Electrical Formulas

VOLTAGE	CURRENT	LOAD	RESISTANCE
$V = IR$	$I = \frac{V}{R}$	$P = \frac{V^2}{R}$	$R = \frac{V}{I}$
$V = \frac{P}{I}$	$I = \frac{P}{V}$	$P = VI$	$R = \frac{V^2}{P}$
$V = \sqrt{PR}$	$I = \sqrt{\left(\frac{P}{R}\right)}$	$P = I^2R$	$R = \frac{P}{I^2}$

V - Voltage measured in Volts (V)

I - Current measured in Amperes (Amps)

R - Resistance measured in Ohms (Ω)

P - Power measured in Watts (W) **N.B.** 1kW = 1000W

Three Phase Calculations For Heater Batteries

V_L - Line Voltage : voltage between lines i.e. R-Y, R-B, B-Y

I_L - Line Current : current through each line.

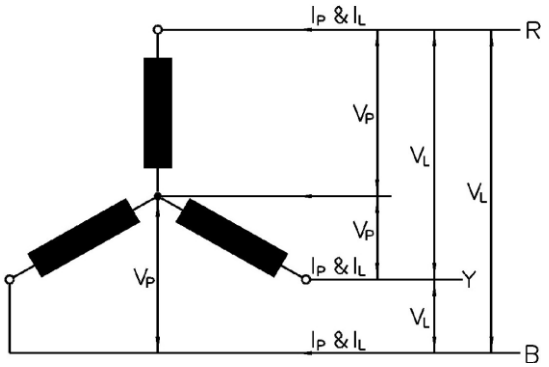
V_P - Phase Voltage : voltage over each phase i.e
Star : R-N, B-N, Y-N; Delta : R-Y, R-B, B-Y

I_P - Phase Current : current through each phase.

P - Load (Power) of the system measured in Watts (W). **N.B.** 1kW = 1000W

Note: Heating elements are purely resistive i.e. they do not possess inductive or capacitive characteristics.

STAR CONNECTED



For Balanced Systems

Line Current (I_L)

$I_L = I_P$

$I_L = P / (\sqrt{3} \times V_L)$

$I_L = P / (3 V_P)$

Line Voltage (V_L)

$V_L = \sqrt{3} \times V_P$

Phase Current (I_P)

$I_P = I_L = P / (\sqrt{3} \times V_L)$

Phase Voltage (V_P)

$V_P = V_L / \sqrt{3}$

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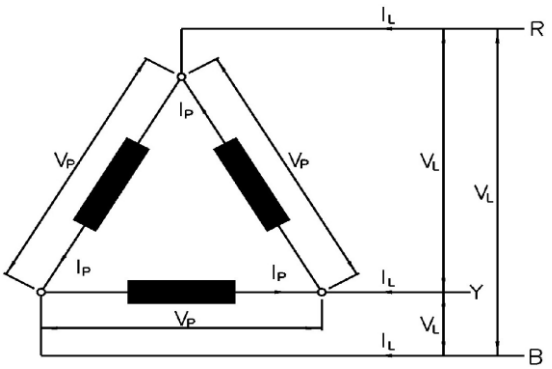
No Responsibility will be accepted for the consequences of any inaccuracies in the data or formulas provided.

DELTA CONNECTED



For Balanced Systems

Line Current (IL)

$$I_L = \sqrt{3} \times I_P$$

$$I_L = P / (\sqrt{3} \times V_L)$$

Line Voltage (VL)

$$V_L = V_P$$

Phase Current (IP)

$$I_P = (1/\sqrt{3}) \times I_L$$

$$I_P = P / V_P$$

Phase Voltage (VP)

$$V_P = V_L$$

Note 1: For a given load the line current in star and delta systems is the same.

Note 2: In star systems where the neutral is left to float and where the system becomes unbalanced, then the voltage across each phase may rise or fall below the phase voltage as stated above. This should be taken into account when selecting components to be wired within a phase, e.g. thermostats should be rated for operation up to the line voltage.

Load Calculation at Various Voltages

All heaters in this catalogue are rated at either 240 volts single phase or 415V volts three phase. The table below gives a list of factors which when multiplied to the loading at either 240 volts or 415 volts will give the equivalent loading at the new voltage.

e.g. A 3kW heater rated at 240V will give 2.5kW (3kW x 0.84) at 220V.

Load Factor	0.84	0.92	1.00	1.12
Single Phase	220V	230V	240V	254V
Three Phase	380V	400V	415V	440V

Note: While there is no detrimental effect of operating a heater at a voltage lower than it's rating, operating the heater at a voltage higher than it's rating may cause the heater to fail prematurely.

General Technical

230V European Harmonization. From the 1st January 1995, the official voltage within the U.K. is 230V single phase or 400V three phase in accordance with CENELEC Harmonization Document HD472-SI.

This has been achieved by widening the tolerance bands and full harmonization will not be completed before 2020. For this reason, all heaters specified by Howden are suitable for 230V single phase or 400V three phase, however the stated loadings are calculated at either 240V single phase or 415V three phase, whichever is appropriate.

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