HERMON LABORATORIES

ELECTRICAL TESTING
0839.01

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TEST REPORT

ACCORDING TO: FCC CFR 47 Part 90, subpart I, and RSS-119 Issue 12:2015

FOR:

ST Engineering Telematics Wireless Ltd

Water meter

Model: ALLEGRO2I

FCC ID: NTA2W4GB2

IC: 4732A-2W4GB2

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1 Applicant information

Client name:	ST Engineering Telematics Wireless Ltd
Address:	26 Hamelaha street, POB 1911, Holon 5811801, Israel
Telephone:	+972 3557 5767
Fax:	+972 3557 5753
E-mail:	itsikk@tlmw.com
Contact name:	Mr. Itsik Kanner

2 Equipment under test attributes

Product:	Water meter with internal antenna
Product name:	Allegro
Product type:	Transceiver
Model(s):	ALLEGRO2I
Serial number:	02525679
Hardware version:	REV A
Software release:	4.65
Receipt date	23-May-21

3 Manufacturer information

Manufacturer name:	ST Engineering Telematics Wireless Ltd
Address:	26 Hamelaha street, POB 1911, Holon 5811801, Israel
Telephone:	+972 3557 5767
Fax:	+972 3557 5753
E-Mail:	itsikk@tlmw.com
Contact name:	Mr. Itsik Kanner

4 Test details

Project ID:	42897
Location:	Hermon Laboratories Ltd. P.O. Box 23, Binyamina 3055001, Israel
Test started:	23-May-21
Test completed:	06-Jul-21
Test specification(s):	FCC part 90, subpart I; RSS-119 isue 12

5 Tests summary

Test	Status
FCC Section 90.205 / RSS-119 Section 5.4, Maximum output power	Pass
FCC Section 90.209 / RSS-119 Section 5.5, Occupied bandwidth	Not required*
FCC Section 90.210 / RSS-119 Section 5.8.4, Emission mask	Not required*
FCC Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions	Pass
FCC Section 90.210 / RSS-119 Section 5.8.4, Conducted spurious emissions	Not required*
FCC Section 90.213 / RSS-119 Section 5.3, Frequency stability	Not required*
FCC Section 90.214 / RSS-119 Section 5.9, Transient frequency behaviour	Not required*
FCC Section 2.1091 / RSS-102 section 2.5, RF radiation exposure evaluation	Pass, Exhibit in application for certification provided

Note*. The test results provided in the test report TELRAD_FCC.42897_EA for device version with external antenna.

This test report supersedes the previously issued test report identified by Doc ID: TELRAD_FCC.42897_IA

Testing was completed against all relevant requirements of the test standard. The results obtained indicate that the product under test complies in full with the requirements tested.
The test results relate only to the items tested. Pass/ fail decision was based on nominal values.

	Name and Title	Date	Signature
Tested by:	Mr. A. Morozov, test engineer, EMC & Radio	23-May-21 – 06-Jun-21	
Reviewed by:	Mrs. S. Peysahov Sheynin, test engineer, EMC & Radio	23-Jul-21	
Approved by:	Mr. S. Samokha, technical manager, EMC & Radio	04-Aug-21	

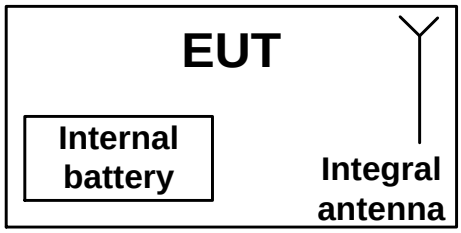
6 EUT description

Note: The following data in this clause is provided by the customer and represents his sole responsibility

6.1 General information

The EUT is a Water Meter, operating in 450-470 MHz band, battery powered. The battery rated voltage is 3.6V.

6.2 Test configuration



6.3 Changes made in EUT

No changes were implemented in the EUT during testing.

6.4 Transmitter characteristics

Type of equipment	
X	Stand-alone (Equipment with or without its own control provisions)
	Combined equipment (Equipment where the radio part is fully integrated within another type of equipment)
	Plug-in card (Equipment intended for a variety of host systems)

Intended use		**Condition of use**
	fixed	Always at a distance more than 2 m from all people
X	mobile	Always at a distance more than 20 cm from all people
	portable	May operate at a distance closer than 20 cm to human body

Assigned frequency range	450- 470 MHz

Maximum rated output power	At transmitter 50 Ω RF output connector	33.2 dBm
	Effective radiated power	

Is transmitter output power variable?	X	No		
		Yes		continuous variable
				stepped variable with stepsize
				minimum RF power
				maximum RF power

Antenna connection			
unique coupling	standard connector	X integral	with temporary RF connector
			without temporary RF connector

Antenna/s technical characteristics			
Type	Manufacturer	Model number	Gain
Internal	Arad Technologies	NA	0.5 dBi

Transmitter 99% power bandwidth	6 kHz

Transmitter aggregate data rate/s	4.8 kbps

Type of modulation	4GFSK

Modulating test signal (baseband)	PRBS

Maximum transmitter duty cycle in normal use	0.0023 %	**Tx ON time**	1 s	**Period**	12 hours
Transmitter duty cycle supplied for test	100 %	**Tx ON time**		**Period**	

Transmitter power source						
X	Battery	**Nominal rated voltage**	3.6 VDC	Battery type	Lithium	
	DC	**Nominal rated voltage**	VDC			
	AC mains	**Nominal rated voltage**	VAC	Frequency	Hz	

Common power source for transmitter and receiver	X yes	no

Test specification:	**Section 90.205 / RSS-119 Section 5.4, Maximum output power**		
Test procedure:	47 CFR, Section 2.1046; TIA/EIA-603-E, Section 2.2.1		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	04-Jun-21 - 04-Jul-21		
Temperature: 23 ºC	**Relative Humidity:** 46 %	**Air Pressure:** 1012 hPa	**Power:** 3.6 VDC
Remarks:			

7 Transmitter tests according to 47CFR part 90 and RSS-119 requirements

7.1 Effective radiated power of carrier

7.1.1 General

This test was performed to measure effective radiated power emanated by transmitter at carrier frequency. Specification test limits are given in Table 7.1.1.

Table 7.1.1 Effective radiated power limit

Assigned frequency band, MHz	ERP		Equivalent field strength limit @ 3m, dB(μV/m)*
	W	dBm	
According to FCC part 90.205			
450-470	2	33.00	130.38
According to RSS-119			
450-470	60	47.78	145.16

* - Equivalent field strength limit was calculated from maximum allowed ERP as follows: E=sqrt(30×P×1.64)/r, where P is ERP in Watts, 1.64 is numeric gain of ideal dipole and r is antenna to EUT distance in meters

7.1.2 Test procedure for field strength measurements

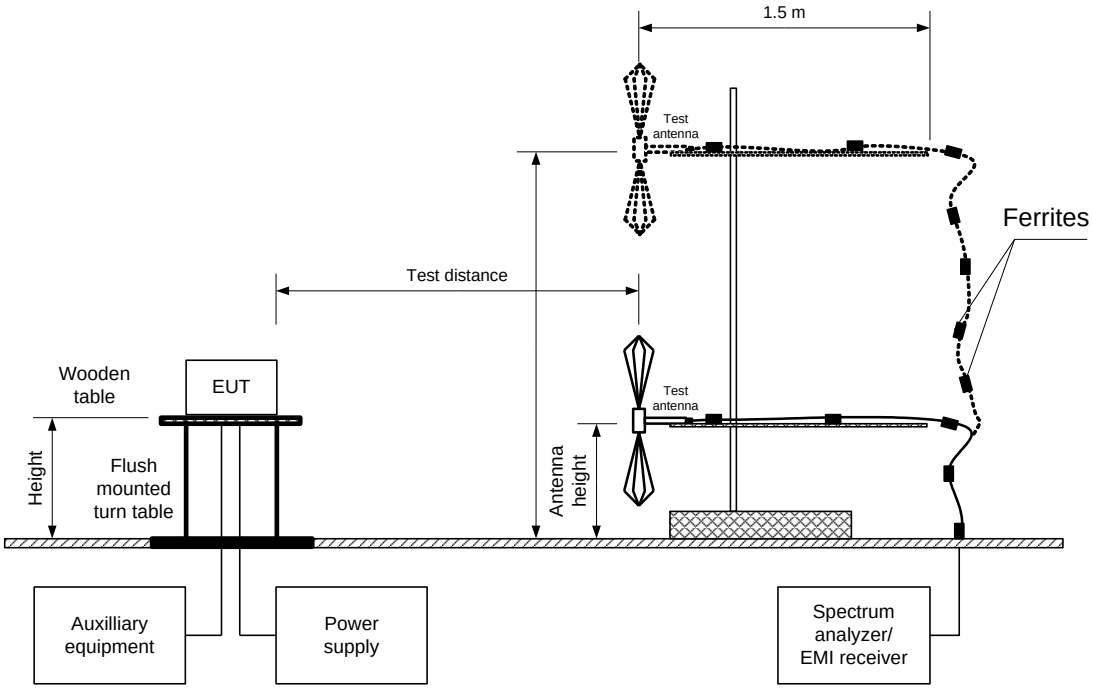
7.1.2.1 The EUT was set up as shown in Figure 7.1.1, energized and the performance check was conducted.

7.1.2.2 The field strength of the EUT carrier frequency was measured with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360, the measuring antenna height was swept throughout the range, specified in Table 7.1.2 and Table 7.1.3, in both vertical and horizontal polarizations.

7.1.2.3 The worst test results (the lowest margins) were recorded in Table 7.1.2 and Table 7.1.3 and shown in the associated plots.

Test specification:	**Section 90.205 / RSS-119 Section 5.4, Maximum output power**		
Test procedure:	47 CFR, Section 2.1046; TIA/EIA-603-E, Section 2.2.1		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	04-Jun-21 - 04-Jul-21		
Temperature: 23 ºC	**Relative Humidity:** 46 %	**Air Pressure:** 1012 hPa	**Power:** 3.6 VDC
Remarks:			

Figure 7.1.1 Setup for carrier field strength measurements



Test specification:	**Section 90.205 / RSS-119 Section 5.4, Maximum output power**		
Test procedure:	47 CFR, Section 2.1046; TIA/EIA-603-E, Section 2.2.1		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	04-Jun-21 - 04-Jul-21		
Temperature: 23 ºC	**Relative Humidity:** 46 %	**Air Pressure:** 1012 hPa	**Power:** 3.6 VDC
Remarks:			

Table 7.1.2 Transmitter carrier field strength according to FCC requirements

ASSIGNED FREQUENCY RANGE: 450 - 470 MHz
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
EUT HEIGHT: 0.8 m
TEST ANTENNA HEIGHTS RANGE: 1.0 – 4.0 m
DETECTOR USED: Peak
VIDEO BANDWIDTH: > Resolution bandwidth
TEST ANTENNA TYPE: Biconilog
MODULATION: 4GFSK
TRANSMITTER OUTPUT POWER SETTINGS: Maximum

Frequency, MHz	Field strength, dB(µV/m)	Antenna polarization	Antenna height, m	Azimuth, degrees	EUT antenna gain, dBi	ERP, dBm***	Peak output power (conducted), dBm*	ERP Limit, dBm	Margin, dB**	Verdict
450.003125	128.3	Vertical	1.5	-160	0.5	30.9	32.6	33.00	-2.10	Pass
460.000000	128.9	Vertical	1.4	-160	0.5	31.5	33.2	33.00	-1.50	Pass
469.996875	125.4	Vertical	1.5	-110	0.5	28.0	29.7	33.00	-5.00	Pass

*****- Peak output power was calculated from the field strength of carrier as follows: $P = (E \times d)^2 / (30 \times G)$,
where P is the peak output power in W, E is the field strength in V/m, d is the test distance in meters and G is the transmitter numeric antenna gain over an isotropic radiator. The above equation was converted in logarithmic units for 3 m test distance:
Peak output power in dBm = Field strength in dB(µV/m) - Transmitter antenna gain in dBi – 95.2 dB

******- Margin = ERP – specification ERP limit.
*** ERP=Field strength in dB(µV/m) – 97.4 dB

Test specification:	**Section 90.205 / RSS-119 Section 5.4, Maximum output power**		
Test procedure:	47 CFR, Section 2.1046; TIA/EIA-603-E, Section 2.2.1		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	04-Jun-21 - 04-Jul-21		
Temperature: 23 ºC	**Relative Humidity:** 46 %	**Air Pressure:** 1012 hPa	**Power:** 3.6 VDC
Remarks:			

Table 7.1.3 Transmitter carrier field strength according to RSS-119 requirements

ASSIGNED FREQUENCY RANGE: 450 - 470 MHz
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
EUT HEIGHT: 0.8 m
TEST ANTENNA HEIGHTS RANGE: 1.0 – 4.0 m
DETECTOR USED: Peak
VIDEO BANDWIDTH: > Resolution bandwidth
TEST ANTENNA TYPE: Biconilog
MODULATION: 4GFSK
TRANSMITTER OUTPUT POWER SETTINGS: Maximum

Frequency, MHz	**Field strength, dB(µV/m)**	**Antenna polarization**	**Antenna height, m**	**Azimuth, degrees**	**EUT antenna gain, dBi**	**ERP, dBm*** **	**Peak output power (conducted), dBm***	**ERP Limit, dBm**	**Margin, dB****	**Verdict**
450.003125	128.3	Vertical	1.5	5	0.5	30.9	32.6	47.78	-16.88	Pass
460.000000	128.9	Vertical	1.4	5	0.5	31.5	33.2	47.78	-16.28	Pass
469.996875	125.4	Vertical	1.5	5	0.5	28.0	29.7	47.78	-19.78	Pass

*****- Peak output power was calculated from the field strength of carrier as follows: $P = (E \times d)^2 / (30 \times G)$,
where P is the peak output power in W, E is the field strength in V/m, d is the test distance in meters and G is the transmitter numeric antenna gain over an isotropic radiator. The above equation was converted in logarithmic units for 3 m test distance:
Peak output power in dBm = Field strength in dB(µV/m) - Transmitter antenna gain in dBi – 95.2 dB

******- Margin = ERP – specification ERP limit.
*** ERP=Field strength in dB(µV/m) – 97.4 dB

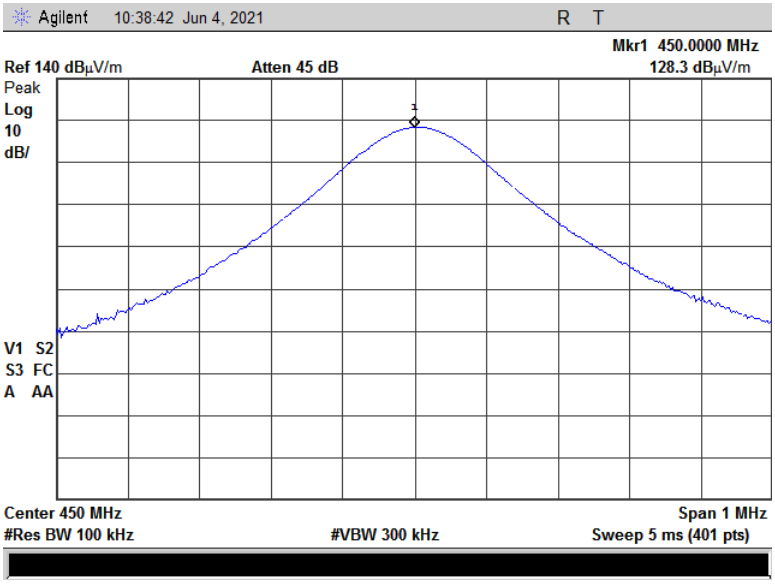
Reference numbers of test equipment used

HL 5288	HL 2909	HL 3903	HL 5404				

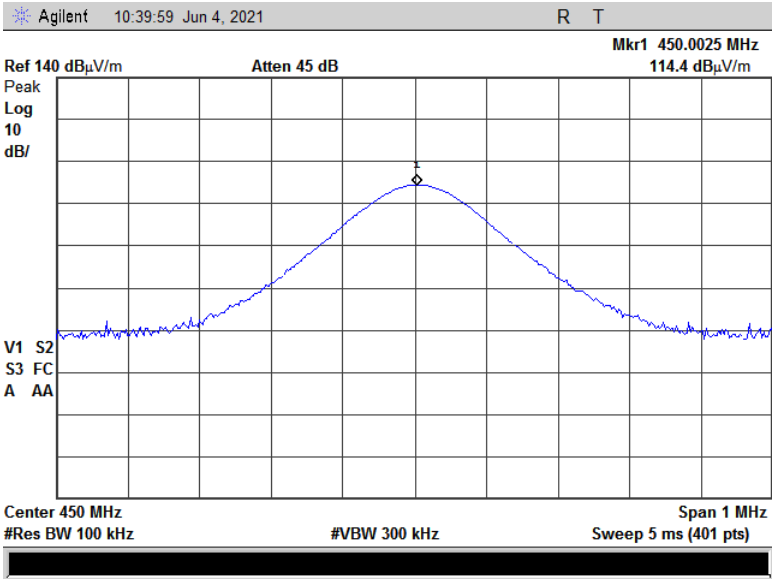
Full description is given in Appendix A.

Test specification:	Section 90.205 / RSS-119 Section 5.4, Maximum output power		
Test procedure:	47 CFR, Section 2.1046; TIA/EIA-603-E, Section 2.2.1		
Test mode:	Compliance	Verdict:	PASS
Date(s):	04-Jun-21 - 04-Jul-21		
Temperature: 23 ºC	Relative Humidity: 46 %	Air Pressure: 1012 hPa	Power: 3.6 VDC
Remarks:			

Plot 7.1.1 Transmitter carrier field strength at low frequency in vertical antenna polarization

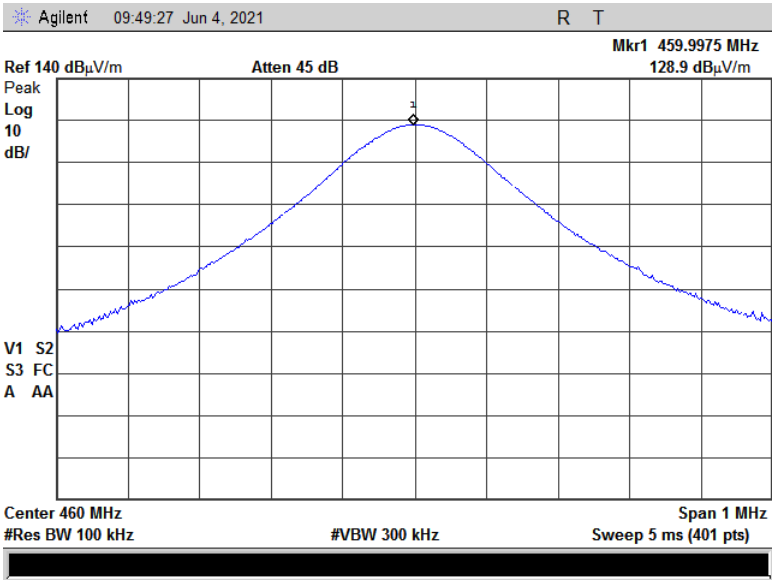


Plot 7.1.2 Transmitter carrier field strength at low frequency in horizontal antenna polarization

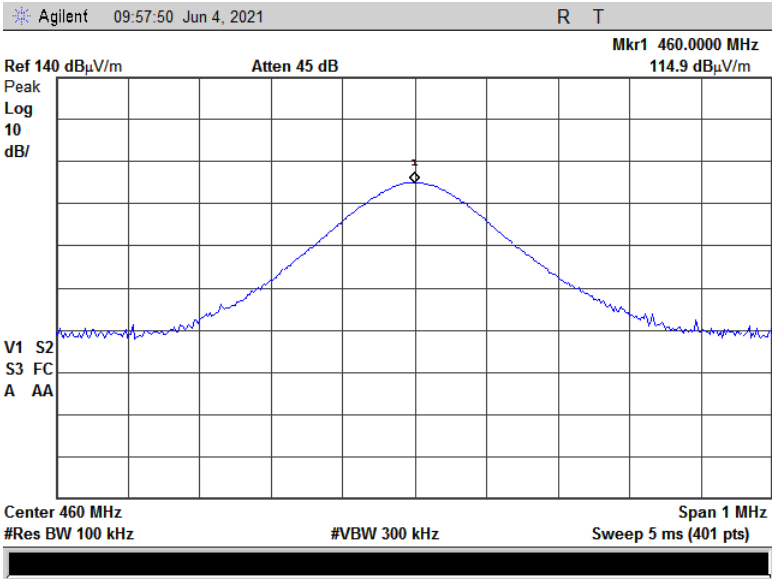


Test specification:	Section 90.205 / RSS-119 Section 5.4, Maximum output power		
Test procedure:	47 CFR, Section 2.1046; TIA/EIA-603-E, Section 2.2.1		
Test mode:	Compliance	Verdict:	PASS
Date(s):	04-Jun-21 - 04-Jul-21		
Temperature: 23 ºC	Relative Humidity: 46 %	Air Pressure: 1012 hPa	Power: 3.6 VDC
Remarks:			

Plot 7.1.3 Transmitter carrier field strength at mid frequency in vertical antenna polarization

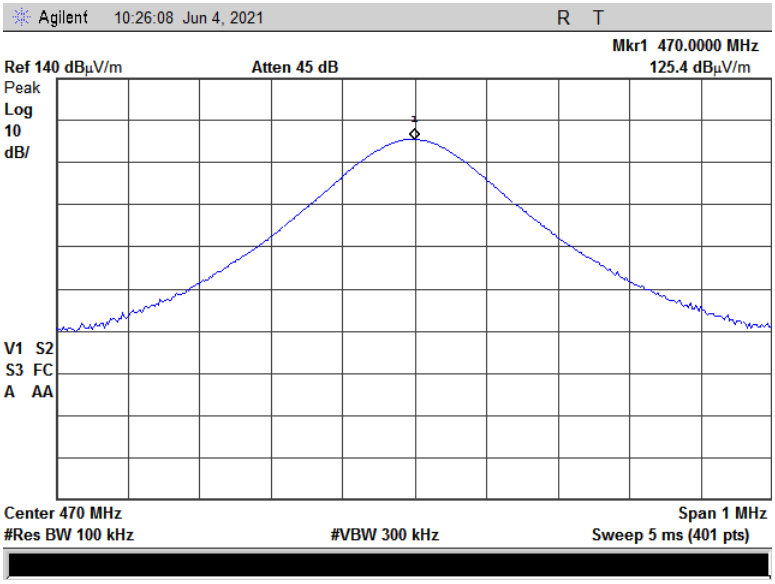


Plot 7.1.4 Transmitter carrier field strength at mid frequency in horizontal antenna polarization

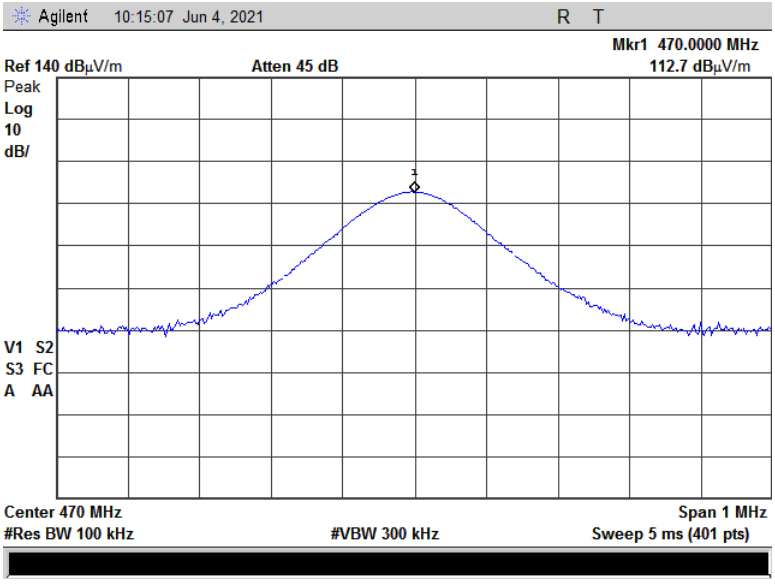


Test specification:	Section 90.205 / RSS-119 Section 5.4, Maximum output power		
Test procedure:	47 CFR, Section 2.1046; TIA/EIA-603-E, Section 2.2.1		
Test mode:	Compliance	Verdict:	PASS
Date(s):	04-Jun-21 - 04-Jul-21		
Temperature: 23 ºC	Relative Humidity: 46 %	Air Pressure: 1012 hPa	Power: 3.6 VDC
Remarks:			

Plot 7.1.5 Transmitter carrier field strength at high frequency in vertical antenna polarization



Plot 7.1.6 Transmitter carrier field strength at high frequency in horizontal antenna polarization



Test specification:	**Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions**		
Test procedure:	47 CFR, Sections 2.1053 and 90.210(m); TIA/EIA-603-A, Section 2.2.12		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	04-Jun-21 - 04-Jul-21		
Temperature: 23 ºC	**Relative Humidity:** 46 %	**Air Pressure:** 1012 hPa	**Power:** 3.6 VDC
Remarks:			

7.2 Radiated spurious emission measurements

7.2.1 General

This test was performed to measure radiated spurious emissions from the EUT. Specification test limits are given in Table 7.2.1.

Table 7.2.1 Radiated spurious emission test limits

Frequency, MHz	Attenuation below carrier, dBc	ERP of spurious, dBm	Equivalent field strength limit @ 3m, dB(µV/m)***
0.009 – 10th harmonic*	55+10logP**	-25	72.35

* - Excluding the in band emission within ± 250 % of the authorized bandwidth from the carrier
** - P is transmitter output power in Watts
*** - Equivalent field strength limit was calculated from maximum allowed ERP of spurious as follows: E=sqrt(30×P×1.64)/r, where P is ERP in Watts, 1.64 is numeric gain of ideal dipole and r is antenna to EUT distance in meters

7.2.2 Test procedure for spurious emission field strength measurements in 9 kHz to 30 MHz band

7.2.2.1 The EUT was set up as shown in Figure 7.2.1, energized and the performance check was conducted.

7.2.2.2 The specified frequency range was investigated with antenna connected to spectrum analyzer. To find maximum radiation the turntable was rotated 360^0 and the measuring antenna was rotated around its vertical axis.

7.2.2.3 The worst test results (the lowest margins) were recorded in Table 7.2.2 and shown in the associated plots.

7.2.3 Test procedure for spurious emission field strength measurements above 30 MHz

7.2.3.1 The EUT was set up as shown in Figure 7.2.2, energized and the performance check was conducted.

7.2.3.2 The specified frequency range was investigated with antenna connected to spectrum analyzer. To find maximum radiation the turntable was rotated 360^0 and the measuring antenna height was swept from 1 to 4 m in both, vertical and horizontal, polarizations.

7.2.3.3 The worst test results (the lowest margins) were recorded in Table 7.2.2 and shown in the associated plots.

Test specification:	**Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions**		
Test procedure:	47 CFR, Sections 2.1053 and 90.210(m); TIA/EIA-603-A, Section 2.2.12		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	04-Jun-21 - 04-Jul-21		
Temperature: 23 ºC	**Relative Humidity:** 46 %	**Air Pressure:** 1012 hPa	**Power:** 3.6 VDC
Remarks:			

Figure 7.2.1 Setup for spurious emission field strength measurements in 9 kHz to 30 MHz band

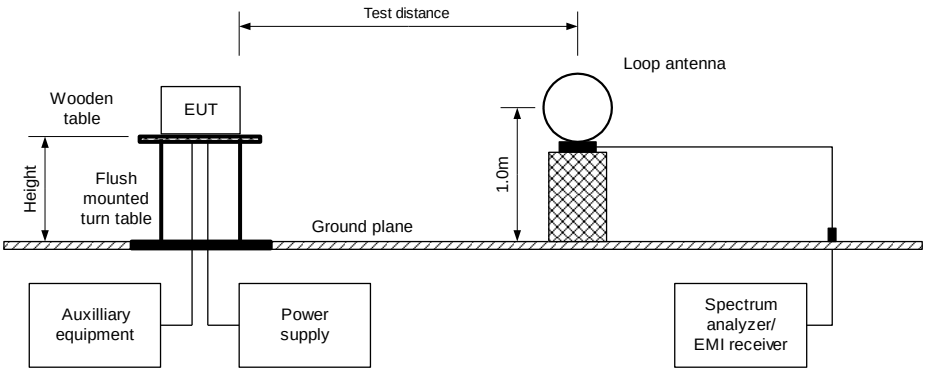
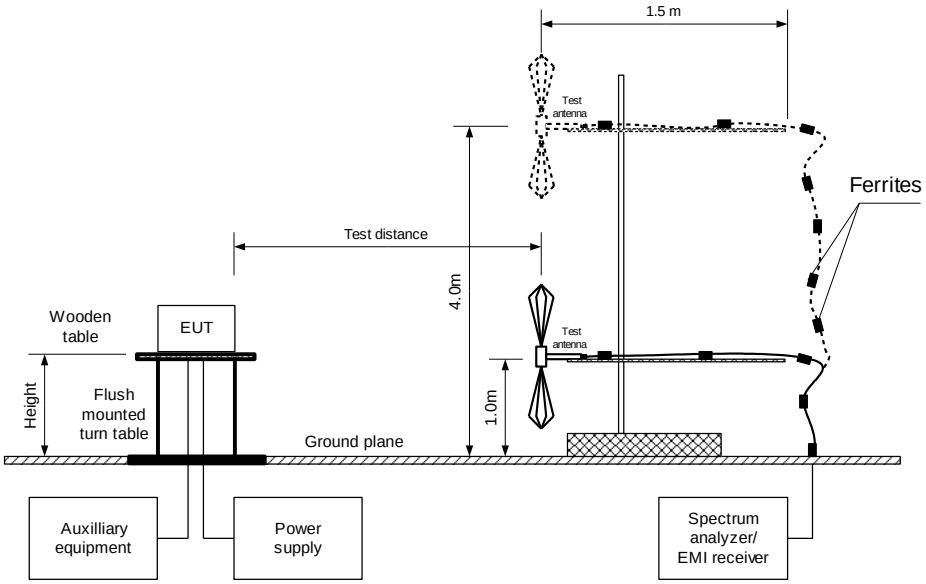


Figure 7.2.2 Setup for spurious emission field strength measurements above 30 MHz



Test specification:	**Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions**		
Test procedure:	47 CFR, Sections 2.1053 and 90.210(m); TIA/EIA-603-A, Section 2.2.12		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	04-Jun-21 - 04-Jul-21		
Temperature: 23 ºC	**Relative Humidity:** 46 %	**Air Pressure:** 1012 hPa	**Power:** 3.6 VDC
Remarks:			

Table 7.2.2 Spurious emission field strength test results

ASSIGNED FREQUENCY RANGE:	450 - 470 MHz
TEST DISTANCE:	3 m
TEST SITE:	Semi anechoic chamber
EUT HEIGHT:	0.8 m
INVESTIGATED FREQUENCY RANGE:	0.009 – 5000 MHz
DETECTOR USED:	Peak
VIDEO BANDWIDTH:	> Resolution bandwidth
TEST ANTENNA TYPE:	Active loop (9 kHz – 30 MHz) Biconilog (30 MHz – 1000 MHz) Double ridged guide (above 1000 MHz)
MODULATION:	4GFSK
BIT RATE:	4.8 kbps
TRANSMITTER OUTPUT POWER SETTINGS:	Maximum

Frequency, MHz	Field strength, dB(µV/m)	Limit, dB(µV/m)	Margin, dB*	RBW, kHz	Antenna polarization	Antenna height, m	Turn-table position**, degrees	Verdict
Low carrier frequency 450.003125 MHz								
900.00625	64.21	72.3	-8.09	120	Vert	1.4	-160	Pass
1350.00937	50.54	72.3	-21.76	1000	Vert	1.4	130	Pass
Mid carrier frequency 460.000000 MHz								
920.000	64.63	72.3	-7.67	120	Vert	1.5	-160	Pass
1380.000	56.21	72.3	-16.09	1000	Vert	1.4	-180	Pass
High carrier frequency 469.996875 MHz								
939.99375	63.58	72.3	-8.72	120	Vert	1.5	-140	Pass
1410.000	60.00	72.3	-12.30	1000	Vert	1.3	-180	Pass

*****- Margin = Field strength of spurious – calculated field strength limit.
******- EUT front panel refers to 0 degrees position of turntable.

Reference numbers of test equipment used

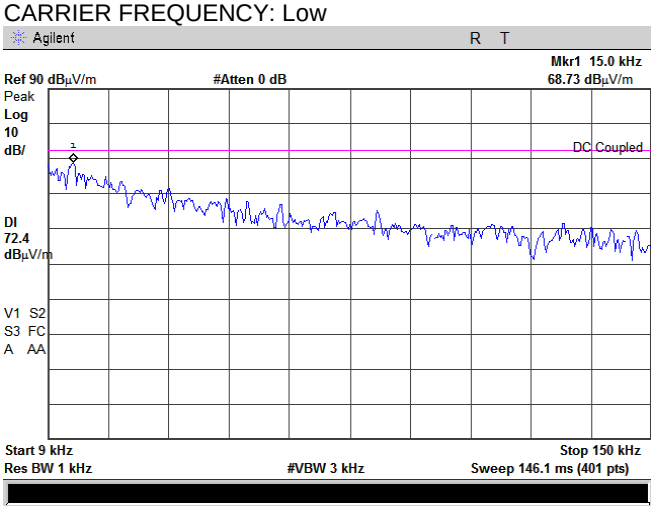
HL 0446	HL 2909	HL 3339	HL 3903	HL 4280	HL 4339	HL 4933	HL 5288
HL 5902							

Full description is given in Appendix A.

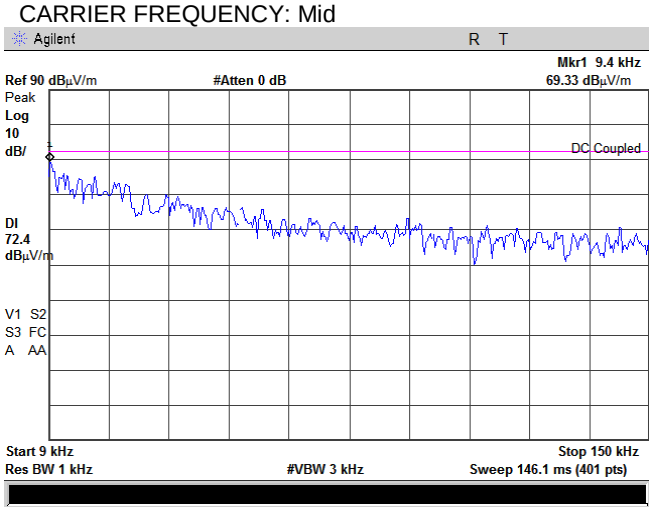
Test specification:	Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions		
Test procedure:	47 CFR, Sections 2.1053 and 90.210(m); TIA/EIA-603-A, Section 2.2.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	04-Jun-21 - 04-Jul-21		
Temperature: 23 ºC	Relative Humidity: 46 %	Air Pressure: 1012 hPa	Power: 3.6 VDC
Remarks:			

Plot 7.2.1 Radiated emission measurements in 9 - 150 kHz range

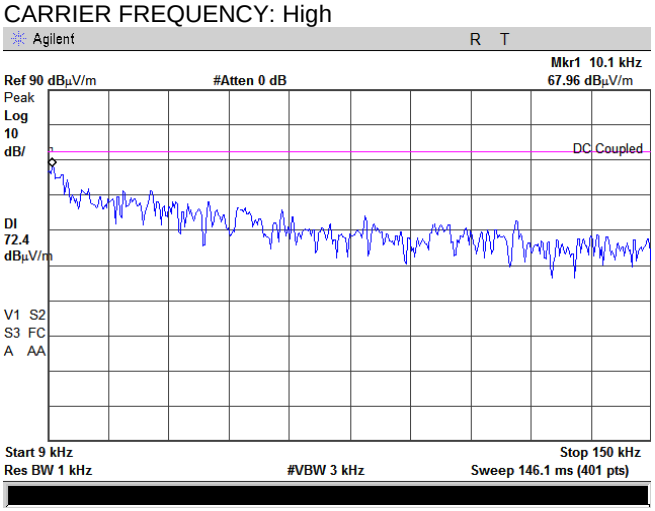
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
CARRIER FREQUENCY: Low



CARRIER FREQUENCY: Mid



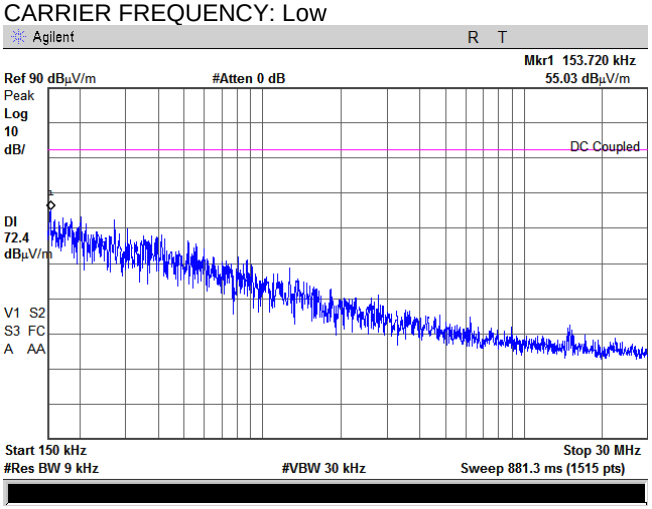
CARRIER FREQUENCY: High



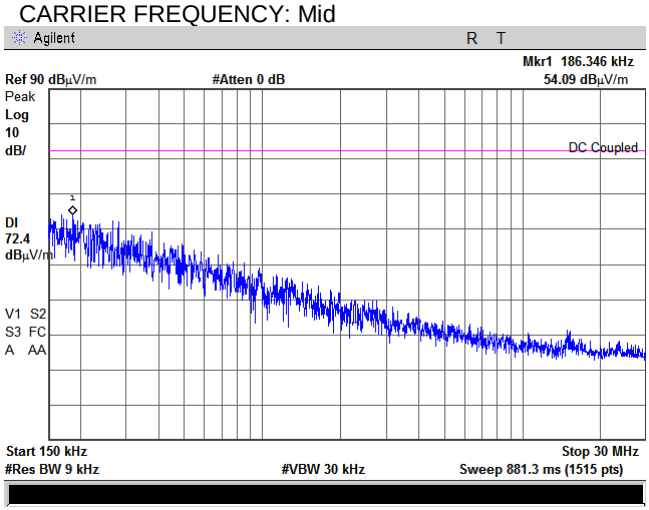
Test specification:	Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions		
Test procedure:	47 CFR, Sections 2.1053 and 90.210(m); TIA/EIA-603-A, Section 2.2.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	04-Jun-21 - 04-Jul-21		
Temperature: 23 ºC	Relative Humidity: 46 %	Air Pressure: 1012 hPa	Power: 3.6 VDC
Remarks:			

Plot 7.2.2 Radiated emission measurements in 0.15 - 30 MHz range

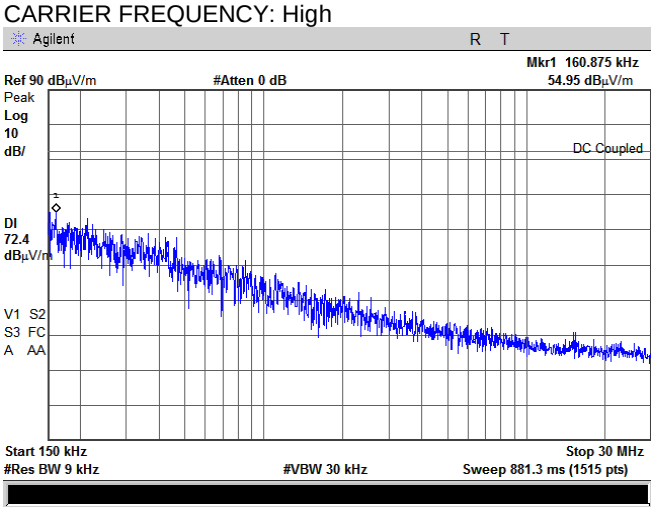
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
CARRIER FREQUENCY: Low



CARRIER FREQUENCY: Mid



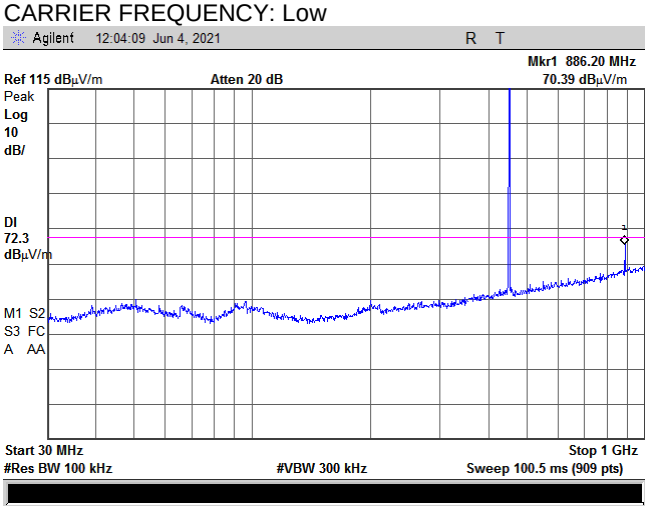
CARRIER FREQUENCY: High



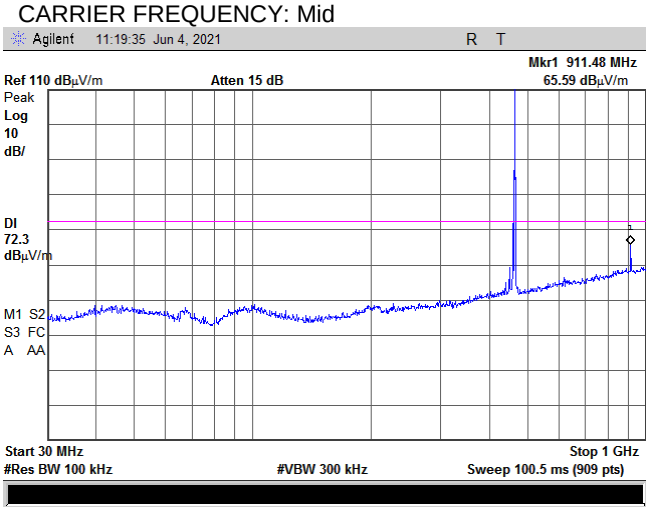
Test specification:	Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions		
Test procedure:	47 CFR, Sections 2.1053 and 90.210(m); TIA/EIA-603-A, Section 2.2.12		
Test mode:	Compliance	Verdict:	PASS
Date(s):	04-Jun-21 - 04-Jul-21		
Temperature: 23 ºC	Relative Humidity: 46 %	Air Pressure: 1012 hPa	Power: 3.6 VDC
Remarks:			

Plot 7.2.3 Radiated emission measurements in 30 - 1000 MHz range

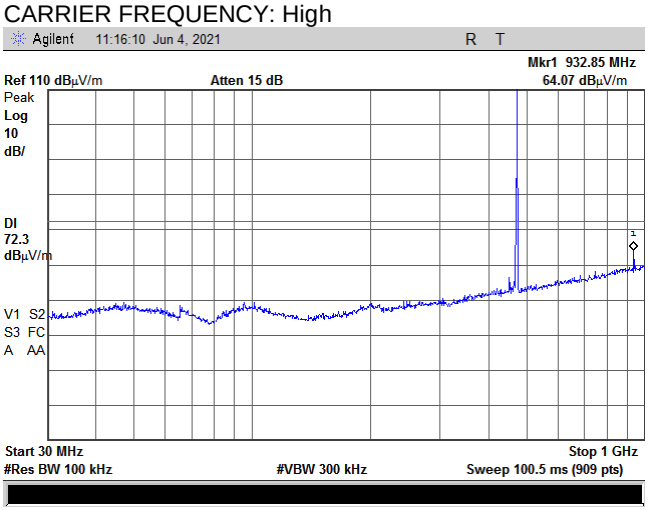
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
CARRIER FREQUENCY: Low



CARRIER FREQUENCY: Mid



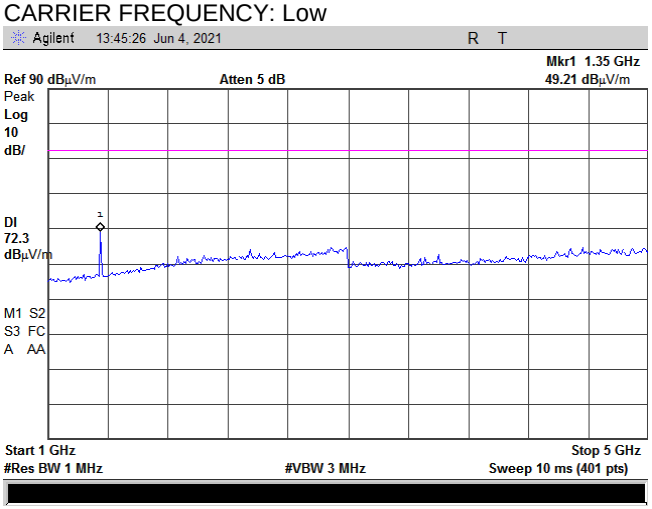
CARRIER FREQUENCY: High



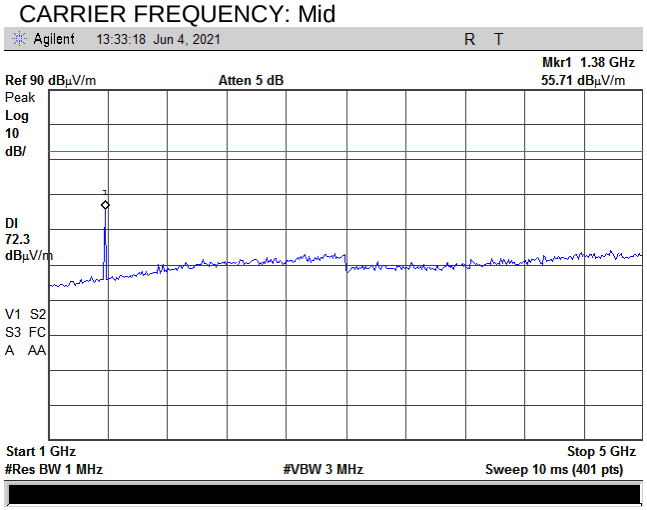
Test specification:	**Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions**		
Test procedure:	47 CFR, Sections 2.1053 and 90.210(m); TIA/EIA-603-A, Section 2.2.12		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	04-Jun-21 - 04-Jul-21		
Temperature: 23 ºC	**Relative Humidity:** 46 %	**Air Pressure:** 1012 hPa	**Power:** 3.6 VDC
Remarks:			

Plot 7.2.4 Radiated emission measurements in 1000 – 5000 MHz range

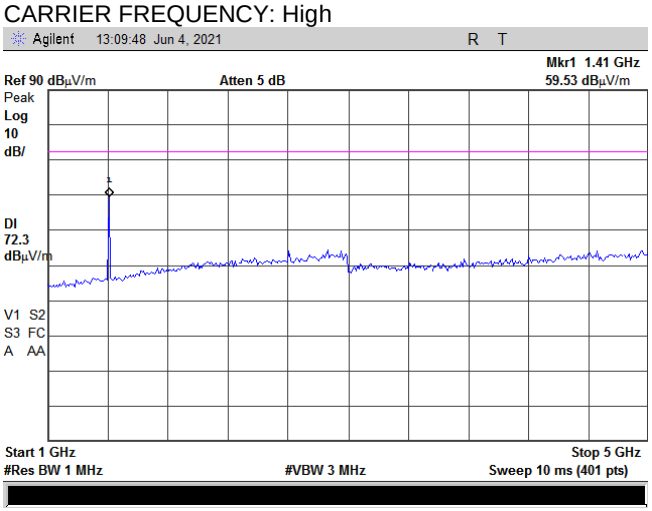
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
CARRIER FREQUENCY: Low



CARRIER FREQUENCY: Mid



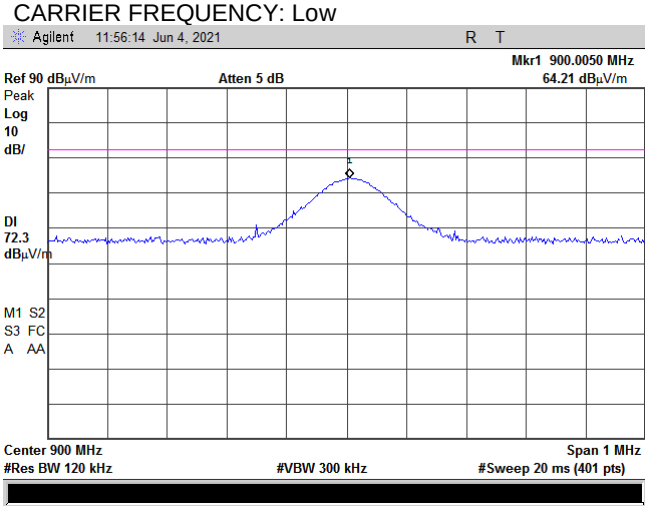
CARRIER FREQUENCY: High



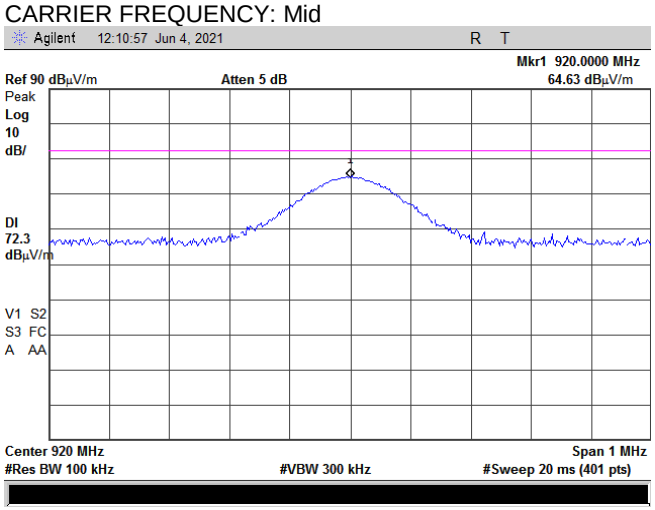
Test specification:	**Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions**		
Test procedure:	47 CFR, Sections 2.1053 and 90.210(m); TIA/EIA-603-A, Section 2.2.12		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	04-Jun-21 - 04-Jul-21		
Temperature: 23 ºC	**Relative Humidity:** 46 %	**Air Pressure:** 1012 hPa	**Power:** 3.6 VDC
Remarks:			

Plot 7.2.5 Radiated emission measurements at the 2nd harmonic

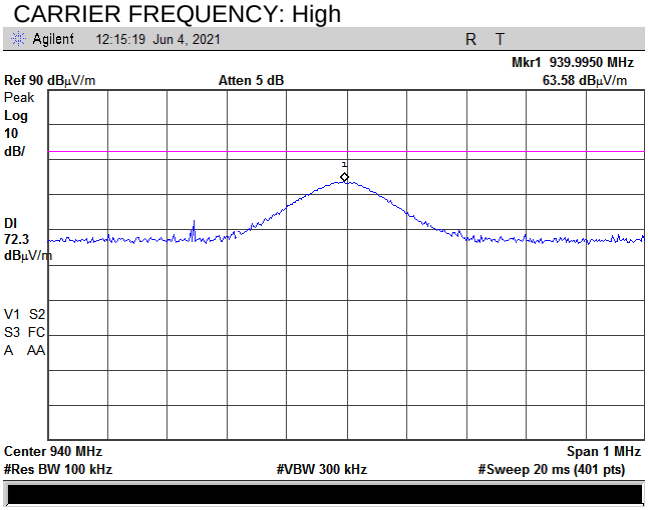
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical & Horizontal
CARRIER FREQUENCY: Low



CARRIER FREQUENCY: Mid



CARRIER FREQUENCY: High

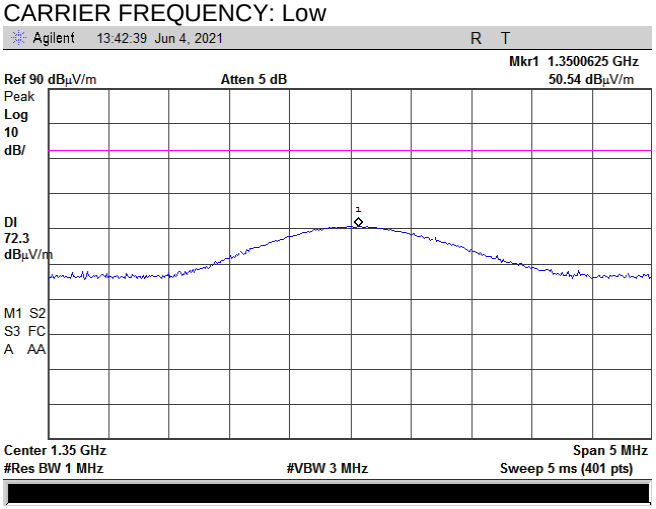


Test specification:	**Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions**		
Test procedure:	47 CFR, Sections 2.1053 and 90.210(m); TIA/EIA-603-A, Section 2.2.12		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	04-Jun-21 - 04-Jul-21		
Temperature: 23 ºC	**Relative Humidity:** 46 %	**Air Pressure:** 1012 hPa	**Power:** 3.6 VDC
Remarks:			

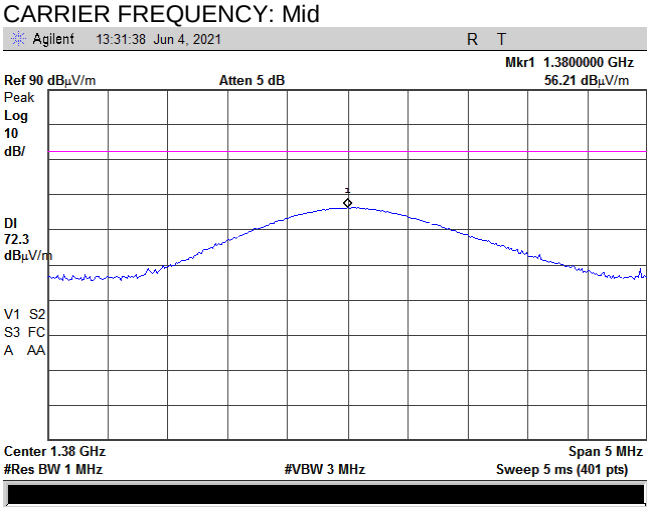
Plot 7.2.6 Radiated emission measurements at the 3 harmonic

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical & Horizontal

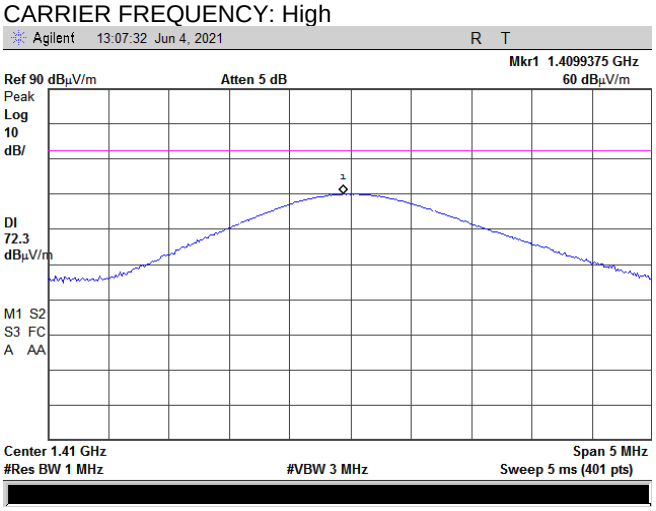
CARRIER FREQUENCY: Low



CARRIER FREQUENCY: Mid



CARRIER FREQUENCY: High



8 APPENDIX A Test equipment and ancillaries used for tests

HL No	Description	Manufacturer	Model	Ser. No.	Last Cal./ Check	Due Cal./ Check
0446	Antenna, Loop, Active, 10 (9) kHz - 30 MHz	EMCO	6502	2857	28-Feb-21	28-Feb-22
2016	Attenuator, Manual Step, 0-9/1 dB, 0-8 GHz, 2 W	Midwest Microwave	1072	1315	13-Apr-21	13-Apr-22
2017	Attenuator, Manual Step, 0-60/10 dB, 0-8.0 GHz	Midwest Microwave	1071	2017	13-Apr-21	13-Apr-22
2227	Crystal Detector 0.01-18 GHz, 100 mW	Hewlett Packard Co	8472A	NA	24-Dec-19	24-Dec-21
2358	Power Supply, 2 X 0-36VDC / 5A, 5VDC / 5A	Horizon Electronics	DHR3655 D	767469	25-Jun-20	25-Jun-21
2909	Spectrum analyzer, ESA-E, 100 Hz to 26.5 GHz	Agilent Technologies	E4407B	MY41444762	12-May-21	12-Jun-22
3339	High Pass Filter, 50 Ohm, 600 to 3000 MHz.	Mini-Circuits	SHP-600+	NA	05-Jun-19	05-Jun-21
3433	Test Cable , DC-18 GHz, 1.5 m, SMA - SMA	Mini-Circuits	CBL-5FT-SMSM+	25679	19-Apr-21	19-Apr-22
3434	Test Cable , DC-18 GHz, 1.5 m, SMA - SMA	Mini-Circuits	CBL-5FT-SMSM+	25683	19-Apr-21	19-Apr-22
3766	Attenuator, N-type, 20 dB, DC to 18 GHz, 5 W	Mini-Circuits	BW-N20W5+	NA	15-Sep-20	15-Sep-21
3901	Microwave Cable Assembly, 40.0 GHz, 3.5 m, SMA/SMA	Huber-Suhner	SUCOFLEX 102A	1225/2A	06-Apr-21	06-Apr-22
3903	Microwave Cable Assembly, 40.0 GHz, 1.5 m, SMA/SMA	Huber-Suhner	SUCOFLEX 102A	1226/2A	06-Apr-21	06-Apr-22
4280	Test Cable , DC-18 GHz, 4.6 m, N/M - N/M	Mini-Circuits	APC-15FT-NMNM+	0763A	03-Aug-20	03-Aug-21
4339	High pass Filter, 50 Ohm, 1000 to 18000 MHz, SMA-FM / SMA-M	Micro-Tronics	HPM50115-02	001	05-Jun-19	05-Jun-21
4355	Signal and Spectrum Analyzer, 9 kHz to 7 GHz	Rohde & Schwarz	FSV 7	101630	09-Sep-20	09-Sep-21
4360	EMI Test Receiver, 20 Hz to 40 GHz.	Rohde & Schwarz	ESU40	100322	19-Jan-21	19-Jan-22
4366	Directional coupler, 1 GHz to 18 GHz, 10 dB, SMA Female	Tiger Micro-Electronics Institute	TGD-A1101-10	01e-JSDE805-007	03-Jun-20	03-Jun-22
4914	Bandpass filter, 600 to 1100 MHz, SMA/F-SMA/F	K&L Microwave Inc.	7IB44-900/U600-O/O	24	05-Jun-19	05-Jun-21
4933	Active Horn Antenna, 1 GHz to 18 GHz	COM-POWER CORPORATION	AHA-118	701046	26-Jan-21	26-Jan-22
5288	Trilog Antenna, 25 MHz - 8 GHz, 100W	Frankonia	ALX-8000E	00809	08-Feb-19	08-Feb-22

HL No	Description	Manufacturer	Model	Ser. No.	Last Cal./ Check	Due Cal./ Check
5369	Digital storage oscilloscope, 350 MHz	Keysight Technologies	DSOX3034T	MY58032630	01-Jun-20	01-Aug-21
5371	EXG Analog Signal Generator, 9 kHz - 40 GHz	Keysight Technologies	N5173B	MY57280540	25-Aug-20	25-Aug-21
5372	MXE EMI receiver, 3 Hz to 44 GHz	Keysight Technologies	N9038A	MY57290155	15-Mar-21	15-Mar-22
5404	RF cable, 18 GHz, N-N, 6 m	Huber-Suhner	SF118/11N(x2)	500024/18	19-Nov-20	19-Nov-21
5409	RF cable, 40 GHz, SMA-SMA, 2 m	Huber-Suhner	SF102EA/11SK/11SK/2000MM	503973/2EA	03-Aug-20	03-Aug-21
5472	Power Splitter / Combiner 0.5-1 GHz	Mini Circuits	ZAPD-1	NA	28-Jan-21	28-Jan-23
5623	Precision Fixed Attenuator, 50 Ohm, 5 W, 20 dB, DC to 18 GHz	Mini Circuits	BW-N20W5+	NA	14-Sep-20	14-Sep-21
5902	RF cable, 18 GHz, 6.0m, N-type	Huber-Suhner	SF126EA/11N/11N/6000		01-Dec-20	01-Dec-21

9 APPENDIX B Test equipment correction factors

HL 0446: Active Loop Antenna
EMCO, model: 6502, s/n 2857

Frequency,	Measured antenna factor, dBS/m	Measurement uncertainty, dB
10	-33.4	±1.0
20	-37.8	±1.0
50	-40.5	±1.0
75	-41.0	±1.0
100	-41.2	±1.0
150	-41.2	±1.0
250	-41.1	±1.0
500	-41.2	±1.0
750	-41.3	±1.0
1000	-41.3	±1.0

Frequency,	Measured antenna factor, dBS/m	Measurement uncertainty, dB
2000	-41.4	±1.0
3000	-41.4	±1.0
4000	-41.5	±1.0
5000	-41.5	±1.0
10000	-41.7	±1.0
15000	-42.1	±1.0
20000	-42.7	±1.0
25000	-44.2	±1.0
30000	-45.8	±1.0

The antenna factor shall be added to receiver reading in dBμV to obtain field strength in dBμA/m.

HL 4933: Active Horn Antenna
COM-POWER CORPORATION, model: AHA-118, s/n 701046

Frequency, MHz	Measured antenna factor (with preamplifier), dB/m
1000	-16.1
1500	-15.1
2000	-10.9
2500	-11.9
3000	-11.1
3500	-10.6
4000	-8.6
4500	-8.3
5000	-5.9
5500	-5.7
6000	-3.3
6500	-4.0
7000	-2.2
7500	-1.7
8000	1.1
8500	-0.8
9000	-1.5
9500	-0.2

Frequency, MHz	Measured antenna factor (with preamplifier), dB/m
10000	1.8
10500	1.0
11000	0.3
11500	-0.5
12000	3.1
12500	1.4
13000	-0.3
13500	-0.4
14000	2.5
14500	2.2
15000	1.9
15500	0.5
16000	2.1
16500	1.2
17000	0.6
17500	3.1
18000	4.2

The antenna factor shall be added to receiver reading in dBμV to obtain field strength in dBμV/m.

HL 5288: Trilog Antenna
Frankonia, model: ALX-8000E, s/n: 00809
30-1000 MHz

Frequency, MHz	Antenna factor, dB/m	Frequency, MHz	Antenna factor, dB/m
30	14.96	160	12.67
35	15.33	180	13.34
40	16.37	200	15.40
45	17.56	250	16.42
50	17.95	300	17.28
60	16.87	400	19.98
70	13.22	500	21.11
80	10.56	600	22.90
90	13.61	700	24.13
100	15.46	800	25.25
120	14.03	900	26.35
140	12.23	1000	27.18

The antenna factor shall be added to receiver reading in dBμV to obtain field strength in dBμV/m.

above 1000 MHz

Frequency, MHz	Antenna factor, dB/m	Frequency, MHz	Antenna factor, dB/m
1000	26.9	3600	38.9
1100	28.1	3700	39.4
1200	28.4	3800	39.4
1300	29.6	3900	39.6
1400	29.1	4000	39.7
1500	30.4	4100	39.8
1600	30.7	4200	40.5
1700	31.5	4300	40.9
1800	32.3	4400	41.1
1900	32.6	4500	41.4
2000	32.5	4600	41.3
2100	32.9	4700	41.6
2200	33.5	4800	41.9
2300	33.2	4900	42.3
2400	33.7	5000	42.7
2500	34.6	5100	43.0
2600	34.7	5200	42.9
2700	34.6	5300	43.5
2800	35.0	5400	43.6
2900	35.5	5500	44.3
3000	36.2	5600	44.7
3100	36.8	5700	45.0
3200	36.8	5800	45.0
3300	37.0	5900	45.3
3400	37.5	6000	45.9
3500	38.2		

The antenna factor shall be added to receiver reading in dBμV to obtain field strength in dBμV/m.

HL 5405: RF Cable
Huber-Suhner, model: SF118/11N(x2), s/n: 500023/118

Set / Applied, MHz	Measured, dB	Uncertainty, dB
0.1	0.01	±0.07
50	0.23	±0.07
100	0.32	±0.07
200	0.45	±0.08
300	0.55	±0.08
400	0.64	±0.08
500	0.71	±0.08
600	0.78	±0.08
700	0.85	±0.08
800	0.91	±0.08
900	0.97	±0.08
1000	1.02	±0.08
1100	1.07	±0.08
1200	1.12	±0.08
1300	1.16	±0.08
1400	1.21	±0.08
1500	1.25	±0.08
1600	1.30	±0.08
1700	1.34	±0.08
1800	1.38	±0.08
1900	1.42	±0.08
2000	1.47	±0.08
2500	1.64	±0.10
3000	1.81	±0.10
3500	1.97	±0.10
4000	2.11	±0.10
4500	2.25	±0.10
5000	2.38	±0.10
5500	2.48	±0.10
6000	2.59	±0.10
6500	2.72	±0.10
7000	2.84	±0.13
7500	2.97	±0.13
8000	3.08	±0.13
8500	3.21	±0.13
9000	3.31	±0.13
9500	3.42	±0.13
10000	3.52	±0.13

10 APPENDIX C Measurement uncertainties

Expanded uncertainty at 95% confidence in Hermon Labs EMC measurements

Test description	Expanded uncertainty
Transmitter tests	
Carrier power conducted at antenna connector	± 1.7 dB
Carrier power radiated (substitution method)	± 4.5 dB
Occupied bandwidth	±8%
Conducted emissions at RF antenna connector	9 kHz to 2.9 GHz: ± 2.6 dB 2.9 GHz to 6.46 GHz: ± 3.5 dB 6.46 GHz to 13.2 GHz: ± 4.3 dB 13.2 GHz to 22.0 GHz: ± 5.0 dB 22.0 GHz to 26.8 GHz: ± 5.5 dB 26.8 GHz to 40.0 GHz: ± 4.8 dB
Spurious emissions radiated 30 MHz – 40 GHz (substitution method)	± 4.5 dB
Frequency error	30 – 300 MHz: ± 50.5 Hz (1.68 ppm) 300 – 1000 MHz: ± 168 Hz (0.56 ppm)
Transient frequency behaviour	187 Hz ± 13.9 %
Duty cycle, timing (Tx ON / OFF) and average factor measurements	± 1.0 %
Unintentional radiator tests	
Conducted emissions with LISN	9 kHz to 150 kHz: ± 3.9 dB 150 kHz to 30 MHz: ± 3.8 dB
Radiated emissions at 3 m measuring distance Horizontal polarization Vertical polarization	 Biconilog antenna: ± 5.3 dB Biconical antenna: ± 5.0 dB Log periodic antenna: ± 5.3 dB Double ridged horn antenna: ± 5.3 dB Biconilog antenna: ± 6.0 dB Biconical antenna: ± 5.7 dB Log periodic antenna: ± 6.0 dB Double ridged horn antenna: ± 6.0 dB

Hermon Laboratories is accredited by A2LA for calibration according to present requirements of ISO/IEC 17025 and NCSL Z540-1. The accreditation is granted to perform calibration of parameters that are listed in the Scope of Hermon Laboratories Accreditation.

Hermon Laboratories calibrates its reference and transfer standards by calibration laboratories accredited to ISO/IEC 17025 by a mutually recognized Accreditation Body or by a recognized national metrology institute. All reference and transfer standards used in the calibration system are traceable to national or international standards.

In-house calibration of all test and measurement equipment is performed on a regular basis according to Hermon Laboratories calibration procedures, manufacturer calibration/verification procedures or procedures defined in the relevant standards. The Hermon Laboratories test and measurement equipment is calibrated within the tolerances specified by the manufacturers and/or by the relevant standards.

11 APPENDIX D Test laboratory description

Tests were performed at Hermon Laboratories Ltd., which is a fully independent, private, EMC, Radio, Safety, Environmental and Telecommunication testing facility.
Hermon Laboratories is recognized and accredited by the Federal Communications Commission (USA) for relevant parts of Code of Federal Regulations 47 (CFR 47), Test Firm Registration Number is 927748, Designation Number is IL1001; Recognized by Innovation, Science and Economic Development Canada for wireless and terminal testing (ISED), ISED #2186A, CAB identifier is IL1001; Certified by VCCI, Japan (the registration numbers for OATS are R-10808 for RE measurements below 1 GHz, G-20112 for RE measurements above 1 GHz, R-11082 for anechoic chamber for RE measurements below 1 GHz, G-10869 for RE measurements above 1 GHz, C-10845 for conducted emissions site and T-11606 for conducted emissions at telecommunication ports).
The laboratory is accredited by American Association for Laboratory Accreditation (USA) according to ISO/IEC 17025 for electromagnetic compatibility, product safety, telecommunications testing, environmental simulation and calibration (for exact scope please refer to Certificate No. 839.01, 839.03 and 839.04).

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12 APPENDIX E Specification references

FCC 47CFR part 90: 2020	Private land mobile radio services
FCC 47CFR part 2: 2020	Frequency allocations and radio treaty matters; general rules and regulations
ANSI/TIA/EIA-603-E:2016	Land Mobile FM or PM Communications Equipment Measurement and Performance Standards
RSS-119 Issue 12: 2015	Land Mobile and Fixed Equipment Equipment Operating in the Frequency Range 27.41-960 MHz
RSS-Gen Issue 5: 2019	General Requirements for Compliance of Radio Apparatus

13 APPENDIX F Abbreviations and acronyms

A	ampere
AC	alternating current
AM	amplitude modulation
AVRG	average (detector)
BB	broad band
cm	centimeter
dB	decibel
dBm	decibel referred to one milliwatt
dB(μV)	decibel referred to one microvolt
dB(μV/m)	decibel referred to one microvolt per meter
dB(μA)	decibel referred to one microampere
DC	direct current
EIRP	equivalent isotropically radiated power
ERP	effective radiated power
EUT	equipment under test
F	frequency
GHz	gigahertz
GND	ground
H	height
HL	Hermon laboratories
Hz	hertz
k	kilo
kHz	kilohertz
LO	local oscillator
m	meter
MHz	megahertz
min	minute
mm	millimeter
ms	millisecond
μs	microsecond
NA	not applicable
NB	narrow band
OATS	open area test site
Ω	Ohm
QP	quasi-peak
RE	radiated emission
RF	radio frequency
rms	root mean square
Rx	receive
s	second
T	temperature
Tx	transmit
V	volt

END OF DOCUMENT