

# Ampere

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The **ampere** (SI unit symbol: A), often shortened to "amp",<sup>[1]</sup> is the SI unit of electric current<sup>[2][3]</sup> (dimension symbol: I)<sup>[4]</sup> and is one of the seven<sup>[5]</sup> SI base units. It is named after André-Marie Ampère (1775–1836), French mathematician and physicist, considered the father of electrodynamics.

The ampere is equivalent to one coulomb (roughly  $6.241 \times 10^{18}$  times the elementary charge) per second.<sup>[6]</sup> Amperes are used to express flow rate of electric charge. For any point experiencing a current, if the number of charged particles passing through it — or the charge on the particles passing through it — is increased, the amperes of current at that point will proportionately increase.

The ampere should not be confused with the coulomb (also called "ampere-second") or the ampere-hour (A·h). The ampere is a unit of current, the amount of charge transiting per unit time, and the coulomb is a unit of charge. When SI units are used, constant, instantaneous and average current are expressed in amperes (as in "the charging current is 1.2 A") and the charge accumulated, or passed through a circuit over a period of time is expressed in coulombs (as in "the battery charge is 30 000 C"). The relation of the ampere (C/s) to the coulomb is the same as that of the watt (J/s) to the joule.

Ampere



Demonstration model of a moving iron ammeter. As the current through the coil increases, the plunger is drawn further into the coil and the pointer deflects to the right.

Unit information

Unit system	SI base unit
Unit of	Electric current
Symbol	A
Named after	André-Marie Ampère

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# Definition

Ampère's force law<sup>[7][8]</sup> states that there is an attractive or repulsive force between two parallel wires carrying an electric current. This force is used in the formal definition of the ampere, which states that the ampere is the constant current that will produce an attractive force of  $2 \times 10^{-7}$  newtons per metre of length between two straight, parallel conductors of infinite length and negligible circular cross section placed one metre apart in a vacuum.<sup>[2][9]</sup>

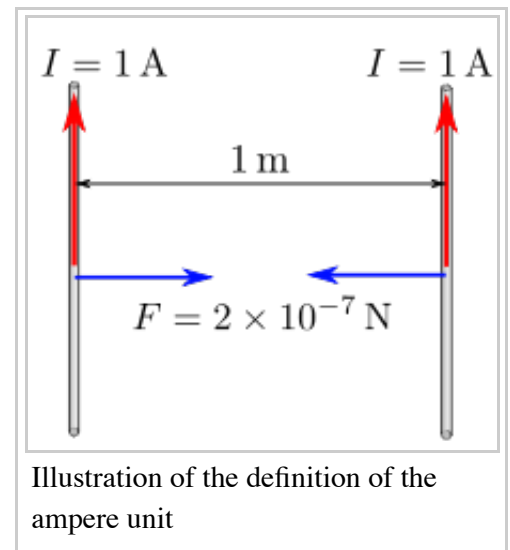
The SI unit of charge, the coulomb, "is the quantity of electricity carried in 1 second by a current of 1 ampere".<sup>[10]</sup> Conversely, a current of one ampere is one coulomb of charge going past a given point per second:

$$1 \text{ A} = 1 \frac{\text{C}}{\text{s}}.$$

In general, charge  $Q$  is determined by steady current  $I$  flowing for a time  $t$  as  $Q = It$ .

# History

The ampere was originally defined as one tenth of the unit of electric current in the centimetre–gram–second system of units; that unit, now known as the abampere, was defined as the amount of current that generates a force of two dynes per centimetre of length between two wires one centimetre apart.<sup>[11]</sup> The size of the unit was chosen so that the units derived from it in the MKSA system would be conveniently sized.



The "international ampere" was an early realization of the ampere, defined as the current that would deposit 0.001 118 000 grams of silver per second from a silver nitrate solution.<sup>[12]</sup> Later, more accurate measurements revealed that this current is 0.999 85 A.

## Realization

The standard ampere is most accurately realized using a watt balance, but is in practice maintained via Ohm's law from the units of electromotive force and resistance, the volt and the ohm, since the latter two can be tied to physical phenomena that are relatively easy to reproduce, the Josephson junction and the quantum Hall effect, respectively.<sup>[13]</sup>

At present, techniques to establish the realization of an ampere have a relative uncertainty of approximately a few parts in  $10^7$ , and involve realizations of the watt, the ohm and the volt.<sup>[13]</sup>

## Proposed future definition

Rather than a definition in terms of the force between two current-carrying wires, it has been proposed to define the ampere in terms of the rate of flow of elementary charges.<sup>[8]</sup> Since a coulomb is approximately equal to  $6.241\,5093 \times 10^{18}$  elementary charges (such as electrons), one ampere is approximately equivalent to  $6.241\,5093 \times 10^{18}$  elementary charges moving past a boundary in one second, or the reciprocal of the value of the elementary charges in coulombs.<sup>[14]</sup> The proposed change would define 1 A as being the current in the direction of flow of a particular number of elementary charges per second. In 2005, the International Committee for Weights and Measures (CIPM) agreed to study the proposed change. The new definition was discussed at the 25th General Conference on Weights and Measures (CGPM) in 2014 but for the time being was not adopted.

## Everyday examples

The current drawn by typical constant-voltage energy distribution systems is usually dictated by the power (watt) consumed by the system and the operating voltage. For this reason the examples given below are grouped by voltage level.

### Portable devices

- Hearing aid (typically 1 mW at 1.4 V): 0.7 mA

### Internal combustion engine vehicles – 12 V DC

A typical motor vehicle has a 12 V battery. The various accessories that are powered by the battery might include:

- Instrument panel light (typically 2 W): 166 mA.

- Headlights (typically 60 W): 5 A each.
- Starter motor (typically 1–2 kW): 80–160 A

## North American domestic supply – 120 V AC

Most Canada, Mexico and United States domestic power suppliers run at 120 V.

Household circuit breakers typically provide a maximum of 15 A or 20 A of current to a given set of outlets.

- 22-inch/56-centimeter portable television (35 W): 290 mA
- Tungsten light bulb (60–100 W): 500–830 mA
- Toaster, kettle (1.5 kW): 12.5 A
- Hair dryer (1.8 kW): 15 A

## European & Commonwealth domestic supply – 230-240 V AC

Most European domestic power supplies run at 230 V, and most Commonwealth domestic power supplies run at 240 V. For the same amount of power (in watts), the current drawn by a particular European or Commonwealth appliance (in Europe or a Commonwealth country) will be less than for an equivalent North American appliance.<sup>[Note 1]</sup> Typical circuit breakers will provide 16 A.

The current drawn by a number of typical appliances are:

- 22-inch/56-centimeter portable television (35 W): 145–150 mA
- Tungsten light bulb (60–100 W): 240–450 mA
- Compact fluorescent lamp (11–30 W): 56–112 mA
- Toaster, kettle (2 kW): 9 A
- Immersion heater (4.6 kW): 19–20 A

## See also

- Ammeter
- Ampacity (current-carrying capacity)
- Electric current
- Electric shock
- Hydraulic analogy
- Magnetic constant
- Orders of magnitude (current)

## Notes

1. The formula for power is given by

$$P(t) = I(t) \cdot V(t)$$

so it follows that if the voltage is doubled and the power remains the same, the current will be halved.

## References

- SI supports only the use of symbols and deprecates the use of abbreviations for units."Bureau International des Poids et Mesures" (PDF). 2006. p. 130. Retrieved 21 November 2011.
- "2.1. Unit of electric current (ampere)", *SI brochure* (8th ed.), BIPM, retrieved 19 November 2011
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- History of the ampere*, Sizes
- "Appendix 2: Practical realization of unit definitions: Electrical quantities", *SI brochure*, BIPM.
- "Value", *Physics*, USA: NIST.

## External links

- The NIST Reference on Constants, Units, and Uncertainty (<http://physics.nist.gov/cuu/>)
- NIST *Definition of ampere and  $\mu_0$*  (<http://physics.nist.gov/cuu/Units/ampere.html>)
- Tutorial video explaining amperes and current (<http://afrotechmods.com/tutorials/2011/11/29/basic-electricity-amps/>)

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