Instruction Manual
AVTM 246005J

For

Miniature Battery Impedance Test Equipment (MBITE)

Catalog No. 246005 and 246005-47

AVO INTERNATIONAL
BLUE BELL, PA 19422 • (215) 646-9200

Instruction Manual AVTM246005J

for

Miniature Battery Impedance Test Equipment (MBITE) Catalog Number 246005 and 246005-47

Read the entire manual before operating.
Antes de operar este producto lea este manual enteramente.

AVO International
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(215) 646-9200

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Section 1

Introduction

RECEIVING INSTRUCTIONS

Check the equipment received against the packing list to ensure that all materials are present. Notify AVO International of any shortage. Telephone (215) 646-9200.

Examine the instrument for damage received in transit. If any damage is discovered, file a claim with the carrier at once and notify AVO International or its nearest authorized sales representative, giving a detailed description of the damage.

This instrument has been thoroughly tested and inspected to meet rigid specifications before being shipped. It is ready for use when set up as indicated in this manual.

GENERAL INFORMATION

This manual contains instructions for the operation of the Miniature Battery Impedance Test Equipment (MBITE). See Figure 1. The equipment comprises a base measurement unit with printer, current source leads, potential probes, clamp-on current sensor (CT) with 6-ft extension cable, canvas carrying case for leads, and instruction manual. The base measurement unit is housed in a rugged molded plastic case with carrying handle. An optional canvas carrying case can be ordered for the instrument. The MBITE is easily operated by one person and is intended for small battery system applications that do not justify the purchase of the large BITE test systems.

History

Internal battery cell impedance testing has been studied since the turn of the century. Significant studies were performed in 1955 by A. Fleischer and in 1959 by Willihngenz and Rohner. The 1955 study concerned the impedance of nickel-cadmium batteries at audio frequencies and was documented in a Signal Corps contract report No. DA 36-039-SC-42657. The 1959 study was published in an AIEE paper No. 59-823 on battery impedance. Willihngenz said that an equivalent circuit of a battery consists of resistance, inductance, and capacitance as shown in Figure 2.

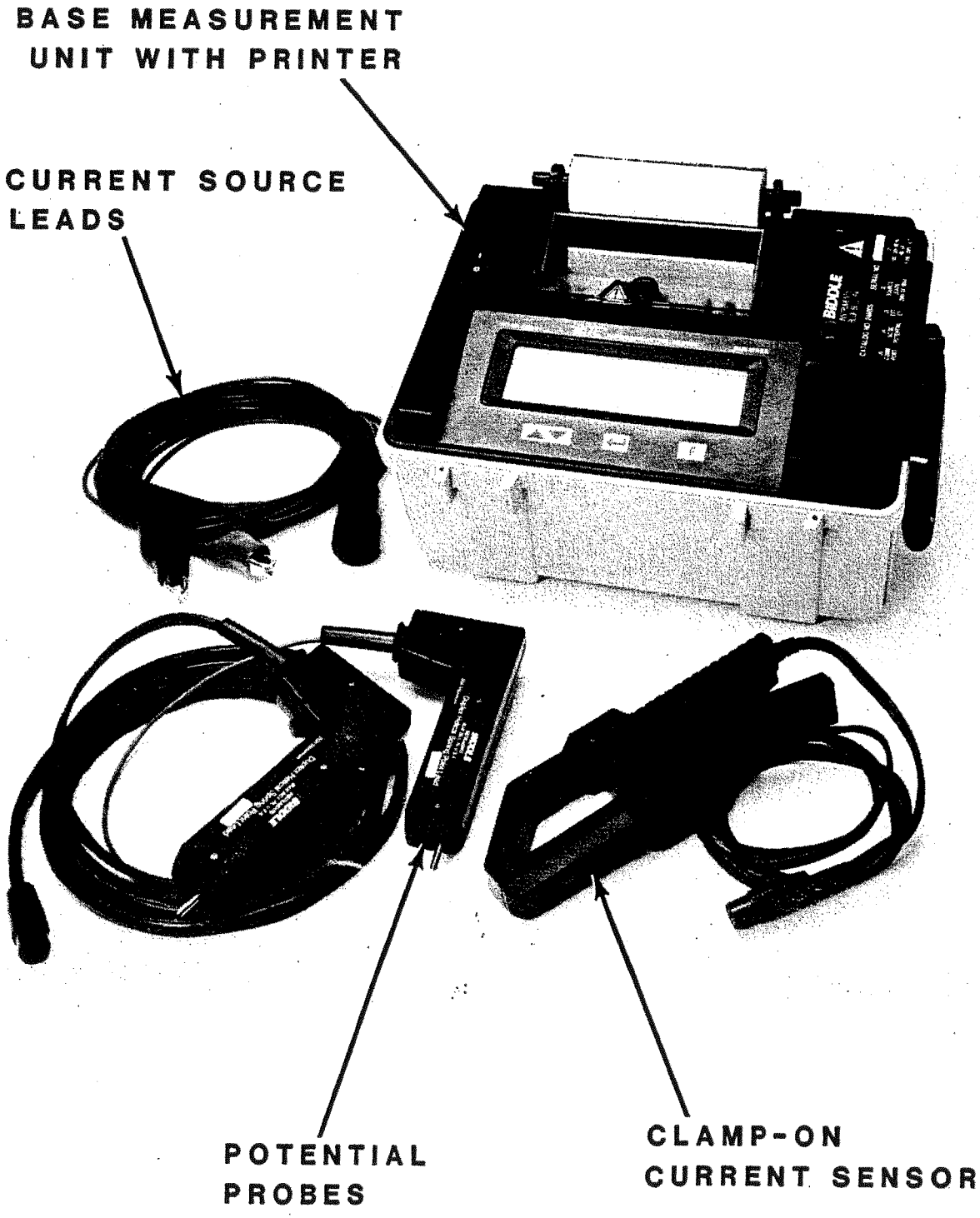


Figure 1: MBITE and Accessories

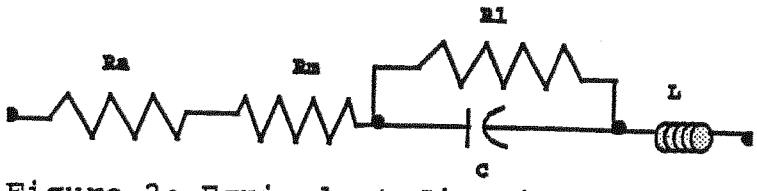


Figure 2: Equivalent Circuit of a Cell

The series battery resistance consists of the metal resistance (Rm) and the acid resistance (Ra), while the capacitance is shunted by a nonlinear resistance (Rl). During evaluation at Commonwealth Edison of Illinois, it was determined that the resistance of a stationary battery cell increases as the cell is discharged. A cell in poor condition due to either sulfating of the plates or poor interconnection resistance exhibits a high internal impedance. Other problems such as poor intercell and intertier connections can also be discovered. Cells of different size and manufacturer exhibit different impedance readings, but cells of similar size, age, and manufacturer should exhibit similar readings until conditions noted above dictate otherwise. Temperature and state-of-charge of the cell also affect cell impedance values.

Test Description

The MBITE is used to evaluate secondary battery cells by measuring ac impedance, dc terminal voltage, and interconnection resistance. These measurements along with other maintenance data, such as ambient and pilot cell temperatures and ac ripple currents, help determine the condition of the battery system.

Installations include but are not limited to:

- Telecommunications
- Electrical power substations
- UPS systems
- Aircraft power supplies
- Marine and military applications
- Emergency lighting applications
- Factory qualification tests (with optional probes)

The MBITE is used to test for conditions of sulfating, post-strap corrosion, poor intercell connections, and poor intercell connections in a stationary battery while the battery is in full float operation. A 60-Hz (50 Hz for Cat. No. 246005-47) ac test current is capacitively coupled through the battery cells in a series string. Since the impedance of a healthy battery is small when compared to the load or the battery charger, most of the ac current passes through the battery. The impedance test can be performed with the charger and load connected or disconnected.

When the small ac voltage impressed across the cell terminals is divided by the ac source test current passing through the battery, the result is battery cell impedance. The impedance of a healthy cell may be determined by testing a large number of similar cells under similar conditions and calculating the average value or by obtaining supporting data from AVO International. The deteriorating condition of a cell can be determined by comparing the cell impedance measured with the previously calculated average value.

By selecting available menu options, the operator can also measure intercell or strap connections and store them with the cell impedance values (Refer to Section 5, Operation). A digital low-resistance ohmmeter, such as the Biddle™ DLRO®, is recommended for more accurate measurement and qualification of integral bus connections and battery straps.

The MBITE also measures and records the cell voltage and time of test. This voltage could represent float voltage while measuring an operational string of cells or be an open circuit reading for factory quality applications.

Measurement Theory

The purpose of the MBITE measurement is to evaluate the relative impedance and coincident voltage of the battery cell under test. Since the environment provides many transient and harmonic signals, the true indicator of impedance will be in vector rms (root mean squared) form. This provides a direct measure of the power or heating value of the ac waveform with relationship to dc. The rms value of both the current and voltage vector is digitized with 10-bit resolution and stored for direct computation of impedance. The rms vector of the voltage is divided by the rms current vector and the resultant impedance displayed on an LCD with three ranges between 0 and 99.99 mΩ. The dc voltage is also referenced in true rms fashion and the range of measurement is 0 to 25.00 V. There are two ranges in the voltage measurement operation.

Section 2

Safety

It should be understood that any use of electricity inherently involves some degree of safety hazard. While every effort has been made by AVO International to reduce the hazard, the operator must assume responsibility for his or her own safety. Any work on batteries is hazardous and requires constant attention to safety; particularly guard against the possibility of acid spills, explosion, and electrical shock.

- Observe all industry standard safety rules for testing batteries.
- The MBITE is designed for connection to energized systems. Keep power on/off switch set to O (off) when making connections or disconnections at the battery. Always wear rubber gloves during these operations.
- Always connect the source leads to the instrument (base measurement unit) before connecting to the battery under test.
- Always remove the instrument test leads from the battery under test when not in use.
- Safety is the responsibility of the operator.
- The purpose of this equipment is limited to use as described in this manual. Do not use the equipment or its accessories for any purpose other than specifically described.
- Do not operate in an explosive atmosphere. Explosive gases such as hydrogen can be present around batteries. A properly vented battery environment is considered safe but it is the responsibility of the operator to verify conditions before using the MBITE.
- Wear protective clothing and eye protection to guard against skin and eye damage from battery acid or the event of short-circuit sparking.
- Ensure that test leads and probes are in good condition, clean and free of broken or cracked insulation. Replacement leads can be obtained from AVO International.
- Observe all cautions and warnings in this manual and on the equipment.

- This instrument is only to be used by suitably trained personnel who are familiar with the hazards involved in testing high-voltage dc systems.

This instrument operates from a single-phase power source. It has a three-wire power cord and requires a two-pole, three-terminal, live, neutral, and ground type connector. The voltage to ground from either pole of the power source must not exceed the maximum rated operating voltage (120 V for Cat. No. 246005 and 250 V for Cat. No. 246005-47). Before making connection to the ac power source, determine that the instrument rating matches the voltage of the power source and has a suitable two-pole, three-terminal grounding type connector.

The power input plug must be inserted only into a mating receptacle with a ground contact. Do not bypass the grounding connection. Any interruption of the grounding connection can create an electric shock hazard. Determine that the receptacle is properly wired before inserting the plug.

Refer fuse replacement to qualified service personnel only. To avoid electric shock and fire hazard, use only the fuse specified in the parts list which is identical in respect to type, voltage rating, and current rating.

The following warning and caution notices are used throughout this manual where applicable:

WARNING

Warning, as used in this manual, is defined as a condition or practice which could result in personal injury or loss of life.

CAUTION

Caution, as used in this manual, is defined as a condition or practice which could result in damage to or destruction of the equipment or apparatus under test.

Section 3

Specifications

APPLICATION

Lead-acid and nickel-cadmium cells of less than 250 Ah capacity.

Tests on most battery systems require the standard clamp-on current sensor (CT) with a 2-in. opening. An optional current sensor (CT) with a 0.5 in. opening is available.

Maximum total voltage at MBITE current source connections is 250 V dc (larger battery systems can be sectioned to accommodate this specification).

ELECTRICAL

Supply voltage (base measurement unit):
120 V ac, 60 Hz, 100 VA max (Cat. No. 246005)
220 V ac, 50 Hz, 100 VA max (Cat. No. 246005-47)
IEC 1010-1 installation category II.

Nominal source output current: 1 A for 50/60 Hz operation

Maximum battery test voltage: 250 V dc (IEC 1010-1 installation category I)

Electrical noise: Bandpass filters are installed to center receiver frequency at 60 Hz for Catalog No. 246005 and 50 Hz for Catalog No. 246005-47. Filter attenuation is -20 dB per octave minimum.

Accuracy:

Function	Accuracy	Resolution
DC VOLTS	±(1% of reading +2 LSD)	2.5 V dc range, 1 mV 25 V dc range, 10 mV
mΩ	±(5% of reading +2 LSD)	1.0 mΩ range, 1 μΩ 10 mΩ range, 10 μΩ 100 mΩ range, 100 μΩ

Fuses:

Function	Location	Type
Primary (Cat. No. 246005)	J1, Conn. Panel	T, 1 A, 250 V time delay
Primary (Cat. No. 246005-47)	J1, Conn. Panel	T, 500 mA, 250 V time delay
Secondary	Internal	MDX, 2 A, 250 V slo blo

MECHANICAL

Dimensions (base measurement unit): 11 x 7.5 x 8.2 in. (280 x 190 x 210 mm)
Weight (base measurement unit): 10 lb (4.53 kg)

Display: Digital LCD meter, 256 x 128 pixel with a viewing area of 5 x 2.75 in. (127 x 70 mm), displays measured parameters in dark numbers on an electroluminescent background. Commercial temperature and humidity ranges for the LCD will limit the useful measurement environment.

Printer: The integrally installed printer has a 4.25 in. (110 mm) printing width. Thermal paper for the printer, as currently stocked by AVO International, is listed in the Replaceable Parts List, Section 7. The following information is available in English for all versions as shown.

Battery Analysis Report

Notes:.....
.....

01/04/94

TST	Zb mΩ	Rs mΩ	VOLTS DC	TIME
001	1.025	0.258	2.155	12:58
002	1.036	0.265	2.145	12:59
003	1.054	0.365	2.225	13:02
004	1.024	0.555	2.215	13:04
005	1.006	0.235	2.135	13:09
006	1.059	0.365	2.228	13:15
007	1.074	0.258	2.226	13:18
008	1.036	0.158	2.245	13:25
009	2.56	0.104	2.225	13:27

Key: * Low Current

Cell Impedance Summary

Minimum	Average	Maximum
1.006	1.208	2.56

Where:

TST =	TEST NUMBER
Zb =	BATTERY CELL IMPEDANCE IN mΩ
Rs =	STRAP OR INTERCONNECT RESISTANCE
VOLTS DC=	DC VOLTAGE AT TIME OF IMPEDANCE READING
TIME =	RECORDED AT TIME OF IMPEDANCE READING
Key: * =	INDICATES LOW MEASUREMENT CURRENT DURING TEST
Minimum =	LOWEST VALUE CELL IMPEDANCE CURRENTLY STORED
Average =	AVERAGE VALUE CELL IMPEDANCE CURRENTLY STORED
Maximum =	MAXIMUM VALUE CELL IMPEDANCE CURRENTLY STORED

ENVIRONMENTAL

Operating temperature range: 32 to 104°F (0 to 40°C)

Storage temperature range: -4 to 131°F (-20 to 55°C)

Humidity: 20 to 90% relative humidity, noncondensing.

ACCESSORIES SUPPLIED

- Current source leads (base measurement unit to battery): two 18 AWG stranded copper leads with acid resistant insulation.

Wire rating:	600 V dc
Length:	10 ft (3.0 m)
Termination (base measurement unit):	7-pin, shrouded
Termination (battery):	Bulldog-type Mueller clips rated 15 A

- Potential probes: two helical spring point leads with data send switch.

Wire rating:	300 V dc (sheathed)
Length:	8 ft (2.4 m)
Termination (base measurement unit):	Nonmetallic twist-loc 12 pin
Termination (battery):	Helical spring point

- Current sensor: clamp-on CT with 2-in. opening. See Figure 3.

Wire rating:	600 V dc
CT ratio:	1000:1, 4% accuracy
Length:	5 ft (1.5 m)
Termination (base measurement unit):	Nonmetallic push loc 7 pin
Termination (CT):	Direct connection

- Extension cable: for either clamp-on current sensor (CT).

Wire rating:	300 V
Length:	6 ft (1.8 m)
Termination:	Nonmetallic push loc 7 pin

- Canvas carrying case: for leads.
- ac line cord: 8 ft (2.4 m).
- Instruction Manual AVTM246005J.

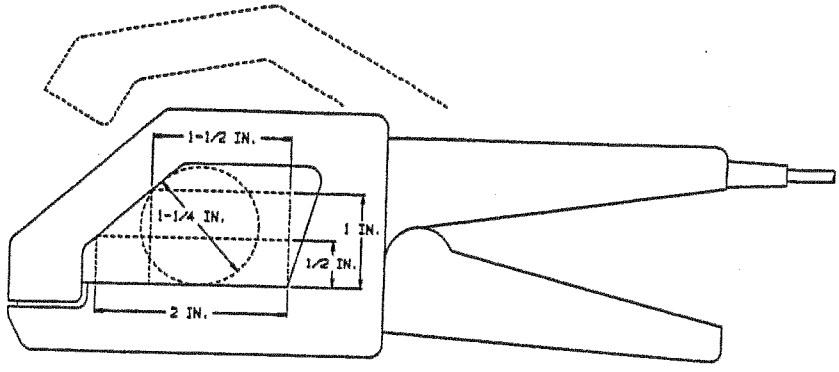


Figure 3: Clamp-On Current Sensor

OPTIONAL EQUIPMENT

To accommodate the testing requirements of various battery installation configurations, AVO International offers the following optional equipment. Custom designs may be possible if kept within strict safety guidelines and within the operating specifications of the instrument.

- Current sensor: clamp-on CT with 0.5-in. (12.7-mm) opening for use in small subscriber line cabinets (SLCs). This current sensor has shrouded banana-jack connections and includes a 2.5 ft (0.76 m) lead.

- Dual-point probes (factory probes): for testing single cell/modules in factory quality control and emergency lighting applications. Other applications include tests on cells arriving from battery vendors or being stored in shipping cartons, awaiting installation. Similar to the standard potential probes, these probes have an additional helical spring point on each probe. The additional probe point carries the measurement current to the cell under test and allows for a four-point measurement.

- Bar-code wand: for use with the serial port connection as a means of providing cell, location, and operator identification. This option includes a wand and prompt sheets with alphanumeric characters for discreet entry. Software for producing bar-code labels using a personal computer and printer is included.

- Source leads: 20, 30, and 40 ft (6, 9.1, and 12.2 m).

- Extension cable: 20 ft (6 m) for clamp-on current sensor.

- Canvas carrying case: for instrument.

Section 4

Description

FRONT PANEL CONTROLS (Fig. 4)

Power on/off switch - marked | (on) and O (off).

▲▼ - Up/down arrow keys allow vertical movement through the selected menu options and also serve as disconnect function for ac source current.

↵ - **ENTER** arrow used to select items from the menu and to respond to questions on the menu.

F - Function switch used for menu option paging, current source disconnect, and cancel and resume functions.

DISCON (disconnect switch) - The capability of opening the source current internal to the base measurement unit is available via up/down arrow keys (▲ ▼). This function controls a signal to a relay with 5-A contacts connected between the blocking capacitor and dc fusing. The operator can move the dc source current leads to another location in the battery string without having to wait for power up.

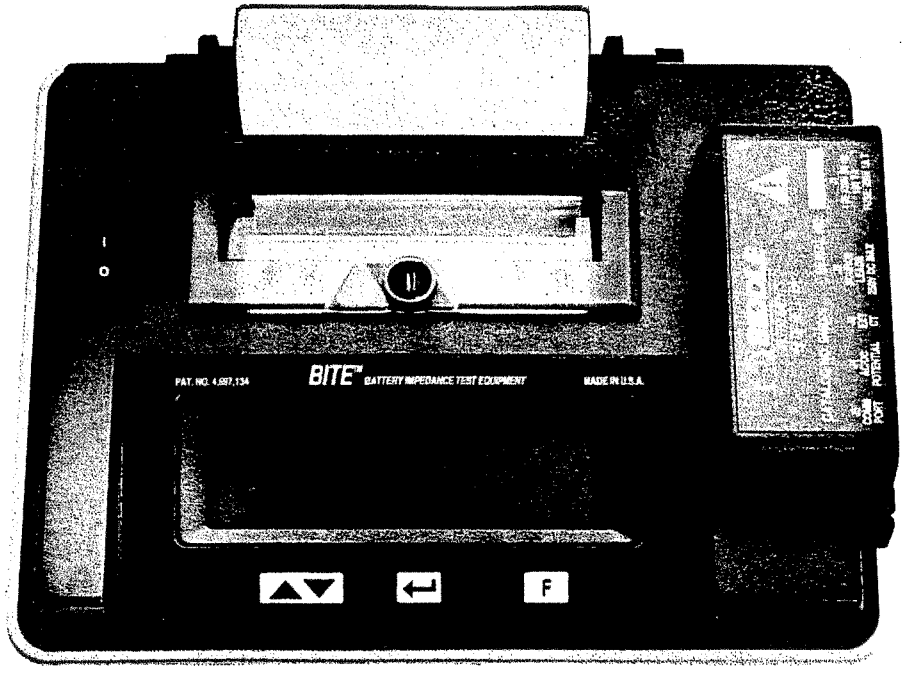


Figure 4: MBITE Front Panel

CONNECTORS (Fig. 5)

J1 120 V, 60 Hz (220 V, 50 Hz for Cat. No. 246005-47) receptacle for ac power. Use standard line cord supplied with the instrument. The Catalog No. 246005-47 is not terminated with a power input plug. Depending on whether the test set is supplied with a black, white, and green input supply cord or a brown, blue, and green/yellow supply cord, the black or brown cord lead must be connected to the live pole and the white or blue cord lead must be connected to the neutral pole of an approved power input plug. The green or green/yellow ground lead of the input supply cord must be connected to the protective ground (earth) contact of the input plug. Protection fuse and replacement are located in pull-out drawer under the ac line plug.

J2 Receptacle for current source lead connection to battery under test.

J3 Receptacle for clamp-on current sensor (CT).

J4 Receptacle for potential probes with data send switch.

J5 Nine-pin serial communications connector provides data transfer from unit memory to an external personal computer serial port. Refer to Data Storage and Transmission in Section 5, Operation. This connector is also used for the optional bar-code wand.

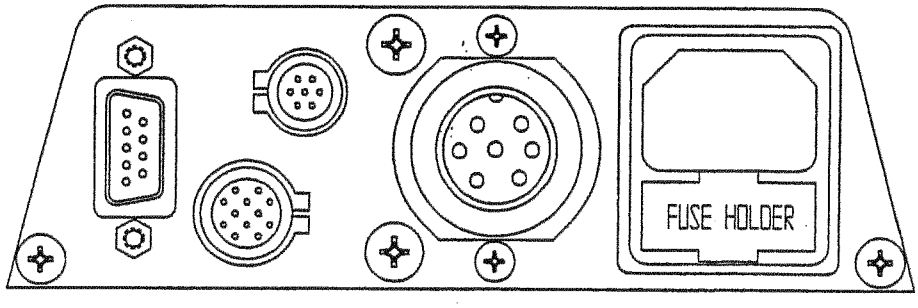


Figure 5: MBITE Connector Panel

MBITE MENU SYSTEM

See Figure 6 for screen displays numbered (1) through (20).

START-UP SCREEN (8) Upon initialization after power-up, the START-UP SCREEN (8) prompts the operator to connect all leads before starting testing. The base measurement unit reads the test lead connections, determines which options are in place, and programs the test sequence accordingly.

If there are data stored in memory from a previous test, then the DATA PRESENT AT START-UP SCREEN (2) is displayed. Selecting options on this screen prompts the operator into the UPLOAD DATA SCREEN (10) or CLEAR STORAGE SCREEN (12). Selecting **RESUME TESTING** on screen (2) displays the START-UP SCREEN (8).

When all connections are made, press **ENTER** to proceed with the test. An audible signal introduces the AC POWER UP SEQUENCE SCREEN (9) and a sliding time bar indicates time remaining on the charging sequence of the dc blocking capacitors.

TEST SCREEN (3) and (4) After initialization is complete, TEST SCREEN (3,4) indicates that the unit is ready to accept data or access options through the menu system. Using either the ▲ or ▼ soft keys allows the operator to disconnect the source ac current from the battery string under test. This function can be used when sectioning the battery in parallel string applications or when the battery string is greater than 250 V and the leads must be moved.

The MENU1 selection, chosen by pressing the **F** key, places the operator into the MENU 1 SCREEN (5). The **FFEED** selection, chosen by pressing the ↵ key, provides a series of line feeds to the printer for data view or additional spacing between readings.

At the top of TEST SCREEN (3) and (4) there is a test sequence number (**TST 001**) and an identification number that can be entered using the optional bar-code wand. Without the bar-code wand, there is no way to enter this information. This accessory may be helpful if the cells under test are equipped with vendor bar-code encryption for warranty information.

The measured values of dc voltage and ac impedance are displayed in the center of this screen; the text **VDC** and **mΩ** illustrates the placement of this data. The **LOW CURRENT** text and the absence of the sine-wave symbol indicate insufficient test current being returned to the base measurement unit via the measurement CT.

MENU 1 SCREEN (5) The first of three general menu screens allows the following functions. Toggling the **UP DN** keys places the cursor at a menu selection and **ENTER** activates the selection. Selecting **MENU2** displays the next menu screen.

UPLOAD READINGS Allows the operator to transfer stored data to another media via the serial communication port. This selection produces the UPLOAD DATA SCREEN (10) and UPLOAD COMPLETE SCREEN (11).

CLEAR STORAGE Allows all data currently stored to be purged. This screen is followed by the CLEAR STORAGE SCREEN (12) which verifies that you do indeed want to purge the data. This function should be used before starting a new test since the storage capability is limited to 300 test records.

VIEW/PRINT MENU Calls up the VIEW/PRINT MENU (13) whereby the printer can be turned off or on and the stored data records printed on demand as opposed to being printed as they are stored.

DATA STORAGE ON Toggles the default setting of whether all data are to be stored and the test record incremented by one. Turning this function off will not affect the capability to make measurements but data will not be stored for future reference.

Optional
WAND OPERATOR ID Only active if the bar-code wand option is installed, this selection allows the operator to scan in a bar-code identification for indicating who performed the test.

RETURN TO TEST Returns the operator to the original test screen.

MENU 2 SCREEN (6) The second of three general menu screens allows the following functions. MENU 2 soft keys function the same as in MENU 1, except that the succeeding menu selection is **MENU3**.

BACKLIGHT ON Toggles the LCD backlight feature on and off. If the backlight is not required, turn it off to increase the life expectancy of the display module.

SET BACKLIGHT Allows the backlight to be dimmed or brightened to the preference of the operator. Selecting this function enables the **UP DN** keys to act as a dimmer switch. When optimum brightness is achieved, press **ENTER** to exit the function.

SET CONTRAST Adjusts the contrast between dark characters on light background on LCD to suit personal preference of the operator.

DEFAULT SETTINGS Allows the operator to predefine several variables of operation for repeated function. The options are selected by moving the flashing cursor to the selection requiring change and pressing **ENTER**. The selected feature will change status with each depression of the **ENTER** key. Selecting **DEFAULT SETTINGS** produces the following DEFAULT SETTING SCREEN (15).

- **BACKLIGHT ON** Selects backlight option always on or off.
- **FIXED RANGES OFF** Allows for auto-ranging or fixed voltage and impedance ranges (described under MENU 3).
- **PRINTER OFF** Allows the printer to be always on or off.

DATA STORAGE ON Selects between always storing data and incrementing test number and diagnostic mode with independent storage.

TEST TYPE Selects intercell strap resistance readings (**STRAP**), dc voltage and ac impedance measurements (**CELL**), or all three (**CELL/STRAP**).

SAVE AND RETURN Stores the above settings, as currently displayed, as default operation conditions.

WAND ON Allows the prompt for operator interaction with the optional bar-code wand or defeats same.

MENU 3 SCREEN (7) The third of three general menu screens provides additional performance options and the **MENU1** selection which takes the operator back to the first general menu screen (5).

FACTORY ONLY For factory calibration only. If selected, the screen that follows will request a password which is maintained at AVO International. Proceeding further in this menu will compromise the warranty for this instrument.

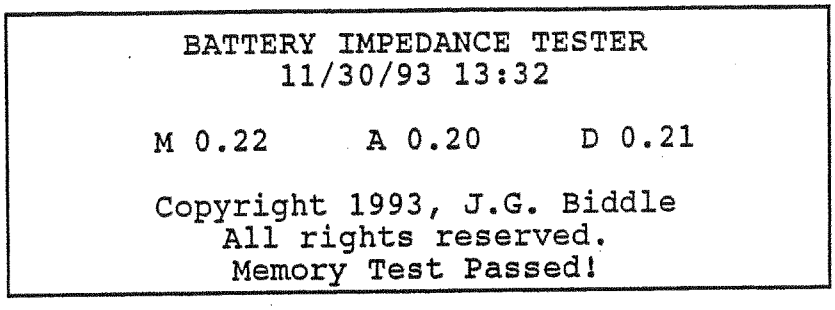
FIXED RANGES OFF Toggles the auto-ranging and fixed range selection option. If the fixed range is selected as off, then the unit is free to auto-range through multiple scales for dc voltage and ac impedance.

SET CLOCK Changes the clock time and date to accommodate time zone changes and daylight savings time. The real-time clock installed in the MBITE allows time-date-stamping of all measurements.

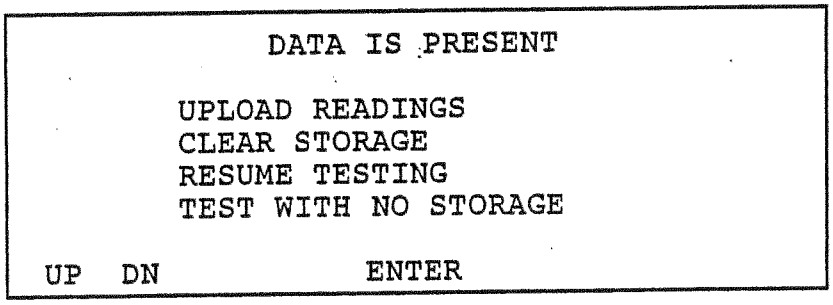
TEST TYPE Toggles the capability of measuring the intercell connections immediately following the cell test. Selecting **STRAP TEST ON** prompts the operator to measure the adjoining strap resistance immediately following the dc voltage and ac impedance test.

SET FIXED RANGES Prompts the SET FIXED RANGES SCREEN (17). Using the **UP DN** keys, selects the required dc voltage range and ac impedance range; press **ENTER**. Exit the menu by pressing **SAVE AND RETURN**. This limits operation within these ranges and increases the speed of measurements by eliminating the range hunting associated with auto-ranging. If the operator is performing a test on similar cells and the variation of dc voltage and ac impedance is expected to fall within these selected ranges, the fixed range option should be used.

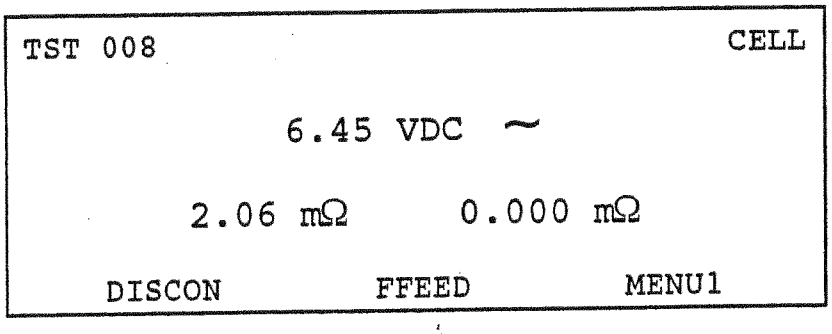
RETURN TO TEST Places the operator back at the TEST SCREEN when **ENTER** is pressed for this selection.



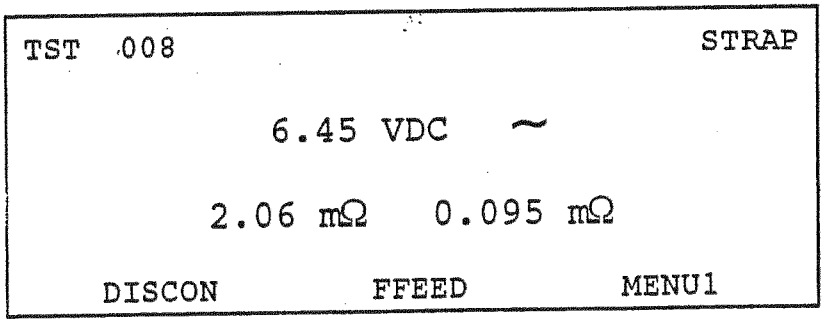
1. SYSTEM INITIALIZATION SCREEN



2. DATA PRESENT AT START-UP SCREEN

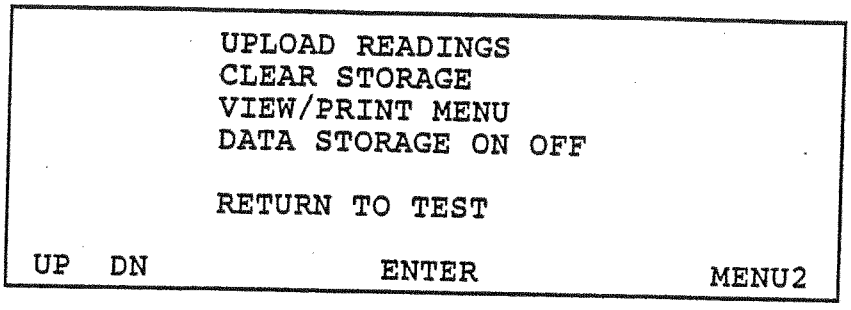


3. TEST SCREEN

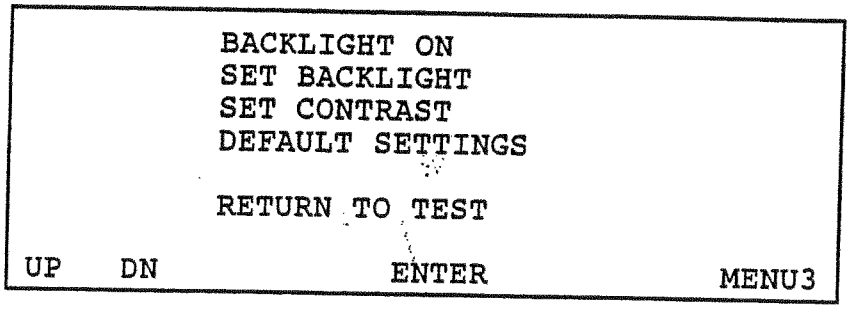


4. TEST SCREEN

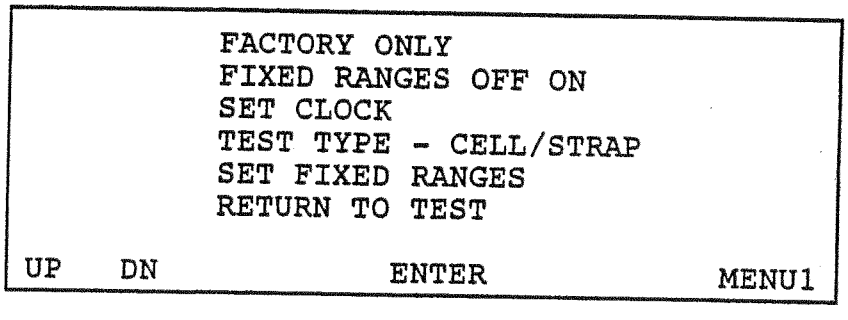
Figure 6: Menu and Display Screens



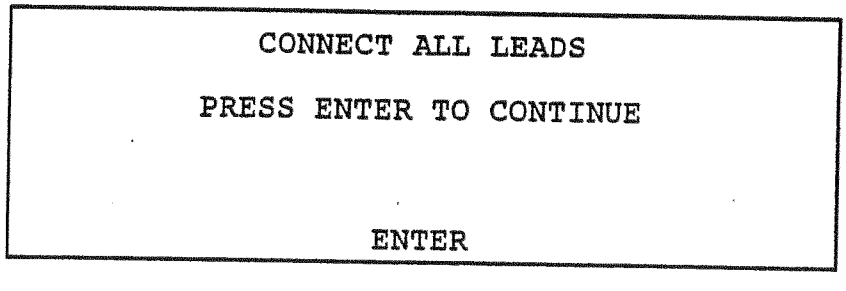
5. MENU 1 SCREEN



6. MENU 2 SCREEN

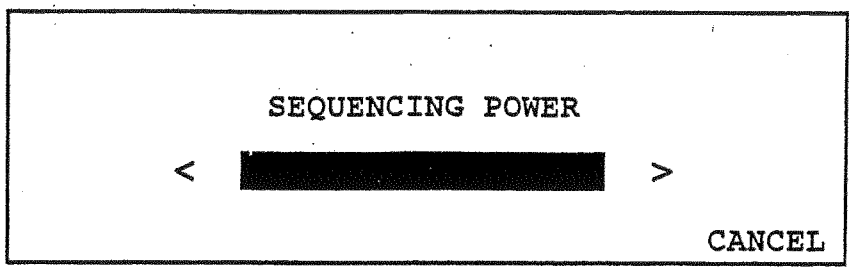


7. MENU 3 SCREEN

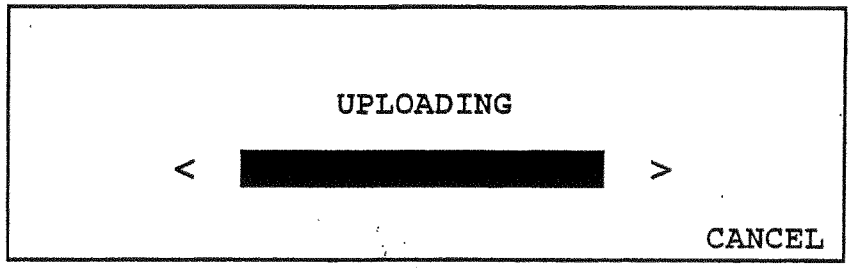


8. START-UP SCREEN

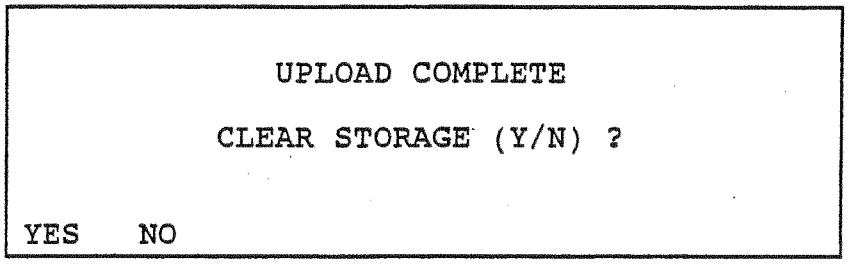
Figure 6: Menu and Display Screens (contd)



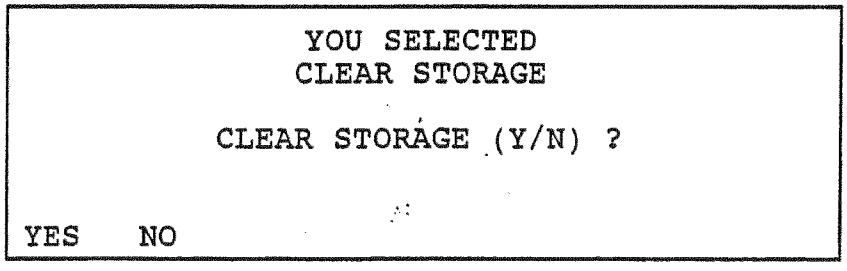
9. AC POWER UP SEQUENCE SCREEN



10. UPLOAD DATA SCREEN

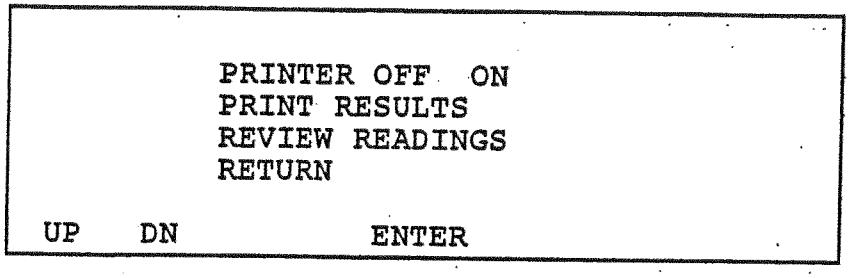


11. UPLOAD COMPLETE SCREEN

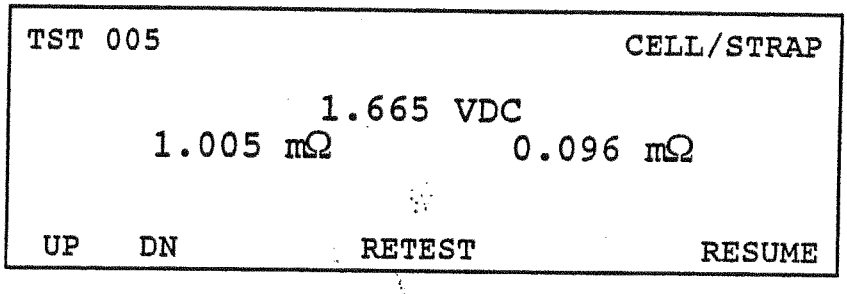


12. CLEAR STORAGE SCREEN

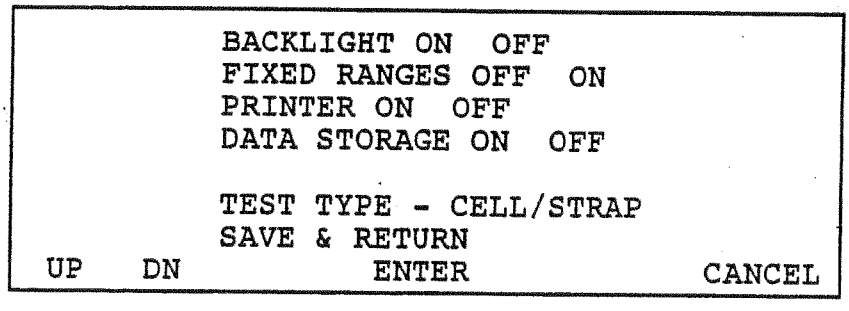
Figure 6: Menu and Display Screens (contd)



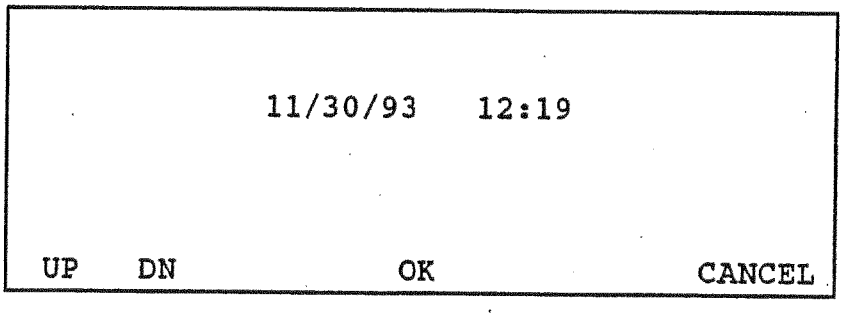
13. VIEW/PRINT MENU



14. REVIEW MODE SCREEN

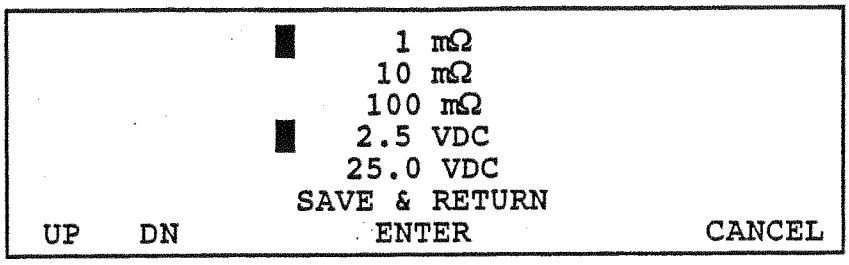


15. DEFAULT SETTING SCREEN

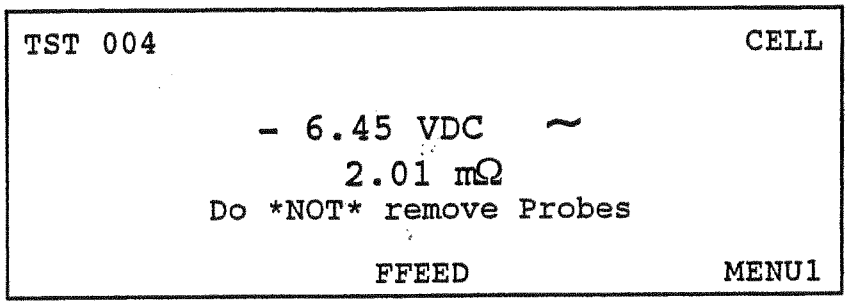


16.SET TIME SCREEN

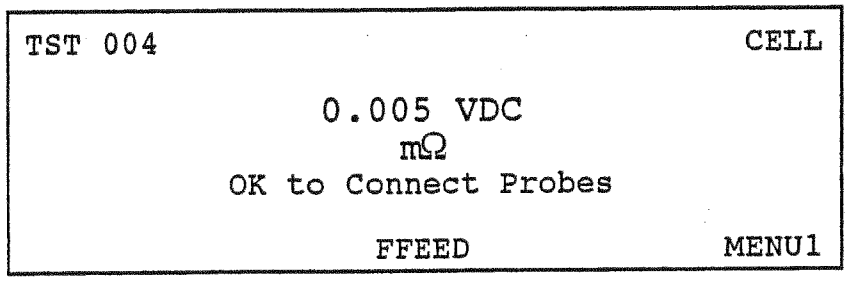
Figure 6: Menu and Display Screens (contd)



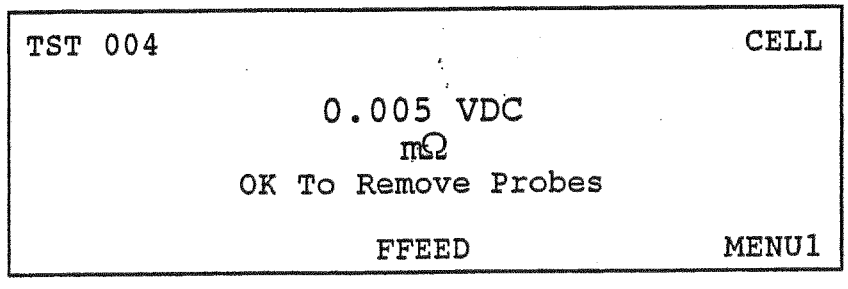
17. SET FIXED RANGES SCREEN



18. TEST SCREEN FOR DUAL POINT PROBES



19. TEST SCREEN FOR DUAL POINT PROBES



20. TEST SCREEN FOR DUAL POINT PROBES

Figure 6: Menu and Display Screens (contd)

Section 5

Operation

MEASUREMENT FEATURES

The MBITE performs voltage and impedance measurements on battery string applications while the system is at float potential. It is recommended that the proper leads and connections be used. If single cell/module tests are required, obtain the optional dual-point probes and follow the instructions for "Operation with Optional Equipment."

Voltage measurements are accepted on a per cell/module basis for a battery string of 300 cells or less. Test numbers start with number one (001) and toggle upward after each successfully acquired dc terminal voltage and ac milliohm reading. Data acquisition is initiated by the operator pressing a button switch on one of the potential probes. Measurement range for dc voltage is from 0 to 25 V dc with an accuracy of 1 percent of reading.

Milliohm impedance measurements are made on a per cell/module basis for a battery string of 300 cells or less. These impedance readings are calibrated to 5 percent of reading over the specified temperature range. For ac impedance, the LCD selectively presents data as ranges 1.000, 10.00, and 100.0 mΩ. The top of the measurement range is 99.99 mΩ.

Cell strap and intertier connection measurements are made following the ac internal cell impedance measurements by selecting **STRAP** under **TEST TYPE** in MENU 3. This feature provides resistance measurements in the same ranges as the cell/module impedance with 5 percent accuracy.

Source current measurement is monitored with each impedance measurement to compute both cell and strap impedance. Accuracy is limited to 1 percent above the selected CT sensor accuracy. Typical sensor accuracy is 4 percent which will total 5 percent at the display stage. Filtering has been selected at the factory as either 50 Hz or 60 Hz depending on the base measurement unit ordered.

A low current cutoff alarm is maintained at 0.5 A and the maximum current allowed is 1.5 A for ac milliohm computations. An ac current over-range display warns of high ripple current contribution.

Time and date are automatically recorded and stored with data.

OPERATING PROCEDURE

Strictly observe all safety precautions. Refer to Section 2.

1. From the information at the stationary battery site, record the installation date and the type and location of cells being tested on a data sheet or on the printer header notes section. Ensure that the charger associated with the battery under test is supplying load float current and that the battery is not in a discharged condition. The best repeatable data will occur when the battery is operating at recommended float voltage. Do not perform tests while the battery is under a heavy charge or discharge. If the battery under test has been recently subjected to boost charging, a waiting period of 72 hours is recommended before performing an ac impedance test. If the battery alone is supplying load current, nonrelative impedance measurements can be calculated. Relative impedance values are affected by charge and discharge status, cell age and ambient temperature considerations.

2. Perform a visual check of all cells and connections. For flooded cells, using a flashlight and mirror if necessary, check for plate corrosion and other internal defects. Record and correct all problems encountered before impedance testing.

3. Using a thermometer, measure and record the temperature of a pilot cell. Cell impedance can be affected by changing ambient and electrolyte temperatures. For consistent results, always record both ambient and pilot cell electrolyte temperatures to simplify interpretation. For valve-regulated (sealed) cells, measure the temperature by placing a contact probe on the negative connection post.

WARNING

To avoid electric shock, always wear rubber gloves when making connection to battery systems. Voltages to ground in excess of 600 V are possible.

4. Connect the current source leads to base measurement unit connector J2. Connect the clamp-on current sensor (CT) plug to the base measurement unit connector J3. Also connect the potential probes to connector J4. See Figure 5 for the location of connections and Figure 7 for a connection diagram. Confirm that connections are to the battery post and not to intercell connection hardware.

CAUTION

Do not exceed the maximum battery voltage allowed at MBITE current source lead terminals, 250 V dc. Section battery at convenient intertier or intercell connections as necessary.

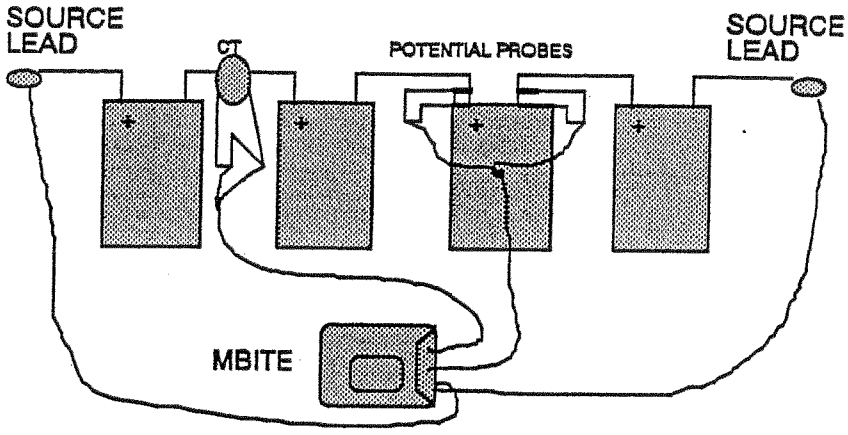


Figure 7: Connection Diagram

5. Position the clamp-on current sensor (CT) around a convenient intertier or intercell connection such that the current being measured is within the loop created by the current source leads from J2 and the battery string. Loads, parallel strings and charging equipment can create parallel paths for the measurement current; therefore, place the current sensor at a location that verifies the measurement current for the cells under test.

6. Plug the MBITE base measurement unit into a 120 V (or 220 V for 246005-47 models) outlet, as appropriate. Set the power on/off switch to | (on). The LCD will present initialization information and if default settings allow, the display backplane will illuminate. The base measurement unit checks all probes for connectivity, sequences power through the current source leads, and charges the internal dc blocking capacitor to the dc potential of the battery under test. After approximately 20 seconds, the sine-wave signal is displayed indicating that the MBITE is producing an ac current through the battery under test and its connections.

NOTE

If there is less than 0.5 A flowing within the string of cells selected, the MBITE receiver will respond with a display of **LOW CURRENT**. This ensures proper current amplitude for accurate measurement since the total current includes both current from the MBITE and any ac ripple current produced by the battery charger. If significant ripple current is present and out of phase with the injected source current, a low current condition may occur. Simply reverse the source leads to bring the two currents in phase. For the majority of applications, this will not present any difficulty.

7. With the MBITE unit energized, take individual cell impedance and voltage measurements. This is accomplished by firmly placing the potential probes from J4 across the battery cell terminals. The twisting action of the probe tips as the handle is pushed down will clean the point of contact and allow a positive test connection. View the battery terminal voltage and ac impedance value and push the data send button on the potential probe to store the viewed reading.

CAUTION

Do not exceed 25 V dc, the maximum allowed between voltage probes.

Nominal cell voltage for lead-acid cells should be less than 2.5 V dc per cell. Multicell modules will have this nominal voltage value per cell value multiplied by the number of cells in the module. Record the impedance across each cell on the data sheets provided or elect to print on demand while making the measurements.

Some valve regulated modules will not provide exposed individual cell terminals and the impedance of the entire module will have to be recorded. Modify the data sheets accordingly to reflect this measurement. The impedance of the cell is calculated internal to the base measurement unit by the following formula:

$$Z = \frac{Vb}{I}$$

where:

Z = impedance of cell
Vb = rms vector voltage drop across battery cell
I = total rms vector current through the cell

All cells of a given type, age and discharge history should have approximately the same impedance.

8. Measure the impedance between the posts of adjoining cells. From this measurement is measured the total resistance of the number of connections (including post-to-washer and washer-to-nut contact resistance) and resistance due to the connecting bar or cable. The feature for prompting strap resistance testing is accessible through the DEFAULT SETTING SCREEN (15).

WARNING

Do not remove MBITE base measurement unit current source leads from the battery until the MBITE base measurement unit is de-energized or the current disconnect feature (DISCON) is applied. Always remove leads at battery connection before removing J2 connection. Do not leave MBITE connected to the battery when not in use.

9. When steps 1 through 8 are complete, test data can either be sent to a personal computer through the serial communications port or can be printed with the integral printer.

CAUTION

Always remove all test leads from the battery under test before connecting the serial data cable.

On the MENU 1 SCREEN (5), select **UPLOAD READINGS** or **VIEW/PRINT MENU.** If there is no longer a need for the data collected, select **CLEAR STORAGE** to remove the stored data and prepare for new data entry. When all operations are satisfactorily completed, set the MBITE base measurement unit power on/off switch to O (off).

DATA TRANSMISSION AND STORAGE

Data are transmitted using the connector panel nine-pin serial port (J5). Data are sent in ASCII, comma-delimited format using standard asynchronous serial communication protocols. A typical data stream from the communication port for one record of test data would resemble the following:
"001","12/16/93,"14:39:50","0.587","0.453","2.10","0","0" as described below.

Test No.	Date/ Time	Cell Impedance	Strap Impedance	DC Voltage	Low Current Indication	Probe Polarity
001	12/16/93 14:39:50	0.587109	0.453560	2.106928	0	0

Data are stored in the base measurement unit for on-screen presentation or integral printer hard copy and are also available for serial transfer to an external personal computer using the UPLOAD DATA SCREEN.

NOTE

It is intended that the operator provide application software to interface with this serial link. Communications software such as Crosstalk™ or Pro Com™ as well as spreadsheet applications such as Lotus™ or Excel™ should be used within the operating characteristics of each application. The operator must also supply a null modem RS-232 interface cable or connector.

One set of 300 records maximum can be stored. Data are replaced on a first-in-first-out (FIFO) basis. The data remain nonvolatile until deleted by the operator using the CLEAR STORAGE SCREEN (12).

INTERPRETING MEASUREMENTS

MBITE measurements should be made a part of a battery maintenance program with readings taken and recorded semiannually. A change in cell impedance is not necessarily due to degradation of the cell. Impedance shifts may be due to temperature, state of charge, load conditions or a combination of all three. All these conditions should be monitored and recorded before making measurements. A large difference in the impedance of an individual or group of cells indicates a potential problem with a cell and warrants additional investigation.

Short-Term Interpretation

Impedance readings for individual cells can be used in the short term to compare with the average impedance reading for the entire battery. Individual cell values varying by more than ±20 percent of the battery average typically indicate a problem with that cell. Additional investigation of that cell is recommended, including a verification of intercell connections and a load cycle test.

Long-Term Interpretation

Impedance readings for the entire battery can be used in the long term to determine the need for replacement. Battery cell impedance values should be recorded and compared to previous readings to determine the position of the cell on the curve of impedance versus cell life. A sample curve for a generic lead-acid cell is shown in Figure 8. Curves may differ for other manufacturers and battery chemistries, such as nickel-cadmium. AVO International maintains a data base of cell impedance values of many battery manufacturers at various temperatures, applications, and cell age; information is available upon request.

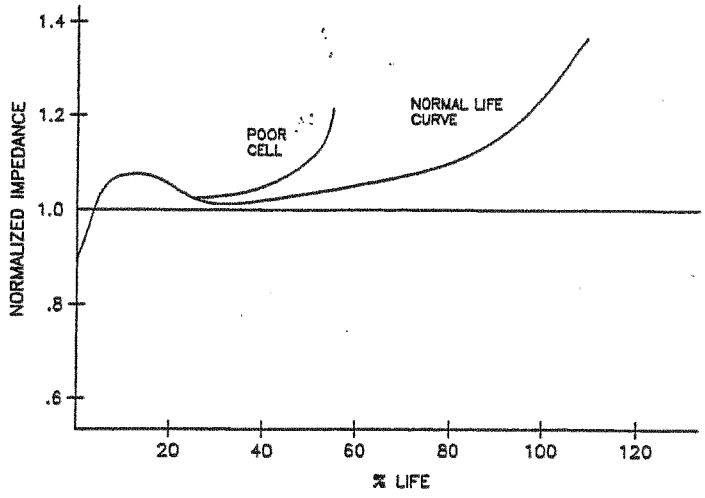


Figure 8: Generic Curve of Impedance vs Cell Life

Temperature Corrections

The internal impedance of a cell is inversely influenced by temperature; the degree of influence depends on battery type and length of exposure to the present ambient temperature. Flooded battery types have a significant thermal mass and are slow to react to changing ambient temperatures. The actual internal cell temperature can be measured by inserting a thermometer into the cell via a fill tube or vent cap and determine the temperature present during impedance testing. A suggested correction factor for impedance values of flooded lead acid cells is shown below:

$$Z_b \text{ @ } 77^\circ F = \frac{0.088\,(Z_m)}{(T+30)^{-0.520}}$$

where:

Z_b = corrected battery impedance to 77°F
Z_m = measured impedance value
T = measured temperature value in °F

Valve-regulated or sealed cell technology is relatively new and temperature response may differ among battery vendors and electrolyte types. Gel style cells will have a different temperature response curve than the starved-electrolyte or absorbed electrolyte types. If temperature correction is required, contact the battery manufacturer for this data, or contact AVO International for assistance.

The preceding operating procedure represents the generic test philosophy of the instrument. Actual test scenarios may differ with each application. Consult the Applications Department for help with any test procedure.

OPERATION WITH OPTIONAL EQUIPMENT

Dual-Point Probes (Factory Probes)

Software in the base measurement unit senses the connection of the dual-point probes. TEST SCREEN FOR DUAL POINT PROBES (18-20) shows the MBITE display in **TEST TYPE - CELL** operation. To select **STRAP** or **CELL/STRAP** test types, use MENU 3 SCREEN (7) or DEFAULT SETTINGS SCREEN (15). The displayed screen prompts the operator to make the four-point connection.

WARNING

Due to the possibility of spark generation at the battery terminals, do not remove the test probes until the measurement unit displays the message - OK TO REMOVE PROBES.

Once the base measurement unit detects a dc voltage at the potential probes, TEST SCREEN FOR DUAL POINT PROBES (18) is displayed. This screen shows the sine-wave symbol to the right of the measured dc voltage indicating current flow and the message - **DO NOT REMOVE PROBES** - as a reminder to hold the probes in contact with the cell posts.

Since the probe tip placement is critical for measurement, the base measurement unit will not allow measurement current to flow unless proper contact is made with the cell post and a dc voltage is present at the potential probes. Once measurement current is allowed to flow, the display shows the measured readings; store readings by pressing the button on the probe handle.

If the dual-point probes lose contact with the cell under test and there is a loss of dc voltage present at the potential probes, the base measurement unit prompts the operator by sounding the annunciator and again displaying TEST SCREEN FOR DUAL POINT PROBES (19).

After the measurement value is established and accepted by pressing the button on the probe handle, TEST SCREEN FOR DUAL POINT PROBES (20) is displayed. Notice that the sine-wave symbol is missing, indicating that the test current is no longer flowing and the displayed value was accepted when the data send button was pressed on the probe handle. At this time, the message - **OK TO REMOVE PROBES** - is displayed.

Move to the next cell under test and repeat the procedure until all cells have been tested. Data can be uploaded using the same menu commands described in Section 4. The printer functions as described previously by printing on-line or as a review using menu commands.

Bar-Code Wand

If the bar-code wand option has been installed at the factory, connect the wand to the base measurement unit serial communications connector (J5) (Fig. 5). Upon power up, the base measurement unit will detect the presence of the bar-code wand option and provide access to the appropriate screens.

APPLICATION NOTES

When performing battery impedance tests using the MBITE, the operator needs to be aware of battery string configurations, the interaction of ripple currents, charger impedances, cell or strap impedances, and noise generated by invertors or switching power supplies.

Typical Battery Systems

Typical battery systems are shown in Figures 9, 10, and 11. Figure 9 shows a battery system with a single string of cells. After connecting the MBITE current source leads, the operator must select an alternative location for source current location if a **HIGH CURRENT** or **LOW CURRENT** message is displayed. The external influences shown in Figure 9 can be measured with a true rms current meter or an oscilloscope to show their magnitude. The **HIGH CURRENT** or **LOW CURRENT** message must be extinguished to ensure that there is sufficient test current in the section of the battery string and to turn on the MBITE and enable computation of cell impedance or strap resistance.

Figure 10 shows an impedance analysis of a battery system with parallel strings of cells. The operator must section this system to supply the proper level of test current to stimulate the cell impedance or strap resistance measurements. The impedance analysis shows how to start sectioning. Use the graph shown on Figure 10 as a guide to determine the amount of current that should be flowing in each section. The operator may see other ripple current influences as noted in the single string of cells (Fig. 9) and may have to interchange the position of the source current clips (i.e., reverse the polarity).

WARNING

Do not remove current source leads from the battery until the MBITE base measurement unit is de-energized or the current disconnect (DISCON) feature is applied. Always remove leads at battery connection before removing J2 connection.

Figure 11 shows a 600 V dc UPS system in which the source current leads are connected across a 200 V section of the battery string.

Notes Regarding MBITE Operation

The timing circuit controls the current injection to the battery, load, and charger systems. The current is held off by a timer so that the internal coupling capacitor is at the same voltage as the battery system. This prevents transients from occurring when the ac current is injected into the cells of the battery.

The coupling capacitor is designed to operate on battery systems up to 250 V dc. When testing systems over 250 V dc, the operator must test sections of the system at a time, connecting the source current leads across a portion of the string less than 250 V dc.

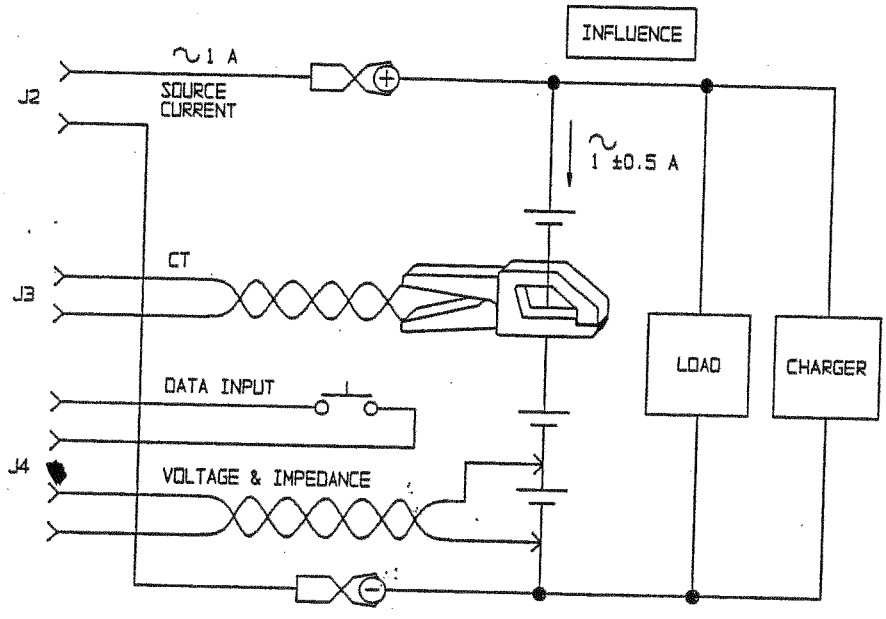
Ripple Current

A **LOW CURRENT** or **HIGH CURRENT** message indicates that the summation of rms test current from the MBITE and the ripple current from the

battery string charger may be outside the limits required for impedance testing. As corrective action, the operator may reverse the positions of the source current lead clips to shift the test current by 180 degrees and offset the effect of the system ripple current in the receiver. It is possible that the ripple current in the cell string is sufficient to enable measurements. The current source leads would be disconnected from the battery string and remain open.

Open Cell/High-Resistance Straps

The **LOW CURRENT** message may also be caused by high resistance in the cell string. This situation limits the source current in the cell string. The operator can verify whether the magnitude of the source current is within the required limits (1 ±0.5 A) by connecting the source lead clips together. If the **LOW CURRENT** message disappears, the instrument test current is sufficient. The operator can then section the battery system by connecting the current source leads across various sections of the cell string to isolate high resistance or open cells and straps.



TYPES OF TEST INFLUENCE	CORRECTIVE ACTION
LOW IMPEDANCE CHARGER	SECTION
RIPPLE CURRENT FROM CHARGER	REVERSE SOURCE LEADS
SWITCHING NOISE FROM LOAD	SECTION

Figure 9: Battery System with Single String of Cells

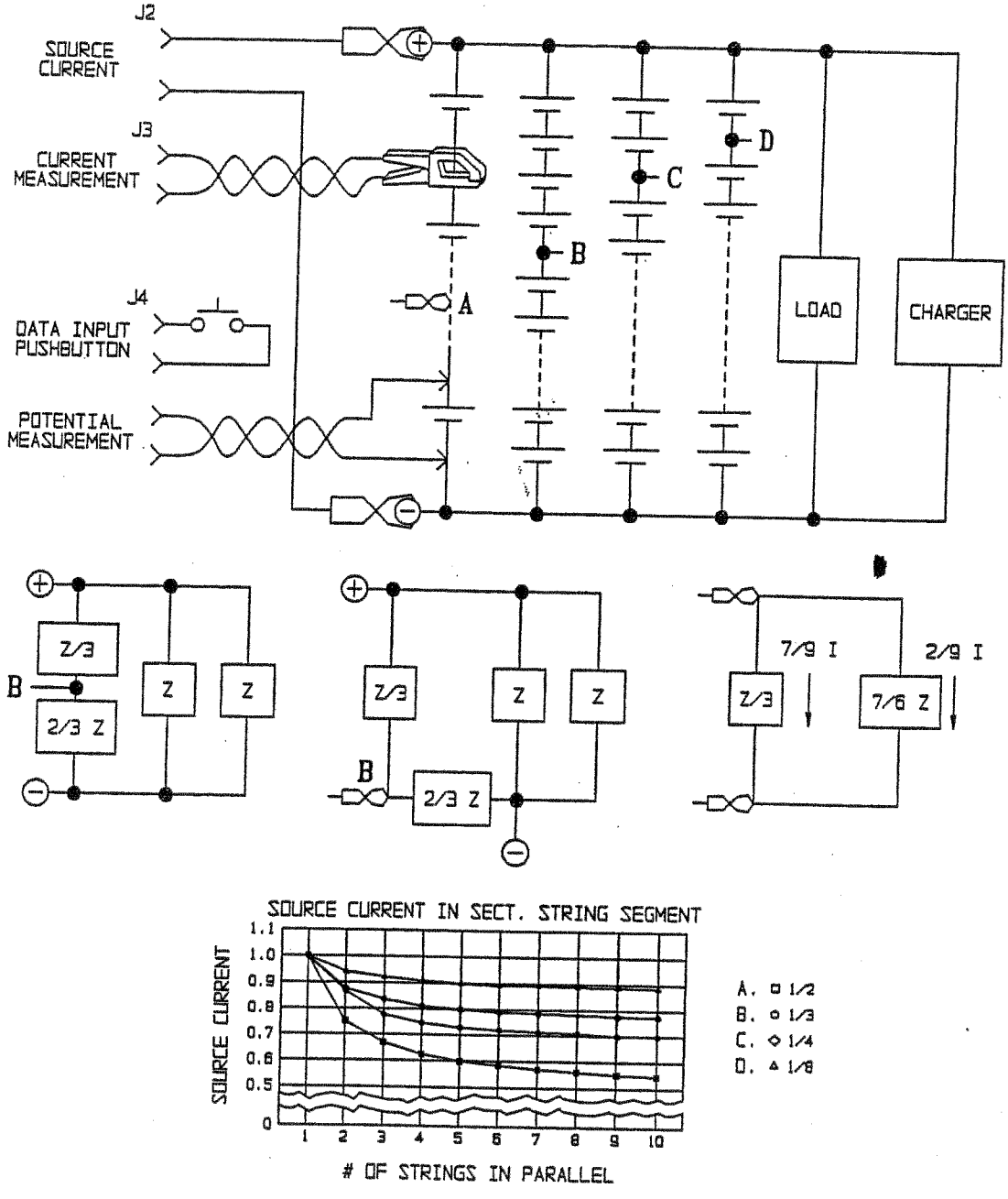


Figure 10: Battery System with Parallel String of Cells

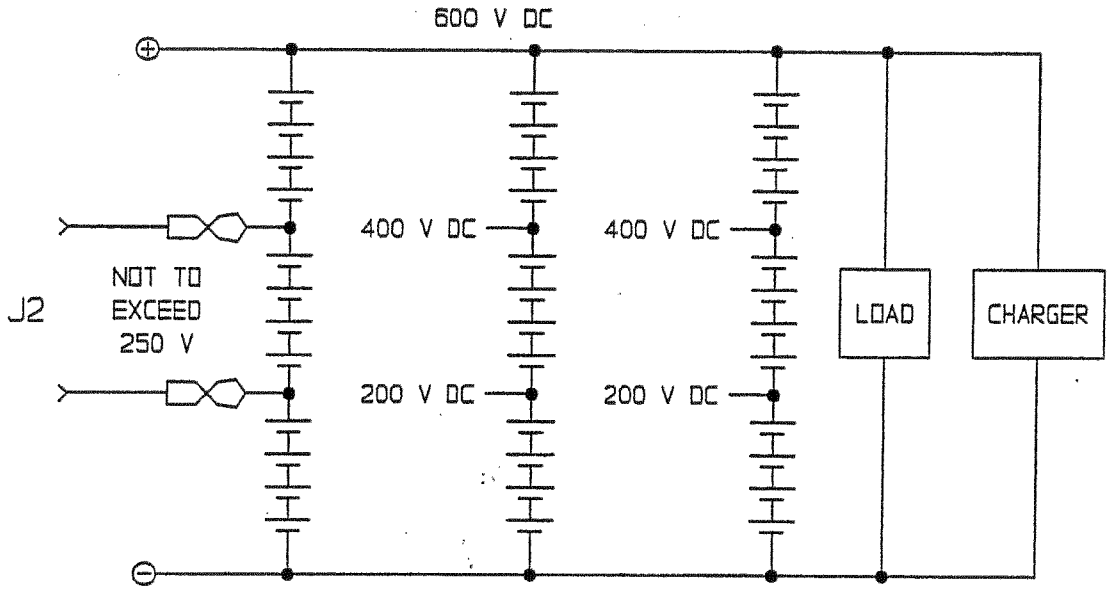


Figure 11: Sectioned 600 V UPS Battery System

High-Voltage UPS Batteries

The nonpolarized coupling capacitor in the current source is limited to 250 V. This restricts the injection of the source current across battery systems of 250 V dc and higher. The source current is generated from an isolating transformer which allows the operator to connect across a section of the battery system that is within the 250 V range. It is recommended that the operator structure the test procedure so that the same number of sections (group of cells less than 250 V) are stimulated as the test proceeds.

Some UPS systems with voltages up to 600 V dc are designed with parallel strings of cells. The operator should position the current source lead accordingly to satisfy both the test current and the voltage limit of the MBITE.

Noisy UPS Systems

The source current may be affected by the noise generated by the switching power supply or the invertor. In this situation, the operator should test a few cells at a time.

Section 6

Service

MAINTENANCE

Strictly observe all safety precautions. Refer to Section 2, Safety. Maintenance should only be performed by qualified personnel familiar with the hazards involved with line operated test equipment.

WARNING

The MBITE contains a large high-voltage capacitor. During operation this capacitor could be charged up to 250 V. Normally this capacitor is automatically discharged when the instrument is switched off. However, under certain fault conditions, this capacitor may be left charged. Always use a voltmeter to check the state of the charge and wear rubber gloves as necessary when touching the capacitor and the circuits connected to it.

Because the MBITE is used in a corrosive environment, periodically clean all components and test leads with a mild detergent and a soft cloth. Do not immerse in water or allow moisture to enter the case. Clean the plastic overlay front panel with a mild detergent lightly applied to a soft cloth.

Clean the fan filter, situated behind a plastic cover on the side of the case, as needed. Ensure that power to the instrument is off, then remove plastic cover, take out filter, rinse in warm water, dry thoroughly, and replace.

Every six months inspect and clean the case, as previously described, all test leads, and connections. Inspect both measuring and source leads for effects of corrosion and wear.

When the printer is not being used, ensure that the head-up lever is up. Storing the printer with the lever in contact with the platen risks damage to the platen.

FUSE REPLACEMENT

The ac receptacle on the connector panel (Fig. 5) contains a time-delay fuse and replacement to protect the instrument from current overloads. In the Catalog No. 246005, the primary side fuse is rated for 1 A at 250 V ac; in the Catalog No. 246005-47, the primary side fuse is rated for 500 mA at 250 V.

A secondary side fuse, rated 2 A at 250 V ac, is installed to protect the operator from possible shock and to protect the MBITE circuitry in the event of catastrophic component failure. This fuse is mounted internally on the bottom base panel (see Fig. 12).

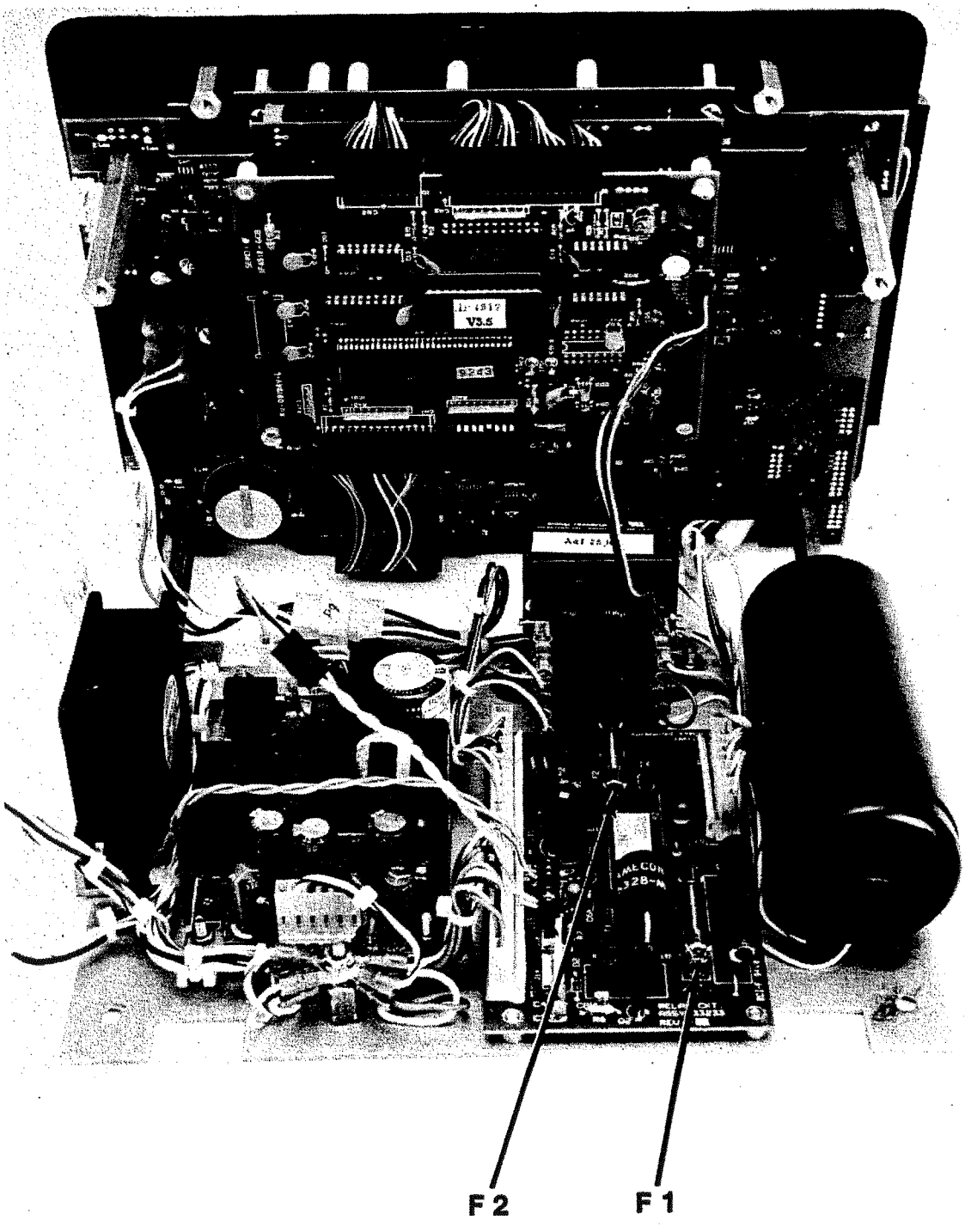


Figure 12: Internal View Showing Fuse Location

This fuse is coordinated for fast response to a dc inrush from the battery under test.

WARNING

Under no circumstances should any fuse be defeated or replaced with another type fuse. Replace with the types specified in Section 7, Replaceable Parts List.

To verify that the problem is fuse related, move the instrument from the vicinity of the battery under test. With the MBITE current source leads connected to J2, short the two clip ends together. Connect the CT plug at J3. Clamp the CT around a single conductor of the output source leads. Apply power to the MBITE. Verify that the ac power remains on and that after the time delay, the sine-wave signal is present on the TEST SCREEN. If there is no indication of current, then the fuse is most likely damaged.

If suitably trained repair personnel are available and fuse replacement is required, follow this procedure:

1. Remove all ac power to the instrument by setting the MBITE power on/off switch to O (off). Disconnect the ac line cord from the 120/220 V ac outlet.

2. Remove the current source leads from the battery under test.

3. Remove the current source leads from their J2 connection on the MBITE connector panel.

4. Remove four rubber feet from the base of the instrument case and remove the screws under them. Lift the chassis from the instrument case.

5. Remove four screws from the standoffs on the chassis baseplate and carefully raise the right side of the instrument (as viewed in Fig. 12) approximately 1-1/2 in., being careful not to dislodge internal wiring.

6. Find the two fuses, located on the bottom base plate mounted relay printed circuit board, in a fuse holder (Fig. 12).

7. Remove the damaged fuse or fuses and replace with spares (not provided). Verify with an ohmmeter that the removed fuses are indeed bad.

8. Visually inspect all components within the MBITE base measurement unit for damage. Since the fuse was installed and sized to protect under component fault situations, this may indeed be the case. If no damage is observed, proceed to the next step. If damage is observed, return the base measurement unit to the Repair Department.

9. Carefully lower the front panel assembly on the chassis assembly and replace the four screws in their standoffs.

10. Replace chassis in the instrument case, replace four screws in the base of the instrument case, and test again as described above. If the instrument still does not respond correctly, return it to the Repair Department.

PRINTER PAPER REPLACEMENT

When it is necessary to change the paper roll, be sure to obtain the correct thermal paper replacement (Part No. 26999), otherwise clear printing and normal service life of the printer head may be compromised.

1. With the MBITE base measurement unit de-energized (power on/off switch set to O (off)), remove printer paper cover using a screwdriver or coin in the slot immediately to the right of the triangle symbol on the front panel of the instrument. Turn one-quarter turn in either direction and lift off cover.

2. Move head-up lever toward front of instrument to lift head off platen (roller) and release tension on the paper. Then manually roll remaining paper out of instrument.

3. Remove depleted roll of paper by pulling paper roll support spindles away from roll to release roll. Discard roll.

4. Ensure that replacement roll of paper has a straight edge. Cut or tear approximately half an inch from each corner. This makes feeding the paper easier. Rest the new roll in the lid of the instrument, then feed paper through the back entrance between the platen and the head until paper goes around and appears at front of the platen.

5. Carefully pull out approximately 6 in. of paper, centering paper in printer.

6. Return head-up lever to its original position and replace printer paper cover, feeding paper through the cover opening.

7. Install replacement roll in paper roll support spindles.

8. Turn MBITE base measurement unit on, select **RESUME TESTING** on the DATA PRESENT AT START-UP SCREEN (2) by pressing **ENTER**.

9. When the START-UP SCREEN (8) appears, press **ENTER** again.

10. When the TEST SCREEN appears, select **FFEED** (form feed) by pressing **ENTER**. Press **ENTER** again to ensure that the paper

advances smoothly. Tear off any excess paper. The printer is now ready for use.

NOTE

The printer must be on for the **FFEED** function to operate. The **PRINTER ON/OFF** selection is on MENU 2 SCREEN (6) under **DEFAULT SETTINGS.** Refer to MBITE Menu System in Section 4.

REPAIR

AVO International offers a complete repair service and recommends that its customers take advantage of this service in the event of equipment malfunction. Please indicate all pertinent information, including problem symptoms and attempted repairs. Equipment returned for repair must be shipped prepaid and insured and marked for the attention of the Repair Department.

Section 7

Replaceable Parts List

Description	Part Number
ac line cord, 8 ft (2.4 m)	17032
Bar-code wand option	246005-13
Base measurement unit (MBITE)	246005
Canvas carrying case, instrument	218746
Canvas carrying case, leads	246005-4
Clamp-on current sensor, CT with 0.5-in. opening (includes 2.5 ft (0.76 m) lead	246005-2
Clamp-on current sensor, CT with 2-in. opening	246005-9
Current source lead, 10 ft (3 m)	246005-1
Current source lead, 20 ft (6 m)	246005-5
Current source lead, 30 ft (9.1 m)	246005-6
Current source lead, 40 ft (12 m)	246005-7
Dual-point probes (factory probes), 6 ft (1.8 m)	246005-10
Extension cable for CT, 6 ft (1.8 m)	246005-12
Extension cable for CT, 20 ft (6 m)	246005-8
Instruction Manual	AVTM246005J
Primary fuse, 1 A, 250 V, time-delay (Cat. No. 246005)	2554-9
Primary fuse, 500 mA, 250 V, time delay (Cat No. 246005-47)	2554-7
Secondary fuse, 2 A, 250 V, slo blo	2567-27
Standard potential probe assembly, 8 ft (2.4 m)	246005-3
Thermal paper for printer	26999

GLOSSARY

Use only in accordance with Instruction Manual.

base measurement unit	Consists of current source supply, data acquisition, computation and display circuitry and data transmission and print devices.
cell	A receptacle containing electrodes and an electrolyte either generating electricity by chemical action or for use in electrolysis.
equivalent circuit	An arrangement of circuit elements that has characteristics, over a range of interest, electrically equivalent to those of a different circuit or device (used for convenience of analysis).
float	A method of operation for storage batteries in which a constant voltage is applied to the battery terminals sufficient to maintain an approximately constant stage of charge.
LCD	Liquid crystal display.
MBITE	Battery Impedance Test Equipment, Patent No. 4,697,134.
ripple	The alternating component whose instantaneous current values are the difference between the average and instantaneous values of a pulsating unidirectional current.
rms	Root mean squared.
SLC	Subscriber line cabinet.
stationary battery	A storage battery designed for service in permanent battery location.
sulfating	Deposit formation of a white scale containing lead sulfate (on the plates of a storage battery).
UPS	Uninterrupted power supply.

WARRANTY

Products supplied by AVO International are warranted against defects in material and workmanship for a period of one year following shipment. Our liability is specifically limited to replacing or repairing, at our option, defective equipment. Equipment returned to the factory for repair must be shipped prepaid and insured. This warranty does not include batteries, lamps or similar items, where the original manufacturer's warranty shall apply. We make no other warranty. The warranty is void in the event of abuse (failure to follow recommended operating procedures) or failure by the customer to perform specific maintenance as indicated in this manual.

Description

Figure 1 is the new MBITE connector panel. The J3 and J4 connectors are new and replace those on the old connector panel assembly (Fig. 2). **All Combination** and **Factory** leads will connect to the J2 and J4 connectors (see Fig. 1). The current sensor (CT) is still connected at J3. The CT is **not** required when any of the factory leads is used

Combination leads, potential probes/current source:
These leads combine the old potential probes and current source leads into one assembly. These lead assemblies require two connections to be made at the MBITE connector panel (two connections were also required to be made on the previous versions); one connection at J4 and the other at J2. The current source leads supplied with these assemblies is standard as 10 ft. in length.

Fused current source lead extensions:
These leads extend the current source portion of any combination lead assembly simply by unscrewing the fuse connector and replacing it with the appropriate extension.

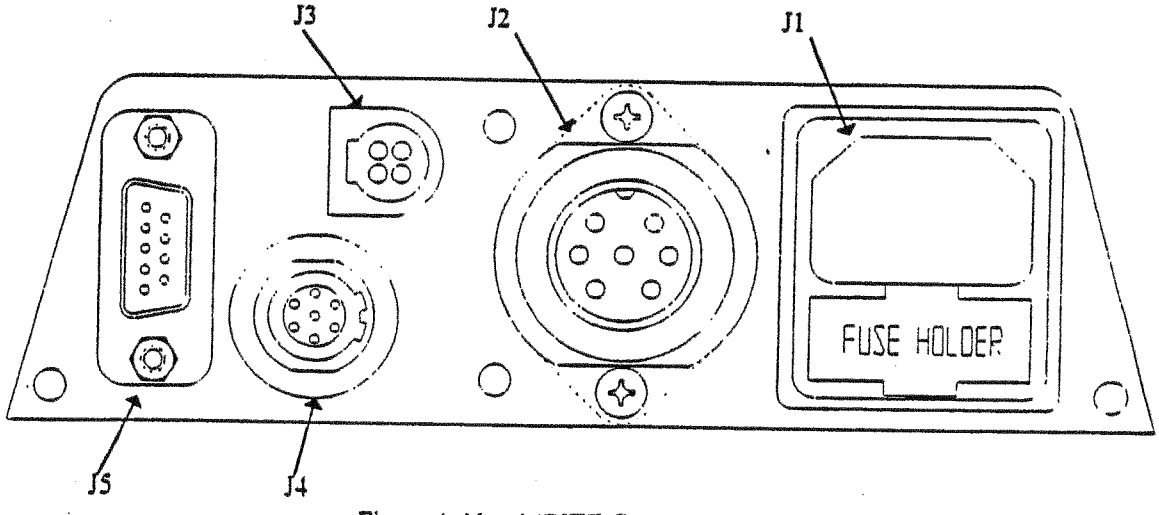


Figure 1: New MBITE Connector Panel

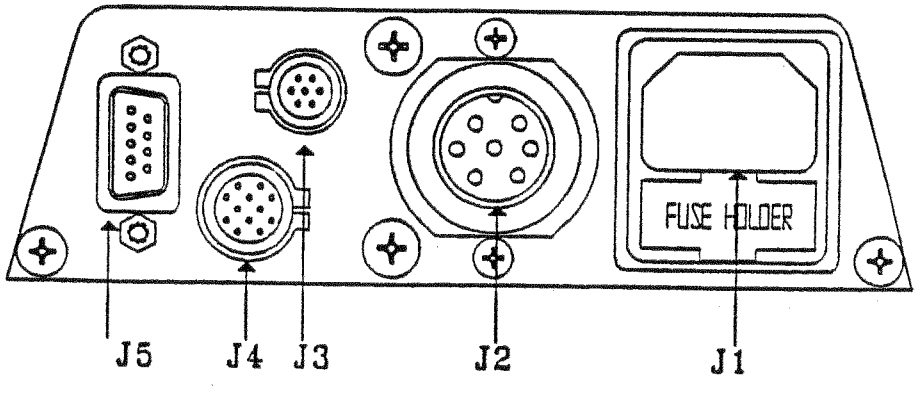


Figure 2: Old MBITE Connector Panel

Please replace the following page:
Instruction Manual AVTM246005J, page 27

Section 7
Replaceable Parts List

Description	Part Number
ac line cord, 8 ft (2.4 m)	17032
Data extraction tool (windows)	33734
Data extraction tool manual	AVTM33734
Bar-code wand option	246036
Bar-code labeling software (windows)	246039
Bar-code labeling software (dos)	246040
Canvas carrying case, instrument	218746
Canvas carrying case, leads	25340-3
Clamp-on current sensor, CT with 0.5 in. opening & 2.5 ft. (0.76 m) lead	246034
Clamp-on current sensor, CT with 2 in. opening & 5 ft. (1.5 m) lead	33863
Extension cable for CT, 6 ft. (1.8 m)	33864-1
Extension cable for CT, 20 ft. (6 m)	246033
Fused current source lead extension, 10 ft. (3 m)	34378-1
Fused current source lead extension, 20 ft. (6 m)	246038
Fused current source lead extension, 30 ft. (9.1 m)	246041
Fused current source lead extension, 40 ft. (12 m)	246042
Instruction Manual	AVTM246005J
Primary fuse, 1 A, 250 V, time delay (Cat. No. 246005)	2544-9
Primary fuse, 2 A, 250 V, time delay (Cat. No. 246005-47)	27708-3
Secondary fuse, 2 A, 250 V, slo blo, F1 & F2	2544-22
Secondary fuse, 250 mA, 250 V, slo blo, F3 (Cat. No. 246005)	2544-5
Secondary fuse, 200 mA, 250 V, slo blo, F3 (Cat. No. 246005-47)	27708-4
Source lead fuse, 1 A, 600 V Fast blo	29440-4
Combination leads, potential probes/current source, 8 ft./10 ft. (2.4 m/3 m)	34377
Combination leads, potential probes/current source, 12 ft./10 ft. (3.6 m/3m)	246045
Combination leads, aligator clips/current source, 8 ft./10 ft. (2.4 m/3m)	246046
Combination leads, potential probes 2.5 in. tips/current source, 8 ft./10 ft. (2.4 m/3m)	246047
Factory probes with Amp/Burndy connector, 10 ft. (3 m)	246048
Factory probes with dual-point helical hand spikes, 6 ft. (1.8 m)	246037
Thermal paper for printer	26999

Accessories Supplied

- Combination leads, potential probes/current source, 8 ft./10 ft. (2.4 m/3 m)
- Clamp-on current sensor, CT with 2 in. opening & 5 ft. (1.5 m) lead
- Extension cable for CT, 6 ft. (1.8 m)
- Canvas carrying case, leads
- ac line cord, 8 ft (2.4 m)
- Instruction Manual
- Data extraction tool
- Data extraction tool manual

Optional Equipment

- Clamp-on current sensor, CT with 0.5 in. opening & 2.5 ft. (0.76 m) lead
- Dual-point probes (factory probes), 6 ft. (1.8 m)
- Combination leads, potential probes/current source, 12 ft./10 ft. (3.6 m/3m)
- Combination leads, aligator clips/current source, 8 ft./10 ft. (2.4 m/3m)
- Combination leads, potential probes 2.5 in. tips/current source, 8 ft./10 ft. (2.4 m/3m)
- Factory probes with Amp/Burndy connector, 10 ft. (3 m)
- Bar-code wand with preprinted alphanumeric code sheet
- Bar-code labeling software (windows)
- Bar-code labeling software (dos)
- Fused current source lead extension, 20 ft. (6 m)
- Fused current source lead extension, 30 ft. (9.1 m)
- Fused current source lead extension, 40 ft. (12 m)
- Extension cable for CT, 20 ft. (6 m)
- Canvas carrying case, instrument

Page 9, Figure 5

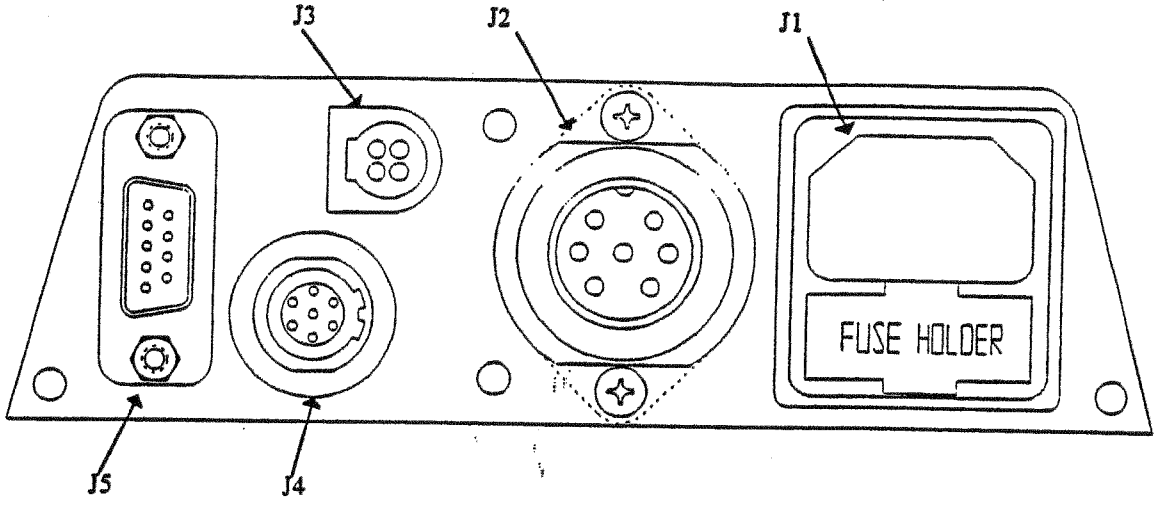


Figure 5: MBITE Connector Panel

Add to page 4, Safety:

- Do not use the MBITE nor any of the accessories on batteries with terminal voltage in excess of 300 V above ground

Add to page 5, Specifications:

ELECTRICAL
IEC 1010-1 Class I equipment, installation category II, 300 V working voltage.

Nominal source output current: 1 A for 50/60 Hz operation, maximum voltage between leads 250 Vdc

Maximum battery voltage: 300 Vdc above ground. (IEC 1010-1 installation category I)

Remove from page 18:
Do not look directly at the red light since it is a laser and if placed close to the eye, damage to the eye could occur.

Add to page 22, High-Voltage UPS Batteries:

Warning

Do not use the MBITE nor any of the Accessories on batteries with a terminal voltage in excess of 300 V above ground.