TEAM

064

Thermo-opti: Thermal Insulation Thickness Optimizer

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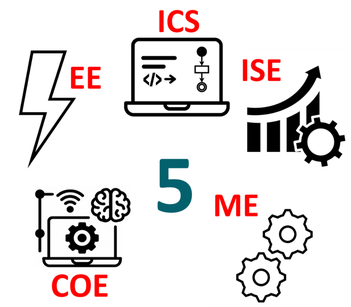


Objective

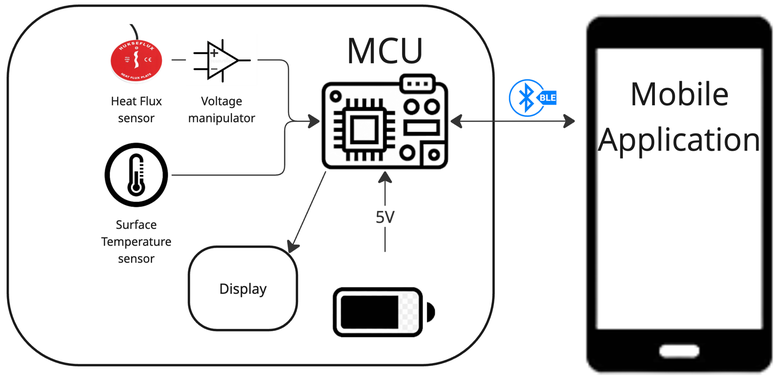
This innovative device is engineered to calculate the optimal thermal insulation thickness to meet user-defined energy efficiency targets. This device distinguishes itself by eliminating the need for wall composition. Featuring an interface and rapid response , it delivers timely, recommendations that streamline the decision-making process, reduce costs, without expert consultations.

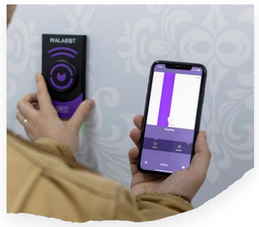
Constraints & Specifications

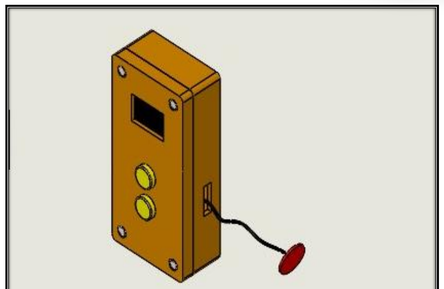
Constraint	Status
5V DC power source	Met
5000 SAR or less	Met
Works for Plannar Surfaces with curvature angle less than 3 degrees	Met
The android app must function correctly on various screen sizes	Met
The device must use a lowpower communication protocol	Met

Specification	Status
The device is going to enter a sleep mode after 2 mins of being passive	Met
Navigation Level Less Than 4	Met
The device should consume less than 15 W	Met
The app should support Android 8.0 and above	Met
Device measurement range of 2000 W/m^2	Met
Sensor Accuracy -+10%	Met
Size<30cmx30cmx30cm	Met
Operation temperature is -20 C to +60 C	Met
Response time: within 2min	Met
Mass<3 kg	Met
Device gives 3 materials recommendations	Met
Insulation thickness at a range of ±15%	Met

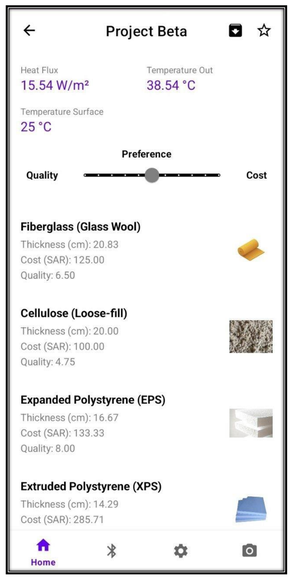
Prototype & Schematics







ITEM NO.	PART NUMBER	MASS (gram)	QTY.
1	Casing - Lower Half	123.53*1.24=153.18	1
2	battery	11	1
3	ESP32 Micro-controller	10	1
4	Screen	12	1
5	Casing - Upper Half	71.813*1.24=89.04	1
6	B18.2.3.2M - Formed hex screw, M5 x 0.8 x 25 --16WN	0.671*7.85*4=21.07	4
7	Screen to ESP32 Wiring	8	1
8	Heatflux Sensor	500	1
	TOTAL	796.29	11



Testing & Validation

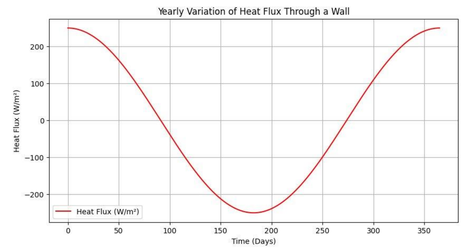
The following data shows the projected/hypothetical results of the testing & validation sessions, they serve as a placeholder currently until the actual data is obtained. These data represents controlled environment tests on three insulation materials.

Insulation Material	Heatflux Pre Insulation (W/m^2)	Heatflux Post-Insulation (W/m^2)	Device Estimated Efficiency%	Actual Efficiency%	Error %
Fiberglass	178.9	48.3	80%	73%	8%
Foam	185.3	46.3	80%	75%	6%
Aluminum	181.4	52.6	80%	71%	11%

Theory & Simulation

$$q''_{sensor} = \frac{T_1 - T_4}{\frac{x_1}{k_1} + \frac{x_2}{k_2} + \frac{x_3}{k_3}} = \frac{T_1 - T_4}{R_1 + R_2 + R_3} = \frac{T_1 - T_4}{R_{total}}$$

$$T_{\text{outside}} = T_{\text{avg}} + T_{\text{amp}} \times \cos\left(\frac{2\pi t}{365}\right)$$



$$R_{total} = \frac{T_1 - T_4}{q''_{sensor}}$$

$$L_i = K_i \left(\frac{\Delta T_{\max}}{q_{\text{target}}} - R_{\text{wall}} \right)$$