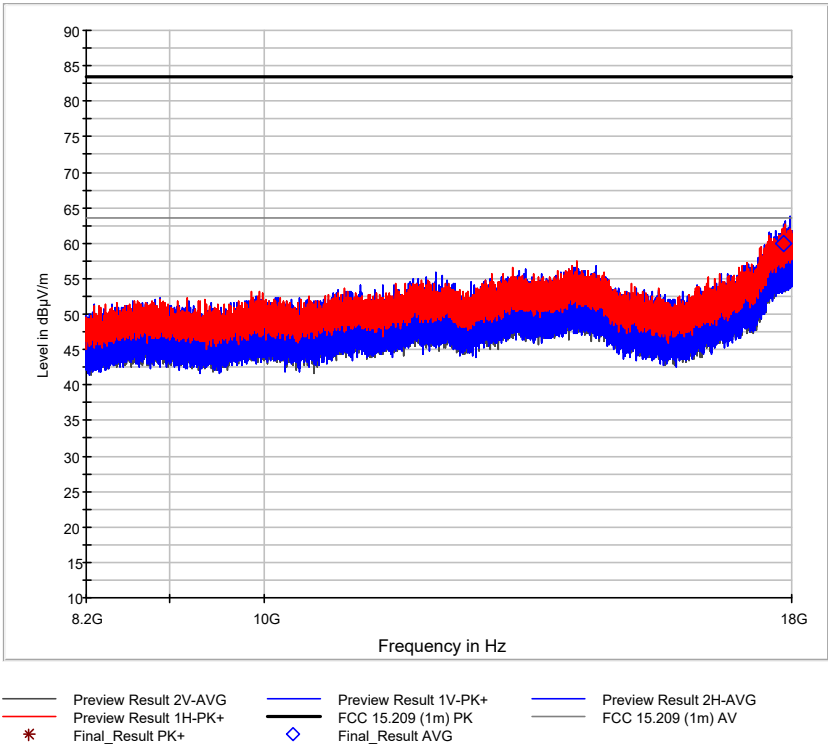




Product Service

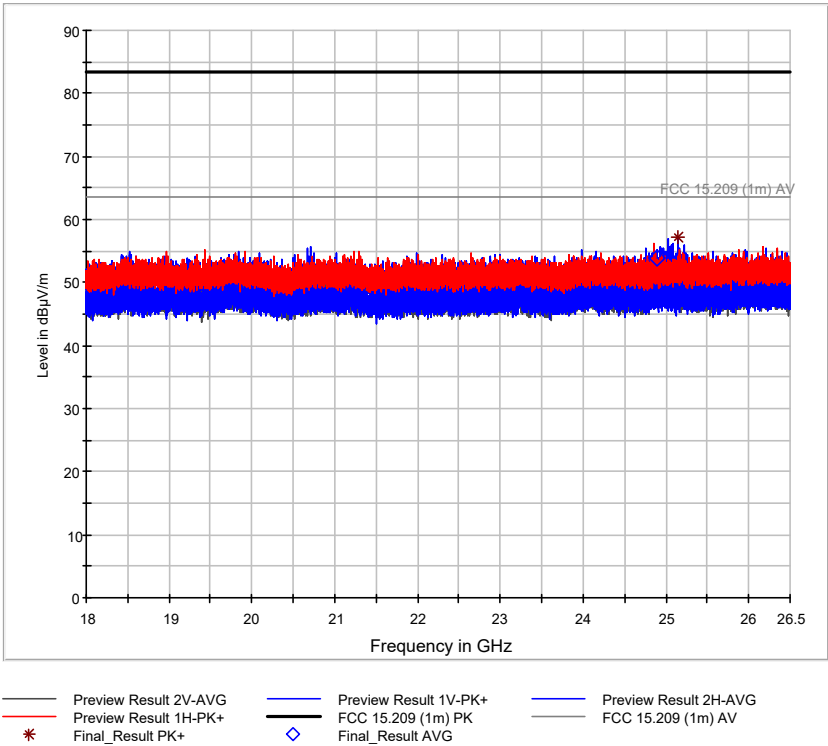


Final Results:

Frequency	MaxPeak	Average	Limit	Margin	Meas. Time	Bandwidth	Height	Pol	Azimuth	Corr.
MHz	dBµV/m	dBµV/m	dBµV/m	dB	ms	kHz	cm		deg	dB/m
17853.326667	---	60.01	63.50	3.49	2.5	1000.000	150.0	V	290.0	48



Product Service

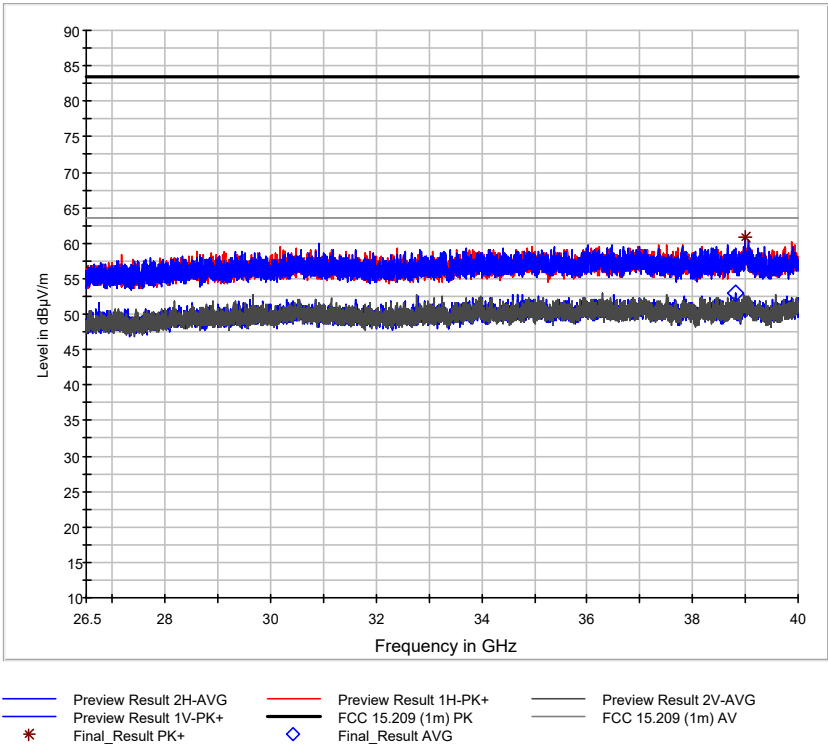


Final Results:

Frequency	MaxPeak	Average	Limit	Margin	Meas.	Bandwidth	Height	Pol	Azimuth	Corr.
MHz	dBµV/m	dBµV/m	dBµV/m	dB	Time ms	kHz	cm		deg	dB
24890.795455	---	53.88	63.50	9.62	2.5	1000.000	150.0	V	126.0	40.4
25148.886364	57.27	---	83.50	26.23	2.5	1000.000	150.0	V	126.0	40.4



Product Service

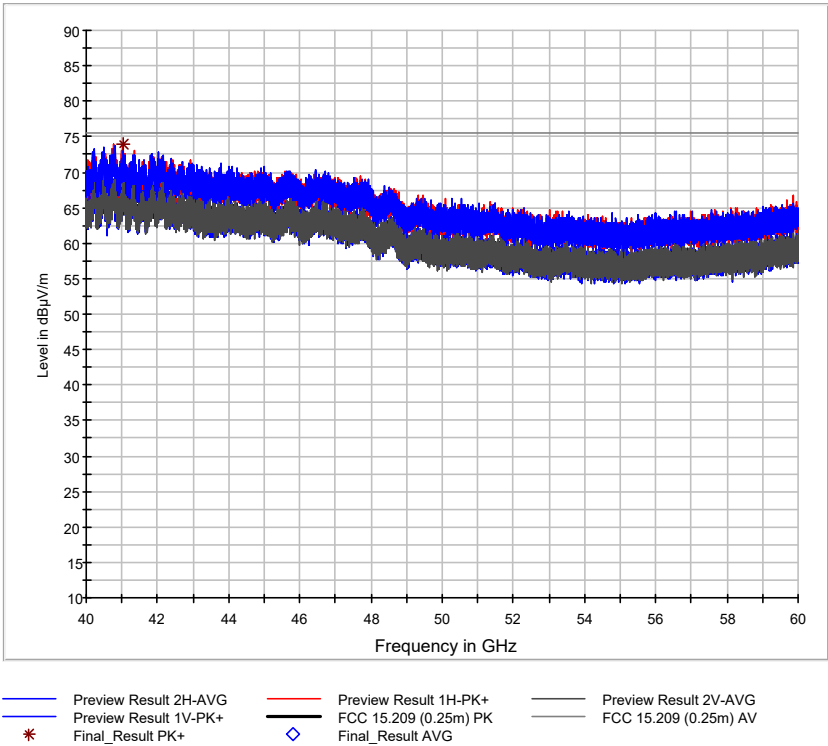


Final Results:

Frequency	MaxPeak	Average	Limit	Margin	Meas. Time	Bandwidth	Height	Pol	Azimuth	Corr.
MHz	dBµV/m	dBµV/m	dBµV/m	dB	ms	kHz	cm		deg	dB/m
38807.950000	---	53.02	63.50	10.48	2.5	1000.000	150.0	H	278.0	44
38995.600000	60.85	---	83.50	22.65	2.5	1000.000	150.0	V	159.0	44



Product Service

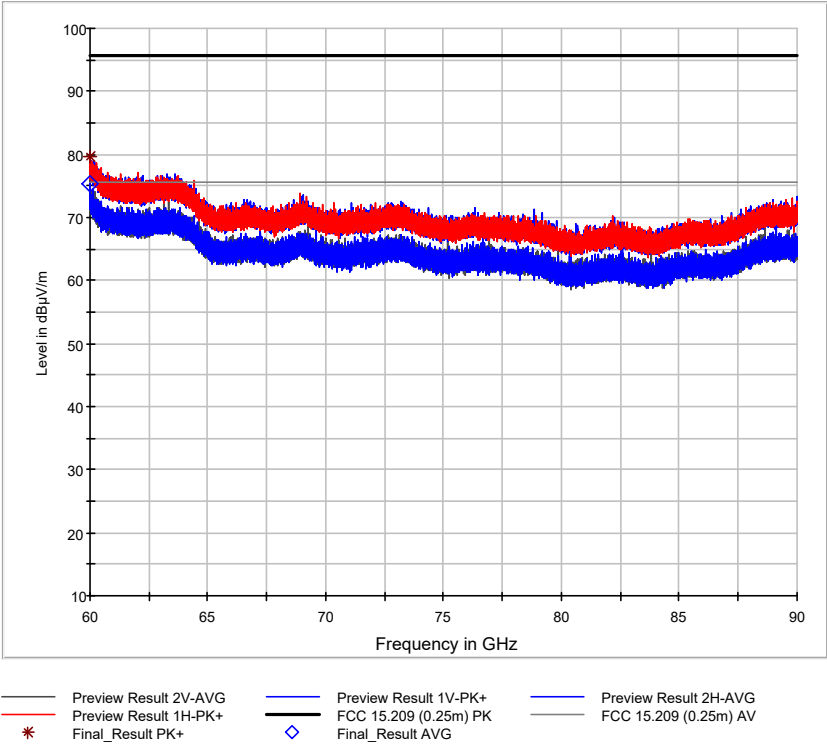


Final Results:

Frequency	MaxPeak	Average	Limit	Margin	Meas. Time	Bandwidth	Height	Pol	Azimuth	Corr.
MHz	dBµV/m	dBµV/m	dBµV/m	dB	ms	kHz	cm		deg	dB/m
41033.750000	---	70.20	75.60	5.40	2.5	1000.000	150.0	V	0.0	44
41053.125000	73.98	---	95.60	21.62	2.5	1000.000	150.0	H	142.0	44

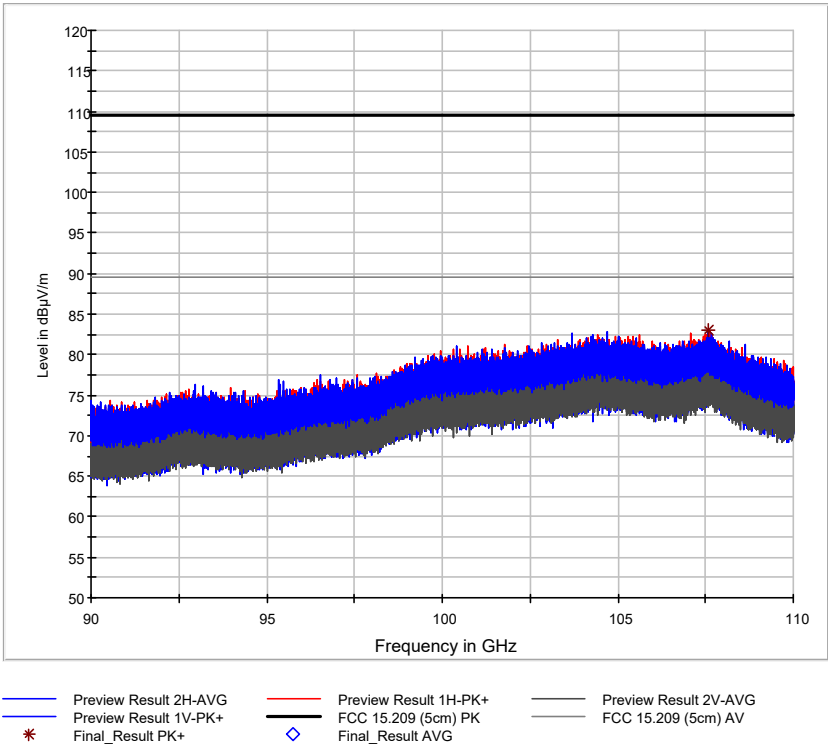


Product Service



Final Results:

Frequency	MaxPeak	Average	Limit	Margin	Meas.	Bandwidth	Height	Pol	Azimuth	Corr.
MHz	dBµV/m	dBµV/m	dBµV/m	dB	Time ms	kHz	cm		deg	dB
60000.000000	79.67	---	95.60	15.93	2.5	1000.000	150.0	V	225.0	47.8
60016.875000	---	75.26	75.60	0.34	2.5	1000.000	150.0	H	228.0	47.8



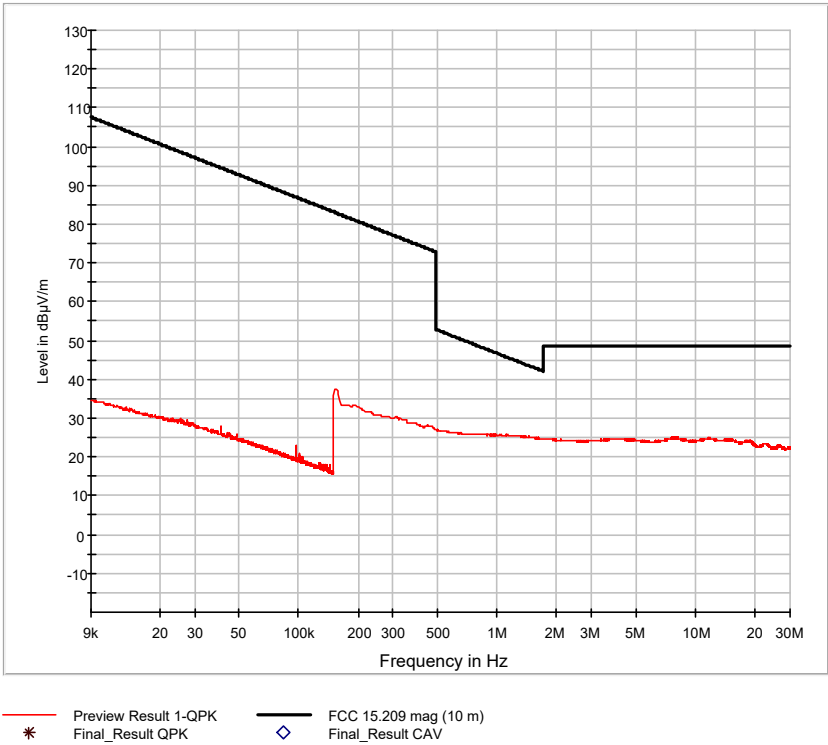
Final Results:

Frequency	MaxPeak	Average	Limit	Margin	Meas. Time	Bandwidth	Height	Pol	Azimuth	Corr.
MHz	dBµV/m	dBµV/m	dBµV/m	dB	ms	kHz	cm		deg	dB/m
107584.444445	83.04	---	109.56	26.52	2.5	1000.000	150.0	V	216.0	50
107660.888889	---	80.53	89.56	9.03	2.5	1000.000	150.0	H	33.0	50



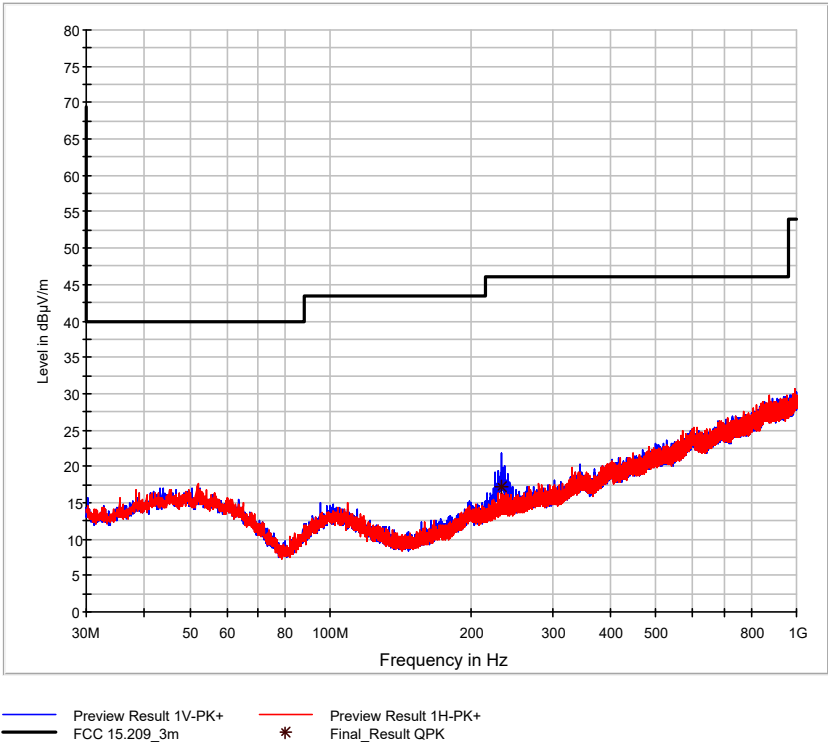
Product Service

EUT: P3 in TLPR operation (radar mounted to tank)
Normal operation mode: Measurement with pulsed signal, Radar mounted to the tank





Product Service

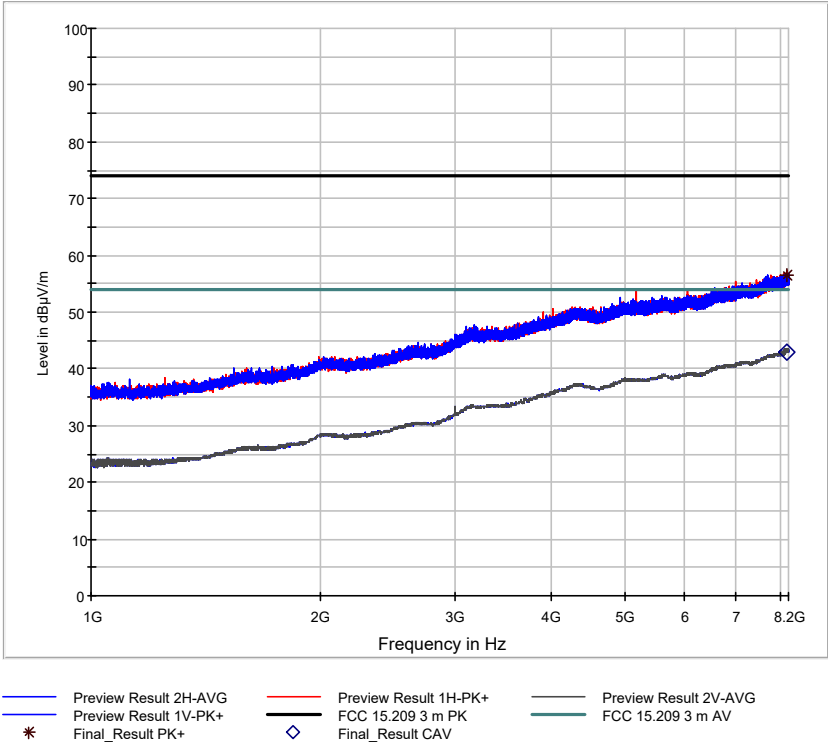


Final Results:

Frequency MHz	QuasiPeak dBµV/m	Limit dBµV/m	Margin dB	Meas. Time ms	Bandwidth kHz	Height cm	Pol	Azimuth deg	Corr. dB
232.680000	17.11	46.00	28.89	1000.0	120.000	110.0	V	-154.0	13.7



Product Service

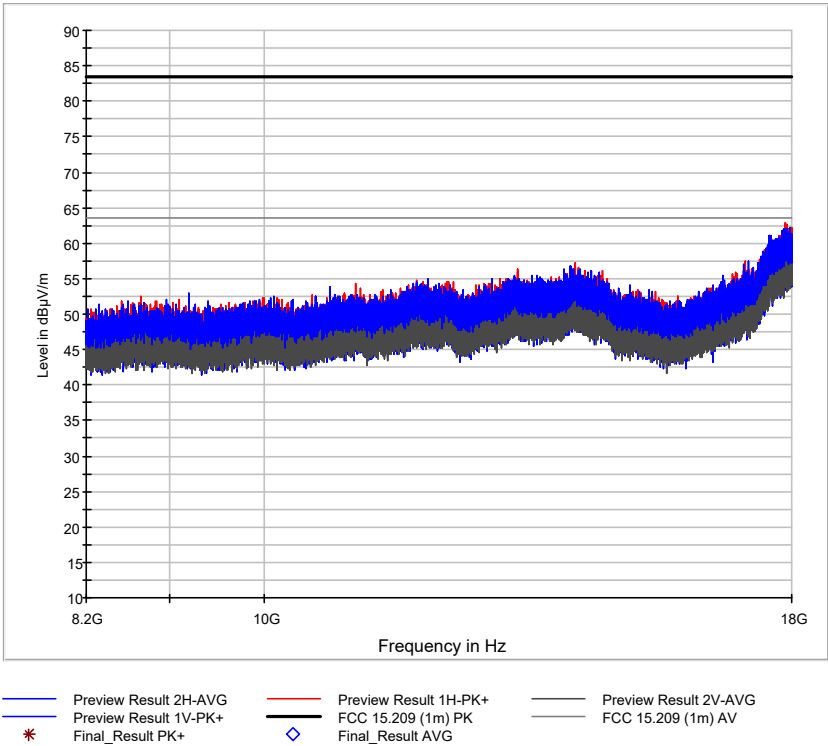


Final Results:

Frequency	MaxPeak	CAverage	Limit	Margin	Meas. Time	Bandwidth	Height	Pol	Azimuth	Corr.
MHz	dBµV/m	dBµV/m	dBµV/m	dB	ms	kHz	cm		deg	dB
8170.250000	---	43.01	53.98	10.97	1000.0	1000.000	392.0	H	39.0	46.7
8170.250000	56.62	---	73.97	17.35	1000.0	1000.000	392.0	H	39.0	46.7



Product Service

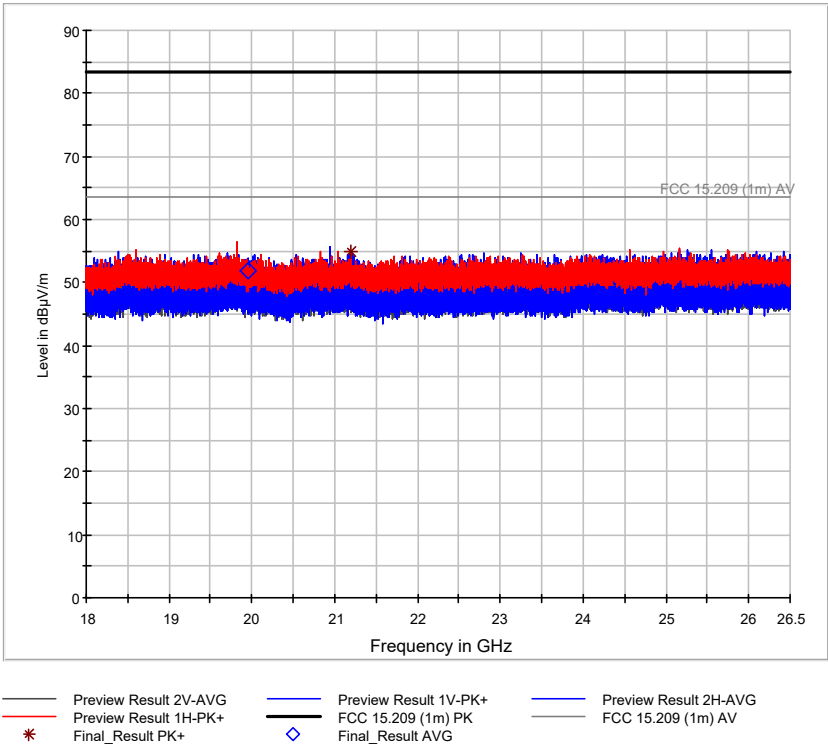


Final Results:

Frequency	MaxPeak	Average	Limit	Margin	Meas. Time	Bandwidth	Height	Pol	Azimuth	Corr.
MHz	dBµV/m	dBµV/m	dBµV/m	dB	ms	kHz	cm		deg	dB
17848.426667	---	59.92	63.50	3.58	2.5	1000.000	150.0	V	0.0	47.9



Product Service

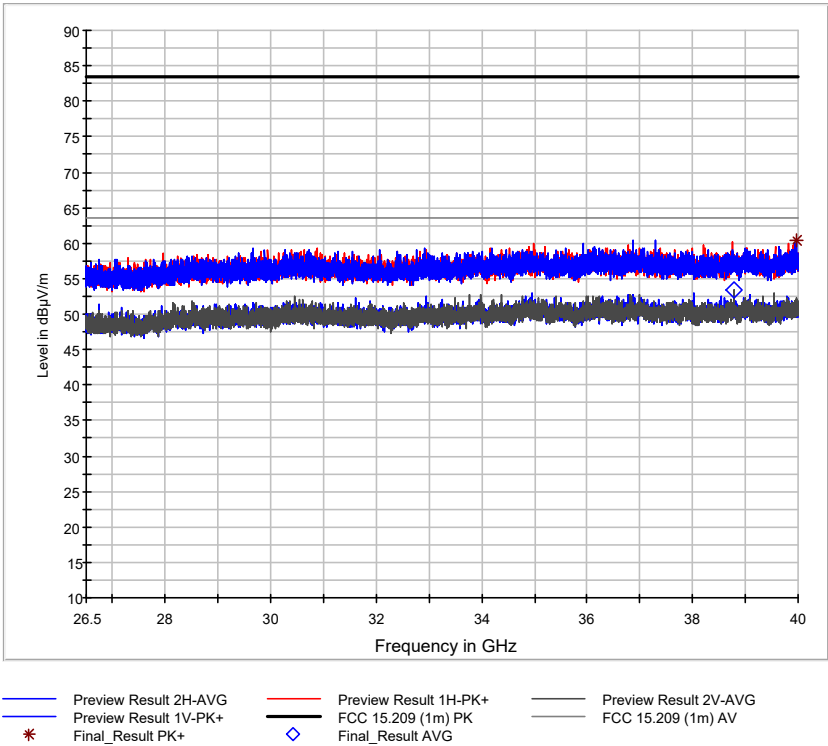


Final Results:

Frequency	MaxPeak	Average	Limit	Margin	Meas. Time	Bandwidth	Height	Pol	Azimuth	Corr.
MHz	dBµV/m	dBµV/m	dBµV/m	dB	ms	kHz	cm		deg	dB
19946.113636	---	51.94	63.50	11.56	2.5	1000.000	150.0	V	54.0	40.3
21191.750000	54.89	---	83.50	28.61	2.5	1000.000	150.0	H	353.0	40.3



Product Service

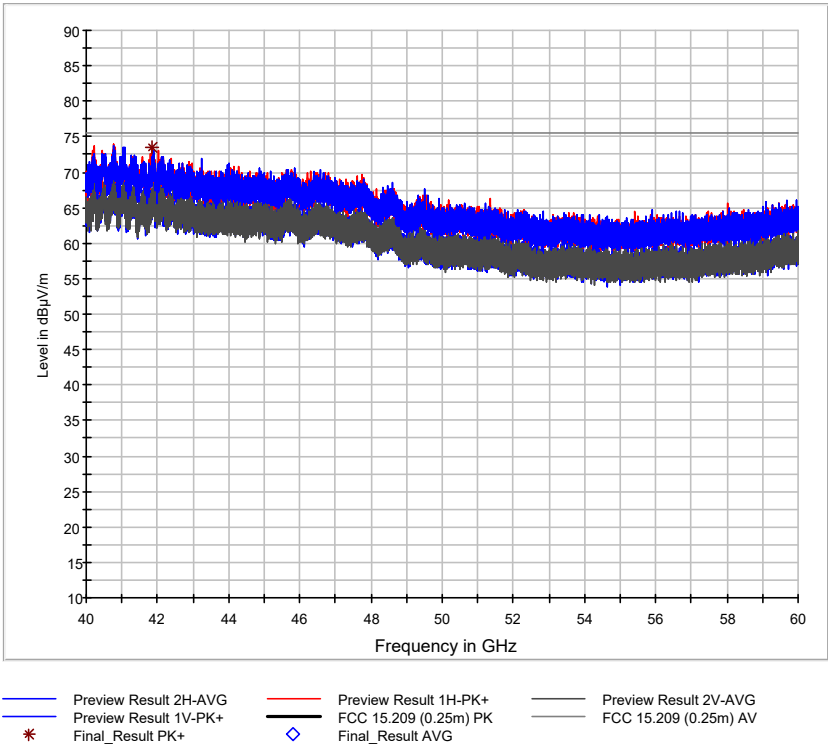


Final Results:

Frequency	MaxPeak	Average	Limit	Margin	Meas.	Bandwidth	Height	Pol	Azimuth	Corr.
MHz	dBµV/m	dBµV/m	dBµV/m	dB	Time ms	kHz	cm		deg	dB
38793.100000	---	53.31	63.50	10.19	2.5	1000.000	150.0	V	343.0	43.7
39968.950000	60.42	---	83.50	23.08	2.5	1000.000	150.0	V	213.0	43.8



Product Service

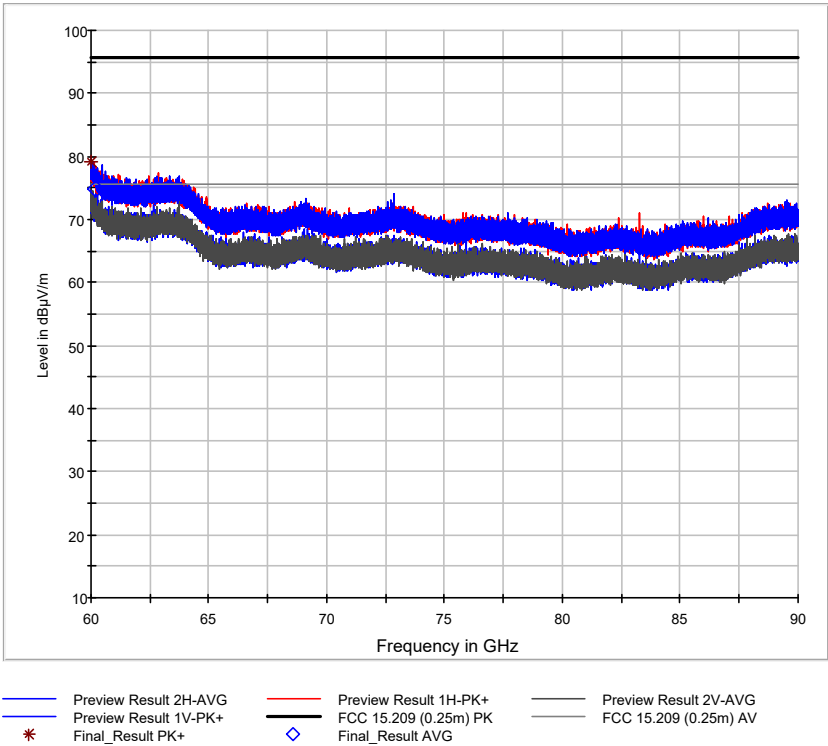


Final Results:

Frequency	MaxPeak	Average	Limit	Margin	Meas. Time	Bandwidth	Height	Pol	Azimuth	Corr.
MHz	dBµV/m	dBµV/m	dBµV/m	dB	ms	kHz	cm		deg	dB
40781.875000	---	70.35	75.60	5.25	2.5	1000.000	150.0	V	297.0	44.2
41837.500000	73.52	---	95.60	22.08	2.5	1000.000	150.0	H	168.0	44.2



Product Service

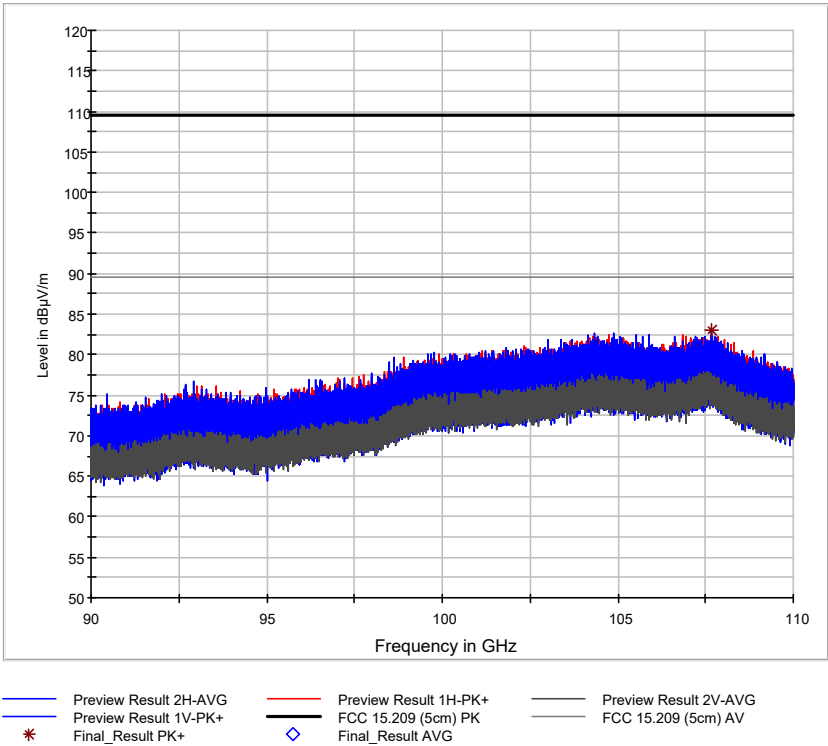


Final Results:

Frequency	MaxPeak	Average	Limit	Margin	Meas.	Bandwidth	Height	Pol	Azimuth	Corr.
MHz	dBµV/m	dBµV/m	dBµV/m	dB	Time ms	kHz	cm		deg	dB
60010.312500	79.15	---	95.60	16.45	2.5	1000.000	150.0	V	337.0	47.8
60190.312500	---	74.90	75.60	0.70	2.5	1000.000	150.0	H	303.0	47.8



Product Service



Final Results:

Frequency	MaxPeak	Average	Limit	Margin	Meas. Time	Bandwidth	Height	Pol	Azimuth	Corr.
MHz	dBµV/m	dBµV/m	dBµV/m	dB	ms	kHz	cm		deg	dB/m
107469.333333	---	79.69	89.56	9.88	2.5	1000.000	150.0	H	254.0	50
107650.222222	82.96	---	109.56	26.60	2.5	1000.000	150.0	V	284.0	50

FCC 47 CFR Part 15. Limit Clause 15.209

The emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

<i>Frequency (MHz)</i>	<i>Field strength (microvolts/meter)</i>	<i>Measurement distance (meters)</i>
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100**	3
88-216	150**	3
216-960	200**	3
Above 960	500	3

RSS 210 and Industry Canada

The emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

<i>Frequency (MHz)</i>	<i>Field strength (microvolts/meter)</i>	<i>Measurement distance (meters)</i>
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100**	3
88-216	150**	3
216-960	200**	3
Above 960	500	3

RSS-211. Limit Clause:

<i>Frequency Band (GHz)</i>	<i>Maximum Average EIRP (in dBm/MHz) Outside Tank Enclosure Structure Inside the Operating Frequency Range</i>
5.65–8.50	-41.3
8.50–10.55	-41.3
24.05–29.00	-41.3
75-85	-41.3

3.4.7 Test Location and Test Equipment Used

This test was carried out in Semi Anechoic Room no. 8.

<i>T-ID</i>	<i>Designation</i>	<i>Type</i>	<i>Last Cal.</i>	<i>Next Cal.</i>
19125	Horn antenna	3160-09	Verified	
19383	Double ridged waveguide horn antenna	3115	2017-02	2020-02
19442	Horn antenna	3160-10	Verified	
19946	Horn antenna	24240-20	Verified	
22553	Waveguide mixer	FS-Z170	2016-08	2019-08
25849	Waveguide mixer	FS-Z60	2017-04	2020-04
25850	Waveguide mixer	FS-Z90	2016-12	2019-12
25851	Waveguide mixer	FS-Z110	2016-11	2019-11
27898	Horn antenna	26240-20	Verified	
27899	Horn antenna	27240-20	Verified	
39897	EMI test receiver	ESW44	2019-02	2020-02
36954	Harmonic Mixer	FS-Z220	2018-03	2021-03
36955	Harmonic Mixer	FS-Z325	2018-02	2021-02
37863	Horn antenna	30240-20 WG30	Verified	
37864	Horn antenna	32240-20 WG32	Verified	
38401	ULTRALOG Antenna	HL562E	2018-05	2021-05

Table 11



Product Service

3.5 Restricted bands of operation

3.5.1 Specification Reference

FCC 47 CFR Part 15C. Clause 15.205
Industry Canada RSS-211

3.5.2 Equipment Under Test and Modification State

P1. S/N: N/A - Modification State 0
P3. S/N: N/A - Modification State 0

Radar Mounted to the tank.

3.5.3 Date of Test

2019-08-06

3.5.4 Test Method

The test was performed in accordance with
ANSI C63.10
RSS-211

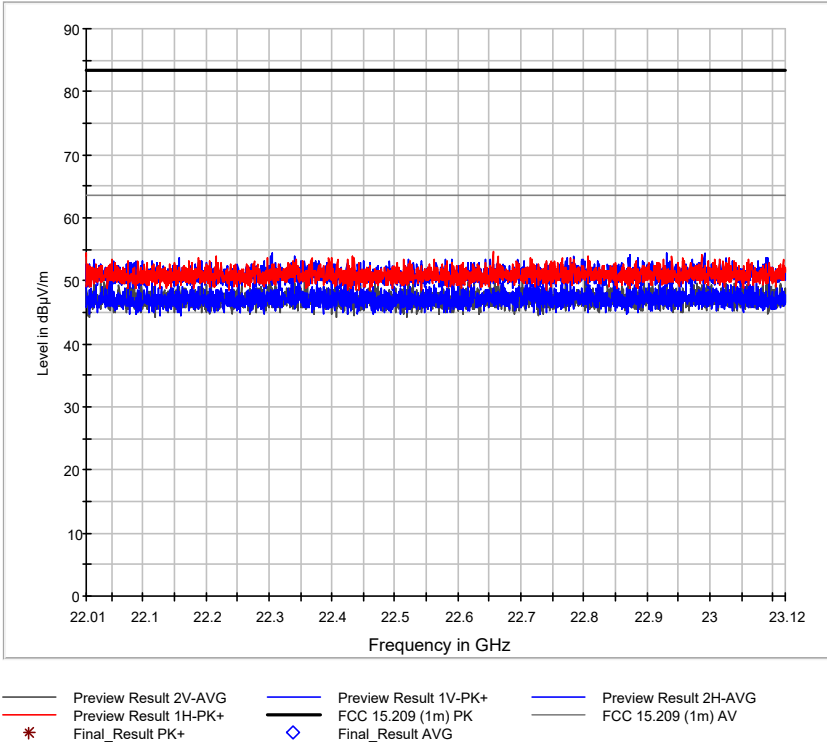
3.5.5 Environmental Conditions

Ambient Temperature	25.0 °C
Relative Humidity	58.0 %

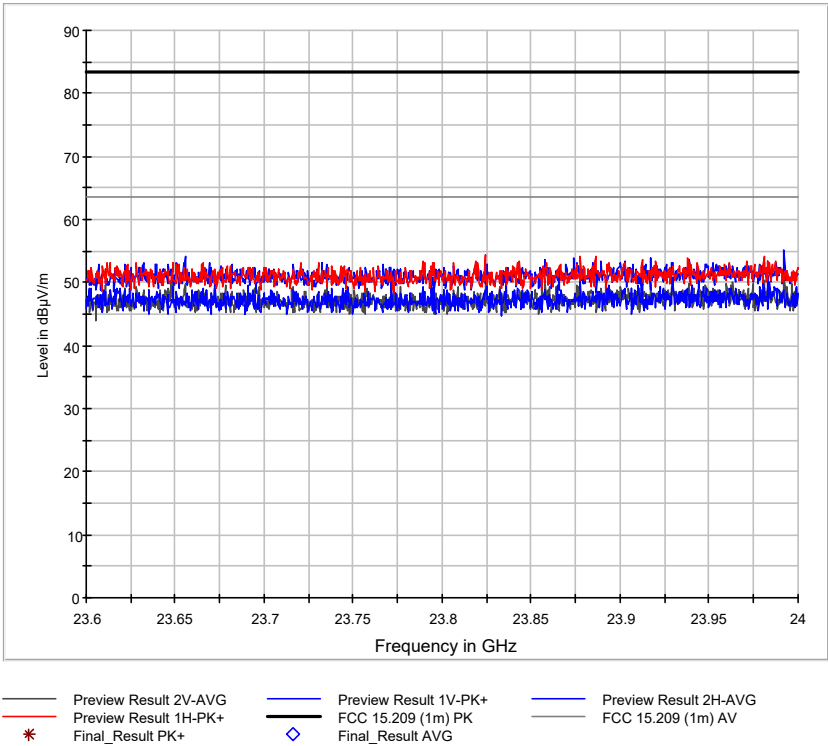


3.5.6 Test Results

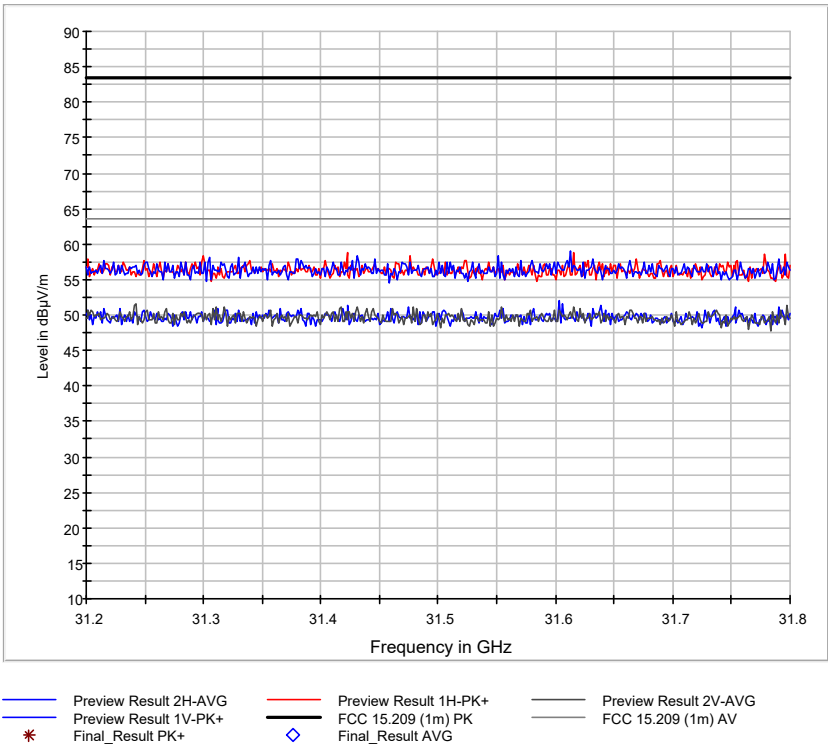
EUT: P1 in TLPR operation (radar mounted to tank)
Normal operation mode: Measurement with pulsed signal, Radar mounted to the tank



Restricted Band 22.01 to 23.12 GHz



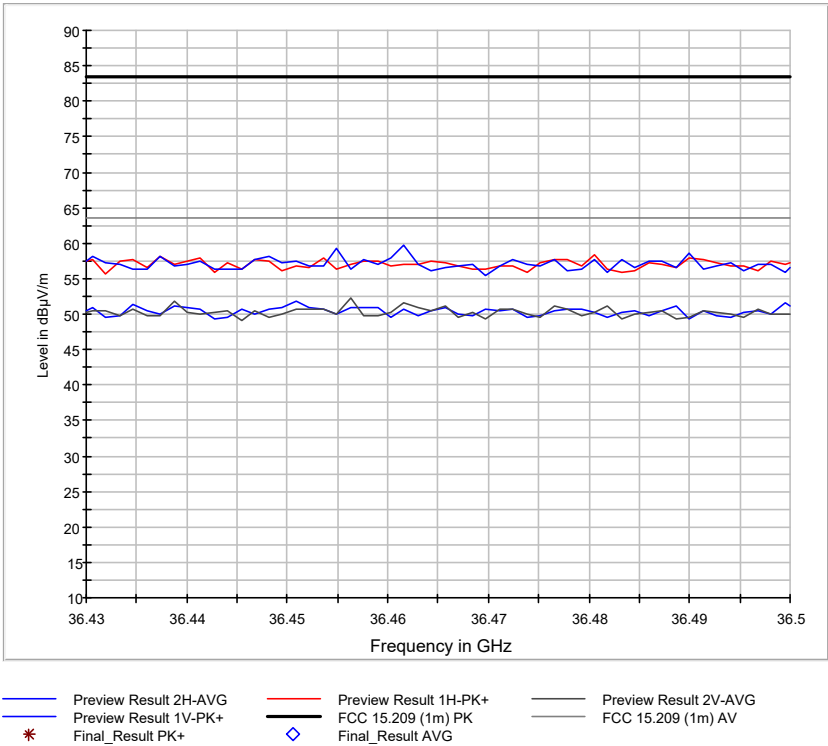
Restricted Band 23.6 to 24.0 GHz



Restricted Band 31.2 to 31.8 GHz



Product Service

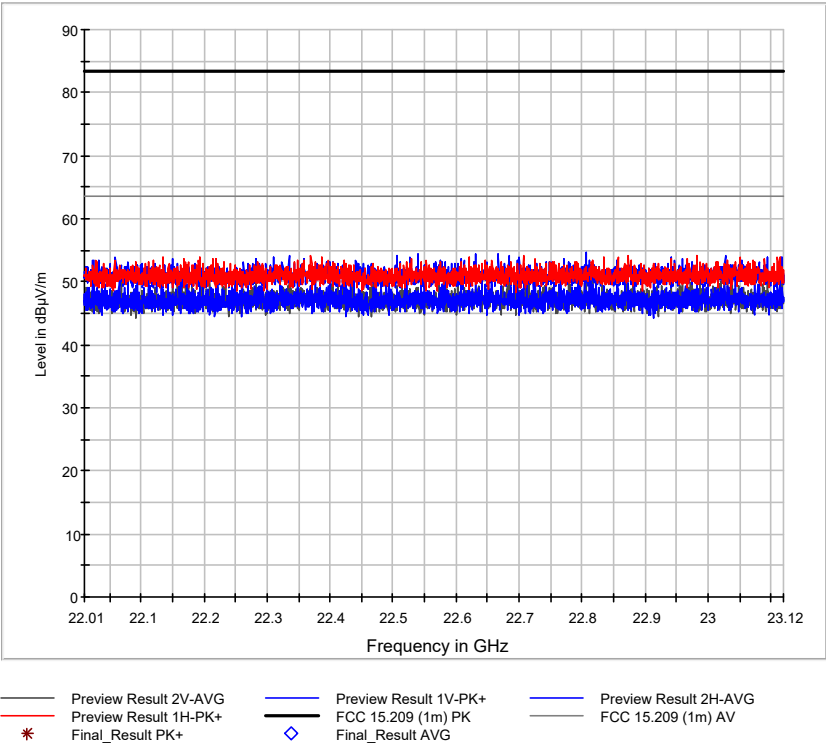


Restricted Band 36.43 to 36.5 GHz

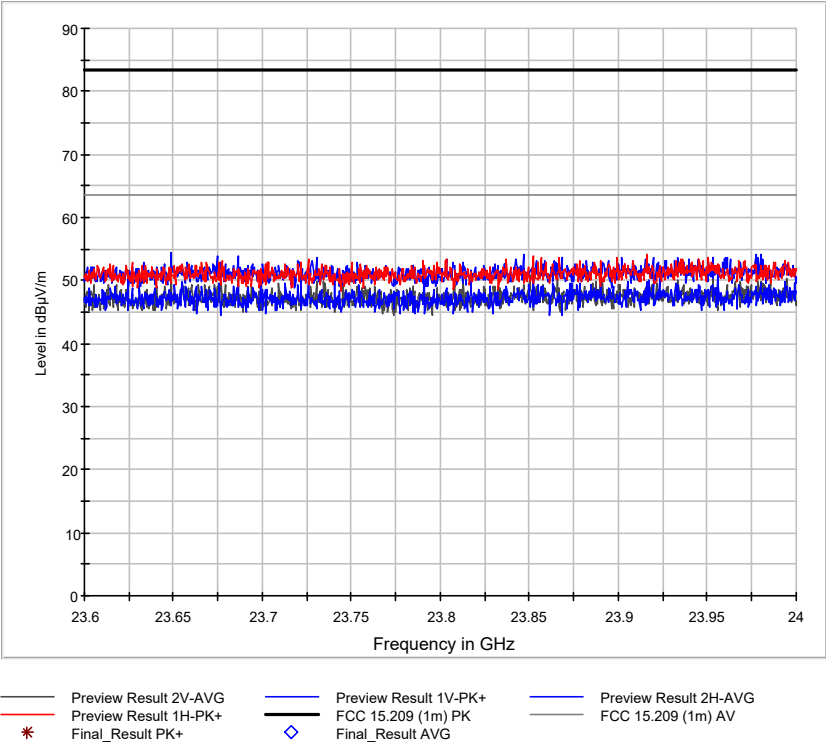


Product Service

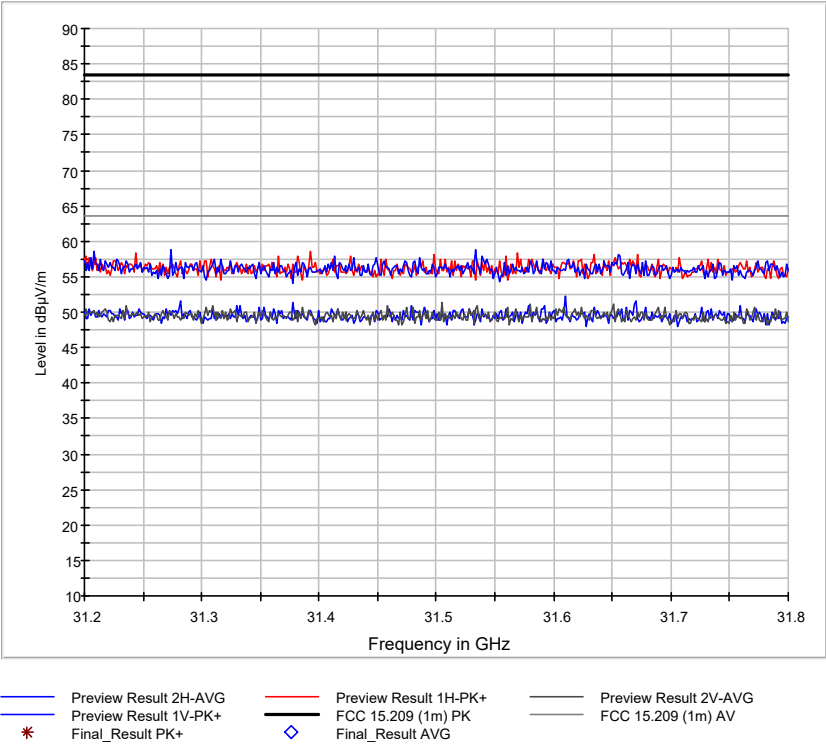
EUT: P3 in TLPR operation (radar mounted to tank)
Normal operation mode: Measurement with pulsed signal, Radar Mounted to the tank.



Restricted Band 22.01 to 23.12 GHz



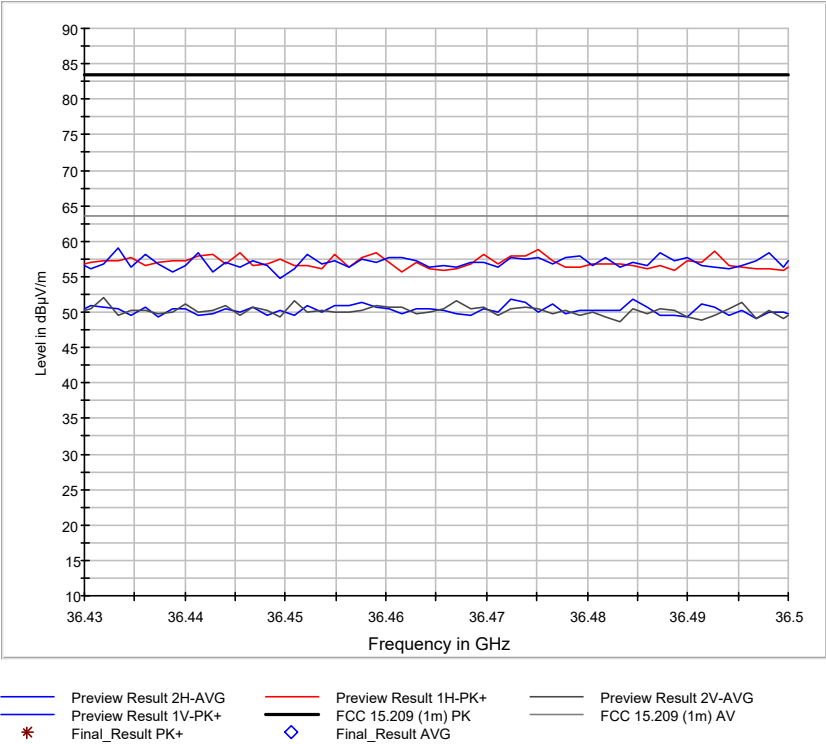
Restricted Band 23.6 to 24.0 GHz



Restricted Band 31.2 to 31.8 GHz



Product Service



Restricted Band 36.43 to 36.5 GHz

FCC 47 CFR Part 15. Limit Clause 15.205 / Industry Canada RSS-211

Only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
¹ 0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	
13.36-13.41			

3.5.7 Test Location and Test Equipment Used

This test was carried out in Fully Anechoic Room no. 2.

<i>T-ID</i>	<i>Designation</i>	<i>Type</i>	<i>Last Cal.</i>	<i>Next Cal.</i>
19125	Horn antenna	3160-09	Verified	
19383	Double ridged waveguide horn antenna	3115	2017-02	2020-02
19442	Horn antenna	3160-10	Verified	
19946	Horn antenna	24240-20	Verified	
22553	Waveguide mixer	FS-Z170	2016-08	2019-08
25849	Waveguide mixer	FS-Z60	2017-04	2020-04
25850	Waveguide mixer	FS-Z90	2016-12	2019-12
25851	Waveguide mixer	FS-Z110	2016-11	2019-11
27898	Horn antenna	26240-20	Verified	
27899	Horn antenna	27240-20	Verified	
39897	EMI test receiver	ESW44	2019-02	2020-02
36954	Harmonic Mixer	FS-Z220	2018-03	2021-03
36955	Harmonic Mixer	FS-Z325	2018-02	2021-02
37863	Horn antenna	30240-20 WG30	Verified	
37864	Horn antenna	32240-20 WG32	Verified	
38401	ULTRALOG Antenna	HL562E	2018-05	2021-05

Table 12

3.6 Exposure of Humans to RF Fields

FCC

DUT duty cycle is very low. The overall transmission time in an observation period of 100s is 270ms.

$$\begin{aligned} T_{\text{cycle}} &= 1/\text{PRF} = 556\text{ns} \\ T_{\text{Pulse}} &= 1.5\text{ns} \\ \text{DutyCycle} &= T_{\text{Pulse}}/T_{\text{Cycle}} = 0.0027 = 0.27\% \\ \text{TxOn in 100s} &= 100\text{s} \times 0.0027 = 270\text{ms} \end{aligned}$$

The Source based Time Averaging Power is $5.62 \text{ nW} \times 0.27\% = 15.2 \text{ pW}$. (52,77dBμV/m at 1 m (see chapter 3.4.6)), when built in to the tank).

The FCC have provided a new rule for devices operating over 6 GHz, where if the Maximum time averaged conducted power is 1mW or less then the radio would qualify for FCC SAR Exemption. Therefore this device qualifies for SAR exemption.

Canada

DUT duty cycle is very low. The overall transmission time in an observation period of 100s is 270ms.

$$\begin{aligned} T_{\text{cycle}} &= 1/\text{PRF} = 556\text{ns} \\ T_{\text{Pulse}} &= 1.5\text{ns} \\ \text{DutyCycle} &= T_{\text{Pulse}}/T_{\text{Cycle}} = 0.0027 = 0.27\% \\ \text{TxOn in 100s} &= 100\text{s} \times 0.0027 = 270\text{ms} \end{aligned}$$

The Source based Time Averaging Power is $5.62 \text{ nW} \times 0.27\% = 15.2 \text{ pW}$

At the present time ISED Canada SAR Exemption calculations are valid only for frequencies up to and including 6 GHz, and RSS-102 Clause 2.5.1 refers. Furthermore, ISED Canada RF Exposure calculations are valid only for distances of 20cm or more. Therefore, the applicant cannot perform RF Exposure calculations at 4.5 cm for demonstration of compliance without ISED Canada permission.

The power density calculations at a minimum distance of 4.5cm based on power with no accounting for duty cycle is:

EUT	f Max Level (GHz)	Max EIRP Peak Level	Max EIRP Peak Level	Min distance to radiator	Power Density Limit	Power Density at Min distance	Test Result
P5LPR	25	-52.5 dBm	5.62 nW	4.5 cm	1.0 mW/cm ²	22.1 pW/cm ²	PASS

4 Measurement Uncertainty

For a 95% confidence level, the measurement uncertainties for defined systems are:

Radio Testing			
Test Name	kp	Expanded Uncertainty	Note
Occupied Bandwidth	2.0	$\pm 1.14 \%$	2
RF-Frequency error	1.96	$\pm 1 \cdot 10^{-7}$	7
RF-Power, conducted carrier	2	$\pm 0.079 \text{ dB}$	2
RF-Power uncertainty for given BER	1.96	$+0.94 \text{ dB} / -1.05$	7
RF power, conducted, spurious emissions	1.96	$+1.4 \text{ dB} / -1.6 \text{ dB}$	7
RF power, radiated			
25 MHz – 4 GHz	1.96	$+3.6 \text{ dB} / -5.2 \text{ dB}$	8
1 GHz – 18 GHz	1.96	$+3.8 \text{ dB} / -5.6 \text{ dB}$	8
18 GHz – 26.5 GHz	1.96	$+3.4 \text{ dB} / -4.5 \text{ dB}$	8
40 GHz – 170 GHz	1.96	$+4.2 \text{ dB} / -7.1 \text{ dB}$	8
Spectral Power Density, conducted	2.0	$\pm 0.53 \text{ dB}$	2
Maximum frequency deviation			
300 Hz – 6 kHz	2	$\pm 2.89 \%$	2
6 kHz – 25 kHz	2	$\pm 0.2 \text{ dB}$	2
Maximum frequency deviation for FM	2	$\pm 2.89 \%$	2
Adjacent channel power 25 MHz – 1 GHz	2	$\pm 2.31 \%$	2
Temperature	2	$\pm 0.39 \text{ K}$	4
(Relative) Humidity	2	$\pm 2.28 \%$	2
DC- and low frequency AC voltage			
DC voltage	2	$\pm 0.01 \%$	2
AC voltage up to 1 kHz	2	$\pm 1.2 \%$	2
Time	2	$\pm 0.6 \%$	2

Table 13



Radio Interference Emission Testing			
Test Name	kp	Expanded Uncertainty	Note
Conducted Voltage Emission			
9 kHz to 150 kHz (50Ω/50μH AMN)	2	± 3.8 dB	1
150 kHz to 30 MHz (50Ω/50μH AMN)	2	± 3.4 dB	1
100 kHz to 200 MHz (50Ω/5μH AMN)	2	± 3.6 dB	1
Discontinuous Conducted Emission			
9 kHz to 150 kHz (50Ω/50μH AMN)	2	± 3.8 dB	1
150 kHz to 30 MHz (50Ω/50μH AMN)	2	± 3.4 dB	1
Conducted Current Emission			
9 kHz to 200 MHz	2	± 3.5 dB	1
Magnetic Fieldstrength			
9 kHz to 30 MHz (with loop antenna)	2	± 3.9 dB	1
9 kHz to 30 MHz (large-loop antenna 2 m)	2	± 3.5 dB	1
Radiated Emission			
Test distance 1 m (ALSE)			
9 kHz to 150 kHz	2	± 4.6 dB	1
150 kHz to 30 MHz	2	± 4.1 dB	1
30 MHz to 200 MHz	2	± 5.2 dB	1
200 MHz to 2 GHz	2	± 4.4 dB	1
2 GHz to 3 GHz	2	± 4.6 dB	1
Test distance 3 m			
30 MHz to 300 MHz	2	± 4.9 dB	1
300 MHz to 1 GHz	2	± 5.0 dB	1
1 GHz to 6 GHz	2	± 4.6 dB	1
Test distance 10 m			
30 MHz to 300 MHz	2	± 4.9 dB	1
300 MHz to 1 GHz	2	± 4.9 dB	1
Radio Interference Power			
30 MHz to 300 MHz	2	± 3.5 dB	1
Harmonic Current Emissions			4
Voltage Changes. Voltage Fluctuations and Flicker			4

Table 14

Immunity Testing			
Test Name	kp	Expanded Uncertainty	Note
Electrostatic Discharges			4
Radiated RF-Field			
Pre-calibrated field level	2	+32.2 / -24.3 %	5
Dynamic feedback field level	2.05	+21.2 / -17.5 %	3
Electrical Fast Transients (EFT) / Bursts			4
Surges			4
Conducted Disturbances. induced by RF-Fields			
via CDN	2	+15.1 / -13.1 %	6
via EM clamp	2	+42.6 / -29.9 %	6
via current clamp	2	+43.9 / -30.5 %	6
Power Frequency Magnetic Field	2	+20.7 / -17.1 %	2
Pulse Magnetic Field			4
Voltage Dips. Short Interruptions and Voltage Variations			4
Oscillatory Waves			4
Conducted Low Frequency Disturbances			
Voltage setting	2	± 0.9 %	2
Frequency setting	2	± 0.1 %	2
Electrical Transient Transmission in Road Vehicles			4

Table 15

Note 1:

The expanded uncertainty reported according to CISPR 16-4-2:2003-11 is based on a standard uncertainty multiplied by a coverage factor of $k_p = 2$. providing a level of confidence of $p = 95.45\%$

Note 2:

The expanded uncertainty reported according to UKAS Lab 34 (Edition 1. 2002-08) is based on a standard uncertainty multiplied by a coverage factor of $k_p = 2$. providing a level of confidence of $p = 95.45\%$

Note 3:

The expanded uncertainty reported according to UKAS Lab 34 (Edition 1. 2002-08) is based on a standard uncertainty multiplied by a coverage factor of $k_p = 2.05$. providing a level of confidence of $p = 95.45\%$

Note 4:

It has been demonstrated that the used test equipment meets the specified requirements in the standard with at least a 95%confidence.

Note 5:

The expanded uncertainty reported according to IEC 61000-4-3 is based on a standard uncertainty multiplied by a coverage factor of $k_p = 2$. providing a level of confidence of $p = 95.45\%$

Note 6:

The expanded uncertainty reported according to IEC 61000-4-6 is based on a standard uncertainty multiplied by a coverage factor of $k_p = 2$. providing a level of confidence of $p = 95.45\%$

Note 7:

The expanded uncertainty reported according ETSI TR 100 028 V1.4.1 (all parts) to is based on a standard uncertainty multiplied by a coverage factor of $k_p = 1.96$. providing a level of confidence of $p = 95.45\%$

Note 8:

The expanded uncertainty reported according to ETSI TR 102 273 V1.2.1 (all parts) is based on a standard uncertainty multiplied by a coverage factor of $k_p = 1.96$. providing a level of confidence of $p = 95.45\%$