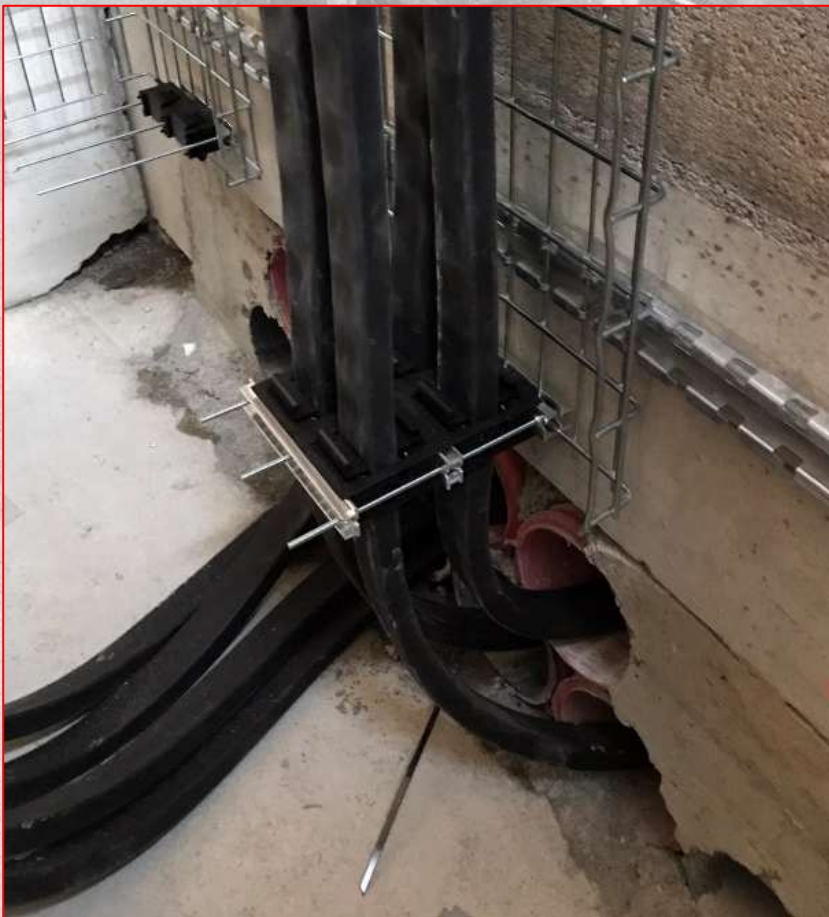



# FleXbus System

**FleXbus conductors buried or embedded in concrete.  
Recommendations for calculating admissible currents.  
(According to IEC Standard)**



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## 1) Introduction :

The Flexbus System is a flexible, easy-to-install electrical power connection solution for currents **from 500 A to 6300 A**.

**nVent ERIFLEX Flexbus is an innovative and patented connection solution between two electrical equipment installations**, such as transformers, switchboards, generators or large uninterrupted power supplies (UPS). Due to its unique concept, nVent ERIFLEX Flexbus is an alternative power connection solution for up to **50% quicker installation and 20% reduction in total installed cost** at a minimum.

Flexbus conductors are usually routed between the two connected elements in the open air, on cable trays (perforated, wired or ladder) or fixed directly to the wall or ceiling.

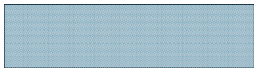
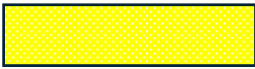







Some installations will require Flexbus conductors to be routed in **buried systems, in conduits, sleeves or channels**.

The purpose of this document is to specify our recommendations for calculating the permissible currents of Flexbus conductors in buried systems.

The recommendations given in this document are based on the reference standard: **IEC 60364 (Low-voltage electrical installations) Part 5-52: Selection and erection of electrical equipment – Wiring systems**.



## 2) Symbols used :

	Soil / Ground / Concrete
	Sand or loose soil
	Conduit / Cable ducting
	Added mechanical protection
	Closed service channel
	Open service channel
	FleXbus conductor support / bracing system
	FleXbus conductor
	Water / Flood-prone - Without water presence

## 3) Definitions :

### **Service channel**

open, ventilated or closed section of pipe located in the ground, with dimensions that do not allow people to move around, but in which the conduits or conductors are accessible over their entire length, during and after installation.

### **Conduit**

closed, circular cross-section enclosure for protecting insulated conductors or cables, allowing them to be installed or replaced by pulling. (IEC 61386)

### **Cable ducting**

A closed, buried enclosure with a straight, non-circular cross-section for protecting insulated conductors or cables, enabling them to be installed or replaced by pulling. (EN 50085)

### **Sheath**

an element that surrounds a pipe and provides it with additional protection in wall penetrations (wall, partition, floor, ceiling) or underground runs. (IEC 61386)

### **Trench**

opening made in a plot of land to lay insulated conductors, and filled in after they have been laid.

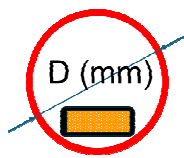
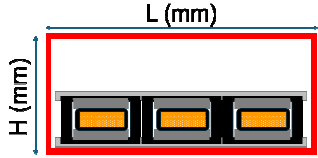
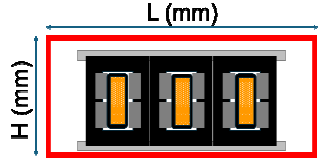


#### 4) FleXbus conductors in underground Conduit / Cable ducting

The inside dimensions of conduits, cable ducting or sheath must allow FleXbus conductors to be easily pulled out and removed after the conduits have been laid.

In the case of FleXbus conductors installed after the conduits or cable ducting have been laid, this rule is satisfied if their cross-sectional area, including insulation, does not exceed 30% of the internal cross-sectional area of the conduit or cable ducting.

#### Minimum dimensions for conduits and Cable ducting

		Minimum dimensions for conduits and Cable ducting	
		FleXbus conductors 220, 360, 545 and 640mm <sup>2</sup>	FleXbus conductors 800, 960, 1280 and 1810mm <sup>2</sup>
Conduit / Sheath		D min= 90mm	D min= 160mm
Cable Ducting		H min = 400mm L min = 400mm (3P) L min = 500mm (3P+N)	H min = 200mm L min = 600mm (3P) L min = 800mm (3P+N)
			

For two conductors per phase in symmetrical configuration, the height "H" must be multiplied by 2.

Only one conductor should be installed in a conduit/sheath. Positioning two or more conductors in the same conduit will not ensure the right distance between them for good temperature dissipation.

If there are several FleXbus conductors in the same cable ducting, a distance between these conductors must be maintained to allow proper cooling of the insulation. Therefore, FleXbus supports must be installed, and the distance between conductors will be achieved automatically by these supports.

In all cases, power and communication networks must be routed in separate conduits.

The conduit/sheath must be made of non-magnetic material.

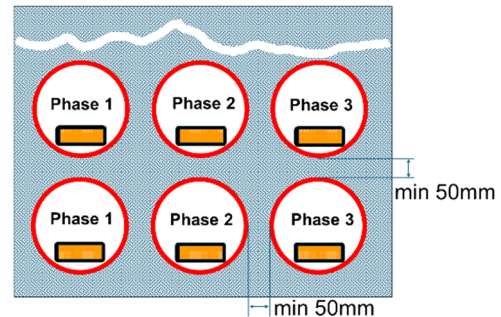
It is preferable to use conduits/sheath capable of withstanding temperatures of 90°C, in order to limit derating values. If you use conduits that can withstand temperatures up to 60°C, additional derating will be required.

Conduits that do not have flame-retardant properties must be completely encased in non-combustible materials.

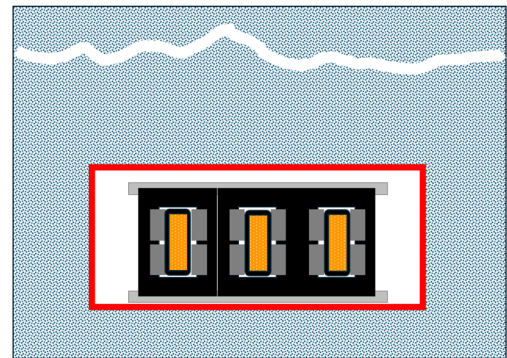
However, the ends of these conduits may be visible over a maximum length of 11 cm, except in premises where there is a risk of fire or explosion, where they must be flush with the floor.

Conduits/sheaths must be separated by a minimum distance of 50mm. Separator combs are available on the market.

Each Flexbus conductor must be installed in a separate conduit/sheath. In case of connection with several conductors per phase, it will be necessary to position the conduits/sheaths in tiers to allow a balanced load in each conductor.



If Flexbus conductors are in a single cable ducting, a distance must be maintained between them to allow proper cooling of the insulation. This distance between conductors is automatically created by the supports. The conductors must not touch the cable ducting.



Not clogging the ends of the conduit will allow some heat dissipation.

If the ends of the conduit are plugged, the ambient temperature will rise and a higher derating coefficient will apply.

However, the standard states that conductor conduits, sheaths, cable ducting, etc. must be sealed to prevent the passage of flammable gases, vapors, dusts or liquids between a hazardous and a non-hazardous location, or between one area and another.

## **Recommendations for pulling Flexbus conductors into conduits and Cable ducting**

- When pulling cables and conductors in conduit, sheath and cable ducting, the addition of lubricants is permitted, with the exception of silicone-containing lubricants.
- The inside of the conduits must be free of elements that could damage the conductor insulation during pulling, such as stones, damaged conduit, etc....
- Conduits or sheaths should be as straight as possible. Draught chambers must be installed if ducts change direction.
- The temperature of the Flexbus conductor before pulling must be between 5°C and 40°C.
- Reduce friction by using rollers, diabolos and pulleys, and protect Flexbus conductors from sharp edges, right angles, cable tray wings, concrete reinforcing bars protruding into hoppers....
- The Flexbus conductor must be tapered at the end to avoid snagging in the conduit.
- Carefully hook the Flexbus conductor to the pulling device to avoid twisting during pulling (never hook onto the ready-to-use palm of the Flexbus conductor).
- Use a dynamometric winch to control the pulling force during uncoiling. The pulling force should never exceed 200 daN for the smallest Flexbus conductor section (220mm<sup>2</sup>) and up to 480 daN for the largest section (1810mm<sup>2</sup>).
- The pulling speed should be reduced (approx. 10m/min) to avoid excessive self-heating of the Flexbus conductor insulation due to friction.
- Unwinding is carried out from the top of the reel, with one or two people constantly monitoring the flow, controlling and braking the conductor to prevent loop formation and loosening of the turns.
- The Flexbus conductor must never come into contact with sharp edges, and particular care must be taken to prevent stones or other objects from entering the sheath and damaging the Flexbus conductor insulation during pulling.
- The use of a self-tightening pulling sock on the outer sheath is acceptable only when the pulling force is reduced.
- After pulling, the section of Flexbus conductor to which the pulling sock has been applied, increased by one meter, must be removed.
- Once the Flexbus conductor has been passed through, the end of the conductor must be sealed to prevent water penetrating the conductor before electrical connection.

## Example of conduits, buried sheath and cable ducting



## Derating factor to be applied to Flexbus conductors installed in ducts or conduits

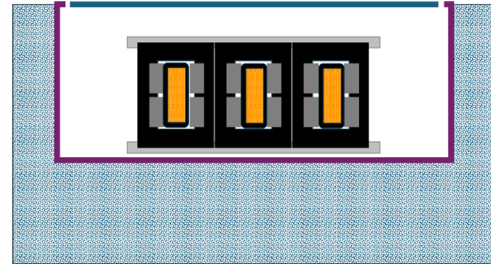
Conduit / sheath / Cable ducting			Length of conduit / sheath / cable ducting (meters)			
			<=1	>1 up to 3	>3 up to 5	> 5
			Derating factor			
		90°C conduit / sheath, plugged at both ends, Without water presence	0,75			
		90°C conduit / sheath, Not plugged, Without water presence	1	0,81	0,78	0,75
		60°C or more conduit / sheath , plugged or not, Water / Flood-prone	0,64			
		Cable ducting, plugged at both ends, Without water presence	0,83			
		Cable ducting, plugged at both ends, Water / Flood-prone	0,71			
		Cable ducting, Not plugged, Without water presence	1	0,93	0,88	0,83



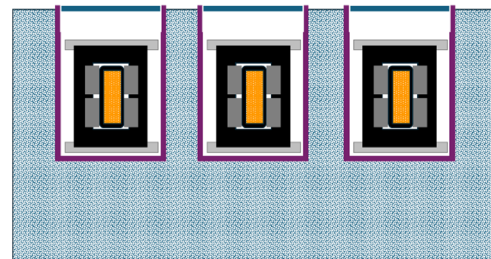
## 5) FleXbus conductors in buried service channel (closed or open)

FleXbus conductors can be installed in separate channels or in a single channel.

If installed in a single channel, FleXbus supports must be installed to ensure the right distance between conductors for proper cooling.



If they are installed in separate channels, the use of supports is also mandatory, so that the conductors do not come into contact with the channel. This will also ensure better cooling of the conductors. Separate channels must be made of non-magnetic material.



FleXbus conductors must not occupy more than 30% of the channel's interior volume.

### Minimum service channel dimensions

			Minimum service channel dimensions (1 conductor / phase)	
			FleXbus conductors 220, 360, 545 et 640mm <sup>2</sup>	FleXbus conductors 800, 960, 1280 et 1810mm <sup>2</sup>
Separate channels	Closed		H min = 250mm L min = 250mm	H min = 300mm L min = 300mm
	Open and ventilated		H min = 250mm L min = 250mm	H min = 250mm L min = 300mm
Single channel	Closed		H min = 400mm L min = 400mm (3P) L min = 500mm (3P+N)	H min = 400mm L min = 600mm (3P) L min = 800mm (3P+N)
	Open and ventilated		H min = 250mm L min = 400mm (3P) L min = 500mm (3P+N)	H min = 250mm L min = 600mm (3P) L min = 800mm (3P+N)

For two conductors per phase in symmetrical configuration, the height "H" must be multiplied by 2.









In all cases, power and communication networks must be routed in separate channels.

Open or ventilated channels allow better heat dissipation from conductors. As a result, this type of equipment offers lower derating factors. On the other hand, open channels can expose conductors to solar radiation (UV). If this is the case, admissible currents must be calculated taking into account an additional correction factor. This correction factor can be adapted to the estimated irradiance at the installation site. Nevertheless, we recommend that Flexbus conductors be protected against UV exposure by, for example, a protective cover on top, without touching the conductor and allowing normal ventilation.

### Example of service channel



### Derating factor to be applied to Flexbus conductors installed in service channel

Service Channel			All lenghts Derating factor
		Closed service channel, plugged at both ends, Without water presence	0,84
		Closed service channel, plugged at both ends, Water / Flood-prone	0,77
		Open service channel, conductors not UV exposed, Without water presence	0,95
		Open service channel, conductors UV exposed, Water / Flood-prone	0,77

## 6) FleXbus underground conductors - in a trench

FleXbus conductors are thickly insulated and can be buried directly in the ground under the following conditions:

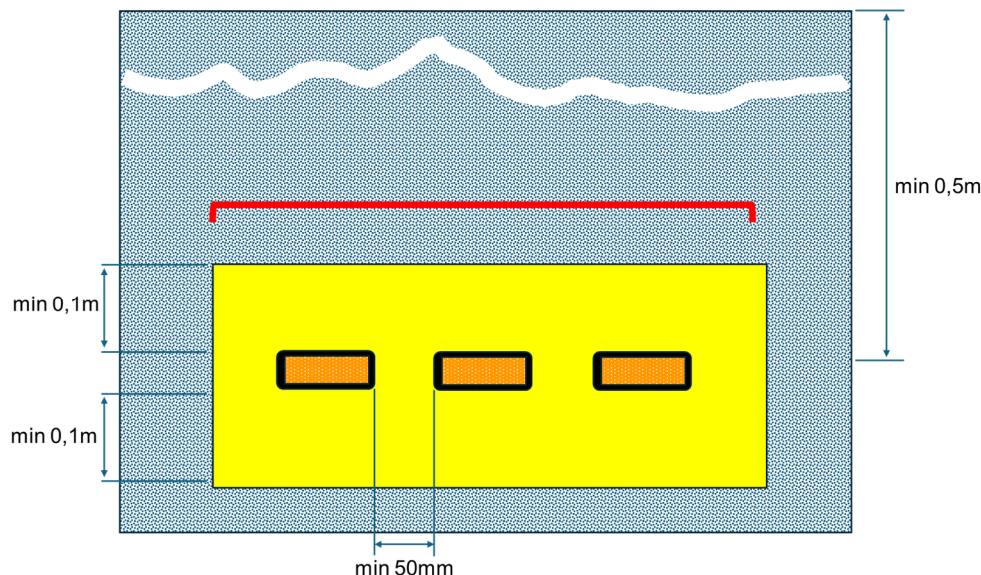
FleXbus conductors must be protected against damage caused by soil compaction, contact with hard objects, and the impact of hand tools when digging.

To counter the effects of soil compaction, FleXbus conductors must be buried in normal soil, at least 0.50 m from the surface (Note: in some countries, this depth must be 0.70 m). This depth is increased to 0.85 m at road crossings and under sidewalks.

These depths may not be respected, for example in rocky terrain, if steps are taken to ensure that FleXbus conductors are not directly subjected to the effects of soil compaction, for example by using sheaths.

FleXbus conductors are placed between two layers of river sand or loose earth, each 0.10 m thick. It is important that there should be no risk of contact with sharp stones.

Independent mechanical protection (to EN 50520) against the impact of metal hand tools must be provided. It is recommended to place this independent mechanical protection at a distance of at least 0.10 m above the FleXbus conductors and covering at least the entire width of the conductors.



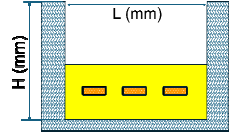
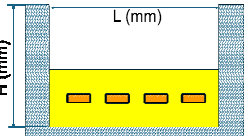
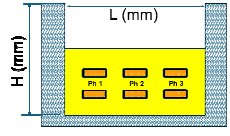
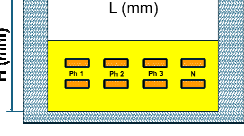
If there are several Flexbus conductors in the same trench, a distance must be maintained between them to allow proper cooling of the insulation.

This distance must be at least 50 mm. Flexbus supports must not be used, as they must not be buried.

When connecting several conductors per phase, Flexbus conductors should be positioned in tiers to allow balanced loading of each conductor. A 0.10 m layer of sand or loose earth is required between the two layers of conductors.

Where the nature of the ground is such that special chemical action may be expected, Flexbus conductors should be installed in conduits or channels.

## Minimum trench dimensions

		Minimum trench dimensions	
		Flexbus conductors 220, 360, 545 et 640mm <sup>2</sup>	Flexbus conductors 800, 960, 1280 et 1810mm <sup>2</sup>
3P 1 conductor per Phase		H min = 650mm L min = 500mm	H min = 650mm L min = 700mm
3P+N 1 conductor per Phase		H min = 650mm L min = 600mm	H min = 650mm L min = 800mm
3P 2 conductors per Phase		H min = 800mm L min = 500mm	H min = 800mm L min = 650mm
3P+N 2 conductors per Phase		H min = 800mm L min = 600mm	H min = 800mm L min = 800mm


Trench dimensions for Flexbus conductors at 0.5m depth



Example of trenching and additional mechanical protection



Derating factor to be applied to Flexbus conductors installed in a trench

<div>Trench</div> <div></div>	All lenghts
	Derating factor
	0,72

## 7) Ground temperature

All derating factors in this document apply to a ground temperature of 20°C, as recommended by the standard.

The ambient temperature value to be used is the temperature of the surrounding environment when the cable or conductor in question is unloaded.

**Correction factors for ambient floor temperatures other than 20°C to be applied to admissible current values**

Ground temperature (°C)	Correction factors for ground temperatures other than 20°C
10	1,07
15	1,04
<b>20</b>	<b>1</b>
25	0,96
30	0,93
35	0,89
40	0,85
45	0,8
50	0,76
55	0,71
60	0,65

## 8) Soil thermal resistivity

All derating coefficients in this document apply to a soil resistivity of 2.5 K-m/W, as recommended by the standard.

If the soil resistivity is different from 2.5 K-m/W, an additional correction factor applies

**Correction factors for Flexbus conductors directly in the ground or in conduits in soils with resistivities other than 2.5 K-m/W to be applied to admissible current values.**

Soil thermal resistivity, K·m/W	0,5 to 2,5	3
Correction factor for Flexbus conductors in conduits, sheaths, cable ducting and channels	1	0,96
Correction factor for Flexbus conductors directly in the ground	1	0,9

## 9) FleXbus conductors water resistance

FleXbus insulation has been tested for water resistance.







The test sequence includes:





- Tested for 14 weeks with conductor immersed in water at 60°C. Regular resistivity tests - PASSE.


FleXbus Conductor is not designed to be a permanent water submerged conductor. However, according to our tests and certification, FleXbus Conductor can be temporarily in contact with water or submerged, for example, in the case of flooding.

It is important that water does not penetrate the inside of the conductor through the ends, between the insulation and the braid. See our IP55 & IP66 conductor entry to protect the termination against dust and water.

## 10) Summary of correction factors for FleXbus conductors buried or embedded in concrete

Conduit / sheath / Cable ducting		Length of conduit / sheath / cable ducting (meters)			
		<=1	>1 up to 3	>3 up to 5	> to 5
		Derating factor			
	90°C conduit / sheath, plugged at both ends, Without water presence	0,75			
	90°C conduit / sheath, Not plugged, Without water presence	1	0,81	0,78	0,75
	60°C or more conduit / sheath , plugged or not, Water / Flood-prone	0,64			
	Cable ducting, plugged at both ends, Without water presence	0,83			
	Cable ducting, plugged at both ends, Water / Flood-prone	0,71			
	Cable ducting, Not plugged, Without water presence	1	0,93	0,88	0,83

Service Channel		All lenghts
		Derating factor
	Closed service channel, plugged at both ends, Without water presence	0,84
	Closed service channel, plugged at both ends, Water / Flood-prone	0,77
	Open service channel, conductors not UV exposed, Without water presence	0,95
	Open service channel, conductors UV exposed, Water / Flood-prone	0,77

Trench		All lenghts
		Derating factor
		0,72

Correction factors for ambient soil temperature at 20°C and soil resistivity at 2.5 K-m/W

## 11) FleXbus conductor current ratings

The correction factors (k) to be applied to FleXbus conductors buried or embedded in concrete are based on the following current ratings (In):

FleXbus conductor type	Cross Section (mm <sup>2</sup> )	Nominal current rating 1 conductor per phase <b>In</b>	Nominal current rating 2 conductors per phase (symmetrical) <b>In</b>
FLEXCOND220	220	666 A	1332 A
FLEXCOND360	360	901 A	1802 A
FLEXCOND545	545	1127 A	2254 A
FLEXCOND640	640	1233 A	2466 A
FLEXCOND800	800	1533 A	3066 A
FLEXCOND960	960	1761 A	3522 A
FLEXCOND1280	1280	1984 A	3968 A
FLEXCOND1810	1810	2356 A	4712 A

Note: The above currents (In) are valid for the open-air sections of the FleXbus conductor path for an ambient temperature of 30°C and for a current frequency in DC and up to 60Hz. If, for example, the open-air derating coefficient is higher than that for the buried part, (e.g. for an open-air path of 50°C: k = 0.82) the more severe derating coefficient should always be used.

**FleXbus buried current = In x k buried**

### Example 1:

For a desired electrical connection of 1400A. (1000kVA @ 410V)

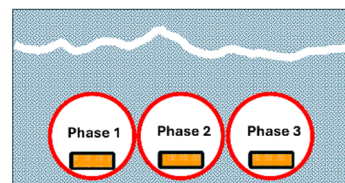
Conductors in unplugged 90°C sheaths over 7 meters, without water (k = 0.75)

In FleXbus conductor 960mm<sup>2</sup> = 1761A

Buried current = 1761A x 0.75 = 1320A. Insufficient cross-section 😞

In FleXbus conductor 1280mm<sup>2</sup> = 1984A

Buried current = 1984A x 0.75 = 1488A. Appropriate cross-section 😊



### Example 2:

For a desired electrical connection of 2816A. (2000kVA @ 410V)

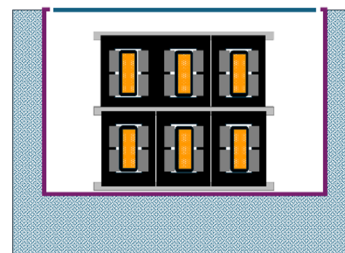
Conductor routing in closed, floodable channel over 12 meters (k = 0.77)

In FleXbus conductor 2 x 960mm<sup>2</sup> = 3522A

Buried current = 3522A x 0.77 = 2711A. Insufficient cross-section 😞

In FleXbus conductor 2 x 1280mm<sup>2</sup> = 3968A

Buried current = 3968A x 0.77 = 3055A. Appropriate cross-section 😊





## 12) FleXbus conductor protection against rodents and termites.

Electrical conductors are installed in a wide variety of environments, with some being more susceptible to pests, rodents, or termites. This is especially true for nVent ERIFLEX FleXbus conductors or cables, which are often laid close to the ground or directly buried in underground conduits or trenches.

To guard against this risk, a new version of FleXbus conductors is now available, featuring a rodent and termite repellent. During the extrusion process, an additive/masterbatch is incorporated into the outer sheath of the FleXbus conductor, guaranteeing long-lasting effectiveness thanks to the controlled release of active ingredients.



For further data and specifications on the FleXbus system, please refer to the catalog/technical guide.



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