RMIPPPP Scatec Kenhardt – SKA EMPr

Engineering Note

Contents

Abbreviations and Acronyms

Abbreviation/ Acronym	Description
BESS	Battery Energy Storage System
dB	Decibels
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
MHz	Megahertz
MWp	Megawatt Peak (DC power)
MW	Megawatt (Power)
MWh	Megawatt hour (Energy)
PV	Photovoltaic
RMIPPPP	Risk Mitigation Independent Power Producer Procurement Program
SKA AAA	Square Kilometer Array Astronomy Advantage Area
SARAO	South African Radio Astronomy Observatory

References

[1] C. Fouché, "Report Adressing Electromagnetic Interference (EMI), Path Loss and Risk Assesment for Scatec Kenhardt PV Suite," Interference Testing and Consultancy Services (Pty) Ltd, Pretoria, 2021.

1 Introduction

Scatec has preferred bidder status for three PV plus storage projects in the South African government's RMIPPPP. The three projects will have a combined installed capacity of 540 MWp PV and 225 MW/1140 MWh BESS. These projects will be situated ±20 km North-East of Kenhardt in the Northern Cape province of South Africa, which falls within the SKA AAA 1.

The location of the Scatec Kenhardt project portfolio within SKA AAA 1 warrants the identification of potential risks related to EMI in the 100-2170 MHz frequency range. The identification process allows for the proposal of focused mitigation measures and actions to manage the impact of potential EMI risk.

ITC Services performed a risk assessment [1] which approximates the cumulative EMI on a project basis and provides the levels of mitigation required on an equipment level. The purpose of this document is to summarize the findings of the risk assessment report [1]. Appendix B provides the necessary references to figures and tables as given in the risk assessment report [1].

2 Potential risk identification

The risk assessment [1] reports the cumulative EMI in the 100-2170 MHz range of Scatec Kenhardt PV6 which has the closest proximity to the affected SKA infrastructure. The technology and quantities under evaluation in the risk assessment are:

- Tracker motors
    - PVH – 2949 units
    - STi Norland – 2949 units
- String inverters
    - Huawei – 744 units
    - Sungrow – 595 units

2.1 Methodology

The following methodology was followed to approximate the cumulative EMI of the project and as a result determine the necessary mitigation measures.

2.1.1 Path loss calculation

The path loss was calculated based on the elevation maps between Scatec Kenhardt PV6 and the relevant SKA infrastructure namely: M000, SKA005, SKA006, SKA007 and SKAT [1]. A frequency range of 70-6000 MHz was used for the path loss calculation; however the 100-2170 MHz is applicable to the Scatec Kenhardt case. The referenced path loss graphs are given in Appendix B.

2.1.2 Cumulative approximation

The EMI profile of each technology variant is used to calculate the approximated cumulative EMI on a project basis. The cumulative EMI of one project is approximated with $10 \times logN$ where N is the total number of EMI sources [1] i.e. number of tracker motors or string inverters.

The approximated cumulative EMI is then used to calculate the required mitigation on a per unit basis.

2.2 Mitigation required per unit

The outcome of the risk assessment indicates that the required mitigation for all technology variants applies to the 125-850 MHz range [1]. As per the risk assessment [1], the following levels of mitigation are required per technology variant:

- Tracker motors
  - PVH – 61 dB at 174.4 MHz
  - STi Norland – 42 dB at 835.1 MHz
- String inverters
  - Huawei – 51 dB at 125 MHz
  - Sungrow – 11 dB at 850 MHz

Appendix B provides the risk assessment [1] result tables for reference.

3 Mitigation measures

Depending on the final chosen technology variants and the outcome of SARAO's approval, some of the following measures can be implemented to mitigate EMI by the required levels [1]:

- Shielding of cables with Raybraid which is expected to reduce EMI by 60 dB.
- Increase insertion loss with sufficient EMI filtering of DC and AC inputs to equipment.
- Seal enclosures with conductive gaskets.
- Waveguide (honeycomb) filters for enclosures with air ventilation openings.
- Good installation practices such as equipotential bonding, grounding etc. will be followed to ensure the overall mitigation of EMI.

The impact management actions and outcomes are provided in Appendix A.

4 Testing and procedures

An EMC Control plan will capture the procedures and mitigations implemented during the design and construction of the projects [1]. Ambient EMI measurements can be conducted before and after construction to verify that the required EMI levels are met [1]. The pre-construction ambient measurements will provide a reference of current EMI levels at the project sites.

Appendix A: Impact management outcomes and actions

Impact management outcome: To ensure that the chosen technology variants (trackers and inverters) operate with acceptable EMI levels.

Impact Management Actions	Responsible person	Method implementation	Timeframe for implementation	Responsible party for monitoring	Frequency of monitoring	Evidence of compliance
• Ambient EMI measurements will be taken at the project locations prior to construction to serve as reference of current EMI levels. • Mitigations will be reported in the form of an EMC Control Plan. • The necessary equipment level mitigations will be implemented in order to be compliant in the 100-2170 MHz range. • Good installation practices such as equipotential bonding, grounding etc. will be followed to ensure the overall mitigation of EMI.	EPC Contractor	EMC Control Plan	Design and construction phase	SARAO	Once-off	Approval of EMC Control Plan

Appendix B: Reference tables and figures

B.1. Site location

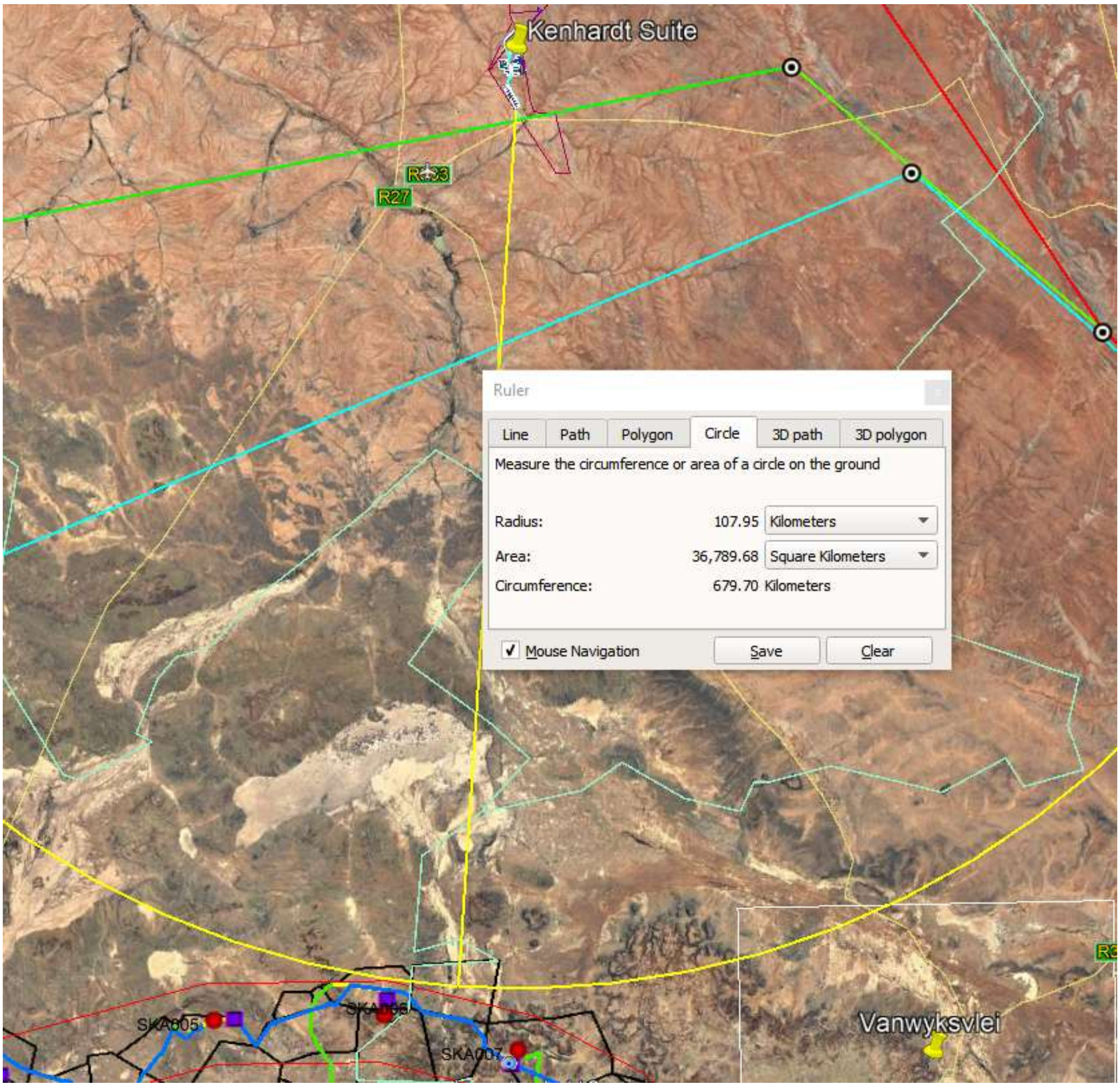

Figure 1: Map indicating the Scatec Kenhardt projects' proximity to the closest SKA infrastructure [1].

B.2. Path loss calculations

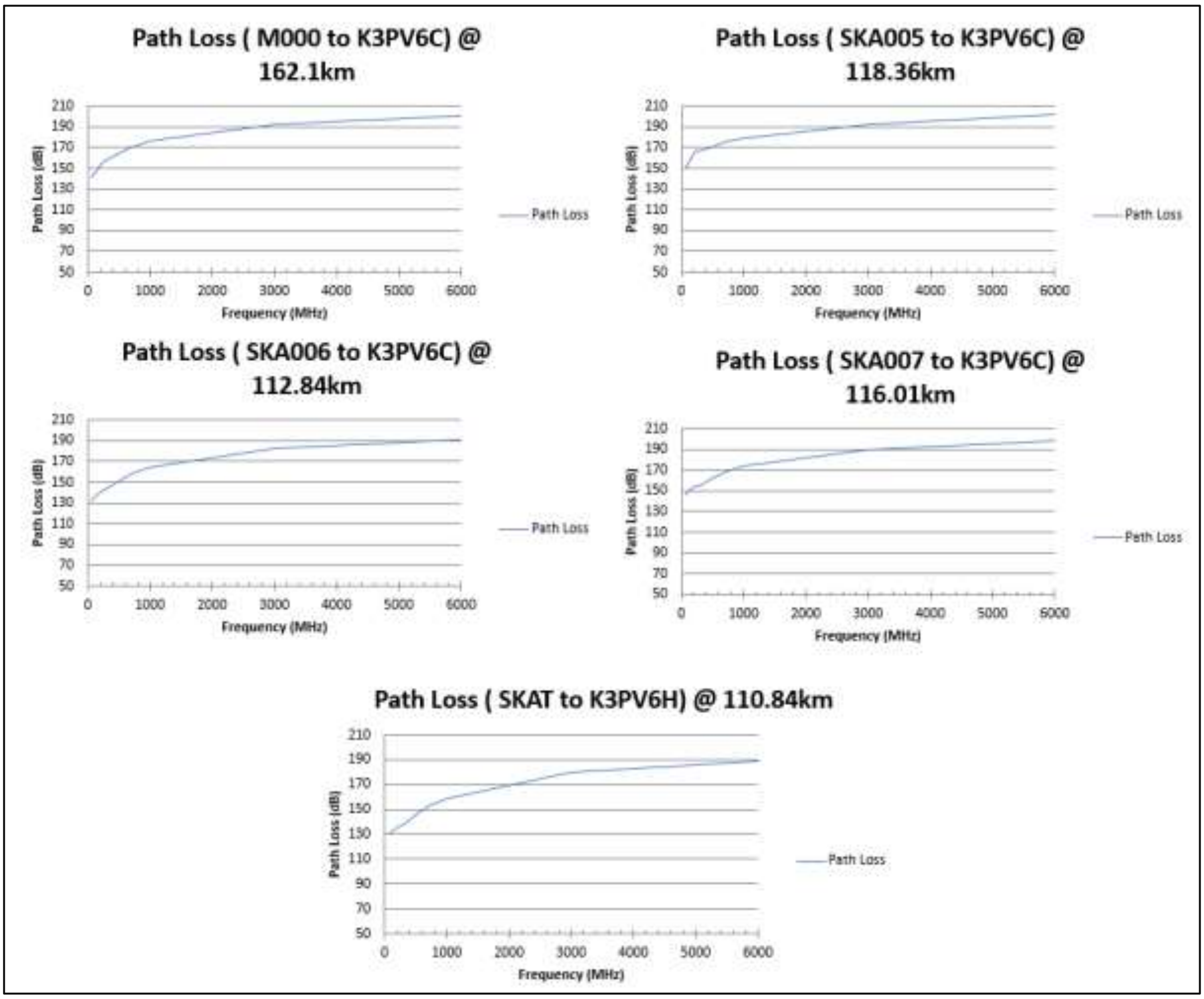

Figure 2: Path loss between Scatec Kenhardt PV6 and relevant SKA infrastructure [1].

B.3. Mitigation required – Trackers

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SKA006 to K3PV6H										
Frequency [MHz]	Actual Measurements [dBµV/m]	Test Distance [m]	Cispr Bandwidth [MHz]	SARAS Requirement [dBW/Hz]	Required Path Loss SARAS (incl 10dB) [dB]	Required Path Loss Saturation (incl 10dB) [dB]	Calculated Path Loss [dB]	Number of units	Facility Mitigation required [dB]	Unit Mitigation required [dB]
106.5	49	3	0.12	-257.09	140.04	63.74	129.1	2949	10.94	45.64
174.4	63	3	0.12	-260.78	157.74	77.74	131.71	2949	26.03	60.73
455	55	3	0.12	-267.98	156.93	69.74	141.45	2949	15.48	50.18

Figure 3: Mitigation required for PVH tracker [1].

STI09178										
SKAT to K3PV6H										
Frequency	Actual Measurements	Test Distance	Cispr Bandwidth	SARAS Requirement	Required Path Loss SARAS (incl 10dB)	Required Path Loss Saturation (incl 10dB)	Calculated Path Loss	Number of units	Facility Mitigation required	Unit Mitigation required
[MHz]	[dBμV/m]	[m]	[MHz]	[dBW/Hz]	[dB]	[dB]	[dB]		[dB]	[dB]
185.8	46	3	0.12	-261.26	141.21	60.74	134.89	2949	6.32	41.02
200	43	3	0.12	-261.81	138.76	57.74	135.42	2949	3.34	38.04
270	28	3	0.12	-264.06	126.01	42.74	137.37	2949	-11.36	23.34
310	25	3	0.12	-265.1	124.05	39.74	138.37	2949	-14.32	20.38
835.1	56	3	0.12	-272.53	162.48	70.74	155.26	2949	7.22	41.92
1891	62	3	1	-278.66	165.4	76.74	168.22	2949	-2.82	31.88

Figure 4: Mitigation required for STi tracker [1].

B.4. Mitigation required – Inverters

Huawei										
SKA006 to K3PV6H										
Frequency	Actual Measurements	Test Distance	Cispr Bandwidth	SARAS Requirement	Required Path Loss SARAS (incl 10dB)	Required Path Loss Saturation (incl 10dB)	Calculated Path Loss	Number of units	Facility Mitigation required	Unit Mitigation required
[MHz]	[dBμV/m]	[m]	[MHz]	[dBW/Hz]	[dB]	[dB]	[dB]		[dB]	[dB]
125	49	10	0.12	-258.29	151.69	74.2	129.81	744	21.88	50.60
190	40	10	0.12	-261.43	145.84	65.2	132.31	744	13.53	42.25
268	39.5	10	0.12	-264.01	147.92	64.7	134.71	744	13.21	41.93
640	35	10	0.12	-270.54	149.94	60.2	148.02	744	1.92	30.64

Figure 5: Mitigation required for Huawei inverter [1].

Sungrow SG250HX										
SKA006 to K3PV6H										
Frequency	Actual Measurements	Test Distance	Cispr Bandwidth	SARAS Requirement	Required Path Loss SARAS (incl 10dB)	Required Path Loss Saturation (incl 10dB)	Calculated Path Loss	Number of units	Facility Mitigation required	Unit Mitigation required
[MHz]	[dBμV/m]	[m]	[MHz]	[dBW/Hz]	[dB]	[dB]	[dB]		[dB]	[dB]
255.62	14	3	0.12	-263.65	111.6	28.74	134.43	595	-22.83	4.92
330	19	3	0.12	-265.57	118.52	33.74	136.6	595	-18.08	9.67
558.73	24	3	0.12	-269.52	127.47	38.74	145.22	595	-17.75	10.00
850	30	3	0.12	-272.66	136.62	44.74	153.69	595	-17.07	10.68
1250	40	3	1	-275.56	140.3	54.74	160.05	595	-19.75	8.00

Figure 6: Mitigation required for Sungrow inverter [1].