

## **World Electricity Standards**

There is no standard mains voltage throughout the world and also the frequency, i.e. the number of times the current changes direction per second, is not everywhere the same.

Moreover, plug shapes, plug holes, plug sizes and sockets are also different in many countries. Those seemingly unimportant differences, however, have some unpleasant consequences.

Most appliances bought overseas simply cannot be connected to the wall outlets at home. There are only two ways to solve this problem: you just cut off the original plug and replace it with the one that is standard in your country, or you buy an unhandy and ugly adapter.

While it is easy to buy a plug adapter or a new "local" plug for your "foreign" appliances, in many cases this only solves half the problem, because it doesn't help with the possible voltage disparity. A 110-volt electrical appliance designed for use in North America or Japan will provide a nice fireworks display - complete with sparks and smoke - if plugged into a European socket.

It goes without saying that the lack of a single voltage, frequency and globally standardized plugs entail many extra costs for manufacturers and increase the burden on the environment.

Pure waste and unnecessary pollution!

### **Voltage and frequency**

Europe and most other countries in the world use a voltage which is twice that of the US. It is between 220 and 240 volts, whereas in Japan and in most of the Americas the voltage is between 100 and 127 volts.

The system of three-phase alternating current electrical generation and distribution was invented by a nineteenth century creative genius named Nicola Tesla. He made many careful calculations and measurements and found out that 60 Hz (Hertz, cycles per second) was the best frequency for alternating current (AC) power generating. He preferred 240 volts, which put him at odds with Thomas Edison, whose direct current (DC) systems were 110 volts. Perhaps Edison had a useful point in the safety factor of the lower voltage, but DC couldn't provide the power to a distance that AC could.

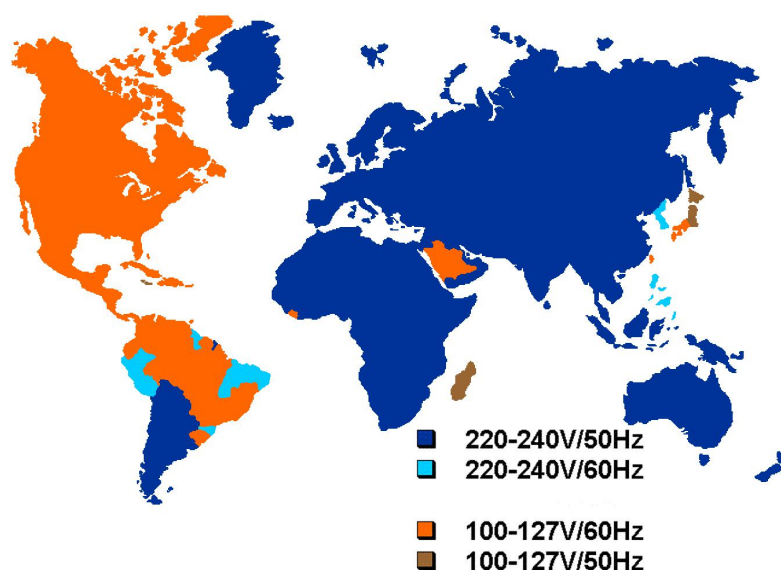
When the German company AEG built the first European generating facility, its engineers decided to fix the frequency at 50 Hz, because the number 60 didn't fit the metric standard unit sequence (1,2,5). At that time, AEG had a virtual monopoly and their standard spread to the rest of the continent. In Britain, differing frequencies proliferated, and only after World War II the 50-cycle standard was established. A big mistake, however.

Not only is 50 Hz 20% less effective in generation, it is 10-15% less efficient in transmission, it requires up to 30% larger windings and magnetic core materials in transformer construction. Electric motors are much less efficient at the lower frequency, and must also be made more robust to handle the electrical losses and the extra heat generated. Today, only a handful of countries (Antigua, Guyana, Peru, the Philippines, South Korea and the Leeward Islands) follow Tesla's advice and use the 60 Hz frequency together with a voltage of 220-240 V.

Originally Europe was 110 V too, just like Japan and the US today. It has been deemed necessary to increase voltage to get more power with less losses and voltage drop from the same copper wire diameter. At the time the US also wanted to change but because of the cost involved to replace all electric appliances, they decided not to. At the time (50s-60s) the average US household already had a fridge, a washing-machine, etc., but not in Europe.

The end result is that now, the US seems not to have evolved from the 50s and 60s, and still copes with problems as light bulbs that burn out rather quickly when they are close to the transformer (too high a voltage), or just the other way round: not enough voltage at the end of the line (105 to 127 volt spread !).

Note that currently all new American buildings get in fact 230 volts split in two 115 between neutral and hot wire. Major appliances, such as ovens, are now connected to 230 volts. Americans who have European equipment, can connect it to these outlets.



There are 214 countries listed below.

175 of the countries mentioned use 220-240 volts (50 or 60 Hz).

The 39 other countries use 100-127 volts.

<b>COUNTRY</b>	<b>VOLTAGE</b>	<b>FREQUENCY</b>
Afghanistan	220 V	50 Hz
Albania	230 V	50 Hz
Algeria	230 V	50 Hz
American Samoa	120 V	60 Hz
Andorra	230 V	50 Hz
Angola	220 V	50 Hz
Anguilla	110 V	60Hz
Antigua	230 V	60 Hz
Argentina	220 V	50 Hz
Armenia	230 V	50 Hz
Aruba	127 V	60 Hz
Australia	230 V	50 Hz
Austria	230 V	50 Hz
Azerbaijan	220 V	50 Hz
Azores	230 V	50 Hz
Bahamas	120 V	60 Hz
Bahrain	230 V	50 Hz
Balearic Islands	230 V	50 Hz
Bangladesh	220 V	50 Hz
Barbados	115 V	50 Hz
Belarus	230 V	50 Hz
Belgium	230 V	50 Hz
Belize	110/220 V	60 Hz
Benin	220 V	50 Hz
Bermuda	120 V	60 Hz
Bhutan	230 V	50 Hz
Bolivia	230 V	50 Hz
Bosnia	230 V	50 Hz

Botswana	230 V	50 Hz
Brazil	110/220 V*	60 Hz
Brunei	240 V	50 Hz
Bulgaria	230 V	50 Hz
Burkina Faso	220 V	50 Hz
Burundi	220 V	50 Hz
Cambodia	230 V	50 Hz
Cameroon	220 V	50 Hz
Canada	120 V	60 Hz
Canary Islands	230 V	50 Hz
Cape Verde	230 V	50 Hz
Cayman Islands	120 V	60 Hz
Central African Republic	220 V	50 Hz
Chad	220 V	50Hz
Channel Islands (Guernsey & Jersey)	230 V	50 Hz
Chile	220 V	50 Hz
China, People's Republic of	220 V	50 Hz
Colombia	110 V	60Hz
Comoros	220 V	50 Hz
Congo, People's Rep. of	230 V	50 Hz
Congo, Dem. Rep. of ( <i>formerly Zaire</i> )	220 V	50 Hz
Cook Islands	240 V	50 Hz
Costa Rica	120 V	60 Hz
Côte d'Ivoire (Ivory Coast)	220 V	50 Hz
Croatia	230 V	50Hz
Cuba	110/220 V	60Hz
Cyprus	230 V	50 Hz
Czech Republic	230 V	50 Hz
Denmark	230 V	50 Hz
Djibouti	220 V	50 Hz
Dominica	230 V	50 Hz
Dominican Republic	110 V	60 Hz
East Timor	220 V	50 Hz

Ecuador	110 V	60 Hz
Egypt	220 V	50 Hz
El Salvador	115 V	60 Hz
Equatorial Guinea	220 V	50 Hz
Eritrea	230 V	50 Hz
Estonia	230 V	50 Hz
Ethiopia	220 V	50 Hz
Faeroe Islands	230 V	50 Hz
Falkland Islands	240 V	50 Hz
Fiji	240 V	50 Hz
Finland	230 V	50 Hz
France	230 V	50 Hz
French Guyana	220 V	50 Hz
Gaza	230 V	50 Hz
Gabon	220 V	50 Hz
Gambia	230 V	50 Hz
Germany	230 V	50 Hz
Ghana	230 V	50 Hz
Gibraltar	230 V	50 Hz
Greece	230 V	50 Hz
Greenland	230 V	50 Hz
Grenada (Windward Islands)	230 V	50 Hz
Guadeloupe	230 V	50 Hz
Guam	110 V	60Hz
Guatemala	120 V	60 Hz
Guinea	220 V	50 Hz
Guinea-Bissau	220 V	50 Hz
Guyana	240 V	60 Hz
Haiti	110 V	60 Hz
Honduras	110 V	60 Hz
Hong Kong	220 V	50 Hz
Hungary	230 V	50 Hz
Iceland	230 V	50 Hz
India	240 V	50 Hz

Indonesia	230 V	50 Hz
Iran	230 V	50 Hz
Iraq	230 V	50 Hz
Ireland (Eire)	230 V	50 Hz
Isle of Man	230 V	50 Hz
Israel	230 V	50 Hz
Italy	230 V	50 Hz
Jamaica	110 V	50 Hz
Japan	100 V	50/60 Hz**
Jordan	230 V	50 Hz
Kenya	240 V	50 Hz
Kazakhstan	220 V	50 Hz
Kiribati	240 V	50 Hz
Korea, South	220 V	60 Hz
Kuwait	240 V	50 Hz
Kyrgyzstan	220 V	50 Hz
Laos	230 V	50 Hz
Latvia	230 V	50 Hz
Lebanon	230 V	50 Hz
Lesotho	220 V	50 Hz
Liberia	120 V	60 Hz
Libya	127/230 V	50 Hz
Lithuania	230 V	50 Hz
Liechtenstein	230 V	50 Hz
Luxembourg	230 V	50 Hz
Macau	220 V	50 Hz
Macedonia	230 V	50 Hz
Madagascar	127/220 V	50 Hz
Madeira	230 V	50 Hz
Malawi	230 V	50 Hz
Malaysia	240 V	50 Hz
Maldives	230 V	50 Hz
Mali	220 V	50 Hz
Malta	230 V	50 Hz

Martinique	220 V	50 Hz
Mauritania	220 V	50 Hz
Mauritius	230 V	50 Hz
Mexico	127 V	60 Hz
Micronesia, Federal States of	120 V	60 Hz
Moldova	230 V	50 Hz
Monaco	230 V	50 Hz
Mongolia	230 V	50 Hz
Montserrat (Leeward Islands)	230 V	60 Hz
Morocco	220 V	50 Hz
Mozambique	220 V	50 Hz
Myanmar ( <i>formerly Burma</i> )	230 V	50 Hz
Namibia	220 V	50 Hz
Nauru	240 V	50 Hz
Nepal	230 V	50 Hz
Netherlands	230 V	50 Hz
Netherlands Antilles	127/220 V	50 Hz
New Caledonia	220 V	50 Hz
New Zealand	230 V	50 Hz
Nicaragua	120 V	60 Hz
Niger	220 V	50 Hz
Nigeria	240 V	50 Hz
Norway	230 V	50 Hz
Okinawa	100 V	60 Hz
Oman	240 V	50 Hz
Pakistan	230 V	50 Hz
Palmyra Atoll	120 V	60Hz
Panama	110 V	60 Hz
Papua New Guinea	240 V	50 Hz
Paraguay	220 V	50 Hz
Peru	220 V	60 Hz
Philippines	220 V	60 Hz
Poland	230 V	50 Hz
Portugal	230 V	50 Hz

Puerto Rico	120 V	60 Hz
Qatar	240 V	50 Hz
Réunion Island	230 V	50 Hz
Romania	230 V	50 Hz
Russian Federation	230 V	50 Hz
Rwanda	230 V	50 Hz
St. Kitts and Nevis (Leeward Islands)	230 V	60 Hz
St. Lucia (Windward Islands)	240 V	50 Hz
St. Vincent (Windward Islands)	230 V	50 Hz
Saudi Arabia	127/220 V	60 Hz
Senegal	230 V	50 Hz
Serbia & Montenegro	230 V	50 Hz
Seychelles	240 V	50 Hz
Sierra Leone	230 V	50 Hz
Singapore	230 V	50 Hz
Slovakia	230 V	50 Hz
Slovenia	230 V	50 Hz
Somalia	220 V	50 Hz
South Africa	230 V	50 Hz
Spain	230 V	50 Hz
Sri Lanka	230 V	50 Hz
Sudan	230 V	50 Hz
Suriname	127 V	60 Hz
Swaziland	230 V	50 Hz
Sweden	230 V	50 Hz
Switzerland	230 V	50 Hz
Syria	220 V	50 Hz
Tahiti	110/220 V	60 Hz
Tajikistan	220 V	50 Hz
Taiwan	110 V	60 Hz
Tanzania	230 V	50 Hz
Thailand	220 V	50 Hz
Togo	220 V	50 Hz
Tonga	240 V	50 Hz



Trinidad & Tobago	115 V	60 Hz
Tunisia	230 V	50 Hz
Turkey	230 V	50 Hz
Turkmenistan	220 V	50 Hz
Uganda	240 V	50 Hz
Ukraine	230 V	50 Hz
United Arab Emirates	220 V	50 Hz
United Kingdom	230 V	50 Hz
United States of America	120 V	60 Hz
Uruguay	220 V	50 Hz
Uzbekistan	220 V	50 Hz
Venezuela	120 V	60 Hz
Vietnam	220 V	50 Hz
Virgin Islands	110 V	60 Hz
Western Samoa	230 V	50 Hz
Yemen, Rep. of	230 V	50 Hz
Zambia	230 V	50 Hz
Zimbabwe	220 V	50 Hz

\* In Brazil there is no standard voltage; most states use 110-127 V electricity (Rio Grande do Sul, Paraná, São Paulo, Minas Gerais, Bahia, Rio de Janeiro, Pará, Amazonas,...). In many hotels, however, 220 V can be found. 220-240 V is used mainly in the northeast: in the capital Brasilia (Distrito Federal) and, among others, in the states of Ceará, Pernambuco and Santa Catarina.

\*\* Although the mains voltage in Japan is the same everywhere, the frequency differs from region to region. Eastern Japan uses predominantly 50 Hz (Tokyo, Kawasaki, Sapporo, Yokohama, Sendai), whereas Western Japan prefers 60 Hz (Osaka, Kyoto, Nagoya, Hiroshima).

## **Plugs and sockets**

When electricity was first introduced into the domestic environment it was primarily for lighting. However, as it became a viable alternative to other means of heating and also the development of labour saving appliances, a means of connection to the supply other than via a light socket was required. In the 1920s, the two-prong plug made its appearance.

At that time, some electricity companies operated a split tariff system where the cost of electricity for lighting was lower than that for other purposes, which led to low wattage appliances (e.g. vacuum cleaners, hair dryers, etc.) being connected to the light fitting. The picture below shows a 1909 electric toaster with a lightbulb socket plug.



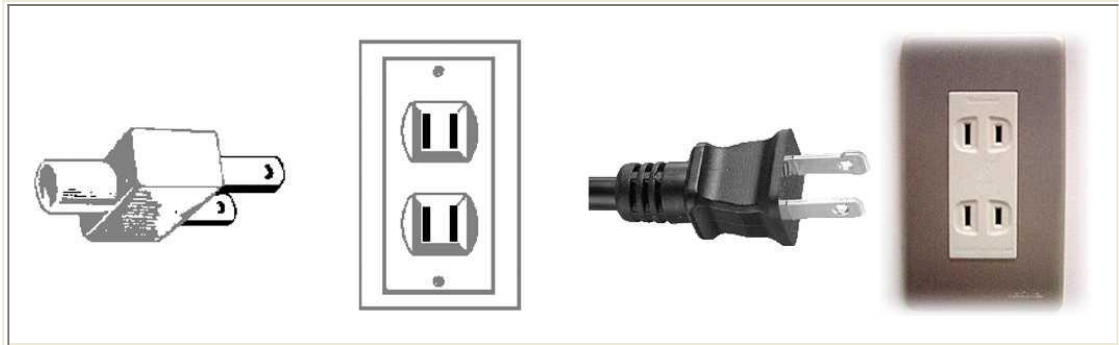
As the need for safer installations grew, three-pin outlets were developed. The third pin on the outlet was an earth pin, which was effectively connected to earth, this being at the same potential as the neutral supply line. The idea behind it was that in the event of a short circuit to earth, a fuse would blow, thus disconnecting the supply.

The reason why we are now stuck with no less than 13 different styles of plugs and wall outlets, is because many countries preferred to develop a plug of their own, instead of adopting the US standard. Moreover, the plugs and sockets are only very rarely compatible, which makes it often necessary to replace the plug when you buy appliances abroad.

Below is a brief outline of the plugs and sockets used around the world in domestic environment.

## **TYPE A**

(used in, among others, North and Central America and Japan)



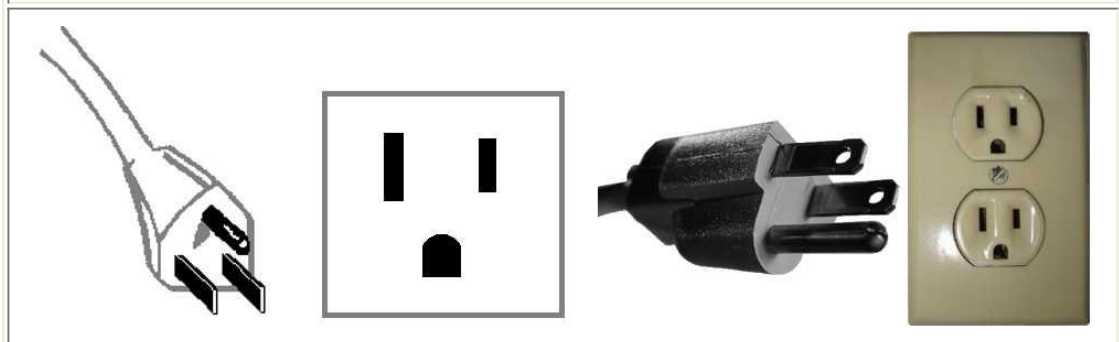
This class II ungrounded plug with two flat parallel prongs is pretty much standard in most of North and Central America. At first glance, the Japanese plug and socket seem to be identical to this standard. However, the Japanese plug has two identical flat prongs, whereas the US plug has one prong which is slightly larger. Therefore it is no problem to use Japanese plugs in the US, but the opposite does not work often. Furthermore, Japanese standard wire sizes and the resulting current ratings are different than those used on the American continent.

Type A and B plugs have two flat prongs with a hole near the tip. These holes aren't there without a reason. If you were to take apart a type A or B socket and look at the contact wipers that the prongs slide into, you would find that in some cases they have bumps on them. These bumps fit into the holes so that the outlet can grip the plug's prongs more firmly. This prevents the plug from slipping out of the socket due to the weight of the plug and cord. It also improves the contact between the plug and the outlet. Some sockets, however, don't have those bumps but just two spring-action blades that grip the sides of the plug pin, in which case the holes aren't necessary.

There are also some special outlets which allow you to lock the cord into the socket, by putting rods through the holes. This way, for example vending machines cannot be unplugged. Moreover, electrical devices can be "factory-sealed" by the manufacturer using a plastic tie or a small padlock through one or both of the plug prong holes. For example, a manufacturer might apply a plastic band through the hole and attach it to a tag that says: "You must do X or Y before plugging in this device". The user cannot plug in the device without removing the tag, so the user is sure to see the tag.

## TYPE B

(used in, among others, North and Central America and Japan)

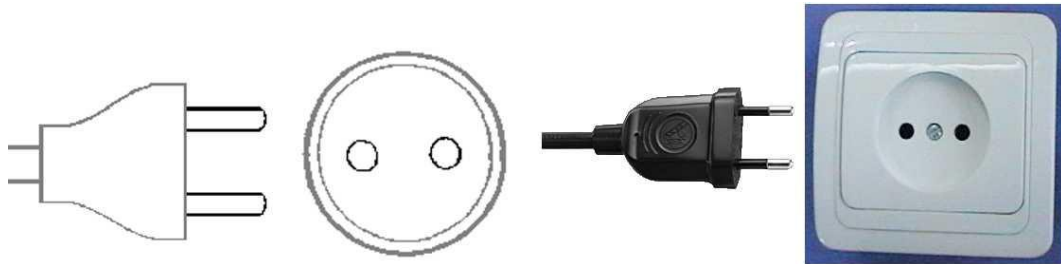


This is a class I plug with two flat parallel prongs and a grounding pin (American standard NEMA 5-15/Canadian standard CS22.2, n°42). It is rated at 15 amps and although this plug is also standard in Japan, it is less frequently used than in North America. Consequently, most appliances sold in Japan use a class II ungrounded plug. As is the case with the type A standard, the Japanese type B plugs and sockets are slightly different from their American counterparts.

An ungrounded version of the North American NEMA 5-15 plug is commonly used in Central America and parts of South America. It is therefore common for equipment users to simply cut off the grounding pin that the plug can be mated with a two-pole ungrounded socket.

## TYPE C

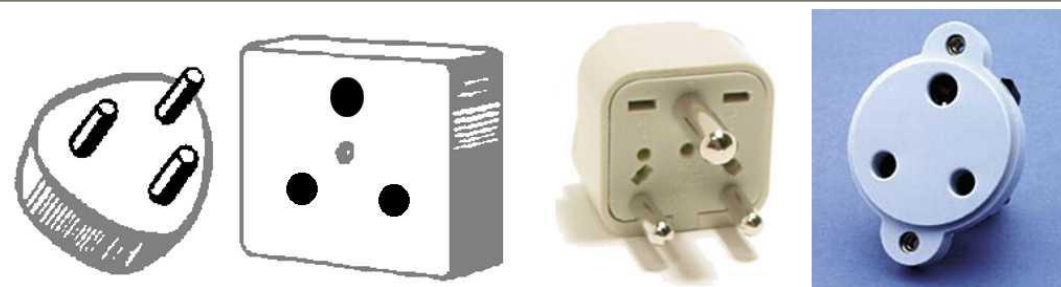
(used in all countries of Europe except the United Kingdom, Ireland, Cyprus and Malta)



This two-wire plug is ungrounded and has two round prongs. It is popularly known as the Europlug which is described in CEE 7/16. This is probably the single most widely used international plug. It will mate with any socket that accepts 4.0-4.8 mm round contacts on 19 mm centres. It is commonly used in all countries of Europe except the United Kingdom and Ireland. It is also used in various parts of the developing world. This plug is generally limited for use in class II applications that require 2.5 amps or less. It is, of course, unpolarised.

## TYPE D

(used almost exclusively in India, Sri Lanka, Nepal and Namibia)

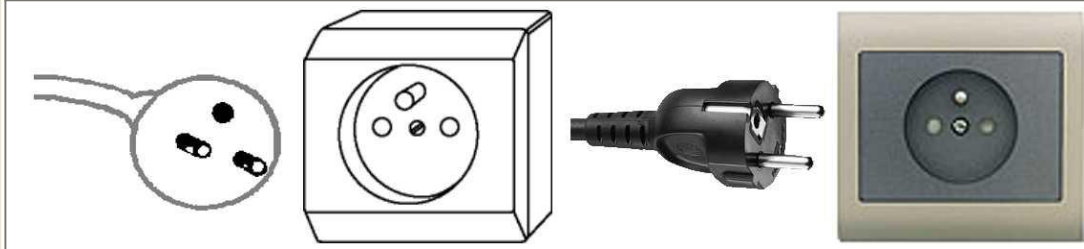


India has standardised on a plug which was originally defined in British Standard 546 (the standard in

Great Britain before 1962). Although type D is now almost exclusively used in India, Sri Lanka, Nepal and Namibia, it can still occasionally be found in specialist applications such as hotels and theatres in the UK. This plug has three large round pins in a triangular pattern. It is rated at 5 amps. Type M, which has larger pins and is rated at 15 amps, is used alongside type D for larger appliances in India, Sri Lanka, Nepal and Namibia. Some sockets can take both type M and type D plugs.

## TYPE E

(primarily used in France, Belgium, Poland, Slovakia, the Czech Republic, Tunisia and Morocco)



France, Belgium and some other countries have standardised on a socket which is different from the CEE 7/4 socket (type F) that is standard in Germany and other continental European countries. The reason for incompatibility is that grounding in the E socket is accomplished with a round male pin permanently mounted in the socket. The plug itself is similar to C except that it is round and has the addition of a female contact to accept the grounding pin in the socket. In order to bridge the differences between sockets E and F, the CEE 7/7 plug was developed: it has grounding clips on both sides to mate with the type F socket and a female contact to accept the grounding pin of the type E socket. The original type E plug, which does not have grounding clips, is no longer used, although very rarely it can still be found on some older appliances. Note that the CEE 7/7 plug is polarised when used with a type E outlet. The plug is rated at 16 amps. Above that, equipment must either be wired permanently to the mains or connected via another higher power connector such as the IEC 309 system.

## TYPE F

(used in, among others, Germany, Austria, the Netherlands, Sweden, Norway, Finland, Portugal, Spain and Eastern Europe)



Plug F, known as CEE 7/4 and commonly called "Schuko plug", is similar to C except that it is round and has the addition of two grounding clips on the side of the plug. It has two 4.8 mm round contacts on 19 mm centres. Because the CEE 7/4 plug can be inserted in either direction into the receptacle, the Schuko connection system is unpolarised (i.e. line and neutral are connected at random). It is used in applications up to 16 amps. Above that, equipment must either be wired permanently to the mains or connected via another higher power connector such as the IEC 309 system. In order to bridge the differences between sockets E and F, the CEE 7/7 plug was developed. This plug, which is shown above, has grounding clips on both sides to mate with the type F socket and a female contact to accept the grounding pin of the type E socket. The original type F plug, which does not have this female contact, is still available at the DIY shops but only in a rewirable version.

The Soviet Republics use a standard plug and socket defined in Russian Standard Gost 7396 which is similar to the Schuko standard. Contacts are also on 19 mm centres, but the diameter of this contact is 4.0 mm compared to 4.8 mm which is standard in Continental Europe. It is possible to mate Russian plugs with Schuko outlets, but Russian sockets will not allow to connect type E and F plugs as the outlets have smaller hole diameters than the pins of those two plugs mentioned. Many official standards in Eastern Europe are virtually identical to the Schuko standard. Furthermore, one of the protocols governing the reunification of Germany provided that the DIN and VDE standards would prevail without exception. The former East Germany was required to confirm to the Schuko standard. It appears that most if not all of the Eastern European countries generally use the Schuko standard internally but, until recently, they exported appliances to the Soviet Union with the Soviet standard plug installed. Because the volumes of appliance exports to the Soviet Union were large, the Soviet plug has found its way into use in Eastern Europe as well.

## TYPE G

(mainly used in the United Kingdom, Ireland, Cyprus, Malta, Malaysia and Singapore)



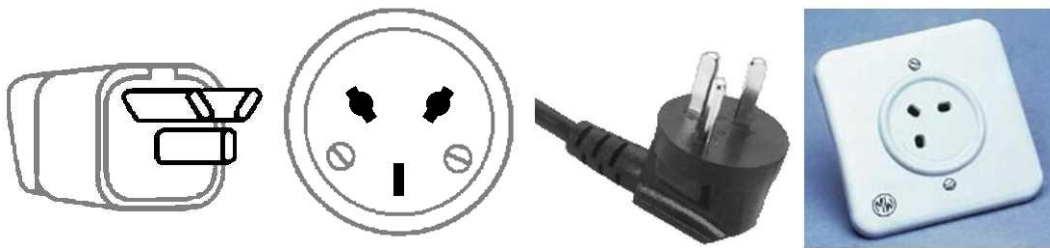
This plug has three prongs (two flat and one rectangular) that form a triangle. British Standard BS 1363 requires use of a three-wire grounded and fused plug for all connections to the power mains (including class II, two-wire appliances). British power outlets incorporate shutters on line and neutral contacts to prevent someone from pushing a foreign object into the socket.

The British domestic electrical system uses a ring main in the building which is rated for 30 amps (5 amps for lighting rings). Moreover, there is also a fusing in the plug; a cartridge fuse, usually of 3

amps for small appliances like radios etc. and 13 amps for heavy duty appliances such as heaters. Almost everywhere else in the world a spur main system is used. In this system each wall socket, or group of sockets, has a fuse at the main switchboard whereas the plug has none. So if you take some foreign appliance to the UK, you can use an adaptor, but technically it must incorporate the correct value fuse. Most would have a 13 amps one, too big for the computer for example. BS 1363 was published in 1962 and since that time it has gradually replaced the earlier standard plugs and sockets (type D) (BS 546).

## TYPE H

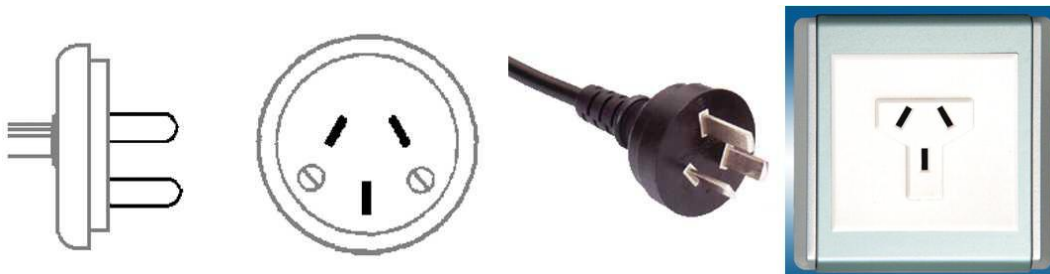
(used exclusively in Israel)



This plug, defined in SI 32, is unique to Israel. It has two flat prongs like the type B plug, but they form a V-shape rather than being parallel like B plugs. Type H plugs have got a grounding pin as well and are rated at 16 amps. Type H sockets are so shaped as to accommodate type C plugs as well. The slots for the non-grounded prongs have widenings in the middle specifically to allow type C prongs to fit in.

## TYPE I

(mainly used in Australia, New Zealand, Papua New Guinea and Argentina)



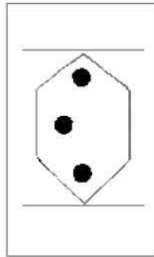
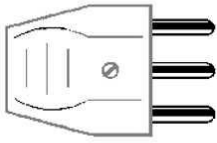
This plug has also a grounding pin and two flat prongs forming a V-shape. There is an ungrounded version of this plug as well, with only two flat V-shaped prongs. Although the above plug looks very similar to the one used in Israel (type H), both plugs are not compatible. Australia's standard plug/socket system is described in SAA document AS 3112 and is used in applications up to 10 amps.



A plug/socket configuration with rating at 15 amps (ground pin is wider: 8 mm instead of 6.35 mm) is also available. A standard 10 amp plug will fit into a 15 amp outlet, but a 15 amp plug only fits this special 15 amp socket. Although there are slight differences, the Australian plug mates with the socket used in the People's Republic of China (mainland China).

## TYPE J

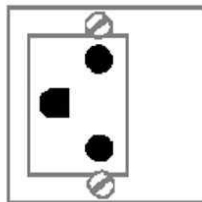
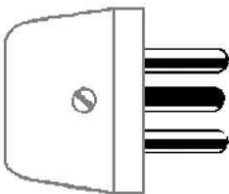
(used almost exclusively in Switzerland, Liechtenstein and Brazil)



Switzerland has its own standard which is described in SEC 1011. This plug is similar to C, except that it has the addition of a grounding pin. This connector system is rated for use in applications up to 10 amps. Above 10 amps, equipment must be either wired permanently to the electrical supply system with appropriate branch circuit protection or connected to the mains with an appropriate high power industrial connector. Type J is also the official grounded standard in Brazil, as described in NBR 14136.

## TYPE K

(used almost exclusively in Denmark and Greenland)



The Danish standard is described in Afsnit 107-2-D1. The plug is similar to F except that it has a grounding pin instead of grounding clips. The Danish socket will also accept either the CEE 7/4 or CEE 7/7 plugs: however, there is no grounding connection with these plugs because a male ground pin is required on the plug. The correct plug must be used in Denmark for safety reasons. A variation of this plug intended for use only on surge protected computer circuits has been introduced. The current rating on both plugs is 10 amps.



## TYPE L

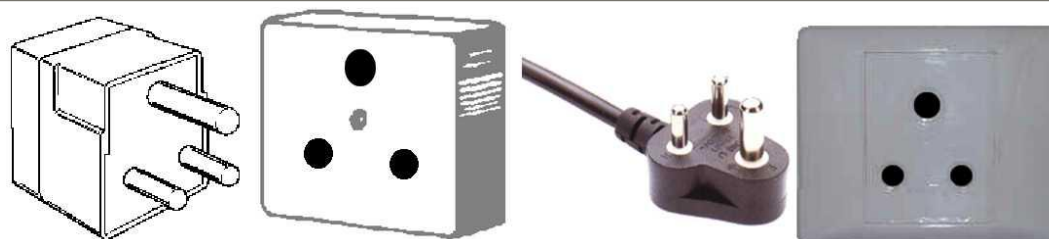
(used almost exclusively in Italy and randomly found throughout North Africa)



The Italian grounded plug/socket standard, CEI 23-16/VII, includes two styles rated at 10 and 16 amps. They differ in terms of contact diameter and spacing, and are therefore incompatible with each other. The plugs are similar to C except that they are earthed by means of a centre grounding pin. Because they can be inserted in either direction at random, they are unpolarised.

## TYPE M

(used almost exclusively in South Africa, Swaziland and Lesotho)



This plug resembles the Indian type D plug, but its pins are much larger. Type M is rated at 15 amps. Although type D is standard in India, Sri Lanka, Nepal and Namibia, type M is also used for larger appliances. Some sockets over there can take both type M and type D plugs.

COUNTRY	SOCKET
Afghanistan	C / F
Albania	C / F
Algeria	C / F
American Samoa	A / B / F / I
Andorra	C / F
Angola	C

Anguilla	A
Antigua	A / B
Argentina	I
Armenia	C / F
Aruba	A / B / F
Australia	I
Austria	C / F
Azerbaijan	C
Azores	B / C / F
Bahamas	A / B
Bahrain	G
Balearic Islands	C / F
Bangladesh	A / C / D / G / K
Barbados	A / B
Belarus	C
Belgium	E
Belize	B / G
Benin	E
Bermuda	A / B
Bhutan	D / F / G
Bolivia	A / C
Bosnia	C / F
Botswana	D / G
Brazil	A / B / C / I / J*
Brunei	G
Bulgaria	C / F
Burkina Faso	C / E
Burundi	C / E
Cambodia	A / C / G
Cameroon	C / E
Canada	A / B
Canary Islands	C / E / L
Cape Verde	C / F
Cayman Islands	A / B

Central African Republic	C / E
Chad	D / E / F
Channel Islands	C / G
Chile	C / L
China, People's Republic of	A / I / G
Colombia	A / B
Comoros	C / E
Congo, People's Rep. of	C / E
Congo, Dem. Rep. of ( <i>formerly Zaire</i> )	C / D
Cook Islands	I
Costa Rica	A / B
Côte d'Ivoire (Ivory Coast)	C / E
Croatia	C / F
Cuba	A / B / C / L
Cyprus	G (north & south) / F (north)
Czech Republic	E
Denmark	C / K
Djibouti	C / E
Dominica	D / G
Dominican Republic	A
East Timor	C / E / F / I
Ecuador	A / B
Egypt	C
El Salvador	A / B / C / D / E / F / G / I / J / L
Equatorial Guinea	C / E
Eritrea	C
Estonia	F
Ethiopia	D / J / L
Faeroe Islands	C / K
Falkland Islands	G
Fiji	I
Finland	C / F
France	E

French Guyana	C / D / E
Gaza	H
Gabon	C
Gambia	G
Germany	C / F
Ghana	D / G
Gibraltar	C / G
Greece	C / F
Greenland	C / K
Grenada (Windward Islands)	G
Guadeloupe	C / D / E
Guam	A / B
Guatemala	A / B / G / I
Guinea	C / F / K
Guinea-Bissau	C
Guyana	A / B / D / G
Haiti	A / B
Honduras	A / B
Hong Kong	D / M / G
Hungary	C / F
Iceland	C / F
India	C / D / M
Indonesia	C / F / G
Iran	C / F
Iraq	C / D / G
Ireland (Eire)	G
Isle of Man	C / G
Israel	H / C
Italy	F / L
Jamaica	A / B
Japan	A / B
Jordan	B / C / D / F / G / J
Kenya	G
Kazakhstan	C

Kiribati	I
Korea, South	C / F
Kuwait	C / G
Kyrgyzstan	C
Laos	A / B / C / E / F
Latvia	C / F
Lebanon	A / B / C / D / G
Lesotho	M
Liberia	A / B
Libya	D
Lithuania	C / E
Liechtenstein	J
Luxembourg	C / F
Macau	D / G
Macedonia	C / F
Madagascar	C / D / E / J / K
Madeira	C / F
Malawi	G
Malaysia	G
Maldives	A / D / G / J / K / L
Mali	C / E
Malta	G
Martinique	C / D / E
Mauritania	C
Mauritius	C / G
Mexico	A
Micronesia, Federal States of	A / B
Moldova	C
Monaco	C / D / E / F
Mongolia	C / E
Montserrat (Leeward Islands)	A / B
Morocco	C / E
Mozambique	C / F / M
Myanmar ( <i>formerly Burma</i> )	C / D / F / G

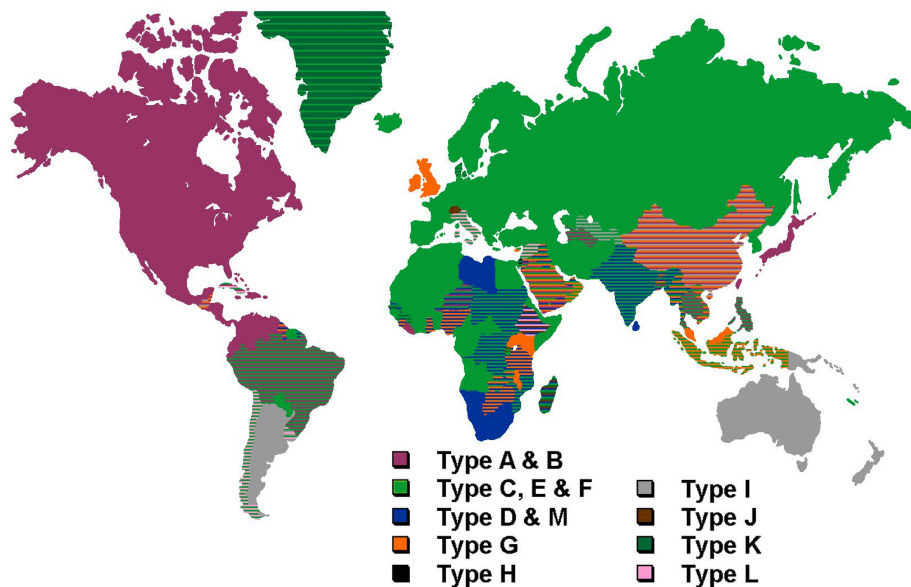
Namibia	D / M
Nauru	I
Nepal	C / D / M
Netherlands	C / F
Netherlands Antilles	A / B / F
New Caledonia	F
New Zealand	I
Nicaragua	A
Niger	A / B / C / D / E / F
Nigeria	D / G
Norway	C / F
Okinawa	A / B / I
Oman	C / G
Pakistan	C / D
Palmyra Atoll	A / B
Panama	A / B
Papua New Guinea	I
Paraguay	C
Peru	A / B / C
Philippines	A / B / C
Poland	C / E
Portugal	C / F
Puerto Rico	A / B
Qatar	D / G
Réunion Island	E
Romania	C / F
Russian Federation	C / F
Rwanda	C / J
St. Kitts and Nevis (Leeward Islands)	D / G
St. Lucia (Windward Islands)	G
St. Vincent (Windward Islands)	A / C / E / G / I / K
Saudi Arabia	A / B / F / G
Senegal	C / D / E / K
Serbia & Montenegro	C / F

Seychelles	G
Sierra Leone	D / G
Singapore	G
Slovakia	E
Slovenia	C / F
Somalia	C
South Africa	M (type C plugs are very commonly used with an adapter)
Spain	C / F
Sri Lanka	D / M
Sudan	C / D
Suriname	C / F
Swaziland	M
Sweden	C / F
Switzerland	J
Syria	C / E / L
Tahiti	A / B / E
Tajikistan	C / I
Taiwan	A / B
Tanzania	D / G
Thailand	A / C
Togo	C
Tonga	I
Trinidad & Tobago	A / B
Tunisia	C / E
Turkey	C / F
Turkmenistan	B / F
Uganda	G
Ukraine	C / F
United Arab Emirates	C / D / G
United Kingdom	G
United States of America	A / B
Uruguay	C / F / I / L
Uzbekistan	C / I
Venezuela	A / B

Vietnam	A / C / G
Virgin Islands (British and U.S.)	A / B
Western Samoa	I
Yemen, Rep. of	A / D / G
Zambia	C / D / G
Zimbabwe	D / G

\* Although many types of plugs and receptacles are used all over Brazil, only type J plugs and sockets are allowed. Type C plugs (NOT type C sockets!) are authorized as well.

The outline map below visualizes the spread of the different plug types used around the world. For easy reference, compatible plug types are represented with the same color.



## What do I need to use my appliances abroad ?

### Plug Adapters

They do not convert electricity. They simply allow a dual-voltage appliance, a transformer or a converter from one country to be plugged into the wall outlet of another country. The plug of a Continental European appliance will not fit into an outlet in a foreign country without an adapter.

### Converters



Converters and transformers both step up or down the voltage, but there is a difference in use between them. Converters should be used only with "electric" products. Electric products are simple heating devices or have mechanical motors. Examples are hair dryers, steam irons, shavers, toothbrushes or small fans. Converters are not designed for "continuous duty" and should only be used for short periods of time (1 to 2 hours). Additionally, most converters can only be used for ungrounded appliances (2 pins on the plug). Converters must be unplugged from the wall when not in use.

## Transformers

Transformers also step up or down the voltage, but they are more expensive than converters and are used with "electronic" products. Electronic products have a chip or circuit. Examples are radios, CD or DVD players, shavers, camcorder battery rechargers, computers, computer printers, fax machines, televisions and answering machines. Transformers can also be used with electric appliances and may be operated continually for many days. The advantage of converters, however, is that they are lighter and less expensive.

Computers are electronic devices and therefore they must be used with a transformer, unless they are dual voltage. Fortunately, most laptop battery chargers and AC adapters are dual voltage, so they can be used with only a plug adapter for the country you will be visiting.

Transformers are sold in various sizes based on how much wattage they can support. Therefore one must pay careful attention to the wattage ratings of the appliances to be plugged into a transformer. The wattage rating of the transformer must always be larger than the wattage rating of the appliance to be plugged into it (plus a 25% buffer to allow for heat build-up in the transformer or converter). When plugging multiple items into a power strip, then into the transformer, you must calculate the combined wattage of all appliances and the power strip, then add an additional 25% to that total.

The appliance's voltage and wattage requirements are listed on the manufacturer's label located on the back or at the bottom of the appliance. In some cases, the voltage and amperage will be listed, but not the wattage. If this is the case, simply multiply the voltage by the amperage rating to find the wattage rating (e.g.  $230\text{ V} * 1\text{ A} = 230\text{ W}$ ).

Below is a list that gives an idea what the wattage of common appliances is. Use this as a guide only. Always check your appliance first !

- 75 watts: small, low-wattage appliances such as radios, CD players, heating pads, and some televisions.

- 300 watts: larger radios, stereo consoles, electric blankets, sewing machines, hand mixers, small fans and most TV sets.
- 500 watts: refrigerators, hair dryers, stand mixers, blenders and some stereo equipment.
- 750 watts: projectors, some sewing machines and small electric broom type vacuums.
- 1000 watts: washing machines, small heaters, some coffee makers and vacuums.
- 1600 – 2000 watts: dishwashers, most appliances that have heating elements such as toasters, electric deep-frying pans, irons, and grills.
- 3000 watts: heaters and air conditioners.

Transformers and converters only convert the voltage, not the frequency. The difference in cycles may cause the motor in a 50 Hz appliance to operate slightly faster when used on 60 Hz electricity. This cycle difference will cause electric clocks and timing circuits to keep incorrect time: European alarm clocks will run faster on 60 Hz electricity and American clocks will lose some 10 minutes every hour when used in Europe. However, most modern electronic equipment like battery chargers, computers, printers, stereos, DVD players, etc. are usually not affected by the difference in cycles and adjust themselves accordingly the slower cycles.

Why can only “electric” appliances be used with a converter, and not “electronic” ones ?

The difference between a converter and a transformer lies in how the device converts voltage current. Alternating current power is supplied in alternating bursts that are in a shape called a "sine wave". To reduce 230 V to 110 V, for example, a converter chops off the sine waves in half, whereas a transformer alters the amplitude of the waves. This is a critical difference because electronic devices require a full sine wave for operation. This is why they can only operate with a transformer. Electric appliances function with either a full or a half sine wave, so they can be used with either a converter or a transformer.

The converter's "chopping" off of sine waves is a relatively simple and compact function. The transformer's alteration of sine waves is a relatively sophisticated function and requires more space. As a result, transformers are generally larger, heavier and much more expensive than converters.

Trick to know the local voltage

In case you forget to check what the local voltage is in the country you're going to: here's a small trick. Just take a look at the glass of an ordinary light bulb or stop at a supermarket and note what is printed on a light bulb packet!