

Circular connector



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MI	400/30V	6/1A	6+6(5+PE)	crimp terminal, solder terminal	P27-05~ P27-06

• Technical data

- Binding for the applications of connectors are the requirements of the equipment specifications of the users.
- We reserve the right to change the design due to improvements in quality, further development or production requirements.
- All technical data mentioned in this catalog are related to connectors, meaning connecting devices which in normal use (when under load) shall not be inserted or withdrawn.
- Regarding the CE marking it has to be noted that electronic components such as connectors are not subject to a marking, and therefore must not be marked with a CE mark. This is confirmed by the rules of the European commission for low voltage and EMC guidelines.
- The listed technical data are intended to help selecting the appropriate product and to secure a proper application.
- The connectors are developed and designed for the use in the field of equipment, control and electrical appliances. Whether they also can be used in other applications has to be checked by the user.
- When mounting electrical conductive socket housings, they have to be integrated into the protection measures.
- The wires to be connected shall be stripped only so far that distances to conductive parts are not shortened. When wires are soldered, it has to be beared in mind that no single strands stick out and no short circuit can occur.
- All dimensions in this catalog are in mm.
- For connectors with strain relief the following minimum parameters are valid:

		Recommended tightening torque of the pressing screw
2-3	Cable Φ : min.20N	30-40 Ncm
3-4	Cable Φ : min.30N	30-40 Ncm
4-5	Cable Φ : min.40N	80-100 Ncm
5-6	Cable Φ : min.50N	80-100 Ncm
6-7	Cable Φ : min.60N	80-100 Ncm
7-8	Cable Φ : min.70N	80-100 Ncm
8-12	Cable Φ : min.80N	100-140 Ncm

• Connectors

Connectors are components which are not to be engaged or disengaged in normal use (under live).

• Plug and socket devices

Plug and socket devices are components which in normal use (under live or load) may be engaged or disengaged when live or under load.

• Termination methods

• Screw termination

A Screw termination is a detachable electrical connection between a conductor and a screw clamp. Screw clamps are designed acc. to DIN/EN 60999/VDE 0609. The chart below shows the screw size and the required clamping and testing torque.

Screw size	M2.5	M3	M3.5
Torque(Ncm) Cap screw	40	50	60
Headless screw	20	25	40

• Solder connection

Besides the soldering of single wires with solder irons or soldering machines, the method of wave soldering or infra-red vapor phase soldering has gained great importance for connectors for printed boards or flexible wiring.

We recommend the following soldering parameters

- hand-soldering: soldering bold temperature max. 370° C/max. 4s
- dip soldering: soldering bath temperature max. 270° C/max. 4s
- alternativ dip soldering: soldering bath temperature max. 260° C/max. 10s

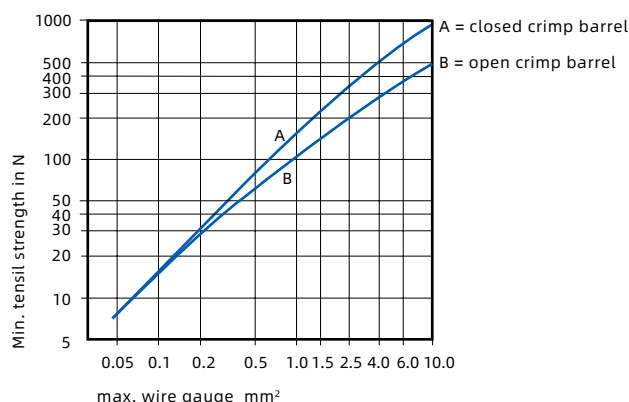
When wires are soldered, it has to be watched that no single strands stick out which could lead to a short circuit and that no large solder joints occur which would reduce the clearance and creepage distances unfavourably. Testing and valuation of solder joints and the relevant components is regulated in DIN EN 60068

• Technical data

• Crimp connection

A crimp connection is a non-detachable electrical connection between a conductor and a crimp contact produced with the crimp technology. The requirements for crimp connections are defined in DIN IEC 60352 part 2.

An important point for the quality of a crimp connection is the achieved tensile strength of the termination. Since easy to measure, the tensile strength is a practicable means for quality control purposes. The diagram below shows the required minimum tensile strength depending on the wire size.



• American Wire Gauges

Since various areas of industry are also using wires according to the American Wire Gauge (AWG), the following comparison chart is included to allow a cross reference between AWG and metric wire sizes

AWG	Wire composition (mm)	Wire-Ø(mm)	Wire gauge(mm²)
30	1 x 0.25 7 x 0.10	2-3	2-3
28	1 x 0.32 7 x 0.13	3-4	3-4
26	1 x 0.40 7 x 0.16 19 x 0.10	0.40 0.48 0.51	0.13 0.14 0.15
24	1 x 0.51 7 x 0.20 19 x 0.13	0.51 0.61 0.64	0.21 0.22 0.25
22	1 x 0.64 7 x 0.25 19 x 0.16	0.64 0.76 0.81	0.33 0.34 0.38
20	1 x 0.81 7 x 0.32 19 x 0.20	0.81 0.97 1.02	0.52 0.56 0.60
18	1 x 1.02 19 x 0.25	1.02 0.27	0.82 0.93
16	19 x 0.29	1.44	1.25
14	19 x 0.36	1.80	1.93
12	19 x 0.46	2.29	3.16
10	19 x 0.56	3.10	4.65

- Composition and dimensions of commonly used copper wires based on VDE 0295

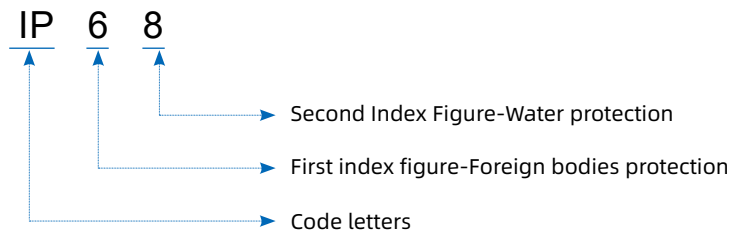
Wire gauge(mm²)	Wire composition (mm)	Wire-Ø(mm)
0.09	12 x 0.10	0.5
0.14	18 x 0.10	0.5
0.25	14 x 0.16 32 x 0.10	0.7 0.7
0.34	19 x 0.16 42 x 0.10	0.8 0.9
0.5	7 x 0.30 16 x 0.21 28 x 0.16	1.0 1.1 1.1
0.75	7 x 0.37 24 x 0.21 42 x 0.16	1.2 1.2 1.3
1.0	7 x 0.43 32 x 0.21 56 x 0.16	1.4 1.4 1.5
1.5	7 x 0.52 30 x 0.26 84 x 0.16	1.6 1.7 1.8
2.5	7 x 0.67 50 x 0.26 140 x 0.16	2.2 2.3 2.3
4.0	7 x 0.85 56 x 0.31 224 x 0.16	2.7 2.8 2.9

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

• Hoods/housings connector insert protection

For safety reasons, connectors have to be protected from outside influences like dust, foreign objects, direct contact, moisture and water. This protection is provided on industrial connectors by their 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 and divided the degree of protection into several classes.

The degree of protection is indicated in the following way:



Index figure	Degree of protection	Index figure	Degree of protection
0	No protection: No protection against accidental contact, no protection against solid foreign bodies	0	No protection against water
1	Protection against large foreign bodies: Protection against contact with any large area by hand and against large solid foreign bodies with $\varnothing > 50$ mm	1	Drip-proof: Protection against vertical water drips
2	Protection against medium sized foreign bodies: Protection against contact with the fingers, protection against solid foreign bodies with $\varnothing > 12$ mm	2	Drip-proof: Protection against water drips (up to a 15° angle)
3	Protection against small solid foreign bodies: Protection against tools, wires or similar objects with $\varnothing > 2.5$ mm, protection against small foreign solid bodies with $\varnothing > 2.5$ mm	3	Spray-proof: Protection against diagonal water drips (up to a 60° angle)
4	Protection against grain-shaped foreign bodies: As 3 however $\varnothing > 1$ mm	4	Spray-proof: Protection against splashed water from all directions
5	Protection against injurious deposits of dust: Full protection against contact. Protection against interior injurious dust deposits	5	Hose-proof: Protection against water (out of a nozzle) from all directions
6	Protection against ingress of dust: Total protection against contact. Protection against penetration of dust	6	Strong hose-proof: Protection against strong water (out of a nozzle) from all directions
		7	Protected against immersion: Protected against temporary immersion
		8	Water-tight: Protected against water pressure

• Electrotechnical information

• Voltage grading of connectors (insulation coordination)

Clearances and creepage distances are the base of voltage grading of connectors. Valuation and dimensioning of clearances and creepage distances have changed since the introduction of insulation coordination. The following standards apply for this:

- IEC 60664-1/11.92 Insulation coordination for equipment within low-voltage systems
- DIN VDE 0110/4.97 Insulation coordination for equipment within low-voltage systems

Insulation coordination comprises the selection of the electrical insulation performances of an equipment (e.g. connector), taking into account the expected use and its environment.

• In this respect some definitions are explained in short:

Rated voltage: The value of voltage assigned by the manufacturer to the connector and to which operation and performance characteristics are referred.

Rated impulse voltage: The value of an impulse withstand voltage assigned by the manufacturer to the connector characterising the specified withstand capability of its insulation against transient overvoltages.

Clearance: The shortest distance in air between two conductive parts.

Creepage distance: The shortest distance along the surface of the insulating material between two conductive parts.



• Voltage grading of connectors (insulation coordination)

Overvoltage categories: The standard has divided the possible overvoltages into four categories. The three categories which relate to connectors are shortly described below:

Overvoltage category I

Equipment (e.g. connectors) intended for the use in applications or parts of installations in which no overvoltage can occur. Examples are low voltage equipments.

Overvoltage category II

Equipment (e.g. connectors) 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. Examples are household appliances.

Overvoltage category III

Equipment (e.g. connectors) 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 (e.g. connectors) or its dependent circuits are subject to special requirements. Examples are protecting means, switches and sockets.

Material groups

For the dimensioning of the creepage distance, the tracking formation of the insulating material used by the manufacturer has to be considered. The materials are separated into three groups according to their CTI values (Comparative Tracking Index):

Material group I $600 \leq \text{CTI}$

Material group II $400 \leq \text{CTI} < 600$

Material group III $175 \leq \text{CTI} < 400$

• Pollution degree of connectors

Pollution degree: The expected pollution around the equipment (e.g. connector) was established in the standard in four degrees:

Pollution degree 1: No pollution or only dry, non-conductive pollution occurs. The pollution has no influence. Examples: The inside of electrical measuring instruments, electronic measuring devices.

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

Examples: Household appliances, installation material, lamps, power supplies of office equipment.

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

Examples: Electrical equipment of machine tools and processing machines, low voltage switches at machine tools.

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

Examples: Equipment on wagon roofs and beneath wagons at electrical locomotives, rail cars, trolley busses. Equipment at electrical locomotives underground.

Additional remarks: If connectors being defined for pollution degree 1 and overvoltage categorie 1 are applied for other conditions (higher pollution degree and higher overvoltage category), voltage levels reduce correspondingly. But the connectors can be used without any problems at reduced maximum voltages.

It has to be noted that for a connector with a degree of protection of at least IP 54 the parts inside the enclosure may be dimensioned for a lower pollution degree. This also applies to mated connectors whose enclosure is ensured through the connector housing and which may only be disengaged for test and maintenance purposes.

• Current carrying capacity

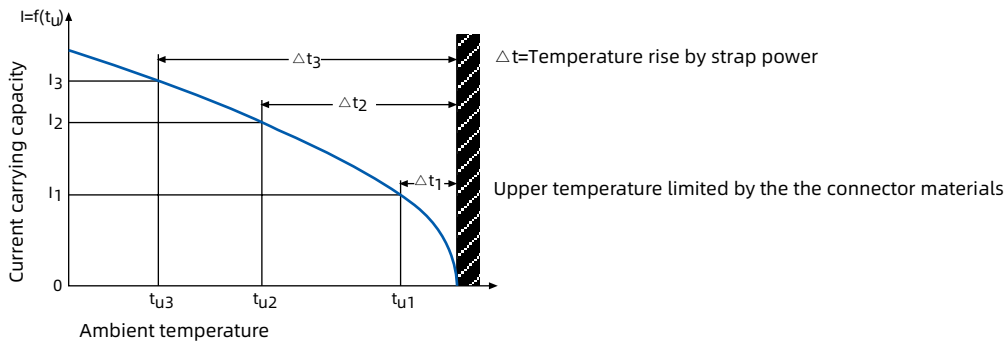
The current carrying capacity of a connector denotes the current that can be carried continuously and simultaneously through all its contacts. It is determined by testing following the standard DIN IEC 60512.

The upper limit temperature results from the thermal properties of the contact and insulating materials. The sum of the ambient temperature and the temperature created by the current flow may not exceed the upper limit temperature of the connector.

This means, that the current carrying capacity is no fixed value but decreases with increasing ambient temperatures. This relation between current, the caused temperature rise and ambient temperature of the connector is depicted in a curve, the so-called derating curve. As one can see, the current carrying capacity decreases with increasing ambient temperature.

On the other hand, very often not all contacts are loaded simultaneously with the whole rated current, so that some single contacts can carry a higher current than that according to the derating curve. These currents have to be determined by testing.

Derating curve:



• Shielding, Electromagnetic compatibility (EMC)

Since the issue of the German law about electromagnetic compatibility of equipment, more attention is paid to EMC within the concerned equipment.

The equipment has to be designed in such a way that:

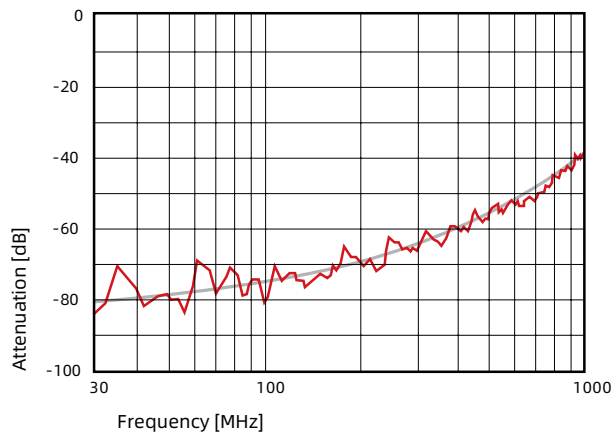
1. the generation of electromagnetic interference is limited to such extend that the determined operation of this equipment is not hampered,
2. the equipment has a reasonable resistance against electromagnetic interference so that the determined operation is not hampered.

To satisfy the requirements of the equipment manufacturers, more and more connectors with shielding properties are applied where shielded cables can be connected. In use are conductive housings to which the cable shield can be terminated. In case of circular connectors, it should be watched that the cable shield is carefully connected to the connector shield. A circumferentially (360°) contact is optimal in this case. Good shielding values (and very often sufficient for practical use) are also achieved when the shielding braid is firmly connected to the conductive housing. Not sufficient are fully plastic connectors without metal sleeves with no possibility to terminate the cable shield.

Furthermore, it is important that during mating a secure electrical connection between plug and socket housing is achieved and that the panel mounted connector part has a good metallic connection with the chassis wall.

The shielding attenuation is stated in decibel (dB) and depends on the frequency. Good shieldings have a high attenuation, which over a large frequency band (MHz) does not decrease too heavily.

Attenuation curve acc. to DIN 47250-6
Example 360° shielding: M12-A series



• Information about used materials

Two material groups are used to manufacture the connectors described in this catalog:

- 1: Metals for contacts and housings
- 2: Plastic material for inserts and housings

Materials for contacts

The properties of contacts are defined to a large extent by the used materials. Decisive features are:

- strength and spring properties
- electrical conductivity
- max. operating temperature

Considering these points, Wain is using proven copper-alloys for the manufacture of contacts;

Materials for metal housings

Depending on the application, the metal housings are produced from either brass, zinc die-cast or an aluminium alloy. For circular housing parts, mainly brass is used due to its good machine ability and strength. For angled housings and parts with minor finishing work, zinc diecast or an aluminium alloy is used.

Plastic material for inserts

The inserts of Wain-connectors are manufactured primarily from PBT (Polybutylen-terephthalate), a plastic material with a temperature stability of up to 130 °C and special properties for high grade moulded parts. The material has very good chemical and electrical properties and very good dimensional stability.

Surface finishes

In order to protect contacts and housings from aggressive environments and to improve the conductivity, the surfaces are treated accordingly. At wain, contacts are gold or silver plated. These platings improve the conductivity and are very corrosion-proof. For applications in the mA-range at very low voltages, gold plated contacts are recommended to improve the electrical properties and in addition, it increases the corrosion-proofness. Housings are anodised or covered with a plating of either nickel or chromium for anti-corrosion and decorative reasons.

Material for sealing gaskets

To achieve the required protection class, all Wain circular connectors are equipped with sealing rings of an elastomeric material. Depending on the final use, wain has selected Chloroprene Rubber (Trademark Neoprene), Nitrid Rubber (Trademark Perbunan) or Fluorsilicon Rubber (Trademark Viton). The chemical resistance of these elastomeric materials can be depicted from table on page 16-09.

Plastic material for housings

Plastic housings are primarily manufactured from PA (Polyamide). This wellproven material (internationally known under the name Nylon) is very tough, non-abrasive, resistant against solvents, oils and greases and can be used at temperatures up to 120 °C.

• Important data of used metals

Material	Letter symbol	Conductivity ($\frac{m}{\Omega \times mm^2}$)	Tensile strength (N/mm ²)	Limit temperature (°C)	Corrosion resistance ¹⁾
Coatings					
Gold	Au	44	-	-	Very good
Silver	Ag	62	-	-	Good
Nickel	Ni	10	-	-	Very good
Optaloy	CuSnZn	15	-	-	Good
Basic material					
Copper	Cu	55	ca.400	90	Partially resistant. Surface coating recommended.
Brass	CuZn	15	ca.500	90	Partially resistant. Surface coating recommended.
Phos. bronze	CuSn	9	ca.700	120	Good
Zinc die-cast	GD-Zn	16	ca.300	-	Non-resistant. Surface coating required.
Aluminium die-cast	GD-Al	20	ca.250	-	Partially resistant. Surface coating recommended.

1) Depends on environmental influences.

- Information about used materials

- Chemical resistance of used plastic material and elastomeres

	PA	PBT	CR	NBR	FPM	PUR(Ester) ¹⁾	PUR(Ether) ¹⁾
Hydrocarbons							
Gasolin	+	+	0	+	+	+	+
Fuel oil	+	+	+	+	+	+	+
Benzole	+	0	-	-	+	0	0
Naphthalene	+	0	-	+	+	0	0
Alcohols							
Ethyl alcohol	0	+	+	+	+	+	+
Isopropanol	0	0	+	+	+	+	+
Glycol	-	0	+	+	+	+	+
Glycerine	+	+	+	+	0	+	+
Ketons							
Acetone	+	+	0	-	-	-	-
Acids							
Hydrochloric acid(20%)	-	0	0	0	+	-	+
Nitric acid(10%)	-	0	0	0	+	-	-
Phosphoric acid(30%)	-	0	+	+	+	-	+
Sulphuric(30%)	-	0	+	+	+	-	+
Citric acid(10%)	+	+	+	+	+	0/-w	+
Lactic acid(10%)	+	+	0	0	+	0/-	+
Acetic acid(10%)	0	0	+	+	+	0/-	+
Bases (solutions)							
Caustic soda(10%)	+	-	0	0	0	0	+
Ammonia, diluted	+	+	+	+	+	-	+
Oils, greases							
Soybean oil	+	+	+	+	0	0/-	0
Olive oil	+	+	+	+	+	0/-	0
Butter	+	+	+	+	+	0/-	0/-
Salt water	+	+	+	+	+	0	+
Cleaning agents							
Detergents	+	0	+	+	+	+/-	+/-
Detergents	+	+	+	+	+	+/-	+/-

• Information to used standards

- The standards used in this catalog for definition and testing of the connectors are described below in more detail. These are:

IEC 60664-1; (2007-4), Insulation coordination

This international standard, which is identical to the German standard DIN VDE 0110-1 issued April 1997, is a basic safety standard to achieve insulation coordination. It provides the information necessary to specify clearances, creepage distances and solid insulation for electrical equipment (e.g. connectors), taking into account the expected micro-environment and other influencing stresses to which it is likely to be subjected during its anticipated lifetime. Included are methods for voltage testing in regards to the insulation coordination.

IEC 60512; (2001-1), Testing procedures and measuring methods

This international standard, which is identical with the European standard DIN EN 60512, has replaced the earlier German standard DIN 41640. It is the basic standard for testing procedures and measuring methods for electromechanical components (e.g. connectors). The standard is very comprehensive and consists of nine parts in total in which all electrical, mechanical and climatic tests are described. Furthermore, it contains tests about solderability, sealing, shielding and cable strain relieve.

IEC 60529; (2001-2), Degrees of protection provided by enclosures (IP-Code)

This international standard, which is identical with the European standard DIN EN 60529 and the German standard DIN VDE 0470-1 of Nov. 1992, defines the designation, requirements and testing for the classification of degrees of protection by enclosures for electrical equipment (e.g. connectors). It classifies the protection against access to hazardous parts, protection against foreign objects and protection against ingress of water. The degree of protection is indicated by an IP-Code.

IEC 60068-1; March 1995, Environmental testing

This international standard, which is identical with the European standard DIN EN 60068, contains basic procedures for environmental tests and test severities. The test procedures are intended to prove the resistance of components against expected environmental influences under working conditions. Typical tests are: cold, dry and damp heat, shock, vibration, temperature change and more.

DIN EN 61984 (VDE 0627); 2009-11, Connectors and Connection devices

This international standard is applicable for plug connectors with rated voltages ranging from 50 V to 1000 V AC and DC and rated currents up to 500 A per contact for which there is either no detail specification (DS), or if the detail specification with reference to the safety requirements is based on this standard. This standard may be used as a guide for plug connector with rated voltages up to 50 V. In this case the design for clearances and leakage paths must be based on IEC 60664-1.

This standard may also be used as a guide for plug connectors with rated voltages greater than 125 V per pole.

This standard is not applicable for plug connectors in or on equipment for which there are application-specific safety requirements for plug connectors.