LUDLUM MODEL 9-7
ION CHAMBER

October 2009

Serial Number 253039 Succeeding

Serial Numbers

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Serial Numbers

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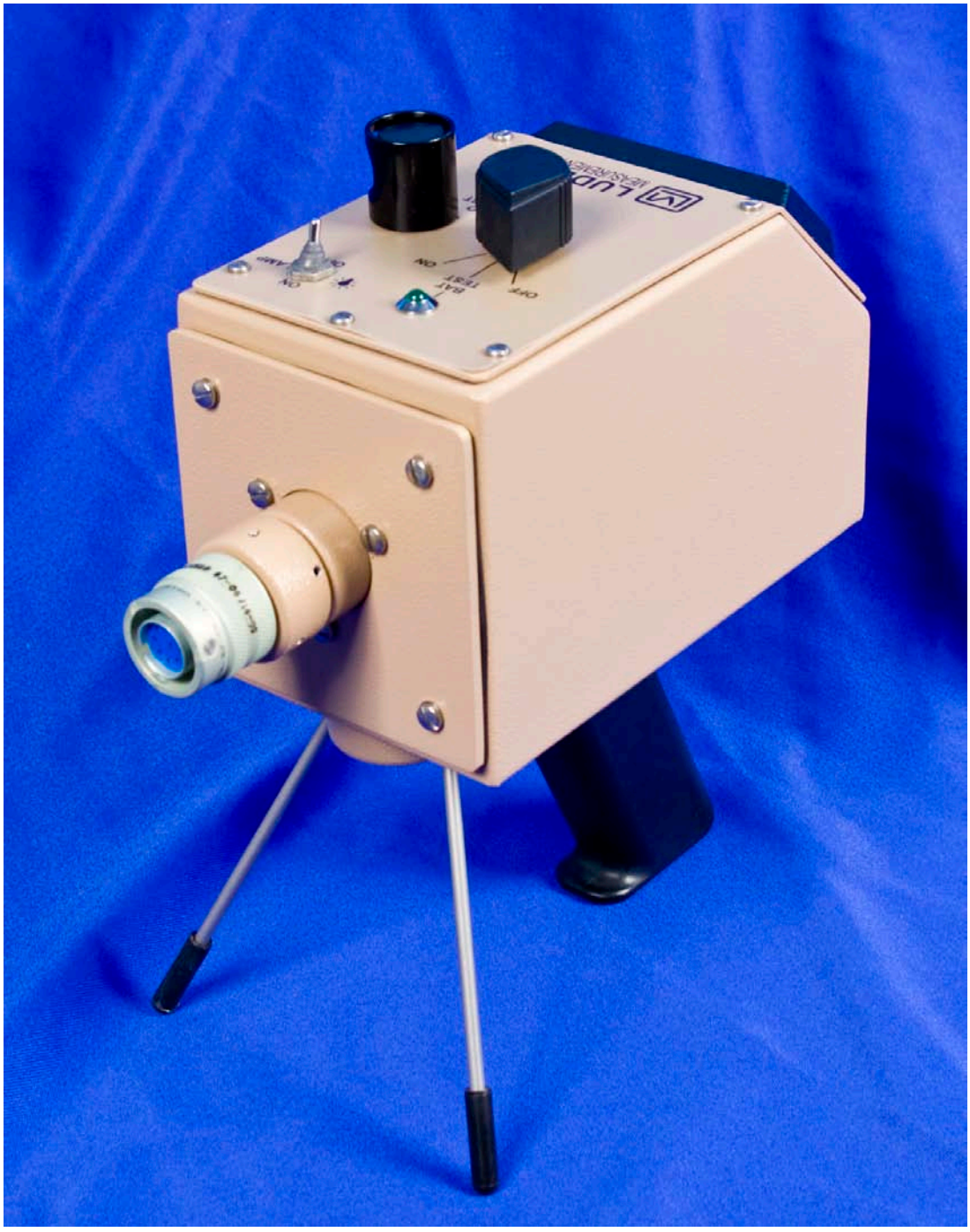
LUDLUM MEASUREMENTS
ON
BAT TEST
OFF

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Section

1

Introduction

The Ludlum Model 9-7 is an ion chamber capable of measuring high range beta and gamma fields. The user may purchase and alternate between three detectors. For measuring gamma fields, the ion chamber detectors extend from one mR/hr to 20,000 R/hr, no recalibration is required when indicating kR/hr.

The detectors are connected to the Model 9-7 by flexible cables, by rigid extensions, or by mounting directly on the instrument. Combinations of flexible cables and rigid extensions may also be used. Underwater detectors are also available.

Each of the three detectors reads out directly in R/hr or kR/hr on the liquid crystal display of the Model 9-7. The decimal point is automatically located according to the detector attached. A red LED is on when the highest range detector is in use. If the maximum rate is exceeded, for a particular detector the display will show a 1 in the most significant digit and the rest of the display will be blank.

The model numbers assigned to the various components are as follows:

Model 9-7	Basic Digital Readout
(48-3689)	Instrument
Model 9-7-LD	Low Range Detector
(47-3693)	(Gamma Only)
Model 9-7-BM	Mid Range Detector
(47-3694)	(Beta/Gamma-with removable beta shields)
Model 9-7-BH	High Range Detector
(47-3696)	(Beta/Gamma-with removable beta shields)
Model 9-7-C15	Flexible Cable,
(8293-689-15)	15 ft (4.6 m) long
Model 9-7-C60	Flexible Cable,
(8293-689-60)	60 ft (18.3 m) long

Section

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Specifications

Model 9-7 Basic Electronics

Readout: *Green Lamp* indicates battery OK, *Red Lamp* indicates 20 kR/hr range (20,000 R).

Displays: Liquid crystal 3 ½ digits, digit height ½ in (1.3 cm). Includes decimal points and negative sign. Illumination is provided. The reading is updated approximately 3 times a second.

Signal Sensitivity: Displays maximum reading (1999, with decimal point) with -1 Vdc input.

Response time: Detector dependent.

Linearity: (9-7 only): within 2%

Controls: Power Switch labeled OFF, BAT TEST and ON. Toggle Switch Lamp ON-Off controls the Readout Back Light. Zero Adjust allows readout to be zeroed in a low radiation field.

Batteries: Two type "D" cell.

Battery Life: 160 hours.

Overall Dimensions: 9.5 in x 3.8 in x 9.3 in (24.1 cm x 9.7 cm x 23.6 cm), excluding detector.

Weight: 3.5 lbs (1.6 kg) with batteries.

Temperature: Operational from -4º F to 122º F (-20º C to 50º C)

Model 9-7 LD Low Range Detector (Gamma Only):

Range: 0.001 R/hr to 1.999 R/hr.

Resolution: 0.001 R/hr (1mR/hr).

Linearity: Within 10%.

Ion Chamber: Aluminum housing, plastic lined, filled with air at atmospheric pressure. Aluminum housing thickness, nominally 0.060 inch (1.5 mm). Acrylic thickness nominally 0.125 in. (3.2 mm). Chamber dimensions, 1 in diameter x 4 in long, (2.5 cm diameter x 10 cm long).

Chamber Active Volume: 50 $cm^{3.}$

Signal Output: -1.0 V at full scale.

Power Input: Supplied by the Model 9-7.

Detector Dimensions: 1.5 in x 8.5 in (3.8 cm x 21.6 cm)

Weight: 0.7 lbs (0.3 kg)

Temperature Range: -4° F to 122° F (-20° C to 50° C)

Model 9-7- BM Mid Range Detector

Range: 0.1 R/hr to 199.9 R/hr

Resolution: 0.1 R/hr

Linearity: Within 10 %

Ion Chamber: Aluminum housing, plastic lined thin entry window, filled with air at atmospheric pressure. Aluminum housing thickness nominally 0.060 in (1.5 mm). Acrylic thickness nominally 0.125 in (3.2 mm).

Chamber Active Volume: 7 cm^3

Signal Output: -1.0 V at full scale.

Power Input: Supplied by Model 9-7.

Detector Dimensions: 1.9 in x 5.5 in (4.8 cm x 13.97 cm), including beta shield.

Weight: 0.4 lbs (0.18 kg), including beta shield.

Temperature Range: -4° F to 122° F (20° C to 50° C)

Window : 7 mg/cm^2 aluminized mylar

Model 9-7 BH High Range Detector

Range: 0.01 kR/hr – 19.99 kR/hr

Resolution: 0.01 kR/hr

Linearity: Within 10%.

Ion Chamber: Aluminum housing, plastic lined thin entry window, filled with air at atmospheric pressure. Aluminum housing thickness nominally 0.060 in (1.5 mm). Acrylic thickness nominally 0.125 in (3.2 mm).

Chamber Active Volume: 7 cm^3

Signal Output: -1.0 V at full scale.

Power Input: supplied by Model 9-7.

Detector Dimensions: 1.9 in x 5.5 in (4.8 cm x 13.97 cm), including beta shield.

Weight: 0.4 lbs (0.18 kg), including beta shield

Temperature Range: -4° F to 122° F (-20° C to 50° C)

Window : 7 mg/cm^2 aluminized mylar

Cables

Model 9-7-C15: 15 ft (4.6 m)

Model 9-7-C60: 60 ft (18.3 m)

Model 9-7-RX2: Rigid Extension, 2 ft (62 cm)

Model 9-7-RX5: Rigid Extension. 5 ft (1.5m)

Section

3

Operation

Description of Controls

External Controls, Model 9-7 Chassis:

OFF - BAT CHECK - ON: Controls all power in the instrument except ion chamber wall voltage. Provides battery check.

ZERO Knob: A zero control to set the reading to zero when the detector is in an insignificant field relative to its range.

Lamp Switch: switch used to illuminate the display.

Internal Controls 9-7 Chassis

Calibration control: located on the circuit board to adjust full scale reading (1999) with a -1V input signal.

Internal Controls, Detectors:

CAL control: A screwdriver adjustable control, located under the noted screw labeled "CAL," is used to calibrate the output signal to correspond to the gamma field strength at the detector. Output at full scale is approximately -1.0 Volts.

Preparation for Use:

1. Connect a detector to the instrument by an appropriate method. A cable, a rigid extension, or a combination of both may be used or the detector may be connected directly to the instrument. To install a rigid extension, remove the four screws in the front plate, gently pull the assembly forward and disconnect the internal connector. Install the extension by reversing the procedure. All connectors are of the quarter turn, quick disconnect type.

2. Set the switch to BAT TEST, note the green lamp is on.

3. Set the switch to ON.

4. If a 9-7-BM or 9-7-BH (mid or high range detector) was installed, the reading should go rapidly toward zero (in the absence of a significant gamma field).

5. If a 9-7-LD (low range detector) was installed, the reading may be beyond full scale for a few seconds and then go more gradually toward zero (insignificant gamma field). Allow time for the reading to settle before making zero adjustments or taking measurements.

6. Check for proper display indications according to the detector installed.

a. 9-7-LD, Low Range: 1.999 R/hr maximum possible reading (decimal point check)

b. 9-7-BM, Mid Range: 199.9 R/hr maximum possible reading (decimal point check)

c. 9-7-BH, High Range: 19.99kR/hr maximum possible reading (decimal point check). Note that the red kR/hr lamp is on.

7. Operate the light switch to check for display illumination

8. Set the *ZERO* control for zero reading if the detector is in an insignificant gamma field. The minus sign appears if the reading is "down scale" and this is useful in adjusting toward zero.

Using the Instrument

Warning

This is a very high range instrument and is not to be hand held in high range fields. Place the instrument in position for measurement and move to a safe place before radiation source is exposed.

1. After reviewing section II.B above, set the switch to the ON position.

2. Place the detector in the area to be measured. The active ion chamber volume begins at the beta window and extends back one inch for the Model 9-7 BM and the Model 9-7 BH. The active volume of the Model 9-7 LD starts at 1/8 inch behind the front edge and extends back 4 inches. The

field strength of narrow beams which do not encompass the entire volume will be measured in error.

3. The basic calibration specified in Section IV of this manual is to a gamma field. The Model 9-7 BM and the Model 9-7 BH are calibrated with the beta shield in place.

Section

4

Safety Considerations and Maintenance

Environmental Conditions for Normal Use

Indoor or outdoor use

Altitude dependant: Response decreases approximately 3% for every increase in 1000 feet of elevation above the calibration elevation. (For further information, see the Average Model 9-7 Altitude Dependence graph in Section 8 of this manual).

Temperature range of -4° F to 122° F (-20° C to 50° C).

Maximum relative humidity of less than 95% (non-condensing)

Pollution Degree 3 (as defined by IEC 664)

Warning Markings and Symbols

Caution!

The operator or responsible body is cautioned that the protection provided by the equipment may be impaired if the equipment is used in a manner not specified by Ludlum Measurements, Inc.

The Model 9-7 Ion Chamber is marked with the following symbols:

The "**crossed-out wheelie bin**" symbol notifies the consumer that the product is not to be mixed with unsorted municipal waste when discarding; each material must be separated. The symbol is placed on the battery compartment lid. See section 6, "Recycling," for further information.

DIRECT CURRENT (DC) (IEC 417, No. 5032) - designates that the unit is powered by direct current. This symbol appears on the battery door.

CAUTION (per ISO 3864, No. B.3.1) – designates hazardous live voltage and risk of electric shock. During normal use, internal components are hazardous live. This symbol appears on the front panel. **Note the following precautions:**

Warning!

The operator is strongly cautioned to take the following precautions to avoid contact with internal hazardous live parts that are accessible using a tool:

1. Turn the instrument power OFF and remove the batteries.
2. Allow the instrument to sit for 1 minute before accessing internal components.

Mylar Window Precaution

Caution!

Damage to the Mylar window on the front side of the detector may result if careful instrument handling is not practiced. The window is very fragile and may be punctured quite easily.

Cleaning and Maintenance Precautions

Instrument maintenance consists of keeping the instrument clean and periodically checking the batteries, and calibration. The Model 9-7 may be cleaned externally with a damp cloth, using only water as the wetting agent. Do not immerse the instrument in any liquid. Observe the following precautions when cleaning or performing maintenance on the instrument:

1. Turn the instrument OFF and remove the batteries.

2. Allow the instrument to sit for 1 minute before cleaning the exterior or accessing any internal components for maintenance.

Note:

The wall voltage is always ON when batteries are installed.

Maintenance

RECALIBRATION

Recalibration should be accomplished after maintenance or adjustments have been performed on the instrument or detector. Recalibration is not normally required following instrument cleaning, or battery replacement

Note:

Ludlum Measurements, Inc. recommends recalibration at intervals no greater than one year. Check the appropriate regulations to determine required recalibration intervals.

Ludlum Measurements offers a full service repair and calibration department. We not only repair and calibrate our own instruments but most other manufacturer's instruments. Calibration procedures are available upon request for customers who choose to calibrate their own instruments.

BATTERIES

The batteries should be removed any time the instrument is placed into storage. Battery leakage may cause corrosion on the battery contacts, which must be scraped off and/or washed using a paste solution made from baking soda and water.

Note:

Never store the instrument over 30 days without removing the batteries. Although this instrument will operate at very high ambient temperatures, battery seal failure may occur at temperatures as low as 100°F.

If the instrument is stored in an area with high humidity, rapid changes in temperature should be avoided. A storage cabinet with a light bulb inside is one means of keeping the instrument in a slightly warmer than ambient temperature environment, in order to prevent problems from rapid changes in temperature and humidity.

Section

5

Technical Theory of Operation

Model 9-7

General

The Model 9-7 is designed to accept a negative 1.0 volt signal from an ion chamber resulting in a read out signal of 1999. The range is controlled by the connected ion chamber assembly that controls where the decimal display is placed.

The instrument provides -56 volts with a floating ± 5 volt supply for the electrometer circuitry. The instrument is compatible with any manufacturers' ion chambers with the same connector and electronic requirements. The readout and internal circuitry floats on the -56 volt supply, allowing the chamber wall to operate at ground potential. The battery test lamp and readout back light operate directly from the battery pack.

An internal shunt allows the -56 volt supply to be on with the instrument ON or OFF. This shunt minimizes warm up time.

-56 Volt Supply

U307 is a negative DC-DC converter that converts the 2-3 volts battery power to -75 volts at R305/307, which is then filtered and regulated by CR311 to -56 volts. JP1 allows the supply to run continuously if pin 2-3 is shunted or only with instrument on with 1-2 shunted.

± 5 Volt Supply with -56 Volt Reference

U305 is a positive DC-DC converter that generates approximately 6.2 volts at CR302/C305 relative to -56 volts. The output is isolated from ground by T301 and C314. U303 is a DC-AC converter that supplies an output signal in proportion to the DC voltage on pin 4 U303. The output signal is coupled thru C314 to AC-DC converter CR306-CR307 which is then coupled back to the sense pin on U305 allowing the circuit to control the 6.2 voltage.

U301 allows development of a negative voltage. The negative voltage is regulated to -5 volts by U304 and the positive voltage is regulated to + 5 volts by U302

+ 5 Volt Supply with Chassis Ground Reference

DC-DC converter U306 develops +5 volt supply for the read out back light, pin 3 and 4 of P1. U306 also detects adequate battery voltage and allows the battery OK lamp to receive power thru pin 1 and 2 of P1.

Readout and Zero Control

Pin 3 U304 relative to pin 1 U304 provides the input signal. With no signal, the Zero control connected to P302 can adjust the readout least significant digit to 0. With 1 volt present at pin3 relative to pin 1 P304, R334 can adjust the voltage at pin 7 relative to pin6 of P305 to 0.2 volts which corresponds to a 1999 readout. The decimal point is controlled by another circuit. This is the only internal control and is set normally with negative 0.8 volts input with an output reading of 1600. Readout power is provided by the + 5 volt converter relative to -56 volt at pin 1 P305.

Decimal Point

The decimal point is selected by the voltage at pin 2 of P2, relative to -56 volts. With the voltage at -56 +5, the decimal point is at 00.00. With -56 the decimal point is 000.0 and with -56 -5 volts the decimal point is 0.000. The logic circuits Q307 thru U310 control the circuit path for the proper digit pins 11, 12 and 13 of P3. Note that on the high range, -56 +5 is applied thru CR313 to turn the kR/hr lamp on.

Model 9-7 Detectors

General

The operating principles of the detectors are identical. The Model 9-7 LD is a gamma only detector with a longer chamber. The electrometer feedback resistor is 100 GIG OHM. The Model 9-7 BM and Model 9-7 BH respond to beta gamma.

The Model 9-7 BM utilizes a 7.5 GIG OHM feedback resistor. The Model 9-7 BH utilizes a 75 MEG OHM. R106 and R104 are changed for a slightly different temperature coefficient.

Decimal Point

Model 9-7 LD Connect pin F to pin C
Model 9-7 BM Connect pin F to pin D
Model 9-7 BH Connect pin F to pin E

5293-565 Power Supply

Pin 4 operates at -56 volts and is the guard and the common circuit reference line. +5 volts at pin2 P1 is regulated to +2.5 volts by regulator U1 and -5 volts at pin 5 P1 is regulated to -2.5 volts by regulator U2, R6 provides gain control. Pin2 receives the electrometer signal and the calibrated output signal, (Chassis connector pin B) is connected to pin 1

Electrometer Board

Model 9-7 LD Board 5293-558

The constant current signal from the ion chamber electrode is connected to op amp input pin 8 U 100 and is converted to a voltage output calibrated by 100 GIGOHM feedback resistor R100. Temperature compensation is controlled by RT100 and associated components in the feedback loop.

Model 9-7 BM board 5293-692

This circuit is identical to the Model 9-7 LD except the feedback resistor R100 is 7.5 GIGOHM.

Model 9-7 BH Board 5293-691

This circuit is identical to the Model 9-7 LD except the feedback R100 is 75 MEGOHM. An additional change uses different values for R104 and R106 for temperature compensation.

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Section

6

Recycling

Ludlum Measurements, Inc. supports the recycling of the electronics products it produces for the purpose of protecting the environment and to comply with all regional, national and international agencies that promote economically and environmentally sustainable recycling systems. To this end, Ludlum Measurements, Inc. strives to supply the consumer of its goods with information regarding reuse and recycling of the many different types of materials used in its products. With many different agencies, public and private, involved in this pursuit it becomes evident that a myriad of methods can be used in the process of recycling. Therefore, Ludlum Measurements, Inc. does not suggest one particular method over another, but simply desires to inform its consumers of the range of recyclable materials present in its products, so that the user will have flexibility in following all local and federal laws.

The following types of recyclable materials are present in Ludlum Measurements, Inc. electronics products, and should be recycled separately. The list is not all-inclusive, nor does it suggest that all materials are present in each piece of equipment:

Batteries **Glass** **Aluminum and Stainless Steel**

Circuit Boards **Plastics**

Liquid Crystal Display (LCD)

Ludlum Measurements, Inc. products which have been placed on the market after August 13, 2005 have been labeled with a symbol recognized internationally as the "crossed-out wheelie bin" which notifies the consumer that the product is not to be mixed with unsorted municipal waste when discarding; each material must be separated. The symbol will be placed near the AC receptacle, except for portable equipment where it will be placed on the battery lid.

The symbol appears as such: 

Section

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Parts List

	Reference	Description	Part Number
Model 9-7 Ion Chamber	UNIT	Completely Assembled Model 9-7 Ion Chamber	48-3689
	*	Model 9-7 LD Low Range Ion Chamber	47-3693
	*	Model 9-7 BM Mid Range Ion Chamber	47-3694
	*	Model 9-7 BH High Range Ion Chamber	47-3696
Main Circuit Board, Drawing 293 x 583	BOARD	Completely Assembled Main Circuit Board	5293-583
CAPACITORS	C301, C302	10uF, 10V-DT	04-5766
	C303	68uF, 10V	04-5654
	C304	10uF, 10V-DT	04-5766
	C305, C306	68uF, 10V	04-5654
	C307	0.47uF, 100V	04-5776
	C308	10uF, 10V-DT	04-5766
	C309, C310	68uF, 10V	04-5654
	C311	0.01uF, 50V	04-5664
	C312	0.001uF, 100V	04-5659
	C313	100pF, 100V	04-5661
	C314-C321	0.01uF, 200V	04-5765
	C322	0.01uF, 50V	04-5664
	C323	68uF, 10V	04-5654
TRANSISTORS	Q302	2N7002L	05-5840
	Q303, Q305	SI2301BDS-TI	07-6486
	Q306-Q308	2N7002L	05-5840

	Reference	Description	Part Number
INTEGRATED CIRCUITS	U301	ICL7660SCBA	06-6437
	U302	LT1761ES5-5	06-6540
	U303	MIC1557BM5	06-6457
	U304	LT1964ES5-BYP	06-6663
	U305	LT1304CS8	06-6394
	U306	LT1304CS8-5	06-6434
	U307	LT1617	06-6755
	U309	LMC6041M	06-6502
	U310	SN74AHHC1G00GW	06-6644
	U311	LMC6462AIM	06-6584
DIODES	CR301, CR302	CMSH1-40M	07-6411
	CR303, CR304	BZX84C18	07-6447
	CR305	CMSH1-40M	07-6411
	CR306, CR307	MMBD914LT1	07-6353
	CR308-CR310	CMPD2005S	07-6468
	CR311	MMBZ5263BLT1	07-6475
	CR312, CR313	CMPD	07-6498
POTENTIOMETER	R334	1M, 64W105, X10K	09-6814
RESISTORS	R301	1M, 1/4W, 1%	12-7844
	R302	22uH, 1/4W, 5%	12-7972
	R303	75K, 1/4W, 1%	12-7876
	R304	22.1K, 1/4W, 1%	12-7843
	R305, R306	10M, 1/4W, 1%	12-7996
	R306	1M, 1/4W, 1%	12-7844
	R307	4.02M, 1/4W, 1%	12-7042
	R308	75K, 1/4W, 1%	12-7876
	R309	68.1K, 1/8W, 1%	12-7881
	R310	24.3K, 1/4W, 1%	12-7867
	R311	665Ohm, 1/4W, 1%	12-7066
	R312	22uH, 1/4W, 5%	12-7972
	R313	75K, 1/4W, 1%	12-7876
	R314	27K, 1/4W, 1%	12-7243
	R315, R316	1M, 1/4W, 1%	12-7844
	R317	332 Ohm,1/4W, 1%	12-7854
	R318-R326	1M, 1/4W, 1%	12-7844
	R327	221 K, 1/4W, 1%	12-7845
	R328-R330	1M, 1/4W, 1%	12-7844
	R331	221K, 1/4W, 1%	12-7845

	Reference	Description	Part Number
	R332, R333	665Ohm, 1/4W, 1%	12-7066
	R335	200K, 1/4W, 1%	12-7992
	R336	49.9Ohm, 1/4W, 1%	12-7011
CONNECTORS	P301	103-185-3 Jumper	13-8612
	P302	640456-3 MTA100×3	13-8081
	P303	640456-4 MTA100×4	13-8088
	P304	640456-9 MTA100×9	13-8094
	P305	1-640456-3 MTA100×13	13-8100
	P306	640456-2 MTA100×2	13-8073
TRANSFORMERS	T301	B66296-B1006-T1	4275-162
INDUCTORS	L301, L302	22uH	21-9808
Low Range Electrometer Board, Drawing 293 x 558	BOARD	Completely Assembled Low Range Electrometer Board	5293-558
CAPACITORS	C100	2pF, 200V	04-5726
	C102, C103	0.1uF, 100V	04-5792
INTEGRATED CIRCUIT	U100	LMP7721MA	06-6728
RESISTORS	R100	100G, 20%, Power	12-8023
	R102	10K, 1/4W, 1%	12-7839
	R104	100K, 1/4W, 1%	12-7834
	R106	12.1K, 1/8W, 1%	12-7879
MISC	RT100	10K	21-8919
CONNECTORS	P100	640456-6 MTA100×6	13-8095

Mid Range Electrometer Board, Drawing 293 x 692	BOARD	Completely Assembled Mid Range Electrometer Board	5293-692
CAPACITORS	C100	2pF, 200V	04-5726
	C102, C103	0.1uF, 100V	04-5792
INTEGRATED CIRCUIT	U100	LMP7721MA	06-6728
RESISTORS	R100	7.5G	12-8023
	R102	10K 1/4W, 1%	12-7839
	R104	100K, 1/4W, 1%	12-7834
	R106	12.1K, 1/8W, 1%	12-7879
MISC	RT100	10K	21-8919
CONNECTORS	P200	640456-6 MTA100×6	13-8095

High Range Electrometer Board, Drawing 293 x 691	BOARD	Completely Assembled High Range Electrometer Board	5293-691
CAPACITORS	C100	2pF, 200V	04-5726
	C102, C103	0.1uF, 100V	04-5792
INTEGRATED CIRCUIT	U100	LMP7721MA	06-6728
RESISTORS	R100	75M, 5%	12-8025
	R102	10K, 1/4W, 1%	12-7839
	R104	61.9K, 1/8W, 1%	12-7026
	R106	15K, 1/4W, 1%	12-7998
	R7	500G, 330 mW, 20%	12-7248
	R8	1M, 1/4W, 1%	12-7844
	R9	100K, 1/4W, 1%	12-7834
MISC	RT100	10K	21-8919
CONNECTORS	P300	1-640456-1 MTA100×11	13-8059

Calibration Board
Drawing 293 x 565

BOARD		Completely Assembled Model 9-7 Calibration Board	5293-565
CAPACITORS	C1	1uF, 35V	04-5656
	C2	10uF, 10V	04-5757
	C3	1uF, 35V	04-5656
	C4	10uF, 10V	04-5757
	C5, C6	0.01uF, 500V	04-5747
POTENTIOMETER	R6	100K, 64W	09-6813
INTEGRATED CIRCUIT	U1	LT1761ES5-BYP	06-6662
	U2	LT1964ES5-BYP	06-6663
RESISTORS	R1, R2	61.9K, 1/8W, 1%	12-7026
	R3	14.7K, 1/4W, 1%	12-7068
	R4	61.9K, 1/8W, 1%	12-7026
CONNECTORS	P400	640456-5, MTA 100×5	13-8057
	P401	640456-2, MTA 100×2	13-8073

Section

8

Drawings

MAIN BOARD, Drawing 293 x 583 (3 sheets)

MAIN BOARD LAYOUT, Drawing 293 x 584

CALIBRATION BOARD, Drawing 293 x 565

CALIBRATION BOARD LAYOUT, Drawing 293 x 566 (2 sheets)

LOW RANGE ELECTROMETER BOARD, Drawing 293 x 558

LOW RANGE ELECTROMETER BOARD LAYOUT, Drawing 293 x 559

MID RANGE ELECTROMETER BOARD, Drawing 293 x 692

MID RANGE ELECTROMETER BOARD LAYOUT, Drawing 293 x 716

HIGH RANGE ELECTROMETER BOARD, Drawing 293 x 691

HIGH RANGE ELECTROMETER BOARD LAYOUT, Drawing 293 x 714

WIRING DIAGRAM, Drawing 293 x 718 (2 sheets)