



Indian Institute of Science Bangalore

Prof. Mayank Shrivastava
Associate Professor
Department of Electronic Systems Engineering
Indian Institute of Science Bangalore
560012, Bangalore, Karnataka, India

Global Tender Notification for the procurement of Quantum measurement and control setup for 2 quantum dot/semiconducting qubit system

GTE Approval Number: IISc-GTE-2022-212

Publishing Date: 14/10/2022

Reference Number: GTE/DESE/LU/MSA/15/2022-23

Request for Quote from Global Original Equipment Manufacturer (OEM) or their authorized distributor for Quantum measurement and control setup for 2 quantum dot/semiconducting qubit system

**Indian Institute of Science, Bangalore
(Last Date: 4th November 2022)**

Dear Sir/Madam,

Kindly send your best price quotation for the following item with various accessories on CIP, Bangalore basis to the undersigned. Your quotation should clearly indicate the terms of delivery, delivery schedule, payment terms, etc.

Your quote should also include mode of payment and should reach the undersigned, duly signed on or before 1000 hours (IST) on 4th November 2022.

The quote must include all details of technical specifications of the equipment along with the commercial terms and conditions, the bill of materials, printed technical brochure and any other supporting document. Vendors will be required to submit a technical proposal and a commercial proposal in two separate sealed envelopes. Please enclose a compliance certificate, printed on your letter head, along with the quote. The commercial bid must be in CIP Bangalore and the quotation should address to:

The Chairman,
Department of Electronic Systems Engineering
Indian Institute of Science, Bangalore – 560 012

General Description and specifications:

The purpose of this setup is to control and measure the status of 1 or 2 semiconducting qubits/Quantum dots. This system needs to be integrated with the dilution refrigerator. The system should be able to control and do all the measurements and gating operations on single qubit configuration and two qubits configurations independently. Below are some of the quantum gates that will be implemented in initial stage of our exploration & instruments/setups that are needed for such measurements are therefore required to be integrated/provided with the quantum measurement setup.

Single Qubit Gates: Pauli X, Y & Z gates, Rotation gates to manipulate, general & special (Hadamard) superposition

E-mail : mayank@iisc.ac.in (write to msdlab.ese@iisc.ac.in for tender related queries)
Phone : +91-80-2293-2732
Faculty Web : <https://faculty.dese.iisc.ac.in/mayank/>
Institute Web : <http://www.iisc.ac.in/>



Indian Institute of Science Bangalore

Prof. Mayank Shrivastava
Associate Professor
Department of Electronic Systems Engineering
Indian Institute of Science Bangalore
560012, Bangalore, Karnataka, India

gates, General & special phase gates (Z, S, T) to manipulate phase angle.

Two Qubit Gates: Controlled NOT gate to implement basic 2 qubit-controlled operations, SWAP Gate to allow swapping of two qubit states, Controlled Phase Gates that enables to manipulate phase of target qubit via a control qubit. All quantum gates should have the ease of integration into quantum circuits at a later stage of research.

Also, if possible we would like to know if an integrated setup can be provided to create Bell states for entanglement operations.

Software:

All the aforementioned operations on single and two qubit systems should be individually performed by the software. Furthermore, we would like to know if a reconfigurable software-controlled setup is possible for performing all single & two qubit gates. To avoid having to build scripts for each action that needs to be performed on semiconducting qubits or quantum dots, this software must already have all the necessary instructions (Inbuilt). The hardware and software should be properly calibrated.

I. Technical Specifications of Different Parts of Qubit measurement setup

The setup may include following parts whose specifications are mentioned below:

1. Ultra-high frequency Lock-in Amplifier

- 600 MHz dual lock-in amplifier, dual signal generator, 4 dual-phase demodulators per channel with LAN and USB ports
- Capability of directly measuring signals in the frequency range from DC to 600 MHz without switching between ADCs.
- Lowest signal input noise of $4 \text{ nV}/\sqrt{\text{Hz}}$ for frequencies higher than 5 MHz.
- Analog signal output with amplitude of more than 1 V and more than 500 MHz (1.5 V up to 600 MHz).
- Lock-in amplifier for frequencies $> 200 \text{ MHz}$ with an input range as small as 10 mV.
- Frequency response analyzer up to 600 MHz.

2. Ultra-high frequency -Multi frequency lock-in amplifier

- Lock-in amplifier with 8 arbitrary frequencies
- Low noise input
- Sampling rate in MSa/s
- DC characteristics, low frequency conductance, and gate transimpedance measurement capability at the same time.

3. Arbitrary Waveform Generator

- Two signal outputs, dual generator engine
- High sampling rate $> 1 \text{ GSa/s}$
- 8 Channels per unit
- Less trigger to output delay
- Less delay for dynamic sequencing with multi-bit input signals

4. Ultra-high frequency digitizer

- Two signal inputs



Indian Institute of Science Bangalore

Prof. Mayank Shrivastava
Associate Professor
Department of Electronic Systems Engineering
Indian Institute of Science Bangalore
560012, Bangalore, Karnataka, India

- High sampling rate >1 GSa/s
 - Minimum 12 bit resolution
 - Memory per channels in hundreds of MSa/s
- 5. High Density Arbitrary waveform generator**
- 8 outputs, Frequency=750MHz
 - Sampling rate 2.4GSa/s, 16 bit output
 - Less than 50 ns trigger to output delay
 - Less than 150 ns delay for dynamic sequencing with multi-bit input signals
- 6. Multi frequency Lock-in Amplifier**
- Frequency range 500kHz
 - One demodulator, field upgradable
 - Toolset: Scope, sweeper and spectrum analyzer
- 7. Setup details:**
- Should include a written guide (tutorial) as well as a demonstration of how to integrate numerous components of the measurement setup.
 - The setup should include all the hardware and software modules that are necessary for the Quantum measurement setup.
- 8. Other Necessities**
- IQ mixers and directional couplers should be provided.
 - Required RF and DC cables and connectors that are needed to connect different equipments together and with the dilution refrigerator should be provided
 - RF and DC cable connectors
 - Please provide the details about the required equipments that need to be purchased separately (if any).

II. Optional Items:

1. Multiple frequency-Multi demodulators (eg; which can extend number of oscillators and demodulators to a total of 4 and also adds 1 external reference PLL)
2. Multiple frequency-digitizer option (Up to 30 MHz FFT span, sampling rate 60 MSa/s, 2.5MSa/channel, 16bit and input bandwidth up to 7 MHz etc)
3. Please provide separate letter indicating annual maintenance charges (AMC) post warranty / guarantee period

III. Additional Items (Must be added to compliance certificate as well):

1. Support: Please provide details of support provided within the warranty period
2. Shipping: The quote must be in CIP, Bangalore.
3. Installation: Please list a set of acceptance tests for on-site (vendor) inspection and after installation at IISc Bangalore.

E-mail : mayank@iisc.ac.in (write to msdlab.es@iisc.ac.in for tender related queries)
Phone : +91-80-2293-2732
Faculty Web : <https://faculty.dese.iisc.ac.in/mayank/>
Institute Web : <http://www.iisc.ac.in/>



Indian Institute of Science Bangalore

Prof. Mayank Shrivastava
Associate Professor
Department of Electronic Systems Engineering
Indian Institute of Science Bangalore
560012, Bangalore, Karnataka, India

4. Other Options: Necessary spare parts should be quoted as an option.
5. Please include any other options currently available that can be added on in the future.
6. Training: Please state if training is required to operate this instrument, and if yes, please highlight the extent of training provided as part of this purchase and for how many days.

Any setup that has slightly different hardware or configuration, but meets the required purpose is also acceptable.

All of the above-mentioned technical specifications are highly desired. However, lower technical specifications may be considered if the above-mentioned specifications are found to be unsuitable in financial terms. The Institute reserves the right to go for lower specifications taking into consideration its technical preferences and financial constraints. Vendors are encouraged to highlight the advantages of their tools over comparable tools from the competitors.

PI Terms and conditions (should be included in compliance certificate):

1. Necessary training to operate the procured setup and required literature support should be provided without additional cost.
2. In principle onsite installation should be free of cost. The amount of time / day committed by the engineer during installation must be clearly stated.
3. Software upgrade, if any, must be free of cost for next 5 years.
4. The vendor must assure that there are no bugs and glitches with the integration. In case of glitches or bugs at the time of installation, vendor must fix the issues in less than three days from the start date.
5. In case of hardware/software issues or support, vendor should be able to provide required solution within three days.
6. All equipment must be well calibrated before and after installation.
7. Additional quote for an annual maintenance contract should be included for the next 5 years.
8. The vendor should have a good track record of delivering such equipment at universities/research institutions (please furnish the details).
9. Please provide list of customers who have procured your equipment in last 5 years.
10. The vendor should be able to repair and maintain the equipment, once it is installed in India. No travel claims must be made by vendor for servicing during the warranty/guarantee period.
11. The lead time for the delivery of the equipment should not be more than 2 months from the date of receipt of our letter of intent. The smallest lead time will be appreciated. Our expectation is shipment immediately after PO and full or part payment post-installation.
12. On all systems the payment terms will be specified in the commercial proposal and is subject to negotiation.
13. The validity period of the quotation should be 90 days at least.
14. Please provide details of the number of trained personnel in India, who can service the machine.
15. Highlight the system/computer requirement to integrate the setup, if any other than specified in the specifications above.
16. See other Terms & Conditions in enclosed document in the next pages.



Indian Institute of Science Bangalore

Prof. Mayank Shrivastava
Associate Professor
Department of Electronic Systems Engineering
Indian Institute of Science Bangalore
560012, Bangalore, Karnataka, India

Sincerely,

Prof. Mayank Shrivastava
Associate Professor
Department of Electronic Systems Engineering,
Indian Institute of Science,
Bangalore, Karnataka 560012, India
Secretary (Ms. Rekha's) Contact: 9972525771
(On Behalf of Purchase Committee)
Email: msdlab.esse@iisc.ac.in (for tender related queries)

Enclosures / Annexures

Annexure 1 – Terms and Conditions:

A) Submission of Tender:

1. All documentations in the tender should be in English.
2. Tender should be submitted in two envelopes (two bid system).
 - a. Technical Bid (Part-A) – Technical bid consisting of all technical details and check list for conformance to technical specifications.

The technical proposal should contain a technical compliance table with 5 columns.

- i. The first column must list the technical requirements, in the order that they are given in the technical requirement below.
- ii. The second column should provide specifications of the instrument/product against the requirement. Please provide quantitative responses wherever possible.
- iii. The third column should describe your compliance with a “Yes” or “No” only. Ensure that the entries in column 2 and column 3 are consistent.
- iv. The fourth column should state the reasons/explanations/context for deviations, if any.
- v. The fifth column can contain additional remarks from the OEM. You can use this opportunity to highlight technical features, qualify response of previous columns, or provide additional details, compare your solution with that of your competitors or provide details as requested in the technical requirements table below.

- b. Commercial Bid (Part-B) – Indicating item-wise price for the items mentioned in the technical bid, as per the format of quotation provided in tender, and other commercial terms and conditions.

3. The technical bid and price bid should each be placed in separate sealed covers, superscripting on both the envelopes the tender no. and the due date. Both these sealed covers are to be placed in a bigger cover which should also be sealed and duly superscripted with the Tender No, Tender Description & Due Date.
4. The SEALED COVER superscripting tender number / due date & should reach **Chairman Office, Department of Electronic Systems Engineering, Indian Institute of Science, Bangalore – 560012, India** on or before due date mentioned in the tender

notice. In case due date happens to be holiday the tender will be accepted and opened on the next working day. If the quotation cover is not sealed, it will be rejected.

5. All queries are to be addressed to the person identified in “Section 1 – Bid Schedule” of the tender notice.

8. If price is not quoted in Commercial Bid as per the format provided in tender document the bid is liable to be rejected.

9. The Institute reserves the right to accept or reject any bid and to annul the bidding process and reject all bids at any time prior to the award of contract, without thereby incurring any liability to the affected bidder or bidders or any obligation to inform the affected bidder or bidders.

10. Incomplete bids will be summarily rejected.

B) Cancellation of Tender:

Notwithstanding anything specified in this tender document, IISc Bangalore, in its sole discretion, unconditionally and without having to assign any reason, reserves the rights:

- a. To accept OR reject lowest tender or any other tender or all the tenders.
- b. To accept any tender in full or in part.
- c. To reject the tender, offer not confirming to the tender terms.

C) Validity of the Offer:

The offer shall be valid 90 Days from the date of opening of the commercial bid.

D) Evaluation of Offer:

1. The technical bid (Part A) will be opened first and evaluated.
2. Bidders meeting the required eligibility criteria as stated in Section 2 of this Document shall only be considered for Commercial Bid (Part B) opening. Further, Agencies not furnishing the documentary evidence as required will not be considered.
3. Pre- qualification of the bidders shall not imply final acceptance of the Commercial Bid. The agency may be rejected at any point during technical evaluation or during commercial evaluation. The decision in regard to acceptance and/or rejection of any offer in part or full shall be the sole discretion of IISc Bangalore, and the decision in this regard shall be binding on the bidders.
4. The award of contract will be subject to acceptance of the terms and conditions stated in this tender.

5. Any offer which deviates from the vital conditions (as illustrated below) of the tender is liable to be rejected:

- a. Non-submission of complete offers.
- b. Receipt of bids after due date and time and or by email / fax (unless specified otherwise).
- c. Receipt of bids in open conditions.

6. In case any BIDDER is silent on any clauses mentioned in these tender documents, IISc Bangalore shall construe that the BIDDER had accepted the clauses as of the tender and no further claim will be entertained.

7. No revision in the terms and conditions quoted in the offer will be entertained after the last date and time fixed for receipt of tenders.

8. Lowest bid will be calculated based on the total price of all items tendered for Basic equipment along with accessories selected for installation, operation, pre-processing and post-processing, optional items, recommended spares, warranty, annual maintenance contract.

E) Pre-requisites:

The bidder will provide the prerequisite installation requirement of the equipment along with the technical bid.

F) Warranty:

The complete system is to be under warranty period of minimum 1-3 years (year wise breakup value should be shown in the commercial bid) including free supply of consumables, spare parts and data analysis software from the date of functional installation. If the instrument is found to be defective, it has to be replaced or rectified at the cost of the bidder within 30 days from the date of receipt of written communications from IISc, Bangalore. If there is any delay in replacement or rectification, the warranty period should be correspondingly extended.

G) Annual Maintenance Contract:

An annual maintenance contract for a period of at least 2 years post-warranty if the warranty is for 1 year, should be provided on completion of warranty period. The AMC costs will not be considered towards classifying the domestic nature (class 1 or class 2) of the vendor (see eligibility criteria in section 2). AMC for 1 year is sought for warranty of 2 years, and AMC will be optional for 3 year warranty.

H) Purchase Order:

1. The order will be placed on the bidder whose bid is accepted by IISc based on the terms & conditions mentioned in the tender document.
2. The quantity of the items in tender is only indicative. IISc, Bangalore reserves the right to increase /decrease the quantity of the items depending on the requirement.
3. If the quality of the product and service provided is not found satisfactory, IISc, Bangalore reserves the right to cancel or amend the contract.

I) Delivery, Installation and Training:

The bidder shall provide the lead time to delivery, installation and made functional at IISc, Bangalore from the date of receipt of purchase order. The system should be delivered, installed and made functional within 90 days from the date of receipt of purchase order. The supply of the items will be considered as effected only on satisfactory installation and inspection of the system and inspection of all the items and features/capabilities tested by the IISc, Bangalore. After successful installation and inspection, the date of taking over of entire system by the IISc, Bangalore shall be taken as the start of the warranty period. No partial shipment is allowed. The bidder should also arrange for technical training to the local facility technologists and users.

J) Payment Terms:

We prefer net 30 days.

K) General:

1. All amendments, time extension, clarifications etc., within the period of submission of the tender will be communicated electronically. No extension in the bid due date/time shall be considered on account of delay in receipt of any document(s) by mail.
2. The bidder may furnish any additional information, which is necessary to establish capabilities to successfully complete the envisaged work. It is, however, advised not to furnish superfluous information.
3. Any information furnished by the bidder found to be incorrect, either immediately or at a later date, would render the bidder liable to be debarred from tendering/taking up of work in IISc, Bangalore.

Annexure – 2:

Declaration for acceptance of terms and conditions

To,

The Chairman,

Department of Electronic Systems Engineering

Indian Institute of Science,

Bangalore – 560012, India

Ref: Tender No: XXXXXX

Dated: XXXX

Supply and/or installation of <Item Name> at Prof. Mayank Shrivastava's Lab, Department of ESE, IISc Bangalore

Sir,

I've carefully gone through the Terms & Conditions as mentioned in the above referred tender document. I declare that all the provisions of this tender document are acceptable to my company. I further certify that I'm an authorized signatory of my company and am, therefore, competent to make this declaration.

Yours faithfully,

(Signature of the Bidder)

Name

Designation, Seal

Date: