

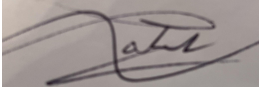


# MARKET SURVEY (EXPRESSION OF INTEREST) – MID SPFRx 123

Revision 2

Date: 2022-08-24

<i>Role</i>	<i>Name</i>	<i>Designation</i>	<i>Affiliation</i>	<i>Signature</i>	<i>Date</i>
Author	P. Oosthuizen	Procurement Specialist	SKAO		2022-07-15
Owner	N. Mnyandu	Project Manager SKA-MID Digital	SKAO		2022-07-09
Approver	Z. Patel	Senior Contracts Specialist	SKAO		2022-07-14

© Copyright 2021 SKA Observatory.



This work is licensed under a [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/)

## TABLE OF CONTENTS

<b>INTRODUCTION</b>	<b>3</b>
<b>DESCRIPTION OF PROJECT</b>	<b>3</b>
<b>TECHNICAL DESCRIPTION</b>	<b>3</b>
3.1 Design Overview	3
3.2 SPFRx Architecture	4
3.3 SPFRx Digitizer System Design	4
3.4 Design Status	6
3.5 Procurement Approach	6
<b>Instructions to Contractors</b>	<b>7</b>
<b>Market Survey Responses</b>	<b>7</b>
<b>INDUSTRY BRIEFING EVENT</b>	<b>8</b>
<b>Pre-Qualification Criteria</b>	<b>8</b>
<b>TENDER EVALUATION CRITERIA</b>	<b>8</b>
<b>BASIS OF PROPOSED CONTRACT TERMS</b>	<b>8</b>
<b>INDICATIVE DELIVERY DATES OR PROGRAMME SCHEDULE</b>	<b>9</b>
<b>INDICATIVE PROCUREMENT SCHEDULE</b>	<b>9</b>
<b>CONTACT DETAILS</b>	<b>9</b>



# 1 Introduction

This Market Survey Notice (Expression of interest) is to solicit interest from organisations in tendering for SKAO requirements: MID SPFRx 123. This procurement is open to companies within Sweden. Interested parties will be expected to register their interest on the Procurement Portal (<https://www.kommersannonse.se/skaobservatory/>). The Market Survey closing date will be 2022-09-02.

The award of the contract to the winning tenderer is planned to be in January 2023.

## 2 Description of Project

The SKAO, formally known as the SKA Observatory, is a global collaboration of Member States whose mission is to build and operate cutting-edge radio telescopes to transform our understanding of the Universe, and deliver benefits to society through global collaboration and innovation. Headquartered in the UK, its two telescope arrays will be constructed in Australia and South Africa and be the two most advanced radio telescope networks on Earth. A later expansion is envisioned in both countries and other African partner countries.

Together with other state-of-the-art research facilities, the SKAO's telescopes will explore the unknown frontiers of science and deepen our understanding of key processes, including the formation and evolution of galaxies, fundamental physics in extreme environments and the origins of life. Through the development of innovative technologies and its contribution to addressing societal challenges, the SKAO will play its part to address the United Nations' Sustainable Development Goals and deliver significant benefits across its membership and beyond.

## 3 Technical Description

### 3.1 Design Overview

The Single Pixel Feed Receiver (SPFRx) is a key performance-determining part of the SKA Mid telescope and its main functions are digitisation and conditioning of the RF output signals from Single Pixel Feeds (SPF), and forwarding the data to the Central Signal Processor (CSP). The SPFRx consists of three main modules which are the RXS123 (Receiver Sampler Band123), RXS45 (Receiver Sampler



Band45) and RXPU (Receiver Pedestal unit). The RXS123 is mounted on the SKA MID Dish Indexer while the RXPU is mounted inside the SKA MID Dish Pedestal.

## 3.2 SPFRx Architecture

The SPFRx receives RF signals captured by the SKA mid Dish (DSH) and pre-amplified by the Single Pixel Feed (SPF) Sub-Element components. The RF signals are delivered to SPFRx in two polarizations on 50 ohm coaxial lines, one pair of coaxial lines dedicated to each SPF Band. The main task for the SPFRx hardware, firmware and software is to perform analogue to digital conversion on the incoming RF and to send the digital RF samples to the SKA1-mid Central Signal Processing (CSP) Element. The digitised RF data is sent to CSP as 100G Ethernet packets via dedicated 100G links provided by the SaDT Element.

The SPFRx operation is controlled by the Dish Local Monitoring and Control (LMC). SPFRx responds to LMC commands to initialize and self-test its components, select the SPF Band input for digitization, adjust the RF path gain, align the sampling clock with the 1PPS mark, select and initialize the calibration noise timer, start RF sampling, verify RF spectrum with on board gated spectrometer and start or stop sending the samples to the CSP.

## 3.3 SPFRx Digitizer System Design

The SKA-mid Band 1-5 feeds are rotated into the Dish focus by the Indexer mechanism. From an RF signal quality perspective, the SPFRx should be located in close proximity to the feeds to make coaxial cables short and thus avoid frequency dependent loss and impedance mismatch ripple. This is the architecture implemented in the MeerKAT telescope. The downside is that the digital circuits driving the analogue-to-digital converter (ADC) devices and performing digital processing of RF samples tend to emit high levels of EMI. To minimize interference SPFRx should be kept away from the SPF components on the Dish Indexer and enclosed in multiple layers of RF shielding in the Dish Pedestal.

The trade-off study completed after SPFRx PDR identified the Optical Digital Link (ODL) architecture as offering the best compromise between RF performance and EMI suppression. In this architecture the SPFRx circuitry is distributed between Dish Indexer and Pedestal as illustrated in Figure 4.

The SPFRx Indexer Sampler enclosure located on the Dish Indexer contains all of the RF circuitry responsible for the SPF signal amplification and filtering and the ADC devices with a minimal digital support circuitry. The Indexer Sampler obtains DC voltages from a linear power supply and thus avoids EMI from the switching circuitry conventionally used to generate low voltages. ADC control signals are generated by the FPGA circuits in the SPFRx Pedestal Unit and are sent to the Indexer Sampler by Optical Digital Links consisting of optical/digital transceivers linked with fibre optic cables. Multiple layers of EMI shielding around



the FPGA and power supply circuits in the SPFRx Pedestal Unit allow the use of a switcher power supply.

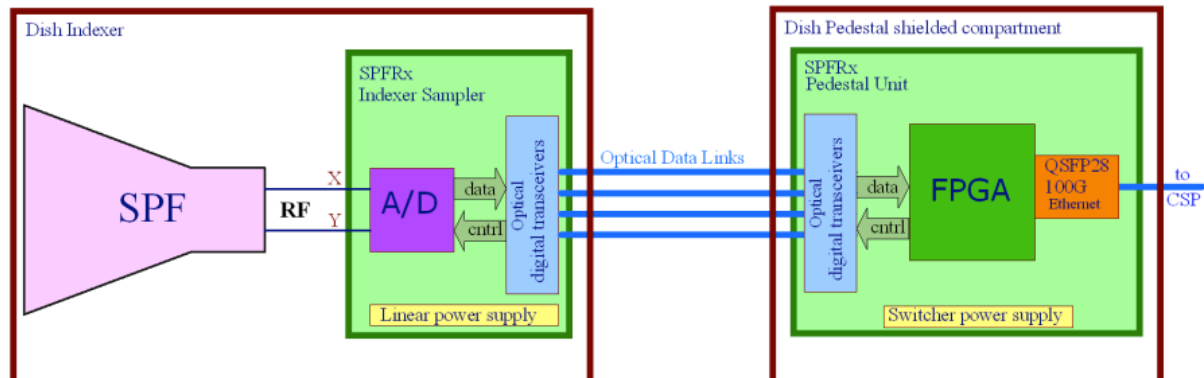


Figure 4 – SPFRx ODL architectural scheme

The varied data sampling rates and bit depths required by SPF Bands 1-5 are compiled in Table 3.1. The need to preserve signal coherence through band changes allows sharing a common ADC among the SPF bands sampled at a common rate; but demanding dedicated ADCs for all different sampling rates to run concurrently uninterrupted through the band changes. Thus four pairs of ADCs are deployed to sample two RF polarizations at nominal sampling rates 3.168 GSps, 3.96 GSps, 8.91 GSps and 15.84 GSps. Bands 1 and 2 share ADCs running at 3.96 GSps, Band 3 has its own ADC running at 3.168 GSps and Bands 4 and 5b share ADCs running 15.84 GSps. Each dish sampling rates are uniquely offset from the nominal sample rate as described by the Sample Clock Frequency Offset scheme in the DSH to CSP ICD.

	RF frequency range (GHz)	RF bandwidth (GHz)	Sampling rate (GSps)	Nyquist zone	Minimal ADC sampling bit depth	Transport sampling rate (GSps)	Transport bit depth	Transport raw data rate (Gbps)
<b>Band 1</b>	0.35 – 1.05	0.70	3.96	1	8	3.96	12	95.04
<b>Band 2</b>	0.95 – 1.76	0.81	3.96	1	8	3.96	12	95.04
<b>Band 3</b>	1.65 – 3.05	1.40	3.168	2	6	3.168	12	76.032
<b>Band 4</b>	2.80 – 5.18	2.38	15.84	1	4	5.94	8	95.04
<b>Band 5a</b>	4.60 – 8.50	3.9	8.91	2	3	2x5.94	4	95.04
<b>Band 5b</b>	8.30 – 15.40	7.0	15.84	2	3	2x5.94	4	95.04

Table 3.1 Digitisation Parameters

Different time schedules for Bands 1-2 and Band 5 development motivate the indexer sampler units for these bands to be housed in physically separate enclosures while the digital processor common to all bands is housed in a pedestal enclosure. Since the frequency range and bit depth of Band 3 fall within the capability of the ADC devices selected for Bands 1 and 2, provisions have



been made to accommodate Band 3 inside the enclosure with the RF and ADC circuits for Bands 1 and 2. The required bit depth and frequency regime of Band 4 qualify it for shared ADC and digital processing circuits with Bands 5a and 5b. Therefore, although the SKA1 will be initially populated with only Bands 1, 2& 5 Single Pixel Feeds, the SPFRx Sub-Element are being developed to cover all Bands. The resulting architecture is shown as a block diagram in Figure 5 and consists of two indexer sampler units denoted as RXS123 and RXS45 and one common Pedestal Unit denoted RXPU.

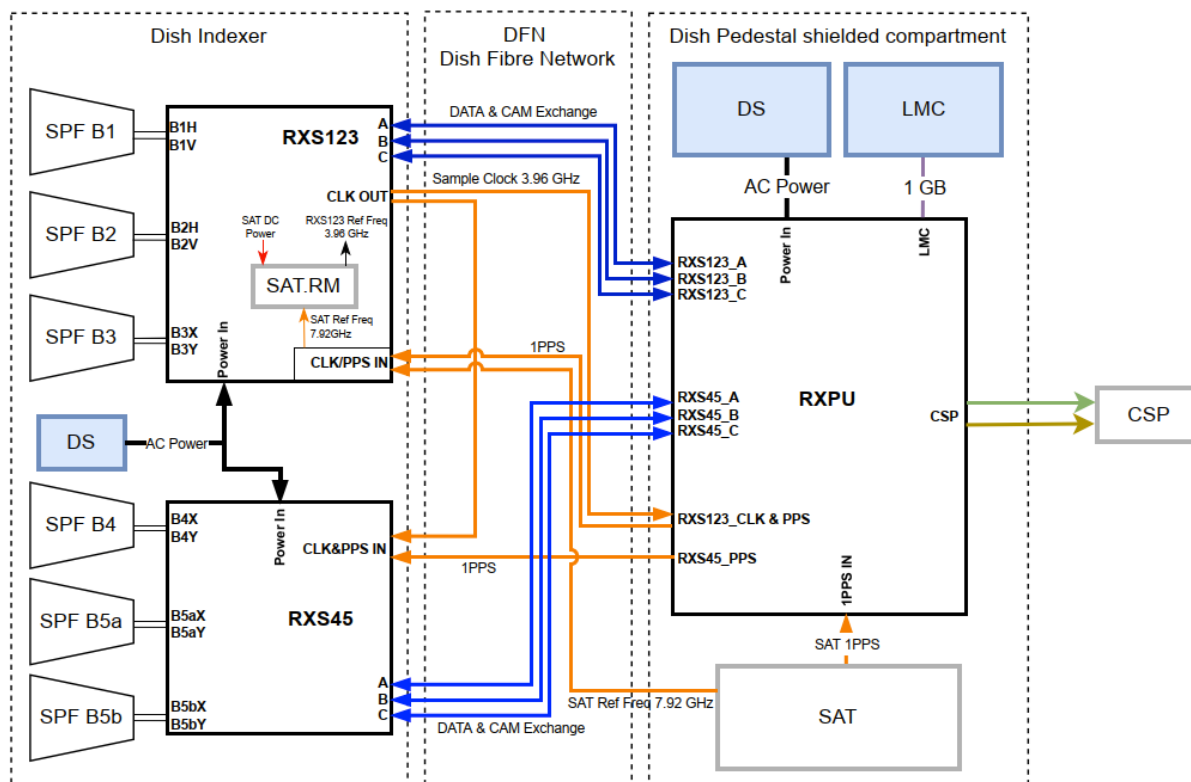


Figure 5 – Indexer RF Samplers RXS123, RXS45 with Optical Links to RXPU in Pedestal

### 3.4 Design Status

The designs for the SPFRx123 (RXS123 and RXPU) were completed and a Critical Design Review was conducted early July 2022. The design will be provided to all interested companies as part of the ITT.

### 3.5 Procurement Approach

The SKAO will procure, in accordance with the SKAO Procurement Policy and Procedures, a MID SPFRx 123 Contract from Sweden. SKAO seeks to enter into a NEC4 Engineering and Construction Contract (ECC) with a Contractor to perform



the industrialisation and manufacture of 144 SPFRx123 units plus spares and related external cables, based on the designs from SKAO. The Contractor will subcontract the RXPU manufacturing and delivery to an entity based in Switzerland. The manufacture and supply of the MID SPFRx 123 units will be in batches and will be aligned with the SKAO rollout plan.

The Contractor will also take on ownership of the design and system engineering responsibilities for the overall SPFRx system.

A commercial and technical tender data pack containing details of the scope of work will be prepared by the SKAO.

## 4 Instructions to Contractors

This document shall not be construed as a request or authorisation to perform work at SKAO's expense. Any work performed by a tenderer will be at the tenderer's own discretion and expense. This Market Survey does not represent a commitment to procure, purchase or lease. Submission of a response constitutes acknowledgement that the tenderer has read and agrees to be bound by such terms.

SKAO intends to submit a Pre-Qualification Questionnaire (PQQ) for the work described in this document. There is no guarantee that SKAO will submit a PQQ or, if a PQQ is submitted, that it will occur in the time frame described in this Market Survey. If submitted, the PQQ will be sent to tenderers, via the SKAO Procurement Supplier Portal. The information in this Market survey is accurate to the best of the author's knowledge but is not guaranteed to be correct.

## 5 Market Survey Responses

All Contractors should create an account (if they have not already) and then register their interest in this Market survey through the SKAO Procurement Supplier Portal (<https://www.kommersannons.se/skaobservatory/Notice/NoticeList.aspx>) by 2022-09-02. Tenderers should also inform the relevant country's ILO (Industry Liaison Officer) of their interest via email. The ILO for this Market Survey is: Patrik Carlsson, Chalmers University of Technology – patrik.carlsson@cit.chalmers.se.



## 6 Industry Briefing Event

On the 2022-09-02 at 12:00 BST, SKAO will hold an Industry Briefing Event with the aim of providing more information about SKAO and the Mid SPFRx 123 competitive tender. As long as you have registered your interest in the Market Survey on the SKAO Procurement Portal by 2022-08-29, using the guidance in "Market Survey Responses", you will be sent a meeting invitation via Zoom.

## 7 Pre-Qualification Criteria

Once parties have registered their interest, a Pre-Qualification Document Pack will be issued to interested parties. The Pre-Qualification Document Pack will contain a Pre-Qualification Questionnaire (PQQ) which includes a Quality Assurance Questionnaire and a Health and Safety Questionnaire. Developed in order to accurately determine if the tenderer has the necessary financial, economic, quality, technical and professional capacity and competencies to perform the required scope of work in a manner compliant with SKAO expectations.

## 8 Tender Evaluation Criteria

- Technical and financial submissions will be assessed separately.
- A minimum quality score (threshold) must be achieved in order to progress to the next stage, i.e. the financial evaluation.
- The Most Economically Advantageous Tender Evaluation Method/Lowest Priced Technically Qualified Supplier Evaluation Method will be used and tender submissions will be assessed on a 30:70 weighting of price:quality.

## 9 Basis of Proposed Contract Terms

The form of contract used will be the NEC4 Engineering and Construction Contract (ECC) Option A (fixed priced contract with an activity schedule). It is SKAOs preference that NEC4 subcontracts are used to ensure back-to-back applicability of contract clauses across the supply chain. More information on the NEC4 suite of contracts can be found at <http://www.neccontract.com/About-NEC/NEC4-suite-of-contracts>.





## 10 Indicative Delivery Dates or Programme Schedule

SPFRX Delivery Outline	Timelines
S-ITF Delivery : 4 Units	2023/08
AA0.5 Delivery : 5 Units	2023/11
AA1 Delivery : 5 Units	2024/04
AA2 Delivery : 58 Units	2025/01
AA3 Delivery : 69 Units	2025/10
AA4 Delivery : 9 Units	2026/04

## 11 Indicative Procurement Schedule

Activity	Start	End
Market Survey	2022-07-15	2022-09-02
Period for submission of pre-qualification packs	2022-09-05	2022-09-26
Tender period for submission of ITT packs	2022-10-24	2022-12-19
Contract award	2023-01	

## 12 Contact Details

Procurement related questions should in the first instance be directed to Paul Oosthuizen - Procurement Specialist, with the responsible ILOs (Industry Liaison officer) in Cc.

- Paul Oosthuizen - Procurement Specialist Paul.Oosthuizen@skao.int
- Responsible ILO (Industry Liaison officer)
  - Sweden: Patrik Carlsson, Chalmers University of Technology - patrik.carlsson@cit.chalmers.se

If you are having issues with the Kommers Supplier Portal or have any procurement related questions, these should be addressed to Paul Oosthuizen with the responsible ILOs in Cc.

Additional Information:



- Link to SKAO Procurement Website([www.skatelescope.org/procurement](http://www.skatelescope.org/procurement)).
- Link to Industry Liaison Officers for each country (<https://www.skatelescope.org/ska-industry/>).



## LIST OF ABBREVIATIONS

HSE	Health, Safety & Environment
IGO	Intergovernmental organization
ILO	Industry Liaison Officer
ITT	Invitation to Tender
S-ITF	System Integration and Testing Facility
PQQ	Pre-qualification Questionnaire
QA	Quality Assurance
SKA	Square Kilometre Array
SKAO	SKA Observatory
SPF	Single Pixel Feed
SPFRx	Single Pixel Feed Receiver



## DOCUMENT HISTORY

Revision	Date Of Issue	Engineering Change Number	Comments
A	2022-06-28		First draft release for internal review
1	2022-07-15		First release
2	2022-08-24		Revision of Industry Briefing Event dates

## DOCUMENT SOFTWARE

	Package	Version	Filename
Word processor	MS Word	Office 365	MARKET SURVEY (EXPRESSION OF INTEREST) – MID SPFRx 123
Block diagrams			
Other			

## ORGANISATION DETAILS

Name	SKA Observatory
Registered Address	Jodrell Bank Lower Withington Macclesfield Cheshire, SK11 9FT, UK
Fax	+44 (0)161 306 9600
Website	<a href="http://www.skao.int">www.skao.int</a>

