



**ohmic instruments co.**

508 August St. Easton, MD 21601

Voice: (410) 820-5111

Fax: (410) 822-9633

[www.ohmicinstruments.com](http://www.ohmicinstruments.com)

BIOMEDICAL ELECTRICAL TEST SET  
Models BET-300AD  
And BET-300ADL

OPERATOR'S MANUAL

© Ohmic Instruments Company  
2006

All rights reserved. This manual may not be reproduced in complete form without written permission of Ohmic Instruments Company. Test forms may be copied as required by the original purchaser of the instrument. Information contained in this manual is believed to be accurate and reliable; however, no responsibility is assumed by Ohmic Instruments Company for its use. Ohmic reserves the right to supply its instruments with design changes and/or component substitutions that may not be documented in this manual.

## TABLE OF CONTENTS

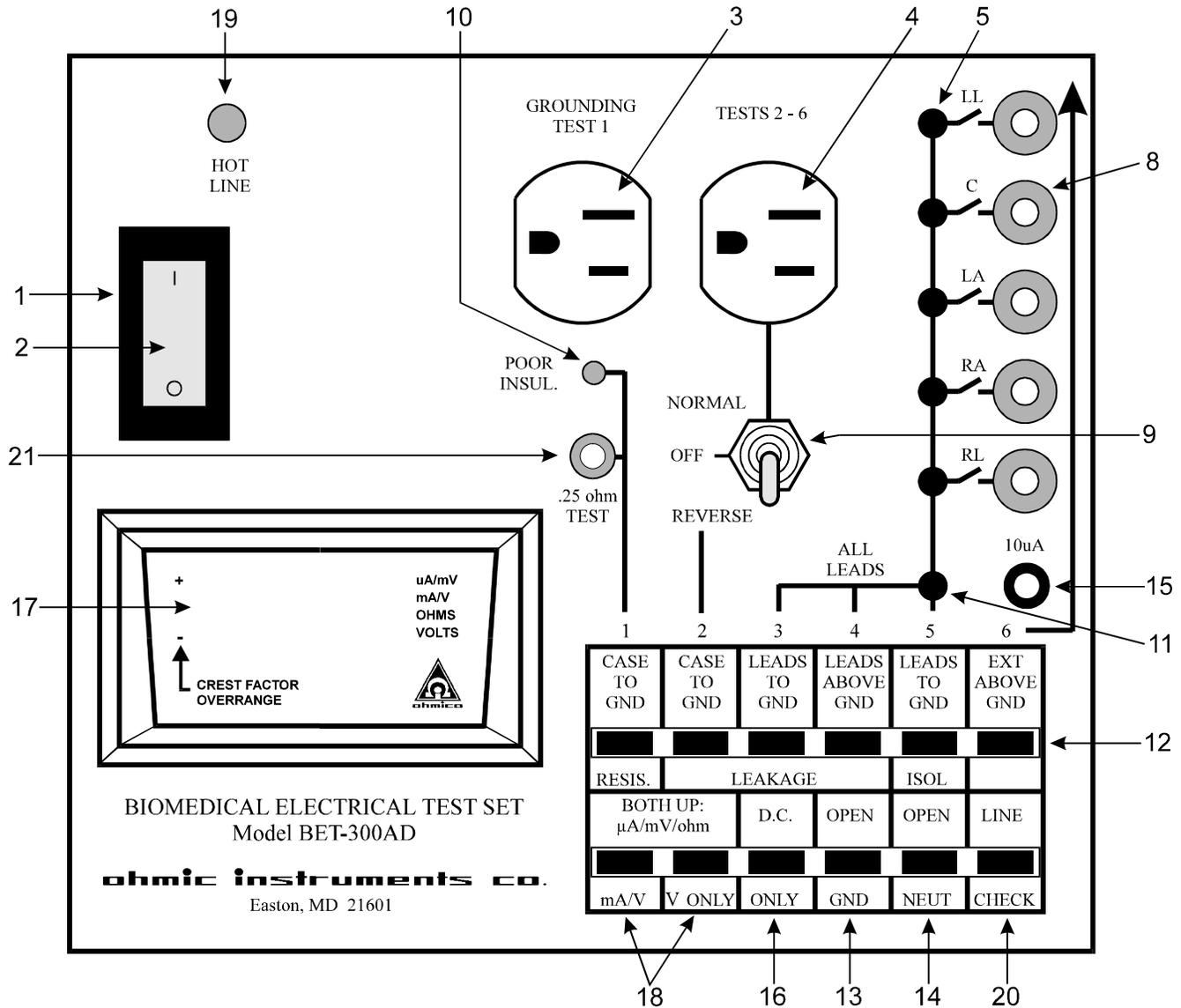
Introduction.....	5
Panel Controls .....	6
Short Operating Notes .....	8
Detailed Operation.....	10
Trouble-Shooting .....	13
Recalibration.....	13
Isolated Power Systems Test Introduction .....	14
Model BET-300ADL - Isolated Power Test Option (Test 7).....	15
Description of Isolated Power Test Panel .....	15
Test 7 Procedure .....	16
Warranty.....	18
Specifications .....	19
Test Form TF-2: ECG Safety Test .....	20
Test Form TF-4: Testing Medical Equipment Without Patient Leads.....	21
Test Form F-64L: Isolated Power System Test (BET-300ADL only) .....	22



## **INTRODUCTION**

Ohmic Company's Biomedical Electrical Test Set, model BET-300AD(L) was engineered and field tested by hospitals and biomedical engineers for ease of operation, ruggedness, and portability. The unit is capable of performing safety tests on electrically operated equipment including the wiring on both grounded and isolated power systems (Model BET-300ADL). It can simulate probable fault conditions, such as loss of equipment ground and reversed power wiring. The BET-300AD(L) reads leakage current and voltages above or referenced to ground while resistance tests are made with respect to ground. The test set's case is earth grounded in order to minimize any shock hazard to the operator and it acts as a shield to limit frequency interference from external sources. In conformance with both the 1985 Association for the Advancement of Medical Instrumentation (AAMI) standard and the 1988 Underwriters Laboratories UL 544 standard, the BET-300AD(L) has a constant 1-kilohm input impedance and a flat frequency response from D.C. to 1KHz. Above 1KHz, there is a frequency response attenuation of approximately -20db per decade. In the V ONLY range, the input impedance is 100 kilohms.

## PANEL CONTROLS



1) *Two-Pole Magnetic Breaker.* Provides overload protection while testing and act as the main power ON/OFF switch.

2) *Power On Light.* Gives a visual indication that power is applied to the BET-300AD. Some units use unlighted breakers; in those cases the Power On Light is separate from the breaker.

3) *Grounding and Insulation Test Receptacle:* This non-energized receptacle is used for the Grounding and Insulation Resistance tests (Tests 1-A and 1-B).

4) *Leakage Test Receptacle:* This energized receptacle is used for Leakage and Current tests (Tests 2-6) on the Equipment Under Test (EUT).

5) *ECG Lead Test Pushbuttons:* When depressed, these five pushbuttons allow any combination of patient lead testing during Tests 3, 4, and 5.

6) *Test Probes (not shown)*: Test probe jacks are located on the rear panel and are used for carrying out external ground resistance and leakage tests (Tests 1, 4, and 6). The black test probe is common and will be grounded or floating depending on test selection.

7) *1/16 and 1/2 Amp Fuses (not shown)*: These rear panel mounted fuses provide overcurrent protection for the Resistance test circuit (1/16 amp) and internal power supply circuit (1/2 amp). (NOTE: Some units may have a 1/4 amp fuse here instead of a 1/2 amp fuse due to power transformer variations).

**IMPORTANT!** Only fast-blow fuses, of the correct value, should be used in the BET-300AD and BET-300ADL. The use of slow-blow and/or higher-value fuses in this unit can affect the accuracy of the Resistance measuring circuit, expose the unit's circuitry to a greater risk of damage, and void the warranty.

8) *Color-coded Patient Lead Connectors*: Binding posts allow the patient leads to be connected to the Test Set. A variety of patient lead test adapters are available from Ohmic for snap-on type patient leads.

9) *Polarity Switch (Normal, Off, Reverse)*: This toggle switch is used to reverse the Hot and Neutral lines to the energized test receptacle. A center Off position is provided to remove power from the EUT.

10) *Poor Insulation Light*: This light comes on if the EUT has a short circuit or if there is a leakage resistance path less than one megohm between the combined Hot and Neutral lines and ground (Test 1).

11) *All Leads Pushbutton*: When depressed, this pushbutton connects all patient leads to the test set during Tests 3 and 5.

12) *Test Function Selector*: These numbered pushbuttons select the conditions for making the Resistance, Leakage, Isolation and External Leakage Tests (Tests 1-6).

13) *Open Ground Pushbutton*: Depress this pushbutton to disconnect the ground from the energized receptacle and to simulate loss of equipment ground for Tests 3, 4, and 6.

14) *Open Neutral Pushbutton*: Depress this pushbutton to disconnect the neutral from the energized receptacle and to simulate loss of equipment neutral for Tests 3, 4, and 6.

15) *10 $\mu$ A Jack*: Use this 10 $\mu$ A source to check unit operation.

16) *DC Only Pushbutton*: When this pushbutton is depressed, the display reads only the DC component of leakage current or voltage.

17) *3½ Digit LED Display*: This display shows the measured current, voltage, and resistance readings.

18) *Range Selection Pushbuttons with Auto-Range Feature*: Two pushbuttons provide selection of three ranges: The left button selects the **mA/V** range which can measure from 0 to 20 milliamps or volts in two auto-ranges; the right button selects the **V Only** range which can measure from 0 to 200 volts in two auto-ranges; with neither of these buttons selected (both up), the default selection is  **$\mu$ A/mV/ohms** which can measure from 0 to 2000 microamps, millivolts, or ohms in two auto-ranges.

Four LED's, to the right of the display, indicate which electrical quantity is being measured: **μA/mV**, **mA/V**, **Ohms**, or **Volts**. The following table shows all the autorange specifications:

Range	Autorange	Full Scale	Input Impedance
μA/mV/ohms	Low	199.9μA/mV 19.99 ohms	1K AAMI
μA/mV/ohms	High	1999μA/mV 19.99 ohms	1K AAMI
mA/V	Low	1.999mA/V	1K AAMI
mA/V	High	19.99mA/V	1K AAMI
V Only	Low	19.99 Volts	100K flat
V Only	High	199.9 Volts	100K flat

19) *Hot Line Indicator*: This red light comes on to warn the operator whenever a hazardous voltage is present on test leads or terminals.

20) *Line Check Pushbutton*: Pressing this button allows the operator to check the integrity of the line voltage receptacle used with the BET-300AD. Readings can be used to determine if there is a faulty ground or reversed polarity. For best results, this feature can be used in any position of the ground function selections except **Case to Gnd, Resis**.

21) *0.25 Ohm Test Jack*: With red probe plugged into this test jack, the calibration of the resistance test is verified.

## SHORT OPERATING NOTES

### Using the Biomedical Electrical Test Set - Model BET-300AD

#### Line Check

Before proceeding with any of the following equipment tests, it is important to determine the integrity of the line voltage receptacle to be used with the BET-300AD. Faulty or incorrect receptacle wiring is not uncommon and can cause erroneous measurements. To check line receptacle integrity, plug the BET-300AD into the receptacle (**For the BET-300ADL only: Make sure the topmost switch of the Test 7 switch group is depressed. Doing so turns off the Test 7 function, which can interfere with other functions if left on**) and turn power on. Press the **Line Check** pushbutton located in the lower right corner. If the line voltage reads approximately 120 volts, ± 10%, then the line receptacle is wired correctly and equipment tests can be made. If the reading is close to zero, the line receptacle wiring has a reversed polarity. If the reading is low, but not close to zero (about 10 volts), the line receptacle wiring has a faulty ground. **Do not perform any equipment tests using a faulty line receptacle.** Have a qualified electrician correct the wiring.

## SHORT OPERATING NOTES (Cont'd.)

### Test 1-A: Grounding Resistance

Plug the Equipment Under Test (EUT) into the Non-Energized Receptacle (labeled TEST 1). Select **Case to Gnd, Resis.** using Test Function Selector Switch #1. Select the  **$\mu\text{A/mV/ohms}$**  setting on the range switch by allowing both range buttons to remain up. Check ohms calibration by plugging the red test probe into the 0.25 Ohm Test jack. Measure grounding resistance by touching the red test probe to the EUT case. The grounding resistance should not exceed 0.1 ohm (UL 544 par. 33.1).

### Test 1-B: Power Side Insulation

Plug the EUT into the Non-Energized Receptacle (labeled TEST 1). If the Grounding Resistance test was OK, turn on the EUT power switch. The Poor Insulation light will come on if the combined Hot and Neutral to ground resistance is less than 1 megohm (NFPA 56A).

### Test #2: Leakage from Case to Ground

Plug the EUT into the Energized Receptacle (labeled TEST 2-6). Select **Case to Gnd, Leakage** using Test Function Selector Switch #2. Take current leakage readings as required using Normal and Reverse polarity with or without Open Neutral.

### Test #3: Leakage from Leads to Ground

Connect ECG leads to binding posts. Select **Leads to Gnd, Leakage** using Test Function Selector Switch #3, and hold down the All Leads pushbutton to read total lead leakage-to-ground. Individual leakages may be read by depressing the pushbutton beside each patient lead.

### Test #4: Leakage Between Leads Above Ground

Select **Leads Above Gnd, Leakage** using Test Function Selector Switch #4. Touch the red test probe to one patient lead post (example, LL), and sequentially depress the pushbuttons beside the other leads.

### Test #5: Isolation of Leads to Ground

Select **Leads to Gnd, Isol.** using Test Function Selector Switch #5. Push each of the five lead pushbuttons and record the highest reading. Isolation impedance equals 120 volts divided by the leakage reading.

### Test #6: External Above Ground

Select **Ext. Above Gnd** using Test Function Selector Switch #6. Use both the black and red test probes to measure current or voltage between any conductive surfaces. The BET-300AD is floating above ground during this test, with an effective isolation over 10 megohms. This test method must be used in order to measure case-to-ground leakage with an Open Gnd. Current calibration can be checked by plugging the red test probe into the 10 $\mu\text{A}$  jack. The display should indicate 10 $\mu\text{A}$ .

## DETAILED OPERATION

*Note: Use Ohmic Test Form TF-2 for ECG and TF-4 for General Equipment. Originals for these forms can be found at the back of this manual.*

### Line Check

Before proceeding with any tests, the 120 volt AC receptacle must be checked for proper grounding and polarity. Turn the Power on (*For the BET-300ADL only: Make sure the topmost switch of the Test 7 switch group is depressed. Doing so turns off the Test 7 function, which can interfere with some other functions if left on*) and check the line voltage by depressing the **Line Check** switch. If the receptacle wiring is correct, the display will indicate a normal line voltage of 120 volts,  $\pm 10\%$ . Record the results on Test Forms TF-2 and TF-4. If the grounding is poor, the display will indicate substantially less than 120 volts to as low as 10 volts. If the wiring polarity is reversed, the display will read very close to zero volts. Release the **Line Check** switch when done by pushing one of the range switches only enough to cause the switch to come up. Do not proceed with any equipment testing if the line receptacle is not properly wired. Have a qualified electrician correct the wiring.

### Test 1-A: Grounding Resistance

This test can be performed on all types of line-operated equipment. Use Part 1 of Test Forms TF-2 and TF-4 to record all measurements. Plug the Equipment Under Test (EUT) into the Grounding (Test 1) non-energized receptacle. Depress **Case to Gnd, Resis.** (switch #1) on the Test Function Selector. Select the  **$\mu\text{A/mV/ohms}$**  range (both range buttons up). The display will indicate over-range by causing the first digit to read "1" and the remaining three digits to go dark. An open circuit condition causes this overrange. Check calibration by plugging the red test probe into the 0.25 Ohm Test jack. The black test probe is internally connected to the line cord ground and is not needed and should not be used during this test. Touch the red probe to the chassis of the EUT at a screw head or unpainted surface. The display will indicate the line cord resistance and should not exceed 0.1 ohm as required by UL 544, par. 33.1. Flex the line cord at the plug and the chassis to check for intermittent connections. A fluctuation in the reading could be caused by contact resistance or a corroded connection.

**CAUTION! Do not measure the grounding resistance on any equipment which has a direct electrical connection to a patient's heart. The DC test current used to measure resistance is 10 milliamperes and may cause electrical shock.**

### Test 1-B: Power Side Insulation

This test can be performed on all types of line operated equipment and should be performed only after Test 1-A is completed first. Use Part 1 of Test Forms TF-2 and TF-4 to record the measurements. The EUT should be plugged into the Grounding (Test 1) non-energized receptacle and **Case to Gnd, Resis.** function should be selected. If the grounding resistance is acceptable from Test 1-A, turn on the EUT power switch. The Poor Insulation light will come on if the combined Hot and Neutral to Ground resistance is below 1 megohm. This test will detect gross equipment insulation resistance faults due to cracked or deteriorated wiring insulation, dampness in equipment, or grounded neutral.

### Test 2: Leakage From the Case to Ground

This test can be performed on 120 volt AC equipment with a grounded line cord. Use Part 2 of Test Forms TF-2 and TF-4 to record the measurements. Depress **Case to Gnd, Leakage** (switch #2) on the Test Function Selector. Select  **$\mu\text{A/mV/ohms}$**  range. Plug the EUT into the energized receptacle (labeled TESTS 2-6), then make sure that the EUT case is isolated from earth ground, with all secondary ground paths removed. Test probes are not required for this test. Read the case-to-ground leakage under the following polarity and neutral wire conditions: **Normal** Polarity with Neutral closed, **Normal** Polarity with Open Neutral switch depressed; **Reverse** Polarity with Neutral closed, **Reverse** Polarity with Open Neutral switch depressed. Open Ground readings cannot be measured using Test #2 but can be measured using Test #6. Line cord leakage is typically 1 $\mu\text{A}$  per foot.

**IMPORTANT NOTE:** A zero leakage reading is incorrect and may be caused by a bad ground at the wall outlet, a broken ground wire to the EUT, or a secondary ground path causing current nulls at the point of measurement.

### **Test 3: Leakage From Leads to Ground**

Use Part 3 of Test Form TF-2 to record the measurement.

#### **A) Checking ECG or Monitor**

Connect the patient leads to the binding posts of the BET-300AD, and set ECG or monitor lead selector to V position. Depress **Leads to Gnd, Leakage** on the Test Function Selector (switch #3) and hold down the All Leads pushbutton to read the total lead leakage-to-ground. Individual leakages may be read by depressing the pushbutton beside each patient lead instead of the All Leads pushbutton. Record the highest reading of the three to five patient leads for each of these combinations: Test with Normal or Reverse polarity and the EUT grounded or ungrounded (the red and black probes are not used here because the connections are internal). It is recommended to perform these tests in all ECG lead selector positions. NOTE: If the DC Only switch is depressed and a leakage at RL is noted, the DC leakage is probably the driven reference signal used in certain ECG machines to reduce noise and interference. If pushing the All Leads and DC Only pushbuttons gives a zero reading, it indicates a proper operation of the Right Leg drive.

#### **B) To Check Other External Devices With Patient Connections**

For other patient lead equipment such as pacemaker, defibrillator, EEG, muscle stimulator, temperature probe, pressure transducer, etc., use the procedure described in Test 6.

### **Test 4: Leakage Between Leads Above Ground**

Use Part 4 of Test Form TF-2 to record measurements. To test ECG's and monitors, depress **Leads Above Gnd, Leakage** on the Test Function Selector (switch #4). Insert the red test probe into the LL patient lead binding post. Depress the pushbutton beside C, LA, RA, and RL in sequence. Repeat with ECG lead selector switches in all active lead positions; EUT power switch on and off, Open Ground and Normal Ground, Normal and Reverse polarity. Record the highest reading from all of the lead combinations and fault conditions. The All Leads pushbutton is not used for this test.

### **Test 5: Isolation of Leads to Ground**

Use Part 5 of Test Form TF-2 to record measurements. Depress **Leads to Gnd, Isol.** on the Test Function Selector (switch #5). Push the All Leads pushbutton and record the reading. Push each of the five lead pushbuttons and record the highest current reading. The isolation test indicates the amount of current that would flow through the patient if he accidentally came in contact with 120 volt line. For ECG machines, this leakage reading should be no more than 20 microamperes per lead. A leakage of 20 microamperes corresponds to 6 megohms, ( $120 \text{ VAC} \div 20\mu\text{A} = 6 \text{ megohms}$ ). A current reading from 0 to 20 microamperes would indicate good isolation or adequately high impedance to ground. For operator safety, the test current is internally limited to approximately 1.0 milliampere. Therefore, a reading between  $20\mu\text{A}$  and  $1.0\text{mA}$  indicates a low impedance path to ground through the patient leads.

### **Test 6: External Above Ground**

Use Part 6 of Test Form TF-2 and Part 3 of Test Form TF-4 to record measurements. Depress **External Above Gnd** on the Test Function Selector (switch #6). Use the red and the black test probes to measure current or voltage. The test set is floating above earth ground during this test. To make tests with respect to ground, connect the black test probe to a ground reference point such as a known grounded outlet, grounded chassis or a water pipe. Current calibration can be checked by plugging the red test probe into the  $10\mu\text{A}$  Test jack. This should yield a display reading of  $10\mu\text{A}$ .

## Some Simple Tests:

### A) Ungrounded Equipment

Some examples of ungrounded equipment are 2-wire ungrounded appliances, battery-operated equipment, and grounded equipment having an ungrounded outer cover. Connect the black test probe to a ground reference at an outlet. Touch the red test probe to the case of the equipment to be tested and measure current leakage or current.

### B) Patient-Connected Devices

Some examples of patient-connected devices are electroencephalographs, muscle stimulators, flowmeter probes, diagnostic illuminators, and defibrillators. Connect the black test probe to a ground reference at an outlet. Touch the red probe to the conductive surface of the electrodes and measure current leakage or voltage.

For testing of patient care and non-patient equipment according to UL 544, par. 27.12 A, B, and C, follow this procedure:

#### General Test Setup

- 1) Depress **External Above Ground** on the Test Function Selector (switch #6).
- 2) Select the desired current range.
- 3) Plug the EUT into the energized (Tests 2-6) receptacle.
- 4) Plug the BET-300AD(L) into a properly polarized and grounded AC receptacle.
- 5) Connect the black probe to a grounded supply conductor (earthed).
- 6) Connect the red test probe to the EUT at point(s) where leakage current is to be measured.

#### A) Leakage Test per Par. 27.12(A)

- 1) Depress the Open Neutral switch and measure the leakage current with the polarity switch in both the Normal and Reverse positions.
- 2) While pressing both the Open Neutral and Open Ground switches, measure the leakage current with the polarity switch in both the Normal and Reverse positions.

#### B) Leakage Test per Par. 27.12(B)

- 1) With both Open Neutral and Open Ground switches released, measure the leakage current with the Polarity switch in both the Normal and Reverse positions.
- 2) While pressing the Open Ground switch, measure the leakage current with the Polarity switch in both the Normal and Reverse positions.

#### C) Leakage test per Par. 27.12(C)

- 1) With the Polarity switch in both Normal position and then Reverse, monitor the leakage current at sufficient intervals to determine the maximum leakage current from the time of the previous measurement to the conditions under which the normal temperature test would be terminated.
- 2) The Open Neutral and Open Ground switches should both be released for this test.

- Non-patient equipment is tested in accordance with procedures (A), (B), and (C).
- Patient care equipment is tested in accordance with procedures (B) and (C).

## TROUBLE-SHOOTING

If the BET-300AD does not operate, check the items listed below.

### Fuses:

- A) *Line Fuse:* This fuse is the inside fuse below the probe jacks. Replace with a type AGC, fast-acting fuse with the ampere rating ( $\frac{1}{4}$  amp or  $\frac{1}{2}$  amp) as labeled on the panel.
- B) *Resistance Fuse:* This fuse is the one that is closer to where the red probe connects to the chassis. It provides protection in case high voltage is encountered during resistance measurements. Replace with a type AGC 1/16 amp, fast-acting fuse.

**IMPORTANT!** The use of slow-blow and/or higher-value fuses in this unit can affect the accuracy of the Resistance measuring circuit, expose the unit's circuitry to a greater risk of damage, and void the warranty. Only fast-blow fuses, of the correct value, should be used in the BET-300AD and BET-300ADL.

### Circuit Breaker:

The Power switch doubles as a circuit breaker which protects the test set from current overloads. If the 15 ampere rating is exceeded by the equipment under test, this breaker will interrupt the power to the test set and the energized receptacle. When testing small induction motors, the breaker may trip during motor starting. This is normal since motor starting currents can be from 5 to 8 times the running current. Therefore, a 1/3 H.P. induction motor which draws a running current of 4 amps could easily trip the circuit breaker during start-up.

### Power Source Receptacle:

A common problem that drastically affects the performance of the Biomedical Electrical Test Set is an incorrectly wired line voltage receptacle from which the unit is operated. Most of the tests rely on the receptacle polarity and grounding as a reference. If the receptacle is wired incorrectly, the test set will not measure correctly. Before using the BET-300AD for any testing, verify the integrity of the line receptacle wiring by performing the **Line Check** as described on Page 10.

## RECALIBRATION

For optimal performance Ohmic recommends that the BET-300AD be returned to Ohmic's facility in Easton, Maryland annually for recalibration. Shipping instructions can be found on the Warranty page (page 18). A nominal fee will be charged and a calibration certificate will be returned with the unit. Due to the complexity of the circuit, user calibration is not recommended.

## **ISOLATED POWER SYSTEMS TEST**

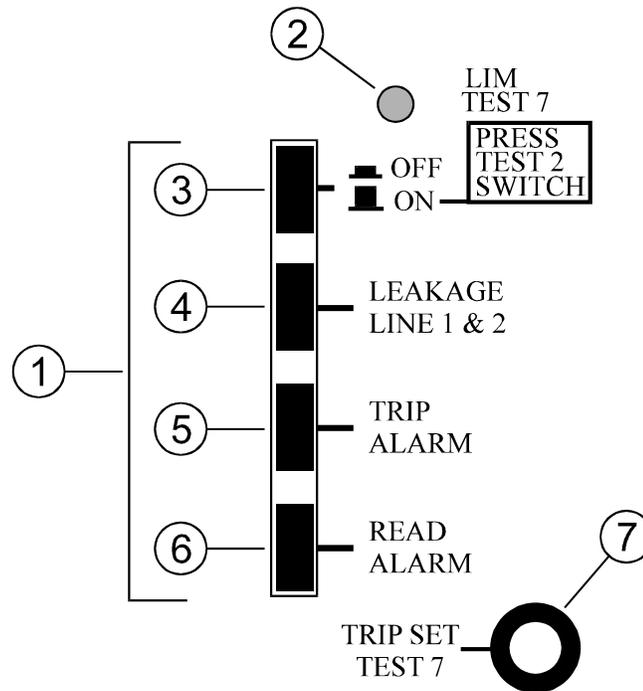
Model BET-300ADL Only

### **Introduction**

In some C.C.U. and I.C.U. areas, and in most operating rooms, isolation transformers are used to reduce explosion and shock hazards caused by sparking, ground faults, and leakage currents. In an isolated power system, neither of the two current-carrying wires is connected to ground, as opposed to a grounded system which has one side of the line (neutral) connected to ground at the service entrance. On an isolated system, we refer to the current-carrying wires as Line 1 and Line 2. The NFPA requires continuous monitoring of the isolation of the transformers, to determine the total amount of current flowing to ground due to leakage currents. This monitoring device originally called a *Ground Fault Detector* is now called a *Line Isolation Monitor* (LIM). This monitor measures and displays the total hazard current to ground, that is, the leakages produced by the transformer, wiring, connected load, as well as the leakage of the detector itself. The total hazard current to ground is also referred to as *total hazard index*. A practical alarm point value is established by Code, beyond which, the isolation of the system is no longer considered to be safe. In earlier Codes, it was 2 to 5 milliamperes. Now it is between 0.7 and 1 milliampere plus the current used by the LIM which can be up to 1 milliampere, therefore allowing between 1.7 and 2.0 milliamperes before alarm.

## MODEL BET-300ADL - ISOLATED POWER TEST OPTION (TEST 7)

The Model BET-300ADL has an additional test function which allows for testing Line Isolation Monitors (LIM) and for measuring the leakage current associated with isolation transformers used in isolated power distribution systems. This test function is called **Test 7** and is selected using a 4-position isolated power test selector switch. An alarm trip set adjustment is also provided to simulate a fault current and verify proper operation of the LIM. The Test 7 panel section is shown below:



### DESCRIPTION OF ISOLATED POWER TEST PANEL

- 1) *Isolated Power Test Selection:* This 4-position selector switch selects the test function used during testing of isolated power systems.
- 2) *Test 7 LED Indicator:* When Test 7 is selected, this LED illuminates to alert the operator that this test function has been selected. Tests 1 through 6 cannot be properly performed if this LED is on.
- 3) *On/Off Selector:* Normally this switch is selected (pushed in) when Tests 1 through 6 are being performed. When any Test 7 functions are selected, this switch will pop up and the LED indicator will come on. A reminder to depress Test Function Selector Switch #2 (**Case to Gnd, Leakage**) during Test 7, is printed next to this switch.
- 4) *Leakage Line 1 & 2 Selector:* This selection allows measurement of current leakage between either of the isolated line conductors and ground.
- 5) *Trip Alarm Selector:* This selection allows a simulated ground fault current of 0.5 to 5.0 milliamperes to be injected into either Line 1 or Line 2 (depending on Polarity Switch position).
- 6) *Read Alarm Selector:* This selection allows actual fault trip current setting of the LIM to be measured.
- 7) *Trip Set Adjustment:* This potentiometer allows the current to be varied between 0.5mA and 5.0mA during Trip Alarm or Read Alarm selections.

## TEST 7 PROCEDURE

Before proceeding, disconnect patient from equipment that is plugged into the isolated power system. Since portable equipment adds leakage, disconnect all equipment from the power system. This allows the operator to record leakage values which will reflect the actual condition of the isolation transformer, LIM, and associated power wiring.

*Note: Use Test Form F-64L. An original for this form can be found at the back of this manual.*

1) Check LIM Audible Alarm:

Depress the Test button on the Line Isolation Monitor. When the audible alarm activates, push the Silence button to mute the alarm. Check the appropriate sections of the F-64L test form.

2) Check LIM Visual Indicators:

- A) Green is normally illuminated when leakage is under specified alarm point.
- B) Red illuminates during alarm condition in conjunction with the audible alarm.
- C) Yellow indicates that the audible alarm is disabled during a first fault or test conditions. The red lamp should remain illuminated until the fault condition is cleared.

3) Record LIM Reading:

Always record the reading under the same load conditions. This reading indicates the degree of hazard which may exist if someone would accidentally contact either one of the power lines and the ground at the same time. The reading may vary depending on various conditions, such as humidity, insulation, and the leakages caused by load on the line. Record the Alarm Point specified by the manufacturer of the Line Isolation Monitor (typically 1.7 to 2 milliamperes) and the LIM reading on Test Form F-64L.

4) Isolated Power System - Leakage to Ground Test (Leakage Line 1 and 2):

The purpose of this test is to check the current from each side of the line to ground with a meter that simulates the patient. This is a suggested test in all cases either to check the calibration of the LIM meter or to verify acceptable leakage levels in power systems with no display meter.

A) Line One Leakage Test:

- (1) Depress Test Function Selector Switch #2 (**Case to Gnd, Leakage**)
- (2) Depress the Isolated Power Test Selector Switch **Leakage Lines 1 & 2**.
- (3) Place the Polarity switch in the Normal position (which tests Line 1). This inserts the meter between Line 2 and ground. The leakage of Line 1 completes the circuit. Silence the audible alarm and record the current reading on Form F-64L.
- (4) To protect the BET-300ADL circuitry and alert the operator, The Hot Line warning lamp will illuminate if a power line to ground hazard exists. However, this condition should activate the line isolation monitor as noted in previous tests.

B) Line Two Leakage Test:

- (1) Place the Polarity switch in the Reverse position (which will test Line 2). With the meter between Line 1 and ground, the circuit is completed by the leakages from Line 2 to ground.
- (2) Silence the audible alarm.
- (3) Record the current reading on Form F-64L.
- (4) Return the Polarity switch to the center Off position.

5) Trip Alarm Current:

During this test either power line can be faulted to ground through a resistive network consisting of a 250 kilohm potentiometer and a 22 kilohm resistor to provide an approximate injection current from 0.5 to 5.0 milliamperes. In the **Trip Alarm** position, the fault is placed between ground and the line selected by the Polarity switch. When the **Trip Set** knob is rotated clockwise, the fault current is increased. If provided, observe the panel mounted line isolation monitor meter until the alarm point is reached and both the audible and visible alarms are activated. Silence the audible alarm. Depress the **Read Alarm** switch. This places the meter input between the line opposite of the resistive fault and ground.

A) Line One Testing:

- (1) Depress the **Trip Alarm** switch.
- (2) Select the Normal position of the Polarity switch. This selects Line 1 for testing.
- (3) Rotate the **Trip Set** knob clockwise until the Line Isolation Monitor alarm sounds.
- (4) Depress the **Read Alarm** switch.
- (5) Record the Line Isolation Monitor trip current on Test Form F-64L.
- (6) Return the Polarity switch to the center Off position.
- (7) Depress the **Trip Alarm** switch.
- (8) Rotate the **Trip Set** knob fully counterclockwise.

B) Line Two Testing:

- (1) Select the Reverse position of the Polarity switch. This selects Line 2 for testing.
- (2) Rotate the **Trip Set** knob clockwise until the Line Isolation Monitor alarm sounds.
- (3) Depress the **Read Alarm** switch.
- (4) Record the Line Isolation Monitor trip current on Test Form F-64L.
- (5) Return the Polarity switch to the center Off position.

6) Panel Breakers:

Check for proper functioning and identification of circuit breakers in each branch circuit. Record data on Test Form F-64L.

7) Emergency Isolated Power:

Power transfer to the emergency power should occur in less than 10 seconds. Record the information as shown on Test Form F-64L.

## **WARRANTY**

Notwithstanding any provision of any agreement the following warranty is exclusive.

Ohmic Instruments COMPANY warrants each instrument it manufactures to be free from defects in material and workmanship under normal use and service for the period of 1-year from date of purchase. This warranty extends only to the original purchaser. This warranty shall not apply to fuses or any product or parts which have been subjected to misuse, neglect, accident, or abnormal conditions of operation.

In the event of failure of a product covered by this warranty, Ohmic Instruments Co. will repair and recalibrate an instrument returned within 1 year of the original purchase: provided the warrantor's examination discloses to its satisfaction that the product was defective. The warrantor may, at its option, replace the product in lieu of repair. With regard to any instrument returned within 1 year of the original purchase, said repairs or replacement will be made without charge. If the failure has been caused by misuse, neglect, accident, or abnormal conditions of operations, repairs will be billed at a nominal cost. In such case, an estimate will be submitted before work is started, if requested.

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS, OR ADEQUACY FOR ANY PARTICULAR PURPOSE OR USE. OHMIC INSTRUMENTS COMPANY SHALL NOT BE LIABLE FOR ANY SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER IN CONTRACT, TORT, OR OTHERWISE.

### **If any failure occurs, the following steps should be taken:**

1. Notify Ohmic Instruments Co. giving full details of the difficulty, and include the model, type, and serial numbers (where applicable). On receipt of this information, service data, or shipping instructions will be forwarded to you.

2. On receipt of shipping instructions, forward the instrument, transportation prepaid. Repairs will be made and the instrument returned, transportation prepaid.

### **SHIPPING TO MANUFACTURER FOR REPAIR OR ADJUSTMENT**

All shipments of Ohmic Instruments Co. instruments should be made via United Parcel Service or "Best Way" prepaid. The instrument should be shipped in the original packing carton, or if it is not available, use any suitable container that is rigid and of adequate size. If a substitute container is used, the instrument should be wrapped in packing material and surrounded with at least four inches of excelsior or similar shock absorbing material.

### **CLAIM FOR DAMAGE IN SHIPMENT TO ORIGINAL PURCHASER**

The instrument should be thoroughly inspected immediately upon delivery to purchaser. All material in the shipping container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument is damaged in any way, a claim should be filed with the carrier immediately. (To obtain a quotation to repair shipment damage, contact Ohmic Instruments.) Final claim and negotiations with the carrier must be completed by the customer.

Ohmic Instruments Company will be pleased to answer all application or use questions, which will enhance your use of this instrument. Please address your requests or correspondence to: Ohmic Instruments Company, 508 August St., Easton, Maryland 21601, ATTN: Technical Support; or call Ohmic Technical Support at 410-820-5111.

## **SPECIFICATIONS**

### **LEAKAGE CURRENT**

Ranges: 0 to 1999 $\mu$ A and 19.99mA  
Accuracy:  $\pm$  2% of Full Scale  
Test Load Impedance: AAMI Load, 1Kilohm  $\pm$  5%; Response flat to  $-3$ dB at DC to 1KHz and  $-20$ dB per decade from 1 to 10KHz  
Calibration Test: 10 $\mu$ A DC Regulated Current Source

### **GROUNDING RESISTANCE**

Range: 0 to 19.99 Ohms  
Accuracy:  $\pm$  3% of Full Scale  
Test Current: 10mA DC  
Circuit Protection: 1/16A, 250V Fast-acting fuse  
Calibration Test: Internal 0.25 Ohm Resistor

### **INSULATION TEST**

Indicator: Red Light-Emitting Diode (LED)  
Poor Insulation Level: Below 1 Megohm, Ground to Hot/Neutral  
Test Voltage: 100 Volts DC,  $\pm$  5%  
Test Current: 250 $\mu$ A Max.

### **VOLTAGE MEASUREMENT**

Range: 0 to 199.9 Volts  
Accuracy: 3%  
Voltage Input Impedance: 100 Kilohms

### **LINE VOLTAGE TEST**

Accuracy:  $\pm$  3%

### **LINE ISOLATION TEST (BET-300ADL ONLY)**

Fault Current: 0 to 5.5mA (in faulty system)  
Accuracy:  $\pm$ 5%

### **ELECTRICAL/MECHANICAL**

Test Receptacles: Heavy-Duty NEMA Duplex, Hospital Grade; One Half Non-energized for Grounding/Insulation Test; One Half Energized for Leakage Tests  
Overload Protection: 15 Ampere Two-pole Circuit Breaker  
Display: 3½ Digit Red LED, ½" high  
External Test Probe: Removable, Hand-held, Coiled-cord Probe for External Chassis Leakage and Resistance Tests  
Standby Power: 120 Volts AC, 60Hz, 5 Watts  
Power Cord: 6-foot 14/3, Type SJ  
Patient Lead Adapters: Five Color-Coded Binding Posts  
Case Dimensions: 5" High x 9" Wide x 11" Long  
Weight: 10 Pounds net, 14 Pounds shipping



**ohmic instruments CO.**  
 Easton, MD 21601  
 www.ohmicinstruments.com

**TEST FORM TF-2: ECG SAFETY TEST**

EQUIPMENT:

MANUFACTURER:

MODEL NO.:

SERIAL NO.:

CONTROL NO.:

LOCATION:

	LIMITS*	1	2	3	4	5	6	7	8
DATE OF TEST:									
INITIALS OF TECHNICIAN:									
PHYSICAL INSPECTION:	GOOD								
VOLTAGE**	120V								
POLARITY	CORRECT								
GROUND	GOOD								

**GROUNDING AND INSULATION TESTS (NON-ENERGIZED RECEPTACLE)**

1	GROUNDING RESISTANCE (EUT CASE TO PLUG GROUND)	0.1 OHM							
	INSULATION RESISTANCE (HOT/NEUTRAL TO GROUND)	1 MEG							

**LEAKAGE TESTS (ENERGIZED RECEPTACLE)**

2	CASE TO GROUND	NORMAL POLARITY	NEUTRAL CLOSED		NEUTRAL OPEN		NEUTRAL CLOSED		NEUTRAL OPEN	
			100µA	50µA	100µA	50µA	100µA	50µA		
3	LEADS TO GROUND	NORMAL POLARITY	GND	HIGHEST	10µA					
			UNGND	ALL	50µA					
			UNGND	HIGHEST	10µA					
		REVERSE POLARITY	GND	ALL	50µA					
			UNGND	HIGHEST	10µA					
			UNGND	ALL	50µA					
4	LEADS ABOVE GROUND	NORM/REV	GND/UNGND	HIGHEST	10µA					
			UNGND/UNGND	HIGHEST	10µA					
5	ISOLATION OF EACH PATIENT LEAD TO GROUND (TEST CURRENT LIMITED TO 1.0MA NOMINAL)				20µA					
					6 MEG					
6	LEAKAGE CURRENT OR VOLTAGE DIFFERENTIAL BETWEEN CONDUCTIVE SURFACES				100µA					
					100mV					

\* Maximum allowable readings suggested by NFPA, NEC, AAMI and UL.  
 \*\* All voltages and currents are RMS values.



**ohmic instruments co.**  
 Easton, MD 21601  
 www.ohmicinstruments.com

**TEST FORM TF-4: TESTING MEDICAL EQUIPMENT  
 WITHOUT PATIENT LEADS**

<b>EQUIPMENT:</b>	<b>MANUFACTURER:</b>
<b>SERIAL NO.:</b>	<b>MODEL NO.:</b>
<b>CONTROL NO.:</b>	<b>LOCATION:</b>

	LIMITS*	1	2	3	4	5	6	7	8
DATE OF TEST:									
INITIALS OF TECHNICIAN:									
PHYSICAL INSPECTION:	GOOD								
VOLTAGE**	120V								
LINE CHECK: POLARITY	CORRECT								
GROUND	GOOD								

**GROUNDING AND INSULATION TESTS (NON-ENERGIZED RECEPTACLE)**

1	GROUNDING RESISTANCE (EUT CASE TO PLUG GROUND)	0.1 OHM
	INSULATION RESISTANCE (HOT/NEUTRAL TO GROUND)	1 MEG

**LEAKAGE TESTS (ENERGIZED RECEPTACLE)**

	TEST TYPE	LIMITS
2	NORMAL POLARITY	NEUTRAL CLOSED 100µA
	REVERSE POLARITY	NEUTRAL OPEN 100µA
3	NORMAL POLARITY	NEUTRAL CLOSED 10µA
	REVERSE POLARITY	NEUTRAL OPEN 10µA

\* MAXIMUM ALLOWABLE READINGS SUGGESTED BY NFPA, NEC, AAMI AND UL.  
 \*\* ALL VOLTAGES AND CURRENTS ARE RMS VALUES.



**ohmic instruments co.**

Easton, MD 21601

www.ohmicinstruments.com

**TEST FORM F-64L: ISOLATED POWER SYSTEM TEST**

(Model BET-300ADL Only)

**CAUTION: THESE TESTS ARE NOT TO BE CONDUCTED WHILE PATIENTS ARE CONNECTED TO ANY EQUIPMENT PLUGGED INTO THE ISOLATED POWER SYSTEM.**

LOCATION:

DATE OF TESTS:

INITIALS OF TECHNICIAN:

	1	2	3	4	5	6	7	8	9	10
1	AUDIBLE INDICATOR	SELF TEST								
		SILENCE / MUTE								
2	VISUAL INDICATORS	RED (HAZARD)								
		GREEN (SAFE)								
		YELLOW (SILENCE)								
3	CHECK BOX IF INDICATOR IS OPERATIONAL	MANUFACTURER'S SPECIFIED ALARM POINT (MA)								
		METER READING (MA)								
4	LINE ISOLATION MONITOR	LINE ONE (MA)								
		LINE TWO (MA)								
		LINE ONE (MA)								
5	ISOLATED POWER SYSTEM LINE LEAKAGE TO GROUND	LINE TWO (MA)								
		LINE ONE (MA)								
6	ALARM POINT	LINE TWO (MA)								
		LINE ONE (MA)								
7	ARE ALL BREAKERS OPERATIONAL AND CIRCUITS LABELED?	TURN-ON TIME (SEC)								
		AREAS SUPPLIED								
		EMERGENCY LIGHTING								
		TOTAL CAPACITY (KW)								
8	EMERGENCY POWER									

NOTES:

## NOTES

