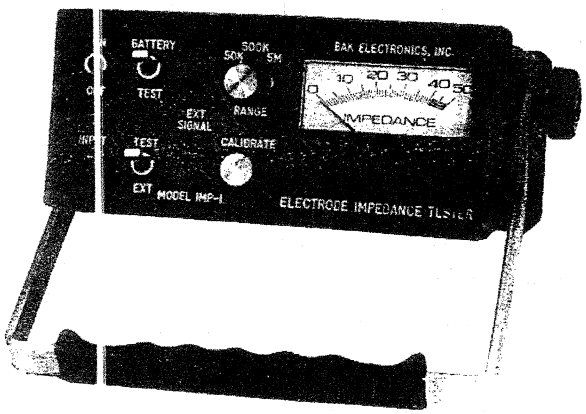
BAK ELECTRONICS, INC.
Biomedical Instrumentation

METAL ELECTRODE IMPEDANCE TESTER

Model IMP-1



- *3 RANGES - ACCURATE FROM 5 K TO 5 MEGOHMS*
- *STANDARD 1 kHZ TESTING FREQUENCY*
- *SAFE TO USE IN PREP: NANOAMP TEST CURRENT*
- *EASILY PORTABLE BATTERY OPERATED*

Description:

The Model IMP-1 is an instrument for measuring metal electrode impedance at 1 kilohertz. The Model IMP-1 will measure impedances between 5 kilohms and 5 megohms and display the value on an easy to read quality meter. A switch is provided which in one position will test the electrodes' impedance (the Model IMP-1 has its own internal oscillator) or in the other position will allow an externally derived current or voltage source to be applied to the electrode for the purpose of breaking down an oxide layer, bubble testing or lowering the tip impedance.

The Model IMP-1 is not only useful for characterizing high impedance metal microelectrodes but is also an excellent instrument for matching the lower impedance values normally associated with electrodes used in differential EMG recordings. When differential recordings are done with electrode pairs having approximately the same impedance value, the common mode rejection factor will substantially increase, thus increasing the signal-to-noise ratio. The batteries are easily tested by a battery test switch in which the battery voltage is read on the meter. The Model IMP-1 is a bench model unit with an adjustable carrying handle for tilting the unit to any angle.

Elec trode Impedance Tester

Spe cifications:

Sine Wave Frequency ----------1 kilohertz

Test ng current ----------Less than 40 nanoamps

Impe dance Testing Range ----------Zero to 5 megohms

Accuracy ----------Less than 10% error any measurement

Pow r Requirements ----------Two 9 volt alkaline transistor batteries

Batt ry Life ----------Greater than 50 hours

Size ----------9" w x 3.5" h x 7.5" d

Wei ht ----------1.5 lbs.

Other related BAK products:

Parylene coated Micro-electrodes - The Model IMP-1 is specifically designed to test the full full range of impedance normally encountered with these electrodes and facilitates the bubble testing procedure which lowers and stabilizes impedance after use or prolonged storage.

Amplifiers - The Model IMP-1 test circuit is identical to that incorporated in the BAK A-1 and A-1B Metal Microelectrode Amplifiers.

CERTIFICATION

BAK Electronics certifies that this instrument has been tested and inspected thoroughly and was found to meet all published specifications before shipment from the factory.

WARRANTY

All BAK Electronics' products are warranted against defects in materials and workmanship for one full year from the date of delivery. Products which prove to be defective during the warranty period will be repaired or replaced without charge provided they are returned to the factory. No other warranty is expressed or implied. We are not liable for consequential damages.

SERVICE

BAK Electronics will provide for servicing and calibration after the warranty period for a reasonable service charge. The instrument should be shipped to the factory postage prepaid. There is a minimum service charge of eighty dollars ($80.00) and all instruments will be repaired, calibrated and returned promptly. Please enclose a cover letter with the instrument explaining deficiencies and identify by serial number in all correspondence pertaining to any instrument.

TABLE OF CONTENTS

SECTION I

INTRODUCTION

The Model IMP-1 Impedance Tester was designed to be an easy to use, portable, battery operated instrument for measuring the magnitude of the impedance of metal electrodes at a frequency of one kilohertz. The value of one kilohertz was selected since most of the energy in a neurological signal is around this value and, therefore, gives the best characterization of the electrode's "true" impedance value. In most cases a researcher is primarily interested in knowing that his electrode has the proper tip impedance which is usually reflective of tip exposure and that there are no pin holes in the insulation. The Model IMP-1 assures the investigator of both of these criteria.

The Model IMP-1 also allows the investigator to bubble test the electrode for breaks in the insulation or to lower the tip impedance by applying an externally derived current or voltage source across the electrode without having to manipulate the leads to the electrode. This can be done quickly allowing for frequent checks of the impedance value by alternating the mode switch between TEST and EXT.

SECTION II

GENERAL INFORMATION

2.1 INTRODUCTION

This section contains general information about the BEI's Model IMP-1 Impedance Tester. The Impedance Tester shall be referred to as the Model IMP-1 throughout the rest of this manual.

2.2 DESCRIPTION

The Model IMP-1 is an instrument for measuring electrode impedances at 1 kilohertz. The Model IMP-1 will measure impedances between 5 kilohms and 5 megohms which are displayed by an easy to read. high quality taut band meter or its equivalent. A switch is provided to test the electrode from either the internal oscillator or by applying an externally derived source to the electrode for the purpose of bubble testing or lowering the electrode's tip impedance.

The batteries are easily tested by a battery test switch in which the battery voltage is read on the meter as B1 + B2/6.

The Model IMP-1 is a bench model unit with an adjustable carrying handle that can be used for tilting the unit to any viewing angle.

2.3 INSTALLATION

This instrument was thoroughly inspected both mechanically and electrically before leaving the factory. Please check for physical damage which may have occurred during shipment and file a report with the carrier if any damage is found.

2.3 INSTALLATION (cont.)

The power requirements for the Model IMP-1 are supplied by two 9 volt Mallory Batteries. The batteries are mounted on the rear panel within the instrument package. The Model IMP-1 is self-contained in an attractive convenient-to-use table mounting chassis. Due to the meter movement, care should be taken not to drop or physically mistreat the instrument.

2.4 SPECIFICATIONS

Sine wave frequency.....1 kilohertz

Test current.....less than 10^{-8} amp

Impedance testing range.....5 kilohms to 5 megohms

Accuracy.....less than 10% error

Power requirements.....two 9 volt TR246 Mallory batteries
+8 ma and -7 ma

Size.....5.5"w x 2.5"h x 6.5"d

Weight.....1 ½lbs.

S E C T I O N I I I

O P E R A T I N G I N S T R U C T I O N S

3.1 I N T R O D U C T I O N

Although the use of the instrument is straightfoward, it is suggested that some time be spent in understanding the controls, input requirements and limitations respectively.

3.2 B A T T E R I E S - O N / O F F A N D B A T T E R Y T E S T S W I T C H

The two 9 volt batteries should last an average of 75 hours of operation. Care must be taken not to leave the instrument on or the life of the batteries will be shortened due to prolonged continuous discharge.

The BATTERY TEST switch will allow the user to test the battery voltage by pushing the switch down and reading the battery voltage on the meter. The batteries are connected in series with a 360 kilohm resistor to the front panel meter. Therefore, the meter reading is normalized so that a full scale reading represents 17 volts. A reading of 35 or less means the batteries should be changed, although there will still be several hours of use left. Battery test jacks are provided at the rear of the instrument for precise battery measurements.

3.3 INPUT CONNECTOR

The red pin jack connector goes simultaneously to a one kilohertz sine wave constant current source and is also capacitively coupled to a F.E.T. input voltage amplifier and the circuit common is connected to the green pin jack. The input voltage amplifier measures the voltage drop across the electrode. Two mating connectors with mini-gator clips are included with the Model IMP-1.

3.4 CALIBRATE PUSH BUTTON SWITCH KNOB AND RANGE SWITCH

See Addendum Paragraph on RANGE SWITCH.

3.5 EXTERNAL SIGNAL INPUT CONNECTORS

The red and green banana jack connectors, labeled EXT SIGNAL, provide the user with the option to delivering signals directly to the input connector, the red pin jack, by positioning the mode switch to EXT. The red banana jack connector goes tot he red pin jack and the green connector to circuit ground. This option is helpful in passing a negative D.C. current across an electrode in order to lower its tip impedance or for bubble testing to detect breaks in the insulation.

SECTION IV

CIRCUIT DESCRIPTION

4.1 GENERAL

The Model IMP-1 Impedance Tester has its own internal 1 KHZ oscillator designed to deliver a constant current through the electrode in which the input F.E.T. high impedance amplifier stage detects a voltage drop proportional to the electrode's tip impedance. The 1 KHz voltage signal is then amplified, full wave rectified and applied to the current meter displaying the magnitude of the electrode's impedance. By positioning the mode switch to EXT, an external signal may be applied across the electrode without having to change the leads to the electrode.

4.2 CIRCUIT DESCRIPTION

The operational amplifier U1A (half of a LF353N) is incorporated as part of a wien bridge oscillator circuit which is set to 1 kilohertz. This signal is fed through a 10^9 ohm resistor, R5, (a much larger resistance value than any electrode impedance value the instrument is designed to measure) and simultaneously goes to the input connector and F.E.T. input voltage amplifier, U3. Because of the parallel resistance of R5 and R6, the input resistance to U3 is equal to 5×10^8 or 100 times the maximum resistance the device is intended to measure. A constant current can be justified, therefore, for all impedances less than 5 megohms. The output of U3 is

4.2 C I R C U I T D E S C R I P T I O N (cont.)

capacitively coupled through C4 to U2A whose feedback resistors R8, R9 and R10 are connected to the front panel range switch. Its output is then fed to U2B through C4 in which the feedback potentiometer R14 (which is mounted on the front panel) allows the user to calibrate the device for a known resistance value. The signal is again capacitively coupled to the next stage via C6 where it is full wave rectified by CR3, CR4, CR5 and CR6 which are in the feedback loop of amplifier U1B. The meter, which is placed across the bridge, detects the current in the feedback loop which is directly proportional to the A.C. voltage drop across the electrode.

SECTION V

MAINTENANCE AND CALIBRATION

BATTERY SUPPLY

The Model IMP-1 is powered by two TR246 Mallory 9 volt batteries. A front panel momentary lever switch is provided to give an instantaneous battery check by observing the meter reading which is B1 + B2/3.5. A more precise indication of the battery voltages can be made by using a volt meter and testing the batteries directly via the rear panel test jacks.

INTERNAL TRIMPOT ADJUSTMENTS

The Model IMP-1 has only one internal trimpot adjustment. The trimpot, R3, adjusts the voltage gain of the wein bridge oscillator. It is normally set to about 10 volts peak to peak. This value does not, however, have to be precise, since the calibrate knob can accommodate any value around the 10V peak to peak value.

IMPEDANCE CALIBRATION ADJUST

Place a known resistance value across the input lead and adjust the calibration knob on the front panel so that the meter reads the appropriate number. To achieve the best accuracy through the meter's scale, a 10K, 100K and 1 megohm 17% resistor can be used in calibrating the meter for the three ranges.

SECTION VI

APPLICATIONS

6.1 IMPEDANCE MEASUREMENTS

The most crucial component when attempting to record from single neural elements is, without exception, the integrity of the electrode. Ideally, the electrode's recording area should be as small as possible for good single unit selectivity. Also it should have a relatively low impedance, normally measured at a kilohertz, for low noise. It should have a pin hole free insulation right down to the tip to minimize shunt capacity. BEI now sells Parylene-C coated tungsten electrodes whose tips can be very cleanly exposed by a reliable high voltage arcing technique. These elextrodes optimize state of the art techniques and materials for an extremely reproducible and reliable recording electrode. Any electrode, however, with a tip size on the order of one to two microns is very delicate and can withstand only a finite number of penetrations. Because of the Model IMP-1's low testing current it can also be used to characterize electrodes in vivo.

The Model IMP-1 is also ideal in characterizing lower impedance electrodes, such as EMG electrodes. Since EMG recordings are normally made differentially, I.E. between two electrodes with a common reference, it is most advantageous that both electrodes have nearly the same impedance values. This is so that maximum common mode rejection is achieved in the differential recording

S E C T I O N V I

6.1 I M P E D A N C E M E A S U R E M E N T S (cont.)

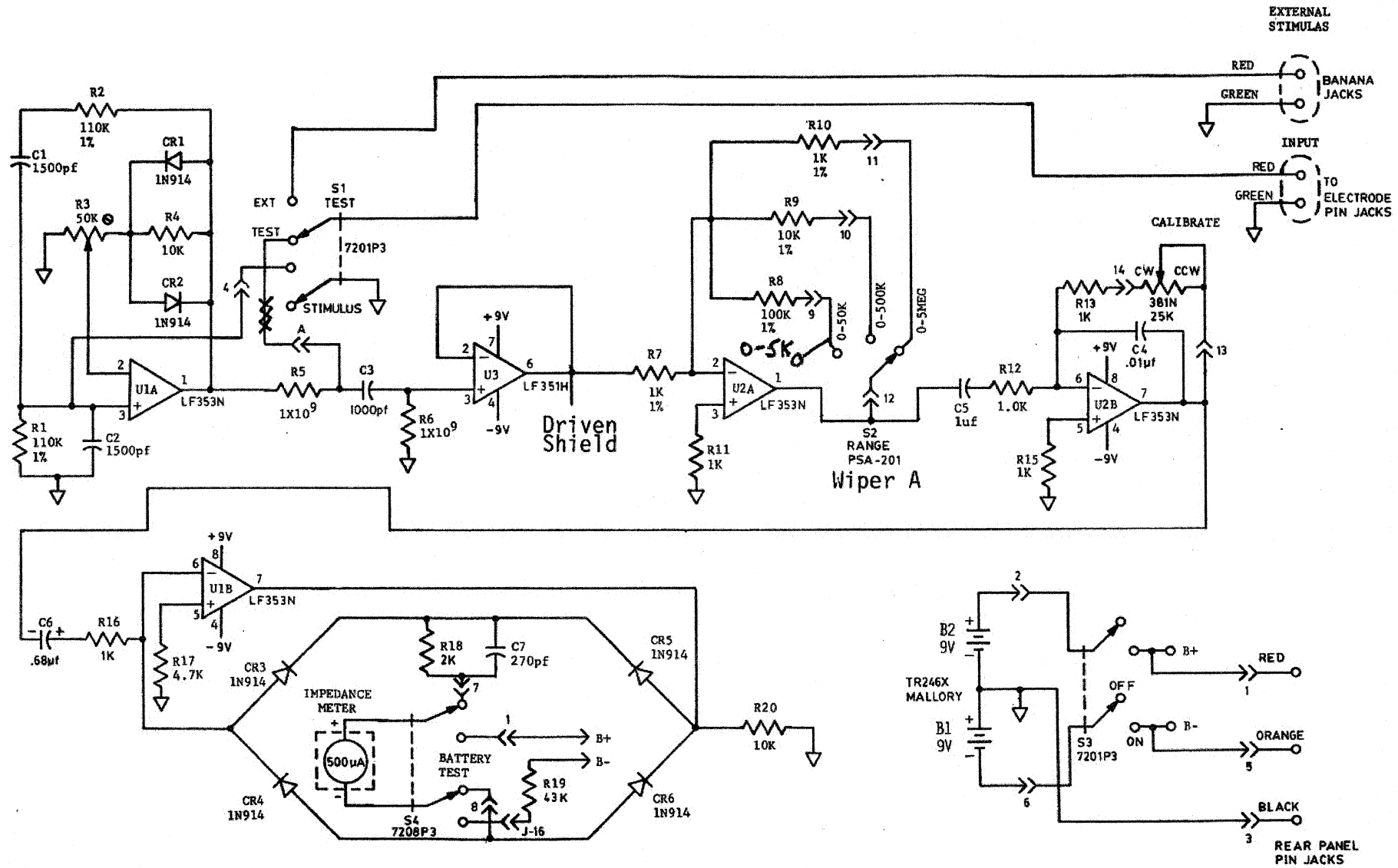
amplifier. We define impedance as it is read on the meter as the absolute value of the square root of the sum of the square's of the real and imaginary parts, I.E..

6.2 B U B B L E T E S T I N G

Microelectrodes insulated with various types of varnishes, epoxies etc., and glass (Pt/Ir type electrodes) can be tested for pin holes along the shaft by passing a negative current about 1 to 5 microamps through an electrode and observing for bubbling along the shaft, the electrode being totally immersed in saline and observed under a zoom type microscope. Any bubbling which appears is a definite pin hole indicating the electrode is not adequate for recording. Also by passing these currents, the tips of some electrodes may become de-oxidized, thus lowering the tip impedance to its "true" value. The Model IMP-1 has a front panel switch allowing the user to alternate between the impedance testing mode and external signal injection without having to manipulate the leads to the electrode, therefore saving time.

MODEL IMP-I
ELECTRODE IMPEDANCE TESTER
BAK ELECTRONICS INC

7-81



APPENDIX TO BAK ELECTRONICS METAL ELECTRODE IMPEDANCE TESTER

(IMP-2A)

You are receiving the IMP-2A which differs slightly from the IMP-2 as well as the IMP-1. We are currently revising the manual for future orders but haven't completed it as of this time (February 2013). The IMP-2 as well as the newest (IMP-2A) version has built-in calibration features that greatly simplify the calibration procedure. The IMP-2A was developed to bring the design up to current state-of-the-art. In the new design, surface-mount-devices are employed, the wein-bridge oscillator was replaced with a more stable oscillator, and select-at-test calibration resistors were replaced with four internal calibration potentiometers. These are factory set and require no servicing in the field.

Calibration should be performed each time a probe's impedance is to be measured. The procedure is simple and straight forward.

1. Select the desired impedance range (5k, 50k, 500k or 5Meg).
2. Press the "calibrate" button and turn the "calibrate" knob until the meter reads mid-scale (25).
3. Release the button. You can now take measurements.
   NOTE: Calibration MUST be performed whenever a range change is made.

We believe that these improvements will make the IMP series of impedance testers simpler and more reliable. As always, these devices are guaranteed for one year from date of delivery.

Dwight D. Pray, Chief Engineer/co-owner

BAK Electronics

246 Krider Rd.

Sanford, FL 32773