11.4 SINGLE-STAGE MODULE CALCULATIONS: These equations mathematically describe the performance of a single-stage thermoelectric module as illustrated in Figure (11-l). When entering numerical data, do not forget that temperature values must be expressed in degrees Kelvin (°K). Calculations of the various parameters should be performed in the order shown.

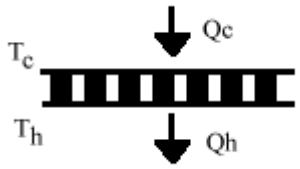


Figure (11-1)

a) The temperature difference (DT) across the module in °K or °C is:

$DT = T_h - T_c$

b) Heat pumped (Qc) by the module in watts is:

$Q_c = (S_M \times T_c \times I) - (0.5 \times I^2 \times R_M) - (K_M \times DT)$

c) The input voltage (Vin) to the module in volts is:

$V_{in} = (S_M \times DT) + (I \times R_M)$

d) The electrical input power (Pin) to the module in watts is:

$P_{in} = V_{in} \times I$

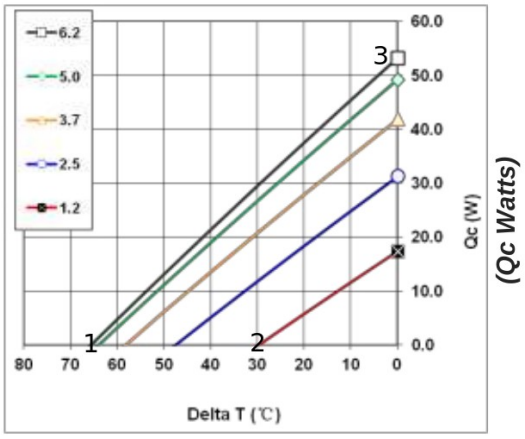
e) The heat rejected by the module (Qh) in watts is:

$Q_h = P_{in} + Q_c$

f) The coefficient of performance (COP) as a refrigerator is:

$COP = Q_c / P_{in}$

Extract peltier parameters from performance Curve (Q_c vs DeltaT)



We can solve eq. (b) for K

$$K=\frac{S*T_c*I-0.5*I^2*R-Q_c}{DT}$$

we can choose two points 1 and 2 on the Curve where $Q_c = 0$ so we have

$$\frac{S*T_{c1}*I_1-0.5*I_1^2*R}{DT_1}=\frac{S*T_{c2}*I_2-0.5*I_2^2*R}{DT_2}$$

$$S*\left(\frac{T_{c1}*I_1}{DT_1}-\frac{T_{c2}*I_2}{DT_2}\right)=0.5*R*\left(\frac{I_1^2}{DT_1}-\frac{I_2^2}{DT_2}\right)$$

$$S*(T_{c1}*I_1*DT_2-T_{c2}*I_2*DT_1)=0.5*R*(I_1^2*DT_2-I_2^2*DT_1)$$
$$R=S*2*\left(\frac{T_{c1}*I_1*DT_2-T_{c2}*I_2*DT_1}{I_1^2*DT_2-I_2^2*DT_1}\right)=S*A$$

if whe consider point 3 in the performance Curve where dT=0 we can write

$$Q_c=S*T_h*I_1-0.5*I_1^2*R=S*(T_h*I_1-0.5*I_1^2*A)$$

$$S=\frac{Q_c}{T_h*I_1-0.5*I_1^2*A}$$

$$R=S*A$$

finally we can consider again point 3 where $Q_c = 0$ in order to calculate K

$$K=\frac{S*T_{c1}*I_1-0.5*I_1^2*R}{DT_1}$$