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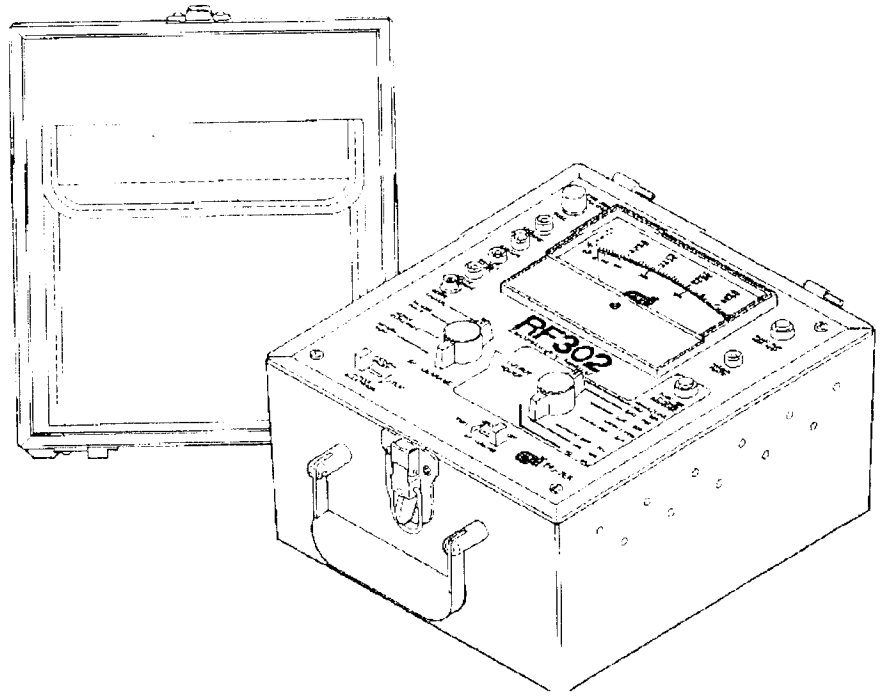
## INTRODUCTION

The Model RF302 is a passive, power-analyzing system designed to test electrosurgery units (ESU's) by:

1. measuring output power at the manufacturer's specified load and heavy load conditions,
2. measuring isolation-to-ground of the electrosurgical output,
3. testing for dangerous low-frequency currents,
4. enabling verification of output waveforms,
5. testing return electrode monitor (REM) systems, and
6. testing return fault systems.

The Model RF302 may be used by technical and non-technical personnel to test all ESUs for proper operation and calibration. Outputs can be recorded on the RF3R tag (see Figure 2 on page 3) and attached to the front panel of the ESU to ensure the operator that the unit outputs the proper power. An isometric view of the unit is provided in Figure 1 on the following page.

The Model RF302 simulates the load experienced by the ESU during an operation. The resistive loads inside the Model RF302 are non-inductive, accurate, and are not damaged by prolonged use at maximum output settings. The measuring system of the Model RF302 uses precise thermocouples that measure the electrical power for any frequencies from DC to 2 MHz. These thermocouples are connected to a precision analog meter that reads directly in power units of measure. The meter is protected by an ultrafast blow fuse. The filter switch is connected to precision inductive and capacitive components that act as a low pass filter. The meter reads the low-frequency component of the incoming power when the filter switch is activated.



*Figure 1. Model RF302 - Isometric View*

**ELECTROSURGERY UNIT (ESU)  
PERFORMANCE RECORD**


---

Model \_\_\_\_\_ Serial No. \_\_\_\_\_  
 Tested By \_\_\_\_\_ Date \_\_\_\_\_

---

Load ESU Setting	Output In Watts	
	Cut	Coag
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Isolation Test:  O.K.  Not Satisfactory  
 Heavy Load Test Output: \_\_\_\_\_  
 Low Frequency Output:  Negligible  Not Satisfactory  
 Tag RF3R



**THE INSTRUMENTS  
DIVISION, GE HEALTH CARE  
TW 100 677 1011**

Figure 2. RF3R Tag

**SPECIFICATIONS**

**Selectable Loads and Ranges (Monopolar and Bipolar)**

<u>Load (Ohms)</u>	<u>Range (Watts)</u>
50	50
100	100
100	300
200	300
300	300
400	500
500	500

<b>Isolation Test Range:</b>	0 - 50 Watts with 200-Ohm Load from Patient Plate, Active Electrode, and Chassis
<b>Current Range:</b>	0 - 500 mA
<b>Return Fault:</b>	150 picofarads
<b>Frequency Response :</b>	0 - 5 MHz
<b>Frequency Response:</b>	(Filter Pushed) 0 - 50 kHz
<b>Load Accuracy:</b>	$\pm 2\%$ at 50 ohms $\pm 1.5\%$ at 100 ohms $\pm 1\%$ 200 to 500 ohms
<b>Meter Accuracy:</b>	$\pm 2\%$
<b>Power Output Accuracy:</b>	$\pm 5\%$ (Calibrated in Watts)
<b>REM Test:</b>	Normal 24.6 Ohm Resistance, 137.0 Ohms with REM Switch Activated
<b>Oscilloscope:</b>	Isolated (Uncalibrated)
<b>Power Requirements:</b>	None
<b>Measuring Technique:</b>	RF Thermocouples
<b>Weight:</b>	5.4 kg (12 lbs)
<b>Dimensions:</b>	28 cm X 23 cm X 18 cm (11" X 9.1" X 7")

## ACCESSORIES

<u>Description</u>	<u>Quantity Supplied</u>	<u>Bio-Tek Part Number</u>
Complete Set of Leads	—	3020600
Red Lead	1	—
Black Lead	2	—
White Lead	1	—
Green Lead	1	—
Large Clamp	1	7770014
Alligator	3	48009
RF3R Tags	100	93008
User's Guide	1	3021005
Ground Adapter	1	48005
Fuse	5	46012
Warranty Card	1	—

**NOTE:** Figure 3 on the following page shows the various accessories provided with the Model RF302.

## INSTALLATION

**Operating Precautions** - Refer to the manual's inside front cover for precautions that must be followed to ensure the safety of the RF302 operator.

**Unpacking Instructions** - Inspect the RF302 for cracks or scratches on either the panel or the case. Check the meter needle to ensure that it is intact. Carefully inspect the handle to assure that it is firmly attached to the case. If any damage is found, call BIO-TEK Instruments immediately at: 1 (800) 451-5172.

**Preparations for use** - Find a relatively level surface on which to place the RF302. Unlatch the locks on the unit and place it facing the operator so that the meter scale can be easily read.

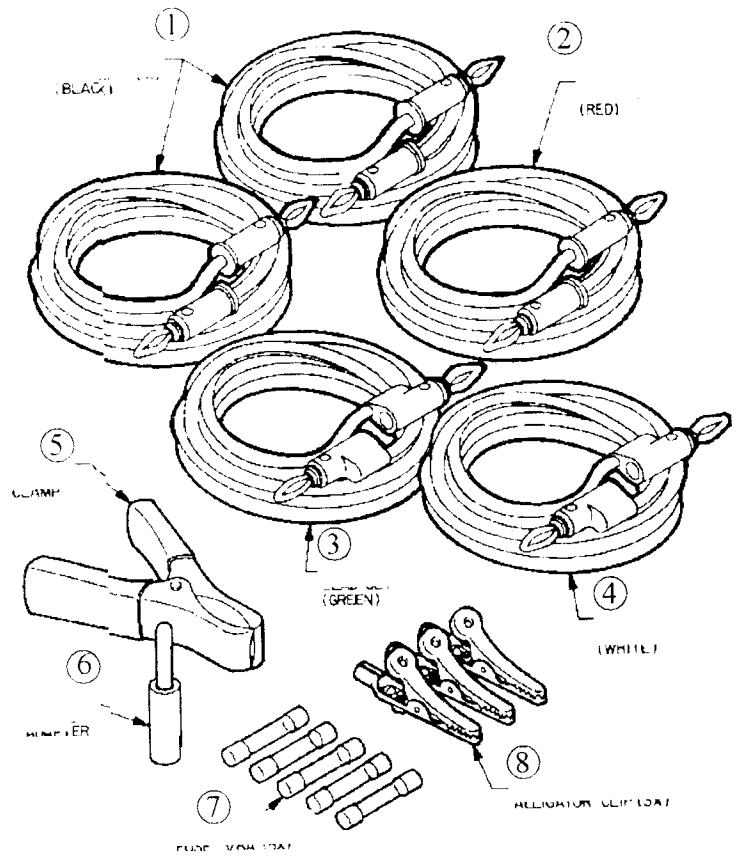


Figure 3. Accessories

ITEM#	PART#	NO. PER ASSY	DESCRIPTION	REF
1)	48017	2.00	LEAD SET (BLACK)	—
2)	48016	1.00	LEAD SET (RED)	—
3)	48158	1.00	LEAD SET (GREEN)	—
4)	48157	1.00	LEAD SET (WHITE)	—
5)	7770014	1.00	LARGE CLAMP	—
6)	48005	1.00	GROUND ADAPTER	—
7)	46012	5.00	FUSE .5A	—
8)	48009	3.00	ALLIGATOR CLIP LEAD	—

## STORAGE AND SHIPPING

The RF302 should be stored at 77° F (25° C) with a relative humidity of 50%. The cover on the RF302 should always be closed and the latches snapped during storage and shipping. The storage environment should be free from vibration.

## WARRANTY

**BIO-TEK** warrants the RF302 to the original purchaser for a period of one year from the original purchase date. The warranty is for normal use and service, against defective materials or workmanship. If the customer ships the Model RF302 Electrosurgery Analyzer to **BIO-TEK**, postage prepaid, and **BIO-TEK** determines the defect to be in materials or manufacturing, **BIO-TEK** shall either repair or replace the unit at **BIO-TEK's** option, without cost to the customer.

This warranty is void if the RF302 has been visibly damaged by accident, misuse, or has been repaired or altered by persons or stations not authorized by **BIO-TEK**, or which has had the serial number altered, defaced, or removed.

**BIO-TEK** reserves the right to discontinue the RF302 at any time and to change specifications, price, or design without notice and without incurring any obligation. **BIO-TEK** will continue to stock service parts for up to 5 years after the manufacture of the unit has been discontinued. Parts shall include all materials, charts, instructions, diagrams, and accessories that are furnished with the unit.

The purchaser agrees to assume all liability for any damages or bodily injury which may result from the use or misuse of the unit by the purchaser, his employees, agents, or customers.



## EQUIPMENT CARE

The RF302 must be kept clean and moisture-free at all times. The unit can be cleaned effectively as follows:

**Circuit Board** - After soldering, use an acid brush dipped in isopropyl alcohol to remove flux and dirt residue. Wipe dry with a paper towel. Repeat if necessary.

**CAUTION:** Use the isopropyl alcohol in a well ventilated area. Do not smoke or use near heat or flame.

**Panel** - Use compressed air, 30 psi maximum, to blow dust off the panel. Use all-purpose spray cleaner (409 or equivalent) on the meter and overlay.

**CAUTION:** Avoid using solvents that damage plastic.

**Case** - Clean the outside formica surface with the all-purpose spray cleaner. Wipe dry with a paper towel. Use compressed air to blow dust out of the inside of the case.

**CAUTION:** The inside of the case must be moisture-free to prevent corrosion of the electrical components.

## DESCRIPTION

An illustration of the Model RF302 front panel is shown in Figure 4 on the following page. The components of the front panel are described starting in the upper lefthand corner of the panel and proceeding counterclockwise.

- ① **Fuse Holder** - The RF302 utilizes an AGX .5A ultrafast blow fuse to provide circuit protection for the thermocouple and meter.
- ② **Banana Jacks** - The Model RF302 can accommodate 5 electrosurgical leads (banana jacks). The 4 jacks on the left hand side of the front panel include:

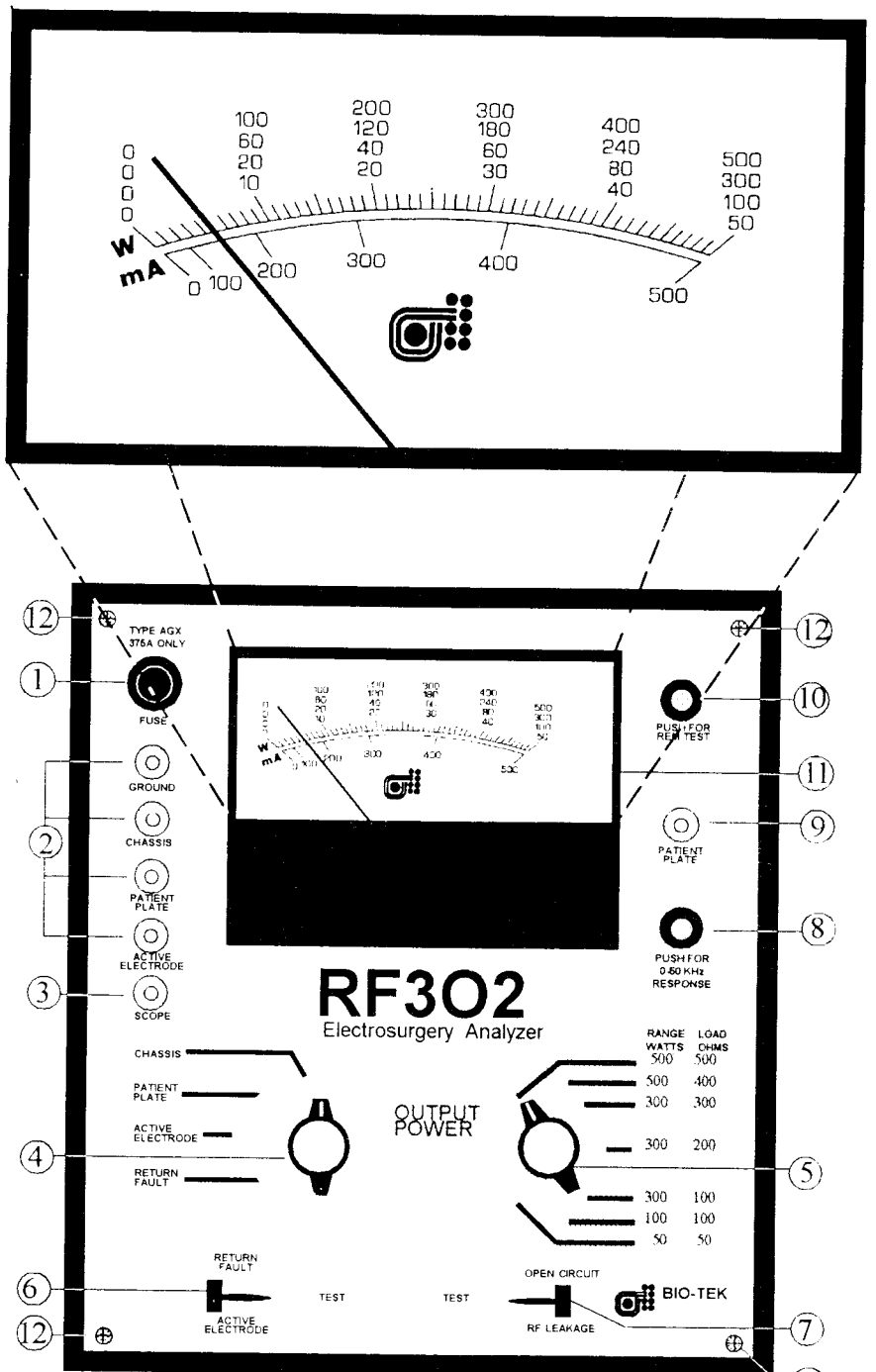


Figure 4. Front Panel and Meter Detail

GROUND (green)  
CHASSIS (white)  
PATIENT PLATE (black)  
ACTIVE ELECTRODE (red)

- ③ **BNC Connector** - The BNC connector is labeled "SCOPE" and enables the user to output a signal to an oscilloscope to verify the waveform shape.

**NOTE: This output is isolated and is not calibrated.**

**Selector Knobs** - The Model RF302 has 2 selector knobs that enable the user to:

- test output power for 7 different load/range options;
- test the RF leakage between the chassis and ground, the patient plate and ground, or the active electrode and ground with or without load;
- perform the return fault test.

- ④ **RF Leakage** - The RF LEAKAGE selector knob can be set to one of the five following test options:

- CHASSIS
- PATIENT PLATE
- ACTIVE ELECTRODE
- RETURN FAULT
- OUTPUT POWER

- ⑤ **Output Power** - The OUTPUT POWER selector knob enables the user to test the ESU in a given range (50 - 500 watts) with a given load (50 -500 ohms).

**Sliding Switches** - There are 2 sliding switches found underneath the selector knobs:

- ⑥ - RETURN FAULT/ACTIVE ELECTRODE Test
- ⑦ - OPEN CIRCUIT/RF LEAKAGE Test

- ⑧ **50 kHz Response** - The blue button above the OUTPUT POWER ranges and loads enables the user to test for the frequency response in the 0-50 kHz range.

- ⑨ **Banana Jack #5** - The fifth banana jack (black) provides the user with an additional PATIENT PLATE input during RETURN ELECTRODE MONITOR testing.
- ⑩ **REM Test Button** - The blue button in the upper right-hand corner of the Model RF302 front panel enables the user to perform a REM test.
- ⑪ **Meter** - Ranges and loads are selected by the OUTPUT POWER knob. For each ohm load selected, there is a corresponding meter range to ensure accurate readings (refer to the chart on the following page).
- ⑫ **Front Panel Screws** - There are 4 screws that hold the front panel in place. When these screws are removed from the 4 corners of the front panel, the internal components of the Model RF302 are exposed.

**WARNING: Never open the unit when the ESU is connected to the RF302.**

### THEORY OF OPERATION

The Model RF302 is a precise instrument for measuring the output power of ESU's. The Model RF302 simulates the load seen by the electrosurgery machine during operation. The resistive loads inside the Model RF302 are non-inductive, accurate, and are not affected by prolonged use at the maximum electrosurgery machine output. The measuring system is a precise thermocouple that measures the electrical power for any frequency from DC to 3 MHz. The thermocouples are connected to a precision analog meter that directly reads ESU power. The meter is protected by a fast-blow instrument fuse. The filter switch is connected to precision inductive/capacitive components that act as a low pass filter. The meter will read the low frequency component of incoming power when the filter switch is activated.

## OPERATION

**WARNING:** ESUs emit high frequency currents at voltages from 100 to 500 volts. The operator must be certain that the electrosurgery unit is OFF or non-active when making the necessary connections to the Model RF302.

**Load/range Selection** - For each load in Ohms (selected by the right selector switch) there is a corresponding meter range for accurate measurements.

<u>RANGE</u> <u>(Watts)</u>	<u>LOAD</u> <u>(Ohms)</u>	<u>EACH</u> <u>DIVISION</u> <u>(Watts)</u>
0 - 500	500	10
0 - 500	400	10
0 - 300	300	6
0 - 300	200	6
0 - 300	100	6
0 - 100	100	2
0 - 50	50	1

RF leakage tests are indicated on the red "mA" range on the meter face or the "50 W" range for readings in watts.

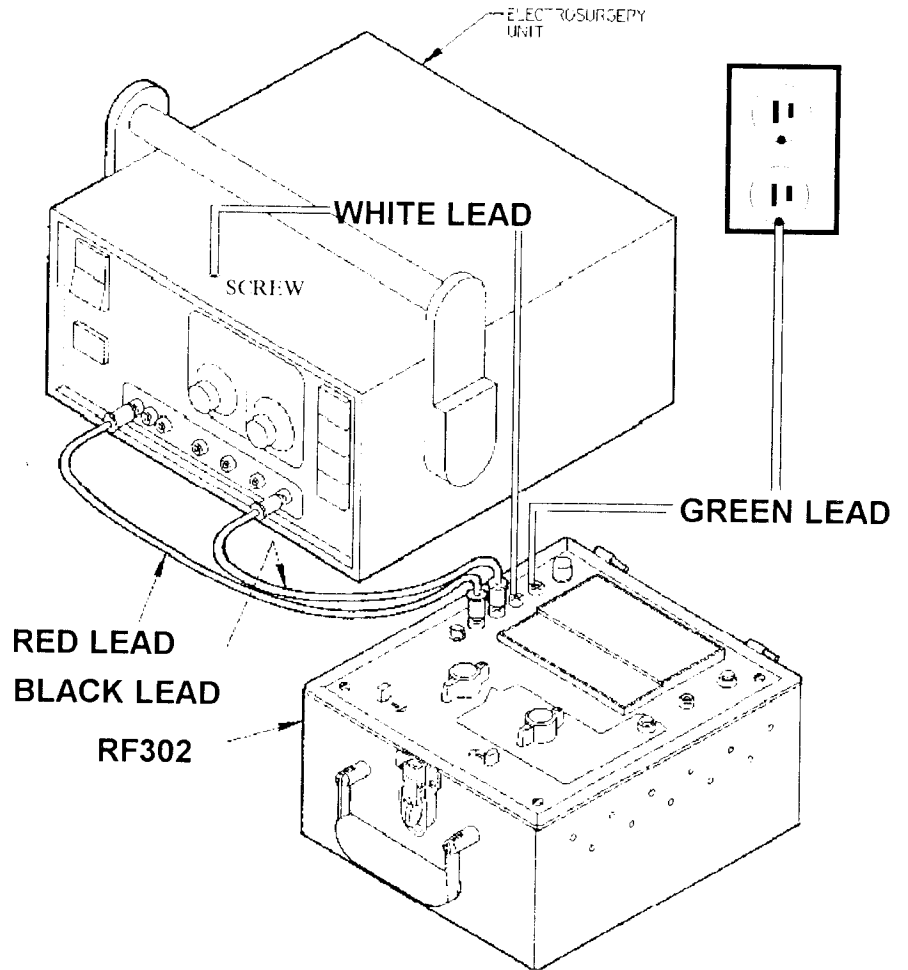
## SETUP

Attach the 4 color-coded leads (provided as accessories) to the corresponding colored jacks on the Model RF302 front panel.

**NOTE:** The extra black lead on the right of the meter is used to test REM features only. The connection is explained under "REM TESTING".

**Black & Red Leads:**

- 1) Attach a small alligator clip to one end of each black and red lead.
- 2) Connect the red lead (alligator clip) to the ACTIVE electrode of the ESU.



*Figure 5. Test Setup*

- 3) Connect the black lead (alligator clip) to the PATIENT PLATE electrode (the return electrode on bipolar units) of the ESU.

**White lead:**

- 1) Attach the large clamp to the end of the white lead.
- 2) Connect the white lead (clamp) to the chassis of the ESU.

**NOTE: Be sure to attach the clamp to a bare screw connected to the chassis.**

**Green lead:**

- 1) Attach the ground adapter to the green lead.
- 2) Plug the ground adapter into a ground pin of a grounded receptacle.
- 3) Plug the ESU into an appropriate power receptacle.

**OUTPUT MEASUREMENTS**

- 1) Consult the ESU manufacturer's manual for load impedance for power specifications.
- 2) Set the Model RF302 left selector knob to OUTPUT POWER.
- 3) Set the Model RF302 right selector knob (OUTPUT POWER) to the load specified in the ESU operator's manual.

- 4) Fill in the data on the top of the ESU performance record tag (see Figure 2 for RF3R tag) and indicate the load setting used.
- 5) Turn the ESU ON.
- 6) Set the power setting on the ESU on the first setting or partial power.
- 7) Activate the CUT and then the COAG switch on the ESU. Record the power setting, CUT power, and COAG power on the Model RF302 performance record tag.
- 8) Repeat Step 7, preceding, for 4 more power settings up to and including full power.

#### HEAVY LOAD TEST

- 1) Set the Model RF302 left selector knob to OUTPUT POWER.
- 2) Set the range switch to a 100 ohm load (either 100 or 300 watt range can be chosen).

**NOTE: For bipolar units, the 50 ohm load 50 watt range may be chosen.**

- 3) Set ESU to a power setting already used for output power.
- 4) Turn the ESU on and activate the CUT switch.
- 5) Compare the output on the Model RF302 with the output obtained with the manufacturer's recommended test load.



- 6) Activate the COAG switch on the ESU and compare the reading to the corresponding output using the manufacturer's recommended test load.
- 7) Test the other power settings in the same manner, including full power.
- 8) If the output power for this test is less than half of the output obtained with the manufacturer-specified load, the ESU should be checked by the user's service department.
- 9) Record the output power at maximum setting on the RF3R performance tag (see Figure 2 on page 3).

#### **LOW FREQUENCY OUTPUT TEST**

- 1) Set the OUTPUT POWER switch of the Model RF302 to the ESU manufacturer's recommended test load.
- 2) Set the Model RF302 left selector knob to OUTPUT POWER.
- 3) Set the power setting of the ESU to the maximum setting.
- 4) Turn the ESU ON.
- 5) Activate the CUT switch on the ESU.
- 6) Push the switch on the RF302 labeled: PUSH FOR 0 -50 kHz RESPONSE.

- 7) The Model RF302 should read zero or less than 10 watts.
- 8) Activate the coag switch on the ESU.
- 9) The Model RF302 should read zero or less than 10 watts.
- 10) If the Model RF302 reads below 10 on both tests, record "NEGLIGIBLE" on the inspection tag. If there is a substantial reading when the filter button is activated; i.e., more than 10 watts, record "NOT SATISFACTORY" on the RF3R tag. The ESU must than be checked further by the user's service department before use.

### ISOLATION TEST

The Model RF302 can measure RF leakage to ground from:

1. the chassis,
2. the active electrode,
3. the patient electrode.

**CAUTION: Do not measure leakage from ACTIVE ELECTRODE to GROUND on non-isolated electrosurgery units. This may damage the Model RF302. PATIENT ELECTRODE to GROUND and CHASSIS to GROUND leakage may be measured without risk of damage.**

High frequency leakage to ground from the Model RF302 electrosurgery analyzer is measured as follows:

- 1) Remove all test leads except for the test being performed (i.e. chassis lead and ground lead for chassis test.

Set the Model RF302 right selector knob (OUTPUT POWER) to the load recommended by the manufacturer.

- 2) Set the power setting of the ESU to the maximum setting.
- 3) Set the Model RF302 left selector knob (RF LEAKAGE) to CHASSIS.

Remove all test leads except the chassis lead and the ground lead.

- 4) Turn the ESU ON.

- 5) Activate the CUT switch on the ESU. Read the leakage on the red mA Scale or the 50 W scale of the Model RF302.

- 6) With the CUT switch on the ESU activated, slide the OPEN CIRCUIT switch on the Model RF302 to test RF leakage under open circuit conditions.

- 7) Activate the COAG switch on the ESU. Read the leakage on the red mA scale or the 50 W scale of the Model RF302.

- 8) With the COAG switch on the ESU activated, slide the OPEN CIRCUIT switch on the Model RF302 to test RF leakage under open circuit conditions.

- 9) Set the Model RF302 left selector knob (RF LEAKAGE) to PATIENT PLATE.

Remove the chassis lead and connect the patient plate lead

10) Repeat the preceding Steps 4 through 8.

**CAUTION: Do not perform the following Steps 11 through 15 unless the ESU has an isolated output. Proceed to Step 16 for non-isolated ESU's.**

11) Set the Model RF302 left selector knob (RF LEAKAGE) to ACTIVE ELECTRODE.

Remove the patient plate lead and connect the active electrode lead.

12) Activate the CUT switch on the ESU.

13) Slide the OPEN CIRCUIT and ACTIVE ELECTRODE switches on the Model RF302 simultaneously. Read the leakage on the red mA scale or the 50 W scale.

14) Activate the COAG switch on the ESU and again perform Step 14, preceding.

15) If the maximum RF leakage is less than the manufacturer's specifications (or less than a preestablished limit), check OK on the RF3R tag. If not, the ESU needs to be serviced.

#### MEASURING OUTPUT CURRENT

The Model RF302 reads power output in watts of ESU's. If the root mean square (rms) current is desired, it can be calculated as described in the following paragraphs.

The current **I** is equal to the square root of the power **P** divided by the load impedance **Z** such that:

$$I = \sqrt{P/Z}$$

For example, given a power reading of 410 watts on the 500 ohm range, the current in Amperes is:

$$I = \sqrt{410/500}$$

$$I = \sqrt{0.82}$$

$$I = 0.906 A_{\text{rms}}$$

Table 1 on page 53 is a quick reference of many current levels.

### MEASURING OUTPUT VOLTAGE

The AC<sub>rms</sub> voltage of ESU's can be calculated. Table 2 on page 54 is a quick reference of many voltages. The output voltage is equal to the square root of the product of the power "P" and the load impedance "Z" such that:

$$V = \sqrt{P \times Z}$$

For example, for a given power reading of 410 W on the 500 ohm range, the voltage is:

$$V = \sqrt{410 \times 500}$$

$$V = \sqrt{205,000}$$

$$V = 452.8 V_{\text{rms}}$$

## MEASURING RF LEAKAGE-TO-GROUND CURRENT

The AC<sub>rms</sub> current flow to ground during RF isolation testing can be approximated in the Model RF302 meter red mA scale. To achieve more accurate numbers, calculate current using Ohm's law with current equal to the square root of the power "P" divided by the resistance load "Z" such that:

$$I = \sqrt{P/Z}$$

Given a power reading of 4 watts, for example, the current is:

$$I = \sqrt{4/200}$$

$$I = \sqrt{0.02}$$

$$I = 141 \text{ mA.}$$

Table 3 on page 55 is a quick reference for any currents in milliamperes.

## OSCILLOSCOPE OUTPUT

The Model RF302 is equipped with the BNC connection that is inductively coupled to a conductor inside the unit. This permits viewing of the waveform to verify proper operation of the ESU. The oscilloscope output is not calibrated for amplitude; however, precise frequency measurements can be made. To use the oscilloscope output:

- 1) Connect an oscilloscope to the output connector.
- 2) Set the amplitude selector of the oscilloscope on 1 V/cm.
- 3) Set the time sweep selector on the oscilloscope on 1 microsecond/cm.

- 4) Adjust the signal to maximum amplitude and time for an effective analysis while using the maximum output power of the ESU.
- 5) Set the Model RF302 left selector knob (RF LEAKAGE) to OUTPUT POWER and the right selector knob (OUTPUT POWER) to the 500 ohm load for best resolution.

### MEASURING CREST FACTORS

The oscilloscope output on the Model RF302 can be used to calculate Crest Factors. The following equipment should be assembled before beginning the procedure:

- 1) Oscilloscope: 1 MHz, VDC, and
- 2) Digital voltmeter (DVM): 1 MHz, VDC (true rms). (The DVM can be a unit such as the Fluke 8920A.)

The following equation is used to calculate the Crest Factor:

$$\text{Crest Factor} = \frac{V_{\text{peak}}}{V_{\text{rms}}}$$

where:

$$V_{\text{peak}} = \text{peak voltage obtained on the oscilloscope}$$

$$V_{\text{rms}} = \text{voltage root mean square measured as VAC.}$$

- 1) Connect the oscilloscope to the BNC output connector (SCOPE) on the Model RF302 and then set the oscilloscope amplitude of 1 V/cm and the sweep speed of 1 microsecond/cm.
- 2) Connect the ESU to the Model RF302 as instructed in the section titled OUTPUT POWER MEASUREMENTS.
- 3) Adjust the signal on the oscilloscope to the maximum amplitude and time to effectively analyze the output power.

**NOTE: Maximum amplitude can be obtained with the maximum output power from the ESU.**

- 4) Record the peak voltage obtained on the oscilloscope as  $V_{\text{peak}}$
- 5) Connect the DVM to the BNC output of the Model RF302 to measure the VAC with the DVM. Record the readings displayed on the DVM as  $V_{\text{rms}}$

**NOTE: Maintain the same output power level as in the preceding steps.**

- 6) Substitute the test values into the Crest Factor equation given at the beginning of this section and calculate the Crest Factor.
- 7) For additional information on determining Crest Factors for the Model RF302, please call BIO-TEK toll free at: 1 (800) 451-5172.

#### **RETURN FAULT TEST**

The Model RF302 tests ESUs equipped with return fault interrupters. It does this by simulating a capacitance from active-to-ground and when activated, the ESU should alarm and disable. The Return Fault System is tested as follows:

- 1) Set up the ESU and Model RF302 as instructed in the Section titled SETUP
- 2) Turn the Model RF302 left selector knob (RF LEAKAGE) to RETURN FAULT.
- 3) Switch the ESU to ON and apply 100 watts of power.
- 4) Slide the RETURN FAULT and OPEN FAULT slide switches to the TEST position; the ESU should alarm and disable.



## REM TEST

The Model RF302 is able to verify proper operation of Return Electrode Monitor (REM) systems. Typically, there are two patient plate electrode inputs on ESUs instead of one. This circuit should alarm only if the patient electrode loses sufficient patient contact (see Figure 6 on the following page). To test this system, the Model RF302 increases the resistance between the two return plates thereby simulating a loose patient plate.

- 1) Set up the ESU and the Model RF302 as instructed in the Section titled SETUP
- 2) Use an actual REM patient plate connected to the ESU. Cut off the plate and expose the two wires.
- 3) Connect the first black lead to either exposed wire with an alligator clip.
- 4) Connect the second black lead to the black banana jack marked PATIENT PLATE on the upper right hand corner of the Model RF302 front panel.
- 5) Attach a small alligator clip to the end of the black lead.
- 6) Connect this alligator clip (black lead) to the other exposed wire.
- 7) Switch the ESU power ON and apply 100 watts of power.
- 8) To test, press the REM TEST button.

# REM CIRCUIT\*

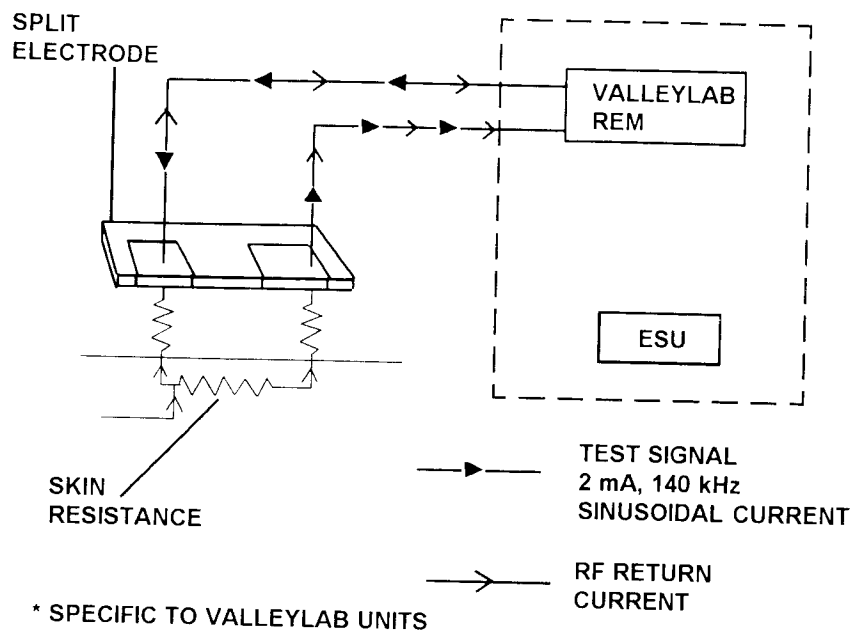


Figure 6. REM Circuit (Specific to Valleylab)

