T.O. 33DA39-71-1

Avtron Aerospace, Inc.

Avtron Model T477W Bonding Meter

with B14703 Battery Pack Replacement Instructions

Part Number T477WC15292

December 11, 1981
Revised August 28, 2018

AVTRON AEROSPACE

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WARRANTY

The last page of this document contains an express limited warranty. The provisions of this warranty cover any and all rights extended to holders of Avtron equipment.

Rev. November 1, 2011

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SB1242 Outline Drawing

1 DESCRIPTION

The Model T477W Bonding Meter is a precision instrument using digital techniques to identify the integrity of electrical connections by measuring and displaying small values of resistance (less than 2 ohms). The range of measurement is 0.2 to 2000 milliohms. Resistance measurements smaller than 0.2 milliohms are possible with reduced accuracy.

The T477W Bonding Meter is supplied with a set of probes having four wire (Kelvin) connections. In addition, a separate power supply is provided for charging the T477W batteries.

The T477W Bonding Meter is certified by Underwriter Laboratories per UL 913 as an intrinsically safe device for use in hazardous locations, Class I--Group A, B, C, or D. These locations are identified by the National Electrical Code, National Fire Protection Association (NFPA) document number 70, and are typified by the presence of flammable vapors such as hydrogen, propane, methane, and gasoline.

SPECIFICATIONS

RANGES AND ACCURACY **NOTE:** Accuracy expressed as: +/- (% of reading + x digits). Please refer to probe descriptions for additional accuracy considerations.	2 milliohms (C15479 and C16695 probes only) 2 milliohms (C22161 probe only) 20 milliohms 200 milliohms 2000 milliohms	+/- (1% + 5) + (1% + 30) and – (1% + 10) +/- (1% + 5)* +/- (1% + 5)* +/- (1% + 5)* * *Applies to T477W used with C15479, C16695, and C22161 probes only*
OUTPUT:	Maximum Current Output Maximum Voltage Output	200 mA rms 200 mV rms, 500 mV(p-p)
WEIGHT:	T477W T477W, Probe Set, Charger and Case	3.22 lbs. / 1.46 kg 8.26 lbs. / 3.75 kg

C A U T I O N

ESD The Model T477W Bonding Meter contains Class I parts and assemblies susceptible to damage by electrostatic discharge (ESD). Refer to MIL-STD-1686A for ESD protective procedures.

Description

2 OPERATING INSTRUCTIONS

2.1 Initial Operation

The T477W Bonding Meter is shipped with charged batteries. If the meter is not used for a period of 30 days following shipment, the batteries should be charged before use.

2.2 Battery Charging

Batteries are recharged by disconnecting the probe from the input connector J1 and connecting the battery charger B15693 to connector J1. Batteries should nominally be charged for 14-16 hours. Continuous charging for prolonged periods (weeks or months) is not recommended. Refer to Section VI for further details on battery charging and power sources other than 120 VAC, 60 Hz.

W A R N I N G

Do not attempt to charge batteries in hazardous locations. Battery charging should be done only in a location known to be free from flammable gases or vapors.

2.3 Probes

One set of probes, Part Number C22161, is supplied with the T477W Bonding Meter. There are four optional probe sets available that may be purchased separately. All of the probe sets are useful for particular applications; however, care must be exercised in the use and selection of probes. The use of a particular probe set depends on the size and shape of the two bonded materials in the vicinity of the bond. Below is a brief description of each:

Part Number	Description
C22161	Two Pistol Grip probes with a pair of probe tips on each
C15479	Two single point (current) clamps and two pencil style voltage probes
C15478	Compass style probe and dual point clamp
C15480	Dual compass style probes
C16695	Four pencil style probes

Reference the optional probe set sketches in Figure 2-2.

When making a measurement, always place the voltage leads closest to the bond being measured for better accuracy.

C A U T I O N

Probes are equipped with sharp points. Exercise caution when handling probes to prevent puncture wounds or scratches.

2.4 Minimizing Error Contributed by Probes

The above probe sets consist of two current leads which connect the Bonding Meter regulated current output to the unknown resistance and two voltage sensing leads to measure the voltage developed across the unknown. The voltage sensed is small and the current is alternating; therefore, a small transformer effect (coupling) exists between the current sourcing and voltage sensing leads. This effect is best minimized when the voltage sensing leads are separate from the current leads and bound together for the majority of the length of the cable as in the C15479 and C16695 probe sets. The distance that the voltage sense leads are spread from each other is to be considered the cable loop diameter. The amount of meter reading error caused by the coupling effect on metal surfaces is directly proportional to the cable loop diameter. Minimizing the cable loop diameter with any of the five probe sets is advised to achieve the most accurate reading possible. See Figure 2-1.

2.5 C22161 Probe Set

This probe set utilizes two pistol grip style probes that facilitate obtaining a quick and easy reading. The best-rated meter accuracy is obtained with the C22161 probe set, except in the 2 milliohm range. The accuracy in the 2 milliohm range is + (1% of reading + 30 digits) and – (1% of reading + 10 digits).

NOTE

Each pistol grip probe is labeled “P” and “C” indicating which pin is for potential (voltage) and current.

In the 2 milliohm range, reduce the cable loop diameter (see Figure 2-1) as much as possible to minimize reading errors.

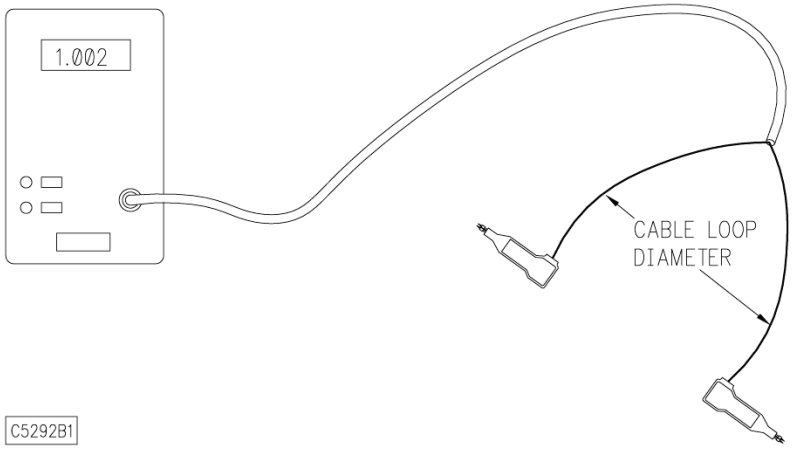


Figure 2-1. Two Pistol Grip Probes with a Pair of Probe Tips

2.6 C15479 Probe Set (Optional)

These probes (Figure 2-2) have separate current and voltage leads, and the voltage sensing leads are bound together for nearly the full length of the cable, which best minimizes the coupling effect described above. The best-rated meter accuracy is obtained with this probe set when connected such that the meter reading is ***positive*** only. This probe set may be used for calibrating the T477W Bonding Meter and whenever measurement accuracy is crucial.

NOTE

The red clamp and pencil style probe are positive current and voltage respectively while the black clamp and pencil style probe are negative current and voltage respectively. The polarity signs on the clamps have no meaning. Older probe sets current clamps and voltage pencil probes polarities are determined solely by the lead color wired to them.

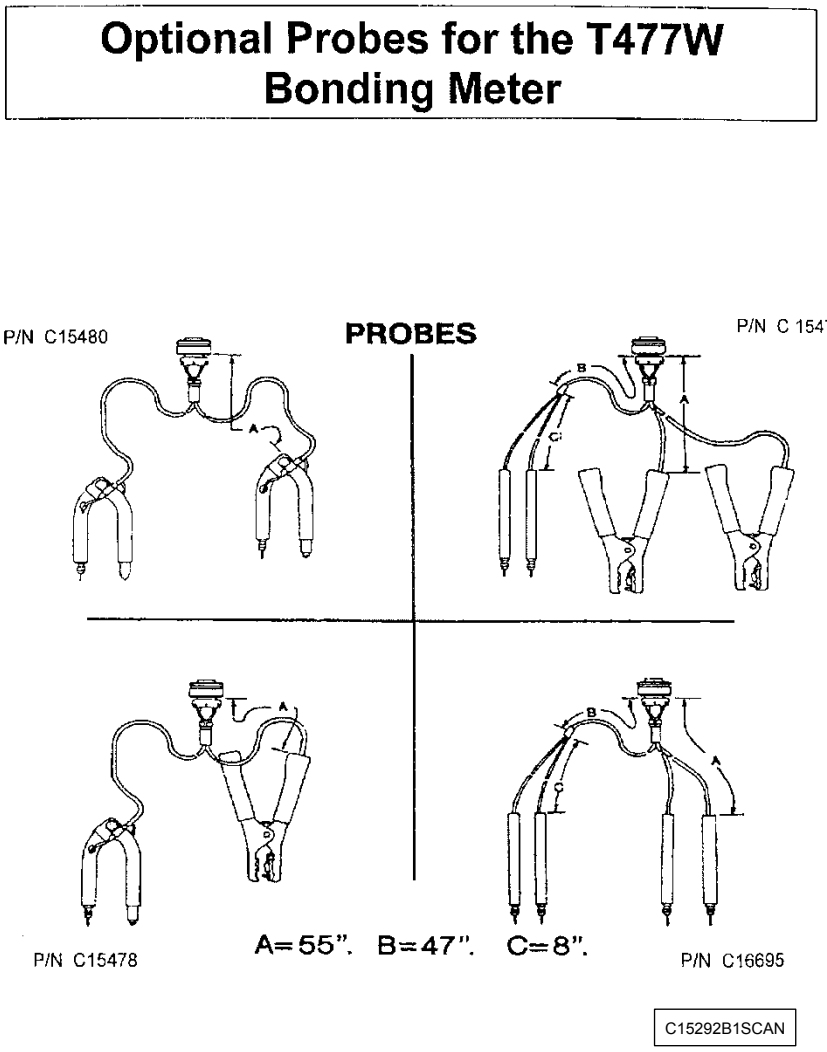


Figure 2-2. Optional Probe Sets

2.7 C15478 and C15480 Probe Sets (Optional)

These probe sets (Figure 2-2) do not have separate current and voltage leads. Their use may cause meter reading error exceeding the allowed tolerance due to the coupling effect. They should only be used for survey work to establish an approximate resistance.

Meter reading error caused by the use of probe sets C15478 and C15480 depends on the probe lead configuration. In order to identify the magnitude of error, tests have been conducted using a wooden surface to simulate air and an aluminum sheet to simulate an aircraft structure. Meter error on wooden surfaces was on the order of 20 digits. Error measured on the aluminum surface ranged from 20 to 240 digits, depending on the size of the cable loop formed. When using the C15478 and C15480, form the smallest possible cable loop diameter (see Figure 2-1).

NOTE

The current and voltage leads are identified by the following GRIP COLOR CODE:

Black is for positive and negative current.
Red is for positive and negative voltage.

(Additionally, on the compass style probes, the blunt spring-loaded tip is voltage, while the pins are current.)

On the C15478 and C15480 probe sets sold after November 1989, Avtron Aerospace, Inc. has enhanced their design by adding sleeving to the first 40 inches of the cables. This helps to minimize the meter reading error induced by the coupling effect.

The polarity signs imprinted on the clamps of these probes have no meaning.

2.8 C16695 Probe Set (Optional)

These probes (Figure 2-2) have separate current and voltage leads, and the voltage sensing leads are bound together for nearly the full length of the cable, which best minimizes the coupling effect. The best-rated meter accuracy is obtained with this probe set when connected such that the meter reading is ***positive*** only. This probe set may be used for calibrating the T477W Bonding Meter and whenever measurement accuracy is crucial. Since all the probes are of the pencil type, they are well suited for taking accurate measurements on small parts or in cramped space locations.

NOTE

The black pencil style probes are positive and negative current while the red pencil style probes are positive and negative voltage. Make sure to observe polarity while making a measurement such that the voltage and current probes on each side of the bond are of the same ***lead*** color.

2.9 Custom Probe Sets

T477W probe sets are constructed with extensive use of non-sparking materials such as aluminum, brass, and copper. This design minimizes the possibility of spark ignition if the probes are dropped and happen to strike a surface. The fabrication of custom-made probes is not recommended.

2.10 Meter Operation

Select one of the five probes and connect it to the front panel J1. In making a measurement, make sure that the probe tips penetrate any non-conductive film that may be present (and there are no flashing decimal points or erratic digits flickering in the display). The accuracy is known only when the meter reading is ***positive***. Momentarily press the TEST button located on the front panel. The TEST button not only turns on the display but also changes the meter range. The first TEST button activation causes the meter to operate at the 2 milliohm range. Subsequent activations of the TEST button will change the range from 2 to 20 to 200 to 2000 and back to 2 milliohms. The decimal point is automatically positioned for each range.

In order to conserve battery power, a built-in timer automatically shuts off the display after 52 seconds of operation. The display may be illuminated by pressing the LAMP button located on the front panel. Meter range is not affected by the lamp button; however, meter shutdown timing is delayed while the lamp button is activated.

2.11 Leading "1" Display

A leading "1" display indicates an over-range condition. If the display indicates a leading 1 (as in Figure 3), press the test button once to advance to the next highest range. If the meter is over-ranging in the 2000 milliohm range, then the unknown resistance is greater than 1999 milliohms and is out of the range of the Bonding Meter.

2.12 Erratic Digits

Erratic digits (erratic numbers flickering in the display) are an indication that the voltage sense connections are open or a large over-range condition exists. Ensure that the voltage sense probes are making a good, low resistance connection. Advance the range using the test button if necessary.

2.13 Flashing Decimal Points

Flashing decimal points are an indication that the resistance of the path formed by the current probes is excessive. This is most common in the 2 milliohm range. The 2 milliohm range requires a current probe path of less than 200 milliohms. Ensure that the current probes are making a good, low resistance connection.

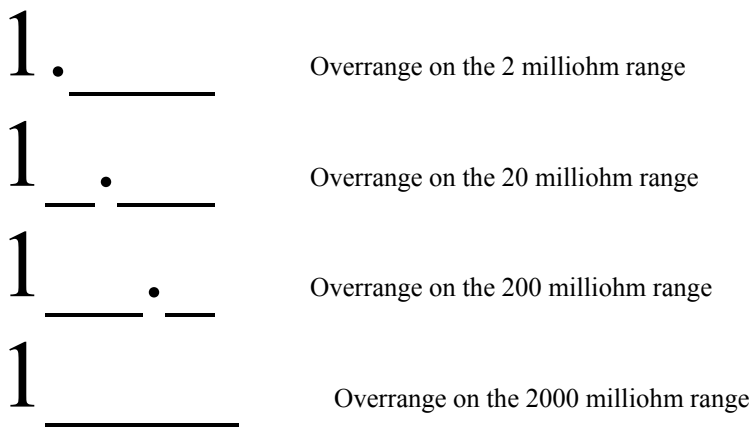


Figure 2-3. Flashing Decimal Points

C A U T I O N

The T477W Bonding Meter accuracy is significantly affected by the presence of direct current (DC) potentials on the unknown resistance. The presence of DC potentials at or on the unknown resistance causes saturation of the output and input transformers. Some small DC potential is tolerated; however, that potential varies with the magnitude of the unknown resistance. DC potentials on the order of 10 millivolts per milliohm cause no problem. When in doubt about the presence of DC potentials, do not use the T477W Bonding Meter. Significant meter damage may result.

2.14 Battery Endurance

The T477W is powered from internal rechargeable batteries. Battery endurance depends on capacity (amp/hours) which is affected by the following factors:

Temperature - Capacity is rated for room temperature operation (25°C) and is tested for operation at –15 and 60°C. Operation above room temperature causes significant reduction in capacity.

Charge History - Capacity is based on a full charge within 10 days. To minimize charge loss (as much as 25% in one month), batteries must be charged frequently. However, charging a battery repeatedly prior to the "LO BAT" being illuminated in the display will cause a loss of endurance as the battery develops a memory, which is characteristic of nickel cadmium cells. (Memory can sometimes be erased; see Section 7.)

Age - The battery ages after many charge/discharge cycles. Its ability (capacity) to sustain a load after a full charge is diminished. Thus the meter has a shortened operating time before a recharge is necessary.

Battery endurance is rated under the worst conditions (50% capacity) to provide eight (8) hours of continuous operation providing the battery has been charged not more than 10 days prior to the time of operation. New batteries (100% capacity) are anticipated to have sufficient energy to make twice the rated measurements. Because the T477W has a built-in timer for automatic shutdown after 52 seconds, "Continuous Operation" is defined in terms of the following 3-minute measurement cycle:

	26 seconds current probes connected to load
	26 seconds current probes not connected to load (including 2 seconds lamp operation)
	128 seconds shutdown
Total:	180

When the battery is nearing discharge, a "LO BAT" indication is displayed on the left side of the meter display. Meter readings remain accurate, but the batteries ***should*** be recharged.

3 CIRCUIT DESCRIPTION

The T477W is designed to measure values of resistance from 2000 milliohms to less than 0.2 milliohms. Connections to the unknown resistance are made by four wire (Kelvin) connections that consist of two current and two voltage sensing leads. The meter circuit provides a regulated alternating current @ 78 Hz that is fed through the unknown resistance while the voltage generated across that unknown resistance is sensed. Since the sensed voltage is caused by a constant current, and voltage is proportional to resistance, the meter interprets voltages in terms of resistance.

Circuit Description

4 CALIBRATION AND MAINTENANCE PROCEDURES

4.1 Calibration

The circuit is composed of solid state devices which have been subjected to extensive testing and therefore few failures are anticipated. However, periodic testing against a known resistance standard is recommended. Testing may be easily performed using the K777 Verification Fixture. The meter may also be returned to Avtron Aerospace, Inc., for a complete calibration for a reasonable fee as described below.

4.2 Field Calibration Procedure

Equipment required:

Avtron T477W, Part Number C15292 Bonding Meter (Unit Under Test)

Avtron K777, Part Number C15293 Calibration Test Fixture

Procedure:

1. Connect P1 of the K777 Calibration Test Fixture to J1 of the T477W Bonding Meter (Unit Under test).

2. Follow the table below to verify the accuracy of the Bonding Meter. For each K777 switch position in column one, set the T477W to the range in column two by pressing the test button. Read the T477W display and compare to desired value.

K777 Switch Position	T477W Milliohm Range	Tolerance (in milliohms)	T477W Display Reading
Zero	2.000	+/-0.002*	_____
0.10	2.000	+/-0.006	_____
1.00	2.000	+/-0.015	_____
1.00	20.00	+/-0.06	_____
10.0	20.00	+/- 0.15	_____
10.0	200.0	+/-0.6	_____
100	200.0	+/-1.5	_____
100	2000	+/-6	_____
1000	2000	+/-15	_____

* The 0.002 milliohm tolerance is an internal unpublished specification. The official published specification is 0.005 milliohms for the 2 milliohm range. All other ranges are as published +/- 5 least significant digits for the allowable zero error.

3. This completes the field verification procedure. There are no user adjustable components. If an alignment failure is found during the verification, contact Avtron Aerospace, Inc., to return the unit for repair.

NOTE

Perform the above field calibration procedure after a full charge while on a non-metallic work surface without any other T477W Bonding Meters in the near vicinity.

The K777 unit provides a good field verification of the T477W Bonding Meter's performance excluding the probes. The probe sets should also be tested to verify that they provide proper readings with the Bonding Meter. Avtron provides calibration service on both the T477W and the K777 products.

Our calibration service provides, in addition to the K777 test values, the following: environmental tests from 5 degrees to 140 degrees Fahrenheit; battery response/endurance at the preceding extremes, accuracy of the unit at the preceding extremes, uncertainties induced from the different styles of probes, auto-shutoff time verification, charging waveform check, the unit's burden/threshold levels and additional measurement test points not available on the K777. The calibration includes a detailed certificate and data if requested. Factory repair is available at additional cost if required.

Prior to sending equipment to Avtron Aerospace, Inc., for calibration or service, please contact us to receive an RMA number and instructions on where to send the items. Please visit our website for contact and product information at http://www.avtronaero.com/rma.htm.

4.3 Calibration Period or Frequency

As the manufacturer, Avtron suggests a calibration interval of one year. However, it is the sole responsibility of the end user to determine an interval that satisfies their quality system requirements.

4.4 Maintenance

The T477W is composed of solid state components and requires minimal maintenance. Field repairs are not recommended. Component substitution with other than approved Avtron parts may impair intrinsic safety, thus voiding the UL approval and putting property and people at risk. It is recommended that a malfunctioning meter be returned to Avtron for repair.

W A R N I N G

Please note that breaking the tamper seal on the T477W Bonding Meter for any reason whatsoever shall relieve Avtron Aerospace, Inc., of any and all liability with regard to personal injury or property damage, whether directly or indirectly resulting from the use of the meter. Warranty claims on meters with a broken tamper seal may be honored only after an evaluation of the meter is performed by Avtron.

4.5 Preventive Maintenance

The T477W is powered by rechargeable nickel cadmium batteries.

The battery pack is the most likely component in the T477W to require maintenance. The pack is potted to ensure proper operation of current limiting resistors which were required for safety certification by Underwriter Laboratories. The potting makes battery replacement awkward and expensive, but it is necessary for safety. Battery preventive maintenance procedures have been developed to identify battery problems before they become serious.

Nickel cadmium batteries are reliable and will provide hundreds of charge/discharge cycles. Relatively frequent use is recommended and batteries should be discharged to the point the “LO BAT” indicator is displayed before recharging. The most common battery problems anticipated are over-discharged, overcharged, and short cycled batteries.

Over-discharge occurs when the T477W is used following the "LO BAT" display. Over-discharging may cause batteries to become depleted to the point where one or more battery cells have reversed current flow. Furthermore, extremely deep discharge may obstruct automatic shutdown of the meter display.

Overcharging occurs when the T477W is placed on charge continuously for weeks or months. This will cause some drying of the battery and the possibility of reduced capacity.

Short cycled usage is encountered when fully charged batteries are partially discharged and then fully recharged. Short cycling causes battery capacity to be progressively reduced and has been referred to as memory conditioning. Generally, but not always, a reconditioning process in which the battery is given several deep discharge/charge cycles corrects a short cycled memory.

4.6 Battery Testing

It is recommended that the T477W battery pack be periodically tested to identify problems before they become serious. One method of testing the battery pack is to load it with 22 ohm, 2 watt resistor, and measure the terminal voltage. It should be 4 volts + or -0.2 volts for a fully charged battery. A better test to ensure battery capacity is to make a time-current test as described in the Appendix, Section 7.

W A R N I N G

In order to retain Underwriter Laboratory certification and to permit safe use in hazardous locations, replace defective batteries with Avtron part number B14703 only.

Substitution of ordinary batteries for a defective battery pack may impair safe meter operation in a flammable environment.

The batteries and current limiting resistors contained in the Avtron battery pack are needed to ensure safety. The testing procedures outlined in the appendix will be helpful in avoiding unnecessary replacement.

4.7 Meter Shutdown

The meter is supplied with a timer set to provide 52 seconds of operating time. This time may be lengthened or shortened by Avtron Aerospace, Inc., during a calibration at no charge if requested.

5 TROUBLESHOOTING

5.1 Battery Problems

Problems with the battery pack are relatively easy to diagnose and correct.

Access to the T477W battery pack is achieved by removing two screws located on the back of the meter case and separating the front panel from the case. The battery is the large blue/black panel labeled B14703, located in the middle of the bottom circuit board. The battery connections are the four terminals labeled 1, 2, 3, and 4 on the sides of the pack.

Unless a battery is known to be bad, it is recommended that the battery be charge/discharge tested as described in the Appendix, Section 7. This test requires time to perform, but it is the only good means of identifying battery condition. The simple measurement of battery voltage is ***not*** an accurate indication of battery condition.

Following battery testing, a defective battery pack may be removed and replaced by following the B14703 battery pack supplemental installation instructions at the end of this manual. If the replacement battery is not fully charged, it is recommended that it be charged and re-tested per the Appendix battery testing procedures.

TROUBLESHOOTING WHEN BATTERY DOES NOT CHARGE

PROBABLE CAUSES

1. Charger not plugged in
2. Broken charger connection wire
3. Defective charger
4. Charger input voltage switch set to wrong position
5. Open or shorted battery

6 BATTERY CHARGING

Batteries located within the T477W Bonding Meter are charged from external power supply B15693. Connections from the power supply to the T477W are made through the front panel connector J1 and prevent the use of the Bonding Meter during charging. This procedure is necessary because the power supply is not rated for use in hazardous locations.

The battery charger is a transformer isolated power supply which is designed to accommodate a wide range of input power. Two basic ranges of input voltage are available: 115 or 230 volts, 50 or 60 Hz. A voltage range switch is located on the back of the power supply and must be set to the appropriate range before use. Failure to position the switch to the appropriate range may damage the power supply.

It is recommended that power supplies operated from input power voltage between 100 and 125 volts have the voltage selector positioned to 115 volts and those operated from input power voltage between 200 and 250 volts have the voltage selector positioned to 230 volts.

The battery charger is designed to provide sufficient power to recharge T477W batteries overnight (14-16 hours). When the power supply is used on voltage and frequency other than 115 volts, 60 Hz, charging time will vary. Power supply input voltage smaller than 115 volts (115 volt range) or 230 volts (230 volt range) will require a longer charging time. If the input voltage is greater than 115 volts (115 volt range) or 230 volts (230 volt range), a shorter charging time is required.

The power supply has an adapter plug to convert the standard type plug to a European (round pin) plug.

The power supply connector is provided with a jumper wire used to short the meter voltage sensing input. If the meter is turned on (2 milliohm range) during charge, the meter display should be .000 + or – 2 digits.

NOTE

The power supply design was changed during T477W production from a single voltage 120 volt, 60 Hz, power supply, B15422, to the more flexible B15693 type, which is a voltage selectable 120/240 volt, 50/60 Hz design. Early production T477W Bonding Meters purchased for use in the U.S.A. were supplied with B15422.

Battery Charging

7 APPENDIX - BATTERY TESTING

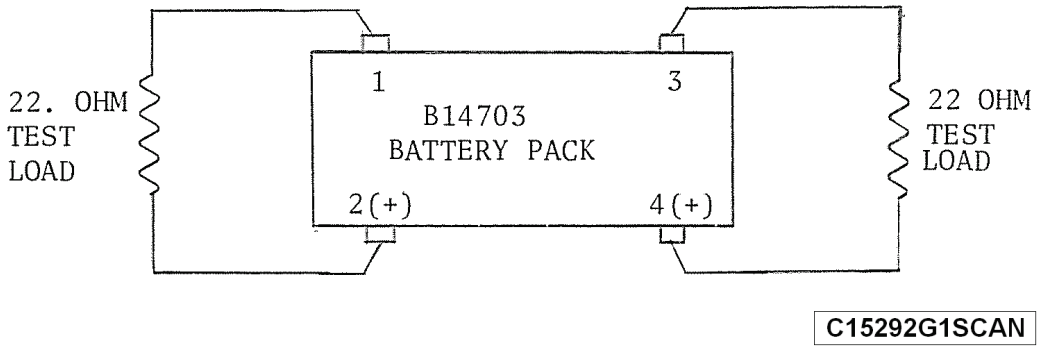


Figure 7-1. Battery Test Schematic

7.1 BATTERY TESTING

1. Recharge the battery pack overnight to assure full charge. Battery may remain on the circuit board with the meter display off.

2. Open the case to gain access to battery pack leads as described in steps 1 and 2 in the B14703 Battery Replacement Instructions (at the end of this manual).

3. Connect 22 ohm, 2 watt, 10% tolerance resistors between terminals 1 and 2 and between terminals 3 and 4. Record the time at which those connections were made. Measure the voltage across the resistors. It should be 4.0 volt + or - 0.2 volts. Leave the resistors connected.

4. Periodically (every 5 minutes or less) measure the voltage across the resistors. When the voltage reaches 3.7 volts, note the time and disconnect the load resistor.

5. Calculate the discharge time, the difference between the time of attaching the load resistor and the time at which the battery voltage reached 3.7 volts. If discharge time is less than 20 minutes (50% capacity), either replace the battery pack or attempt to recycle the battery per step 7.

6. If the battery pack is within test limits, recharge the battery and return it to service.

7. Batteries failing the discharge test may have a memory problem. A battery pack that has a memory problem may be restored to a useable state by repeating the charge/discharge cycle described in steps 1 through 6. Usually batteries require more than one recycle to regain normal capacity. Older batteries or others that have been mistreated may never regain normal capacity but only recover to an acceptable capacity (≥50%). Those batteries which do not regain an acceptable capacity should be replaced.

8. If battery pack is operating properly, reassemble the Bonding Meter.

8 B14703 BATTERY PACK REPLACEMENT INSTRUCTIONS

The B14703 Battery Pack is a UL approved replacement for use in the Avtron T477W Bonding Meter. The use of other Battery Packs voids UL certification and may impair intrinsic safety for meter use in hazardous locations.

Battery Packs are shipped in a discharged condition. Therefore, newly installed batteries must be recharged overnight before use. See T477W manual for recharging instructions.

8.1 Battery Replacement Instructions

1. Remove two screws located on the bottom side of the T477W meter case and remove the case.
2. Remove the two screws retaining the supports attached to the spacers located in each corner of the Printed Circuit Board; then remove supports.
3. Marker, unsolder, and disconnect the four wires connected to battery terminals 1, 2, 3, and 4.
4. Remove the four ¼ inch hexagonal spacers located in each corner of the printed circuit board.
5. Carefully spread the P.C. Boards apart by pivoting the rear board at the end having interboard connections.
6. Remove two screws and washers located on the underside of the printed circuit board which are used to retain the Battery Pack.
7. Remove the Battery Pack. Install the replacement Battery Pack. The Battery Pack must be located within the P.C. Board outline. If not, it may be upside down. If a keying block is not installed, it is recommended that one be installed using epoxy cement as shown below (Figure 8-1).

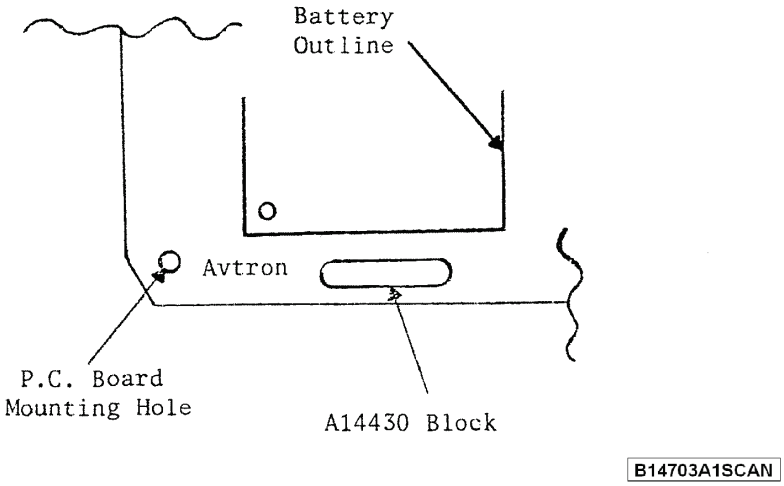


Figure 8-1. Battery Pack Location

8. Check Battery Pack identification terminal numbers. They must be located adjacent to similar numbered connecting wires; that is, 1 goes to 1, 2 goes to 2, 3 goes to 3, and 4 goes to 4.

9. Install Battery Pack mounting screws and washers, previously removed.

10. Reposition printed circuit boards together. Then reinstall ¼" hexagonal spacers in each corner of board.

11. Connect and solder the four wires to their respective battery connections.

NOTE

The instructions in step 12 below may be possible if the replacement battery has sufficient charge.

12. Measure Battery Pack terminal voltages:

    Terminal 2 (Positive) to 1 (Negative)
    Terminal 4 (Positive) to 3 (Negative)

    If voltage is greater than 4.8 volts, the meter may be briefly tested for satisfactory operation. Then recharge overnight.

    If Battery Pack voltage is less than 4.8 volts, do not test meter. Recharge Battery Pack overnight before testing.

13. Following recharge, Battery Pack voltage must be approximately 5.5 ± 0.3 volts.

14. Reinstall case supports and case using hardware previously removed. Do not install case until Battery Pack voltage testing is completed.

9 ESD PRECAUTIONARY GUIDELINES

C A U T I O N

Certain circuit card assemblies and their components, typically integrated circuits, may be damaged by seemingly undetectable electrostatic discharge (ESD). Care must be exercised during handling/repair of these items. Use electrostatic discharge precautionary procedures.

The following guidelines are not necessarily all inclusive but rather serve as reminders for good shop practices for the handling/ repair of ESD sensitive circuit card assemblies and devices.

- Store ESD sensitive items in their original containers. These items are often marked with the symbol shown at the top of this page.
- Put on a grounded wrist strap before handling any ESD sensitive item.
- Clear work area of Styrofoam®*, plastic, and vinyl items such as coffee cups.
- Handle ESD items by the body, never the open edge connectors.
- Never slide ESD sensitive items over any surface.
- Transport ESD sensitive items in a static shielding container to a static-free work station.
- If a static-free work station is not available, ground the transport container before removing or inserting an ESD item.
- Electric tools used during repair should be grounded. For example, use only anti-static type solder suckers and grounded tip soldering irons. Discharge non-electric tools before use.
- Pack ESD items in static shielding containers before shipping them to Avtron for repair.

* Styrofoam® is a registered trademark of Dow Chemical.

ESD Precautionary Guidelines

10 REPLACEMENT PARTS LIST

10.1 Introduction

The parts list in this section contains the description, quantity required, and Avtron part numbers for each listed part. The list also includes, where appropriate, schematic reference designators to facilitate parts identification.

NOTE

Every effort has been made to ensure the accuracy of this information. However, changes are sometimes necessary and revisions to the parts list may be made at any time without notice.

10.2 Reference Designators

Service personnel may use this parts list along with the Avtron system schematics to identify and order replaceable parts. The reference designators were carefully selected and matched to those on the schematic diagrams and equipment to simplify the troubleshooting and repair process.

NOTE

When ordering replacement parts, be certain to state the part's description, Avtron part number, and the schematic reference designator number if one is available. Also include the model and serial number of the equipment

REPLACEMENT PARTS LIST

SCHEMATIC REFERENCE	DESCRIPTION	AVTRON P/N	QTY/ UNIT
	AVTRON MODEL T477W BONDING METER	C15292	
	.Charging Unit	B15693	1
	..Adapter (European)	A14166	1
	.Battery Assembly	B14703	1
	.Probe Set	C22161	1
	.Carrying Case	A15960	1
	Optional Probe Sets:		
	Probe Set	C15478	1
	Probe Set	C15479	1
	Probe Set	C15480	1
	Probe Set	C16695	1
	NOTE: Miscellaneous probe set replacement parts available.		

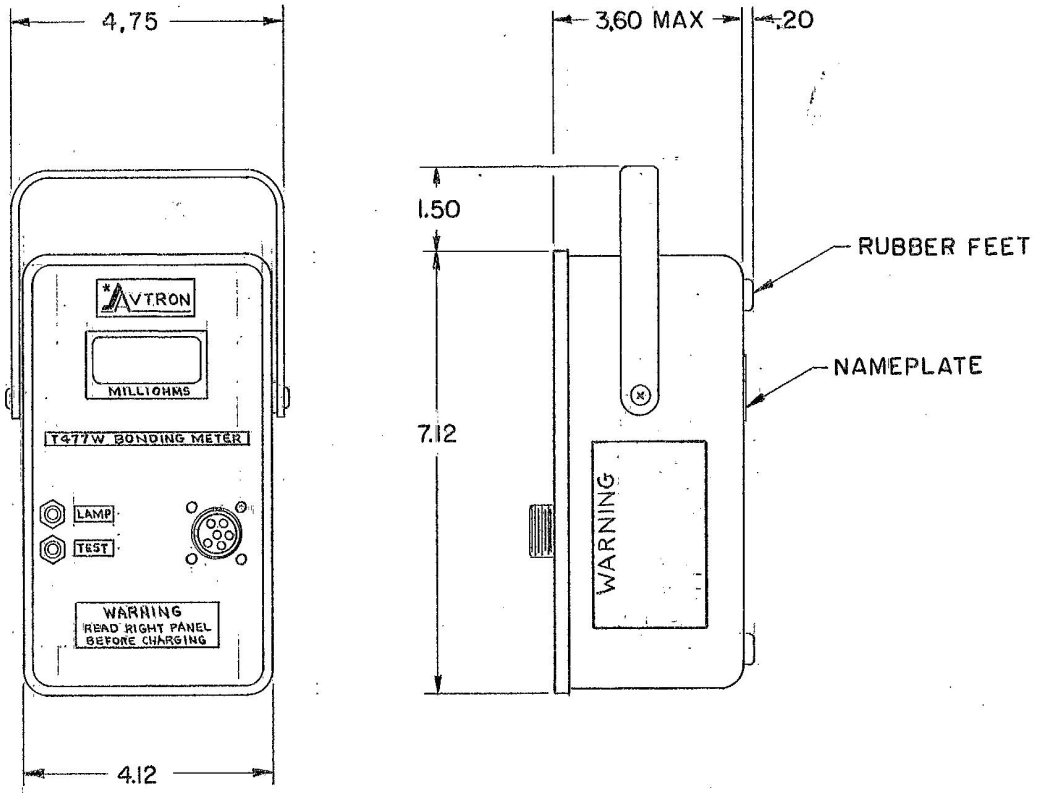
Form No. 755

DRAWINGS

PROPRIETARY NOTE

The wiring diagrams and schematics which follow contain information PROPRIETARY to Avtron Aerospace, Inc. They are furnished solely to provide information sufficient for instruction, operation, maintenance, evaluation, and testing of the equipment herein disclosed; are not to be used for manufacturing or procurement; and are not to be disclosed to anyone other than persons in the Division, or the Company, or the Government, as the case may be, responsible for action relating to this document without the express written permission of Avtron Aerospace, Inc.

Rev. November 1, 2011



FOR APPLICATION ENGINEERING USAGE ONLY

CHG. NO.	LOC. LET.	CHANGE	CHG'D	CHK'D
C		REVISE DIM. ECN Y0846	10-12-84	RD 10/12/84
B		REVISE DIM. ECN X1148	KAS 4-30-81	RM 5-1-81
A		REVISED ECN X997 JC	1-19-81	RM

DRAWN LS | DATE 5-5-80
CHECKED
APPROVED LGK | SCALE 1/2

AVTRON Manufacturing Inc. CLEVELAND, OHIO

BONDING METER

DRAWING NUMBER SB1242

SCAN

OUTLINE DRAWING DWG

2 - ALL DIMENSIONS ARE APPROX.
1 - WEIGHT: 3 LBS.
NOTES:

AVTRON AEROSPACE

Warranty

Warranty and Duration

For a period of one (1) year after installation or fifteen (15) months from date of shipment from its facility, whichever expires first, Avtron Aerospace, Inc. (Avtron) warrants the equipment (Equipment) covered hereunder to be free from harmful defects in material and workmanship. Notwithstanding the foregoing, Avtron warrants its repairs for a period of ninety (90) days from date of shipment from its facility or for the time remaining on any prevailing warranty that covers the item, whichever is the longer.

Use of Equipment

This Warranty applies only on the condition that the Equipment has been utilized, operated, and maintained in a manner consistent with its design parameters and, in accordance with applicable instructions provided by Avtron. Avtron makes no express or implied warranties or representations, except as herein expressly provided, with respect to the Equipment or its intended use. Unless otherwise agreed in writing by Avtron, use of the Equipment in a nuclear facility or application shall render this Warranty null and void and any claims of any kind arising from or after such use are expressly excluded from this Warranty.

Notification of Breach

When claiming a breach of this Warranty, Buyer must promptly (within 15 days from the date of the discovery of the breach) notify Avtron in writing of the claim within the respective and above mentioned warranty period. Notifications (claims) received after such warranty period will be rejected.

Equipment Disposition

Upon notification of a claimed breach of this Warranty, Avtron, at its discretion, will either (i) authorize the return of the defective Equipment, or part thereof, for repair (transportation costs to be prepaid by Buyer), (ii) provide a suitable replacement, or (iii) authorize the Buyer in writing to effect repairs at Avtron's expense. Avtron will pay the freight costs associated with the return of repaired or replacement Equipment to Buyer. Any customs fees, tariffs, duties or taxes incurred in shipping Equipment pursuant to this Warranty shall be the responsibility of the Buyer. The costs associated with the removal of a defective part, the installation of a repaired/replacement part and re-calibration, if any, are the responsibility of the Buyer

Exclusive Remedy

Buyer hereby agrees that its sole and exclusive remedy for any claim arising from or relating to this Warranty shall be for Avtron, at its option, to either replace or repair the defective Equipment or part thereof, or to issue a credit with respect to the defective Equipment or part thereof equal to its purchase price, less depreciation. In no event shall Avtron's liability exceed the original purchase price of the Equipment or part thereof.

Warranty Exclusions

This Warranty specifically excludes Equipment and components that Avtron purchases and resells as part of a system, product, or spare part order. Any warranties provided to Avtron by the manufacturers of the foregoing will be, to the extent possible, passed to the Buyer. Copies of such warranties, if on file at Avtron, will be made available for inspection upon the request of Buyer. It is recommended that purchased items that normally have a short warranty period, such as, but not limited to, computers, operator interface modules and monitors, be covered by a continuous service contract generally available from the original manufacturer. Consumable items, including, but not limited to, lamps, filters, fuses, fluids, motor brushes, are excluded from this Warranty. Paint degradation, e.g., peeling, cracking, dissolving, discoloration, due to harsh environments (high temperatures, phosphate ester oils, etc.) is not covered by this Warranty. Other items or components may be excluded from this Warranty to the extent noted in a governing purchase order or contract. Unless otherwise agreed in advance by Avtron, this Warranty does not cover travel costs of Avtron service personnel to and from the end-user's site, or the living expenses incurred while there.

Assignment

In the event Buyer resells or leases Equipment purchased from Avtron, Buyer may assign the rights and obligations of this Warranty to said purchaser or lessee. It is the responsibility of Buyer to inform Avtron of such an assignment.

Unauthorized Repairs/Modifications

Unless written authorization is first obtained from Avtron, this Warranty does not apply where Buyer has made repairs or modifications of the Equipment and any claim by Buyer for reimbursement of costs associated with such repair/modification will be rejected. Correction by Avtron of any unauthorized repairs or modifications shall be at the expense of Buyer.

Governing Law/Venue/Statute of Limitations/Saving Clause

This Warranty shall be governed by the laws of the State of Ohio and any legal action arising from or relating to this Warranty or the Equipment shall be adjudicated in the state or federal courts encompassed by the U. S District Court for the Northern District of Ohio, USA, and Buyer hereby consents to jurisdiction and venue therein. Buyer and Avtron agree that the statute of limitations for any claimed breach of this Warranty shall be brought within one year of said breach or within such other minimum period allowed by law. Any provision hereof which is deemed prohibited or unenforceable shall not serve to prohibit or make unenforceable any other provision of this Warranty.

Limitation of Liability

IN NO EVENT SHALL AVTRON BE LIABLE IN CONTRACT, IN TORT OR OTHERWISE, FOR SPECIAL, INCIDENTAL, CONSEQUENTIAL OR PUNITIVE DAMAGES INCLUDING, BUT NOT LIMITED TO, LOSS OF PROFITS OR REVENUES, LOSS OF USE OF THE EQUIPMENT OR ANY DAMAGE TO ASSOCIATED EQUIPMENT, PROPERTY DAMAGE OR PERSONAL INJURY, COST OF CAPITAL, COST OF SUBSTITUTE OR TEMPORARY EQUIPMENT, DOWNTIME OR CLAIMS OF CUSTOMERS, ARISING OUT OF OR RELATING TO THIS WARRANTY, THE EQUIPMENT, OR ANY CLAIMED OBLIGATION, ACT OR OMISSION OF AVTRON.

Disclaimer of All Other Warranties

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Form 297 Rev. 4/2014