COLLISION PREVENTION SYSTEMS EMI/EMC AMBIENT MEASUREMENTS – GENERAL FINDINGS AND RECOMMENDATIONS

INDUSTRY ALIGNMENT ON TMM REGULATIONS: SPECIAL PROJECT OF THE MINERALS COUNCIL SOUTH AFRICA

REV 1.0

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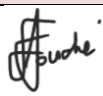
Anica Fouche	ITC Services		05/11/2025

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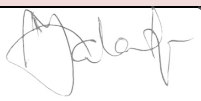
Stanford Malatji	Minerals Council		17/12/2025

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REV	**DATE**	**AUTHOR**	**PAGES AFFECTED**	**CHANGE PROPOSAL**
0.5	26/06/2025	A Fouche	All	Initial Draft Report
0.6	11/07/2025	A Fouche	9-10	Added results for surface coal mine
1.0	05/11/2025	A Fouche	5; 12	Amended margins and spelling

CLIENT INFORMATION	
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Acronyms and Abbreviations

Table 1: Acronyms and Abbreviations

ACRONYMS AND ABBREVIATIONS	
CAS	Collision Avoidance Systems
CPS	Collision Prevention Systems
DMPR	Department of Mineral and Petroleum Resources
DSRC	Dedicated Short-Range Communications
EIRP	Effective Isotropic Radiated Power
EMESRT	Earth Moving Equipment Safety Round Table
EMI	Electromagnetic Interference
ESA	Electronic Subassembly
EUT	Equipment Under Test
FAR	Full Anechoic Room
GPS	Global Positioning System
GSM	Global System for Mobile Communication
ICASA	Independent Communications Authority of South Africa
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
ISM	Industrial, Scientific, Medical
ISO	International Organization for Standardization
ITU	International Telecommunications Union
LHD	Load, haul, dump machine
OEM	Original Equipment Manufacturer
PAT	Personal Alarm Tag
PDS	Proximity Detection Systems
RF	Radio Frequency
RFI	Radio Frequency Interference
RFID	Radio Frequency Identification
SAC	Semi-Anechoic Chamber
TMMs	Trackless Mobile Machines
UHF	Ultra-High Frequency
V2X	Vehicle-to-Anything
VLF	Very Low Frequency

Referenced and Applicable Documents

Referenced and Applicable Documents	
[1]	ISO 17025 General requirements for the competence of testing and calibration laboratories
[2]	WP8068_4/23, Collision Prevention System EMI/EMC Test Methodology
[3]	Mine Health and Safety Act No. 29 of 1996
[4]	Government Gazette Vol.690 No. 47790 – 21 December 2022 – *Commencement of the Regulations Relating to Trackless Mobile Machinery.*
[5]	ICASA. *National Radio Frequency Plan 2021.* No.46088
[6]	Government Gazette Vol.597 No. 38641 – 30 March 2015 – *The Radio Frequency Spectrum Regulations 2015*
[7]	Government Gazette vol. 490 Cape Town 18 April 2006 No. 36 of 2005: Electronic Communications act, 2005.
[8]	MS-02-2010: *Control over the use of radio transmitter frequencies and radiated power transmitted by equipment used in underground mines.*

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1. Introduction

Following changes in South African regulations regarding trackless mobile machines (TMMs) and collision prevention systems (CPS) installed on such vehicles, ITC Services was contracted by Minerals Council South Africa to investigate and advise the mining industry on the effect of electromagnetic interference (EMI) on CPS.

As part of the investigation, ITC Services performed electromagnetic ambient measurements on various mining sites, to characterise the electromagnetic ambient emissions that would be present under normal operating conditions.

2. Aim

The aim of this report is to present the ambient data gathered at six mines – three of which were underground operations and three of which were surface operations – and provide guidance on how to interpret the results. Furthermore, this report aims to provide recommendations for future testing campaigns and best practices to avoid CPS failures due to EMI.

3. How to interpret the measurement results

The graphs shown in the current report depicts the maximum and average signal amplitudes, using data gathered from measuring ambient emissions at five different locations on each mining site. Intentional transmitter frequencies and amplitudes should be shared with any provider of equipment to ensure that the frequency spectrum are coordinated and that a dedicated channel or band is allocated to users.

3.1. Average vs MAX results

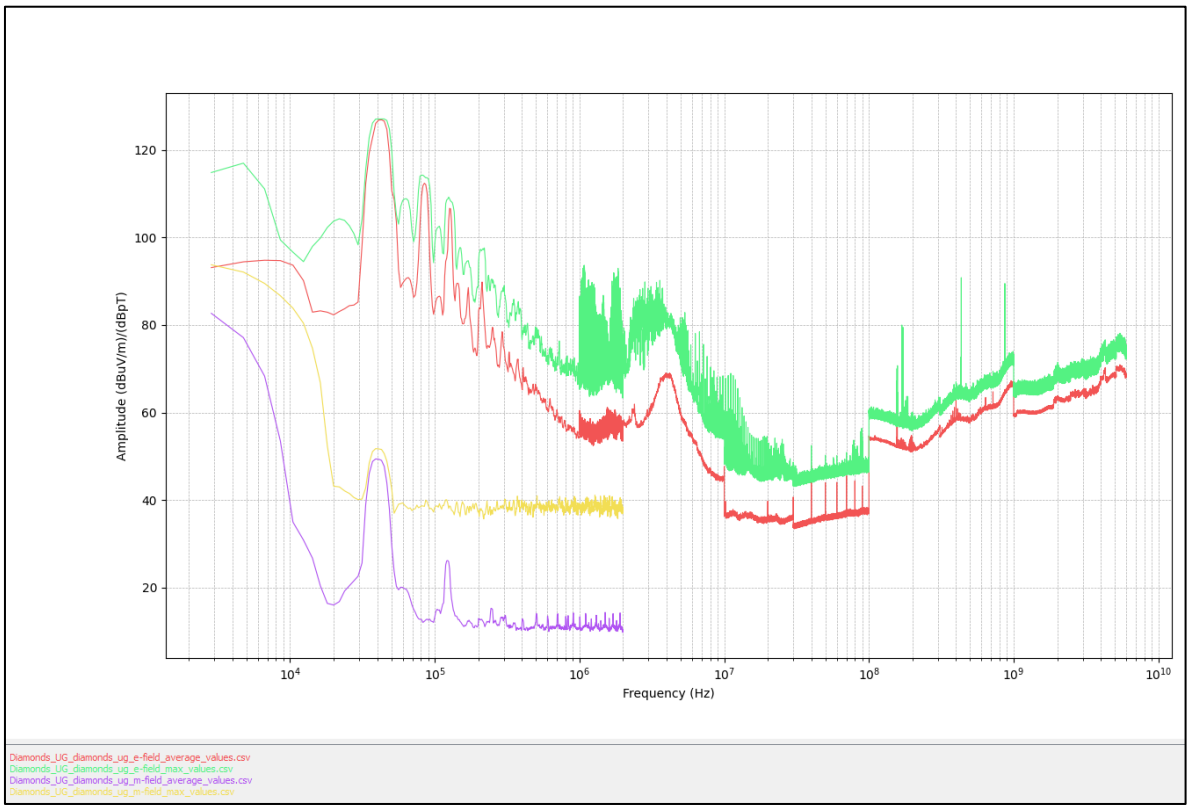
The MAX results include individual transient events, whereas the Average results reflect signals that are consistently present. Transient events included in the MAX result might have such a short duration and low energy content that the impact on an electronic circuit might not be noticed. The MAX result could how ever be interpreted as the worst-case emission amplitude at a specific frequency. A single transient could result in a mode change or even hardware damage.

4. Test locations

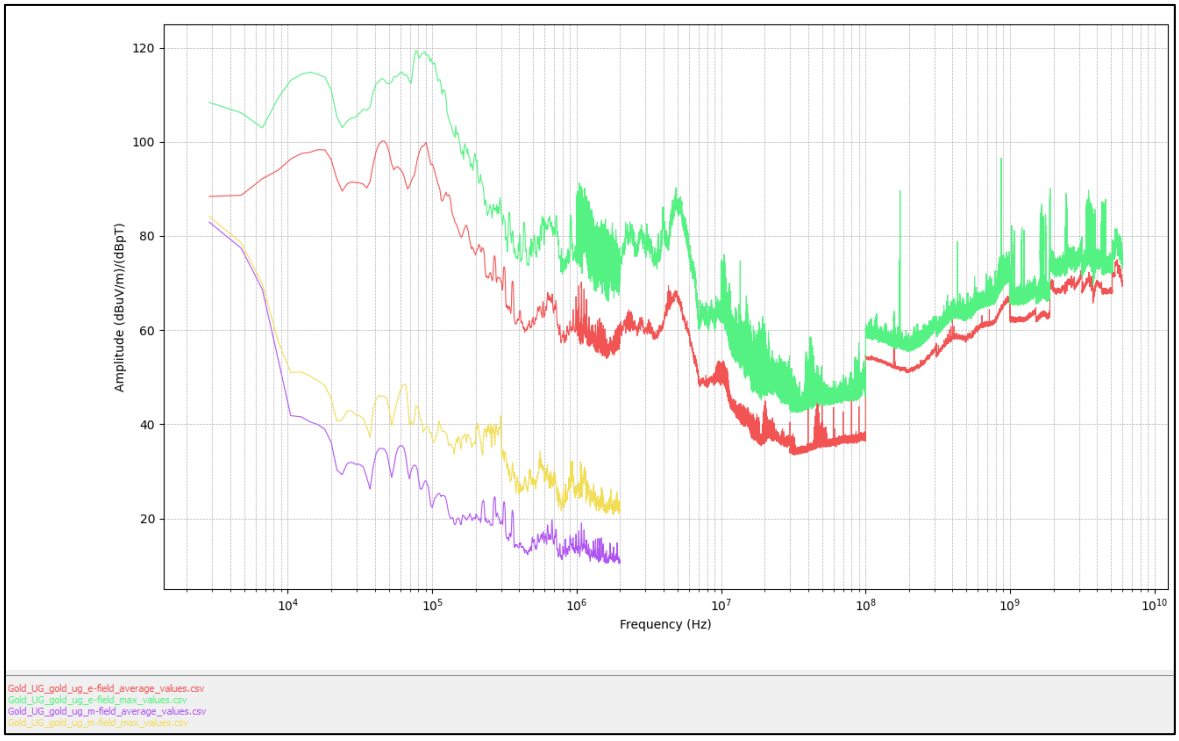
Test personnel safety took precedence in selecting test locations, followed by the requirement for minimal disruption on production. Four to five locations at each site had been selected and measured.

5. Results

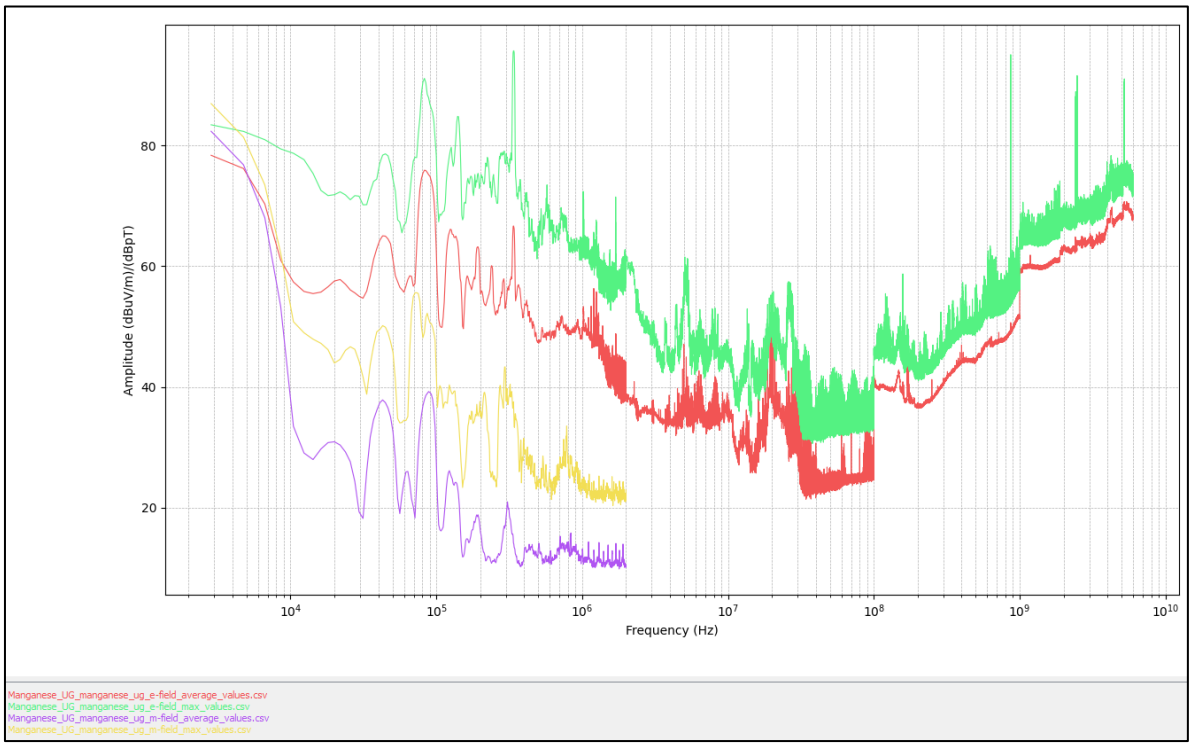
It should be noted that magnetic field amplitudes (denoted in the key below each graph as m-fields) is depicted in **dBpT**, while electric fields (denoted in the key below as e-fields) are depicted in **dBµV/m**.



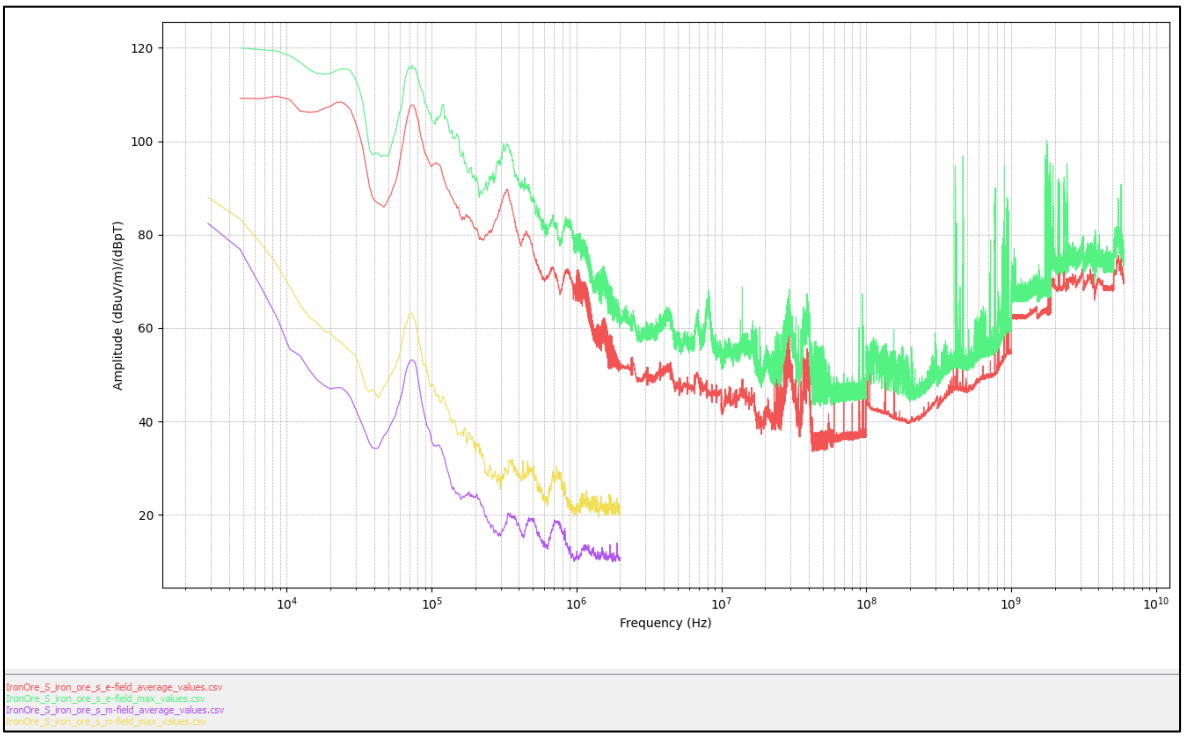
Graph 1: Underground diamond mine ambient environment (1KHz – 6GHz)



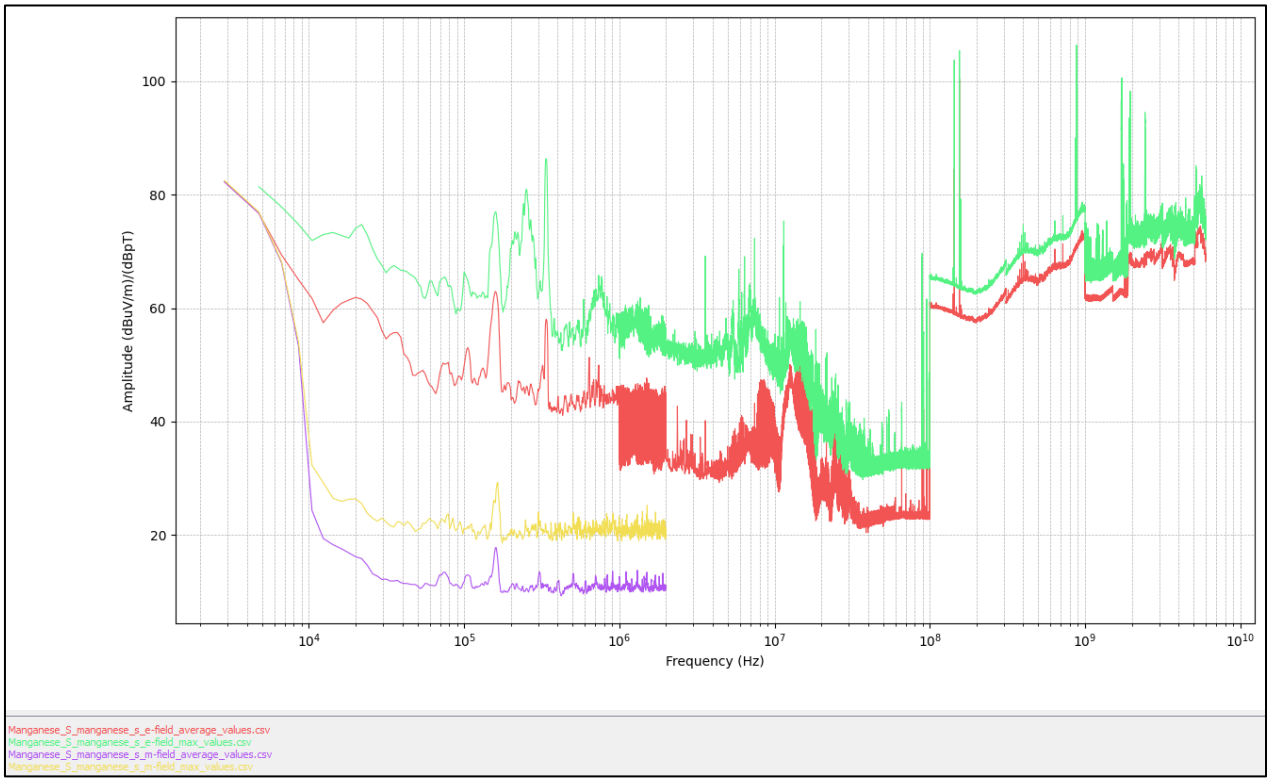
Graph 2: Underground gold mine ambient environment (1KHz – 6GHz)



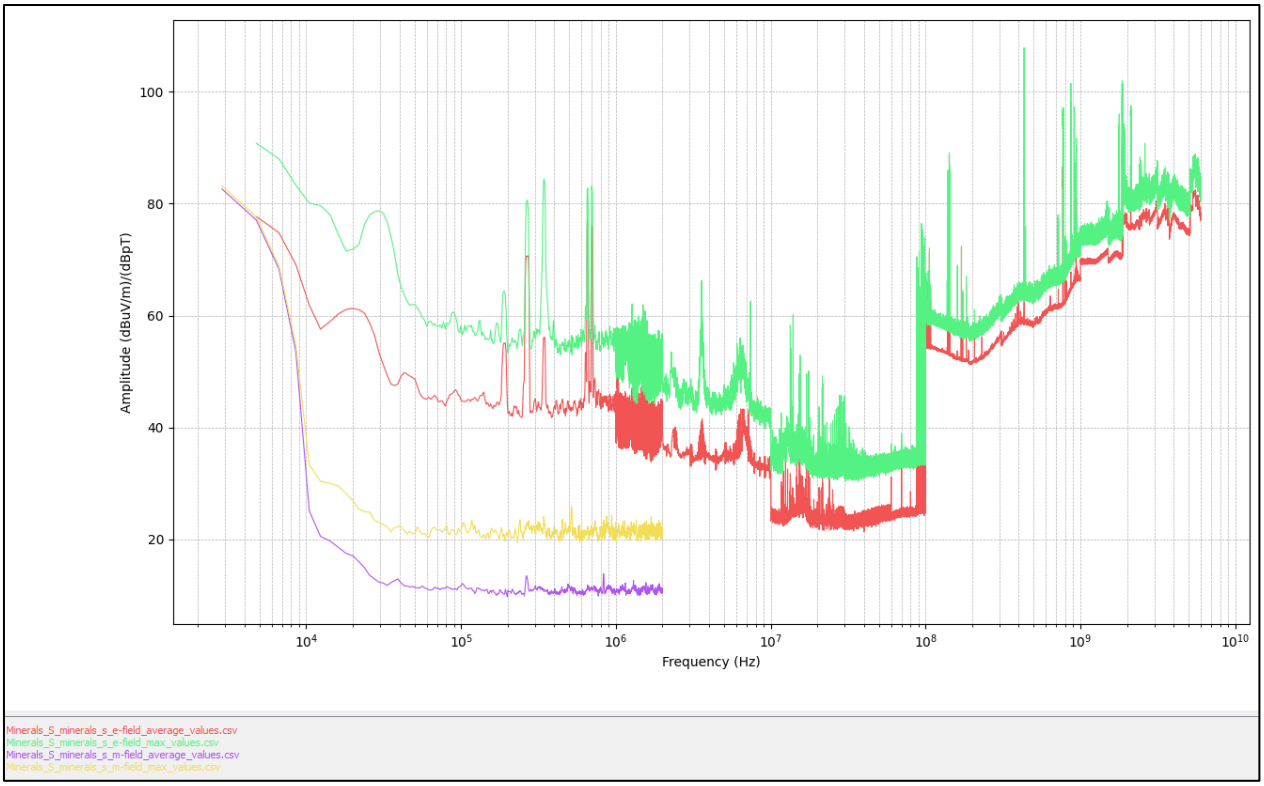
Graph 3: Underground manganese mine ambient environment (1KHz – 6GHz)



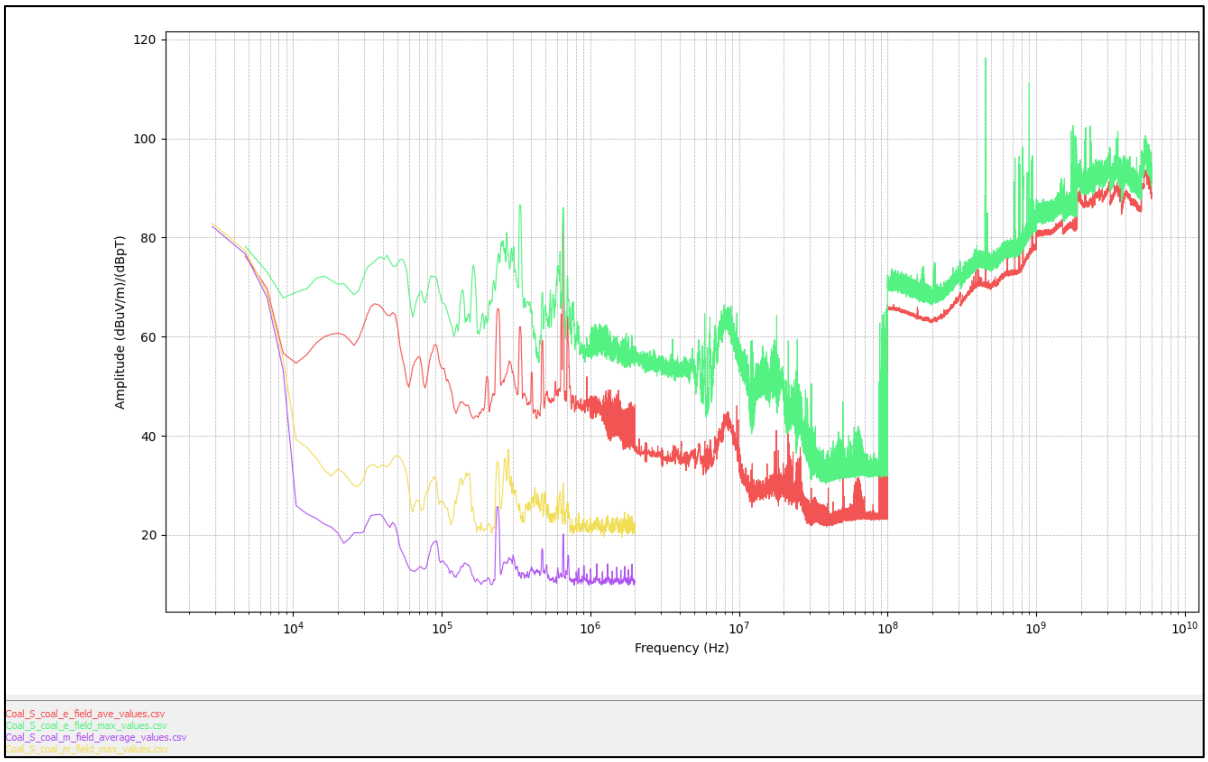
Graph 4: Surface iron ore mine ambient environment (1KHz – 6GHz)



Graph 5: Surface manganese mine ambient environment (1KHz – 6GHz)



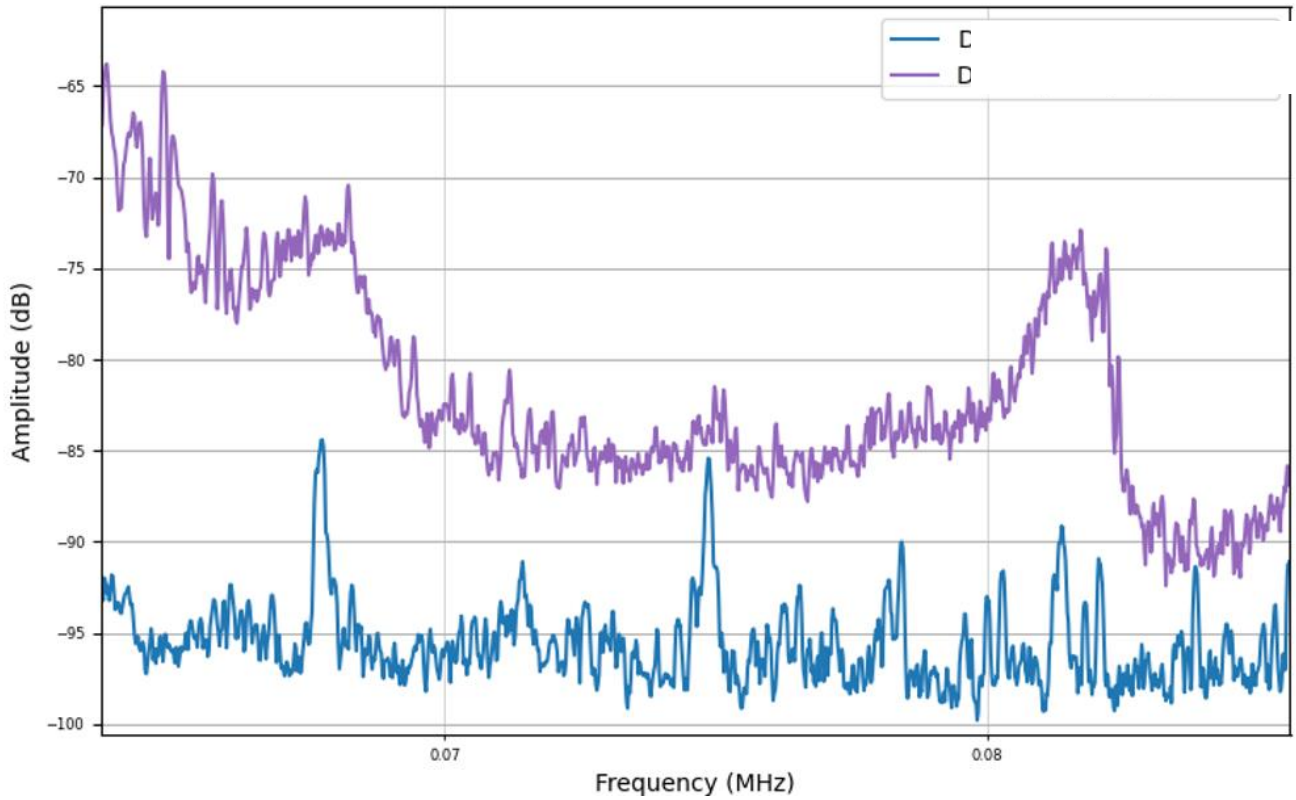
Graph 6: Surface platinum mine ambient environment (1KHz – 6GHz)



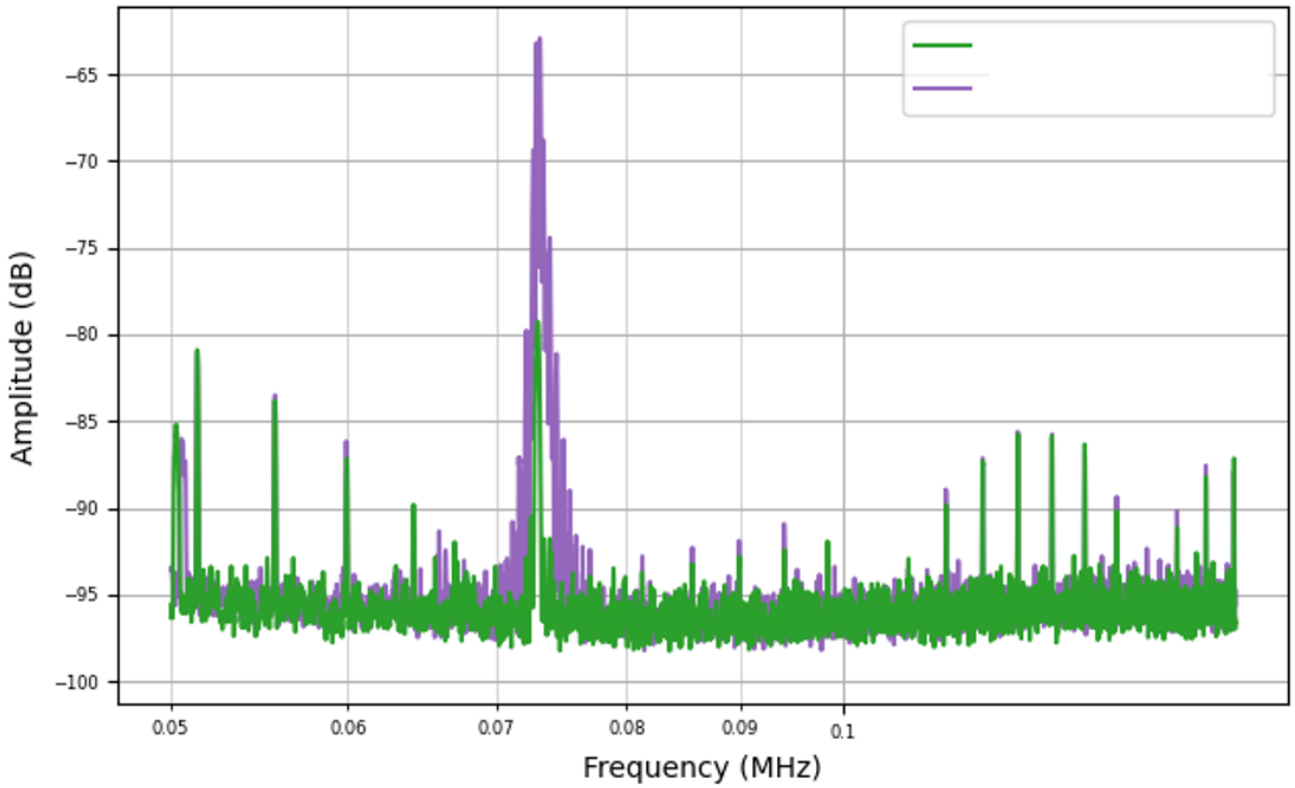
Graph 7: Surface platinum mine ambient environment (1KHz – 6GHz)

6. Impact on CPS

The signal to noise ratio (amplitude of the intentional signal vs amplitude of the unintentional signal) is critical for valid received-signal detection. Shown in Graph 8 is a case where the intentional signal (blue trace) is masked by interference (purple trace). It is unlikely that the CPS would be able to detect the intentional signal (blue trace), and the CPS would not operate correctly in such an ambient environment.



Graph 8: Intentional signal masked by interference



Graph 9: Intentional signal well above interfering signal

In Graph 9 the intentional signal (purple trace) is much higher in amplitude compared to the interfering signal (green trace) although they are on the same frequency. The CPS would be able to detect the intentional signal and the system will function correctly.

7. Conclusions and Recommendations from the EMI/EMC Study Related to CPS on TMMs

Following the EMI/EMC alignment project spearheaded by Minerals Council South Africa, the following have been concluded:

- A frequency register is an important control mechanism to implement and maintain at a mining operation. It ensures that all relevant parties, including the mine's engineering team and the potential / existing suppliers of CPS, are aware of the existing devices and signals that may interfere with the communication methods of CPS.
- The electromagnetic ambient environment on a mining site is dependent on the types of machinery that the mine uses in its daily operations.
- The most prominent EMI/EMC related risk to CPS installed on a TMM seems to be the emissions of the TMM itself (its inherent systems) and third-party installations that could cause interference with the CPS antennas mounted on the TMM. Examples of possible sources of interference include emergency lights, fuel management systems, engine health systems, fire detection/extinguishing systems etc.
- Testing the RF levels that a TMM emits before CPS installation takes place is a highly recommended practice, since this data shows the frequencies that the pre-installed systems operate on and that the CPS system will have to be immune to once mounted on the TMM.
- Depending on the CPS principle of operation, the regulatory CPS immunity tests (ICASA/ DMPR requirements) which include but are not limited to SANS/ IEC 61000-4-3 and SANS/ IEC 61000-4-6 should be customised to include the electromagnetic profile of the mine.

END OF DOCUMENT