Formula Handbook

172 electronics formulas, each with its symbols and units, a worked example and the lesson it comes from

The companion reference to the DC and AC Circuits Workbooks

$$V = IR$$

$$f_c = \frac{1}{2\pi RC}$$

$$X_C = \frac{1}{2\pi fC}$$

$$V_T = \frac{k_B T}{q_e}$$

12 topics

DC, power, capacitors and inductors, timing, AC, filters, semiconductors, supplies, the 555, op-amps, magnetics, and signals and measurement.

India and North America, equal weight

230 V 50 Hz and 120 V 60 Hz, mm² and AWG, kWh units on Indian bills and kWh on US bills, and every temperature in °C with °F.

Checked numbers

We recomputed every worked example from the values printed in it and checked each result at the digits shown.

Linked to practice

Each formula names its free lesson on electronicsinfoline.com and the workbook chapters that drill it. 6 formulas are new in this edition.

Edition 2.0, November 2026 · A4 and US Letter · 57 pages.
For your own study; please do not share the file.

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How to use this book

Every entry has the same parts. A number and a name; the formula in a box; each symbol with its meaning and unit; one worked example, or two side by side where India and North America differ; and the lesson it comes from on electronicsinfoline.com, with the matching calculator and the chapters of the DC and AC Circuits Workbooks that practise it.

Numbers. Entry 5.12 is the twelfth formula in topic 5. The index at the back lists every formula by name. Put values in the units given in the symbol table (volts, amps, ohms, farads, seconds) unless the entry says otherwise.

Rounding. Results are given to three significant figures unless they come out exact, so 6.10 ns means the third figure really is 0. Keep full precision between steps and round at the end. Page 3 gives the full rules.

How the numbers were checked. We recomputed every worked example from the values printed in it and compared each result with the book at the digits shown. We also redid every intermediate step from the numbers as printed, and checked every formula against its standard textbook form.

"Also used in N more lessons" counts the other lessons on electronicsinfoline.com that show the same formula, as the site stood on 1 November 2026. It is left out for formulas that appear in only one lesson or are written in words there.

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India and North America, and the number rules

Physics is the same on both sides of the world; supplies, wire sizes, bills and thermometers are not. Where it matters, an example is worked twice, labelled India and North America.

Mains supplies

	India	North America (US)
Single-phase	230 V, 50 Hz	120 V, 60 Hz; 120/240 V split-phase
Peak of the sine	325 V	170 V
Three-phase	400 V line, 230 V phase	208Y/120 V; 480Y/277 V
Normal range	±6 % at low voltage, 216–244 V (supply codes)	Range A 114–126 V (ANSI C84.1)
One period	20 ms; ω = 314 rad/s	16.7 ms; ω = 377 rad/s

Electricity bills

Both bill in kilowatt-hours. Indian bills call one kilowatt-hour one **unit**, so 360 units means 360 kWh; US bills print kWh directly. Energy in kWh = power in watts × hours / 1000 (entry 2.5). Multiply by your own tariff; this book quotes no prices.

Temperature

°F = °C × 1.8 + 32 and K = °C + 273.15. A temperature *difference* of 1 °C is 1.8 °F (and 1 K). Every temperature in the examples is given in °C with °F beside it.

°C	-40	0	20	25	40	50	65	85	100	105	125
°F	-40	32	68	77	104	122	149	185	212	221	257

Room 20–25 °C; electrolytic ratings 85 °C and 105 °C; semiconductor junctions 125 °C or more.

Wire sizes: metric (mm²) and AWG

Metric	mΩ/m	Nearest common AWG	Diameter	Area	mΩ/m
0.5 mm²	34.4	20 AWG	0.812 mm	0.518 mm²	33.2
0.75 mm²	22.9	18 AWG	1.02 mm	0.823 mm²	20.9
1.5 mm²	11.5	16 AWG	1.29 mm	1.31 mm²	13.1
2.5 mm²	6.88	14 AWG	1.63 mm	2.08 mm²	8.27
4 mm²	4.3	12 AWG	2.05 mm	3.31 mm²	5.20
6 mm²	2.87	10 AWG	2.59 mm	5.26 mm²	3.27

AWG diameters from $d = 0.127\ \text{mm} \times 92^{(36\ -\ n)/39}$ (entry 12.12). Resistance from $R = \rho L / A$ with copper $\rho = 1.72 \times 10^{-8}\ \Omega\cdot\text{m}$ at 20 °C (68 °F), solid conductor; stranded cable tables allow a few per cent more. 1 mΩ/m = 0.3048 Ω per 1000 ft.

Number rules

- Three significant figures, rounded half up (2.345 → 2.35). Trailing zeros are kept when they are real figures: 9.60 V, 17.0 dB.
- A value that is exact at fewer figures is printed as it is: 600 Ω, 0.25, 7.2 V.
- Where the exact value ends in a 5 just past the third figure (4.465 kΩ), the book prints 4.47 kΩ and the note gives the exact value.
- Numbers of five or more digits are grouped with a thin space: 32 000 h.
- SI prefixes in steps of a thousand (page 53); powers of ten where a prefix would be awkward.
- The working uses rounded constants (page 53 lists them with their exact SI values). Recomputing with the exact values changes no worked result.

New in Edition 2.0

Six formulas: **1.23** Norton current from the Thevenin equivalent (source transformation) · **2.5** Energy in kilowatt-hours (the billing unit) · **5.21** Current drawn by a single-phase load from its power and power factor · **8.8** Ideal duty cycle of a buck (step-down) converter · **12.11** Voltage drop along a two-wire cable run · **12.12** Diameter and area of an AWG wire gauge. Paired India and North America examples, every temperature in °C and °F, and workbook chapter pointers on every entry.

Worked for both regions (18 entries)

These entries carry an India example and a North America example side by side: **2.5** energy in kilowatt-hours (the billing unit) · **2.12** RMS voltage of a sine conducting over part of each half cycle (phase control) · **5.1** period from frequency · **5.2** angular frequency from ordinary frequency · **5.3** instantaneous voltage of a sine wave at time t · **5.4** RMS value of a sinusoidal voltage · **5.8** frequency of the nth harmonic of a fundamental · **5.14** apparent power from RMS voltage and RMS current · **5.17** shunt capacitance that supplies a given reactive power at a given frequency and voltage · **5.18** line-to-line voltage of a balanced wye (star) supply from its phase voltage · **5.20** total real power of a balanced three-phase load from line quantities · **5.21** current drawn by a single-phase load from its power and power factor · **6.4** voltage gain magnitude of a single-pole RC high-pass at a given frequency · **8.2** peak-to-peak ripple across a reservoir capacitor · **11.14** secondary voltage of an ideal transformer from the turns ratio · **11.16** RMS emf of one transformer winding on a sinusoidal flux of stated peak · **12.10** resistance from resistivity and geometry · **12.11** voltage drop along a two-wire cable run.

TOPIC 1 · ENTRIES 1.1–1.23

DC circuits

Ohm's law, series and parallel parts, dividers, sources and bridges. Most other pages lean on these.

1.1 Ohm's law

$$V = IR$$

V	voltage across the part	V
I	current through it	A
R	resistance	Ω

EXAMPLE

A 2.2 kΩ resistor carries 4 mA. What voltage is across it?

V = 4 mA × 2.2 kΩ = 8.8 V

Lesson: Ohm's Law · electronicsinfoline.com/fundamentals/electricity-basics/ohms-law/ · Also used in 83 more lessons

Practise it: DC Circuits Workbook ch. 1

1.2 Conductance as the reciprocal of resistance

$$G = \frac{1}{R}$$

G	conductance	S
R	resistance	Ω

EXAMPLE

What is the conductance of a 470 Ω resistor?

G = 1 / (470 Ω) = 2.13 mS

Note. Siemens (S) is the SI name for the old mho. Conductances in parallel simply add.

Lesson: Resistivity & Conductance · electronicsinfoline.com/fundamentals/electricity-basics/resistivity-conductance/ · Also used in 3 more lessons

Practise it: DC Circuits Workbook ch. 1 · AC Circuits Workbook ch. 3

1.3 Three resistances in series

$$R_s = R_1 + R_2 + R_3$$

R_s	total series resistance	Ω
R_1	first resistance	Ω
R_2	second resistance	Ω
R_3	third resistance	Ω

EXAMPLE

Resistors of 1 kΩ, 2.2 kΩ and 4.7 kΩ are wired end to end. What is the total?

R_s = 1 kΩ + 2.2 kΩ + 4.7 kΩ = 7.9 kΩ

Lesson: Series Circuits · electronicsinfoline.com/fundamentals/dc-circuits/series-circuits/ · Also used in 11 more lessons · **Calculator:** electronicsinfoline.com/calculators/resistor-combination

Practise it: DC Circuits Workbook ch. 2

1.4 Two resistances in parallel

$$R_p = \frac{R_1 R_2}{R_1 + R_2}$$

R_p	combined resistance	Ω
R_1	first resistance	Ω
R_2	second resistance	Ω

EXAMPLE

A 1 kΩ and a 1.5 kΩ resistor sit in parallel. What do they combine to?

R_p = 1 kΩ × 1.5 kΩ / (1 kΩ + 1.5 kΩ) = 600 Ω

Note. The result is always smaller than the smaller resistor. Two equal resistors give half of one.

Lesson: Parallel Circuits · electronicsinfoline.com/fundamentals/dc-circuits/parallel-circuits/ · Also used in 28 more lessons · **Calculator:** electronicsinfoline.com/calculators/resistor-combination

Practise it: DC Circuits Workbook ch. 2

TOPIC 5 · ENTRIES 5.1–5.27

AC, reactance and resonance

Sine waves, RMS values, reactance, impedance, power factor, three-phase supplies and resonant circuits, on 50 Hz and 60 Hz mains.

5.1 Period from frequency

$$T = \frac{1}{f}$$

T	period	s
f	frequency	Hz

EXAMPLE India (50 Hz)

What is the period of the 50 Hz mains?

T = 1 / 50 Hz = 20 ms

EXAMPLE North America (60 Hz)

What is the period of the 60 Hz mains?

T = 1 / 60 Hz = 16.7 ms

Lesson: Frequency & Period · electronicsinfoline.com/fundamentals/ac-circuits/frequency-period/ · Also used in 11 more lessons

Practise it: AC Circuits Workbook ch. 1

5.2 Angular frequency from ordinary frequency

$$\omega = 2\pi f$$

ω	angular frequency	rad/s
f	frequency	Hz

EXAMPLE India (50 Hz)

What is the angular frequency of 50 Hz?

ω = 2π × 50 Hz = 314 rad/s

EXAMPLE North America (60 Hz)

What is the angular frequency of 60 Hz?

ω = 2π × 60 Hz = 377 rad/s

Lesson: Frequency & Period · electronicsinfoline.com/fundamentals/ac-circuits/frequency-period/ · Also used in 8 more lessons

Practise it: AC Circuits Workbook ch. 1

5.3 Instantaneous voltage of a sine wave at time t

$$v = V_{pk} \sin(\omega t + \varphi)$$

v	voltage at time t	V
V_{pk}	peak voltage	V
ω	angular frequency	rad/s
t	time	s
φ	phase at t = 0	rad

EXAMPLE India (230 V, 50 Hz)

The 325 V peak mains sine (ω = 314.16 rad/s) starts at zero (φ = 0). What is it at 2.5 ms?

v = 325 V × sin(314.16 rad/s × 2.5 ms) = 325 V × sin(π/4) = 230 V

EXAMPLE North America (120 V, 60 Hz)

The 170 V peak sine of a 120 V supply (ω = 376.99 rad/s) starts at zero. What is it at 2 ms?

v = 170 V × sin(376.99 rad/s × 2 ms) = 116 V

Note. Set your calculator to radians when ωt is in rad.

Lesson: The Sine Wave · electronicsinfoline.com/fundamentals/ac-circuits/sine-wave/ · Also used in 8 more lessons

Practise it: AC Circuits Workbook ch. 1