



 **ULTIMHEAT® UNIVERSITY** 



# **Université Ultimheat**

## **Tableau des différentes méthodes de connexion de résistances chauffantes**

## **Table of different connection methods of heating elements**

**J.Jumeau  
20100424**



### Power formula

P = Power in watts  
U = Voltage  
I = Current in amperes

$$P = UI$$

$$I = P/U \quad U = P/I$$

### OHM'S law

U = Voltage  
R = Resistance in ohms  
I = Current in amperes

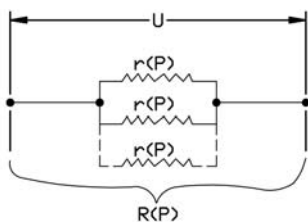
$$U = RI$$

$$R = U/I \quad P = U^2/R \quad R = U^2/P$$

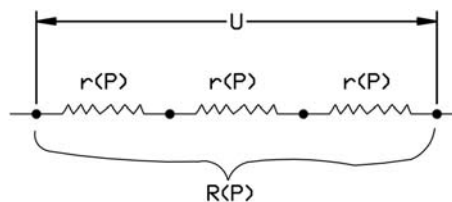
### Heating elements connections

(Heating elements resistance "r" of unit power "p" with nominal voltage "U")

#### Parallel wiring



#### Serial wiring

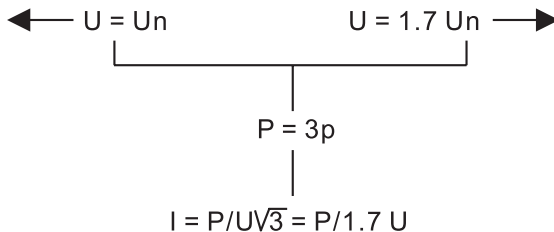
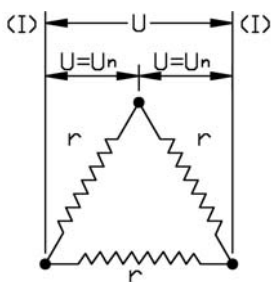


Quantity of elements (n)	Total resistance (R)	Total power (P)
2	$R = r/2$	$P = 2p$
3	$R = r/3$	$P = 3p$
X	$R = r/x$	$P = xp$
NOTE: Watt density (W/cm <sup>2</sup> ) for each element is unchanged		

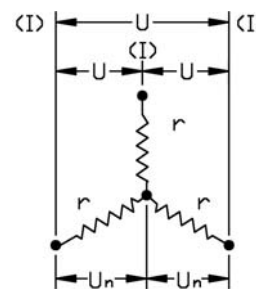
Quantity of elements (n)	Total resistance (R)	Total power (P)	Heating element Watt density (w/cm <sup>2</sup> )
2	$R = 2r$	$P = p/2$	Devided by 4
3	$R = 3r$	$P = p/3$	Devided by 9
X	$R = Xr$	$P = p/x$	Devided by x <sup>2</sup>

### Delta and star element connections

#### Delta connection



#### Star connection



Delta (triangle) connection :			
The voltage supplied to the heating elements is the same than the power supply voltage measured between phases: U= Un			
Supply voltage (U)	230V, 3 phases	230V, 3 phases	400V, 3 phases
Heating elements nominal voltage (Un)	230V	400V	230V
Watt density (W/cm <sup>2</sup> )	No change in watt density	Watt density is divided by 3	Watt density is multiplied by 6
Total power (P)	Total power is 3 time nominal power of one heating element (P= 3 p)	Total power is divided by 9. It is 1/3 of nominal power of one heating element (P= p/3)	Total power is 9 time nominal power of one heating element (P= 9 p)
comments	No problem solution	This can be used a reduced power step by using a Star/ Delta (triangle) connection system	<b>Never use Fire hazard!</b>

Star connection :				
The voltage supplied to the heating elements is the same than the power voltage divided by √3: U= 1.737 Un. Example: power supply is 400V, the heating element is energized with 400/1.737= 230V				
Supply voltage (U)	230V, 3 phases	230V, 3 phases	400V, 3 phases	400V, 3 phases
Heating elements nominal voltage (Un)	230V	400V	230V	400V
Watt density (W/cm <sup>2</sup> )	Watt density is divided by 3	Watt density is divided by 9	No change in watt density	Watt density is divided by 3
Total power (P)	Total power is 1/3 of total possible power: it is the same than one heating element (P=p)	Total power is 1/9 of total possible power. 1/3 nominal power of one heating element (P= 1/3 p)	Total power is 3 time nominal power of one heating element (P= 3 p)	Total power is 1/3 of total possible power. it is the same than one heating element (P=p)
comments	Not recommended	Not recommended	<b>This is the most standard connection, allows the same heaters to be used with 400V star connection or 230V delta connection without power change</b>	Not recommended