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Report

on the testing of the device „motor with permanent magnets”

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Accepted: _____ Signature

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Table of contents

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Technical assignment Nr.1

1. To complete the testing of the device GEB 3500 - "motor with permanent magnets" (hereinafter: DPM) by means of dynamometric bench:
    a. To determine the mechanical power on the motor shaft;
    b. To determine the electric power consumed by the motor;
    c. To calculate efficiency factor of the motor;
    d. To determine an optimal operation point of the motor at 3000 rev/min;
    e. To determine the temperature of the motor at 3000 rev/min and variable load;
2. To complete the protocol of the measurements;
3. To illustrate the obtained data in graphically.

The testing of the device DPM took place on August 31, 2016 at the presence of a customer representative. The customer agreed with the proposed testing and calculation methodology and the working process.

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List of the applied devices

1. Sensor of torque: ETH messtechnik DRBK-100n
2. Power measurement device: PPA
3. Loading motor: induction machine 7.5kW
4. Control of the loading motor: ABB ACS-880 11kW frequency converter
5. Loading variable resistances: total resistance 140 Ω
6. Voltmeter
7. Supply source of the torque sensor:
8. AC-DC converter: (provided by the customer)

Methodology of the testing

The testing is realised by the measurement of the torque developed on the motor shaft, the number of the shaft revolutions and the instantaneous value of electric power consumed by the motor from the DC supply.

The measurements of the tested DPM parameters are performed in accordance with the scheme in fig.1. The mechanical power developed by DPM is calculated as:

$$P_m = M \cdot n \cdot \frac{2 \cdot \pi}{60} \approx \frac{M \cdot n}{9{,}55}, \quad (1)$$

where M – the torque developed on the motor shaft (measurement by means of DRPK-100n), n – the number of revolutions of the motor shaft (measurement by means of ABB ACS-880 frequency converter) measured in accordance with the scheme in fig.1.

The efficiency factor of the electric machine is calculated as:

$$\eta = \frac{P_m}{P_e}, \quad (2)$$

where Pe – electric power supplied to the motor, Pm – mechanical power developed by the motor.

The measurements are made twice (2 times) with the motor loading increased and decreased at the values of 500W, 1000W, 1500W and 2400W, maintaining the number of the shaft rotation speed at the level of 3000 rev/min.

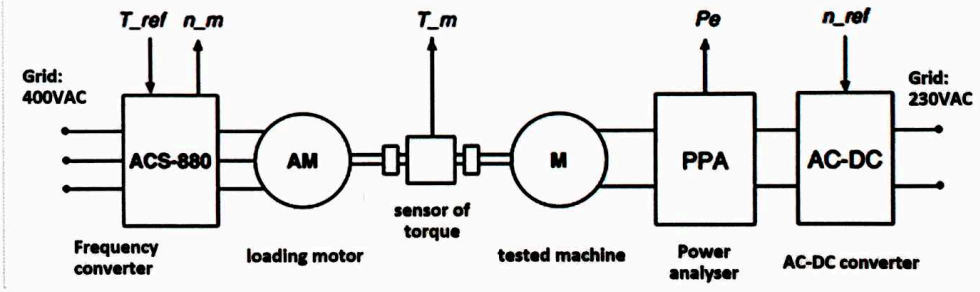

Fig.1. The principal scheme of the testing bench: T_ref – reference torque; n_ref – reference speed (indirectly supplied by means of output voltage of the converter); n_m – measured speed; T_m – measured torque (indirectly measured by means of voltmeter); Pe – electric power

Calculations

The data are fixed and processed in MS Excel software. The protocol of the measurements is available in Appendix 1.

Calculation of error of direct measurements

The errors of the direct measurements are calculated from the number of the measurements:

$$\Delta X = t(\beta) \cdot \sqrt{\frac{\sum_{i=1}^{k}(X_{vid} - X_i)^2}{k \cdot (k-1)}}, \quad (3)$$

where X – measurable parameter; $t(\beta)$ – Student's distribution, k – number of measurements; X_{vid} – average value of the measurements; X_i – the i-th value of the measurements.

Table 1. Student's distribution

measurement	confidential probability		
	90%	95%	99%
3	2,920	4,303	9,925
4	2,353	3,182	5,841
5	2,132	2,776	4,604
6	2,015	2,571	4,032
7	1,943	2,447	3,707
8	1,895	2,365	3,499
9	1,860	2,306	3,355
10	1,833	2,262	3,250
11	1,812	2,228	3,169
12	1,796	2,201	3,106
13	1,782	2,179	3,055
14	1,771	2,160	3,012
15	1,761	2,145	2,977
16	1,753	2,131	2,947
17	1,746	2,120	2,912
18	1,740	2,110	2,898

In a particular case $t(\beta)$ for 4 measurements is assumed 2.352, $t(\beta)$ for 3 measurements it is assumed 2.920. The distribution states that the measurements are valid for 90% of the cases.

Calculation of errors of indirect measurements

Indirectly measured values are those for the obtaining of which the calculations are applied: mechanical power and efficiency factor. The error is calculated by means of partial error application method:

$$\Delta P_{mM} = (M + \Delta M) \cdot n \cdot \frac{2\pi}{60} - M \cdot n \cdot \frac{2\pi}{60}, \quad (4)$$

$$\Delta P_{mn} = M \cdot (n + \Delta n) \cdot \frac{2\pi}{60} - M \cdot n \cdot \frac{2\pi}{60}, \quad (5)$$

$$\Delta P_m = \sqrt{\Delta P_M^2 + \Delta P_n^2}, \quad (6)$$

where ΔP_{mM} – partial error of mechanical power by torque; ΔP_{mn} – partial error of mechanical power by shaft revolutions; ΔP_m – error of mechanical power. The error of the efficiency factor of the device is calculated in the similar way:

$$\Delta\eta_{P_m} = \frac{P_m+\Delta P_m}{P_e} - \frac{P_m}{P_e}, \quad (7)$$

$$\Delta\eta_{P_e} = \frac{P_m}{P_e+\Delta P_e} - \frac{P_m}{P_e}, \quad (8)$$

$$\Delta\eta = \sqrt{\Delta\eta_{P_m}^2 + \Delta\eta_{P_e}^2}, \quad (9)$$

where $\Delta\eta_{Pm}$ – partial error of the efficiency factor by mechanical power; $\Delta\eta_{Pe}$ – partial error of the efficiency factor by electric power; $\Delta\eta$ – error of the efficiency factor.

Class of efficiency

IEC 60034-30-1 is an international standard determining the efficiency class of AC electric motors.

In accordance with this standard a 2 poles pairs motor of 2.2kW power corresponds to the following minimum requirements in each IE class:

79,7% - IE1 – standard efficiency
83,2% - IE2 – high efficiency
85,9% - IE3 - premium efficiency
88,0% - IE4 – super-premium efficiency

The distribution of efficiency in classes for the motors of different power is given in fig.2.

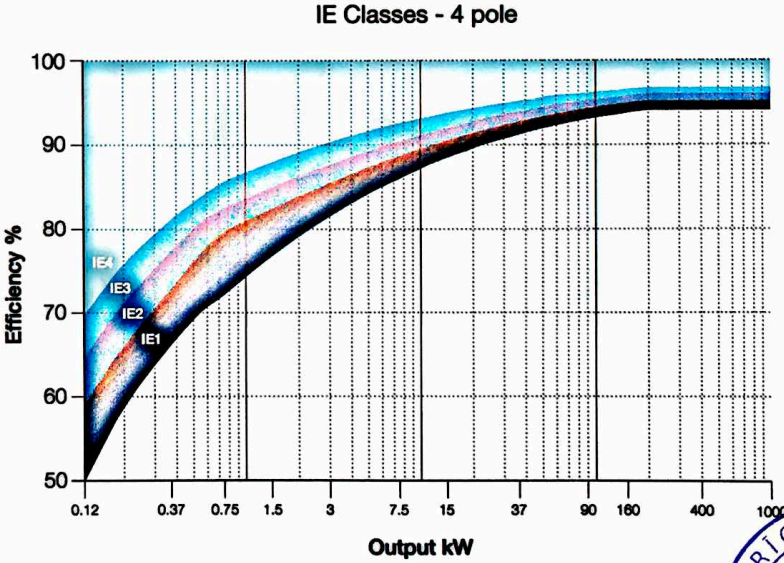

Fig.2. Efficiency classes of 2 poles pairs induction motors according to power (source: ABB)

Conclusions

1. The parameters of DPM device are measured, the data are fixed in the protocol (Appendix 1).
2. Efficiency factor of the device is calculated at different loads (Appendix 2).
3. Point of the optimal operation of the device is determined: at Pm = 2272W and n=3000rev/min.
4. During the testing the temperature of the device did not exceed 27°C.
5. The obtained data are illustrated in graphical form (Appendix 3).

Summary

The tested device (motor with permanent magnets) achieves the maximum efficiency factor 0.95 +/- 1.5% (min. value: 0.94, max. value: 0.97), that corresponds to class IE4. The optimum operation of the motor (within the range of the tested power and rotation frequency determined by the customer) is achieved at mechanical power 2272W.

Table 2. Comparison of EI4 DPM with induction motor EIC class (minimum requirements)

	DPM	**EI1 class**	**EI2 class**	**EI3 class**	**EI4 class**
Efficiency factor	0.95	0.80	0.83	0.86	0.88
Mechanical power, W	2272	2200	2200	2200	2200
Electric power, W	2387	2750	2650	2558	2500
Economy, W	-	363	263	171	113
Economy %	-	13.2%	9.9%	6.6%	4.5%

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Technical assignment Nr.2

1. To test device GEB 3500 - "motor with permanent magnets" (hereinafter: DPM) and a standard AC motor ("WEG" AL-100L-02):
    a. To arrange the testing bench and the measurement devices;
    b. To determine the consumption of electric energy of motor GEB 3500 during 1 hour of operation with the load of industrial fan (~2900 rev/min);
    c. To determine the consumption of electric energy of motor "WEG" AL-100L-02 during 1 hour of operation with the load of industrial fan (~2900 rev/min);
    d. To measure the consumption of active, reactive and apparent energy in the both cases;
    e. To determine the temperature of the motor during the operation;
2. To complete the protocol of the measurements;
3. To calculate the expenses for the electric energy consumption of the both motors;

The testing of the device DPM took place on August 31, 2016 at the presence of a customer representative. The customer agreed with the proposed testing and calculation methodology and the working process.

List of the applied devices

1. Sensor of speed: Lutron DT-1236L, SN: AB.28221
2. Power analyser: N4L PPA5530
3. Infrared camera: FLUKE Ti10
4. Motor with permanent magnets: [redacted] GEB-3500 (provided by the customer)
5. Autotransformer with rectifier and capacitor filter: (provided by the customer)
6. AC-DC experimental supply block: EA-PS9360-30 (provided by the customer)
7. AC motor: "WEG" AL-100L-02 (provided by the customer)
8. Load – mechanical industrial fan (air pump): (provided by the customer)

Methodology of the testing

Both motors under testing were operating during 1 hour prior the measurements to be heated for a stationary temperature regime.
The consumption of the both motors is determined under the conditions of the same loading with an industrial mechanical fan rotating with constant speed of 2900 revolutions per minute therefore both motors can be considered to perform identical mechanical work. The electric parameters are measured by means of a power analyser of a high accuracy, the schemes of the measurements are illustrated in figures 3 – 6.

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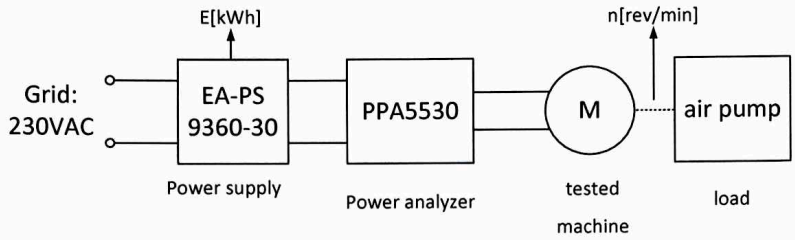

Fig. 3. Realisation of the measurements: GEB-3500 motor without taking into account the consumption by EA-PS9360-30.

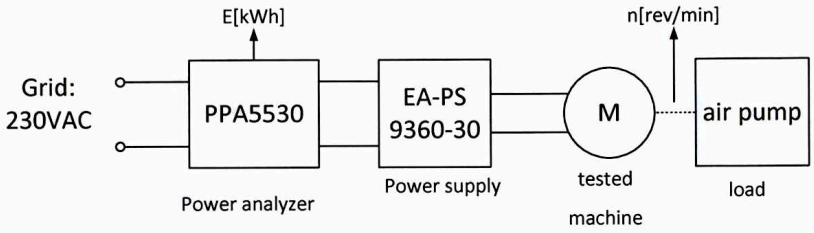

Fig. 4. Realisation of the measurements: GEB-3500 motor taking into account the consumption by EA-PS9360-30.

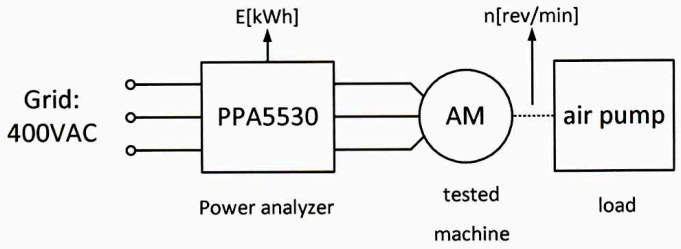

Fig. 5. Realisation of the measurements: WEG AL-100L-02 .

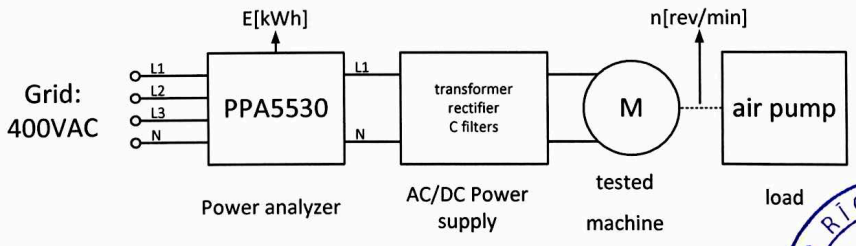

Fig.6. Realisation of the measurements: GEB-3500 with rectifier.

Obtained measurements

Table 3. Testing of the starting process: motor GEB-3500

Nr.	t,s *	n, rev/min	E, Wh	Q,VArh	S, VAh	Power factor (PF)
1	10	2900	4.8400	1.85900	5.2139	0.9280
2	5	2900	1.9824	0.76710	2.1373	0.9280
3	4.68	2900	1.9970	0.74200	2.1410	0.9330
4	4.29	2900	1.6417	0.71350	1.8060	0.9090
5	4.43	2900	1.7333	0.71340	1.8930	0.9170
6	3.85	2900	1.5477	0.61290	1.6738	0.9250
average	5.375	2900	2.2904	0.90132	2.4775	0.9233

* - accuracy +/- 1 second

Table 4. Testing of braking process: motor GEB-3500

Nr.	t,s *	n, rev/min	E, Wh	Q,VArh	S, VAh	Power factor (PF)
1	17	0	1.4000	1.53000	2.3000	0.9600

* - accuracy +/- 1 second

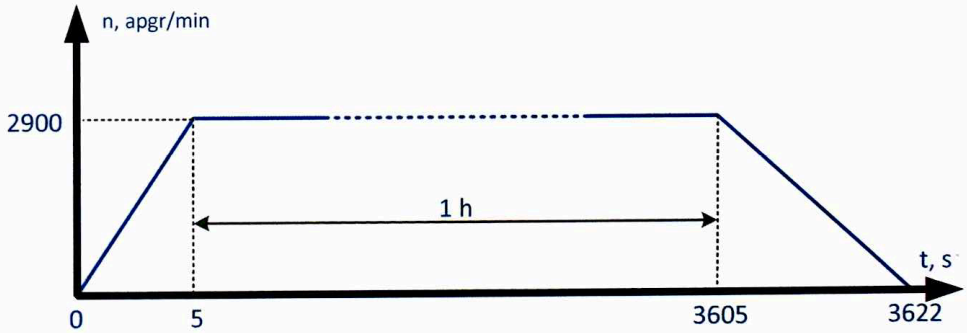

Fig.7. Time diagram of the measurements

As motor GEB-3500 is supplied from a DC source and its rated speed of rotation 2900 rev/min is regulated manually then the starting and braking time (see Fig.7) and the correspondent parameters of the consumed electric energy are measured and given in Tables 5 and 6.

Table 5. Consumption of electric energy with load at rotation speed 2900 rev/min

motor	t, min	n, rev/min	E, kWh	Q, kVArh	S, kVAh	Power factor (PF)	temperature, °C
GEB-3500 with Lab.PSU	30	2922	1.2284	0.35779	1.2795	0.960	22.5
GEB-3500 with Lab.PSU	60	2900	2.4487	0.71455	2.5508	0.960	24.2
WEG	30	2922	1.3694	1.22060	1.8345	0.747	40
WEG	60	2900	2.6550	2.38210	3.5671	0.744	41

* - the maximum deviation of the revolutions about 0.76% from the stated value (2900 rev/min)

Table 6. Consumption of electric energy with the same load.

motor	t,min	n, rev/min	E, kWh	Q, kVArh	S, kVAh	Power factor (PF)	temperature, oC
GEB-3500 with rectifier and PFC (AC side)	35	2934	1.2726	1.06700	1.6609	0.766	26.5
GEB-3500 with rectifier and PFC (AC side)	60	2900	2.1040	1.76070	2.7437	0.767	26.5
GEB-3500 without rectifier and PFC (DC side)	35	2934	1.1539	0.55900	1.2823	0.900	26.5
GEB-3500 without rectifier and PFC (DC side)	60	2900	1.9017	0.91561	2.1107	0.901	26.5

* - the maximum deviation of the revolutions about 1.17% from the stated value (2900 rev/min)

The output data obtained during the measures and applied in the calculations of the electric energy effectiveness are given in Table 7.

In accordance with the regulations of the Cabinet of Ministers from January 21, 2014 Nr. 50 "Regulations Of the Electric Energy Trade and Usage":

1. The user has to pay for the consumed reactive energy, if tg φ is higher than 0,4 (power factor cos φ < 0,929) correspondingly to the price 0,004 EUR/kVArh – for the users, the electric devices of which are supplied from at least 6 kV voltage with an allowed load 100 kW and higher, or for other users with the current of input protective devices 200 A and higher;

2. It is forbidden for the users to supply the reactive energy to the network of the system's operator. If the operator registers the supply of the reactive energy to the system then the users, the equipment of which is supplied to at least 6 kV voltage with an allowed load 100 kW and higher and other users with the current of input protective devices 200 A and higher, have to pay for the reactive energy supplied to the network in accordance with the price 0,013

EUR/kVArh. Further, the price for the reactive energy of 0,004 EUR/kVArh is applied in the calculations.

For the consumed active energy the current rate of 0,13697 EUR/kWh is applied at the moment. It should be noted that different rating plans are valid, and the industrial customers are paying in accordance with the individual contract conditions, that can differ for different cases. The calculations and their results are given in Tables 7- 9.

Table 7. Parameters of the electric energy consumption within the period of one hour.

	E, kWh	Q, kvarh	S, kVAh	PF
WEG motor	2.6550	2.38210	3.5671	0.744
GEB-3500 with the laboratory supply block consumption (losses)	2.4487	0.71455	2.5508	0.960
GEB-3500 with the rectifier and capacitor filter consumption (losses)	2.1040	1.76070	2.7437	0.767
GEB-3500 without the rectifier and capacitor filter consumption (losses)	1.9017	0.91561	2.1107	0.901

Table 8. Safe of electric energy in comparison with WEG motor consumption, %

	E, kWh	Q, kvarh	S, kVAh	PF
GEB-3500 with the laboratory supply block consumption (losses)	**7.77%**	70.00%	28.49%	29.03%
GEB-3500 with the rectifier and capacitor filter consumption (losses)	**20.75%**	26.09%	23.08%	3.09%
GEB-3500 without the rectifier and capacitor filter consumption (losses)	28.37%	61.56%	40.83%	21.10%

Table 9. Comparative price of one hour operation, EUR

	E, EUR (per kWh)	Q, EUR (per kvarh)	total, EUR	Safe if to compare WEG motor, %
rate (A/S Latvenergo data)	*0.136970*	*0.004*		
WEG motor	0.363655	0.0095284	0.37318375	
GEB-3500 with the laboratory supply block consumption	0.335398	0.0028582	0.33825664	9.36%
GEB-3500 with the rectifier and capacitor filter consumption	0.288185	0.0070428	0.29522768	20.89%
GEB-3500 without the rectifier and capacitor filter consumption	0.260476	0.0036624	0.26413829	29.22%

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Summary on the comparative measurements of the parameters of electric energy consumption:

For GEB-3500 device with voltage converting

The device under examination "GEB-3500" (motor with permanent magnets), considered as a prototype, in the case of a particular load (air pump operating with an average speed of rotation 2900 revolutions per minute within the period of one hour) and supplied from laboratory supplied source consumes 2.4487kWh (including own consumption and losses). With the supply from the rectifier with capacitor filter produced by [redacted] LTD the total consumption of the system is **2.1040 kWh** (including own consumption of the rectifier with capacitor filter and losses) or 1.9017kWh (without own consumption and losses, for the case with DC source – e.g. accumulator). For the case of the same load (air pump operating with an average speed of rotation 2900 revolutions per minute within the period of one hour) and supply from three-phase AC network the consumption of three- phase AC motor "WEG AL-100L-02" is **2.6550 kWh**.

Therefore it can be estimated that from the active power consumption point of view the device under examining "GEB-3500" (with rectifier and capacitor filter) has **20.75% higher effectiveness** than three-phase AC motor "WEG AL-100L-02".

For GEB-3500 device without voltage converting

The device under examination "GEB-3500" (motor with permanent magnets), considered as a prototype, for the case of a particular load (air pump operating with an average speed of rotation 2900 revolutions per minute within the period of one hour) and DC electric supply or other (e.g. accumulator), has the consumption of active power 1.9017kWh. The apparent power, calculated according to the formula $\boldsymbol{P^2 + Q^2 = S^2}$, is **2.1107 kVAh**.

For the case of the same load (air pump operating with an average speed of rotation 2900 revolutions per minute within the period of one hour) and supply from three-phase AC network the consumption of active power of three-phase AC motor "WEG AL-100L-02" is 2.6550 kWh, but the apparent power is **3.5671 kVAh.**

Therefore it can be estimated that at the point of a particular load measurement the device under examining "GEB-3500" (without voltage converters) has **40.83% higher effectiveness in respect to the apparent power (S) consumption (during 1 hour)** than three-phase AC motor "WEG AL-100L-02".

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Sources of information

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Appendices

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Appendix 1 – Original measurement protocol (in Latvian)

Momenta devēja kļūda:	0,10	
Mēraparāta kļūda, Nm	0,1	Nm
Ātruma mērīšanas kļūda	2	RPM
Jaudas mērīšanas kļūda	1	W
M devēja nobīde pie 0 slodzes 0 RPM	0,05	V
M devēja nobīde pie 0 slodzes 0 RPM	0,042	V
M devēja nobīde pie 0 slodzes 0 RPM	0,046	V
M devējam pie 0 slodzes 1500RPM	0,034	V
	0,043	V
Mašīnas temperatūra	27	oC
stjūdenta koeficients 3 mēr. 90%	2,92	3
stjūdenta koef. 4 mēr. 90%	2,353	4

	M, V	M_cor, V	M, Nm	n, RPM	Pm, W	Pe, W	ni
tukšgaita ar stendu	0,06	**0,02**	0,4	3010	138,7	276	0,50
tukšgaita bez stenda				3006	0	149	
palielinot slodzi 1.	0,10	**0,07**	1,4	3000	439,8	567	0,78
	0,16	**0,13**	2,6	3005	805,5	883	0,91
	0,24	**0,21**	4,1	3000	1294,2	1377	0,94
	0,32	**0,29**	5,8	3002	1810,6	1894	0,96
	0,40	**0,36**	7,3	3008	2293,0	2384	0,96
samazinot slodzi 1.	0,10	**0,07**	1,4	3002	433,8	528	0,82
	0,16	**0,13**	2,5	3001	798,2	884	0,90
	0,24	**0,21**	4,1	3000	1300,5	1385	0,94
	0,32	**0,29**	5,8	3001	1816,3	1896	0,96
	0,40	**0,36**	7,3	3004	2290,0	2382	0,96
palielinot slodzi 2.							
	0,16	**0,13**	2,5	3002	798,4	926	0,86
	0,24	**0,21**	4,1	3002	1295,1	1430	0,91

	0,32	**0,29**	5,8	3002	1810,6	1943	0,93
	0,39	**0,36**	7,2	3002	2250,7	2391	0,94
samazinot slodzi 2.	0,11	**0,08**	1,5	3001	471,4	594	0,79
	0,16	**0,13**	2,6	3002	811,0	931	0,87
	0,24	**0,21**	4,1	3003	1295,5	1415	0,92
	0,32	**0,29**	5,7	3002	1798,1	1922	0,94
	0,39	**0,36**	7,2	2999	2254,7	2391	0,94

Moments	**M_vid.**	Md1	Md2	Md3	Md4
	1,4	0,0	0,0		-0,1
	2,6	0,0	0,0	0,0	0,0
	4,1	0,0	0,0	0,0	0,0
	5,8	0,0	0,0	0,0	0,0
	7,2	-0,1	-0,1	0,1	0,0
	Md^2 vid	Md1^2	Md2^2	Md3^2	Md4^2
	0,00276	0,00071	0,00218		0,00538
	0,00028	0,00003	0,00022	0,00022	0,00063
	0,00007	0,00002	0,00022	0,00002	0,00002
	0,00048	0,00002	0,00063	0,00002	0,00123
	0,00307	0,00302	0,00302	0,00422	0,00202
	dM - kļūda	**Saliktā kļūda**			**r_n**
	0,1	**0,1**	1,5	1,3	**8%**
	0,0	**0,1**	2,7	2,5	**4%**
	0,0	**0,1**	4,2	4,0	**2%**
	0,0	**0,1**	5,9	5,7	**2%**
	0,0	**0,1**	7,3	7,1	**1%**

Apgriezieni	**n_vid**	nd1	nd2	nd3	nd4
	3001	1,0	-1,0		0,0
	3003	-2,5	1,5	0,5	0,5
	3001	1,3	1,3	-0,8	-1,8
	3002	-0,3	0,8	-0,3	-0,3
	3003	-4,8	-0,8	1,3	4,3
	nd_vid	nd1^2	nd2^2	nd3^2	nd4^2

	0,7	1,0	1,0		0,0
	2,3	6,3	2,3	0,3	0,3
	1,7	1,6	1,6	0,6	3,1
	0,2	0,1	0,6	0,1	0,1
	10,7	22,6	0,6	1,6	18,1
	dn - kļūda	saliktā kļūda			**r_n**
	1,0	2	2999	3003	**0,07%**
	1,0	2	3001	3004	**0,07%**
	0,9	2	3000	3002	**0,07%**
	0,3	2	3001	3002	**0,07%**
	2,2	3	3001	3005	**0,10%**

Elektriskā jauda	**Pe_vid**	Ped1	Ped2	Ped3	Ped4
	563,0	-4,0	35,0		-31,0
	906,0	23,0	22,0	-20,0	-25,0
	1401,8	24,8	16,8	-28,3	-13,3
	1913,8	19,8	17,8	-29,3	-8,3
	2387,0	3,0	5,0	-4,0	-4,0
	Ped^2_vid	Ped1^2	Ped2^2	Ped3^2	Ped4^2
	734,0	16,0	1225,0		961,0
	509,5	529,0	484,0	400,0	625,0
	466,7	612,6	280,6	798,1	175,6
	407,2	390,1	315,1	855,6	68,1
	16,5	9,0	25,0	16,0	16,0
	dPe	Saliktā kļūda	Pe_min	Pe_max	**r_Pe**
	32,3	**32,3**	530,7	595,3	**5,74%**
	15,3	**15,4**	890,6	921,4	**1,70%**
	14,7	**14,7**	1387,0	1416,5	**1,05%**
	13,7	**13,7**	1900,0	1927,5	**0,72%**
	2,8	**2,9**	2384,1	2389,9	**0,12%**

Mehāniskā jauda	dPm_M	dPm_n	Sqrt_sum	**Pm_vid**	**r_Pm**	Pm_min	Pm_max
	37,1	0,3	37,1	**448,3**	**8,3%**	411,2	485,4
	31,6	0,6	31,6	**803,3**	**3,9%**	771,6	834,9
	31,5	0,9	31,5	**1296,4**	**2,4%**	1264,9	1327,8
	31,8	1,2	31,8	**1808,9**	**1,8%**	1777,1	1840,7
	33,6	2,3	33,7	**2272,1**	**1,5%**	2238,4	2305,8
Lietderības koef.	dNi_M	dNi_Pe	Sqrt_sum	**Ni_vid**	**r_Ni**	Ni_min	Ni_max
	0,066	-0,043	0,079	**0,80**	**9,9%**	0,72	0,88
	0,035	-0,015	0,038	**0,89**	**4,3%**	0,85	0,92
	0,022	-0,010	0,024	**0,92**	**2,6%**	0,90	0,95
	0,017	-0,007	0,018	**0,95**	**1,9%**	0,93	0,96
	0,014	-0,001	0,014	**0,95**	**1,5%**	0,94	0,97

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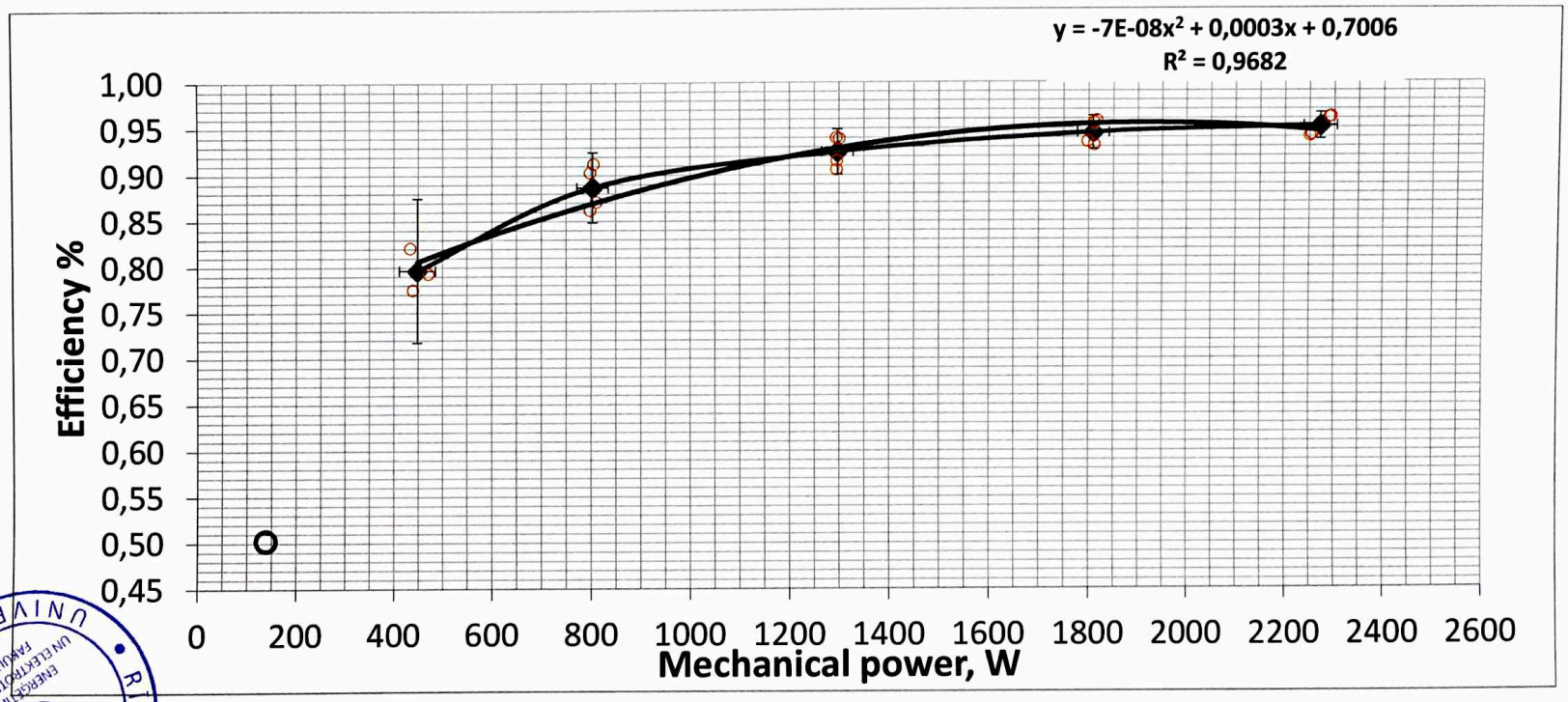
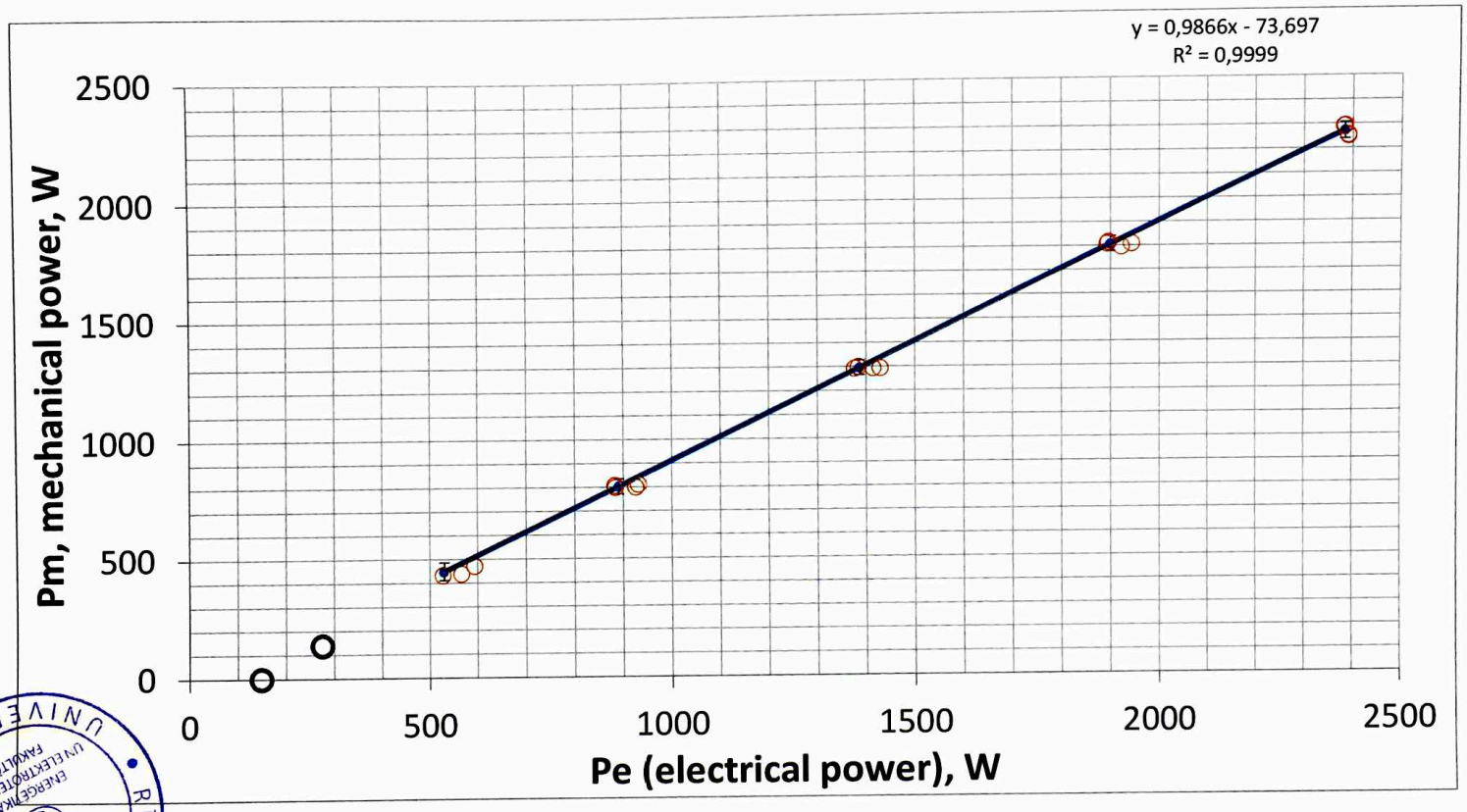
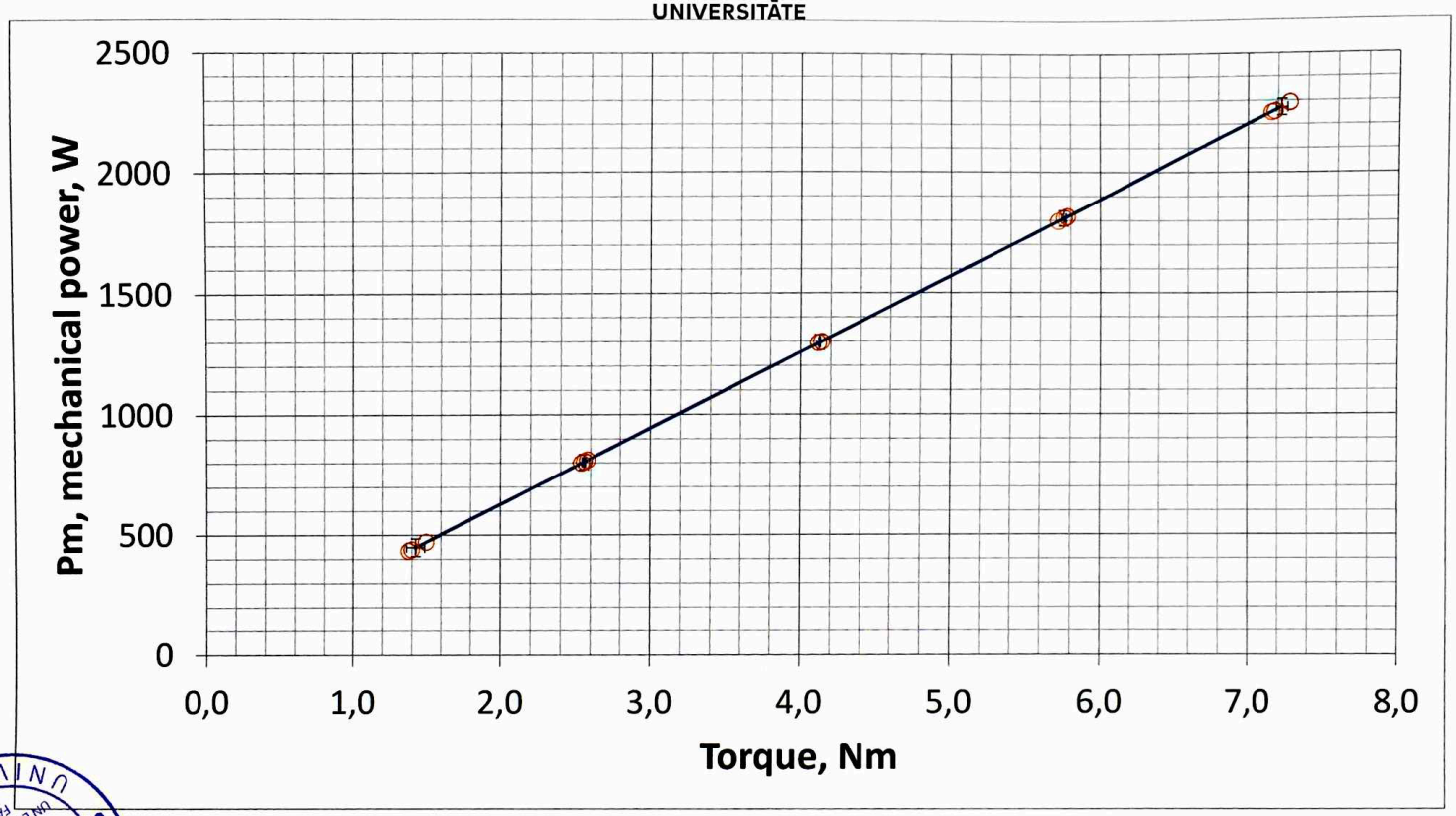
Appendix 2 – Efficiency of device at various loads

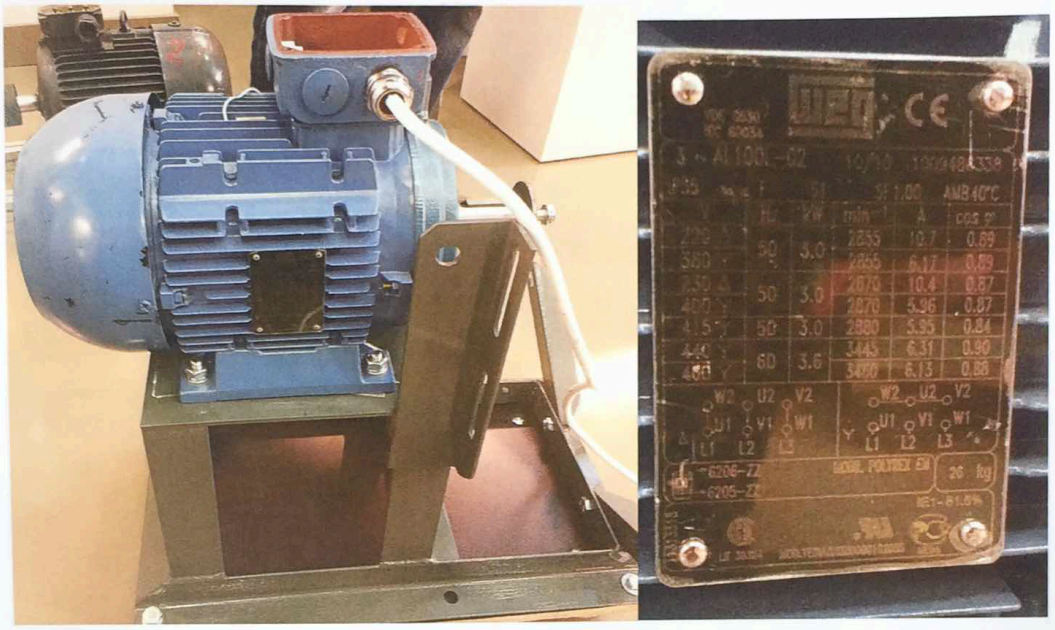


Appendix 3 – Obtained data in graphical format





Appendix 4 - AC motor WEG

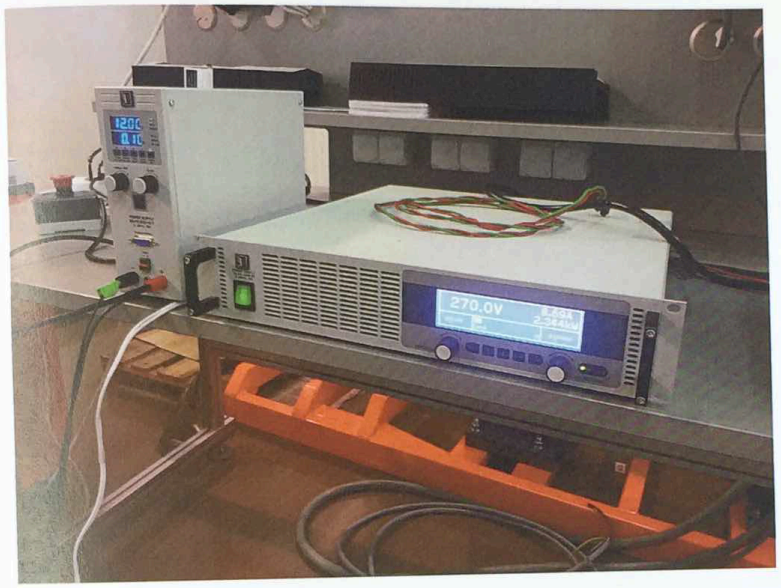


Appendix 5 - device GEB 3500 - "motor with permanent magnets" and air pump

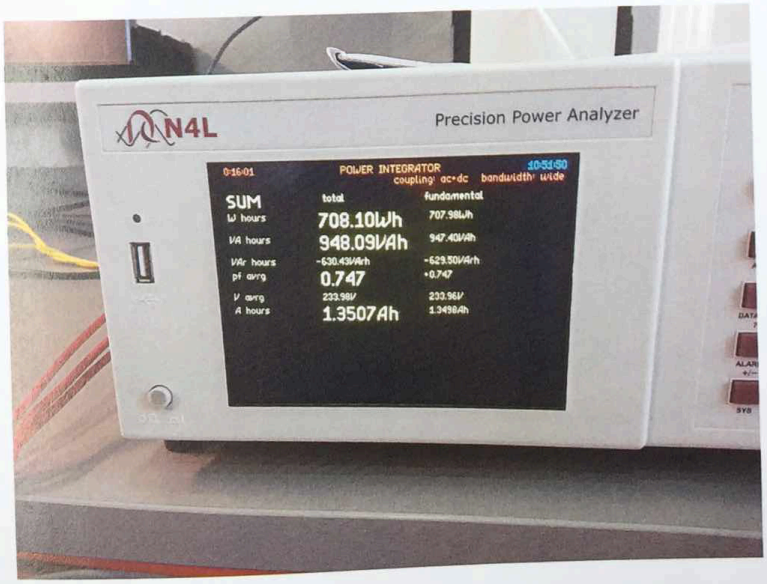
Data of the device GEB 3500 - "motor with permanent magnets", provided by the producer

Nr.	Technical parameters	Value
1	Rated power (Pnom)	2500 W
2	Rotation frequency	Min 10 …. 3000 rev/min
3	Rated rotation frequency	3000 rev/min
4	Rated torque	0-7.28 Nm (at 3000 rev/min, 2300W)
5	Rated current	0….10 A
6	Input voltage	12 …. 350 V_{DC}
7	Mass	45-50 Kg
8	Working temperature	0 – 30 °C
8	Size X*Y*Z	530mm*400mm*530mm

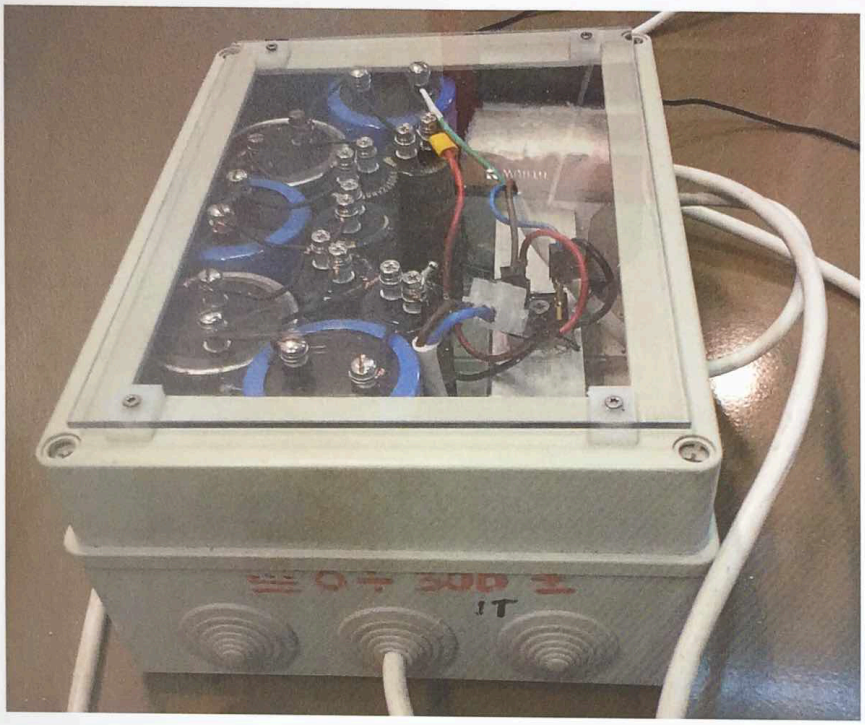
Appendix 6 –equipment used in measurements



DC supply blocks



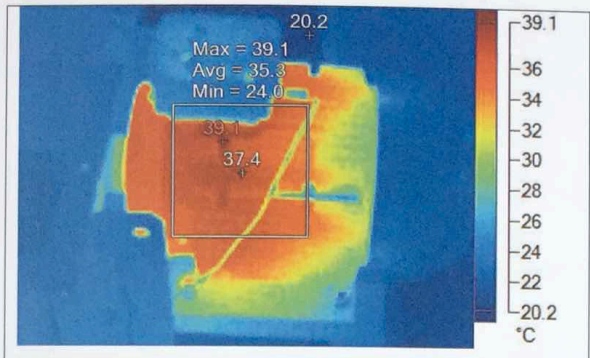
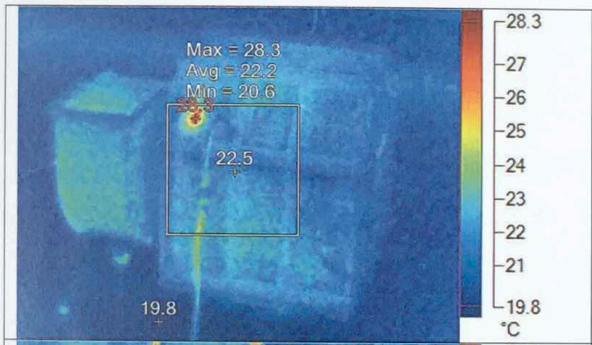
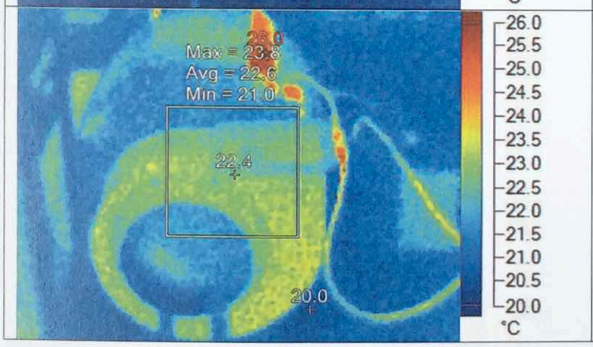
Power analyser N4L

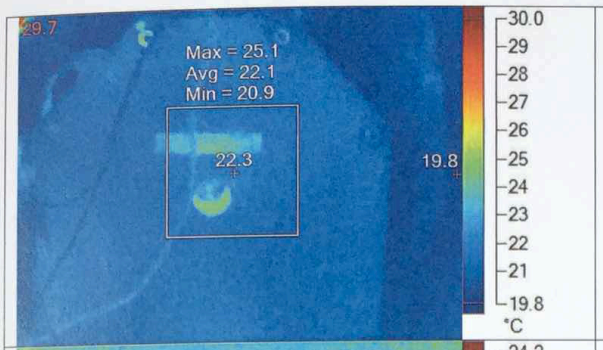
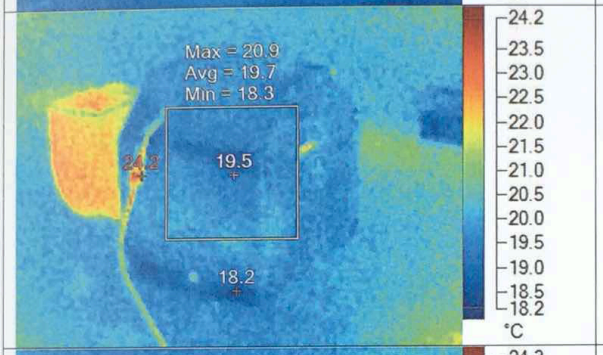
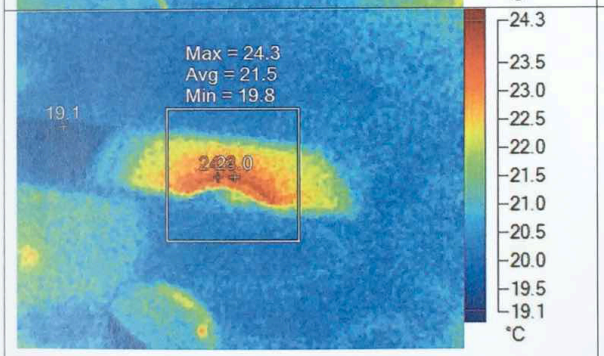
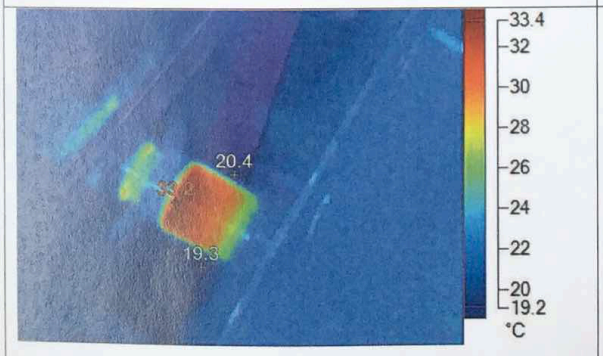


Capacitor filter and rectifier

autotransformer

Appendix 7 – Measurements of the temperature

	WEG motor with the load
	GEB-3500 motor with the load
	GEB-3500 load of the motor

	GEB-3500 motor
	GEB-3500 motor with the load
	GEB-3500 motor windings
	GEB-3500 motor join with the load