



TERMALINE[®] SEMICONDUCTOR
LOAD RESISTOR
SERIES 8920

OPERATION MANUAL

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

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

CAUTION

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



This symbol indicates that a shock hazard exists if the precautions in the instruction manual are not followed.



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



This symbol indicates that the unit radiates heat and should not be touched while hot.

Note: Calls 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
BOTH vent plugs must be used at all times when the unit is operating or cooling.
Failure to do so could result in an explosion or severe burns.

See page 3, 6, and 9

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

See page 7 and 9

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.

See page 5, 6, 7, and 8

Caution Statements

The following equipment cautions appear in the text whenever the equipment is in danger of damage and are repeated here for emphasis.

CAUTION
This load is designed for operation in a horizontal position only, with the vent plugs up. Do not use in any other manner.

See page 3

CAUTION
If installed, connect optional interlock before applying RF power.

See page 4

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

See page 9

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 PROIZIONE 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 HACERLO.

WARTUNG

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

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

ENTRETIEN

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 EFFETTUARE ALCUNA RIPARAZIONE A MENO CHE QUALIFICATI A FARLA.

CONNECT INTERLOCK TO TRANSMITTER/GENERATOR/AMPLIFIER BEFORE OPERATING.

BRANCHER LE VERROUILLAGE À L'ÉMETTEUR/GÉNÉRATEUR/AMPLIFICATEUR AVANT EMPLOI.

CONECTE EL INTERBLOQUEO AL TRANSMISOR/GENERADOR/AMPLIFICADOR ANTES DE LA OPERACION.

VOR INBETRIEBNAHME VERRIEGELUNG AM SENDER/GENERATOR/VERSTÄRKER ANSCHLIESSEN.

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

About This Manual

This instruction book covers the models listed below:

8921SC13

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.

Chapter Layout

This manual is arranged so that essential information on safety is in the front of the book. Reading the Safety Precautions before operating the equipment is strongly advised. The remainder of this instruction book is divided into Chapters and Sections.

Introduction — Describes the features of the 8920 Semiconductor series, lists equipment supplied and optional equipment, and provides power-up instructions.

Theory of Operation — Describes how the 8920 Semiconductor series works and its functions.

Installation — Describes the how to install the 8920 Semiconductor series.

Operating Instructions — Describes procedures require for operating the 8920 Semiconductor series.

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

TABLE OF CONTENTS

Safety Precautions	i
Safety Symbols	ii
Warning Statements	iii
Caution Statements	iv
Safety Statements	v
About This Manual	viii
Changes to this manual	viii
Chapter Layout	viii
Chapter 1 Introduction	1
Items Supplied	1
Items Required but not Supplied	1
Optional Accessories	1
Chapter 2 Theory of Operation	2
Load Resistor	2
Coolant	2
Thermal Interlock	2
Chapter 3 Installation	3
Unpacking and Inspection	3
Setup	3
Mounting	3
Installing Thermoswitch	3
Interlock Connection	4
Connecting RF Power	5
Chapter 4 Operating Instructions	6
Normal Operation	6
Operation Under Abnormal Conditions	6
Shutdown	6
Emergency Shutdown	6
Chapter 5 Maintenance	7
Troubleshooting	7
Maintenance	7
Cleaning	7
Inspection	8
RF Assembly Resistance Test	8
Coolant Level	9
Repair	9
Replace RF Connector	9
Load Resistor	10
Customer Service	10
Specifications	11
Replacement Parts	11
Available "QC" Type Connectors	12
Limited Warranty	13

Bird 8920 Series Semiconductor Loads are portable, 50 ohm, coaxial RF transmission line terminations. They are designed for frequency ranges of DC – 28 MHz, specially calibrated for greater stability at 13.56 MHz. They provide accurate, dependable, and low reflection line terminations. Up to 5000 watts of RF power can be dissipated.

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 pair of vent plugs at the top of the unit relieves internal pressure from coolant expansion. The load's simple and rugged design minimizes maintenance requirements.

Items Supplied

- Load Resistor: Pre-filled with coolant at the factory
- Two Shipping Plugs
- Two Vent Plugs
- Instruction Manual

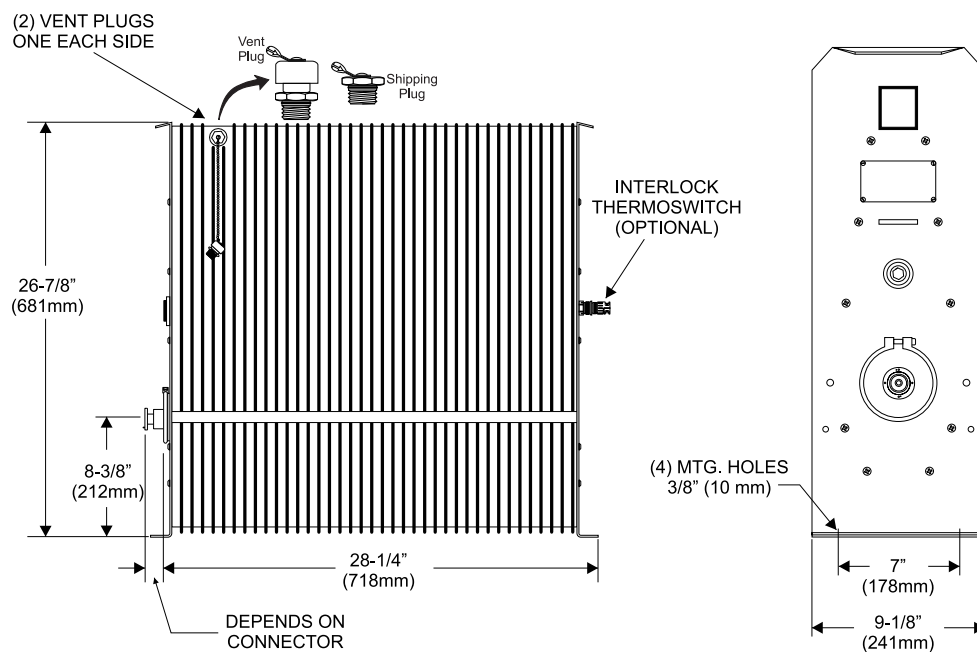
Items Required but not Supplied

- Coupling Kit: Connects the load to the RF line

Optional Accessories

- Interlock Thermoswitch: Automatically shuts off the RF generator to prevent overheating of the load

Figure 1 8920 Series Outline Drawing



Load Resistor

Bird 8920 series loads consist of a thin-film-on-ceramic resistor immersed in a dielectric coolant. The resistor, individually selected for its accuracy, is 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 plugs relieve this pressure while protecting the opening from dirt or other contaminants.

Thermal Interlock

Loads can be supplied with an optional passive over-temperature thermoswitch. Normally closed, it opens at the maximum safe load temperature of 236 °C (457 °F), turning off power to the RF generator. The interlock system will not permit use of the generator until the load has reached a safe temperature.

Unpacking and Inspection

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.*

Setup

- Before first using the load, get a resistance baseline for future maintenance. Refer to "[RF Assembly Resistance Test](#)" on [page 8](#) for details.
- Remove both shipping plugs from the load and replace them with the vent plugs. Refer to [Figure 1](#) for images of the plugs.

WARNING
BOTH vent plugs must be used at all times when the unit is operating or cooling.
 Failure to do so could result in an explosion or severe burns.

Mounting

Place the load in a dry, dust and vibration free environment. Do not use outdoors or in areas of condensing humidity. Allow at least 12" (30 cm) of clearance on all sides of the load.

CAUTION
 This load is designed for operation in a horizontal position only, with the vent plugs up.
 Do not use in any other manner.

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 $4\frac{1}{2}" \times 14\frac{7}{32}"$ rectangle (114.3 x 361.2 mm). Use a screw with a $\frac{3}{8}"$ (9.53 mm) diameter max.

Installing Thermoswitch

Bird 8920 series loads can be equipped with an optional interlock thermoswitch, P/N 8890-008. It is normally closed, opening at 236 °C (457 °F), with a rating of 10A @ 120 VAC and 5A @ 230 VAC.

WARNING
BOTH vent plugs must be used at all times when the unit is operating or cooling.
 Failure to do so could result in an explosion or severe burns.

To install or replace the thermoswitch:

1. Remove the vent plugs. Install the shipping plugs.

2. Stand the unit on its front, supporting it so that the connector is not damaged. In this position there is no danger of the coolant pouring out through the socket plug hole.
3. Remove the socket plug just above the connector assembly, using a $\frac{9}{16}$ " hex wrench.
4. Replace the plug with the thermoswitch. Sparingly apply pipe sealing compound to the external threads, only, of the thermoswitch. Do not contaminate the coolant with pipe sealant.
5. Check for coolant leaks upon completion.
6. Remove the shipping plugs. Install the vent plugs.

Interlock Connection

Connect the thermoswitch to the interlock as follows (see [Figure 2](#)):

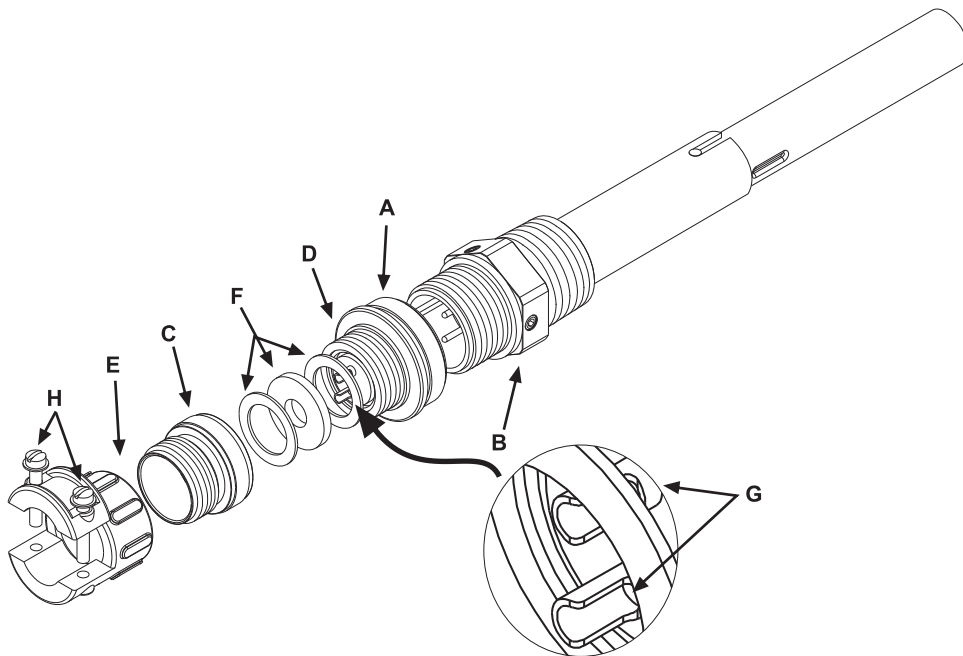
CAUTION
If installed, connect optional interlock before applying RF power.

1. Unscrew the large knurled ring-nut (A) at the lower end of the coupling jack assembly. Pull it off the thermoswitch jack (B). Unscrew the small knurled cover fitting from the base plug (D) of the connector to release the base.
2. Thread the control switch wires through the clamp (E) with the washers (F) inside and with its threaded fitting in place. Service the control switch wire with short tips and put spaghetti sleeves over the wire ends if necessary.
3. Securely solder the control switch leads to the lugs (G) of the connector base.

Note: The ring-nut (A) must be in place over the base plug (D) with the knurled end facing out.

4. Screw on the cover ring, then fasten the cable clamp (E) in place and tighten both yoke screws (H).
5. Put the plug back on the thermoswitch and tighten the nut (A).

Figure 2 Thermoswitch Assembly



Connecting RF Power

After installing the load, 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.

“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

BOTH vent plugs must be used at all times when the unit is operating or cooling.
Failure to do so could result in an explosion or severe burns.

Normal Operation

Bird 8920 series 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. If this is likely, make sure the interlock is properly connected to prevent damage to the load.

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.

If the interlock thermostwitch is properly connected, RF power will be automatically turned off when the coolant temperature reaches an unsafe level.

This chapter covers cleaning, inspection, trouble-shooting, and specifications for the Bird 8920 series loads.

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 contains troubleshooting information for problems which can 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 " 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 9)
	Faulty resistor	Replace the resistor (See " Load Resistor " on page 10)
Overheating radiator	RF power too high	Lower RF power (See " Specifications " on page 11 for maximum RF power)
	Coolant level too low	Check the coolant level. Add coolant if necessary (See " Coolant Level " on page 9)
	Coolant degraded	Replace the coolant (See " Coolant Level " on page 9)
	Faulty resistor	Replace the resistor (See " Load Resistor " on page 10)

Maintenance

Cleaning

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

Inspection

Inspect the unit every six months. Check for coolant leakage around the clamping band and the thermoswitch. Also check for corrosion.

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. The resistor should provide at least 5,000 hours of operation before requiring any additional service. DC resistance should be measured annually.

Preparation:

- Tools: Common hand tools.
- Ohmmeter with an accuracy of $\pm 1\%$ 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).

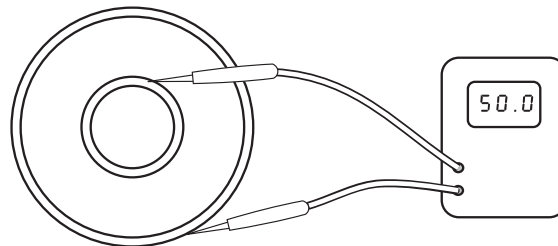
DC Resistance Measurement

<p style="text-align: center;">WARNING</p> <p style="text-align: center;">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.</p>
--

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 1 ohm this could be an indication of a failing resistive element.

Figure 3 *Measuring DC Resistance*



Coolant Level

Coolant lifetime will vary greatly depending on operating conditions. For heavy use (full RF power for long times, high ambient temperature), check the coolant every 500 hours. If the load has only had light duty (fraction of full power, low ambient temperature), then coolant inspection may only be necessary every 2,000 hours.

Note: NOTE: Correct any coolant leakage before inspection. (See “Troubleshooting” on page 11)

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

To inspect the coolant:

- ★ Remove the load resistor (Refer to “Load Resistor” on page 18).

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

- ★ The coolant should be clear, with a faint yellow tinge, and have a slightly sweet smell. If it is black with a burnt or acrid smell, drain it and add about 6.7 gal (25.2 L) of coolant.
- ★ With the load still on end, the coolant level should be 4³/₄" (125 mm) below the top surface of the resistor assembly mounting ring, at ambient temperature. Add coolant if necessary.

Repair

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

WARNING
BOTH vent plugs must be used at all times when the unit is operating or cooling.
 Failure to do so could result in an explosion or severe burns.

Replace RF Connector

The following procedure may be used to remove and replace Bird QC connectors.

1. Remove four 8-32 round head machine screws from the corners of the connector flange.
2. Pull the connector straight out.
3. Align the replacement connectors center contact pin with the socket and seat QC connector.
4. Install four 8-32 round head machine screws in the corners of the connector flange to secure the QC connector in place.

Note: If not using the LC connector normally supplied, the frequency and power must be limited to the capabilities of the connector.

Load Resistor

To change the load resistor assembly:

1. Remove the vent plugs. Install the shipping plugs.
2. Supporting the unit to prevent damage to the interlock, stand it on its back with the connector end up. In this position there is no danger of the coolant pouring out through the resistor hole.
3. Unscrew and remove the clamping band.
4. Lift the load resistor assembly out of the tank and allow any coolant to drip back into the tank.
5. 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.
6. Replace the entire load resistor assembly. It cannot be further disassembled.
7. Put the clamping band in place and tighten it.
8. Remove the shipping plugs. Install the vent plugs.

Storage and Shipment

Cover the load before storing to keep out dust and dirt. It is not necessary to install the shipping plugs. Store in a dry, dust-free environment where the ambient temperature will remain between –40 and +45 °C (–40 to +113 °F).

To ship the load, take the following precautions:

1. Remove both vent plugs and replace them with the shipping plugs. Wrap the vent plugs with padding and tape them to the side of the load for protection.

Note: With the shipping plugs installed, it is not necessary to empty out the coolant.

2. Wrap the connector in padding.
3. Pack and brace the load in a sturdy wooden crate for shipment.

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 – 28 MHz
Power Rating	5000 W continuous duty
Impedance, Nominal	50 ohms
VSWR	1.1 max
VSWR Stability	< 0.1 dB, from 0 to 100% rated power at stability frequency
Stability Frequency	13.56 MHz \pm 10 kHz
Connectors	“QC” Type, Female LC normally supplied
Interlock Thermoswitch (Optional)	Normally closed. Opens at 236 °C (457 °F)
Thermoswitch Rating:	
115 VAC	10 A
230 VAC	5 A
Temperature, Operating	+5 to +40 °C (+41 to +104 °F)
Temperature, Storage	–40 to +45 °C (–40 to +113 °F)
Altitude*	1520 m (5000 ft.)
Humidity	95% noncondensing max
Cooling Method	Oil dielectric and convection currents
Dimensions	29”L x 9-1/2”W x 26-53/64”H (737 x 241 x 681 mm)
Weight, Nominal	119 lb. (54 kg)
Finish	Black Epoxy Resin

* 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	8890-060
Resistor O-Ring	1	5-230
Clamping band assembly	1	2430-055
Plug		
Vent	2	2450-094
Shipping		2450-049
Interlock Thermoswitch	1	8890-008
Thermoswitch Body	1	8890-005
Thermoswitch Jack	1	2450-018
Radiator Assembly	1	8921-002
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

* 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.