



Test Report Number PR066693.PSL

Testing of
MPU5, RF-2100 Module, RF-4100 Module, PTT and Embedded Module
Board

PREPARED FOR: Persistent Systems
303 5th Avenue Suite 306
New York, NY 10016

PREPARED BY: National Technical Systems
36 Gilbert Street South
Tinton Falls, NJ 07701



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693env.PSL

Revision 0

REVISION PAGE

Rev. #	Date	Page #	Para. #	Description
0	2/15/19			Initial Release



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693env.PSL
Revision 0

SIGNATURES

Prepared By: 
Brian Pasznik, Test Technician

Reviewed By: 
Mark Betts, Program Manager

Approved By: 
Mark Betts, Quality Manager



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693env.PSL
Revision 0

TABLE OF CONTENTS

TABLE OF CONTENTS.....	4
1.0 PURPOSE.....	6
1.1 Test Program Sequence	6
1.1.1. Receipt Inspection	6
1.1.2. Functional Test.....	6
1.1.3. Testing.....	7
2.0 APPLICABLE DOCUMENTS.....	7
2.1 NTS Quotation Number OP0222985	7
2.2 Persistent Systems PO Number 15930	7
2.3 NTS Project Number PR066693	7
2.4 MIL-STD-810G	7
2.5 NTS Corporate Quality Policy Manual	7
3.0 TEST ITEMS	7
3.1 Description	8
3.2 Security Classification of Items	8
4.0 TEST DATE(S) AND EQUIPMENT	9
4.1 Test Date(s).....	9
4.2 Test Equipment	9
5.0 GENERAL TEST REQUIREMENTS	9
5.1 Test Facility	9
5.2 Test Sample Configuration.....	10
5.3 Functional Pass/Fail Criteria	10
6.0 TEST PROCEDURE	11
6.1 High Temperature Storage	11
6.1.1. Requirement.....	11
6.1.2. Test Procedure	11
6.1.3. Comments.....	12
6.2 Humidity	14
6.2.1. Requirement.....	14
6.2.2. Test Procedure	14
6.2.3. Comments.....	14
6.3 Blowing Dust.....	17
6.3.1. Requirement	17
6.3.2. Test Procedure	17
6.3.3. Comments.....	17
6.4 Vibration	21



6.4.1.	Requirement	21
6.4.2.	Test Procedure	21
6.4.3.	Comments	21
6.5	Blowing Rain	29
6.5.1.	Requirement	29
6.5.2.	Test Procedure	29
6.5.3.	Comments	29
6.6	Icing	34
6.6.1.	Requirement	34
6.6.2.	Test Procedure	34
6.6.3.	Comments	34
6.7	Altitude (Storage)	39
6.7.1.	Requirement	39
6.7.2.	Test Procedure	39
6.7.3.	Comments	39
6.8	Low Temperature (Storage)	42
6.8.1.	Requirement	42
6.8.2.	Test Procedure	42
6.8.3.	Comments	42
6.9	Low Temperature (Operational)	44
6.9.1.	Requirement	44
6.9.2.	Test Procedure	44
6.9.3.	Comments	44



1.0 PURPOSE

This test report describes the methods used for the Environmental and Dynamic Testing of the Equipment Under Test tested for Persistent Systems This test program was conducted to determine the ability of the Equipment Under Test to successfully satisfy the requirements specified in the references listed in section 2.0 of this report.

1.1 Test Program Sequence

1.1.1. Receipt Inspection

Upon receipt at NTS, the Equipment Under Test was visually inspected to ensure there had been no damage due to shipping/handling, and to confirm that the test model number and serial number coincide with those on the packing list.
No discrepancies or damage was observed.

1.1.2. Functional Test

The Equipment Under Test was checked for functionality before, during and after testing as applicable.

1.1.3. Testing

Tests and Test Methods

Test	Standard/Test Method	Test Result
High Temperature Operation	MIL-STD-810G Method 501.5 Procedure I	Pass
Humidity Aggravated	MIL-STD-810G Method 507.5 Procedure II	Pass
Blowing Dust	MIL-STD-810G Method 510.5, Procedure I, 71C	Pass
Vibration	MIL-STD-810G Method 514.6 Procedure I	Pass
Blowing Rain	MIL-STD-810G Method 506.5 Procedure I	Pass
Icing	MIL-STD-810G Method 521.3, 6mm-13mm	Pass
Low Temperature Operation	MIL-STD-810G Method 502.5, Procedure II, -20C	Pass
Low Temperature Storage	MIL-STD-810G Method 502.5, Procedure I, -55C	Pass
Altitude	MIL-STD-810G Method 500.6, Procedure I, Storage Altitude, 60kft	Pass

2.0 APPLICABLE DOCUMENTS

- 2.1 NTS Quotation Number OP0222985**
- 2.2 Persistent Systems PO Number 15930**
- 2.3 NTS Project Number PR066693**
- 2.4 MIL-STD-810G**
- 2.5 NTS Corporate Quality Policy Manual**
Revision 9, Dated September 20, 2018.

3.0 TEST ITEMS



3.1 Description

Item #	Qty	Description	Part #	Serial #
1	1	MPU5 + RF-2100 Module	WR-5100	28147, 2410, B01694
2	1	PTT	WR-PTT-01	00324, 00938
3	1	MPU5 + RF-4100 Module	WR5100	25574, B-76, B014704
4	1	*Embedded Module Board	N/A	0-EM40- 0000187

*Was not tested for Icing, Blowing Rain, Blowing Dust and Humidity.

3.2 Security Classification of Items

None

4.0 TEST DATE(S) AND EQUIPMENT

4.1 Test Date(s)

Test Performed	Test Date(s)	Test Results
MIL-STD-810G Method 521.3, Icing, 6mm-13mm	8/9/17	Pass
MIL-STD-810G Method 506.5 Procedure I, Blowing Rain	9/6/17	Pass
MIL-STD-810G Method 514.6 Procedure I, Vibration	8/23/17- 8/24/17	Pass
MIL-STD-810G Method 500.6, Procedure I, Storage Altitude, 60kft (4 units)	10/2/17	Pass
MIL-STD-810G Method 502.5, Procedure I, -55C (4 units)	10/5/17	Pass
MIL-STD-810G Method 507.5, Procedure II	12/8/17	Pass
MIL-STD-810G Method 510.5, Procedure I, 71C	12/13/17	Pass
MIL-STD-810G Method 502.5, Procedure II, Low Temp Operational -20C	7/26/18	Pass
MIL-STD-810G Method 502.5, Procedure I, Low Temp Storage -55C	10/5/17	Pass
MIL-STD-810G Method 501.5, Procedure I, High Temp Storage, 85C	7/26/18- 8/2/18	Pass

4.2 Test Equipment

A list of the test equipment to be used is included in Appendix A of this procedure. This equipment is calibrated according to ISO 10012-1 and calibration is traceable to the National Institute of Standards and Technology (NIST). Calibration records are maintained on file at National Technical Systems.

5.0 GENERAL TEST REQUIREMENTS

5.1 Test Facility

The Equipment Under Test was tested for Environmental and Dynamic tests at NTS test facilities located in Tinton Falls, NJ.



5.2 Test Sample Configuration

The test item configurations are documented in the photographs contained in this test report.

5.3 Functional Pass/Fail Criteria

The Equipment Under Test shall successfully satisfy the requirements specified in the references listed in Section 2.0 of this procedure. The Equipment Under Test will be checked for functionality before, during and after testing as applicable.



6.0 TEST PROCEDURE

6.1 High Temperature Storage

6.1.1 Requirement

The Equipment Under Test shall be tested for High Temperature Storage using MIL-STD-810G, Method 501.5 Procedure I at 85°C maximum.

6.1.2 Test Procedure

The Equipment Under Test was placed into the temperature chamber in operational configuration.

The chamber temperature was adjusted to 35°C.

After temperature stabilization occurred, the following profile was run for 7 cycles (adjusted for 85°C).

The chamber was brought back to ambient temperature.

The Equipment Under Test was visually examined for damage and operated.

TABLE 501.4-II. High temperature cycles, climatic category - Hot.¹

Time of Day	Ambient Air Conditions		Induced Conditions	
	Temperature ² °C (°F)	Humidity ³ % RH	Temperature ² °C (°F)	Humidity ³ % RH
0100	35 (95)	6	35 (95)	6
0200	34 (94)	7	34 (94)	7
0300	34 (93)	7	34 (94)	7
0400	33 (92)	8	33 (92)	7
0500	33 (91)	8	33 (92)	7
0600	32 (90)	8	33 (91)	7
0700	33 (91)	8	36 (97)	5
0800	35 (95)	6	40 (104)	4
0900	38 (101)	6	44 (111)	4
1000	41 (106)	5	51 (124)	3
1100	43 (110)	4	56 (133)	2
1200	44 (112)	4	63 (145)	2
1300	47 (116)	3	69 (156)	1
1400	48 (118)	3	70 (158)	1
1500	48 (119)	3	71 (160)	1
1600	49 (120)	3	70 (158)	1
1700	48 (119)	3	67 (153)	1
1800	48 (118)	3	63 (145)	2
1900	46 (114)	3	55 (131)	2
2000	42 (108)	4	48 (118)	3
2100	41 (105)	5	41 (105)	5
2200	39 (102)	6	39 (103)	6
2300	38 (100)	6	37 (99)	6
2400	37 (98)	6	35 (95)	6

¹ These cycles were derived from AR 70-38, 1 August 1979, and essentially conform to those in MIL-HDBK-310 and NATO STANAG 2895. These values represent typical conditions throughout a typical day in this climatic category.

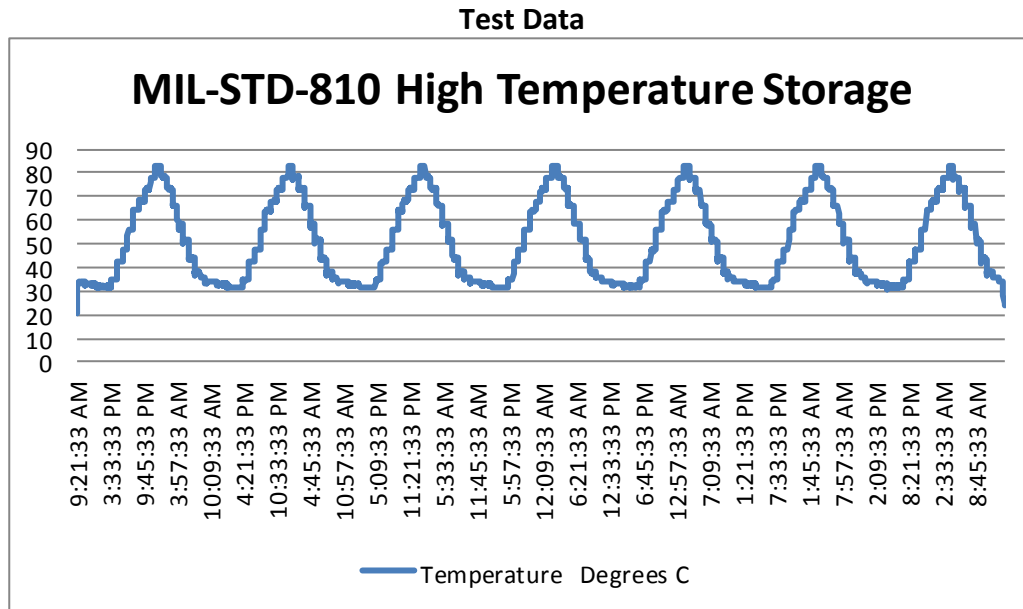
² "Induced Conditions" are air temperature levels to which materiel may be exposed during storage or transit situations that are aggravated by solar loading.

³ Humidity control during high temperature testing is generally not necessary. Use these values only in special cases.

⁴ Data were originally recorded in °F and converted to °C. Hence, table data conversion may not be consistent.

6.1.3. Comments

The Equipment Under Test complied with the High Temperature Storage test.



Test Equipment Used

NTS #	Manufacturer	Make	Model	S/N	Cal. Date	Cal. Due
WC058388	Thermotron	Temperature Chamber	SE-600-5-5	30390	5/3/2017	5/3/2018

Photographs



6.2 Humidity

6.2.1. Requirement

The Equipment Under test shall be tested for Humidity using MIL-STD-810G, Method 507.5 Procedure II as in the profile below.

6.2.2. Test Procedure

The Equipment Under test was placed into the temperature/humidity chamber in storage configuration.

The chamber temperature was adjusted to 30°C at 95% relative humidity.

After temperature stabilization occurred, the following profile was run for 10 cycles (1 cycle is 24 hours).

Operational checks were done on the 5th and 10th cycles.

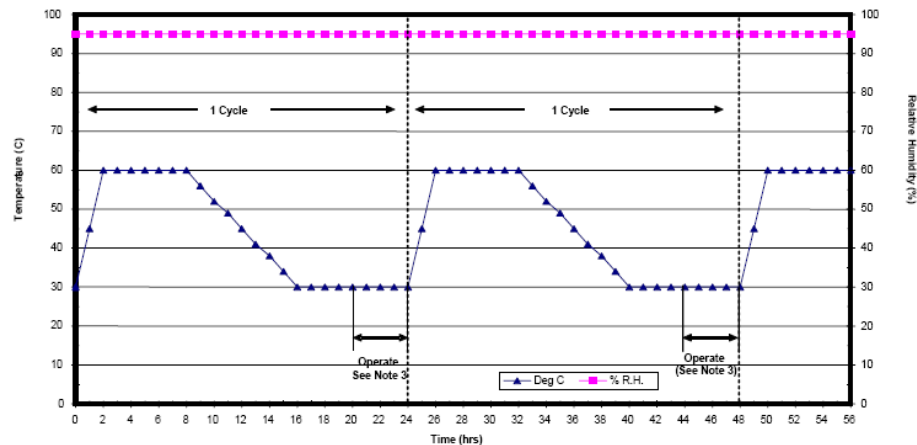
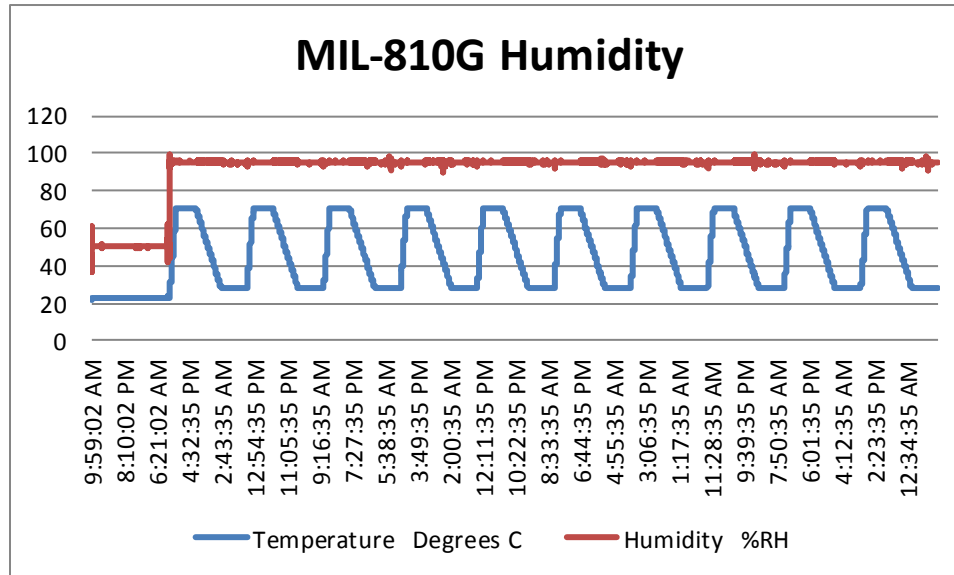


Figure 507.5-7. Aggravated temperature-humidity cycle.

6.2.3. Comments

The Equipment Under test complied with the Humidity test.

Test Data

Test Equipment Used

NTS #	Manufacturer	Make	Model	S/N	Cal. Date	Cal. Due
WC005349	Espec	Environmental Chamber	ESL28-6CA	165010	10/18/2017	10/18/2018

Photographs



6.3 Blowing Dust**6.3.1. Requirement**

The Equipment Under Test shall be subjected to the conditions of the Blowing Dust test per MIL-STD-810G Method 510.5, Procedure I.

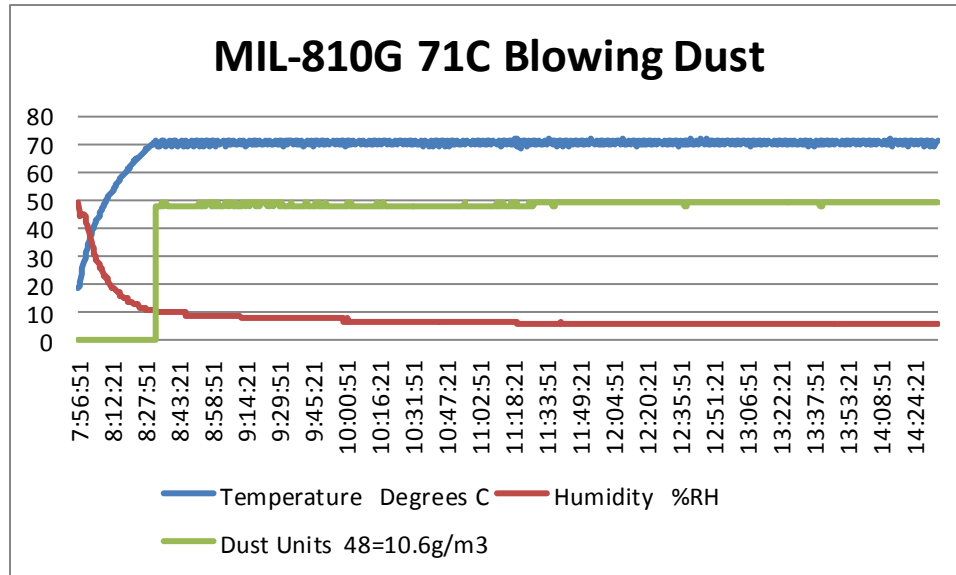
6.3.2. Test Procedure

The Dust Test was performed on the Equipment Under Test at 71°C for 6 hours. The dust concentration was 10.6g/m³ at a velocity of 8.9 m/sec.

The Equipment Under Test was removed from the chamber and visually examined for damage and operated

6.3.3. Comments

The Equipment Under Test complied with the Blowing Dust Test requirements.

Test Data

Test Equipment Used

NTS #	Manufacturer	Make	Model	S/N	Cal. Date	Cal. Due
WC005410	NTS	Dust Chamber	N/A	1	5/11/2017	5/11/2018
WC024133	Pacer	Anemometer	DA400	1017001	8/30/2017	8/30/2018

Photographs





6.4 Vibration**6.4.1. Requirement**

The Equipment Under Test shall be tested for Vibration using MIL-STD-810G, Method 514.6 Procedure I ground vehicles.

6.4.2. Test Procedure

The Equipment Under Test was mounted to the vibration table in non-operational condition.

The vibration profile was run for 1 hour per axis.

The Equipment Under Test was visually examined and an operational check was conducted after the test.

6.4.3. Comments

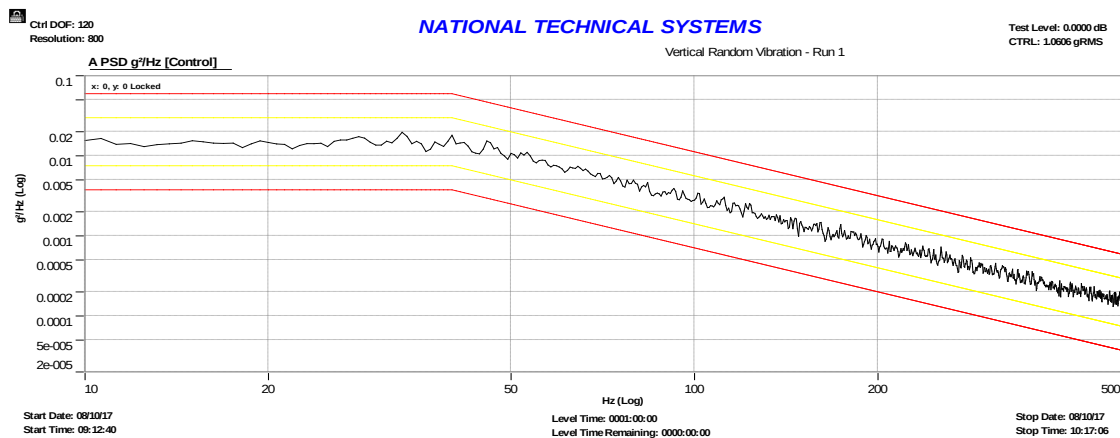
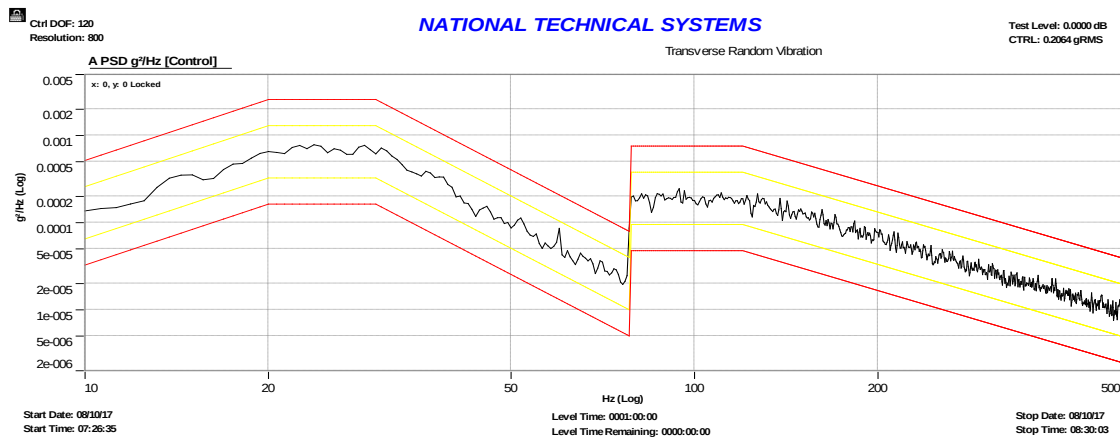
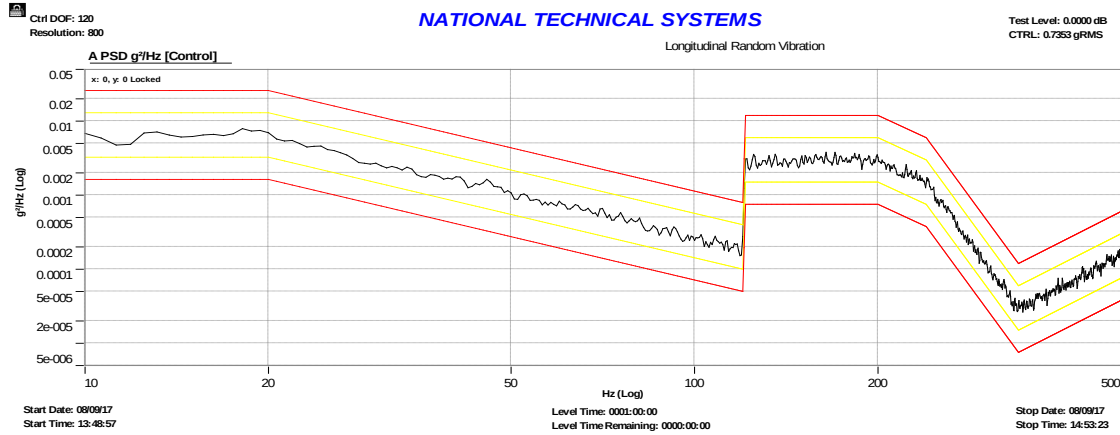
The Equipment Under Test complied with the Vibration test requirements.



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693env.PSL
Revision 0

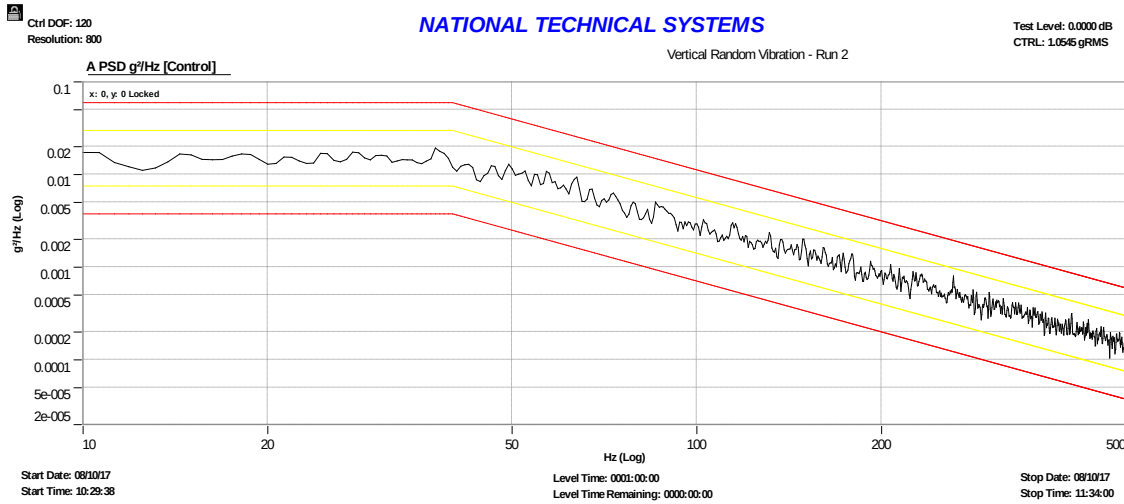
Test Data





NATIONAL TECHNICAL SYSTEMS

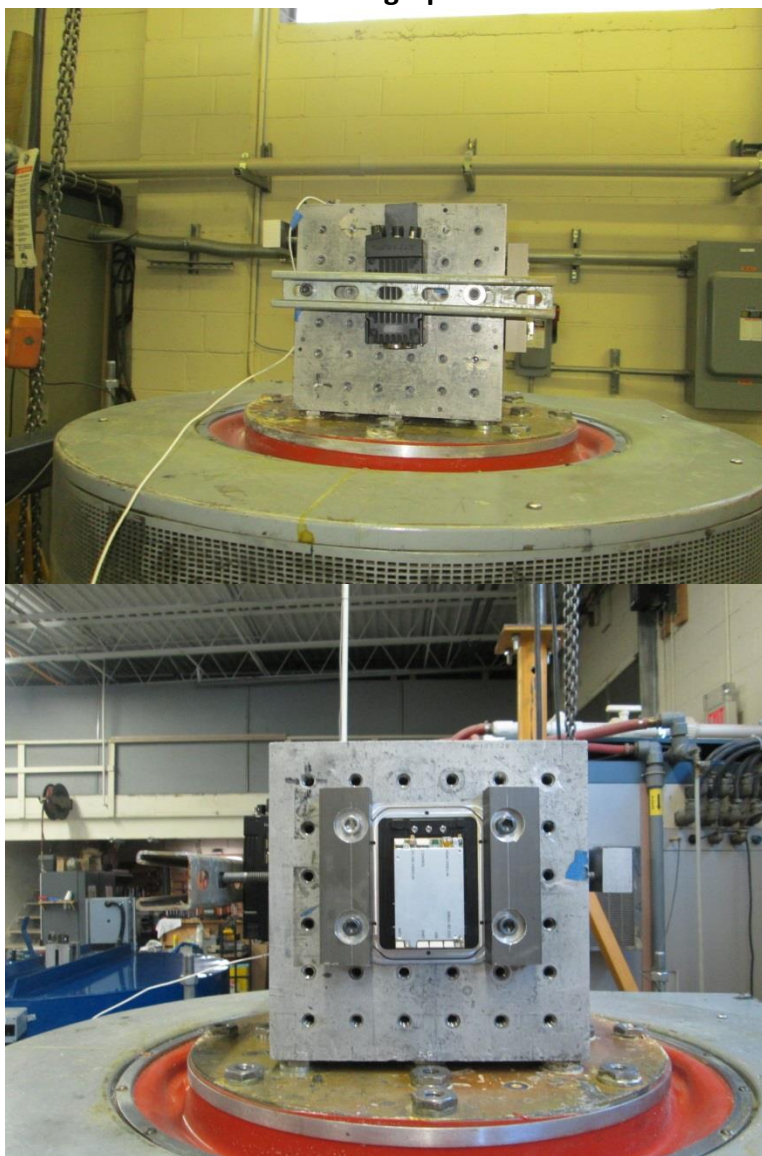
NTS Test Report Number: PR066693env.PSL
Revision 0



Test Equipment Used

NTS #	Manufacturer	Make	Model	S/N	Cal. Date	Cal. Due
WC005346	Unholtz-Dickie	Amplifier	MA145A-130IAR	2418	NCR	NCR
WC005343	Unholtz-Dickie	Shaker	T1000	476	NCR	NCR
WC040825	Spectral Dynamics	Vibration Controller	2405-9700-1	2400-1709	5/25/2017	5/25/2018
WC040768	PCB	Accelerometer	353B16	173657	6/10/2017	6/10/2018

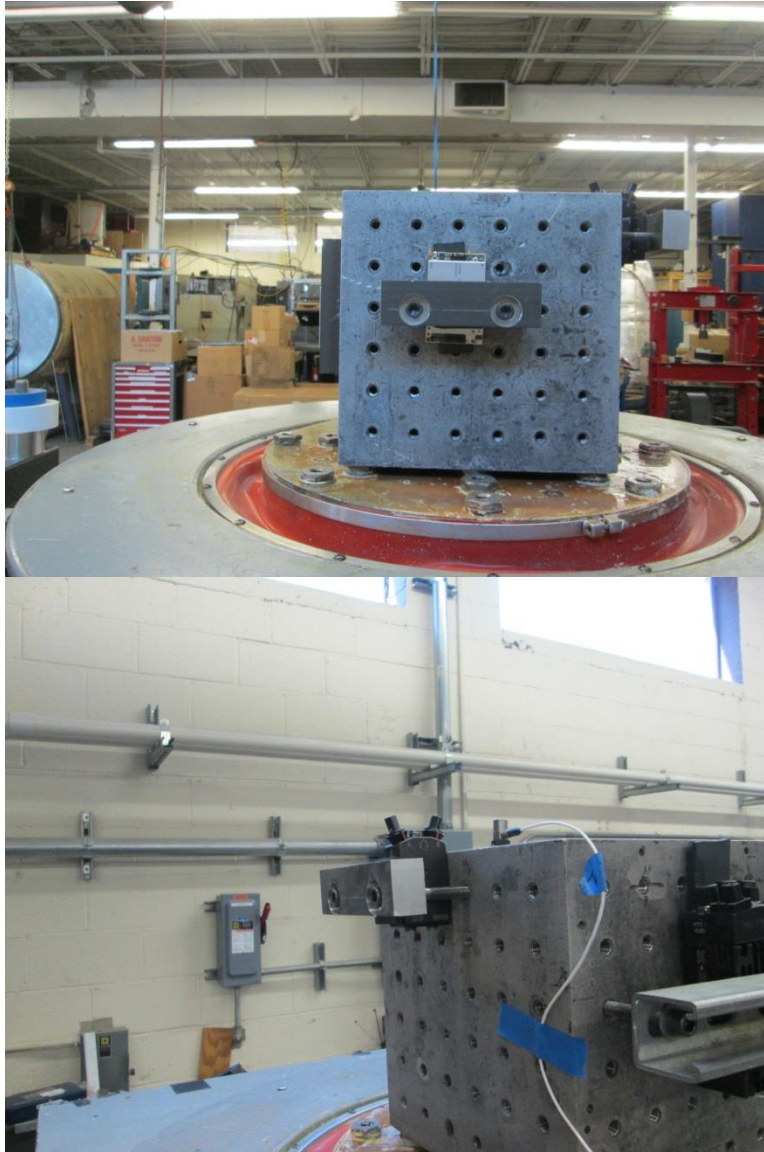
Photographs



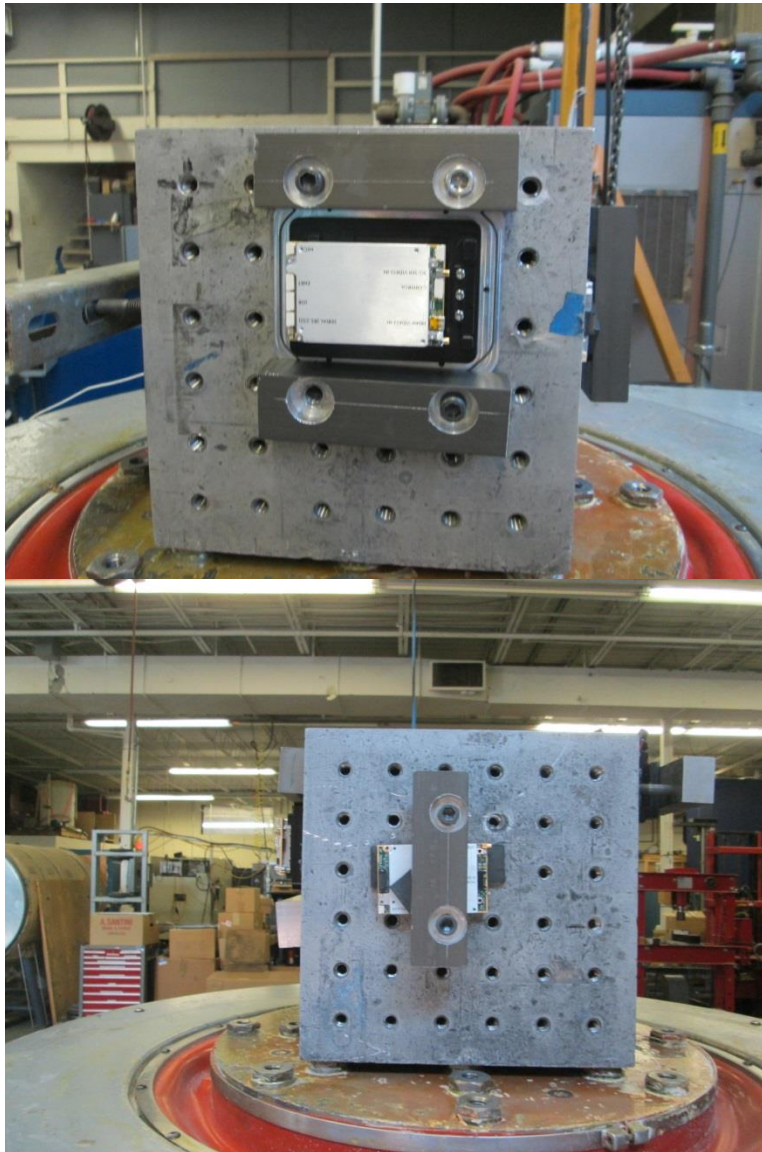


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693env.PSL
Revision 0



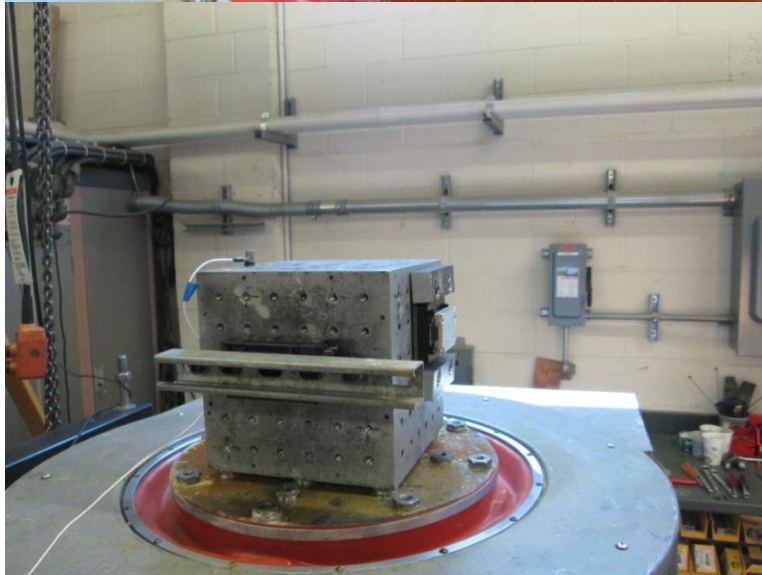
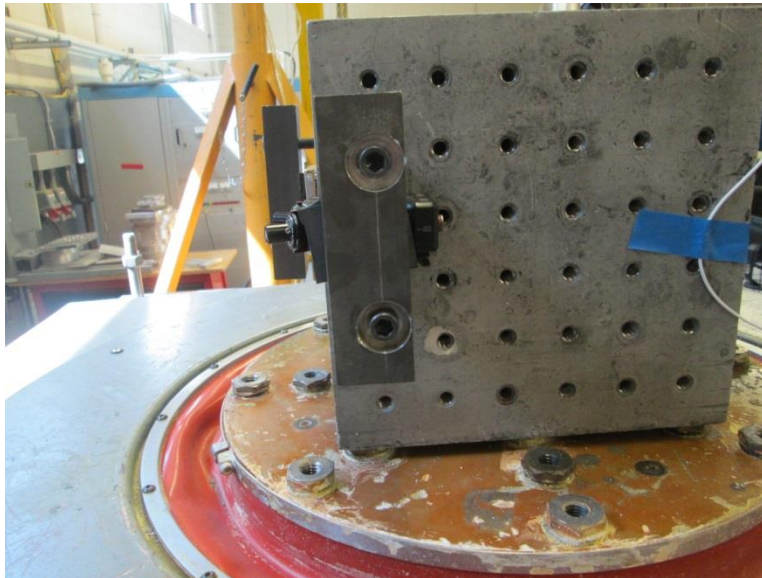
36 Gilbert Street South • Tinton Falls, New Jersey 07701
(732) 936-0800 • Fax (732) 936-0700
www.ntscorp.com





NATIONAL TECHNICAL SYSTEMS

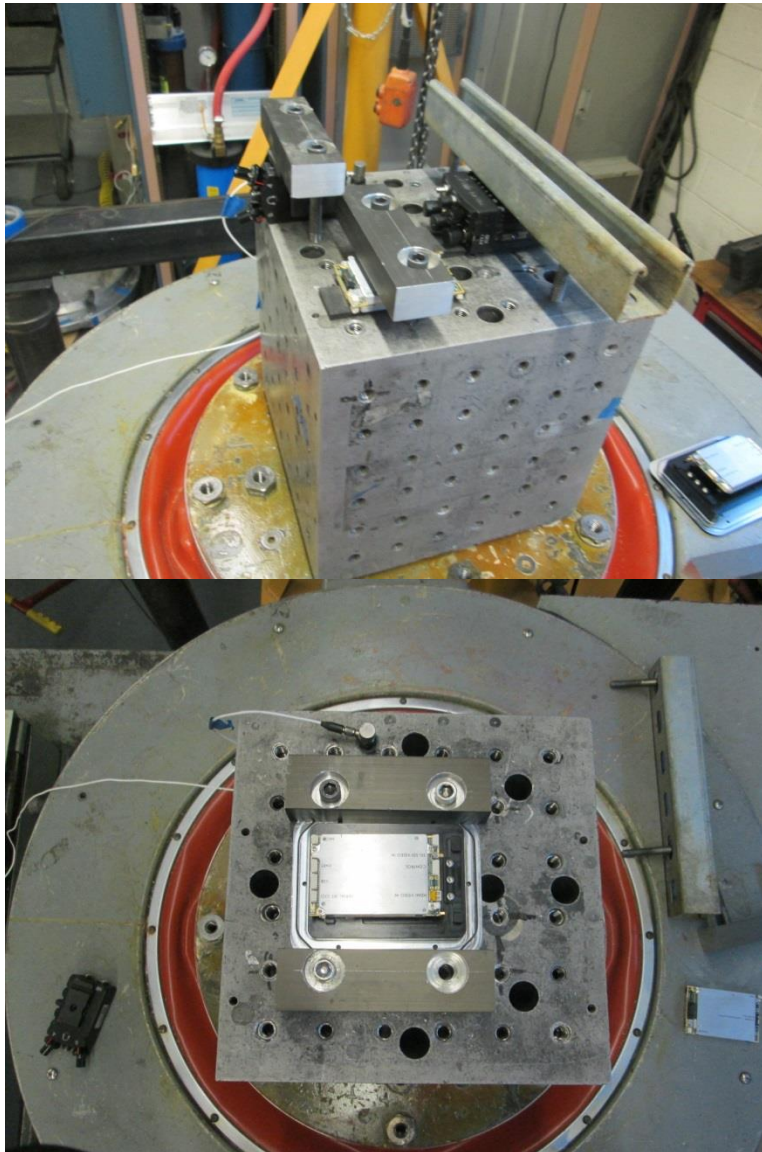
NTS Test Report Number: PR066693env.PSL
Revision 0





NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693env.PSL
Revision 0



6.5 Blowing Rain**6.5.1. Requirement**

The Equipment Under Test shall be tested for Blowing Rain using MIL-STD-810G Method 506.5 Procedure I.

6.5.2. Test Procedure

The Equipment Under Test was pre-conditioned to 10°C above the water temperature used for the blowing rain test.

The Equipment Under Test was inserted into the rain test chamber in fused mode. The wind velocity was adjusted to 40 MPH and rainfall rate was adjusted to 4" per hour. The test item temperature was 10 ±2°C higher than the rainwater. This condition was maintained for 30 minutes.

The Equipment Under Test was oriented to expose 6 faces to the blowing rain for 30 minutes each.

The Equipment Under Test was removed from the test chamber and a visual inspection for water penetration was performed.

An operational check on the Equipment Under Test was performed.

6.5.3. Comments

The Equipment Under Test complied with the Blowing Rain requirements.



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693env.PSL
Revision 0

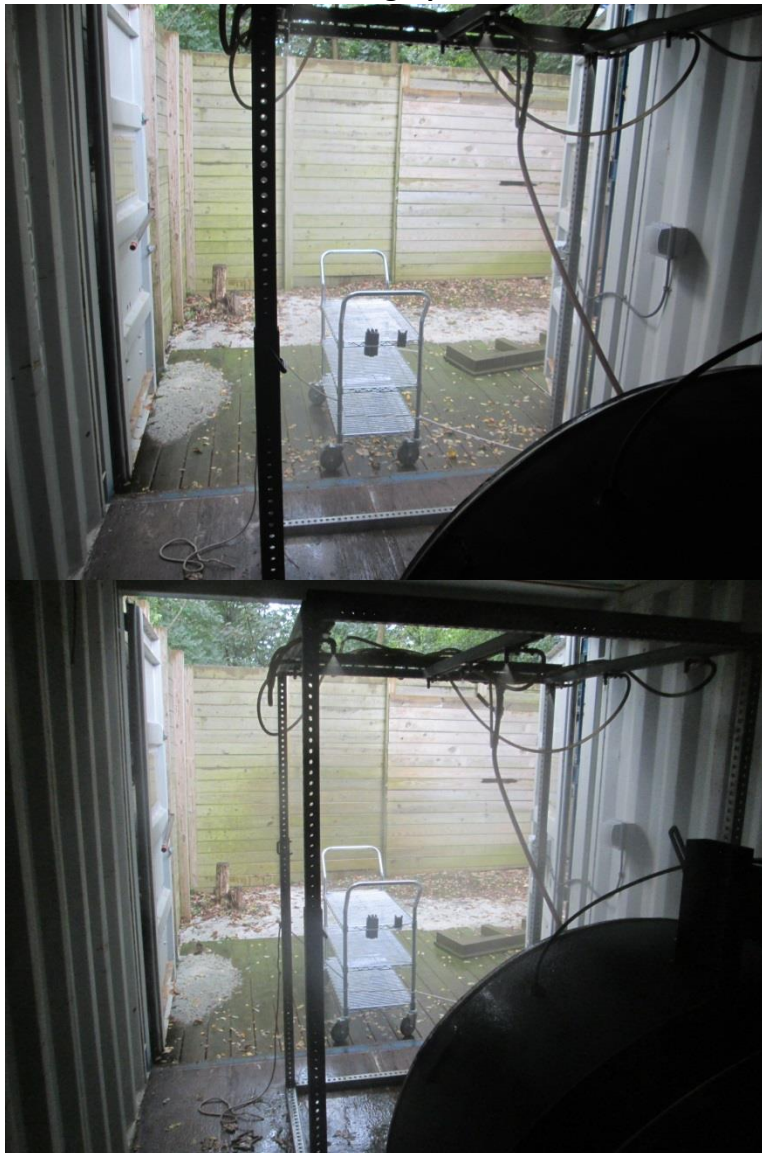
Test Data

DATA SHEET					
Job Number:	PR066693		Date:	9/6/17	Page 1 of 1
Client:	Persistent Systems		P. O. No.:		
Test:	Blowing Rain		Test Item: MPU5/PTT		
Specification:	Mil-Std-810G		Model or P/N: WR-5100/WR-PTT-01		
Para./Sect.:	Method 506.5 Procedure I		S/N(s): 28147/00324		
Remarks:	Testing was conducted for 30 minutes on each face with the EUT not operating.				
Test Duration (minutes)	Unit Temp. (°C)	Water Temp. (°C)	Wind Velocity (MPH)	Rainfall Rate (in/hour)	Test Item Orientation
30	35	21	42	4	Front of EUT
30	35	21	42	4	Rotated EUT 90°
30	35	21	42	4	Rotated EUT 90°
30	35	21	42	4	Rotated EUT 90°
30	35	21	42	4	Rotated EUT 90°
30	35	21	42	4	Rotated EUT 90°
Test Performed By: Brian Pasznik					
Project Manager: Mark Betts					

Test Equipment Used

NTS #	Manufacturer	Make	Model	S/N	Cal. Date	Cal. Due
WC058388	Thermotron	Temperature Chamber	SE-600-5-5	30390	5/3/2017	5/3/2018
WC024133	Pacer	Anemometer	DA400	1017001	8/30/2017	8/30/2018
NJ1348	NTS	Rain Test System	N/A	N/A	NCR	NCR
WC064029	Buffalo Turbine	Turbine Blower	BT-Mega	26228	NCR	NCR

Photographs





NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693env.PSL
Revision 0



36 Gilbert Street South • Tinton Falls, New Jersey 07701
(732) 936-0800 • Fax (732) 936-0700
www.ntscorp.com



6.6 Icing**6.6.1. Requirement**

The Equipment Under Test shall operate during and after exposure to icing (rime and/or glaze) and freezing rain conditions without degradation in performance or useful life, for a total ice accumulation of up to 6 mm (.25 inches).

Normal operation to remove ice buildup or input force required to clear ice buildup shall not damage the component.

6.6.2. Test Procedure

The Equipment Under Test was installed into the chamber.

The chamber temperature was stabilized at 0°C.

A uniform, pre-cooled water spray was delivered for 1 hour to allow water penetration into the test item crevices/openings.

The chamber air temperature was adjusted to -10°C (14°F) water penetration was allowed into the test item until 6 mm (.25 inches) thickness of ice had accumulated on the appropriate surfaces.

The chamber air temperature was maintained for a minimum of 4 hours to allow the ice to harden.

6.6.3. Comments

The Equipment Under Test complied with the Icing requirements.



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693env.PSL

Revision 0

Test Data

NTS		TEST PROFILE		PR066693	
Customer Name:	Persistent Systems	Unit(s) Under Test:	MPU5+RF, PTT		
Test Name:	Icing/Freezing Rain	Quantity:	2		
Specification:	MIL-810G	P/N(s):	WR5100, WR-PTT-01		
Spec. Date		S/N(s):	28147, 324		
Para. / Method:	Method 521.3				

Accumulated Ice	6mm
Initial Temperature in Degrees C	1°C
End Temperature in Degrees C	-20°C
Initial Dwell at 1°C	1 hour
Dwell Time After Ice Accumulated	4 Hours

TEST SETUP AND RESULTS

Test Started:	8/23/2017	Test Completed:	8/25/2017
---------------	-----------	-----------------	-----------

Unit Under Test Information	Y	N	N/A	Comments
Tested in shipping container:		X		
Operating during test:		X		
Operated by client:		X		
Powered during testing:			X	
Passes post-test functionals:	X			
Physical damage noted:		X		
Does unit(s) pass requirements:	X			

COMMENTS: Examined for physical damage only.

Test Technician:	Brian Pasznik
------------------	---------------



NATIONAL TECHNICAL SYSTEMS

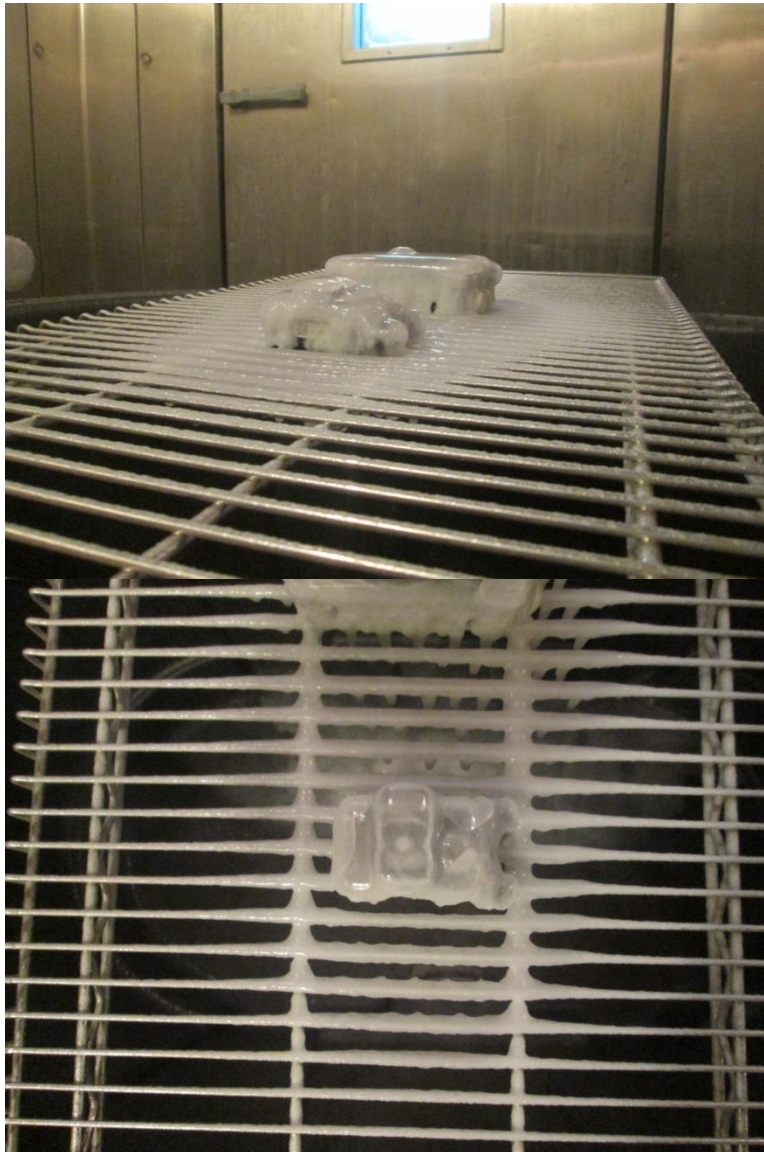
NTS Test Report Number: PR066693env.PSL
Revision 0

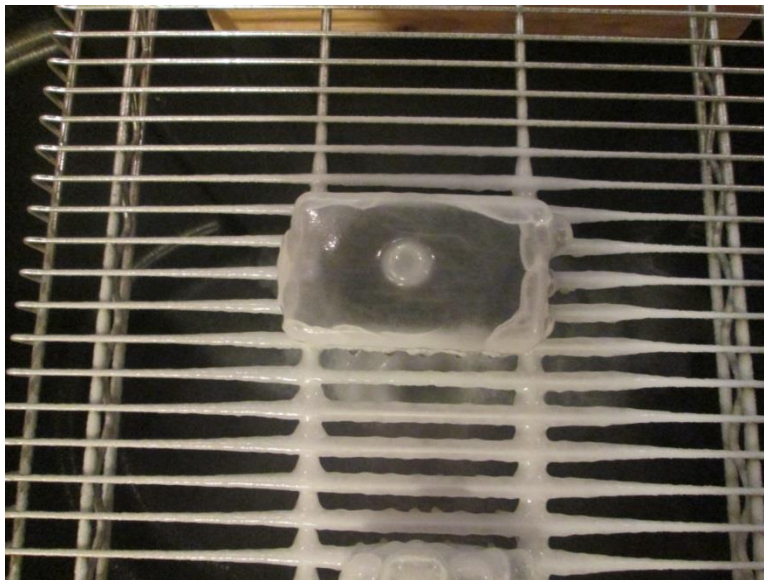
Test Equipment

NTS #	Manufacturer	Make	Model	S/N	Cal. Date	Cal. Due
WC005475	Thermotron	Temperature Chamber	WP-904-TCM-10	DX89140201	5/11/2017	5/11/2018

Photographs







6.7 Altitude (Storage)

6.7.1. Requirement

The Equipment Under Test and all support equipment subject to air transport shall operate after exposure to air transport at altitudes up to 60,000ft above sea level in unpressurized vehicles with no degradation in performance or useful life.

6.7.2. Test Procedure

The Equipment Under Test was installed into the chamber.

The test chamber's temperature and humidity were maintained at ambient conditions and the chamber altitude was ramped to 18,300 m (60,000 ft.). The pressure ramp was performed at a rate not to exceed 10 m/s (2,000 ft./min). The chamber altitude versus time conditions was continuously recorded.

These chamber conditions were maintained for a period of 60 minutes. The chamber altitude versus time conditions was continuously recorded.

6.7.3. Comments

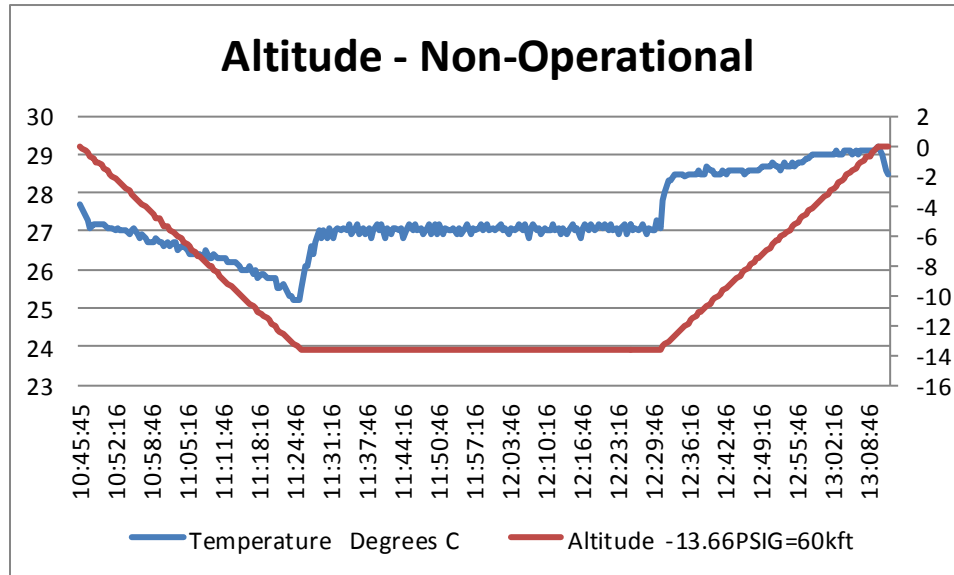
The Equipment Under Test complied with the Altitude requirements.



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693env.PSL
Revision 0

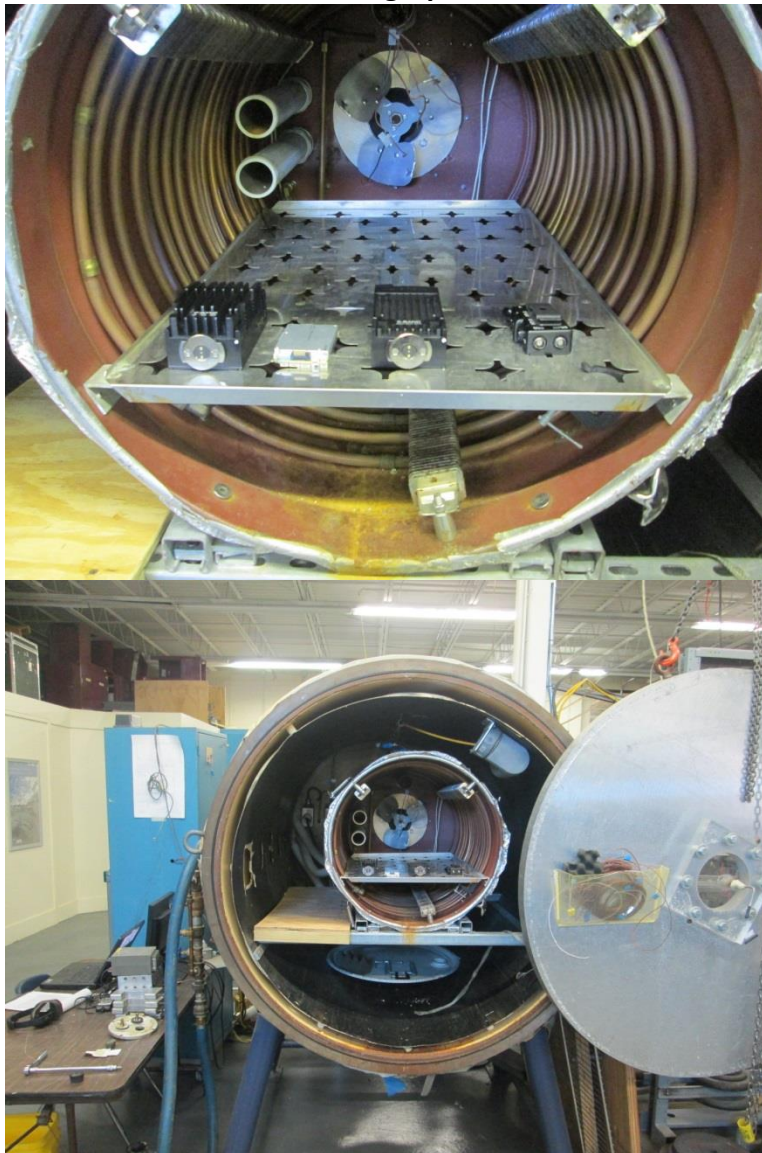
Test Data



Test Equipment

NTS #	Manufacturer	Make	Model	S/N	Cal. Date	Cal. Due
WC005408	NTS	Altitude Chamber	N/A	1	8/24/2017	8/24/2018

Photographs



6.8 Low Temperature (Storage)**6.8.1. Requirement**

The Equipment Under Test shall be tested for Low Temperature using MIL-STD-810G, Method 502.5 Procedure I at -55°C.

6.8.2. Test Procedure

The Equipment Under Test was installed into the chamber.

The Equipment Under Test was placed into the temperature chamber in operational configuration, turned off.

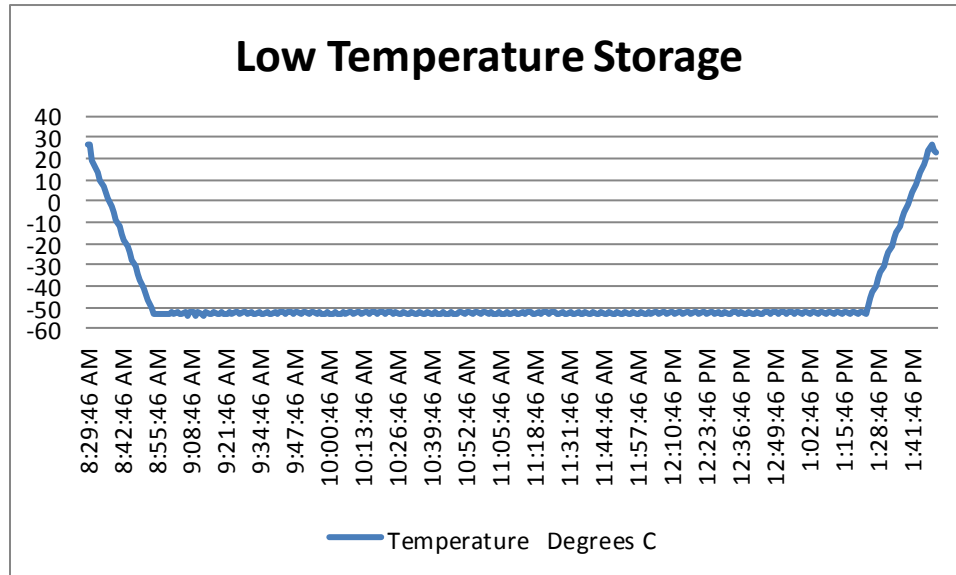
The chamber temperature was adjusted to -55°C.

After temperature stabilization occurred, the test was continued for 4 hours.

The chamber was brought back to ambient and Equipment Under Test was visually examined for damage and operated.

6.8.3. Comments

The Equipment Under Test complied with the Low Temperature Storage requirements.

Test Data

Test Equipment

NTS #	Manufacturer	Make	Model	S/N	Cal. Date	Cal. Due
WC058388	Thermotron	Temperature Chamber	SE-600-5-5	30390	5/3/2017	5/3/2018

Photographs


6.9 Low Temperature (Operational)**6.9.1. Requirement**

The Equipment Under Test shall be tested for Low Temperature using MIL-STD-810G, Method 502.5 Procedure II at -20°C.

6.9.2. Test Procedure

The Equipment Under Test was installed into the chamber.

The Equipment Under Test was placed into the temperature chamber in operational configuration, turned on.

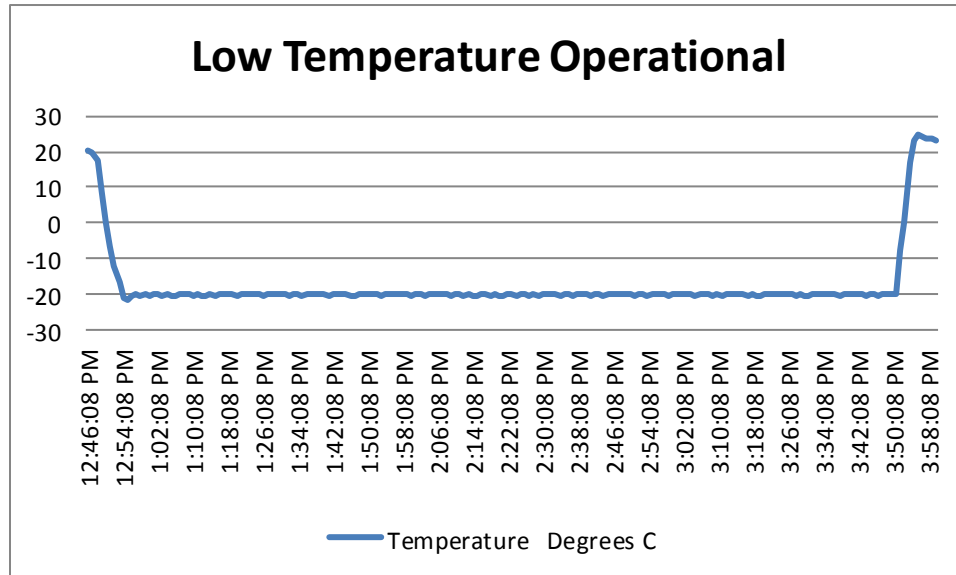
The chamber temperature was adjusted to -20°C.

After temperature stabilization occurred, the test was continued for 3 hours while monitoring the functionality of the Equipment Under test for the duration of the low temperature test.

The chamber was brought back to ambient and Equipment Under Test was visually examined for damage and operated.

6.9.3. Comments

The Equipment Under Test complied with the Low Temperature Operational requirements.

Test Data

Test Equipment

NTS #	Manufacturer	Make	Model	S/N	Cal. Date	Cal. Due
WC005759	Thermotron	Temperature Chamber	F-16-CHMV-5-5	28376	8/24/2017	8/24/2018

Photographs



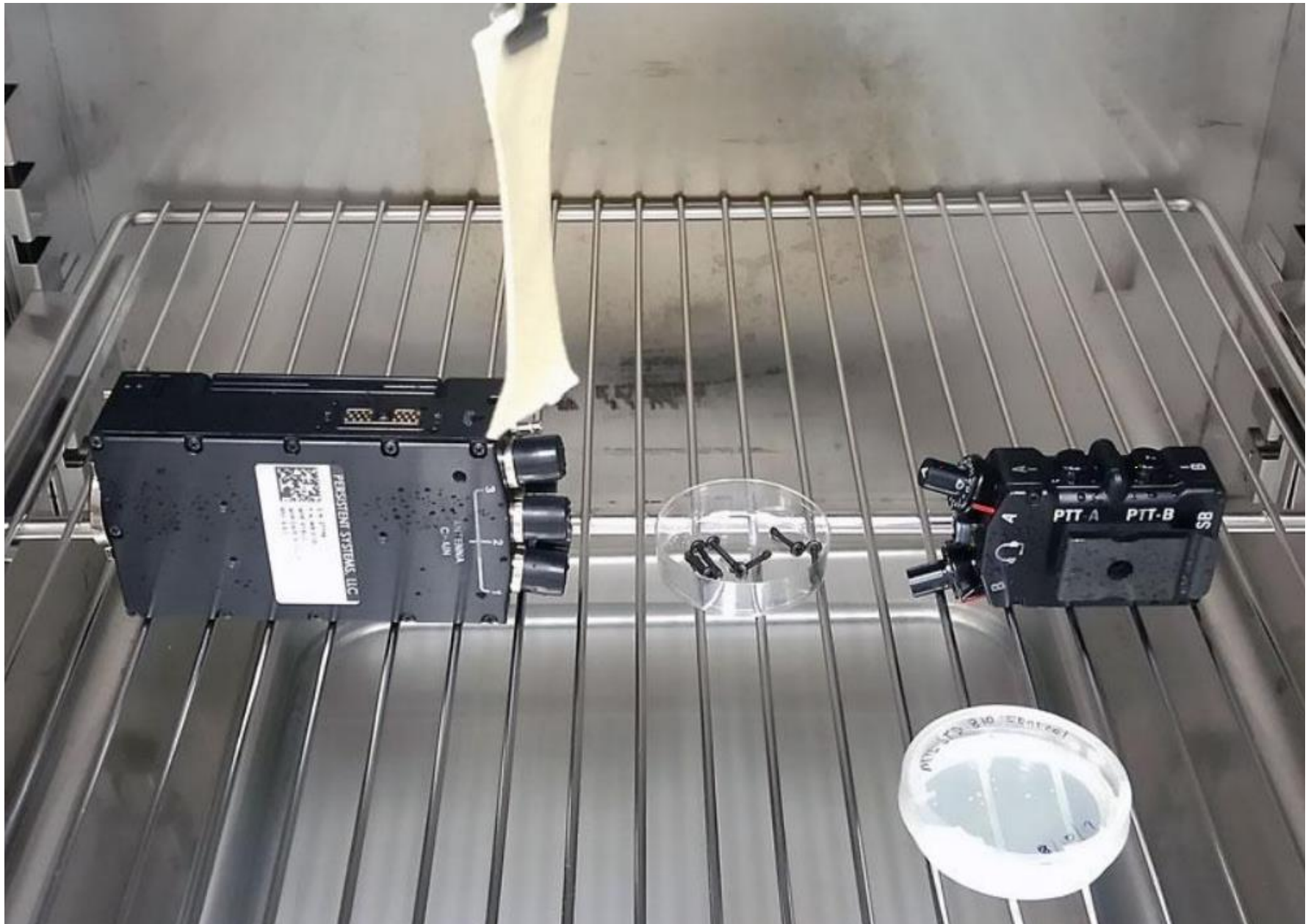

NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693env.PSL
Revision 0

END OF REPORT



In the chamber



MPU5 View1 – After Exposure



WR-5100 Label Side



WR-5100 Connector Side

MPU5 View2 – After Exposure



WR-5100 Enclosure Fins



WR-5100 Bottom



WR-5100 On/Off Knob and Connectors

PTT View1 – After Exposure



WR-PTT-01 Side and Belt Clip



PTT View2 – After Exposure



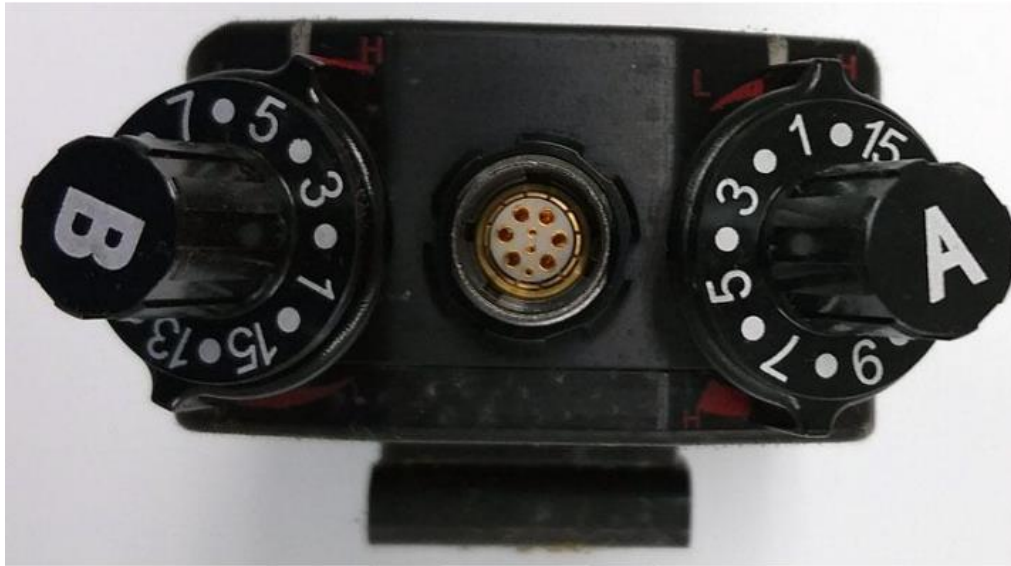
WR-PTT-01 Label Side



WR-PTT-01 PTT Buttons



PTT View3 – After Exposure

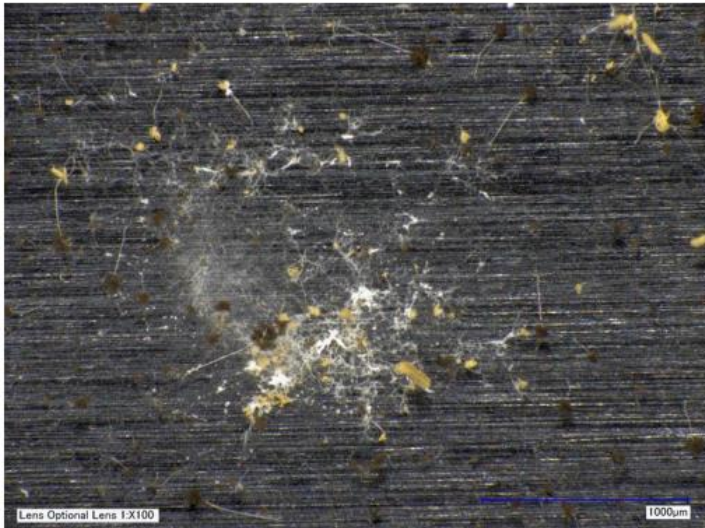


WR-PTT-01 Knobs and Connector

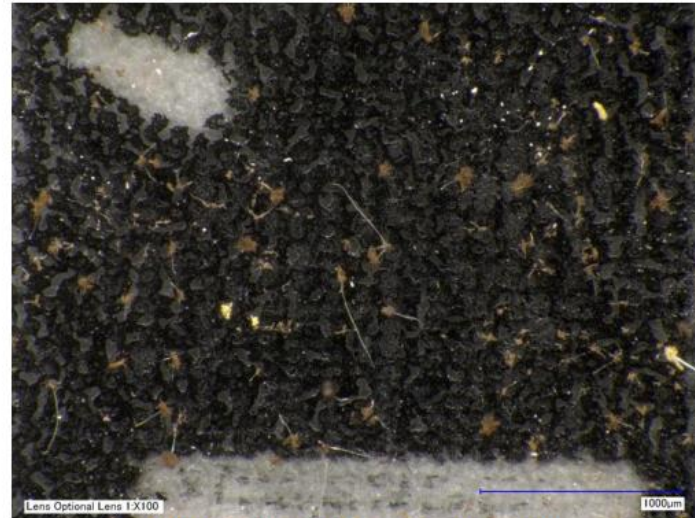


Exposed Areas - Magnified

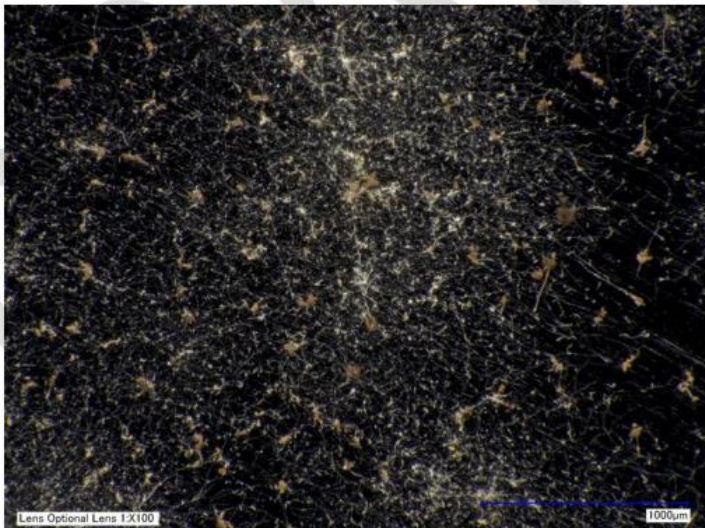
Microscopic Images of Fungal Growth on Samples



WR-5100 Enclosure - Label Side Black Paint (Magnification x100)



WR-5100 Label (Magnification x100)



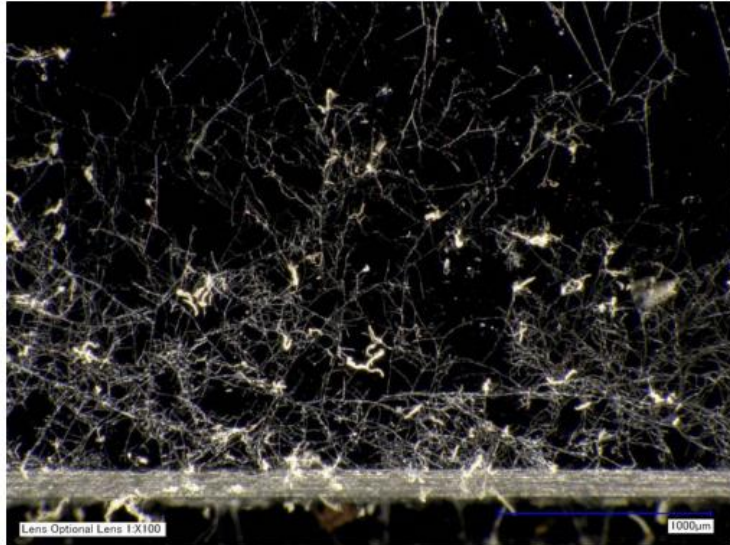
WR-5100 Enclosure - Example of Other Side Black Paint (Magnification x100)



WR-5100 White Letters (Magnification x25)



Exposed Areas - Magnified



WR-5100 Side Connector (Magnification x100)



WR-PTT-01 Black Paint and White Letters (Magnification x25)



WR-5100 ON/OFF Knob (Magnification x25)



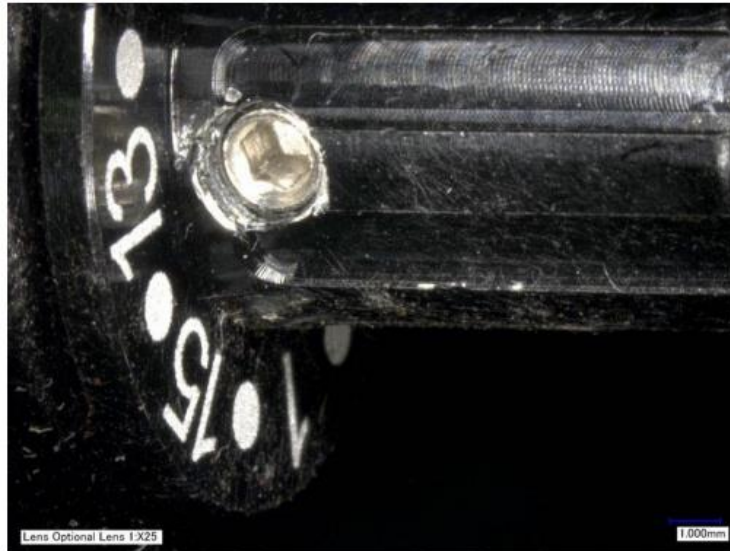
WR-PTT-01 Belt Clip (Magnification x25)



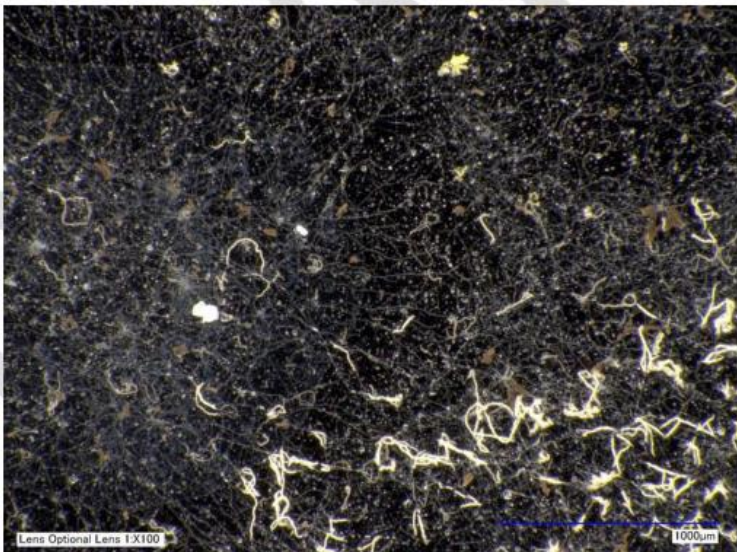
Exposed Areas - Magnified



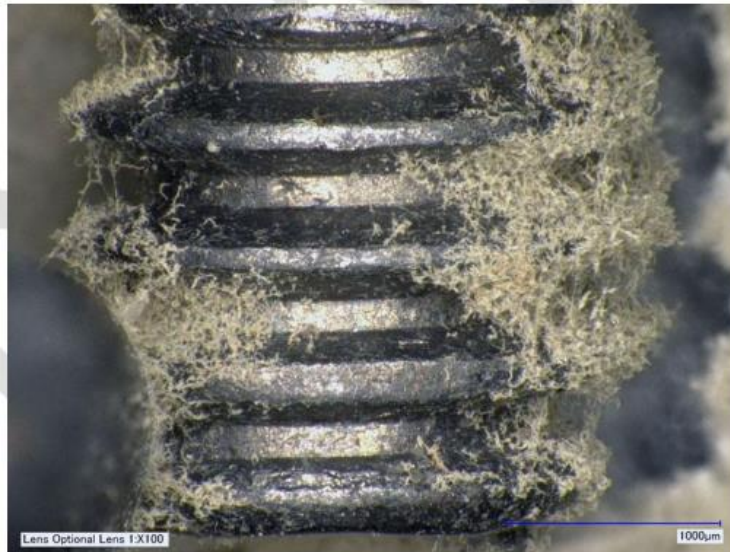
WR-PTT-01 Label (Magnification x100)



WR-PTT-01 Knob (Magnification x25)



WR-PTT-01 PTT Button (Magnification x100)



Screws (Magnification x100)



The table below was used to rate the amount of fungal growth.

Amount of Growth	Rating	Comments
None	0	Substrate is devoid of microbial growth.
Trace	1	Scattered, sparse or very restricted microbial growth.
Light	2	Intermittent infestations or loosely spread microbial colonies on substrate surface. Includes continuous filamentous growth extending over the entire surface, but underlying surfaces are still visible.
Medium	3	Substantial amount of microbial growth. Substrate may exhibit visible structural change.
Heavy	4	Massive microbial growth.

	Part	Description of Fungal Growth	Species	MIL-STD-810 Growth Rating
WR-5100				
1	Label	Even distribution of loosely arranged <i>A. niger</i> fruiting bodies over label, with more sporadic presence of the other two species.	<i>Aspergillus niger</i> <i>Penicillium funiculosum</i> <i>Aspergillus versicolor</i>	2

	Part	Description of Fungal Growth	Species	MIL-STD-810 Growth Rating
2	Black paint	White Label Side: Even distribution of loosely arranged <i>A. niger</i> fruiting bodies, with more scattered, intermittent infestations of the other two species. Other Sides: Consistent growth of both <i>A. niger</i> fruiting bodies and <i>P. funiculosum</i> colonies; more growth than on white label side.	<i>Aspergillus niger</i> <i>Aspergillus versicolor</i> <i>Aspergillus flavus</i> <i>Penicillium funiculosum</i>	2
3	White letters on black paint	There is a surge in growth on these letters, with much greater density than the black paint; some letters have very dense growth.	<i>Aspergillus niger</i> <i>Penicillium funiculosum</i> <i>Aspergillus versicolor</i> <i>Aspergillus flavus</i>	2
4	Connector	Intermittent infestations of sporulating fungi over much of surface; mycelial growth also visible.	<i>Aspergillus niger</i> <i>Penicillium funiculosum</i>	2
5	On-off knob	Growth is dense on the white numbers/letters, but nearly absent on the black parts without numbers/letters; also dense on the red "Z"	<i>Aspergillus niger</i> <i>Penicillium funiculosum</i>	2
WR-PTT-01				
6	Black paint	Even distribution of loosely arranged <i>A. niger</i> fruiting bodies, with more scattered, intermittent infestations of the other two species.	<i>Aspergillus niger</i> <i>Aspergillus flavus</i> <i>Penicillium funiculosum</i> <i>Aspergillus versicolor</i>	2
7	Label	Large number of very tall <i>A. niger</i> fruiting bodies are dominant.	<i>Aspergillus niger</i> <i>Penicillium funiculosum</i> <i>Aspergillus versicolor</i>	2

	Part	Description of Fungal Growth	Species	MIL-STD-810 Growth Rating
8	Belt clip	Loosely arranged colonies of sporulating fungi over the entire surface	<i>Aspergillus niger</i> <i>Penicillium funiculosum</i> <i>Aspergillus versicolor</i>	2
9	A & B buttons	Fruiting bodies present evenly over the surface; network of mycelium also visible.	<i>Aspergillus versicolor</i> <i>Penicillium funiculosum</i> <i>Aspergillus niger</i>	2
10	Knobs	Some light growth of mycelium and small fruiting bodies	<i>Penicillium funiculosum</i> <i>Aspergillus niger</i>	2
11	Screws	Dense growth of <i>Penicillium</i> in many areas – generally heavier growth in the threads. The screws were heavily covered in grease upon receipt and were cleaned but it is possible that some grease residues remained.	<i>Penicillium funiculosum</i> <i>Aspergillus niger (rare)</i>	2

Test Results:

Four of the five species from the inoculation mix were observed growing on various inspected items post incubation (*Aspergillus versicolor*, *Aspergillus flavus*, *Aspergillus niger*, and *Penicillium funiculosum*). All of the observed parts were given a growth rating of 2. A rating of 2 indicates consistent growth, of a level unlikely to be explained by sporadic contamination (though in some cases this could result from more thorough contamination of grease, adhesives, or environmental residues coating an object). Therefore a rating of 2 suggests that the surface tested provides sufficient nutrients to fuel light to moderate fungal growth. Photographs and the post-treatment returned sample parts can be viewed to judge the risk of material degradation under longer exposure to warm humid growth conditions.

Photographs and the post-treatment returned samples can be viewed to judge the risk of material degradation under longer exposure to warm humid growth conditions.



National Technical Systems

MIL-STD-461F Test Report for the

Persistent Systems LLC

MPU5 Radio with RF-2150 10W S-Band Card

Prepared For

Persistent Systems LLC | 303 Fifth Avenue, Suite 409, New York, NY 10016

Product

MPU5 Radio with RF-2150 10W S-Band Card

Prepared By

National Technical Systems | 36 Gilbert Street South | Tinton Falls NJ, 07701 | (732) 936-0800 |
www.nts.com

Date: April 16, 2021 (Rev 2)

A handwritten signature in black ink, appearing to read "Jeff Maselli", written over a horizontal line.

Jeff Maselli, Technical Writer

A handwritten signature in black ink, appearing to read "Jeff Maselli", written over a horizontal line.

Jeff Maselli, Project Manager

A handwritten signature in black ink, appearing to read "Mark Betts", written over a horizontal line.

Mark Betts, Quality Assurance

Distribution Statement: Distribution authorized to the Department of Defense and U.S. DoD contractors only; Critical Technology: December 21, 2017. Other requests shall be referred to NAVSEA.

WARNING - This document contains technical data whose export is restricted by Arms Export Control Act (Title 22, U.S.C., Sec. 2751, et seq.) or the Export Administration Act of 1979, as amended, Title 50, U.S.C., App. 2401, et seq.). Violations of these export laws are subject to severe criminal penalties. Disseminate in accordance with the provisions of DoD Directive 5230.25.

Destruction Notice: For unclassified, limited documents, destroy by any method that will prevent disclosure of contents or reconstruction of the document. No public releases or public displays of any kind are authorized without the expressed written consent of COMNAVSEASYS COM (SEA OOD) or higher authority.

This report and the information contained herein represent the results of testing articles/products identified and selected by the customer. The tests were performed to specifications and/or procedures approved by the customer. National Technical Systems ("NTS") makes no representations expressed or implied that such testing fully demonstrates efficiency, performance, reliability, or any other characteristic of the articles being tested, or similar products. This report should not be relied upon as an endorsement or certification by NTS of the equipment tested, nor does it represent any statement whatsoever as to its merchantability or fitness of the test article or similar products for a particular purpose. This document shall not be reproduced except in full without written approval from National Technical Systems ("NTS").



Revision History

Rev	Description	Issue Date
Rev 0	Initial release.	1/31/2020
Rev 1	Corrected RS103 data page specification table and summary tables in Section 5.3.5 to reflect Army Ground test level.	10/5/20
Rev 2	Added CE106 test results.	4/16/21

Table of Contents

1.0 Introduction.....	6
1.1 Purpose.....	6
1.2 Acronyms.....	6
1.3 Definitions	6
2.0 References	7
3.0 Equipment Under Test	8
3.1 Description.....	8
3.2 EUT System Setup	8
3.3 EUT Operation and Monitoring	10
3.4 Susceptibility Criteria	10
3.5 EUT Bonding / Grounding Requirements	10
3.5.1 Bonding / Grounding Measurement Results.....	10
3.6 Security Classification	11
4.0 Test Requirements.....	11
4.1 Tests and Location	11
4.2 Test Resources.....	11
4.2.1 Test Equipment	11
4.2.2 Test Automation and Data Collection Software.....	12
4.3 General Test Requirements	13
4.3.1 Test Facility.....	13
4.3.2 Ground Plane and General Setup.....	13
4.4 Emissions Testing.....	14
4.5 Susceptibility Testing	15
5.0 Test Methods, Procedures and Test Results	16
Test Methods and Test Results Summary	16
5.1 Method RE102: Radiated Emissions, Electric Field, 2 MHz to 18 GHz.....	17
5.1.1 RE102 Purpose	17
5.1.2 RE102 Measurement System Check.....	18
5.1.3 RE102 EUT Test Setup	19
5.1.4 RE102 Antenna Positioning	19
5.1.5 RE102 Test Procedure	21
5.1.6 RE102 Test Data	22
5.1.7 RE102 Photographs	38
5.1.8 RE102 Test Equipment	41
5.2 Method RS101: Radiated Susceptibility, Magnetic Field	42
5.2.1 RS101 Purpose.....	42
5.2.2 RS101 Limits	42
5.2.3 RS101 Calibration	43
5.2.4 RS101 EUT Test Setup	43
5.2.5 RS101 Test Procedure	44
5.2.6 RS101 Test Data	45
5.2.7 RS101 Test Photographs.....	55
5.2.8 RS101 Test Equipment	57
5.3 Method RS103: Radiated Susceptibility, Electric Field, 2 MHz - 18 GHz.....	58
5.3.1 RS103 Purpose.....	58
5.3.2 RS103 Limits	58
5.3.3 RS103 Test Setup.....	59



5.3.4	RS103 Test Procedure	61
5.3.5	RS103 Test Data	62
5.3.6	RS103 Data Plots	65
5.3.7	RS103 Photographs	72
5.3.8	RS103 Test Equipment	74
5.4	Conducted Emissions: Method CE106, Conducted Emissions Antenna Terminal, 10kHz to 40GHz	75
	CE106 Test Results Summary	75
5.4.1	CE106 Purpose	75
5.4.2	CE106 Limits	75
5.4.3	CE106 Test Setup.....	76
5.4.4	CE106 Test Procedure	76
5.4.5	CE106 Data	80
5.4.6	CE106 Photographs	92
5.4.7	CE106 Test Equipment	94
Appendix A: Test Software Description.....		95
	AutoScan™ EMI Measurement Software	95
	ETS-Lindgren Totally Integrated Laboratory Environment (TILE!)	97

List of Figures

Figure 3.2-1: MPU5 Radio with RF-2150 10W S-Band Card EMI Setup Overview	9
Figure 4.3-1: General Test Setup Example.....	13
Figure RE102-1: RE102 limit for ground applications (Navy Mobile & Army).	17
Figure RE102-2: RE102 Measurement System Check Setup.....	18
Figure RS101-1: RS101 limit for all Army applications.....	42
Figure RS101-2: Calibration of the radiating system.	43
Figure RS101-3: RS101 Basic test setup.....	44
Figure RS103-1: RS103 Limit – Army Ground	58
Figure CE106-1: Setup for Low Power Transmitters and Amplifiers	77
Figure CE106-2: Setup for High Power Transmitters and Amplifiers.....	78
Figure CE106-3: Setup for Receivers and Stand-by Mode for Transmitters and Amplifiers.....	79

List of Tables

Table 2.0-1: Government Specifications, Standards, and Handbooks.....	7
Table 2.0-2: Other Documents, Drawings, and Publications	7
Table 3.1-1: EUT Info	8
Table 3.5-1: Bonding / Grounding Test Equipment	10
Table 4.1-1: Tests and Locations.....	11
Table 4.2-1: Test Automation and Data Collection Software	12
Table 4.4-1: Bandwidth and Measurement Times	14
Table 4.5-1: Susceptibility Scanning	15
Table 5.0-1: Test Methods and Test Results Summary	16
Table RE102-1: RE102 Antenna Position Calculations, 2 MHz to 200 MHz	19
Table RE102-2: RE102 Antenna Coverage Calculations, 200 MHz to 18 GHz	20
Table RE102-3: RE102 Antenna Position Calculations, 200 MHz to 18 GHz	20
Table RE102-4: Antenna Type and Applicable Frequencies	21
Table RE102-5: RE102 Test Equipment List	41
Table RS101-1: RS101 Test Equipment List	57



Table RS103-1: RS103 Antenna Position Calculations, 2 MHz to 200 MHz	59
Table RS103-2: RS103 Antenna Coverage Calculations, 200 MHz to 18 GHz	60
Table RS103-3: RS103 Antenna Position Calculations, 200 MHz to 18 GHz	60
Table RS103-4: RS103 Test Equipment List	74
Table 5.2-1: CE106 Test Equipment.....	94



1.0 Introduction

1.1 Purpose

The purpose of this report is to document the procedural steps for testing and criteria for evaluating the results of the Electromagnetic Interference (EMI) testing of the MPU5 Radio with RF-2150 10W S-Band Card. The test program was conducted to determine the ability of the MPU5 Radio with RF-2150 10W S-Band Card to successfully satisfy the requirements specified Section 4.

This EMI Test Report (EMITR) is contracted by Persistent Systems LLC. It is the end user who is ultimately responsible for the compliance of the equipment installed. The contracted test facility is National Technical Systems (NTS) in Tinton Falls, New Jersey.

Scope

This EMITR is applicable to the qualification of the MPU5 Radio with RF-2150 10W S-Band Card. The MPU5 Radio with RF-2150 10W S-Band Card is required to meet the Army Ground requirements per MIL-STD-461F.

1.2 Acronyms

EMC: Electromagnetic Compatibility

ODBC: Open Database Connectivity

EMI: Electromagnetic Interference

OLE: Object Linking and Embedding

EMITP: Electromagnetic Interference Test Procedure

PSA: Performance Spectrum Analyzer

EMITR: Electromagnetic Interference Test Report

RF: Radio Frequency

EUT: Equipment Under Test

TEM: Transverse Electromagnetic

LISN: Line Impedance Stabilization Network

TPD: Terminal Protection Device

1.3 Definitions

Decibel (dB) is a logarithmic unit of measurement that expresses the magnitude of a physical quantity (usually power or intensity) relative to a specified or implied reference level.

Metric Units are a system of measures defined by the International System on Units based on the "Le System International d' Unites (SI)", of the International Bureau of Weights and Measures. These units are described in ASTM E3380.

Non-Developmental Item is a broad, generic term that covers material available from a wide variety of sources both industry and Government with little or no development effort required by the procuring activity.

Octave refers to the interval between one frequency and another with double its frequency.

Semi-Anechoic Chamber refers to a chamber with RF absorber lining on all walls and ceiling, but not the floor.

Safety Critical is a category of subsystems and equipment whose degraded performance could result in loss of life or loss of vehicle platform.

Test Setup Boundary includes all enclosures of the EUT and the 2 m of exposed interconnecting leads (except for leads which are shorter in actual installation) and power leads required by MIL-STD-461F.

2.0 References

The following listed in Tables 2.0-1 and 2.0-2 form a part of this document to the extent specified herein.

Table 2.0-1: Government Specifications, Standards, and Handbooks

No	Specification	Title
1	MIL-STD-461F	Department of Defense Interface Standard, Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment, dated December 10, 2007

Table 2.0-2: Other Documents, Drawings, and Publications

No	Specification	Title
2	ISO/IEC 17025	General Requirements for the Competence of Testing and Calibration Laboratories, 2005
3	NTS QPM	National Technical Systems Quality Policy Manual, Rev 10, 8/1/2019
4	ANSI NCSL Z540-1	Calibration Laboratories and Measuring and Test Equipment—General Requirements
5	P.O # 19415	Persistent Systems LLC Purchase Order.
6	OP0523616	NTS Quotation to Persistent Systems LLC.

3.0 Equipment Under Test

3.1 Description

The Equipment Under Test (EUT) for this test program shall be the MPU5 Radio with RF-2150 10W S-Band Card.

Table 3.1-1: EUT Info

Unit Designation	MPU5 Radio with RF-2150 10W S-Band Card
Type	Assembly
Model Number	WR-5100, RF-2150
Serial Number	31783 (MPU5), 38126 (S-Band Card)
Serial Number (CE106)	28360 (MPU5), 67820 (S-Band Card)
Power Rating	Battery Powered

3.2 EUT System Setup

Figure 3.2-1 shows the general system setup and connections.

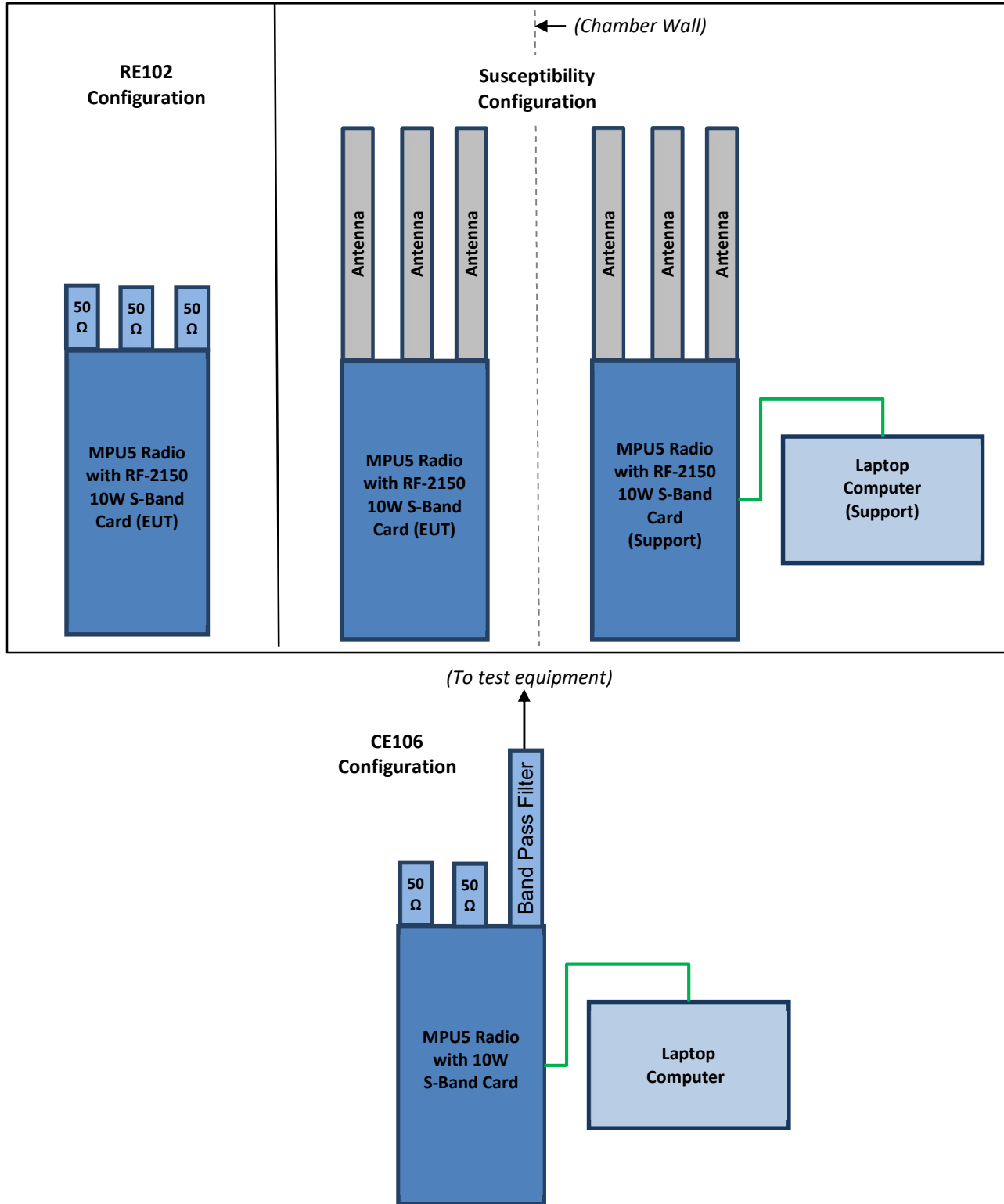


Figure 3.2-1: MPU5 Radio with RF-2150 10W S-Band Card EMI Setup Overview

3.3 EUT Operation and Monitoring

The EUT was turned on placed in transmit/receive mode.

During susceptibility testing, another radio, connected to a laptop computer was used to communicate with the EUT radio.

3.4 Susceptibility Criteria

- It shall not be acceptable for the EUT to lose communication with the laptop computer.
- The ping session shall not show any lost packets.
- The bandwidth tester shall not show decreased bandwidth.

3.5 EUT Bonding / Grounding Requirements

There were no bonding / grounding requirements specified for the EUT.

3.5.1 Bonding / Grounding Measurement Results

There were no bonding / grounding requirements specified for the EUT.

Date:	N/A	Location:	N/A
Test(s):	N/A	Tested By:	N/A

Test Point	Measured (mΩ)
N/A	N/A

3.5.1.1 Bonding / Grounding Test Equipment

Table 3.5-1: Bonding / Grounding Test Equipment

Asset No.	Manufacturer	Item	Model	S/N	Cal Cycle (Months)	Cal. Due
N/A	N/A	N/A	N/A	N/A	N/A	N/A

Calibration Abbreviation
NCR: No Calibration Required

3.6 Security Classification

The MPU5 Radio with RF-2150 10W S-Band Card is considered an unclassified defense article. While unclassified, it should be handled only by authorized personnel. This equipment contains technical data within the definition of the International Traffic in Arms Regulations, and is subject to the export control laws of the USG. Retransfer of this data by any means to any Foreign Person, whether in the United States or abroad, without the written approval of the U. S. Department of State, is prohibited. See CFR 22 Parts 120-130.

4.0 Test Requirements

This section provides an overview of the EMI test plan.

4.1 Tests and Location

Table 4.1-1: Tests and Locations

Section	Test	MIL-STD-461F Section	Location ¹
5.1	RE102	5.17	AR1
5.2	RS101	5.19	AR1
5.3	RS103	5.20	AR1
5.4	CE106	5.6	AR1
Note 1: All testing was performed at NTS in Tinton Falls, NJ.			

4.2 Test Resources

4.2.1 Test Equipment

Lists of the NTS provided equipment used during testing will be included in each test section. This equipment is calibrated according to ISO/IEC 17025, ANSI NCSL Z540-1, and calibration is traceable to the National Institute of Standards and Technology (NIST). Calibration records are maintained on file at NTS.

Frequency Accuracy

In order for the EUT to successfully satisfy the requirements specified in the references listed in Section 2.0, the frequency accuracy of the recorded measurements shall be within $\pm 2\%$. Verification with a frequency counter or other measuring device shall be required. Amplitude Accuracy shall be ± 2 dB

4.2.2 Test Automation and Data Collection Software

Various software packages are used for test automation and data collection, depending on the test type. Refer to Table 4.2-1 below for information on the software used for each test.

Refer to Appendix A for detailed descriptions of each software package.

Table 4.2-1: Test Automation and Data Collection Software

Test	Manufacturer	Model	Rev	Date Verified
RE102	EMCware	AutoScan	7.4.4.14	9/12/2019
RS101	ETS Lindgren	TILE!	7.4.3.2	2/25/2019
RS103	ETS Lindgren	TILE!	7.4.3.2	2/25/2019
CE106	EMCware	AutoScan	2020.8.26	8/26/2020

4.3 General Test Requirements

4.3.1 Test Facility

All testing occurred within a shielded semi anechoic enclosure or shielded room, located in Tinton Falls, NJ. Semi anechoic chambers are lined with anechoic Radio Frequency (RF) absorbing tiles and cones on the walls and the ceiling. Peripheral equipment are located outside the shielded enclosure. All power leads entering the shielded enclosures will be routed via electromagnetic interference filters to provide at least 80 dB of attenuation above 10 kHz when measured in accordance with MIL-STD-220B. Interconnecting cables are routed via feed-through ports when practical. Shielding effectiveness to electric fields and plane waves of this EMI test chamber exceed 80 dB from 14 kHz-10 GHz, and 60 dB from 10 GHz-40 GHz.

4.3.2 Ground Plane and General Setup

When a ground plane is not present in the EUT installation, the EUT shall be placed on a non-conductive table as shown in Figure 4.3-1.

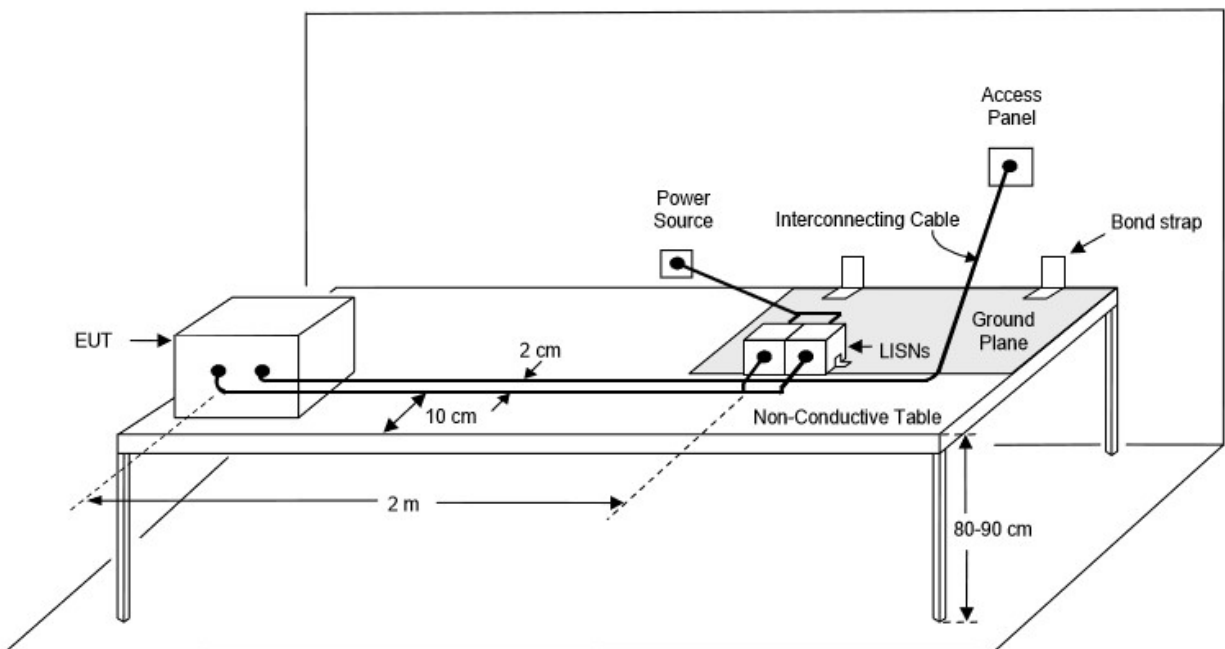


Figure 4.3-1: General Test Setup Example

4.4 Emissions Testing

Receiver Bandwidth and Measurement Time

The measurement receiver bandwidths listed in Table 4.4-1, which are derived from MIL-STD-461F, are used for emissions testing. These bandwidths are specified at the 6 dB down points for the overall selectivity curve of the receivers. Video filtering is not used to bandwidth limit the receiver response. A controlled video bandwidth is available on the measurement receivers used; it was set to its greatest value. This value was 50 MHz.

Table 4.4-1: Bandwidth and Measurement Times

Frequency Range	6 dB Bandwidth	Dwell Time ¹	Min Measurement Time of Analog Measurement Receiver
30 Hz-1 kHz	10 Hz	0.15 sec	0.015 sec/Hz
1 kHz-10 kHz	100 Hz	0.015 sec	0.15 sec/kHz
10 kHz-150 kHz	1 kHz	0.015 sec	0.015 sec/kHz
150 kHz-30 MHz	10 kHz	0.015 sec	1.5 sec/MHz
30 MHz-1 GHz	100 kHz	0.015 sec	0.15 sec/MHz
> 1GHz	1 MHz	0.015 sec	15 sec/GHz

Ambient Electromagnetic Level

During testing, the ambient electromagnetic level is measured with EUT de-energized and all auxiliary equipment turned on and shall be at least 6 dB below the allowable specified limits. Ambient conducted levels on power leads are measured with the leads disconnected from the EUT and connected to a resistive load which draws the same current as the EUT. The ambient are recorded in the EMITR.

4.5 Susceptibility Testing

For susceptibility measurements, the entire frequency range for each applicable test are scanned. For swept frequency susceptibility testing, frequency scan rates and frequency step sizes of signal sources did not exceed the values listed in Table 4.5-1. The rates and step sizes are specified in terms of a multiplier of the tuned frequency (f_o) of the signal source. Analog scans refer to signal sources which are continuously tuned. Stepped scans refer to signal sources which are sequentially tuned to discrete frequencies. Stepped scans dwell at each tuned frequency for 3 seconds. Scan rates and step sizes are decreased when necessary to permit observation of a response.

Table 4.5-1: Susceptibility Scanning

Frequency Range	Analog Scans Max Scan Rates	Stepped Scans Max Step Size
30 Hz - 1 MHz	$0.0333f_o/\text{sec}$	$0.05 f_o$
1 MHz - 30 MHz	$0.00667 f_o/\text{sec}$	$0.01 f_o$
30 MHz - 1 GHz	$0.00333 f_o/\text{sec}$	$0.005 f_o$
1 GHz - 40 GHz	$0.000667 f_o/\text{sec}$	$0.0025 f_o$

Modulation of Susceptibility RF Signals

Susceptibility test signals for RS103 and CS14 are pulse modulated (on/off ratio of 40 dB minimum) at 1 kHz rate with a 50% duty cycle.

Thresholds of Susceptibility

When susceptibility indications are noticed in EUT operation, a threshold level shall be determined when possible, and where the susceptible condition shall be no longer present. Thresholds of susceptibility are determined as follows:

- When a susceptibility condition is detected, the interference signal shall be reduced until the EUT recovered.
- The interference shall be reduced by an additional 6 dB.
- The interference signal shall be gradually increased until the susceptibility condition reoccurred.
- The level, frequency range of occurrence, frequency and level of greatest susceptibility, and other test parameters, as applicable will be recorded.

5.0 Test Methods, Procedures and Test Results

Test Methods and Test Results Summary

Table 5.0-1: Test Methods and Test Results Summary

Test Report Section	MIL-STD-461F Test Method	Description	Test Date(s)	Result
5.1	RE102	Radiated Emissions, Electric Field, 2 MHz to 18 GHz	7/24/19, 8/9/19	PASS
5.2	RS101	Radiated Susceptibility, Magnetic Field	9/6/19	PASS
5.3	RS103	Radiated Susceptibility, Electric Field, 2 MHz to 18 GHz	9/3/19 – 9/5/19	PASS
5.4	CE106	Conducted Emissions: Method CE106, Conducted Emissions Antenna Terminal, 10kHz to 40GHz	2/17/21	PASS

5.1 Method RE102: Radiated Emissions, Electric Field, 2 MHz to 18 GHz

5.1.1 RE102 Purpose

This test verifies that electric field emissions from the EUT shall not exceed the limit specified in Figure RE102-1 over the frequency range of 2 MHz to 18 GHz.

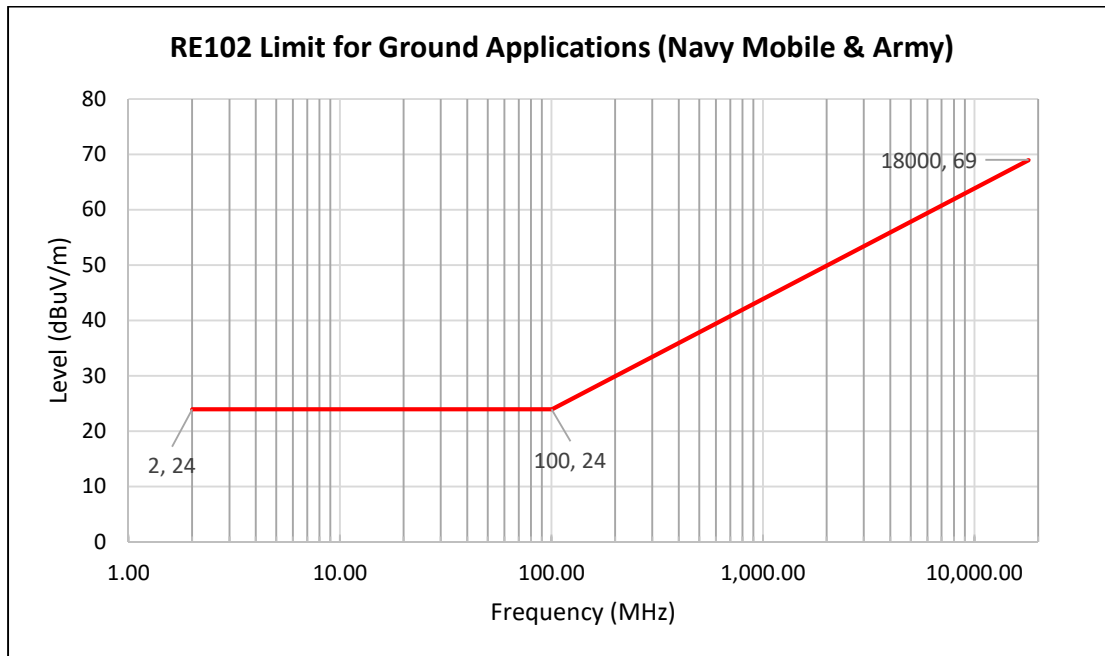


Figure RE102-1: RE102 limit for ground applications (Navy Mobile & Army).

5.1.2 RE102 Measurement System Check

1. The measurement system check was performed prior to testing.
 2. The measurement system was set up per Figure RE102-2.
 3. The evaluation was performed on the overall measurement system from each antenna to the data output device at the highest measurement frequency of the antenna. For the active rod antenna, the evaluation was performed at the lowest frequency of test, at a mid-band frequency, and at its highest measurement frequency.
 4. A signal generator was connected to the coax in place of the measurement antenna. For the active rod antenna, the active rod antenna calibration fixture was used in place of the rod element and the signal was injected across a 10 pF capacitor in the calibration fixture.
 5. The signal generator was adjusted to produce a signal 6 dB below the RE102 limit shown in Figure RE102-1.
 6. The signal detected at the measurement receiver was within ± 3 dB of the calibrated level.
 7. This process was repeated for each frequency defined as follows:
 - Active rod Antenna: 10.5 kHz (only for testing performed between 10 kHz and 2 MHz), 2.1MHz, 12MHz, 29.5 MHz
 - Biconical Antenna: 197 MHz
 - Large Double Ridged Horn Antenna: 990 MHz
 - Small Double Ridged Horn Antenna: 17.5 GHz
 8. Correction factors were added to the raw data collected from the measurement receiver. For example:

$$\text{Cable loss (dB)} + \text{Antenna factors (dB)} + \text{Raw Data (dB}\mu\text{V)} - \text{Preamplifier gain (dB)} = \text{corrected data (dB}\mu\text{V/m)}$$
 9. Using the measurement path of Figure RE102-2, the following evaluation for each antenna was performed to demonstrate that there is electrical continuity through the antenna:
 - A. A signal was radiated using an antenna or stub radiator at the highest measurement frequency of each antenna.
 - B. The measurement receiver was tuned to the frequency of the applied signal and the received signal of appropriate amplitude was present.
- Note:** This evaluation is intended to provide a coarse indication that the antenna is functioning properly. There is no requirement to accurately measure the signal level.
10. An ambient measurement was performed across the frequency range with the EUT power leads disconnected. All auxiliary support equipment was powered during this measurement.

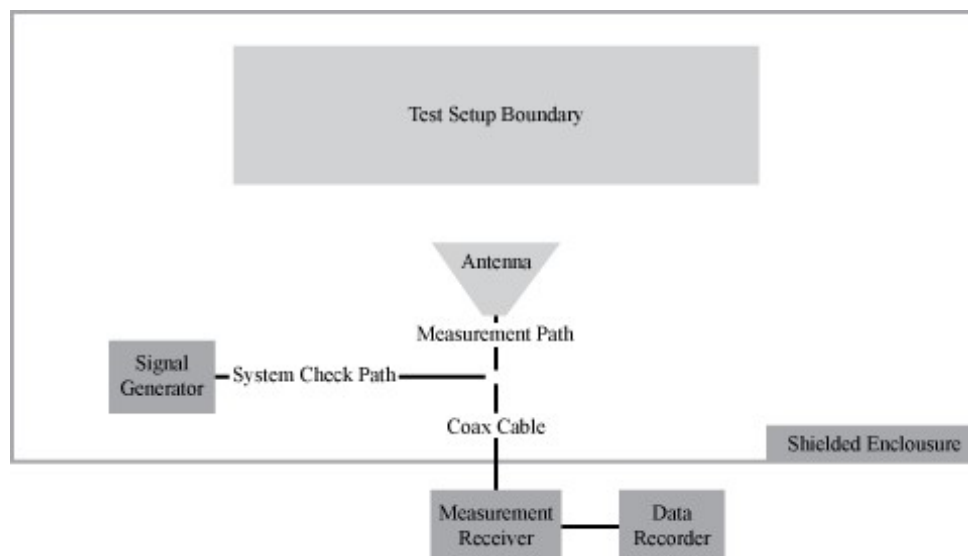


Figure RE102-2: RE102 Measurement System Check Setup

5.1.3 RE102 EUT Test Setup

The EUT was setup in accordance with Section 3.2, Figure 3.2-1 and operated according to Section 3.3.

5.1.4 RE102 Antenna Positioning

1. Measure the EUT and test setup boundary for use in positioning of antennas. Use the physical reference points on the antennas shown in Figure RE102-4 for measuring heights of the antennas and distances of the antennas from the test setup boundary.
2. Position antennas 1 meter from the front edge of the test setup boundary for all setups.
3. Position antennas other than the 104 cm rod antenna 120 cm above the floor ground plane.
4. Ensure that no part of any antenna is closer than 1 meter from the walls and 0.5 meter from the ceiling of the shielded enclosure.

The number of required antenna positions depends on the size of the EUT and test setup boundary and the number of enclosures included in the setup.

For testing below 200 MHz, use the following criteria to determine the individual antenna positions.

- a. For setups with the side edges of the boundary 3 meters or less, one position is required and the antenna was centered with respect to the side edges of the boundary.
- b. For setups with the side edges of the boundary greater than 3 meters, use multiple antenna positions at spacings as shown in Figure RE102-5. Determine the number of antenna positions (N) by dividing the edge-to-edge boundary distance (in meters) by 3 and rounding up to an integer.

For testing from 200 MHz up to 1 GHz, place the antenna in a sufficient number of positions such that the entire width of each EUT enclosure and the first 35 cm of cables and leads interfacing with the EUT enclosure are within the 3 dB beamwidth of the antenna.

For testing at 1 GHz and above, place the antenna in a sufficient number of positions such that the entire width of each EUT enclosure and the first 7 cm of cables and leads interfacing with the EUT enclosure are within the 3 dB beamwidth of the antenna.

Table RE102-1: RE102 Antenna Position Calculations, 2 MHz to 200 MHz

Antenna Model	Range Used (MHz)	Antenna Coverage (cm)	Test Setup Boundary (cm)	Antenna Positions
ETS 3301C	2 – 30	300	6.5	1
EMCO 3109	30 - 200	300	6.5	1

Table RE102-2: RE102 Antenna Coverage Calculations, 200 MHz to 18 GHz

Antenna Model	Range Used (GHz)	Minimum 3dB Beamwidth (°)	Coverage at 1 M Distance (cm)
ETS 3106	0.2 – 1.0	28	49.87
EMCO 3115	1 - 18	8	13.99
Antenna Coverage = $2 * (\tan(\Theta) * a)$ Where $\Theta = 1/2$ (antenna 3dB beamwidth) a = antenna distance from setup boundary			

Table RE102-3: RE102 Antenna Position Calculations, 200 MHz to 18 GHz

Antenna Model	Range Used (GHz)	Antenna Coverage @ 1 M (cm)	EUT Width ¹ (cm)	Antenna Positions Required
ETS 3106	0.2 – 1.0	49.87	6.5	1
EMCO 3115	1 - 18	13.99	6.5	1

Note 1: Did not add 35cm of cable (200 MHz – 1GHz) or 7cm of cable (>1 GHz), because the EUT has no cables.

5.1.5 RE102 Test Procedure

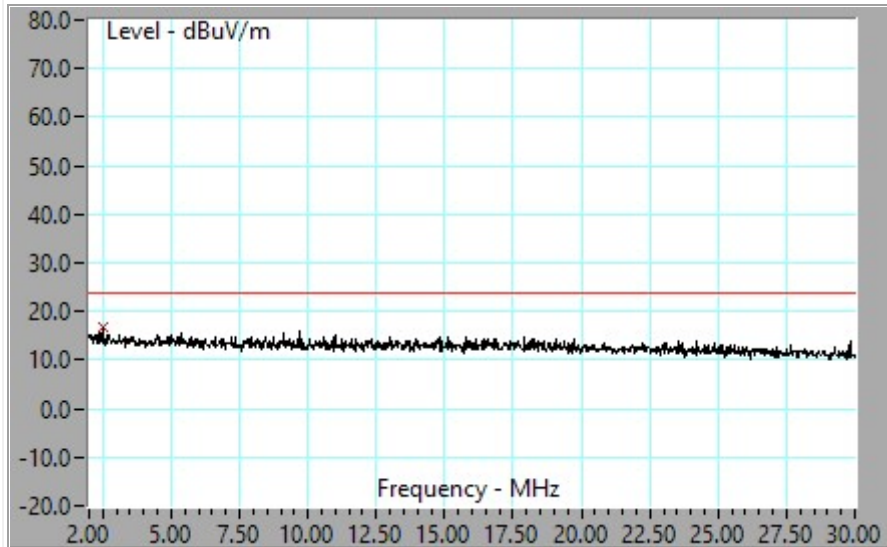
1. The EUT and test equipment were set up in accordance with Section 5.9.3.
2. The required frequency range was scanned using the bandwidths and minimum measurement times specified in Table 4.4-1.
3. Above 30 MHz, both horizontal and vertical polarities were tested. Below 30 MHz, only vertical polarity measurements were performed.
4. Correction factors were added to the raw data collected from the measurement receiver. For example:
5. Cable loss (dB) + Antenna factors (dB) + Raw Data (dBμV) - Preamplifier gain (dB) = corrected data (dBμV/m)
6. The following types of antennas, listed in Table RE102-2, were used to scan the entire frequency range:

Table RE102-4: Antenna Type and Applicable Frequencies

Antenna	Characteristics	Frequency Range
41" Active Rod	104 cm with impedance matching network, preamplifier, and square counterpoise measuring 60cm on a side	2 MHz - 30 MHz
Biconical	137 cm tip to tip	30 MHz - 200 MHz
Double Ridged Horn	69 x 94.5 cm opening	200 MHz - 1 GHz
Double Ridged Horn	24.2 x 13.6 cm opening	1 GHz - 18 GHz

5.1.6 RE102 Test Data

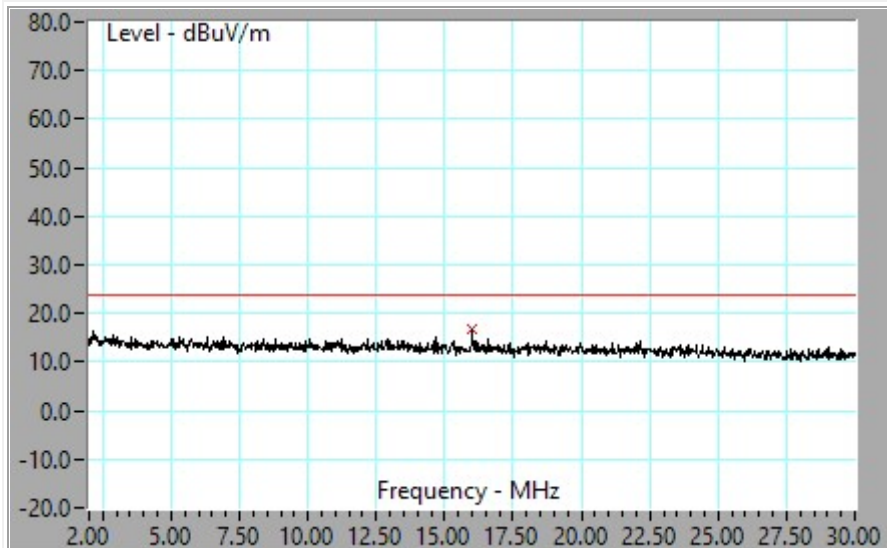
RE102 System Check: Calibrated Injected Signal 17dBuV @ 2.5MHz



Tue, Jul 23, 2019
10:26:31 AM
AutoScan 7.4.4.11
Res BW (kHz) 10
Vid BW (kHz) 50000
HORIZONTAL
ETS-Lindgren 3301C Active Monopole
Graph # 5
Sweep Time 90.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
2.504	16.9	24.0	-7.1	16.65	0.00	0.24	0.00	-0.24

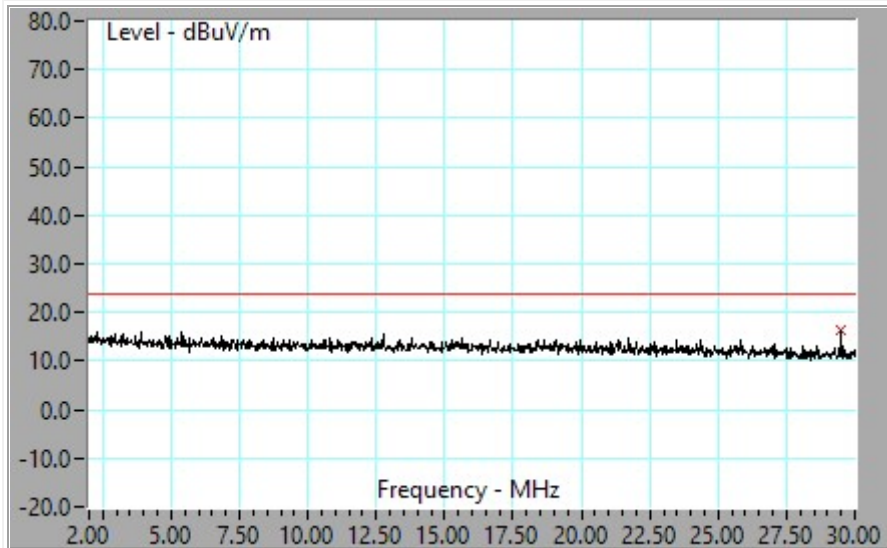
RE102 System Check: Calibrated Injected Signal 17dBuV @ 16MHz



Tue, Jul 23, 2019
10:45:08 AM
AutoScan 7.4.4.11
Res BW (kHz) 10
Vid BW (kHz) 50000
HORIZONTAL
ETS-Lindgren 3301C Active Monopole
Graph # 6
Sweep Time 90.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
16.000	16.9	24.0	-7.1	15.87	0.00	1.03	0.00	-1.03

RE102 System Check: Calibrated Injected Signal 17dBuV @ 29.5MHz



Tue, Jul 23, 2019

10:48:34 AM

AutoScan 7.4.4.11

Res BW (kHz) 10

Vid BW (kHz) 50000

HORIZONTAL

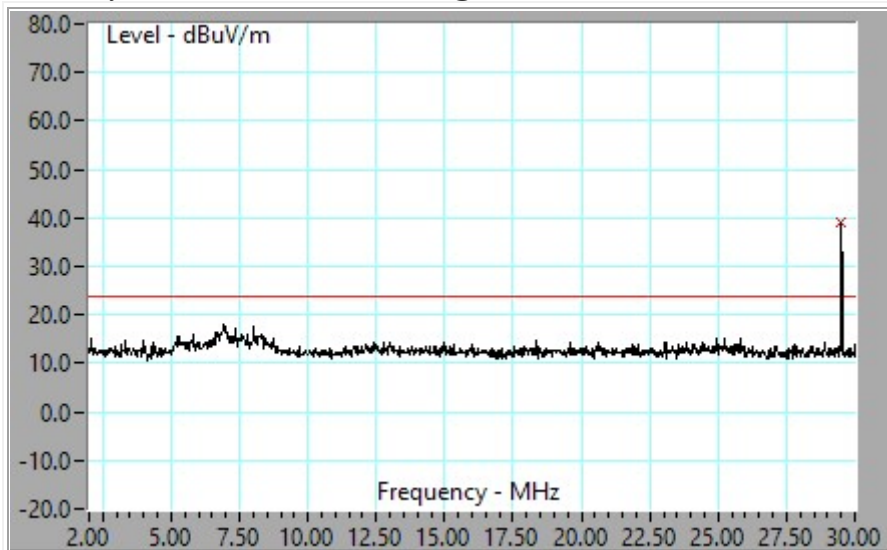
ETS-Lindgren 3301C Active Monopole

Graph # 7

Sweep Time 90.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
29.50	16.3	24.0	-7.7	14.69	0.00	1.62	0.00	-1.62

RE102 System Check: Stub Radiator @ 29.5MHz



Tue, Jul 23, 2019

11:17:59 AM

AutoScan 7.4.4.11

Res BW (kHz) 10

Vid BW (kHz) 50000

VERTICAL

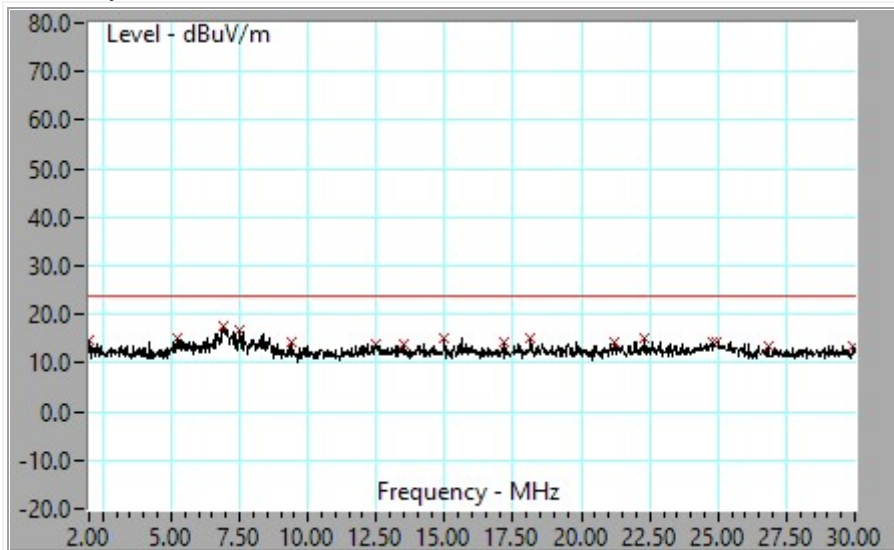
ETS-Lindgren 3301C Active Monopole

Graph # 3

Sweep Time 90.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
29.50	39.1	24.0	15.1	* 36.72	0.76	1.62	0.00	-2.38

RE102 System Check: 2-30MHz Ambient



Tue, Jul 23, 2019

11:32:06 AM

AutoScan 7.4.4.11

Res BW (kHz) 10

Vid BW (kHz) 50000

VERTICAL

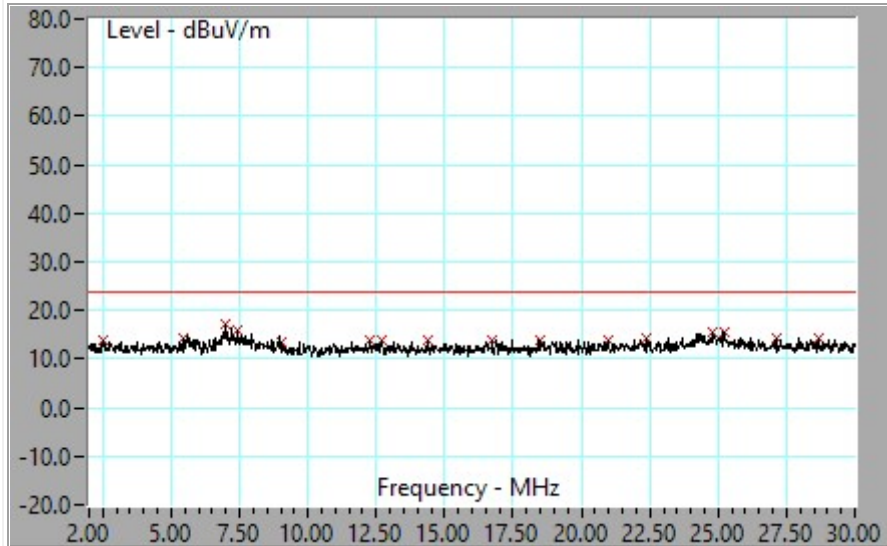
ETS-Lindgren 3301C Active Monopole

Graph # 5

Sweep Time 90.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
2.000	14.9	24.0	-9.1	16.33	-1.69	0.23	0.00	1.46
5.192	15.0	24.0	-9.0	16.33	-1.63	0.32	0.00	1.32
6.900	17.4	24.0	-6.6	18.64	-1.56	0.36	0.00	1.20
7.516	16.6	24.0	-7.4	17.73	-1.53	0.38	0.00	1.15
9.420	14.5	24.0	-9.5	15.44	-1.41	0.43	0.00	0.97
12.472	13.8	24.0	-10.2	14.30	-1.16	0.69	0.00	0.47
13.480	14.0	24.0	-10.0	14.30	-1.07	0.79	0.00	0.29
14.992	15.2	24.0	-8.8	15.15	-0.93	0.93	0.00	-0.00
17.204	14.5	24.0	-9.5	14.05	-0.70	1.15	0.00	-0.45
18.156	14.9	24.0	-9.1	14.31	-0.60	1.24	0.00	-0.63
21.180	14.4	24.0	-9.6	13.23	-0.25	1.44	0.00	-1.19
22.328	15.0	24.0	-9.0	13.61	-0.12	1.46	0.00	-1.35
24.792	14.4	24.0	-9.6	12.70	0.18	1.52	0.00	-1.70
24.932	14.5	24.0	-9.5	12.76	0.20	1.52	0.00	-1.72
26.836	13.7	24.0	-10.3	11.66	0.43	1.56	0.00	-1.99
29.944	13.7	24.0	-10.3	11.21	0.81	1.63	0.00	-2.44

RE102, 2 - 30MHz: SN 31783 w/ Terminators.



Wed, Jul 24, 2019

9:11:53 AM

AutoScan 7.4.4.11

Res BW (kHz) 10

Vid BW (kHz) 50000

VERTICAL

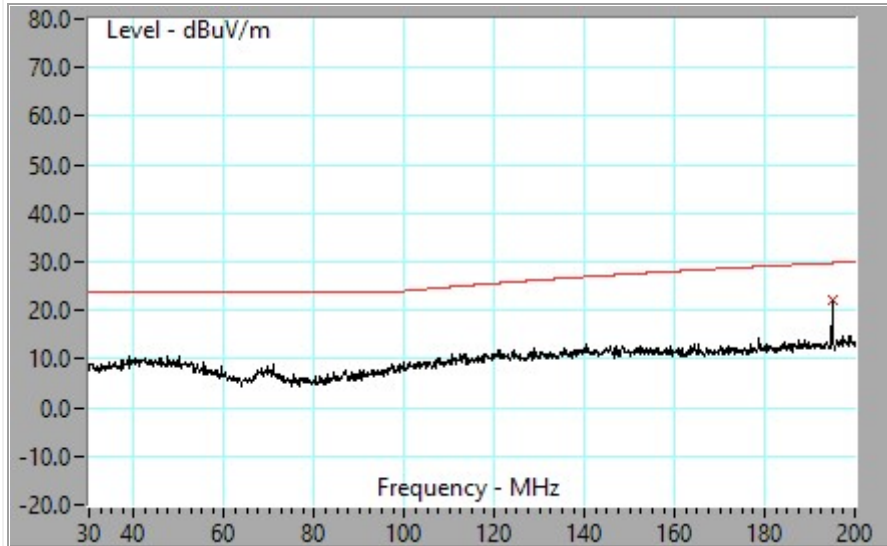
ETS-Lindgren 3301C Active Monopole

Graph # 11

Sweep Time 90.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
2.504	13.7	24.0	-10.3	15.15	-1.69	0.24	0.00	1.45
5.472	14.4	24.0	-9.6	15.73	-1.62	0.32	0.00	1.30
6.956	17.1	24.0	-6.9	18.29	-1.56	0.36	0.00	1.20
7.404	15.8	24.0	-8.2	16.99	-1.54	0.38	0.00	1.16
9.056	13.4	24.0	-10.6	14.43	-1.43	0.42	0.00	1.01
12.276	13.7	24.0	-10.3	14.21	-1.18	0.67	0.00	0.51
12.724	13.9	24.0	-10.1	14.29	-1.15	0.71	0.00	0.43
14.376	13.7	24.0	-10.3	13.83	-0.99	0.87	0.00	0.12
16.728	14.0	24.0	-10.0	13.66	-0.76	1.10	0.00	-0.34
18.464	14.0	24.0	-10.0	13.32	-0.56	1.27	0.00	-0.70
20.984	13.8	24.0	-10.2	12.70	-0.28	1.44	0.00	-1.15
22.356	14.2	24.0	-9.8	12.88	-0.11	1.46	0.00	-1.35
24.820	15.6	24.0	-8.4	13.89	0.18	1.52	0.00	-1.70
25.240	15.7	24.0	-8.3	13.92	0.23	1.53	0.00	-1.76
27.116	14.2	24.0	-9.8	12.15	0.46	1.57	0.00	-2.03
28.712	14.3	24.0	-9.7	12.00	0.66	1.60	0.00	-2.26

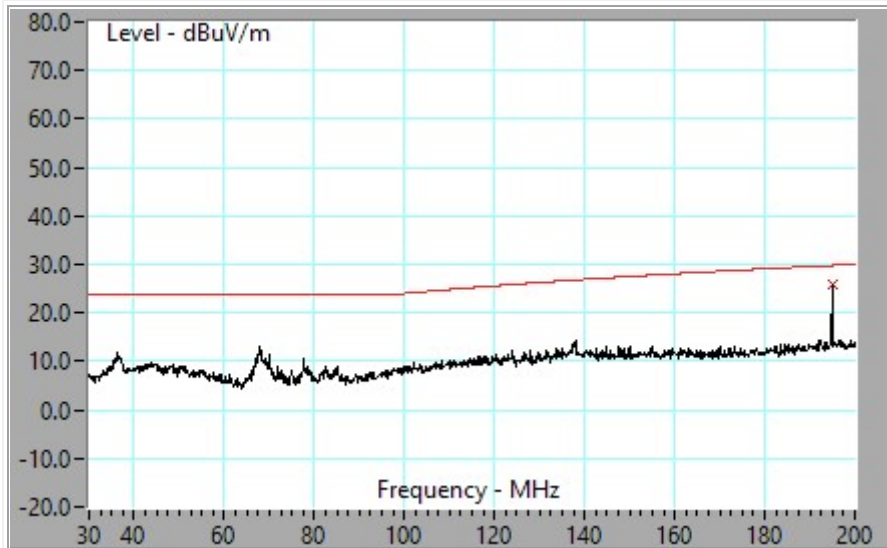
RE102 System Check: 19.92 dBuV @195MHz.



Mon, Jul 22, 2019
10:12:16 AM
AutoScan 7.4.4.11
Res BW (kHz) 100
Vid BW (kHz) 50000
VERTICAL
EMCO 3109
Pasternack PE15A1012
Graph # 1
Sweep Time 60.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
195.07	22.0	29.8	-7.8	43.71	14.92	4.06	40.68	21.70

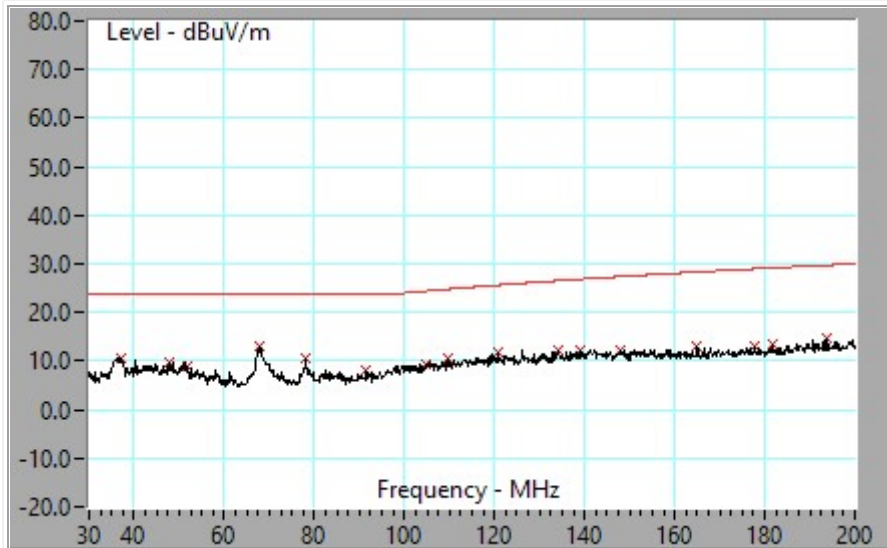
RE102 System Check: Stub Radiator @195MHz.



Mon, Jul 22, 2019
10:23:31 AM
AutoScan 7.4.4.11
Res BW (kHz) 100
Vid BW (kHz) 50000
VERTICAL
EMCO 3109
Pasternack PE15A1012
Graph # 2
Sweep Time 60.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
195.07	26.0	29.8	-3.8	47.69	14.92	4.06	40.68	21.70

RE102 System Check: 30-200MHz Ambient

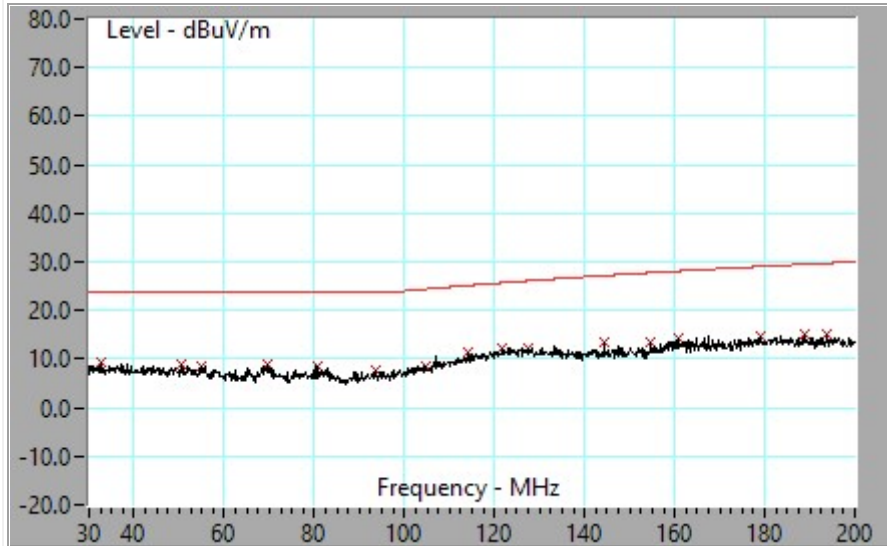


Mon, Jul 22, 2019
10:26:32 AM
AutoScan 7.4.4.11

Res BW (kHz) 100
Vid BW (kHz) 50000
VERTICAL
EMCO 3109
Pasternack PE15A1012
Graph # 3
Sweep Time 60.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
37.14	10.7	24.0	-13.3	37.12	12.38	1.80	40.61	26.43
47.68	9.9	24.0	-14.1	35.91	12.57	2.02	40.57	25.98
51.59	8.7	24.0	-15.3	35.07	12.13	2.10	40.56	26.33
67.74	12.9	24.0	-11.1	40.84	10.28	2.37	40.54	27.90
78.11	10.4	24.0	-13.6	40.07	8.35	2.54	40.57	29.68
91.37	8.3	24.0	-15.7	36.49	9.61	2.74	40.58	28.23
104.63	9.5	24.4	-14.8	35.74	11.45	2.93	40.58	26.20
109.73	10.4	24.8	-14.4	35.96	12.04	3.01	40.61	25.56
120.61	11.7	25.6	-13.9	36.19	12.97	3.16	40.60	24.46
134.04	12.2	26.5	-14.4	36.17	13.31	3.34	40.63	23.98
138.97	12.3	26.9	-14.5	35.85	13.70	3.39	40.63	23.54
148.15	12.4	27.4	-15.0	35.87	13.67	3.51	40.66	23.47
164.98	13.2	28.3	-15.2	36.42	13.70	3.71	40.68	23.27
177.73	13.2	29.0	-15.8	36.10	13.91	3.88	40.71	22.92
181.81	13.3	29.2	-15.8	35.95	14.15	3.93	40.70	22.62
193.88	14.9	29.7	-14.8	36.71	14.82	4.06	40.67	21.80

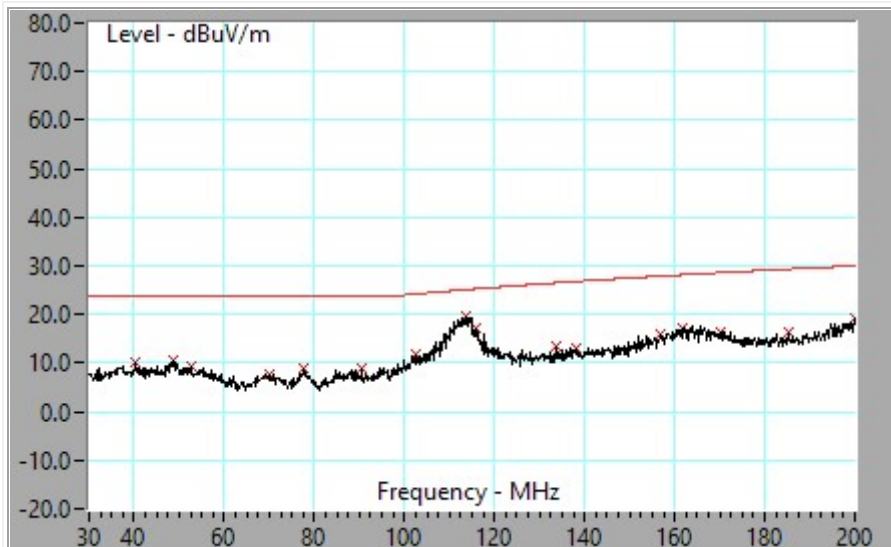
RE102, 30-200MHz: SN 31783 w/ Terminators.



Wed, Jul 24, 2019
8:51:00 AM
AutoScan 7.4.4.11
Res BW (kHz) 100
Vid BW (kHz) 50000
HORIZONTAL
EMCO 3109
Pasternack PE15A1012
Graph # 8
Sweep Time 60.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
32.72	9.2	24.0	-14.8	35.79	12.34	1.69	40.64	26.60
50.40	8.8	24.0	-15.2	35.69	11.55	2.08	40.56	26.94
54.99	8.6	24.0	-15.4	35.76	11.24	2.16	40.57	27.17
69.78	8.9	24.0	-15.1	36.10	10.99	2.40	40.56	27.18
80.83	8.5	24.0	-15.5	37.92	8.60	2.58	40.58	29.39
93.58	7.5	24.0	-16.5	35.96	9.37	2.77	40.57	28.43
104.63	8.6	24.4	-15.8	35.34	10.86	2.93	40.58	26.78
114.32	11.3	25.2	-13.9	36.06	12.73	3.08	40.60	24.79
121.80	12.4	25.7	-13.3	35.84	13.99	3.18	40.60	23.43
127.58	12.4	26.1	-13.7	35.62	14.13	3.26	40.63	23.24
144.41	13.5	27.2	-13.7	37.49	13.20	3.46	40.64	23.98
154.61	13.3	27.8	-14.5	37.58	12.78	3.59	40.66	24.29
160.73	14.4	28.1	-13.7	38.39	12.98	3.66	40.67	24.02
179.26	14.6	29.1	-14.4	36.08	15.35	3.90	40.71	21.46
188.78	15.1	29.5	-14.4	36.52	15.23	4.02	40.67	21.42
193.88	15.0	29.7	-14.8	36.63	14.96	4.06	40.67	21.66

RE102 30-200MHz: SN 31783 w/ Terminators.



Wed, Jul 24, 2019

9:01:18 AM

AutoScan 7.4.4.11

Res BW (kHz) 100

Vid BW (kHz) 50000

VERTICAL

EMCO 3109

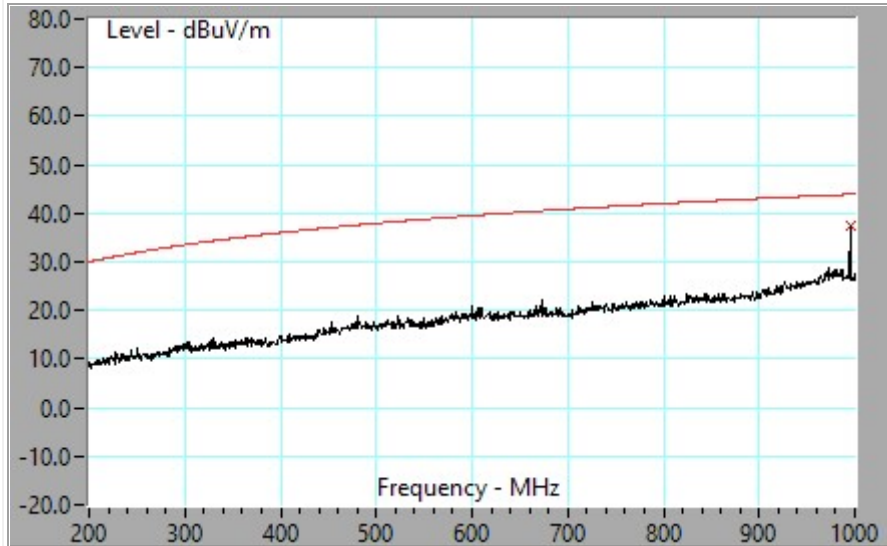
Pasternack PE15A1012

Graph # 9

Sweep Time 60.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
40.37	10.4	24.0	-13.6	36.41	12.68	1.88	40.61	26.05
48.53	10.7	24.0	-13.3	36.79	12.48	2.04	40.57	26.05
52.61	9.2	24.0	-14.8	35.73	11.87	2.11	40.56	26.58
70.12	7.8	24.0	-16.2	35.44	10.52	2.40	40.56	27.64
77.77	8.8	24.0	-15.2	38.47	8.35	2.53	40.57	29.69
90.52	8.9	24.0	-15.1	37.27	9.49	2.72	40.58	28.37
102.59	11.9	24.2	-12.3	38.34	11.24	2.90	40.56	26.42
113.47	19.5	25.1	-5.6	44.57	12.51	3.06	40.60	25.03
115.68	17.4	25.3	-7.9	42.21	12.65	3.09	40.60	24.86
133.87	13.4	26.5	-13.1	37.42	13.30	3.34	40.63	23.99
138.29	13.2	26.8	-13.6	36.79	13.62	3.39	40.63	23.62
156.82	16.1	27.9	-11.8	39.34	13.77	3.62	40.66	23.27
161.58	17.4	28.2	-10.8	40.61	13.74	3.67	40.67	23.26
170.08	16.5	28.6	-12.1	39.65	13.73	3.77	40.70	23.19
185.21	16.4	29.3	-12.9	38.92	14.24	3.97	40.69	22.47
200.00	19.3	30.0	-10.7	40.54	15.35	4.09	40.69	21.24

RE102 System Check: Calibrated Injected Signal 36.64 dBuV @ 995MHz.



Tue, Jul 23, 2019

8:57:53 AM

AutoScan 7.4.4.11

Res BW (kHz) 100

Vid BW (kHz) 50000

HORIZONTAL

ETS 3106

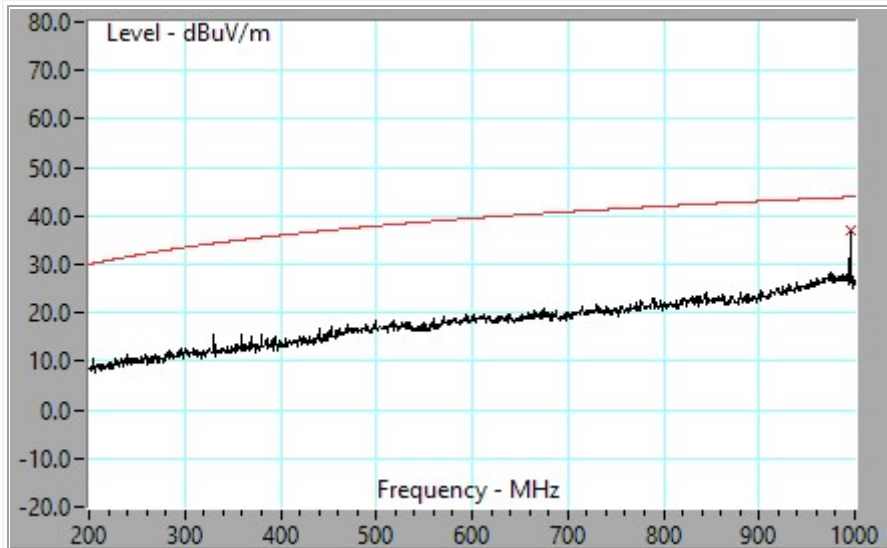
Pasternack PE15A1012

Graph # 1

Sweep Time 45.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
995.2	37.6	43.9	-6.3	44.25	22.64	9.87	39.11	6.61

RE102 System Check: Stub Radiator @ 995MHz



Tue, Jul 23, 2019

9:34:51 AM

AutoScan 7.4.4.11

Res BW (kHz) 100

Vid BW (kHz) 50000

HORIZONTAL

ETS 3106

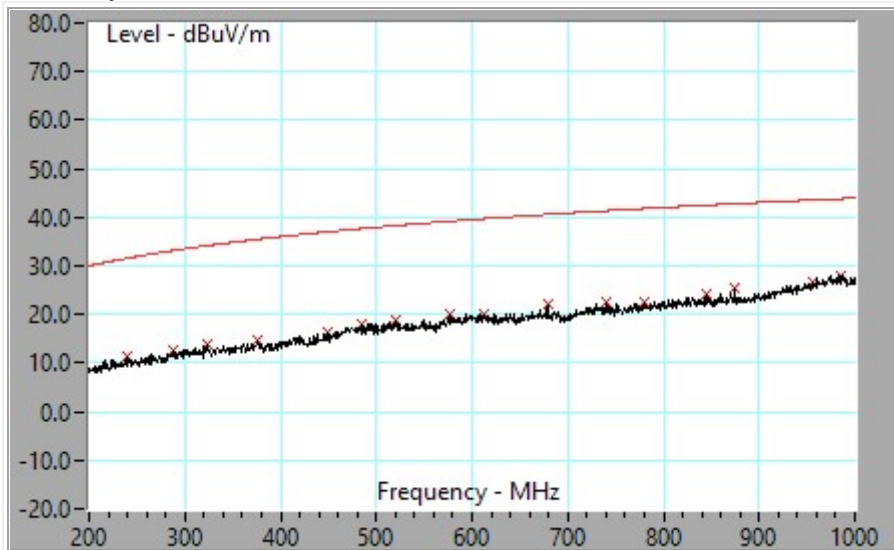
Pasternack PE15A1012

Graph # 2

Sweep Time 45.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
995.2	36.9	43.9	-7.0	43.55	22.64	9.87	39.11	6.61

RE102 System Check: 200MHz-1GHz Ambient



Tue, Jul 23, 2019

9:39:24 AM

AutoScan 7.4.4.11

Res BW (kHz) 100

Vid BW (kHz) 50000

HORIZONTAL

ETS 3106

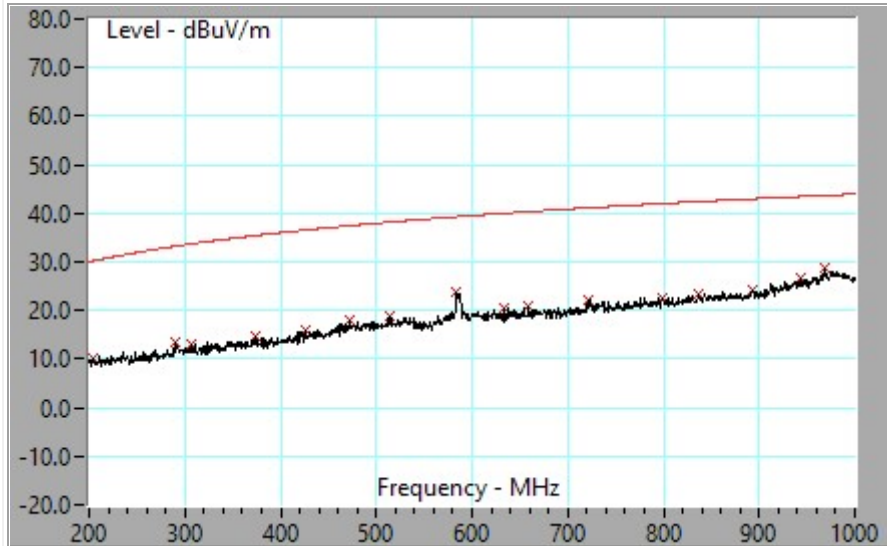
Pasternack PE15A1012

Graph # 4

Sweep Time 45.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
240.00	11.5	31.6	-20.1	36.44	11.25	4.50	40.72	24.97
287.20	12.6	33.1	-20.6	36.28	12.14	4.94	40.78	23.70
324.00	13.7	34.2	-20.5	36.29	12.89	5.30	40.78	22.59
376.00	14.6	35.5	-20.9	36.30	13.46	5.66	40.86	21.73
448.80	16.5	37.0	-20.5	36.25	14.81	6.28	40.86	19.77
484.80	18.2	37.7	-19.5	36.21	15.97	6.77	40.78	18.04
520.00	18.7	38.3	-19.6	36.42	16.26	6.78	40.75	17.71
577.60	20.0	39.2	-19.2	36.57	16.73	7.43	40.71	16.55
612.80	20.2	39.7	-19.5	36.27	17.24	7.31	40.65	16.10
679.20	22.3	40.6	-18.3	37.31	17.75	7.73	40.46	14.98
740.00	22.5	41.3	-18.8	36.53	18.13	8.05	40.16	13.98
780.00	22.7	41.8	-19.1	35.75	18.45	8.50	40.02	13.06
844.80	24.3	42.5	-18.2	35.96	19.55	8.62	39.81	11.64
875.20	25.5	42.8	-17.3	36.45	19.60	9.12	39.67	10.94
955.20	26.5	43.6	-17.1	34.09	22.26	9.25	39.12	7.60
985.60	27.9	43.8	-15.9	34.35	22.90	9.80	39.11	6.42

RE102, 200MHz-1GHz: SN 31783 w/ Terminators.



Wed, Jul 24, 2019

8:38:21 AM

AutoScan 7.4.4.11

Res BW (kHz) 100

Vid BW (kHz) 50000

HORIZONTAL

ETS 3106

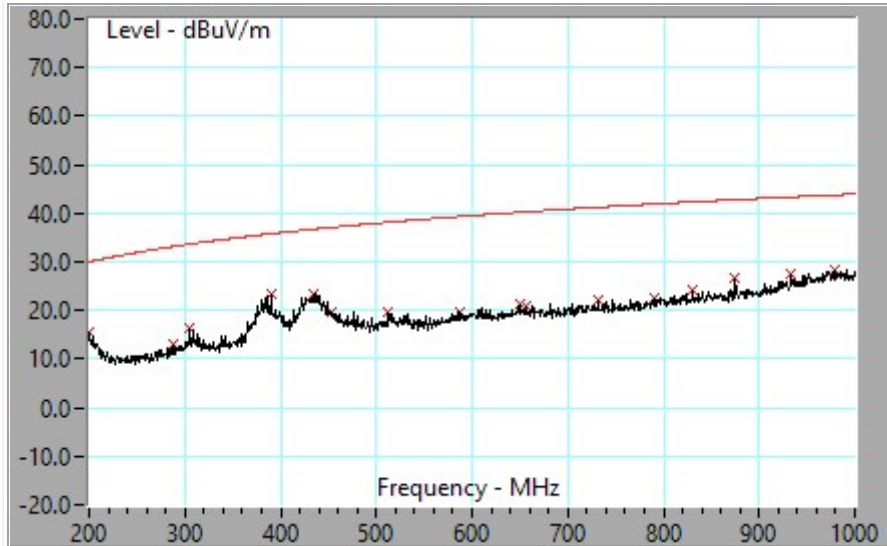
Pasternack PE15A1012

Graph # 5

Sweep Time 45.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
203.20	10.4	30.1	-19.8	36.52	10.42	4.12	40.69	26.15
289.60	13.4	33.2	-19.8	36.98	12.21	4.96	40.77	23.60
306.40	13.3	33.7	-20.5	36.30	12.60	5.11	40.76	23.05
372.80	14.6	35.4	-20.8	36.39	13.45	5.63	40.85	21.78
425.60	15.8	36.6	-20.8	36.66	13.81	6.15	40.86	20.90
472.80	18.1	37.5	-19.4	36.55	15.68	6.66	40.81	18.47
514.40	18.9	38.2	-19.3	36.65	16.27	6.77	40.75	17.71
583.20	23.9	39.3	-15.3	40.33	16.86	7.45	40.70	16.39
632.80	20.3	40.0	-19.7	36.30	17.24	7.38	40.62	16.00
658.40	20.8	40.3	-19.5	36.34	17.44	7.60	40.55	15.52
721.60	22.3	41.1	-18.9	36.39	18.08	8.04	40.25	14.13
799.20	22.7	42.0	-19.3	35.53	18.53	8.60	39.96	12.83
836.80	23.6	42.4	-18.8	35.30	19.53	8.60	39.84	11.72
892.80	24.3	43.0	-18.6	34.49	19.93	9.49	39.58	10.15
944.00	26.8	43.5	-16.6	35.09	21.75	9.14	39.17	8.28
968.00	28.6	43.7	-15.1	35.36	22.86	9.49	39.12	6.77

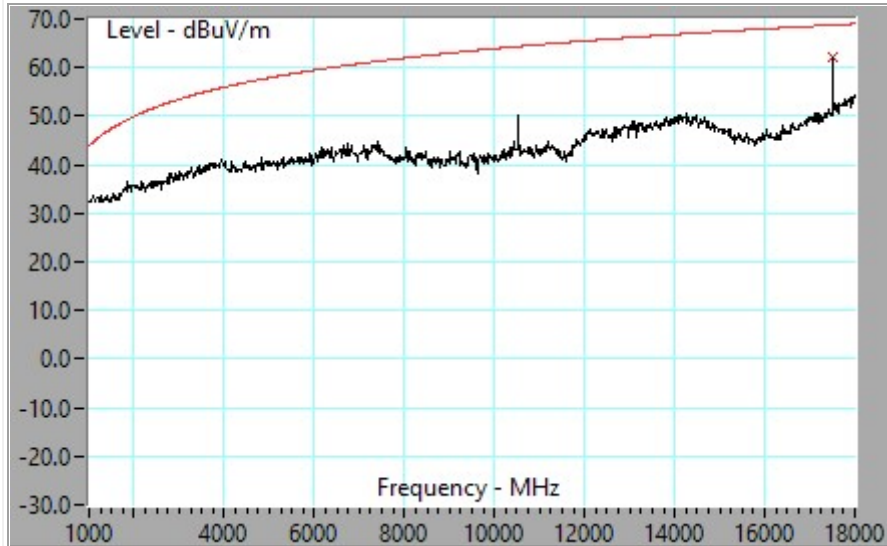
RE102, 200MHz-1GHz: SN 31783 w/ Terminators.



Wed, Jul 24, 2019
8:43:45 AM
AutoScan 7.4.4.11
Res BW (kHz) 100
Vid BW (kHz) 50000
VERTICAL
ETS 3106
Pasternack PE15A1012
Graph # 6
Sweep Time 45.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
200.00	15.4	30.0	-14.6	41.52	10.47	4.09	40.69	26.12
288.80	12.9	33.2	-20.3	36.48	12.27	4.96	40.77	23.55
305.60	16.2	33.7	-17.5	39.26	12.58	5.11	40.76	23.07
390.40	23.2	35.8	-12.6	44.66	13.56	5.87	40.86	21.43
433.60	23.4	36.7	-13.3	43.93	14.21	6.17	40.86	20.48
454.40	19.9	37.1	-17.2	39.45	14.91	6.36	40.85	19.58
512.00	19.5	38.2	-18.6	37.06	16.45	6.76	40.75	17.54
587.20	19.8	39.3	-19.5	36.02	17.06	7.45	40.69	16.18
651.20	21.2	40.2	-19.0	36.65	17.60	7.54	40.59	15.44
656.00	21.0	40.3	-19.3	36.31	17.62	7.58	40.56	15.36
732.00	22.3	41.2	-18.9	36.29	18.20	8.05	40.20	13.95
789.60	22.7	41.9	-19.2	35.40	18.70	8.62	39.99	12.66
830.40	24.1	42.3	-18.2	35.94	19.46	8.60	39.86	11.81
875.20	26.8	42.8	-16.0	37.53	19.83	9.12	39.67	10.71
933.60	27.4	43.4	-15.9	36.18	21.37	9.12	39.26	8.77
979.20	28.4	43.8	-15.3	34.87	22.99	9.70	39.12	6.43

RE102 System Check: Calibrated Injected Signal 63.54 dBuV @ 17.5GHz



Tue, Jul 23, 2019

1:23:13 PM

AutoScan 7.4.4.11

Res BW (kHz) 1000

Vid BW (kHz) 50000

VERTICAL

EMCO 3115

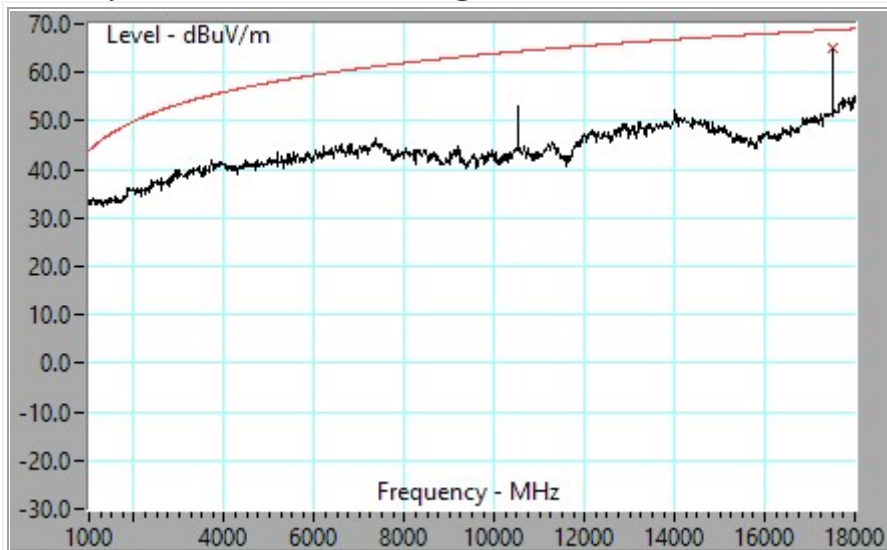
A.H. Systems PAM-0118P

Graph # 6

Sweep Time 60.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
17507.0	62.3	68.8	-6.5	49.82	44.54	12.36	44.45	-12.46

RE102 System Check: Stub Radiator @ 17.5GHz



Tue, Jul 23, 2019

1:50:58 PM

AutoScan 7.4.4.11

Res BW (kHz) 1000

Vid BW (kHz) 50000

HORIZONTAL

EMCO 3115

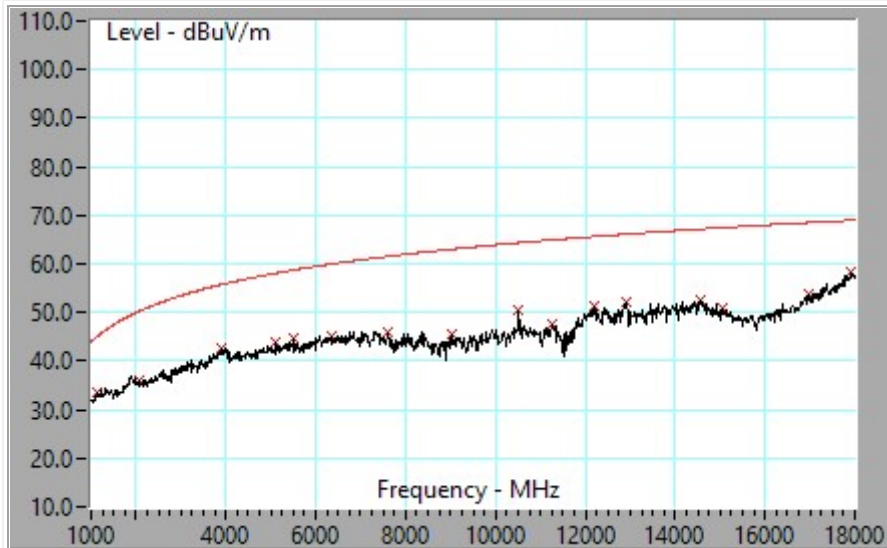
A.H. Systems PAM-0118P

Graph # 7

Sweep Time 60.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
17507.0	64.9	68.8	-3.8	51.46	45.54	12.36	44.45	-13.46

RE102 System Check: 1-18GHz Ambient



Fri, Aug 9, 2019

9:10:40 AM

AutoScan 7.4.4.11

Res BW (kHz) 1000

Vid BW (kHz) 50000

HORIZONTAL

EMCO 3115 (1 Meter)

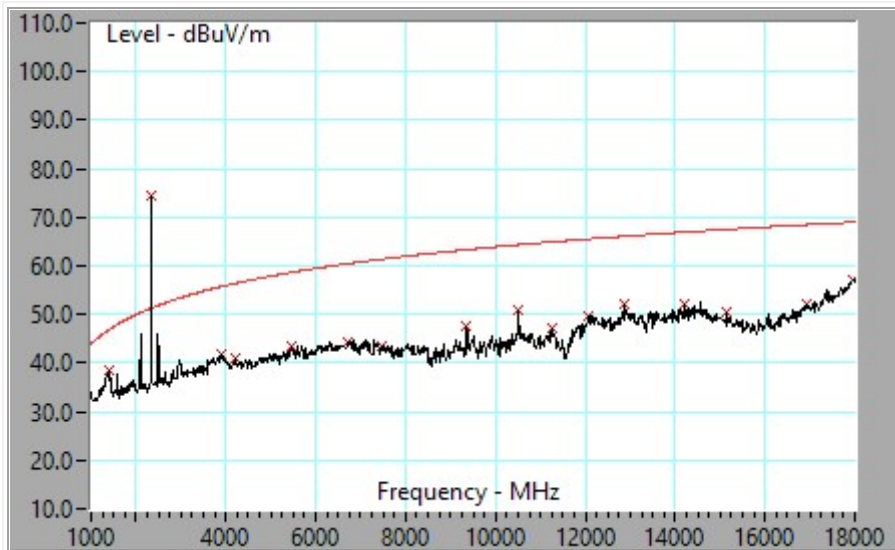
A.H. Systems PAM-0118P

Graph # 5

Sweep Time 60.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
1119.0	33.4	44.9	-11.5	45.24	25.80	3.56	41.20	11.85
2088.0	36.2	50.3	-14.2	44.37	28.90	4.30	41.40	8.19
3907.0	42.6	55.8	-13.1	44.28	34.19	6.11	41.96	1.66
5114.0	43.7	58.1	-14.4	44.08	35.26	7.09	42.71	0.36
5505.0	44.7	58.7	-14.1	43.87	35.99	7.25	42.45	-0.79
6355.0	45.3	60.0	-14.7	43.44	36.40	8.18	42.70	-1.88
7613.0	45.9	61.5	-15.7	40.82	38.57	8.77	42.31	-5.04
9041.0	45.7	63.0	-17.4	39.49	39.60	9.03	42.45	-6.18
10520.0	50.6	64.3	-13.7	43.53	39.70	10.13	42.73	-7.10
11268.0	47.7	64.9	-17.2	39.60	40.14	10.85	42.85	-8.13
12203.0	51.2	65.6	-14.4	39.37	40.40	13.55	42.09	-11.86
12900.0	52.3	66.1	-13.9	40.15	41.40	12.69	41.97	-12.12
14566.0	52.6	67.2	-14.6	40.17	42.57	11.78	41.92	-12.42
15042.0	50.9	67.4	-16.5	40.83	41.13	11.19	42.24	-10.08
16963.0	53.8	68.5	-14.7	41.14	43.26	12.53	43.17	-12.62
17915.0	58.2	69.0	-10.7	40.65	48.57	12.70	43.69	-17.58

RE102: 1-18GHz: SN 38126 w/ Terminators.



Fri, Aug 9, 2019

10:42:38 AM

AutoScan 7.4.4.11

Res BW (kHz) 1000

Vid BW (kHz) 50000

VERTICAL

EMCO 3115

A.H. Systems PAM-0118P

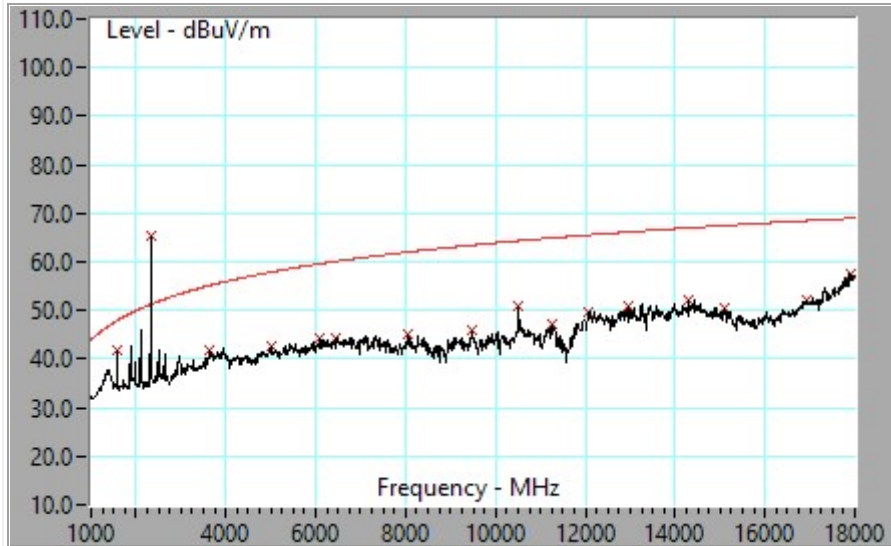
Graph # 14

Sweep Time 60.0000

Frequency	Level	Limit	Delta		Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB		dBuV	dB	dB	dB	dB
1408.0	38.5	46.9	-8.5		50.45	25.12	4.25	41.36	11.99
2343.0	74.4	N/A	N/A	*	82.89	28.46	4.53	41.45	8.47
3890.0	41.8	55.7	-13.9		44.58	33.22	6.06	42.02	2.74
4213.0	40.8	56.4	-15.6		43.90	32.60	6.54	42.23	3.09
5454.0	43.5	58.7	-15.2		43.63	34.92	7.31	42.39	0.16
6712.0	44.5	60.5	-16.0		42.19	36.12	8.61	42.45	-2.28
7460.0	43.6	61.4	-17.8		39.04	37.68	8.31	41.46	-4.53
9364.0	47.5	63.3	-15.9		43.61	38.67	9.21	44.02	-3.86
10520.0	51.0	64.3	-13.4		44.86	38.74	10.13	42.73	-6.14
11251.0	47.1	64.9	-17.8		39.93	39.20	10.83	42.83	-7.20
12067.0	49.9	65.5	-15.7		39.41	39.63	12.93	42.11	-10.45
12883.0	52.2	66.1	-13.9		40.82	40.47	12.88	41.94	-11.41
14226.0	52.3	67.0	-14.6		40.19	42.45	11.48	41.80	-12.13
15144.0	50.5	67.5	-17.0		40.58	40.32	11.52	41.93	-9.91
16929.0	52.2	68.5	-16.2		40.90	42.20	12.27	43.13	-11.34
17949.0	57.2	69.0	-11.8		40.46	47.50	12.77	43.52	-16.75

* 2.343 GHz is the EUT fundamental frequency. RE102 limit does not apply.

RE102: 1-18GHz: SN 38126 w/ Terminators.



Fri, Aug 9, 2019

10:46:52 AM

AutoScan 7.4.4.11

Res BW (kHz) 1000

Vid BW (kHz) 50000

HORIZONTAL

EMCO 3115

A.H. Systems PAM-0118P

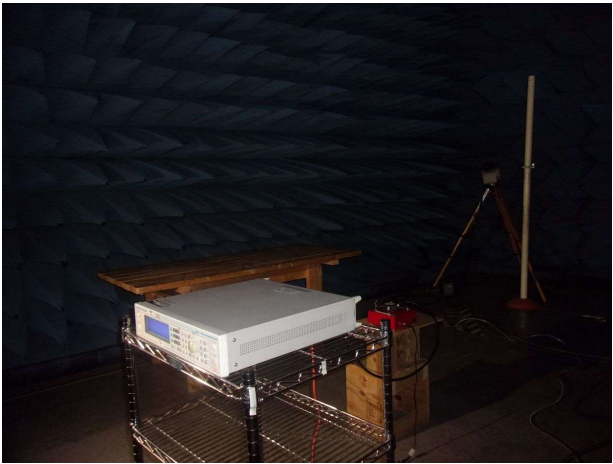
Graph # 15

Sweep Time 60.0000

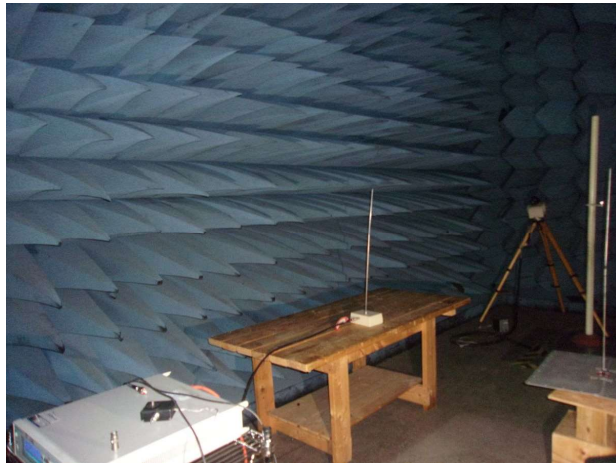
Frequency	Level	Limit	Delta		Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB		dBuV	dB	dB	dB	dB
1578.0	41.8	47.9	-6.1		53.56	25.51	4.02	41.34	11.80
2343.0	65.5	N/A	N/A	*	73.96	28.46	4.53	41.45	8.47
3652.0	42.0	55.2	-13.2		45.67	32.31	5.82	41.80	3.67
4995.0	42.5	57.9	-15.4		44.03	34.09	6.75	42.34	1.50
6100.0	44.2	59.6	-15.5		43.78	35.30	8.04	42.97	-0.38
6457.0	44.3	60.1	-15.8		43.30	35.30	8.30	42.55	-1.04
8072.0	45.0	62.1	-17.1		40.58	37.81	8.77	42.20	-4.38
9466.0	45.7	63.4	-17.7		41.03	38.63	9.27	43.18	-4.72
10520.0	50.9	64.3	-13.5		44.75	38.74	10.13	42.73	-6.14
11251.0	47.2	64.9	-17.7		40.02	39.20	10.83	42.83	-7.20
12067.0	49.8	65.5	-15.7		39.37	39.63	12.93	42.11	-10.45
12951.0	51.1	66.1	-15.0		39.59	40.60	12.78	41.86	-11.52
14311.0	52.1	67.0	-14.9		40.48	42.28	11.26	41.94	-11.59
15093.0	50.3	67.5	-17.2		40.72	40.51	11.20	42.12	-9.60
16929.0	52.3	68.5	-16.2		40.91	42.20	12.27	43.13	-11.34
17898.0	57.5	69.0	-11.5		41.00	47.59	12.67	43.77	-16.49

* 2.343 GHz is the EUT fundamental frequency. RE102 limit does not apply.

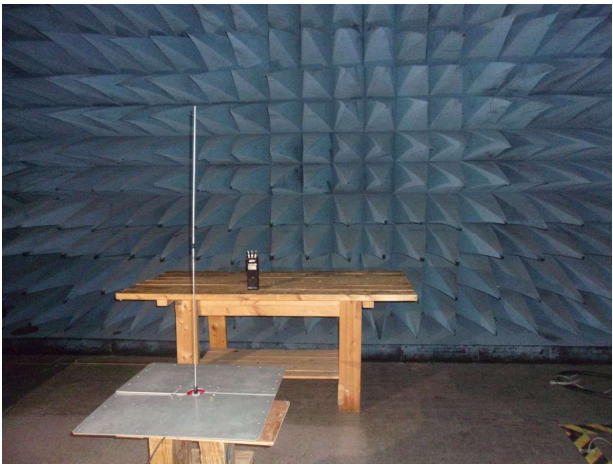
5.1.7 RE102 Photographs



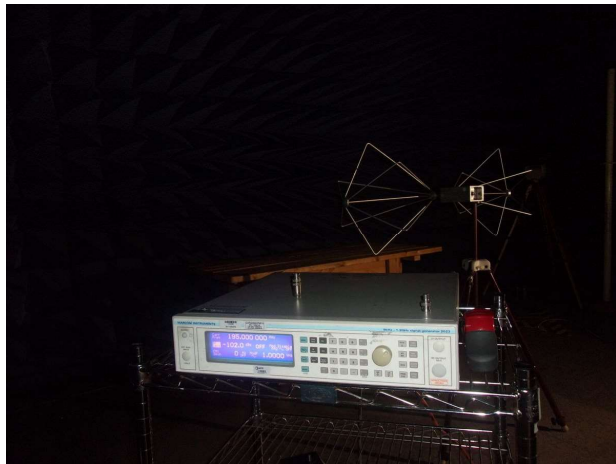
01 - 2-30MHz Calibrated Signal



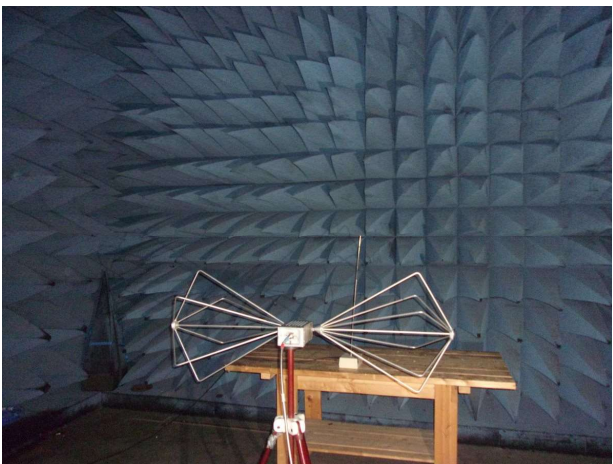
02 - 2-30MHz Stub Radiator



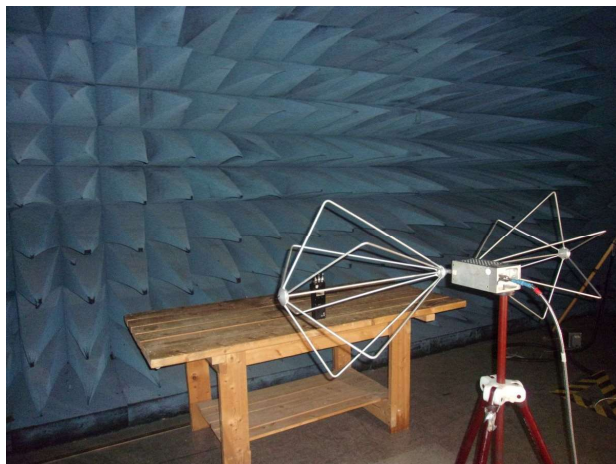
03 - 2-30MHz EUT Scan



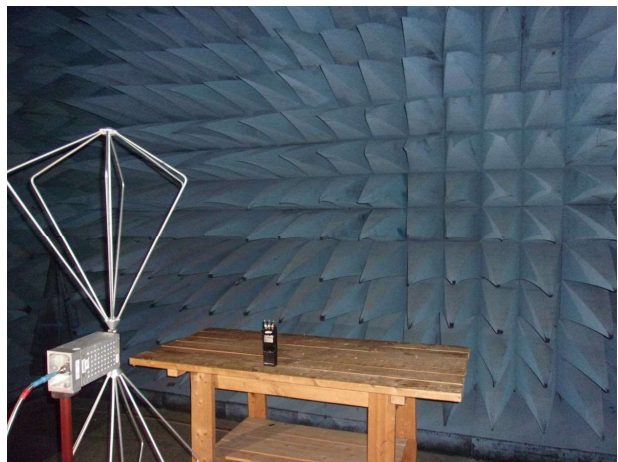
04 - 30-200MHz Calibrated Signal



05 - 30-200MHz Stub Radiator



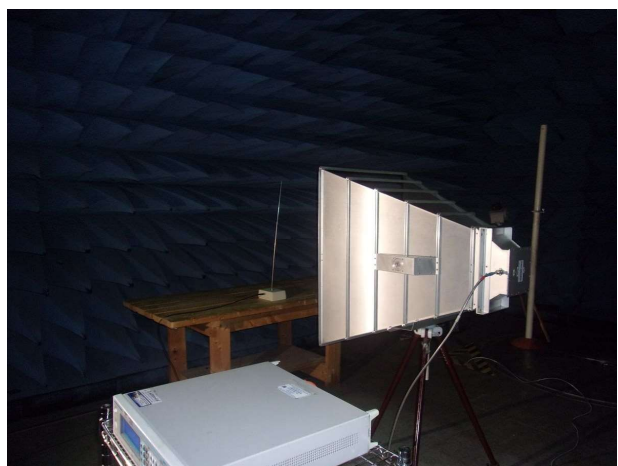
06 - 30-200MHz Horizontal EUT Scan



07 - 30-200MHz Vertical EUT Scan



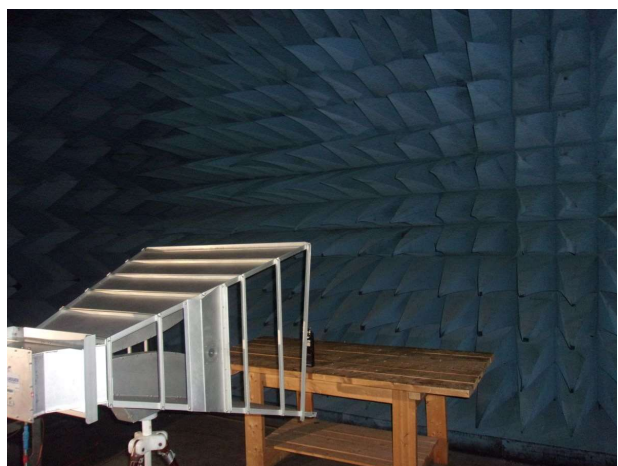
08 - 200MHz-1GHz Calibrated Signal



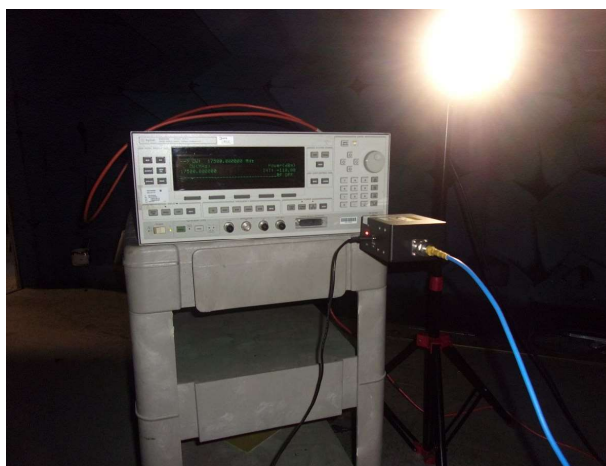
09 - 200MHz-1GHz Stub Radiator



10 - 200MHz-1GHz Horizontal EUT Scan



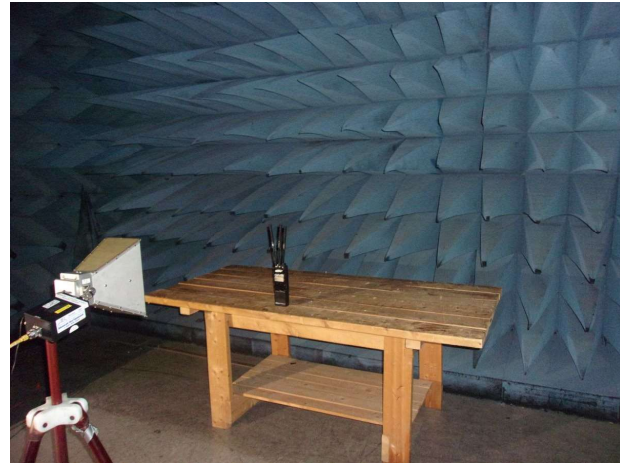
11 - 200MHz-1GHz Vertical EUT Scan



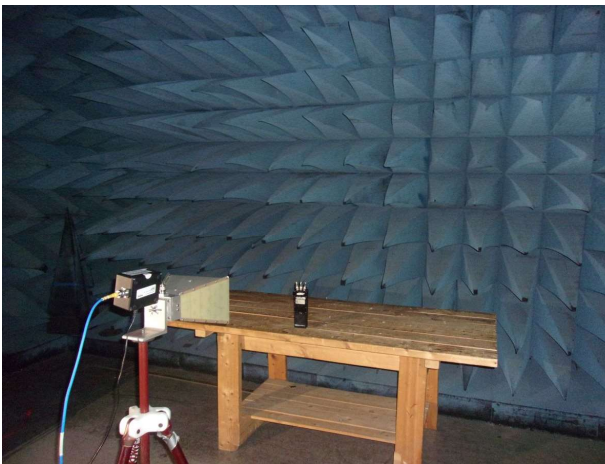
12 - 1-18GHz Calibrated Signal



13 - 1-18GHz Stub Radiator



14 - 1-18GHz Horizontal EUT Scan



15 - 1-18GHz Vertical EUT Scan

5.1.8 RE102 Test Equipment

Table RE102-5: RE102 Test Equipment List

Asset No.	Manufacturer	Item	Model	S/N	Cal Cycle (Months)	Cal. Due
WC024135	Agilent	MXE EMI Receiver	N9038A	MY51210117	12	8/6/20
WC005829	ETS-Lindgren	Active Rod Antenna	3301C	00114485	12	10/15/20
WC006573	EMCO	Biconical Antenna	3109	9411-2853	36	3/9/20
WC005310	ETS-Lindgren	Large Horn Antenna	3106	35382	36	3/9/20
WC005297	ETS-Lindgren	Horn Antenna	3115	2328	36	9/15/20
WC005615	A.H. Systems	Preamplifier	PAM-0118P	393	12	10/5/19
WC058460	Pasternack	Preamplifier	PE15A1012	V00140120190430G59	12	7/19/20
WC024134	Winchester	50 Ohm Coaxial Cable	250-250-3803600	AR3	24	3/15/21
WC005733	NTS	Stub Radiator	MIL-STD-461 Stub Radiator	None	NCR	NCR
WC005477	Marconi	Signal Generator	2023	112253/143	12	5/7/20
WC005556	Agilent	Signal Generator	8372B	US34490403	12	5/7/20

NCR = No Calibration Required; as per NTS QA policy, the equipment does not require calibration as long as the test signal being generated can be verified with other calibrated equipment prior to or during the test.

5.2 Method RS101: Radiated Susceptibility, Magnetic Field

This requirement is applicable from 30 Hz to 100 kHz for equipment and subsystem enclosures, including electrical cable interfaces. The requirement is not applicable for electromagnetic coupling via antennas.

5.2.1 RS101 Purpose

This test procedure is used to verify the ability of the EUT to withstand radiated magnetic fields.

5.2.2 RS101 Limits

The EUT shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to the magnetic fields shown on Figure RS101-1.

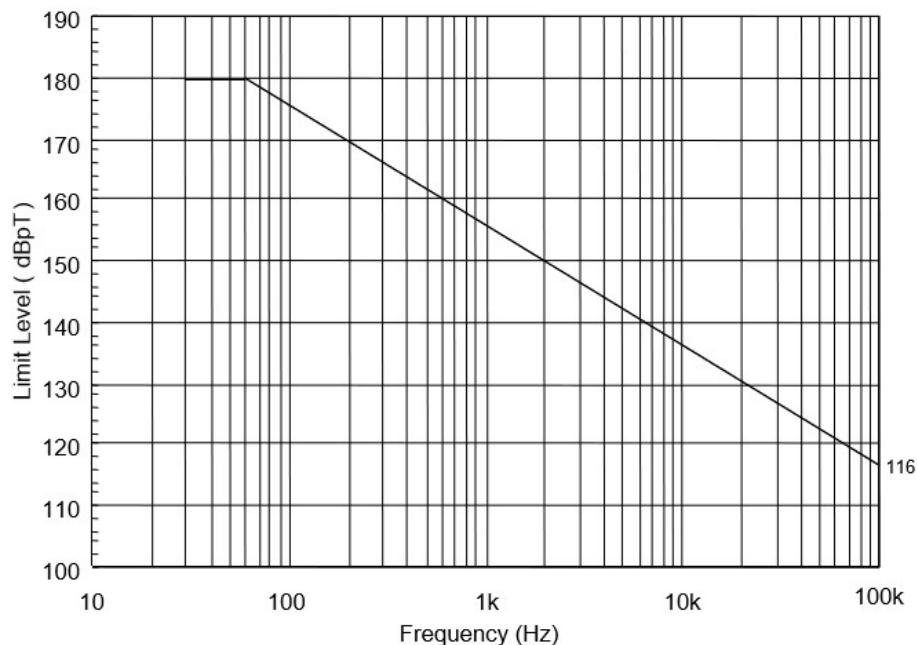


Figure RS101-1: RS101 limit for all Army applications.

5.2.3 RS101 Calibration

This procedure was performed prior to the start of testing, to assure that the overall system is operating properly.

1. Configure the measurement equipment, radiating loop, and loop sensor as shown in Figure RS101-2.
2. Set the signal source to a frequency of 1 kHz and adjust the output current to generate a magnetic flux density of 110 dB above one picotesla as determined by the reading obtained on measurement receiver A.
3. Measure the voltage output from the loop sensor using measurement receiver B.
4. Verify that the output on measurement receiver B is within ± 3 dB of the expected value based on the antenna factor and record this value.
5. Set the signal source to a frequency of 30Hz and adjust the output current to generate a magnetic flux density of 10dBpT above the applicable limit.
6. Record the current required to achieve the required field.
7. Repeat Steps 5 and 6 for each frequency between 30Hz and 100kHz, using the step size defined in Table 4.5-1.

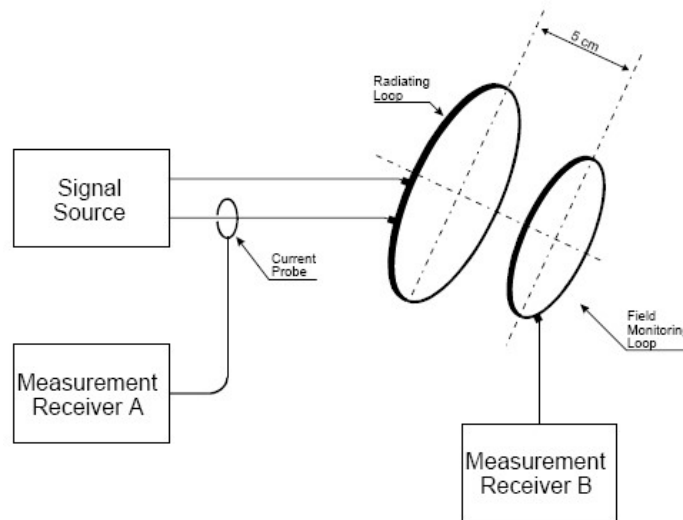


Figure RS101-2: Calibration of the radiating system.

5.2.4 RS101 EUT Test Setup

The EUT was setup in accordance with Section 3.2, Figure 3.2-1, 4.3-1 and operated according to Section 3.3.

5.2.5 RS101 Test Procedure

1. The plane of the transmitting loop was placed 5 cm from and oriented parallel to each of the EUT faces and parallel to the axis of connectors (refer to test data and photos for details).
2. While monitoring the EUT for susceptibility, the loop was supplied with the calibrated current levels required to produce magnetic field strengths indicated on the calibration sheet (applicable limit +10dBpT). The frequency range of 30Hz – 100KHz was swept using the step sizes specified in Table 4.5-1.

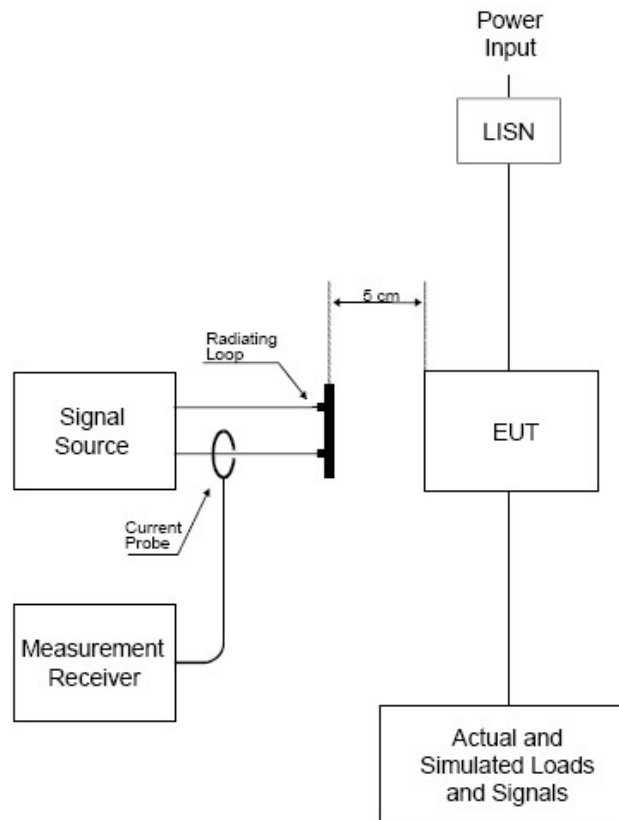


Figure RS101-3: RS101 Basic test setup.

5.2.6 RS101 Test Data

RS101 Data Sheet

Job Number:	PR102216	Standard:	MIL-STD-461F
Date:	9/6/19	Procedure:	None
Manufacturer:	Persistent Systems LLC	EUT:	MPU5 Radio with RF-2150 10W S-Band Card
Model Number:	WR-5100, RF-2150	S/N:	31783
Input Power	Battery	Test Personnel:	Tristian Gaines

RS101 Specification Limits:

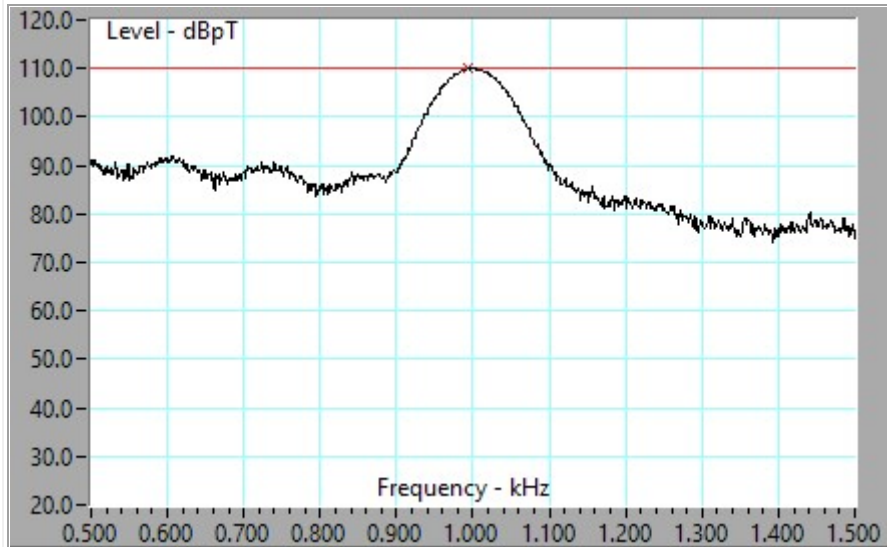
Signal Applied	Test Specification Limit	Susceptibility Criteria
Magnetic Field	30Hz – 60Hz: 180dBpT 60Hz – 100kHz: 180 – 116dBpT (RS101-2 Army)	The EUT was monitored for any degradation in performance according to Section 3.4.

RS101 Test Results:

Probe Position	Level (dBpT)	EUT Abnormalities	Results (Pass/Fail)
Front Side	Limit +10dB	None	PASS
Back Side	Limit +10dB	None	PASS
Right Side	Limit +10dB	None	PASS
Left Side	Limit +10dB	None	PASS
Bottom	Limit +10dB	None	PASS
Antennas/Connectors Front	Limit +10dB	None	PASS
Antennas/Connectors Rear	Limit +10dB	None	PASS

RS101 System Check Graphs

RS101 System Check: 1kHz Signal Measured with Current Probe

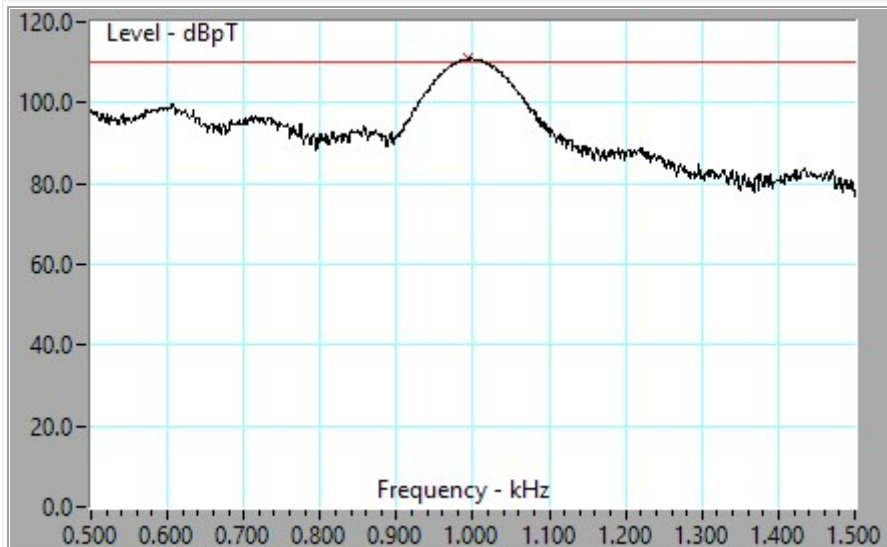


Fri, Sept 6, 2019
7:54:21 AM
AutoScan 7.4.4.13
Res BW (kHz) 0.10
Vid BW (kHz) 50000
BCP-510
Graph # 1
Sweep Time 3.0000

Scan Data

Frequency	Level	Limit	Delta	Raw	LISN	Cable	Xducer	All Factors
kHz	dBpT	dBpT	dB	dBpT	dB	dB	dB	dB
0.994	110.0	110.0	0.0	45.35	0.00	0.00	64.68	-64.68

RS101 System Check: 1kHz Signal Measured with Loop Sensor

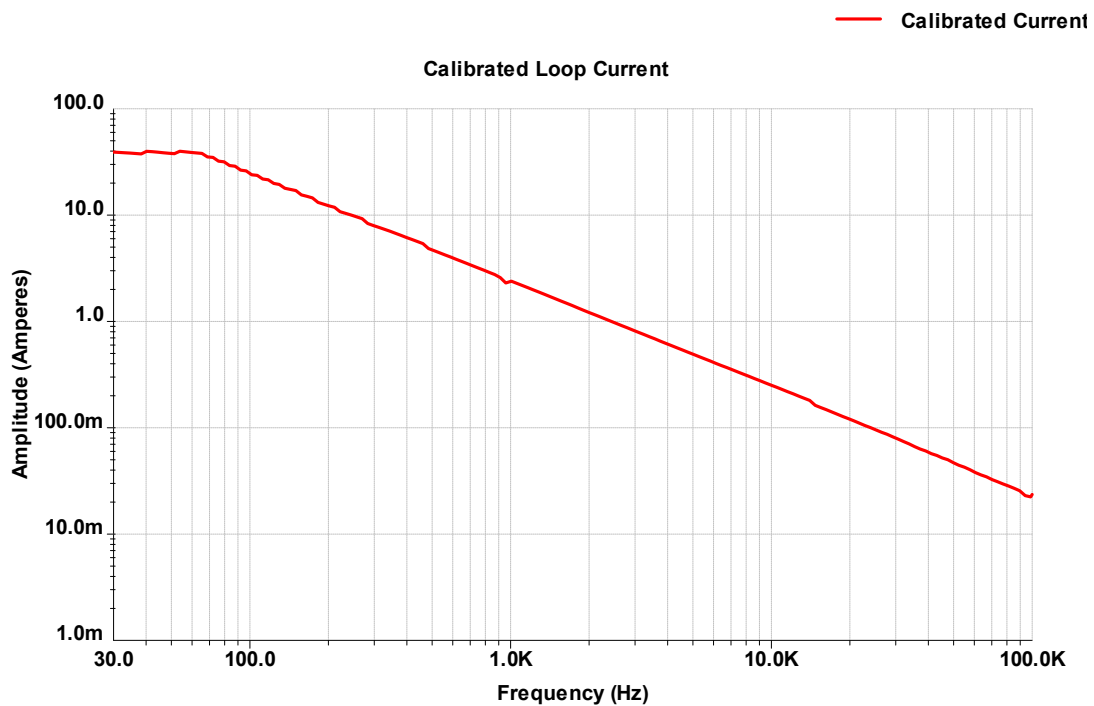
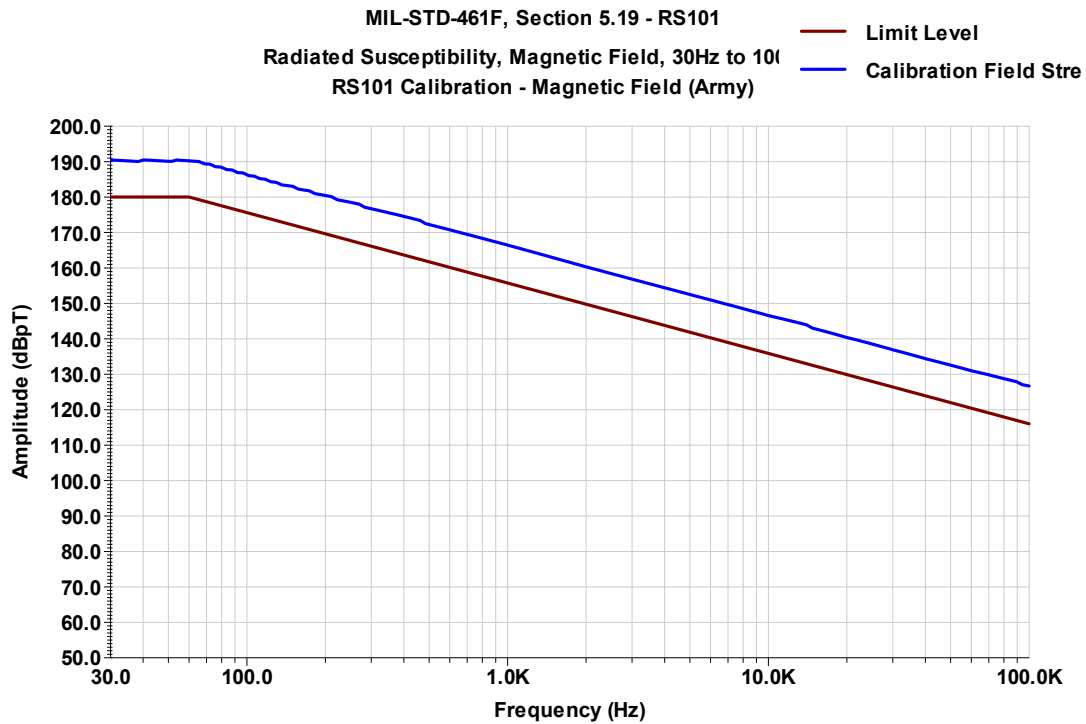


Tue, Apr 23, 2019
10:59:44 AM
AutoScan 7.4.4.13
Res BW (kHz) 0.10
Vid BW (kHz) 50000
RS101 Loop
Graph # 3
Sweep Time 3.0000

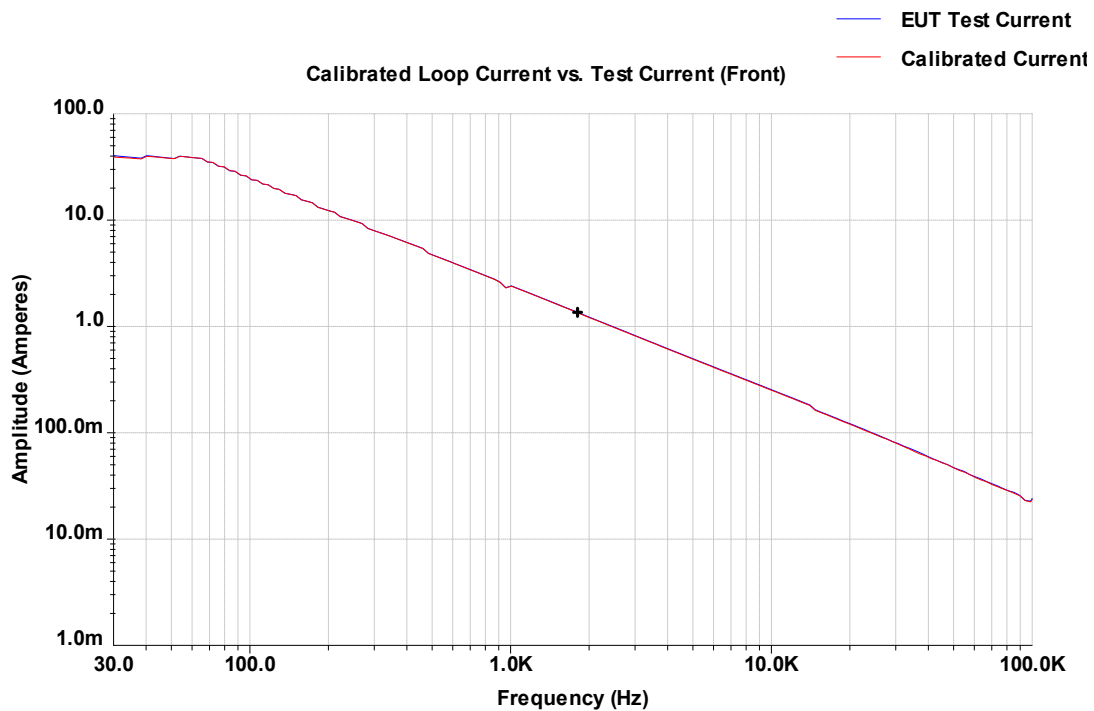
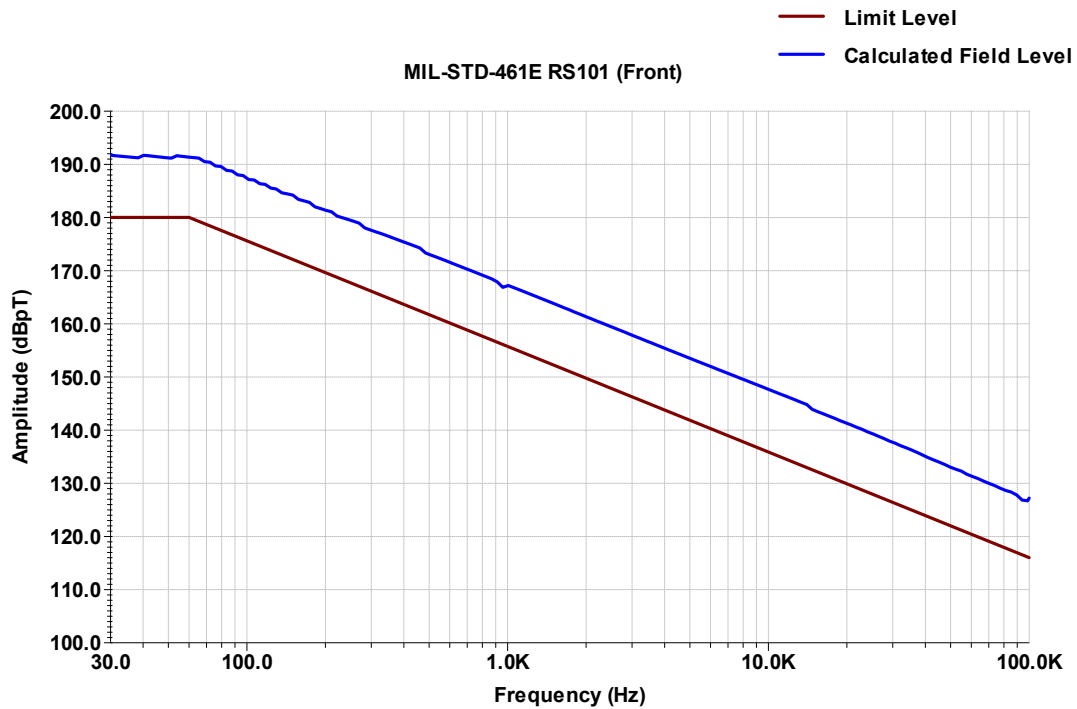
Scan Data

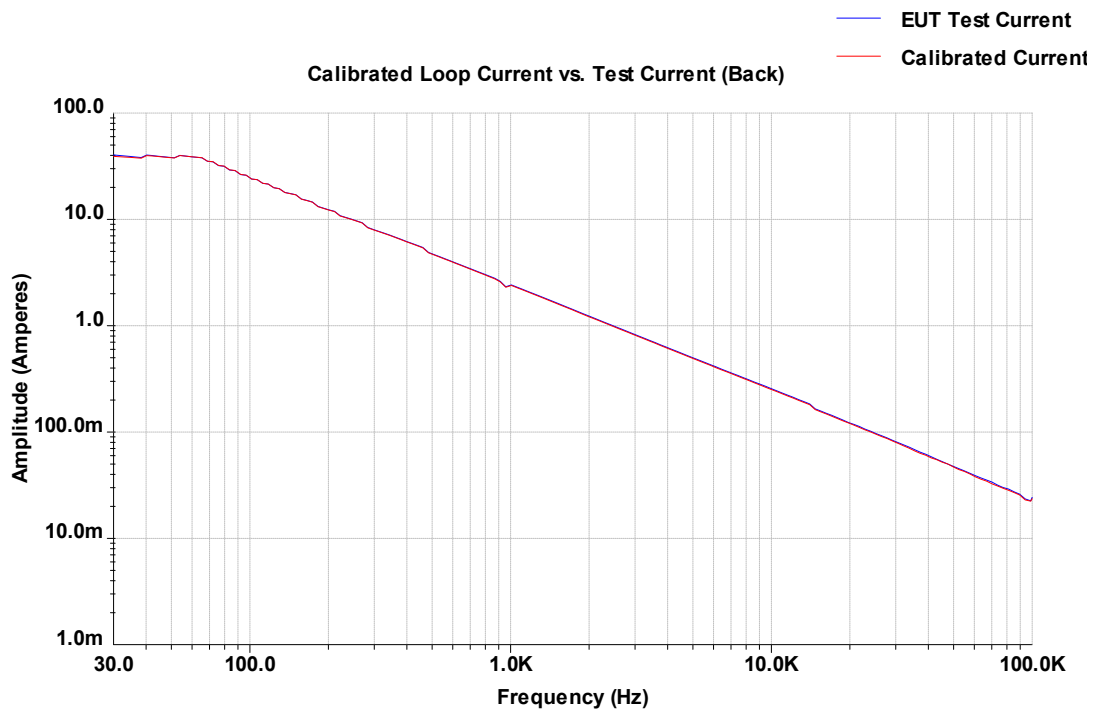
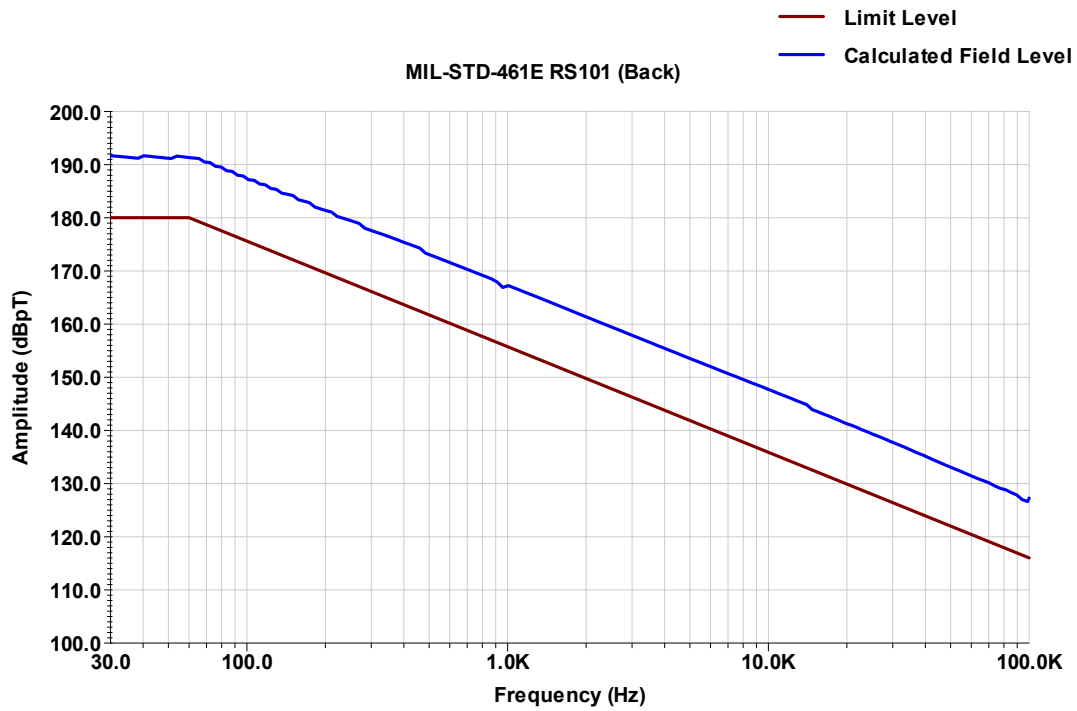
Frequency	Level	Limit	Delta	Raw	LISN	Cable	Xducer	All Factors
kHz	dBpT	dBpT	dB	dBpT	dB	dB	dB	dB
0.994	110.8	110.0	0.8	42.62	0.00	0.00	68.22	-68.22

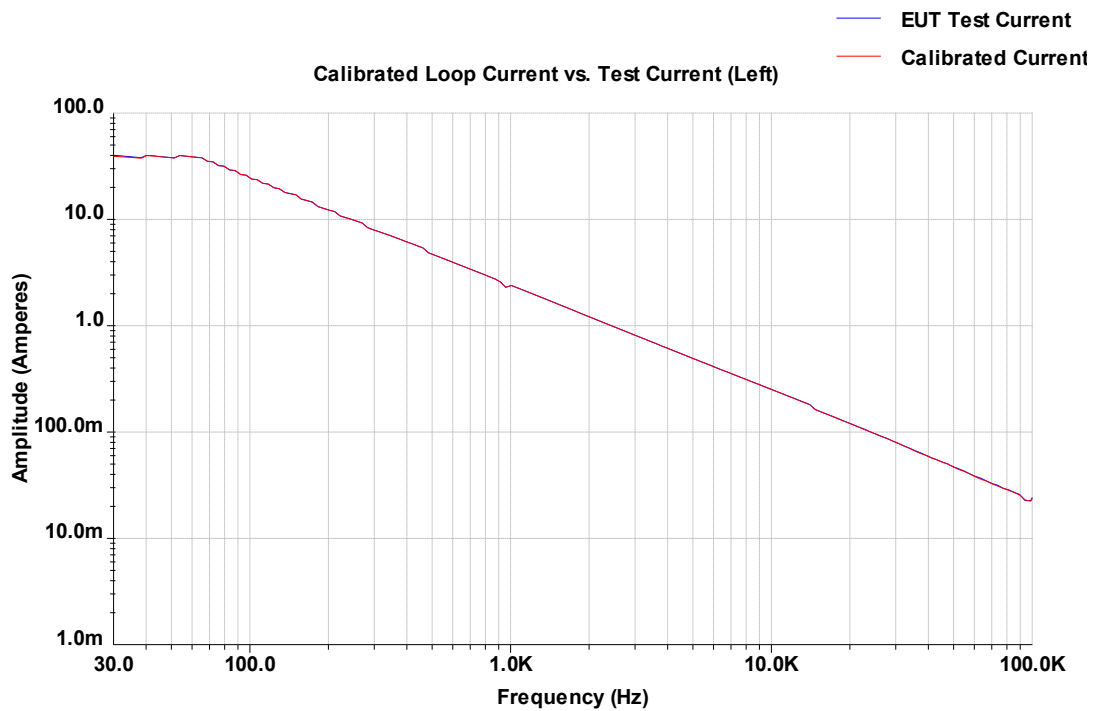
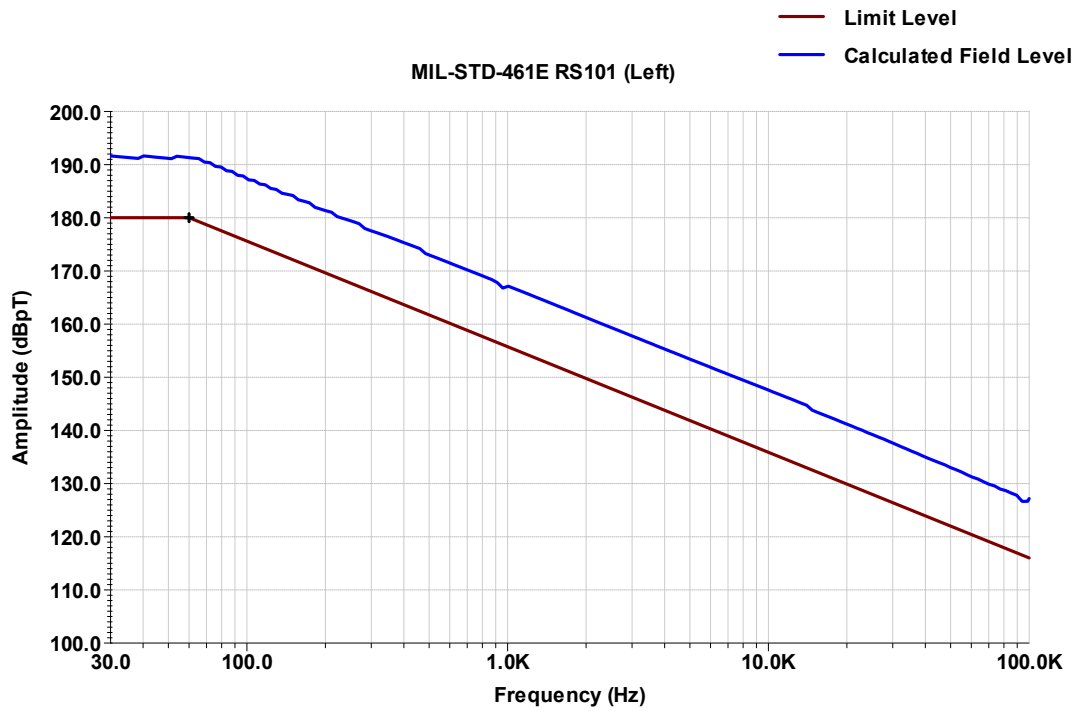
RS101 Calibration Graphs

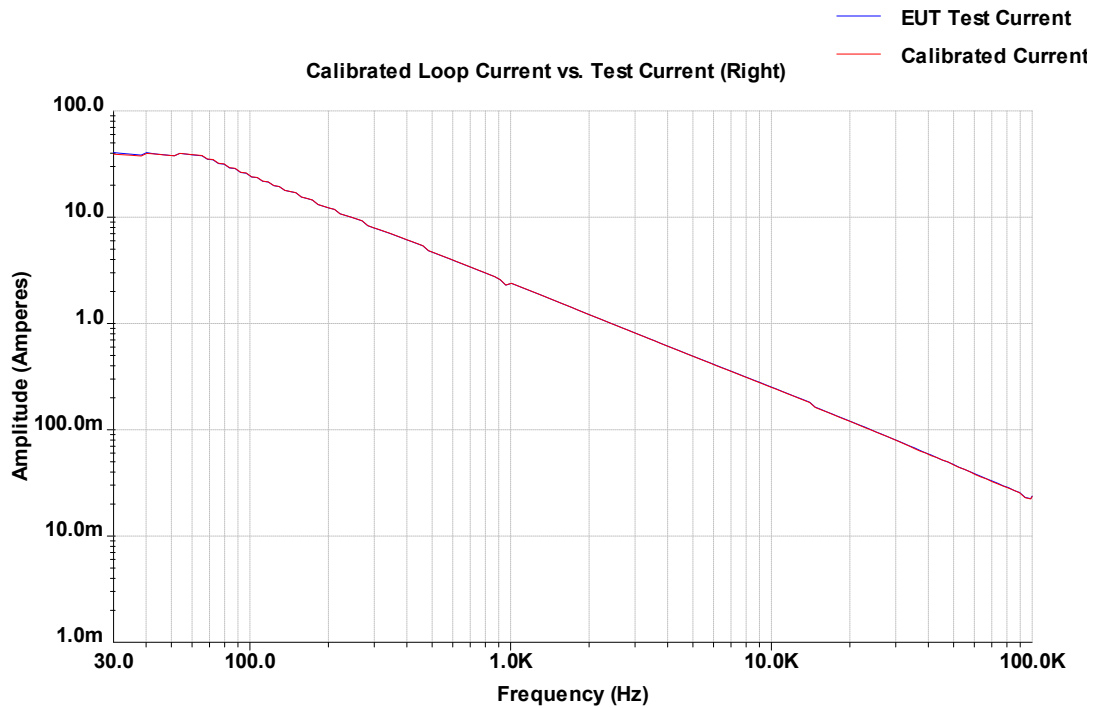
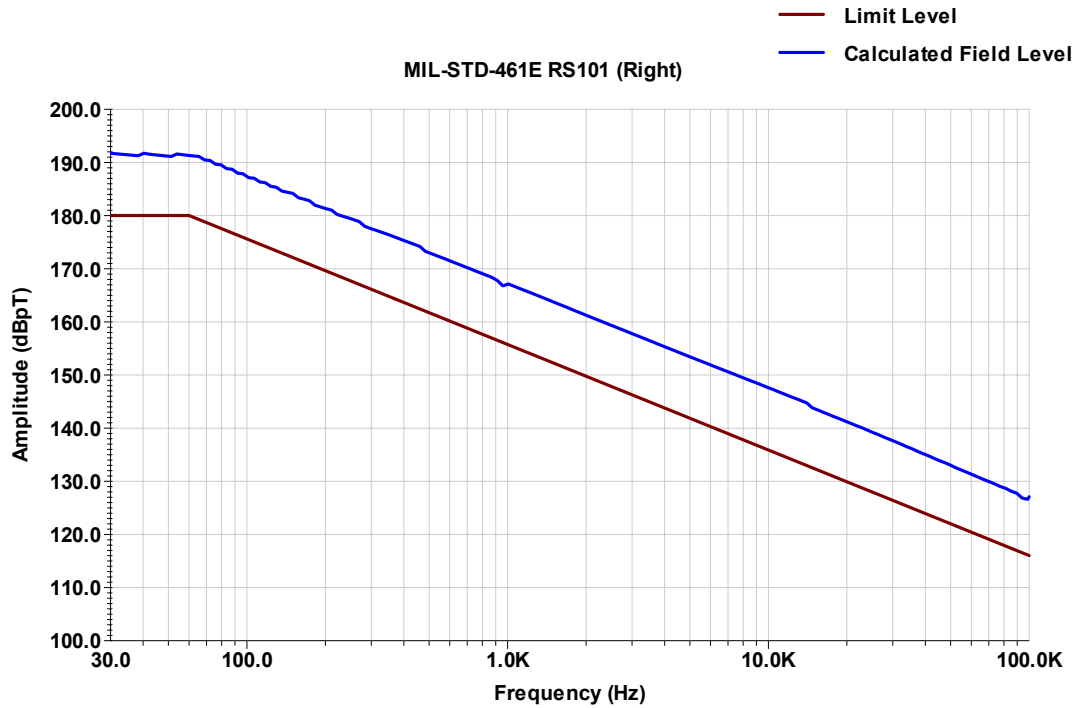


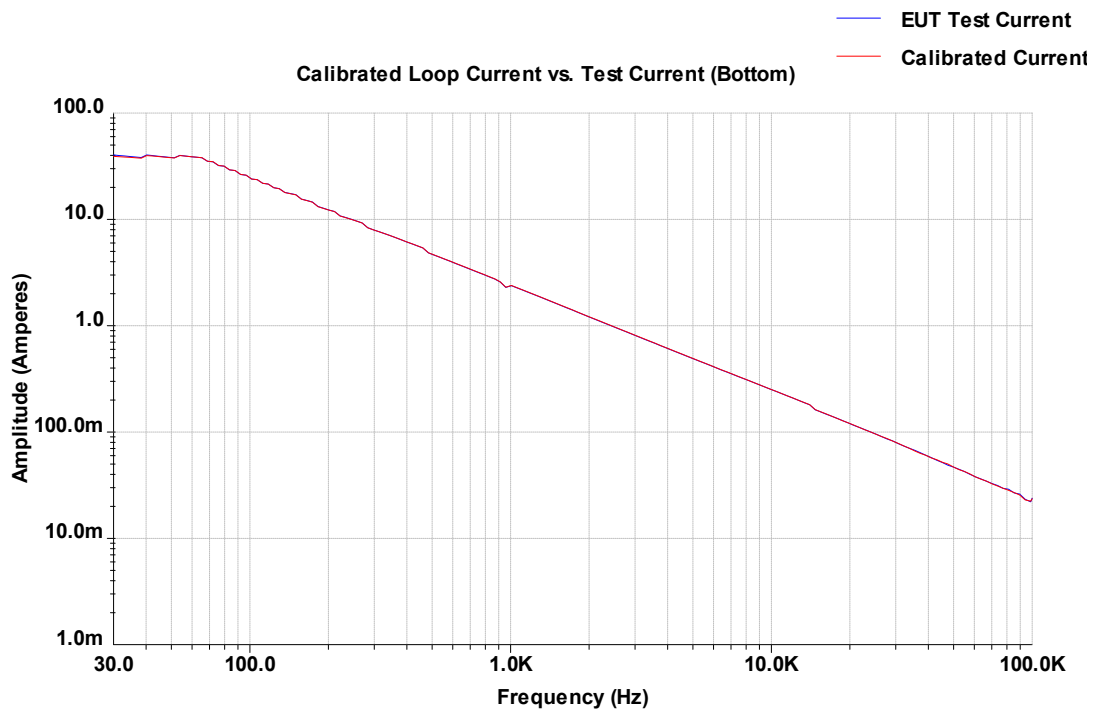
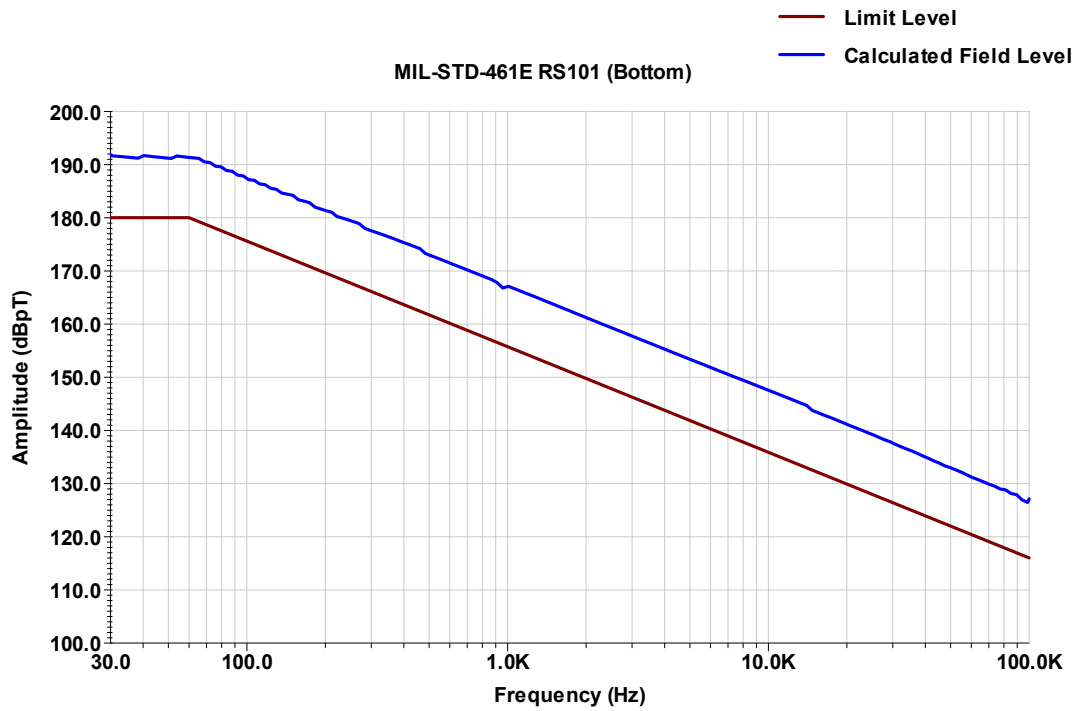
RS101 Test Graphs

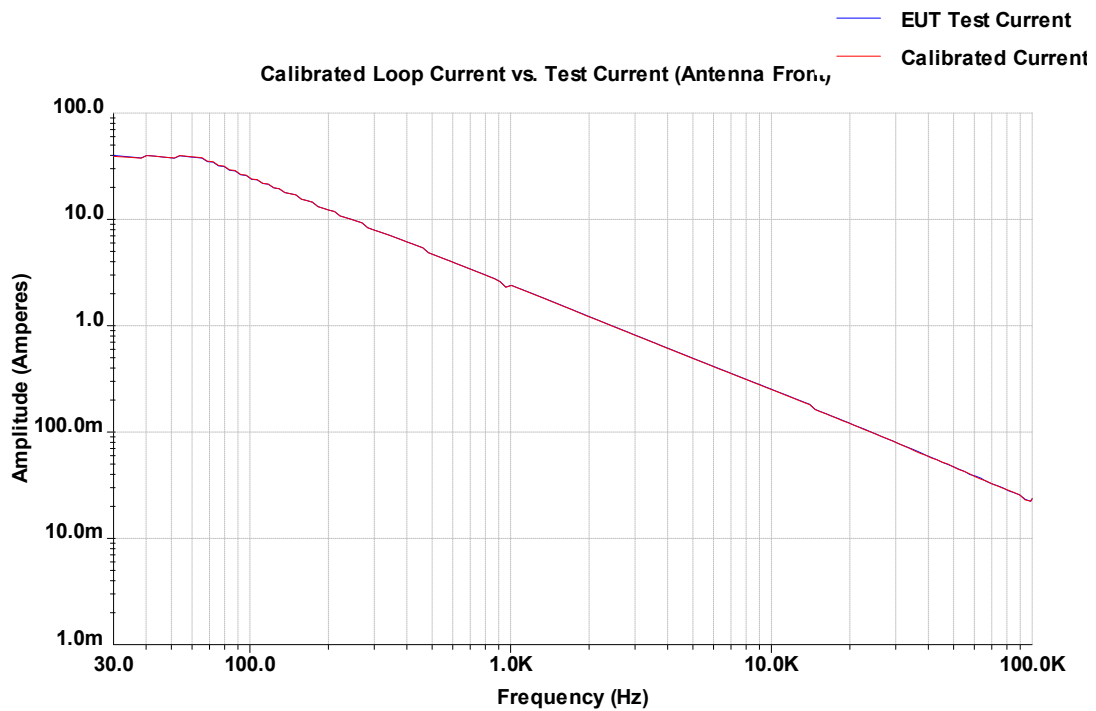
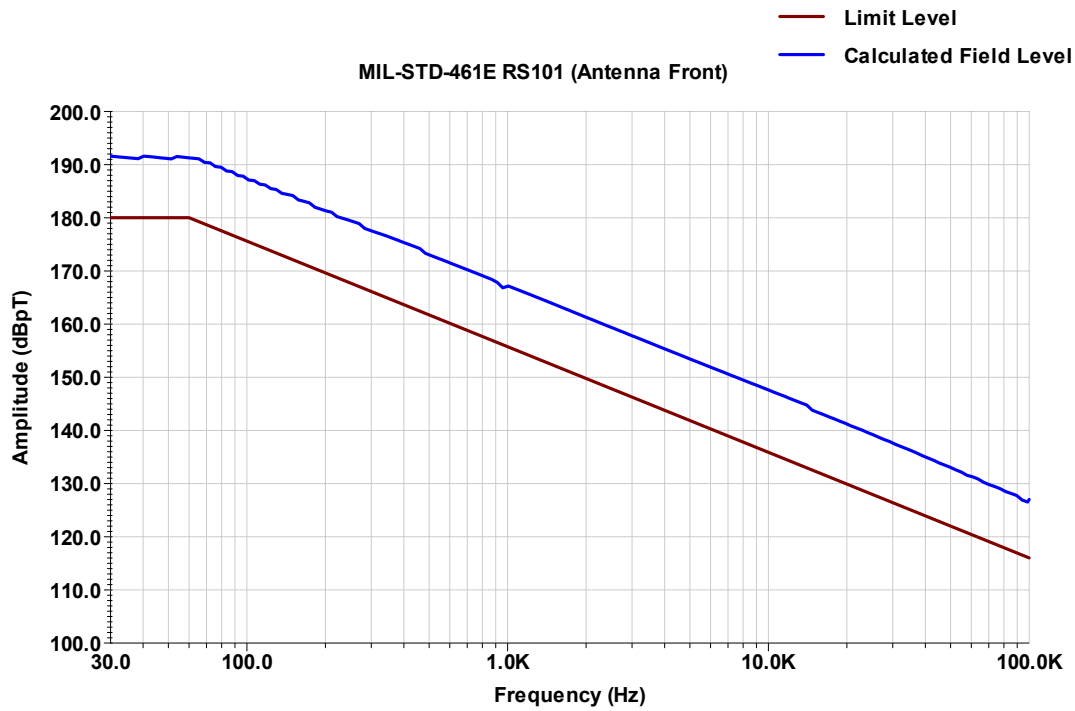


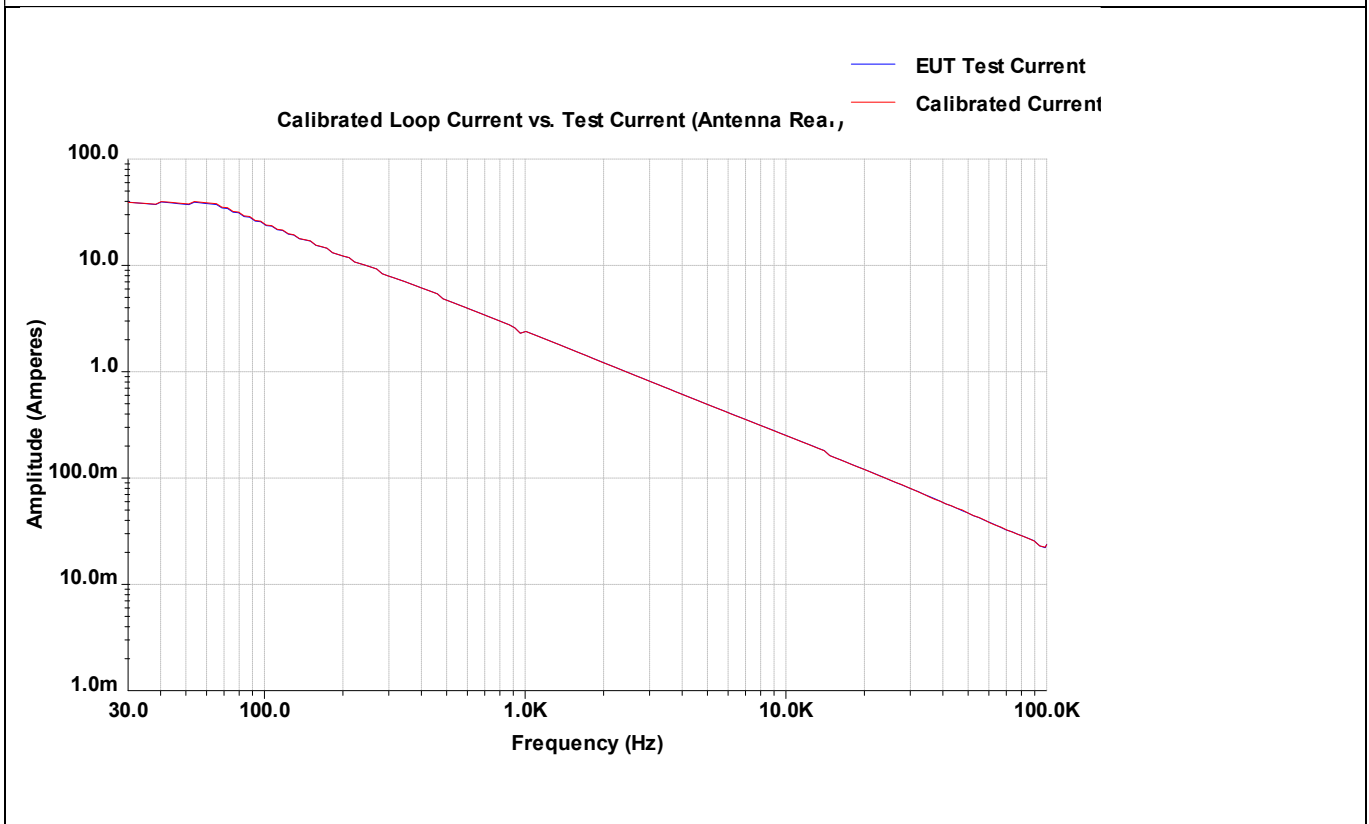
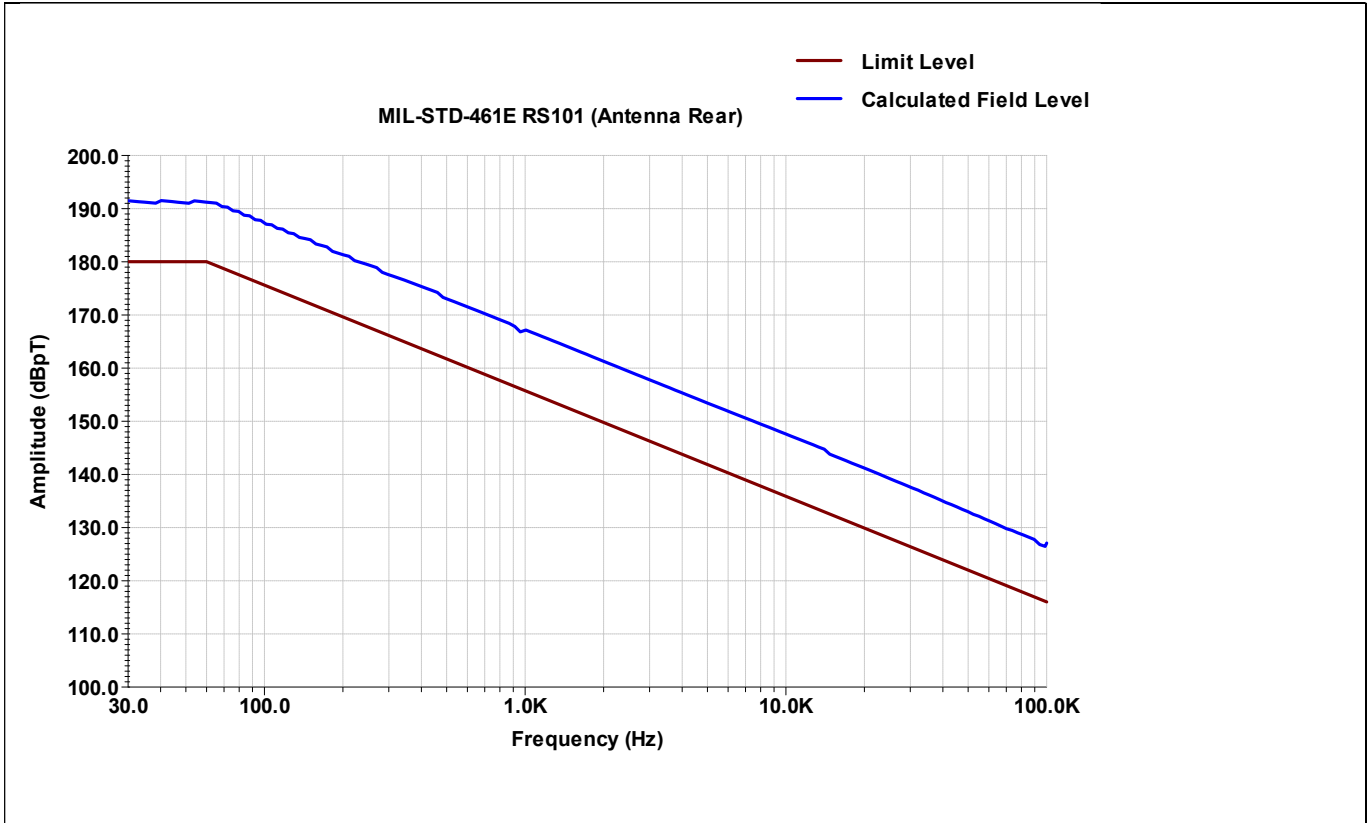








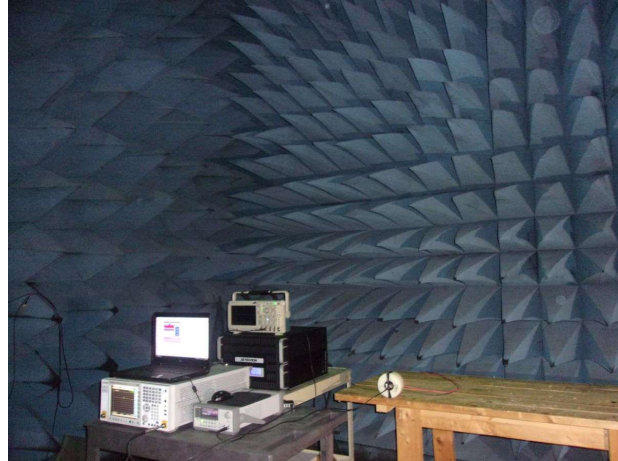




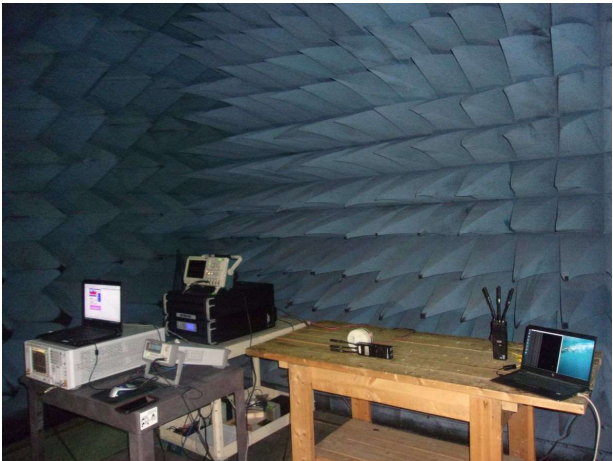
5.2.7 RS101 Test Photographs



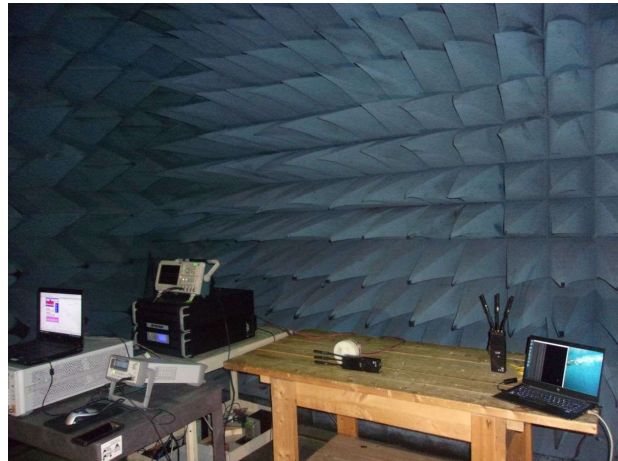
01 - RS101 Calibration



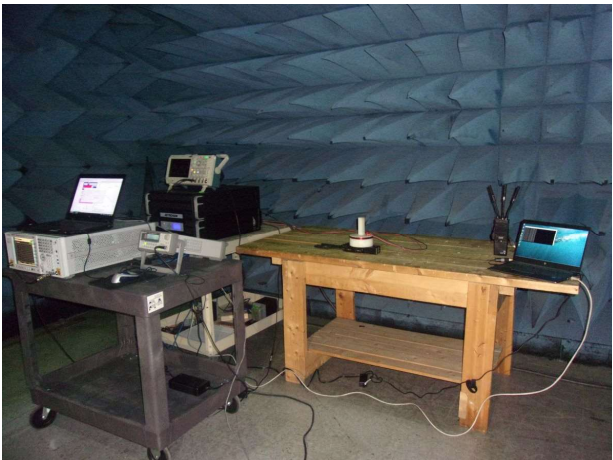
02 - RS101 Calibration



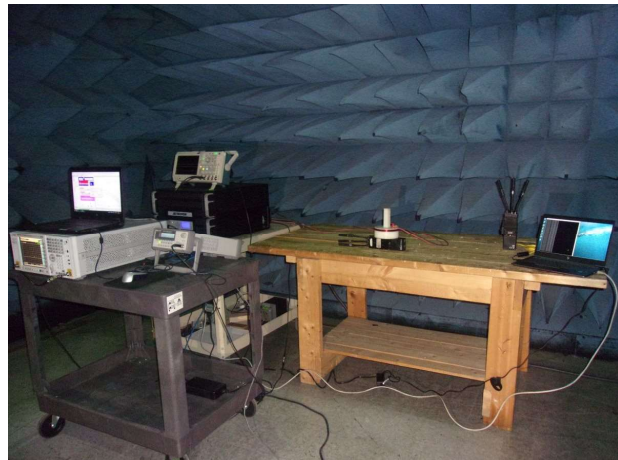
03 - RS101 Antennas Front



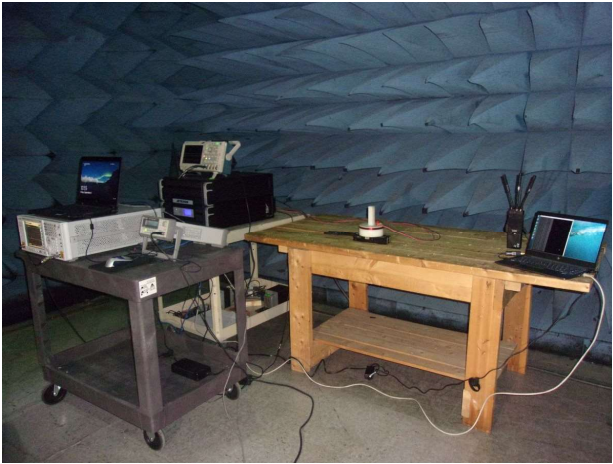
04 - RS101 Antennas Rear



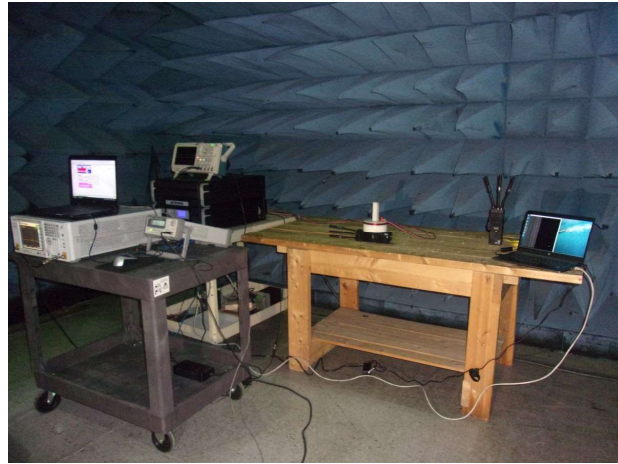
05 - RS101 Front



06 - RS101 Left



07 - RS101 Rear



08 - RS101 Right



5.2.8 RS101 Test Equipment

Table RS101-1: RS101 Test Equipment List

Asset No.	Manufacturer	Item	Model	S/N	Cal Cycle (Months)	Cal. Due
WC058452	Agilent Technologies	Arbitrary Wave-form Generator	33250A	MY40025425	12	2/12/20
WC058455	AE Techtron	Amplifier	7794	7794-0419-0021	NCR	NCR
WC058456	Agilent	PSA Spectrum Analyzer	E4440A	MY446187964	12	4/2/20
WC005323	Solar Electronics	Loop Sensor	9229-1	0310503	36	3/22/22
WC005324	Solar Electronics	Radiating Loop	9231-1	0311003	36	3/22/22
WC005777	A.H. Systems	Current Probe	BCP-510	1152	36	9/12/20
WC058386	Tektronix	Digital Oscilloscope	MDO3034	C011435	12	8/15/20

NCR = No Calibration Required; as per NTS QA policy, the equipment does not require calibration as long as the test signal being generated can be verified with other calibrated equipment prior to or during the test.

5.3 Method RS103: Radiated Susceptibility, Electric Field, 2 MHz - 18 GHz

5.3.1 RS103 Purpose

This test verifies the ability of the EUT, and their associated cabling, to withstand electric fields and continue to operate as intended.

5.3.2 RS103 Limits

The EUT shall not exhibit any malfunction, degradation of performance, or deviation from specified indications beyond the tolerances indicated in the individual equipment or subsystem specification when subjected to the radiated electric fields listed in Figure RS103-1.

Up to 30 MHz, the EUT shall meet the requirement for vertically polarized fields, and above 30 MHz it shall meet the requirement vertically and horizontally. Circular polarized fields are not acceptable.

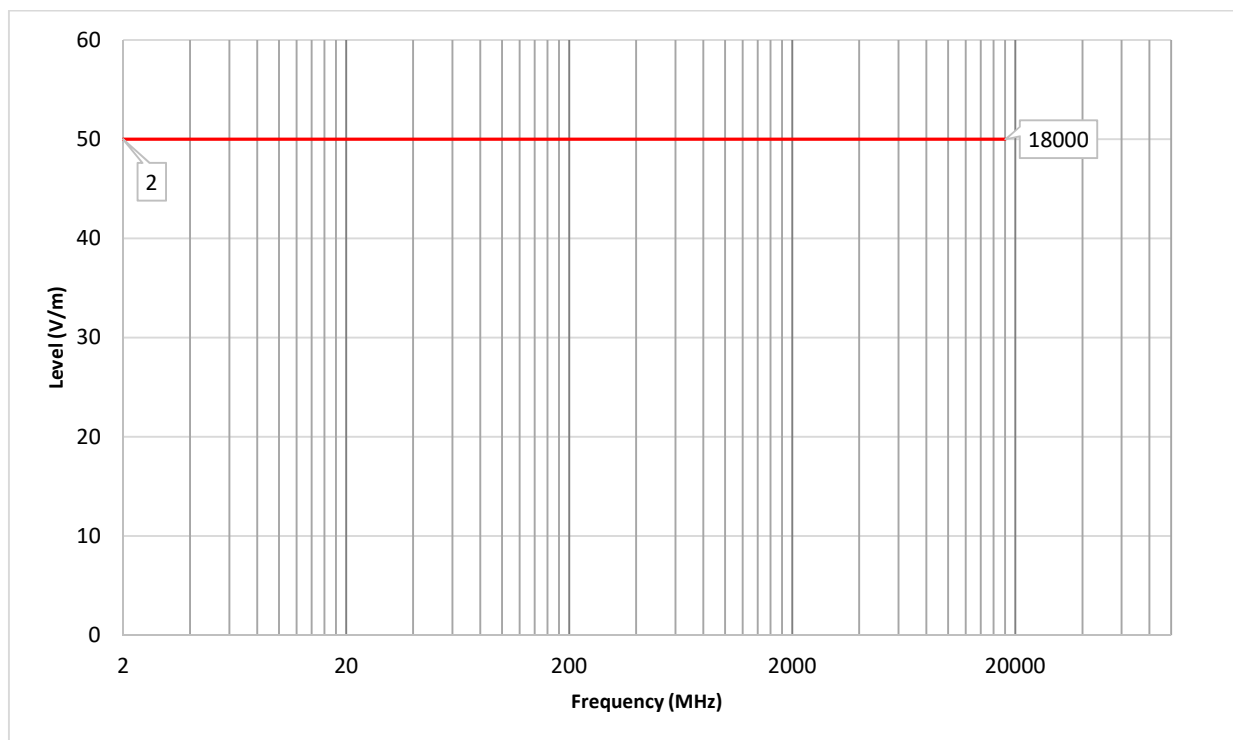


Figure RS103-1: RS103 Limit – Army Ground

5.3.3 RS103 Test Setup

The EUT was setup in accordance with Section 3.2, Figure 3.2-1 and operated according to Section 3.3.

5.3.3.1 Placement of Electronic Field Sensors

1. Place the sensors at the same distance as the EUT is located from the transmit antenna while staying in the plane of the test setup boundary edge closest to the antenna.
2. Position the sensors directly opposite the transmit antenna, while a minimum of 30 cm above the ground plane at or below 1 GHz. Above 1 GHz, place the sensors at the height corresponding to the area of the EUT being illuminated.
3. Do not place sensors directly at corners or edges of components.

5.3.3.2 Placement of Transmit Antennas

1. Antennas were placed 1 meter or greater from EUT.
2. For 200 MHz and below, center the transmit antenna between the edges of the test setup boundary. This boundary should include all enclosures of the EUT and the 2 meters of exposed interconnecting and power leads.
3. At and above 200 MHz, testing may require multiple antenna positions. Determine the number of position (N) as follows:
 - A. 200 MHz to 1 GHz: Place the antenna in a sufficient number of positions such that the entire area of each EUT face and the first 35 cm of cable and leads interfacing the EUT are within 3 dB beam width of the antenna.
 - B. 1 GHz and above place the antenna in a sufficient number of position such that the entire area of each EUT face and the first 7 cm of cable and leads interfacing the EUT are within 3 dB beam width of the antenna.

Table RS103-1: RS103 Antenna Position Calculations, 2 MHz to 200 MHz

Antenna Model	Range Used (MHz)	Antenna Coverage (cm)	Test Setup Boundary (cm)	Antenna Positions
NTS10k30M	2 – 30	300	6.5	1
EMCO 3109	30 - 200	300	6.5	1

Table RS103-2: RS103 Antenna Coverage Calculations, 200 MHz to 18 GHz

Antenna Model	Range Used (GHz)	Minimum 3dB Beamwidth (°)	Coverage at 1 M Distance (cm)
ETS 3106	0.2 – 1.0	28	49.87
AR ATH800M6G	1 - 4	13.5	23.67
AR ATH800M6G	4 - 6	8	13.99
AR ATH6G18	6 - 8	15.5	27.22
AR ATH6G18	8 - 18	8	13.99
Antenna Coverage = $2 * (\text{TAN}(\Theta) * a)$ Where $\Theta = 1/2$ (antenna 3dB beamwidth) a = antenna distance from setup boundary			

Table RS103-3: RS103 Antenna Position Calculations, 200 MHz to 18 GHz

Antenna Model	Range Used (GHz)	Antenna Coverage @ 1 M (cm)	EUT Width ¹ (cm)	Required Antenna Positions
ETS 3106	0.2 – 1.0	49.87	6.5	1
AR ATH800M6G	1 - 4	23.67	6.5	1
AR ATH800M6G	4 - 6	13.99	6.5	1
AR ATH6G18	6 - 8	27.22	6.5	1
AR ATH6G18	8 - 18	13.99	6.5	1

Note 1: Did not add 35cm of cable (200 MHz – 1GHz) or 7cm of cable (>1 GHz), because the EUT has no cables.

5.3.4 RS103 Test Procedure

Testing proceeded as follows:

1. The measurement equipment and EUT were turned on, and sufficient time was allowed for stabilization.
2. E-field sensor procedure:
 - A. The signal source was set to 1 kHz pulse modulation, 50% duty cycle.
 - B. Using an appropriate amplifier and transmit antenna, an electric field was established at the test start frequency.
 - C. The electric field level was gradually increased until it reaches the applicable limit.
 - D. The required frequency ranges will be scanned in accordance with the step size specified in Table 4.5-1. The field strength was maintained in accordance with the applicable limit.
 - E. The EUT performance was monitored for susceptibility effects.
3. If susceptibility was noted, the threshold level was determined and it was verified to be above the limit.
4. Testing was performed over the required frequency range with the transmit antenna vertically polarized.
5. Testing above 30 MHz was repeated with transmit antenna horizontally as well as vertically polarized.
6. Steps 1-5 were repeated for each transmits antenna position.

5.3.5 RS103 Test Data

Job Number:	PR102216	Standard:	MIL-STD-461F
Date:	9/3/19 – 9/5/19	Procedure:	None
Manufacturer:	Persistent Systems LLC	EUT:	MPU5 Radio with RF-2150 10W S-Band Card
Model Number:	WR-5100, RF-2150	S/N:	31783
Input Power	Battery	Test Personnel:	Tristian Gaines

RS103 Specification Limits:

Signal Applied	Test Specification	Susceptibility Criteria
Radiated RF Electromagnetic Field	2MHz – 18GHz: 50V/m 1kHz / 80% Duty Cycle Pulse Modulated (Army Ground)	The EUT was monitored for any degradation in performance according to Section 3.4.

RS103 Test Results:

Frequency (MHz)	Pol. (H/V)	Antenna Position	Step Size (%f)	Level (V/m)	Dwell (Sec)	Modulation	Observation	Results (Pass/Fail)
2 - 30	V	1	1	50	3	1kHz PM	None	PASS
30 - 200	H	1	0.5	50	3	1kHz PM	None	PASS
30 - 200	V	1	0.5	50	3	1kHz PM	None	PASS

Frequency (MHz)	Pol. (H/V)	Antenna Position	Step Size (%f)	Level (V/m)	Dwell (Sec)	Modulation	Observation	Results (Pass/Fail)
200 - 1000	V	1	0.5	50	3	1kHz PM	None	PASS
200 - 1000	V	1	0.5	50	3	1kHz PM	None	PASS

Frequency (GHz)	Pol. (H/V)	Antenna Position	Step Size (%f)	Level (V/m)	Dwell (Sec)	Modulation	Observation	Results (Pass/Fail)
1 - 2	V	1	0.25	50	3	1kHz PM	None	PASS
1 - 2	V	1	0.25	50	3	1kHz PM	None	PASS

Frequency (GHz)	Pol. (H/V)	Antenna Position	Step Size (%f)	Level (V/m)	Dwell (Sec)	Modulation	Observation	Results (Pass/Fail)
2 - 4	V	1	0.25	50	3	1kHz PM	None	PASS
2 - 4	V	1	0.25	50	3	1kHz PM	None	PASS

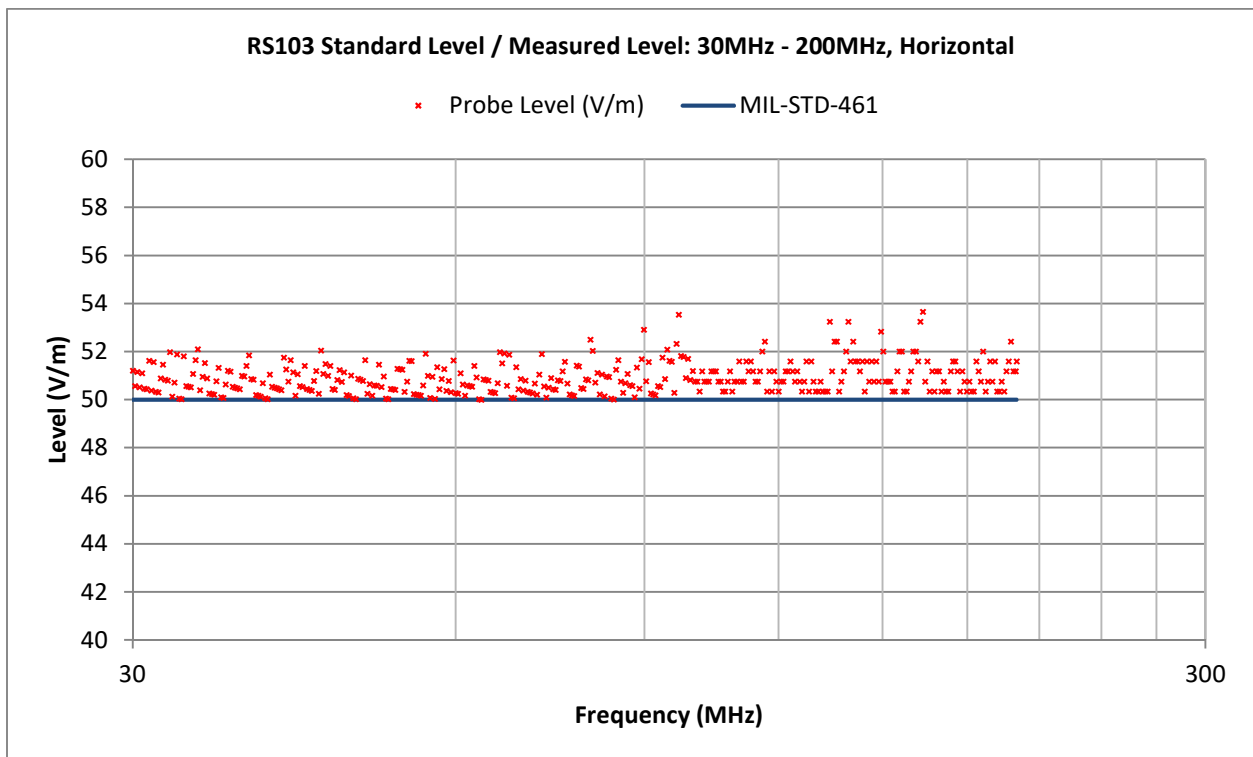
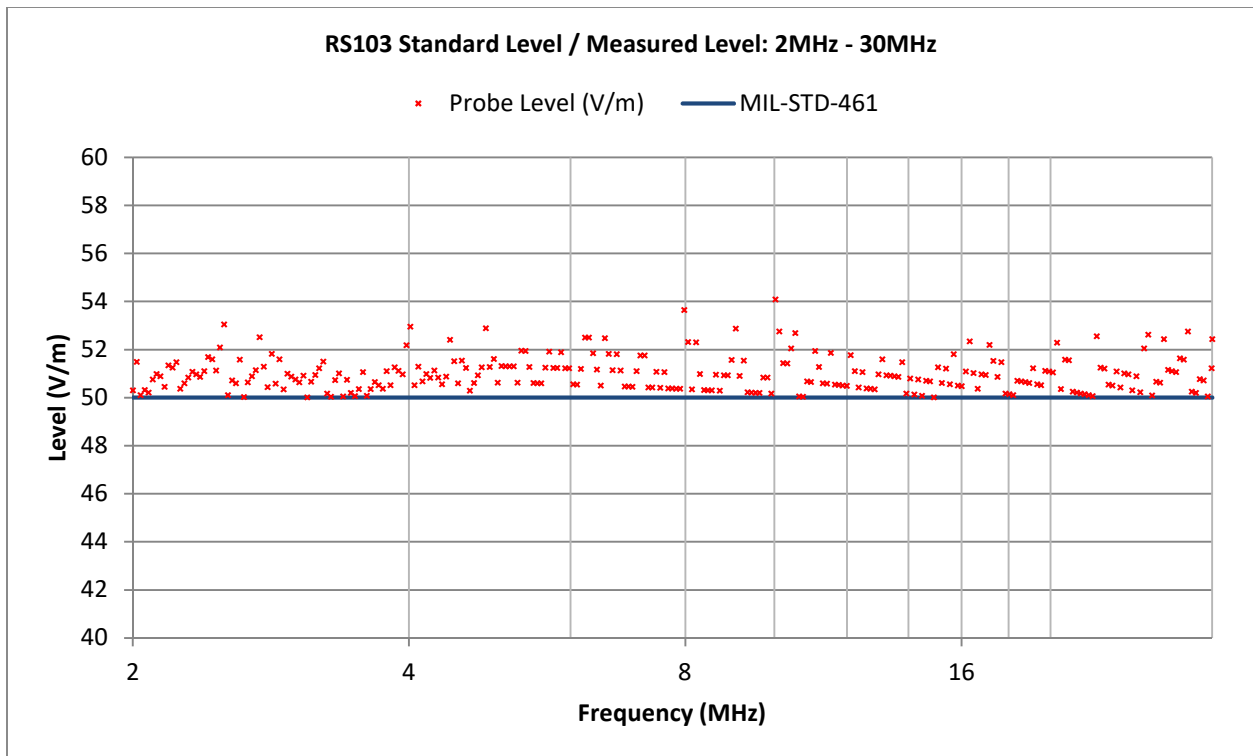


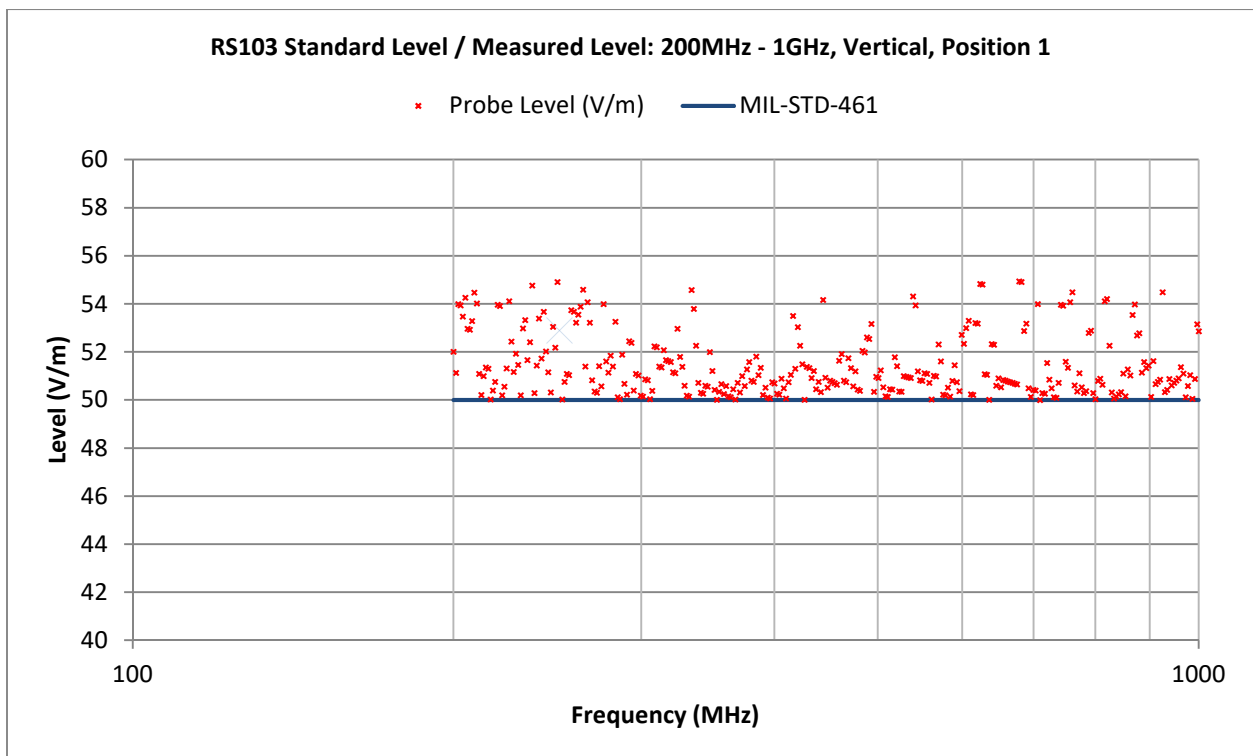
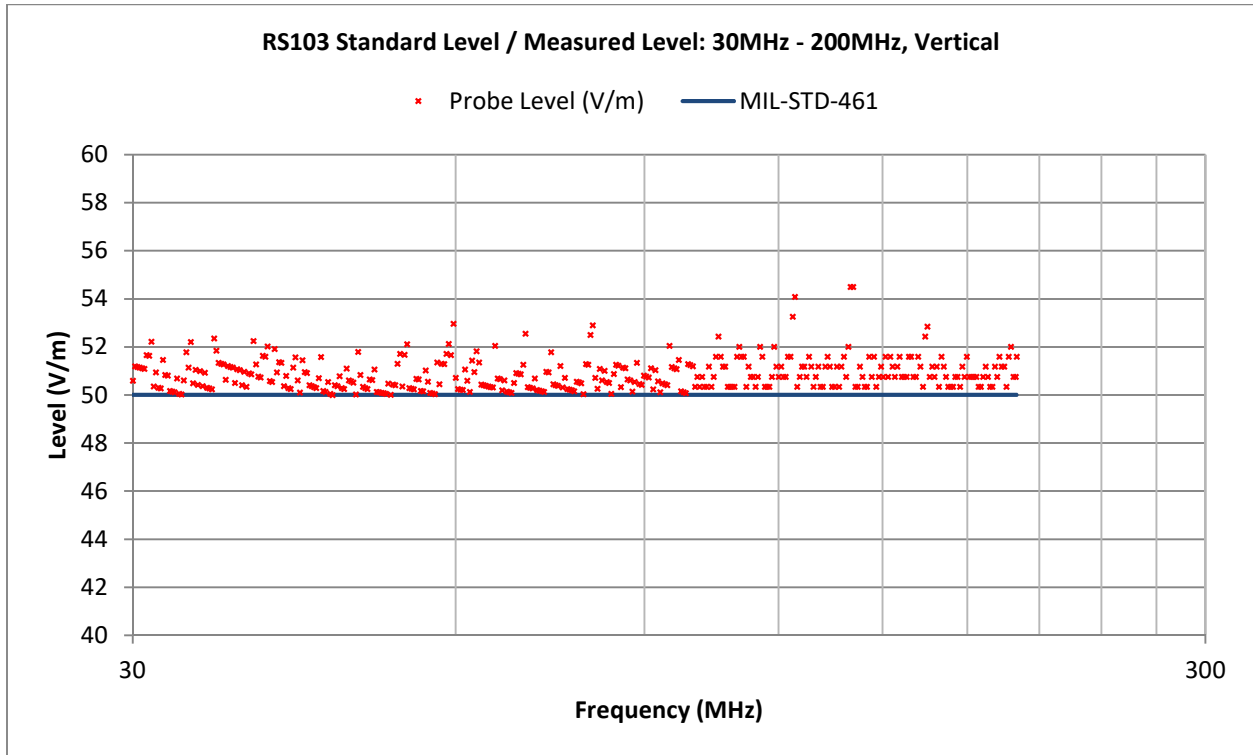
Frequency (GHz)	Pol. (H/V)	Antenna Position	Step Size (%f)	Level (V/m)	Dwell (Sec)	Modulation	Observation	Results (Pass/Fail)
4 - 6	V	1	0.25	50	3	1kHz PM	None	PASS
4 - 6	V	1	0.25	50	3	1kHz PM	None	PASS

Frequency (GHz)	Pol. (H/V)	Antenna Position	Step Size (%f)	Level (V/m)	Dwell (Sec)	Modulation	Observation	Results (Pass/Fail)
6 - 8	H	1	0.25	50	3	1kHz PM	None	PASS
6 - 8	V	1	0.25	50	3	1kHz PM	None	PASS

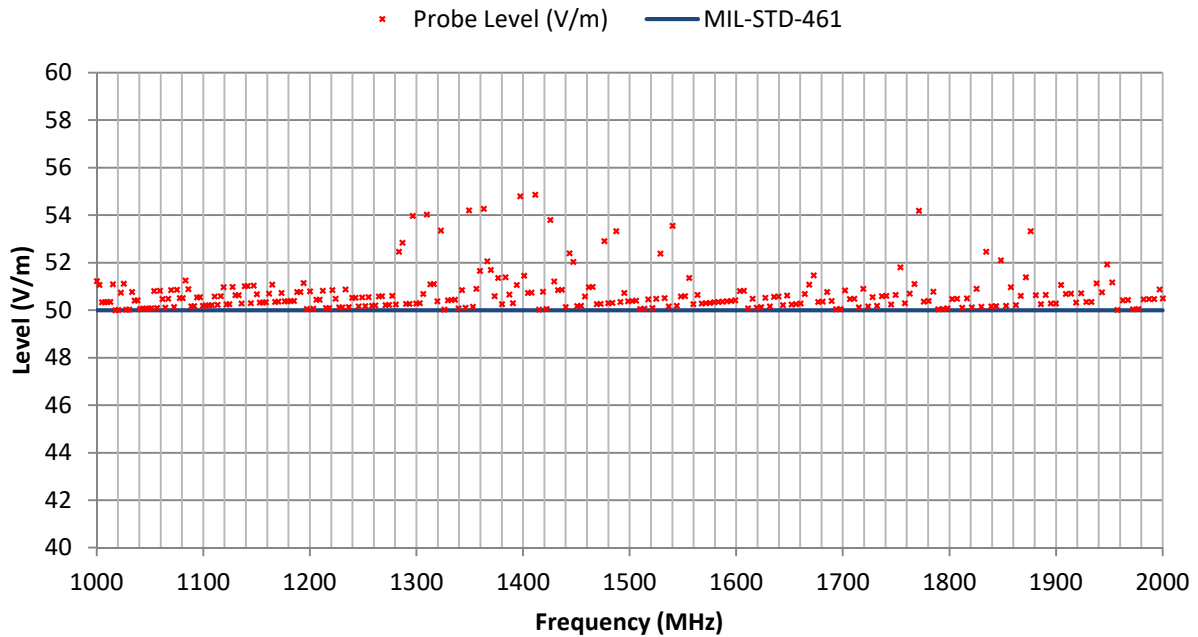
Frequency (GHz)	Pol. (H/V)	Antenna Position	Step Size (%f)	Level (V/m)	Dwell (Sec)	Modulation	Observation	Results (Pass/Fail)
8 - 18	V	1	0.25	50	3	1kHz PM	None	PASS
8 - 18	V	1	0.25	50	3	1kHz PM	None	PASS

5.3.6 RS103 Data Plots

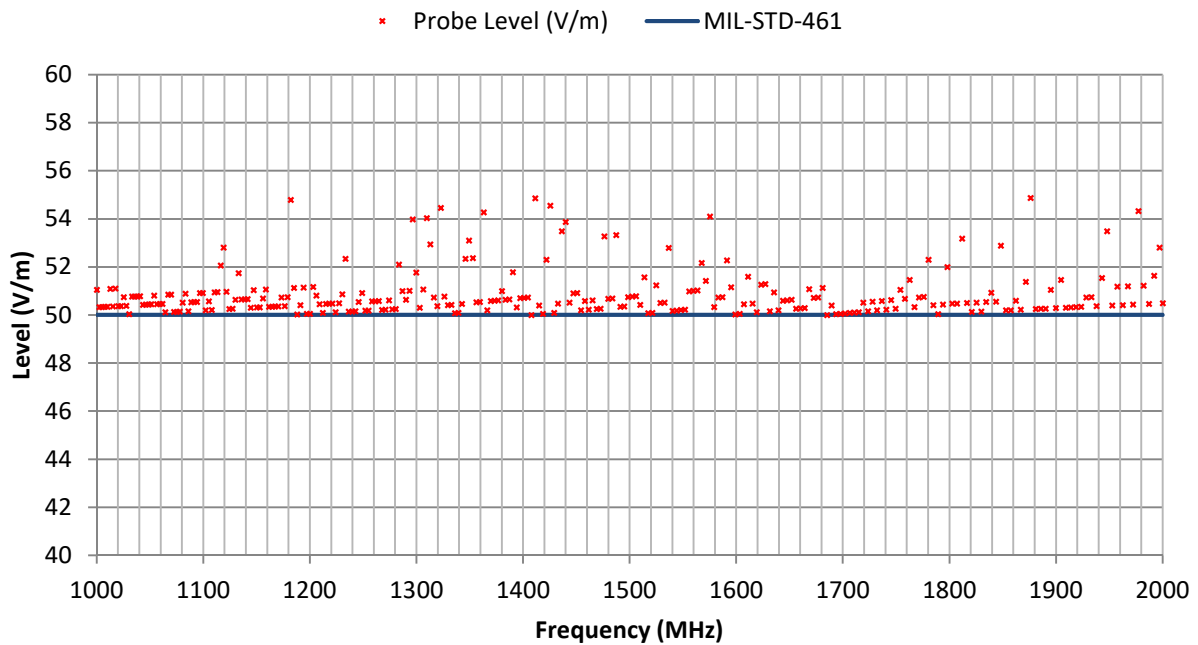


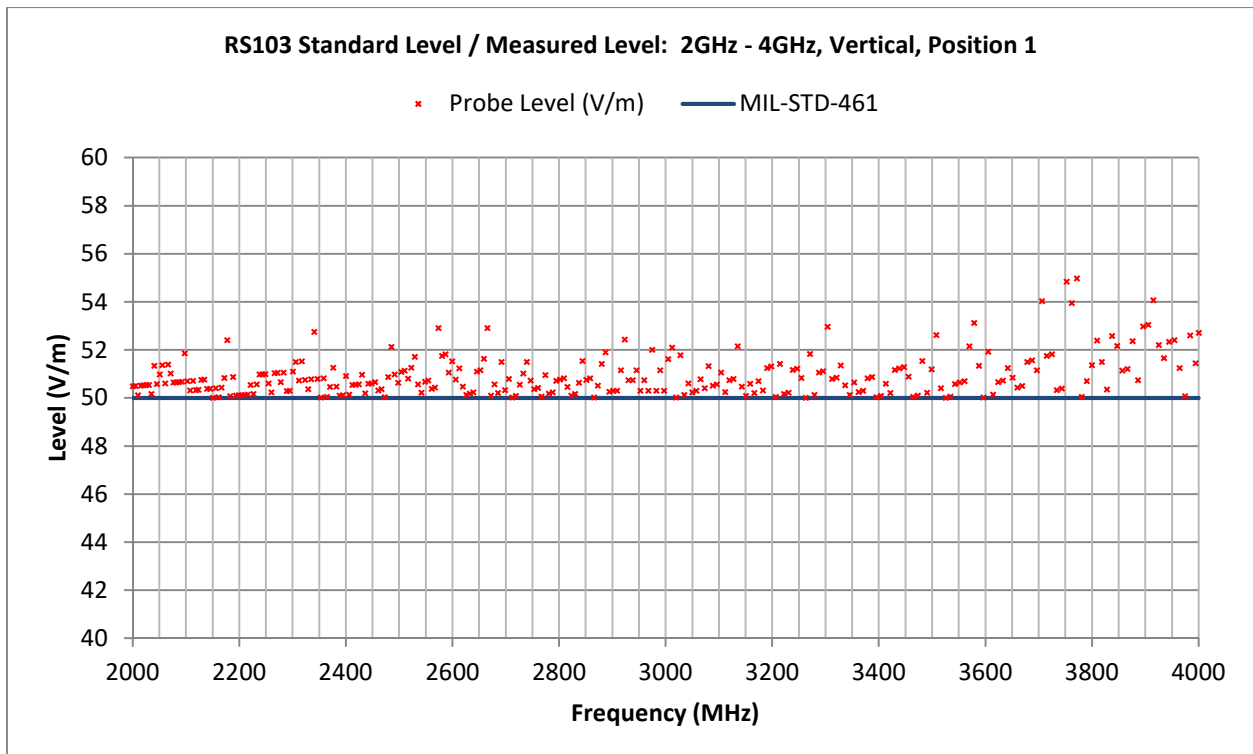
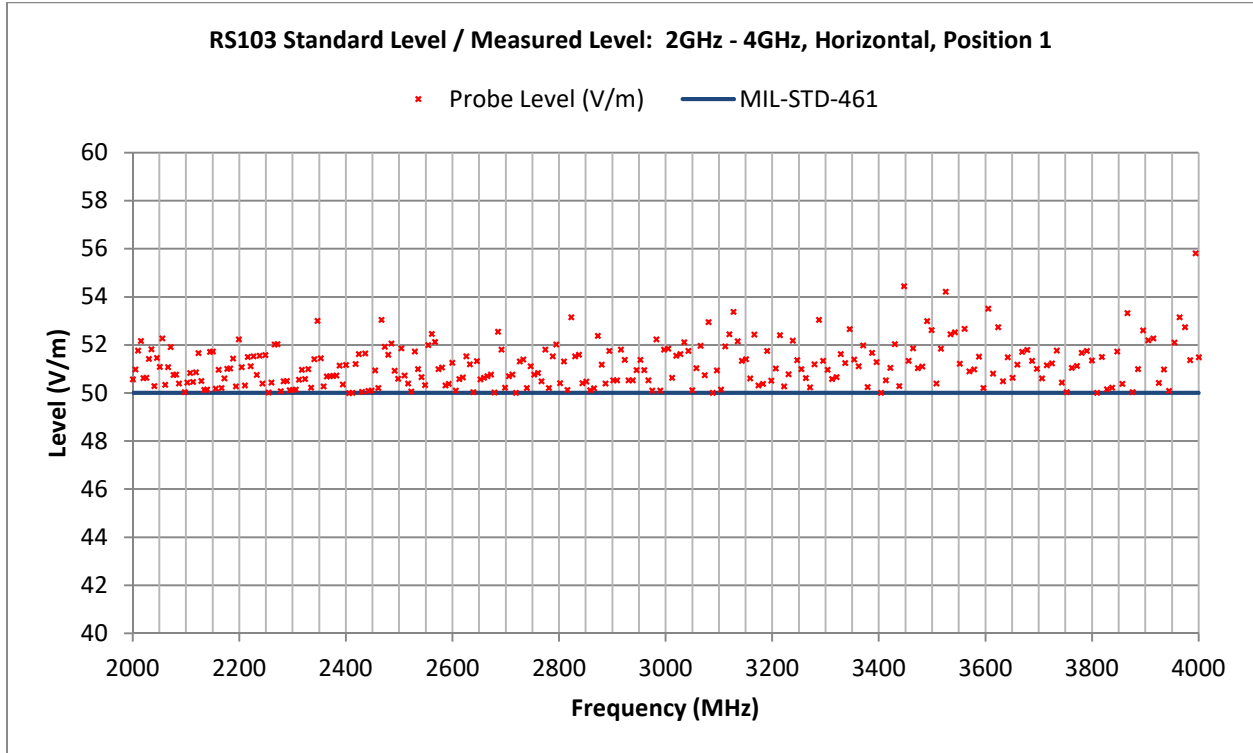


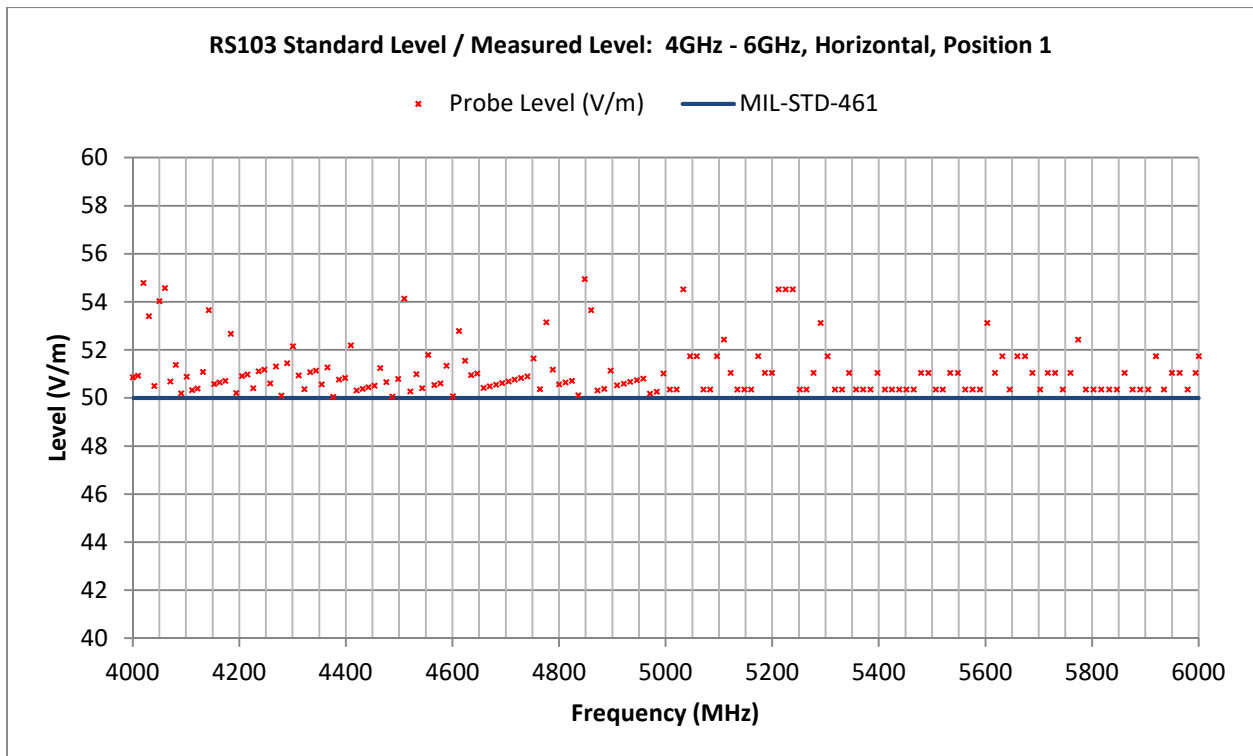
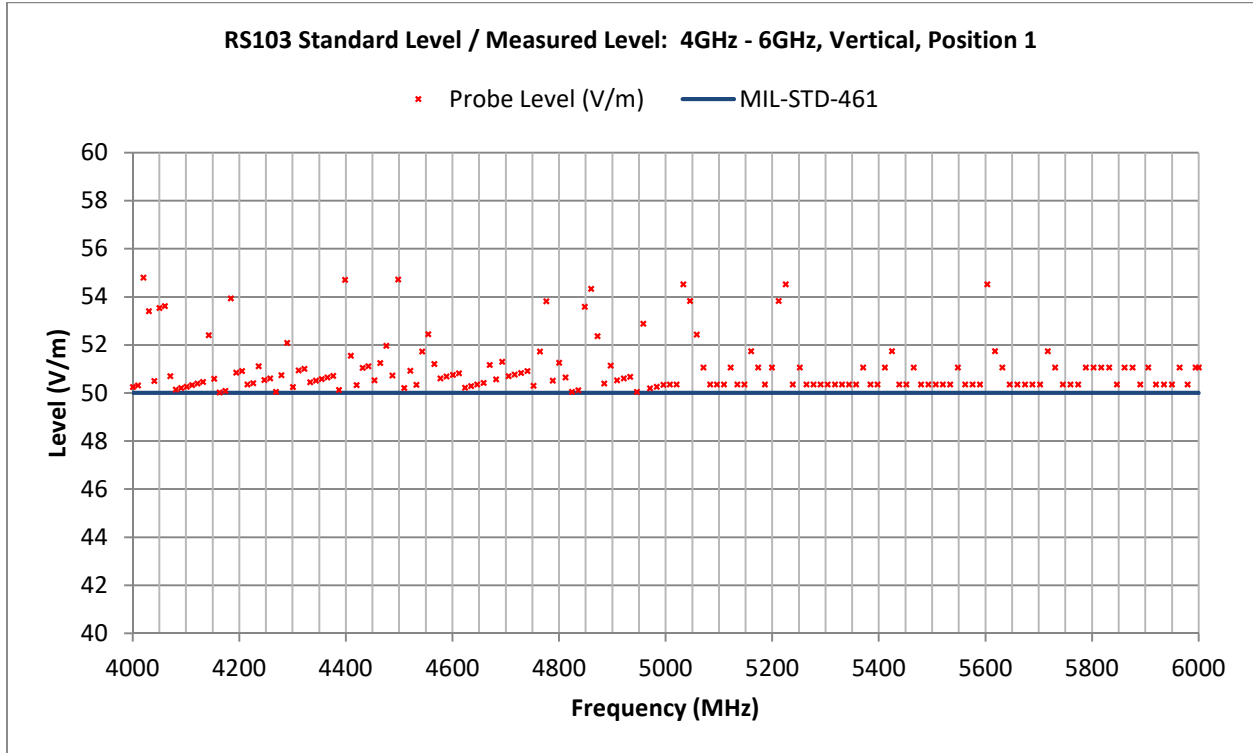
RS103 Standard Level / Measured Level: 1GHz - 2GHz, Horizontal, Position 1

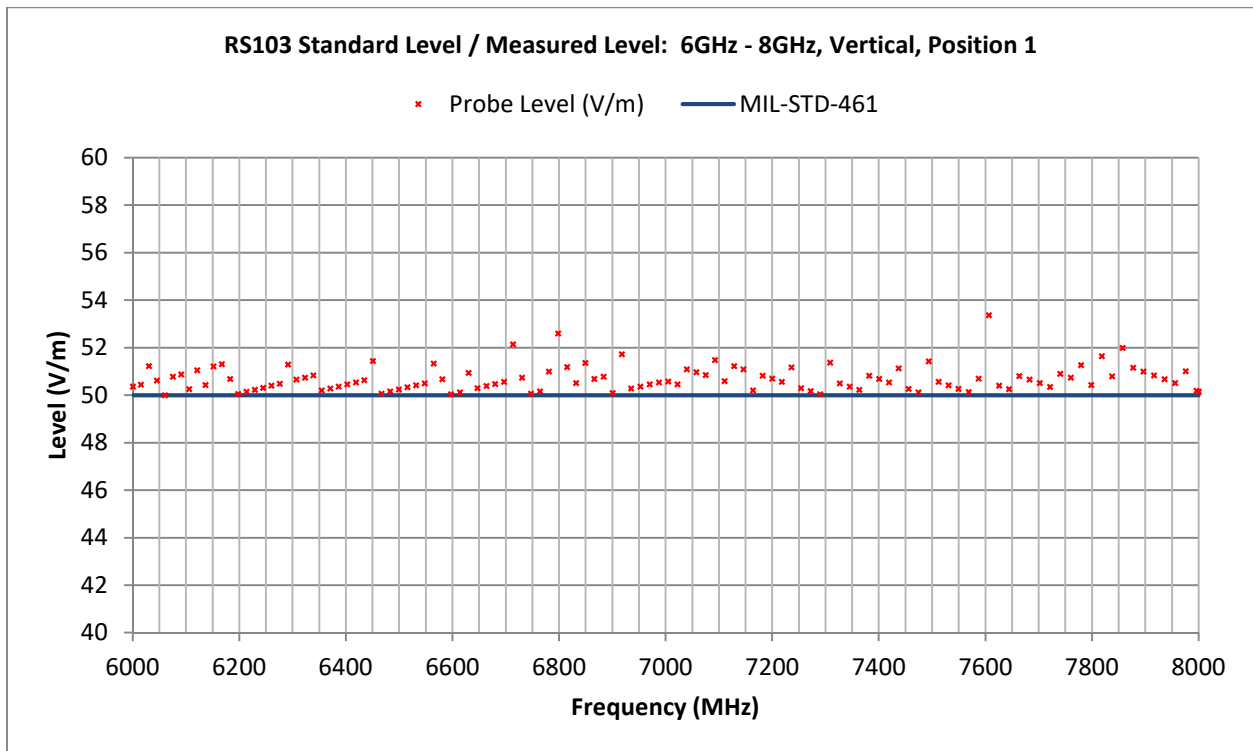
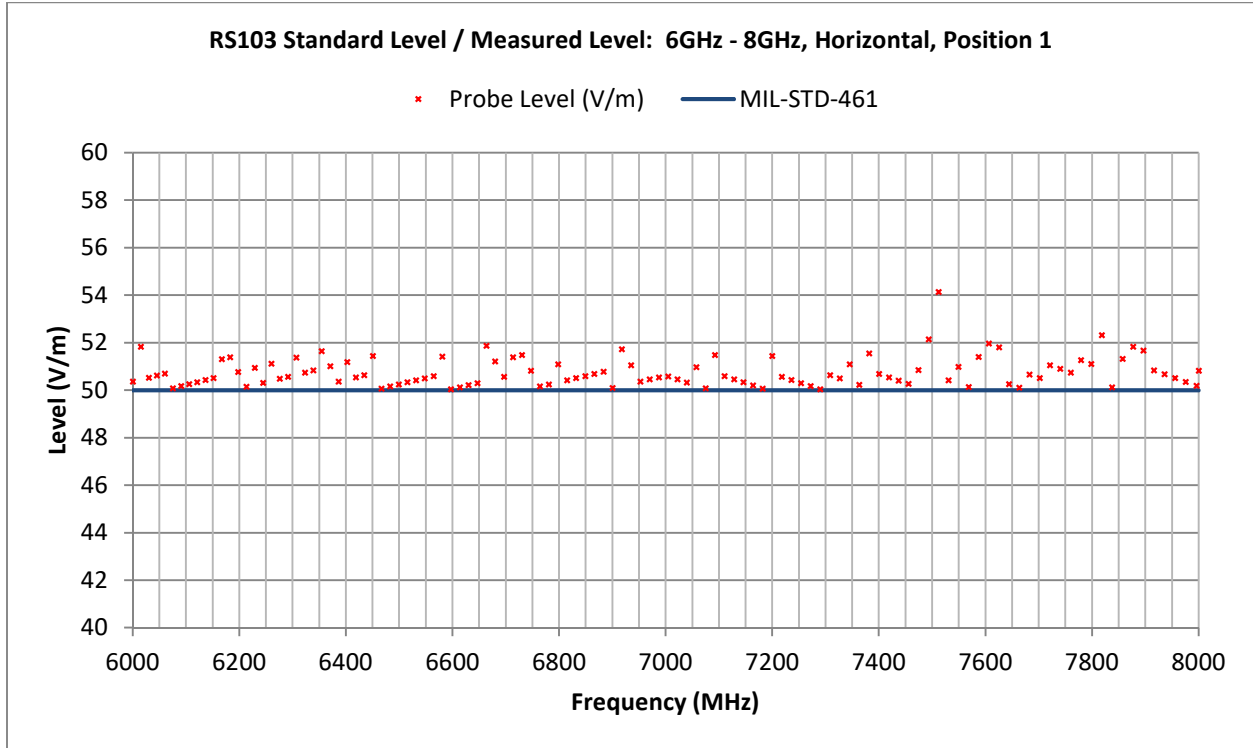


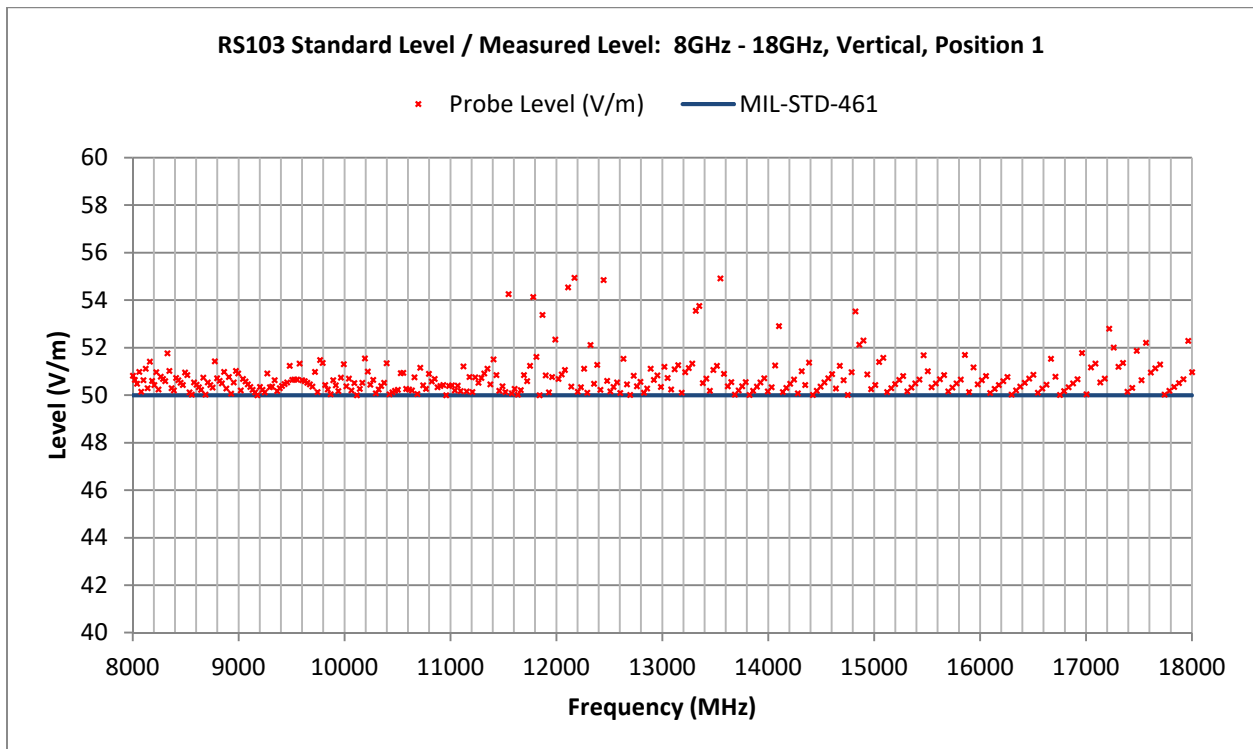
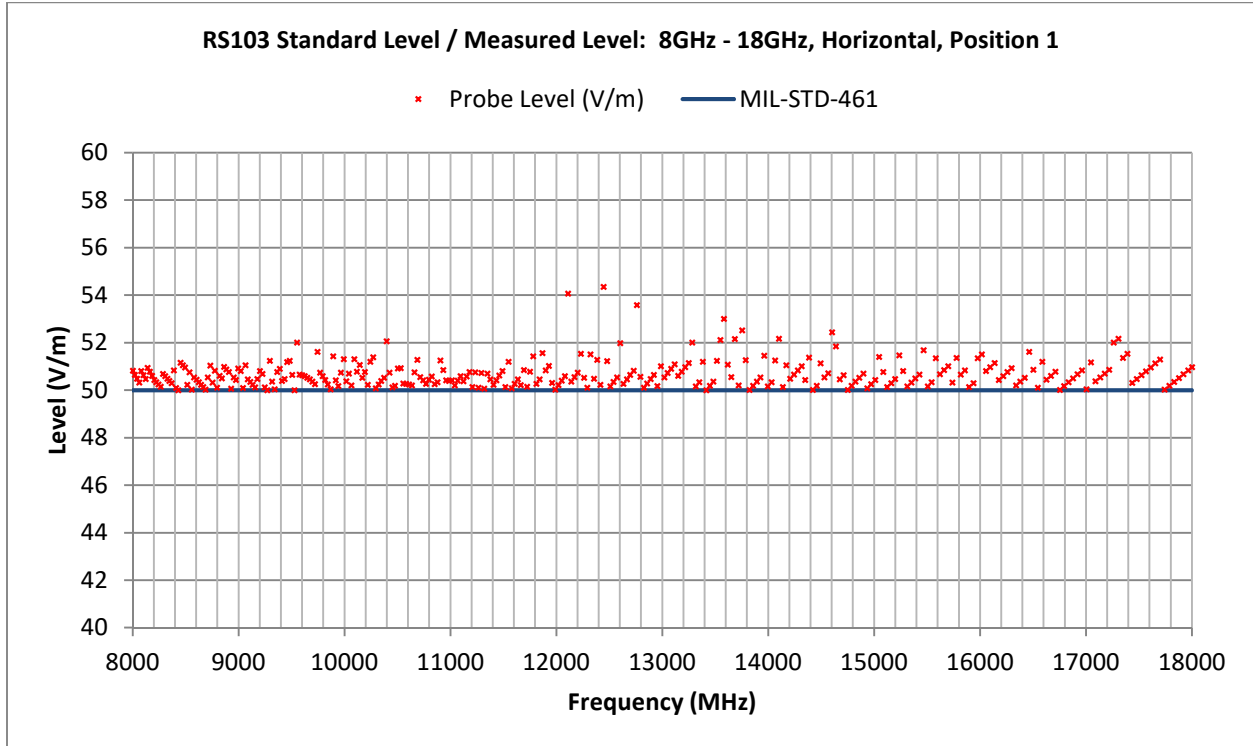
RS103 Standard Level / Measured Level: 1GHz - 2GHz, Vertical, Position 1







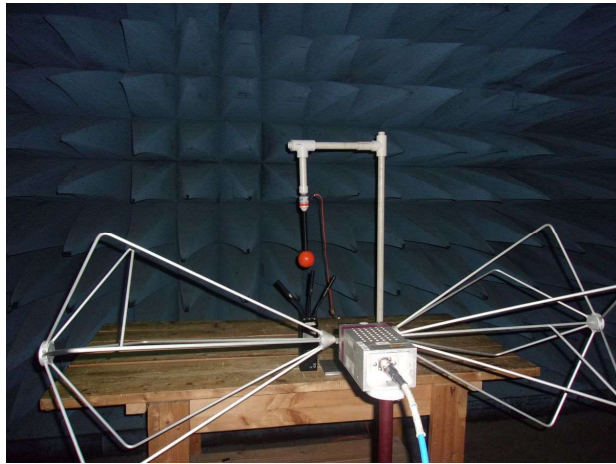




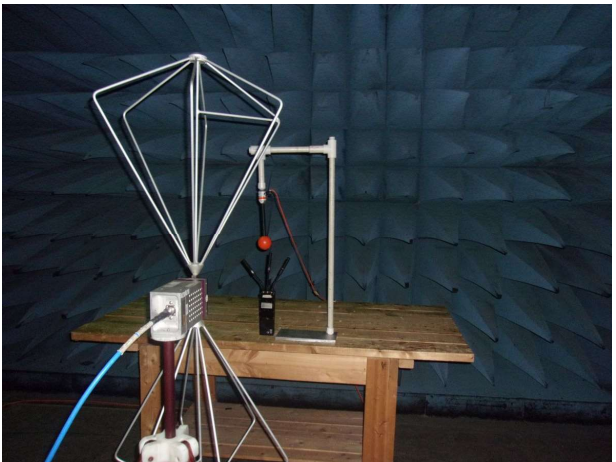
5.3.7 RS103 Photographs



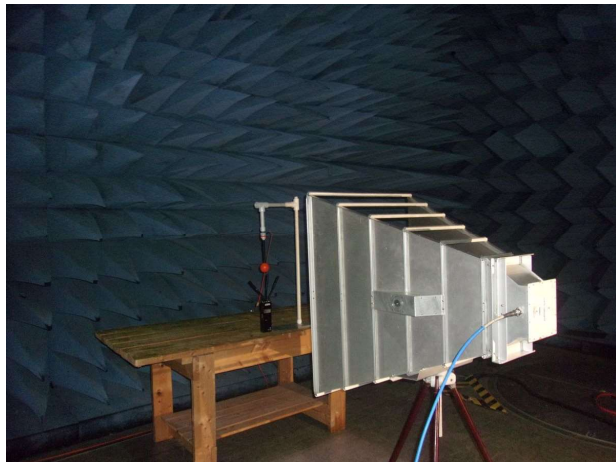
01 - 2-30MHz



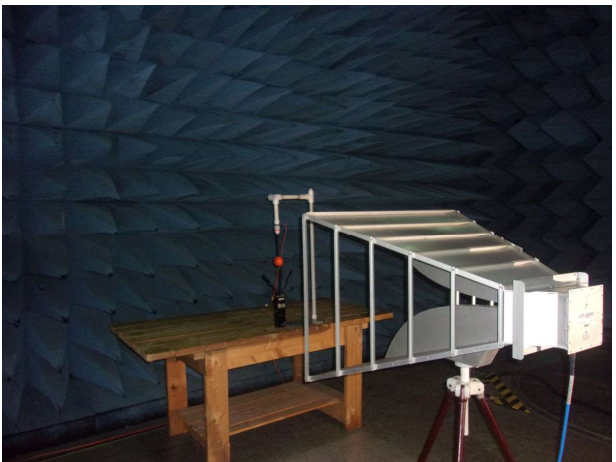
02 - 30-200MHz Horizontal



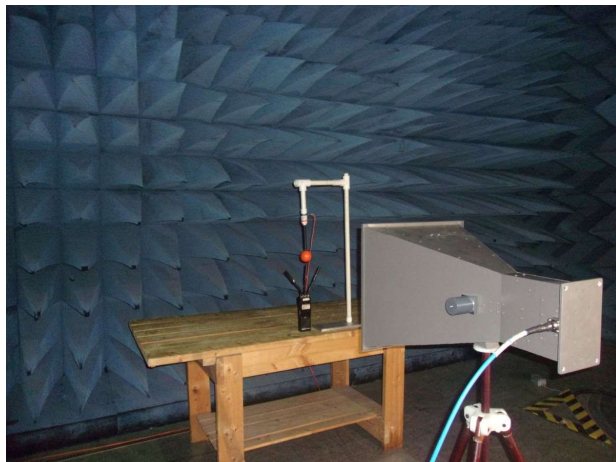
03 - 30-200MHz Vertical



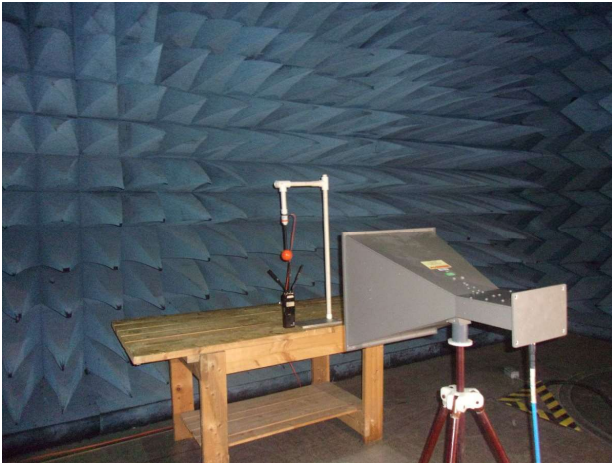
04 - 200MHz-1GHz Horizontal



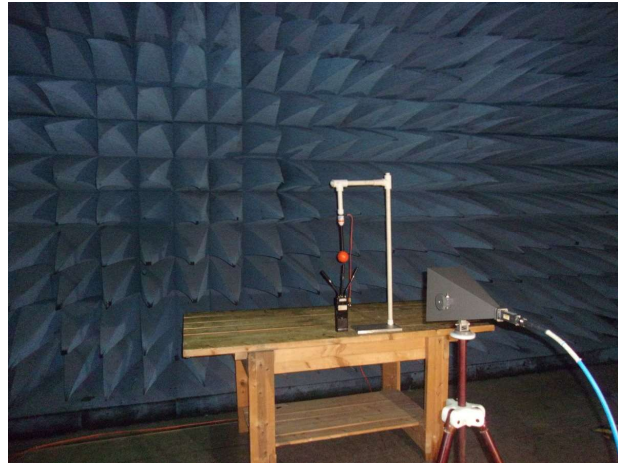
05 - 200MHz-1GHz Vertical



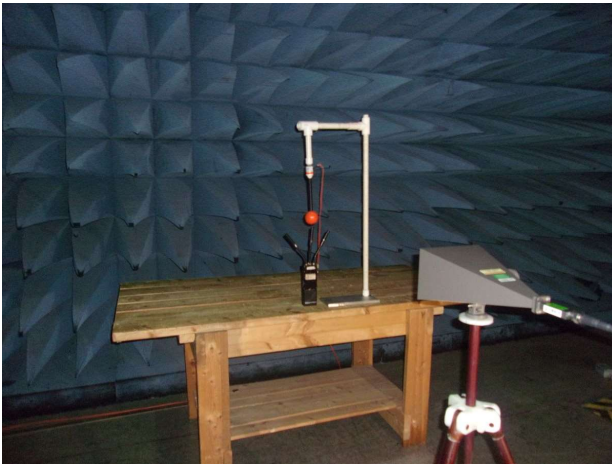
06 - 1-6GHz Horizontal



07 - 1-6GHz Vertical



08 - 6-8GHz Horizontal



09 - 6-8GHz Vertical



10 - 8-18GHz Horizontal



11 - 8-18GHz Vertical

5.3.8 RS103 Test Equipment

Table RS103-4: RS103 Test Equipment List

Asset No.	Manufacturer	Item	Model	S/N	Cal. Cycle (Months)	Cal. Due
WC005630	NTS	10kHz – 30MHz E-Field Generator	NTS10k30M	None	NCR	NCR
WC005618	EMCO	Biconical Antenna	3109	8811-2392	NCR	NCR
WC005310	ETS-Lindgren	200MHz – 1GHz DRG Horn Antenna	3106	35382	NCR	NCR
WC058429	AR	1-6GHz Horn Antenna	ATH800M6G	0351558	NCR	NCR
WC058430	AR	6-18GHz Horn Antenna	ATH6G18	0351643	NCR	NCR
WC005477	Amplifier Research	Signal Generator 9kHz-1.2GHz	SG1200	202308/251	12	5/7/20
WC005556	Agilent	Signal Generator 10MHz-20GHz	83620B	US34490403	12	5/10/20
WC005629	IFI	10 KHz - 200Mz Amplifier	TCCX 2500	L499-0408	NCR	NCR
WC005628	IFI	Amplifier 200 MHz – 1GHz	SMCC1000	L374-0507	NCR	NCR
WC005660	IFI	1-2GHz Amplifier	GT251-500A	L500-0408	NCR	NCR
WC005776	LogiMetrics	2-4 GHz Amplifier	A600/S	M701-0508	NCR	NCR
WC005662	Amplifier Research	4-8 GHz Amplifier	200T4GB	326913	NCR	NCR
WC005682	CPI	8-18 GHz Amplifier	VZM6993J5	SJ7213C7	NCR	NCR
WC005814	ETS Lindgren	Field Probe 10kHz - 1GHz	HI-6022	114361	12	9/22/20
WC005790	ETS Lindgren	Field Probe 10MHz - 40GHz	HI-6053	110384	12	8/21/20

NCR = No Calibration Required; as per NTS QA policy, the equipment does not require calibration as long as the test signal being generated can be verified with other calibrated equipment prior to or during the test.

5.4 Conducted Emissions: Method CE106, Conducted Emissions Antenna Terminal, 10kHz to 40GHz

CE106 Test Results Summary		
Antenna Port	Operating State	Result
MPU5 Chain 1 Antenna Port	Receive / Standby	PASS
MPU5 Chain 1 Antenna Port	Transmit	PASS

5.4.1 CE106 Purpose

This requirement is applicable from 10 kHz to 40 GHz for the antenna ports of transmitters, receivers, and amplifiers. The requirement is not applicable to equipment designed with antennas permanently mounted to the EUT. The transmit mode portion of this requirement is not applicable within the bandwidth of the EUT transmitted signal or within ± 5 percent of the fundamental frequency, whichever is larger. For Navy shipboard applications with peak transmitter power greater than 1 kW, the 5% frequency exclusion will be increased by an additional 0.1% of the fundamental frequency for each dB above 1 kW of peak power.

$$\text{Frequency Exclusion} = \pm f * (0.05 + (0.001/\text{dB}) * (\text{PtPk [dBm]} - 60 [\text{dBm}]))$$

CE106 Frequency Range

Depending on the operating frequency range of the EUT, the start frequency of the test is as follows:

EUT Operating Frequency Range	Start Frequency of Test
10 kHz to 3 MHz	10 kHz
3 MHz to 300 MHz	100 kHz
300 MHz to 3 GHz	1 MHz
3 GHz to 40 GHz	10 MHz

The equipment will be tested to an upper frequency limit based on the highest frequency generated or received by the EUT. For systems with the frequencies generated or received less than 1 GHz, the upper frequency limit will be 20 times the highest frequency or 18 GHz whichever is greater. For systems with frequencies generated or received greater than or equal to 1 GHz, the upper frequency limit will be 10 times the highest frequency or 40 GHz whichever is less. For equipment using waveguide, the requirement does not apply below eight-tenths of the waveguide's cutoff frequency. RE103 may be used as an alternative for CE106 for testing transmitters with their operational antennas.

5.4.2 CE106 Limits

Conducted emissions at the EUT antenna terminal shall not exceed the values given below.

- Receivers: 34 dB μ V
- Transmitters and amplifiers (standby mode): 34 dB μ V
- Transmitters and amplifiers (transmit mode): Harmonics, except the second and third, and all other spurious emissions shall be at least 80 dB down from the level at the fundamental. The second and third harmonics shall be suppressed to a level of -20 dBm or 80 dB below the fundamental, whichever requires less suppression. For Navy shipboard applications, the second and third harmonics will be suppressed to a level of -20 dBm and all other harmonics and spurious emissions shall be suppressed to -40 dBm, except if the duty cycle of the emissions are less than 0.2%, then the limit may be relaxed to 0 dBm.

5.4.3 CE106 Test Setup

- a. Calibration. Configure the test setup for the signal generator path shown in Figures CE106-1 through CE106-3 as applicable.
- b. EUT Testing. Configure the test setup for the EUT path shown in Figures CE106-1 through CE106-3 as applicable.

5.4.4 CE106 Test Procedure

Transmit mode for transmitters and amplifiers.

The test procedure shall be as follows:

1. Turn on the measurement equipment and allow a sufficient time for stabilization.
2. Calibration.
 - a. Apply a known calibrated signal level from the signal generator through the system check path at a mid-band fundamental frequency (f_0).
 - b. Scan the measurement receiver in the same manner as a normal data scan. Verify the measurement receiver detects a level within ± 3 dB of the expected signal.
 - c. If readings are obtained which deviate by more than ± 3 dB, locate the source of the error and correct the deficiency prior to proceeding with the test.
 - d. Repeat (1) through (3) at the end points of the frequency range of test.
3. EUT Testing.
 - a. Turn on the EUT and allow sufficient time for stabilization.
 - b. For transmitters, tune the EUT to the desired test frequency and apply the appropriate modulation for the EUT as indicated in the equipment specification.
 - c. For amplifiers, apply an input signal to the EUT that has the appropriate frequency, power level, and modulation as indicated in the equipment specification. For transmitters and amplifiers for which these parameters vary, test parameters shall be chosen such that the worst case emissions spectrum will result.
 - d. Use the measurement path to complete the rest of this procedure.
 - e. Tune the test equipment to the operating frequency (f_0) of the EUT and adjust for maximum indication.
 - f. Record the power level of the fundamental frequency (f_0) and the measurement receiver bandwidth.
 - g. Insert the fundamental frequency rejection network, when applicable.
 - h. Scan the frequency range of interest and record the level of all harmonics and spurious emissions. Add all correction factors for cable loss, attenuators and rejection networks. Maintain the same measurement receiver bandwidth used to measure the power level of the fundamental frequency (f_0).
 - i. Verify spurious outputs are from the EUT and not spurious responses of the measurement system.
 - j. Repeat (2) through (8) for other frequencies.

Receivers and stand-by mode for transmitters and amplifiers.

The test procedure shall be as follows:

1. Turn on the measurement equipment and allow a sufficient time for stabilization.
2. Calibration.
 - a. Apply a calibrated signal level, which is 6 dB below the applicable limit, from the signal generator through the system check path at a midpoint test frequency.
 - b. Scan the measurement receiver in the same manner as a normal data scan. Verify the measurement receiver detects a level within ± 3 dB of the injected signal.
 - c. If readings are obtained which deviate by more than ± 3 dB, locate the source of the error and correct the deficiency prior to proceeding with the test.
 - d. Repeat (1) through (3) at the end points of the frequency range of test.
3. EUT Testing.
 - a. Turn on the EUT and allow sufficient time for stabilization.
 - b. Tune the EUT to the desired test frequency and use the measurement path to complete the rest of this procedure.
 - c. Scan the measurement receiver over the applicable frequency range, using the bandwidths and minimum measurement times of Table II of MIL-STD-461F.
 - d. Repeat (2) and (3) for other frequencies.

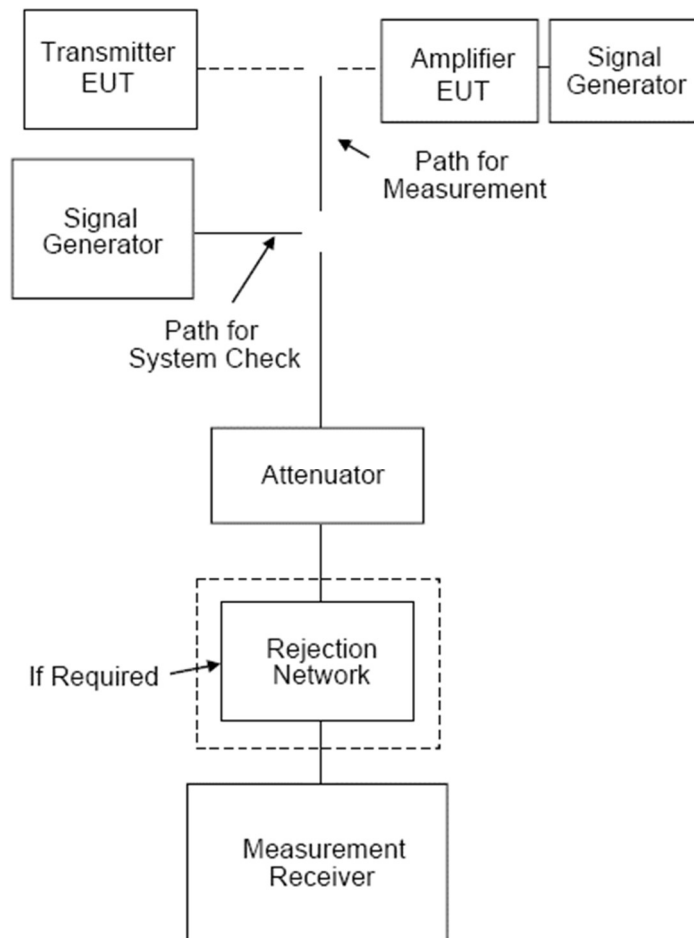


Figure CE106-1: Setup for Low Power Transmitters and Amplifiers

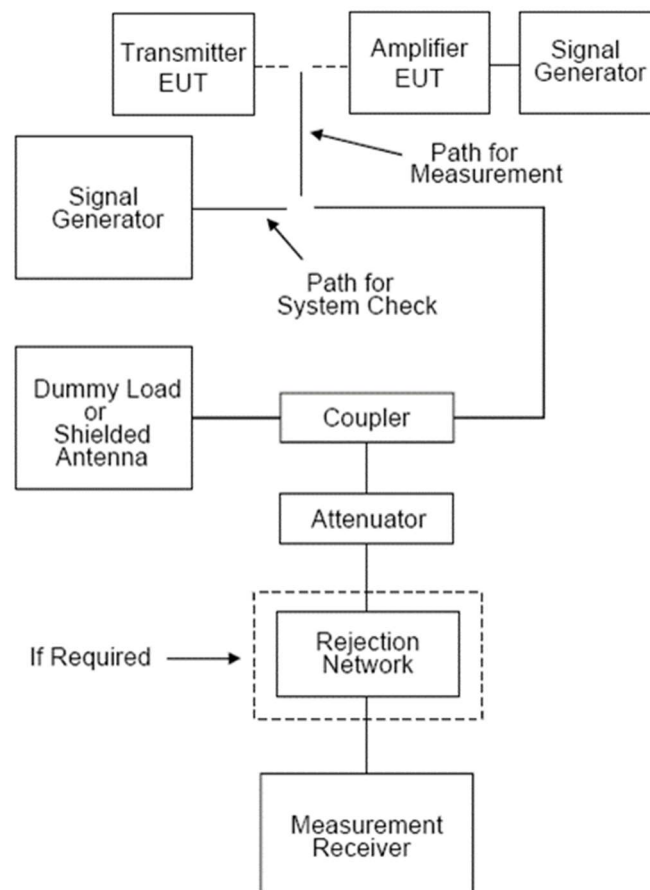


Figure CE106-2: Setup for High Power Transmitters and Amplifiers

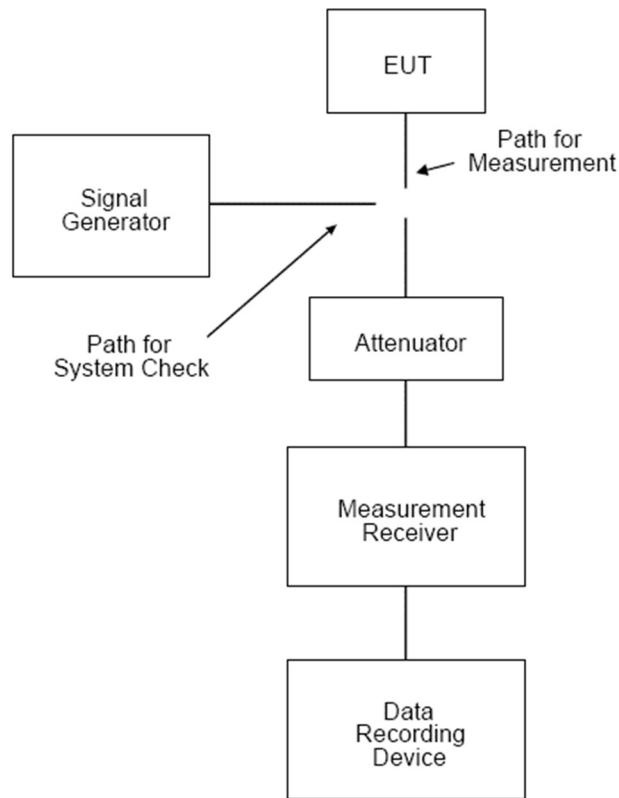


Figure CE106-3: Setup for Receivers and Stand-by Mode for Transmitters and Amplifiers

5.4.5 CE106 Data

CE106 Datasheet

Job Number:	PR132717	Standard:	MIL-STD-461F
		Procedure:	None
Date:	2/21/21	EUT:	MPU5 Radio with RF-2150 10W S-Band Card
Model:	MPU5, RF-2150	S/N:	28360 (MPU5), 67820 (S-Band Card)
Test Personnel:	Jeff Maselli	Manufacturer:	Persistent Systems

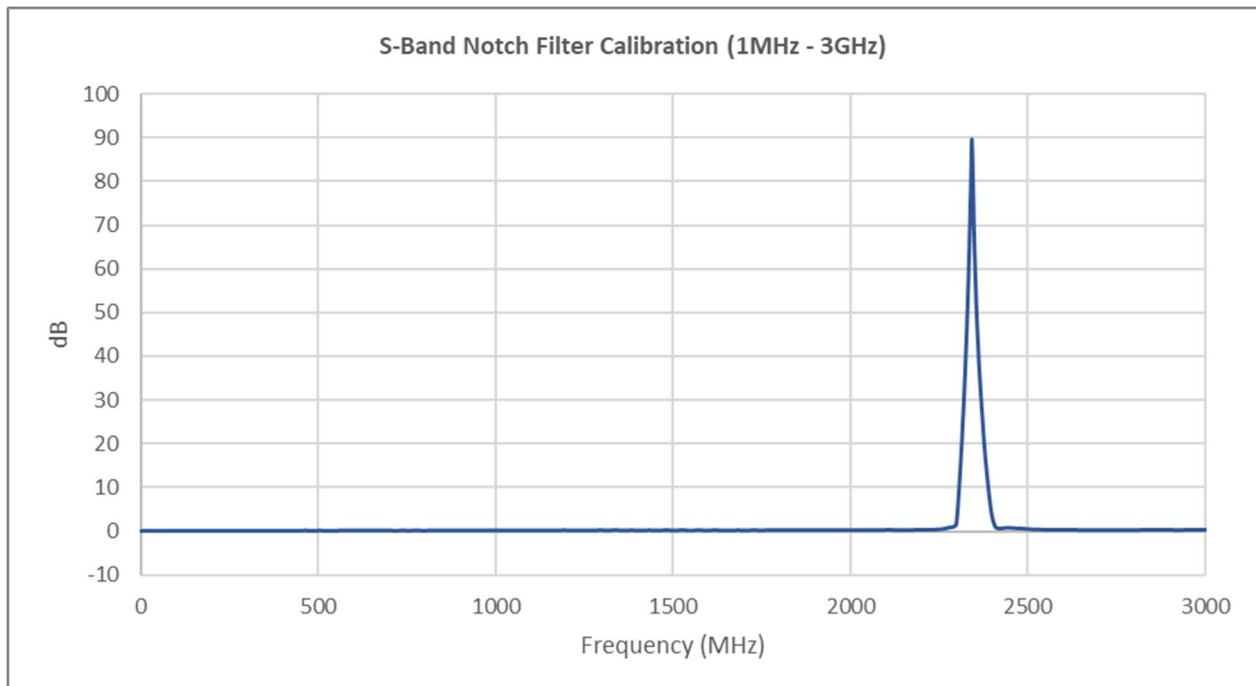
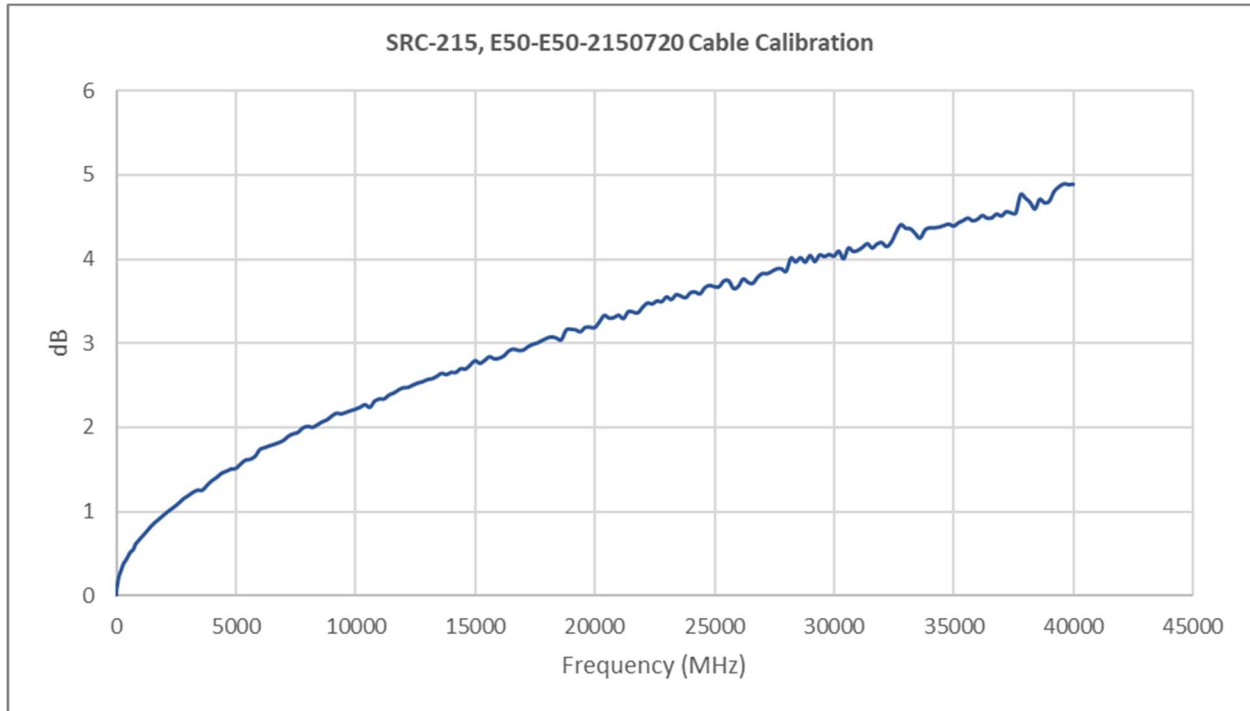
CE106 Test Specification:

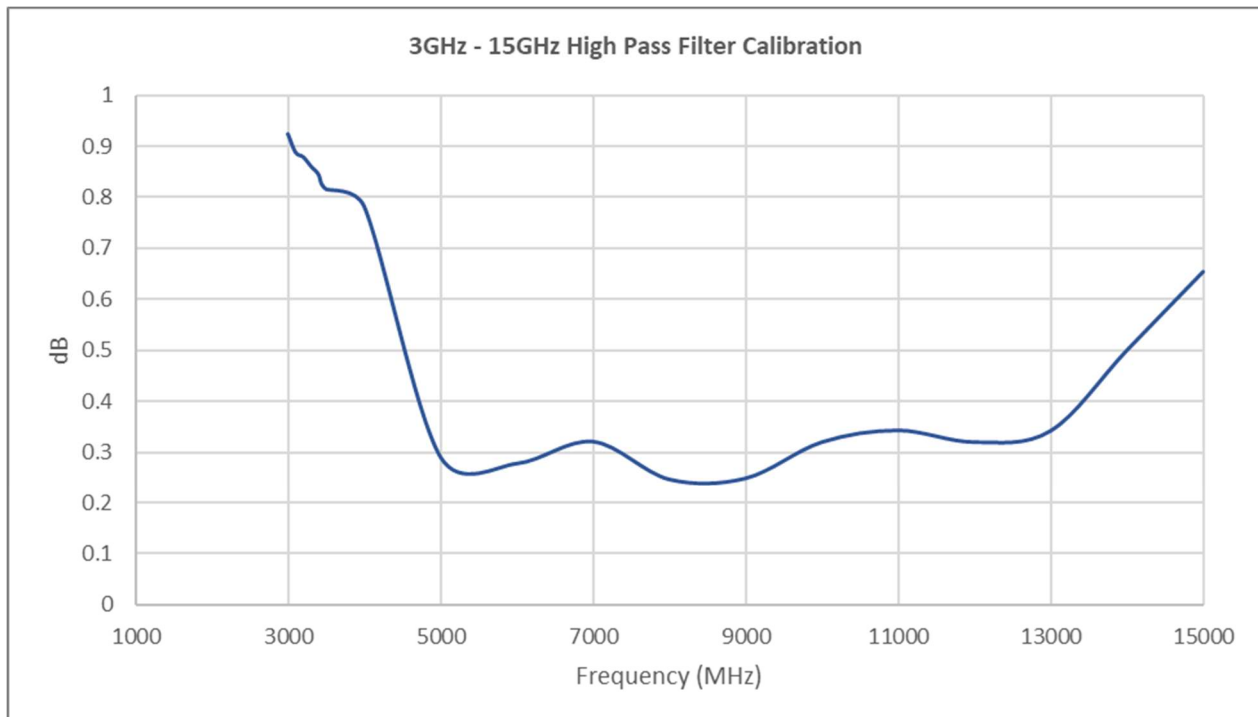
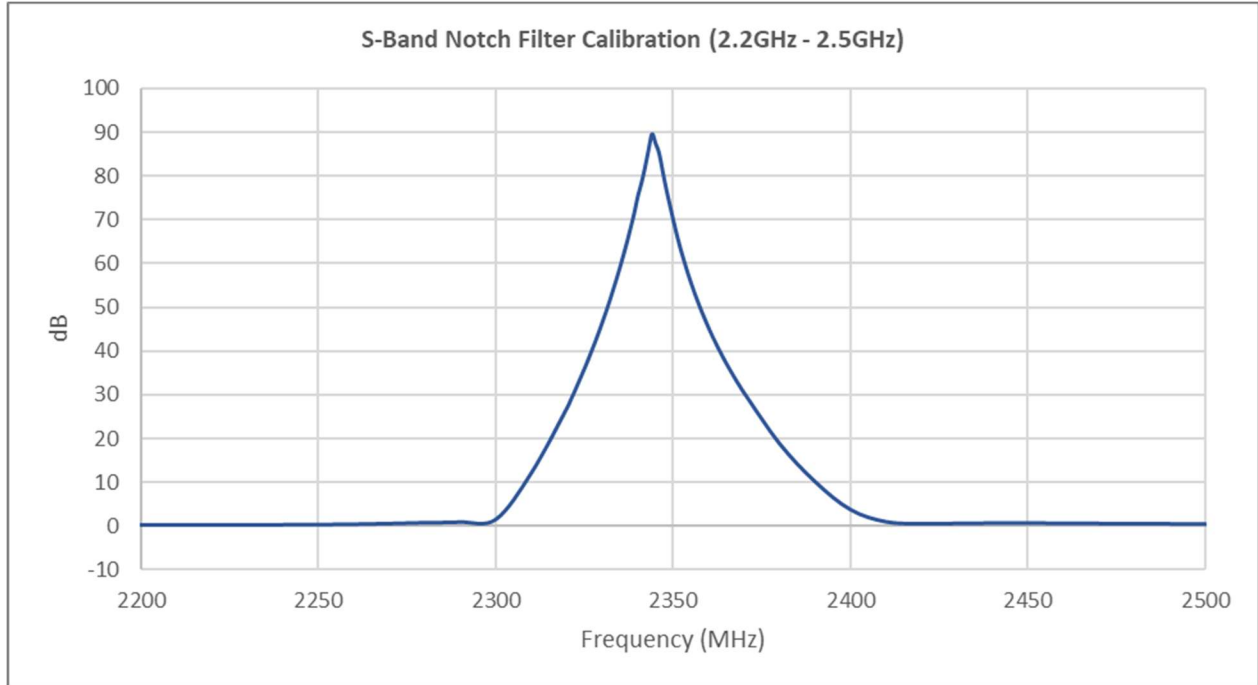
Test Type	Test Specification	Performance Criteria
Conducted Emissions, Antenna Terminal, 10 kHz to 40 GHz.	a. Receivers: 34 dB μ V b. Transmitters and amplifiers (standby mode): 34 dB μ V c. Transmitters and amplifiers (transmit mode): Harmonics, except the second and third, and all other spurious emissions shall be at least 80 dB down from the level at the fundamental. The second and third harmonics shall be suppressed to a level of -20 dBm or 80 dB below the fundamental, whichever requires less suppression.	The EUT emissions must not exceed the limit.

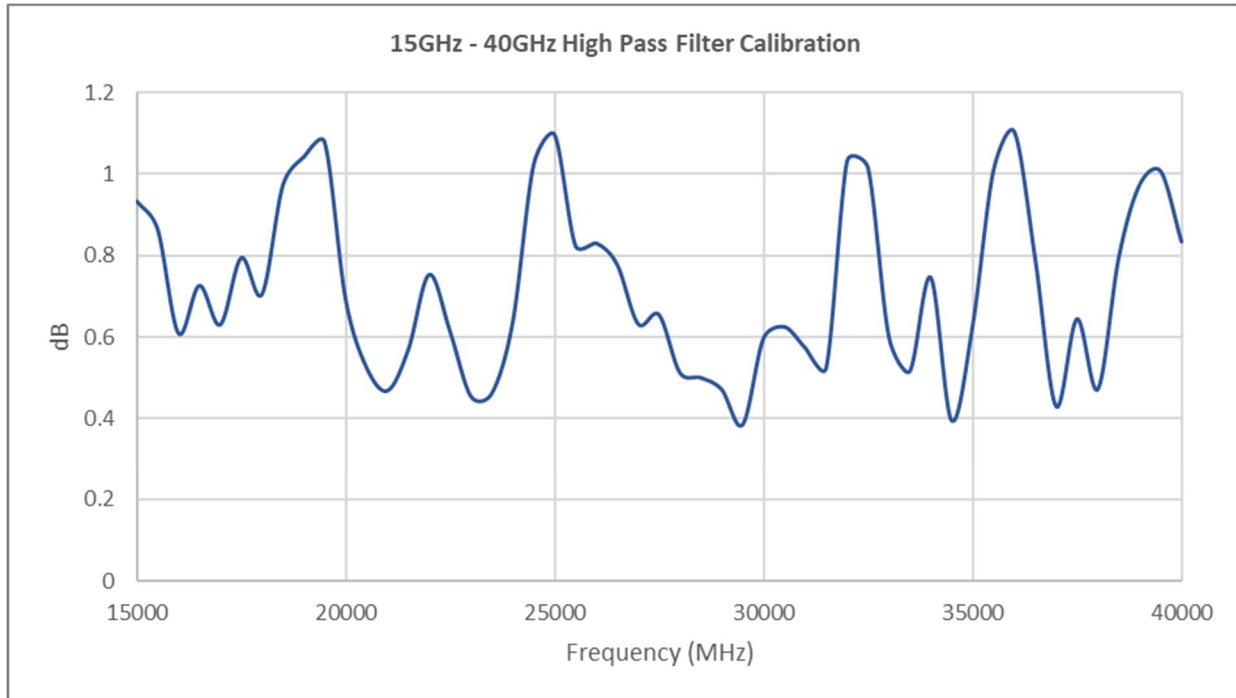
CE106 Test Results Summary:

Port Tested	Radio Module	Mode	Frequency (MHz)	Results (Pass/Fail)
Chain 1 Antenna Port	S-Band	Standby / Receive	1 – 25,000	PASS
Chain 1 Antenna Port	S-Band	Transmit	1 – 25,000	PASS

5.4.5.1 CE106 Calibration Data

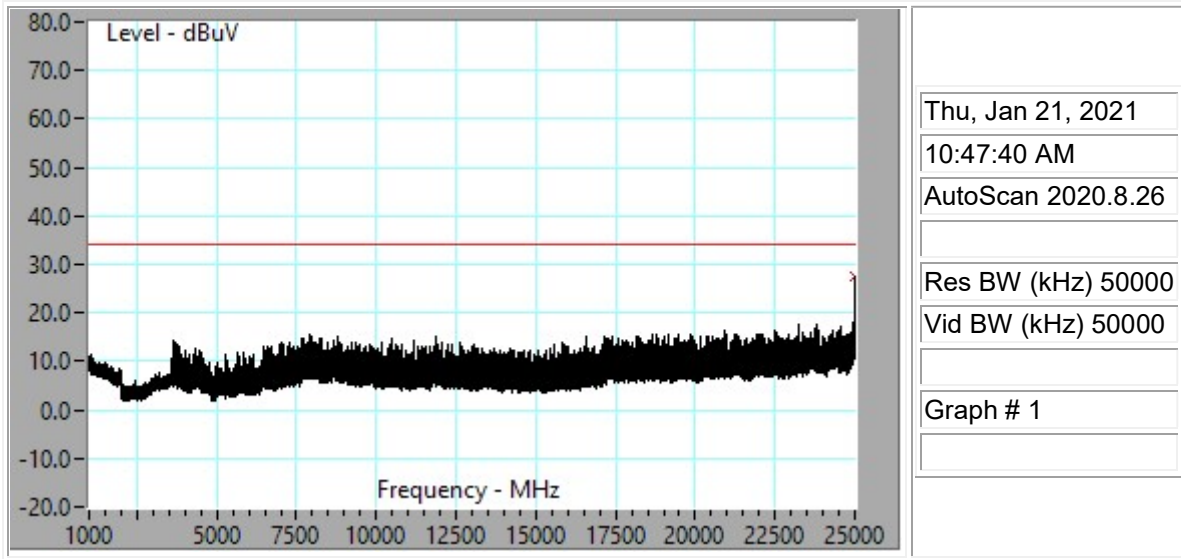






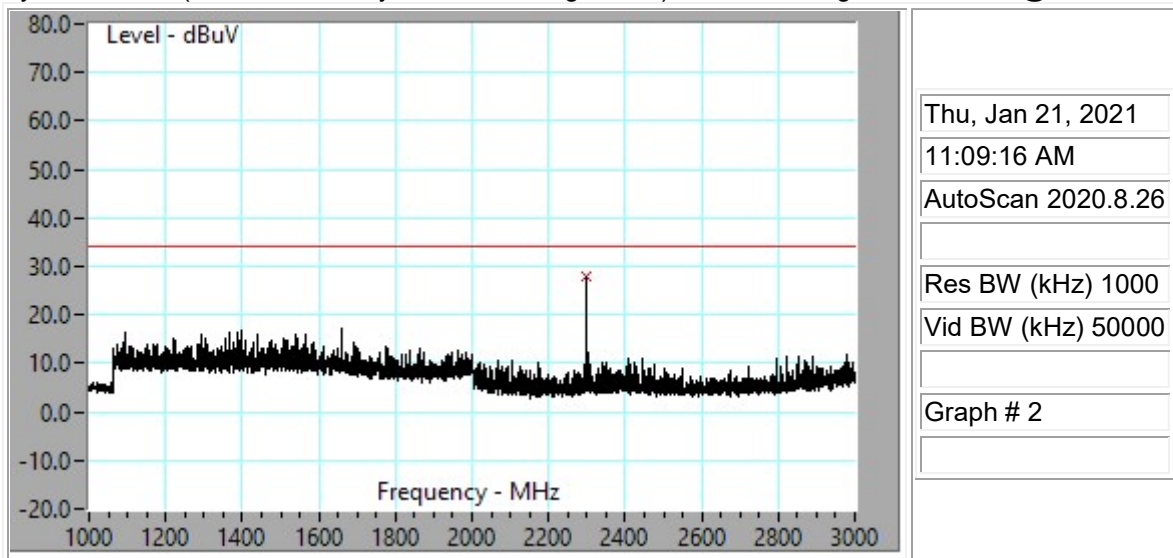
5.4.5.2 CE106 System Check Data

System Check (S-Band, Standby/Receive Configuration): Calibrated Signal = 27dBuV @ 25GHz.



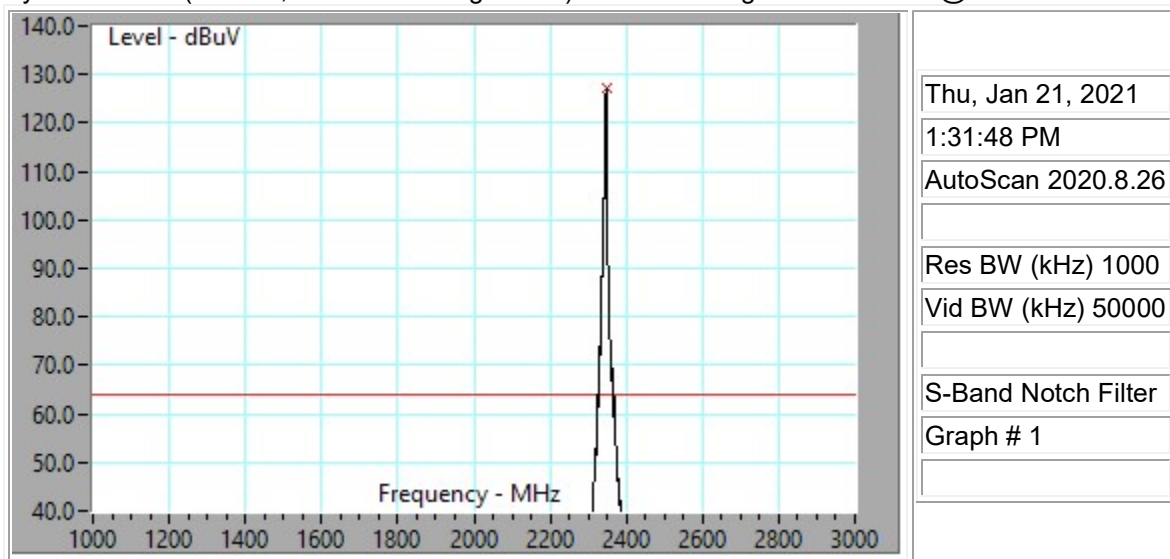
Frequency	Level	Limit	Delta	Raw	Cable	Xducer	All Factors
MHz	dBuV	dBuV	dB	dBuV	dB	dB	dB
25000.0	27.7	34.0	-6.3	24.03	3.67	0.00	-3.67

System Check (S-Band, Standby/Receive Configuration): Calibrated Signal = 27dBuV @ 2.3GHz.



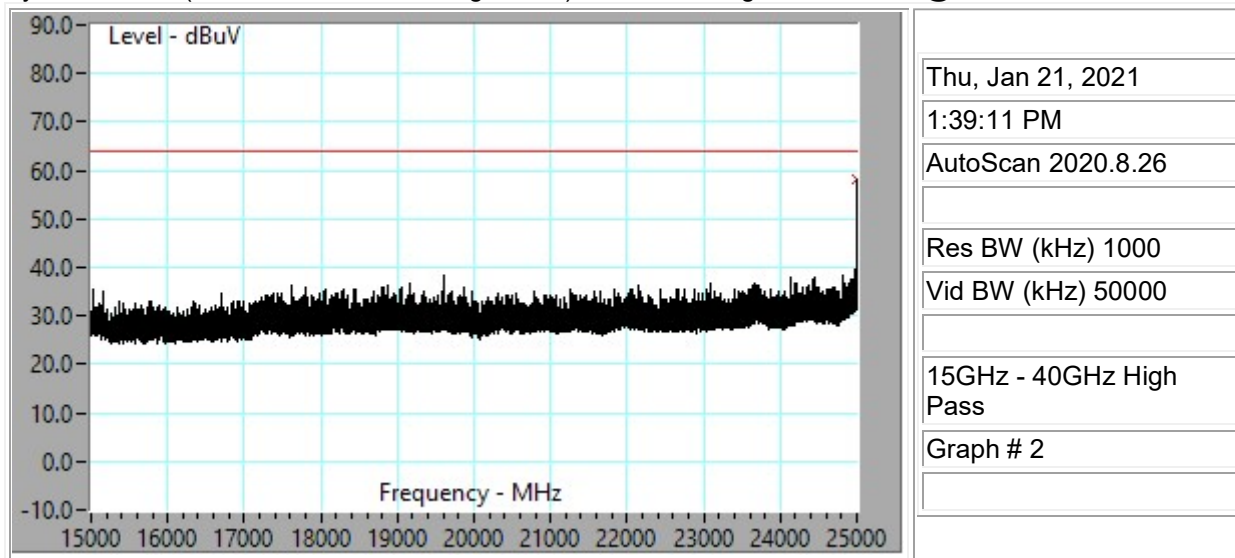
Frequency	Level	Limit	Delta	Raw	Cable	Xducer	All Factors
MHz	dBuV	dBuV	dB	dBuV	dB	dB	dB
2299.8	28.0	34.0	-6.0	26.95	1.03	0.00	-1.03

System Check (S-Band, Transmit Configuration): Calibrated Signal = 127dBuV @ 2.347GHz



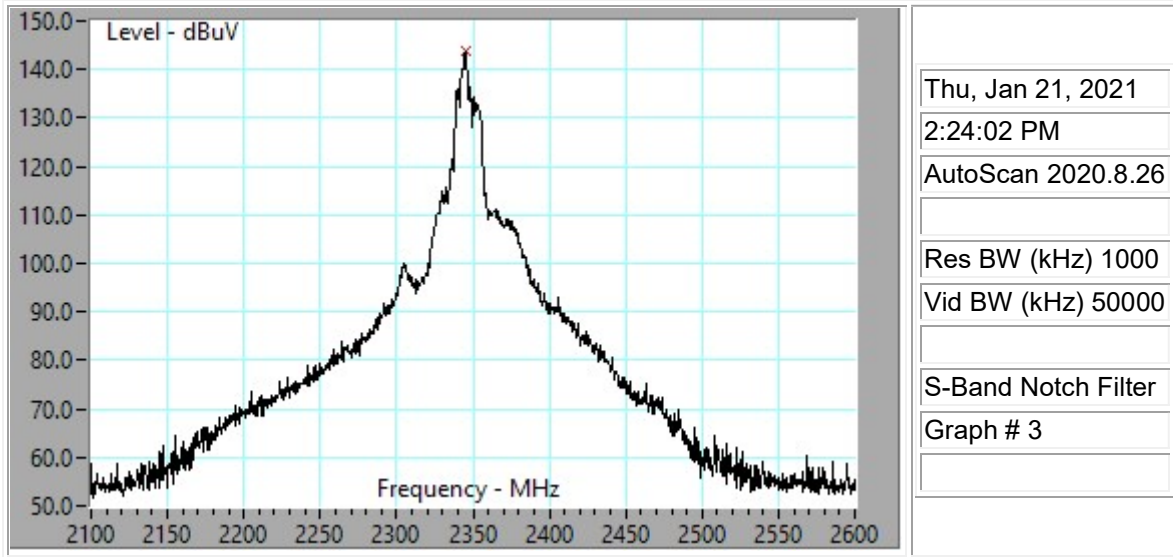
Frequency	Level	Limit	Delta		Raw	Cable	Xducer	All Factors
MHz	dBuV	dBuV	dB		dBuV	dB	dB	dB
2346.8	127.3	64.0	63.3		44.45	1.04	81.79	-82.83

System Check (S-Band, Transmit Configuration): Calibrated Signal = 57dBuV @ 25GHz



Frequency	Level	Limit	Delta		Raw	Cable	Xducer	All Factors
MHz	dBuV	dBuV	dB		dBuV	dB	dB	dB
25000.0	58.0	64.0	-6.0		53.26	3.67	1.10	-4.77

5.4.5.3 CE106 Fundamental Frequency Amplitude Measurement Data Fundamental (S-Band)



Frequency	Level	Limit	Delta		Raw	Cable	Xducer	All Factors
MHz	dBuV	dBuV	dB		dBuV	dB	dB	dB
2346.0	144.0				57.71	1.04	85.26	-86.30

Notes:

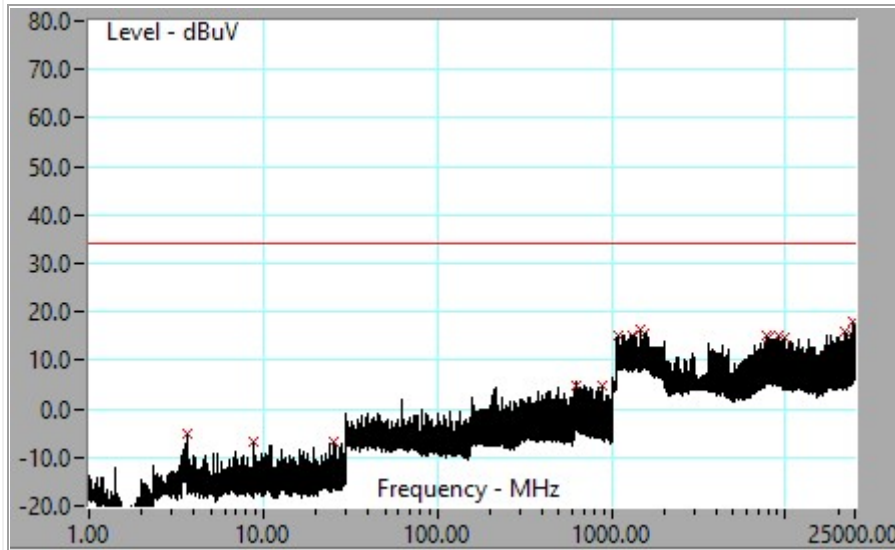
136dBuV = 37dBm

Spurious Limit = 37dBm – 80dB = -43dBm = 64dBuV

2nd/3rd Harmonic Limit = -20dBm = 87dBuV

5.4.5.4 CE106 Test Data

Ambient Scan (S-Band)



Thu, Jan 21, 2021

12:30:04 PM

AutoScan 2020.8.26

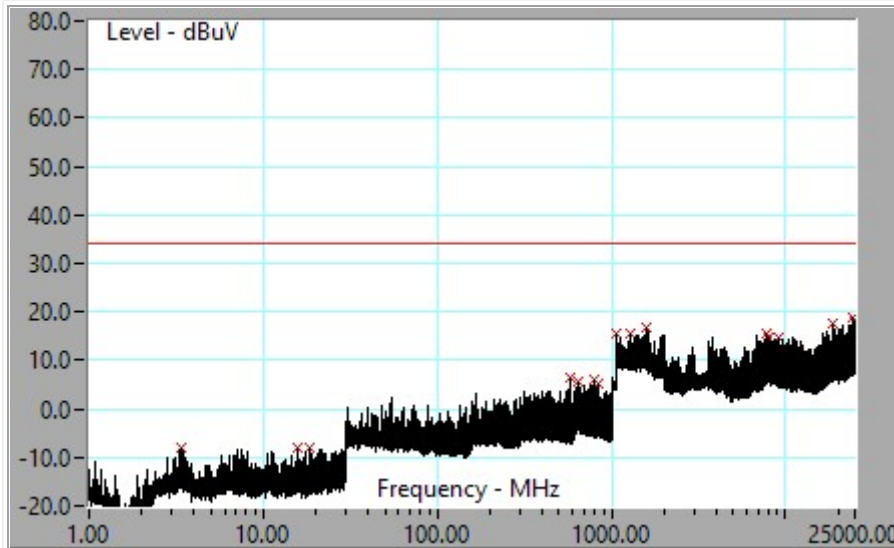
Res BW (kHz) 10, 100, 1000

Vid BW (kHz) 50000

Graph # 1

Frequency	Level	Limit	Delta		Raw	Cable	All Factors
MHz	dBuV	dBuV	dB		dBuV	dB	dB
3.630	-5.1	34.0	-39.1		-5.08	0.02	-0.02
8.846	-6.7	34.0	-40.7		-6.77	0.06	-0.06
25.229	-6.9	34.0	-40.9		-7.04	0.09	-0.09
624.494	5.0	34.0	-29.0		4.44	0.53	-0.53
895.332	4.7	34.0	-29.3		4.06	0.64	-0.64
1106.527	15.3	34.0	-18.7		14.59	0.71	-0.71
1327.582	15.3	34.0	-18.7		14.51	0.78	-0.78
1453.113	16.3	34.0	-17.7		15.49	0.82	-0.82
1564.141	15.7	34.0	-18.3		14.81	0.86	-0.86
7805.201	15.2	34.0	-18.8		13.22	1.99	-1.99
8033.210	14.9	34.0	-19.1		12.84	2.01	-2.01
9206.259	15.2	34.0	-18.8		12.99	2.17	-2.17
9996.792	14.7	34.0	-19.3		12.49	2.22	-2.22
22088.855	15.8	34.0	-18.2		12.33	3.45	-3.45
23459.924	15.5	34.0	-18.5		11.94	3.57	-3.57
24282.965	18.2	34.0	-15.8		14.56	3.60	-3.60

MPU5 Radio (S-Band), Chain 1 Antenna Port, Standby Mode



Thu, Jan 21, 2021

12:53:49 PM

AutoScan 2020.8.26

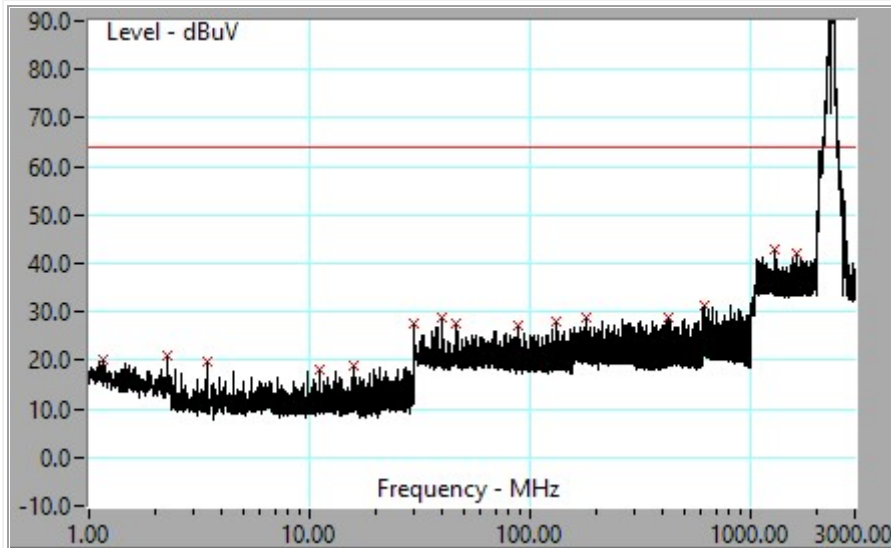
Res BW (kHz) 10, 100, 1000

Vid BW (kHz) 50000

Graph # 2

Frequency	Level	Limit	Delta		Raw	Cable	All Factors
MHz	dBuV	dBuV	dB		dBuV	dB	dB
3.369	-8.2	34.0	-42.2		-8.23	0.02	-0.02
15.614	-7.8	34.0	-41.8		-7.91	0.08	-0.08
18.384	-8.1	34.0	-42.1		-8.20	0.08	-0.08
583.752	6.3	34.0	-27.7		5.75	0.51	-0.51
639.530	5.8	34.0	-28.2		5.28	0.53	-0.53
791.343	6.2	34.0	-27.8		5.55	0.61	-0.61
829.514	5.2	34.0	-28.8		4.59	0.62	-0.62
1064.516	15.4	34.0	-18.6		14.69	0.70	-0.70
1270.568	15.7	34.0	-18.3		14.90	0.76	-0.76
1574.144	16.7	34.0	-17.3		15.84	0.86	-0.86
7880.204	15.4	34.0	-18.6		13.35	2.00	-2.00
8095.213	14.8	34.0	-19.2		12.82	2.01	-2.01
9130.756	14.7	34.0	-19.3		12.58	2.16	-2.16
18433.672	17.7	34.0	-16.3		14.69	3.06	-3.06
24601.980	18.7	34.0	-15.3		15.05	3.66	-3.66
24971.498	17.8	34.0	-16.2		14.14	3.68	-3.68

Transmit Mode (S-Band)



Thu, Jan 21, 2021

2:47:12 PM

AutoScan 2020.8.26

Res BW (kHz) 10, 100, 1000

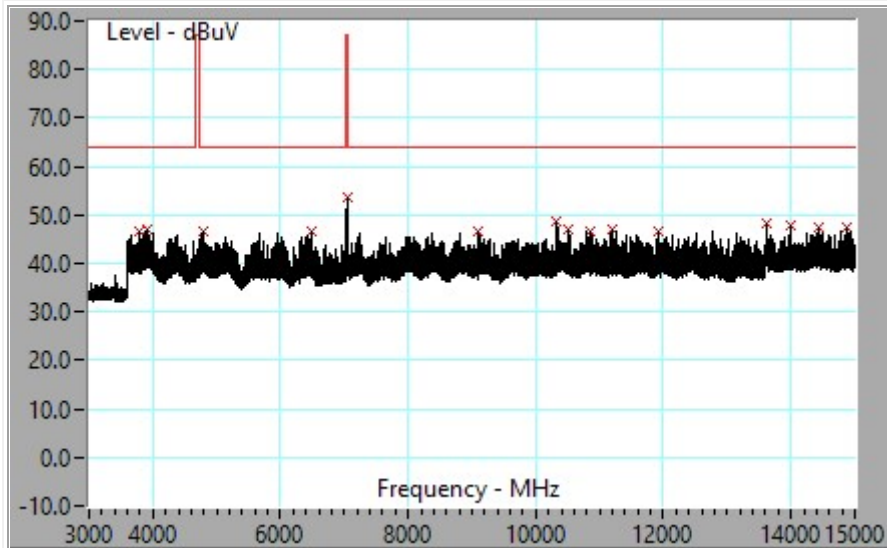
Vid BW (kHz) 50000

S-Band Notch Filter

Graph # 4

Frequency	Level	Limit	Delta		Raw	Cable	Xducer	All Factors
MHz	dBuV	dBuV	dB		dBuV	dB	dB	dB
1.150	20.3	64.0	-43.7		20.30	0.01	0.01	-0.03
2.271	20.9	64.0	-43.1		20.84	0.02	0.02	-0.03
3.427	19.7	64.0	-44.3		19.64	0.02	0.02	-0.04
11.026	18.3	64.0	-45.7		18.20	0.07	0.03	-0.10
15.952	18.9	64.0	-45.1		18.78	0.08	0.03	-0.11
30.000	27.6	64.0	-36.4		27.46	0.10	0.03	-0.14
40.283	28.7	64.0	-35.3		28.58	0.12	0.03	-0.15
46.782	27.8	64.0	-36.2		27.61	0.13	0.03	-0.16
88.833	27.0	64.0	-37.0		26.79	0.20	0.04	-0.24
131.807	27.9	64.0	-36.1		27.62	0.24	0.04	-0.28
180.552	28.6	64.0	-35.4		28.31	0.29	0.05	-0.34
426.265	29.0	64.0	-35.0		28.51	0.44	0.09	-0.52
627.695	31.4	64.0	-32.6		30.74	0.53	0.10	-0.63
1299.075	42.9	64.0	-21.1		41.92	0.77	0.18	-0.96
1621.655	42.0	64.0	-22.0		41.00	0.87	0.17	-1.05

Transmit Mode (S-Band)



Thu, Jan 21, 2021

2:58:30 PM

AutoScan 2020.8.26

Res BW (kHz) 50000

Vid BW (kHz) 50000

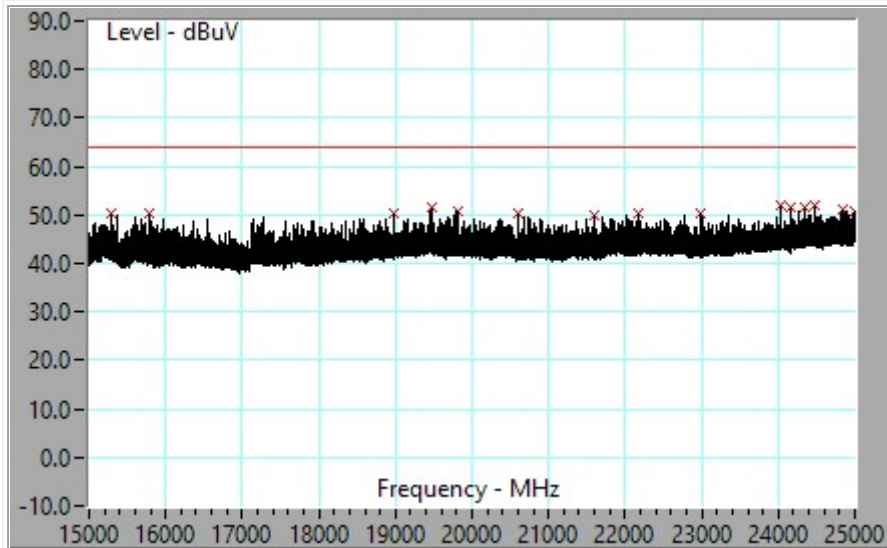
3GHz-15GHz High Pass
Filter

Graph # 5

Frequency	Level	Limit	Delta		Raw	Cable	Xducer	All Factors
MHz	dBuV	dBuV	dB		dBuV	dB	dB	dB
3798.0	46.8	64.0	-17.2		44.65	1.31	0.79	-2.11
3922.0	46.9	64.0	-17.1		44.74	1.35	0.79	-2.13
4787.1	46.5	64.0	-17.5		44.57	1.50	0.39	-1.90
6471.6	46.5	64.0	-17.5		44.41	1.79	0.30	-2.09
7043.7	53.6	87.0	-33.4		51.38	1.86	0.32	-2.18
9109.3	46.5	64.0	-17.5		44.09	2.15	0.26	-2.41
10316.3	48.7	64.0	-15.3		46.08	2.26	0.33	-2.58
10498.3	47.1	64.0	-16.9		44.51	2.25	0.33	-2.59
10839.3	46.6	64.0	-17.4		43.90	2.32	0.34	-2.66
11210.8	47.0	64.0	-17.0		44.33	2.34	0.34	-2.68
11933.4	46.7	64.0	-17.3		43.94	2.46	0.32	-2.78
13604.4	48.4	64.0	-15.6		45.29	2.64	0.44	-3.08
13982.0	47.9	64.0	-16.1		44.73	2.65	0.50	-3.15
14432.5	47.5	64.0	-16.5		44.27	2.70	0.57	-3.26
14884.0	47.4	64.0	-16.6		43.95	2.76	0.64	-3.40



Transmit Mode (S-Band)



Thu, Jan 21, 2021
3:07:47 PM
AutoScan 2020.8.26

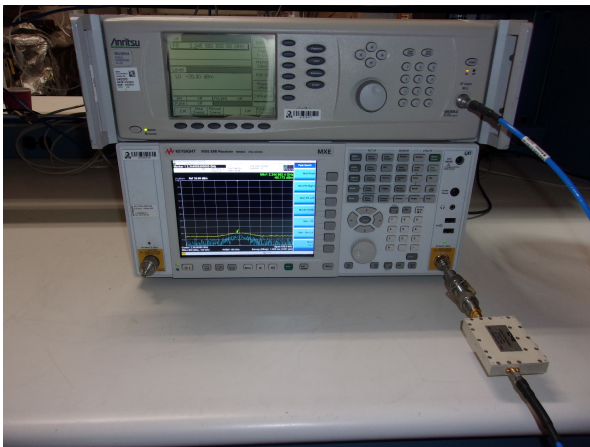
Res BW (kHz) 1000
Vid BW (kHz) 50000

15GHz - 40GHz High
Pass

Graph # 6

Frequency	Level	Limit	Delta		Raw	Cable	Xducer	All Factors
MHz	dBuV	dBuV	dB		dBuV	dB	dB	dB
15282.0	50.4	64.0	-13.6		46.75	2.78	0.89	-3.67
15777.5	50.5	64.0	-13.5		46.96	2.82	0.72	-3.54
18981.2	50.4	64.0	-13.6		46.20	3.17	1.04	-4.20
19481.2	51.4	64.0	-12.6		47.14	3.16	1.07	-4.23
19808.2	50.8	64.0	-13.2		46.81	3.19	0.84	-4.03
20600.3	50.2	64.0	-13.8		46.42	3.30	0.51	-3.81
21585.8	49.9	64.0	-14.1		45.95	3.37	0.60	-3.97
22161.4	50.5	64.0	-13.5		46.33	3.47	0.71	-4.17
22976.4	50.2	64.0	-13.8		46.22	3.54	0.46	-4.00
24040.0	52.1	64.0	-11.9		47.81	3.60	0.67	-4.27
24150.5	51.7	64.0	-12.3		47.38	3.61	0.75	-4.36
24351.5	51.5	64.0	-12.5		47.02	3.59	0.91	-4.50
24465.5	51.8	64.0	-12.2		47.24	3.61	1.00	-4.61
24850.5	51.2	64.0	-12.8		46.48	3.68	1.07	-4.76
24994.5	50.6	64.0	-13.4		45.83	3.67	1.09	-4.77

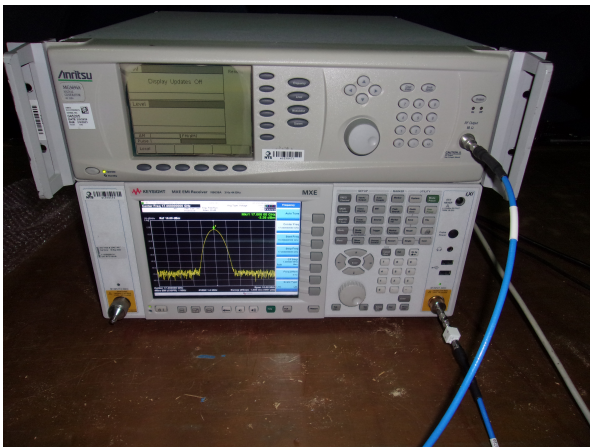
5.4.6 CE106 Photographs



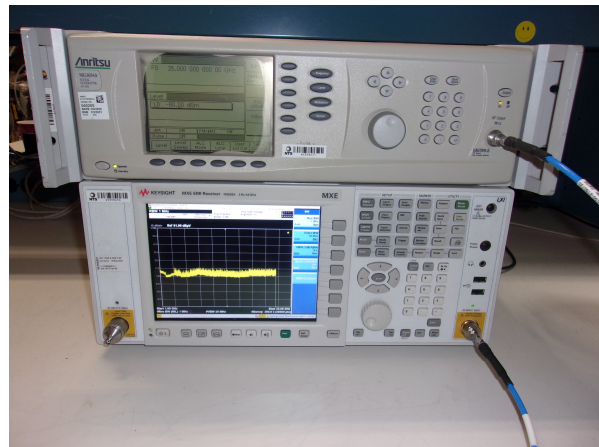
01 - S-Band Notch Filter Calibration



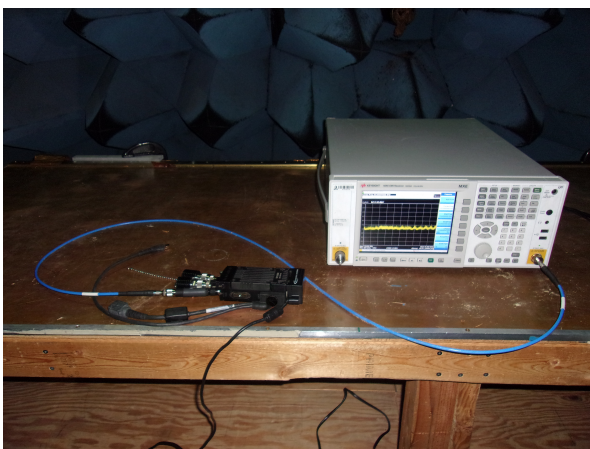
02 - 3GHz to 15GHz High Pass Filter Calibration



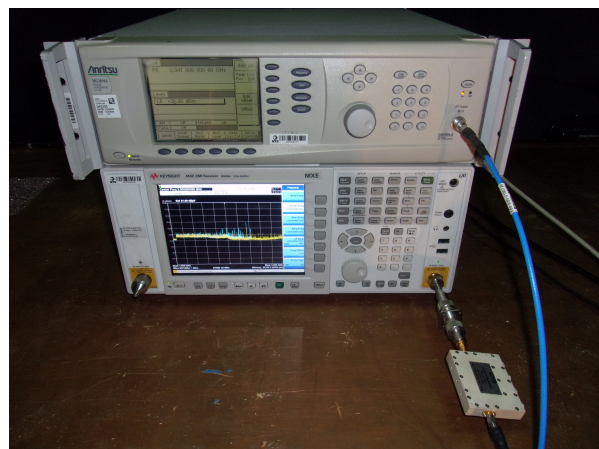
03 - 15GHz to 40GHz High Pass Filter Calibration



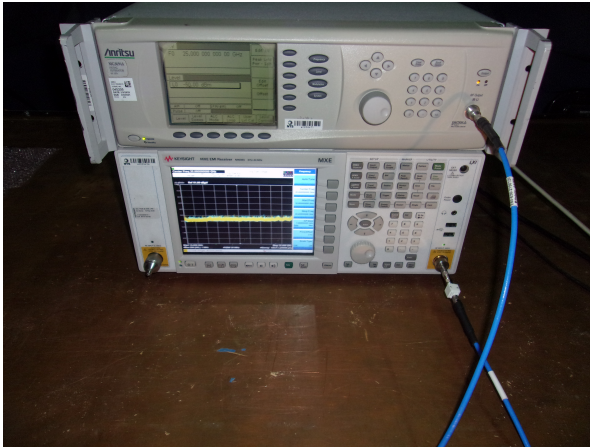
04 - System Check, (Standby Configuration)



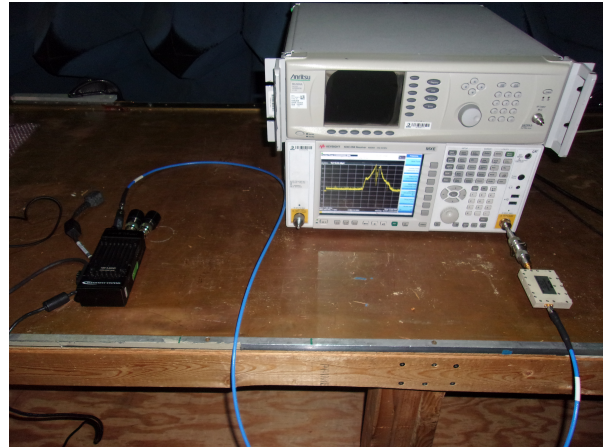
05 - S-Band CE106 Test Setup (Standby)



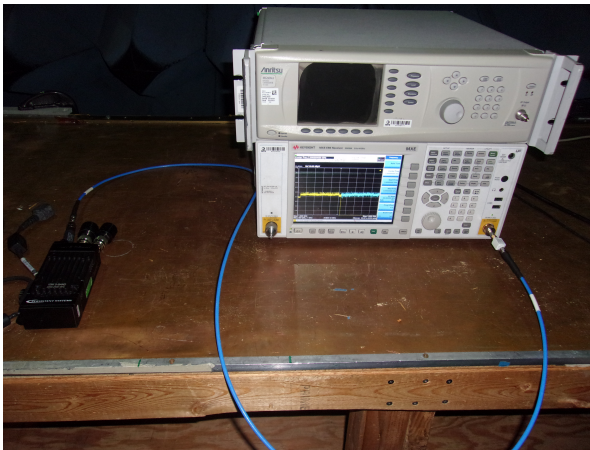
06 - S-Band System Check (Transmit Configuration, Mid-band)



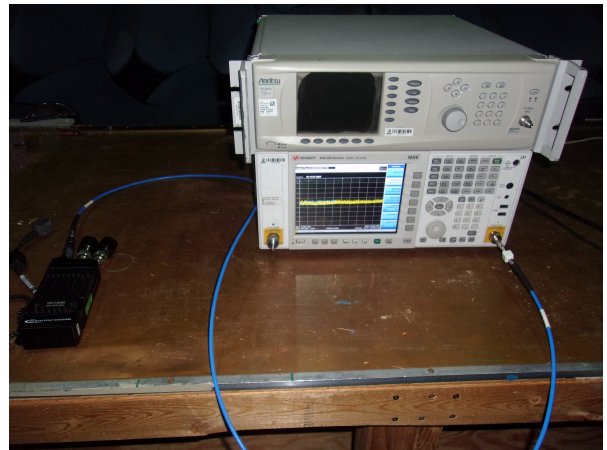
07 - S-Band System Check (Transmit Configuration, 25GHz)



08 - S-Band CE106 Test Setup, 1MHz to 3GHz



09 - S-Band CE106 Test Setup, 3GHz to 15GHz



10 - S-Band CE106 Test Setup, 15GHz to 25GHz

5.4.7 CE106 Test Equipment

Table 5.2-1: CE106 Test Equipment

Asset Number	Manufacturer	Make	Model Number	Serial Number	Cal Cycle (Months)	Cal Due
WC058456	Agilent	MXE EMI Receiver, 2Hz – 44GHz	N9038A	MY57190108	12	5/19/21
WC058471	Anritsu	10MHz – 40GHz Signal Generator	MG3694A	045205	12	03/03/21
WC058500	Winchester Interconnect	SRC-215, 2.9mm Coax Cable, 72"	E50-E50-2150720	None	24	6/2/22
WC005821	Narda	20dB Attenuator	766A-20	100230	36	10/4/21
WC058436	Weinschel	20dB Attenuator	34-20-34	BP8101	36	9/27/21
None	Corry Micronics, Inc.	S-Band Notch Filter	CMINF02280240B01	C194000122	NCR	NCR
None	Microwave Circuits	3 – 15GHz High Pass Filter	H3G020G2	505818	NCR	NCR
None	Microwave Circuits	15 – 40GHz High Pass Filter	H11F40G1	505817	NCR	NCR

NCR = No Calibration Required; as per NTS QA policy, the equipment does not require calibration as long as the test signal being generated can be verified with other calibrated equipment prior to or during the test.

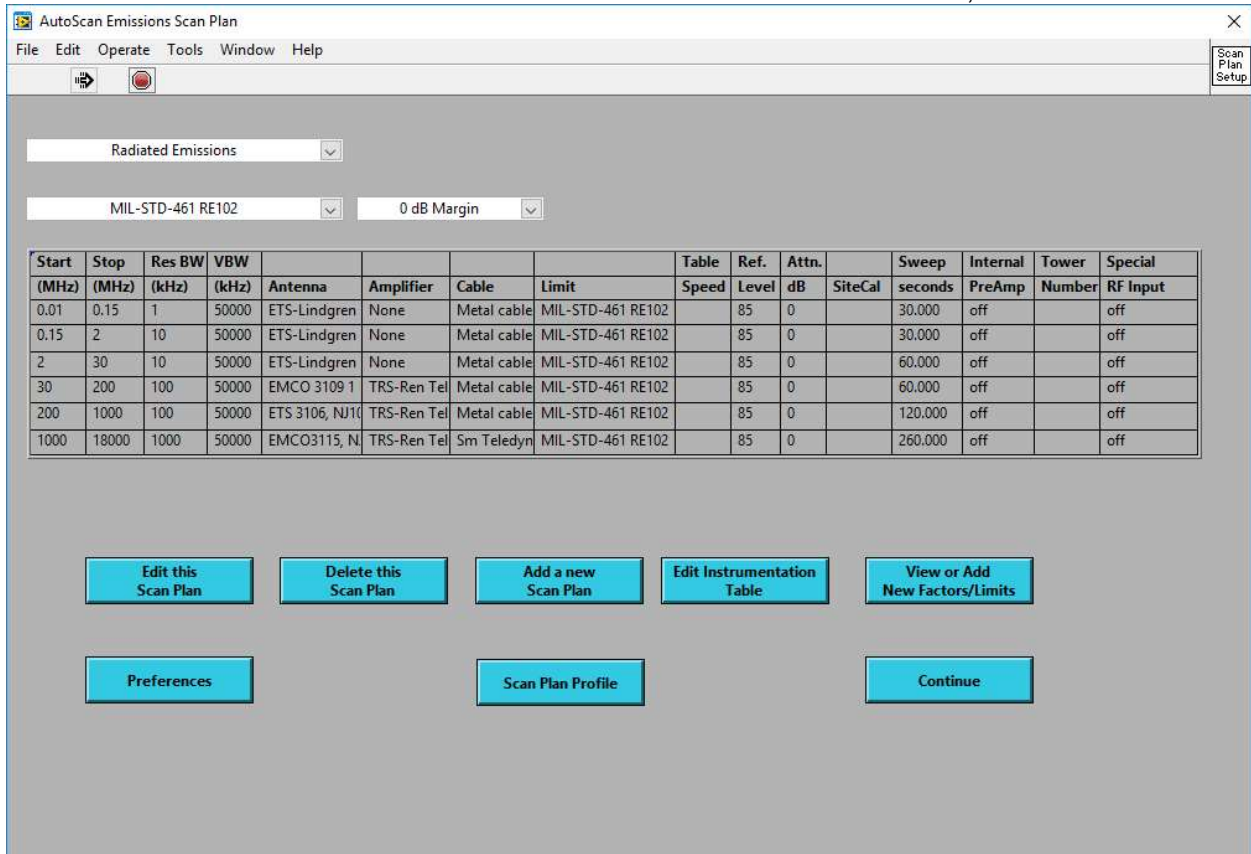
Appendix A: Test Software Description

AutoScan™ EMI Measurement Software

The AutoScan software is a National Instruments LabVIEW™ compiled package, specifically designed by EMCware for automation of Radiated and Conducted RF Emission measurements.

The AutoScan Emissions Scan Plan window shows the administrator defined test parameters including Start Frequency, Stop Frequency, Resolution Bandwidth, Video Bandwidth, Antenna, Amplifier, Cable, Limit, Reference Level, Attenuation and Sweep Time.

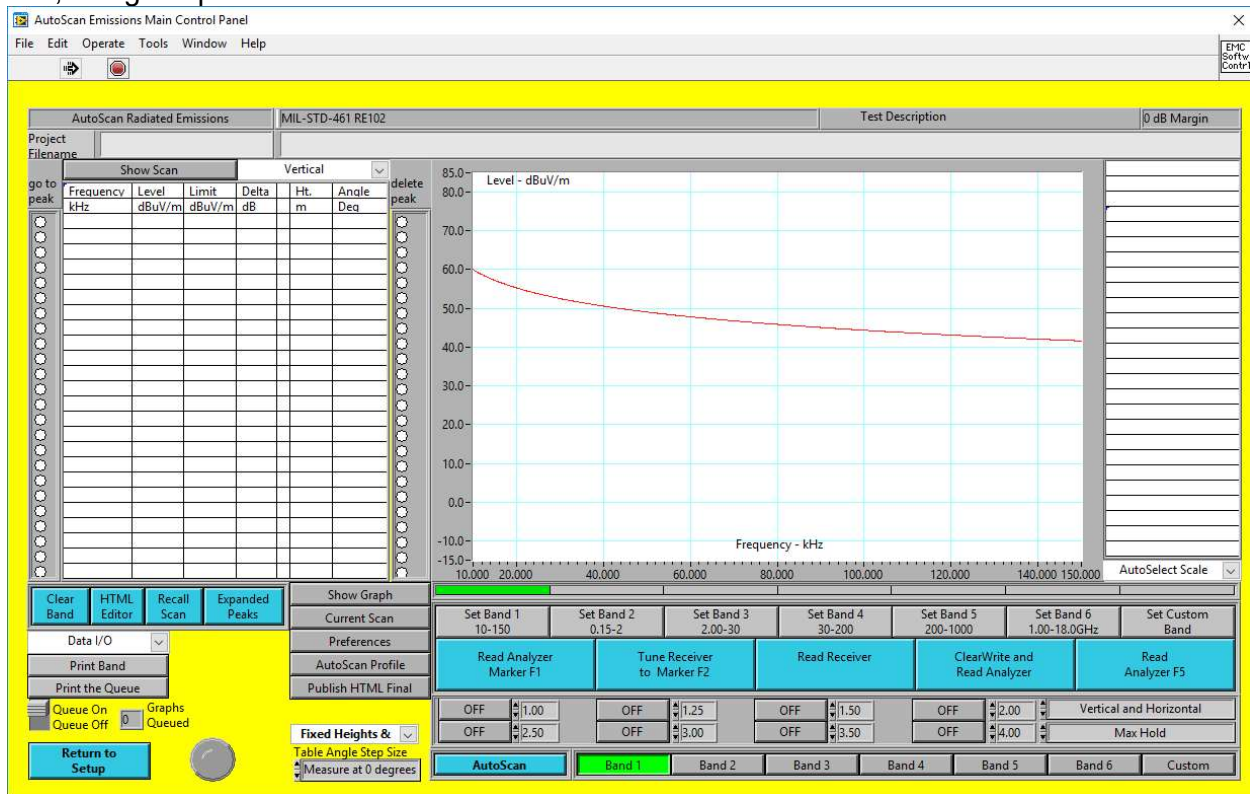
The Scan Plan shown below has been defined in order to perform the radiated emissions test in accordance with MIL-STD-461 RE102. Similar Scan Plans have been defined for CE101, CE102 and RE101.



Start (MHz)	Stop (MHz)	Res BW (kHz)	VBW (kHz)	Antenna	Amplifier	Cable	Limit	Table	Ref. Level	Attn. dB	SiteCal	Sweep seconds	Internal PreAmp	Tower Number	Special RF Input
0.01	0.15	1	50000	ETS-Lindgren	None	Metal cable	MIL-STD-461 RE102	Speed	85	0		30.000	off		off
0.15	2	10	50000	ETS-Lindgren	None	Metal cable	MIL-STD-461 RE102		85	0		30.000	off		off
2	30	10	50000	ETS-Lindgren	None	Metal cable	MIL-STD-461 RE102		85	0		60.000	off		off
30	200	100	50000	EMCO 3109 1	TRS-Ren Tel	Metal cable	MIL-STD-461 RE102		85	0		60.000	off		off
200	1000	100	50000	ETS 3106, NJ10	TRS-Ren Tel	Metal cable	MIL-STD-461 RE102		85	0		120.000	off		off
1000	18000	1000	50000	EMCO3115, N	TRS-Ren Tel	Sm Teledyn	MIL-STD-461 RE102		85	0		260.000	off		off



The AutoScan Emissions Main Control Panel window shown below was used to execute the test, using the parameters defined in the Scan Plan.

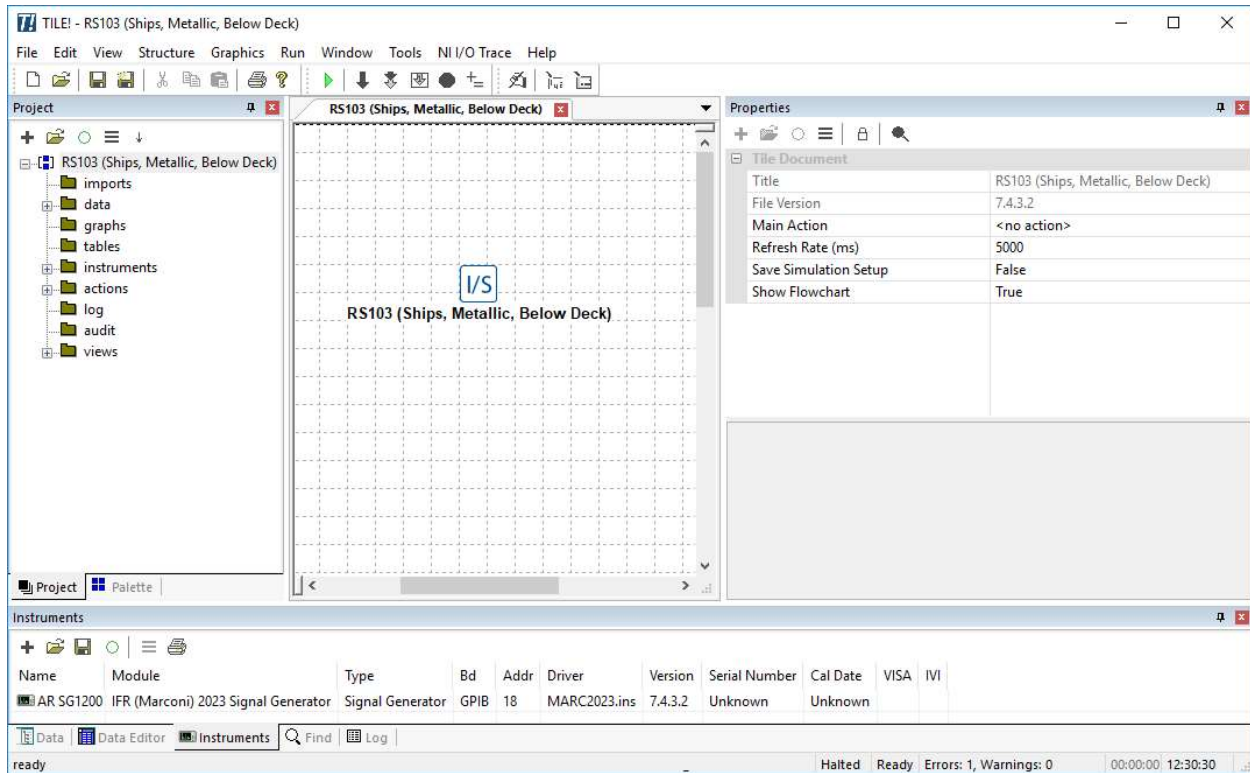




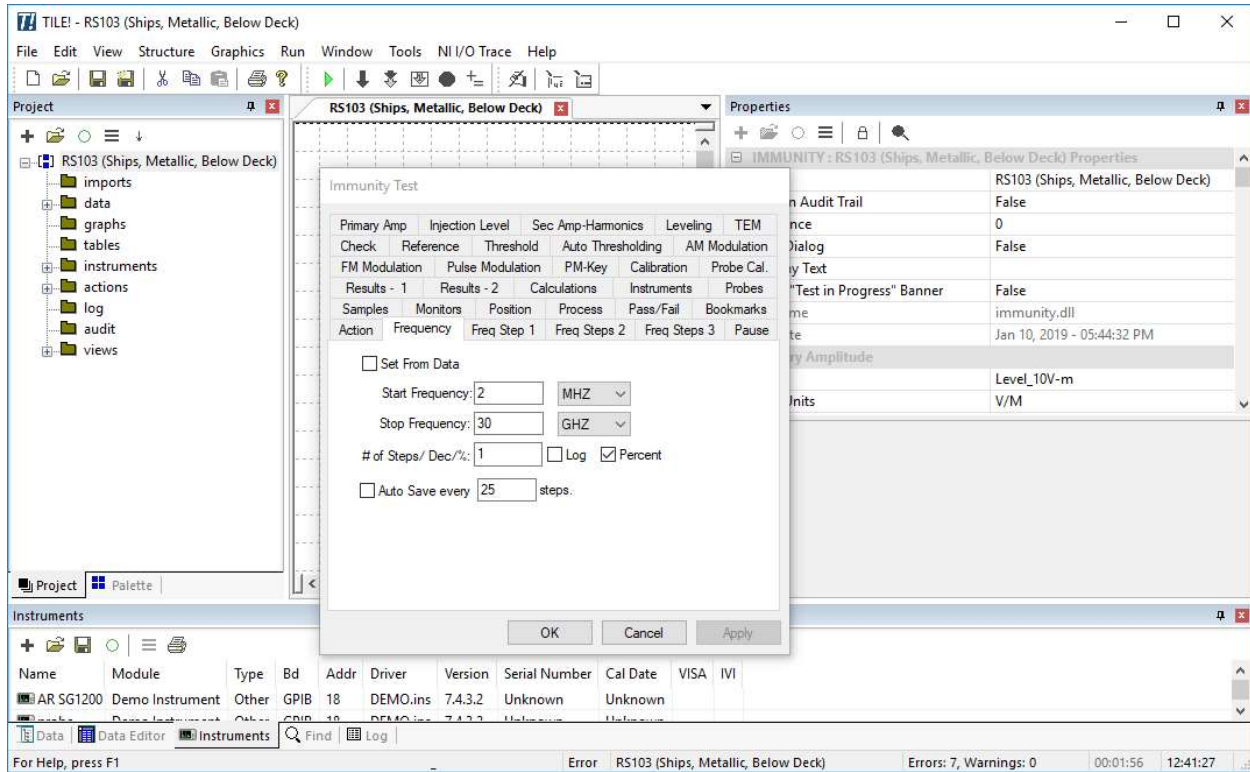
ETS-Lindgren Totally Integrated Laboratory Environment (TILE!)

The C++ compiled Totally Integrated Laboratory Environment (TILE!™) software by ETS-Lindgren is used for RS103 and CS101 testing.

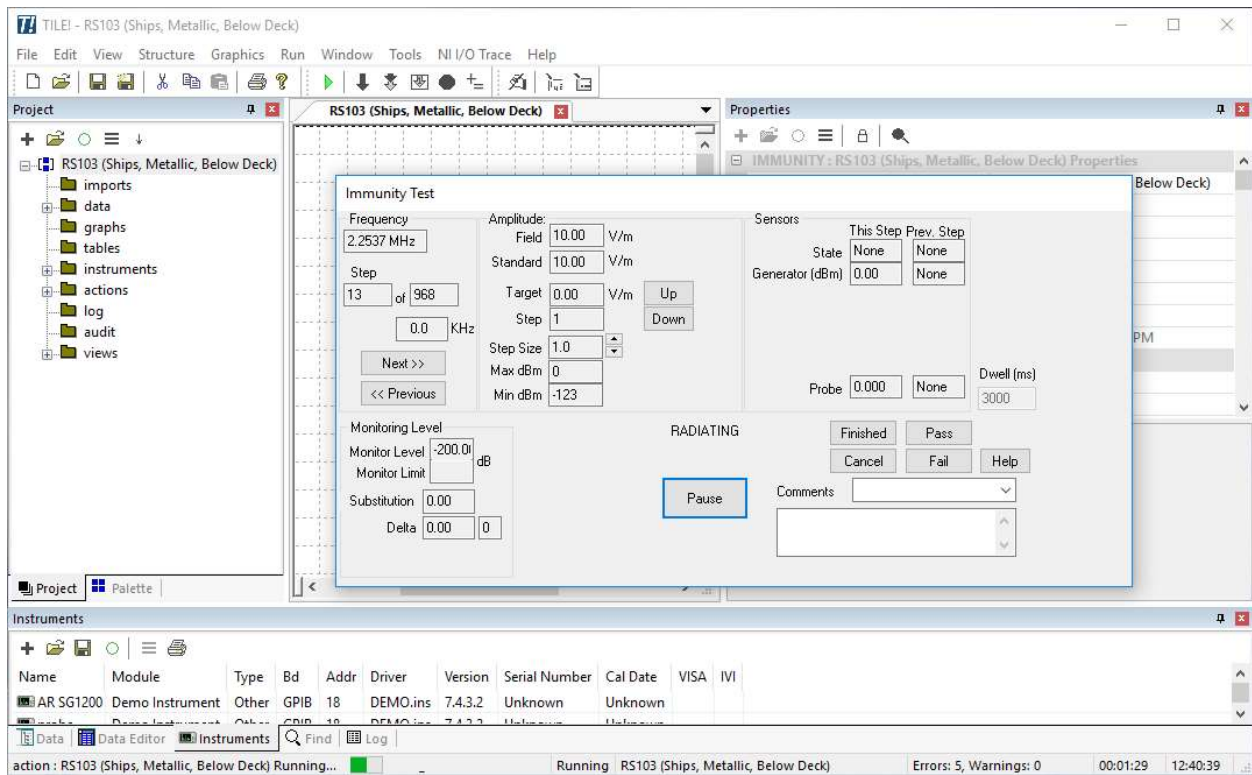
The screen below shows the main TILE! Program with the Administrator defined profile opened for MIL-STD-461 RS103 (Ships, Metallic, Below Deck). Similar profiles have been defined for CS101.



The screen below shows the properties tabs of the Administrator defined profile. In these tabs, the administrator has defined the frequency range, step size, test level, modulation type, dwell time, instrumentation, etc.



The screen below shows the running profile, where the user can monitor the test in progress.



----- End of Test Report -----



Test Report Number PR043362.PSL

Testing of
Wave Relay

PREPARED FOR: Persistent Systems
303 5th Avenue Suite 306
New York, NY 10016

PREPARED BY: National Technical Systems
36 Gilbert Street South
Tinton Falls, NJ 07701

This report and the information contained herein represents the results of testing of only those articles/products identified in this document and selected by the client. The tests were performed to specifications and/or procedures approved by the client. National Technical Systems ("NTS") makes no representations expressed or implied that such testing fully demonstrates efficiency, performance, reliability, or any other characteristic of the articles being tested, or similar products. This report should not be relied upon as an endorsement or certification by NTS of the equipment tested, nor does it present any statement whatsoever as to the merchantability or fitness of the test article or similar products for a particular purpose. This document shall not be reproduced except in full without written approval from NTS.



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR043362.PSL

Revision 0

REVISION PAGE

Rev. #	Date	Page #	Para. #	Description
0	6/1/16			Initial Release

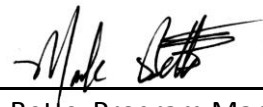


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR043362.PSL
Revision 0

SIGNATURES

Prepared By: 
Brian Pasznik, Test Technician

Reviewed By: 
Mark Betts, Program Manager

Approved By: 
David Potpinka, Quality Manager



TABLE OF CONTENTS

1.0	PURPOSE.....	5
1.1	Test Program Sequence	5
1.1.1.	Receipt Inspection	5
1.1.2.	Functional Test.....	5
1.1.3.	Testing.....	5
2.0	APPLICABLE DOCUMENTS.....	6
2.1	NTS Quotation Number OP0184398.....	6
2.2	Persistent Systems PO Number 13800	6
2.3	MIL-STD-810G	6
2.4	ISO 17025:2005.....	6
2.5	ANSI NCSL Z540-1	6
2.6	NTS Corporate Quality Policy Manual	6
3.0	TEST ITEMS	6
3.1	Description	6
3.2	Security Classification of Items	6
4.0	TEST DATE(S) AND EQUIPMENT	7
4.1	Test Date(s).....	7
4.2	Test Equipment	7
5.0	GENERAL TEST REQUIREMENTS	7
5.1	Test Facility	7
5.2	Test Sample Configuration.....	7
5.3	Functional Pass/Fail Criteria	7
6.0	TEST PROCEDURE	8
6.1	High Temperature Operation	8
6.1.1.	Requirement	8
6.1.2.	Test Procedure	8
6.1.3.	Comments.....	8
6.2	Vibration	11
6.2.1.	Requirement	11
6.2.2.	Test Procedure	11
6.2.3.	Comments.....	11
6.3	Transit Drop	17
6.3.1.	Requirement	17
6.3.2.	Test Procedure	17
6.3.3.	Comments.....	17

1.0 PURPOSE

This test report describes the methods used for the Environmental and Dynamic Testing of the Wave Relay tested for Persistent Systems. This test program was conducted to determine the ability of the Wave Relay to successfully satisfy the requirements specified in the references listed in section 2.0 of this report.

1.1 Test Program Sequence

1.1.1. Receipt Inspection

Upon receipt at NTS, the Wave Relay was visually inspected to ensure there had been no damage due to shipping/handling, and to confirm that the test model number and serial number coincide with those on the packing list.
No discrepancies or damage was observed.

1.1.2. Functional Test

The Wave Relay was checked for functionality before, during and after testing as applicable.

1.1.3. Testing

Tests and Test Methods

Test	Standard/Test Method	Test Result
High Temperature Operation	MIL-STD-810G Method 501.5 Procedure I	Pass
Vibration	MIL-STD-810G Method 514.6 Procedure I	Pass
Transit Drop	MIL-STD-810G Method 516.6 Procedure IV	Pass



2.0 APPLICABLE DOCUMENTS

- 2.1 NTS Quotation Number OP0184398**
- 2.2 Persistent Systems PO Number 13800**
- 2.3 MIL-STD-810G**
- 2.4 ISO 17025:2005**
- 2.5 ANSI NCSL Z540-1**
- 2.6 NTS Corporate Quality Policy Manual**
Revision 8, Dated April 22, 2016.

3.0 TEST ITEMS

3.1 Description

Qty.	Item	P/N	S/N
1	Wave Relay	WR-5100	19493
1	Wave Relay	WR-5100	19260
1	Wave Relay	WR-5100	19490

3.2 Security Classification of Items

None

4.0 TEST DATE(S) AND EQUIPMENT

4.1 Test Date(s)

Test	Date(s)
High Temperature Operation	2/19/16-2/22/16
Vibration	2/17/16
Transit Drop	2/17/16

4.2 Test Equipment

The instrumentation used in the performance of these tests is periodically calibrated and standardized within manufacturer's rated accuracies and are traceable to the National Institute of Standards and Technology. The calibration procedures and practices are in accordance with ANSI/NCSL Z540-1 and ISO 17025:2005. Certification of calibration is on file subject to inspection by authorized personnel.

5.0 GENERAL TEST REQUIREMENTS

5.1 Test Facility

The Wave relay was tested for Environmental and Dynamic tests at NTS test facilities located in Tinton Falls, NJ.

5.2 Test Sample Configuration

The test item configurations are documented in the photographs contained in this test report.

5.3 Functional Pass/Fail Criteria

The Wave Relay shall successfully satisfy the requirements specified in the references listed in Section 2.0 of this procedure. The Wave Relay will be checked for functionality before, during and after testing as applicable.

6.0 TEST PROCEDURE**6.1 High Temperature Operation****6.1.1. Requirement**

The Wave Relay shall be tested for High Temperature Operation using MIL-STD-810G, Method 501.5 Procedure I at 85°C maximum.

6.1.2. Test Procedure

The Wave Relay was placed into the temperature chamber in operational configuration.

The chamber temperature was adjusted to 35°C.

After temperature stabilization occurred, the following profile was run for 7 cycles (adjusted for 85°C).

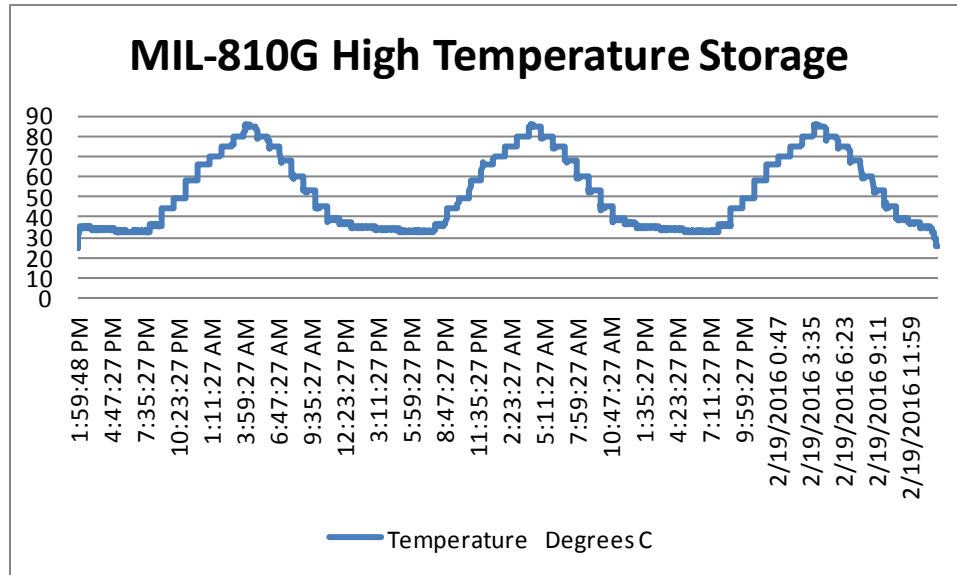
The chamber was brought back to ambient temperature.

The Wave Relay was visually examined for damage and operated.

Time of Day	MIL-810G Profile	Modified Profile
0100	35°C	35°C
0200	34°C	34°C
0300	34°C	34°C
0400	33°C	33°C
0500	33°C	33°C
0600	33°C	33°C
0700	36°C	36°C
0800	40°C	44°C
0900	44°C	49°C
1000	51°C	58°C
1100	56°C	66°C
1200	63°C	70°C
1300	69°C	75°C
1400	70°C	80°C
1500	71°C	85°C
1600	70°C	80°C
1700	67°C	75°C
1800	63°C	68°C
1900	55°C	60°C
2000	48°C	53°C
2100	41°C	45°C
2200	39°C	39°C
2300	37°C	37°C
2400	35°C	35°C

6.1.3. Comments

The Wave Relay complied with the High Temperature Operation test.

Test Data

Test Equipment Used

NTS #	Manufacturer	Make	Model	S/N	Cal. Date	Cal. Due
WC005759	Thermotron	Environmental Chamber	F-16-CHMV-5-5	28376	4/28/2015	4/28/2016

Photographs



6.2 Vibration

6.2.1. Requirement

The Wave Relay shall be tested for Vibration using MIL-STD-810G, Method 514.6 Procedure I ground vehicles.

6.2.2. Test Procedure

The Wave Relay was mounted to the vibration table in non-operational condition.

The following vibration profile was run for 1 hour per axis.

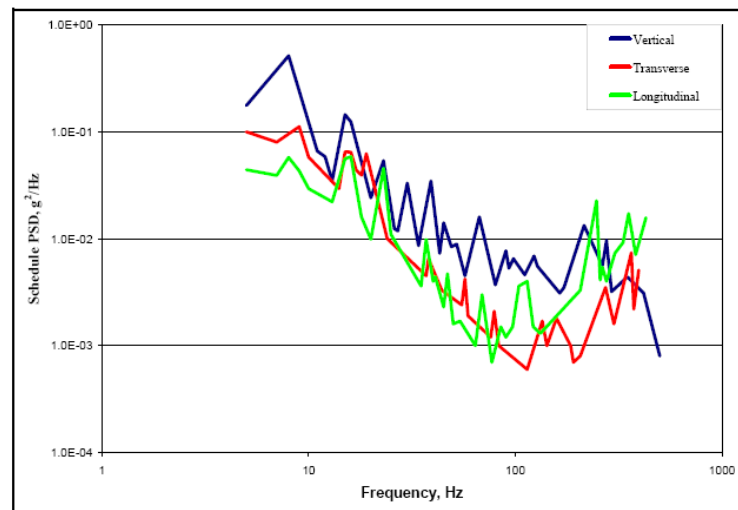


Figure 514.6C-3 – Category 4 - Composite wheeled vehicle vibration exposure.

The Wave Relay was visually examined and an operational check was conducted after the test.

6.2.3. Comments

The Wave Relay complied with the Vibration test requirements.

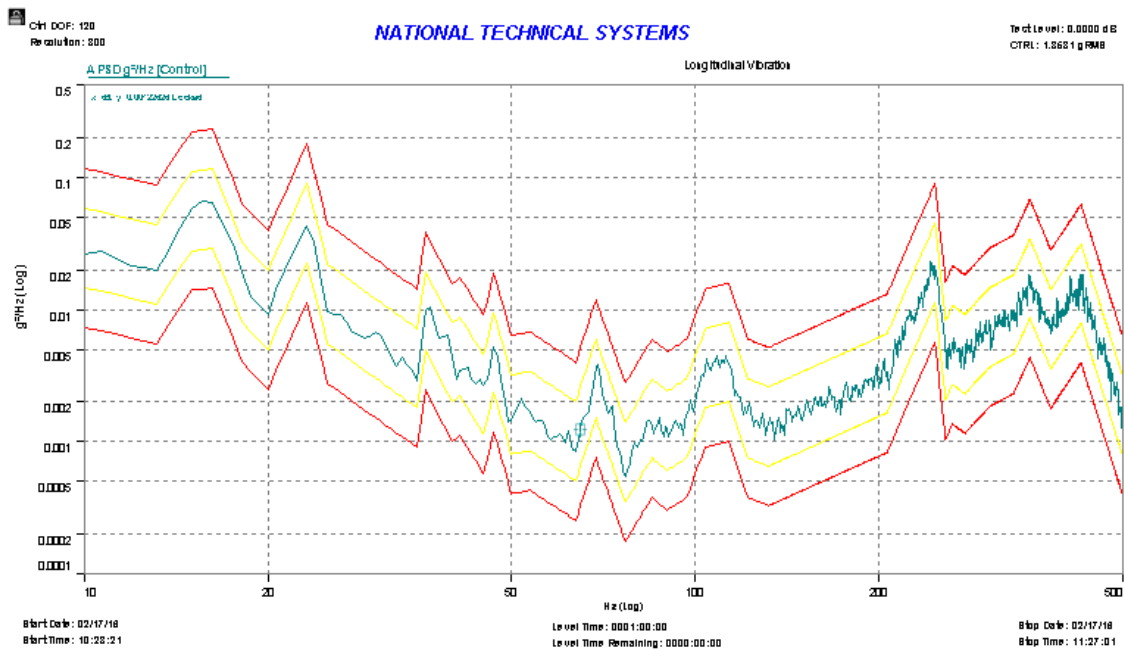
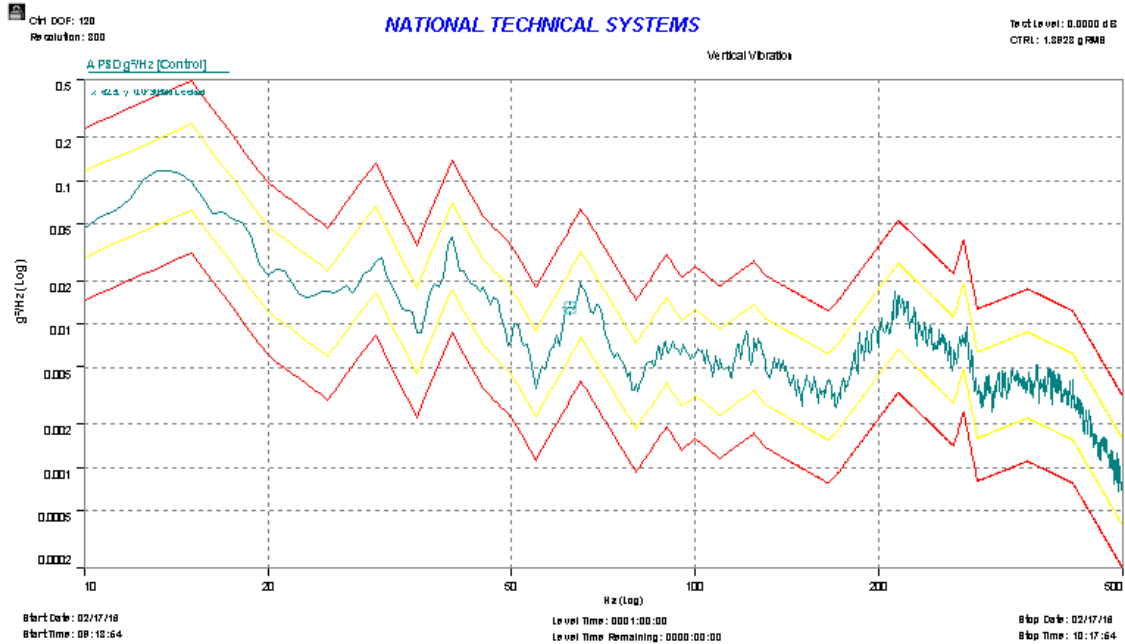


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR043362.PSL

Revision 0

Test Data

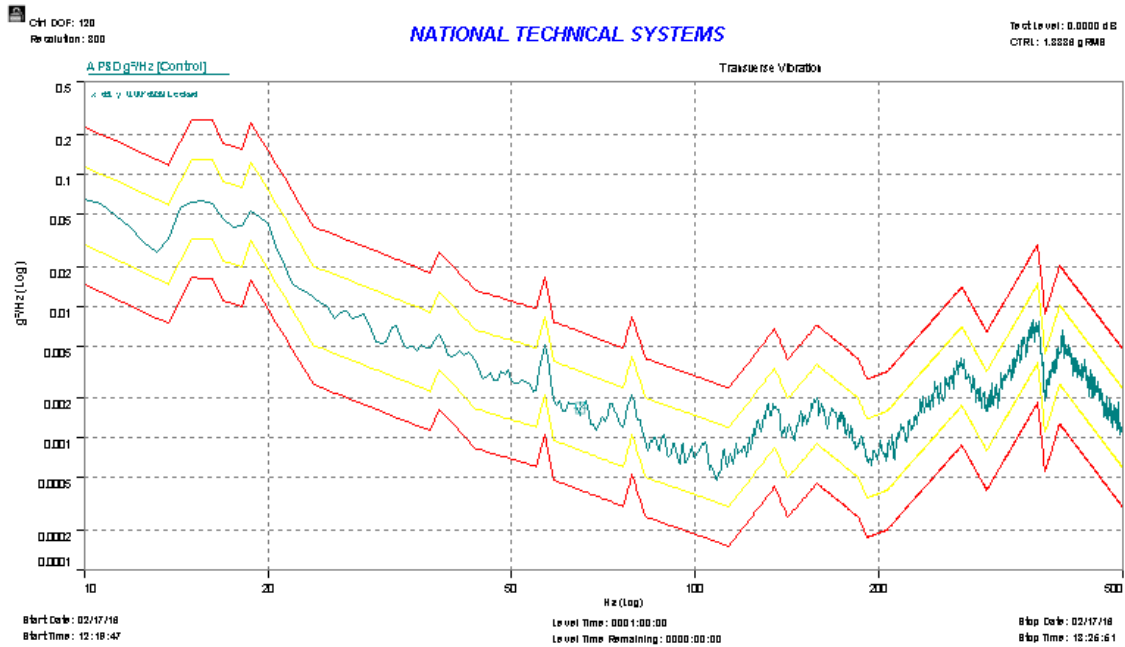




NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR043362.PSL

Revision 0




PERSISTENT SYSTEMS

 7711B, Avenue 500 - New York, NY 10019
 212-317-8000 • Fax: 212-317-8001 • Email: sales@persistent.com

Wave Relay - Quality Control Test Report
Product Information

 Part Number: 909120
 Serial Number: 15060
 Date Manufactured: 10/11/2015

Reference Diagrams

None available

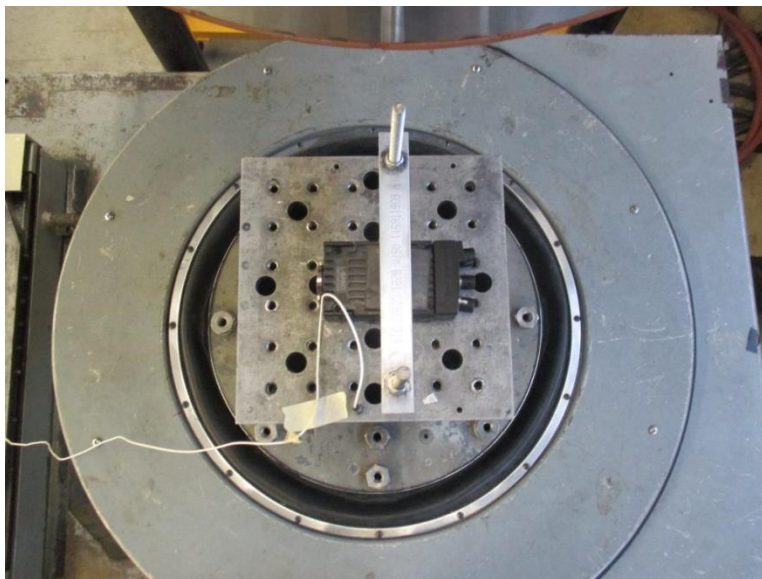
TEST TYPE	CRITERIA	RESULT
PRE		
1. Push Button - Functional Test	PASS/FAIL	PASS
ON/OFF	PASS/FAIL	PASS
LED	PASS/FAIL	PASS
Display	PASS/FAIL	PASS
2. GPS Functionality Test		
Lock Time	30 - 120s	PASS
Number of GPS Fixes	405	
3. Autobackup - Functional Test		
Auto Copy Test	PASS/FAIL	PASS
Self Loop Back Test	PASS/FAIL	PASS
4. Power - Functional Test		
POC	PASS/FAIL	PASS
Auto	PASS/FAIL	PASS
Smart Battery	PASS/FAIL	PASS
OTD Test	-2.5V	4.1V
5. External Connectivity Test		
Ethernet 1	SUCCESSFUL PING	PASS
Ethernet 2	SUCCESSFUL PING	N/A
Wireless 2	SUCCESSFUL PING	N/A
Ethernet 3	SUCCESSFUL PING	N/A
Ethernet 4	SUCCESSFUL PING	N/A
6. RF Performance Test		
Range1	TYPE	C-DAHD
Max. Antenna	MAC	N/A
Tx/Rx Sensitivity	PASS/FAIL	PASS
Range2	TYPE	N/A
Max. Antenna	MAC	
Tx/Rx Sensitivity	PASS/FAIL	
Range3	TYPE	N/A
Max. Antenna	MAC	
Tx/Rx Sensitivity	PASS/FAIL	
Range4	TYPE	N/A
Max. Antenna	MAC	
Tx/Rx Sensitivity	PASS/FAIL	

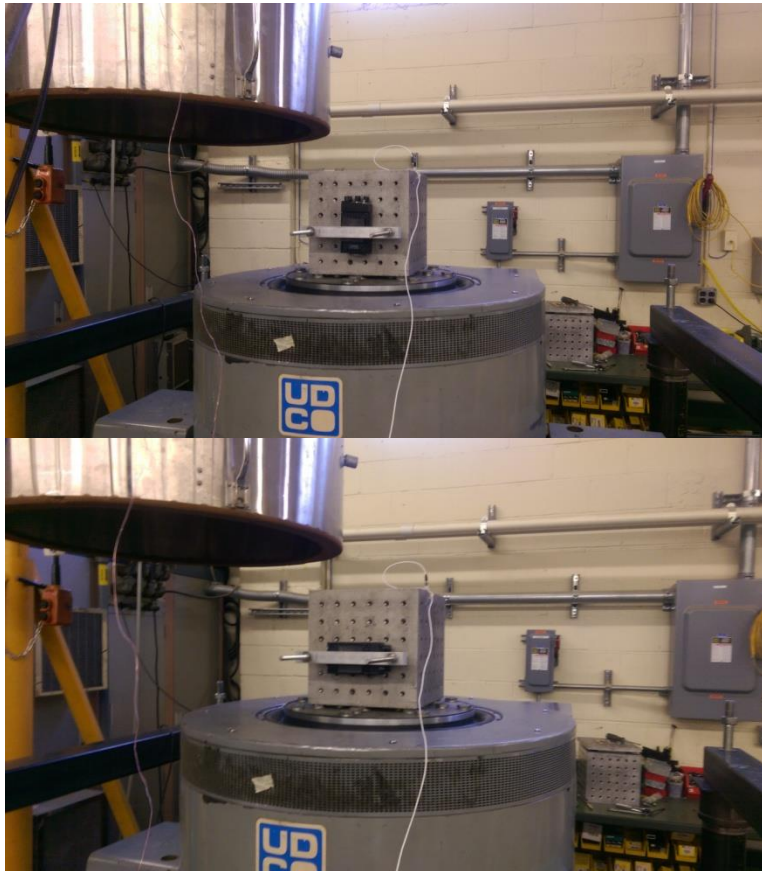
© 2014 Persistent Systems, L.C. All rights reserved. The Wave Relay is a Persistent Systems, L.C. product. All other registered trademarks are the property of their respective owners. All other trademarks are the property of their respective owners. This document is provided for informational purposes only. Persistent Systems, L.C. assumes no liability related to this and expressly disclaims any implied warranties of accuracy, reliability, or fitness for any purpose.

Vib. *[Signature]*
 02/18/2016

Test Equipment Used

NTS #	Manufacturer	Make	Model	S/N	Cal. Date	Cal. Due
NJ1130	Unholtz-Dickie	Amplifier	MA145A-130IAR	2418	NCR	NCR
NJ1127	Unholtz-Dickie	Shaker	T1000	476	NCR	NCR
NJ1205	Spectral Dynamics	Vibration Controller	2405-9700-1	2400-2041	10/22/2015	10/22/2016
WC005385	PCB	Accelerometer	353B18	54920	3/25/2015	3/25/2016

Photographs




6.3 Transit Drop**6.3.1. Requirement**

The Wave Relay shall be tested for Transit Drop using MIL-STD-810G, Method 516.6 Procedure IV. The units will be outside of the shipping container. The Wave Relay will be dropped from a height of 48" on all faces, edges and corners. 26 total drops.

6.3.2. Test Procedure

The Wave Relay was dropped 26 times from a height of 48" as noted above.

The Wave Relay was visually examined and an operational check was conducted.

6.3.3. Comments

The Wave Relay complied with the Transit Drop requirements.



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR043362.PSL

Revision 0

Test Data



TEST PROFILE

TR- 43362

Customer Name:	Persistent Systems	Unit(s) Under Test:	Wave Relay
Test Name:	Shock	Quantity:	1
Specification:	MIL-810G	P/N(s):	WR-5100
Spec. Date:		S/N(s):	19260
Para. / Method:	516.6/IV		

# of Drops (each)	26
Height of Drop (inches)	48
Width of Bench (cm)	N/A
Point of Contact on Drops	Each face, edge, and corner of shipping container

TEST SETUP AND RESULTS

Test Started:	2/17/2016	Test Completed:	2/17/2016
---------------	-----------	-----------------	-----------

Unit Under Test Information	Y	N	N/A	Comments
Tested in shipping container:		X		
Powered during testing:		X		
Functionally operated during test:		X		
Functional test witnessed by NTS:		X		
Physical damage noted:		X		

COMMENTS:

Test Technician:

Brian Pasznik



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR043362.PSL
Revision 0



PERSISTENT SYSTEMS

801 N. 1st Avenue, Suite 100, Tinton Falls, NJ 07788
201.341.1200 • Sales@persistent.com • 800.445.4454

Q.C. PASSED
By: [Signature] Date: 02/15/2016

Wave Relay - Quality Control Test Report

Product Information

Part Number: WRS513
Serial Number: 14076
Date Manufactured: 12/01/2015

Reference Diagram

Image not available

TEST TYPE	CRITERIA	RESULT
1-EMI/Immunity - Power Line Test	100% Pass	PASS
2-EMI/Immunity - Radiated Emissions	100% Pass	PASS
3-EMI/Immunity - Radiated Emissions	100% Pass	PASS
4-EMI/Immunity - Radiated Emissions	100% Pass	PASS
5-EMI/Immunity - Radiated Emissions	100% Pass	PASS
6-EMI/Immunity - Radiated Emissions	100% Pass	PASS
7-EMI/Immunity - Radiated Emissions	100% Pass	PASS
8-EMI/Immunity - Radiated Emissions	100% Pass	PASS
9-EMI/Immunity - Radiated Emissions	100% Pass	PASS
10-EMI/Immunity - Radiated Emissions	100% Pass	PASS
11-EMI/Immunity - Radiated Emissions	100% Pass	PASS
12-EMI/Immunity - Radiated Emissions	100% Pass	PASS
13-EMI/Immunity - Radiated Emissions	100% Pass	PASS
14-EMI/Immunity - Radiated Emissions	100% Pass	PASS
15-EMI/Immunity - Radiated Emissions	100% Pass	PASS
16-EMI/Immunity - Radiated Emissions	100% Pass	PASS
17-EMI/Immunity - Radiated Emissions	100% Pass	PASS
18-EMI/Immunity - Radiated Emissions	100% Pass	PASS
19-EMI/Immunity - Radiated Emissions	100% Pass	PASS
20-EMI/Immunity - Radiated Emissions	100% Pass	PASS
21-EMI/Immunity - Radiated Emissions	100% Pass	PASS
22-EMI/Immunity - Radiated Emissions	100% Pass	PASS
23-EMI/Immunity - Radiated Emissions	100% Pass	PASS
24-EMI/Immunity - Radiated Emissions	100% Pass	PASS
25-EMI/Immunity - Radiated Emissions	100% Pass	PASS
26-EMI/Immunity - Radiated Emissions	100% Pass	PASS
27-EMI/Immunity - Radiated Emissions	100% Pass	PASS
28-EMI/Immunity - Radiated Emissions	100% Pass	PASS
29-EMI/Immunity - Radiated Emissions	100% Pass	PASS
30-EMI/Immunity - Radiated Emissions	100% Pass	PASS
31-EMI/Immunity - Radiated Emissions	100% Pass	PASS
32-EMI/Immunity - Radiated Emissions	100% Pass	PASS
33-EMI/Immunity - Radiated Emissions	100% Pass	PASS
34-EMI/Immunity - Radiated Emissions	100% Pass	PASS
35-EMI/Immunity - Radiated Emissions	100% Pass	PASS
36-EMI/Immunity - Radiated Emissions	100% Pass	PASS
37-EMI/Immunity - Radiated Emissions	100% Pass	PASS
38-EMI/Immunity - Radiated Emissions	100% Pass	PASS
39-EMI/Immunity - Radiated Emissions	100% Pass	PASS
40-EMI/Immunity - Radiated Emissions	100% Pass	PASS
41-EMI/Immunity - Radiated Emissions	100% Pass	PASS
42-EMI/Immunity - Radiated Emissions	100% Pass	PASS
43-EMI/Immunity - Radiated Emissions	100% Pass	PASS
44-EMI/Immunity - Radiated Emissions	100% Pass	PASS
45-EMI/Immunity - Radiated Emissions	100% Pass	PASS
46-EMI/Immunity - Radiated Emissions	100% Pass	PASS
47-EMI/Immunity - Radiated Emissions	100% Pass	PASS
48-EMI/Immunity - Radiated Emissions	100% Pass	PASS
49-EMI/Immunity - Radiated Emissions	100% Pass	PASS
50-EMI/Immunity - Radiated Emissions	100% Pass	PASS
51-EMI/Immunity - Radiated Emissions	100% Pass	PASS
52-EMI/Immunity - Radiated Emissions	100% Pass	PASS
53-EMI/Immunity - Radiated Emissions	100% Pass	PASS
54-EMI/Immunity - Radiated Emissions	100% Pass	PASS
55-EMI/Immunity - Radiated Emissions	100% Pass	PASS
56-EMI/Immunity - Radiated Emissions	100% Pass	PASS
57-EMI/Immunity - Radiated Emissions	100% Pass	PASS
58-EMI/Immunity - Radiated Emissions	100% Pass	PASS
59-EMI/Immunity - Radiated Emissions	100% Pass	PASS
60-EMI/Immunity - Radiated Emissions	100% Pass	PASS
61-EMI/Immunity - Radiated Emissions	100% Pass	PASS
62-EMI/Immunity - Radiated Emissions	100% Pass	PASS
63-EMI/Immunity - Radiated Emissions	100% Pass	PASS
64-EMI/Immunity - Radiated Emissions	100% Pass	PASS
65-EMI/Immunity - Radiated Emissions	100% Pass	PASS
66-EMI/Immunity - Radiated Emissions	100% Pass	PASS
67-EMI/Immunity - Radiated Emissions	100% Pass	PASS
68-EMI/Immunity - Radiated Emissions	100% Pass	PASS
69-EMI/Immunity - Radiated Emissions	100% Pass	PASS
70-EMI/Immunity - Radiated Emissions	100% Pass	PASS
71-EMI/Immunity - Radiated Emissions	100% Pass	PASS
72-EMI/Immunity - Radiated Emissions	100% Pass	PASS
73-EMI/Immunity - Radiated Emissions	100% Pass	PASS
74-EMI/Immunity - Radiated Emissions	100% Pass	PASS
75-EMI/Immunity - Radiated Emissions	100% Pass	PASS
76-EMI/Immunity - Radiated Emissions	100% Pass	PASS
77-EMI/Immunity - Radiated Emissions	100% Pass	PASS
78-EMI/Immunity - Radiated Emissions	100% Pass	PASS
79-EMI/Immunity - Radiated Emissions	100% Pass	PASS
80-EMI/Immunity - Radiated Emissions	100% Pass	PASS
81-EMI/Immunity - Radiated Emissions	100% Pass	PASS
82-EMI/Immunity - Radiated Emissions	100% Pass	PASS
83-EMI/Immunity - Radiated Emissions	100% Pass	PASS
84-EMI/Immunity - Radiated Emissions	100% Pass	PASS
85-EMI/Immunity - Radiated Emissions	100% Pass	PASS
86-EMI/Immunity - Radiated Emissions	100% Pass	PASS
87-EMI/Immunity - Radiated Emissions	100% Pass	PASS
88-EMI/Immunity - Radiated Emissions	100% Pass	PASS
89-EMI/Immunity - Radiated Emissions	100% Pass	PASS
90-EMI/Immunity - Radiated Emissions	100% Pass	PASS
91-EMI/Immunity - Radiated Emissions	100% Pass	PASS
92-EMI/Immunity - Radiated Emissions	100% Pass	PASS
93-EMI/Immunity - Radiated Emissions	100% Pass	PASS
94-EMI/Immunity - Radiated Emissions	100% Pass	PASS
95-EMI/Immunity - Radiated Emissions	100% Pass	PASS
96-EMI/Immunity - Radiated Emissions	100% Pass	PASS
97-EMI/Immunity - Radiated Emissions	100% Pass	PASS
98-EMI/Immunity - Radiated Emissions	100% Pass	PASS
99-EMI/Immunity - Radiated Emissions	100% Pass	PASS
100-EMI/Immunity - Radiated Emissions	100% Pass	PASS

© 2011 Persistent Systems, Inc. All rights reserved. The Wave Relay is a Persistent Systems product. All rights are reserved. No part of this document may be reproduced or transmitted in any form or by any means electronic or mechanical, including photocopying, recording, or by any information storage and retrieval system, without permission in writing from Persistent Systems, Inc. This document is the property of Persistent Systems, Inc. and is not to be distributed outside the company without prior written permission.

Shock
H. H. - H.
02/15/2016

Test Equipment Used

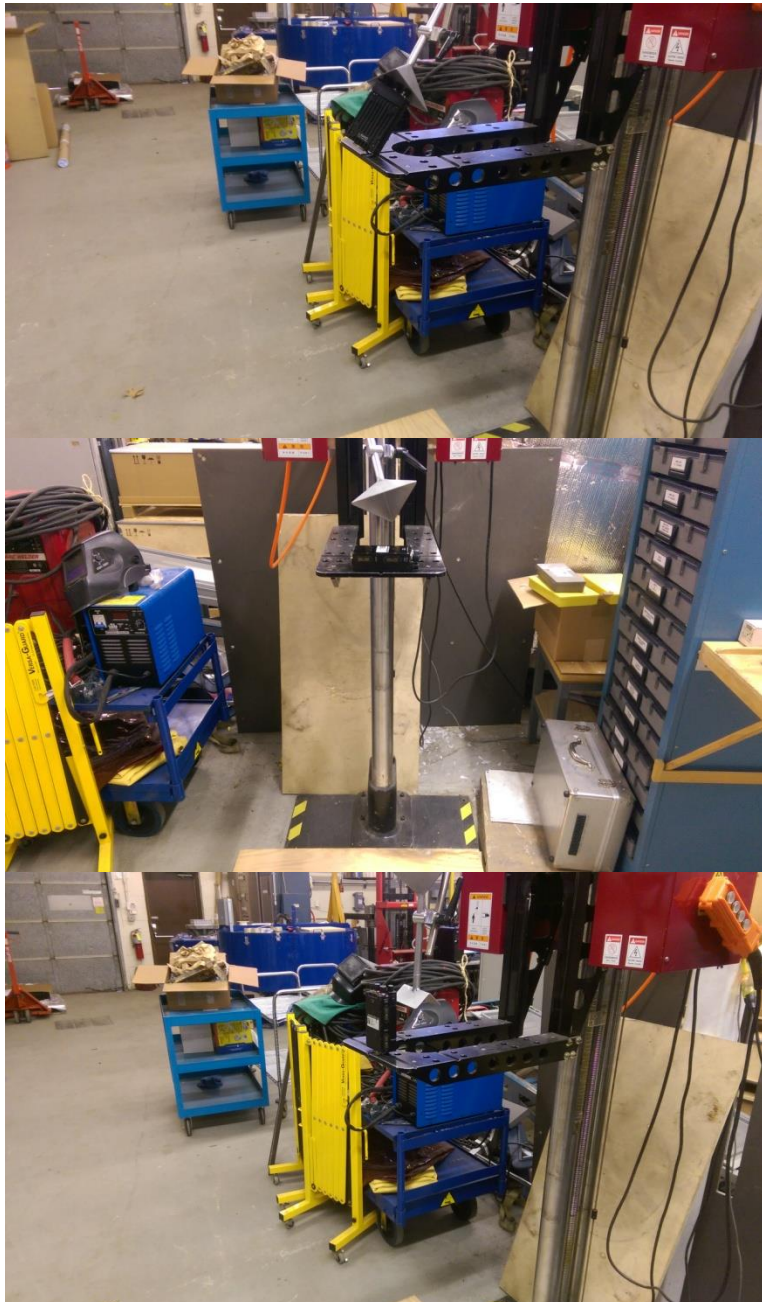
NTS #	Manufacturer	Make	Model	S/N	Cal. Date	Cal. Due
NJ1163	L.A.B.	Drop Test System	AD-160A	291225	NCR	NCR

Photographs



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR043362.PSL
Revision 0



36 Gilbert Street South • Tinton Falls, New Jersey 07701
(732) 936-0800 • Fax (732) 936-0700
www.nts.com



Post Test Photo

END OF REPORT



Test Report Number TR-102218

Testing of
MPU5 and Radio Card

PREPARED FOR: Persistent Systems
303 5th Avenue Suite 409
New York, NY 10016

PREPARED BY: National Technical Systems
36 Gilbert Street South
Tinton Falls, NJ 07701

Page 1 of 37

This report and the information contained herein represents the results of testing of only those articles/products identified in this document and selected by the client. The tests were performed to specifications and/or procedures approved by the client. National Technical Systems ("NTS") makes no representations expressed or implied that such testing fully demonstrates efficiency, performance, reliability, or any other characteristic of the articles being tested, or similar products. This report should not be relied upon as an endorsement or certification by NTS of the equipment tested, nor does it present any statement whatsoever as to the merchantability or fitness of the test article or similar products for a particular purpose. This document shall not be reproduced except in full without written approval from NTS.



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: TR-102218
Revision 0

REVISION PAGE

Rev. #	Date	Page #	Para. #	Description
0	2/7/20			Initial Release



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: TR-102218
Revision 0

SIGNATURES

Prepared By: 
Mark Betts, Senior Engineer

Reviewed By: 
Mark Betts, Program Manager

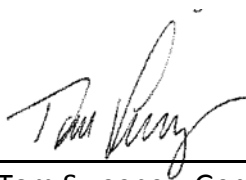
Approved By: 
Tom Sweeney, General Manager



TABLE OF CONTENTS

1.0	PURPOSE	6
1.1	Test Program Sequence	6
1.1.1.	Receipt Inspection	6
1.1.2.	Functional Test	6
1.1.3.	Testing	7
2.0	APPLICABLE DOCUMENTS	7
2.1	NTS Quotation Number OP0523614	7
2.2	Persistent Systems PO Number 19414	7
2.3	MIL-STD-810G	7
2.4	NTS Corporate Quality Policy Manual	7
3.0	TEST ITEMS	7
3.1	Description	7
3.2	Security Classification of Items	8
4.0	TEST DATE(S) AND EQUIPMENT	8
4.1	Test Date(s)	8
4.2	Test Equipment	8
5.0	GENERAL TEST REQUIREMENTS	9
5.1	Test Facility	9
5.2	Test Sample Configuration	9
5.3	Functional Pass/Fail Criteria	9
6.0	TEST PROCEDURE	10
6.1	Altitude (Storage)	10
6.1.1.	Requirement	10
6.1.2.	Test Procedure	10
6.1.3.	Comments	10
6.2	Altitude (Operation)	13
6.2.1.	Requirement	13
6.2.2.	Test Procedure	13
6.2.3.	Comments	13
6.3	High Temperature Storage	16
6.3.1.	Requirement	16
6.3.2.	Test Procedure	16
6.3.3.	Comments	16
6.1	High Temperature Operation	19
6.1.1.	Requirement	19



6.1.2.	Test Procedure	19
6.1.3.	Comments	19
6.2	Low Temperature (Storage)	22
6.2.1.	Requirement	22
6.2.2.	Test Procedure	22
6.2.3.	Comments	22
6.3	Low Temperature (Operational)	25
6.3.1.	Requirement	25
6.3.2.	Test Procedure	25
6.3.3.	Comments	25
6.4	Temperature Shock	28
6.4.1.	Requirement	28
6.4.2.	Test Procedure	28
6.4.3.	Comments	28
6.5	Vibration	32
6.5.1.	Requirement	32
6.5.2.	Test Procedure	32
6.5.3.	Comments	32



1.0 PURPOSE

This test report describes the methods used for the Environmental and Dynamic Testing of the Equipment Under Test tested for Persistent Systems This test program was conducted to determine the ability of the Equipment Under Test to successfully satisfy the requirements specified in the references listed in section 2.0 of this report.

1.1 Test Program Sequence

1.1.1. Receipt Inspection

Upon receipt at NTS, the Equipment Under Test was visually inspected to ensure there had been no damage due to shipping/handling, and to confirm that the test model number and serial number coincide with those on the packing list.
No discrepancies or damage was observed.

1.1.2. Functional Test

The Equipment Under Test was checked for functionality before, during and after testing as applicable.

1.1.3. Testing

Tests and Test Methods

Test	Standard/Test Method
Altitude Storage	MIL-STD-810G Method 500.5, Procedure I
Altitude Operation	MIL-STD-810G Method 500.5, Procedure II
High Temperature Storage	MIL-STD-810G Method 501.5 Procedure II
High Temperature Operation	MIL-STD-810G Method 501.5 Procedure I
Low Temperature Storage	MIL-STD-810G Method 510.5, Procedure I
Low Temperature Operation	MIL-STD-810G Method 510.5, Procedure II
Temperature Shock	MIL-STD-810G, Method 503.5, Procedure I-D
Vibration (Ground Transportation)	MIL-STD-810G Method 514.6 Procedure I, Cat. IV

2.0 APPLICABLE DOCUMENTS

- 2.1 NTS Quotation Number OP0523614**
- 2.2 Persistent Systems PO Number 19414**
- 2.3 MIL-STD-810G**
- 2.4 NTS Corporate Quality Policy Manual**
Revision 9, Dated September 20, 2018.

3.0 TEST ITEMS**3.1 Description**

Item #	Qty	Description	Part #	Serial #
1	1	MPU5 Radio	MPU5	31783
2	1	RF-2150 10W S-Band Card	WR-ACC-088	1815

3.2 Security Classification of Items

None

4.0 TEST DATE(S) AND EQUIPMENT**4.1 Test Date(s)**

Test Performed	Test Date(s)
Altitude Storage	9/24/19
Altitude Operation	12/2/19
High Temperature Storage	9/26/19-10/2/19
High Temperature Operation	11/25/19-11/28/19
Low Temperature Storage	9/25/19
Low Temperature Operation	11/21/19
Temperature Shock	11/19/19
Vibration	11/19/19

4.2 Test Equipment

A list of the test equipment to be used is included in Appendix A of this procedure. This equipment is calibrated according to ISO 10012-1 and calibration is traceable to the National Institute of Standards and Technology (NIST). Calibration records are maintained on file at National Technical Systems.



5.0 GENERAL TEST REQUIREMENTS

5.1 Test Facility

The Equipment Under Test was tested for Environmental and Dynamic tests at NTS test facilities located in Tinton Falls, NJ.

5.2 Test Sample Configuration

The test item configurations are documented in the photographs contained in this test report.

5.3 Functional Pass/Fail Criteria

The Equipment Under Test shall successfully satisfy the requirements specified in the references listed in Section 2.0 of this procedure. The Equipment Under Test will be checked for functionality before, during and after testing as applicable.

6.0 TEST PROCEDURE**6.1 Altitude (Storage)****6.1.1. Requirement**

The Equipment Under Test shall be tested for Altitude Storage per MIL-STD-810G, Method 500.5, Procedure I.

6.1.2. Test Procedure

The Equipment Under Test was installed into the chamber.

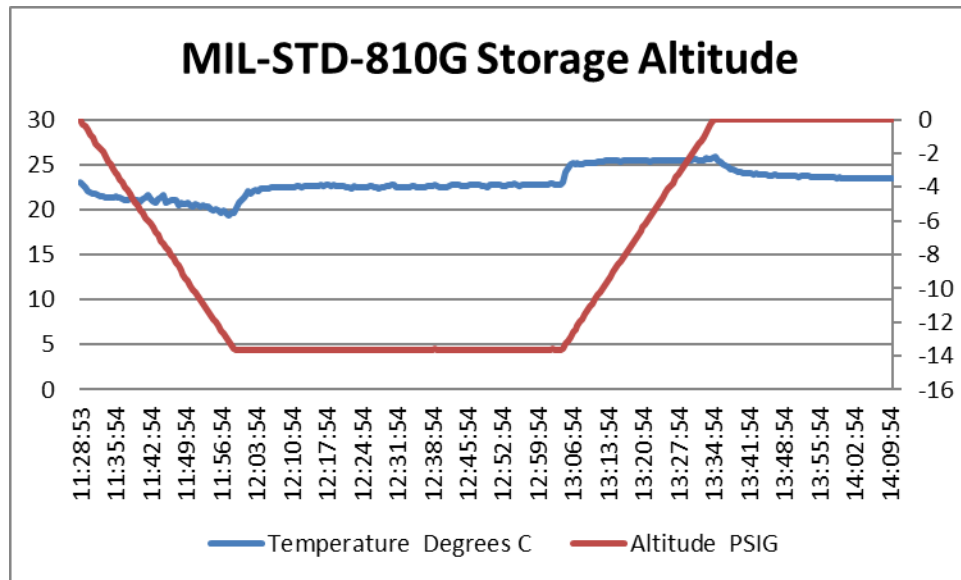
The test chamber's temperature and humidity were maintained at ambient conditions and the chamber altitude was ramped to 18,300 m (60,000 ft.). The pressure ramp was performed at a rate not to exceed 10 m/s (2,000 ft./min). The chamber altitude versus time conditions was continuously recorded.

These chamber conditions were maintained for a period of 60 minutes. The chamber altitude versus time conditions was continuously recorded.

6.1.3. Comments

The Equipment Under Test complied with the Altitude (Storage) requirements.

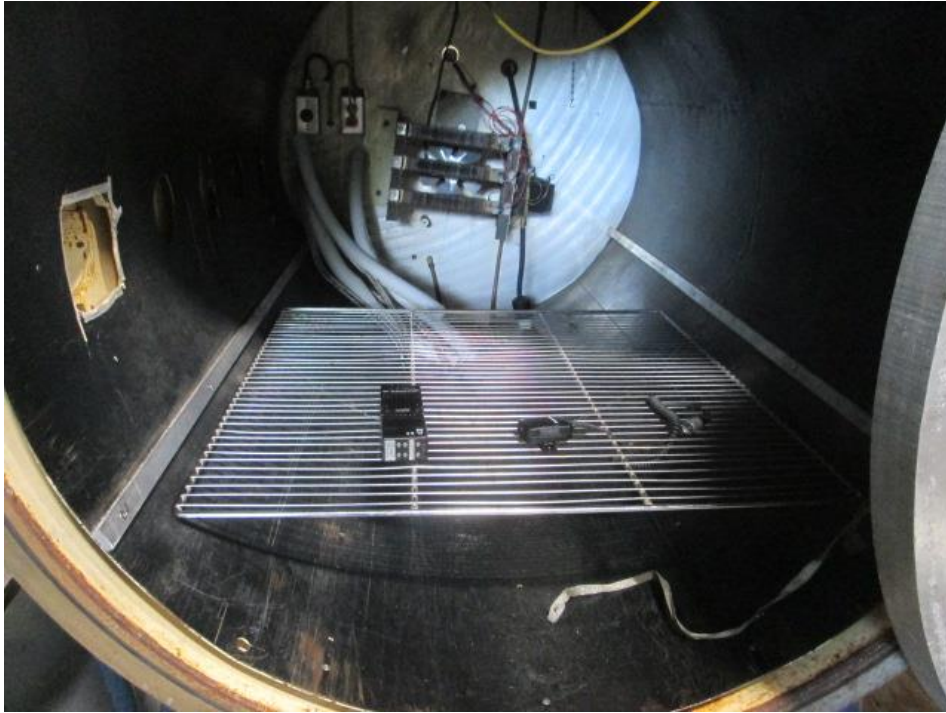
Test Data



Test Equipment

NTS #	Manufacturer	Make	Model	S/N	Cal. Date	Cal. Due
WC005408	NTS	Altitude Chamber	N/A	1	5/2/2019	5/2/2020

Photographs



6.2 Altitude (Operation)**6.2.1. Requirement**

The Equipment Under Test shall be tested for Altitude Operation per MIL-STD-810G, Method 500.5, Procedure II.

6.2.2. Test Procedure

The Equipment Under Test was installed into the chamber in operational configuration.

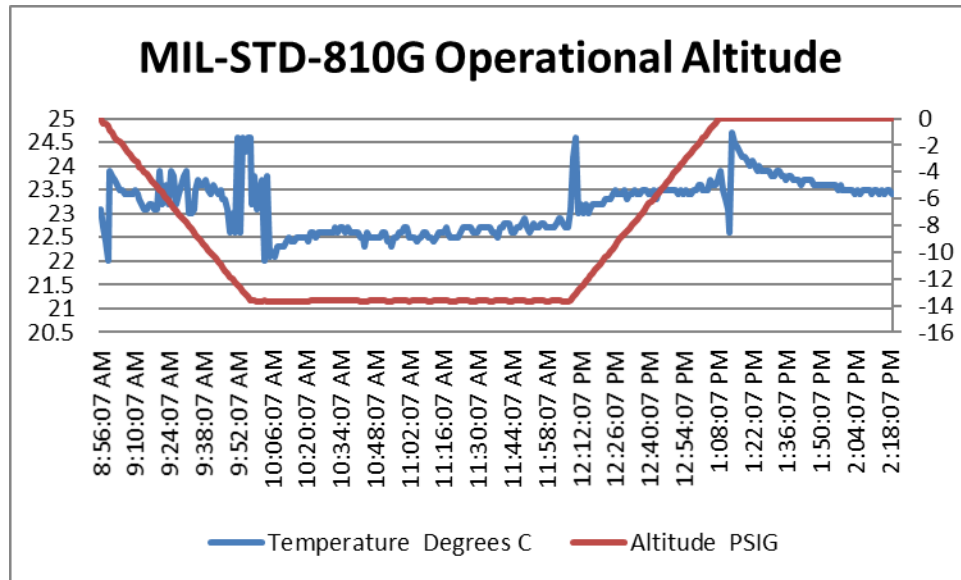
The test chamber's temperature and humidity were maintained at ambient conditions and the chamber altitude was ramped to 18,300 m (60,000 ft.). The pressure ramp was performed at a rate not to exceed 10 m/s (2,000 ft./min). The chamber altitude versus time conditions was continuously recorded.

These chamber conditions were maintained for a period of 60 minutes. The chamber altitude versus time conditions was continuously recorded. An operational check was conducted and the results were documented.

6.2.3. Comments

The Equipment Under Test complied with the Altitude (Operational) requirements.

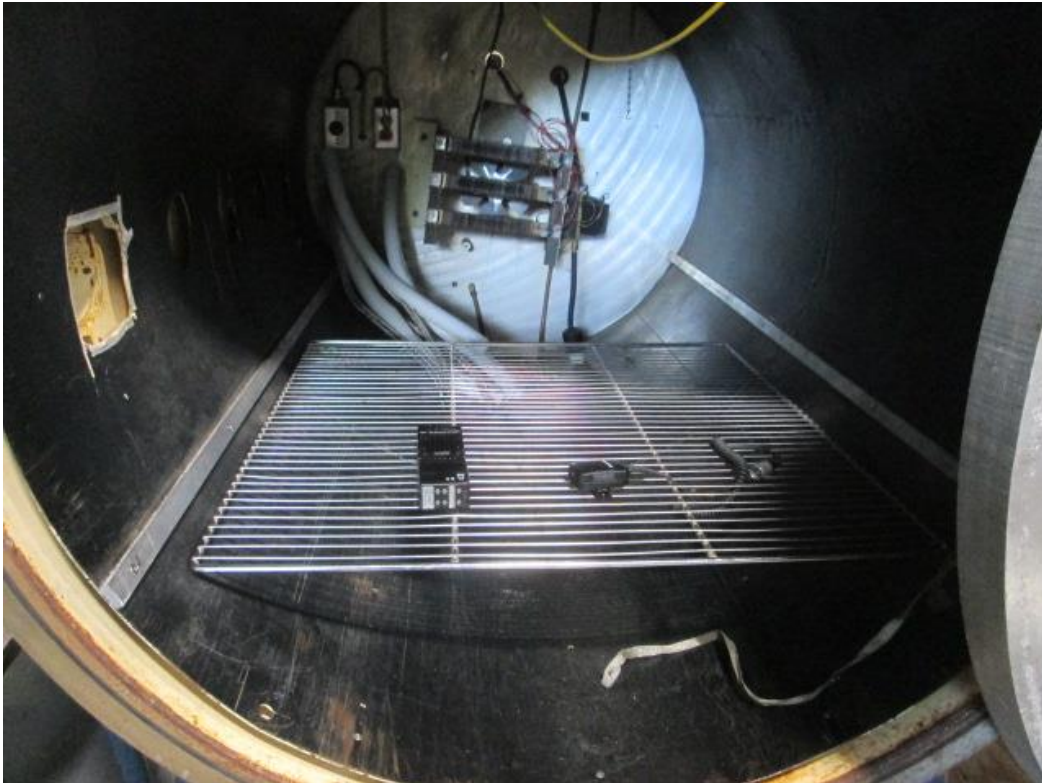
Test Data



Test Equipment

NTS #	Manufacturer	Make	Model	S/N	Cal. Date	Cal. Due
WC005408	NTS	Altitude Chamber	N/A	1	5/2/2019	5/2/2020

Photographs



6.3 High Temperature Storage

6.3.1. Requirement

The Equipment Under Test shall be tested for High Temperature Storage using MIL-STD-810G, Method 501.5 Procedure I at 85°C maximum.

6.3.2. Test Procedure

The Equipment Under Test was placed into the temperature chamber. The chamber temperature was adjusted to 35°C. After temperature stabilization occurred, the following profile was run for 7 cycles (adjusted for 85°C). The chamber was brought back to ambient temperature. The Equipment Under Test was visually examined for damage and operated.

TABLE 501.4-II. High temperature cycles, climatic category - Hot.¹

Time of Day	Ambient Air Conditions		Induced Conditions	
	Temperature ² °C (°F)	Humidity ² % RH	Temperature ² °C (°F)	Humidity ² % RH
0100	35 (95)	6	35 (95)	6
0200	34 (94)	7	34 (94)	7
0300	34 (93)	7	34 (94)	7
0400	33 (92)	8	33 (92)	7
0500	33 (91)	8	33 (92)	7
0600	32 (90)	8	33 (91)	7
0700	33 (91)	8	36 (97)	5
0800	35 (95)	6	40 (104)	4
0900	38 (101)	6	44 (111)	4
1000	41 (106)	5	51 (124)	3
1100	43 (110)	4	56 (133)	2
1200	44 (112)	4	63 (145)	2
1300	47 (116)	3	69 (156)	1
1400	48 (118)	3	70 (158)	1
1500	48 (119)	3	71 (160)	1
1600	49 (120)	3	70 (158)	1
1700	48 (119)	3	67 (153)	1
1800	48 (118)	3	63 (145)	2
1900	46 (114)	3	55 (131)	2
2000	42 (108)	4	48 (118)	3
2100	41 (105)	5	41 (105)	5
2200	39 (102)	6	39 (103)	6
2300	38 (100)	6	37 (99)	6
2400	37 (98)	6	35 (95)	6

¹ These cycles were derived from AR 70-38, 1 August 1979, and essentially conform to those in MIL-HDBK-310 and NATO STANAG 2895. These values represent typical conditions throughout a typical day in this climatic category.

"Induced Conditions" are air temperature levels to which materiel may be exposed during storage or transit situations that are aggravated by solar loading.

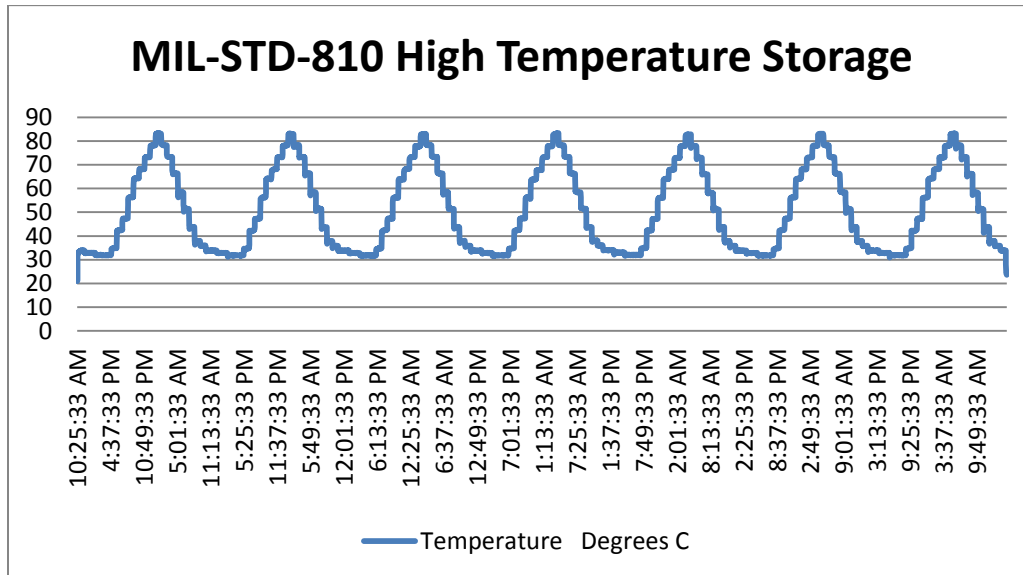
² Humidity control during high temperature testing is generally not necessary. Use these values only in special cases.

³ Data were originally recorded in °F and converted to °C. Hence, table data conversion may not be consistent.

6.3.3. Comments

The Equipment Under Test complied with the High Temperature Storage test.

Test Data



Test Equipment Used

NTS #	Manufacturer	Make	Model	S/N	Cal. Date	Cal. Due
WC058388	Thermotron	Temperature Chamber	SE-600-5-5	30390	8/14/2019	8/14/2020
WC024140	Agilent	Data Acquisition Unit	34970A	US37038572	5/2/2019	5/2/2020

Photographs



6.1 High Temperature Operation

6.1.1. Requirement

The Equipment Under Test shall be tested for High Temperature Operation using MIL-STD-810G, Method 501.5 Procedure II at 85°C maximum.

6.1.2. Test Procedure

The Equipment Under Test was placed into the temperature chamber in operational configuration.

The chamber temperature was adjusted to 35°C.

After temperature stabilization occurred, the following profile was run for 3 cycles (adjusted for 85°C).

The chamber was brought back to ambient temperature.

The Equipment Under Test was visually examined for damage and operated.

TABLE 501.4-II. High temperature cycles, climatic category - Hot.¹

Time of Day	Ambient Air Conditions		Induced Conditions	
	Temperature ² °C (°F)	Humidity ² % RH	Temperature ² °C (°F)	Humidity ² % RH
0100	35 (95)	6	35 (95)	6
0200	34 (94)	7	34 (94)	7
0300	34 (93)	7	34 (94)	7
0400	33 (92)	8	33 (92)	7
0500	33 (91)	8	33 (92)	7
0600	32 (90)	8	33 (91)	7
0700	33 (91)	8	36 (97)	5
0800	35 (95)	6	40 (104)	4
0900	38 (101)	6	44 (111)	4
1000	41 (106)	5	51 (124)	3
1100	43 (110)	4	56 (133)	2
1200	44 (112)	4	63 (145)	2
1300	47 (116)	3	69 (156)	1
1400	48 (118)	3	70 (158)	1
1500	48 (119)	3	71 (160)	1
1600	49 (120)	3	70 (158)	1
1700	48 (119)	3	67 (153)	1
1800	48 (118)	3	63 (145)	2
1900	46 (114)	3	55 (131)	2
2000	42 (108)	4	48 (118)	3
2100	41 (105)	5	41 (105)	5
2200	39 (102)	6	39 (103)	6
2300	38 (100)	6	37 (99)	6
2400	37 (98)	6	35 (95)	6

¹ These cycles were derived from AR 70-38, 1 August 1979, and essentially conform to those in MIL-HDBK-310 and NATO STANAG 2895. These values represent typical conditions throughout a typical day in this climatic category. "Induced Conditions" are air temperature levels to which materiel may be exposed during storage or transit situations that are aggravated by solar loading.

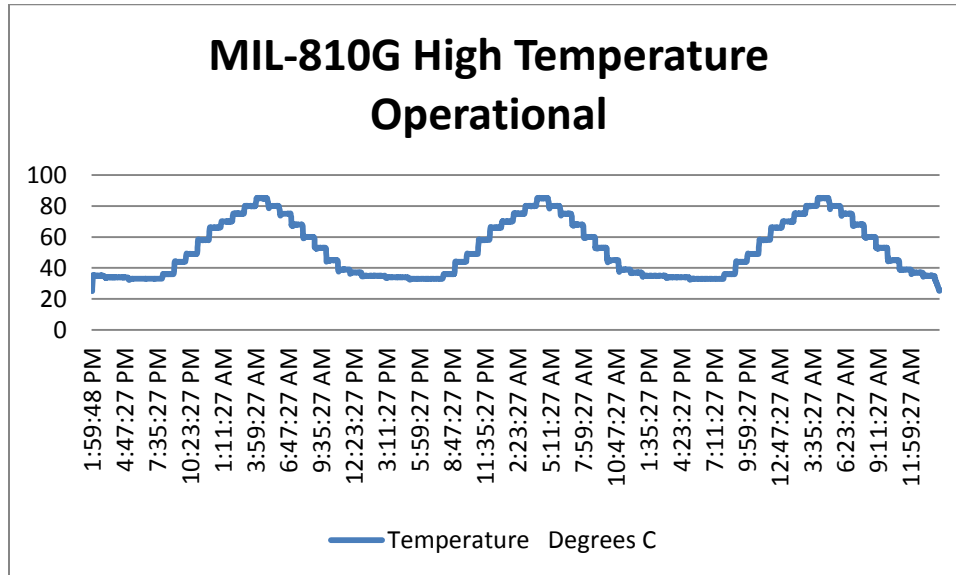
² Humidity control during high temperature testing is generally not necessary. Use these values only in special cases.

³ Data were originally recorded in °F and converted to °C. Hence, table data conversion may not be consistent.

6.1.3. Comments

The Equipment Under Test complied with the High Temperature Operational test.

Test Data



Test Equipment Used

NTS #	Manufacturer	Make	Model	S/N	Cal. Date	Cal. Due
WC058388	Thermotron	Temperature Chamber	SE-600-5-5	30390	8/14/2019	8/14/2020
WC024140	Agilent	Data Acquisition Unit	34970A	US37038572	5/2/2019	5/2/2020

Photographs



6.2 Low Temperature (Storage)**6.2.1. Requirement**

The Equipment Under Test shall be tested for Low Temperature using MIL-STD-810G, Method 502.5 Procedure I at -55°C.

6.2.2. Test Procedure

The Equipment Under Test was installed into the chamber.

The Equipment Under Test was placed into the temperature chamber in operational configuration, turned off.

The chamber temperature was adjusted to -55°C.

After temperature stabilization occurred, the test was continued for 4 hours.

The chamber was brought back to ambient and Equipment Under Test was visually examined for damage and operated.

6.2.3. Comments

The Equipment Under Test complied with the Low Temperature Storage requirements.

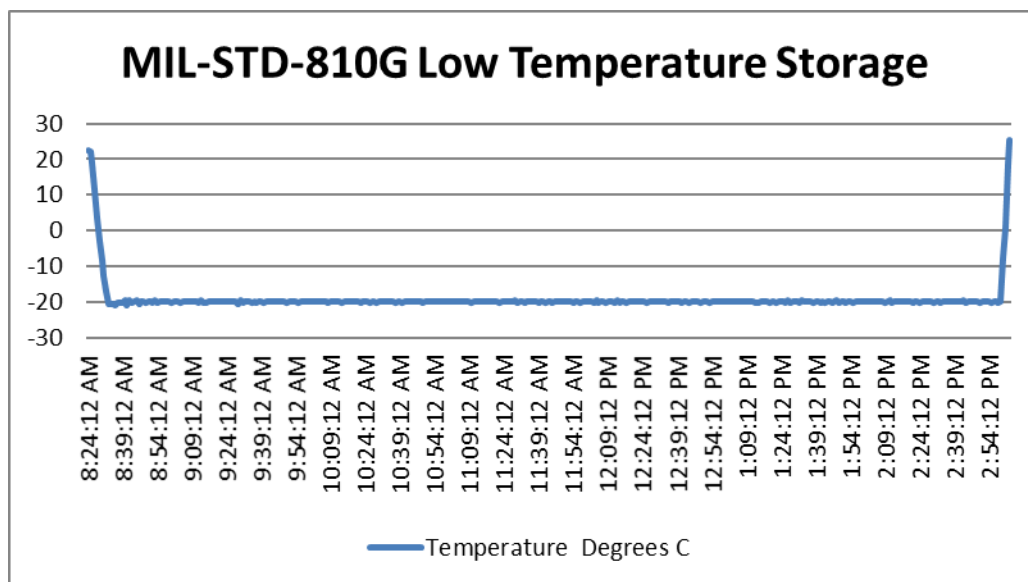


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: TR-102218

Revision 0

Test Data



Test Equipment

NTS #	Manufacturer	Make	Model	S/N	Cal. Date	Cal. Due
WC058389	Thermotron	Temperature Chamber	SE-600-5-5	30915	5/2/2019	5/2/2020
WC024140	Agilent	Data Acquisition Unit	34970A	US37038572	5/2/2019	5/2/2020

Photographs



6.3 Low Temperature (Operational)**6.3.1. Requirement**

The Equipment Under Test shall be tested for Low Temperature using MIL-STD-810G, Method 502.5 Procedure II at -20°C.

6.3.2. Test Procedure

The Equipment Under Test was installed into the chamber.

The Equipment Under Test was placed into the temperature chamber in operational configuration, turned on.

The chamber temperature was adjusted to -20°C.

After temperature stabilization occurred, the test was continued for 3 hours while monitoring the functionality of the Equipment Under test for the duration of the low temperature test.

The chamber was brought back to ambient and Equipment Under Test was visually examined for damage and operated.

6.3.3. Comments

The Equipment Under Test complied with the Low Temperature Operational requirements.

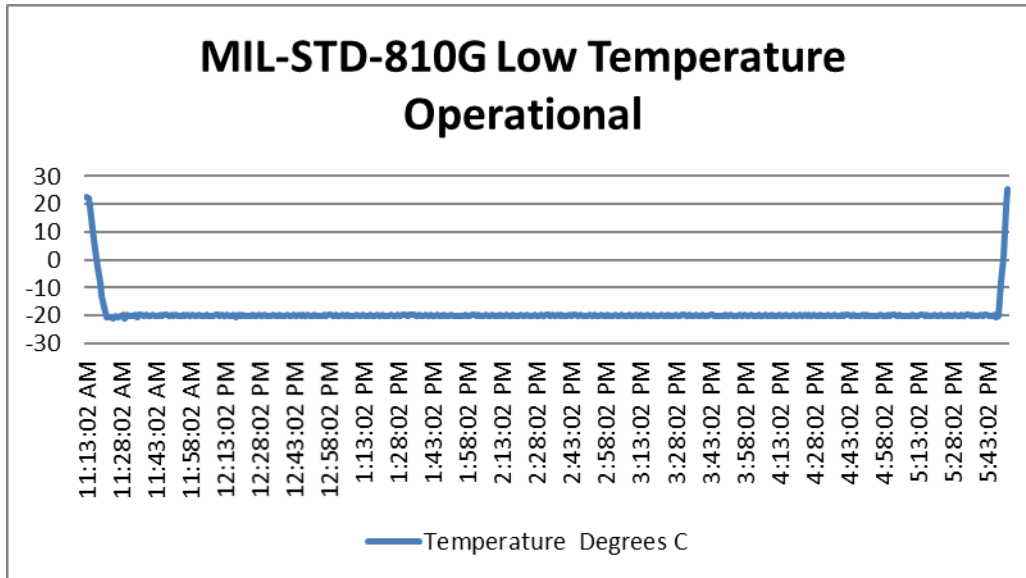


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: TR-102218

Revision 0

Test Data



Test Equipment

NTS #	Manufacturer	Make	Model	S/N	Cal. Date	Cal. Due
WC058389	Thermotron	Temperature Chamber	SE-600-5-5	30915	5/2/2019	5/2/2020
WC024140	Agilent	Data Acquisition Unit	34970A	US37038572	5/2/2019	5/2/2020

Photographs



6.4 Temperature Shock

6.4.1. Requirement

The Equipment Under Test shall be tested for Temperature Shock using MIL-STD-810G, Method 503.5 Procedure I-D.

6.4.2. Test Procedure

The Equipment Under Test was installed into the chamber.

The chamber temperature was adjusted to -20°C.

After temperature stabilization occurred, the test was continued for 1 hour.

The chamber was brought back to ambient conditions, then the EUT was transferred to the second chamber where the temperature was adjusted to 85°C.

The chamber was brought back to ambient and Equipment Under Test was visually examined for damage and operated.

6.4.3. Comments

The Equipment Under Test complied with the Temperature Shock requirements.



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: TR-102218
Revision 0

Test Data

TEST PROFILE		PR102218	
Customer Name:	Persistent Systems	Unit(s) Under Test:	MPU5, Radio Card
Test Name:	Temperature Shock	Quantity:	2
Specification:	MIL-810G	P/N(s):	
Spec. Date:	N/A	S/N(s):	
Para. / Method:	Method 503.5, Proc I-D		

Thermal Controller Profile																									
Step	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Total Time	0.02	1.02	1.03	2.03	2.05	3.05	3.07	4.07	4.08	5.08	5.08	5.08	5.08	5.08	5.08	5.08	5.08	5.08	5.08	5.08	5.08	5.08	5.08	5.08	5.08
Temp	25	25	-20	-20	25	25	85	85	25	25															
Humidity																									
Aux.																									
Hours		1		1		1		1		1															
Minutes	1		1		1		1		1																
Seconds																									
Recycles																									
Next Step																									

Setpoints

Time

TEST SETUP AND RESULTS			
Test Started:	11/19/2019	Test Completed:	11/19/2019

Unit Under Test Information	Y	N	NA	Comments
Tested in shipping container:		X		
Operating during test:		X		
Operated by client:		X		
Powered during testing:		X		
Passes post-test functionals:	X			
Physical damage noted:		X		
Does unit(s) pass requirements:	X			

Test Technician:	Brian Pasznik
------------------	---------------

Test Equipment

NTS #	Manufacturer	Make	Model	S/N	Cal. Date	Cal. Due
WC058389	Thermotron	Temperature/Humidity Chamber	SE-600-5-5	30915	5/2/2019	5/2/2020
WC058388	Thermotron	Temperature Chamber	SE-600-5-5	30390	8/14/2019	8/14/2020

Photographs



6.5 Vibration**6.5.1. Requirement**

The Equipment Under Test shall be tested for Vibration using MIL-STD-810G, Method 514.6 Procedure I ground vehicles.

6.5.2. Test Procedure

The Equipment Under Test was mounted to the vibration table in non-operational condition.

The vibration profile was run for 1 hour per axis.

The Equipment Under Test was visually examined and an operational check was conducted after the test.

6.5.3. Comments

The Equipment Under Test complied with the Vibration test requirements.



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: TR-102218

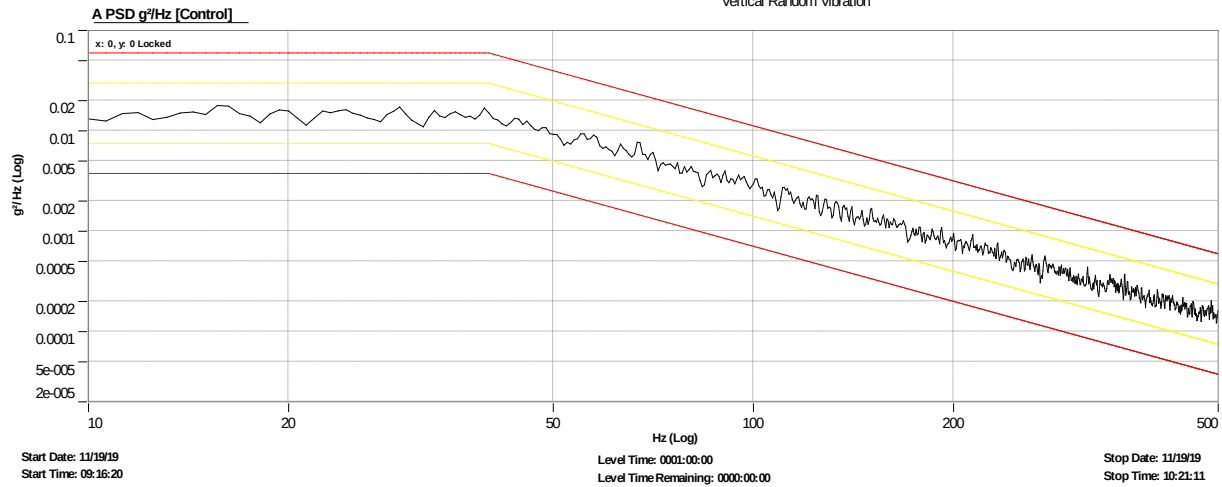
Revision 0

Test Data

NATIONAL TECHNICAL SYSTEMS

Test Level: 0.0000 dB
CTRL: 1.0251 gRMS

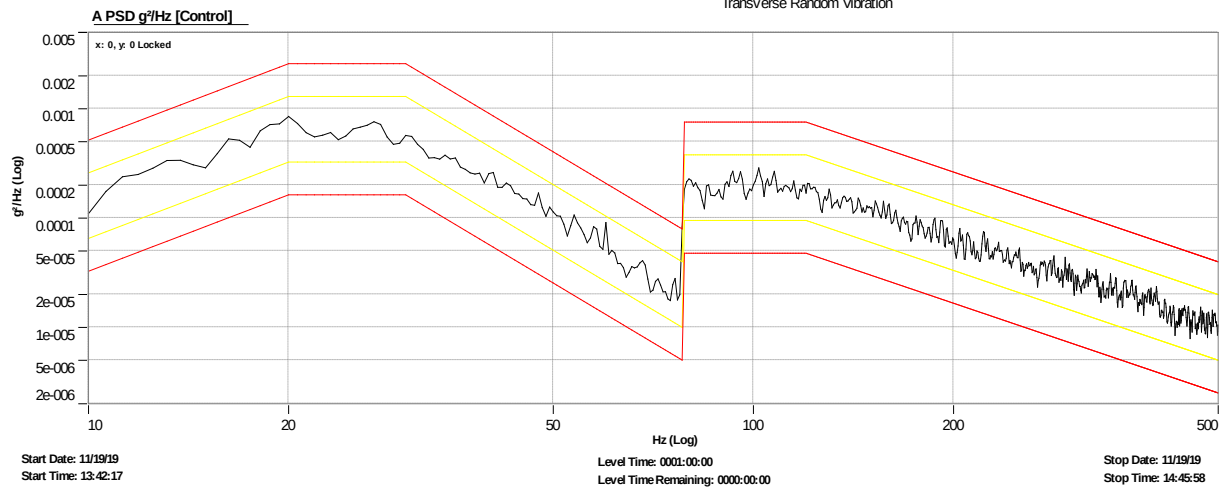
Ctrl DOF: 120
Resolution: 800



Ctrl DOF: 120
Resolution: 800

NATIONAL TECHNICAL SYSTEMS

Test Level: 0.0000 dB
CTRL: 0.2055 gRMS

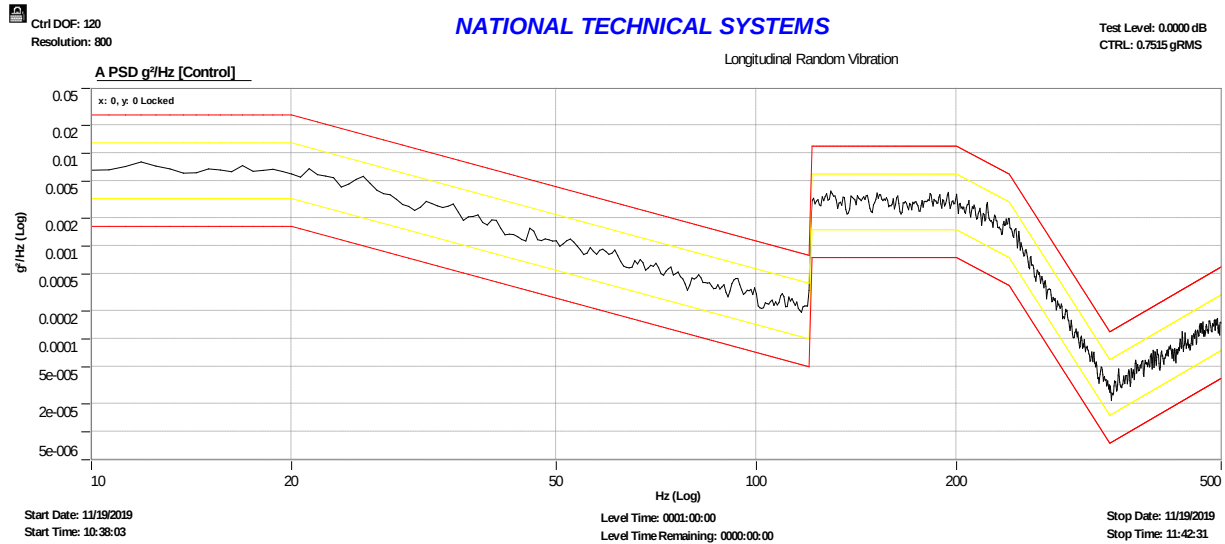




NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: TR-102218

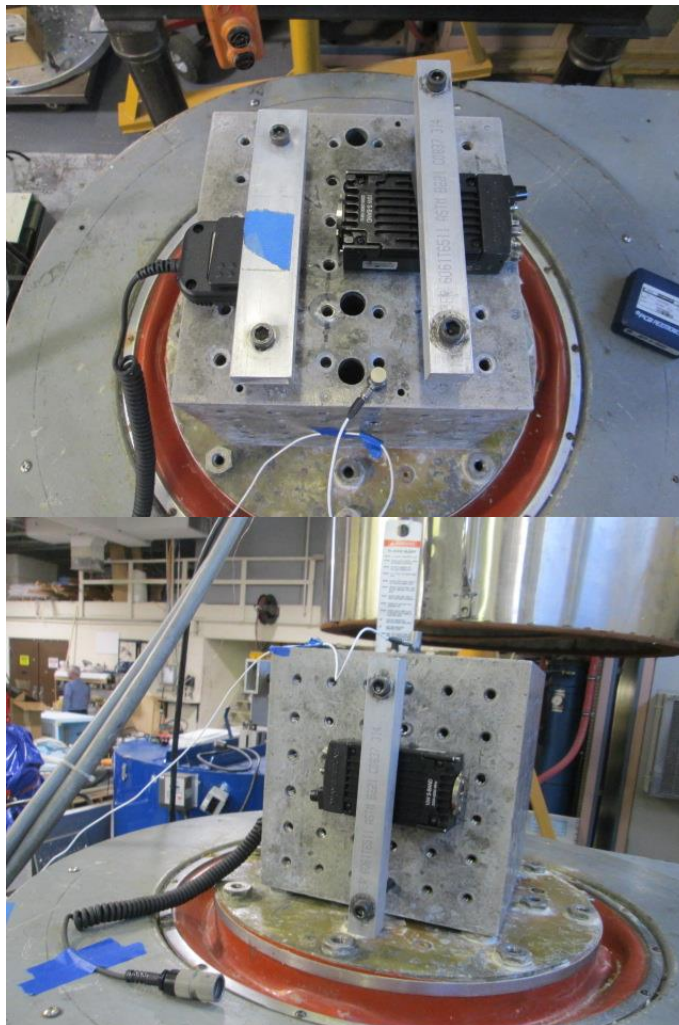
Revision 0

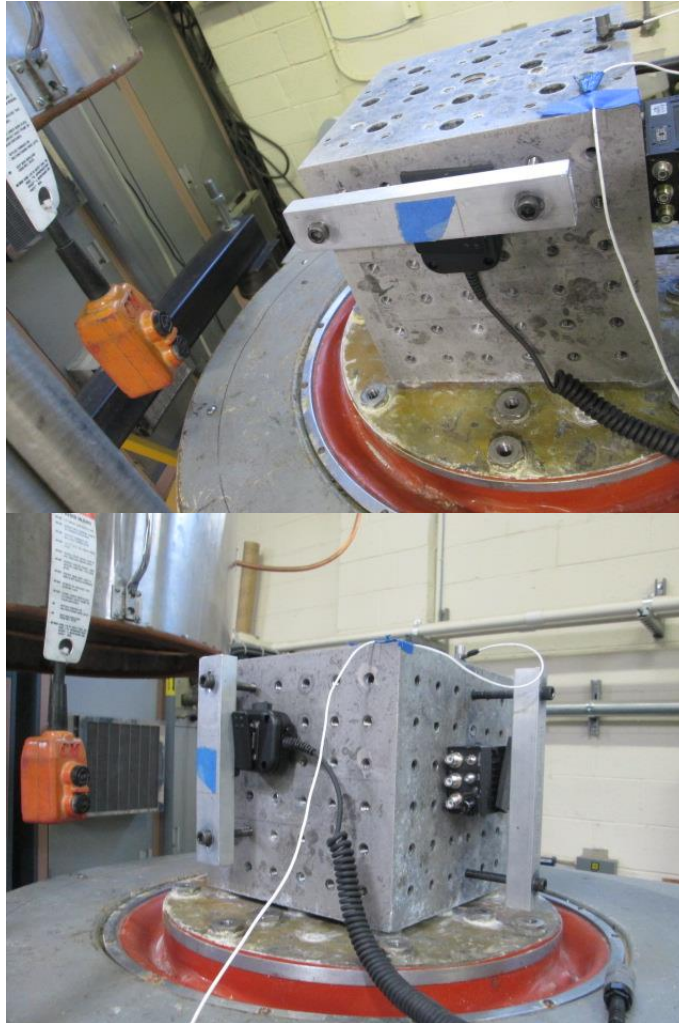


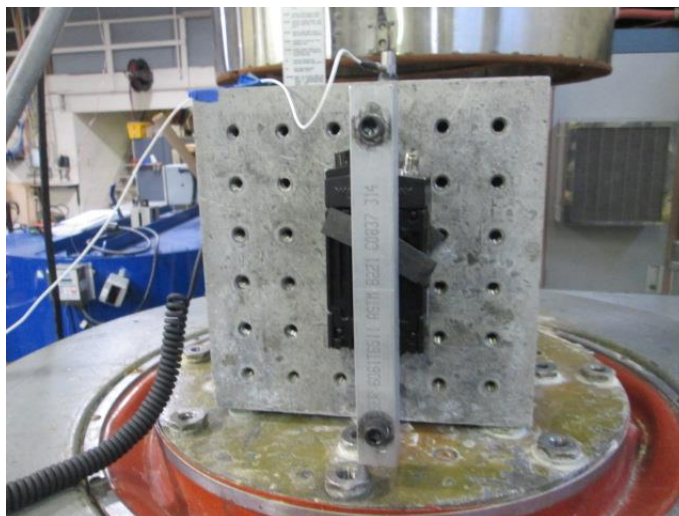
Test Equipment Used

NTS #	Manufacturer	Make	Model	S/N	Cal. Date	Cal. Due
WC005346	Unholtz-Dickie	Amplifier	MA145A-130IAR	2418	NCR	NCR
WC005343	Unholtz-Dickie	Shaker	T1000	476	NCR	NCR
WC040825	Spectral Dynamics	Vibration Controller	2405-9700-1	2400-1709	5/2/2019	5/2/2020
WC005360	PCB	Accelerometer	352C33	LW224492	8/2/2019	8/2/2020

Photographs







END OF REPORT

National Technical Systems
MIL-STD-461 Test Report for the
Persistent Systems LLC
MPU5 Radio with RF-4100 Lower C-Band Card

Prepared For

Persistent Systems LLC | 303 Fifth Avenue, Suite 409, New York, NY 10016

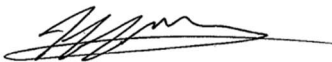
Product

MPU5 Radio with RF-4100 Lower C-Band Card

Prepared By

National Technical Systems | 36 Gilbert Street South | Tinton Falls NJ, 07701 | (732) 936-0800 |
www.nts.com

Date: April 16, 2021 (Rev. 2)

A handwritten signature in black ink, appearing to read "Jeff Maselli", written over a horizontal line.

Jeff Maselli, Technical Writer

A handwritten signature in black ink, appearing to read "Jeff Maselli", written over a horizontal line.

Jeff Maselli, Project Manager

A handwritten signature in black ink, appearing to read "Mark Betts", written over a horizontal line.

Mark Betts, Quality Assurance

This report and the information contained herein represent the results of testing articles/products identified and selected by the customer. The tests were performed to specifications and/or procedures approved by the customer. National Technical Systems ("NTS") makes no representations expressed or implied that such testing fully demonstrates efficiency, performance, reliability, or any other characteristic of the articles being tested, or similar products. This report should not be relied upon as an endorsement or certification by NTS of the equipment tested, nor does it represent any statement whatsoever as to its merchantability or fitness of the test article or similar products for a particular purpose. This document shall not be reproduced except in full without written approval from National Technical Systems ("NTS").



Revision History

Rev	Description	Issue Date
Rev 0	Initial release.	2/3/2020
Rev 1	Removed distribution restrictions (not applicable per Persistent Systems).	2/26/20
Rev 2	Added CE106 test results.	4/16/21



Table of Contents

1.0 Introduction.....	6
1.1 Purpose.....	6
1.2 Acronyms.....	6
1.3 Definitions	6
2.0 References	7
3.0 Equipment Under Test	8
3.1 Description.....	8
3.2 EUT System Setup	8
3.3 EUT Operation and Monitoring	10
3.4 Susceptibility Criteria	10
3.5 EUT Bonding / Grounding Requirements	10
3.5.1 Bonding / Grounding Measurement Results.....	10
3.6 Security Classification	11
4.0 Test Requirements.....	11
4.1 Tests and Location	11
4.2 Test Resources.....	11
4.2.1 Test Equipment	11
4.2.2 Test Automation and Data Collection Software.....	12
4.3 General Test Requirements	13
4.3.1 Test Facility.....	13
4.3.2 Ground Plane and General Setup.....	13
4.4 Emissions Testing.....	14
4.5 Susceptibility Testing	15
5.0 Test Methods, Procedures and Test Results	16
Test Methods and Test Results Summary	16
5.1 Method RE102: Radiated Emissions, Electric Field, 2 MHz to 18 GHz.....	17
5.1.1 RE102 Purpose	17
5.1.2 RE102 Measurement System Check.....	18
5.1.3 RE102 EUT Test Setup	19
5.1.4 RE102 Antenna Positioning	19
5.1.5 RE102 Test Procedure	21
5.1.6 RE102 Test Data	22
5.1.7 RE102 Photographs	41
5.1.8 RE102 Test Equipment	44
5.2 Method RS101: Radiated Susceptibility, Magnetic Field	45
5.2.1 RS101 Purpose.....	45
5.2.2 RS101 Limits	45
5.2.3 RS101 Calibration	46
5.2.4 RS101 EUT Test Setup	46
5.2.5 RS101 Test Procedure	47
5.2.6 RS101 Test Data	48
5.2.7 RS101 Test Photographs.....	57
5.2.8 RS101 Test Equipment	59
5.3 Method RS103: Radiated Susceptibility, Electric Field, 2 MHz - 18 GHz.....	60
5.3.1 RS103 Purpose.....	60
5.3.2 RS103 Limits	60
5.3.3 RS103 Test Setup.....	61



5.3.4	RS103 Test Procedure	63
5.3.5	RS103 Test Data	64
5.3.6	RS103 Data Plots	67
5.3.7	RS103 Photographs	75
5.3.8	RS103 Test Equipment	77
5.4	Conducted Emissions: Method CE106, Conducted Emissions Antenna Terminal, 10kHz to 40GHz	78
	CE106 Test Results Summary	78
5.4.1	CE106 Purpose	78
5.4.2	CE106 Limits	78
5.4.3	CE106 Test Setup.....	79
5.4.4	CE106 Test Procedure	79
5.4.5	CE106 Data	83
5.4.6	CE106 Photographs	96
5.4.7	CE106 Test Equipment	98
Appendix A: Test Software Description.....		99
	AutoScan™ EMI Measurement Software	99
	ETS-Lindgren Totally Integrated Laboratory Environment (TILE!)	101

List of Figures

Figure 3.2-1: MPU5 Radio with RF-4100 Lower C-Band Card EMI Setup Overview	9
Figure 4.3-1: General Test Setup Example.....	13
Figure RE102-1: RE102 limit for ground applications (Navy Mobile & Army).	17
Figure RE102-2: RE102 Measurement System Check Setup.....	18
Figure RS101-1: RS101 limit for all Army applications.....	45
Figure RS101-2: Calibration of the radiating system.	46
Figure RS101-3: RS101 Basic test setup.....	47
Figure RS103-1: RS103 Limit – Army Ground	60
Figure CE106-1: Setup for Low Power Transmitters and Amplifiers	80
Figure CE106-2: Setup for High Power Transmitters and Amplifiers.....	81
Figure CE106-3: Setup for Receivers and Stand-by Mode for Transmitters and Amplifiers.....	82

List of Tables

Table 2.0-1: Government Specifications, Standards, and Handbooks.....	7
Table 2.0-2: Other Documents, Drawings, and Publications	7
Table 3.1-1: EUT Info	8
Table 3.5-1: Bonding / Grounding Test Equipment	10
Table 4.1-1: Tests and Locations.....	11
Table 4.2-1: Test Automation and Data Collection Software	12
Table 4.4-1: Bandwidth and Measurement Times	14
Table 4.5-1: Susceptibility Scanning	15
Table 5.0-1: Test Methods and Test Results Summary	16
Table RE102-1: RE102 Antenna Position Calculations, 2 MHz to 200 MHz	19
Table RE102-2: RE102 Antenna Coverage Calculations, 200 MHz to 18 GHz	20
Table RE102-3: RE102 Antenna Position Calculations, 200 MHz to 18 GHz	20
Table RE102-4: Antenna Type and Applicable Frequencies	21
Table RE102-5: RE102 Test Equipment List	44
Table RS101-1: RS101 Test Equipment List	59



Table RS103-1: RS103 Antenna Position Calculations, 2 MHz to 200 MHz	61
Table RS103-2: RS103 Antenna Coverage Calculations, 200 MHz to 18 GHz	62
Table RS103-3: RS103 Antenna Position Calculations, 200 MHz to 18 GHz	62
Table RS103-4: RS103 Test Equipment List	77
Table 5.2-1: CE106 Test Equipment.....	98

1.0 Introduction

1.1 Purpose

The purpose of this report is to document the procedural steps for testing and criteria for evaluating the results of the Electromagnetic Interference (EMI) testing of the MPU5 Radio with RF-4100 Lower C-Band Card. The test program was conducted to determine the ability of the MPU5 Radio with RF-4100 Lower C-Band Card to successfully satisfy the requirements specified Section 4.

This EMI Test Report (EMITR) is contracted by Persistent Systems LLC. It is the end user who is ultimately responsible for the compliance of the equipment installed. The contracted test facility is National Technical Systems (NTS) in Tinton Falls, New Jersey.

Scope

This EMITR is applicable to the qualification of the MPU5 Radio with RF-4100 Lower C-Band Card. The MPU5 Radio with RF-4100 Lower C-Band Card is required to meet the Army Ground requirements per MIL-STD-461F.

1.2 Acronyms

EMC: Electromagnetic Compatibility

ODBC: Open Database Connectivity

EMI: Electromagnetic Interference

OLE: Object Linking and Embedding

EMITP: Electromagnetic Interference Test Procedure

PSA: Performance Spectrum Analyzer

EMITR: Electromagnetic Interference Test Report

RF: Radio Frequency

EUT: Equipment Under Test

TEM: Transverse Electromagnetic

LISN: Line Impedance Stabilization Network

TPD: Terminal Protection Device

1.3 Definitions

Decibel (dB) is a logarithmic unit of measurement that expresses the magnitude of a physical quantity (usually power or intensity) relative to a specified or implied reference level.

Metric Units are a system of measures defined by the International System on Units based on the "Le System International d' Unites (SI)", of the International Bureau of Weights and Measures. These units are described in ASTM E3380.

Non-Developmental Item is a broad, generic term that covers material available from a wide variety of sources both industry and Government with little or no development effort required by the procuring activity.

Octave refers to the interval between one frequency and another with double its frequency.

Semi-Anechoic Chamber refers to a chamber with RF absorber lining on all walls and ceiling, but not the floor.

Safety Critical is a category of subsystems and equipment whose degraded performance could result in loss of life or loss of vehicle platform.

Test Setup Boundary includes all enclosures of the EUT and the 2 m of exposed interconnecting leads (except for leads which are shorter in actual installation) and power leads required by MIL-STD-461F.

2.0 References

The following listed in Tables 2.0-1 and 2.0-2 form a part of this document to the extent specified herein.

Table 2.0-1: Government Specifications, Standards, and Handbooks

No	Specification	Title
1	MIL-STD-461F	Department of Defense Interface Standard, Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment, dated December 10, 2007

Table 2.0-2: Other Documents, Drawings, and Publications

No	Specification	Title
2	ISO/IEC 17025	General Requirements for the Competence of Testing and Calibration Laboratories, 2005
3	NTS QPM	National Technical Systems Quality Policy Manual, Rev 10, 8/1/2019
4	ANSI NCSL Z540-1	Calibration Laboratories and Measuring and Test Equipment—General Requirements
5	P.O # 19972	Persistent Systems LLC Purchase Order.
6	OP0532558	NTS Quotation to Persistent Systems LLC.

3.0 Equipment Under Test

3.1 Description

The Equipment Under Test (EUT) for this test program shall be the MPU5 Radio with RF-4100 Lower C-Band Card.

Table 3.1-1: EUT Info

Unit Designation	MPU5 Radio with RF-4100 Lower C-Band Card
Type	Assembly
Model Number	WR-5100, RF-4100
Serial Number	39628 (MPU5), 31628 (Lower C-Band Card)
Serial Number (CE106)	28360 (MPU5), 47480 (Lower C-Band Card)
Power Rating	Battery Powered

3.2 EUT System Setup

Figure 3.2-1 shows the general system setup and connections.

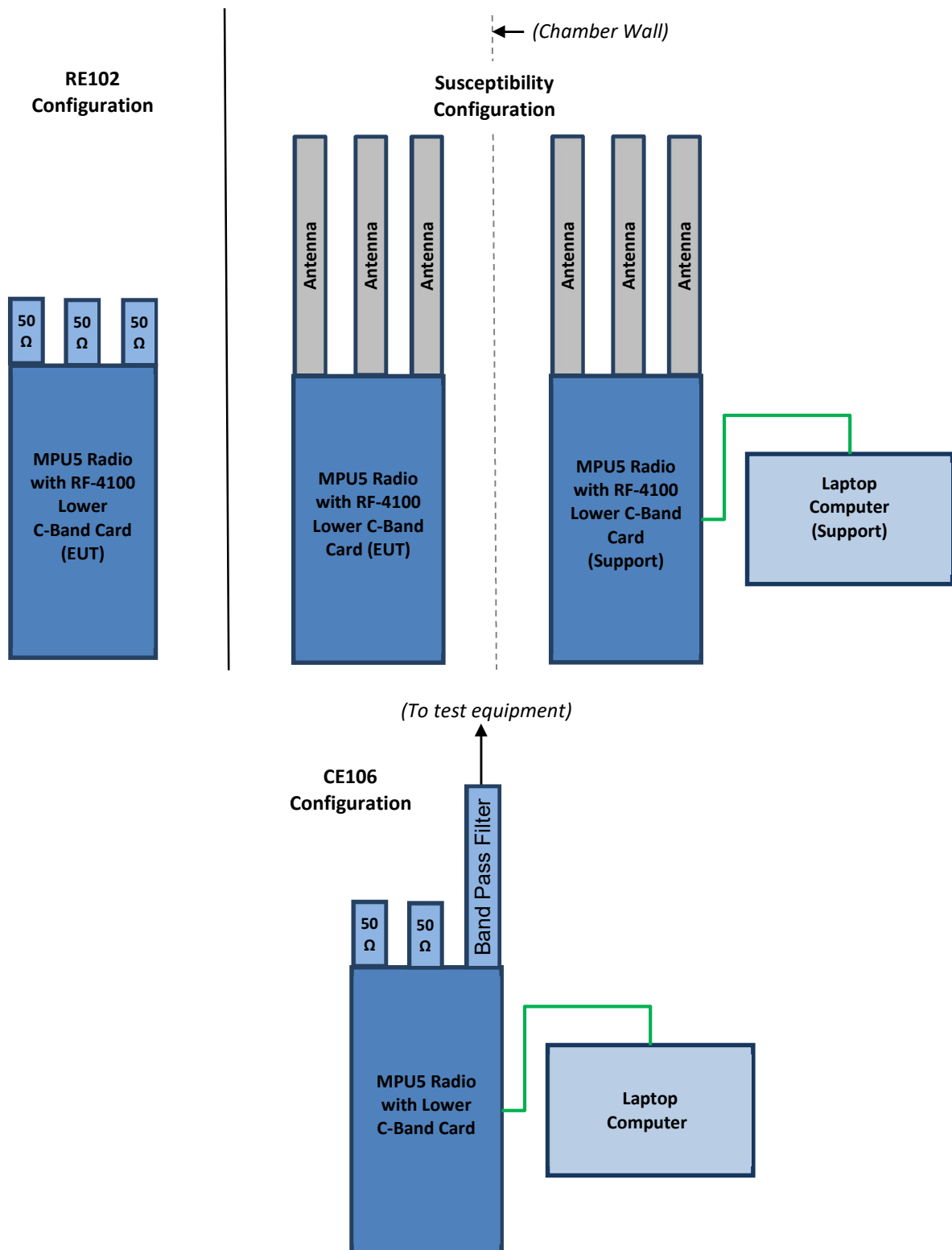


Figure 3.2-1: MPU5 Radio with RF-4100 Lower C-Band Card EMI Setup Overview

3.3 EUT Operation and Monitoring

The EUT was turned on placed in transmit/receive mode.

During susceptibility testing, another radio, connected to a laptop computer was used to communicate with the EUT radio.

3.4 Susceptibility Criteria

- It shall not be acceptable for the EUT to lose communication with the laptop computer.
- The ping session shall not show any lost packets.
- The bandwidth tester shall not show decreased bandwidth.

3.5 EUT Bonding / Grounding Requirements

There were no bonding / grounding requirements specified for the EUT.

3.5.1 Bonding / Grounding Measurement Results

There were no bonding / grounding requirements specified for the EUT.

Date:	N/A	Location:	N/A
Test(s):	N/A	Tested By:	N/A

Test Point	Measured (mΩ)
N/A	N/A

3.5.1.1 Bonding / Grounding Test Equipment

Table 3.5-1: Bonding / Grounding Test Equipment

Asset No.	Manufacturer	Item	Model	S/N	Cal Cycle (Months)	Cal. Due
N/A	N/A	N/A	N/A	N/A	N/A	N/A

Calibration Abbreviation
NCR: No Calibration Required

3.6 Security Classification

The MPU5 Radio with RF-4100 Lower C-Band Card is considered an unclassified defense article. While unclassified, it should be handled only by authorized personnel.

4.0 Test Requirements

This section provides an overview of the EMI test plan.

4.1 Tests and Location

Table 4.1-1: Tests and Locations

Section	Test	MIL-STD-461F Section	Location ¹
5.1	RE102	5.17	AR3
5.2	RS101	5.19	AR2
5.3	RS103	5.20	AR1
5.4	CE106	5.6	AR1
Note 1: All testing was performed at NTS in Tinton Falls, NJ.			

4.2 Test Resources

4.2.1 Test Equipment

Lists of the NTS provided equipment used during testing will be included in each test section. This equipment is calibrated according to ISO/IEC 17025, ANSI NCSL Z540-1, and calibration is traceable to the National Institute of Standards and Technology (NIST). Calibration records are maintained on file at NTS.

Frequency Accuracy

In order for the EUT to successfully satisfy the requirements specified in the references listed in Section 2.0, the frequency accuracy of the recorded measurements shall be within $\pm 2\%$. Verification with a frequency counter or other measuring device shall be required. Amplitude Accuracy shall be ± 2 dB

4.2.2 Test Automation and Data Collection Software

Various software packages are used for test automation and data collection, depending on the test type. Refer to Table 4.2-1 below for information on the software used for each test.

Refer to Appendix A for detailed descriptions of each software package.

Table 4.2-1: Test Automation and Data Collection Software

Test	Manufacturer	Model	Rev	Date Verified
RE102	EMCware	AutoScan	7.4.4.14	9/12/2019
RS101	ETS Lindgren	TILE!	7.4.3.2	2/25/2019
RS103	ETS Lindgren	TILE!	7.4.3.2	2/25/2019
CE106	EMCware	AutoScan	2020.8.26	8/26/2020

4.3 General Test Requirements

4.3.1 Test Facility

All testing occurred within a shielded semi anechoic enclosure or shielded room, located in Tinton Falls, NJ. Semi anechoic chambers are lined with anechoic Radio Frequency (RF) absorbing tiles and cones on the walls and the ceiling. Peripheral equipment are located outside the shielded enclosure. All power leads entering the shielded enclosures will be routed via electromagnetic interference filters to provide at least 80 dB of attenuation above 10 kHz when measured in accordance with MIL-STD-220B. Interconnecting cables are routed via feed-through ports when practical. Shielding effectiveness to electric fields and plane waves of this EMI test chamber exceed 80 dB from 14 kHz-10 GHz, and 60 dB from 10 GHz-40 GHz.

4.3.2 Ground Plane and General Setup

When a ground plane is not present in the EUT installation, the EUT shall be placed on a non-conductive table as shown in Figure 4.3-1.

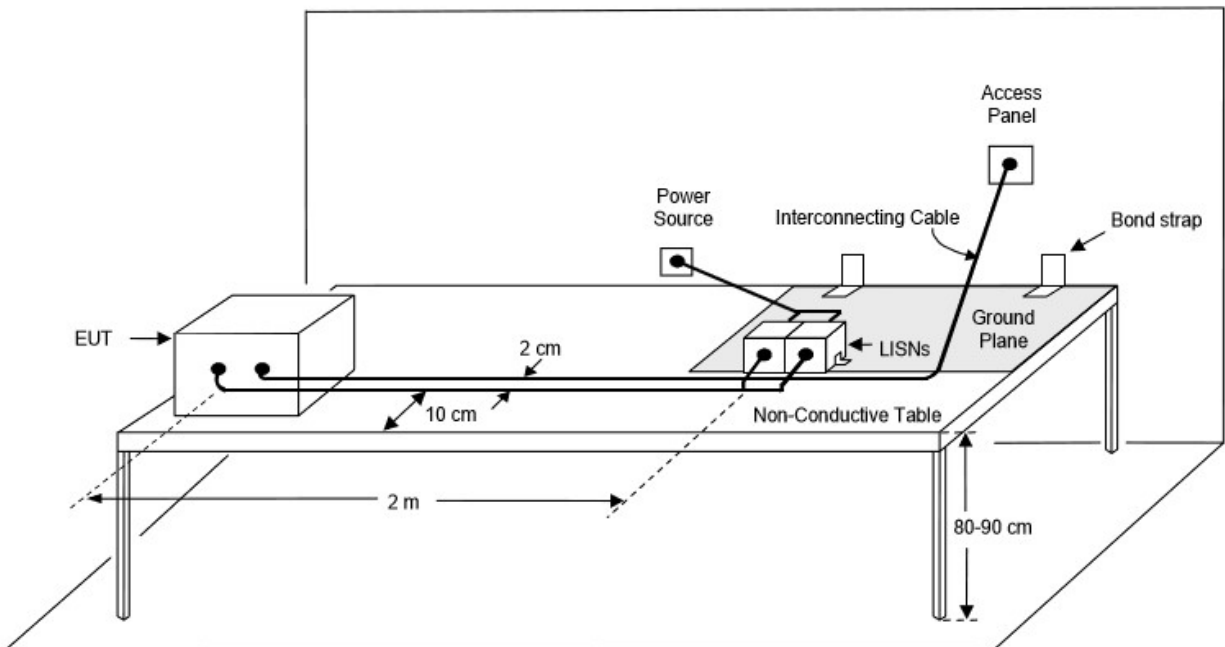


Figure 4.3-1: General Test Setup Example

4.4 Emissions Testing

Receiver Bandwidth and Measurement Time

The measurement receiver bandwidths listed in Table 4.4-1, which are derived from MIL-STD-461F, are used for emissions testing. These bandwidths are specified at the 6 dB down points for the overall selectivity curve of the receivers. Video filtering is not used to bandwidth limit the receiver response. A controlled video bandwidth is available on the measurement receivers used; it was set to its greatest value. This value was 50 MHz.

Table 4.4-1: Bandwidth and Measurement Times

Frequency Range	6 dB Bandwidth	Dwell Time ¹	Min Measurement Time of Analog Measurement Receiver
30 Hz-1 kHz	10 Hz	0.15 sec	0.015 sec/Hz
1 kHz-10 kHz	100 Hz	0.015 sec	0.15 sec/kHz
10 kHz-150 kHz	1 kHz	0.015 sec	0.015 sec/kHz
150 kHz-30 MHz	10 kHz	0.015 sec	1.5 sec/MHz
30 MHz-1 GHz	100 kHz	0.015 sec	0.15 sec/MHz
> 1GHz	1 MHz	0.015 sec	15 sec/GHz

Ambient Electromagnetic Level

During testing, the ambient electromagnetic level is measured with EUT de-energized and all auxiliary equipment turned on and shall be at least 6 dB below the allowable specified limits. Ambient conducted levels on power leads are measured with the leads disconnected from the EUT and connected to a resistive load which draws the same current as the EUT. The ambient are recorded in the EMITR.

4.5 Susceptibility Testing

For susceptibility measurements, the entire frequency range for each applicable test are scanned. For swept frequency susceptibility testing, frequency scan rates and frequency step sizes of signal sources did not exceed the values listed in Table 4.5-1. The rates and step sizes are specified in terms of a multiplier of the tuned frequency (f_o) of the signal source. Analog scans refer to signal sources which are continuously tuned. Stepped scans refer to signal sources which are sequentially tuned to discrete frequencies. Stepped scans dwell at each tuned frequency for 3 seconds. Scan rates and step sizes are decreased when necessary to permit observation of a response.

Table 4.5-1: Susceptibility Scanning

Frequency Range	Analog Scans Max Scan Rates	Stepped Scans Max Step Size
30 Hz - 1 MHz	$0.0333f_o/\text{sec}$	$0.05 f_o$
1 MHz - 30 MHz	$0.00667 f_o/\text{sec}$	$0.01 f_o$
30 MHz - 1 GHz	$0.00333 f_o/\text{sec}$	$0.005 f_o$
1 GHz - 40 GHz	$0.000667 f_o/\text{sec}$	$0.0025 f_o$

Modulation of Susceptibility RF Signals

Susceptibility test signals for RS103 and CS14 are pulse modulated (on/off ratio of 40 dB minimum) at 1 kHz rate with a 50% duty cycle.

Thresholds of Susceptibility

When susceptibility indications are noticed in EUT operation, a threshold level shall be determined when possible, and where the susceptible condition shall be no longer present. Thresholds of susceptibility are determined as follows:

- When a susceptibility condition is detected, the interference signal shall be reduced until the EUT recovered.
- The interference shall be reduced by an additional 6 dB.
- The interference signal shall be gradually increased until the susceptibility condition reoccurred.
- The level, frequency range of occurrence, frequency and level of greatest susceptibility, and other test parameters, as applicable will be recorded.

5.0 Test Methods, Procedures and Test Results

Test Methods and Test Results Summary

Table 5.0-1: Test Methods and Test Results Summary

Test Report Section	MIL-STD-461F Test Method	Description	Test Date(s)	Result
5.1	RE102	Radiated Emissions, Electric Field, 2 MHz to 18 GHz	10/2/19, 10/3/19	PASS
5.2	RS101	Radiated Susceptibility, Magnetic Field	11/6/19	PASS
5.3	RS103	Radiated Susceptibility, Electric Field, 2 MHz to 18 GHz	10/14/19, 10/15/19	PASS
5.4	CE106	Conducted Emissions: Method CE106, Conducted Emissions Antenna Terminal, 10kHz to 40GHz	2/17/21	PASS

5.1 Method RE102: Radiated Emissions, Electric Field, 2 MHz to 18 GHz

5.1.1 RE102 Purpose

This test verifies that electric field emissions from the EUT shall not exceed the limit specified in Figure RE102-1 over the frequency range of 2 MHz to 18 GHz.

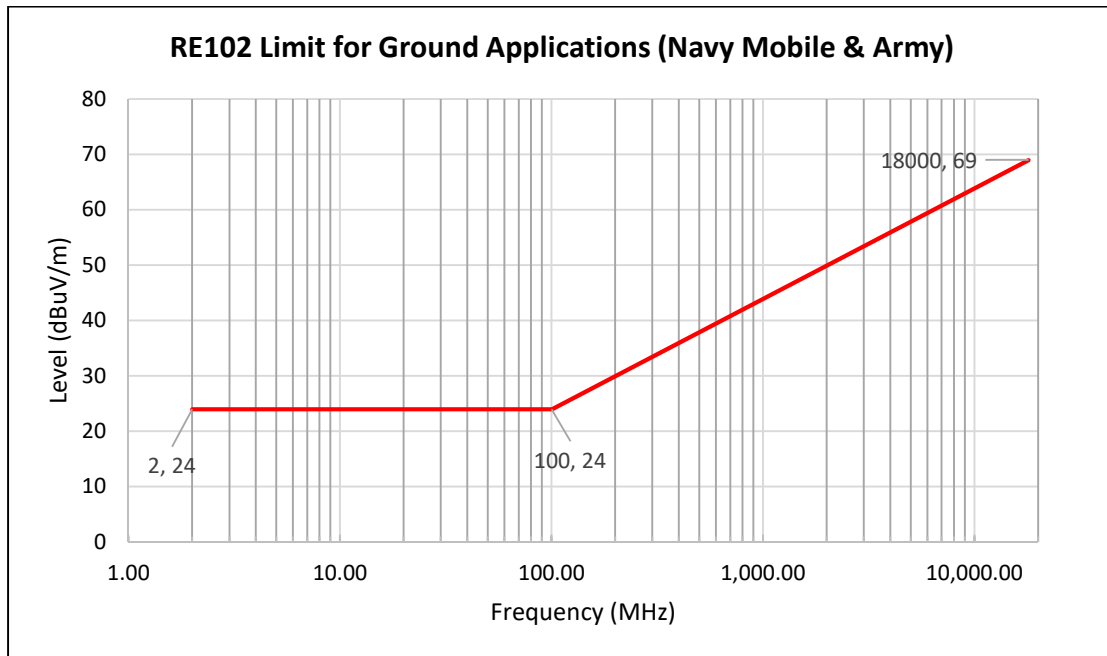


Figure RE102-1: RE102 limit for ground applications (Navy Mobile & Army).

5.1.2 RE102 Measurement System Check

1. The measurement system check was performed prior to testing.
 2. The measurement system was set up per Figure RE102-2.
 3. The evaluation was performed on the overall measurement system from each antenna to the data output device at the highest measurement frequency of the antenna. For the active rod antenna, the evaluation was performed at the lowest frequency of test, at a mid-band frequency, and at its highest measurement frequency.
 4. A signal generator was connected to the coax in place of the measurement antenna. For the active rod antenna, the active rod antenna calibration fixture was used in place of the rod element and the signal was injected across a 10 pF capacitor in the calibration fixture.
 5. The signal generator was adjusted to produce a signal 6 dB below the RE102 limit shown in Figure RE102-1.
 6. The signal detected at the measurement receiver was within ± 3 dB of the calibrated level.
 7. This process was repeated for each frequency defined as follows:
 - Active rod Antenna: 10.5 kHz (only for testing performed between 10 kHz and 2 MHz), 2.1MHz, 12MHz, 29.5 MHz
 - Biconical Antenna: 197 MHz
 - Large Double Ridged Horn Antenna: 990 MHz
 - Small Double Ridged Horn Antenna: 17.5 GHz
 8. Correction factors were added to the raw data collected from the measurement receiver. For example:

$$\text{Cable loss (dB)} + \text{Antenna factors (dB)} + \text{Raw Data (dB}\mu\text{V)} - \text{Preamplifier gain (dB)} = \text{corrected data (dB}\mu\text{V/m)}$$
 9. Using the measurement path of Figure RE102-2, the following evaluation for each antenna was performed to demonstrate that there is electrical continuity through the antenna:
 - A. A signal was radiated using an antenna or stub radiator at the highest measurement frequency of each antenna.
 - B. The measurement receiver was tuned to the frequency of the applied signal and the received signal of appropriate amplitude was present.
- Note:** This evaluation is intended to provide a coarse indication that the antenna is functioning properly. There is no requirement to accurately measure the signal level.
10. An ambient measurement was performed across the frequency range with the EUT power leads disconnected. All auxiliary support equipment was powered during this measurement.

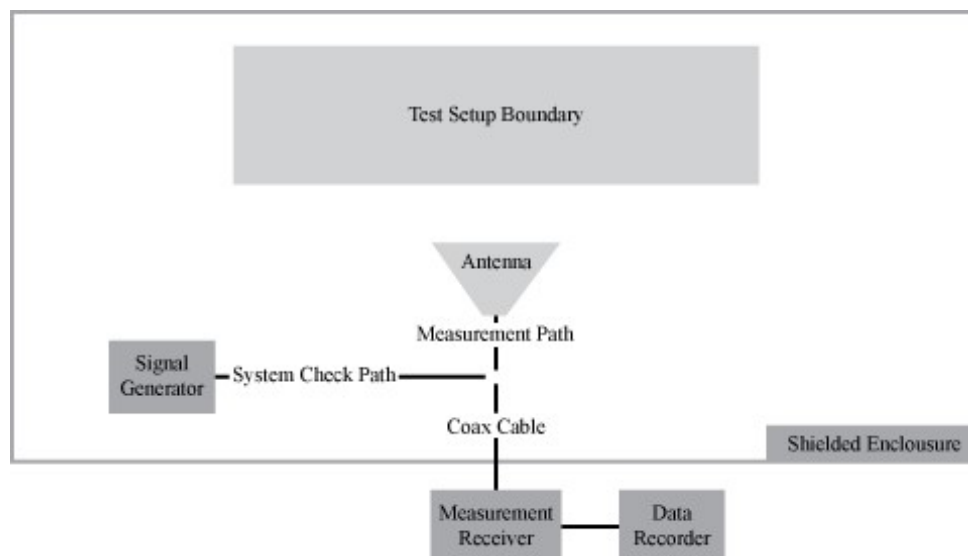


Figure RE102-2: RE102 Measurement System Check Setup

5.1.3 RE102 EUT Test Setup

The EUT was setup in accordance with Section 3.2, Figure 3.2-1 and operated according to Section 3.3.

5.1.4 RE102 Antenna Positioning

1. Measure the EUT and test setup boundary for use in positioning of antennas. Use the physical reference points on the antennas shown in Figure RE102-4 for measuring heights of the antennas and distances of the antennas from the test setup boundary.
2. Position antennas 1 meter from the front edge of the test setup boundary for all setups.
3. Position antennas other than the 104 cm rod antenna 120 cm above the floor ground plane.
4. Ensure that no part of any antenna is closer than 1 meter from the walls and 0.5 meter from the ceiling of the shielded enclosure.

The number of required antenna positions depends on the size of the EUT and test setup boundary and the number of enclosures included in the setup.

For testing below 200 MHz, use the following criteria to determine the individual antenna positions.

- a. For setups with the side edges of the boundary 3 meters or less, one position is required and the antenna was centered with respect to the side edges of the boundary.
- b. For setups with the side edges of the boundary greater than 3 meters, use multiple antenna positions at spacings as shown in Figure RE102-5. Determine the number of antenna positions (N) by dividing the edge-to-edge boundary distance (in meters) by 3 and rounding up to an integer.

For testing from 200 MHz up to 1 GHz, place the antenna in a sufficient number of positions such that the entire width of each EUT enclosure and the first 35 cm of cables and leads interfacing with the EUT enclosure are within the 3 dB beamwidth of the antenna.

For testing at 1 GHz and above, place the antenna in a sufficient number of positions such that the entire width of each EUT enclosure and the first 7 cm of cables and leads interfacing with the EUT enclosure are within the 3 dB beamwidth of the antenna.

Table RE102-1: RE102 Antenna Position Calculations, 2 MHz to 200 MHz

Antenna Model	Range Used (MHz)	Antenna Coverage (cm)	Test Setup Boundary (cm)	Antenna Positions
ETS 3301C	2 – 30	300	6.5	1
EMCO 3109	30 - 200	300	6.5	1

Table RE102-2: RE102 Antenna Coverage Calculations, 200 MHz to 18 GHz

Antenna Model	Range Used (GHz)	Minimum 3dB Beamwidth (°)	Coverage at 1 M Distance (cm)
ETS 3106	0.2 – 1.0	28	49.87
EMCO 3115	1 - 18	8	13.99
Antenna Coverage = $2 * (\tan(\Theta) * a)$ Where $\Theta = 1/2$ (antenna 3dB beamwidth) a = antenna distance from setup boundary			

Table RE102-3: RE102 Antenna Position Calculations, 200 MHz to 18 GHz

Antenna Model	Range Used (GHz)	Antenna Coverage @ 1 M (cm)	EUT Width ¹ (cm)	Antenna Positions Required
ETS 3106	0.2 – 1.0	49.87	6.5	1
EMCO 3115	1 - 18	13.99	6.5	1

Note 1: Did not add 35cm of cable (200 MHz – 1GHz) or 7cm of cable (>1 GHz), because the EUT has no cables.

5.1.5 RE102 Test Procedure

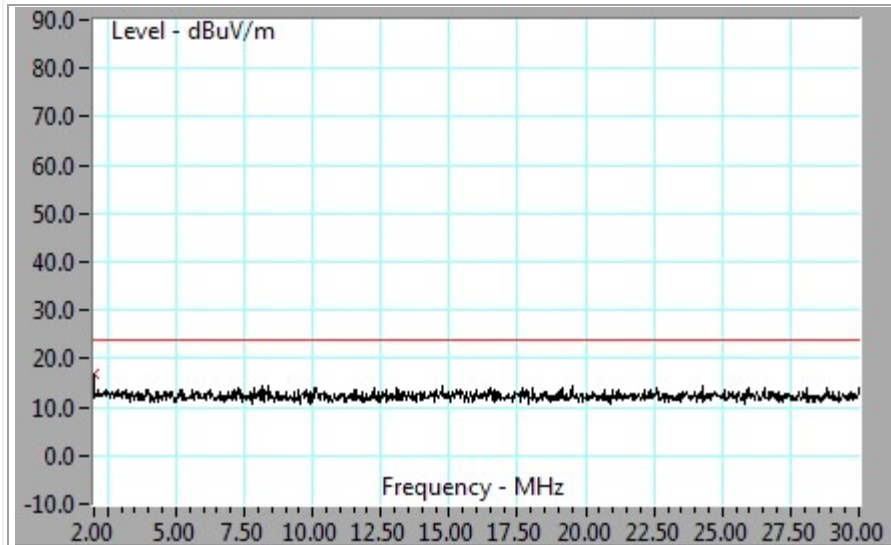
1. The EUT and test equipment were set up in accordance with Section 5.9.3.
2. The required frequency range was scanned using the bandwidths and minimum measurement times specified in Table 4.4-1.
3. Above 30 MHz, both horizontal and vertical polarities were tested. Below 30 MHz, only vertical polarity measurements were performed.
4. Correction factors were added to the raw data collected from the measurement receiver. For example:
5. Cable loss (dB) + Antenna factors (dB) + Raw Data (dB μ V) - Preamplifier gain (dB) = corrected data (dB μ V/m)
6. The following types of antennas, listed in Table RE102-2, were used to scan the entire frequency range:

Table RE102-4: Antenna Type and Applicable Frequencies

Antenna	Characteristics	Frequency Range
41" Active Rod	104 cm with impedance matching network, preamplifier, and square counterpoise measuring 60cm on a side	2 MHz - 30 MHz
Biconical	137 cm tip to tip	30 MHz - 200 MHz
Double Ridged Horn	69 x 94.5 cm opening	200 MHz - 1 GHz
Double Ridged Horn	24.2 x 13.6 cm opening	1 GHz - 18 GHz

5.1.6 RE102 Test Data

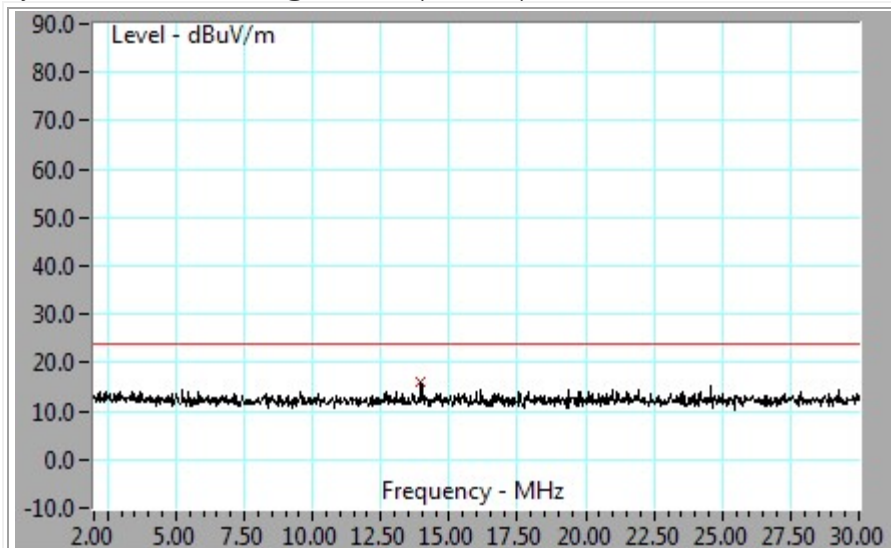
System Check: 2MHz @ -90dBm (17dBuV)



Wed, Oct 02, 2019
11:48:27 AM
AutoScan 7.4.4.14
Res BW (kHz) 10
Vid BW (kHz) 50000
VERTICAL
ETS-Lindgren 3301C Active Monopole
Graph # 6
Sweep Time 90.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
2.000	16.9	24.0	-7.1	18.53	-1.69	0.07	0.00	1.62

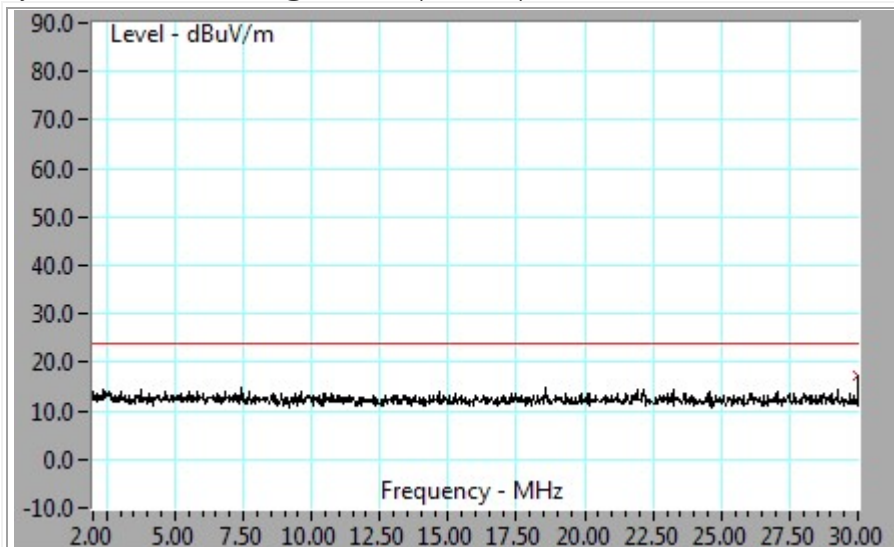
System Check: 14MHz @ -90dBm (17dBuV)



Wed, Oct 02, 2019
11:55:02 AM
AutoScan 7.4.4.14
Res BW (kHz) 10
Vid BW (kHz) 50000
VERTICAL
ETS-Lindgren 3301C Active Monopole
Graph # 7
Sweep Time 90.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
13.984	15.9	24.0	-8.1	16.55	-1.03	0.35	0.00	0.69

System Check: 30MHz @ -90dBm (17dBuV)



Wed, Oct 02, 2019

12:02:28 PM

AutoScan 7.4.4.14

Res BW (kHz) 10

Vid BW (kHz) 50000

VERTICAL

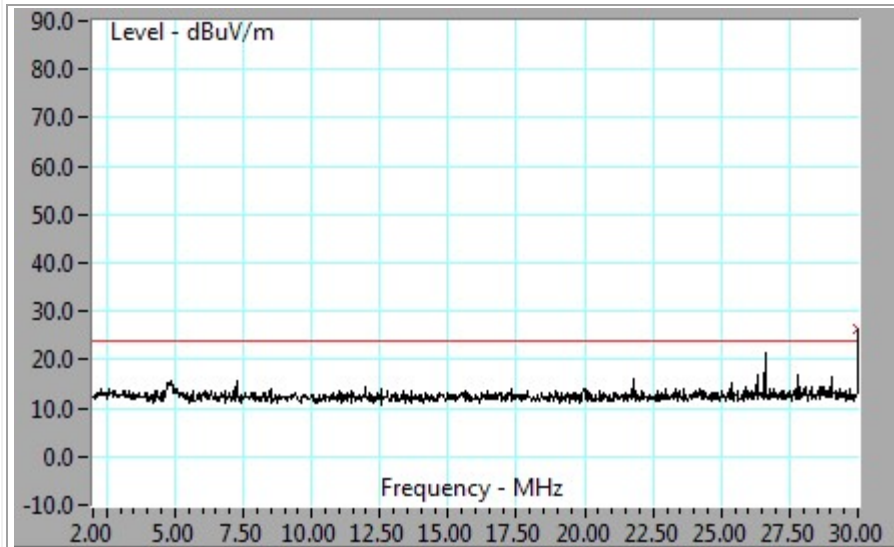
ETS-Lindgren 3301C Active Monopole

Graph # 8

Sweep Time 90.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
30.00	17.1	24.0	-6.9	15.72	0.82	0.53	0.00	-1.35

System Check: Stub Radiator @ 30MHz



Wed, Oct 02, 2019

12:11:30 PM

AutoScan 7.4.4.14

Res BW (kHz) 10

Vid BW (kHz) 50000

VERTICAL

ETS-Lindgren 3301C Active Monopole

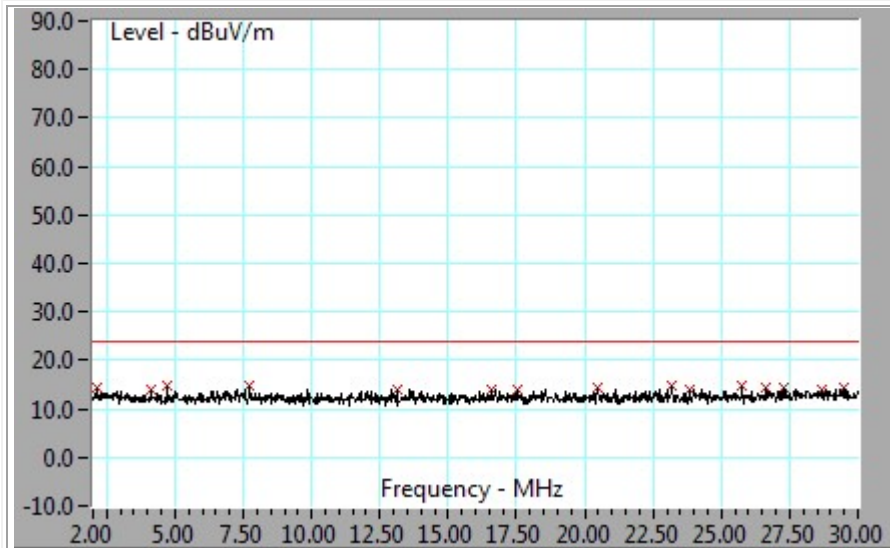
Graph # 9

Sweep Time 90.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
30.00	26.5	24.0	2.5	* 25.16	0.82	0.53	0.00	-1.35



System Check: Ambient



Wed, Oct 02, 2019

12:37:26 PM

AutoScan 7.4.4.14

Res BW (kHz) 10

Vid BW (kHz) 50000

VERTICAL

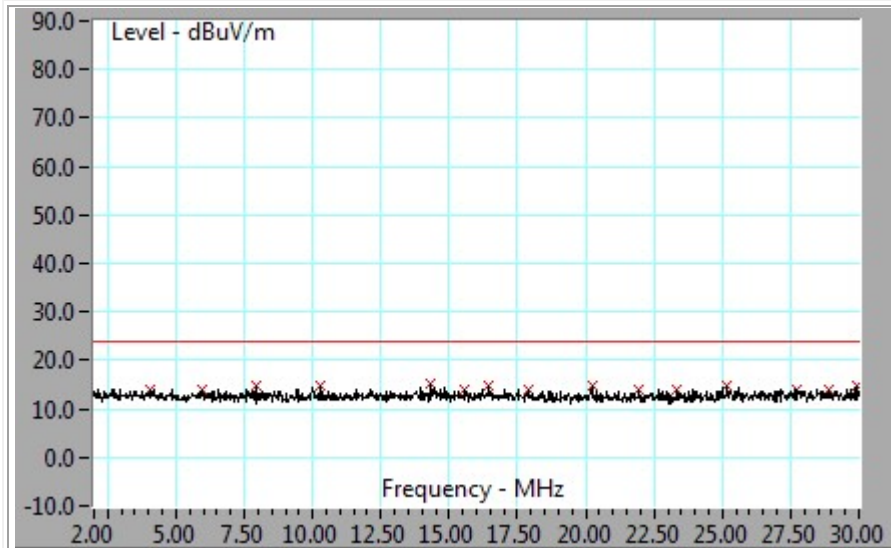
ETS-Lindgren 3301C Active Monopole

Graph # 30

Sweep Time 90.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
2.112	14.2	24.0	-9.8	15.79	-1.69	0.07	0.00	1.62
4.128	14.1	24.0	-9.9	15.65	-1.67	0.10	0.00	1.57
4.716	14.6	24.0	-9.4	16.16	-1.65	0.10	0.00	1.55
7.740	14.6	24.0	-9.4	15.97	-1.52	0.14	0.00	1.38
13.116	14.2	24.0	-9.8	14.97	-1.11	0.31	0.00	0.80
16.560	14.0	24.0	-10.0	14.39	-0.77	0.41	0.00	0.36
17.568	14.0	24.0	-10.0	14.27	-0.66	0.43	0.00	0.24
20.480	14.4	24.0	-9.6	14.30	-0.34	0.47	0.00	-0.13
23.196	14.7	24.0	-9.3	14.20	-0.02	0.50	0.00	-0.48
23.840	14.1	24.0	-9.9	13.55	0.06	0.51	0.00	-0.57
25.772	14.7	24.0	-9.3	13.86	0.30	0.52	0.00	-0.82
26.640	14.3	24.0	-9.7	13.34	0.40	0.53	0.00	-0.93
27.312	14.3	24.0	-9.7	13.26	0.49	0.53	0.00	-1.02
28.684	14.0	24.0	-10.0	12.83	0.66	0.53	0.00	-1.19
29.468	14.3	24.0	-9.7	13.00	0.76	0.53	0.00	-1.29

MPU5 - RF4100 - Lower C Band Card - Chassis 39628 - 4900MHz



Wed, Oct 02, 2019

12:45:05 PM

AutoScan 7.4.4.14

Res BW (kHz) 10

Vid BW (kHz) 50000

VERTICAL

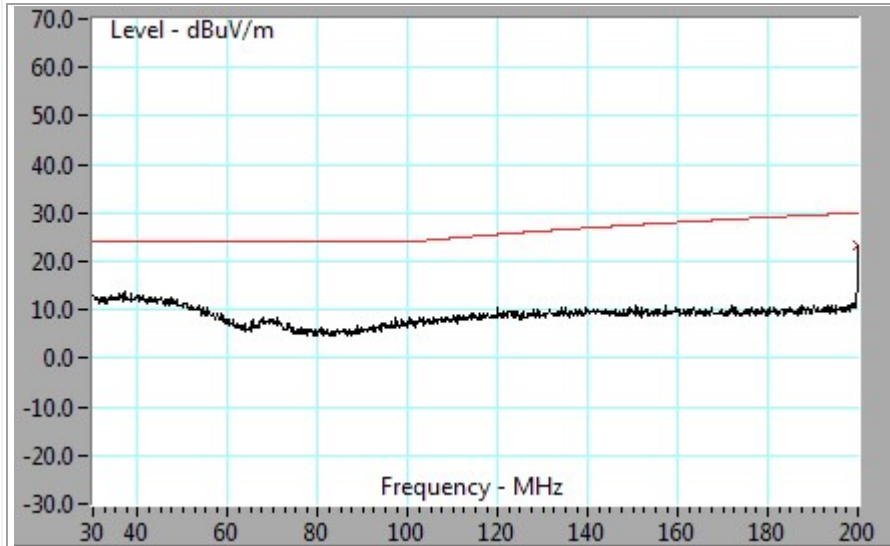
ETS-Lindgren 3301C Active Monopole

Graph # 31

Sweep Time 90.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
4.072	14.1	24.0	-9.9	15.64	-1.67	0.10	0.00	1.57
5.948	14.1	24.0	-9.9	15.61	-1.61	0.12	0.00	1.49
7.908	14.6	24.0	-9.4	15.98	-1.51	0.14	0.00	1.37
10.260	14.7	24.0	-9.3	15.89	-1.34	0.17	0.00	1.17
14.348	15.1	24.0	-8.9	15.75	-1.00	0.36	0.00	0.63
15.552	14.1	24.0	-9.9	14.58	-0.87	0.40	0.00	0.48
16.476	14.7	24.0	-9.3	15.04	-0.78	0.41	0.00	0.37
17.876	14.0	24.0	-10.0	14.16	-0.63	0.43	0.00	0.20
20.228	14.7	24.0	-9.3	14.64	-0.37	0.46	0.00	-0.10
21.964	14.0	24.0	-10.0	13.64	-0.16	0.49	0.00	-0.32
23.364	14.1	24.0	-9.9	13.54	0.01	0.50	0.00	-0.51
25.184	14.6	24.0	-9.4	13.87	0.23	0.52	0.00	-0.75
27.704	14.2	24.0	-9.8	13.09	0.54	0.53	0.00	-1.07
28.936	14.1	24.0	-9.9	12.84	0.69	0.53	0.00	-1.22
29.916	14.7	24.0	-9.3	13.31	0.81	0.53	0.00	-1.34

System Check: 200MHz @ 24.35 dBuV



Wed, Oct 02, 2019

7:52:52 AM

AutoScan 7.4.4.14

Res BW (kHz) 100

Vid BW (kHz) 50000

VERTICAL

EMCO 3109

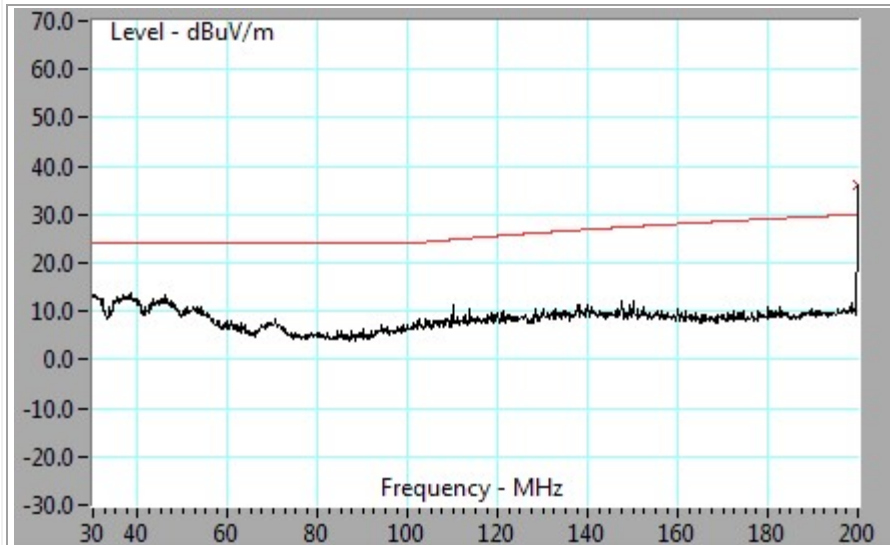
A.H. Systems PAM-0118P

Graph # 1

Sweep Time 60.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
200.00	23.4	30.0	-6.6	48.10	15.35	1.19	41.20	24.66

System Check: 200MHz Stub Radiator



Wed, Oct 02, 2019

8:10:28 AM

AutoScan 7.4.4.14

Res BW (kHz) 100

Vid BW (kHz) 50000

VERTICAL

EMCO 3109

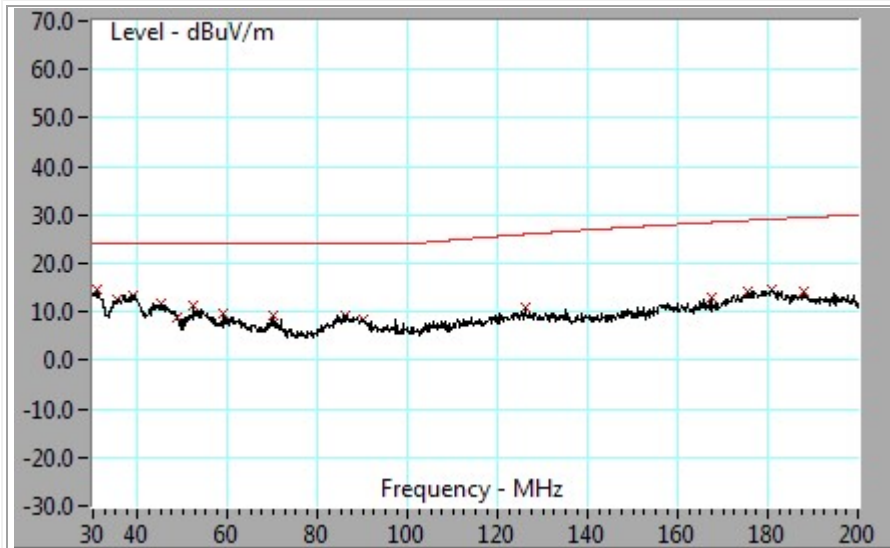
A.H. Systems PAM-0118P

Graph # 2

Sweep Time 60.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
200.00	36.0	30.0	6.0	* 60.66	15.35	1.19	41.20	24.66

System Check: Ambient



Wed, Oct 02, 2019

8:36:39 AM

AutoScan 7.4.4.14

Res BW (kHz) 100

Vid BW (kHz) 50000

HORIZONTAL

EMCO 3109

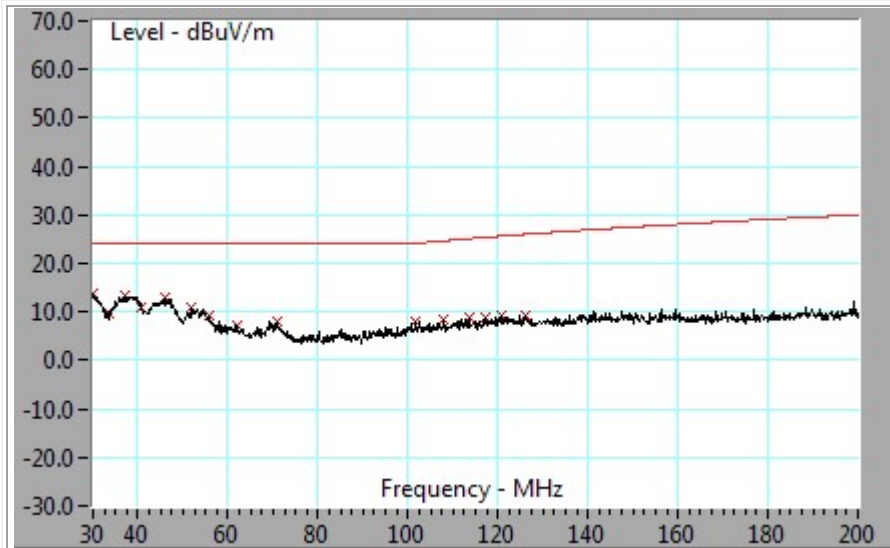
A.H. Systems PAM-0118P

Graph # 4

Sweep Time 60.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
30.68	14.7	24.0	-9.3	40.04	12.43	0.54	38.29	25.32
35.44	12.5	24.0	-11.5	38.28	12.32	0.60	38.65	25.73
39.01	13.5	24.0	-10.5	39.64	12.21	0.61	38.92	26.10
44.96	11.9	24.0	-12.1	38.66	11.85	0.68	39.29	26.75
48.53	8.7	24.0	-15.3	35.92	11.57	0.70	39.50	27.23
52.27	11.3	24.0	-12.7	38.72	11.53	0.71	39.69	27.45
59.07	9.8	24.0	-14.2	38.33	10.69	0.73	39.98	28.57
70.12	9.1	24.0	-14.9	37.72	10.95	0.80	40.35	28.60
85.93	9.3	24.0	-14.7	40.45	8.68	0.84	40.69	31.18
90.01	8.6	24.0	-15.4	39.52	9.00	0.85	40.77	30.91
126.05	11.0	26.0	-15.0	36.82	14.16	0.98	40.98	25.84
167.36	13.1	28.5	-15.3	39.49	13.53	1.10	40.99	26.37
175.52	14.2	28.9	-14.7	39.22	14.91	1.12	41.07	25.04
180.79	14.6	29.1	-14.5	39.13	15.43	1.15	41.11	24.53
187.93	14.3	29.5	-15.2	39.00	15.27	1.16	41.13	24.69

System Check: Ambient



Wed, Oct 02, 2019

8:42:38 AM

AutoScan 7.4.4.14

Res BW (kHz) 100

Vid BW (kHz) 50000

VERTICAL

EMCO 3109

A.H. Systems PAM-0118P

Graph # 5

Sweep Time 60.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
30.17	13.7	24.0	-10.3	39.67	11.77	0.54	38.25	25.95
33.74	9.5	24.0	-14.5	35.58	11.90	0.58	38.52	26.05
37.31	13.5	24.0	-10.5	39.25	12.40	0.61	38.79	25.79
40.88	10.8	24.0	-13.2	36.49	12.72	0.63	39.05	25.70
45.98	12.9	24.0	-11.1	38.84	12.72	0.69	39.35	25.94
51.59	10.9	24.0	-13.1	37.70	12.13	0.71	39.66	26.82
55.84	9.1	24.0	-14.9	37.35	10.91	0.71	39.84	28.22
61.96	7.3	24.0	-16.7	37.50	9.14	0.73	40.09	30.22
70.80	7.9	24.0	-16.1	37.18	10.24	0.80	40.36	29.32
101.74	7.9	24.1	-16.2	36.77	11.15	0.90	40.91	28.86
107.86	8.5	24.7	-16.2	36.78	11.83	0.90	41.02	28.29
113.47	8.8	25.1	-16.3	36.45	12.51	0.92	41.05	27.62
117.04	8.7	25.4	-16.7	36.04	12.73	0.93	41.04	27.37
120.78	9.2	25.6	-16.4	36.33	12.98	0.95	41.02	27.09
126.22	9.3	26.0	-16.7	36.33	12.98	0.98	40.98	27.02

MPU5 - RF4100 - Lower C Band Card - Chassis 39628 - 4900MHz



Wed, Oct 02, 2019

10:52:09 AM

AutoScan 7.4.4.14

Res BW (kHz) 100

Vid BW (kHz) 50000

VERTICAL

EMCO 3109

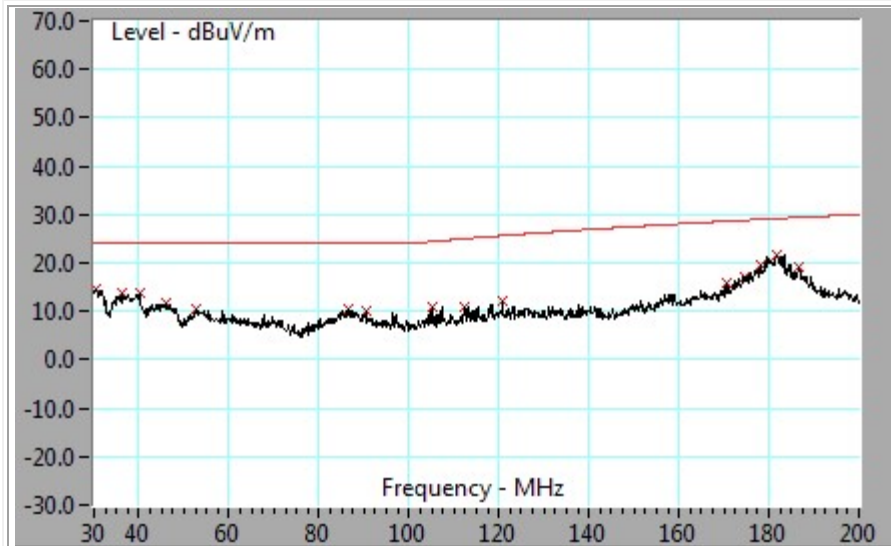
A.H. Systems PAM-0118P

Graph # 23

Sweep Time 60.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
30.00	14.5	24.0	-9.5	40.40	11.85	0.53	38.24	25.86
37.48	13.8	24.0	-10.2	39.62	12.41	0.61	38.81	25.79
45.81	13.1	24.0	-10.9	39.00	12.73	0.69	39.34	25.92
104.80	12.6	24.4	-11.8	41.21	11.47	0.90	40.97	28.60
108.54	14.7	24.7	-10.0	42.95	11.90	0.90	41.04	28.23
112.79	19.7	25.0	-5.3	47.42	12.44	0.91	41.05	27.70
162.43	15.2	28.2	-13.0	41.28	13.72	1.12	40.94	26.10
166.00	17.2	28.4	-11.2	43.34	13.70	1.10	40.98	26.18
170.76	20.2	28.6	-8.5	46.35	13.75	1.09	41.03	26.19
174.50	22.8	28.8	-6.1	48.87	13.84	1.11	41.06	26.11
178.24	25.6	29.0	-3.4	51.65	13.92	1.13	41.09	26.04
181.81	28.8	29.2	-0.4	54.57	14.15	1.15	41.11	25.81
185.72	25.5	29.4	-3.9	51.21	14.25	1.16	41.12	25.71
189.80	20.7	29.6	-8.8	46.17	14.53	1.17	41.13	25.44
195.41	17.6	29.8	-12.2	42.65	14.95	1.18	41.17	25.04

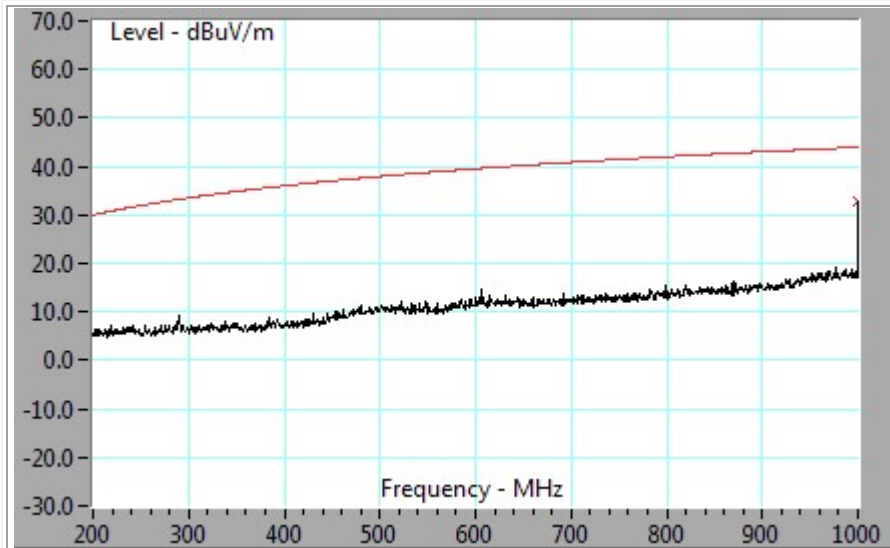
MPU5 - RF4100 - Lower C Band Card - Chassis 39628 - 4900MHz



Wed, Oct 02, 2019
10:56:37 AM
AutoScan 7.4.4.14
Res BW (kHz) 100
Vid BW (kHz) 50000
HORIZONTAL
EMCO 3109
A.H. Systems PAM-0118P
Graph # 24
Sweep Time 60.0000

Frequency MHz	Level dBuV/m	Limit dBuV/m	Delta dB	Raw dBuV	Ant. dB	Cable dB	Amp dB	All Factors dB
30.34	14.5	24.0	-9.5	39.87	12.34	0.54	38.27	25.39
36.12	13.7	24.0	-10.3	39.52	12.32	0.60	38.70	25.78
40.03	13.9	24.0	-10.1	40.10	12.15	0.61	39.00	26.24
45.81	11.6	24.0	-12.4	38.42	11.79	0.69	39.34	26.87
52.61	10.4	24.0	-13.6	37.91	11.51	0.71	39.70	27.48
86.44	10.3	24.0	-13.7	41.50	8.71	0.84	40.70	31.15
90.35	9.9	24.0	-14.1	40.82	9.04	0.86	40.77	30.88
105.31	11.1	24.4	-13.4	40.19	10.98	0.90	40.98	29.10
112.11	11.1	25.0	-13.9	38.95	12.26	0.91	41.06	27.88
120.78	12.1	25.6	-13.5	38.34	13.86	0.95	41.02	26.21
170.76	15.7	28.6	-12.9	41.59	14.08	1.09	41.03	25.86
174.50	17.2	28.8	-11.7	42.37	14.74	1.11	41.06	25.20
178.07	19.4	29.0	-9.6	44.15	15.25	1.13	41.09	24.71
181.81	21.8	29.2	-7.4	46.33	15.45	1.15	41.11	24.52
186.74	19.0	29.4	-10.4	43.64	15.33	1.16	41.12	24.63

System Check: 1GHz @ 34.82 dBuV



Wed, Oct 02, 2019

1:10:55 PM

AutoScan 7.4.4.14

Res BW (kHz) 100

Vid BW (kHz) 50000

VERTICAL

ETS 3106 Large Horn

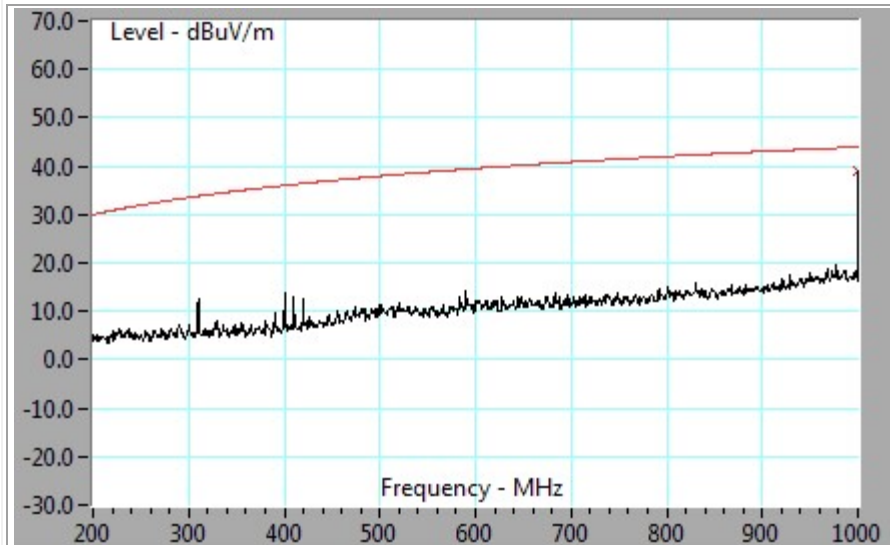
A.H. Systems PAM-0118P

Graph # 10

Sweep Time 45.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
1000.0	32.9	44.0	-11.0	49.09	22.82	2.47	41.45	16.16

System Check: 1GHz Stub Radiator



Wed, Oct 02, 2019

1:28:03 PM

AutoScan 7.4.4.14

Res BW (kHz) 100

Vid BW (kHz) 50000

VERTICAL

ETS 3106 Large Horn

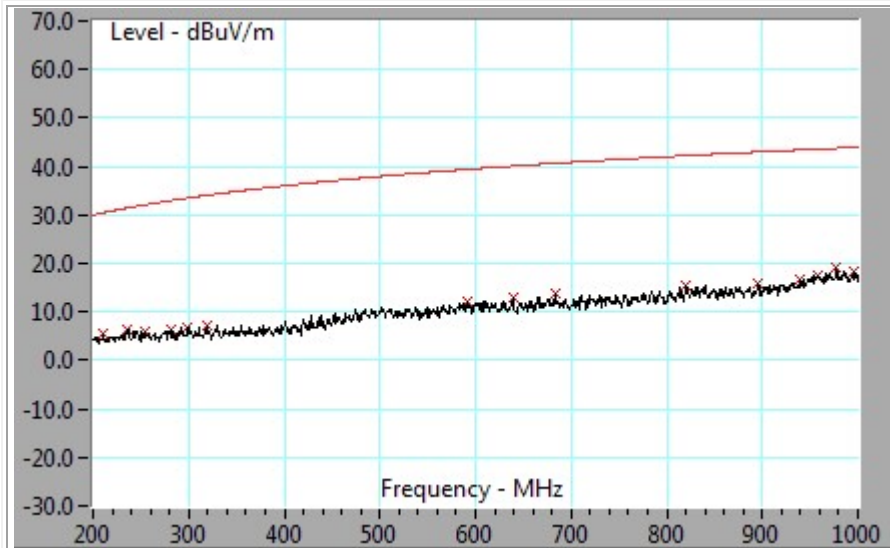
A.H. Systems PAM-0118P

Graph # 11

Sweep Time 45.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
1000.0	39.0	44.0	-4.9	55.19	22.82	2.47	41.45	16.16

System Check: Ambient



Wed, Oct 02, 2019

1:48:56 PM

AutoScan 7.4.4.14

Res BW (kHz) 100

Vid BW (kHz) 50000

HORIZONTAL

ETS 3106 Large Horn

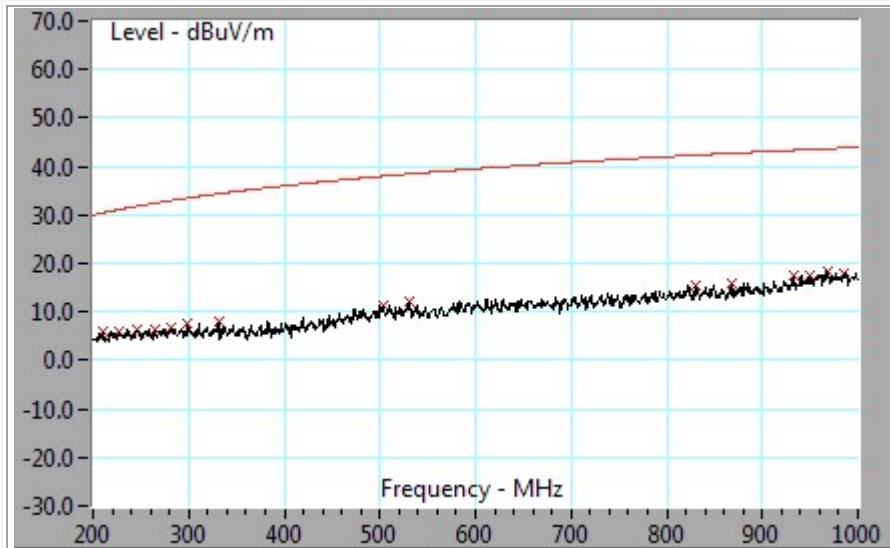
A.H. Systems PAM-0118P

Graph # 41

Sweep Time 45.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
210.40	5.5	30.4	-24.9	34.99	10.60	1.22	41.30	29.48
235.20	6.3	31.4	-25.1	35.23	11.16	1.28	41.39	28.95
254.40	5.9	32.1	-26.2	34.48	11.51	1.32	41.40	28.58
282.40	6.6	33.0	-26.4	34.84	12.01	1.38	41.68	28.29
299.20	6.7	33.5	-26.8	34.72	12.47	1.42	41.88	27.99
318.40	7.3	34.0	-26.7	35.12	12.80	1.46	42.06	27.80
591.20	12.3	39.4	-27.1	34.90	17.05	2.04	41.64	22.56
640.00	13.0	40.1	-27.0	35.35	17.25	2.09	41.65	22.32
684.00	13.7	40.7	-26.9	35.59	17.70	2.13	41.67	21.84
820.80	15.4	42.2	-26.9	35.08	19.33	2.28	41.31	19.70
895.20	16.0	43.0	-27.0	34.98	19.98	2.35	41.32	18.99
939.20	16.9	43.4	-26.5	34.32	21.53	2.40	41.36	17.43
958.40	17.7	43.6	-25.9	34.32	22.41	2.42	41.50	16.66
977.60	19.1	43.8	-24.7	35.04	23.11	2.45	41.50	15.94
996.00	18.4	43.9	-25.5	34.83	22.62	2.47	41.47	16.38

System Check: Ambient



Wed, Oct 02, 2019

1:53:32 PM

AutoScan 7.4.4.14

Res BW (kHz) 100

Vid BW (kHz) 50000

VERTICAL

ETS 3106 Large Horn

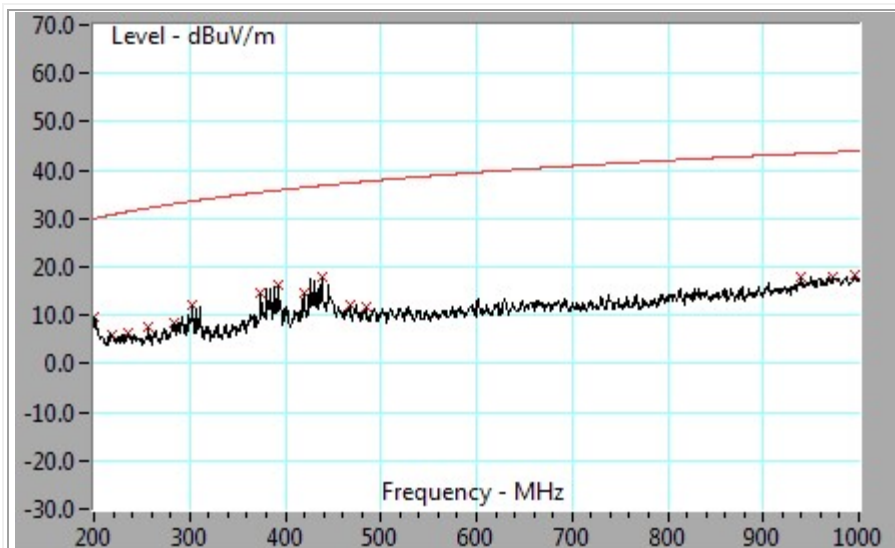
A.H. Systems PAM-0118P

Graph # 42

Sweep Time 45.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
210.40	5.7	30.4	-24.7	35.06	10.76	1.22	41.30	29.32
227.20	6.1	31.1	-25.0	35.07	11.17	1.27	41.38	28.94
245.60	6.2	31.8	-25.6	34.95	11.30	1.30	41.38	28.78
264.00	6.2	32.4	-26.2	34.64	11.75	1.34	41.52	28.43
280.80	7.0	32.9	-26.0	35.07	12.16	1.38	41.65	28.12
299.20	7.6	33.5	-25.9	35.61	12.41	1.42	41.88	28.05
332.80	7.8	34.4	-26.6	35.34	13.21	1.49	42.21	27.51
503.20	11.5	38.0	-26.5	34.98	16.38	1.84	41.67	23.45
530.40	12.3	38.5	-26.2	35.70	16.43	1.90	41.72	23.39
830.40	15.6	42.3	-26.8	35.14	19.46	2.29	41.30	19.55
867.20	15.8	42.7	-26.9	35.08	19.79	2.32	41.38	19.26
932.00	17.3	43.3	-26.0	35.06	21.29	2.39	41.41	17.73
949.60	17.4	43.5	-26.1	34.29	22.10	2.41	41.38	16.86
968.00	18.3	43.7	-25.4	34.64	22.77	2.44	41.57	16.37
985.60	18.1	43.8	-25.8	34.15	22.94	2.46	41.49	16.10

MPU5 - RF4100 - Lower C Band Card - Chassis 39628 - 4900MHz



Wed, Oct 02, 2019

2:00:55 PM

AutoScan 7.4.4.14

Res BW (kHz) 100

Vid BW (kHz) 50000

VERTICAL

ETS 3106 Large Horn

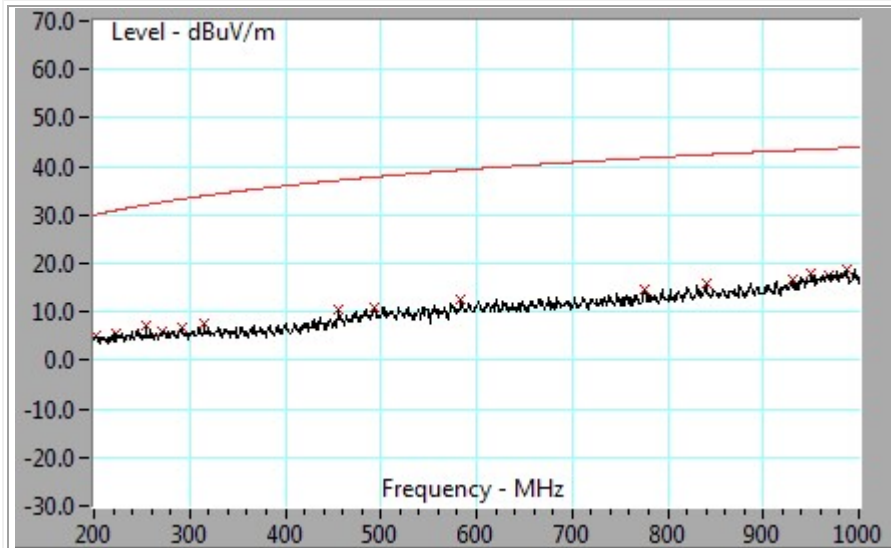
A.H. Systems PAM-0118P

Graph # 43

Sweep Time 45.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
200.00	9.5	30.0	-20.5	39.08	10.47	1.19	41.20	29.54
218.40	5.8	30.8	-25.0	34.98	10.98	1.24	41.38	29.17
236.00	6.2	31.4	-25.3	35.06	11.23	1.28	41.39	28.87
256.80	7.7	32.2	-24.5	36.27	11.53	1.32	41.43	28.57
284.00	8.2	33.0	-24.8	36.36	12.20	1.39	41.70	28.12
303.20	11.9	33.6	-21.7	39.92	12.51	1.44	41.93	27.98
374.40	14.7	35.4	-20.7	41.97	13.45	1.57	42.25	27.23
392.00	16.3	35.8	-19.5	43.31	13.57	1.61	42.17	26.99
420.00	14.7	36.4	-21.7	41.06	13.89	1.74	41.99	26.35
438.40	17.9	36.8	-18.9	43.73	14.35	1.76	41.89	25.79
467.20	12.3	37.4	-25.0	36.71	15.57	1.79	41.72	24.37
484.00	11.8	37.7	-25.9	35.59	16.11	1.80	41.73	23.83
939.20	18.0	43.4	-25.4	35.37	21.62	2.40	41.36	17.34
973.60	17.9	43.7	-25.8	34.04	22.97	2.44	41.54	16.13
996.80	18.2	43.9	-25.7	34.37	22.85	2.47	41.46	16.15

MPU5 - RF4100 - Lower C Band Card - Chassis 39628 - 4900MHz



Wed, Oct 02, 2019

2:05:29 PM

AutoScan 7.4.4.14

Res BW (kHz) 100

Vid BW (kHz) 50000

HORIZONTAL

ETS 3106 Large Horn

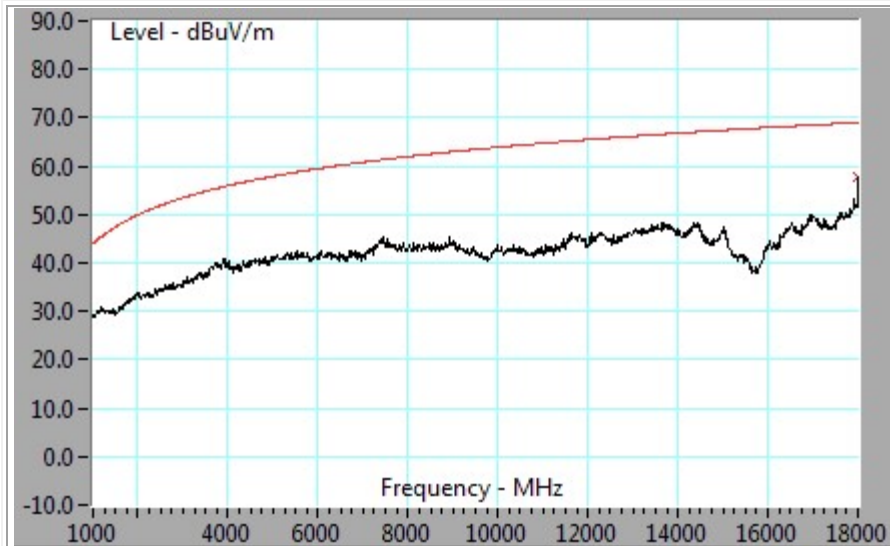
A.H. Systems PAM-0118P

Graph # 44

Sweep Time 45.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
201.60	5.1	30.1	-25.0	34.72	10.38	1.20	41.21	29.64
224.00	5.5	31.0	-25.4	34.74	10.94	1.25	41.39	29.20
254.40	7.2	32.1	-24.9	35.79	11.51	1.32	41.40	28.58
271.20	5.9	32.6	-26.7	34.42	11.75	1.36	41.62	28.50
291.20	6.9	33.3	-26.4	35.02	12.25	1.40	41.81	28.16
315.20	7.5	33.9	-26.5	35.29	12.75	1.47	42.04	27.83
456.00	10.3	37.1	-26.9	35.19	15.08	1.76	41.73	24.90
492.80	11.1	37.8	-26.8	34.78	16.14	1.81	41.68	23.72
584.00	12.8	39.3	-26.5	35.55	16.88	2.02	41.68	22.78
775.20	14.8	41.7	-26.9	35.63	18.43	2.23	41.46	20.80
840.00	15.9	42.4	-26.6	35.36	19.54	2.30	41.32	19.49
931.20	16.6	43.3	-26.8	34.41	21.17	2.39	41.42	17.85
949.60	17.8	43.5	-25.7	34.75	22.00	2.41	41.38	16.96
968.00	17.4	43.7	-26.2	33.70	22.86	2.44	41.57	16.28
987.20	18.7	43.8	-25.1	34.92	22.85	2.46	41.49	16.18

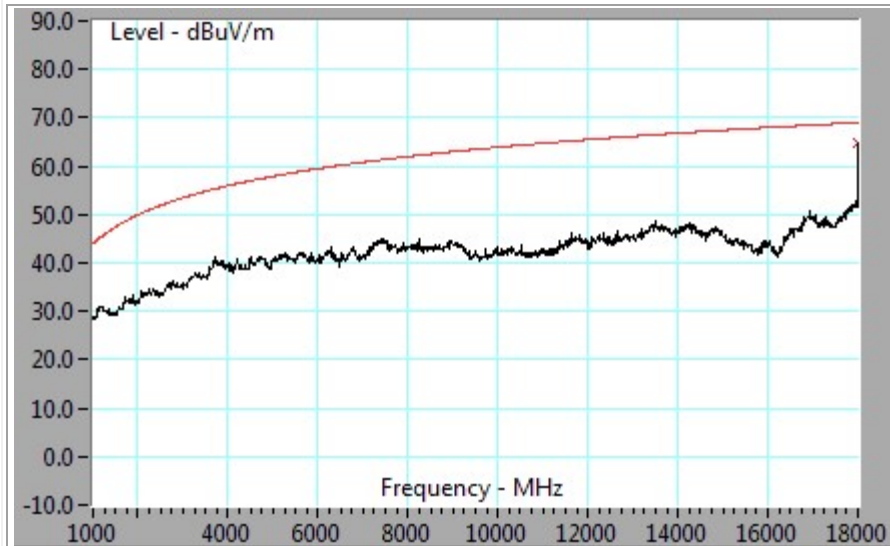
System Check: 18GHz @ 60.5 dBuV



Wed, Oct 02, 2019
3:24:56 PM
AutoScan 7.4.4.14
Res BW (kHz) 1000
Vid BW (kHz) 50000
HORIZONTAL
EMCO 3115
A.H. Systems PAM-0118P
Graph # 15
Sweep Time 60.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
18000.0	57.8	69.0	-11.2	39.92	48.50	12.60	43.26	-17.84

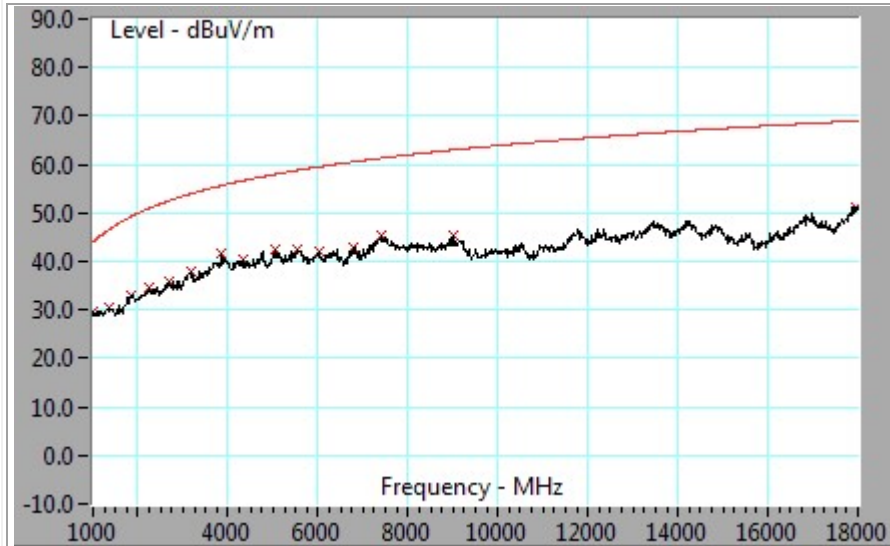
System Check: Stub Radiator @ 18GHz



Thu, Oct 03, 2019
8:43:13 AM
AutoScan 7.4.4.14
Res BW (kHz) 1000
Vid BW (kHz) 50000
HORIZONTAL
EMCO 3115
A.H. Systems PAM-0118P
Graph # 2
Sweep Time 60.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
18000.0	65.0	69.0	-4.0	47.13	48.50	12.60	43.26	-17.84

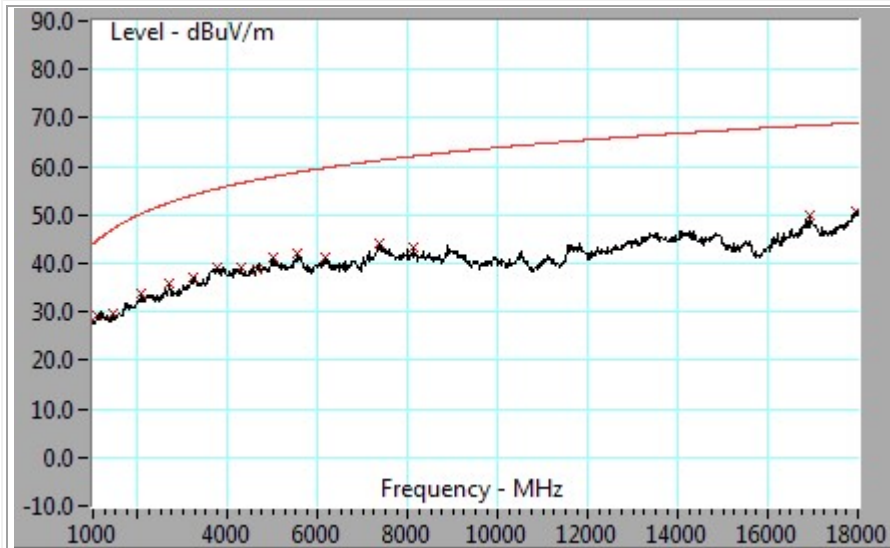
System Check: Ambient



Thu, Oct 03, 2019
9:00:56 AM
AutoScan 7.4.4.14
Res BW (kHz) 1000
Vid BW (kHz) 50000
HORIZONTAL
EMCO 3115
A.H. Systems PAM-0118P
Graph # 68
Sweep Time 60.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
1000.0	29.8	44.0	-14.1	43.88	24.90	2.47	41.45	14.08
1374.0	30.3	46.7	-16.4	42.64	26.15	2.91	41.37	12.31
1867.0	33.0	49.4	-16.4	42.42	28.44	3.30	41.15	9.42
2224.0	34.5	50.9	-16.4	43.04	28.90	3.71	41.17	8.56
2683.0	35.7	52.5	-16.8	42.87	30.33	4.14	41.63	7.16
3159.0	37.8	53.9	-16.2	43.16	32.15	4.36	41.93	5.41
3856.0	41.6	55.6	-14.0	44.59	34.29	4.91	42.19	2.98
4332.0	40.3	56.7	-16.3	43.74	33.50	5.83	42.73	3.39
5029.0	42.7	58.0	-15.3	44.12	35.10	5.83	42.39	1.46
5539.0	42.7	58.8	-16.1	43.20	35.92	5.74	42.21	0.55
6015.0	41.9	59.5	-17.6	42.01	36.26	6.20	42.61	0.15
6797.0	42.9	60.6	-17.7	40.21	37.39	7.19	41.91	-2.67
7426.0	45.5	61.3	-15.8	40.81	38.80	7.22	41.32	-4.70
9024.0	45.5	63.0	-17.6	39.47	39.60	8.81	42.43	-5.99
17966.0	51.3	69.0	-17.6	33.78	48.50	12.50	43.43	-17.57

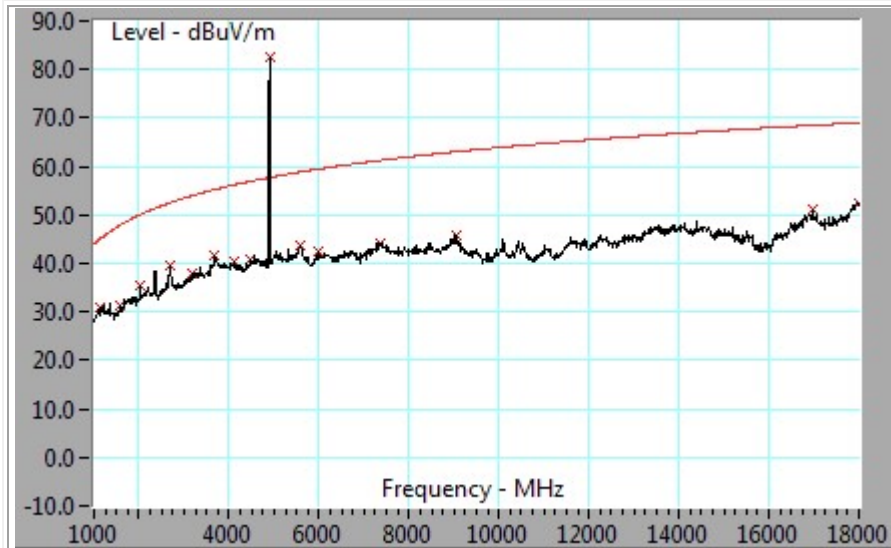
System Check: Ambient



Thu, Oct 03, 2019
9:08:33 AM
AutoScan 7.4.4.14
Res BW (kHz) 1000
Vid BW (kHz) 50000
VERTICAL
EMCO 3115
A.H. Systems PAM-0118P
Graph # 70
Sweep Time 60.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
1085.0	29.4	44.7	-15.2	43.38	24.75	2.53	41.22	13.94
1442.0	29.7	47.1	-17.4	43.02	25.18	2.94	41.43	13.31
2071.0	33.7	50.3	-16.6	43.42	28.04	3.59	41.36	9.73
2700.0	35.8	52.6	-16.7	44.13	29.20	4.16	41.67	8.31
3244.0	37.2	54.2	-16.9	43.30	31.48	4.35	41.90	6.07
3771.0	39.2	55.5	-16.2	43.69	33.04	4.74	42.25	4.47
4281.0	39.1	56.6	-17.4	43.25	32.66	5.78	42.57	4.13
4638.0	38.8	57.2	-18.4	42.73	33.05	5.76	42.73	3.92
4995.0	41.1	57.9	-16.8	43.50	34.09	5.83	42.34	2.42
5556.0	41.9	58.8	-16.9	43.46	34.82	5.75	42.09	1.51
6168.0	41.1	59.7	-18.7	41.64	35.40	6.47	42.46	0.59
7375.0	44.2	61.3	-17.1	40.76	37.70	7.23	41.48	-3.46
8123.0	43.1	62.1	-19.0	39.62	37.84	7.75	42.06	-3.52
16946.0	49.7	68.5	-18.8	38.32	42.20	12.35	43.15	-11.40
17966.0	50.8	69.0	-18.1	34.18	47.60	12.50	43.43	-16.66

MPU5 - RF4100 - Lower C Band Card - Chassis 39628 - 4900MHz

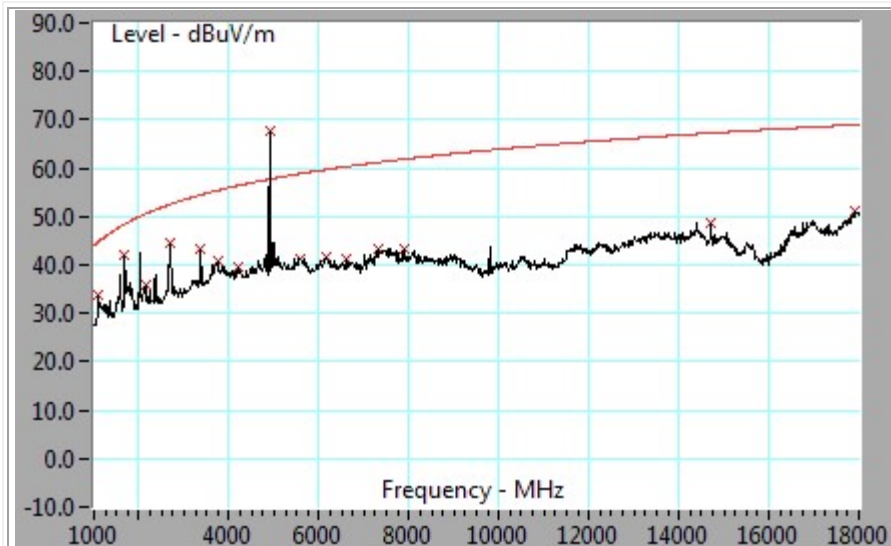


Thu, Oct 03, 2019
9:20:37 AM
AutoScan 7.4.4.14
Res BW (kHz) 1000
Vid BW (kHz) 50000
HORIZONTAL
EMCO 3115
A.H. Systems PAM-0118P
Graph # 72
Sweep Time 60.0000

Frequency	Level	Limit	Delta	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	dBuV	dB	dB	dB	dB
1153.0	30.9	45.2	-14.2	43.72	25.83	2.63	41.24	12.78
1595.0	31.1	48.0	-16.9	42.79	26.57	3.08	41.29	11.64
2020.0	35.4	50.0	-14.6	44.47	28.66	3.55	41.26	9.05
2683.0	39.7	52.5	-12.8	46.90	30.33	4.14	41.63	7.16
3176.0	38.1	54.0	-15.8	43.45	32.26	4.36	41.92	5.31
3686.0	41.6	55.3	-13.6	45.31	33.42	4.68	41.76	3.67
4111.0	40.5	56.2	-15.7	43.98	33.60	5.45	42.52	3.47
4485.0	40.8	57.0	-16.1	43.46	33.97	6.00	42.61	2.64
4910.0	82.5	N/A	N/A	* 84.96	34.90	5.74	43.13	2.50
5590.0	43.8	58.9	-15.1	43.96	35.90	5.79	41.84	0.15
5998.0	42.5	59.5	-17.0	42.70	36.20	6.18	42.55	0.18
7358.0	44.2	61.2	-17.1	39.79	38.82	7.24	41.65	-4.40
9058.0	45.7	63.0	-17.3	39.92	39.58	8.72	42.47	-5.83
16963.0	51.2	68.5	-17.3	38.75	43.26	12.33	43.17	-12.42
18000.0	52.5	69.0	-16.5	34.67	48.50	12.60	43.26	-17.84

* 4910.0 MHz is the EUT fundamental operating frequency. RE102 limits are not applicable.

MPU5 - RF4100 - Lower C Band Card - Chassis 39628 - 4900MHz



Thu, Oct 03, 2019
9:25:10 AM
AutoScan 7.4.4.14
Res BW (kHz) 1000
Vid BW (kHz) 50000
VERTICAL
EMCO 3115
A.H. Systems PAM-0118P
Graph # 73
Sweep Time 60.0000

Frequency MHz	Level dBuV/m	Limit dBuV/m	Delta dB		Raw dBuV	Ant. dB	Cable dB	Amp dB	All Factors dB
1085.0	33.6	44.7	-11.0		47.58	24.75	2.53	41.22	13.94
1680.0	42.2	48.4	-6.2		54.18	26.22	3.17	41.37	11.98
2139.0	35.9	50.5	-14.7		45.60	27.94	3.64	41.29	9.71
2683.0	44.5	52.5	-8.0		52.91	29.13	4.14	41.63	8.36
3363.0	43.5	54.5	-11.0		49.17	31.65	4.48	41.84	5.71
3754.0	40.6	55.4	-14.8		45.07	33.01	4.70	42.13	4.42
4213.0	39.5	56.4	-16.9		43.46	32.60	5.67	42.23	3.96
4910.0	67.5	N/A	N/A	*	71.00	33.92	5.74	43.13	3.48
5573.0	41.3	58.8	-17.5		42.62	34.89	5.77	41.96	1.30
6151.0	41.8	59.7	-17.9		42.57	35.40	6.44	42.59	0.74
6593.0	41.4	60.3	-18.9		41.28	35.67	6.95	42.53	-0.10
7307.0	43.3	61.2	-17.9		40.60	37.61	7.25	42.19	-2.67
7902.0	43.4	61.9	-18.5		40.75	37.60	7.63	42.62	-2.61
14702.0	48.8	67.2	-18.4		38.98	41.79	10.07	42.00	-9.87
17915.0	51.3	69.0	-17.6		35.12	47.57	12.34	43.69	-16.22

* 4910.0 MHz is the EUT fundamental operating frequency. RE102 limits are not applicable.

5.1.7 RE102 Photographs



01 - System Check, Calibrated Signal 2 MHz - 30 MHz



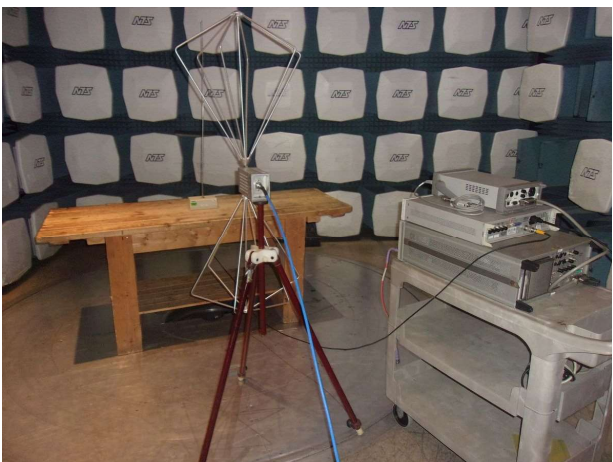
02 - System Check, Stub Radiator 30MHz



03 - EUT Scan, 2 MHz -30 MHz



04 - System Check, Calibrated Signal @ 200 MHz



05 - System Check, Stub Radiator @ 200 MHz



06 - EUT Scan, 30 MHz - 200 MHz, Horizontal



07 - EUT Scan, 30 MHz - 200 MHz, Vertical



08 - System Check, Calibrated Signal @ 1 GHz



09 - System Check, Stub Radiator @ 1 GHz



10 - EUT Scan, 200 MHz - 1 GHz, Horizontal



11 - EUT Scan, 200 MHz - 1 GHz, Vertical



12 - System Check, Calibrated Signal @ 18 GHz



13 - System Check, Stub Radiator @ 18 GHz



14 - EUT Scan, 1 GHz - 18 GHz, Horizontal



15 - EUT Scan, 1 GHz - 18 GHz, Vertical

5.1.8 RE102 Test Equipment

Table RE102-5: RE102 Test Equipment List

Asset No.	Manufacturer	Item	Model	S/N	Cal Cycle (Months)	Cal. Due
WC024135	Agilent	MXE EMI Receiver	N9038A	MY51210117	12	8/6/20
WC005829	ETS-Lindgren	Active Rod Antenna	3301C	00114485	12	10/15/20
WC006573	EMCO	Biconical Antenna	3109	9411-2853	36	3/9/20
WC005310	ETS-Lindgren	Large Horn Antenna	3106	35382	36	3/9/20
WC005297	ETS-Lindgren	Horn Antenna	3115	2328	36	9/15/20
WC005615	A.H. Systems	Preamplifier	PAM-0118P	393	12	10/5/19
WC058460	Pasternack	Preamplifier	PE15A1012	V00140120190430G59	12	7/19/20
WC024134	Winchester	50 Ohm Coaxial Cable	250-250-3803600	AR3	24	3/15/21
WC005733	NTS	Stub Radiator	MIL-STD-461 Stub Radiator	None	NCR	NCR
WC005477	Marconi	Signal Generator	2023	112253/143	12	5/7/20
WC005556	Agilent	Signal Generator	8372B	US34490403	12	5/7/20

NCR = No Calibration Required; as per NTS QA policy, the equipment does not require calibration as long as the test signal being generated can be verified with other calibrated equipment prior to or during the test.

5.2 Method RS101: Radiated Susceptibility, Magnetic Field

This requirement is applicable from 30 Hz to 100 kHz for equipment and subsystem enclosures, including electrical cable interfaces. The requirement is not applicable for electromagnetic coupling via antennas.

5.2.1 RS101 Purpose

This test procedure is used to verify the ability of the EUT to withstand radiated magnetic fields.

5.2.2 RS101 Limits

The EUT shall not exhibit any malfunction, degradation of performance, or deviation from specified indications, beyond the tolerances indicated in the individual equipment or subsystem specification, when subjected to the magnetic fields shown on Figure RS101-1.

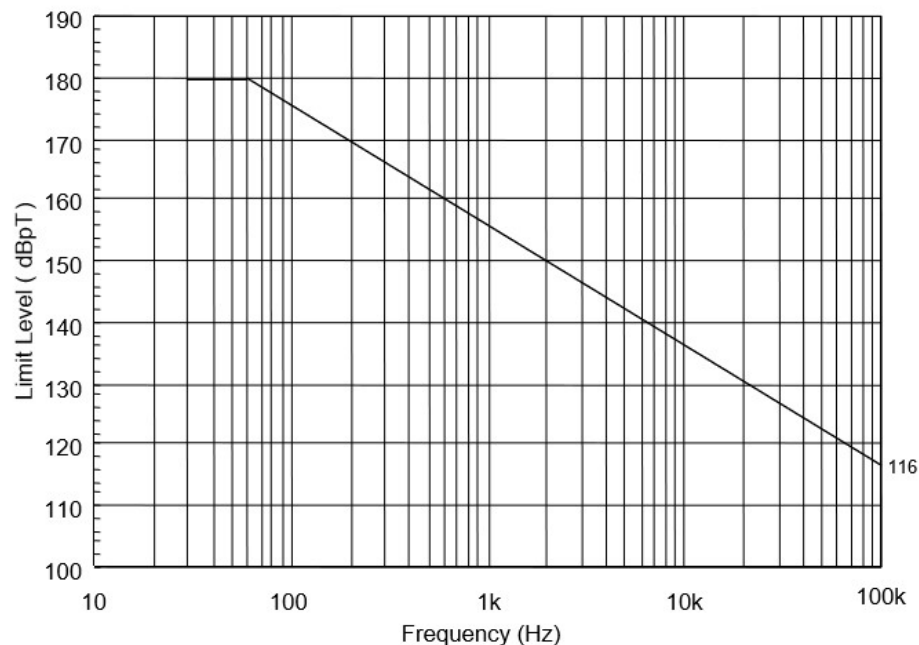


Figure RS101-1: RS101 limit for all Army applications.

5.2.3 RS101 Calibration

This procedure was performed prior to the start of testing, to assure that the overall system is operating properly.

1. Configure the measurement equipment, radiating loop, and loop sensor as shown in Figure RS101-2.
2. Set the signal source to a frequency of 1 kHz and adjust the output current to generate a magnetic flux density of 110 dB above one picotesla as determined by the reading obtained on measurement receiver A.
3. Measure the voltage output from the loop sensor using measurement receiver B.
4. Verify that the output on measurement receiver B is within ± 3 dB of the expected value based on the antenna factor and record this value.
5. Set the signal source to a frequency of 30Hz and adjust the output current to generate a magnetic flux density of 10dBpT above the applicable limit.
6. Record the current required to achieve the required field.
7. Repeat Steps 5 and 6 for each frequency between 30Hz and 100kHz, using the step size defined in Table 4.5-1.

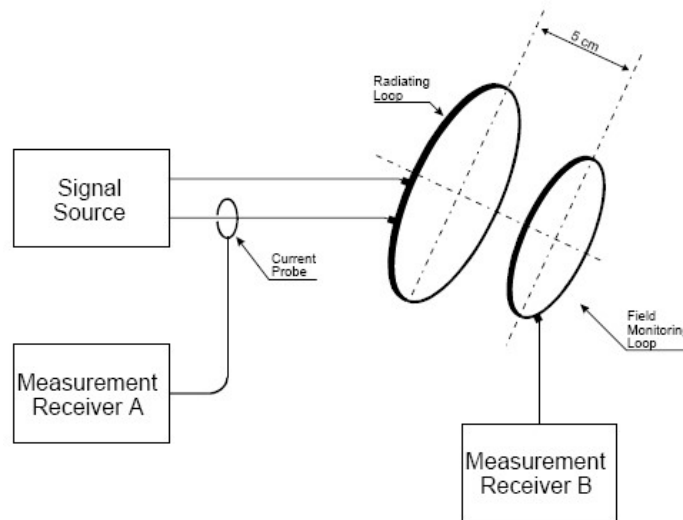


Figure RS101-2: Calibration of the radiating system.

5.2.4 RS101 EUT Test Setup

The EUT was setup in accordance with Section 3.2, Figure 3.2-1, 4.3-1 and operated according to Section 3.3.

5.2.5 RS101 Test Procedure

1. The plane of the transmitting loop was placed 5 cm from and oriented parallel to each of the EUT faces and parallel to the axis of connectors (refer to test data and photos for details).
2. While monitoring the EUT for susceptibility, the loop was supplied with the calibrated current levels required to produce magnetic field strengths indicated on the calibration sheet (applicable limit +10dBpT). The frequency range of 30Hz – 100KHz was swept using the step sizes specified in Table 4.5-1.

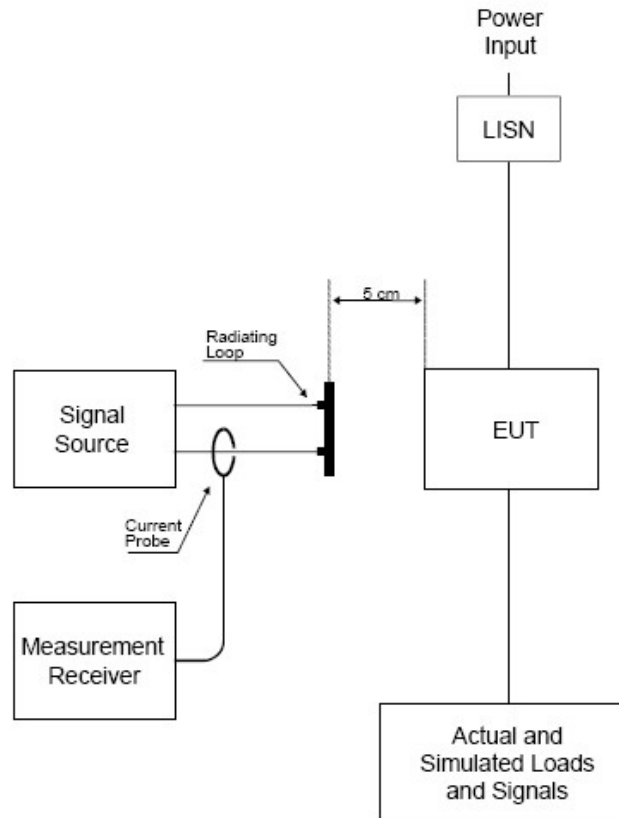


Figure RS101-3: RS101 Basic test setup.

5.2.6 RS101 Test Data

RS101 Data Sheet

Job Number:	PR107729	Standard:	MIL-STD-461F
Date:	11/6/19	Procedure:	None
Manufacturer:	Persistent Systems LLC	EUT:	MPU5 Radio with RF-4100 Lower C-Band Card
Model Number:	WR-5100, RF-4100	S/N:	31628
Input Power	Battery	Test Personnel:	Tristian Gaines

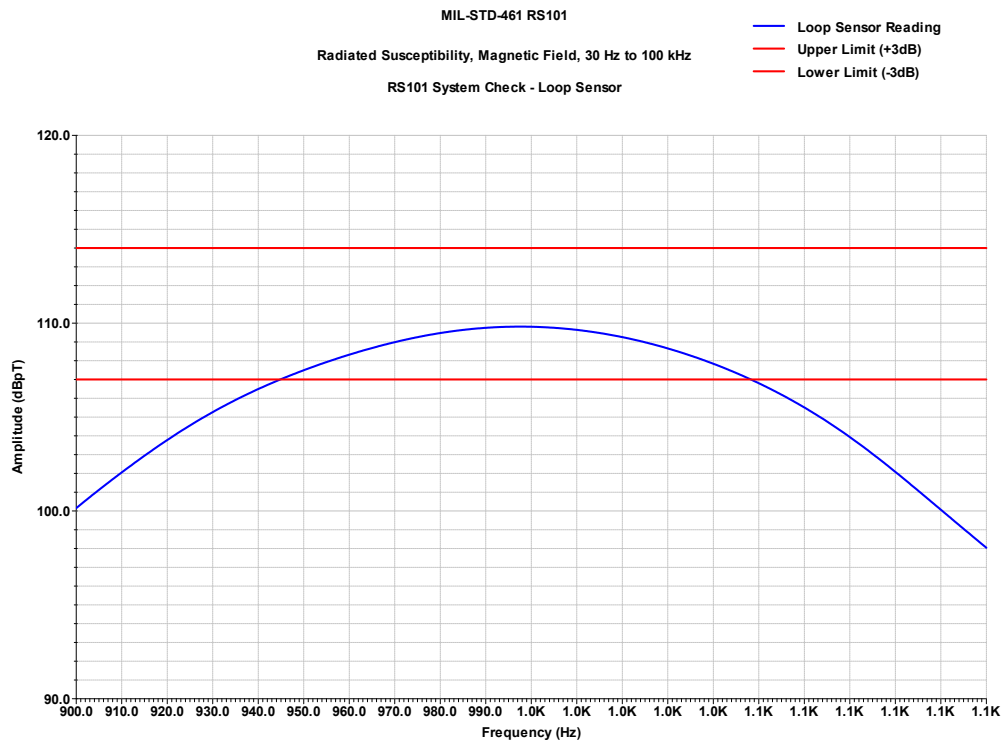
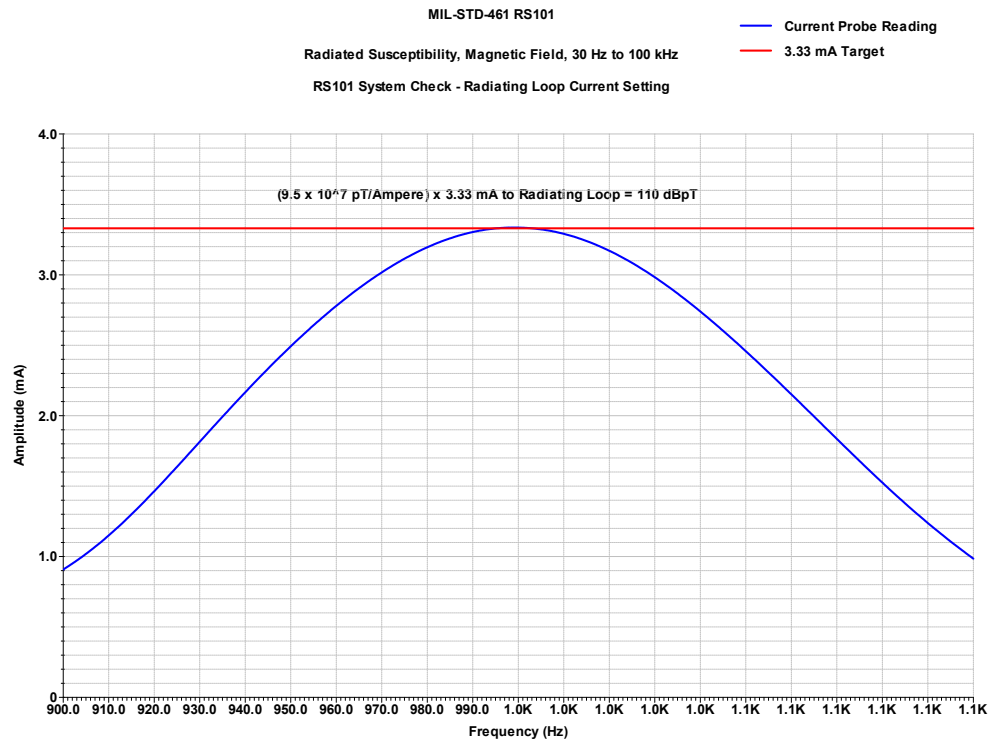
RS101 Specification Limits:

Signal Applied	Test Specification Limit	Susceptibility Criteria
Magnetic Field	30Hz – 60Hz: 180dBpT 60Hz – 100kHz: 180 – 116dBpT (RS101-2 Army)	The EUT was monitored for any degradation in performance according to Section 3.4.

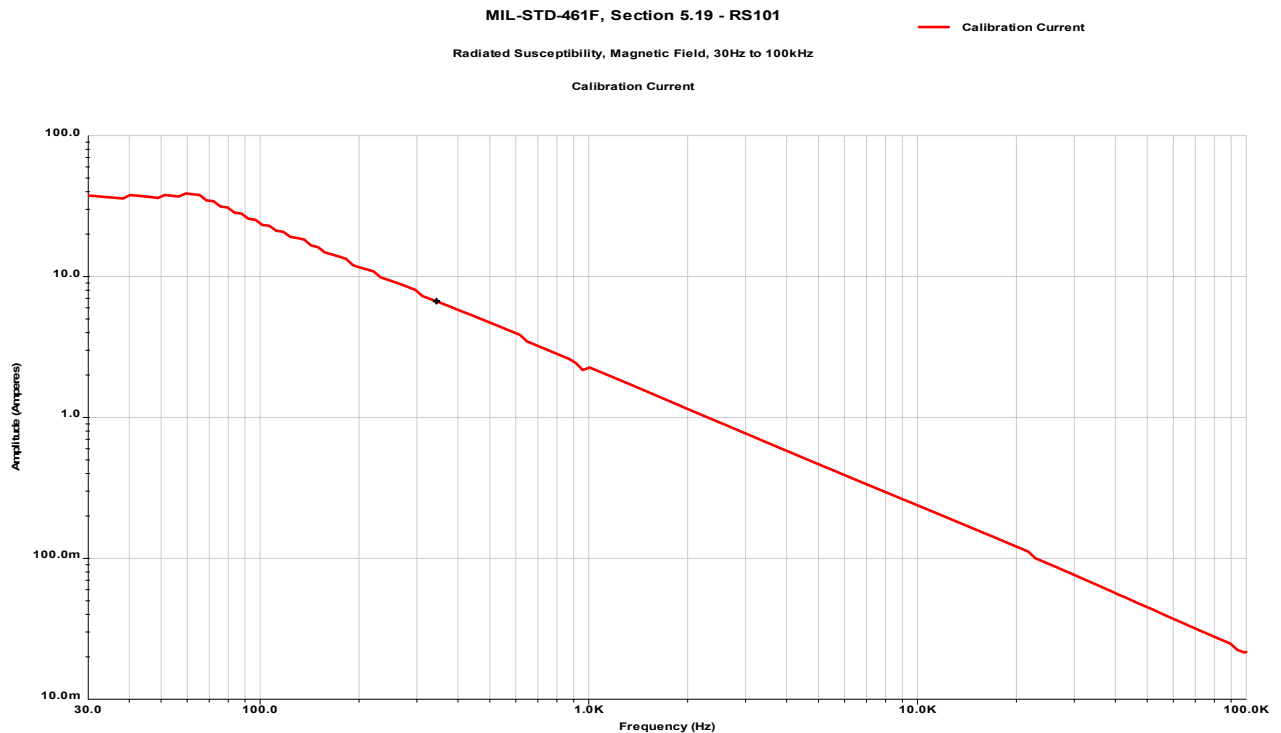
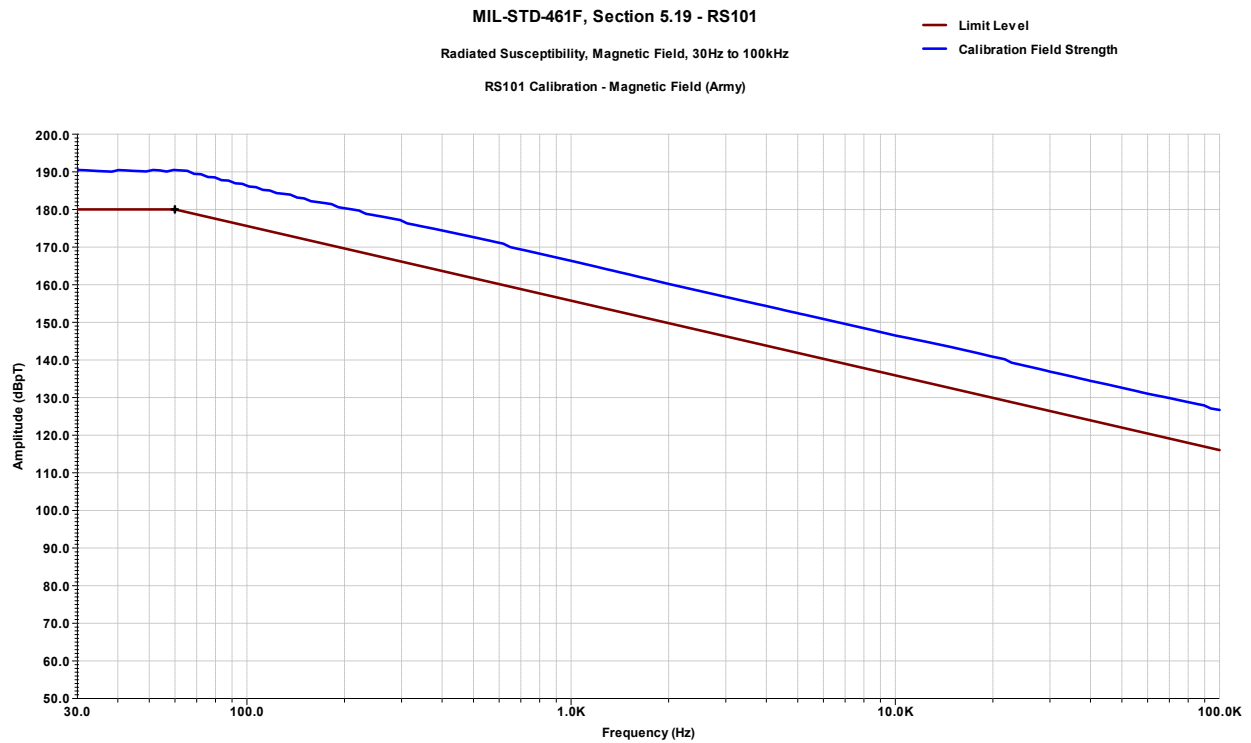
RS101 Test Results:

Probe Position	Level (dBpT)	EUT Abnormalities	Results (Pass/Fail)
Front Side	Limit +10dB	None	PASS
Back Side	Limit +10dB	None	PASS
Right Side	Limit +10dB	None	PASS
Left Side	Limit +10dB	None	PASS
Bottom	Limit +10dB	None	PASS
Top	Limit +10dB	None	PASS
Antennas	Limit +10dB	None	PASS

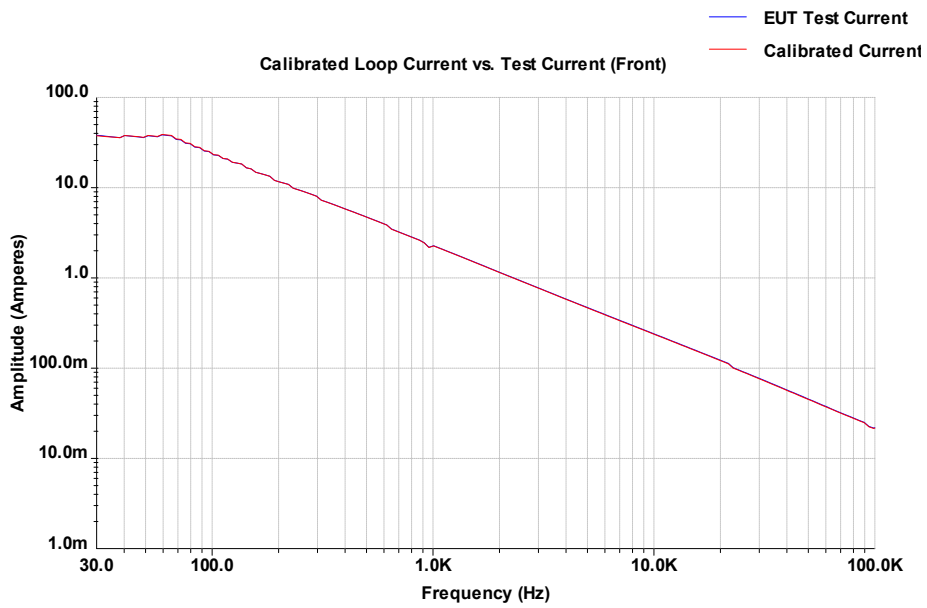
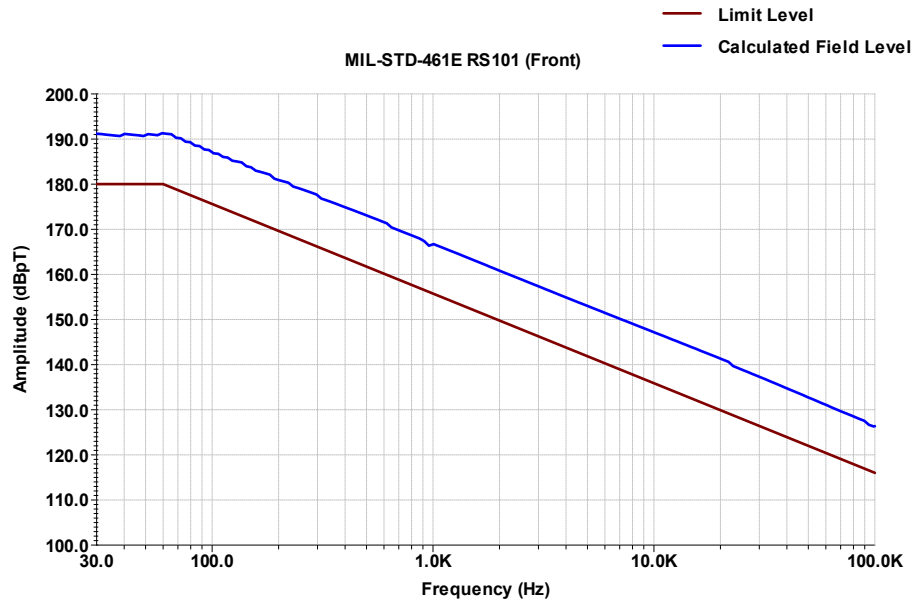
RS101 System Check Graphs

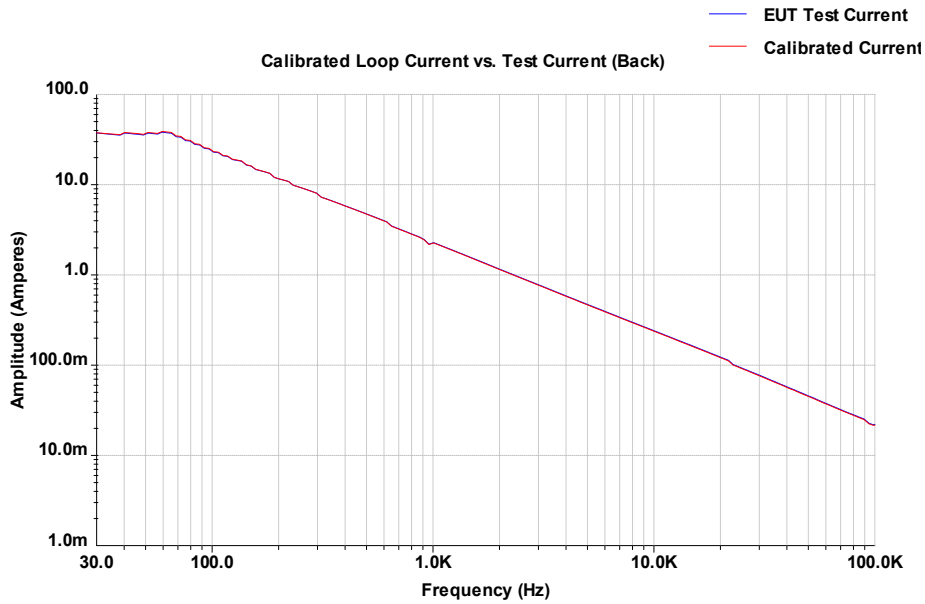
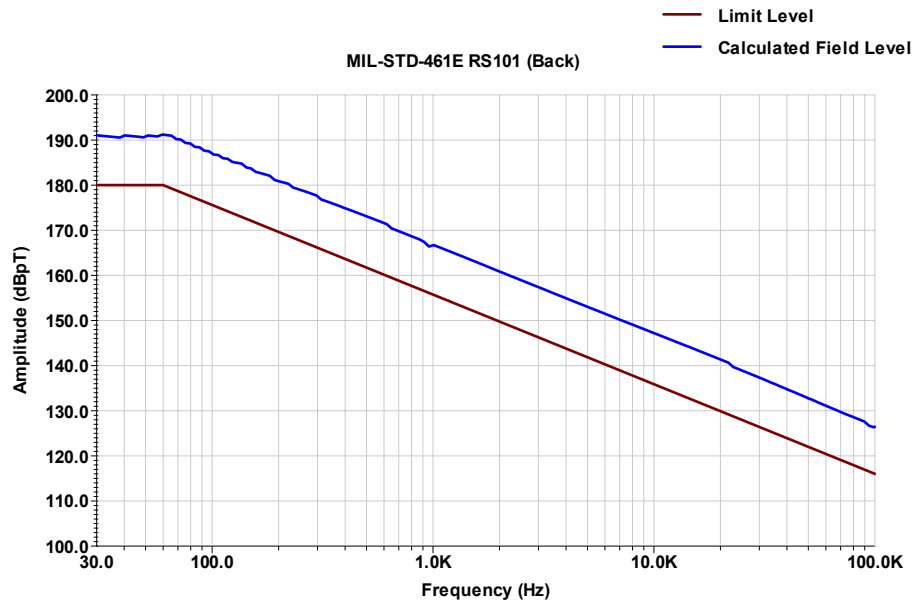


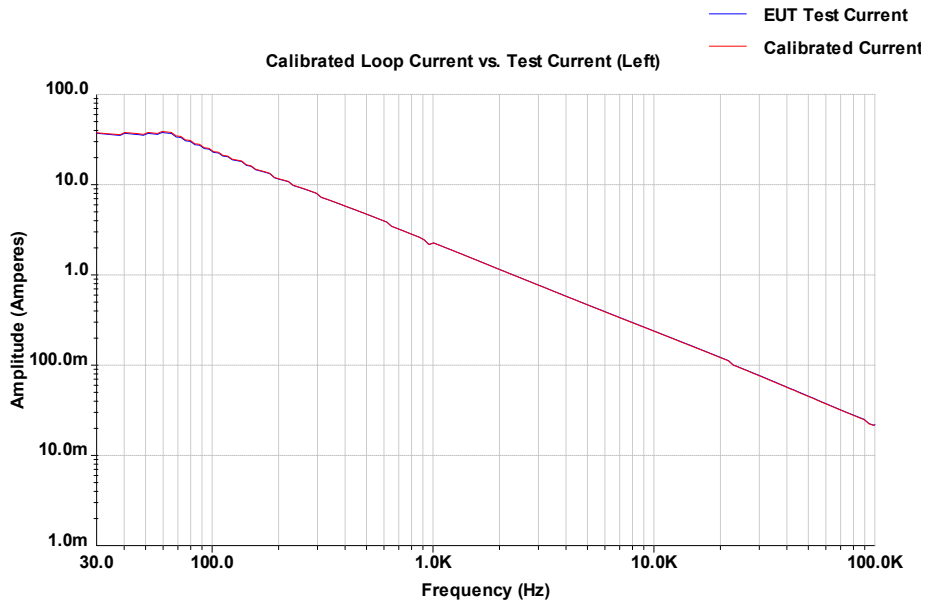
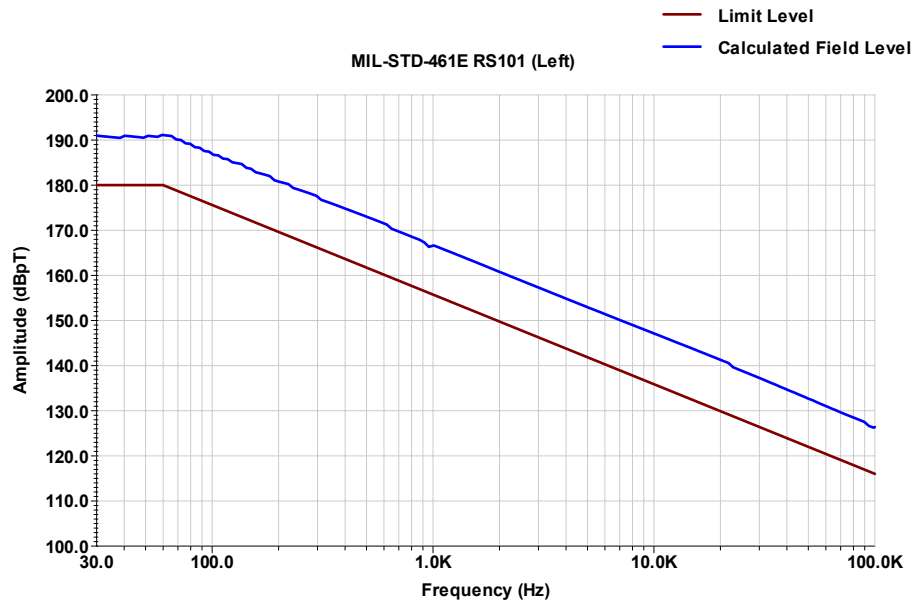
RS101 Calibration Graphs

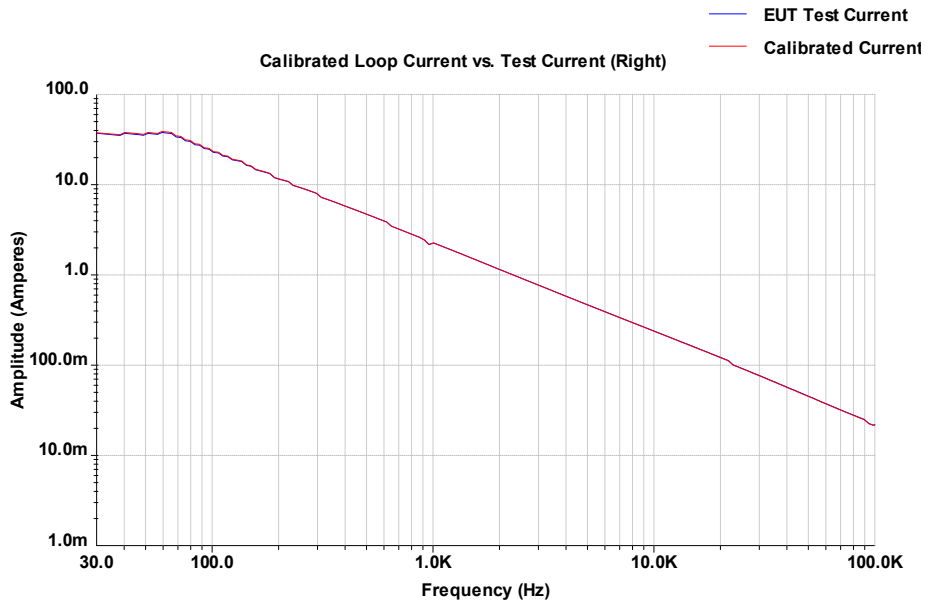
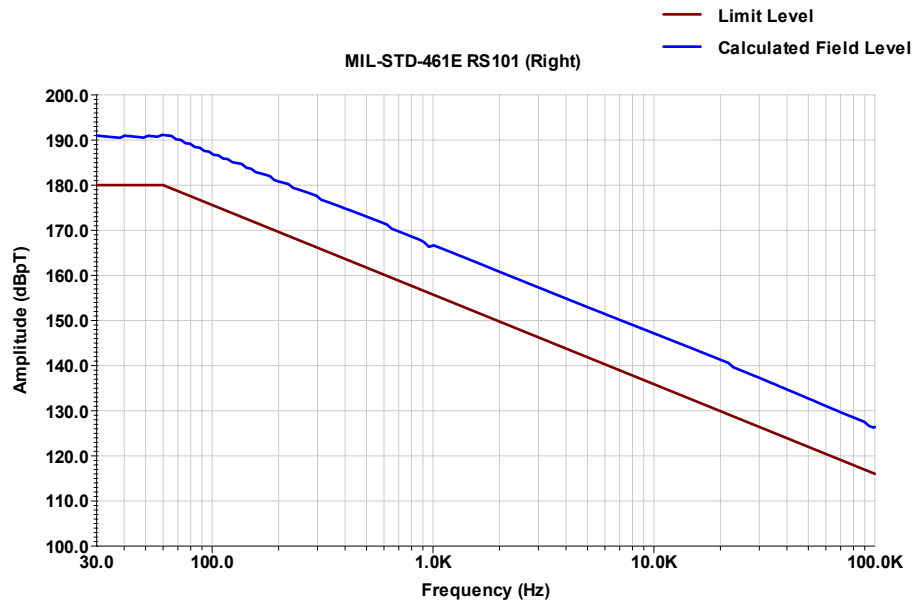


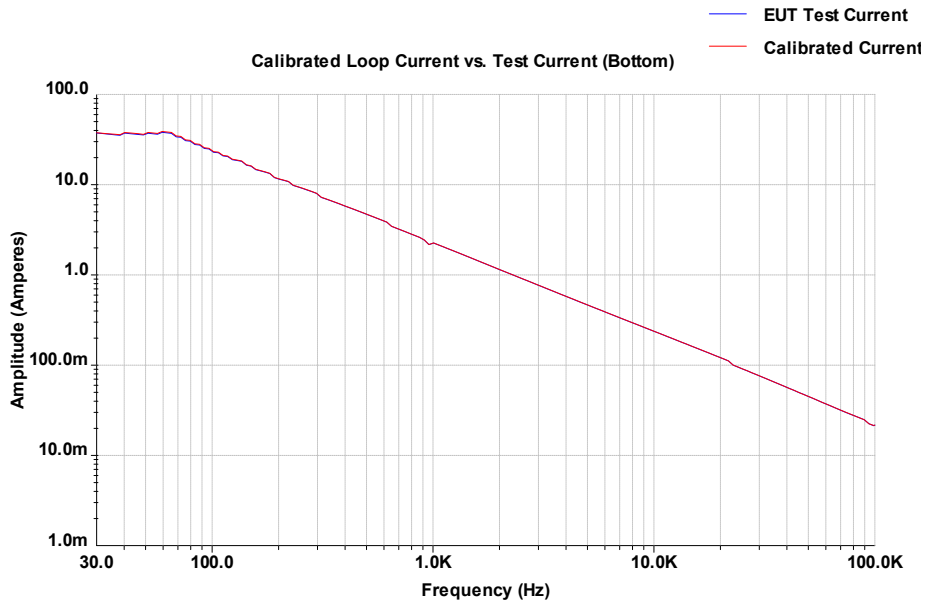
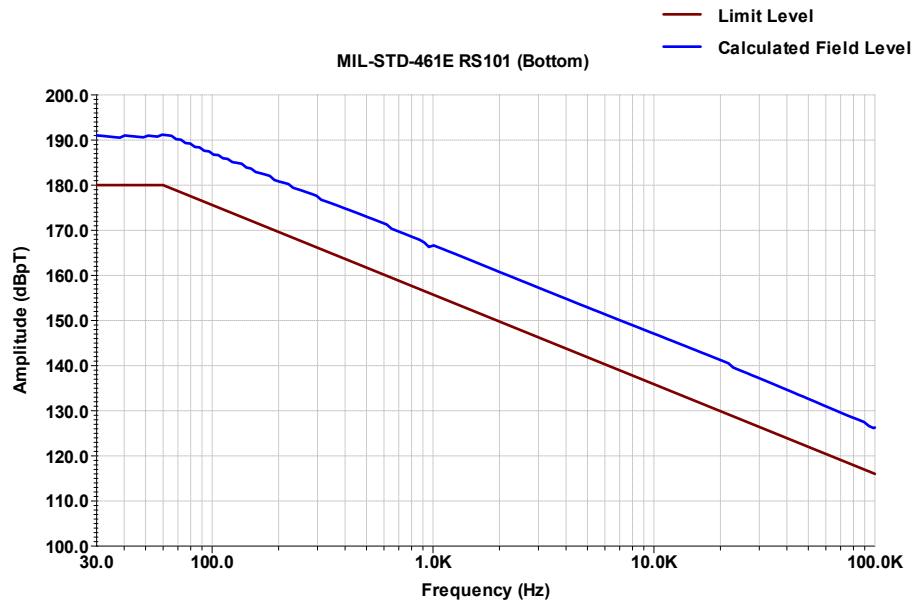
RS101 Test Graphs

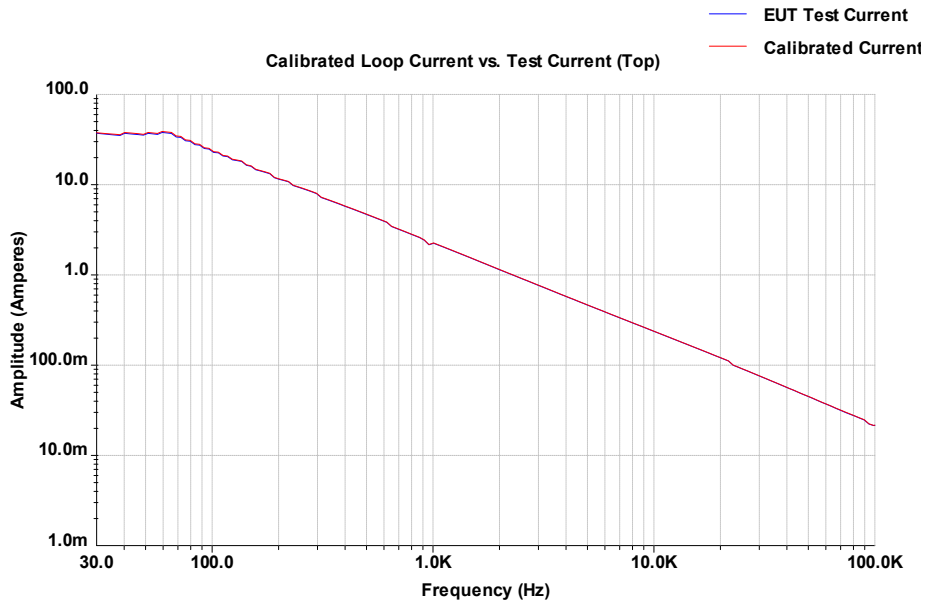
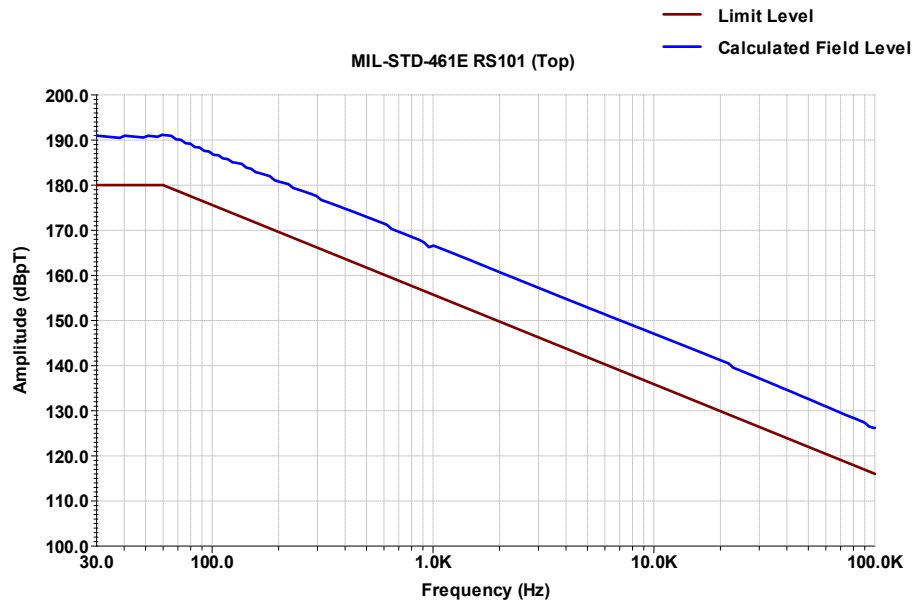




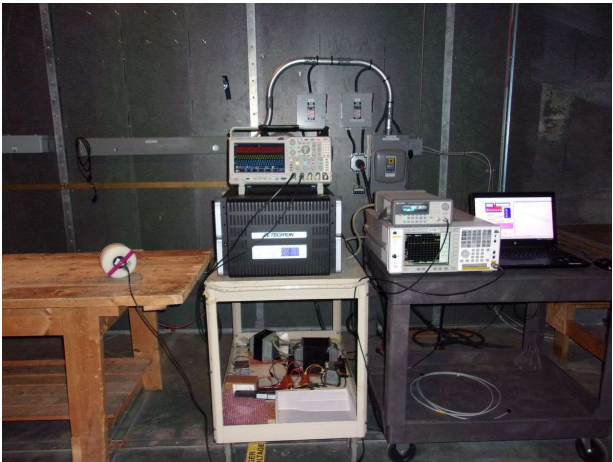








5.2.7 RS101 Test Photographs



RS101 Calibration



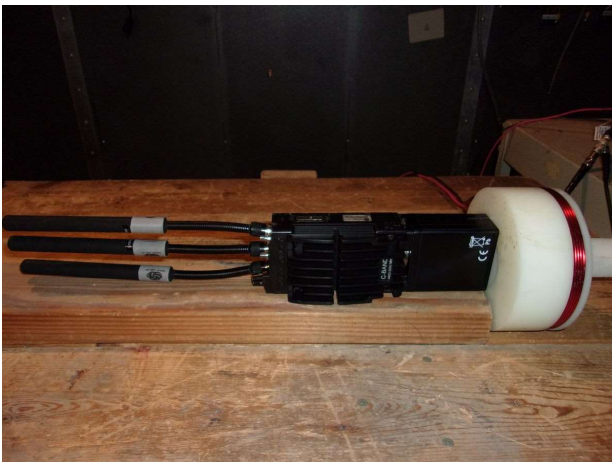
RS101 General Test Setup



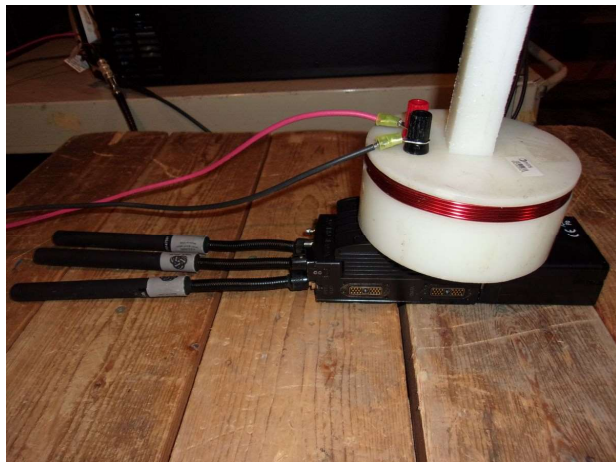
RS101 Test - Antennas



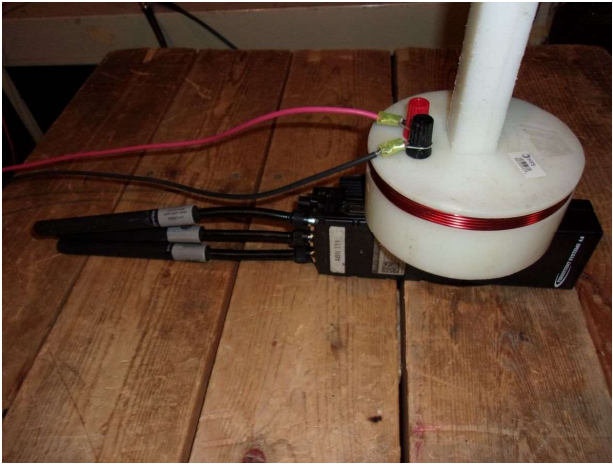
RS101 Test - Back



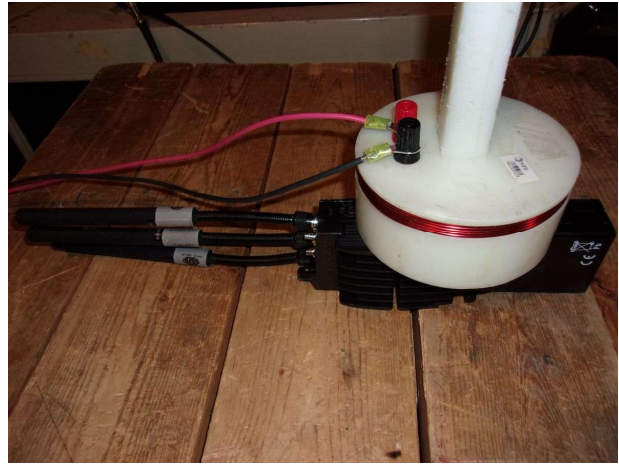
RS101 Test - Bottom



RS101 Test - Front



RS101 Test - Left



RS101 Test - Right



RS101 Test - Top



5.2.8 RS101 Test Equipment

Table RS101-1: RS101 Test Equipment List

Asset No.	Manufacturer	Item	Model	S/N	Cal Cycle (Months)	Cal. Due
WC058452	Agilent Technologies	Arbitrary Wave-form Generator	33250A	MY40025425	12	2/12/20
WC058455	AE Techtron	Amplifier	7794	7794-0419-0021	NCR	NCR
WC058456	Agilent	PSA Spectrum Analyzer	E4440A	MY446187964	12	4/2/20
WC005323	Solar Electronics	Loop Sensor	9229-1	0310503	36	3/22/22
WC005324	Solar Electronics	Radiating Loop	9231-1	0311003	36	3/22/22
WC005777	A.H. Systems	Current Probe	BCP-510	1152	36	9/12/20
WC058386	Tektronix	Digital Oscilloscope	MDO3034	C011435	12	8/15/20

NCR = No Calibration Required; as per NTS QA policy, the equipment does not require calibration as long as the test signal being generated can be verified with other calibrated equipment prior to or during the test.

5.3 Method RS103: Radiated Susceptibility, Electric Field, 2 MHz - 18 GHz

5.3.1 RS103 Purpose

This test verifies the ability of the EUT, and their associated cabling, to withstand electric fields and continue to operate as intended.

5.3.2 RS103 Limits

The EUT shall not exhibit any malfunction, degradation of performance, or deviation from specified indications beyond the tolerances indicated in the individual equipment or subsystem specification when subjected to the radiated electric fields listed in Figure RS103-1.

Up to 30 MHz, the EUT shall meet the requirement for vertically polarized fields, and above 30 MHz it shall meet the requirement vertically and horizontally. Circular polarized fields are not acceptable.

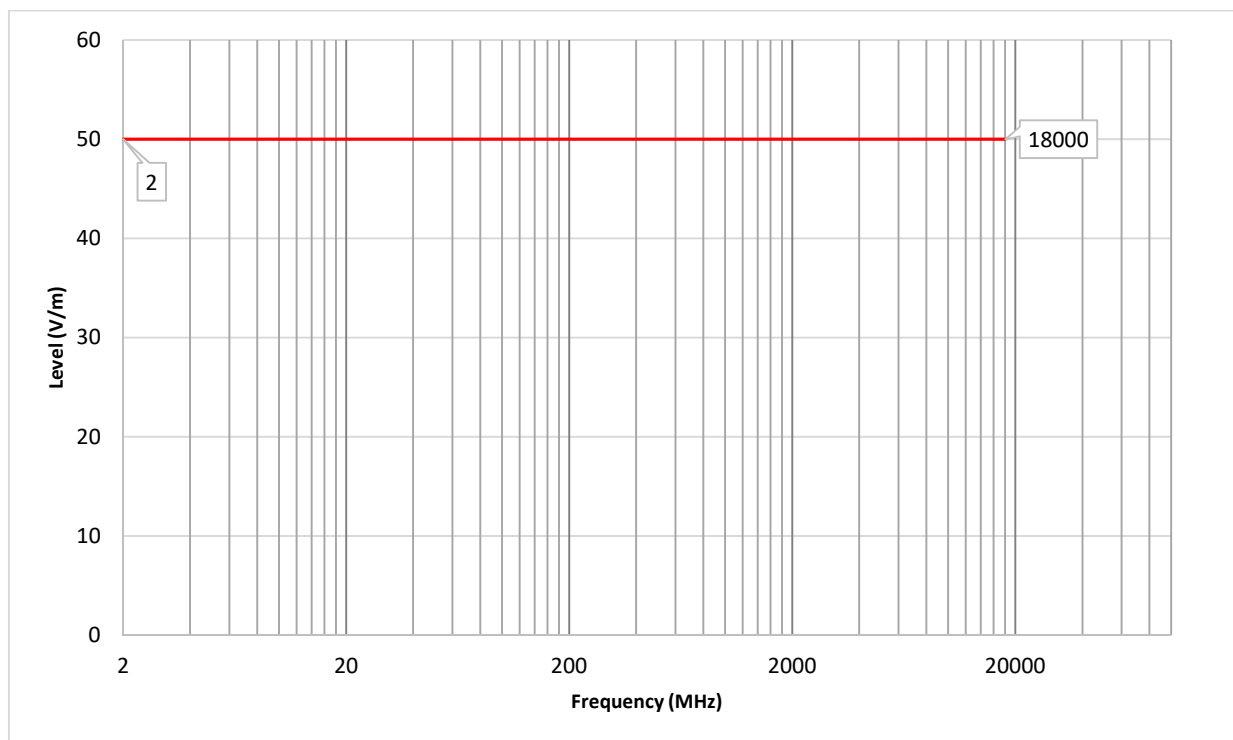


Figure RS103-1: RS103 Limit – Army Ground

5.3.3 RS103 Test Setup

The EUT was setup in accordance with Section 3.2, Figure 3.2-1 and operated according to Section 3.3.

5.3.3.1 Placement of Electronic Field Sensors

1. Place the sensors at the same distance as the EUT is located from the transmit antenna while staying in the plane of the test setup boundary edge closest to the antenna.
2. Position the sensors directly opposite the transmit antenna, while a minimum of 30 cm above the ground plane at or below 1 GHz. Above 1 GHz, place the sensors at the height corresponding to the area of the EUT being illuminated.
3. Do not place sensors directly at corners or edges of components.

5.3.3.2 Placement of Transmit Antennas

1. Antennas were placed 1 meter or greater from EUT.
2. For 200 MHz and below, center the transmit antenna between the edges of the test setup boundary. This boundary should include all enclosures of the EUT and the 2 meters of exposed interconnecting and power leads.
3. At and above 200 MHz, testing may require multiple antenna positions. Determine the number of position (N) as follows:
 - A. 200 MHz to 1 GHz: Place the antenna in a sufficient number of positions such that the entire area of each EUT face and the first 35 cm of cable and leads interfacing the EUT are within 3 dB beam width of the antenna.
 - B. 1 GHz and above place the antenna in a sufficient number of position such that the entire area of each EUT face and the first 7 cm of cable and leads interfacing the EUT are within 3 dB beam width of the antenna.

Table RS103-1: RS103 Antenna Position Calculations, 2 MHz to 200 MHz

Antenna Model	Range Used (MHz)	Antenna Coverage (cm)	Test Setup Boundary (cm)	Antenna Positions
NTS10k30M	2 – 30	300	6.5	1
EMCO 3109	30 - 200	300	6.5	1

Table RS103-2: RS103 Antenna Coverage Calculations, 200 MHz to 18 GHz

Antenna Model	Range Used (GHz)	Minimum 3dB Beamwidth (°)	Coverage at 1 M Distance (cm)
ETS 3106	0.2 – 1.0	28	49.87
AR ATH800M6G	1 - 4	13.5	23.67
AR ATH800M6G	4 - 6	8	13.99
AR ATH6G18	6 - 8	15.5	27.22
AR ATH6G18	8 - 18	8	13.99
Antenna Coverage = $2 * (\tan(\Theta) * a)$ Where $\Theta = 1/2$ (antenna 3dB beamwidth) a = antenna distance from setup boundary			

Table RS103-3: RS103 Antenna Position Calculations, 200 MHz to 18 GHz

Antenna Model	Range Used (GHz)	Antenna Coverage @ 1 M (cm)	EUT Width ¹ (cm)	Required Antenna Positions
ETS 3106	0.2 – 1.0	49.87	6.5	1
AR ATH800M6G	1 - 4	23.67	6.5	1
AR ATH800M6G	4 - 6	13.99	6.5	1
AR ATH6G18	6 - 8	27.22	6.5	1
AR ATH6G18	8 - 18	13.99	6.5	1

Note 1: Did not add 35cm of cable (200 MHz – 1GHz) or 7cm of cable (>1 GHz), because the EUT has no cables.

5.3.4 RS103 Test Procedure

Testing proceeded as follows:

1. The measurement equipment and EUT were turned on, and sufficient time was allowed for stabilization.
2. E-field sensor procedure:
 - A. The signal source was set to 1 kHz pulse modulation, 50% duty cycle.
 - B. Using an appropriate amplifier and transmit antenna, an electric field was established at the test start frequency.
 - C. The electric field level was gradually increased until it reaches the applicable limit.
 - D. The required frequency ranges will be scanned in accordance with the step size specified in Table 4.5-1. The field strength was maintained in accordance with the applicable limit.
 - E. The EUT performance was monitored for susceptibility effects.
3. If susceptibility was noted, the threshold level was determined and it was verified to be above the limit.
4. Testing was performed over the required frequency range with the transmit antenna vertically polarized.
5. Testing above 30 MHz was repeated with transmit antenna horizontally as well as vertically polarized.
6. Steps 1-5 were repeated for each transmits antenna position.

5.3.5 RS103 Test Data

Job Number:	PR107729	Standard:	MIL-STD-461F
Date:	10/14/19 – 10/15/19	Procedure:	None
Manufacturer:	Persistent Systems LLC	EUT:	MPU5 Radio with RF-4100 Lower C-Band Card
Model Number:	WR-5100, RF-4100	S/N:	31628
Input Power	Battery	Test Personnel:	Tristian Gaines

RS103 Specification Limits:

Signal Applied	Test Specification	Susceptibility Criteria
Radiated RF Electromagnetic Field	2MHz – 18GHz: 50V/m 1kHz / 80% Duty Cycle Pulse Modulated (Navy below deck)	The EUT was monitored for any degradation in performance according to Section 3.4.

RS103 Test Results:

Frequency (MHz)	Pol. (H/V)	Antenna Position	Step Size (%f)	Level (V/m)	Dwell (Sec)	Modulation	Observation	Results (Pass/Fail)
2 - 30	V	1	1	50	3	1kHz PM	None	PASS
30 - 200	H	1	0.5	50	3	1kHz PM	None	PASS
30 - 200	V	1	0.5	50	3	1kHz PM	None	PASS

Frequency (MHz)	Pol. (H/V)	Antenna Position	Step Size (%f)	Level (V/m)	Dwell (Sec)	Modulation	Observation	Results (Pass/Fail)
200 - 1000	V	1	0.5	50	3	1kHz PM	None	PASS
200 - 1000	V	1	0.5	50	3	1kHz PM	None	PASS

Frequency (GHz)	Pol. (H/V)	Antenna Position	Step Size (%f)	Level (V/m)	Dwell (Sec)	Modulation	Observation	Results (Pass/Fail)
1 - 2	V	1	0.25	10	3	1kHz PM	None	PASS
1 - 2	V	1	0.25	10	3	1kHz PM	None	PASS

Frequency (GHz)	Pol. (H/V)	Antenna Position	Step Size (%f)	Level (V/m)	Dwell (Sec)	Modulation	Observation	Results (Pass/Fail)
2 - 4	V	1	0.25	10	3	1kHz PM	None	PASS
2 - 4	V	1	0.25	10	3	1kHz PM	None	PASS

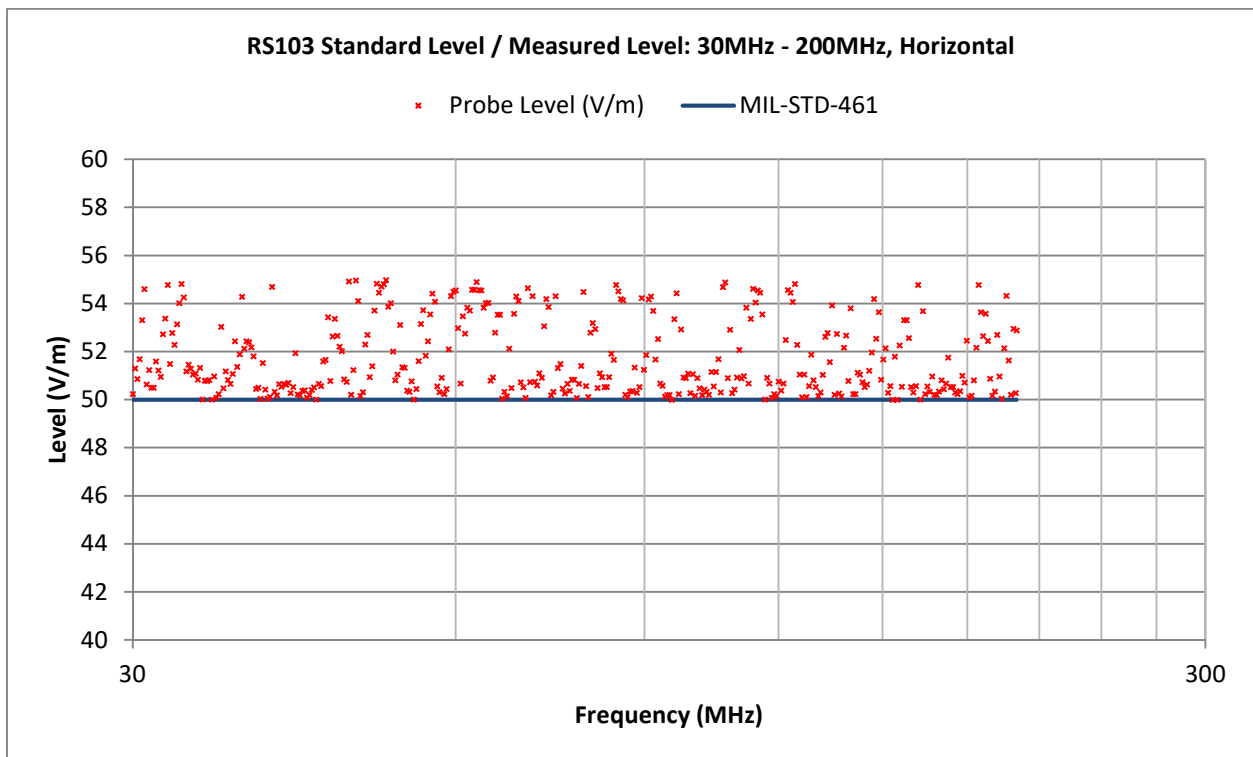
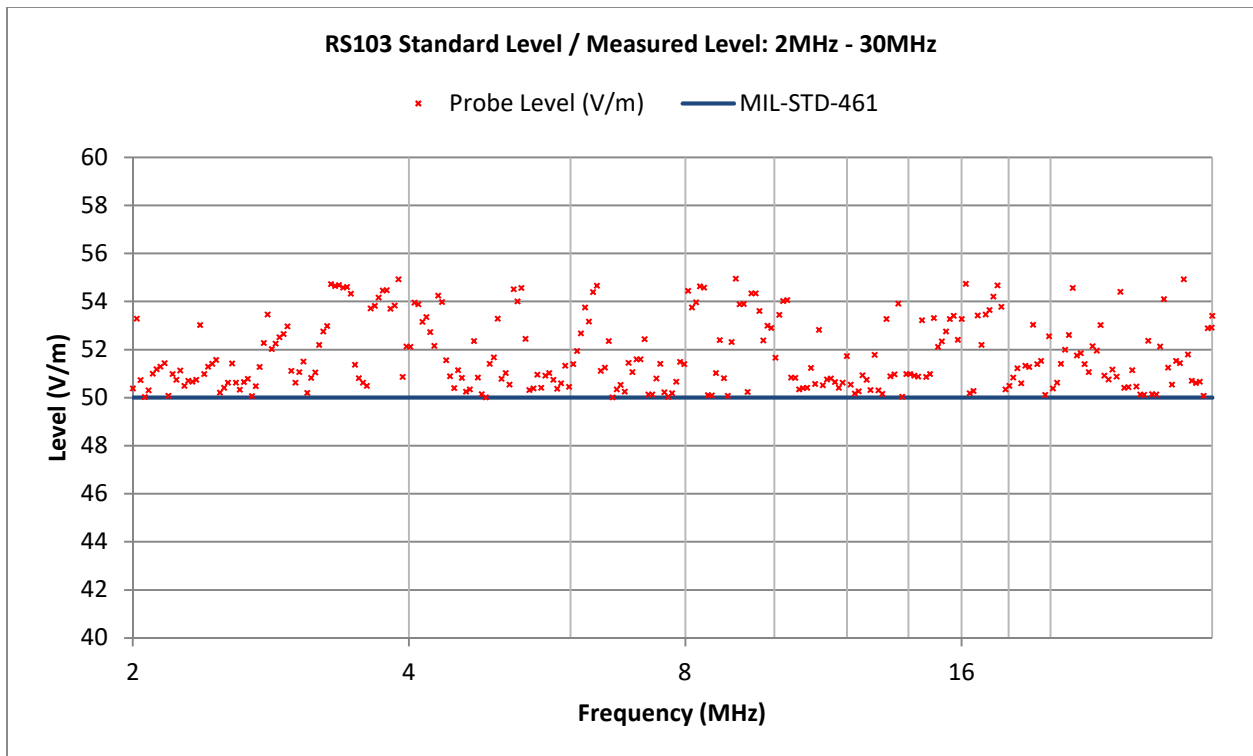


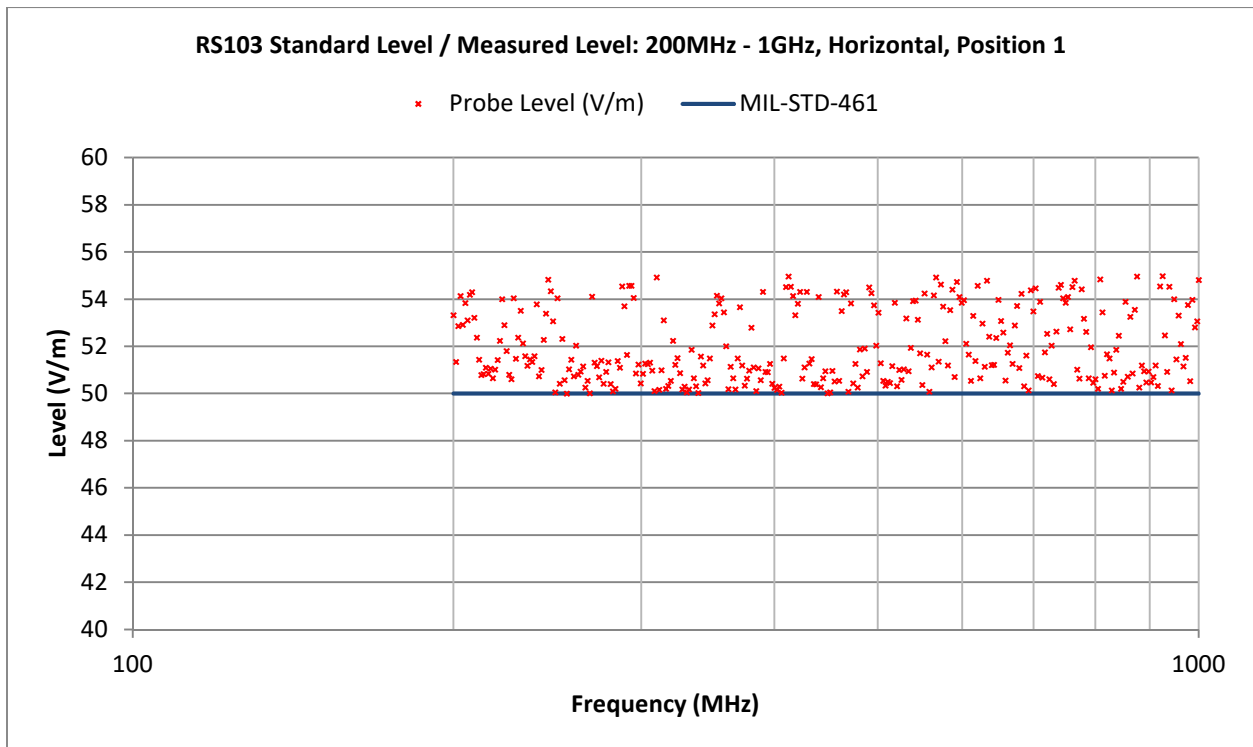
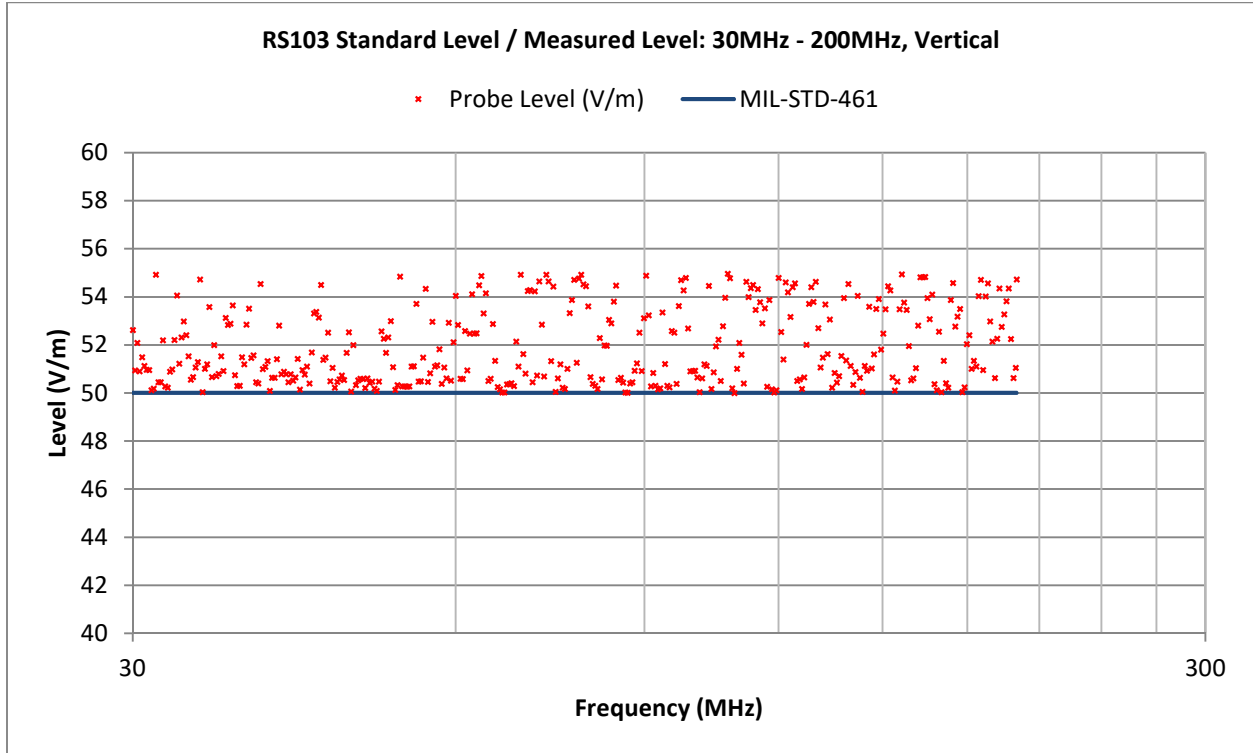
Frequency (GHz)	Pol. (H/V)	Antenna Position	Step Size (%f)	Level (V/m)	Dwell (Sec)	Modulation	Observation	Results (Pass/Fail)
4 - 6	V	1	0.25	10	3	1kHz PM	None	PASS
4 - 6	V	1	0.25	10	3	1kHz PM	None	PASS

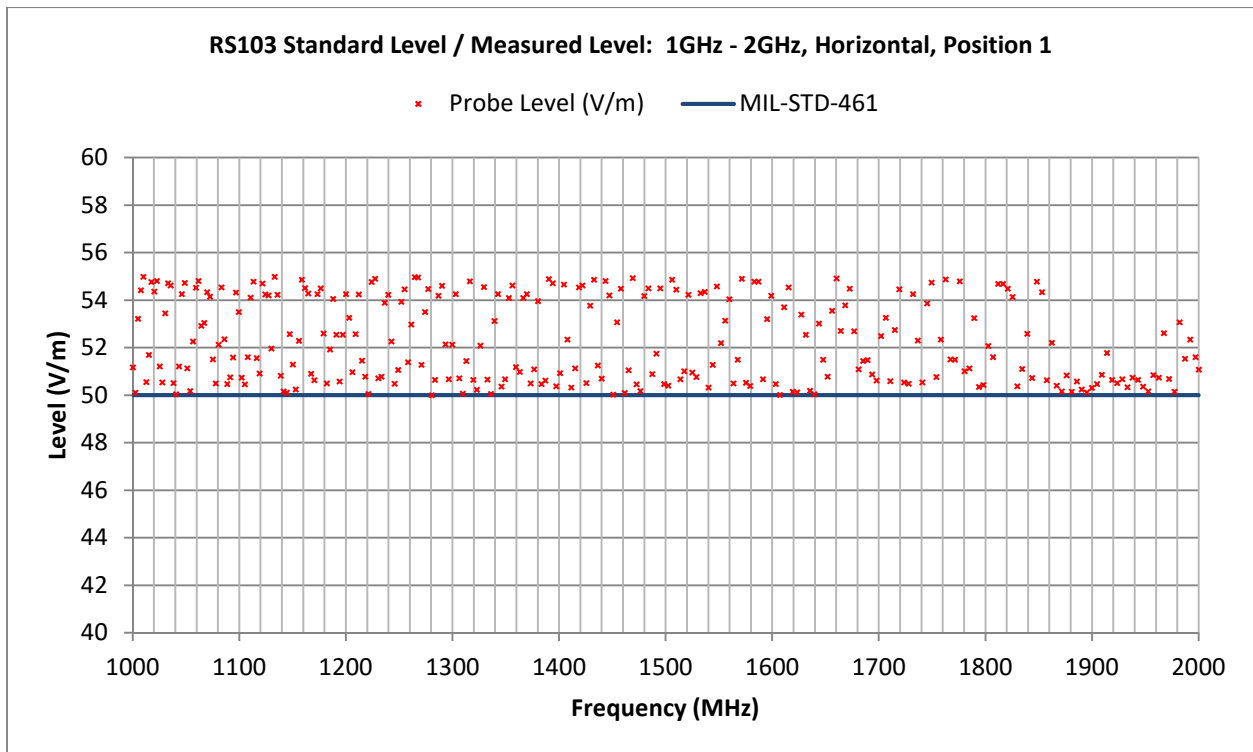
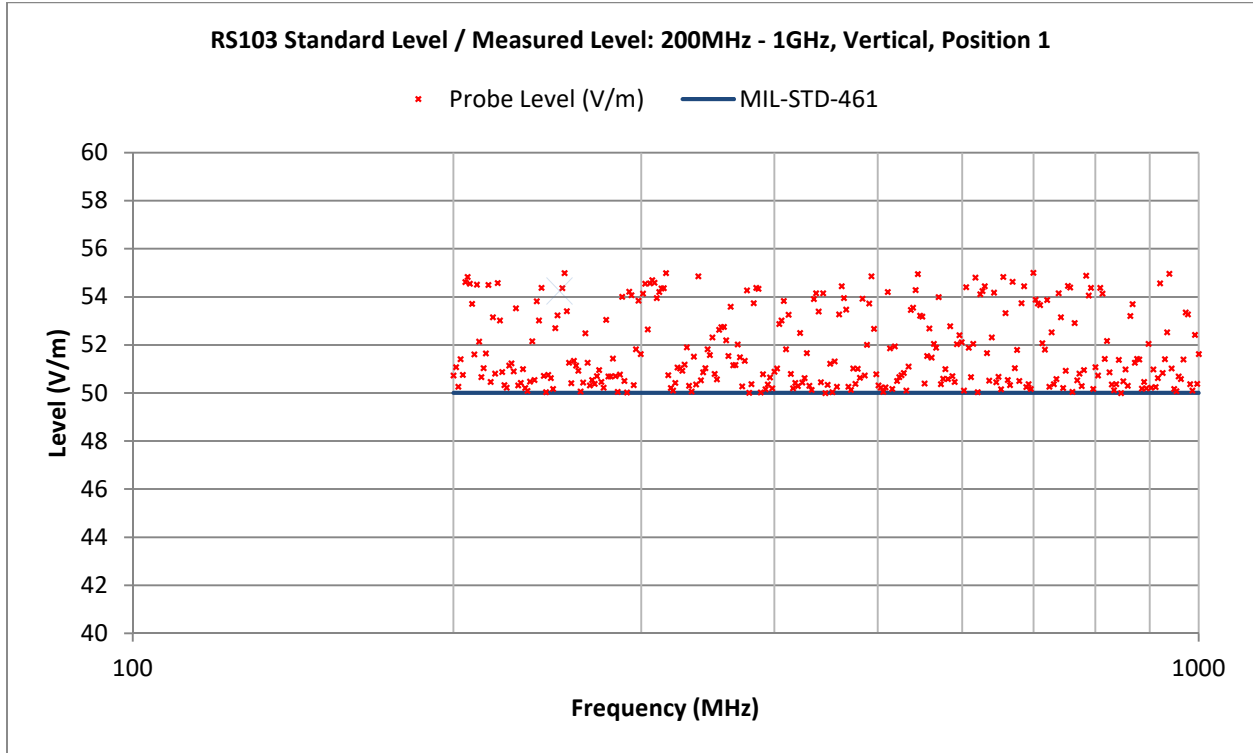
Frequency (GHz)	Pol. (H/V)	Antenna Position	Step Size (%f)	Level (V/m)	Dwell (Sec)	Modulation	Observation	Results (Pass/Fail)
6 - 8	H	1	0.25	10	3	1kHz PM	None	PASS
6 - 8	V	1	0.25	10	3	1kHz PM	None	PASS

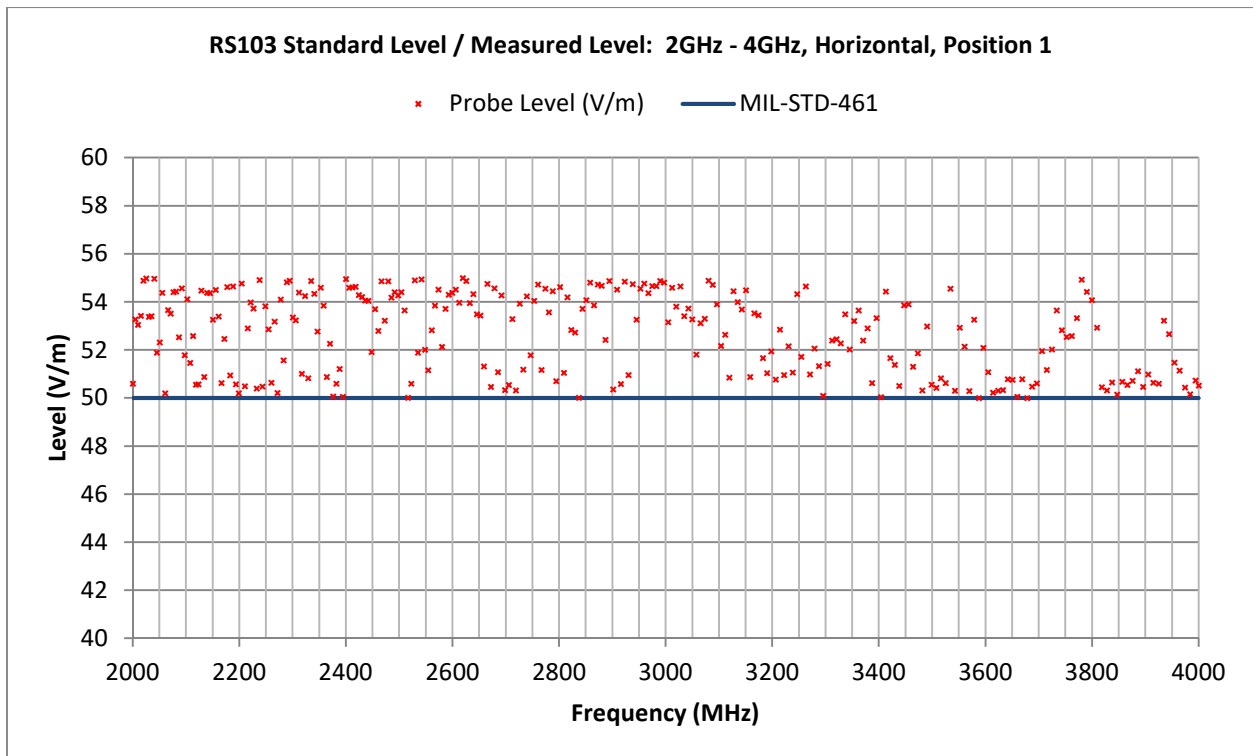
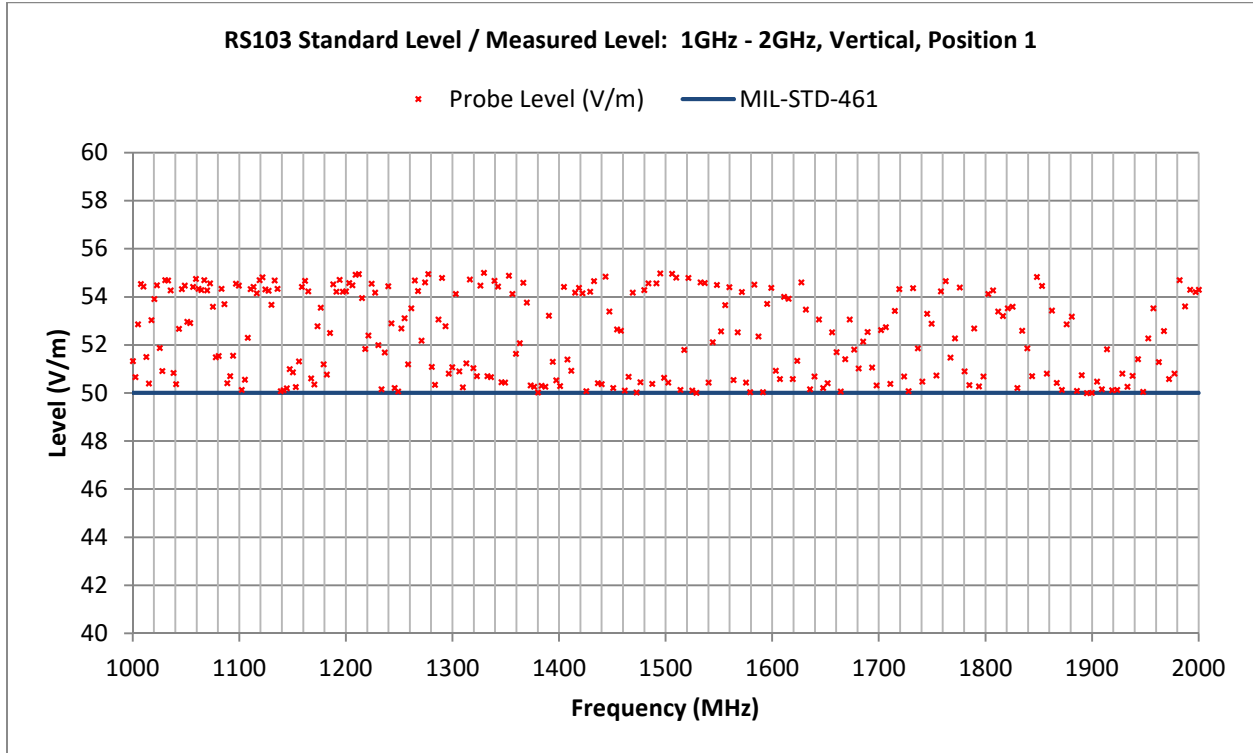
Frequency (GHz)	Pol. (H/V)	Antenna Position	Step Size (%f)	Level (V/m)	Dwell (Sec)	Modulation	Observation	Results (Pass/Fail)
8 - 18	V	1	0.25	10	3	1kHz PM	None	PASS
8 - 18	V	1	0.25	10	3	1kHz PM	None	PASS

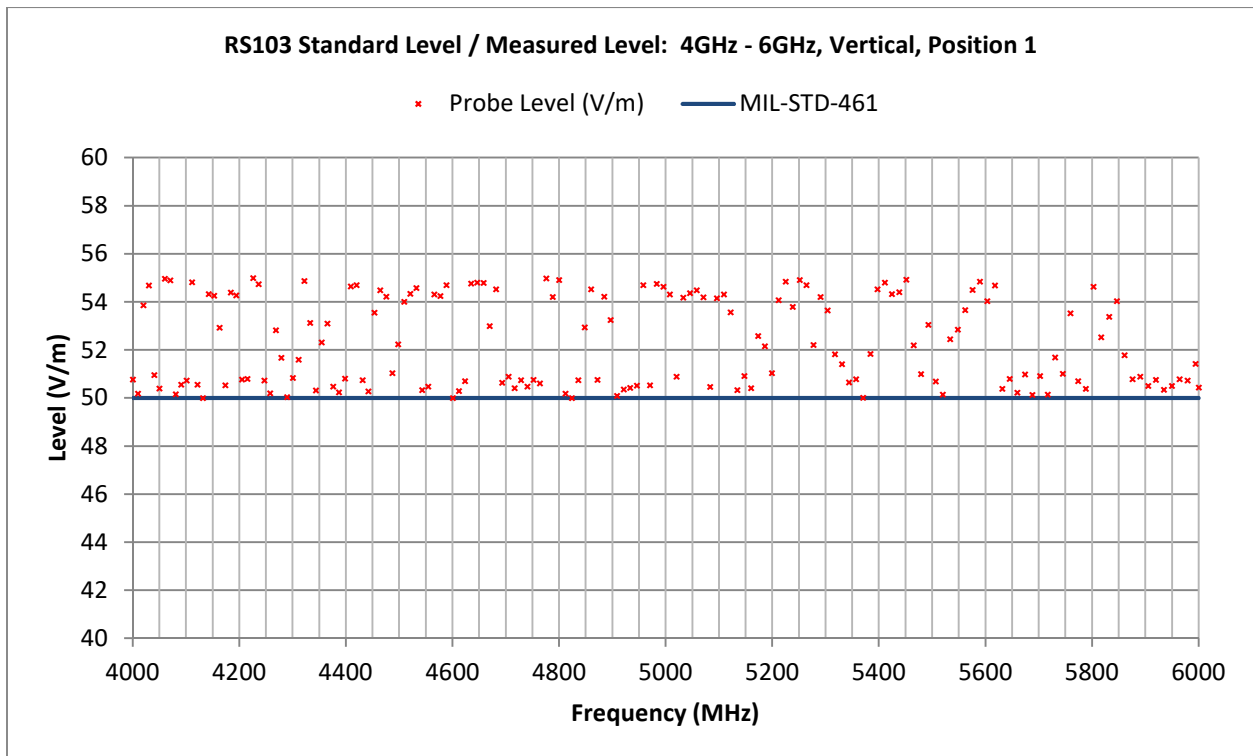
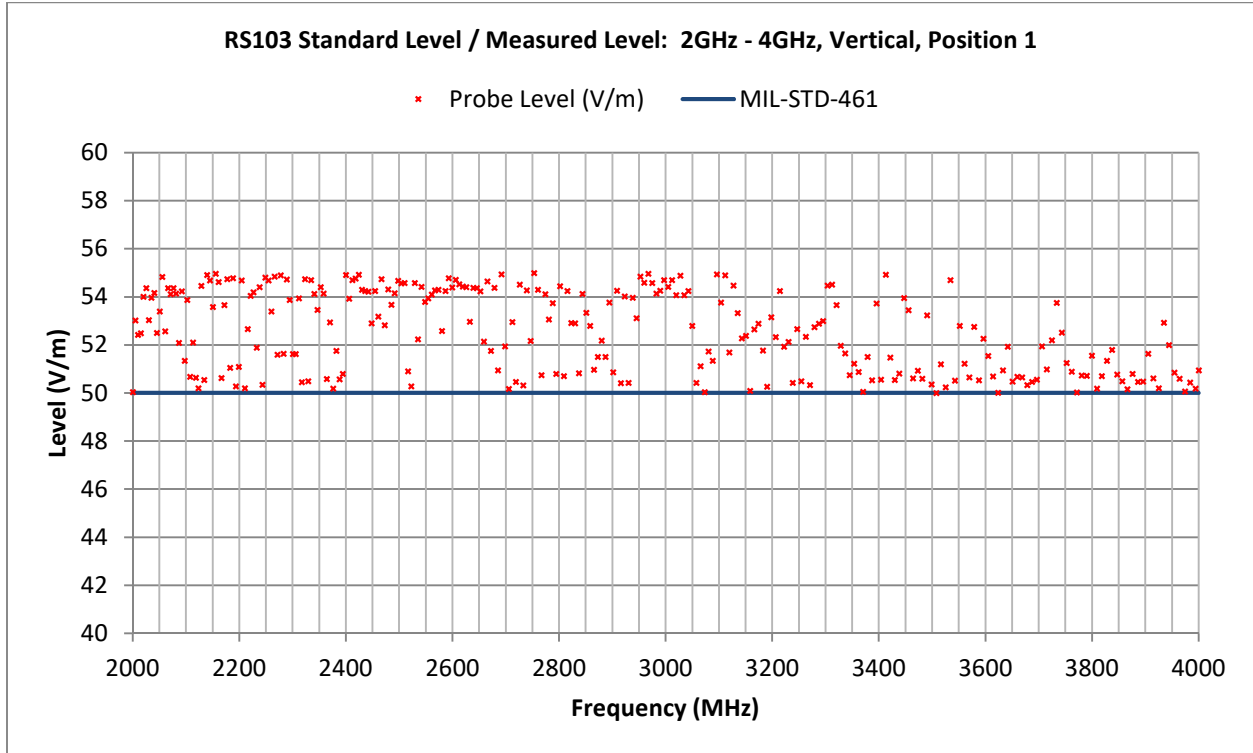
5.3.6 RS103 Data Plots

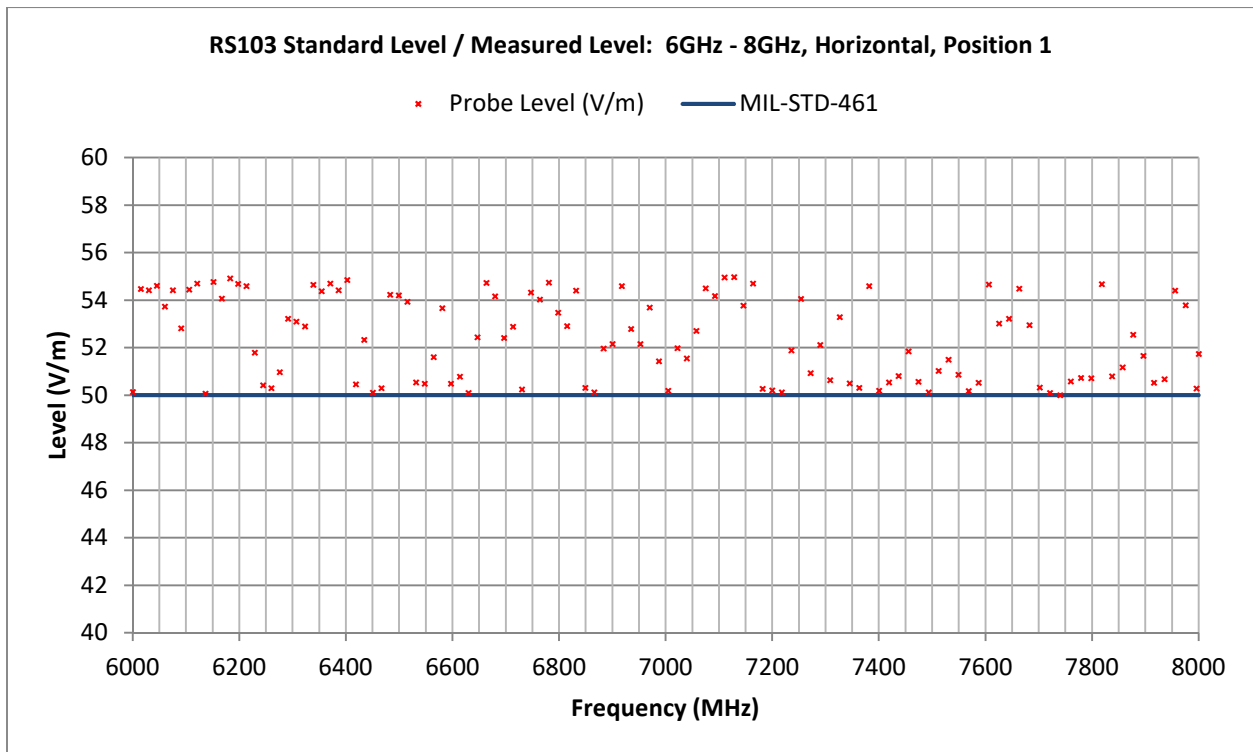
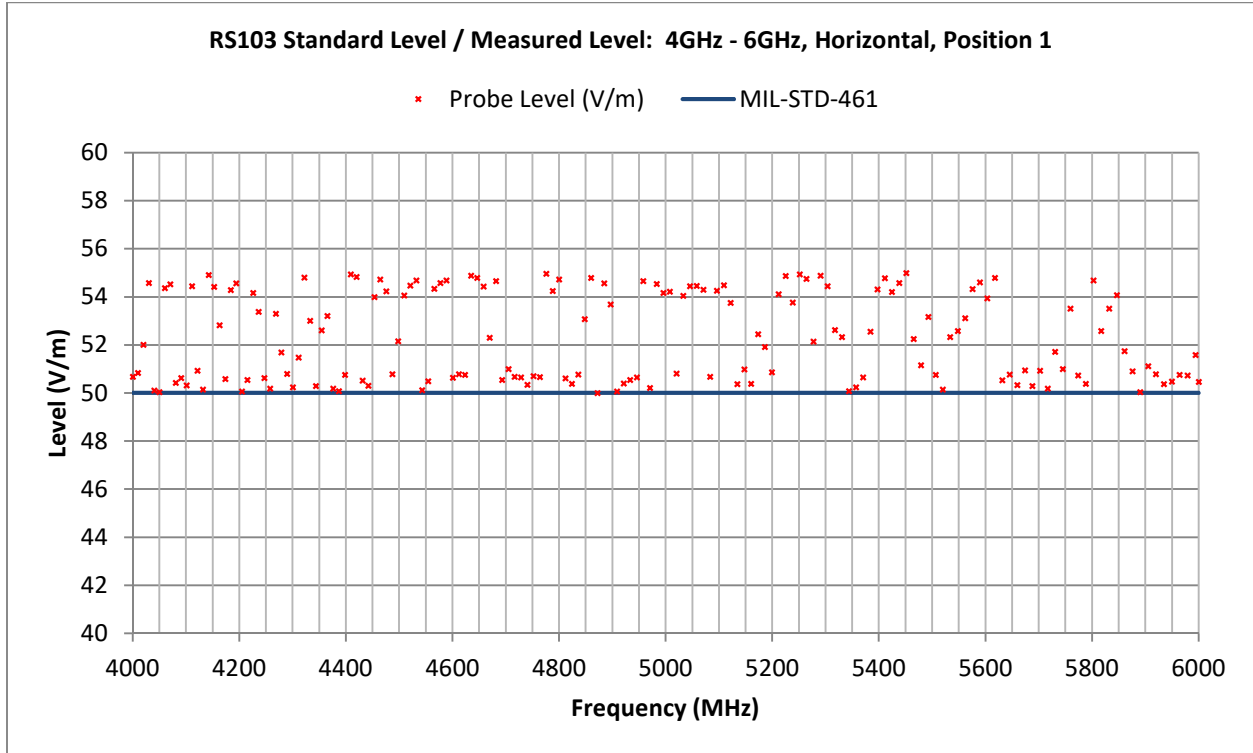


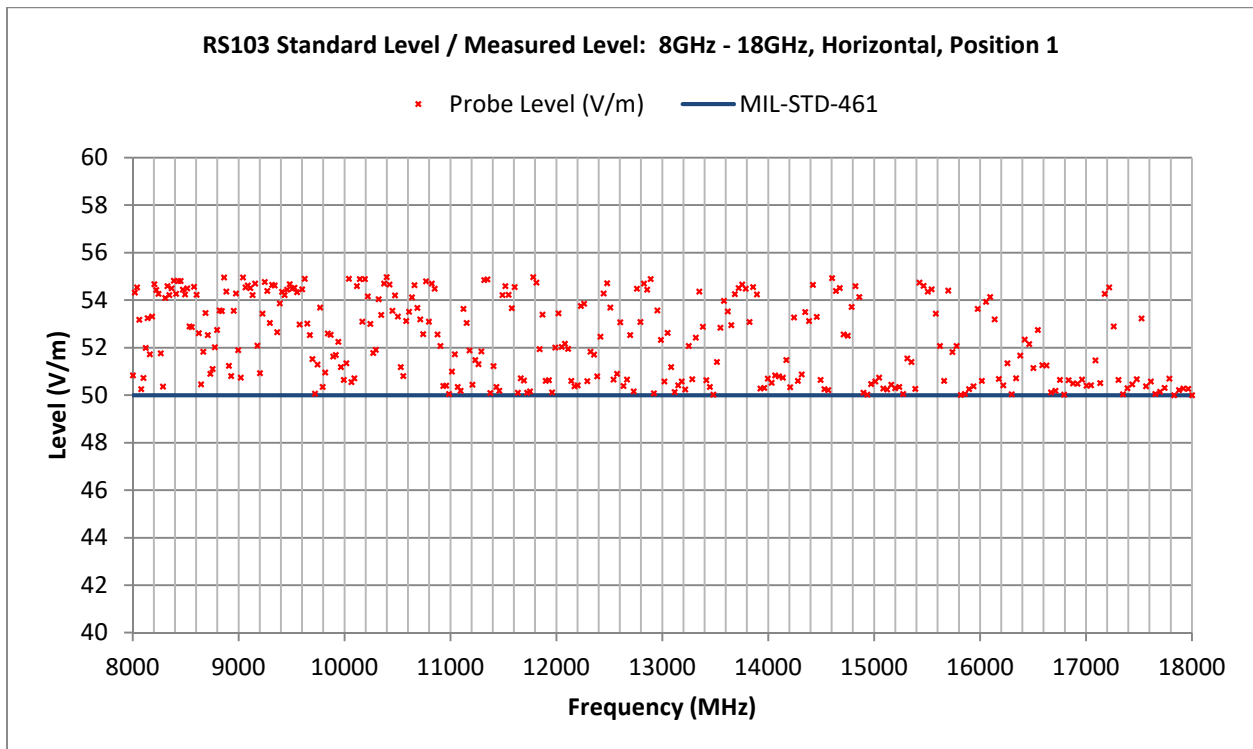
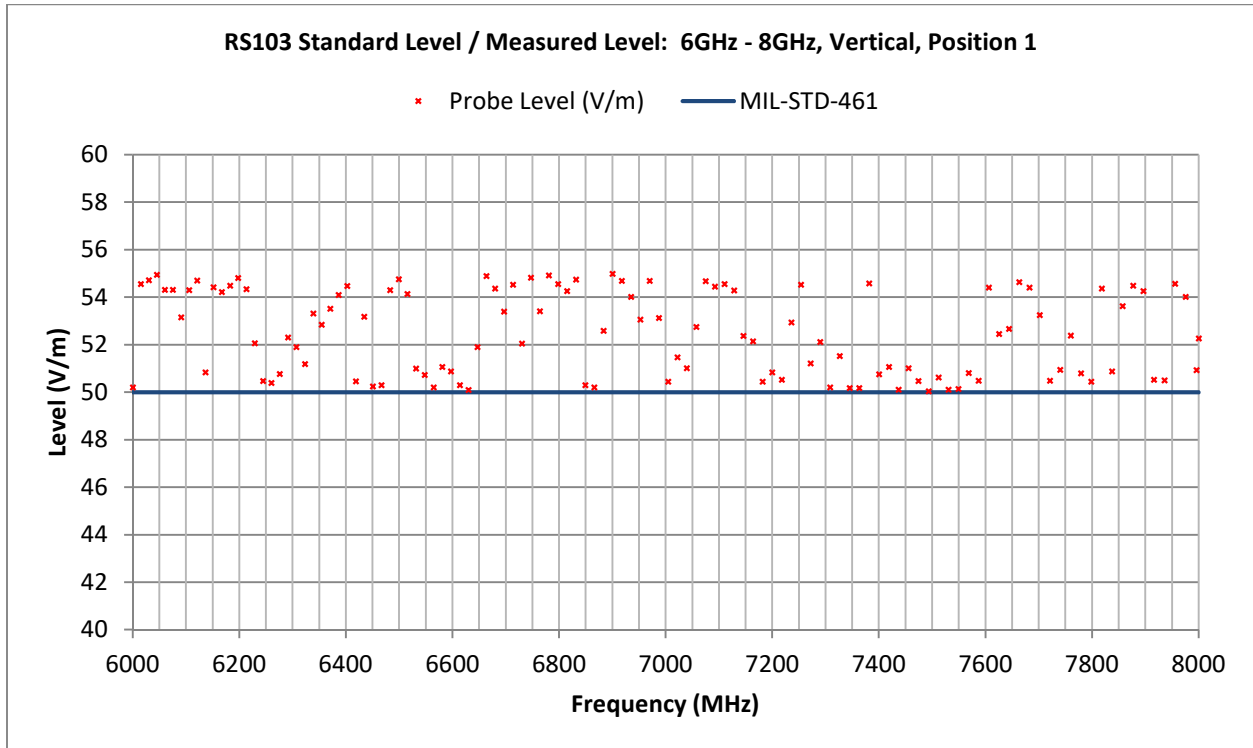


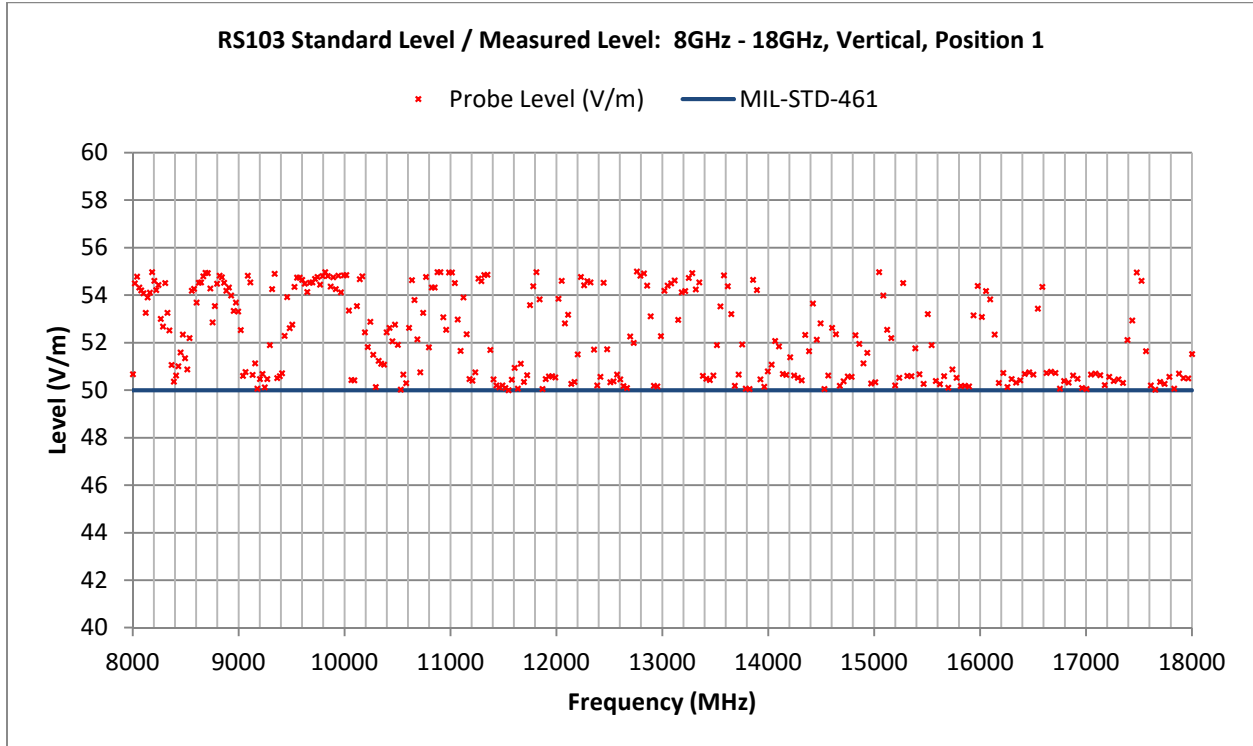




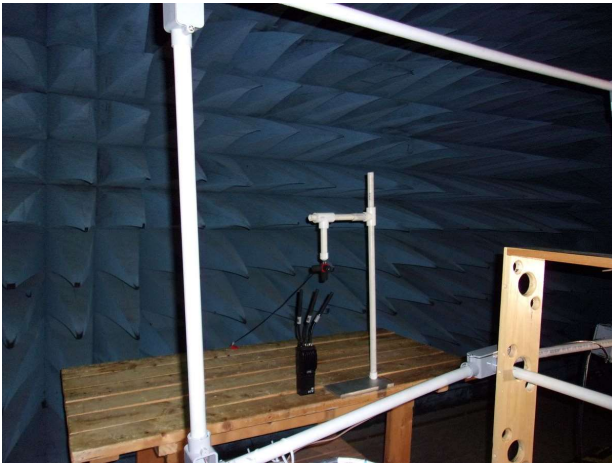




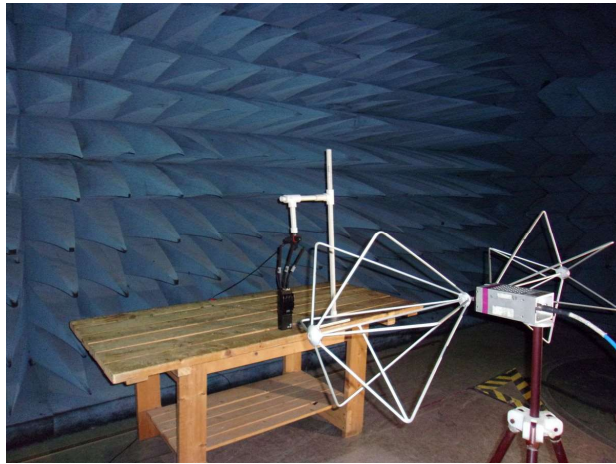




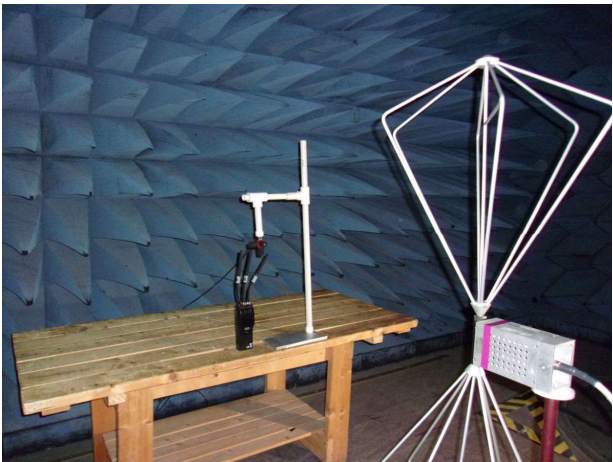
5.3.7 RS103 Photographs



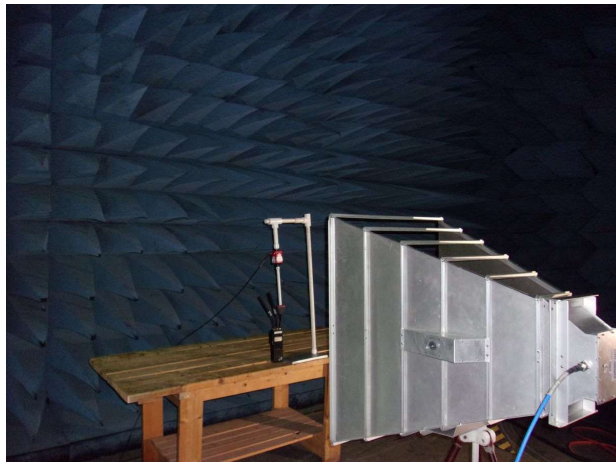
01 - 2-30MHz



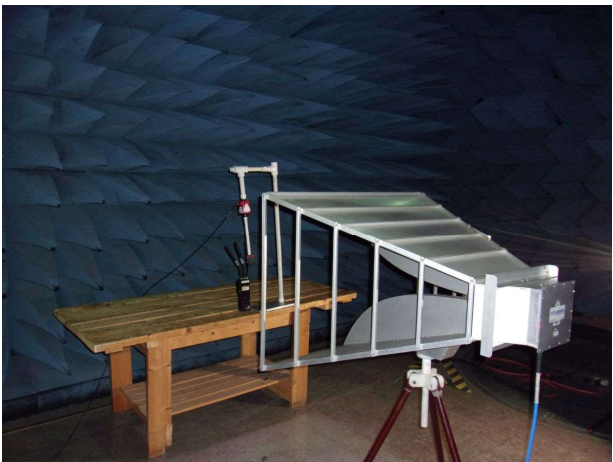
02 - 30-200MHz Horizontal



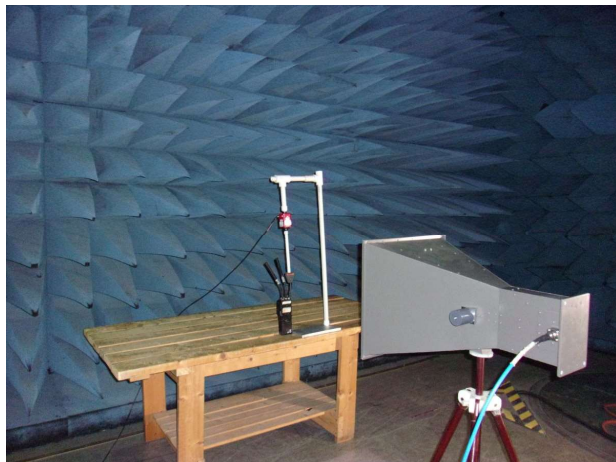
03 - 30-200MHz Vertical



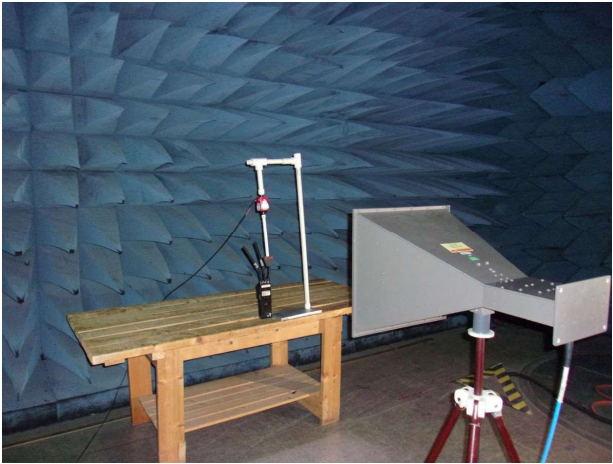
04 - 200MHz-1GHz Horizontal



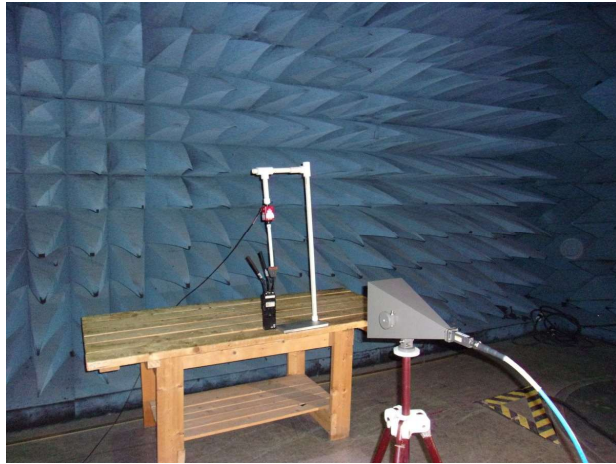
05 - 200MHz-1GHz Vertical



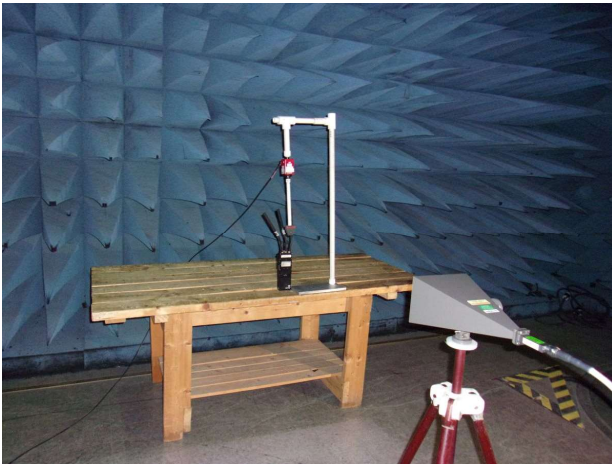
06 - 1-6GHz Horizontal



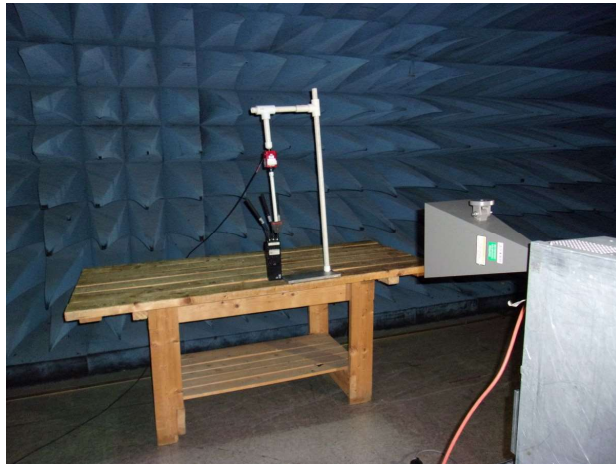
07 - 1-6GHz Vertical



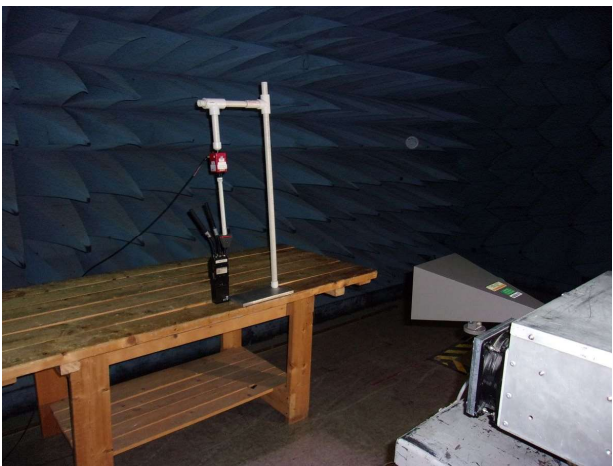
08 - 6-8GHz Horizontal



09 - 6-8GHz Vertical



10 - 8-18GHz Horizontal



11 - 8-18GHz Vertical



5.3.8 RS103 Test Equipment

Table RS103-4: RS103 Test Equipment List

Asset No.	Manufacturer	Item	Model	S/N	Cal. Cycle (Months)	Cal. Due
WC005630	NTS	10kHz – 30MHz E-Field Generator	NTS10k30M	None	NCR	NCR
WC005618	EMCO	Biconical Antenna	3109	8811-2392	NCR	NCR
WC005310	ETS-Lindgren	200MHz – 1GHz DRG Horn Antenna	3106	35382	NCR	NCR
WC058429	AR	1-6GHz Horn Antenna	ATH800M6G	0351558	NCR	NCR
WC058430	AR	6-18GHz Horn Antenna	ATH6G18	0351643	NCR	NCR
WC005477	Amplifier Research	Signal Generator 9kHz-1.2GHz	SG1200	202308/251	12	5/7/20
WC005556	Agilent	Signal Generator 10MHz-20GHz	83620B	US34490403	12	5/10/20
WC005629	IFI	10 KHz - 200Mz Amplifier	TCCX 2500	L499-0408	NCR	NCR
WC005628	IFI	Amplifier 200 MHz – 1GHz	SMCC1000	L374-0507	NCR	NCR
WC005660	IFI	1-2GHz Amplifier	GT251-500A	L500-0408	NCR	NCR
WC005776	LogiMetrics	2-4 GHz Amplifier	A600/S	M701-0508	NCR	NCR
WC005662	Amplifier Research	4-8 GHz Amplifier	200T4GB	326913	NCR	NCR
WC005682	CPI	8-18 GHz Amplifier	VZM6993J5	SJ7213C7	NCR	NCR
WC005814	ETS Lindgren	Field Probe 10kHz - 1GHz	HI-6022	114361	12	9/22/20
WC005790	ETS Lindgren	Field Probe 10MHz - 40GHz	HI-6053	110384	12	8/21/20

NCR = No Calibration Required; as per NTS QA policy, the equipment does not require calibration as long as the test signal being generated can be verified with other calibrated equipment prior to or during the test.

5.4 Conducted Emissions: Method CE106, Conducted Emissions Antenna Terminal, 10kHz to 40GHz

CE106 Test Results Summary		
Antenna Port	Operating State	Result
MPU5 Chain 1 Antenna Port	Receive / Standby	PASS
MPU5 Chain 1 Antenna Port	Transmit	PASS

5.4.1 CE106 Purpose

This requirement is applicable from 10 kHz to 40 GHz for the antenna ports of transmitters, receivers, and amplifiers. The requirement is not applicable to equipment designed with antennas permanently mounted to the EUT. The transmit mode portion of this requirement is not applicable within the bandwidth of the EUT transmitted signal or within ± 5 percent of the fundamental frequency, whichever is larger. For Navy shipboard applications with peak transmitter power greater than 1 kW, the 5% frequency exclusion will be increased by an additional 0.1% of the fundamental frequency for each dB above 1 kW of peak power.

$$\text{Frequency Exclusion} = \pm f * (0.05 + (0.001/\text{dB}) * (\text{PtPk [dBm]} - 60 [\text{dBm}]))$$

CE106 Frequency Range

Depending on the operating frequency range of the EUT, the start frequency of the test is as follows:

EUT Operating Frequency Range	Start Frequency of Test
10 kHz to 3 MHz	10 kHz
3 MHz to 300 MHz	100 kHz
300 MHz to 3 GHz	1 MHz
3 GHz to 40 GHz	10 MHz

The equipment will be tested to an upper frequency limit based on the highest frequency generated or received by the EUT. For systems with the frequencies generated or received less than 1 GHz, the upper frequency limit will be 20 times the highest frequency or 18 GHz whichever is greater. For systems with frequencies generated or received greater than or equal to 1 GHz, the upper frequency limit will be 10 times the highest frequency or 40 GHz whichever is less. For equipment using waveguide, the requirement does not apply below eight-tenths of the waveguide's cutoff frequency. RE103 may be used as an alternative for CE106 for testing transmitters with their operational antennas.

5.4.2 CE106 Limits

Conducted emissions at the EUT antenna terminal shall not exceed the values given below.

- Receivers: 34 dB μ V
- Transmitters and amplifiers (standby mode): 34 dB μ V
- Transmitters and amplifiers (transmit mode): Harmonics, except the second and third, and all other spurious emissions shall be at least 80 dB down from the level at the fundamental. The second and third harmonics shall be suppressed to a level of -20 dBm or 80 dB below the fundamental, whichever requires less suppression. For Navy shipboard applications, the second and third harmonics will be suppressed to a level of -20 dBm and all other harmonics and spurious emissions shall be suppressed to -40 dBm, except if the duty cycle of the emissions are less than 0.2%, then the limit may be relaxed to 0 dBm.

5.4.3 CE106 Test Setup

- a. Calibration. Configure the test setup for the signal generator path shown in Figures CE106-1 through CE106-3 as applicable.
- b. EUT Testing. Configure the test setup for the EUT path shown in Figures CE106-1 through CE106-3 as applicable.

5.4.4 CE106 Test Procedure

Transmit mode for transmitters and amplifiers.

The test procedure shall be as follows:

1. Turn on the measurement equipment and allow a sufficient time for stabilization.
2. Calibration.
 - a. Apply a known calibrated signal level from the signal generator through the system check path at a mid-band fundamental frequency (f_0).
 - b. Scan the measurement receiver in the same manner as a normal data scan. Verify the measurement receiver detects a level within ± 3 dB of the expected signal.
 - c. If readings are obtained which deviate by more than ± 3 dB, locate the source of the error and correct the deficiency prior to proceeding with the test.
 - d. Repeat (1) through (3) at the end points of the frequency range of test.
3. EUT Testing.
 - a. Turn on the EUT and allow sufficient time for stabilization.
 - b. For transmitters, tune the EUT to the desired test frequency and apply the appropriate modulation for the EUT as indicated in the equipment specification.
 - c. For amplifiers, apply an input signal to the EUT that has the appropriate frequency, power level, and modulation as indicated in the equipment specification. For transmitters and amplifiers for which these parameters vary, test parameters shall be chosen such that the worst case emissions spectrum will result.
 - d. Use the measurement path to complete the rest of this procedure.
 - e. Tune the test equipment to the operating frequency (f_0) of the EUT and adjust for maximum indication.
 - f. Record the power level of the fundamental frequency (f_0) and the measurement receiver bandwidth.
 - g. Insert the fundamental frequency rejection network, when applicable.
 - h. Scan the frequency range of interest and record the level of all harmonics and spurious emissions. Add all correction factors for cable loss, attenuators and rejection networks. Maintain the same measurement receiver bandwidth used to measure the power level of the fundamental frequency (f_0).
 - i. Verify spurious outputs are from the EUT and not spurious responses of the measurement system.
 - j. Repeat (2) through (8) for other frequencies.

Receivers and stand-by mode for transmitters and amplifiers.

The test procedure shall be as follows:

1. Turn on the measurement equipment and allow a sufficient time for stabilization.
2. Calibration.
 - a. Apply a calibrated signal level, which is 6 dB below the applicable limit, from the signal generator through the system check path at a midpoint test frequency.
 - b. Scan the measurement receiver in the same manner as a normal data scan. Verify the measurement receiver detects a level within ± 3 dB of the injected signal.
 - c. If readings are obtained which deviate by more than ± 3 dB, locate the source of the error and correct the deficiency prior to proceeding with the test.
 - d. Repeat (1) through (3) at the end points of the frequency range of test.
3. EUT Testing.
 - a. Turn on the EUT and allow sufficient time for stabilization.
 - b. Tune the EUT to the desired test frequency and use the measurement path to complete the rest of this procedure.
 - c. Scan the measurement receiver over the applicable frequency range, using the bandwidths and minimum measurement times of Table II of MIL-STD-461F.
 - d. Repeat (2) and (3) for other frequencies.

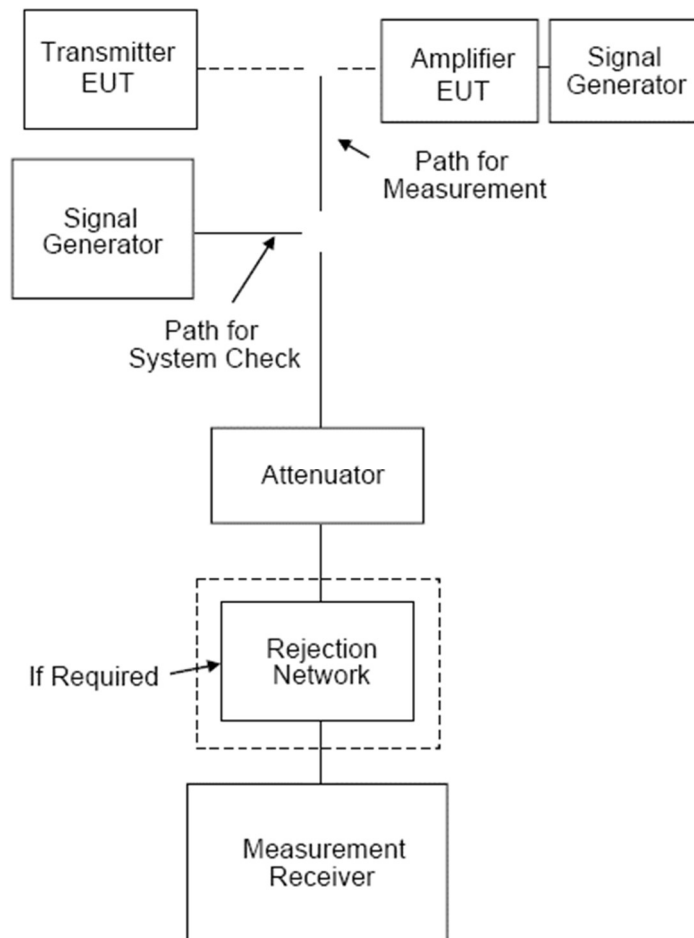


Figure CE106-1: Setup for Low Power Transmitters and Amplifiers

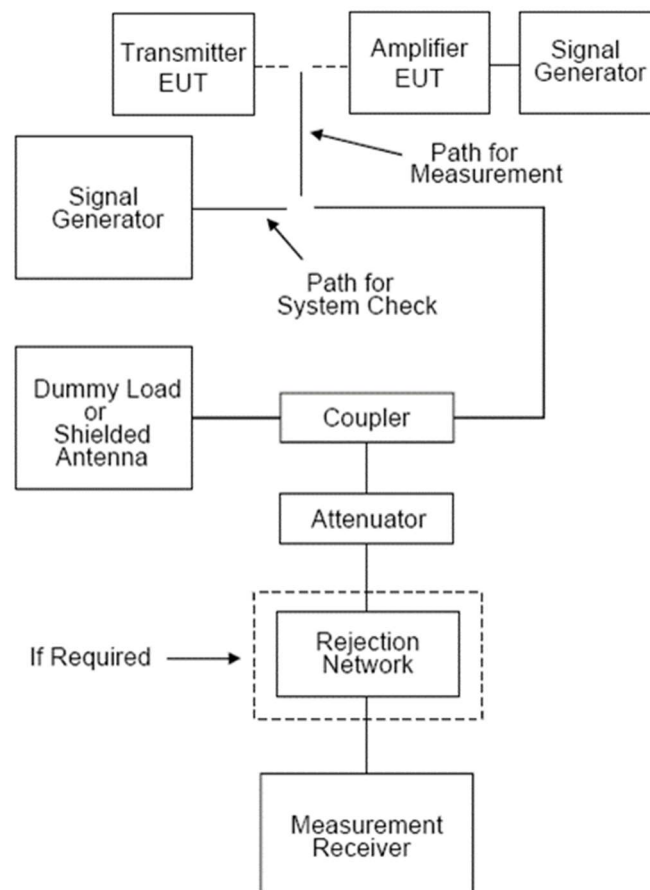


Figure CE106-2: Setup for High Power Transmitters and Amplifiers

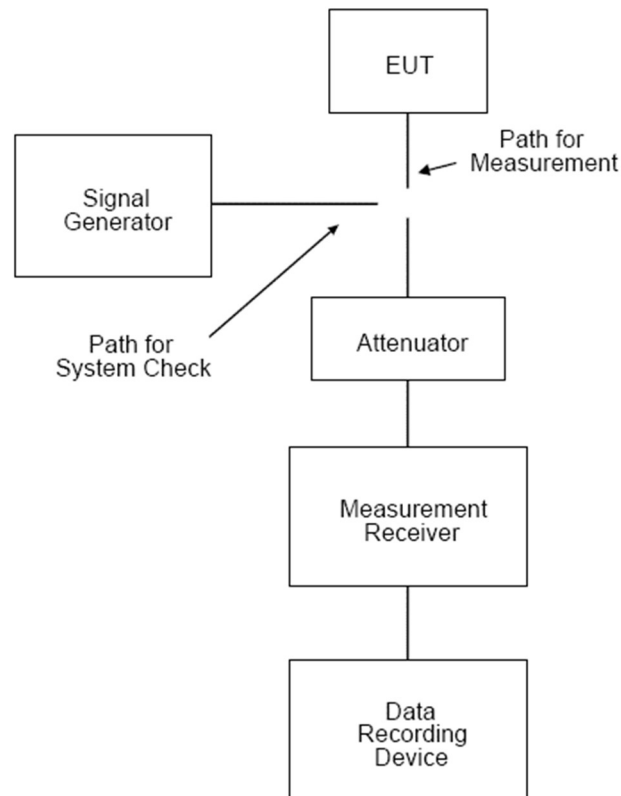


Figure CE106-3: Setup for Receivers and Stand-by Mode for Transmitters and Amplifiers

5.4.5 CE106 Data

CE106 Datasheet

Job Number:	PR132717	Standard:	MIL-STD-461F
		Procedure:	None
Date:	2/17/21	EUT:	MPU5 Radio with RF-4100 Lower C-Band Card
Model:	MPU5, RF-4100	S/N:	28360 (MPU5), 47480 (C-Band Card)
Test Personnel:	Jeff Maselli	Manufacturer:	Persistent Systems

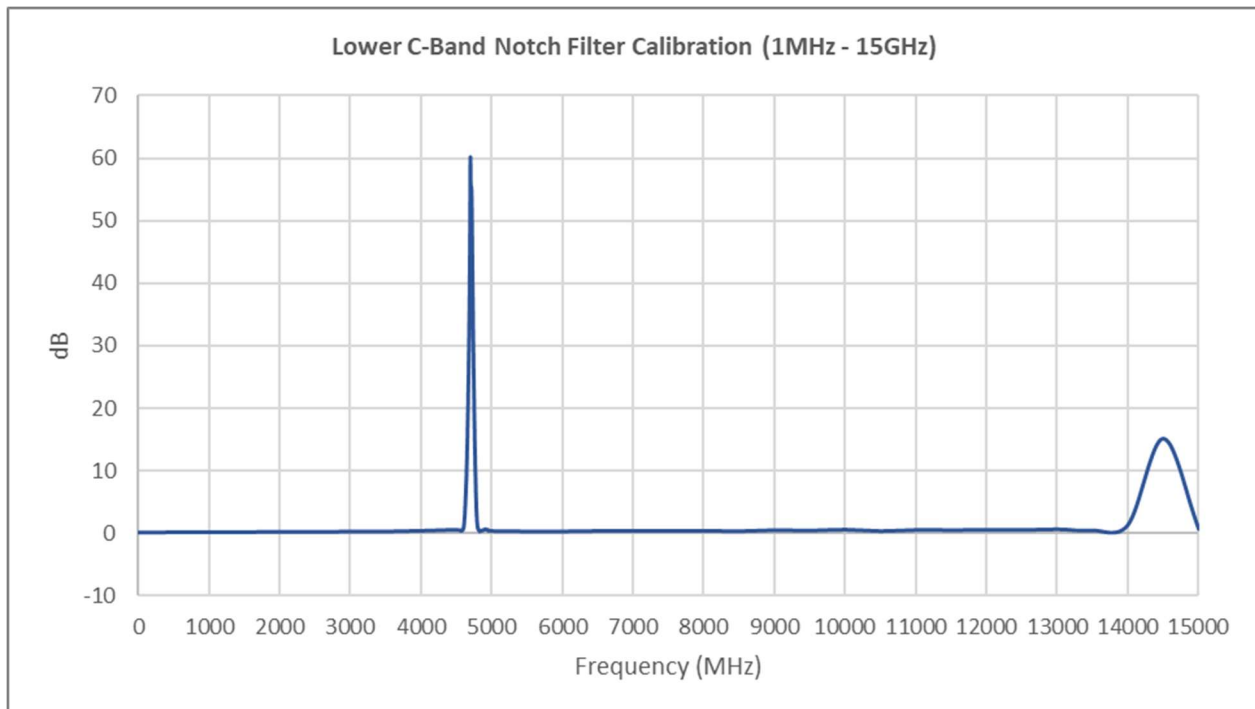
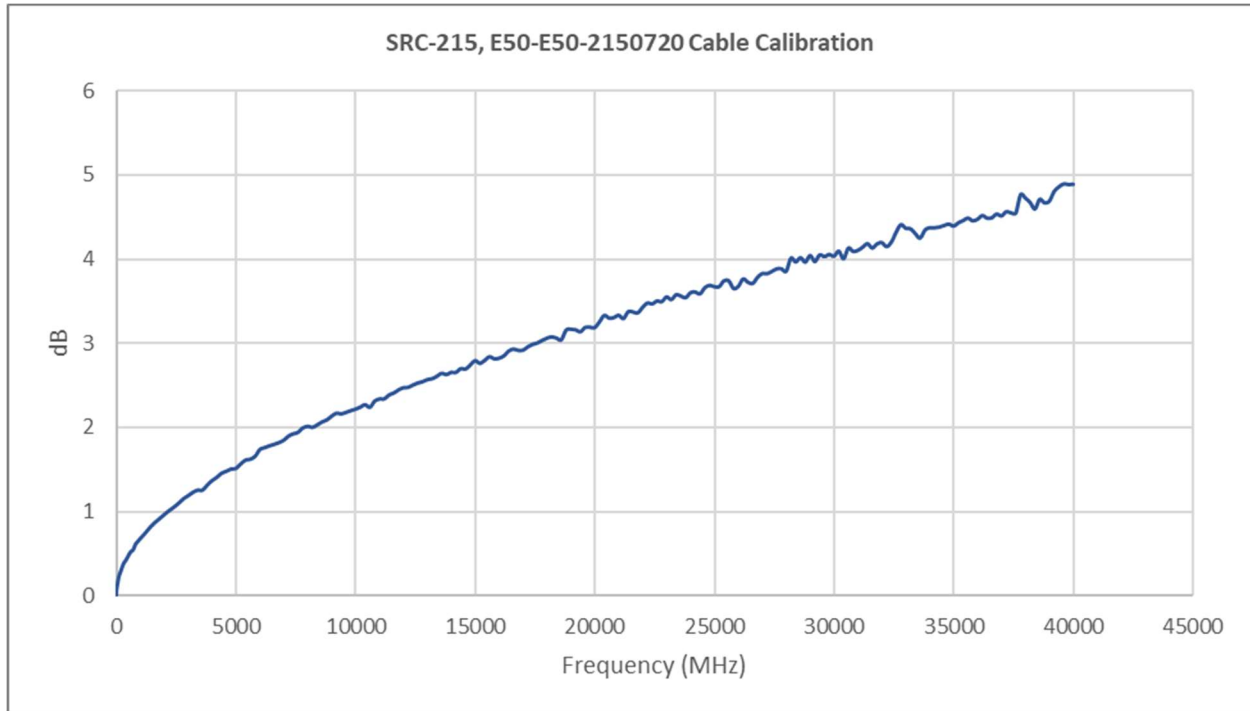
CE106 Test Specification:

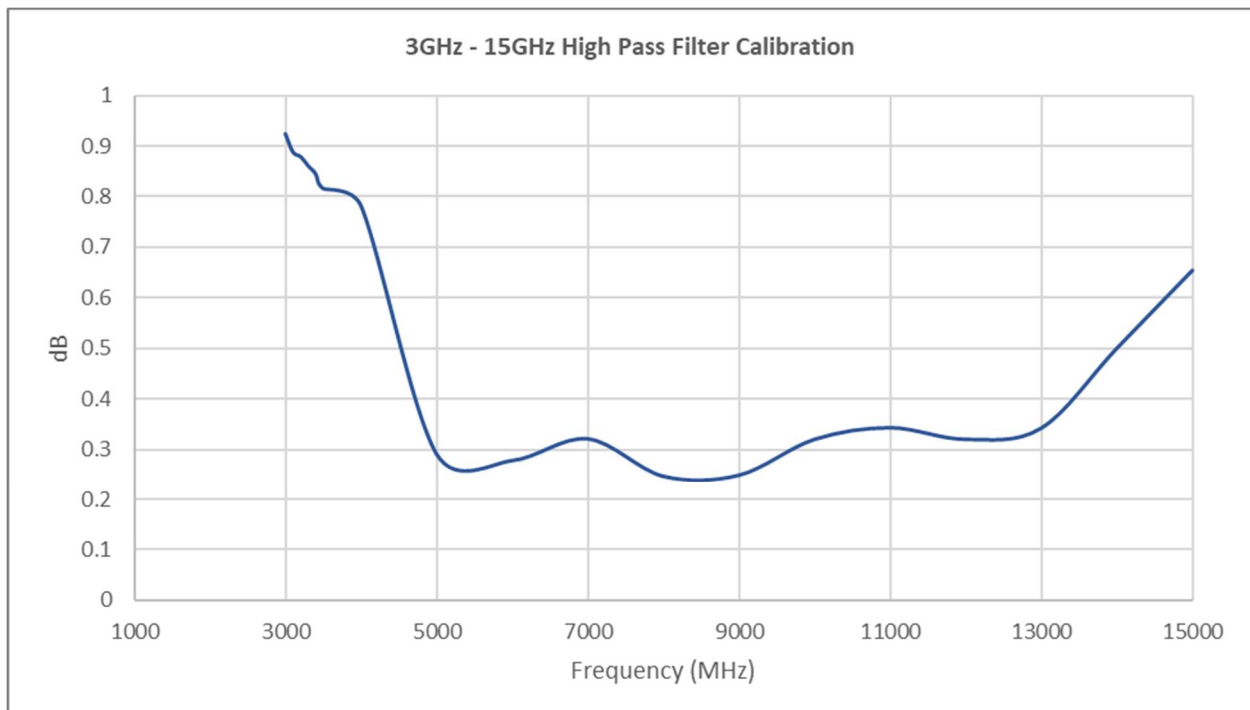
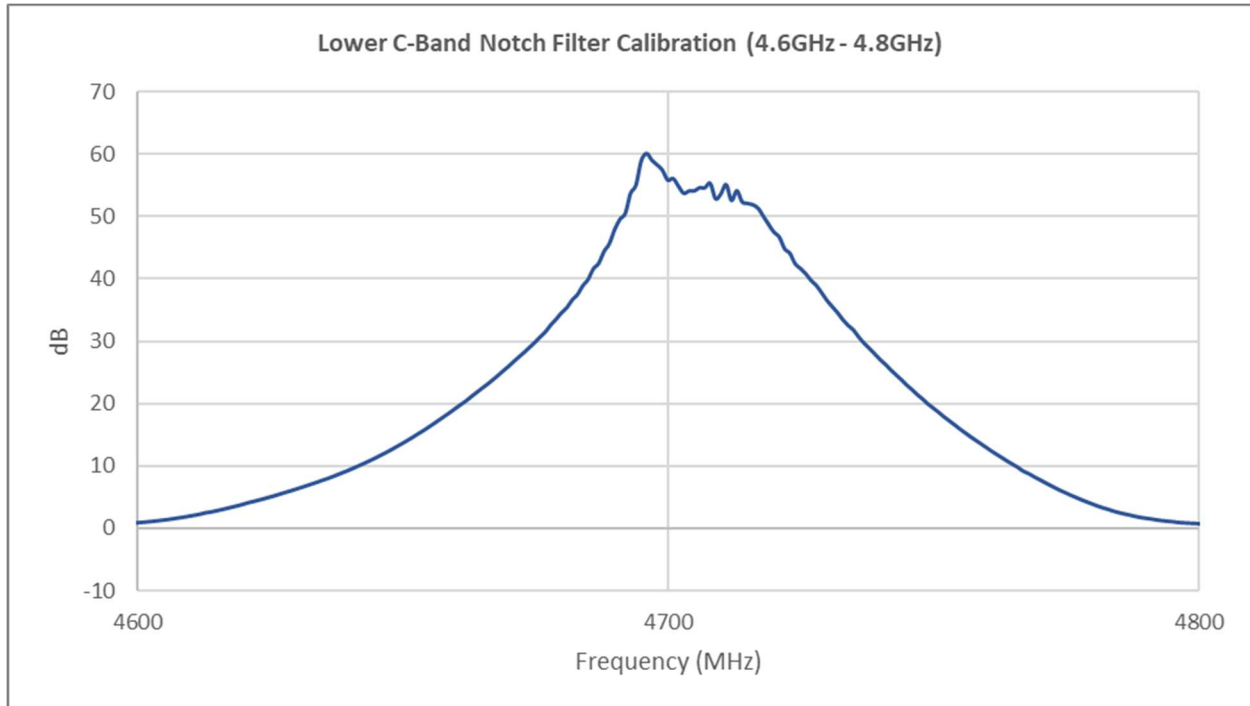
Test Type	Test Specification	Performance Criteria
Conducted Emissions, Antenna Terminal, 10 kHz to 40 GHz.	a. Receivers: 34 dB μ V b. Transmitters and amplifiers (standby mode): 34 dB μ V c. Transmitters and amplifiers (transmit mode): Harmonics, except the second and third, and all other spurious emissions shall be at least 80 dB down from the level at the fundamental. The second and third harmonics shall be suppressed to a level of -20 dBm or 80 dB below the fundamental, whichever requires less suppression.	The EUT emissions must not exceed the limit.

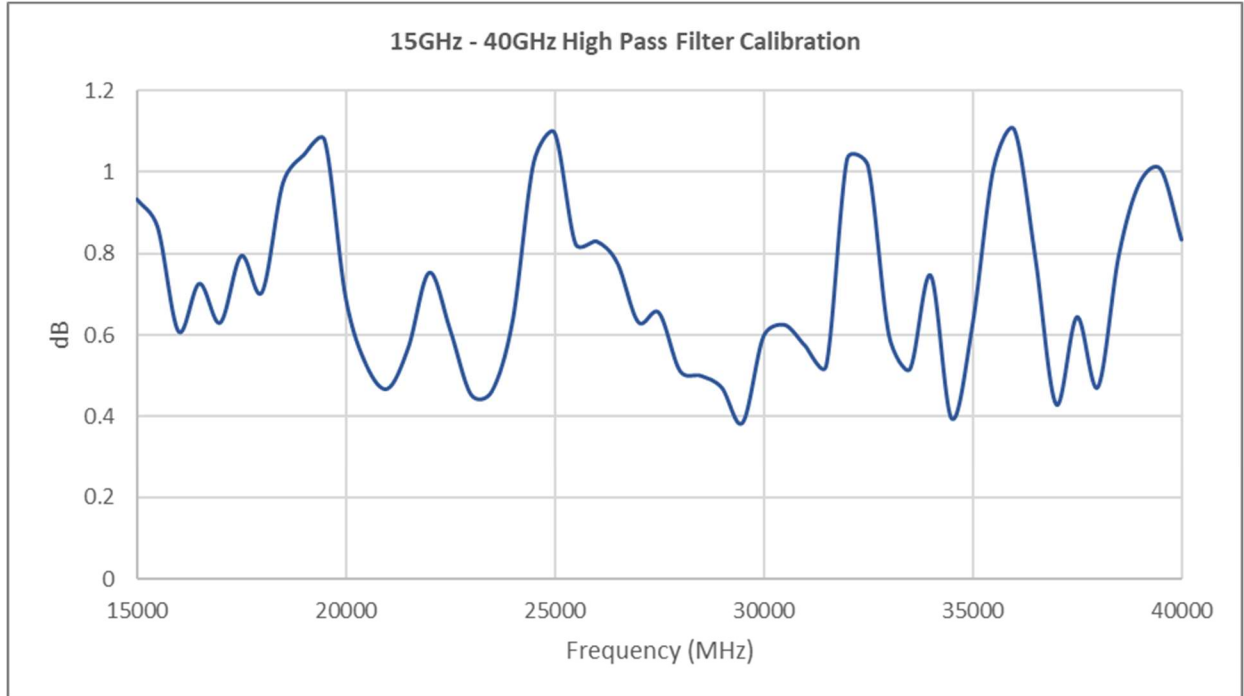
CE106 Test Results Summary:

Port Tested	Radio Module	Mode	Frequency (MHz)	Results (Pass/Fail)
Chain 1 Antenna Port	Lower C-Band	Standby / Receive	1 – 40,000	PASS
Chain 1 Antenna Port	Lower C-Band	Transmit	1 – 40,000	PASS

5.4.5.1 CE106 Calibration Data

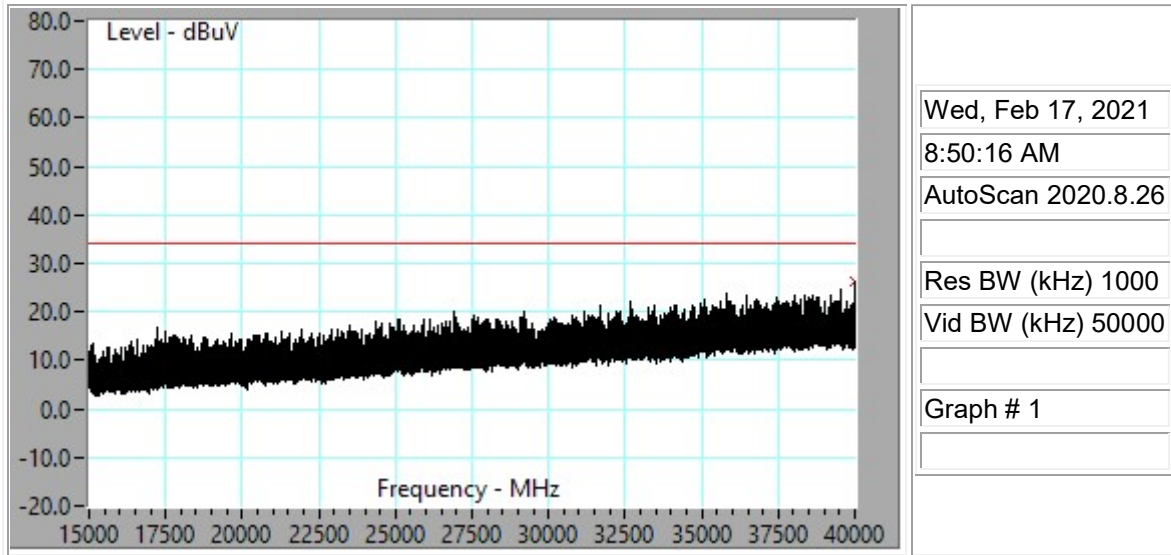






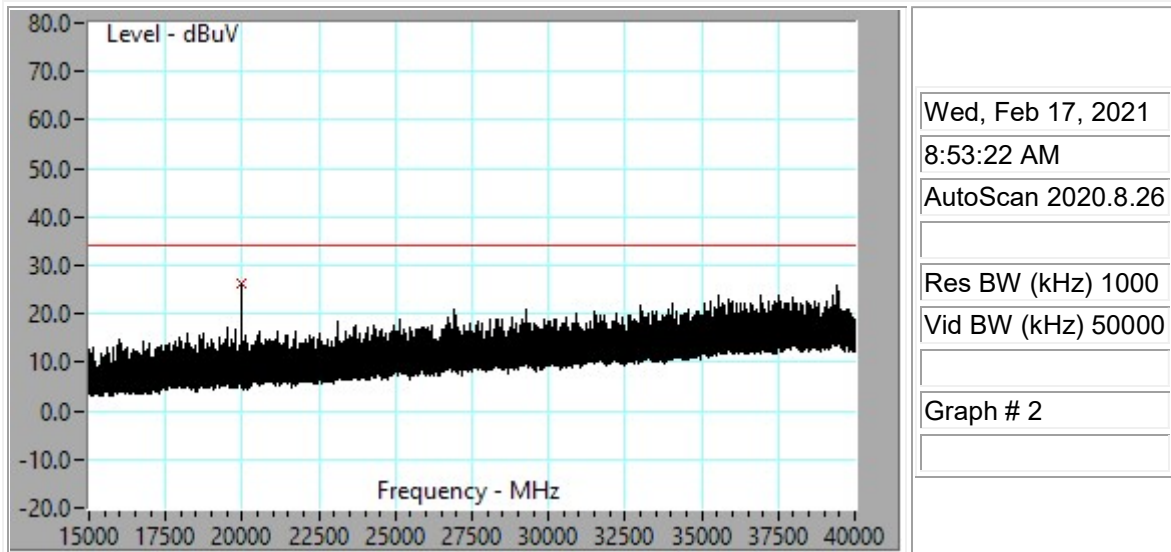
5.4.5.2 CE106 System Check Data

CE106 System Check (Lower C-Band, Standby/Receive Configuration): Calibrated Signal = 26dBuV @ 40GHz.



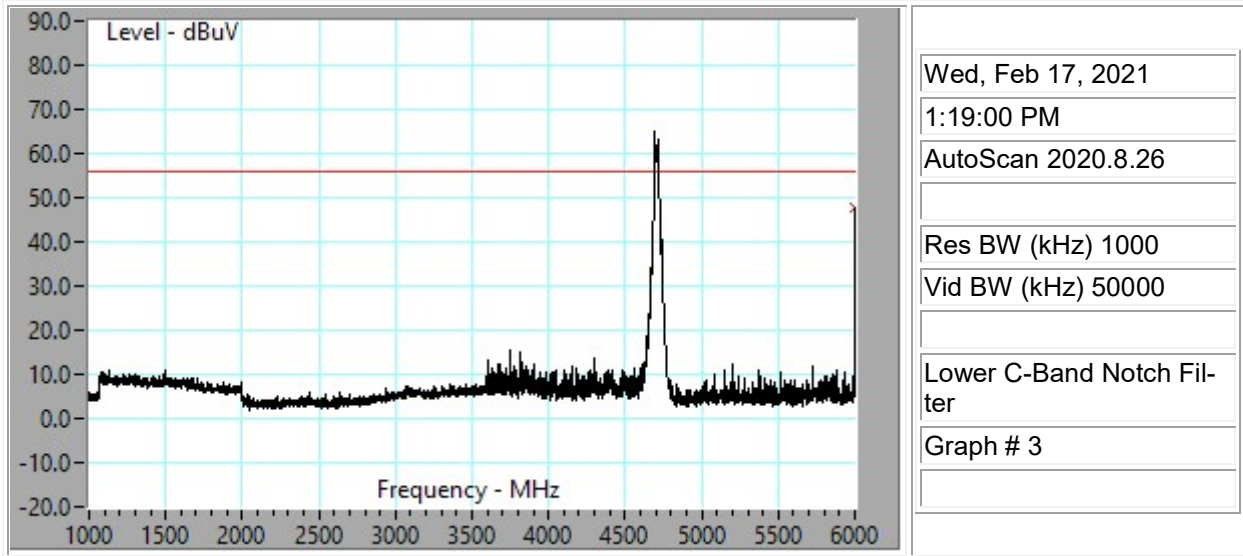
Frequency	Level	Limit	Delta	Raw	Cable	Xducer	All Factors
MHz	dBuV	dBuV	dB	dBuV	dB	dB	dB
39999.5	26.1	34.0	-7.9	21.21	4.89	0.00	-4.89

CE106 System Check (Lower C-Band, Standby/Receive Configuration): Calibrated Signal = 26dBuV @ 20GHz.



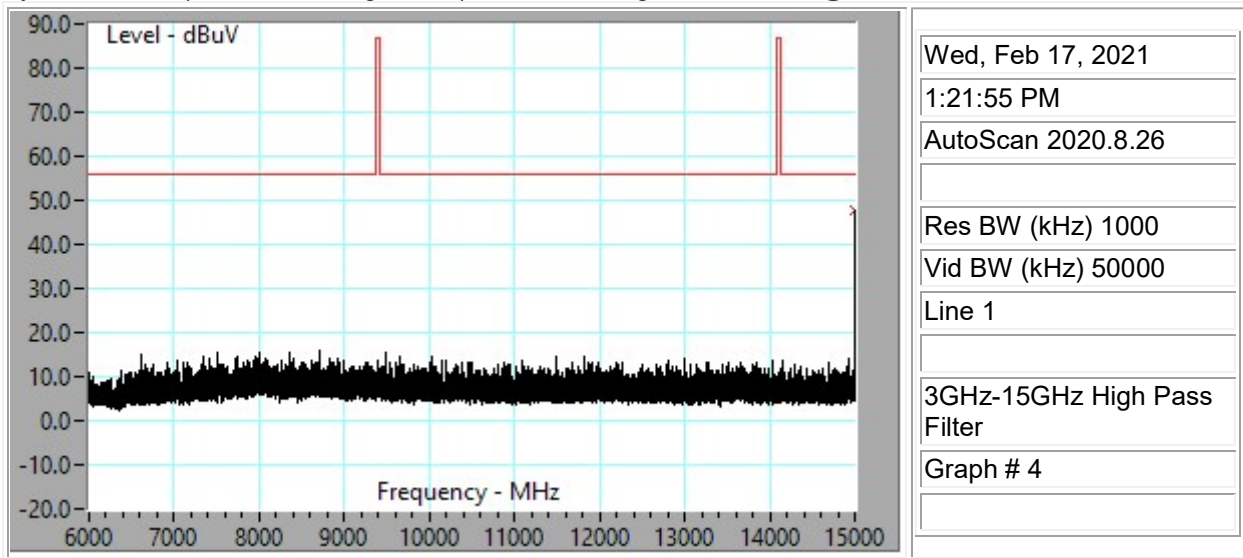
Frequency	Level	Limit	Delta	Raw	Cable	Xducer	All Factors
MHz	dBuV	dBuV	dB	dBuV	dB	dB	dB
20000.1	26.3	34.0	-7.7	23.08	3.19	0.00	-3.19

System Check (Transmit Configuration): Calibrated Signal = 47dBuV @ 6GHz.



Frequency	Level	Limit	Delta		Raw	Cable	Xducer	All Factors
MHz	dBuV	dBuV	dB		dBuV	dB	dB	dB
6000.0	47.5	56.0	-8.5		45.56	1.74	0.21	-1.94

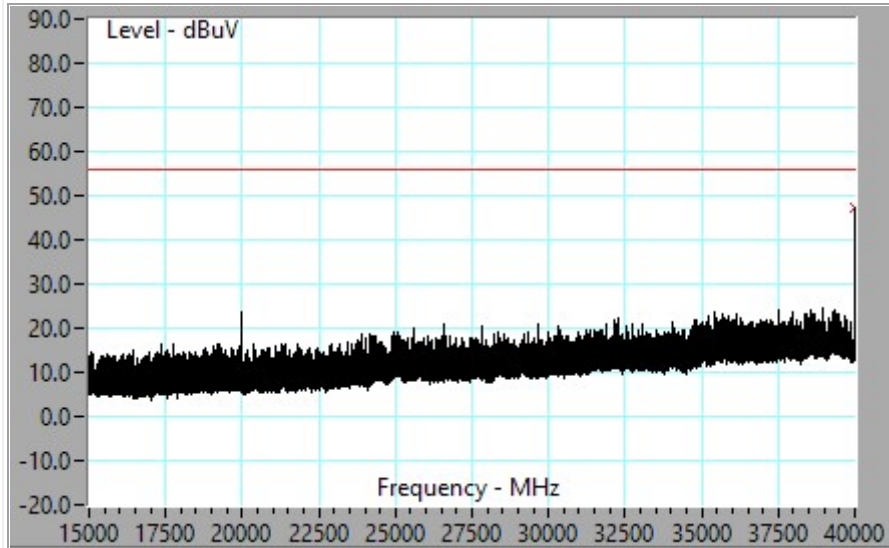
System Check (Transmit Configuration): Calibrated Signal = 47dBuV @ 15GHz.



Frequency	Level	Limit	Delta		Raw	Cable	Xducer	All Factors
MHz	dBuV	dBuV	dB		dBuV	dB	dB	dB
15000.0	47.8	56.0	-8.2		44.33	2.79	0.65	-3.45



System Check (Transmit Configuration): Calibrated Signal = 47dBuV @ 40GHz.



Wed, Feb 17, 2021

1:24:44 PM

AutoScan 2020.8.26

Res BW (kHz) 1000

Vid BW (kHz) 50000

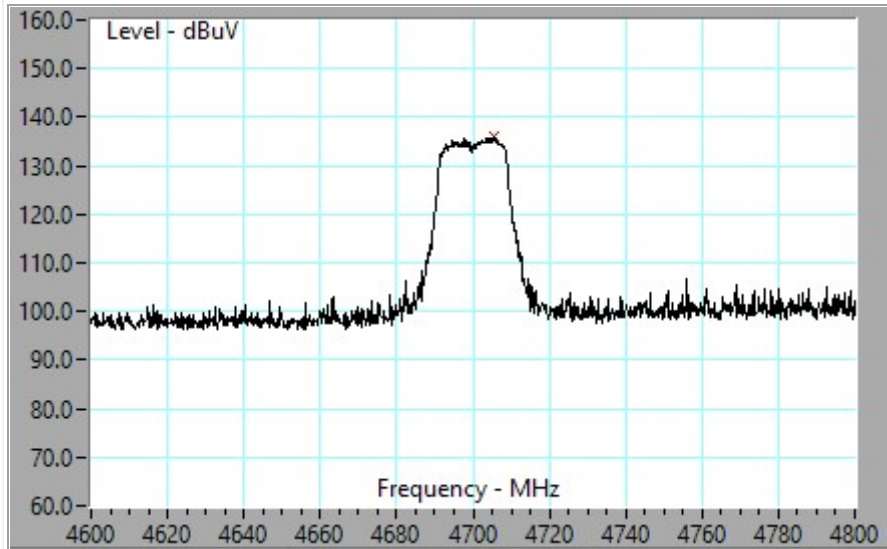
15GHz - 40GHz High
Pass

Graph # 5

Frequency	Level	Limit	Delta		Raw	Cable	Xducer	All Factors
MHz	dBuV	dBuV	dB		dBuV	dB	dB	dB
40000.0	47.2	56.0	-8.8		41.49	4.89	0.83	-5.72

5.4.5.3 CE106 Fundamental Frequency Amplitude Measurement Data

MPU5 Radio (Lower C-Band), Fundamental Measurement.



Wed, Feb 17, 2021

1:00:23 PM

AutoScan 2020.8.26

Res BW (kHz) 1000

Vid BW (kHz) 50000

WC005821 & WC058437

Graph # 2

Frequency	Level	Limit	Delta		Raw	Cable	Xducer	All Factors
MHz	dBuV	dBuV	dB		dBuV	dB	dB	dB
4705.4	136.0	34.0	102.0	F	94.54	1.49	40.00	-41.49

Notes:

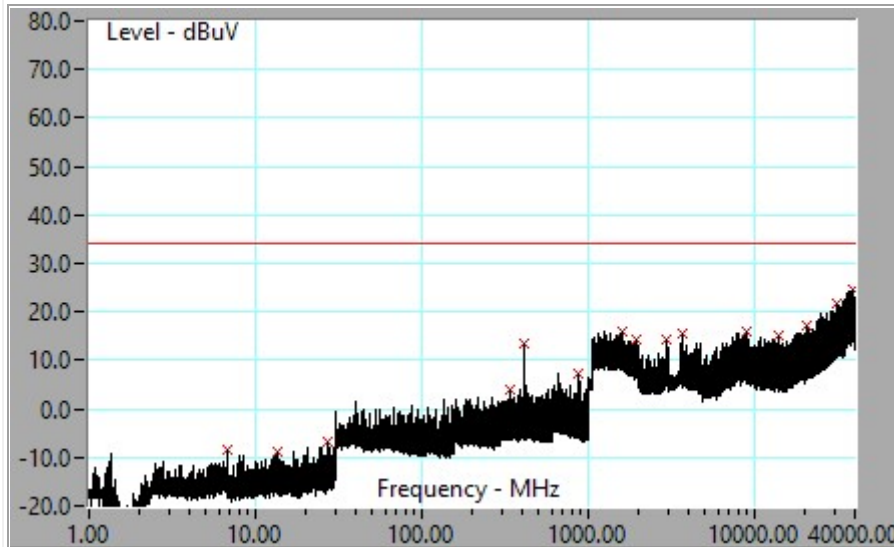
136dBuV = 29dBm

Spurious Limit = 29dBm – 80dB = -51dBm = 56dBuV

2nd/3rd Harmonic Limit = -20dB = 87dBuV

5.4.5.4 CE106 Test Data

CE106 Ambient Scan (Lower C-Band).



Wed, Feb 17, 2021

12:19:28 PM

AutoScan 2020.8.26

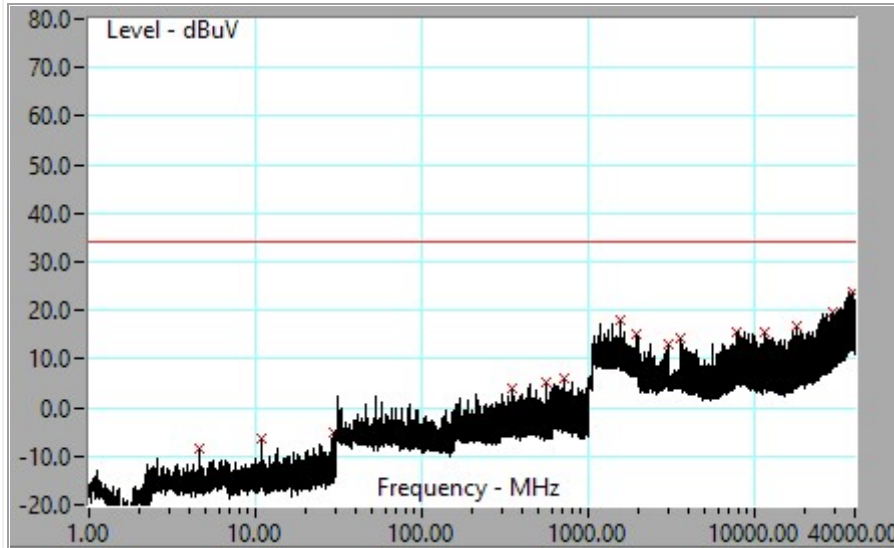
Res BW (kHz) 10, 100, 1000

Vid BW (kHz) 50000

Graph # 13

Frequency	Level	Limit	Delta		Raw	Cable	Xducer	All Factors
MHz	dBuV	dBuV	dB		dBuV	dB	dB	dB
6.748	-8.6	34.0	-42.6		-8.67	0.04	0.00	-0.04
13.433	-9.0	34.0	-43.0		-9.08	0.08	0.00	-0.08
26.930	-6.8	34.0	-40.8		-6.93	0.10	0.00	-0.10
339.300	4.0	34.0	-30.0		3.64	0.40	0.00	-0.40
406.670	13.3	34.0	-20.7		12.87	0.43	0.00	-0.43
878.356	7.5	34.0	-26.5		6.82	0.64	0.00	-0.64
1604.651	16.0	34.0	-18.0		15.16	0.87	0.00	-0.87
1949.237	14.3	34.0	-19.7		13.30	0.95	0.00	-0.95
2968.492	14.3	34.0	-19.7		13.10	1.18	0.00	-1.18
3693.029	15.6	34.0	-18.4		14.36	1.28	0.00	-1.28
8883.246	16.1	34.0	-17.9		13.96	2.11	0.00	-2.11
14037.461	15.0	34.0	-19.0		12.36	2.65	0.00	-2.65
20342.107	17.3	34.0	-16.7		14.03	3.31	0.00	-3.31
31373.328	21.8	34.0	-12.2		17.64	4.18	0.00	-4.18
39267.984	24.8	34.0	-9.2		19.96	4.82	0.00	-4.82

MPU5 Radio (Lower C-Band), Chain 1 Antenna Port, Standby Mode.



Wed, Feb 17, 2021

12:50:37 PM

AutoScan 2020.8.26

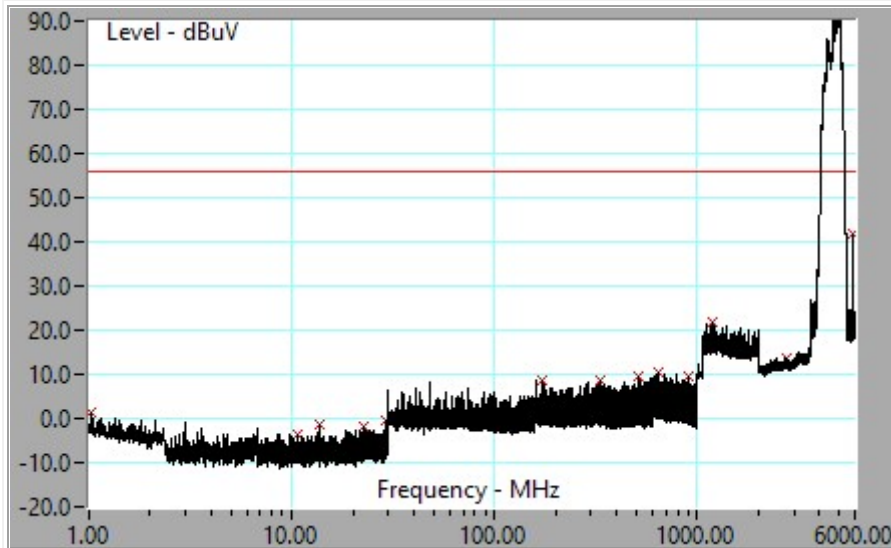
Res BW (kHz) 10, 100, 1000

Vid BW (kHz) 50000

Graph # 1

Frequency	Level	Limit	Delta		Raw	Cable	Xducer	All Factors
MHz	dBuV	dBuV	dB		dBuV	dB	dB	dB
4.601	-8.4	34.0	-42.4		-8.45	0.03	0.00	-0.03
10.862	-6.4	34.0	-40.4		-6.45	0.07	0.00	-0.07
29.855	-5.0	34.0	-39.0		-5.07	0.10	0.00	-0.10
352.396	4.2	34.0	-29.8		3.75	0.40	0.00	-0.40
556.057	5.1	34.0	-28.9		4.62	0.50	0.00	-0.50
707.870	6.0	34.0	-28.0		5.45	0.55	0.00	-0.55
1572.143	18.1	34.0	-15.9		17.26	0.86	0.00	-0.86
1970.243	14.9	34.0	-19.1		13.97	0.96	0.00	-0.96
2999.500	13.1	34.0	-20.9		11.86	1.19	0.00	-1.19
3612.526	14.2	34.0	-19.8		12.96	1.26	0.00	-1.26
7717.197	15.5	34.0	-18.5		13.57	1.97	0.00	-1.97
11589.358	15.5	34.0	-18.5		13.13	2.41	0.00	-2.41
17962.561	16.6	34.0	-17.4		13.57	3.06	0.00	-3.06
29349.287	19.9	34.0	-14.1		15.83	4.03	0.00	-4.03
38625.973	23.7	34.0	-10.3		19.02	4.71	0.00	-4.71

MPU5 Radio (Lower C-Band), Transmit Mode.



Wed, Feb 17, 2021

1:44:13 PM

AutoScan 2020.8.26

Res BW (kHz) 10, 100, 1000

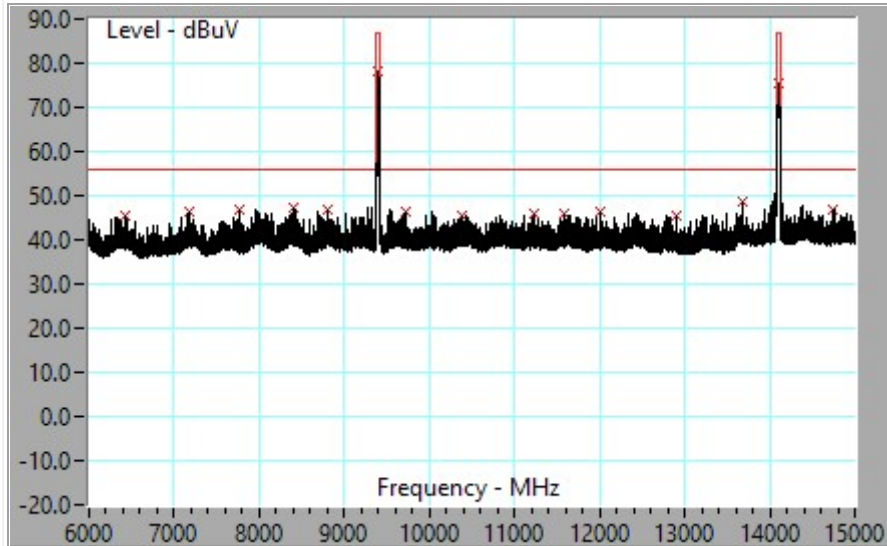
Vid BW (kHz) 50000

Lower C-Band Notch Filter

Graph # 6

Frequency	Level	Limit	Delta		Raw	Cable	Xducer	All Factors
MHz	dBuV	dBuV	dB		dBuV	dB	dB	dB
1.024	1.5	56.0	-54.5		1.44	0.01	0.06	-0.08
10.644	-3.4	56.0	-59.4		-3.50	0.07	0.02	-0.09
13.835	-1.4	56.0	-57.4		-1.51	0.08	0.02	-0.10
22.696	-2.0	56.0	-58.0		-2.11	0.09	0.02	-0.11
29.347	-0.4	56.0	-56.4		-0.56	0.10	0.02	-0.13
173.567	8.7	56.0	-47.3		8.40	0.28	0.05	-0.33
330.230	8.7	56.0	-47.3		8.24	0.39	0.07	-0.46
518.128	9.5	56.0	-46.5		8.92	0.48	0.09	-0.57
647.872	10.5	56.0	-45.5		9.88	0.53	0.09	-0.62
906.342	9.5	56.0	-46.5		8.80	0.65	0.10	-0.75
1197.549	21.8	56.0	-34.2		20.96	0.74	0.11	-0.85
2739.185	13.6	56.0	-42.4		12.29	1.13	0.16	-1.29
5846.211	41.9	56.0	-14.1		39.99	1.68	0.21	-1.88

MPU5 Radio (Lower C-Band), Transmit Mode.



Wed, Feb 17, 2021

2:00:16 PM

AutoScan 2020.8.26

Res BW (kHz) 50000

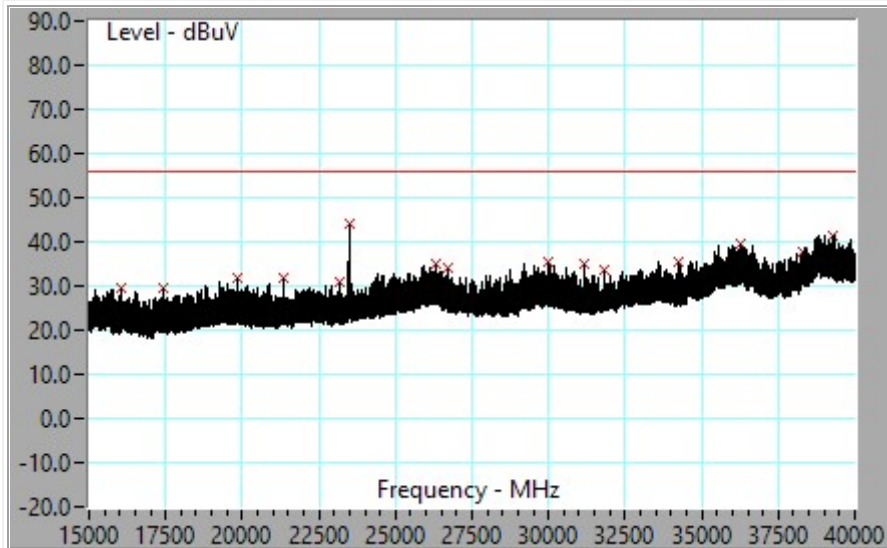
Vid BW (kHz) 50000

3GHz-15GHz High Pass
Filter

Graph # 7

Frequency	Level	Limit	Delta		Raw	Cable	Xducer	All Factors
MHz	dBuV	dBuV	dB		dBuV	dB	dB	dB
6417.5	45.3	56.0	-10.7		43.26	1.78	0.29	-2.08
7180.1	46.5	56.0	-9.5		44.33	1.89	0.31	-2.20
7776.1	46.7	56.0	-9.3		44.42	1.99	0.26	-2.25
8397.6	47.1	56.0	-8.9		44.82	2.03	0.25	-2.28
8795.2	46.7	56.0	-9.3		44.36	2.09	0.25	-2.34
9400.2	78.3	87.0	-8.7		75.90	2.16	0.28	-2.44
9723.7	46.5	56.0	-9.5		44.05	2.19	0.30	-2.49
10392.7	45.6	56.0	-10.4		42.99	2.27	0.33	-2.60
11234.3	45.8	56.0	-10.2		43.14	2.35	0.34	-2.68
11595.3	45.7	56.0	-10.3		42.98	2.41	0.33	-2.74
12002.3	46.2	56.0	-9.8		43.40	2.47	0.32	-2.79
12900.4	45.4	56.0	-10.6		42.47	2.56	0.34	-2.89
13681.9	48.8	56.0	-7.2		45.67	2.64	0.45	-3.09
14110.0	75.5	87.0	-11.5		72.29	2.65	0.52	-3.17
14750.0	47.0	56.0	-9.0		43.63	2.73	0.61	-3.35

MPU5 Radio (Lower C-Band), Transmit Mode.



Wed, Feb 17, 2021

2:20:25 PM

AutoScan 2020.8.26

Res BW (kHz) 1000

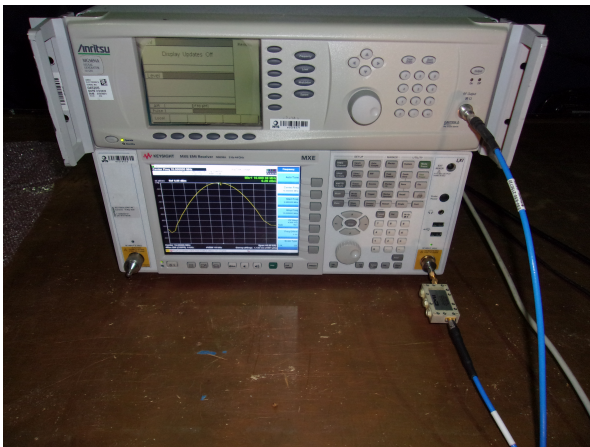
Vid BW (kHz) 50000

15GHz - 40GHz High
Pass

Graph # 8

Frequency	Level	Limit	Delta		Raw	Cable	Xducer	All Factors
MHz	dBuV	dBuV	dB		dBuV	dB	dB	dB
16078.0	29.3	56.0	-26.7		25.88	2.83	0.63	-3.46
17408.0	29.4	56.0	-26.6		25.63	2.99	0.76	-3.75
19817.1	31.7	56.0	-24.3		27.66	3.19	0.83	-4.02
21318.1	31.8	56.0	-24.2		27.90	3.34	0.53	-3.87
23200.7	30.7	56.0	-25.3		26.74	3.52	0.46	-3.98
23494.7	44.0	56.0	-12.0		40.00	3.57	0.46	-4.03
26333.2	34.9	56.0	-21.1		30.39	3.74	0.79	-4.53
26709.2	34.0	56.0	-22.0		29.52	3.75	0.72	-4.47
29992.3	35.6	56.0	-20.4		30.96	4.04	0.59	-4.63
31175.3	35.0	56.0	-21.0		30.28	4.14	0.56	-4.69
31833.3	33.7	56.0	-22.3		28.68	4.18	0.86	-5.05
34239.9	35.6	56.0	-20.4		30.68	4.37	0.58	-4.95
36283.4	39.7	56.0	-16.3		34.26	4.51	0.93	-5.43
38313.0	37.7	56.0	-18.3		32.35	4.63	0.67	-5.30
39255.0	41.5	56.0	-14.5		35.66	4.82	0.99	-5.81

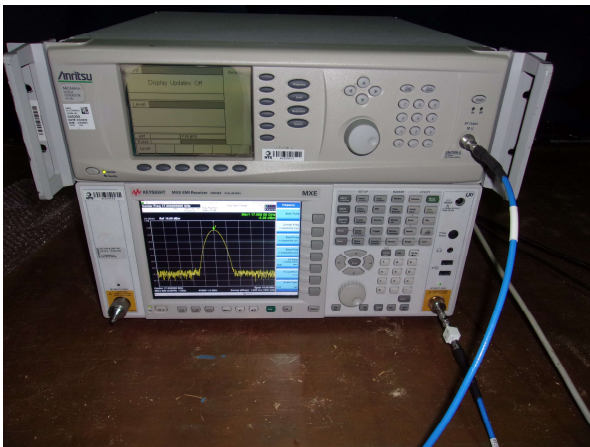
5.4.6 CE106 Photographs



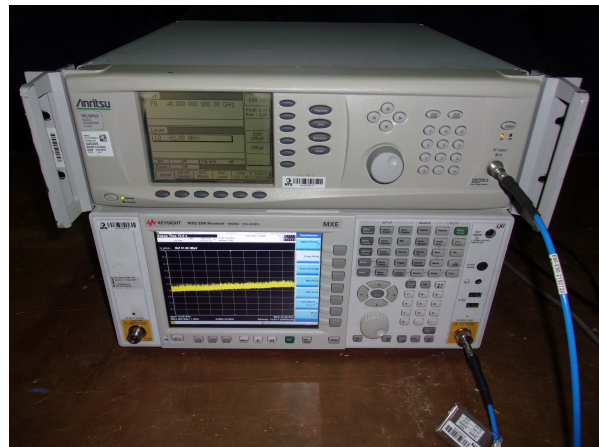
01 - Lower C-Band Notch Filter Calibration



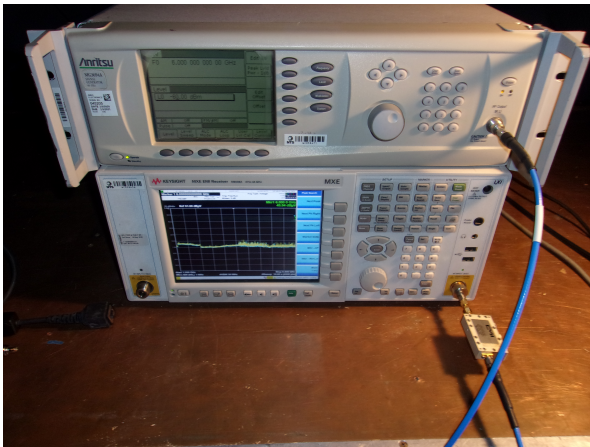
02 - 3GHz to 15GHz High Pass Filter Calibration



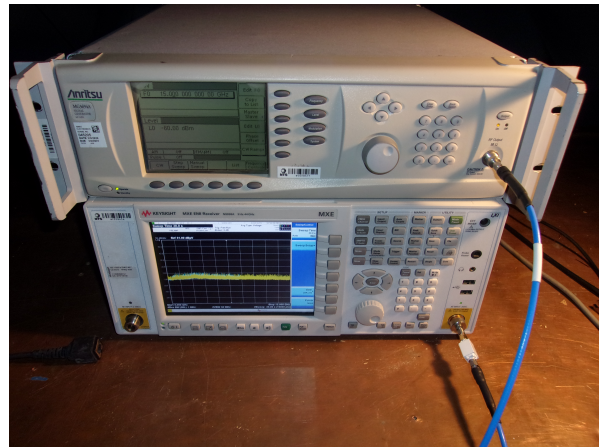
03 - 15GHz to 40GHz High Pass Filter Calibration



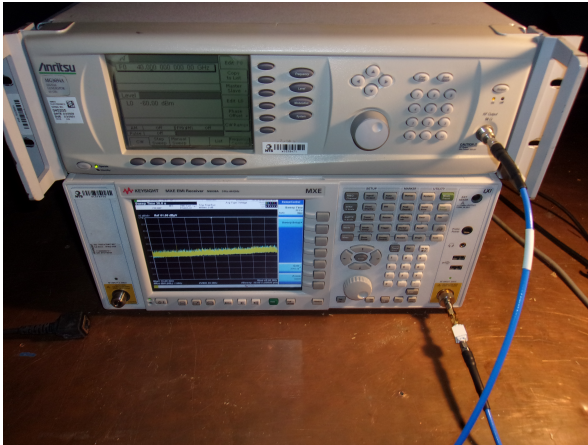
04 - System Check, (Standby Configuration)



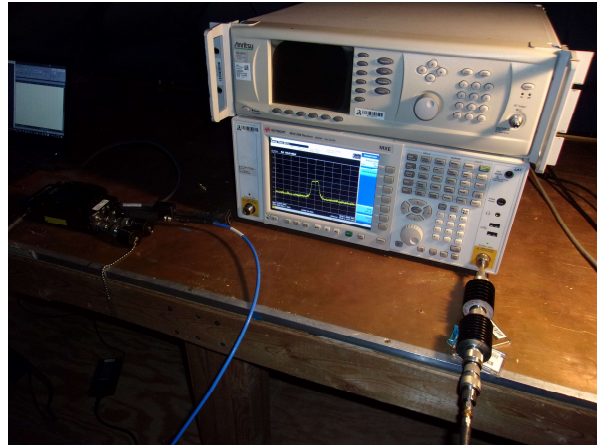
05 - System Check, 1MHz to 6GHz



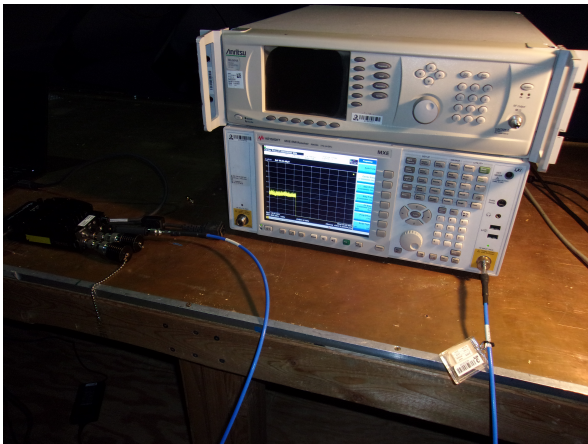
06 - System Check, 6GHz to 15GHz



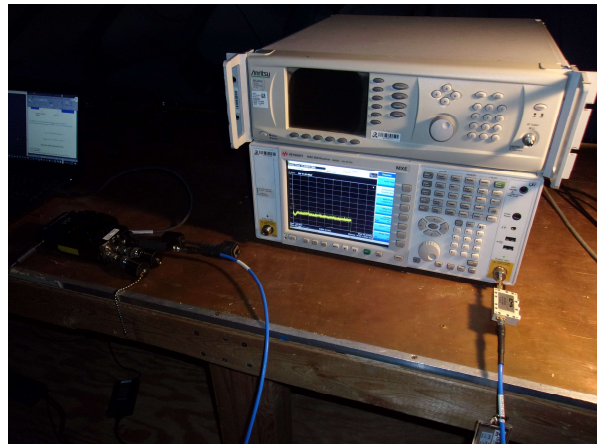
07 - System Check, 15GHz to 40GHz



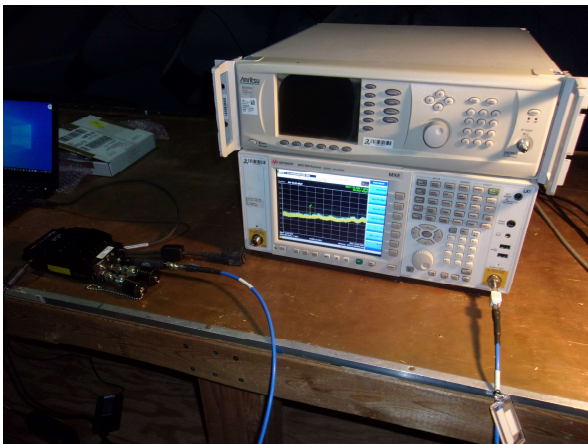
08 - Lower C-Band Fundamental Measurement



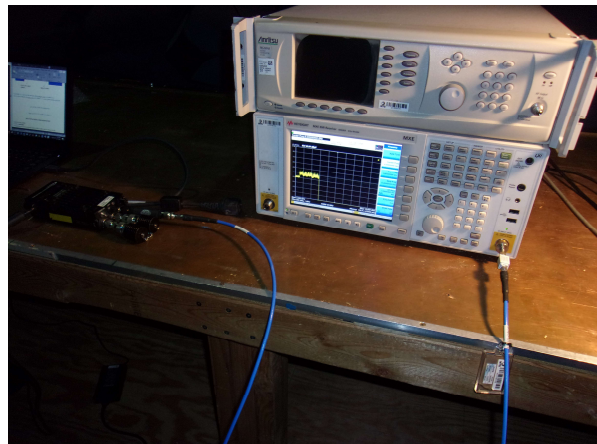
09 - CE106 Test Setup (Standby)



10 - CE106 Test Setup, 1MHz to 6GHz



11 - CE106 Test Setup, 6GHz to 15GHz



12 - CE106 Test Setup, 15GHz to 40GHz

5.4.7 CE106 Test Equipment

Table 5.2-1: CE106 Test Equipment

Asset Number	Manufacturer	Make	Model Number	Serial Number	Cal Cycle (Months)	Cal Due
WC058456	Agilent	MXE EMI Receiver, 2Hz – 44GHz	N9038A	MY57190108	12	5/19/21
WC058471	Anritsu	10MHz – 40GHz Signal Generator	MG3694A	045205	12	03/03/21
WC058500	Winchester Interconnect	SRC-215, 2.9mm Coax Cable, 72"	E50-E50-2150720	None	24	6/2/22
WC005821	Narda	20dB Attenuator	766A-20	100230	36	10/4/21
WC058436	Weinschel	20dB Attenuator	34-20-34	BP8101	36	9/27/21
None	Corry Micronics, Inc.	Lower C-Band Notch Filter	CMINF04580482B01	194000123	NCR	NCR
None	Microwave Circuits	3 – 15GHz High Pass Filter	H3G020G2	505818	NCR	NCR
None	Microwave Circuits	15 – 40GHz High Pass Filter	H11F40G1	505817	NCR	NCR

NCR = No Calibration Required; as per NTS QA policy, the equipment does not require calibration as long as the test signal being generated can be verified with other calibrated equipment prior to or during the test.

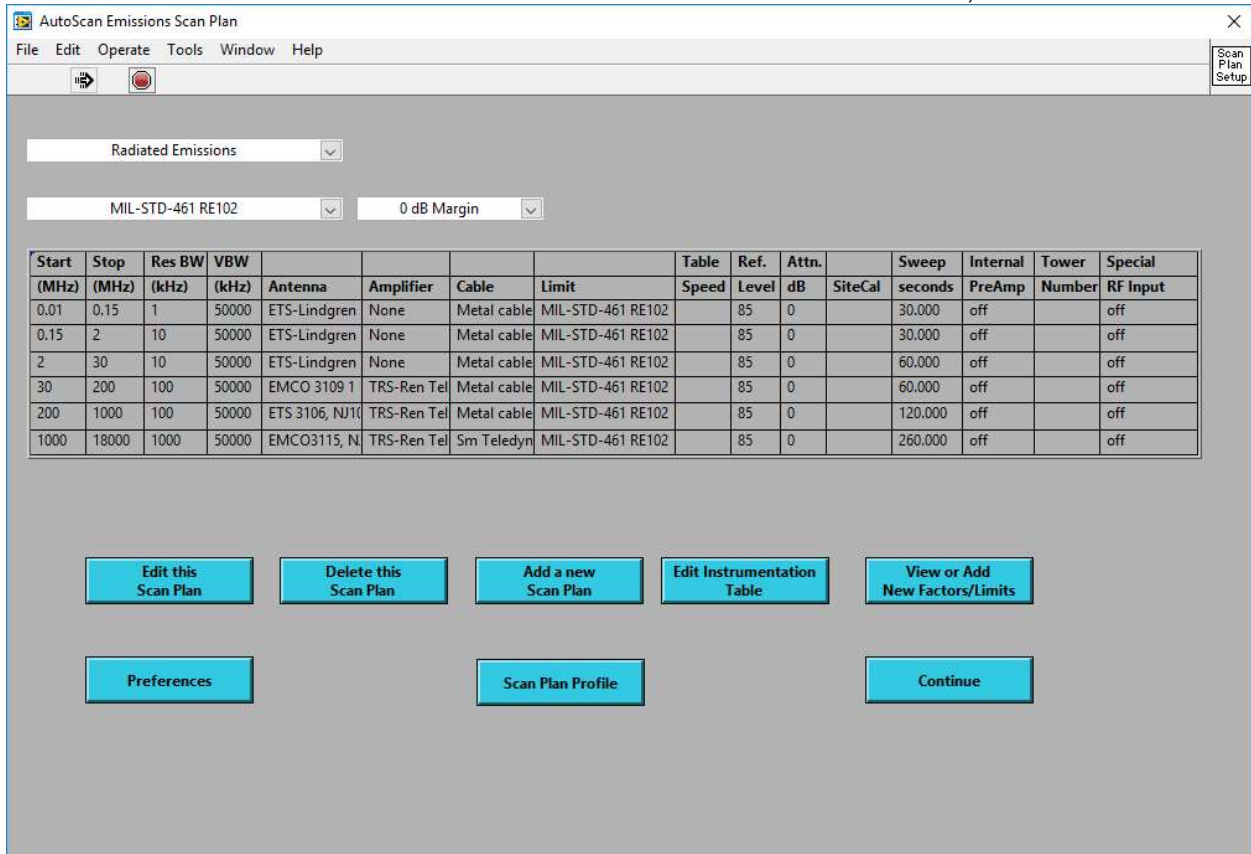
Appendix A: Test Software Description

AutoScan™ EMI Measurement Software

The AutoScan software is a National Instruments LabVIEW™ compiled package, specifically designed by EMCware for automation of Radiated and Conducted RF Emission measurements.

The AutoScan Emissions Scan Plan window shows the administrator defined test parameters including Start Frequency, Stop Frequency, Resolution Bandwidth, Video Bandwidth, Antenna, Amplifier, Cable, Limit, Reference Level, Attenuation and Sweep Time.

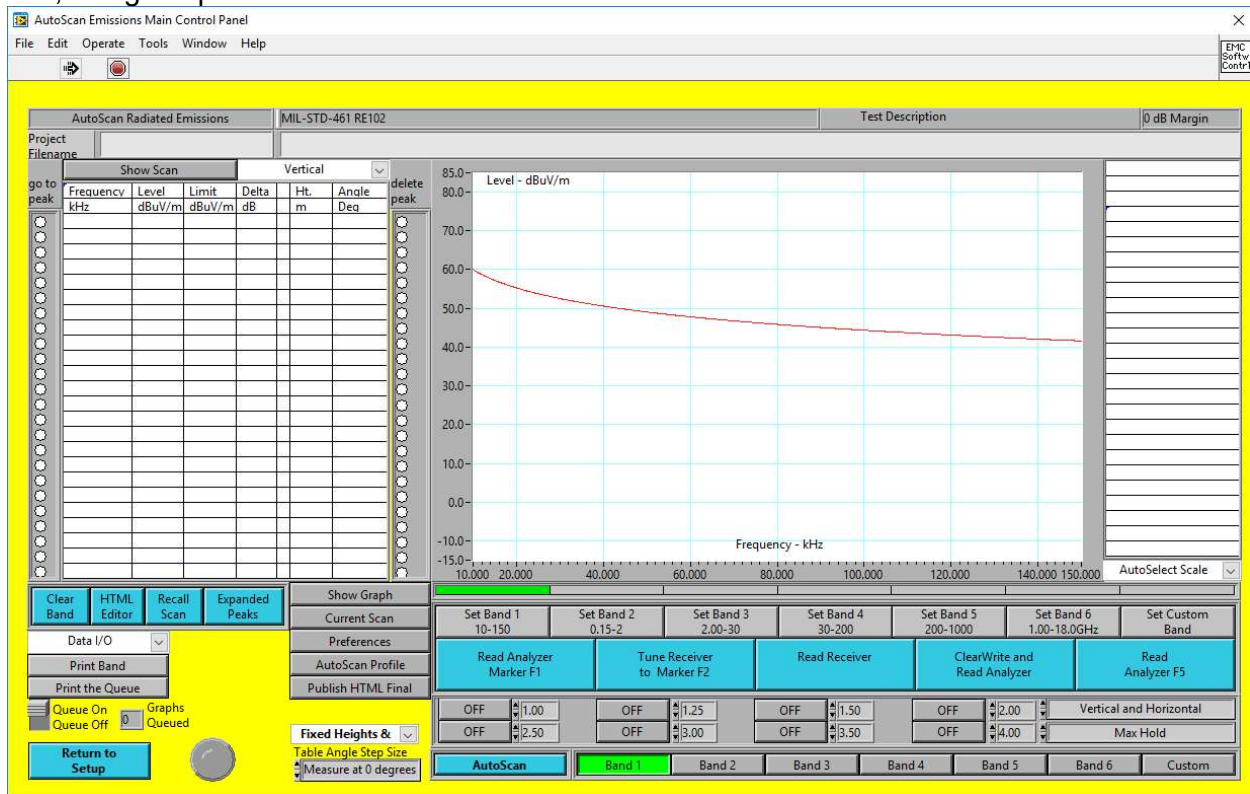
The Scan Plan shown below has been defined in order to perform the radiated emissions test in accordance with MIL-STD-461 RE102. Similar Scan Plans have been defined for CE101, CE102 and RE101.



Start (MHz)	Stop (MHz)	Res BW (kHz)	VBW (kHz)	Antenna	Amplifier	Cable	Limit	Table	Ref. Level	Attn. dB	SiteCal	Sweep seconds	Internal PreAmp	Tower Number	Special RF Input
0.01	0.15	1	50000	ETS-Lindgren	None	Metal cable	MIL-STD-461 RE102		85	0		30.000	off		off
0.15	2	10	50000	ETS-Lindgren	None	Metal cable	MIL-STD-461 RE102		85	0		30.000	off		off
2	30	10	50000	ETS-Lindgren	None	Metal cable	MIL-STD-461 RE102		85	0		60.000	off		off
30	200	100	50000	EMCO 3109 1	TRS-Ren Tel	Metal cable	MIL-STD-461 RE102		85	0		60.000	off		off
200	1000	100	50000	ETS 3106, NJ10	TRS-Ren Tel	Metal cable	MIL-STD-461 RE102		85	0		120.000	off		off
1000	18000	1000	50000	EMCO3115, N	TRS-Ren Tel	Sm Teledyn	MIL-STD-461 RE102		85	0		260.000	off		off



The AutoScan Emissions Main Control Panel window shown below was used to execute the test, using the parameters defined in the Scan Plan.

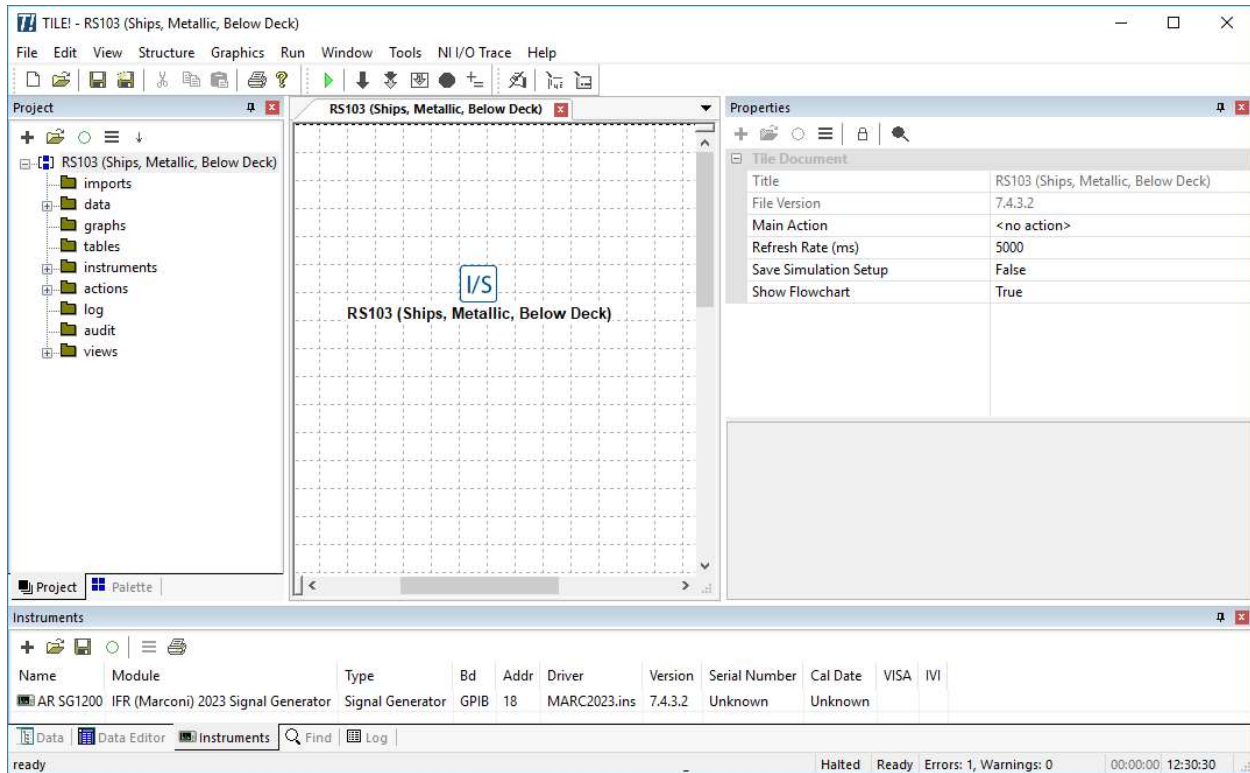




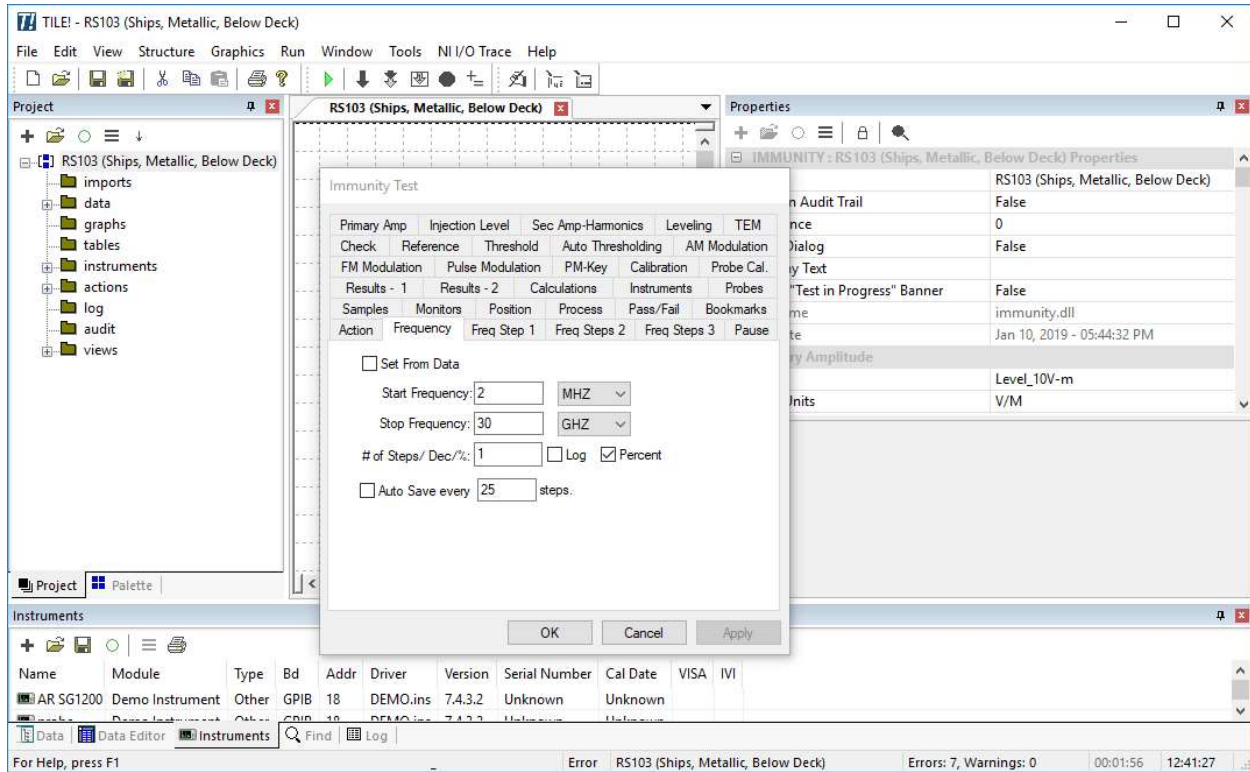
ETS-Lindgren Totally Integrated Laboratory Environment (TILE!)

The C++ compiled Totally Integrated Laboratory Environment (TILE!™) software by ETS-Lindgren is used for RS103 and CS101 testing.

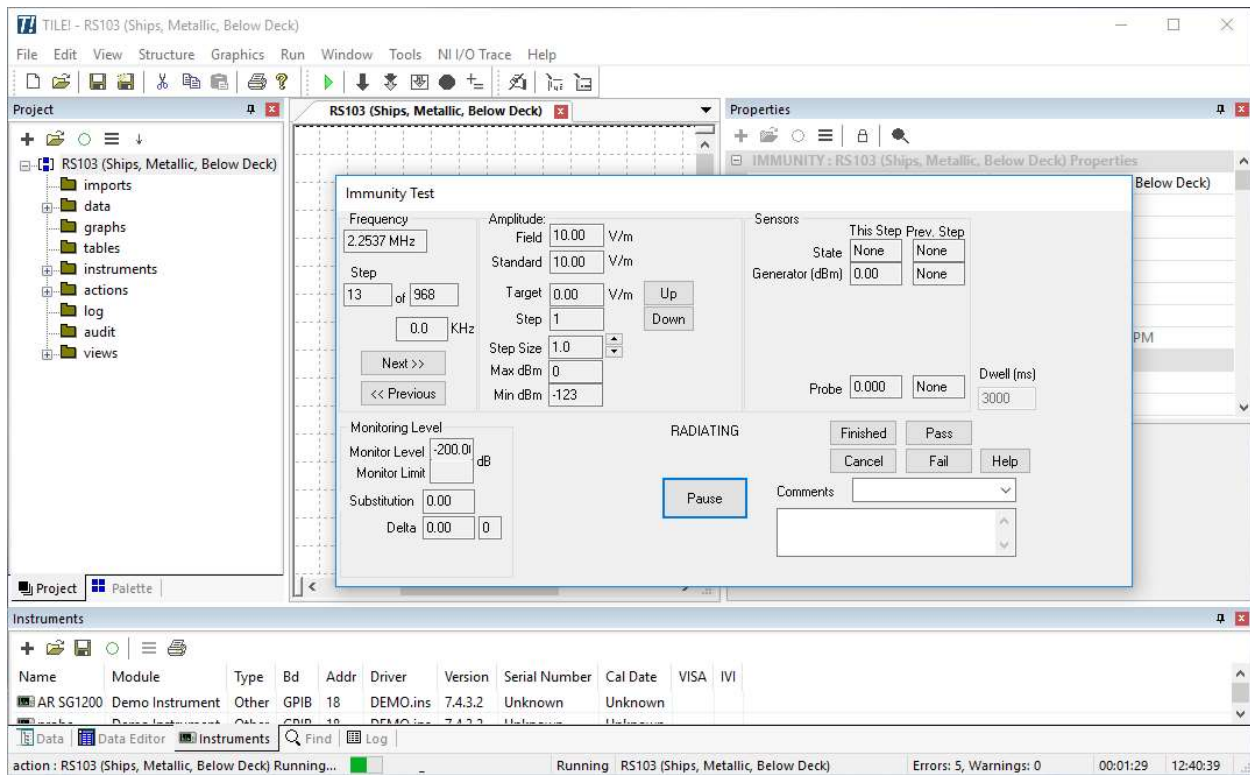
The screen below shows the main TILE! Program with the Administrator defined profile opened for MIL-STD-461 RS103 (Ships, Metallic, Below Deck). Similar profiles have been defined for CS101.



The screen below shows the properties tabs of the Administrator defined profile. In these tabs, the administrator has defined the frequency range, step size, test level, modulation type, dwell time, instrumentation, etc.



The screen below shows the running profile, where the user can monitor the test in progress.



----- End of Test Report -----



National Technical Systems Test Report for Environmental Testing of the MPU5

Prepared For

Persistent Systems LLC | 303 Fifth Avenue, Suite 306 | New York, NY 10016

Performed By

National Technical Systems | 36 Gilbert Street South | Tinton Falls, NJ 07701 | 732-936-0800 | www.nts.com

A handwritten signature in black ink, reading "Brett Leslie", positioned above a horizontal line.

Brett Leslie
Technical Writer

A handwritten signature in black ink, reading "Mark Betts", positioned above a horizontal line.

Mark Betts
ENV Project Engineer

A handwritten signature in black ink, reading "Mark Betts", positioned above a horizontal line.

Mark Betts
Quality Management Representative

This report and the information contained herein represents the results of testing of only those articles/products identified in this document and selected by the client. The tests were performed to specifications and/or procedures approved by the client. National Technical Systems ("NTS") makes no representations expressed or implied that such testing fully demonstrates efficiency, performance, reliability, or any other characteristic of the articles being tested, or similar products. This report should not be relied upon as an endorsement or certification by NTS of the equipment tested, nor does it present any statement whatsoever as to the merchantability or fitness of the test article or similar products for a particular purpose. This document shall not be reproduced except in full without written approval from NTS.



Revision History

Rev.	Description	Issue Date
0	Initial Release	06/30/2021
1	Added requested test items and part numbers, as well as a note to the test log	07/08/2021

Table of Contents

1.0	Introduction	4
2.0	References	4
3.0	Product Selection and Description.....	4
	3.0.1 Received EUT Photographs.....	4
	3.1 Security Classification	5
4.0	General Test Requirements.....	5
	4.1 Test Equipment	5
5.0	Test Descriptions and Results.....	6
	5.1 Explosive Atmosphere	7
	5.1.1 Test Procedure	7
	5.1.2 Test Result	7
	5.1.3 Test Datasheets	7
	5.1.4 Test Photographs	9
	5.1.5 Test Data.....	10
	5.1.6 Test Equipment List.....	11

List of Tables

Table 3.0-1: Product Identification - Equipment Under Test (EUT).....	4
Table 5.0-1: Summary of Test Information & Results	6
Table 5.1-1: Explosive Atmosphere Test Equipment List	11

1.0 Introduction

This document presents the test procedures used and the results obtained during the performance of an Environmental (ENV) test program. The test program was conducted to assess the ability of the specified Equipment Under Test (EUT) to successfully satisfy the requirements listed in Section 2.0.

2.0 References

The following references listed below form a part of this document to the extent specified herein.

- Test Specification: MIL-STD-810G, *Department of Defense Test Method Standard, Environmental Engineering Considerations and Laboratory Tests*, dated 10/31/2008
- Persistent Systems LLC Purchase Order(s) PS00000560, dated 06/22/2021
- National Technical Systems (NTS) Quote(s) OP0587069-0, dated 06/17/2021
- ISO/IEC 17025:2017(E) *General Requirements for the Competence of Testing and Calibration Laboratories*, dated 11/1/2017

3.0 Product Selection and Description

Persistent Systems LLC selected and provided the test sample(s) to be used as the Equipment Under Test. Details below:

Table 3.0-1: Product Identification - Equipment Under Test (EUT)

Item	Qty.	Name/Description	Part Number	Serial Number
1	1	MPU5	WR-5100	50697
1	1	Lower C-Band Radio Module	RF-4100	B20614
1	1	MPU5 Battery	BAT06	N/A
1	1	3.5 dBi Omnidirectional Gooseneck Antenna	ANT-4006	N/A
1	1	22-Pin to IP67-Rated Ethernet Jack	CBL-DATA-2013	N/A
1	1	GPS Antenna	ANT-4001	N/A

3.0.1 Received EUT Photographs



MPU5



RF-4100



3.1 Security Classification

Non-classified

4.0 General Test Requirements

4.1 Test Equipment

The instrumentation used in the performance of these tests is periodically calibrated and standardized within manufacturer's rated accuracies and are traceable to the National Institute of Standards and Technology. The calibration procedures and practices are in accordance with ISO 17025:2017. Certification of calibration is on file subject to inspection by authorized personnel.



5.0 Test Descriptions and Results

Table 5.0-1: Summary of Test Information & Results

Section	Test	Specification	Test Facility	Test Date	Part #	Serial #	Test Result
5.1	Explosive Atmosphere	MIL-STD-810G, Method 511.5	Tinton Falls	06/24/2021	WR-5100	50697	Passed
					RF-4100	B20614	
					BAT06	N/A	
					ANT-4006	N/A	
					CBL-DATA-2013	N/A	
					ANT-4001	N/A	

The decision rule for Test Results was based on the Test Specification used for testing.



GENERAL LOG SHEET			
Job Number: PR141191		Date: 6/24/21	Page 1 of 1
Client: Persistent Systems			
Test: Explosive Atmosphere		Test Item: MPU5	
Specification: MIL-STD-810G		Model or P/N: WR-5100, RF-4100, BAT06, ANT-4006, CBL-DATA-2013, ANT-4001	
Para./Sect.: Method 511.5		S/N(s): 50697, B20614	
Date	Time	Log Entries	Init.
6/24	9:11	Started heating chamber to 50C	BP
6/24	13:15	Brought chamber to 2000ft in altitude	BP
6/24	13:19	Added 215ml of hexane	BP
6/24	13:23	Verified the explosiveness of the chamber	BP
6/24	13:25	Powered on the EUT and performed a functional check	BP
6/24	13:31	Completed Testing - Pass	BP
		Note: The function check included a wireless throughput test to simulate operational radio frequency transmission of the EUT.	
Test Performed By: Brian Pasznik			

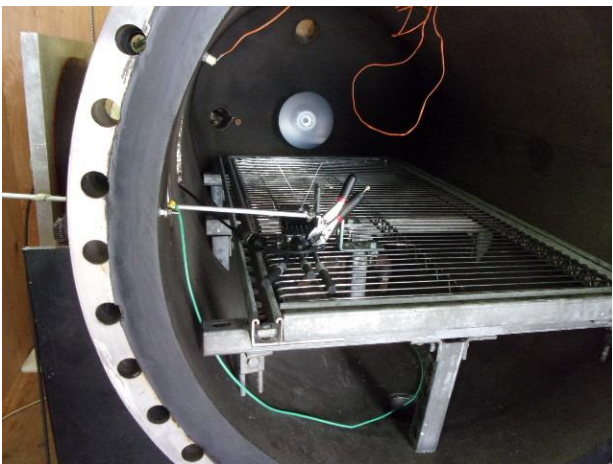
5.1.4 Test Photographs



MPU5



RF-4100

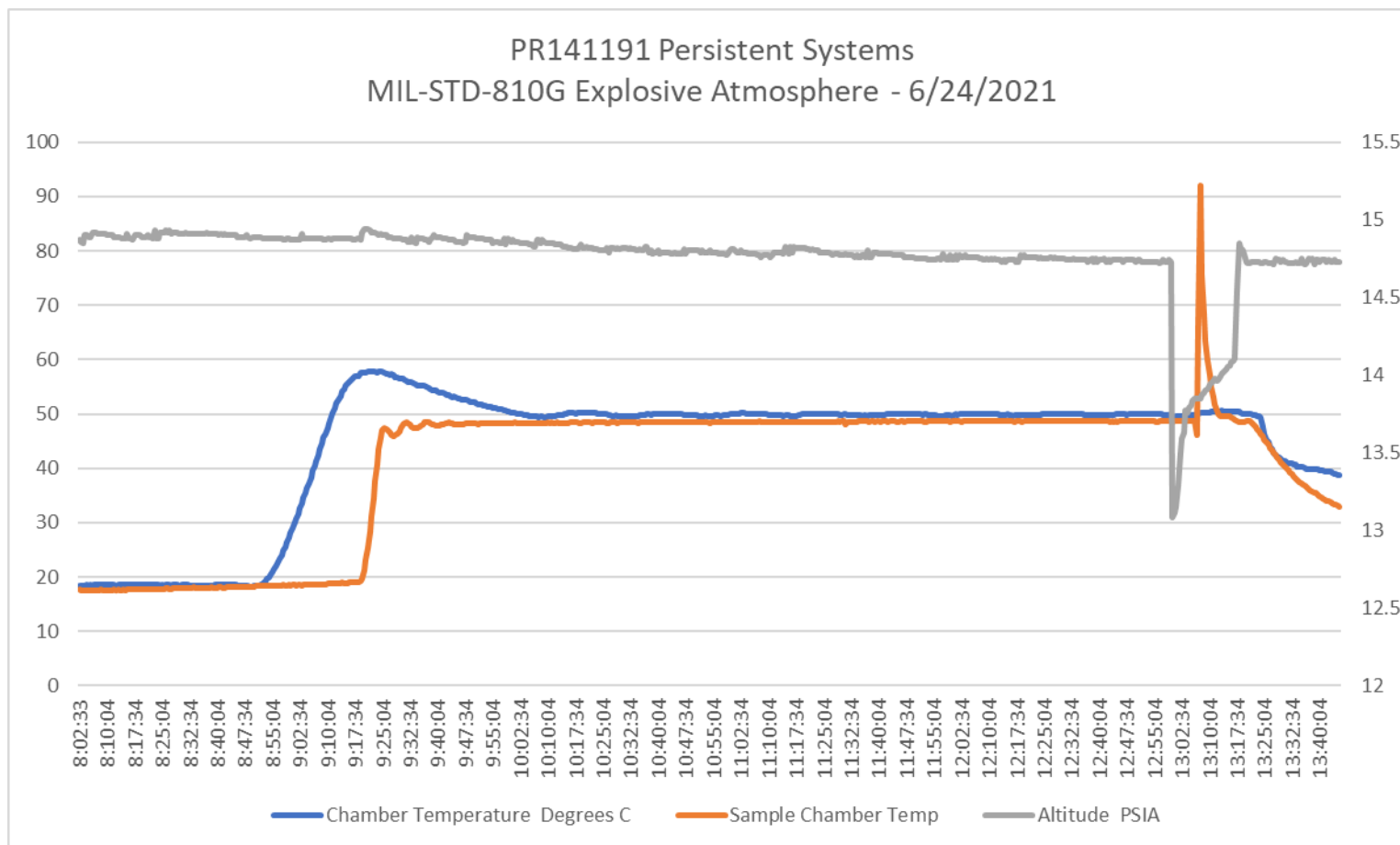


Explosive Atmosphere



Explosive Atmosphere 2

5.1.5 Test Data





5.1.6 Test Equipment List

Table 5.1-1: Explosive Atmosphere Test Equipment List

Asset Number	Asset Type	Manufacturer	Model	Calibrated	Due
WC005609	Chamber (Explosive Atmosphere)	National Technical Systems	NTS	10/13/2020	10/13/2021

Calibration Abbreviations

CAL: Calibration

NCR: No Calibration Required



End of Test Report



Test Report No. PRO66693.PER.EMC Rev 3

MIL-STD-461F Electromagnetic Compatibility Testing of the Persistent Systems, Inc.

**MPU5 - Model No. WR5100 with S-Band Radio Card and Embedded
Module, Model 5200 paired with L-Band Card, Model No. RF1100**

Prepared For: Persistent Systems LLC.
303 Fifth Avenue, Suite 306
New York, NY 10016

Prepared By: National Technical Systems
36 Gilbert Street South
Tinton Falls, NJ 07724
(732) 936-0800
www.nts.com

Issued: 3/16/18 (Rev. 3)

This report and the information contained herein represents the results of testing of only those articles/products identified in this document and selected by the client. The tests were performed to specifications and/or procedures approved by the client. National Technical Systems ("NTS") makes no representations expressed or implied that such testing fully demonstrates efficiency, performance, reliability, or any other characteristic of the articles being tested, or similar products. This report should not be relied upon as an endorsement or certification by NTS of the equipment tested, nor does it present any statement whatsoever as to the merchantability or fitness of the test article or similar products for a particular purpose. This document shall not be reproduced except in full without written approval from NTS.



Revision Page

Rev. No	Date	Page No.	Para. No.	Description
0	10/06/17	-	-	Initial Release
1	10/9/17	6	3	Added PN & SN for WR5200 & RF1100.
2	2/23/18	Various	Various	Various minor formatting & informational changes.
3	3/16/18	69	8.1	Removed Graph # 26, as it was a duplicate of Graph # 25.



Signatures

Prepared by _____
Paul Scott, EMC Test Engineer

Reviewed by _____
Mark Betts, Program Manager

Approved by _____
David Potpink, Quality Manager

Table of Contents

1.0 Purpose.....	5
2.0 References.....	5
3.0 Equipment Under Test	6
4.0 Test Equipment	6
5.0 Test Dates.....	6
6.0 General Test Conditions and Requirements	7
7.0 Test Program Summary	10
8.0 Test Methods	11
8.1 Radiated Emissions: Method RE102 Electric Field 10 kHz to 18 GHz	11
Appendix A - Beam Width Calculations.....	92
Appendix B - Test Software Description.....	98

1.0 Purpose

This document contains the test procedures for an Electromagnetic Interference (EMI)/Electromagnetic Compatibility (EMC) test program. The purpose of this test program is to determine the ability of the MPU5 - Model No. WR5100 with S-Band Radio Card and Embedded Module, Model 5200 paired with L-Band Card, Model No. RF1100 to successfully satisfy the requirements specified in the references listed in Section 2.0 of this document.

2.0 References

- NTS Quote Number – OP0222985, Dated 07/24/2017.
- Persistent Systems LLC. Purchase Order Number: 15930, Dated 07/17/17.
- Persistent Systems LLC. Test Procedure: None
- ISO/IEC 17025, *General Requirements for the Competence of Testing and Calibration Laboratories*, 2005
- ANSI NCSL Z540-1, *Calibration Laboratories and Measuring and Test Equipment—General Requirements*
- MIL-STD-461F, *Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment*, 10December 2007

2.1 Definitions

The terms used in this document are defined in ANSI C63.14. In addition, the following definitions are applicable for the purpose of this test report.

2.1.1 Acronyms Used in This Document

- a. EMC - Electromagnetic Compatibility
- b. EMI - Electromagnetic Interference
- c. EUT - Equipment Under Test
- d. LISN - Line Impedance Stabilization Network
- e. RF - Radio Frequency

2.2 Test Article Identification

2.2.1. Name: MPU5 - Model No. WR5100 with S-Band Radio Card and Embedded Module, Model 5200 paired with L-Band Card, Model No. RF1100

3.0 Equipment Under Test

Item #	Description	Manufacturer	Part/Model Number	Serial Number
1	MPU5 - Model No. WR5100 with S-Band Radio Card	Persistent Systems LLC.	WR5100 & RF2100	28320 & 5822
2	Embedded Module, Model 5200 paired with L-Band Card, Model No. RF1100	Persistent Systems LLC.	WR5200 & RF1100	0187 & B-507

3.1 Support Equipment and Monitoring

The EUT was setup and monitored by Persistent Systems personnel.

4.0 Test Equipment

The instrumentation used in the performance of these tests is periodically calibrated and standardized within manufacturer's rated accuracies and are traceable to the National Institute of Standards and Technology. The calibration procedures and practices are in accordance with ANSI/NCSL Z540-1 and ISO 17025:2005. Certification of calibration is on file subject to inspection by authorized personnel.

5.0 Test Dates

Test	Test Dates
RE102	10/02/17 – 10/04/17

6.0 General Test Conditions and Requirements

6.1 Test Facility

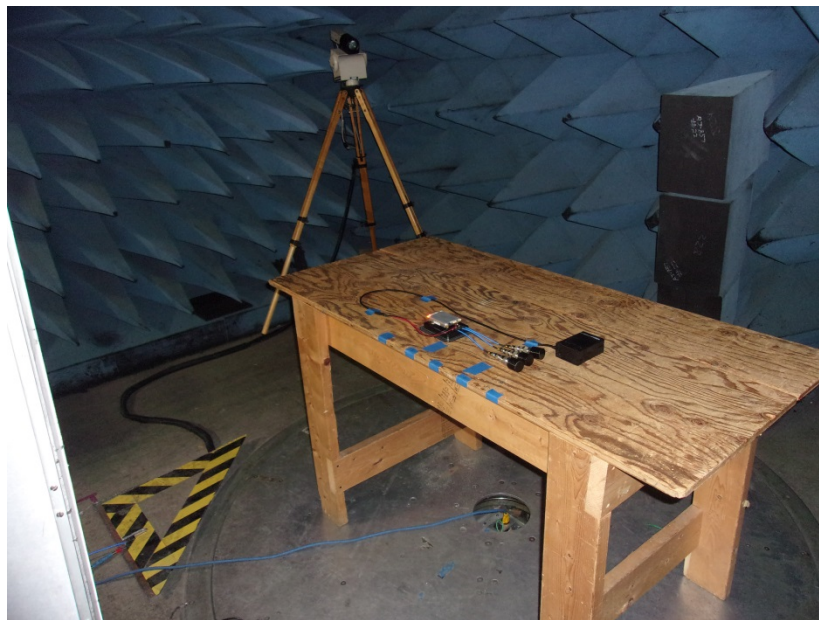
Testing occurred within a shielded semi anechoic enclosure, measuring 30' x 20' x 20', located in Tinton Falls New Jersey. The chamber walls were lined with anechoic RF absorbing cones on all four walls and the ceiling. Peripheral equipment was located in an adjacent shielded enclosure. All power leads entering the shielded enclosures were routed via electromagnetic interference filters to provide at least 80 dB of attenuation above 10 kHz when measured in accordance with MIL-STD-220A. Interconnecting cables are routed via feed through ports connecting the two enclosures. Shielding effectiveness to electric fields and plane waves exceeded 80 dB from 14 kHz to 10 GHz. Ancillary equipment was installed in an adjacent shielded enclosure. All testing was performed in accordance with MIL-STD-461F tabletop EUT's.

6.2 Ground Plane

As ground plane is not present in the EUT installation, the EUT was placed on a non-conductive table. The ground plane met the requirements of MIL-STD-461F. All testing was performed in accordance with MIL-STD-461F for tabletop EUT's.



Test Setup for MPU5, Model WR5100 with S-Band Radio Card



Test Setup Embedded Module, Model 5200 paired with L-Band Card, Model No. RF1100

6.3 Measurement Accuracies

All measurements were made in accordance with MIL-STD-461F and have the following accuracies:

6.3.1 Frequency Accuracy

Frequency accuracy was $\pm 2\%$.

6.3.2 Amplitude Accuracy

Amplitude accuracy was ± 2 dB.

6.4 Emissions Testing**6.4.1 Bandwidths**

The measurement receiver bandwidths listed in Table I of this document were used for emissions testing. These bandwidths are specified at the 6dB down points for the overall selectivity curve of the receivers. Video filtering was not used to bandwidth limit the receiver response. When a controlled video bandwidth was available on the measurement receiver, it was set to its greatest value.

Frequency Range	6 dB Bandwidth	Dwell Time	Minimum Measurement Time Analog Measurement Receiver
30Hz-1KHz	10Hz	0.15 sec	0.015 sec/Hz
1KHz-10KHz	100Hz	0.015 sec	0.15 sec/KHz
10KHz- 150KHz	1KHz	0.015 sec	0.015/KHz
150KHz – 30MHz	10KHz	0.015 sec	1.5sec/MHz
30MHz – 1GHz	100KHz	0.015 sec	0.15sec/MHz
Above 1GHz	1MHz	0.015 sec	15sec/GHz

Table I Bandwidth & Measurement Time

7.0 Test Program Summary

Test Summary

Test	Reference MIL-STD-461F Section	Met Criteria? (Y/N)
RE102	5.17	Y

7.1 Receipt Inspection

The MPU5 - Model No. WR5100 with S-Band Radio Card and Embedded Module, Model 5200 paired with L-Band Card, Model No. RF1100 were hand carried to NTS Tinton Falls, New Jersey, by Persistent Systems LLC. personnel.

8.0 Test Methods

8.1 Radiated Emissions: Method RE102 Electric Field 10 kHz to 18 GHz

This test measured the radiated electric field emissions from the EUT in the frequency range of 2 MHz to 18 GHz and compared the results to the requirement of MIL-STD-461F, and Figure RE102-4 (RE102 limit for ground applications (Navy Mobile & Army)) of this document.

Note that RE102 testing on the EUT was performed in a semi-anechoic chamber.

See Appendix B for EMI software description.

Comments

The MPU5 - Model No. WR5100 with S-Band Radio Card as well as the Embedded Module, Model 5200 paired with L-Band Card, Model No. RF1100 complied with the requirements of RE102 as defined in MIL-STD-461F and Sec 2 of this document. See below for test data.

RE102 Test System Calibration

This procedure was performed prior to the start of any measurements to ensure that the overall system was operating properly.

1. The measurement system was set up per MIL-STD-461F and Figure RE102-1 of this document.
2. A signal generator was connected to the coax in place of the measurement antenna.
3. The signal generator was adjusted to produce a signal 6 dB below the appropriate RE102 limit.
4. The signal was detected at the measurement receiver and confirmed to be within ± 3 dB.
5. This procedure was repeated at the highest measurement range for each antenna used, covering the frequency range specified by MIL-STD-461F.
 - Rod antenna 2 MHz - 30 MHz
 - Bi-conical antenna 200 MHz
 - Large Double Ridged waveguide 1 GHz
 - Small Double Ridged waveguide 18GHz
6. For the active rod antenna, a matching network was used which is connected to the rod mount through a 10pF capacitor. This introduced 11dB attenuation to the overall measurement and was evaluated at the lowest, mid-band, and highest frequency measurement ranges.

7. Radiated a signal using an antenna or stub radiator at the highest measurement frequency of each antenna.
 - Rod antenna 30 MHz
 - Bi-conical antenna 200 MHz
 - Large Double Ridged waveguide 1 GHz
 - Small Double Ridged waveguide 17.95 GHz

The measurement receiver was tuned to the frequency of the applied signal and verified that a received signal of appropriate amplitude was present. Note: This evaluation was intended to provide a course indication that the antenna is functioning properly. There is no requirement to accurately measure the signal level.

RE102 Testing

1. Antenna positioning.
 1. The test setup boundary of the EUT and associated cabling was determined for use in positioning of antennas.
 2. The physical reference points on the antennas shown in Figure RE102-6 of MIL-STD-461F were used for measuring heights of the antennas and distances of the antennas from the test setup boundary.
 - Antennas were positioned 1 meter from the front edge of the test setup boundary for all setups. Reference the general set up for free standing equipment in shielded enclosures as specified in figure 3 of Section 6 of this document.
 - Antennas were positioned 120 cm above the floor ground plane.
 - No part of any antenna was closer than 1 meter from the walls and 0.5 meter from the ceiling of the shielded enclosure.
 3. The number of required antenna positions below 200 MHz was 1, due to the fact that the test setup boundary is less than 3 meters.
 4. The number of required antenna positions from 200-1000 MHz was 2. See calculation in appendix A.
 5. The number of required antenna positions from 200-1000 MHz was 5. See calculation in appendix A.

RE102 Test Procedure

1. The MPU5 - Model No. WR5100 with S-Band Radio Card and Embedded Module, Model 5200 paired with L-Band Card, Model No. RF1100 were tested while operating. See setup in Sec 3.1.
2. The appropriate antenna was positioned one meter from the front edge of the equipment under test.
3. The antennae were kept at a minimum of one meter from all shielded walls.
4. The frequency range from 2MHz to 18 GHz is scanned using EMI Measurement Software and observing the bandwidths and minimum measurement times specified in Table II of MIL-STD-461F, and in accordance with Section 6.5 of this document.
5. Above 30 MHz, both horizontal and vertical polarities were performed.
6. Below 30 MHz, only vertical polarity measurements were performed.

Comments

The EUT complied with the requirements of RE102 as defined in MIL-STD-461F and Sec 2 of this document. See below for test data.

Antenna	Frequency Range
Active Rod	10 kHz – 30 MHz
Bi-conical	30 MHz – 200 MHz
Large Double Ridged Waveguide	200 MHz – 1 GHz
Small Double Ridged Waveguide	1 - 18 GHz

Radiated Emissions Data Sample Calculation

Frequency	Level	Limit	Delta	Ht.	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV	dB	m	dBuV	dB	dB	dB	dB
30.94	42.5	44.0	-1.5	V	82.05	10.86	1.65	52.04	39.53

Frequency = EUT emission frequency in MHz.

Level = Corrected amplitude of EUT emission (Raw reading + Ant CF + Cable CF + Preamp CF).

Limit = Radiated emission limit.

Delta = Level – Limit (Negative number indicates margin under limit. Positive number indicates failure over limit).

Raw = Uncorrected amplitude measurement from EMI receiver.

Ant. = Antenna correction factor.

Cable = Insertion Loss of Coaxial Cable.

Amp =Preamp (if used) gain.

All Factors = Amp – Cable – Ant. (A negative number indicates a net loss. A positive number indicates a net gain).

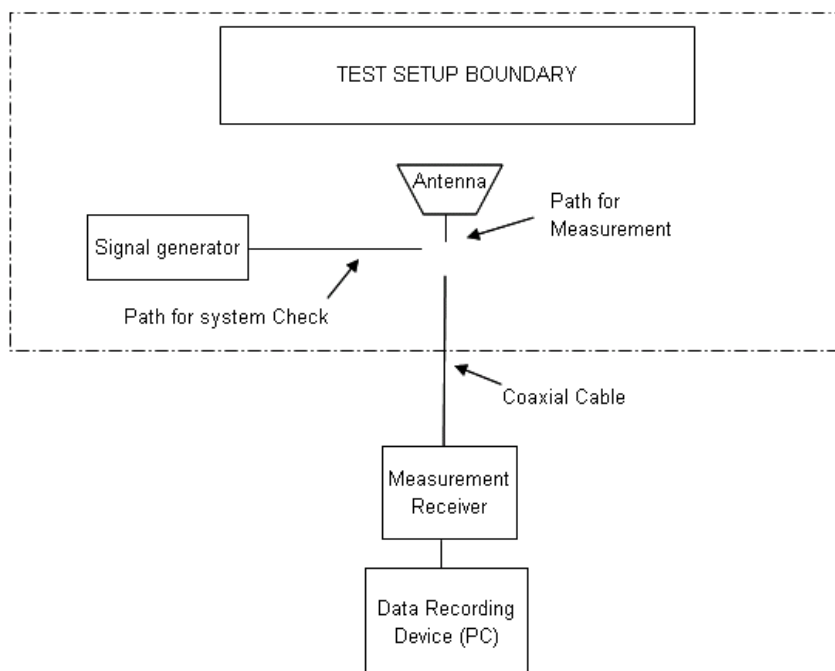


Figure RE102-1. System Verification Setup

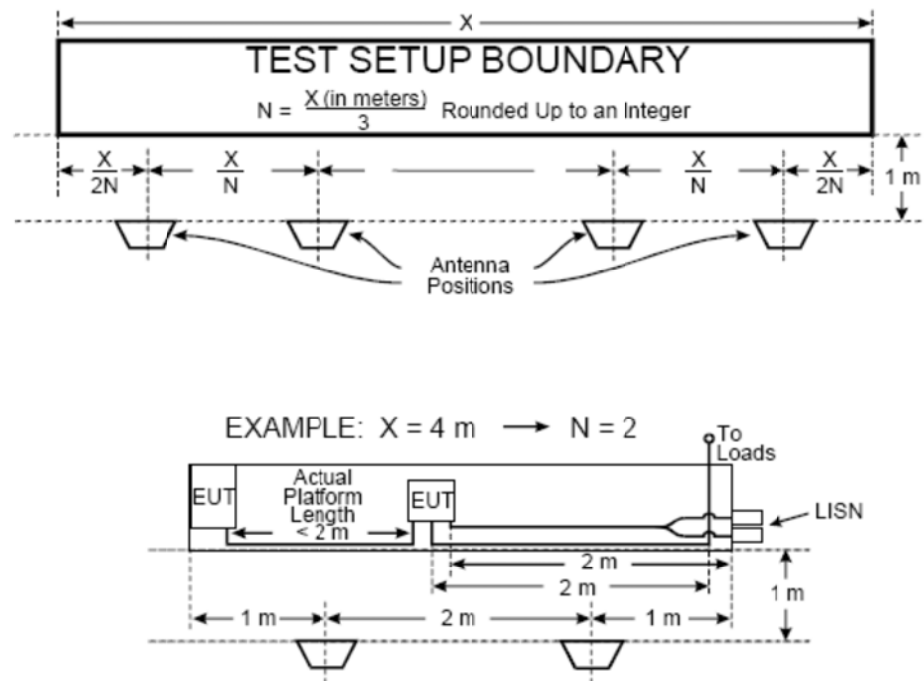


Figure RE102-2. Multiple Antenna Positioning

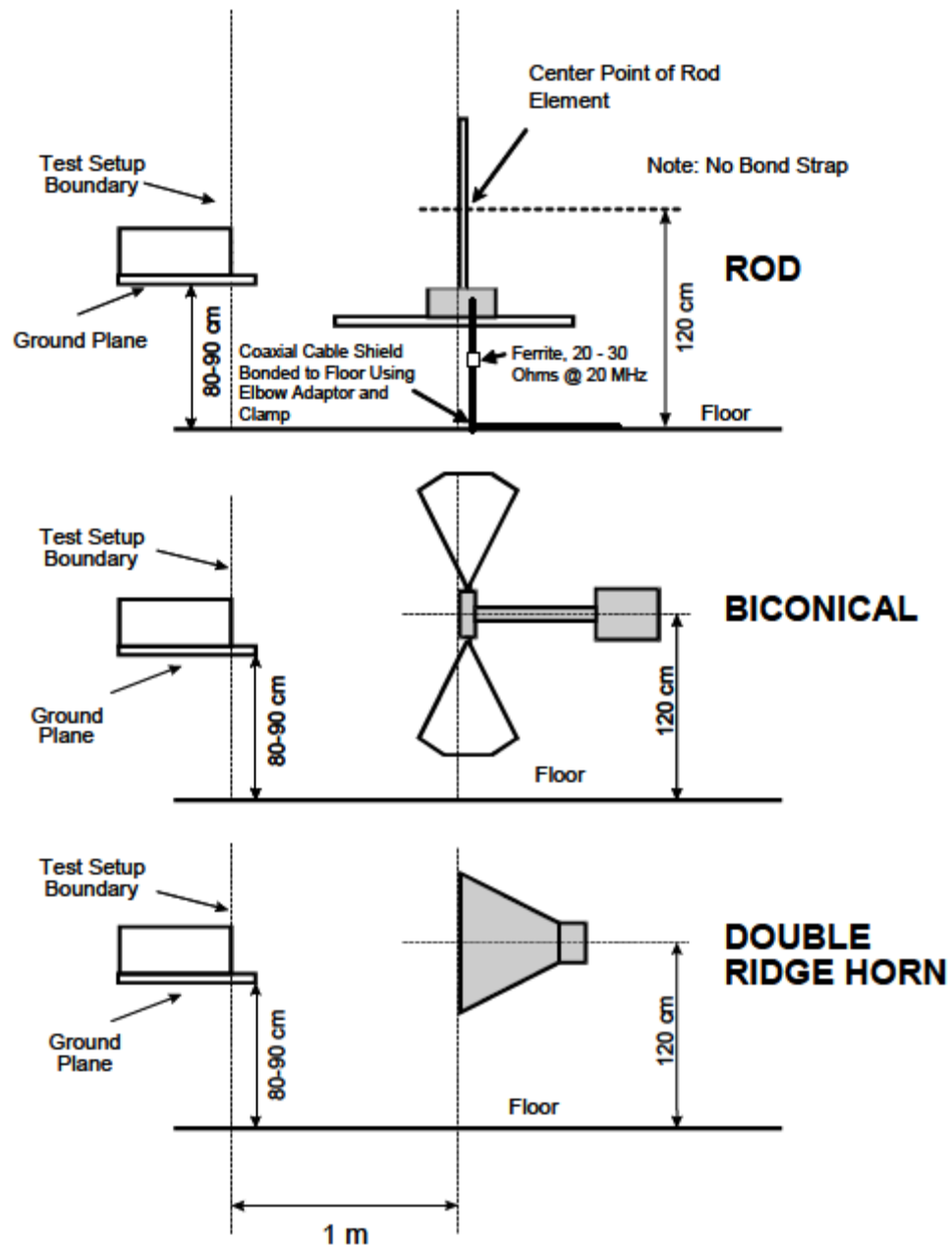


FIGURE RE102-6 Antenna Positioning.

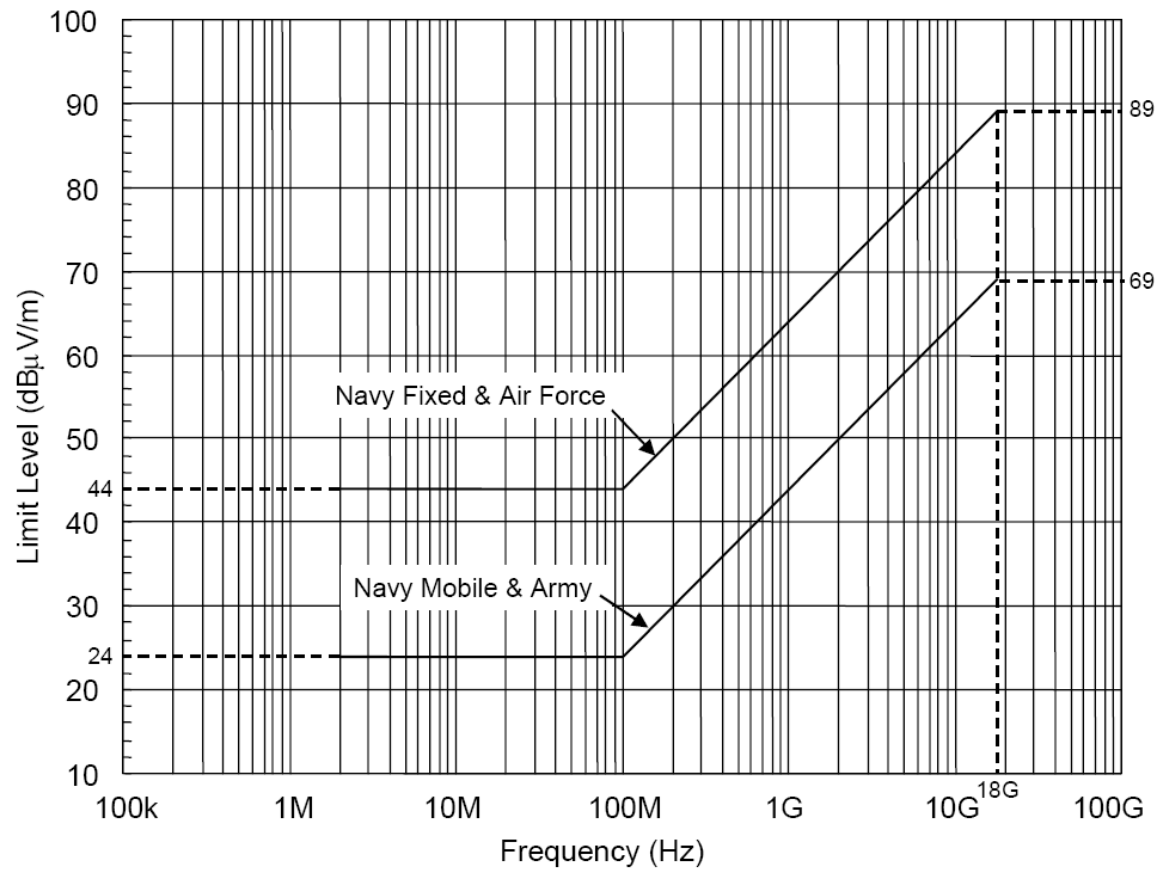


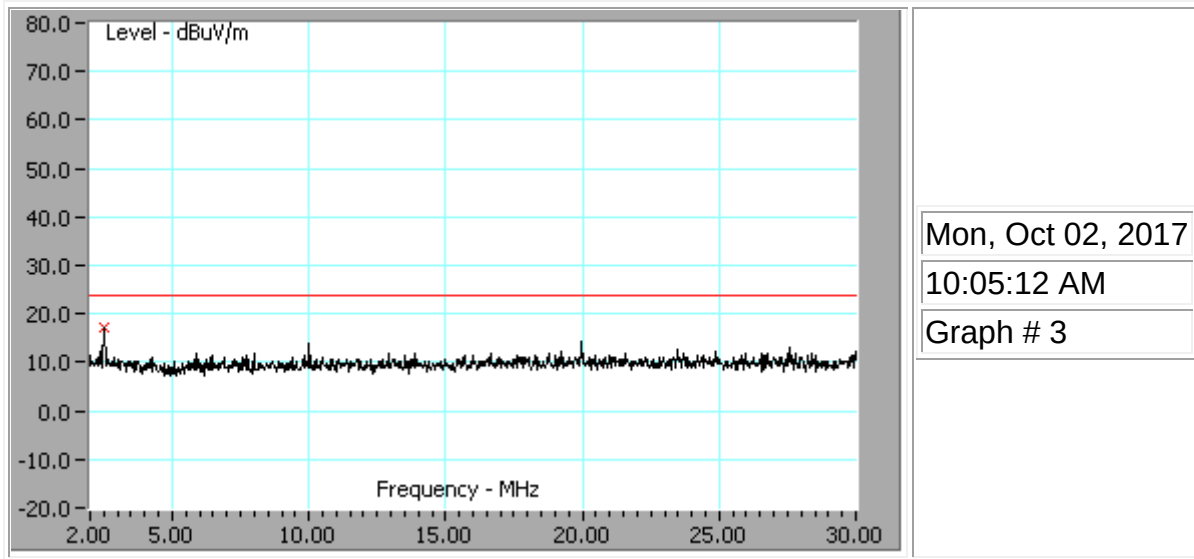
FIGURE RE102-4. RE102 limit for ground applications.



RE102 Data: MPU5 - Model No. WR5100 with S-Band Radio Card

Project: Persistent

System Check: Injected Signal = 15.6dBuV (+/-3dB) @ 2.5MHz.



Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
2.529	17.0	24.0	-7.0	V		18.45	-1.69	0.24	0.00	1.45

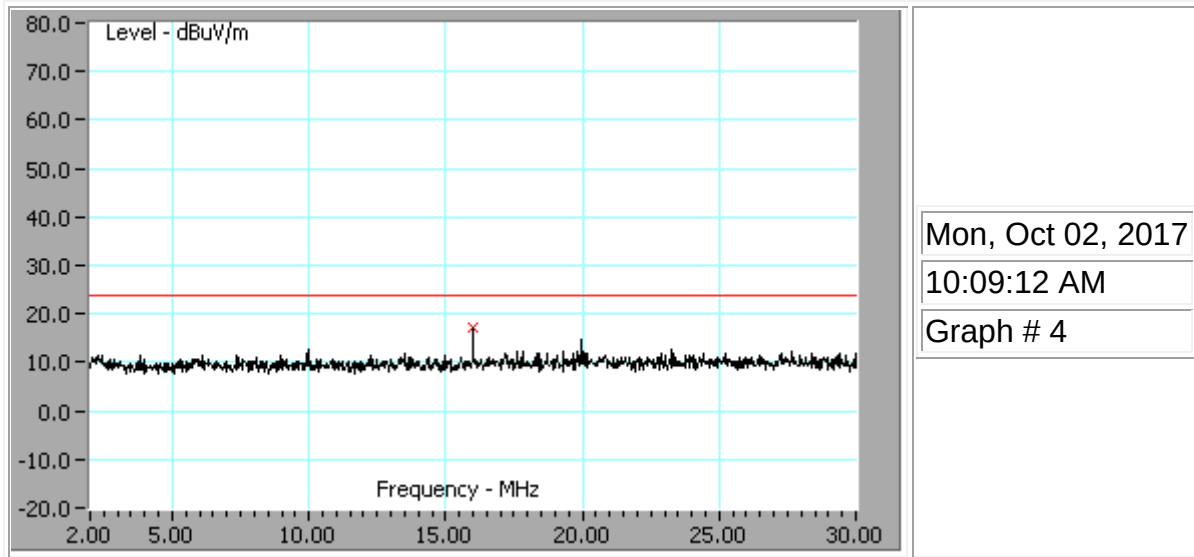


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent

System Check: Injected Signal = 15.6dBuV (+/-3dB) @ 16.0MHz.



Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
16.000	17.0	24.0	-7.0	V		16.82	-0.83	1.03	0.00	-0.20

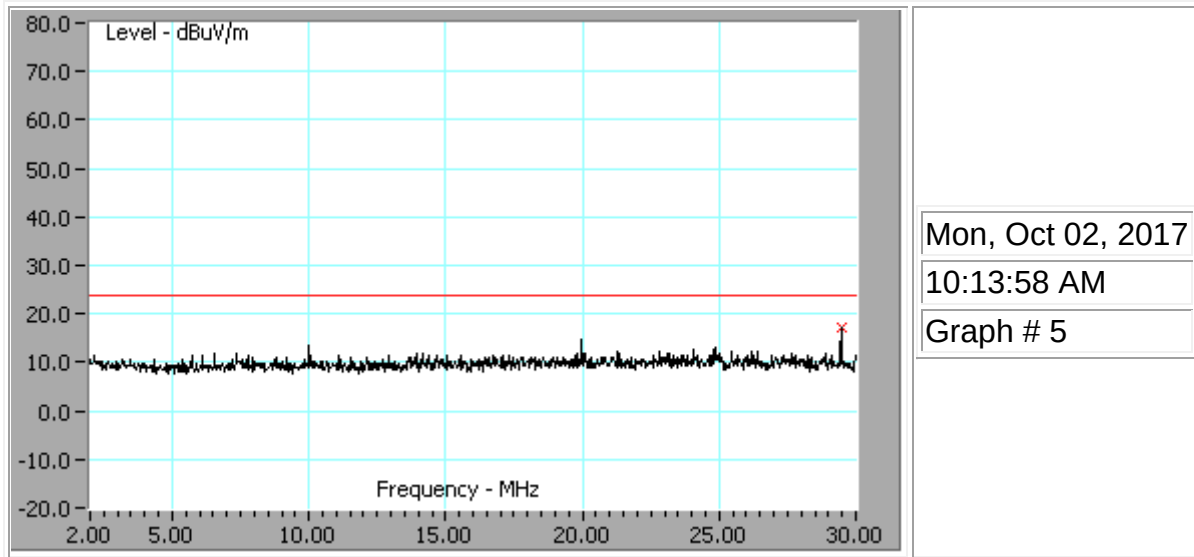


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent

System Check: Injected Signal = 15.6dBuV (+/-3dB) @ 29.5MHz.



Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
29.47	17.0	24.0	-7.0	V		14.66	0.76	1.62	0.00	-2.37

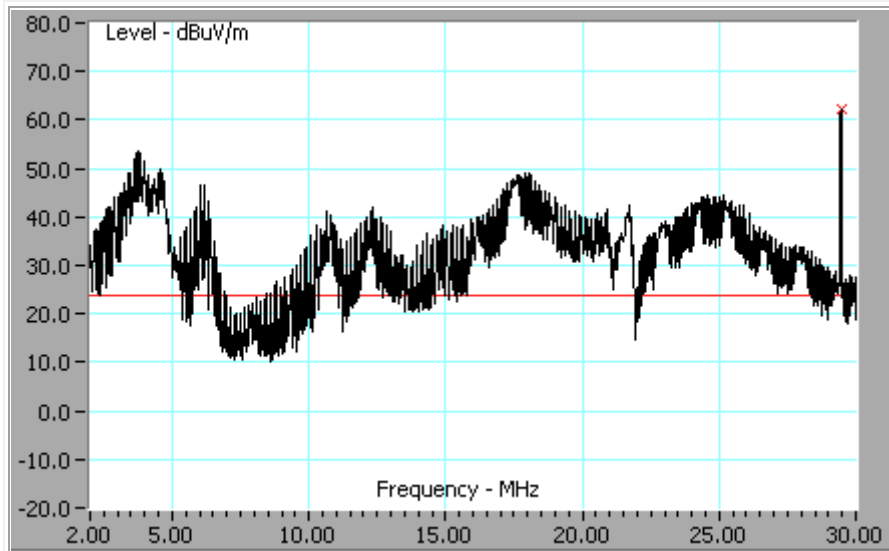


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent

System Check: Injected Signal = 29.5 MHz Radiated Stub



Mon, Oct 02, 2017

2:27:31 PM

VERTICAL

Graph # 11

Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
29.47	62.1	24.0	38.1	V		59.71	0.76	1.62	0.00	-2.37

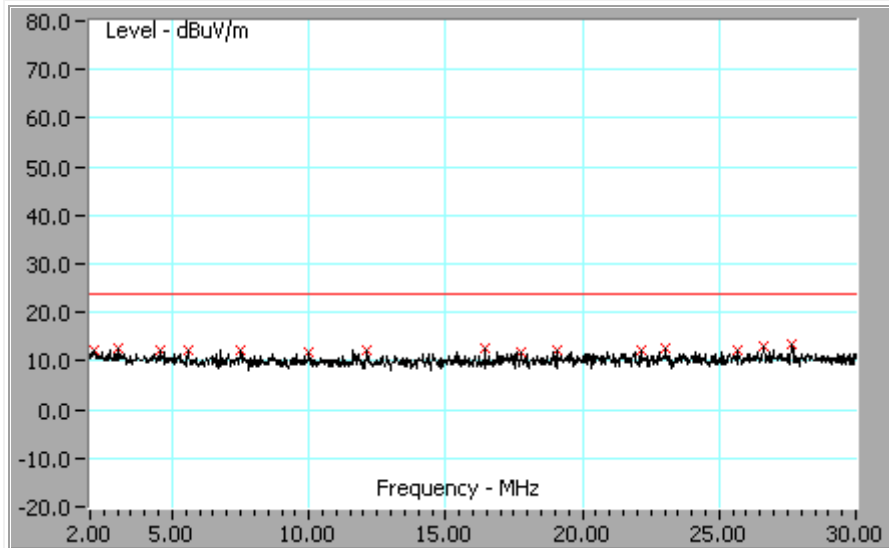


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent

System Check: Ambient 2-30MHz



Tue, Oct 03, 2017

7:49:01 AM

VERTICAL

Graph # 1

Scan Data

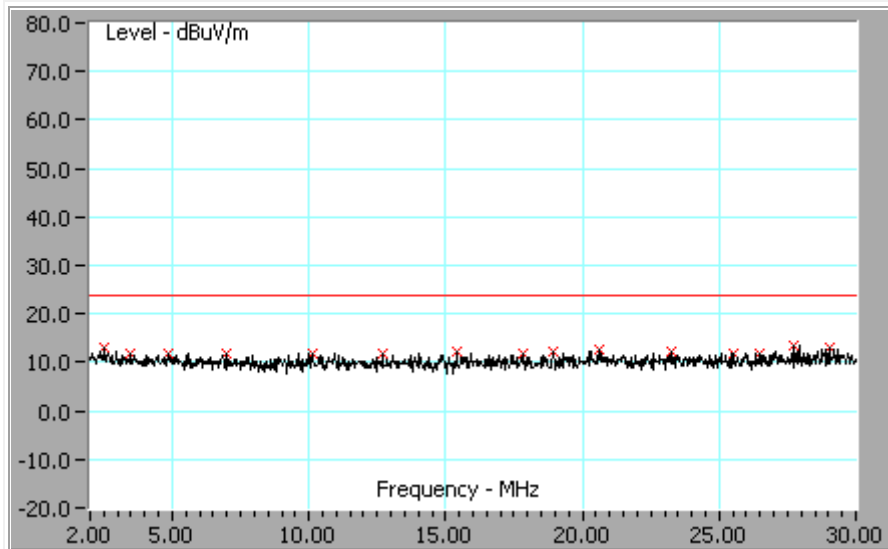
Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
2.156	12.3	24.0	-11.7	V		13.72	-1.69	0.23	0.00	1.46
3.058	12.8	24.0	-11.2	V		14.18	-1.68	0.26	0.00	1.43
4.582	12.2	24.0	-11.8	V		13.60	-1.65	0.30	0.00	1.35
5.578	12.1	24.0	-11.9	V		13.37	-1.62	0.33	0.00	1.29
7.476	12.3	24.0	-11.7	V		13.47	-1.53	0.38	0.00	1.15
9.996	11.9	24.0	-12.1	V		12.86	-1.37	0.45	0.00	0.92
12.142	12.1	24.0	-11.9	V		12.66	-1.20	0.66	0.00	0.54
16.436	12.5	24.0	-11.5	V		12.17	-0.79	1.07	0.00	-0.28
17.773	12.0	24.0	-12.0	V		11.41	-0.64	1.20	0.00	-0.56
19.049	12.1	24.0	-11.9	V		11.26	-0.51	1.32	0.00	-0.82
22.129	12.1	24.0	-11.9	V		10.75	-0.15	1.46	0.00	-1.31
23.062	12.5	24.0	-11.5	V		11.03	-0.03	1.48	0.00	-1.45
25.644	12.3	24.0	-11.7	V		10.47	0.28	1.53	0.00	-1.82
26.609	13.0	24.0	-11.0	V		11.08	0.40	1.56	0.00	-1.96
27.667	13.5	24.0	-10.5	V		11.41	0.53	1.58	0.00	-2.11



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent
EUT Running: 2-30MHz



Tue, Oct 03, 2017

8:06:02 AM

VERTICAL

Graph # 19

Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
2.529	13.0	24.0	-11.0	V		14.48	-1.69	0.24	0.00	1.45
3.462	11.6	24.0	-12.4	V		13.06	-1.68	0.27	0.00	1.41
4.831	11.9	24.0	-12.1	V		13.27	-1.65	0.31	0.00	1.34
7.009	11.8	24.0	-12.2	V		12.99	-1.56	0.37	0.00	1.19
10.120	11.9	24.0	-12.1	V		12.76	-1.36	0.46	0.00	0.90
12.702	11.7	24.0	-12.3	V		12.12	-1.15	0.71	0.00	0.44
15.409	12.0	24.0	-12.0	V		11.95	-0.89	0.97	0.00	-0.08
17.867	11.6	24.0	-12.4	V		11.06	-0.63	1.21	0.00	-0.58
18.924	12.3	24.0	-11.7	V		11.54	-0.52	1.31	0.00	-0.79
20.604	12.5	24.0	-11.5	V		11.44	-0.33	1.43	0.00	-1.10
23.249	12.3	24.0	-11.7	V		10.83	-0.01	1.48	0.00	-1.47
25.520	12.0	24.0	-12.0	V		10.22	0.27	1.53	0.00	-1.80
26.453	12.0	24.0	-12.0	V		10.04	0.39	1.55	0.00	-1.94
27.729	13.6	24.0	-10.4	V		11.44	0.54	1.58	0.00	-2.12
29.036	12.9	24.0	-11.1	V		10.55	0.70	1.61	0.00	-2.31

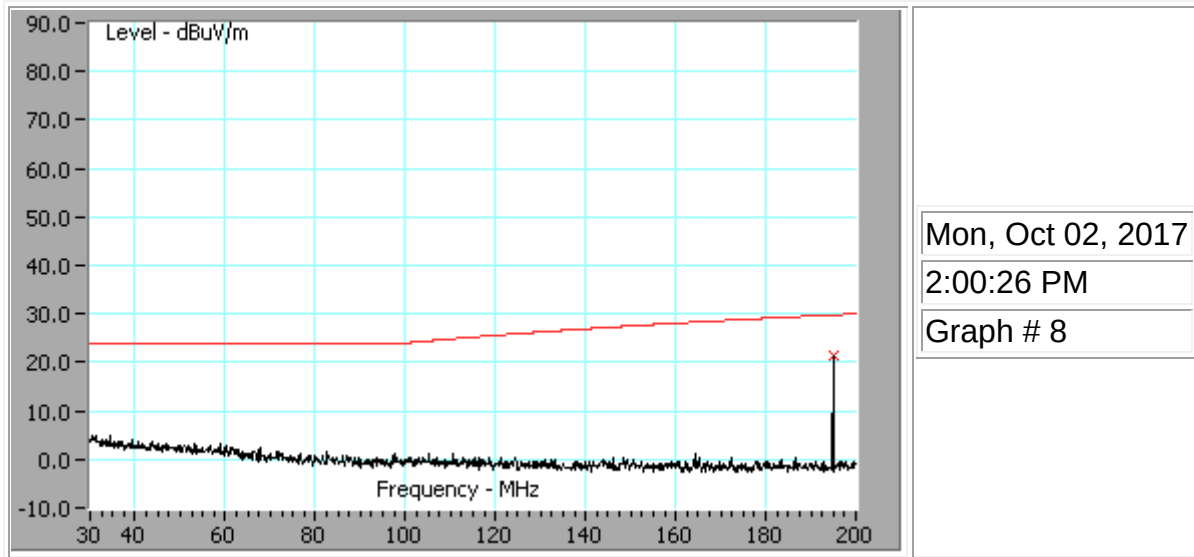


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent

System Check: Injected Signal = 20 dBuV (+/- 3) dB @195MHz



Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
195.09	21.2	29.8	-8.6			61.03	0.00	1.35	41.17	39.81

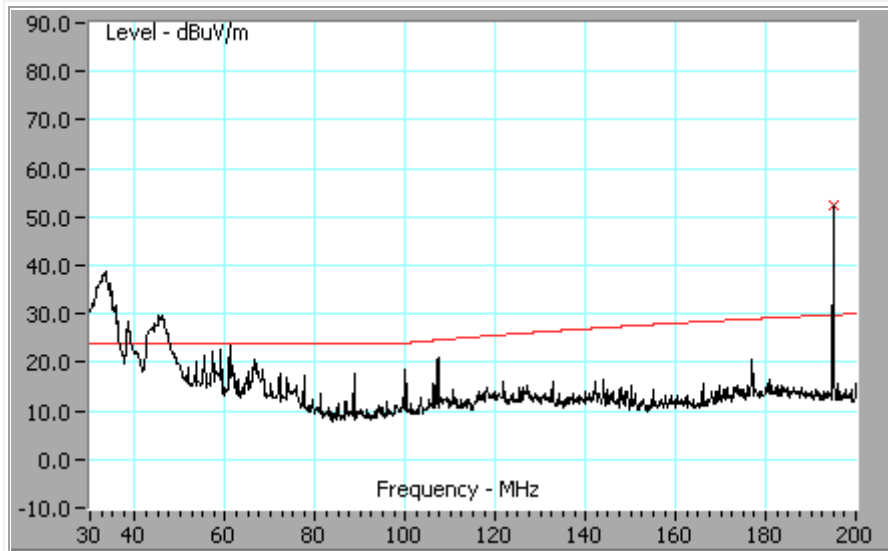


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent

System Check: Injected Signal = 195 MHz Radiated Stub



Mon, Oct 02, 2017

2:40:37 PM

HORIZONTAL

Graph # 14

Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
195.09	52.3	29.8	22.5	H		77.58	14.56	1.35	41.17	25.25

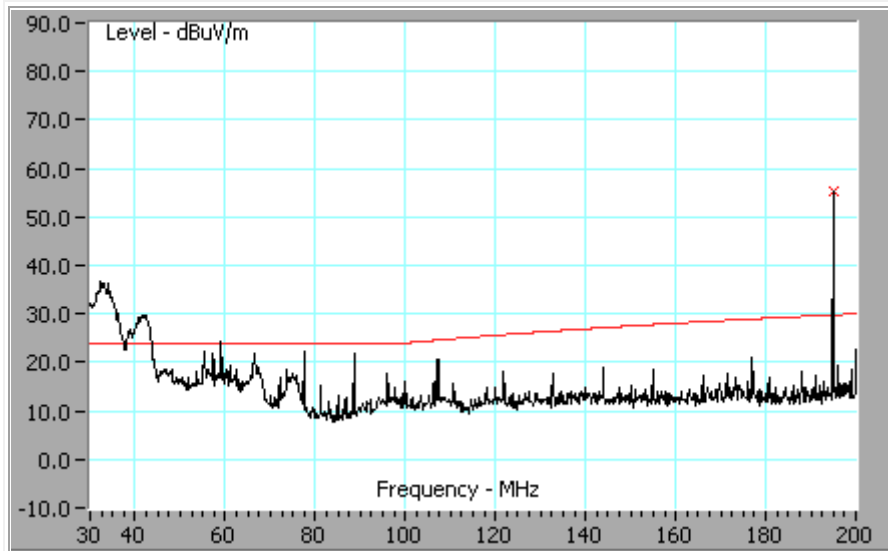


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent

System Check: Injected Signal = 195 MHz Radiated Stub



Mon, Oct 02, 2017

2:43:39 PM

VERTICAL

Graph # 15

Scan Data

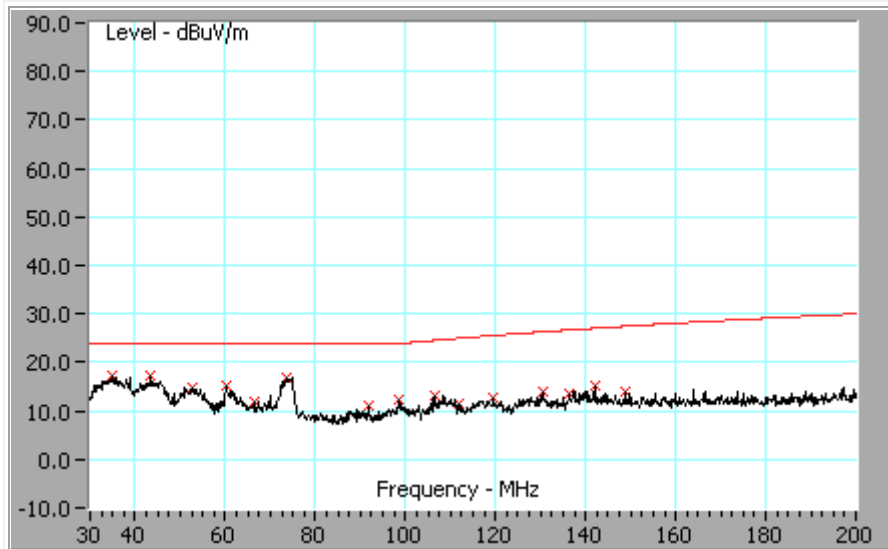
Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
195.09	55.4	29.8	25.6	V		80.73	14.49	1.35	41.17	25.33



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent
System Check Ambient 30-200MHz



Tue, Oct 03, 2017

8:27:53 AM

VERTICAL

Graph # 20

Scan Data

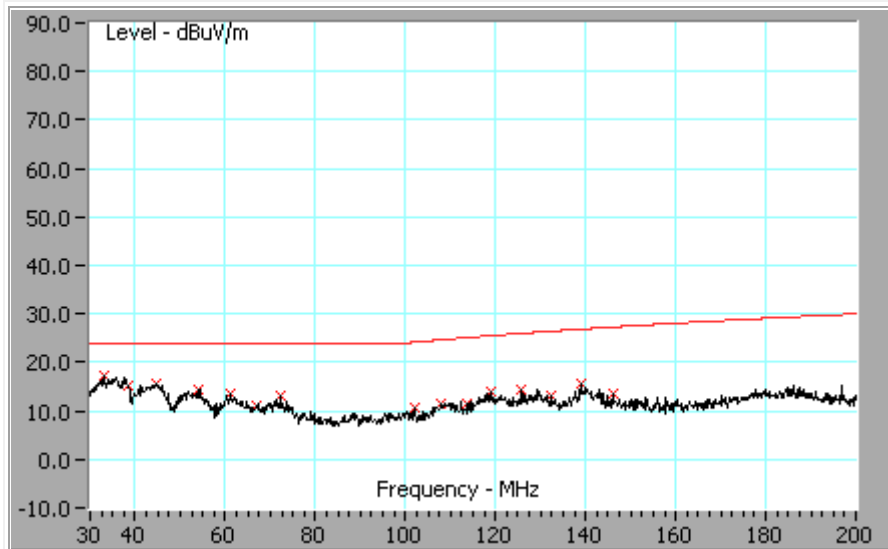
Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
35.10	17.3	24.0	-6.7	V		43.99	11.46	0.53	38.63	26.64
43.41	17.1	24.0	-6.9	V		43.73	11.97	0.60	39.20	26.63
52.48	14.9	24.0	-9.1	V		42.69	11.19	0.66	39.70	27.84
60.22	15.0	24.0	-9.0	V		44.72	9.66	0.70	40.03	29.67
66.64	11.8	24.0	-12.2	V		41.98	9.33	0.74	40.24	30.16
73.82	17.0	24.0	-7.0	V		47.59	9.07	0.79	40.43	30.58
91.77	11.0	24.0	-13.0	V		41.47	9.38	0.90	40.79	30.51
98.38	12.2	24.0	-11.8	V		41.75	10.34	0.94	40.86	29.58
106.50	13.0	24.5	-11.6	V		41.68	11.32	0.98	41.00	28.70
111.79	11.5	25.0	-13.4	V		39.77	11.81	1.00	41.06	28.25
119.53	12.8	25.5	-12.8	V		40.36	12.41	1.02	41.03	27.59
130.49	13.8	26.3	-12.5	V		40.63	13.10	1.06	40.95	26.79
136.34	13.6	26.7	-13.1	V		40.03	13.39	1.09	40.89	26.42
142.01	15.1	27.0	-12.0	V		41.27	13.54	1.11	40.85	26.20
148.81	14.1	27.4	-13.4	V		40.30	13.46	1.14	40.84	26.24



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent
System Check Ambient 30-200MHz



Tue, Oct 03, 2017

8:33:29 AM

HORIZONTAL

Graph # 21

Scan Data

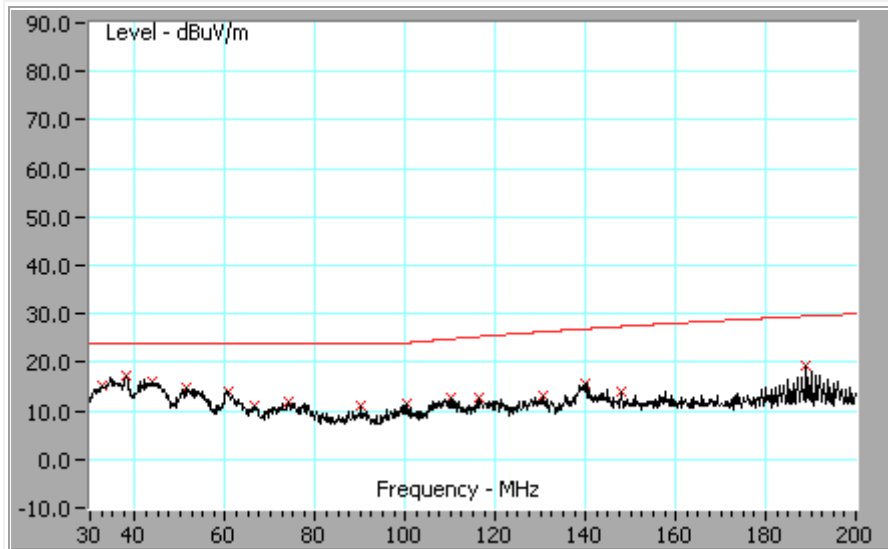
Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
33.02	17.4	24.0	-6.6	H		43.94	11.38	0.52	38.47	26.57
38.50	15.1	24.0	-8.9	H		41.93	11.45	0.56	38.88	26.87
44.54	15.7	24.0	-8.3	H		43.05	11.32	0.61	39.27	27.34
53.99	14.4	24.0	-9.6	H		42.79	10.75	0.67	39.76	28.34
60.98	13.6	24.0	-10.4	H		42.67	10.27	0.70	40.06	29.08
67.02	11.1	24.0	-12.9	H		40.23	10.34	0.74	40.25	29.16
72.31	13.1	24.0	-10.9	H		42.67	10.01	0.78	40.40	29.61
101.97	10.5	24.2	-13.7	H		40.30	10.12	0.96	40.92	29.83
108.01	11.6	24.7	-13.1	H		40.48	11.14	0.98	41.03	28.90
113.87	11.3	25.1	-13.8	H		39.09	12.31	1.01	41.05	27.74
119.16	13.8	25.5	-11.7	H		40.48	13.34	1.02	41.03	26.66
125.77	14.3	26.0	-11.6	H		40.46	13.82	1.04	40.98	26.12
132.57	13.1	26.4	-13.4	H		39.26	13.68	1.07	40.93	26.18
138.99	15.5	26.9	-11.3	H		41.88	13.41	1.10	40.87	26.35
145.98	13.5	27.3	-13.8	H		40.15	13.04	1.13	40.84	26.68



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent
EUT Running 30-200MHz



Tue, Oct 03, 2017

9:28:04 AM

VERTICAL

Graph # 26

Scan Data

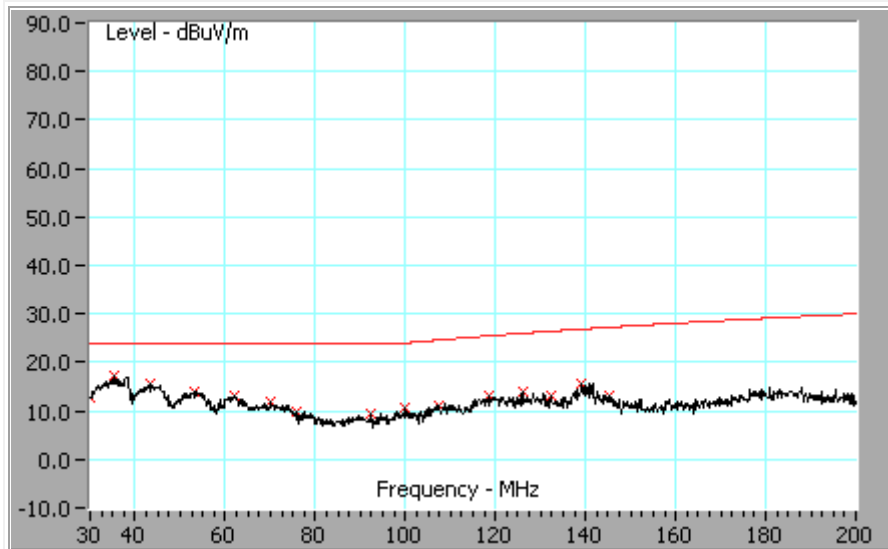
Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
32.46	15.3	24.0	-8.7	V		42.16	11.08	0.51	38.43	26.84
37.93	17.1	24.0	-6.9	V		43.78	11.64	0.56	38.84	26.64
43.79	16.2	24.0	-7.8	V		42.82	11.99	0.60	39.22	26.63
51.53	14.8	24.0	-9.2	V		42.46	11.36	0.66	39.66	27.64
60.60	13.9	24.0	-10.1	V		43.66	9.61	0.70	40.04	29.73
66.46	11.2	24.0	-12.8	V		41.37	9.30	0.74	40.23	30.19
74.20	12.1	24.0	-11.9	V		42.77	8.99	0.79	40.44	30.67
90.07	11.1	24.0	-12.9	V		41.88	9.15	0.88	40.77	30.73
100.27	11.3	24.0	-12.7	V		40.61	10.62	0.95	40.88	29.31
109.90	12.8	24.8	-12.0	V		41.22	11.67	0.99	41.06	28.40
116.32	12.5	25.3	-12.8	V		40.41	12.15	1.01	41.04	27.88
130.49	13.0	26.3	-13.3	V		39.80	13.10	1.06	40.95	26.79
139.74	15.7	26.9	-11.1	V		41.93	13.58	1.10	40.86	26.18
147.87	14.1	27.4	-13.3	V		40.30	13.46	1.13	40.84	26.24
189.04	19.5	29.5	-10.0	V		45.13	14.19	1.32	41.13	25.62



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent
EUT Running 30-200MHz



Tue, Oct 03, 2017

9:39:23 AM

HORIZONTAL

Graph # 27

Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
30.00	12.9	24.0	-11.1	H		39.54	11.13	0.49	38.24	26.62
35.29	17.1	24.0	-6.9	H		43.68	11.54	0.53	38.64	26.56
43.41	15.5	24.0	-8.5	H		42.79	11.34	0.60	39.20	27.26
53.04	13.9	24.0	-10.1	H		42.13	10.81	0.66	39.72	28.25
61.92	13.3	24.0	-10.7	H		42.49	10.21	0.71	40.09	29.17
70.23	11.8	24.0	-12.2	H		40.66	10.77	0.77	40.35	28.82
75.71	9.8	24.0	-14.2	H		40.51	8.94	0.79	40.48	30.75
92.33	9.5	24.0	-14.5	H		40.41	9.02	0.90	40.79	30.87
100.08	10.5	24.0	-13.5	H		40.53	9.87	0.95	40.88	30.06
107.44	11.2	24.6	-13.4	H		40.25	11.03	0.98	41.02	29.01
118.40	13.1	25.5	-12.4	H		39.90	13.20	1.02	41.03	26.81
125.96	14.0	26.0	-12.0	H		40.10	13.82	1.04	40.98	26.12
132.19	13.0	26.4	-13.4	H		39.16	13.70	1.07	40.93	26.16
139.18	15.7	26.9	-11.2	H		42.03	13.41	1.10	40.86	26.36
145.41	13.3	27.2	-13.9	H		39.95	13.07	1.12	40.85	26.65

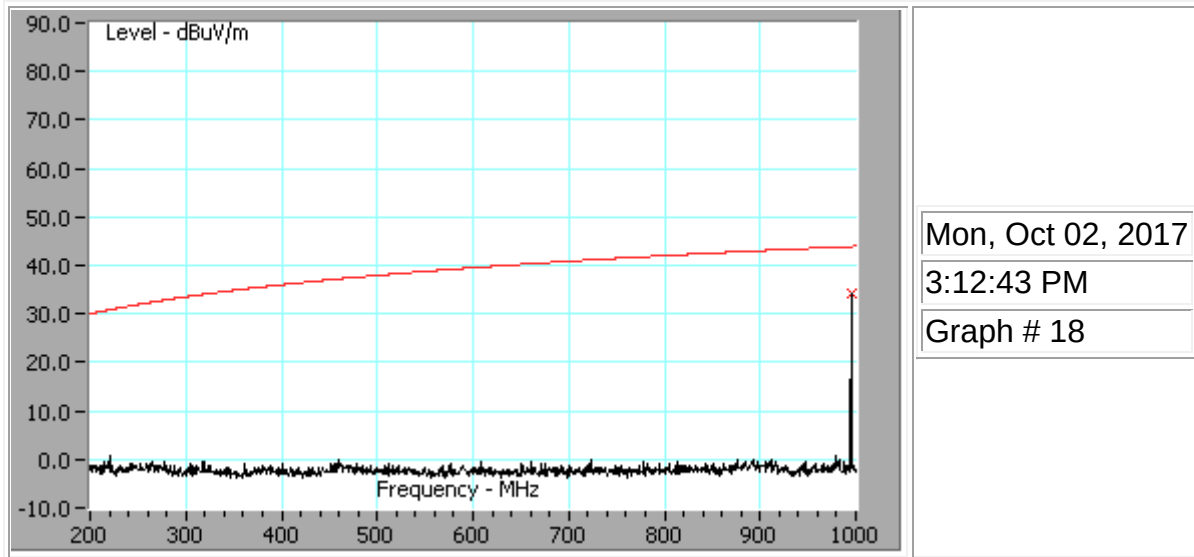


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent

System Check: Injected Signal = 35dBuV (+/- 3dB) @ 995 MHz



Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
995.6	34.2	43.9	-9.8	H		72.05	0.00	3.58	41.47	37.90

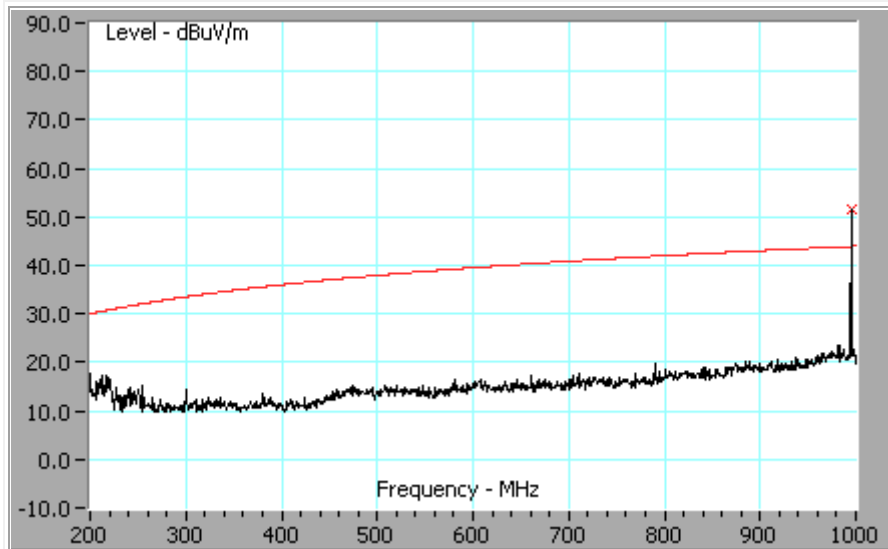


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent

System Check: Injected Signal = 995 MHz Radiated Stub



Mon, Oct 02, 2017

2:52:13 PM

VERTICAL

Graph # 16

Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
995.6	51.5	43.9	7.6	V		66.54	22.86	3.58	41.47	15.04

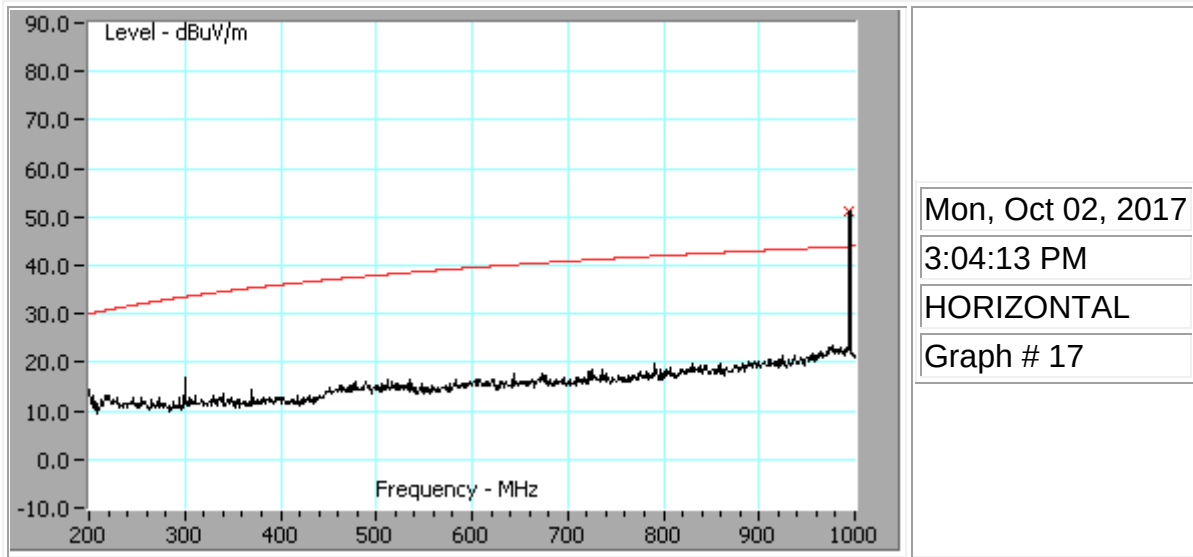


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent

System Check: Injected Signal = 995 MHz Radiated Stub



Scan Data

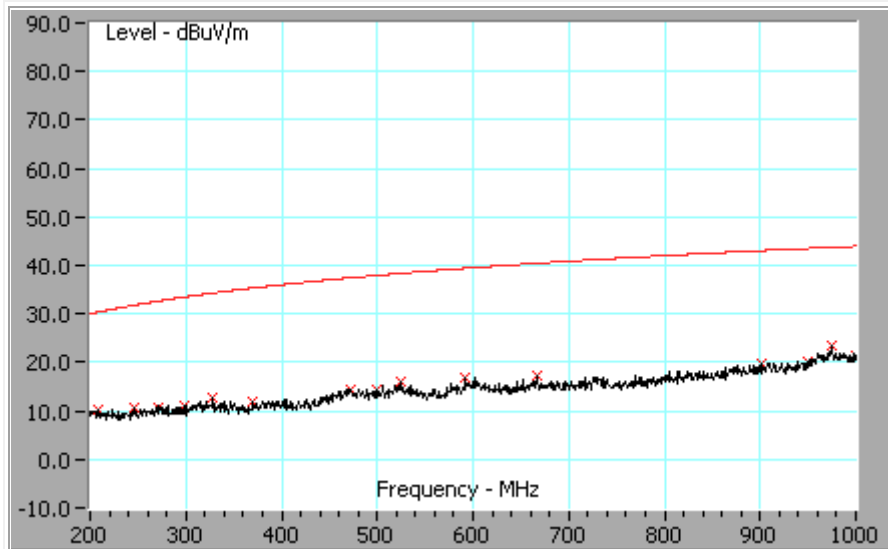
Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
993.8	51.2	43.9	7.3	H		66.41	22.68	3.58	41.48	15.22



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent
Ambient 200 - 1GHz



Tue, Oct 03, 2017

10:11:36 AM

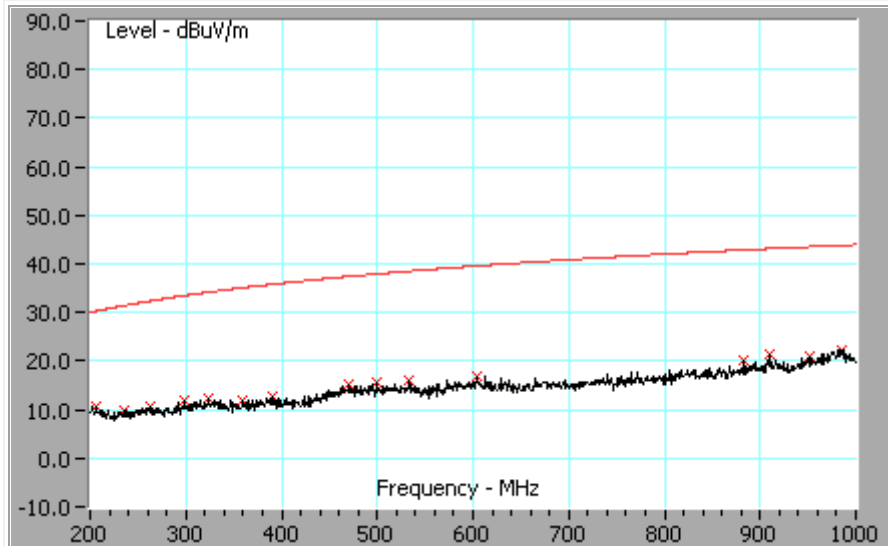
VERTICAL

Graph # 30

Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
208.00	10.2	30.3	-20.2	V		38.91	11.16	1.37	41.27	28.74
247.11	10.8	31.8	-21.0	V		39.47	11.31	1.42	41.37	28.64
272.00	10.8	32.7	-21.9	V		38.91	11.99	1.48	41.62	28.16
297.78	11.2	33.5	-22.2	V		39.21	12.39	1.52	41.87	27.96
328.00	12.9	34.3	-21.4	V		40.23	13.15	1.63	42.15	27.37
370.67	11.9	35.4	-23.4	V		39.04	13.44	1.72	42.29	27.13
472.89	14.4	37.5	-23.0	V		37.97	15.86	2.35	41.73	23.53
500.44	14.4	38.0	-23.5	V		37.38	16.35	2.35	41.68	22.98
525.33	16.1	38.4	-22.3	V		39.01	16.55	2.22	41.71	22.94
592.00	16.7	39.4	-22.7	V		38.70	17.24	2.41	41.63	21.99
666.67	17.5	40.4	-23.0	V		39.09	17.67	2.39	41.69	21.64
901.33	19.7	43.1	-23.3	V		37.59	20.35	3.20	41.39	17.85
949.33	20.3	43.5	-23.2	V		36.75	22.09	2.80	41.38	16.49
974.22	23.6	43.7	-20.1	V		38.96	22.99	3.17	41.54	15.38
999.11	21.6	43.9	-22.3	V		36.67	22.83	3.56	41.45	15.06

Project: Persistent
Ambient 200 - 1GHz



Tue, Oct 03, 2017

10:16:14 AM

HORIZONTAL

Graph # 31

Scan Data

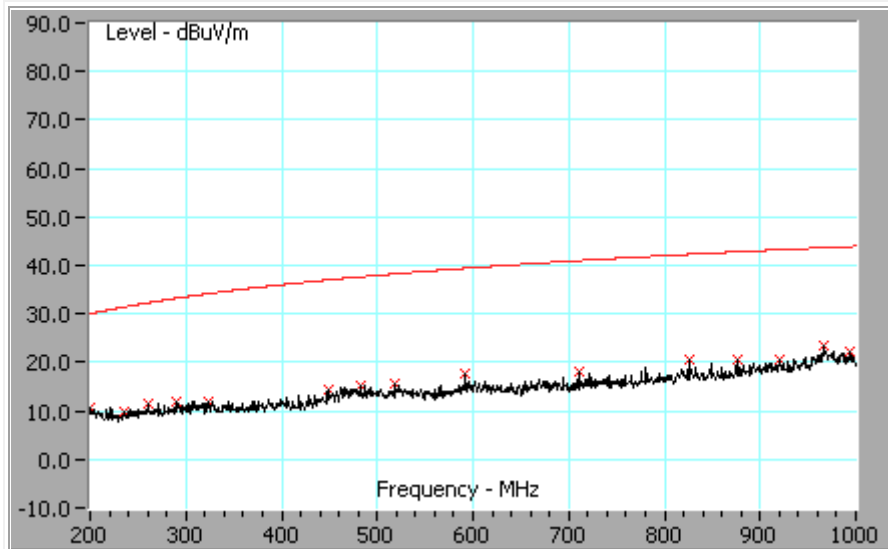
Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
206.22	10.7	30.3	-19.6	H		39.62	10.96	1.37	41.26	28.92
234.67	10.0	31.4	-21.4	H		38.81	11.15	1.42	41.39	28.82
263.11	10.8	32.4	-21.6	H		39.21	11.63	1.48	41.51	28.39
298.67	11.9	33.5	-21.6	H		39.80	12.45	1.52	41.88	27.91
324.44	12.3	34.2	-21.9	H		39.90	12.90	1.62	42.12	27.60
360.00	11.9	35.1	-23.2	H		39.14	13.38	1.69	42.29	27.23
390.22	12.9	35.8	-22.9	H		39.75	13.52	1.84	42.18	26.82
471.11	15.1	37.4	-22.4	H		38.81	15.62	2.35	41.72	23.75
498.67	15.5	37.9	-22.4	H		38.55	16.27	2.37	41.68	23.04
533.33	16.2	38.5	-22.3	H		39.64	16.13	2.17	41.72	23.42
604.44	17.0	39.6	-22.6	H		38.96	17.25	2.37	41.59	21.98
883.56	20.0	42.9	-22.9	H		38.50	19.76	2.92	41.22	18.54
909.33	21.3	43.1	-21.8	H		39.01	20.38	3.39	41.43	17.67
952.00	20.8	43.5	-22.7	H		37.26	22.11	2.83	41.41	16.47
984.89	22.3	43.8	-21.5	H		37.44	22.91	3.42	41.49	15.15



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent
EUT Running 200 - 1GHz



Tue, Oct 03, 2017

10:00:17 AM

HORIZONTAL

Graph # 28

Scan Data

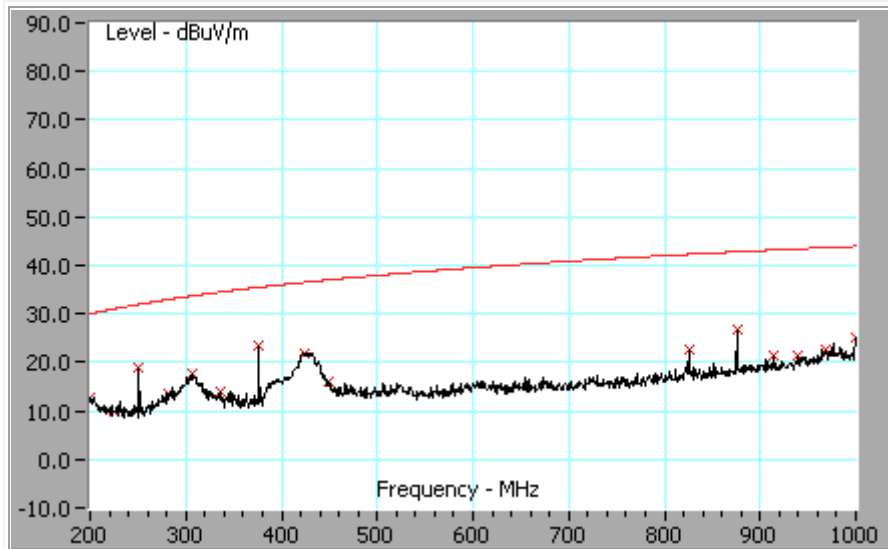
Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
200.89	10.7	30.0	-19.4	H		39.54	10.96	1.38	41.21	28.87
234.67	9.8	31.4	-21.6	H		38.65	11.15	1.42	41.39	28.82
260.44	11.3	32.3	-21.0	H		39.72	11.59	1.49	41.47	28.39
289.78	11.9	33.2	-21.3	H		39.97	12.21	1.50	41.80	28.08
324.44	12.1	34.2	-22.1	H		39.67	12.90	1.62	42.12	27.60
448.89	14.6	37.0	-22.5	H		39.44	14.81	2.05	41.75	24.89
482.67	15.1	37.6	-22.5	H		38.60	15.93	2.35	41.75	23.47
518.22	15.5	38.3	-22.7	H		38.68	16.26	2.28	41.69	23.15
592.00	17.5	39.4	-21.9	H		39.67	17.06	2.41	41.63	22.16
710.22	18.2	41.0	-22.8	H		39.42	17.80	2.54	41.57	21.23
825.78	20.7	42.3	-21.6	H		39.92	19.49	2.60	41.30	19.20
875.56	20.6	42.8	-22.2	H		39.44	19.61	2.83	41.26	18.83
920.00	20.7	43.2	-22.6	H		38.10	20.73	3.31	41.48	17.44
966.22	23.3	43.7	-20.3	H		39.09	22.77	3.04	41.56	15.74
994.67	22.2	43.9	-21.7	H		37.44	22.65	3.58	41.48	15.24



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent
EUT Running 200 - 1GHz



Tue, Oct 03, 2017

10:07:45 AM

VERTICAL

Graph # 29

Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
200.00	12.7	30.0	-17.3	V		41.35	11.16	1.38	41.20	28.66
224.89	9.9	31.0	-21.1	V		38.73	11.16	1.38	41.39	28.85
250.67	18.9	32.0	-13.1	V		47.47	11.35	1.41	41.37	28.61
280.89	13.7	32.9	-19.2	V		41.73	12.16	1.51	41.65	27.99
307.56	17.7	33.7	-16.1	V		45.46	12.63	1.57	41.98	27.78
336.00	13.9	34.5	-20.6	V		41.27	13.25	1.65	42.25	27.35
376.00	23.6	35.5	-11.8	V		50.67	13.46	1.74	42.23	27.03
424.00	22.0	36.5	-14.6	V		47.97	13.95	2.01	41.97	26.01
448.89	16.1	37.0	-20.9	V		41.17	14.65	2.05	41.75	25.05
825.78	22.6	42.3	-19.7	V		41.85	19.40	2.60	41.30	19.30
875.56	26.8	42.8	-16.0	V		45.38	19.84	2.83	41.26	18.60
914.67	21.3	43.2	-21.9	V		38.68	20.70	3.36	41.46	17.40
939.56	21.3	43.4	-22.2	V		38.17	21.64	2.81	41.36	16.91
968.00	22.6	43.7	-21.1	V		38.30	22.77	3.08	41.57	15.73
1000.00	25.1	44.0	-18.8	V		40.20	22.82	3.56	41.45	15.07

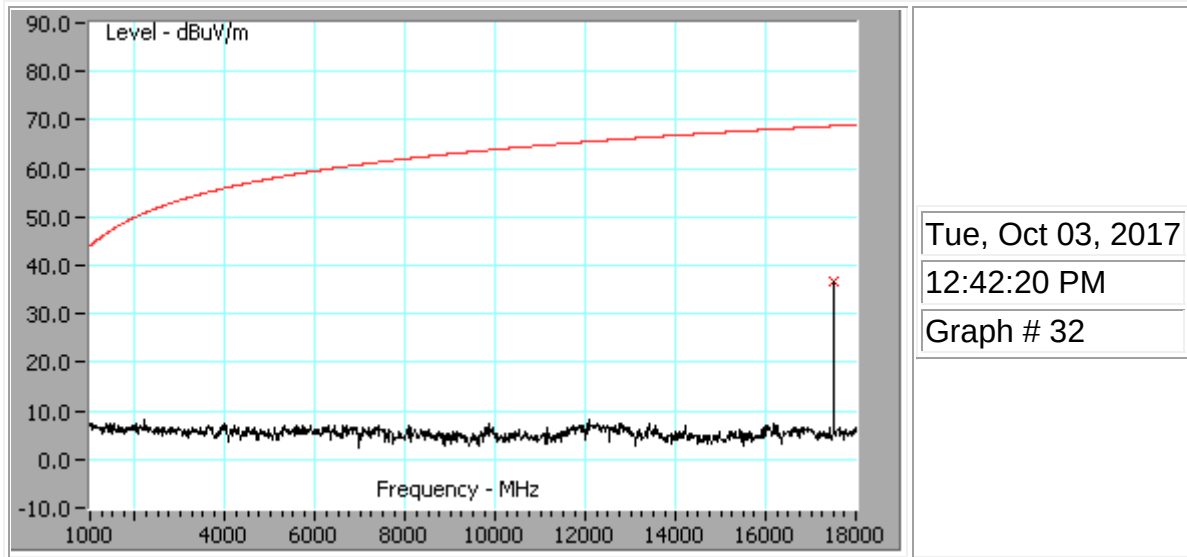


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent

System Check: Injected Signal = 37 dBuV (+/- 3dB) @ 17.5 GHz



Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
17507.0	36.6	68.8	-32.2			68.65	0.00	12.36	44.45	32.09

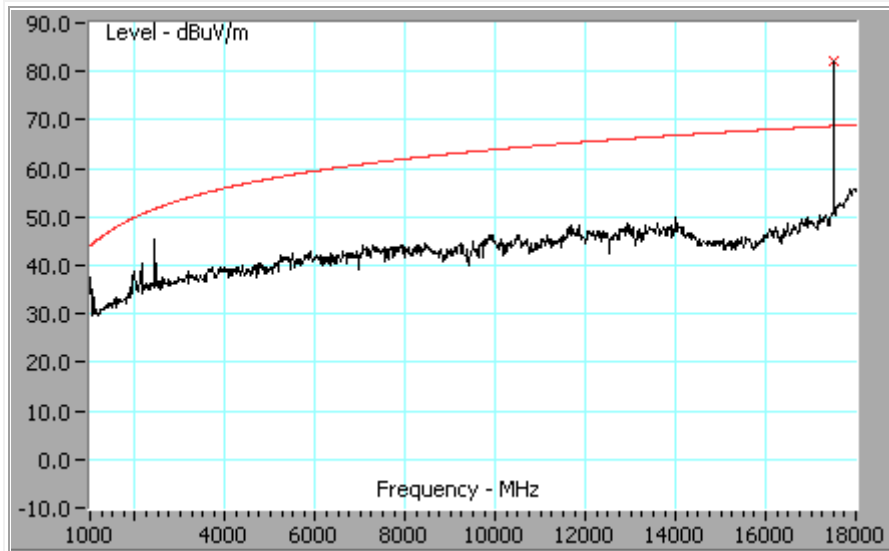


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent

System Check: Injected Signal = 17.5 GHz Radiated Stub



Tue, Oct 03, 2017

12:56:13 PM

VERTICAL

Graph # 33

Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
17507.0	82.1	68.8	13.4	V		69.16	45.07	12.36	44.45	-12.98

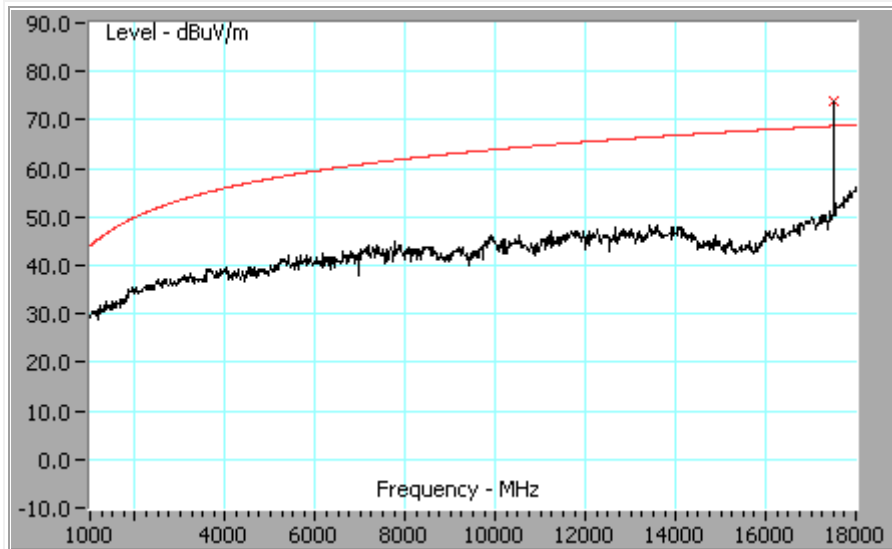


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent

System Check: Injected Signal = 17.5 GHz Radiated Stub



Tue, Oct 03, 2017

1:03:04 PM

HORIZONTAL

Graph # 34

Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
17507.0	74.0	68.8	5.2	H		60.79	45.27	12.36	44.45	-13.18

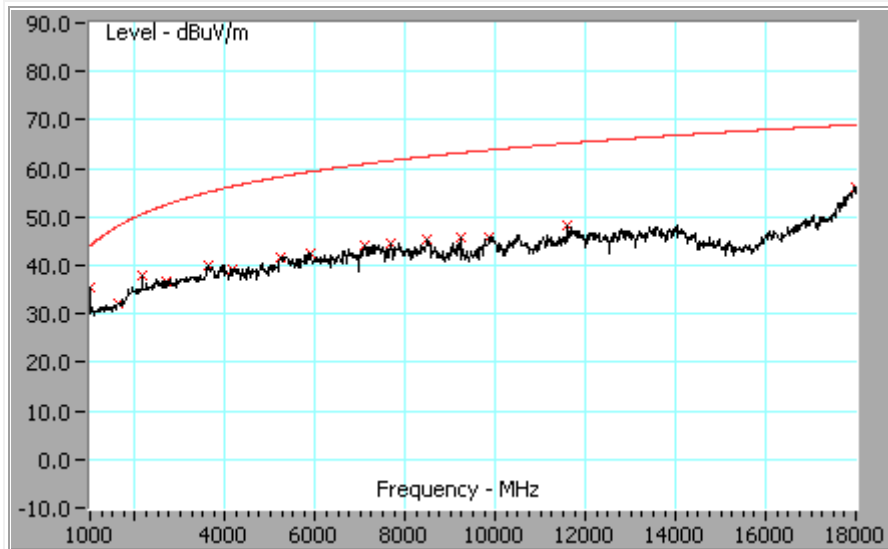


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent

System Check: Ambient 1 - 18 GHz



Tue, Oct 03, 2017

1:13:20 PM

HORIZONTAL

Graph # 35

Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
1000.0	35.3	44.0	-8.6	H		49.42	23.80	3.56	41.45	14.09
1629.0	32.2	48.2	-16.0	H		43.31	26.25	3.93	41.31	11.13
2156.0	38.1	50.6	-12.5	H		45.84	29.11	4.35	41.23	7.78
2683.0	36.7	52.5	-15.8	H		43.10	30.37	4.88	41.63	6.39
3635.0	39.9	55.1	-15.2	H		43.67	32.19	5.86	41.82	3.77
4179.0	39.2	56.3	-17.1	H		42.35	32.70	6.44	42.25	3.11
5216.0	41.5	58.3	-16.8	H		42.75	34.69	7.12	43.06	1.25
5879.0	42.4	59.3	-16.9	H		41.82	35.28	7.96	42.68	-0.56
7086.0	44.2	60.9	-16.7	H		41.27	36.74	8.79	42.57	-2.96
7681.0	44.4	61.6	-17.2	H		40.77	37.58	8.50	42.47	-3.61
8497.0	45.4	62.5	-17.1	H		40.78	37.80	8.80	42.01	-4.60
9211.0	45.7	63.2	-17.5	H		40.81	37.94	9.03	42.10	-4.87
9857.0	46.0	63.8	-17.8	H		39.71	39.40	9.82	42.95	-6.27
11608.0	48.4	65.2	-16.8	H		39.11	40.48	10.92	42.15	-9.25
18000.0	56.3	69.0	-12.7	H		36.46	50.20	12.87	43.26	-19.81

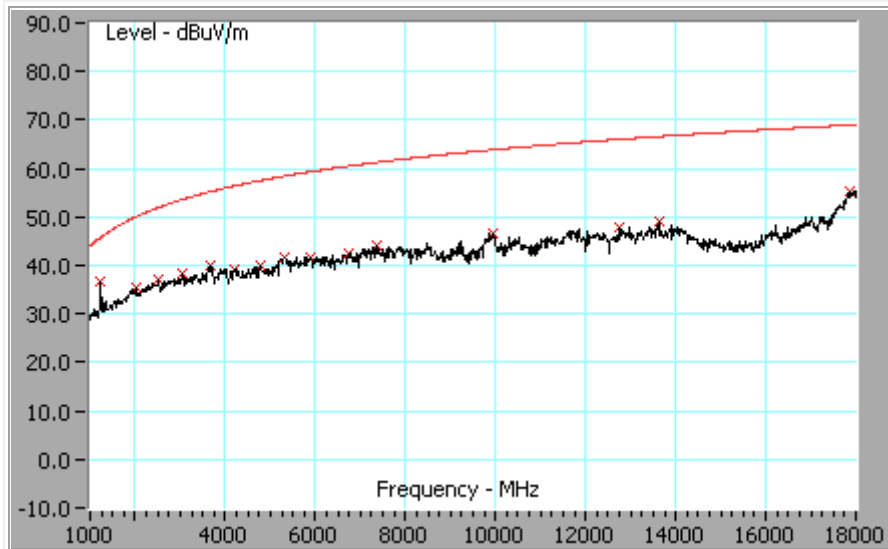


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent

System Check: Ambient 1 - 18 GHz



Tue, Oct 03, 2017

1:16:53 PM

VERTICAL

Graph # 36

Scan Data

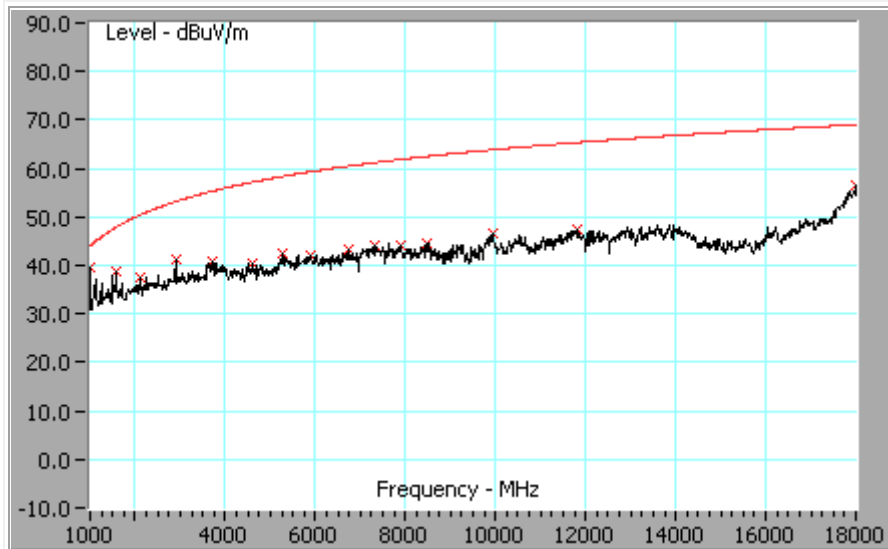
Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
1238.0	36.7	45.8	-9.1	V		49.91	24.55	3.56	41.35	13.23
2003.0	35.3	50.0	-14.7	V		43.64	28.51	4.35	41.23	8.37
2530.0	37.1	52.0	-14.9	V		43.81	30.06	4.64	41.44	6.74
3057.0	38.4	53.6	-15.3	V		43.86	31.09	5.26	41.83	5.48
3652.0	40.0	55.2	-15.2	V		43.86	32.07	5.82	41.80	3.90
4196.0	39.2	56.4	-17.1	V		42.13	32.74	6.55	42.18	2.90
4774.0	40.2	57.5	-17.3	V		42.06	33.68	6.77	42.33	1.88
5301.0	41.7	58.4	-16.7	V		41.83	34.88	7.27	42.31	0.15
5896.0	41.8	59.3	-17.5	V		41.11	35.44	7.88	42.60	-0.72
6729.0	42.6	60.5	-17.8	V		40.28	36.01	8.69	42.34	-2.36
7375.0	44.3	61.3	-17.0	V		40.03	37.32	8.38	41.48	-4.23
9959.0	46.8	63.9	-17.1	V		40.61	39.60	9.61	43.04	-6.17
12764.0	48.0	66.0	-18.0	V		36.48	40.04	13.42	41.93	-11.54
13631.0	49.1	66.6	-17.5	V		36.67	41.83	12.02	41.38	-12.47
17847.0	55.5	68.9	-13.5	V		38.27	48.47	12.53	43.82	-17.19



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent
EUT Running: 1- 18GHz



Tue, Oct 03, 2017

1:21:35 PM

VERTICAL

Graph # 37

Scan Data

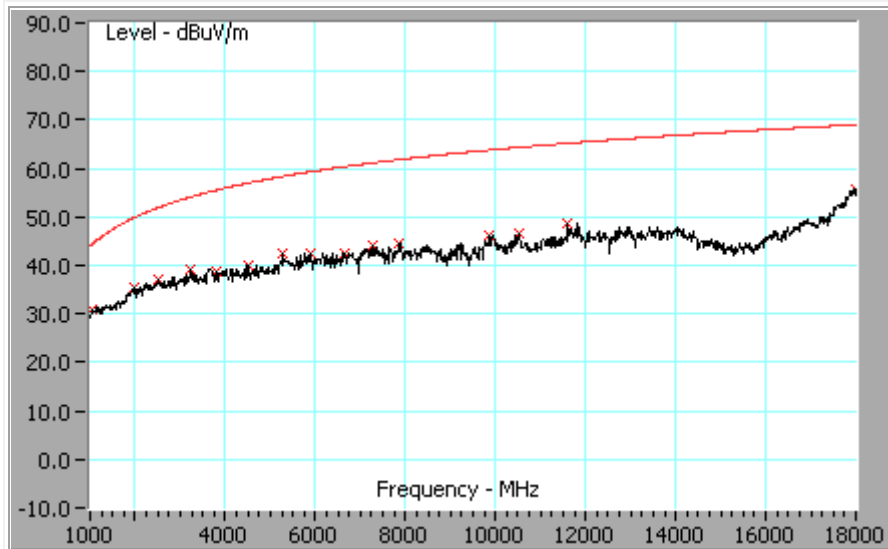
Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
1000.0	39.5	44.0	-4.4	V		53.80	23.60	3.56	41.45	14.29
1578.0	38.7	47.9	-9.3	V		49.91	26.05	4.02	41.34	11.26
2105.0	37.6	50.4	-12.8	V		45.93	28.82	4.30	41.40	8.29
2904.0	41.3	53.2	-11.9	V		46.95	30.81	5.35	41.79	5.64
3703.0	41.0	55.3	-14.3	V		44.85	32.17	5.72	41.76	3.88
4587.0	40.5	57.2	-16.7	V		43.67	33.08	6.61	42.89	3.20
5267.0	42.5	58.4	-15.9	V		43.03	34.83	7.21	42.60	0.56
5913.0	42.1	59.4	-17.3	V		41.36	35.45	7.85	42.58	-0.72
6729.0	43.3	60.5	-17.2	V		40.90	36.01	8.69	42.34	-2.36
7307.0	44.0	61.2	-17.2	V		40.56	37.18	8.45	42.19	-3.43
7902.0	44.0	61.9	-17.9	V		40.14	37.76	8.73	42.62	-3.87
8497.0	44.5	62.5	-18.0	V		40.01	37.70	8.80	42.01	-4.50
9925.0	46.4	63.8	-17.4	V		39.94	39.52	9.89	42.90	-6.50
11795.0	47.4	65.3	-18.0	V		37.25	39.92	12.12	41.90	-10.13
18000.0	56.4	69.0	-12.6	V		36.84	50.00	12.87	43.26	-19.61



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent
EUT Running: 1- 18GHz



Tue, Oct 03, 2017

1:24:16 PM

HORIZONTAL

Graph # 38

Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
1051.0	30.7	44.4	-13.7	H		44.50	23.96	3.56	41.31	13.79
1969.0	35.4	49.8	-14.5	H		43.71	28.50	4.34	41.19	8.35
2496.0	37.1	51.9	-14.8	H		43.94	29.99	4.59	41.43	6.85
3227.0	39.2	54.1	-14.9	H		44.23	31.45	5.45	41.91	5.01
3822.0	38.8	55.6	-16.8	H		42.85	32.45	5.85	42.35	4.04
4519.0	39.9	57.0	-17.1	H		43.05	32.76	6.78	42.64	3.10
5267.0	42.4	58.4	-16.0	H		42.99	34.78	7.21	42.60	0.61
5896.0	42.6	59.3	-16.8	H		42.00	35.28	7.88	42.60	-0.56
6661.0	42.6	60.4	-17.8	H		40.73	35.92	8.49	42.53	-1.89
7256.0	44.0	61.1	-17.2	H		40.93	37.01	8.52	42.49	-3.04
7851.0	44.5	61.8	-17.3	H		41.09	37.75	8.65	43.01	-3.39
9857.0	46.1	63.8	-17.7	H		39.84	39.40	9.82	42.95	-6.27
10503.0	46.5	64.3	-17.8	H		39.40	39.50	10.25	42.67	-7.08
11608.0	48.8	65.2	-16.4	H		39.55	40.48	10.92	42.15	-9.25
18000.0	55.8	69.0	-13.2	H		35.96	50.20	12.87	43.26	-19.81



System Check 2-30MHz



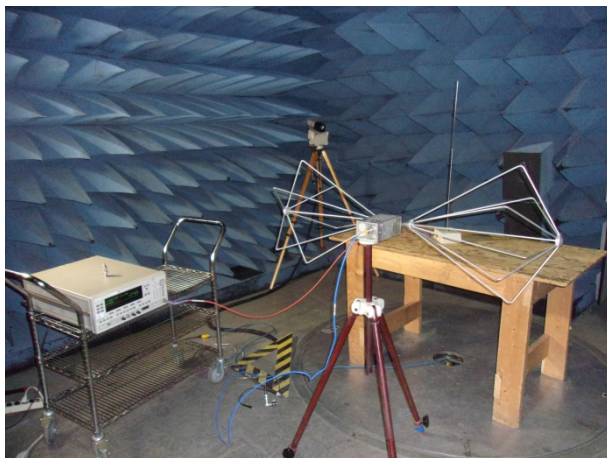
System Check Radiated Stub 2-30MHz



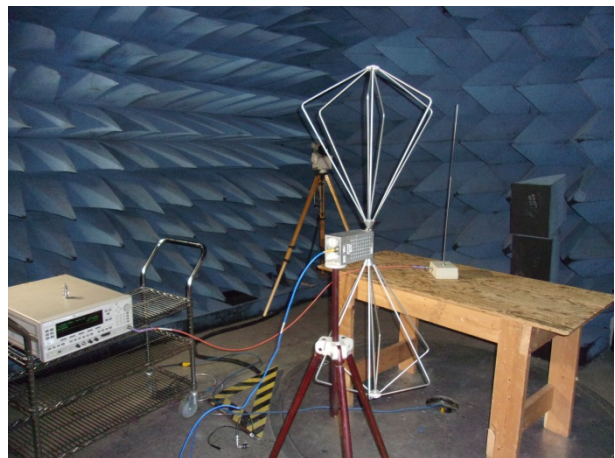
EUT Ambient / Running 2 - 30MHz



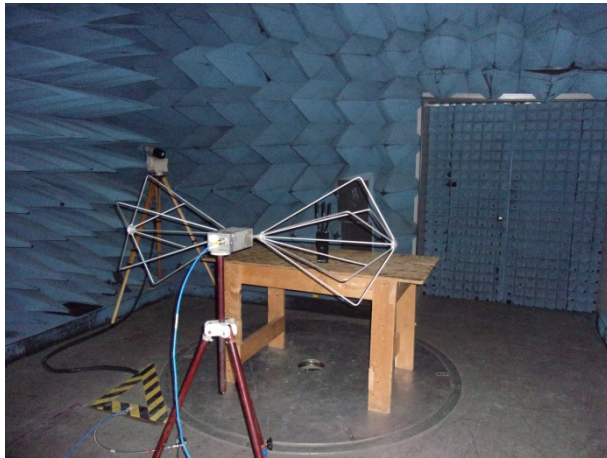
System Check: 30-200MHz



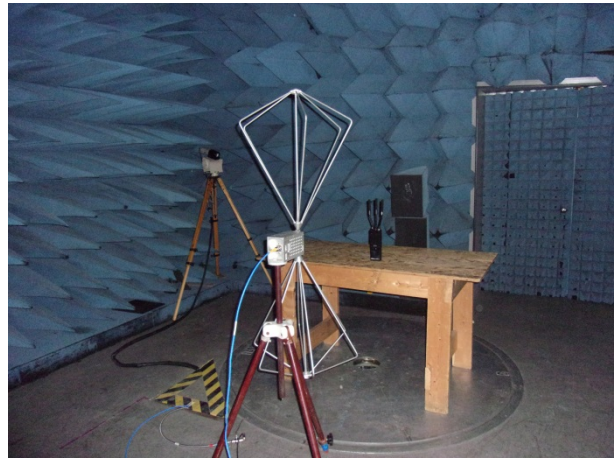
System Check: 30 – 200 MHz Radiated Stub Horizontal



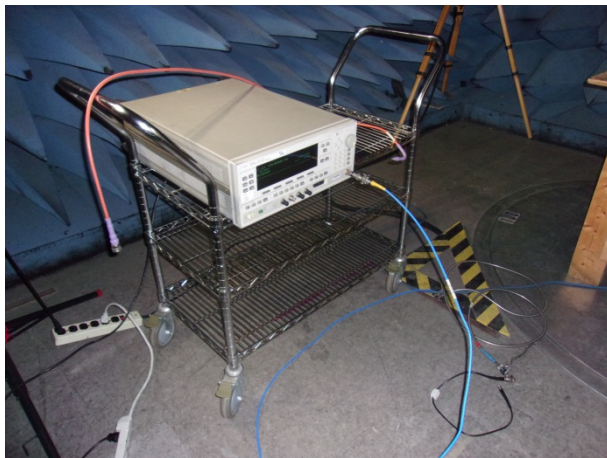
System Check: 30 – 200 MHz Radiated Stub Vertical



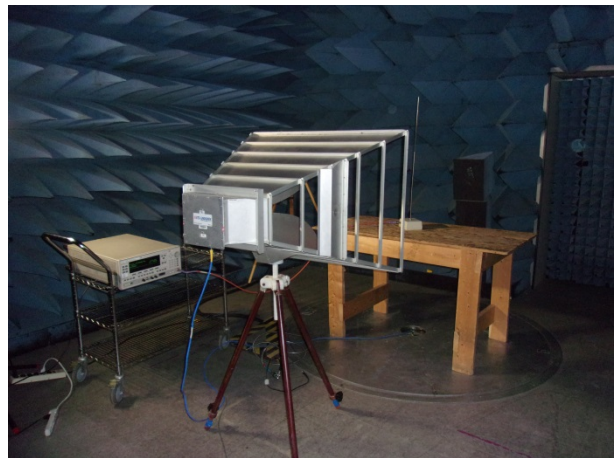
EUT Ambient / Running 30 - 200 MHz
Horizontal



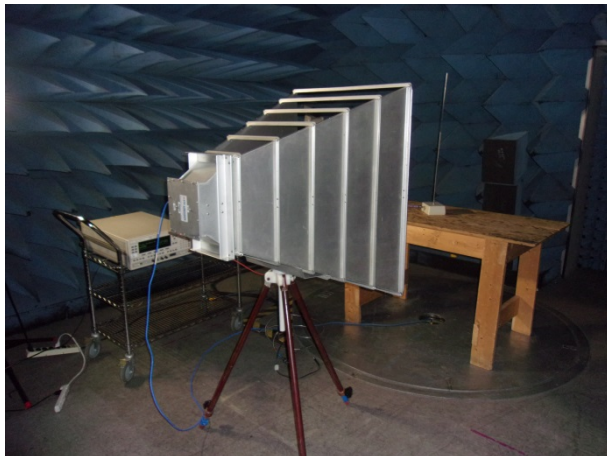
EUT Ambient / Running 30 - 200 MHz
Vertical



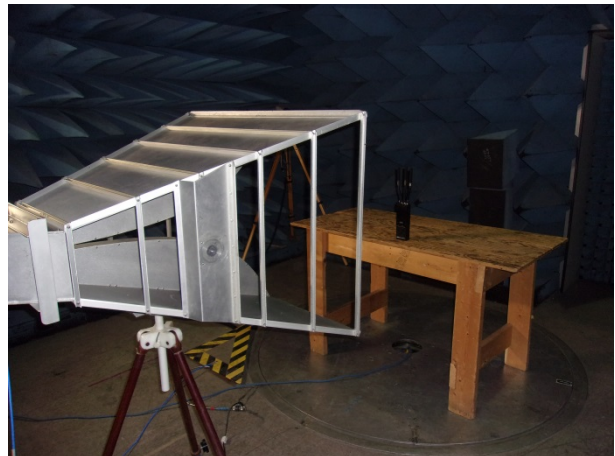
System Check 200-1GHz



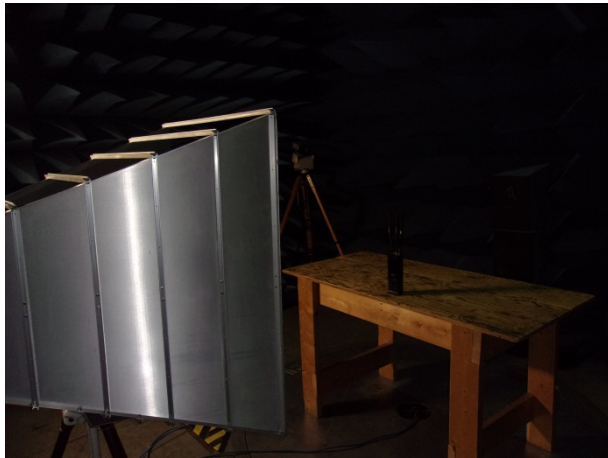
System Check 200-1GHz Radiated Stub
Vertical



System Check 200-1GHz Radiated Stub
Horizontal



EUT Ambient / Running 200-1GHz Vertical



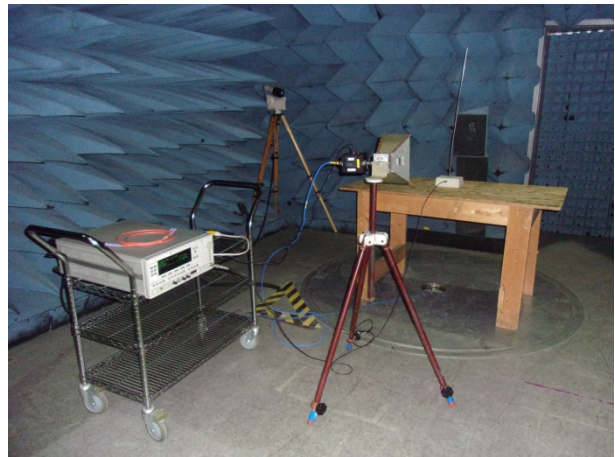
EUT Ambient / Running 200-1GHz Horizontal



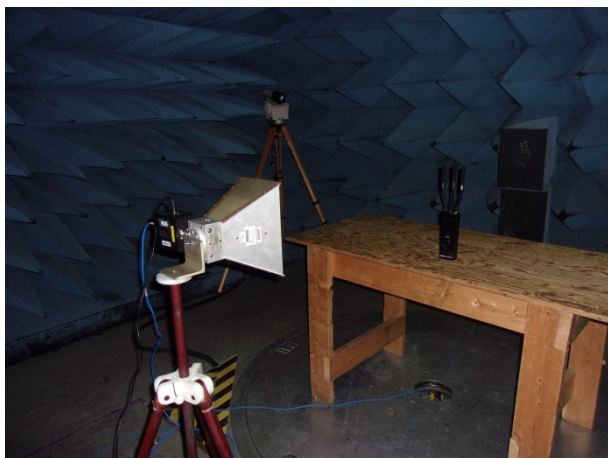
System Check 1 - 18GHz



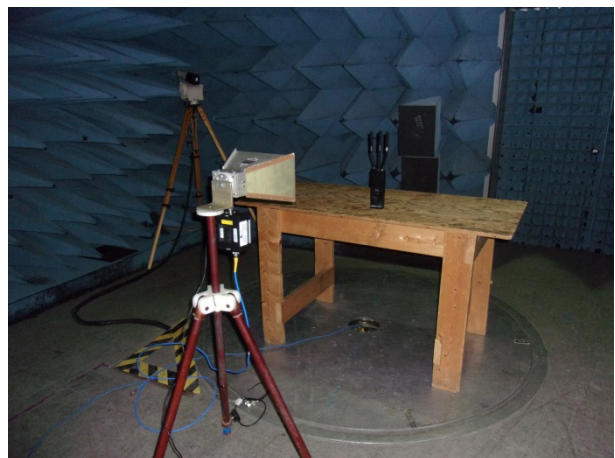
System Check 1 - 18GHz Radiated Stub Vertical



System Check 1 - 18GHz Radiated Stub Horizontal



EUT Ambient / Running 1 - 18 GHz Horizontal



EUT Ambient / Running 1 - 18 GHz Vertical



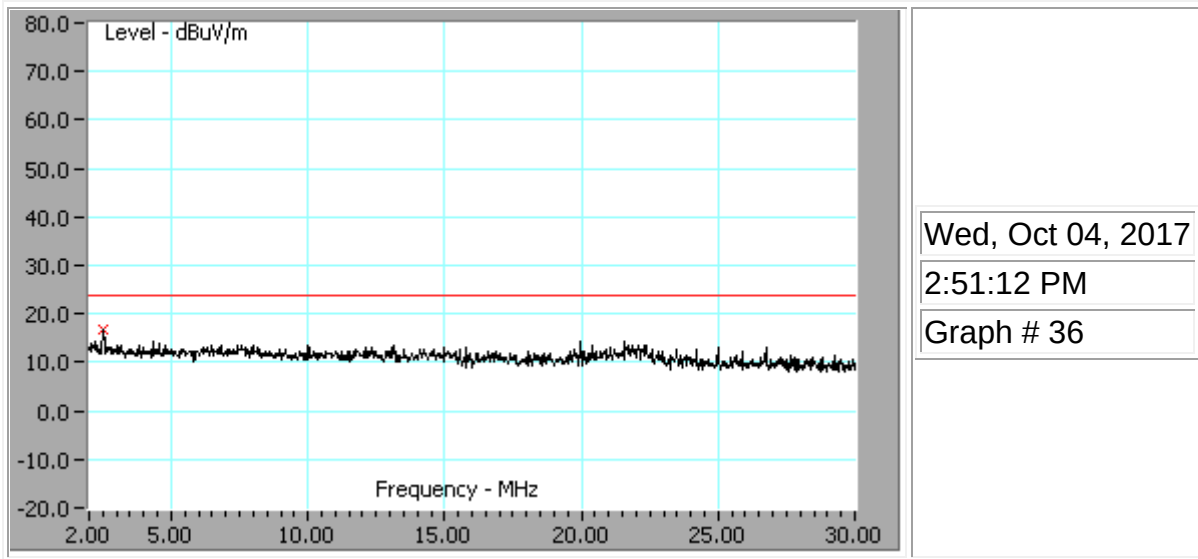
NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

RE102 Data: Embedded Module, Model 5200 paired with L-Band Card, Model No. RF1100

Project: Persistent

Systems Check: Injected Signal = 15.6 dBuV (+/- 3dB) @ 2.5 Mhz



Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
2.529	16.9	24.0	-7.1			16.62	0.00	0.24	0.00	-0.24

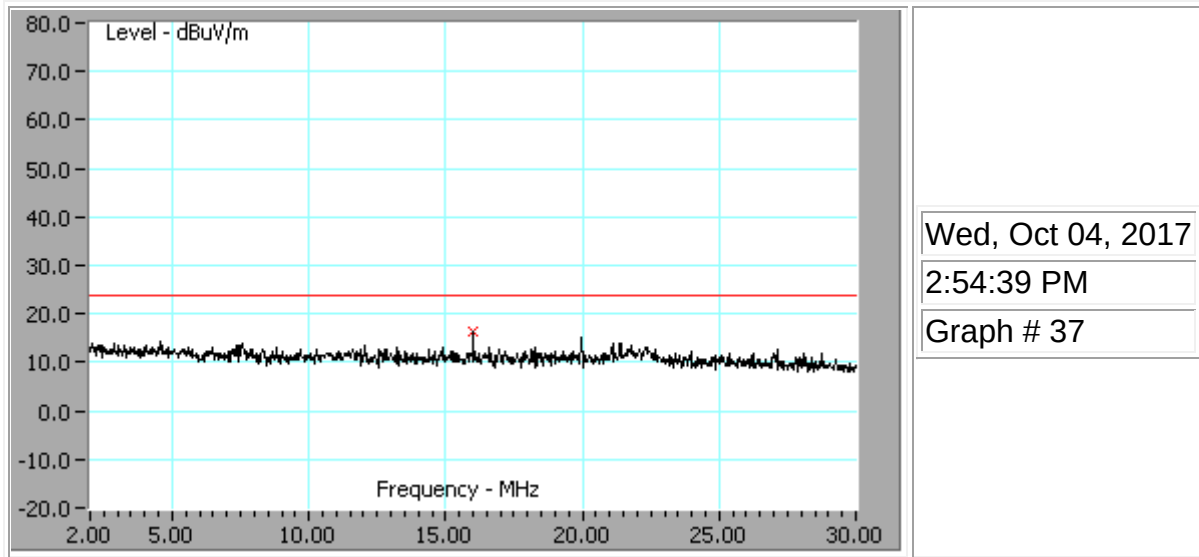


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent

Systems Check: Injected Signal = 15.6 dBuV (+/- 3dB) @ 16.0 Mhz



Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
16.000	16.6	24.0	-7.4			15.53	0.00	1.03	0.00	-1.03

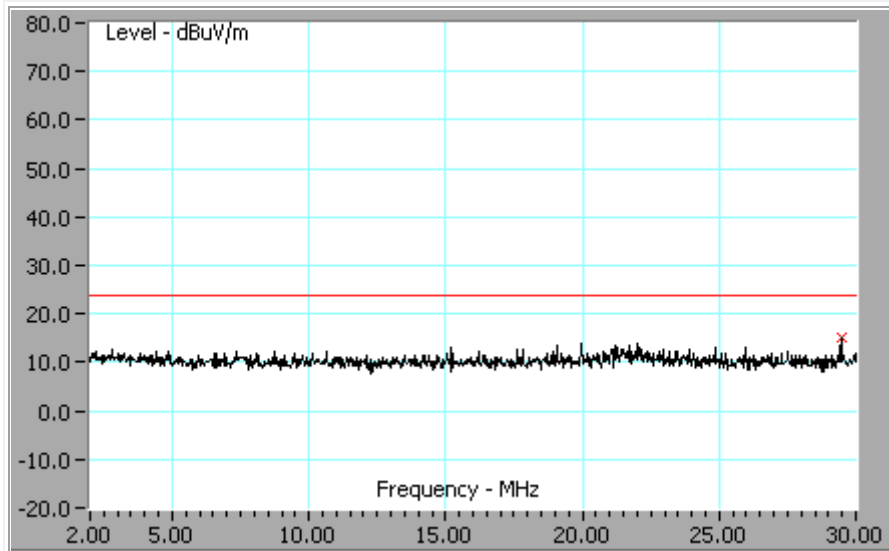


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent

Systems Check: Injected Signal = 15.6 dBuV (+/- 3dB) @ 29.5 Mhz



Wed, Oct 04, 2017

2:57:18 PM

Graph # 38

Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
29.47	15.3	24.0	-8.7			12.88	0.76	1.62	0.00	-2.37

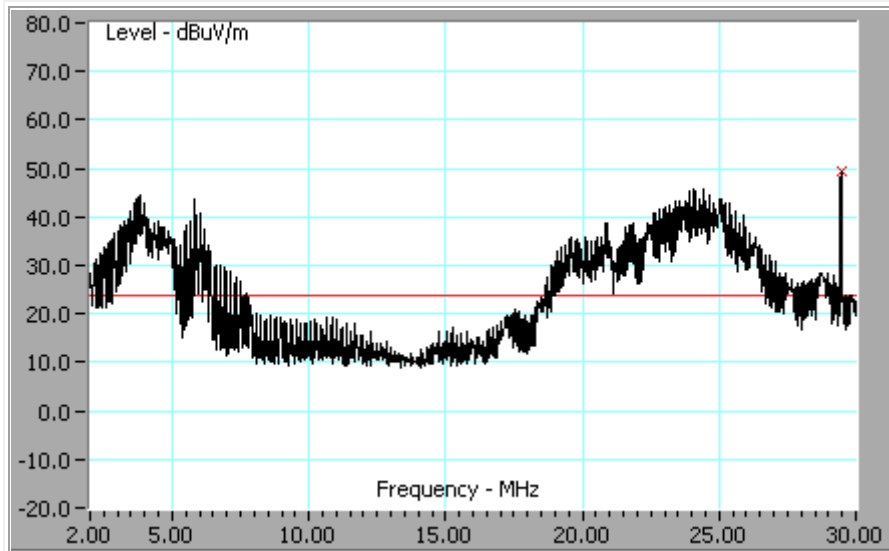


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent

Systems Check: Injected Signal = 29.5 MHz Radiated Stub



Wed, Oct 04, 2017

3:17:27 PM

VERTICAL

Graph # 39

Scan Data

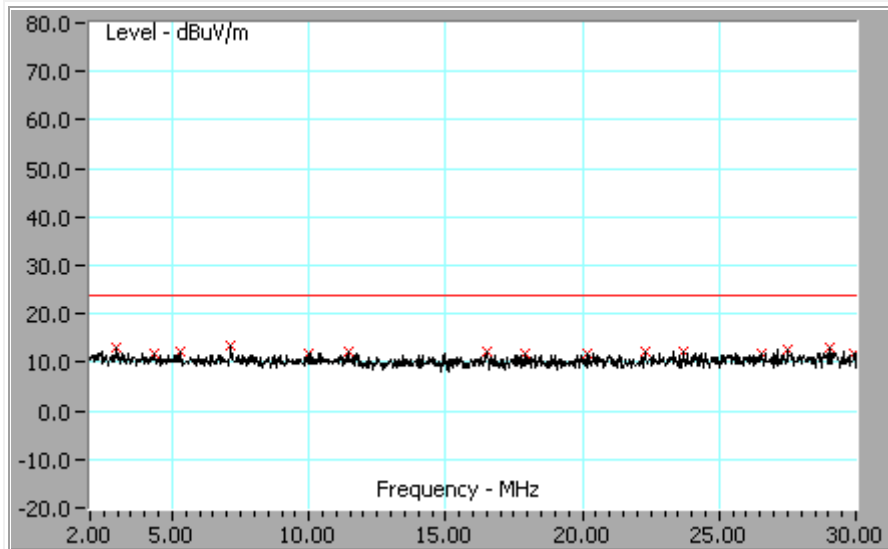
Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
29.47	49.4	24.0	25.4	V		47.04	0.76	1.62	0.00	-2.37



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent
Systems Check: Ambient 2 -30 MHz



Wed, Oct 04, 2017

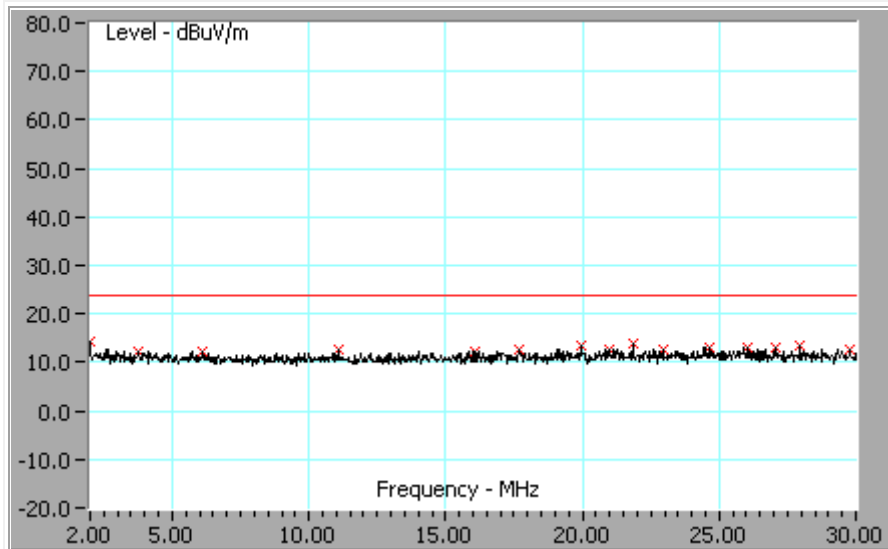
3:22:52 PM

Graph # 40

Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
2.964	13.0	24.0	-11.0	V		14.48	-1.69	0.25	0.00	1.44
4.364	12.0	24.0	-12.0	V		13.39	-1.66	0.29	0.00	1.37
5.267	12.3	24.0	-11.7	V		13.65	-1.63	0.32	0.00	1.31
7.164	13.3	24.0	-10.7	V		14.46	-1.55	0.37	0.00	1.18
9.964	11.9	24.0	-12.1	V		12.78	-1.37	0.45	0.00	0.92
11.427	12.4	24.0	-11.6	V		13.04	-1.25	0.59	0.00	0.66
16.498	12.0	24.0	-12.0	V		11.74	-0.78	1.08	0.00	-0.30
17.929	12.0	24.0	-12.0	V		11.41	-0.63	1.22	0.00	-0.59
20.169	11.8	24.0	-12.2	V		10.73	-0.37	1.42	0.00	-1.05
22.284	12.3	24.0	-11.7	V		10.93	-0.12	1.46	0.00	-1.34
23.684	12.4	24.0	-11.6	V		10.85	0.04	1.49	0.00	-1.53
26.547	11.8	24.0	-12.2	V		9.81	0.39	1.55	0.00	-1.95
27.511	12.6	24.0	-11.4	V		10.47	0.51	1.57	0.00	-2.09
29.036	13.0	24.0	-11.0	V		10.73	0.70	1.61	0.00	-2.31
29.938	11.9	24.0	-12.1	V		9.48	0.81	1.63	0.00	-2.44

Project: Persistent
EUT Running 2 -30 MHz



Wed, Oct 04, 2017

3:38:54 PM

Graph # 41

Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
2.000	14.2	24.0	-9.8	V		15.70	-1.69	0.23	0.00	1.46
3.773	12.3	24.0	-11.7	V		13.70	-1.67	0.28	0.00	1.39
6.138	12.3	24.0	-11.7	V		13.60	-1.60	0.34	0.00	1.25
11.084	12.6	24.0	-11.4	V		13.29	-1.28	0.55	0.00	0.73
16.093	12.4	24.0	-11.6	V		12.15	-0.82	1.04	0.00	-0.22
17.680	12.6	24.0	-11.4	V		12.02	-0.65	1.19	0.00	-0.54
19.951	13.5	24.0	-10.5	V		12.50	-0.40	1.41	0.00	-1.01
20.978	12.5	24.0	-11.5	V		11.31	-0.28	1.44	0.00	-1.15
21.849	13.7	24.0	-10.3	V		12.45	-0.18	1.45	0.00	-1.28
22.938	12.5	24.0	-11.5	V		11.03	-0.05	1.48	0.00	-1.43
24.680	13.1	24.0	-10.9	V		11.44	0.17	1.51	0.00	-1.68
26.049	13.2	24.0	-10.8	V		11.34	0.33	1.54	0.00	-1.88
27.076	12.9	24.0	-11.1	V		10.85	0.46	1.57	0.00	-2.02
27.978	13.6	24.0	-10.4	V		11.46	0.57	1.58	0.00	-2.15
29.782	12.8	24.0	-11.2	V		10.40	0.80	1.62	0.00	-2.42

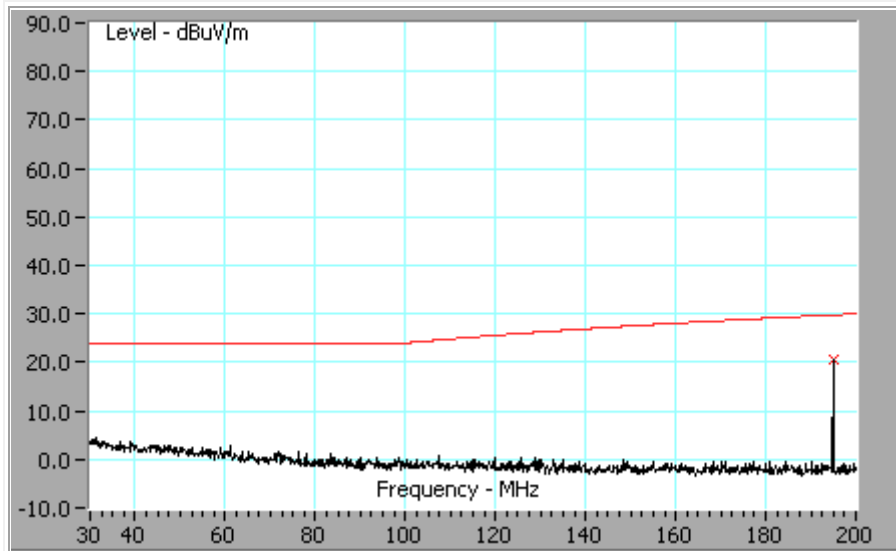


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent

System Check Inject Signal: 20 dBuV (+/- 3dB) @ 195 MHz



Wed, Oct 04, 2017

1:32:26 PM

Graph # 27

Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
195.09	20.4	29.8	-9.4			60.19	0.00	1.35	41.17	39.81

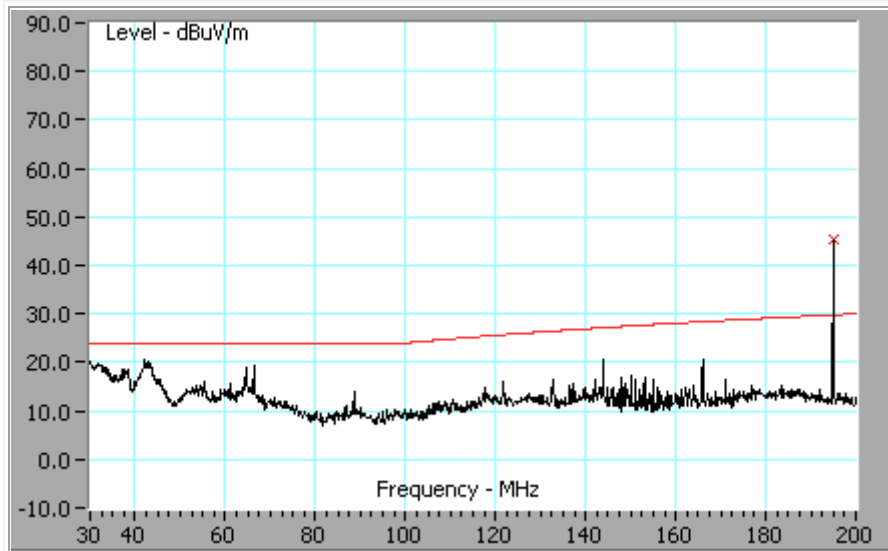


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent

System Check Ambient: Radiated Stub @ 195 MHz



Wed, Oct 04, 2017

2:03:30 PM

HORIZONTAL

Graph # 32

Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
195.09	45.2	29.8	15.4	H		70.45	14.56	1.35	41.17	25.25

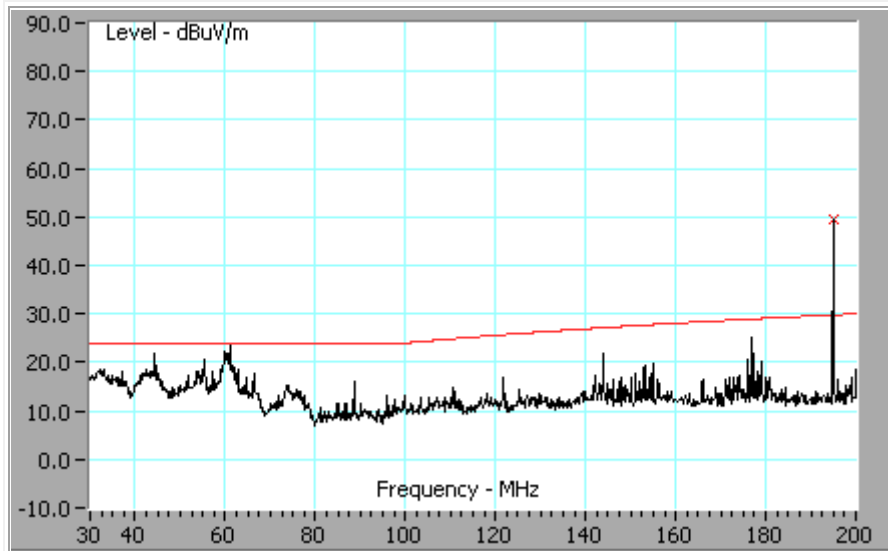


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent

System Check Ambient: Radiated Stub @ 195 MHz



Wed, Oct 04, 2017

2:07:52 PM

VERTICAL

Graph # 33

Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
195.09	49.4	29.8	19.6	V		74.76	14.49	1.35	41.17	25.33

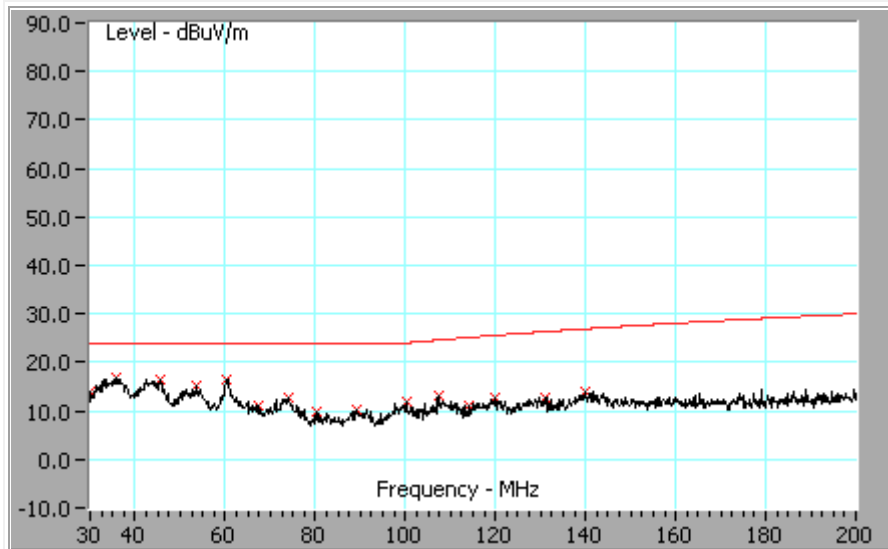


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent

System Check Ambient: 30 - 200MHz



Wed, Oct 04, 2017

1:50:23 PM

VERTICAL

Graph # 30

Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
30.19	14.1	24.0	-9.9	V		41.12	10.75	0.49	38.26	27.02
35.67	16.8	24.0	-7.2	V		43.45	11.49	0.54	38.67	26.64
45.68	16.4	24.0	-7.6	V		43.07	12.00	0.62	39.33	26.72
53.61	15.4	24.0	-8.6	V		43.48	11.00	0.67	39.75	28.08
60.22	16.5	24.0	-7.5	V		46.22	9.66	0.70	40.03	29.67
67.40	11.2	24.0	-12.8	V		41.24	9.46	0.75	40.26	30.05
74.01	12.6	24.0	-11.4	V		43.25	9.03	0.79	40.44	30.63
80.24	9.8	24.0	-14.2	V		41.24	8.32	0.82	40.59	31.45
89.12	10.3	24.0	-13.7	V		41.17	9.03	0.88	40.75	30.85
100.27	11.8	24.0	-12.2	V		41.12	10.62	0.95	40.88	29.31
107.26	13.0	24.6	-11.6	V		41.60	11.40	0.98	41.01	28.63
114.24	11.2	25.2	-14.0	V		39.24	11.99	1.01	41.05	28.06
119.72	12.6	25.6	-13.0	V		40.15	12.43	1.03	41.03	27.57
130.87	12.9	26.3	-13.5	V		39.62	13.12	1.06	40.94	26.76
140.12	14.0	26.9	-12.9	V		40.15	13.59	1.10	40.86	26.16

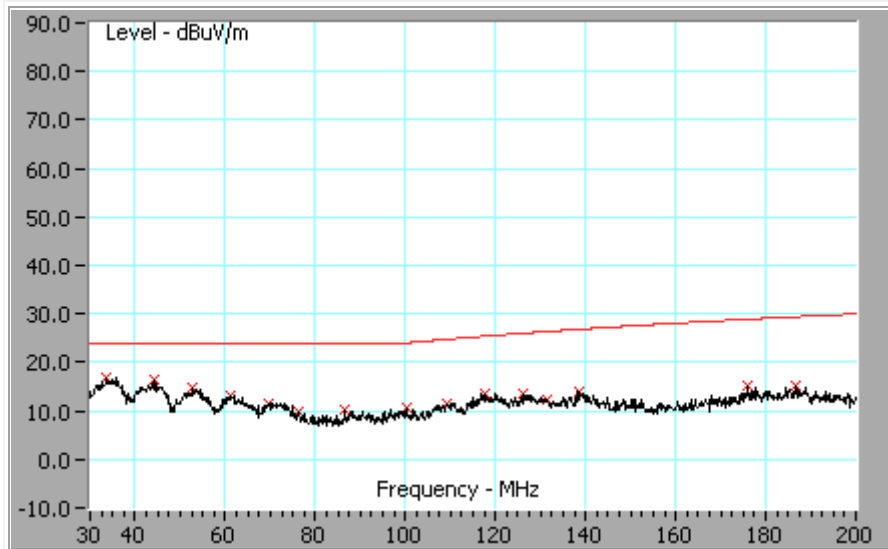


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent

System Check Ambient: 30 - 200MHz



Wed, Oct 04, 2017

1:54:56 PM

HORIZONTAL

Graph # 31

Scan Data

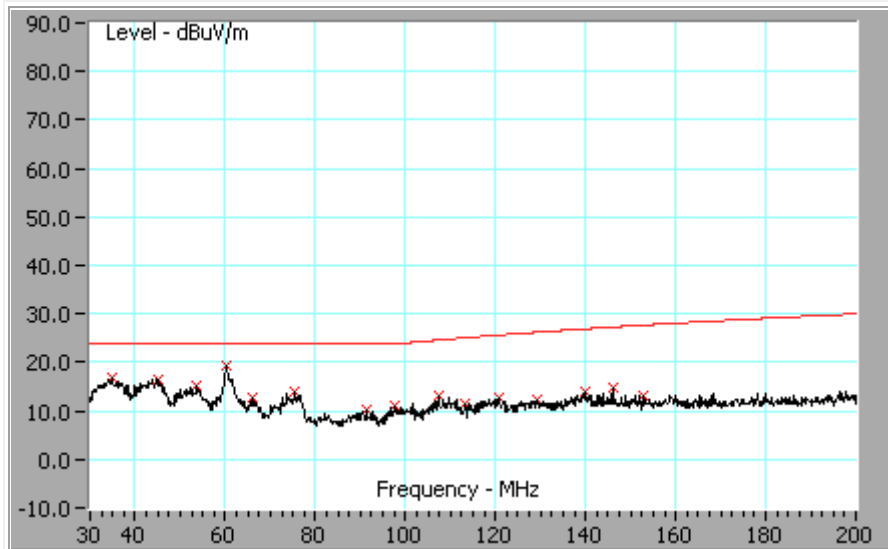
Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
33.78	17.0	24.0	-7.0	H		43.58	11.45	0.52	38.53	26.56
44.17	16.3	24.0	-7.7	H		43.58	11.33	0.61	39.24	27.31
52.86	15.0	24.0	-9.0	H		43.22	10.82	0.66	39.71	28.23
60.98	13.2	24.0	-10.8	H		42.23	10.27	0.70	40.06	29.08
69.67	11.6	24.0	-12.4	H		40.41	10.79	0.76	40.33	28.78
76.47	9.8	24.0	-14.2	H		40.66	8.83	0.80	40.50	30.87
86.67	10.2	24.0	-13.8	H		41.55	8.52	0.86	40.70	31.32
100.27	10.6	24.0	-13.4	H		40.66	9.90	0.95	40.88	30.04
109.14	11.5	24.8	-13.2	H		40.20	11.38	0.99	41.05	28.68
117.64	13.6	25.4	-11.8	H		40.61	13.05	1.02	41.03	26.97
125.96	13.6	26.0	-12.4	H		39.70	13.82	1.04	40.98	26.12
131.24	12.1	26.4	-14.2	H		38.25	13.75	1.06	40.94	26.12
138.61	14.0	26.8	-12.8	H		40.33	13.43	1.10	40.87	26.34
176.01	15.1	28.9	-13.8	H		40.00	14.90	1.24	41.07	24.93
186.59	15.2	29.4	-14.2	H		39.67	15.32	1.31	41.12	24.49



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent
EUT Running 30 - 200 MHz



Wed, Oct 04, 2017

2:15:05 PM

VERTICAL

Graph # 34

Scan Data

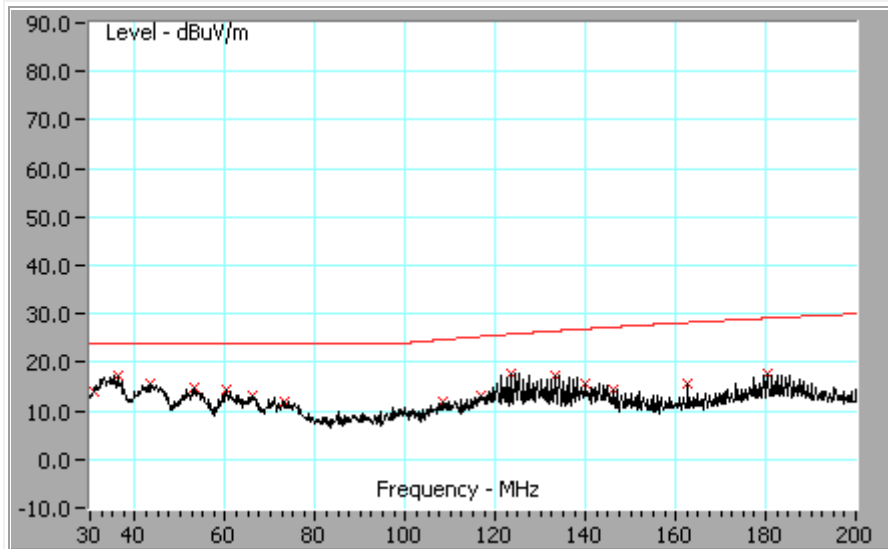
Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
34.72	16.8	24.0	-7.2	V		43.43	11.41	0.53	38.60	26.66
44.92	16.5	24.0	-7.5	V		43.15	12.06	0.61	39.29	26.62
53.80	15.2	24.0	-8.8	V		43.35	10.97	0.67	39.75	28.12
60.22	19.5	24.0	-4.5	V		49.17	9.66	0.70	40.03	29.67
66.08	12.8	24.0	-11.2	V		43.05	9.24	0.74	40.22	30.24
75.52	13.8	24.0	-10.2	V		44.72	8.76	0.79	40.48	30.92
91.20	10.1	24.0	-13.9	V		40.66	9.31	0.89	40.78	30.58
97.81	11.2	24.0	-12.8	V		40.89	10.26	0.94	40.85	29.66
107.44	13.0	24.6	-11.7	V		41.57	11.42	0.98	41.02	28.62
113.30	11.5	25.1	-13.6	V		39.64	11.92	1.00	41.05	28.13
120.67	12.8	25.6	-12.9	V		40.28	12.49	1.03	41.02	27.50
129.36	12.3	26.2	-13.9	V		39.19	13.04	1.06	40.96	26.86
139.74	13.8	26.9	-13.1	V		39.95	13.58	1.10	40.86	26.18
145.98	14.7	27.3	-12.6	V		40.94	13.47	1.13	40.84	26.25
152.78	13.2	27.7	-14.4	V		39.42	13.52	1.15	40.86	26.18



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent
EUT Running 30 - 200 MHz



Wed, Oct 04, 2017

2:24:01 PM

HORIZONTAL

Graph # 35

Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
30.76	13.8	24.0	-10.2	H		40.43	11.19	0.50	38.30	26.61
36.04	17.3	24.0	-6.7	H		43.91	11.52	0.54	38.70	26.64
43.41	15.6	24.0	-8.4	H		42.89	11.34	0.60	39.20	27.26
53.04	14.6	24.0	-9.4	H		42.87	10.81	0.66	39.72	28.25
60.22	14.2	24.0	-9.8	H		43.22	10.32	0.70	40.03	29.01
65.89	13.0	24.0	-11.0	H		42.29	10.15	0.74	40.21	29.32
73.26	11.8	24.0	-12.2	H		41.75	9.67	0.78	40.42	29.97
108.20	12.0	24.7	-12.7	H		40.89	11.18	0.98	41.03	28.86
116.70	13.2	25.3	-12.1	H		40.41	12.86	1.01	41.04	27.16
123.31	17.7	25.8	-8.2	H		43.91	13.72	1.04	41.00	26.25
133.13	17.4	26.5	-9.1	H		43.56	13.65	1.07	40.92	26.20
140.12	15.7	26.9	-11.2	H		42.11	13.37	1.10	40.86	26.38
145.98	14.5	27.3	-12.8	H		41.17	13.04	1.13	40.84	26.68
162.79	15.7	28.2	-12.5	H		42.54	12.91	1.19	40.94	26.85
180.36	17.8	29.1	-11.3	H		42.08	15.58	1.27	41.11	24.26

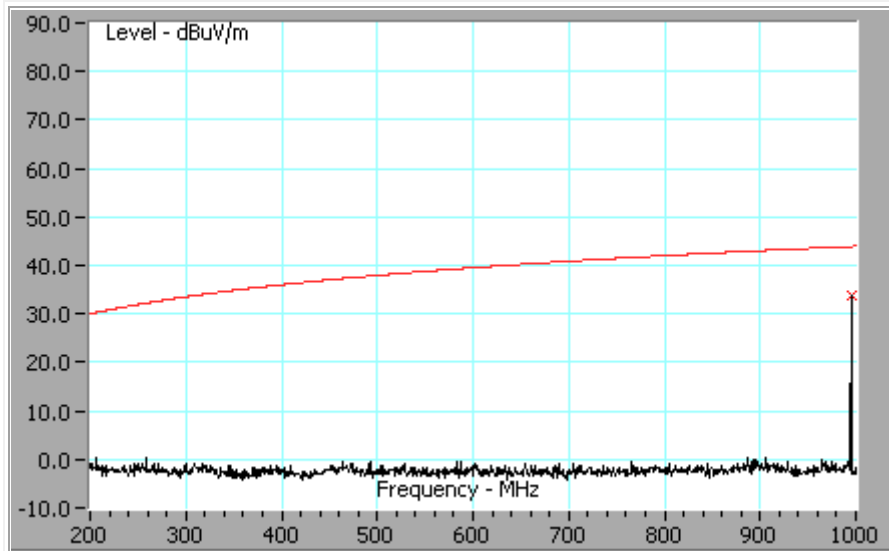


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent

System Check Inject Signal: 35 dBuV (+/- 3dB) @ 995 MHz



Wed, Oct 04, 2017

11:42:28 AM

Graph # 18

Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
995.6	33.9	43.9	-10.0			71.84	0.00	3.58	41.47	37.90

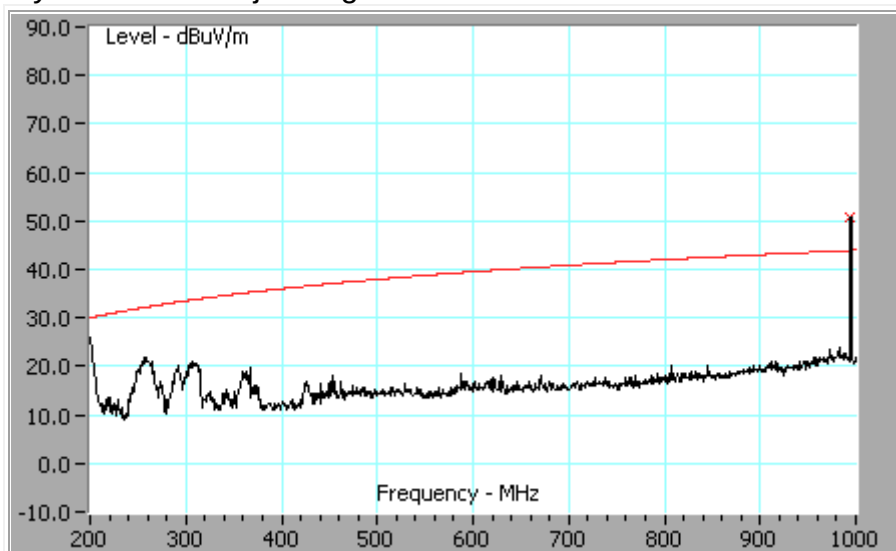


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent

System Check Inject Signal: 995 MHz Radiated Stub



Wed, Oct 04, 2017

11:55:17 AM

VERTICAL

Graph # 19

Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
993.8	50.9	43.9	7.0	V		65.93	22.87	3.58	41.48	15.03

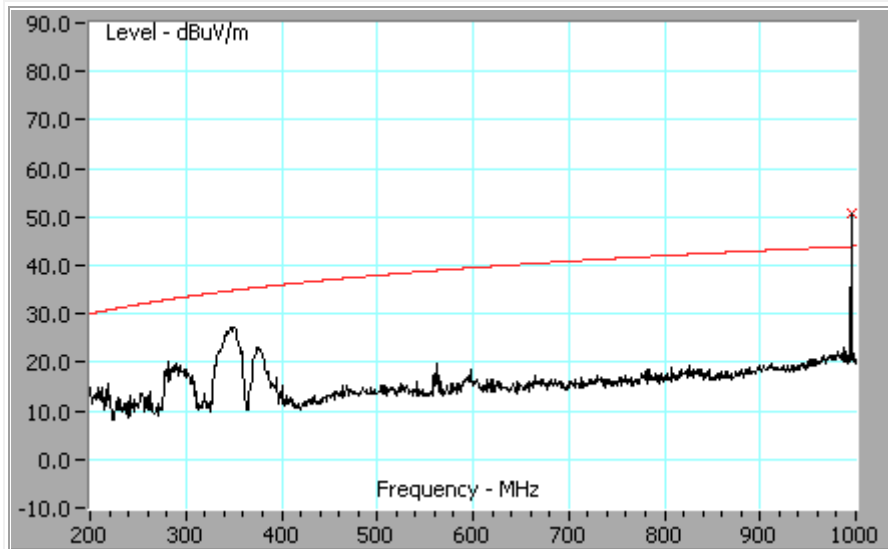


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent

System Check Inject Signal: 995 MHz Radiated Stub



Wed, Oct 04, 2017

12:02:02 PM

HORIZONTAL

Graph # 20

Scan Data

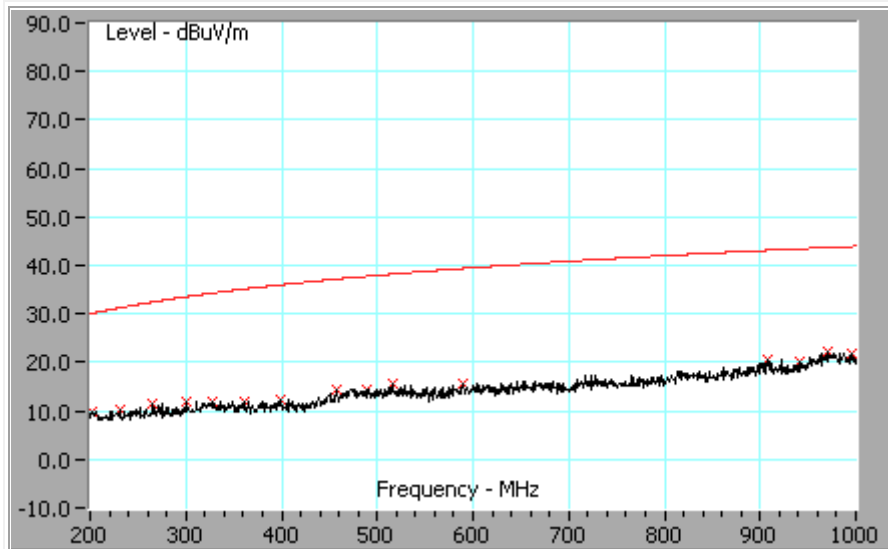
Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
995.6	50.6	43.9	6.7	H		65.90	22.63	3.58	41.47	15.27



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent
System Check: Ambient 200 - 1GHz



Wed, Oct 04, 2017

12:09:32 PM

HORIZONTAL

Graph # 21

Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
201.78	9.9	30.1	-20.2	H		38.76	10.96	1.38	41.21	28.88
231.11	10.3	31.3	-21.0	H		39.21	11.08	1.39	41.38	28.91
265.78	11.3	32.5	-21.2	H		39.70	11.67	1.48	41.55	28.40
300.44	11.8	33.5	-21.8	H		39.64	12.50	1.52	41.89	27.87
328.00	11.9	34.3	-22.4	H		39.47	12.96	1.63	42.15	27.56
360.89	11.9	35.1	-23.3	H		39.09	13.38	1.69	42.29	27.23
398.22	12.4	36.0	-23.6	H		39.01	13.55	1.94	42.11	26.62
456.89	14.3	37.2	-22.9	H		38.76	15.11	2.17	41.73	24.46
488.00	14.3	37.7	-23.4	H		37.51	16.04	2.44	41.69	23.21
515.56	15.6	38.2	-22.6	H		38.76	16.27	2.28	41.67	23.12
589.33	15.7	39.4	-23.7	H		37.92	17.00	2.42	41.65	22.23
908.44	20.4	43.1	-22.7	H		38.10	20.35	3.37	41.43	17.71
942.22	20.0	43.4	-23.4	H		36.93	21.67	2.80	41.36	16.89
969.78	22.0	43.7	-21.7	H		37.56	22.94	3.11	41.58	15.54
995.56	21.8	43.9	-22.1	H		37.11	22.63	3.58	41.47	15.27

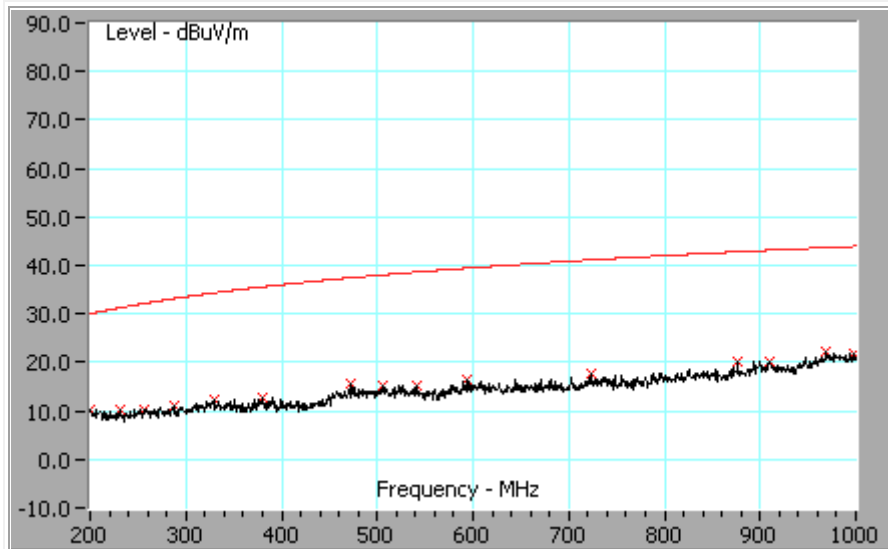


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent

System Check: Ambient 200 - 1GHz



Wed, Oct 04, 2017

12:16:49 PM

VERTICAL

Graph # 22

Scan Data

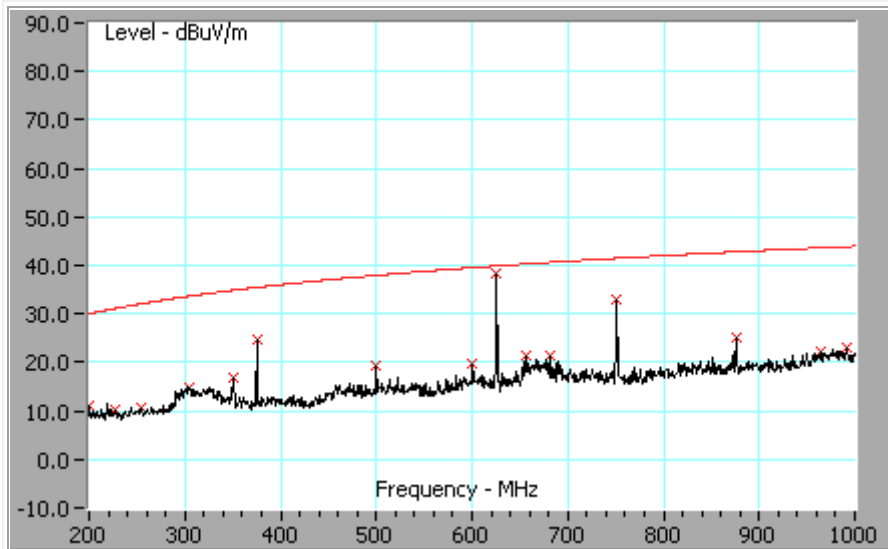
Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
200.89	10.4	30.0	-19.6	V		39.11	11.16	1.38	41.21	28.67
231.11	10.2	31.3	-21.0	V		39.01	11.20	1.39	41.38	28.78
256.89	10.4	32.2	-21.8	V		38.83	11.54	1.46	41.43	28.43
287.11	11.1	33.1	-22.0	V		39.11	12.24	1.50	41.76	28.01
328.89	12.4	34.3	-21.9	V		39.80	13.17	1.63	42.16	27.36
379.56	12.8	35.6	-22.7	V		39.77	13.48	1.76	42.19	26.95
472.89	15.8	37.5	-21.7	V		39.29	15.86	2.35	41.73	23.53
505.78	15.2	38.0	-22.8	V		38.15	16.40	2.32	41.66	22.94
541.33	15.3	38.6	-23.3	V		38.68	16.15	2.18	41.73	23.39
594.67	16.4	39.4	-23.0	V		38.30	17.33	2.40	41.61	21.88
722.67	17.6	41.1	-23.5	V		38.50	18.15	2.57	41.57	20.85
876.44	20.4	42.8	-22.5	V		38.91	19.86	2.84	41.25	18.56
910.22	20.4	43.1	-22.8	V		37.82	20.58	3.40	41.44	17.46
968.89	22.2	43.7	-21.5	V		37.89	22.80	3.09	41.58	15.68
998.22	22.0	43.9	-21.9	V		37.05	22.83	3.57	41.46	15.06



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent
EUT Running 200 - 1GHz Position 1



Wed, Oct 04, 2017

12:45:50 PM

VERTICAL

Graph # 24

Scan Data

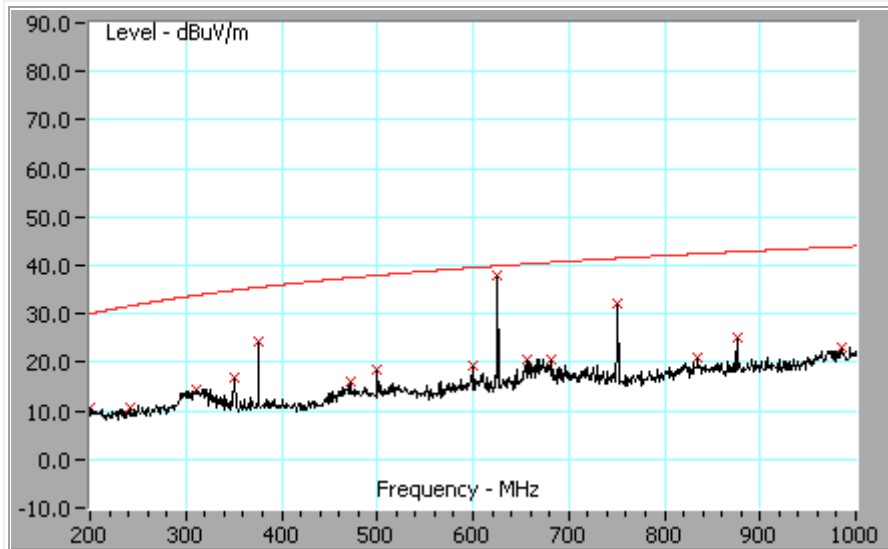
Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
200.00	11.2	30.0	-18.8	V		39.90	11.16	1.38	41.20	28.66
227.56	10.1	31.1	-21.1	V		38.88	11.18	1.38	41.38	28.82
254.22	10.8	32.1	-21.3	V		39.29	11.46	1.44	41.40	28.51
304.89	14.7	33.7	-18.9	V		42.56	12.56	1.55	41.95	27.84
350.22	16.8	34.9	-18.0	V		43.96	13.41	1.67	42.22	27.15
375.11	24.7	35.5	-10.8	V		51.73	13.45	1.74	42.24	27.05
500.44	19.3	38.0	-18.6	V		42.29	16.35	2.35	41.68	22.98
600.00	19.5	39.5	-20.0	V		41.22	17.52	2.38	41.58	21.67
625.78	38.2	39.9	-1.7	V		60.29	17.37	2.23	41.69	22.09
656.00	21.4	40.3	-18.9	V		43.15	17.62	2.33	41.70	21.74
680.89	21.2	40.6	-19.4	V		42.74	17.72	2.44	41.67	21.51
751.11	32.9	41.5	-8.6	V		53.76	18.22	2.45	41.56	20.89
875.56	25.2	42.8	-17.6	V		43.81	19.84	2.83	41.26	18.60
963.56	22.3	43.6	-21.3	V		38.25	22.61	3.00	41.54	15.94
991.11	23.2	43.9	-20.7	V		38.17	22.89	3.59	41.50	15.01



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent
EUT Running 200 - 1GHz Position 2



Wed, Oct 04, 2017

12:42:50 PM

VERTICAL

Graph # 23

Scan Data

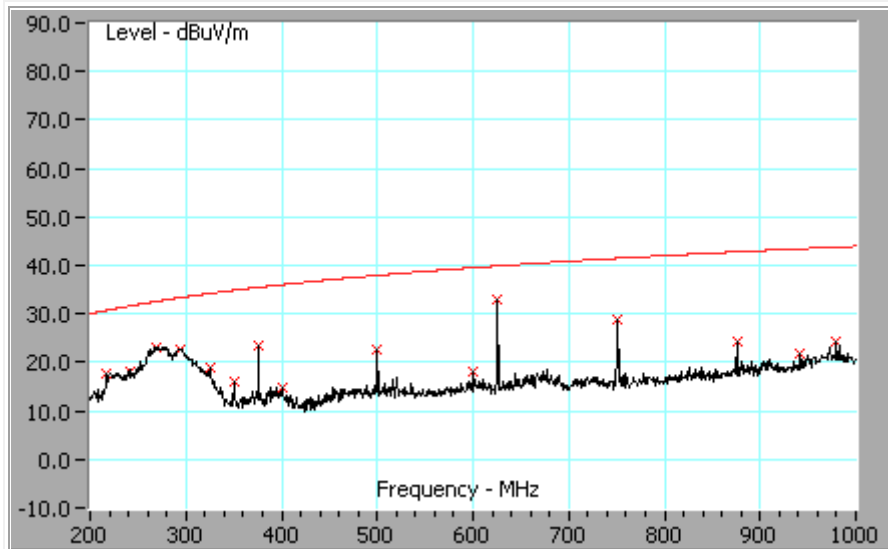
Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
200.00	10.6	30.0	-19.4	V		39.24	11.16	1.38	41.20	28.66
242.67	10.8	31.7	-20.8	V		39.49	11.28	1.45	41.39	28.66
312.00	14.5	33.9	-19.4	V		42.13	12.76	1.59	42.02	27.68
350.22	17.0	34.9	-17.8	V		44.19	13.41	1.67	42.22	27.15
376.00	24.4	35.5	-11.1	V		51.40	13.46	1.74	42.23	27.03
472.00	15.9	37.4	-21.5	V		39.49	15.82	2.35	41.73	23.56
500.44	18.6	38.0	-19.4	V		41.57	16.35	2.35	41.68	22.98
600.89	19.4	39.5	-20.2	V		41.07	17.51	2.38	41.58	21.69
625.78	37.8	39.9	-2.1	V		59.91	17.37	2.23	41.69	22.09
656.00	20.8	40.3	-19.5	V		42.51	17.62	2.33	41.70	21.74
681.78	20.4	40.6	-20.2	V		41.96	17.72	2.44	41.67	21.51
751.11	32.0	41.5	-9.4	V		52.93	18.22	2.45	41.56	20.89
834.67	21.0	42.4	-21.4	V		40.20	19.51	2.59	41.31	19.20
875.56	25.1	42.8	-17.7	V		43.66	19.84	2.83	41.26	18.60
984.89	22.9	43.8	-20.9	V		38.04	22.94	3.42	41.49	15.13



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent
EUT Running 200 - 1GHz Position 1



Wed, Oct 04, 2017

12:54:54 PM

HORIZONTAL

Graph # 25

Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
217.78	17.9	30.7	-12.9	H		46.93	10.96	1.37	41.37	29.04
242.67	17.9	31.7	-13.8	H		46.55	11.30	1.45	41.39	28.64
268.44	23.1	32.6	-9.4	H		51.55	11.71	1.47	41.59	28.41
294.22	22.7	33.4	-10.7	H		50.67	12.33	1.51	41.84	28.00
325.33	19.1	34.2	-15.1	H		46.68	12.92	1.62	42.13	27.59
350.22	16.0	34.9	-18.8	H		43.28	13.32	1.67	42.22	27.24
376.00	23.4	35.5	-12.1	H		50.41	13.46	1.74	42.23	27.02
400.89	14.8	36.0	-21.3	H		41.32	13.57	1.97	42.08	26.55
500.44	22.6	38.0	-15.3	H		45.66	16.30	2.35	41.68	23.03
600.89	18.3	39.5	-21.2	H		40.25	17.25	2.38	41.58	21.95
625.78	33.0	39.9	-6.9	H		55.26	17.23	2.23	41.69	22.22
751.11	28.8	41.5	-12.7	H		49.75	18.11	2.45	41.56	21.00
875.56	24.4	42.8	-18.4	H		43.25	19.61	2.83	41.26	18.83
942.22	21.9	43.4	-21.6	H		38.76	21.67	2.80	41.36	16.89
979.56	24.4	43.8	-19.3	H		39.62	23.06	3.24	41.48	15.18



Project: Persistent
EUT Running 200 - 1GHz Position 2

Scan Data

69 of 100

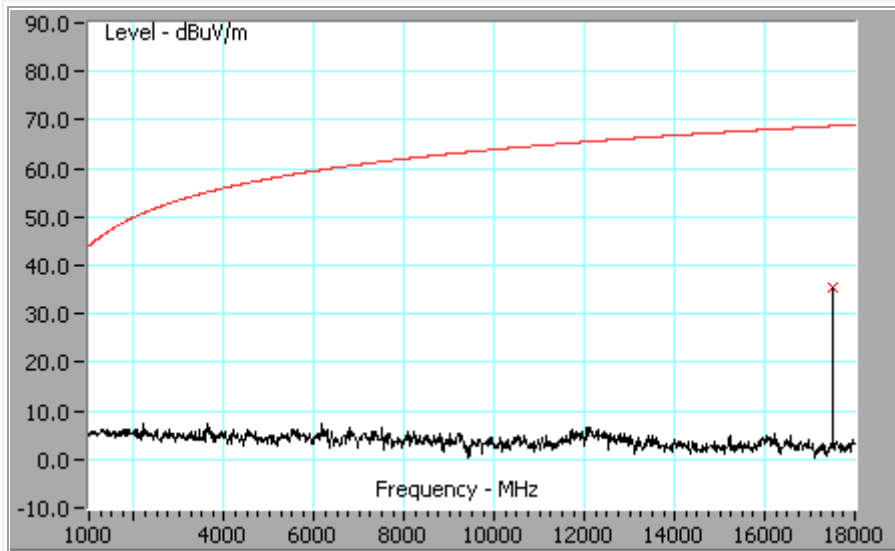


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent

System Check: Injected Signal = 37 dBuV (+/- 3dB) @ 17.5 GHz



Wed, Oct 04, 2017

9:27:14 AM

VERTICAL

Graph # 2

Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
17507.0	35.6	68.8	-33.1			67.72	0.00	12.36	44.45	32.09

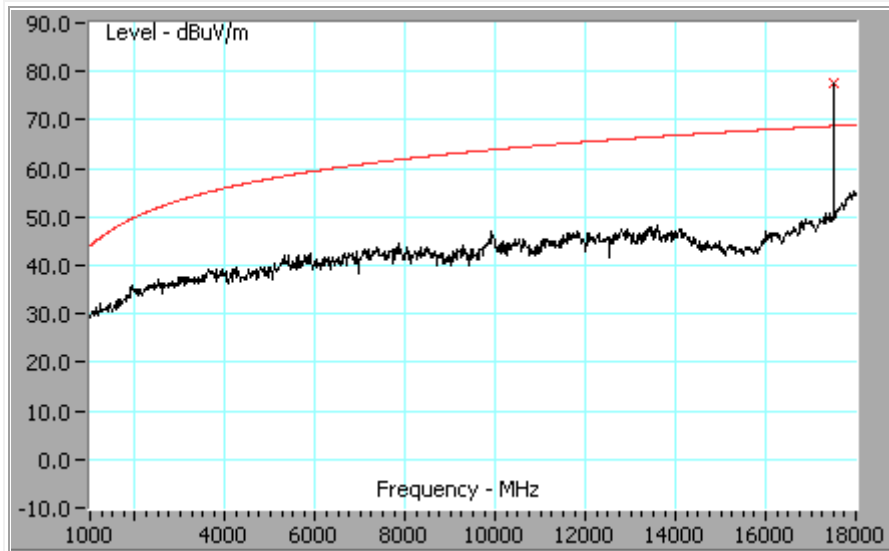


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent

System Check: Injected Signal = 17.5 GHz Radiated Stub



Wed, Oct 04, 2017

9:46:02 AM

HORIZONTAL

Graph # 3

Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
17507.0	77.5	68.8	8.7	H		64.27	45.27	12.36	44.45	-13.18

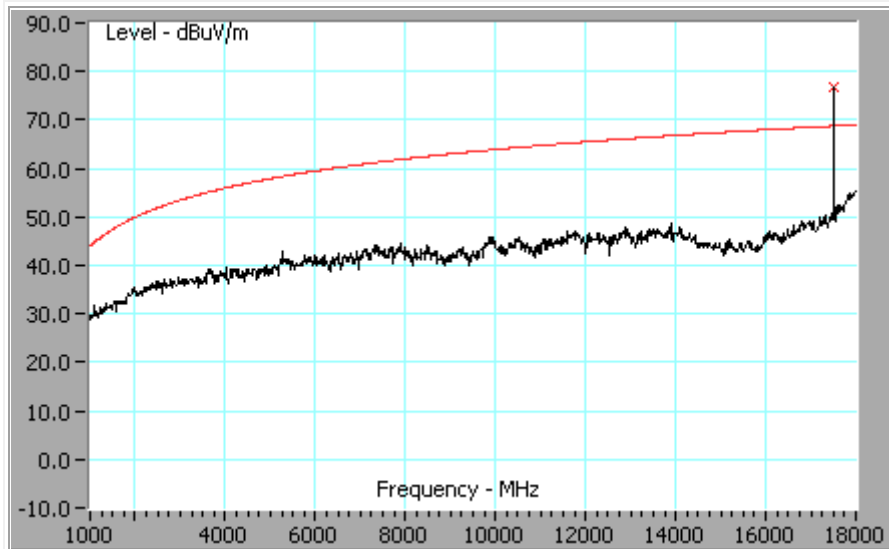


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent

System Check: Injected Signal = 17.5 GHz Radiated Stub



Wed, Oct 04, 2017

9:50:44 AM

VERTICAL

Graph # 4

Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
17507.0	76.8	68.8	8.0	V		63.81	45.07	12.36	44.45	-12.98

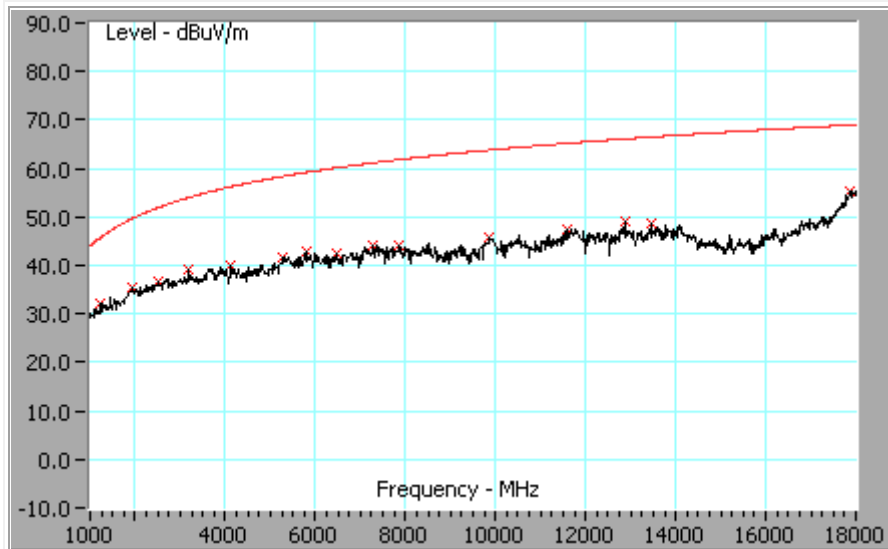


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent

System Check: Ambient 1 - 18GHz



Wed, Oct 04, 2017

10:14:17 AM

VERTICAL

Graph # 5

Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
1221.0	32.1	45.7	-13.6	V		45.42	24.48	3.54	41.32	13.30
1935.0	35.5	49.7	-14.2	V		44.19	28.12	4.34	41.15	8.69
2530.0	36.8	52.0	-15.2	V		43.56	30.06	4.64	41.44	6.74
3176.0	39.3	54.0	-14.6	V		44.60	31.28	5.36	41.92	5.28
4111.0	40.1	56.2	-16.1	V		43.89	32.72	6.03	42.52	3.77
5267.0	41.7	58.4	-16.6	V		42.30	34.83	7.21	42.60	0.56
5794.0	42.9	59.2	-16.3	V		42.23	35.38	8.27	42.99	-0.65
6457.0	42.3	60.1	-17.8	V		40.97	35.59	8.30	42.55	-1.34
7273.0	44.1	61.1	-17.0	V		40.95	37.10	8.50	42.41	-3.19
7851.0	44.1	61.8	-17.7	V		40.71	37.74	8.65	43.01	-3.38
9857.0	45.9	63.8	-17.9	V		39.67	39.36	9.82	42.95	-6.23
11608.0	47.5	65.2	-17.7	V		38.24	40.48	10.92	42.15	-9.25
12866.0	49.0	66.1	-17.1	V		37.42	40.37	13.08	41.92	-11.53
13461.0	48.5	66.5	-18.0	V		36.42	41.63	11.48	41.05	-12.06
17864.0	55.3	68.9	-13.6	V		37.87	48.64	12.58	43.80	-17.42

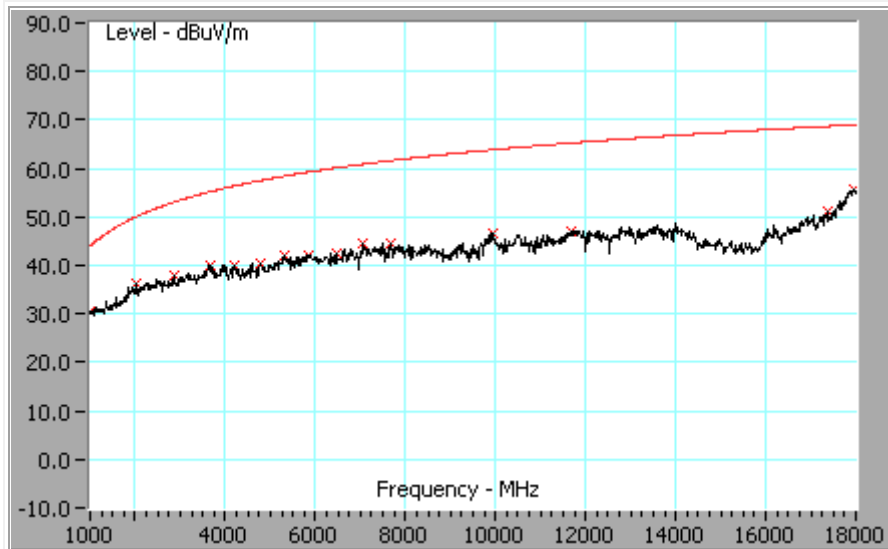


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent

System Check: Ambient 1 - 18GHz



Wed, Oct 04, 2017

10:19:19 AM

HORIZONTAL

Graph # 6

Scan Data

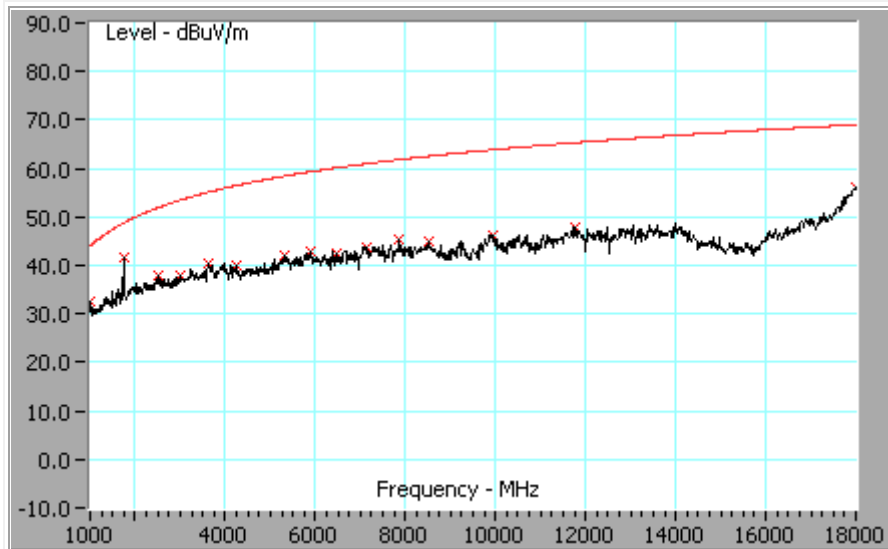
Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
1000.0	30.4	44.0	-13.6	H		44.46	23.80	3.56	41.45	14.09
2003.0	36.2	50.0	-13.8	H		44.36	28.71	4.35	41.23	8.17
2853.0	37.8	53.0	-15.2	H		43.57	30.71	5.18	41.64	5.75
3669.0	40.1	55.2	-15.2	H		43.82	32.24	5.78	41.78	3.76
4196.0	40.1	56.4	-16.3	H		42.98	32.70	6.55	42.18	2.93
4774.0	40.6	57.5	-16.9	H		42.56	33.58	6.77	42.33	1.98
5318.0	42.2	58.4	-16.3	H		42.29	34.87	7.29	42.30	0.14
5845.0	42.1	59.3	-17.1	H		41.57	35.27	8.11	42.83	-0.55
6457.0	42.4	60.1	-17.7	H		41.10	35.57	8.30	42.55	-1.32
7069.0	44.6	60.9	-16.3	H		41.72	36.71	8.77	42.62	-2.86
7664.0	44.3	61.6	-17.3	H		40.64	37.56	8.57	42.43	-3.70
9925.0	46.8	63.8	-17.1	H		40.18	39.59	9.89	42.90	-6.57
11693.0	47.2	65.3	-18.0	H		37.64	40.22	11.50	42.15	-9.58
17371.0	51.2	68.7	-17.5	H		38.35	44.63	12.24	44.05	-12.82
17949.0	55.9	69.0	-13.1	H		36.94	49.69	12.77	43.52	-18.94



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent
EUT Running 1-18GHz Antenna Position 1



Wed, Oct 04, 2017

10:41:59 AM

HORIZONTAL

Graph # 7

Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
1000.0	32.7	44.0	-11.3	H		46.74	23.80	3.56	41.45	14.09
1748.0	41.8	48.8	-7.0	H		51.97	27.04	4.07	41.32	10.21
2496.0	37.9	51.9	-14.0	H		44.72	29.99	4.59	41.43	6.85
3023.0	37.8	53.5	-15.7	H		43.16	31.05	5.34	41.74	5.36
3618.0	40.5	55.1	-14.6	H		44.25	32.17	5.89	41.84	3.78
4247.0	40.0	56.5	-16.5	H		43.23	32.70	6.47	42.40	3.23
5301.0	42.2	58.4	-16.2	H		42.36	34.84	7.27	42.31	0.19
5913.0	42.7	59.4	-16.6	H		42.19	35.28	7.85	42.58	-0.56
6474.0	42.6	60.1	-17.6	H		41.15	35.58	8.36	42.53	-1.41
7120.0	43.7	61.0	-17.3	H		40.68	36.79	8.77	42.58	-2.98
7851.0	45.4	61.8	-16.4	H		42.02	37.75	8.65	43.01	-3.39
8514.0	44.8	62.5	-17.7	H		40.39	37.79	8.77	42.12	-4.44
9959.0	46.3	63.9	-17.5	H		40.10	39.69	9.61	43.04	-6.25
11761.0	48.0	65.3	-17.3	H		38.08	40.02	11.91	41.99	-9.94
18000.0	56.3	69.0	-12.7	H		36.45	50.20	12.87	43.26	-19.81

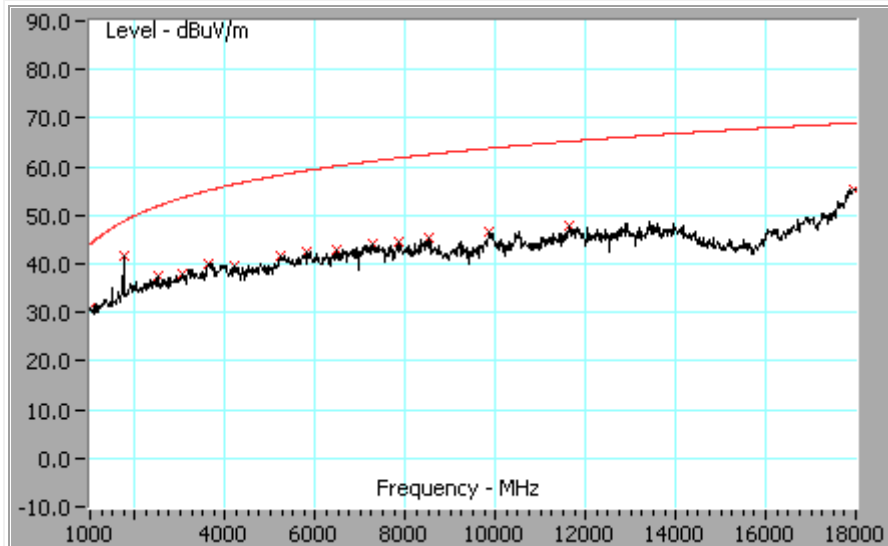


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent

EUT Running 1-18GHz Antenna Position 2



Wed, Oct 04, 2017

10:43:50 AM

HORIZONTAL

Graph # 8

Scan Data

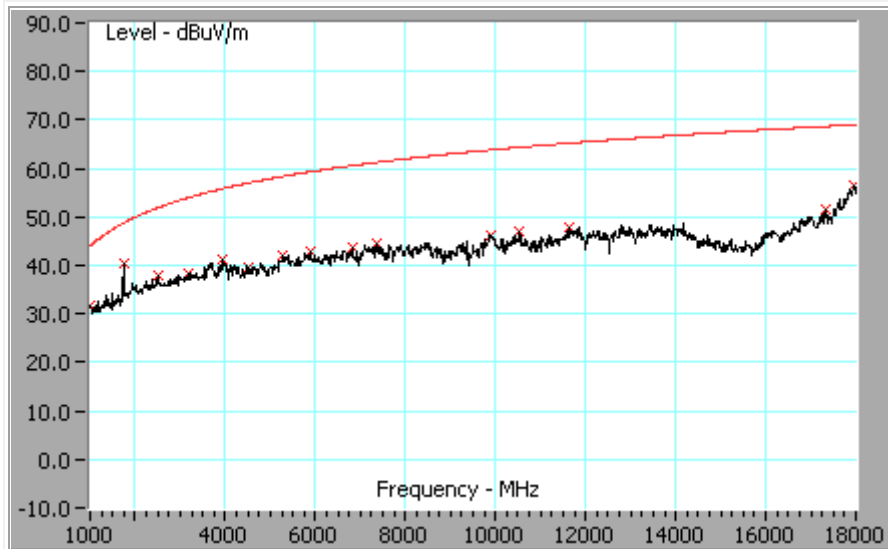
Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
1017.0	31.0	44.1	-13.1	H		45.02	23.85	3.56	41.40	13.99
1748.0	41.5	48.8	-7.3	H		51.74	27.04	4.07	41.32	10.21
2496.0	37.3	51.9	-14.5	H		44.18	29.99	4.59	41.43	6.85
3040.0	37.9	53.6	-15.7	H		43.32	31.08	5.30	41.79	5.41
3635.0	40.2	55.1	-15.0	H		43.95	32.19	5.86	41.82	3.77
4196.0	39.6	56.4	-16.8	H		42.52	32.70	6.55	42.18	2.93
5216.0	41.7	58.3	-16.6	H		42.95	34.69	7.12	43.06	1.25
5794.0	42.4	59.2	-16.8	H		41.89	35.26	8.27	42.99	-0.53
6457.0	42.8	60.1	-17.3	H		41.48	35.57	8.30	42.55	-1.32
7256.0	44.1	61.1	-17.1	H		41.04	37.01	8.52	42.49	-3.04
7851.0	44.5	61.8	-17.4	H		41.07	37.75	8.65	43.01	-3.39
8514.0	45.4	62.5	-17.1	H		40.95	37.79	8.77	42.12	-4.44
9857.0	46.8	63.8	-17.0	H		40.54	39.40	9.82	42.95	-6.27
11642.0	47.8	65.2	-17.5	H		38.38	40.37	11.15	42.15	-9.38
17949.0	55.5	69.0	-13.5	H		36.54	49.69	12.77	43.52	-18.94



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent
EUT Running 1-18GHz Antenna Position 3



Wed, Oct 04, 2017

10:46:21 AM

HORIZONTAL

Graph # 10

Scan Data

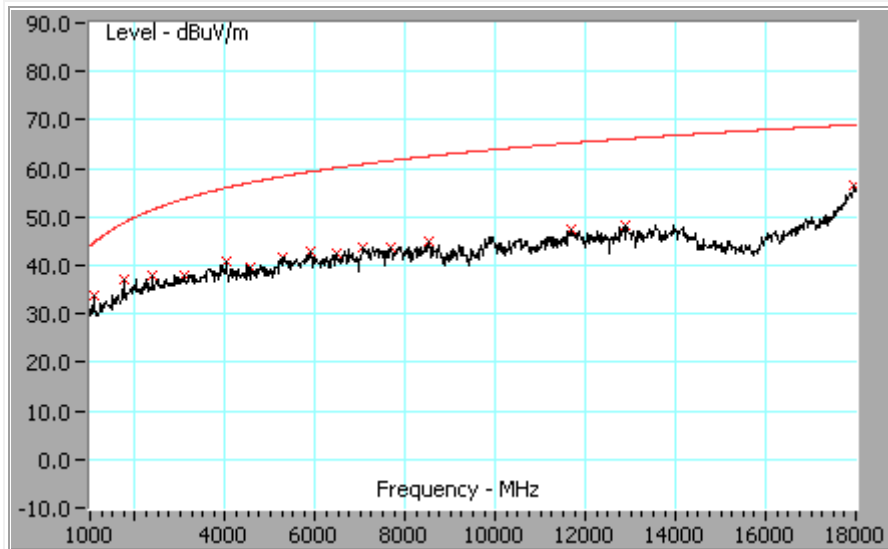
Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
1017.0	31.9	44.1	-12.2	H		45.90	23.85	3.56	41.40	13.99
1748.0	40.3	48.8	-8.5	H		50.48	27.04	4.07	41.32	10.21
2496.0	37.9	51.9	-13.9	H		44.78	29.99	4.59	41.43	6.85
3176.0	38.2	54.0	-15.8	H		43.42	31.35	5.36	41.92	5.21
3958.0	41.1	55.9	-14.8	H		44.03	32.64	6.26	41.86	2.96
4536.0	39.8	57.1	-17.3	H		42.93	32.82	6.74	42.70	3.15
5267.0	42.1	58.4	-16.3	H		42.69	34.78	7.21	42.60	0.61
5879.0	42.7	59.3	-16.6	H		42.19	35.28	7.96	42.68	-0.56
6831.0	43.9	60.6	-16.7	H		40.87	36.26	8.96	42.24	-2.99
7375.0	44.5	61.3	-16.8	H		40.41	37.20	8.38	41.48	-4.11
9908.0	46.3	63.8	-17.5	H		39.60	39.54	10.03	42.83	-6.74
10520.0	47.1	64.3	-17.2	H		40.22	39.52	10.13	42.73	-6.92
11625.0	47.7	65.2	-17.5	H		38.37	40.42	11.04	42.15	-9.31
17320.0	51.7	68.7	-17.0	H		39.07	44.41	12.06	43.88	-12.59
17966.0	56.4	69.0	-12.6	H		37.20	49.86	12.80	43.43	-19.23



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent
EUT Running 1-18GHz Antenna Position 4



Wed, Oct 04, 2017

10:49:13 AM

HORIZONTAL

Graph # 11

Scan Data

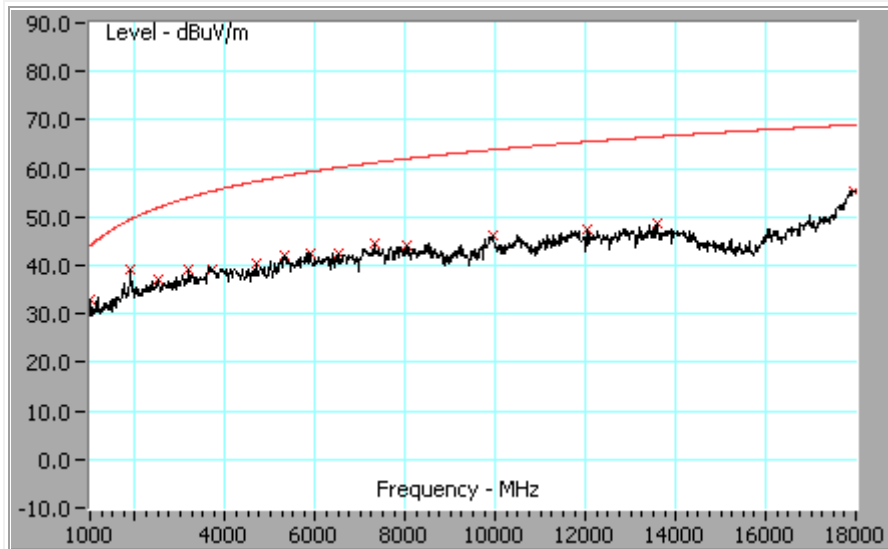
Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
1068.0	33.8	44.5	-10.7	H		47.49	24.02	3.56	41.27	13.69
1748.0	37.2	48.8	-11.6	H		47.39	27.04	4.07	41.32	10.21
2377.0	38.1	51.5	-13.4	H		45.31	29.68	4.58	41.48	7.22
3074.0	38.1	53.7	-15.6	H		43.62	31.15	5.22	41.87	5.51
4026.0	40.6	56.0	-15.4	H		43.65	32.70	6.26	41.98	3.02
4570.0	39.4	57.1	-17.7	H		42.67	32.92	6.65	42.83	3.25
5284.0	41.8	58.4	-16.6	H		42.18	34.81	7.24	42.45	0.40
5879.0	43.0	59.3	-16.3	H		42.42	35.28	7.96	42.68	-0.56
6457.0	42.4	60.1	-17.7	H		41.09	35.57	8.30	42.55	-1.32
7052.0	43.8	60.9	-17.1	H		41.06	36.68	8.74	42.67	-2.76
7664.0	43.9	61.6	-17.7	H		40.17	37.56	8.57	42.43	-3.70
8514.0	44.9	62.5	-17.6	H		40.49	37.79	8.77	42.12	-4.44
11693.0	47.5	65.3	-17.8	H		37.93	40.22	11.50	42.15	-9.58
12866.0	48.3	66.1	-17.8	H		36.73	40.40	13.08	41.92	-11.56
17966.0	56.5	69.0	-12.5	H		37.29	49.86	12.80	43.43	-19.23



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent
EUT Running 1-18GHz Antenna Position 5



Wed, Oct 04, 2017

10:52:29 AM

HORIZONTAL

Graph # 12

Scan Data

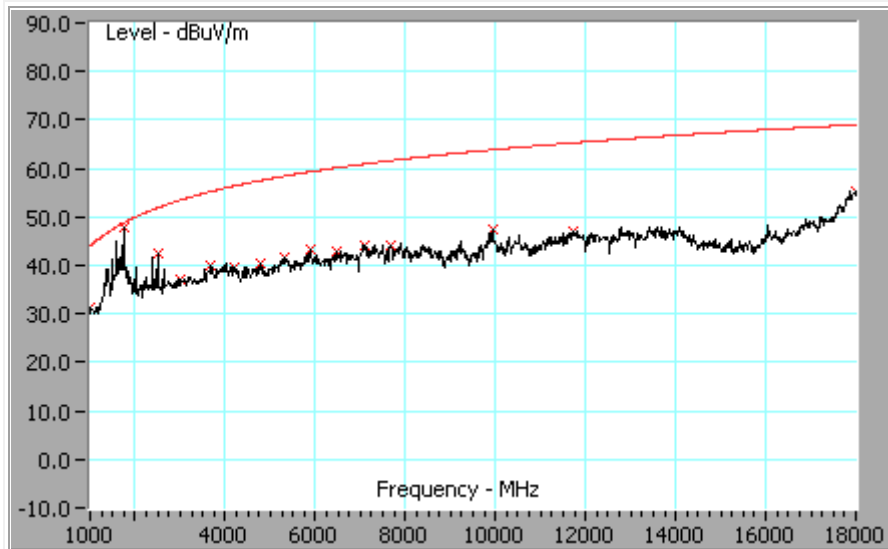
Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
1017.0	33.2	44.1	-10.9	H		47.15	23.85	3.56	41.40	13.99
1901.0	39.2	49.5	-10.3	H		47.96	28.05	4.33	41.11	8.73
2496.0	37.2	51.9	-14.7	H		44.07	29.99	4.59	41.43	6.85
3176.0	39.1	54.0	-14.8	H		44.34	31.35	5.36	41.92	5.21
3703.0	39.1	55.3	-16.2	H		42.89	32.28	5.72	41.76	3.76
4672.0	40.6	57.3	-16.7	H		43.29	33.25	6.61	42.55	2.69
5301.0	42.1	58.4	-16.3	H		42.33	34.84	7.27	42.31	0.19
5879.0	42.7	59.3	-16.7	H		42.09	35.28	7.96	42.68	-0.56
6525.0	42.6	60.2	-17.6	H		41.04	35.65	8.44	42.50	-1.58
7307.0	44.3	61.2	-16.8	H		40.99	37.09	8.45	42.19	-3.35
8021.0	44.1	62.0	-17.9	H		40.14	37.90	8.66	42.55	-4.01
9925.0	46.0	63.8	-17.8	H		39.47	39.59	9.89	42.90	-6.57
12050.0	47.5	65.5	-18.0	H		37.46	39.30	12.90	42.15	-10.05
13580.0	48.5	66.6	-18.0	H		36.09	41.60	12.22	41.36	-12.46
17949.0	55.5	69.0	-13.5	H		36.52	49.69	12.77	43.52	-18.94



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent
EUT Running 1-18GHz Antenna Position 1



Wed, Oct 04, 2017

11:03:17 AM

VERTICAL

Graph # 13

Scan Data

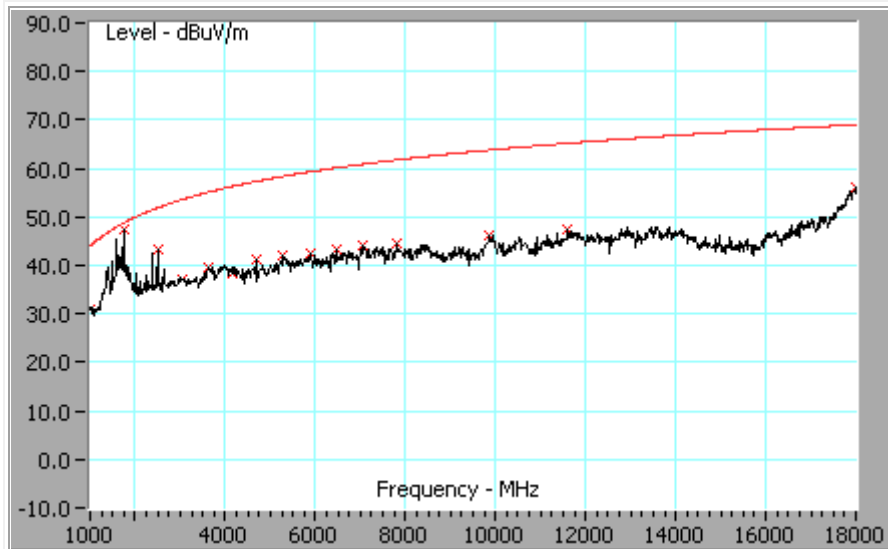
Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
1000.0	31.4	44.0	-12.6	V		45.67	23.60	3.56	41.45	14.29
1748.0	47.8	48.8	-1.0	V		58.01	27.04	4.07	41.32	10.21
2496.0	42.5	51.9	-9.3	V		49.38	29.99	4.59	41.43	6.85
3023.0	37.0	53.5	-16.5	V		42.36	31.04	5.34	41.74	5.37
3669.0	39.8	55.2	-15.4	V		43.72	32.10	5.78	41.78	3.89
4196.0	39.6	56.4	-16.8	V		42.46	32.74	6.55	42.18	2.90
4774.0	40.4	57.5	-17.1	V		42.25	33.68	6.77	42.33	1.88
5335.0	41.5	58.5	-17.0	V		41.54	34.94	7.31	42.30	0.05
5879.0	43.2	59.3	-16.1	V		42.51	35.43	7.96	42.68	-0.71
6474.0	43.0	60.1	-17.2	V		41.54	35.59	8.36	42.53	-1.42
7103.0	44.0	60.9	-16.9	V		41.05	36.73	8.81	42.54	-3.00
7664.0	44.3	61.6	-17.3	V		40.52	37.67	8.57	42.43	-3.80
9925.0	47.3	63.8	-16.5	V		40.84	39.52	9.89	42.90	-6.50
11710.0	47.2	65.3	-18.0	V		37.57	40.17	11.61	42.12	-9.66
18000.0	55.4	69.0	-13.6	V		35.75	50.00	12.87	43.26	-19.61



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent
EUT Running 1-18GHz Antenna Position 2



Wed, Oct 04, 2017

11:06:34 AM

VERTICAL

Graph # 14

Scan Data

Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
1000.0	31.1	44.0	-12.9	V		45.37	23.60	3.56	41.45	14.29
1748.0	47.4	48.8	-1.3	V		57.66	27.04	4.07	41.32	10.21
2496.0	43.3	51.9	-8.5	V		50.19	29.99	4.59	41.43	6.85
3040.0	37.2	53.6	-16.4	V		42.66	31.06	5.30	41.79	5.43
3618.0	39.6	55.1	-15.5	V		43.54	32.01	5.89	41.84	3.93
4145.0	38.4	56.3	-17.8	V		41.85	32.73	6.24	42.38	3.42
4672.0	41.1	57.3	-16.2	V		43.74	33.35	6.61	42.55	2.59
5267.0	42.0	58.4	-16.3	V		42.61	34.83	7.21	42.60	0.56
5913.0	42.3	59.4	-17.1	V		41.56	35.45	7.85	42.58	-0.72
6474.0	43.2	60.1	-17.0	V		41.73	35.59	8.36	42.53	-1.42
7052.0	44.2	60.9	-16.6	V		41.54	36.61	8.74	42.67	-2.69
7817.0	44.6	61.8	-17.1	V		41.60	37.73	8.60	43.28	-3.04
9857.0	46.3	63.8	-17.5	V		40.06	39.36	9.82	42.95	-6.23
11608.0	47.5	65.2	-17.7	V		38.29	40.48	10.92	42.15	-9.25
18000.0	56.3	69.0	-12.7	V		36.68	50.00	12.87	43.26	-19.61

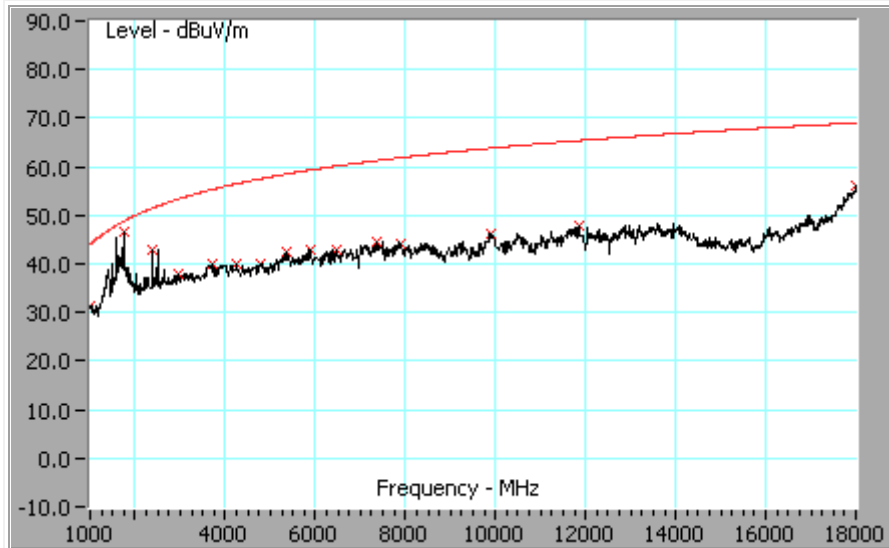


NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent

EUT Running 1-18GHz Antenna Position 3



Wed, Oct 04, 2017

11:09:20 AM

VERTICAL

Graph # 15

Scan Data

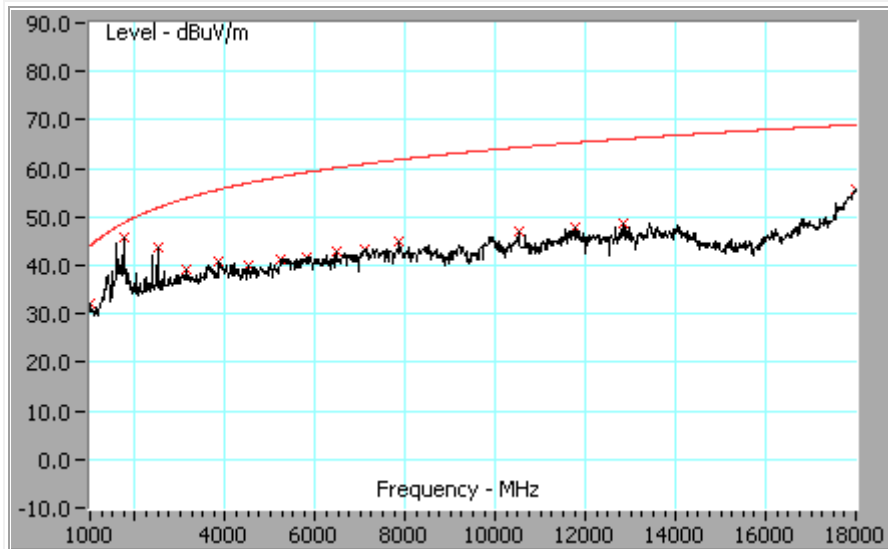
Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
1000.0	31.3	44.0	-12.7	V		45.59	23.60	3.56	41.45	14.29
1748.0	46.8	48.8	-2.0	V		56.97	27.04	4.07	41.32	10.21
2377.0	42.9	51.5	-8.5	V		50.18	29.63	4.58	41.48	7.27
2955.0	37.9	53.3	-15.4	V		43.39	30.91	5.37	41.73	5.46
3703.0	40.0	55.3	-15.3	V		43.87	32.17	5.72	41.76	3.88
4247.0	39.9	56.5	-16.5	V		43.12	32.75	6.47	42.40	3.18
4774.0	39.9	57.5	-17.6	V		41.75	33.68	6.77	42.33	1.88
5352.0	42.3	58.5	-16.2	V		42.33	34.96	7.33	42.29	-0.01
5896.0	42.7	59.3	-16.6	V		41.98	35.44	7.88	42.60	-0.72
6457.0	43.0	60.1	-17.1	V		41.65	35.59	8.30	42.55	-1.34
7375.0	44.7	61.3	-16.6	V		40.47	37.32	8.38	41.48	-4.23
7902.0	44.2	61.9	-17.6	V		40.37	37.76	8.73	42.62	-3.87
9908.0	46.1	63.8	-17.7	V		39.47	39.48	10.03	42.83	-6.67
11863.0	47.7	65.4	-17.6	V		37.62	39.71	12.14	41.73	-10.13
18000.0	55.9	69.0	-13.1	V		36.31	50.00	12.87	43.26	-19.61



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent
EUT Running 1-18GHz Antenna Position 4



Wed, Oct 04, 2017

11:11:04 AM

VERTICAL

Graph # 16

Scan Data

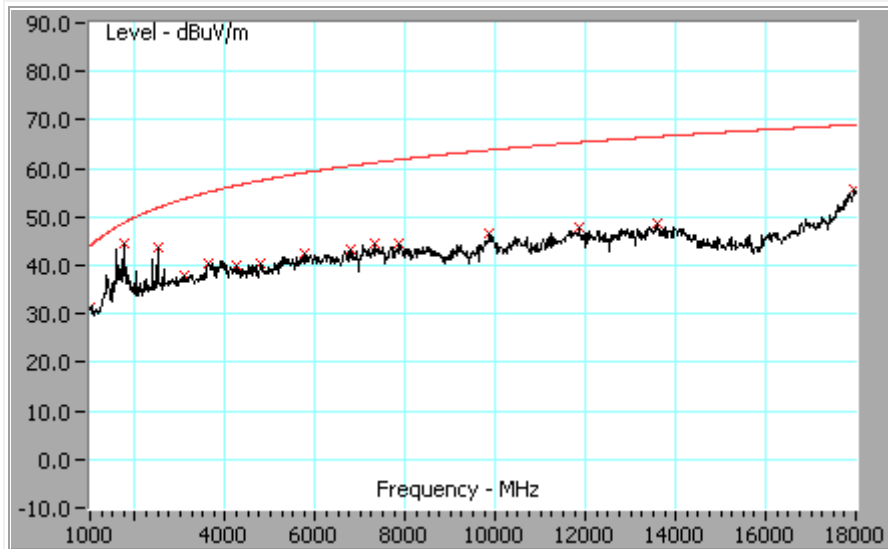
Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
1000.0	32.0	44.0	-11.9	V		46.34	23.60	3.56	41.45	14.29
1748.0	46.0	48.8	-2.8	V		56.18	27.04	4.07	41.32	10.21
2496.0	43.7	51.9	-8.1	V		50.59	29.99	4.59	41.43	6.85
3125.0	39.0	53.8	-14.8	V		44.50	31.20	5.23	41.93	5.51
3856.0	40.9	55.6	-14.8	V		44.64	32.44	5.96	42.19	3.79
4502.0	40.1	57.0	-16.9	V		43.08	32.81	6.82	42.58	2.95
5233.0	41.3	58.3	-17.0	V		42.24	34.77	7.15	42.91	0.98
5794.0	41.7	59.2	-17.5	V		41.05	35.38	8.27	42.99	-0.65
6457.0	43.0	60.1	-17.1	V		41.65	35.59	8.30	42.55	-1.34
7086.0	43.1	60.9	-17.8	V		40.20	36.69	8.79	42.57	-2.91
7851.0	44.8	61.8	-17.0	V		41.40	37.74	8.65	43.01	-3.38
10520.0	46.9	64.3	-17.5	V		40.08	39.42	10.13	42.73	-6.82
11761.0	48.0	65.3	-17.3	V		38.08	40.02	11.91	41.99	-9.94
12849.0	48.6	66.1	-17.5	V		36.91	40.32	13.28	41.89	-11.70
17983.0	55.6	69.0	-13.4	V		36.24	49.83	12.83	43.35	-19.32



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

Project: Persistent
EUT Running 1-18GHz Antenna Position 5



Wed, Oct 04, 2017

11:13:18 AM

VERTICAL

Graph # 17

Scan Data

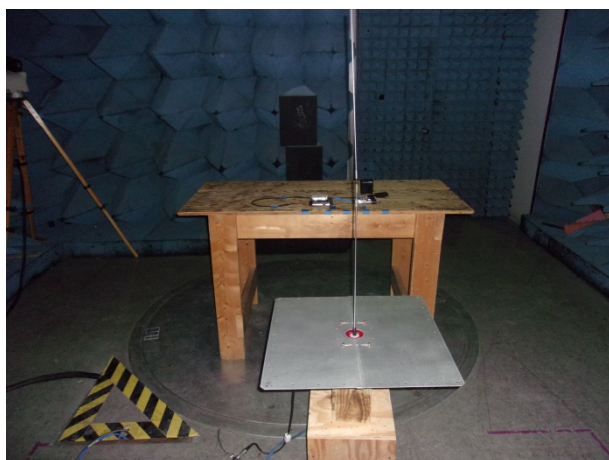
Frequency	Level	Limit	Delta	Ht.	Angle	Raw	Ant.	Cable	Amp	All Factors
MHz	dBuV/m	dBuV/m	dB	m	Deg	dBuV	dB	dB	dB	dB
1000.0	31.5	44.0	-12.4	V		45.80	23.60	3.56	41.45	14.29
1748.0	44.4	48.8	-4.4	V		54.62	27.04	4.07	41.32	10.21
2496.0	43.9	51.9	-8.0	V		50.77	29.99	4.59	41.43	6.85
3108.0	38.0	53.8	-15.7	V		43.62	31.17	5.18	41.94	5.58
3635.0	40.5	55.1	-14.7	V		44.40	32.04	5.86	41.82	3.92
4264.0	39.9	56.5	-16.6	V		43.20	32.75	6.43	42.49	3.30
4791.0	40.3	57.5	-17.2	V		42.08	33.73	6.81	42.31	1.77
5760.0	42.5	59.1	-16.6	V		41.96	35.36	8.00	42.82	-0.54
6780.0	43.4	60.5	-17.1	V		40.40	36.10	8.94	42.02	-3.02
7307.0	44.7	61.2	-16.5	V		41.22	37.18	8.45	42.19	-3.43
7851.0	44.5	61.8	-17.3	V		41.14	37.74	8.65	43.01	-3.38
9874.0	46.4	63.8	-17.4	V		39.98	39.40	9.93	42.89	-6.44
11863.0	48.0	65.4	-17.4	V		37.86	39.71	12.14	41.73	-10.13
13580.0	48.6	66.6	-18.0	V		35.95	41.78	12.22	41.36	-12.64
17966.0	55.9	69.0	-13.1	V		36.88	49.66	12.80	43.43	-19.03



2 - 30 MHz Rod Antenna System Check



2 - 30MHz Radiated Stub



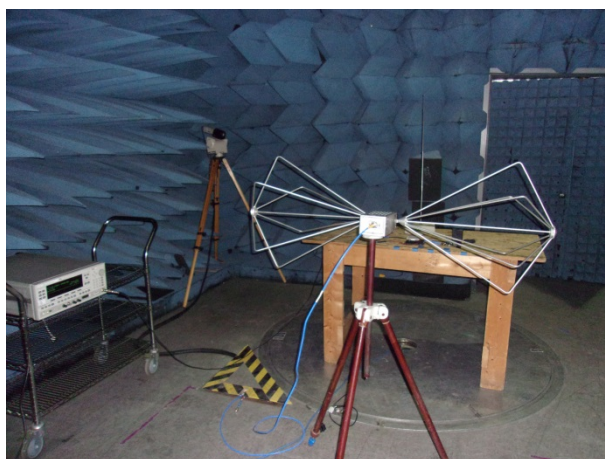
2 - 30 Mhz Ambient



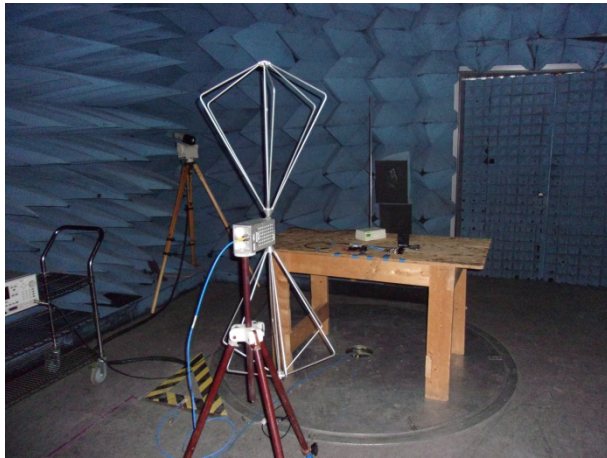
2 -30 Mhz EUT Running



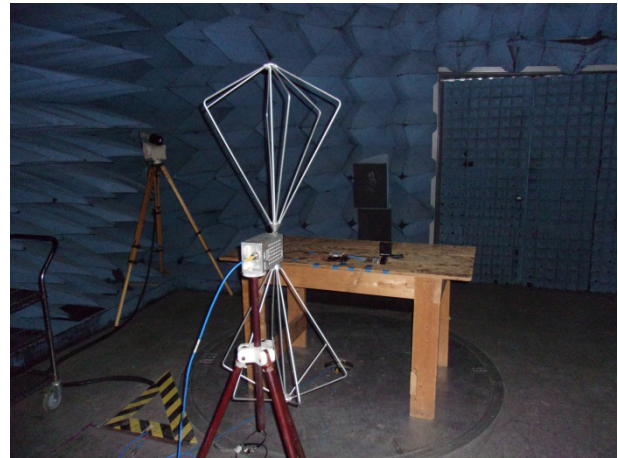
30 – 200 MHz System Check



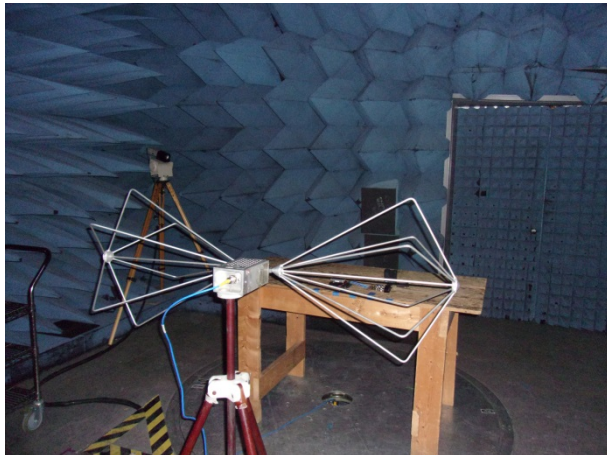
30 – 200 MHz Radiated Stub Horizontal



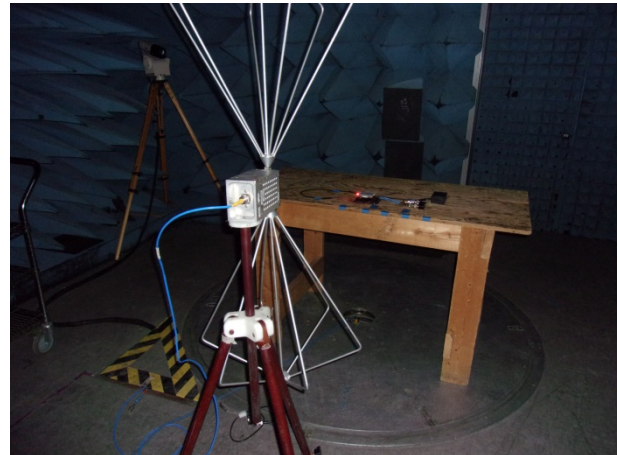
30 - 200 MHz Radiated Stub Vertical



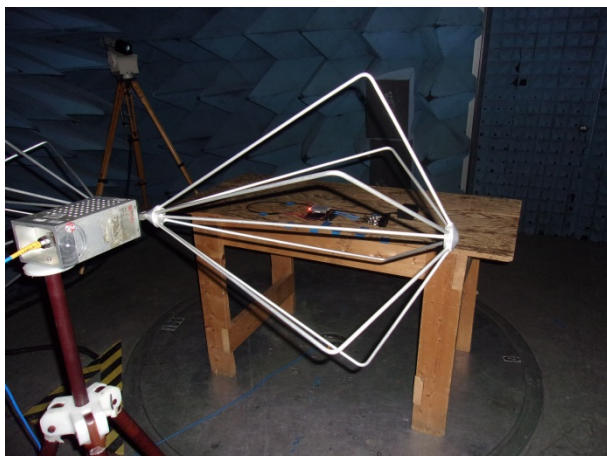
30 - 200MHz Ambient Vertical



30 - 200MHz Ambient Horizontal



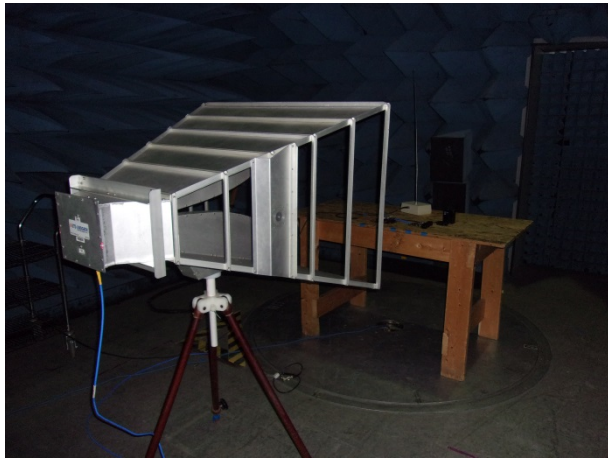
30 - 200 MHz EUT Running Vertical



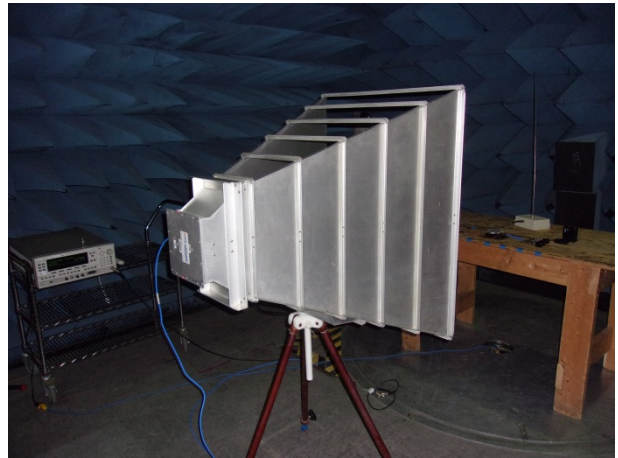
30 - 200 MHz EUT Running Horizontal



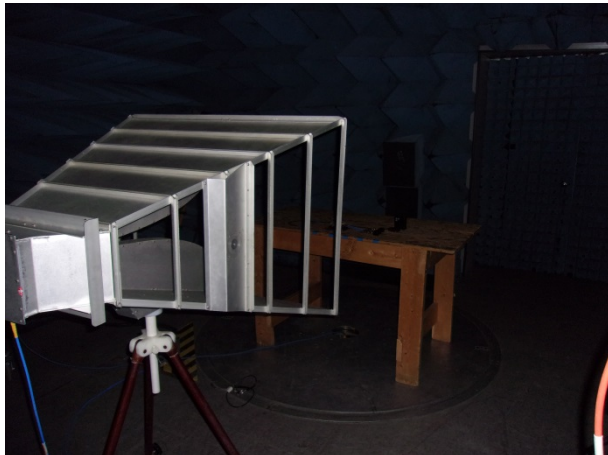
200 - 1GHz System Check



200 – 1GHz Radiated Stub Vertical



200 – 1GHz Radiated Stub Horizontal



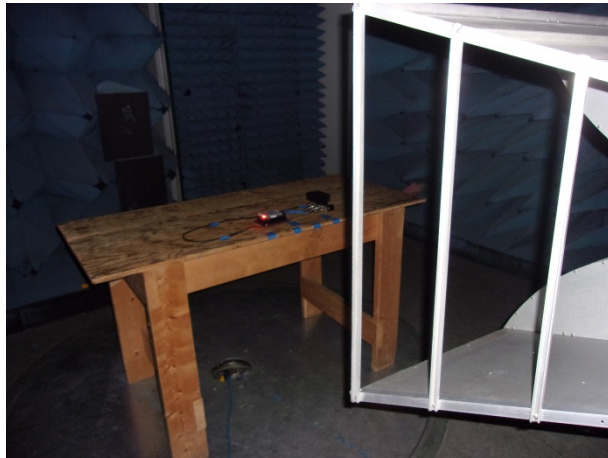
200 - 1GHz Ambient Vertical



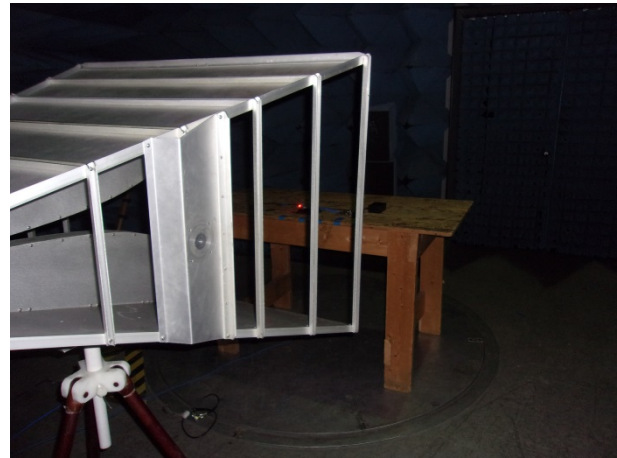
200 - 1GHz Ambient Horizontal


200 - 1 GHz EUT Running, Horizontal,
Position 1

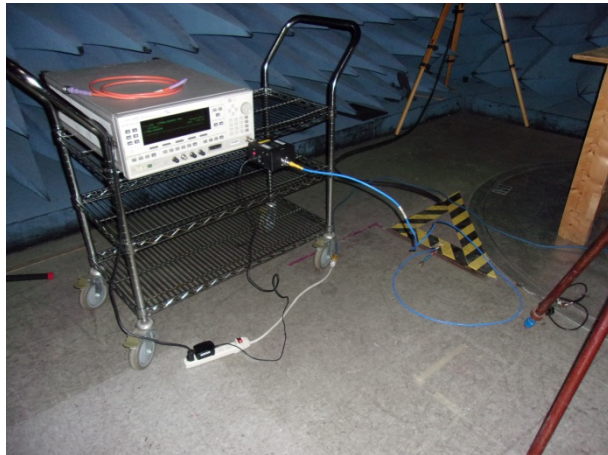
200 - 1 GHz EUT Running, Horizontal,
Position 2



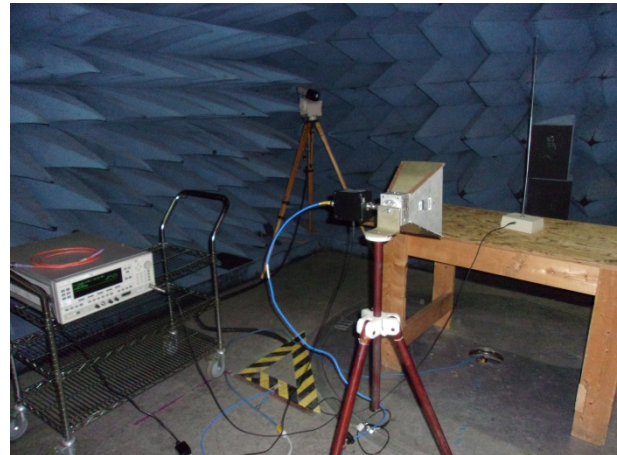
200 - 1 GHz EUT Running, Vertical, Position 1



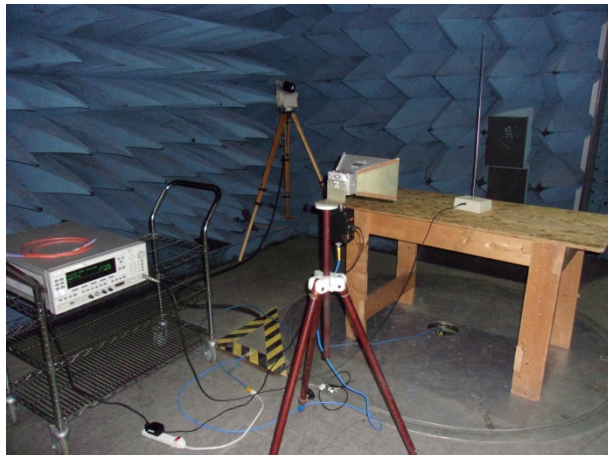
200 - 1 GHz EUT Running, Vertical, Position 2



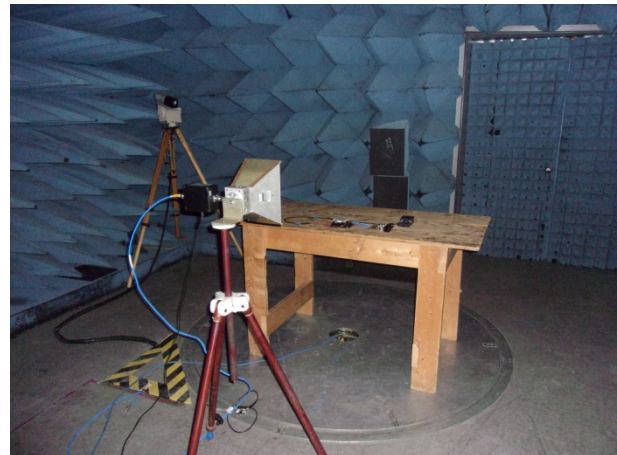
1 - 18GHz System Check



1 - 18 GHz Radiated Stub Horizontal



1 - 18 GHz Radiated Stub Vertical



1- 18 GHz Ambient Horizontal



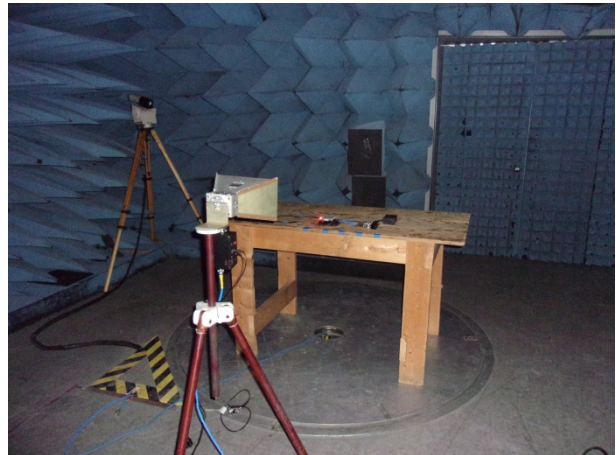
1- 18 GHz Ambient Vertical



EUT Running 1-18GHz, Position 1, Horizontal



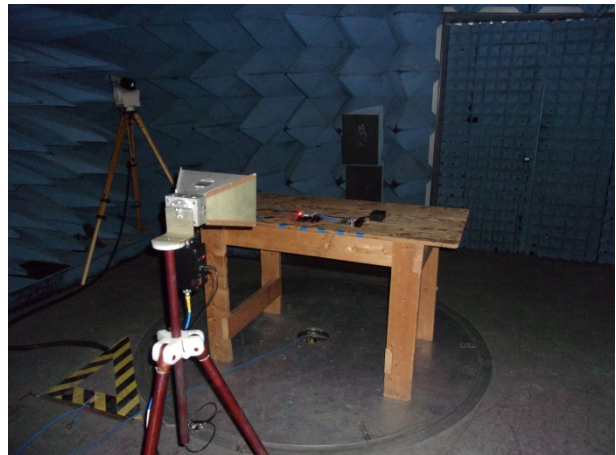
EUT Running 1-18GHz, Position 1, Vertical



EUT Running 1-18GHz, Position 2, Vertical



EUT Running 1-18GHz, Position 2, Horizontal



EUT Running 1-18GHz, Position 3, Vertical



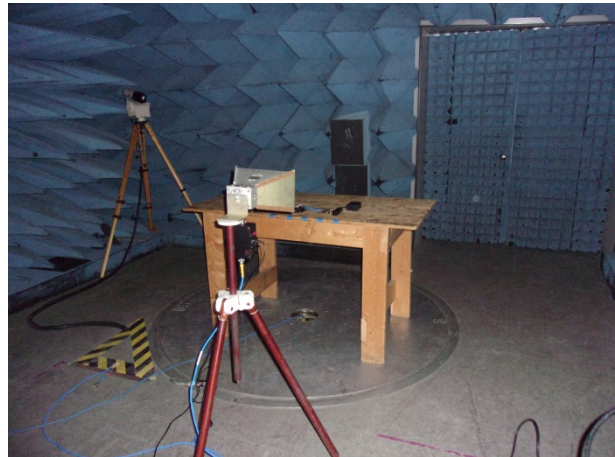
EUT Running 1-18GHz, Position 3, Horizontal



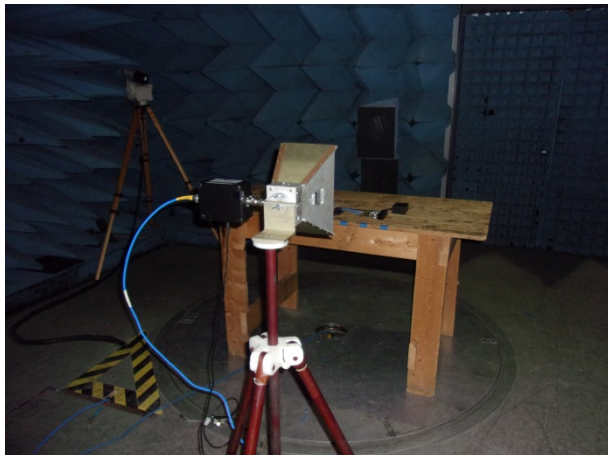
EUT Running 1-18GHz, Position 4, Vertical



EUT Running 1-18GHz, Position 4, Horizontal



EUT Running 1-18GHz, Position 5, Vertical



EUT Running 1-18GHz, Position 5, Horizontal

This Cel Intentionally Left Blank



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR066693.PER.EMC Rev 3

RE102 Test Equipment List:

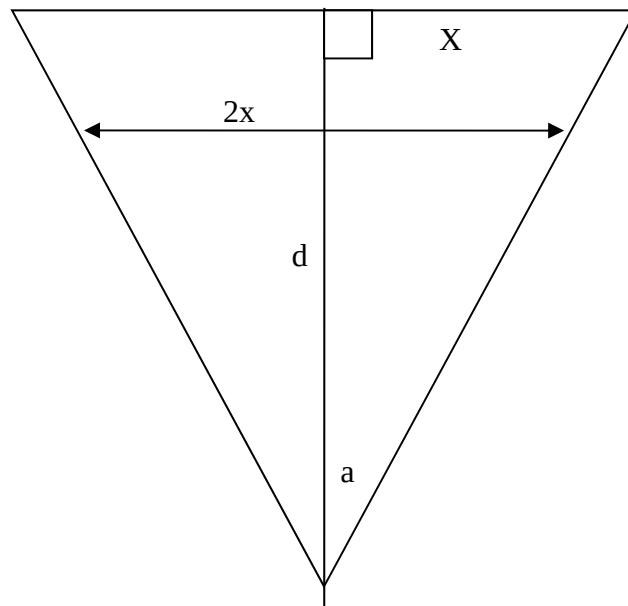
Asset No.	Manufacturer	Item	Model	S/N	Cal. Cycle (Months)	Cal. Due
WC005510	Teknet	Anechoic Chamber #1	n/a	n/a	NCR	NCR
WC024127	Hewlett Packard	Laptop	ProBook 4510S	CNU006001R	NCR	NCR
n/a	Teledyne	AR1 cable	n/a	AR1	24	6/25/18
WC005872	Amplifier Research	Signal Generator	SG1200 Opt 9	202310/228	12	5/28/18
WC058400	A.H Systems	20MHz – 18 Ghz Preamplifier	2641-1	393	12	6/28/18
WC024135	Agilent	EMC Analyzer	N9038A	MY51210117	12	12/8/17
WC005506	Rohde & Schwarz	EMI Receiver	ESBI-RF	842088/012	12	11/16/17
WC005507	Rohde & Schwarz	EMI Receiver Display	ESAI-D	13335	12	11/16/17
WC005283	Electro-Metrics	Small Horn Antenna	Rga-60	6150	36	02/22/20
WC005310	ETS-Lindgren	Large Horn Antenna	3106	35382	36	3/9/20
WC006573	EMCO	Biconical Antenna	3109	9411-2853	36	12/7/17
WC005829	ETS-Lindgren	Active Rod Antenna	3301C	00114485	12	8/1/18

Appendix A - Beam Width Calculations

MPU5 - Model No. WR5100 with S-Band Radio Card

Mil Std 461 BEAM WIDTH CALCULATIONS					
Job Number:	PRO66693	Client:	Persistent Systems LLC	Date:	10/03/17

Test Setup Boundary



3106 Large Horn Calculations 200-1000 MHz(.5% steps)

EUT boundary 11 cm + 0 cm cable= 11 cm

d=1m

28° Beamwidth from chart below/2=14°

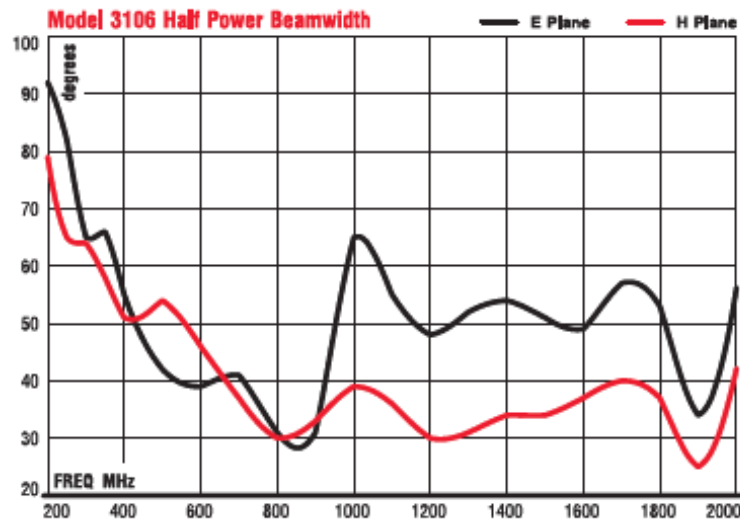
 $\tan 14^\circ = x/1.0\text{m}$
 $1.0 \tan 14^\circ = x$

.249=x

.498=2x

11 /49.8= 1 Horizontal and Vertical Antenna Orientations

1 antenna positions Horizontal and Vertical Antenna Orientations



3115 Small Double Ridge Guide Ant. Calculations 1-14 GHz (.1-.05% steps)

EUT boundary 11 cm + 0 cm cable= 11 cm
d=1.0m

30° Beamwidth from chart below/2=15°

$\tan 15^\circ = x/1.0\text{m}$

1.0 $\tan 15^\circ = x$

.267=x

.535=2x

11 /53.5= 1 Horizontal and Vertical Antenna Orientations

1 antenna positions Horizontal and Vertical Antenna Orientations

3115 Calculations 14-18 GHz at 1 meter (.05% steps)

EUT boundary 11 cm + 0 cm cable= 11 cm
d=1m

7° Beamwidth from chart below/2=3.5°

$\tan 3.5^\circ = x/1.0\text{m}$

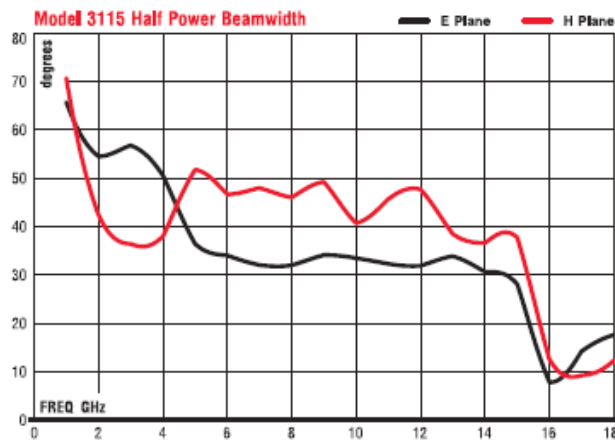
1.0 $\tan 3.5^\circ = x$

.061=x

.122=2x

11 /12.2= 1 Horizontal and Vertical Antenna Orientations

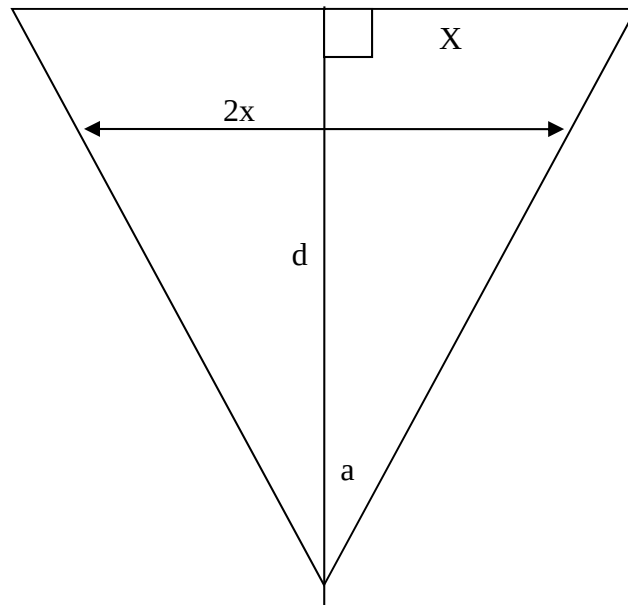
1 antenna positions Horizontal and Vertical Antenna Orientations



Embedded Module, Model 5200 paired with L-Band Card, Model No. RF1100

Mil Std 461 BEAM WIDTH CALCULATIONS					
Job Number:	PRO66693	Client:	Persistent Systems LLC	Date:	10/04/17

Test Setup Boundary



3106 Large Horn Calculations 200-1000 MHz(.5% steps)

EUT boundary 54 cm + 35 cm cable= 89 cm

d=1m

28° Beamwidth from chart below/2=14°

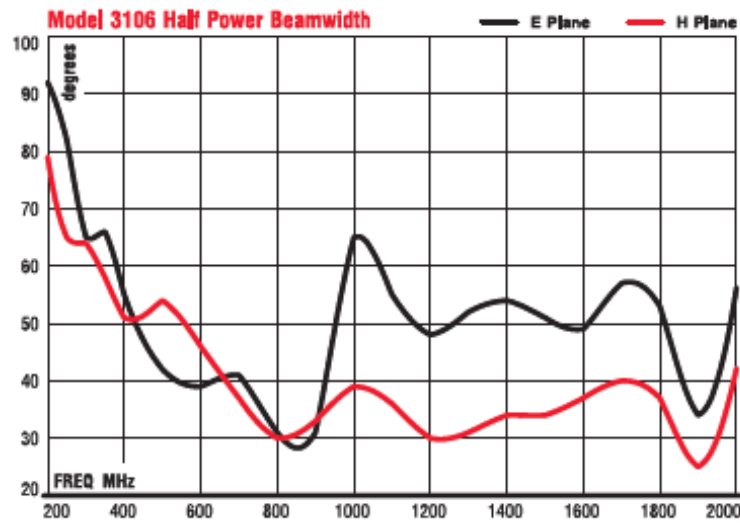
$\tan 14^\circ = x/1.0\text{m}$

$1.0 \tan 14^\circ = x$

.249=x

.498=2x

89 /49.8= 2 Horizontal and Vertical Antenna Orientations
2 antenna positions Horizontal and Vertical Antenna Orientations



3115 Small Double Ridge Guide Ant. Calculations 1-14 GHz (.1-.05% steps)

EUT boundary 54 cm + 7 cm cable= 61 cm
d=1.0m

30° Beamwidth from chart below/2=15°

$\tan 15^\circ = x/1.0\text{m}$

1.0 $\tan 15^\circ = x$

.267=x

.535=2x

61 /53.5= 2 Horizontal and Vertical Antenna Orientations

2 antenna positions Horizontal and Vertical Antenna Orientations

3115 Calculations 14-18 GHz at 1 meter (.05% steps)

EUT boundary 54 cm + 7 cm cable= 61 cm
d=1m

7° Beamwidth from chart below/2=3.5°

$\tan 3.5^\circ = x/1.0\text{m}$

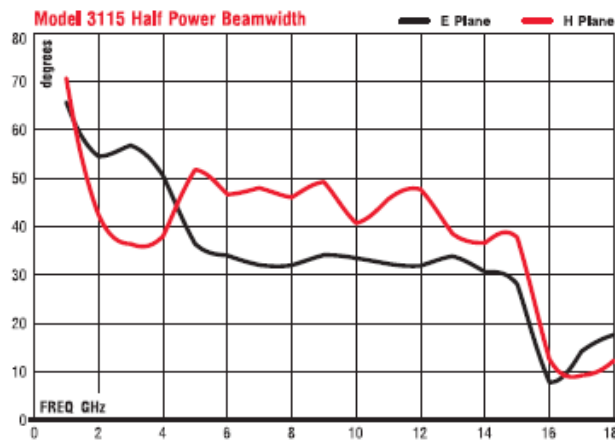
1.0 $\tan 3.5^\circ = x$

.061=x

.122=2x

61 /12.2= 5 Horizontal and Vertical Antenna Orientations

5 antenna positions Horizontal and Vertical Antenna Orientations



Appendix B - Test Software Description

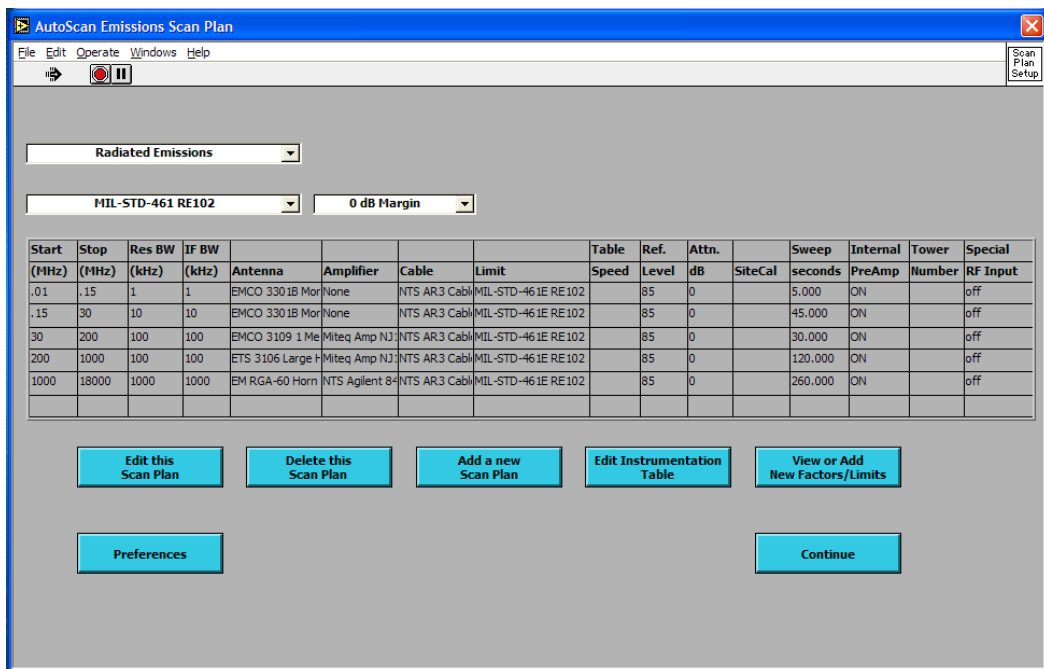
AutoScan Automated Test Software (V7.4.4.4)

The AutoScan software is a National Instruments LabVIEW compiled package, specifically designed by EMCware for automation of Radiated and Conducted RF Emission measurements.

AutoScan Emissions Scan Plan

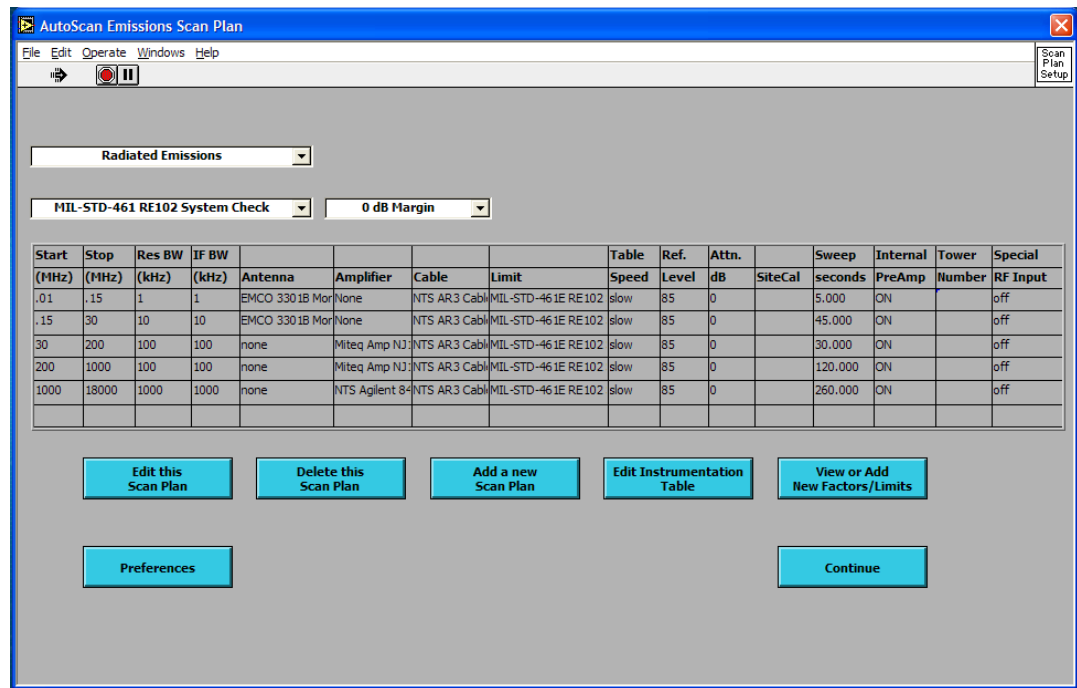
The AutoScan Emissions Scan Plan window shows the administrator defined test parameters including Start Frequency, Stop Frequency, Resolution Bandwidth, IF Bandwidth, Antenna, Amplifier, Cable, Limit, Reference Level, Attenuation and Sweep Time.

The Scan Plan shown in Figure below has been defined in order to perform the radiated emissions test in accordance with MIL-STD-461 CE102 & RE102.



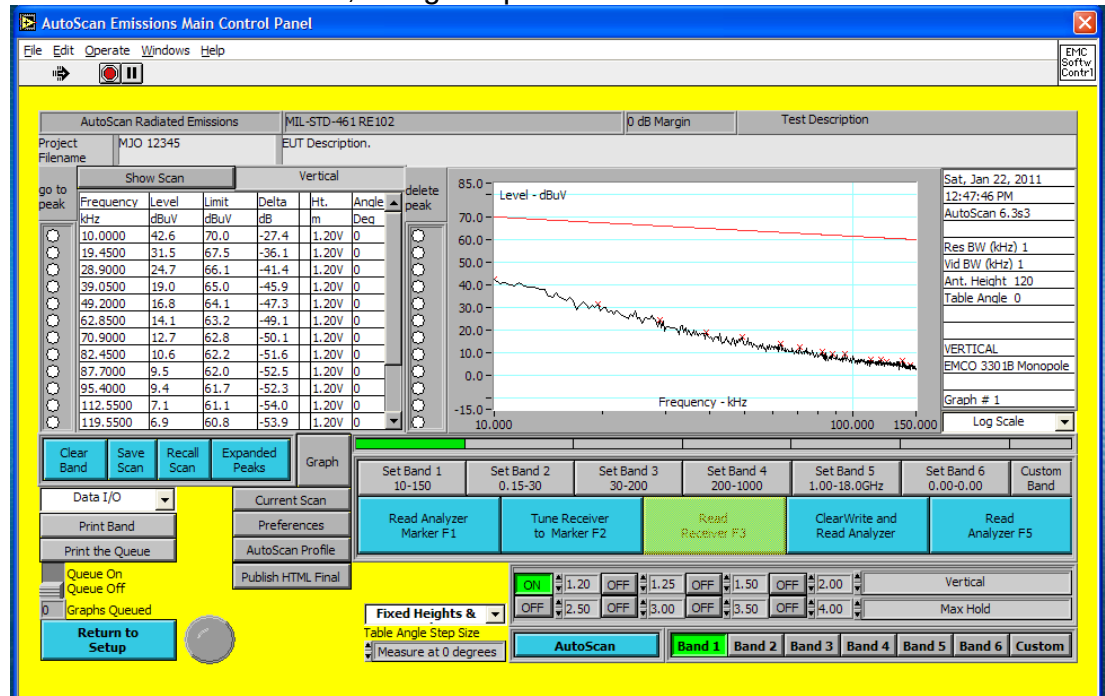
Start (MHz)	Stop (MHz)	Res BW (kHz)	IF BW (kHz)	Antenna	Amplifier	Cable	Limit	Table	Ref. Level	Attn. dB	SiteCal	Sweep seconds	Internal PreAmp	Tower Number	Special RF Input
.01	.15	1	1	EMCO 3301B Mor	None	NTS AR3 Cabl	MIL-STD-461E RE102		85	0		5.000	ON		off
.15	30	10	10	EMCO 3301B Mor	None	NTS AR3 Cabl	MIL-STD-461E RE102		85	0		45.000	ON		off
30	200	100	100	EMCO 3109 1 Me	Miteq Amp NJ	NTS AR3 Cabl	MIL-STD-461E RE102		85	0		30.000	ON		off
200	1000	100	100	ETS 3106 Large H	Miteq Amp NJ	NTS AR3 Cabl	MIL-STD-461E RE102		85	0		120.000	ON		off
1000	18000	1000	1000	EM RGA-60 Horn	NTS Agilent 8	NTS AR3 Cabl	MIL-STD-461E RE102		85	0		260.000	ON		off

A similar Scan Plan has been defined in order to perform system checks in accordance with MIL-STD-461 RE102, as shown below in Figure Below.



AutoScan Emissions Main Control Panel

The AutoScan Emissions Main Control Panel window shown in below was used to execute the test, using the parameters defined in the Scan Plan.





----- END OF REPORT -----

Rev.	comment	Release	Owner
A	Initial	6/6/2016	HM

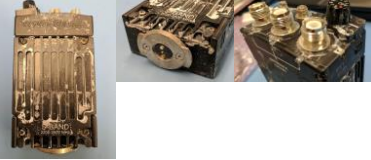
Very Low Risk Acceptable Can be resolved, prevented with process control systems in place in day to day activities
Low Risk Acceptable with few actions Some disruption possible, Not significant loss
Moderate Risk Doesn't stop process, needs mit Significant time / Resources are lost - Requires detailed action plan (ECN)
High Risk Stops Process - Unacceptable Significant time / resources are lost - High index repeatability - Requires detailed action plan and execution - Management involvement and approval is required.

Likely Hood	Risk Assessment Table	Consequence				
		1 (Negligible)	2 (Minor)	3 (Moderate)	4 (Major)	5 (Extreme)
1 (Rare) < 5%		1	2	3	4	5
2 (Unlikely) 5 - 10%		2	4	6	8	10
3 (Moderate) 10 - 50%		3	6	9	12	15
4 (Likely) 50 - 90%		4	8	12	16	20
5 (Certain) >90%		5	10	15	20	25



Overall Risk Level	
Before Action	After Action
21.33%	14.22%

Project, Task, Process, Product	MPUS Salt Fog Exposure - Risk Evaluation - Exposure IAW MIL-STD-810G		
Completed by:	Helson Maria, Quality Engineer	3/31/2017	
Sample:	Name	Part Number	Revision
	MPUS	WR-5100 Rev. 4.0 B	Serial 31552
	S-band Card	RF-2100 Rev. 3234.A	Serial 3271

Risk Before Action:	Type of risk	Who's Affected?	Severity	Likelihood	Risk Total	Mitigation Taks - After Rinsing with water.	Risk After Comp.	Severity afater comp.	New Total
Salt deposits found in several areas of the MPUS. Some low risk, other medium risk. No high risk items observed. 					6				6
Low Risk: Power pins observed with lots of salt deposit accumulated. After rinsing with water, the deposit went away. No functional issues noted, before or after rinsing. 			1	4	4		1	4	4
Low Risk: High amounts of salt deposits observed around the battery pin. This prevents user from disengaging the battery pin. Pin got stuck on disengaged position. When rinsed with water and pin was cycled 3x times, it began to function properly. 			1	4	4		1	4	4
Low Risk: lost conductivity on some of the side connector pins. All pins function correctly after rinsing with water. 			1	4	4		1	4	4
Low to mid risk: discoloration observed on RF ports. Most was gone after rinsing with water. No RF functionality noted before or after rinsing. 			2	4	8	No issues observed after rinsing with water: Ensure users rinse with water after exposure to salty environments.	2	2	4
Low Risk: It became difficult to disengage the zeroize latch. After cycling a couple of times and rinsing with water, latch functionality returned to normal. 			2	4	8	No issues observed after rinsing with water: Ensure users rinse with water after exposure to salty environments.	2	2	4
Mid Risk: signs of rust observed on radio module screws. 			2	4	8	Screws protective coating wears off after usage. If worn and exposed to salty environments, screws can rust. Recommendations: - Recommend customers to replace the screws as a preventive measure. Inspect after salt/fog exposure.	2	2	4
Mid Risk: Gasket came off after removing radio card. It was difficult to remove the card, as if it had gotten bonded to the gasket itself. Recommend to periodically replace gasket, if unit is exposed to salty/water. 			2	4	8	Recommendations: Recommend to replace gasket periodically as part of a preventive maintenance.	2	2	4

[illegible]

Low Risk	Acceptable	Can be reduced, prevented with process control systems in place in day to day activities
Low Risk	Acceptable with few actions	Some reduction possible, Not significant loss
Moderate Risk	Don't stop process, needs	Significant time / resources are lost - Requires detailed action plan (DCN)
		Don't stop process, resources are lost - Low acceptability. Requires detailed action plan and execution. Management involvement and approval is required.

Risk Assessment Table		Consequence				
		1 (Negligible)	2 (Minor)	3 (Moderate)	4 (Major)	5 (Extreme)
Likely to occur	1 (Hazard < 5%)	1	2	3	4	5
	2 (Hazard 5% - 10%)	2	3	4	5	10
	3 (Moderate 10% - 20%)	3	4	5	10	20
	4 (Hazard 20% - 50%)	4	5	10	20	50
	5 (Hazard 50% - 100%)	5	10	20	50	100



Overall Risk Level					
Before Action					
After Action					
Project, Task, Process, Product	MPUS Salt For Exposure - Risk Evaluation - Exposure IAW MIL-STD-810G				

Sample:	Completed by:	Helson Maria, Quality Engineer			4/4/2017
		Name	Part Number	Revision	Serial #
		PTT Devine	WB.PTT-01	A	EDAR000007

[illegible]



Test Report Number PR059996.PSL

Testing of

WR-5100 and WR-PTT-01 Radios

PREPARED FOR: Persistent Systems
303 Fifth Avenue, Suite 306
New York, NY 10016

PREPARED BY: National Technical Systems
36 Gilbert Street South
Tinton Falls, NJ 07701

36 Gilbert Street South • Tinton Falls, New Jersey 07701
(732) 936-0800 • Fax (732) 936-0700
www.nts.com

This report and the information contained herein represents the results of testing of only those articles/products identified in this document and selected by the client. The tests were performed to specifications and/or procedures approved by the client. National Technical Systems ("NTS") makes no representations expressed or implied that such testing fully demonstrates efficiency, performance, reliability, or any other characteristic of the articles being tested, or similar products. This report should not be relied upon as an endorsement or certification by NTS of the equipment tested, nor does it present any statement whatsoever as to the merchantability or fitness of the test article or similar products for a particular purpose. This document shall not be reproduced except in full without written approval from NTS.



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR059996.PSL

Revision 0

REVISION PAGE

Rev. #	Date	Page #	Para. #	Description
0	6/27/17			Initial Release
1	5/21/19	8	6.1.3	Added post test observations



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR059996.PSL

Revision 0

SIGNATURES

Prepared By: 
Mark Betts, Senior Engineer

Reviewed By: 
Mark Betts, Program Manager

Approved By: 
David Potpinka, Quality Manager



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR059996.PSL

Revision 0

1.0	PURPOSE.....	5
1.1	Test Program Sequence	5
1.1.1.	Receipt Inspection	5
1.1.2.	Functional Test.....	5
1.1.3.	Testing.....	5
2.0	APPLICABLE DOCUMENTS.....	6
2.1	Persistent Systems Purchase Order Number: 15220	6
2.2	NTS Quotation Number: OP0215866.....	6
2.3	MIL-STD-810G	6
2.4	ANSI NCSL Z540-1	6
2.5	ISO 17025:2005.....	6
2.6	NTS Corporate Quality Policy Manual	6
3.0	TEST ITEMS	6
3.1	Description	6
3.2	Security Classification of Items	6
4.0	TEST DATE(S) AND EQUIPMENT	7
4.1	Test Date(s).....	7
4.2	Test Equipment	7
5.0	GENERAL TEST REQUIREMENTS	7
5.1	Test Facility	7
5.2	Test Sample Configuration.....	7
5.3	Pass/Fail Criteria.....	7
6.0	TEST PROCEDURE	8
6.1	Salt Fog:	8
6.1.1.	Requirements.....	8
6.1.2.	Test Procedure.....	8
6.1.3.	Results.....	8



1.0 PURPOSE

This report describes the methods used for testing of the WR-5100 and WR-PTT-01 Radios submitted by Persistent Systems. This test program was conducted to determine the ability of the samples to successfully satisfy the requirements specified in the references listed in section 2.0 of this report.

1.1 Test Program Sequence

1.1.1. Receipt Inspection

Upon receipt at NTS, the samples were visually inspected to ensure there had been no damage due from shipping/handling, and to confirm that the test model numbers and serial numbers coincide with those on the packing list.

No discrepancies were found.

There were no model numbers or serial numbers referenced.

1.1.2. Functional Test

No functional tests were performed. The units were tested and returned to the client for post-test examination.

1.1.3. Testing

Tests and Test Methods

Test	Standard/Test Method
Salt Fog	MIL-STD-810G Method 509.5



2.0 APPLICABLE DOCUMENTS

2.1 Persistent Systems Purchase Order Number: 15220

2.2 NTS Quotation Number: OP0215866

2.3 MIL-STD-810G

2.4 ANSI NCSL Z540-1

2.5 ISO 17025:2005

2.6 NTS Corporate Quality Policy Manual
Revision 8, Dated April 22, 2016.

3.0 TEST ITEMS

3.1 Description

Quantity	Item Description	P/N	S/N
1	Radio	WR-5100	21552
1	Radio	WR-PTT-01	EDM00007

3.2 Security Classification of Items

None



4.0 TEST DATE(S) AND EQUIPMENT

4.1 Test Date(s)

Test	Date(s)
Salt Fog	3/9/17-3/12/17

4.2 Test Equipment

The instrumentation used in the performance of these tests is periodically calibrated and standardized within manufacturer's rated accuracies and are traceable to the National Institute of Standards and Technology. The calibration procedures and practices are in accordance with ANSI/NCSL Z540-1 and ISO 17025:2005. Certification of calibration is on file subject to inspection by authorized personnel.

5.0 GENERAL TEST REQUIREMENTS

5.1 Test Facility

The WR-5100 and WR-PTT-01 Radios were tested at NTS test facilities located in Tinton Falls, NJ.

5.2 Test Sample Configuration

The test item configurations are documented in the photographs contained in this test report.

5.3 Pass/Fail Criteria

The WR-5100 and WR-PTT-01 Radios shall successfully satisfy the requirements specified in the references listed in Section 2.0 of this report. The units were tested and returned to the client for post-test examination.



6.0 TEST PROCEDURE

6.1 Salt Fog:

6.1.1. Requirements

The WR-5100 and WR-PTT-01 Radios shall be tested for Salt Fog using MIL-STD-810G Method 509.5.

6.1.2. Test Procedure

The WR-5100 and WR-PTT-01 Radios were placed in the salt fog chamber.

The temperature within the testing apparatus was maintained at 35°C and the salt solution was continuously atomized at a fallout rate between 1 and 2 ml/80cm²/hr. The test condition was maintained for 24 hours.

The WR-5100 and WR-PTT-01 Radios were removed from the salt spray chamber and allowed to dry for 24 hours. This cycle was repeated one time for a total of two cycles.

The WR-5100 and WR-PTT-01 Radios were then gently washed in clean running water not warmer than 100°F and dried.

The WR-5100 and WR-PTT-01 Radios were returned to the client for post-test examination.

6.1.3. Results

The WR-5100 and WR-PTT-01 Radios were tested in accordance with the Salt Fog requirements. The unit was rinsed, inspected and no sign of corrosion was noted. The unit has met the requirements of the Standard.



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR059996.PSL

Revision 0

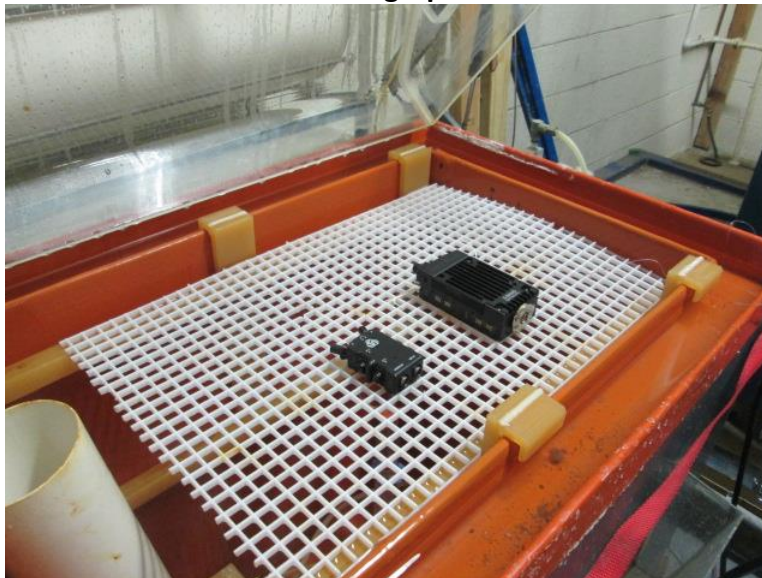
Test Data

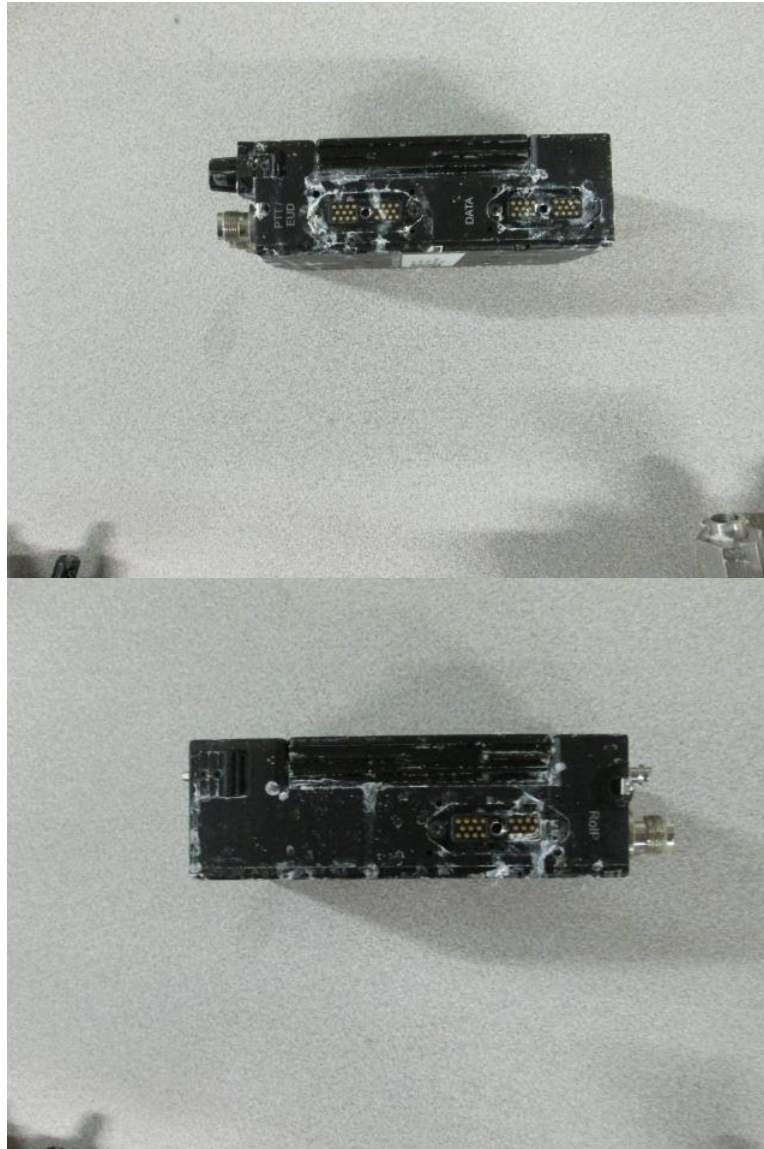
GENERAL LOG SHEET								
Job Number: PR059996				Date: 3/9/17		Pg 1 of 1		
Client: Persistent Systems								
Test: Salt Fog		Test Item: Radios						
Specification: MIL-STD-810G				Model or P/N: WR-5100/WR-PTT-01				
Para./Sect.: Method 509.5				S/N(s): 21552/EDM00007				
Items to be Verified Before Starting Test								
Water			Salt Solution					
Type of Water: Deionized			Type of Salt			Density @ 20°C (1.025758 to 1.038867)		
			Salt Solution 5 parts by weight salt in 95 parts water (5% ± 1% salt solution) 0.053 x Mass of Water = Mass of NaCl required			pH @ 25°C: 7.41 pH @ 35°C: 7.09		
						1.037475 (5.48% salt solution)		
Log Entries								
Readings Below to be Monitored Daily								
Date	Time	Chamber Temp 35 ± 2°C (95 ± 3°F)	Fallout Rate 1 to 3.0 mL/hour	Salt Concentration of Fallout 5 ± 1 mass %	Density of Fallout (1.025758 to 1.038867)	pH Of Collection 6.5 to 7.2 @ 35°C	Days in Test	Tech Init
3/9/17	11:34	35C	1.1	5.48%	1.037475	7.09	1	BP
3/10/17	11:38	24 Hour Drying Period						BP
3/11/17	11:45	35C	1.4	5.48%	1.037475	7.09	1	BP
3/12/17	11:59	24 Hour Drying Period						BP
Test Performed By: Brian Pasznik								

Test Equipment

NTS #	Manufacturer	Make	Model	S/N	Cal. Date	Cal. Due
NJ1190	Singleton	Salt Fog Chamber	20	19266	10/19/2016	10/19/2017
WC024107	Glassco	Graduated Cylinders, Class A, 250mL	142.236.04	801 & 403	No Periodic Calibration Required	No Periodic Calibration Required
WC024105	Wilmad LabGlass	Gay-Lussic adjusted specific gravity bottle, 25mL	LG-3540-106	196	No Periodic Calibration Required	No Periodic Calibration Required
WC024110	Hanna	pH/TDS/Salinity Meter	HI 3512	8699357	5/23/2016	5/23/2017

Photographs



Post-Test



NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR059996.PSL

Revision 0

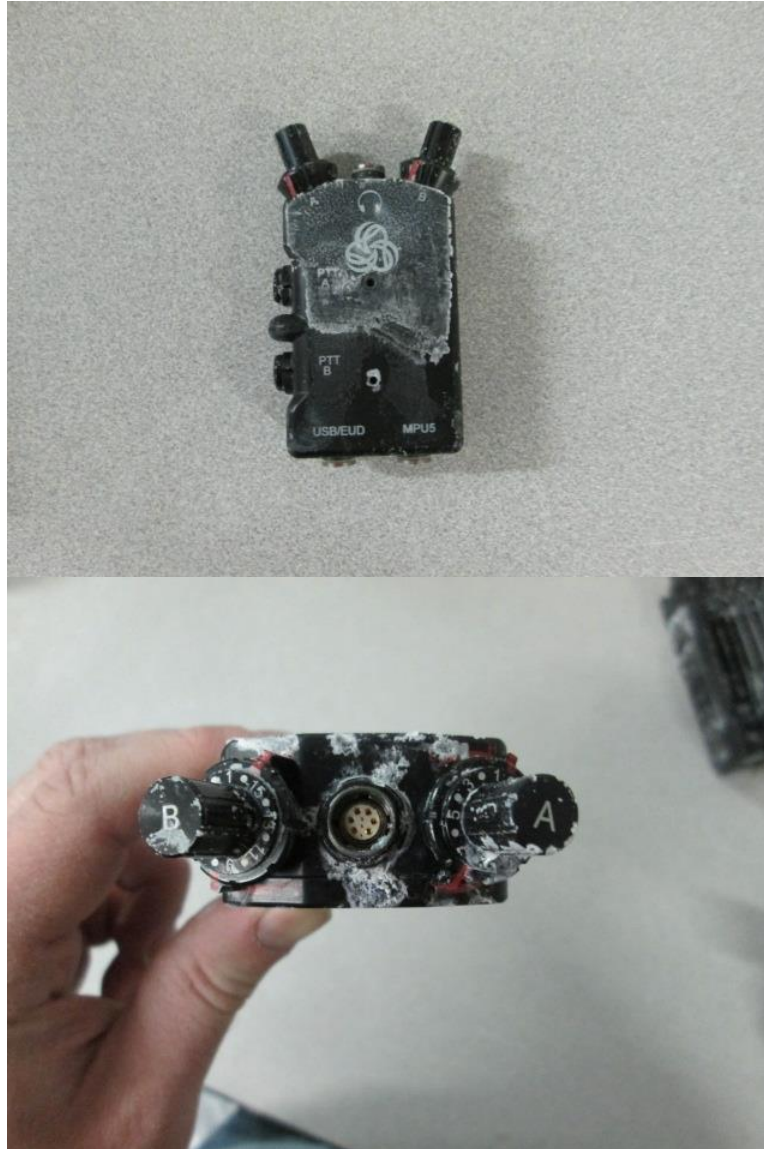




NATIONAL TECHNICAL SYSTEMS

NTS Test Report Number: PR059996.PSL

Revision 0



END OF REPORT



NATIONAL TECHNICAL SYSTEMS

CERTIFICATE OF COMPLIANCE

February 3, 2020

Customer: Persistent Systems LLC
303 Fifth Avenue, Suite 306
New York, NY 10016

Purchase Order #: 19414
NTS PR #: PR102218

Test Items:

Item #	Qty	Description	Part #	Serial #
1	1	MPU5 Radio with RF-2150 10W S-Band Card	MPU5/WR-ACC-088	31783/1815

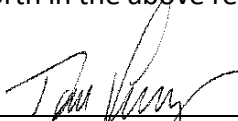
Test Specifications:

Persistent Systems LLC Purchase Order No. 19414 dated 7/2/19
MIL-STD-810G

Test Performed	Test Date(s)	Test Results
MIL-STD-810G Method 500.6, Procedure I, Altitude Storage	9/24/19	Pass
MIL-STD-810G Method 500.6, Procedure I, Altitude Operation	12/2/19	Pass
MIL-STD-810G Method 501.5, Procedure I, High Temp Storage	9/26/19-10/3/19	Pass
STD-810G Method 501.5, Procedure II, High Temp Operation	11/25/19-11/28/19	Pass
MIL-STD-810G Method 502.5, Procedure I, Low Temp Storage	9/25/19	Pass
MIL-STD-810G Method 502.5, Procedure II, Low Temp Operation	11/21/19	Pass
MIL-STD-810G Method 503.5, Procedure I-D, Temperature Shock	11/19/19	Pass
MIL-STD-810G Method 514.6 Procedure I, Vibration	11/19/19	Pass

National Technical Systems (NTS) certifies that the above referenced item(s) has/have been tested in accordance with the above Requirements set forth in the above referenced documents.


Mark Betts
NTS Quality Representative


Tom Sweeney
NTS General Manager

CERTIFICATE OF COMPLIANCE

January 30, 2020

Customer: Persistent Systems. LLC
303 Fifth Avenue, Suite 409
New York, NY 10016

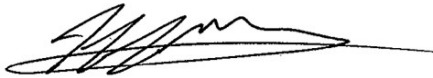
NTS MJO #: PR102216
NTS Certificate # TC102216 Rev 0

Test Items:

Item #	Description	Model #	Serial #
1	MPU5 Radio with RF-2150 10W S-Band Card	WR-5100, RF-2150	31783, 38126

Test Performed
MIL-STD-461F, Emissions
RE102, radiated emissions, electric field, 2 MHz to 18 GHz (RE102-4: Navy Mobile & Army).
MIL-STD-461F, Susceptibility
RS101, radiated susceptibility, magnetic field, 30 Hz to 100 kHz (RS101-2: Army).
RS103, radiated susceptibility, electric field, 2 MHz to 18 GHz (Army Ground, 50V/m).

National Technical Systems (NTS) certifies that the above referenced test item(s) has/have been tested and found to be in compliance with the above requirements.



Jeff Maselli
Project Manager



Mark Betts
Deputy Quality Representative



NATIONAL TECHNICAL SYSTEMS

CERTIFICATE OF COMPLIANCE

February 12, 2019

Customer: Persistent Systems LLC.
303 Fifth Avenue, Suite 306
New York, NY 10016

NTS MJO #: PRO66693

Test Items:

Item #	Description	Model #	Serial #
1	MPU5 - Model No. WR5100 with S-Band Radio Card	WR5100 & RF2100	28320 & 5822
2	Embedded Module, Model 5200 paired with L-Band Card, Model No. RF1100	WR5200 & RF1100	0187 & B-507

Test Specifications:

MIL-STD-461F Emissions
CE101, conducted emissions, power leads, 30 Hz to 10 kHz
CE102, conducted emissions, power leads, 10 kHz to 10 MHz
RE102, radiated emissions, electric field, 10 kHz to 18 GHz
MIL-STD-461F Immunity
CS101, conducted susceptibility, power leads, 30 Hz to 150 kHz
RS101, radiated susceptibility, magnetic field, 30 Hz to 100 kHz
RS103, radiated susceptibility, electric field, 2 MHz to 40 GHz

National Technical Systems (NTS) certifies that the above referenced item(s) has/have been tested in accordance with the above Requirements set forth in the above referenced documents.

Mark Betts
Deputy Quality Representative

Mark Betts
NTS Project Manager



NATIONAL TECHNICAL SYSTEMS

CERTIFICATE OF COMPLIANCE

September 7, 2017

Customer: Persistent Systems LLC
303 Fifth Avenue, Suite 306
New York, NY 10016

Purchase Order #: 15930
NTS PR #: PR066693

Test Items:

Item #	Qty	Description	Part #	Serial #
1	1	MPU5 + RF-2100 Module	WR-5100	28147, 2410
2	1	PTT	WR-PTT-01	00324
3	1	MPU5 + RF-4100 Module	WR5100	25574, B-76
4	1	*Embedded Module Board	N/A	0-EM40-0000187

*Was not tested for Icing, Blowing Rain, Blowing Dust and Humidity.

Test Specifications:

Persistent Systems LLC Purchase Order No. 15930 dated 7/17/17
MIL-STD-810G

Test Performed	Test Date(s)	Test Results
MIL-STD-810G Method 521.3, Icing, 6mm-13mm	8/9/17	Pass
MIL-STD-810G Method 506.5 Procedure I, Blowing Rain	9/6/17	Pass
MIL-STD-810G Method 514.6 Procedure I, Vibration	8/23/17-8/24/17	Pass
MIL-STD-810G Method 508.6, Fungus, US Spores	8/11/17-9/18/17	Pass
MIL-STD-810G Method 500.6, Procedure I, Storage Altitude, 60kft (4 units)	10/2/17	Pass
MIL-STD-810G Method 502.5, Procedure I, -55C (4 units)	10/5/17	Pass
MIL-STD-810G Method 507.5, Procedure II	12/8/17	Pass
MIL-STD-810G Method 510.5, Procedure I, 71C	12/13/17	Pass

National Technical Systems (NTS) certifies that the above referenced item(s) has/have been tested in accordance with the above Requirements set forth in the above referenced documents.

David Potpink
NTS Quality Representative

Mark Betts
NTS Project Manager



NATIONAL TECHNICAL SYSTEMS

CERTIFICATE OF COMPLIANCE

June 7, 2021

Customer: Persistent Systems, LLC
601 W 26th Street
Suite M292
New York, NY 10001

Purchase Order #: PS00000477
NTS MJO #: PR140175

Test Items:

Item #	Qty	Description	Model #	Serial #
1	1	MPU5	WR-5100	51400
2	1	High Power S-Band Radio Module	RF-2150	B-79930
3	1	Embedded Module	WR-5200	56613
4	1	Embedded Module Lite	WR-5250	58385
5	1	Dual PTT	WR-PTT-SYS-01	B01767
6	1	Rugged Display & Controller (RDC)	WR-DISP-SYS-01	00520

Test Specifications:

Persistent Systems, LLC Purchase Order No. PS00000477 dated 6/3/21.

MIL-STD-810G

Test Performed	Test Date(s)
Random Vibration per MIL-STD-810G Method 514.6, Procedure I	6/7/2021

National Technical Systems (NTS) certifies that the above referenced item(s) has/have been tested in accordance with the above Requirements set forth in the above referenced documents.

Tom Sweeney
NTS General Manager

Mark Betts
NTS Project Manager



NATIONAL TECHNICAL SYSTEMS

CERTIFICATE OF COMPLIANCE

June 7, 2021

Customer: Persistent Systems, LLC
601 W 26th Street
Suite M292
New York, NY 10001

Purchase Order #: PS000000070
NTS MJO #: PR135585

Test Items:

Item #	Qty	Description	Model #	Serial #
1	1	MPU5	WR-5100	51400
2	1	High Power S-Band Radio Module	RF-2150	B-79930
3	1	Embedded Module	WR-5200	56613
4	1	Embedded Module Lite	WR-5250	58385
5	1	Dual PTT	WR-PTT-SYS-01	B01767
6	1	Rugged Display & Controller (RDC)	WR-DISP-SYS-01	00520

Test Specifications:

Persistent Systems, LLC Purchase Order No. PS000000070 dated 3/21/21.
MIL-STD-810G

Test Performed	Test Date(s)
Shock per MIL-STD-810G Method 516.6, Procedure I (20g/11mS)	4/22/2021

National Technical Systems (NTS) certifies that the above referenced item(s) has/have been tested in accordance with the above Requirements set forth in the above referenced documents.

Tom Sweeney
NTS General Manager

Mark Betts
NTS Project Manager