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TEST REPORT

ACCORDING TO: FCC 47CFR part 15 subpart C §15.247 (DTS)

FOR:

**Triple Jump Israel Ltd.
Insulin Patch Pump of
Triple Jump System
Model number: 002-001
FCC ID: 2AUPA-TJENG**

This report is in conformity with ISO/ IEC 17025. The "A2LA Accredited" symbol endorsement applies only to the tests and calibrations that are listed in the scope of Hermon Laboratories accreditation. The test results relate only to the items tested. This test report shall not be reproduced in any form except in full with the written approval of Hermon Laboratories Ltd.

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1 Applicant information

Client name: Triple Jump Israel Ltd.
Address: 5 HaCarmel St., P.O 205, Yokneam 2069203, Israel
Telephone: +972 73-7079070
E-mail: LidarD@triplejumpmed.com
Contact name: Ms.Lidar Dvir

2 Equipment under test attributes

Product name: Insulin Patch Pump of TJ0010 Triple Jump System
Model numbers: 002-001 (Engine)
TJ0005 (Controller)
022-001 (Docker)
SWM6-5-NH-U (Charger, manufactured by CUI INC)
Serial numbers: 43 (Engine)
SN00009 (Controller)
D06 (Docker)
172300162 (Charger)
Hardware versions: AA (Engine)
01 (Controller)
BB (Docker)
Software releases: 5.56 (Engine)
1.97 (Controller)
Receipt date 01-Sep-19

3 Manufacturer information

Manufacturer name: Triple Jump Israel Ltd.
Address: 5 HaCarmel St., P.O 205, Yokneam 2069203, Israel
Telephone: +972 73-7079070
E-Mail: LidarD@triplejumpmed.com
Contact name: Ms.Lidar Dvir

4 Test details

Project ID: 33992
Location: Hermon Laboratories Ltd. P.O. Box 23, Binyamina 3055001, Israel
Test started: 03-Sep-19
Test completed: 12-Sep-19
Test specification(s): FCC 47CFR part 15 subpart C §15.247 (DTS)

5 Tests summary

Test	Status
Transmitter characteristics	
FCC section 15.247(a)2, 6 dB bandwidth	Pass
FCC section 15.247(b)3, Field strength of spurious emissions	Pass
FCC section 15.247(b)3, Peak output power	Pass
FCC section 15.247(i), RF exposure	Pass, the exhibit to the application of certification is provided
FCC section 15.247(d), Emissions at band edges	Pass
FCC section 15.247(e), Peak power density	Pass
FCC section 15.203, Antenna requirement	Pass
FCC section 15.207(a), Conducted emission	Not required

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. S. Samokha test engineer EMC & Radio	04 Sep 19 – 12 Sep 19	
Reviewed by:	Mrs. S Peysahov Sheynin test engineer EMC & Radio	20 Nov 19 – 09 Dec 19	
Approved by:	Mr. M. Nikishin, EMC and Radio group leader	24 Dec 19	

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, Insulin Patch Pump, consisting of Engine and Reservoir, is a part of Triple Jump System ("TJ System") that comprised three main components:

- Engine - includes the Pump's electronics, driving mechanism, and a rechargeable battery.
- Controller - a rechargeable hand-held component for Pump programming and data acquisition.
- Disposable Pack - comprised of three parts:
 - Reservoir - includes the insulin cartridge and adhesive base. The Reservoir is used for up to 72 hours and then disposed.
 - Inserter - the single use Inserter is pre-attached to the Reservoir (Loaded Inserter) and is intended for cannula insertion. After cannula insertion, the Inserter is removed from the Pump and disposed.
 - Syringe - for single use, designed to draw insulin from the insulin vial and fill Reservoir's insulin cartridge. The Engine and Reservoir are attached to form the Pump. The Pump is a miniature, portable, programmable insulin patch pump that adheres to the user's skin. The Pump is operated by the Controller, using a BLE communication protocol.

The TJ System also includes secondary components: a Charger, used to charge the Engine, a Docker, used for covering the Engine, when it is not in use and for connecting the Engine to the Charger. The Charger is also used to charge the Controller

6.2 EUT modules and sub-assemblies

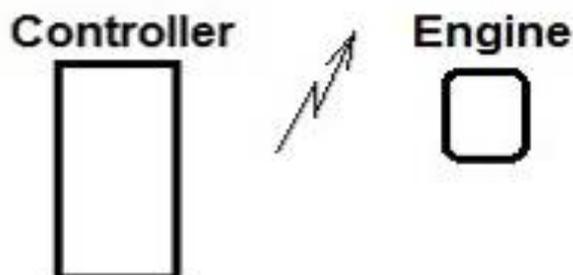
Description	Manufacturer	Model or P/N	Hardware rev.	Serial number
Engine	Triple Jump Israel Ltd	002-001	AA	43
Controller	Triple Jump Israel Ltd	TJ0005	01	SN00009
Docker	Triple Jump Israel Ltd	022-001	BB	D06
Charger	CUI INC	SWM6-5-NH-U	NA	172300162

6.3 Operating frequencies

Source	Frequency, MHz					
Clock	0.032768	32	NA	NA	NA	NA
Bluetooth	2400-2483.5	NA	NA	NA	NA	NA

6.4 Test configuration

Controller with Engine (operating mode)



6.5 Changes made in EUT

No changes were implemented in the EUT during the testing.



6.6 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				
	mobile	Always at a distance more than 20 cm from all people				
X	portable	May operate at a distance closer than 20 cm to human body				
Assigned frequency range		2400 – 2483.5 MHz				
Operating frequency		2402 - 2480 MHz				
Maximum rated output power		Peak output power		-0.16 dBm		
Is transmitter output power variable?		X	No			
			Yes	continuous variable		
				stepped variable with stepsize		dB
				minimum RF power		dBm
				maximum RF power		dBm
Antenna connection						
unique coupling		standard connector		X	integral	
				X	with temporary RF connector without temporary RF connector	
Antenna/s technical characteristics						
Type	Manufacturer		Model number		Gain	
Integral	Johanson Technology Inc.		2450AT18B100E		0.5 dBi	
Modulation		GFSK				
Transmitter aggregate data rate/s		2 Mbps				
Modulating test signal (baseband)		ID Code				
Transmitter power source						
X	Battery	Nominal rated voltage	3.7 VDC	Battery type	Lithium-ion	
	DC	Nominal rated voltage	VDC			
	AC mains	Nominal rated voltage	VAC	Frequency		
Spread spectrum technique used		Frequency hopping (FHSS)				
		X	Digital transmission system (DTS)			
			Hybrid			



Test specification: Section 15.247(a)2, 6 dB bandwidth			
Test procedure: ANSI C63.10 section 11.8.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 05-Sep-19			
Temperature: 24.7 °C	Relative Humidity: 47 %	Air Pressure: 1006 hPa	Power: 3.7 VDC
Remarks:			

7 Transmitter tests according to 47CFR part 15 subpart C requirements

7.1 Minimum 6 dB bandwidth

7.1.1 General

This test was performed to measure 6 dB bandwidth of the EUT carrier frequency. Specification test limits are given in Table 7.1.1.

Table 7.1.1 The 6 dB bandwidth limits

Assigned frequency, MHz	Modulation envelope reference points*, dBc	Minimum bandwidth, kHz
902.0 – 928.0	6.0	500.0
2400.0 – 2483.5		
5725.0 – 5850.0		

* - Modulation envelope reference points provided in terms of attenuation below the peak of modulated carrier.

7.1.2 Test procedure

7.1.2.1 The EUT was set up as shown in Figure 7.1.1, energized and its proper operation was checked.

7.1.2.2 The EUT was set to transmit modulated carrier.

7.1.2.3 The transmitter minimum 6 dB bandwidth was measured with spectrum analyzer as frequency delta between reference points on modulation envelope and provided in Table 7.1.2 and associated plot.

Figure 7.1.1 The 6 dB bandwidth test setup





Test specification: Section 15.247(a)2, 6 dB bandwidth			
Test procedure: ANSI C63.10 section 11.8.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 05-Sep-19			
Temperature: 24.7 °C	Relative Humidity: 47 %	Air Pressure: 1006 hPa	Power: 3.7 VDC
Remarks:			

Table 7.1.2 The 6 dB bandwidth test results

ASSIGNED FREQUENCY BAND: 2400.0 - 2483.5 MHz
DETECTOR USED: Peak
SWEEP MODE: Single
SWEEP TIME: Auto
RESOLUTION BANDWIDTH: 100 kHz
VIDEO BANDWIDTH: 300 kHz
MODULATION ENVELOPE REFERENCE POINTS: 6.0 dBc
MODULATION: GFSK
BIT RATE: 2Mbps

Carrier frequency, MHz	6 dB bandwidth, kHz	Limit, kHz	Margin, kHz	Verdict
Low frequency				
2402	876.571	500.00	-376.571	Pass
Mid frequency				
2440	910.768	500.00	-410.768	Pass
High frequency				
2480	891.555	500.00	-391.555	Pass

Reference numbers of test equipment used

HL 2909	HL 4136	HL 3434	HL 1809	HL 337				
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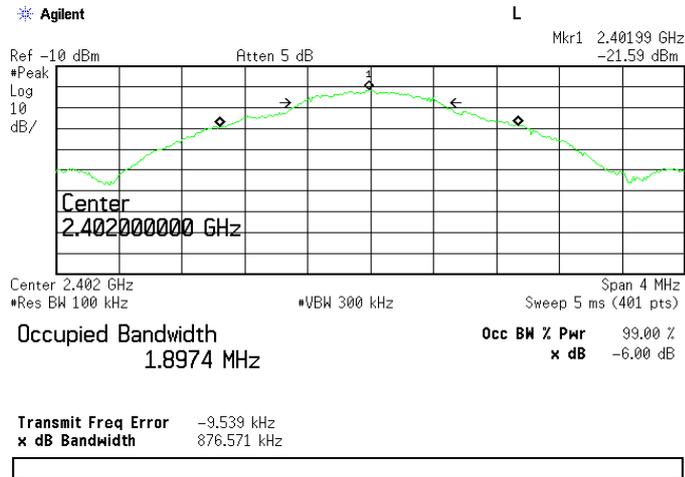
Full description is given in Appendix A.



HERMON LABORATORIES

Test specification: Section 15.247(a)2, 6 dB bandwidth			
Test procedure: ANSI C63.10 section 11.8.1			
Test mode: Compliance			Verdict: PASS
Date(s): 05-Sep-19			
Temperature: 24.7 °C	Relative Humidity: 47 %	Air Pressure: 1006 hPa	Power: 3.7 VDC
Remarks:			

Plot 7.1.1 The 6 dB bandwidth test result at low frequency

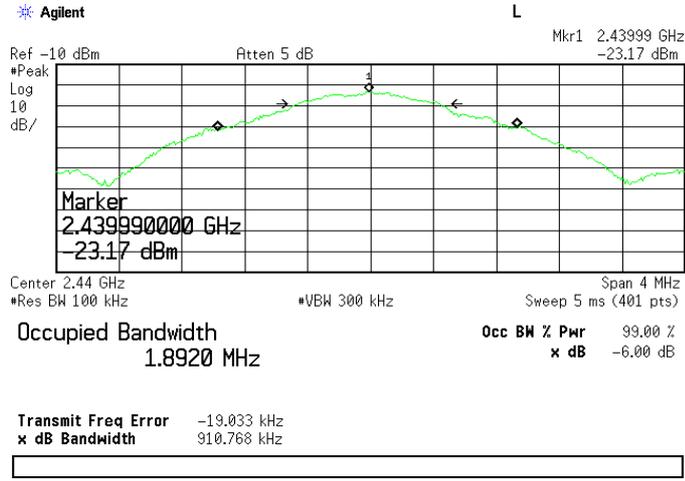




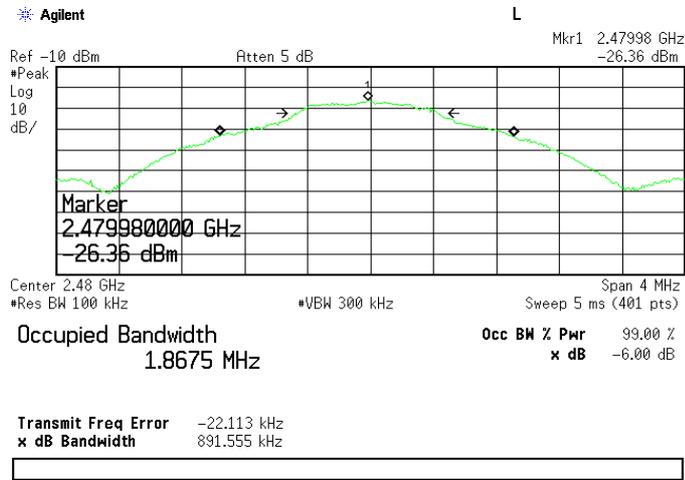
HERMON LABORATORIES

Test specification: Section 15.247(a)2, 6 dB bandwidth			
Test procedure: ANSI C63.10 section 11.8.1			
Test mode: Compliance		Verdict:	PASS
Date(s): 05-Sep-19			
Temperature: 24.7 °C	Relative Humidity: 47 %	Air Pressure: 1006 hPa	Power: 3.7 VDC
Remarks:			

Plot 7.1.2 The 6 dB bandwidth test result at mid frequency



Plot 7.1.3 The 6 dB bandwidth test result at high frequency





Test specification: Section 15.247(d), Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 05-Sep-19			
Temperature: 25.1 °C	Relative Humidity: 51 %	Air Pressure: 1006 hPa	Power: 3.7 VDC
Remarks:			

7.2 Field strength of spurious emissions

7.2.1 General

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

Table 7.2.1 Radiated spurious emissions limits

Frequency, MHz	Field strength at 3 m within restricted bands, dB(μ V/m)*			Attenuation of field strength of spurious versus carrier outside restricted bands, dBc***
	Peak	Quasi Peak	Average	
0.009 – 0.090	148.5 – 128.5	NA	128.5 – 108.5**	20.0
0.090 – 0.110	NA	108.5 – 106.8**	NA	
0.110 – 0.490	126.8 – 113.8	NA	106.8 – 93.8**	
0.490 – 1.705	NA	73.8 – 63.0**	NA	
1.705 – 30.0*		69.5		
30 – 88		40.0		
88 – 216		43.5		
216 – 960		46.0		
960 - 1000		54.0		
1000 – 10 th harmonic	74.0	NA	54.0	

*- The limit for 3 m test distance was calculated using the inverse square distance extrapolation factor as follows:

$$\text{Lim}_{S_2} = \text{Lim}_{S_1} + 40 \log(S_1/S_2),$$

where S_1 and S_2 – standard defined and test distance respectively in meters.

** - The limit decreases linearly with the logarithm of frequency.

*** - The field strength limits applied from the lowest radio frequency generated in the device, without going below 9 kHz up to the tenth harmonic of the highest fundamental frequency.

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/ EMI receiver. To find maximum radiation the turntable was rotated 360° and the measuring antenna was rotated around its vertical axis.

7.2.2.3 The worst test results (the lowest margins) were recorded 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, Table 7.2.3, energized and the performance check was conducted.

7.2.3.2 The specified frequency range was investigated with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360°, the measuring antenna height was changed from 1 to 4 m, its polarization was switched from vertical to horizontal.

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



Test specification: Section 15.247(d), Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 05-Sep-19			
Temperature: 25.1 °C	Relative Humidity: 51 %	Air Pressure: 1006 hPa	Power: 3.7 VDC
Remarks:			

Figure 7.2.1 Setup for spurious emission field strength measurements below 30 MHz

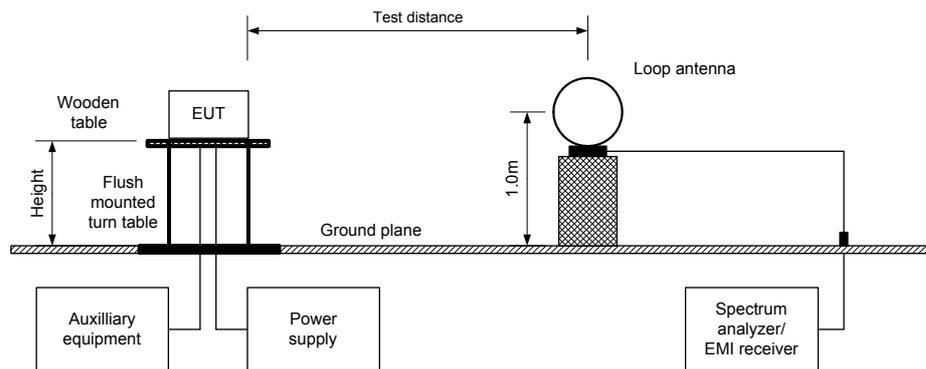
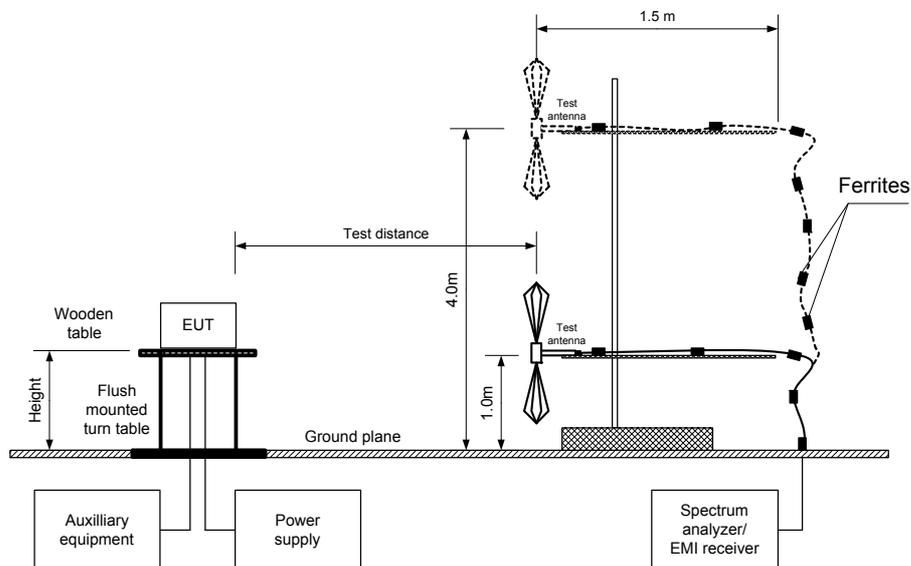


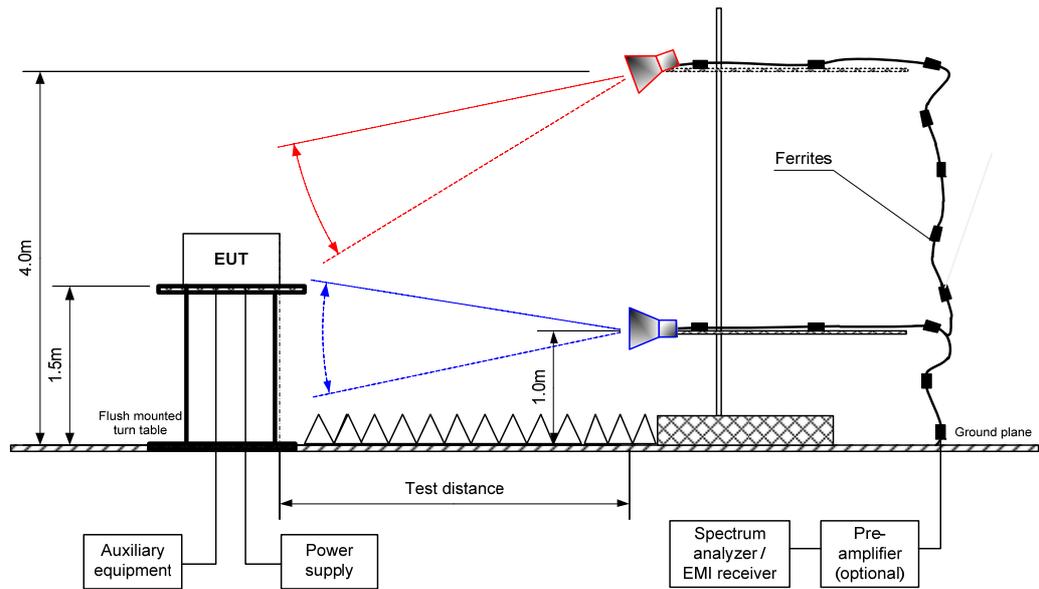
Figure 7.2.2 Setup for spurious emission field strength measurements in 30 – 1000 MHz





Test specification: Section 15.247(d), Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 05-Sep-19			
Temperature: 25.1 °C	Relative Humidity: 51 %	Air Pressure: 1006 hPa	Power: 3.7 VDC
Remarks:			

Figure 7.2.3 Setup for spurious emission field strength measurements above 1000 MHz





Test specification: Section 15.247(d), Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 05-Sep-19			
Temperature: 25.1 °C	Relative Humidity: 51 %	Air Pressure: 1006 hPa	Power: 3.7 VDC
Remarks:			

Table 7.2.2 Field strength of emissions outside restricted bands

ASSIGNED FREQUENCY: 2400 - 2483.5 MHz
 INVESTIGATED FREQUENCY RANGE: 0.009 - 25000 MHz
 TEST DISTANCE: 3 m
 MODULATION: GFSK
 BIT RATE: 2Mbps
 DUTY CYCLE: 100 %
 TRANSMITTER OUTPUT POWER SETTINGS: Maximum
 DETECTOR USED: Peak
 RESOLUTION BANDWIDTH: 100 kHz
 VIDEO BANDWIDTH: 300 kHz
 TEST ANTENNA TYPE: Active loop (9 kHz – 30 MHz)
 Biconical (30 MHz – 10000 MHz)
 Horn (above 1000 MHz)

Frequency, MHz	Field strength of spurious, dB(µV/m)	Antenna polarization	Antenna height, m	Azimuth, degrees*	Field strength of carrier, dB(µV/m)	Attenuation below carrier, dBc	Limit, dBc	Margin, dB**	Verdict
Low carrier frequency									
No emissions were found									Pass
Mid carrier frequency									
No emissions were found									Pass
High carrier frequency									
No emissions were found									Pass

*- EUT front panel refers to 0 degrees position of turntable.
 **- Margin = Attenuation below carrier – specification limit.



Test specification: Section 15.247(d), Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 05-Sep-19			
Temperature: 25.1 °C	Relative Humidity: 51 %	Air Pressure: 1006 hPa	Power: 3.7 VDC
Remarks:			

Table 7.2.3 Field strength of spurious emissions above 1 GHz

ASSIGNED FREQUENCY: 2400 - 2483.5 MHz
 INVESTIGATED FREQUENCY RANGE: 1000 - 25000 MHz
 TEST DISTANCE: 3 m
 MODULATION: GFSK
 BIT RATE: 2Mbps
 DUTY CYCLE: 100 %
 TRANSMITTER OUTPUT POWER SETTINGS: Maximum
 DETECTOR USED: Peak
 RESOLUTION BANDWIDTH: 1000 kHz
 TEST ANTENNA TYPE: Double ridged guide

Frequency, MHz	Antenna		Azimuth, degrees*	Peak field strength(VBW=3 MHz)			Average field strength(VBW=10 Hz)				Verdict
	Polarization	Height, m		Measured, dB(μV/m)	Limit, dB(μV/m)	Margin, dB**	Measured, dB(μV/m)	Calculated, dB(μV/m)	Limit, dB(μV/m)	Margin, dB***	
Low carrier frequency											
No emissions were found											Pass
Mid carrier frequency											
7320.927500	Vert	1.02	15	61.20	74.0	-12.80	61.20	13.77	54.0	-40.23	Pass
No emissions were found											
High carrier frequency											
7441.057333	Vert	1.02	25	57.73	74.0	-26.27	57.73	10.30	54.0	-43.70	Pass

*- EUT front panel refers to 0 degrees position of turntable.
 **- Margin = Measured field strength - specification limit.
 ***- Margin = Calculated field strength - specification limit,
 where Calculated field strength = Measured field strength + average factor.

Table 7.2.4 Average factor calculation

Transmission pulse		Transmission burst		Transmission train duration, ms	Average factor, dB
Duration, ms	Period, ms	Duration, ms	Period, ms		
0.425	100	NA	NA	NA	-47.43

*- Average factor was calculated as follows for pulse train shorter than 100 ms:

$$Average\ factor = 20 \times \log_{10} \left(\frac{Pulse\ duration}{Pulse\ period} \times \frac{Burst\ duration}{Train\ duration} \times Number\ of\ bursts\ within\ pulse\ train \right)$$



Test specification: Section 15.247(d), Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 05-Sep-19			
Temperature: 25.1 °C	Relative Humidity: 51 %	Air Pressure: 1006 hPa	Power: 3.7 VDC
Remarks:			

Table 7.2.5 Field strength of spurious emissions below 1 GHz

ASSIGNED FREQUENCY: 2400 - 2483.5 MHz
 INVESTIGATED FREQUENCY RANGE: 0.009 - 1000 MHz
 TEST DISTANCE: 3 m
 MODULATION: GFSK
 BIT RATE: 2Mbps
 DUTY CYCLE: 100 %
 TRANSMITTER OUTPUT POWER SETTINGS: Maximum
 RESOLUTION BANDWIDTH: 0.2 kHz (9 kHz – 150 kHz)
 9.0 kHz (150 kHz – 30 MHz)
 120 kHz (30 MHz – 1000 MHz)
 VIDEO BANDWIDTH: > Resolution bandwidth
 TEST ANTENNA TYPE: Active loop (9 kHz – 30 MHz)
 Biconical (30 MHz – 10000 MHz)

Frequency, MHz	Peak emission, dB(µV/m)	Quasi-peak			Antenna polarization	Antenna height, m	Turn-table position**, degrees	Verdict
		Measured emission, dB(µV/m)	Limit, dB(µV/m)	Margin, dB*				
Low carrier frequency								
299.174528	42.71	38.52	46.00	-7.48	Horizontal	1.07	- 54.00	Pass
Mid carrier frequency								
288.997024	42.30	37.91	46.00	-8.09	Horizontal	1.02	-54.0	Pass
High carrier frequency								
286.744527	40.72	36.55	46.00	-4.17	Horizontal	1.04	-54.0	Pass

*- Margin = Measured emission - specification limit.
 **- EUT front panel refer to 0 degrees position of turntable.

Table 7.2.6 Restricted bands

MHz	MHz	MHz	MHz	MHz	GHz
0.09 - 0.11	8.37625 - 8.38675	73 - 74.6	399.9 - 410	2690 - 2900	10.6 - 12.7
0.495 - 0.505	8.41425 - 8.41475	74.8 - 75.2	608 - 614	3260 - 3267	13.25 - 13.4
2.1735 - 2.1905	12.29 - 12.293	108 - 121.94	960 - 1240	3332 - 3339	14.47 - 14.5
4.125 - 4.128	12.51975 - 12.52025	123 - 138	1300 - 1427	3345.8 - 3358	15.35 - 16.2
4.17725 - 4.17775	12.57675 - 12.57725	149.9 - 150.05	1435 - 1626.5	3600 - 4400	17.7 - 21.4
4.20725 - 4.20775	13.36 - 13.41	156.52475 - 156.52525	1645.5 - 1646.5	4500 - 5150	22.01 - 23.12
6.215 - 6.218	16.42 - 16.423	156.7 - 156.9	1660 - 1710	5350 - 5460	23.6 - 24
6.26775 - 6.26825	16.69475 - 16.69525	162.0125 - 167.17	1718.8 - 1722.2	7250 - 7750	31.2 - 31.8
6.31175 - 6.31225	16.80425 - 16.80475	167.72 - 173.2	2200 - 2300	8025 - 8500	36.43 - 36.5
8.291 - 8.294	25.5 - 25.67	240 - 285	2310 - 2390	9000 - 9200	Above 38.6
8.362 - 8.366	37.5 - 38.25	322 - 335.4	2483.5 - 2500	9300 - 9500	

Reference numbers of test equipment used

HL 0446	HL 2909	HL 3903	HL 4011	HL 4360	HL 4933	HL 4956	HL 5111
HL 5085	HL 5309	HL 5288	HL 5311	HL 5405			

Full description is given in Appendix A.



Test specification: Section 15.247(d), Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 05-Sep-19			
Temperature: 25.1 °C	Relative Humidity: 51 %	Air Pressure: 1006 hPa	Power: 3.7 VDC
Remarks:			

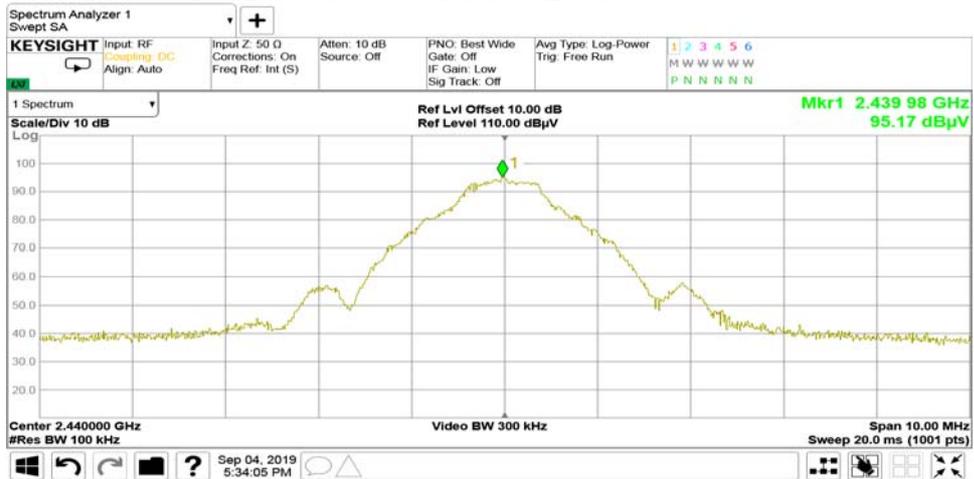
Plot 7.2.1 Radiated emission measurements at the low carrier frequency

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



Plot 7.2.2 Radiated emission measurements at the mid carrier frequency

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

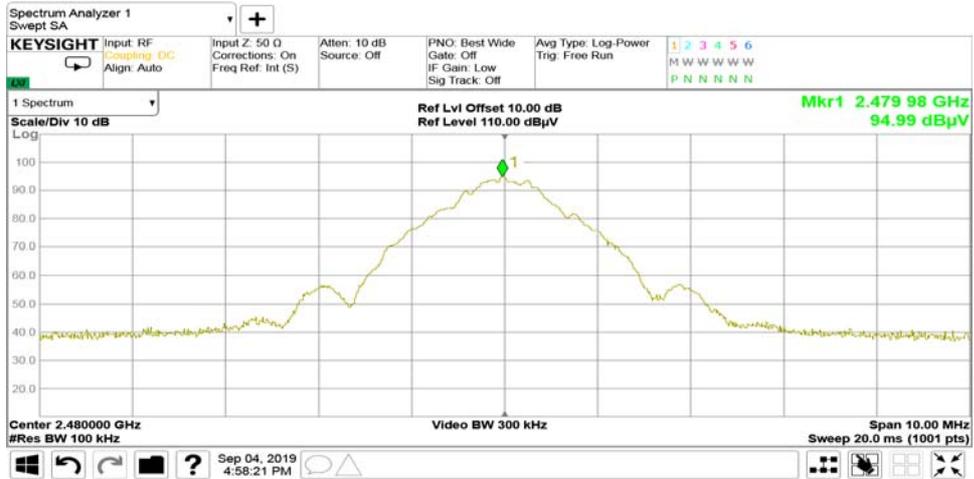




Test specification: Section 15.247(d), Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 05-Sep-19			
Temperature: 25.1 °C	Relative Humidity: 51 %	Air Pressure: 1006 hPa	Power: 3.7 VDC
Remarks:			

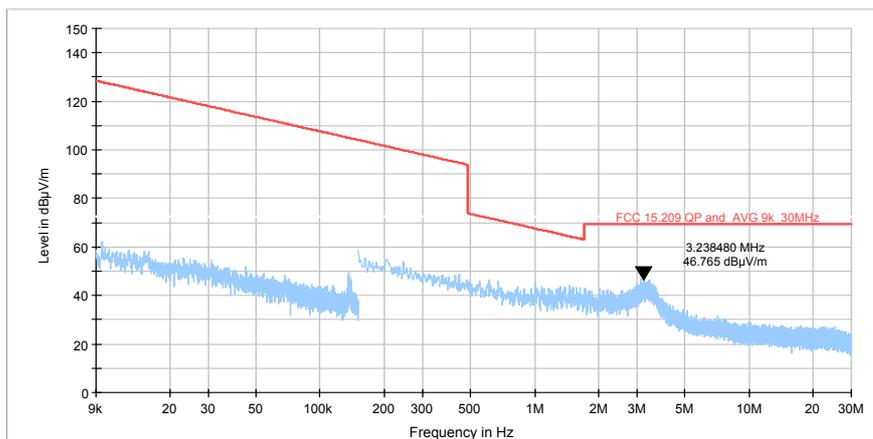
Plot 7.2.3 Radiated emission measurements at the high carrier frequency

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



Plot 7.2.4 Radiated emission measurements from 9 to 30000 kHz at the low carrier frequency

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

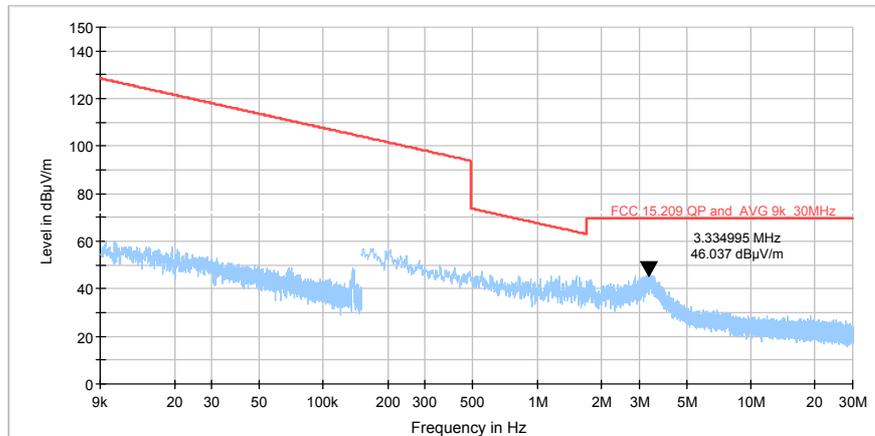




Test specification: Section 15.247(d), Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 05-Sep-19			
Temperature: 25.1 °C	Relative Humidity: 51 %	Air Pressure: 1006 hPa	Power: 3.7 VDC
Remarks:			

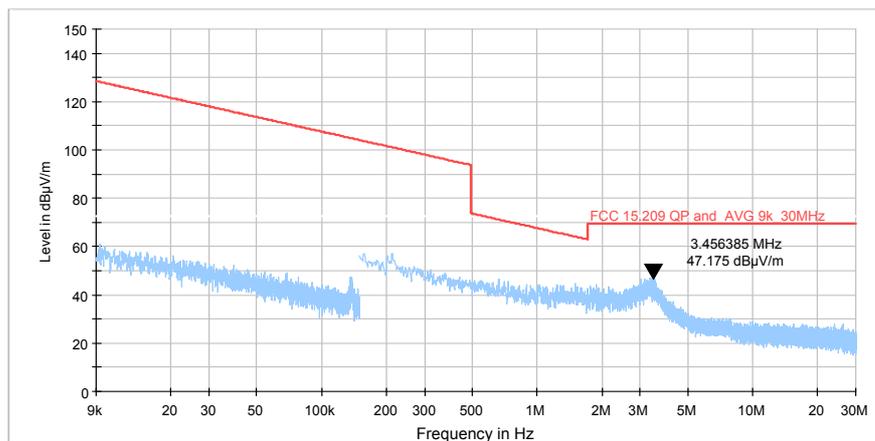
Plot 7.2.5 Radiated emission measurements from 9 to 30000 kHz at the mid carrier frequency

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



Plot 7.2.6 Radiated emission measurements from 9 to 30000 kHz at the high carrier frequency

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

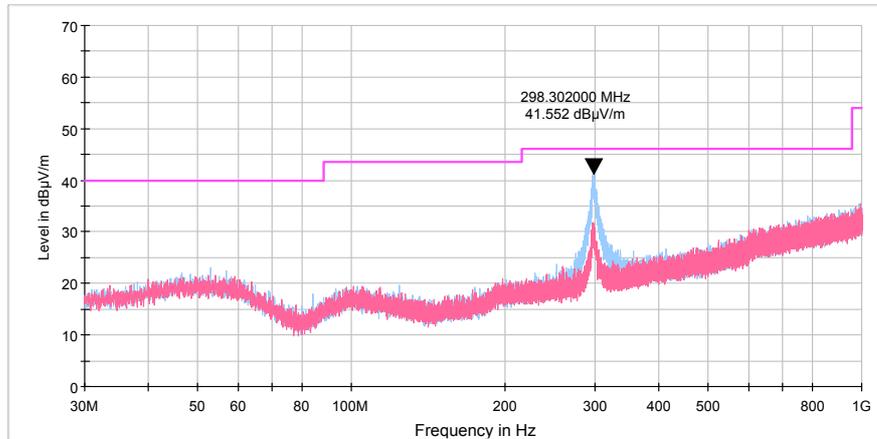




Test specification: Section 15.247(d), Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 05-Sep-19			
Temperature: 25.1 °C	Relative Humidity: 51 %	Air Pressure: 1006 hPa	Power: 3.7 VDC
Remarks:			

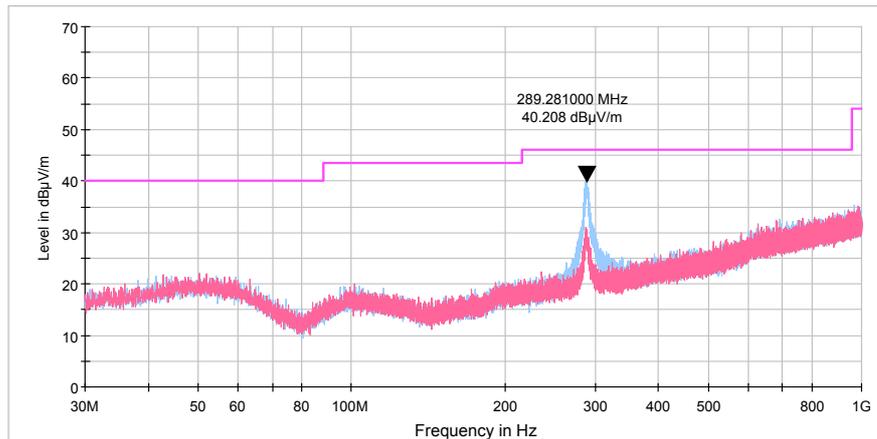
Plot 7.2.7 Radiated emission measurements from 30 to 1000 MHz at the low carrier frequency

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



Plot 7.2.8 Radiated emission measurements from 30 to 1000 MHz at the mid carrier frequency

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

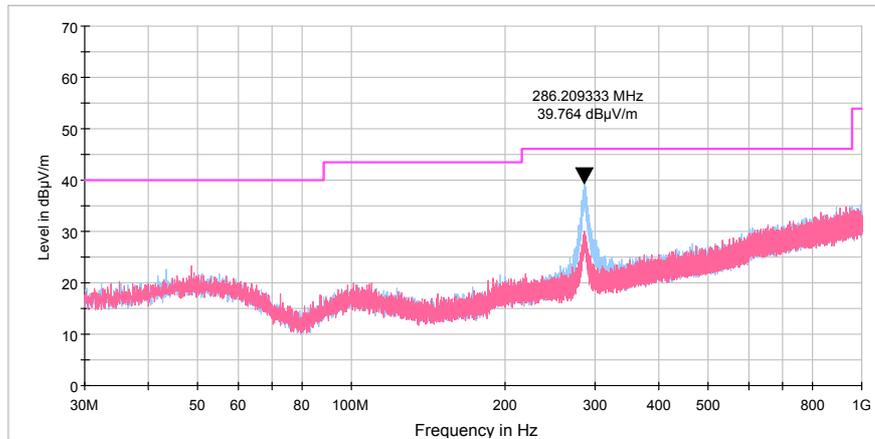




Test specification: Section 15.247(d), Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 05-Sep-19			
Temperature: 25.1 °C	Relative Humidity: 51 %	Air Pressure: 1006 hPa	Power: 3.7 VDC
Remarks:			

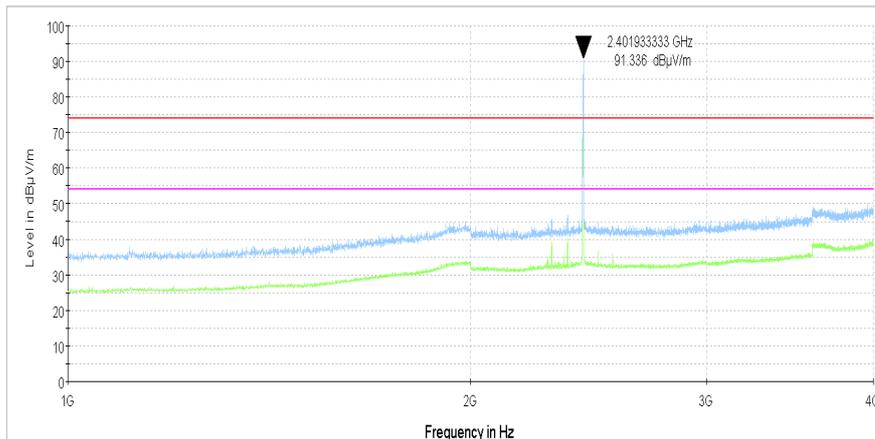
Plot 7.2.9 Radiated emission measurements from 30 to 1000 MHz at the high carrier frequency

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



Plot 7.2.10 Radiated emission measurements from 1000 to 4000 MHz at the low carrier frequency

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

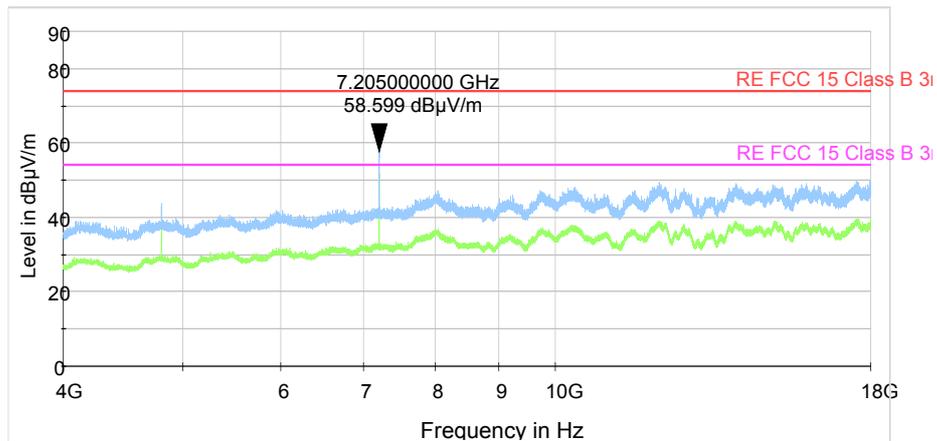




Test specification: Section 15.247(d), Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 05-Sep-19			
Temperature: 25.1 °C	Relative Humidity: 51 %	Air Pressure: 1006 hPa	Power: 3.7 VDC
Remarks:			

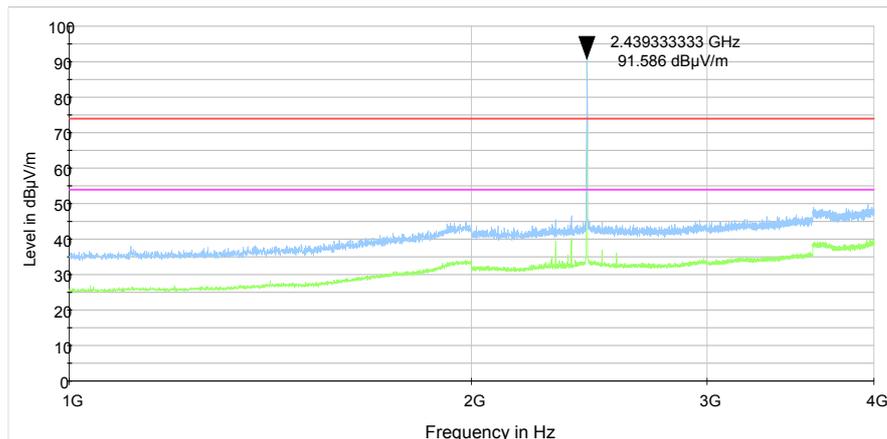
Plot 7.2.11 Radiated emission measurements from 4000 to 18000 MHz at the low carrier frequency

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



Plot 7.2.12 Radiated emission measurements from 1000 to 4000 MHz at the mid carrier frequency

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

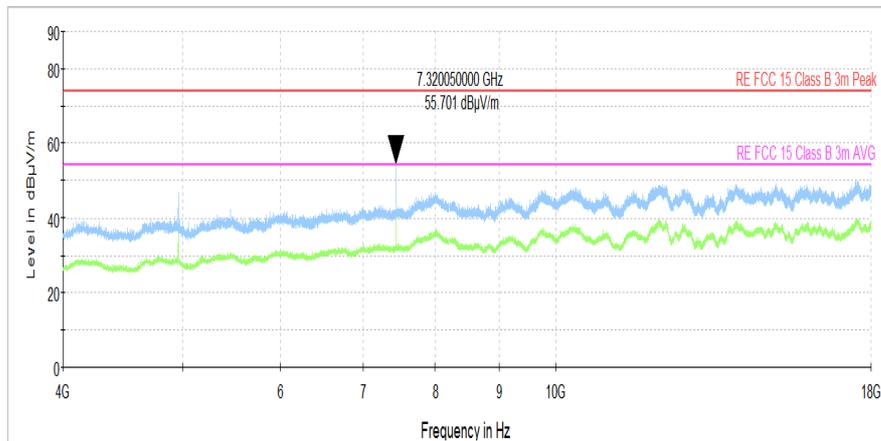




Test specification: Section 15.247(d), Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 05-Sep-19			
Temperature: 25.1 °C	Relative Humidity: 51 %	Air Pressure: 1006 hPa	Power: 3.7 VDC
Remarks:			

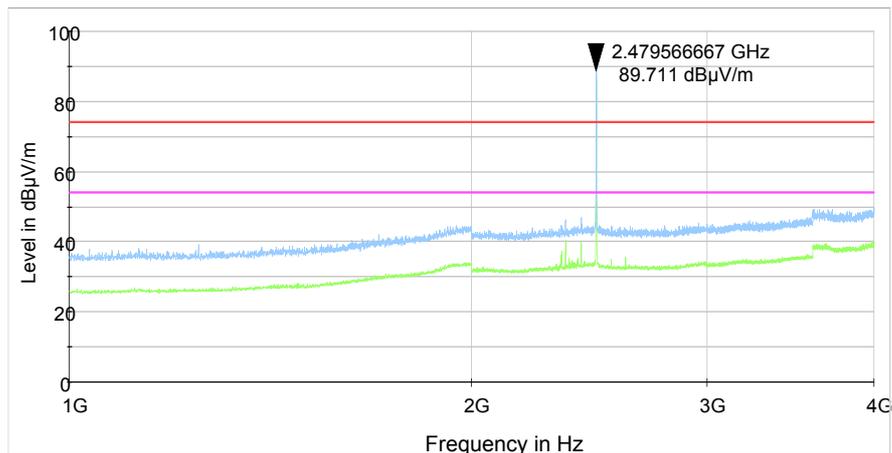
Plot 7.2.13 Radiated emission measurements from 4000 to 18000 MHz at the mid carrier frequency

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



Plot 7.2.14 Radiated emission measurements from 1000 to 4000 MHz at the high carrier frequency

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

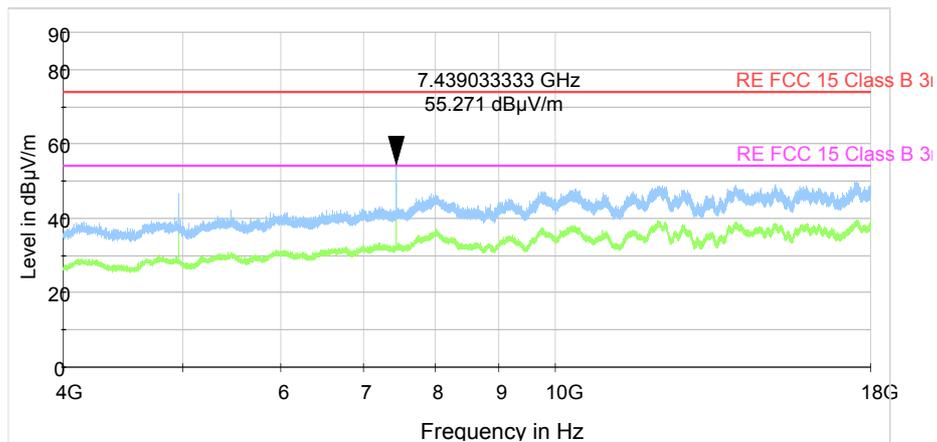




Test specification: Section 15.247(d), Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 05-Sep-19			
Temperature: 25.1 °C	Relative Humidity: 51 %	Air Pressure: 1006 hPa	Power: 3.7 VDC
Remarks:			

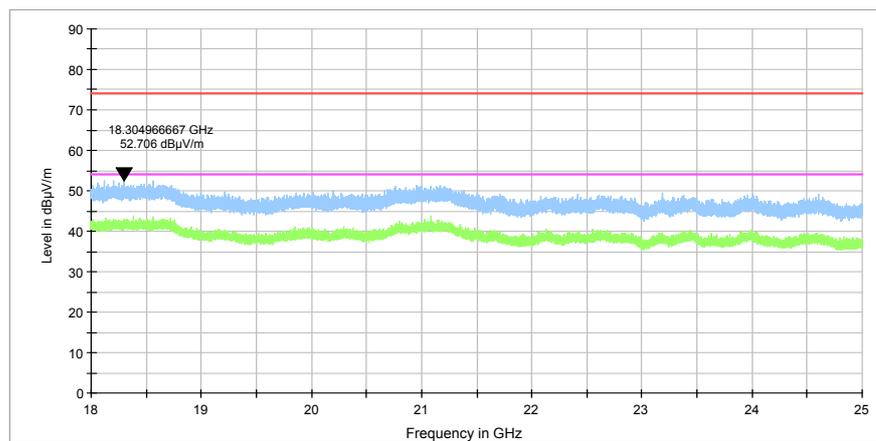
Plot 7.2.15 Radiated emission measurements from 4000 to 18000 MHz at the high carrier frequency

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



Plot 7.2.16 Radiated emission measurements from 18000 to 25000 MHz at the low carrier frequency

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

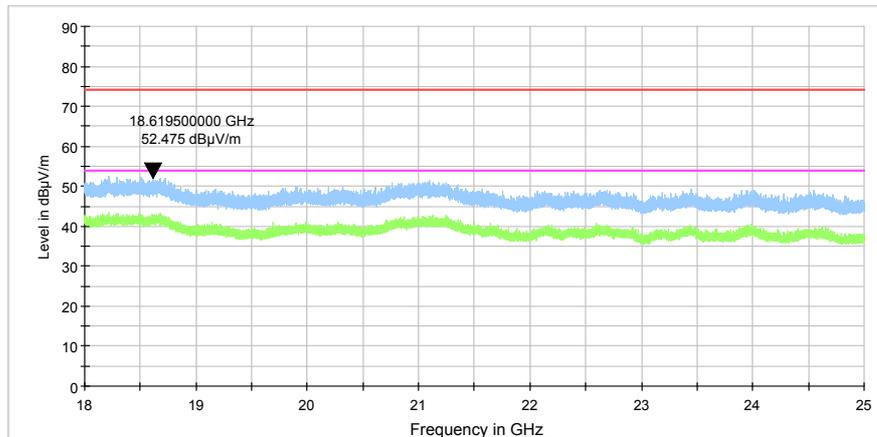




Test specification: Section 15.247(d), Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 05-Sep-19			
Temperature: 25.1 °C	Relative Humidity: 51 %	Air Pressure: 1006 hPa	Power: 3.7 VDC
Remarks:			

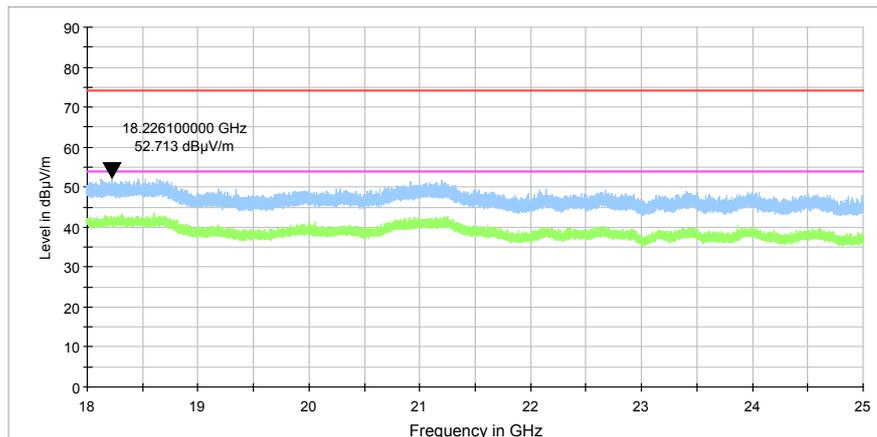
Plot 7.2.17 Radiated emission measurements from 18000 to 25000 MHz at the mid carrier frequency

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



Plot 7.2.18 Radiated emission measurements from 18000 to 25000 MHz at the high carrier frequency

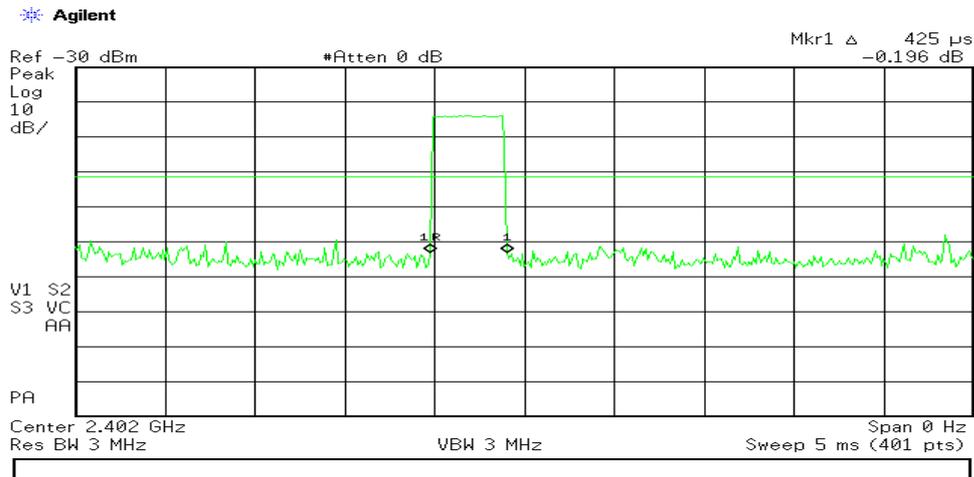
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



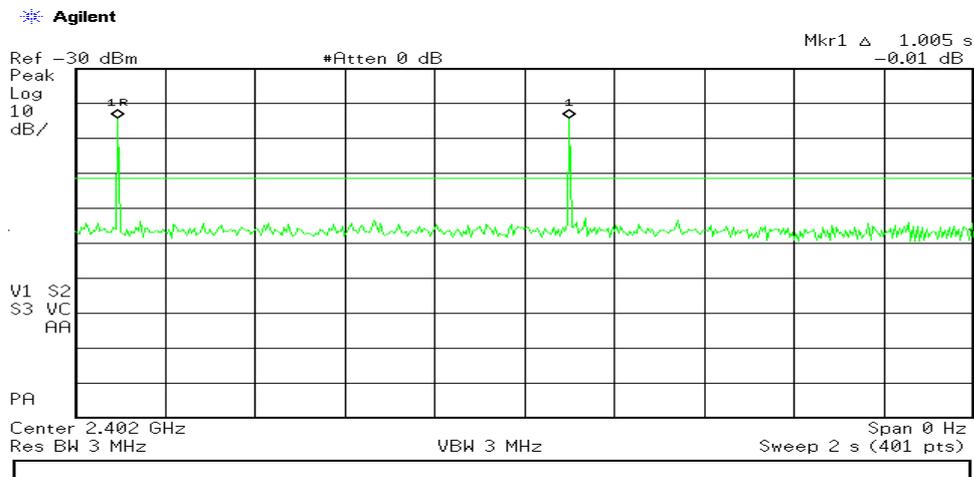


Test specification: Section 15.247(d), Radiated spurious emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 05-Sep-19			
Temperature: 25.1 °C	Relative Humidity: 51 %	Air Pressure: 1006 hPa	Power: 3.7 VDC
Remarks:			

Plot 7.2.19 Transmission pulse duration



Plot 7.2.20 Transmission pulse period





Test specification: Section 15.247(b)3, Peak output power			
Test procedure: ANSI C63.10 sections 11.9.2.2.4			
Test mode: Compliance		Verdict: PASS	
Date(s): 03-Sep-19 - 04-Sep-19			
Temperature: 25.4 °C	Relative Humidity: 51 %	Air Pressure: 1006 hPa	Power: 3.7 VDC
Remarks:			

7.3 Peak output power

7.3.1 General

This test was performed to measure the maximum peak output power radiated by transmitter. Specification test limits are given in Table 7.3.1.

Table 7.3.1 Peak output power limits

Assigned frequency range, MHz	Maximum antenna gain, dBi	Peak output power*		Equivalent field strength limit @ 3m, dB(μV/m)**
		mW	dBm	
902.0 – 928.0	6.0	10	10.0	105
2400.0 – 2483.5				
5725.0 – 5850.0				

*- The limit is provided in terms of conducted RF power at the antenna connector. If transmitting antennas of directional gain greater than 6 dBi are used, the peak output power limit shall be reduced below the stated value as follows:

- by 1 dB for every 3 dB that the directional gain of antenna exceeds 6 dBi for fixed point-to-point transmitters operate in 2400-2483.5 MHz band;
- without any corresponding reduction for fixed point-to-point transmitters operate in 5725-5850 MHz band;
- by the amount in dB that the directional gain of antenna exceeds 6 dBi for the rest of transmitters.

** - Equivalent field strength limit was calculated from the peak output power as follows: $E = \sqrt{(30 \times P \times G)} / r$, where P is peak output power in Watts, r is antenna to EUT distance in meters and G is transmitter antenna gain in dBi.

7.3.2 Test procedure

7.3.2.1 The EUT was set up as shown in Figure 7.3.1, energized and its proper operation was checked.

7.3.2.2 The EUT was adjusted to produce maximum available to end user RF output power.

7.3.2.3 The resolution bandwidth of spectrum analyzer was set wider than 6 dB bandwidth of the EUT and 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° and the measuring antenna height was swept in both vertical and horizontal polarizations.

7.3.2.4 The maximum field strength of the EUT carrier frequency was measured as provided in Table 7.3.2 and associated plots.

7.3.2.5 The maximum 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 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:

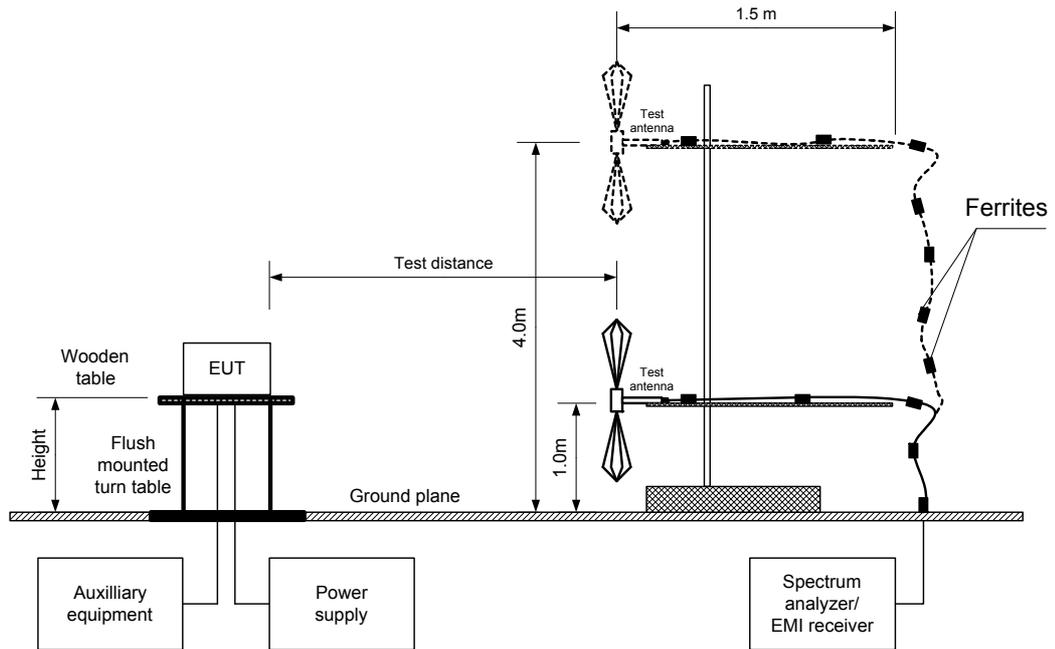
$$\text{Peak output power in dBm} = \text{Field strength in dB}(\mu\text{V/m}) - \text{Transmitter antenna gain in dBi} - 95.2 \text{ dB}$$

7.3.2.6 The worst test results (the lowest margins) were recorded in Table 7.3.2.



Test specification: Section 15.247(b)3, Peak output power			
Test procedure: ANSI C63.10 sections 11.9.2.2.4			
Test mode: Compliance	Verdict: PASS		
Date(s): 03-Sep-19 - 04-Sep-19			
Temperature: 25.4 °C	Relative Humidity: 51 %	Air Pressure: 1006 hPa	Power: 3.7 VDC
Remarks:			

Figure 7.3.1 Setup for carrier field strength measurements





Test specification: Section 15.247(b)3, Peak output power			
Test procedure: ANSI C63.10 sections 11.9.2.2.4			
Test mode: Compliance		Verdict: PASS	
Date(s): 03-Sep-19 - 04-Sep-19			
Temperature: 25.4 °C	Relative Humidity: 51 %	Air Pressure: 1006 hPa	Power: 3.7 VDC
Remarks:			

Table 7.3.2 Peak output power test results

ASSIGNED FREQUENCY: 2400 -2483.5 MHz
TEST DISTANCE: 3 m
TEST SITE: Semi anechoic chamber
EUT HEIGHT: 1.5 m
DETECTOR USED: Peak
TEST ANTENNA TYPE: Double ridged Horn (above 1000 MHz)
MODULATION: GFSK
BIT RATE: 2 Mbps
TRANSMITTER OUTPUT POWER SETTINGS: Maximum
DETECTOR USED: Peak
RESOLUTION BANDWIDTH: 3.0MHz
VIDEO BANDWIDTH: 8.0MHz

Frequency, MHz	Field strength, dB(□V/m)	Antenna polarization	Antenna height, m	Azimuth, degrees*	EUT antenna gain, dBi	Peak output power, dBm**	Limit, dBm	Margin, dB***	Verdict
2402.20	95.54 X	Vertical	1.02	87	0.5	-0.16	10	-10.16	Pass
2439.70	95.33 Z	Horizontal	1.28	-180	0.5	-0.37	10	-10.37	Pass
2479.64	95.15 Z	Horizontal	1.53	155	0.5	-0.55	10	-10.55	Pass

*- EUT front panel refer to 0 degrees position of turntable.

** - 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 = Peak output power - specification limit.

Note: Maximum peak output power was obtained at Unom (115%Unom, 85%Unom) input power voltage.

Reference numbers of test equipment used

HL 3903	HL 4011	HL 4360	HL 4933	HL 5085	HL 5309	HL 5311	HL 5376
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Full description is given in Appendix A.



Test specification: Section 15.247(b)3, Peak output power			
Test procedure: ANSI C63.10 sections 11.9.2.2.4			
Test mode: Compliance		Verdict: PASS	
Date(s): 03-Sep-19 - 04-Sep-19			
Temperature: 25.4 °C	Relative Humidity: 51 %	Air Pressure: 1006 hPa	Power: 3.7 VDC
Remarks:			

Plot 7.3.1 Field strength of carrier at low frequency Axis X (Vert)



Plot 7.3.2 Field strength of carrier at mid frequency Axis X (Vert)





Test specification: Section 15.247(b)3, Peak output power			
Test procedure: ANSI C63.10 sections 11.9.2.2.4			
Test mode: Compliance		Verdict: PASS	
Date(s): 03-Sep-19 - 04-Sep-19			
Temperature: 25.4 °C	Relative Humidity: 51 %	Air Pressure: 1006 hPa	Power: 3.7 VDC
Remarks:			

Plot 7.3.3 Field strength of carrier at high frequency Axis X (Vert)



Plot 7.3.4 Peak output power at low frequency Axis Y (Side)





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Test specification: Section 15.247(b)3, Peak output power			
Test procedure: ANSI C63.10 sections 11.9.2.2.4			
Test mode: Compliance		Verdict: PASS	
Date(s): 03-Sep-19 - 04-Sep-19			
Temperature: 25.4 °C	Relative Humidity: 51 %	Air Pressure: 1006 hPa	Power: 3.7 VDC
Remarks:			

Plot 7.3.5 Peak output power at mid frequency Axis Y (Side)



Plot 7.3.6 Peak output power at high frequency Axis Y (Side)





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Test specification: Section 15.247(b)3, Peak output power			
Test procedure: ANSI C63.10 sections 11.9.2.2.4			
Test mode: Compliance		Verdict: PASS	
Date(s): 03-Sep-19 - 04-Sep-19			
Temperature: 25.4 °C	Relative Humidity: 51 %	Air Pressure: 1006 hPa	Power: 3.7 VDC
Remarks:			

Plot 7.3.7 Peak output power at low frequency Axis Z (Horizontal)



Plot 7.3.8 Peak output power at mid frequency Axis Z (Horizontal)





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Test specification: Section 15.247(b)3, Peak output power			
Test procedure: ANSI C63.10 sections 11.9.2.2.4			
Test mode: Compliance		Verdict: PASS	
Date(s): 03-Sep-19 - 04-Sep-19			
Temperature: 25.4 °C	Relative Humidity: 51 %	Air Pressure: 1006 hPa	Power: 3.7 VDC
Remarks:			

Plot 7.3.9 Peak output power at high frequency Axis Z (Horizontal)





Test specification: Section 15.247(d), Band edge emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 12-Sep-19			
Temperature: 24.3 °C	Relative Humidity: 44 %	Air Pressure: 1009 hPa	Power: 3.7 VDC
Remarks:			

7.4 Band edge radiated emissions

7.4.1 General

This test was performed to measure emissions, radiated from the EUT at the assigned frequency band edges. Specification test limits are given in Table 7.4.1.

Table 7.4.1 Band edge emission limits

Output power	Assigned frequency, MHz	Attenuation below carrier*, dBc	Field strength at 3 m within restricted bands, dB(µV/m)	
			Peak	Average
Peak	902.0 – 928.0	20.0	74.0	54.0
	2400.0 – 2483.5			
	5725.0 – 5850.0			

* - Band edge emission limit is provided in terms of attenuation below the peak of modulated carrier measured with the same resolution bandwidth.

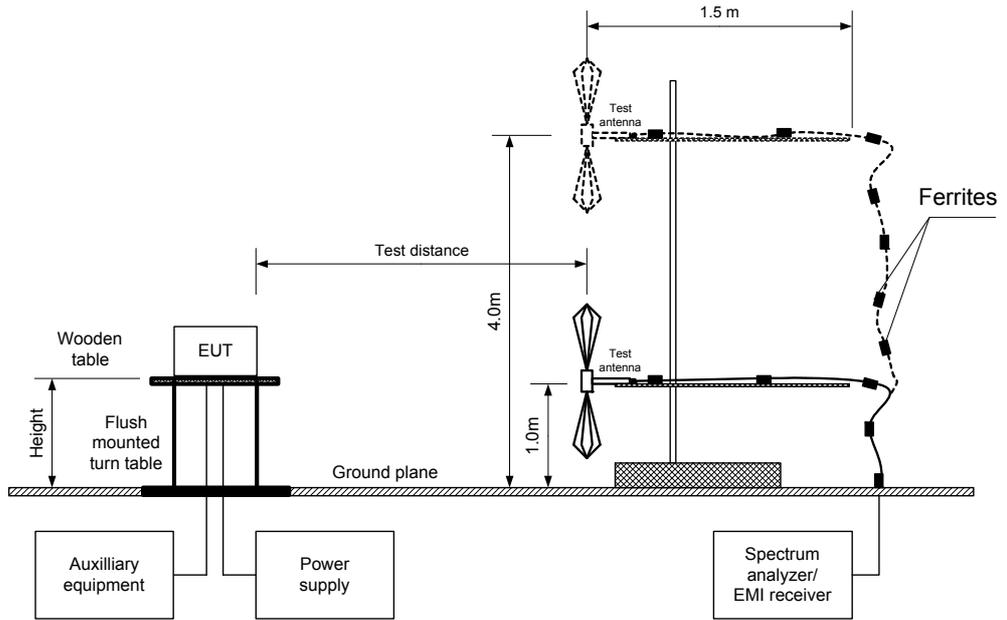
7.4.2 Test procedure

- 7.4.2.1 The EUT was set up as shown in Figure 7.4.1, energized normally modulated at the maximum data rate and its proper operation was checked.
- 7.4.2.2 The EUT was adjusted to produce maximum available to end user RF output power at the lowest carrier frequency.
- 7.4.2.3 The spectrum analyzer span was set to capture the carrier frequency and associated modulation products. The resolution bandwidth was set wider than 1 % of the frequency span.
- 7.4.2.4 The spectrum analyzer was set in max hold mode and allowed trace to stabilize. The highest emission level within the authorized band was measured.
- 7.4.2.5 The maximum band edge emission and modulation product outside of the band were measured as provided in Table 7.4.2 and associated plots and referenced to the highest emission level measured within the authorized band.
- 7.4.2.6 The above procedure was repeated with the EUT adjusted to produce maximum RF output power at the highest carrier frequency.
- 7.4.2.7 The above procedure was repeated with the frequency hopping function enabled.



Test specification: Section 15.247(d), Band edge emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 12-Sep-19			
Temperature: 24.3 °C	Relative Humidity: 44 %	Air Pressure: 1009 hPa	Power: 3.7 VDC
Remarks:			

Figure 7.4.1 Band edge emission test setup





Test specification: Section 15.247(d), Band edge emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 12-Sep-19			
Temperature: 24.3 °C	Relative Humidity: 44 %	Air Pressure: 1009 hPa	Power: 3.7 VDC
Remarks:			

Table 7.4.2 Band edge emission test results

OPERATING FREQUENCY RANGE: 2400 – 2483.5MHz
 DETECTOR USED: Peak hold
 MODULATION: GFSK
 BIT RATE: 2Mbps
 TRANSMITTER OUTPUT POWER SETTINGS: Maximum

FREQUENCY RANGE: Within restricted bands

Modulation envelope		Peak field strength (VBW=3 MHz)			Average field strength (VBW=10kHz)			Verdict
Band edge	Frequency, MHz	Measured, dB(µV/m)	Limit, dB(µV/m)	Margin, dB**	Measured, dB(µV/m)	Limit, dB(µV/m)	Margin, dB***	
Low	2337.99	49.92	74.0	-24.08	49.92	54.0	-4.08	Pass
Mid	2390.00	47.73	74.0	-26.27	47.73	54.0	-6.27	
High	2483.50	50.70	74.0	-23.30	50.70	54.0	-3.30	

FREQUENCY RANGE: Outside restricted bands

Frequency, MHz	Band edge emission, dBm	Emission at carrier, dBm	Attenuation below carrier, dBc	Limit, dBc	Margin, dB*	Verdict
Peak power						
2400.00	71.55	95.34	23.79	20.0	3.79	Pass

* - Measured frequency beyond which the emission dropped 50 dB below the carrier emission or below the field strength limit whichever was a less stringent

** - Margin = Measured field strength reading – Band edge Limit

Reference numbers of test equipment used

HL 4360	HL 3903	HL 4011	HL 5311	HL 5309	HL 4933		
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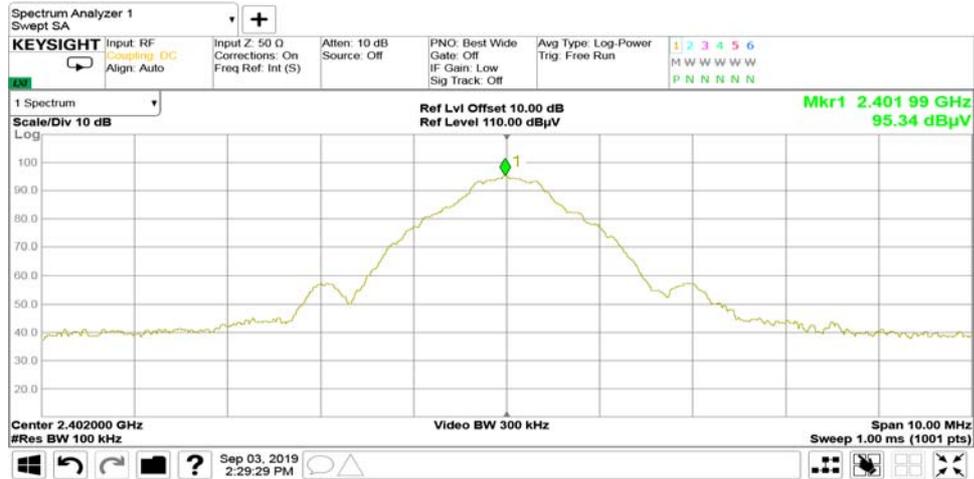
Full description is given in Appendix A.



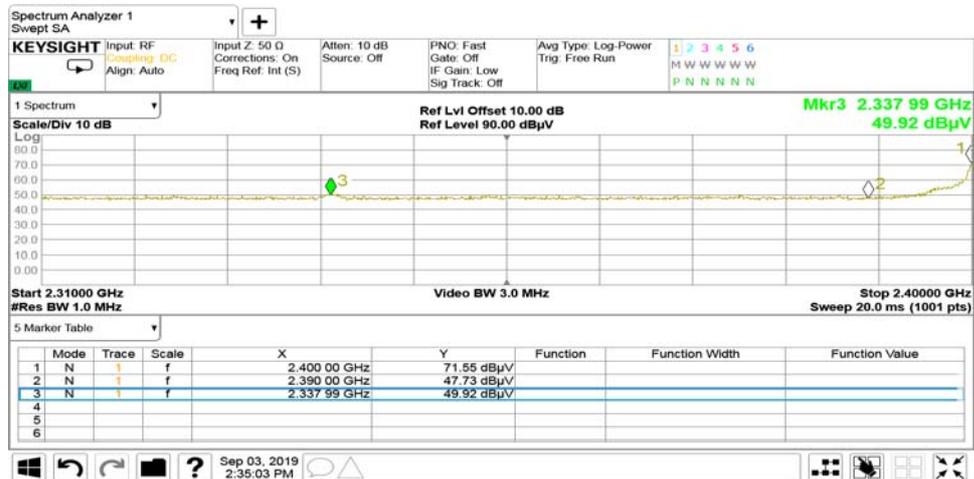
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Test specification: Section 15.247(d), Band edge emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict:	PASS
Date(s): 12-Sep-19			
Temperature: 24.3 °C	Relative Humidity: 44 %	Air Pressure: 1009 hPa	Power: 3.7 VDC
Remarks:			

Plot 7.4.1 The highest emission level within the assigned band at low carrier frequency



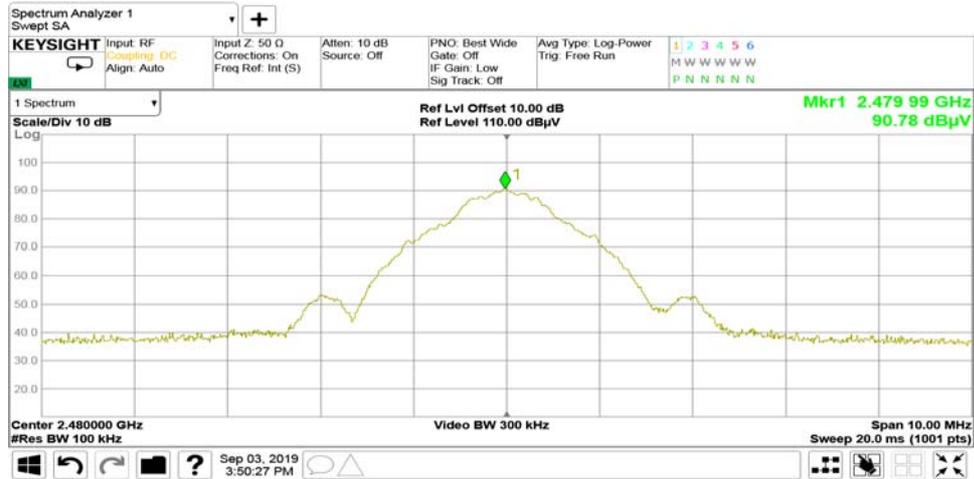
Plot 7.4.2 The highest band edge emission at low carrier frequency



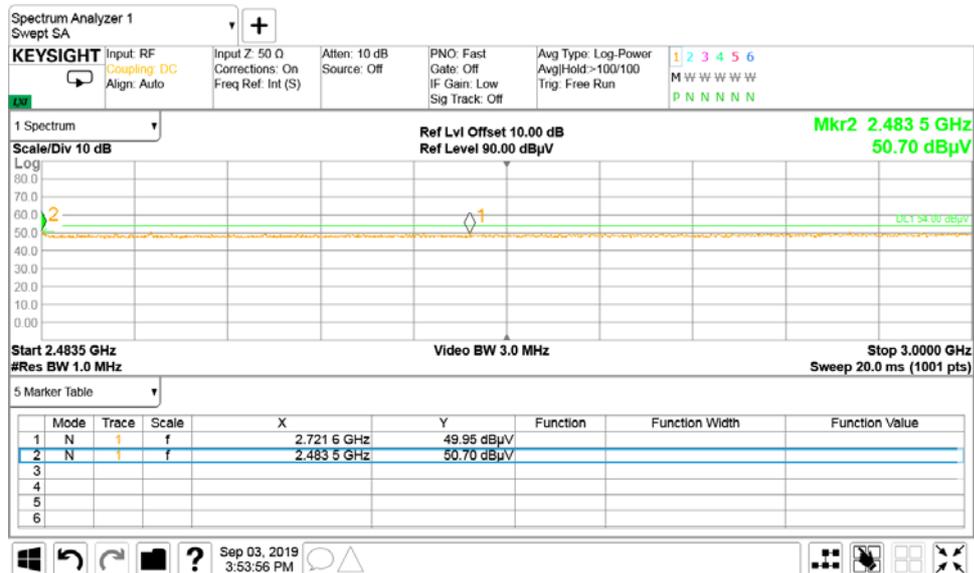


Test specification: Section 15.247(d), Band edge emissions			
Test procedure: ANSI C63.10 section 11.12.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 12-Sep-19			
Temperature: 24.3 °C	Relative Humidity: 44 %	Air Pressure: 1009 hPa	Power: 3.7 VDC
Remarks:			

Plot 7.4.3 The highest emission level within the assigned band at high carrier frequency



Plot 7.4.4 The highest band edge emission at high carrier frequency





Test specification: Section 15.247(e), Peak power density			
Test procedure: ANSI C63.10 section 11.10.2			
Test mode: Compliance		Verdict: PASS	
Date(s): 08-Sep-19			
Temperature: 24.7 °C	Relative Humidity: 46 %	Air Pressure: 1009 hPa	Power: 3.7 VDC
Remarks:			

7.5 Peak spectral power density

7.5.1 General

This test was performed to measure the peak spectral power density radiated by the transmitter RF antenna. Specification test limits are given in Table 7.5.1.

Table 7.5.1 Peak spectral power density limits

Assigned frequency range, MHz	Measurement bandwidth, kHz	Peak spectral power density, dBm	Equivalent field strength limit @ 3m, dB(µV/m)*
902.0 – 928.0	3.0	8.0	103.2
2400.0 – 2483.5			
5725.0 – 5850.0			

* - Equivalent field strength limit was calculated from the peak spectral power density as follows: $E = \sqrt{30 \times P} / r$, where P is peak spectral power density and r is antenna to EUT distance in meters.

7.5.2 Test procedure for field strength measurements

7.5.2.1 The EUT was set up as shown in Figure 7.5.1, energized and its proper operation was checked.

7.5.2.2 The EUT was adjusted to produce maximum available to end user RF output power.

7.5.2.3 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° and the measuring antenna height was swept in both vertical and horizontal polarizations.

7.5.2.4 The frequency span of spectrum analyzer was set to capture the entire 6 dB band of the transmitter, in peak hold mode with resolution bandwidth set to 3.0 kHz, video bandwidth wider than resolution bandwidth, auto sweep time and sufficient number of sweeps was allowed for trace stabilization. The spectrum lines spacing was verified to be wider than 3 kHz. Otherwise the resolution bandwidth was reduced until individual spectrum lines were resolved and the power of individual spectrum lines was integrated over 3 kHz band.

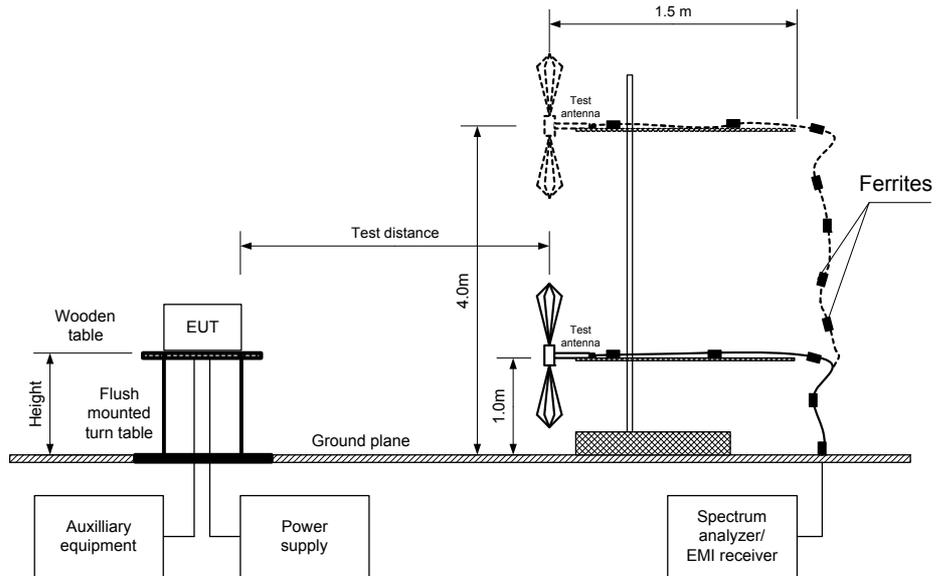
7.5.2.5 The peak of emission was zoomed with span set just wide enough to capture the emission peak area and sweep time was set equal to span width divided by resolution bandwidth. Spectrum analyzer was set in peak hold mode, sufficient number of sweeps was allowed for trace stabilization and peak spectral power density was measured as provided in Table 7.5.2 and associated plots.



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Test specification: Section 15.247(e), Peak power density			
Test procedure: ANSI C63.10 section 11.10.2			
Test mode: Compliance		Verdict: PASS	
Date(s): 08-Sep-19			
Temperature: 24.7 °C	Relative Humidity: 46 %	Air Pressure: 1009 hPa	Power: 3.7 VDC
Remarks:			

Figure 7.5.1 Setup for carrier field strength measurements





Test specification: Section 15.247(e), Peak power density			
Test procedure: ANSI C63.10 section 11.10.2			
Test mode: Compliance		Verdict: PASS	
Date(s): 08-Sep-19			
Temperature: 24.7 °C	Relative Humidity: 46 %	Air Pressure: 1009 hPa	Power: 3.7 VDC
Remarks:			

Table 7.5.2 Field strength measurement of peak spectral power density

ASSIGNED FREQUENCY: 2400.0 – 2483.5 MHz
TEST DISTANCE: 3 m
TEST SITE: Semi anechoic chamber
EUT HEIGHT: 1.5 m
DETECTOR USED: Peak
RESOLUTION BANDWIDTH: 100 kHz
VIDEO BANDWIDTH: 300 kHz
TEST ANTENNA TYPE: Double ridged guide (above 1000 MHz)
MODULATION: GFSK
TRANSMITTER OUTPUT POWER SETTINGS: Maximum

BIT RATE: 2 Mbps

Frequency, MHz	Field strength, dBm	EUT antenna gain, dBi	Limit, dBm	Margin, dB*	Antenna polarization	Antenna height, m	Turn-table position**, degrees	Verdict
2402.0	-0.39	0.5	8.0	-8.89	Vertical	1.0	103	Pass
2440.0	-0.78	0.5	8.0	-9.28	Vertical	1.0	136	Pass
2480.0	-1.27	0.5	8.0	-9.77	Vertical	1.0	132	Pass

*- Margin = Field strength - EUT antenna gain - calculated field strength limit.

** - EUT front panel refer to 0 degrees position of turntable.

Reference numbers of test equipment used

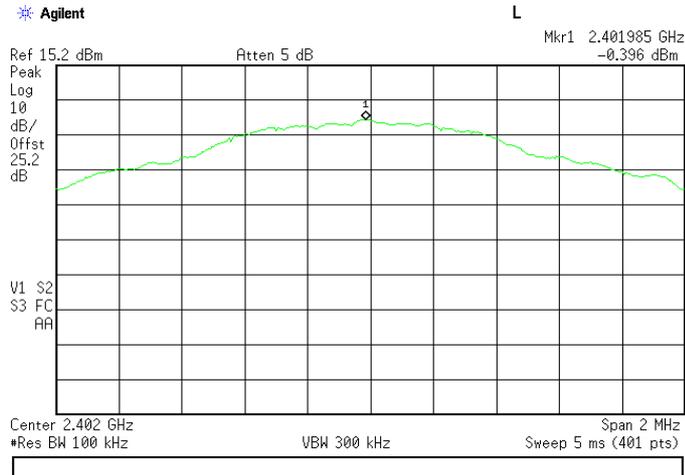
HL 3818	HL 3903	HL 4011	HL 4933	HL 5085	HL 5404	HL	HL
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Full description is given in Appendix A.

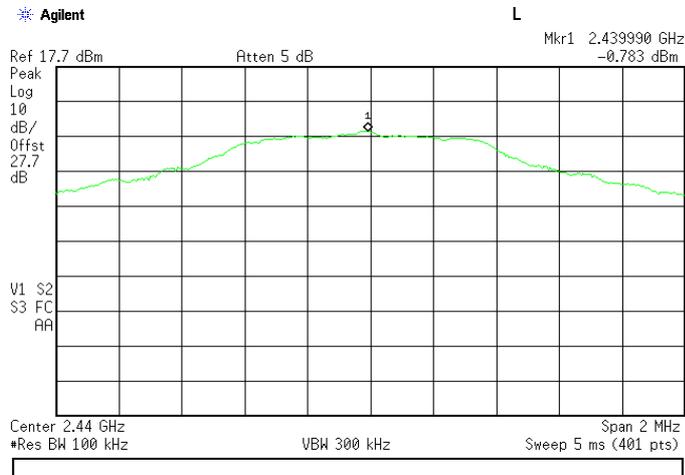


Test specification: Section 15.247(e), Peak power density			
Test procedure: ANSI C63.10 section 11.10.2			
Test mode: Compliance		Verdict: PASS	
Date(s): 08-Sep-19			
Temperature: 24.7 °C	Relative Humidity: 46 %	Air Pressure: 1009 hPa	Power: 3.7 VDC
Remarks:			

Plot 7.5.1 Peak spectral power density at low frequency



Plot 7.5.2 Peak spectral power density at mid frequency

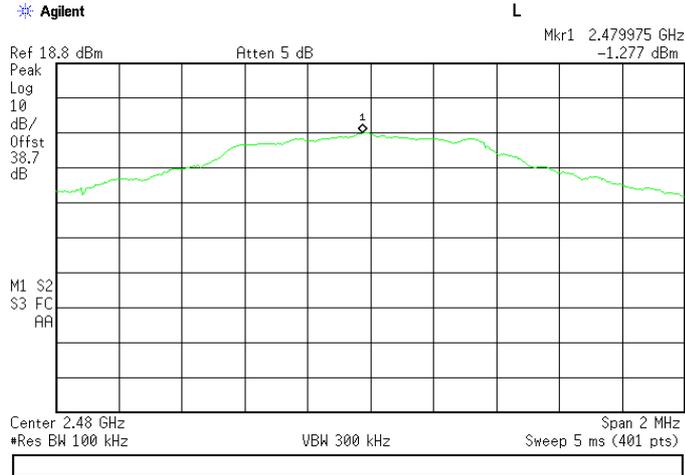




HERMON LABORATORIES

Test specification: Section 15.247(e), Peak power density			
Test procedure: ANSI C63.10 section 11.10.2			
Test mode: Compliance		Verdict: PASS	
Date(s): 08-Sep-19			
Temperature: 24.7 °C	Relative Humidity: 46 %	Air Pressure: 1009 hPa	Power: 3.7 VDC
Remarks:			

Plot 7.5.3 Peak spectral power density at high frequency





Test specification: Section 15.203, Antenna requirements			
Test procedure: Visual inspection			
Test mode: Compliance		Verdict: PASS	
Date(s): 05-Jun-19			
Temperature: 24 °C	Relative Humidity: 55 %	Air Pressure: 1011 hPa	Power: 3.7 VDC
Remarks:			

7.6 Antenna requirements

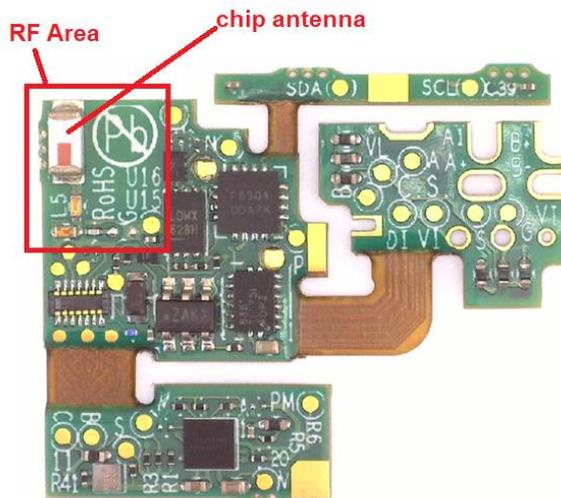
The EUT was verified for compliance with antenna requirements. A transmitter shall be designed to ensure that no antenna other than that furnished by the responsible party will be used with the device. It may be either permanently attached or employs a unique antenna connector for every antenna proposed for use with the EUT. This requirement does not apply to professionally installed transmitters.

The rationale for compliance with the above requirements was either visual inspection results or supplier declaration. The summary of results is provided in Table 7.6.1.

Table 7.6.1 Antenna requirements

Requirement	Rationale	Verdict
The transmitter antenna is permanently attached	Visual inspection	Comply
The transmitter employs a unique antenna connector	NA	
The transmitter requires professional installation	NA	

Photograph 7.6.1 Antenna assembly



**8 APPENDIX A Test equipment and ancillaries used for tests**

HL No	Description	Manufacturer	Model	Ser. No.	Last Cal./ Check	Due Cal./ Check
0337	Probe Set, Hand held, 5 probes	Electro-Metrics	EHFP-30	238	26-Jun-19	26-Jun-20
0446	Antenna, Loop, Active, 10 (9) kHz - 30 MHz	EMCO	6502	2857	24-Feb-19	24-Feb-20
1809	HygroThermometer, Min/Max Memory	Delta TRAK	13301	NA	11-Aug-19	11-Aug-20
2909	Spectrum analyzer, ESA-E, 100 Hz to 26.5 GHz	Agilent Technologies	E4407B	MY41444762	04-Apr-19	04-Apr-20
3434	Test Cable , DC-18 GHz, 1.5 m, SMA - SMA	Mini-Circuits	CBL-5FT-SMSM+	25683	15-Apr-19	15-Apr-20
3818	PSA Series Spectrum Analyzer, 3 Hz- 44 GHz	Agilent Technologies	E4446A	MY48250288	24-Apr-19	24-Apr-20
3903	Microwave Cable Assembly, 40.0 GHz, 1.5 m, SMA/SMA	Huber-Suhner	SUCOFLEX 102A	1226/2A	07-Apr-19	07-Apr-20
4011	Temp. & Humidity Meter, (-50 - +70) deg, (20 - 99)% RH	Mad Electronics	HTC-1	NA	11-Aug-19	11-Aug-20
4136	Shield Box	TESCOM CO., LTD	TC-5916A	5916A000137	24-Apr-19	24-Apr-20
4360	EMI Test Receiver, 20 Hz to 40 GHz.	Rohde & Schwarz	ESU40	100322	31-Dec-18	31-Dec-19
4933	Active Horn Antenna, 1 GHz to 18 GHz	COM-POWER CORPORATION	AHA-118	701046	06-Jan-19	06-Jan-20
4956	Active horn antenna, 18 to 40 GHz	COM-POWER CORPORATION	AHA-840	105004	25-Jan-19	25-Jan-20
5085	Attenuator, 4 dB, DC - 6 GHz, 1 W	Mini-Circuits	UNAT-4+	NA	08-Feb-19	08-Feb-20
5111	RF cable, 40 GHz, 5.5 m, K-type	Huber-Suhner	SF102EA/11SK/11SK/5500MM	502493/2EA	14-Aug-19	14-Aug-20
5288	Trilog Antenna, 25 MHz - 8 GHz, 100W	Frankonia	ALX-8000E	00809	08-Feb-19	08-Feb-22
5309	Antenna Mast, 1-4 meter, Pneumatic polarization	Dolev Ltd	FMB 1-4	NA	24-Apr-19	24-Apr-20
5311	Controller	Dolev Ltd	FC-06	FC06.1-2016-024	24-Apr-19	24-Apr-20
5376	EXA Signal Analyzer, 10 Hz - 32 GHz	Keysight Technologies	N9010B	MY57470404	18-Mar-19	18-Mar-20
5404	RF cable, 18 GHz, N-N, 6 m	Huber-Suhner	SF118/11N(x2)	500024/18	11-Aug-19	11-Aug-20
5405	RF cable, 18 GHz, N-N, 6 m	Huber-Suhner	SF118/11N(x2)	500023/118	11-Aug-19	11-Aug-20



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 dB μ V to obtain field strength in dB μ A/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 dB μ V to obtain field strength in dB μ V/m.



HL 4956: Active horn antenna
COM-POWER Corp., model: AHA-840, s/n 105004

Frequency, MHz	Measured antenna factor, dB/m
18000	5.1
18500	3.6
19000	2.2
19500	0.7
20000	0.7
20500	0.8
21000	0.5
21500	-1.3
22000	-2.1
22500	-2.0
23000	-1.6
23500	-2.9
24000	-2.3
24500	-2.6
25000	-1.8
25500	-1.2
26000	-0.5
26500	-1.2
27000	-0.1
27500	-1.0
28000	-0.7
28500	0.5

Frequency, MHz	Measured antenna factor, dB/m
29500	1.4
30000	2.9
30500	2.9
31000	2.9
31500	1.2
32000	0.7
32500	0.2
33000	-1.7
33500	-2.2
34000	2.3
34500	-1.1
35000	0.7
35500	-1.1
36000	0.1
36500	1.4
37000	3.7
37500	5.8
38000	6.6
38500	7.3
39000	6.5
39500	7.3
40000	7.1

The antenna factor shall be added to receiver reading in dB μ V to obtain field strength in dB μ V/m



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

Frequency, MHz	Antenna factor, dB/m
30	14.96
35	15.33
40	16.37
45	17.56
50	17.95
60	16.87
70	13.22
80	10.56
90	13.61
100	15.46
120	14.03
140	12.23

Frequency, MHz	Antenna factor, dB/m
160	12.67
180	13.34
200	15.40
250	16.42
300	17.28
400	19.98
500	21.11
600	22.90
700	24.13
800	25.25
900	26.35
1000	27.18

The antenna factor shall be added to receiver reading in dB μ V to obtain field strength in dB μ V/m.
above 1000 MHz

Frequency, MHz	Antenna factor, dB/m
1000	26.9
1100	28.1
1200	28.4
1300	29.6
1400	29.1
1500	30.4
1600	30.7
1700	31.5
1800	32.3
1900	32.6
2000	32.5
2100	32.9
2200	33.5
2300	33.2
2400	33.7
2500	34.6
2600	34.7
2700	34.6
2800	35.0
2900	35.5
3000	36.2
3100	36.8
3200	36.8
3300	37.0
3400	37.5
3500	38.2

Frequency, MHz	Antenna factor, dB/m
3600	38.9
3700	39.4
3800	39.4
3900	39.6
4000	39.7
4100	39.8
4200	40.5
4300	40.9
4400	41.1
4500	41.4
4600	41.3
4700	41.6
4800	41.9
4900	42.3
5000	42.7
5100	43.0
5200	42.9
5300	43.5
5400	43.6
5500	44.3
5600	44.7
5700	45.0
5800	45.0
5900	45.3
6000	45.9

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



HL 5111: RF cable
Huber-Suhner, SF102EA/11SK/11SK/5500MM, s/n 502493/2EA

Set / Applied, MHz	Measured, dB	Uncertainty, dB
100	0.70	±0.07
200	0.99	±0.08
300	1.21	±0.08
500	1.56	±0.08
1000	2.20	±0.08
1500	2.69	±0.08
2000	3.11	±0.08
2500	3.50	±0.10
3000	3.85	±0.10
3500	4.16	±0.10
4000	4.47	±0.10
4500	4.74	±0.10
5000	5.03	±0.10
5500	5.30	±0.10
6000	5.57	±0.10
6500	5.76	±0.10
7000	6.00	±0.10
7500	6.20	±0.10
8000	6.44	±0.10
8500	6.67	±0.10
9000	6.82	±0.10
9500	7.04	±0.10
10000	7.18	±0.10
10500	7.36	±0.10
11000	7.55	±0.10
11500	7.75	±0.10
12000	7.90	±0.10
12500	8.08	±0.13
13000	8.19	±0.13
13500	8.39	±0.13
14000	8.58	±0.13
14500	8.76	±0.18
15000	8.92	±0.18
15500	9.03	±0.18
16000	9.18	±0.18
16500	9.34	±0.18
17000	9.51	±0.18
17500	9.66	±0.18
18000	9.80	±0.18
18500	9.94	±0.23
19000	10.05	±0.23
19500	10.22	±0.23

Set / Applied, MHz	Measured, dB	Uncertainty, dB
20000	10.32	±0.23
20500	10.48	±0.23
21000	10.60	±0.23
21500	10.73	±0.23
22000	10.87	±0.23
22500	10.97	±0.29
23000	11.09	±0.29
23500	11.26	±0.29
24000	11.37	±0.29
24500	11.50	±0.29
25000	11.61	±0.23
25500	11.72	±0.23
26000	11.87	±0.23
26500	11.99	±0.23
27000	12.09	±0.33
27500	12.24	±0.33
28000	12.34	±0.40
28500	12.47	±0.40
29000	12.61	±0.40
29500	12.70	±0.40
30000	12.86	±0.40
30500	12.92	±0.33
31000	13.09	±0.33
31500	13.16	±0.33
32000	13.33	±0.33
32500	13.40	±0.33
33000	13.62	±0.33
33500	13.70	±0.33
34000	13.88	±0.33
34500	13.97	±0.40
35000	14.05	±0.40
35500	14.23	±0.40
36000	14.25	±0.40
36500	14.46	±0.40
37000	14.49	±0.33
37500	14.72	±0.33
38000	14.77	±0.33
38500	14.97	±0.33
39000	15.04	±0.33
39500	15.22	±0.33
40000	15.63	±0.47



10 APPENDIX C Measurement uncertainties

Expanded uncertainty at 95% confidence in Hermon Labs EMC measurements

Test description	Expanded uncertainty
Occupied bandwidth	± 8.0 %
Duty cycle, timing (Tx ON / OFF) and average factor measurements	± 1.0 %
Radiated emissions at 3 m measuring distance	
Horizontal polarization	Biconilog antenna: ± 5.3 dB Biconical antenna: ± 5.0 dB Log periodic antenna: ± 5.3 dB Double ridged horn antenna: ± 5.3 dB
Vertical polarization	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 1, 2, 15, 18 parts of Code of Federal Regulations 47 (CFR 47), Test Firm Registration Number is 927748, Designation Number is IL1001; registered by Industry Canada for electromagnetic emissions, file number IC 2186A-1 for OATS, certified by VCCI, Japan (the registration numbers are R-10808 for OATS, R-1082 for anechoic chamber, 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 15:2018
ANSI C63.10:2013

558074 D01 DTS
Meas_Guidance v05

Radio Frequency Devices.

American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

Guidance for compliance measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid System Devices operating under section 15.247 of the FCC rules



13 APPENDIX F Abbreviations and acronyms

A	ampere
AC	alternating current
A/m	ampere per meter
AM	amplitude modulation
AVRG	average (detector)
cm	centimeter
dB	decibel
dBm	decibel referred to one milliwatt
dB(μ V)	decibel referred to one microvolt
dB(μ V/m)	decibel referred to one microvolt per meter
dB(μ A)	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
μ s	microsecond
NA	not applicable
NB	narrow band
OATS	open area test site
Ω	Ohm
PM	pulse modulation
PS	power supply
ppm	part per million (10^{-6})
QP	quasi-peak
RE	radiated emission
RF	radio frequency
rms	root mean square
Rx	receive
s	second
T	temperature
Tx	transmit
V	volt
WB	wideband

END OF DOCUMENT