



# Safety for all applications and all speeds

Surge arresters for railway systems

Answers for energy.

**SIEMENS**

# Surge arresters from Siemens

Quality and reliability for all applications



This catalogue features the complete range of Siemens surge arresters for railway applications. Detailed information about the outstanding 3EB and 3EC product lines can be found [here](#). Further information about the standard product lines 3EQ, 3EP and 3EL (specifically for your electrification needs) can be obtained directly from Siemens.

## Over 75 years of experience

Experience is the most important factor when it comes to the reliability of medium- and high-voltage systems. Since 1929, Siemens has been manufacturing high-voltage surge arresters for standard and specialized applications. Continuous research and development as well as the coordinated application of expertise at factories give Siemens' surge arresters a leading edge in overvoltage protection. The very high quality and cost-effectiveness of Siemens' products ensure a long service life and reliability in every application. The range of Siemens' surge arresters offers optimum protection for all power transmission and distribution systems, not just in the railway sector.

## Standardized and customized solutions

Countless generators, transformers, switchgears, overhead transmission lines and cables as well as complex gas-insulated substations throughout the world have been reliably protected by Siemens surge arresters for many decades. In addition to standard applications, Siemens offers customized surge arresters for virtually any application from 300 V up to 800 kV AC and DC, and the range of Siemens' surge arresters is also designed for many different environmental conditions, from the arctic cold to the heat of the desert and the extreme humidity of tropical climates. The protection of electrified railway systems has always been a central part of the portfolio. Siemens surge arresters protect every part of your system, from generators and transformer substations, transmission lines, cables and catenaries to rail vehicles for local, long-distance and high-speed services.



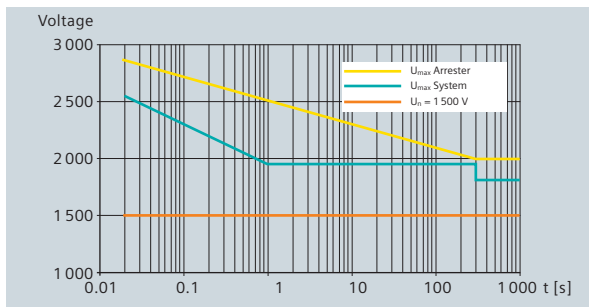


# Reliable overvoltage protection

## For railway power supply systems and electric motive power units



Nominal Voltage	750 V	1 500 V	3 000 V	15 000 V	25 000 V
$U_{\max 1}$ (V)	900	1 800	3 600	17 250	27 500
$U_{\max 2}$ (V)	1 000	1 950	3 900	18 000	29 000
$U_{\max 3}$ (V)	1 270	2 540	5 075	25 300	38 750



Feed voltages for railway networks:

The top curve shows the surge arrester operating range.

The second curve represents the  $U_{\max}$  system voltage according to IEC 60850 and the curve at the bottom is the rated voltage  $U_n$ . These curves show an example for  $U_n = 1500$  V DC.

The surge arrester is suitable for all voltages possible in normal operation.



More than 50 years experience in the development and manufacture of surge arresters for transportation systems gives Siemens a leading position with overvoltage protection products in this specialized field. Excellent reliability has always been the outstanding feature of these products. Siemens has developed four types of surge arresters on this basis:

- The 3EC3, a porcelain-housed surge arrester for DC systems up to 3 kV for use on rolling stock and for fixed installation.
- The 3EB1 with a glass fiber reinforced plastic (GFRP) housing and silicone rubber sheds, for DC and AC systems up to 3 kV DC and 25 kV AC and for use on rolling stock.
- The 3EB2 with silicone housing for DC systems up to 1.5 kV for fixed installation.
- The 3EB4 with a glass fiber reinforced plastic (GFRP) housing and silicone rubber sheds, for DC systems up to 4 kV, for use on rolling stock as well as for fixed installation.

While this catalogue lists a great number of standard arresters for use in railway power supply systems, Siemens also offers inner-cone plug-on arresters for direct attachment to transformers or switchgear, and arresters for railway power distribution systems. In addition, Siemens can also offer surge arresters for special requirements (for example, greater creepage distances or special methods of connections) upon request.

### Supply voltages for railway power supply systems

Supply voltages of railway power supply systems are defined in standard DIN EN 50163 (VDE 0115 part 102). The terms and definitions used there include the following:

#### Nominal Voltage $U_n$

Design value for system equipment

#### Maximum continuous voltage $U_{\max 1}$

Maximum value of the voltage that can occur indefinitely

#### Maximum non-permanent voltage $U_{\max 2}$

Maximum value of the voltage that can occur as a non-permanent voltage (applies for long duration transition states)

#### Highest long-term overvoltage $U_{\max 3}$

R. m. s. value of an AC voltage as a maximum value of the long-term overvoltage for  $T = 20$  ms

#### Long-term overvoltage

Overvoltage  $> U_{\max 2}$  and  $> 20$  ms, (e.g., due to a rise in substation primary voltage)





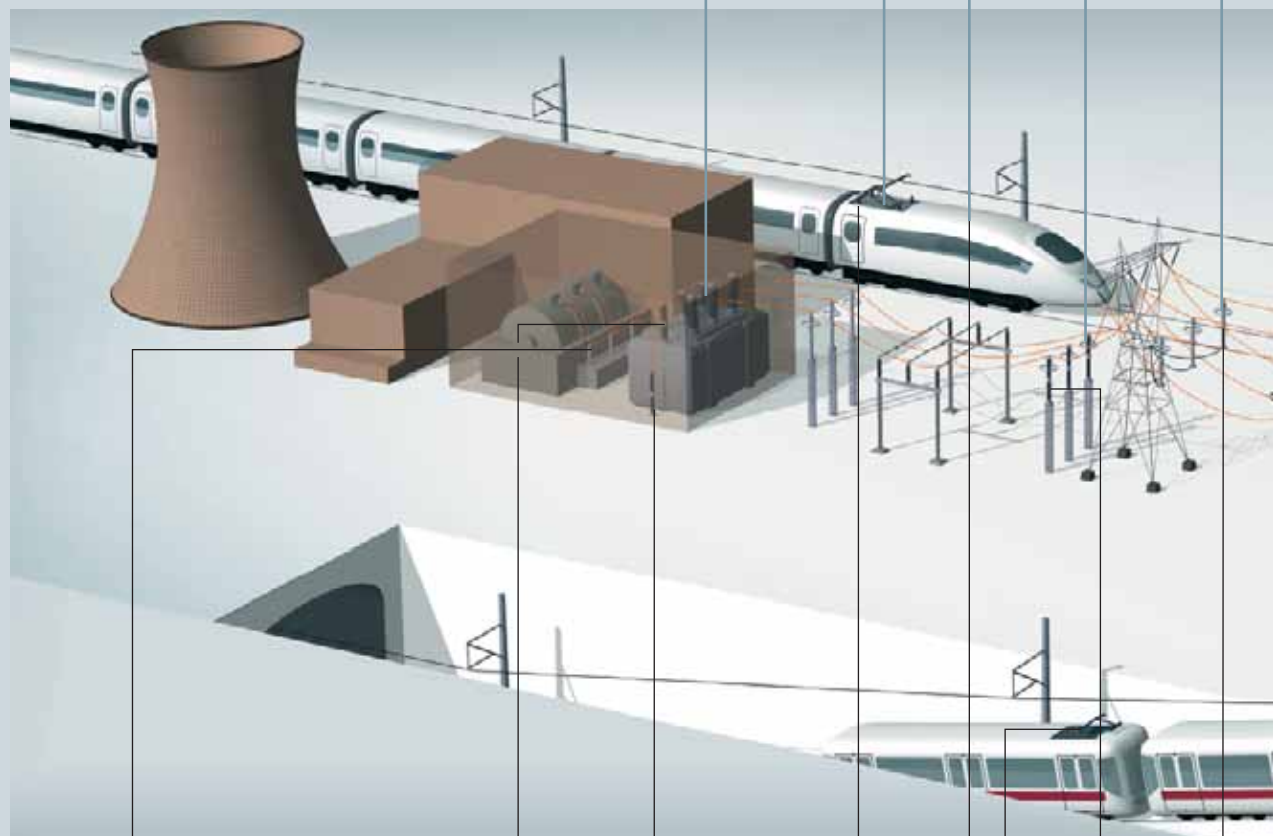
3EB1



3EB4



3EP



Generator protection  
3EE2

Transformer protection  
3EP  
3EL  
3EQ  
3ES

Neutral point arrester  
3EP  
3EL  
3EQ  
3ES

Arrester for rolling stock  
3EB1  
3EB4  
3EC3

Substation protection  
3EL  
3EQ  
3EP



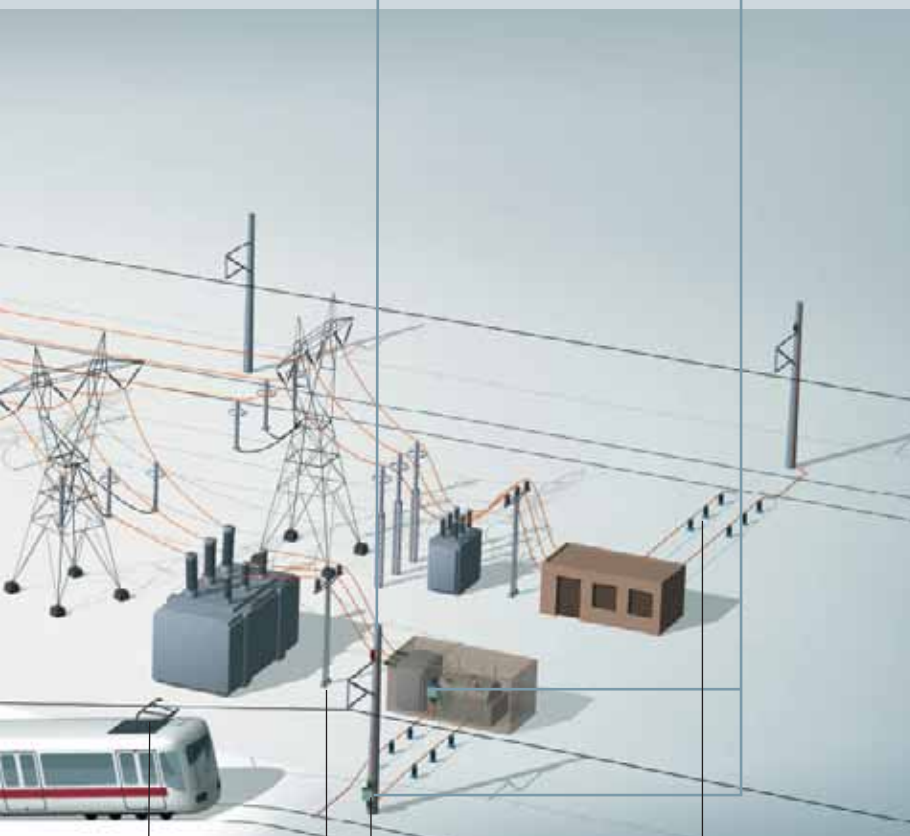
3EL



3EC3



3EB2



Surge arresters from Siemens play a vital part in the reliability of today's power transmission and distribution systems at all voltage levels, including generators, transformers, transformer neutral points, overhead power lines and medium-voltage systems. Siemens' comprehensive expertise in high-voltage applications has also enabled the company to develop specialized surge arresters for transportation systems. This means Siemens can offer optimum over-voltage protection for all these applications.

The product portfolio therefore also includes limiters for protecting power converters as well as a range of DC surge arresters and surge arresters. They're all designed to meet the highest standards of security and reliability (3EB1/3EB4) to protect electric motive power units against overvoltage.

The following pages concentrate on the description of surge arresters for railway systems.

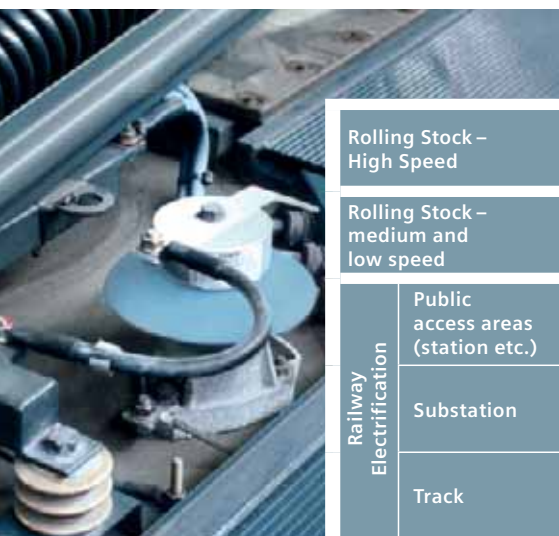
Power line  
arrester  
3EL

Arrester for medium  
voltage systems  
3EK7

Arrester for  
DC systems  
3EB1  
3EC3  
3EB2  
3EB4

Arrester for  
AC systems  
3EB1  
3EK7  
3EL

# The best choice for every application



		3EB1		3EB4		3EB2	3EC3	3EK, 3EL, 3EP, 3EQ
		AC	DC	AC*	DC	DC	DC	AC
Rolling Stock – High Speed		✓	✓	✗	✗	✗	✗	✗
Rolling Stock – medium and low speed		✓	✓	✓	✓	✗	✓	✗
Railway Electrification	Public access areas (station etc.)	✓	✓	✓	✓	✗	✓	✗
	Substation	✓	✓	✓	✓	✓	✓	✓
	Track	✓	✓	✓	✓	✓	✓	✓

\* Upon request

✓ optimally suited

✓ suitable with reservations

✗ not suitable

From high-speed trains between the major cities of the world, subway services every few minutes from train station to airport, or everyday mass transit, the requirements of rail transport vary from one extreme to the other.

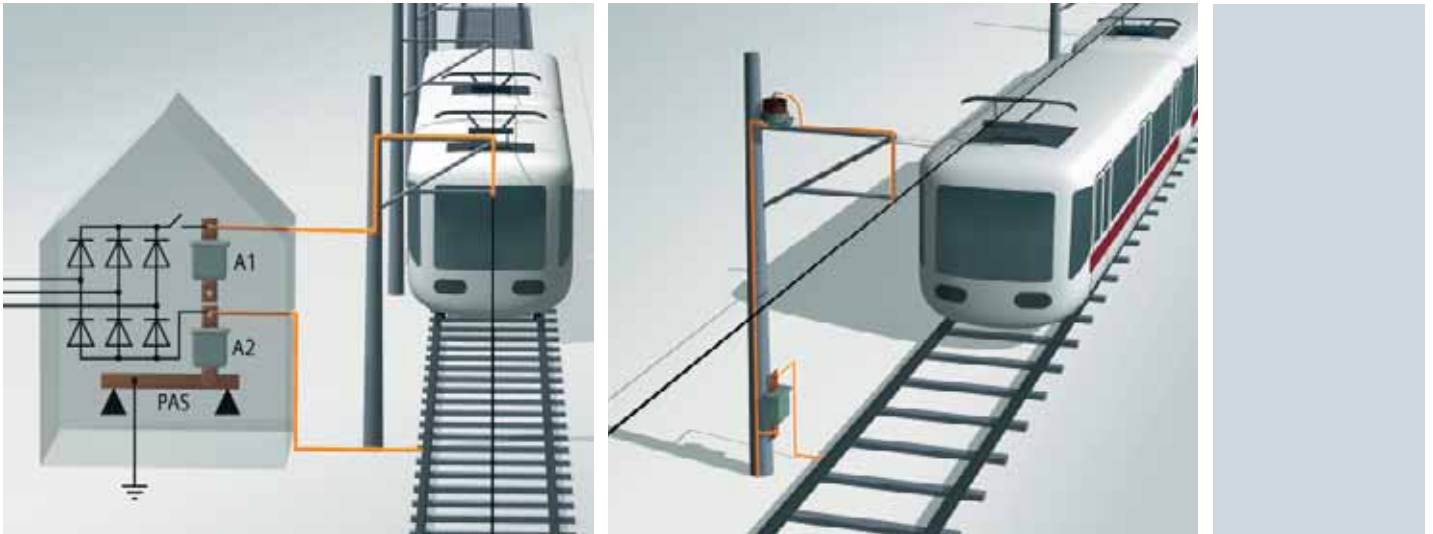
That's why Siemens also offers its customers tailored solutions for overvoltage protection in the railway sector. Apart from the system voltage, the main criteria relevant for selection of the correct surge arrester are the type of application, or in other words the speed of travel, and the resulting load. With its insulator sheds designed for extreme mechanical loads, the polymer surge arrester 3EB1 is outstandingly well suited for high-speed trains. The 3EB4 offers the same basic mechanical construction, but due to the design of its sheds is optimized rather for applications in the medium-speed range or for stationary applications.

Both surge arresters have extremely rugged housings offering maximum security in areas accessible to the public. The porcelain-housed 3EC3 is particularly suitable for use on rolling stock as well as for stationary applications in DC systems, whereas the 3EB2 polymer surge arrester was designed specifically for overvoltage protection in accordance with the VDV A1 – A2 arrester concept in DC systems. Through its dedicated portfolio of railway surge arresters, Siemens also offers its proven medium- and high-voltage surge arresters for AC networks and substations.





# A1 – A2 surge arrester concept



## A1 – A2 surge arrester concept according to VDV 525 Recommendation for applications in DC systems

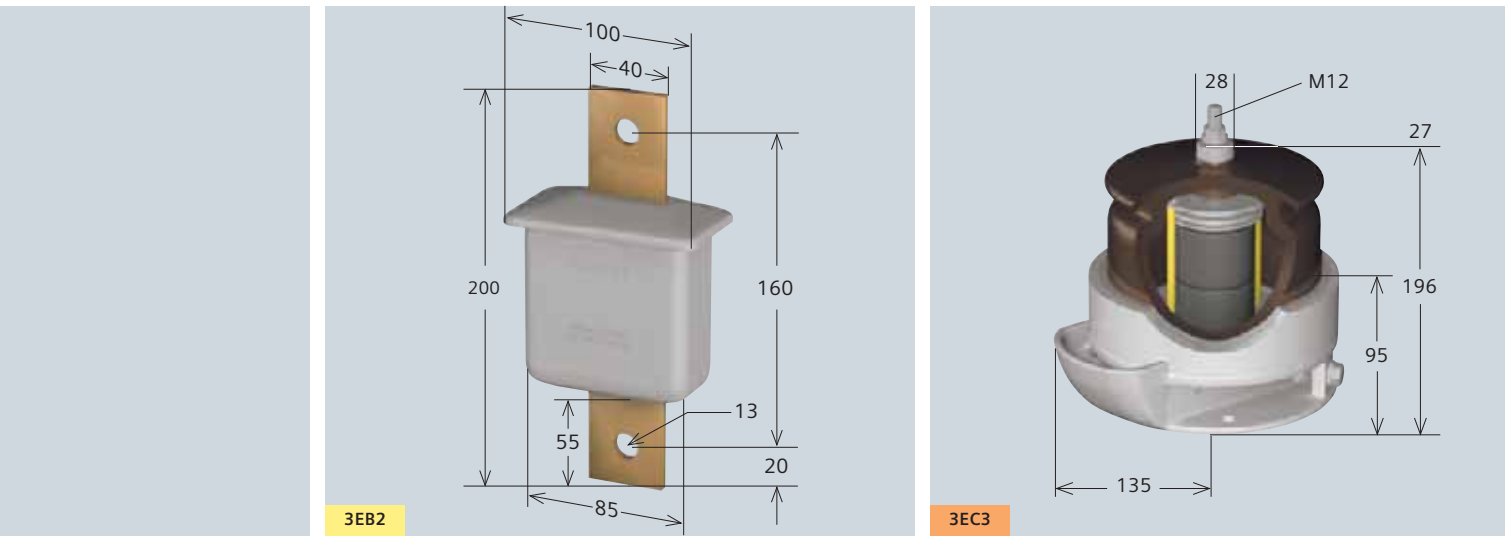
The “Verband deutscher Verkehrsunternehmen (VDV)” (Association of German Transportation Companies) offers operators of DC railways recommendations for effective overvoltage protection in case of lightning strikes in its publication no. 525. The grounding of the power distribution system is especially important in the planning of lightning protection concepts. If the rails of DC railway systems are isolated from earth for the purpose of reducing stray current corrosion (as required when laying new rails), they cannot be used as earth terminations. In this case, low-resistance tower footings, driven piles, the reinforcements of reinforced concrete tracks or separate earth rods must be used as earth terminations. However, rails laid without any additional isolation measures generally only have a low leakage resistance and can be used as earth terminations. The surge current then will be discharged via the rails endangering electrical or electronic equipment located near or on the tracks. Additional surge arresters within this equipment provide an effective remedy against overvoltages caused by this process.

To provide full protection for the catenary, outdoor surge arresters with VDV 525 designation “A1” should be installed at every power feeding point, at the ends of feeding sections and dead-end feeders, at coupling points as well as at current taps. Additional A1 surge arresters are recommended if sections are hit by lightning strikes very often, for example, on bridges or on open stretches.

Protecting supply and return lines at substations with surge arresters is an essential element of a lightning protection concept in railway power supply systems. Two surge arresters of different ratings are used for this purpose. Surge arresters of type A1 are connected between section circuit-breakers/cable terminals and the return line. The unavoidable potential rise in a return line as a result of a lightning surge current is limited by a type A2 surge arrester between return line and structure earth.

Although metal oxide surge arresters are exceptionally reliable devices with failure rates of well below 1 % per year, a failure may occur under unfavorable circumstances, which in this case leads to a state of permanent conductivity of the type A1 surge arrester. If the rails have a small leakage per unit length, the ground electrode in this case may receive an inadmissibly high fault voltage for a long time. However, if an additional A2 surge arrester with a low continuous operating voltage ( $120 \text{ V} \leq U_c \leq 300 \text{ V}$ ) is connected between ground electrode and return line, this surge arrester is intentionally overloaded. This limits the fault voltage and trips the section circuit breaker due to feeding from the catenary system.

# 3EB2 or 3EC3 – surge arresters for DC applications



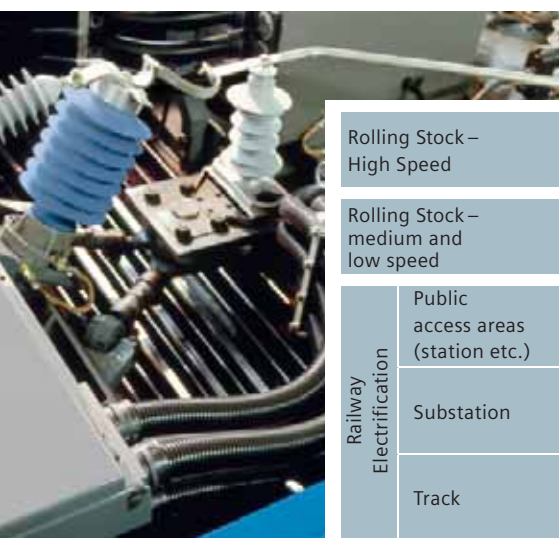
The 3EC3 surge arrester can be used in DC supply systems, either in stationary applications or on vehicles. For use in accordance with Recommendation VDV 525, the 3EB2 surge arrester is used as described below.

Arrester data									
Nominal system voltage	Type	Maximum continuous operating voltage	Energy capability	Maximum values of the residual voltages at discharge currents of the following impulses					
				30/60 µs 0,5 kA	30/60 µs 1 kA	8/20 µs 1 kA	8/20 µs 5 kA	8/20 µs 10 kA	1/2 µs 10 kA
kV		kV	kJ	kV	kV	kV	kV	kV	kV
–	3EB2 003-7D	0.3	3	0.58	0.60	0.61	0.68	0.72	0.76
0.75	3EB2 010/3EC3 010-7D	1	10	1.9	2.0	2.0	2.3	2.4	2.5
1.5	3EB2 020/3EC3 020-7D	2	20	3.9	4.0	4.1	4.5	4.8	5.1
3.0	3EC3 040	4	40	7.8	8.0	8.2	9.0	9.6	10.2

Arrester housings											
Arrester data											
Housing size	Height	Flash over distance	Creepage distance	Sheds quantity	Short circuit capability	Housing insulation withstand level			Max. top load		Max. arrester weight
						Lightning impulse withstand voltage	Power-frequency withstand voltage 50 Hz, 1 min		static	dynamic	
						1.2/50 µs	dry	wet			
	mm	mm	mm		kA	kV	kV	kV	kN	kN	kg
3EB2 xxx - 7D	200	127	133	1	40	25	13	10	0.16	0.4	1.4
3EC3 xxx	223	135	165	1	40	65	45	25	0.24	0.6	6.8



# Reliable and safe – railway surge arresters 3EB1 and 3EB4

		AC		DC			
		Rolling Stock – High Speed		3EB1			
		Rolling Stock – medium and low speed		3EB4*			3EC3
		Railway Electrification	Public access areas (station etc.)				
Substation	3EK 3EL			3EB2	3EC3		
Track	3EP 3EQ						

\* For 3EB4 AC type upon request

The railway surge arresters 3EB1 und 3EB4 have to withstand a great deal: exposure to extremes of weather, temperatures from –40°C to +70°C, and the effects of UV radiation. But that’s exactly what they were designed for, and they were effectively protected with suitably resilient technology and durable materials, to ensure problem-free operation under all conditions of use.

### The right combination for your success

The 3EQ surge arrester family combines the outstanding properties of a special silicone sheathing and an extremely strong GFRP housing (glass fiber reinforced plastic). Stemming originally from the power supply sector, they set new standards of safety and reliability for railway applications as well:

- Specially tailored to the feeding voltages of railway power supply systems
- Optimum protection against atmospheric or operationally caused overvoltages.

### Tailored performance –

#### the 3EB1 and 3EB4 railway surge arresters

In terms of materials and geometry, the housing was developed especially for the special conditions of use in rolling stock. The silicone sheathing has also been optimized so that today there are two different materials available for high speeds and for normal speeds:

- Railway surge arrester 3EB1 for vehicles with maximum speeds over 160 km/h
- Railway surge arrester 3EB4 for vehicle speeds up to 160 km/h and for stationary application in areas accessible to the public



# Railway surge arresters from Siemens: the right solution for every travel speed

Speed in km/h

70

160

200

280

360



160 km/h

3EB4

3EB1



250 km/h

3EB4

3EB1



360 km/h

3EB4

3EB1

## The wind tunnel reveals the differences

As an experienced and expert partner for surge arrester technology, Siemens can offer you two different polymer surge arresters for the vehicle sector, matched precisely to your particular area of application. For speeds up to 160 km/h (100 mph) the new 3EB4 is recommended, and for higher speeds up to the high-speed range the high-performance 3EB1.

While both arrester types are comparable with regard to their electrical specifications, dimensions and connections, comparison in the wind tunnel reveals the difference between the two systems. The 3EB4 uses an insulating material that has been tried and tested in high-voltage applications and has large creepage distances due to the change from large to small sheds. It is ideally suited for use with air flow speeds of up to 160 km/h (44.4 m/s).

The more rigid, high-temperature cross-linked silicone of the 3EB1 on the other hand is specially designed for railway applications in the speed range of up to 360 km/h (88 m/s).

The outstanding material properties of silicone insulators apply for both surge arresters:

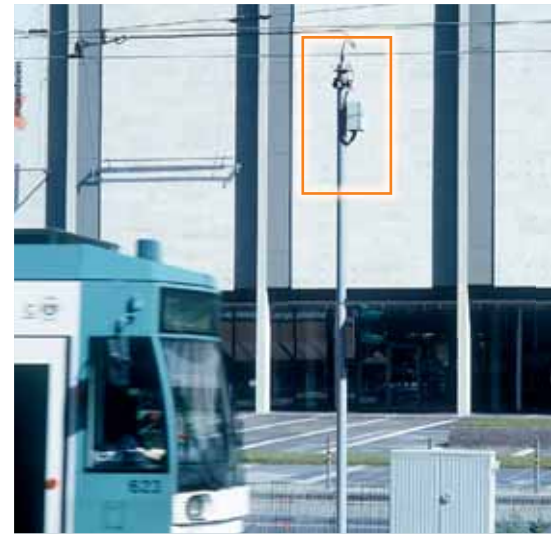
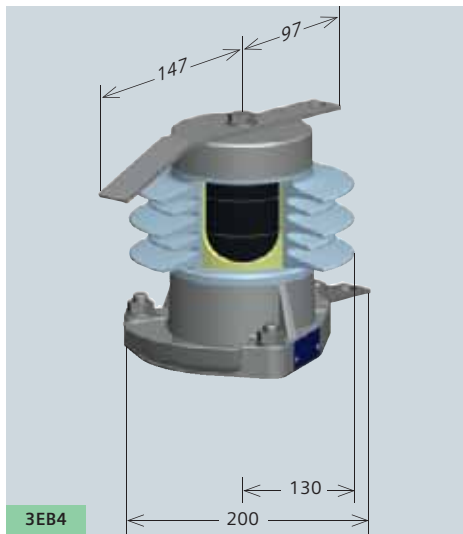
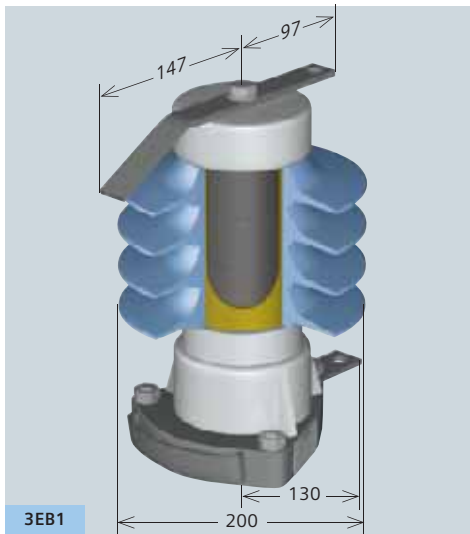
- High resistance against leakage currents and material erosion
- High resistance against UV radiation
- High mechanical strength
- High resistance to fire
- Outstanding dielectric properties
- Permanently water- and dirt-repellent surface

	Silicone material	No. of sheds	Creepage distance mm	Max. speed km/h
3EB1 xxx-7DS ...	HTV	1	125	360
3EB1 xxx-7DM ...	HTV	2	230	360
3EB4 xxx-7DS ...	LSR	3	226	160
3EB4 xxx-7DM ...	LSR	5	392	160

In the medium speed range, the 3EB4 provides a solution that is both economical and reliable. The 3EB1 railway surge arrester is always the first choice whenever it comes to high-speed links.



# 3EB1 and 3EB4 – surge arresters for DC and AC applications



Surge arresters for DC applications				Arrester data					
Nominal system voltage	Type	Maximum continuous operating voltage	Energy capability	Maximum values of the residual voltages at discharge currents of the following impulses					
				30/60 $\mu$ s 0.5 kA	30/60 $\mu$ s 1 kA	8/20 $\mu$ s 1 kA	8/20 $\mu$ s 5 kA	8/20 $\mu$ s 10 kA	1/2 $\mu$ s 10 kA
kV		kV	kJ	kV	kV	kV	kV	kV	kV
0.75	3EB1 010/3EB4 010	1	10	1.9	2.0	2.0	2.3	2.4	2.5
1.5	3EB1 020/3EB4 020	2	20	3.9	4.0	4.1	4.5	4.8	5.1
3.0	3EB1 040/3EB4 040	4	40	7.8	8.0	8.2	9.0	9.6	10.2

Surge arresters for AC applications				Arrester data					
Nominal system voltage	Type	Maximum continuous operating voltage	Energy capability	Maximum values of the residual voltages at discharge currents of the following impulses					
				30/60 $\mu$ s 0.5 kA	30/60 $\mu$ s 1 kA	8/20 $\mu$ s 1 kA	8/20 $\mu$ s 5 kA	8/20 $\mu$ s 10 kA	1/2 $\mu$ s 10 kA
kV		kV	kJ	kV	kV	kV	kV	kV	kV
15	3EB1230-5AL2...	18	97	46	48	49	56	60	64
15	3EB1230-6AL2...	18	180	44	45	46	52	55	58
25	3EB1370-5AX2...	30	155	74	77	79	89	96	102
25	3EB1370-6AX2...	30	290	71	73	75	84	89	94

Arrester housings						Arrester data					
Housing size	Height	Flash over distance	Creepage distance	Sheds quantity	Short circuit capability	Housing insulation withstand level			Max. top load		Max. arrester weight
						Lightning impulse withstand voltage	Power-frequency withstand voltage 50 Hz, 1 min		static	dynamic	
						1.2/50 μs	dry	wet			
	mm	mm	mm		kA	kV	kV	kV	kN	kN	kg
3EB1 0x0-7DS2...	191	100	125	1	40	55	28	23	5.5	13.5	5.2
3EB1 0x0-7DM2...	226	130	230	2	40	70	37	30	4.5	11.5	5.6
3EB4 0x0-7DS...	191	100	248	3	40	55	28	23	5.5	13.5	6.2
3EB4 0x0-7DM...	226	130	392	5	40	70	37	30	4.5	11.5	6.5
3EB1 230-xAL2...	296	195	460	4	40	110	55	45	3.5	9	8.2
3EB1 370-xAX2...	425	297	800	7	40	170	85	70	2.5	6	11.6



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