

Instruction Manual for use of DLRO (R)
Digital Low Resistance Ohmmeters;
Catalog Numbers 247150, 247250,
and 247350

Biddle Instruments
Blue Bell, Pa. 19422

July, 1987

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SECTION 1

SAFETY PRECAUTIONS

Safety is the responsibility of the user.

La seguridad es la responsabilidad del operador.

**DO NOT CONNECT THIS INSTRUMENT
TO ENERGIZED CIRCUITS!**

Biddle Digital Low Resistance Ohmmeters are constructed to meet the requirements of ANSI C39.5-1974 "Safety Requirements for Electrical and Electronic Measuring and Controlling Instrumentation". The instrument should be used and maintained by trained personnel who are familiar with the usual precautions for handling line-operated equipment.

Do not use this equipment or any accessories supplied for any purpose not described in this manual.

When using this instrument to check high voltage equipment, all standard high voltage safety procedures and precautions should be observed. In particular, be sure that the equipment under test is completely de-energized and has been grounded before it is touched. Also be sure that adjacent high voltage equipment does not cause a safety hazard.

WARNING!

Care should be taken when measuring the windings of transformers. Dangerous high voltages may be present in other windings. Do not attempt to measure high voltage transformers unless you are familiar with the theory and understand the risks involved.

SECTION 2

INTRODUCTION and RECEIVING INSTRUCTIONS

INTRODUCTION

This manual describes, in detail, how BIDDLE DLRO Digital Low Resistance Ohmmeters work and how they should be operated. It is strongly recommended that all personnel responsible for the use of the DLRO instrument read the respective Operating Instructions before actually using the instrument.

RECEIVING INSTRUCTIONS

This instrument has been thoroughly burnt-in and performance tested prior to shipment and is ready for immediate use.

When your BIDDLE instrument arrives, check the equipment received against the packing list to be sure that all items are present. Notify BIDDLE Instruments, Blue Bell, Pa. 19422 of any shortage.

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

To acceptance test the instrument, simply plug it into any 120 V ac outlet; connect the test leads to a suitable precision $\mu\Omega$ shunt. Verify that the resistance reading on the lowest two scales is within 1%.

SECTION 3

WARRANTY & REPAIRS

WARRANTY

All products supplied by BIDDLE Instruments are warranted against all defects in material and workmanship for a period of one year following shipment. Our liability is specifically limited to replacing or repairing, at our option, defective equipment. Equipment returned to the factory for repair will be shipped Prepaid and Insured. The warranty does not include batteries, lamps, or tubes, where the original manufacturer's warranty shall apply. WE MAKE NO OTHER WARRANTY.

The warranty is void in the event of abuse or failure by the customer to perform specified maintenance as indicated in the manual.

REPAIRS

BIDDLE Instruments maintains a complete instrument repair service. Should this instrument ever require repairs we recommend that it be returned to the factory for repair by our instrument specialists. When returning instruments for repairs, either in or out of warranty, they should be shipped Prepaid and Insured, and marked for the attention of the Instrument Service Manager.

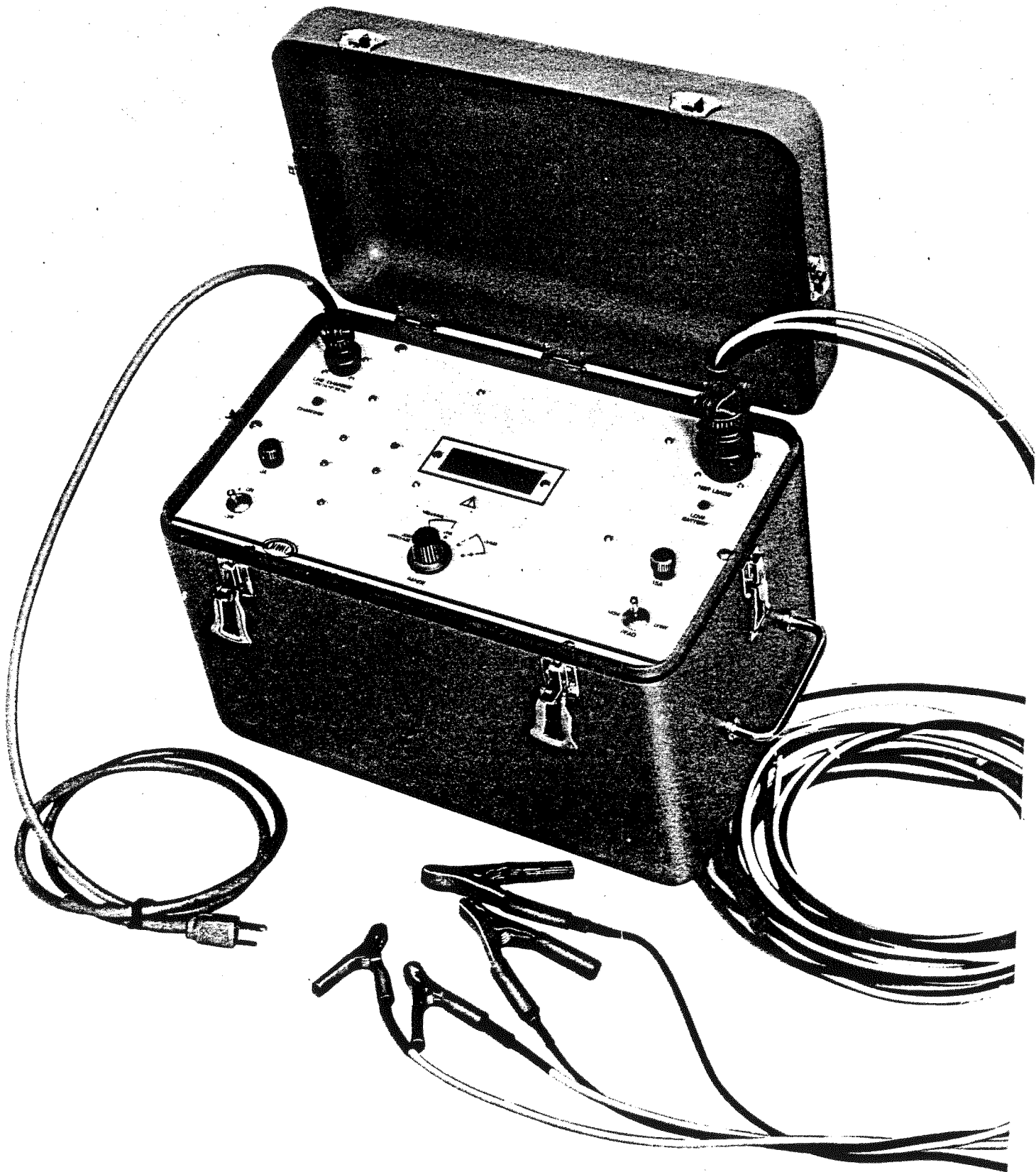


Figure 1: The Cat. No. 247150 Digital Low Resistance Ohmmeter, showing connection cables and leads supplied.

SECTION 4

INSTRUCTION FOR CATALOG NO. 247150 DIGITAL LOW RESISTANCE OHMMETER

GENERAL DESCRIPTION

The BIDDLE Catalog No. 247150 is a highly accurate, portable, low resistance tester with digital readout. The instrument is housed in a rugged aluminum case and has been designed for both field and laboratory use. The lid is hinged and removable. The power and test leads are carried separately and are connected to the instrument by mil-spec connectors. To facilitate handling once the lid has been opened, or removed, two handles are located on the side of the case.

The front panel controls were designed to simplify use of the instrument so that unskilled personnel can use it. A light-emitting diode type display meter is located in the center of the front panel and is internally scaled to provide readings directly in microhms or milliohms. High quality components have been used throughout to guarantee long, maintenance-free operation in an industrial environment.

The Cat. No. 247150 operates on a ripple-free dc current of 10 amps and is designed to measure everything from purely resistive loads to highly inductive loads within the measuring range of the instrument.

The test current is derived from either a continuous 10 amp power supply or a rechargeable sealed lead acid battery capable of supplying in excess of 100 readings of 15 or less seconds in time duration.

SPECIFICATIONS

- . Input Power: Less than 2 amp @ 120 VAC
- . Battery (Internal): 8 V - 2 Lead acid rechargeable
- . Accuracy: 1% of reading - 1 count (20⁰-130⁰ F)
- . Ranges: 2000 Microhm; 20.00 milliohm;
200.0 milliohm; 2.000 ohm; 20.00 ohm.
- . Test Current: 10 amps
- . Test Modes: Momentary or continuous
- . Temperature Range: 20⁰F to 130⁰F (-6.6⁰C to 54⁰C)
- . Size: 16" x 10" x 12" (406 x 254 x 305 mm)
- . Weight: 25 lbs. (11.4 kg)
- . Test Leads: 20 ft. standard (6 m)
- . High drive capability allows instrument to be operated with long test leads.

THEORY OF OPERATION

The instrument operates on the four-wire measurement principle with a known current applied through the load and a digital panel meter (DPM) used to sample the load voltage. The voltmeter scaling is designed to display the reading directly in microhms, milliohms or ohms.

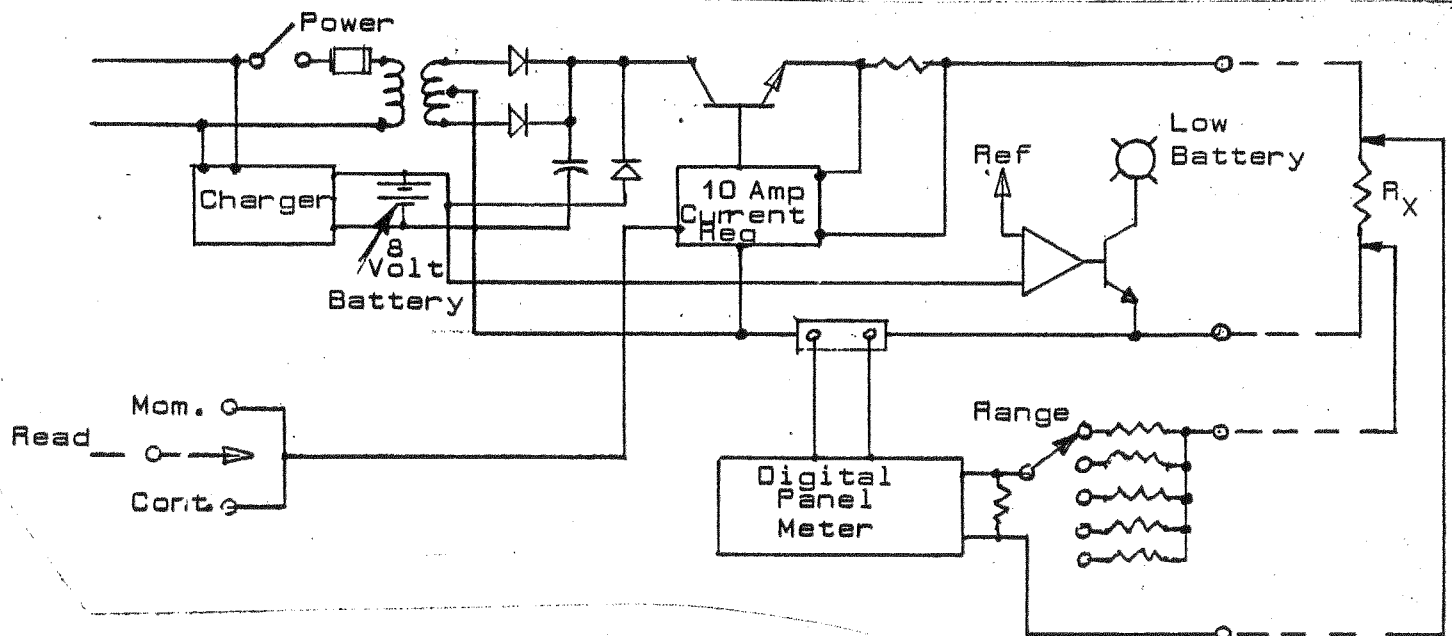


Figure 2: Simplified Block Diagram of Cat. No. 247150

The above sketch shows a simplified block diagram of the instrument. Notice that the read function is initiated by applying current through the load using the "READ" switch.

An important feature that has been designed into the instrument to help guarantee its superior performance is the use of a ratio-type DPM which derives its reference signal from an internal reference shunt. Should the actual current flowing vary as a result of load conditions, temperature, or age, the meter senses the percentage change and automatically compensates the scaling of the input voltage. In actual use, the current may vary anywhere from 50-150% of nominal without any loss of accuracy.

TEST LEADS

Unlike other instruments of this type, the Cat. No. 247150 does not require calibrated leads. This means that the user can repair his own leads should a clip fall off or if they are damaged in some other way. It also means that a user can keep an extra set of leads on hand. For instance, it is desirable to have long leads to reach the extra high voltage breakers from the ground, but those same leads become very cumbersome to handle in a service shop environment.

Because of the high drive capability of the Cat. No. 247150, small and easy-to-handle current leads may be used. The standard 20-ft. leads are AWG #12 flexible cable.

The potential leads can be practically any length or gauge wire; the only requirement is that a braided shield wire be used. When repairing potential leads, it is important that the shield not touch the meter clip.

BATTERIES

As stated previously, the instrument is powered by sealed, lead-acid batteries which should provide many years of trouble-free operation. Battery life is normally measured in number of discharge cycles and the number of cycles obtainable from the instrument's batteries is a function of depth of discharge. Batteries that are only discharged 25% before recharge will last five times longer than batteries that are discharged 85%. The Cat. No. 247150 design alerts the operator via a Low Battery Light that the batteries are approximately 80% discharged. In normal operation, where the instrument is used several times a week and discharged until the Low Battery Light comes on, the expected life of the batteries is more than two years. As explained above, the expected life can be extended considerably if the batteries are kept at a high charge level. Battery end-of-life is defined as a failure to achieve 70% of rated capacity.

BATTERY CHARGING

The charger incorporated in the unit is a constant potential current limited type. In operation, the charger will supply 40% of full charge within the first two hours and will taper the current to a trickle charge after the batteries are fully charged. This means that the instrument is essentially ready to use any time (may be used with ac charger cord plugged in), and can be left on charge for extended periods of time without damage to the batteries.

It is not recommended that the instrument be used with the charger cord connected at ambient temperatures exceeding 85°F and the instrument may only be charged for extended periods between 40°F to 85°F.

A charger light indicating actual charge condition is mounted next to the charger power receptacle. This light extinguishes when the batteries reach approximately 90% of charge.

TEMPERATURE

The operating temperature range of the Cat. No. 247150 is 20°F to 130°F. Because of the ratio-type design described in the "Theory of Operation" paragraph earlier, the temperature coefficient of the instrument is extremely low (less than .01%/°F) therefore, even under worse case conditions, the accuracy of the instrument will be $\pm 1\%$.

Note: Changing temperature range is 40°F to 85°F

OPERATING INSTRUCTIONS

GENERAL

The Cat. No. 247150 was designed with the operator in mind. The following simple steps will put the instrument into use:

- . Connect the current and potential lead to "test leads" mating connector on the instrument.
- . Connect the power cord to any standard 120 VAC, 50/60 HZ outlet, if power is available. If not, the internal battery will be used.
- . Connect the current clips to the exposed metal portions of the equipment to be tested. The potential lead clips must connect to the same circuit as the current clips. Make sure that the potential clips are between the current clips and the load under test.
- . Turn instrument power "ON" (panel meter will light up).
- . Select the desired position on the Range Switch.
- . Move the "READ" Switch to "MOMENTARY" position and hold until the meter reading is stable.

Note: Load current flows while the switch is in either "MOMENTARY" or "CONTINUOUS" position.

The meter reading should stabilize within the first second when the load being tested is purely resistive. When testing inductive loads such as power circuit breakers with CT's, transformer windings, or motor windings, the time required may vary from 1 second to several minutes. For best results, allow reading to stabilize and hold for 5 seconds. A meter reading of 1 in the left digit followed by 3 blank positions indicate an over-range condition.

The reading should begin to settle within about 10 seconds; if not, switch to the next higher range. The Range Switch may be changed with the "Read" Switch energized.

APPLICATIONS

Before connecting the instrument to any load, clean the surface where the test clips are to be connected and make sure the current clips are solidly in contact with the metal surface.

If the standard test clips supplied with the instrument are not well suited for a given application, then customer-made adaptors may be used without loss of meter accuracy.

When testing in a high voltage environment such as a switchyard, make sure that one side of the load under test is earth grounded for operator and instrument safety.

Measuring Contact Resistance of Circuit Breakers

Before connecting the instrument to the circuit breaker, close the breaker and ground one side of it. If the circuit breaker under test has CT's associated with it, the meter reading will take several seconds to stabilize due to the inductive transients induced by the CT's. For best results, take at least a 15-second reading.

Measuring Winding Resistance of Transformers

Select the meter range to the expected value. When the reading is first initiated, the reading will appear high and the meter may even overrange before it settles. Allow ample time for the current to build up through the inductive load and for the meter to stabilize.

Because of the energy required to saturate a power transformer before the reading stabilizes, it is recommended that the instrument be plugged into a 120 VAC source.

CAUTION

Because of the enormous amount of energy that can be stored in a magnetic field, the following precautions must be taken before disconnecting the test leads from the transformer under test:

- . Check that the "Read" Switch is in the "Off" position.
- . Check that the meter reads at or near zero.
- . Do not touch the transformer terminal when disconnecting the current clip.

Due to the stored up energy being discharged, the instrument will continue to read after the "Read" Switch has been selected "off". The reading may initially overrange and then gradually settle towards zero. Remember that in the case of large transformers (18 MVA or larger), the de-energization time can take several minutes. As a routine safety procedure, we recommend the use of rubber gloves in making connections to the high-voltage terminals.

CALIBRATION

The Cat. No. 247150 instrument has 6 calibration adjustments which should not require adjusting more than once per year.

To set up and calibrate, the instrument should be connected to a known-value resistor for each of the five ranges. Ideally, the resistors should be of such a value that they yield a meter reading of between 1000 and 1500 counts. It is assumed that the following certified lab-standard shunts are available: 1 milliohm, 10 milliohm, 100 milliohm, 1 ohm and 10 ohms.

The zero adjustment (Pot Pz) must be performed first and is done as follows:

Connect the current leads across the 1-milliohm calibration shunt, then clip both potential leads together on one end of the shunt. Switch the Read switch "On" and verify a zero reading on the-panel meter. If none is observed, adjust Pz until a zero reading is obtained.

To gain access to the calibration adjustments located on the PC board, remove the 6 front panel screws and lift the panel into the hinged lid. This exposes the bottom of the panel where the PC board is mounted.

To calibrate the remainder of the instrument, one at a time, the Cat. No. 247150 instrument test leads should be connected across the shunts. Verify that the readings obtained are within the tolerances shown in Table I. If not, adjust the reading using the appropriate potentiometer referenced in Table I.

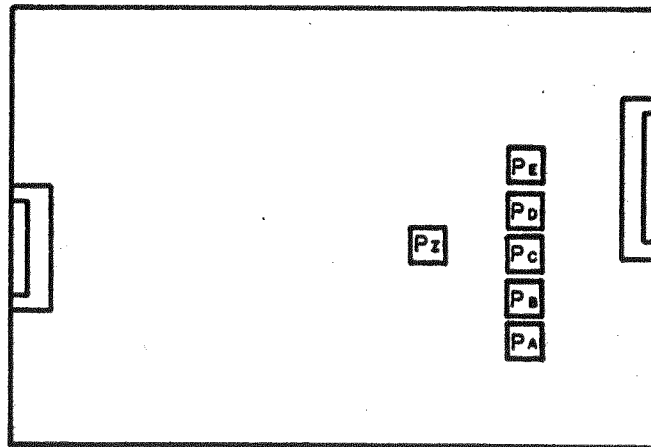


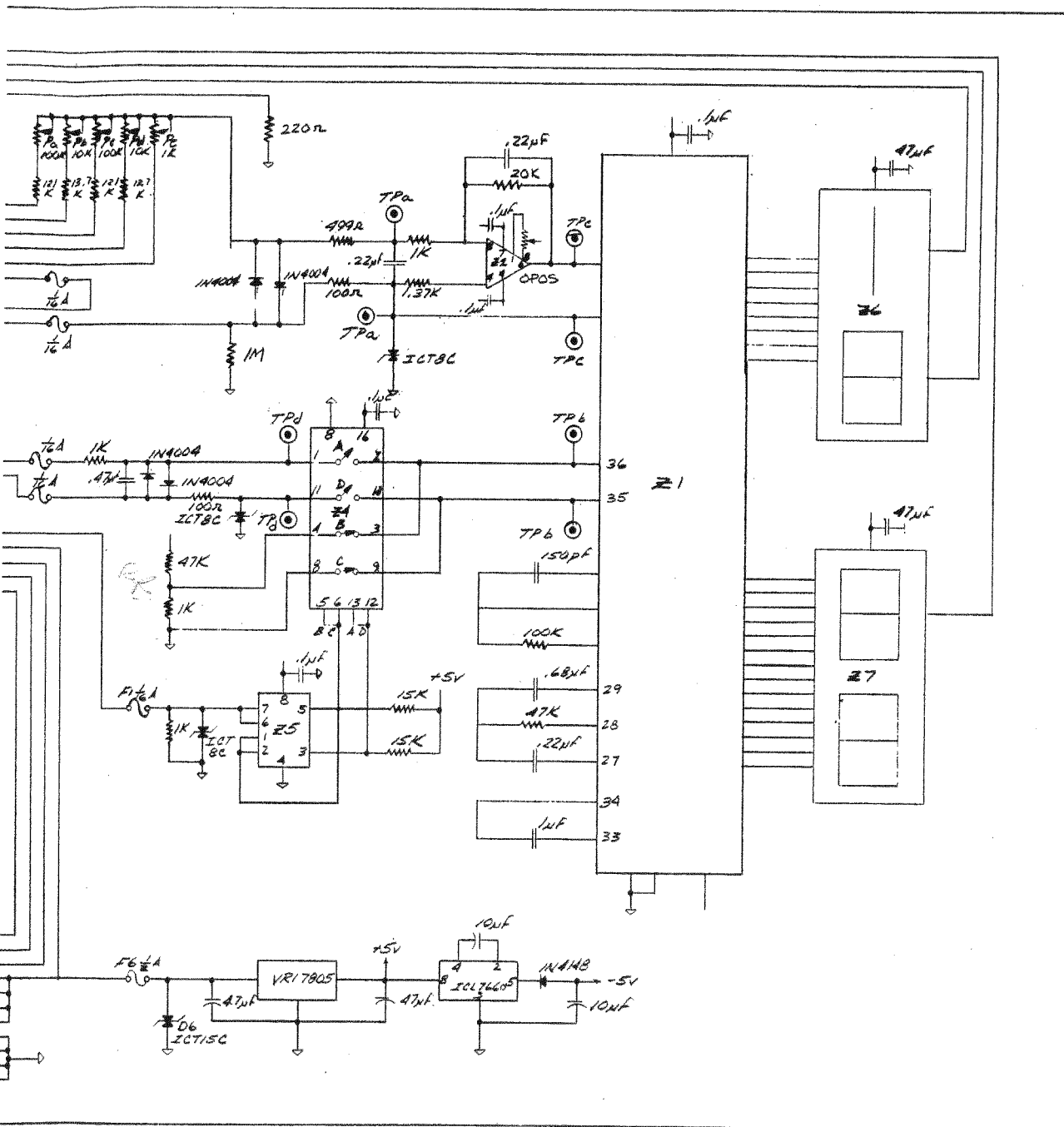
Figure 3: Control Circuit PC Board of Cat. No. 247150.

TABLE I

RANGE	POTENTIOMETER TO ADJUST	CALIBRATION RESISTOR	METER READING	APPROXIMATE TEST CURRENT
2000 Microhms	Pe	1000 $\mu\Omega$	998-1002	10A
20 Milliohms	Pd	10.00 $m\Omega$	9.98-10.02	10A
200 Milliohms	Pc	100.0 $m\Omega$	99.8-100.2	10A
2 Ohms	Pb	1.000 Ω	.098-1.002	.15A
20 Ohms	Pa	10.00 Ω	9.98-10.02	.15A

Note the approximate test current for each range and make sure that the current ratings of the calibration shunts are compatible.

Charger Calibration: Allow the batteries to charge overnight, 12 to 14 hours minimum, then adjust the charger pot located on the charger board until the voltage across the batteries measures 9.4 to 9.6 Volts.



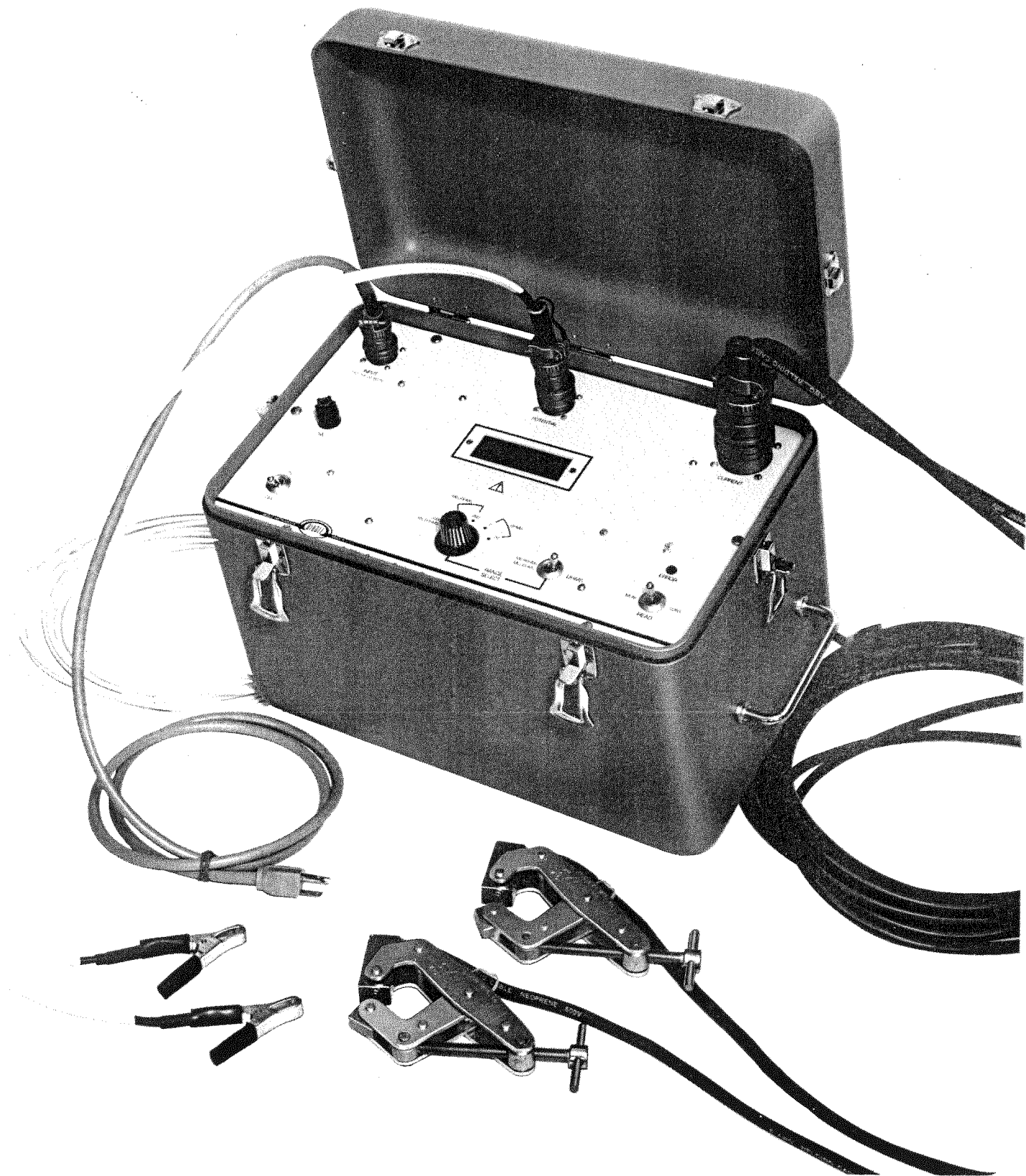


Figure 5: The Cat. No. 247250 Digital Low Resistance Ohmmeter

SECTION 5

INSTRUCTIONS FOR THE CATALOG NO. 247250 DIGITAL LOW RESISTANCE OHMMETER

GENERAL DESCRIPTION

The Cat. No. 247250 is a highly accurate, portable, low resistance tester with digital readout. The instrument is housed in a rugged aluminum case and has been designed for both field and laboratory use. The lid is hinged and removable. The power test leads are carried separately and are connected to the instrument by mil-spec connectors. To facilitate handling once the lid has been opened or removed, two handles are located on each side of the case.

The front panel controls were designed to simplify use of the instrument so that even untrained personnel can use it. A light-emitting, diode-type display meter is located in the center of the front panel and is internally scaled to provide readings directly in microhms, milliohms or ohms. High quality components have been used throughout to guarantee long, maintenance-free operation in an industrial environment.

The Cat. No. 247250 operates on a ripple free dc current of 25 or 12.5 amps depending on range selected and is designed to measure everything from purely resistive loads to highly inductive loads within the measuring range of the instrument.

SPECIFICATIONS

- . Input Power: Less than 5 amp @ 120 VAC
- . Accuracy: .25% of reading ± 1 count (20-130°F)
- . Test Current and Ranges

Current	Range
23-25A	2000 microhm
23-25A	20.00 milliohm
10-25A	200.0 milliohm
5-7A	2.000 ohm
1-7A	20.00 ohm
- . Test Modes: Momentary or Continuous
- . Temperature Range: 20°F to 130°F (-6°C to 54°C)
- . Size: 16" x 10" x 12" (406 x 254 x 305 mm)
- . Weight: 25 lbs. (11.4 kg)
- . Test Leads: 20 ft. standard (6 m)
- . High drive capability allows instrument to be operated with long test leads.

THEORY OF OPERATION

The instrument operates on the four-wire measurement principle with a known current applied through the load and a digital panel meter (DPM) used to sample the load voltage. The voltmeter scaling is designed to display the reading directly in microhms, milliohms or ohms.

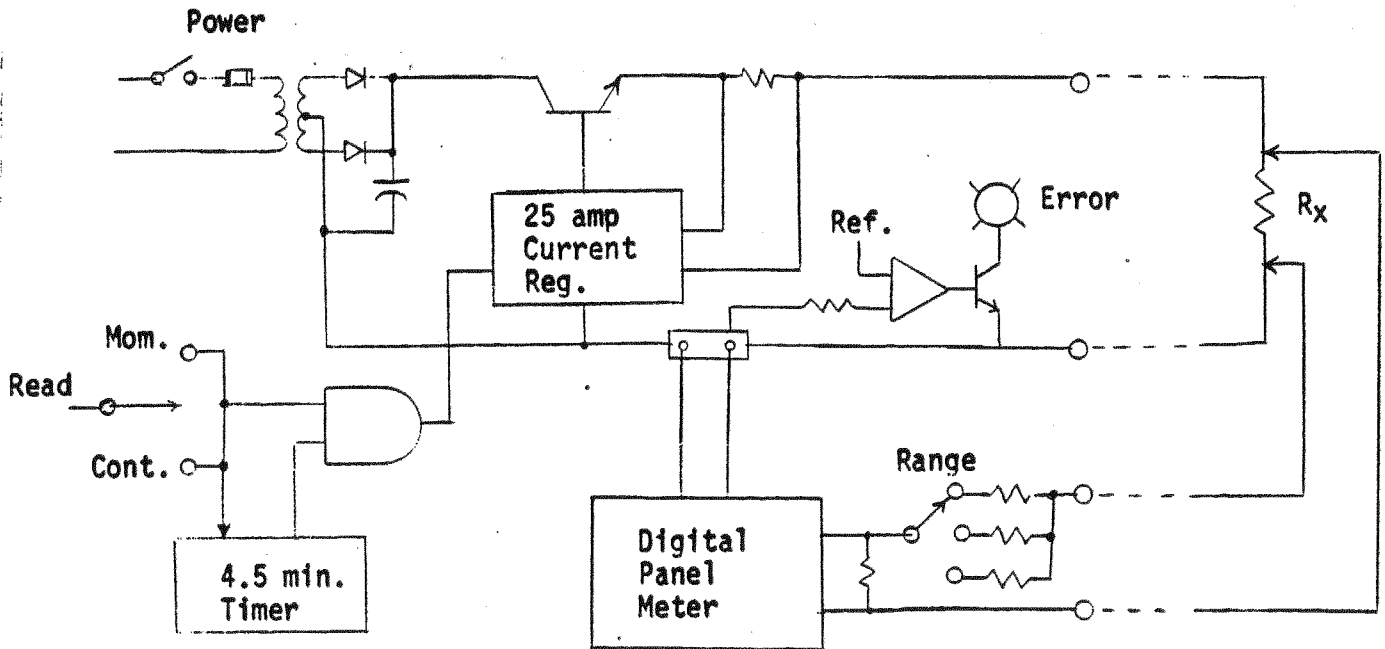


Figure 6: Simplified Block Diagram of Cat. No. 247250

A simplified block diagram of the instrument is shown above. Notice that the "Read" function is initiated by applying current through the load. The "Read" switch signal is gated with a 4.5-minute timer which will automatically power the test current off when it times out. This feature was added to prevent the unit from being left in the "Continuous On" mode.

Two important features have been designed into the instrument to help guarantee its superior performance. One of these is the use of a ratio-type DPM which derives its reference signal from an internal reference shunt. Should the actual current flowing vary as a result of load conditions, temperature, or age, the meter senses the percentage change and automatically compensates the scaling of the input voltage.

The other feature is an independent current monitor which is calibrated to activate the "Error" light should the actual load current drop below a preset value. This feature will alert the operator that the load current required to assure instrument accuracy is not being met.

TEST LEADS

Unlike other instruments of this type, the Cat No. 247250 does not require calibrated leads. This means that the user can repair his own leads should a clip fall off or if they are damaged in some other way. It also means that a user can keep an extra set of leads on hand. For instance, it is desirable to have long leads to reach the extra high voltage breakers from the ground, but those same leads become very cumbersome to handle in a service shop environment.

Because of the high drive capability of the Cat. No. 247250, small and easy-to-handle current leads may be used. The standard 20 ft. leads are AWG #8 flexible welding cable.

The potential leads can be practically any length or gauge wire; the only requirement is that a braided shield wire be used. When repairing potential leads, it is important that the shield not touch the meter clip.

TEMPERATURE

The operating temperature range of the Cat. No. 247250 is 20°F to 130°F. Because of the ratio-type design described in the "Theory of Operation" paragraph earlier, the temperature coefficient of the instrument is extremely low (less than .01%/°F) therefore, even under worse case consideration, the accuracy of the instrument will be $\pm 1\%$.

OPERATING INSTRUCTIONS

GENERAL

The Cat. No. 247250 was designed with the operator in mind. The following simple steps will put the instrument into use:

- . Connect the current and potential leads to their respective mating connectors on the instrument.
- . Connect the line cord to any standard 120 VAC, 50/60 HZ outlet.
- . Connect the current clamps to the exposed metal portions of the equipment to be tested. The potential lead clips must connect to the same circuit as the current clamps. Make sure that the potential clips are between the current clamps and the load under test.
- . Turn instrument power "On" (panel meter and Error light will light up).
- . Turn the Range Switch to the desired position.
- . Turn the Read Switch to the "MOMENTARY" position and hold until the meter reading is stable.

Note: Load current flows while the switch is in either Momentary or Continuous position.

The meter reading should stabilize within the first second when the load being tested is purely resistive. When testing inductive loads such as power circuit breakers with CT's, transformer windings, or motor windings, the time required may vary from 1 second to several minutes. For best results, allow reading to stabilize and hold for 10 seconds. A meter reading of 1 in the left digit followed by 3 blank positions indicates an overrange condition.

The meter reading will typically overrange when current is first applied to an inductive load. Once the "Error" light goes off, the meter reading should be on scale; if not, switch to the next higher range. The Range Switch may be changed with the "Read" Switch energized.

The "Error" light will reset "Off" when the proper load current is flowing, and as long as the light is off the meter reading should be considered valid. The error indicator is set as follows for the various ranges: 2000 microhms - 13 amps, 20.00 milliohms - 13 amps, 200 milliohms - 6 amps, 2 ohms - 1 amp, 20 ohms - .1 amp. If the meter reading appears stable, but the error indicator is on, then select the next higher range.

APPLICATIONS

Before connecting the instrument to any load, clean the surface where the test clips are to be connected and make sure the current clamps are solidly in contact with the metal surface.

If the standard test clips supplied with the instrument are not well-suited for a given application, then customer-made adaptors may be used without loss of meter accuracy.

When testing in a high voltage environment such as a switchyard, make sure that one side of the load under test is earth grounded for operator and instrument safety.

Measuring Contact Resistance of Circuit Breakers

Before connecting the instrument to the circuit breaker, close the breaker and ground one side of it. If the circuit breaker under test also has CT's, the meter reading will take several seconds to stabilize due to the inductive transients induced by the CT's. For best results, take at least a 15 second reading.

Measuring Winding Resistance of Transformers

Select the meter range to the expected value. When the reading is first initiated, the reading will appear high and the meter may even overrange before it settles. Allow ample time for the current to build up through the inductive load and for the meter to stabilize.

CAUTION!

Prior to making any connections to transformer or motor terminals with test leads, short the test terminals with a jumper to discharge any energy stored in the magnetic winding.

CAUTION!

Because of the enormous amount of energy that can be stored in a magnetic field, the following precautions must be taken before disconnecting the test leads from the transformer under test:

- . Check that the "Read" Switch is in the "Off" position.
- . Check that the meter reads at or near zero.
- . Do not touch the transformer terminal when disconnecting the current clip.

Due to the stored up energy being discharged, the instrument will continue to read after the Read Switch has been selected "Off". The reading may initiate overrange and then gradually settle towards zero. Remember that in the case of large transformers (18 MVA or larger), the de-energization time can take several minutes. As a routine safety procedure, however, some users require the use of rubber gloves in making connections to the high voltage terminals. Biddle Instruments considers this to be an excellent safety practice.

MAINTENANCE

The No. 247250 is designed for low maintenance operation and requires very little preventative maintenance.

The test leads should be inspected periodically to see that the test clips are firmly attached and clean, especially the contact blocks on the current leads. The potential leads are single conductor, shielded wire and the shield must not touch the test clips.

For operator safety, the case ground should be verified periodically. This may consist of a simple continuity check from the ground pin on the power cord to one of the screw heads on the instrument case.

CALIBRATION

The Cat. No. 247250 instrument has 6 calibration adjustments which should require adjustment no more than once per year.

To set up and calibrate, the instrument should be connected to a known-value resistor for each of the five ranges. Ideally, the resistors should be of such a value that they yield a meter reading of between 1000 and 1500 counts. It is assumed that the following certified lab-standard shunts are available: 1 milliohm, 10 milliohm, 100 milliohm, 1 ohm, and 10 ohms.

The zero adjustment (Pot P6) must be performed first, as follows:

Connect the current leads across the 1-milliohm calibration shunt, then clip both potential leads together on one end of the shunt. Switch the Read switch "On" and verify a zero reading on the panel meter. If none is observed, adjust P6 until a zero reading is obtained.

To gain access to the calibration adjustments located on the PC board, remove the 6 front panel screws and lift the panel into the hinged lid. This exposes the bottom of the panel where the PC board is mounted.

To calibrate the remainder of the instrument, one at a time the Cat. No. 247250 potential leads should be connected across the shunts; the current leads should be connected from the shunt to a laboratory instrument for measuring actual current flow. Verify that the readings obtained are within the tolerances shown in Table II. If not, adjust the reading using the appropriate potentiometer referenced in Table II. Since the P1 adjustment affects ranges 1, 2 and 3, and the P5 adjustment affects ranges 4 and 5, the calibration must be done in the following range sequence: 1, 2, 3, 5 and 4.

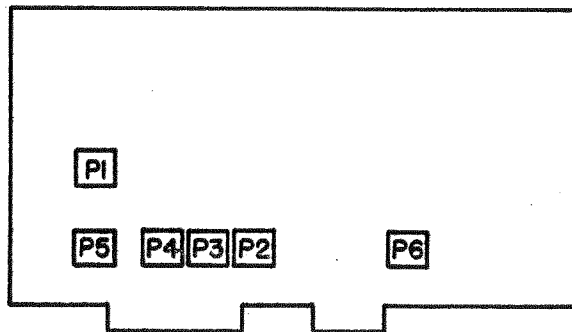


Figure 7: Cat. No. 247250 Control Circuit PC Board.

Table II

Range	Potentiometer to Adjust	Calibration Resistor	Meter Reading	Approximate Test Current
2000 Microhms	P1	1000 $\mu\Omega$	998-1002	25A
20 Milliohms	P2	10.00 m Ω	9.98-10.02	25A
200 Milliohms	P3	100.0 m Ω	99.8-100.2	12A
20 Ohms	P5	10.00 Ω	9.98-10.02	2A
2 Ohms	P4	1.000 Ω	.998-1.002	6A

Note the approximate test current for each range; make sure that the current ratings of the calibration shunts are compatible.

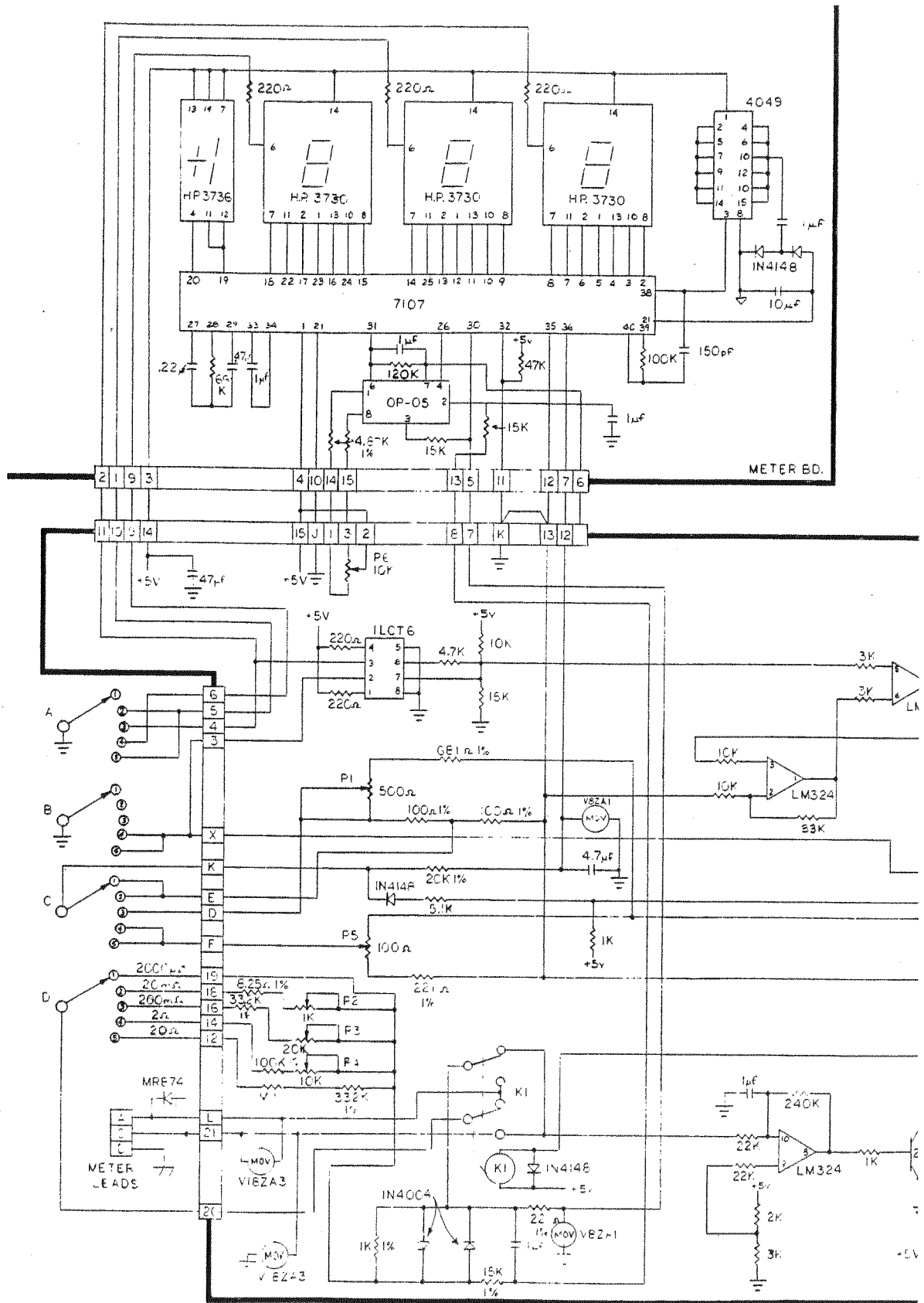
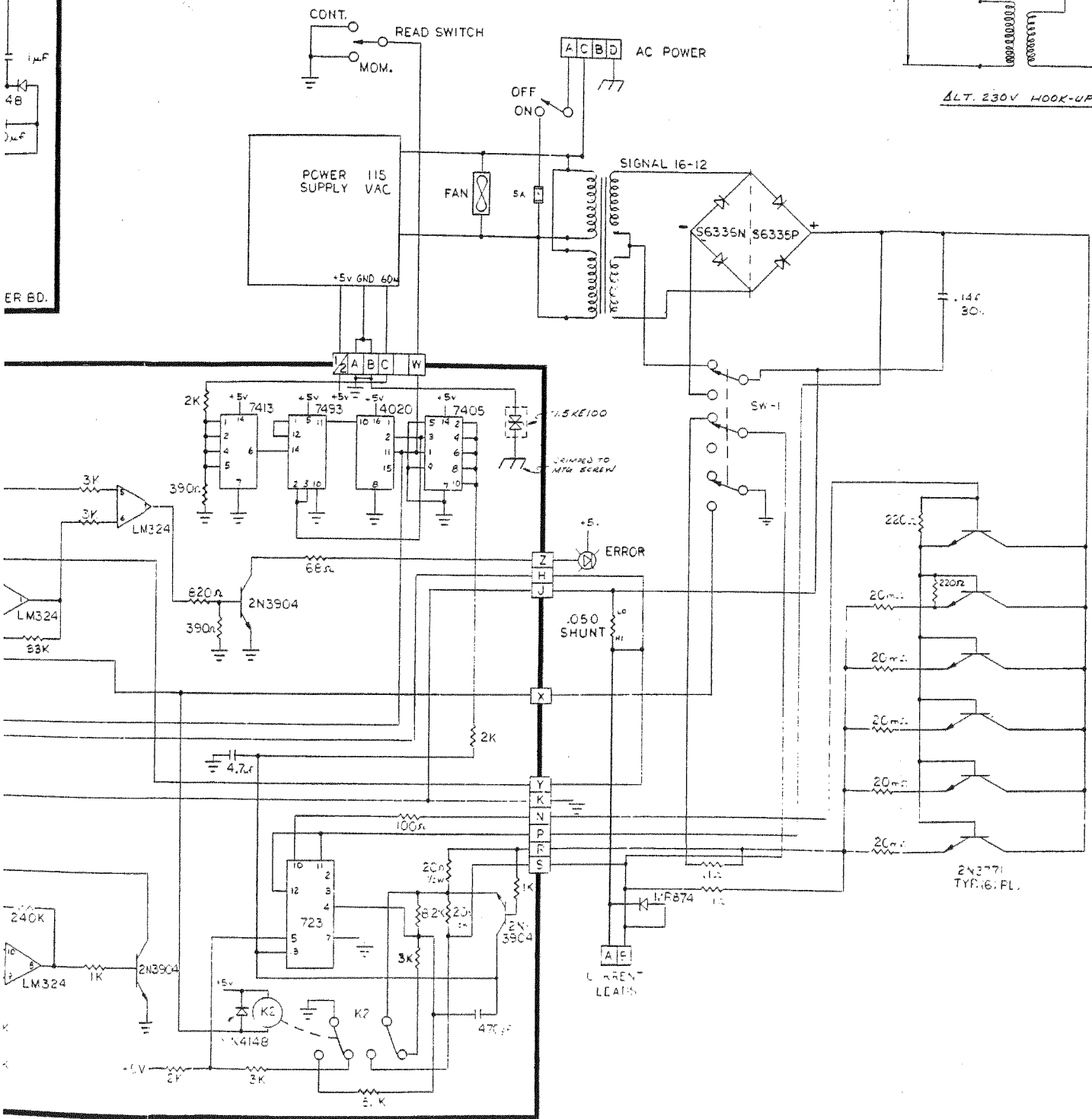
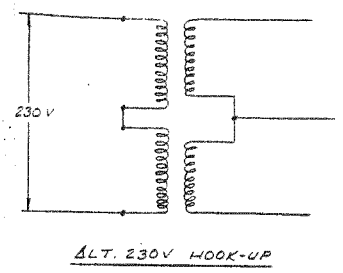
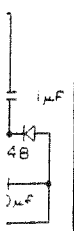


Figure 8: Overall Schematic of the Cat. No. 247250 Digital Low Resistance Ohmmeter

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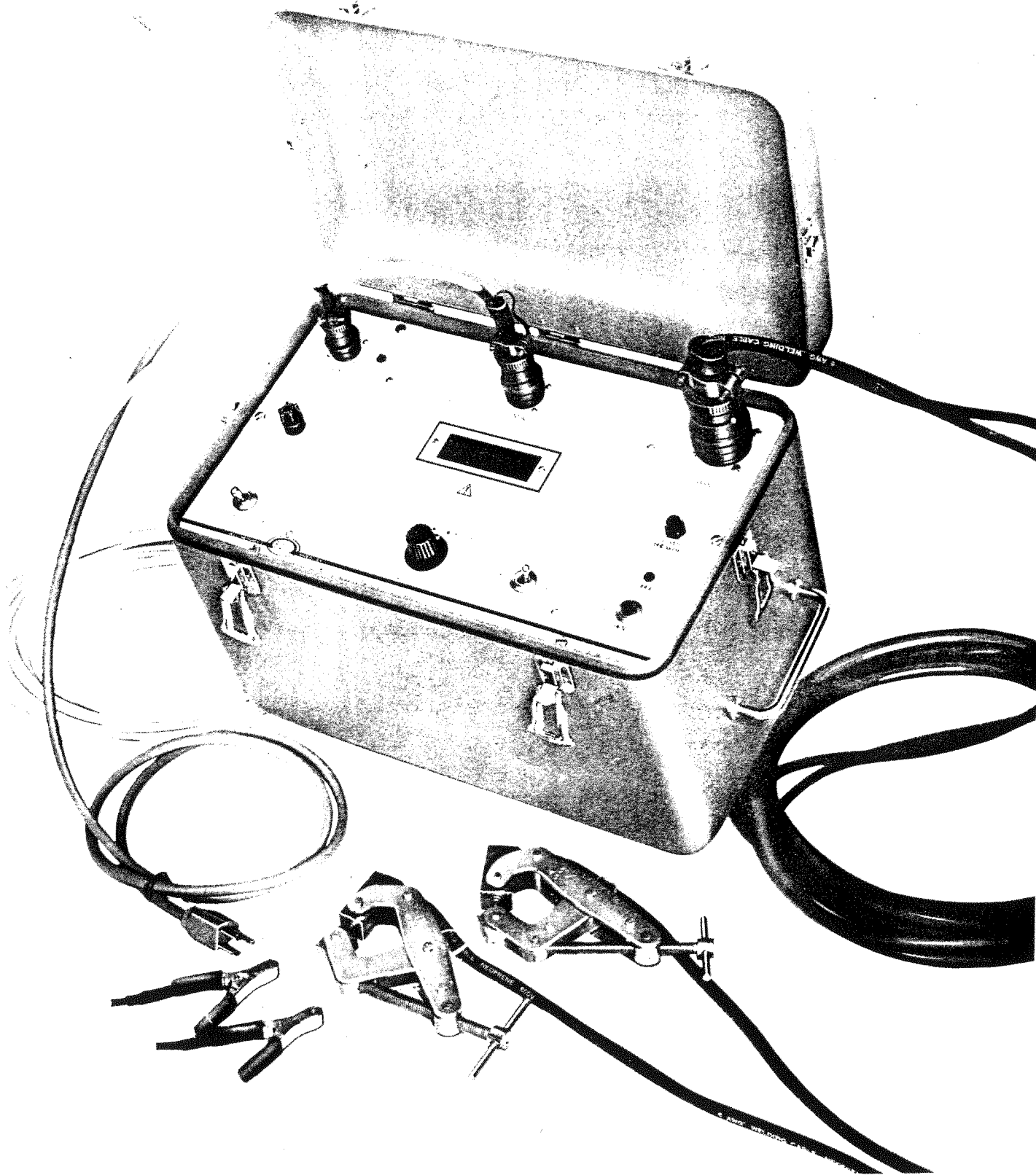


Figure 9: The Cat. No. 247350 Digital Low Resistance Ohmmeter.

SECTION 6

INSTRUCTIONS FOR THE CATALOG NO. 247350 DIGITAL LOW RESISTANCE OHMMETER

GENERAL DESCRIPTION

The Cat. No. 247350 is a portable, highly accurate low resistance tester with digital readout. The instrument is housed in a rugged aluminum case and has been designed for both field and laboratory use. The lid is hinged and removable. The power and test leads are carried separately and are connected to the instrument by mil-spec connectors. To facilitate handling, once the lid has been opened or removed, one handle is located on each side of the case.

The front panel controls were designed to simplify use of the instrument so that even untrained personnel can use it. A light-emitting, diode-type display meter is located in the center of the front panel and is internally scaled to provide readings directly in microhms or milliohms. High quality components have been used throughout to guarantee long, maintenance-free operation in an industrial environment.

The Cat. No. 247350 derives its power from the rechargeable, sealed, lead-acid batteries and may be operated with or without the ac line cord plugged in.

The instrument, with its one-microhm resolution and high drive capability, may be used wherever there is a need for measuring extremely low resistances accurately. A typical application for the instrument is in field and production testing of power circuit breakers. The instrument meets ANSI standards for this type of testing.

SPECIFICATIONS

- . Accuracy: 1% of reading \pm 1 microhm
- . Resolution: 1 microhm
- . Temperature Coefficient: less than .02%/c⁰
- . Range: 2000 microhm - standard
20.00 milliohm - standard
- . Test Current: 100 amps
- . Test Modes: Short current pulse for purely resistive loads,
Long current pulse for inductive loads.
- . Battery Capacity: More than 350 short pulse readings or
more than 35 long pulse readings.
- . Battery Recharge Time: 12-14 hours.

SPECIFICATIONS (Continued)

- . Automatic Power Down: Saves and protects batteries.
- . Weight: 32 lbs. (14.5 kg).
- . Size: 16" x 10" x 12" (406 x 254 x 350 mm).
- . Temperature Range: 20°F to 140°F (6°C to 54°C)
- . Test Leads: 20' standard (6 m).
- . Fully portable and easy to use in both shop and field.
- . Completely operator safe since the instrument operates with low voltage batteries only; mechanically safe due to its light weight.
- . Easy to operate.
- . High drive capability allows the instrument to be operated with long test leads.

FUNCTIONAL DESCRIPTION

Operating Principle

The instrument operates on the four-wire measurement principle with a known current applied through the load and a digital panel meter (DPM) used to sample the load voltage. The voltmeter scaling is designed to display the reading directly in microhms or milliohms.

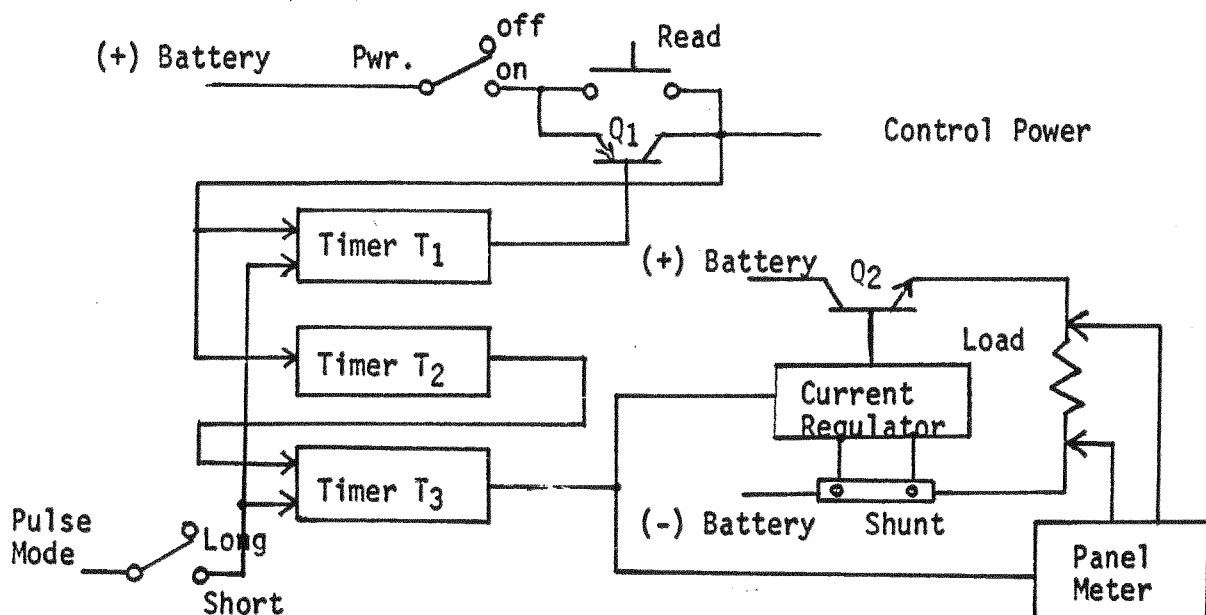


Figure 10: Simplified Block Diagram of Cat. No. 247350

SEQUENCE OF OPERATION

Figure 10 shows a simplified system block diagram. Note that even with the control power switch in the "On" position, the instrument is still in its normally powered-down state. When the "Read" pushbutton is depressed, the sequence of operation is:

- Timers T_1 and T_2 are energized and start timing. T_1 turns on a power transistor Q_1 which supplies control power the entire instrument for either 30 seconds or 50 seconds, depending on whether the pulse mode is selected to "Short" or "Long". When Timer T_1 times out, the entire instrument is powered down. Timer T_2 is a .8 second timer which allows the current regulator and DPM time to power on and stabilize.
- When Timer T_2 times out, it turns on Timer T_3 which controls the length of the current flow through the load (approximately one second in short pulse and 8.5 seconds in long pulse). The DPM is enabled to sample the load voltage (sample rate is 30 readings per second) as long as current is flowing and is commanded to store and hold the last reading when Timer T_3 times out.
- After T_3 times out, the actual load resistance reading is displayed until T_1 powers the entire instrument down.

The normal powered-down feature of the Cat. No. 247350 conserves battery power and prevents the batteries from being discharged fully. Battery life is directly related to the number of deep or full discharges. The Cat. No. 247350 batteries with the built-in protection are expected to last more than four years, even in applications such as production test which require constant usage.

ACCURACY AND ERROR MONITOR

Not shown in Figure 10 are two very important features of the instrument which help guarantee its superior performance. One of these is an independent current monitor which is calibrated to activate the Error Light should the actual load current drop below approximately 90 amps. The other is the ratio-type DPM used. In addition to regulating the load current, the accuracy of the instrument is further guaranteed by using a ratio-type meter which senses actual load current across an internal shunt. Should current regulation change for any reason, the meter senses the percentage change and automatically compensates the scaling of the input voltage. The accuracy of the Cat. No. 247350 remains the same for load current variations from 85 to 135 amps. This means that the current regulator and Error light calibrations are not very critical and can usually be performed in two minutes. The recommended calibration settings are:

Load Current - 100 amp \pm 3 amp

Error Monitor - 90 amp \pm 2 amp

When the Error Light remains on at the end of a current pulse, it indicates that the load current flow was low. The reason for this is either an extremely high load resistance or low batteries. Should there ever be any doubts about the instrument reading, it should be checked with a shunt.

ACCURACY AND ERROR MONITOR (Continued)

BATTERIES

As stated previously, the instrument is powered by sealed, lead-acid batteries which should provide many years of trouble-free operation. Battery life is normally measured in number of discharge cycles and the number of cycles obtainable from the Cat. No. 247350 batteries is a function of depth of discharge. Batteries that are only discharged 25% before re-charge will last five times longer than batteries that are discharged 85%. The Cat. No. 247350 design alerts the operator via the Error Light that the batteries are approximately 80% discharged. In normal operation, where the instrument is used several times a week and discharged until the Error Light comes on, the expected life of the batteries is more than two years. As explained above, the expected life can be extended considerably if the batteries are kept at a high charge level. Battery end-of-life is defined as a failure to achieve 70% of rated capacity.

BATTERY CHARGING

The charger incorporated in the unit is a constant potential, current limited type. In operation, the charger will supply 40% of full charge within the first two hours and will taper the current to a trickle charge after the batteries are fully charged. This means that the instrument is essentially ready to use any time and can be left on charge for extended periods of time without damage to the batteries. The instrument may be used while the ac charger cord is plugged in.

It is not recommended that the instrument be used with the charger cord connected at ambient temperatures exceeding 85°F and the instrument may only be charged for extended periods between 40°F to 85°F.

A charger light indicating actual charge condition is mounted next to the charger power receptacle. This light extinguishes when the batteries reach approximately 90% of charge.

TEMPERATURE

The operating temperature range of the Cat. No. 247350 is 20°F to 140°F. Since the instrument is battery powered, it is not recommended that it be operated outside the high temperature range. (Note: charging temperature range is 40°F to 85°F).

The effect of cold temperature is a loss of battery capacity. The battery capacity at 0°F is approximately 75% of rated.

The temperature coefficient of the instrument is less than .015% per degree Fahrenheit which means that even under worst-case consideration, the accuracy of the instrument will be better than $\pm 1\%$.

TEST LEADS

The Cat. No. 247350 does not require calibrated leads. This means that the user can repair his own leads should a clip fall off or if they are damaged in some other way. It also means that a user can keep an extra set of leads on hand. For instance, it is desirable to have long leads to reach the extra high voltage breakers from the ground, but those same leads become very cumbersome to handle in a service shop environment.

Because of the high drive capability of the Cat. No. 247350, small and easy-to-handle current leads may be used. The standard 20' leads are AWG #6 flexible welding cable. For long 40-50 ft. leads, an AWG #3 or AWG #4 is used. For optimum battery usage, the total current lead resistance should be in the 12-22 milliohm range.

The potential leads can be practically any length or gauge wire; the only requirement is that a braided shield wire be used. When repairing potential leads, it is important that the shield not touch the meter clip.

OPERATING INSTRUCTIONS

GENERAL

The Cat. No. 247350 Microhmmeter is shipped with the batteries only partially charged; therefore, before the instrument is put into production or field test use, the batteries should be allowed to charge for 10-12 hours. The batteries will charge, as indicated by the charge light, any time the instrument power plug is connected to a 120 VAC source. The instrument may be used with or without the charger connected.

The following simple steps will put the instrument into use:

- . Connect the current and potential leads to their respective mating connectors on the instrument.
- . Connect the current clamps to the exposed metal portions of the equipment to be tested. The potential lead clips must connect to the same metal as the current clamps. Make sure that the potential clips are between the current clamps at the load under test.
- . Turn control power on. (Also verify that instrument circuit breaker is in "Reset" position.)
- . Turn the pulse mode switch to the desired position. Note: The Short pulse mode should be used for purely resistive load testing. The Long pulse mode should be used for inductive loads such as circuit breakers with current transformers. (See the paragraph entitled "Circuit Breaker Testing" that follows.)
- . Turn the range switch to the desired position.
- . Press the "Read" button. In approximately one second the resistance of the equipment under test will be displayed on the digital panel meter. The reading is retained for approximately 30 seconds, at which time the meter automatically powers down completely. A second reading may be taken immediately.

Note: Under normal meter operation, the Error Light will illuminate during the current pulse and then reset "Off". If the Error Light remains on, the reading should be considered invalid. The Error Light implies an insufficient flow of current through the load and the following should be checked before a second reading is taken:

- . Current lead connections
- . Circuit breaker
- . Is unit fully charged?

If at any time the accuracy of the instrument is in question, a test should be made with a test shunt.

After the reading is erased, the instrument is ready for another reading. Several readings can be taken in quick succession without affecting the accuracy of the instrument; however, repeated readings can cause internal heating. To prevent instrument damage from excessive heating, no more than six long-pulse readings may be taken in any given 10-minute period. Short pulse readings may be taken continuously.

The error indicator will light if the load current is not maintained at 90 amps or greater. Usually the only time this will happen is if battery charge is low or the load resistance exceeds 20 milliohms. (Load resistance in this case means total resistance between current clips.) The error indicator will remain On for the same length of time as the meter reading.

The maximum meter reading is 1999. Should the load being measured exceed this value, the meter will show that it has been overranged by indicating "1" in the left digit followed by three blank positions. In circuit breaker testing, an overrange-plus-error indication implies that the circuit breaker is open. An Error Light accompanied by a low meter reading (zero or close to zero) indicates that there is an open circuit in the loop somewhere other than in the breaker. This indication is typical of one of the current clips not being connected or making poor contact.

Test resistors are available to periodically check instrument calibration. The test should read within 1% of ohmic value. Calibration of the instrument should not be required more than once every year. Biddle will perform this service free of charge during the Warranty period.

If for some reason the instrument batteries have been allowed to run down to where the error indicator is on continuously, the following procedure should be followed:

- . If instrument use is not required during the present work day, it should be connected ac power and allowed to charge overnight as approximately 12 hours are required to fully restore the batteries.
- . If the instrument is needed during the present work day, it must be connected to ac and allowed to charge for one hour before using. After the one-hour charge, the instrument can be used but should remain plugged in to ac power.

CIRCUIT BREAKER TESTING

For operating personnel as well as instrument safety, it is important that one side of the power circuit breaker be grounded prior to connecting the Cat. No. 247350 instrument. Although it is protected against high static voltages, it is not recommended that the instrument be allowed to discharge the high voltages to ground. It should also be noted that if the circuit breaker under test is not grounded, the instrument case may reach a high voltage with respect to ground. Should it be necessary to test a breaker without safety grounds, it is recommended that the Cat. No. 247350 case be grounded and that the current leads be connected to the breaker before the potential leads.

As a routine safety procedure, however, some users require the use of rubber gloves in making connections to the high-voltage terminals. BIDDLE Instruments considers this to be an excellent safety practice.

When testing high current circuit breakers with current transformers, the meter reading will start out high initially and then slowly decay down to a steady final reading. This is a result of the inductive transient related to the current transformers. On certain breakers, this transient may last as long as 6-7 seconds. It is because of this transient that the Cat. No. 247350 unit must be used in the long pulse mode when testing circuit breakers.

CONNECTING TO THE LOAD

When making connections to a load, it is important that the load surface be as clean as possible. Dirt, grease, paint, etc. may prevent the required current flow (90 amps or greater). A poor load connection is indicated by the Error Light staying "On".

If meter reading appears erratic, check all of the test lead connections. For further test lead information, see paragraph entitled "Temperature" on page 25.

MAINTENANCE

The Cat. No. 247350 is designed for low maintenance operation and requires very little preventative maintenance.

The test leads should be inspected periodically to see that the test clips are firmly attached and clean, especially the contact blocks on the current leads. The potential leads are single conductor, shielded wire and the shield must not touch the test clips.

The batteries will require replacement in anywhere from two to eight years (see paragraphs entitled "Batteries" and "Battery Charging" on page 26). They may only be replaced with the same part number or equivalent since the charger and current control circuits have specifically been designed for this battery.

To gain access to the batteries, the front panel and battery hold-down

panel must be removed. The front panel, which is held by six screws, must be lifted up into the hinged lid. Prior to removing the hold-down panel, all battery leads must be carefully disconnected. Any time the battery leads are connected or disconnected, care must be exercised to assure that leads are not reversed or allowed to touch other circuits.

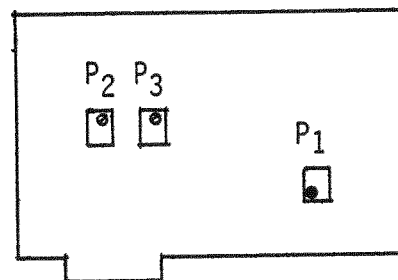
CALIBRATION

The Cat. No. 247350 has three adjustments which should be checked every six months. Because of the low drift design, the instrument should not require adjustment for several years.

To set up and calibrate the Cat. No. 247350, the instrument should be connected to the calibration resistor. The sense lead of the resistor should be connected to a laboratory millivoltmeter for measuring the actual current flow.

To reach the calibration adjustments located on the PC Board, remove the six front panel screws and lift the panel up into the hinged lid. This exposes the bottom of the panel where the PC Board is mounted.

CONTROL CIRCUIT
PC BOARD



ERROR LIGHT ADJUSTMENT

1. Connect external millivoltmeter across a calibration resistor.
2. Turn pulse mode switch to "Long" (current pulse is approximately 8.5 seconds in this mode).
3. Insert screwdriver or adjustment tool in Pot P₃ and be ready to adjust the current flow (CW adjustment decreases the current).
4. Press the read button and adjust P₃ for a reading of 86 to 88 amps on the lab ammeter.

The Error light should remain "on" at the end of the current pulse when the current is below 88 amps and should extinguish at the end of the current pulse when the current flow is 90 amps or greater.

The error threshold setting is not critical and the tolerances may be opened up by 2% or 3% as desired. The threshold adjustment is P₂ and it should be adjusted in small increments (45°) until the error light is set (CW adjustment lowers the threshold setting).

CURRENT SETTING

Because of the ratio-type digital panel meter used by Biddle, the absolute current flow is not critical. However, for optimum battery usage, the current should be set for 100 amps ± 3 amps.

1. Connect the external millivoltmeter across the calibration resistor.
2. Turn pulse mode switch to "Long".
3. Press Read button and adjust P_3 for a current of 100 amps ± 3 amps.

PANEL METER ADJUSTMENT

The only adjustment required is a gain adjustment using P_1 . (The meter has a built-in auto/zero feature.)

1. Connect the Cat. No. 247350 potential leads across the calibration resistor (be sure to use the potential lead screws on the resistor).
2. Turn pulse mode switch to "Long".
3. Press "Read" button and adjust P_1 for a panel meter reading of calibration resistor $\pm 1\%$ of ohmic value. (CW adjustment lowers reading.)

