Telenor, Skelagervej 9, 9000 Aalborg

Measurement of power fields from Telenor telecom tower
12/2019

Date	2019-12-xx
Made by	FLSOD
Checked by	FRL
Approved by	FRL
Description	

Ref. 1100041072 – Telenor, Skelagervej 9, 9000 Aalborg

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CONTENT

1. CONCLUSION

Measurements of field strength have been made by request of the owner of the address Skelagervej 9, 9000 Aalborg. The measurements indicates that the combined field strength does not exceed the limit values for public areas at the measured locations.

There are in total five measurement points made at 5m, 10m, 25m, 50m and 100m distance from antenna tower. The locations have been selected by Telenor in cooperation with the operator of the measurement equipment.

The maximum combined field power is measured at location 5 at approx. 0.3 % of the limit values, equivalent to approx. 1/335 part of the limit values of the maximum allowed field power in public areas with permanent residence. 5G at 3.5 GHz only contributes with 0.019% at this location.

The location with the highest 5G field strength, was at location 4, where 5G contributes with approx. 0.08 % of limit values. However, the total field strength measured is approx. 0.15 % of the limit values, equivalent to approx. 1/688 part of the maximum allowed field power in public areas with permanent residence.

2. PREFACE

Telenor has requested Rambøll to perform measurements of field strength at the address Skelagervej 9, 9000 Aalborg. See section 9.

Measurements of radio field strength was made 20. December 2019 in foggy weather in the time period 11.00 and 13.30.

Telenor has installed antennas in a tower, providing service for the cellphone systems GSM 900, UMTS 900 & 2100, LTE 900, 2100 & 2600 and a test-site for 5G 3500 MHz.

The results of the measurements are compared to ICNIRPs limit values for public areas with permanent residence (ref 1.).

3. MEASUREMENT EQUIPMENT

The measurements are performed using a spectrum analyzer – Narda SRM-3006 with the listed calibration reports:

- Selective Radio Meter Basic SRM-3006, D-0139, Calibration date 17. July 2019.
- Antenna SRM, E-Field, Three-Axis 27 MHz to 3 GHz, Type p/n 3501/03, Serial number K-0310, Calibration date 19. July 2019.
- Antenna SRM, E-Field, Three-Axis 420 MHz to 6 GHz, Type p/n 3502/01, Serial number G-0088, Calibration date March 2017.

The calibration is valid for 36 months.

The equipment is capable of measuring field strength in the frequency span 27 MHz to 6000 MHz.

4. REFERENCES

- **ICNIRP Guidelines** (International Commission on Non-Ionizing Radiation Protection) Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz), 1998

- **EN50400 June 2006 CENELEC**
  Basic standard to demonstrate the compliance of fixed equipment for radio transmission (110 MHz – 40 GHz) intended for use in wireless telecommunication networks with the basic restrictions or the reference levels related to general public human exposure to radio frequency electromagnetic fields, when put into service.

- **EU directive 2013/35/EU** on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields). (100kHz to 300GHz).

- Ramboll's quality system for Measuring of EMR according DS/ISO 9001.

5. BACKGROUND

For electromagnetic fields the following limit values for FM-Radio, GSM, UMTS and LTE are listed in the tables below:

Public areas with permanent residence

Service	Frequency approx. (MHz)	Limit value approx. Field strength (V/m)	Limit value approx. Power density (W/m^2)
FM-radio	100	28	2,0
TV	47 - 860	28-40	2,0 – 4,3
LTE 800, GSM 900 and UMTS 900	900	41	4,5
GSM 1800 (DCS) and LTE 1800	1800	58	9,0
UMTS (2100)	2100	61	10
LTE 2600	2600	61	10
5G 3500	3500	61	10

Table 1: Limit values for public areas

Workers in non-public areas (except workers that are pregnant or have medical implants, where the limit values in table 1 applies).

Service	Frequency approx. (MHz)	Limit value approx. Field strength (V/m)	Limit value approx. Power density (W/m^2)
FM-radio	100	61	10
TV	47 - 860	61-88	10-20,5
LTE 800, GSM 900 and UMTS 900	900	90	21,5
GSM 1800 (DCS) and LTE 1800	1800	127	43
UMTS (2100)	2100	140	50
LTE 2600	2600	140	50
5G 3500	3500	140	50

Table 2: Limit values for workers

The total field strength value for each measurement location, is calculated by the sum of each contributing frequency, weighted according to ICNIRP formula (9).

6. MEASUREMENT LOCATIONS

The measurement locations are displayed on the map in section 10.

Measurement point 1 is at 5m distance from tower.

Measurement point 2 is at 10m distance from tower.

Measurement point 3 is at 25m distance from tower.

Measurement point 4 is at 50m distance from tower.

Measurement point 5 is at 100m distance from tower.

The measurements are made approx. 1,0 m above the ground. Point number 1 and 2 are approx. 1.5m higher than the remaining locations (due to variation in ground levels).

7. MEASUREMENT METHOD

The measurements have been made isotrophical (in all directions) in order to take different orientations of field power into account. The measurement duration is 6 minutes, where the measurement value is averaged over this period of time.

There has been made power field measurements from 27 MHz to 6000 MHz. This covers among others GSM, UMTS, LTE, 5G, FM-radio, TV, cordless phones.

Measurements are made without 5G at 3,5GHz as well as with 5G at 3,5GHz while having an active iPerf TCP session on 5G on a device close by, for maximum downlink radio traffic.

The influence of the measurement equipment (noise floor) has been eliminated in the measurement results in this report.

8. MEASUREMENTS 5G OFF

The measurements are performed according to EN50400 June 2006.

The field strengths are measured with a NARDA SRM-3006, which is a spectrum analyzer with an antenna.

The measurement results, which are averaged over a period of 6 minutes, are displayed in the table below.

In Table 3 below, the percentual part of the measured power-density according to the limit value, is listed under the measurement location number. At the bottom of the table, the percentual total according to the limit values are displayed. 100 % equals the limit value for permanent residence in public areas.

Measurement point	1	2	3	4	5
	%	%	%	%	%
28 - 88	-	-	-	-	-
Radio	0.022880	0.010630	0.006734	0.033180	0.093070
108 - 200	0.000078	0.000079	0.000079	0.000077	0.000092
200 - 300	0.000931	0.000850	0.000753	0.000383	0.001260
300 - 380	-	-	-	-	-
Tetra Mobile tel.	-	-	-	-	-
Tetra Motorola	0.000169	0.000322	0.000127	0.000443	0.001600
400 - 410	0.000002	0.000002	0.000002	0.000002	0.000002
Nord Mob 410 band	-	-	-	-	-
430 - 453	-	-	-	-	-
Nord Mob 450 band	0.000001	0.000001	0.000001	0.000001	0.000001
Nord Mob 460 band	0.000004	0.000002	-	0.000002	0.000004
467 - 500	-	-	-	-	-
500 - 600	0.000703	0.000415	0.000173	0.000197	0.000810
600 - 700	0.000633	0.000228	0.000081	0.000161	0.000624
700 - 800	0.000470	0.000360	0.000072	0.000121	0.001727
TT-net 800 band	0.011170	0.011140	0.001232	0.016640	0.106800
TDC 800 band	0.002607	0.001947	0.000299	0.000878	0.001923
TT-net 800 band	-	-	-	-	-
TDC 800 band	-	-	-	-	-
Butler Upload	-	-	-	-	-
Mobile 900 band	0.000002	0.000003	0.000002	0.000002	0.000002
Butler DL	-	-	-	-	-
TT-net 900 band	0.000204	0.000750	0.000845	0.000125	0.004512
Bane GSM R	0.000382	0.000874	0.001956	0.000159	0.007030
TT-net 900 band	0.002933	0.003793	0.005284	0.000840	0.039490
3 - 900 band	0.000214	0.000087	0.000018	0.000055	0.000106
TDC 900 band	0.001091	0.000177	0.000086	0.000218	0.000696
TT-net 900 band	0.004614	0.006612	0.003620	0.008009	0.011490
Mobil tel. 1800	-	-	-	-	-
3 - 1800 band	0.000280	0.000204	0.000044	0.000097	0.000757
TDC 1800 band	0.000366	0.000234	0.000078	0.000186	0.000620

TT-net 1800 band	0.000233	0.000159	0.000065	0.000064	0.000136
TT-net 1800 band	0.000358	0.002304	0.000124	0.000583	0.001233
Cordless phone	-	0.000002	-	-	0.000004
Mobile tel. 2100	-	-	-	-	-
3 - 2100 band	0.000088	0.000065	0.000026	0.000032	0.000061
TDC 2100 band	0.000498	0.000105	0.000032	0.000177	0.000539
TT-net 2100 band	0.000388	0.000473	0.000511	0.002037	0.000891
TT-net 2100 band	0.000157	0.000366	0.000175	0.000725	0.000769
WiFi network	-	-	-	-	-
Mobil tel. 2600	0.000007	0.000007	0.000079	0.000007	0.000008
3 - TDD band	-	-	-	-	-
TDC 2600 band	0.000221	0.000033	0.000045	0.000032	0.000521
3 - 2600 band	0.000079	0.000080	0.000010	0.000023	0.000079
TT-net 2600 band	0.000097	0.001367	0.000369	0.000176	0.000484
TT-net 2600 band	0.000177	0.000738	0.000119	0.000192	0.000126
TT-Net 5G 3.5 GHz	0.000003	0.000008	0.000003	0.000003	0.000003
WiFi Old Chan.	0.000013	0.000043	0.000013	0.000013	0.000013
WiFi Band A	0.000015	0.000048	0.000015	0.000015	0.000015
WiFi Band B	0.000025	0.000078	0.000025	0.000025	0.000025
WiFi Band C	0.000012	0.000040	0.000013	0.000013	0.000013
Other	0.000227	0.000305	0.000457	0.000150	0.001863
Total	**0.0523**	**0.0449**	**0.0236**	**0.0660**	**0.2794**
Part of limit value approx.	**1911**	**2226**	**4243**	**1514**	**358**

Table 3: Measurement results 5G turned off

The highest compiled field strength is measured at measurement point 5 – approx. 0.28 % of the limit value, equivalent to approx. 1/358 part of the limit value, of the maximum allowed power density for permanent residence.

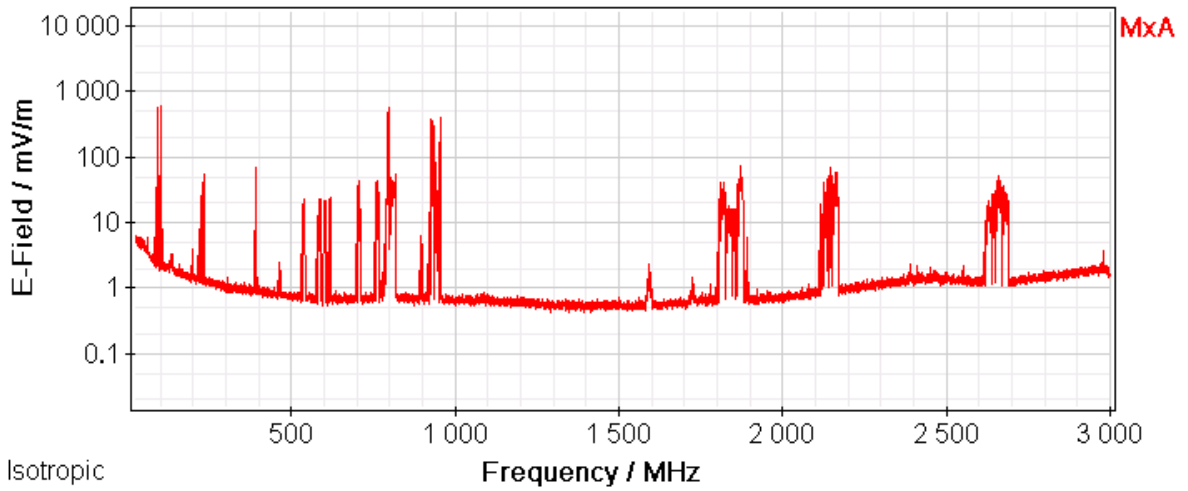
Regarding mobile telephony, the quantities of the measured values will vary according to the amount of calls/traffic load. The measurements have been performed at a time, where a reasonably network-load is to be expected, but the measurement values can be up to 4 times bigger at peak load.

Measurement point	1	2	3	4	5
	W/m2	W/m2	W/m2	W/m2	W/m2
TT-net 800 band	0.000442	0.000441	0.000049	0.000658	0.004224
TDC 800 band	0.000104	0.000078	0.000012	0.000035	0.000077
TT-net 800 band	-	-	-	-	-
TDC 800 band	-	-	-	-	-
Mobile tel. 900	0.000000	0.000000	0.000000	0.000000	0.000000
TT-net 900 band	0.000009	0.000035	0.000039	0.000006	0.000209
TT-net 900 band	0.000136	0.000176	0.000245	0.000039	0.001832
3 - 900 band	0.000010	0.000004	0.000001	0.000003	0.000005
TDC 900 band	0.000051	0.000008	0.000004	0.000010	0.000033
TT-net 900 band	0.000219	0.000314	0.000172	0.000381	0.000546
Mobile tel. 1800	-	-	-	-	-
3 - 1800 band	0.000025	0.000018	0.000004	0.000009	0.000068
TDC 1800 band	0.000033	0.000021	0.000007	0.000017	0.000056
TT-net 1800 band	0.000021	0.000015	0.000006	0.000006	0.000012
TT-net 1800 band	0.000033	0.000214	0.000012	0.000054	0.000114
Mobile tel. 2100	-	-	-	-	-
3 - 2100 band	0.000009	0.000007	0.000003	0.000003	0.000006
TDC 2100 band	0.000050	0.000011	0.000003	0.000018	0.000054
TT-net 2100 band	0.000039	0.000047	0.000051	0.000204	0.000089
TT-net 2100 band	0.000016	0.000037	0.000018	0.000073	0.000077
Mobile tel. 2600	0.000001	0.000001	0.000008	0.000001	0.000001
3 - TDD band	-	-	-	-	-
TDC 2600 band	0.000022	0.000003	0.000004	0.000003	0.000052
3 - 2600 band	0.000008	0.000008	0.000001	0.000002	0.000008
TT-net 2600band	0.000010	0.000137	0.000037	0.000018	0.000048
TT-net 2600band	0.000018	0.000074	0.000012	0.000019	0.000013
TT-Net 5G 3.5 GHz	0.000000	0.000001	0.000000	0.000000	0.000000

Table 4: Equivalent quantities of power densities in W/m^2

The table above displays the equivalent quantities of power densities based on table 3.

Battery:	Ext. Power	GPS:	57°1'15.4" N	Ant:	3AX 27M-3G	SrvTbl:	DK frekvenser
20.12.19	13:02:38		9°53'51.2" E	Cable:	---	Stnd:	ICNIRP GP

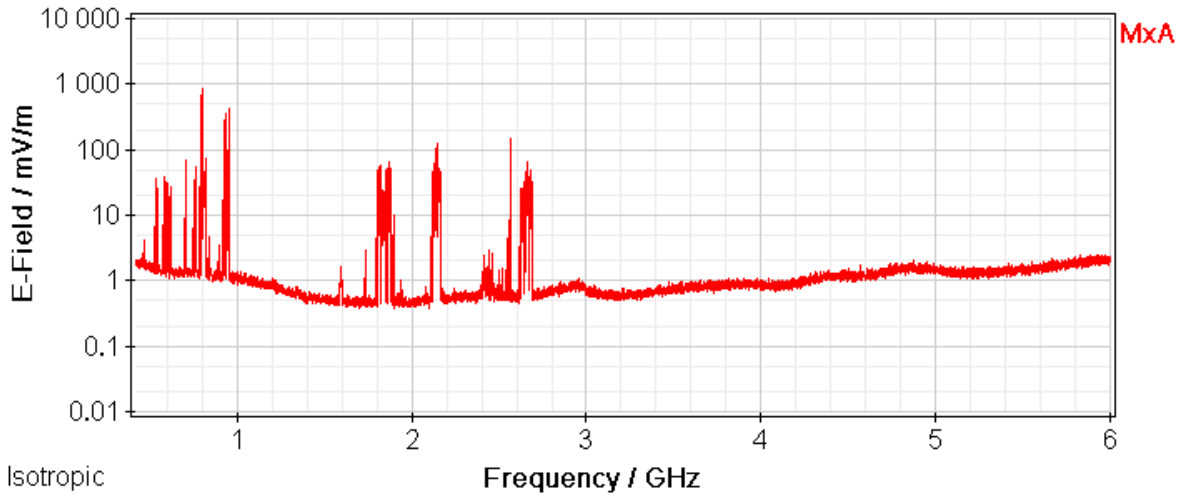


Index: 115.1 • MAN • Date: 20.12.19 13:02:38

Fmin:	26 MHz	Fmax:	3 GHz	Sweep Time:	866 ms	RECALL	
MR:	1.6 V/m	RBW:	300 kHz			No. of Runs:	48
		VBW:	Off			AVG:	4

Measurement point 5 – diagram displaying frequency measurement from 27 MHz to 3000 MHz.

Battery:	Ext. Power	GPS:	57°1'15.4" N	Ant:	3AX 0.4-6G	SrvTbl:	DK frekvenser
20.12.19	12:20:30		9°53'51.1" E	Cable:	---	Stnd:	ICNIRP GP



Index: 100.1 • MAN • Date: 20.12.19 12:20:31

Fmin:	420 MHz	Fmax:	6 GHz	Sweep Time:	985 ms	RECALL	
MR:	1 V/m	RBW:	500 kHz			No. of Runs:	36
		VBW:	Off			AVG:	4

Measurement point 5 – diagram displaying frequency measurement from 420 MHz to 6000 MHz.

9. MEASUREMENTS 5G ON

The measurement results, which are averaged over a period of 6 minuttes, are displayed in the table below.

The measurements are made during an active IPerf TCP session, to create radio traffic on 5G.

In table 4 below, the percentual part of the measured power-density according to the limit value, is listed under the measurement location number. At the bottom of the table, the percentual total according to the limit values are displayed. 100 % equals the limit value for permanent residence in public areas.

Measurement point	1	2	3	4	5
	%	%	%	%	%
28 - 88	-	-	-	-	-
Radio	0.022880	0.010630	0.006734	0.033180	0.093070
108 - 200	0.000078	0.000079	0.000079	0.000077	0.000092
200 - 300	0.000931	0.000850	0.000753	0.000383	0.001260
300 - 380	-	-	-	-	-
Tetra Mobile tel.	-	-	-	-	-
Tetra Motorola	0.000169	0.000322	0.000127	0.000443	0.001600
400 - 410	0.000002	0.000002	0.000002	0.000002	0.000002
Nord Mob 410 band	-	-	-	-	-
430 - 453	-	-	-	-	-
Nord Mob 450 band	0.000001	0.000001	0.000001	0.000001	0.000001
Nord Mob 460 band	0.000004	0.000002	-	0.000002	0.000004
467 - 500	-	-	-	-	-
500 - 600	0.000703	0.000415	0.000173	0.000197	0.000810
600 - 700	0.000633	0.000228	0.000081	0.000161	0.000624
700 - 800	0.000470	0.000360	0.000072	0.000121	0.001727
TT-net 800 band	0.011170	0.011140	0.001232	0.016640	0.106800
TDC 800 band	0.002607	0.001947	0.000299	0.000878	0.001923
TT-net 800 band	-	-	-	-	-
TDC 800 band	-	-	-	-	-
Butler Upload	-	-	-	-	-
Mobile tel. 900	0.000002	0.000003	0.000002	0.000002	0.000002
Butler DL	-	-	-	-	-
TT-net 900 band	0.000204	0.000750	0.000845	0.000125	0.004512
Bane GSM R	0.000382	0.000874	0.001956	0.000159	0.007030
TT-net 900 band	0.002933	0.003793	0.005284	0.000840	0.039490
3 - 900 band	0.000214	0.000087	0.000018	0.000055	0.000106
TDC 900 band	0.001091	0.000177	0.000086	0.000218	0.000696
TT-net 900 band	0.004614	0.006612	0.003620	0.008009	0.011490
Mobile tel. 1800	-	-	-	-	-
3 - 1800 band	0.000280	0.000204	0.000044	0.000097	0.000757
TDC 1800 band	0.000366	0.000234	0.000078	0.000186	0.000620
TT-net 1800 band	0.000233	0.000159	0.000065	0.000064	0.000136
TT-net 1800 band	0.000358	0.002304	0.000124	0.000583	0.001233
Cordless phone	-	0.000002	-	-	0.000004

Mobile tel. 2100	-	-	-	-	-
3 - 2100 band	0.000088	0.000065	0.000026	0.000032	0.000061
TDC 2100 band	0.000498	0.000105	0.000032	0.000177	0.000539
TT-net 2100 band	0.000388	0.000473	0.000511	0.002037	0.000891
TT-net 2100 band	0.000157	0.000366	0.000175	0.000725	0.000769
WiFi network	-	-	-	-	-
Mobile tel. 2600	0.000007	0.000007	0.000079	0.000007	0.000008
3 - TDD band	-	-	-	-	-
TDC 2600 band	0.000221	0.000033	0.000045	0.000032	0.000521
3 - 2600 band	0.000079	0.000080	0.000010	0.000023	0.000079
TT-net 2600 band	0.000097	0.001367	0.000369	0.000176	0.000484
TT-net 2600 band	0.000177	0.000738	0.000119	0.000192	0.000126
TT-Net 5G 3.5 GHz	0.040460	0.048310	0.013280	0.079260	0.018690
WiFi Old Chan.	0.000013	0.000043	0.000013	0.000013	0.000013
WiFi Band A	0.000015	0.000048	0.000015	0.000015	0.000015
WiFi Band B	0.000025	0.000078	0.000025	0.000025	0.000025
WiFi Band C	0.000012	0.000040	0.000013	0.000013	0.000013
Other	0.000227	0.000305	0.000457	0.000150	0.001863
Total	**0.0928**	**0.0932**	**0.0368**	**0.1453**	**0.2981**
Part of limit value approx.	**1078**	**1073**	**2714**	**688**	**335**

Table 5: Measurement results

The highest compiled field strength is measured at measurement point 5 – approx. 0.3 % of the limit value, equivalent to approx. 1/335 part of the limit value, of the maximum allowed power density for permanent residence.

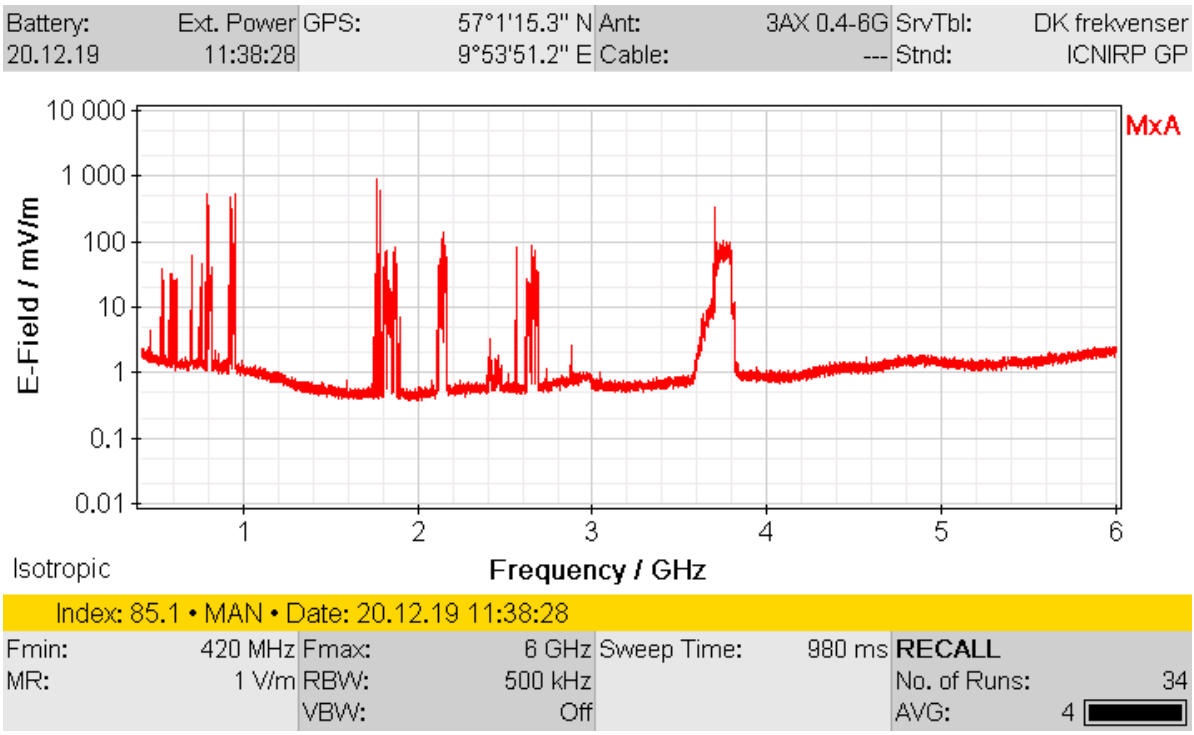
The location of the highest 5G field is measurement point 4, where 5G contributes approx. 0.08 % of the limit value.

Regarding mobile telephony, the quantities of the measured values will vary according to the amount of calls/traffic load. The measurements have been performed at a time, where a reasonably network-load is to be expected, but the measurement values can be up to 4 times bigger at peak load.

Measurement point	1	2	3	4	5
	W/m2	W/m2	W/m2	W/m2	W/m2
TT-net 800 band	0.000442	0.000441	0.000049	0.000658	0.004224
TDC 800 band	0.000104	0.000078	0.000012	0.000035	0.000077
TT-net 800 band	-	-	-	-	-
TDC 800 band	-	-	-	-	-
Mobile tel. 900	0.000000	0.000000	0.000000	0.000000	0.000000
TT-net 900 band	0.000009	0.000035	0.000039	0.000006	0.000209
TT-net 900 band	0.000136	0.000176	0.000245	0.000039	0.001832
3 - 900 band	0.000010	0.000004	0.000001	0.000003	0.000005
TDC 900 band	0.000051	0.000008	0.000004	0.000010	0.000033
TT-net 900 band	0.000219	0.000314	0.000172	0.000381	0.000546
Mobile tel. 1800	-	-	-	-	-
3 - 1800 band	0.000025	0.000018	0.000004	0.000009	0.000068
TDC 1800 band	0.000033	0.000021	0.000007	0.000017	0.000056
TT-net 1800 band	0.000021	0.000015	0.000006	0.000006	0.000012
TT-net 1800 band	0.000033	0.000214	0.000012	0.000054	0.000114
Mobile tel. 2100	-	-	-	-	-
3 - 2100 band	0.000009	0.000007	0.000003	0.000003	0.000006
TDC 2100 band	0.000050	0.000011	0.000003	0.000018	0.000054
TT-net 2100 band	0.000039	0.000047	0.000051	0.000204	0.000089
TT-net 2100 band	0.000016	0.000037	0.000018	0.000073	0.000077
Mobile tel. 2600	0.000001	0.000001	0.000008	0.000001	0.000001
3 - TDD band	-	-	-	-	-
TDC 2600 band	0.000022	0.000003	0.000004	0.000003	0.000052
3 - 2600 band	0.000008	0.000008	0.000001	0.000002	0.000008
TT-net 2600band	0.000010	0.000137	0.000037	0.000018	0.000048
TT-net 2600band	0.000018	0.000074	0.000012	0.000019	0.000013
TT-Net 5G 3.5 GHz	0.004046	0.004831	0.001328	0.007926	0.001869

Table 6: Equivalent quantities of power densities in W/m^2

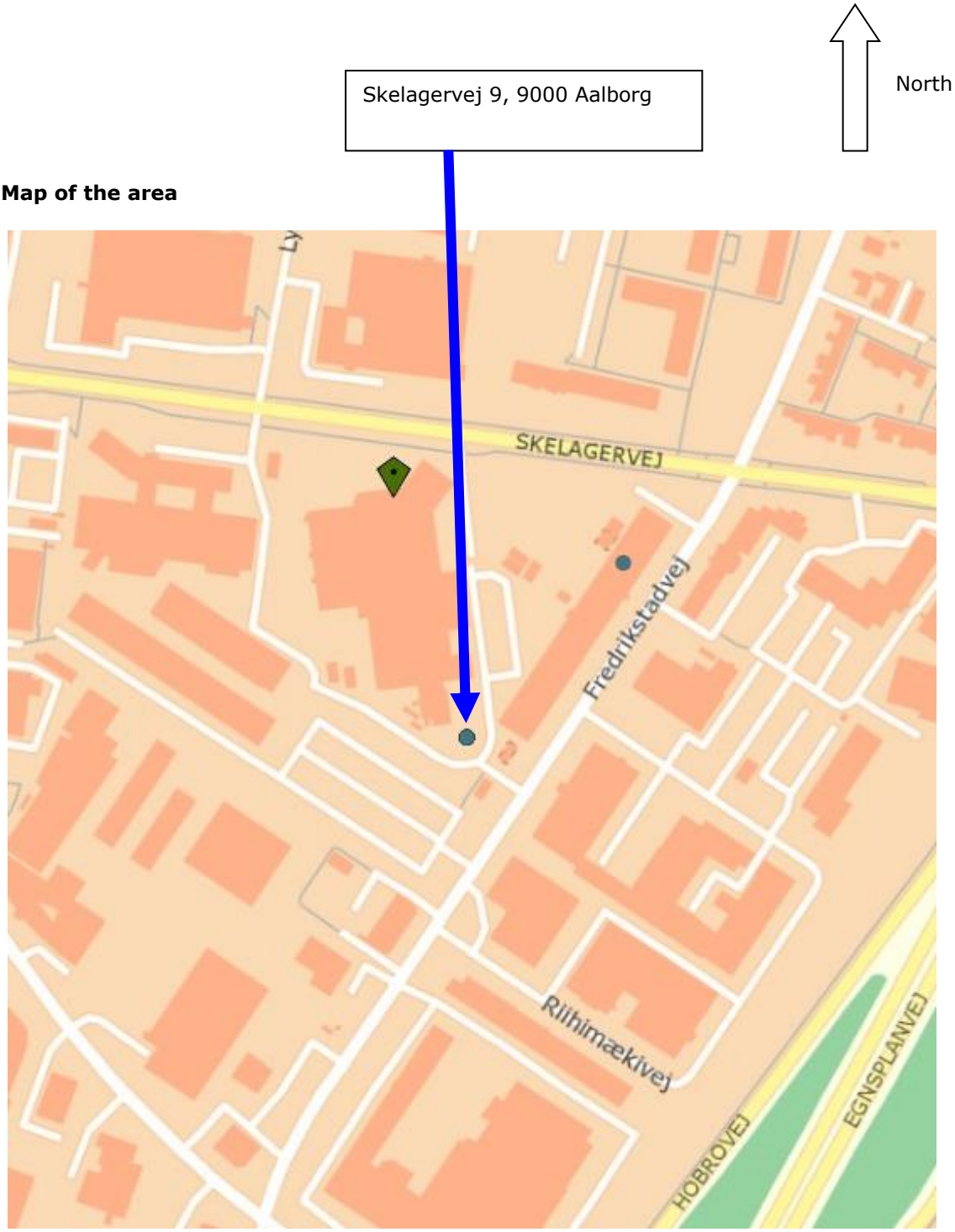
The table above displays the equivalent quantities of power densities based on table 5.



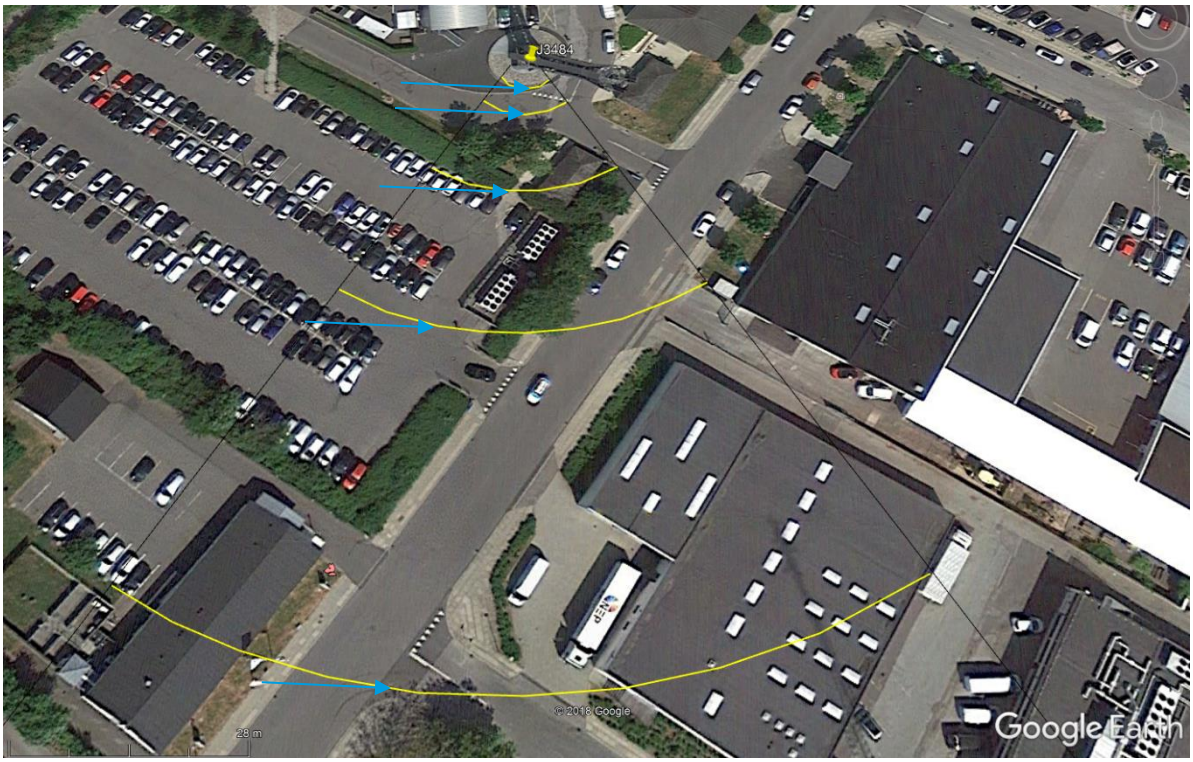
Measurement point 5 - diagram displaying frequency measurement from 420 MHz to 6000 MHz.

10. MAPS AND PHOTOS

Map of the area



Measurement locations pointed out by the client



The arrows are indicating the measuring points.

Measurement location 1 – 5m from antenna tower (white dot on the ground marking exact measurement point)

Measurement location 2 – 10m from the antenna tower (white dot on the ground marking exact measurement point)

Measurement location 3 – 25m from the antenna tower (white dot on the ground marking exact measurement point)

Measurement location 4 – 50m from antenna tower (white dot on the ground marking exact measurement point)

Measurement location 5 – 100m from antenna tower (white dot on the ground marking exact measurement point)