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## **\*Limited Report On**

Application for Grant of Equipment Authorization of the  
Hughes Network Systems

9105 Thuraya WLAN Satellite Terminal

IP Voyager and Orion IP

FCC Part 15 Subpart C §15.247

EN 300-328 V1.9.1 (2015-02)

\* Spurious Radiated Emissions

Report No. SD72113553-0216C

April 2016





**REPORT ON** Radio Testing of the  
Hughes Network Systems  
9105 Thuraya WLAN Satellite Terminal IP Voyager and Orion IP

**TEST REPORT NUMBER** SD72113553-0216C

**PREPARED FOR** Hughes Network Systems  
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Title: Commercial/Wireless EMC Lab Manager

**DATED** April 05, 2016

**Revision History**

SD72113553-0216C Hughes Network Systems 9105 Thuraya WLAN Satellite Terminal IP Voyager and Orion IP					
DATE	OLD REVISION	NEW REVISION	REASON	PAGES AFFECTED	APPROVED BY
04/05/2016	Initial Release				Juan M. Gonzalez



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## **SECTION 1**

### **REPORT SUMMARY**

Radio Testing of the  
Hughes Network Systems  
9105 Thuraya WLAN Satellite Terminal  
IP Voyager and Orion IP



## 1.1 INTRODUCTION

The information contained in this report is intended to show Limited verification of the Hughes Network Systems 9105 Thuraya WLAN Satellite Terminal IP Voyager and Orion IP to the requirements of FCC Part 15 Subpart C §15.247 and ETSI EN 300 328 V1.9.1 (Radiated Spurious Emissions Only).

Objective	To perform Radio Testing to determine the Equipment Under Test's (EUT's) compliance with the Test Specification, for the series of tests carried out.
Manufacturer	Hughes Network Systems
Model Name(s)	IP Voyager and Orion IP
Model Number(s)	9105
FCC ID Number	Contains FCC ID: XM5-SMG2SMT
IC Number	N/A
Serial Number(s)	357932-01-020007-2
Number of Samples Tested	1
Test Specification/Issue/Date	<ul style="list-style-type: none"> <li>FCC Part 15 Subpart C §15.247 (October 1, 2015).</li> <li>558074 D01 DTS Meas Guidance v03r02 June 05, 2014 (Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247)</li> <li>ETSI EN 300 328 V1.9.1 (2015-02)</li> </ul>
Start of Test	February 06, 2016
Finish of Test	February 06, 2016
Name of Engineer(s)	Ivan Retana
Related Document(s)	SMG2SMT-xx Spectrum report GTSE14080140802 WIFI



## 1.2 BRIEF SUMMARY OF RESULTS

A brief summary of the tests carried out in accordance with FCC Part 15 Subpart C §15.247 and with ETSI EN 300 328 v1.9.1 (2015-02) is shown below.

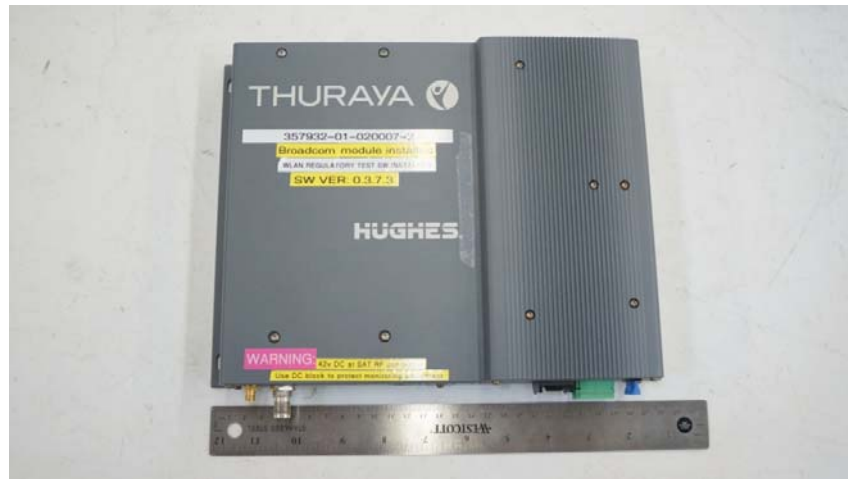
Report Section	§15.247 Spec Clause	Test Description	Result	Comments/ Base Standard
2.1	§15.247(d)	Spurious Radiated Emissions	Compliant	

Report Section	300-328 Standard Section	300-328 Spec Clause	Test Description	Result	Comments/ Base Standard
2.2	4.3.1.10 or 4.3.2.9	5.3.10	Unwanted emissions in the spurious domain	Compliant	

### 1.3 PRODUCT INFORMATION

#### 1.3.1 Technical Description

The Equipment Under Test (EUT) was a Hughes Network Systems Thuraya WLAN Satellite Terminal as shown in the photograph below. EUT is available in two configurations, IP Voyager (Land Mobile) and Orion IP (Maritime), the Thuraya WLAN Satellite Terminal, model 9105, allows the user to send and receive IP traffic via Ethernet and 802.11 b/g/n Wi-Fi interfaces over the Thuraya satellite network. The IP Voyager configuration is installed in a land mobile vehicle; the Orion IP configuration is installed in a maritime vessel, powered by 12/24VDC from the host vehicle or maritime vessel. The modem unit with WLAN antenna is common to both configurations, the difference being in the connected satellite antenna which is specific for the installed vehicle or maritime vessel purpose.



**Equipment Under Test Model 9105**





**WLAN Antenna**



**HN221 – Land Mobile**

**For Land Mobile operation, the 9105 is provided with HN221 and designated Thuraya IP Voyager**



**HN321 – Maritime**

**For Maritime operation, the 9105 is provided with HN321 and designated Thuraya Orion IP**



### 1.3.2 EUT General Description

EUT Description	Thuraya WLAN Satellite Terminal
Model Name(s)	IP Voyager and Orion IP
Model Number(s)	9105
Rated Voltage	12/24VDC from vehicle or maritime vessel battery
Mode Verified	802.11 b (20MHz)
Capability	802.11 b/g/n WLAN (DTS) 2.4GHz band (20MHz for 802.11n) and 1.6GHz Mobile Satellite Service
Frequency Range	2412 MHz to 2462 MHz in the 2400 MHz to 2483.5 MHz Band
Number of Operating Frequencies	11 (b, g, n HT20)
Channels Verified (b, g, n HT20)	Channel 1 (Low Channel 2412 MHz)
Channels Verified(n HT40)	-
Modulation Used	DSSS

### 1.3.3 Antenna Details

Model	HG2403RD
Manufacturer	L-com Global Connectivity
Antenna Type	Rubber Duck Antenna
Antenna Gain	3 dBi
EUT Antenna Connector	Reverse Polarity SAM Plug (RP-SMA Plug)
Maximum Dimensions	137mm (Length) x 13mm (Diameter)



## 1.4 EUT TEST CONFIGURATION

### 1.4.1 Test Configuration Description

Test Configuration	Description
Default	The EUT was set on continuous transmission modulated in low channel per worst case scenario.

### 1.4.2 EUT Exercise Software

“Perl Command” software provided by the client was used to program the EUT. A file containing commands to change channels and data rates. Specific channel/modulation combination is copied from this file and transferred to the test software, once executed the EUT will transmit at max power (default setting if TX) at that channel.

### 1.4.3 Support Equipment and I/O cables

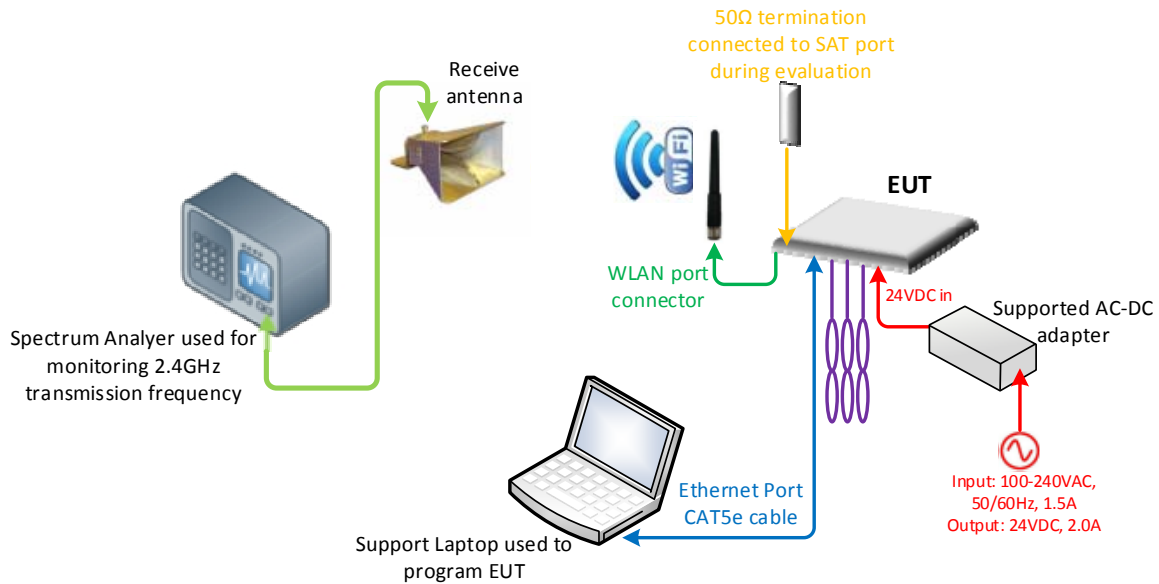
Manufacturer	Equipment/Cable	Description
Acer	Laptop	Aspire E1 Series, Model: V5WE2
-	CAT5e (Laptop to EUT)	2.1m unshielded RJ45 connector

### 1.4.4 Worst Case Configuration

Worst-case configuration used in this test report as per previous related document measurements:

Mode	Channel	Data Rate
802.11b	1 (Low Channel)	1 Mbps

#### 1.4.5 Simplified Test Configuration Diagram



**Not To Scale – Illustration Purpose Only**  
Objects may not represent actual image of original equipment/s or set-up.



## 1.5 DEVIATIONS FROM THE STANDARD

No deviations from the applicable test standards or test plan were made during testing.

## 1.6 MODIFICATION RECORD

Description of Modification	Modification Fitted By	Date Modification Fitted
Serial Number 357932-01-020007-2		
N/A	—	—

The table above details modifications made to the EUT during the test programme. The modifications incorporated during each test (if relevant) are recorded on the appropriate test pages.

## 1.7 TEST METHODOLOGY

All measurements contained in this report were conducted with ANSI C63.4-2014, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9 kHz to 40 GHz.

For conducted and radiated emissions the equipment under test (EUT) was configured to measure its highest possible emission level. This level was based on the maximized cable configuration from exploratory testing per ANSI C63.4-2014. The test modes were adapted according to the Operating Instructions provided by the manufacturer/client.

## 1.8 TEST FACILITY LOCATION

### 1.8.1 TÜV SÜD America Inc. (Mira Mesa)

10040 Mesa Rim Road, San Diego, CA 92121-2912 (32.901268,-117.177681). Phone: 858 678 1400 FAX: 858-546 0364

### 1.8.2 TÜV SÜD America Inc. (Rancho Bernardo)

16530 Via Esprillo, San Diego, CA 92127-1708 (33.018644,-117.092409). Phone: 858 678 1400 Fax: 858 546 0364.



## **1.9 TEST FACILITY REGISTRATION**

### **1.9.1 FCC – Registration No.: US1146**

TUV SUD America Inc. (San Diego), is an accredited test facility with the site description report on file and has met all the requirements specified in §2.948 of the FCC rules. The acceptance letter from the FCC is maintained in our files and the Registration is US1146.

### **1.9.2 Industry Canada (IC) Registration No.: 3067A**

The 10m Semi-anechoic chamber of TUV SUD America Inc. (San Diego) has been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing with Registration No. 3067A.



## **SECTION 2**

### **TEST DETAILS**

Radio Testing of the  
Hughes Network Systems  
9105 Thuraya WLAN Satellite Terminal  
IP Voyager and Orion IP



## **2.1 SPURIOUS RADIATED EMISSIONS**

### **2.1.1 Specification Reference**

Part 15 Subpart C §15.247(d)

### **2.1.2 Standard Applicable**

(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

### **2.1.3 Equipment Under Test and Modification State**

Serial No: 357932-01-020007-2 / Default Test Configuration

### **2.1.4 Date of Test/Initial of test personnel who performed the test**

February 06, 2016 / IR

### **2.1.5 Test Equipment Used**

The major items of test equipment used for the above tests are identified in Section 3.1.

### **2.1.6 Environmental Conditions**

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	24.8°C
Relative Humidity	17.5%
ATM Pressure	99.9 kPa

### **2.1.7 Additional Observations**

- This is a radiated test. The spectrum was searched from 30MHz to the 10<sup>th</sup> harmonic.
- There are no emissions found that do not comply to the restricted bands defined in FCC Part 15 Subpart C, 15.205 or Part 15.247(d).
- Only the considered worst case WLAN configuration (802.11b, Low Channel, 1.0 Mbps) presented for radiated emissions below 1GHz. There are no significant differences in emissions between all modes below 1GHz.





- Only noise floor measurements observed above 18GHz.
- Measurement was done using EMC32 automated software. Reported level is the actual level with all the correction factors factored in. Correction Factor column is for informational purposes only. See Section 2.7.8 for sample computation.

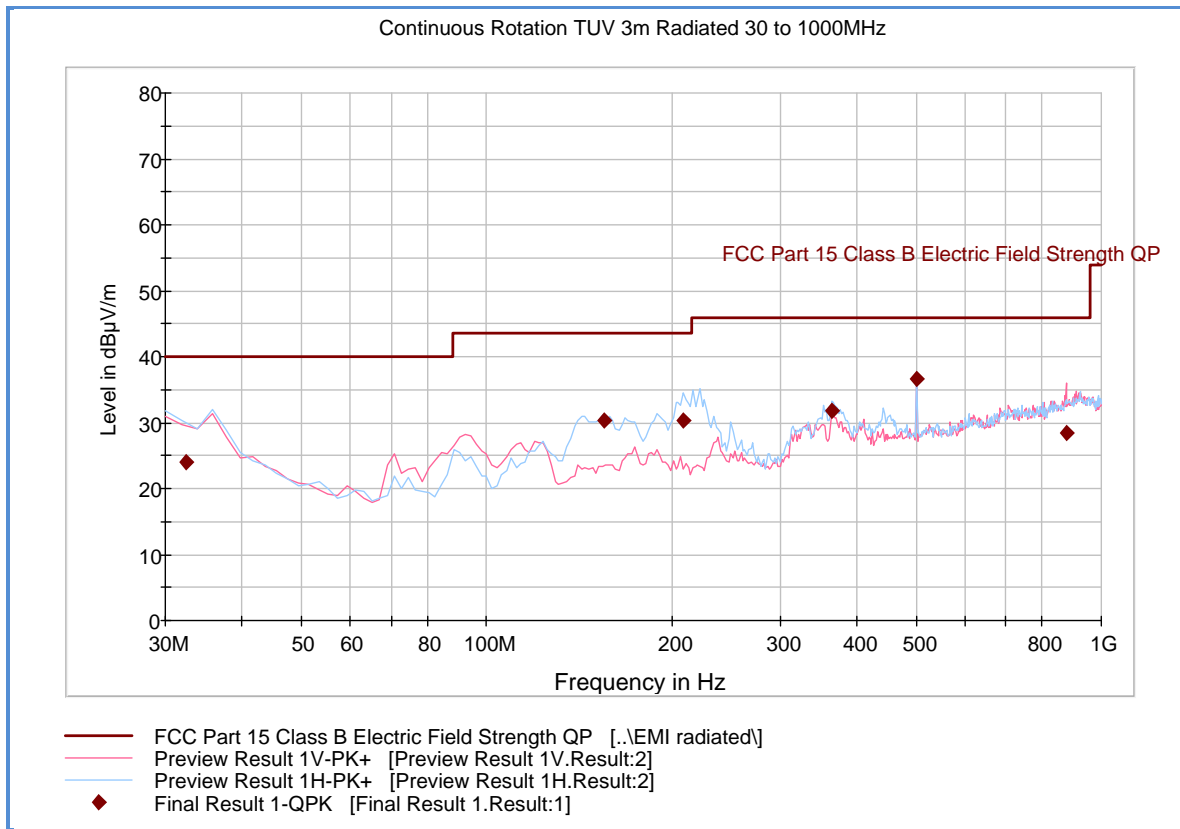
### 2.1.8 Sample Computation (Radiated Emission)

Measuring equipment raw measurement (db $\mu$ V) @ 30 MHz			24.4
Correction Factor (dB)	Asset# 1066 (cable)	0.3	-12.6
	Asset# 1172 (cable)	0.3	
	Asset# 1016 (preamplifier)	-30.7	
	Asset# 1175(cable)	0.3	
	Asset# 1002 (antenna)	17.2	
Reported QuasiPeak Final Measurement (db $\mu$ V/m) @ 30MHz			11.8

### 2.1.9 Test Results

See attached plots.

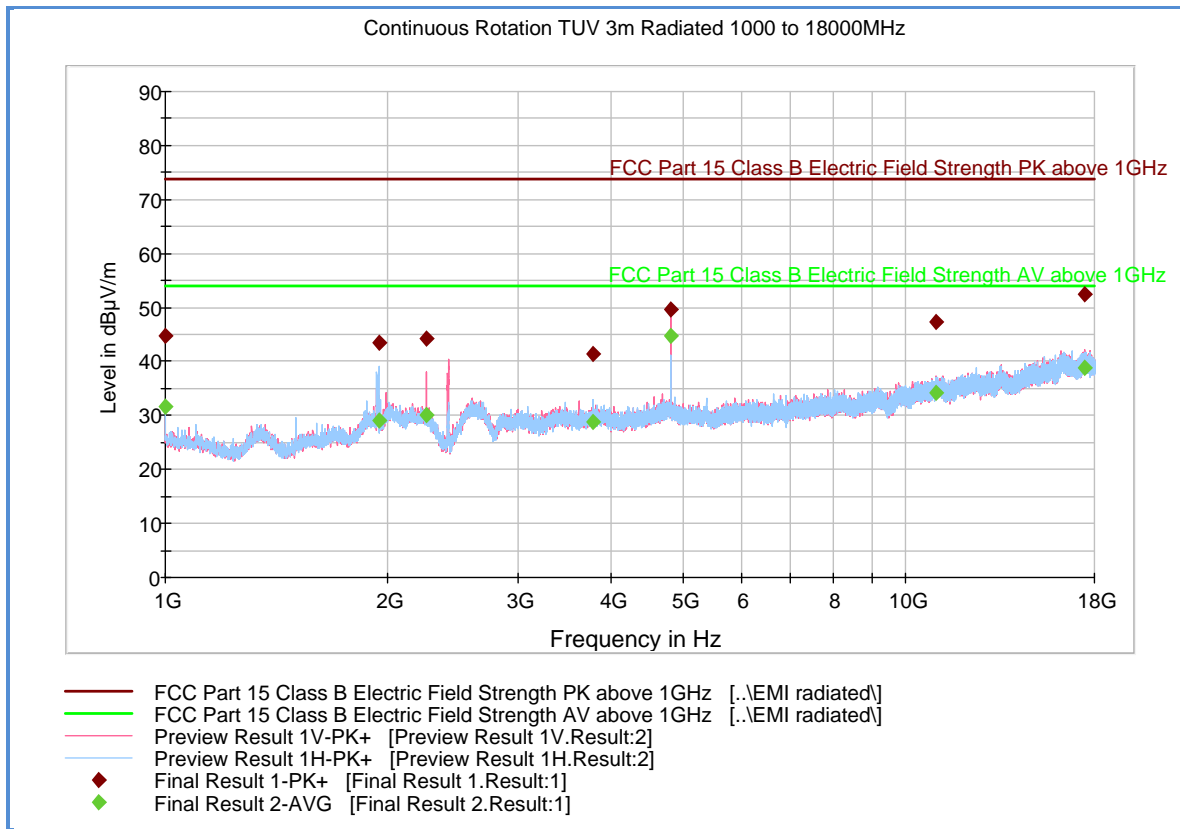
## 2.1.10 Test Results Below 1GHz (WLAN Worst Case Configuration)



### Quasi Peak Data

Frequency (MHz)	QuasiPeak (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
32.471663	24.0	1000.0	120.000	377.0	H	89.0	-7.0	16.0	40.0
155.008818	30.3	1000.0	120.000	109.0	H	133.0	-12.8	13.2	43.5
208.877675	30.4	1000.0	120.000	100.0	H	112.0	-10.9	13.1	43.5
364.988697	31.7	1000.0	120.000	100.0	H	314.0	-4.6	14.3	46.0
500.020842	36.6	1000.0	120.000	100.0	H	164.0	-1.6	9.4	46.0
876.695070	28.4	1000.0	120.000	250.0	V	123.0	5.4	17.6	46.0

## 2.1.11 Test Results Above 1GHz (802.11b mode\_Low Channel\_1.0 Mbps)



## Peak Data

Frequency (MHz)	MaxPeak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1000.000000	44.7	1000.0	1000.000	177.0	H	121.0	-7.9	29.2	73.9
1941.033333	43.6	1000.0	1000.000	336.0	H	85.0	-1.5	30.3	73.9
2251.766667	44.2	1000.0	1000.000	162.0	V	54.0	-1.7	29.7	73.9
3779.500000	41.5	1000.0	1000.000	177.0	H	85.0	1.4	32.4	73.9
4824.066667	49.5	1000.0	1000.000	203.0	V	38.0	2.9	24.4	73.9
11019.066667	47.3	1000.0	1000.000	200.0	V	46.0	11.7	26.6	73.9
17497.033333	52.4	1000.0	1000.000	400.0	V	118.0	18.0	21.5	73.9

## Average Data

Frequency (MHz)	Average (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1000.000000	31.6	1000.0	1000.000	177.0	H	121.0	-7.9	22.3	53.9
1941.033333	29.0	1000.0	1000.000	336.0	H	85.0	-1.5	24.9	53.9
2251.766667	30.1	1000.0	1000.000	162.0	V	54.0	-1.7	23.8	53.9
3779.500000	28.7	1000.0	1000.000	177.0	H	85.0	1.4	25.2	53.9
4824.066667	44.7	1000.0	1000.000	203.0	V	38.0	2.9	9.2	53.9
11019.066667	34.1	1000.0	1000.000	200.0	V	46.0	11.7	19.8	53.9
17497.033333	38.8	1000.0	1000.000	400.0	V	118.0	18.0	15.1	53.9

**Test Notes:** No significant emissions observed above 6 GHz. Measurements above 6 GHz are noise floor figures.



## **2.2 UNWANTED EMISSIONS IN THE SPURIOUS DOMAIN**

### **2.2.1 Specification Reference**

Clause 5.3.10

### **2.2.2 Standard Applicable**

#### **4.3.2.9.2 Definition**

Transmitter unwanted emissions in the spurious domain are emissions outside the allocated band and outside the Out-of-band Domain as indicated in the figure of Section 2.4 of this test report when the equipment is in Transmit mode

#### **4.3.2.9.3 Limit**

The transmitter unwanted emissions in the spurious domain shall not exceed the values given in the following table:

### **2.2.3 Equipment Under Test and Modification State**

Serial No: 357932-01-020007-2 / Default Test Configuration

### **2.2.4 Date of Test/Initial of test personnel who performed the test**

February 06, 2016/IR

### **2.2.5 Test Equipment Used**

The major items of test equipment used for the above tests are identified in Section 3.1.

### **2.2.6 Environmental Conditions**

Test performed at TÜV SÜD America Inc. Rancho Bernardo facility

Ambient Temperature	25.2°C
Relative Humidity	41.2%
ATM Pressure	99.4kPa

### **2.2.7 Additional Observations**

- The test shall be performed on normal environmental conditions only.
- The level of spurious emissions was measured as the effective radiated power when radiated by the cabinet or structure of the equipment (cabinet radiation).
- Test performed on Low channel only (non-hopping).
- 12 dB noise floor sensitivity should be maintained during the test.
- RBW is set to 100 kHz (30 MHz to 1 GHz).
- VBW is set to 300 kHz.
- Detector is Peak
- Trace Mode is Max Hold
- Sweep Points is set to 19400.
- Sweep time = 2X EUT transmit burst/100 kHz step (for EUT not transmitting 100% duty cycle otherwise Sweep Time is set to Auto).

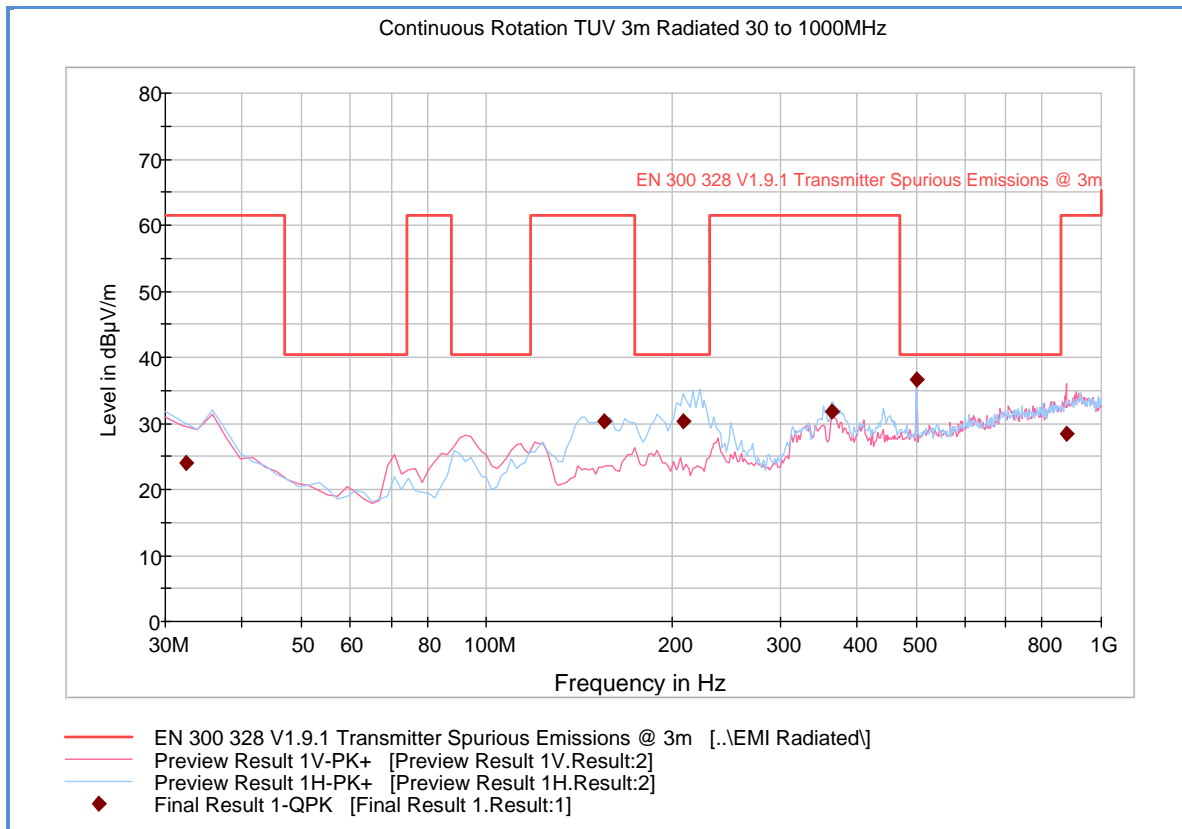


- For prescan from 1GHz to 12.75 GHz, the following settings will be used:
- RBW is set to 1MHz.
- VBW is set to 3 MHz.
- Detector is Peak
- Trace Mode is Max Hold
- Sweep Points is set to 23500.
- Sweep time = 2X EUT transmit burst/1 MHz step (for EUT not transmitting 100% duty cycle).
- For emissions within 6 dB of the limit during prescans, the level will be measured using the following settings, however no such emissions observed:
  1. Measurement mode is Time Domain Power.
  2. Frequency of the emission identified during the pre-scan.
  3. Zero Span.
  4. Sweep is single.
  5. Sweep time is > 120 % of the duration of the longest burst detected during the measurement of the RF Output Power.
  6. Sweep points set to 30000.
  7. Trigger is Video.
  8. Detector is RMS.

#### **2.2.8 Test Results**

See attached plots and tables. EUT complies.

## 2.2.9 Test Results Below 1GHz (Low Channel)



### Quasi Peak Data

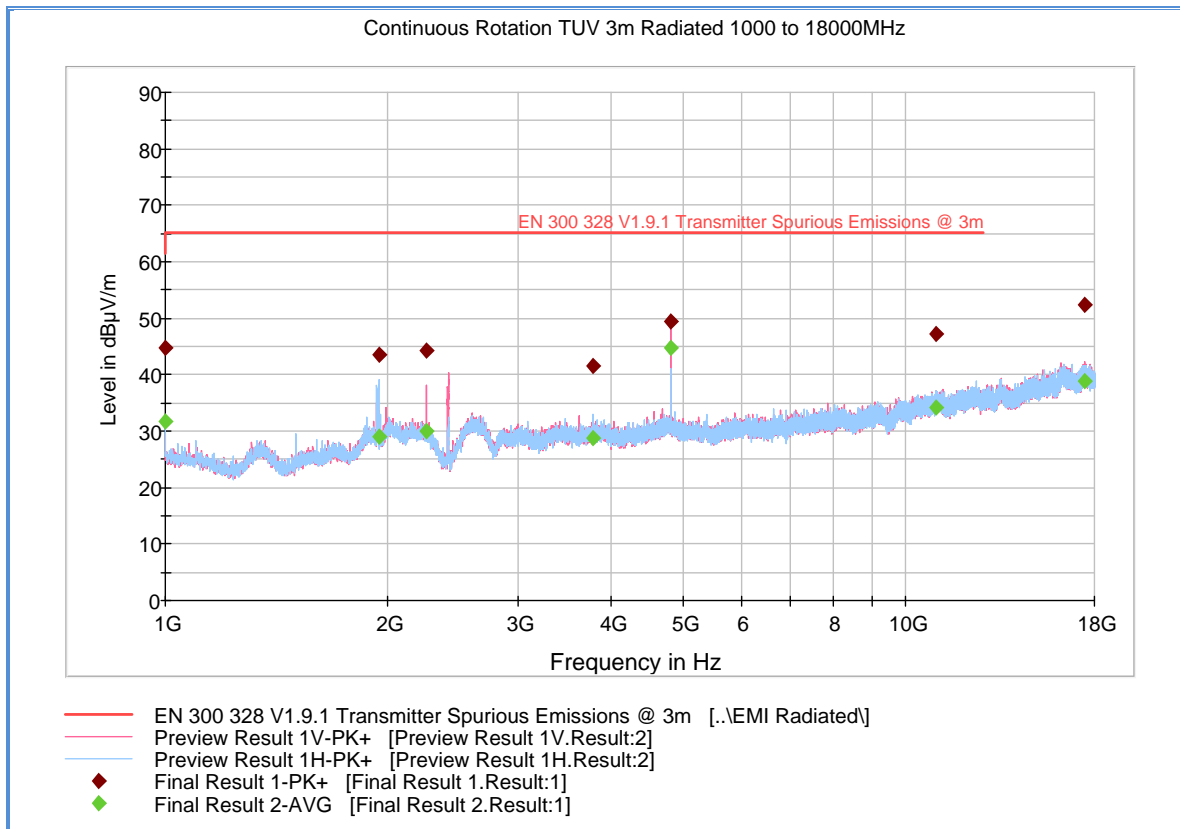
Frequency (MHz)	Quasi Peak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
32.471663	24.0	1000.0	120.000	377.0	H	89.0	-7.0	37.4	61.4
155.008818	30.3	1000.0	120.000	109.0	H	133.0	-12.8	31.1	61.4
208.877675	30.4	1000.0	120.000	100.0	H	112.0	-10.9	10.0	40.4
364.988697	31.7	1000.0	120.000	100.0	H	314.0	-4.6	29.7	61.4
500.020842	36.6	1000.0	120.000	100.0	H	164.0	-1.6	3.8	40.4
876.695070	28.4	1000.0	120.000	250.0	V	123.0	5.4	33.0	61.4

### Substitution Data

Frequency (MHz)	Field Strength @ 3 meters (dBµV/m)	Cable Loss (dB)	Substitution Antenna Gain (dBi)	Signal Generator Level (dBm)	Substitution Data SGL+AG-CL (dBm)	Limit (dBm)	Compliance (Margin in dB)
500.020842	36.6	-1.7	6.1	-63.0288	-58.628	-54	4.628

**Test Notes:** All emissions within 6dB of the limit will be proven by substitution method.

## 2.2.10 Test Results Above 1GHz (Low Channel)



### Peak Data

Frequency (MHz)	Max Peak (dBµV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBµV/m)
1000.000000	44.7	1000.0	1000.000	177.0	H	121.0	-7.9	20.5	61.4
1941.033333	43.6	1000.0	1000.000	336.0	H	85.0	-1.5	21.7	65.2
2251.766667	44.2	1000.0	1000.000	162.0	V	54.0	-1.7	21.0	65.2
3779.500000	41.5	1000.0	1000.000	177.0	H	85.0	1.4	23.8	65.2
4824.066667	49.5	1000.0	1000.000	203.0	V	38.0	2.9	15.7	65.2
11019.06666	47.3	1000.0	1000.000	200.0	V	46.0	11.7	18.0	65.2
17497.03333	52.4	1000.0	1000.000	400.0	V	118.0	18.0	12.8	65.2

### Substitution Data

Frequency (MHz)	Field Strength @ 3 meters (dBµV/m)	Cable Loss (dB)	Substitution Antenna Gain (dBi)	Signal Generator Level (dBm)	Substitution Data SGL+AG-CL (dBm)	Limit (dBm)	Compliance (Margin in dB)

**Test Notes:** All emissions within 6dB of the limit will be proven by substitution method, however no such emission observed using Quasi-Peak detector.



### **SECTION 3**

#### **TEST EQUIPMENT USED**





### 3.1 TEST EQUIPMENT USED

List of absolute measuring and other principal items of test equipment.

ID Number (SDGE/SDRB)	Test Equipment	Type	Serial Number	Manufacturer	Cal Date	Cal Due Date
Radiated Test Setup						
1040	EMI Test Receiver	ESIB40	100292	Rhode & Schwarz	09/29/15	09/29/16
1033	Bilog Antenna	3142C	00044556	EMCO	09/25/14	09/25/16
1016	Pre-amplifier	PAM-0202	187	PAM	12/15/15	12/15/16
7575	Double-ridged waveguide horn antenna	3117	00155511	EMCO	04/27/15	04/27/16
8628	Pre-amplifier	QLJ 01182835-JO	8986002	QuinStar Technologies Inc.	01/11/16	01/11/17
Miscellaneous						
7619	Barometer/Temperature/Hu midity Transmitter	iBTHX-W	15250268	Omega	10/19/15	10/19/16
	Test Software	EMC32	V8.53	Rhode & Schwarz	N/A	

### 3.2 MEASUREMENT UNCERTAINTY

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

#### 3.2.1 Radiated Emission Measurements (Below 1GHz)

Contribution		Probability Distribution Type	Probability Distribution $x_i$	Standard Uncertainty $u(x_i)$	$[u(x_i)]^2$
1	Receiver/Spectrum Analyzer	Rectangular	0.45	0.26	0.07
2	Cables	Rectangular	0.50	0.29	0.08
3	Preamp	Rectangular	0.50	0.29	0.08
4	Antenna	Rectangular	0.75	0.43	0.19
5	Site	Rectangular	3.89	2.25	5.04
6	EUT Setup	Rectangular	1.00	0.58	0.33
Combined Uncertainty ( $u_c$ ):					2.41
Coverage Factor (k):					2
Expanded Uncertainty:					4.82

#### 3.2.2 Radiated Emission Measurements (Above 1GHz)

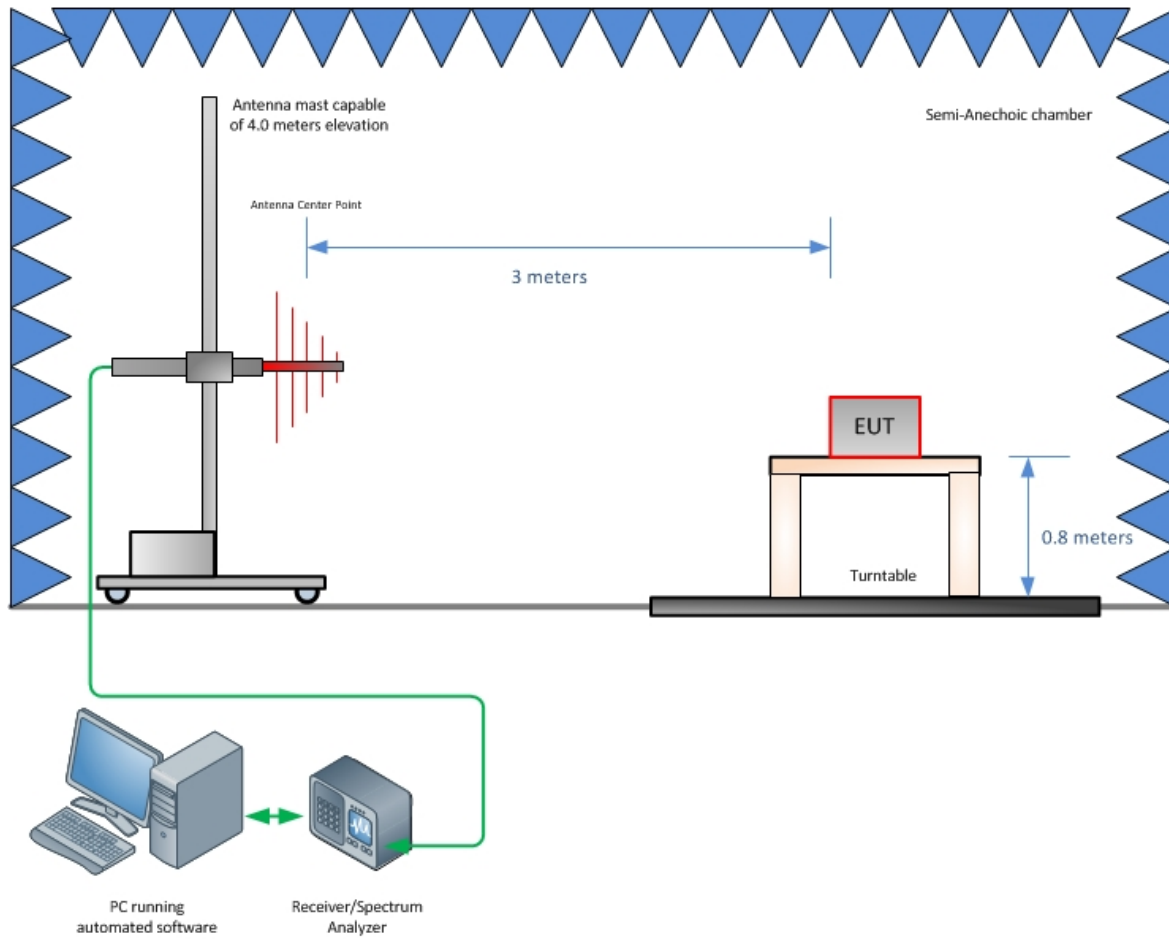
Contribution		Probability Distribution Type	Probability Distribution $x_i$	Standard Uncertainty $u(x_i)$	$[u(x_i)]^2$
1	Receiver/Spectrum Analyzer	Rectangular	0.57	0.33	0.11
2	Cables	Rectangular	0.70	0.40	0.16
3	Preamp	Rectangular	0.50	0.29	0.08
4	Antenna	Rectangular	0.37	0.21	0.05
5	Site	Rectangular	3.89	2.25	5.04
6	EUT Setup	Rectangular	1.00	0.58	0.33
Combined Uncertainty ( $u_c$ ):					2.40
Coverage Factor (k):					2
Expanded Uncertainty:					4.81



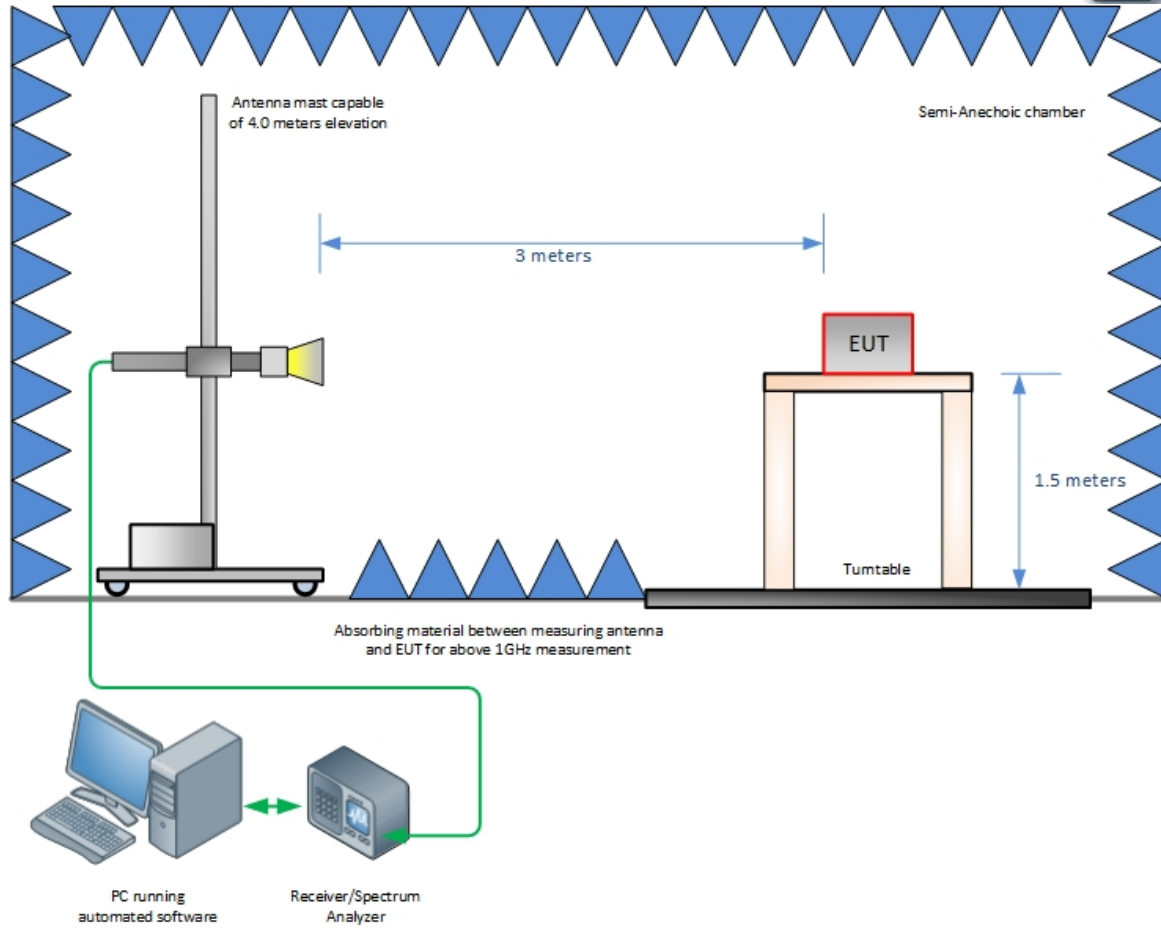
## **SECTION 4**

### **DIAGRAM OF TEST SETUP**

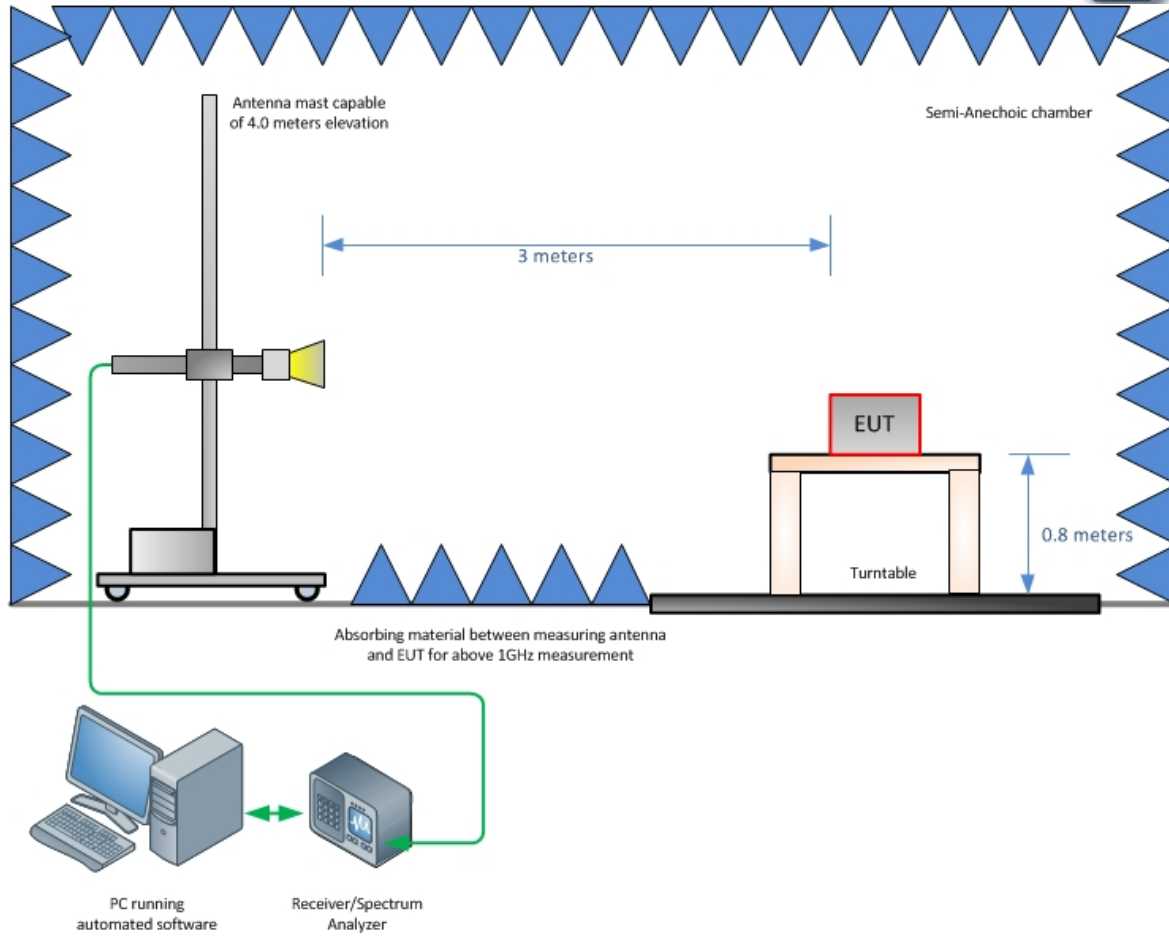
#### 4.1 TEST SETUP DIAGRAM



**Radiated Emission Test Setup (Below 1GHz)**



**Radiated Emission Test Setup (Above 1GHz – EN300 328)**



**Radiated Emission Test Setup (Above 1GHz - FCC)**



## **SECTION 5**

### **ACCREDITATION, DISCLAIMERS AND COPYRIGHT**



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