

OMRON



CONNECTOR

Fundamentals of CONNECTORS

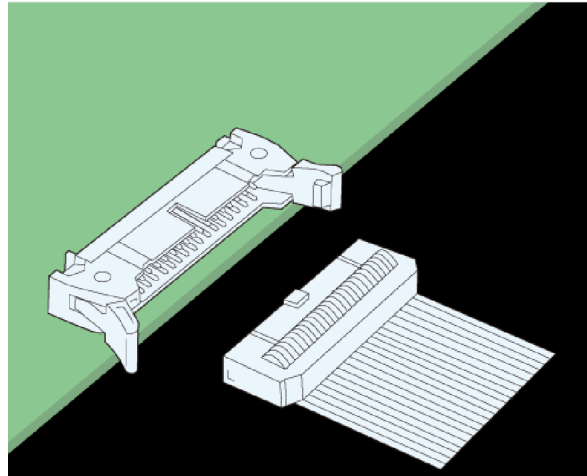
Connectors are parts or devices used for electrically connecting or disconnecting circuits etc.

Contents

Basics	
03	Definition of Electrical Connectors
04	Types & Classifications
04	Connector Basics
05	Structure and Principle
05	Basic Connector Structure
Technology	
06	Ratings / Characteristics
06	Electrical Characteristics
07	Mechanical Characteristics
07	Other Characteristics
Applications	
08	Precautions for Proper Connector Use
09	Failure of Connector
09	Life of Connector
Standards	
10	Connector Standards
12	Safety Standards
12	Safety Standards by Country
13	Basic Safety Standard Requirements by Region
13	Main Safety Standards

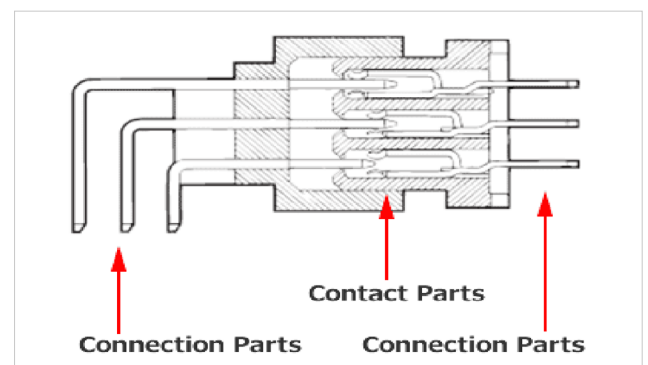
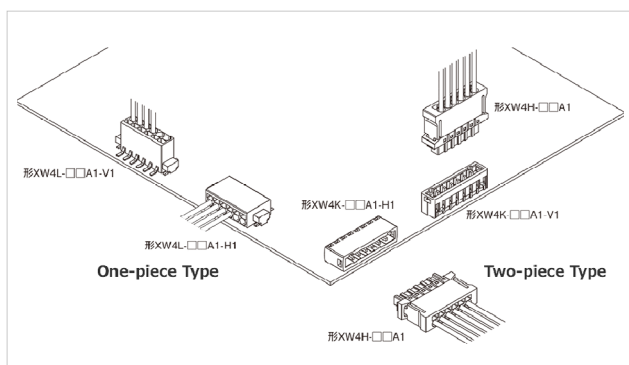
Definition of Electrical Connectors

Connectors are parts or devices used for electrically connecting or disconnecting circuits etc. They can connect and disconnect by hands or with simple tools without requiring special tools or processes such as soldering.



Although there are various types of connectors, the large majority are one-piece types that are used alone or two-piece types consisting of a plug and socket. One-piece types directly connect printed circuit boards and wires to connectors.

Two-piece types are divided into plug and socket, the part where the plug and the socket are fitted is called the contact part, and the part where the printed circuit board or the electric wire is attached is called the connection part.

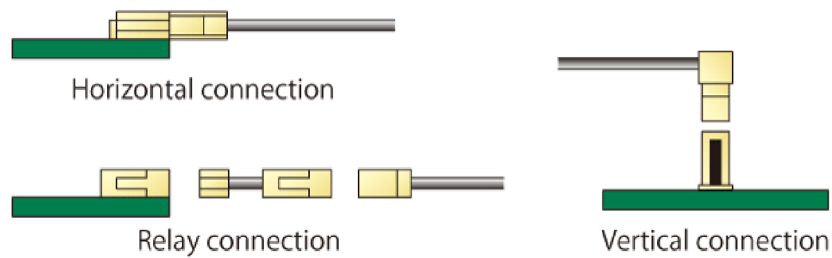


Types & Classifications

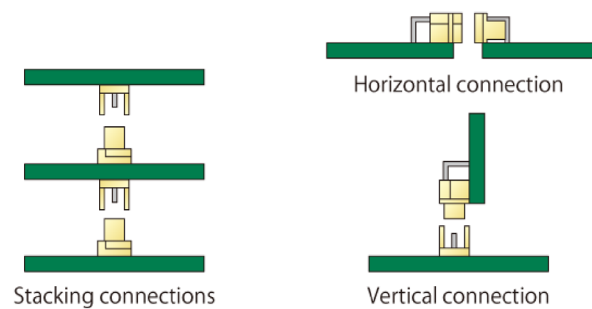
Connector Basics

There are roughly four types of connection for connectors.

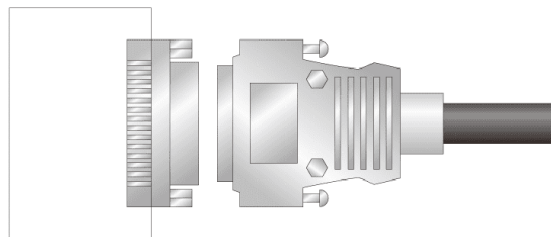
1. Board to Wire



2. Board to Board



3. Input / Output



4. Others - Jumper Plugs, IC Socket, etc.



Structure and Principle

Basic Connector Structure

There are various kinds of connectors. Connectors have various structures and parts to be used, however, basically they consist of contacts and a housing.

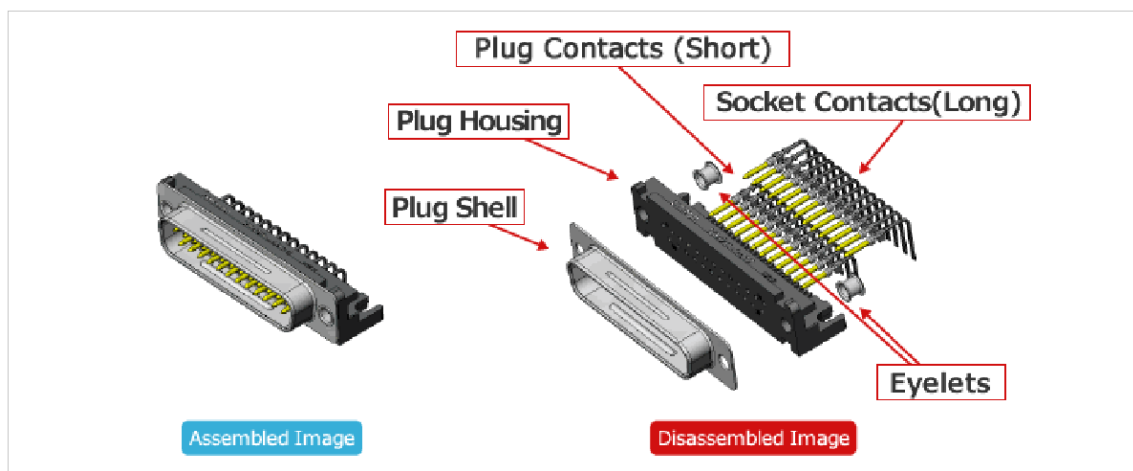
Contact: Contact for making electrical connection with each other when connectors are connected

Housing: Main body part into which the contact is installed (Usually made of insulator)

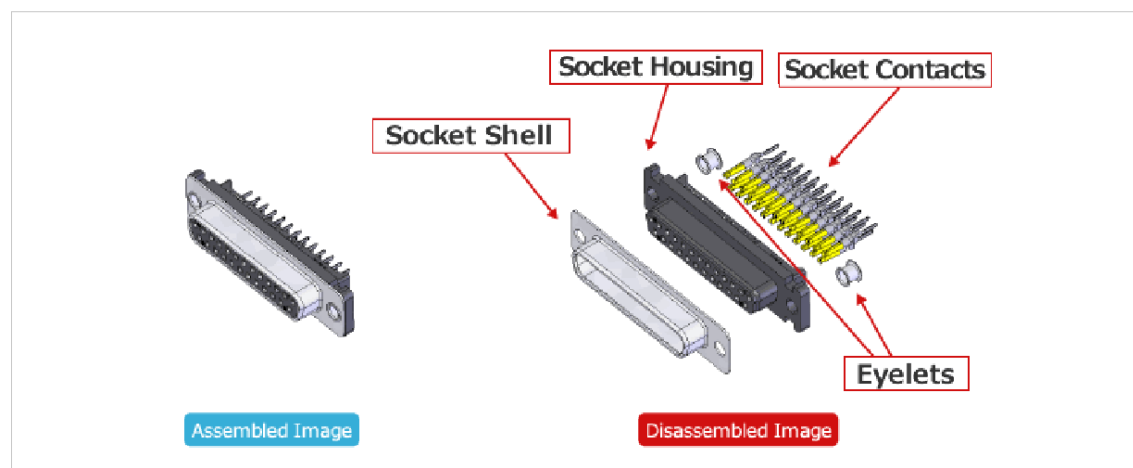
Other parts will be added depending on the type and use of the connectors. The following is an example of D sub connector.

Shell: Outer case which houses the insulator and the contact

Eyelet: Fastener that fixes the housing and the shell



Connector image (Plug side)



Connector image (Socket side)

Ratings / Characteristics

The rating and performance of connectors are generally classified into the following four categories.

1. Electrical performance

Rated voltage, Rated current, Contact resistance, Insulation resistance, Dielectric strength etc.

2. Mechanical performance

Insertion and Removal force, Insertion and extraction durability, Vibration resistance, Impact resistance etc.

3. Environmental performance

Heat resistance, Cold resistance, Moisture resistance, Gas resistance, etc.

4. Mounting performance

Solderability, Solder heat resistance, etc.

Electrical Characteristics

1. Rated current

Maximum current that can be continuously flowed without deterioration of electrical and mechanical characteristics.

2. Rated voltage

Voltage that can be applied continuously without deterioration of electrical and mechanical characteristics.

3. Contact resistance

The electrical resistance of the contact bonded under specified conditions.

Normally, resistance (total resistance) generated by adding conductor resistance to contact resistance is often referred to as contact resistance, and stability is more important than resistance value.

4. Insulation resistance

Resistance between insulated contacts.

5. Dielectric strength

Limit value where dielectric breakdown does not occur when voltage is applied between insulated metal parts for 1 minute.

Mechanical Characteristics

1. Insertion force, Removal force (Drawing force)

The force required to fully insert or extract a pair of connectors without coupling or operating similar devices.

2. Insertion and Removal durability

The number of times of insertion and removal guaranteed. It is also called insertion and removal frequency. Normally, it is determined according to contact pressure and plating.

Omron considers that environmental resistance performance is important in terms of contact reliability of connectors, and the specifications of insertion and removal tolerance are determined by how many times insertion and removal are conducted until nickel base plating of poorer environmental resistance is exposed.

**Reference: Basic thickness of gold plating and number of times of insertion and removal
(In some models this may not apply)**

0.15 μ m : 50 times

0.4 μ m : 200 times

0.76 μ m : 400 times

Nickel base plating starts to be exposed due to friction of a gold plating on the surface of the contact by insertion and removal. However, it is possible to insert and remove quite a lot more than the guaranteed number before a base material (primarily copper alloy) is exposed since nickel is harder than gold and excellent in abrasion resistance, and the plating thickness is also considerably thicker than gold. Therefore, if it is just inserted and withdrawn, the contact resistance is low and stable even when the nickel base plating is exposed, and in terms of the contact resistance value, it can be said that there is no problem when considering only contact resistance value.

However, when using the contact of this condition under an adverse environment, contact resistance increases and becomes unstable due to corrosion of nickel. In consideration of this, Omron determines the number of times of insertion and removal based on friction condition of gold plating, and we recommend exchanging for those exceeding that number.

Other Characteristics

Vibration resistance, shock resistance, various environmental performance, mounting performance are guaranteed by conducting various environmental tests in terms of the environmental condition and the influence of aged deterioration.

These items are generally set as a single item. The tests are not conducted under complex conditions or standards.

Connectors have specific performance requirements depending on the function and structure. There are various performance characteristics such as lock strength, electric wire tensile strength, etc.

Precautions for Proper Connector Use

1. Ambient operating temperature range

The ambient operating temperature range includes the self temperature rise due to energization of the connector. This is described below.

$$\text{Ambient operating temperature} + \text{Self-temperature rise of connector} \leq \text{Upper temperature range}$$

2. Ambient storage temperature range

The ambient storage temperature range is the condition when storing the packed connector. The ambient operating temperature range is applied when storing, without energizing, the connector which has been mounted on a printed circuit board.

3. The specifications of the wire and printed circuit board to be used for the connector

Please use wires and printed circuit boards whose wire specifications (size, material etc.) and printed circuit board specifications (substrate thickness, board through hole specifications, etc.) conform to the connector to be used. In addition, please use appropriate tools and equipment for connecting.

4. Connector insertion / removal

- Insert and remove connectors straight
- Insert deeply
- If there is a lock, please make sure that the lock is secure
- When removing please make sure that it has been unlocked

There are some other points to be aware. Please refer to the catalog and specifications before use.

Failure of Connector

There are three major failures of the connector.

1. Initial failure

Connectors have been broken before being used as applications.

- Contact failure due to excessive fluxing or adhesion of cleaning liquid on contact
- Contact failure due to solidified substrate coating liquid adhered to the contact

2. Accidental failure

Sudden failure mainly due to mechanical stress

- Dropping / hitting products
- Corrupt connector due to pulling cable
- Corrupt connector due to reverse insertion

3. Friction failure

Failures that occur while using as application

- The plating on the contact part is peeled off due to insertion and removal exceeding the limit and become eroded, and this causes conduction failure.
- By using the connector in a high temperature environment exceeding the limit to guarantee the performance, the contact portion of the contact wears out, and then conduction failure occurs due to insufficient contact pressure caused by lowering of a insertion and removal force.
- Lock breaks down due to friction caused by locking more than the number of times of limit to guarantee the performance.

Please observe the precautions to avoid these failures.

Life of Connector

Contact failures and breakages are judged as the life of the connector, but regarding such a lifetime, connectors do not have life by operation time.

The connectors' life is judged by mechanical deterioration, environmental deterioration, and electric deterioration, etc. .

However, in either case, the judgment will change depending on which condition is judged as life.

It depends on the environment in which the connector is used, the deteriorated state, the required level for the connector of the application being used, and so on.

Life of the connector itself is judged by contact resistance and the number of insertion and removal since the connector is a mechanical part (connection part) and is not a part that operates something (an active part) or a part that operates with something (a passive part).

Connector Standards

The connector standard is broadly divided into two categories.

- Specified standards for the connector itself
- Communication standard adopting standard connector and other standards

According to the standard that specifies the connector itself, there are specifications of connector specifications, and specifications up to connector specifications by communication standards.

Specification example defining connectors

DIN 41612 standard

DIN standards are defined by the German Institute for Standardization. There are a number of standards which specify connectors, with the DIN 41612 standard (board-to-board connector commonly referred to as a DIN connector) as the most widely known. Other standards also define round connectors.

MIL-C-83503 standard

MIL standards are defined by the U.S. Department of Defense. These standards also define standards for various connectors, but the most widely known is the MIL-C-83503 standard (a flat cable connector generally called a MIL connector).

IEC 61076-4-101 standard

IEC standards are international standards.

IEC 61076-4-101 is the standard specification for 2 mm pitch HM connectors.

USB standard

Although this is a communication standard called Universal Serial Bus, the connector itself is specified within the standard.

Other examples of communication standards that use standard connectors

VME Bus standard

The VME Bus (Versa Module Eurocard) standard is a communication standard for rack systems which uses the DIN 41612 connector.

Compact PCI standard

RS-The Compact PCI standard is a 3U or 6U Eurocard based industrial computer standard.

It uses IEC 61076-4-101 standard HM connectors.

It has its own signal arrangement according to the Compact PCI standard, which does not match the terminal numbers of IEC 61076-4-101.

RS-232C standard

RS-232C (Recommended Standard 232 version C) is a standard from EIA, and the official name is TIA/EIA-232-E.

This standard is widely used to connect peripheral equipment such as modems and printers to COM ports, and 25 pole and 9 pole D sub connectors are often used for the terminals.

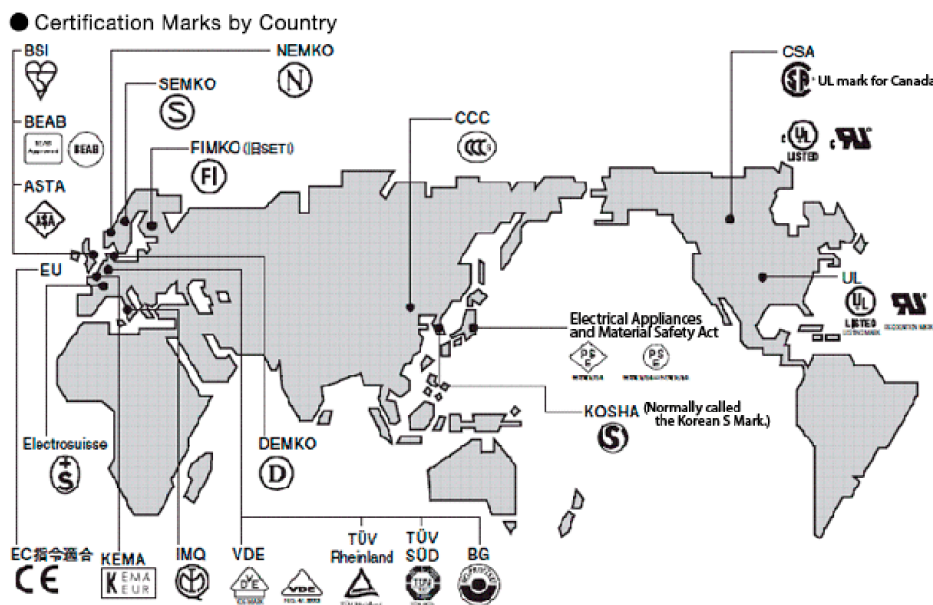
Safety Standards

Safety standards represent the minimum standards that are required from devices and components to prevent accidents and protect consumers who use electric devices from the hazards presented by electric shock and fire.

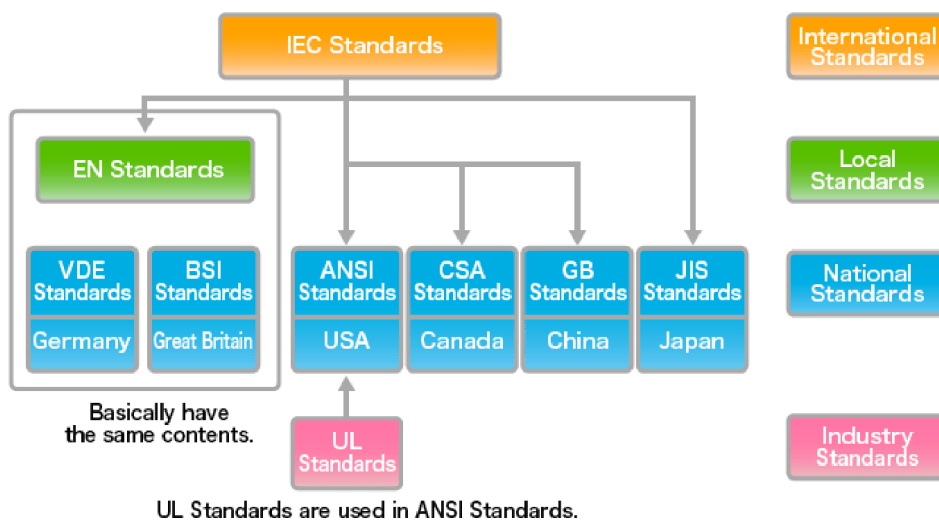
Each country has different voltage conditions, weather conditions and safety concepts, and they all adopt their own safety standards.

If the connectors are certified for the safety standards, the connectors are exempt from testing when applying standard certification to devices that use those connectors.

Safety Standards and Certification Bodies by Country



Safety Standards by Country



Basic Safety Standard Requirements by Region

North America:

The combustibility and ignitability of the insulation materials used in devices and components and temperature increases are regulated to emphasize the prevention of fires caused by electric devices. The main standards are UL in the USA and CSA in Canada.

Europe:

The Insulation distances and proof tracking of devices and components are regulated to emphasize the prevention of electric shock accidents caused by electric devices. The main standards are EN/IEC (Europe/International).

*Proof Tracking

The proof tracking index is degree of loss of insulation when a carbonized conductive path forms on the surface of an insulation between electric poles with a difference in electric potential.

	Voltage	Accidents	Most Important Requirement
North America	120 / 240 Vac	Fire	Combustibility
Europe	230 / 400 Vac	Electric Shock	Insulation Distance

Main Safety Standards

Name	National Standards	Country	Description	Certification Body	Certification Mark
IEC	-	International	Technical electric standards based on the most recent scientific technology. Forms the basis for standards in other countries.	-	-
UL	ANSI Standards	United States	To prevent fires, standards are enforced for the sale of electric products in the USA by state and city. Components must also be certified.	UL	 
CSA	CSA Standards	Canada	North American safety standards are applied and operated to prevent fire accidents, in the same way as in the USA.	CSA	
EU	EN Standards	Europe	Standards are designed to prevent electric shock and fires, but are not legally enforced. Enforcement is achieved through strict penalties.	VDE, TÜV-Rh	 
CCC	Chinese National Standards: GB Standards	China	Items for which certification is enforced are specified, and the import and sale of uncertified items in China is prohibited.	CCC	 

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