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Global Product Certification
EMC-EMF Safety Approvals

RADIO TEST REPORT FOR CERTIFICATION
to
FCC PART 15 Subpart C (Section 15.247)

Test Sample:	Collison Avoidance System Node – Vehicle to Vehicle 920 MHz Transceiver Component
Model:	CAS-GPS NODE
Part Number:	PROD1052-LF2 (FCC ID: YIY-PROD10522)
Report Number:	M160206-2
Tested for:	GE Mining Industrea Mining Technology
Issue Date:	16 November 2016

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Contents

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Report Number:	M160206-2
FCC ID:	YIY-PROD10522
Contains FCC ID:	SIFNANOPAN5375V1
Contains FCC ID:	PVH0946
Test Sample:	Collison Avoidance System Node – Vehicle to Vehicle 920 MHz Transceiver Component
Model:	CAS-GPS NODE
Part Number:	PROD1052-LF2
Equipment Type:	Intentional Radiator (Transceiver)
Manufacturer:	GE Mining Industrea Mining Technology
Address:	3 Co-Wyn Close, Fountaindale, NSW, 2258, Australia
Phone:	+612 4336 1800
Contact:	Neil Mosley
Email:	neil.mosley@ge.com
Test Standards:	**FCC Part 15** – Radio Frequency Devices **FCC Part 15 Subpart C** – Intentional Radiators **Section 15.247** – Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz
Test Date:	5th, 8th and 14th March 2016

Test Engineer: Mahan Ghassempouri

Attestation: *I hereby certify that the device(s) described herein were tested as described in this report and that the data included is that which was obtained during such testing.*

Authorised Signatory: Chris Zombolas
Technical Director
EMC Technologies Pty Ltd

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RADIO TEST REPORT FOR CERTIFICATION
to
FCC PART 15 Subpart C (Section 15.247)

1.0 INTRODUCTION

Radio testing was performed on the Collision Avoidance System Node Model: CAS-GPS NODE.

Test results and procedures were performed in accordance with the following Federal Communications Commission (FCC) standards/regulations:

47 CFR, Part 15, Subpart C:	Rules for intentional radiators (particularly section 15.247)
Section 15.203:	Antenna requirements
Section 15.205:	Restricted bands of operation
Section 15.207:	Conducted Emission Limits
Section 15.209:	Radiated Emission Limits (General requirements)
Section 15.247:	Operation in the bands 902-928 MHz, 2400-2483.5 MHz, 5725-5850 MHz

The test sample **complied** with the requirements of 47 CFR, Part 15 Subpart C - Section 15.247.

The measurement procedure used was in accordance with ANSI C63.10-2013. **KDB 558074 v03r05** was used for guidance. The instrumentation conformed to the requirements of ANSI C63.2-2009.

1.1 Summary of Results

FCC Part 15 Subpart C	Test Performed	Results
15.203	Antenna requirement	Complied
15.205	Operation in restricted Band	Complied
15.207	Conducted emissions limits	N/A as the EUT was DC powered
15.209	Radiated emissions limits	Complied
15.247 (a)(2)	Minimum 6 dB Bandwidth	Complied
15.247 (b)(3)	Peak Output Power	Complied
15.247 (c)	Antenna Gain > 6 dBi	N/A as EUT uses integral antenna with less than 6 dBi gain with no external antenna connector
15.247 (d)	Out of Band Emissions	Complied
15.247 (e)	Peak Power Spectral Density	Complied
15.247 (f)	Hybrid Systems	N/A assessed to digital modulation requirements
15.247 (g)	Hopping channel application	N/A assessed to digital modulation requirements
15.247 (h)	Incorporation of intelligence within FHSS	N/A assessed to digital modulation requirements
15.247 (i)	Radio Frequency Hazard	Complied

N/A: Not Applicable

1.2 Modifications by EMC Technologies

No modifications were required to achieve compliance.

2.0 GENERAL INFORMATION

(Information supplied by the Client)

2.1 EUT (Transmitter) Details

The RF transmitter was a Short Range Device (SRD) operating in 920 MHz band used for Vehicle to Vehicle (V2V) communication. It employed a PCB antenna. A temporary SMA connector was mounted on the device to provide a means for measuring conducted output power. Transmitter specifications are shown in below table.

Test Sample:	Collison Avoidance System
Model Number:	CAS-GPS NODE
DC Supply Port Voltage Rating:	12 to 24 VDC (Nominal),
Operating Frequency Range:	902 MHz to 928 MHz Single Channel at 920 MHz
Nominal Output Power:	20 dBm
Number of Channels:	1
99% Bandwidth:	1.09 MHz
Maximum Gain of Antenna Assembly:	3.32 dBi
Operating Temperature Range:	-20 °C to 55 °C

2.2 EUT (Host) Details

The CAS-GPS NODE is a smart antenna used as a location and interaction beacon feeding a host device via the various available communication busses. The Node is designed for mobile use as a part of GE's range of Collision Awareness System (CAS) components.

2.3 Test Procedure

Radio measurements were performed in accordance with the procedures of ANSI C63.10-2013. KDB 558074 v03r05- *Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.*247 was used to demonstrate compliance with FCC part 47CFR15.247.

2.4 Test Facility

2.4.1 General

Measurements were performed at EMC Technologies' laboratory in Keilor Park, Victoria Australia. EMC Technologies Pty Ltd is listed by the FCC as a test laboratory able to perform compliance testing for the public. EMC Technologies is listed as an FCC part 47CFR2.948 test lab and may perform the testing required under Parts 15 and 18 – **FCC Registration Number 90560**

EMC Technologies Pty Ltd has also been accredited as a Conformity Assessment Body (CAB) by Australian Communications and Media Authority (ACMA) under the APECTEL MRA and is designated to perform compliance testing on equipment subject to Declaration of Conformity (DoC) and Certification under Parts 15 & 18 of the FCC Commission's rules – **Registration Number 494713 & FCC Designation number AU0001.**

EMC Technologies' indoor open are test site (iOATS) has been accepted by Industry Canada for the performance of radiated measurements in accordance with RSS-Gen Issue 8 - **Industry Canada iOATS number - IC 3569B**

2.4.2 NATA Accreditation

NATA is the Australian National laboratory accreditation body and has accredited EMC Technologies to operate to the IEC/ISO17025 requirements. A major requirement for accreditation is the assessment of the company and its personnel as being technically competent in testing to the standards. This requires fully documented test procedures, continued calibration of all equipment to the National Standard at the National Measurements Institute (NMI), NPL (UK), NIST (USA) and an internal quality system to ISO 9002. NATA has mutual recognition agreements with the National Voluntary Laboratory Accreditation Program (NVLAP) and the American Association for Laboratory Accreditation (A^2LA).

EMC Technologies is accredited in Australia by the National Association of Testing Authorities (NATA). All testing in this report has been conducted in accordance with EMC Technologies' scope of NATA accreditation.

The current full scope of accreditation can be found on the NATA website: www.nata.asn.au

It also includes a large number of emissions, immunity, SAR, EMR and Safety standards.

2.5 Test Equipment Calibration

Measurement instrumentation and transducers were calibrated in accordance with the applicable standards by an independent NATA registered laboratory such as Agilent Technologies (Australia) Pty Ltd, Rohde and Schwarz, NMI, NPL or NIST. All equipment calibration is traceable to Australia national standards at the National Measurements Institute. The reference antenna calibration was performed by NPL and the working antennas (BiLog and horn) calibrated by EMC Technologies. The complete list of test equipment used for the measurements, including calibration dates and traceability is contained in Appendix A

FCC PART 15 Subpart C (Section 15.247)

3.0 ANTENNA REQUIREMENT (§15.203)

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

EUT uses a permanently attached PCB antenna therefore considered sufficient to comply with the provisions of this section. There is no external antenna connector available to the user.

4.0 CONDUCTED EMISSIONS (§15.207)

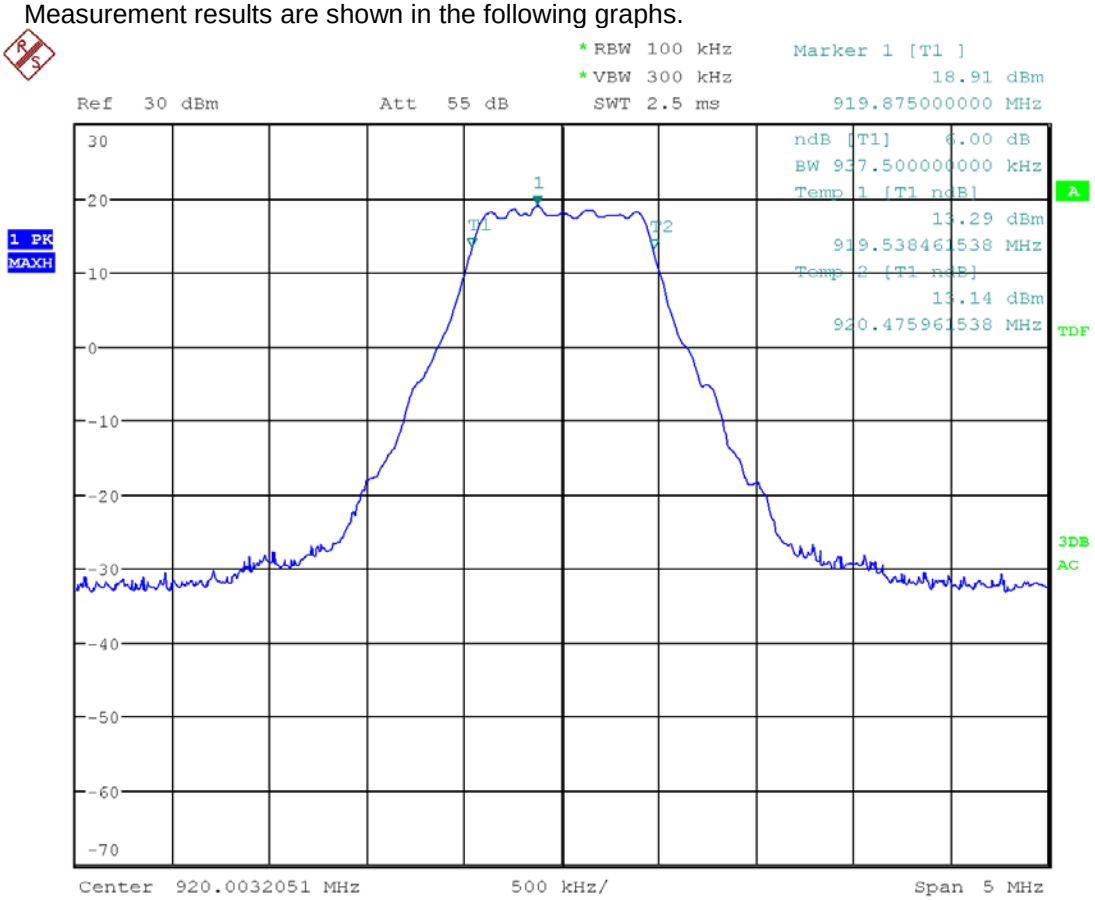
Not applicable as the EUT only employs DC power for operation and does not operate from an AC power network, directly or indirectly.

5.0 DTS 6 dB BANDWIDTH (§15.247 (a)(2))

Minimum 6 dB bandwidth shall be at least 500 kHz. Care was taken so that the bandwidth measurement was not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 dB.

5.1. Results

Measurement results are shown in the following graphs.



Modulation	6 dB Bandwidth (kHz)	Limit (kHz)	Result
DTS	937.50	> 500	Pass

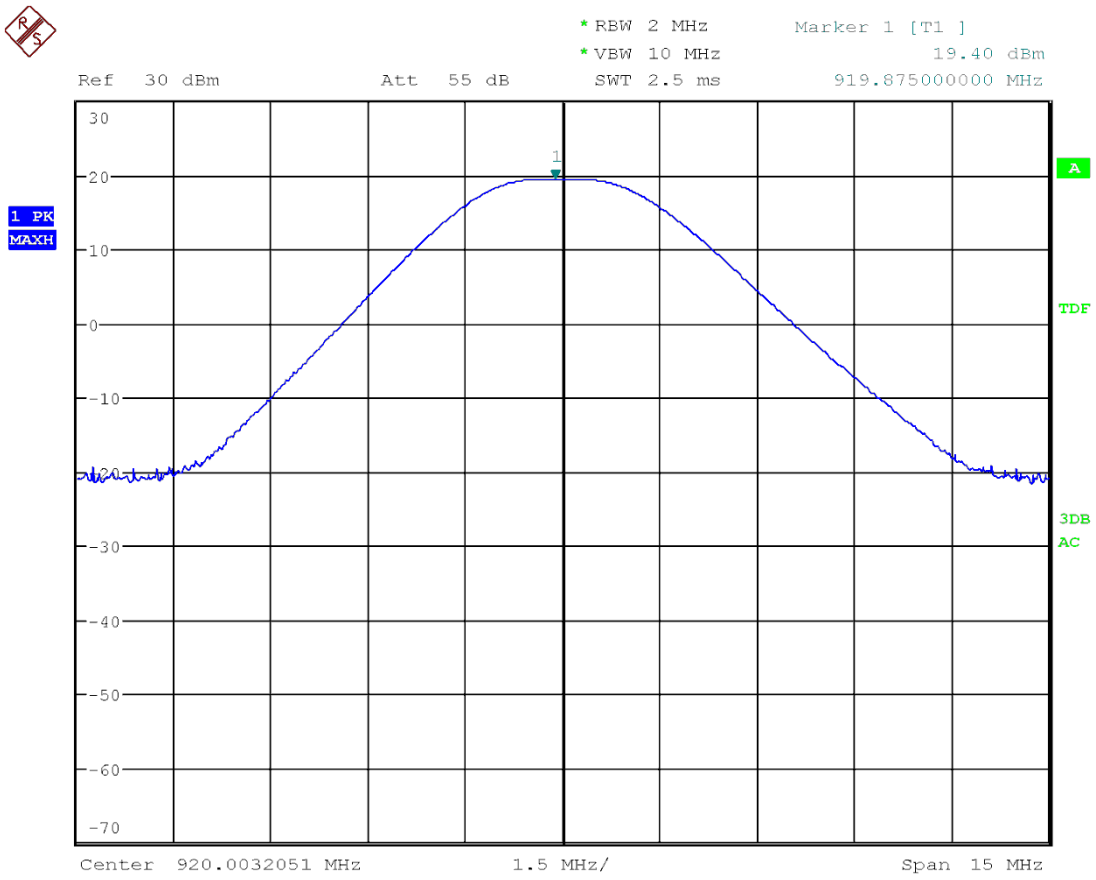
Graph 1: 6 dB bandwidth

6.0 PEAK OUTPUT POWER (§15.247 (b)(3))

As there was a temporary antenna connector available on the PCB the test was performed using conducted measurement. Maximum peak conducted power method (clause 9.1.1 of KDB 558074 v03r05) was used for measurement. Cable loss between connector and spectrum analyser were accounted for in reading.

6.1. Results

Measurement results are shown in the following graphs.



Conducted Power (dBm)	Limit (dBm)	Margin (dB)	Result
19.40	30	-10.6	Pass

Graph 2: Conducted power, low channel

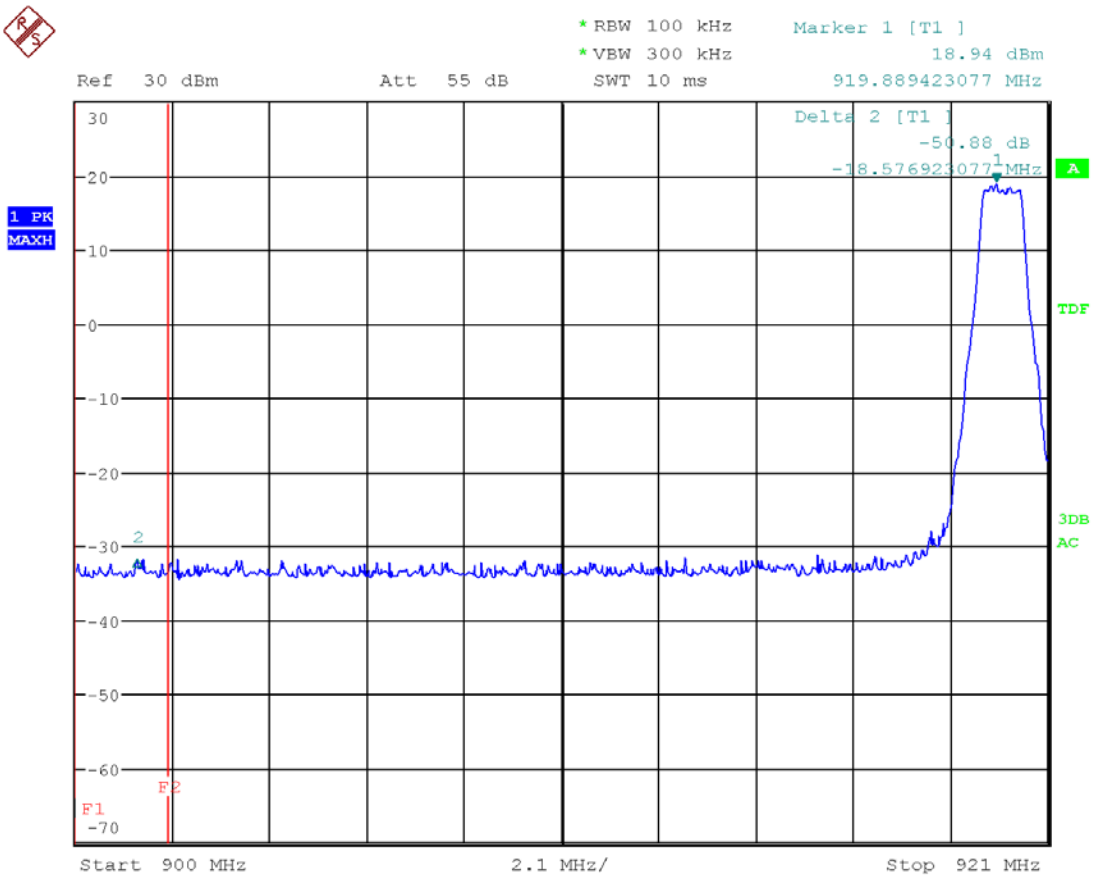
7.0 BAND-EDGE EMISSION MEASUREMENTS

Emissions within 2 MHz of an authorized band edge were measured using the marker-delta method. The in-band emission of section 6.0 was used while applying marker-delta method. Emissions were measured using conducted method.

7.1. Results

All emissions above and below the edge of the authorised band were more than 20 dB below the in band intentional emission.

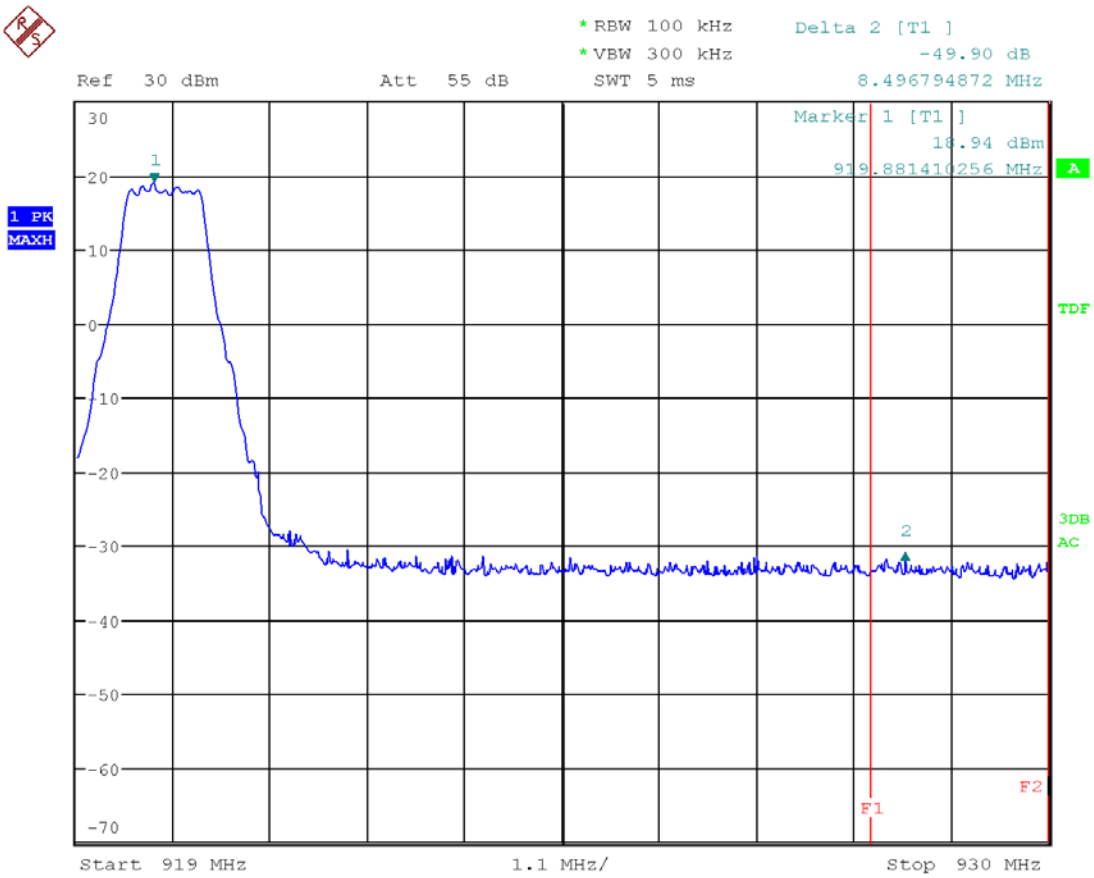
Measurement results are shown in the following graphs.



Vertical marker F1 and F2 were positioned at 900 MHz and 902 MHz respectively. Marker 1 shows the peak in band emission and marker 2 shows the peak band edge emission.

In Band Emission (dBm)	Delta (dB)	Band Edge Emission (dBm)	Limit (dBm)	Margin (dB)	Result
19.40	50.88	-31.48	-0.60	-30.88	Pass

Graph 3: Lower band-edge emissions



Vertical marker F1 and F2 were positioned at 928 MHz and 930 MHz respectively. Marker 1 shows the peak in band emission and marker 2 shows the peak band edge emission.

In Band Emission (dBm)	Delta (dB)	Band Edge Emission (dBm)	Limit (dBm)	Margin (dB)	Result
19.40	-49.90	-30.50	-0.60	-29.90	Pass

Graph 4: Upper band-edge emissions

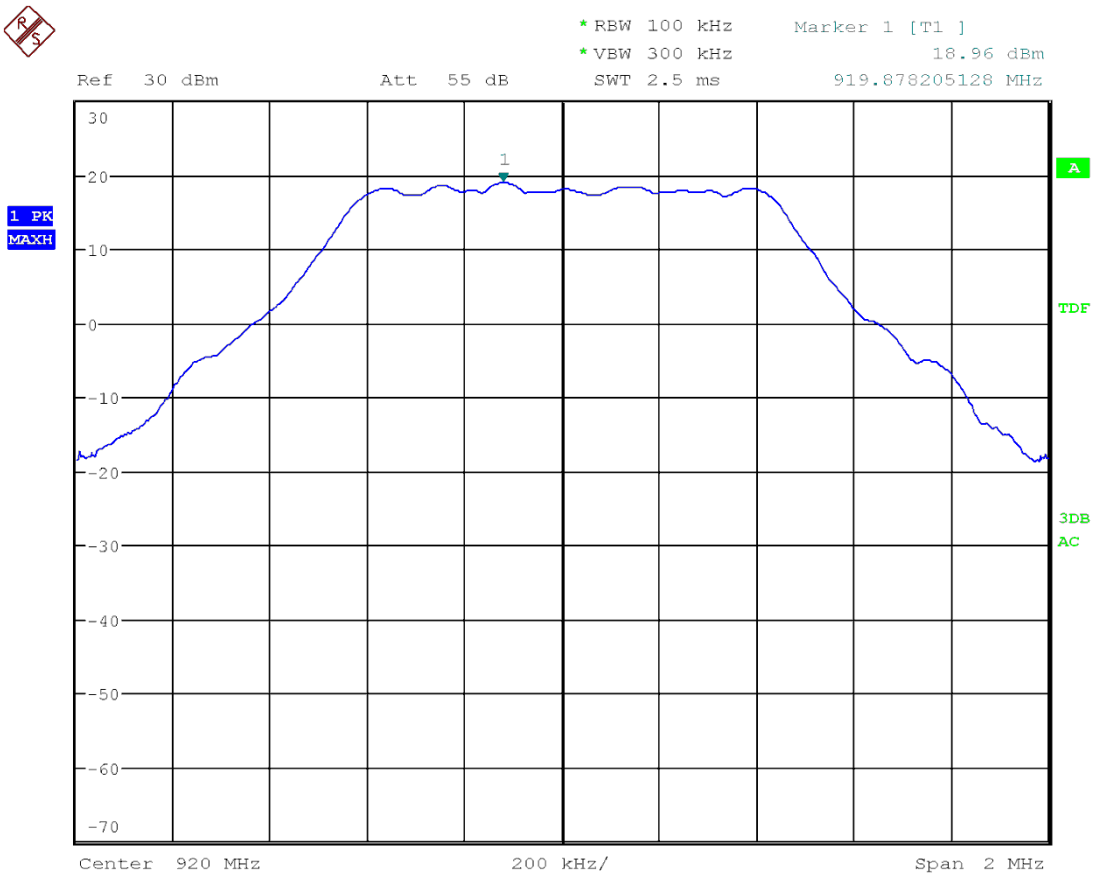
All emissions were more than 20 dB below the maximum in-band emission.

8.0 SPURIOUS EMISSION MEASUREMENTS (§15.247 (d))

8.1. Emission in non-restricted bands

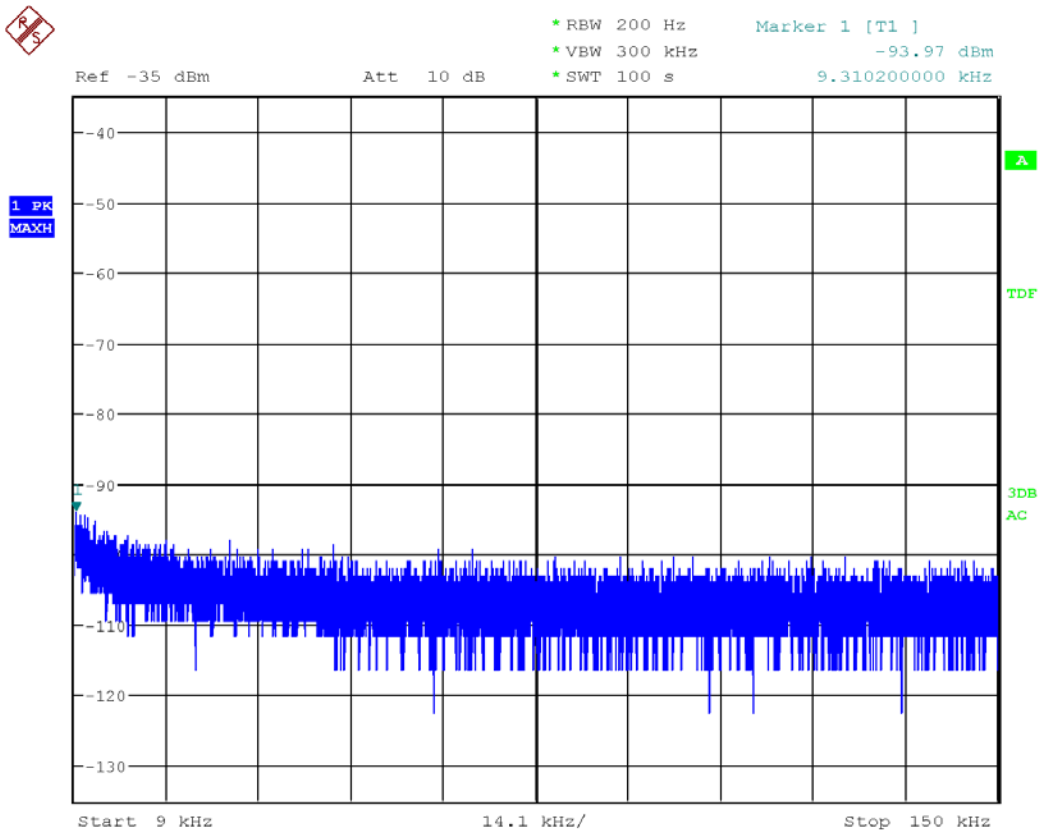
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power. Conducted method was used according to clause 11 of KDB 558074 D01.

8.1.1. Results

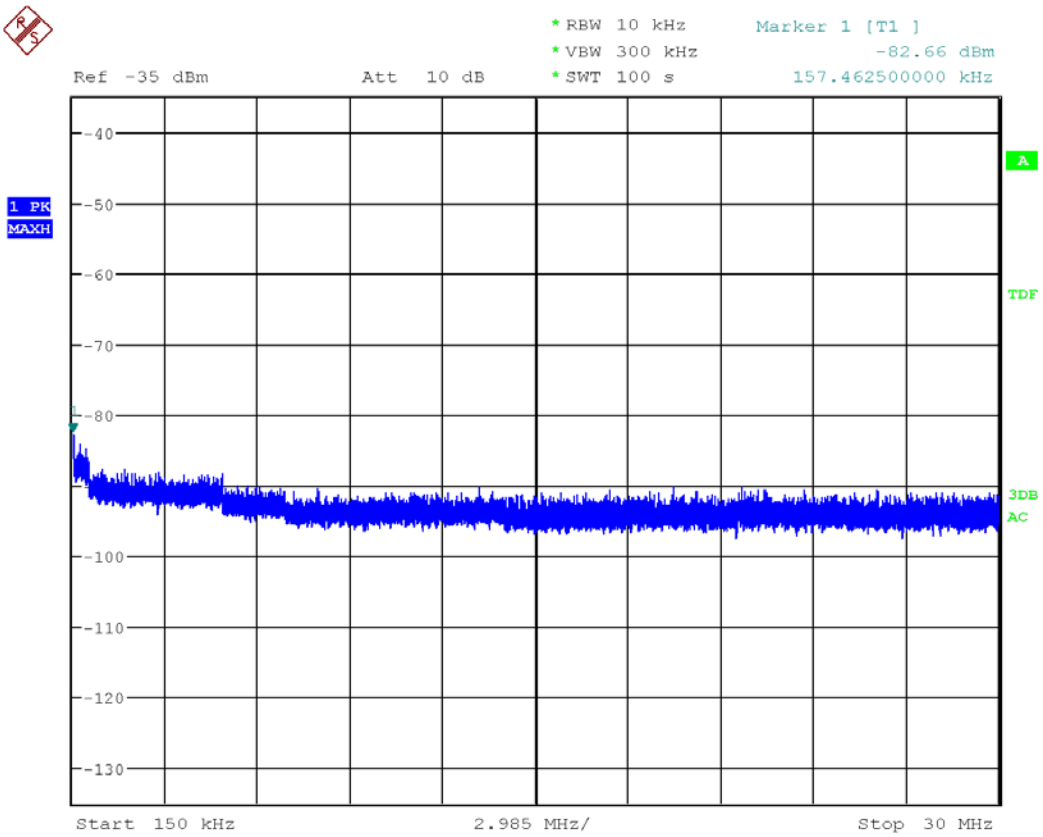


Peak	Frequency (MHz)	SA Reading (dBm)	Limit (dBm)
1	919.88	18.96	-1.04

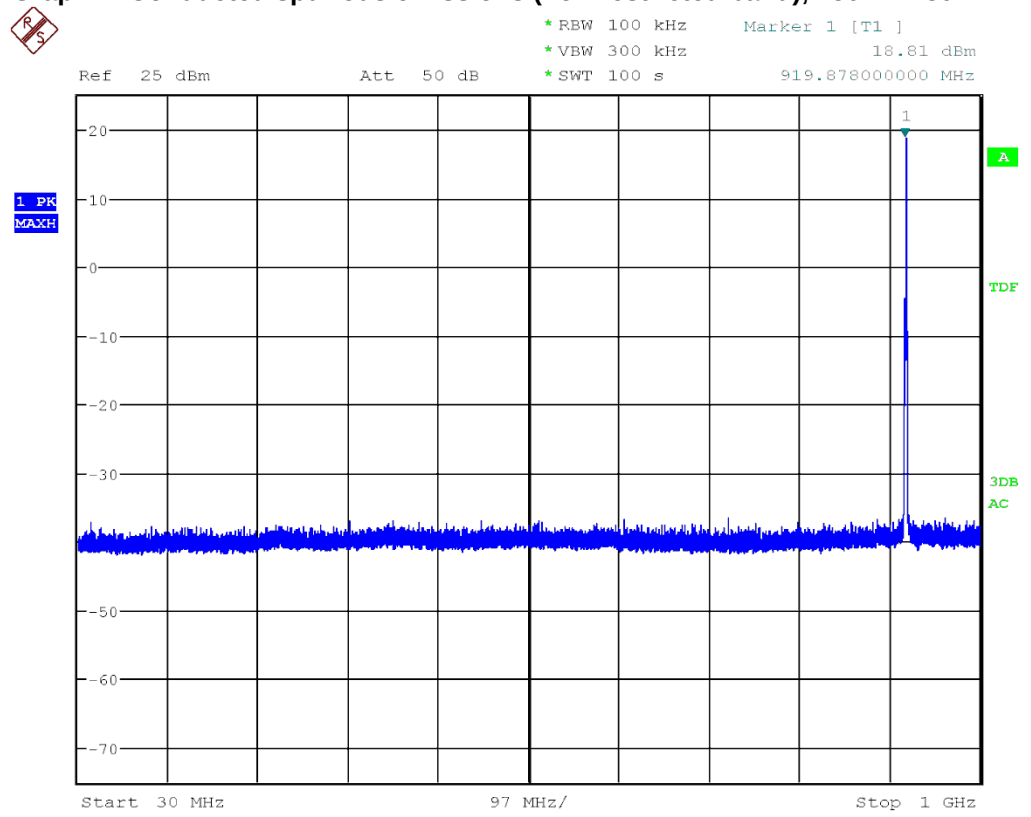
Graph 5: Reference level measurement (in band emission)



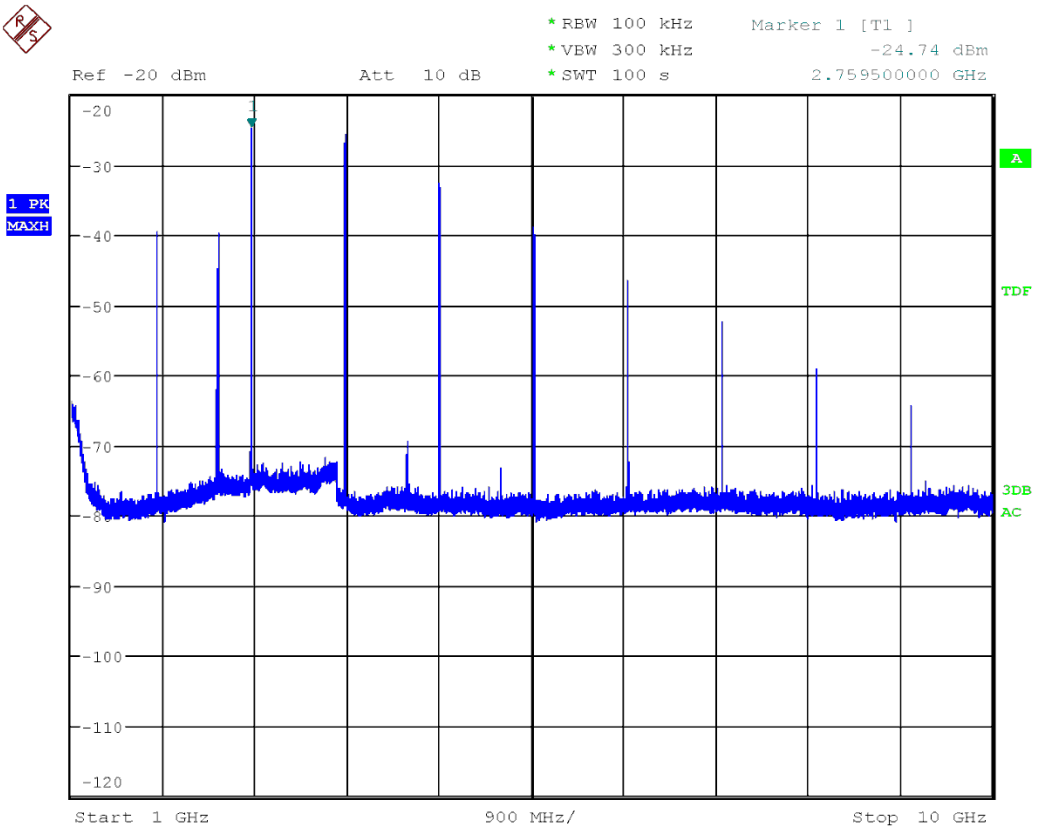
Graph 6: Conducted spurious emissions (non-restricted band), 9 kHz-150 kHz



Graph 7: Conducted spurious emissions (non-restricted band), 150 kHz-30 MHz



Graph 8: Conducted spurious emissions (non-restricted band), 30 MHz-1 GHz



Graph 9: Conducted spurious emissions (non-restricted band), 1 GHz-10 GHz

All emissions were more than 20 dB below the maximum in-band emission.

8.2. Emission in restricted bands (radiated)

In order to ensure the compliance to the requirements of emission in restricted bands, radiated measurements were performed. Frequency range of 9 kHz to 10 GHz was investigated for any emissions falling in restricted frequency bands. Provisions of FCC 15.35 were observed selecting the detector and bandwidth. Limits of FCC 15.209 were applied.

The EUT was placed 0.8 m and 1.5 m above the floor during the test for frequency range of below 1 GHz and above 1 GHz respectively. The EUT was checked in three orthogonal planes to determine maximum emission, only the worst case is reproduced for the report.

Radiated EMI tests were performed inside a compliant CISPR16-1-4 semi-anechoic chamber for a 2m x 2m x 2m test volume up to 18 GHz, at a test distance of 10, 3 and 1 metres. The EUT was set up on the table top (placed on turntable). The test frequency range was sub-divided into smaller bands with sufficient frequency resolution to permit reliable display and identification of possible EMI peaks while also permitting fast frequency scan times. A calibrated loop antenna was used for measurements between 9 kHz and 30 MHz. A calibrated Biconilog antenna was used for measurements between 30 MHz and 1000 MHz. Calibrated horn antenna were used for measurements between 1 to 10 GHz.

The measurement of emissions between 30 - 1000 MHz was measured with the resolution bandwidth of 120 kHz and the video bandwidth of 300 kHz.

The measurement of emissions above 1000 MHz was measured using a following setting:
Peak measurements setting: RBW = VBW = 1 MHz
Average measurements setting: RBW = 1 MHz and VBW = 10 Hz

The receiver bandwidth was set to 6 dB.

The EUT was slowly rotated with the Peak Detector set to Max-Hold. This was performed for two antenna heights. When an emission was located, it was positively identified and its maximum level found by rotating the automated turntable and by varying the antenna height. The procedure was repeated with the device orientated in three orthogonal axis to further maximise the emission.

Each significant peak was investigated with the Quasi-peak, Peak or Average Detectors as appropriate. The measurement data for each frequency range was corrected for cable losses, antenna factors and preamplifier gain. This process was performed for both horizontal and vertical antenna polarisations.

The field strength was calculated automatically by the software using all the pre-stored calibration data. The method of calculation is shown below:

E = V + AF - G + L
Where:

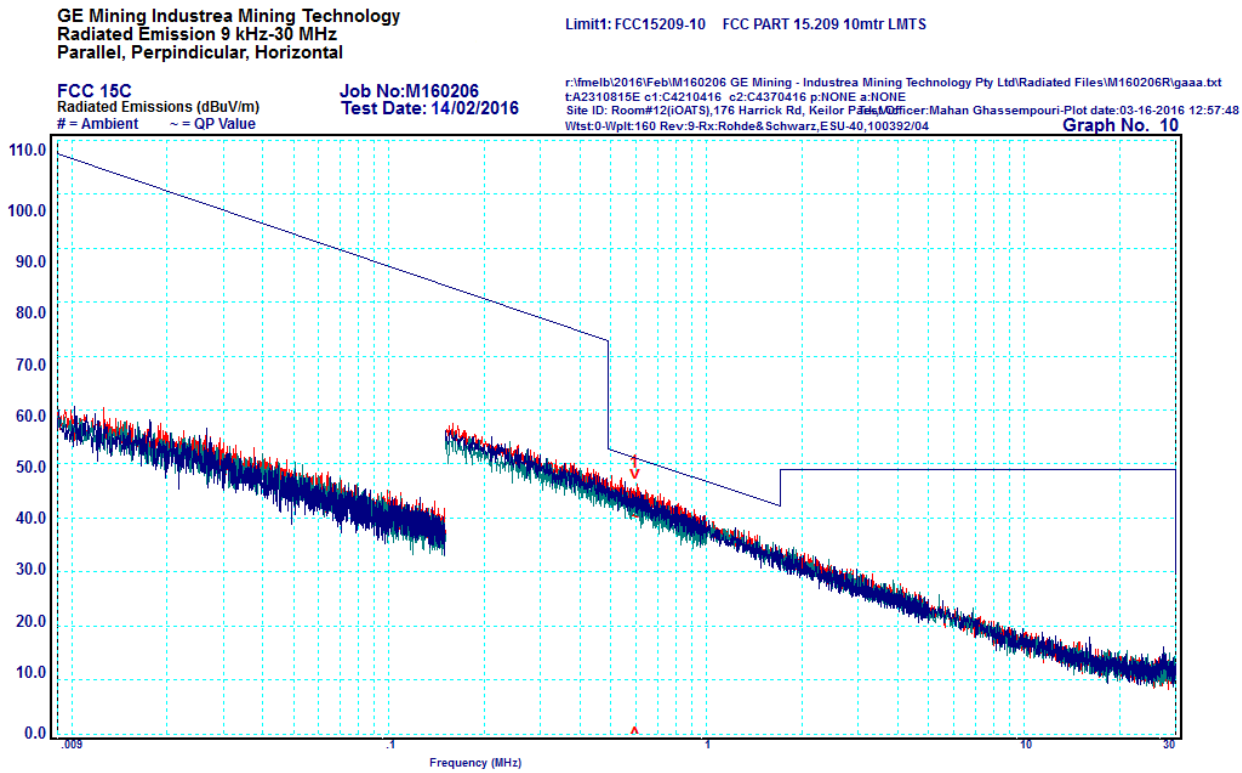
E	=	Radiated Field Strength in dBµV/m.
V	=	EMI Receiver Voltage in dBµV. (measured value)
AF	=	Antenna Factor in dB. (stored as a data array)
G	=	Preamplifier Gain in dB. (stored as a data array)
L	=	Cable loss in dB. (stored as a data array of Insertion Loss versus frequency)

- **Example Field Strength Calculation**

Assuming a receiver reading of 34.0 dBµV is obtained at 90 MHz, the Antenna Factor at that frequency is 9.2 dB (1/m). The cable loss is 1.9 dB while the preamplifier gain is 20 dB. The resulting Field Strength is therefore as follows:

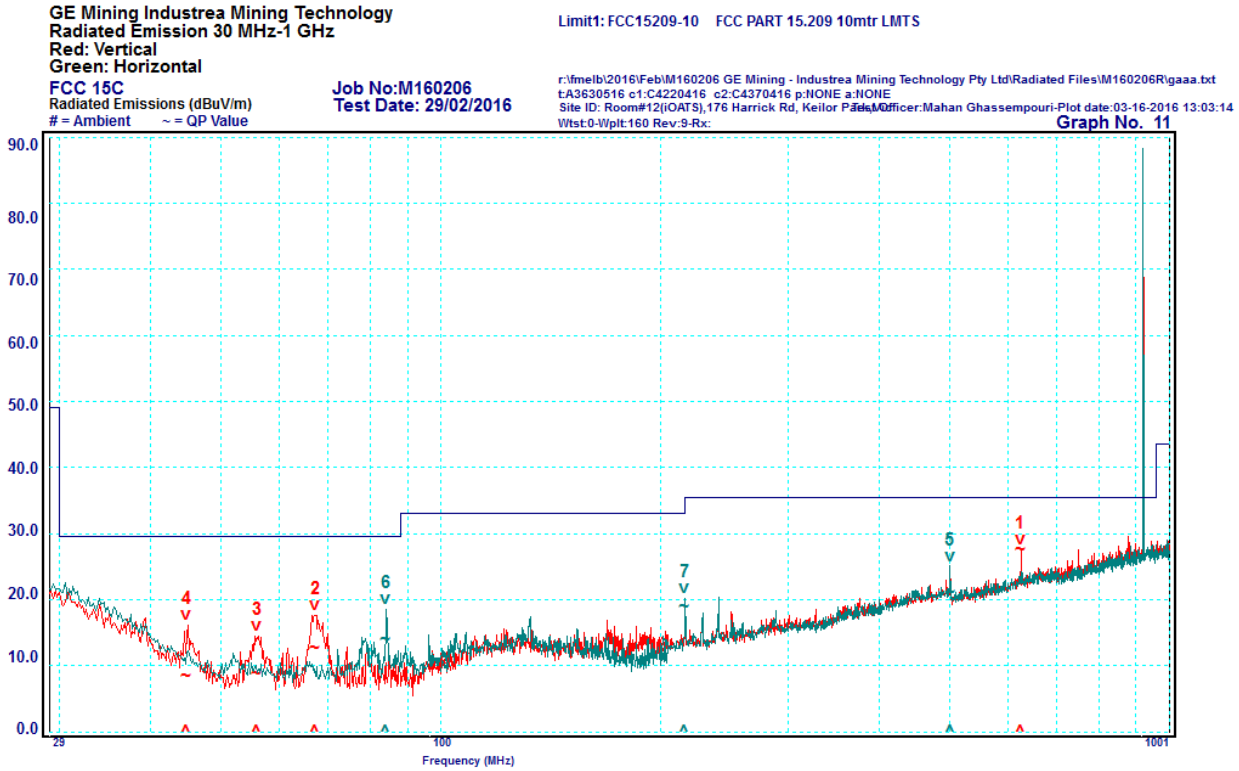
34.0 + 9.2 + 1.9 - 20 = 25.1 dBµV/m

8.2.1. Results



Graph 10: 9 kHz-150 kHz, radiated emissions in restricted bands

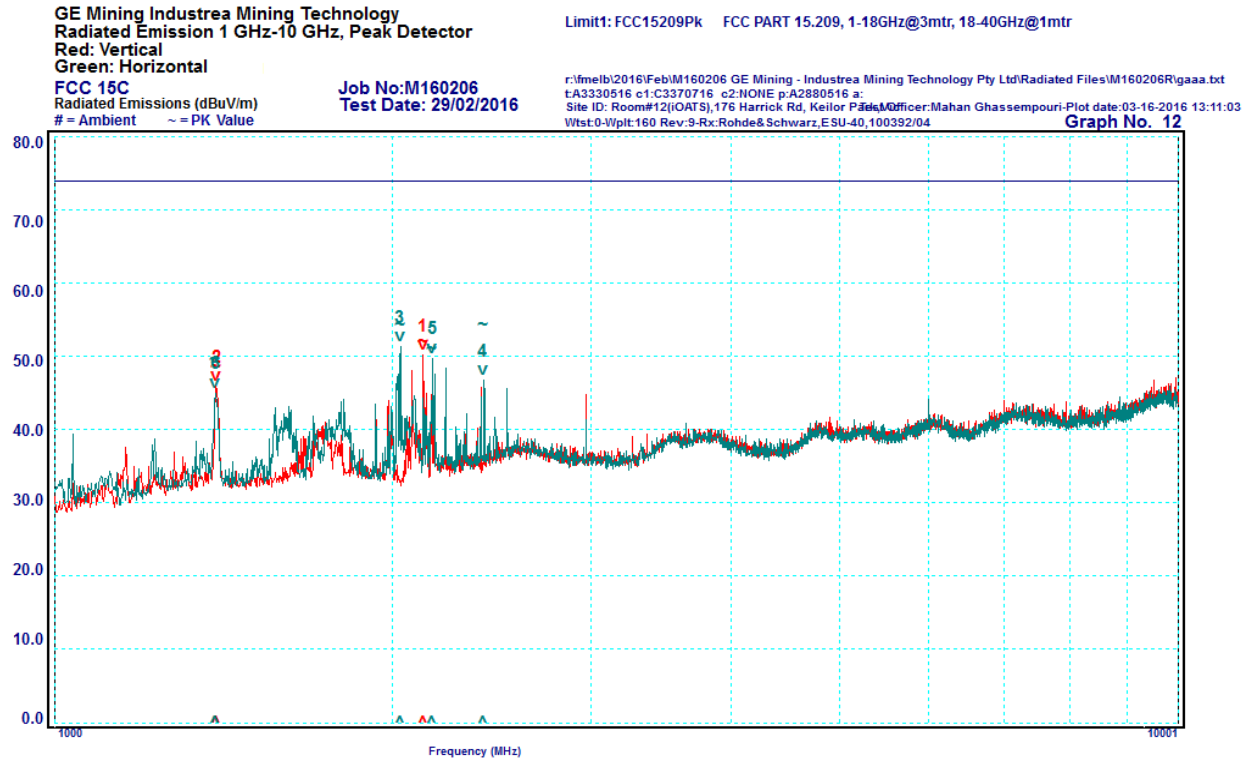
No emissions were detected above noise floor



Peak	Frequency (MHz)	Polarisation	Measured QP Level (dBµV/m)	QP Limit (dBµV/m)	ΔPeak ±dB
1	625.09	Vertical	27.50	35.5	-8.0
2	67.23	Vertical	12.70	29.5	-16.8
3	55.95	Vertical	8.70	29.5	-20.8
4	44.79	Vertical	8.30	29.5	-21.2
5	500.07	Horizontal	12.10	35.5	-14.4
6	83.99	Horizontal	13.90	29.5	-15.6
7	216.07	Horizontal	19.00	29.5	-16.5

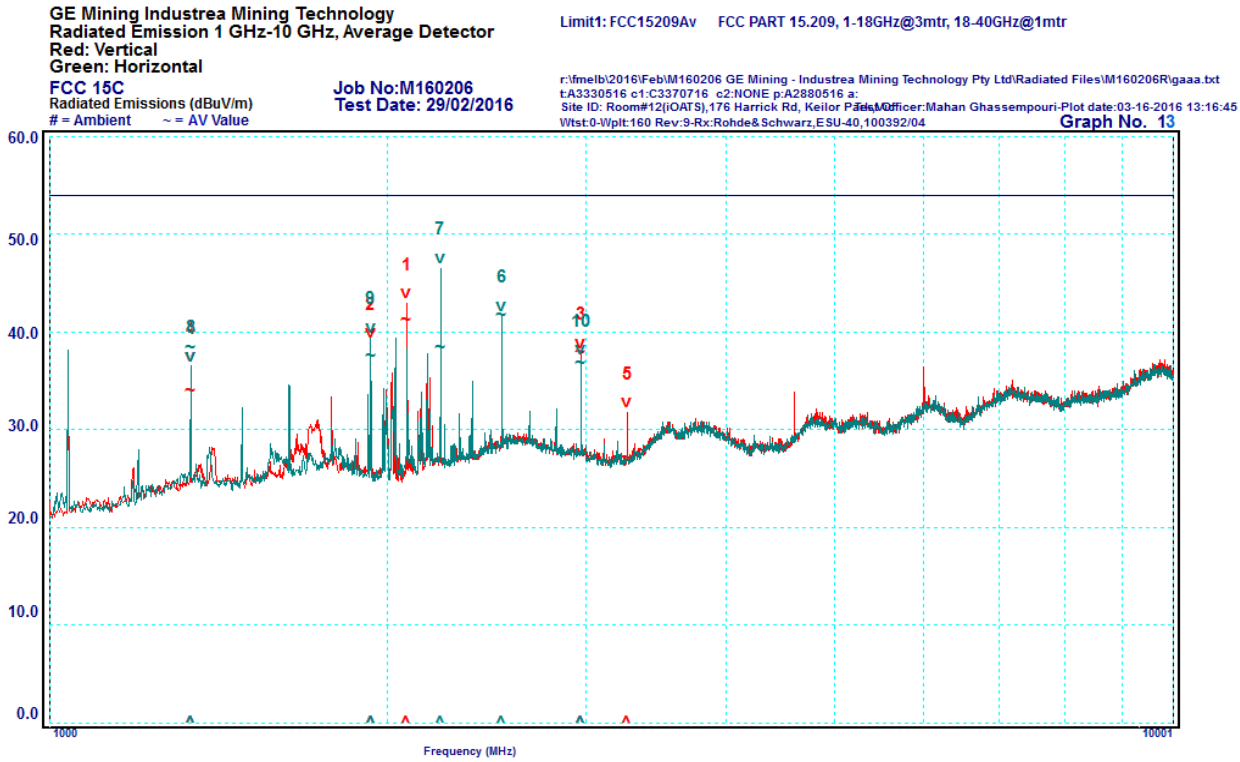
Note: Intentional radiation is excluded from measurement

Graph 11: 30 MHz – 1 GHz, radiated emissions in restricted bands



Peak	Frequency (MHz)	Polarisation	Measured Peak Level (dBµV/m)	Peak Limit (dBµV/m)	ΔPeak ±dB
1	2128.43	Vertical	52.00	74.0	-22.0
2	1394.10	Vertical	48.60	74.0	-25.4
3	2029.48	Horizontal	54.30	74.0	-19.7
4	2407.00	Horizontal	54.30	74.0	-19.7
5	2168.09	Horizontal	50.90	74.0	-23.1
6	1391.50	Horizontal	49.50	74.0	-24.5

Graph 12: 1 GHz – 10 GHz, radiated emissions in restricted bands, peak detector



Peak	Frequency (MHz)	Polarisation	Measured Average Level (dBµV/m)	Average Limit (dBµV/m)	ΔAverage ±dB
1	2078.96	Vertical	41.20	54	-12.8
2	1930.49	Vertical	40.00	54	-14.0
3	2970.03	Vertical	37.90	54	-16.1
4	1336.44	Vertical	33.90	54	-20.1
5	3267.05	Vertical	27.10	54	-26.9
6	2524.46	Horizontal	41.70	54	-12.3
7	2227.50	Horizontal	38.30	54	-15.7
8	1336.57	Horizontal	38.30	54	-15.7
9	1930.48	Horizontal	37.60	54	-16.4
10	2969.92	Horizontal	36.80	54	-17.2

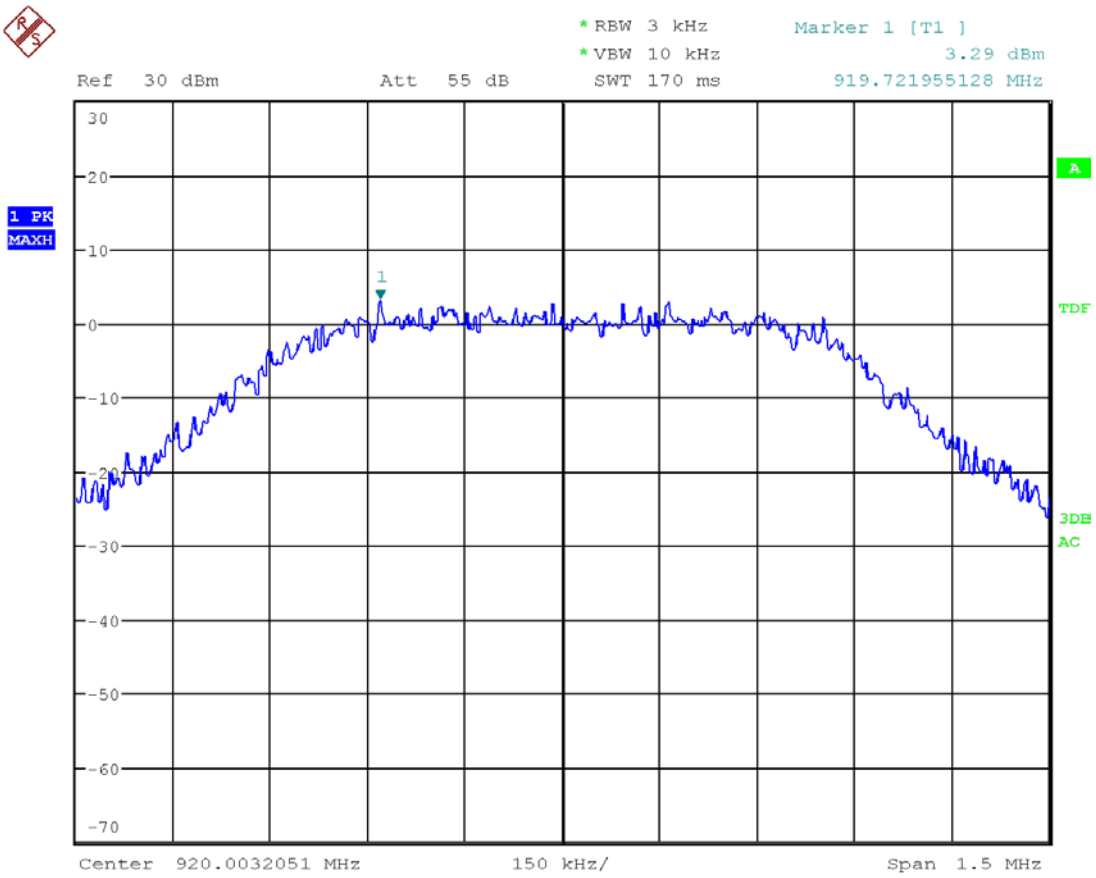
Graph 13: 1 GHz – 10 GHz, radiated emissions in restricted bands, average detector

9.0 POWER SPECTRAL DENSITY (§15.247 (d))

The PKPSD method according to KDB 558074 was used to demonstrate compliance.

9.1. Results

Measurement results are shown in the following graphs.



Peak PSD (dBm/3 kHz)	Limit (dBm)	Margin (dB)	Result
3.29	8	-4.71	Pass

Graph 14: Transmitter peak power spectral density

10.0 RADIO FREQUENCY EXPOSURE (HAZARD) (§15.247 (i))

The EUT complies with FCC requirements for human exposure. Refer to EMC Technologies test report No. M160206-3.

11.0 COMPLIANCE STATEMENT

GE Mining Collision Avoidance System, Model: CAS-GPS NODE tested on behalf of GE Mining Industrea Mining Technology, **complied** with the requirements of 47 CFR, Part 15 Subpart C - Rules for Radio Frequency Devices (intentional radiators), Section 15.247 - Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.

Summary of results are shown in below table:

FCC Part 15 Subpart C	Test Performed	Results
15.203	Antenna requirement	Complied
15.205	Operation in restricted Band	Complied
15.207	Conducted emissions limits	N/A as the EUT is DC powered
15.209	Radiated emissions limits	Complied
15.247 (a)(2)	Minimum 6 dB bandwidth	Complied
15.247 (b)(3)	Peak output power	Complied
15.247 (c)	Antenna gain > 6 dBi	N/A as the EUT uses integral antenna with less than 6 dBi gain and there is no external antenna connector
15.247 (d)	Out of band emissions	Complied
15.247 (e)	Peak power spectral density	Complied
15.247 (f)	Hybrid systems	N/A as the EUT uses digital modulation
15.247 (g)	Hopping channel application	N/A as the EUT uses digital modulation
15.247 (h)	Incorporation of intelligence within FHSS	N/A as the EUT uses digital modulation
15.247 (i)	Radio Frequency Hazard	Complied

12.0 UNCERTAINTY

EMC Technologies has evaluated the equipment and the methods used to perform the emissions testing. The estimated measurement uncertainty for emissions tests shown within this report are as follows:

Conducted Emissions:	9 kHz to 30 MHz	±3.2 dB
Radiated Emissions:	9 kHz to 30 MHz	±4.1 dB
	30 MHz to 300 MHz	±5.1 dB
	300 MHz to 1000 MHz	±4.7 dB
	1 GHz to 18 GHz	±4.6 dB
	18 GHz to 26 GHz	±5.1 dB
Peak Output Power:		±1.5 dB
Peak Power Spectral Density:		±1.5 dB

The above expanded uncertainties are based on standard uncertainties multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

APPENDIX A

MEASUREMENT INSTRUMENT DETAILS

Equipment Type	Make/Model/Serial Number	Last Cal. dd/mm/yy	Due Date dd/mm/yy	Cal. Interval
Chamber	Frankonia SAC-10-2 (R-139)	10/01/2016	10/01/2017	1 Year, *1
EMI Receiver	R&S ESU40 20 Hz – 40 GHz Sn: 100392 (R-140)	19/11/2015	19/11/2016	1 Year, *2
	R&S ESU40 20 Hz – 40 GHz Sn: 100182 (R-037)	18/02/2016	18/02/2017	1 Year, *2
	HP 8546A Sn: 3520A00249 & 3448A00287 (R-017)	10/11/2015	10/11/2016	1 YEAR *2
Antennas	SUNOL JB6 BICONILOG 30 – 6000 MHz Sn. A012312 (A-363)	16/05/2014	16/05/2016	2 Year, *2
	EMCO 3115 Broadband Horn 1 – 18 GHz Sn. 8908-3282 (A-004)	09/05/2013	09/05/2016	3 Year, *1
	AH-118 Com-Power Horn Antenna 1 – 18 GHz Sn. 71168	19/05/2013	19/05/2016	3 Year, *1
	EMCO 6502 Active Loop Antenna 20 Hz – 30 MHz Sn. 9311-2801	20/07/2015	20/07/2018	3 Year, *1

Note *1. Internal NATA calibration.
Note *2. External NATA / A2LA calibration