

<i>Document ID</i>	RFOF-SOW
<i>Revision</i>	02
<i>Document</i>	<i>Capitolato tecnico-prestazionale Statement of work</i>
<i>Tender</i>	<i>Fornitura di 40 moduli in fibra ottica a larga banda per il collegamento dei ricevitori ad alta frequenza del Sardinia Radio Telescope ai back-end di acquisizione e processing dei segnali radio astronomici</i> <i>Supply of 40 wideband fiber optic links to be installed on the Sardinia Radio Telescope for connecting high frequency receivers to remoted back-ends.</i>
<i>Tender procedure</i>	Open call pursuant to art. 60 d.lgs. 50/2016
<i>Decision act</i>	Determinazione n. 123 del 4 giugno 2021
<i>Tender value</i>	€ 700.000,00
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<i>CIG</i>	8782252F9A

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Art. 1 Definitions

- **Technical requirements.** Requirements that define the characteristics and technical specifications of the supply.
- **Functional requirements.** Requirements that indicate the purpose and function of the supply.
- **Performance requirements.** Requirements that define what performance and level of service the supply must have.
- **Reward requirements.** They identify the characteristics of a technical and/or functional nature and/or performance that improve the minimum requirements set by the contracting **Authority**, subject to discretionary or tabular evaluation by the adjudicating commission.

Art. 2 Subject of the contract

The bid is finalized to the acquisition of **40 (forty) fiber optic links grouped into enclosures able to operate in the band 1 to 18 GHz** to be used on the Sardinia Radio Telescope (SRT). Under this contract, the terms “fiber optic link” and “enclosure” will have the following meaning:

A *fiber optic link* is a combination of one OTX (optical transmitter) and one ORX (optical receiver). The fiber cable in between isn't part of the supply contract.

An *enclosure* is a box containing an amount of OTX (OTX enclosure) and an amount of ORX (ORX enclosure).

These links aim to route the signal coming from various high frequency microwave receivers (18-26GHz, K-band; 33-50GHz, Q-band; 75-116GHz, W-band), all of them showing an output band within the 1-18GHz range. These receivers are of the multi-feed class with a maximum of 38 outputs, each of them with its own optical link (no WDM). The request for 40 links comes for providing two spare parts. The 1-18GHz signals will be sent to the optic receivers about 600m away located in the main building of the observatory, (fig. 1).

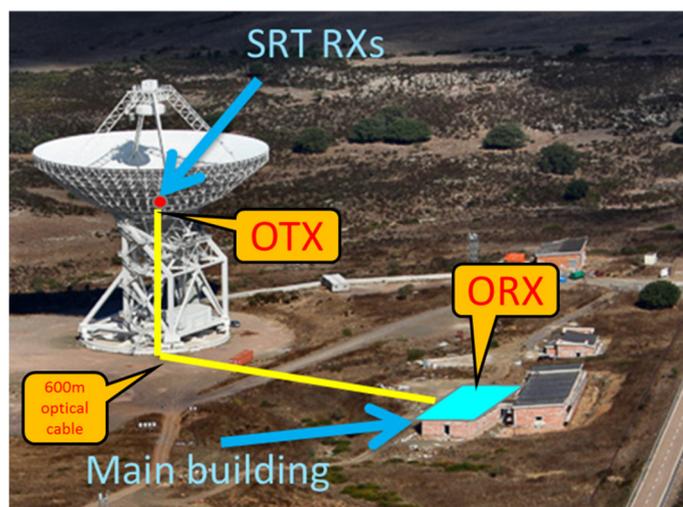


Fig. 1 SRT antenna remoting system

Due to various scientific programs to be developed with this radio astronomical facility the main specifications of the wideband Radio Frequency over Fiber (RFoF) link have to be as the following:

1. Very low noise and convenient gain to fit the design of the overall receiving chains
2. Reduced dimensions fitting the space available, both at the transmitting and receiving stage
3. High input and output compression point
4. Better than usual input and output return loss

The links will not experience a harsh environment. The fiber optic transmitters and receivers will be located in closed and thermal controlled rooms.

The optical transmitters installed on the antenna will be subjected to two different movements: one coming from the slewing of the antenna when the source on the sky has to be changed (speed=0.85 degree/s; acceleration=0.5 degree/s²); another one when the rotating drum is moved to place on focus a microwave receiver (speed=3.5 degree/s; acceleration=1.75 degree/s²). These movements may happen at the same time or may not, however the receiving system is not acquiring data.

The supply contract will be split into two different phases:

Phase 1) Pre-production of **3 (three)** links to verify the fulfilment of the requested RF specifications. Together with the links also the enclosure with the respective OTX and ORX should be designed and produced, at least at the level of prototype unit, and the test performed with the OTX and ORX modules assembled within. If the enclosures which will power and control the OTX and the ORX will be functionally the same and can host and operate at the same time OTX and ORX modules, only one is requested to be evaluated. Otherwise two units must be evaluated, one for the OTX and one for the ORX. The contracting authority plans to visit the factory in order to tightly follow the tests on the prototypes either in presence or remotely, both for what concerns the obtained results as well as the instrumentation and test methods used. On the basis of the achievements, the contracting authority could require to repeat the whole characterization, or only part of it, at the contracting authority site using own instrumentation and personnel. In any case the company will deliver the due report which must include all graphs and tables of the measurements which demonstrate the fulfilment of the requirements along with the description of the test methods used.

Phase 2) Once INAF verified as positive the results obtained, the company will be allowed to supply the whole production of 40 links housed into their enclosures.

Art. 3 Minimum Functional Requirements

The winning economic operator must supply original, new, uncontracted products bearing the manufacturer's mark, be non-regenerated or of unlawful origin (or from unauthorized sources), regularly marketed, and such as not necessary to obtain, for the requested functions, subsequent additions of hardware and/or software components or in any case modifications that entail an economic burden for the contracting **Authority**.

Art. 4 Minimum Technical Requirements

The supply consists of **40 (forty)** RFoF very low noise wideband optical links which must have the following minimum technical requirements. The economic operator has to fill in the Compliance Matrix, annex **RFof-annex_08-compliance**, with Y (yes) or N (no) on each item. Add the ensured value if known. It will be used in the award criteria as described in art. 28 of the **RFof-TSP-02** file. Short notes can be added. Please, note that the offer has to fulfil all the minimum technical

requirements, as stated in the RFOF-TSP-02 file, art. 23, requirement 1T).

Please note that the specifications are given considering the optical connections between OTX and ORX made by three fiber patch cords 1m long using single mode fiber G652D with FC/APC connectors. This is to emulate the final installation at the antenna site where the attenuation introduced by the optical connectors dominate the overall optical losses due to the short length of the optical fiber (about 600m), fig. 2 and 3.

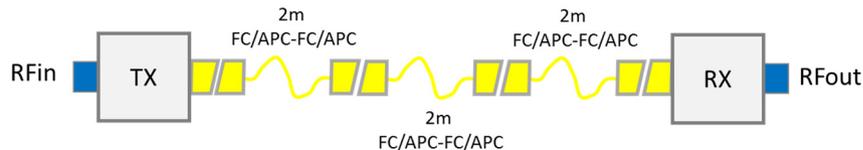


Fig. 2 Lab testing optical connections

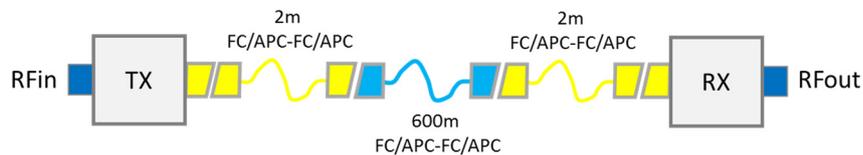


Fig. 3 Actual on-site optical connections

RF specifications (in the RF bandwidth and at the operational temperature indicated in the environmental and mechanical specifications)

- RF bandwidth (not less than): 1-18GHz;
- Noise figure: < 6 dB, a better value will be rewarded with adding points in the bidding evaluation as stated in the “Tender specifications” document, Art. 28, “Award criteria and scoring methods”;
- Gain: 14 dB \pm 2.5dB, a better value of the flatness will be rewarded with adding points in the bidding evaluation as stated in the “Tender specifications” document, Art. 28, “Award criteria and scoring methods”;
- Gain smoothness: \pm 1dB (on 2GHz bandwidth)
- Input Return Loss: 10dB min, 12dB typ, a better typical value will be rewarded with adding points in the bidding evaluation as stated in the “Tender specifications” document, Art. 28, “Award criteria and scoring methods”;
- Output Return Loss: 10dB min, 12dB typ, a better typical value will be rewarded with adding points in the bidding evaluation as stated in the “Tender specifications”, document Art. 28, “Award criteria and scoring methods”;
- Input P1dB (IP1dB): > -11dBm, better values will be rewarded in the bidding evaluation as stated in the “Tender specifications” document, Art. 28, Award criteria and scoring methods”;
- Input IP3 (IIP3) and Input IP2 (IIP2): best effort \geq the IP1dB value;
- Group delay: the link be “linear phase” and the group delay difference among links be within 10% of the average value;
- SSB Phase noise: < -80dBc/Hz at 10Hz offset;
- Phase stability: \leq 5 degree rms within 1 sec integration through band;

- RF Input connection: SMA female or equivalent/compatible;
- RF Output connection: SMA female or equivalent/compatible;
- RF impedance: 50Ω

Optical specifications

- Link length: about 600m, standard single mode fiber G652D (fiber is not supplied by the company);
- Wavelength: 1550nm or 1310nm;
- Optical connector: FC/APC;

Power supply specifications

- Main power supply: 230 VAC/50 Hz; the plug must be placed on the rear panel.
- Power consumption: less than a total of 450W for all the enclosures powered on and with 38 OTX working; less than 80W for all the enclosures powered on and with 38 ORX working. The two spare OTX and the two spare ORX have to be installed in their respective enclosure together with the other modules as normal operating, powered off or in stand-by mode. They will be switched on in case of fault of an operating OTX/ORX.

Environmental specifications

- Ambient temperature of the room where OTX and ORX are placed: 15 to 30 °C (set up is depending on the season);
- Max ambient temperature variation of the room where OTX and ORX are placed: ± 2 °C;

Mechanical specifications

- The enclosures with the 40 OTX/ORX will be arranged by INAF into standard cabinets;
- At least 10 OTX/ORX, including the power supply, should be placed in a standard 19"/3U enclosure which must have a max depth less or equal than 600mm for OTXs and 400 mm for ORXs; It is required that optical and coaxial connectors be placed on the front panel;
- The enclosures must be designed from both mechanical and thermal dissipation point of view in order to allow them to be stacked without any empty space in between and without the necessity to add auxiliary fan systems. This means the overall height of all enclosures when installed must be less or equal than 12U;
Smaller dimensions or a larger number of OTX/ORX for each enclosure will be rewarded with adding points in the bidding evaluation as stated in the "Tender specifications" document, Art. 28, "Award criteria and scoring methods";
- Marking of OTX and ORX: use permanently mark on the modules. The marking shall contain type number, serial number, a progressive number from 1 to 40 and the marking of input, output ports.

Operational and functional specifications

- The enclosure has to be designed such that it is possible to easily replace a faulty OTX/ORX without the need to remove it from the rack where it is placed;
- Both the enclosure and the OTX/ORX should be designed to allow insertion and removal of any

OTX/ORX in the enclosure regardless to the other ones, installed or not, in the same enclosure;

- An enclosure must be able to operate and control the OTX/ORX therein contained regardless their number and their position in the enclosure itself;
 - One or more visible light indicators (LED) must be present on the front panel of each OTX/ORX which must indicate the main information of the status, like on/off and normal/anomalous functioning.
 - Each enclosure must have the capability to remotely monitor/control vital parameters of any OTX/ORX by using standard serial or LAN interfaces;
- **Product technical accessories features.** No technical accessories must be provided.
 - **Technical features of accessory services.** No ancillary services must be provided.
 - **Certificates of product originality.** A product datasheet should be provided with detailed information on the measurement for each link. Each unit must be supplied with measurements results about the requested specifications.
The measurement must include, the whole operating bandwidth of the link with a step of 0.01 GHz at least.
The results must be supplied as:
 - Description of the measurement setups
 - Graphs in electronic format using files (e.g.: .pdf, .doc);
 - Data in tabular form. The file format must be .xlsx and ASCII (.txt), one file per module.

Art. 5 Minimum Performance Requirements

- **Commercial guarantee - Duration and extension.** Not less than **12 (twelve)** months. A longer duration will be rewarded with adding points in the bidding evaluation as stated in the “Tender specifications” document, Art. 28, “Award criteria and scoring methods”.
- **Lead / Delivery Time.**
From the date of transmission of the purchase/loyalty order on the e-procurement platform U-BUY, **3 (three)** prototypes must be completed and available for their validation within 4 (four) months (Phase 1). A faster delivery of prototypes is welcomed and will allow the company to add the saved months to the delivery time of Phase 2.
After the formal INAF acceptance of prototypes, the supply of the **40 (forty)** enclosed OTX/ORX can be delivered by the company (Phase 2).
The overall delivery time for these two phases must be within **8 (eight)** months.
The time spent by INAF for the acceptance of the prototypes (including the case INAF will test the prototypes after the Phase 1) is outside this period.
A delivery time shorter than 8 months will be rewarded with adding points in the bidding evaluation as stated in the tender specifications, the RFOF-TSP-02 file.
- **After-sales technical assistance to be provided.**
 - 1) *times for replacement of defective products / spare parts.* The defective component must be replaced within **30 (thirty)** solar days from the notification.
 - 2) *mode that will be used to notify the malfunction.* The contracting authority will

communicate the malfunction to the contractor using the certified e-mail address or corporate e-mail in the case of a foreign contractor without an operational headquarters in Italy.

- 3) *charges for replacement of spare/malfunctioning parts.* During the warranty period the replacement of the non-functioning product will be borne by the supplier both for the collection of the defective part and for the delivery of the replacement part. The parties will decide if the replacement will be conducted by the contracting authority remotely assisted by the contractor or on site by the supplier.

Art. 6 Supply conditions

- **Items / costs included in the price.** With the price requested by the economic operator at the time of the economic offer, it is intended as fully compensated and included, without involving additional costs for the contracting authority:
 - the supply of the product.
 - the charges foreseen by **INCOTERMS 2020® DDP**¹.
 - the costs incurred by the contractor for the replacement of the products found to be defective during the commercial warranty period and possibly, during the additional period guaranteed by the economic operator during the offer.
- **Items / costs not included in the price.** The contracting authority will only pay the V.A.T.
- **Terms of payment.** Once completed the on-site acceptance procedure (see below), that has to be evaluated, approved and released by the Director of the contracting Authority, the contractor may issue the invoice. Pursuant to Legislative Decree 192/2012, the contracting Authority will make, within **30 (thirty)** days from the date of submission of the (electronic) invoice, the payment of the due amount by bank transfer to the dedicated current account communicated by the contractor itself. The payment mandate may be issued only in the presence of a positive tax payment verification. If the contractor is a Temporary Grouping of Companies, the invoicing will be carried out, for the entire amount due on account and in full, by the agent alone, to whom the commitment will be taken relative expense. Since the contracting Authority is one of the public administrations subject to split payment, the contractor will have to issue an invoice with the words "Operation subject to the split of payments (split payment) with VAT not collected by the transferor pursuant to art. 17-ter of Presidential Decree 633/1972" and will collect only the taxable amount, while V.A.T. will be paid to the Treasury by the same contracting authority, instead of to the supplier. Pursuant to art. 35 point 18 of the Italian **Public Procurement Act** (d.lgs. 50/2016), a **30% (thirty percent)** payment on account is allowed **provided that a guarantee policy is available**.
- **Transport insurance policy.** It must be paid by the contractor.
- **Packaging method.** It is care and responsibility of the contractor to choose quality external materials, rigid and in good condition. The box must be new and must not have been used beforehand. Choose the size of the box based on the final size of the product you are sending: semi-empty packages can be easily bent and damaged, those that are too full can break. The

¹ *Delivered Duty Paid* means that the goods are placed at the disposal of the buyer, the INAF-Osservatorio Astronomico di Cagliari, cleared for import, on the arriving means of transport, ready for unloading, at the named place of destination, the Sardinia Radio Telescope observational facility, located at località "Pranusanguni", San Basilio (SU). It is intended that the buyer will pay the V.A.T.

handling instructions (such as brittle and / or similar) do not guarantee the safety of the goods by the transport company. Take care of the internal packaging, which provides protection for the goods during transport and during delivery. A good internal packaging must be able to protect the product from shocks and vibrations. Seal all possible openings, using quality resistive products. Insert on the outer edges of the box plastic or cardboard protectors that distribute the pressure evenly and avoid damage to the outer casing.

Art. 7 Delivery

- **Location.** The three prototypes must be delivered to the following location:
INAF-IRA Via P. Gobetti 101, 40129 (Bologna, Italy) to the attention of Alessandro Orfei. Detailed information will be provided at the time of shipping.
- **Shipping methods.** Pursuant to **INCOTERMS 2020® DDP**.
- **Method of unloading goods.** Pursuant to **INCOTERMS 2020® DDP** (ground floor, by the courier appointed by the contractor).
- **Presence of specialized contractor personnel.** For the delivery phase, the presence of specialized contractor personnel is not required, but it is allowed.

Art. 8 Acceptance procedures

- **FAT – Factory Acceptance Testing. Testing in progress at the supplier's headquarters. Modes and times. Required documentation.** The contracting Authority does not plan to be part of FAT. On the other hand, upon request of the contracting authority, one or more inspections may be carried out, to be agreed, at the contractor's premises.
- **OAT – Onsite Acceptance Testing. Test on delivery at the headquarters of the customer. Modes and times. Presence of specialized supplier personnel during the OAT phase. Required documentation.** The contracting authority will verify with its own personnel the compliance of the delivered products with the technical and functional requirements indicated by the contractor at the time of the offer, comparing them with the test report associated with each individual product. The contracting authority will decide whether testing the supply on a small sample of the whole delivery.

Terms and conditions: OAT will be completed within 15 consecutive calendar days from the delivery date of the product.

Documentation for OAT: test report and datasheets of the products with graphs and number tables, as previously requested and specified.

Supplier personnel: the presence of supplier personnel during OAT is not required but permitted. At the end of OAT a certificate of regular execution (test certificate) will be issued signed by the Execution Director, if appointed, alternatively by the Responsible for the procedure.

Art. 9 Obligations of the supplier

- **Appointment and duties of the Contract Manager.** The contractor will have to indicate his own Contract Manager with whom the contracting authority will be able to interact until the issue of the certificate of conformity (test certificate) of the supply.

- **Appointment and duties of the technical manager of the supply.** The contractor will have to indicate his own technical manager of the supply with which the contracting authority will be able to interact until the issuing phase of the certificate of conformity of the supply. The figures of Contract Manager and Technical Manager of the supply may coincide.