LUDLUM MODEL 9-3
ION CHAMBER

May 2020

Serial Number 261657 and Succeeding

Serial Numbers

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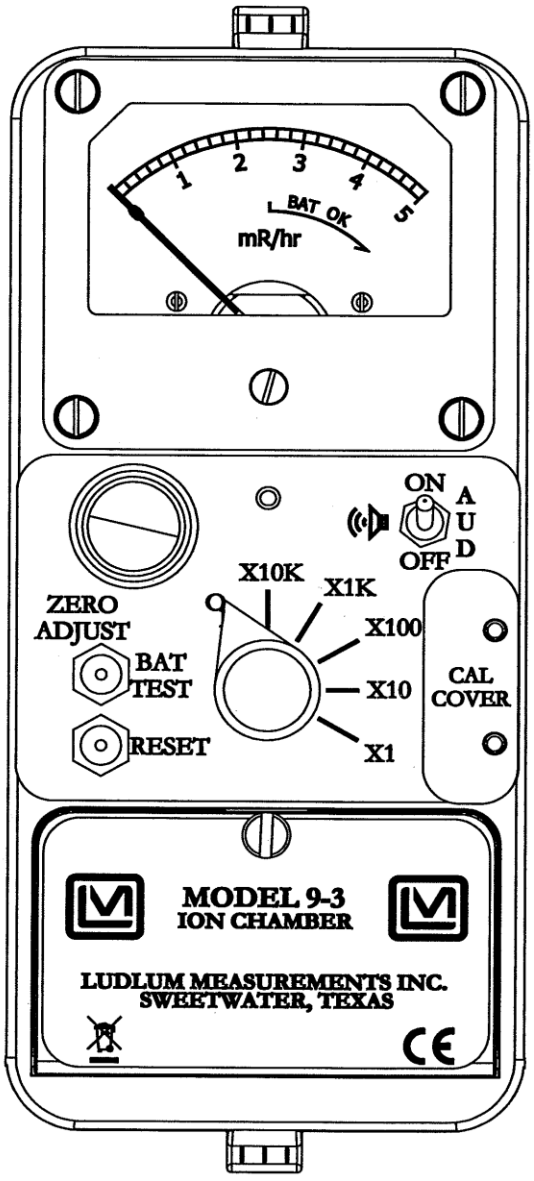
LUDLUM MEASUREMENTS, INC
501 OAK STREET, P.O. BOX 810
SWEETWATER, TEXAS 79556
325-235-5494, FAX: 325-235-4672

REVISION HISTORY			
REV	DESCRIPTION	DATE	BY
1	VALID	6/30/2008	DDW



DWN DDW	DATE 6/30/08	CHK	DATE	APP	DATE 6-30-08
DWG NUM: 4293-481.iam				SCALE: 1:1	
TITLE M 9-3 FRONT PANEL					
LUDLUM MEASUREMENTS, INC. 501 OAK STREET SWEETWATER, TEXAS 79556		SERIES 293		SHEET 548	

STATEMENT OF WARRANTY

Ludlum Measurements, Inc. warrants the products covered in this manual to be free of defects due to workmanship, material, and design for a period of twelve months from the date of delivery. The calibration of a product is warranted to be within its specified accuracy limits at the time of shipment. In the event of instrument failure, notify Ludlum Measurements to determine if repair, recalibration, or replacement is required.

This warranty excludes the replacement of photomultiplier tubes, G-M and proportional tubes, and scintillation crystals which are broken due to excessive physical abuse or used for purposes other than intended.

There are no warranties, express or implied, including without limitation any implied warranty of merchantability or fitness, which extend beyond the description of the face there of. If the product does not perform as warranted herein, purchaser's sole remedy shall be repair or replacement, at the option of Ludlum Measurements. In no event will Ludlum Measurements be liable for damages, lost revenue, lost wages, or any other incidental or consequential damages, arising from the purchase, use, or inability to use product.

RETURN OF GOODS TO MANUFACTURER

If equipment needs to be returned to Ludlum Measurements, Inc. for repair or calibration, please send to the address below. All shipments should include documentation containing return shipping address, customer name, telephone number, description of service requested, and all other necessary information. Your cooperation will expedite the return of your equipment.

LUDLUM MEASUREMENTS, INC.
ATTN: REPAIR DEPARTMENT
501 OAK STREET
SWEETWATER, TX 79556

800-622-0828 325-235-5494
FAX 325-235-4672

Table of Contents

Section 1

Introduction

The Ludlum Model 9-3 is a five-range ion chamber instrument for measuring beta-gamma radiation up to 50 R/hr. The chamber wall, including the instrument case, is 1000 mg/cm². A 1000 mg/cm² retractable beta shield allows beta measurement with a 7 mg/cm² window.

The six-position selector switch selects OFF, ×10K, ×1K, ×100, ×10, and ×1. Each range has a front-panel mounted calibration control. Other features include an audio pulsing in proportion to the meter reading, RESET, and ZERO ADJUST. An additional calibration control "L" is utilized to zero electrometer offset voltage.

The unit is powered by two "AA" cell batteries for operation from -20 to 50 °C (-4 to 122 °F).

Section 2

Getting Started

Battery Installation

Ensure the Model 9-3 range selector switch is in the OFF position. Open the battery lid by pushing down and turning the quarter-turn thumbscrew counterclockwise one quarter of a turn. Install two "AA" size batteries in the compartment.

Note the (+) and (-) marks inside the battery holder. Match the battery polarity to these marks. Insert the negative end of the battery firmly against the spring in the battery holder, then push the positive end of the battery forward to ensure contact is made at both ends of the battery. Close the battery box lid, then push down and turn the quarter-turn thumb screw clockwise one quarter of a turn.

Note:

The center post of a battery is positive. The batteries are placed in the battery compartment in opposite directions.

Battery Test

The batteries should be checked each time the instrument is turned on. This is accomplished simply by pressing the BAT TEST button. Ensure that the meter needle deflects to the battery test portion of the meter scale. If the meter does not respond, check to see if the batteries have been correctly installed. Replace the batteries if necessary.

Instrument Test

Note:

The Model 9-3 has two options for chamber wall voltage. An internal jumper may be selected to allow continuous voltage on the chamber wall with the instrument turned off. This option allows a faster, three-minute settling time when the instrument is frequently used. If the instrument is infrequently used, it is recommended that this option not be used, because of battery drain. Battery life with the continuous wall voltage on and instrument off is approximately six months.
Without this option, the battery drain is zero with the instrument OFF. When the instrument is turned on, a settling time of 5 minutes is required for a reading of less than 0.2 mR/hr, 10 minutes for less than 0.1 mR/hr, and several hours for readings near zero.
The instrument will be shipped with the chamber wall voltage turned on when the instrument is turned off.

After checking the batteries with the range switch on the ×10K position, turn the instrument range switch to the ×1 position. Note that as the selector switch moves from ×100 to ×10, a meter transient will occur. This transient is caused by an internal range relay and is normal. Allow time for the ×1 scale to stabilize. Open the beta shield slide. Switch the AUD ON OFF switch to ON. Expose the chamber window to a check source. Observe that the audio click frequency increases as the meter reading increases.

Note:

The RESET circuit discharges the chamber and opens the chamber connection to the electrometer. This causes a transient on the ×1 and ×10 scales. The meter will indicate full scale and count-down for five seconds when the RESET switch is pressed and released. For near zero reading on ×1 scale, allow several more seconds for setting time after RESET is released.

Open the beta shield and expose the check source to the center of the chamber window. The instrument reading should be within 20% of the check source reference after settling time.

Note:

The depressions on the side of the instrument housing indicate the center of the chamber.

Once this procedure has been completed, the instrument is ready for use. When using the instrument, open the beta shield for greater beta response, and close for less.

Caution!

Damage to the metalized polyester window on the back side of the instrument may result when the slide is open if careful instrument handling is not practiced. The window is very fragile and may be punctured quite easily.

Operational Check

To assure proper operation of the instrument between calibrations and periods of non-use, an instrument operational check, including battery test and instrument test (as described above), should be performed prior to use. A reference reading with a check source should be obtained at the time of initial calibration, or as soon as possible, for use in confirming proper instrument operation. In each case, ensure a proper reading on each scale. If the instrument fails to read within 20% of a proper reading, it should be sent to a calibration facility for recalibration.

Section 3

Specifications

Range: typically 0.2-50,000 mR/hr.

Linearity: reading within 10% of true value.

Response: approximately five seconds for 90% of final meter deflection on the ×1 scale and ×10, and two seconds on the remaining scales

Background: approximately every three minutes an up-scale "kick" may be noted on the ×1 scale. This is due to normal cosmic background radiation.

Chamber:

Chamber Wall Construction: carbon-coated acrylic

Chamber Volume: 220 cm^3 (13.4 in^3)

Window: 7 mg cm^2 metallized polyester

Window Area: 40 cm^2 (6.2 in^3) (31.5 cm^2 {4.9 in^2}) open with optional 79% open screen)

Beta Shield: retractable 1000 mg/cm^2 phenolic slide

Beta Factor with the instrument exposed to a depleted uranium slab of 234 mrad/hr:

Reading with slide open: 50 mR/hr

Reading with slide closed: 1.2 mR/hr

Thus, Beta Factor = 234 divided by (50 minus 1.2) = 4.8

Energy Response: within 20% of true value from 40 keV to 2 MeV

Battery Dependence: Instrument calibration change is less than 5% within battery check limits on the meter.

Warm-up Time: After power-up, ×10 through ×10K scales will be ready for use in two minutes. For the ×1 scale and if the wall voltage option is on with the instrument off, the scale will settle within 0.1 mR/hr within three minutes. If the wall voltage option is off, allow 15 minutes for the ×1 scale to settle within 0.1 mR/hr. Allow 30 minutes for the ×1 scale to settle to near zero in a very low radiation field.

Magnetic Field Exposure: per ANSI 42-17A, magnetic fields of 800 A/m cause than a 15% deviation in instrument response

Instrument Controls

Multipliers: ×1, ×10, ×100, ×1K, and ×10K selected by a front-panel range selector switch

Reset: The RESET circuit discharges the chamber and opens the chamber connection to the electrometer. This causes a transient on the ×1 and ×10 scales. The meter will indicate full scale and count-down for five seconds when the RESET switch is pressed and released. For near zero reading on ×1 scale, allow several more seconds for setting time after RESET is released.

Battery Check: At 2.0 Vdc, the meter needle will drop to the edge of the BAT OK area when the BAT TEST pushbutton is pressed. The audio circuit will start clicking when the battery voltage drops to 1.9 V.

Zero Adjust: a control allowing limited background subtract and an external one-turn potentiometer, also used to compensate electrometer drift

Calibration Controls: individual potentiometers for each range; accessible from the front cover while in operational status

Meter: 6.4 cm (2.5 in.) arc, 1 mA, pivot-and-jewel suspension

Meter Dial: 0-5 mR/hr, BAT TEST

Audio: built-in unimorph speaker with ON-OFF switch (greater than 60 dB at 61 cm {2 ft})

Power: two "AA" cell batteries housed in a sealed externally accessible compartment

Battery Life: ×100 and higher ranges at full scale without display light, 1050 hours; at ×1 and ×10 in low background without display light, 1500 hours

Construction: cast-and-drawn aluminum with beige powder coating

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

Dimensions: 23.4 x 8.9 x 21.6 cm (9.2 x 3.5 x 8.5 in.), including instrument handle

Weight: 1.6 kg (3.6 lb), including batteries

Section 4

Identification of Controls and Functions

Range Selector Switch: This is a six-position switch marked OFF, ×10K, ×1K, ×100, ×10, and ×1. Turning the range selector switch from OFF to one of the range multiplier positions (×10K, ×1K, ×100, ×10, and × 1) provides the operator with an overall range of 0 to 50,000 mR/hr. Multiply the scale reading by the multiplier to determine the actual scale reading.

BAT TEST: Press this switch to check the battery. The meter should read within the BAT TEST scale on the meter. The range switch may be in any position except OFF for the battery test.

AUD ON-OFF Toggle Switch: In the ON position, this switch energizes the unimorph speaker, located on the left side of the instrument. The frequency of the clicks is relative to the meter reading; the higher the reading, the higher the audio frequency.

ZERO ADJUST: This is a full one-turn control that allows for compensation of electrometer drift. Press and hold the RESET button until the meter counts down, then adjust for a zero reading.

Range Calibration Adjustments: recessed potentiometers located under the calibration cover, on the right side of the front panel. These adjustment controls allow for individual calibration of each range multiplier, and are labeled 1, 10, 100, 1K, and 10K

L: Recessed potentiometer located under the calibration cover; used to adjust the meter to zero before the ZERO ADJUST is adjusted for a zero meter reading with the RESET button depressed. Set range switch to ×100 and move the instrument to an area of low radiation and adjust L for a meter reading of zero.

RESET Button: The RESET circuit discharges the chamber and opens the chamber connection to the electrometer. This causes a transient on the ×1 and ×10 scales. The meter will indicate full scale and count-down for five seconds

when the RESET switch is pressed and released. For near zero reading on ×1 scale, allow several more seconds for setting time after RESET is released

Beta Shield (on bottom): A retractable shield allowing exposure to beta radiation with a window thickness of 7 mg/cm². With the slide closed, the window is 1000 mg/cm². Depress the button on the side of the slide assembly to release the slide. Release the button to hold the slide open or closed.

Section 5

Safety Considerations and Maintenance

Environmental Conditions for Normal Use

Indoor or outdoor use

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

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

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

Pollution Degree 3 (as defined by IEC 664) (Occurs when conductive pollution or dry nonconductive pollution becomes conductive due to condensation. This is typical of industrial or construction sites.)

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 9-3 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 7, "Recycling," for further information.

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 discharge before accessing internal components. The 90-volt wall voltage will require several hours to discharge. It may be discharged with a 10 megohm resistor.

Metalized Polyester (Mylar) Window Precaution

Caution!

Damage to the metalized polyester window on the back side of the instrument 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, desiccants, and calibration. The Model 9-3 (excluding chamber window) 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 one minute before cleaning the exterior or accessing any internal components for maintenance.

3. Discharge the wall voltage with a 10 megohm resistor, or allow several hours for discharge if the instrument is opened.

Maintenance

RECALIBRATION

Recalibration should be accomplished after maintenance or adjustments have been performed on the instrument. Recalibration is not normally required following instrument cleaning, desiccant servicing 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 also most other manufacturers' 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.

DESICCANT

Remove the instrument can and observe the translucent plastic desiccant box. If the desiccant is blue, close the can and use the instrument. If the desiccant is pink, replace with a fresh box. The restraining strap may be loosened by pressing the center tab toward the strap.

The pink (wet) desiccant may be recycled by placing it in an oven at 55 °C (131 °F) for two hours, or in a microwave on the HI setting for 10 seconds. If water vapor is apparent, wipe off the water and heat for another 10 seconds. Repeat until the box and desiccant appear dry. When fully dried out, the desiccant will be blue in color.

Caution!

The desiccant box will be HOT when removed from the microwave or oven!

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.

Return for Repair or Calibration

To return an instrument for repair or recalibration, provide sufficient Return Form, which can be downloaded from the Ludlum website at www.ludlums.com. Find the form by clicking the "Support" tab and selecting "Repair and Calibration" from the drop-down menu. Then choose the appropriate Repair and Calibration dvision where you will find a link to the form.

Section 6

Technical Theory of Operation

Chamber

The chamber housing is constructed from acrylic and is coated inside and outside with carbon. The internal wall is maintained at approximately 90 volts. The external wall is at ground potential.

The electrode is connected to the electrometer input and is maintained at ground potential by the electrometer.

Chamber Window

The chamber window consists of three parts. The beta shield is 1000 mg/cm² phenolic. One layer of 3.5 mg/cm² metallized polyester is glued to the bottom of the can and one layer of 3.5 mg/cm² metalized polyester covers the ion chamber, resulting in a window thickness of 7 mg/cm² with the beta slide open, and a 1000 mg/cm^2 window with the beta slide closed.

Electrometer

The electrometer consists of U1, R2, and supporting components. On the ×1 scale, RL1 and RL2 are open. With conduction in the chamber to the negative wall, pin 8 of U1 goes slightly negative causing pin 4 of U1 to go positive, drawing current through R2, holding pin 8 of U1 near the guard voltage (+1.5 volts).

With the chamber exposed to a 5 mR/hr field, the chamber current will be approximately 70 fA (70 x 10^{-15} amps) and electrometer output voltage will be 35 mV (0.035 V) relative to the guard voltage. At 50 mR/hr on the x10 range, the output voltage will be 350 mV (0.35 V) relative to the guard voltage.

Range Change

When the instrument is switched to the ×100, ×1K, or ×10K range, RL1 is closed, reducing the feedback resistance to approximately 4.2 x 10^9 ohms. At 500 mR/hr on the x100 range, the chamber current will be approximately 7 pA (7 x 10^{-12} amps) and the voltage out at pin 6 of U1 will be approximately 30 mV (0.03 V). Full-scale voltage outputs relative to the guard voltage for the x1K and x10K are 300 mV (0.3 V) and 3 V respectively.

Reset

Relay RL2 allows the chamber to be shorted to ground and the electrometer to be isolated for input bias current compensation. The reset switching transient lasts about five seconds. When the RESET button is pressed, the meter will read full scale, and then count down for five seconds. When released, the countdown will begin again. The countdown function occurs on the ×1 and ×10 scales.

Offset Adjustment

The electrometer op amp will have some offset voltage. Control L (R60) will provide an offset voltage that can be adjusted to null out the electrometer offset voltage. Select ×100 scale and adjust L for zero meter reading.

Zero Adjust

The primary function of the zero adjust is to control input bias current in the electrometer. With the RESET (SW2) closed, the reset relay (RL2) opens the electrometer input and shorts the chamber output to ground. With the RESET held closed, input bias current is adjusted with the zero control for a zero meter dial reading.

Note:

Allow a five-second recovery period for the meter to settle when the RESET button is closed, and a 15-second recovery to settle when opened

Range Calibration

For full-scale voltage for the electrometer output, pin 4 of U1 (electrometer board 5293-442) is approximately +0.03 volts for the ×1 range; 0.3 volts for the ×10 range; +0.025 volts for the ×100; and +0.025 volts for the ×1K range. The ×10K range will be somewhat lower than +2.5 volts due to nonlinear collection.

On the ×1 scale, the electrometer voltage is coupled through voltage follower U16 to the analog switch U9A to a series of op amps. U6 provides gain; U10 provides gain and reduces the output and reference from guard voltage to 0.2 volts. With voltage output at pin 1, U10 is approximately two volts at full scale. Higher scales follow the same scheme through the analog switches selected by the range switch.

The output voltage of U10 is connected to microprocessor U11, which allows calibration and temperature correction.

The signal reference voltage is 0.2 volts at the output of digital analog converter U12, allowing a below zero meter reading when adjusting the zero control.

Internal calibration control R60 is utilized to set the meter reading at zero with the electrometer disconnected.

Internal calibration control R35 is utilized to calibrate full scale signal for the reset countdown.

Range Changing

The microprocessor U110 detects the selected range and then selects the appropriate analog switch (U7A, U7B, U8A, U8B, or U9A) for the signal.

A calibration constant is then provided by the microprocessor for each range.

In the special case of ×10K scale, the microprocessor also provides a linearity correction.

Power Supplies

Six voltages are provided for instrument operation.

U2 and associated components generate -90 volts for chamber wall voltage. The supply will run continually with the instrument off if the jumper is placed between pins 1 and 2 of JP1. If the operator chooses to have wall voltage off with the instrument switched off, then the jumper should be moved to pins 2 and 3 of JP1.

U4 and associated components generate +5 volts for the main board circuits.

U3 provides a regulated +2.5-volt reference.

VR1 provides +4.85 volts for the electrometer.

U5 and associated components provides a 1.5-volt guard voltage for the electrometer.

U1 provides meter reference of 0.2 volts.

Audio Circuit

Microprocessor U11, in conjunction with unimorph DS1, converts the analog output signal to an audio signal. A series of audio clicks will increase in frequency as the output voltage increases. The audio may be turned on or off by SW4.

Meter Circuit

Microprocessor U11 is connected to DA converter U12 to drive the meter movement. R35 is adjusted for the reset countdown to start at full scale (5) on the ×1 scale.

Section 7

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." This 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 8

Parts List

	Reference	Description	Part Number
Model 9-3 Ion Chamber	UNIT	Completely Assembled Model 9-3 Ion Chamber	48-3633
Main Circuit Board, Drawing 293 × 680	BOARD	Completely Assembled Main Circuit Board	5293-680
CAPACITORS	C1	0.001uF, 100V	04-5659
	C2-C5	0.01uF, 200V	04-5765
	C6	68uF, 10V	04-5654
	C7-C10	0.01uF, 200V	04-5765
	C11	1uF, 35V	04-5656
	C12	1uF, 25V-T	04-5822
	C13	0.1uF, 100V	04-5792
	C14	0.01uF, 200V	04-5765
	C15, C16	0.47uF, 50V	04-5760
	C17, C18	68uF, 10V	04-5654
	C19	0.47uF, 50V	04-5760
	C20	1uF, 35V	04-5656
	C21	10uF, 10V-DT	04-5766
	C22	0.47uF, 50V	04-5760
	C23	1uF, 25V-T	04-5822
	C24	1uF, 35V	04-5656
	C25	0.01uF, 500V	04-5747

	Reference	Description	Part Number
CAPACITORS	C26	0.1uF, 100V	04-5792
	C27	10uF, 10V	04-5757
	C28	0.01uF, 50V	04-5664
	C29	1uF, 35V 0	4-5656
	C30	0.1uF, 100V	04-5792
	C30	0.1uF, 100V	04-5792
	C31, C32	0.47uF, 50V	04-5760
TRANSISTORS	Q1	SI2301BDS-TI	07-6486
INTEGRATED CIRCUITS	U1	LMC7111BIM5X	06-6410
	U2	LT1617ESS-1	06-6760
	U3	LT1790BIS6-2.5	06-6691
	U4	LT1304CS8-5	06-6434
	U5- U6	LMC7111BIM5X	06-6410
	U7- U9	MAX4542ESA	06-6453
	U10	LMC7111BIM5X	06-6410
	U11	PIC18LF1320-I/SO	06-6709
	U12	LTC1669-1CS5	06-6657
	U13	MAX809JTRG	06-6423
	U14	MCP9800AOT-M/OTG	06-6687
	U15	SN74HC148D	06-6765
	U16	LMC7111BIM5X	06-6410
DIODES	CR1-CR4	CMPD2005SLF	07-6468
	CR5	MMBZ5270BLT1G	07-6474
	CR6	CMSH1-40M	07-6411
	CR7, CR8	CMPD3003A	07-6498
	CR9	CMPSH-3 TR	07-6489
	CR6-CR7	CMPD3003A	07-6498
POTENTIOMETER	R8	100K, 3266X1-104, Meter Offset	09-6823
	R35	500Ohm, 3266X1-501, Meter Adj	09-6848
	R55	20K, 3296W-1-203LF, X1 X100	09-6835
	R56	200K, 3296W-1-204LF, X1K,X10	09-6964
	R57	20K, 3296W-1-203LF, X1 X100	09-6835
	R58	200K, 3296W-1-204LF, X1K,X10	09-6964
	R59	1M, 3296W-1-105LF, X10K	09-6814
	R60	100K, 3296W-1-104LF, Elec Off	09-6813

	Reference	Description	Part Number
RESISTORS	R1	90.9K, 250mW, 1%	12-7224
	R2, R3	1M, 250mW, 1%	12-7844
	R4	100Ohm, 250mW, 1%	12-7840
	R5	1M, 250mW, 1%	12-7844
	R6	61.9K, 250mW, 1%	12-7026
	R7	10K, 250mW, 1%	12-7844
	R9	47.5K, 250mW, 1%	12-7872
	R10, R11	1M, 250mW, 1%	12-7844
	R12	10M, 250mW, 1%	12-7996
	R13	124K, 250mW, 1%	12-7032
	R14	47.5K, 250mW, 1%	12-7872
	R15	68.1K, 250mW, 1%	12-7881
	R16	27K, 250mW, 1%	12-7243
	R17	750K, 250mW, 1%	12-7882
	R18	100K, 250mW, 1%	12-7834
	R19, R20	1M, 250mW, 1%	12-7844
	R21	82.5K, 250mW, 1%	12-7849
	R22, R23	1M, 250mW, 1%	12-7844
	R24	365K, 250mW, 1%	12-7049
	R25	100K, 250mW, 1%	12-7834
	R26	10M, 250mW, 1%	12-7996
	R27	10K-100K, 250mW, 1%	12-7844
	R28	100Ohm, 250mW, 1%	12-7840
	R29	4.02K, 250mW, 1%	12-7006
	R30	332K, 250mW, 1%	12-7976
	R31	365K, 250mW, 1%	12-7049
	R32	1M, 250mW, 1%	12-7844
	R33	3.01M, 250mW, 1%	12-7209
	R34	750K, 250mW, 1%	12-7882
	R36	499K, 250mW, 1%	12-7037
	R37	182K, 250mW, 1%	12-7860
	R38	100K, 250mW, 1%	12-7834
	R39	221K, 250mW, 1%	12-7845
	R40	100Ohm, 250mW, 1%	12-7840
	R41	27K, 250mW, 1%	12-7243
	R42	1K, 250mW, 1%	12-7832
	R43	1M, 250mW, 1%	12-7844
	R44	221K, 250mW, 1%	12-7845
	R45	1M, 250mW, 1%	12-7844
	R46	82.5K, 250mW, 1%	12-7849
	R47, R48	47.5K, 250mW, 1%	12-7872
	R49-R51	1M, 250mW, 1%	12-7844

	Reference	Description	Part Number
	R52	10K, 250mW, 1%	12-7839
	R53	1M, 250mW, 1%	12-7844
	R54	499 Ohm, 250mW, 1%	12-7907
	R61	61.9K, 250mW, 1%	12-7026
CONNECTORS	P1	640456-4 MTA100×4	13-8088
	P2	1-640456-0 MTA100×10	13-8066
	P3	640456-2 MTA100×2	13-8073
	P4	53014-0610Molex	13-8974
	P5	640456-3 MTA100×3	13-8081
	JP1	5-146280-3Cham Wall Volt	13-8571
VOLTAGE REGULATORS	VR1	LT1761ES5-BYP	06-6662
SWITCHES	SW1	D5G0206S-9802 Range	08-6761
	SW2, SW3	3SI-SP9-B8-M2QE Bat Test	7464-186
	SW4	A123S1CWCQ Audio On-Off	08-6781
INDUCTORS	L1, L2	22µH	21-9808
Electrometer Board, Drawing 293 × 670	BOARD	Completely Assembled Electrometer Board	5293-670
CAPACITORS	C1	2pF, 200V	04-5726
INTEGRATED CIRCUIT	U1	IC-LMP7721MA	06-6728
DIODES	CR1-CR2	CMPSH-3	07-6489
RESISTORS	R1	1M, 1/4W, 1%	12-7844
	R2	500G, 330 mW, 20%	12-7248
	R3	4.2G, 5%	12-7249
	R6	169K, 0.25W, 1%	12-8008
	R7	500G, 330 mW, 20%	12-7248
	R8	1M, 1/4W, 1%	12-7844
	R9	100K, 1/4W, 1%	12-7834
RELAYS	RL1	SPST-NC 4293-541	4293-339
	RL2	SPDT 4293-538	08-6845

CONNECTORS	P1	1-640456-0 MTA100	13-8066
	P2	103186-1	13-8471

Wiring Diagram 293 × 525

AUDIO	DS1	UNIMORPH SPEAKER 60690	21-9251
MISCELLANEOUS	*	Model 9-3 Casting Assy (AA)	4293-490
	*	Model 9-3 Pushbutton Can Assy	4293-506
	*	Model 9-3 Chamber Assy	4293-521
	*	Portable Bezel with Movement Assembly	4363-188
	*	Can Mylar Window	7293-792
	*	Chamber Window Assembly	4293-500
	*	Portable Handle (Rolled)	4464-154
	*	Model 9-3 Chamber Top Co-Netic Shield	7536-223
	*	Model 9-3 Chamber Top Netic Shield	7536-224

Section

9

Drawings

AVERAGE MODEL 9 ALTITUDE DEPENDENCE

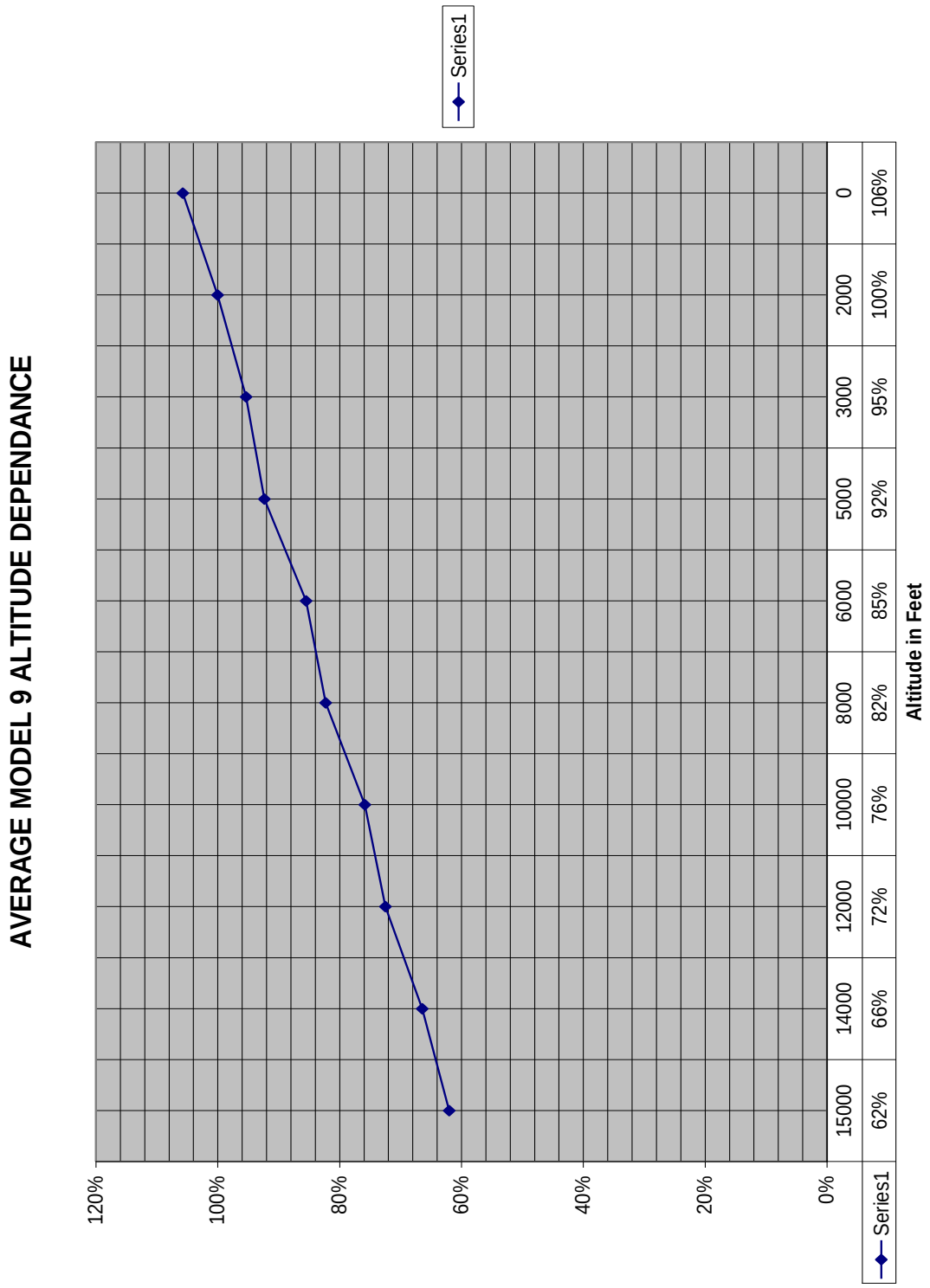
MAIN BOARD SCHEMATIC, Drawing 293 × 680 (4 Sheets)

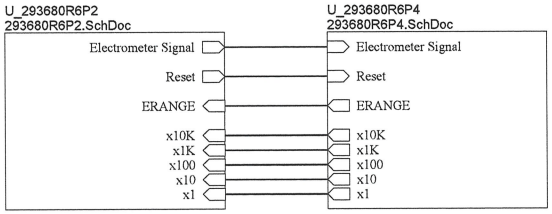
MAIN BOARD LAYOUT, Drawing 293 × 681 (2 Sheets)

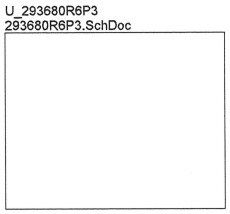
ELECTROMETER BOARD, Drawing 293 × 670

ELECTROMETER BOARD OVERLAY Drawing 293 × 671

WIRING DIAGRAM, Drawing 293 × 525


AVERAGE MODEL 9 ALTITUDE DEPENDANCE
Series1
120%
100%
80%
60%
40%
20%
0%
Altitude in Feet
0 2000 3000 5000 6000 8000 10000 12000 14000 15000
106% 100% 95% 92% 85% 82% 76% 72% 66% 62%
Series1





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Drawn: MC	10/11/2010	**Title:** MAIN BOARD	
Design: DL	10/11/2010	**Model:** 9-3	
		Board#: 5293-680	
Approve: RB 26Aug13		**Sheet:** 1 of 4	**Series** 293 / **Sheet** 680
11:43:09 AM 8/21/2013		**Rev:** 6	
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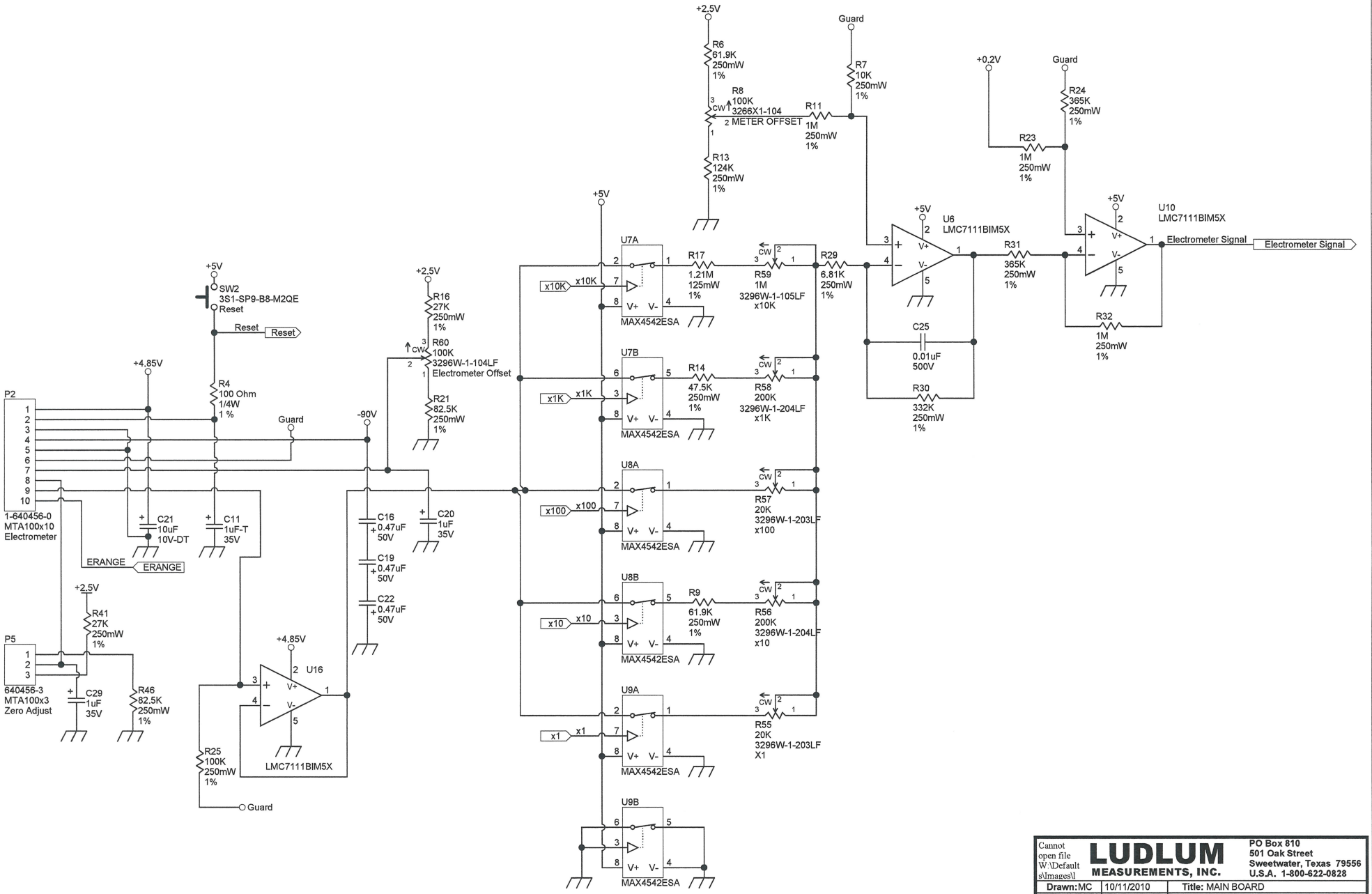

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LUDLUM MEASUREMENTS, INC.

PO Box 810
501 Oak Street
Sweetwater, Texas 79556
U.S.A. 1-800-622-0828

Drawn: MC	10/11/2010	Title: MAIN BOARD	
Design: DL	10/11/2010	Model: 9-3	
		Board#: 5293-680	
Approve:		Sheet: 2 of 4	Series: 293 / Sheet: 680
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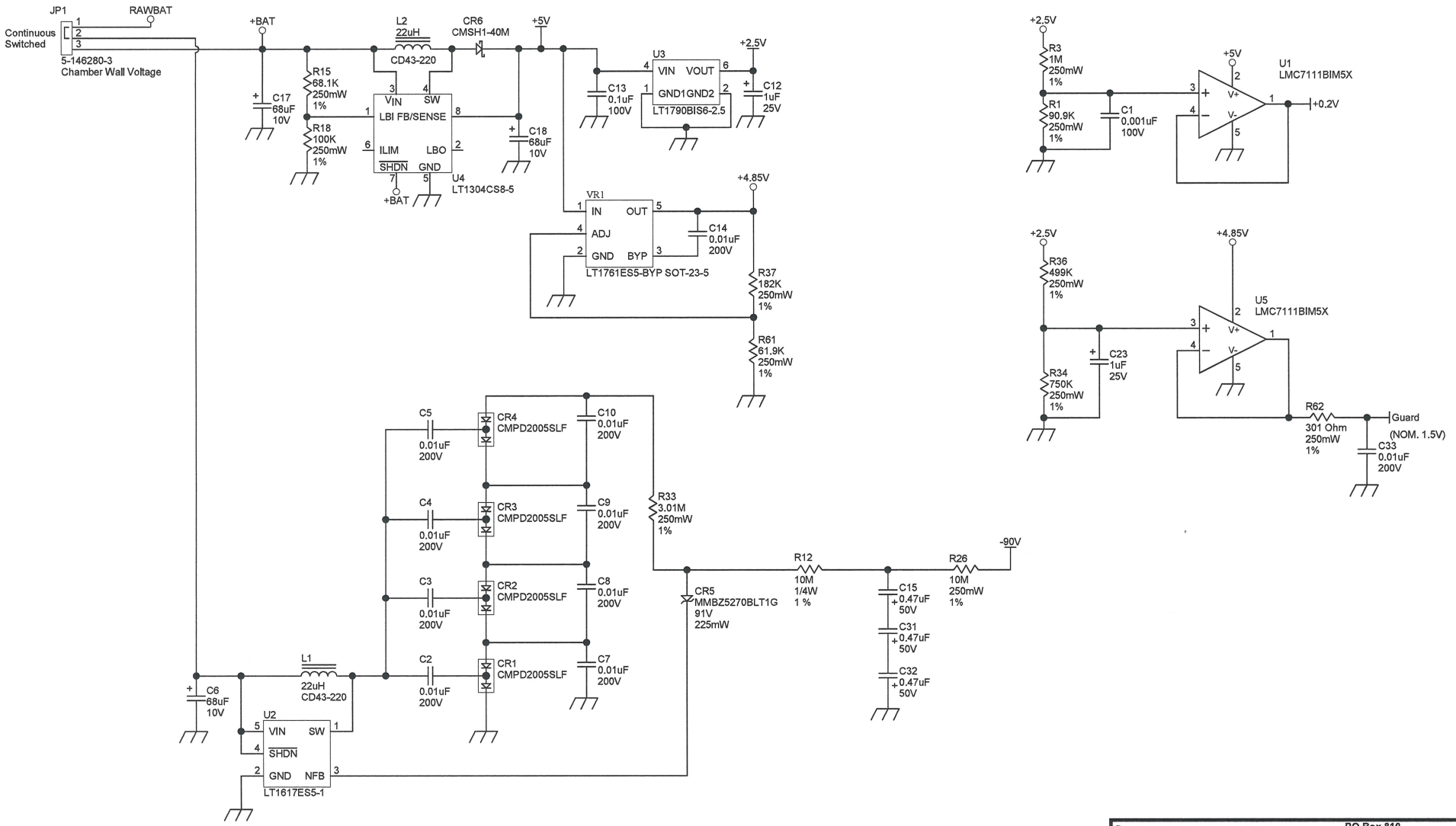

Cannot open file W:\Default s\Images\l	**LUDLUM MEASUREMENTS, INC.**	PO Box 810 501 Oak Street Sweetwater, Texas 79556 U.S.A. 1-800-622-0828	
Drawn: MC	10/11/2010	**Title:** MAIN BOARD	
Design: DL	10/11/2010	**Model:** 9-3	
		Board#: 5293-680	
Approved:		**Sheet:** 3 of 4	**Series** 293 / **Sheet** 680
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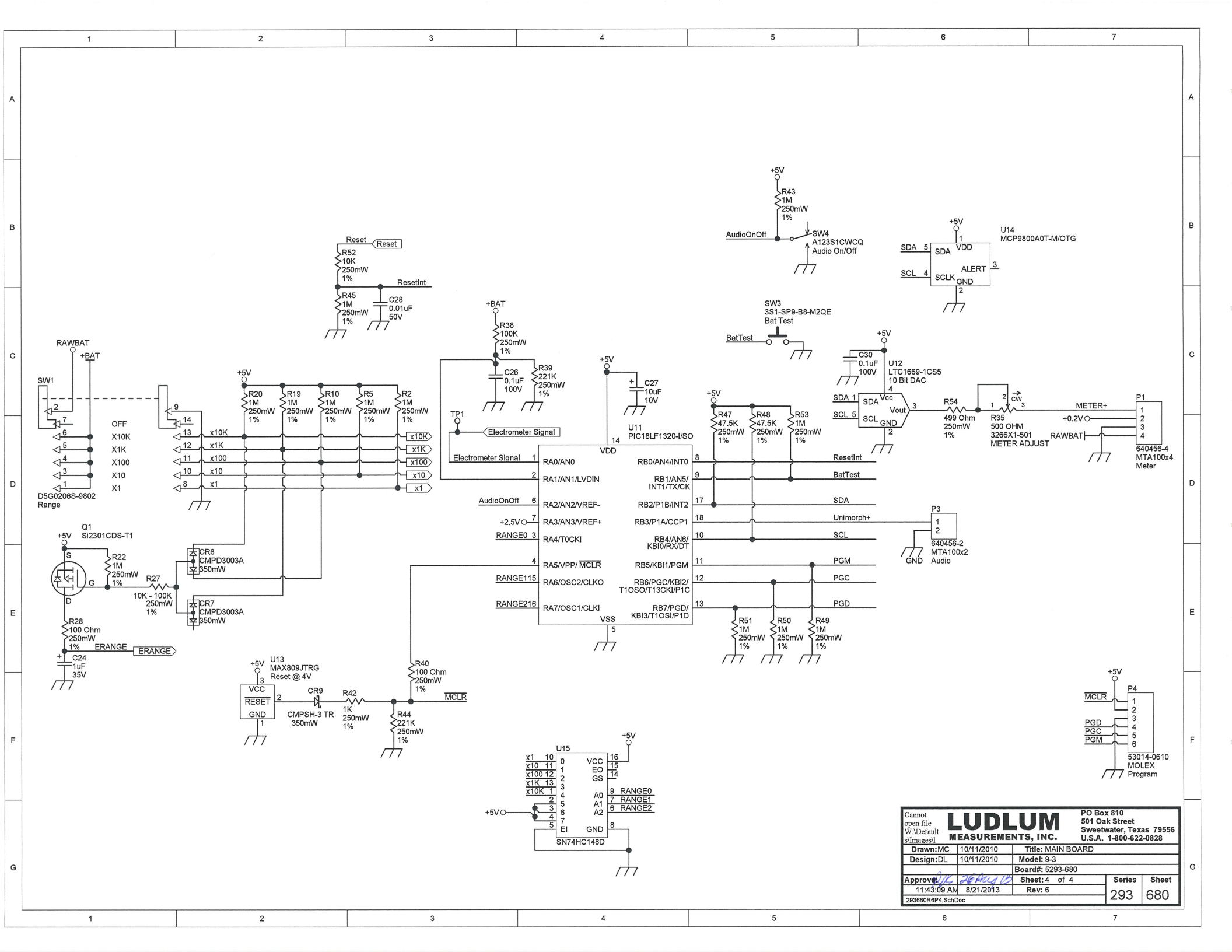
RAWBAT
+BAT
SW1
OFF
X10K
X1K
X100
X10
X1
D5G0206S-9802
Range
+5V
R20 1M 250mW 1%
R19 1M 250mW 1%
R10 1M 250mW 1%
R5 1M 250mW 1%
R2 1M 250mW 1%
x10K
x1K
x100
x10
x1
Reset
R52 10K 250mW 1%
ResetInt
R45 1M 250mW 1%
C28 0.01uF 50V
+BAT
R38 100K 250mW 1%
C26 0.1uF 100V
R39 221K 250mW 1%
TP1
Electrometer Signal
+5V
C27 10uF 10V
U11
PIC18LF1320-I/SO
VDD
VSS
RA0/AN0
RA1/AN1/LVDIN
RA2/AN2/VREF-
RA3/AN3/VREF+
RA4/T0CKI
RA5/VPP/MCLR
RA6/OSC2/CLKO
RA7/OSC1/CLKI
RB0/AN4/INT0
RB1/AN5/INT1/TX/CK
RB2/P1B/INT2
RB3/P1A/CCP1
RB4/AN6/KBI0/RX/DT
RB5/KBI1/PGM
RB6/PGC/KBI2/T1OSO/T13CKI/P1C
RB7/PGD/KBI3/T1OSI/P1D
AudioOnOff
+2.5V
RANGE0
RANGE115
RANGE216
ResetInt
BatTest
SDA
Unimorph+
SCL
PGM
PGC
PGD
+5V
R43 1M 250mW 1%
AudioOnOff
SW4
A123S1CWCQ
Audio On/Off
SW3
3S1-SP9-B8-M2QE
Bat Test
BatTest
U14
MCP9800A0T-M/OTG
SDA
SCL
SCLK
VDD
ALERT
GND
C30 0.1uF 100V
U12
LTC1669-1CS5
10 Bit DAC
Vcc
Vout
SDA
SCL
GND
R54 499 Ohm 250mW 1%
R35 500 OHM 3266X1-501 METER ADJUST
CW
METER+
+0.2V
RAWBAT
P1
640456-4
MTA100x4
Meter
R47 47.5K 250mW 1%
R48 47.5K 250mW 1%
R53 1M 250mW 1%
R51 1M 250mW 1%
R50 1M 250mW 1%
R49 1M 250mW 1%
P3
640456-2
MTA100x2
Audio
GND
Q1
Si2301CDS-T1
S
G
D
R22 1M 250mW 1%
R27 10K - 100K 250mW 1%
R28 100 Ohm 250mW 1%
ERANGE
C24 1uF 35V
CR8 CMPD3003A 350mW
CR7 CMPD3003A 350mW
U13
MAX809JTRG
Reset @ 4V
VCC
RESET
GND
CR9
CMPSH-3 TR 350mW
R42 1K 250mW 1%
R40 100 Ohm 250mW 1%
R44 221K 250mW 1%
MCLR
U15
SN74HC148D
VCC
EO
GS
EI
A0
A1
A2
RANGE0
RANGE1
RANGE2
P4
MCLR
PGD
PGC
PGM
53014-0610
MOLEX
Program
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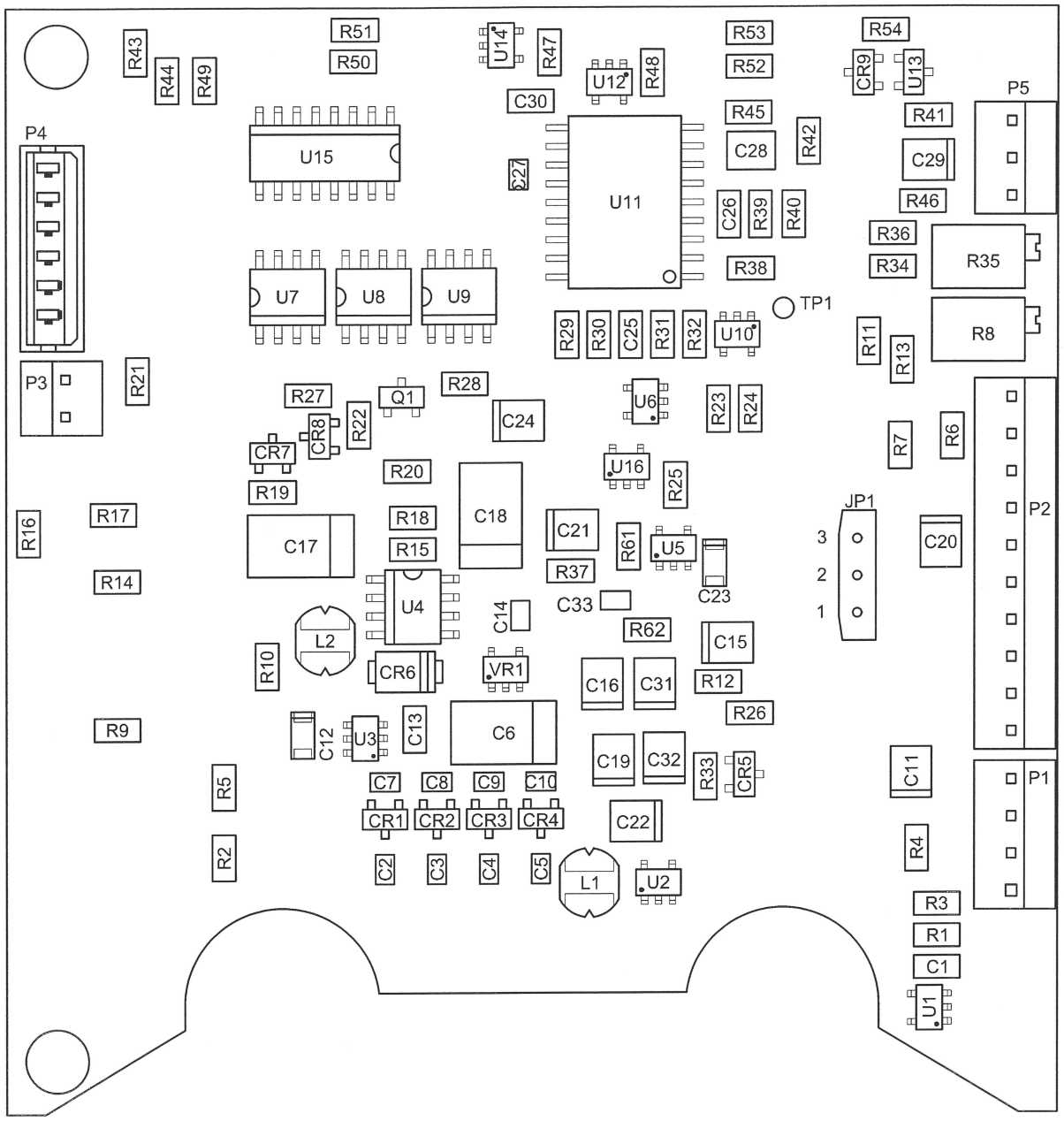
LUDLUM MEASUREMENTS, INC.
PO Box 810
501 Oak Street
Sweetwater, Texas 79556
U.S.A. 1-800-622-0828
Drawn: MC 10/11/2010
Design: DL 10/11/2010
Title: MAIN BOARD
Model: 9-3
Board#: 5293-680
Approved:
Sheet: 4 of 4
Rev: 6
11:43:09 AM 8/21/2013
293680R6P4.SchDoc
Series 293
Sheet 680



LUDLUM MEASUREMENTS, INC.

PO Box 810
501 Oak Street
Sweetwater, TX 79556
U.S.A. 1-800-622-0828

Title: Main Board			
Drawn: MC	11-OCT-10	**Model:** 9-3	
Design: DL	11-OCT-10	**Board#:** 5293-680	
Approve: RSS	25 Oct 11	**Rev:** 6.0	
Print Date: 10/25/2011 12:13:33 PM		**SCALE: 2.14** Top Overlay	**Series** 293 / **Sheet** 681
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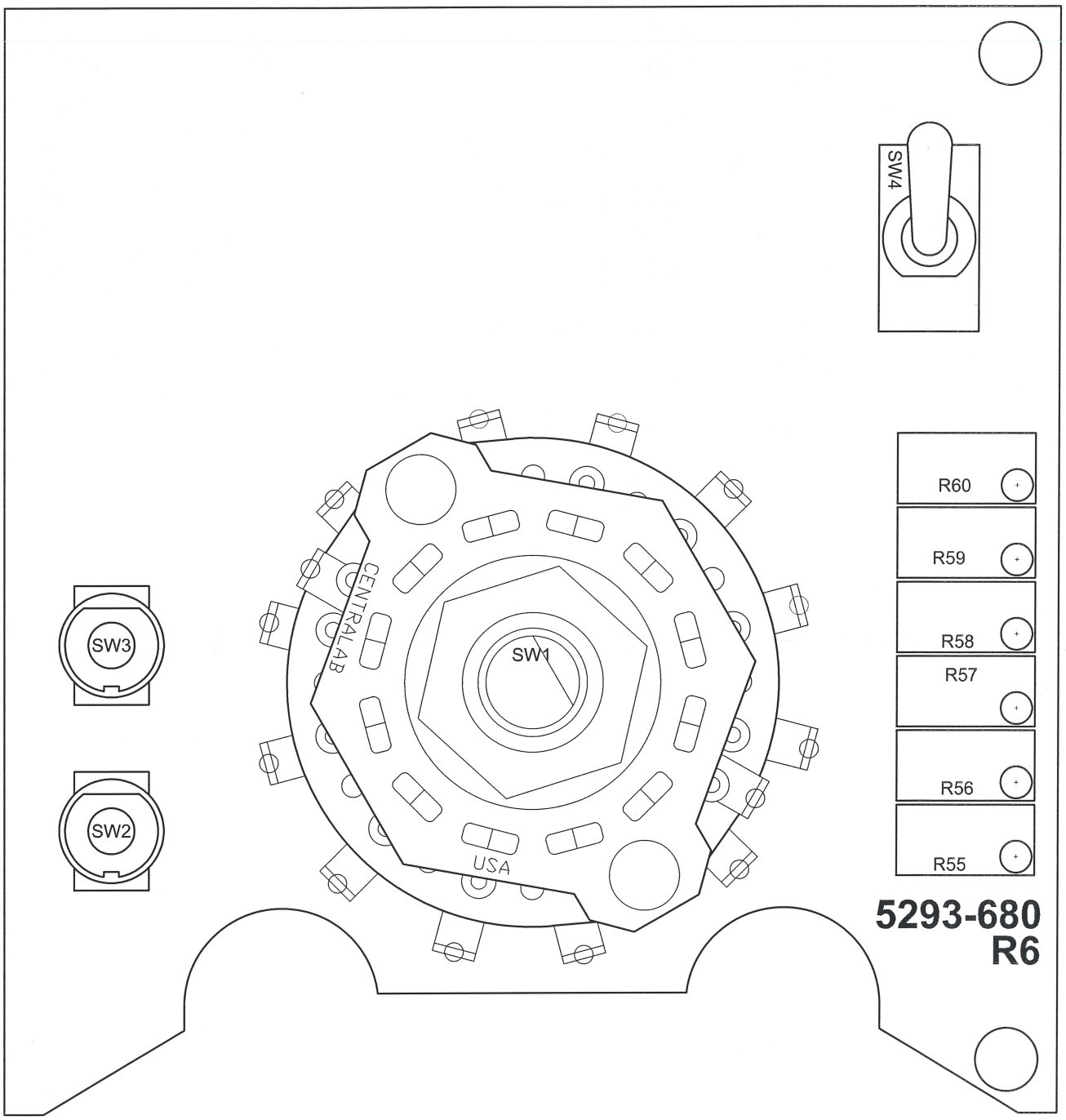

LUDLUM MEASUREMENTS, INC.

PO Box 810
501 Oak Street
Sweetwater, TX 79556
U.S.A. 1-800-622-0828

Title: Main Board					
Drawn: MC	11-OCT-10	**Model:** 9-3			
Design: DL	11-OCT-10	**Board#:** 5293-680			
Approve: RBS	7 Dec 10	**Rev:** 6.0			
Print Date: 12/7/2010 8:30:24 AM		**SCALE: 2.37** Bottom Overlay	**Series** 293	**Sheet** 681	

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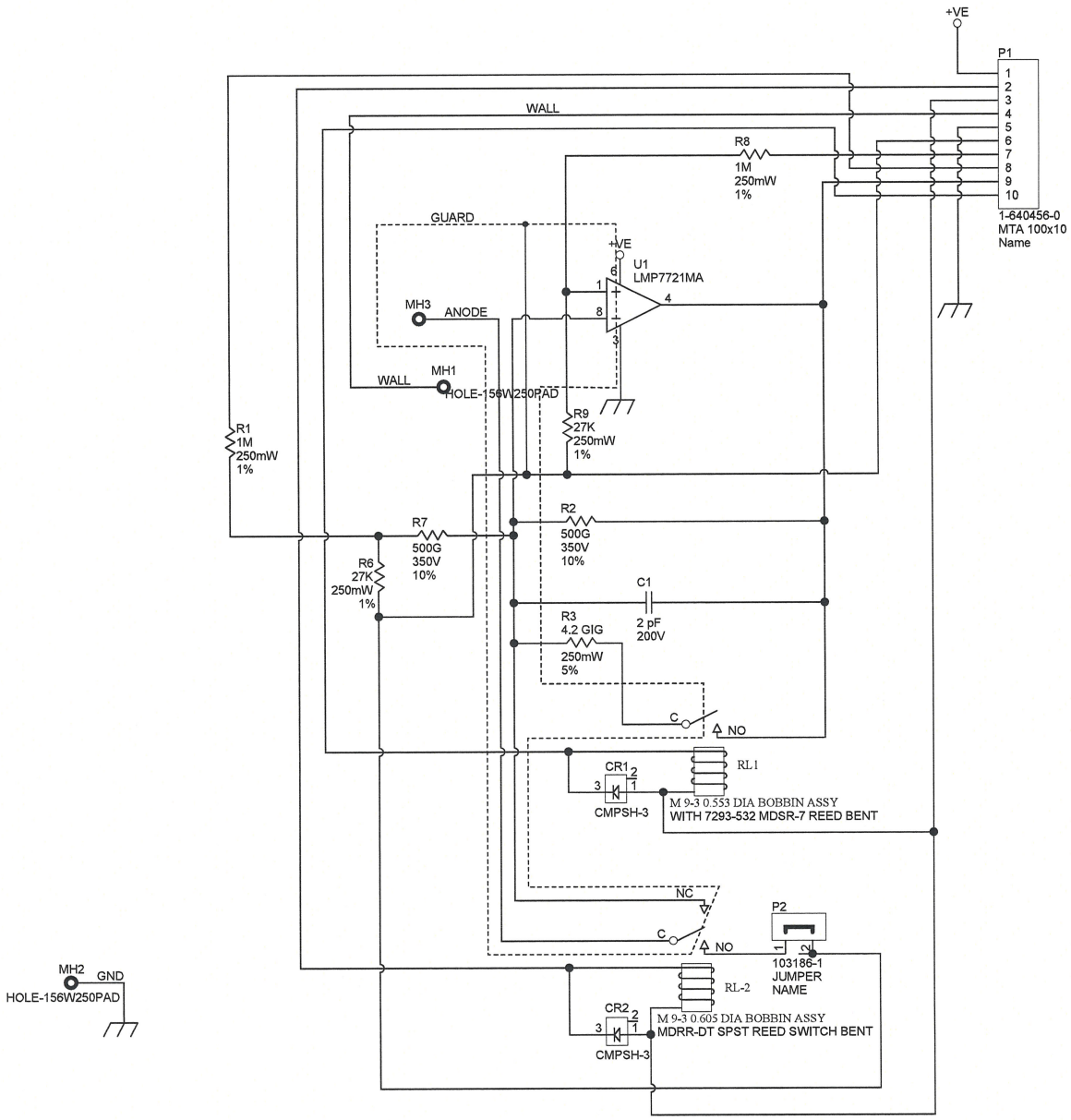

LUDLUM MEASUREMENTS, INC.
PO Box 810
501 Oak Street
Sweetwater, Texas 79556
U.S.A. 1-800-622-0828

Drawn: ALC	10/16/2012	Title: ELECTROMETER BOARD	
Design: DL	10/16/2012	Model: 9-3/9-4	
		Board#: 5293-670	
Approve: JW 10-17-12		Sheet: 1 of 1	Series 293 / Sheet 670
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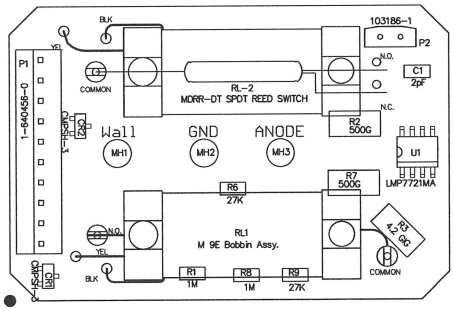

LUDLUM MEASUREMENTS, INC.	PO Box 810 501 Oak Street Sweetwater, TX 79556 U.S.A. 1-800-622-0828		
Title: ELECTROMETER BOARD			
Drawn: ALC	10/16/2012	**Model:** 9-3/9-4	
Design: DL	10/16/2012	**Board#:** 5293-670	
Approve: JGW	10-17-12	**Rev:** 2	
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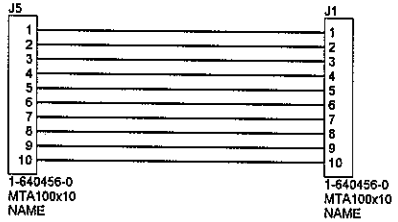

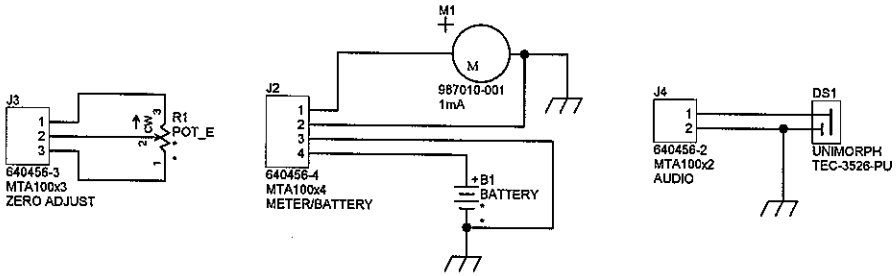

LUDLUM MEASUREMENTS, INC.			PO Box 810 501 Oak Street Sweetwater, Texas 79556 U.S.A. 1-800-622-0828
Drawn: MC	5/28/08	Title: WIRING DIAGRAM	
Design: DL	5/28/08	Model: M9-3	
		Board#: 293-525	
Approved: RH 28APR10		Sheet: 1 of 1	Series: 293 / Sheet: 525
14:55:30	28-Apr-2010	Rev: 2	
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