INDUSTRIAL@AMPHENOL
TRUSTED GLOBALLY

Amphenol Sine Systems, **USA**
Amphenol Tuchel Industrial, **GmbH**
Amphenol Audio, **USA**

eco|mate® rm

Rugged Metal Shielded Connectors

Assembly Instructions

eco|mate® rm
Rugged Metal Shielded Connectors

Technical Information

Tooling

Assembly Instructions

Technical Data

Tooling

Machined

Hand Crimp Tool for Machine Contacts

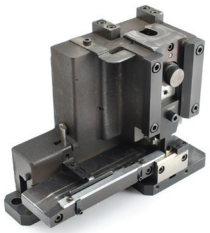
MFX-3959

Pneumatic Crimp Tool for Machined Contacts

MFX-3960

Stamped & Formed

Crimp Die for Stamped & Form Contact



MFX-3957

Hand Tool, Stamped & Form Contact, 2.5 mm

MFX-3962

Hand Tool, Stamped & Form Contact, 16 AWG

MFX-3954

Hand Tool, Stamped & Form Contact, 20 AWG

MFX-3958

Contact Extraction Tool

Contact Extraction Tool

Part Number	Description
QRT08	3.6 mm contacts
QXRT08R	3.6 mm contacts (eco|mate® rm High Amperage)
QXRT12S	2.5 mm contacts
QXRT16	#16 contacts
QXRT20	#20 contacts

Tooling

Contact Extraction Tool Table

Contact Size	Contact Part Number		Extraction Tool
	Male	Female	
2.5 mm	SP12A1T	SS12A1T	QXRT12S
3.6mm	HP10ACS	HS10ACS	QRT0BR
	HP10AHS	HS10AHS	
	HP10ASS	HS10ASS	
6 mm	HP25BCS	HS25BCS	N/A
	HP25BHS	HS25BHS	
	HP25BSS	HS25BSS	
8 mm	HP35CSS	HS35CSS	N/A
	HP35CCS	HS35CCS	
	HP35CHS	HS35CHS	
10 mm	HP50DCS	HS50DCS	N/A
	HP50DHS	HS50DHS	
	HP50DSS	HS50DSS	
8	MP10A23S	MS10A23S	N/A

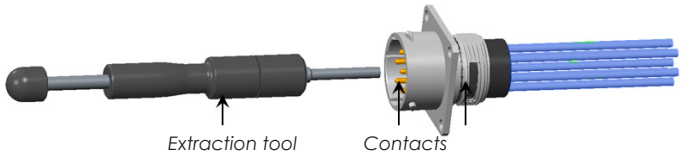
Contact Size 16	
Extraction Tool QXRT16	
Contact Part Number	
Male	Female
MP14M23F	MS14M23F
SP14M2F	SS14M2F
MP14M23FG5	MS14M23G5
SP14M2G5	SS14M2G5
SP14M2G10	SS14M2G10
MP14M23FG10	MS14M23G10
SP14M2G15	SS14M2G15
MP14M23FG15	MS14M23G15
MP14M23G30	MS14M23G30
SP14M2G30	SS14M2G30
MP16M23F	MS16M23F
SP16M2F	SS16M2F
MP16M23G5	MS16M23G5
SP16M2G5	SS16M2G5
SP16M2G10	SS16M2G10
MP16M23G10	MS16M23G10
SP16M2G10	SS16M2G15
MP16M23G15	MS16M23G15
SP16M2G30	SS16M2G30
MP16M23G30	MS16M23G30

Contact Size 16 (con't)	
Extraction Tool QXRT16	
Contact Part Number	
Male	Female
SP20M2F	SS20M2F
MP20M23F	MS20M23F
SP20M2G5	SS20M2G5
MP20M23G5	MS20M23G5
SP20M2G10	SS20M2G10
MP20M23G10	MS20M23G10
SP20M2G15	SS20M2G15
MP20M23G15	MS20M23G15
SP20M2G30	SS20M2G30
MP20M23G30	MS20M23G30
SP24M2F	SS24M2F
MP24M23F	MS24M23F
SP24M2G5	SS24M2G5
MP24M23G5	MS24M23G5
MP24M23G10	MS24M23G10
SP24M2G10	SS24M2G10
MP24M23G15	MS24M23G15
SP24M2G15	SS24M2G15
MP24M23G30	MS24M23G30
SP24M2G30	SS24M2G30

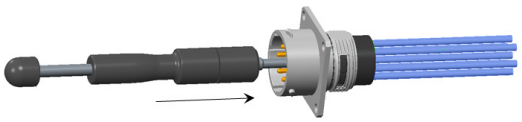
Contact Size 20	
Extraction Tool QXRT20	
Contact Part Number	
Male	Female
MP20W23F	MS20W23F
SP20W2F	SS20W2F
SP20W2G5	SS20W2G5
MP20W23G5	MS20W23G5
SP20W2G10	SS20W2G10
MP20W23G10	MS20W23G10
MP20W23G15	MS20W23G15
SP20W2G15	SS20W2G15
MP20W23G30	MS20W23G30
SP20W2G30	SS20W2G30
MP24W23F	MS24W23F
SP24W2F	SS24W2F
SP24W2G5	SS24W2G5
MP24W23G5	MS24W23G5
SP24W2G10	SS24W2G10
MP24W23G10	MS24W23G10
MP24W23G15	MS24W23G15
SP24W2G15	SS24W2G15
SP24W2G30	SS24W2G30
MP24W23G30	MS24W23G30
MP28W23F	MS28W23F
SP28W2F	SS28W2F
SP28W2G5	SS28W2G5
MP28W23G5	MS28W23G5
SP28W2G10	SS28W2G10
MP28W23G10	MS28W23G10
MP28W23G15	MS28W23G15
SP28W2G15	SS28W2G15
SP28W2G30	SS28W2G30
MP28W23G30	MS28W23G30

Tooling

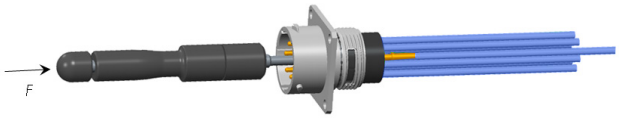
Contact Extraction Tool Instruction



Step 1 Put extraction tool into insert



Step 2 Push the handle to take out the contacts



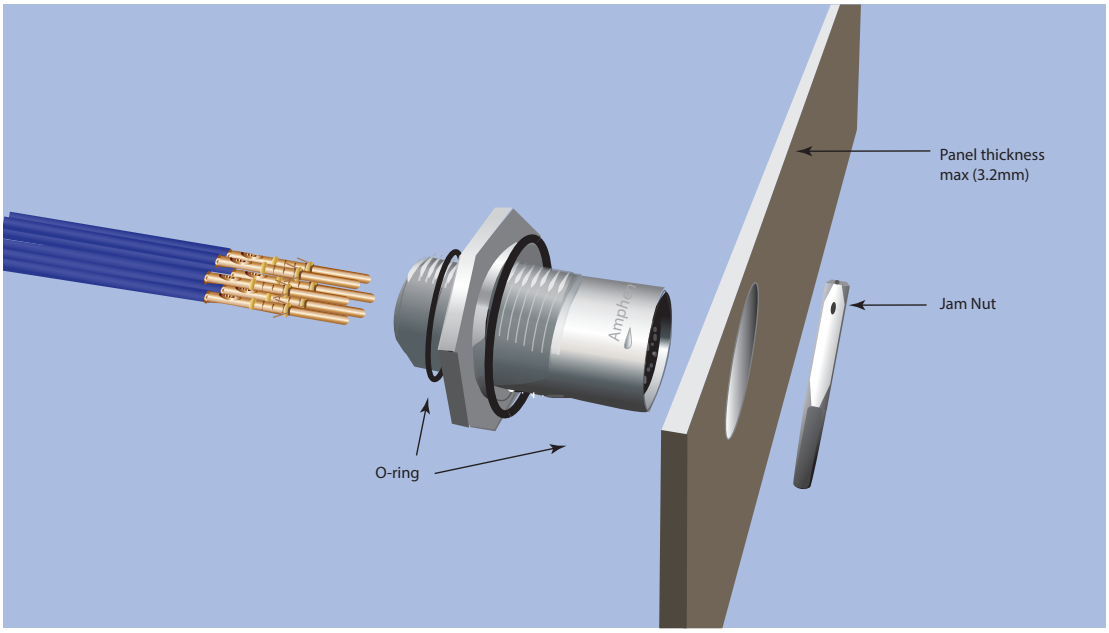
Step 3

Step 4

Assembly Instructions

Jam Nut Assembly and Installation Instructions

1. Remove insulation from wires and terminate contacts
2. Push contacts into connector insert
3. Seat o-ring, install and fasten receptacle in the panel cut-out
4. Tighten jam nut

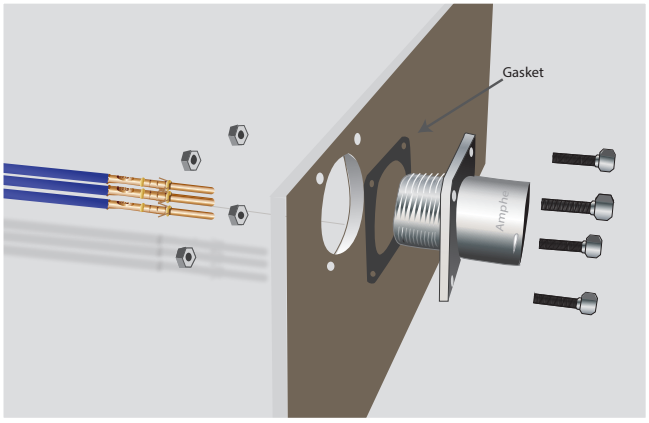


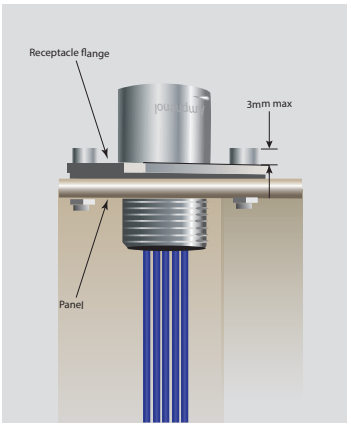
Shell Size	Jam Nut torque (Nm)	Exterior jam nut dim. (min)	Ø Wire max (mm)	Panel thickness max (mm)
10	3.4-4.1	22.2	3.2	3.2
12	5.2-5.6	27.0	3.2	3.2
14	6.2-6.8	32.0	3.2	3.2
16	7.9-8.5	33.3	3.2	3.2
18	9.0-9.6	36.5	3.2	3.2
20	10.2-10.7	39.7	3.2	3.2
22	11.3-12.4	42.9	3.2	3.2
24	12.4-13.6	46.0	3.2	3.2

Assembly Instructions

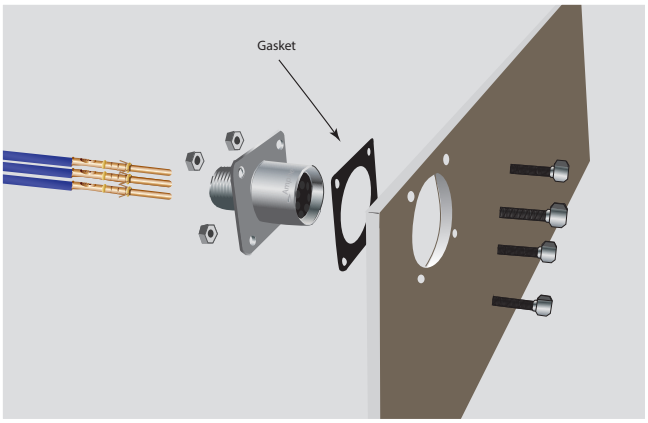
Flange Assembly and Installation Instructions

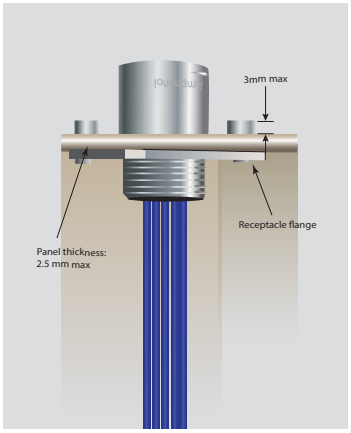
Front Assembly





Rear Assembly





Shell Size	Screw tightening torque (Nm)
10	0.30/0.40
12	0.30/0.40
14	0.30/0.40
16	0.30/0.40
18	0.35/0.45
20	0.50/0.60
22	0.55/0.65
24	0.55/0.65

1. Remove insulation from wires and terminate contacts
2. Push contacts into connector insert
3. Install and fasten receptacle in the panel cutout
4. For increased sealing of the system, use optional gasket

Assembly Instructions

eco | mate® rm Straight Plug and Receptacle Cable Assembly

Step 1: Slide parts onto cable

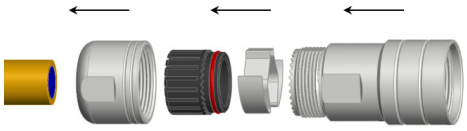
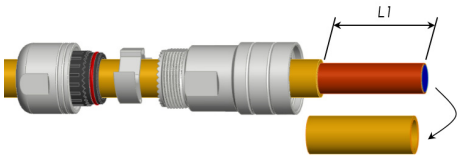


Table 1		
Shell Size	L1 (long back shell)	L1 (short back shell)
10	25~30 mm	20~25 mm
12	30~35 mm	25~30 mm
14	30~35 mm	25~30 mm
16	35~40 mm	30~35 mm
18	35~40 mm	30~35 mm
22	45~50 mm	N/A

Dimensions are for reference only

Step 2: Strip jacket



**** Make sure exposed shielding is not nickedor cut***

Step 3: Attach tie-wrap

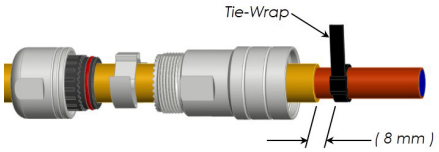
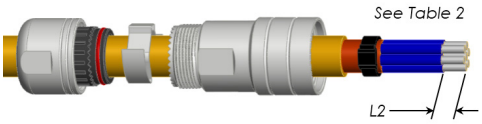


Table 2		
Contact Size	L2 (stamped)	L2 (machined)
8#	NA	7.5~8.5 mm
12#	8.2~9.2 mm	8.5~9.5 mm
16#	5.0~5.5 mm	7.5~8.5 mm
20#	5.5~6.0 mm	7.0~8.0 mm

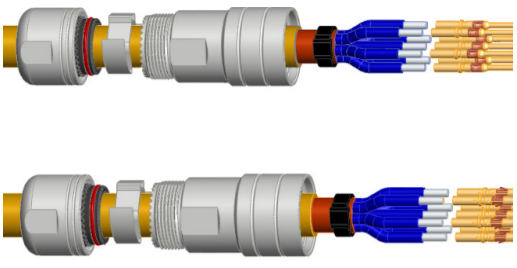
Step 4: Trim tie-wrap

Step 5: Trim braided shield flush to edge of tie-wrap

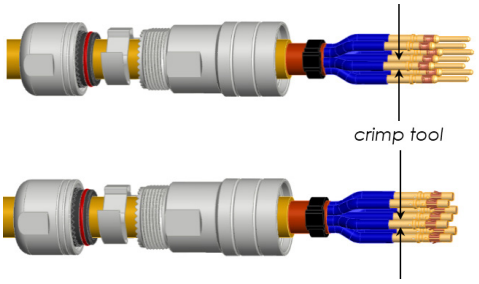
Step 6: Strip to conductor



Step 7: Attach contacts to wire leads



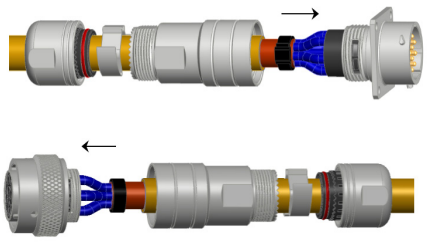
Step 8: Crimp contacts



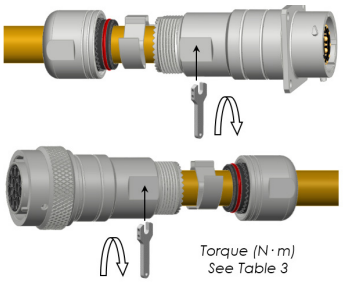
Assembly Instructions

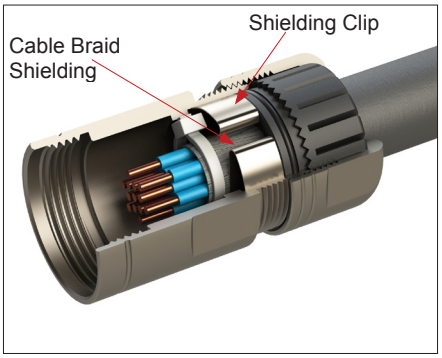
eco | mate® rm Straight Plug and Receptacle Cable Assembly (con't)

Step 9: Insert contacts into connector cavities



Step 10: Assemble back shell





Step 11: Push shielding clip into backshell

Step 12: Push cable grommet into backshell

Step 13: Tighten metal nut

Step 14 Mate receptacle & plug (align the master key)

Table 3	
Size	Torque=T1 (N.m)
10	1.5~2.5 N.m
12	2.5~4.0 N.m
14	2.5~4.0 N.m
16	3.0~4.5 N.m
18	3.0~4.5N.m
22	4.0~5.5N.m

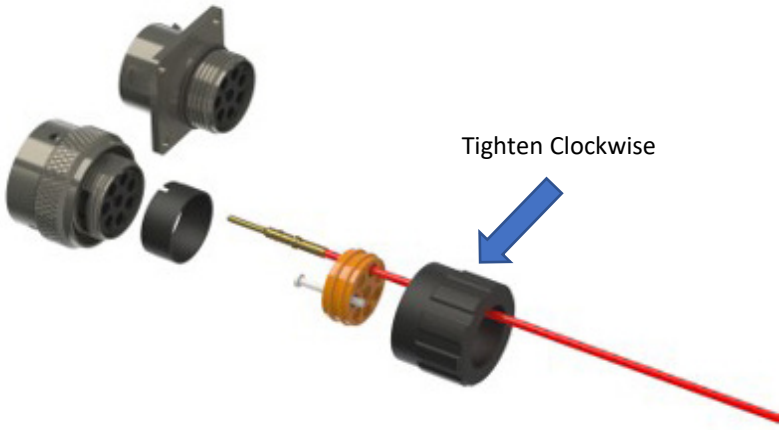
Table 4	
Size	Torque=T2 (N.m)
10	2.0~3.0 N.m
12	3.0~5.0 N.m
14	3.5~5.5 N.m
16	4.0~6.0 N.m
18	5.0~8.0 N.m
22	6.0~8.5 N.m

Assembled Dimensions

Shell Size	Plug with socket match with long cord grip	Plug with socket match with short cord grip	Plug with pin match with long cord grip	Plug with pin match and short cord grip
10	68.0mm	58.0mm	68.0mm	58.0mm
12	74.0mm	65.0mm	74.0mm	64.0mm
14	74.0mm	65.0mm	74.0mm	64.0mm
16	77.0mm	66.0mm	77.0mm	66.0mm
18	77.0mm	66.0mm	77.0mm	66.0mm
22	97.0mm	N/A	97.0mm	N/A

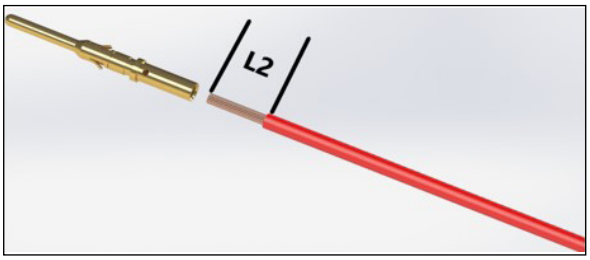
Assembly Instructions

eco | mate® rm Straight Plug and Receptacle with End Cap



Step 1: Slide accessories onto the wire

Step 2: Strip per chart (Table 1)



Step 3: Crimp contacts on wire

Step 4: Insert first contact in the grommet through required cavity. Then insert the contact into the insulator matching cavity.

Step 5: Place the grommet and compression ring on the connector

Step 6: Insert the remaining contacts, insert wire seals behind unwired contacts, push wire seal large end first until seated, trim length if needed

Step 7 Itighten nut to recommended torque (Table 2)

Table 1		
Contact Size	L2 (stamped)	L2 (machined)
6#	N/A	1.5-15.5mm
8#	NA	7.5~8.5 mm
12#	8.2~9.2 mm	8.5~9.5 mm
16#	5.0~5.5 mm	7.5~8.5 mm
20#	5.5~6.0 mm	7.0~8.0 mm

Table 2	
Shell Size	Torque
10	0.80
12	1.20
14	1.70
16	2.40
18	2.40
20	3.00
22	3.60
24	4.20

Assembly Instructions

eco | mate® rm Right Angle Plug and Receptacle Cable Assembly

Step 1: Slide parts onto cable

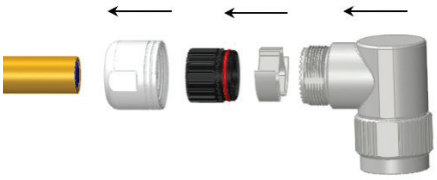
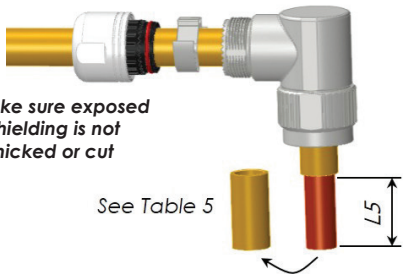


Table 5	
Size	L5 (90° cord grip)
10	NA
12	60~65 mm
14	60~65 mm
16	65~70 mm
18	NA

Dimensions are for reference only

Step 2: Strip jacket



Step 3: Attach tie-wrap

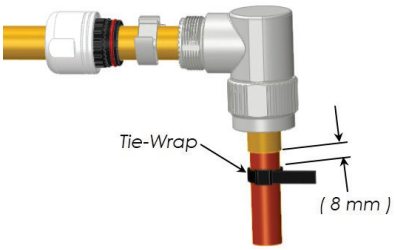
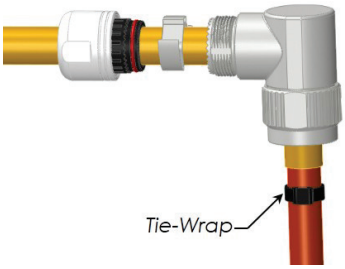
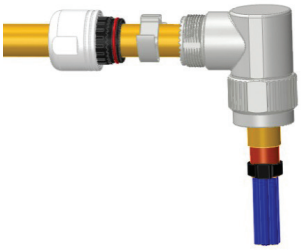


Table 2		
Contact Size	L2 (stamped)	L2 (machined)
8#	NA	7.5~8.5 mm
12#	8.2~9.2 mm	8.5~9.5 mm
16#	5.0~5.5 mm	7.5~8.5 mm
20#	5.5~6.0 mm	7.0~8.0 mm

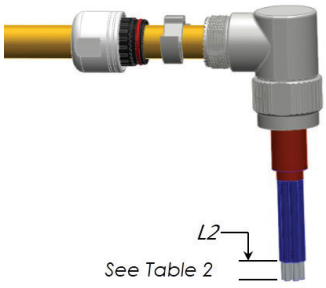
Step 4: Trim tie-wrap



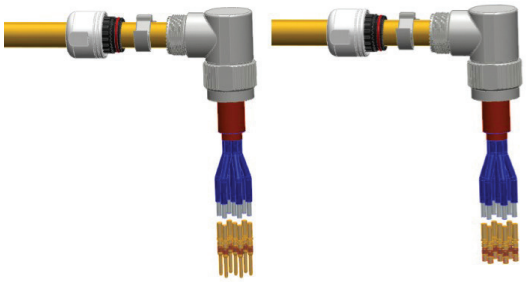
Step 5: Trim braided shield flush to edge of tie-wrap



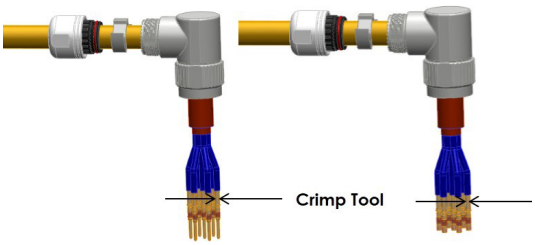
Step 6: Strip to conductor



Step 7: Attach contacts to wire leads



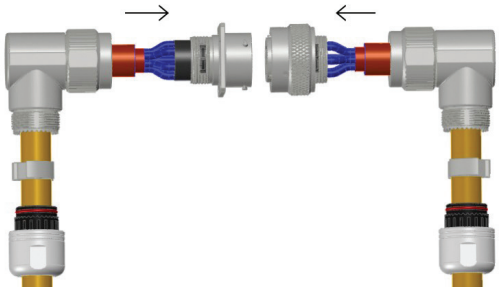
Step 8: Crimp contacts



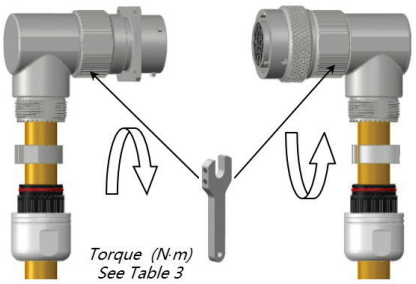
Assembly Instructions

eco | mate® rm Right Angle Plug and Receptacle Cable Assembly (cont.)

Step 9: Insert contacts into connector cavities



Step 10: Assemble back shell



Step 11: Push shielding clip into backshell

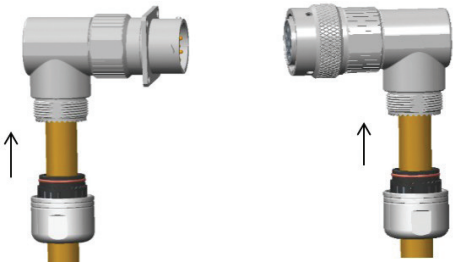
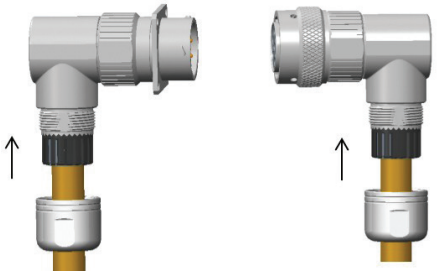
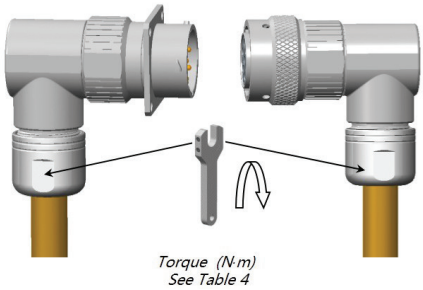


Table 4	
Size	Torque= T2 (N.m)
10	2.0-3.0 N.m
12	3.0-5.0 N.m
14	3.5-5.5 N.m
16	4.0-6.0 N.m
18	5.0-8.0 N.m

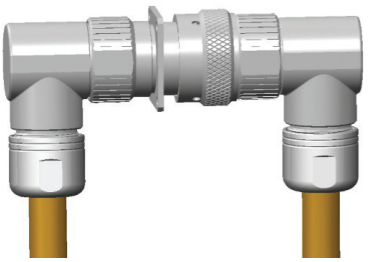
Step 12 Push cable grommet into backshell



Step 13: Tighen metal nut

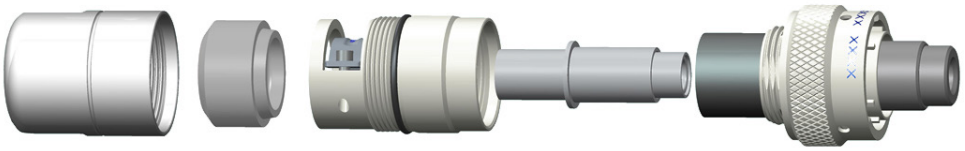


Step 14: Male receptacle & plug (align the master key)

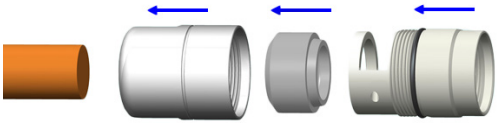


Assembly Instructions

eco | mate® rm High Amperage Straight Plug Cable Assembly

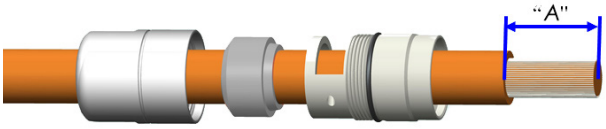


Step 1: Slide components onto cable

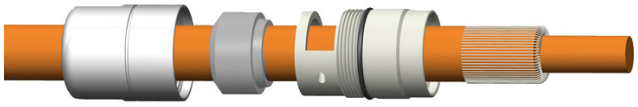


Step 2: Strip jacket

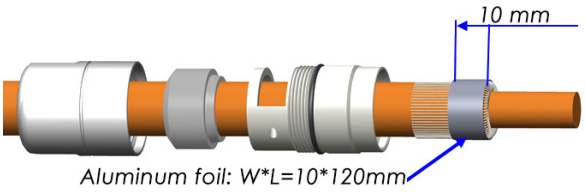
** Make sure exposed shielding is not nicked or cut*



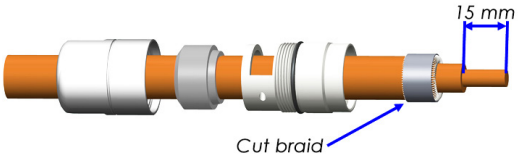
Step 3: Fold braided shielding over jacket



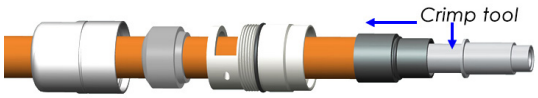
Step 4: Wrap foil over braided shielding



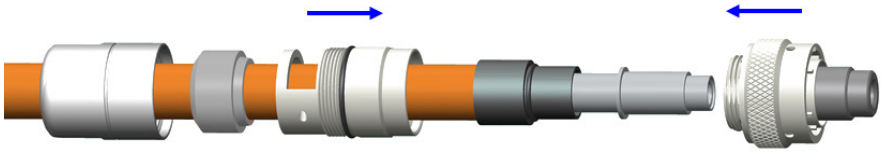
Step 5: Strip to conductor



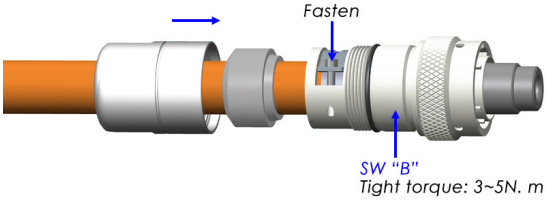
Step 6: Slide onto conductor and crimp



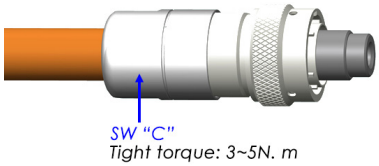
Step 7: Slide plug onto barrel



Step 8: Attach and tighten plug as shown



Step 9: Attach and tighten backshell as shown



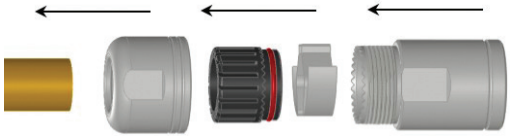
Data Chart

Instruction	Shell 14	Shell 16	Shell 20
Dimension "A"	25 mm	25 mm	30 mm
SW "B"	24 mm	28 mm	32 mm
SW "C"	24.5 mm	29 mm	32.5 mm

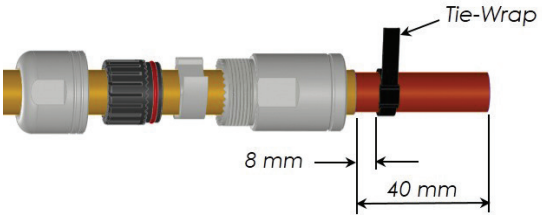
Assembly Instructions

RTHP SERIES™ Straight Plug - Shell Size 12 Cable Assembly

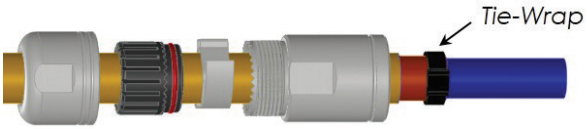
Step1: Slide parts onto cable



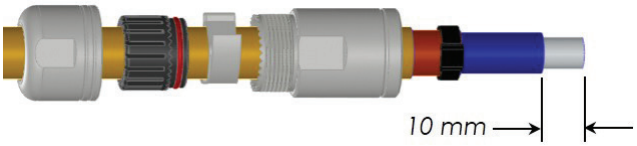
Step 2: Strip jacket to braided shielding and attach tie wrap



Step 3: Cut tie wrap to remove excessive material. Trim shielding flush to edge of tie wrap

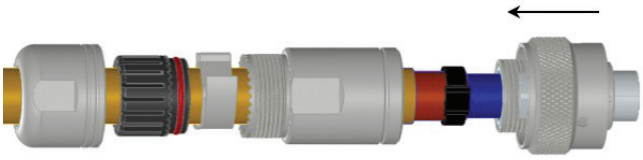


Step 4: Strip to conductor

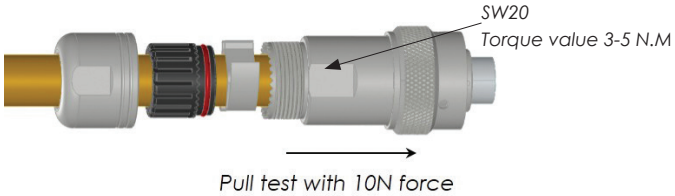


Step 5: Crimp terminal to conductor

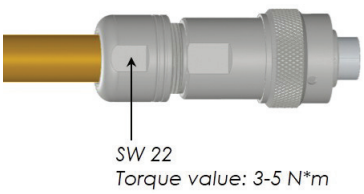
Step 6: Slide plug onto crimped terminal assembly



Step 7: Tighten plug to backhell. Perform pull test to assure correct contact assembly

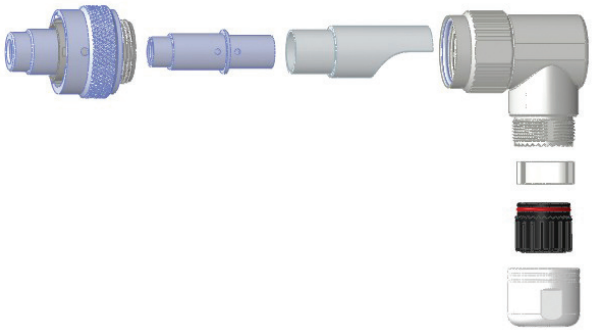


Step 8: Insert shielding clip and cable grommet. Attach and tighten back-nut to backshelll

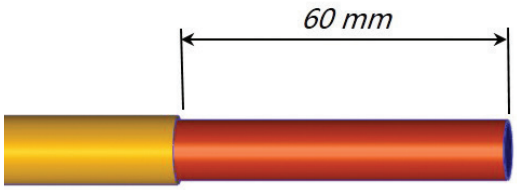


Assembly Instructions

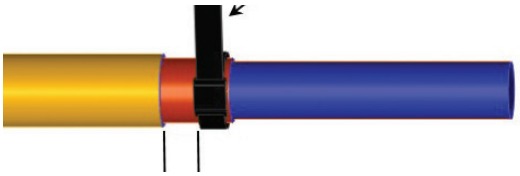
eco | mate® rm High Amperage 90° Plug Cable Assembly



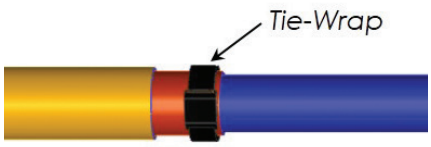
Step 1: Strip jacket to metal braiding



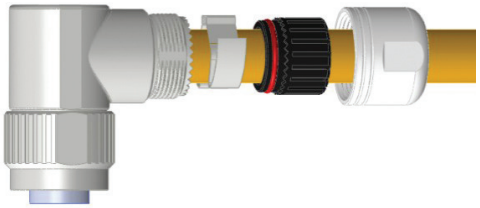
Step 2: Attach tie wrap and trim braiding flush to edge of tie-wrap



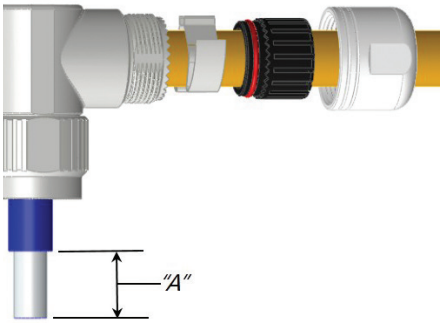
Step 3: Trim tie-wrap



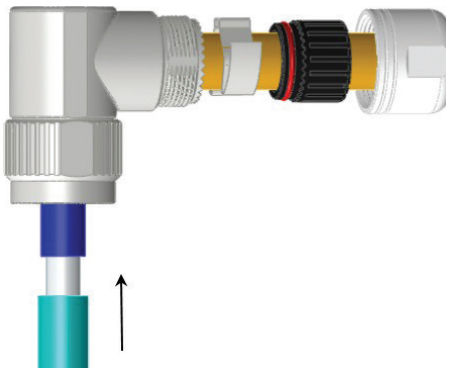
Step 4: Push cable into backshell. Slide components onto cable



Step 5: Trim jacket to conductor



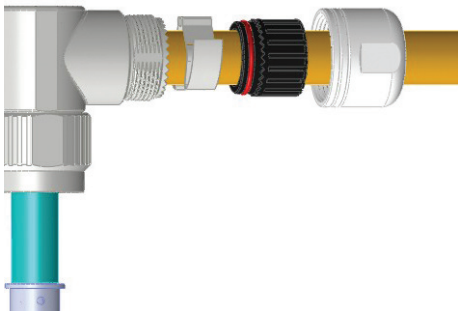
Step 6: Slide heat shrink tubing onto cable



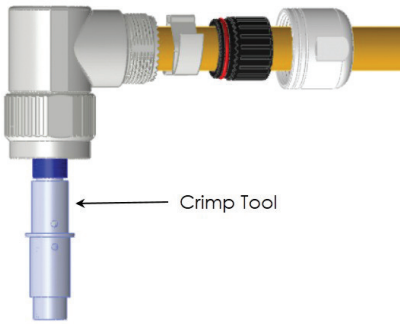
Assembly Instructions

eco | mate® rm High Amperage 90° Plug Cable Assembly (cont.)

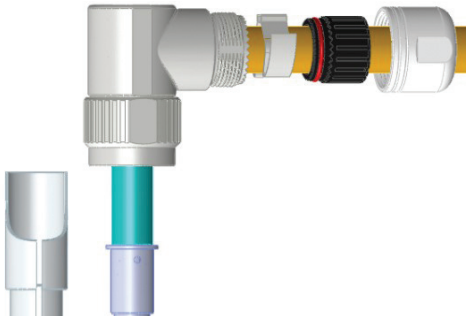
Step 7: Crimp barrel to conductor



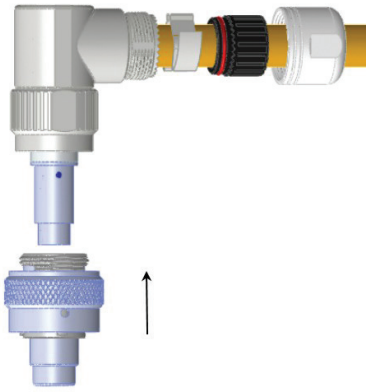
Step 8: Heat shrink tube over crimp



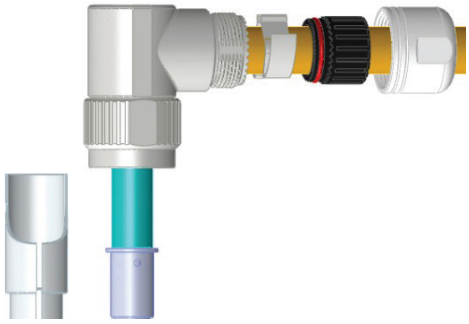
Step 9:



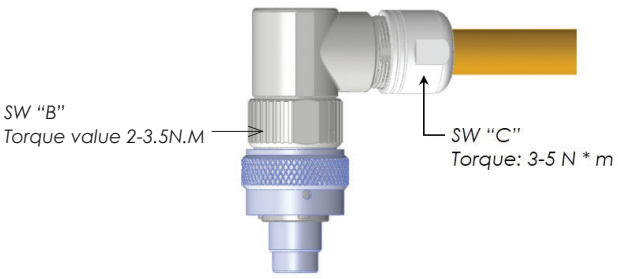
Step 10: Attach plug to backshell



Step 11: Insert shielding clip and cable grommet. Tighten connector to backshell as shown



Step 12: Attach cable-nut to backshell and tighten as shown

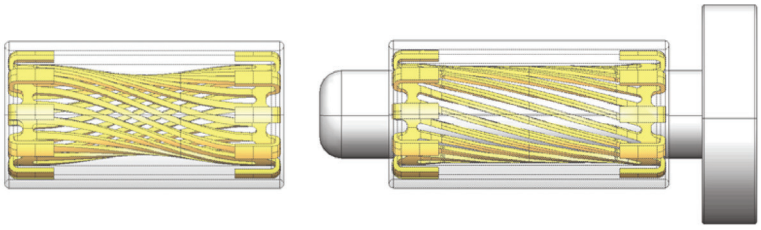


Data Chart

Instruction	Shell 12	Shell 14	Shell 16
Dimension "A"	10 mm	15 mm	15 mm
SW "B"	22 mm	25 mm	28 mm
SW "C"	22 mm	22 mm	25 mm

Technical Data

RADSOK® Product Overview



The RADSOK® Design

- Socket cylinder within female contact has several equally spaced longitudinal beams twisted into a hyperbolic shape
- As a male pin is inserted, axial members in the female half deflect, imparting high current flow across the connection with minimal voltage loss
- The hyperbolic, stamped grid configuration ensures a large, coaxial, face-to-face surface area engagement
- Ideal for crimp termination applications requiring repeated mating cycles and high current with a low multi-volt drop

RADSOK® technology is based upon a stamped and formed flat grid, uniquely twisted into a hyperbolic geometry to provide robust, high density contact to the mating pin contact. Most pin and socket technologies rely on spring (beam element) properties of the contact elements, which tend to weaken over time. Unlike most other pin and socket solutions, the RADSOK®contact also utilizes the tensile strength properties of the flat, high conductivity alloy grid. This provides the high normal forces required for conductivity while also providing a large conductive surface area. Correspondingly low voltage drop and low temperature rise are also achieved while maintaining low insertion forces.

RADSOK® Contact (Max. current carrying capacity meet DIN EN 60512 specification.)

Shell size	Applicable Cable	Contact Plating	current (AC)
			temperature
12 (3.6mm)	10mm², 16mm²	Silver Plated	65A (10mm²), 86A (16mm²)
14 (6.0mm)	25mm²	Silver Plated	120A (25mm²)
16 (8.0mm)	35mm², 50mm²	Silver Plated	130A (35mm²), 180A (50mm²)
20 (10.0mm)	50mm², 70mm², 95mm²	Silver Plated	180A (50mm²), 250A (70mm²), 300A (95mm²)

Note: The given electrical values correspond to a single contact. With the addition of a housing, an increased number of poles or other modifications, the values must be adjusted downwards accordingly.

Technical Data

RADSOK® Advantages and Custom Developed Solutions

RADSOK® Technology Advantages

- **High Reliability** - Unique design and construction technology create an electrical contact interface that exceeds typical interconnect requirements.
- **Low Contact Engagement/Separation Forces** - The hyperbolic lamella socket contact construction distributes normal forces over a high percentage of the mating pin surface. This creates a smooth, even engagement effort. This force distribution also contributes to excellent performance in vibration applications with resistance to typical fretting corrosion.
- **Low Contact Resistance** - The large interface area between the socket lamella and pin surface result in very low contact resistance, enabling the RADSOK® contacts high current ratings compared to traditional power contact designs.
- **High Mating Cycle Durability** - RADSOK® contacts with typical silver plating finishes have demonstrated survival of 20,000 mating cycles. Specialized plating and contact lubricants can extend cycle life to 200,000 matings or higher. Even with continuous exposure to harsh environmental abuse, RADSOK® contacts have been tested to maintain low contact resistance beyond 10,000 mating cycles.

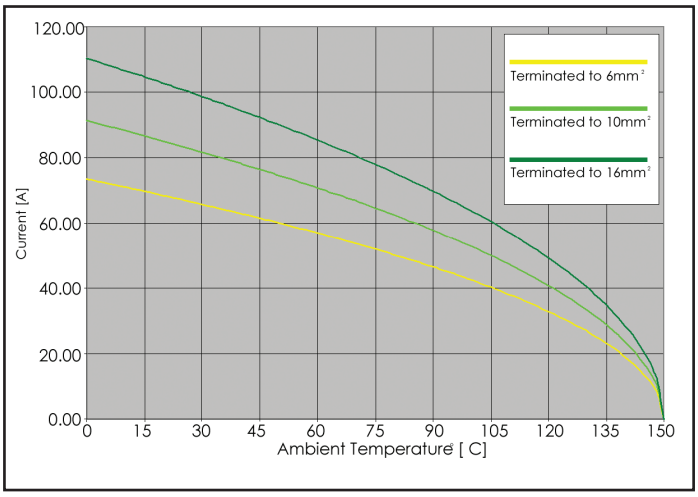
Standard and Custom-Developed Solutions

- In addition to the various standard sizes of RADSOK® components, custom-developed solutions are also available. Amphenol has the global design, engineering and manufacturing resources to provide RADSOK® sockets pressed into basbars, crimped to cables, assembled into connectors, assembled into customer or Amphenol designed specialized electrical devices, or as stand-alone components. Amphenol also manufactures a full compliment of mating pin contacts for any application.
- Steady-state current capacities for RADSOK® products range from 50 amps to over 1000 amps.
- Amphenol connectors with RADSOK® contacts are offered with a variety of positive locking features (HiLok® and SurLok®) that insure and maintain fully mated connections.
- Sealing (Sealtac™) and high voltage hot break options are available within the RADSOK® itself or within a very wide range of IP rated connector housings to provide environmental protection to the contact area.

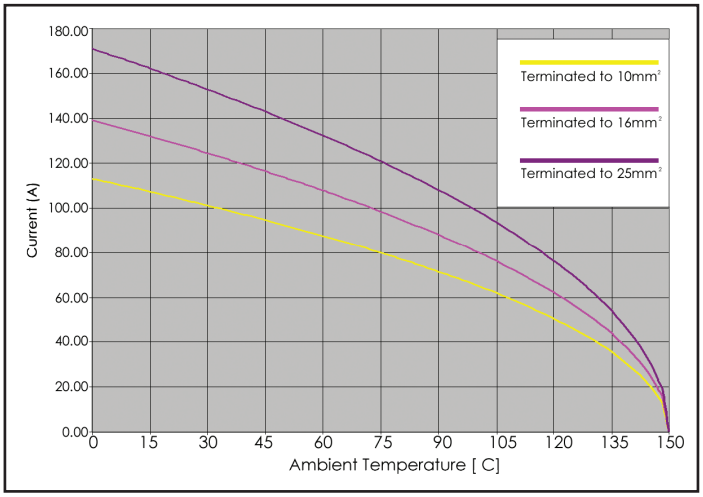
Technical Data

RADSOK® Series Rated Current and Working Voltage
Contact Current Carrying Capacity

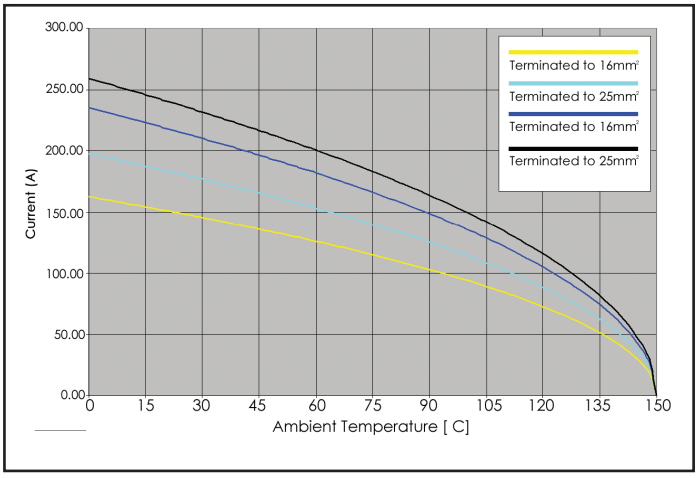
Derating 3.6mm



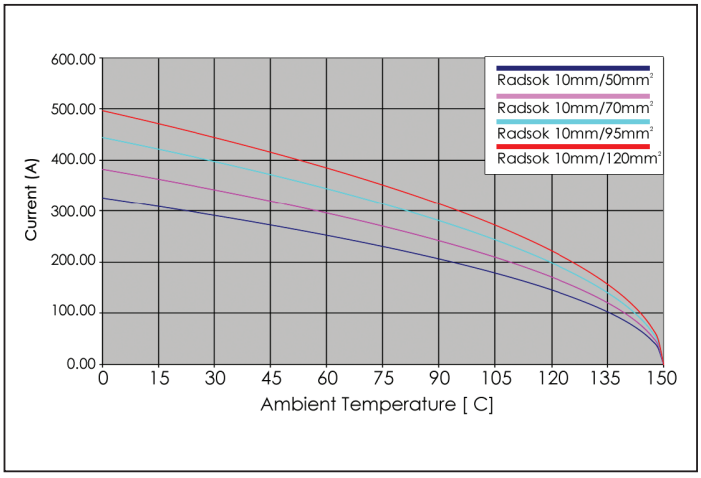
Derating 6mm



Derating 8mm



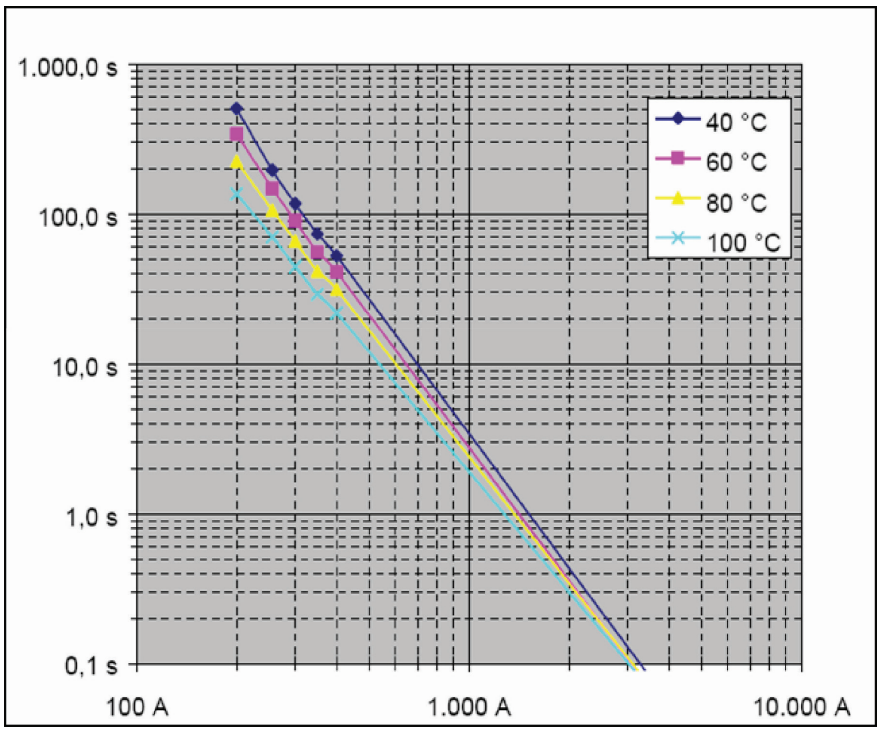
Derating 10mm



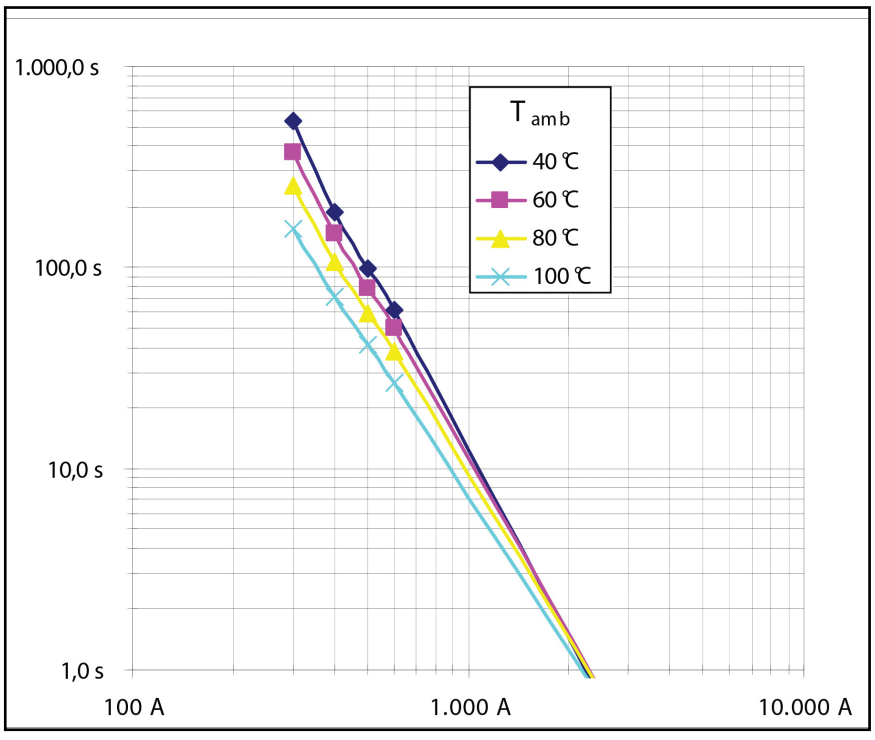
Technical Data

RADSOK® Series Dynamic Overload Tests at Different Temperatures

6mm RADSOK®

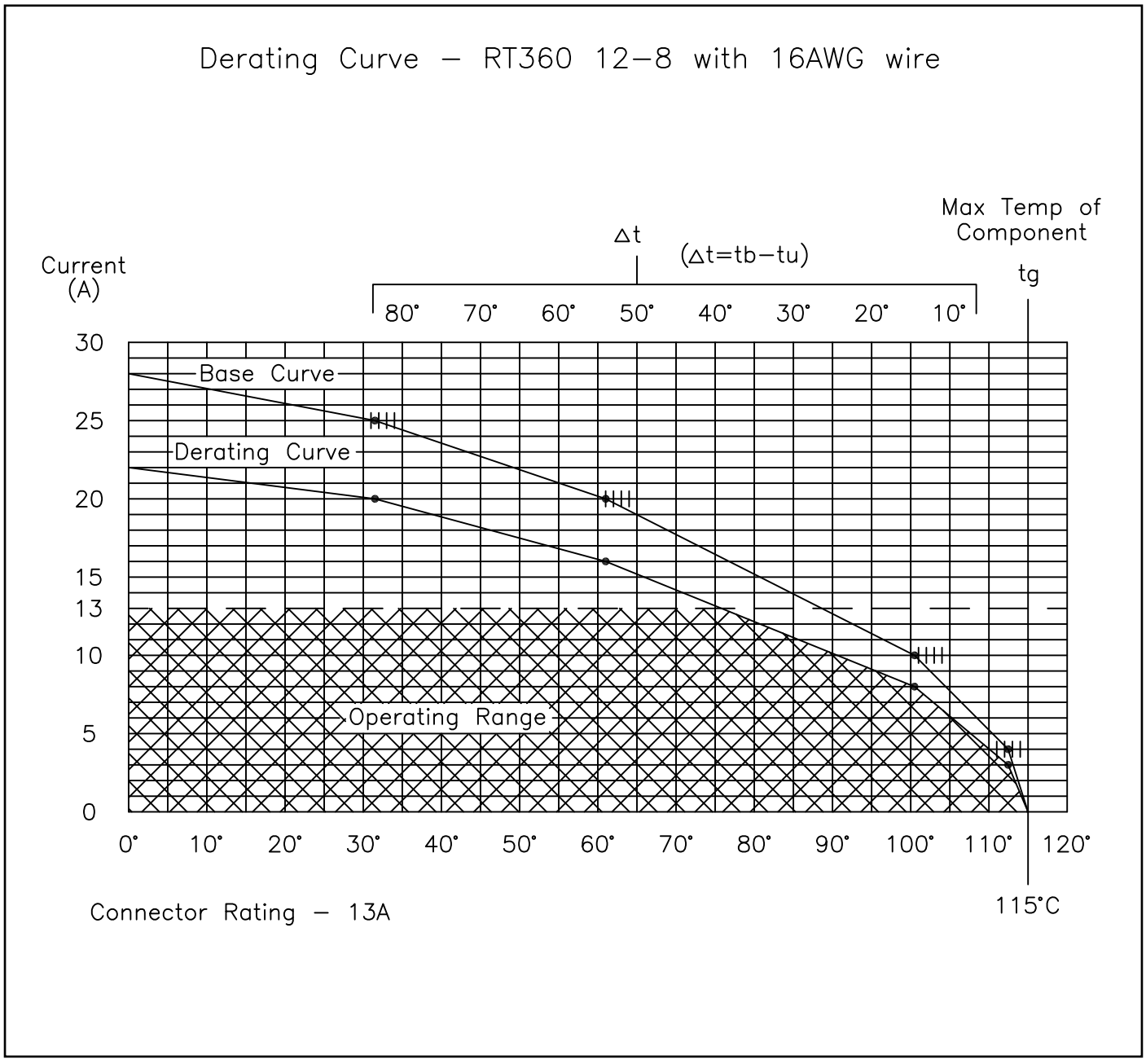


8mm RADSOK®



Technical Data

eco | mate® rm Rated Current and Working Voltage
Current Carrying Capacity



Technical Data

UL94 + UL1977 Industry Standards

There are two main standards for electrical conductors: UL94 and UL1977.

UL94 - The standard for safety of flammability of plastic material for parts in devices and appliance testing.

The eco|mate® rm series has been rated at V-0

The Test Program: Specimen is orientated in a vertical position and is subjected to a flame for ten seconds, then removed. Once the specimen has stopped burning, the flame is then reapplied for another ten seconds and then removed.

V-0 Vertical Burning

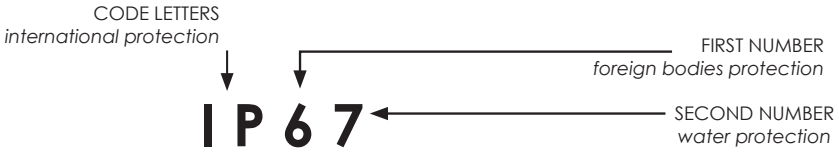
- Specimen self extinguishes within 10 seconds after each test flame application
- Specimen must not drip flaming particles that ignite the cotton indicator

UL1977 - The standard for connectors used in data, signal, control and power applications-component.

ECBT2 - A standard of UL1977 covering single and multi-pole connectors. Intended for factory assembly, includes devices that are incomplete in certain constructional features or are restricted in performance capabilities and are intended for use as components of complete equipment submitted for investigation rather than for direct separate installation in the field. The final acceptance of the component is dependent upon its installation and use in complete equipment submitted to UL.

Technical Data

IP Codes



1st digit	Brief description	Definition	2nd digit	Brief Description	Definition
0	Non-protected	--	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.	1	Protected against vertically falling water drops	Vertically falling drops shall have no harmful effects.
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.	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° .
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.	3	Protected against spraying water	Water sprayed at any angle up to 60° shall have no harmful effects.
4	Protected against access to hazardous parts with a wire.	The probe of 1mm Ø shall not penetrate at all.	4	Protected against splashing water	Water splashed against the enclosure from any direction shall have no harmful effects.
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.	5	Protected against water jets	Water projected in jets against the enclosure from any direction shall have no harmful effects.
6	Protected against access to hazardous parts with a wire Dust-tight.	The probe of 1mm Ø shall not penetrate. No intrusion of dust.	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 temporarily immersed in water for 30 min. in 1m depth.
			8	Protected against the effects of continuous 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.
			9K[1)]	Protected against water during high pressure/steam jet cleaning	Water projected in powerful jets with high pressure and heat against the enclosure from any direction shall have no harmful effects.

Electrical connector devices 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 the housing latching devices and sealed cable entries. The degree of protection depends on the type of intended use. The standard IEC 60529 and/or DIN EN 60529 has specified the degree of protection and divided them into several classes. The attached charts gives an overview of all of the protection degrees.

Technical Data

Crimp Connection

Crimp connection

A crimp connection is a non-detachable electrical connection between a wire and a crimp contact produced with the crimp technology. Precise crimping dies are matched to the crimp barrel and the wire size and a defined deformation results in a reliable electrical connection. There are open barrels (stamped contacts) and closed crimp barrels (turned contacts).

The main advantages of crimp connections are:
- Efficient termination of contacts.
- Reproducible electrical and mechanical figures by a constant crimp quality.

The requirements for crimp connections are defined in DIN EN 60352-2.

An important point for the quality of a crimp connection is the achieved tensile strength of the termination. Measuring the tensile strength is a practical means for quality control purposes. Chart 2 below shows the required minimum tensile strength for open and closed barrels according to the wire size.

Chart 2: Tensile strength for crimp connections

Wire size		Tensile strength
mm²	AWG [1]	N
0.05	30	6
0.08	28	11
0.12	26	15
0.14		18
0.22	24	28
0.25		32
0.32	22	40
0.5	20	60
0.75		85
0.82	18	90
1.0		108
1.3	16	135
1.5		150
2.1	14	200
2.5		230
3.3	12	275
4.0		310
5.3	10	355
6.0		360
8.4	8	370
10.0		380

Cross reference AWG - mm2

The chart below allows a cross reference between American Wire Gauge (AWG) and metric wire sizes (mm2).

Chart 3

AWG	Wire composition	Leiter-Ø	Wire size	AWG	Wire composition	Leiter-Ø	Wire size
30	1 x 0.25	0.25 mm	0.05 mm2	20	1 x 0.81	0.81 mm	0.52 mm2
	7 x 0.10	0.36 mm	0.06 mm2		7 x 0.32	0.97 mm	0.56 mm2
28	1 x 0.32	0.32 mm	0.08 mm2		19 x 0.20	1.02 mm	0.62 mm2
	7 x 0.13	0.38 mm	0.09 mm2	18	1 x 1.02	1.02 mm	0.79 mm2
26	1 x 0.40	0.40 mm	0.13 mm2		19 x 0.25	1.27 mm	0.96 mm2
	7 x 0.16	0.48 mm	0.14 mm2	16	19 x 0.29	1.44 mm	1.23 mm2
	19 x 0.10	0.51 mm	0.15 mm2	14	19 x 0.36	1.80 mm	1.95 mm2
24	1 x 0.51	0.51 mm	0.21 mm2	12	19 x 0.46	2.29 mm	3.09 mm2
	7 x 0.20	0.61 mm	0.23 mm2	10	37 x 0.40	3.10 mm	4.60 mm2
	19 x 0.13	0.64 mm	0.24 mm2	8	133 x 0.29	4.0 mm	8.80 mm2
22	1 x 0.64	0.64 mm	0.33 mm2	6	133 x 0.36	5.5 mm	
	7 x 0.25	0.76 mm	0.36 mm2				
	19 x 0.16	0.81 mm	0.38 mm2				

It has to be noted that wires of the same AWG number but with different composition have slightly different mm2.

Technical Data

Composition and Dimensions of Copper Wires

Chart 4: 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

Current carrying capacity

The current carrying capacity of a connector is shown by a derating curve. The curve shows the currents that the connector can carry continuously and simultaneously through all its contacts. The curve is determined by testing following the standard DIN EN 60512. The upper temperature is limited by the contact and insulation material used . The sum of the ambient temperature and the temperature created by the current flow may not exceed the upper temperature. This means that the current carrying capacity has no fixed value but decreases with increasing ambient temperatures.

As a general example it can be said that a given connector which can carry 16A through all its contacts at 40°C ambient temperature can carry less, e.g. 12A, at an ambient temperature of 80°C.
On the other hand it is often the case that not all contacts carry the whole rated current, which means that some single contacts may carry a higher current than that according to the derating curve. These currents have to be defined by testing.

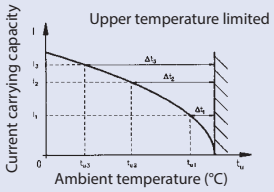
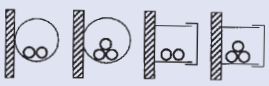
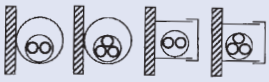


Chart 5: Current carrying capacity of copper wires in (A)

Installation type / Wire size (mm^2)	0.25	0.34	0.5	0.75	1	1.5	2.5	4	6	10
 B1 Wires in conduits and installation channels	-	-	-	7.6	10.4	13.5	18.3	25	32	44
 B2 Cables and conductors in conduits or installation channels	-	-	-	-	9.6	12	16.5	23	29	40
 C Cables and conductors along walls	4.0	5.0	7.1	9.1	11.7	15.2	21	28	36	50
 E Cables and conductors on plank	4.0	5.0	7.1	9.1	11.5	16.1	22	30	37	52

Description according to DIN EN 60204 for PVC insulated copper wires with a working temperature of +40C. For other requirements, such as for other temperatures, mountings, or wires corresponding correction factors are used (see next page).

Technical Data

Reduction Values

Reduction values	Chart 6	
The values in chart 5 are based on an ambient temperature of 40 °C. For other ambient temperatures the values have to be adjusted using the correction values of chart 6 below. For installations with many cables and conductors under load the current carrying capacity is reduced according to the two following charts 7 and 8.	Ambient temperature (°C)	Correction value
	30	1.15
	35	1.03
	40	1.00
	45	0.91
	50	0.82
	55	0.71
	60	0.58

Chart 7: Reduction values for accumulated conductors

Installation type	Number of cables and conductors / pairs under load			
	2	4	6	9
Three phase cable and conductor				
B1 and B2	0.80	0.85	0.87	0.86
C	0.65	0.75	0.78	0.76
E-one row	0.57	0.72	0.75	0.72
E-multi row	0.50	0.70	0.73	0.88
DC conductor (pair), independent of installation type	1.0	0.76	0.64	0.43

Chart 8: Reduction values for multicore cable and conductors up to 10mm^2

Number of conductors (pairs) under load	AC (conductor > 1 mm2)	DC (Pairs 0,2 to 0,75 mm2)
5	0.75	0.52
7	0.65	0.45
10	0.55	0.39
24	0.40	0.27

Conductors of control circuits generally do not need a reduction.

Impulse current carrying capacity

A surge can happen to a connector and its contacts by an impulse current, e.g. through a short circuit in the system or by switching operations. The short-timed high current heat cannot be transferred outside fast enough so the contacts are stressed by the high temperature which in the worst case can lead to a local weld. The robust design of our connectors prevents most damage by impulse currents.

Voltage grading of connectors

General

Clearances and creepage distances are the base for voltage grading of connectors. Valuation and dimensioning of clearances and creepage distances have changed since the introduction of insulation coordination.

Insulation coordination comprises the selection of the electrical insulation performances of the equipment, taking into account the expected use and its environment.

The following standards apply for this:

IEC 60664-1/10.92
Insulation coordination for equipment within low-voltage systems

DIN VDE 0110-1/4.97
Isolationskoordination für elektrische Betriebsmittel in Niederspannungsanlagen

Technical Data

Voltage Grading of Connectors

Clearances

The clearance is the shortest distance in air between two conductive parts. An important point for the dimensioning of clearances is the determination of the overvoltage category. The above standard specifies the possible overvoltages into the four following categories:

Overvoltage category I
Equipment intended for the use in appliances or parts of installations in which no overvoltage can occur.
Examples are low-voltage equipment.

Overvoltage category II
Equipment intended for the use in installations or parts of it in which lightning overvoltages do not need to be considered, but switching overvoltages generated by the equipment do need to be considered.
Examples are household appliances.

Once the overvoltage category has been defined the rated impulse withstand voltage can be selected for the equipment based on the nominal voltage of the supply system and the overvoltage category using chart 9 below:

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.

Overvoltage category IV
Equipment intended for the use in installations or parts of it in which lightning overvoltage has to be considered.
Examples are electricity meters, overcurrent protection switches.

Chart 9

Nominal voltage of the supply system in V (based on IEC 60038)	Rated impulse voltage in kV for overvoltage category			
Three phase systems	IV	III	II	I
230/400 277/480	6	4	2,5	1,5
400/690	8	6	4	2,5
1000	12	8	6	4

After the rated impulse withstand voltage has been selected the pollution degree must be defined taking the expected pollution around the equipment into account. The following four degrees of pollution are established:
After the rated impulse withstand voltage has been selected the pollution degree must be defined taking the expected pollution around the equipment into account. The following four degrees of pollution are established:

Pollution degree 1
No pollution or only dry, non-conductive pollution occurs. The pollution has no influence.

Pollution degree 2
Only non-conductive pollution occurs except occasionally a temporary conductivity caused by condensation is to be expected.

Pollution degree 3
Conductive pollution occurs or dry non-conductive pollution occurs which becomes conductive due to condensation which is to be expected.

Pollution degree 4
The pollution generates persistent conductivity caused by conductive dust or by rain or snow.

It has to be noted that for a connector or plug and socket devise with a degree of protection of min. IP 54 the parts inside the enclosure may be dimensioned for a lower pollution degree. This also applies to mated connectors which enclosure is ensured through the connector housing and which may only be disengaged for test and maintenance purposes.
When impulse withstand voltage and the pollution degree are defined the minimum clearances can be selected from chart 10.

Technical Data

Voltage Grading of Connectors (cont.)

Chart 10

Impulse withstand voltage in kV	Minimum clearances in air in mm up to 2000 m above sea level							
	Case A (non homogeneous field)				Case B (homogeneous field)			
	Pollution degree				Pollution degree			
	1	2	3	4	1	2	3	4
0.33	0.01	0.2	0.8	1.6	0.01	0.2	0.8	1.6
0.40	0.02				0.02			
0.50	0.04				0.04			
0.60	0.06				0.06			
0.80	0.10				0.1			
1.0	0.15				0.15			
1.2	0.25	0.25			0.2			
1.5	0.5	0.5			0.3	0.3		
2.0	1.0	1.0	1.0		0.45	0.45		
2.5	1.5	1.5	1.5		0.6	0.6		
3.0	2	2	2	2	0.8	0.8		
4.0	3	3	3	3	1.2	1,2	1.2	
5.0	4	4	4	4	1.5	1.5	1.5	
6.0	5.5	5.5	5.5	5.5	2	2	2	2
8.0	8	8	8	8	3	3	3	3
10	11	11	11	11	3.5	3.5	3.5	3.5
12	14	14	14	14	4.5	4.5	4.5	4.5
15	18	18	18	18	5.5	5.5	5.5	5.5
20	25	25	25	25	8	8	8	8
25	33	33	33	33	10	10	10	10
30	40	40	40	40	12.5	12.5	12.5	12,5
40	60	60	60	60	17	17	17	17
50	75	75	75	75	22	22	22	22
60	90	90	90	90	27	27	27	27
80	130	130	130	130	35	35	35	35
100	170	170	170	170	45	45	45	45

When defining the minimum clearances for connectors generally the values of the inhomogeneous field can be chosen or the required clearance has to be defined by a voltage test.

Creepage distances

The creepage distance is the shortest distance along the surface of the insulating material between two conductive parts.
For the dimensioning of the creepage distance the following factors are taken into account: the rated voltage, the pollution degree and the tracking formation of the insulating material.

The materials are separated into four groups according to their CTI values (Comparative Tracking Index):

Material group I	600 ≤ CTI
Material group II	400 ≤ CTI < 600
Material group IIIa	175 ≤ CTI < 400
Material group IIIb	100 ≤ CTI < 175

The minimum creepage distances can be selected from chart 11 .

Technical Data

Creepage Distance

Chart 11

U-eff Rated voltage U in V	Min. creepage distance in mm													
	Printed circuits		Other devices											
	Pollution degree		Pollution degree											
	1	2	1	2				3				4		
			Material group					Material group				Material group		
	2)	3)	2)	I	II	IIIa	IIIb	I	II	IIIa	IIIb	I	II	IIIa	IIIb
10	0.025	0.04	0.08	0.4		0.4	0.4	1		1		1.6		1.6	
12.5	0.025	0.04	0.09	0.42		0.42	0.42	1.05		1.05		1.6		1.6	
16	0.025	0.04	0.1	0.45		0.45	0.45	1.1		1.1		1.6		1.6	
20	0,025	0.04	0.11	0.48		0.48	0.48	1.2		1.2		1.6		1,6	
25	0,025	0.04	0.125	0.5		0.5	0.5	1.25		1.25		1.7		1.7	
32	0.025	0.04	0.14	0.53		0.53	0.53	1.3		1.3		1.8		1.8	
40	0.025	0.04	0.16	0.56		0.8	1.1	1.4		1.6	1.8	1.9		2.4	3
50	0.025	0.04	0.18	0.6		0.85	1.2	1.5		1.7	1.9	2		2.5	3.2
63	0.04	0.063	0.2	0.63		0.9	1.25	1,6		1.8	2	2.1		2.6	3.4
80	0.063	0.1	0.22	0.67		0.95	1.3	1.7		1.9	2.1	2.2		2.8	3.6
100	0.1	0.16	0.25	0.71		1	1.4	1.8		2	2.2	2.4		3.0	3.8
125	0.16	0.25	0.28	0.75		1.05	1.5	1.9		2.1	2.4	2.5		3.2	4
160	0.25	0.4	0.32	0.8		1.1	1.6	2		2.2	2.5	3.2		4	5
200	0.4	0.63	0.42	1		1.4	2	2.5		2.8	3.2	4		5	6.3
250	0.56	1	0.56	1.25		1.8	2.5	3.2		3.6	4	5		6.3	8
320	0.75	1.6	0.75	1.6		2.2	3.2	4		4.5	5	6.3		8	10
400	1	2	1	2		2.8	4	5		5.6	6.3	8		10	12.5
500	1.3	2.5	1.3	2.5		3.6	5	6.3		7.1	8.0	10		12.5	16
630	1.8	3.2	1.8	3.2		4.5	6.3	8		9	10	12.5		16	20
800	2.4	4	2.4	4		5.6	8	10		11	12.5	16		20	25
1000	3.2	5	3.2	5		7.1	10	12.5		14	16	20		25	32
1250			4.2	6.3		9	12.5	16		18	20	25		32	40
1600			5.6	8		11	16	20		22	25	32		40	50
2000			7.5	10		14	20	25		28	32	40		50	63
2500			10	12.5		18	25	32		36	40	50		63	80
3200			12.5	16		22	32	40		45	50	63		80	100
4000			16	20		28	40	50		56	63	80		100	125
5000			20	25		36	50	63		71	80	100		125	160
6300			25	32		45	63	80		90	100	125		160	200
8000			32	40		56	80	100		110	125	160		200	250
10000			40	50		71	100	125		140	160	200		250	320

Connectors in this catalogue are allocated to fixed rated voltages which apply to the machine building industry. In case of other applications the above chart can be used to determine other rated voltages.