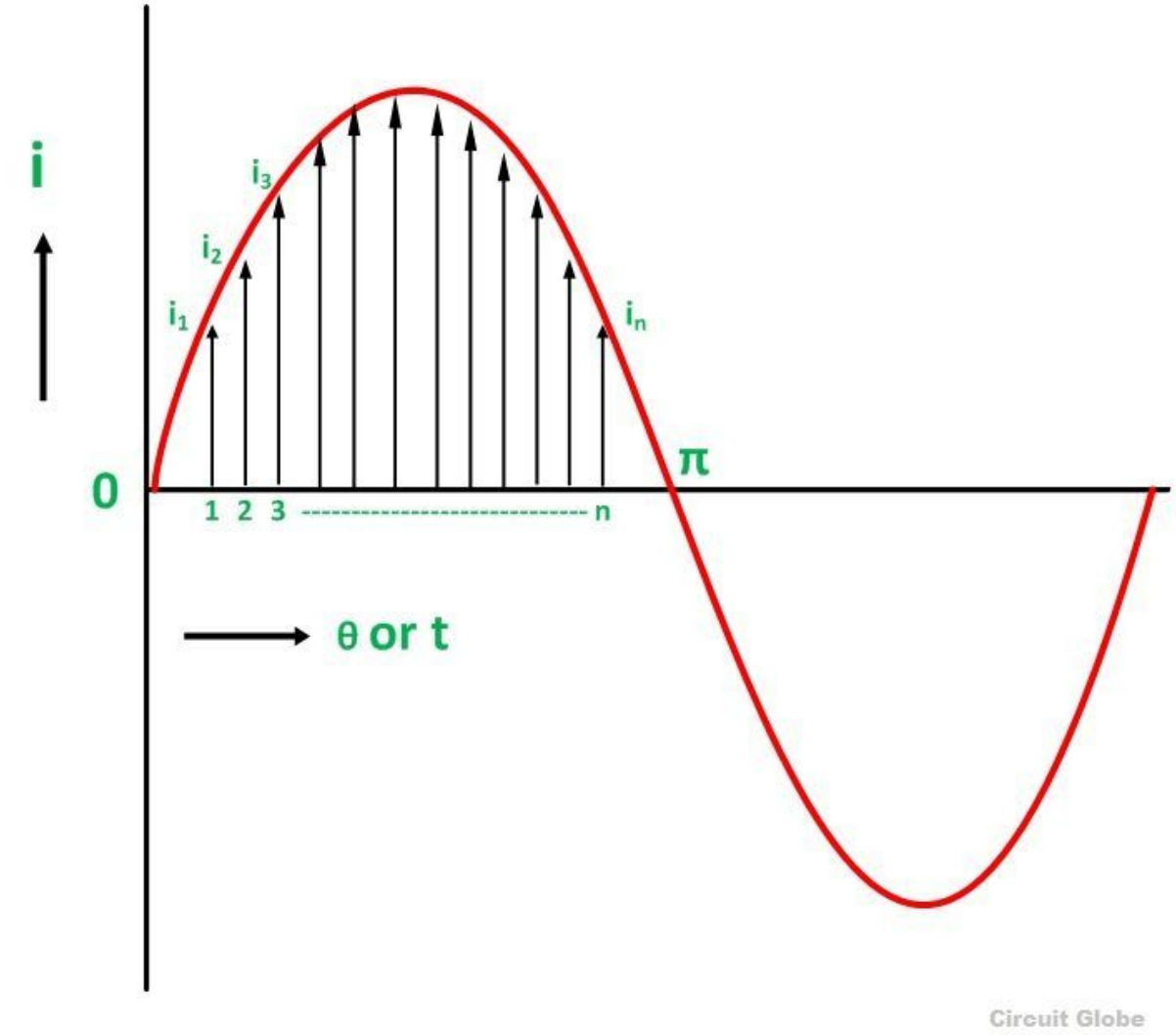
Useful equations

- **Electrical:**

1-Average value:



$$I_{av} = \frac{i_1 + i_2 + i_3 + \dots\dots\dots + i_n}{n} = \frac{\text{Area of alternation}}{\text{Base}}$$

$$A = \frac{1}{T}\int_0^T V(t)dt$$

2-Root Mean Square (RMS) or Effective value:

$$V_{RMS} = \sqrt{\frac{1}{T}\int_0^T V(t)^2 dt}$$

3-Crest Factor or Peak Factor:

crest factor indicates how extreme the peaks are in a waveform. Crest factor 1 indicates no peaks, such as direct current or a square wave.

$$\text{Peak Factor} = \frac{\mathrm{I_m}}{\mathrm{I_{r.m.s}}} \text{ or } \frac{\mathrm{E_m}}{\mathrm{E_{r.m.s}}}$$

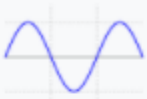
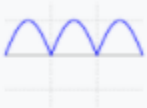
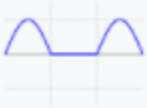
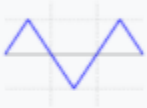
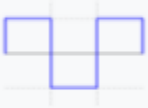
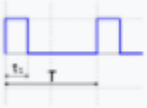
Im and Em are the maximum value of the current and the voltage respectively, and Ir.m.s and Er.m.s are the roots mean square value of the alternating current and the voltage respectively.

4-Form Factor:

AC measuring instruments are often built with specific waveforms in mind. For example, many multimeters on their AC ranges are specifically scaled to display the RMS value of a sine wave. Since the RMS calculation can be difficult to achieve digitally, the absolute average is calculated instead and the result multiplied by the form factor of a sinusoid. This method will give less accurate readings for waveforms other than a sinewave waveform .

$$\text{Form Factor} = \frac{\mathrm{I_{r.m.s}}}{\mathrm{I_{av}}} \text{ or } \frac{\mathrm{E_{r.m.s}}}{\mathrm{E_{av}}}$$

Examples:

Wave type	Waveform	RMS value	Crest factor	PAPR (dB)
DC		1	1	0.0 dB
Sine wave		$\frac{1}{\sqrt{2}} \approx 0.707$[6]	$\sqrt{2} \approx 1.414$	3.01 dB
Full-wave rectified sine		$\frac{1}{\sqrt{2}} \approx 0.707$[6]	$\sqrt{2} \approx 1.414$	3.01 dB
Half-wave rectified sine		$\frac{1}{2} = 0.5$[6]	2	6.02 dB
Triangle wave		$\frac{1}{\sqrt{3}} \approx 0.577$	$\sqrt{3} \approx 1.732$	4.77 dB
Square wave		1	1	0 dB
PWM Signal V(t) ≥ 0.0 V		$\sqrt{\frac{t_1}{T}}$[6]	$\sqrt{\frac{T}{t_1}}$	$10 \log \frac{T}{t_1}$ dB
QPSK		1	1	1.761 dB[7]
8PSK				3.3 dB[8]
π/4DQPSK				3.0 dB[8]
OQPSK				3.3 dB[8]
8VSB				6.5–8.1 dB[9]
64QAM		$\sqrt{\frac{3}{7}}$	$\sqrt{\frac{7}{3}} \approx 1.542$	3.7 dB[10]
∞-QAM		$\frac{1}{\sqrt{3}} \approx 0.577$	$\sqrt{3} \approx 1.732$	4.8 dB[10]
WCDMA downlink carrier				10.6 dB

Note:

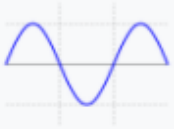
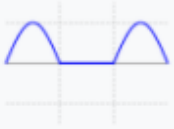
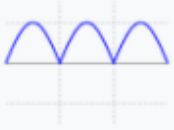
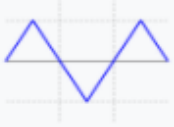
The form factor Kf is the smallest of the other two factors:

Crest factor Ka and the other less known factor averaging factor Ka = max signal/ average signal

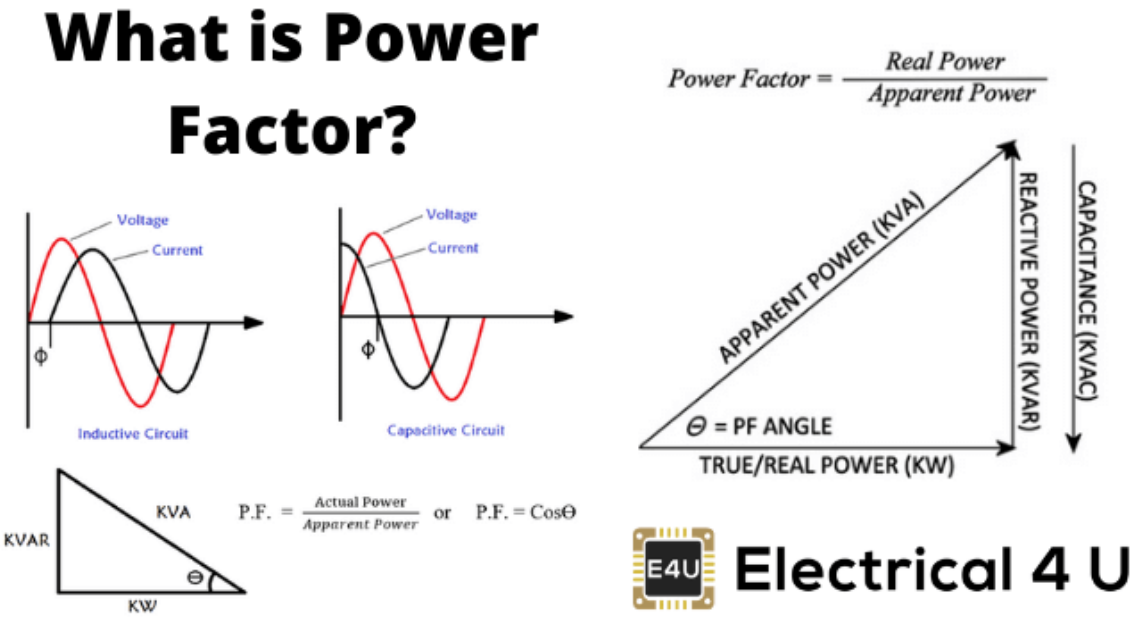
Kav > Ka > Kf

We have: Kf=Kav/Ka

Examples:

Waveform	Image	RMS	ARV	Form Factor
Sine wave		$\frac{a}{\sqrt{2}}$[2]	$a\frac{2}{\pi}$[2]	$\frac{\pi}{2\sqrt{2}} \approx 1.11072073$[3]
Half-wave rectified sine		$\frac{a}{2}$	$\frac{a}{\pi}$	$\frac{\pi}{2} \approx 1.571$
Full-wave rectified sine		$\frac{a}{\sqrt{2}}$	$a\frac{2}{\pi}$	$\frac{\pi}{2\sqrt{2}}$
Square wave, constant value		a	a	$\frac{a}{a} = 1$
Pulse wave		$a\sqrt{D}$[6]	aD	$\frac{1}{\sqrt{D}} = \sqrt{\frac{T}{\tau}}$
Triangle wave		$\frac{a}{\sqrt{3}}$[7]	$\frac{a}{2}$	$\frac{2}{\sqrt{3}} \approx 1.15470054$
Sawtooth wave		$\frac{a}{\sqrt{3}}$	$\frac{a}{2}$	$\frac{2}{\sqrt{3}}$
Gaussian white noise $U(-1,1)$		$\frac{1}{\sqrt{3}}$ [citation needed]	$\frac{1}{2}$ [citation needed]	$\frac{2}{\sqrt{3}}$

4- Power Factor:



Power factor refers to the general efficiency of a system. Crest factor describes the ability of an AC power source or device to generate current or voltage at a particular level.

- Networking And Telecommunication:
  1-Client Connection Quality CCQ:

Client Connection Quality (CCQ) is a value in percent that shows how effective the bandwidth is used regarding the theoretically maximum available bandwidth. CCQ is weighted average of values Tmin/Treal, that get calculated for every transmitted frame, where Tmin is time it would take to transmit given frame at highest rate with no retries and Treal is time it took to transmit frame in real life (taking into account necessary retries it took to transmit frame and transmit rate).

2- Signal parameters:

		RSRP (dBm)	RSRQ (dB)	SINR (dB)
RF Conditions	Excellent	>=-80	>=-10	>=20
	Good	-80 to -90	-10 to -15	13 to 20
	Mid Cell	-90 to -100	-15 to -20	0 to 13
	Cell Edge	<=-100	<-20	<=0

Below are explanations of these values (and also RSSI in relation to LTE):

SINR/SNR – The signal-to-noise ratio of the given signal.

RSRP – The average power received from a single Reference signal, and Its typical range is around -44dbm (good) to -140dbm(bad).

RSRQ – Indicates quality of the received signal, and its range is typically -19.5dB(bad) to -3dB (good).

RSSI – Represents the entire received power including the wanted power from the serving cell as well as all cochannel power and other sources of noise and it is related to the above parameters through the following formula:

RSRQ=N*(RSRP/RSSI)

Where N is the number of Resource Blocks of the E-UTRA carrier RSSI measurement bandwidth.

3-Standing Wave Ratio(SWR):

$$\mathrm{SWR} = \frac{|V_{\max}|}{|V_{\min}|} = \frac{1 + |\Gamma|}{1 - |\Gamma|}$$

Ideal SWR =1 real should range between 1 and 1.5

SWR=3 no transmission bad