



Expression of Interest (Eol) for Technology Tie-up for Insulated Gate Bipolar Transistor (IGBT) module manufacturing

Subject: Technology Tie-up for Insulated Gate Bipolar Transistor (IGBT) module manufacturing: Substrate (IGBT Chip on Direct Copper Bonded) to IGBT module encapsulation

1) Introduction:

This Expression of Interest (Eol) seeks response from Original Equipment Manufacturers (OEMs) of IGBT module who are meeting the requirements of this Eol and are willing to be associated with BHEL through a License & Technology Collaboration Agreement on long term basis to enable BHEL to manufacture IGBT modules from Substrate (IGBT Chip on Direct Copper Bonded) to IGBT module encapsulation level for use in traction, high power range Power Conditioning Units (PCUs), drives & other industrial applications.

1.1) About Bharat Heavy Electricals Limited (BHEL):

BHEL is a leading state owned company, wherein Government of India is holding 63.06% of its equity. BHEL is an integrated power plant equipment manufacturer and one of the largest engineering and manufacturing organization in India, catering to the core infrastructure sectors of Indian economy viz. energy, transportation, heavy engineering industry, defence, renewable and non-conventional energy. The energy sector covers generation, transmission and distribution equipment for hydro, thermal, nuclear and solar photo voltaic. BHEL has been in this business for more than 50 years and BHEL supplied equipment account for more than 57% of the total thermal generating capacity in India. BHEL is also listed in Indian stock exchanges. The company has 17 manufacturing units, 4 power sector regions, 8 service centers, 4 overseas offices and 15 regional offices besides host of project sites spread all over India and abroad. The annual turnover of BHEL for the year 2016-17 was US\$ 4.45 Billion*. BHEL's highly skilled and committed manpower of approximately 39500 employees, the state-of-the-art manufacturing facilities and latest technologies, has helped BHEL to deliver a consistent track record of performance. To position leading state owned companies as "Global Industrial giant" and as a recognition for their exemplary performance, Government of India categorized BHEL as "Maharatna Company" in 2013, empowering the company with enhanced autonomy in decision making. With the current order book exceeding US\$ 16.2 Billion*, BHEL is poised for excellent future growth. Our ongoing major technology tie-ups include agreements with GE Technology GmbH, Switzerland (for Once through Boilers and Coal Pulverisers); Siemens, Germany (for Steam Turbines, Generators and Condensers); Metso Automation Inc., Finland (for Control & Instrumentation); MHI, Japan (for Pumps); MHPS, Japan (for Flue Gas Desulfurization Systems); Vogt Power International, USA (for HRSG); GENP, Italy (for Compressors); Turbo Lufttechnik, Germany (for Fans), Sheffield Forge Masters International, UK (for Forgings), Kawasaki Heavy Industries Ltd., Japan (for Stainless Steel Metro Coaches & Bogies) and Indian Space Research Organisation (for Space Grade Lithium Ion Cells). More details about the entire range of BHEL's products and operations are available at www.bhel.com.

1.2) About Electronics Division unit of BHEL:

Electronics Division (BHEL-EDN) (www.bheledn.com), a unit of BHEL, was established in 1976 at Bengaluru (India), with the objective of being a nodal agency for electronics in BHEL & to provide a strong base in the areas of Automation and Power Electronics and to supplement the Company's pioneering efforts in the above mentioned core sectors. Many of the power plants and industries in the country today are equipped with electronic products and systems that have been manufactured and supplied by BHEL EDN.

EDN supplied equipment accounts for about 63 % of total Control & Instrumentation(C&I) equipment in the country and continue to be the leader in power industry for past several decades. EDN has a strong base in Photovoltaics which was started first time in India by BHEL in 1983. Today EDN has manufacturing capacity of 105 MW per annum for Solar PV Cells

[*Note: Currency conversion rate considered: 1 US \$= Rs. 64.84 as on 31st March 2017]



Expression of Interest (Eoi) for Technology Tie-up for Insulated Gate Bipolar Transistor (IGBT) module manufacturing

besides executing MW sized power plant systems and roof top solar systems from concept to commissioning on turnkey basis. BHEL-EDN also manufactures space grade solar modules and batteries, which are being used in various satellites launched by Indian Space Research Organization (ISRO). EDN also has a strong international reference base by way of its exports to Europe, Middle-East and South-East Asian markets. EDN has been accredited with ISO 9001, ISO 14001 and OHSAS 18001 standard certifications.

1.3) About Experience of BHEL in Semiconductor Devices:

Since 1978, BHEL has been in the field of manufacture of discrete power semiconductor diodes and thyristors. At present, the ratings of diodes manufactured by BHEL, at the Electronics Division, Bengaluru, are in the range of 250-2000A / 1400-4600 V. The ratings of phase control thyristor manufactured by BHEL are in the range of 150-3300A and 1400-7000V. BHEL has been supplying these diodes and thyristors to various domestic and export market segments such as traction locomotives, variable frequency drives, high-current rectifiers, high-voltage DC transmission stations, static excitations systems, brushless exciters in turbo-generators & alternators and high-frequency inverters. National HVDC, Rihand-Delhi and Chandrapur-Padghe transmission line projects in India, 3100 HP and 4500 HP Diesel-Electric locomotives of Indian Railways and Exciters of 250 MW to 800 MW Turbo-generators for power stations are some of the major contracts in which BHEL devices are used.

In past, BHEL had technical collaboration with M/s Siemens, Germany and M/s ABB, Switzerland for Semiconductor Diodes & Thyristor manufacturing from Wafer to device. Subsequently, BHEL has developed and manufactured custom-specific diodes, thyristors and heat-sink assemblies against specific requirements such as rotational application in brushless exciters, parallel connected application in VFD drives, series connected applications in HVDC circuits etc based on technical expertise available in-house. Cumulatively, BHEL has manufactured and supplied more than 500,000 semiconductor devices so far. BHEL also supplies IGBT based propulsion systems comprising of Traction Converter & Auxiliary Converter for Indian Railways. As part of BHEL's Strategy to further diversify the semiconductor product portfolio, BHEL intends to enter into the area of encapsulation of IGBT modules at its Electronics Division, Bengaluru. More details of semiconductor products can be found at www.bheledn.com.

2) Business model:

BHEL intends to enter into a long term Technology Collaboration Agreement with the prospective technology partner, who meets the pre-qualification requirements indicated in Para 5, so as to enable BHEL to develop in-house capabilities and to establish state-of-the-art manufacturing & testing facilities from Substrate (IGBT Chip on Direct Copper Bonded) to IGBT module encapsulation.

3) Product scope:

The transfer of technology shall cover the product range of IGBT modules having insulated base and in-built with Fly Wheel Diode (FWD) as follows:

Sl. No	Voltage (VCE)	Current (IC) in the range	Package	Viso(V) Minimum
1.	1200 V	upto & inclusive of 400A/600A	Dual	4 kV
2.	1700V	upto & inclusive of 2400A/3600A	Single	4 kV
3.	3300V	upto & inclusive of 1200A/1500A	Single	6 kV
4.	4500V	upto & inclusive of 1000A/1200A/1500A	Single	7.4 kV
5.	6500V	upto & inclusive of 600A/750A/900A	Single	10 kV



4) Scope of Cooperation:

Indicative scope of technology transfer along with its associated subsystems is given in **Annexure-2**. The Transfer of Technology (ToT) shall enable BHEL to receive technical know-how related to specification of substrate components / module components / setting up of manufacturing facilities & equipment / testers / service facilities, process technology, process control, vendor details etc. Indicative scope of technical know-how and technical information expected to be transferred is detailed out at **Annexure-3** of this Eol document. Business sharing during the initial period of technology assimilation by BHEL may also be considered.

The prospective partner would assist BHEL in setting up an encapsulation and testing facility with an annual indicative installed capacity of 50k-100k nos. of IGBT modules.

The ToT scope shall also include training of BHEL personnel at the design & manufacturing facilities of prospective partner. Similarly, the partner shall send their technical experts to provide assistance in setting up the facilities at BHEL and subsequently demonstrate successful production and testing runs at BHEL.

5) Prequalification requirements:

Prospective Collaborator/OEM to meet the following criteria:

- 5.1 Should be original manufacturer of IGBT modules for past 10 years through encapsulation of IGBT chips and should have manufactured cumulatively 50,000 or above nos. of IGBT modules of various ratings in the last 5 years.
And
- 5.2 Should have in-house IGBT encapsulation facility from chip to module.
And
- 5.3 Should have supplied IGBT modules for traction application to at least 1 country outside its country of origin.

6) Instructions to the OEMs / Prospective Collaborators for submission of offer against the Eol:

Offers / Proposals to be submitted as per following details:

- (a) Annexure-1: "Prequalification criteria" duly filled by the OEM with signature and company seal.
 - (b) Annexure-2: Indicative Scope of technology transfer duly signed along with company seal.
 - (c) Annexure-3: duly filled up by the OEM for acceptance of individual clauses / sub-clauses, with signature and seal on each page.
 - (d) Annexure-4: "Company profile" duly filled up by the OEM with signature and seal on each page along with required attachments, brochures, catalogues, reference lists, customer certificates and annual reports.
 - (e) Annexure-5: "Checklist" duly filled up by the OEM with signature and seal.
- 7) The interested OEM shall ensure that their response is received by BHEL on or before **May 11, 2018, Friday**. The response shall necessarily be accompanied with details on company background, technical features/ product catalogue, reference list, annual audited financial reports for last 3 (three) years including auditors report & duly filled Annexures 1 to 5. In case any clarifications are needed, kindly feel free to contact us.



Your response may be sent to the following address:

General Manager (TL, JV, M&A)
Corporate Technology Management
Bharat Heavy Electricals Limited
BHEL House, Siri Fort
New Delhi - 110049, India
Phone: +91 11 66337210 / 7218
Email: techeoi@bhel.in

8) Miscellaneous:

8.1.1 Right to accept or reject any or all Applications:

- a) Notwithstanding anything contained in this Eoi, BHEL reserves the right to accept or reject any Application and to annul the Eoi Process and reject all Applications, at any time without any liability or any obligation for such acceptance, rejection or annulment and without assigning any reasons thereof. In the event that BHEL rejects or annuls all the Applications, it may, at its discretion, invite all eligible Prospective Collaborators to submit fresh Applications.
- b) BHEL reserves the right to disqualify any Applicant during or after completion of Eoi process, if it is found there was a material misrepresentation by any such Applicant or the Applicant fails to provide, within the specified time, supplemental information sought by BHEL.
- c) BHEL reserves the right to verify all statements, information and documents submitted by the Applicant in response to the Eoi. Any such verification or lack of such verification by BHEL shall not relieve the Applicant of his obligations or liabilities hereunder nor will it affect any rights of BHEL.

8.2.1 Governing Laws & Jurisdiction:

The Eoi process shall be governed by, and construed in accordance with, the laws of India and the Courts at New Delhi (India) shall have exclusive jurisdiction over all disputes arising under, pursuant to and / or in connection with the Eoi process



Pre-qualification Requirement (PQR) Confirmation by the responding Party

Sl. No	Description	Response
1.	Whether prospective collaborator is an original manufacturer of IGBT modules for past 10 years through encapsulation of IGBT chips. Kindly indicate the no of years of experience.	
2.	Whether prospective collaborator has manufactured cumulatively 50,000 or above nos. of IGBT modules of various ratings in the last 5 years. Kindly indicate the nos. of IGBT modules of various ratings supplied by prospective collaborator.	
3.	Whether prospective collaborator has in-house IGBT encapsulation facility from chip to module. If yes, provide broad details thereof.	
4.	Whether prospective collaborator has supplied IGBT modules for traction application to at least 1 country outside its country of origin. If yes, provide details thereof.	

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Indicative Scope of Technology Transfer

a)	Licensing & transfer of state-of-the-art technology relating to the manufacture, assembly, quality control, quality assurance, testing of the IGBT modules.
b)	Information to enable sourcing by BHEL of all types of DCB substrate, required to be used in the IGBT module encapsulation, as per the present design of the OEM.
c)	Information to enable BHEL to source/procure all the items, which the OEM sources from outside (not manufactured by the OEM) as well as those manufactured in-house for use in the IGBT module encapsulation facilities.
d)	Transfer of any proprietary computer programs including logics and source code
e)	Improvement/modification/developments/up gradations carried out by the OEM over the duration of the technology transfer agreement for taking care of new market requirements and obsolescence of components used in the system.
f)	Assistance in preparing feasibility study to plan a viable IGBT encapsulation facility by way of providing appropriate inputs for identifying, sizing & selection of equipment required for manufacturing, service plants, tools, jigs & fixtures and their layout, foundation etc.
g)	Assistance in establishing manufacturing & test facilities, production of prototype at the new facility and its testing, as well as approval of prototype/ type testing. For this purpose, collaborator shall depute its experts for agreed number of man days as required by BHEL.
h)	Training of BHEL personnel at BHEL & prospective collaborator's facilities and any engineering services requested by BHEL

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Format for furnishing compliance to scope of technology transfer:

Prospective collaborator shall indicate its response on right-side column.

Sl. No	Description	Response / Counter proposal (if any)
1.0	TECHNOLOGY SCOPE Transfer of Technology for IGBT Module Encapsulation from IGBT Chip on Direct Copper Bonded (substrate) to IGBT module.	
2.0	PRODUCT RANGE BHEL requirement of ratings of IGBT modules: V_{CE} & I_C : Range as below "Scope of detailed product range": Note: Ratings and Outline packages of the IGBT modules offered shall be explicitly indicated against each clause 2.1 to 2.5. Preferably, a separate attachment / catalogue shall be enclosed.	
2.1	$V_{CE} = 1200V$, $I_C =$ upto & inclusive of 400A/600A	
2.2	$V_{CE} = 1700V$, $I_C =$ upto & inclusive of 2400A/3600A	
2.3	$V_{CE} = 3300V$, $I_C =$ upto & inclusive of 1200A/1500A	
2.4	$V_{CE} = 4500V$, $I_C =$ upto & inclusive of 1000A/1200A/1500A	
2.5	$V_{CE} = 6500V$, $I_C =$ upto & inclusive of 600A/750A/900A	
3.0	INFORMATION SCOPE TO BE COVERED UNDER TECHNOLOGY TRANSFER Note: For the following clauses 3.1 to 3.8, Acceptance (YES / NO) or Counter proposal (if NO) shall be expressed.	
3.1	Furnishing Information regarding Bill of Materials for all types of IGBT Modules covered under product range/ scope.	
3.2	Furnishing product design information: Technical datasheets, drawings and specifications of all the module components including IGBT chips and diode chips, IGBT Chip on Direct Copper Bonded.	
3.3	Furnishing Information regarding recommended vendor list for all the individual components of IGBT module.	
3.4	Furnishing process technology information including Manufacturing instructions, Routine/type test as per Quality Plan protocols	
3.5	Furnishing technical information and recommended vendor list for the manufacturing and testing equipment & tools, jigs & fixtures and accessories.	
3.6	Furnishing technical information on service / utility facilities.	
3.7	Furnishing information related to improvements, modifications and additions in product variants and processing technology during the term of agreement.	



Expression of Interest (Eoi) for Technology Tie-up for Insulated Gate Bipolar Transistor (IGBT) module manufacturing

3.8	Furnishing information related to applications/ interfacing of IGBT modules in various power electronic circuits including failure analysis methods.	
4.0	TECHNICAL ASSISTANCE Note: For the following clauses 4.1 to 4.5, Acceptance (YES / NO) or Counter proposal (if NO) shall be indicated.	
4.1	Training at collaborators works for mutually agreed BHEL engineers man-days. Scope of training shall include technology transfer aspects like engineering (process & application), manufacturing, quality assurance and testing of the product.	
4.2	Deputation of experts to BHEL works, for following technical support from technology partner:	
4.2.1)	Technical support to BHEL during installation & commissioning of manufacturing / testing facilities.	
4.2.2)	Technical support to BHEL by way of demonstration of production runs through the complete manufacturing cycle (from input materials to finished IGBT module) using the manufacturing facilities commissioned at BHEL.	
4.2.3)	Technical support to BHEL by way of demonstration of Routine Tests (as per relevant international standards / test protocols) on IGBT chips, diode chips and fully-finished IGBT modules using the test facilities commissioned at BHEL.	
4.2.4)	Technical support to BHEL on Type Tests (as per relevant international standards / test protocols) of IGBT Modules manufactured at BHEL, either at collaborator's facility or any other testing labs.	
4.3	Technical support to BHEL for measuring BHEL modules at collaborators' works for the purpose of verification & validation of BHEL measurements (Routine tests).	
4.4	Technical support / guidance to BHEL on trouble shooting, process control, etc on any manufacturing related problems encountered during the period of collaboration agreement.	
4.5	Technical support to BHEL on customizing/adapting the standard IGBT modules for acceptance by customer.	
5.0	During the validity of the Agreement and/or post expiry of the Agreement, BHEL shall either use in-house developed substrate (IGBT Chip on DCB) or procure the same from third party vendors. Prospective collaborator to explicitly confirm that there are no restrictions from their side for the above approach and BHEL is free to exercise any option to manufacture IGBT module in its facility.	
6.0	Whether prospective collaborator owns the IPRs for the IGBT encapsulation technology being proposed for transfer under the TCA, Or have unencumbered right from the owner of the IPRs to sub-license the technology	

(SIGNATURE)



Format for Company Profile

1.0	General information	
1.1	Name of company: (Manufacturer)	
1.2	Head Office: Address: Telephone: E-mail: Website:	
1.3	Factory / Works: Address: Telephone: E-mail: Website:	
1.4	Details of marketing agent (Outside India, if any) Address: Telephone: E-mail: Website:	
1.5	Indian representative / Marketing agent, if any Address: Telephone: E-mail: Website:	
1.6	Chief Executive:	
1.7	Contact person(s) Name(s): Official capacity: Address: Telephone: E-mail:	
1.8	Year of establishment of the company	
2.0	TECHNICAL/COMMERCIAL INFORMATION:	
2.1	Production capacity (IGBT Modules) per annum:	
2.2	Particulars of products (IGBT Modules) including technical specifications, ranges. Individual datasheets of IGBT module ratings offered complete with technical specifications and outline dimensional diagrams. Attach company profile, product profile, technical brochures / catalogues and any other document as deemed relevant.	
2.3	Country of origin for offered products and technology	
2.4	Quality and Environmental Management System	
2.4.1	Is the company ISO:9001 certified? If Yes, enclose copy of certificate.	
2.4.2	Is the company ISO:18001 certified? If Yes, enclose copy of certificate.	



Expression of Interest (Eoi) for Technology Tie-up for Insulated Gate Bipolar Transistor (IGBT) module manufacturing

2.4.3	Is the company ISO:14001 certified? If Yes, enclose copy of certificate.	
2.5	Experience list for offered / similar items:	
2.6	Whether IGBT technology offered is suitable for traction application. Details of usage in traction application may be furnished.	
3.0	FINANCIAL INFORMATION:	
3.1	Physical and annual turnovers, and profit-after-tax for last 3 years: (Attach copies of audited Balance Sheet and P&L Account) Year-1: Year-2: Year-3:	
4.0	Whether prospective collaborator has licensed out its technology for IGBT module to any company in world so far, please provide details thereof.	

(SIGNATURE)



CHECK LIST

Sl. No.	Description	Whether submitted
1.	Covering letter signed by an authorized signatory on company letter head listing clearly the enclosures	YES / NO
2.	Details as per Annexure-1: PQR Criteria	YES / NO
3.	Details as per Annexure-2: Indicative Scope of Technology Transfer	YES / NO
4.	Details as per Annexure-3: Compliance to Scope of ToT	YES / NO
5.	Details as per Annexure-4: Company Profile	YES / NO

(SIGNATURE)