

South African Square Kilometre Array Project Postgraduate Bursary Programme

MEng Research Project Proposal to be considered for Bursary Funding to Commence in 2020

1. Title of Research Project: Applied Filtering and Shielding for EMC

2. Academic Level: M Eng

3. Supervisor's Title and Full Name: Dr Pieter Gideon Wiid

4. Co-supervisor's title and full name:

5. Supervisor's University: Stellenbosch University

6. Overview and Aims of the Research Project:

Important aspects of Electromagnetic Compatibility (EMC) design with regard to filtering and shielding need to be applied in the design of shielded enclosures to be used on the Square Kilometre Array (SKA) site. With solid electromagnetic theoretical basis, including differential mode and common mode evaluation in modelling, measuring and implementation, the correct EMC design principles for common mode and differential mode filtering and shielding will be examined. Important areas in filter applications, like impedance matching, wire- and trace layout, correct low-impedance grounding principles and component choices, as well as correct use of EMC gaskets and influences of shield apertures will be highlighted and the correct application explained and implemented. A typical enclosure which can be duplicated for multiple uses on the SKA site will be manufactured and tested.

7. Relevance of the research proposed to the priority areas of MeerKAT / SKA:

With several systems of measurement and monitoring of RFI planned, the principles of this project can be applied to these systems to ensure that RFI measurements and monitoring does not itself create unwanted RFI. Only with correctly applied shielding and filtering will this be achieved.

This falls in priority area 4.2.3 Hardware and data analysis systems for detecting, monitoring and identifying Radio Frequency Interference (RFI), including the use of telescope data (e.g. using MeerKAT visibilities to locate RFI sources).

8. Research work breakdown:

- a. Year 1: The student will conduct an in-depth literature study in the first semester of EMC design principles for common mode and differential mode filtering and shielding. Important areas in filter applications, like impedance matching, wire- and trace layout, correct low-impedance grounding principles and component choices, as

well as correct use of EMC gaskets and influences of shield apertures will form part of this study. The second semester will include thorough simulation of typically used mains and data filters, which will include the effects of parasitic elements of real-world components, influences of wire and trace layout and grounding principles, impedance matching to typical applications and simulated test environments. Shielding will be investigated through simulation as well, showing the effects of gaskets, seams and apertures in the application of filtering and shielding. With this simulation knowledge, different applicable designs can be proposed and evaluated.

- b. Year 2: The first semester of year 2 will include construction and testing of selected proposed designs, where component selection, filter layouts and practical implementation will be of utmost importance. Controlled physical testing will be required and will be compared to simulation. Further improvements will be made to obtain a design suitable for SKA site use. Some dissertation writing will be done during this time as well, where the second semester will be used for the final analysis and completing the dissertation.

9. Availability of required data / access to required equipment /availability of research facilities and other resources required:

The Stellenbosch University has a shielded reverberation chamber, an anechoic chamber, a Rohde and Schwarz 8 GHz network analyser, as well as a Rohde and Schwarz 40 GHz Spectrum Analyser and soon a Tektronix 2.5 GHz oscilloscope for testing purposes. A 3D-printer as well as numerous fine-mechanic machinery and materials are available at the E&E Department workshops, for prototype container parts. A PCB milling facility is also available in the department. Electronic components for filters and other system hardware components can be sourced through the university as well.