Test Report

FINAS
Finnish Accreditation Service
T004 (EN ISO/IEC 17025)

INTENTIONAL RADIATOR TESTS ACCORDING TO FCC PART 15 C and INDUSTRY CANADA REQUIREMENTS

Equipment Under Test:	WiFi Location Tag Transmitter
Type/ Model:	A4+
Manufacturer:	Ekahau Oy Hiilikatu 3 FI-00180 HELSINKI FINLAND
Customer:	Ekahau Oy Hiilikatu 3 FI-00180 HELSINKI FINLAND
FCC Rule Part:	15.247: 2012
IC Rule Part:	RSS-210, Issue 8, 2010 RSS-GEN Issue 3, 2010
KDB:	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 (April 9, 2013)

Date:	November 18, 2013	Date:	November 18, 2013
Issued by:		Checked by:	
	Niko Kotsalo Testing Engineer		Jari Merikari Technical Manager

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Equipment Under Test (EUT)

WiFi Location Tag	
Type/ Model:	A4+
Serial Number:	N/A

The EUT is a wrist watch-sized, battery powered, location tag device, which utilizes 802.11b/g radio technology.

Classification of the device

Fixed device	☐
Mobile Device (Human body distance > 20cm)	☐
Portable Device (Human body distance < 20cm)	☒

Modifications Incorporated in the EUT

No modifications were applied to the EUT during testing

Ratings and declarations

Operating Frequency Range (OFR):	2412 – 2462 MHz
Channels:	11
Channel separation:	5 MHz
Channel bandwidth:	20 MHz
Conducted power:	+11.94 dBm
Transmission technique:	DSSS
Modulation:	CCK, OFDM
Transmission rate:	1, 2, 5.5, 6, 9, 11, 12, 18, 24, 36, 48, 54 Mbps
Antenna gain (Fractus ceramic chip antenna):	1.1 dBi

Power Supply

The EUT has an internal lithium battery (CR2, 3V) and uses and external USB-battery pack.

Disclaimer

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SUMMARY OF TESTING

Test Specification	Description of Test	Result
§15.247(b)(3) / RSS-210 8.4	Maximum Conducted Output Power	PASS
§15.209 / RSS-GEN 7.2.3.2	Unintentional Radiated Emissions	PASS

EUT Test Conditions during Testing

The EUT was configured into the wanted channel and was in continuous transmit mode during all the tests

The power of all modes and data rates were measured with a power meter (low, mid and high channel) and the signal giving the highest power was selected for the measurements (802.11 g-mode with 6 Mbps data rate).

Following channels were used during the tests:

Channel	Frequency/ MHz
LOW	2412
MID	2437
HIGH	2462

Test Facility

☐	Testing Location / address: FCC registration number: **90598**	SGS Fimko Ltd Särkiniementie 3 FI-00210, HELSINKI FINLAND
☒	Testing Location / address: FCC registration number: **178986** Industry Canada registration number: **8708A-2**	SGS Fimko Ltd Karakaarenkuja 4 FI-02610, ESPOO FINLAND

Maximum Conducted Output Power Measurement

Standard:	ANSI C63.10	(2009)
Tested by:	NKO	
Date:	11.11.2013	
Temperature:	22 °C	
Humidity:	18 % RH	

FCC Rule: 15.247 (b) (3)

For systems using digital modulation in the 2400-2483.5 MHz band: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the *maximum conducted output power* is the highest total transmit power occurring in any mode.

Output power was measured with a power meter. The EUT was using “9” parameter for the power setting.

802.11b

Data rate [Mbps]	Conducted power [dBm]			Limit [dBm]	Result
	Low channel	Mid channel	High channel		
1	10.48	10.77	11.11	30	PASS
2	10.37	10.72	10.98	30	PASS
5.5	9.97	10.30	10.60	30	PASS
11	10.10	10.43	10.67	30	PASS

802.11g

Data rate [Mbps]	Conducted power [dBm]			Limit [dBm]	Result
	Low channel	Mid channel	High channel		
6	11.49	11.72	11.94	30	PASS
9	11.39	11.60	11.83	30	PASS
12	11.30	11.52	11.74	30	PASS
18	11.13	11.47	11.54	30	PASS
24	10.95	11.19	11.39	30	PASS
36	10.56	10.85	11.14	30	PASS
48	10.35	10.61	10.92	30	PASS
54	10.32	10.52	10.83	30	PASS

The output power in the original test report (LS Research, LLC: Report #: 310207) was 12.04 dBm. The deviation with measured maximum value is 0.1 dBm.

Transmitter Radiated Emissions 30 – 26 500 MHz and Band Edge

Standard:	ANSI C63.10	(2009)
Tested by:	NKO/RRE	
Date:	11.11 – 12.11.2013	
Temperature:	22 – 22.6 °C	
Humidity:	18 – 22 % RH	
Measurement uncertainty:	± 4.51 dB	Level of confidence 95 % (k = 2)

FCC Rule: 15.247(d), 15.209(a)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a).

The correction factor in the final result table contains the sum of the transducers (antenna + amplifier + cables).

The QuasiPeak value is the measured value corrected with the correction factor.

Measurements are done with 6 Mbps data rate.

Test results

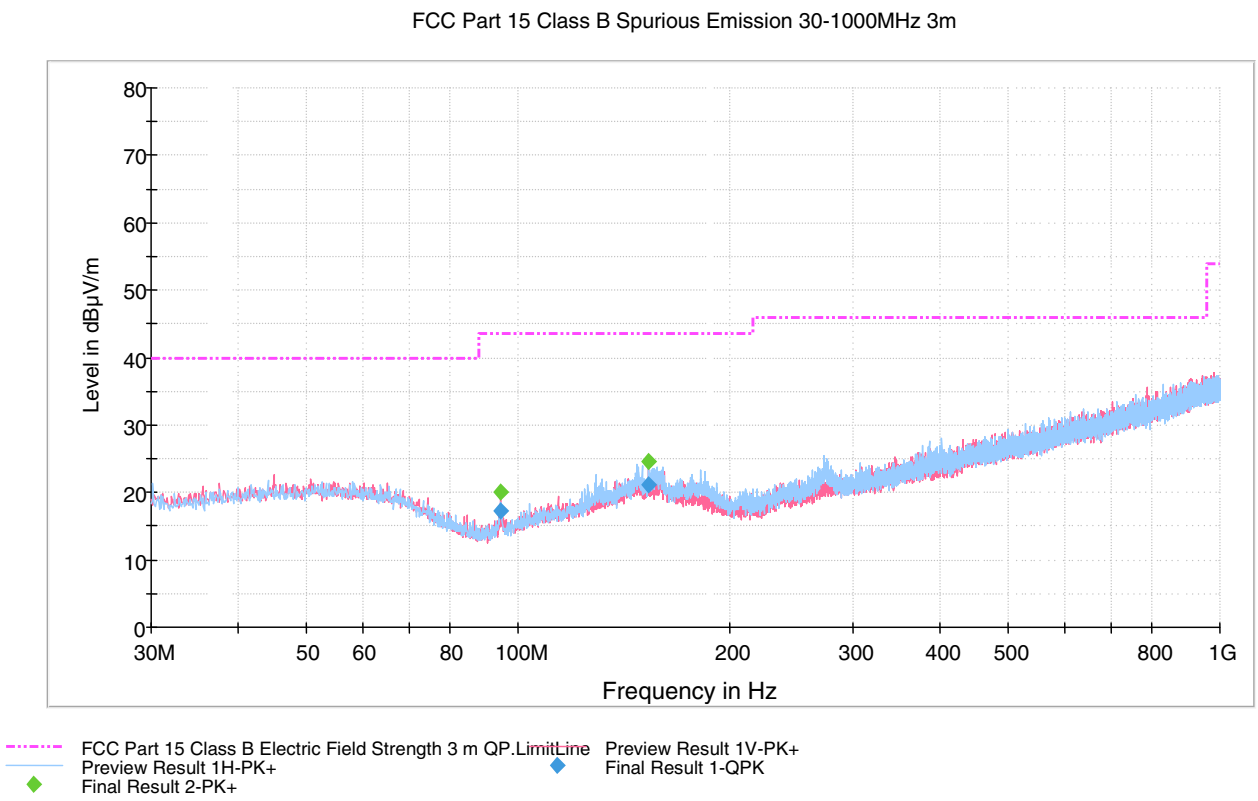

Figure 1. Measured curves with peak-detector (low channel).

Table 1. Final measurements from the worst frequencies.

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
94.505000	17.3	1000.0	120.000	110.0	V	266.0	9.1	26.2	43.5	
153.261000	21.1	1000.0	120.000	186.0	H	99.0	15.0	22.4	43.5	

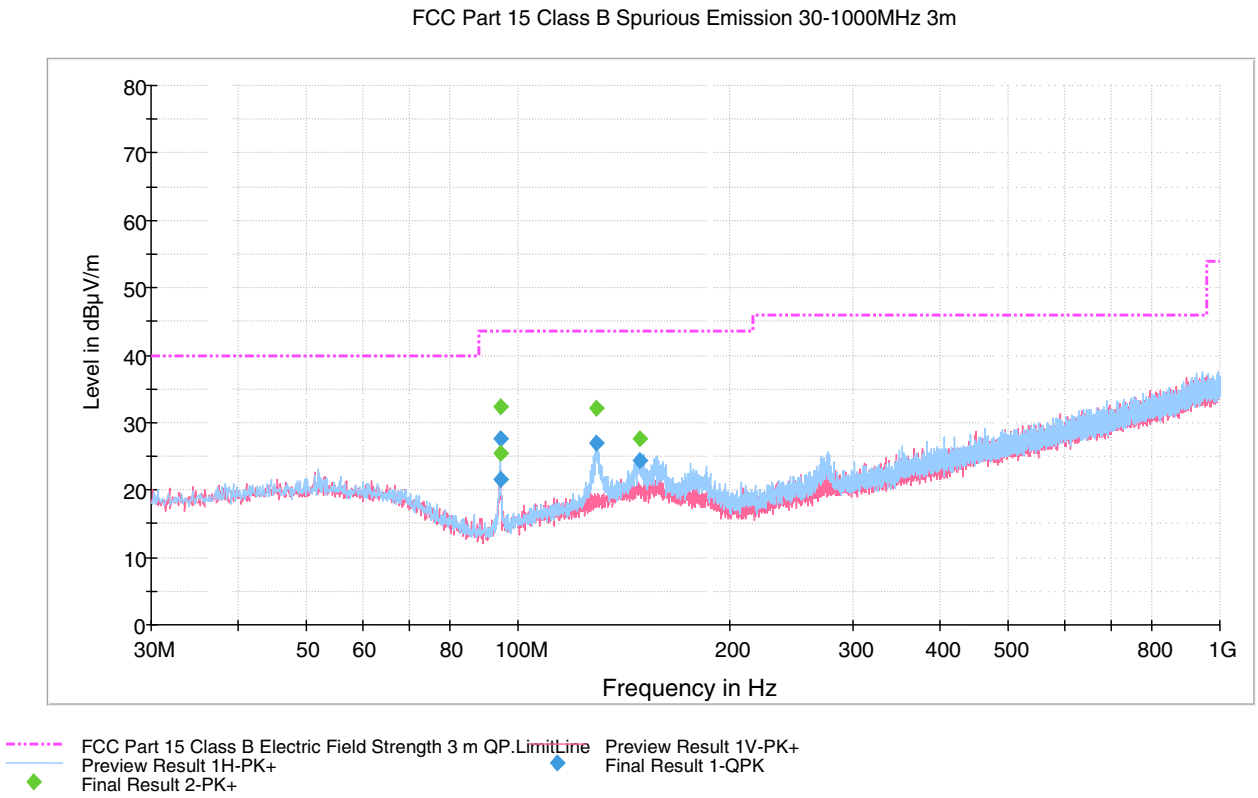

Figure 2. Measured curve with peak-detector (middle channel).

Table 2. Final measurements from the worst frequencies.

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
94.234000	27.7	1000.0	120.000	241.0	H	232.0	9.0	15.8	43.5	
94.254000	21.5	1000.0	120.000	100.0	V	13.0	9.0	22.0	43.5	
129.262000	26.9	1000.0	120.000	223.0	H	106.0	12.8	16.6	43.5	
148.753000	24.4	1000.0	120.000	220.0	H	93.0	14.8	19.1	43.5	

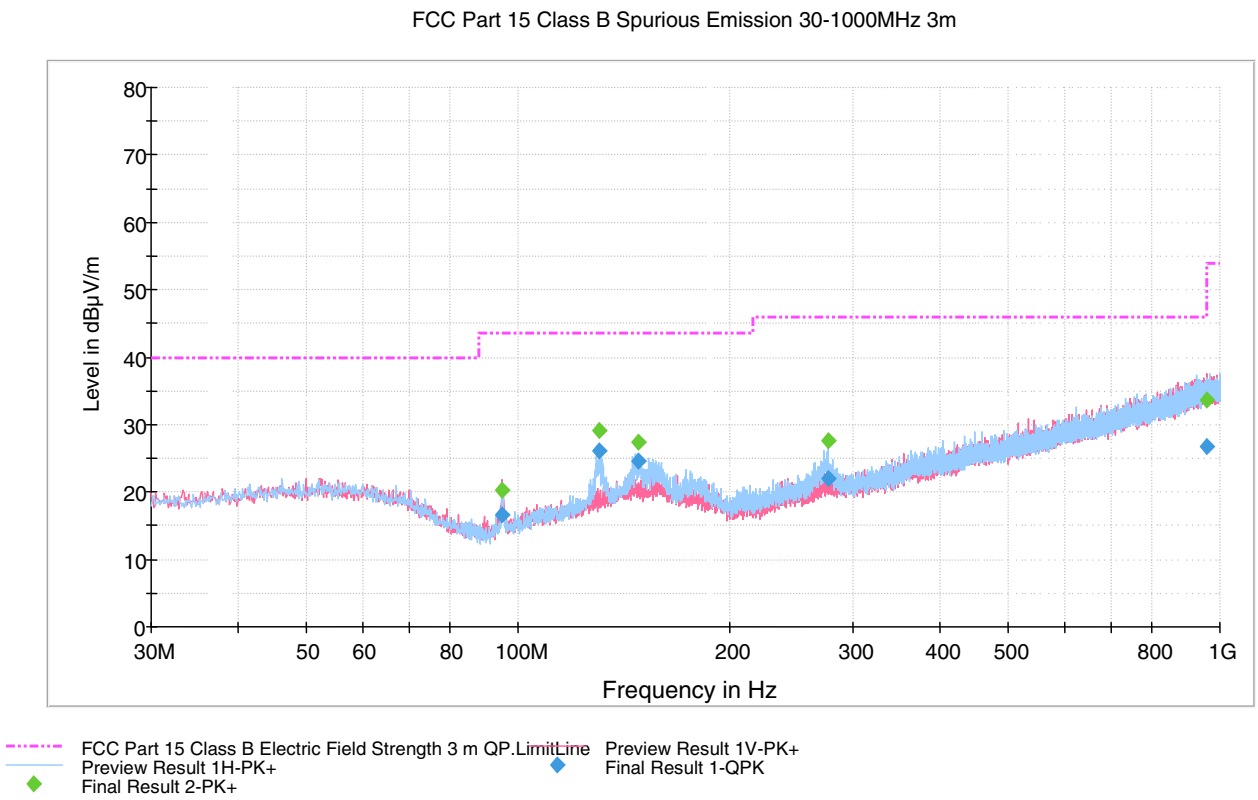

Figure 3. Measured curve with peak-detector (high channel).

Table 3. Final measurements from the worst frequencies

Frequency (MHz)	QuasiPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
94.970000	16.6	1000.0	120.000	110.0	V	271.0	9.1	26.9	43.5	
130.263000	26.1	1000.0	120.000	230.0	H	96.0	12.9	17.4	43.5	
148.743000	24.6	1000.0	120.000	178.0	H	105.0	14.8	18.9	43.5	
277.045000	22.1	1000.0	120.000	100.0	H	104.0	15.2	23.9	46.0	
959.566000	26.7	1000.0	120.000	148.0	V	77.0	28.1	19.3	46.0	

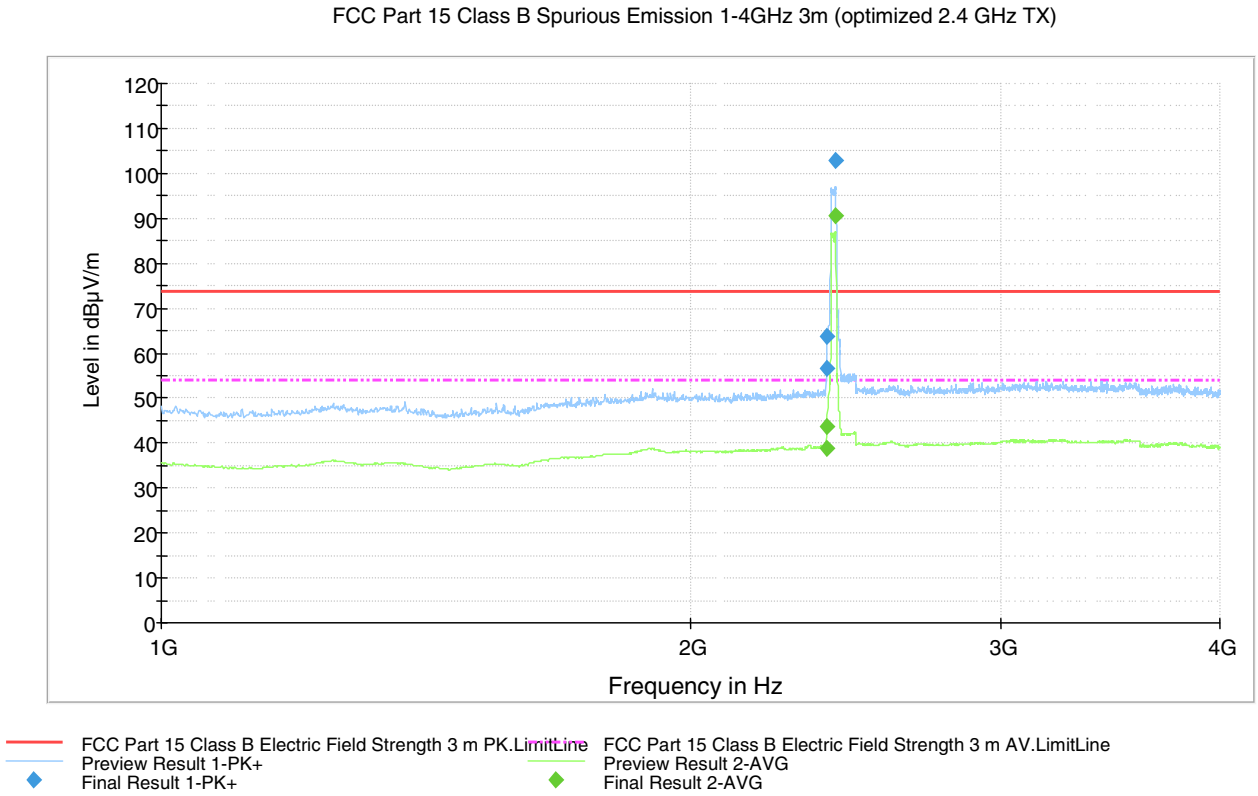

Figure 4. Measured curve with peak- and average detector (low channel).

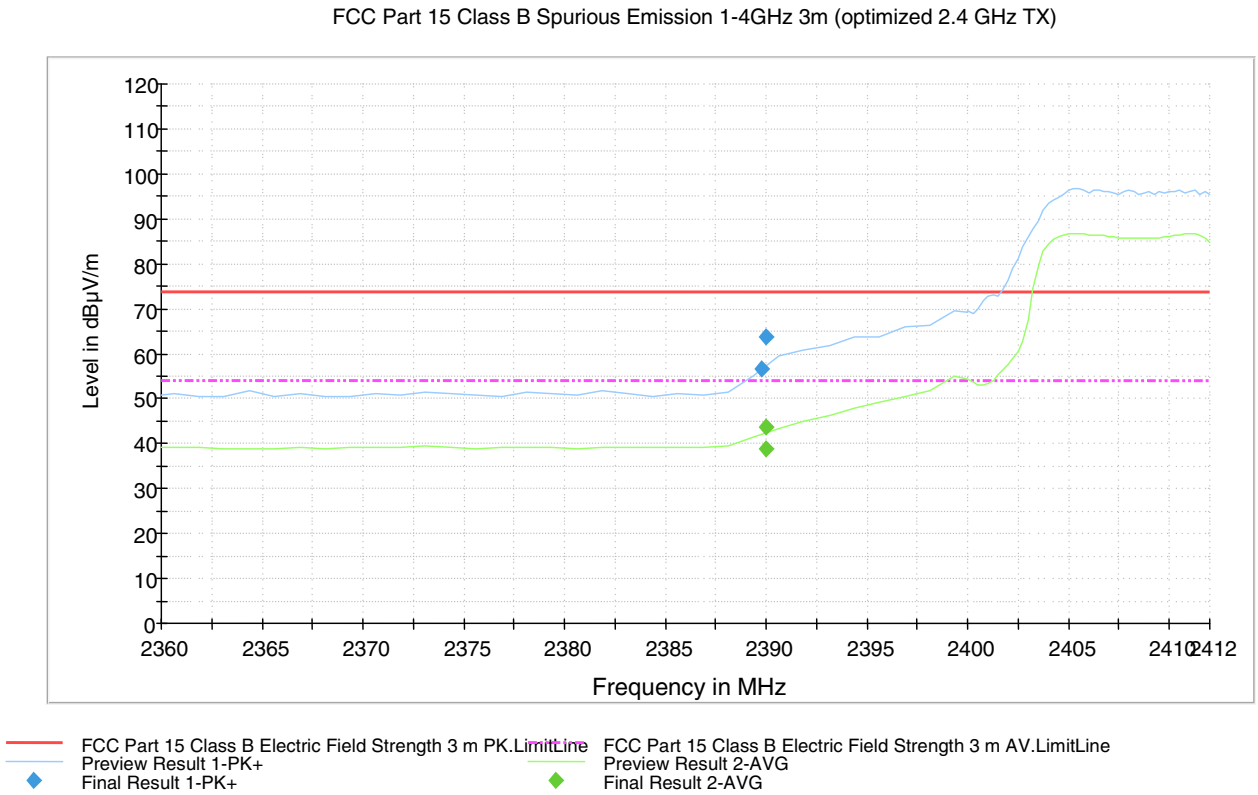

Figure 5. Low channel band edge

Final measurements from the worst frequencies

Table 4. Final Max Peak results.

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
2389.800000	56.5	1000.0	1000.000	168.0	V	120.0	14.4	17.4	73.9	
2390.000000	63.7	1000.0	1000.000	211.0	H	140.0	14.4	10.2	73.9	
2418.550000	103.0	1000.0	1000.000	203.0	H	146.0	14.4	-29.1	73.9	carrier

Table 5. Final Average results.

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
2390.000000	43.5	1000.0	1000.000	206.0	H	146.0	14.4	10.4	53.9	
2390.000000	38.9	1000.0	1000.000	198.0	V	120.0	14.4	15.0	53.9	
2418.300000	90.5	1000.0	1000.000	203.0	H	146.0	14.4	-36.6	53.9	carrier

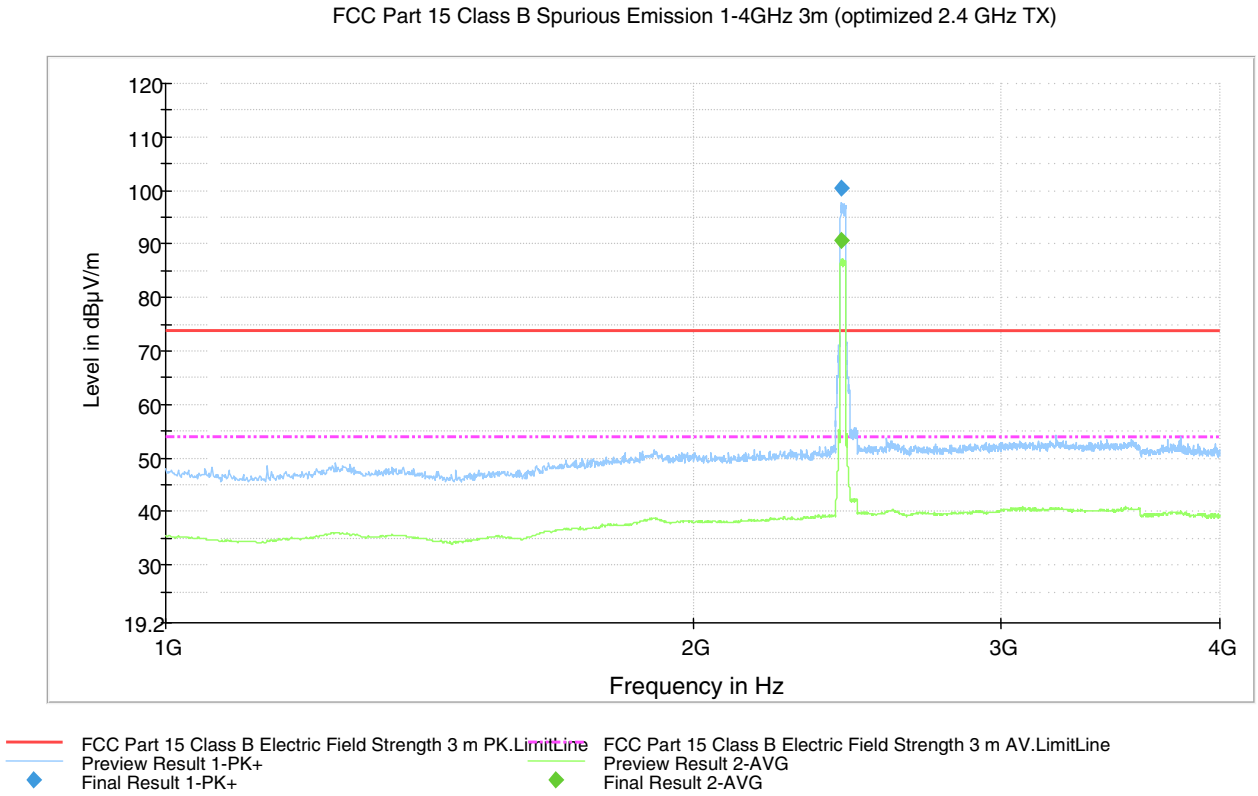

Figure 6. Measured curve with peak- and average detector (middle channel).

Final measurements from the worst frequencies

Table 6. Final Max Peak results.

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
2432.000000	100.5	1000.0	1000.000	203.0	H	163.0	14.4	-26.6	73.9	carrier

Table 7. Final Average results.

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
2432.000000	100.5	1000.0	1000.000	203.0	H	163.0	14.4	-26.6	73.9	carrier

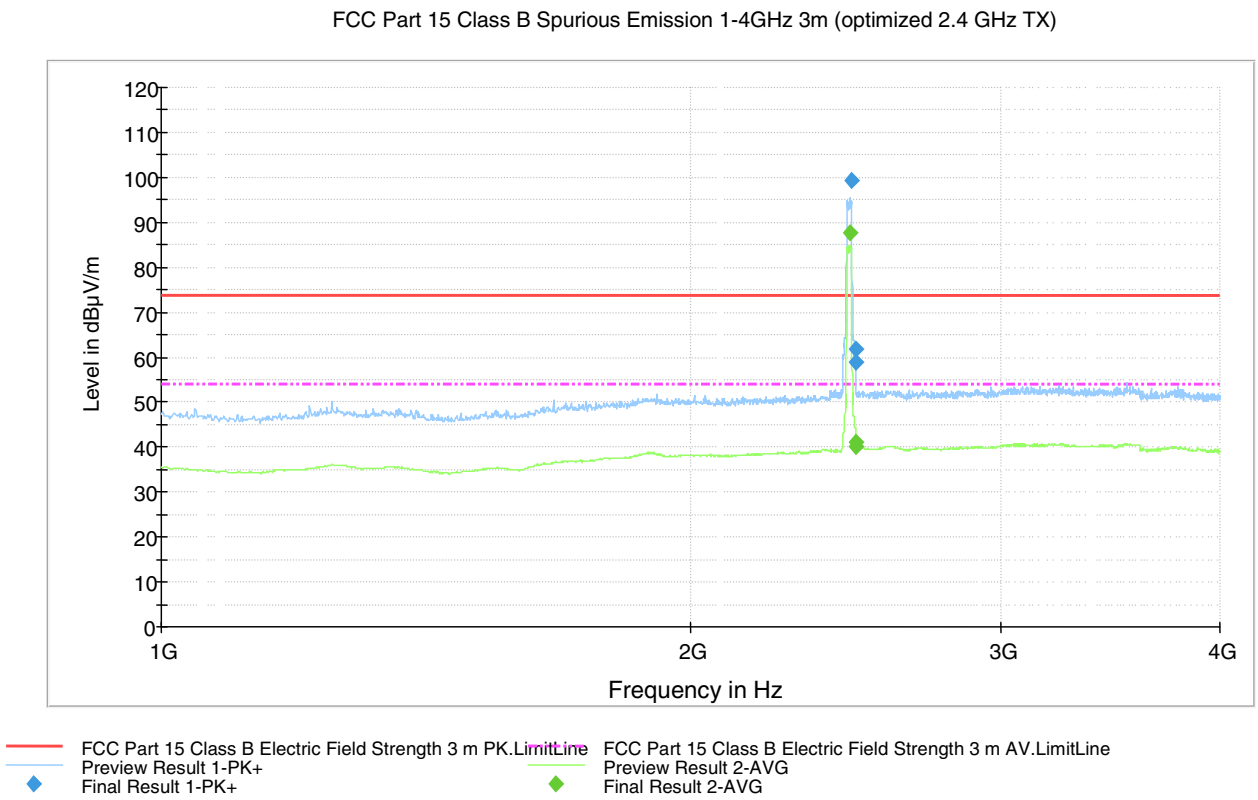

Figure 7. Measured curve with peak- and average detector (high channel).

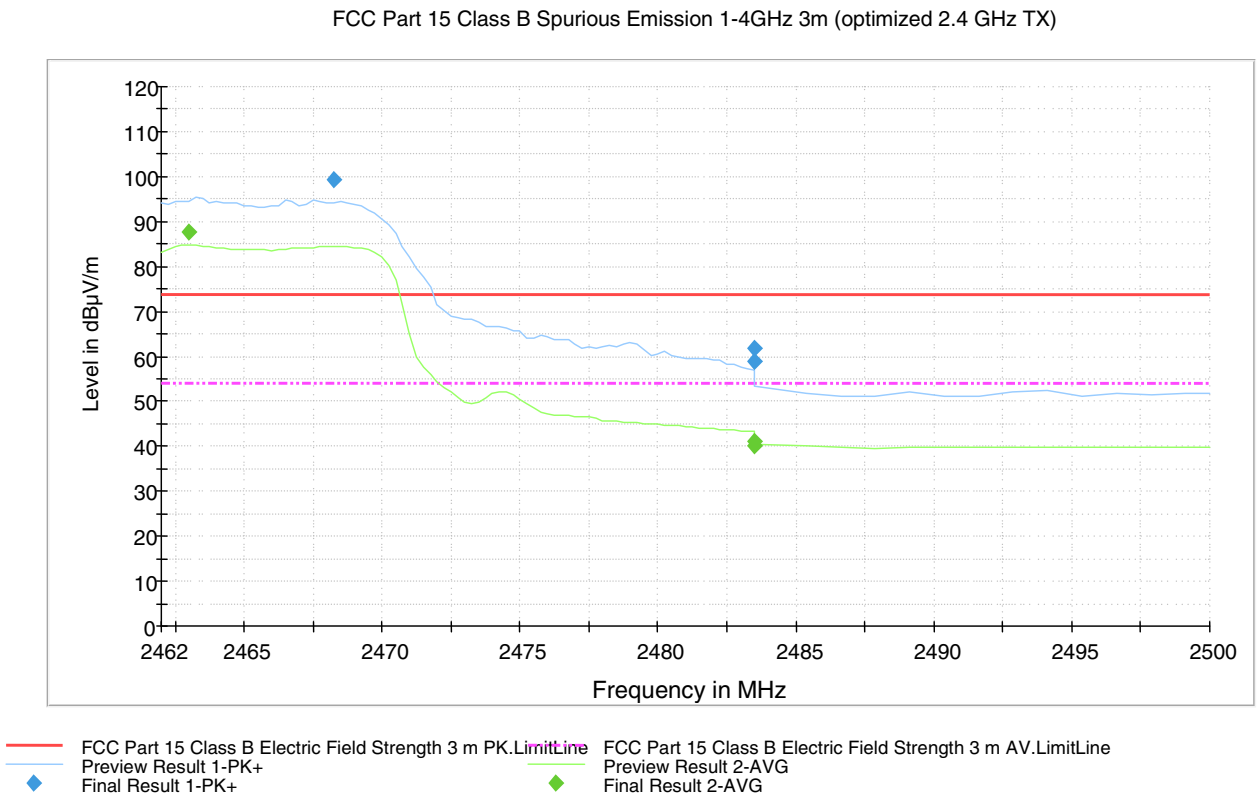

Figure 8. High channel band edge

Final measurements from the worst frequencies

Table 8. Final Max Peak results.

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
2468.250000	99.1	1000.0	1000.000	202.0	H	158.0	14.6	-25.2	73.9	carrier
2483.500000	61.8	1000.0	1000.000	164.0	H	158.0	14.8	12.1	73.9	
2483.500000	58.8	1000.0	1000.000	145.0	V	180.0	14.8	15.1	73.9	

Table 9. Final Average results.

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
2468.250000	99.1	1000.0	1000.000	202.0	H	158.0	14.6	-25.2	73.9	carrier
2483.500000	61.8	1000.0	1000.000	164.0	H	158.0	14.8	12.1	73.9	
2483.500000	58.8	1000.0	1000.000	145.0	V	180.0	14.8	15.1	73.9	

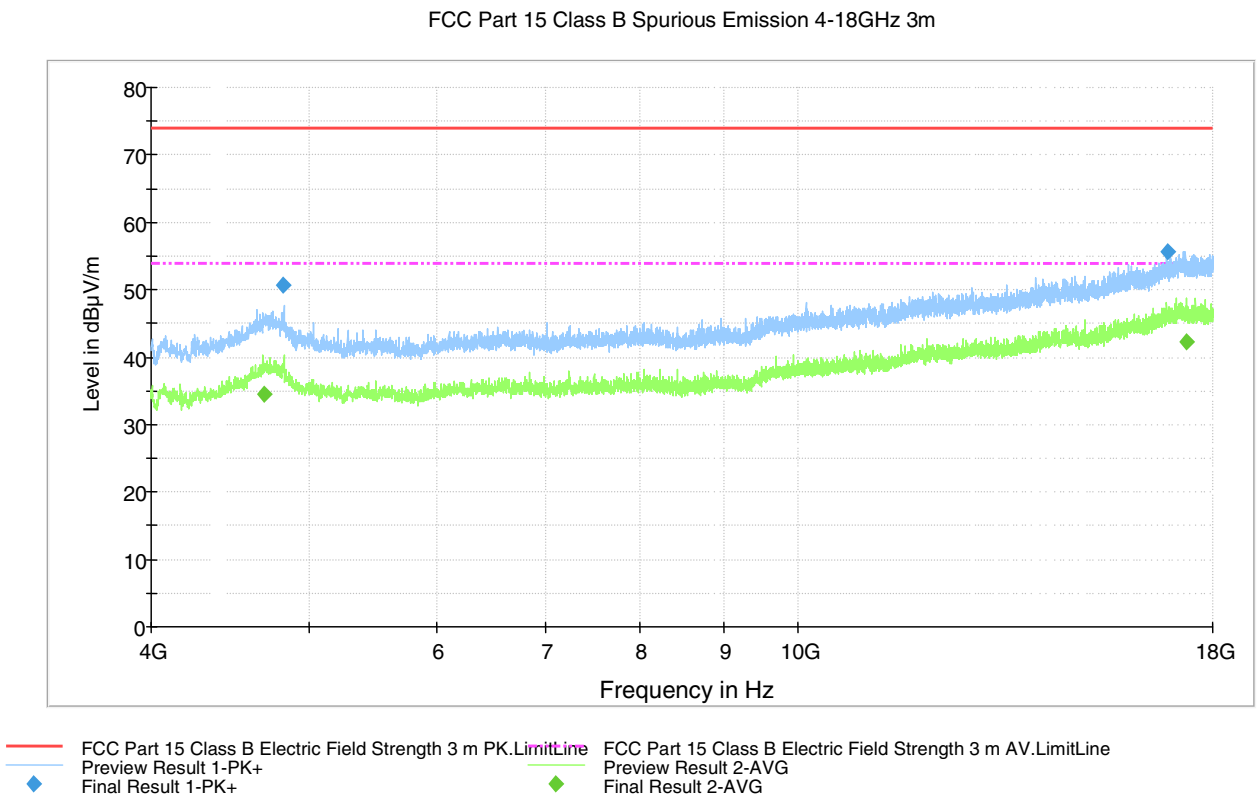

Figure 9. Measured curve with peak- and average detector (low channel).

Final measurements from the worst frequencies

Table 10. Final Max Peak results.

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
4825.600000	50.6	1000.0	1000.000	216.0	V	196.0	13.5	23.3	73.9	
16874.000000	55.7	1000.0	1000.000	311.0	H	204.0	27.8	18.2	73.9	

Table 11. Final Average results.

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
4694.600000	34.5	1000.0	1000.000	333.0	H	159.0	14.3	19.4	53.9	
17347.000000	42.4	1000.0	1000.000	105.0	V	85.0	28.2	11.5	53.9	

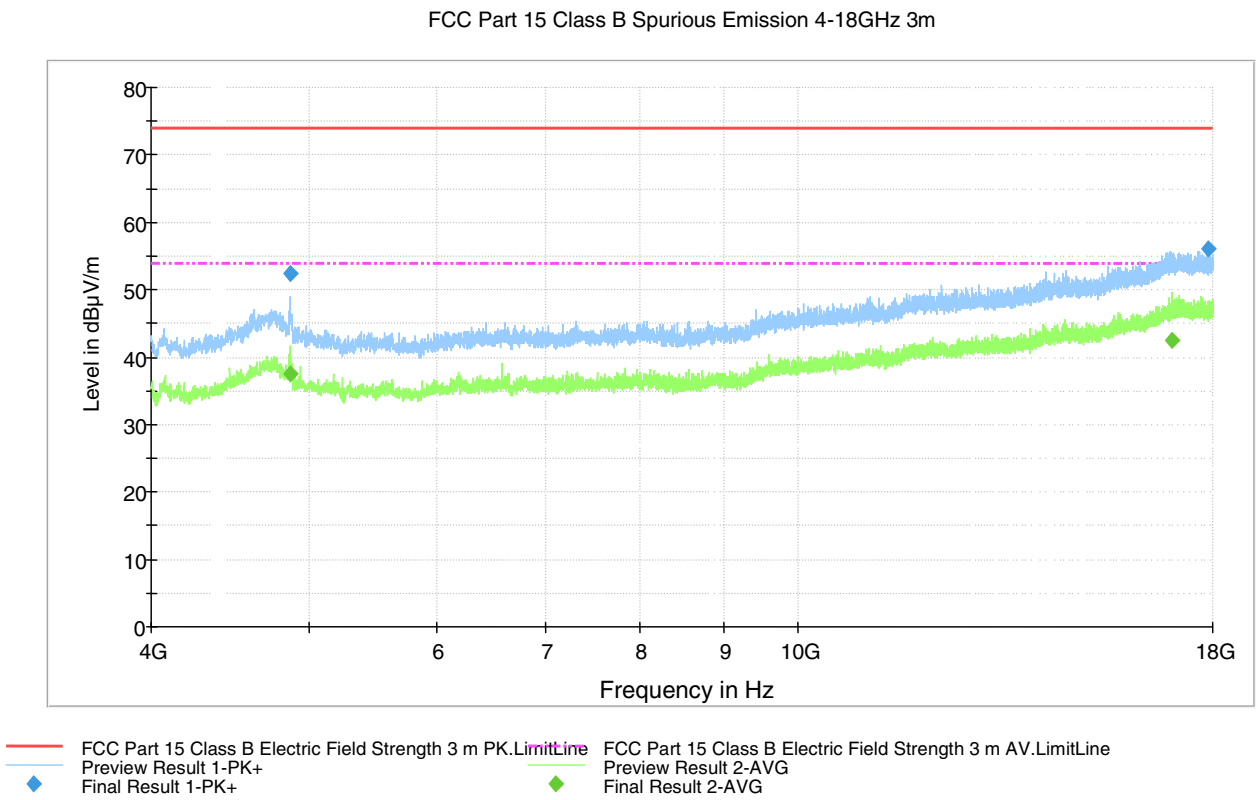

Figure 10. Measured curve with peak- and average detector (middle channel).

Final measurements from the worst frequencies

Table 12. Final Max Peak results.

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
4871.600000	52.4	1000.0	1000.000	100.0	H	160.0	12.9	21.5	73.9	
17898.600000	56.1	1000.0	1000.000	211.0	V	241.0	28.6	17.8	73.9	

Table 13. Final Average results.

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
4874.000000	37.6	1000.0	1000.000	105.0	H	174.0	12.9	16.3	53.9	
17001.400000	42.4	1000.0	1000.000	243.0	V	327.0	28.1	11.5	53.9	

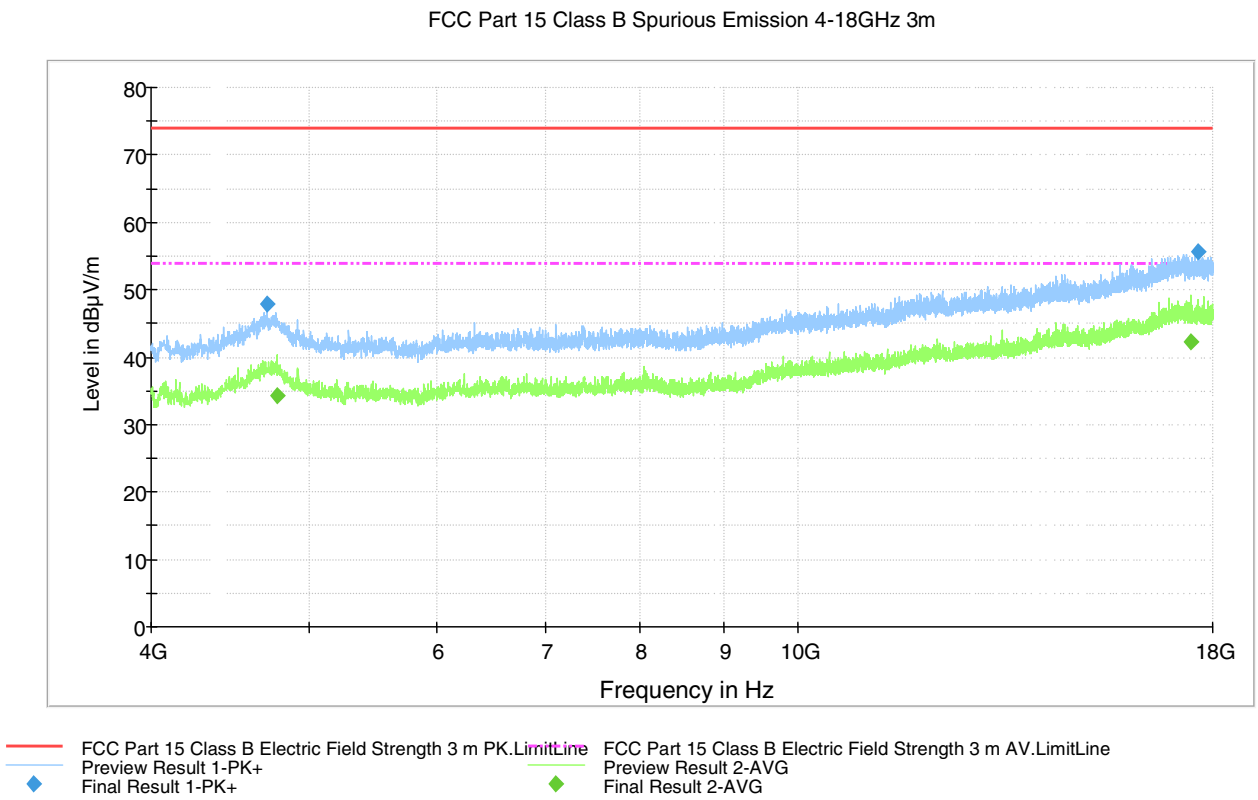

Figure 11. Measured curve with peak- and average detector (high channel).

Final measurements from the worst frequencies

Table 14. Final Max Peak results.

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
4713.000000	47.9	1000.0	1000.000	277.0	V	0.0	14.4	26.0	73.9	
17618.000000	55.6	1000.0	1000.000	304.0	V	129.0	28.2	18.3	73.9	

Table 15. Final Average results.

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
4713.000000	47.9	1000.0	1000.000	277.0	V	0.0	14.4	26.0	73.9	
17618.000000	55.6	1000.0	1000.000	304.0	V	129.0	28.2	18.3	73.9	

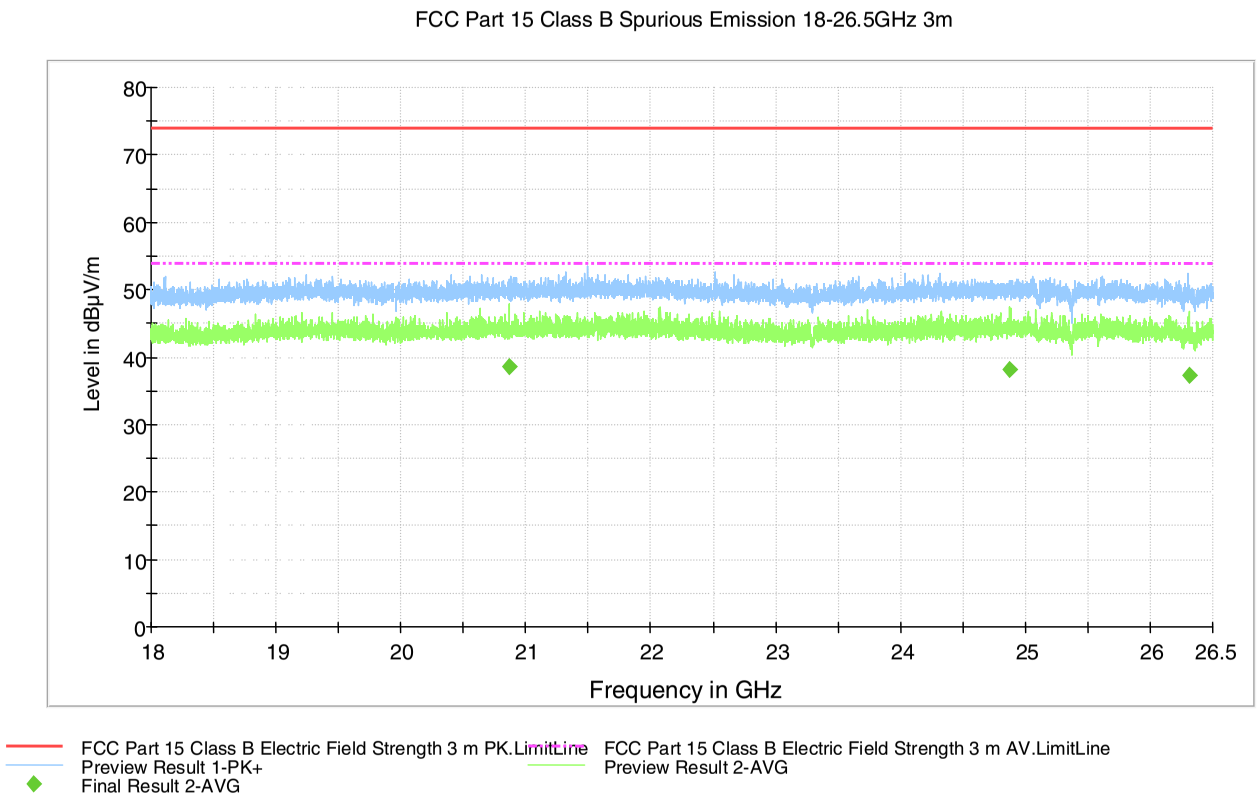

Figure 12. Measured curve with peak- and average detector (low channel).

Table 16. Final Average results.

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
20872.200000	38.6	1000.0	1000.000	105.0	H	4.0	26.5	15.3	53.9	
24870.000000	38.1	1000.0	1000.000	306.0	H	334.0	28.8	15.8	53.9	
26311.150000	37.2	1000.0	1000.000	100.0	H	339.0	29.7	16.7	53.9	

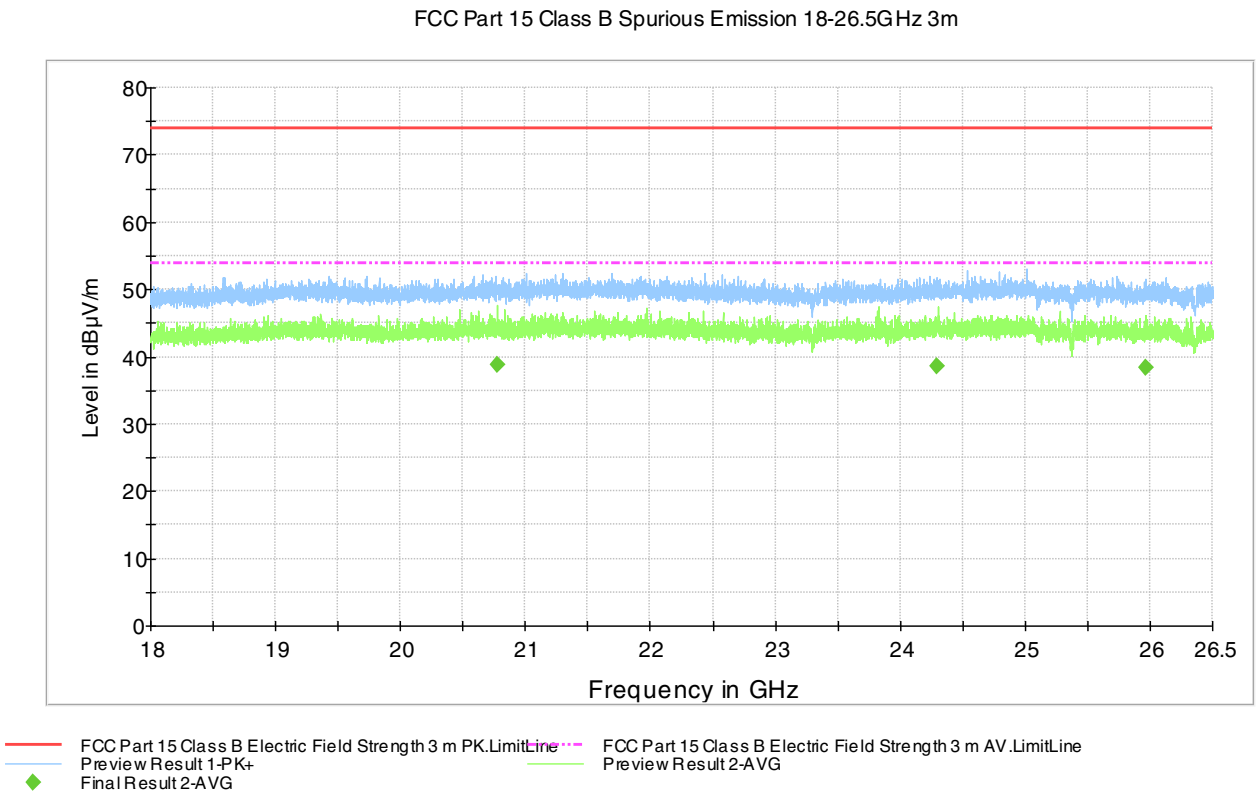

Figure 13. Measured curve with peak- and average detector (middle channel).

Table 17. Final Average results.

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
20772.100000	38.9	1000.0	1000.000	100.0	V	99.0	26.5	15.0	53.9	
24299.100000	38.5	1000.0	1000.000	105.0	H	34.0	28.4	15.4	53.9	
25970.500000	38.5	1000.0	1000.000	100.0	V	296.0	29.6	15.4	53.9	

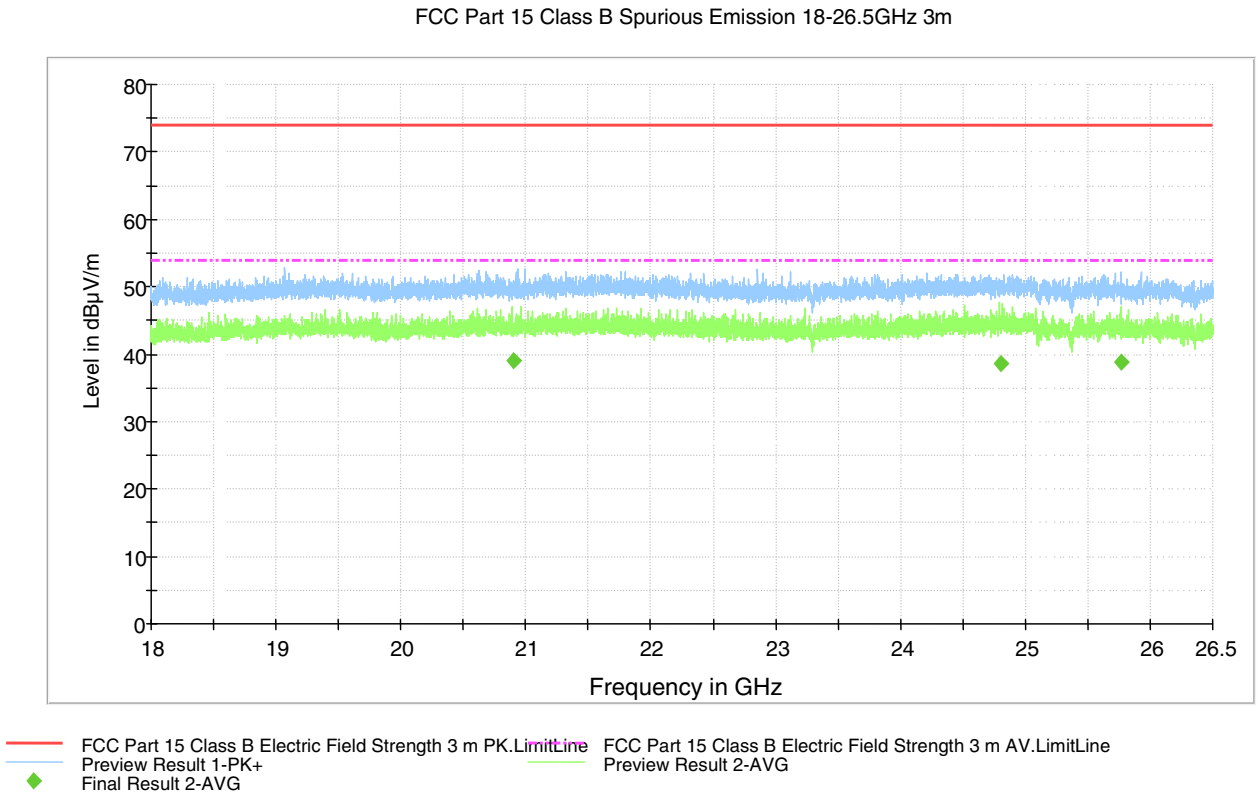

Figure 14. Measured curve with peak- and average detector (high channel).

Table 18. Final Average results.

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)	Comment
20898.650000	39.0	1000.0	1000.000	100.0	H	150.0	26.6	14.9	53.9	
24799.750000	38.6	1000.0	1000.000	100.0	H	81.0	28.6	15.3	53.9	
25765.700000	38.9	1000.0	1000.000	100.0	V	248.0	29.6	15.0	53.9	

LIST OF TEST EQUIPMENT

Manufacturer	Type	Serial no	Inv. no
ROHDE & SCHWARZ			
Signal Analyzer	FSV40	101068	9093
EMI Test receiver	ESU 26	100185	8453
Test software	EMC32	-	-
BOONTON			
RF power meter	4300	87105ED	5029
Power sensor	51075	34999	8266
DAVIS			
Weather station	Vantage Pro	-	5297
EMCO			
Antenna (1 - 18 GHz)	3117	29617	7293
ETS-LINDGREN			
Antenna (18 GHz – 26 GHz)	3160-09	28535	7294
SCHWARZBECK			
Antenna (30 MHz - 1 GHz)	VULB 9168	9168-503	8911
HEWLETT- PACKARD			
Microwave amplifier	83017A	-	5226
HUBER-SUHNER			
Attenuator 10dB	6810.17B	-	-
DEISEL			
Antenna mast	MA 240	240/455	7896
Turntable	DS 430	-	-
WAINWRIGHT			
High Pass Filter	WHKX	10	8267

All used measurement equipment was calibrated (if required).