

Title	Development of Digital Optical Transceiver Module
Subtitle	Section C: Scope of Supply, Scope of Work and Technical Specifications



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Abbreviations

ITER	International Thermonuclear Experimental Reactor
RF	Radio Frequency
HVPS	High voltage power supplies
cRIO	Compact Reconfigurable Input & Output
OPTXRX	Optical Transmitter and Receiver
PCB	Printed Circuit Board
EMI/EMC	Electromagnetic Interference/Electromagnetic Compatibility
BOM	Bill of Material
BBT	Bare Board Test reports
QC	Quality Check
CoC	Certificate of Compliance
SMD	Surface Mount Device
DUT	Device Under Test
NABL	National Accreditation Board for testing & calibration Laboratories

1 Introduction

ITER-India has High Power RF source system. The RF source is operated using a set of High voltage power supplies (HVPS), auxiliary power supplies & auxiliary services. The HVPS are remotely operated through dedicated control System. The hardwire signals between control system and field system are exchanged optically due to harsh operating environment with potential electromagnetic interference. To cater this requirement a prototype custom digital optical transceiver module is developed by ITER-India.

Figure.1 shows the block diagram of Digital optical transceiver module called cRIO-OPTXRX. This module converts the digital Input signal on 15-pin connector into optical signal and viseversa. The prototype module schematic is shown in Fig.1, PCB in the Fig.2 and module assembled into enclosure in Fig.3

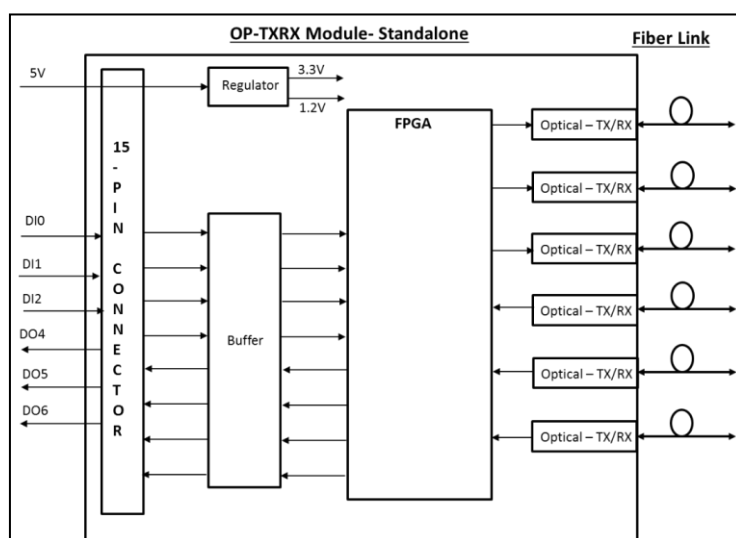


Figure 1: Prototype Module Block Diagram



Figure 2: Prototype Module PCB

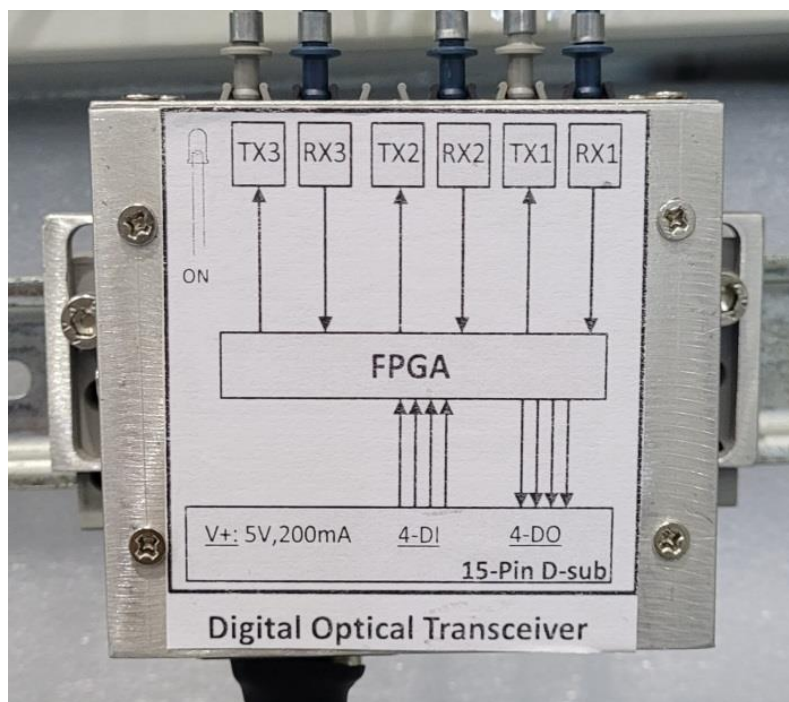


Figure 3: Prototype Module with Enclosure

ITER-India has already designed & developed the prototype modules. ITER-India wants the supplier to develop the module as per the specification with good quality and considering the specified industrial standards.

2 Scope of Work

The development will be divided in three parts

Sr. No	Activity	Scope of Work
1	<u>Part-1</u> Development of one module as per the Section-5.1	<ol style="list-style-type: none"> 1. The Schematic, PCB design and gerber files of the prototype modules will be provided by ITER-India. 2. Supplier has to review & update the design for EMI/EMC compliance. Supplier has to update schematic, PCB design & gerber files accordingly 3. Perform PCB fabrication, Component procurment (with spares), Component mounting. 4. Design and fabrication of custom enclosure. Enclosure cutout, labeling & moudle assembly
2	<u>Part-2:</u> Functional & EMI/EMC Test of one module as per Section-5.2.	<ol style="list-style-type: none"> 1. First the Functional testing will be performed. The functional responsibilites & FPGA firmware logic responsibility will be of ITER-India. 2. Second the EMI/EMC testing will be performed in development mode against the standard defined in section-5.2.2. Additional components as required for ensuring compliance shall be procured and implemented by supplier. The EMI/EMC test performance & compliance responsibility will be of suplier 3. Finally EMI/EMC testing will be performed in certification mode & final EMI/EMC compliance certificate against standard defined in section-5.2.2 shall be provided to ITER-India.
3	<u>Part-3:</u> Production of the nine modules as per Section-5.3	<ol style="list-style-type: none"> 1. On successful demonstration of the developmental module, final 9 modules shall be manufactured as per the approved design and their functionally shall be tested at factory before supplying to ITER-India

Table 1: Scope of Work

3 Scope of Supply & Deliverables

Sr. No	Scope	Quantity
1	1.1 Development & Supply of Digital Optical Transceiver Module with procurement of spare components as per section-5.1	1 Set
	1.2 EMI/EMC testing in Development mode as per test defined in section 5.2.2	
	1.3 EMI/EMC testing in Certification mode as per test defined in section 5.2.2	
2	Production, Testing & Supply of Digital Optical Transceiver Modules	9 Nos

Table 2: Scope of Supply & Deliverables

4 Responsibility Matrix between ITER-INDIA and Supplier

Refer to section 5.1.1, 5.1.3

5 Technical Specifications

5.1 Part-1 Development of one module

5.1.1 Fabrication of module

Sr. No	Activity	ITER-India	Supplier
1	ITER-India will provide Block diagram, schematics, BOM and Gerber files of prototype module	√	
2	Review & modification (if required) of given design to ensure compliance for EMI/EMC requirements		√
3	Schematic, PCB designing and BOM finalization.		√
4	Submission of PCB design files in editable format. Submission of final BOM		√
5	Review and Approval of schematic, PCB design & BOM	√	
6	PCB Fabrication. Submission of PCB QC reports and /or Bare Board Test (BBT) reports		√
7	Review and Approval of PCB Fabrication report	√	
8	Component procurement		√
9	Component wiring		√

Table 3: Responsibility Matrix for Fabrication of Module

Note:

- 1) PCB design and fabrication should be done as per the industrial standards
- 2) If faults are found in PCB due to PCB fabrication or malfunctioning of procured components, the supplier has to implement appropriate corrective actions like repeat PCB fabrication, replace defective components etc. free of cost.
- 3) The PCB design and PCB fabrication editable files should be provided by the supplier preferably in Orcad software
- 4) Additional components as required for ensuring EMI/EMC compliance shall be procured and implemented by the supplier

5.1.2 Bill of Material (BOM)

Part	Value	MFG P/N	Footprint	Quantity (1 module)	Quantity (9 module)	Additional Component	Total
Capacitor	1uF/25V	GRM155R61E105KA12J	r0402	3	27	20	50
	10uF/16V	GRM188R61C106MA73D	R0603	1	9	40	50
	22uF/16V	EMK212BBJ226MG-T	r0402	1	9	40	50
	0.1uF/16V	GCM155R71C104KA55D	r0402	26	234	140	400
	10uF/10V	TAJA106K010TNJ	CASE_A_CAP	12	108	30	150
	0.01uF/16V	C0402C103J4RACTU	r0402	1	9	40	50
	0.01uF/16V	GCM155R71C104KA55D	r0402	2	18	30	50
	10uF/16V	GRM188R61C106KAALD	r0603	2	18	30	50
	0.01uF/16V	0402YC103KAT2A	r0402	1	9	40	50
Connector	K66X-E15S-N	K66X-E15S-N	k66X-E15S-N	1	9	40	50
Inductor		BLM18AG601SN1D	r0603	1	9	40	50
Inductor	10uH/0.95A	1R103C	11R104C	1	9	40	50
LED		LTST-C190KGKT	l0603	2	18	30	50
		LTST-C190KGKT	hdr1x2	1	9	40	50
Resistor	0E/0.25W	ERJ-8GEY0R00V	1206r	2	18	30	50
	0E/0.1W	ERJ-2GE0R00X	r0402	39	351	110	500
	10K/0.1W	ERJ-2GEJ103X	r0402	1	9	40	50
	1K/0.1W	ERJ-2GEJ102X	r0402	4	36	60	100
	2K/0.1W	ERJ-2GEJ202X	r0402	4	36	60	100
	5.1K/0.063W	RC0402FR-075K1L	r0402	3	27	70	100
	4.7K/0.1W		r0402	3	27	70	100
	0E/0.33W	CRCW06030000Z0EAHP	R0603	5	45	50	100
IC		NCP1117LPST50T3G	SOT-223	1	9	10	20
		TLV1117LV12DCYR	sot-223	1	9	10	20
	ADG5419BRMZ-RL7	ADG5419BRMZ-RL7	msop-8	1	9	10	20
	LCMX02-7000HE-4TG144C	LCMX02-7000HE-4TG144C	LQFP144	1	9	10	20
	CB3LV-3C-50M0000	CB3LV-3C-50M0000	CB3LV-xtal	1	9	10	20
	HFBR-2624	HFBR-2624	HFBR1521-TX	3	27	10	40
	HFBR-1624	HFBR-1624	HFBR2521-RX	3	27	10	40
		ADUM142D0BRWZ	SOIC-16(WIDE)	2	18	20	40
	MEV1S0505DC	MEV1S0505DC	MEV1D0512DC	1	9	10	20
DC Power Supply	DIN Rail DC Power Supplies 12W 5V, 2.4A	SN74LVT244BNSR	soic_20-n	1	9	10	20
		Mean Well HDR-15-5	DIN Rail	1	9	5	15

Table 4: Bill of Material (BOM)

Note:

- 1) The total quantity shown in the table that cover the quantity for 10 module and additional component has to be procured.
- 2) There may be minor changes in BOM upon mutual understanding during design finalization
- 3) All the components should be purchased from its authorized dealers only. Supplier has to provide procurement component Certificate Of Compliance (CoC). Purchaser at its own discretion may ask for evidence for procurement from authorized dealers.
- 4) All electronic components and PCBs used shall be of industrial grade (-40°C to +70°C)
- 5) Components should be checked before the actual use
- 6) Inward Inspection/QC report of the procured components should be provided.
- 7) Make and part number of the components may be changed if not available in the market, to superior or equivalent to the specified technical specifications, subject to prior approval of ITER-India in this regard.
- 8) Change of the make or part number other than the reasons specified above, subject to a maximum of 10 % of total components of a given card may be approved by ITER-India on its own discretion
- 9) The SMD component should be soldered through machine at standard lab. The stencils details should be provided to ITER-India.

5.1.3 PCB DESIGN CONSIDERATION

1. The module PCB must be 1.57 mm (0.062 in.) thick and must have outer dimensions of 73.38 × 66.04 mm (2.889 × 2.600 in.). The *primary* side of the PCB is the top side where you place most of the components. The maximum component height on the primary side of the PCB is 13.46 mm (0.530 in.). There are additional height restrictions of 4.44 mm (0.175 in.) on the upper edge of the PCB and 2.64 mm (0.104 in.) on the lower edge. The maximum component height on the secondary side of the PCB is 2.64 mm (0.104 in.). Figure 4 shows the maximum component height & PCB thickness consideration as per the OEM recommendation.

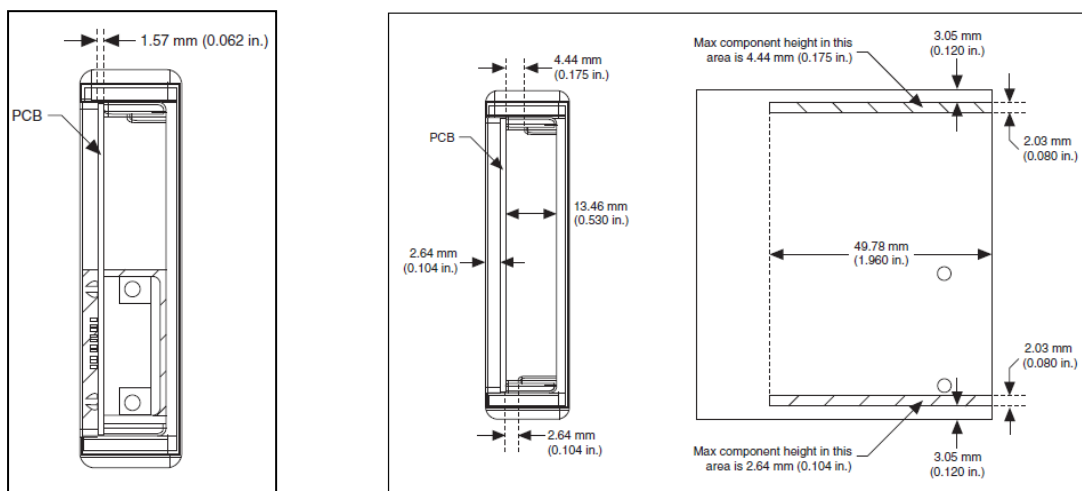


Figure 4: PCB Thickness and Component Height

2. Figure 5 shows the keep-out areas for the components, routes, and vias in order to hold the PCB in the enclosure. PCBs are typically implemented with either four or six layers. It should be implemented with one of the stack up shown in fig-6
3. Matched trace impedance on the module PCB will help to minimize signal integrity issues. Module shall be designed with a nominal impedance of $55\Omega \pm 5\%$
4. Proper isolation with PCB labeling should be considered

Note:

- 1) Nominal impedance is determined using the typical values for all impedance contributors, such as trace width, layer spacing, etc. It will tend to center the distribution of actual impedance around impedance around 55 Ω .
- 2) A nominal impedance of $55\Omega \pm 5\%$ will usually result in maximum $55\Omega \pm 15\%$ impedance so long as the recommended stack-up is used.
- 3) Achieving the nominal impedance with the recommended stack-up requires relatively wide trace widths. Care must be taken to minimize current loops and crosstalk

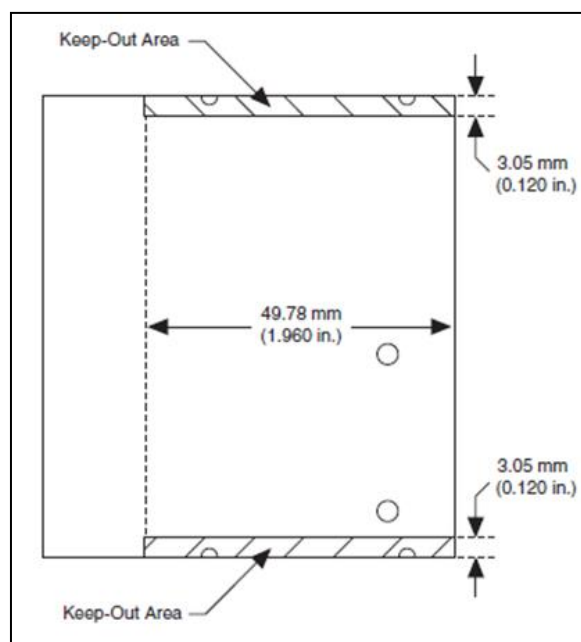


Figure 5: PCB Keep out area

7.5	7.5	<p>Dimensions in mils</p> <p>Outer Layers: 1.5 oz</p> <p>Inner Layers: 1 oz</p>
15		
7.5	39	
15		
7.5	7.5	
6 Layer	4 Layer	

Figure 6: PCB Stack-up

5.1.4 PCB fabrication Specification:

Sr. No	ITER-India Specifications
1	Type: Double sided
2	Layer: 4 layer (including power and Ground layers)
3	Material: Glass epoxy (FR-4)
4	Base copper : 35 micron each side
5	Finish copper: 70 micron each side, Gold/ENIG Finish
6	Solder Mask Top & Bottom : Red
7	Legend Top & Bottom : White

Table 5: PCB Fabrication Specification

5.1.5 Custom Enclosure design and fabrication

Scope of work

Sr. No	Activity	ITER-India	Supplier
1	Custom Enclosure design & submission of drawing for review & approval		√
2	Approval of enclosure drawing	√	
3	Fabrication/Procurement of Enclosure		√
4	Preparation of drawing for modules assembly (cutout & labeling)		√
5	Review and Approval of assembly drawings	√	
6	Cutout and module Assembly		√

Table 6: Responsibility Matrix for Enclosure design

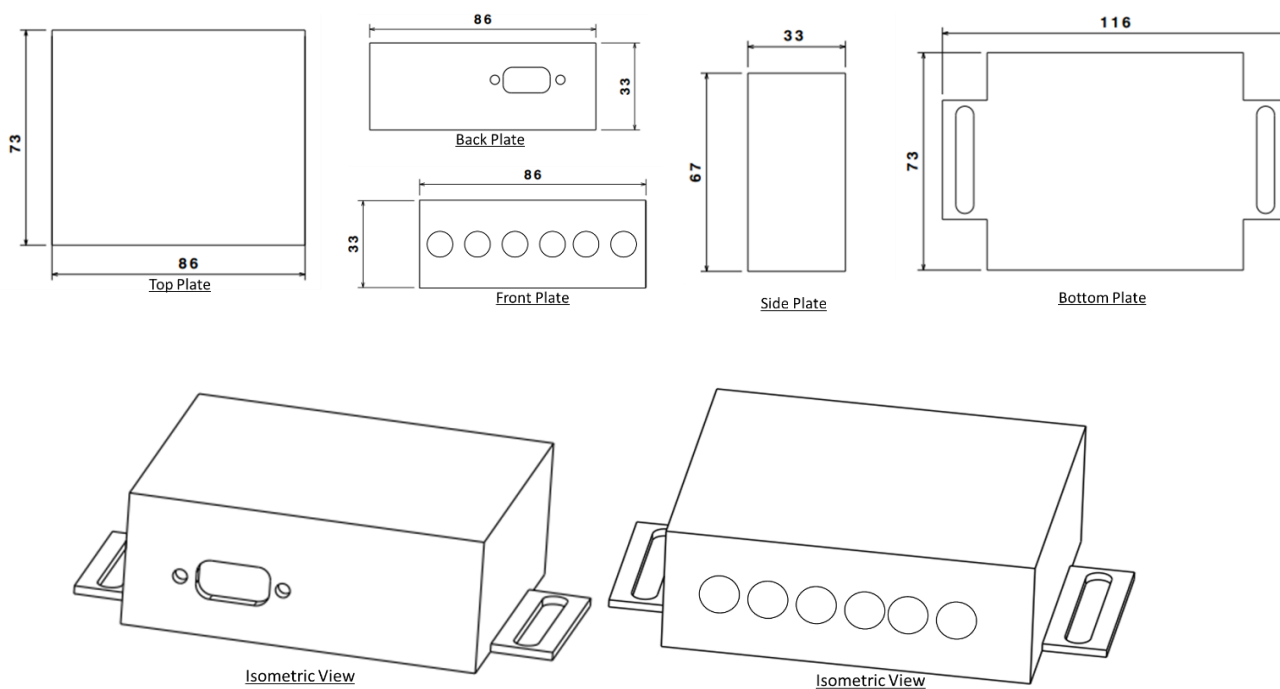
Thechincal Specification

Sr. No	ITER-India Specifications
1	Constructed from extruded aluminum with a minimum thickness of 1.5 mm. should have slots extruded into the enclosure body
2	PCB mounting should be Horizontally by sliding into internal slots of the enclosure body
3	Front and back opening with EMI/RFI Shielded gaskets
4	Should have flange (for DIN Rail or wall mounting).

Table 7: Enclosure Technical Specification

Drawing & Dimensions

- All the dimensiones are in mm
- The drawing is draft and there can be changes during the development phase



5.2 Part-2: Functional Testing & EMI/EMC testing

5.2.1 Functional Testing

Sr. No	Test	Discription
1	Visual inspection (Routine)	1. Component check, soldering check 2. Continuity check.
2	Measurement	1. Connect DC power supply (+5V,1A) to 15-pin connector 2. Deploy the FPGA bit file into the FPGA (FPGA bit file & programmer will be provided by ITER-India) 3. Connect LVTTTL signal (0-3.3v) to Digital inputs of 15-pin connector & check the status of the Optical Transmitter. 4. Apply light to Optical Receiver and check the Digital output signals of 15-pin connector Note: Manufacture defects attributes to supplier scope of work should be addressed by supplier.

Table 8: Functional Testing Specification

1. Supplier have to arrange the necessary calibrated test & measurement equipment (Function generator, oscilloscope, Digital Multi Meter etc.) for functional testing
2. Supplier have to arrange necessary cable & accessories required for the functional testing
3. Supplier shall inform ITER-India 3 week before for witnessing the Test

5.2.2 EMI/EMC Testing

Sr. No	Test Port	Environmental Phenomena	Test Specifications	Basic Standard	Observation
1	DUT	Power-frequency magnetic field	50 Hz 30 A/m	IEC 61000-4-8	A
		Radiated, Radio-frequency electromagnetic field immunity Test	80 to 1 000 MHz 10 V/m 80 % AM (1 KHz)	IEC 61000-4-3	A
		Electro Static Discharge	Direct - Air Discharge + 8 kV	IEC 61000-4-2	A
		Radiation Emission Test	Antenna scanning: Vertical & Horizontal	CISPR11 (EN55011)	A
2	Signal Port/DC power port	Radio-frequency common mode	0.15 to 80 MHz 10 V 80 % AM (1 kHz)	IEC 61000-4-6	A
		Electrical Fast Transient (EFT)/Burst immunity Test	±1 kV Tr/Th : 5/50 (ns) Repetition frequency : 5 kHz	IEC 61000-4-4	A
		Surges line-to-earth	Tr/Th : 1.2/50 (8/20) μ s ± 1 kV	IEC 61000-4-5	A

Table 9: EMI/EMC Testing Specification

1. This test shall be performed at NABL certified laboratory.
2. ITER-India representative will witness the EMI/EMC test
3. Supplier shall inform ITER-India 3 week before for witnessing the Test
4. Test specifications/criteria for all the tests are tentative and will be finalized mutually after completion of functional testing of the module.

5.3 Part-3: Production of the nine modules

After successful demonstration of the developmental module, final 9 modules shall be manufactured as per the approved design, functionally tested at factory and supplied to ITER-India

6 Pre-dispatch/FAT at Supplier site

As per section-5.2

The supplier shall dispatch the ordered items only after receipt of dispatch clearance letter from ITER-India

7 Site Acceptance tests:

The acceptance will be given after functional testing of all the module at ITER-India site. Supplier may participate/witness final acceptance test at ITER-India lab in-person/remotely at his discretion

8 Document Deliverables


Sr. No	Activity	Document
1	Development of one module	1. Approved BOM for procurement of components 2. QC reports and /or Bare Board Test (BBT) report of PCBs 3. Final Schematic design files in editable format 4. Final PCB artwork-layout in editable format and Gerber files 5. Final Bill of material (BOM) and General Assembly (GA) 6. Custom Enclosure design & drawings in editable format
2	Functional & EMI/EMC Testing	1. Functional Test Report 2. EMI/EMC development mode test report 3. EMI/EMC certificate mode test certificate
3	Production of the nine modules	1. Functional Test Report 2. Warranty Certificate

9 Warranty

After Site Acceptance Test at ITER-India Lab, Supplier should provide standard one-year warranty from the date of successful completion of site acceptance test of the ordered items

10 Input drawings / documents:

1. Along with the Enquiry:
Technical Specification document (with BOM) & Schematic (separate PDF file)
2. After Purchase Order:
ITER-India will provide editable Design files (Schematic, BOM & Gerber files) to successful bidder only.

	ITER-India
	Title: Development of Digital Optical Transceiver Module

Technical Compliance Format

The supplier must fill, sign, and stamp the below table as part of compliance to the requirements.

Specifications for item name from ITER-India		Offered specification (to be filled by the supplier)	Remark (to be filled by the Supplier)
Specification	Values		