Petri Dish Heated Envelope

# Specification:

* Maintain an internal temperature of 37.5C +/-2C for 14hrs
* Function in ambient temperatures from 0 C to 36 C
* Under £30 total cost
* High degree of reusability
* Light weight
* Powered by 9V PP3 NiMh Battery

# Assumed form factor:

* Thermally insulated envelope with combined PCB petri dish holder and heater
* Silica gel packet put in envelope to reduce humidity inside envelope
* PCB epoxy dipped (apart from battery holder) for protection from moisture
* Envelope and silica gel is disposable other components re-used.

# Basic calculations:

We need to know if the power source (9V Battery) will be sufficient in the worst case to maintain the 37.5C internal temperature for 14.5hrs.

* Envelope TPS ThermaPack Ultra Double 200MM x 255MM ( <https://tpsolutions.eu/insulated-envelopes.html#order-section>) insulate equivalent to 55 mm polystyrene (R=47.6 mk/w, lower bound). Surface area 0.051m2.
* Assuming worst case temperature differential of 37.5 C (0C ambient) a power input of 40.2 mW is required to maintain this temperature difference inside the envelope.
* Total energy required = 0.5628 J
* Varta Accu 9V PP3 6HR61 200mAh, nominal 8.4V, total energy storage capacity = 1.68 J (sufficient)

We would like to know what length of PCB trace is required to make a trace heater that can dissipate 80 mW (double minimum requirement to ensure envelope gets to temperature quickly and so that minimum heating will be met with large tolerance). A PCB trace is used so that the heating can be distributed around the board to avoid hotspots.

* With 8.4V supply 80mW requires a resistance of 882Ω
* Low cost minimum trace width is 150 um, board plating thickness 1oz.. However this trace would only have resistance of 3.33Ω/m therefore too long a trace would be needed. Therefore to distribute heating we will use many surface mount resistors in a series string rather than a PCB trace.