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Project	:	Heat Energy loss in Scanvogn Products

Heat Energy loss in Scanvogn Products

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REVISION RECORD

Rev. No.	Date	Section(s)	Page(s)	Reason

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1. GENERAL

1.1 Project Description

The heat loss and U values of Scanvogn Trailers are to be determined by testing.

1.2 Scope of Document

The purpose of this document is to provide evidence of the tests performed and describe the methodology used. The document shall serve as documentation of the actual heatloss for Scanvogn Products.

1.3 Definitions

Client : Scanvogn A/S
Contractor : n/a
Project : Energiregnskab

1.4 Abbreviations

-

2. REFERENCES

2.1 Codes & Standards

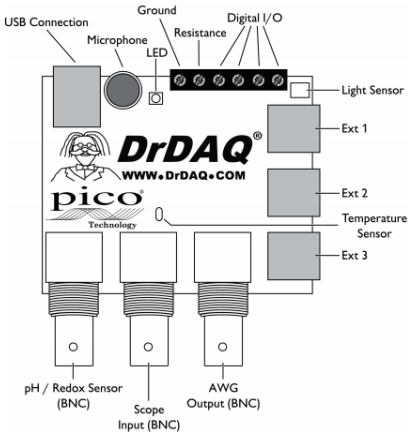
Ref.	Doc. number	Title
/1/	DS 418:2011	Beregning af bygningers varmetab
/2/	BR15	Bygningsreglement 2015 (BR15)
/3/	CENELEC	CENELEC Harmonization Document HD 472 S1:1988

3. Methodology

3.1 Test conditions

Each test will be performed during night time to avoid radiation from the sun. At the same time this allows for the highest possible temperature difference between the inside of the subjects and the environment. In optimal conditions the test shall be performed at wintertime to allow for a temperature difference of at least 32 degrees. The first tests will however be performed during summer at approximately 12 degrees' Celsius environmental temperature. The internal temperature will be targeted at a mean value of 34 degrees C. The test has been run for 6 hours with data sampling rate of test has been run for 6 hours with data sampling rate of one sample pr. Two seconds.

3.2 Test equipment & Design



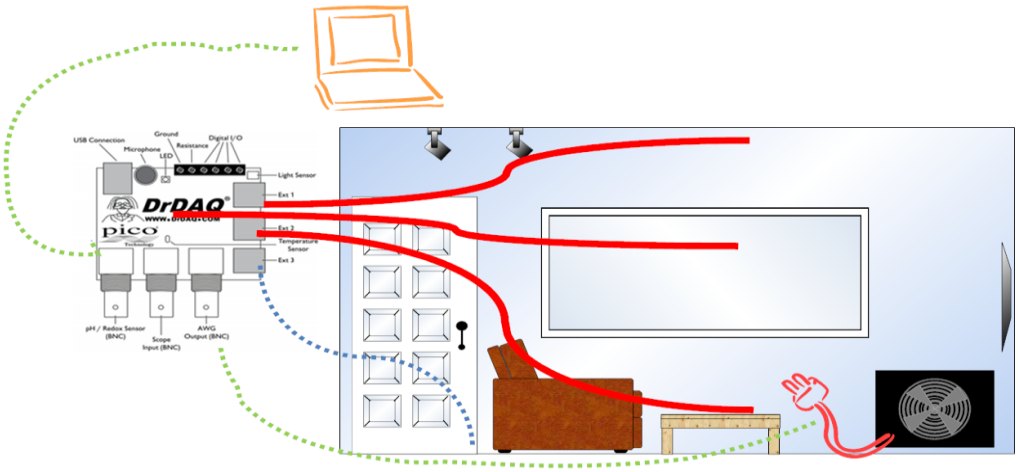
3.2.1 DAQ equipment

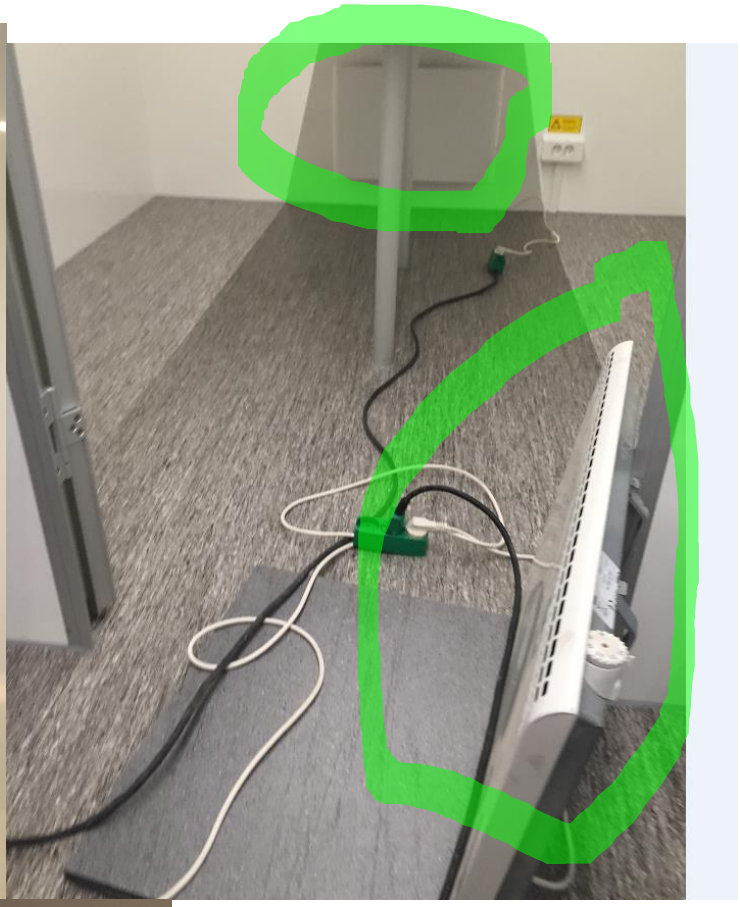
The data logger used is a Picotech 14 channel logger with a maximum sampling rate of 1kS/s.

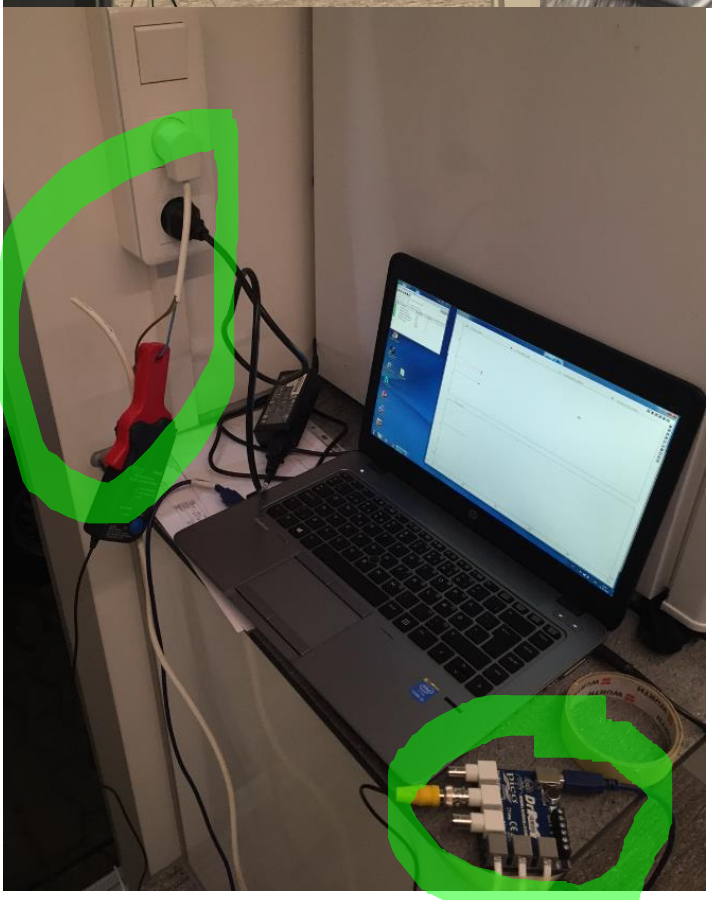
As the hot air rises the data logger will record internal temperatures at three different levels and the mean value will be used for calculation. One sensor will be placed outside the subject to record the reference temperature of the environment. A 1000W electrical radiator will be used to heat up the inside of the subject. The current will be recorded continuously.

The temperature sensors is PT100 with 2000mm cord and can measure in the range of -10 to +105 deg.C.

The current is measured with a 60 C AC/DC probe with input ranges; Low (1 mV/10 mA): 10 mA to 20 A
High (1 mV/100 mA): 100 mA to 60 A







3.2.2 General Calculations & Formulas used

Heat loss (Samlede Transmissionstab Φ) :

$U := 240$

$W := I \cdot U$

Total heat loss from test[J/s]: $\Phi_{test} := W$

Allowed heat loss : (Ref.BR15;2020) $\Phi_{allowed} := \sum_{n=1}^{n} \Delta K \cdot A \cdot U_{værdi}$

Floor area [m^2]: $A := 17.28$

Calculated U_value pr. sqm trailer (Uværdi)[W/m^2K]: $U_{værdi} := \Phi = \Delta K \cdot A \cdot U_{værdi} \xrightarrow{U_{værdi}} ?$

Calculated U_value pr. sqm panel (Uværdi)[W/m^2K]:

3.2.3 Heat loss from test on 520 Mandskabsvogn

Origin := 0

data :=

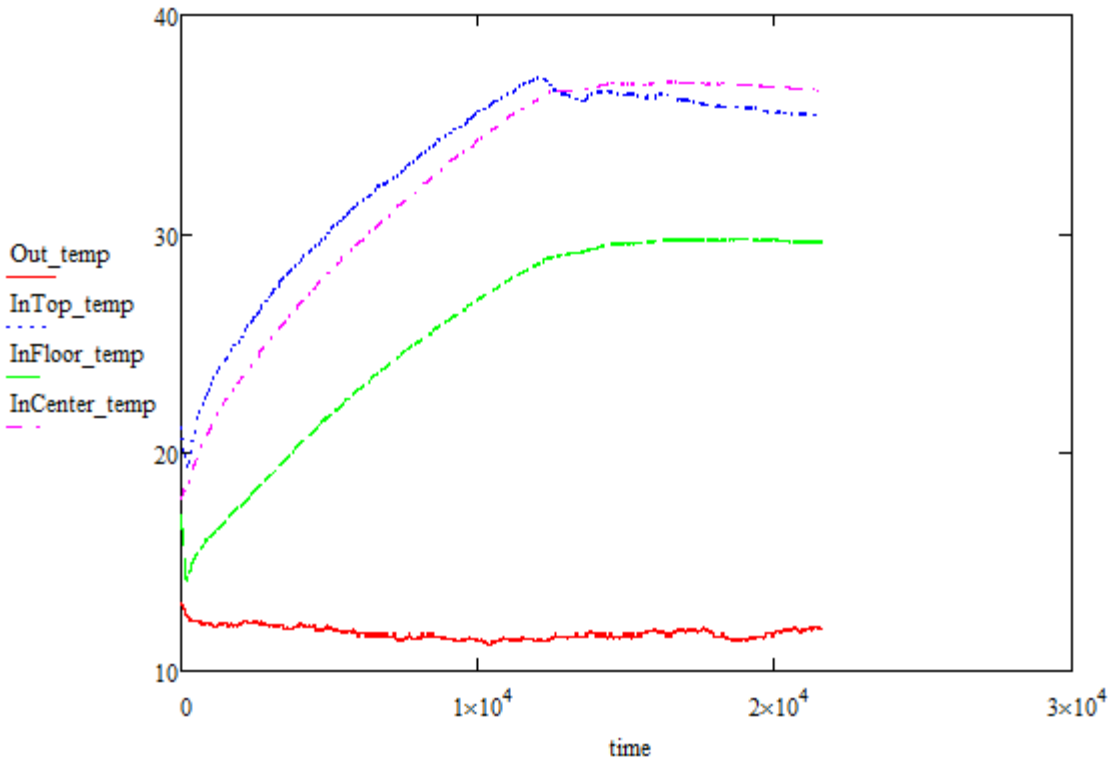
300616_test_1-2.txt

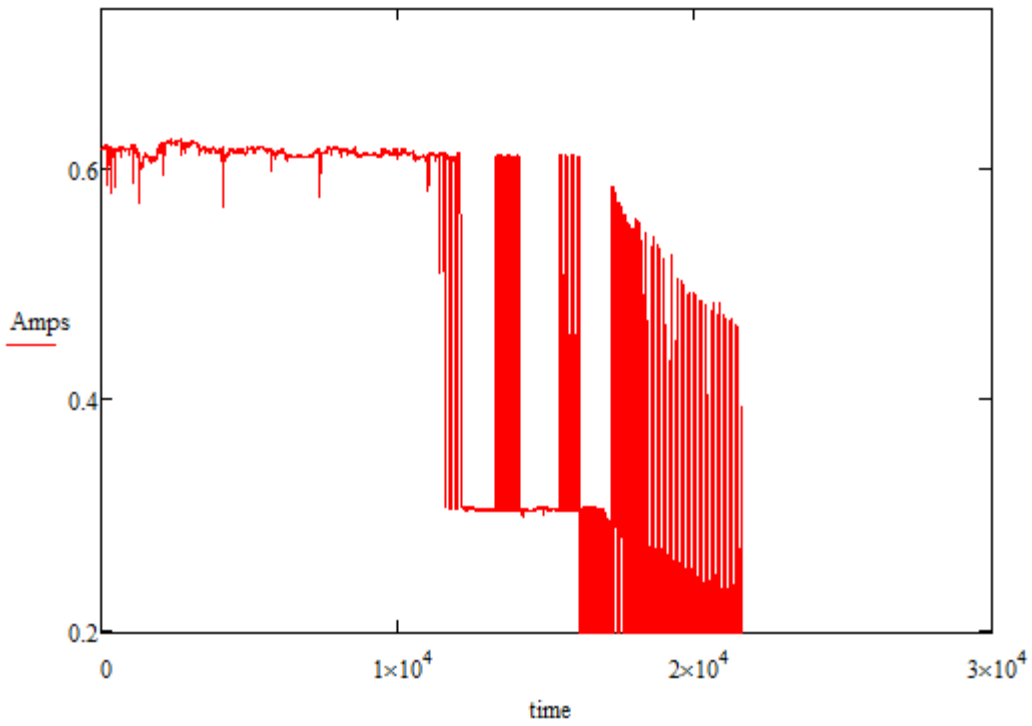
time := data$^{\langle 0 \rangle}$ Out_temp := data$^{\langle 1 \rangle}$ InTop_temp := data$^{\langle 2 \rangle}$

InFloor_temp := data$^{\langle 3 \rangle}$ InCenter_temp := data$^{\langle 4 \rangle}$ Amps := data$^{\langle 5 \rangle}$

data =

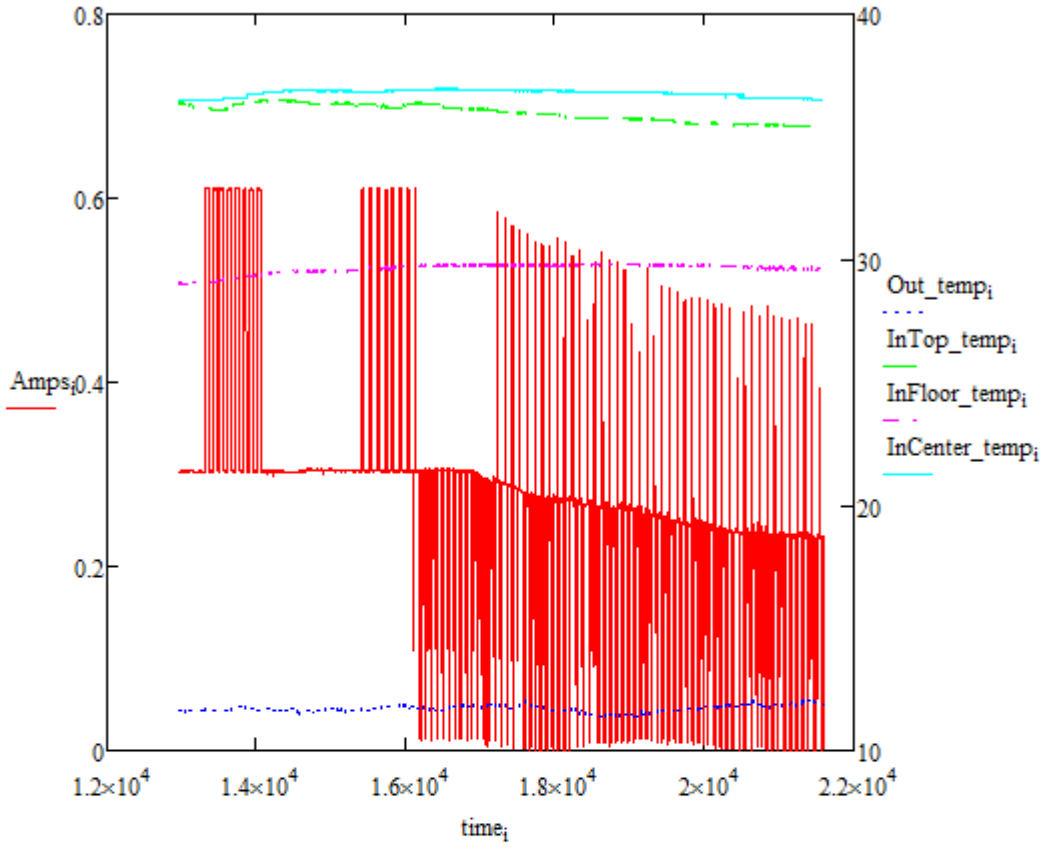
	0	1	2	3	4	5
6477	$1.296 \cdot 10^4$	11.6	36.4	29	36.5	0.303
6478	$1.296 \cdot 10^4$	11.6	36.3	29	36.5	0.304
6479	$1.296 \cdot 10^4$	11.6	36.3	29.1	36.5	0.303
6480	$1.296 \cdot 10^4$	11.6	36.4	29	36.5	0.303
6481	$1.296 \cdot 10^4$	11.6	36.3	29	36.5	0.303
6482	$1.297 \cdot 10^4$	11.6	36.3	29	36.5	0.303
6483	$1.297 \cdot 10^4$	11.6	36.4	29	36.5	0.303
6484	$1.297 \cdot 10^4$	11.6	36.4	29	36.5	0.303
6485	$1.297 \cdot 10^4$	11.6	36.3	29	36.5	0.303
6486	$1.297 \cdot 10^4$	11.6	36.3	29	36.5	0.303
6487	$1.298 \cdot 10^4$	11.6	36.3	29	36.5	0.303
6488	$1.298 \cdot 10^4$	11.6	36.3	29	36.5	0.303
6489	$1.298 \cdot 10^4$	11.6	36.3	29	36.5	0.303
6490	$1.298 \cdot 10^4$	11.6	36.3	29	36.5	0.303
6491	$1.298 \cdot 10^4$	11.6	36.3	29	36.5	0.303
6492	$1.299 \cdot 10^4$	11.6	36.3	29	36.5	...

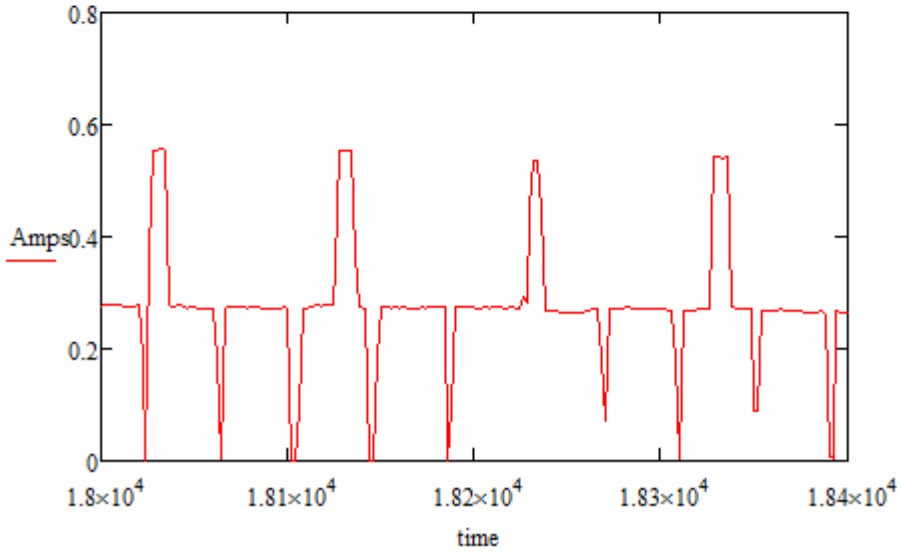




$m := 6479 \quad n := 10799$

$i := m .. n$





$m := 8300 \quad n := 10799$

$T_{inTop} := submatrix(InTop\_temp, m, n, 0, 0)$

$T_{inFloor} := submatrix(InFloor\_temp, m, n, 0, 0)$

$T_{inCenter} := submatrix(InCenter\_temp, m, n, 0, 0)$

$Time_1 := submatrix(time, m, n, 0, 0)$

$T_{out} := submatrix(Out\_temp, m, n, 0, 0)$

$I := submatrix(Amps, m, n, 0, 0) \cdot 10$

Voltage: $U := 230$

Mean value Current: $I_{mean} := mean(I) = 2.538$

Calculated Heat loss [W]: $\lambda := I_{mean} \cdot U = 583.628$

$mean(T_{inTop}) = 35.73$

$mean(T_{inFloor}) = 29.721$

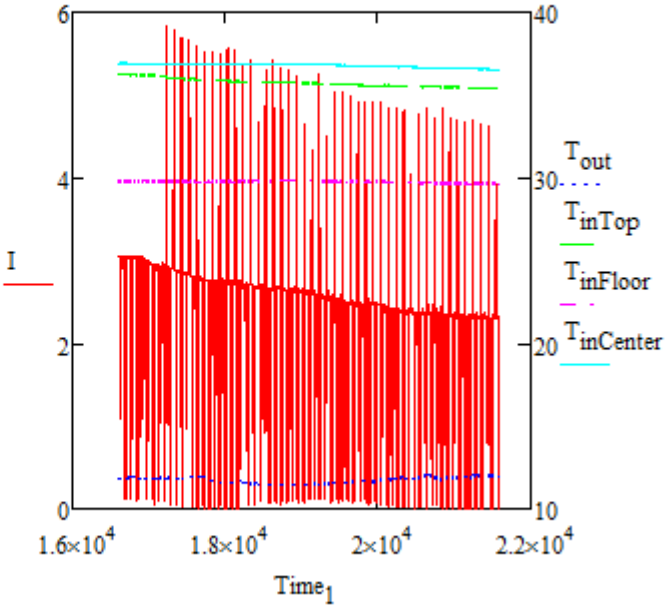
$mean(T_{inCenter}) = 36.762$

Mean temperature inside: $T_{inside} := mean(T_{inTop}, T_{inFloor}, T_{inCenter}) = 34.071$

Mean temperature Outside: $T_{outside} := mean(submatrix(Out\_temp, m, n, 0, 0)) = 11.728$

$\Delta K := T_{inside} - T_{outside} = 22.343$

$$Hrs := \frac{\left(Time_{1_{n-m}}\right) - \left(Time_{1_1}\right)}{3600} = 1.388$$



Tolerance of Ampaere Prope [in % @100mA-40A(40Hz-1kHz):

$$I_{tol} := \begin{pmatrix} 2 \\ -2 \end{pmatrix}$$

$$W := \left(I_{mean} + \frac{I_{mean} \cdot I_{tol}}{100}\right) \cdot U = \begin{pmatrix} 595.3 \\ 571.955 \end{pmatrix}$$

Tolerance of voltage[in %] (CENELEC Harmonization Document HD 472 S1:1988):

$$U_{tol} := \begin{pmatrix} 10 \\ -10 \end{pmatrix}$$

$$W := \left(I_{mean} + \frac{I_{mean} \cdot I_{tol}}{100}\right) \cdot U + U \cdot \frac{U_{tol}}{100} = \begin{pmatrix} 618.3 \\ 548.955 \end{pmatrix}$$

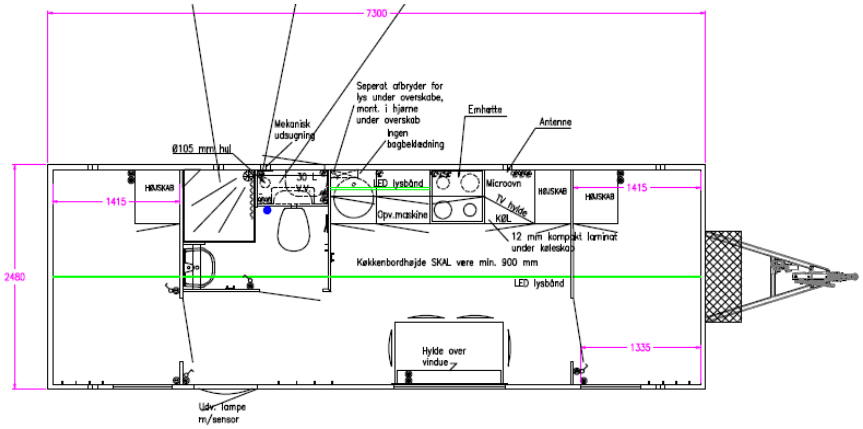
3.2.4 Total allowed heat loss for 520 Mandskabsvogn

Max heat loss 520 Mandskabsvogn @ deltaK = 22,4

Description(Danish)	Area [m^2]	Required U value [W/m²K]	Temp.1	Temp.2	
Wall panels	30,571975	0,2	11,6	34	136,9624
Floor	12,54	0,12	11,6	34	33,70752
Roof	12,54	0,15	11,6	34	42,1344
Windows ans doors	2,608025	1,5	11,6	34	87,62964
Partitonwall to technical room	1,85	0,4	11,6	34	16,576
Roof hatch	0,079	1,8	11,6	34	3,18528
Linear Loss	Længde [m]	W/mK			
Foundation	0	0,2	11,6	34	0
Connection of windows and doors	11,224	0,03	11,6	34	7,542528
Connection of roof hatch	0	0,1	11,6	34	0
		Total allowed heatloss [W]			327,7378

3.2.5 Total allowed heat loss for 1000178 - 730 - 4P Beboelsevogn – Gulvarme

A typical temporary accommodation trailer is used to calculate the effective total heat loss allowed according to Bygningsreglement 2015 (BR15) table 3 exhibit 6.



Max heat loss 1000178 @ deltaK = 32

Description(Danish)	Area [m^2]	Required U value [W/m²K]	Temp.1	Temp.2	
Wall panels	38,348595	0,2	-12	20	245,431
Floor	17,28	0,12	-12	20	66,3552
Roof	17,28	0,15	-12	20	82,944
Windows ans doors	3,891405	1,5	-12	20	186,7874
Roof hatch	0	1,8	-12	20	0
Linear Loss	**Length [m]**	**W/mK**			
Foundation	0	0,2	-12	20	0
Connection of windows and doors	8,278	0,03	-12	20	7,94688
Connection of roof hatch	0	0,1	-12	20	0
		Total allowed heat loss [W]			589,4645

3.3 Acceptance Criteria

As a vehicle or temporary structure there is no regulated minimum requirement. However, the results will be compared to European building codes.

Following is copied from Ref./2/, thus text is only available in Danish.

4. Midlertidige, flytbare pavilloner Ref./2/.
Midlertidige, flytbare pavilloner er pavilloner, der opstilles f.eks. som led i renovering af en skole, en børneinstitution eller en kontorbygning eller for at løse et akut pladsbehov, herunder genhusning. Midlertidig er her 0-5 år. Permanente pavilloner eller pavillonerne, der benyttes udover 5 år, skal opfylde de gældende krav til nybyggeriet.

Midlertidige, flytbare pavilloner skal opfylde bygningsreglementets bestemmelser. For isolering af klimaskærmen gælder bestemmelserne i tabel 3.

Frem til 2020 er det for midlertidige, flytbare pavilloner tilladt at anvende direkte elvarme for opstillinger op til 2 år. For opstillinger mellem 2 og 5 år, skal direkte elvarme midlertidigt erstattes af anden varmeforsyning, eller der skal kompenseres herfor ved etablering af tilsvarende produktion af vedvarende energi. Efter 2020 forventes det, at direkte elvarme alene kan forekomme i forbindelse med etablering af tilsvarende produktion af vedvarende energi, uanset opstillingsperiodens længde.

Nybyggede pavillonmoduler skal være forberedt for anden varme end direkte elvarme. Det kan for eksempel være ved at forberede for vandbåren varme.

Det er en betingelse for anvendelsen af U-værdierne og linjetabene i tabel 3, at det samlede areal af vinduer og døre ikke overstiger 22 pct. af det opvarmede etageareal.

U-værdier og linjetab kan ændres og vinduesareal mv. forøges, hvis pavillonens varmetab ikke derved bliver større, end hvis kravene i tabel 3 var opfyldt.

Tabel 3. U-værdier og linjetab for midlertidige, flytbare pavilloner

Skema med U-værdier for pavilloner	**W/m²K**
Ydervægge	0,20
Skillevægge mod rum, der er uopvarmede eller opvarmet til en temperatur, der er mere end 5 °C lavere end temperaturen i det aktuelle rum.	0,40
Terrændæk og etageadskillelser over det fri eller ventileret kryberum.	0,12
Loft- og tagkonstruktioner, herunder skunkvægge, flade tage og skråvægge direkte mod tag.	0,15
Vinduer herunder glasvægge, yderdøre, porte og lemme mod det fri eller mod rum, der er uopvarmede eller opvarmet til en temperatur, der er mere end 5 °C lavere end temperaturen i det aktuelle rum (gælder ikke ventilationsåbninger på under 500 cm²).	1,50
Ovenlysvinduer og ovenlyskupler.	1,80
Linjetab	**W/mK**
Fundamenter	0,20
Samling mellem ydervæg, vinduer eller yderdøre, porte og lemme.	0,03
Samling mellem tagkonstruktion og ovenlysvinduer eller ovenlyskupler	0,10

4. RESULTS

Subject	@ delta K	Allowed heat loss [W]	Measured Heat loss [W]	Tolerance H/L[W]
520 Mandskabsvogn	22,4	327,7	583,6	595/572

4.1 Conclusion

5. EXHIBITS

5.1 DAQ logger Datasheet

PRODUCT SPECIFICATIONS

VERTICAL

Number of channels	14
Bandwidth	100 kHz
Resolution	8 bits
Input characteristics	BNC connector, 1 MΩ, DC coupled
Input ranges	±1.25 V, ±2.5 V, ±5 V, ±10 V
DC accuracy	±3 %
Input sensitivity	10 µs/div to 200 s/div
Input overvoltage protection	±30 V

HORIZONTAL

Maximum sampling rate*	1 MS/s
Maximum sampling rate (continuous USB streaming)*	1 kS/s (Using PicoLog and PicoScope software) 100 kS/s (Using the supplied API)
Buffer memory*	16 kS
Buffer memory (continuous USB streaming)*	1 MS Unlimited using API

* Shared between active channels

FUNCTION GENERATOR/ARBITRARY WAVEFORM GENERATOR

Connector	1 x BNC
Standard output signals	Sine, square, triangle, DC voltage, ramp
Standard signal frequency	DC to 20 kHz
Output voltage range	±1.5 V amplitude plus ±1.5 V offset
AWG update rate	2 MS/s
AWG buffer size	4096 samples
AWG resolution	10 bit

GENERAL

PC connectivity	USB 2.0 (USB 1.1 compatible)
Dimensions	77 x 70 x 23 mm (3 x 2.7 x 0.9 in approx.) including BNC connectors
Weight	60 g (2.1 oz approx.)
Power requirements	Powered from USB connection
Temperature	Operating: 0 °C to 70 °C (20 °C to 30 °C for stated accuracy). Storage: -20 °C to 80 °C.
Humidity	Operating: 5% to 80% RH, non-condensing. Storage: 0% to 95% RH, non-condensing.
Compliance	FCC (EMC), CE (EMC and LVD), RoHS compliant
Languages - PicoLog	English, French, German (full support). Italian, Spanish, Swedish (software only).
Languages - PicoScope	English, Chinese (Simplified), Chinese (Traditional), Czech, Danish, Dutch, Finnish, French, German, Greek, Hungarian, Italian, Japanese, Norwegian, Polish, Portuguese, Romanian, Russian, Spanish, Swedish, Turkish
Kit contents	DrDAQ data logger, USB 2.0 cable, user manuals, software CD

BUILT-IN SENSORS/OUTPUTS

Type	Range	Resolution	Accuracy
Sound waveform	±100	±0.2	Not calibrated
Sound level	55 dB to 100 dB	1 dB	5 dB
Temperature	-10 to +70 °C (+14 to +158 °F)	0.1 °C @ 25 °C (0.18 °F @ 77 °F)	2 °C @ 25 °C (3.6 °F @ 77 °F)
Light	0 to 100	0.1	Not calibrated
RGB LED	16.7 million colours	8 bit x 3	Not applicable

ANALOG INPUTS

Type	Channel	Range	Resolution	Accuracy
pH	BNC (shared)	0 to 14 pH	0.02 pH	Sensor-calibration dependent
Redox/ORP (Oxidation/Reduction)		±2 V @10^{12} Ω	1.2 mV	Sensor-calibration dependent
Resistance	screw terminal	0 to 1 MΩ	250 Ω @ 10 k	5%
External sensors	3 x FCC68 4/4	Measure 0 to 2.5V (Also supply power to external sensors and identify sensor type via ID resistor)	1 mV	1%

DIGITAL I/O, CONFIGURABLE

Channels	4 (screw terminals)
Input characteristics	0 to 5 V (Low: Ground to 0.8 V, High: 2 to 5.5 V), TTL compatible.
Output characteristics	3.3 V, 2.2 kΩ output impedance
PWM output	Period and Pulse: < 65535 µs. Resolution: 1 µs.
Pulse counting	up to 65535 counts @ 1 MHz

USB DrDAQ

5.1 Exhibit 1 – Test journals

AX number	Drawing Number	Description