



DEHN

Surge protection for frequency converters

White Paper



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A frequency converter typically consists of a rectifier, d.c. link, inverter and control electronics (**Figure 1**).

At the inverter input, a single-phase a.c. voltage or three-phase line-to-line a.c. voltage is converted into a pulsating d.c. voltage and is fed into the d.c. link which also serves as an energy storage system (buffer).

Capacitors in the d.c. link and earthed L-C sections in the mains filter can cause problems with upstream residual current protective devices (RCDs). These problems are often incorrectly associated with surge arresters. They are, however, caused by short-time fault currents of the frequency converter which are sufficiently high to trip sensitive RCDs. This can be prevented by using a surge-proof RCD circuit breaker which is available with a discharge capacity of 3 kA (8/20 μ s) and higher for a tripping current $I_{\Delta n} = 30$ mA.

The inverter provides a pulsed output voltage via the control electronics. The higher the pulse frequency of the control electronics for pulse width modulation, the more the output voltage resembles a sinusoidal curve. However, with each pulse a volt-

age peak occurs that is superimposed on the fundamental wave. This voltage peak reaches values of more than 1200 V (depending on the frequency converter). The better the simulation of the sinusoidal curve, the better the run and control performance of the motor. This, however, means that voltage peaks occur more frequently at the output of the frequency converter.

In order to select the correct surge arrester for your frequency converter, the maximum continuous operating voltage U_c must be observed. This specifies the maximum permissible operating voltage to which a surge protective device can be connected. Owing to the voltage peaks that occur during the operation of frequency converters, arresters with a high U_c value must be used to avoid "artificial ageing" due to the heating of the surge arrester under "normal" operating conditions and the associated voltage peaks. Even using a sinusoidal filter cannot exclude this.

The high pulse frequency at the output of the frequency converter causes field-based interference. To avoid interference with other systems, the motor feeder cable must be shielded.

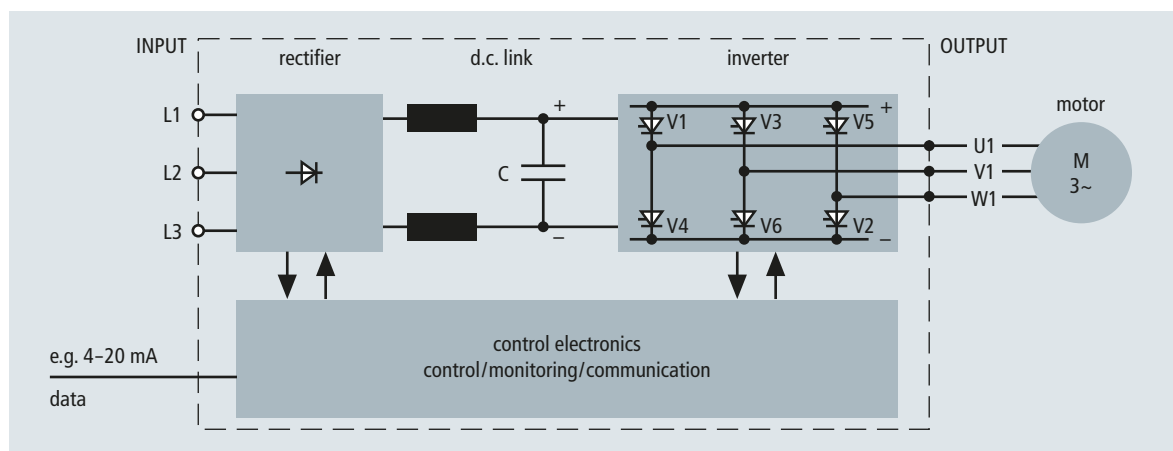


Figure 1 Basic principle of a frequency converter

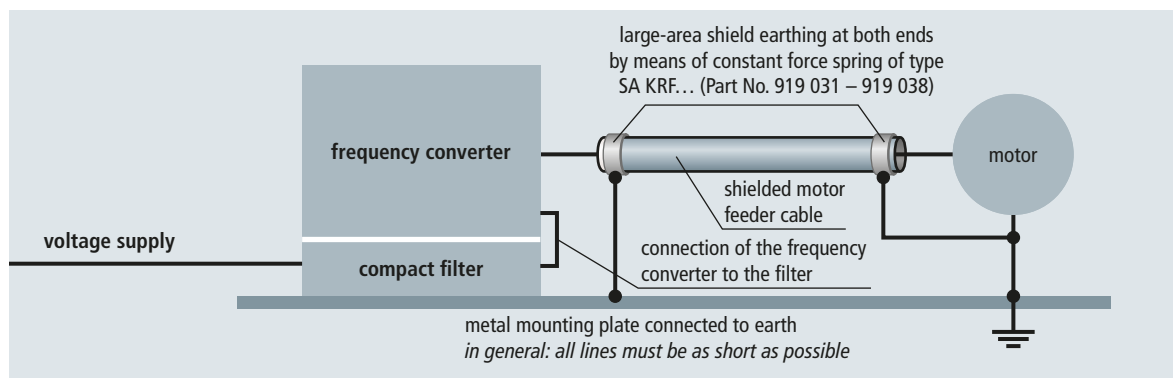


Figure 2 EMC-compatible shield connection of the motor feeder cable

Surge protection for frequency converters

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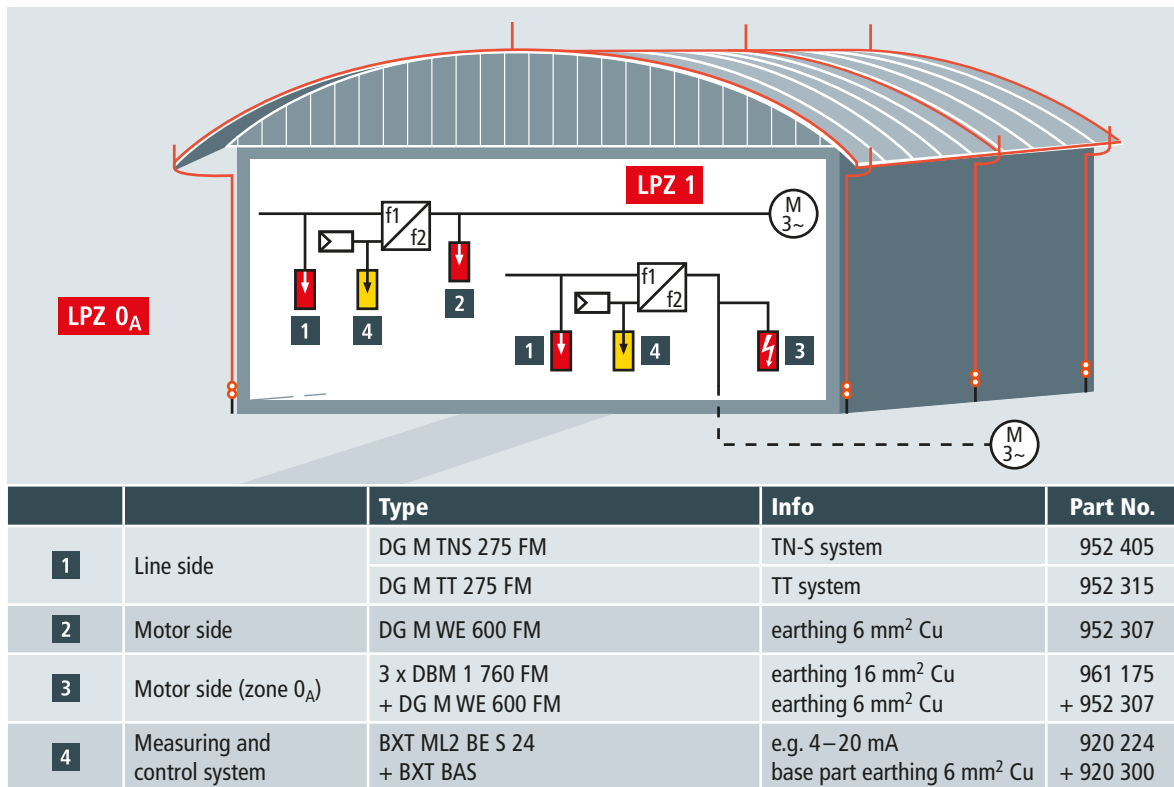


Figure 3 Frequency converter with drives in LPZ 0_A and LPZ 1

The shield of the motor feeder cable must be earthed at both ends, namely at the frequency converter and at the motor. It is important to make sure that the shield has a large contact area. The implementation of contact force springs is advantageous here (Figure 2). Intermeshed earth-termination systems, namely the connection of the earth-termination system of the frequency converter to that of the drive motor, reduce potential differences between the different parts of the in-

stallation, thus preventing equalising currents from flowing through the shield.

When integrating a frequency converter in the building automation, all evaluation and communication interfaces must be protected by surge protective devices to prevent surge-related system failure. Figure 3 shows an example of this for the controller interface 4–20 mA.

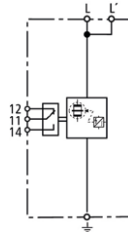
DEHNbloc

DBM 1 760 FM (961 175)

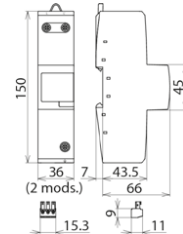
- Extremely high lightning current discharge capacity
- High follow current extinction and limitation due to RADAX Flow technology
- Directly coordinated with DEHNguard surge protective devices without additional cable length



Figure without obligation



Basic circuit diagram DBM 1 760 FM



Dimension drawing DBM 1 760 FM

Coordinated single-pole lightning current arrester with high follow current limitation for $U_C = 760$ V.

Type	DBM 1 760 FM
Part No.	961 175
SPD according to EN 61643-11 / IEC 61643-11	type 1 / class I
Nominal voltage (a.c.) (U_N)	690 V
Max. continuous operating voltage (a.c.) (U_C)	760 V
Lightning impulse current (10/350 μ s) (I_{imp})	25 kA
Specific energy (W/R)	156.25 kJ/ohms
Nominal discharge current (8/20 μ s) (I_n)	25 kA
Voltage protection level (U_p)	≤ 4 kV
Follow current extinguishing capability (a.c.) (I_e)	25 kA _{rms}
Follow current limitation / Selectivity	no tripping of a 32 A gG fuse up to 50 kA _{rms} (prosp.)
Response time (t_A)	≤ 100 ns
Max. backup fuse (L) up to $I_K = 25$ kA _{rms} ($t_a \leq 5$ s)	250 A gG
Max. backup fuse (L) at $I_K > 25$ kA _{rms}	100 A gG
Max. backup fuse (L-L')	125 A gG
Temporary overvoltage (TOV) (U_T) – Characteristic	1320 V / 120 min. – withstand
Operating temperature range (parallel connection) (T_{UP})	-40 °C ... +80 °C
Operating temperature range (series connection) (T_{US})	-40 °C ... +60 °C
Operating state / fault indication	green / red
Number of ports	1
Cross-sectional area (L, L', \pm) (min.)	10 mm ² solid / flexible
Cross-sectional area (L, \pm) (max.)	50 mm ² stranded / 35 mm ² flexible
Cross-sectional area (L') (max.)	35 mm ² stranded / 25 mm ² flexible
For mounting on	35 mm DIN rails acc. to EN 60715
Enclosure material	thermoplastic, red, UL 94 V-0
Place of installation	indoor installation
Degree of protection	IP 20
Capacity	2 module(s), DIN 43880
Approvals	UL, CSA
Type of remote signalling contact	changeover contact
Switching capacity (a.c.)	250 V / 0.5 A
Switching capacity (d.c.)	250 V / 0.1 A; 125 V / 0.2 A; 75 V / 0.5 A
Cross-sectional area for remote signalling terminals	max. 1.5 mm ² solid / flexible
Weight	507 g
Customs tariff number (Comb. Nomenclature EU)	85363090
GTIN	4013364116283
PU	1 pc(s)

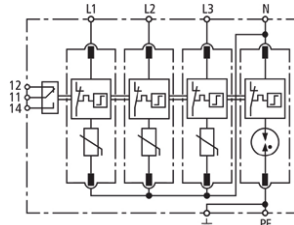
DEHNGuard

DG M TT 275 FM (952 315)

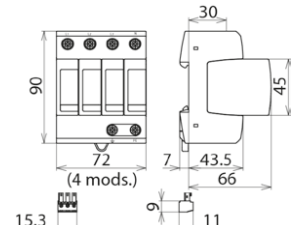
- Prewired complete unit consisting of a base part and plug-in protection modules
- High discharge capacity due to heavy-duty zinc oxide varistors / spark gaps
- High reliability due to "Thermo Dynamic Control" SPD monitoring device



Figure without obligation



Basic circuit diagram DG M TT 275 FM



Dimension drawing DG M TT 275 FM

Modular surge arrester for use in TT and TN-S systems (3+1 configuration); with floating remote signalling contact.

Type	DG M TT 275 FM
Part No.	952 315
SPD according to EN 61643-11 / IEC 61643-11	type 2 / class II
Energy coordination with terminal equipment (≤ 10 m)	type 2 + type 3
Nominal voltage (a.c.) (U_N)	230 / 400 V (50 / 60 Hz)
Max. continuous operating voltage (a.c.) [L-N] (U_C)	275 V (50 / 60 Hz)
Max. continuous operating voltage (a.c.) [N-PE] (U_C)	255 V (50 / 60 Hz)
Nominal discharge current (8/20 μ s) (I_n)	20 kA
Max. discharge current (8/20 μ s) (I_{max})	40 kA
Lightning impulse current (10/350 μ s) [N-PE] (I_{imp})	12 kA
Voltage protection level [L-N]/[N-PE] (U_p)	≤ 1.5 / ≤ 1.5 kV
Voltage protection level [L-N] / [N-PE] at 5 kA (U_p)	≤ 1 / ≤ 1.5 kV
Follow current extinguishing capability [N-PE] (I_f)	100 A _{rms}
Response time [L-N] (t_A)	≤ 25 ns
Response time [N-PE] (t_A)	≤ 100 ns
Max. mains-side overcurrent protection	125 A gG
Short-circuit withstand capability for max. mains-side overcurrent protection (I_{SCCR})	50 kA _{rms}
Temporary overvoltage (TOV) [L-N] (U_T) – Characteristic	335 V / 5 sec. – withstand
Temporary overvoltage (TOV) [L-N] (U_T) – Characteristic	440 V / 120 min. – safe failure
Temporary overvoltage (TOV) [N-PE] (U_T) – Characteristic	1200 V / 200 ms – withstand
Operating temperature range (T_U)	-40 °C ... +80 °C
Operating state / fault indication	green / red
Number of ports	1
Cross-sectional area (min.)	1.5 mm ² solid / flexible
Cross-sectional area (max.)	35 mm ² stranded / 25 mm ² flexible
For mounting on	35 mm DIN rails acc. to EN 60715
Enclosure material	thermoplastic, red, UL 94 V-0
Place of installation	indoor installation
Degree of protection	IP 20
Capacity	4 module(s), DIN 43880
Approvals	KEMA, VDE, UL
Type of remote signalling contact	changeover contact
Switching capacity (a.c.)	250 V / 0.5 A
Switching capacity (d.c.)	250 V / 0.1 A; 125 V / 0.2 A; 75 V / 0.5 A
Cross-sectional area for remote signalling terminals	max. 1.5 mm ² solid / flexible
Extended technical data:	-----
Voltage protection level [L-PE] (U_p)	1.5 kV
Weight	415 g
Customs tariff number (Comb. Nomenclature EU)	85363030
GTIN	4013364108486
PU	1 pc(s)

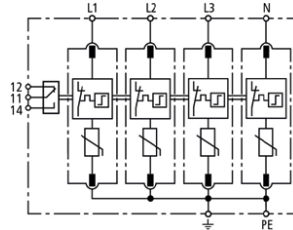
DEHNguard

DG M TNS 275 FM (952 405)

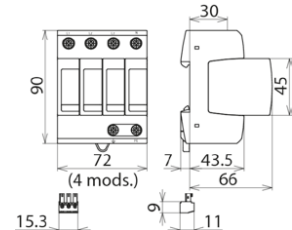
- Prewired complete unit consisting of a base part and plug-in protection modules
- High discharge capacity due to heavy-duty zinc oxide varistors / spark gaps
- High reliability due to "Thermo Dynamic Control" SPD monitoring device



Figure without obligation



Basic circuit diagram DG M TNS 275 FM



Dimension drawing DG M TNS 275 FM

Modular surge arrester for use in TN-S systems; with floating remote signalling contact.

Type	DG M TNS 275 FM
Part No.	952 405
SPD according to EN 61643-11 / IEC 61643-11	type 2 / class II
Energy coordination with terminal equipment (≤ 10 m)	type 2 + type 3
Nominal voltage (a.c.) (U_N)	230 / 400 V (50 / 60 Hz)
Max. continuous operating voltage (a.c.) (U_C)	275 V (50 / 60 Hz)
Nominal discharge current (8/20 μ s) (I_n)	20 kA
Max. discharge current (8/20 μ s) (I_{max})	40 kA
Voltage protection level [L-PE]/[N-PE] (U_P)	≤ 1.5 / ≤ 1.5 kV
Voltage protection level [L-PE] / [N-PE] at 5 kA (U_P)	≤ 1 / ≤ 1 kV
Response time (t_A)	≤ 25 ns
Max. mains-side overcurrent protection	125 A gG
Short-circuit withstand capability for max. mains-side overcurrent protection (I_{SCCR})	50 kA _{rms}
Temporary overvoltage (TOV) (U_T) – Characteristic	335 V / 5 sec. – withstand
Temporary overvoltage (TOV) (U_T) – Characteristic	440 V / 120 min. – safe failure
Operating temperature range (T_U)	-40 °C ... +80 °C
Operating state / fault indication	green / red
Number of ports	1
Cross-sectional area (min.)	1.5 mm ² solid / flexible
Cross-sectional area (max.)	35 mm ² stranded / 25 mm ² flexible
For mounting on	35 mm DIN rails acc. to EN 60715
Enclosure material	thermoplastic, red, UL 94 V-0
Place of installation	indoor installation
Degree of protection	IP 20
Capacity	4 module(s), DIN 43880
Approvals	KEMA, VDE, UL
Type of remote signalling contact	changeover contact
Switching capacity (a.c.)	250 V / 0.5 A
Switching capacity (d.c.)	250 V / 0.1 A; 125 V / 0.2 A; 75 V / 0.5 A
Cross-sectional area for remote signalling terminals	max. 1.5 mm ² solid / flexible
Weight	453 g
Customs tariff number (Comb. Nomenclature EU)	85363030
GTIN	4013364108462
PU	1 pc(s)

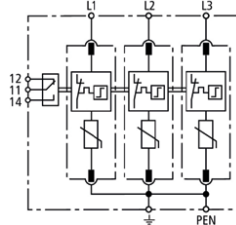
DEHNguard

DG M WE 600 FM (952 307)

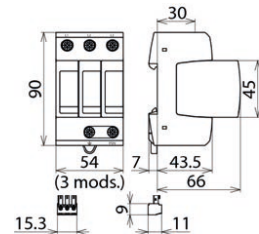
- Prewired complete unit consisting of a base part and plug-in protection modules
- High discharge capacity due to heavy-duty zinc oxide varistors / spark gaps
- High reliability due to "Thermo Dynamic Control" SPD monitoring device



Figure without obligation



Basic circuit diagram DG M WE 600 FM



Dimension drawing DG M WE 600 FM

Modular three-pole surge arrester for use in wind turbines with a rated varistor voltage $U_{mov} = 750$ V a.c.; FM version with floating remote signalling contact.

Type	DG M WE 600 FM
Part No.	952 307
SPD according to EN 61643-11 / IEC 61643-11	type 2 / class II
Energy coordination with terminal equipment (≤ 10 m)	type 2 + type 3
Nominal voltage (a.c.) (U_N)	480 V (50 / 60 Hz)
Max. continuous operating voltage (a.c.) (U_C)	600 V (50 / 60 Hz)
Rated varistor voltage (U_{mov})	750 V
Nominal discharge current (8/20 μ s) (I_n)	15 kA
Max. discharge current (8/20 μ s) (I_{max})	25 kA
Voltage protection level (U_p)	≤ 3 kV
Voltage protection level at 5 kA (U_p)	≤ 2.5 kV
Response time (t_A)	≤ 25 ns
Max. mains-side overcurrent protection	100 A gG
Short-circuit withstand capability for max. mains-side overcurrent protection (I_{SCCR})	25 kA _{rms}
Temporary overvoltage (TOV) (U_T) – Characteristic	900 V / 5 sec. – withstand
Temporary overvoltage (TOV) (U_T) – Characteristic	915 V / 120 min. – safe failure
Operating temperature range (T_U)	-40 °C ... +80 °C
Operating state / fault indication	green / red
Number of ports	1
Cross-sectional area (min.)	1.5 mm ² solid / flexible
Cross-sectional area (max.)	35 mm ² stranded / 25 mm ² flexible
For mounting on	35 mm DIN rails acc. to EN 60715
Enclosure material	thermoplastic, red, UL 94 V-0
Place of installation	indoor installation
Degree of protection	IP 20
Capacity	3 module(s), DIN 43880
Approvals	KEMA, UL
Type of remote signalling contact	changeover contact
Switching capacity (a.c.)	250 V / 0.5 A
Switching capacity (d.c.)	250 V / 0.1 A; 125 V / 0.2 A; 75 V / 0.5 A
Cross-sectional area for remote signalling terminals	max. 1.5 mm ² solid / flexible
Weight	388 g
Customs tariff number (Comb. Nomenclature EU)	85363030
GTIN	4013364113312
PU	1 pc(s)

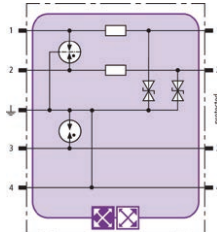
BLITZDUCTOR XT

BXT ML2 BE S 24 (920 224)

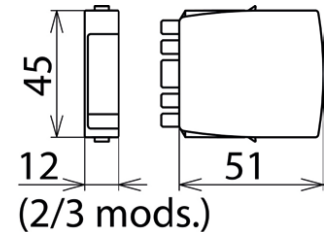
- LifeCheck SPD monitoring function
- Optimal protection of two single lines and the cable shield
- For use in conformity with the lightning protection zone concept at the boundaries from $0_A -2$ and higher



Figure without obligation



Basic circuit diagram BXT ML2 BE S 24



Dimension drawing BXT ML2 BE S 24

Space-saving combined lightning current and surge arrester module with LifeCheck feature for protecting two single lines sharing a common reference potential as well as unbalanced interfaces, with direct or indirect shield earthing. If LifeCheck detects thermal or electrical overload, the arrester has to be replaced. This status is indicated contactlessly by the DEHNrecord LC / SCM / MCM reader.

Type	BXT ML2 BE S 24
Part No.	920 224
SPD monitoring system	LifeCheck
SPD class	TYPE 1 PI
Nominal voltage (U_N)	24 V
Max. continuous operating voltage (d.c.) (U_c)	33 V
Max. continuous operating voltage (a.c.) (U_c)	23.3 V
Nominal current at 45 °C (I_L)	0.75 A
D1 Total lightning impulse current (10/350 μ s) (I_{imp})	9 kA
D1 Lightning impulse current (10/350 μ s) per line (I_{imp})	2.5 kA
C2 Total nominal discharge current (8/20 μ s) (I_n)	20 kA
C2 Nominal discharge current (8/20 μ s) per line (I_n)	10 kA
Voltage protection level line-line for I_{imp} D1 (U_p)	≤ 102 V
Voltage protection level line-PG for I_{imp} D1 (U_p)	≤ 66 V
Voltage protection level line-line at 1 kV/ μ s C3 (U_p)	≤ 90 V
Voltage protection level line-PG at 1 kV/ μ s C3 (U_p)	≤ 45 V
Series resistance per line	1.8 ohm(s)
Cut-off frequency line-PG (f_c)	6.8 MHz
Capacitance line-line (C)	≤ 0.5 nF
Capacitance line-PG (C)	≤ 1.0 nF
Operating temperature range (T_U)	-40 °C ... +80 °C
Degree of protection (with plugged-in protection module)	IP 20
Pluggable into	BXT BAS / BSP BAS 4 base part
Earthing via	BXT BAS / BSP BAS 4 base part
Enclosure material	polyamide PA 6.6
Colour	yellow
Test standards	IEC 61643-21 / EN 61643-21, UL 497B
Approvals	CSA, EAC, ATEX, IECEx, CSA & USA Hazloc, SIL
SIL classification	up to SIL3 [*]
ATEX approvals	DEKRA 11ATEX0089 X: II 3 G Ex nA IIC T4 Gc
IECEx approvals	DEK 11.0032X: Ex nA IIC T4 Gc
CSA & USA Hazloc approvals (1)	2516389: Class I Div. 2 GP A, B, C, D T4
CSA & USA Hazloc approvals (2)	2516389: Class I Zone 2, AEx nA IIC T4
Weight	37 g
Customs tariff number (Comb. Nomenclature EU)	85363010
GTIN	4013364117785
PU	1 pc(s)

^{*}For more detailed information, please visit www.dehn-international.com.

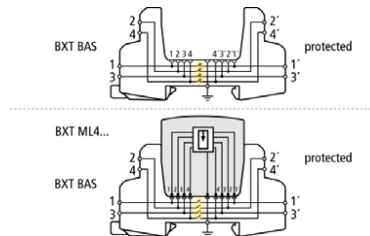
BLITZDUCTOR XT

BXT BAS (920 300)

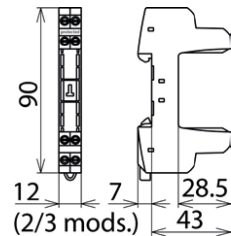
- Four-pole version for universal use with all types of BSP and BXT / BXTU protection modules
- No signal interruption if the protection module is removed
- Universal design without protection elements



Figure without obligation



Basic circuit diagram with and without plugged-in module



Dimension drawing BXT BAS

The BLITZDUCTOR XT base part is an extremely space-saving and universal four-pole feed-through terminal for the insertion of a protection module without signal disconnection if the protection module is removed. The snap-in mechanism at the supporting foot of the base part allows the protection module to be safely earthed via the DIN rail. Since no components of the protective circuit are situated in the base part, maintenance is only required for the protection modules.

Type	BXT BAS
Part No.	920 300
Operating temperature range (T_U)	-40 °C ... +80 °C
Degree of protection	IP 20
For mounting on	35 mm DIN rails acc. to EN 60715
Connection (input / output)	screw / screw
Signal disconnection	no
Cross-sectional area, solid	0.08-4 mm ²
Cross-sectional area, flexible	0.08-2.5 mm ²
Tightening torque (terminals)	0.4 Nm
Earthing via	35 mm DIN rails acc. to EN 60715
Enclosure material	polyamide PA 6.6
Colour	yellow
ATEX approvals	DEKRA 11ATEX0089 X: II 3 G Ex nA IIC T4 Gc ^{*)}
IECEX approvals	DEK 11.0032X: Ex nA IIC T4 Gc ^{*)}
Approvals	CSA, UL, EAC, ATEX, IECEx ^{*)}
Weight	34 g
Customs tariff number (Comb. Nomenclature EU)	85369010
GTIN	4013364109179
PU	1 pc(s)

^{*)} only in connection with an approved protection module

Shield Connection / Constant Force Spring



Figure without obligation

Type	SA KRF 10 V2A
Part No.	919 031
Lightning impulse current carrying capability (10/350 µs)	10 kA
Clamping range (Rd)	4-10 mm
Material	StSt
Colour	bare surface
For mounting on	cable shields
Weight	2 g
Customs tariff number (Comb. Nomenclature EU)	73209090
GTIN	4013364103511
PU	20 pc(s)

Type	SA KRF 15 V2A
Part No.	919 032
Lightning impulse current carrying capability (10/350 µs)	10 kA
Clamping range (Rd)	9-15 mm
Material	StSt
Colour	bare surface
For mounting on	cable shields
Weight	2 g
Customs tariff number (Comb. Nomenclature EU)	73209090
GTIN	4013364103528
PU	20 pc(s)

Type	SA KRF 22 V2A
Part No.	919 033
Lightning impulse current carrying capability (10/350 µs)	10 kA
Clamping range (Rd)	14-22 mm
Material	StSt
Colour	bare surface
For mounting on	cable shields
Weight	5 g
Customs tariff number (Comb. Nomenclature EU)	73209090
GTIN	4013364103535
PU	20 pc(s)

Type	SA KRF 29 V2A
Part No.	919 034
Lightning impulse current carrying capability (10/350 µs)	10 kA
Clamping range (Rd)	18.5-29 mm
Material	StSt
Colour	bare surface
For mounting on	cable shields
Weight	7 g
Customs tariff number (Comb. Nomenclature EU)	73209090
GTIN	4013364103542
PU	10 pc(s)

Shield Connection / Constant Force Spring

- For solderless connection of a conductor to the shield
- For use with all plastic and lead-sheathed cables
- Also suitable for steel-reinforced lead-sheathed cables

Constant force springs allow solderless shield connections for equipotential bonding or lightning equipotential bonding. They can be installed subsequently without interrupting the cable shield or requiring tools for installation.

Type	SA KRF 37 V2A
Part No.	919 035
Lightning impulse current carrying capability (10/350 µs)	10 kA
Clamping range (Rd)	23.5-37 mm
Material	StSt
Colour	bare surface
For mounting on	cable shields
Weight	12 g
Customs tariff number (Comb. Nomenclature EU)	73209090
GTIN	4013364103559
PU	10 pc(s)

Type	SA KRF 50 V2A
Part No.	919 036
Lightning impulse current carrying capability (10/350 µs)	10 kA
Clamping range (Rd)	31-50 mm
Material	StSt
Colour	bare surface
For mounting on	cable shields
Weight	23 g
Customs tariff number (Comb. Nomenclature EU)	73209090
GTIN	4013364103566
PU	25 pc(s)

Type	SA KRF 70 V2A
Part No.	919 037
Lightning impulse current carrying capability (10/350 µs)	10 kA
Clamping range (Rd)	44-70 mm
Material	StSt
Colour	bare surface
For mounting on	cable shields
Weight	50 g
Customs tariff number (Comb. Nomenclature EU)	73209090
GTIN	4013364103573
PU	20 pc(s)

Type	SA KRF 94 V2A
Part No.	919 038
Lightning impulse current carrying capability (10/350 µs)	10 kA
Clamping range (Rd)	58-94 mm
Material	StSt
Colour	bare surface
For mounting on	cable shields
Weight	82 g
Customs tariff number (Comb. Nomenclature EU)	73209090
GTIN	4013364103580
PU	10 pc(s)

Surge Protection
Lightning Protection
Safety Equipment
DEHN protects.

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