NASA Technical Memorandum 86224

Performance Interface Document for the S-Band Diplexer for Space Users of NASA Networks

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Performance Interface Document for the S-Band Diplexer for Space Users of NASA Networks

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1985

All measurement values are expressed in the International System of Units (SI) in accordance with NASA Policy Directive 2220.4, paragraph 4.

CONTENTS

PERFORMANCE INTERFACE DOCUMENT FOR THE S-BAND DIPLEXER FOR SPACE USERS OF NASA NETWORKS

HISTORICAL BACKGROUND OF SPACE DATA SYSTEMS

The success of all space missions has been based on the ability to gather data in space and return that data to Earth-based investigators. The National Aeronautics and Space Administration (NASA) tracking and data acquisition stations, located on various parts of the Earth, underwent three distinct evolutions. These three evolutions are as follows:

a. Space Tracking and Data Acquisition Network (STADAN)--STADAN, completed in 1958, was used for tracking unmanned spacecraft in Earth orbits from ground facilities that used sensitive receivers and powerful transmitters.

b. Manned Space Flight Network (MSFN)--During the Mercury, Gemini, and Apollo programs of the early 1960's, MSFN was used to provide the astronauts with two-way contact between the ground, the sea, and space.

c. Deep Space Network (DSN)--Implemented in the early 1960's to support NASA lunar and planetary missions, DSN used parabolic dish antennas in three stations each located apart by approximately 120° of longitude. DSN is still operational and continues to support planetary missions under the Jet Propulsion Laboratory (JPL) management.

The Spaceflight Tracking and Data Network (STDN), operational from May 1971 to the era of the Tracking and Data Relay Satellite (TDRS) System (TDRSS) Network, is a combination of the STADAN and the MSFN.

TDRSS NETWORK

It was recognized that the GSTDN's limitations could be removed through a new network that used geostationary satellites rather than ground stations for tracking and communicating with user spacecraft. This network could provide coverage for almost the entire orbital period of a user spacecraft, support a number of spacecraft simultaneously, and have a high assurance of availability. Several NASA studies showed that this network was feasible by using state-of-the-art technology developed in the middle to late 1970's and by using the ATS-6 and the Nimbus-6 spacecraft as demonstration models. This research led to the development of the TDRSS network, which demands higher performance on the TDRSS user spacecraft.

The impact on the user spacecraft is the requirement for increased Effective Isotropic Radiated Power (EIRP), higher gain antennas, higher power transmitters, more sensitive receivers, and other components including high-performance diplexers.

The TDRSS network provides a bent-pipe communications link from the user spacecraft to the relay satellite to the ground station and vice versa. The ATS-6's tracking and data relay experiment demonstrated that the Earth-orbiting Nimbus-6 could be commanded from a ground station by the ATS-6 Earth Synchronous satellite. Data generated on board the Nimbus-6 were sent back to the ATS-6 and were then relayed by the ATS-6 to the ground. In addition, the range and range-rate measurements of the Nimbus-6 through the ATS-6 determined the relative distance and velocity of two of the three spacecraft. These measurements were then compared with similar direct measurements made by the ground station.

RELEVANCE OF THE S-BAND DIPLEXER

A diplexer is most commonly thought of as two simple bandpass filters that are close in frequency and have one end of each filter common to a RF terminal (antenna). The other ends connect to a receiver and a transmitter as shown in Figure 1.

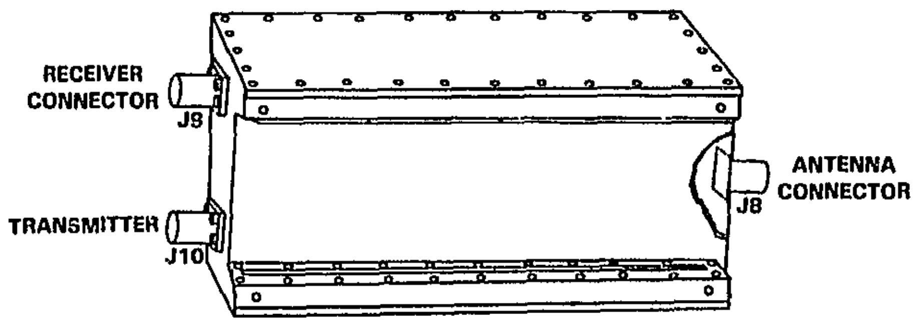

Figure 1. S-band Diplexer

To meet most of today's challenges in the ever increasing crowded frequency spectrum, the diplexer has become a complex series of bandpass and band rejection filters. In the 1960's, spaceborne diplexers were utilized by the Orbiting Geophysical Observatory (OGO) project with the S-band transponders. At that time, the receivers had a maximum sensitivity of -105 dBm with the transmitters delivering 1 watt of RF power. Today, TDRSS users have receiver sensitivities of -140 dBm and transmitters that can deliver anywhere from 5 to 28 watts of RF output power. With this increase in sensitivity and RF output power, more design considerations had to be taken into account to meet the demands of the universal system performance capabilities.

For instance, it was discovered that noise produced by the RF power amplifier desensitized the receiver, which would decrease the efficiency of command throughput. To alleviate the problem, a band reject filter with 100 dB of receiver frequency rejection was installed at the output of the final power amplifier. The past design, as previously discussed, solved the problem until the higher power amplifiers were used with pin diode switches causing receiver desensitization.

Another area of improvement was the final noise figure of the S-band receiver. The first generation transponder had an overall noise figure of 5 dB, of which 2.5 dB was accounted for by the silicon bipolar Low Noise Amplifier (LNA), 1.1 dB to the receive channel of the original diplexer, and the remaining losses to switches and cables. By using a G_AA_S Field Effect Transistor (FET) for the LNA, the noise figure was improved to 2 dB and by using the NASA-developed TDRSS user diplexer that had an 0.60-dB insertion loss, the overall noise figure was improved to 3.5 dB, which is an improvement of 1.5 dB.

DEVELOPMENT PROGRAM

A development program was initiated with 310 Research and Technology Objective Plans (RTOPs) funding to accomplish the following design improvements.

RECEIVER CHANNEL FILTER

- Minimum insertion loss in bandpass at 2106.4 ±6 MHz.
- Increase transmitter frequency rejection at 2287.5 MHz.
- Add a harmonic suppressor filter to reject all signals from 2.3 to 16.0 GHz.

- Provide Space Transportation System (STS) compatibility by:
  - Maximum rejection at 2217 $\pm$10 MHz Shuttle S-band data link.
  - Maximum rejection at K-band 15.0 GHz data link.
  - Maximum rejection at K-band 13.775 GHz KSA.

TRANSMITTER CHANNEL FILTER

- Minimum insertion loss in bandpass 2287.5 $\pm$10 MHz.
- Provide increased receiver rejection at 2106.4 $\pm$6 MHz.
- Do away with the externally mounted band reject filter and utilize the internal design version, thus reducing insertion loss, volume, and weight.

PERFORMANCE CONSIDERATIONS

The primary function of the receive channel is to pass the received signal at 2106.4 MHz with a minimum signal degradation and insertion loss, while rejecting the unwanted signals such as the S-band transmitter, S-band Shuttle Data and Link, and the K-band Shuttle radar.

The primary purpose of the transmitter channel is to pass the modulated transmit signal with a minimum signal degradation and insertion loss, while rejecting any noise created at the receiver frequency by the power amplifier on its path to the antenna.

DESIGN CONSIDERATIONS

RECEIVER CHANNEL

The unit should have minimum insertion loss since it adds directly to the noise figure of the low noise preamplifier of the receiver. A savings in tenths of a dB is important to overall system performance.

The receive channel should also have approximately 80 dB of rejection at the transmit frequency of 2287.5 MHz as shown in Figure 2. This rejection is required to reduce any desensitization caused by the final power amplifier stage. An additional improvement over the original diplexers is the 70-dB wide band rejection from 2217 MHz up to 16 GHz. This new additional filter provides 70-dB rejection of the K-band data link and the K-band single access signal. See Figure 3 for the receiver channel insertion loss versus frequency.

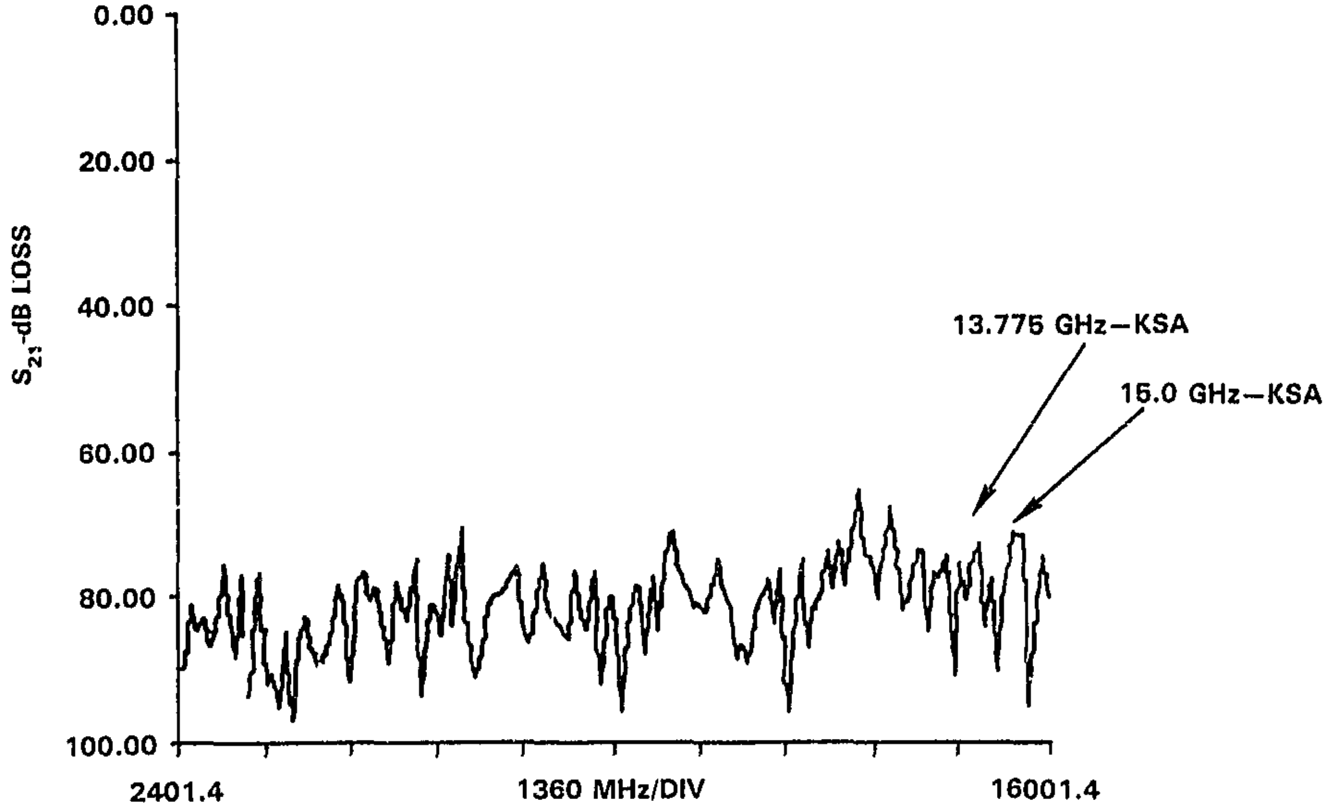

Figure 2. Receiver Channel Band Reject Insertion Loss

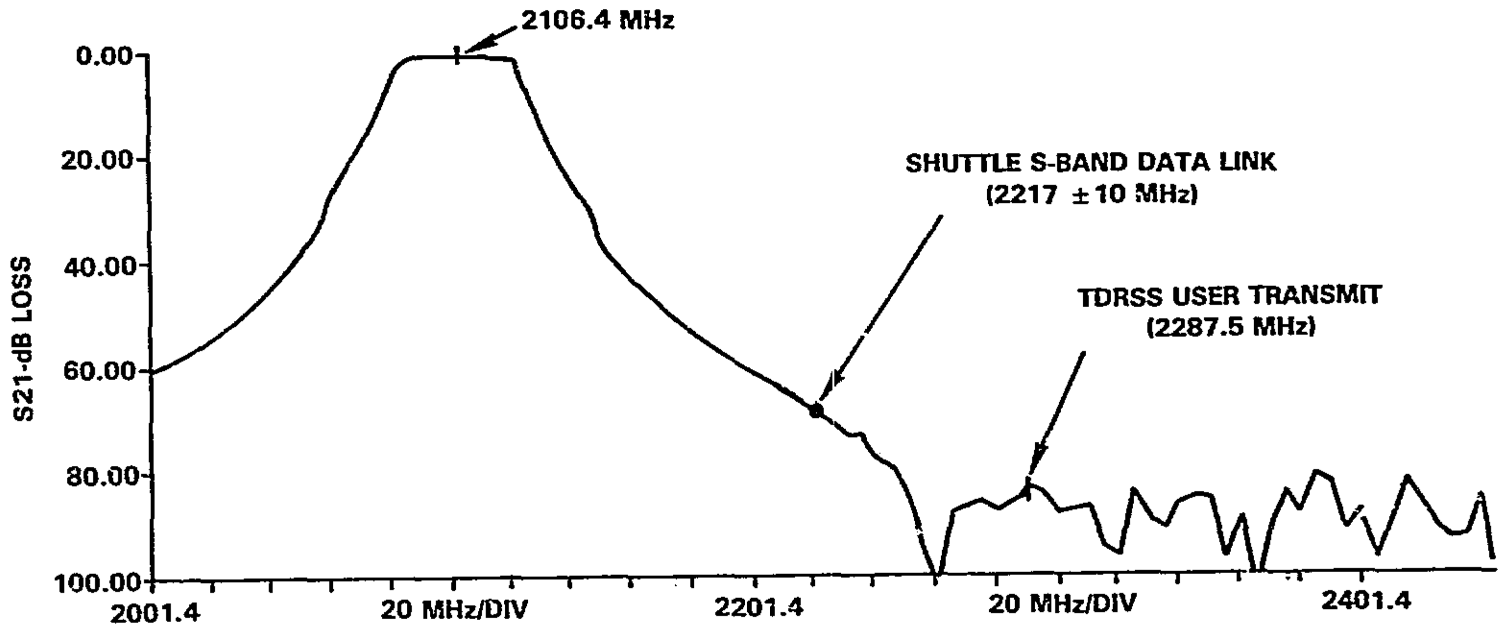

Figure 3. S-band Diplexer Receive Channel Forward Insertion Loss (S_{21}) Versus Frequency

TRANSMITTER CHANNEL

The transmitter channel has approximately 75-dB rejection at the receiver channel frequency as shown in Figure 4. If system performance requires an additional 100-dB rejection, the optional internal band reject filter can be selected.

This option is achieved without any increase in mass or weight to the original diplexer. The optional reject filter also ensures that transmitter generated noise in the receiver bandpass frequency will be rejected at 135 dB, which is the maximum sensitivity of the TDRSS transponder.

TRANSMIT CHANNEL POWER HANDLING CAPABILITY

The transmit channel is able to handle 20 watts cw at 1×10^{-3} torr or 1 micron of pressure, while operating into a 50-ohm load with no evidence of corona, multipactor, or any other breakdown.

The standard output of the TDRSS transponder is 5 watts, therefore, a 20-watt power handling test is more than adequate to confirm this capability.

The diplexer qualified for the Earth Radiation Budget Satellite (ERBS) project was successfully power tested at the 40-watt level because of the higher output power of 28 watts.

INPUT IMPEDANCE AND VSWR

The RF impedance of the diplexer receive and transmit port should be carefully matched to ensure minimum signal loss and reflection.

Impedance mismatch is indicated by a Voltage Standing Wave Ration (VSWR) greater than unity. VSWR that is not greater than 1.2 to 1 over the operating bandwidth is satisfactory.

The VSWR measurement is determined with the unmeasured post terminated with a 1.2:1 or better 50-ohm termination.

TEST REQUIREMENTS

Tests are performed to ensure the following:

- Adequacy of the functional performance requirements
- Capability to withstand environmental conditions
- Life expectancy
- Unit performance during pre-integration, postintegration, and prelaunch activities

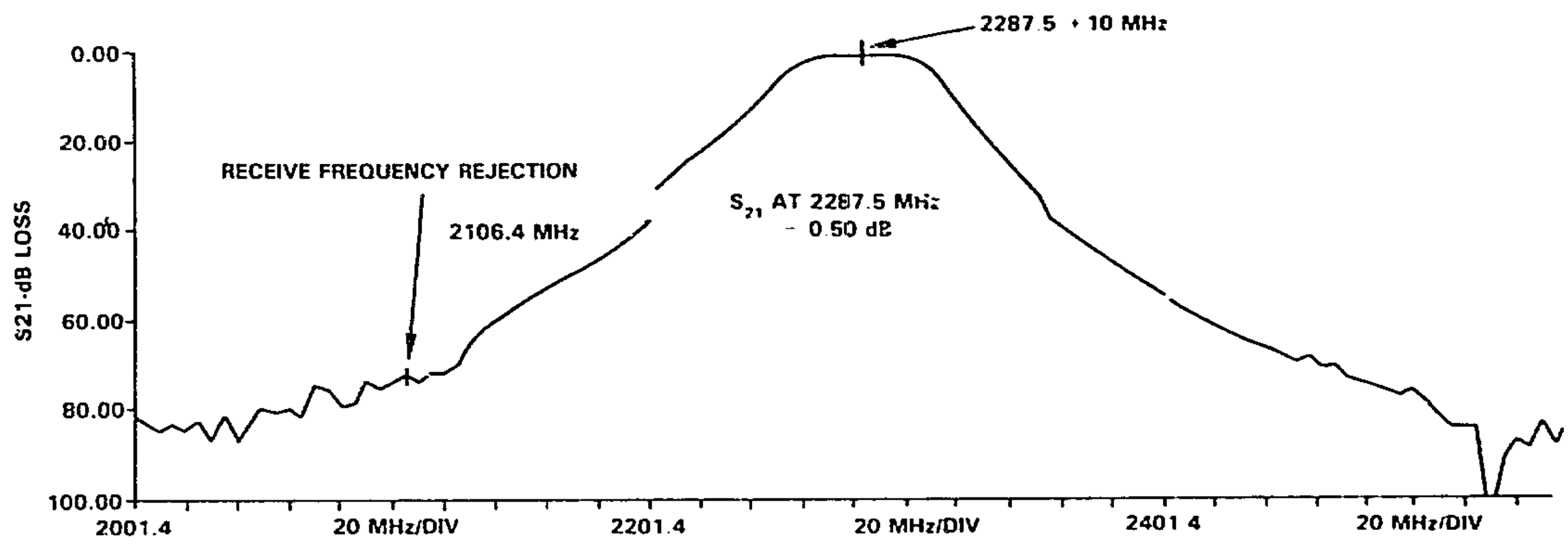

Figure 4. S-band Diplexer Transmit Channel Forward Insertion Loss (S_{21}) Versus Frequency

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The project will determine the amount of testing for the diplexer. In defining the extent of the required testing, previous testing and test levels should be compared. It should be emphasized that if this system does not function, the mission will most likely fail.

INTERFACES

a. Mechanical--The diplexer/BRF will normally be mounted on a mounting surface near the S-band transponder. Location of mounting holes and RF connectors will be determined by the diplexer/BRF contractor. The diplexer/BRF will be capable of being mounted in any plane.

b. Thermal--Heat dissipated in the diplexer/BRF shall be conducted to the mounting surface. Heat dissipated in the diplexer is approximately 10 percent of the RF power input to the transmit channel.

c. Electrical--The antenna port will interface to a network connecting to the antenna. The receive port will interface to a network connecting to the S-band transponder receiver, and the transmit port will interface to a network connecting to the S-band transponder power amplifier or to an external power amplifier.

DIPLEXER AND SYSTEM APPLICATIONS

The diplexer housing is manufactured from an aluminum 6061-T6 alloy, which is plated with zincate, copper, and silver. The unit is then primed and the final coating is Chemglaze Z-305. The mounting surface is left uncoated to facilitate thermal conduction. The diplexer, presently on the Earth Resources Budget Satellite (ERBS), can be seen in Figure 5.

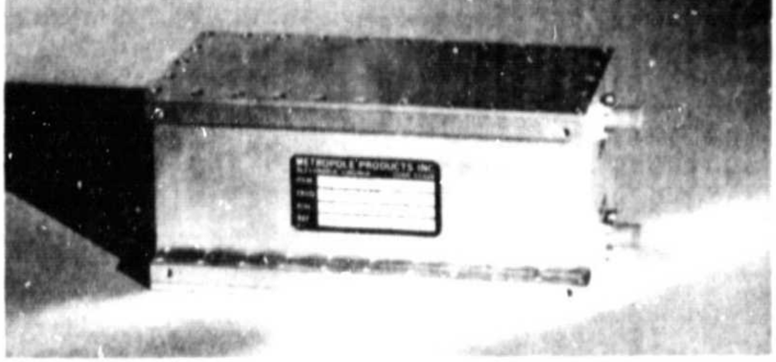

Figure 5. S-band Diplexer for Space Users

The first flight application of the S-band diplexer was on the ERBS with the transmitter output power at 28 watts cw. The overall system diagram is illustrated in Figure 6.

Gamma Ray Observatory (GRO) is also utilizing the same design with the standard 5-watt output (Figure 7).

The Cosmic Background Explorer (COBE) will have the benefit of the integral band reject filter (Figure 8) incorporated in its specifications.

SUMMARY

In conclusion, a flight S-band diplexer that is TDRSS compatible has been developed, qualified, and flown successfully. The unit can be designed with or without an interval band reject filter. The unit exhibits less insertion loss, while at the same time, it is also STS compatible.

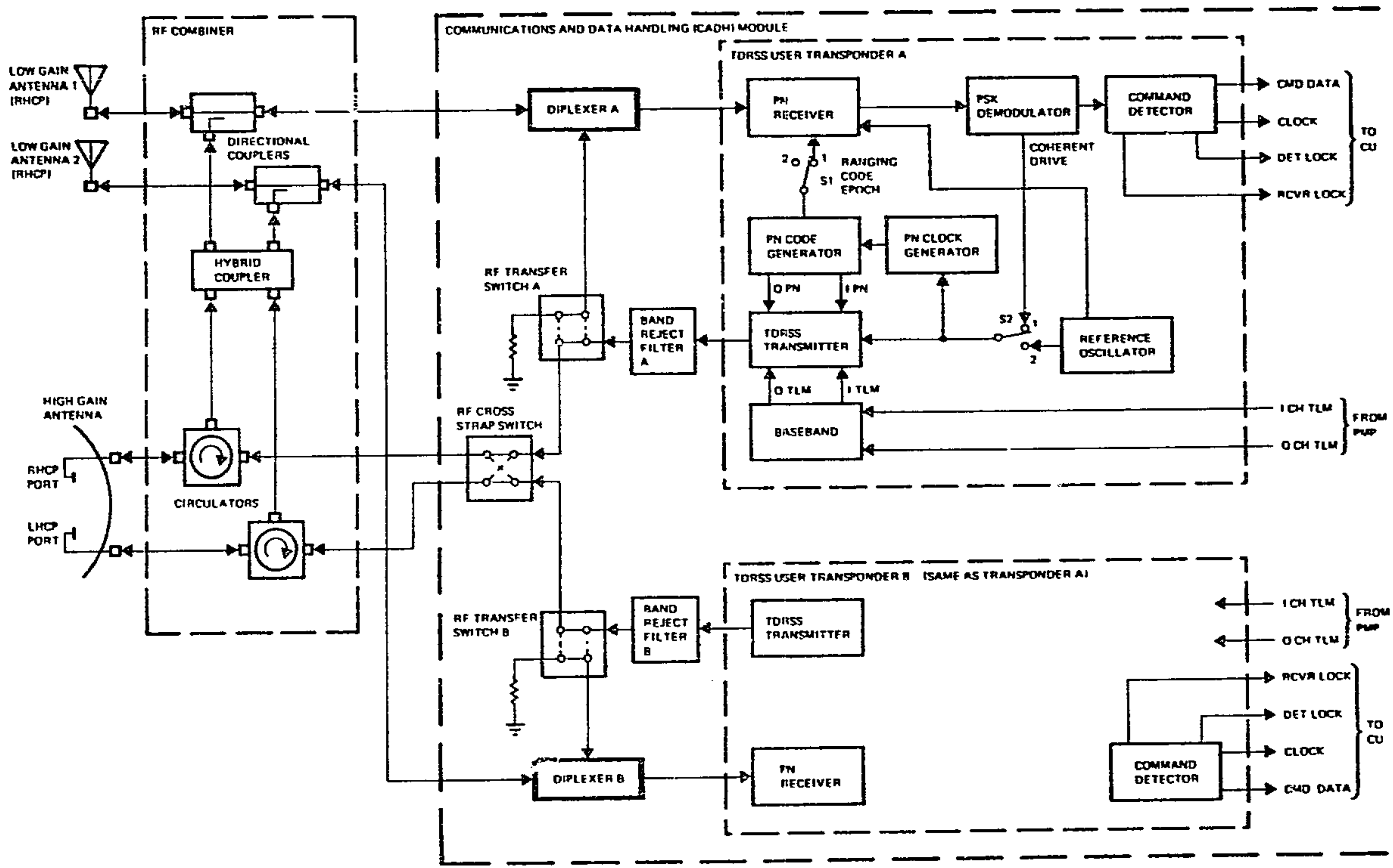

Figure 6. GRO Communications Equipment--TDRSS Configuration

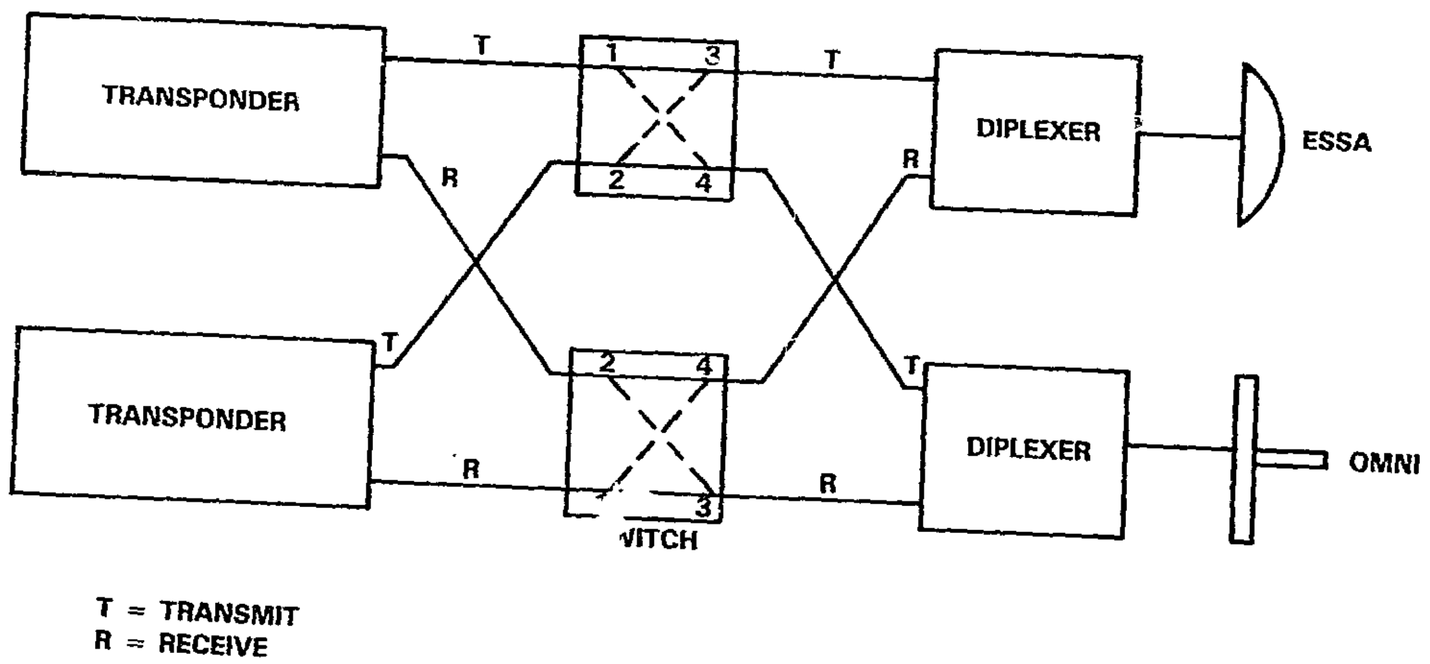

Figure 7. COBE Communications Subsystem Block Diagram

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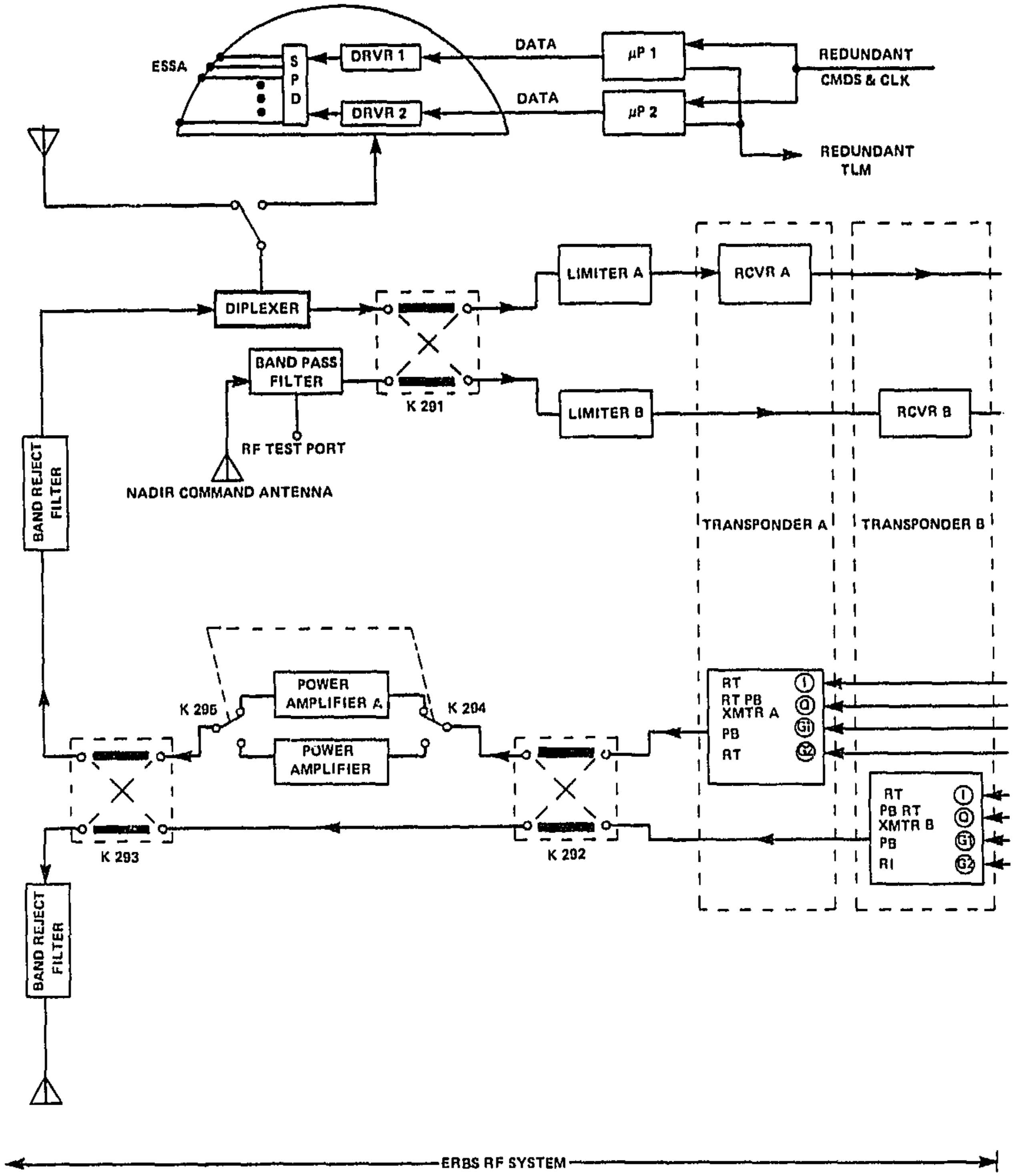

Figure 8. ERBS RF System

APPENDIX A

GSFC GENERAL SPECIFICATION FOR THE S-BAND DIPLEXER FOR SPACE USERS OF NASA NETWORKS

GSFC GENERAL SPECIFICATION FOR THE S-BAND DIPLEXER FOR SPACE USERS OF NASA NETWORKS

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APPENDIX A

GSFC GENERAL SPECIFICATION FOR THE S-BAND DIPLEXER FOR SPACE USERS OF NASA NETWORKS

1. SCOPE

This specification defines the general requirements for an S-band diplexer to be used by TDRSS compatible users such as Earth Radiated Budget Satellite (ERBS), Gamma Ray Observatory (GRO), and Cosmic Background Explorer (COBE).

The required design shall exhibit a minimum size and weight consisent with high performance and reliability.

The diplexer will contain selective circuits that will interconnect the S-band transponder receiver and transmitter to the S-band antenna.

The user has a choice of a simple diplexer or a diplexer with an integral band reject filter. The latter unit offers less insertion loss at Fr than would separate units. Less weight and volume is another benefit encountered. A Band Reject Filter (BRF) is also available as a separate unit.

2. APPLICABLE DOCUMENTS

The documents listed in this section are of the most current issue in effect on the date of issue of this specification and shall apply to the extent specified herein.

a. NHB 5300.4 (1C) "Inspection System Provisions for Aeronautical and Space Systems, Materials, Parts, Components, and Services," July 1971.

b. X-673-64-16 "GSFC Engineering Standards Design Manual," Revision 3, January 1972.

c. ICD 403135004 "GSFC Interface Control Document," December 1983.

3. PERFORMANCE REQUIREMENTS

The S-band diplexer shall meet the performance requirements established in this section.

3.1 FUNCTIONAL DESCRIPTION

The diplexer is comprised of two channels, receive and transmit both connected to a common antenna port as shown in the functional block diagram in Figure A-1. The receive channel signal at 2106.4 MHz for most TRDSS users is coupled from the S-band antenna to the input of the receiver low noise amplifier with minimum insertion loss. All other frequencies are to be attenuated as specified.

The transmit channel at 2287.5 MHz for most Tracking and Data Relay Satellite System (TDRSS) users, couples the output of the S-band power amplifier to the S-band antennas. The bandpass and band reject filter combine to suppress any receive signal component in the output of the S-band power amplifier so as to maintain the S-band receive system capability.

The unit is compatible with NASA telemetry and command functions whose frequencies are related by the 221/240 ratio.

The Voltage Standing Wave Ratio (VSWR) of both channels should be as good or better as those specified in Table A-1.

The insertion loss specifications for both the receive and transmit channels are available in Table A-2.

3.2 POWER HANDLING

The transmit port of the diplexer shall be able to handle 20 watts of cw power for 2 hours at 1 micron of Hg (1×10^{-3} torr).

4. INTERFACE REQUIREMENTS

This section defines the mechanical, electrical, and thermal interface requirements of the diplexer/BRF.

4.1 MECHANICAL INTERFACE REQUIREMENTS

The diplexer/BRF will normally be mounted on a mounting surface near the S-band transponder. The diplexer/BRF shall be capable of being mounted in any plane.

4.2 THERMAL INTERFACE REQUIREMENTS

Heat dissipated in the diplexer/BRF shall be conducted to the mounting surface. (Refer to Section 5.3 for mounting surface specifications.)

4.3 ELECTRICAL INTERFACE REQUIREMENTS

The antenna port will interface to a network connecting to the antenna. The receive port will interface to a network connecting

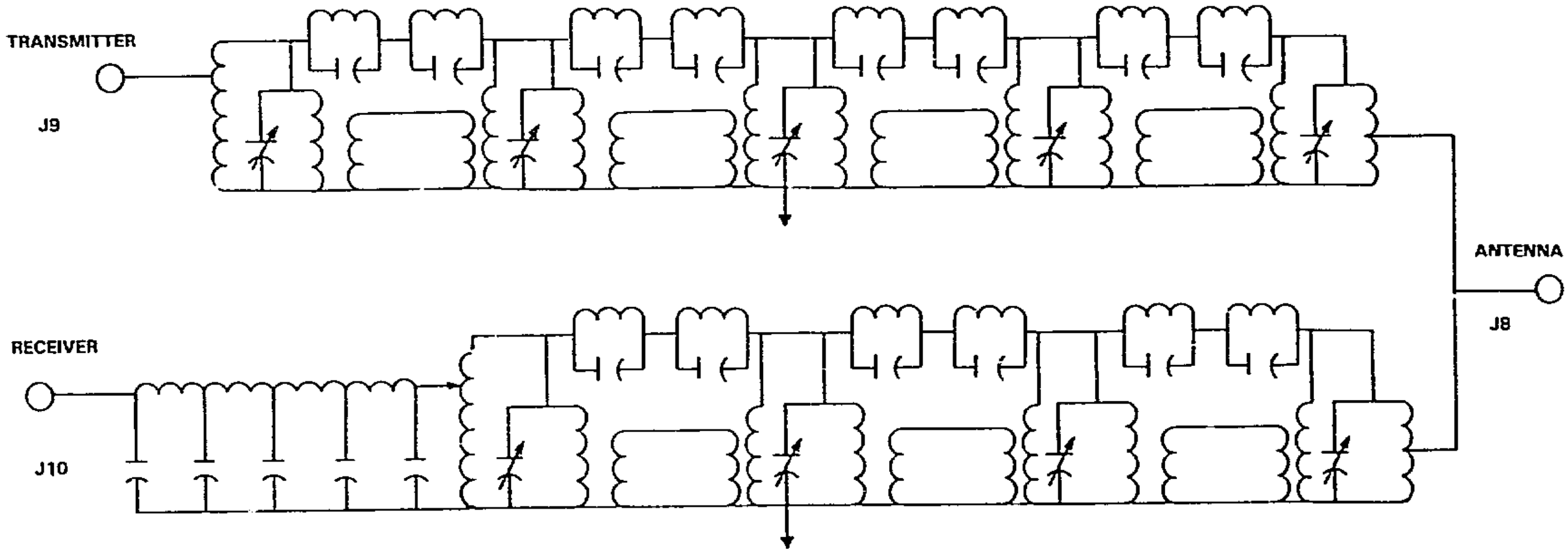

Figure A-1. Functional Diagram of the S-band Diplexer

Table A-1
VSWR Specifications

PORT	VSWR	CONDITION
Receive (J-10)	1.2:1 over receive BW per either antenna or RX port	Transmit port terminated in 1.2:1 or better 50-ohm load.
Transmit (J-9)	1.2:1 over transmit BW per either antenna or transmit port	Receive port terminated in 1.2:1 or better 50-ohm load.

Table A-2
Insertion Loss Specification*

Port	Frequency (MHz)	Insertion Loss (dB) Minimum Within Passband
Receive	1866 ±10 Image rejection	70.00
Receive	2046 ±10 1/2 IF rejection	40.00
Receive	2106.4 ±6	0.65 maximum
Receive	2217 ±7.5	70.00
Receive	2287.5 ±6	80.00
Receive	2217 to 16,000	70.00 to 16 GHz
Transmit	2106.4 ±6	135.0**
Transmit	2106.4 ±6	55.0 (diplexer only, no BRF)
Transmit	2287.5 ±10	0.55 maximum**
BRF	2106.4 ±6	100.0 (band reject filter only)
BRF	2287.5 ±6	0.15 maximum (band reject filter only)

*Unused port shall be terminated into a 1.2:1 50-ohm load.
**Unit includes integral band reject filter.

to the S-band transponder receiver and the transmit port will interface to a network connecting to the S-band transponder power amplifier or to an external power amplifier.

5. CONSTRAINTS

5.1 WEIGHT

The diplexer/BRF shall not exceed 0.700 kg. The unit shall also be lightened as much as possible to keep the weight to a minimum.

5.2 SIZE

Figure A-2 represents the mechanical and mounting dimensions.

5.3 MOUNTING SURFACES

The mounting surfaces shall have a flatness within 0.003* of an inch per foot and a surface finish of 32 microinches rms or better. The design shall allow for mounting on a flat surface in any plane.

MOUNTING HOLES--Four clearance holes shall be provided to accommodate 10/32 bolts as specified in Interface Control Document GSFC, 403135004. A template shall be provided by the contractor with match-drilled mounting holes.

5.4 ENVIRONMENTAL CONSTRAINTS

5.4.1 Test Levels

5.4.1.1 Vibration--The diplexer/BRF shall be designed to withstand the following sinusoidal and random vibration specifications (Table A-3) that are in accordance with STS and Delta launches.

5.4.1.2 Thermal--Both channels of the diplexer/BRF shall be designed to operate within specifications over the temperature range of -25 to +50°C and to withstand repeated thermal cycling between these limits with no degradation.

5.4.1.3 Magnetics

Nonoperating--The diplexer/BRF shall meet all performance requirements after exposure to an ac magnetic field up to 35 gauss in any direction.

*Because of the widespread use of English units, that convention has been followed in this section.

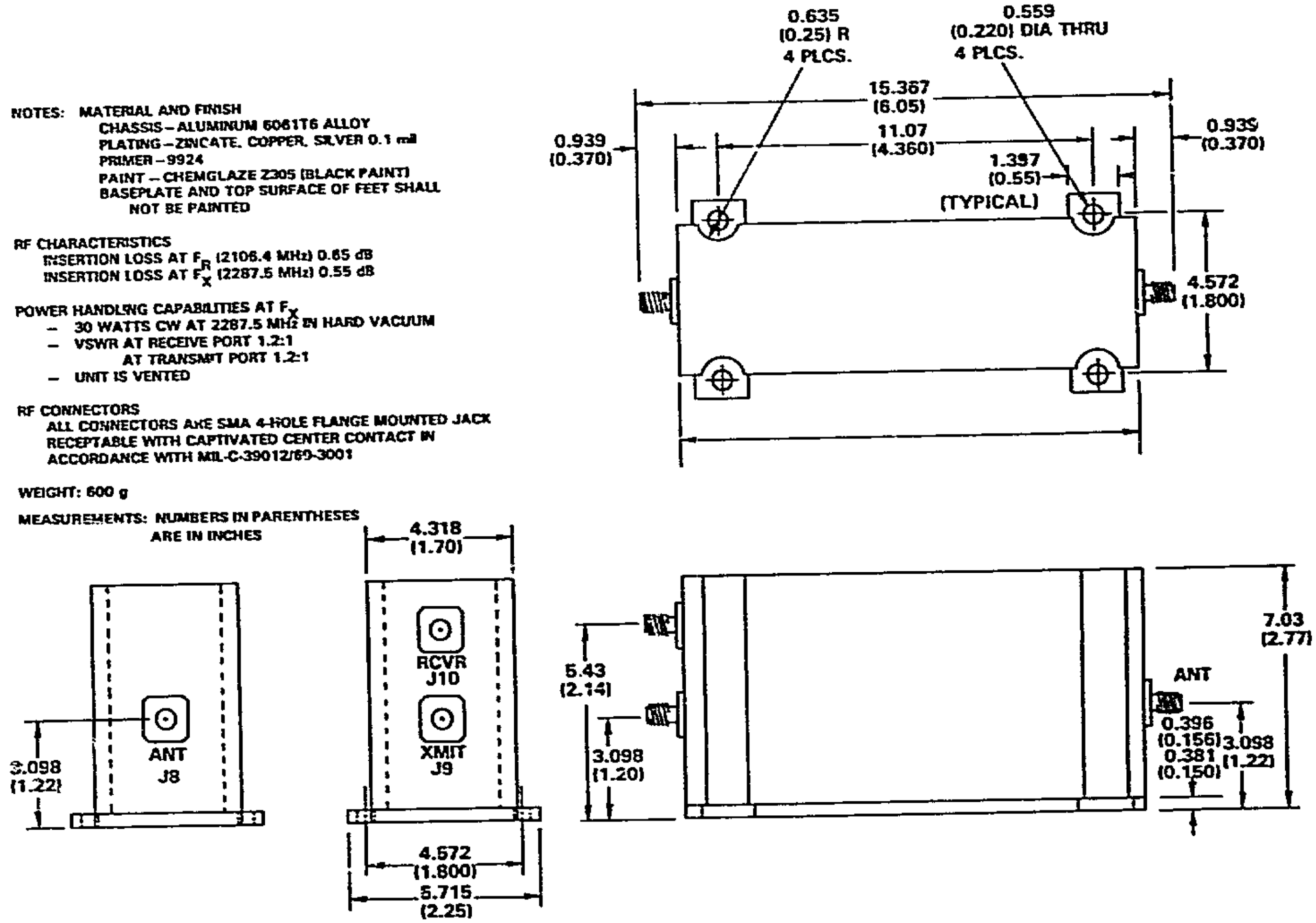

Figure A-2. Specification Drawing for the S-band Diplexer

Table A-3
Vibration Specifications

Sinusoidal--All Axis		
Frequency (Hz)	Level	Rate
5-17 17-200	1.016 cm (0.4) d.a. ±6.4 g	2.0 octave/minimum 2.0 octave/minimum
Random--All Axis		
Frequency (Hz)	Level	Duration minimum/axis
20-60 60-100 100-1000 1000-2000	+6 dB/octave 0.36^2/Hz -3 dB/octave -6 dB/octave Grms = 10.2	3.0 (qualification) 1.0 (flight unit)

Operating--The diplexer/BRF shall meet all performance requirements under conditions of steady state exposure to a dc magnetic field up to 5 gauss in any direction.

5.4.2 Venting

The unit shall have adequate venting to ensure outgassing in vacuum from atmosphere to 1×10^{-6} torr within 60 seconds. The unit must also be designed so that a particle with a 0.3 mm diameter cannot escape through the venting apertures.

5.5 ELECTRICAL CONSTRAINTS

5.5.1 RF Leakage

RF leakage from the diplexer/BRF shall be down at least 90 dB from the applied power at 1 meter from the transmit port.

5.5.2 RF Breakdown

The diplexer/BRF transmit channel shall be able to handle 20 watts cw at 10^{-3} torr, while operating into a 1.2:1 VSWR 50-ohm load with no evidence of corona, multipactor, or any other breakdown. The transmit frequency is 2287.5 MHz.

Delta launched users will be operational through the critical pressure region therefore, the power handling capabilities have to be determined. Shuttle launched users do not have a requirement for transmitter operation through the critical pressure region.

The power handling capability in the critical pressure region will not have to be determined.

5.5.3 Lifetime

The lifetime of the S-band diplexer/BRF shall be a minimum of 10 years.

5.6 THERMAL COATING

The diplexer will be primed and painted by the contractor. The unit will be primed with 9924 and the final coating sprayed with Chemglaze Z-305.

6. IMPLEMENTATION REQUIREMENTS

6.1 CONNECTORS

RF connectors shall be a type SMA four-hole flange mounted jack receptacle with a captivated center contact in accordance with MIL-C-39012 160-3001.

6.2 PLATING

The chassis and associated critical components shall be plated as follows: zincate, copper, silver--0.0001 of an inch.

6.3 LOCKING OF FREQUENCY DETERMINING COMPONENTS

All frequency determining components shall be locked fast utilizing locknuts and a two part Hysol Epoxy 151.

6.4 RELIABILITY AND QUALITY ASSURANCE

(Refer to Appendix B for the general requirement.)

6.4.1 Contamination and Cleanliness Control

The diplexer/BRF shall be designed to minimize its susceptibility to contaminants and to minimize its contribution of contaminants that could possibly adversely affect other sensors or instruments throughout the diplexer/BRF lifetime. When the unit is packaged for delivery, it shall be bagged and sealed in noncontaminating material.

There must be in the contractor's proposal, a cleanliness control plan describing how the diplexer/BRF will be handled to ensure that both particle and volatile contaminants are held to a minimum.

6.5 TEST PROGRAM

The test program included in this section will demonstrate that the diplexer/BRF meets the required performance for the TDRSS user operations and the Shuttle STS environments.

6.5.1 Environmental Tests Requirements

All tests will be conducted with the diplexer bolted to a baseplate.

The environmental test program for the diplexer/BRF consists of nonoperating vibration tests as indicated in Table A-3, an operating power handling test in thermal vacuum as shown in Figure A-3, and a thermal cycle test as discussed in 6.5.2.5. Details of test procedures and set-ups will be subject to GSFC review and approval.

6.5.2 Test Procedures

6.5.2.1 Measurement Precision--All frequency measurements shall be within a tolerance of ±100 KHz relative to the specified measurement frequency, except the 2.3 to 16 GHz that can be ±100 MHz. All insertion loss measurements from 0 to +10 dB shall have a tolerance of ±0.05 dB, and losses greater than 10 dB, shall be ±2.0 dB.

6.5.2.2 Insertion Loss Measurement Data Sheet--The following tests shall be performed at indicated frequency bands from 1.8 to 16 GHz and from furnished data. Acceptance will be based on RF performance at the frequencies listed in Table A-4.

6.5.2.3 VSWR of Receive and Transmit Ports--VSWR shall not exceed 1.2:1 at both the receive and the transmit port at the specified frequencies with the antenna port terminated in a 1.2:1 50-ohm load.

6.5.2.4 Power Handling Test--The diplexer/BRF is required to handle 20 watts of cw power at 2287.5 MHz in ambient pressure and also in $10x^{-3}$ torr for orbital operations. The diplexer/BRF must be controlled with appropriate thermal controls and monitors. A minimum of three cycles from -25 to +40°C are to be performed with continuous monitoring of the transmit channel output power.

6.5.2.5 Thermal Cycle Test--A minimum of eight cycles from -60 to +80°C are to be performed with continuous monitoring of both channels for RF performance requirements.

Test Procedure--The power handling capability of the diplexer/BRF shall be demonstrated by using the indicated test setup or equivalent. The unit shall be adequately mounted so as to provide a heatsink in a vacuum chamber with a pump down capability exceeding

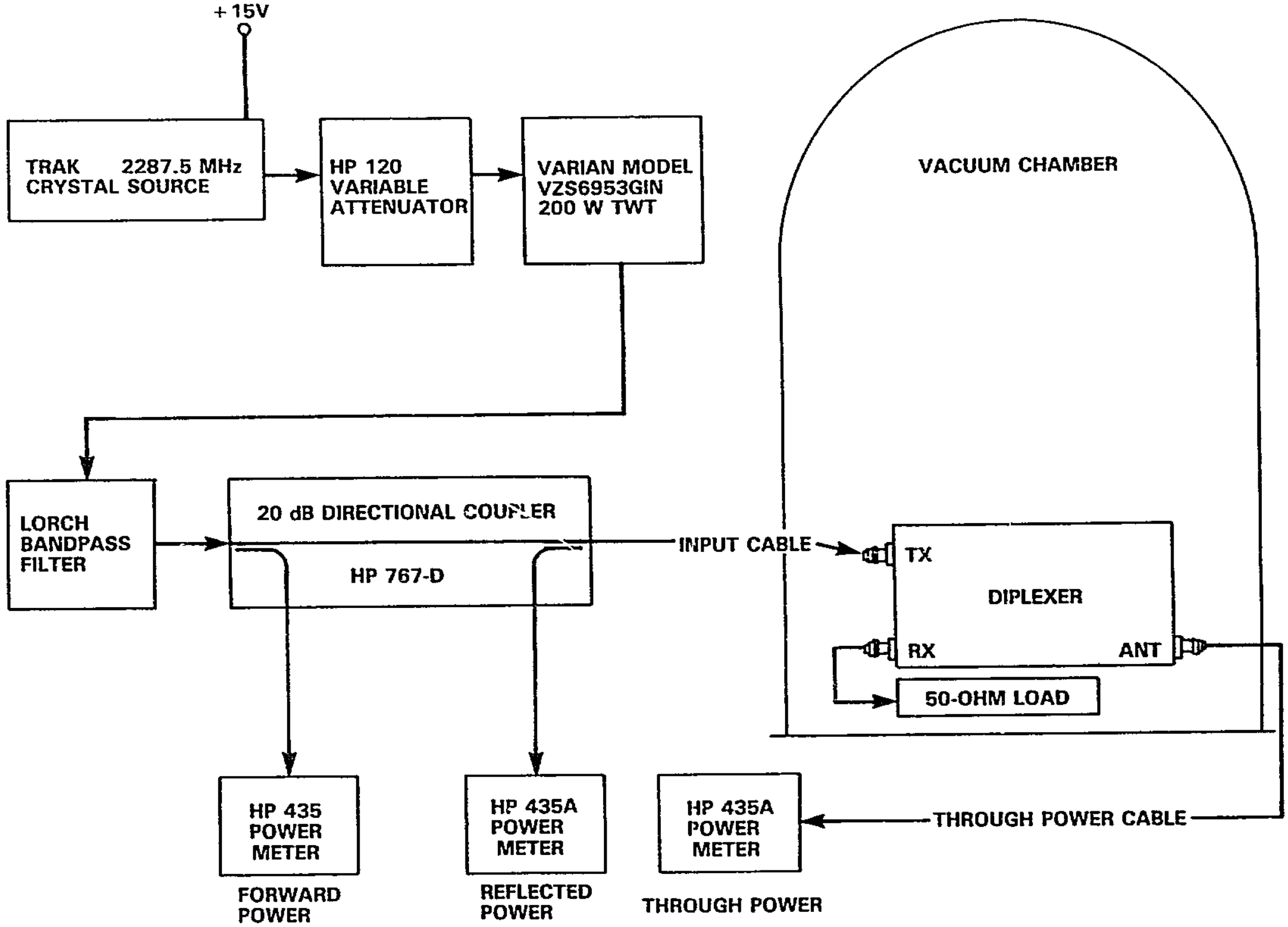

Figure A-3. Suggested Setup for Power Handling Test

Table A-4
Insertion Loss Measurement Data Sheet*

Port	Frequency (MHz)	Insertion Loss (dB)	Actual
Receive	1866 ±10 Image rejection	70.00 minimum, within passband	
Receive	2046 ±10 1/2 IF rejection	40.00 minimum	
Receive	2106.4 ±6	0.65 maximum	
Receive	2217 ±7.5	70.00 minimum	
Receive	2287.5 ±6	80.00 minimum	
Receive	2217 to 16,000	70.00	
Transmit	2106.4 ±6	135.0**	
Transmit	2106.4 ±6	55.0 (diplexer only, no BRF)	
Transmit	2287.5 ±10	0.55 maximum**	
BRF	2106.4 ±6	100.0 (BRF only)	
BRF	2287.5 ±6	0.15 maximum (BRF only)	

*All equipment used for data measurements shall have recent calibration approved by GSFC.

**Unit includes integral BRF.

10^{-3} torr. The test shall be conducted only for the transmit channel. Calibrate the forward input power meter to read precisely the same reading as the measured input power at the end of the transmit port input cable. After calibration is complete, disconnect the through power meter and connect to the ambient pressure side of the feedthrough output connector. Inside the bell jar the diplexer antenna port will be connected with a 0.141-inch semiridged cable to the input connector of the bell jar plate. Connect the diplexer transmit port to the output connector of the bell jar plate, which will provide data for the through power meter. Upon reading 1 micron of pressure (1_{-3} torr), 20 watts can be applied to the unit. The forward and reflected power meters shall be monitored so as to observe any variations in levels. If any should occur, it would indicate RF breakdown.

Power Handling Test Setup Diagram--The diagram for the power handling test is shown in Figure A-3.

6.6 DOCUMENTATION

6.6.1 General

The contractor shall meet the documentation requirements of Section 7.0 of Applicable Document 2.1 (see Appendix B).

6.6.2 Interface Control Drawings

The contractor shall furnish engineering drawings showing unit outlines, connector placement and identification, mounting holes, and overall dimensions for GSFC approval.

Interface Control Drawing 403135004 includes all the above stated information on the diplexer/BRF but not on the discrete band reject filter.

APPENDIX B

QUALITY ASSURANCE REQUIREMENTS FOR THE S-BAND DIPLEXER PROCUREMENT

CONTENTS

APPENDIX B

QUALITY ASSURANCE REQUIREMENTS FOR THE S-BAND DIPLEXER PROCUREMENT

1. GENERAL

The contractor shall establish and maintain for National Aeronautics and Space Administration/Goddard Space Flight Center (NASA/GSFC) procurements, an inspection and documentation system conforming to the requirements described below.

1.1 PARTS AND MATERIALS

a. Contractor-purchased parts and materials must comply with the requirement stated in the purchase request. Parts and material lists shall be submitted to the GSFC for approval prior to the contractor initiating procurements.

b. Government-Furnished Parts and Materials (GFP). All parts and materials provided by NASA/GSFC as GFP shall be accompanied by a GSFC certification log.

1.2 PARTS AND MATERIAL STORAGE

a. Contractor-furnished parts and materials that comply with paragraph 1.1a shall be identified to the NASA/GSFC procurement and stored separately from routine stock.

b. Government-furnished parts and materials shall be identified to the NASA/GSFC procurement and stored separately from routine stock.

1.3 PART AND MATERIAL SUBSTITUTION

Replacement or substitution of parts and materials covered by paragraph 1.2a and 1.2b require the approval of the GSFC technical representative.

2. INSPECTION

2.1 GENERAL

All work shall be inspected by contractor personnel prior to shipment to GSFC. If the contractor does not have inspection personnel, this inspection shall be performed by personnel other than those who peformed the work. The use of inspection equipment having calibration traceable to the National Bureau of Standards is required. The use of personally owned equipment is discouraged.

2.2 INPROCESS INSPECTION

Inprocess inspection shall be performed at each level where the next fabriation step will obscure previous work.

2.3 FINAL INSPECTION

Final inspection for dimensional accuracy and general workmanship shall be performed prior to shipment to GSFC.

2.4 DISCREPANCIES

The contractor shall be responsible for timely notification to the GSFC technical representative of discrepancies discovered during inprocess or final inspections. Hardware that is discrepant shall not be shipped to GSFC without the prior approval of the GSFC technical representative.

3. ACCEPTANCE TEST

3.1 GENERAL

Each diplexer manufactured for delivery to NASA/GSFC shall be tested for compliance to specifications contained in the procurement documentation. The use of test equipment having calibration traceable to the National Bureau of Standards is required.

3.2 CONTRACTOR ASSURANCE PERSONNEL

Contractor assurance personnel shall witness and document all end item acceptance testing. Test documentation shall be to NASA/GSFC approved format.

3.3 DISCREPANCIES, ANOMALIES, AND FAILURES

All discrepancies, anomalies, and failures discovered during acceptance testing, shall be documented on GSFC Form 4-2, GSFC malfunction report.

4. CONTAMINATION

The contractor shall submit a detailed contamination control plan for GSFC approval prior to final assembly of flight hardware.

This plan shall define:

- Cleaning procedure to be used prior to assembly.
- Cleaning materials to be used.

- Verification of cleanliness.
- Handling, storage, and packaging of cleaned hardware.

5. DOCUMENTATION

The following documentation shall be delivered with the hardware:

- Material certification
- Certification of compliance for plating
- GSFC certification log (if supplied with GFP)
- Inspection report
- Acceptance test data

BIBLIOGRAPHIC DATA SHEET

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
TM86224		

4. Title and Subtitle	5. Report Date
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15. Supplementary Notes

16. Abstract

This report discusses the test results and interfacing information of the S-band diplexer development program supported by RTOP 310 funding. The program was implemented to reduce the S-band transponder noise figure by minimizing the receive channel insertion loss and to also provide Space Transportation System (STS) compatibility by providing 70-db rejection up to 16 GHz in the receive channel. This compatibility includes rejection of signals from the Shuttle S-band Data Link, the K-band Data Link, and the K-band Rendezvous Radar. The first of many projects to benefit from this accomplishment was the Earth Radiation Budget Satellite (ERBS).

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