

IEC 60320

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IEC 60320 is a set of standards from the International Electrotechnical Commission specifying non-locking appliance couplers and interconnection couplers for the connection of power supply cords to electrical appliances up to 250 V.

^[1] **Appliance couplers** enable the use of standard inlets and country-specific cord sets which allows manufacturers to produce the same appliance for many markets, where only the cord set has to be changed for a particular market.

Interconnection couplers provide a means of providing a power supply from one equipment or appliance to be made available to other equipment or appliances. Couplers described under these standards have standardized current and temperature ratings.

Different types of connector (distinguished by shape and size) are specified for different combinations of current, temperature and earthing requirements. Unlike IEC 60309 connectors, they are not coded for voltage; users must ensure that the voltage rating of the equipment is compatible with the main supply.

Each type of coupler is identified by a standard sheet number. For appliance couplers this consists of the letter C followed by a number, where the standard sheet for the appliance inlet is 1 higher than the sheet for the corresponding cable connector. As well as the codes given in the specification many types have common names. The most common names are *IEC connector* for the common C13/C14, the *figure eight connector* for C7/C8, and the *cloverleaf connector* or *Mickey Mouse connector* for the C5/C6. A *kettle plug* is an inexact colloquial term which may refer to either the high-temperature C15/C16 or the regular temperature C13/C14 connectors.

The first edition of IEC 320 (later renumbered IEC 60320) was published in 1970.^[2]

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Application

Detachable appliance couplers are used in office equipment, in measuring instruments, in IT environments and in medical devices, among many other types of equipment for worldwide distribution. Each appliance's power system must be adapted to the different plugs used in different regions. An appliance with a permanently attached plug intended for use in one country cannot be readily sold in another country using an incompatible wall socket. This requires keeping track of variations throughout the life cycle of the product from assembly and testing through to shipping and repairs.

Since a country-specific power supply cord can be included in the product packaging, model variations are minimized and factory testing is simplified. A cord which is fitted with non-rewireable (usually moulded) connectors at both ends is termed a *cord set*. Appliance manufacturing may be simplified by mounting an appliance coupler directly on the printed circuit board. Assembly and handling of an appliance is made easier if the power cord can be easily removed.

Appliances can be easily used in another country, with a simple change of the power supply cord including a connector and a country-specific power plug. When the power supply cord is damaged, it can be replaced easily, because it is a standardized part that can simply be unplugged and re-inserted. Safety hazards, maintenance expenditure and repairs are thus minimized.

Standards

Parts of the standard

IEC 60320-1 specifies two-pole appliance couplers for the connection of power supply cords to electrical appliances.

^[1] The female part, the *connector*, supplies power to the male part, the *appliance inlet*. The male part is designated by the even number one greater than the odd number assigned to the female part, so a C1 connector mates with a C2 inlet, and a C15A mates with a C16A.

IEC 60320-2-2 specifies *interconnection couplers*, a means of enabling the connection and disconnection at will of an appliance or equipment to a cord leading to another appliance or equipment. It consist of two parts: a *plug connector*, which is the part integral with, or intended to be attached to, the cord, and an *appliance outlet*, which is the part integrated or incorporated in the appliance or equipment or intended to be fixed to it, and from which the supply is obtained.^[3]

IEC 60320-2-1 specifies couplers, not interchangeable with other 60320 couplers, for use with household sewing machines, rated no higher than 2.5 amperes and 250 volts.^[4]

IEC 60320-2-3 specifies couplers with a degree of protection higher than IPX0.^[5]

IEC 60320-2-4 specifies couplers dependent on appliance weight for engagement.^[6]

Contents of standards

The standards define the mechanical, electrical and thermal requirements and safety goals of power couplers. The standard scope is limited to appliance couplers with a rated voltage not exceeding 250 VAC at 50 Hz or 60 Hz, and a rated current not exceeding 16A. Further sub-parts of IEC 60320 focus on special topics such as protection ratings and appliance specific requirements.

The shape and dimensions of appliance inlets and connectors are coordinated, so that a connector with lower current rating, temperature rating, or polarization cannot be inserted into an appliance inlet that requires higher ratings. It is impossible, for instance, to connect a Protection Class II connector, which has no earthing, to a Protection Class I appliance inlet which requires an earth. The opposite (i.e., connecting a Protection Class I connector to a Protection Class II appliance inlet) is possible because it creates no safety hazard for the appliance user. The same applies to the nominal current and the pin temperature. This coding plays a significant role in the safe operation of appliances and the protection against improper use.

Pin temperature is measured where the pin projects from the engagement surface. The maximum permitted pin temperatures, are 70 °C, 120 °C, and 155 °C, respectively (the higher temperatures are not applicable to interconnection couplers). The pin temperature is determined by the design of the appliance, and its interior temperature, rather than by its ambient temperature. Typical applications with increased pin temperatures include appliances with heating coils such as ovens or electric grills. It is generally possible to use a connector with a higher rated temperature with a lower rated appliance inlet, but the keying feature of the inlet prevents use of a connector with a lower temperature rating.

Selection of a coupler depends in part on the IEC appliance classes. Class I appliances must have their chassis connected to electrical earth and require a coupler with earthing. Class II double insulated electrical appliances do not require a safety connection to electrical earth and can use a coupler with only two circuit conductors.

Connectors are also classified according to the method of connecting the cord, either as rewirable connectors or non-rewirable connectors.

In addition to the limiting values described, the standards define further general criteria such as withdrawal forces, testing procedures, the minimum number of insertion cycles, and the number of flexings of cords. IEC 60320-1 codes the various coupler outlines using a combination of letters and numbers, *e.g.*, "C14", while IEC 60320-2-2 uses a single letter, *e.g.*, "F".

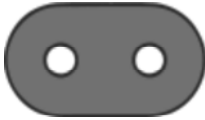
IEC 60320-1 defines a ***cord set*** as an *assembly consisting of one cable or cord fitted with one plug and one connector, intended for the connection of an electrical appliance or equipment to the electrical supply*. It also defines an ***interconnection cord set*** as an *assembly consisting of one cable or cord fitted with one plug connector and one connector, intended for the interconnection between two electrical appliances*.

In addition to the connections within the standards, as mentioned, there are possible combinations between IEC 60320-1 and IEC 60320-2-2. Fitted with a flexible cord, the components become interconnection cords to be used for connecting appliances or for extending other interconnection cords or power supply cords.

Appliance Coupler standard sheets

The dimensions and tolerances for connectors and appliance inlets are given in standard sheets, which are dimensioned drawings showing the features required for safety and interchangeability.

IEC 60320-1 Appliance Couplers

Connector (Female)	Appliance Inlet (Male)	Drawing	Pin spacing, centres (mm)	Earth contact	Appliance class	Rewirable connector allowed?	Max. current (A)	Max. pin temp. (°C)	Remarks and example uses
C1	C2		6.6	No	II	No	0.2	70	Not polarized. Electric shaver.
C3	C4		10	No	II		2.5	70	Polarized, similar connector to C5/C6 but with a key ridge instead of an earthing conductor, withdrawn from standard. ^[7]
C5	C6		10 (H) 4.5 (V)	Yes	I	No	2.5	70	Apple iMac, many small switched-mode power supplies used for laptops. Commonly referred to as a Clover-leaf connector due to its shape.
C7	C8		8.6	No	II	No	2.5	70	Not polarized. Domestic Audio, video, radio equipment and double insulated power supplies. C8 inlet is 10 mm deep, C8A and C8B inlets are 15.5 mm deep. Commonly referred to as a "figure of 8". There used to be a polarised version with squared (line) side C7P, C8P (see outline below), but this is not in the current standard. 
C9	C10		10	No	II	No	6	70	

									Not polarized. This kind of coupler is used by Roland Corporation for a couple of synthesizer and drum computer models (for example: TR-909) and by Revox for many older models of their HiFi equipment (for example, A76, A77, A78, B77, B225).
C11	C12		10	No	II		10	70	Polarized, similar to C9 with a slot in the connector, withdrawn from standard. ^[7]
C13	C14		14 (H) 4 (V)	Yes	I	Yes	10	70	Very common on personal computers and peripherals.
C15	C16		14 (H) 4 (V)	Yes	I	Yes	10	120	For appliances that get hot (for example, electric Kettle). Also used in some networking equipment, such as HP ProCurve 3500/5400/8200 series switches. Commonly referred to as a kettle lead, due to usually being found on old kettles, many modern kettles however are cordless and no longer feature this connector.
C15A	C16A		14 (H) 4 (V)	Yes	I	Yes	10	155	For appliances that get very hot; like C15/C16, but the top is narrowed as well to exclude

									the lower-rated connectors.
C17	C18		14	No	II	No	10	70	Xbox 360, some vacuum cleaners, a few models of CPAP machines, some higher end audio equipment.
C19	C20		13 (H) 8 (V)	Yes	I	Yes	16	70	Common on Enterprise-class servers and datacenter rack-mounted power distribution units, Late 2005 PowerMac G5, Cisco 6500 Series Power Supplies, Cisco UCS 5108 Chassis, Nexus 7000 Series Core Router Power Supplies.
C21	C22		13 (H) 8 (V)	Yes	I	Yes	16	155	High-temperature variant of C19/C20
C23	C24		13	No	II	No	16	70	Ungrounded variant of C19/C20

C1/C2 coupler



The C1 coupler and C2 inlet were commonly used for mains powered electric shavers. These have largely been supplanted by cordless shavers with rechargeable batteries or corded shavers which use an AC adapter.

C5/C6 coupler



This coupler is sometimes colloquially called a *cloverleaf* coupler or "Mickey Mouse" (because the cross section looks like the silhouette of the Disney character).

The C6 inlet is used on laptop power supplies and portable projectors, and on the Apple desktop computer iMac G4.

C7/C8 coupler



Commonly known as a *figure-8* or *shotgun* connector due to the shape of its cross-section. It is also known as a *euro-connector* in electronic shops. A polarized C7 (C7-PW) used to exist, but is not part of the standard, it was asymmetrical, with one side rounded (neutral) and the other side squared off (line).

This coupler is often used for small cassette recorders, battery/mains operated radios, some full size audio-visual equipment, laptop computer power supplies, video game consoles, and similar double-insulated appliances. Unpolarised C7 connectors can be inserted into polarized C8 inlets; however, doing so might be a safety risk if the device is designed to expect polarized power.

A C8B inlet type is defined by the standard, for use by dual-voltage appliances; it has three pins, and can hold a C7 connector in either of two positions, allowing the user to select voltage by choosing the position the connector is inserted.^[8]

C13/C14 coupler



Most desktop computers use the C14 inlet to attach the power cord to the power supply, as do many instrument amplifiers, monitors, printers and other peripherals. Many AT form factor computers also provided a panel-mounting C13 outlet controlled by the physical power switch for powering the monitor. With the arrival of ATX the readily accessible permanent power switch was removed and the outlet was either permanently powered or completely removed.

A power cord with a suitable power plug for the locality in which the appliance is used on one end and a C13 connector on the other is commonly called an *IEC cord*. IEC cords are used to power many pieces of electronic equipment, including computers, instrument amplifiers and professional audio equipment.

Cables with a C14 coupler at one end and a C13 coupler at the other are commonly available. They have a variety of common uses including connecting power between older PCs and their monitors, extending existing power cords, connecting to C13 coupler strips (commonly used with rack-mount gear to save space and for international standardization) and connecting computer equipment to the output of a uninterruptible power supply (UPS) (larger UPSs often have C19 outlets as well.)

There are also a variety of splitter blocks, splitter cables, and similar devices available. These, along with the cables mentioned above, are nearly always un-fused (with the exception of BS 1363 to IEC cables which are always fused but sometimes at more than the rating of the IEC connector), and in 230 V countries the cables are often made with only 0.75 mm² cable which is rated only to 6 A. Therefore, care must be taken to avoid overloading the cables and connectors when using such products.

In some countries these cables are sometimes referred to as a "kettle cord", but the C13/14 connectors are only rated for 70 degrees, not 120 degrees rated for the C15/16 connector that are actually used for devices such as a kettle.

C15/C16 coupler



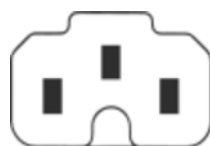
Some electric kettles and similar hot household appliances like home stills use a supply cord with a C15 connector, and a matching C16 inlet on the appliance; their temperature rating is 120 °C rather than the 70 °C of the similar C13/C14 combination. The official designation in Europe for the C15/C16 coupler is a 'hot condition' coupler.

These are similar in form to the C13/C14 coupler, except with a ridge opposite the earth in the C16 inlet (preventing a C13 fitting), and a corresponding valley in the C15 connector (which doesn't prevent it fitting a C14 inlet). For example, an electric kettle cord can be used to power a computer, but an unmodified computer cord cannot be used to power a kettle.

Many people are not aware of the subtle differences between the C13/C14 and C15/C16 couplers, and so all are loosely referred to as *kettle plug* and *kettle lead* (in the UK) and *jug plug* (in Australia)^[*citation needed*] when referring to these mains cords.

In Sweden, the Netherlands, Germany and some other countries the C15/C16 coupler has replaced and made obsolete the formerly common type of appliance coupler in most applications. In the United Kingdom it has also replaced a once-common large, round connector which had two round pins for power and a larger round pin for earth. These were common on kettles, particularly those from Russell Hobbs and were also used on home-brewing machines and large film projectors.

C15A/C16A coupler



There is also a C15A/C16A coupler, with an even higher (155 °C) temperature rating.

C17/C18 coupler



Similar to C13/C14 coupler, but unearthed. A C18 inlet will accept a C13 connector but a C14 inlet will not accept a C17 connector.

The IBM Wheelwriter series of electronic typewriters are one common application. Three wire cords with C13 connectors, which are easier to find, are sometimes used in place of the two wire cords for replacement. In this case, the ground wire will not be connected.

The C17/C18 coupler is often used in audio applications where a floating ground is maintained to eliminate hum caused by ground loops. Other common applications are the power supplies of Xbox 360 game consoles, replacing the C15/C16 coupler employed initially, and large CRT televisions manufactured by RCA in the early 1990s.

C19/C20 coupler



Earthed, 16 A, polarized. This coupler is used for some IT applications where higher currents are required, as for instance, on high-power workstations and servers, uninterruptible power supplies, power distribution units, large network routers, switches, blade enclosures, and similar equipment. It is rectangular and has pins parallel to the long axis of the coupler face.

Withdrawn and other standard sheets

Some connector types are no longer in the current standard. The C3 and C4 standard sheets, and the C11 and C12 standard sheets, are no longer listed.

Standard sheet C25 shows retaining device dimensions. Sheet C26 shows detail dimensions for pillar-type terminals, where the end of the screw bears on a wire directly or through a pressure plate. Sheet 27 shows details for screw terminals, where the wire is held by wrapping it around the head of a screw.

Interconnection Coupler standard sheets

The dimensions and tolerances for plug connectors and appliance outlets are given in standard sheets, which are dimensioned drawings showing the features required for safety and interchangeability.

IEC 60320-2-2 Interconnection Couplers

Plug Connector (Male)	Appliance Outlet (Female)	Drawing	Pin spacing, centres (mm)	Earth contact	Appliance class	Rewirable connector allowed?	Max. current (A)	Remarks and example uses
A	B		10 (H) 4.5 (V)	Yes	I	No	2.5	Commonly referred to as a Clover-leaf connector due to its shape.
C	D		8.6	No	II	No	2.5	Not polarized. Commonly referred to as a "figure of 8".
E	F		14 (H) 4 (V)	Yes	I	Yes	10	Very common for power distribution on computer and instrument equipment racks, used to be common as a means of connecting power from a PC to a monitor.
G	H		14	No	II	No	10	Ungrounded variant of E/F
I	J		13 (H) 8 (V)	Yes	I	Yes	16	Common on Enterprise-class servers and datacenter rack-mounted power distribution units.
K	L		13	No	II	Yes	16	Ungrounded variant of I/J

See also

- AC power plugs and sockets
- Power entry module
- IEC 60309 specifies larger couplers used for higher currents, higher voltages, and polyphase systems.
- IEC 60906-1 A proposed standard for domestic wall sockets.
- NEMA connector North American standard for building receptacles and compatible cord connectors

References

- [^] ^a ^b IEC 60320-1 consolidated edition 2.1 with amendment 1 *Appliance couplers for household and similar general purposes — Part 1: General requirements* (<http://webstore.iec.ch/webstore/webstore.nsf/artnum/038670>)
- [^] Sophie J. Chumas (ed), *Index of international standards, Volume 390 of NBS special publication*, U.S. Department of Commerce, National Bureau of Standards 1974, page 2014
- [^] IEC 60320-2-2 edition 2.0 *Interconnection couplers for household and similar equipment* (<http://webstore.iec.ch/webstore/webstore.nsf/artnum/023204>)

4. ^ IEC 60320-2-1 edition 2.0 *Appliance couplers for household and similar general purposes — Part 2-1: Sewing machine couplers* (<http://webstore.iec.ch/webstore/webstore.nsf/artnum/026278>)
5. ^ IEC 60320-2-3 consolidated edition 1.1 with amendment 1 *Appliance couplers for household and similar general purposes — Part 2-3: Appliance couplers with a degree of protection higher than IPX0* (<http://webstore.iec.ch/webstore/webstore.nsf/artnum/033613>)
6. ^ IEC 60320-2-4 edition 1.0 *Appliance couplers for household and similar general purposes - Part 2-4: Couplers dependent on appliance weight for engagement* (<http://webstore.iec.ch/webstore/webstore.nsf/artnum/035019>)
7. ^ ^{a b} IEC 320 data sheet (<http://www.accesscomms.com.au/reference/iec320.htm>)
8. ^ *Australian/New Zealand Standard AS/NZS 60320.1:2004, Appliance couplers for household and similar general purposes Part 1: General Requirements (IEC 60320-1, Ed. 2.0 (2001) MOD)*. This is the Australian version of the IEC standard with national variations shown.
 - IEC 60799 edition 2.0 *Electrical accessories — Cord sets and interconnection cord sets* (<http://webstore.iec.ch/webstore/webstore.nsf/artnum/023182>)
 - International Standardized Appliance Connectors (IEC-60320) Reference Chart (<http://www.stayonline.com/reference-iec320.aspx>) Includes diagrams of all couplers, their rated current, equipment class, and temperature rating.

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