



EMISSION TEST REPORT

Report Number: 3191230BOX-001a

Project Number: 3191230

Testing performed on the
Ground Penetration Radar

Model: 270LL3P

To

FCC Part 15 Subpart F – Ultra-Wideband Operation

For

Geophysical Survey Systems, Inc.

Test Performed by:
Intertek – ETL SEMKO
70 Codman Hill Road
Boxborough, MA 01719

Test Authorized by:
Geophysical Survey Systems, Inc.
12 Industrial Way
Salem, NH 03079

Prepared by: 
Kouma Sinn, Sr. Project Engineer

Date: 09/29/09

Reviewed by: 
Jeff Goulet

Date: 09/29/09

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1.0 Job Description

1.1 Client Information:

This equipment under test (EUT) has been tested at the request of:

Company: Geophysical Survey Systems, Inc.
12 Industrial Way
Salem, NH 03079
Contact: Alan Schutz
Telephone: (603) 893-1109
Fax: (603) 889-3984
Email: alan.s@geophysical.com

1.2 Equipment Under Test:

Equipment Type: Ground Penetration Radar
Model Number(s): 270LL3P
Serial number(s): 151
Manufacturer: Geophysical Survey Systems, Inc.
EUT receive date: 09/28/09
EUT received condition: A production unit was received with no visible damage
Test start date: 09/28/09
Test end date: 09/28/09

1.3 Test Plan Reference: ANSI C63.4-2003, FCC Part 15 Subpart F

1.4 Test Configuration:

1.4.1 EUT Voltage Range:

The EUT powers from internal battery

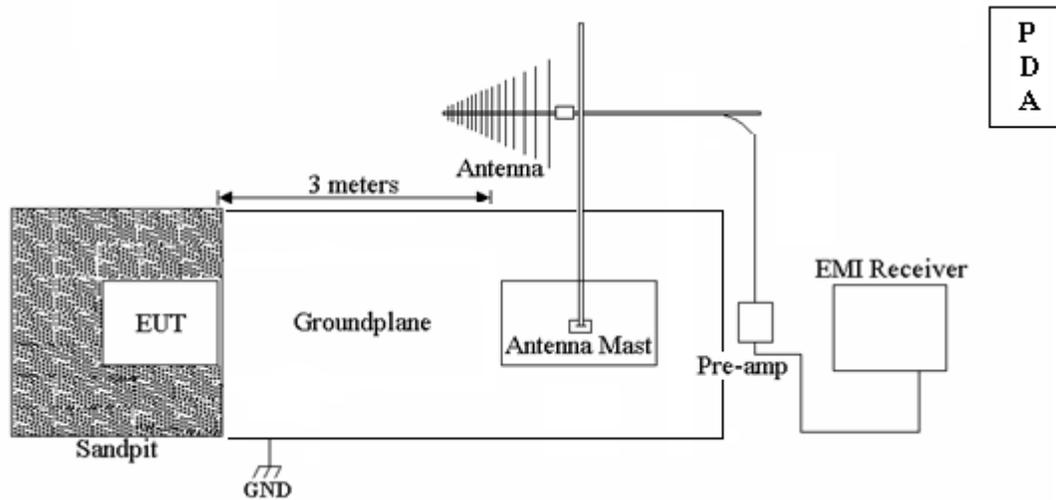
1.4.2 Cables:

Description	Shielding	Connector	Length (m)	Qty.
None				

1.4.3 Support Equipment:

Description	Manufacturer	Model	Serial No.
PDA	TDS	Nomad	3

1.4.4 Block Diagram:



1.5 Mode(s) of Operation:

The EUT was continuous transmitting and collecting data during testing.

1.6 Modifications Required For Compliance:

None



2.0 Test Summary:

TEST STANDARD	RESULTS	
FCC Part 15 Subpart F – Ultra-Wideband Operation		
SUB-TEST	TEST PARAMETER	PASS/FAIL
Radiated Emissions	Emissions below 15.509	Pass
10 dB Bandwidth	15.503(d): The UWB bandwidth is the frequency band bounded by the points that are 10 dB below the highest radiated emission, as based on the complete transmission system including the antenna. The fractional bandwidth shall be equal to or greater than 0.20 or has a UWB bandwidth equal to or greater than 500 MHz, regardless of the fractional bandwidth.	Pass
Line Conducted Emissions	N/A	N/A

REVISION SUMMARY – The following changes have been made to this Report:

<u>Date</u>	<u>Project No.</u>	<u>Project Handler</u>	<u>Page(s)</u>	<u>Item</u>	Description of Change
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3.0 Sample Calculations:

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF - AG$$

Where

- FS = Field Strength in dB μ V/m
- RA = Receiver Amplitude (including preamplifier) in dB μ V
- CF = Cable Attenuation Factor in dB
- AF = Antenna Factor in dB
- AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 dB μ V is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dB μ V/m. This value in dB μ V/m was converted to its corresponding level in μ V/m.

RA = 52.0 dB μ V
 AF = 7.4 dB/m
 CF = 1.6 dB
 AG = 29.0 dB
 FS = 32 dB μ V/m

$$\text{Level in } \mu\text{V/m} = [10(32 \text{ dB}\mu\text{V/m})/20] = 39.8 \mu\text{V/m}$$

The following is how net line-conducted readings were determined:

$$NF = RF + LF + CF + AF$$

Where NF = Net Reading in dB μ V

- RF = Reading from receiver in dB μ V
- LF = LISN Correction Factor in dB
- CF = Cable Correction Factor in dB
- AF = Attenuator Loss Factor in dB

To convert from dB μ V to μ V or mV the following was used:

$$UF = 10^{(NF / 20)}$$

Where UF = Net Reading in μ V
 NF = Net Reading in dB μ V

Example:

$$NF = RF + LF + CF + AF = 28.5 + 0.2 + 0.4 + 20.0 = 49.1 \text{ dB}\mu\text{V}$$

$$UF = 10^{(49.1 \text{ dB}\mu\text{V} / 20)} = 285.1 \mu\text{V}$$

4.0 Measurement Uncertainty:

For radiated emissions, U_{lab} (4.9 dB at 3m and 4.2 dB at 10m) $<$ U_{CISPR} (5.2 dB), which is the reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required, based on CISPR 22 and CISPR 11 (for 2006 and later revisions) Clause 11.

For conducted emissions, U_{lab} (3.2 dB in worst case) $<$ U_{CISPR} (3.6 dB), which is the reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required, based on CISPR 22 and CISPR 11 (for 2006 and later revisions) Clause 11.

5.0 Site Description:

Test Site(s): 1 (Sandpit)

The sandpit test site used during testing was made in accordance with Part 15 Subpart F. The test site was constructed with a dimension of 16.40ft x 16.40ft x 30 inches deep. The whole area was filled with dry sand. The equipment under test (EUT) was placed directly on the sand while the receiving antenna was placed at a distance of 3m from the closest point of the EUT. A groundplane with a dimension of 15.75ft x 19.50ft was placed between the EUT and receiving antenna and connected to earth ground via a ground rod.

6.0 Testing Procedure

The system was configured for testing in a typical fashion (as a customer would normally use it), and in the confines as outlined in ANSI C63.4 (2003).

All support equipment was remotely located. The EUT was placed directly on the sand 3 meters away from the receiving antenna with groundplane in between.

Initial testing was performed to maximize the emissions. The system was rotated every 45° and cables were oriented to get the worst emissions, the antenna height was varied from 1 meter to 4 meters above the ground, and the antenna polarization was changed. The EUT azimuth of maximum emissions was recorded. The worst-case orientation will be used in the final testing.



Test Results: Pass

Test Standard: FCC Part 15 Subpart F – Ultra-Wideband Operation

Test: Radiated Emissions

Performance Criterion: Not Applicable

Test Environment:

Environmental Conditions During Testing:	Ambient (°C):	See data tables	Humidity (%):	See data tables	Pressure (hPa):	See data tables	
Pretest Verification Performed	Yes		Equipment under Test:	270LL3P			
Test Engineer(s):	Kouma Sinn		EUT Serial Number:	151			
Engineer's Initials:	<i>KPS</i>	Date Test Performed:	09/28/09	Reviewer's Initials:	<i>JK</i>	Date Reviewed:	09/29/09

Maximum Test Disturbance Parameters: Emissions below the limits specified in 15.209

Test Equipment Used:

TEST EQUIPMENT LIST					
Item	Equipment Type	Make	Model No.	Serial No.	Next Cal. Due
1	HORN ANTENNA	EMCO	3115	9610-4980	02/25/2010
2	High Frequency Cable	Megaphase	TM40-K1K1-197	8148601-001	12/10/2009
3	High Frequency Cable 40GHz	Megaphase	TM40 K1K1 80	CBL030	12/10/2009
4	Weather Station	Davis Instruments	7400	PE80519A61	06/10/2010
5	Spectrum Analyzer 20Hz - 40 GHz	Rohde & Schwartz	FSEK-30	100225	12/01/2009
6	9kHz to 3GHz EMI Test Receiver	Rohde & Schwartz	ESCI 1166.5950K03	100067	02/17/2010
7	100MHz-40GHz Preamp	MITEQ	NSP4000-NFG	1260417	04/03/2010
8	RG223 50ohm Coaxial Cable	Intertek	BNC-30	CBLBNC6	02/25/2010
9	ANTENNA	EMCO	3142	9701-1116	12/02/2009



Software Utilized:

Name	Manufacturer	Version
Excel 2003	Microsoft	(11.8231.8221) SP3
EMI Boxborough.xls	Intertek	4/17/09

Test Details:

Test Point	Standard Limit (as published)	Compliance Level	Pass/Fail N/A	Comment
EUT Enclosure	Per 15.209	Emissions below 15.209 limits	Pass	None



Test Results:

Radiated Emissions From 30-960MHz

Radiated Emissions

Company: Geophysical Survey Systems, Inc. Antenna & Cables: N Bands: N, LF, HF, SHF
 Model #: 270LL3P Antenna: LOG1 12-02-2009 V3.txt LOG1 12-02-2009 H3.txt
 Serial #: 151 Cable(s): CBLBNC6 02-25-10.txt NONE
 Engineers: Kouma sinn Location: 1 Barometer: DAV001 Filter: NONE
 Project #: 3186354 Date(s): 09/28/09 Temp/Humidity/Pressure: 18C 80% 999mbar
 Standard: FCC Part 15 Subpart F
 Receiver: ROS002 Limit Distance (m): 3
 PreAmp: PRE9 04-03-10.txt Test Distance (m): 3
 PreAmp Used? (Y or N): N Voltage/Frequency: Battery powered Frequency Range: 30-960MHz
 Net = Reading (dBuV/m) + Antenna Factor (dB1/m) + Cable Loss (dB) - Preamp Factor (dB) - Distance Factor (dB)
 Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS: NF = Noise Floor, RB = Restricted Band; Bandwidth denoted as RBW/VBW

Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB	Bandwidth
Model: 270LL3P, Serial: 151 EUT operating at 270MHz											120/300 kHz
QP	H	30.000	4.50	18.70	1.19	0.00	0.00	24.39	40.00	-15.61	120/300 kHz
QP	H	40.000	7.80	13.10	1.34	0.00	0.00	22.24	40.00	-17.76	120/300 kHz
QP	H	60.000	14.95	7.10	1.54	0.00	0.00	23.59	40.00	-16.41	120/300 kHz
QP	H	76.000	19.10	7.48	1.64	0.00	0.00	28.22	40.00	-11.78	120/300 kHz
QP	H	84.880	20.00	8.29	1.73	0.00	0.00	30.02	40.00	-9.98	120/300 kHz
QP	H	88.000	24.90	8.60	1.77	0.00	0.00	35.27	40.00	-4.73	120/300 kHz
QP	H	93.896	21.20	8.96	1.84	0.00	0.00	31.99	43.50	-11.51	120/300 kHz
QP	H	99.838	21.50	9.19	1.91	0.00	0.00	32.60	43.50	-10.90	120/300 kHz
QP	H	111.000	23.50	8.54	1.97	0.00	0.00	34.01	43.50	-9.50	120/300 kHz
QP	H	132.000	26.40	7.90	2.07	0.00	0.00	36.37	43.50	-7.13	120/300 kHz
QP	H	144.000	27.50	8.70	2.13	0.00	0.00	38.33	43.50	-5.17	120/300 kHz
QP	H	157.000	28.20	9.86	2.20	0.00	0.00	40.26	43.50	-3.25	120/300 kHz
QP	H	171.000	25.70	10.16	2.27	0.00	0.00	38.13	43.50	-5.38	120/300 kHz
QP	H	184.000	23.70	10.58	2.33	0.00	0.00	36.61	43.50	-6.89	120/300 kHz
QP	H	194.000	25.20	10.44	2.38	0.00	0.00	38.02	43.50	-5.48	120/300 kHz
QP	H	216.000	19.50	11.14	2.48	0.00	0.00	33.12	43.50	-10.38	120/300 kHz
QP	H	218.000	19.50	11.22	2.49	0.00	0.00	33.21	46.00	-12.79	120/300 kHz
QP	H	230.000	19.40	11.68	2.54	0.00	0.00	33.62	46.00	-12.38	120/300 kHz
QP	H	235.000	19.73	11.86	2.56	0.00	0.00	34.15	46.00	-11.85	120/300 kHz
QP	H	252.800	20.50	12.46	2.64	0.00	0.00	35.60	46.00	-10.40	120/300 kHz
QP	H	278.160	20.00	13.08	2.75	0.00	0.00	35.83	46.00	-10.17	120/300 kHz
QP	H	307.000	17.90	14.47	2.88	0.00	0.00	35.25	46.00	-10.75	120/300 kHz
QP	H	337.400	18.70	15.25	3.01	0.00	0.00	36.96	46.00	-9.04	120/300 kHz
QP	H	368.000	15.20	15.96	3.15	0.00	0.00	34.31	46.00	-11.69	120/300 kHz
QP	H	410.700	16.50	16.40	3.34	0.00	0.00	36.24	46.00	-9.76	120/300 kHz
QP	H	458.640	12.72	17.28	3.58	0.00	0.00	33.58	46.00	-12.42	120/300 kHz
QP	H	528.000	8.70	18.65	3.92	0.00	0.00	31.27	46.00	-14.73	120/300 kHz
QP	H	556.000	6.80	19.05	4.06	0.00	0.00	29.91	46.00	-16.09	120/300 kHz
QP	H	589.000	5.50	19.54	4.23	0.00	0.00	29.26	46.00	-16.74	120/300 kHz
QP	H	658.000	4.60	21.36	4.53	0.00	0.00	30.49	46.00	-15.51	120/300 kHz NF
QP	H	709.000	4.60	22.03	4.75	0.00	0.00	31.38	46.00	-14.62	120/300 kHz NF
QP	H	763.000	4.30	22.31	4.98	0.00	0.00	31.59	46.00	-14.41	120/300 kHz NF
QP	H	800.000	4.60	22.40	5.14	0.00	0.00	32.14	46.00	-13.86	120/300 kHz NF
QP	H	845.000	5.00	22.78	5.23	0.00	0.00	33.01	46.00	-12.99	120/300 kHz NF
QP	H	909.000	5.40	23.64	5.36	0.00	0.00	34.40	46.00	-11.60	120/300 kHz NF
QP	H	960.000	5.60	23.80	5.47	0.00	0.00	34.87	46.00	-11.13	120/300 kHz NF



Test Results Continued:

Radiated Emissions From 960MHz-18GHz

Radiated Emissions

Company: Geophysical Survey Systems, Inc. Antenna & Cables: LF Bands: N, LF, HF, SHF
 Model #: 270LL3P Antenna: HORN3 V1m 02-25-10.txt HORN3 H1m 02-25-10.txt
 Serial #: 151 Cable(s): MEG005 12-10-2009.txt CBL030 12-10-09.txt
 Engineers: Kouma sinn Location: 1 Barometer: DAV001 Filter: NONE
 Project #: 3186354 Date(s): 09/28/09 Temp/Humidity/Pressure: 22 65% 989mbar
 Standard: FCC Part 15 Subpart F
 Receiver: ROS001 Limit Distance (m): 3
 PreAmp: PRE9 04-03-10.txt Test Distance (m): 1
 PreAmp Used? (Y or N): Y Voltage/Frequency: Battery powered Frequency Range: 960MHz-18GHz
 Net = Reading (dBuV/m) + Antenna Factor (dB1/m) + Cable Loss (dB) - Preamp Factor (dB) - Distance Factor (dB)
 Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS; NF = Noise Floor, RB = Restricted Band; Bandwidth denoted as RBW/VBW

Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB	Bandwidth
Model: 270LL3P, Serial: 151 EUT operating at 270MHz at 1 meter											
RMS	H	960.000	34.30	23.93	2.53	27.84	9.54	23.37	29.90	-6.53	1/3MHz
RMS	H	975.870	35.73	24.08	2.55	27.82	9.54	25.00	29.90	-4.90	1/3MHz
RMS	H	993.186	36.00	24.24	2.58	27.81	9.54	25.48	29.90	-4.42	1/3MHz
RMS	H	1015.310	35.50	24.36	2.61	27.80	9.54	25.12	29.90	-4.78	1/3MHz
RMS	H	1055.230	35.41	24.48	2.66	27.80	9.54	25.21	29.90	-4.69	1/3MHz
RMS	H	1073.500	35.57	24.54	2.69	27.81	9.54	25.44	29.90	-4.46	1/3MHz
RMS	H	1112.940	32.42	24.66	2.74	27.81	9.54	22.46	29.90	-7.44	1/3MHz
RMS	H	1154.789	32.18	24.79	2.79	27.81	9.54	22.40	29.90	-7.50	1/3MHz
RMS	H	1192.786	32.72	24.90	2.84	27.81	9.54	23.11	29.90	-6.79	1/3MHz
RMS	H	1405.800	27.56	25.56	3.12	27.83	9.54	18.86	29.90	-11.04	1/3MHz
RMS	H	2000.000	26.90	27.91	3.84	27.88	9.54	21.23	43.90	-22.67	1/3MHz
RMS	H	3000.000	26.60	30.57	5.00	27.95	9.54	24.68	43.90	-19.22	1/3MHz
RMS	H	5000.000	27.83	34.75	6.45	28.10	9.54	31.39	53.90	-22.51	1/3MHz
RMS	H	8000.000	26.40	37.69	8.51	27.02	9.54	36.04	53.90	-17.86	1/3MHz
RMS	H	10000.000	24.70	40.27	9.69	26.30	9.54	38.82	53.90	-15.08	1/3MHz
RMS	H	13000.000	25.10	40.48	11.31	26.36	9.54	40.99	43.90	-2.91	1/3MHz
RMS	H	15000.000	24.70	41.62	12.57	26.40	9.54	42.95	43.90	-0.95	1/3MHz
1164-1240MHz, 1559-1610MHz at 1 meter											
RMS	V	1163.900	15.30	24.79	2.80	27.81	9.54	5.54	19.90	-14.36	1/3kHz
RMS	V	1175.980	7.00	24.83	2.82	27.81	9.54	-2.70	19.90	-22.60	1/3kHz
RMS	V	1195.500	18.18	24.90	2.84	27.81	9.54	8.57	19.90	-11.33	1/3kHz
RMS	V	1239.990	8.50	25.06	2.90	27.82	9.54	-0.89	19.90	-20.79	1/3kHz
RMS	V	1559.000	2.00	26.23	3.31	27.84	9.54	-5.85	19.90	-25.75	1/3kHz
RMS	V	1572.000	3.71	26.28	3.33	27.84	9.54	-4.07	19.90	-23.97	1/3kHz
RMS	V	1596.000	2.50	26.37	3.36	27.84	9.54	-5.17	19.90	-25.07	1/3kHz
RMS	V	1610.000	2.20	26.42	3.37	27.85	9.54	-5.40	19.90	-25.30	1/3kHz



Test Results Continued:

Highest Emissions Above 960MHz

Radiated Emissions

Company: Geophysical Survey Systems, Inc. Antenna & Cables: LF Bands: N, LF, HF, SHF
 Model #: 270LL3P Antenna: HORN3 V1m 02-25-10.txt HORN3 H1m 02-25-10.txt
 Serial #: 151 Cable(s): MEG005 12-10-2009.txt CBL030 12-10-09.txt
 Engineers: Kouma sinn Location: 1 Barometer: DAV001 Filter: NONE
 Project #: 3186354 Date(s): 09/28/09 Temp/Humidity/Pressure: 22 65% 989mbar
 Standard: FCC Part 15 Subpart F Receiver: ROS001 Limit Distance (m): 3
 PreAmp: PRE9 04-03-10.txt Test Distance (m): 1
 PreAmp Used? (Y or N): Y Voltage/Frequency: Battery powered Frequency Range: 960MHz-18GHz
 Net = Reading (dBuV/m) + Antenna Factor (dB1/m) + Cable Loss (dB) - Preamp Factor (dB) - Distance Factor (dB)
 Peak: PK Quasi-Peak: QP Average: AVG RMS: RMS; NF = Noise Floor, RB = Restricted Band; Bandwidth denoted as RBW/VBW

Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB	Bandwidth
Model: 270LL3P, Serial: 151 EUT operating at 270MHz. Highest emissions above 960MHz											
PK	H	1054.951	59.69	24.48	2.66	27.80	9.54	49.48	70.76	-21.28	3/10MHz

The highest radiated emission occurs, f_M , above 960MHz, there is a limit on the peak level of the emissions contained within a 50MHz bandwidth centered on f_M . That limit is 0 dBm EIRP which is 95 dBuV/m in field strength. The resolution bandwidth of 3MHz was used so, the new limit is $95.2 - 20 * \text{LOG}(3\text{MHz}/50\text{MHz}) = 95.2 - 24.437 = 70.763 \text{ dBuV/m}$.

Setup Photos





Test Results: Pass

Test Standard: FCC Part 15 Subpart F – Ultra-Wideband Operation

Test: 10 dB Bandwidth

Performance Criterion: Not Applicable

Test Environment:

Environmental Conditions During Testing:	Ambient (°C):	22	Humidity (%):	65	Pressure (hPa):	989	
Pretest Verification Performed	Yes		Equipment under Test:	270LL3P			
Test Engineer(s):	Kouma Sinn		EUT Serial Number:	151			
Engineer's Initials:	<i>KPS</i>	Date Test Performed:	09/28/09	Reviewer's Initials:	<i>JS</i>	Date Reviewed:	09/29/09

Maximum Test Disturbance Parameters: 15.503(d): The UWB bandwidth is the frequency band bounded by the points that are 10 dB below the highest radiated emission, as based on the complete transmission system including the antenna. The fractional bandwidth shall be equal to or greater than 0.20 or has a UWB bandwidth equal to or greater than 500 MHz, regardless of the fractional bandwidth.

Test Equipment Used:

TEST EQUIPMENT LIST					
Item	Equipment Type	Make	Model No.	Serial No.	Next Cal. Due
1	Weather Station	Davis Instruments	7400	PE80519A61	06/10/2010
2	9kHz to 3GHz EMI Test Receiver	Rohde & Schwartz	ESCI 1166.5950K03	100067	02/17/2010
3	ANTENNA	EMCO	3142	9701-1116	12/02/2009
4	RG223 50ohm Coaxial Cable	Intertek	BNC-30	CBLBNC6	02/25/2010

Software Utilized:

None

Test Details:

Test Point	Standard Limit (as published)	Compliance Level	Pass/Fail N/A	Comment
Highest Peak	Per Standard	Per Standard	Pass	See notes

Notes: The calculated fractional bandwidth is greater than 0.2, therefore, the EUT met the requirement.

Test Results:

10dB Bandwidth



Date: 28.SEP.2009 11:16:38

$F_L = 70.34\text{MHz}$
 $F_H = 215.94\text{MHz}$
 $F_C = (f_h + f_l)/2$
 $F_C = 143.14\text{MHz}$

Fractional Bandwidth = $2(F_H - F_L)/(F_H + F_L)$
 Fractional Bandwidth = $145.6\text{MHz}/286.28\text{MHz}$
 Fractional Bandwidth = 1.0172

10dB Bandwidth Photo

