



Request for Quote and Specifications of RF Load pull & Pulse I-V for Semiconductor Wafer Characterization

- The GEECI (Gallium Nitride Ecosystem Enabling Centre and Incubator) at SID-Indian Institute of Science is seeking bids from qualified industries for this tool as per the specifications below.
- Companies need to submit two bids, a technical bid and a commercial bid, in **two separate** sealed envelopes. The bids should be submitted no later than 30 days from the date of posting of this tender, as listed on the website date/time stamp, and by 5 pm on the 30th day or next weekday in case the 30th day falls on a weekend or a national holiday.
- Both technical and commercial bids should be addressed to “The Chief Executive, SID, IISc, Bangalore 560012, GST # 29AAATS5333E1ZJ.”
- All quotations should be CIF Bangalore.
- Cost of last mile transportation, including any insurance, from port of shipment to IISc has to be quoted as an option.
- In case of courier shipments maximum permissible weight would be 70kgs.
- The envelopes should be addressed to “Prof. Srinivasan Raghavan, CeNSE, IISc, Bangalore, 560012” and submitted to the office at CeNSE, IISc in Room No. GF 15 between 9 am and 5 pm.
- All questions regarding this tender should be addressed to Prof. Srinivasan Raghavan at the email address sraghavan@iisc.ac.in
- Post such submission all vendors should send an email to sraghavan@iisc.ac.in with the subject line: “GEECI_Bidder’s name_Tool Name” to intimate him of the submission within one day.
- Deviations from the technical specifications requested are allowed. Such deviations must be highlighted and justified. Their acceptance or rejection will be left to the discretion of the technical committee.
- The equipment sought will be placed at the Centre for Nano Science and Engineering (CeNSE), Indian Institute of Science (IISc). IISc is India’s No. 1 institution on higher learning and the Center for Nano Science and Engineering is home to one of the best academic fabs in the world.
- The technical and commercial response, corresponding to the tool being offered, should be in the form of a compliance table with at least 5 columns. Serial number in column 1. Each of the items below, **technical and non-technical**, should be addressed in a separate row of the table in column 2. Compliance to this requirement, in Yes/No, deviation from it and justification should be provided in the neighbouring columns 3-5. Post the opening of a hard copy of the technical bid the committee will request for a soft copy of the files for further processing. Companies should **NOT** mail soft copies of the files unless specifically requested for.
- A compliance table for the terms and conditions mentioned at the end of the RFQ should also be included in all bids.
- Detailed technical specifications of the tool being offered should be included.
- Any additional capabilities or technical details, that you would like to bring to the attention of the purchase committee, can be listed at the end of the technical table.
- If multiple systems can fulfill the requirements, vendors can submit multiple bids.
- Vendors are encouraged to highlight the advantages of their tools over comparable tools from the competitors.
- The commercial bid should be broken up to the maximum extent possible into separate items with a cost against each to enable better comparison of price for various configurations across the bidders. As an option, please provide itemized cost for any *suggested* accessories/add-ons that may enhance the usability, capability, accuracy or reliability of the tool. Vendors are encouraged to quote for as many add-ons as their tool portfolio permits.

The system capabilities should include the following capabilities:

- Non-Linear power characterization system
- Pulsed IV and Pulsed RF characterization system
- Source and Load Pull from 1.8GHz to 60GHz
- Noise Parameter Extraction capability up to 50 GHz
- Compact Modeling
- Behavioral Modeling

Each Specification will be detailed in the following sections

SPECIFICATIONS FOR THE LOAD TUNER

Single tuner or multiple tuners to cover the frequency band are acceptable.

Parameter	Specifications
Frequency coverage	1.8 – 60 GHz
Fundamental tuning	Fundamental tuning for entire frequency band
Harmonic tuning	Independent tuning & control of the 2 nd and 3 rd harmonics
Tuning modes	Fundamental and Harmonic
Tuning range Fundamental (min[dB]/typical[dB])	10:1/20:1 @ Tuner reference plane
Tuning range Harmonic (min[dB]/typical [dB])	10:1/15:1 @Tuner reference plane
Insertion Loss (dB)	< 2.5 dB @ 60 GHz
Maximum power handling	5W, CW
Repeatability (min, dB/ typical, dB)	-40dB/50dB
Design compatibility for probe station	Integration capability to existing probe station
Interface	Ethernet or USB
Bidirectional couplers	Supports internal or external bidirectional couplers for Vector load pull

Supports external coupler for Scalar load pull	Yes
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SPECIFICATIONS FOR THE SOURCE TUNER

Single tuner or multiple tuners to cover the frequency band are acceptable.

Parameter	Specifications
Frequency coverage	1.8 – 60 GHz
Fundamental tuning	Fundamental tuning for entire frequency band
Harmonic tuning	Independent tuning & control of the 2 nd harmonic
Tuning modes	Fundamental and Harmonic
Tuning range Fundamental (min[dB]/typical[dB])	10:1/20:1 @Tuner reference plane
Tuning range Harmonic (min[dB]/typical [dB])	10:1/15:1 @Tuner reference plane
Insertion Loss (dB)	< 2.5 dB @ 60 GHz
Maximum power handling	5W, CW
Repeatability (min, dB/ typical, dB)	-40dB/50dB
Design compatibility for probe station	Integration capability to existing probe station
Interface	Ethernet or USB
Bidirectional couplers	Supports internal or external bidirectional couplers for Vector load pull
Supports external couplers for Scalar load pull	Yes

SOFTWARE REQUIREMENTS

Parameter	Minimum Specifications
Software requirements	Load pull measurement which records a and b waves at the input and output of the DUT at the fundamental and harmonic frequencies to calculate delivered

	input power, output power, power gain and efficiency.
	System should display magnitude and phase of vector corrected time domain waveforms of voltage and current curves
	Standalone CW and pulsed S-parameter measurement
	Standalone DC IV and Pulsed DC measurement
	Synchronized DC IV/S-parameters and Pulsed IV/S-parameter measurement
	All measurements properly de-embedded to the DUT reference plane. Additional ability to de-embed extrinsic parameter and perform load pull at the intrinsic reference plane for high efficiency PA design.
Load Pull Measurements	Live-measurement and post-measurement visualization of measured data to plot load pull parameter on XY graphs and smith charts, including maximum power, gain and efficiency.
	Passive load and source pull at the fundamental frequency, including the measurement of controlled harmonic impedances and powers between 1.8 GHz and 60 GHz
	Embedding and de-embedding of known S-parameter blocks
	De-embedding to device reference plane
	Smith Chart pattern and section-based Load/Source Pull
	Specialized Load pull project types for standard load pull
	DC-IV curve measurement (with RF measurements included or excluded)
	Power sweep measurement and Power sweep or IV sweep-based load pull
	Software controlled DC biasing
Non-Linear Device Modeling	System should be capable of generating non-linear behavioral model like Poly Harmonic Distortion (PHD) model or similar of GaN HEMT devices
	Vector corrected time domain waveforms of reflected, incident, and transmitted signals
	Dynamic Load line
	Power waveforms of reflected and transmitted signal up to maximum specified frequency
	The generated model should be compatible with Keysight Advanced Design System (ADS) and AWR Microwave Office to accurately simulate and design the modules

ACCESSORIES SPECIFICATIONS FOR LOAD PULL

SL No.	Parameter	Minimum Specification
1	RF phase stable cables	Set of phase stable flexible cables required for standalone operation of the system up to 60 GHz 1.85 mm connectors for operation up to 60 GHz. Minimum quantity required (x8).
2	Driver Amplifier	Set of amplifiers to cover the frequency 2-40 GHz. Band I: 2-18 GHz Gain 35 dB, Psat Maximum 5W Band II 18-26.5GHz 5 Watts Band III-26.5-40GHz 5 Watts Gain 40 dB, Psat Maximum 5W
3	Set of Isolators	Set of coaxial isolators for the frequency band 2-40 GHz
4	RF Probes	Set of RF probes to support the on-wafer measurements up

		to 60 GHz
5	RF integration cables	Set of RF cables for on-wafer integration (x2)
6	Phase correlation unit	Phase correlation unit for 1.8 GHz to 60 GHz. Multiple units to cover the frequency bands are acceptable
7	Bias tees	Set of pulsed bias tees for operation up to 60 GHz Maximum DC current 1A and voltage 50V Insertion loss less than 3.5 dB
8	Attenuators	Set of attenuators as required for system operation up to 60 GHz
9	RF Load	Set of RF Load as required for system operation up to 60 GHz
10	Adapters	Adapters to interconnect the supplied system for proper operation
11	Warranty	1 year warranty on the complete system
12	System Integration	The On-wafer integration will be provided by the vendor to mount the supplied load pull system on to the customer supplied 3 rd party probe station
13	VNA Calibration kit	Mechanical VNA calibration Kit (SOLT/TRL) up to 60 GHz

IISc will provide: RF Probe station, Vector Network Analyzer, Precision dual channel DC supply, Power sensor.

Specification for On-wafer Noise Parameter Measurement System

1. This system is intended for on-wafer noise parameter measurements of microwave transistors and amplifiers. The system should be fully integrated turn-key solution with high flexibility and modularity. All measurement control must be available at one central user interface.
2. Supports Cold-source technique and the Y factor techniques for Noise figure measurements.
3. Frequency range is from 2 GHz to 50 GHz.
4. General noise figure range should be 0.5 dB - 10 dB with an accuracy of ± 0.3 dB at above mentioned frequency range.
5. The system should comprise the following basic components:
 - i. Bias-tee input (gate/base)-standalone or integrated.
 - ii. Bias-tee output (drain/collector)-standalone or integrated.
 - iii. Input switch (es) -standalone or integrated.
 - iv. Output switch (es) -standalone or integrated.
 - v. Source impedance tuner
 - vi. LNA (Low noise amplifier) -standalone or integrated.
 - vii. Noise source
 - viii. Control software
 - ix. Parts for mechanical adaptation to wafer probe station.

The system must integrate with the third-party probe station provided by IISc.

Customer furnished Accessories: RF Probe station, Vector Network Analyzer with Noise receiver access, Precision dual channel DC supply.

SPECIFICATIONS OF THE SYSTEM COMPONENTS

Bias-tee input (gate/base)	
Frequency range	2 GHz - 50 GHz
Max. Current	100 mA
Max. Voltage	20 V
Insertion Loss	2.5 dB or less
Standalone or integrated, vendor to specify	

Bias-tee output (drain/collector)	
Frequency range	2 GHz - 50 GHz
Max. Current	1 A
Max. Voltage	40 V
Insertion Loss	2.5 dB or less
Standalone or integrated, vendor to specify	

Input switch (es)	
Frequency range	2 GHz - 50 GHz
Switching between Noise source and Vector Network Analyzer	
Type	Electromechanical switch

Output switch(es)	
Frequency range	2 GHz - 50 GHz
Switching between Noise receiver path(s) and Vector Network Analyzer	
Type	Electromechanical switch
Standalone or integrated, vendor to specify	

Source Impedance Tuner	
Frequency range	2 GHz – 50 GHz
Type	Electro-mechanical tuners
Interface	USB or Ethernet
Multiple tuners to be changed with the frequency bands are acceptable	

LNA (Low noise amplifier)	
Frequency range	2 GHz - 50 GHz
Detailed specification of LNA according to general noise figure range and accuracy to be provided by vendor	
Multiple LNA to be changed with frequency bands are acceptable	
Standalone or integrated, vendor to specify	

Noise source	
Broadband noise source	
Frequency range	2 GHz - 50 GHz or better
ENR Typical	12 to 15 dB
Multiple Noise sources to cover the frequency bands are acceptable	

Control software	
PC based control software	
Software for automated noise parameter measurement.	
All raw data must be available for external calculations	
Measurement data file format: ASCII, XML	
De-embedding option for device pad parasitic should be available as inline or post processing option in the software	
Interfaces: GPIB, Ethernet, USB	

Parts for mechanical adaptation to wafer probe station	
Necessary parts for mechanical adaptation to the wafer probe station provided by IISC	

Specification for Pulsed IV and RF characterization System.

Standalone synchronous dual pulsing system capable of simultaneously pulsing gate and drain of FET'S from a quiescent point to any point on the desired IV curve.

System should be suitable for measuring DC IV measurement.

System should be able to perform Standalone S-Parameters in both CW and Pulsed mode.

The system should be fully integrated turn-key solution with high flexibility and modularity.

All measurement control must be available at one central user interface.

The system should comprise the following basic components:

- i. Pulsed IV system for Pulsed, DC and RF characterization
- ii. Control software
- iii. Compact Modelling Software

SPECIFICATIONS OF THE PULSED IV SYSTEM

SL No	Equipment	Qty	Specification Details	Specifications
1	Drain Pulsar Head	1	Maximum voltage	200V or higher
			Maximum current pulsed	30A
			Power Handling	1000W or higher
			Pulse Width (Min. /Max.)	750 ns or lower
			Duty cycle (Min. /Max.)	up to 100% (i.e., continuous DC)
			Maximum measurement error	1% or better
2	Gate Pulsar Head	1	Maximum voltage	+/- 20V or higher
			Maximum current pulsed	+/- 100mA or higher
			Power Handling	2W or higher
			Pulse Width (Min. /Max.)	300 ns or lower
			Duty cycle (Min. /Max.)	up to 100% (continuous DC)
			Maximum measurement error	1% or better
3	Pulsed IV & RF Characterization Software		Vendor to supply suitable software for the instrument control, display of test results and analysis of test data	
4	Compact Modeling Extraction Software		Nonlinear compact model extraction software. Vendor to supply basic software for model extraction and display of test results and analysis of test data	
5	System configuration		Pulsed IV System with enhanced user interface, high-definition display, system software and documentation	

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.

Terms and conditions:

1. SEMI Standards (if applicable): The technical bid should include details of the SEMI standards the tool confirms to.
2. Shipping: On all systems the cost of shipping up to IISc should be included. IISc will take care of the customs clearance at Bangalore Airport. Please include your payment option. IISc

would prefer to retain at least 40% of payment till instruments have been commissioned and successfully demonstrated.

3. Tool Training: Necessary training to operate the procured setup and required literature support should be provided without additional cost. In principle onsite installation should be free of cost. The amount of time / day committed by the engineer during installation must be clearly stated. The engineers must spent enough time at the installation site (at least 4 days to train all engineers/staff and students).
4. **Tool Qualification and Acceptance:** Commissioning shall involve demonstration of tool performance as per terms and conditions mutually agreed upon between the client and vendor and characterized by the client within time frames agreed upon. Given the requirements in the RFQ, details of the stage wise certification protocols to be pursued for tool acceptance should be included in the technical bid. The PO will include a mutually agreed upon set of tool qualification criteria. Please list a set of acceptance tests for on-site (vendor) inspection and after installation at IISc.
5. **Tool footprint and utilities:** A floor plan should be part of the technical bid. A list of utility requirements should be part of the technical bid. The system should be compatible with 240±10V, 50 Hz single phase or 415±20V, 50 Hz 3 phase supplies. The MINIMUM set of utility requirements needed are provided in Table 1. If there are additional utility requirements please include them in the technical bid. Please list connector types for all utilities.
6. Software upgrade, if any, must be free of cost for next 5 years.
7. 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.
8. Maintenance: The cost of an annual maintenance contract and cost of emergency technical support that may involve an engineer being on site should be quoted for in the commercial bid and addressed in the technical bid. The availability of trained engineers in India for servicing the system will be preferred and should be described in the technical bid.
9. Maintenance: On all systems a set of basic tools required (like non-standard screw or spanner head that is required for routine tool maintenance) should be provided for performing routine maintenance.
10. Maintenance: System operation, process and troubleshooting manuals and detailed drawings are a must. Their inclusion must be indicated in the technical bid.
11. **Cost of Ownership and supply of spares:** The quote should include a listing of spares that need to be replaced periodically to ensure that the system is in operation in a stable fashion – the stability parameters being defined by the vendor and agreed to by the client – the cost of such items, the ability to guarantee their availability at this cost for a period of 5 years from the time of procurement. The aim of this exercise is to compare cost of ownerships between reactors.
12. Online support: System should have the capability for online diagnostics from a remote location in case of tool problems.
13. Post sales service and Indian Presence: Bidders should provide details of after sales service and support and in particular that available in India. If not India, the nearest geographical location should be specified. Please provide details of the number of trained personnel in India who can service the machine, the number of tools sold in India and the corresponding number in the southern region or in Bangalore.

14. Payment Terms and Conditions: On all systems the payment terms should be specified in the technical and commercial proposal and is subject to negotiation. Please include your payment option. IISc would prefer to retain at least 40% of payment till instruments have been commissioned and successfully demonstrated.
15. References: Bidders should provide details of other locations in India with similar tool installations. Vendor should have installed the same or similar tool at minimum 3 other locations in India.
16. References: Bidders should provide details of at least 10 other locations globally where similar tool installations have been deployed.
17. Company financials: Bidder shall have to submit audited accounts of financial year 2017-18, 2018-19 and 2019-20. Audited statement must be signed and stamped by qualified chartered accountant. Income Tax return for assessment year – 2017-18, 2018-19 and 2019-20.
18. The following documentation should be provided. ISO9001 quality certification. CE marking confirmation.
19. Guarantee: As high as possible (at least 3 years)
20. In case of software issues, vendor should be able to provide required solution within five days.
21. The lead time for the delivery of the equipment should preferably be less than 6 weeks from the date of receipt of our purchase order. The smallest lead time will be appreciated.
22. The validity period of the quotation should be 90 days at least.
23. System/computer required to operate the tool must come with the system with all software pre-loaded.
24. Free copies of analysis software must be provided with the tool (list out numbers)

Details to be provided in addition to other utility requirements the tool may require. If not applicable mark as NA: Not applicable.

				Electric	Chilled Water	Gases														Exhaust	Thermic load		
L (mm)	Tool Foot Print, (LXBXH)			Power consumption average	Cooling capacity maximum	UHP Nitrogen	UHP Hydrogen	Dopant Silane	Pure Silane	Ammonia	Chlorine	He	Oxygen	Regular Nitrogen	CF4	CHF3	SF6	NO2	BCl3	Argon	Forming Gas		Thermic load to clean room
B (mm)			Area	Peak power	Cooling Water Process	slpm	slpm	slpm	slpm	slpm	slpm	slpm	slpm	slpm	slpm	slpm	slpm	slpm	slpm	slpm	slpm	m ³ /h	kW