

	<p style="text-align: center;">INDIAN INSTITUTE OF TECHNOLOGY MADRAS Chennai 600 036</p> <p style="text-align: center;">Telephone : [044] 22574468 E-mail: ani@ee.iitm.ac.in</p>	
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Dr. Sankaran Aniruddhan
Project Coordinator

Ref: ELE/ANIR/07/2017
Dated: 22.06.2017

Limited Tender No: ELE/ANIR/07/2017

Due Date: DEADLINE EXTENDED TO 24.07.2017, 3:00pm

Dear Sir/Madam,

On behalf of the Indian Institute of Technology Madras, offers are invited for the supply of the following items.

- A. 5G Testbed – 5G testbed consisting of Vector Signal Generator/Arbitrary Waveform Generator, Spectrum/signal analyser and Vector network analyser and accessories.
- B. Probe station - Silicon Die probing solution consisting of Probe Station, vibration isolation table, vacuum pump and accessories.

The technical requirements are attached.

Vendor may quote for either item A or item B or both. Vendor must quote for all components of the item. Quotations for individual components of items will not be entertained. The details terms and conditions are attached. **{Clarification: You are allowed to quote partially in EURO/USD and partially in INR in the same quotation, as long as it meets all other conditions listed in the tender. We will convert all Euro/USD quotes to INR with exchange rate on that day for comparison purposes, and choose the lowest number among all quotations.}**

All additional options possible should be mentioned clearly with corresponding quote in the bid.

Instructions to the Bidder

- (i) **Preparation of Bids:** - The Limited tenders should be submitted under two-bid system (i.e.) Technical bid and Financial bid in two separate sealed envelopes.
- (ii) **Delivery of the tender:** - The tender shall be sent to the below-mentioned addresses either by post or by courier so as to reach the following address before the due date and time specified in our Schedule:

Dr. Sankaran Aniruddhan, c/o EE department Office, Dept. of Electrical Engineering,
IIT Madras-600 036.

(iii) **Opening of the tender:** - A committee duly constituted for this purpose will open the offer/Bids. The technical bids will be opened first and a technical committee, which will decide the suitability of the bid as per our specifications and requirements, will examine it.

(iv) **Prices:** - The price should be quoted in net per unit (after breakup) and must include all packing and delivery charges to the Department. The offer/bid should be exclusive of taxes and duties, which will be paid by the purchaser as applicable. However the percentage of tax & duties should be clearly indicated.

The price should be quoted without custom duty and excise duty, since I.I.T. Madras is exempt from payment of excise duty, and the custom duty will be paid at concessional rate against duty exemption certificate.

In case of import supply, the price should be quoted on EX-WORKS, CIF basis indicating the mode of shipment.

The price may be quoted in USD, Euro and/or INR. The prevailing market exchange rate on the day of bid evaluation will be used to compare bids.

(v) **Agency Commission:** - Agency commission, if any, will be paid to the Indian agents in Rupees on receipt of the equipment and after satisfactory installation. Agency Commission will not be paid in foreign currency under any circumstances. The details should be explicitly shown in Tender even in the case of 'Nil' commission. The tenderer should indicate the percentage of agency commission to be paid to the Indian agent. The foreign Principal should indicate about the percentage of payment.

(vi) **Terms of Delivery:** - The item should be supplied to our Department as per Purchase Order. In case of import supply, the item should be delivered at the cost of the supplier to our Institution. The Installation/Commissioning should be completed within three months from the date of Purchase Order.

(vii) IIT Madras reserves the full right to accept / reject any tender at stage without assigning any reason.

Yours sincerely,
Sankaran Aniruddhan

SCHEDULE

Important Conditions of the tender

1. The due date for the submission of the tender is **Due Date: 24.07.2017, 3:00pm**
2. The offers / bids should be submitted in two bids systems (i.e.) Technical bid and Financial bid. The Technical bid should consist of all technical details / specifications only. The Financial bid should indicate item-wise price for each item and it should contain all Commercial Terms and Conditions including Taxes, transportation, packing & forwarding, installation, guarantee, payment terms, pricing terms etc. The Technical bid and Financial bid should be put in separate covers and sealed. Both the sealed covers should be put in a bigger cover. The Limited Tender for supply of

- A. 5G Testbed**
- B. Probe Station**

should be written on the left side of the Outer bigger cover and sealed.

3. **Performance Security:-** The successful bidder should submit Performance Security for an amount of 5% of the value of the Purchase Order. The Performance Security may be furnished in the form of an Account Payee DD, FD Receipt from the commercial bank, Bank Guarantee from any nationalized bank of India will be acceptable.

Only after submission of Performance Security, Purchase Order/Work Order will be released / L.C will be opened.

Performance Security in the form of Bank Guarantee:- In case the successful bidder wishes to submit Performance Security in the form of Bank Guarantee, the Bank Guarantee should be routed through the Beneficiary Bank to the end user bank. Otherwise, the Indian Agent of the foreign vendor has to submit a Bank Guarantee from a Nationalized Bank of India.

The Bank Guarantee should remain valid for a period of sixty days beyond the date of completion of all contractual obligations of the supplier including the warranty obligations.

4. If an Indian agent is involved, the following documents must be enclosed:
Foreign principal's proforma invoice indicating the commission payable to the Indian Agent and nature of after-sales service to be rendered by the Indian Agent.
 - ✓ Copy of the agency agreement with the foreign principal and the precise relationship between them and their mutual interest in the business.
 - ✓ The enlistment of the Indian agent with Director General of Supplies & Disposals under the Compulsory Registration Scheme of Ministry of Finance.
5. The offer/bids should be sent only for a machine that is available in the market and supplied to a number of customers. A list of customers with details must accompany the quotations. Quotations for a prototype machine will not be accepted.
6. Original catalogue (not any photocopy) of the quoted model duly signed by the principals must accompany the quotation in the Technical bid. No prices should ever be included in the Technical bid.
7. Documentary proof for the claimed position and repetition accuracies must be obtained from the principals and submitted along with the relevant pages of the standards.
8. Compliance or Confirmation report with reference to the specifications and other terms & conditions should also be obtained from the principal.
9. **Validity:** Validity of Quotation not less than 90 days from the due date of tender.
10. **Delivery Schedule:-** The tenderer should indicate clearly the time required for delivery (less than three months from the date of Purchase Order) of the item. In case there is any deviation in the delivery schedule, liquidated damages clause will be enforced or penalty for the delayed supply period will be levied.
11. **Risk Purchase Clause:-** In the event of failure of supply of the item/equipment within the stipulated delivery schedule, the purchaser has all the right to purchase the item/equipment from other sources on the total risk of the supplier under risk purchase clause.
12. **Payment:-** No Advance payment will be made for Indigenous purchase. However 90% Payment against Delivery and 10% after installation are agreed to wherever the installation is involved. In case of import supplies the payment will be made only through 100% Letter of Credit i.e. (90% payment will be released against shipping documents and 10% after successful installation wherever the installation is being done).
13. **Advance Payment:-** No advance payment is generally admissible. In case of specific percentage of advance payment is required, the Foreign Vendor has to submit a Bank Guarantee equal to the amount of advance payment and it should be routed through the

Beneficiary Bank to the end user Bank. Otherwise, the Indian Agent of the foreign vendor has to submit a Bank Guarantee through a Nationalized Bank of India.

14. **On-site Installation:** - The equipment or machinery has to be installed or commissioned by the successful bidder within 15 to 20 days from the date of receipt of the item at site of IIT Madras.
15. **Warranty/Guarantee:** - Vendor should quote 3 year as standard warranty for all test equipment. The offer should clearly specify the warranty or guarantee period for the machinery/equipment complying to the attached document. Any extended warranty offered for the same has to be mentioned separately. (for more details please refer our Technical Specifications).
16. **Late offer:** - The offers received after the due date and time will not be considered. The Institute shall not be responsible for the late receipt of Tender on account of Postal, Courier or any other delay.
17. **Acceptance and Rejection:** - I.I.T. Madras has the right to accept the whole or any part of the Tender or portion of the quantity offered or reject it in full without assigning any reason.
18. **Other conditions:** - Only OEMs and their authorized resellers will be permitted to submit the offer. Any offer from unauthorized dealers/distributors/traders will be disqualified. Equipment items 2 to 6 in part A quoted for should be from the same vendor. Vendor should have local support capability in India. Vendor should quote for all items in Part A or Part B of tender. Partial offers in A or B will not be permitted. However, partial shipment will be permitted time of final shipment.
19. **Do not quote the optional items or additional items unless otherwise mentioned in the Tender documents / Specifications.**
20. **Disputes and Jurisdiction:** -
 - a. **Settlement of Disputes:** Any dispute, controversy or claim arising out of or in connection with this PO including any question regarding its existence, validity, breach or termination, shall in the first instance be attempted to be resolved amicably by both the Parties. If attempts for such amicable resolution fails or no decision is reached within 30 days whichever is earlier, then such disputes shall be settled by arbitration in accordance with the Arbitration and Conciliation Act, 1996. Unless the Parties agree on a sole arbitrator, within 30 days from the receipt of a written request by one Party from the other Party to so agree, the arbitral panel shall comprise of three arbitrators. In that event, the supplier will nominate one arbitrator and the Project Coordinator of IITM shall nominate one arbitrator. The Dean IC&SR will nominate the Presiding Arbitrator of the arbitral tribunal. The arbitration proceedings shall be carried out in English language. The

cost of arbitration and fees of the arbitrator(s) shall be shared equally by the Parties. The seat of arbitration shall be at IC&SR IIT Madras, Chennai..

- b. **The Applicable Law:** This Purchase Order shall be construed, interpreted and governed by the Laws of India, Court at Chennai shall have exclusive jurisdiction subject to the arbitration clause.
21. All Amendments, time extension, clarifications etc., will be uploaded on the website only and will not be published in newspapers. Bidders should regularly visit the above website to keep themselves updated. No extension in the bid due date/ time shall be considered on account of delay in receipt of any document by mail.

Acknowledgement:- It is hereby acknowledged that the tenderer has gone through all the conditions mentioned above and agrees to abide by them.

**SIGNATURE OF TENDERER
ALONG WITH SEAL OF THE
COMPANY WITH DATE**

Technical specifications of RF Testbed

1) Overall system (details in sections 2-6 below):

1. End to end wideband signal analysis - (at least 1GHz bandwidth up to 50GHz & at least 2GHz bandwidth above 50GHz)
2. Generation: operation up to at least 40GHz in a single box with at least 1GHz IF input, 50-75GHz extension using a second box (that may use an external source as LO for up-conversion).
3. Spectrum Analysis: operation up to at least 85GHz in a single box.
4. System calibration at least up to 40GHz to verify system performance.
5. Evidence of experience with mm-wave test equipment setup with universities or companies in India or worldwide.
6. Complete system integration with flexible low-loss cables, low-loss adaptors, calibration accessories and rack. All accessories such as cables, connectors etc and any other items required for proper operation should be included and supplied by the vendor. Minimum cable length of 24 inches. Cables and connectors should be supplied independently for each instrument.
7. The overall testbed should be set up and demonstrated. The demonstration will be evaluated for the following parameters: (a) operating frequency of 29GHz (b) Demonstration with coaxial cable and over-the-air using the provided horn antennas (c) 1GHz RF modulation bandwidth, 1024 QAM modulation, OFDM with approximately 1MHz sub-carrier spacing (d) appropriate amplifiers, band-pass-filter and pre-amplifiers for demonstration at 29GHz (e) Vector Network Analyzer 4-port calibration and test with the probe station on a sample die (sample die to be provided by IITM).
{Clarification: we require demonstration of calibrated measurements with coaxial cables, and functional tests over-the-air using provided horn antennas.}
8. 3-year Warranty for all equipment

2) Modulated Signal generation:

1. To generate wideband (at least 1GHz RF BW) RF and millimeter wave frequency signals
2. Frequency coverage: 1) up to at least 40GHz in a single box with at least 1GHz IF input and 2) Extension using one external box to cover a 50-75GHz band
3. ≥ 2 GSa memory to store 2GHz wideband signal
4. Provision to access baseband and millimeter-wave signals should be available individually for analysis. Millimeter-wave output should be accessible with single channel providing instantaneous RF bandwidth of at least 1GHz
5. IF Signal Characteristics: Two channels (I/Q) each with at least 12-bit resolution at 4.8 GSa/s or better at 50 Ohm impedance.
6. Built-in modulation types: OFDM, BPSK, QPSK, OQPSK, $\pi/4$ DQPSK, 8PSK, QAM (16 to 1024) or user defined. Should include 802.11ad and 5G modulation schemes.

7. Waveguide Antenna: Horn antennas with tripods and other required accessories must be supplied for making over-the-air measurements; 1 pair for 28-34GHz.

3) Signal Analysis:

1. Spectrum analyser capable of analysis wideband signals at millimeter wave frequencies up to 85GHz. Should be capable of analysis of at least 2GHz wideband signals from 50GHz to 85GHz and at least 1GHz wideband signals up to 50GHz. **{Clarification: we require operation up to at least 85GHz in a single box. No external upconverters should be utilized.}**
2. Measurements: Phase Noise, Noise Figure (up to at least 50GHz), Channel power, Occupied bandwidth, ACPR, Harmonic Distortion should be available.
3. Oscilloscope with minimum bandwidth (3 dB) of 4 GHz or higher should be included for complete IF signal analysis. No. of channels: 2 (for analyzing I/Q); max. sample rate: ≥ 20 GSa/s across all channels; Memory: 50MSa per channel; ADC resolution: ≥ 8 bit; Scaling: 2mV/div to 1V/div vertical; 50 Ohm.
4. Vector Signal Analysis: Software for vector signal analysis should be available to conduct measurements in time, frequency and modulation domain, with at least 1 license. For measurements at mmWave, RF and IF stage, same software must be compatible with various instruments i.e. signal analyzer, oscilloscope in user modulation format: OFDM, FSK, MSK, BPSK, QPSK, OQPSK, DQPSK, 8PSK, D8PSK, QAM, etc. measurements: spectrum analysis, constellation diagram, EVM, EVM vs. time, EVM vs. frequency, IQ offset, quadrature error, gain imbalance, SNR etc. Should include modulation schemes for the following wireless technologies 1) 2G, 3G and 4G cellular systems 2) WLAN (a,b,g,n, ac) systems 3) 60GHz 802.11ad systems and 4) 5G cellular systems. **{Clarification: We require demodulation as per standards for the following schemes:**

I) 2G GSM measurements, 3G WCDMA/HSPA/HSPA+ measurements, 4G LTE FDD UPLINK & Downlink + LTE Advanced measurements

II) WLAN (a,b,g,n,ac)

III) 60 GHz 802.11ad systems

IV) 5G cellular systems.}

4) Vector Network Analysis:

1. Frequency coverage upto 67GHz, with no external combiners. Should have: 4 test ports, with at least 2 sources, 1.85mm connectors, Internal bias tee, intermodulation measurement capability; Frequency translation capability to measure mixers; P1dB measurement capability; Gain compression application; direct access to generator and receiver to be provided.
2. Generator step attenuators on 2 test ports of VNA, and Receiver step attenuators on other 2 test ports of VNA.

3. 4 test port cables (high phase stable) up to 67GHz; Suitable 1.85mm calibration kit; accessories and adaptors to convert 1.85mm to 2.92mm/SMA.

5) Power measurement:

Power sensor/meter for measurement up to 110GHz, with appropriate adaptors so as to be compatible with other above test equipment.

6) Noise source:

- a) Noise sources for NF measurement on the spectrum analyzer up to 50 GHz so as to be compatible with other above test equipment.
- b) Noise sources for 50-85 GHz testing (for NF measurement on future 50-85GHz bands). **{Clarification: Vendor to quote for the 50-85GHz noise source as an option (with additional cost for the option) and not as part of the main offer.}**

RF probe station specifications

SR. NO.	PARAMETER	SPECIFICATION	COMPLIANCE YES / NO	REMARK
1	Substrate size	1 x 1 cm ² to 6-inch diameter wafer.		
2	chuck details	(i) RF chuck : ≥6" inch diameter (ii) Dedicated RF chuck with imbedded ceramic AUX (iii) Chuck Planarity : <±3 μm		
3	X, Y, Theta stage :	(i) Range of movement : Movement of stage to be at least 15 cm x 15 cm in x-y direction (ii) Fine Theta travel : ± 8° (iii) Resolution in x-y positioning : < 5 microns or better (iv) Load stroke, Y axis : 90 mm (v) Chuck Z height adjustment range : 10mm (vi) Z contact / separation / load stroke : 0 to 3 mm		
4	Platen	(i) Platen space (typical) : Universal platen : space up to twelve DPP105 positioners (ii) Z-Height adjustment range : 40 mm (iii) Separation lift : 200um (iv) Separation repeatability : <1 um		
5	Vacuum pump	Suitable vacuum pump compatible to system along with necessary accessories including vacuum tubing		
6	Stereo Microscope	Trinocular 6.7x stereo zoom Magnification : Total magnification ≥ 150X Camera : CCD/CMOS high-resolution digital camera with resolution ≥ 3 Mega pixel with compatible software & hardware to view and store the picture of the device in the computer. Microscope mount : system compatible microscope mount. Light source : LED/ suitable light source and suitable power supply. Head with CMOS port.		
7	DC Micropositioners :	(i) 2 sets of Mini magnetic base DC micropositioners footprint : 60mm x 20mm (ii) Movement of micropositioners should be 8 mm / 6mm / 25 mm in x-y-z directions (iii) 350 μm / 500 μm / 70 μm (iv) 1.5m coaxial cable and connector		
8	DC probe tips :	25 nos. Tungsten tip with radius 12 microns or better		
9	RF Micropositioners :	(i) 4 sets of Magnetic base micropositioners (ii) Movement of micropositioners should be 12.5 mm in x-y-z directions (iii) Resolution : 2μm or better (iv) Four 65GHz probes (GSG, 150 um): - Insertion Loss (Max) : < 2.0 dB - Probe Isolation (typical): Probes on Alumina : > 40 dB - Maximum DC Current: 5A - Wide operating temperature: -65°C to +200°C - Maximum RF Power @ 2 GHz: 30W - Typical Contact Resistance on Al: 100mΩ - Compliance: 25um (v) Four RF cables: Straight 1.85(F) to straight 1.85(M) of 36" length (vi) Two sets of 2.4 mm(F) to K(M) adapters to be included (vii) Includes ProbePolish, Contact substrate and Probe Cleaning brush		
10		Proprietary calibration software for RF with Multi-line TRL cal, eLRRM, Hybrid LRRM-SOLR Cal (multiport), 16-Term SVD, LRRM and LRM+		
11		Self-developed RF calibration substrate (NIST verified) for RF probes.		
12	Vibration isolatin table :	(i) Granite top : 800x800x750 mm (ii) Natural Frequency : 2.5 Hz (Vert. & Horiz.)		
13		At least 3MP Digital CCD to be provided		
14		Supplier should provide technical compliance including explanations without fail against each point given in the technical specifications for consideration of the offer.		
15	Power requirement :	As per Indian electrical standards (230V, AC, 50Hz)		
16		Warranty : Comprehensive warranty for 3 years from the date of installation. The extended warranty for 2 more years for which the Terms should include labour free of cost		
17		Parent company should be an established company with good number of installation (at least 50) and after sales support in India as well.		
18		Standard configurations will be required NO CUSTOM BUILT SYSTEMS WILL BE ENTERTAINED		