grenzwert (dB)	42.8	43.3	28.2	27.9

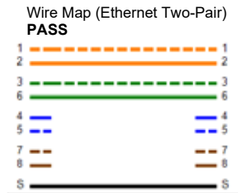
PASS	MAIN	SR	MAIN	SR
Schlechtest Paar	12-36	36-12	12-36	36-12
ACR-F (dB)	28.1	28.1	28.1	28.1
Freq. (MHz)	99.3	99.3	99.5	99.5
Grenzwert (dB)	17.5	17.5	17.4	17.4
Schlechtest Paar	36	12	36	12
PS ACR-F (dB)	31.1	31.1	31.1	31.1
Freq. (MHz)	99.3	99.3	99.5	99.5
Grenzwert (dB)	14.5	14.5	14.4	14.4

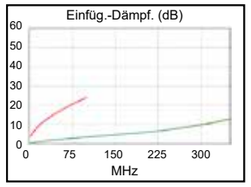
PASS	MAIN	SR	MAIN	SR
Schlechtest Paar	12-36	12-36	12-36	12-36
ACR-N (dB)	21.8	21.0	39.7	39.4
Freq. (MHz)	3.0	2.1	86.0	91.3
Grenzwert (dB)	51.6	54.0	9.1	7.9
Schlechtest Paar	12	12	12	36
PS ACR-N (dB)	24.8	24.0	42.6	42.4
Freq. (MHz)	3.0	2.1	86.0	91.3
Grenzwert (dB)	48.6	51.0	6.1	4.9

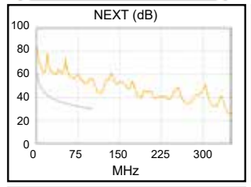
PASS	MAIN	SR	MAIN	SR
Schlechtest Paar	12	12	12	12
RL (dB)	6.9	6.7	7.2	6.7
Freq. (MHz)	85.5	89.8	99.8	89.8
Grenzwert (dB)	10.7	10.5	10.0	10.5

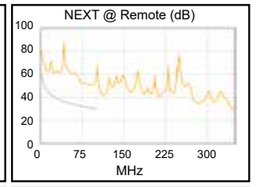
Erfüllte Network Standards:
10BASE-T, 100BASE-TX, 100BASE-T4, 1000BASE-T, ATM-25, ATM-51, ATM-155, 100VG-AnyLan, TR-4, TR-16 Active, TR-16 Passive

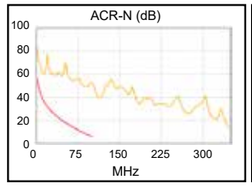


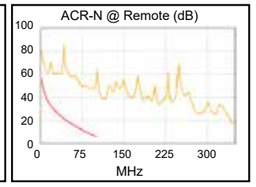


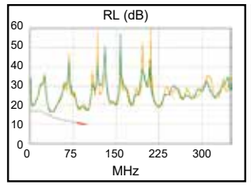


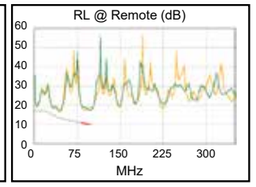












LinkWare™ PC Version 9.6

Projekt: CHAINFLEX
Unbenannt1

Ort: LABOR

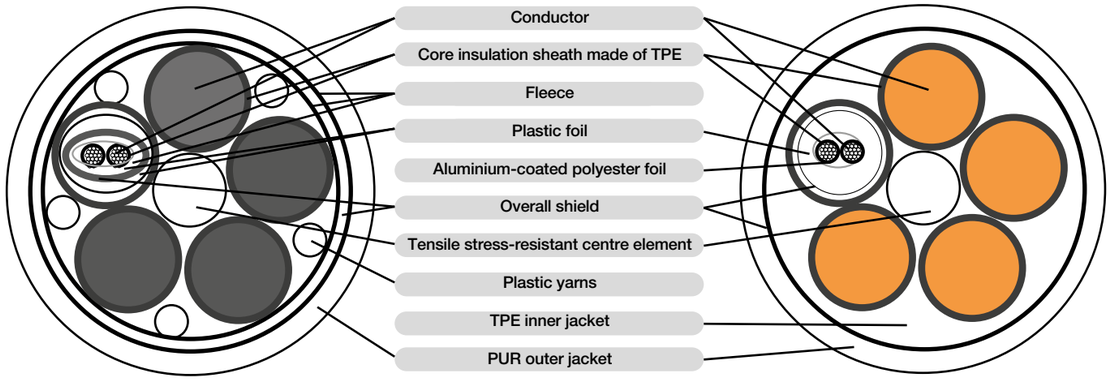
FLUKE networks

A test result from the igus® database	
Test no.	4866
Bend radius factor in e-chain®	8.5 x d
Measuring device	Fluke DTX-ELT
Double strokes without damage	29 million

Details of the test online:
www.igus.eu/test4866

Calculate service life online:
www.igus.eu/chainflexlife

Example: tested, tested, tested!
Servo cable structure



Sample B with fleece and filler experimental production 4x10+(2x1.0) C

The purpose of the test is to determine the advantages of the more expensive internal jacket in shielded servo cables versus the less expensive fleece taping with fillers.

In the case of flexible shielded cables, the shield is usually separated from the core structure. On the one hand, this is done in order to achieve a rounder braid form and, on the other hand, the friction of the core insulation against the braided shield is prevented due to the separation of the cores and shield. This can be achieved with an internal jacket or a fleece taping which is wrapped around the core structure. The internal jacket is more sophisticated and therefore more expensive to produce. Following the twisting process, the core structure must run through the extruder in which the internal jacket is then put on. In contrast to this method, the fleece tape can be put on between twisting and reeling-up during the twisting process and therefore does not require an extra operation.

Product information CF27.D
▶ Page 296

Sample A with inner jacket igus® chainflex® CF27.100.10.02.01.D

Comparison between the igus® solution with the gusset-filling internal jacket and the fleece version with fillers

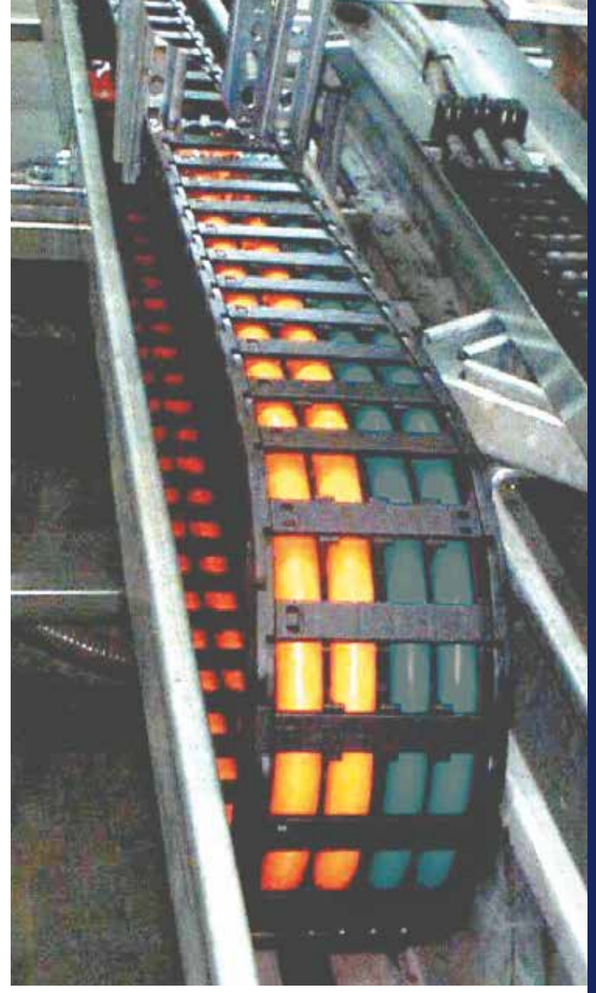
Here, the servo cables are highly flexible motor cables with a complete copper shield and an integrated, shielded pair of control cores. This cable type was selected due to the fact that the structure is not axisymmetric due to the different core cross sections, and therefore emphasises the bending behaviours of the different production methods.

- **Sample A: CF27.100.10.02.01.D (igus® GmbH) (4x10mm²) + (2x1.0mm²)**
- **Sample B: experimental (4x10mm²) + (2x1.0mm²)**

Both cables are provided with identical nominal cross sections and insulation materials. Cable A is equipped with an internal jacket and cable B with a fleece taping and fillers.

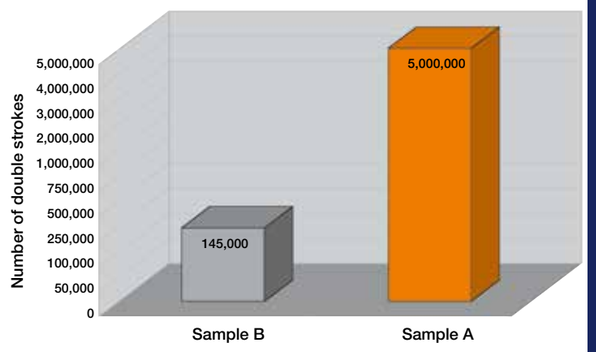
The experimental production (sample B) shows the formation of a corkscrew after just 145,000 double strokes. In the case of a cable, the so-called corkscrew refers to the wave-shaped deformation like that seen in the picture of sample B.

In the case of cable A, the internal jacket fills up the gussets and a round braided structure is created as a result, cable B requires fillers in the gussets. Like the core, the fillers are made of filbrated polyethylene. They are easy to compress and are therefore don't offer much support. By contrast, the internal jacket, which is made of TPE, and the cable A centre element hold the cores in a defined position. The cores of cable B are able to move about with no resistance. During the bending process, cores can detach themselves from the braid structure and shift into the inner bend radius or outer radius. This results in the corkscrew-type deformations that repeat themselves periodically along the length.



Assessment

Despite the extremely low bending factor of 4.76, no signs of wear can be detected in sample A (CF27.100.10.02.01.D) even after 5 million double strokes. Sample B, on the other hand, with its fillers and fleece taping, succumbs to a corkscrew formation after just 145,000 double strokes. Therefore, the result justifies the extra expenditure of the cable with the gusset-filling internal jacket.



Sample A: CF27.100.10.02.01.D

Sample B: experimental production

Example: tested, tested, tested! "Millions of double strokes" in an energy chain

Profibus cables for constant moving industrial use

For customers, it is hard to get an overview of the cable market. Competition between cable suppliers is intensifying and manufacturers are outshining one another with their promises to "guarantee service life for cables used in energy chains". Catalogues claim ten million - or even as many as 50 million - double strokes service life of cables used in moving applications.

Taking a closer look at figures claimed, one must ask what testing was done, or how realistic the tests carried out actually were (for example length of travel, test radii, etc.) in order to be able to provide such a guarantee. Even information stating that cables are tested in accordance with VDE (Association of German electrical engineers) 0472, part 603, test method H, is not helpful when it comes to determining the service life of a cable in energy chains, since the roller testing stand cannot provide any conclusive results and there is no VDE test for special cables in energy chains.

Differences in service life

At the beginning of 2002, a test to determine the service life of Profibus cables in a real application was commissioned in igus® test laboratory. The aim was to examine any differences in the service life of igus' CFBUS.001 chainflex® cable and another market leading Profibus cable. The parameters required for the test were selected on the basis of data contained in the competitor's catalogue:

Catalogue details	Test item "A" Twin-core Profibus cable	Test item "B" igus® chainflex® CFBUS.001
Cross section	(2 x AWG24)C	(2 x 0.25mm²)C
Guaranteed service life	Min. 4.0 million cycles	To be determined in a test
Bend radius	> = 60mm	85mm
Diameter	8.0mm	8.5mm
Catalogue details	Issue 2002	Issue 2002

Table 2: Test parameters according to catalogue data of the competition

Picture 1: Gliding e-chain® application as the basis of the test

A gliding application was chosen as a suitable test structure since Profibus cable systems are often used here because of their data integrity, particularly over long travel lengths and transmission distances.

In order to be able to carry out non-destructive testing and achieve a large number of bending cycles in a short period of time, a genuine Profibus transmission path was constructed. In a PC at the fixed end of the test chain there was a Profibus master insert card. A connection to a profibus slave was located on the moving end. This enabled the transmission rate to be determined with the help of a diagnostic program. Any data packets which might have been transmitted incorrectly would be indicated. The highest-possible transmission rate of 12 megabits/s was set.

This important test, which commenced at the beginning of 2002 and is still in progress today, showed that only a relatively low number of cycles (420,000) led to the total failure of test item "A", which, according to the competitor's catalogue, should have functioned safely for at least 4.0 million cycles. Thus the real lifetime reaches only about 10% of the stated catalogue value.

On the other hand test item "B", the CFBUS.001, is still undergoing testing without any faulty data transmissions. So far, it has accomplished more than 14.0 million double strokes.

Structure and materials

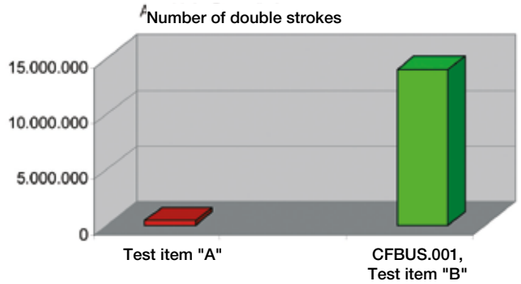
The main reason for the major differences in service life is the differing structural parameters of test item "A" and test item "B" (CFBUS.001), as well as the different materials used for producing the cables.
The conductor insulation of the bus pair comprised of a foam material for both test items. The electrical properties of this material ensured better transmission properties were achieved. A disadvantage of this material, however, was its weakness under mechanical stresses. The forces which affect the bus pair should be absorbed by the element insulation in order to alleviate the mechanical stress on a conductor insulation.

Highly-elastic element insulation

For this reason, test item "B" (igus®) was provided with a mechanically superior, extruded TPE inner, or element, gusset-filling insulation, in order to protect the bus pair against mechanical influences during the bending procedure. The element insulation must be highly elastic. A mechanically inferior element insulation made of inexpensive filling material only serves to make the bus pair round, just like often used fillers or banding. It is not able to protect the bus pairs from the high degree of mechanical stress present in the chain. Tensile and compressive forces which occur particularly affect those parts of the cable core in which there is a break in the element insulation.

Test parameters	
Travel distance:	S = 5.0m
Speed, approx.:	V = 3.5m/s
Acceleration, approx.:	a = 7.5m/s²
Bend radius, approx.:	55mm

The insulation of test item "B" (CFBUS.001) is on the one hand characterised by a mechanically superior, gusset-filling TPE element jacket, which mechanically relieves the bus pair, fixes the cores in a defined position.



The extremely short pitch of the core strands ensure that no great tensile or compressive force has an effect on a long length of core. So relatively small bend radii with high cycle rates can be realised.

New: UL and CSA approval

chainflex® CFBUS cables are now also available for all standard field bus systems, complete with UL and CSA approval and DESINA compliance. The highly abrasion-resistant, flame-retardant TPE outer jacket is extruded onto the fully braided shield with an optimised angle in order to provide the cable with additional stability.

The bus elements wound with a particularly short pitch are protected by means of a gap-filling, extruded TPE inner jacket. The bus parameters required are fulfilled by means of a combination of optimised insulating materials and production procedures.

As with all chainflex® cables, the new standard field bus cables of the CFBUS series are now available ex-stock, without any cutting costs or extra charges for small quantities.

Product information CFBUS
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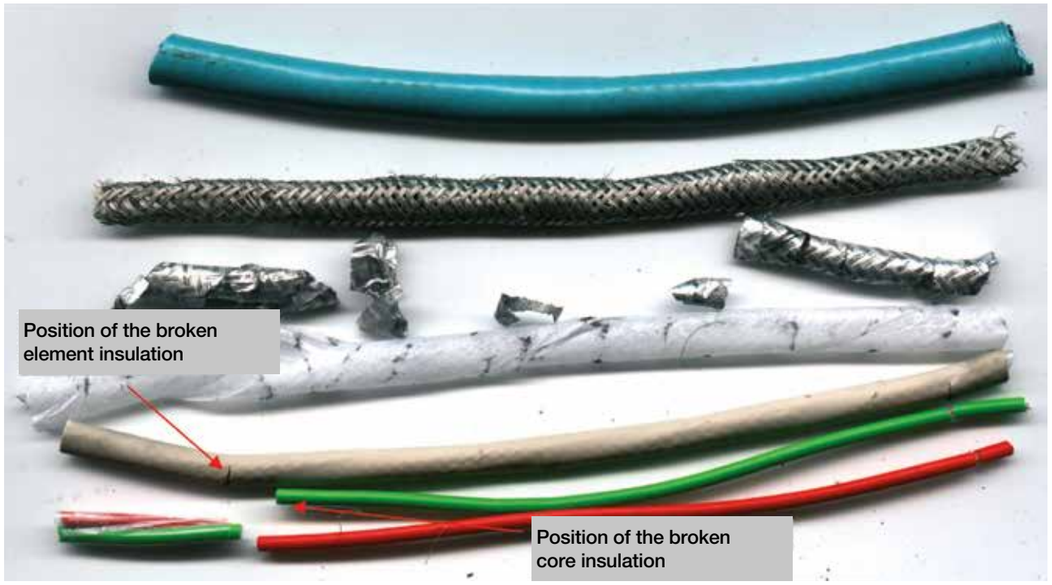


Picture 3: A mechanically low-quality element jacket can't protect the bus pair against the high mechanical loads inside an energy chain.

Example: tested, tested, tested! CF98 with < 4xd!

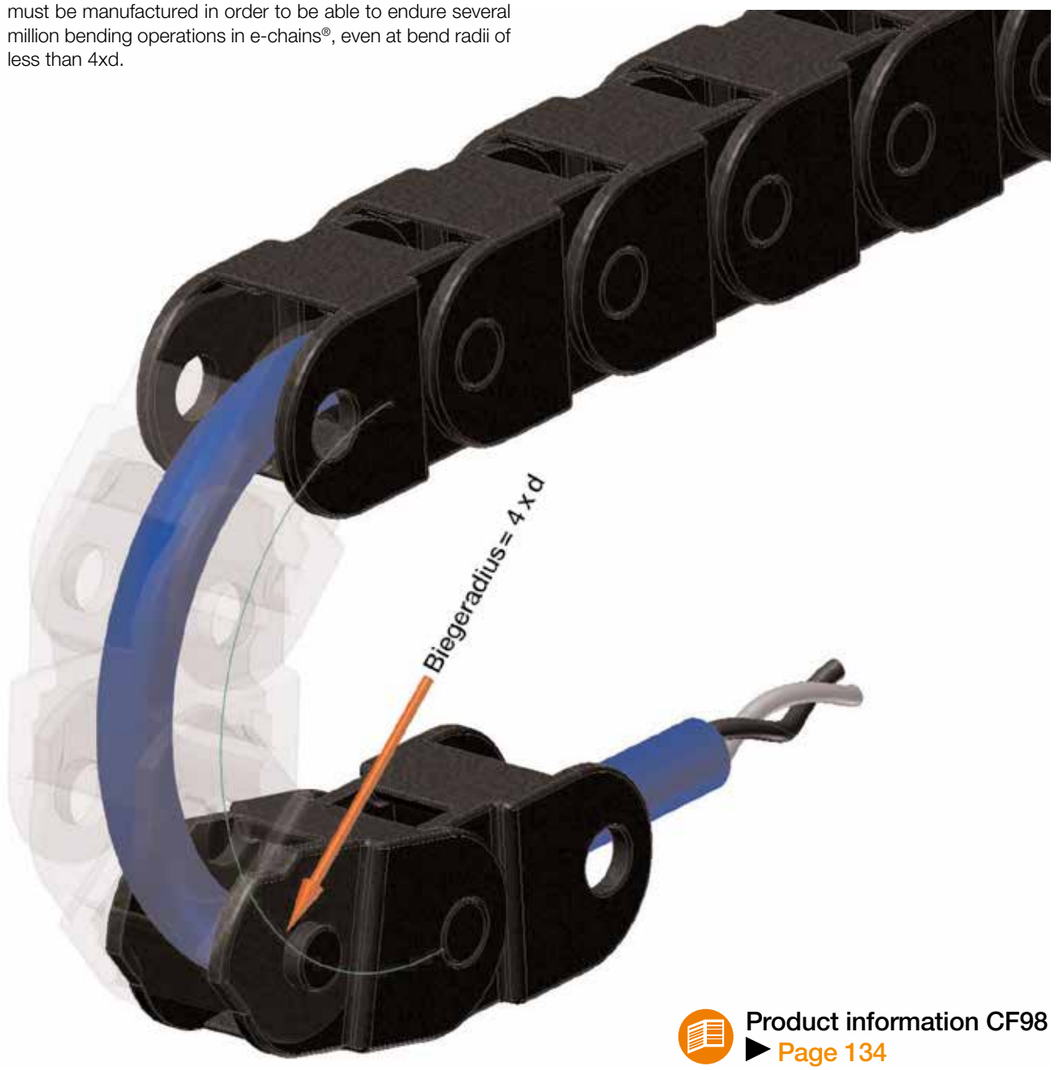
For users of very small energy supply chains with very small bend radii, the question of a suitable cable for very high cycle life has come up many times in the past.

At bend radii of less than 5xd, copper quickly reaches its physical limits, which necessitated the search for suitable substitute conductor materials or for a fundamentally different conductor structure.

Many series of tests with a variety of conductor structures and materials were performed in order to find out how cables must be manufactured in order to be able to endure several million bending operations in e-chains®, even at bend radii of less than 4xd.

Test setup:
Horizontal, short travel distance

Test parameters	
Travel distance:	S = 0.8m
Speed, approx.:	V = 1.5m/s
Acceleration, approx.:	a = 0.5m/s²
Bend radius, approx.:	18 m



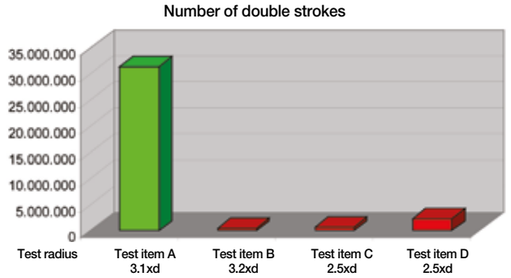
Product information CF98
▶ Page 134

Test 1:
Inspection of four different cable designs

Four different cable designs have been analysed:
Test item A - conductor in special conductor alloy
Test item B - conductor same as test item A, but in copper
Test item C - conductor with braided structure
Test item D - conductor with layered construction

This long-term inspection, which was carried out over a period of 2 years, provided the following results:

	Number of double strokes	Cross section	d [mm]	Test radius
Test item A	47,434,277	7x0.20	5.8	3.1xd = 18
Test item B	450,000	7x0.20	5.6	3.2xd = 18
Test item C	638,000	7x0.25	7.3	2.5xd = 18
Test item D	2,350,000	7x0.25	7.3	2.5xd = 18

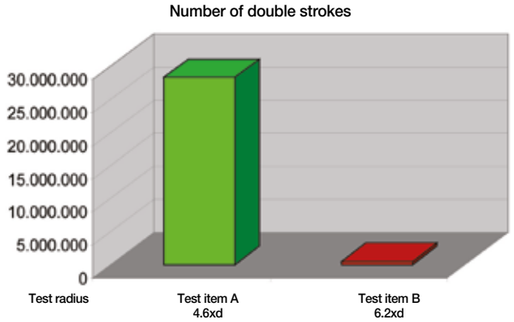


Test 2:

Two different cable designs were tested, and different core numbers and cross-sections were selected in comparison with test 1:
Test item A - conductor in special conductor alloy
Test item B - conductor in copper

In this case, test item B was manufactured completely identically to test item A except for the conductor material. The test showed that not a single case of wire breakage could be detected for test item A even after 28 million double strokes. Test item B, however, only achieved approx. 1.4 million double strokes before complete destruction of the conductor was observed. This test demonstrates that the alloy concept clearly surpasses the life of the copper conductor by more than 19 times and achieves these extraordinary results in the critical area of very small cross sections!

	Number of double strokes	Cross section	d [mm]	Test radius
Test item A	28,267,000	2x0.14	3.9	4.6xd = 18
Test item B	1,450,000	2x0.14	2.9	6.2xd = 18



Conductivity of alloys

However, the outstanding mechanical properties of this alloy also come with a reduced conductivity versus copper, but this can be compensated for by means of slightly increased cross-sections. This means that the cross-sections mentioned in the catalogue meet the electrically defined cross-section defined using the conductivity value. The conductor diameter of the alloyed conductor increases slightly compared to the conductor diameter of a copper conductor.

This compromise results in a 10% greater external diameter for the CF98 series versus a comparable CF9 type, although the service life differences between the CF98 versus the CF9 speak for themselves and increase by a multiple factor in comparison with other so-called chain-suitable cables.

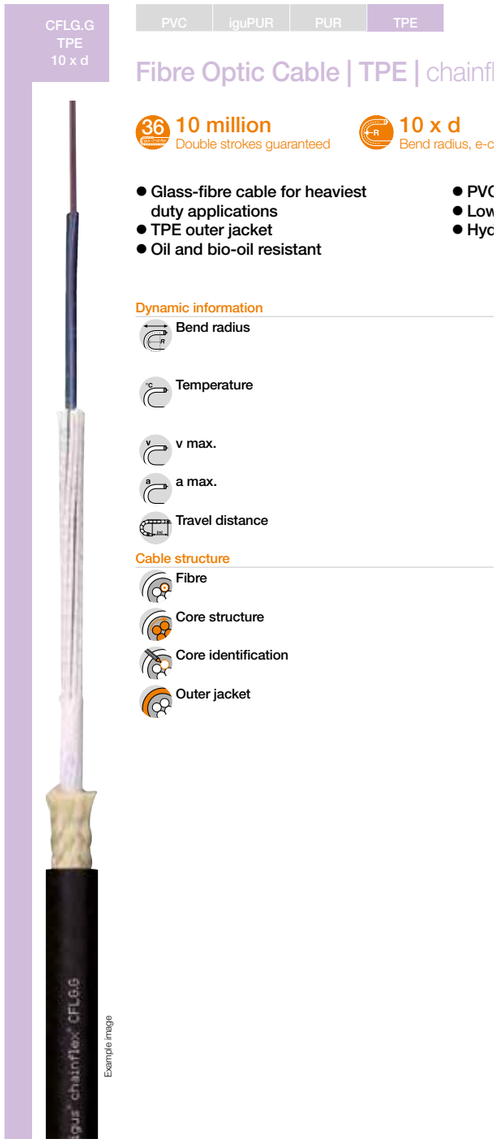
As in the case of the CF9 series, further characteristics of the chainflex® CF98 include the highly abrasion-resistant, gusset-filling extruded TPE outer jacket, the oil resistance and the UV resistance as well as the absence of any PVC and halogen compounds.

In application areas with minimum space but which demand a large number of strokes, the igus® cable offers an increased degree of operational safety and reliability. Relevant application areas are in the: semiconductor and component parts industry, automation sector as well as the automotive and banking sector. New application possibilities can also be found in automatic doors for motor vehicles and trains as well as in automatic food and self-service machines, and in the packaging industry.

Example: ...tested!
Light in the cold

Light in the cold - igus® graded index glass-fibre cable in a deep freeze test

The igus® CFLG graded index glass-fibre cable has already become a standard in numerous crane applications for the safe transmission of large amounts of bus data at high speeds and over long distances. Insensitivity to electro-magnetic interference and resistance to tough environmental influences enable this, alongside the energy supply cables in very long travels.



What happens in crane facilities in regions with extremely low temperatures? Does the maximum possible cable length of several hundred metres reduce through increase in attenuation at low temperatures, or can the cable even break in extreme applications, for example at -40 °C?

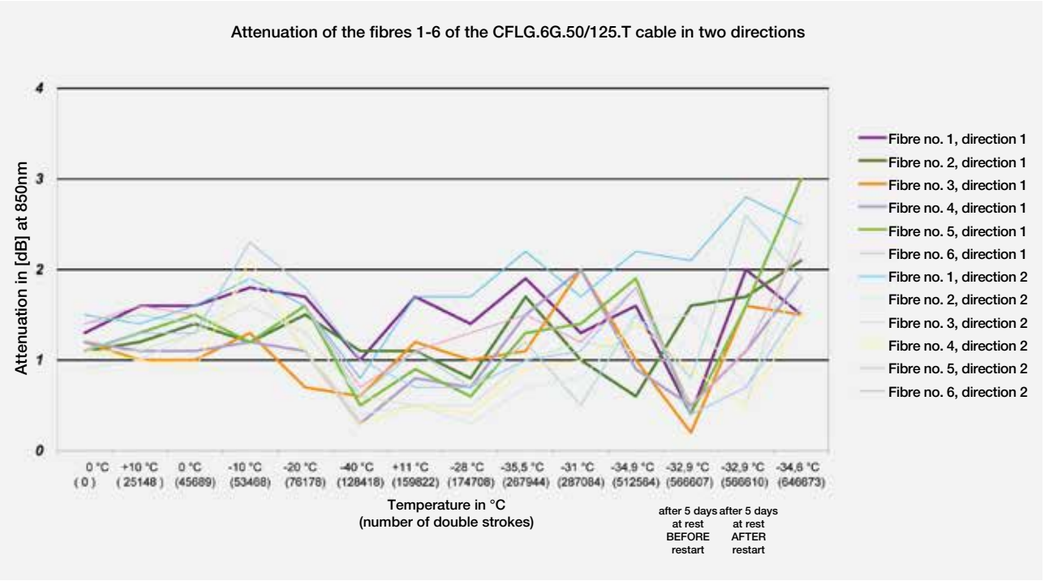
The sensitive glass fibres are carried in a gel-filled tube. How does the gel behave in highly dynamic conditions and what happens in restarts after long downtimes? As no precise information about this could be found in relevant technical journals, and as little was known particularly about the thermal features of the gel, igus® undertook its own tests to determine the reliable specifications for applications in e-chain systems®. To carry out this task, the igus® test laboratory was equipped with a cold chamber that can generate constant temperatures of -40 °C and a test facility was created for long travels up to 7 m with a speed of 1.6 m/s and an acceleration up to 6 m/s². The igus® graded index glass-fibre cable CFLG.6G.50/125.TC was tested with a length of about 15 m as loop within an igus® e-chain system® 3500.125.200.0 with a bend radius of 200 mm. Varied and extreme temperatures simulated environmental influences, particularly when the temperature plunged during downtimes from above freezing to -40 °C in a short time and the motion was restarted afterwards.

Under these application conditions, the attenuation of the cable was not permitted to rise above 3dB at 850nm wave length. After one million double strokes, which correspond to an operational performance of about 7,000 kilometres, the maximum attenuation was reached and remained significantly below 3dB.

The measurements highlighted in the diagram reveal that variations in temperature combined with the constant movement in the e-chain have only minor effects on the attenuation of the CFLG.6G.TC cable. The noticeable high initial attenuation is attributed to the plugs used and also reflects the reality here because, in practice, 90% of the cables used in automation are plugged fibre optic cables.

The test with the igus® cable makes it quite clear that only expensive and realistic tests can offer clarity about the service life of cables.

Product information CFLG.G
▶ Page 232



Example: ...tested!
Completely twisted

chainflex® cables for e-chain system® are designed for application in linear movements and their efficiency has been proved a million times.

But industrial applications and their motion sequences are becoming increasingly complex, so that special cables are needed more and more for torsional movements. The service life of the different designs are even harder to calculate for torsion applications, as there are no fixed parameters such as radii, travels etc. Shielded cables however are particularly vulnerable in torsion applications. Braided shields are generally braided in the opposite directions. Whether a cable survives the torsional demands is very strongly dependent on the application and type of installation.

Unshielded cables, particularly bundled chainflex® types, can be successfully used in many twisted applications.
In twisting movements with a braided shield, the strand wires wound in one direction are in tension and the other direction in compression. This leads quickly to shield breakage.

PVC | iguPUR | PUR | **TPE**

Spindle cable/Single core | TPE

10 million
Double strokes guaranteed

10 x d
Bend radius, e-chai

- For torsion applications
- TPE outer jacket
- Shielded
- Oil and bio-oil resistant
- PVC-f
- UV-re
- Flame
- Hydrc

Dynamic information
- Bend radius
- Temperature
- v max.
- a max.
- Travel distance
- Torsion

Cable structure
- Conductor
- Core insulation
- Overall shield
- Outer jacket

Electrical information
- Nominal voltage
- Testing voltage

At igus®, the emphasis is not only on technology but also on aesthetically designed products. The TRC and TRE series both received the iF-Design-Award.

Product information CFROBOT
▶ Page 404

The igus® development of a new twistable, shielded single core cable accounts for this and ensures, due to its special shield design and structure, that no, or absolutely minimal, forces act on the shield wire.

As the test clearly shows, massive service life extension can be observed when compared, for example, to a CF310.250.01.

Test setup:
The new CFROBOT cable was tested at the igus® laboratory in a specially developed torsion test rig.
The torsion angle is ±270° for a total cable length of about 2.5 m (tested within different versions of the triflex® R).

Cables tested were:
- **3 cables of CFROBOT.037**
- **3 cables of the series CF310.250.01.UL**
- **3 cables of the series CF310.250.01**

igus® test lab: The cables were tested in movements of ± 270°

The initial test sample of the CF310 with braided shield and the CFROBOT were taken after 250,000 movements with a torsion angle of ± 270°.

The cable dissection was undertaken in three areas of the cable length. In the sample illustrated in Picture 1, distinct damage to the overall shield is noticeable in the upper third of the cable.

Picture 1: Damaged overall shield sample of the braid version after 250,000 movements

The detail inspection of the shield braid shows damage on the shield strand wires.

The samples (picture 2) of the CFROBOT.037 (so far samples were taken after 250,000, 1.5 million and 3 million movements) showed no damage in the area of the cable or the overall shield even after above 3 million torsional movements of ± 270°.

Picture 2: The CFROBOT shows absolutely no damage after more than 3 million movements

The detailed analyses (picture 3) of the shield wires, buffer fibres, PTFE film and the cable show no damage. The test is being continued further to determine the maximum service life of the cable.

Picture 3: Detail pictures of the CFROBOT after more than 3 million movements of ±270°

Example: tested live! Container crane with 50m travel distance

In the crane engineering industry, energy supply systems are increasingly proving their technical and economic benefits.Flexibility, variability, and space-saving installation are just a few of the important criteria. An important building block of an energy supply system is the cable. Here, users expect a high degree of operational reliability.

In the chainflex® laboratory, igus® cables undergo constant testing which can be used to obtain important information on the service life of a cable and to develop improvements for the future structural design of the cable. However, the situation becomes very exciting if you get the rare opportunity to remove cables from their tough, real-life applications and inspect them.

Current inspection
The chainflex® cable CF9.60.05 has been used in container cranes for many years; in the case here with a total travel distance of approx. 47m.
An inspection contract commissioned by the owner-operator was to present a performance balance sheet after more than 40,000 chain kilometres and determine the date for which the next preventive maintenance work should be planned.

Following the removal of the CF9.60.05, inspections were performed with the following objectives:
1. outer jacket, abrasion behaviour, other damage;
2. overall structure, insulation behaviour of the individual cores;
3. strand wire structure, number of any individual broken wires which might be an indication of an early failure of the entire cable.

An igus® energy supply system with a length of approx. 26m in a stainless steel trough.

The energy chain system was filled with many different igus® chainflex® cables, including the CF9.60.05

Result regarding 1:
No or only barely measurable traces of abrasion could be detected on the highly abrasion-resistant TPE outer jacket. This means that a failure due to abrasion or jacket breakage, despite the extreme environmental factors (temperature differences, UV irradiation, etc.), is not expected.

Result regarding 2:
The overall structure showed no indications of fatigue and had not changed in its pitch length.
Due to the large amount of talc, no abrasion was observed between the TPE-insulated cores. The high-voltage tests did not show any age-related changes.

Result regarding 3:
The cable was opened all the way to the copper conductor in the most stressed section of the radius. Here too, after more than 40,000 km, the inspection of the individual strand wires also showed no fatigue breakages which would indicate an early failure of the cable.

To sum up, it can be said that this cable, which was used in a real crane application in the trolley of an STS crane, was still completely intact even after more than 40,000 km and that preventive repair work was not required.

Product information CF9
▶ Page 114


An igus® energy supply system with a length of approx. 26m in a stainless steel trough.


The individual elements of the CF9 from the dissected cable.


A close-up of the completely intact copper conductor. The inspection performed over the entire length shows that the conductor is still completely intact and does have any individual strand wire breakages.

Example: ...tested!
Comparison of jacket materials exposed to different oils

For years now, specially developed tests tailored to the individual requirements of igus® customers have been used to obtain more meaningful results than if standard tests were used. The relatively general terms such as "oil-resistant" or "coolant-resistant" are little help in making the right selection in terms of jacket material to be used for an application with oil, lubricant or coolant influence.

Alongside the generally applicable tests according to e.g. DIN EN 60811-2-1 and IEC 60811-1-1, "everyday application conditions" are simulated as realistically as possible in a test set-up matching our customers' requirements. Thus, for example, test samples are mounted in an energy chain that moves into an "oil bath" and then back out of it again. There is direct and alternating contact between the outer jacket and the medium to be tested and the air surrounding the energy chain and cable - just as in a real application.

After a test duration for a customer application or defined according to the igus® standard, test samples can be examined for changes in material characteristics e.g. by comparing material strength, elongation at tear and swelling with the values noted before the test started.

In this way, customers not only get a statement about the different resistance of the various materials such as given by following the above-mentioned standards, but also an estimation of the real service life of the cable in an e-chain® in these conditions.

If the test samples - such as the cables shown - do not complete the prescribed test duration, we advise against use in the respective application.

Cracks in the outer jackets of materials from competitors caused by the use in e-chains®.

Example: ...tested!
Completely twisted, take two.

The "torsion-resistant" requirement for cables for energy chains is not new, but is seldom exactly defined. So how is a statement such as "This cable is torsion-resistant up to ±180 °" to be understood? This makes it all the more important to be able to deliver comparable and meaningful test results.

In order to satisfy this requirement, the "torsion test bench" was developed according to the igus® standard. Here, various cable types are twisted to a prescribed cable length of 1 metre, which also corresponds to the distance between the fixed points. The degree of torsion can be chosen, and is defined individually according to the test requirement, and the standard test is ±180 °.

After a prescribed number of double strokes or a negative electrical or mechanical test result, the test specimen is dissected, and the type and position of any damage can be exactly determined.

The first chainflex® CFROBOT cable types were developed to series with help of the data of these tests.

Product information CFROBOT
▶ Page 404

The "torsion test bench" developed according to the igus® standard

Information | **DIN 47100 colour code**

DIN 47100 colour code (however, deviating from DIN: without colour repetition after 44th core)*

1	white
2	brown
3	green
4	yellow
5	grey
6	pink
7	blue
8	red
9	black
10	violet
11	grey-pink
12	red-blue
13	white-green
14	brown-green
15	white-yellow
16	yellow-brown
17	white-grey
18	grey-brown
19	white-pink
20	pink-brown
21	white-blue
22	brown-blue
23	white-red
24	brown-red
25	white-black
26	brown-black
27	grey-green
28	yellow-grey
29	pink-green
30	yellow-pink
31	green-blue
32	yellow-blue
33	green-red
34	yellow-red
35	green-black
36	yellow-black
37	grey-blue
38	pink-blue
39	grey-red
40	pink-red
41	grey-black
42	pink-black
43	blue-black
44	red-black
45	white-brown-black
46	yellow-green-black
47	grey-pink-black
48	red-blue-black
49	white-green-black
50	brown-green-black
51	white-yellow-black
52	yellow-brown-black
53	white-grey-black
54	grey-brown-black
55	white-pink-black
56	pink-brown-black
57	white-blue-black
58	brown-blue-black
59	white-red-black
60	brown-red-black
61	black-white

*Exception: 4-core cables are braided in the colour sequence white, green, brown, yellow.

The first colour indicates the basic colour of the core insulation, and the second colour indicates the colour of the printed-on ring. In the case of three colours, the second and colours are printed on the basic colour.

Information | **Copper price**

Calculation of the copper surcharge

The copper surcharge is the calculation of the difference between the calculated price (copper basis) and the actual price listed on the stock exchange of the copper share in a cable. In calculatory terms, the price of each chainflex® cable listed in the catalogue is based on a copper price to the amount of €150.–/100kg copper.

Calculation of the copper surcharge:

- LME[1] (London Metal Exchange) price in USD/ton
- ECB exchange rate, USD/euro
- Plus surcharges

[1] LME stands for London Metal Exchange.
Together with Shanghai and New York, it is one of the world's largest metal trading centres.This basis has been used in Europe for many decades to determine the copper price listed on the stock.

More Information online
▶ igus.eu/CF-copper

Calculate the copper surcharge online
The copper surcharge can be calculated directly for each chainflex® cable and individual length in our copper surcharge calculator on the igus® website:
▶ igus.eu/quickcopper

Copper wire dimensions according to Anglo-American AWG numbers

AWG No.	Diameter [mm]	Cross section [mm²]
500	17.96	253.00
350	15.03	177.00
250	12.70	127.00
4/0	11.88	107.20
3/0	10.40	85.00
2/0	9.27	67.50
1/0	8.25	53.50
1	7.35	42.40
2	6.54	33.60
4	5.19	21.20
6	4.12	13.30
8	3.26	8.37
10	2.59	5.26
12	2.05	3.31
14	1.63	2.08
16	1.29	1.31

AWG No.	Diameter [mm]	Cross section [mm²]
18	1.024	0.823
20	0.813	0.519
22	0.643	0.324
24	0.511	0.205
26	0.405	0.128
28	0.320	0.0804
30	0.255	0.0507
32	0.203	0.0324
34	0.160	0.0200
36	0.127	0.0127
38	0.102	0.00811
40	0.079	0.00487
42	0.064	0.00317
44	0.051	0.00203

Information | **Load-carrying capacity of cores**

	Control/data cables			Motor/servo cables			Single-core cables	
chainflex® type	CF5, CF6, CF2, CF150.UL, CF160.UL	CF880, CF881, CF130.UL, CF140.UL, CF890, CF891, CF240, CF211, CF884	CF77.UL.D, CF78.UL, CF9, CF10, CF9.UL, CF10.UL, CF98, CF98.PLUS, CF99, CF99.PLUS, CF112, CF11, CF12, CF298, CF299, CF894, CF113.D, CF111.D, CF11.D, CFROBOT2, CFROBOT3, CFROBOT9	CF885, CF886, CF30, CF31, CF887, CF897, CF210.UL, CF220.UL.H, CF21.UL , CF895, CF896	CFROBOT6, CFROBOT7	CF34.UL.D, CF35.UL, CF37.D, CF38, CF270.UL.D, CF280.UL.H, CF27.D, CF29.D	CF885, CF885.PE, CF886	CF270.UL.D, CF300.UL, CF310.UL, CF330.D, CF340, CFPE, CFROBOT
Insulation material	PVC	TPE	TPE	TPE/XLPE	TPE	XLPE	PVC	TPE
Loaded cores	2 or 3	2 or 3	2 or 3	2 or 3	2 or 3	2 or 3	1	1
Nominal cross section of copper core [mm²]	Load capacity [A]	Load capacity [A]	Load capacity [A]	Load capacity [A]	Load capacity [A]	Load capacity [A]	Load capacity [A]	Load capacity [A]
0.14	2.5	2.5	2.5	-	-	-	-	-
0.25	4	5	5	-	5	-	-	-
0.34	5	7	7	7	7	-	-	-
0.5	8	10	10	10	10	11	-	-
0.75	12	13	14	13	14	14	-	-
1	15	15	17	15	17	17	-	-
1.5	18	19	21	19	21	21	-	25
2.5	26	27	30	27	30	30	30	34
4	-	37	41	37	41	41	41	46
6	-	48	53	48	53	53	53	58
10	-	-	74	69	74	74	74	81
16	-	-	99	92	99	99	99	110
25	-	-	131	121	131	131	131	144
35	-	-	162	152	-	162	162	179
50	-	-	-	191	-	202	202	228
70	-	-	-	239	-	-	250	285
95	-	-	-	-	-	-	301	348
120	-	-	-	-	-	-	-	394
150	-	-	-	-	-	-	-	466
185	-	-	-	-	-	-	-	532
240	-	-	-	-	-	-	-	610
300	-	-	-	-	-	-	-	754
400	-	-	-	-	-	-	-	903

Table 1: Load-carrying capacity for chainflex® cables fixed or moving in e-chains® and e-tubes

Information | **Load-carrying capacity of cores**

The values in these tables have been taken from the standard DIN VDE 0298, Part 4. These values have been simplified and only apply approximately. For each application, it is advisable to obtain and comply with the regulations that apply to each individual case (e.g. measures for protection in case of indirect contact in accordance with DIN VDE 0100 Part 410, overcurrent protective devices in accordance with DIN VDE 0100 Part 430 or voltage drop in accordance with DIN VDE 0100 Part 520). It is not possible to provide all the regulations or overviews in this catalogue. Due to the harmonisation that has been carried out, it is possible that different load-carrying values may be permissible for the same cable in some cases. For the selection of the relevant cross section, the load capacity in undisturbed operation is the determining factor, i.e. the use with permissible operating temperature or permissible maximum temperature on the core.
The load-carrying capacity according to **Table 1** applies to operating-current-carrying cores.

Ambient temperature [°C]	Conversion factor	
	PVC insulation	TPE /XLPE insulation
10	1.22	1.15
15	1.17	1.12
20	1.12	1.08
25	1.06	1.04
30	1.00	1.00
35	0.94	0.96
40	0.87	0.91
45	0.79	0.87
50	0.71	0.82
55	0.61	0.76
60	0.50	0.71
65	–	0.65
70	–	0.58
75	–	0.50
80	–	0.41
85	–	0.29
90	–	0.14

Table 2: Conversion factors in case of varying ambient temperature

Normally, these are 2 loaded cores in the case of 2-core and 3-core cables, as well as 3 loaded cores in the case of 4-core and 5-core cables. Please take this into account when planning for the use of multi-core cables in electrical installation conduits or energy chains. This information is based on an ambient temperature of 30°C and a non-loaded cable. Please apply the conversion factors according to **Table 2** if the air temperature is increased due to the heat loss of the cables (please take thermal radiation into account as well, e.g. effects of exposure to the sun).

The possible cable installation types in energy chains result in such a broad range of loading profiles that no generalised conversion factors can be offered for this large range of cables. The installation type and the conversion factors must be taken from **Table 3**, according to each individual application.

Loaded cores	Conversion factor
5	0.75
7	0.65
10	0.55
14	0.50
19	0.45
24	0.40
40	0.35
61	0.30

Table 3: Conversion factors for multi-core cables with cable cross sections up to 10 mm²

Chemical resistance | **Selection chart**

Group	chainflex® cable	Jacket material	1	2	3	4	5	Page
Control cables								
Control cable	CF880	PVC	1					58
Control cable	CF881	PVC	1					62
Control cable	CF130.UL	PVC	1					66
Control cable	CF140.UL	PVC	1					70
Control cable	CF150.UL	PVC		2				74
Control cable	CF160.UL	PVC		2				78
Control cable	CF5	PVC		2				82
Control cable	CF6	PVC		2				86
Control cable	CFSOFT1	PVC		2				90
Control cable	CFSOFT2	PVC		2				92
Control cable	CF890	iguPUR			3			94
Control cable	CF891	iguPUR			3			98
Control cable	CF77.UL.D	PUR				4		102
Control cable	CF78.UL	PUR				4		106
Control cable	CF2	PUR				4		110
Control cable	CF9	TPE					5	114
Control cable	CF10	TPE					5	118
Control cable	CF9.UL	TPE					5	122
Control cable	CF10.UL	TPE					5	126
Control cable	CF98	TPE					5	130
Control cable	CF99	TPE					5	132
Control cable	CF98.PLUS	TPE					5	134
Control cable	CF99.PLUS	TPE					5	138
Data cables								
Data cable	CF240	PVC		2				146
Data cable	CF240.PUR	PUR				4		152
Data cable	CF211	PVC		2				154
Data cable	CF211.PUR	PUR				4		158
Data cable	CF11	TPE					5	162
Data cable	CF112	PUR				4		166
Data cable	CF12	TPE					5	170
Data cable	CF298	TPE					5	172
Data cable	CF299	TPE					5	174
Data cable	CFKoax	TPE					5	176
Bus cables								
Bus cable	CF888	PVC	1					188
Bus cable	CFBUS.PVC	PVC		2				192
Bus cable	CF898	iguPUR			3			196
Bus cable	CFBUS.PUR	PUR				4		200
Bus cable	CFBUS	TPE					5	204
Bus cable	CFBUS.LB	TPE					5	210
Fibre Optic Cables								
Fibre Optic Cable	CFLK	PUR				4		220
Fibre Optic Cable	CFLG88	PVC	1					222
Fibre Optic Cable	CFLG.LB.PUR	PUR				4		224
Fibre Optic Cable	CFLG.LB	TPE					5	228
Fibre Optic Cable	CFLG.G	TPE					5	232
Measuring system cables								
Measuring system cable	CF884	PVC	1					242
Measuring system cable	CF211	PVC		2				246
Measuring system cable	CF894	iguPUR			3			252
Measuring system cable	CF111.D	PUR				4		256
Measuring system cable	CF113.D	PUR				4		262
Measuring system cable	CF11.D	TPE					5	268

Chemical resistance | **Selection chart**

Group	1	2	3	4	5
Inorganic chemicals					
Aqueous solutions, neutral					
Water	+	+	O	+	+
Common salt (10%)	+	+	O	+	+
Glauber's salt (10%)	+	+	O	+	+
Aqueous solutions, alkaline					
Soda (10%)	O	+	+	O	+
Aqueous solutions, acid					
Sodium bisulfate (10%)	O	+	+	O	+
Aqueous solutions, oxidising					
Hydrogen peroxide (10%)	+	+	O	+	+
Potassium permanganate (2%)	+	+	O	+	+
Inorganic acids					
Hydrochloric acid, concentrated	–	–	–	–	–
Hydrochloric acid (10%)	O	O	+	O	+
Sulfuric acid, concentrated	–	–	–	–	–
Sulfuric acid (10%)	O	O	+	O	+
Nitric acid, concentrated	–	–	–	–	–
Nitric acid (10%)	O	O	+	–	O
Inorganic caustic solutions					
Sodium hydroxide, concentrated	–	–	–	–	O
Soda lye (10%)	O	O	+	O	+
Caustic potash, concentrated	–	–	–	–	O
Caustic potash (10%)	O	O	+	O	+
Ammonia, concentrated	O	O	–	O	+
Ammonia (10%)	+	+	+	+	+
Organic chemicals					
Organic acids					
Acetic acid, concentrated (glacial acetic acid)	–	–	–	–	O
Acetic acid(10% in H_2O)	O	+	+	O	+
Tartaric acid (10% in H_2O)	O	+	+	+	+
Citric acid (10% in H_2O)	O	+	+	+	+
Ketone					
Acetone	–	–	–	–	O
Methyl ethyl ketone (MEK)	–	–	–	–	O
Alcohols					
Ethyl alcohol (spirit)	–	O	+	O	+
Isopropyl alcohol	–	O	+	O	+
Diethylene glycol	O	O	+	+	+
Aromatic compounds					
Toluol	–	–	–	O	–
Xylol	–	–	–	O	–
Fuels					
Gasoline	–	O	O	+	+
Diesel fuel	–	O	O	+	+
Synthetic oils					
Lubricating oil					
ASTM oil #2	O	+	+	+	+
Hydraulic oil					
Mineral oil base	–	O	+	+	+
Glycol base	O	O	+	+	+
Synthetic ester base	–	O	–	+	+
Vegetable oils					
Rapeseed oil	O	+	O	+	+
Olive oil	O	+	O	+	+
Soya bean oil	O	+	O	+	+
Cold cleaning agent					
Cold cleaning agent	–	O	+	+	O

\+ no or minimum negative influence
O medium reciprocal effect, short-term exposure permissible
– unstable, material partly destroyed

All information applies to room temperature

Chemical resistance | **Selection chart**

Group	chainflex® cable	Jacket material	1	2	3	4	5	Page
Servo cables								
Servo cable	CF887	PVC	1					280
Servo cable	CF210.UL	PVC		2				282
Servo cable	CF21.UL	PVC		2				286
Servo cable	CF897	iguPUR			3			290
Servo cable	CF270.UL.D	PUR				4		292
Servo cable	CF27.D	PUR				4		296
Servo cable	CF29.D	TPE					5	300
Servo cable	CF220.UL.H	PVC		2				302
Servo cable	CF280.UL.H	PUR				4		306
Motor cables								
Motor cable	CF885	PVC	1					318
Motor cable	CF886	PVC	1					320
Motor cable	CF210.UL	PVC		2				322
Motor cable	CF30	PVC		2				324
Motor cable	CF31	PVC		2				328
Motor cable	CF895	iguPUR			3			332
Motor cable	CF896	iguPUR			3			334
Motor cable	CF270.UL.D	PUR				4		336
Motor cable	CF27.D	PUR				4		340
Motor cable	CF34.UL.D	TPE					5	344
Motor cable	CF35.UL	TPE					5	348
Motor cable	CF37.D	TPE					5	352
Motor cable	CF38	TPE					5	354
Spindle cable/Single core	CF885	PVC	1					356
Spindle cable/Single core	CF885.PE	PVC	1					358
Spindle cable/Single core	CF886	PVC	1					360
Spindle cable/Single core	CF270.UL.D	PUR				4		362
Spindle cable/Single core	CF300.UL.D	TPE					5	364
Spindle cable/Single core	CFPE	TPE					5	366
Spindle cable/Single core	CF310.UL	TPE					5	368
Spindle cable/Single core	CF330.D	TPE					5	370
Spindle cable/Single core	CF340	TPE					5	372
Medium voltage cable	CFCRANE.PUR	TPE					5	374
Twistable cables								
Twistable cable	CF77.UL.D	PUR				4		384
Twistable cable	CFROBOT2	PUR				4		388
Twistable cable	CFROBOT3	PUR				4		390
Twistable cable	CFROBOT4	PUR				4		392
Twistable cable	CFROBOT5	TPE					5	396
Twistable cable	CFROBOT6	PUR				4		398
Twistable cable	CFROBOT7	PUR				4		400
Twistable cable	CFROBOT	TPE					5	404
Twistable cable	CFROBOT8	PUR				4		406
Twistable cable	CFROBOT8.PLUS	PUR				4		410
Twistable cable	CFROBOT9	PUR				4		414
Special cables								
Special cable	CFTHERMO	PUR				4		420
Special cable	CFFLAT	TPE					5	422
Special cable	CFSPECIAL.182	PUR				4		424
Special cable	CFSPECIAL.192	PUR				4		426
Special cable	CFSPECIAL.532	PUR				4		432
Special cable	CFSPECIAL.562.PE	PUR				4		434
Special cable	CFSPECIAL.572	PUR				4		436
Special cable	CFSPECIAL.592	PUR				4		438
Special cable	CFSPECIAL.792	PUR				4		440

Chemical resistance | **Selection chart**

Group	1	2	3	4	5
Inorganic chemicals					
Aqueous solutions, neutral					
Water	+	+	O	+	+
Common salt (10%)	+	+	O	+	+
Glauber's salt (10%)	+	+	O	+	+
Aqueous solutions, alkaline					
Soda (10%)	O	+	+	O	+
Aqueous solutions, acid					
Sodium bisulfate (10%)	O	+	+	O	+
Aqueous solutions, oxidising					
Hydrogen peroxide (10%)	+	+	O	+	+
Potassium permanganate (2%)	+	+	O	+	+
Inorganic acids					
Hydrochloric acid, concentrated	–	–	–	–	–
Hydrochloric acid (10%)	O	O	+	O	+
Sulfuric acid, concentrated	–	–	–	–	–
Sulfuric acid (10%)	O	O	+	O	+
Nitric acid, concentrated	–	–	–	–	–
Nitric acid (10%)	O	O	+	–	O
Inorganic caustic solutions					
Sodium hydroxide, concentrated	–	–	–	–	O
Soda lye (10%)	O	O	+	O	+
Caustic potash, concentrated	–	–	–	–	O
Caustic potash (10%)	O	O	+	O	+
Ammonia, concentrated	O	O	–	O	+
Ammonia (10%)	+	+	+	+	+
Organic chemicals					
Organic acids					
Acetic acid, concentrated (glacial acetic acid)	–	–	–	–	O
Acetic acid (10% in H_2O)	O	+	+	O	+
Tartaric acid (10% in H_2O)	O	+	+	+	+
Citric acid (10% in H_2O)	O	+	+	+	+
Ketone					
Acetone	–	–	–	–	O
Methyl ethyl ketone (MEK)	–	–	–	–	O
Alcohols					
Ethyl alcohol (spirit)	–	O	+	O	+
Isopropyl alcohol	–	O	+	O	+
Diethylene glycol	O	O	+	+	+
Aromatic compounds					
Toluol	–	–	–	O	–
Xylol	–	–	–	O	–
Fuels					
Gasoline	–	O	O	+	+
Diesel fuel	–	O	O	+	+
Synthetic oils					
Lubricating oil					
ASTM oil #2	O	+	+	+	+
Hydraulic oil					
Mineral oil base	–	O	+	+	+
Glycol base	O	O	+	+	+
Synthetic ester base	–	O	–	+	+
Vegetable oils					
Rapeseed oil	O	+	O	+	+
Olive oil	O	+	O	+	+
Soya bean oil	O	+	O	+	+
Cold cleaning agent					
Cold cleaning agent	–	O	+	+	O

\+ no or minimum negative influence
O medium reciprocal effect, short-term exposure permissible
– unstable, material partly destroyed

All information applies to room temperature

Design parameters | **Cable and hose packages**

Rules for:
- **Maximum cable diameters**
- **Separation**
- **Bend radius**

General rules for cables and hoses in e-chains®

Data and energy supply in all forms – in an energy chain system

The key advantage of an igus® e-chain system® is the safe accommodation of various forms of data cables and energy supply in one system. We recommend the optimal separation layout of the cables and hoses in the e-chain®, but you, the customer, are still afforded the final choice. It is possible, for instance, to maintain minimum distances between bus and motor cables and mix pneumatics, electric and hydraulics in the same compartments.

In addition to the quality of the cables used, the arrangement of each service within the e-chain® and the space allowed, are important for the service life of the system. Various separation options enable the adaptation of the e-chains® to the specific requirements of each respective application. Generalised rules such as "No more than 80% of the clear space of energy chains should be used" no longer make sense given the complexity of present-day applications. In this chapter, we give you detailed recommendations. Due to the variety of the application parameters, we strongly recommend you take advantage of our free consultation services.Simply give us a list of your cable requirements (or merely the required electrical or other services) and you will receive our recommendation.

Hydraulics and electric cables are separated from one another in this example

Well ordered cables with igus® interior separation

Maximum cable and hose diameters

The maximum cable and/or hose diameter corresponds to the inner height of the selected e-chain®/e-tube, with additional minimum clearance. This minimum clearance would be, for example, 10% for round electrical cables, 20% for hydraulic hoses. An e-chain® is ideal if a minimum lateral gap to the next cable or hose has been factored in. Depending on the nature of the cables, the dynamics, and the expected service life, more clearance must be allowed. In specific cases, clearances may be altered further. Please contact us.

Electrical cables need at least 10% clearance space all around, hydraulic hoses need 20%

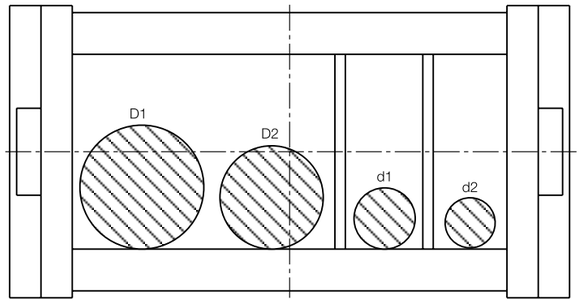
The maximum cable diameter is specified for each series in its respective chapter

Design parameters | **Cable and hose packages**

Designing with igus®

Distribution in e-chains®

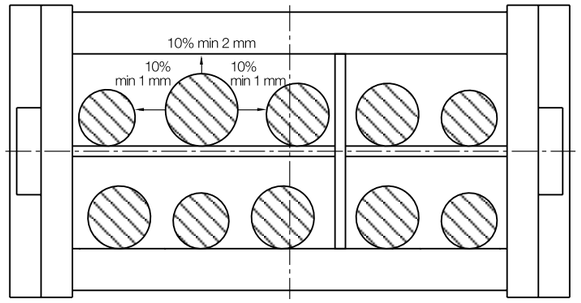
- Cables and hoses with very different diameters should be laid separately. The separation is achieved using modular separators.
- Cables and hoses must under no circumstances have the opportunity to tangle. Therefore, the clearance height of a compartment with several similar cables or hoses next to one another must **not amount to more than one and a half times the cable/hose diameter.**



D1 + D2 > 1.2 x hi **d1 + d2 ≤ 1.2 x hi**

Expressed in rules, this means:

Rule 1:
If D1 + D2 > 1.2 x e-chain® inner height, no separation between the two cables/ hoses is necessary. Two cables/ hoses should never be left unguided on top of one another or be allowed to become tangled.



d1 + d2 ≤ 1.2 x hi

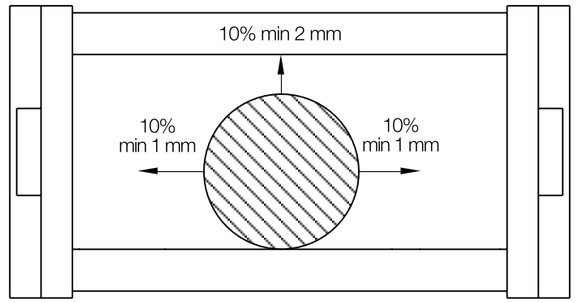
Rule 2:
if d1 + d2 ≤ 1.2 x e-chain® inner height, a vertical separator or a horizontal shelf must be used to reduce the inner height. Thereby preventing the entanglement of d1 and d2.

The reason for this rule is:
The cables and hoses must be laid so that they can move freely at all times and so that no tensile force is exerted at the radius of the e-chains®.

For high-speed applications and high cycles, cables or hoses **must not be laid on top of each other without horizontal separation**. The standard values for this are:

Travel speed over **0.5m/s** and cycles over **10,000 p.a.**

igus® interior separation offers a safe solution for this situation.



Clearance space for round electrical cables

Clearance space in % for various cables

Cables	Clearance space
Round electrical cables	**10%**
Electrical flat cables	**10%**
Pneumatics	**5-10%**
Hydraulics	**20%**
Media hoses	**15-20%**

Design parameters | **Cable and hose packages**

Further guidelines for distribution

- The cable weight should be symmetrically distributed across the width of the e-chain®.
- Cables with different outer jacket materials must not be allowed to rub together. If necessary, they must be laid separately. All igus® chainflex® cables can be combined with each other and other brands of cables.
- The cables should always be fixed at the moving end. The fixed end should also always have strain relief. Exceptions are made only for certain hydraulic hoses with length compensation issues or other high pressure hoses. (refer to "hydraulic hoses").
- Generally, the faster and more frequently the e-chain® operates, the more important the exact positioning of the cables and hoses inside the e-chain® becomes. Due to the wide variety of the possibilities, we strongly recommend you take advantage of our free consultation services for your specific applications.

Bend radius R

- The bend radius of your e-chain® depends on the thickest or stiffest cable or hose in your application.
- The bend radii of the e-chains® should be adjusted to the recommendations of the cable or hose manufacturer. The selection of a larger radius than the minimum will positively affect service life.
- The specification of minimum bend radii for cables refers to use at normal temperatures. Other bend radii may be recommended. Please ask your cable supplier for details.

The igus® construction kit of energy chain systems solves all the requirements for interior separation known today.

igus® chainflex® cables permit the smallest bend radius of 5 x d for one million strokes.

The igus® product range offers up to 12 different bend radii for each chain series from stock. Here series 50 in the Storebaelt bridge project.

We recommend complete e-chain systems®, - where bend radii for all cables and hoses, interior separation and service life are optimally matched. Also ask for the igus® system guarantee. ▶ readychain® **from page 910**

Design parameters | **Round electrical cables**

Round electrical cables

For electrical cables, the round cable is a safe, modular and cost-effective solution for e-chain systems®. We recommend the following criteria for selecting the proper round electrical cables:

Selection criteria:

- Small minimum bend radii and mounting heights
- Long service life at minimum bend radius
- Service life expectations for your application (short or long travel, hanging)
- Test data on service life from realistic tests
- Uncomplicated installation process - no hanging, laying out, etc, of cables required
- Strain relief integrated directly into the mounting bracket
- Flexible shields for shielded cables
- Abrasion-resistant and non-adhesive outer jackets
- Large selection to avoid expensive custom designs

For bus cables and fibre optic cables, special attention must be paid to how effective transmission rates and shielding remain after millions of cycles at the minimum bend radius.

Example at igus® test laboratory: constant development and testing of chainflex® cables

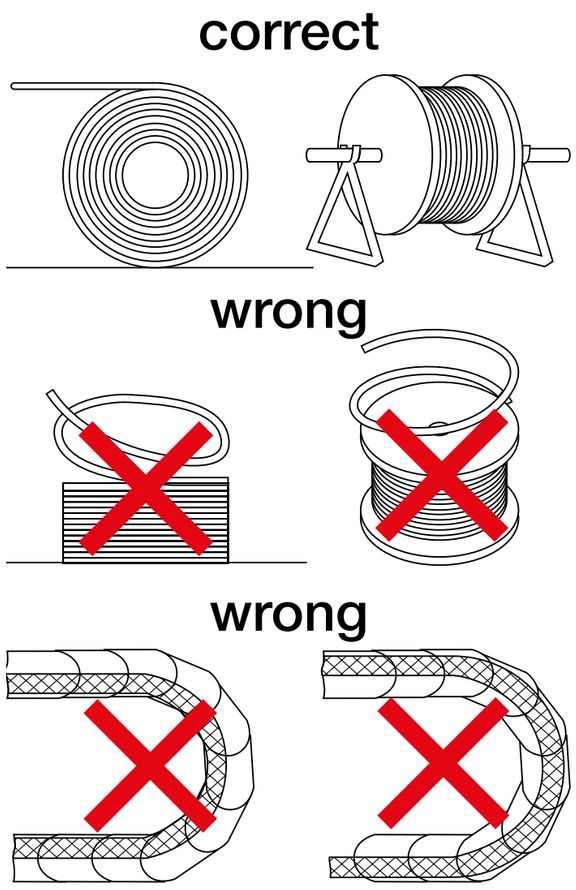
Design parameters | **Round electrical cables**

Installation and strain relief of round electrical cables

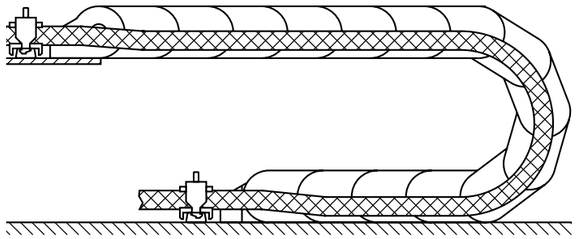
1. The cables must be laid straight, without twisting. Cables must not be uncoiled from the top of the spool. igus® chainflex® cables are immediately ready for fitting directly into the e-chain®. They need not be disconnected or laid out before installation.
2. The cables must be laid so that each individual cable can move freely from side to side.
3. The cables must be able to move freely along the radius. This must be double-checked if the upper run operates at the cable's maximum bend radius.
4. The division of the e-chains® interior using igus® interior separators or shelves is necessary if several cables and/or hoses with varying diameters are laid out. It is important to prevent cables and hoses from tangling.
5. For cables and hoses with different jacket materials, it is important to prevent them from "sticking" to one another. If necessary, they should be separated. igus® chainflex® cables can be combined with all others.
6. Round electrical cables must be secured with strain relief at both ends. In exceptional cases, the cables may be fixed with strain relief at the moving end of the e-chain® only. A gap of 10-30 x cable diameter between the end of the bend segment and the fixed point is recommended for most cables. chainflex® cables can, on the other hand, be secured directly to the mounting bracket with strain relief (this has been confirmed with testing).

We will be pleased to provide you with recommendations for complete e-chain systems®:
"readychain®: chain-cable harnessing".

▶ readychain® **from page 910**



The cables must be able to move freely along the radius



chainflex® cables can be strain-relieved directly at the mounting bracket.

Corkscrewing: an effect of improper cable and hose placement in an e-chain®

Design parameters | **Pneumatic hoses**

Pneumatic hoses

In principle, the same rules apply for pneumatic hoses as for round cables. In practice, it has been demonstrated that pneumatic hoses are less susceptible to wear. After consultation, they can be laid together more closely than the "10% all-around clearance" rule. A double-sided strain relief is required under these conditions. For pneumatic hoses made of rubber, we recommend strictly following the "10% clearance" rule because they tend to adhere to each other and to other cables and hoses.

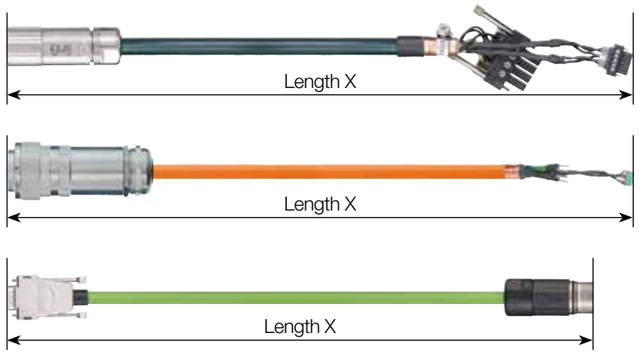
Fully pre-assembled e-chain system® with several pneumatic and hydraulic hoses.

The igus® product range also offers thermo polymer pneumatic hoses called "chainflex® CFAir and CFCleanAir" ▶ **Page 462**

Design parameters| **Definition of length**

Harnessed cables

igus® GmbH defines cable length as entire length including connectors or open harnessing.
Further length definitions possible on request. Feel free to contact us!



Welcome to the world ...

The chainflex® approvals and their significance:
www.igus.eu/chainflex-certificates

UL Marketing Claim Verification

Today, plant safety or availability can be the decisive reason to choose one machine over another.
As the complexity of the machines and number of electrical parts increases, the difficulty for designers to choose the best product also increases.
This is not helped by the fact that there is a lot of marketing information given, which is not norm based, and therefore difficult for the designer to verify the facts.
This is where the UL Marketing Claim Verification initiated by UL will help the designer.
This is because UL checks the marketing statements of the supplier for the technical data and accuracy.

The UL verified label now proves that the guarantee and quality statements for chainflex® cables and their durability, service life and functionality have been certified by UL. For companies that use these cables in their equipment, they offer more safety from purchasing parts for machine construction, customs clearance and shipping of the machines to America, right through to commissioning. Those who use chainflex® cables in energy chains can have confidence in terms of parameters such as temperature, type of movement, torsion, media influence or minimum bend radius.

The complex certification procedure (diagram 1) for the "igus® 36-month chainflex® cable guarantee and service life calculator based on 2 billion test cycles per year" claim, was carried out by auditors of the US institute at the igus® HQ in Cologne.

To achieve this, the processes and logic of service life determination were evaluated in a comprehensive audit program of the 3,800 m² chainflex® test laboratory, which has over 800 parallel running tests and over 2 billion test cycles per year.

The following four areas were scrutinised:

Figure 1: The complex process to get the UL marketing certificate (source: igus®)

More details online:
verify.ul.com/verifications/368

More information:
www.igus.eu/chainflex-welcome-to-the-world

UL listed

Cables for applications that can be fully described in a standard are certified as "UL Listed". Example: A cable for a washing machine power supply can be clearly described for its application; therefore a normative description of the application of the cable and the associated test setup can be clearly defined. To certify that the cable is in accordance with "UL Listed" and then to manufacture, test and mark according to "UL Listed". It is not permissible to use a different kind of cable in such a clearly described application in the USA.

UL/CSA Recognized

The "UL/CSA Recognized" certification marks are issued for components of larger systems. In this case, only components that are not intended for a single, precisely defined installation or application are certified.
Cables for applications that cannot be described normatively and completely are then certified according to "UL/CSA Recognized" (AWM).

Example: Cables for use in energy chains are so diverse and complex that a normative description is impossible. This is where the " UL/CSA Recognized" certification is applicable. It allows cable developers a whole range of different combinable options with respect to insulation material, jacket material and design. From this cable manufacturers develop a combination that works, which means that it can be used for a specific customer application.

Be aware: "UL/CSA Recognized" describes a large, extremely varied range of applications. Here, it is the responsibility of the designer and manufacturer of such an "AWM cable" to work out and carry out appropriate additional tests to prove a specific application, e.g. in an energy chain.

UL

The institution responsible for approval in the USA is Underwriters Laboratories (UL). The Canadian Standards Association (CSA) is responsible for it in Canada. Certification guidelines and certification processes differ in their complexity, depending on the market and country. A so-called Memorandum of Understanding allows use in both countries, regardless of the place of certification. Both testing organisations distinguish between the so-called "UL/CSA Listed" and "UL/CSA Recognized" certification, both of which fulfil normative safety requirements that are verified by test procedures.

More details online:
iq.ul.com/

More information:
www.igus.eu/chainflex-welcome-to-the-world

NFPA

The US **N**ational **F**ire **P**rotection **A**ssociation (NFPA), is a non-profit organisation that has been active in fire protection since 1896.
NFPA publishes numerous safety standards including electrical standards that are used in the USA today.
These include the "NFPA 79 - Electrical Standard for Industrial Machinery". The subject of the standard is primarily the correct application of electrical systems in industrial machinery and equipment used in the USA. With the help of the standard, designers can develop safe machines with the highest level of protection for operating personnel.
NFPA 79-2018 includes the topic "*Special Cables and Conductors*" relevant for chainflex cables in section 12.9.

More details online:
www.nfpa.org/

CLPA

The **C**C-**L**ink **P**artner **A**ssociation is an organisation based in Japan and represented in 11 regions of the world.
The purpose of CLPA is to spread and establish the industry network "CC-Link" standard worldwide.
In addition to the marketing of this standard, CC-Link products that are to be used for this standard are tested by this organisation and, if they are technically compliant with the corresponding certificates, are approved for use in CC-Link networks.

More details online:
www.cc-link.org/sch/c012List?userSeqNo=76&menuSeqNo=2

DNV approval

The maritime economy is developing towards more automation and digitalisation: Whether vessel manufacture, shipping companies or the gas and oil industry - ships are becoming autonomous factories, shipping companies are becoming fully-fledged logistics providers, and refineries are becoming automated conveyor systems.
DNV is responsible for certifications in the maritime environment, offshore facilities, gas and oil pipelines, and onshore applications such as wind, tidal or solar energy. The classification society was formed in 2012 through the merger of the Norwegian company Det Norske Veritas (DNV) and Germanischer Lloyd (GL).
The components used in maritime environments have to meet different requirements than those of classic factory automation on land.
This requires a separate approval for the operation of these components. The certification society checks compliance with international standards and guidelines, which are applied accordingly to these components. If existing regulations or standards do not describe the application sufficiently, additional testing measures are defined or developed.

If products have DNV approval, it simplifies and speeds up their use in the maritime sector, as it is not necessary to test individual components.

More details online:
www.dnv.com

More information:
www.igus.eu/chainflex-welcome-to-the-world

EAC certificates

EAC (Eurasian Conformity) is a testing standards that is binding for components to be exported to Russia. The proof of compliance with fire protection regulations for Russia, Kazakhstan and Belarus (previously covered by CTP), is now integrated in the EAC certificates. The certifications were introduced after Russia's accession to the World Trade Organisation (WTO) in 2012. They replace the so-called GOST certifications.

The EAC certification is for export products and provides proof that the products conform to the technical requirements of the customs union of Russia, Belarus and Kazakhstan. Without this verification, imports into the customs union are prohibited.
The EAC follows the Russian machinery directive TR-753, which previously had to be taken into account when exporting to the Eurasian economic area.

Prior to certification, companies must submit an application to an accredited certification body in the EAWU (Eurasian Economic Union).
The application includes:

- Detailed product description
- Product designation
- Customs tariff code
- {0}Technical pass
- Security review
- Operating instructions
- Technical drawings
- Technical data sheet
- Test reports
- Already existing certificates: ISO, DIN, CE

The certificate/approval document for a product must generally be available in Russian and in the local language.

If products have EAC and CTP certification, this speeds up their release at customs and thus enables fast and uncomplicated import into the destination country of the customs union.

More details online:
www.eaeunion.org/?lang=en#info

More information:
www.igus.eu/chainflex-welcome-to-the-world

REACH directive

The term REACH stands for a regulation called **R**egistration, **E**valuation, **A**uthorisation and Restriction of **Ch**emicals.

Its scope covers manufacturers or importers of more than one tonne of substances per year into the European Union.

The REACH directive is only partially valid for igus®: As a manufacturer of cables, the company is defined as a so-called "downstream user" with regard to the value add chain. Nevertheless, the contents of the REACH directive and its rules for the production and processing of chemical substances are observed at igus®. For example, no chemicals are used in the production of chainflex® cables that are above the valid REACH limits. The entire range of chainflex® cables is free from materials such as sodium peroxometaborates, cadmium sulphides or also dihexyl phthalates.

More details online:
echa.europa.eu/de/regulations/reach/understanding-reach

RoHS-II / RoHS-III

More safety for people and the environment

The abbreviation RoHS stands for **R**estriction **o**f **H**azardous **S**ubstances and regulates the use of selected hazardous substances in electrical and electronic equipment, which includes cables. By complying with this directive, companies prove that problematic materials such as lead, mercury or phthalates - known as plasticisers - have been banned from electronic waste and also from working environments. One example is lead. It occurs, among other things, in the form of solder on circuit boards, which are installed in complex machine systems in a variety of ways.

Materials research in recent years has also produced new jacket materials which, among other things, do not contain hazardous plasticisers and thus function flexibly in dynamic applications. Until now, plasticisers have been used in industry mainly where plastics had to remain particularly pliable, soft and elastic in use.

igus® develops and tests special jacket materials for use in e-chains in its own laboratory, which are RoHS II /III compliant according to the respective requirements.

More details online:
ec.europa.eu/environment/waste/rohs_eee/legis_en.htm

CE mark

The CE marking makes it clear that the manufacturer of a product such as chainflex® cables complies with the applicable EU directives. The CE marking is not a seal of approval or quality mark and was created for trade in the European Economic Area.

- The CE certification basis has come to encompass more than 25 EU directives (issue 2020).
- The CE certificate is a kind of voluntary commitment.
- The CE mark on a machine and the corresponding signature confirms that this machine was planned, designed and built in accordance with the applicable standards.
- The CE marking is part of further regulations. These include the Machinery Directive, the Electromagnetic Compatibility (EMC) Directive, the Low Voltage Directive (often referred to as LVD), RoHS substance restrictions and protective equipment, etc.

CE conformity is based on a complex risk assessment.

Risk assessment - the iterative procedure consists of:

- Verification of the intended use of e.g. e-chain® and chainflex® cables
- Analysis of conceivable, foreseeable misuse
- Determination of relevant and valid standards for the production of chainflex® cables and e-chains®
- Determination of specific requirements and conditions for the use of chainflex® cables
- Research of the responsible "notified body", e.g. at the accreditation body DAkkS (Institute for the monitoring of all certification, testing and inspection bodies)
- (Laboratory) tests of the chainflex® cables and e-chains®
- Data evaluation
- Preparation of technical documentation and translation into target languages
- Creation of the certificate/provision for download
- Attaching the CE mark

More details online:
c.europa.eu/growth/single-market/ce-marking_de

More information:
www.igus.eu/chainflex-welcome-to-the-world

UKCA

Like CE marking, UKCA marking ("United Kingdom Conformity Assessed") is a marking requirement for certain technical products.
With this marking, the manufacturer declares that the products are manufactured according to the applicable directives or regulations of the "United Kingdom". UKCA marking is not a seal of approval or sign of quality and was created for trade with the "United Kingdom". Technical details and further regulations in this regard are still being developed by the English government and trade associations.

Technical details and further regulations in this regard are still being developed by the English government and trade associations.
As a result of the national development of product regulations, it is possible that there will be product requirements that differ from those of the EU and must be complied with by manufacturers and importers wishing to place products on the market in the United Kingdom.

All information: As at 08/2021.

Information | **Approvals and standards**

igus® chainflex® cables for DESINA

DESINA: **DE**central and **S**tandardised **IN**st**A**llation technique is a recommendation of the Verein Deutscher Werkzeugmaschinenfabriken (VDW = Association of German machine tool industry) for the purpose of standardising components, interfaces and connecting systems.
DESINA describes an extensive whole concept for standardisation and decentralisation of the fluid technical and electrical installation of machines and plants.
For further information: www.desina.de

Det Norske Veritas Germanischer Lloyd

For further information: www.dnvgl.com

Underwriters Laboratories Inc.

For further information: www.ul-europe.com

Canadian Standards Association

For further information: www.csa.ca

Commission Électrotechnique Internationale

Communauté Européenne

EurAsian Conformity

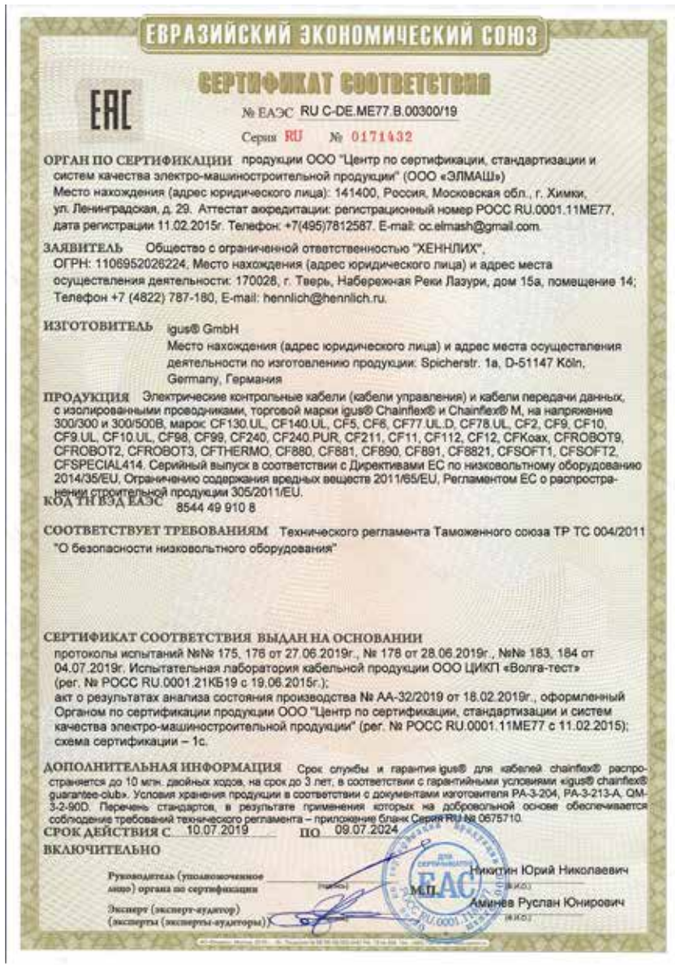
Information | **Approvals and standards**

chainflex® cables now certified for the Russian market

igus® chainflex® cables are now certified for Russia, Belarus and Kazakhstan.
These certificates replace the outdated GOST certificates.

EAC

Certified according to the standards of the technical regulations of the customs union
Nr. RU C-DE.ME77.B.01218 (TR ZU)
Nr. RU C-DE.ME77.B.02324 (TR ZU)
Nr. RU C-DE.ME77.B.02806 (TR ZU)
Nr. RU C-DE.ME77.B.00295/19
Nr. RU C-DE.ME77.B.00300/19
Nr. RU C-DE.ME77.B.00302/19



ЕВРАЗИЙСКИЙ ЭКОНОМИЧЕСКИЙ СОЮЗ

СЕРТИФИКАТ СООТВЕТСТВИЯ

EAC

№ ЕАЭС RU C-DE.ME77.B.00300/19

Серия RU № 0171432

ОРГАН ПО СЕРТИФИКАЦИИ продукции ООО "Центр по сертификации, стандартизации и систем качества электро-машиностроительной продукции" (ООО «ЭЛМАШ»)
Место нахождения (адрес юридического лица): 141400, Россия, Московская обл., г. Химки, ул. Ленинградская, д. 29. Аттестат аккредитации: регистрационный номер РОСС RU.0001.11ME77, дата регистрации 11.02.2015г. Телефон: +7(495)7812587. E-mail: oc.elmash@gmail.com.

ЗАЯВИТЕЛЬ Общество с ограниченной ответственностью "ХЕННЛИХ", ОГРН: 1106952026224, Место нахождения (адрес юридического лица) и адрес места осуществления деятельности: 170026, г. Тверь, Набережная Реки Лазури, дом 15а, помещение 14; Телефон +7 (4822) 787-180, E-mail: hennlich@hennlich.ru.

ИЗГОТОВИТЕЛЬ igus® GmbH
Место нахождения (адрес юридического лица) и адрес места осуществления деятельности по изготовлению продукции: Spicherstr. 1a, D-51147 Köln, Germany, Германия

ПРОДУКЦИЯ Электрические контрольные кабели (кабели управления) и кабели передачи данных, с изолированными проводниками, торговой марки igus® Chainflex® и Chainflex® M, на напряжение 300/300 и 300/500В, марок: CF130.UL, CF140.UL, CF5, CF6, CF77.UL.D, CF78.UL, CF2, CF9, CF10, CF9.UL, CF10.UL, CF98, CF99, CF240, CF240.PUR, CF211, CF11, CF112, CF12, CFKoax, CFROBOT9, CFROBOT2, CFROBOT3, CFTHERMO, CF880, CF881, CF890, CF891, CF8821, CFSOFT1, CFSOFT2, CFSPECIAL414. Серийный выпуск в соответствии с Директивами ЕС по низковольтному оборудованию 2014/35/EU, Ограничению содержания вредных веществ 2011/65/EU, Регламентом ЕС о распространении строительной продукции 305/2011/EU.

КОД ТН ВЭД ЕАЭС 8544 49 910 8

СООТВЕТСТВУЕТ ТРЕБОВАНИЯМ Технического регламента Таможенного союза ТР ТС 004/2011 "О безопасности низковольтного оборудования"

СЕРТИФИКАТ СООТВЕТСТВИЯ ВЫДАН НА ОСНОВАНИИ
протоколы испытаний №№ 175, 176 от 27.06.2019г., № 178 от 28.06.2019г., №№ 183, 184 от 04.07.2019г. Испытательная лаборатория кабельной продукции ООО ЦИКП «Волга-тест» (рег. № РОСС RU.0001.21КБ19 с 19.06.2015г.);
акт о результатах анализа состояния производства № АА-32/2019 от 18.02.2019г., оформленный Органом по сертификации продукции ООО "Центр по сертификации, стандартизации и систем качества электро-машиностроительной продукции" (рег. № РОСС RU.0001.11ME77 с 11.02.2015); схема сертификации – 1с.

ДОПОЛНИТЕЛЬНАЯ ИНФОРМАЦИЯ Срок службы и гарантия igus® для кабелей chainflex® распространяется до 10 млн. двойных ходов, на срок до 3 лет, в соответствии с гарантийными условиями «igus® chainflex® guarantee-club». Условия хранения продукции в соответствии с документами изготовителя PA-3-204, PA-3-213-A, QM-3-2-90D. Перечень стандартов, в результате применения которых на добровольной основе обеспечивается соблюдение требований технического регламента – приложение бланк Серия RU № 0675710.

СРОК ДЕЙСТВИЯ С 10.07.2019 ПО 09.07.2024

ВКЛЮЧИТЕЛЬНО

Руководитель (уполномоченное лицо) органа по сертификации (подпись) Никитин Юрий Николаевич (Ф.И.О.)

М.П.

Эксперт (эксперт-аудитор) (эксперты (эксперты-аудиторы)) (подпись) Аминев Руслан Юнирович (Ф.И.О.)

All certificates can be found on ▶ www.igus.eu/CTP-EAC

General conditions

The General Conditions of Sale of igus® shall apply. Excessive and short deliveries of ± 10 % for cables conform with contractual agreements. Deliveries can be made in part-lengths. Statutory VAT must be added to the prices. The General Conditions of Sale and Delivery of igus® GmbH, Cologne, can be found online under www.igus.eu.
The prices quoted in the catalogue or other media are subject to alteration. igus® can modify the prices at any time at their own discretion.

User information

Since our products are constantly being developed further in the interest of our customers, we reserve the right to make technical alterations at any time. With the issue of this catalogue, all previous publications lose their validity. Subject to printing errors.

Disclaimer

The terms "igus", "chainflex", "CFRIP", "readycable", "readychain", "e-chain", "e-chain systems", "e-ketten", "e-kettensysteme", "flizz", "iglidur", "drylin" are legally protected trademarks in the Federal Republic of Germany and in case also in foreign countries.

Outer jacket color according to RAL

chainflex® cable jacket colours are given with the similar RAL colour number; for example yellowgreen, similar to RAL 6018. Slight differences can occur from the exact RAL colour, depending on the cable jacket material. However, this has no effect on the quality or functionality of the cable.

A RAL number is used to describe different shades of colour more consistently. For example, RAL 7040 is light grey and RAL 7016 is a dark grey. The RAL number describes the colour, but cannot guarantee the same shade in different applications.

RAL: German Institute for Quality Assurance and Certification e.V. ▶ www.RAL.de

KTG

If cable drums are to be used, please visit KTG directly online.▶ www.kabeltrommel.de

Product illustrations

The products illustrated are photos showing examples for whole series, i.e. the original cable can deviate from the cable shown.

Technical notes

The USB, FireWire and GigE cables listed on this page have been developed and manufactured for the mechanically demanding industrial application in e-chain systems®. High resistance against oil and lubricants are guaranteed, and also a high protection against electro-magnetic interference fields. This high mechanical service life was reached with the usage of high quality materials which even care for the electrical safeness.
In single cases communication errors can occur, if very different hardware and software is combined. We recommend tests with all components and the cables before starting serial production, to get the proof for a perfectly running system.
Of course we support you with the details of these electrical tests.

The specifications in the catalogue referring to temperature range, bend radius and travel must be seen as limiting value specifications. If two limiting value specifications are combined, this can lead to a reduction of the cable's service life.

The term "oil-resistant" refers to a few selected oil types which have been tested accordingly. This does not mean, however, that the products are automatically resistant to all the oils on the market.

Length printing: Respective printing of the metre length is already on many cables. These are not calibrated measurements, they are only intended as an orientation aid.
Just give us a call!

Storage made easy ...

chainflex® CASE S and CASE M

The chainflex® CASE is a cardboard box that allows cable drum shipping without a pallet. This means that the goods can be sent by a parcel carrier. The chainflex® CASE is not only used for transport, but also works as a storage system for cable drums. The cable can be easily unreeled directly from the box. Thanks to its stackability, you can set up flexible storage facilities. The QR code on the shipping box makes online re-ordering easy. All in all, this system helps you save shipping, process and storage costs.

chainflex® CASE application example from the field: BSH Hausgeräte GmbH
"The maintenance staff at the BSH plant in Bad Neustadt an der Saale have implemented a real "out of the box" solution. Electrical cables no longer arrive by hank or cable drum, but in the "chainflex CASE" shipping and storage solution. This saves costs, space and waste."

chainflex® CASE allows cable drums to be shipped in a cardboard box via parcel carriers. Very simple and you can save up to 84% shipping cost compared to standard shipping on a pallet by a freight forwarder.

Remove expensive storage systems for cable drums. Unreel the cable immediately from the chainflex® CASE. Carrying handles and stackability allow for individual storage spaces.

This system makes storage mobile and can be used directly on construction sites, for instance. Expensive special shelving is not required, instead, it can be stored simply in standard shelving systems.

With the QR code on every chainflex® CASE, you can re-order your cable online in a few seconds. Simply use your smartphone's scanner.

▶ www.igus.eu/cf-case

Two sizes ... can be ordered separately ...

Just add the required CASE to your order

chainflex® CASE

chainflex® CASE S

Cables available in the chainflex® CASE

Control cables

Part No.	Number of cores and conductor nominal cross section [mm²]	Max. cable length [m] CASE M	CASE S
Control cables			
CF880.05.02	2x0.5	200	200
CF880.05.03	3G0.5	200	200
CF880.05.04	4G0.5	200	200
CF880.05.05	5G0.5	200	200
CF880.05.07	7G0.5	200	150
CF880.05.12	12G0.5	150	100
CF880.05.18	18G0.5	100	100
CF880.07.02	2x0.75	200	200
CF880.07.03	3G0.75	200	200
CF880.07.04	4G0.75	200	200
CF880.07.05	5G0.75	200	150
CF880.07.07	7G0.75	200	150
CF880.07.12	12G0.75	150	100
CF880.07.18	18G0.75	100	-
CF880.10.02	2x1.0	200	200
CF880.10.03	3G1.0	200	200
CF880.10.04	4G1.0	200	150
CF880.10.05	5G1.0	200	150
CF880.10.07	7G1.0	150	100
CF880.10.12	12G1.0	100	-
CF880.15.02	2x1.5	200	200
CF880.15.03	3G1.5	200	150
CF880.15.04	4G1.5	200	150
CF880.15.05	5G1.5	150	100
CF880.15.07	7G1.5	100	100
CF880.25.03	3G2.5	150	100
CF880.25.04	4G2.5	150	100
CF880.25.05	5G2.5	100	100
CF881.05.03	(3G0.5)C	200	200
CF881.05.04	(4G0.5)C	200	200
CF881.05.05	(5G0.5)C	200	150
CF881.05.07	(7G0.5)C	200	150
CF881.05.12	(12G0.5)C	150	100
CF881.05.18	(18G0.5)C	100	-
CF881.07.02	(2x0.75)C	200	200
CF881.07.03	(3G0.75)C	200	150
CF881.07.04	(4G0.75)C	200	150
CF881.07.05	(5G0.75)C	200	150
CF881.07.07	(7G0.75)C	150	100
CF881.07.12	(12G0.75)C	100	-
CF881.10.02	(2x1.0)C	200	200
CF881.10.03	(3G1.0)C	200	150
CF881.10.04	(4G1.0)C	200	150
CF881.10.05	(5G1.0)C	200	150
CF881.10.07	(7G1.0)C	150	100
CF881.10.12	(12G1.0)C	100	-
CF881.15.02	(2x1.5)C	200	150
CF881.15.03	(3G1.5)C	200	150
CF881.15.04	(4G1.5)C	150	100
CF881.15.05	(5G1.5)C	100	100
CF881.15.07	(7G1.5)C	100	-
CF881.25.04	(4G2.5)C	100	100
CF881.25.05	(5G2.5)C	100	-
CF130.02.03.UL	3x0.25	200	200
CF130.02.04.UL	4x0.25	200	200
CF130.02.06.UL	6x0.25	200	200
CF130.02.07.UL	7x0.25	200	200
CF130.02.12.UL	12x0.25	200	100
CF130.02.18.UL	18x0.25	150	100
CF130.02.20.UL	20x0.25	150	-
CF130.02.25.UL	25x0.25	100	-
CF130.02.30.UL	30x0.25	100	-
CF130.03.02.UL	2x0.34	200	200
CF130.03.05.UL	5x0.34	200	200
CF130.05.02.UL	2x0.5	200	200
CF130.05.03.UL	3G0.5	200	200
CF130.05.04.UL	4G0.5	200	200
CF130.05.05.UL	5G0.5	200	200
CF130.05.07.UL	7G0.5	200	150
CF130.05.12.UL	12G0.5	150	100
CF130.05.18.UL	18G0.5	100	-
CF130.07.02.UL	2x0.75	200	200
CF130.07.03.UL	3G0.75	200	200
CF130.07.04.UL	4G0.75	200	200
CF130.07.05.UL	5G0.75	200	150
CF130.07.07.UL	7G0.75	200	150
CF130.07.12.UL	12G0.75	100	-
CF130.10.02.UL	2x1.0	200	200
CF130.10.03.UL	3G1.0	200	200
CF130.10.04.UL	4G1.0	200	150
CF130.10.05.UL	5G1.0	200	150
CF130.10.07.UL	7G1.0	200	100
CF130.10.12.UL	12G1.0	100	-
CF130.15.02.UL	2x1.5	200	200
CF130.15.03.UL	3G1.5	200	150
CF130.15.04.UL	4G1.5	200	150
CF130.15.05.UL	5G1.5	200	100
CF130.15.07.UL	7G1.5	150	-
CF130.15.12.UL	12G1.5	100	-
CF130.25.03.UL	3G2.5	200	100
CF130.25.04.UL	4G2.5	150	100
CF130.25.07.UL	7G2.5	100	-
CF130.40.03.UL	3G4.0	100	100
CF140.02.12.UL	(12x0.25)C	150	-
CF140.03.05.UL	(5x0.34)C	200	150
CF140.05.03.UL	(3G0.5)C	200	150
CF140.05.05.UL	(5G0.5)C	200	150

Cables available in the chainflex® CASE

Control cables

chainflex® CASE

Part No.	Number of cores and conductor nominal cross section [mm²]	Max. cable length [m] CASE M	CASE S
CF140.07.03.UL	(3G0.75)C	200	150
CF140.07.04.UL	(4G0.75)C	200	100
CF140.07.05.UL	(5G0.75)C	200	100
CF140.07.07.UL	(7G0.75)C	150	100
CF140.07.12.UL	(12G0.75)C	100	-
CF140.10.02.UL	(2x1.0)C	200	150
CF140.10.03.UL	(3G1.0)C	200	100
CF140.10.04.UL	(4G1.0)C	200	100
CF140.10.05.UL	(5G1.0)C	150	100
CF140.10.07.UL	(7G1.0)C	150	-
CF140.15.03.UL	(3G1.5)C	200	100
CF140.15.04.UL	(4G1.5)C	150	100
CF140.15.05.UL	(5G1.5)C	150	100
CF140.15.07.UL	(7G1.5)C	100	-
CF140.25.03.UL	(3G2.5)C	100	-
CF140.25.04.UL	(4G2.5)C	100	-
CF150.UL.10.03	3G1.0	200	150
CF150.UL.10.04	4G1.0	200	100
CF150.UL.10.05	5G1.0	200	100
CF150.UL.10.07	7G1.0	150	-
CF150.UL.15.03	3G1.5	200	100
CF150.UL.15.04	4G1.5	200	100
CF150.UL.15.05	5G1.5	150	100
CF150.UL.15.07	7G1.5	100	-
CF150.UL.25.03	3G2.5	150	100
CF150.UL.25.04	4G2.5	150	100
CF150.UL.25.05	5G2.5	100	-
CF150.UL.25.07	7G2.5	100	-
CF160.UL.10.03	(3G1.0)C	150	100
CF160.UL.10.04	(4G1.0)C	150	100
CF160.UL.10.05	(5G1.0)C	100	-
CF160.UL.10.07	(7G1.0)C	100	-
CF160.UL.15.03	(3G1.5)C	150	100
CF160.UL.15.04	(4G1.5)C	100	-
CF160.UL.15.05	(5G1.5)C	100	-
CF160.UL.25.03	(3G2.5)C	100	-
CF160.UL.25.04	(4G2.5)C	100	-
CF160.UL.25.05	(5G2.5)C	100	-
CF5.03.18	18x0.34	100	-
CF5.05.02	2x0.5	200	200
CF5.05.03	3G0.5	200	200
CF5.05.04	4G0.5	200	200
CF5.05.05	5G0.5	200	150
CF5.05.07	7G0.5	200	150
CF5.05.12	12G0.5	100	-
CF5.05.18	18G0.5	100	-
CF5.07.03	3G0.75	200	200
CF5.07.04	4G0.75	200	150
CF5.07.05	5G0.75	200	150
CF5.07.07	7G0.75	200	100
CF5.07.12	12G0.75	100	-
CF5.10.03	3G1.0	200	200
CF5.10.04	4G1.0	200	150
CF5.10.05	5G1.0	200	150
CF5.10.07	7G1.0	150	100
CF5.10.12	12G1.0	100	-
CF5.15.03	3G1.5	200	150
CF5.15.04	4G1.5	200	150
CF5.15.05	5G1.5	200	100
CF5.15.07	7G1.5	150	-
CF5.25.04	4G2.5	150	100
CF5.25.05	5G2.5	100	-
CF6.02.04	(4x0.25)C	200	150
CF6.03.05	(5x0.34)C	200	150
CF6.05.02	(2x0.5)C	200	150
CF6.05.05	(5G0.5)C	200	100
CF6.05.07	(7G0.5)C	150	100
CF6.05.09	(9G0.5)C	100	-
CF6.05.12	(12G0.5)C	100	-
CF6.07.03	(3G0.75)C	200	150
CF6.07.04	(4G0.75)C	200	100
CF6.07.05	(5G0.75)C	200	100
CF6.07.07	(7G0.75)C	150	-
CF6.10.03	(3G1.0)C	200	150
CF6.10.04	(4G1.0)C	200	100
CF6.10.05	(5G1.0)C	150	100
CF6.10.07	(7G1.0)C	100	-
CF6.15.03	(3G1.5)C	200	100
CF6.15.04	(4G1.5)C	150	100
CF6.15.05	(5G1.5)C	150	-
CF6.15.07	(7G1.5)C	100	-
CF6.25.03	(3G2.5)C	150	-
CF6.25.04	(4G2.5)C	100	-
CFSOFT1.02.03	3x0.25	200	200
CFSOFT1.02.08	8x0.25	200	150
CFSOFT1.03.04	4x0.34	200	200
CFSOFT1.05.04	4x0.5	200	150
CFSOFT2.02.03	(3x0.25)C	200	200
CFSOFT2.02.08	(8x0.25)C	200	150
CFSOFT2.03.04	(4x0.34)C	200	200
CFSOFT2.05.04	(4x0.5)C	200	150
CF890.05.02	2x0.5	200	200
CF890.05.03	3G0.5	200	200
CF890.05.04	4G0.5	200	200
CF890.05.05	5G0.5	200	200
CF890.05.07	7G0.5	200	150
CF890.05.12	12G0.5	150	100
CF890.05.18	18G0.5	100	100

Cables available in the chainflex® CASE

Control cables

Part No.	Number of cores and conductor nominal cross section [mm²]	Max. cable length [m] CASE M	CASE S
Control cables			
CF890.07.02	2x0.75	200	200
CF890.07.03	3G0.75	200	200
CF890.07.04	4G0.75	200	200
CF890.07.05	5G0.75	200	150
CF890.07.07	7G0.75	200	150
CF890.07.12	12G0.75	150	100
CF890.07.18	18G0.75	100	-
CF890.10.02	2x1.0	200	200
CF890.10.03	3G1.0	200	200
CF890.10.04	4G1.0	200	150
CF890.10.05	5G1.0	200	150
CF890.10.07	7G1.0	150	100
CF890.10.12	12G1.0	100	-
CF890.15.02	2x1.5	200	200
CF890.15.03	3G1.5	200	150
CF890.15.04	4G1.5	200	150
CF890.15.05	5G1.5	150	100
CF890.15.07	7G1.5	100	100
CF890.25.03	3G2.5	200	100
CF890.25.04	4G2.5	150	100
CF890.25.05	5G2.5	100	100
CF891.05.02	(2x0.5)C	200	200
CF891.05.03	(3G0.5)C	200	200
CF891.05.05	(5G0.5)C	200	150
CF891.05.12	(12G0.5)C	150	100
CF891.05.18	(18G0.5)C	100	-
CF891.07.02	(2x0.75)C	200	200
CF891.07.03	(3G0.75)C	200	150
CF891.07.04	(4G0.75)C	200	150
CF891.07.05	(5G0.75)C	200	150
CF891.07.07	(7G0.75)C	150	100
CF891.07.12	(12G0.75)C	100	-
CF891.10.02	(2x1.0)C	200	200
CF891.10.03	(3G1.0)C	200	150
CF891.10.04	(4G1.0)C	200	150
CF891.10.05	(5G1.0)C	200	150
CF891.10.07	(7G1.0)C	150	100
CF891.10.12	(12G1.0)C	100	-
CF891.15.02	(2x1.5)C	200	150
CF891.15.03	(3G1.5)C	200	150
CF891.15.04	(4G1.5)C	150	100
CF891.15.05	(5G1.5)C	100	100
CF891.15.07	(7G1.5)C	100	-
CF891.25.04	(4G2.5)C	100	100
CF891.25.05	(5G2.5)C	100	-
CF77.UL.02.03.INI	3x0.25	200	200
CF77.UL.02.04.D	4x0.25	200	200
CF77.UL.02.05.D	5x0.25	200	200
CF77.UL.02.07.D	7x0.25	200	200
CF77.UL.02.12.D	12x0.25	200	100
CF77.UL.02.18.D	18x0.25	150	-
CF77.UL.02.25.D	25x0.25	100	-
CF77.UL.03.04.INI	4x0.34	200	200
CF77.UL.03.05.INI	5x0.34	200	200
CF77.UL.03.05.INI.D	5x0.34	200	200
CF77.UL.05.04.D	4G0.5	200	200
CF77.UL.05.05.D	5G0.5	200	200
CF77.UL.05.07.D	7G0.5	200	150
CF77.UL.05.12.D	12G0.5	150	100
CF77.UL.05.18.D	18G0.5	100	-
CF77.UL.07.03.D	3G0.75	200	200
CF77.UL.07.04.D	4G0.75	200	150
CF77.UL.07.05.D	5G0.75	200	150
CF77.UL.07.07.D	7G0.75	200	100
CF77.UL.07.12.D	12G0.75	100	-
CF77.UL.10.02.D	2x1.0	200	200
CF77.UL.10.03.D	3G1.0	200	200
CF77.UL.10.04.D	4G1.0	200	150
CF77.UL.10.05.D	5G1.0	200	150
CF77.UL.10.07.D	7G1.0	200	100
CF77.UL.10.12.D	12G1.0	100	-
CF77.UL.15.03.D	3G1.5	200	150
CF77.UL.15.04.D	4G1.5	200	150
CF77.UL.15.05.D	5G1.5	200	150
CF77.UL.15.07.D	7G1.5	150	100
CF77.UL.25.03.D	3G2.5	200	100
CF77.UL.25.04.D	4G2.5	150	100
CF77.UL.25.05.D	5G2.5	150	100
CF77.UL.25.07.D	7G2.5	100	-
CF77.UL.40.04.D	4G4.0	100	-
CF78.UL.05.04	(4G0.5)C	200	150
CF78.UL.05.05	(5G0.5)C	200	150
CF78.UL.05.07	(7G0.5)C	150	100
CF78.UL.05.09	(9G0.5)C	100	-
CF78.UL.05.12	(12G0.5)C	100	-
CF78.UL.07.03	(3G0.75)C	200	150
CF78.UL.07.04	(4G0.75)C	200	100
CF78.UL.07.05	(5G0.75)C	150	100
CF78.UL.07.07	(7G0.75)C	150	-
CF78.UL.10.03	(3G1.0)C	200	100
CF78.UL.10.04	(4G1.0)C	200	100
CF78.UL.10.05	(5G1.0)C	150	100
CF78.UL.10.07	(7G1.0)C	100	-
CF78.UL.15.03	(3G1.5)C	150	100
CF78.UL.15.04	(4G1.5)C	150	100
CF78.UL.15.05	(5G1.5)C	150	-
CF78.UL.15.07	(7G1.5)C	100	-

Cables available in the chainflex® CASE

chainflex® CASE

Control cables

Part No.	Number of cores and conductor nominal cross section [mm²]	Max. cable length [m] CASE M	CASE S
CF78.UL.25.03	(3G2.5)C	150	100
CF78.UL.25.04	(4G2.5)C	100	-
CF78.UL.25.05	(5G2.5)C	100	-
CF2.01.04	(4x0.14)C	200	200
CF2.01.08	(8x0.14)C	200	150
CF2.01.12	(12x0.14)C	150	100
CF2.01.18	(18x0.14)C	150	-
CF2.01.24	(24x0.14)C	100	-
CF2.02.04	(4x0.25)C	200	150
CF2.02.08	(8x0.25)C	200	150
CF2.02.18	(18x0.25)C	100	-
CF9.02.02	2x0.25	200	200
CF9.02.03.INI	3x0.25	200	200
CF9.02.06	6x0.25	200	200
CF9.02.07	7x0.25	200	200
CF9.02.08	8x0.25	200	200
CF9.02.12	12x0.25	200	150
CF9.02.18	18x0.25	150	100
CF9.02.20	20x0.25	150	100
CF9.02.25	25x0.25	100	-
CF9.03.04.INI	4x0.34	200	200
CF9.03.05.INI	5x0.34	200	200
CF9.03.06	6x0.34	200	200
CF9.03.08	8x0.34	200	150
CF9.03.16.07.03.INI	16x0.34+3x0.75	100	-
CF9.05.02	2x0.5	200	200
CF9.05.03	3x0.5	200	200
CF9.05.04	4x0.5	200	200
CF9.05.05	5x0.5	200	200
CF9.05.07	7x0.5	200	150
CF9.05.12	12x0.5	150	100
CF9.05.18	18x0.5	100	-
CF9.05.25	25x0.5	100	-
CF9.07.04	4G0.75	200	200
CF9.07.05	5G0.75	200	200
CF9.07.07	7G0.75	200	150
CF9.07.12	12G0.75	100	-
CF9.10.03	3G1.0	200	200
CF9.10.04	4G1.0	200	200
CF9.10.05	5G1.0	200	150
CF9.10.12	12G1.0	100	-
CF9.15.02	2x1.5	200	200
CF9.15.04	4G1.5	200	150
CF9.15.05	5G1.5	200	150
CF9.15.07	7G1.5	150	100
CF9.25.04	4G2.5	150	100
CF9.25.05	5G2.5	150	100
CF9.25.07	7G2.5	100	-
CF9.40.04	4G4.0	100	-
CF10.01.12	(12x0.14)C	200	150
CF10.01.18	(18x0.14)C	150	100
CF10.02.04	(4x0.25)C	200	200
CF10.02.08	(8x0.25)C	200	150
CF10.02.12	(12x0.25)C	150	100
CF10.02.25	(25x0.25)C	100	-
CF10.03.05.INI	(5x0.34)C	200	150
CF10.05.04	(4x0.5)C	200	150
CF10.05.05	(5x0.5)C	200	150
CF10.05.07	(7x0.5)C	200	100
CF10.05.12	(12x0.5)C	100	-
CF10.07.04	(4G0.75)C	200	150
CF10.07.05	(5G0.75)C	200	150
CF10.07.07	(7G0.75)C	150	100
CF10.07.12	(12G0.75)C	100	-
CF10.10.02	(2x1.0)C	200	150
CF10.10.03	(3G1.0)C	200	150
CF10.10.04	(4G1.0)C	200	150
CF10.10.05	(5G1.0)C	200	100
CF10.10.07	(7G1.0)C	150	100
CF10.15.04	(4G1.5)C	150	100
CF10.15.05	(5G1.5)C	150	100
CF10.15.07	(7G1.5)C	100	-
CF10.25.04	(4G2.5)C	100	-
CF9.UL.02.02	2x0.25	200	200
CF9.UL.02.03.INI	3x0.25	200	200
CF9.UL.02.04	4x0.25	200	200
CF9.UL.02.06	6x0.25	200	200
CF9.UL.02.08	8x0.25	200	150
CF9.UL.02.12	12x0.25	200	100
CF9.UL.03.04.INI	4x0.34	200	200
CF9.UL.03.05.INI	5x0.34	200	200
CF9.UL.03.06	6x0.34	200	200
CF9.UL.03.08	8x0.34	200	150
CF9.UL.05.02	2x0.5	200	200
CF9.UL.05.03	3x0.5	200	200
CF9.UL.05.04	4x0.5	200	150
CF9.UL.05.05	5x0.5	200	150
CF9.UL.05.07	7x0.5	200	100
CF9.UL.05.12	12x0.5	150	-
CF9.UL.05.18	18x0.5	100	-
CF9.UL.07.05	5G0.75	200	150
CF9.UL.07.07	7G0.75	200	100
CF9.UL.07.12	12G0.75	100	-
CF9.UL.10.03	3G1.0	200	150
CF9.UL.10.04	4G1.0	200	150
CF9.UL.10.12	12G1.0	100	-
CF9.UL.15.04	4G1.5	200	100
CF9.UL.15.05	5G1.5	200	100

Cables available in the chainflex® CASE

Control and data cables

Part No.	Number of cores and conductor nominal cross section [mm²]	Max. cable length [m] CASE M	CASE S
Control cables			
CF9.UL.15.07	7G1.5	150	-
CF9.UL.25.04	4G2.5	100	-
CF9.UL.25.05	5G2.5	100	-
CF9.UL.40.04	4G4.0	100	-
CF10.UL.02.04	(4x0.25)C	200	150
CF10.UL.02.08	(8x0.25)C	200	100
CF10.UL.02.12	(12x0.25)C	150	-
CF10.UL.02.25	(25x0.25)C	100	-
CF10.UL.05.04	(4x0.5)C	200	100
CF10.UL.05.05	(5x0.5)C	200	100
CF10.UL.05.12	(12x0.5)C	100	-
CF10.UL.07.04	(4G0.75)C	200	100
CF10.UL.07.05	(5G0.75)C	200	100
CF10.UL.07.07	(7G0.75)C	150	-
CF10.UL.07.12	(12G0.75)C	100	-
CF10.UL.10.02	(2x1.0)C	200	100
CF10.UL.10.03	(3G1.0)C	200	100
CF10.UL.10.04	(4G1.0)C	200	100
CF10.UL.10.05	(5G1.0)C	200	-
CF10.UL.10.07	(7G1.0)C	100	-
CF10.UL.15.04	(4G1.5)C	100	-
CF10.UL.15.05	(5G1.5)C	150	-
CF10.UL.15.07	(7G1.5)C	100	-
CF10.UL.25.04	(4G2.5)C	100	-
CF98.01.02	2x0.14	200	200
CF98.01.03	3x0.14	200	200
CF98.01.04	4x0.14	200	200
CF98.01.08	8x0.14	200	200
CF98.02.03.INI	3x0.25	200	200
CF98.02.04	4x0.25	200	200
CF98.02.08	8x0.25	200	150
CF98.03.04.INI	4x0.34	200	200
CF98.05.04	4x0.5	200	200
CF98.PLUS.01.02	2x0.14	200	200
CF98.PLUS.01.03	3x0.14	200	200
CF98.PLUS.01.04	4x0.14	200	200
CF98.PLUS.01.08	8x0.14	200	200
CF98.PLUS.02.03.INI	3x0.25	200	200
CF98.PLUS.02.04	4x0.25	200	200
CF98.PLUS.02.08	8x0.25	200	150
CF98.PLUS.03.04.INI	4x0.34	200	200
CF98.PLUS.05.04	4x0.5	200	200
CF99.01.02	(2x0.14)C	200	200
CF99.01.04	(4x0.14)C	200	200
CF99.01.08	(8x0.14)C	200	150
CF99.02.04	(4x0.25)C	200	150
CF99.03.08	(8x0.34)C	200	150
CF99.PLUS.01.02	(2x0.14)C	200	200
CF99.PLUS.01.04	(4x0.14)C	200	200
CF99.PLUS.01.08	(8x0.14)C	200	150
CF99.PLUS.02.04	(4x0.25)C	200	150
CF99.PLUS.03.08	(8x0.34)C	200	100
Data cables			
CF240.01.03	(3x0.14)C	200	200
CF240.01.04	(4x0.14)C	200	200
CF240.01.05	(5x0.14)C	200	200
CF240.01.07	(7x0.14)C	200	200
CF240.01.14	(14x0.14)C	200	150
CF240.01.18	(18x0.14)C	200	150
CF240.01.24	(24x0.14)C	200	100
CF240.02.03	(3x0.25)C	200	200
CF240.02.04	(4x0.25)C	200	200
CF240.02.05	(5x0.25)C	200	200
CF240.02.07	(7x0.25)C	200	200
CF240.02.08	(8x0.25)C	200	150
CF240.02.14	(14x0.25)C	200	150
CF240.02.18	(18x0.25)C	200	100
CF240.02.24	(24x0.25)C	150	100
CF240.03.02	(2x0.34)C	200	200
CF240.03.03	(3x0.34)C	200	200
CF240.03.04	(4x0.34)C	200	200
CF240.03.05	(5x0.34)C	200	200
CF240.03.07	(7x0.34)C	200	150
CF240.03.10	(10x0.34)C	200	150
CF240.03.14	(14x0.34)C	200	150
CF240.03.18	(18x0.34)C	150	100
CF240.03.24	(24x0.34)C	100	100
CF240.PUR.01.04	(4x0.14)C	200	200
CF240.PUR.01.07	(7x0.14)C	200	200
CF240.PUR.01.08	(8x0.14)C	200	150
CF240.PUR.01.14	(14x0.14)C	200	150
CF240.PUR.01.18	(18x0.14)C	200	150
CF240.PUR.01.25	(25x0.14)C	150	100
CF240.PUR.02.03	(3x0.25)C	200	200
CF240.PUR.02.04	(4x0.25)C	200	200
CF240.PUR.02.05	(5x0.25)C	200	200
CF240.PUR.02.07	(7x0.25)C	200	150
CF240.PUR.02.08	(8x0.25)C	200	150
CF240.PUR.02.14	(14x0.25)C	200	150
CF240.PUR.02.18	(18x0.25)C	200	100
CF240.PUR.02.25	(25x0.25)C	150	-
CF240.PUR.03.03	(3x0.34)C	200	200
CF240.PUR.03.04	(4x0.34)C	200	200
CF240.PUR.03.05	(5x0.34)C	200	200
CF240.PUR.03.07	(7x0.34)C	200	200
CF240.PUR.03.14	(14x0.34)C	150	150
CF240.PUR.03.18	(18x0.34)C	150	100

Cables available in the chainflex® CASE

chainflex® CASE

Data, coax and bus cables

Part No.	Number of cores and conductor nominal cross section [mm²]	Max. cable length [m] CASE M	CASE S
CF211.02.01.02	(2x0.25)C	200	200
CF211.02.02.02	(2x(2x0.25))C	200	200
CF211.02.03.02	(3x(2x0.25))C	200	150
CF211.02.04.02	(4x(2x0.25))C	200	150
CF211.02.05.02	(5x(2x0.25))C	200	100
CF211.02.06.02	(6x(2x0.25))C	200	100
CF211.02.08.02	(8x(2x0.25))C	150	-
CF211.02.10.02	(10x(2x0.25))C	100	-
CF211.02.14.02	(14x(2x0.25))C	100	-
CF211.03.03.02	(3x(2x0.34))C	200	150
CF211.03.08.02	(8x(2x0.34))C	100	-
CF211.05.01.02	(2x0.5)C	200	200
CF211.05.02.02	(2x(2x0.5))C	200	100
CF211.05.03.02	(3x(2x0.5))C	200	100
CF211.05.04.02	(4x(2x0.5))C	150	100
CF211.05.05.02	(5x(2x0.5))C	150	-
CF211.05.06.02	(6x(2x0.5))C	100	-
CF211.05.08.02	(8x(2x0.5))C	100	-
CF211.PUR.02.01.02	(2x0.25)C	200	200
CF211.PUR.02.02.02	(2x(2x0.25))C	200	200
CF211.PUR.02.03.02	(3x(2x0.25))C	200	150
CF211.PUR.02.04.02	(4x(2x0.25))C	200	150
CF211.PUR.02.05.02	(5x(2x0.25))C	200	100
CF211.PUR.02.06.02	(6x(2x0.25))C	200	100
CF211.PUR.02.08.02	(8x(2x0.25))C	150	-
CF211.PUR.02.10.02	(10x(2x0.25))C	100	-
CF211.PUR.03.03.02	(3x(2x0.34))C	200	150
CF211.PUR.03.08.02	(8x(2x0.34))C	100	-
CF211.PUR.05.01.02	(2x0.5)C	200	200
CF211.PUR.05.02.02	(2x(2x0.5))C	200	100
CF211.PUR.05.03.02	(3x(2x0.5))C	200	100
CF211.PUR.05.04.02	(4x(2x0.5))C	150	100
CF211.PUR.05.05.02	(5x(2x0.5))C	150	-
CF211.PUR.05.06.02	(6x(2x0.5))C	100	-
CF211.PUR.05.08.02	(8x(2x0.5))C	100	-
CF11.01.04.02	(4x(2x0.14))C	200	150
CF11.01.18.02	(18x(2x0.14))C	100	-
CF11.02.01.02	(2x0.25)C	200	200
CF11.02.02.02	(2x(2x0.25))C	200	200
CF11.02.03.02	(3x(2x0.25))C	200	150
CF11.02.04.02	(4x(2x0.25))C	200	100
CF11.02.05.02	(5x(2x0.25))C	200	100
CF11.02.06.02	(6x(2x0.25))C	150	100
CF11.02.10.02	(10x(2x0.25))C	100	-
CF11.03.08.02	(8x(2x0.34))C	100	-
CF11.05.04.02	(4x(2x0.5))C	150	100
CF11.05.06.02	(6x(2x0.5))C	100	-
CF11.07.03.02	(3x(2x0.75))C	150	-
CF11.10.04.02	(4x(2x1.0))C	100	-
CF112.02.02.02	(2x(2x0.25)C)C	150	100
CF112.02.03.02	(3x(2x0.25)C)C	150	100
CF112.02.04.02	(4x(2x0.25)C)C	100	-
CF112.02.05.02	(5x(2x0.25)C)C	100	-
CF112.05.02.02	(2x(2x0.5)C)C	100	-
CF112.05.04.02	(4x(2x0.5)C)C	100	-
CF12.02.04.02	(4x(2x0.25)C)C	100	-
CF298.01.02	2x0.14	200	200
CF298.01.04	4x0.14	200	200
CF298.01.08	8x0.14	200	150
CF298.02.03	3x0.25	200	200
CF298.02.04	4x0.25	200	200
CF298.02.07	7x0.25	200	150
CF298.02.08	8x0.25	200	150
CF298.03.04	4x0.34	200	200
CF298.03.07	7x0.34	200	150
CF298.05.04	4x0.5	200	200
CF299.01.02	(2x0.14)C	200	200
CF299.01.04	(4x0.14)C	200	200
CF299.01.08	(8x0.14)C	200	100
CF299.02.04	(4x0.25)C	200	150
CF299.02.07	(7x0.25)C	200	100
Coax cables			
CFKoax1.01	1xHF75-0.3/1.6	200	200
CFKoax1.05	5xHF75-0.3/1.6	150	100
CFKoax2.01	1xHF50-0.9/2.95	200	200
CFKoax3.01	1xHF50-0.3/0.84	200	200
Bus cables			
CFBUS.LB.001	(2x0.25)C	200	100
CFBUS.LB.020	(4x0.25)C	200	200
CFBUS.LB.021	(2x0.5)C	200	150
CFBUS.LB.022	(4x0.5)C	200	150
CFBUS.LB.040	(4x0.25)C	200	150
CFBUS.LB.045	(4x(2x0.15))C	200	100
CFBUS.LB.049	(4x(2x0.15))C	200	100
CFBUS.LB.060	(4x0.38)C	200	150
CF888.001	(2x0.25)C	200	150
CF888.021	(2x0.5)C	200	100
CF888.045	(4x(2x0.14))C	200	150
CF888.060	(4x0.34)C	200	150
CFBUS.PVC.001	(2x0.25)C	200	100
CFBUS.PVC.020	(4x0.25)C	200	150
CFBUS.PVC.021	(2x0.5)C	200	100
CFBUS.PVC.022	(4x0.5)C	200	100
CFBUS.PVC.035	(3x0.5)C	200	150
CFBUS.PVC.040	(4x0.25)C	200	200
CFBUS.PVC.045	(4x(2x0.15))C	200	150
CFBUS.PVC.049	(4x(2x0.15))C	200	150
CFBUS.PVC.050	4x(2x0.20)C	150	100

Cables available in the chainflex® CASE

Bus, FOC and measuring system cables

Part No.	Number of cores and conductor nominal cross section [mm²]	Max. cable length [m] CASE M	CASE S
Bus cables			
CFBUS.PVC.052	(4x(2x0.15)C)C	150	100
CFBUS.PVC.060	(4x0.38)C	200	150
CFBUS.PVC.068	(2x(2xAWG28) +2x(2xAWG28)C)C	200	150
CF898.001	(2x0.25)C	200	150
CF898.021	(2x0.5)C	200	100
CF898.045	(4x(2x0.14))C	200	150
CF898.060	(4x0.34)C	200	150
CF898.061.FC	(4x0.34)C	200	150
CFBUS.PUR.001	(2x0.25)C	200	100
CFBUS.PUR.020	(4x0.25)C	200	150
CFBUS.PUR.021	(2x0.5)C	150	100
CFBUS.PUR.022	(4x0.5)C	200	100
CFBUS.PUR.035	(3x0.5)C	200	150
CFBUS.PUR.040	(4x0.25)C	200	200
CFBUS.PUR.042	(2x0.15)C	200	200
CFBUS.PUR.045	(4x(2x0.15))C	150	150
CFBUS.PUR.049	(4x(2x0.15))C	150	150
CFBUS.PUR.050	4x(2x0.20)C	200	100
CFBUS.PUR.052	(4x(2x0.15)C)C	200	100
CFBUS.PUR.056	(2x(2x0.15)C+2x0.38)C	200	100
CFBUS.PUR.060	(4x0.38)C	200	150
CFBUS.PUR.068	(2x(2xAWG28) +2x(2xAWG28)C)C	200	150
CFBUS.PUR.H01.049	((4x(2x0.15))C+4x1.5)C	200	-
CFBUS.PUR.H01.060	((4x0.38)C+4x1.5)C	150	-
CFBUS.001	(2x0.25)C	100	100
CFBUS.002	(2x0.25)C+4x1.5	100	-
CFBUS.003	(2x0.25)C+3G0.75	200	-
CFBUS.010	(3x(2x0.25))C	100	100
CFBUS.011	(3x(2x0.25)+(3G1.0))C	100	-
CFBUS.020	(4x0.25)C	200	200
CFBUS.021	(2x0.5)C	200	150
CFBUS.022	(4x0.5)C	200	150
CFBUS.030	((2xAWG24)C+2xAWG22)C	150	150
CFBUS.031	((2xAWG18)C+2xAWG15)C	150	-
CFBUS.035	(3xAWG20)C	100	100
CFBUS.040	(4x0.25)C	100	150
CFBUS.045	(4x(2x0.15))C	200	100
CFBUS.049	(4x(2x0.15))C	200	100
CFBUS.050	(4x(2x0.15)C)C	200	-
CFBUS.052	(4x(2x0.15)C)C	200	-
CFBUS.055	2x(2x0.15)C+2x(0.34)C	200	150
CFBUS.060	(4x0.38)C	200	150
CFBUS.065	((2xAWG28)+2xAWG20)C	150	200
CFBUS.066	((2xAWG24)+2xAWG20)C	100	200
CFBUS.070	(4x(2xAWG28)C +(2xAWG28)+3xAWG28)C	100	100

Part No.	Number of cores and conductor nominal cross section [mm²]	Max. cable length [m] CASE M	CASE S
Fibre Optic Cable			
CFLK.L1.01	1x980/1,000	200	200
CFLK.L1.02	2x980/1,000	200	150
CFLG88.2.50/125	2x50/125	200	150
CFLG88.2.62.5/125	2x62.5/125	200	150
CFLG.2LB.PUR.62.5/125	2x62.5/125	200	100
CFLG.4LB.PUR.62.5/125	4x62.5/125	200	100
CFLG.6LB.PUR.50/125	6x50/125	100	-
CFLG.6LB.PUR.62.5/125	6x62.5/125	100	-
CFLG.6LB.PUR.9/125	6x9/125	100	-
CFLG.2LB.200/230	2x200/230	200	100
CFLG.2LB.50/125	2x50/125	200	100
CFLG.2LB.62.5/125	2x62.5/125	200	100
CFLG.4LB.50/125	4x50/125	200	100
CFLG.4LB.62.5/125	4x62.5/125	200	100
CFLG.6LB.50/125	6x50/125	100	-
CFLG.6LB.62.5/125	6x62.5/125	100	-
CFLG.12E.9/125.TC	12x9/125	150	100
CFLG.12G.50/125.TC	12x50/125	150	100
CFLG.12G.62.5/125.TC	12x62.5/125	150	100
CFLG.6G.50/125.TC	6x50/125	150	100
CFLG.6G.62.5/125.TC	6x62.5/125	150	100
Measuring system cables			
CF884.001	(3x(2x0.14)C +(4x0.14)+(2x0.5))C	200	100
CF884.006	(3x(2x0.14)C+(4x0.14) +(4x0.22)+(2x0.5))C	200	100
CF884.009	(4x(2x0.25)+2x0.5)C	200	150
CF884.011	(4x(2x0.34)+4x0.5)C	150	100
CF884.015	(4x(2x0.14)+4x0.5)C	200	100
CF884.022	((2x0.25)+5x0.5)C	200	150
CF884.028	(2x(2x0.15)+(2x0.38))C	200	150
CF211.001	(3x(2x0.14)C +(4x0.14)+(2x0.5))C	200	100
CF211.002	(3x(2x0.14)C+2x(0.5)C)C	150	100
CF211.004	(2x(2x(2x0.14)) +(4x0.14)C+(4x0.5))C	150	100
CF211.006	(3x(2x0.14)C+(4x0.14) +(4x0.25)+(2x0.5))C	150	100
CF211.009	(4x(2x0.25)+2x0.5)C	200	150
CF211.010	(4x(2x0.25)+2x1.0)C	200	100
CF211.011	(4x(2x0.34)+4x0.5)C	200	100
CF211.014	(4x(2x0.25)C+(2x0.5))C	150	-
CF211.015	(4x(2x0.14)+4x0.5)C	200	100
CF211.016	(3x(2x0.25)C)C	200	100
CF211.017	(4x(2x0.14) +(4x0.14)C+4x1.0)C	150	100
CF211.018	(2x(2x0.25)+2x0.5)C	200	200

Cables available in the chainflex® CASE

Measuring system cables

chainflex® CASE

Part No.	Number of cores and conductor nominal cross section [mm²]	Max. cable length [m] CASE M	CASE S
CF211.019	(3x(2x0.25)C +(3x0.25)+2x1.0)C	150	100
CF211.022	((2x0.25)+5x0.5)C	200	150
CF211.024	((4x0.14)+2x(2x0.34))C	200	150
CF211.027	(5x(2x0.14)+2x0.5)C	200	150
CF211.028	(2x(2x0.15)+(2x0.38))C	200	150
CF211.032	3x(2x0.14)C+(3x0.14)C	200	150
CF211.033	4x(2x0.14)C+2x(1.0)C	150	100
CF211.036	(5x(2x0.25))C	200	150
CF211.037	(6x(2x0.25))C	200	100
CF211.038	(3x(2x0.14)+(2x0.34))C	200	150
CF211.039	(4x(2x0.14)C+2x(0.5)C)C	150	100
CF211.041	(2x(2x0.18)+5x0.5)C	200	150
CF211.042	(3x(2x0.18)+6x0.5)C	200	100
CF894.001	(3x(2x0.14)C +(4x0.14)+(2x0.5))C	200	100
CF894.006	(3x(2x0.14)C+(4x0.14) +(4x0.22)+(2x0.5))C	200	100
CF894.009	(4x(2x0.25)+2x0.5)C	200	150
CF894.011	(4x(2x0.34)+4x0.5)C	150	100
CF894.015	(4x(2x0.14)+4x0.5)C	200	100
CF894.022	((2x0.25)+5x0.5)C	200	150
CF894.028	(2x(2x0.15)+(2x0.38))C	200	150
CF111.001.D	(3x(2x0.14)C +(4x0.14)+(2x0.5))C	200	100
CF111.002.D	(3x(2x0.14)C+2x(0.5)C)C	150	100
CF111.004.D	(2x(2x(2x0.14)) +(4x0.14)C+(4x0.5))C	150	-
CF111.006.D	(3x(2x0.14)C+(4x0.14) +(4x0.25)+(2x0.5))C	150	100
CF111.009.D	(4x(2x0.25)+2x0.5)C	200	150
CF111.010.D	(4x(2x0.25)+2x1.0)C	200	100
CF111.011.D	(4x(2x0.34)+4x0.5)C	200	100
CF111.014.D	(4x(2x0.25)C+(2x0.5))C	150	-
CF111.015.D	(4x(2x0.14)+4x0.5)C	200	100
CF111.020.D	(3x(2x0.14) +2x(4x0.14)+(2x0.5))C	200	100
CF111.021.D	((4x0.25) +3x(2x0.25+2x0.5))C	150	100
CF111.022.D	((2x0.25)+5x0.5)C	200	150
CF111.024.D	((4x0.14)+2x(2x0.34))C	200	150
CF111.026.D	(6x(2x0.25) +(2x0.34)C+(2x0.5))C	150	-
CF111.027.D	(5x(2x0.14)+2x0.5)C	200	150
CF111.028.D	(2x(2x0.15)+(2x0.38))C	200	150
CF111.032.D	3x(2x0.14)C+(3x0.14)C	200	100
CF111.040.D	(3x(4x0.14) +(2x0.14+2x0.34)+2x1.5)C	200	100
CF111.041.D	(2x(2x0.18)+5x0.5)C	200	150

Part No.	Number of cores and conductor nominal cross section [mm²]	Max. cable length [m] CASE M	CASE S
CF111.042.D	(3x(2x0.18)+6x0.5)C	200	100
CF113.001.D	(3x(2x0.14)C +(4x0.14)+(2x0.5))C	150	100
CF113.002.D	(3x(2x0.14)C+2x(0.5)C)C	100	100
CF113.003.D	(3x(2x0.14)+2x1.0)C	200	150
CF113.004.D	(2x(2x(2x0.14)) +(4x0.14)C+(4x0.5))C	100	-
CF113.005.D	(4x(2x0.14)+4x0.5)C	150	100
CF113.006.D	(3x(2x0.14)C+(4x0.14) +(4x0.25)+(2x0.5))C	100	-
CF113.007.D	(4x0.34)C	200	200
CF113.008.D	(3x(2x0.25))C	200	150
CF113.009.D	(4x(2x0.25)+2x0.5)C	150	100
CF113.010.D	(4x(2x0.25)+2x1.0)C	150	100
CF113.011.D	(4x(2x0.34)+4x0.5)C	100	100
CF113.013.D	(3x(2x0.14)C+2x0.5)C	150	100
CF113.014.D	(4x(2x0.25)C+(2x0.5))C	100	-
CF113.015.D	(4x(2x0.14)+4x0.5)C	150	100
CF113.016.D	(3x(2x0.25)C)C	150	100
CF113.017.D	(4x(2x0.14) +(4x0.14)C+4x1.0)C	100	100
CF113.018.D	(2x(2x0.25)+2x0.5)C	200	200
CF113.019.D	(3x(2x0.25)C +(3x0.25)+2x1.0)C	100	100
CF113.022.D	((2x0.25)+5x0.5)C	200	150
CF113.025.D	(3x(2x0.14)C+(2x0.5)C)C	100	100
CF113.027.D	(5x(2x0.14)+2x0.5)C	200	100
CF113.028.D	(2x(2x0.20)+(2x0.38))C	200	150
CF113.029.D	(5x(2x0.25)C +(2x0.25+2x0.5))C	100	-
CF113.031.D	(2x(2x0.25)C+2x1.0)C	150	100
CF113.032.D	3x(2x0.14)C+(3x0.14)C	150	100
CF113.033.D	4x(2x0.14)C+2x(1.0)C	100	100
CF113.036.D	(5x(2x0.25))C	150	100
CF113.037.D	(6x(2x0.25))C	150	100
CF113.038.D	(3x(2x0.14)+(2x0.34))C	200	100
CF113.040.D	(3x(4x0.14) +(2x0.14+2x0.34)+2x1.5)C	150	100
CF11.001.D	(3x(2x0.14) C+(4x0.14)+(2x0.5))C	150	100
CF11.002.D	(3x(2x0.14)C+2x(0.5)C)C	150	100
CF11.003.D	(3x(2x0.14)+2x1.0)C	200	150
CF11.004.D	(2x(2x(2x0.14)) +(4x0.14)C+(4x0.5))C	100	-
CF11.005.D	(4x(2x0.14)+4x0.5)C	150	100
CF11.006.D	(3x(2x0.14)C+(4x0.14) +(4x0.25)+(2x0.5))C	100	-
CF11.007.D	(4x0.34)C	200	200
CF11.008.D	(3x(2x0.25))C	200	150

Cables available in the chainflex® CASE

Measuring system, servo and motor cables

Part No.	Number of cores and conductor nominal cross section [mm²]	Max. cable length [m] CASE M	CASE S
Measuring system cables			
CF11.009.D	(4x(2x0.25)+2x0.5)C	150	100
CF11.010.D	(4x(2x0.25)+2x1.0)C	150	100
CF11.011.D	(4x(2x0.34)+4x0.5)C	100	100
CF11.012.D	(3x(2x0.14)C+(3x0.14)C +(4x0.14) +(2x0.14+2x0.5))C	100	-
CF11.013.D	(3x(2x0.14)C+2x0.5)C	150	100
CF11.014.D	(4x(2x0.25)C+(2x0.5))C	100	-
CF11.015.D	(4x(2x0.14)+4x0.5)C	200	100
CF11.017.D	(4x(2x0.14) +(4x0.14)C+4x1.0)C	100	100
CF11.018.D	(2x(2x0.25)+2x0.5)C	200	200
CF11.019.D	(3x(2x0.25)C +(3x0.25)+2x1.0)C	100	100
CF11.021.D	((4x0.25) +3x(2x0.25+2x0.5))C	100	100
CF11.022.D	((2x0.25)+5x0.5)C	200	150
CF11.025.D	(3x(2x0.14)C+(2x0.5)C)C	150	100
CF11.027.D	(5x(2x0.14)+2x0.5)C	200	100
CF11.028.D	(2x(2x0.20)+(2x0.38))C	200	150
CF11.031.D	(2x(2x0.25)C+2x1.0)C	150	100
CF11.032.D	3x(2x0.14)C+(3x0.14)C	150	150
CF11.033.D	4x(2x0.14)C+2x(1.0)C	100	100
CF11.034.D	3x(2x0.14)C+(4x0.14)C +2x(2x0.5)C	100	-
CF11.035.D	(4x(2x0.25)C+2x(2x0.5))C	100	-
CF11.038.D	(3x(2x0.14)+(2x0.34))C	200	150
Servo cables			
CF887.07.05.02.01	(4G0.75+(2x0.5)C)C	150	100
CF887.10.07.02.02	(4G1.0+2x(2x0.75)C)	100	-
CF887.15.15.02.01	(4G1.5+(2x1.5)C)	100	-
CF210.UL.15.15.02.01	(4G1.5+(2x1.5)C)	100	-
CF21.07.03.02.02.UL	(4G0.75+2x(2x0.34)C)C	100	-
CF21.07.05.02.01.UL	(4G0.75+(2x0.5)C)C	100	-
CF21.15.15.02.01.UL	(4G1.5+(2x1.5)C)	100	-
CF897.15.15.02.01	(4G1.5+(2x1.5)C)	100	-
CF270.UL.07.03.02.02.D	(4G0.75+2x(2x0.34)C)C	100	-
CF270.UL.10.07.02.02.D	(4G1.0+2x(2x0.75)C)	100	-
CF270.UL.15.15.02.01.D	(4G1.5+(2x1.5)C)	100	-
CF27.07.03.02.02.D	(4G0.75+2x(2x0.34)C)C	100	-
CF27.07.05.02.01.D	(4G0.75+(2x0.5)C)C	100	-
CF27.15.05.04.D	(4G1.5+(4x0.5)C)C	100	-
CF27.15.15.02.01.D	(4G1.5+(2x1.5)C)	100	-
CF29.15.15.02.01.D	(4G1.5+(2x1.5)C)	100	-
Hybrid servo cables			
CF220.UL.H100.07.04	(4G0.75+(2x0.34)C +(2xAWG22)C)C	100	-
CF220.UL.H101.10.04	(4G1.0+(2x0.75)C +(2xAWG22)C)C	100	-
CF220.UL.H304.15.04.D	(4G1.5+(2x1.5)C +(4xAWG26)C)C	100	-
CF280.UL.H100.07.04.D	(4G0.75+(2x0.34)C +(2xAWG22)C)C	100	-
CF280.UL.H101.10.04.D	(4G1.0+(2x0.75)C +(2xAWG22)C)C	100	-
CF280.UL.H203.15.04.D	(4G1.5+(3x1.0)C)C	100	-
CF280.UL.H300.03.04.D	(4G0.34+(2x0.34)C +(4xAWG26)C)C	150	100
CF280.UL.H301.07.04.D	(4G0.75+(2x0.5)C +(4xAWG26)C)C	100	-
CF280.UL.H304.15.04.D	(4G1.5+(2x1.5)C +(4xAWG26)C)C	100	-
CF280.UL.H401.07.04.D	(4G0.75+(2x0.5)C +(4xAWG24)C)C	100	-
Motor cables			
CF885.15.04	4G1.5	200	150
CF885.25.04	4G2.5	150	100
CF885.40.04	4G4.0	100	-
CF886.15.04	(4G1.5)C	150	100
CF886.25.04	(4G2.5)C	100	-
CF886.40.04	(4G4.0)C	100	-
CF210.UL.05.04	(4G0.5)C	200	150
CF210.UL.15.04	(4G1.5)C	150	100
CF210.UL.25.04	(4G2.5)C	100	-
CF30.15.04	4G1.5	200	150
CF30.25.04	4G2.5	150	100
CF30.25.05	5G2.5	100	-
CF30.40.04	4G4.0	100	-
CF31.15.04	(4G1.5)C	150	100
CF31.25.04	(4G2.5)C	100	-
CF895.15.04	4G1.5	200	150
CF895.25.04	4G2.5	150	100
CF895.40.04	4G4.0	100	-
CF896.07.04	(4G0.75)C	200	150
CF896.15.04	(4G1.5)C	200	100
CF896.25.04	(4G2.5)C	150	-
CF896.40.04	(4G4.0)C	100	-
CF270.UL.07.04.D	(4G0.75)C	200	150
CF270.UL.15.04.D	(4G1.5)C	150	100
CF270.UL.25.04.D	(4G2.5)C	100	-
CF270.UL.10.06.D	(6G1.0)C	150	100
CF27.07.04.D	(4G0.75)C	200	100
CF27.15.04.D	(4G1.5)C	150	-
CF27.25.04.D	(4G2.5)C	100	-
CF34.UL.15.04.D	4G1.5	200	150

chainflex® CASE

Cables available in the chainflex® CASE

Motor/spindle and torsion cables & pneumatic hoses

Part No.	Number of cores and conductor nominal cross section [mm²]	Max. cable length [m] CASE M	CASE S
CF34.UL.25.04.D	4G2.5	150	100
CF34.UL.40.04.D	4G4.0	100	-
CF35.UL.05.04	(4G0.5)C	200	150
CF35.UL.07.04	(4G0.75)C	200	150
CF35.UL.15.04	(4G1.5)C	150	100
CF35.UL.25.04	(4G2.5)C	100	-
CF37.15.04.D	4G1.5	200	150
CF37.25.04.D	4G2.5	150	100
CF37.40.04.D	4G4.0	100	-
CF38.15.04	(4G1.5)C	150	100
CF38.25.04	(4G2.5)C	100	-
Spindle cables/Single cores			
CF885.40.01	1x4.0	200	150
CF885.60.01	1x6.0	200	150
CF885.100.01	1x10	150	100
CF885.160.01	1x16	100	-
CF885.PE.25.01	1G2.5	200	200
CF885.PE.40.01	1G4.0	200	150
CF885.PE.60.01	1G6.0	200	150
CF885.PE.100.01	1G10	150	100
CF885.PE.160.01	1G16	100	-
CF886.160.01	(1x16)C	100	-
CF270.UL.60.01.D	(1x6.0)C	200	150
CF270.UL.160.01.D	(1x16)C	100	100
CF300.UL.40.01.D	1x4.0	200	200
CF300.UL.60.01.D	1x6.0	200	150
CF300.UL.100.01.D	1x10	200	150
CF300.UL.160.01.D	1x16	100	100
CFPE.15.01	1G1.5	200	200
CFPE.25.01	1G2.5	200	200
CFPE.40.01	1G4.0	200	200
CFPE.60.01	1G6.0	200	150
CFPE.100.01	1G10	200	150
CFPE.160.01	1G16	100	100
CF310.UL.25.01	(1x2.5)C	200	200
CF310.UL.40.01	(1x4.0)C	200	200
CF310.UL.60.01	(1x6.0)C	200	150
CF310.UL.100.01	(1x10)C	150	100
CF310.UL.160.01	(1x16)C	100	100
CF330.60.01.D	1x6.0	200	150
CF330.100.01.D	1x10	200	150
CF330.160.01.D	1x16	150	100
CF340.40.01	(1x4.0)C	200	200
CF340.160.01	(1x16)C	100	100
Twistable cables			
CFROBOT2.07.04.C	(4G0.75)C	200	150
CFROBOT2.07.05.C	(5G0.75)C	200	100
CFROBOT2.07.07.C	(7G0.75)C	150	100
CFROBOT3.02.03.02	(3x(2x0.25))C	150	100
CFROBOT3.02.04.02	(4x(2x0.25))C	150	-
CFROBOT3.02.06.02	(6x(2x0.25))C	100	-
CFROBOT3.05.05.02	(5x(2x0.5))C	100	-
CFROBOT4.001	(3x(2x0.14)C +(4x0.14)+(2x0.5))C	150	-
CFROBOT4.006	(3x(2x0.14)C+(4x0.14) +(4x0.22)+(2x0.5))C	100	-
CFROBOT4.009	(4x(2x0.25)+(2x0.5))C	150	100
CFROBOT4.015	(4x(2x0.14)+4x0.5)C	200	100
CFROBOT4.028	(2x(2x0.20)+(2x0.38))C	200	150
CFROBOT5.500	2x62.5/125	200	100
CFROBOT5.501	2x50/125	200	100
CFROBOT7.07.03.02.02.C	(4G0.75+2x(2x0.34)C)C	100	-
CFROBOT7.15.03.C	(3G1.5)C	200	100
CFROBOT7.15.04.C	(4G1.5)C	200	100
CFROBOT7.25.03.C	(3G2.5)C	150	100
CFROBOT7.25.04.C	(4G2.5)C	150	-
CFROBOT.035	(1x10)C	100	-
CFROBOT8.001	(2x0.35)C	200	150
CFROBOT8.022	(4x0.5)C	200	150
CFROBOT8.030	(2xAWG24)C +(2xAWG22)C	150	100
CFROBOT8.045	4x(2x0.15)C	150	100
CFROBOT8.049	4x(2x0.15)C	150	100
CFROBOT8.050	4x(2x0.15)C	150	-
CFROBOT8.052	4x(2x0.15)C	150	-
CFROBOT8.060	(2x(2x0.34))C	200	100
CFROBOT8.PLUS.001	(2x0.25)C	200	100
CFROBOT8.PLUS.022	(4x0.5)C	200	150
CFROBOT8.PLUS.045	(4x(2x0.15))C	200	150
CFROBOT8.PLUS.049	(4x(2x0.15))C	200	150
CFROBOT8.PLUS.050	(4x(2x0.15)C)C	200	150
CFROBOT8.PLUS.060	(4x0.34)C	200	150
CFROBOT9.010	(4x(2x0.25)C)C	150	-
Pneumatic hoses			
CAPE.A.06.0	4.0x1.0x6.0	200	-
CAPE.A.08.0	5.7x1.15x8.0	200	-
CAPU.A.06.0	4x1.0x6.0	200	-
CAPU.A.08.0	5.7x1.15x8.0	200	-

Find & compare cables

Quickcable

The chainflex® product finder simply shows which of our cables is best suited for your e-chain® application:
Select the cable type ❶, the connection and other desired product properties as well as the number of cores and the cross-section ❷, the nominal voltage and type of the e-chain® for your application. Select the bend radius, the maximum and minimum operating temperature ❸, torsion, maximum speed and acceleration, as well as the travel ❹.
The results are displayed at the bottom edge of the screen ❺.

▶ www.igus.eu/quickcable

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QuickLife

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Click on "Calculate"❸ to be shown the results ❹.

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Data sheets online

Technical details for all chainflex® cables series ... to be found online as PDF file:

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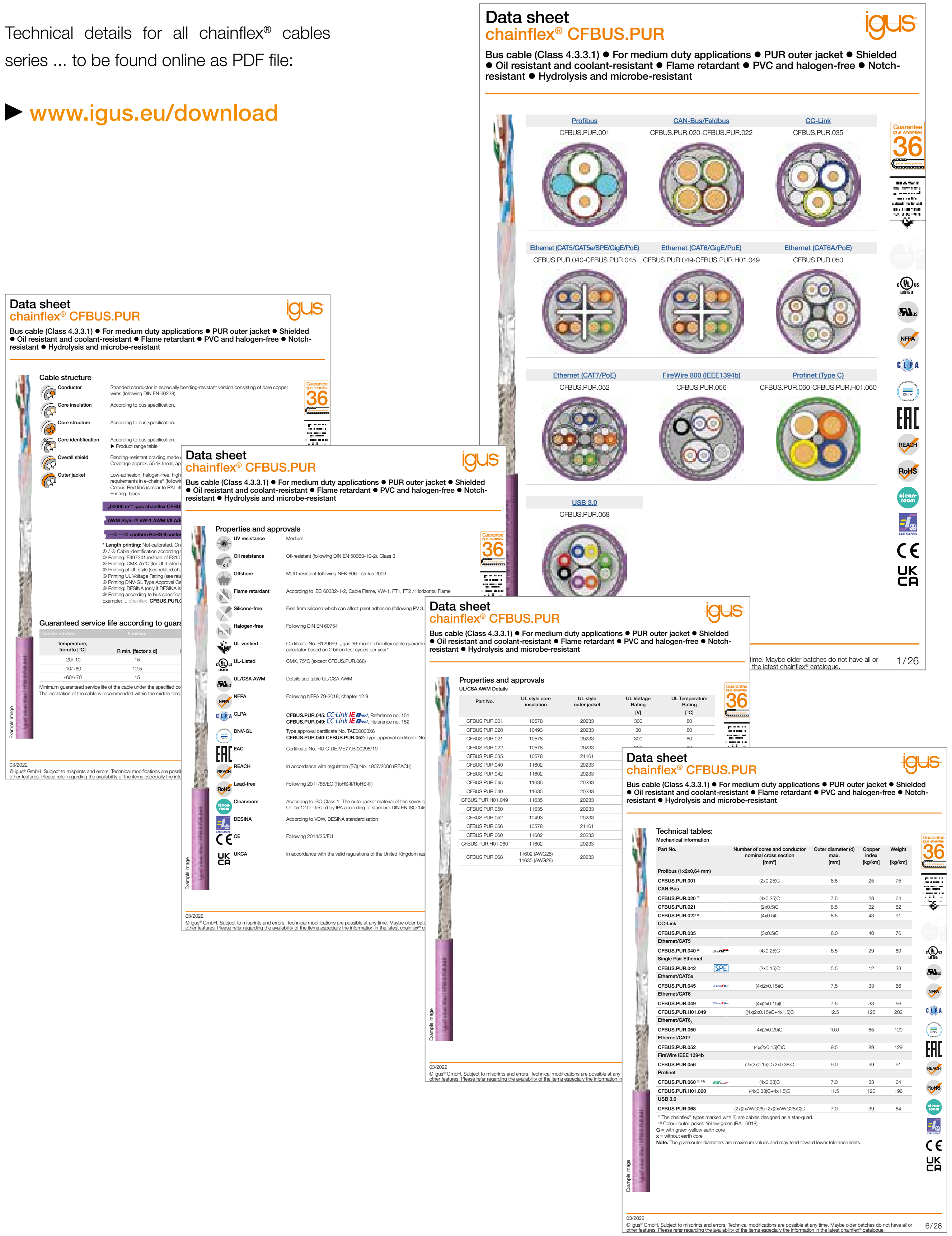

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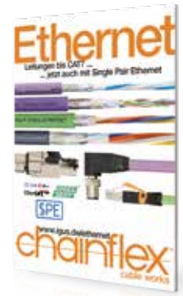

Brochure: chainflex® Ethernet cables
chainflex® cables and harnessed readycable® cables for Ethernet applications: CAT5, CAT5e, CAT6, CAT6A und CAT7, Profinet, Connectors.

MAT0073498.20

White paper
Find our latest whitepaper for these approvals online:
- UL verified
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igus® worldwide

igus® Offices

igus® Distributors

1 Germany

igus® GmbH
Spicher Str. 1a
51147 Köln
P.O. Box 90 61 23
51127 Köln
Phone 02203 9649-0
Fax 02203 9649-222
info@igus.de

2 Argentina

Borintech SRL
Av. Elcano 4971
C1427CIH Buenos Aires
Phone +5411 4556 1000
Fax +5411 4556 1000
igus@borintech.com

3 Australia

Treotham Automation Pty. Ltd.
14 Sydenham Road
Brookvale NSW 2100
Phone +61 2 9907-1788
Fax +61 2 9907-1778
info@treotham.com.au

4 Austria

igus® polymer Innovationen GmbH
Photo-Play-Straße 1
4860 Lenzing
Phone +43 7662 57763
Fax +43 7662 57751
igus-austria@igus.de

5 Belarus

SOOO Hennlich
Biryuzova street, 4/5, office 1012
220073 Minsk
Republik Belarus
Phone +375 17 258 88 28
Fax +375 17 373 39 26
info@hennlich.by

6 Belgium/Luxemburg

igus® B.V.B.A.
Jagersdreef 4A
2900 Schoten
Phone +32 3 330 13 60
Fax +32 3 313 79 91
info@igus.be

7 Bosnia + Herzegowina

HENNLICH industrijska tehnika d.o.o.
Tvornička 3
(Energoinvest-zgrada C&O)
BiH-71210 Ilidža - Sarajevo
Phone +387 33 451 439
Fax +387 33 451 439
info@hennlich.ba

8 Brazil

igus® do Brasil Ltda.
Rua Antônio Christi, nº 611
Parque Industrial III – FAZGRAN
Jundiaí – CEP 13213-183 – SP
Phone +55 11 3531-4487
Fax +55 11 3531-4488
vendas@igus.com.br

9 Bulgaria

Hennlich OOD, BG
4003 Plovdiv, Bulgaria
147A, Brezovsko shose Str.,
Rota center, fl. 3
Phone +359 32 511 326
Fax +359 32 621 929
office@hennlich.bg

10 Canada

igus® Office Canada
Suite 100-180
Bass Pro Mills Dr
Vaughan, ON L4K 5W4
Phone +1 905 7608448
Fax +1 905 7608688
webmaster@igus.com

11 Chile

Vendortec
Avda. Los Pajaritos 3195,
Oficina 1410
Edificio Centro Maipú
Maipú – Santiago
Phone +56 22 710 58 25
+56 23 245 02 00
ventas@vendortec.cl

12 China

igus® Shanghai Co., Ltd.
No.50, North Huancheng Road
Fengxian district
Shanghai 201401
P. R. China
Phone +86 21 8036 6999
Fax +86 21 8036 6116
cnmaster@igus.net

13 Colombia

PRODUCTOS I SAS
Carrera 28a, 15-18 Local 1,
Paloquemao, Bogotá
Phone +57 1 561 2959
ext. 113
igus@igus.com.co

14 Costa Rica

Enesa Equipos Neumaticos S.A.
Del Colegio Marista
100 este, 200 sur, 25 este
Urbanizacion Ciruelas
Alajuela, Costa Rica
Phone +506 2440-2393
Fax +506 2440-2393
equiposneumaticos@enesa.net

15 Croatia

Hennlich, Industrijska d.o.o.
Stupničkoobreška 17
Stupnički Obrež
10255 Gornji Stupnik
Phone +385 1 3874334
Fax +385 1 3874336
hennlich@hennlich.hr

16 Czech Republic

HENNLICH s.r.o.
Českolipská 9
412 01 Litoměřice
Phone e-chains®
+420 416 711332
Phone Plain bearings
+420 416 711339
Fax +420 416 711999
lin-tech@hennlich.cz

17 Denmark

igus® ApS
Lysholt Alle 8
DK-7100 Vejle
Phone +45 86 603373
Fax +45 86 603273
info@igus.dk

18 Ecuador

Ecuainsetec
Yugoeslavia N34-110 y Azuay
Quito
Phone +593 2 2253757
Fax +593 2 2461833
infouio@ecuainsetec.com.ec

19 Egypt

IEE International Company for Electrical Engineering
2nd floor, 25 Orabi St
Down Town, Cairo
Phone +202 25767370
Fax +202 25767375
sales@iee-egypt.com

20 Estonia

igus® OÜ
Vana-Tartu mnt 79a
75312 Peetri
Phone +372 667 5600
info@igus.ee

21 Finland

OEM Finland OY
Fiskarsinkatu 3
20750 Turku
PL 9, 20101 Turku
Phone +358 20 7499499
Fax +358 20 7499456
info@oem.fi

22 France

igus® SARL
49, avenue des Pépinières
Parc Médicis
94260 Fresnes
Phone +33 1 49840404
Fax +33 1 49840394
info@igus.fr

23 Greece

J. & E. Papadopoulos S.A.
12 Polidefkous str
Piraeus, 185 40
Phone +30 210 4113133
Fax +30 210 4116781
sales@papadopoulos-sa.com

24 Hong Kong

Sky Top Enterprises Ltd.
Room 1806 ; Block C; Wah Tat Industrial Center; Wah Sing Street; Kwai Chung Hong Kong
Phone +852 23318928
Fax +852 24269738
info@skytop.com.cn

25 Hungary

igus® Hungária Kft.
Ipari Park u.10.
1044 Budapest
Phone +36 1 3066486
Fax +36 1 4310374
info@igus.hu

25 Hungary

Tech-Con Kft.
Vésö utca 9-11
1133 Budapest
Phone +36 1 4124161
Fax +36 1 4124171
tech-con@tech-con.hu

26 India

igus® (India) Pvt. Ltd.
36/1, Sy No. 17/3
Euro School Road,
Dodda Nekkundi Industrial Area, - 2nd Stage
Mahadevapura Post
Bangalore 560048
Phone +91 80 68127800
Fax +91 80 68127802
info-in@igus.net

27 Indonesia

PT igus® Indonesia
Headquarter Indonesia
Taman Tekno BSD
Sektor XI, Blok L1 No. 15
Tangerang Selatan 15314
Phone +62 21 7588 1933
Fax +62 21 7588 1932
id-info@igus.net

28 Ireland

igus® Ireland
Caswell Rd
Northampton NN4 7PW
Phone +44-1604 677240
Fax +44-1604 677242
sales@igus.ie

29 Israel

Conlog LTD
P.O. Box 3265
17 Hamefalssim Str.
Industrial Zone Kiryat Arie
Petach-Tikva 49130
Phone +972 3 9269595
Fax +972 3 9233367
conlog@conlog.co.il

30 Italy

igus® S.r.l.
Via delle Rovedine, 4
23899 Robbiate (LC)
Phone +39 039 5906.1
Fax +39 039 5906.222
igusitalia@igus.it

31 Japan

igus® k.k.
Arcacentral 15F, 1-2-1 Kinshi,
Sumida-ku Tokyo JAPAN
Zip 130-0013
Phone +81 358 192030
Fax +81 358 192055
info@igus.co.jp

32 Kazakhstan

HENNLICH TOO
Nursultan Nazar-Baev Pros. Build. 4
100002 Kazybek Bi R-N,
Karaganda
Tel. +7 701 419 0756
igus@hennlich.kz

33 Kenya

Mantrad Ltd.
Sterling House, 1St. Floor
Moi Avenue, Mombasa
Phone + 254 722 706 830
Fax + 254 720 765 566
info@mantrad.co.ke

34 Latvia

Techvitas SIA
Daugavas iela 38-3
Mārupe, LV-2167
Phone +371 22 325 004
i_igusLettland_G@igus.de

35 Lebanon

Mecanix Shops SAL
Horsh Tablet - Ste Rita blvd
P.O.Box: 55384 Beirut
Phone +961 1 486701
Fax +961 1 490929
sales@mecanixshops.com

36 Lithuania

Hitech UAB
Terminalo g. 3
54469 Biruliskiu k. (Kauno LEZ)
Kauno raj.
Phone +370 37 323271
Fax +370 37 203273
info@hitech.lt

37 Mazedonien, Albania, Kosovo

Hennlich doo Beograd
Radomira Markovića 1/3
11222 Beograd
Phone +381 11 63 098 17
Fax +381 11 63 098 20
office@hennlich.rs

38 Malaysia

igus® Malaysia Sdn Bhd
Suite 1601-1, Level 16,
Tower 2, Wisma AmFirst,
Jalan SS 7/15 (Jalan Stadium),
47301 Kelana Jaya, Selangor
Phone +603 7803 0618
Fax +603 7886 1328
info@igus.my

39 Morocco

AFIT
5, Rue Amir Abdelkader
20300 Casablanca
Phone +212 522 633769
Fax +212 522 618351
souria.vu@premium.net.ma

40 Mexiko

igus® México S. de R.L. de C.V.
Boulevad Aeropuerto Miguel Alemán 160 Int. 135
Col. Corredor Industrial Toluca Lerma
Lerma, Estado de México C.P. 52004
Phone +52 728284 3185
Fax +52 728284 3187
fmarquez@igus.com

41 Middle East (except of UAE)

JISigus Middle East FZE
FF07, Jebel Ali Free Zone
PO Box- 17483
Dubai, United Arab Emirates
Phone +971 4222 1185
Fax +971 4222 1186
info@jisigus.com

42 Myanmar

Sea Lion Co. Ltd.
181 Bo Myat Tun St
Botataung Yangon
11161 Myanmar
Phone +95 1 29 97 97
Fax +95 1 20 27 51
zaw.m.thant@sealionmyanmar.com

43 Netherlands

igus® B.V.
Sterrenbergweg 9
3769 BS Soesterberg
Phone +31 346 353932
Fax +31 346 353849
info@igus.nl

43 Netherlands – dry-tech®

Elcee B.V.
Kamerlingh Onnesweg 28
NL-3316 GL Dordrecht
Phone +31 (0)78-654 47 77
Fax +31 (0)78-654 47 33
info@elcee.nl

44 Nigeria

Deepee Industrials Ltd.
11 Ishaga Road Surulere
Lagos
Phone +234 803 3899107
ovoachinike@deepeeindustrials.com

45 New Zealand

Treotham Automation Pty Ltd.
Level 4, 21 Putney Way
Manukau, Auckland 2104
Phone +64 9 278 6577
Fax +64 9 278 6578
info@treotham.co.nz

46 Norway

ASI Automatikk AS
Sankt Hallvards vei 3, port 8
3414 Lierstranda
Phone +47 9006 1100
info@asiflex.no

47 Peru

PROIGUS S.A.C.
Calle Bolivar 388/of. 203
Miraflores
Lima 18 – Perú
Phone +51 1 2414370
Fax +51 1 2428608
profaceventas@profaco.com

48 Pakistan

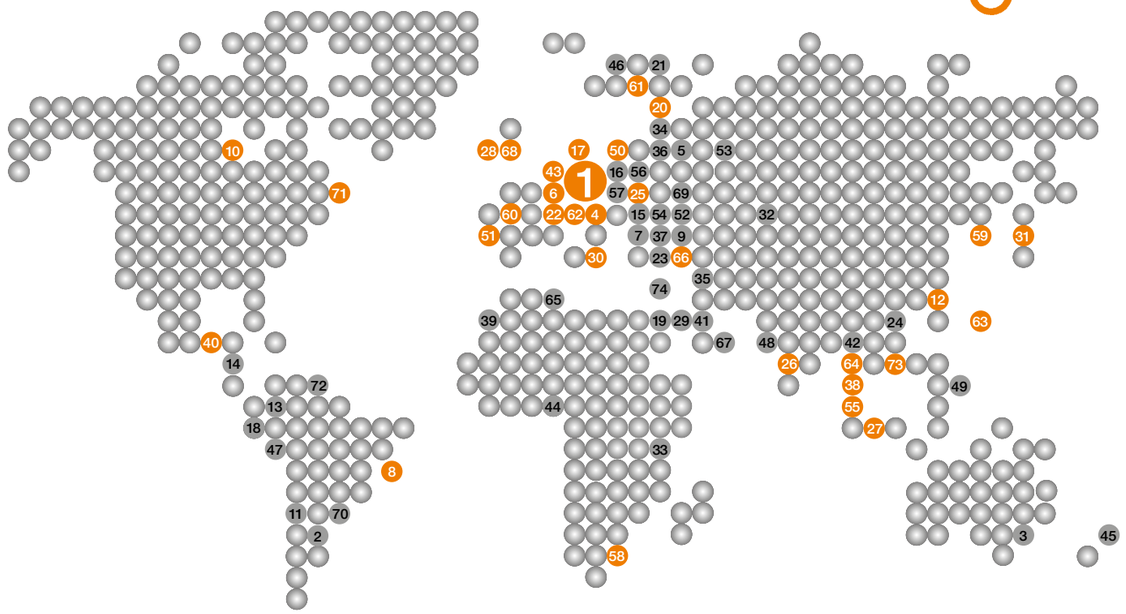
GEMS International Trading
501, Windsong Place, Block 7&8,
K.C.H.S, Off Shaheed-e-Millat Rd.
Karachi - 75350
Phone +92 21 34531505
marketing@gemsinter.com

49 Philippines

Silicon Exponents Corp.
Unit 1-B, 8414 LMN Bldg.
Dr. A. Santos Avenue Brgy.BF Homes Sucat Parañaque City
1700 Philippines
Phone +63 2 8250 126/135
Fax +63 2 8250 141
ryemrigor@sieplus.ph

50 Poland

igus® Sp. z o.o.
ul. Działkowa 121C
02-234 Warszawa
Phone +48 22 8635770
Fax +48-22 8636169
info@igus.pl



51 Portugal

igus® Lda.
R. Eng. Ezequiel Campos, 239
4100-231 Porto
Phone +351 22 6109000
Fax +351 22 8328321
info@igus.pt

52 Romania

Hennlich SRL
Str. Timotei Cipariu, Nr. 5-7
310213 Arad
Phone +40 257 211119
Fax +40 257 211021
igus@hennlich.ro

53 Russia

OOO Hennlich
Room 14
Naberezhnaya reki Lazuri, 15A
170028 Tver
Russian Federation
Phone +7 4822 787 180
Fax +7 4822 787 180, add. 380
hennlich@hennlich.ru

54 Serbia + Montenegro

Hennlich doo Beograd
Radomira Markovica 1/3
11222 Beograd / Srbija
Phone +381 11 63 098 17
Fax +381 11 63 098 20
office@hennlich.rs

55 Singapore – ASEAN HQ

igus® Singapore Pte Ltd
84 Genting Lane
#06-03 Axxel Innovation Centre
Singapore 349584
Phone +65 6487 1411
info@igus.com.sg

56 Slovakia

Hennlich s.r.o.
Na Bystricku 16
SK-036 01 Martin
Phone +421 43 421 2352
lintech@hennlich.sk

57 Slovenia

Hennlich d. o. o.
Ulica Mirka Vadnova 13
SI-4000 Kranj
Slovenija
Phone +386 4 53206-10
info@hennlich.si

58 South Africa

igus® Pty. Ltd.
Unit 29
Midline Business Park
Cnr Le Roux & Richards Drive
Midrand 1682
Phone +27 11312-1848
Fax +27 11312-1594
sales.sa@igus.de

59 South Korea

igus® Korea Co. Ltd.
Venture-ro 12-42,
Yeonsu-gu
Incheon city, 22011
Phone +82 32 82129-11
Fax +82 32 82129-13
kr-info@igus.net

60 Spain

igus® S.L.
Ctra. Llobatona, 6
Polígono Noi del Sucre
08840 Viladecans – BCN
Phone +34 93 647 39 50
Fax +34 93 647 39 51
igus.es@igus.es

61 Sweden

igus® AB
Berga Allé 1
254 52 Helsingborg
Phone +46 42 329270
Fax +46 42 211585
info@igusab.se

61 Sweden – the-chain

OEM Automatic AB
Box 1011 Dalagatan 4
573 28 Tranås
Phone +46 75 2424100
Fax +46 75 2424159
info@oemautomatic.se

61 Sweden – dry-tech®

Colly Components AB
Raseborgsgatan 9
P.O. Box 76
164 94 Kista
Phone +46 8 7030100
Fax +46 8 7039841
info@me.colly.se

62 Switzerland

igus® Schweiz GmbH
Winkelstr. 5
4622 Egerkingen
Phone +41 62 388 97 97
Fax +41 62 388 97 99
info@igus.ch

63 Taiwan

igus® Taiwan Company Ltd.
5F, No. 35, 24th Road
Taichung Industrial Park
Taichung 40850
Phone +886 4 2358-1000
Fax +886 4 2358-1100
info@igus.com.tw

64 Thailand

igus® Thailand Co., Ltd
1340 Soi Bangkok-Nonthaburi 30,
Bangkok-Nonthaburi Rd.,
Bangsue, Bangsue
Bangkok 10800
Phone +66 (0)2 587 4899
Fax +66 (0)2 587 4898
th-info@igus.net

65 Tunisia

BOUDRANT
53, Avenue de Carthage
1000 Tunis – Tunisia
Phone +216 71340244
Fax +216 71348910
info@boudrant.com.tn

66 Turkey

igus® Turkey
Güzeller Org. San. Bölg.
Galvano Teknik San. Sit.
Cumhuriyet Cad. 2/32
P.K. 41400 Gebze / Kocaeli
Phone +90 262 502 14 08
Fax +90 262 502 14 19
info@igus.com.tr

66 Turkey

HIDREL Hidrolik Elemanlar
Sanayi ve Ticaret A.S.
Percemli Sk. No. 7
Tünel Mevkii
34420 Karaköy / Istanbul
Phone +90 212 2494881
Fax +90 212 2920850
info@hidrel.com.tr

67 UAE + Oman

Unigroup FZE
Plot of Land M6-01
Sharjah Airport Free Zone
P.O. Box 120300
Sharjah - U.A.E.
Phone +971 6 5578386
Fax +971 6 5578387
automation@unigroup.ae

68 United Kingdom

igus®
Caswell Rd
Northampton NN4 7PW
Phone +44 1604 677240
sales@igus.co.uk

69 Ukraine

Hennlich Ukraine LLC (HQ)
Kramatorska Street 15
84100 Slovyansk City,
Donetsky Region
Phone +38 06262 33540
hennlich@hennlich.com.ua

69 Ukraine

Cominpro GmbH
Romena Rollana 12,
Office 100
61058 Kharkov
Phone/Fax +38 057-7174914
Mobile +38 050-4012625
cominpro@gmail.com

70 Uruguay

Larrique Rulemanes SA
Galicia 1204
Montevideo-Uruguay
Phone +598 29021773
Fax +598-29084824
larrique@larrique.com.uy

71 USA

igus® inc.
257 Ferris Avenue
P.O. Box 14349
East Providence
RI 02914
Phone +1 401 4382200
Fax +1 401 4387270
webmaster@igus.com

72 Venezuela

Neumatica Rotonda C.A.
Prolong Av. Michelena
C.C. Atlas Locales B-10 y B-11
Valencia, Edo. Carabobo
Phone +58 241 832.64.64
+58 241 832.32.50
+58 241 838.88.19
Fax +58 241 832.62.83
ventas@neumaticar.com

73 Vietnam

igus® Vietnam Company Ltd
Unit 4, 7th Floor, Standard Factory B, Tan Thuan Export Processing Zone
Tan Thuan Street
District 7, HCM City, Vietnam
Phone +84 28 3636 4189
info@igus.vn

74 Cyprus

G.C.V. Spare Parts & Services Ltd (HQ)
Industrial Area Anatoliko
8068 Pafos
Phone +357 26 812444
Fax +357 26 812447
igus@gcv-parts.com

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