Roxtec

DESCRIPTION AND APPLICATION GUIDELINES

Roxtec BG™ B/BG™ sealing solutions

A modular-based cable transit device for bonding and grounding of armored and shielded cables

Prepared for: Roxtec International AB
Date: 2014-09-02
Author: Bo Millevik, Roxtec Group, Box 540, Karlskrona, Sweden

Contents

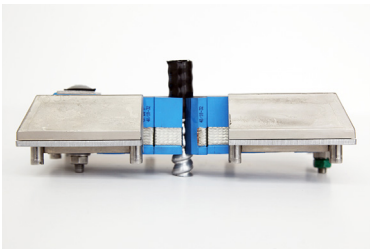
1. Roxtec BG B / BG

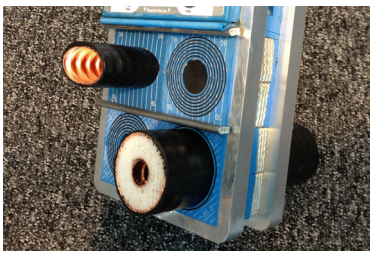
1.1 General description

The Roxtec BG B / BG product family is designed to safely and efficiently bond or ground armored and shielded cables through a single cut-out opening in a wall, floor or electrical enclosure. The product provides a secure means of cable termination and pass-through, provides a fire resistant seal, and establishes a secure bonding path to ground for metallic cable components. The product targets applications where bonding glands, earthing kits or special earthing arrangements traditionally have been deployed.

1.2 Technical description

The system consists of frames and Roxtec BG B / BG sealing modules that, in addition to the environmental sealing functions, provide an integrated earth path for armored and shielded cables in a similar way that bonding or earthing glands do. Each cable passing through the system can be individually connected to earth when the inner metallic layer, such as an armor, shield or screen, is exposed. The modules are separately adapted to fit the dimensions of the outer sheet and the exposed metallic layer. Each module half has an earth strap around its perimeter which is directly, or through adjacent modules, in contact with the frame. Multiple earth paths are created this way. This means that the available conductive mass for current transportation is reinforced with the number of modules in the system, and the stayplates further distribute currents. This ensures that there is enough conductive mass to carry high currents even in case of simultaneous faults in several cables. Frames are either welded to an already earthed structure or will act as an intermediate earthbar when connected to the ordinary earthing system.





The pictures above show how the braid mates both the cable and the frame. The pictures to the right do not demonstrate a real installation, only the different positions of the braid for the BG B and BG system. The tin-plated copper braid is embedded into the EPDM module and gives a flexible design that shapes to irregularities of different cable and armor designs and maximizes the surface for the electrical contact. The braid is dimensioned to meet code requirements for earth conductor seizing, hence the braid grows in cross-sectional-area (csa) per module size.

This cable entry arrangement reduces earth wiring and conductor length to a minimum resulting in very low impedance to earth. Such principles are crucial for an efficient High Frequency/EMI grounding solution required for electromagnetic compatibility, and due to the braid seizing the electrical safety aspect is not compromised.

Beside the electric aspect, this wiring method simplifies the installation which saves time and material. Roxtec systems are compression type sealing solutions. Depending on the type of frame, different types of compression units and stayplates are used for final sealing and mechanical integrity.

2. Applications

There are different reasons for grounding or earthing, and for connecting cable armors, shields, or screens to earth/ground. The basic legal requirements for electrical safety and for preventing fire are given by electrical codes such as NEC/CEC, BS7671 or IEC 60364 series. These codes state that such armor or shields shall be connected to earth.

In most cases this is for the purpose of equipotential bonding of the cable armor, but sometimes the armor is the actual return path for a fault current, the protective earthing conductor.
A Lightning Protection System (LPS) is also legally called for by code in certain facilities. Additional earthing and protection of cables and equipment are part of that as well.

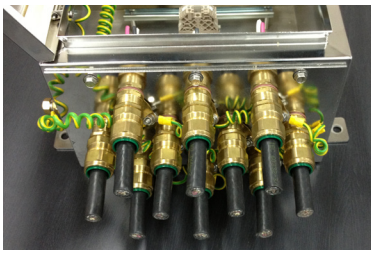
Another aspect of grounding is for electromagnetic compatibility, EMC. This is to minimize risk of electromagnetic interference, EMI. This can in turn cause anything from harmless noise to malfunction in systems having further severe secondary effects. EMC is an area not very well defined but it is slowly being addressed in codes and requirements. In practice this means that there is often a gap in specifications and requirements which the electrical system designer or installer has to fill to make sure that an installation becomes electromagnetically compatible. Armored and shielded cables may have to be used to achieve this which drives a need for connecting such armor or shields to ground/earth too.

On top of this, there are additional legal earthing requirements for hazardous/explosive environments aiming to further minimize voltage levels between metallic objects, such as cable armor and pipes.

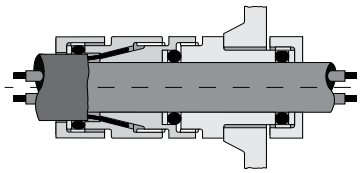
Currently there are no worldwide commonly recognized naming conventions for these different purposes for grounding which often cause confusion. In this document, the information refers to the IEC definitions such as Protective Earthing (PE, Equipment grounding, Power return ground…), Equipotential Bonding (Bonding, Potential Equalization…) or Functional Earthing (Instrument ground, EMI/EMC grounding…).

2.1 Equipotential bonding

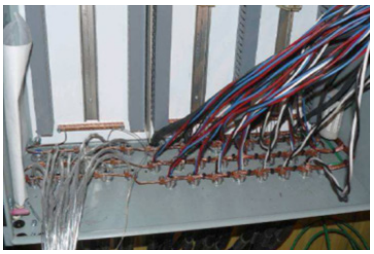
The most common application for BG B / BG systems is for equipotential bonding of armored cables. Even though such armor is a mechanical enforcement, electrical codes which apply for voltages >50V, call for such armor or metallic layers to be connected to ground. For terminations into junction boxes, terminal boxes, cabinets and enclosures, this is an area traditionally served by bonding glands or through-glands with additional individual ground conductors. Pictures below show traditional methods for boxes and enclosures.



Bonding glands with additional external grounding conductor.



Schematic design of a bonding gland.

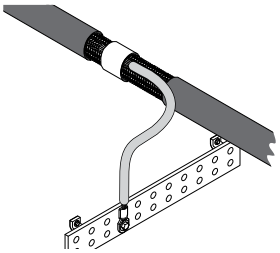


Example of a "Daisy-chained" earth path.

For wall and floor penetrations, this is typically arranged with earthing kits and clamps. There are many such installations carried out in the past with Roxtec standard products.

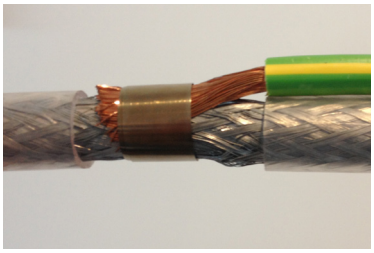
Example of earthing cleats/clamps.

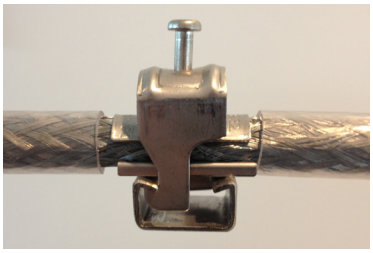
Earthing with external conductors resulting in a so called "pig-tail".



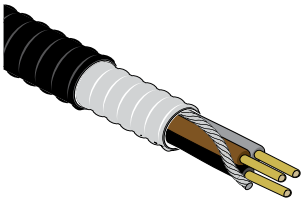
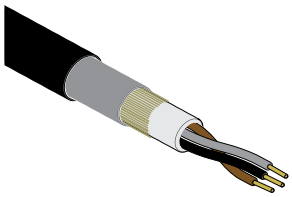
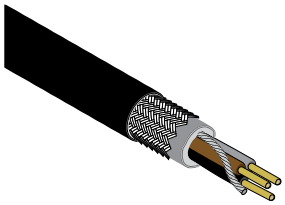
Schematic view of a typical "pig-tail earthing".

Examples of common accessories:

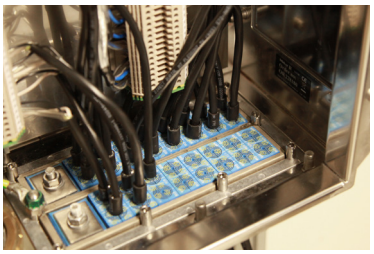




The cable armor can be either corrugated such as for Metal Clad (MC), jacketed AC cables (ACWU, ACIC) and TECK, or having wire (SWA) or a braided armor. In most cases, a separate conductor serves as protective earth and the outer armor is connected for equipotential bonding.

For such cables, the armor is typically terminated at the cable entry in the Roxtec BG B / BG system. The frame will act as an intermediate earth bar and must be connected to bonding bar. For frames welded to an earthed structure, no further earth conductor is required.
The PE conductor inside a cable, or running separately, is connected to a PE bar or terminals as normal. Roxtec BG B / BG solutions will eliminate the individual ground conductors and form a clean and organized solution with less installation efforts. The pictures below show a few actual examples of this.



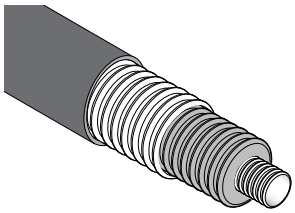
Typical applications are found within the following industries:

Onshore/offshore oil & gas and petrochemical.
Marine
Process industries including mining and metals processing
Explosive/hazardous environments
High-tech buildings
Other heavy industries in general
Note that offshore applications may be different in that protective earthing and equipotential bonding may not be differentiated as the hull/structure serves the purpose for both.

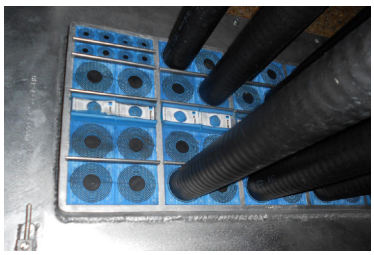
2.2 Equipotential bonding for lightning protection

This is a similar application where it should be noted that the BG B / BG system is not intended to be a part of the direct Lightning Protection System (LPS). However, wherever cables are routed along high-raised structures, which may be a part of the LPS itself, high currents are introduced onto the cable armor even if it is not hit directly by a strike. Earthing through Roxtec BG B / BG systems is a very effective earthing method where such cables enter a structure such as a building, shelter, deck or bulkhead. In addition to the earlier mentioned industries the telecom sector and especially cell sites have such structures. The surge and transients from a strike have a broadband spectrum which requires HF designed grounding methods to avoid equipment damages. Beside cable types already mentioned, antenna and transmission equipment cables need to be earthed.

Typical telecom cables are of coax type, such as feeder cables and transmission lines, where efficient grounding of the outer metallic layer is critical. This layer can be fully homogeneous, smooth or corrugated, but it can also be a braided type of screen.

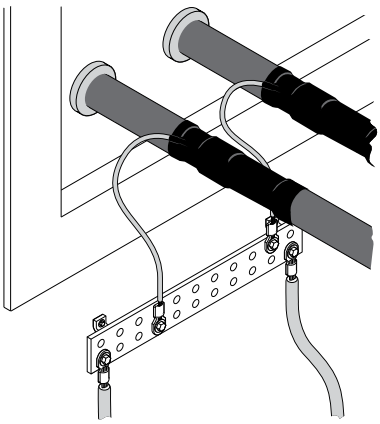


Telecom earthing arrangements traditionally use earthing kits with copper earth bars. Copper thefts have become a huge issue as a missing earth bar leaves a site without protection and causes a high risk for equipment damages, downtime and frequent and expensive replacements. The Roxtec frame replaces the copper bar and becomes an integrated part of the entry panel. The BG B / BG system does not expose any copper, mitigating copper thefts, and a lower ground path impedance is achieved as well thanks to the replaced external wiring.



Typical applications are within:

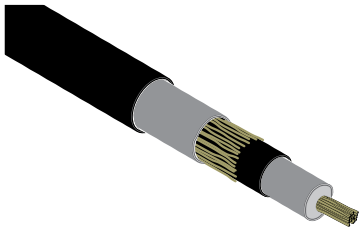
Telecom shelters
Railway and trackside equipment
Mobile and rural applications
Construction, roof-top equipment
Offshore on-deck



Schematic view of traditional solution.

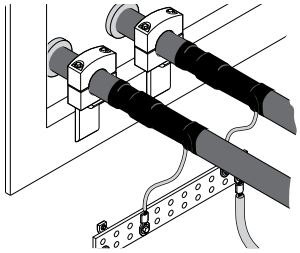
2.3 Protective earthing

These are the applications where single or multi-conductor cables have no separate inner PE conductor and the armor or screen serves this purpose instead. In this category, the armor is not a mechanical protection but serves either as a PE conductor (return path for fault current) or as a screen to contain the electrical field inside a cable (HV cables). Common cable types have helically wound copper wires, with or without metallic tape, but they can also be of a braided design.



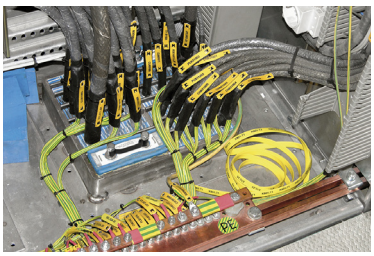
A common installation method is to bundle these wires, or the braid, and connect to a PE bus bar directly or indirectly using various clamps, earthing kits, bonding braids, etc. The intent of such installations is electrical safety, but they may cause EMC issues because of the excessive individual earth conductor routing inside a cabinet or equipment.

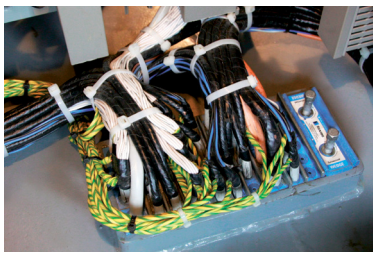
Typical installation material.



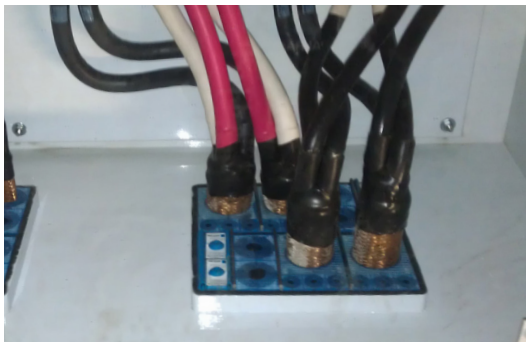
Schematic view.

Pictures below show how this method has been realized frequently in the past using Roxtec systems with additional parts for earthing.

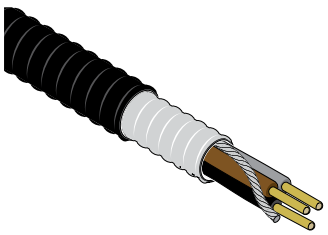




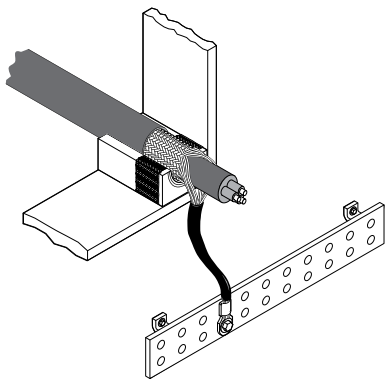
The BG B / BG system excludes this additional wiring. Bolted frames may require a wired connection to PE bar, but in welded constructions this may be omitted as shown in the picture below.



Metal Clad (MC) cables approved for PE applications without the inner PE conductor are normally terminated into earthing glands. Hence, when installed in the BG B / BG system such cables can be handled and terminated in the same way as for equipotential bonding, but in this case they will provide a protective connection to earth. Usually, such cables have a continuous welded corrugated armor. There are, however, also cables with a PE conductor directly beneath and in contact with the armor, a so called drain-wire. In such cases, both together become the PE conductor and both should be connected, see illustration below. The most practical way is to terminate the armor in the BG B / BG system and connect the drain-wire to the PE terminal inside the enclosure.



Braided armored power cables without inner PE conductor are also common. Since such cables are flexible, standard through-glands are often used and the armor is directly or indirectly connected to earth bar. The negative "pig-tailing" effect that comes with this method is now being identified as a potential EMC issue and should be avoided. A common compromise is shown below where the armor is instead connected both to the inner PE bar, or terminal, and at cable entry using an EMC module. The BG B / BG system can of course serve this application too.



For high voltage cables where the metallic layer serves as a screen to contain the electrical field, ordinary termination methods have to be considered as usual. This means that the screen may not be cut at the BG B / BG system but extend to allow for proper HV end-termination.
Note that electrical safety always has priority over EMI issues. A careful design and installation work is required to meet code and safety standards.

Typical applications are:

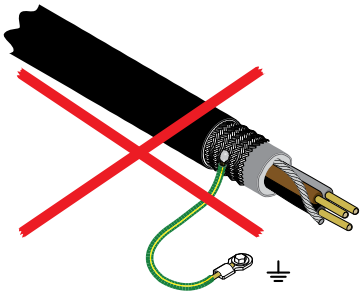
Offshore and marine
Power generation and distribution
Switchgear and converters
Motors and drives

2.4 Functional earthing

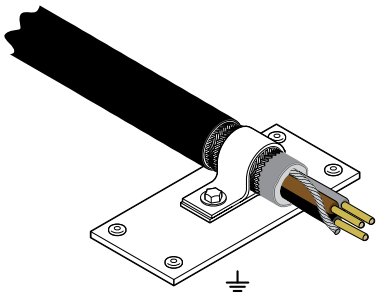
This context is to make sure that equipment or installations are not only safe, but also that they can operate properly in the intended environment, meaning that they should be able to withstand a certain amount of interference and not interfere other equipment. This is regulated by laws such as from Federal Communication Commission (FCC) in the USA, the Electro Magnetic Compatibility requirements (EMC directive) in the European Community and similar. In addition, there are specific requirements on products and equipment levels such as the IEC 61000 series. Cable selection, routing, segregation and earthing system design are important and additional earthing efforts may be required to avoid malfunction due to electromagnetic interference, EMI, and to protect equipment from damages.
Cables used for this purpose are often of a tight braid type, sometimes in combination with a metallic or metalized plastic foil, but also Metal Clad and SWA cables serve these applications. Electromagnetic disturbances are induced and propagate along shields or armor and a low impedance earth termination is required to extinguish such disturbances.
Power cables should have a separate inner PE conductor to simplify proper system design and installation.

Cables with braid or foil screens are, however often fed inside the enclosure using through-glands. The braid is then tied to an internal earth bar, directly or using extra wires. This will introduce high impedance even for moderate lengths and frequencies making this earthing method ineffective for high frequencies. This is commonly referred to as the earlier discussed "pig-tailing" and should be avoided because disturbances will be fed inside the enclosure instead of being coupled to the shield that the enclosure should provide.

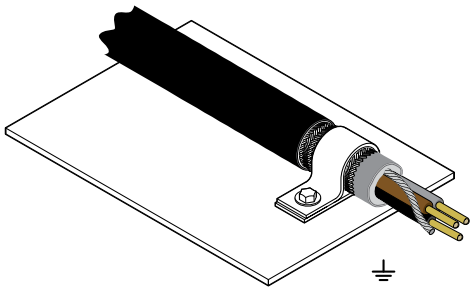
Methods for earth termination



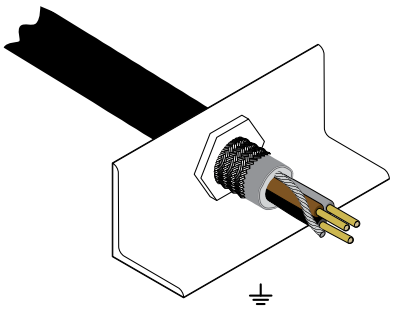
Via "pig-tail".



Direct to bus bar.



To ground plane.



To EMC enclosure, preferred method.

A Roxtec CF 32 BG B in terminal box.

The BG B / BG system fitted to an enclosure, a cabinet or junction box will follow best design principles and provide a low impedance HF ground termination.
Some cables may have several metallic layers such as both armors and screens. In such case, the armor is usually connected to the enclosure and inner screens are fed to terminals at the equipment. The picture above shows an example of a screened SWA instrument cable where the armor is connected to the enclosure through the BG B / BG system and the inner screens are connected to terminals inside the box.

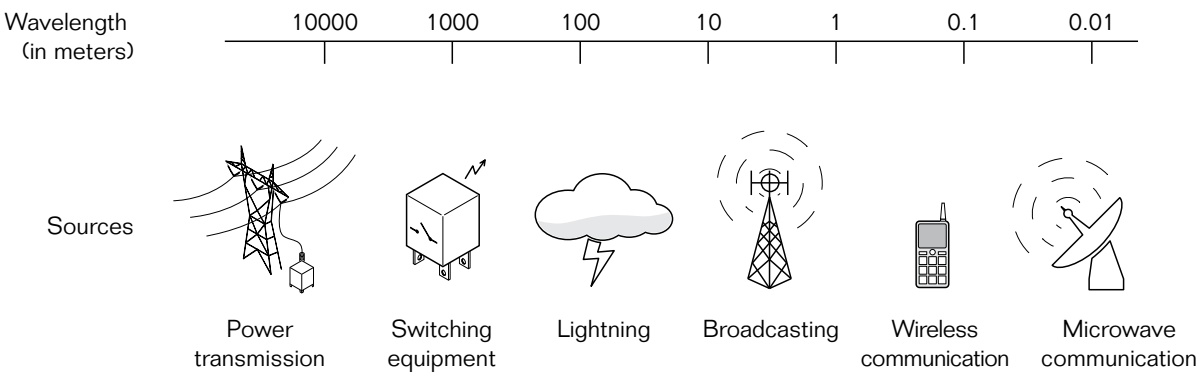
Beside the electrical safety earthing, functional earthing is also a critical aspect for:

Instrument and control
Switchgear and converters
Motors and drives
Military applications

2.5 HF grounding and shielding

Any cable having an armor or shield that is connected to earth provides not only electrical safety but also protects the inner conductors from induced disturbances to some degree. How high in frequency this protection is effective for is determined by the efficiency (tightness) of the armor/screen and the grounding method and arrangement. The HF earthing efficiency can be evaluated through contact/ transfer impedance measurements while standard 2-pole Ohm-measurement is not precise enough. Codes and industry standards only provide basic information in general terms and give guidance in the area of earth conductor length and routing in order to minimize cable inductance. A general rule is to use as short and wide conductors as possible. This is considered in the design of the BG B / BG.
Beside this, shielding effectiveness is a parameter to evaluate how efficiently an enclosure can block radiated interference.
Considering all cables through a BG B / BG system are armored or shielded and connected to the frame through BG B / BG modules, an additional so called waveguide effect will be achieved. Protection for signals up to the range of 50-100MHz can be reached for a shielded enclosure. The maximum frequency is determined by the largest electrical opening in the installation. In this context an electrical opening can be e.g. rebar mesh size in a concrete wall, non-metallic doors, non-screen windows, lids/doors/hatches without conductive gaskets, etc., or set by the biggest module or the compression unit in the BG B / BG system.
For fully shielded environments special products may be required. Customized BG B / BG products adding a HF shield are available providing protection over the full electromagnetic spectrum.

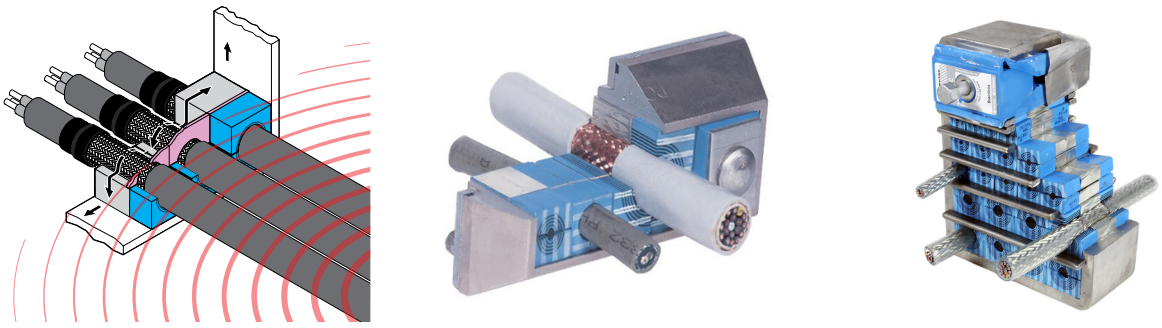
The electromagnetic spectrum



Typical applications are:
Military applications
EMP/HPM protected buildings, rooms and enclosures
Labs and research facilities
Advanced buildings

The pictures below show the Roxtec ES B / ES (Electromagnetic Shielding) system, but the principles would be the same for such versions of BG B / BG.

Note! Ordinary ES B / ES products provide a copper mass of 4mm2 which meets code requirements for earthing conductors equal to power cables <=4mm2 phase conductors. It would also be sufficient for instrument and control cables with signal and voltage levels below 30VAC/50VDC.
For armored cables of type MC, TECK and SWA, ES B / ES modules are not recommended as such armor presents a rough surface against the metallic tape used in the such modules. Therefore, ES B / ES products should be used for braided armored cables only.



Principles and cross-cuts of a few ES systems.

3. Cable segregation

Cable segregation is a part of good electrical design and installation practice in general and means that cables are separated from each other to avoid coupling of unwanted signals from one cable to another. Cables are often classified into different categories such as high voltage, low voltage, control, instrumentation, sensors, etc. The use of multi-openings, so called combinational MCT frames, helps designers and installers accomplish this by the nature of such systems. This is of specific importance when non-armored/non-shielded cables are used with Roxtec standard products.
The pictures below show how openable frames can be used for retrofit to improve EMC.

Before upgrade.

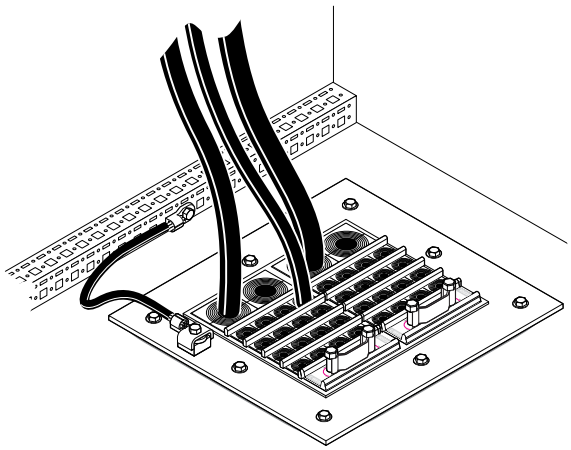
During retrofit installation.

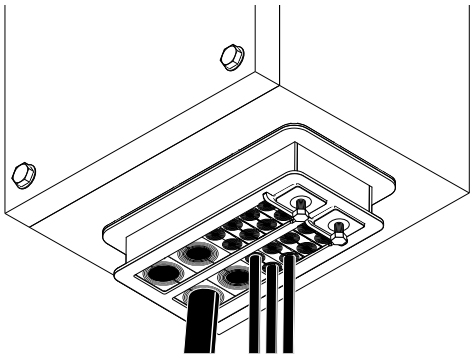
Finished Roxtec openable transit.

4. Installation

4.1 Cabinets and terminal boxes

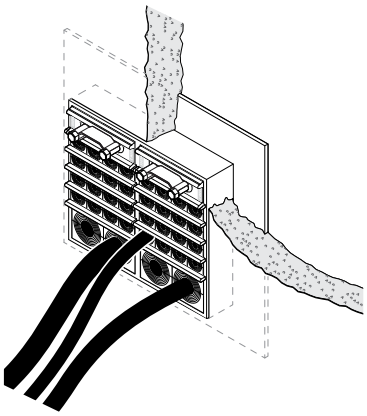
For entry into cabinets, junction and terminal boxes it is usually preferred to have the cable entry at the bottom of the box. This requirement is more easily met with Roxtec products than glands thanks to better area efficiency.

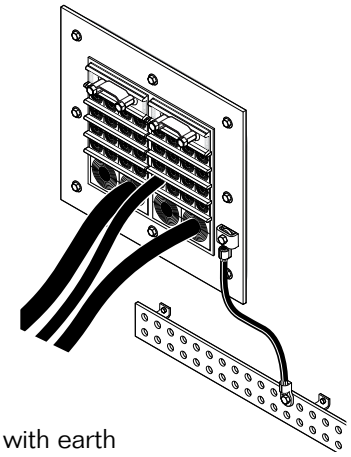




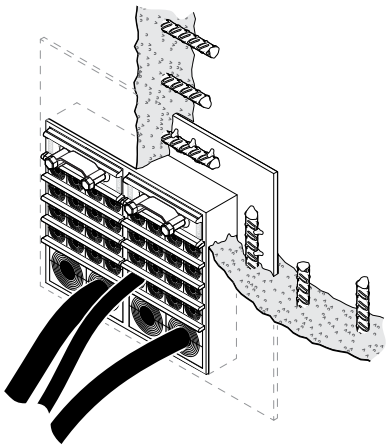
4.2 Frames in walls/floors

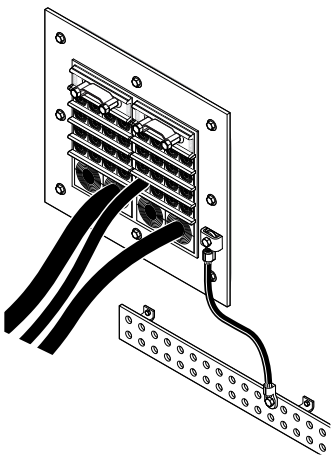
This section shows recommended frame installation principles for different wall designs.



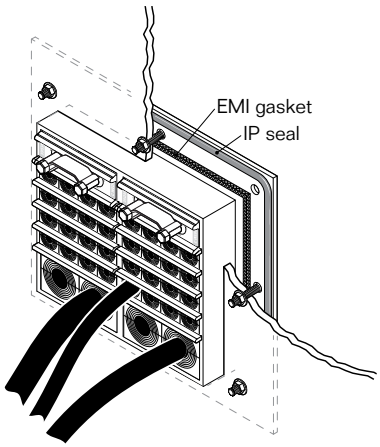


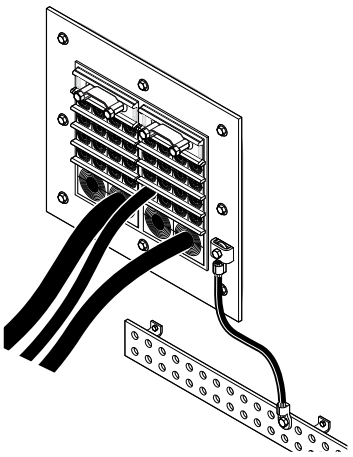
In concrete, masonry and similar wall constructions, frames with earth lugs are easily connected to earth bars with a single properly sized earth conductor.



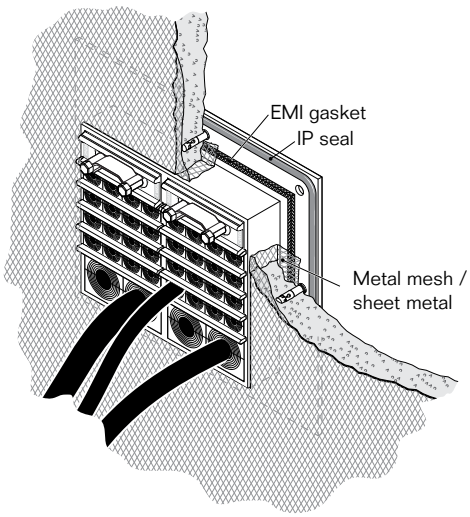


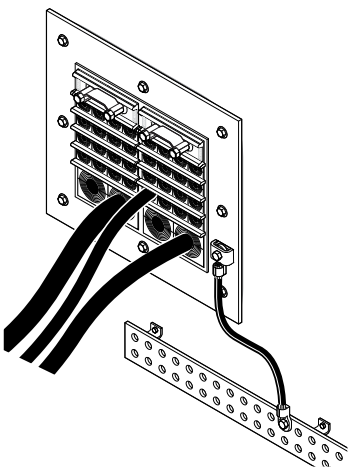
HF properties will be improved if the frame is welded to earthed rebar structure. This can be done in combination with external earthing conductor to make the earth connection visible for inspection.





Frames bolted to steel structures often have an IP seal preventing metal-to-metal contact between frame and structure. Paint or other corrosion protection can be another limiting factor. Frames with integrated earth lugs are recommended, but bolts may be used if contact can be assured using serrated washers and they are safely secured from loosening. For best possible HF properties, a conductive gasket should be applied to clean conductive surfaces of the structure.

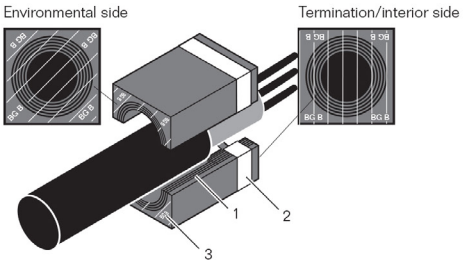




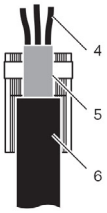
High-tech buildings and rooms may be totally HF shielded and it may be critical to use a conductive gasket. An additional external earth conductor connected to the integrated earth lug is common practice.

4.3 Cable preparation and make-up

The most common applications are for terminations into enclosures. The outer jacket is cut and removed from the cable end and the armor is terminated so it protrudes 0.5-3 cm (depending on cable dimensions) outside the module. For SWA and braided cable, a piece of the outer jacket, or a piece of shrink tube, can be used to cover the armor ends, but leave enough exposed armor so that it can be reached with a test probe after finished installation. For MC and TECK cables, a so called anti-short bushing should be fitted to avoid abrasion to inner conductors as the armor presents a very sharp edge.



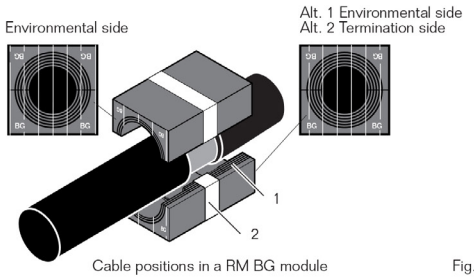
Cable position in a RM BG B module



1. Multidiameter™ – adapts to cables and pipes of different sizes through removable layers
2. Bonding/grounding braid
3. Environmental side
4. Conductors
5. Cable armor
6. Outer jacket

The Roxtec RM BG B can also be used for pass-through systems where there is no need for environmental protection on both sides. In such case, only the outer jacket is removed and just for a section that is equal to the braid width of the selected module, plus 10mm.

For installations that require environmental protection from both sides, the Roxtec BG products shall be used according to alternative 1 below.



Cable positions in a RM BG module

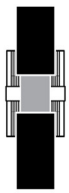


Fig. 1 Alternative 1

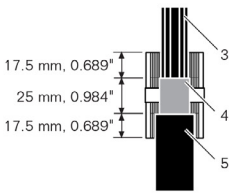
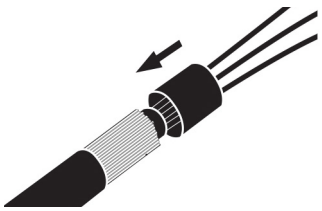
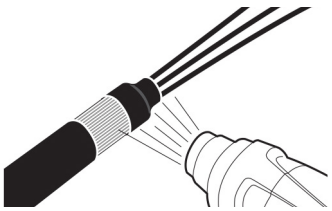


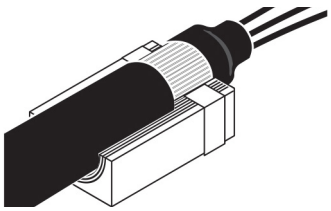
Fig. 2 Alternative 2

1. Multidiameter™ – adapts to cables and pipes of different sizes through removable layers
2. Bonding/grounding braid
3. Conductors
4. Cable armor/shield
5. Outer jacket

The illustrations below show the position of e.g a shrink tube.





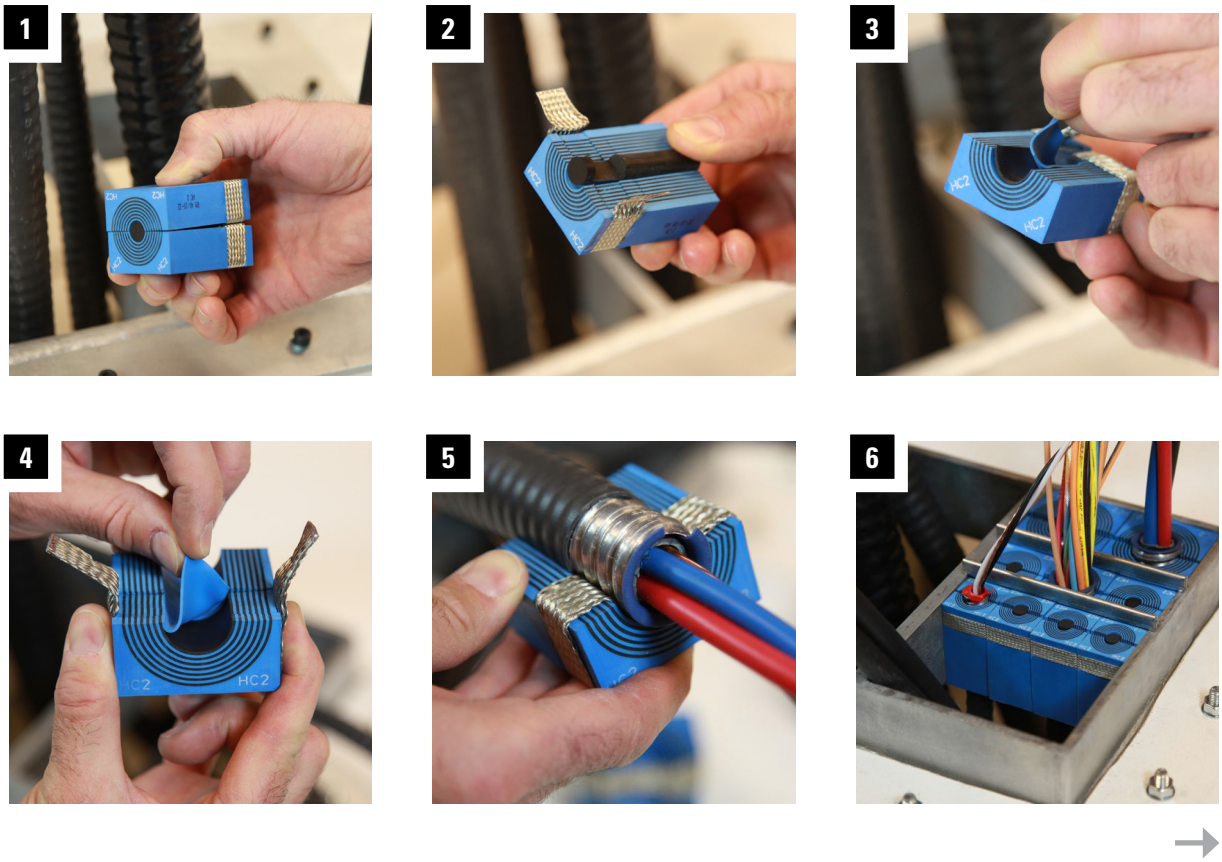


Warning. Braided armored cables normally have a transparent plastic foil between the outer jacket and the braid. This foil can be hard to see but must be removed. This can be the case for SWA cables too.

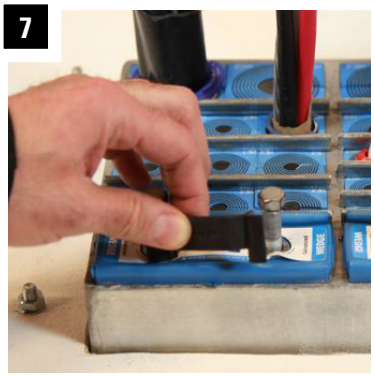
4.4 Installation

Having drip loops on the cables is recommended for enclosure side and wall entries in general. It is a common installation practice as well as having some slack to avoid strain on cables. This extra cable length simplifies the cable preparation where otherwise cables already pulled through a frame may be difficult to prepare. This has to be addressed for both heavy and stiff cables as well as cables with large OD's in general. E.g. telecom feeder cables should not be firmly tightened to the tower or mast bottom until installed in the shelter to allow for lenghtwise movement.

This section shows the basic steps of an installation (see installation instructions for full information). It shall be noted that it is recommended to lubricate the entire inside of the frame and all parts of the modules except the braid itself. Roxtec installation tools, such as the stayplate holder and the pre-compression tools are of great help during the installation. For frames with several openings, it is recommended that the wedges/compression units are not fully tightened until all openings are fully loaded. This is to avoid partition wall bend outwards making adjacent openings more narrow which would make it hard to fill these openings. The standard Roxtec wedge that is used can, just as in Roxtec standard systems, be placed anywhere in the opening. It is, however, recommended to place it at the short end of an opening for easier insertion.

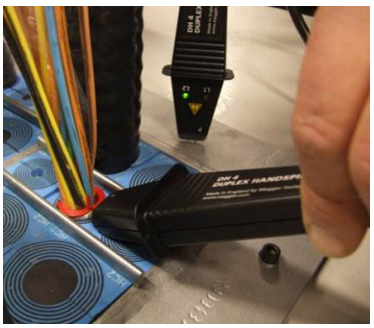


7



4.5 Verification

Each cable should be tested for earth continuity. Tested with an earth continuity tester (4-pol measurement) @10ADC the resistance from armor to frame is typically <1mOhm, except in cases where stainless steel material is used. Then it is typically <2,5mOhm. The value is depending on frame type and material, module size, and armor type and material. Instabilities can often be seen on SWA armor due to oxidation on the galvanized steel wires and the test probe may just hit a few wires. For TECK and MC cables with an interlocked armor, variations can be seen due to the non-controllable "turn-to-turn" contact that occurs with this type of armor. An ordinary DMM (2-pole measurement) would not be sufficient to show actual resistance. However, it works to verify earth continuity and the actual value will be in the same range as if both test-leads were held togheter. The pictures below show a typical earth continuity tester and how a test can be done.



4.6 Available frames

The frames below and variants hereof are suitable for BG applications. In all cases, frame material has to be selected with regards to environmental influences and galvanic corrosion due to dissimilar metals. Primed frames can be used in a controlled environment or if proper corrosion protection precautions are taken. The inside walls of the frame have to be free from rust, paint and contamination before installation of any type of EMC/BG module.

S 6x1 AISI 316

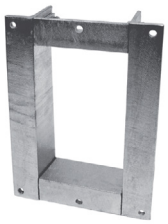
SF 6x1 ALU

SK frame

SBTB frame

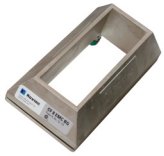
G 6x1 AISI 316

GHM frame



B 6x1 galv

Grounding lug

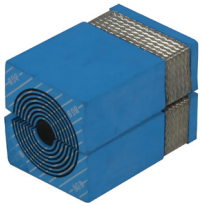


CF 8

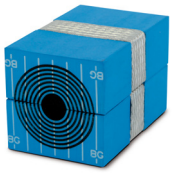
CF 32

4.7 Modules

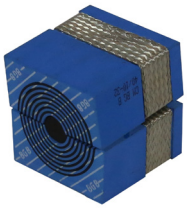
Modules are available in three types.



The BG B is intended for terminations and pass-throughs where environmental protection is required from one side only.
For regular frames.



The BG module for pass-throughs and where environmental protection is required from both sides.
For regular frames.



The CM BG B is intended for terminations and pass-throughs where environmental protection is required from one side only.
For compact frames.

The marking is different in text and lines to simplify the visual inspection after installation.

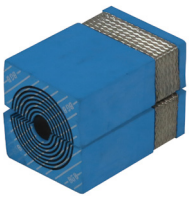
4.8 Standard accessories

Stayplate holders and precompression tools are recommended as aid during installation.

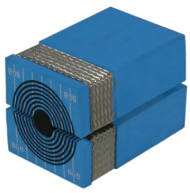
5. Technical data

5.1 Types and dimensions

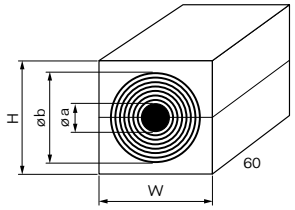
Roxtec RM BG™ B module



Front view



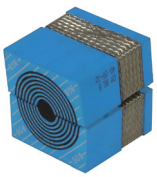
Back view



Module	Number of cables/pipes	For cable/pipe diameter a-b (mm)	a-b (in)	External dim. (mm) HxW	Weight (kg/lb)	Art. No
with core						
RM 20w40 BG B	2	0+3.5-16.5	0+0.138-0.650	20x40	0.07/0.154	**103331**
RM 30 BG B	1	0+10.0-25.0	0+0.394-0.984	30x30	0.08/0.176	**103332**
RM 40 10-32 BG B	1	0+9.5-32.5	0+0.374-1.280	40x40	0.14/0.309	**103333**
RM 60 24-54 BG B	1	0+24.0-54.0	0+0.945-2.126	60x60	0.33/0.728	**103336**
without core						
RM 80 BG B woc	1	48.0-71.0	1.890-2.795	80x80	0.46/1.014	**118502**
RM 90 BG B woc	1	48.0-71.0	1.890-2.795	90x90	0.56/1.235	**103338**
RM 120 BG B woc	1	67.5-99.0	2.657-3.898	120x120	0.94/2.072	**103313**

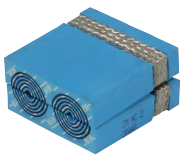
Roxtec CM BG™ B sealing modules

CM 40/10-32 BG B

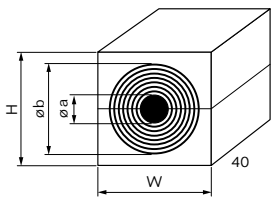


Front view

CM 20w40 BG B

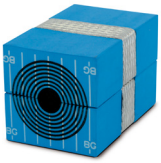


Front view

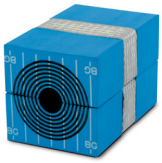


Module	Number of cables/pipes	For cable/pipe diameter a-b (mm)	a-b (in)	External dim. (mm) HxW	Weight (kg/lb)	Art. No
with core						
CM 20w40 BG B	2	0+3.5-16.5	0+0.138-0.650	20x40	0.05/0.110	**103375**
CM 30w40 BG B	1	0+10-25	0+0.394-0.984	30x40	0.08/0.176	**103379**
CM 40 10-32 BG B	1	0+9.5-32.5	0+0.374-1.280	40x40	0.10/0.220	**103381**

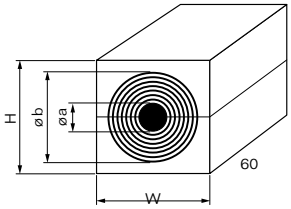
Roxtec RM BG™ module



Front view



Back view



Module	Number of cables/ pipes	For cable/pipe diameter a-b (mm)	a-b (in)	External dim. (mm) HxW	Weight (kg/lb)	Art. No
with core						
RM 20w40 BG	2	0+3.5-16.5	0+0.138-0.650	20x40	0.07/0.154	**102416**
RM 30 BG	1	0+10.0-25.0	0+0.394-0.984	30x30	0.08/0.176	**102417**
RM 40 10-32 BG	1	0+9.5-32.5	0+0.374-1.280	40x40	0.14/0.309	**102419**
RM 60 24-54 BG	1	0+24.0-54.0	0+0.945-2.126	60x60	0.33/0.728	**102422**
without core						
RM 80 BG woc	1	48.0-71.0	1.890-2.795	80x80	0.46/1.014	**118505**
RM 90 BG woc	1	48.0-71.0	1.890-2.795	90x90	0.56/1.235	**102424**
RM 120 BG woc	1	67.5-99.0	2.657-3.898	120x120	0.94/2.072	**102412**

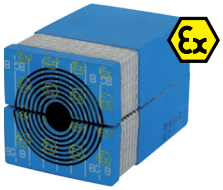
Kit solutions

Roxtec CF 8 BG™ B kit and Roxtec CF 32 BG™ B kit

Kit	Diameter range and number of cables		External dimensions HxW (mm)	HxW (in)	Article number
	0+3.5-16.5 mm 0+0.138-0.650" (CM 20w40 BG B)	0+9.5-32.5 mm 0+0.374-1.280" (CM 40 10-32 BG B)			
CF 8/8 BG B	8 cables		140 x 75	5.512 x 2.952	103464
CF 32/8 BG B		8 cables	230 x 130	9.055 x 5.118	103462
CF 32/20 BG B	16 cables	4 cables	230 x 130	9.055 x 5.118	103463
CF 32/32 BG B	32 cables		230 x 130	9.055 x 5.118	103461

Roxtec CF 8 BG™ B Ex kit and Roxtec CF 32 BG™ B Ex kit

Kit	Diameter range and number of cables		External dimensions HxW (mm)	HxW (in)	Article number
	0+3.5-16.5 mm 0+0.138-0.650" (CM 20w40 BG B Ex)	0+9.5-32.5 mm 0+0.374-1.280" (CM 40 10-32 BG B Ex)			
CF 8/8 BG B Ex	8 cables		140 x 75	5.512 x 2.952	103591
CF 32/20 BG B Ex	16 cables	4 cables	230 x 130	9.055 x 5.118	103736
CF 32/32 BG B Ex	32 cables		230 x 130	9.055 x 5.118	103737



Roxtec RM BG™ B Ex module

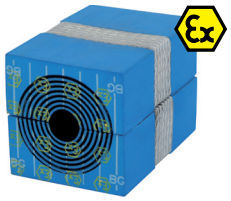
The Roxtec RM BG™ B Ex module is certified according to the ATEX directive and the IECEx, International Certification Scheme, for use where Ex e classified solutions are required. To be used with Roxtec Group RM Ex frames.

RM BG™ B Ex modules with Multidiameter™

to be used with Roxtec S Ex, SF Ex, SF…W Ex, G Ex, and G…W Ex frames

Module	Approx. cross-sectional braid area, mm²/ Approx. eqv. AWG	Øa-Øb (mm)	Øa-Øb (in)	External dimensions HxW (mm) (D= 60mm)	External dimensions HxW (in) (D= 2.362")	Article number
RM 20w40 BG B Ex	4*/11	0+3.5-16.5	0+0.138-0.650	20x40	0.787x1.574	102516
RM 30 BG B Ex	13/6	0+10.0-25.0	0+0.394-0.984	30x30	1.181x1.181	102517
RM 40 10-32 BG B Ex	21/4	0+9.5.0-32.5	0+0.374-1.280	40x40	1.574x1.574	102518
RM 60 24-54 BG B Ex	42/1	0+24.0-54.0	0+0.945-2.126	60x60	2.362x2.362	102530
RM 90 BG B Ex woc	42/1	48.0-71.0	1.890-2.795	90x90	3.543x3.543	102534
RM 120 BG B Ex woc	42/1	67.5-99.0	2.657-3.898	120x120	4.724x4.724	102512

For reference, see Dimension references illustration.
*The braid area is calculated for each cable entry.



Roxtec RM BG™ Ex module

The Roxtec RM BG™ Ex module is certified according to the ATEX directive and the IECEx, International Certification Scheme, for use where Ex e classified solutions are required. To be used with Roxtec Group RM Ex frames.

RM BG™ Ex modules with Multidiameter™

to be used with Roxtec S Ex, SF Ex, SF…W Ex, G Ex, and G…W Ex frames

Module	Approx. cross-sectional braid area, mm²/ Approx. eqv. AWG	Øa-Øb (mm)	Øa-Øb (in)	External dimensions HxW (mm) (D= 60mm)	External dimensions HxW (in) (D= 2.362")	Article number
RM 20w40 BG Ex	4*/11	0+3.5-16.5	0+0.138-0.650	20x40	0.787x1.574	102523
RM 30 BG Ex	13/6	0+10.0-25.0	0+0.394-0.984	30x30	1.181x1.181	102524
RM 40 10-32 BG Ex	21/4	0+9.5-32.5	0+0.374-1.280	40x40	1.574x1.574	102525
RM 60 24-54 BG Ex	42/1	0+24.0-54.0	0+0.945-2.126	60x60	2.362x2.362	102531
RM 90 BG Ex woc	42/1	48.0-71.0	1.890-2.795	90x90	3.543x3.543	102535
RM 120 BG Ex woc	42/1	67.5-99.0	2.657-3.898	120x120	4.724x4.724	102519

For reference, see Dimension references illustration.
*The braid area is calculated for each cable entry.

See the Roxtec EMC catalogue for information on other products.

5.2 Cable retention

Roxtec systems meet and are certified to IEC60079-0 requirements for fixed installations and also meet EN50262/A1/A2 requirements for armored cables Class A corresponding to IEC62444 anchorage for armored cables Type C.

5.3 Braid data and current withstand capabilities per module size

	Technical data					AC short circuit test					
BG™ Module Size	Cable range (Outer dimensions)	Total braid cross-sectional area per cable sq mm	sq mils	Total Ampacity (A)	Approx. Eqv. AWG	UL514B/UL467, CSA 22.2 No 18.3-04/No41.07 requirements Current	Sec	Tested to, Current	Sec	EN 50262/A1/A2, (IEC 62444) , Armored cables Category B current req, 1sec	Tested to, AC RMS 1sec
RM/CM 20w40	3,5-16,5	4	6448	64	11	1180	4	1530	6	Cat A, 500	1180
RM/CM 20	4-14,5	8	12896	128	8	1180	4			3060	3480
RM 30/CM 30w40	10-25	13	20522	184	6	1530	6	1530	6	4000	4101
RM/CM 40(10-32)	9,5-32,5	21	32612	212	4	2450	6	2450	6	5400	5409
RM 60(24-54)	24-54	42	65410	352	1	4900	6	5050	9	7200	7495
RM 90 (RM 80)	48-71	42	65410	352	1	5050	9	5050	9	10400	15274
RM 120	67,5-99	42	65410	352	1	5050	9	8030	9	10400	15274

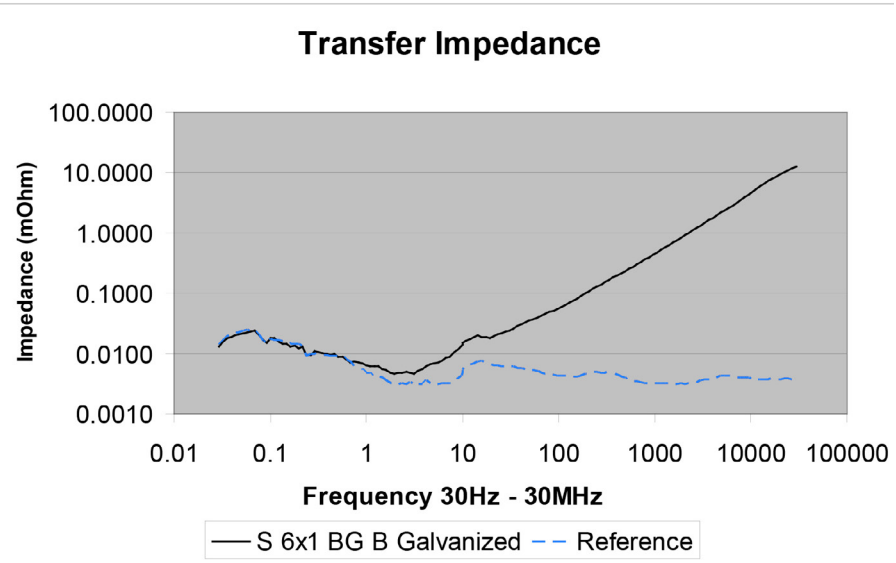
5.4 Current Surge withstand per module size

	Technical data					AC short circuit test						Current Surge test
Module	Cable range (OJ & OA)	Total braid cross-section per cable sq mm	sq mils	Total Ampacity	Approx. Eqv. AWG	UL514B/UL467, CSA 22.2 No 18.3-04/No41.07 requirements Current	Sec	Tested to, witnessed by CSA Current	Sec	EN 50262 , Armored cables Category B current req, 1sec	Tested to, A	IEC 62305 puls shape 10/350. Tested in rectangular RM frames to, kA
RM/CM 5/0	-	8,32	12896	128	8							
RM/CM 10/0	-	8,32	12896	128	8							
RM/CM 15	3,0-11	6,6	10230	100	9	1180	4			3060		
RM/CM 15w40	3,5-10,5	3,3/6,6	5115/10230	50/100	12/9	1180	4			3060		
RM/CM 20	4-14,5	8,32	12896	128	8	1180	4			3060	3480	100
RM/CM 20w40	3,5-16,5	4,16	6448	64	11	1180	4	1530	6	3060		
RM 30/CM 30w40	10-25	13,24	20522	184	6	1530	6			4000	4101	
RM/CM 40(10-32)	9,5-32,5	21,04	32612	212	4	2450	6	2450	6	5400	5409	100
RM 60	28-54	42,2	65410	352	1	4900	6			7200		
RM 60(24-54)	24-54	42,2	65410	352	1	4900	6	5050	9	7200	7495	200 (Life cycle test)
RM 90	48-71	42,2	65410	352	1	5050	9	5050	9	10400	15274	200
RM 120	67,5-99	42,2	65410	352	1	5050	9	8030	9	10400	15274	200

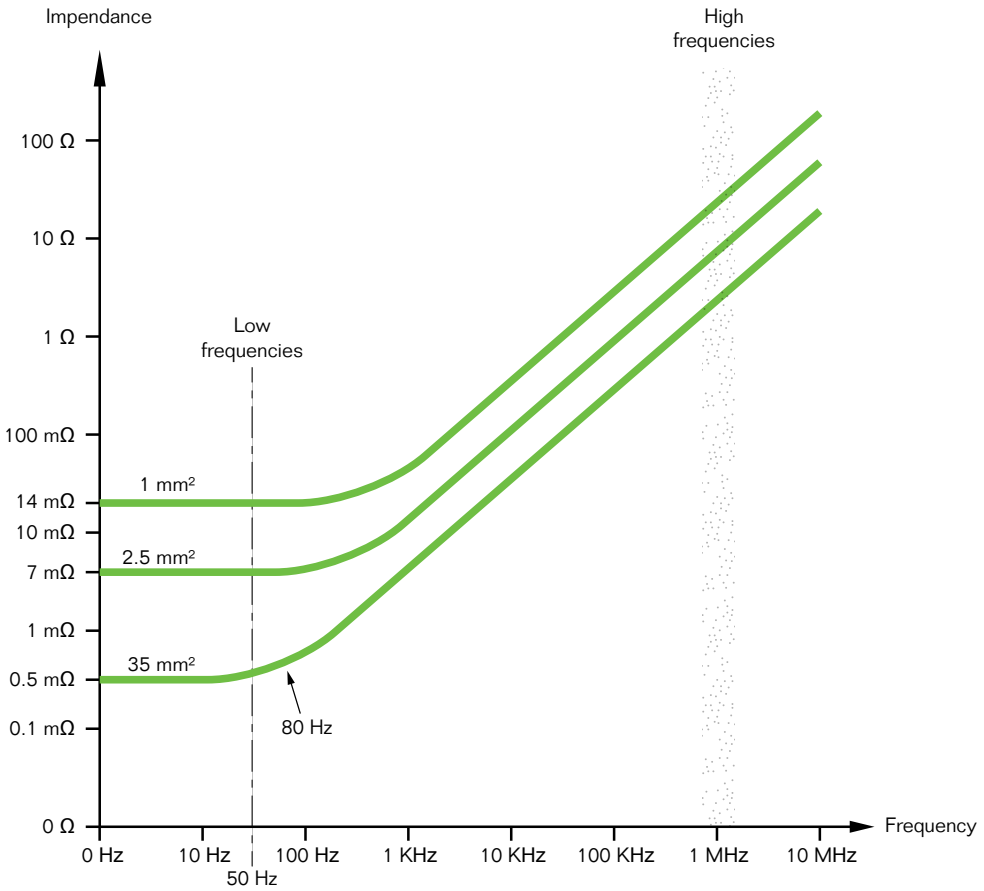
5.5 Contact resistance and impedance

Contact resistance is the measure of how good connection that can be achieved. The lower value, the better. The measurement is done with DC (Direct Current, 0Hz). Even if the power system operates at 50 or 60 Hz, this has very little impact on the value read using DC. For electrical safety, rigidity of the connection is in focus and the measurement is often done with a current of 10 to 30 A.
The resistance measured between an armor and the earthing point/lug is for the BG B / BG system <1mOhm for aluminum, mild and galvanized steel frames and <2mOhm for stainless steel frames measured @10A DC. In telecom and lightning protection applications, typical requirements range from 1 mOhm but can go to 100mOhms or higher as specified in e.g. gland standards and electrical codes.

Impedance is the "resistance" at a certain frequency different from 0 Hz and proves the connections ability to serve as a HF frequency earthing. The result is presented as a graph per below.
(The dynamic range for the test setup is given as a dotted blue reference line.)



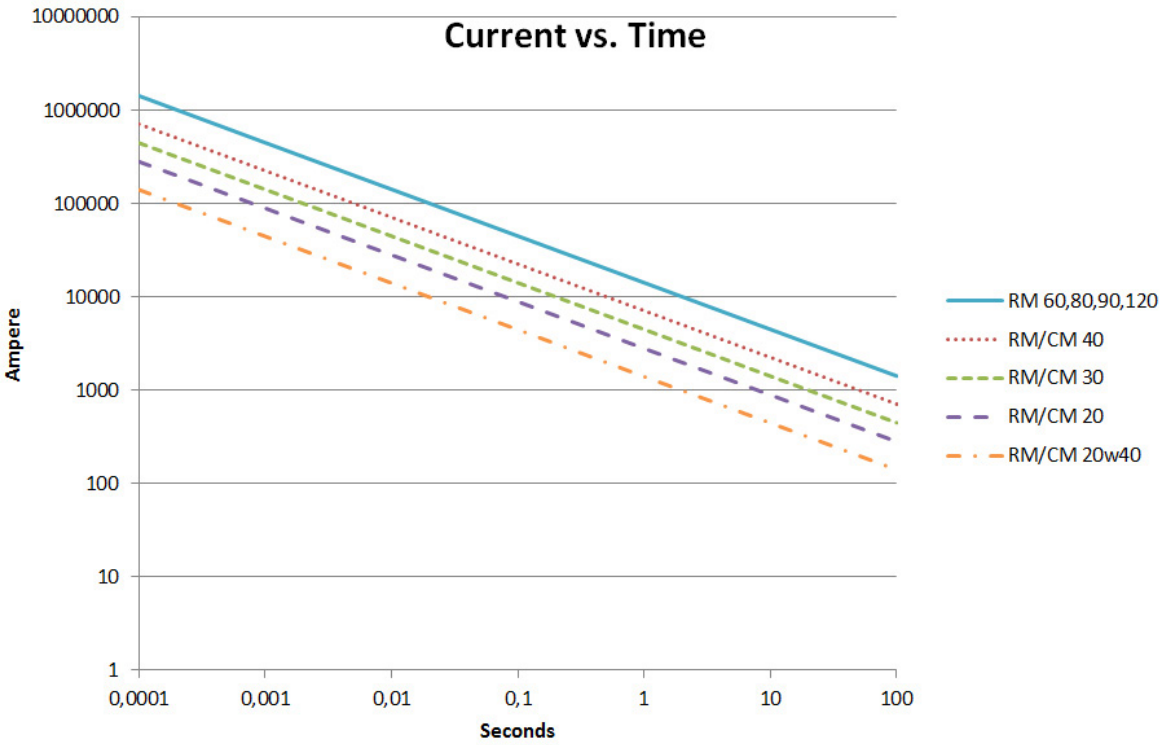
Impedance increases with frequency. The diagram below shows the impedance for a one meter long circular earth conductor with different cross sectional areas. The impedance increases rapidly and clearly shows how inadequate such earthing methods can be for already moderate frequencies. Due to the so called skin effect, higher frequencies cannot utilize the copper mass in a circular conductor but only propagates on the surface. This is the driving factor for using conductors with a rectangular cross section, such as braids, to gain a larger surface area.



Typical impendance values for one meter of wire

5.6 Theoretic current carrying capability per module type.

A calculation of the theoretic braid strength has been carried out based on the melting temperature of copper at an ambient temperature of 20˚ C. Practical testing for surge (lightning strike simulations) and AC short circuit testing show very good correlation with calculated values.



6. Considerations

IEC60079-14 calls for circular cables with a solid inner core to be used to avoid cold flow. As all compression type sealing systems exert a pressure soft bedded cables should be avoided.

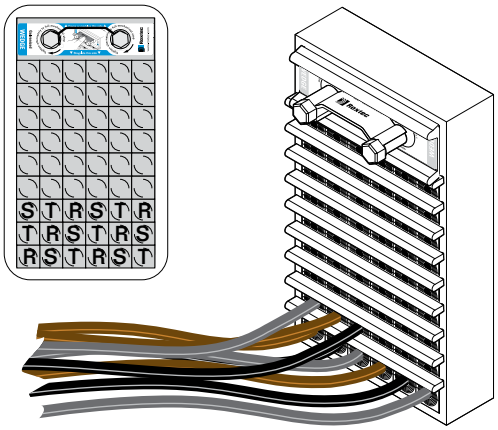
According to Roxtec Ex certifications, all modules have to be of the same type, BG B Ex, BG Ex or ordinary Roxtec Ex modules for the same opening. This is not just a requirement but good engineering practice also for non-classified locations. With the use of multi-opening frames, one opening can be used for armored cables and BG B / BG modules and another for non-armored cables with standard Roxtec modules. This is accepted also for the CF 32 Ex frame.

Cables must be supported and clamped along the run to prevent being pulled out of position. Roxtec systems are intended for fixed installation and are tested and certified as a seal without inner clamping device, hence evaluated to the lower retention requirements corresponding to such applications.

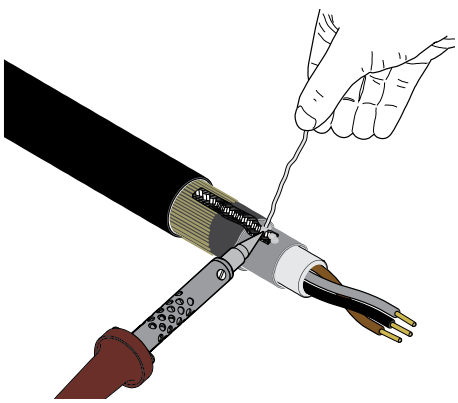
A finished Roxtec BG B installation can easily be electrically verified for continuity using a standard Ohm-meter. As a part of the preventive maintenance program for a facility, such installation should be included in the periodic maintenance schedule. A BG system would require access to the terminations or using a non-intrusive current probe test method.
To give exact resistance value, a so called 4-pole measurement has to be carried out.

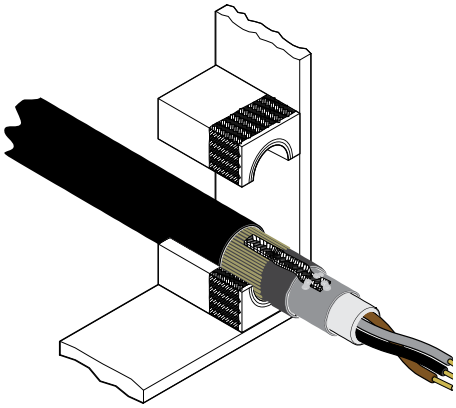
In order to avoid galvanic corrosion, it is a must to select a frame material for use in corrosive environments. The electrical contact function is embedded inside the environmental seal, but corrosion to the frame can over time jeopardize the electrical function.

Single conductor power cables require special attention. No ferromagnetic material is allowed between phases to avoid inductive heating. Offshore standards set a limit of 20A for this. This means that aluminum or stainless steel stayplates and partition walls (frames) have to be used for such cables if not all phases can be fed through the same row or opening in a frame. Where parallel phase conductors have to be used, this is addressed further in that the phases should be mixed to minimize magnetic fields. See fig. for the basic concept.



Lead-sheeted cables and armored cables can be handled with extra efforts if the armor is the outermost metallic layer. Both armor and lead-sheet have to be boned to earth. As it is not allowed to clamp against the lead-sheet due to risk of cold flow, the standard method is to solder on a piece of bonding braid to the lead-sheet. These braids can be tied directly to the earth lug on the Roxtec frame or being fed in under the armor where the BG B / BG is placed and connects to earth. Note that there may be requirements saying that not more than one or two terminals can be placed on the same earth lug.





Cable segregation and routing can be important to maintain safety and to avoid EMC problem due to cross-talk or induction between cables. Electrical codes calls for minimum separation distances between High and Low voltage cables unless separated by earthed metallic partion. The partition wall in an earthed combinational frame can serve this purpose. Cables carrying low level signals are sensitive for external EM influences hence should not be run in close proximity of cables carrying possibly interfering signals. Customer standards often define cable classes and corresponding distances between cables of different classes. This may have to be considered when run through Roxtec frames.

Classified locations
Differential voltages between conductive parts can cause arcs and sparks even at only a few volts. This is a great concern in explosive areas or classified/hazardous locations.
Equipotential bonding is highly addressed and armor and screens shall be connected to ground. Both ends may, however, not always be connected as this can cause circulating (vagabonding) currents. Standards such as IEC60079-14 have specific requirements for this.

7. Safety information

When a system is decompressed there is always a risk that earth connections are lost or become high-ohmic. Modifications or addition of cables to an opening having energized cables should only be done by authorized personnel. A temporary bonding solution shall be arranged for the individual cables. Stayplate holders may be used to further secure that already installed cables are held in place.

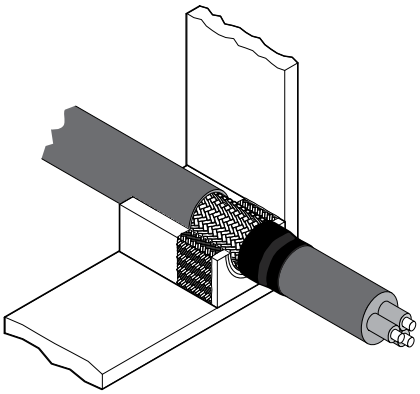
8. Certificates and test

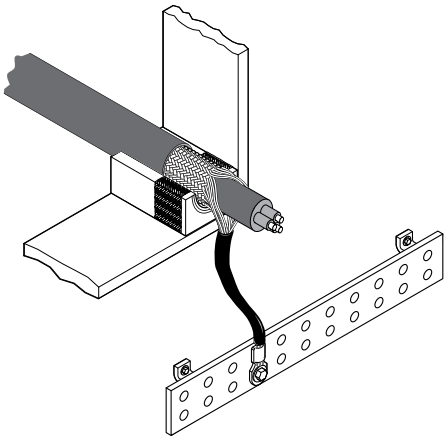
The Roxtec BG B / BG system complies with EU directive 2002/95/EC, Restriction of Hazardous Substances (RoHS) and is certified and tested per below.

Certifying authority	Type of certificate
CSA (CD)	Ordinary locations Canadian standards - Environmental rating: 1, 2, 3, 3R, 3S, 4, 4X, 5, 12, 13 CAN/CSA 22.2, No 94.2 - Bonding and grounding CAN/CSA 22.2, No 18.3-04, No 41-07 US standards - Environmental (NEMA) rating: 1, 2, 3, 3R, 3S, 4, 4X, 5, 12, 13 UL50 - Bonding and grounding UL514B, UL467
CSA (CD)	Hazardous locations - Canada: Ex e IIC - US: AEx e IIC, Class 1, Zone 1
UL (US) FM Approvals (US)	Fire stop device UL1479 Fire stop device
SP (SE), NEMKO (NO)	IECEx certificate of conformity EC-type examination certificate (ATEX) - EX e IIC Gb, EX tb IIIC Db IEC60079-0, IEC60079-7, IEC60079-31
DNV (NO)	A/H-class. Steel bulkhead and deck
ABS (US)	A/H-class. Steel bulkhead and deck
Test lab	**Type of test**
SAAB Technologies (SE)	Earth continuity - IEC60079-0, p26.12 Contact/transfer impedance and shielding effectiveness - VG95373 p15, EN50147-1
Global Lightning Protection Services, (DK)	Short circuit and current withstand capabilities - EN50262/IEC62444 Current surge - IEC62305 Earthing efficiency
Spiez Laboratory (CH)	Blast load
Southwest Research Institute (US)	Gas tightness Blast load

9. Miscellaneous

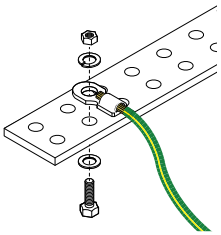
Offshore standards often clearly differentiate installation methods for instrument/control cables and power cables. The criteria is a voltage below or above 30V AC/50V DC (ref. IEC 61892-6, DSB, NORSOK, etc). For control and instrumentation cables (below criteria), the armor can be cut and terminated in the cable entry. Both ES B / ES and BG B / BG can be used for these lower voltages. For power cables (cables carrying higher voltages than criteria), the armor is commonly connected to earth both at the cable entry via e.g a BG B module and further routed to an internal PE bar. These standards mainly refer to braided armored cables.



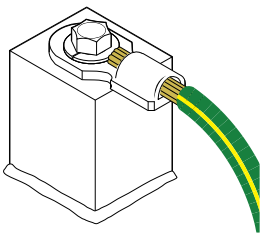


For landbased applications the electrical code applies for voltages >50V AC. See section Protective Earthing for more information.

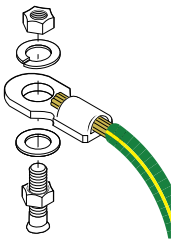
Pictures below shows earth lug arrangement.



Earthing termination



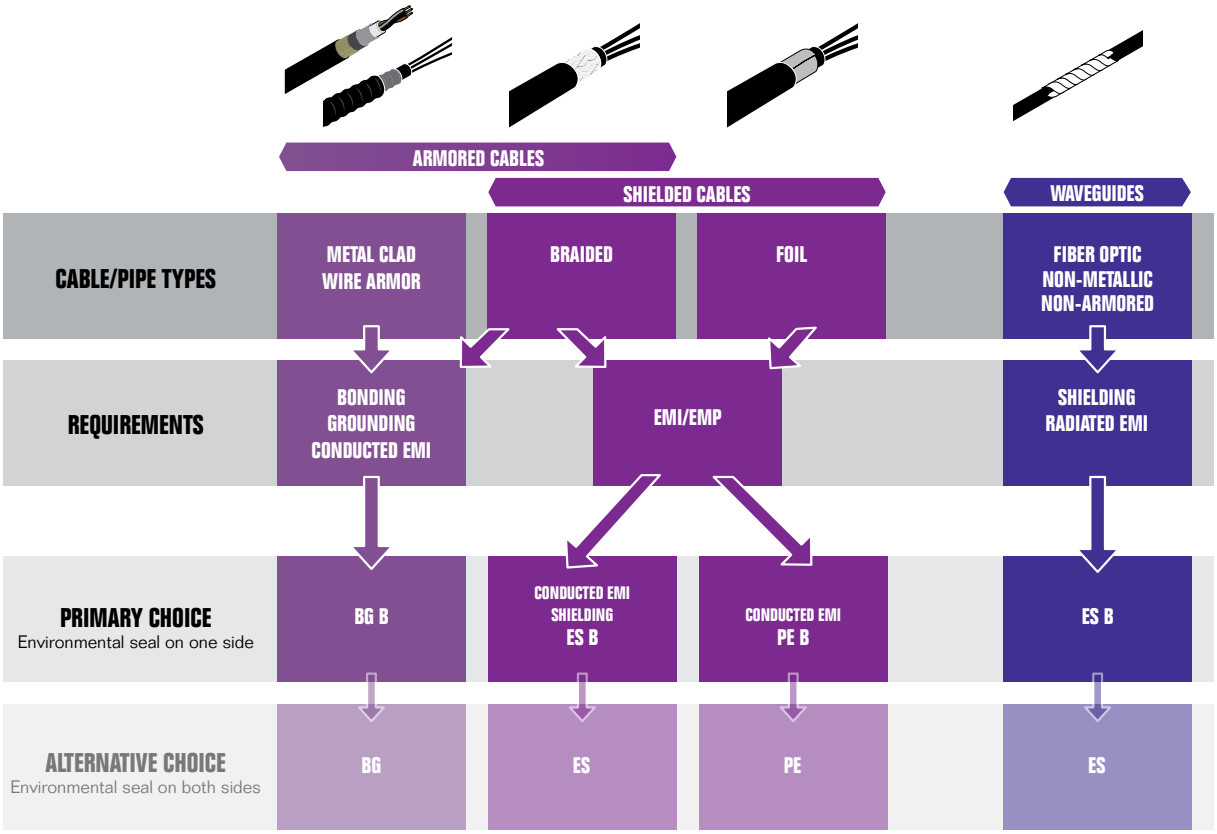
Earth boss



Earth bolt

The simplified product selection chart below shows the protection that can be provided for a certain type of cable.

EMC sealing system selection guide



Pipes can use any module type depending on protection required.

The information in this document is for reference purposes only and Roxtec International AB assumes no obligation or liability for the accuracy or completeness of its content.

Note:
To benefit from the properties that the ES products provide, the enclosure has to be equally electrically tight, like a shielded room or box, a so called Faraday cage design. Such designs can be identified e.g. like conductive gaskets for doors and hatches, honeycomb air vents, etc.
Armored fiberoptic cables may have a metallic armor, and in such case it is not possible to achieve a shielded environment. Instead such armor shall be earthed for potential equalization.

DISCLAIMER

"The Roxtec cable entry sealing system ("the Roxtec system") is a modular-based system of sealing products consisting of different components. Each and every one of the components is necessary for the best performance of the Roxtec system. The Roxtec system has been certified to resist a number of different hazards. Any such certification, and the ability of the Roxtec system to resist such hazards, is dependent on all components that are installed as a part of the Roxtec system. Thus, the certification is not valid and does not apply unless all components installed as part of the Roxtec system are manufactured by or under license from Roxtec ("authorized manufacturer"). Roxtec gives no performance guarantee with respect to the Roxtec system, unless (I) all components installed as part of the Roxtec system are manufactured by an authorized manufacturer and (II) the purchaser is in compliance with (a), and (b), below.

(a) During storage, the Roxtec system or part thereof, shall be kept indoors in its original packaging at room temperature.

(b) Installation shall be carried out in accordance with Roxtec installation instructions in effect from time to time.

The product information provided by Roxtec does not release the purchaser of the Roxtec system, or part thereof, from the obligation to independently determine the suitability of the products for the intended process, installation and/or use.

Roxtec gives no guarantee for the Roxtec system or any part thereof and assumes no liability for any loss or damage whatsoever, whether direct, indirect, consequential, loss of profit or otherwise, occurred or caused by the Roxtec systems or installations containing components not manufactured by an authorized manufacturer.

Roxtec expressly excludes any implied warranties of merchantability and fitness for a particular purpose and all other express or implied representations and warranties provided by statute or common law. User determines suitability of the Roxtec system for intended use and assumes all risk and liability in connection therewith. In no event shall Roxtec be liable for consequential, punitive, special, exemplary or incidental damages."

Roxtec International AB
Box 540, 371 23 Karlskrona, SWEDEN
PHONE +46 455 36 67 00, FAX +46 455 820 12
EMAIL info@roxtec.com, www.roxtec.com

BRO201400101 ver_1.0/EN/1426/stsan