



# gSKIN® application note: U-value measurement in occupied building

U-values of walls can be measured in a reliable way via heat flux measurements. Different types of walls, varying widely in thermal performance, can be assessed accurately. However, concerns were raised about the influence of external conditions on the outcome of the measurement. This is an important issue to address since heat flux measurements are often performed in occupied properties in which constant conditions are hard to reach.

To check the performance of the U-Value KIT under unstable conditions, two measurements are conducted in an occupied apartment room facing large deviation in temperatures. The results allow for an evaluation of the influence of temperature changes on the measurement. Moreover, the reproducibility of such a measurement can be assessed.

## Measurement description

The property which is assessed is an apartment building from 1990 that has not faced large renovation since then. The observed building envelope is a 32 cm thick concrete wall. The building owner could not provide any information about the insulation material or quality. A wall at the north side of the building has been measured. The inside temperature is fluctuating due to changing heater settings and the ventilation through open windows. The heat flux sensor has been mounted to the inside of this wall with the inside temperature sensor next to it, approximately 5 cm distance from the wall surface. The outside temperature is attached on the other side of the wall also around 5 cm from the wall. The measurement periods for both measurements were around 96 hours (4 days) since this time period was required to get a measurement in line with ISO.

## Results

The graphs below show the results of the two measurements. The graphs include the heat flux, inside temperature, outside temperature and the U-value. A table with a quantification of the measurement results is also provided.

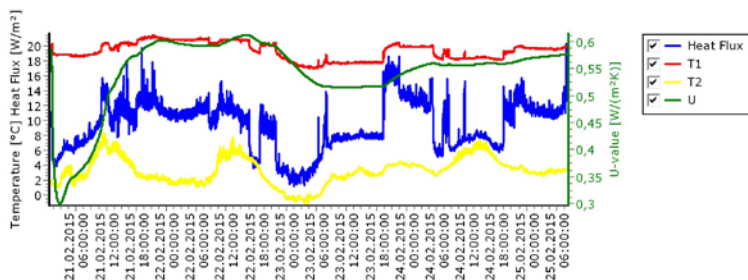


Figure 1: Results of heat flux measurement (Report on basis of greenTEG Software v1.00.03. 2015)

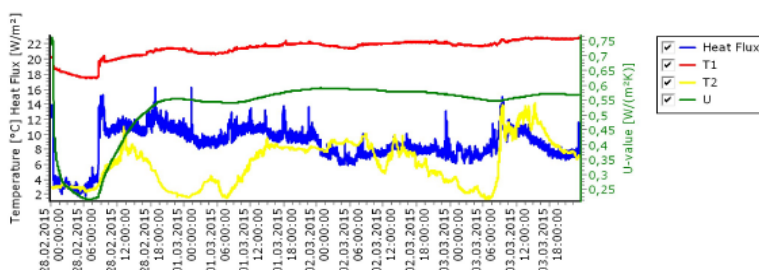


Figure 2: Results of the heat flux measurement (Report on basis of greenTEG Software v1.00.03. 2015)



Table 1: Quantitative results of both measurements

	U-value (W/m <sup>2</sup> K)	Std. Dev.	dU 24h	Measurement time (h)
Measurement 1	0,58	6.7%	3.6%	103
Measurement 2	0.57	10.0%	0.32	95

Figure 1 shows strong temperature fluctuations in the room during the whole measurement period. This was caused by opening and closing of windows and by turning the heating system off and on. The measured heat flux is heavily influenced by the inside temperatures. All the peaks of the heat flux are an instant reaction on a sudden rise of the temperature. The heat flux is fluctuating between 3 W/m<sup>2</sup> and 18 W/m<sup>2</sup>. This has its impact on the calculated average U-value. The average U-value is however rather stable with a standard deviation of 6.7% and a change of only 3.6% in the last 24 hours. The measurement is therefore in line with ISO 9869.

The second measurement has less sudden temperature changes. After the first morning when the window was closed only slight inside temperature changes occurred due to the heating system. The second part of this measurement has therefore a relatively stable heat flux. Although the large temperature increase after the first hours resulted in a slightly higher overall standard deviation, the value over the last 24 hours is very stable (0.32% difference). The outside temperature deviates significantly over time. The impact of the outside temperature fluctuations seems to be more spread out and delayed with a few hours due to the thermal mass of the wall.

Despite the differences in the course of the measurement, the difference in the measured U-value is negligible (0.01 W/m<sup>2</sup>K). The inside temperature changes have a large impact on the measured heat flux but the impact on the long term average of the U-value seems to be levelled out for a large part. Despite the large fluctuations in especially the first measurement, both measurement were in line with ISO after approximately 4 days.

## Conclusion

This case-study shows that a measurement in accordance with the ISO norm can be conducted in a reasonable time, even when the conditions within a building are varying considerably due to the daily routines of the building occupants. Moreover, the results can be easily reproduced by conducting a new measurement a week later. This indicates that a heat flux measurement with greenTEG's U-Value KIT does not affect the daily routines of building occupants at all.

Inside temperature changes have a very large and instant effect on the measured heat flux and therefore on the U-value as well. Over time the impact on the calculated average U-value is levelled out. However, it is advisable to keep the inside temperature constant to reach a reliable U-value as fast as possible. The impact of the outside temperature on the heat flux is less obvious but can also be substantial. A measurement should therefore preferably last a multiple of 24 hours, taking into account the daily change in temperature.