LUDLUM MODEL 14C
SURVEY METER

July 2022
Serial Number 260716 and Succeeding
Serial Numbers

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1. Introduction

The Model 14C is a rugged, portable survey instrument that operates on two standard "D" cell alkaline batteries. The instrument features a regulated high voltage power supply set at 900 volts and provides five linear ranges for measurement from 0 to 2000 mR/hr.

The unit body is made of rugged cast aluminum. Operating features of the instrument include a unimorph speaker, mounted to the instrument can with an audio ON/OFF switch, fast/slow meter response switch, meter reset button, battery check button, and six-position switch for selecting scale multiples of ×0.1, ×1, ×10, ×100, and ×1000. Each range multiplier has its own calibration potentiometer.

The audio provides a brief "click" for every radiation event detected. It also provides a steady tone to warn the user of a low battery condition. This low-battery warning overrides the position of the AUD ON-OFF switch.

This instrument is set for 900-volt GM (Geiger Mueller) tube operation and is typically used with an external, thin-wall GM tube or pancake GM tube; however, other external detectors are compatible with this instrument. An internal energy-compensated, high-range detector is used for the ×1000 range only. The internal detector is active whenever the instrument is on and in a very high radiation field and will drive the meter needle to full scale.

The unit is operated with two "D" cell alkaline batteries for operation from 0 °C (32 °F) to approximately 65.6 °C (150 °F). For operation in temperatures below 0 °C (32 °F), either very fresh alkaline batteries or rechargeable NiCd batteries should be used. Battery drain is typically 5-7 mA in low radiation fields.

2. Getting Started

UNPACKING AND REPACKING

Remove the calibration certificate and place it in a secure location. Remove the instrument and accessories (batteries, cable, etc.) and ensure that all of the items listed on the packing list are in the carton. Check individual item serial numbers and ensure calibration certificates match. The Model 14C serial number is located on the front panel below the battery compartment. Most Ludlum Measurements, Inc. detectors have a label on the base or body of the detector for model and serial number identification.

Important!

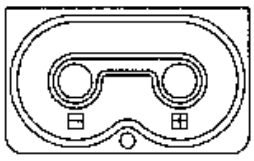
If multiple shipments are received, ensure that the detectors and instruments are not interchanged. Each instrument is calibrated to specific detector(s), and is therefore not interchangeable.

To return an instrument for repair or calibration, provide sufficient packing material to prevent damage during shipment. Also provide appropriate warning labels to ensure careful handling.

Every returned instrument must be accompanied by an Instrument Return Form, which can be downloaded from the Ludlum website at www.ludlums.com. Find the form by clicking the "Support" tab and selecting "Service Department" from the drop-down menu. Then choose the appropriate Service Department division where you will find a link to the form.

BATTERY INSTALLATION

Ensure the Model 14C range selector switch is in the OFF position. Open the battery lid by pushing down and turning the quarter-turn thumbscrew counterclockwise a fourth of a turn. Install two ″D″ size batteries in the compartment.



Note the (+) and (-) marks inside the battery door. Match the battery polarity to these marks. Close the battery box lid, push down, and turn the quarter-turn thumb screw clockwise a fourth of a turn.

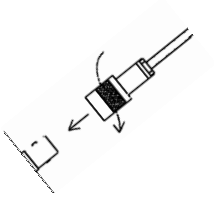
Note:

The center post of a "D" size battery is positive.

CONNECTING A DETECTOR TO THE INSTRUMENT

Caution!

The detector operating voltage (HV) is supplied to the detector via the detector input connector. A mild electric shock may occur if you make contact with the center pin of the input connector. Switch the Model 14C range selector switch to the OFF position before connecting or disconnecting the cable or detector.



Connect one end of a detector cable to the detector by firmly pushing the connectors together while twisting clockwise a fourth of a turn. Repeat the process in the same manner with the other end of the cable and the instrument.

BATTERY TEST

The batteries should be checked each time the instrument is turned on. Move the range switch to the ×1000 position and press the BAT button. Ensure that the meter needle deflects to the battery check portion on 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

After checking the batteries, turn the instrument range switch to the ×1000 position. Place the AUD ON-OFF switch in the ON position. Expose the internal detector to a check source. The instrument speaker should emit ″clicks″ relative to the rate of counts detected. The AUD ON/OFF switch will silence the audible clicks if in the OFF position. It is recommended that the AUD ON/OFF switch be kept in the OFF position when not needed in order to preserve battery life.

Check the meter reset function by depressing the RES pushbutton switch and ensuring the meter needle drops to ″0″.
Once this procedure has been completed, the instrument is ready for use.

READING THE METER-FACE DIAL

Reading the meter face is very important for consistent measurements. There are, in general, three types of meter faces: 1) count rate (typically cpm [counts per minute]); 2) exposure rate (typically mR/hr); and 3) "combo" (typically cpm and mR/hr). The following examples are intended to help the user interpret the correct reading.

The normal procedure is to turn the range selector switch to the highest range, and if no readings are seen on the meter, turn the selector switch down to the lower scales until a reading is seen. The ranges on the instrument selector switch are multipliers for the meter reading. A typical single scale (one arc) meter face with a cpm (counts per minute) dial is shown below.

The count rate scale reads 0-5K COUNTS/MINUTE (kcpm or 1000s of counts per minute) and has BAT TEST on the dial.

If the needle is pointing as indicated below and the instrument range selection switch is on the ×0.1 scale multiple, then the reading is 3.5 kcpm (multiplied by) ×0.1 = 350 cpm.

The same needle indications on successive ranges would be:

×1 = 3.5 kcpm (or 3500 cpm)

×10 = 35 kcpm (or 35,000 cpm)

×100 = 350 kcpm (or 350,000 cpm)

A typical dual scale (two arcs) meter face is shown below. The top scale reads 0-2 mR/hr. The bottom scale also reads 0-2 mR/hr and is for ×100 only scale. The ×100 ONLY scale will work correctly when the multiplier switch is in the ×100 range. The meter face also has a BAT TEST position on the dial.

If the needle is pointing as indicated below and the range selection switch is on the ×0.1 scale, then the reading is 0.1 mR/hr.

The same needle indications on successive ranges would be:

×1 = 1.0 mR/hr (or 1000 μR/hr)

×10 = 10 mR/hr (or 10,000 μR/hr)

×100 = 70 mR/hr (or 70,000 μR/hr)

×1000 = 1.0 R/hr (or 1000 mR/hr)

The dial shown below has three arcs: a counts per minute scale (cpm), a linear mR/hr scale, and a non-linear mR/hr scale for the ×100 range only. The meter face also has a BAT TEST position.

The top cpm scale is valid for the ×0.1, ×1, ×10, and the ×100 ranges. The linear (middle) mR/hr scale is valid for the ×0.1, ×1, ×10, and ×1000 (using the internal detector only) ranges. The non-linear mR/hr scale is valid for the ×100 range only. This meter face is commonly referred to as a "combo" meter face, since it has both count rate (cpm) and exposure rate (mR/hr) arcs. Simpler meter faces may only have a count rate or an exposure rate arc(s) like the previous meter faces shown.

A "combo" meter face is specifically designed for a particular detector. In the example above, the 1.0 mR/hr mark on the middle arc lines up with 3.3 kcpm on the upper arc. The meter face in this example works with a detector that receives 3.3 kcpm per mR/hr (the Ludlum Model 44-9 pancake detector.) Additional detectors may be used with this meter face, but only the cpm dial is valid for these detectors. The mR/hr scale is not valid for these additional detectors.

In the following picture, the needle is on the first tick mark past the 4 kcpm mark. Therefore, if the instrument selector switch is on the ×0.1 range, the reading is 4.2 kcpm (multiplied by) ×0.1 = 420 cpm.

The same needle indication on successive ranges would be:

×1 = 4.2 kcpm (or 4200 cpm)

×10 = 42 kcpm (or 42,000 cpm)

×100 = 420 kcpm (or 420,000 cpm)

If you use the mR/hr scales, then the readings would be:

×0.1 = 0.13 mR/hr

×1 = 1.3 mR/hr

×10 = 13 mR/hr

×100 = 180 mR/hr*

×1000 = 1.3 R/hr (using internal detector)

Note:

*This reading is using the bottom (non-linear) scale.

Many different dials are available, but each can be used as described above.

OPERATIONAL CHECK

To assure proper operation of the instrument and detector(s) between calibrations, an instrument operational check including battery test and instrument test (as described on Page 4) should be performed at least daily or prior to use, whichever is less frequent. A reference reading (or readings) with a check source should be obtained at the time of calibration

If at any time the instrument fails to read within 20% of the reference reading when using the same check source, it should be sent to a calibration facility for recalibration and/or repair.

If desired, multiple readings may be taken at different distances and/or with different sources so that other ranges or scales are checked.

3. Specifications

Compatible Detectors: GM, Scintillation

Meter Dial: typically 0-2 mR/hr and cpm, bat test (others available)

Ranges: rotary range multiplier switch selects multiples of ×0.1, ×1, ×10, ×100, and ×1000

Linearity: reading within 10% of true value with detector connected

Connector: series "C" (others available)

Internal Detector: energy compensated GM (used with ×1000 scale only)

Energy Response: within 15% of true value between 60 keV and 3 MeV (internal detector only)

Input Sensitivity: -40 mV ± 10 mV

Audio: built-in unimorph speaker with on/off switch (greater than 60 dB at 0.61 m [2 ft])

Response: toggle switch for FAST (4 seconds) or SLOW (22 seconds) from 10% to 90% of final reading

Reset: pushbutton to "zero" the meter

Power: 2 each "D" cell batteries (housed in an externally accessible sealed compartment)

Battery Dependence: instrument calibration change of less than 3% within the meter face battery check limits

Battery Life: typically greater than 2000 hours (battery condition may be checked on the meter face)

Meter: 6.4 cm (2.5 in.) arc, 1 mA analog type

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

Size:16.5 x 8.9 x 21.6 cm (6.5 x 3.5 x 8.5 in.) (H x W x L)

Weight: 1.6 kg (3.5 lb) with batteries; 1.2 kg (2.6 lb) without

4. Identification of Controls and Functions

Range Multiplier Selector Switch: a six-position switch marked "OFF", ×1000, ×100, ×10, ×1, and ×0.1. Moving the range selector switch to one of the range multiplier positions (×1000, ×100, ×10, ×1, and × 0.1) provides the operator with five decades of range multipliers. Multiply the scale reading by the multiplier to determine the actual scale reading.

AUDIO ON/OFF Toggle Switch: In the on position, the switch energizes the unimorph speaker, located on the left side of the instrument. The frequency of the clicks is relative to the rate of the incoming pulses. The higher the rate, the higher the audio frequency. The audio should be turned off when not required to reduce battery drain.

Note:

A low-battery condition results in a steady audio tone regardless of the position of the AUD ON-OFF switch.

Fast Slow Toggle Switch: provides meter response. Selecting the fast, F, position of the toggle switch provides 90% of final meter reading within four seconds. In the slow, S, position, 90% of the final meter reading takes approximately 22 seconds. Set this switch to the F position for fast response and large meter deviation. The "S" position should be used for slow response and damped meter deviation.

Note:

The slow response position is normally used when the instrument is displaying low numbers, which require a more stable meter movement. The fast response position is used at high rate levels.

RESET Button: When depressed, this button provides a rapid means to drive the meter to 0.

BAT Check Button: When depressed, this button provides a visual means of checking the battery charge status. The instrument must be turned on to perform this check.

Range Calibration Adjustments: Recessed potentiometers are located under the calibration cover on the right side of the front panel for use in range calibration adjustments. These controls allow individual calibration for each range multiplier.

5. Safety Considerations

ENVIRONMENTAL CONDITIONS FOR NORMAL USE

Indoor or outdoor use

No maximum altitude

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

Maximum relative humidity of less then 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.

Caution!

Verify instrument voltage input rating before connecting to a power converter. If the wrong power converter is used, the instrument and/or power converter could be damaged.

The Model 14C Survey Meter is marked with the following symbols:

CAUTION, RISK OF ELECTRIC SHOCK (per ISO 3864, No. B.3.6): designates a terminal (connector) that allows connection to a voltage exceeding 1 kV. Contact with the subject connector while the instrument is on or shortly after turning off may result in electric shock. This symbol appears on the front panel.

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 instrument must be isolated or disconnected from the hazardous live voltage before accessing the internal components. This symbol appears on the front panel. Note the following precautions:

Warning

The operator is strongly 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 **"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 "Recycling" section for further information.

CLEANING AND MAINTENANCE PRECAUTIONS

The Model 14C 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.

6. Calibration and Maintenance

CALIBRATION

Note:

Measure high voltage with a Ludlum Model 500 Pulser or a high-impedance voltmeter with a high-meg probe. If one of these instruments is unavailable, use a voltmeter with a minimum input resistance of 1000 megohms.

Note:

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

➢ ESTABLISHING AN OPERATING POINT

Efficiency, background sensitivity, and noise are fixed by the physical makeup of the given detector and rarely vary from unit to unit. However, the selection of the operating point makes a significant difference in the contribution of these three sources of count. The purpose of setting the operating point is to establish the system gain so that the desirable signal pulses (including background) are above the discrimination level, and the unwanted pulses from noise are below the discrimination level. The pulses above the discrimination level are counted by the instrument, while those below are not.

The total system gain is controlled by adjusting the instrument high voltage. Voltage affects the output of the detector. In special cases of GM detectors, a minimum voltage must be applied to establish the Geiger-Mueller characteristic.

The operating point for each detector is set at a compromise point between sensitivity, stability, and background contribution. These operating points are best for general monitoring. In application, these arbitrarily selected points may not be a better operating point.

The following guidelines are presented:

G-M Detectors: The output pulse height of the GM detector is not proportional to the energy of the detected radiation. For most GM detectors set the HV to the GM tube recommended high voltage. Most GM detectors operate at 900 volts, however, some miniature detectors operate at 400-600 volts. If a recommended setting is unavailable, run a plateau of HV setting vs. count rate. Then set the high voltage on the low side of the plateau "center."

Scintillators: Carefully increase HV until the instrument plateaus on the background count. This provides the most stable operating point for the detector.

Note:

Access to the HV adjustment potentiometer is achieved by removal of the instrument housing. Potentiometer R8 on the HV Power Supply Board is the control for this adjustment.

Warning!

Open instrument has shock potential! Do not allow any conductive material to come in contact with internal parts while making the following adjustments.

- **SETTING OVERLOAD**

Disconnect the external detector.

Set the instrument range selector multiplier switch to ×100.

On the HV power supply board, adjust R3 until the unit indicates a full-scale reading (on the ×100 scale) at 10 R/hr, and no over-range at 4 R/hr.

- **RANGE CALIBRATION**

Turn the instrument range multiplier selector switch to the appropriate range. Expose the detector to a calibrated gamma field and adjust the respective range calibration potentiometer for proper reading.

Repeat the above procedure for the remaining ranges.

MAINTENANCE

Instrument maintenance consists of keeping the instrument clean and periodically checking the batteries and the calibration. The Model 14C instrument may be cleaned with a damp cloth (using only water as the wetting agent). Do not immerse instrument in any liquid. Observe the following precautions when cleaning:

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

- **RECALIBRATION**

Recalibration should be accomplished after maintenance or adjustments have been performed on the instrument. Recalibration is not normally required following instrument cleaning, battery replacement, or detector cable 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 ful-service repair and calibration department. We not only repair and calibrate our own instruments, but most other manufacturers' instruments as well. 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. Use a spanner wrench to unscrew the battery contact insulators, exposing the internal contacts and battery springs. Removal of the handle will facilitate access to these contacts.

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 38 °C (100 °F).

7. Troubleshooting

Occasionally, you may encounter problems with your LMI instrument or detector that may be repaired or resolved in the field, saving turnaround time and expense in returning the instrument to us for repair. Toward that end, LMI electronics technicians offer the following tips for troubleshooting the most common problems. Where several steps are given, perform them in order until the problem is corrected. Keep in mind that with this instrument, the most common problems encountered are: (1) detector cables, (2) sticky meters, (3) battery contacts.

Note that the first troubleshooting tip is for determining whether the problem is with the electronics or with the detector. A Ludlum Model 500 Pulser is invaluable at this point because of its ability to simultaneously check high voltage, input sensitivity or threshold, and the electronics for proper counting.

We hope these tips will prove to be helpful. As always, please call if you encounter difficulty in resolving a problem or if you have any questions.

TROUBLESHOOTING ELECTRONICS WHICH UTILIZE A GM DETECTOR OR SCINTILLATOR

SYMPTOM	POSSIBLE SOLUTION
no power (or meter does not reach BAT TEST or BAT OK mark)	1. Check batteries and replace if weak. 2. Check polarity (see marks inside battery lid). Are the batteries installed backwards? 3. Check battery contacts. Clean them with rough sandpaper, or use an engraver to clean the tips. 4. Remove the can and check for loose or broken wires.
nonlinear readings	1. Check the high voltage (HV) using a Ludlum Model 500 Pulser (or equivalent). If a multimeter is used to check the HV, ensure that one with high impedance is used, as a standard multimeter could be damaged in this process. 2. Check for noise in the detector cable by disconnecting the detector, placing the instrument on the lowest range setting, and wiggling the cable while observing the meter face for significant changes in readings.

	POSSIBLE SOLUTION
nonlinear readings (continued)	3. Check for "sticky" meter movement. Does the reading change when you change the meter? Does the meter needle "stick" at any spot? 4. Check the "meter zero." Turn the power OFF. The meter should come to rest on zero.
meter goes full-scale or "pegs out"	1. Replace the detector cable to determine whether or not the cable has failed, causing excessive noise. 2. Check the HV, and if possible, the input threshold for proper setting. 3. Ensure that the instrument's "can" is properly attached. When attached properly, the speaker will be located on the left side of the instrument. If the can is on backwards, interference between the speaker and the input preamplifier may cause noise.
no response to radiation	**1.** Substitute a "known good" detector and/or cable. **2.** Has the correct operating voltage been set? Refer to the calibration certificate or detector instruction manual for correct operating voltage. If the instrument uses multiple detectors, confirm that the high voltage is matched to the current detector being used.
no audio	1. Ensure that the AUD ON-OFF switch is in the ON position. 2. Remove the instrument housing and check the connection between the circuit board and the speaker. Plug in the 2-pin connector if necessary.

TROUBLESHOOTING GM DETECTORS

1. If the tube has a thin mica window, check for window breakage. If damage is evident, the tube must be replaced.
2. Check the HV. For most GM tubes, the voltage is normally 900 Vdc, or 460-550 Vdc for "peanut" tubes (Ludlum Model 133 series).
3. If the input sensitivity is too low, the user could see some double pulsing.
4. Wires to the tube may be broken, or the crimped connector could have a loose wire.

TROUBLESHOOTING SCINTILLATORS

1. Alpha or alpha/beta scintillators are prone to light leaks. They can be tested for this problem in a dark room or with a bright light. If a light leak is determined, changing the Mylar window assembly will usually fix the problem.

Note:

When replacing the window, make sure to use a window made with the same thickness mylar and the same number of layers as the original window.

2. Verify that the HV and input sensitivity are correct. Alpha and gamma scintillators typically operate from 10-35 mV. High voltage varies with the photomultiplier tubes (PMT) from as low as 600 Vdc, to as high as 1400 Vdc.
3. On a gamma scintillator, visually inspect the crystal for breakage or humidity leakage. Water inside the crystal will turn it yellow and gradually degrade performance.
4. Check the PMT to see if the photocathode still exists. If the end of the PMT is clear (not brownish), this indicates a loss of vacuum, which will render the PMT useless.

8. Technical Theory of Operation

INPUT

The external detector pulses are coupled from the detector through C4 to amplifier U9/U15/Q2. CR1 protects the amplifier from input shorts. R40 couples the detector to the high-voltage supply.

The internal detector (V1) is located on the HV Power Supply circuit board. V1 pulses are coupled through C6 to comparator U13 on the main circuit board. R46 and R47 set the comparator level to approximately 0.5 volts. R9 on the HV power supply circuit board limits the detector current. With the range selector switch on ×1K, U5B is closed, coupling high-range pulses to the counting circuitry.

The internal detector is used only when the range switch is in the ×1K position. In the ×0.1, ×1, ×10, and ×100 ranges, the external detector is used. When the range selector switch is on the 1K position, Q4 is saturated, blocking external detector pulses.

AMPLIFIER

A self-biased amplifier provides gain in proportion to R43/C11 divided by R41 for the external detector. Transistor (pin 3 of U9) provides amplification. Pin 2 and 5 of U15 are coupled as a current mirror to provide a load for pin 3 of U9. The output self-biases to 2 Vbe (approximately 1.4 volts) at emitter of Q2. This provides just enough bias current through pin 2 of U9 to conduct all of the current from the current mirror.

Positive pulses from emitter of Q2 are coupled to the comparator U12.

DISCRIMINATOR

Comparator U12 provides discrimination. The discriminator is set by the voltage divider, R9 and R25, coupled to pin 3 of U12. The comparator trip point is approximately 0.16 volts. U12 pulses are coupled to pin 5 of U7A for meter drive and pin 12 of U7B for audio.

AUDIO

Discriminator pulses are coupled to univibrator pin 12 of U7B. Front-panel audio ON/OFF selector controls the reset at pin 13 of U7B. When ON, pulses from pin 10 of U7B turn oscillator U17 on. Pin 5 of U17 drives the can-mounted unimorph. Speaker tone is set by R49, C20 duration by R48, C16.

DIGITAL ANALOG CONVERTER

Pins 2, 3, and 5 of U8 are coupled as a current mirror. For each pulse of current through R36, an equal current is delivered to C8. This charge is drained off by R38. The voltage across C8 is proportional to the incoming count rate.

SCALE RANGING

Detector pulses from the discriminator are coupled to univibrator, pin 5 of U7A. For each scale, the pulse width of pin 6 of U7A is increased by a factor of 10 with the actual pulse width being controlled by the front-panel calibration controls and their related capacitors. This arrangement allows the same current to be delivered to C8 by one-tenth of a count on the ×0.1 range, as 10 counts on ×100 range.

METER DRIVE

The meter is driven by the collector of Q1, coupled as a constant current source in conjunction with pin 1 of U10. For battery test, U18A opens and U18B closes, and the meter movement is directly coupled to the battery through R31.

FAST/SLOW TIME CONSTANT

For slow time constant, C7 is switched from the output of the meter drive to parallel C8.

LOW VOLTAGE SUPPLY

Battery voltage is coupled to U16 and associated components (a switching regulator) to provide 5 volts at pin 8 to power all circuits.

HIGH VOLTAGE SUPPLY

On the HV power supply circuit board, high voltage is developed by C1-T1 and rectified by voltage multiplier CR1–CR6. Output voltage increases as R8 decreases.

High voltage is coupled back through R6 to pin 8 of U1. R7/R8 completes the high voltage, circuit to ground. High-voltage output is set by R8. During stable operation, the voltage at pin 8 of U1 will stabilize at approximately 1.2 volts.

OVERLOAD

The cathode of V1 is connected through R3 to ground. With R3 on the main board fully clockwise and the instrument in a 2 R/hr radiation field, voltage at the cathode ranges from 0.2 to 0.4 volts, depending on exact high-voltage setting and the internal tube.

The cathode voltage is conducted from the HV power supply board through P1 to pin 4, U11 on the main circuit board. Comparator U11 is biased at 0.22 volts. When pin 4, U11 exceeds 0.22 volts, U3B switch is closed, grounding R39, causing high-current flow through R38 and causing the meter circuit to drive full scale.

LOW BATTERY ALARM

When the battery voltage drops to 2.2 volts, Pin 2 of U16 causes U5A switch to open, allowing Pin 3 of U17 to go high. The audio will make a continuous noise.

SWITCHING

All switching, except FAST/SLOW and audio ON/OFF, is accomplished with analog switches. Switch schematics are shown enabled, although typically, only one switch is enabled at any given time.

9. Recycling

Ludlum Measurements, Inc. supports the recycling of the electronic 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:

10. Parts List

Model 14C Survey Meter

Reference	Description	Part Number
UNIT	Completely Assembled Model 14C Survey Meter	48-1611

Main Board, Drawing 464 × 454

BOARD	Completely Assembled Main Circuit Board	5464-454
CAPACITORS:		
C1	47pF, 50V	04-5740
C2	100pF, 100V	04-5661
C3	100pF, 100V	04-5661
C4	100pF, 3KV	04-5735
C5	0.1µF, 35V	04-5755
C6	0.0047µF, 100V	04-5669
C7	47µF, 10V	04-5666
C8	10µF, 25V	04-5655
C9	1µF, 16V	04-5701
C10	470pF, 100V	04-5668
C11	10pF, 100V	04-5673
C12	0.01µF, 50V	04-5664
C13-C14	0.001µF, 100V	04-5659
C15	100pF, 100V	04-5661
C16	0.022µF, 50V	04-5667
C17	68µF, 10V	04-5654
C18	68µF, 10V	04-5654
C19	1µF, 16V	04-5701
C20	470pF, 100V	04-5668
C21	0.001µF, 2KV	04-5703
C22	1µF, 16V	04-5701
TRANSISTORS:		
Q1	MMBT4403LT1	05-5842
Q2	MMBT3904LT1	05-5841
Q3	2N7002L	05-5840
Q4	MMBT3904LT1	05-5841
INTEGRATED CIRCUITS:		
U1-U3	MAX4542ESA	06-6453
U5	MAX4543ESA	06-6596
U7	CD74HC4538M	06-6297

Reference	Description	Part Number
U8-U9	CMXT3904	05-5888
U10	LMC7111BIM5X	06-6410
U11	MAX985EUK-T	06-6459
U12-U13	MAX986EUK-T	06-6601
U15	CMXT3906	05-5890
U16	LT1304CS8-5	06-6434
U17	MIC1557BM5	06-6457
U18	MAX4543ESA	06-6596
DIODES:		
CR1	CMPD2004S	07-6402
CR2	CMSH1-40M	07-6411
SWITCHES:		
S1	CENTRAL-2P6P, (RANGE)	08-6761
S2	7101SDCQE, F/S	08-6781
S3	TP11LTCQE, RESET	08-6770
S4	TP11LTCQE, BAT TEST	08-6770
S5	7101SDCQE, AUDIO	08-6781
POTENTIOMETERS:		
R14	250K, 64W254, ×1K	09-6819
R27	250K, 64W254, ×10	09-6819
R28	500K, 64W504, ×1	09-6850
R29	250K, 64W254, ×0.1	09-6819
R30	250K, 64W254, ×100	09-6819
RESISTORS:		
R1-R6	200K, 1/8W, 1%	12-7992
R7-R8	100K, 1/8W, 1%	12-7834
R9	68.1K, 1/8W, 1%	12-7881
R10-R13	100K, 1/8W, 1%	12-7834
R15-R19	10K, 1/8W, 1%	12-7839
R20	100K, 1/8W, 1%	12-7834
R21	4.75K, 1/8W, 1%	12-7858
R22-R24	10K, 1/8W, 1%	12-7839
R25	2.21K, 7/8W, 1%	12-7835
R26	8.25K, 1/8W, 1%	12-7838
R31	2.37K, 1/8W, 1%	12-7861
R32	2K, 1/8W, 1%	12-7926
R33	200 Ohm, 1/8W, 1%	12-7846
R34	100K, 1/8W, 1%	12-7834
R35	1K, 1/4W, 1%	12-7832
R36	14.7K, 1/8W, 1%	12-7068
R37	68.1K, 1/8W, 1%	12-7881
R38-R39	200K, 1/8W, 1%	12-7992
R40	100K, 1/8W, 1%	12-7834

Reference	Description	Part Number
R41-R42	4.75K, 1/8W, 1%	12-7858
R43	165K, 1/8W, 1%	12-7877
R44-R45	1K, 1/8W, 1%	12-7832
R46	137K, 1/8W, 1%	12-7061
R47	14.7K, 1/8W, 1%	12-7068
R48	1M, 1/8W, 1%	12-7844
R49	475K, 1/8W, 1%	12-7859
CONNECTORS:		
P1	640456-5, MTA100×5, CHASSIS CONNECTOR	13-8057
P2	640456-4, MTA100×4, HV/×1K DET CONNECTOR	13-8088
P3	640456-6, MTA100×6, ACCESSORY	13-8095
P4	640456-2, MTA100×2, SPEAKER	13-8073
INDUCTOR:		
L1	22 µH	21-9808
MISCELLANEOUS:		
W1	HV WIRE	**
W1	EXT. DET. WIRE	**

HV Power Supply Board, Drawing 464 × 302

BOARD	Completely Assembled HV Power Supply Board	5464-302
CAPACITORS:		
C1	10µF, 25V	04-5655
C2-C5	0.001µF, 2KV	04-5703
C6	100PF, 3KV	04-5735
C7-C12	0.01µF, 500V	04-5696
C13	68µF, 10V	04-5654
C14	0.1µF, 50V	04-5663
INTEGRATED CIRCUITS:		
U1	LT1304CS8	06-6394
DIODES:		
CR1-CR6	CMSD2004S	07-6417
CR7	CMSH1-40M	07-6411

Reference	Description	Part Number
POTENTIOMETERS:		
R3	25K, 8026EKX-253, OL ADJ.	09-6832
R8	1M, 3266W1-105, HV ADJ	09-6778
RESISTORS:		
R1	1.5M, 1/4W, 1%	12-7987
R2	100K, 1/4W, 1%	12-7834
R4	1M, 1/4W, 1%	12-7844
R5	4.75K, 1/4W, 1%	12-7858
R6	500M, 3KV, 2%	12-7031
R7	475K, 1/4W, 1%	12-7859
R9	1M, 1/4W, 1%	12-7844
CONNECTORS:		
P5	640456-2, MTA100×2, ×1K TEST	13-8073
P6	640456-4, MTA100×4 HV/1K DET	13-8088
TRANSFORMER:		
T1	31032R	21-9925
DETECTOR:		
V1	LND72611	4331-020
MISCELLANEOUS:		
W1	TEFLON WHITE EE22, HV	21-9759
W2	#22 BLACK UL1430, NOT USED	21-9413

Wiring Diagram, Drawing 464 × 175

CONNECTORS:		
J1	640442-5 MTA100	13-8140
J2	640442-4 MTA100	13-8170
J3	640442-6 MTA100	13-8171
J4-J5	640442-2 MTA100	13-8178
J6	640442-4 MTA100	13-8170
AUDIO:		
DS1	UNIMORPH TEC3526-PU	21-9251
BATTERIES:		
B1-B2	″D″ DURACELL BATTERY	21-9313

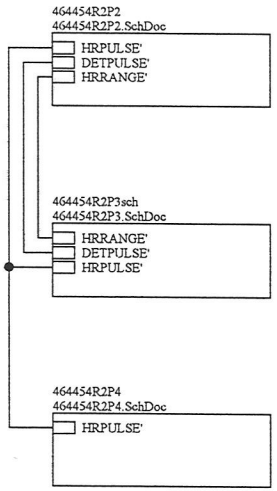
Reference	Description	Part Number
MISCELLANEOUS:		
FL2-FL4	WIRE	**
W1	RECPT-UG706/U "C" LMI	4478-011
M1	METER MOVEMENT	15-8030
*	CABLE-C (STD 1 meter (39 inch)	40-1004
*	BATTERY LID W/STAINLESS CONTACT	2009-036
*	PORTABLE BATTERY NEGATIVE CONTACT ASSEMBLY	2001-065
*	PORTABLE BATTERY POSITIVE CONTACT ASSEMBLY	2001-066
*	CALIBRATION COVER WITH SCREWS	9363-200
*	BEZEL W/MOVEMENT ASSY.	4363-572
*	PORTABLE BEZEL GLASS W/O SCREWS	4363-352
*	PORTABLE KNOB	08-6613
*	CAN ASSEMBLY O-RING	16-8261
*	LATCH KIT W/O PORABLE BATTERY LID	7363-190
*	PORTABLE HANDLE (ROLLED) WITH SCREWS	7363-139
*	PORTABLE HANDLE FOR CLIP WITH SCREWS	7363-203

11. Drawings and Diagrams

MAIN BOARD, Drawing 464 × 454 (4 sheets)
MAIN CIRCUIT BOARD LAYOUT, Drawing 464 × 455A (2 sheets)

HV POWER SUPPLY BOARD, Drawing 464 × 302
HV POWER SUPPLY BOARD LAYOUT, Drawing 464 × 303

MAIN WIRING DIAGRAM, Drawing 464 × 175



LUDLUM MEASUREMENTS, INC.		PO Box 810 501 Oak Street Sweetwater, Texas 79556 U.S.A. 1-800-622-0828	
Drawn: MC	02/24/2009	Title: MAIN BOARD	
Design: DL	02/24/2009	Model: 14C	
		Board#: 5464-454	
Approver:		Sheet: 1 of 4	Series: 464 / Sheet: 454
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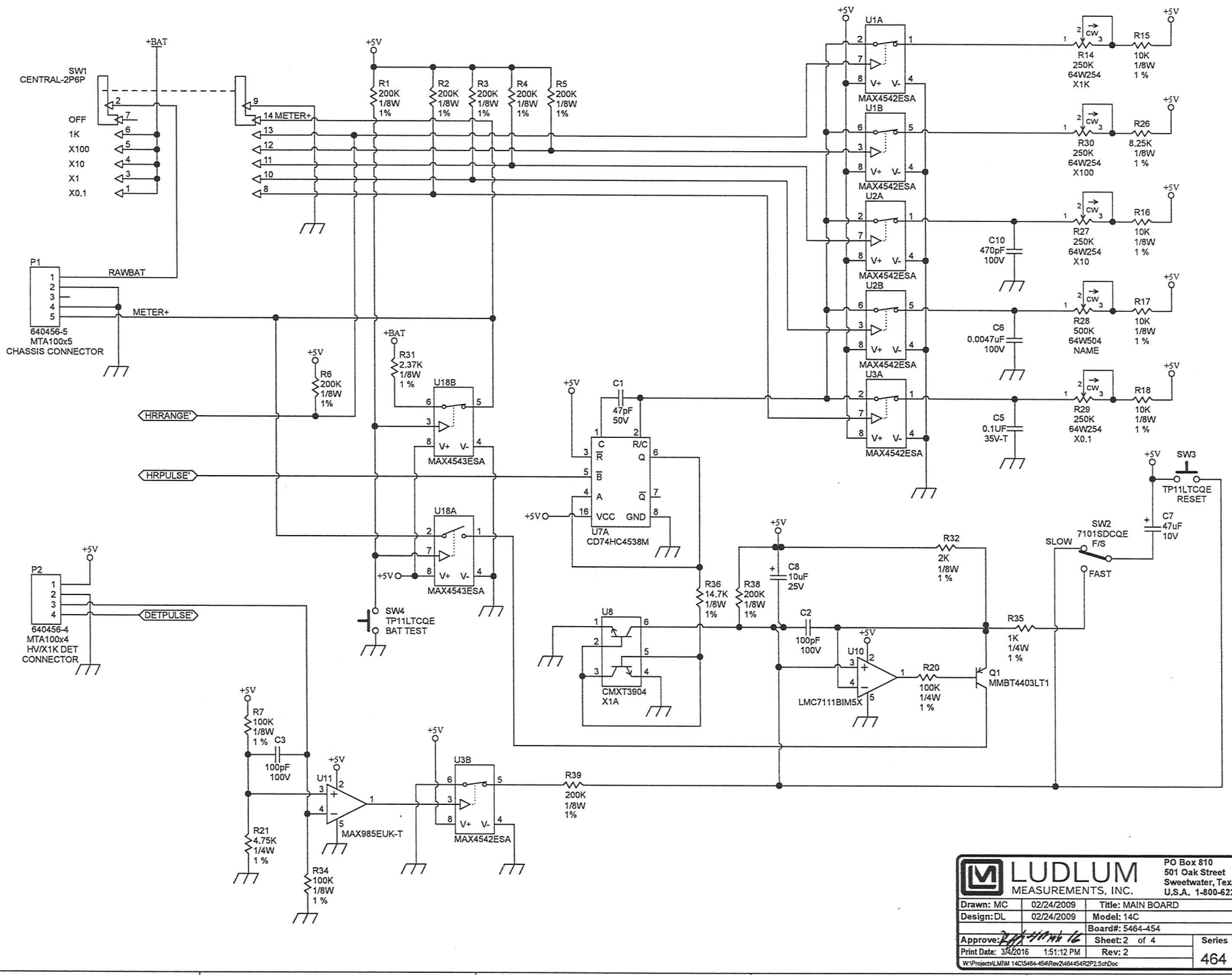

LUDLUM MEASUREMENTS, INC.
PO Box 810
501 Oak Street
Sweetwater, Texas 79556
U.S.A. 1-800-622-0828

Drawn: MC	02/24/2009	Title: MAIN BOARD	
Design: DL	02/24/2009	Model: 14C	
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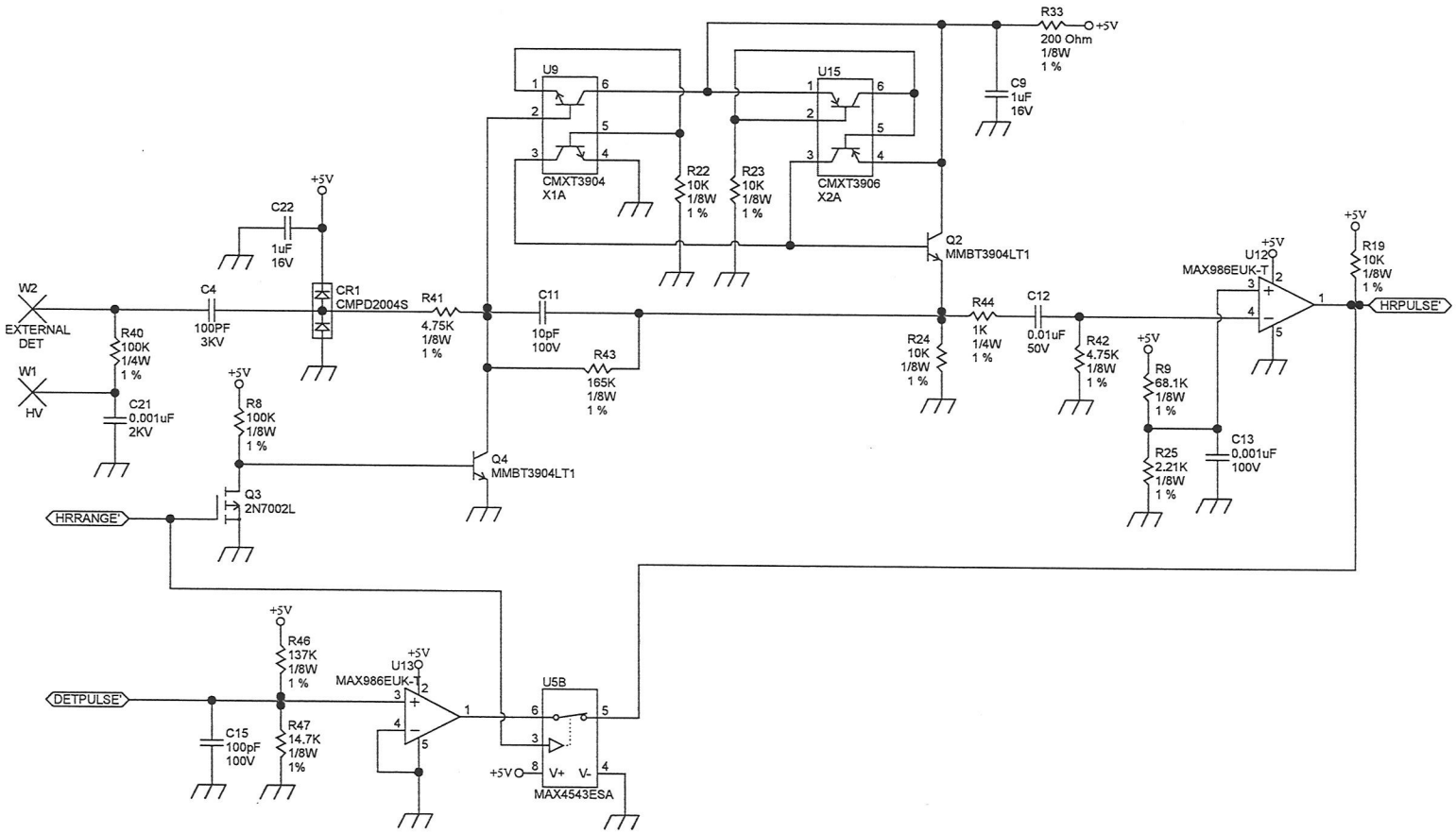

LUDLUM MEASUREMENTS, INC.		PO Box 810 501 Oak Street Sweetwater, Texas 79556 U.S.A. 1-800-622-0828	
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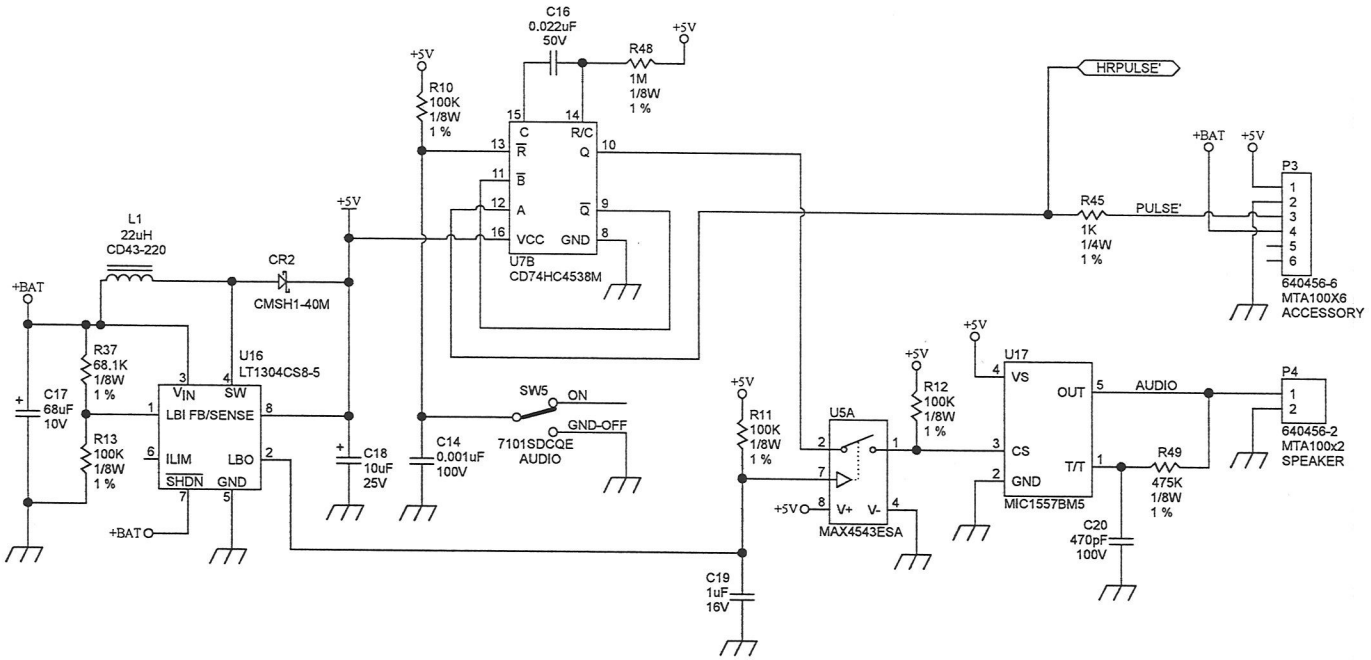

LUDLUM MEASUREMENTS, INC.		PO Box 810 501 Oak Street Sweetwater, Texas 79556 U.S.A. 1-800-622-0828	
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Design: DL	02/24/2009	Model: 14C	
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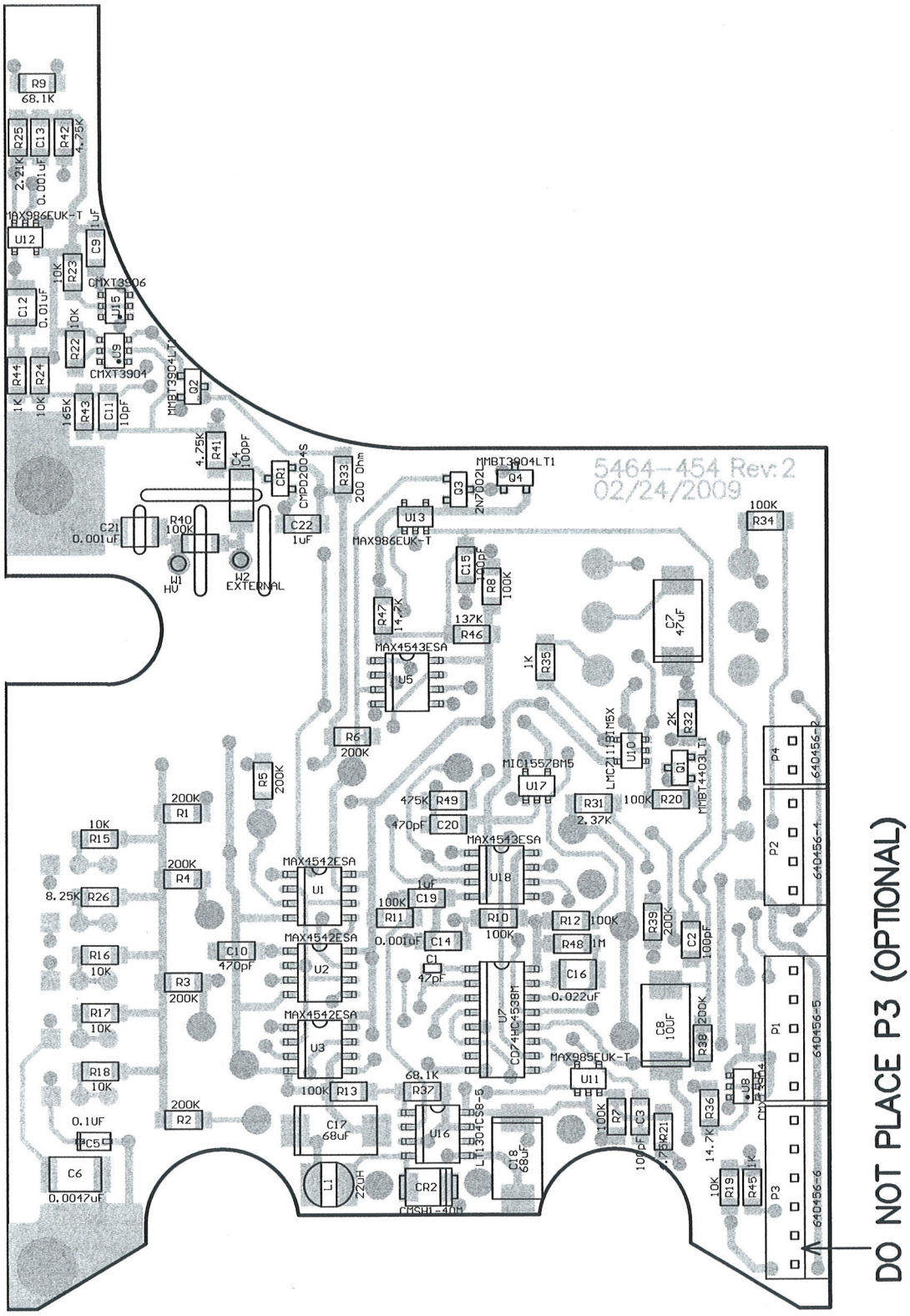

LUDLUM MEASUREMENTS, INC.		PO Box 810 501 Oak Street Sweetwater, TX 79556 U.S.A. 1-800-622-0828	
Title: MAIN BOARD			
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Approve: RDS	26 Jun 14	**Rev:** 2	
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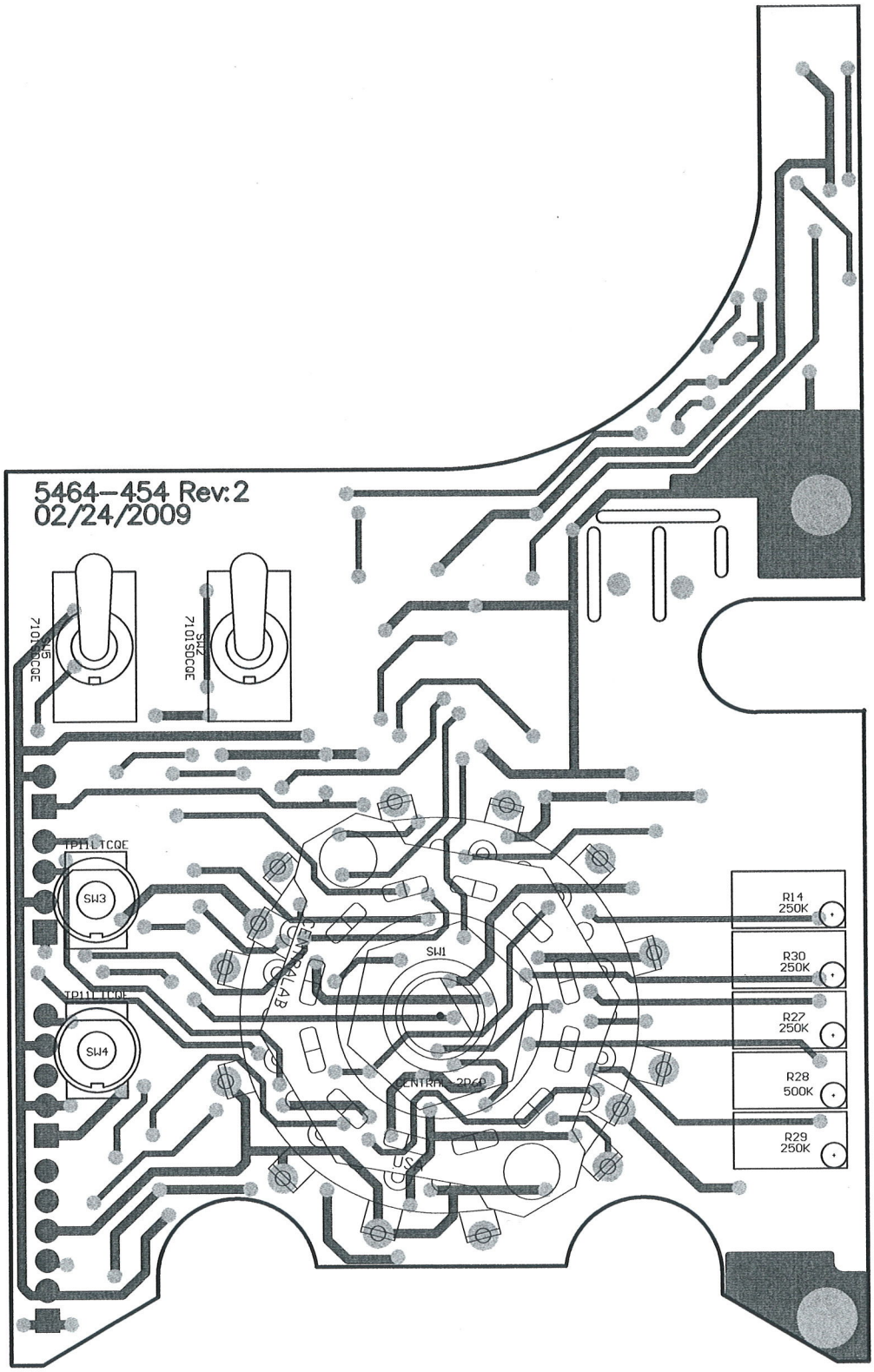

LUDLUM MEASUREMENTS, INC.	PO Box 810 501 Oak Street Sweetwater, TX 79556 U.S.A. 1-800-622-0828		
Title: MAIN BOARD			
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Approve: RDS	26JUN14	**Rev:** 2	
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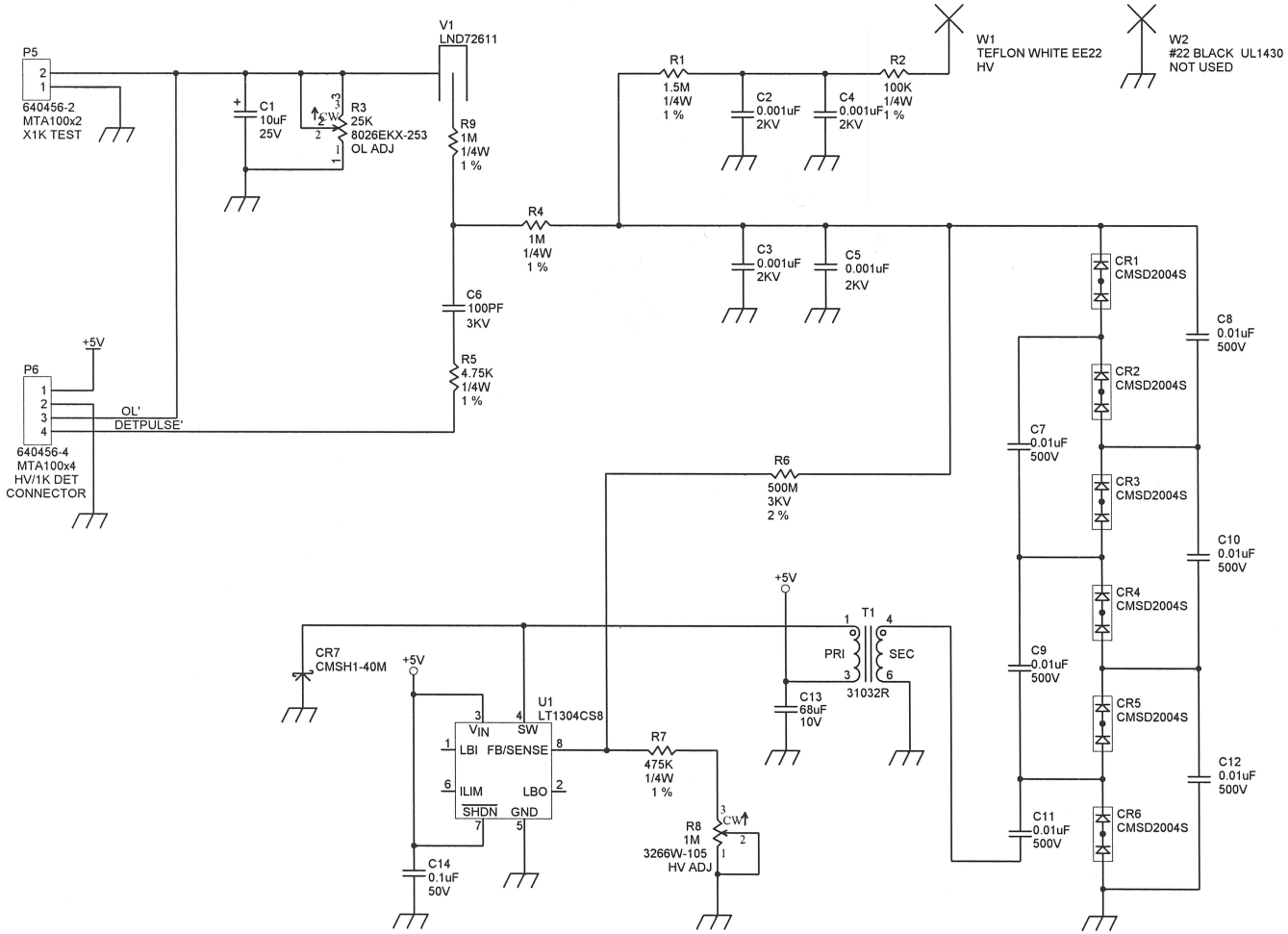

LUDLUM MEASUREMENTS, INC.		PO Box 810 501 Oak Street Sweetwater, Texas 79556 U.S.A. 1-800-622-0828	
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Approve: BSS DTS		Sheet: 1 of 1	Series 464 / Sheet 302
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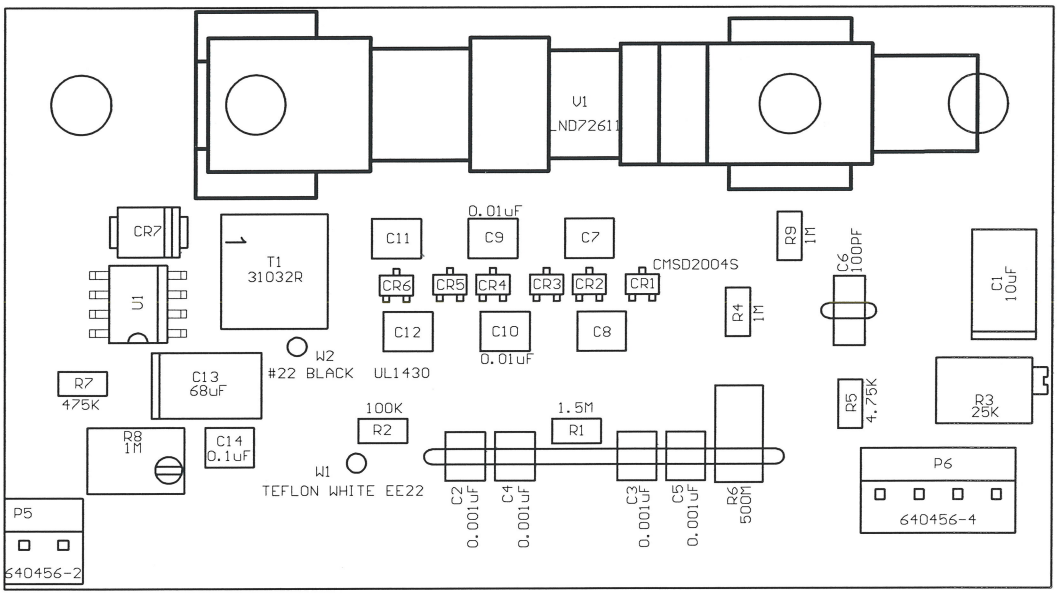

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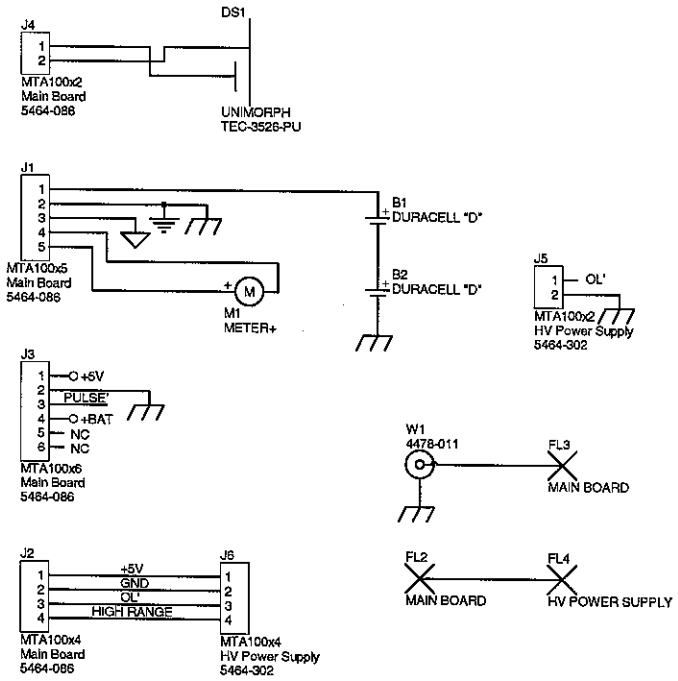

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Sweetwater, Texas 79556
U.S.A. 1-800-622-0828

Drawn: SA	09/01/06	Title: WIRING DIAGRAM	
Design: PW	09/01/06	Model: 14C	
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Approve:		Sheet: 1 of 1	Series 464 / Sheet 175
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