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Test Report for the FCC (USA) and ISED (Canada)Testing of a DA175 Transmitter for Leica Geosystems

Test Report number: C14640TR6
Project number: C6728

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Issue	Description						Issue by	Date
5	*Copy 1*		*Copy 2*		*PDF*	*X*	MR	6th January 2023

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Registered in England and Wales
Company Reg. No. 6048589
VAT Reg. No. GB 887 1276 83

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Test Report Change History

Issue	Date	Modification Details
1	18th May 2022	Original issue of test report
2	20th May 2022	Test set up photos removed
3	20th June 2022	Product Information amended
4	23rd September 2022	Updated to include ISED requirements
5	4th November 2022	FCC ID added
6	6th January 2023	FCC ID amended
7		
8		
9		
10		

Section 1 Test Location

All testing was performed at;

Eurofins York Ltd	Unit 5
	Speedwell Road
	Castleford
	WF10 5PY
Tel:	01977 731173
Website	https://www.yorkemc.com
UKAS Testing No.	1574

1.1 UKAS Accreditation

Tests marked "Not UKAS Accredited" in this report are not included in the UKAS Accreditation Schedule for our laboratory.

Opinions and interpretations expressed herein are outside the scope of UKAS Accreditation.

Eurofins York latest accreditation schedule can be found at:

http://www.ukas.org/testing/lab_detail.asp?lab_id=989&location_id=&vMenuOption=3

For USA testing:

Eurofins York is a recognised test facility with the Federal Communications Commission (FCC).

Designation Number: UK2013

Test Firm Registration Number: 445101

Expiration date 2nd February 2023

For Canadian testing

Eurofins York is a recognised test facility with the Federal Communications Commission (FCC).

Designation Number: UK00004

Company Number: 22959

Expiration date 10th May 2023

Section 2 Customer Information

Company name	Leica Geosystems AG
Address	Heinrich-Wild-Strasse
	9435 Heerbrugg
	Switzerland
Tel:	+41 71 727 3237
Contact	Fabian Ammon
Email	fabian.ammon@leica-geosystems.com
Customer Representative(s) (not present during testing):	Emil-Radu Oprean

Section 3 Equipment Details

3.1 Equipment Under Test (EUT)

Date received:	30th March 2022		
EUT name:	DA175 1 Watt		
Type/Part no:	DA175 1 Watt		
Serial number	Proto016		
FCC ID	RFD-DA175		
EUT description:	Transmitter for use in a cable detection system. Couples inductively (or directly using cables) to the cable, to provide a signal for a Cable Locator to detect.		
No of units tested:	One		
Power	6	V	Battery operation (4 x Alkaline LR20 D Cell)
Highest internal frequency:	32.768kHz		
Cables:	None		
Tested as	Table top – as worse case		
Mode/s of operation	Induction mode. Continuous transmission at 32.768kHz (normal operation). The output from the transmitter was set to its highest output power setting.		
Software Version	V3.01		

The model numbers listed below were declared model variants by the client. The declared difference being labelling differences or less functionality.

- Model Name: DA175 1Watt
  - o Brand: Leica
- Model Name: t100
  - o Brand: GeoMax / BT for UK / Elma for Denmark
- Model Name: t100XF
  - o Brand: Standard
- Model Name: LKN-1000
  - o Brand: Sonel

This test report relates only to the unit(s) tested. The EUT tested in this report was DA175 1 Watt variant.

3.2 EUT Photos

Photographs are supplied separately.

3.3 Configuration of EUT

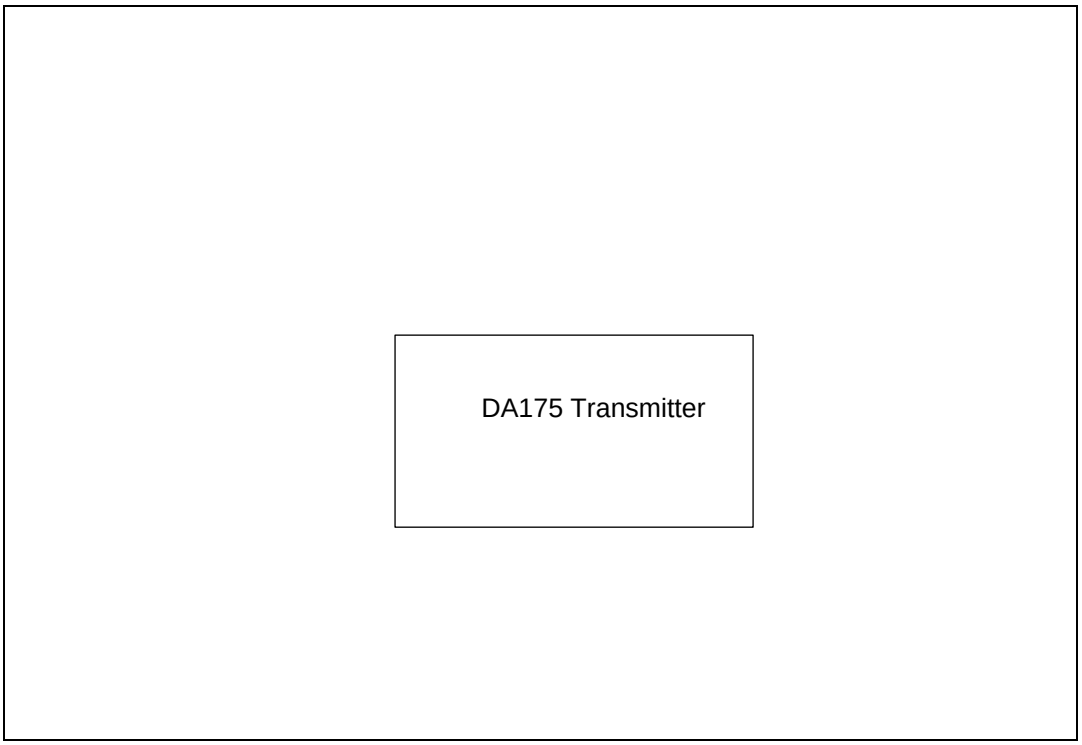

Figure 3.3.1: Diagram of EUT

3.4 EUT Monitoring/Auxiliary Equipment

None.

Section 4 Test Specifications

The tests were performed in accordance with Eurofins York Quotation QuC6728/1.

47CFR Part 15, Sub Part C Intentional Radiators **RSS-310 Issue 5 2020 : Cable locating equipment** **RSS GEN General requirements for compliance of radio apparatus Issue 5 April 2018**
Which references the following specification: - ANSI C63.10-2013 American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

Regulation and test standard clause	Description	Result summary
47CFR15C Section 15.213 Cable Location Equipment	Peak output power: For operation between 9kHz and up to but not including 45kHz 10watts For operation between 45kHz and 490kHz: 1watt	Pass
47 CFR Part 15.C Section 15.209 Test standard: ANSI C63.10-2013 Clause 6.3	General radiated emission limits in Section 15.209, 9kHz to 1GHz.	Pass
47 CFR Part 15C Section 15.207 Test standard: ANSI C63.10-2013 Clause 6.2	Mains conducted emissions 150kHz to 30MHz Applicable if the apparatus connects to the AC supply directly or via other apparatus.	Not applicable The apparatus is battery powered only

4.1 Knowledge Database References

The following KDBs were referenced during the testing of the DA175 Transmitter

The latest knowledge database references are available via the FCC KDB website at:

https://apps.fcc.gov/kdb

4.1.1 Radiated Emissions (9kHz to 30MHz)

Publication Number	Keyword	Publication Date
937606	Test Site Requirements for Part 15 and 18 Devices Operating Below 30 MHz	10/10/2014
460108	Radiated emission measurements below 30 MHz	06/15/2015

4.2 United States Equipment Authorisation

Cable location equipment may be authorised under the Suppliers Declaration of Conformity (47CFR 2.906) procedures or Certification (47CFR 2.907) at the choice of the applicant..

4.3 Canadian Equipment Authorisation

Equipment covered by this standard is classified as Category II equipment. Pursuant to subsection 21(5) of the Canadian Radiocommunication Regulations, Category II equipment is certification-exempt and thus no technical acceptance certificate (TAC) issued by the Certification and Engineering Bureau (CEB) of ISED or a certificate issued by a recognized certification body (CB) is required.

Pursuant to subsection 4(3) of the Radiocommunication Act, the manufacturer, importer and/or distributor shall ensure that Category II equipment is in compliance with all applicable procedures and standards.

4.4 Compliance Statement

The DA175 Transmitter as tested, was shown to meet requirements of the standards listed in Section 4 of this report.

Section 5 Output Power

5.1 Test Specification

Regulation (USA)	**47CFR 15.213 Cable locating equipment.** An intentional radiator used as cable locating equipment, as defined in §15.3(d), may be operated on any frequency within the band 9-490 kHz, subject to the following limits: Within the frequency band 9 kHz, up to, but not including, 45 kHz, the peak output power from the cable locating equipment shall not exceed 10 watts; and, within the frequency band 45 kHz to 490 kHz, the peak output power from the cable locating equipment shall not exceed one watt. If provisions are made for connection of the cable locating equipment to the AC power lines, the conducted limits in §15.207 also apply to this equipment.
Regulation (Canada)	**RSS-310 Issue 5 2020 Clause 10.2: Cable locating equipment.** Peak output power shall not exceed 10 W for the band 9-45 kHz and 1 W for the band 45-490 kHz, respectively.
Standard	ANSI C63.10:2013 General radiated emission limits in Section 15.209, 9kHz to 1GHz
Measurement Uncertainty	The reported uncertainty of measurement y ± U, where expended uncertainty U is based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95% is +/- 4.27dB for the frequency range from 9kHz to 30MHz +/- 5.81dB for the frequency range 30MHz to 1GHz

5.2 Procedure and Test Software Version

Eurofins York Test procedure (9kHz to 30MHz)	CEP22 Issue 8
Test software	Microsoft Excel

5.3 Limits

Frequency range	FCC Limits (W)	ISED Limits (W)
9 – (Not including)45kHz	10.0	10.0
45kHz – 490kHz	1.0	1.0

5.3.1 Receiver Settings

Receiver Parameters	Setting
Detector Function	Peak
Centre Frequency	81.9kHz
Span	10kHz
Resolution Bandwidth	200Hz
Video Bandwidth	Auto

5.3.2 Emissions measurements

5.3.3 Date of Test

12th April 2022

5.3.4 Test Area

Laboratory 5
Anechoic chamber

5.3.5 Tested by

M Render

5.3.6 Test Setup

The apparatus was positioned on an 80cm polystyrene support 3m from the receive antenna positioned at the same height. No ground plane was present during the testing. Please see Section 6.3.7 for further details.

5.3.7 Output Power, 9kHz to 30MHz

At the test site, the electric field strength was measured at a 3m measurement distance using a screened loop antenna.

The transmitted power was then calculated from the received electric field strength at 10m using the following relationship:

$$P_t = \frac{E^2 r^2}{30}$$

Where

P_t is the transmitted power (W)

E is the received electric field strength (V/m)

r is the measurement distance (m)

Parallel orientation:

	Frequency	32.768 kHz
1	Analyser reading (dBμV)	74.39
2	Pre-amplifier gain (dB)	31.50
3	Antenna factor (dB/m)	75.93
4	*E*(dBμV/m) (=1-2+3)	118.82
5	*E*(V/m)	0.87
6	*r*(m)	3.0
7	P_t(W)	0.228
8	Limit (W)	10.0
9	Summary	Below limit - PASS

Perpendicular orientation:

	Frequency	32.768 kHz
1	Analyser reading (dBμV)	71.96
2	Pre-amplifier gain (dB)	31.50
3	Antenna factor (dB/m)	75.93
4	*E*(dBμV/m) (=1-2+3)	116.39
5	*E*(V/m)	0.66
6	*r*(m)	3.0
7	P_t(W)	0.131
8	Limit (W)	10.0
9	Summary	Below limit - PASS

Section 6 Radiated Emission Results – Spurious Emissions

6.1 Test Specification

Regulation (USA)	47CFR15.209
Regulation (Canada)	RSS 310 Licence exempt radio apparatus Category 2 equipment Issue 5 January 2020 RSS GEN General requirements for compliance of radio apparatus Issue 5 April 2018
Standard	ANSI C63.10:2013 General radiated emission limits in Section 15.209, 9kHz to 1GHz
Measurement Uncertainty	The reported uncertainty of measurement y ± U, where expended uncertainty U is based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95% is +/- 4.27dB for the frequency range from 9kHz to 30MHz +/- 5.81dB for the frequency range 30MHz to 1GHz

6.2 Procedure and Test Software Version

Eurofins York Test procedure (9kHz to 30MHz)	CEP22 Issue 8
Eurofins York test procedure (30MHz to 1GHz)	CEP23 Issue 9
Eurofins York test procedure (1GHz to 40GHz)	CEP64 Issue 9
Test software	RadiMation Version 2016.2.8 Microsoft Excel

6.3 Magnetic Field Radiated Emissions (9kHz to 30MHz)

6.3.1 Limits

The limits for field strength in 47CFR15.209 are:

Frequency	Limits (µV/m)	Limits (µA/m)	Specified distance
9kHz to 490kHz	2400/F(kHz)	6.37/F (kHz)	300m
490kHz to 1.705MHz	24000/F(kHz) a	63.7/F (kHz)	30m
1.705MHz to 30MHz	30	0.08	30m

Notes:

1. The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.
2. The magnetic field and electric field limits are related via:

$$\frac{E}{H} = 377 \text{ Ohms}$$

Where,

E is the electric field in V/m

H is the magnetic field strength in A/m

3. The limit decreases linearly with the logarithm of the frequency in the range 9kHz to 490kHz

6.3.2 Receiver Settings

Receiver Parameters	Setting
Detector Function	Peak – for chamber pre-scans
Start Frequency	9kHz
Stop Frequency	150kHz
Resolution Bandwidth	200Hz
Video Bandwidth	Auto

Receiver Parameters	Setting
Detector Function	Peak – for chamber pre-scans
Start Frequency	150kHz
Stop Frequency	30MHz
Resolution Bandwidth	10kHz
Video Bandwidth	Auto

6.3.3 Emissions measurements

6.3.4 Date of Test

12th April 2022

6.3.5 Test Area

Laboratory 5 fully anechoic chamber

6.3.6 Tested by

M Render

6.3.7 Chamber Test Setup

The EUT was configured in the SAC on an 80cm high table.

The measurement was then performed with an antenna to EUT separation distance of 3m within the semi-anechoic chamber based upon the highest emissions results recorded on the outside test site.

The centre of the loop antenna was 1m above the ground and results were obtained with it parallel to the EUT and then perpendicular to the EUT.

The results are maximised in orientation 0-360 degrees.

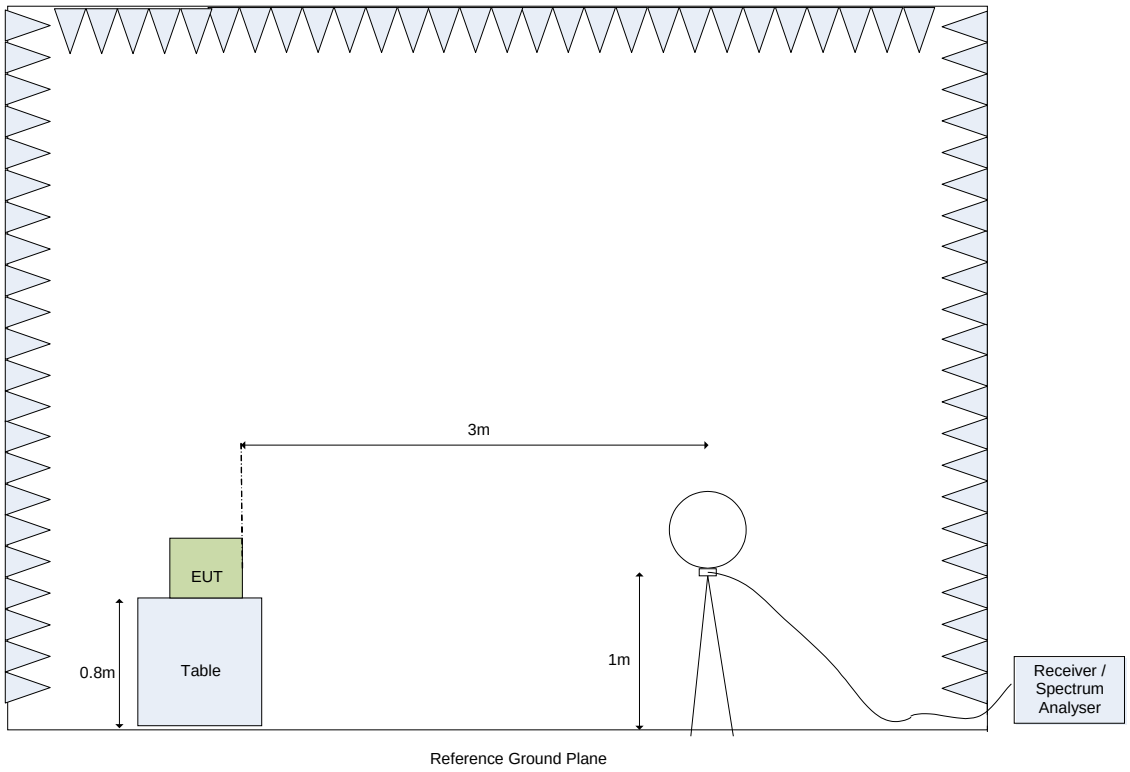

Figure 2: Test Setup for H-Field Measurements from 9kHz to 30MHz

Note 1 : With the EUT de-energized the ambient radio noise and signals met the 6dB peak detection requirement of ANSI C63.10-2013.

Note 2 : There were no significant environmental temperature changes during the test duration and hence it was not considered necessary to consider any variation in cable loss.

6.3.8 Magnetic field emissions, 9kHz to 30MHz – Chamber Measurements

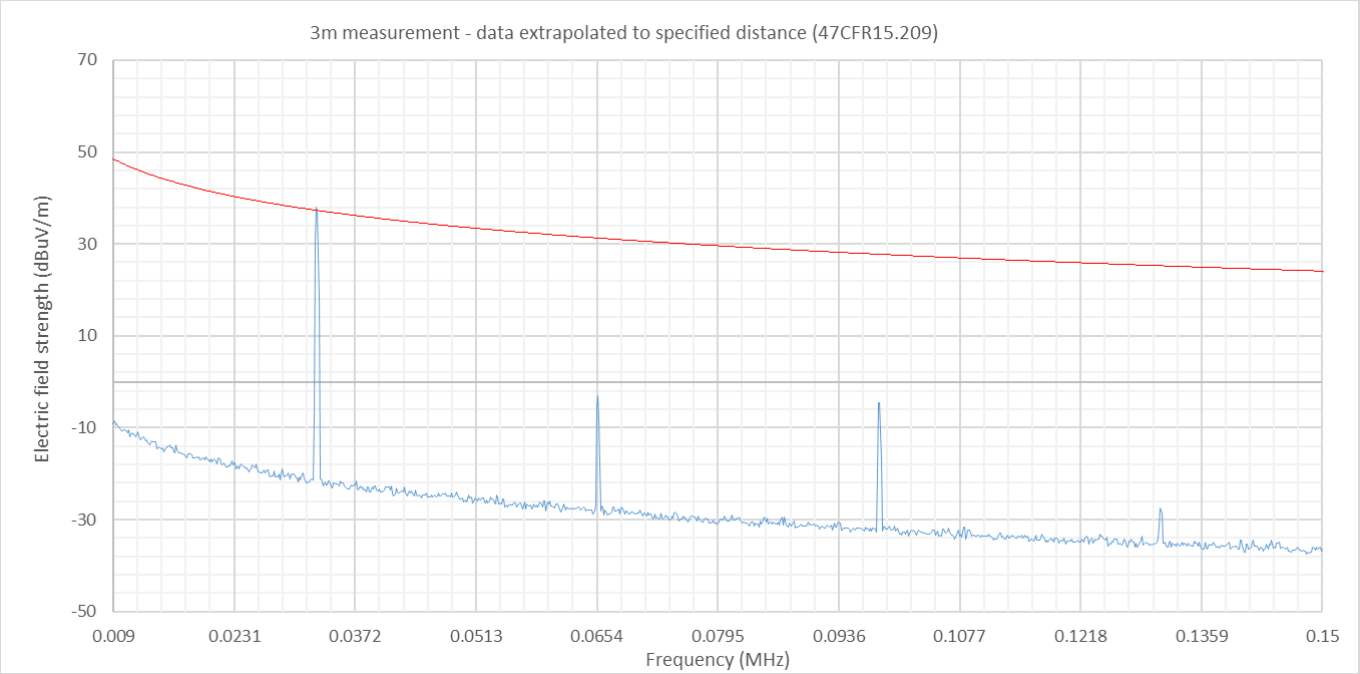

Figure 6.3.8.1: Magnetic field emissions Plot, 9kHz to 150kHz Parallel orientation

All measurements apart from the wanted signal were greater than 10dB from the specification limit. Further measurements were not necessary to determine compliance with the specification limit.

Figure 6.3.8.2: Magnetic field emissions Plot, 9kHz to 150kHz Perpendicular

All measurements apart from the wanted signal were greater than 10dB from the specification limit. Further measurements were not necessary to determine compliance with the specification limit.

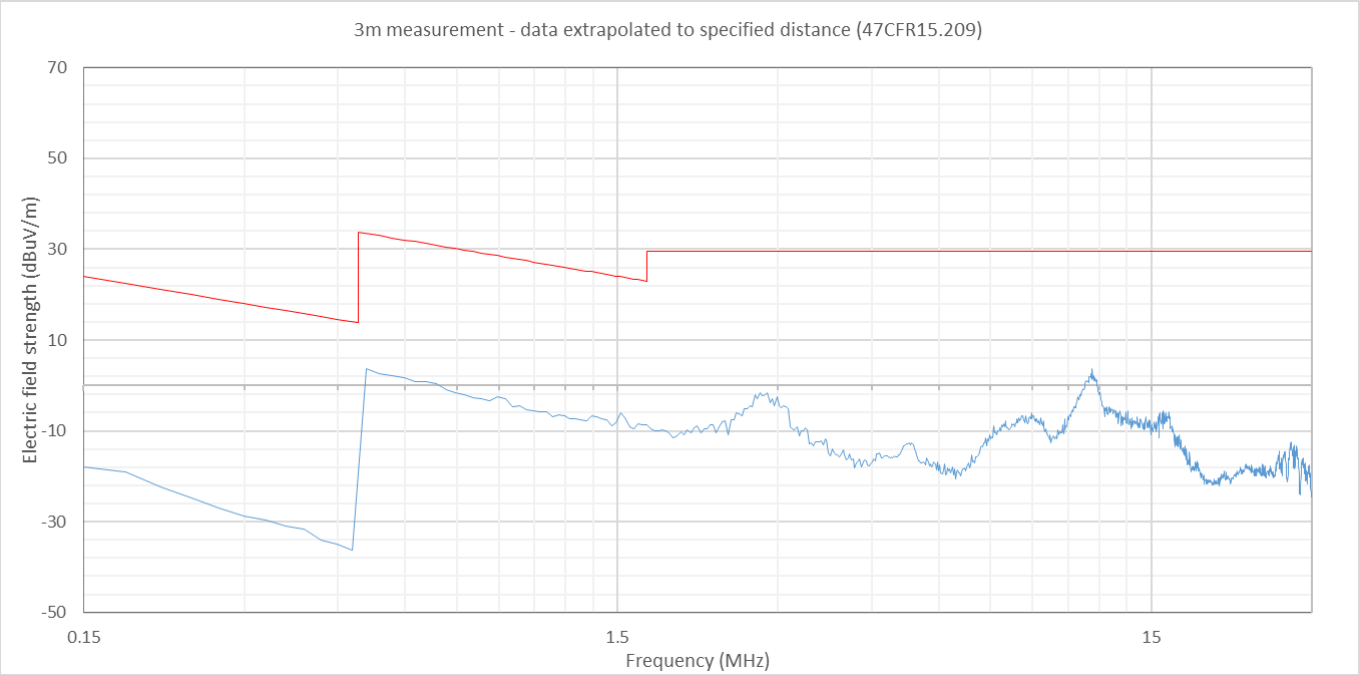

Figure 6.3.8.3: Magnetic field emissions Plot,150kHz to 30MHz Parallel orientation

All measurements apart from the wanted signal were greater than 10dB from the specification limit. Further measurements were not necessary to determine compliance with the specification limit.

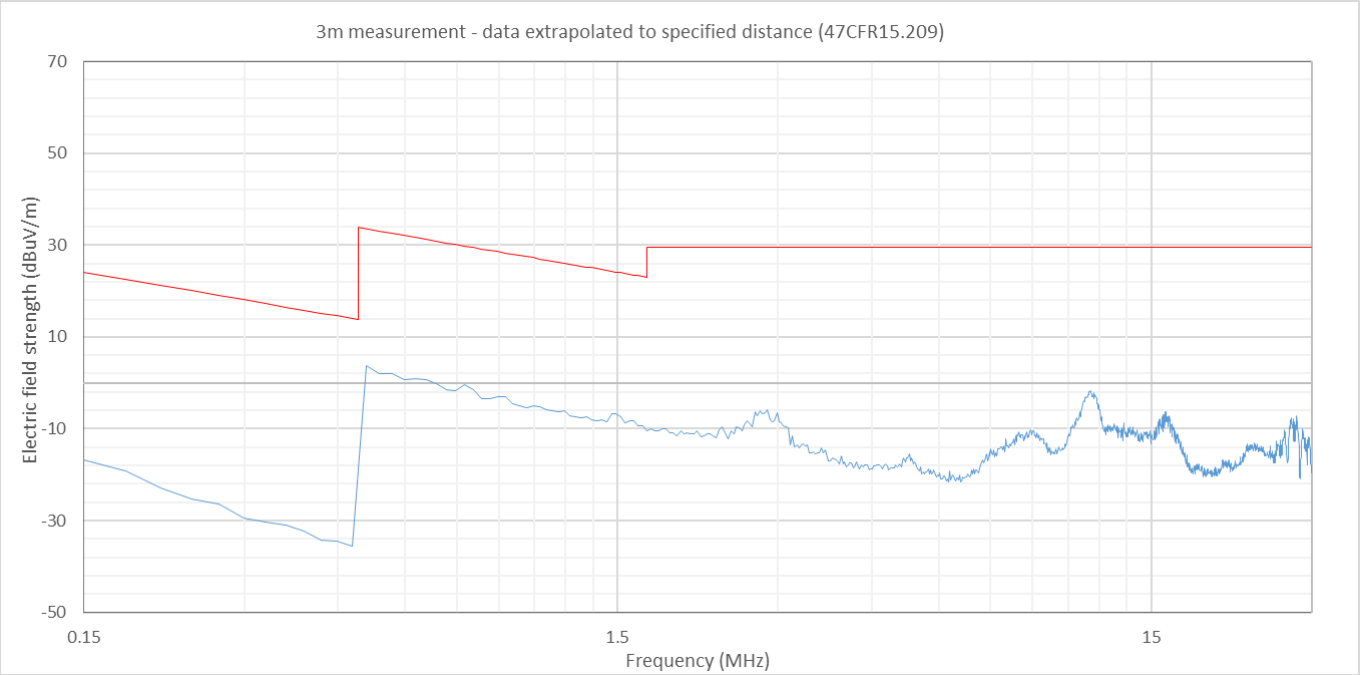

Figure 6.3.8.4 : Magnetic field emissions Plot,150kHz to 30MHz Perpendicular orientation

All measurements apart from the wanted signal were greater than 10dB from the specification limit. Further measurements were not necessary to determine compliance with the specification limit.

6.3.9 Example Calculation

This correction figure consists of indicated signal level (SL) Antenna factor (AF) pre-amplifier gain (PAG) and extrapolation factor (Ext)

Note: Cable loss was not considered to contribute significantly to the measurement.

Field strength (FS) is calculated as follows:

FS (dBµV/m) = Indicated Signal Level (dBµV) – (PAG) +AF(dB/m) – EXT(dB)

The extrapolation factor used was in accordance with ANSI C63.10-2013

$$E_{300m}(dB\mu V/m) = 40\log_{10}(3/SD) + E_{3m}(dB\mu V/m)$$

Where,

$E_{3m}(dB\mu V/m)$ is the field strength measured at 3m

$E_{300m}(dB\mu V/m)$ is the required field strength at 300m

SD is the specified distance (m).

At 65.54kHz:

Indicated signal level = SL(dBµV) = 35.5 dBµV

-PAG(dB) = 31.4 dB

+AF(dB/m) = 69.9 dB/m

-EXT(dB) = 80 dB

= -6.0 dBµV/m

6.4 Radiated Emissions (30MHz to 1GHz)

6.4.1 Limits at 3m

Frequency (MHz)	Electric Field Strength (dBµV/m) Quasi Peak detector	Specification distance (m)
30 - 88	40.0	3
88 -216	43.5	3
216 - 960	46.0	3
960- 1000	54.0	3

6.4.2 Receiver Settings

Receiver Parameters	Setting
Detector Function	Quasi Peak
Start Frequency	30MHz
Stop Frequency	1000MHz
Resolution Bandwidth	120kHz
Video Bandwidth	Auto

6.4.3 Date of Test

11th April 2022

6.4.4 Test Area

LAB 1 (Semi Anechoic Chamber)

6.4.5 Tested by

M Render

6.4.6 Test Setup

The EUT was configured in the SAC on an 80cm high table.

The measurement was performed with an antenna to EUT separation distance of 3m. The Quasi peak limits are therefore increased by 10dB (from the 10m values), to allow for the reduction in the measurement distance.

The results were maximised in orientation 0-360 degrees and height 1-4m.

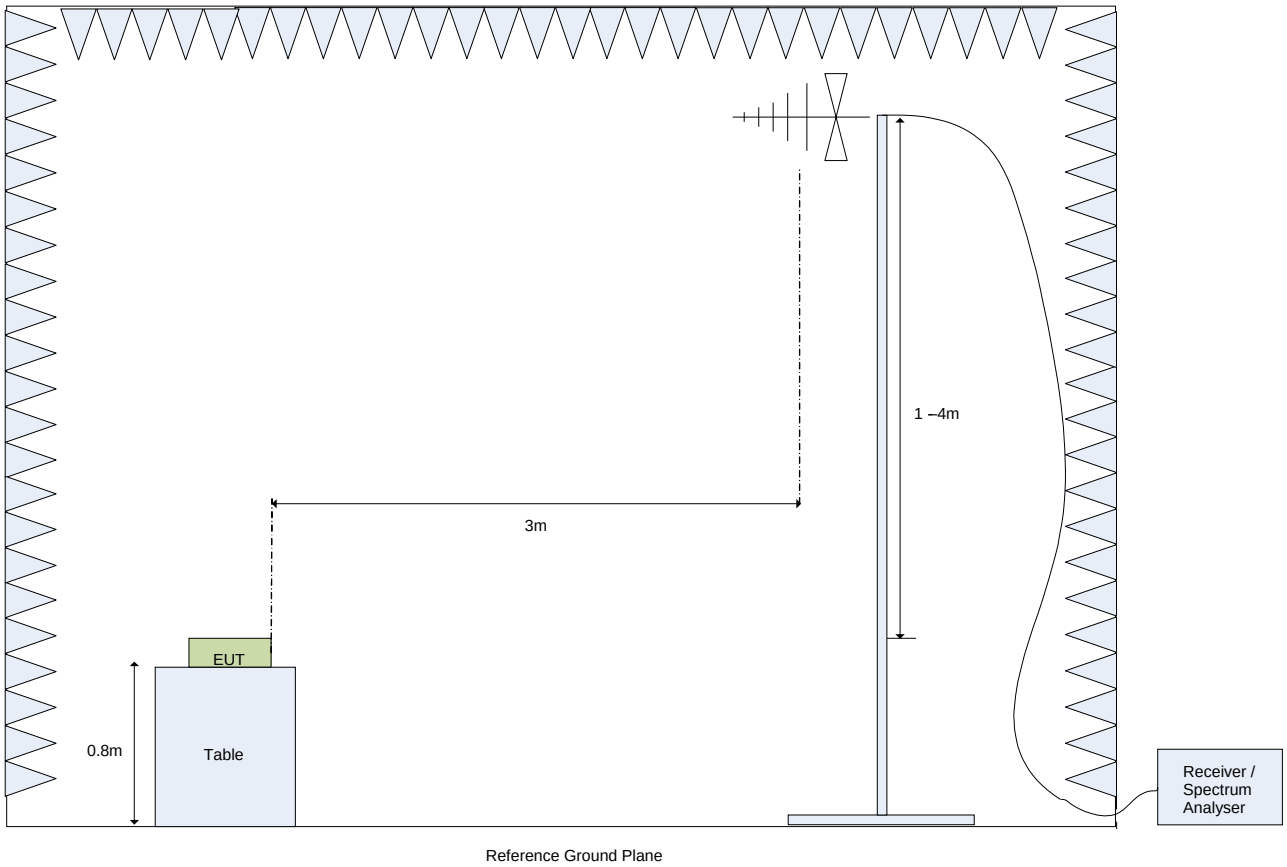

Figure 6.4.6.1: Test Setup for E-Field Measurements from 30MHz to 1GHz

Note 1 : With the EUT de-energized the ambient radio noise and signals met the 6dB peak detection requirement of ANSI C63.10-2013

Note 2 : There were no significant environmental temperature changes during the test duration and hence it was not considered necessary to consider any variation in cable loss.

6.4.7 Electric field emissions, 30MHz to 1GHz

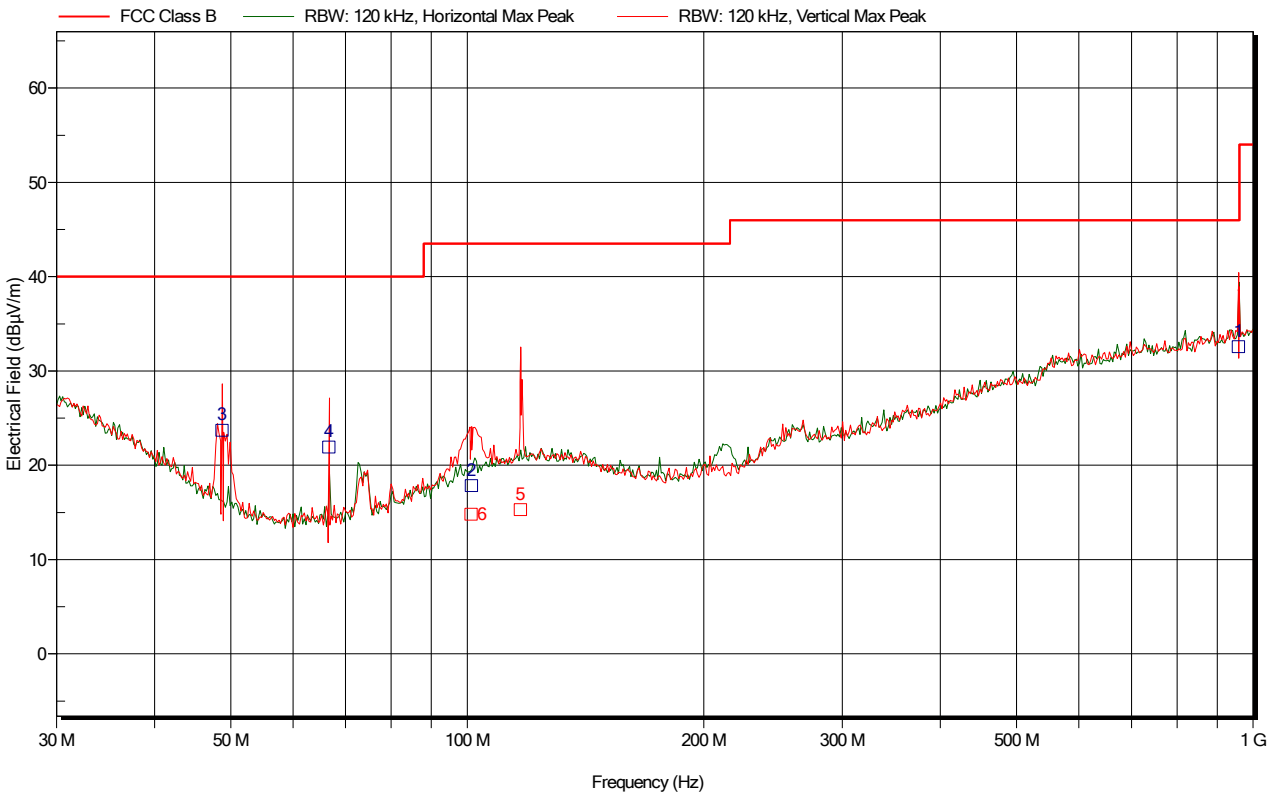

Figure 6.4.7.1: Electric field emissions Plot, 30MHz to 1GHz

Frequency MHz	Quasi-Peak dBµV/m	Quasi Peak Limit dBµV/m	Quasi-Peak Difference dB	Quasi-Peak Status	Angle degrees	Height m	Polarization
958.008	32.6	46.0	-13.4	Pass	200	2.0	Vertical
101.220	17.8	43.5	-25.7	Pass	75	1.0	Vertical
48.708	23.7	40.0	-16.3	Pass	24	2.5	Vertical
66.666	21.9	40.0	-18.1	Pass	220	1.5	Vertical
116.826	15.3	43.5	-28.2	Pass	34	1.4	Vertical
101.100	14.8	43.5	-28.7	Pass	180	1.0	Vertical

Table 6.4.7.1: Electric Field Emissions Peaks, 30MHz to 1GHz

6.4.8 Quasi Peak correction factors

The quasi peak correction is shown in the above table. This correction figure consists of Antenna factor (AF); and Cable loss (CL).

Field strength (FS) is calculated as follows:

FS (dBμV/m) = Indicated Signal Level (dBμV) + AF (dB) + CL (dB)

6.4.9 Sample Data

The Quasi-Peak level at 101.100MHz

Indicated signal level = SL(dBμV) = -2.8dBμV

+AF(dB/m) = 16.7dB/m

+CL= 0.9(dB)

= 14.8dBμV/m

Appendix A EUT Test Photos

Test set up photographs are supplied separately.

Appendix B Test Equipment List

Radiated Emissions 30MHz to 1GHz Equipment

Item	Serial No.	Last Calibration Date	Calibration Interval
Laboratory 1 Semi-Anechoic Chamber	Lab 1	20th January 2020	3 years
ETS Lindgren 2017B Mast (1 – 4m) with tilting mechanism	--	-	-
R & S ESR26	C0502	10th November 2021	12 Months
6dB Attenuator (For use with Bilog Antenna)	C0506B	15th July 2021	36 Months
Teseq CBL6112D Bilog Antenna	C0506	15th July 2021	36 Months
HF26 Cable	HF26	17th January 2022	12 Months
HF35 Cable	HF35	17th January 2022	12 Months
HF27 Cable	HF27	17th January 2022	12 Months
Schwarzbeck D-69250 Antenna 1-18GHz	C0626	23rd December 2021	24 Months

Radiated Emissions 9kHz to 30MHz Equipment

Item	Serial No.	Last Calibration Date	Calibration Interval
Laboratory 5 Fully-Anechoic Chamber	Lab 5	Not required	N/A
Schwarzbeck BBV 9745 preamplifier 9kHz – 2GHz	C0632	4th February 2021	15 months
ETS Lindgren 6512 loop antenna	B0921	21st February 2020	36 Months
RF cables	11, 12, 16 and HF13	10th January 2022	12 Months
Rohde & Schwarz ESW Test Receiver	C0658	15th November 2021	36 Months