

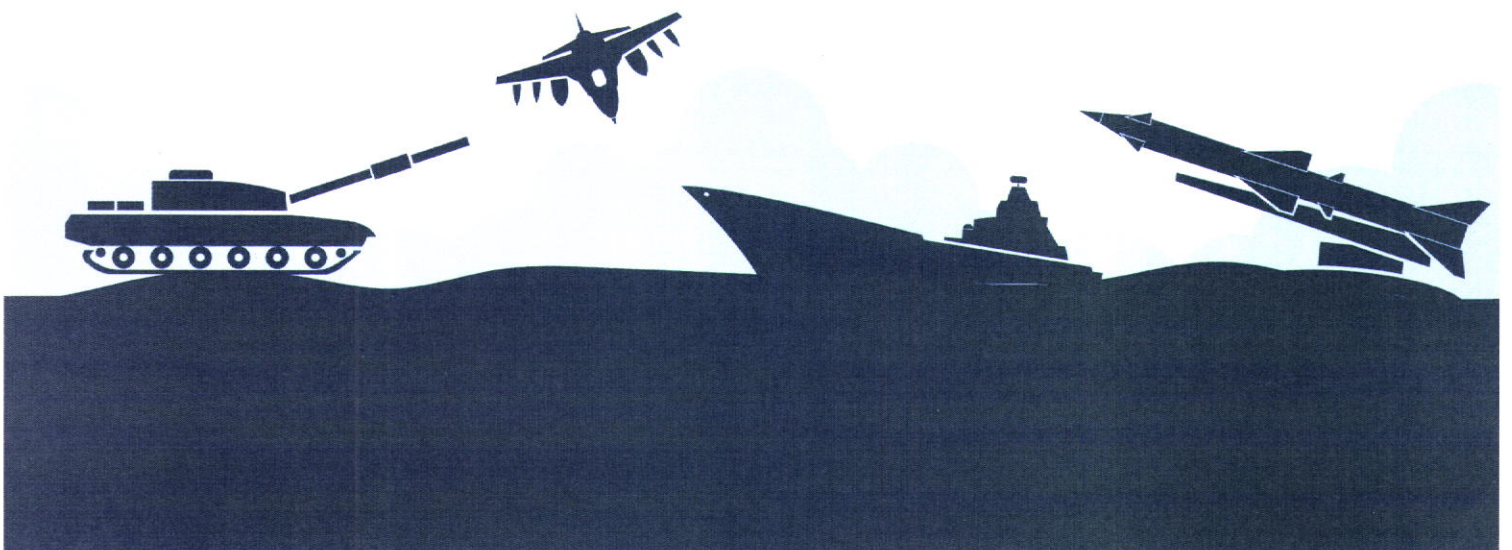


TECHNOLOGY  
DEVELOPMENT FUND

# TECHNOLOGY DEVELOPMENT FUND SCHEME

## Project Definition Document

### Development of RF Component for EW Systems



**Part – A**

1. Brief description of the project: **RF Components for EW System.**
2. Technology Parameter Requirement (TPR): **Placed at Annexure A-G**
3. System requirements and functionalities: **Placed at Appendix A.**
4. Operational requirements: **Placed at Appendix A.**
5. Testing, Certification & Qualification: **Placed at Appendix B**
6. Documentation required to be submitted at the end of successful development of Technology / at each Milestone(s) :
7. **Phases of implementation, Critical activities and Milestones:**

<b>Table 1: Project Milestone</b>			
<b>Milestone No.</b>	<b>Phase</b>	<b>Activities</b>	<b>Remarks</b>
MS1	Preliminary Design	<b>Preliminary Design Review</b> <ul style="list-style-type: none"> <li>• Establishment of design parameters for proposed configuration as per the exact form fit/ samples provide by user.</li> <li>• Understanding of user requirements and its compliance</li> <li>• Identification of Critical Technology</li> <li>• <b>Release of Approved PDR Documents including compliance</b></li> </ul>	Mechanical drawings with 3D Models, ICD, Preliminary Design Document, Project Management Plan, Configuration Management Plan, Risk Management Plan Documents
MS2	Critical Design	<b>Critical Design Review</b> <ul style="list-style-type: none"> <li>• <b>Completion of Design, Development and Testing of identified Critical Technology and component</b></li> <li>• Detailed design of systems and sub-systems down to all components</li> <li>• Finalization of specifications of various equipment, systems &amp; subsystems</li> <li>• Firming up of engineering design drawings/documents and process plan</li> <li>• Finalization of Board design, algorithm selection, optimization, etc.</li> <li>• Incorporation of platform/ equipment inputs in Binding</li> </ul>	Functional Test Plan, Acceptance Test Plan, Mechanical drawings, Schematics, Approved BOM, Structural and Thermal Analysis Reports, Reliability Analysis

		Data <ul style="list-style-type: none"> <li>• Design verification by LRDE along with user.</li> <li>• <b>Release of Approved CDR Document including compliance</b></li> <li>• <b>Initiation of procurement of Essential Components, Tools and Equipment for the project</b></li> </ul>	
MS3	Development & Testing	<b>Development and Fabrication</b> <ul style="list-style-type: none"> <li>• <b>Manufacture of component/ sub-assemblies/ prototype</b></li> <li>• <b>Component/ Module level Integration and functional testing at DA premises.</b></li> </ul>	Qualification Test Plan, ATR
MS4	Integration of the prototype	Integration of the prototype in the EW receiver at User site with support of DA and LRDE	FTR
MS5	Delivery and Acceptance	Delivery as per list of Deliverables Inspection and Acceptance at LRDE with participation of LRDE rep and User rep	QTR, FTR
Final Deliverables:		1QT and 5ESS Units of each types as per Table-2	

**8. Final Deliverables (Pls define technology/prototype along with quantity)**

Table 2: List of Deliverables				
S. No.	Item Nomenclature	QTY in Number		
		QT Unit	ESS Unit	Total No. Of Unit
i.	RF Amplifier	01	05	06
ii.	1 kW Limiter	01	05	06
iii.	Microwave Band Pass Filter	01	05	06
iv.	RF Band Pass Filter	01	05	06
v.	High Pass Filter	01	05	06
vi.	Limiter Pin 2 w	01	05	06
vii.	Power Divider 5 Way	01	05	06

9. Integration details, if required : Not applicable

10. Trial details, Not Applicable

11. Technology demonstrators, if any: As per Milestone 3

12. Acceptance Criteria:

13. Acceptance Test Plan to be submitted before the functional test and to be approved by LRDE QA

14. Vendor has to demonstrate all the functional parameters as per technical specification to LRDE rep and user rep before dispatching/delivering the item to LRDE
15. 6 units of each line item as per Table 2 to be delivered along with relevant documents/Test Reports to LRDE
16. The documents to be delivered at as per serial No. 7 above.
17. COC and Functional Test Reports for each unit.
18. Note: Items will be accepted against the CoC and the Test reports
19. Exit Criteria/ Risk management: As per TDF Provisions.
20. Safety and security aspects: As per safety standards
21. Time frames for execution of the project. As mentioned in Table 1
22. Life cycle management:
23. The module shall have a useful life of 15 years. The unit shall be designed to allow a Mean-Time-To-Repair/Replace (MTTR) of not greater than 60 minutes, when repaired/replaced by adequately trained maintenance personnel. There shall be no scheduled maintenance (including maintenance inspection and parts replacement) required for the module. Any changes/ obsolescence of components should be intimated by the development/ production agency well in time, and suitable substitutes should be provided so as to maintain the useful service life of the module for 15 years.

## Appendix A

### SYSTEM REQUIREMENTS AND FUNCTIONALITIES

#### Functional and Technical Requirements

1. Details of RF components which form part of the proposal for indigenization are as mentioned below:-

Sl. No	System	Sub-Part / Component	Purpose	Frequency Range
(i)	ESM Receiver of EW System	RF Amplifier (Annexure 'A')	The component is required to amplify the received external RF signals within the limits of permissible gain flatness range providing impedance matching and improve VSWR values.	2-18 GHz
(ii)		1kW Limiter (Annexure 'B')	The Component is required to limit the received RF signals of high Pulse power of 1kilowatt providing better VSWR values	2-18 GHz
(iii)		Microwave Band Pass Filter (Annexure 'C')	The component is required pass the RF signals in the frequency band 6-18GHz and better VSWR values	6-18 GHz
(iv)		RF Band Pass Filter (Annexure 'D')	The component is required pass the RF signals in the frequency band 2-18 GHz and better VSWR values	2.2-18 GHz
(v)		High Pass Filter (Annexure 'E')	The component is to eliminate the Cell /Mobile signals from the received RF signals in the frequency band 2-18GHz and better VSWR values.	2.4-18 GHz
(vi)		Limiter Pin 2W (Annexure 'F')	The Component is required to limit the received RF signals of CW of 2 Watt providing better VSWR values	0.25-2 GHz
(vii)		Power Divider 5 way (Annexure 'G')	The Component is required to divide equal power levels into 5 channels providing better VSWR values	DC - 2.5 GHz

Note: Description of each component is elaborated in data sheet placed at Annexure 'A' – 'G'.

2. **Technology Area (Discipline, Sub-discipline).** RF Components for detection, analysis, classification and identification of EM signals.
3. **Objective (to cover Product/System/Item).** More than 30 ESM systems have been supplied to *IN* and the component has been observed to be prone to frequent failures. In order to reduce system downtime in importing the spares and reduce maintenance costs, indigenization of the items is proposed.
4. **Description.** The system performs detection, analysis, classification and identification of EM signals (Radar Emissions in 0.5- 18 GHz band) and calculates Direction of Arrival (DoA) of the emissions. The system is sub-divided into two Bands namely 0.5–2 GHz (C/D Band) and 2-18 GHz (E/J Band).
5. **Functional and operational requirements in qualitative terms.** As per the Data Sheet.
6. **Functional and operational requirements in quantitative terms.** Detailed dimensional details are attached at Appendix A for reference.
7. **Contemporary Solutions known nationally and /or internationally (if nil, then source of idea).**As per the Data Sheet.
8. **Miscellaneous Information.** Nil
9. **References.** NA
10. **Keywords.** NA
11. **Estimated requirement for the Indian Navy over 03 to 05 years: Each fitted ESM system has 36 qty of filters. It is estimated that 200-300 quantities may be required in next 03-04 years.**
12. **Testing Methodology, Free Issue Material, Acceptance Criteria: The unit is to be tested for meeting the required specifications as per the technical parameters. Testing can be undertaken in consultation with LRDE at testing modules/ lab set up available depending upon mutual agreement between the development agency and M/s LRDE. Final testing will be done on a nominated trial platform.**
13. **Likely Civil Spin Offs.** NA
14. **Feasibility Studies (Attach if available).** NA
15. **Technology Readiness Level.** The proposed technologies are matured one overseas. However, limited/ no expertise is available for the same in the domestic industry/ R&D establishments.
16. **Proposal is an equipment /spare, is it an import substitution /replacement/up gradation/new induction.** Spare.

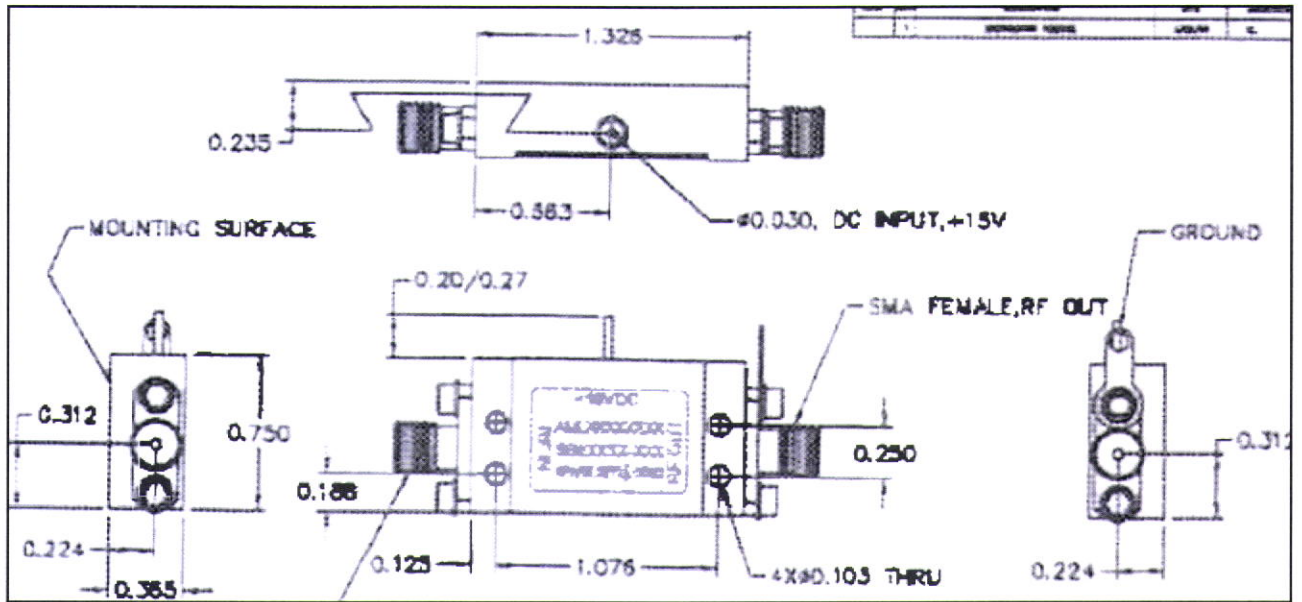
**DATA SHEET FOR RF AMPLIFIER 2-18 GHz**

1. **Title of the Requirement (Including Product/ System/item):** RF amplifier RF 2-18 GHz band for ESM systems.
2. **Technology Area (discipline, Sub-discipline):** The component is used to amplify the received RF signals. Technology discipline is Radio Frequency design and development
3. **Description:** The RF amplifier is used in E/J band in Direction Finding assembly (DFA) Sub-system.
4. **Functional and operational requirements in qualitative terms:** The component required to amplify the received external RF signals within the limits of permissible gain flatness range providing impedance matching and improve VSWR values. The component is mounted on base plate of DFA unit along with other microwave components requiring form-fit configuration. The system is fitted on board IN ships, and should meet the Naval environmental/ reliability requirements.
5. **Functional and operational requirements in quantitative terms:** Detailed functional requirements are as mentioned below:-

**Specifications:**

<b>SI No.</b>	<b>Parameter</b>	<b>Range</b>
(a)	Frequency Range	2 to 18 GHz
(b)	Gain	10 dB (min) at 2 GHz and 14 dB (min) at 18GHz
(c)	Gain Flatness	± 1.5 dB (max)
(d)	Noise Figure	3.6 dB (max)
(e)	P1 dB	9 dBm (min)
(f)	DC Supply Voltage	12 V (min) & 15 V (max)
(g)	DC current	150mA (Typ)
(h)	Connectors	RF i/p and o/p SMA Female Power: feed through
(j)	Mechanical dimensions in inches	As per the outline drawings provided below

# Outline Drawing:



R



**Data Sheet for Limiter 2-18 GHz, 1KW**

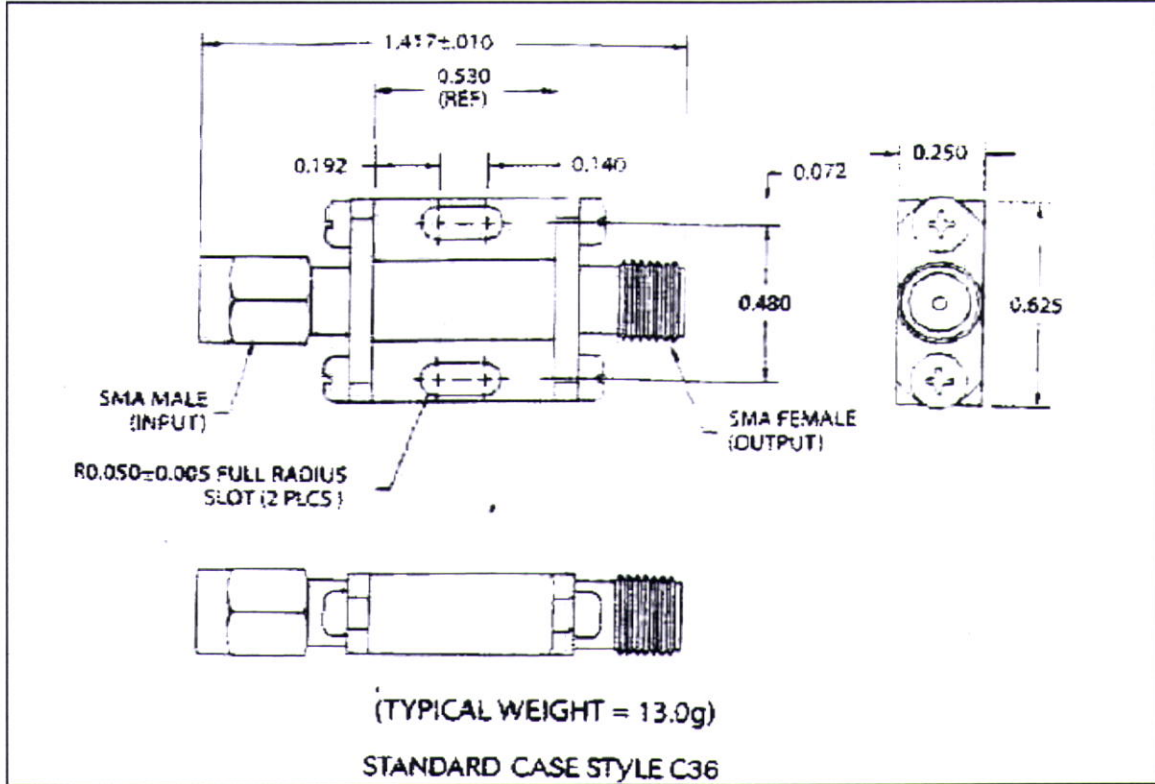
1. **Title of the Requirement (Including Product/ System/item):** LIMITER 2-18 GHz, 1KW, Frequency Band 2-18 GHz for ESM System.
2. **Technology Area (Discipline, Sub-discipline):** The component is used to limit the high Pulse power of 1Kilowatt and CW power of 1 Watts, received from Radar. Technology discipline is Radio Frequency design and development.
3. **Objective (to cover product/system/item):**  
To develop 1 QT qualified unit and 5 Nos of ESS qualified units for indigenization
4. **Description:** The limiter is used in E/J Band in Direction Finding Assembly (DFA) Sub-system.
5. **Functional and operational requirements in qualitative terms:** The component is required to limit the received RF singles of high Pulse power of 1 Kilowatt (Survival Power) with an Pulsed operational Power of 100W Peak and CW of 1 Watt and improve VSWR values. The component is mounted on base plate of DFA unit along with other microwave components requiring form-fit configuration. The system is fitted onboard IN ships, and the component should meet the Naval environmental reliability requirements.
6. **Functional and operational requirements in quantitative terms:** Detailed functional requirements is as mentioned below:-

**Specifications:**

<b>Sl.No</b>	<b>Parameter</b>	<b>Range</b>
<b>(a)</b>	Frequency range	2 to 18 GHz
<b>(b)</b>	Peak Survival input Power	1kW (Max)
<b>(c)</b>	Peak input power	100W (Max)
<b>(d)</b>	CW input power	1 W (Max)
<b>(e)</b>	Peak Flat leakage	21dBm (Max)
<b>(f)</b>	CW Flat leakage	18dBm (max)

(g)	Insertion loss	1.8dB (Max)
(h)	VSWR	1.9:1
(j)	Connectors	RF input: SMA(M) RF Output: SMA (F)
(k)	Mechanical dimensions in inches	As per the outline drawings provided below

**Outline Drawing:**



2/2

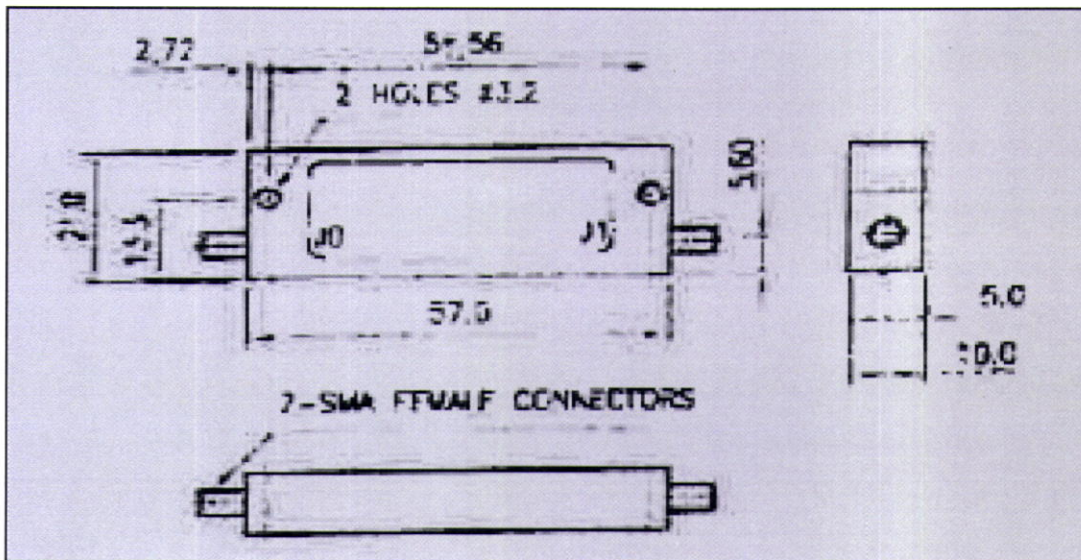
**Datasheet for Microwave Band Pass Filter**

1. **Title of the Requirement (Including Product/ System/item):** Microwave band Pass filter, for ESM Systems.
2. **Technology Area (Discipline, Sub-discipline):** The component is used as a band pass filter to pass the RF signals in the frequency band 6-18 GHz and is related to Radio Frequency design and development.
3. **Description:** The Microwave Band Pass filter mentioned above is used in E/J Band in Direction Finding Assembly (DFA) Sub-system.
4. **Functional and operational requirements in qualitative terms:** The component is required pass the RF signals in the frequency band 6-18 GHz and improve VSWR Values. The component is mounted on base plate of DFA unit along with other microwave components requiring form-fit configuration. The component proposed for development is to be fitted in equipment already installed onboard IN ships and should be able to meet the Naval environmental and reliability requirements.
5. **Functional and operational requirements in quantitative terms:** Detailed functional requirements is as mentioned below:-

**Specifications:**

SI No.	Parameter	Range
(a)	Pass Band frequency	6 to 18GHz
(b)	Insertion Loss	1.2 dB (Max)
(c)	Attenuation at Stop Band(Min) dB	Frequency            Attenuation DC-5.4 GHz            ≥50 dB 18.8-19.3 GHz        ≥15 dB 19.3-22 GHz            ≥50dB
(d)	Return loss	6 to 18 GHz ≥ 9.6 dB
(e)	Connectors	RF input: SMA Female RF output: SMA Female
(f)	Mechanical dimensions in mm	As per the outline drawings provided below

Outline Drawing:



21

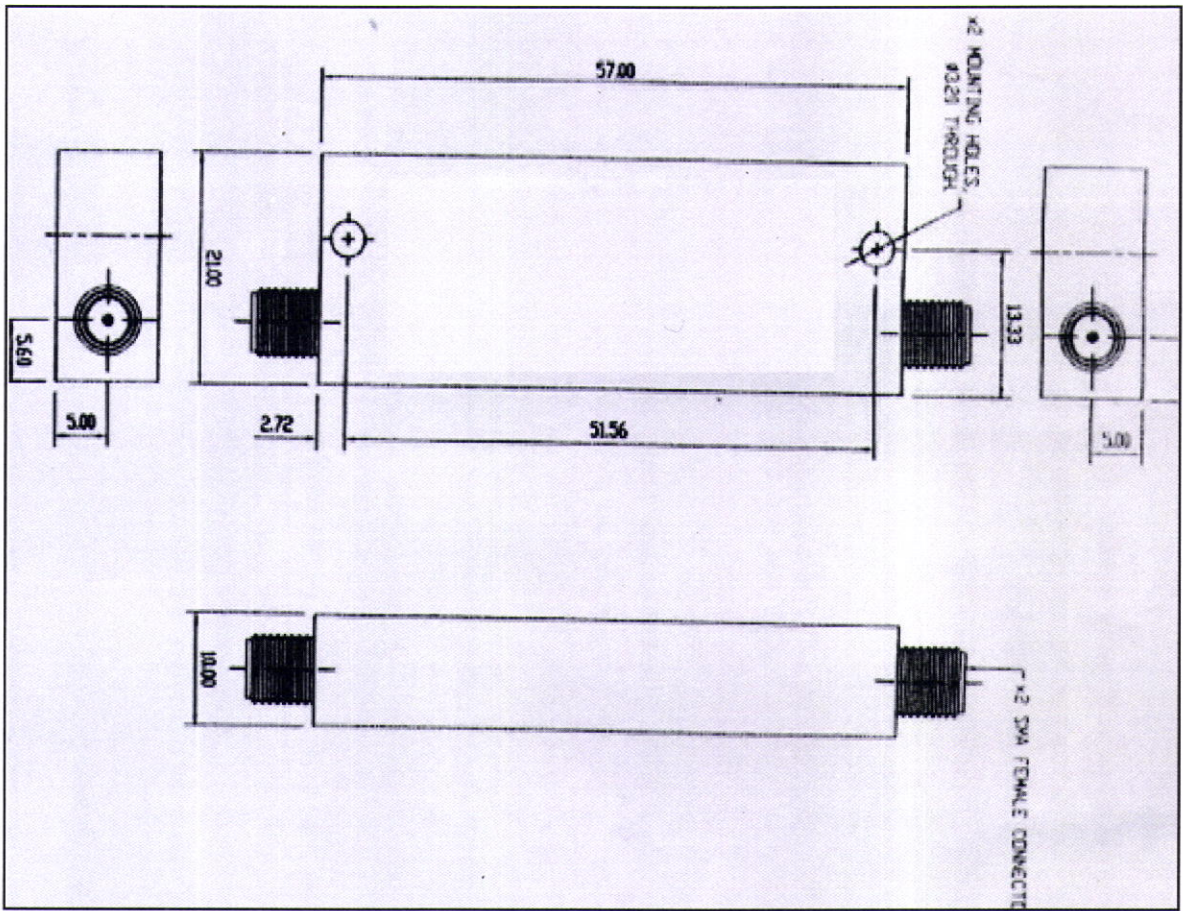
**Data Sheet for RF BAND PASS FILTER (2.2-18 GHz)**

1. **Title of the Requirement (Including Product/ System/Item):** RF band passfilter (2.2-18GHz), for ESM System.
2. **Technology Area (Discipline, Sub-discipline)** The component is used as a band pass filter to pass the RF signals in the frequency band 6-18 GHz and related to RF design and development
3. **Description:** The RF BAND PASS FILTER is used in E/J Band in Direction Finding Assembly (DFA) Sub-System.
4. **Functional and operational requirements in qualitative terms:** The component is required to pass the RF signals in the frequency band 2-18 GHz and improve VSWR values. The component is mounted on Spiral plate of DFA unit along with other microwave components requiring form-fit configuration. The system is fitted onboard IN ships, and should meet the Naval environmental/ reliability requirements.
5. **Functional and operational requirements in quantitative terms:** Detailed functional requirements is as mentioned below:-

**Specifications:**

<b>SINo.</b>	<b>Parameter</b>	<b>Range</b>	
(a)	Pass Band	Frequency (GHz)	Loss (dB)
		2.0-2.2	≤6.0
		2.2-18.0	≤ 1.25
(b)	Stop Band	Frequency (GHz)	Loss (dB)
		DC - 1.87	≥40
		19 – 26	≥ 40
(c)	Return loss Input	Frequency (GHz)	Loss (dB)
		2.2 – 18.0	≥ 11
(d)	Connectors	RF input: SMA Female RF output: SMA Female	
(e)	Mechanical dimensions in mm	As per the outline drawings provided below	

Outline Drawing:



Handwritten mark or signature.

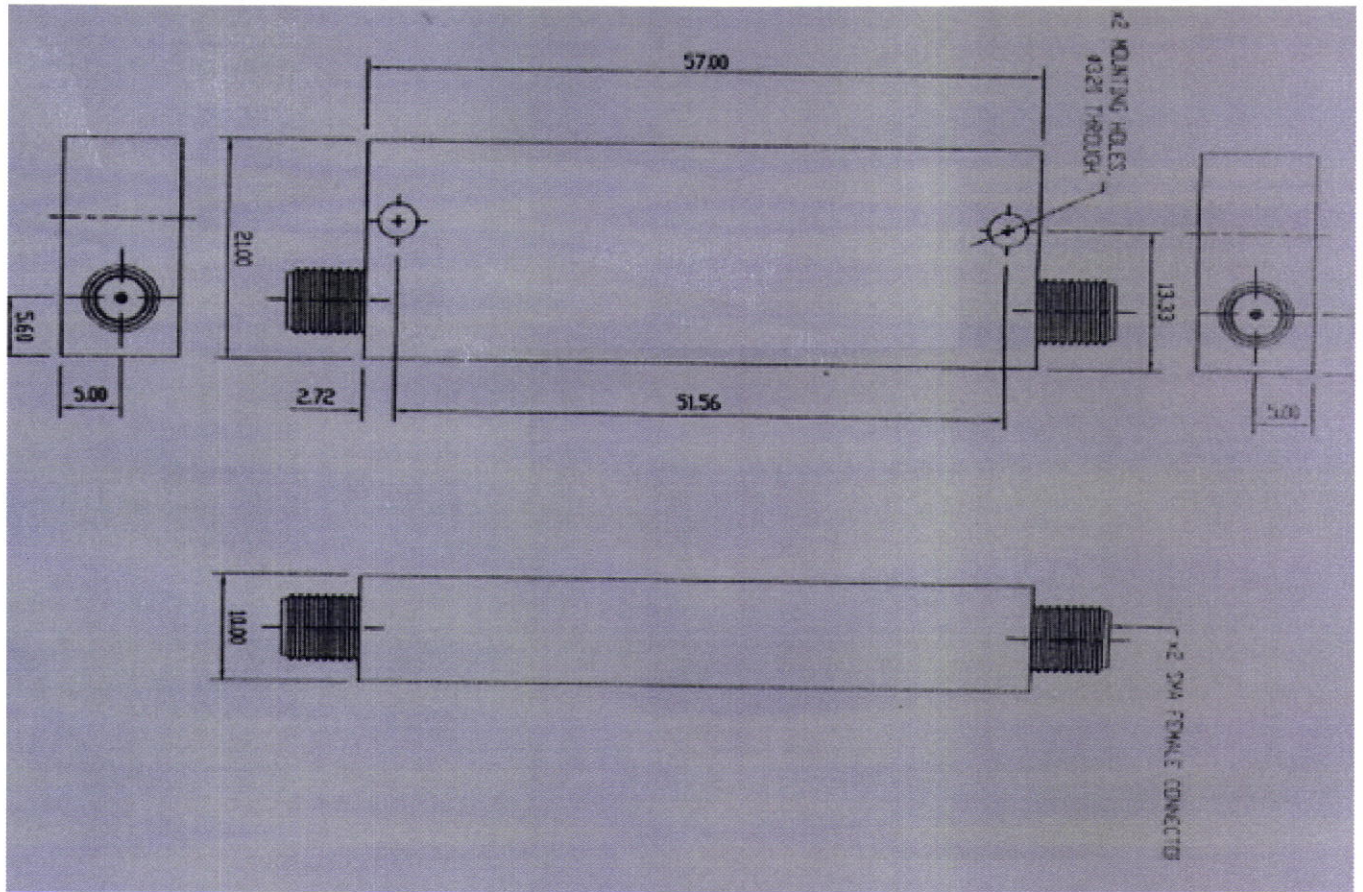
**Data sheet for RF HIGH PASS FILTER (2.4-18 GHz)**

1. **Title of the Requirement (Including Product/ System/Item):** RF High pass filter (2.4-18GHz), for ESM System.
2. **Technology Area (Discipline, Sub-discipline):** The component is used as a high pass filter to pass the RF signals in the frequency band 2-18 GHz. Technology discipline is Radio Frequency design and development.
3. **Description:** The limiter is used in E/J band in Direction Finding Assembly (DFA) Sub-system.
4. **Functional and operational requirements in qualitative terms:** The component is required to eliminate the Cell /Mobile signals from the received RF signals in the frequency band 2-18 GHz and thereby VSWR values. The component is mounted on Spiral plate of DFA unit along with other microwave components requiring form-fit configuration. The system is fitted onboard IN ships and should meet the Naval environmental/ reliability requirements.
5. **Functional and operational requirements in quantitative terms:** Detailed functional requirements is as mentioned below:-

**Specifications:**

<b>Sl No.</b>	<b>Parameter</b>	<b>Range</b>
(a)	Pass Band Frequency	2.4 to 18GHz
(b)	Pass Band Insertion Loss	1.5dB (Max)
(c)	Pass Band Return Loss	≥10.9 dB
(d)	Stop Band Frequency	DC-2.2 GHz
(e)	Stop Band Insertion Loss	≥30 dB (2.0-2.2 GHz) and ≥60dB (DC-2.0GHz)
(f)	Connectors	RF input: SMA Female RF output: SMA Female
(g)	Mechanical dimensions in mm	As per the outline drawings provided below

Outline Drawing:



BT



**DATA SHEET for LIMITER 2W (0.25 TO 2GHz)**

1. **Title of the Requirement (Including Product/ System/Item):** Limiter 2W, Frequency Band 0.25 to 2 GHz for ESM Systems.
2. **Technology Area (Discipline, Sub-discipline):** The component is used to limit the high Pulse power of 1 Kilowatt and CW power of 1 Watts, received from Radar. Technology discipline is Radio Frequency design and development.
3. **Description:** The limiter is used in E/J band in Direction Finding Assembly (DFA) Sub-system.
4. **Functional and operational requirements in qualitative terms:** The component is required to limit received RF signals for high Pulse power of 1 Kilowatt, CW of 1 Watt and improve VSWR values. The component is mounted on base plate of DFA unit along with other microwave components requiring form-fit configuration. The system is fitted onboard IN ships and the component should meet the Naval environmental/ reliability requirements.
5. **Functional and operational requirements in quantitative terms:** Detailed functional requirements is as mentioned below:-

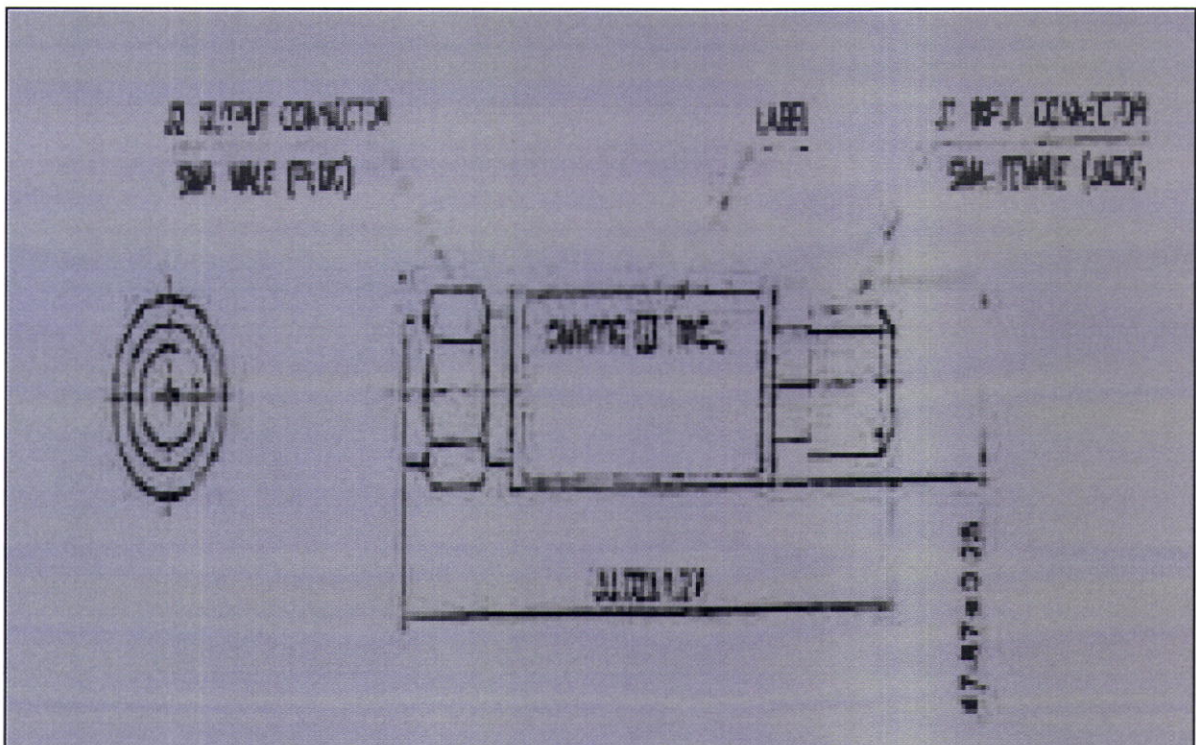
**Specifications:**

<b>Sl.No</b>	<b>Parameter</b>	<b>Range</b>
<b>(a)</b>	Type (Diode)	PIN
<b>(b)</b>	Frequency Range	0.25- 2.0GHz
<b>(c)</b>	Insertion loss	0.6 dB (max)
<b>(d)</b>	VSWR (max)	1.4:1
<b>(e)</b>	Leakage Power Max at 2watts	14dBm
<b>(f)</b>	Input Power CW Max	2W
<b>(g)</b>	Input Power Peak (PW 1Microsec Duty 1% max)	200W
<b>(h)</b>	Survival Peak Power	1KW
<b>(j)</b>	Input Connector	SMA Female
<b>(k)</b>	Output Connector	SMA Male

### Mechanical Specifications

SI.No	Parameter	Range
(a)	Length max	33.1mm
(b)	Diameter max	7.62mm
(c)	Weight max	60 Gms

### Outline Drawing:



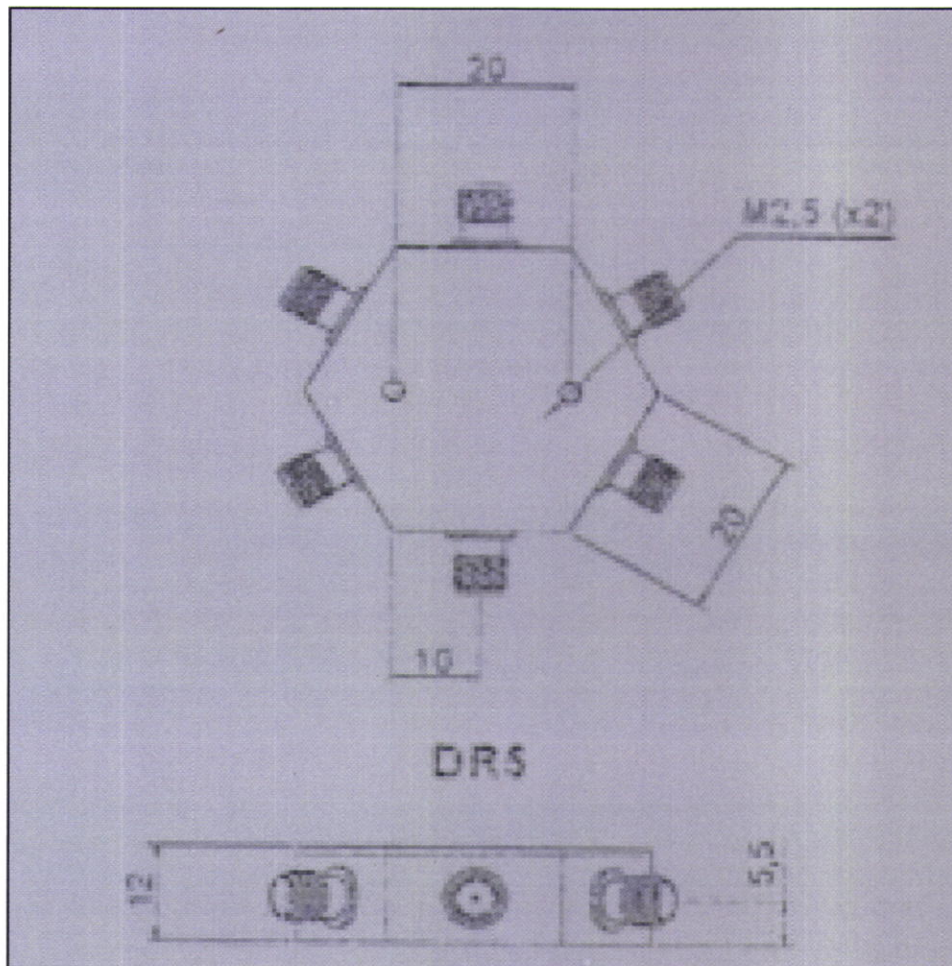
**DATA SHEET for Power Divider 5 Way (DC-2.5 GHz)**

1. **Title of the Requirement (Including Product/ System/Item):** Power Divider 5 way, Frequency Band DC to 2.5 GHz, for ESM System.
2. **Technology Area (Discipline, Sub-discipline):** The component is a 5 way power divider used to divide equal power levels into 5 channels. Technology discipline is Radio Frequency design and development.
3. **Description:** The power divider is used in BITE & auto calibration circuitry of C/D Band Exploration Sensor Unit (Sub-system). The subsystem houses 01 Quantity of power divider to divide the power into 5 equal power levels (5 Channels) that is fed to the 5 RF amplifier modules in the BITE path. The item is being sourced from foreign suppliers.
4. **Functional and operational requirements in qualitative terms:** The component is required to require dividing equal power levels into 5 Channels and improving VSWR value. The component is mounted on the CD band Exploration Sensor Unit (Sub-system) along with other microwave components requiring for-fit configuration. The system is fitted onboard IN ships, and should meet the Naval environmental/ reliability requirements.
5. **Functional and operational requirements in quantitative terms:** Detailed functional requirements is as mentioned below:-

**Specifications:**

<b>Sl No.</b>	<b>Parameter</b>	<b>Range</b>
(a)	Frequency Range	DC to 2.5GHz
(b)	Insertion Loss	14 dB (Max)
(c)	Isolation	14 ± 0.8 dB (max)
(d)	VSWR (max)	1.3:1
(e)	Amplitude Balance	0.4 dB (Max)
(f)	Phase Balance	4 deg max
(g)	Connectors	SMA Female -6Nos
(h)	Mechanical dimensions in mm	As per the outline drawings provided below

Outline Drawing:



Handwritten signature or initials in blue ink.

## **Appendix B**

### **TESTING AND QUALITY ASSURANCE**

1. **Introduction.** The manufacturer shall implement and maintain an effective quality assurance system in accordance with ISO 9001 to assure that assembly designed, manufactured, and shipped under this specification, will comply fully with the herein stated requirements. The module shall conform to the requirements of Appendix A of this document. Conformance shall be verified in accordance with a verification matrix jointly finalized during the DPR Stage. Unless otherwise specified, the manufacturer shall be responsible for the performance of all inspection requirements as specified herein.

2. **Test Equipment and Inspection Facilities.** Test equipment and inspection facilities shall be of sufficiently accurate quality and quantity, to assure that performance of required inspection can be established and maintained by the manufacturer. A calibration system shall be maintained to control the accuracy of test equipment employed and shall be in accordance with ISO-10012-1. The components are to be tested for meeting the required specifications as per the technical parameters. Testing can be undertaken in consultation with LRDE at testing modules/lab set up available depending upon mutual agreement between the development agency and LRDE. Final testing will be done on a nominated trial platform.

3. **Test Conditions.** All operating tests shall be performed with the module mounted on suitable system. All unused DC and signal connections, as applicable, shall be mated to appropriate cables with connectors as to simulate actual connections. All tests shall be performed in accordance with procedures jointly approved during DPR stage.

4. **Rejection and Retest.** If a failure occurs during a test, testing shall be discontinued until an analysis is performed to determine if the condition warrants continuation of test or to discontinue the test for more detailed failure analysis. The test procedure shall be repeated until completed successfully. If the corrective action substantially affects the significance or results of previously completed tests, such tests shall be repeated.

5. **Test Stages.** The testing methodology will be jointly finalized during the DPR stage. However. Broad contours of the testing methodology is specified below:-

(a) **Development Test.** Development tests will be performed in order to demonstrate robustness of the design and ensure early identification of potential

problems. Also, unless otherwise specified, 100% of the manufactured modules shall pass environmental screening tests before being subjected to acceptance tests. The ESS process should be guided by MIL-HDBK-2164A consisting of Temperature and Vibration cycle tests (not limited to).

(b) **Acceptance Test.** Acceptance tests shall be performed on all deliverables (modules) in ambient room conditions. The tests shall include, but not limited to visual/mechanical examination and electrical functional inspections. The tests shall be performed as specified in a detailed Verification Matrix jointly finalized during the DPR stage so as to evaluate conformance of the system to design parameters as highlighted in Appendix A. Further, the modules shall be examined to verify that the materials, design, construction, outline dimensions, weight, marking and workmanship are in accordance with the applicable requirements.

(c) **Qualification Tests.** Qualification tests shall be based on requirements as finalized during the DPR stage and shall include environmental and performance tests. The same will be performed on qualification module. The Qualification tests definition will be based on the Environmental Conditions requirements (Appendix A) and the jointly finalized Verification Matrix at DPR stage. One module, which has passed the acceptance tests, shall be selected at random for qualification tests. Modules, which have been subjected to qualification tests, shall not be delivered against any contract or purchase order

(d) **Quality Assurance Inspection.** Formal verification of performance and design shall be demonstrated by satisfactorily completing the above mentioned tests. Detailed QAP will be jointly finalized during the DPR stage.

(e) **Operational Testing.** The components are to be tested for meeting the required specifications as per the technical parameters. Testing can be undertaken in consultation with LRDE at testing modules/lab set up available depending upon mutual agreement between the development agency and LRDE. Final testing will be done on a nominated trial platform.