TERMALINE® DUAL LOAD RESISTOR SEMICONDUCTOR MODEL 8921A100

Operation Manual

WARNING

This unit requires the supplied vent plug be installed prior to use.
Operating the unit without the vent plug installed WILL result in equipment damage and may cause personal injury.

Instruction Book P/N 920-8921A100 Rev. B

Safety Precautions

The following are general safety precautions that are not necessarily related to any specific part or procedure, and do not necessarily appear elsewhere in this publication. These precautions must be thoroughly understood and apply to all phases of operation and maintenance.

WARNING

Keep Away From Live Circuits

Operating Personnel must at all times observe general safety precautions. Do not replace components or make adjustments to the inside of the test equipment with the high voltage supply turned on. To avoid casualties, always remove power.

WARNING

Shock Hazard

Do not attempt to remove the RF transmission line while RF power is present.

WARNING

Do Not Service Or Adjust Alone

Under no circumstances should any person reach into an enclosure for the purpose of service or adjustment of equipment except in the presence of someone who is capable of rendering aid.

WARNING

Safety Earth Ground

An uninterruptible earth safety ground must be supplied from the main power source to test instruments. Grounding one conductor of a two conductor power cable is not sufficient protection. Serious injury or death can occur if this grounding is not properly supplied.

WARNING

Resuscitation

Personnel working with or near high voltages should be familiar with modern methods of resuscitation.

WARNING

Remove Power

Observe general safety precautions. Do not open the instrument with the power on.

Safety Symbols

WARNING

Warnings call attention to a procedure, which if not correctly performed, could result in personal injury.

CAUTION

Cautions call attention to a procedure, which if not correctly performed, could result in damage to the instrument.

The caution symbol appears on the equipment indicating there is important information in the instruction manual regarding that particular area

NOTE

Notes call attention to supplemental information.

Warning Statements

The following safety warnings appear in the text where there is danger to operating and maintenance personnel, and are repeated here for emphasis.

WARNING

The load weighs 125 lb. (57 kg), do not attempt to lift alone. Two or more people, or mechanical assistance, are required to lift the load. Injury may result from lifting alone.

On pages 3 and 10

WARNING

The vent plug must be installed at all times when the unit is in operation or cooling.
Always check to ensure vent plug is installed prior to operation.
Failure to do so WILL result in damage to the equipment and endanger the operator's safety.

On pages 4, 5, and 11.

WARNING

Never attempt to connect or disconnect RF equipment from the transmission line while RF power is being applied. Leaking RF energy is a potential health hazard.

On pages 4, 5, 6, and 9.

WARNING

Do not touch the load during operation. During operation, load surfaces are extremely hot. Touching the load during or after operation may cause burns.

On page 5

WARNING

Disconnect the unit from all power sources before servicing. The unit may be energized from multiple sources. The potential for electric shock exists.

On pages 6, 8, and 10.

Caution Statements

The following equipment cautions appear in the text and are repeated here for emphasis.

CAUTION

Apply RF power to only one RF connector at a time. Applying power to both connectors simultaneously will overheat the load.

On page 1 and 5.

CAUTION

This load is designed for operation in a horizontal position only, with the mounting brackets down.Operation in any other orientation will cause insufficient cooling of the unit leading to premature failure.

On page 4.

CAUTION

Use only Bird coolant, P/N 5-1070, to prevent damage to the load.

On page 8.

Safety Statements

USAGE

ANY USE OF THIS INSTRUMENT IN A MANNER NOT SPECIFIED BY THE MANUFACTURER MAY IMPAIR THE INSTRUMENT'S SAFETY PROTECTION.

USO

EL USO DE ESTE INSTRUMENTO DE MANERA NO ESPECIFICADA POR EL FABRICANTE, PUEDE ANULAR LA PROTECCIÓN DE SEGURIDAD DEL INSTRUMENTO.

BENUTZUNG

WIRD DAS GERÄT AUF ANDERE WEISE VERWENDET ALS VOM HERSTELLER BESCHRIEBEN, KANN DIE GERÄTESICHERHEIT BEEINTRÄCHTIGT WERDEN.

UTILISATION

TOUTE UTILISATION DE CET INSTRUMENT QUI N'EST PAS EXPLICITEMENT PRÉVUE PAR LE FABRICANT PEUT ENDOMMAGER LE DISPOSITIF DE PROTECTION DE L'INSTRUMENT.

IMPIEGO

QUALORA QUESTO STRUMENTO VENISSE UTILIZZATO IN MODO DIVERSO DA COME SPECIFICATO DAL PRODUTTORE LA PROZIONE DI SICUREZZA POTREBBE VENIRNE COMPROMESSA.

SERVICE

SERVICING INSTRUCTIONS ARE FOR USE BY SERVICE - TRAINED PERSONNEL ONLY. TO AVOID DANGEROUS ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING UNLESS QUALIFIED TO DO SO.

SERVICIO

LAS INSTRUCCIONES DE SERVICIO SON PARA USO EXCLUSIVO DEL PERSONAL DE SERVICIO CAPACITADO. PARA EVITAR EL PELIGRO DE DESCARGAS ELÉCTRICAS, NO REALICE NINGÚN SERVICIO A MENOS QUE ESTÉ CAPACITADO PARA HACERIO.

WARTUNG

ANWEISUNGEN FÜR DIE WARTUNG DES GERÄTES GELTEN NUR FÜR GESCHULTES FACHPERSONAL.

ZUR VERMEIDUNG GEFÄHRLICHE, ELEKTRISCHE SCHOCKS, SIND WARTUNGSARBEITEN AUSSCHLIEßLICH VON QUALIFIZIERTEM SERVICEPERSONAL DURCHZUFÜHREN.

ENTRENTIEN

L’EMPLOI DES INSTRUCTIONS D’ENTRETIEN DOIT ÊTRE RÉSERVÉ AU PERSONNEL FORMÉ AUX OPÉRATIONS D’ENTRETIEN. POUR PRÉVENIR UN CHOC ÉLECTRIQUE DANGEREUX, NE PAS EFFECTUER D’ENTRETIEN SI L’ON N’A PAS ÉTÉ QUALIFIÉ POUR CE FAIRE.

ASSISTENZA TECNICA

LE ISTRUZIONI RELATIVE ALL’ASSISTENZA SONO PREVISTE ESCLUSIVAMENTE PER IL PERSONALE OPPORTUNAMENTE ADDESTRATO. PER EVITARE PERICOLOSE SCOSSE ELETTRICHE NON EFFETTUARRE ALCUNA RIPARAZIONE A MENO CHE QUALIFICATI A FARLA.

CONNECT INTERLOCK TO TRANSMITTER BEFORE OPERATING.

BRANCHER LE VERROUILLAGE À L'ÉMETTEUR AVANT EMPLOI.

CONECTE EL INTERBLOQUEO AL TRANSMISOR ANTES DE LA OPERACION.

VOR INBETRIEBNAHME VERRIEGELUNG AM SENDER ANSCHLIESSEN.

PRIMA DI METTERE IN FUNZIONE L'APPARECCHIO, COLLEGARE IL DISPOSITIVO DI BLOCCO AL TRASMETTITORE.

About This Manual

This manual covers the operating and maintenance instructions for the following models:

8921A100

Changes to this Manual

We have made every effort to ensure this manual is accurate. If you discover any errors, or if you have suggestions for improving this manual, please send your comments to our Solon, Ohio factory. This manual may be periodically updated. When inquiring about updates to this manual refer to the part number and revision on the title page.

Literature Contents

Introduction — Describes the features of the load and lists equipment supplied.

Theory of Operation — Describes how the load works.

Installation — Provides unpacking, setup, mounting a RF Connection instructions.

Operating Instructions — Provides the instructions necessary for operating the load.

Maintenance — Lists routine maintenance tasks as well as troubleshooting for common problems. Specifications and parts information are also included.

Table of Contents

Chapter 1 Introduction

Bird 8921A100 Dual Resistor Semiconductor Loads are portable, 50 ohm, coaxial RF transmission line terminations. They are designed for frequency ranges of DC – 30 MHz. They provide accurate, dependable, and low reflection line terminations. The load has two resistors and two connectors allowing easy dual-frequency high precision measurements. Up to 5000 watts of RF power can be dissipated in each resistor.

CAUTION

Apply RF power to only one RF connector at a time. Applying power to both connectors simultaneously will overheat the load.

The load has a coolant chamber surrounded by radiator fins. The front and rear fins form mounting flanges which can be used as supports for freestanding use or as brackets for fixed mounting. A vent plug at the top of the unit relieves internal pressure from coolant expansion. The load's simple and rugged design minimizes maintenance requirements.

Items Supplied

NOTE

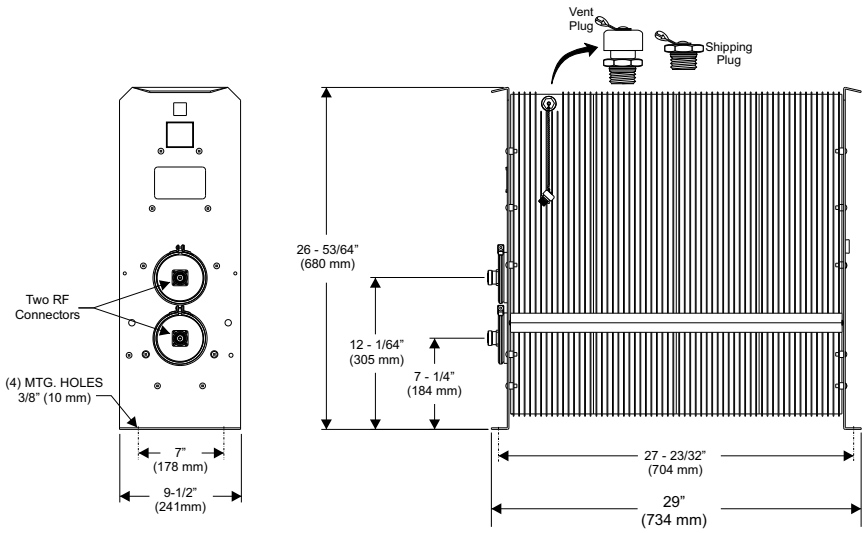
The load is pre-filled with coolant at the factory

- Load Resistor:
- One Shipping Plug
- One Vent Plug
- Instruction Manual

Items Required but not Supplied

- Coupling Kit: Connects the load to the RF line

Figure 1 Bird 8921A100 Outline Drawing



Load Resistor

Bird 8921A100 loads consist of dual thin-film-on-ceramic resistors immersed in the same dielectric coolant. The resistors, individually selected for accuracy, are enclosed in a special housing. When surrounded by the coolant, this produces a uniform, practically reflectionless line termination over the specified frequencies.

Coolant

The load is cooled by natural fluid and air convection currents. The coolant, chosen for its dielectric and thermal characteristics, carries heat from the resistor to the walls of the cooling tank, where radiator fins surrounding the tank transfer the heat to the air.

When the coolant is heated, thermal expansion causes an increase in the internal pressure. The vent plug relieves this pressure while protecting the opening from dirt or other contaminants.

Because the resistors share the same coolant, applying RF power to both resistors simultaneously will overheat the load.

Chapter 3 Installation

This chapter provides information for on-site requirements, unpacking, inspection, and preparing the load for use.

Unpacking and Inspection

WARNING

The load weighs 125 lb. (57 kg), do not attempt to lift alone. Two or more people, or mechanical assistance, are required to lift the load. Injury may result from lifting alone.

1. Carefully inspect shipping container for signs of damage.
   - If the shipping container is damaged, do not unpack the unit. Immediately notify the shipping carrier and Bird Technologies.
   - If the shipping container is not damaged, unpack the unit. Save shipping materials for repackaging.
2. Inspect unit for visual signs of damage.

NOTE

If there is damage, immediately notify the shipping carrier and Bird Technologies.

Site and Shelter Requirements

The unit should be operated in a dry, dust and vibration free environment.

Do not use outdoors or in areas of condensing humidity.

The ambient temperature range should remain between +5 to +40 °C (41 to +104 °F) for proper operation.

Allow at least 12" (305 mm) of clearance around the unit to permit an unimpeded access of convection air currents for adequate heat dissipation.

Place the unit as close as possible to the transmitting equipment, to permit the shortest possible cable length.

Tools Required

The following tools and supplies will be required to prepare the unit for use:

- Wrenches
- Screwdrivers
- Bolt and nut sets or lag screws for mounting) ($\frac{3}{8}$"(9.53 mm) max. diameter)

Mounting

CAUTION

This load is designed for operation in a horizontal position only, with the mounting brackets down.Operation in any other orientation will cause insufficient cooling of the unit leading to premature failure.

The load is equipped for either portable use or fixed installation. The mounting brackets on the front and rear faces have four mounting slots arranged in a 7" x 27 $^{23}/_{32}$" rectangle (178 x 704 mm). Use a screw with a $^{3}/_{8}$" (9.5 mm) diameter max.

The following instructions are for mounting the unit to a suitable surface.

1. Place the unit on a flat surface.
2. Insert the bolts through the surface and the mounting slots.
3. Secure the bolts with nuts and lock washers.

Vent Plug

WARNING

The vent plug must be installed at all times when the unit is in operation or cooling.
Always check to ensure vent plug are installed prior to operation.
Failure to do so WILL result in damage to the equipment and endanger the operator's safety.

Before placing the attenuator into service, the solid shipping plug, P/N 2450-049, must be removed and replaced by the spring loaded vent plug, P/N 2450-094. The plugs are linked together by a short length of bead chain.

1. Locate the vent hole for the plug, located at the top near the front. See Figure 1 on page 1.
2. Remove the shipping plug.
3. Verify the O-Ring is installed on the vent plug.
4. Install the vent plug.

Connecting RF Power

Before first using the load, perform the following steps.

1. Wipe all connectors and insulator surfaces on the transmission line face with a clean soft cloth.
2. Check the RF input connector for signs of wear, damage, or dirt.
3. Clean the connector if necessary. Use a self-drying, non-residue forming contact cleaner on the interior portions of the connector.
4. Check the input resistance of the load. Refer to"RF Assembly Resistance Test" on page 8 for details.
5. The RF transmission line can be attached using standard coaxial line coupling kits.

WARNING

Never attempt to connect or disconnect RF equipment from the transmission line while RF power is being applied. Leaking RF energy is a potential health hazard.

After installing the load, the RF transmission line can be attached using standard coaxial line coupling kits.

"QC" Connector Coupling

- Use 50 ohm coaxial cable such as RG-218/U or -220/U (-17A or -19A), appropriate for the frequency and power level of operation.
- Use a cable connector which will mate with the one on the load.

WARNING

The vent plug must be installed at all times when the unit is in operation or cooling. Always check to ensure vent plug are installed prior to operation. Failure to do so WILL result in damage to the equipment and endanger the operator's safety.

WARNING

Do not touch the load during operation. During operation, load surfaces are extremely hot. Touching the load during or after operation may cause burns.

CAUTION

Apply RF power to only one connector at a time. Applying power to both connectors simultaneously will overheat the load.

Before operating the load make sure vent plug is installed, see "Vent Plug" on page 4.

Normal Operation

Bird 8921A100 loads have no indicators or operating controls. They require no special operating procedures or surveillance when their performance limits are not exceeded. Follow the instructions for the specific generator equipment.

Operation Under Abnormal Conditions

The load can be subjected to moderate overloads for short periods.

Shutdown

These loads are passive devices, so have no way of being turned off. Turn off RF power at the source.

WARNING

Never attempt to connect or disconnect RF equipment from the transmission line while RF power is being applied. Leaking RF energy is a potential health hazard.

Emergency Shutdown

Turn off RF power at the source.

WARNING

Never attempt to connect or disconnect RF equipment from the transmission line while RF power is being applied.
Leaking RF energy is a potential health hazard.

WARNING

Disconnect the unit from all power sources before servicing. The unit may be energized from multiple sources. The potential for electric shock exists.

Troubleshooting

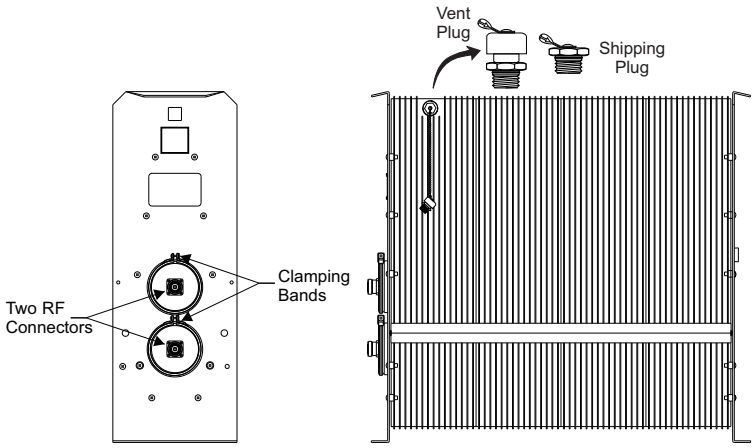
The table below provides troubleshooting information for problems which may occur during normal operation. This manual cannot list all malfunctions that may occur, or their corrective actions. If a problem is not listed or is not corrected by the listed actions, notify a qualified service center.

PROBLEM	POSSIBLE CAUSE	CORRECTION
Leaking coolant	Loose clamping band	Tighten the clamping band
	Defective or improperly installed O-ring	Replace the O-ring (See "Replace Load Resistor" on page 10)
High or low DC resistance	Loose RF input connector	Tighten connector
	Faulty RF input connector	Replace connector (See "Replace RF Connector" on page 10)
	Faulty resistor	Replace the resistor (See "Replace Load Resistor" on page 10)
Overheating radiator	RF power too high	Lower RF power (See "Specifications" on page 13 for maximum RF power)
	Coolant level too low	Check the coolant level. Add coolant if necessary (See "Inspect the Coolant" on page 8)
	Coolant degraded	Replace the coolant (See "Inspect the Coolant" on page 8)
	Faulty resistor	Replace the resistor (See "Replace Load Resistor" on page 10)

Routine Maintenance

Figure 2 shows the location of components which may be referred to in this section.

Figure 2 Maintenance and Repair Locations



Clean the Load

- The outside surface of the instrument should be wiped free of dust and dirt when necessary.
- Clean the cooling fins.

NOTE

Excessive dust on the cooling fins will interfere with heat dissipation.

- Clean the RF connector, both metallic and insulating surfaces, with a dry, non-residue forming solvent.

Inspect the Load

- Inspect the unit every six months.
  a. Check for coolant leakage around the clamping band.
  b. Check for coolant leakage around the thermoswitch.
  c. Check for corrosion.

Inspect the Coolant

Coolant lifetime will vary greatly depending on operating conditions.

- **Heavy Use (full RF power for long times, high ambient temperature):**
  Inspect the coolant every 500 hours.
- **Light Use (fraction of full power, low ambient temperature):**
  Inspect coolant every 2,000 hours.

WARNING

Disconnect the unit from all power sources before servicing. The unit may be energized from multiple sources. The potential for electric shock exists.

NOTE

Correct any coolant leakage before inspection. (See "Troubleshooting" on page 6***).***

1. Remove the load resistor (See "Replace Load Resistor" on page 10).
   - The coolant should be clear, with a faint yellow tinge, and have a slightly sweet smell.
   - If coolant is black with a burnt or acrid smell, drain the coolant, add about 6.7 gal (25.2 L) of coolant.

CAUTION

Use only Bird coolant, P/N 5-1070, to prevent damage to the load.

2. With the load still on end, the coolant level should be $4\frac{3}{4}$" (125 mm) below the top surface of the resistor assembly mounting ring, at ambient temperature.
3. Add coolant if necessary.
4. Install the load resistor (See "Replace Load Resistor" on page 10).

RF Assembly Resistance Test

NOTE

These tests are by no means a necessity to the operation of the* load *but merely guidelines for the users information.

Accurate measurement of the DC resistance between the inner and outer conductors of the RF input connector will provide a good check of the condition of the load resistor.

Checking the DC resistance is simply used to measure a change in the resistance over time. Tracking the DC resistance should start *before* the unit is first put into service. Perform the following steps and record the value for future comparison. Resistance measurements should be taken periodically according to use.

Preparation:

- Tools: Common hand tools.
- Ohmmeter with an accuracy of ± 1% at 50 ohms (or use a resistance bridge).
- Use low resistance leads, preferably a short piece of 50 ohm coaxial cable fitted with an appropriate connector or alligator clips.
- Temperature of the load should be stabilized between 20°C to 25°C (68°F to 77°F).

DC Resistance Measurement

WARNING

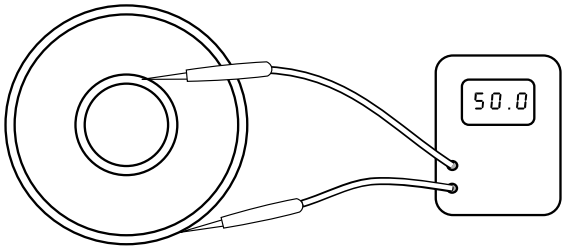
Never attempt to connect or disconnect RF equipment from the transmission line while RF power is being applied. Leaking RF energy is a potential health hazard.

NOTE

It is recommended that this resistance check be performed each time the load is to be used.

1. Turn off RF power and interlock circuitry before making any disconnections.
2. Disconnect the RF coaxial line.
3. Connect the multimeter test leads across the center and outer conductor of the load resistor. See Figure 3.
4. Record the value of the resistance *before* the load is put into service. Compare subsequent values with the latest reading. If the values vary more than 2 ohms this could be an indication of a failing resistive element.

Figure 3 Measuring DC Resistance



Repair

Figure 2 on page 7 shows the location of components which may be referred to in this section.

WARNING

Disconnect the unit from all power sources before servicing. The unit may be energized from multiple sources. The potential for electric shock exists.

Replace RF Connector

The 8921A100 has Bird "QC" connectors which allow easy changing of RF connectors. This does not disturb the coolant seal or affect the electrical continuity of the load. To change a connector:

1. Remove the four screws at the corners of the RF connector.
2. Pull the connector straight out.
3. Push the new connector in. Make sure that the center pin on the connector is properly seated in the mating socket on the load.
4. Replace the screws.

NOTE

If not using the 7/16 connector normally supplied, the frequency and power must be limited to the capabilities of the connector.

Replace Load Resistor

To change the load resistor assembly:

1. Remove the vent plug.
2. Verify the O-Ring is installed on the shipping plug.
3. Install the shipping plug.

WARNING

The load weighs 125 lb. (57 kg), do not attempt to lift alone. Two or more people, or mechanical assistance, are required to lift the load. Injury may result from lifting alone.

4. Stand the resistor on its back with the connector end up, supporting the unit to prevent any damage.

NOTE

In this position there is no danger of the coolant pouring out through the resistor hole.

5. Unscrew and remove the clamping band.
6. Lift the load resistor assembly out of the tank.

NOTE

Allow any coolant to drip back into the tank.

7. Check the O-Ring.

NOTE

The O-Ring should be free of twists and positioned evenly around the flange of the resistor housing. If the O-ring shows signs of deterioration (e.g. is no longer pliable or has surface cracks) replace it.

8. Inspect the coolant, see "Inspect the Coolant" on page 8.
9. Install the entire load resistor assembly.

NOTE

The load resistor assembly cannot be disassembled any further.

10. Put the clamping band in place and tighten it.
11. Lower the unit back onto its feet.
12. Check all seals for signs of leaks.

WARNING

The vent plug must be installed at all times when the unit is in operation or cooling.
Always check to ensure vent plug is installed prior to operation.
Failure to do so WILL result in damage to the equipment and endanger the operator's safety.

13. Remove the shipping plug.
14. Verify the O-Ring is installed on the vent plug.
15. Install the vent plug.

Storage and Shipment

Storing the Load

1. Cover the load before storing to keep out dust and dirt.

NOTE

When storing the load it is not necessary to install the shipping plug.

2. Store in a dry, dust-free environment where the ambient temperature will remain between –40 and +80 °C (–40 to +176 °F).

Shipping the Load

The unit may be shipped with its dielectric coolant; however, do not ship the unit with its dielectric coolant if the unit has developed a leak. Drain the coolant first.

To ship the load, take the following precautions:

1. Remove the vent plug.
2. Verify the O-Ring is installed on the shipping plug.
3. Install the shipping plug.
4. Wrap the vent plug with padding and tape it to the side of the load for protection.

NOTE

With the shipping plug installed, it is not necessary to empty out the coolant.

5. Wrap the RF connectors in padding.
6. Pack and brace the load in a sturdy wooden crate for shipment.

NOTE

All instruments returned for service must be shipped prepaid and to the attention of the Customer Service Group. See "Customer Service" on page 12***.***

Customer Service

Any maintenance or service procedure beyond the scope of those in this chapter should be referred to a qualified service center.

If the unit needs to be returned for any reason, request an Return Material Authorization (RMA) through the Bird Technologies website. All instruments returned must be shipped prepaid and to the attention of the RMA number.

Bird Service Center
30303 Aurora Road
Cleveland (Solon), Ohio 44139-2794
Fax: (440) 248-5426
E-mail: *bsc@birdrf.com*

For the location of the Sales Office nearest you, visit our Web site at:

http://www.birdrf.com

Specifications

Frequency Range	DC – 30 MHz
Power Rating†	5000 W continuous duty
Impedance, Nominal	50 ohms
VSWR	1.1 max
Connectors	"QC" Type, 7/16 Jack normally supplied
Temperature, Operating	–40 to +45 °C (–40 to 113 °F)
Temperature, Storage	–40 to +80 °C (–40 to +176 °F)
Altitude††	3048 m (15000 ft.)
Humidity	85% noncondensing max
Cooling Method	Oil dielectric and convection currents
Dimensions	29"L x 9.5"W x 26.75"H (736 x 241 x 680 mm)
Weight, Nominal	125 lb. (57 kg)
Finish	Gray Epoxy Resin

† Power rating is for single resistor operation only. Do not apply RF power to both resistors simultaneously.

†† Derate RF power by 2.5% for every 305m (1,000 ft.) above 1,520m (5,000 ft.).

Replacement Parts

Description	Qty	Part Number
RF Load Resistor	1	8931A405
Resistor O-Ring	1	5A2663-1
Clamping band assembly	1	5A2662
Plug Vent Shipping	 1 1	 2450-094 2450-049
Radiator Assembly	1	8921A127
Access Plug, 3/4"-14 Hex Socket	1	5020-103
Coolant, 6.7 gal (23 liters)	1	5-1070-3

Available "QC" Type Connectors

Connector	Part Number
BNC-Female	4240-125
BNC-Male	4240-132
C-Female	4240-100
C-Male	4240-110
HN-Female	4240-268
HN-Male	4240-278
LC-Female	4240-031
LC-Male	4240-025
Open Term. # 10-32 Nut	4240-080
LT-Female	4240-018
LT-Male	4240-012
N-Female	4240-062
N-Male	4240-063
SC-Female	4240-090
SMA-Female	4240-336
SMA-Male	4240-334
7/16 Jack, IEC Type 169-4†	4240-344
7/16 Plug, IEC Type 169-4	4240-363
Mini UHF-Female	4240-346
UHF-Female	4240-050
UHF-Male	4240-179
1-5/8" EIA Fixed	4240-096
1-5/8" EIA Swivel	4240-208
7/8" EIA	4240-002
TNC-Female	4240-156
TNC-Male	4240-160
TRU 6934-Female	4240-371
TRU 7958-Female	4240-372

† Normally supplied

Limited Warranty

All products manufactured by Seller are warranted to be free from defects in material and workmanship for a period of one (1) year, unless otherwise specified, from date of shipment and to conform to applicable specifications, drawings, blueprints and/or samples. Seller's sole obligation under these warranties shall be to issue credit, repair or replace any item or part thereof which is proved to be other than as warranted; no allowance shall be made for any labor charges of Buyer for replacement of parts, adjustment or repairs, or any other work, unless such charges are authorized in advance by Seller.

If Seller's products are claimed to be defective in material or workmanship or not to conform to specifications, drawings, blueprints and/or samples, Seller shall, upon prompt notice thereof, either examine the products where they are located or issue shipping instructions for return to Seller (transportation charges prepaid by Buyer). In the event any of our products are proved to be other than as warranted, transportation costs (cheapest way) to and from Seller's plant, will be borne by Seller and reimbursement or credit will be made for amounts so expended by Buyer. Every such claim for breach of these warranties shall be deemed to be waived by Buyer unless made in writing within ten days from the date of discovery of the defect.

The above warranties shall not extend to any products or parts thereof which have been subjected to any misuse or neglect, damaged by accident, rendered defective by reason of improper installation or by the performance of repairs or alterations outside of our plant, and shall not apply to any goods or parts thereof furnished by Buyer or acquired from others at Buyer's request and/or to Buyer's specifications. Routine (regularly required) calibration is not covered under this limited warranty. In addition, Seller's warranties do not extend to the failure of tubes, transistors, fuses and batteries, or to other equipment and parts manufactured by others except to the extent of the original manufacturer's warranty to Seller.

The obligations under the foregoing warranties are limited to the precise terms thereof. These warranties provide exclusive remedies, expressly in lieu of all other remedies including claims for special or consequential damages. SELLER NEITHER MAKES NOR ASSUMES ANY OTHER WARRANTY WHATSOEVER, WHETHER EXPRESS, STATUTORY, OR IMPLIED, INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS, AND NO PERSON IS AUTHORIZED TO ASSUME FOR SELLER ANY OBLIGATION OR LIABILITY NOT STRICTLY IN ACCORDANCE WITH THE FOREGOING.