T.O. 33DA39-71-1

AVTRON MODEL T477W
BONDING METER
Part Number C15292

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PROPRIETARY NOTE

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WARRANTY

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Feb. 1995

AVTRON MANUFACTURING, INC.
Cleveland, Ohio

AVTRON MODEL T477W
BONDING METER
Part Number C15292

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AVTRON MODEL T477W
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SECTION I

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 .2 to 2000 milliohms. Resistance measurements smaller than 0.2 milliohms are possible with reduced accuracy.

The T477W Bonding Meter is supplied with three sets 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	Accuracy
2. Milliohms	1% of Reading + or - 5 digits
20. Milliohms	1% of Reading + or - 5 digits
200. Milliohms	1% of Reading + or - 5 digits
2000. Milliohms	1% of Reading + or - 5 digits

CAUTION

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.

SECTION II

OPERATING INSTRUCTIONS

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.

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 VII for further details on battery charging and power sources other than 120 VAC, 60 Hz.

WARNING

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.

Probes:

Three sets of cables are supplied with the T477W Bonding Meter as follows:

Part Number	Description
C15479	Two single point clamps and two test probes
C15478	Compass probe and dual point clamp
C15480	Dual compass type probes

CAUTION

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

These cables consist of two current leads which connect the bonding meter regulated current output to the unknown resistance and two voltage sensing leads to pick up voltage across the unknown. The voltage sensed is small and the current is alternating; therefore, a small transformer effect (coupling) exists between the current and voltage sensing leads. This effect is minimized when the voltage sensing leads are separate from the current leads. Care must be exercised in the use and selection of probes used with the T477W Bonding Mete

Cable C15479:

Because this cable has separate current and voltage sensing leads, its use minimizes the coupling effect. The rated meter accuracy is obtained only with this cable when connected such that the meter reading is positive. This cable is used for calibrating the T477W Bonding Meter and whenever a measurement accuracy must be within the specified limits.

NOTE

For this cable, the red lead and clamp are positive current. The black lead and clamp are negative current. The red lead and probe are positive potential, while the black lead and probe are negative potential.

The accuracy is known only for meter positive readings. When making a measurement, always place the potential leads closer to the load being measured for better accuracy.

Cables C15478 and C15480:

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

The accuracy is known only for meter positive readings.

When making a measurement, always place the potential leads closer to the load being measured for better accuracy.

These cables do not have separate current and voltage leads. Their use may cause meter reading error due to the coupling effect. These cables should only be used for survey work to establish an approximate resistance.

Meter reading error caused by the use of cables 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 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 C15478 and C15480, form the smallest possible cable loop.

For these two probes, the clamp grip, the compass pin mountings, and all the leads match the specified color code (i.e., black for current, red for potential). When making a measurement using either one of these two probes, the bond being measured should be placed between the two compasses (probe C15480) or between the clamp and the compass (probe C15478) in order to have a meter positive reading.

All three cables--C15479, C15478, and C15480--are useful. The use of a particular cable depends on the size and shape of the two bonded materials in the vicinity of the bond.

C15478: Used where edges are exposed and on tubing. The use of this probe allows the operator to make a measurement and at the same time monitor the meter.
C15479: Used on tubing and where edges are exposed.
C15480: Used where the connections have to be made on the surfaces of the two bonded materials.

Custom Cables:

T477W cables 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 cables is not recommended.

Meter Operation:

Select one of the three probes (see Probes Section II) 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. 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.

In order to conserve battery power, a built-in timer automatically shuts off the display after 52 seconds of operation.

The meter display is a liquid crystal type. The display may be illuminated by pressing the LAMP button located on the front panel. Meter range is not effected by the lamp button; however, meter shutdown timing is delayed while the lamp button is activated.

Battery Endurance:

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

Temperature - Capacity is rated for room temperature operation (25°C) and is tested for operation at 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.

Batteries should be replaced when they have reached 50% capacity or less.

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 probe connected to load
26 seconds current probe not connected to load
(including 2 seconds lamp operation)
128 seconds shutdown
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.

Meter Usage:

The T477W is used by connecting a probe to the input connector J1, turning the meter on, and connecting the probe across the resistance or bond to be measured. If probe connections are not adequate, the meter will display flashing decimal points. This flashing must be corrected to insure meter accuracy. It is frequently caused by poor connections between the probe current connections and the resistance to be measured. Due to the small magnitude (.2 amperes and .1 volts maximum) of the current and voltage presented to the unknown resistance, good electrical connections are necessary. Coatings such as paint or anodizing must be penetrated or removed to insure good electrical connections. The meter display will be stable when probe connections are adequate.

The battery powering the T477W has been designed intentionally to limit power and insure safety when used in hazardous locations. This constraint limits power available to drive current through the unknown resistance. Inadequate current flow is indicated by flashing display decimal points. These power limitations are most noticeable on the .2 milliohm range where power is sufficient to drive current through an external current loop burden resistance of .2 ohms. The combined resistance of probes, contact connections, and unknown resistance must be less than .2 ohms (200 milliohms). Normally this resistance is no problem. However, extra long leads or semi-insulated surfaces may cause difficulty. The external current loop resistance is not a problem on higher resistance ranges since the burden resistance increases. For example, the minimum current loop burden resistance is 4 ohms on the 20 milliohm range, 40 ohms on the 200 milliohm range, and 400 ohms on the 2000 milliohm range.

All meter displays are in milliohms. The decimal point is automatically positioned for each range. If a display is overrange, as indicated by flickering digits, select a less sensitive range by pressing the TEST button.

CAUTION

The T477W Bonding Meter accuracy is significantly effected 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.

SECTION III

CIRCUIT DESCRIPTION

The T477W is designed to measure values of resistance from 2000 milliohms to less than .2 milliohms. Connections to the unknown resistance are made by four wire (Kelvin) connections which consist of 2 current and 2 voltage sensing leads. The meter circuit provides a regulated current which is fed to the unknown, and the voltage generated across that unknown is sensed. Since the sensed voltage is caused by a constant current, voltage is proportional to resistance and the meter interprets voltages in terms of resistance.

Circuit operation is best understood by review of the schematic diagram, D14731.

A crystal controlled oscillator, U7, generates 320 KHz power which is digitally divided by U6. The resulting waveform is processed for phasing by programmed integrated circuit U2 to form three waveforms: 78 Hz square; 256 and 32 Hz pulse width modulated. The 78 Hz waveform is chopped by U5, amplified by U19, Q3 and Q4. Feedback loop filter U17 attenuates unwanted frequencies from the output transformer T3. Another feedback loop formed from T3 through amplifier U18 generates a reference signal for range selector U16. Output from U16 is fed to U19 through range selection resistors R27, R26, R25 and R24. Transistor Q5 is used to reduce low range series resistance inserted by U16.

The output from transformer T3, winding S4-F4, supplies regulated current to the unknown resistor. Maximum current, .2 amperes, is delivered on the 2 milliohm range. The magnitude is proportionally reduced on higher ranges.

Voltage input sensed across the unknown resistance is connected to input transformer T2, winding S3-F3. That input is amplified by U17, U13 and U14 and passed onto transformer T1 where additional amplification is performed by U15. Balanced voltage presented to demodulator U12 is synchronized with 32 Hz and the resulting voltage is passed to the digital voltmeter where it receives further internal processing before display.

An open power lead detector monitors voltage from Q3 and Q4 and identifies the condition where inadequate current is delivered to the probe. Inadequate current is detected by U10 and causes the meter decimal points to flash.

Meter TEST pushbutton, S1, when activated, generates a pulse which causes flip flop U8 to set itself to one of four logic states which are interpreted by range changer U16. Switch S1 also resets timer U4, multi-stage flip-flop, which counts down and generates a pulse to shut down the meter display.

The power supply consists of a battery package containing nickel cadmium batteries, BT1 and BT2, and current limiting resistors, R7 and R8. Battery power is connected to the circuit by switch S1 which turns on transistors Q1 and Q2 (FETS). Batteries are recharged from an external charging supply connected into the circuit through connector J1. The charger supplies

power which is current limited by R11 and rectified by CR1, CR2, CR3 and CR4. One battery is charged on the positive power cycle and the other battery on the negative cycle.

Deactivation of Q1 and Q2 causes shut down of the meter display to conserve battery power. Most but not all battery current drain is shut down and a small sustaining current, less than .05 milliamperes, flows continuously.

SECTION IV

CALIBRATION AND MAINTENANCE PROCEDURES

Calibration:

The T477W Bonding Meter contains no calibration adjustments. Therefore, periodic calibration is not required.

The circuit is composed of solid state devices which have been subjected to extensive testing, and few failures are anticipated. However, periodic testing against a known resistance standard is recommended. Testing may be performed using the K777 Test Fixture.

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 impare intrinsic safety. It is generally recommended that a malfunctioning meter be returned to Avtron for repair.

Preventive Maintenance:

The T477W is powered by rechargable nickel cadmium batteries.

The battery pack is the most likely component in the T477W to require maintenance. The pack is potted to insure 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 needed 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 fully discharged before recharging. The most common battery problems anticipated are overdischarged, overcharged and short cycled batteries.

Overdischarge occurs when the T477W is used following the "LO BAT" display. Batteries may be discharged to the point where one or more battery cells are depleted and cell current flow is reversed. Furthermore, extremely deep discharge may obstruct automatic shut down 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 short cycled memory.

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 a 22. ohm, 2 watt resistor, and measure the terminal voltage. It should be 4 volts + or - .2 volts for a fully charged battery. A better test to insure battery capacity is to make a time-current test as described in the Appendix.

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 insure safety. The testing procedures outlined in the appendix will be helpful in avoiding unnecessary replacement.

Caution During Bench Testing:

The automatic meter display shut down function requires part of the circuit to be powered at all times. Exercise CAUTION when working on the circuit board with the battery connected. If it is necessary to deactivate the circuit board, disconnect battery terminals 1 and 4.

Meter Shutdown Disable:

The automatic meter shut down is inconvenient during test procedures. The meter shut down may be disabled by first pressing the TEST button and then removing the timer jumper wire located adjacent to U4. The meter will remain on unless reset by electrostatic potentials, and must be shut down by reinstalling the jumper wire.

The meter supplied with timer U4 is set to provide 52 seconds of operating time. This time may be lengthened or shortened by unsoldering and repositioning the jumper wire socket to the appropriate timer connection as shown on the circuit board and the schematic diagram.

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 this symbol .
- Put on a grounded wrist strap before handling any ESD sensitive item.
- Clear work area of Styrofoam^{R}*, 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^{R} is a registered trademark of Dow Chemical.

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SECTION V

TROUBLESHOOTING

The T477W troubleshooting procedures are divided into two sections; battery pack and component failure.

Problems with the battery pack are relatively easy to diagnose and correct. It is recommended that component level problem solutions only be attempted by persons having extensive analog/digital experience and appropriate test equipment.

Battery Problems:

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 labelled B14703 located in the middle of the bottom circuit board. The battery connections are the four terminals labelled 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. 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 appropriate indication of battery condition.

Following battery testing, a defective battery pack may be removed by unsoldering the four printed circuit board connections, 1, 2, 3, and 4 and separating the printed circuit boards. To separate the boards, remove the four screws holding the spacers attached at each corner of the board. Remove the four, 1/4 inch hex spacers located at each corner of the boards. Swing the rear board out from the inner board. Care must be exercised during board separation to avoid breaking the board interconnecting wires. After the two boards are separated, remove the two mounting screws, and remove the battery pack. To insure intrinsic safety, replace the battery pack with Avtron part number B14703 only.

A new battery pack may be installed by reversing the procedure followed to remove the old one. Be certain all screws are tightened following battery replacement to prevent loose screws from falling into the circuit.

If the replacement battery is not fully charged, it is recommended that it be charged and retested per the Appendix battery testing procedures.

Component Level Repairs:

These troubleshooting procedures should only be attempted by persons trained in analog/digital techniques and having appropriate test equipment.

TROUBLESHOOTING

Symptom	Probable Cause
Battery does not charge.	-Charger not plugged in. -Broken charger connection wire. -Defective charger. -R11, CR1, CR2, CR3 or CR4 defective. -Open battery.
Display does not turn on.	-Q1 or Q2 defective. -U9 or U4 defective. -S1 defective. -Dead battery.
Meter "Display On" timing error (greater than 2 sec.)	-U7 or Y1 defective. -U6 defective. -U4 defective.
No range change.	-U8, U16 defective. -U4 defective.
No 78 Hz at T3, winding S4-F4.	-U5, U19, Q1, Q2 defective. -U16 defective. -Oscillator U7, Y1 defective. -Open range resistor R27, R26, R25, R24 defective. -U18, CR9, CR10, CR11, CR12 defective.
No 78 Hz input at T1 winding S3.	-No input from probe. -T2, U17, U13, U14 defective.
No balanced input to U12, terminal 4 and 16.	-T1, U15 defective. -R12, R13, C8, C9, C10 defective.
No DPM input (Balanced Pulse Width Modulated)	-U12, R14C, R14D, C11 defective. -No 32 Hz input.
No Meter Digit display.	-DPM defective. -No input voltage, pin 3. -Meter not turned ON.
No DPM lamp illumination.	-S2, R15 defective. -Open lamp.
No open power lead DPM indication of decimal point flashing.	-No open lead condition (waveform flat topping at T3 winding S3). -R29, U10, U11 defective. -CR17, CR18, CR19, R6 defective. -DPM defective.

TROUBLESHOOTING (Cont.)

Symptom	Probable Cause
No decimal point position change with range change.	-U4, U8, U9, U11 defective. -CR17, CR18, CR19 defective. -DPM defective.

Note that zener diodes located inside transformers T1, T2 and T3 perform no active circuit function. Their purpose is to insure safety by preventing a transformer inductive "kick" in the event of circuit malfunction.

CAUTION

Component replacement on Printed Circuit Boards must be conducted with great caution so as not to damage foil paths. A solder point should be heated only to the degree necessary tc remove or install a component. Overheating a solder point can cause breaks in foil paths which can render the board unusable.

Some T477W components may be replaced with commercially available components. These parts are identified in the replacement parts list by a commercial part number. Parts identified only by Avtron number must not be replaced with commercial parts. Substitution of parts with other than Avtron approved parts may affect meter intrinsic safety.

Waveform Comparison Troubleshooting:

This troubleshooting technique makes use of an oscilloscope to display waveforms found in the T477W circuitry. Observed waveforms, when compared to the waveforms depicted on the following pages, serve to localize circuit problems to a section of the circuit. Waveform measurements require the availability of test equipment and a person having extensive analog/digital experience.

Test Equipment Required:

1. Oscilloscope, having:
   - Frequency Response - 15 megahertz or greater
   - Vertical Sensitivity - 2. millivolts/division, minimum
   - Sweep Synchronization - External and Input waveform
   - Probes - X1 (no attenuation) having fine pointed contacts; two probes required
2. Calibration Test Resistors:
   - Milliohm Resistance - 0.10, 1.0
   - Accuracy - ±5% or better
   - (K777, Calibration Test Fixture, is recommended)
3. Adjustable Resistor: 0 to 1.0 ohm (having connections to fit C15479)
4. Test Cable C15479.

Test Procedure:

Before making any waveform measurements, the battery must be fully charged and its open circuit voltage must be 5.3±.3V, as measured at terminals 1-2 and 3-4.

Unless otherwise noted, all oscilloscope ground connections are made to the terminal stud located adjacent and connected to battery terminal 2. Connections having two connection points identified have the oscilloscope ground lead floated. Furthermore, oscilloscope waveforms with the notation "Synchronize Scope to TP2" require use of the external scope sync input which is to be connected to test point 2. Waveforms which require use of loads must have current and voltage connections to the test load to obtain indicated waveforms. It is recommended that those connections be made through the T477W Panel Input Connector.

The T477W Schematic Diagram, D14731, is sectioned off into functional blocks. The names of the functional blocks appear on the schematic and on the following listing of applicable waveforms. Observed waveforms which deviate from those listed are cause to suspect wiring or component malfunction. After checking all wiring, components within a functional block may be isolated and tested using the schematic diagram as a guide.

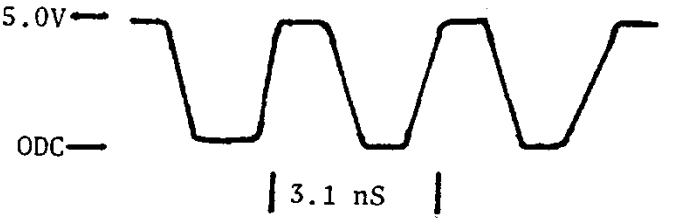
The following conditions apply to waveforms and test set-up:

T477W is activated on 2.0mΩ range unless otherwise indicated.

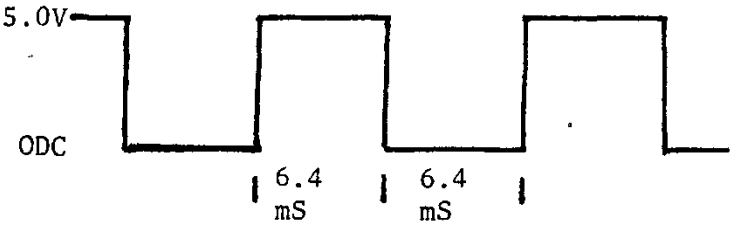
Waveforms generated make use of test load resistors found in the K777 Calibration Test Fixture. If test load is not specified, waveform is not affected by changing the test load.

"REQUIRES EXTERNAL RESISTOR" means that an adjustable resistor (0-1.0 ohm) is required in the current loop (T3; S4-F4) to cause the indicated waveform to be generated. A 0-1.0 ohm variable resistor is not a part of the K777 Calibration Test Fixture and must be provided separately. It may be connected to the current circuit using T477W Cable Set C15479.

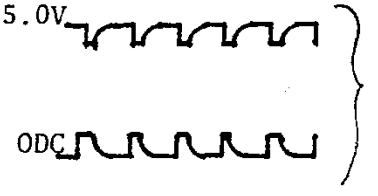
FREQUENCY SYNTHESIZER
TP1
(U7, PIN 9)



TP2
(U5, PIN 11)

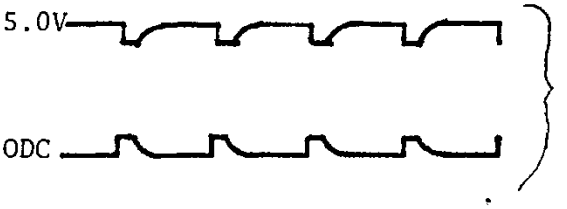


TP3
(U5, PIN 9)
Synchronize Scope to TP2



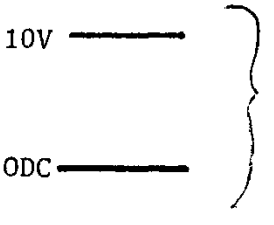
Pulse Width Modulated Waveform with 0.1 µS/DIV. Sweep Speed pulses show width variation from .05 to .03 µS. With 2 mS/DIV sweep a pulse period (notch) is 12.6 mS.

TP4
(U3, PIN 11)
Synchronize Scope to TP2



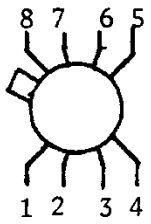
Pulse Width Modulated waveform similar to TP3 except pulse width is significantly greater using .2 µS/DIV.

MODULATION METER
TP5
(U5, PIN 12)



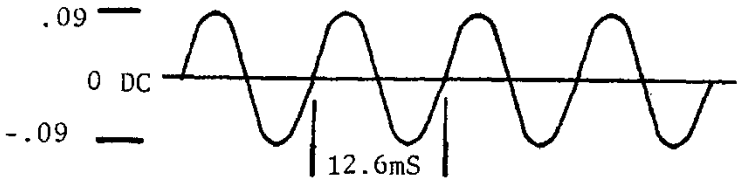
DC Reference Voltage Nominal
Value as displayed by oscilloscope.

TOP VIEW

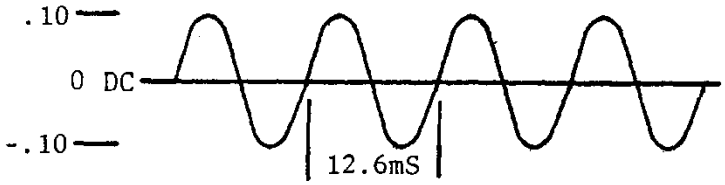


TO-5 Can Contact Location

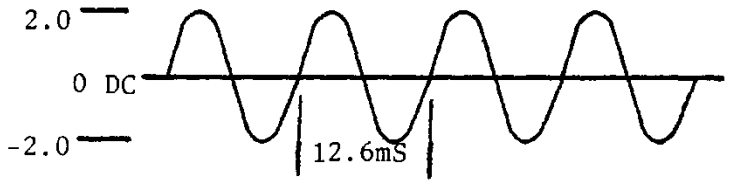
DRIVER
TP6
(U19, PIN 3)



TP7
(U19, PIN 2)

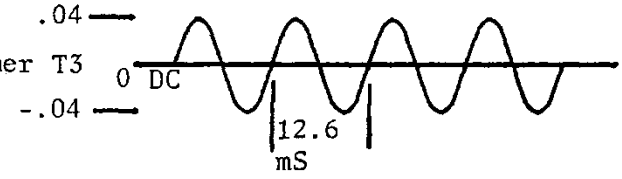


TP8
Transformer T3
S3 to F3



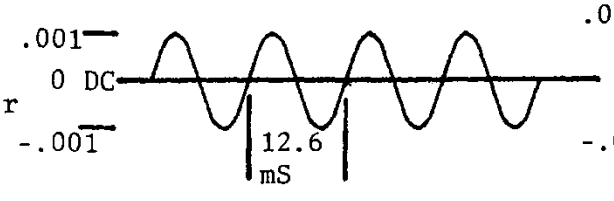
.10 or 1.0mΩ Test Load

TP9
Transformer T3
S4 to F4

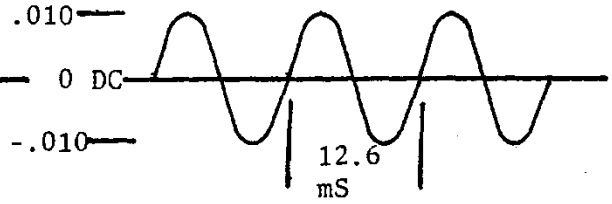


Voltage Amplitude Varies with Current loop resistance. Use optional external adjustable resistor to change amplitude.

DETECTOR
TP10
Transformer
T2
S2 to COM

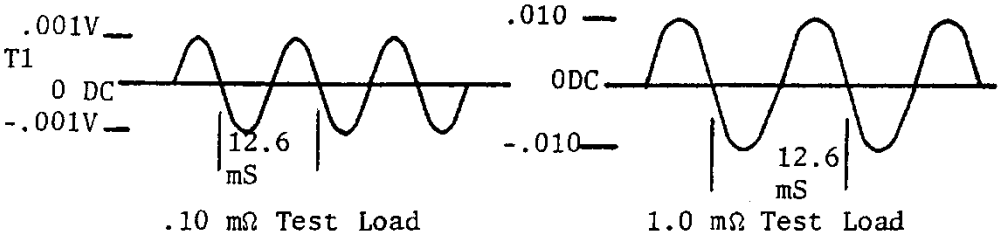


.10 mΩ Test Load



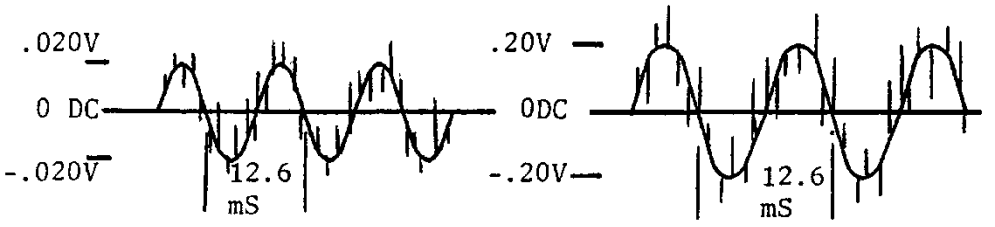
1.0 mΩ Test Load

TP11
Transformer T1
S3 to COM



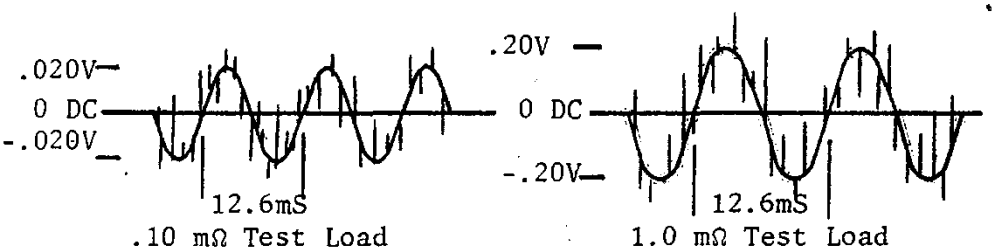
.10 mΩ Test Load — 1.0 mΩ Test Load

TP12
(U12, PIN 4)
Synchronize
Scope
to TP2



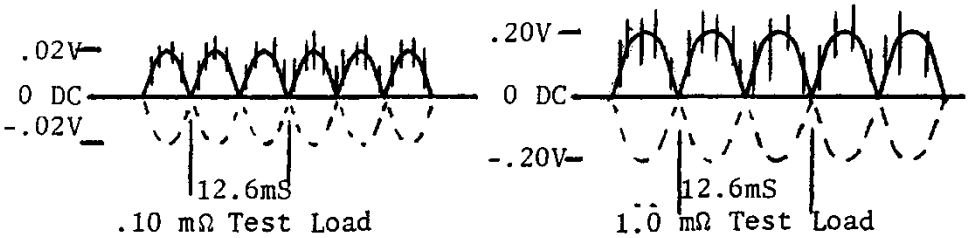
.10 mΩ Test Load — 1.0 mΩ Test Load

TP13
(U12, PIN 16)



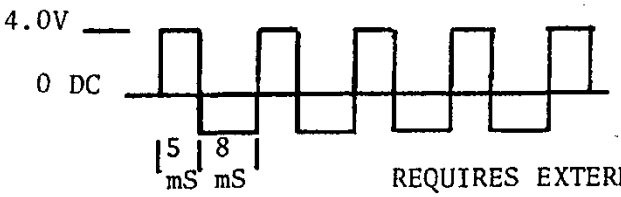
.10 mΩ Test Load — 1.0 mΩ Test Load

DPM & DECIMAL POINT DRIVER
TP14
(DPM, PIN 13)
Synchronize
Scope
to TP2



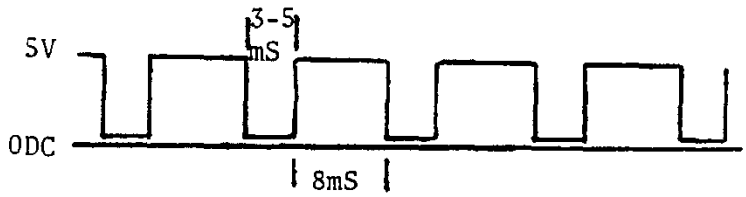
.10 mΩ Test Load — 1.0 mΩ Test Load

OPEN POWER LEAD DETECTOR
TP15
(U10, PIN 10)



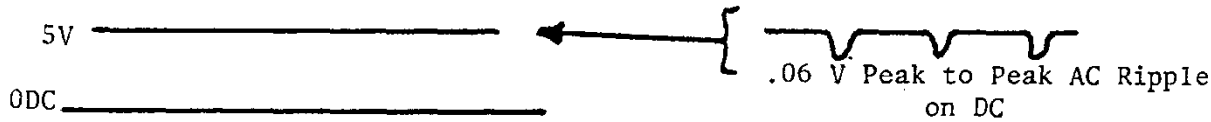
REQUIRES EXTERNAL RESISTOR set to cause decimal point flashing.

TP16
(U10, PIN 2)

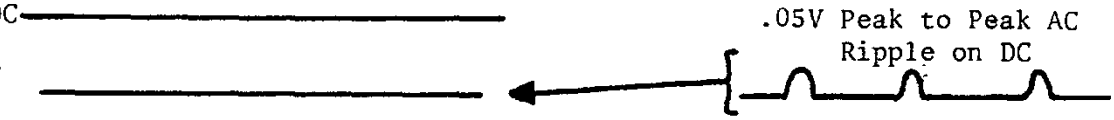


REQUIRES EXTERNAL RESISTOR set to cause decimal point flashing.

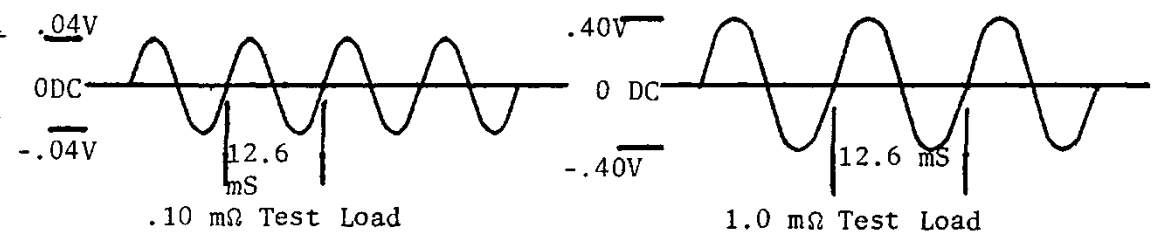
POWER SUPPLY
TP17
Battery
Terminal 4



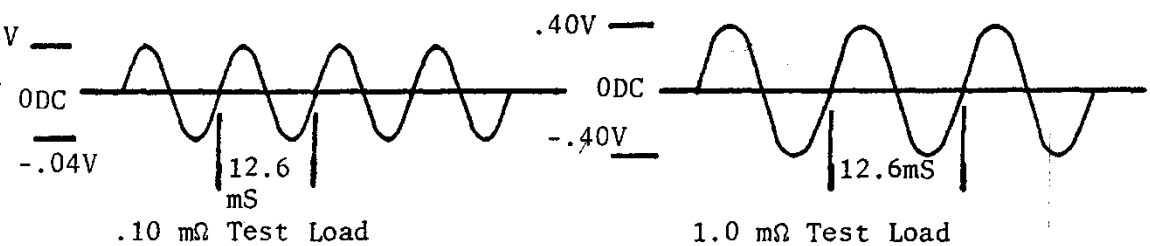
TP18
Battery
Terminal 1



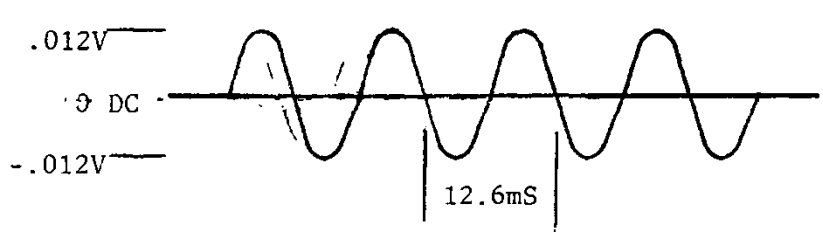
TRANSFORMER
WINDINGS
TP19
Transformer
T1
S1 to F1



TP20
Transformer
T1
S2 to F2

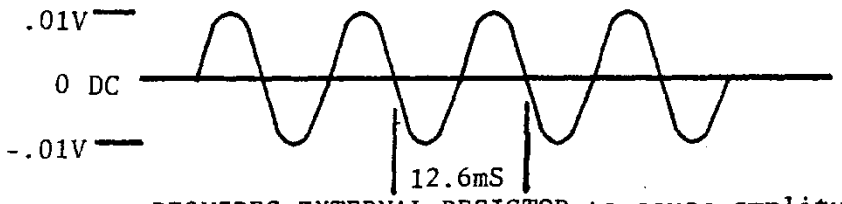


TP21
Transformer
T3
F2 to S2



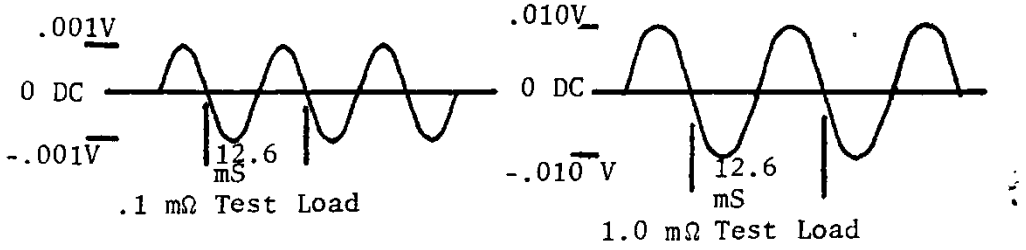
REQUIRES EXTERNAL RESISTOR to cause amplitude variation.

TP22
Transformer T3
F1 to S1



REQUIRES EXTERNAL RESISTOR to cause amplitude variation.

TP23
Transformer T2
S1 to F1



SECTION VI

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 a hazardous location.

The battery charger is a transformer isolated power supply which is designed to accomodate 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.

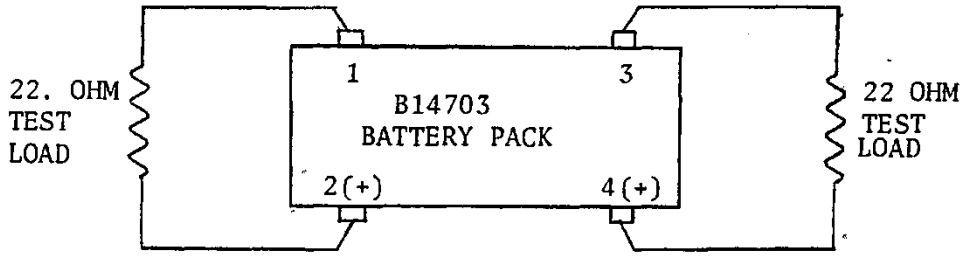
The power supply has an adapter plug to convert the standard type plug to a European (round pin) plug.

The power supply 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 USA are supplied with B15422.

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 ØØØ + or - 2 digits.

SECTION VII

APPENDIX:



Battery Test Schematic

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. 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 - .2 volts. Leave the resistors connected.

3. Periodically (every 5 minutes or less) measure the voltage across the resistors. If and when that voltage reaches 3.3 volts, note the time and disconnect the load resistor.

4. Calculate the discharge time, the difference between the time of attaching the load resistor and the time at which the battery voltage reaches 3.3 volts. If discharge time is less than 20 minutes (50% capacity), either replace the battery pack or attempt to recycle the battery per step 6.

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

6. Batteries failing the discharge test may have a memory problem. This can be determined by repeating the battery charge/discharge cycle starting at step 1. Batteries which recover their rated discharge capacity may be returned to service. Some batteries may require more than one recycle to regain normal capacity. Those batteries which do not regain normal capacity should be replaced.

REPLACEMENT PARTS LIST

SCHEMATIC REFERENCE	DESCRIPTION	MANUFACTURER and PART NO.	AVTRON P/N	QTY/ UNIT
	AVTRON MODEL T477W BONDING METER		C15292	
	.Charging Unit		B15693	1
	..Power Supply		A14165	1
	..Connector, Plug	TRW C48-16R-14-7SN (102)	313932	1
	..Contact, Socket	Bunker-Ramo 248-136-1600S-02	312244	7
	..Adapter (European)		A14166	1
	.P.C. Board, Programmed		630081	1
	..P.C. Board Assembly		A13823	1
T1,T2	...Current Transformer		C15148	2
T3	...Current Transformer		C15147	1
R1,3,4,5,22	...Resistor, 33K, 1/4 W, 5%		113035	5
R2	...Resistor, 1K, 1/4 W, 5%		113024	1
R6	...Resistor, Network, 100K, 0.3W	155018	1	
R9,10,15	...Resistor, 27 ohms, 2W, 5%		134382	3
R11	...Resistor, 180 ohms, 2W, 5%		134381	1
R12,13	...Resistor, 22K, 1/4 W, 5%		113034	2
R14	...Resistor, Network, 1K, 0.3W		155016	1
R16,30,31	...Resistor, 56K, 1/4 W, 5%		113079	2
R17	...Resistor, 8.2M, 1/4 W, 10%		115071	1
R18,19,20, R29,35	...Resistor, 10K 1/4 W, 5%		113030	5
R21	...Resistor, 680 ohms, 1/4 W, 5%		113078	1
R23	...Resistor, 22M, 1/4 W, 10%		115083	1
R24	...Resistor, 10 ohms, 0.15W, 0.01%		118949	1
R25	...Resistor, 90 ohms, 0.15W, 0.01%	118882	1	
R26	...Resistor, 900 ohms, 0.15W, 0.01%		118881	1
R27	...Resistor, 9K, 0.15W, 0.01%		118879	1
R28	...Resistor, 1.2K, 1/4 W, 5%		113080	1
C1,2	...Capacitor, 15mf, 16V	Sprague 199D156X9016CA1	221531	2
C37	...Capacitor, 0.001 uF	AVX Ceramics MA101C102MAA	241110	1
R30	...Resistor, 39K ohms, 1/4 W, 5%		113063	1
R37	...Resistor, 10 M, 5%		113070	1
C3,14,15,16, C17,23,26, C27,30,31	...Capacitor, 0.01mf, 50V	Kemet C315C103K5R5EA	241105	10
C4,20	...Capacitor, 0.001mf, 1000V	Sprague DD-102	245012	2
C5,6,7,12, C13,24	...Capacitor, 33mf, 10V	Kemet T354F336M010AS	221530	6
C35	...Capacitor, 82pf, 500V	Cornell-Dubilier CD15ED820J03	235226	1
C8,9,10, C18,19,36	...Capacitor, 430pf, 500V	Cornell-Dubilier CD19FD431J03	235219	6

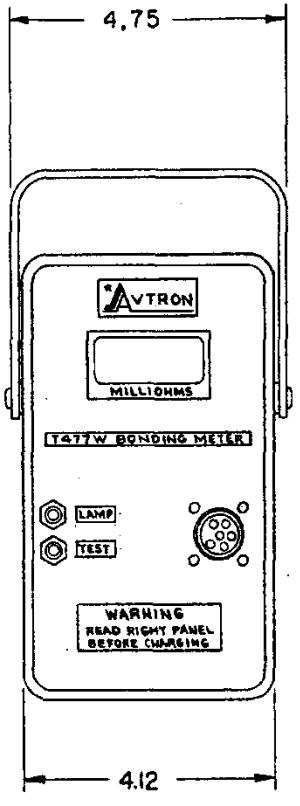
SCHEMATIC REFERENCE	DESCRIPTION	MANUFACTURER and PART NO.	AVTRON P/N	QTY/ UNIT
C11,33	...Capacitor, 33pf, 500V	Cornell-Dubilier CD15ED330J03	235015	2
C21,22,28,34	...Capacitor, 0.1mf, 50V	Kemet C410C104M5U5CA	241056	4
C25	...Capacitor, 0.0047mf, 100V	Centralab CW15A472K	241067	1
C29	...Capacitor, 100pf, 500V	Cornell-Dubilier CD15FD101K03	235204	1
L2	...Choke, 6.8mH	Nytronics, Inc WEE-6800	308117	1
R32	...Resistor, Selected in Test			1
J2	...Connector, Printed Circuit	Bunker-Ramo 143-010-03	313208	1
CR1-20	...Semiconductor, IN457A	TRW IN457A	354397	20
Y1	...Crystal, 320 KHz	Radio Material Corp. Per Description	354817	1
Q1,2	...Transistor		A14201	2
Q3	...Transistor	Per Mil-S-19500 JANTX2N2907A	373618	1
C32	...Capacitor	Cornell-Dubilier CD19FD561J03	235224	1
Q4	...Transistor	Per Mil-S-19500 JANTX2N2222A	373620	1
Q5	...Transistor	Intersil, Inc 2N5434	373992	1
U1,3	...Integrated Circuit	National Semi. MM74C163J	376847	2
U6	...Integrated Circuit	Motorola MC14040AL	376841	1
U5	...Integrated Circuit	RCA CD4053BF	376858	1
U7	...Integrated Circuit	Fairchild 4023DC	376811	1
U8	...Integrated Circuit	Motorola MC14013BCL	376803	1
U9	...Integrated Circuit	Motorola MC14011BCPDS	376802	1
U10	...Integrated Circuit	RCA CD4007AF	376857	1
U11	...Integrated Circuit	Motorola C14070B	376864	1
U12	...Integrated Circuit	Intersil 1H5142CPE	376896	1
U13,18,19	...Integrated Circuit	Fairchild 308AH	376648	3
U14	...Integrated Circuit	Texas Instrmts. TL071CP3	376703	1
U15,17	...Integrated Circuit	Texas Instrmts. TL072CJG	376918	2
U16	...Integrated Circuit	Motorola MC14052BAL	376869	1

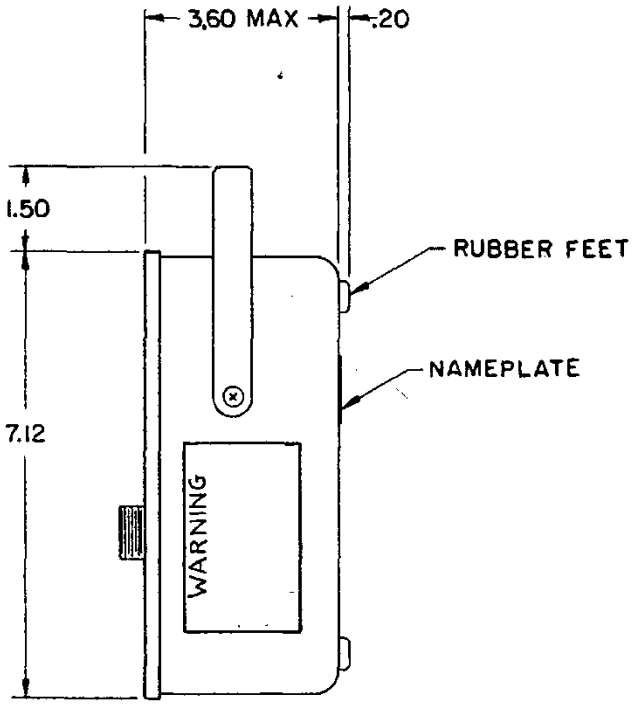
SCHEMATIC REFERENCE	DESCRIPTION	MANUFACTURER and PART NO.	AVTRON P/N	QTY/ UNIT
	...Contact, Pin	Bunker-Ramo 14-1825-02	312245	7
S1,2	...Switch, P.B.	George Risk DC-HA	360149	2
J1	...Connector, Recp	Amphenol 48-10R-14-UPN	313947	1
U4	...Integrated Circuit	RCA CD4020AF	376848	1
U2	...Integrated Circuit		680029	1
R33	...Resistor, 15K, 1/4 W, 5%		113032	1
R34,36	...Resistor, 1M, 1/4 W, 5%		113044	2
DPM	...Meter		A22664	1
	.Cable, Test		C15478	1
	.Cable, Test		C15479	1
	.Cable, Test		C15480	1
	.Schematic		D14731	REF
	.Battery Assembly		B14703	1
	.Schematic		D14731	REF

DRAWINGS

PROPRIETARY NOTE

The wiring diagrams and schematics which follow contain information PROPRIETARY to Avtron Manufacturing, Inc., 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 Manufacturing, Inc.





FOR APPLICATION ENGINEERING USAGE ONLY

- ALL DIMENSIONS ARE APPROX.
- WEIGHT: 3 LBS.

C	REVISE DIM. ECN.Y0846	10-12-84	RD 10/17	DRAWN LS	DATE 5-5-80	AVTRON Electronics Inc. CLEVELAND, OHIO	DRAWING NUMBER SB1242
B	REVISE DIM. ECN X1148	KMS 4-30-91	RM 5-1-91	CHECKED			
A	REVISED ECN1997 JC	1-19-91	R.M.	APPROVED LGK	SCALE 1/2	BONDING METER	

B14703 BATTERY PACK
INSTALLATION INSTRUCTIONS

The B14703 battery pack is a UL approved replacement for the T477W Bonding Meter. The use of other battery packs voids UL certification and may impare intrinsic safety for meter use in hazardous locations.

Battery packs are shipped in a discharged condition. Therefore, it is recommended that newly installed batteries be recharged overnight before use. See T477W manual for recharging instructions.

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.

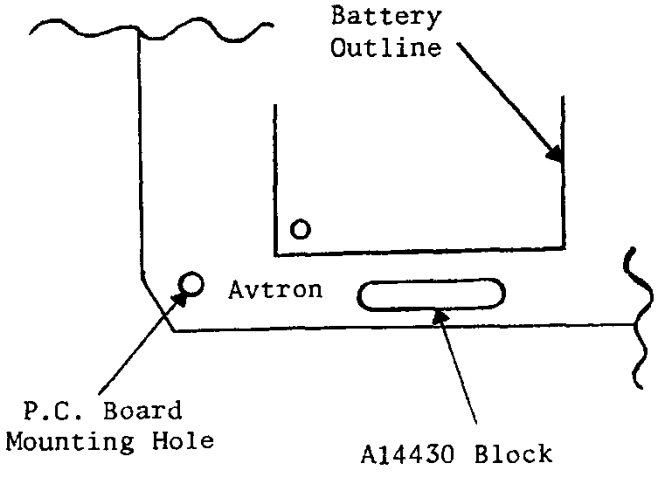
3. Unsolder and disconnect the four wires connected to battery terminals 1, 2, 3 and 4.

4. Remove the four 1/4 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. Install the replacement battery. The battery 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:



8. Check battery 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, 4 goes to 4.

9. Install battery mounting screws and washers, previously removed.

10. Reposition printed circuit boards together. Then reinstall 1/4" hexagonal spacers in each corner of board.

11. Measure battery terminal voltages:

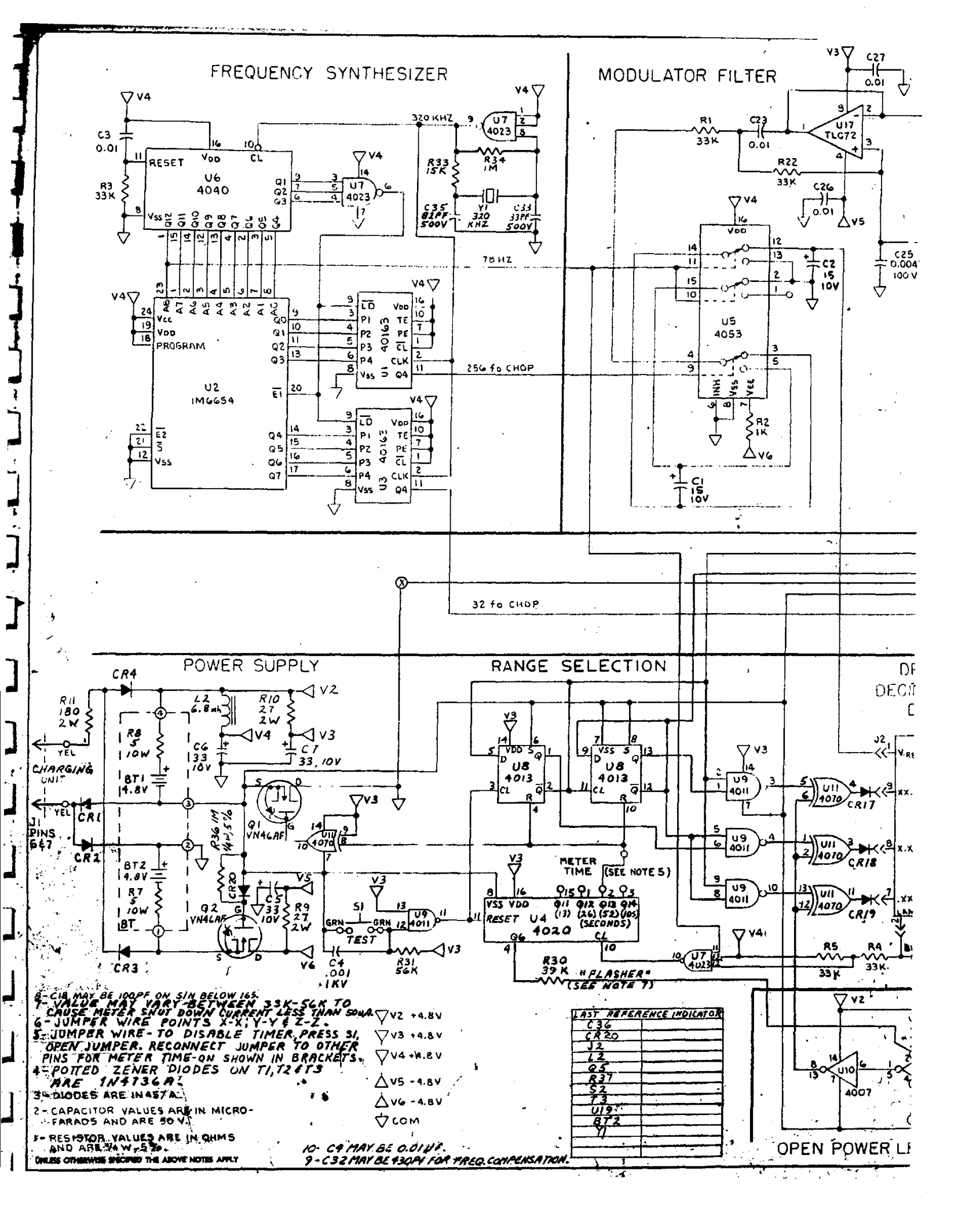
    Terminal 2 (Positive) to 1 (Negative)
    Terminal 4 (Positive) to 3 (Negative)

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

    If battery voltage is less than 4.8 volts do not test meter. Recharge batteries overnight before testing.

12. Following recharge, battery voltage must be approximately 5.5±.3 volts. If not, then check charging circuit for defective connections on components.

13. Reinstall case supports and case using hardware previously removed. Do not install case until battery voltage testing is completed.



8- C18 MAY BE 100PF ON S/N BELOW 165.
7- VALUE MAY VARY BETWEEN 33K-56K TO CAUSE METER SHUT DOWN CURRENT LESS THAN 50uA.
6- JUMPER WIRE POINTS X-X; Y-Y & Z-Z.
5- JUMPER WIRE TO DISABLE TIMER. PRESS S1, OPEN JUMPER. RECONNECT JUMPER TO OTHER PINS FOR METER TIME-ON SHOWN IN BRACKETS.
4- POTTED ZENER DIODES ON T1, T2 & T3 ARE 1N4736A.
3- DIODES ARE IN457A.
2- CAPACITOR VALUES ARE IN MICRO-FARADS AND ARE 50 V.
1- RESISTOR VALUES ARE IN OHMS AND ARE 1/4 W, 5%.
UNLESS OTHERWISE SPECIFIED THE ABOVE NOTES APPLY

10- C9 MAY BE 0.01 uF.
9- C32 MAY BE 430PF FOR FREQ. COMPENSATION.

V2 +4.8V
V3 +4.8V
V4 +9.8V
V5 -4.8V
V6 -4.8V
COM

REVISION				
ECN NO	LTR	DESCRIPTION	DATE	APPROVED
Y8956	L	ADDED R35 & C37	2-29-88	
Y8391	M	R20 WAS 56K	10-31-88	
Z0035	N	REV. 114 & ADDED R36	3/14/89	
Z0823	P	C1 & C2 WERE 100, 3V	7-7-89	
Z3276	R	ADD R37, C32 WAS 100 PF.	7-24-90	

REVISIONS				
ECN NO.	LTR.	DESCRIPTION	DATE	APPROVED
X110	A	REVISED PER ECN	4-15-80	
X946	B	REVISED PER ECN & MARKED PRINT. RPW	1-30-81	
X1101	C	REVISED PER ECN. RPW	3-25-81	
X1184	D	C1 WAS J1/A; C2 WAS J1/B; PROBE CURRENT WAS POWER PROBES; P1 WAS J1/C; P2 WAS J1/D; PROBE POTENTIAL WAS SENSING PROBES; DELETED J1/E AT A14 & J1/F AT A5; CHARGING UNIT WAS CHARGING TRANSFORMER.	4-30-81	
X1636	E	REVISED PER ECN. J.F	11-20-81	
X1730	F	L1 WAS 6.8 mh; ADDED C39, C34 & R32 UPDATED LAST REF INDICATOR CHART	J.L.P. 1-15-82	
X1998	G	REVISED PER ECN & MARKED PRINT. RPW R32 NOTE 7, IS TRANSMITTED ON ECN NO IS THIS OK	2-23-82	
Y1060	H	C18 WAS 100PF. ADDED NOTE 8 JS	11-1-82	
Y1118	J	REVISED PER ECN J.J.A	3-29-83	
Y1219	K	ADDED NOTES 9 & 10; # NOTE WAS #7 & A	JC	B.K 1-12-84

DRIVER

DETECTOR

* R32 IS SELECTED VALUE, GREATER THAN 270K, TO ZERO ENCASED METER ON 2 MILLIOHM RANGE

CURRENT CONNECTIONS

POTENTIAL CONNECTIONS

AD DETECTOR

C15292	T477W		
C14525	T477W		
NEXT ASSY	USED ON		
APPLICATION			

UNLESS OTHERWISE SPECIFIED

DRAWN	PALINKAS	10-17-79
CHECKED		
ENG APP'D		10-19-79
QUAL APP'D		
SHOP ORDER NO.		NO. REQ'D

AVTRON Manufacturing Inc. 10400 BRECK AVENUE CLEVELAND, OHIO 44102

SCHEMATIC, BONDING METER (EFF. S/N #65-UP)

IMF

SIZE	CODE IDENT NO.	DRAWING NO.	REV LTR
D	01014	D14731	R

SCALE | MODEL T477W | SHEET

AVTRON MANUFACTURING, INC.
7900 E. PLEASANT VALLEY RD., INDEPENDENCE, OH 44131, (216) 642-1230, FAX (216) 642-6037

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Thank you for your efforts and for purchasing an Avtron product.

■ PRODUCT	■ DOCUMENTATION
MODEL _____ PART NO. _____	MODEL _____ PART NO. _____
DESCRIPTION _____	DESCRIPTION _____
PROBLEM: _____	PROBLEM (please list section or page no.): _____
SUGGESTION FOR DESIGN/FEATURE CHANGE: _____	SUGGESTION FOR IMPROVEMENT (please list section or page no.): _____

■ PLEASE CHECK THIS BOX IF YOU WISH TO HAVE AN AVTRON SALES REPRESENTATIVE CALL YOU

PLEASE FILL IN THE INFORMATION BELOW:

YOUR NAME: _____ DATE: _____

POSITION: _____

PHONE NUMBER: _____

COMPANY NAME: _____

COMPANY ADDRESS: _____ P.O. BOX: _____

CITY: _____ STATE: _____ ZIP CODE: _____

COUNTRY : _____

NOTE: All suggestions and comments will be reviewed and action taken as deemed appropriate by Avtron Manufacturing, Inc. All suggestions and comments made herein become the property of Avtron Manufacturing, Inc.

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POSTAGE WILL BE PAID BY ADDRESSEE

AVTRON MANUFACTURING, INC.

7900 E. Plesant Valley Rd.
Cleveland, Ohio 44131-9713

ATT: TECH. SERVICES DEPT.

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Warranty

Warranty and Duration

For a period of one year after installation, or fifteen (15) months from date of shipment from our plant, whichever is shorter, Avtron warrants the equipment, except as hereinafter provided, to be free from harmful defects in material and workmanship. Notwithstanding any other term or provision in this Warranty, the warranty provided herein shall terminate unless buyer notifies Avtron, in writing, of a breach hereof within the warranty period; any claims not made within such period are waived by Buyer. The warranty provided herein applies only if Buyer complies with all the other terms and provisions of this Warranty.

Uses of Equipment

The warranty provided herein applies only if the equipment has been used in a normal and proper manner under recommended conditions. Notwithstanding any advice or assistance given to the Buyer by Avtron or its suppliers concerning the equipment or its use, Avtron makes no express or implied warranties or representations, except as herein expressly provided, with respect to the equipment or its use, and Avtron shall not be liable in contract, warranty or tort (including, without limitation, for negligence or strict liability) as a result of such advice or assistance. In addition, unless otherwise agreed in writing signed by a duly authorized representative of Avtron, no equipment covered by this warranty is intended to be used in connection with any nuclear facility or activity, and if so used, Avtron disclaims any and all liability for any damage resulting therefrom.

Notification of Breach

When claiming a breach of this Warranty, Buyer must promptly (within 10 days from the date of the discovery of the defect) notify Avtron in writing.

Equipment Disposition

Upon notification of a claimed breach of this Warranty, Avtron, at its discretion, will either authorize the return of the defective equipment or part thereof (transportation costs to be prepaid by Buyer) or provide a suitable replacement or authorize the Buyer in writing to effect repairs at Avtron's expense. In the event that the equipment returned as authorized is found to be defective and Avtron elects to repair or replace said equipment, Avtron will pay the transportation costs associated with the return of said equipment to Buyer. Avtron shall not however be liable for any customs, tariffs, duties or taxes incurred in shipping equipment pursuant to this Warranty. These shall be the responsibility of the Buyer.

Option of Avtron to Repair or Replace Equipment or to Issue Credit

Avtron's sole obligation under this Warranty shall be, at the option of Avtron, to replace or repair any defective equipment or part thereof or to issue a credit with respect to the defective equipment equal to the purchase price thereof less depreciation.

Equipment Excluded From Warranty

The warranty provided herein does not cover typewriters strip printers, strip or chart recorders, card punch systems, or tape systems. The warranty provided to Avtron by the manufacturers of the foregoing equipment will, to the extent possible, be passed on to the Buyer. Avtron will, upon request of Buyer, make available for inspection the original manufacturer's warranty if Avtron has a copy thereof in its files. Due to the nature of the foregoing equipment, Avtron recommends that it be covered by a continuous service contract which is generally available from the original manufacturer at a reasonable cost. Electronic tubes, thyratrons, readout tubes and armature test fixtures are warranted for 90 days from date of installation. Other items or components may be excluded from the warranty provided herein if specifically excluded by purchase order or contract.

Resale or Lease of Equipment

In the event that the Buyer resells or leases equipment purchased from Avtron, the Buyer shall obtain the signed written agreement of the purchaser or lessee thereof that Avtron's only liability with respect to said equipment is as set forth in this Warranty. In the event that the Buyer fails to obtain such a signed written agreement, the Buyer agrees to indemnify Avtron against any claims, demands, judgments, suits, costs, liabilities and expenses (including reasonable attorney's fees) incurred by Avtron as a result of such failure.

Unauthorized Repairs

Unless otherwise agreed in writing signed by a duly authorized representative of Avtron, if the Buyer has repairs or modifications made to equipment covered by this Warranty by a person other than an authorized Avtron service representative, Avtron shall not be liable for any expenses incurred in connection therewith and the warranty provided herein shall automatically be terminated.

Governing Law; Saving Clause

This Warranty is part of the terms and conditions of the sale of the equipment covered hereunder and shall be governed by and enforced in accordance with the laws of the State of Ohio. Any provision hereof which is prohibited or unenforceable in any jurisdiction shall, as to such jurisdiction, be ineffective to the extent of such prohibition or unenforceability without invalidating the remaining provisions hereof or affecting the validity or enforceability of such provision in any other jurisdiction.

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, DAMAGE OR INJURY TO PERSONS OR PROPERTY, COST OF CAPITAL, COST OF SUBSTITUTE OR TEMPORARY EQUIPMENT, DOWNTIME OR CLAIMS OF CUSTOMERS) ARISING OUT OF OR AS A RESULT OF BREACH OF WARRANTY, DEFECT IN MATERIAL OR WORKMANSHIP OR ANY OTHER OBLIGATION OF AVTRON HEREUNDER.

Disclaimer of All Other Warranties

THIS WARRANTY COMPRISES AVTRON'S SOLE AND ENTIRE WARRANTY OBLIGATION TO BUYER, ITS CUSTOMERS AND ASSIGNS IN CONNECTION WITH EQUIPMENT SOLD, ASSIGNED, LEASED OR OTHERWISE DEALT WITH BY AVTRON. ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO, WARRANTIES OF MERCHANTABILITY AND FITNESS, ARE EXPRESSLY EXCLUDED.

AVTRON

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