

RF Exposure Exhibit

EUT Name:

Product	INDUCTIVE CHARGING SYSTEM
Model No.	Ground Pad Module (GPM) ICSP11W-U0-1X-XX
FCC ID	2AK2AICS115
Accessory	INDUCTIVE CHARGING SYSTEM
Model No.	Car Pad Module (CPM) ICSS115-U0-01X-XXX

Prepared for:

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1 EUT Description

1.1 GPM with CPM

The GPM and CPM can be used for BMW vehicle model G30-PHEV only. If additional models are supported, then additional evaluations will be carried out. The GPM and CPM must be installed by professionals only.

The power of the GPM: Max. 3.3 kW (DC Output Power).

The transmit frequency is 85kHz.

A charging cycle with maximum power is finished within 3.5h

There is a 10kWh Battery charged by a .3kW (output power). There will be 3h of full power and a 30min of reduced power on charging end.

1.2 Live Object Detection (LOD)

A capacitive system is used to detect live objects. A clapp-Oscillator oscillates at a frequency of 4.7MHz. This frequency is determined by means of an RLC oscillating circuit in which the XOD sensor is used as the capacitance. Any capacitance changes of the sensor change the oscillation frequency of the sensor Oscillator. In this way, living objects can move into the loading area, can be recognized. Objects that are already in the field for starting the LOD system cannot be detected. Since all changes to the environment, such as changing the distance GPM to CPM or the loading field, which also results in frequency changes; the detection threshold or detection time can be set in such a way that these changes do not affect the detection threshold or detection time of a living object. For evaluation, the sine wave of the oscillator is adjusted to 3.3V level and then converted to a rectangle using a Schmitt trigger, which is defined by the V850, is measured and evaluated.

1.3 Foreign Object Detection (FOD)

The aim of the FOD system is to detect foreign objects that heat up unacceptably in the magnetic field of the energy transfer, so that they do not pose a danger of fire, etc. A system of several small air coils is used to detect the objects. When triggered by the electronics, these generate a small magnetic field that induces a voltage in another air coil. The amplitude of the induced voltage can be used to measure whether a foreign object is in the magnetic field.

2 Test Methodology

In this document, we evaluate the RF Exposure to human body due the intentional transmission from the transmitter (EUT).

Due to the weight and size of the EUT, the TUV Rheinland NA site in Webster, NY with a 10-meter turntable made the measurements easy to accomplish. The -10 meter turntable was the only place that could support the weight and size of the Vehicle.

Test positions were chosen based on the charging pad location. There are a maximum of nine charging pad locations. Sampling was performed around the vehicle and two spacial gradient measurements were performed with the pad in location 3 and 6. A diagram will be added to show all 9 charging pad locations in relation to the vehicle.

All measurements were taken in a worst-case mode, meaning the device was charging. As a result, the automobile's cooling fan would occasionally cycle to prevent certain components from overheating. There was no ability to override this functionality in any way to leave it on or off all the time.

Note that this intermittent, uncontrollable operation of the vehicle G30-PHEV cooling system fan affects the data set. Where it would seem that the levels should be declining due to increased distance from the GPM-CPM, the measured levels were increased by the fan operation.

Based on previous communication to BMW from the FCC we measured in the middle of the air gap between the GPM-CPM, which we calculated to be 102mm.

Our *Preliminary Measurement Sets* were as follows:

- Heights around the circumference of the vehicle G30-PHEV were 102mm and 240mm.
- Measurement distances between the probe and the vehicle G30-PHEV were 120mm and 240mm.
- Measurement points around the vehicle G30-PHEV were spaced every 20cm.

Due to limited test time, we started at the back end of the driver's door, proceeded to the front of the vehicle G30-PHEV, and around to the back end of the passenger's door.

Among the *Preliminary Measurement Sets* of measurements, the lab recorded spatial 2D mapping for the following positions:

- Position 6 (GPM forward)
- Position 3 (GPM left- rear) **Note: Position 3 was the worst case of the positions tested.**
- Position 2 (GPM rear)

Each Spatial 2D mapping is horizontally centered at the peak of the *Preliminary Measurement* set.

- For the vertical direction mapping at 5 cm resolution from 5 cm between ground and probe surface to the height of a typical person (185cm).
- For the horizontal direction, mapping was also at 5 cm resolution to cover +/- 30 cm each side of center.

With the vehicle hood open and raised up a 6x6 matrix of adjacent measurement points were recorded for selected positions (see figure 5). Inside the vehicle G30-PHEV on the front floor and front seat areas a 4x4 matrix of adjacent measurement points were recorded for selected positions (see figure 4).

For measurement postions refer to KDB Inquiry No. 431672 (for details refer to Exhibit RF Exposure Info. named "KDB 431672_Field Measurement_Q2_V2.0").

2.1 Summary of Results

The limit of 1.63 A/m was taken from Title 47 → Chapter I → Subchapter A → Part 1 → Subpart I → §1.1310 Table1 – Limits For Maximum Permissible Exposure (MPE), (B) Limits for General Population/Uncontrolled Exposure.

Table 1 – Limits For Maximum Permissible Exposure (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposure				
0.3-3.0	614	1.63	*100	6
3.0-30	1842/f	4.89/f	*900/f ²	6
30-300	61.4	0.163	1.0	6
300-1,500			f/300	6
1,500-100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*100	30
1.34-30	824/f	2.19/f	*180/f ²	30
30-300	27.5	0.073	0.2	30
300-1,500			f/1500	30
1,500-100,000			1.0	30

The Maximum emission recorded was **2.31 A/m @ position A5 under the vehicle hood with the hood in the fully open orientation. Refer to Table 2, “Under Open Hood” on page 9 of this report.

**It should be noted that the Vehicle Cooling fan was on during this measurement. The emissions increase during the vehicle cooling fan “on” events.

2.1.1 Statement from the FCC

“The highest exposure emission of 2.31 A/m is sufficiently low enough. We would not consider it an exposure risk. Our rules don’t have a limit at the operating frequency of this device so as was mentioned in the pre-PAG inquiry, compliance is with respect to Sections 1.1307 (c) and (d). Limits in 1.1310 are used only for comparison.”

2.2 EUT Measurements

B-Field measurements were made at positions in and outside the vehicle G30-PHEV with the Ground Pad Module (GPM) at various locations. By making spot measurements around the vehicle, it was determined that the focus of the investigation would be made with the Ground Pad Module in locations 2, 3, 6, and 9.

The B-field measurements were converted from μT to A/m.

Please note that the vehicle G30-PHEV cooling fan cycle influenced some of the measurements. In particular, at GPM position three during the spatial gradient measurement the fan contribution can be seen at distances of -15, -20, -25, and -30 cm from the center.

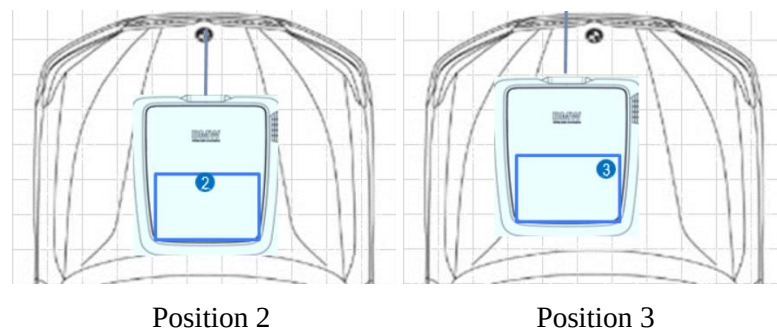


Figure 1 – GPM positions

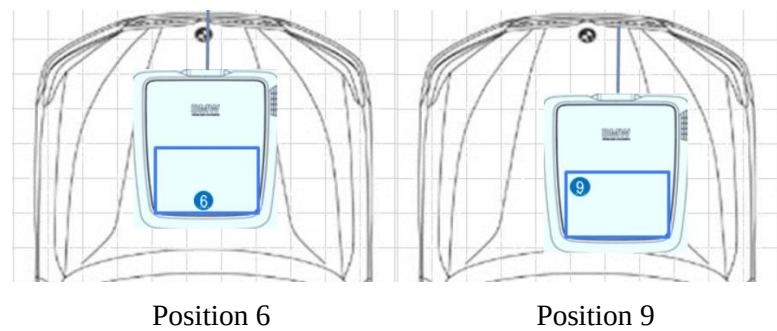


Figure 2 – GPM positions

2.2.1 GPM Position 2

*Measurement units: A/m

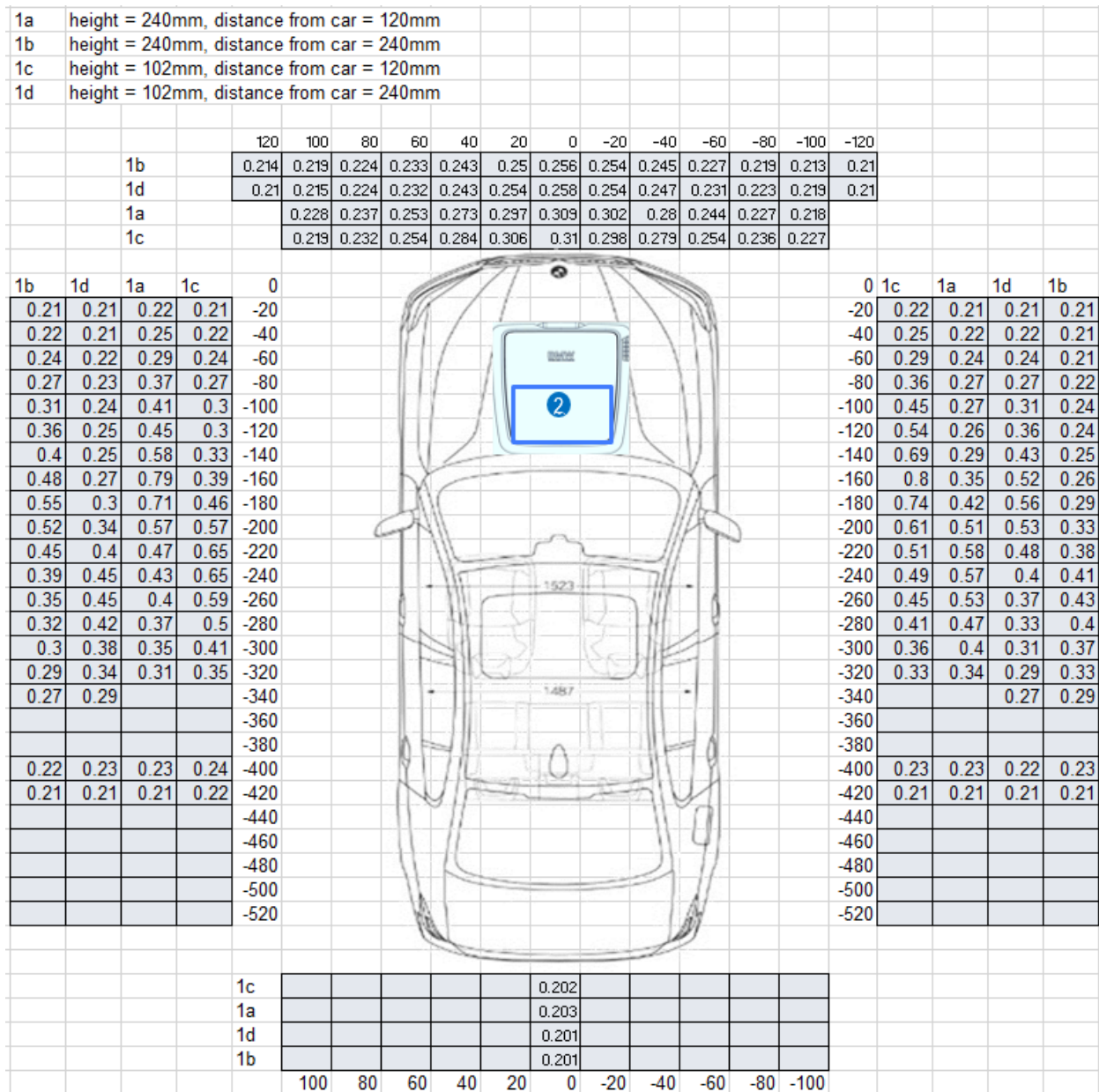


Figure 3 – GPM position 2

					Vehicle G30-PHEV interior measurements					
A	0.3	0.28	0.27	0.27		0.31	0.33	0.39	0.46	A
B	0.28	0.27	0.26	0.26		0.3	0.33	0.37	0.43	B
C	0.28	0.27	0.26	0.26		0.28	0.38	0.34	0.4	C
D	0.29	0.27	0.26	0.26		0.28	0.3	0.34	0.39	D
E	0.27	0.26	0.26	0.26		0.27	0.28	0.29	0.32	E
F	0.27	0.26	0.26	0.26		0.27	0.27	0.29	0.33	F
G	0.27	0.26	0.26	0.26		0.27	0.27	0.28	0.32	G
H	0.26	0.26	0.26	0.26		0.27	0.27	0.29	0.3	H
	1	2	3	4		5	6	7	8	

Table 1 – Interior Cockpit positions

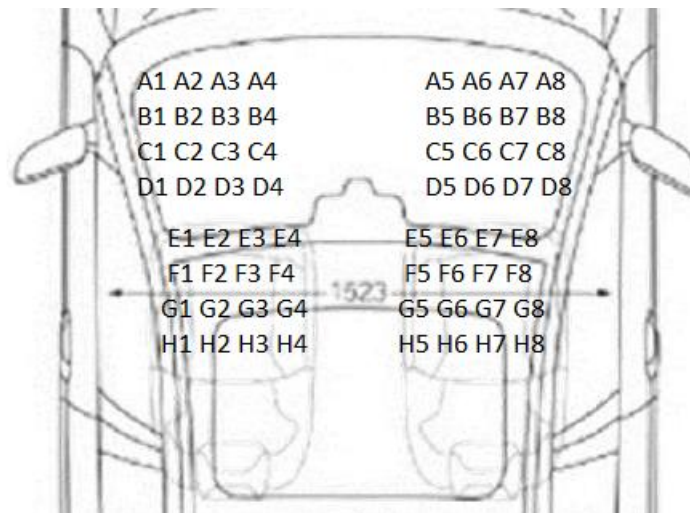


Figure 4 – Interior Cockpit positions

Above engine toward inside of vehicle G30-PHEV

	Under Open Hood						
A	1.75	1.86	2.15	2.24	2.31	1.61	A
B	0.96	1.38	1.54	1.56	1.55	1.36	B
C	0.90	1.17	1.27	1.24	1.22	0.93	C
D	0.97	1.04	1.08	1.12	0.98	0.93	D
E	1.20	1.20	1.12	1.04	1.01	0.91	E
F	1.52	1.52	1.60	1.60	1.33	0.90	F
	1	2	3	4	5	6	

Above engine toward front of vehicle G30-PHEV

Table 2 – Under Open Hood

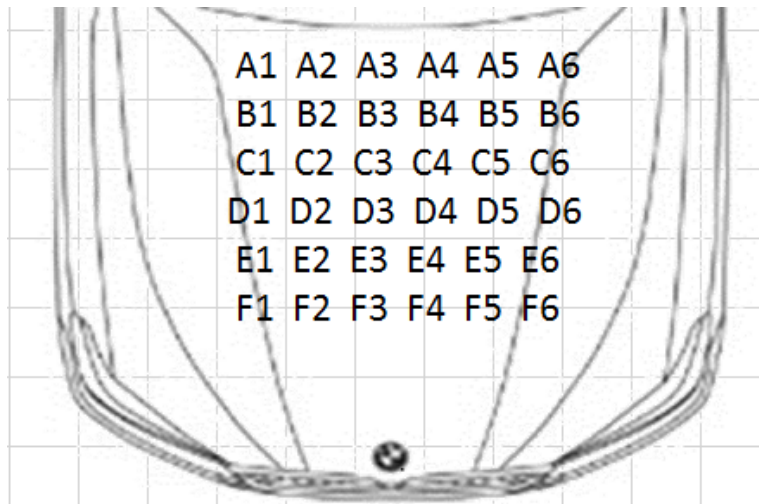


Figure 5 – Positions under the Hood with hood open

2.2.2 GPM Position 3

*Measurement units: A/m

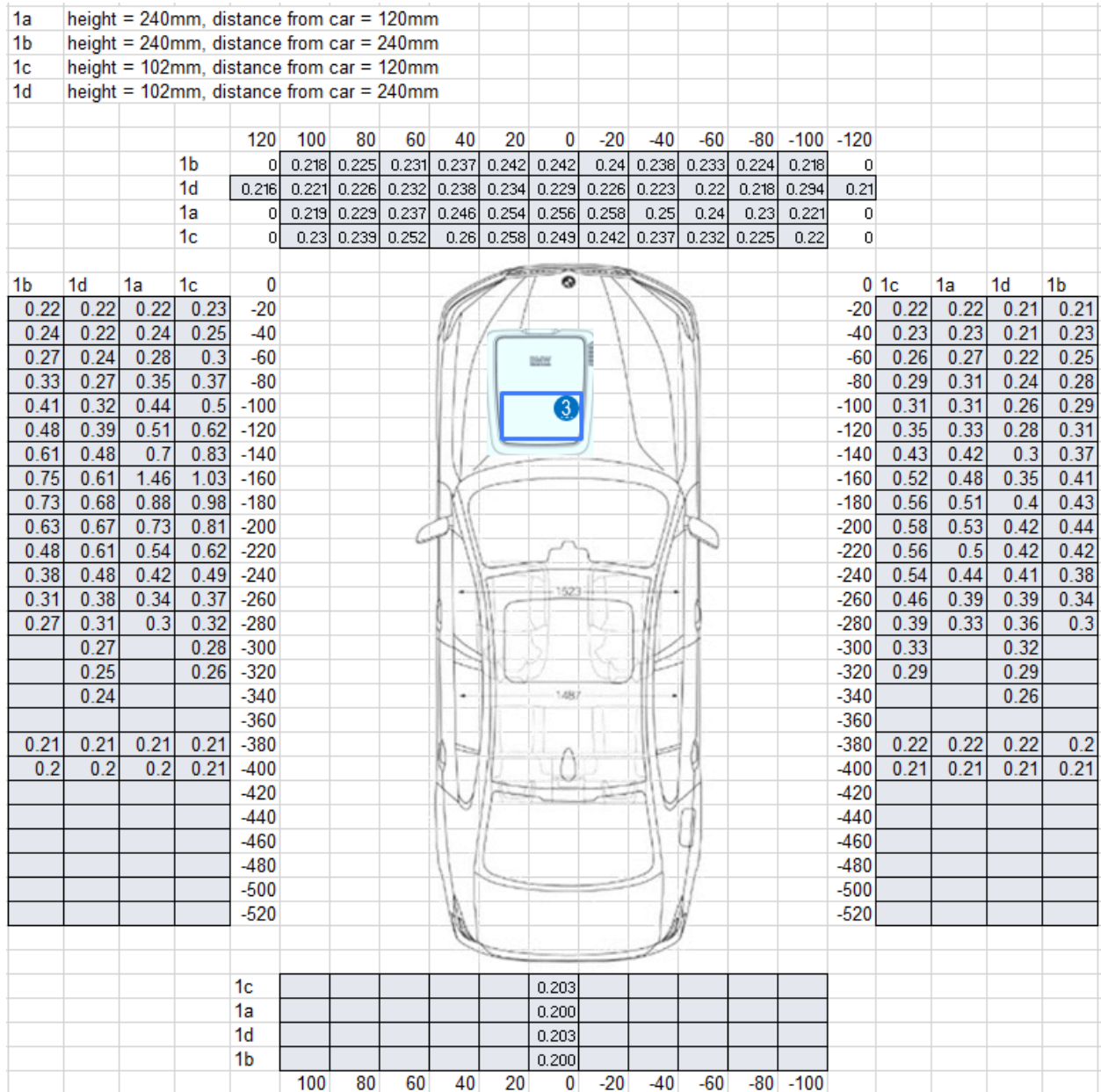


Figure 6 – GPM position 3

185 cm	0.212	0.213	0.212	0.215	0.208	0.21	0.2098	0.21	0.207	0.207	0.207	0.208	0.207
180 cm	0.213	0.215	0.213	0.216	0.209	0.21	0.2106	0.21	0.208	0.208	0.208	0.21	0.209
175 cm	0.215	0.216	0.215	0.217	0.21	0.21	0.2122	0.21	0.209	0.209	0.209	0.211	0.21
170 cm	0.216	0.218	0.216	0.219	0.211	0.21	0.213	0.21	0.21	0.21	0.211	0.211	0.211
165 cm	0.219	0.221	0.217	0.219	0.211	0.21	0.2138	0.21	0.211	0.211	0.211	0.211	0.211
160 cm	0.221	0.224	0.221	0.223	0.213	0.22	0.2154	0.21	0.211	0.211	0.212	0.212	0.212
155 cm	0.223	0.227	0.223	0.228	0.214	0.22	0.2186	0.21	0.214	0.213	0.215	0.215	0.214
150 cm	0.226	0.23	0.227	0.23	0.215	0.22	0.2218	0.21	0.215	0.215	0.216	0.216	0.215
145 cm	0.231	0.235	0.231	0.235	0.216	0.22	0.225	0.21	0.216	0.216	0.219	0.218	0.219
140 cm	0.236	0.239	0.235	0.235	0.219	0.22	0.2281	0.22	0.219	0.219	0.221	0.221	0.223
135 cm	0.241	0.243	0.242	0.24	0.221	0.23	0.2345	0.22	0.223	0.222	0.224	0.225	0.224
130 cm	0.249	0.248	0.247	0.248	0.225	0.23	0.2377	0.23	0.225	0.225	0.23	0.228	0.227
125 cm	0.258	0.258	0.257	0.256	0.228	0.23	0.2401	0.23	0.229	0.228	0.233	0.232	0.231
120 cm	0.267	0.264	0.268	0.266	0.234	0.24	0.2473	0.24	0.235	0.235	0.239	0.239	0.238
115 cm	0.281	0.283	0.283	0.282	0.239	0.25	0.2481	0.25	0.24	0.239	0.239	0.246	0.245
110 cm	0.3	0.31	0.3	0.299	0.248	0.26	0.2577	0.26	0.247	0.246	0.246	0.253	0.253
105 cm	0.323	0.324	0.322	0.321	0.256	0.27	0.2704	0.27	0.257	0.256	0.258	0.262	0.262
100 cm	0.349	0.356	0.348	0.345	0.272	0.28	0.2856	0.28	0.267	0.267	0.266	0.274	0.265
95 cm	0.382	0.371	0.383	0.377	0.285	0.3	0.3047	0.3	0.282	0.278	0.279	0.289	0.272
90 cm	0.424	0.388	0.427	0.418	0.306	0.32	0.3247	0.32	0.297	0.294	0.294	0.307	0.285
85 cm	0.479	0.433	0.479	0.468	0.326	0.35	0.3494	0.34	0.315	0.313	0.308	0.341	0.302
80 cm	0.534	0.477	0.543	0.519	0.354	0.38	0.3757	0.36	0.337	0.337	0.335	0.359	0.318
75 cm	0.598	0.542	0.598	0.572	0.382	0.41	0.4076	0.39	0.358	0.353	0.346	0.367	0.336
70 cm	0.66	0.606	0.666	0.633	0.418	0.44	0.4379	0.42	0.383	0.377	0.368	0.388	0.357
65 cm	0.702	0.696	0.725	0.697	0.459	0.48	0.481	0.43	0.412	0.471	0.4	0.418	0.381
60 cm	0.73	0.722	0.776	0.751	0.498	0.53	0.5297	0.45	0.444	0.439	0.432	0.452	0.408
55 cm	0.749	0.758	0.814	0.768	0.544	0.58	0.5783	0.5	0.487	0.477	0.463	0.456	0.444
50 cm	0.78	0.814	0.838	0.822	0.596	0.59	0.6485	0.54	0.537	0.526	0.509	0.551	0.485
45 cm	0.806	0.838	0.877	0.869	0.642	0.64	0.6988	0.6	0.59	0.58	0.556	0.541	0.533
40 cm	0.877	0.877	0.949	0.893	0.693	0.69	0.7714	0.67	0.665	0.64	0.558	0.597	0.59
35 cm	0.941	0.941	0.997	1.045	0.756	0.76	0.8456	0.74	0.743	0.708	0.726	0.663	0.649
30 cm	1.013	1.021	1.077	1.125	0.814	0.84	0.891	0.82	0.814	0.806	0.798	0.747	0.714
25 cm	1.109	1.101	1.125	1.22	0.893	0.92	1.0211	0.92	0.885	0.869	0.839	0.798	0.797
20 cm	1.133	1.316	1.292	1.292	0.981	0.98	1.0211	0.99	0.965	0.957	0.909	0.877	0.869
15 cm	1.213	1.428	1.396	1.356	1.061	1.06	1.0928	1.08	1.045	1.037	0.989	0.949	0.933
10 cm	1.321	1.436	1.5	1.516	1.125	1.13	1.1726	1.14	1.117	1.109	1.037	0.997	0.989
5 cm	1.412	1.516	1.579	1.595	1.165	1.18	1.2045	1.2	1.157	1.133	1.077	1.029	1.013
	-30 cm	-25 cm	-20 cm	-15 cm	-10 cm	-5 cm	center	5 cm	10 cm	15 cm	20 cm	25 cm	30 cm

Figure 7 – GPM Position 3 Spatial measurements

*vehicle G30-PHEV cooling fan turned on during measurements at -15, -20, -25, and -30 cm.

The center position for these measurements is at -160x60 from GPM position 3.

2.2.3 GPM Position 6

*Measurement units: A/m

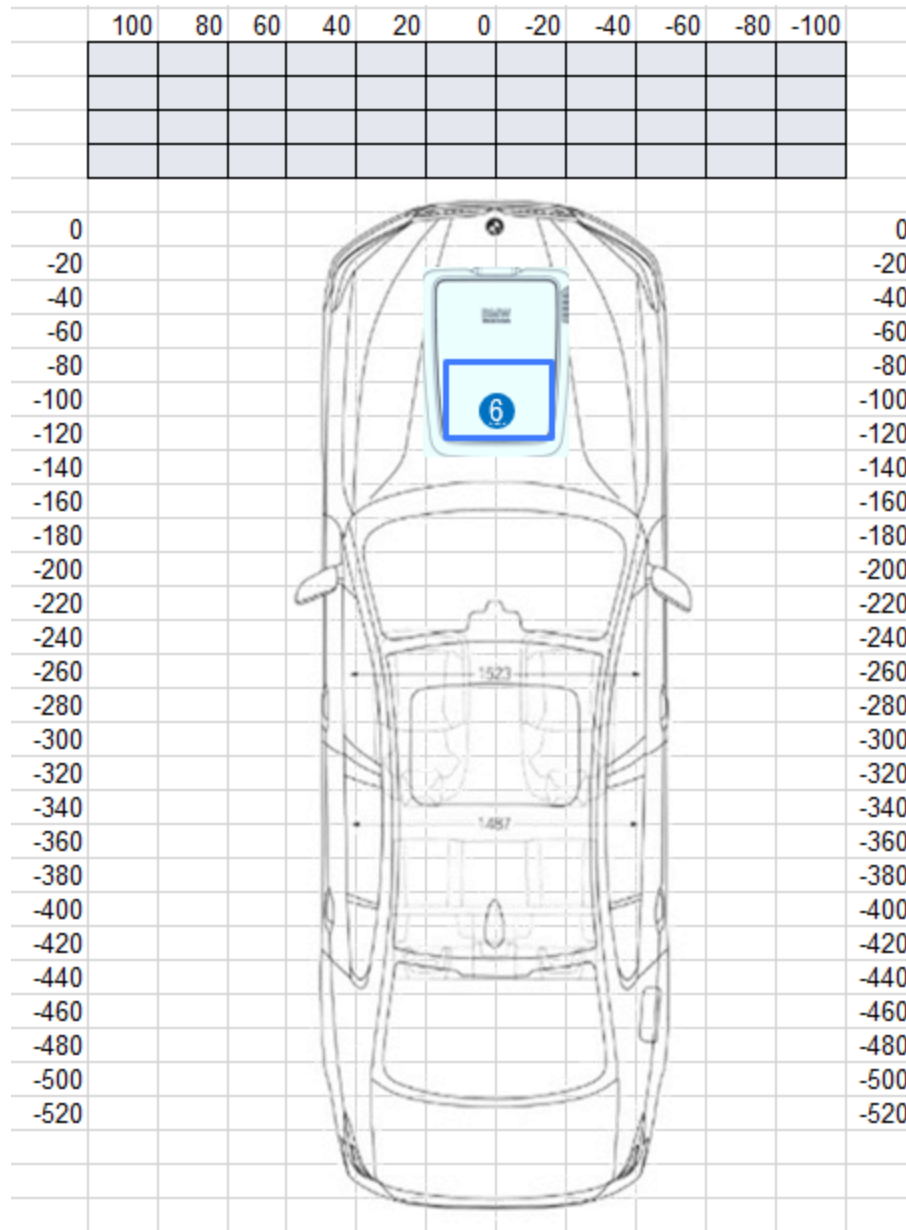


Figure 8 – GPM Position 6
Center at 0 cm in front of vehicle

185 cm	0.207	0.206	0.206	0.204	0.204	0.21	0.2058	0.21	0.205	0.206	0.205	0.205	0.205
180 cm	0.207	0.206	0.206	0.204	0.205	0.21	0.2058	0.21	0.206	0.206	0.205	0.205	0.206
175 cm	0.207	0.206	0.206	0.205	0.206	0.21	0.2066	0.21	0.206	0.207	0.206	0.215	0.206
170 cm	0.207	0.207	0.207	0.205	0.206	0.21	0.2074	0.21	0.207	0.207	0.206	0.205	0.206
165 cm	0.207	0.207	0.207	0.206	0.207	0.21	0.2074	0.21	0.207	0.207	0.207	0.206	0.207
160 cm	0.208	0.207	0.207	0.207	0.207	0.21	0.2074	0.21	0.207	0.208	0.207	0.207	0.207
155 cm	0.21	0.208	0.208	0.207	0.207	0.21	0.2082	0.21	0.207	0.207	0.207	0.207	0.207
150 cm	0.21	0.208	0.208	0.207	0.207	0.21	0.2082	0.21	0.208	0.209	0.207	0.207	0.207
145 cm	0.211	0.21	0.21	0.207	0.208	0.21	0.2098	0.21	0.209	0.209	0.208	0.207	0.207
140 cm	0.211	0.21	0.21	0.209	0.209	0.21	0.2114	0.21	0.21	0.21	0.208	0.207	0.208
135 cm	0.212	0.211	0.211	0.209	0.21	0.21	0.2122	0.21	0.21	0.211	0.209	0.208	0.208
130 cm	0.214	0.212	0.212	0.211	0.211	0.21	0.213	0.21	0.211	0.211	0.21	0.209	0.209
125 cm	0.215	0.213	0.213	0.211	0.211	0.21	0.2138	0.21	0.211	0.212	0.211	0.211	0.21
120 cm	0.216	0.214	0.214	0.215	0.212	0.21	0.2162	0.21	0.213	0.214	0.211	0.211	0.211
115 cm	0.219	0.217	0.217	0.216	0.214	0.21	0.2178	0.21	0.214	0.215	0.213	0.212	0.211
110 cm	0.221	0.219	0.219	0.218	0.215	0.21	0.2194	0.21	0.215	0.217	0.214	0.214	0.213
105 cm	0.224	0.221	0.219	0.221	0.218	0.22	0.2226	0.22	0.217	0.218	0.215	0.215	0.215
100 cm	0.227	0.224	0.223	0.223	0.22	0.22	0.225	0.22	0.219	0.219	0.218	0.217	0.216
95 cm	0.231	0.227	0.227	0.227	0.223	0.22	0.2265	0.22	0.223	0.222	0.219	0.219	0.219
90 cm	0.235	0.231	0.231	0.231	0.226	0.22	0.2289	0.23	0.225	0.224	0.222	0.219	0.221
85 cm	0.239	0.235	0.235	0.235	0.229	0.22	0.2297	0.23	0.228	0.228	0.225	0.222	0.223
80 cm	0.244	0.239	0.239	0.239	0.235	0.23	0.2337	0.23	0.232	0.232	0.229	0.224	0.227
75 cm	0.257	0.248	0.247	0.245	0.239	0.23	0.2385	0.24	0.237	0.237	0.233	0.227	0.23
70 cm	0.263	0.254	0.252	0.252	0.244	0.24	0.2449	0.24	0.243	0.243	0.239	0.231	0.235
65 cm	0.274	0.26	0.26	0.258	0.251	0.24	0.2513	0.25	0.249	0.248	0.243	0.237	0.239
60 cm	0.276	0.264	0.27	0.266	0.257	0.25	0.2577	0.26	0.255	0.254	0.249	0.241	0.244
55 cm	0.286	0.274	0.278	0.276	0.265	0.26	0.2656	0.26	0.263	0.258	0.256	0.248	0.251
50 cm	0.294	0.282	0.284	0.286	0.276	0.27	0.276	0.27	0.273	0.272	0.266	0.254	0.258
45 cm	0.302	0.291	0.294	0.298	0.285	0.28	0.2856	0.28	0.283	0.283	0.274	0.262	0.267
40 cm	0.313	0.299	0.303	0.298	0.298	0.3	0.2983	0.3	0.295	0.295	0.286	0.271	0.278
35 cm	0.323	0.31	0.313	0.313	0.313	0.31	0.3151	0.31	0.311	0.307	0.298	0.281	0.288
30 cm	0.333	0.321	0.321	0.333	0.331	0.33	0.3302	0.33	0.329	0.326	0.312	0.294	0.302
25 cm	0.345	0.332	0.336	0.349	0.346	0.35	0.3494	0.35	0.347	0.345	0.328	0.306	0.315
20 cm	0.357	0.354	0.361	0.368	0.37	0.37	0.4499	0.37	0.367	0.365	0.346	0.329	0.329
15 cm	0.37	0.377	0.378	0.39	0.391	0.39	0.3917	0.39	0.39	0.396	0.364	0.354	0.344
10 cm	0.38	0.409	0.409	0.408	0.411	0.41	0.414	0.41	0.406	0.4	0.379	0.368	0.358
5 cm	0.393	0.416	0.421	0.424	0.418	0.42	0.426	0.42	0.42	0.414	0.392	0.38	0.369
	-30 cm	-25 cm	-20 cm	-15 cm	-10 cm	-5 cm	center	5 cm	10 cm	15 cm	20 cm	25 cm	30 cm

Figure 9 – GPM Position 6 Spatial measurements

The center position for these measurements are at 0 in the front of vehicle with GPM position 6.

2.2.4 GPM Position 9

*Measurement units: A/m

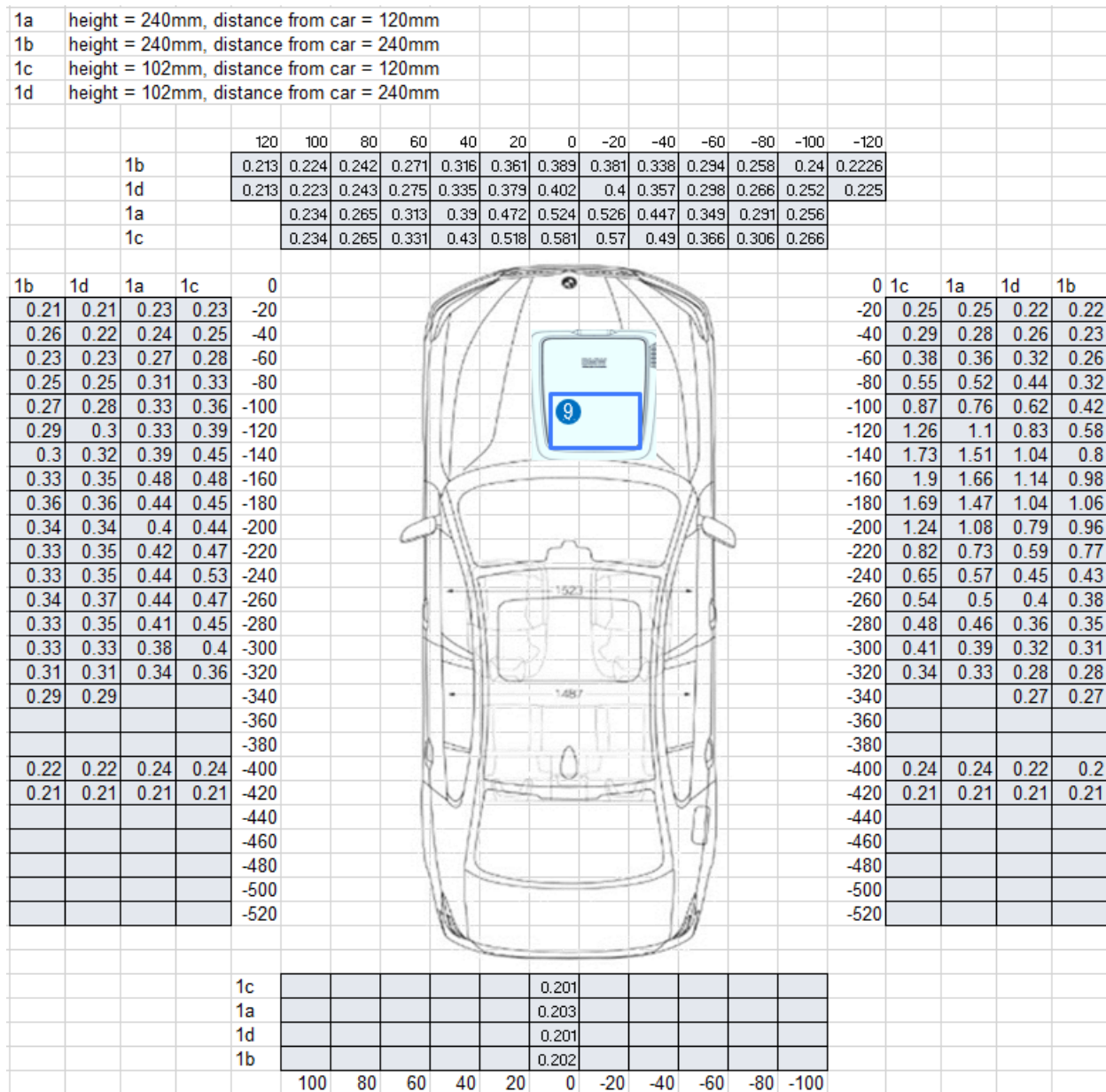


Figure 10 – GPM Position 9

2.3 Equipment

Test Equipment	Serial Number	Calibration Date	Calibration Due
Narda ELT -400	K-0045, L-0002	6/4/2018	6/4/2019

Table 2 – Test Equipment

2.4 Test Positions

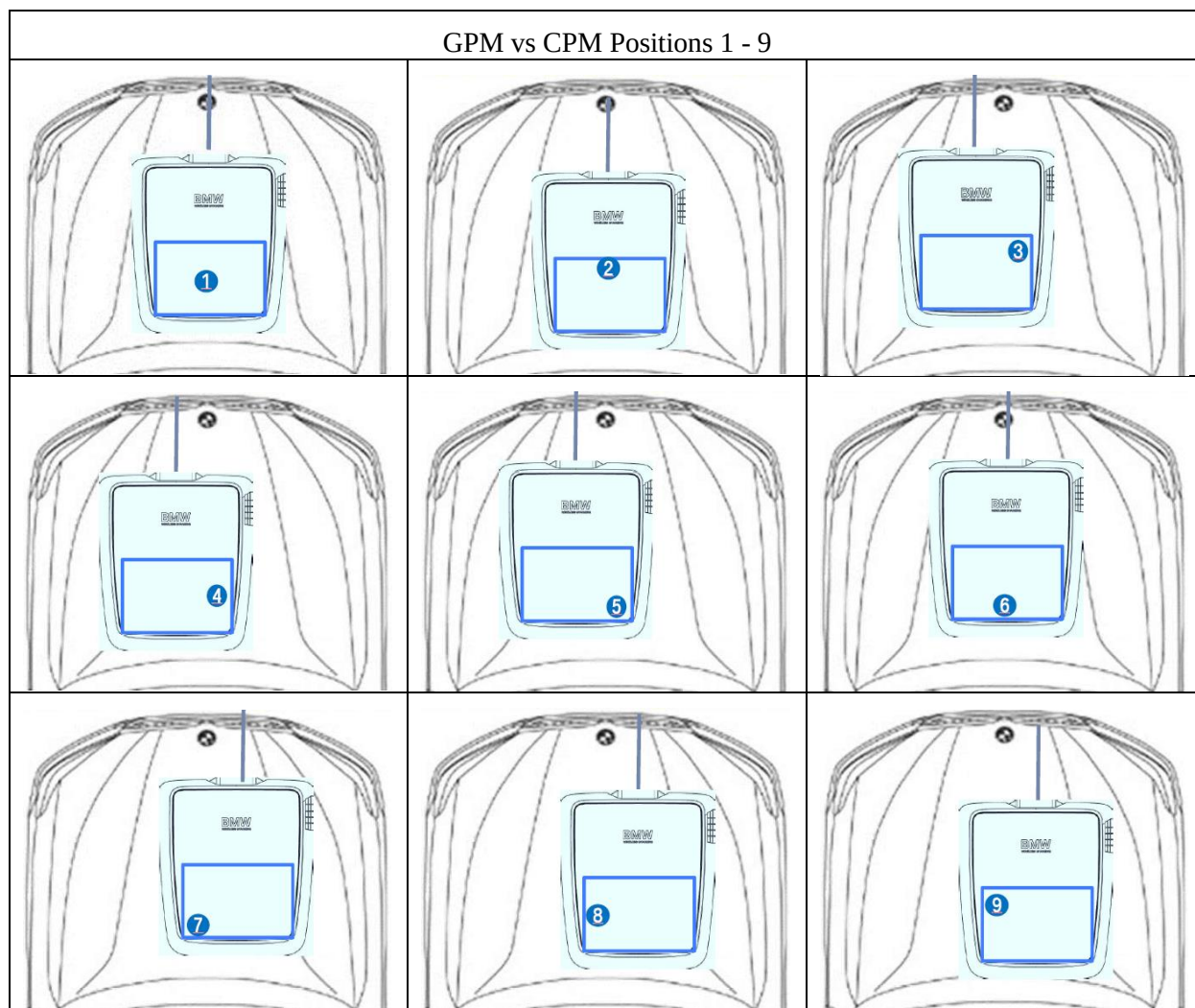


Figure 11 – GPM vs CPM positions