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CERAM INSULATORS

PP

The very Best.

That's what we deliver.

Only a company that develops, produces and delivers products worldwide can provide the optimal solution for your requirements.

The specialists of **PPC** Insulators are dedicated to supplying you with superior advice and global support.

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PPC INSULATORS

Revision 1 / 2003

CERAM INSULATORS

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The very Best.

Long Rod Insulators

PPC INSULATORS

Best Performance in Engineering
Your Request is our Challenge

› ISO 9001 › IEC › DIN › ÖNORM

Index

Excellent design with extra high strength

PPC Insulators is a specialist in long rod insulators with a 60 year history of experience and development of these porcelain insulators.

We produce a comprehensive range of products for overhead transmission lines up to highest system voltages of 525 kV with the most progressive technology, engineering and in-service life.

PPC INSULATORS

Long Rod Insulators
Introduction

Long Rod Insulators
Standards

High Voltage Overhead Transmission Lines

To specify the correct porcelain long rod insulator, the following characteristics have to be defined:

- specified mechanical failing load
- minimum nominal creepage distance
- environmental conditions and grade of pollution
- type of coupling
- standard lightning impulse withstand voltage
- wet power frequency withstand voltage

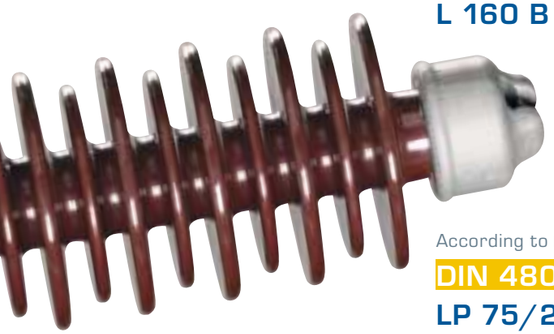
Designation

PPC Insulators manufactures long rod insulators according to IEC 60433 (1998) (including the former German standard DIN 48006 (1986)).

According to **IEC 60433** a porcelain long rod insulator is, for example, defined as follows:

L 160 B 550

L	long rod insulator
160	specified mechanical failing load (kN)
B	ball and socket coupling
C	clevis coupling (when B is replaced by C)
550	standard lightning impulse withstand voltage (kV)



According to the former German standard **DIN 48006** the same insulator was defined as:

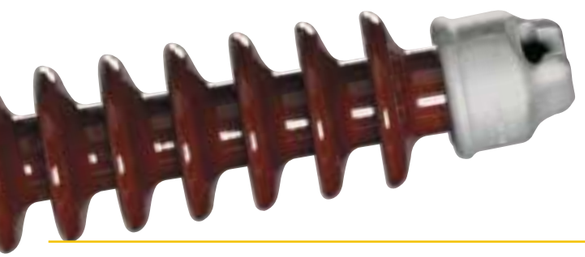
LP 75/22/1250

LP	porcelain long rod insulator with ball and socket coupling
LG	porcelain long rod insulator with clevis coupling (when LP is replaced by LG)
75	core diameter (mm)
22	number of sheds
1250	total length of the long rod insulator (mm)

According to the former Austrian standards **ÖNORM** a long rod insulator was defined as shown in the following example:

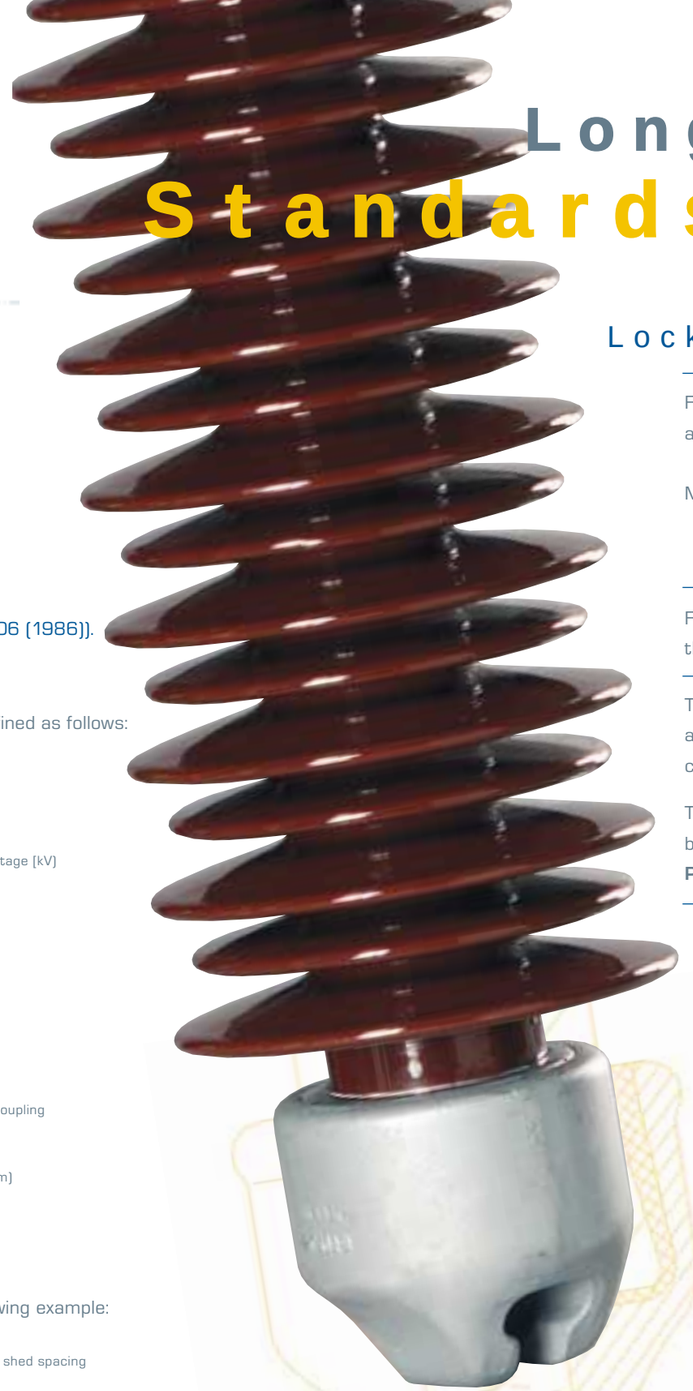
L 60/15-125

L	porcelain long rod insulator with normal shed spacing
60	core diameter (mm)
15	number of sheds
125	mechanical failing load, average value (kN)



Variations are made by changes in the initial letter as shown:

L	standard design with normal creepage distance
LH	normal creepage distance with higher strength
VL	anti-pollution type
NL	fog type
WL	with alternating sheds



Locking Devices

For **ball and socket couplings,** split pins conforming to are normally used. — **IEC 60372 (1984)**

Most of these pins also comply with — **DIN 48063 (1978) = ÖNORM E4130 (1988) ÖNORM E4131 (1988)**

For **ball and socket couplings** complying to the locking is performed by a corresponding split pin. — **ÖNORM E4104 (1988)**

The **clevis coupling** is locked by a corresponding connecting bolt with grooved nut and cotter pin according to — **DIN 48073**

These connecting bolts are not part of regular supplies, but upon customer request, **PPC** can procure these connecting bolts.

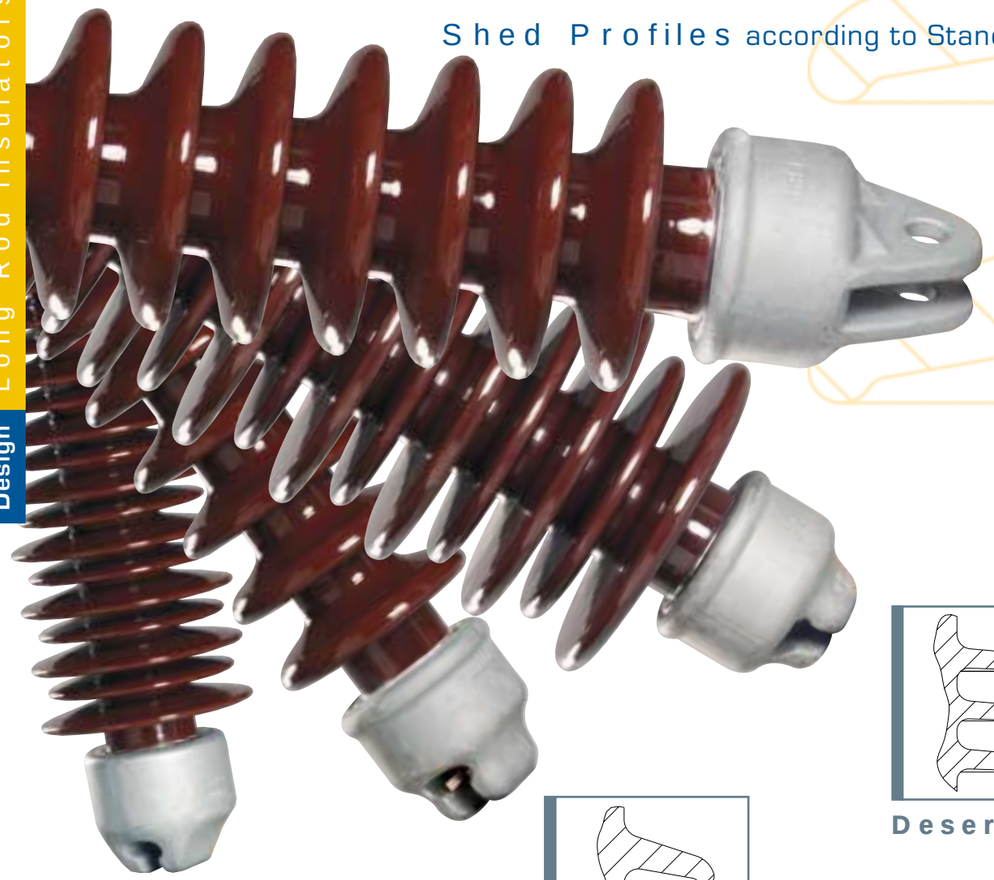
Couplings

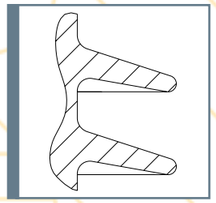
Three types of couplings for porcelain long rod insulators are available:

Ball and socket couplings conforming to
1. **IEC 60120 (1987) = DIN 48064 (1982) = ÖNORM E4125 (1988)**
2. **ÖNORM E4104 (1988)**

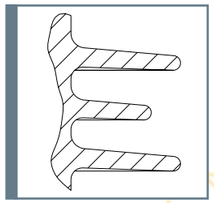
Clevis couplings conforming to — **IEC 60471 (1977) = DIN 48073 (1975) = DIN 48074 (1990) = ÖNORM E4126 (1984)**

Shed Profiles according to Standard IEC 60815

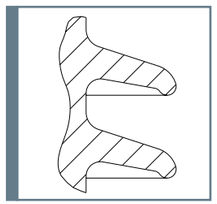




Plain shed



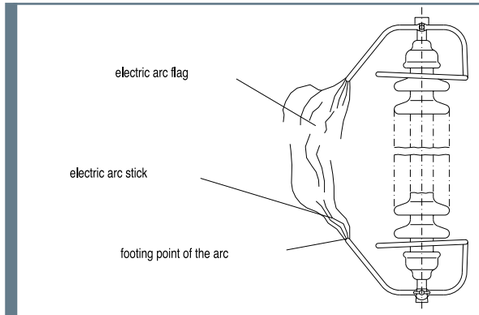
Desert shed



Alternating shed

Standard shed acc. to DIN

Electrical Values



Electric Arc Discharge along a Long Rod Insulator with Protective Fittings

The insulation performance of a long rod insulator is a function of the length, creepage and arcing distance of the insulating part and follows the standard IEC 60071 (1982-1996).

It should be noted that to provide an accurate picture of all electrical relationships, a real tower should be constructed with all relevant distances to earth in conjunction with insulators, arcing horns and protective devices.

Long Rod Insulators
Design

Creepage Distances

Porcelain long rod insulators are produced with different shed profiles to optimize performance according to environmental conditions and the grade of pollution. For example, this includes

› Fog and Salt Pollution

shed profiles for coastal areas (fog and salt pollution) which require a high protected creepage distance

› Dust Pollution

aerodynamic shed profiles for areas with desert conditions (dust pollution)

› Industrial Pollution

shed profiles for areas with heavy industrial pollution

The recommendations of standard IEC 60815 (1986) are valid for the design of the shed profiles of porcelain insulators and for the determination of the adequate tolerances.

PPC INSULATORS

Long Rod Insulators
Design

Long Rod Insulators
Production

Insulating Material

The insulator body of the unit is made from high quality aluminum oxide porcelain, C-130, which conforms to IEC 60672 (1995-1999). By customer request, we can also manufacture from aluminum oxide porcelain, C-120.

Glazing provides a dirt repellent surface. Glazing is normally brown in color; however grey can also be provided upon request.

Marking

Each porcelain long rod insulator carries the trademark of the **PPC** Insulators and of the manufacturing factory and the date of manufacture as well as the type designation and the specific mechanical failing load in accordance with standard IEC 60433.

Cementing

Cementing is provided with a lead-antimony alloy as standard although it is also possible to provide Portland cement or sulfur cement.

Insulator Cap Material (Fittings)

Insulator caps are manufactured in malleable cast iron, in minimum EN-GJMB-550-4 or EN-GJMW-450-7, according to standard DIN EN 1562 (1997). The caps are hot dip galvanized according to standard DIN EN ISO 1461 (1999) with a zinc weight of min. 600 g/m^2 (min. 85 μm) average value.

Inspection and Testing

Porcelain long rod insulators are tested according to standard IEC 60383 (1993).

Inspection and Testing of Porcelain Long Rod Insulators according to Standard IEC 60383

Test programme	Type tests	Sample tests	Routine tests
Dry lightning impulse withstand voltage test	✓		
Wet power-frequency withstand voltage test	✓		
Mechanical failing load test	✓	✓	
Thermal-mechanical performance test	✓		
Verification of the dimensions	✓	✓	
Verification of the displacements		✓	
Verification of the locking system		✓	
Temperature cycle test		✓	
Porosity test		✓	
Galvanizing test		✓	
Routine visual inspection			✓
Routine mechanical test			✓

Long Rod Insulators

Application and Advantages

underribs on sheds
not required as the core parts
between the sheds contribute
to insulation

long rod insulators can be checked ultrasonically for mechanical soundness

protection against power arcs
is achieved by the addition of
protective fittings

- cascade flashovers are not possible
- immune to thermal puncture

electrically and mechanically stressed zones are separated

routine test load = 80% of the specified mechanical failing load

minimum use of metal parts,
which minimizes corrosion problems
and also provides

- lower weight for a complete insulator set
- simpler mounting of strings
- low level of HF interference to radio and television transmissions

long rod insulators are recommended for use
in direct current applications because there is

- no pin corrosion
- no ion migration
- no problems with thermal runaway effects

minimum total life cycle costs through high reliability

long rod insulators can be used for tension
and compression loads

low surface leakage current resulting
in reduced transmission losses

puncture proof

Long rod insulators are solid core and the theoretical puncture path through the porcelain body is almost equal to the dry arcing distance. Since porcelain has several times the dielectric breakdown strength of air, flashover, if any, always occurs in the air outside the porcelain body.

self-fractures of long rod insulators made of
aluminum oxide porcelain are not known

the creepage distance is comprised of sheds and core parts which have

- good self-cleaning properties with respect to climatic conditions
- better insulation performance under pollution conditions

packaging in crates offers the maximum protection
during shipping and storage

insulator body made of aluminum oxide porcelain

- high mechanical strength
- free of internal stresses
- no measurable aging
- resistant to salt pollution
- high resistance to temperature variations
- high resistance to vandalism

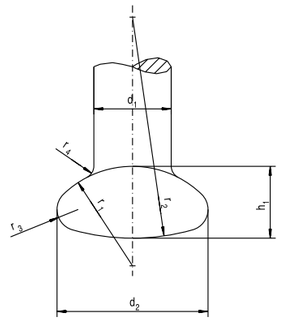
lowest maintenance costs

PPC INSULATORS

Long Rod Insulators
Ball and Socket Couplings

Standard IEC 60120

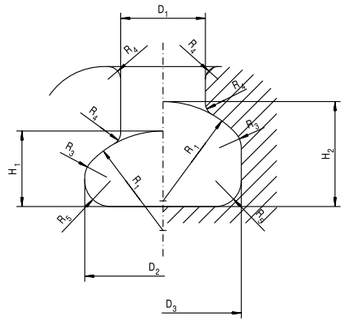
Dimensions of the Pin Ball



Designated size of coupling	d_1	d_2	h_1	r_1	r_2	r_3*	r_4
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
11	$11.9^{+0}_{-1.1}$	$22.8^{+0}_{-1.3}$	$9.1^{+0}_{-1.2}$	35	35	3.5	1.5^{+1}_{-0}
16	$17^{+0}_{-1.2}$	$33.3^{+0}_{-1.5}$	$13.4^{+0}_{-1.3}$	23	50	3	$3^{+1}_{-0.5}$
20	$21^{+0}_{-1.3}$	$41^{+0}_{-1.6}$	$19.5^{+0}_{-1.4}$	27	60	5.7	3.5^{+1}_{-1}
24	$25^{+0}_{-1.4}$	$49^{+0}_{-1.8}$	$21^{+0}_{-1.7}$	40	70	6.6	$4^{+1.5}_{-1}$
28	$29^{+0}_{-1.5}$	$57^{+0}_{-1.9}$	$23.5^{+0}_{-1.8}$	55	80	8	$4.5^{+1.5}_{-1}$
32	$33^{+0}_{-1.6}$	$65^{+0}_{-2.1}$	$27^{+0}_{-1.9}$	70	90	10	$5^{+1.5}_{-1}$

* given for guidance

Dimensions of the Socket End

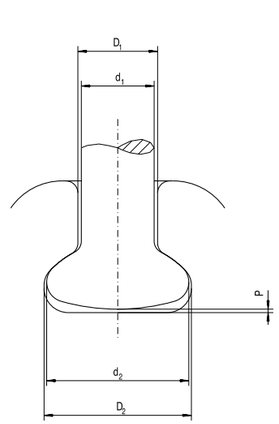


Designated size of coupling	D_1	D_2*	D_3*	H_1	H_2*	R_1	R_3	R_4	R_5	T**
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
11	$12.5^{+1.3}_{-0}$	24.5	24.5	$10.5^{+1.3}_{-0}$	15.5	35	4	1.5	4	4.8
16A	$19.2^{+1.6}_{-0}$	34.5	34.5	$14.5^{+1.6}_{-0}$	20.5	23	3	3	5	5.5
16B	$19.2^{+1.6}_{-0}$	34.5	34.5	$17^{+1.6}_{-0}$	25	23	3	3	5	7.9
20	$23^{+2.1}_{-0}$	42.5	42.5	$20.5^{+2.1}_{+0}$	28.5	27	6	3.5	7	7.0
24	$27^{+2.5}_{-0}$	51	51	$23.5^{+2.5}_{-0}$	33.5	40	5	4	10	8.7
28	$32^{+2.9}_{-0}$	59	59	$26^{+2.9}_{-0}$	36.5	55	8	4.5	12	10.5
32	$36^{+3.3}_{-0}$	67.5	67.5	$30^{+3.3}_{-0}$	42	70	10	5	14	11.5

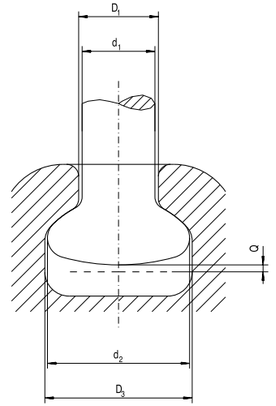
* minimal value
** minimal value of the thickness of the locking device

PPC INSULATORS

Clearance between the Pin Ball and the Socket End



The pin ball in the socket entry.



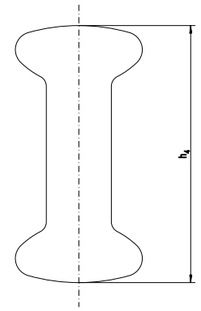
The pin ball in the socket interior.

Designated size of coupling	$D_1 - d_1$		$D_2 - d_2$	$D_3 - d_2$	P		Q*
	Min.	Max.	Min.		Min.	Max.	Min.
11	0.6	3.0	1.7	1.7	1.4	3.9	1.6
16A	2.2	5.0	1.2	1.2	1.1	4.0	1.6
16B	2.2	5.0	1.2	1.2	3.6	6.5	3.7
20	2.0	5.4	1.5	1.5	1.0	4.5	2.0
24	2.5	6.4	2.0	2.0	2.5	6.7	2.8
28	3.0	7.4	2.0	2.0	2.5	7.2	3.0
32	3.0	7.9	2.5	2.5	3.0	8.2	3.5

* clearance between the pin ball and the locking device

Dimensions of the Twin-Balled Pins

Designated size of coupling	h_4
	(mm)
11	$47^{+0}_{-2.5}$
16	$63^{+0}_{-3.0}$
20	$83^{+0}_{-3.2}$
24	$90^{+0}_{-3.5}$
28	$97^{+0}_{-3.5}$
32	$120^{+0}_{-4.0}$

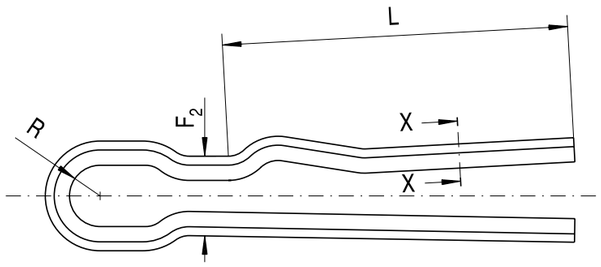


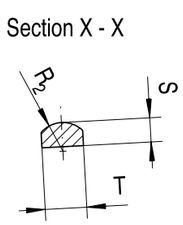
PPC INSULATORS

Long Rod Insulators
Locking Devices

Standard IEC 60372

Dimensions of the Split - Pin (V-Type) for Ball and Socket Couplings

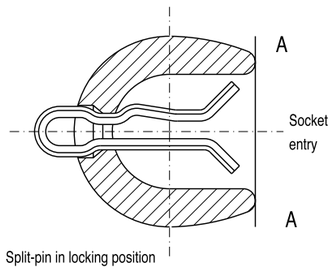




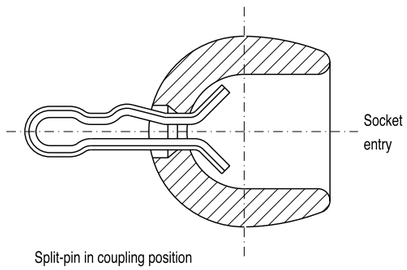
Designated size of standard coupling	Standard V-type split-pin						Alternative V-type split-pin*
	S	T	R_2	$F_{2\,min}$	R_{min}	L_{min}	$F'_{2\,max}$
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
11	2.2 ± 0,1	$4.8^{+0.2}_{-0}$	3.3	8.2	2.5	29	7.3
16A	3.2 ± 0.1	$5.5^{+0.2}_{-0}$	3.8	10.3	3.0	38	9.2
16B	3.2 ± 0.1	$7.9^{+0.2}_{-0}$	4.8	10.7	3.0	38	9.7
20	3.2 ± 0.1	$7.0^{+0.2}_{-0}$	4.8	10.7	3.0	49	9.7
24	4.0 ± 0.1	$8.7^{+0.2}_{-0}$	5.7	12.8	3.5	60	11.7
28	4.5 ± 0.1	$10.0^{+0.3}_{-0}$	6.2	13.8	3.5	71	12.7
32	5.2 ± 0.1	$11.5^{+0.3}_{-0}$	7.2	15.8	3.5	81	14.7

* all the dimensions are the same as for standard split-pins, except the value F_2 replaced by F'_2
The dimension L_{max} shall be specified by the purchaser of the split-pin.

V-Type Split-Pin in Locking and in Coupling Positions

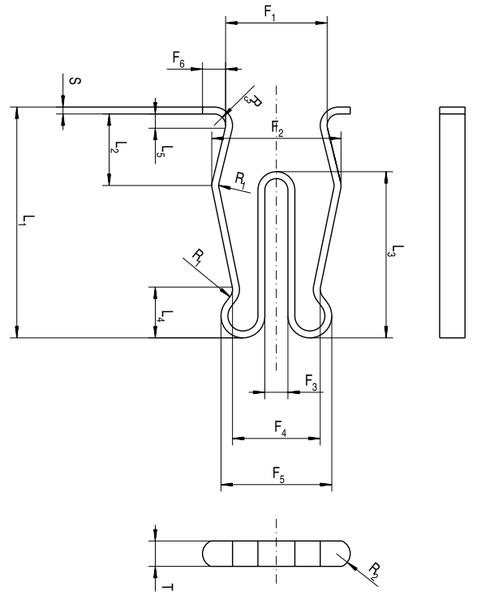


Split-pin in locking position



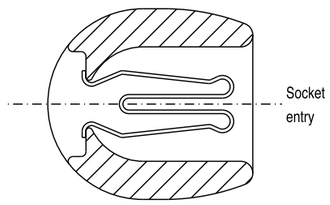
Split-pin in coupling position

Dimensions of the W-Clip for Ball and Socket Couplings

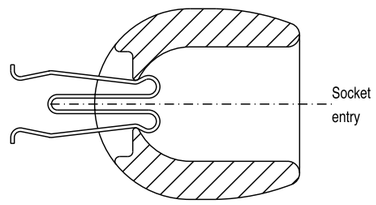


Designated size of standard coupling	F_1	F_2	F_3	F_4	F_5	F_6	L_1	L_2	L_3	L_4	L_5	R_1	R_2	$R_{3\,max}$	S	T
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
11	15	20	4	13	19	$4^{+0.6}_{-0}$	37 ± 1.5	12.0	24 ± 1.5	8.0	3	2.5	3.0	1.5	$1.2^{+0.2}_{-0}$	$4.8^{+0.2}_{-0}$
16A	22	28	5	19	24	5^{+1}_{-0}	50 ± 1.5	15.5	36 ± 1.5	10.5	3	2.5	3.0	2.5	$1.5^{+0.2}_{-0}$	$5.5^{+0.2}_{-0}$
16B	22	28	5	19	24	5^{+1}_{-0}	50 ± 1.5	15.5	36 ± 1.5	10.5	3	2.5	4.5	2.5	$1.5^{+0.2}_{-0}$	$7.9^{+0.2}_{-0}$
20	22	30	5	19	24	5^{+1}_{-0}	62 ± 1.5	15.5	42 ± 1.5	10.5	3	2.5	4.5	2.5	$2.0^{+0.2}_{-0}$	$7.0^{+0.2}_{-0}$
24	22	30	5	19	25	5^{+1}_{-0}	72 ± 1.5	15.5	50 ± 1.5	10.5	3	2.5	5.0	2.5	$2.0^{+0.2}_{-0}$	$8.7^{+0.2}_{-0}$
28	24	32	6	21	28	6^{+1}_{-0}	83 ± 1.5	16.0	62 ± 1.5	12.5	4	3.0	6.0	3.0	$2.2^{+0.2}_{-0}$	$10.0^{+0.2}_{-0}$
32	26	36	6	24	33	7^{+1}_{-0}	96 ± 1.5	18.0	71 ± 1.5	16.0	4	3.0	7.0	3.0	$2.6^{+0.2}_{-0}$	$11.5^{+0.2}_{-0}$

W-Clip in Locking and in Coupling Positions



W-clip in locking position

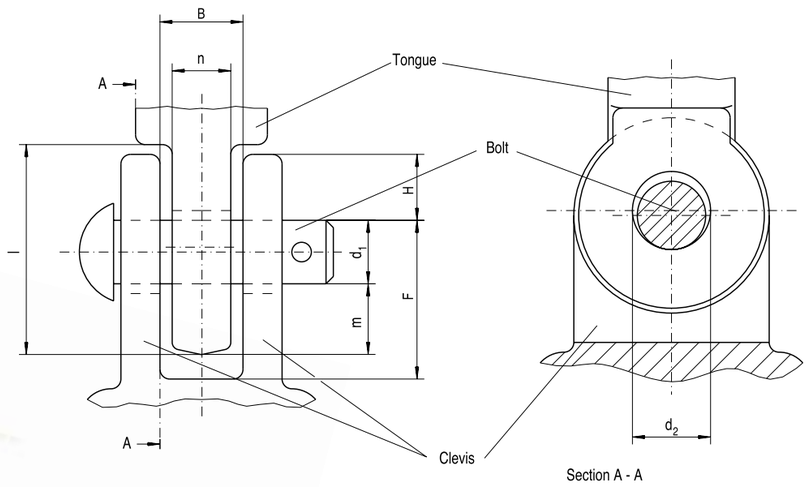


W-clip in coupling position

Long Rod Insulators
Clevis and Tongue Couplings

Standard IEC 60471

Dimensions of Clevis and Tongue Coupling

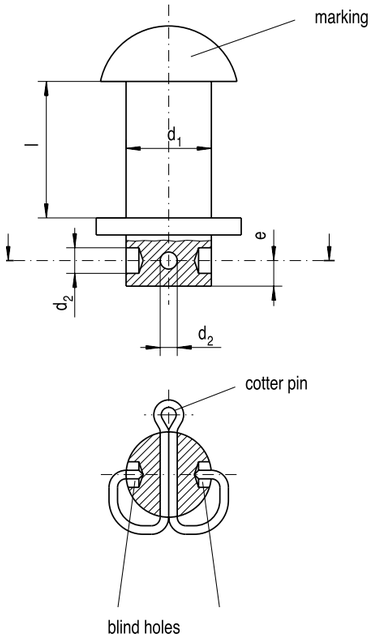


Designation		d_1	d_2	n	B	m	F	H	l
		(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
13L	Min.	12.8	14	12	14	10	32	-	45
	Nom.	13	14	13	14	13	-	-	-
	Max.	13.5	15	13.5	15.5	15	34.5	15	-
19L	Min.	18.6	19.8	17.5	20	14.5	46	-	65
	Nom.	19	20	19	20	18	-	-	-
	Max.	19.4	21.4	19.5	22	22	48.5	22	-
22L	Min.	21.8	23	17.5	20	17.5	53	-	75
	Nom.	22	24	19	20	22	-	-	-
	Max.	22.6	24.6	19.5	22	25	55.5	25	-
25L	Min.	24.2	26	23	26	18	57.5	-	80
	Nom.	25	27	24	26	23	-	-	-
	Max.	25.6	28	25.5	28	26.5	60	26.5	-
28L	Min.	27.2	29	23	26	21.5	67	-	90
	Nom.	28	30	24	26	26	-	-	-
	Max.	28.6	31	25.5	28	30	69.5	30	-
32L	Min.	31.2	33	23	26	24.5	77	-	100
	Nom.	32	34	24	26	29	-	-	-
	Max.	32.6	35	25.5	28	33	79.5	33	-

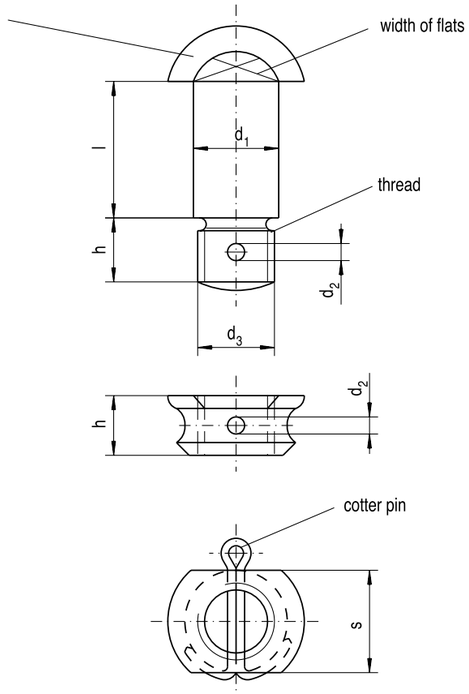
Standard DIN 48 073

Dimensions of Connecting Bolts

Shape N
with cotter pin
and disk



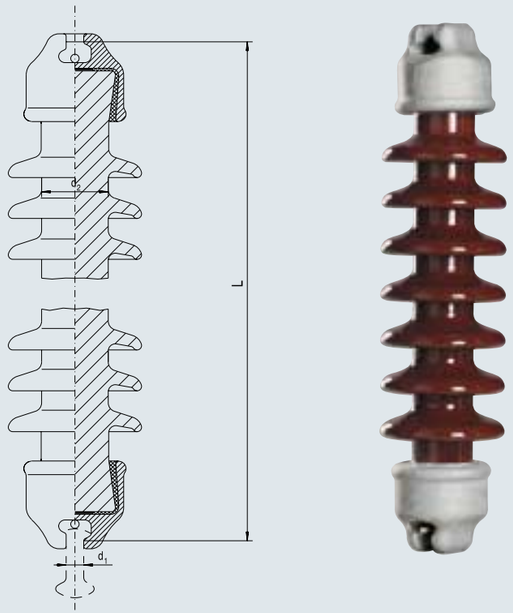
Shape S
with grooved nut
and cotter pin



Designation	d_1	l + 2*	d_2	d_3	e + 2	h ± 2	Width of flats s	Disk acc. to	Cotter pin acc. to
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	DIN 1441	DIN 94
N 13	$13^{+0.3}_{-0.6}$	28, 32, 40, 45	5*	-	5	-	-	15	4 x 25
S 13			5	M12	-	14	19	-	
N 19	$19^{+0.3}_{-0.6}$	34, 38, 43, 48, 52, 60, 105, 125, 145, 165, 185, 205, 225	6	-	6	-	-	21	5 x 45
S 19			5	M16 x 1.5	-	16	24	-	4 x 40
N 22	$22^{+0.5}_{-0.3}$	34, 38, 43, 48, 52, 57, 60, 66	6	-	6	-	-	23	5 x 45
S 22			5	M18 x 1.5	-	16	27	-	4 x 40
N 25	$25^{+0.3}_{-0.8}$	48, 65, 110, 130, 150, 170, 190, 210, 230, 250, 270, 290, 310, 330	6	-	6	-	-	26	5 x 50
S 25				M22 x 1.5	-	16	32	-	
N 28	$28^{+0.4}_{-0.8}$	43, 48, 52, 57, 75, 83, 215, 235, 255, 275, 295, 315, 335	6	-	8	-	-	29	5 x 50
S 28				M24 x 2	-	20	36	-	
N 32	$32^{+0.5}_{-0.8}$	43, 48, 52, 57, 83, 215, 235, 255, 275, 295, 315, 335	6	-	8	-	-	33	5 x 71
S 32				M27 x 2	-	20	41	-	

* Section of the length depending on outside distance of clevis

Long Rod Insulators
with Ball and Socket Couplings

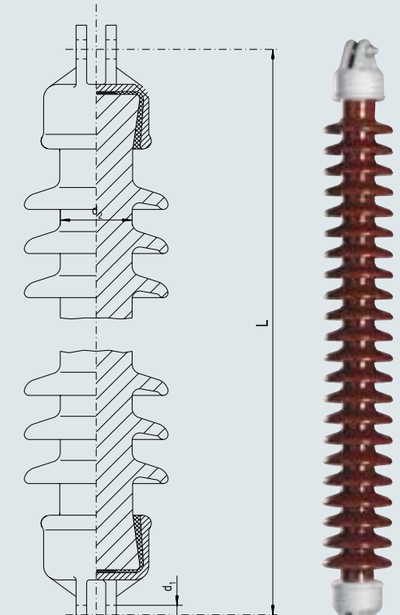


Characteristics of Long Rod Insulators with Ball and Socket Couplings "B" according to the Standard IEC 60433 (1998) and according to the former German Standard DIN 48006 / Part 1

Designation according to	Designation according to former	Core diameter d_2	Highest system voltage Um	Standard lightning impulse withstand voltage	Wet power frequency withstand voltage	Specified mechanical failing load	Routine mechanical test load	Minimum nominal creepage distance (16 mm/kV)	Maximum nominal length L	Standard coupling size (pin diameter) d_1
IEC 60433	DIN 48006/1	(mm)	(kV)	(kV)	(kV)	(kN)	(kN)	(mm)	(mm)	(mm)
L 40 B 170	LP 60/5/380	60	36	170	70	40	32	576	380	11
L 60 B 170	LP 60/5/390	60	36	170	70	60	48	576	400	
L 100 B 170	-	60	36	170	70	100	80	576	450	16
L 100 B 250	-		52	250	95	100	80	832	580	
L 100 B 325	LP 60/19/870		72.5	325	140	100	80	1160	870	
L 100 B 450	-		123	450	185	100	80	1968	1085	
L 100 B 550	LP 60/30/1240		123	550	230	100	80	1968	1240	
L 120 B 325	LP 60/19/870	60	72.5	325	140	120	96	1160	870	16
L 120 B 450	-		123	450	185	120	96	1968	1085	
L 120 B 550	LP 60/30/1240		123	550	230	120	96	1968	1240	
L 120 B 650	-		145	650	275	120	96	2320	1430	
L 160 B 325	LP 75/14/870	75	72.5	325	140	160	128	1160	885	20
L 160 B 450	-		123	450	185	160	128	1968	1100	
L 160 B 550	LP 75/22/1250		123	550	230	160	128	1968	1255	
L 160 B 650	-		145	650	275	160	128	2320	1445	
L 210 B 325	LP 85/14/900	85	72.5	325	140	210	168	1160	905	20
L 210 B 450	-		123	450	185	210	168	1968	1120	
L 210 B 550	LP 85/22 /1270		123	550	230	210	168	1968	1275	
L 210 B 650	-		145	650	275	210	168	2320	1465	
L 250 B 550	LP 95/22/1300	95	123	550	230	250	200	1968	1305	24
L 250 B 650	-		145	650	275	250	200	2320	1500	
L 300 B 550	LP 105/22/1330	105	123	550	230	300	240	1968	1330	24
L 300 B 650	-		145	650	275	300	240	2320	1520	

PPC INSULATORS

Long Rod Insulators
with Clevis and Tongue Couplings



Characteristics of Long Rod Insulators with Clevis and Tongue Couplings "C" according to the Standard IEC 60433 (1998) and according to the former German Standard DIN 48006 / Part 2

Designation according to	Designation according to former	Core diameter d_2	Highest system voltage Um	Standard lightning impulse withstand voltage	Wet power frequency withstand voltage	Specified mechanical failing load	Routine mechanical test load	Minimum nominal creepage distance (16 mm/kV)	Maximum nominal length L	Standard coupling size (connecting bolt diameter) d_1
IEC 60433	DIN 48006/2	(mm)	(kV)	(kV)	(kV)	(kN)	(kN)	(mm)	(mm)	(mm)
L 100 C 170	-	60	36	170	70	100	80	576	475	19
L 100 C 250	-		52	250	95	100	80	832	605	
L 100 C 325	LG 60/14/860		72.5	325	140	100	80	1160	900	
L 100 C 450	-		123	450	185	100	80	1968	1120	
L 100 C 550	LG 60/30/1270		123	550	230	100	80	1968	1270	
L 120 C 325	LG 60/19/900	60	72.5	325	140	120	96	1160	905	19
L 120 C 450	-		123	450	185	120	96	1968	1120	
L 120 C 550	LG 60/30/1270		123	550	230	120	96	1968	1275	
L 120 C 650	-		145	650	275	120	96	2320	1465	
L 160 C 325	LG 75/14/900	75	72.5	325	140	160	128	1160	920	19
L 160 C 450	-		123	450	185	160	128	1968	1135	
L 160 C 550	LG 75/22/1270		123	550	230	160	128	1968	1290	
L 160 C 650	-		145	650	275	160	128	2320	1465	
L 210 C 325	LG 85/14/940	85	72.5	325	140	210	168	1160	940	22
L 210 C 450	-		123	450	185	210	168	1968	1155	
L 210 C 550	LG 85/22/1310		123	550	230	210	168	1968	1310	
L 210 C 650	-		145	650	275	210	168	2320	1500	
L 250 C 550	LG 95/22/1340	95	123	550	230	250	200	1968	1335	22
L 250 C 650	-		145	650	275	250	200	2320	1530	
L 300 C 550	LG 105/22/1370	105	123	550	230	300	240	1968	1365	25
L 300 C 650	-		145	650	275	300	240	2320	1560	

PPC INSULATORS