Termination methods

- **Screw connection**

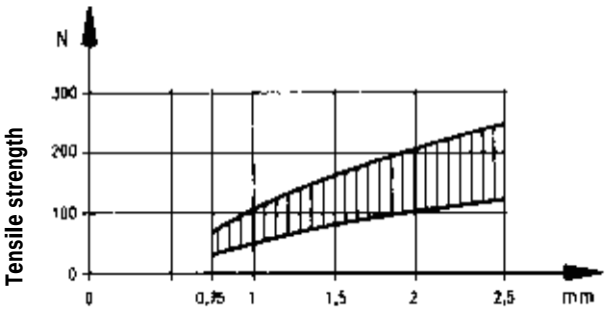
  Screw clamps are designed acc. to EN 60999/VDE 0609. Chart 1 below shows the screw size depending on wire size and the required clamping and testing torque.

Chart 1

Wire size (mm^2)	1	1,5	2,5	4	6	10
Screw size	M 2,6	M 3	M 3	M 3,5	M 4	M 4
Test torque (Ncm)	40	50	50	80	120	120

Diagram 1 below shows the range of tensile strength for a screw connection with a clamp screw M3, fastened with a torque of 50 Ncm, depending on the wire size.

Diagram 1



Wire gauge

This comparison chart allows a cross reference between American Wire Gauge (AWG) and metric wire sizes (mm^2).

Chart 2

AWG	Wire composition	Wire diameter	Wire size
30	1 x 0,25 7 x 0,10	0,25 mm 0,36 mm	0,05 mm^2 0,06 mm^2
28	1 x 0,32 7 x 0,13	0,32 mm 0,38 mm	0,08 mm^2 0,09 mm^2
26	1 x 0,40 7 x 0,16 19 x 0,10	0,40 mm 0,48 mm 0,51 mm	0,13 mm^2 0,14 mm^2 0,15 mm^2
24	1 x 0,51 7 x 0,20 19 x 0,13	0,51 mm 0,61 mm 0,64 mm	0,21 mm^2 0,23 mm^2 0,24 mm^2
22	1 x 0,64 7 x 0,25 19 x 0,16	0,64 mm 0,76 mm 0,81 mm	0,33 mm^2 0,36 mm^2 0,38 mm^2
20	1 x 0,81 7 x 0,32 19 x 0,20	0,81 mm 0,97 mm 1,02 mm	0,52 mm^2 0,56 mm^2 0,62 mm^2
18	1 x 1,02 19 x 0,25	1,02 mm 1,27 mm	0,79 mm^2 0,96 mm^2
16	19 x 0,29	1,44 mm	1,23 mm^2
14	19 x 0,36	1,80 mm	1,95 mm^2
12	19 x 0,46	2,29 mm	3,09 mm^2
10	37 x 0,40	3,10 mm	4,60 mm^2
8	133 x 0,29	4,0 mm	8,80 mm^2
6	133 x 0,36	5,5 mm	13,5 mm^2

It has to be noted that wires of the same AWG number but with different composition have slightly different mm^2.

Chart 3

Composition and Dimensions of Copper Wires

Wire Size	Wire Composition	Wire diameter
0,09 mm^2	12 x 0,10	0,48 mm
0,14 mm^2	18 x 0,10	0,50 mm
0,25 mm^2	14 x 0,15	0,70 mm
0,34 mm^2	7 x 0,25	0,78 mm
0,5 mm^2	16 x 0,20	1,0 mm
0,75 mm^2	24 x 0,20	1,2 mm
1,0 mm^2	32 x 0,20	1,4 mm
1,5 mm^2	30 x 0,25	1,6 mm
2,5 mm^2	35 x 0,30	2,2 mm
4,0 mm^2	56 x 0,30	2,8 mm
6,0 mm^2	19 x 0,64	3,4 mm
10 mm^2	19 x 0,80	4,3 mm

Degree of protection

Electrical devices to which connectors belong to have to be protected for safety reasons from outside influences like dust, foreign objects, direct contact, moisture and water. This protection is provided on industrial connectors by its housings with their latching devices and sealed cable entries. The degree of protection can be selected depending on the type of intended use. The standard IEC 60529 and/or DIN EN 60529 has specified the degree of protection and divided into several classes.

The degree of protection is indicated in the following way:

IP 65

Code letters (Internat. Protection)
1st charact. numeral (degree of protection against access to hazardous parts and against solid foreign objects)
2nd charact. numeral (degree of protection against ingress of water)

The following charts 11 an12 give an overview about all protection degrees.

Chart 4

1st charact. numeral	Brief description	Definition
0	Non-protected	–
1	Protected against access to hazardous parts with the back of a hand. Protected against solid foreign objects of ≥50mm Ø.	The probe, sphere of 50mm Ø, shall not fully penetrate and shall have adequate clearance from hazardous parts.
2	Protected against access to hazardous parts with a finger. Protected against solid foreign objects of ≥12,5mm Ø.	The jointed test finger of 12mm Ø, 80mm length, shall have adequate clearance from hazardous parts. The probe, sphere of 12,5mm Ø, shall not fully penetrate.
3	Protected against access to hazardous parts with a tool. Protected against solid foreign objects of ≥2,5mm Ø.	The probe of 2,5mm Ø shall not penetrate at all.
4	Protected against access to hazardous parts with a wire. Protected against solid foreign objects of ≥1mm Ø.	The probe of 1mm Ø shall not penetrate at all.
5	Protected against access to hazardous parts with a wire. Dust-protected.	The probe of 1mm Ø shall not penetrate. Intrusion of dust is not totally prevented, but dust shall not penetrate in a quantity to interfere with satisfactory operation of the device or to impair safety.
6	Protected against access to hazardous parts with a wire Dust-tight.	The probe of 1mm Ø shall not penetrate. No intrussion of dust.

Chart 5

2nd charact. numeral	Brief description	Definition
0	Non-protected	–
1	Protected against vertically falling water drops	Vertically falling drops shall have no harmful effects.
2	Protected against vertically falling water drops when enclosure tilted up to 15°	Vertically falling drops shall have no harmful effects when the enclosure is tilted at any angel up to 15° on either side of the vertical.
3	Protected against spraying water	Water sprayed at an angle up to 60° on either side of the vertical shall have no harmful effects.
4	Protected against splashing water	Water splashed against the enclosure from any direction shall have no harmful effects.
5	Protected against water jets	Water projected in jets against the enclosure from any direction shall have no harmful effects.
6	Protected against powerful water jets	Water projected in powerful jets against the enclosure from any direction shall have no harmful effects.
7	Protected against the effects of temporary immersion in water	Intrusion of water in quantities causing harmful effects shall not be possible when the enclosure is temporalily immersed in water for 30 min. in 1m depth.
8	Protected against the effects of continous immersion in water	Intrusion of water in quantities causing harmful effects shall not be possible when the enclosure is continuously immersed in water under conditions which shall be agreed between manufacturer and user but which are more severe than for numeral 7.
9 K [1)]	Protected against water during high pressure/steam jet cleaning	Water projected in powerful jets with high pressure against the enclosure from any direction shall have no harmful effects.

1) Remark: Numeral acc. to DIN 40050 part 9, vehicles IP code

C 16-1/16-3

Remarks
Safety classification

1. General Remarks

These connectors are designed and produced in conformity with the low voltage directive (72/23/EWG) respectively Gerätesicherheitsgesetz and according DIN VDE 57627 (German Law). All technical data refers to mated connectors under live conditions. The safety of the connector system depends on the correct selection of products, proper assembly of the connector device, and a precise fit of the connectors.
If in special cases connectors can be used in the sense of plug and socket devices, this is mentioned in the particular section.

2. Application Remarks

Connectors and/or plug and socket devices must be used according to specified technical ratings.
The technical data represents the initial value of mated parts under predetermined conditions and length of time.These values could change with different test parameters or product requirements.
The C 16-1/16-3 Series connectors are used in a wide variety of industries and equipment. Some of these include industrial machines and controls, data processing, instrumentation and test equipment, medical devices, telecommunication's network and equipment, plus outdoor and marine applications.
All rated data for the connectors listed in this catalog are based on over-voltage category III [1] and pollution degree 3 [2] for electronic applications. Connectors were completely mated according to their respective safety locking mechanism. Selection and testing of connectors and/or plug and socket devices to meet specific product or industrial requirements such as rated voltage and the related clearances and creepage distances are the responsibility of the user.

3. Assembling Remarks

Protection against electrical shock of the termination of the connectors shall be secured by correct mounting. Connectors of the same or different series being mounted side by side may be protected against incorrect mating by the use of coding options. Care must be taken to ensure the parts are correctly mated and screws are tightened with the proper torque.

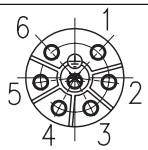
4. Termination Remarks

Cable connectors are effectively secured when using the internal cable clamp. When the connector contains a simple gland bushing for retention without clamping ring the cable should have a strain relief close behind the connector. All cable properties or specifications must be compatible with the connector design and materials.
Designated wire conductors must be terminated to the correct poles in the connector.
Crimp contacts must be fully inserted into the plastic housing and retention assured with a slight tug on the wire.
Wire should be stripped correctly according to printed specifications to insure no electrical contact can be made between the conductors. There should be no nicked or cut strains during the stripping action.

5. Safety Classification acc. to DIN VDE 0627

Style	Safety classification [3]			Connectors		Protective earth contact		Protection against electric shock		Cable clamp	
	A	B	C	free	fixed	with	without	mated	unmated	with	without
Male cable connector	X	X	X	X		X		X		X	X
Female cable connector	X	X	X	X		X		X	X	X	X
Male receptacle	X	X			X	X		X			X
Female receptacle	X	X			X	X		X	X		X

[1] Overvoltage category III: Equipment intended for the use in installations or parts of it in which lightning overvoltages do not need to be considered, however switching overvoltages generated by the equipment, and for cases where the reliability and the availability of the equipment or its dependent circuits are subject to special requirements. Examples are protecting means, switches and sockets.
[2] Pollution degree 3: Conductive pollution occurs or dry non-conductive pollution occurs which becomes conductive due to condensation which is to be expected.
[3] A Connections to and from a device equipment B Connections within a device equipment C Free cable connections

Overview			
No. of contacts	3 + PE	6 + PE	
Termination	screw	solder	crimp
Wire gauge	max. 2,5 mm ^{2}; AWG 14	max. 0,75 mm ^{2}; AWG 18	max. 1,5 mm ^{2}; AWG 16
Rated insulation voltage	400 V	250 V	200 V
Current carrying capacity	16 A	10 A	13 A
Pollution degree	3	3	
Installation category	III	III	
Protection class	IP 67	IP 67	

C 16-1

Product description
Order information
Approvals

Product description	Order information
The circular connectors of the C 16-1 series are designed to meet the high requirements of industrial applications under harsh environmental conditions. The range includes versions with screw, solder and crimp terminations. A selection of crimp contacts for hand crimp tools and crimp machines ensure a reliable termination resulting in qualitative, technical and economical advantages. A large selection of housing styles offers the user an optimal solution. **Main features and advantages:** • Circular connectors with contact arrangements 3 + PE and 6 + PE for power and signal applications • For applications in machine tools, measurement and control, process technology and medical equipment • Housing are made from high grade plastic material • Protected against unlocking by threaded coupling • Cable housing straight with PG 9, 11 and 13,5 cable outlet, Cable housing 90° with PG 9 and 11 cable outlet • Protection degree IP 67 per IEC 60529 in mated condition • Internal strain relief with screw clamp or clamping ring provides a safe cable restrain	**Contact plating** The standard plating is silver. Gold plated contacts are available upon request. Min order quantity = 100 contacts per type. **Color coding** Upon request the coupling ring of the plugs and the housings of the receptacles can be delivered in the colors red, green, blue, yellow and grey. Min order quantity = 250 pcs. per type. **Mechanical coding** Achieved with special coding pins which are inserted into contact cavities. Min. order quantity = 250 pcs. per type. **Crimp version** Order numbers do not include crimp contacts. Please order separately (see page 30/31). Crimp contact for higher currents (up to 16A) are available upon request. **Crimp tooling** Ask for our catalog "Tools"

Testhouse	Characteristis	Approval No.
VDE	3+PE, 400 V, 16 A 6+PE, 250 V, 10 A	1781 1780
SEV	3+PE, 400 V, 16 A 6+PE, 250 V, 6 A	94.1 01173.02
UL	3+PE, 250 V, 12 A 6+PE, 250 V, 8 A	E 63093
CSA	3+PE, 250 V, 12 A 6+PE, 250 V, 8 A 6+PE, 250 V, 15 A	48932
German LLyod	3+PE, 250 V, 16 A 6+PE, 50 V, 8 A	14108 / 84

C 16-1

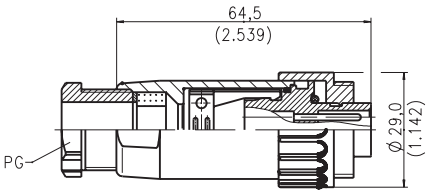
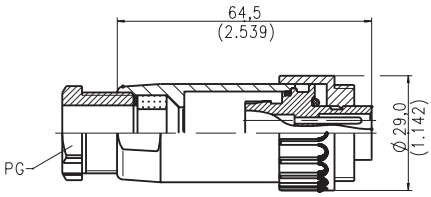
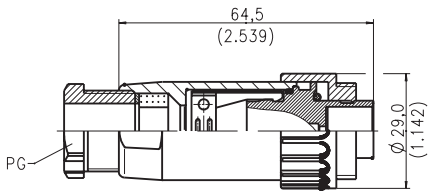
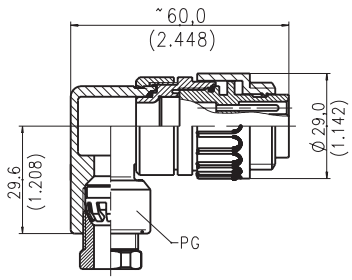
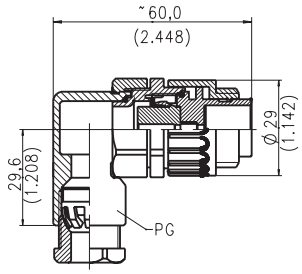
Characteristics

General Characteristics	Standard	Characteristics		
Number of contacts		3 + PE	6 + PE	
Electrical Characteristics		screw type	solder type	crimp type
Rated insulation voltage	IEC 60664-1	400 V	250 V	200 V
Rated impulse withstand voltage	IEC 60664-1	6000 V	4000 V	
Pollution degree	IEC 60664-1	3	3	
Installation (overvoltage) category	IEC 60664-1	III	III	
Material group	IEC 60664-1	II	II	
Test voltage	IEC 60664-1	2450 V	1680 V	1950 V
Current carrying capacity	IEC 60512-3, Test 5b	16 A / + 55 °C	10 A / + 55 °C	13 A / + 55 °C
Insulation resistance	IEC 60512-2, Test 3a	≥ 10^8 Ω	≥ 10^8 Ω	
Contact resistance	IEC 60512-2, Test 2a	≤ 5 m Ω	≤ 5 m Ω	
Climatical Characteristics				
Climatic category	IEC 6068-1	40 / 100 / 56		40 / 125 / 56
Operating temperature		-40°C ... +100°C / -40°F ... +212°F		
Mechanical Characteristics				
IP-degree of protection	IEC 60529	IP 67		
Insertion and withdrawal force	IEC 60512-7, Test 13b	≤ 15 N	≤ 30 N	
Mechanical operation	IEC 60512-5, Test 9a	≥ 500 mating cycles		
Materials				
Housing material		Polyamid 6.6		
Dielectric material		Polyamid 6.6		
Gasket material		Neoprene		
Contact plating		silver plated (gold plated upon request)		
Other Characteristics				
Termination technique		screw type	solder	crimp
Wire gauge mm^2 / AWG		max. 2,5 / 14	0,75 / 18	0,14 - 1,5 / 26 - 16
Flammability		UL 94 VO		
Locking system		round thread DIN 405		

The stated technical values refer to the use as connector.
If these components are used as plug and socket device a reduced current carrying capacity has to be considered.

C 16-1

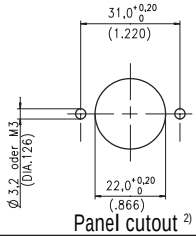
Male cable connectors

Description	Drawing	No. of cont.	*Part. no.* Cable outlet [2]		
			PG 9	PG 11	PG 13,5
Male cable connector, 3+PE screw, 6+PE solder termination, with strain relief, VDE test certificate of conformity		3 + PE	T 3108 001	T 3108 101	T 3108 200 (with clamping ring)
		6 + PE	T 3104 001	T 3104 101	T 3104 200 (with clamping ring)
Male cable connector, 3+PE screw, 6+PE solder termination, without strain relief		3 + PE	T 3108 000	T 3108 100	–
		6 + PE	T 3104 000	T 3104 100	–
Male cable connector, crimp version without contacts [1], with strain relief, VDE test certificate of conformity		6 + PE	T 3104 501	T 3104 601	T 3104 701 (with clamping ring)
Male cable connector, right-angled, 3+PE screw, 6+PE solder termination, with clamping ring, VDE test certificate of conformity		3 + PE	T 3108 081	T 3108 091	–
		6 + PE	T 3104 081	T 3104 091	–
Male cable connector, right-angled, crimp version, without contacts [1], with clamping ring, VDE test certificate with supervision of production		6 + PE	T 3104 581	T 3104 591	–

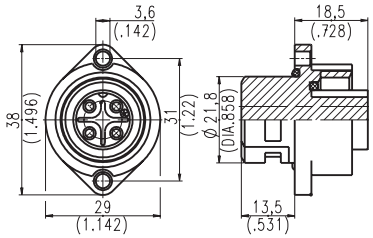
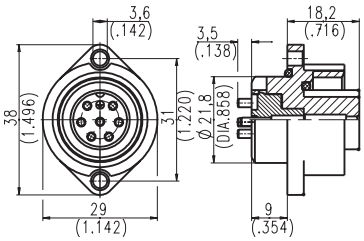
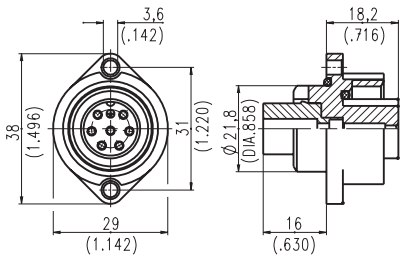
[1] Please order crimp contacts separatly, see page 30/31, part numbersystem for crimpcontacts see page 32.
[2] Cable outlet in mm, see page 32.

C 16-1

Female receptacles



Panel cutout [2]

Description	Drawing	No. of cont.	Part. no.
Female receptacle, screw termination, VDE test certificate of conformity		3 + PE	T 3111 000
Female receptacle, solder termination, VDE test certificate of conformity		6 + PE	T 3107 000
Female receptacle, crimp version, without contacts [1], VDE test certificate of conformity		6 + PE	T 3107 500

[1] Please order crimp contacts separatly, see page 30/31, past numbersystem for crimpcontacts see page 32.
[2] Mounting hole without champter, suitable sealing for screws is necessary.