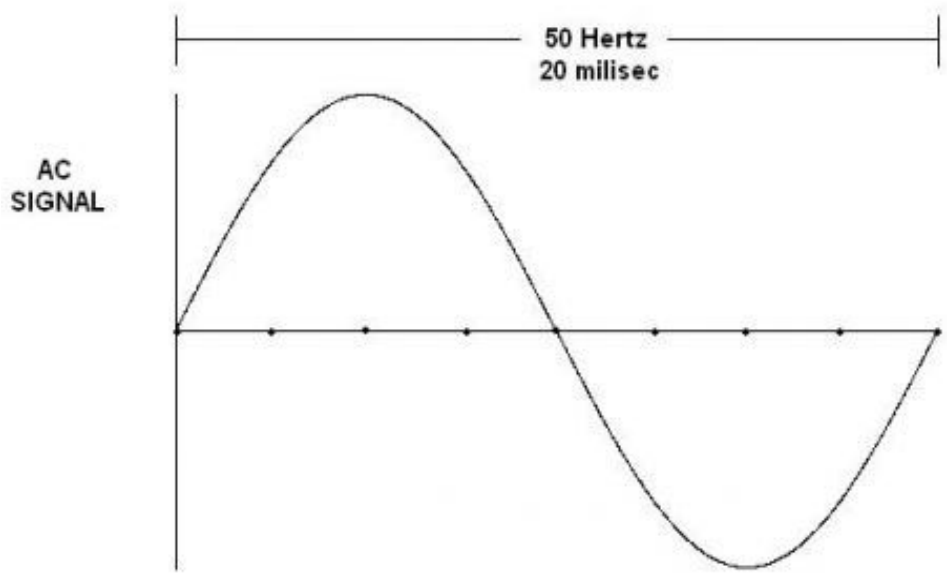
Frequency – what it is, and why it's important.

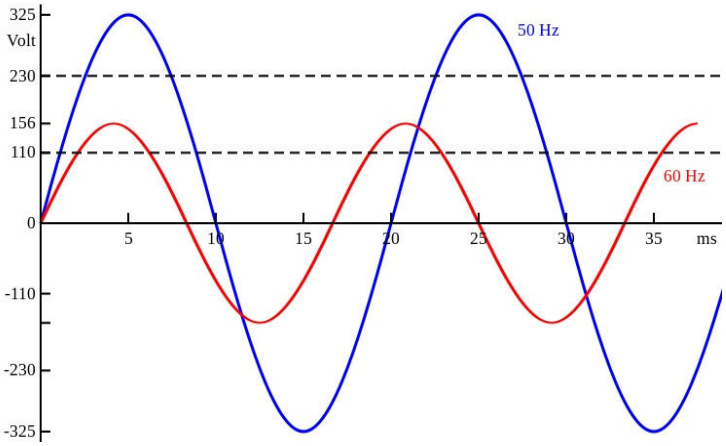
In the UK, most of Europe, Africa, Australia, Southern South America, most of Asia, and Russia, the frequency of the alternating current in household electrical outlets is **50 Hz**

In North America and Northern South America, the frequency of the alternating current in household electrical outlets is **60 Hz**



Frequency is the number of occurrences of a repeating event per unit of time. It is also referred to as temporal frequency. The period is the duration of one cycle in a repeating event, so the period is the reciprocal of the frequency. The sine wave measurement shown in AC electrical systems is measured per second – and refereed to as Hertz (Hz) – so 100Hz means 100 waves per second.

Why is 60Hz frequency used in America instead of the 50Hz used in most of the world?



The use of 50 versus 60 Hz is purely due to historical reasons, with companies in the US making 60 Hz equipment and those in Europe making 50Hz equipment so that they have a monopoly. This rivalry led to the split you see today.

Many different power frequencies were used in the 19th century throughout the world.

Very early isolated AC generating schemes used arbitrary frequencies based on convenience for

steam engine, water turbine and electrical generator design. Frequencies between 16⅔ Hz and 133⅓ Hz were used on different systems. For example, the city of Coventry, England, in 1895 had a unique 87 Hz single-phase distribution system that was in use until 1906. The proliferation of frequencies grew out of the rapid development of electrical machines in the period 1880 through 1900. In the early incandescent lighting period, single-phase AC was common and typical generators were 8-pole machines operated at 2000 RPM, giving a frequency of 133 cycles per second.

Though many theories exist, and quite a few entertaining urban legends, there is little certitude in the details of the history of 60 Hz vs. 50 Hz.

The German company AEG (descended from a company founded by Edison in Germany) built the first German generating facility to run at 50 Hz, allegedly because 60 was not a preferred number. AEG's choice of 50 Hz is thought by some to relate to a more "metric-friendly" number than 60. At the time, AEG had a virtual monopoly and their standard spread to the rest of Europe.

After observing flicker of lamps operated by the 40 Hz power transmitted by the Lauffen-Frankfurt link in 1891, AEG raised their standard frequency to 50 Hz in 1891.

Westinghouse Electric decided to standardize on a lower frequency to permit operation of both electric lighting and induction motors on the same generating system. Although 50 Hz was suitable for both, in 1890 Westinghouse considered that existing arc-lighting equipment operated slightly better on 60 Hz, and so that frequency was chosen. Frequencies much below 50 Hz gave noticeable flicker of arc or incandescent lighting. The operation of Tesla's induction motor required a lower frequency than the 133 Hz common for lighting systems in 1890. In 1893 General Electric Corporation, which was affiliated with AEG in Germany, built a generating project at Mill Creek, California using 50 Hz, but changed to 60 Hz a year later to maintain market share with the Westinghouse standard.

Frequency Standardization

In the early days of electrification, so many frequencies were used that no one value prevailed (London in 1918 had 10 different frequencies). As the 20th century continued, more power was produced at 60 Hz (North America) or 50 Hz (Europe and most of Asia). Standardization allowed international trade in electrical equipment. Much later, the use of standard frequencies allowed interconnection of power grids. It wasn't until after World War II with the advent of affordable electrical consumer goods that more uniform standards were enacted.

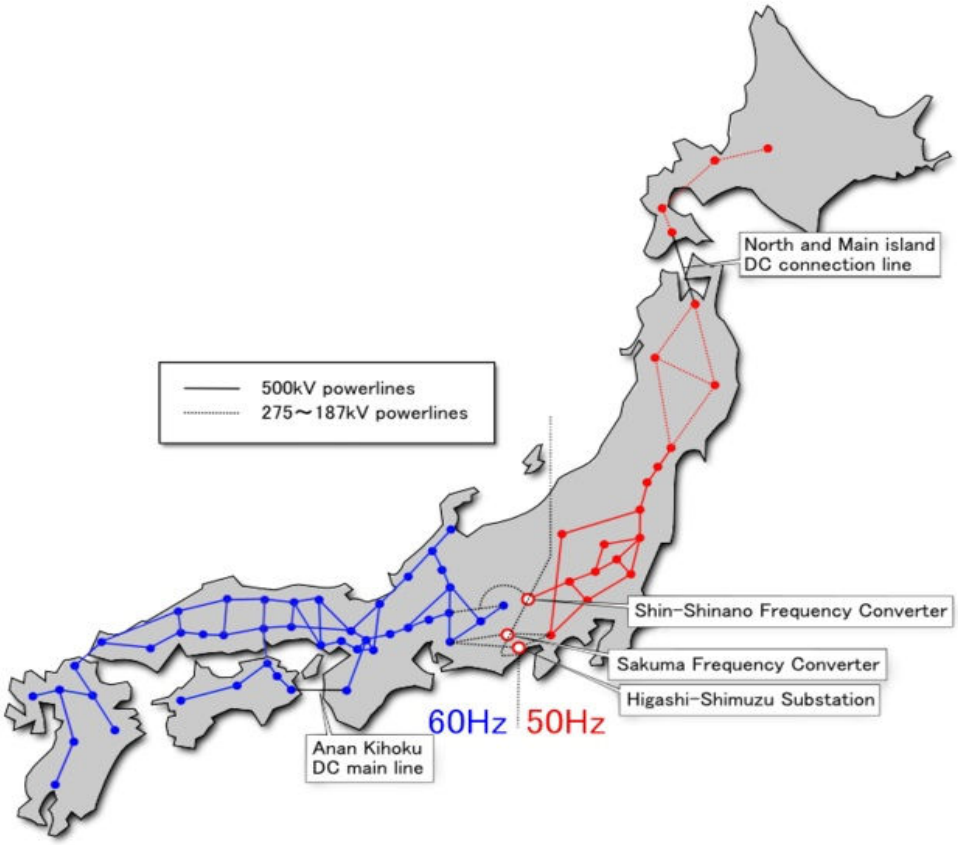
In Britain, a standard frequency of 50 Hz was declared as early as 1904, but significant development continued at other frequencies. The implementation of the National Grid starting in 1926 compelled

the standardization of frequencies among the many interconnected electrical service providers. The 50 Hz standard was completely established only after World War II.

By about 1900, European manufacturers had mostly standardized on 50 Hz for new installations. The German VDE in the first standard for electrical machines and transformers in 1902 recommended 25 Hz and 50 Hz as standard frequencies. VDE did not see much application of 25 Hz, and dropped it from the 1914 edition of the standard. Remnant installations at other frequencies persisted until well after the Second World War. Now in current European Union the frequency is 50Hz throughout (and the voltage within the EU have been adjusted to attain an average of 230V +/- 10% in all countries.

In the US, Southern California Edison had standardized on 50 Hz. Much of Southern California operated on 50 Hz and did not completely change frequency of their generators and customer equipment to 60 Hz until around 1948. Some projects by the Au Sable Electric Company used 30 Hz at transmission voltages up to 110,000 volts in 1914.

In Mexico, areas operating on 50 Hz grid were converted during the 1970s, uniting the country under 60 Hz.



In Japan, the western part of the country (Kyoto and west) uses 60 Hz and the eastern part (Tokyo and east) uses 50 Hz. This originates in the first purchases of generators from AEG in 1895, installed for Tokyo, and General Electric in 1896, installed in Osaka. The boundary between the two regions contains four back-to-back HVDC substations which convert the frequency; these are Shin Shinano, Sakuma Dam, Minami-Fukumitsu, and the Higashi-Shimizu Frequency Converter.