LUDLUM MODEL 177-56
RATEMETER

January 2019

Serial Number 322945 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

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.

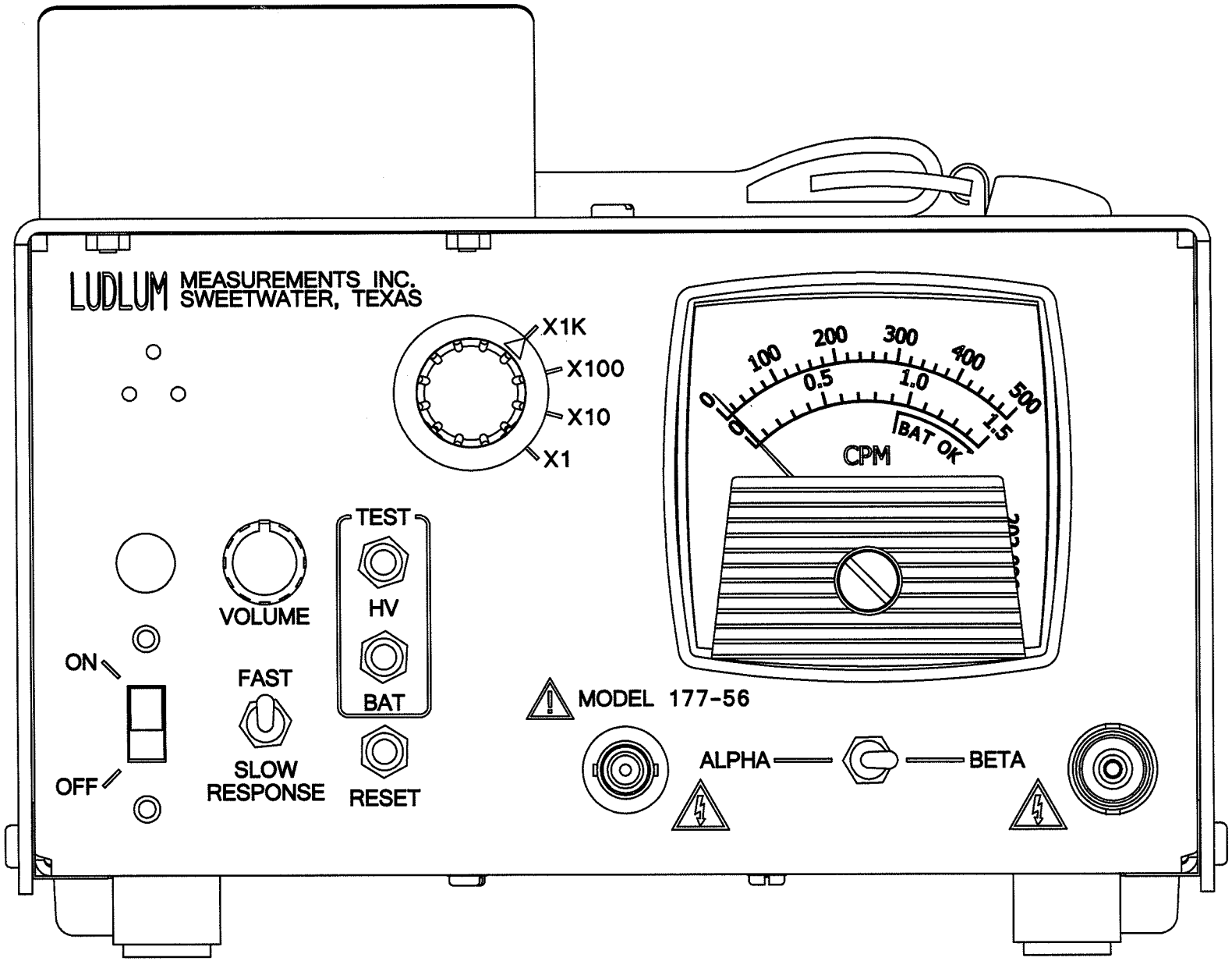
RETURN OF GOODS TO MANUFACTURER

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

REVISION HISTORY			
REV	DESCRIPTION	DATE	BY
1	VALID	6/6/18	JWI



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TITLE M 177-56 ASSEMBLY					
LUDLUM MEASUREMENTS, INC. 501 OAK STREET SWEETWATER, TEXAS 79556			SERIES 347	SHEET 584	

REVISION HISTORY			
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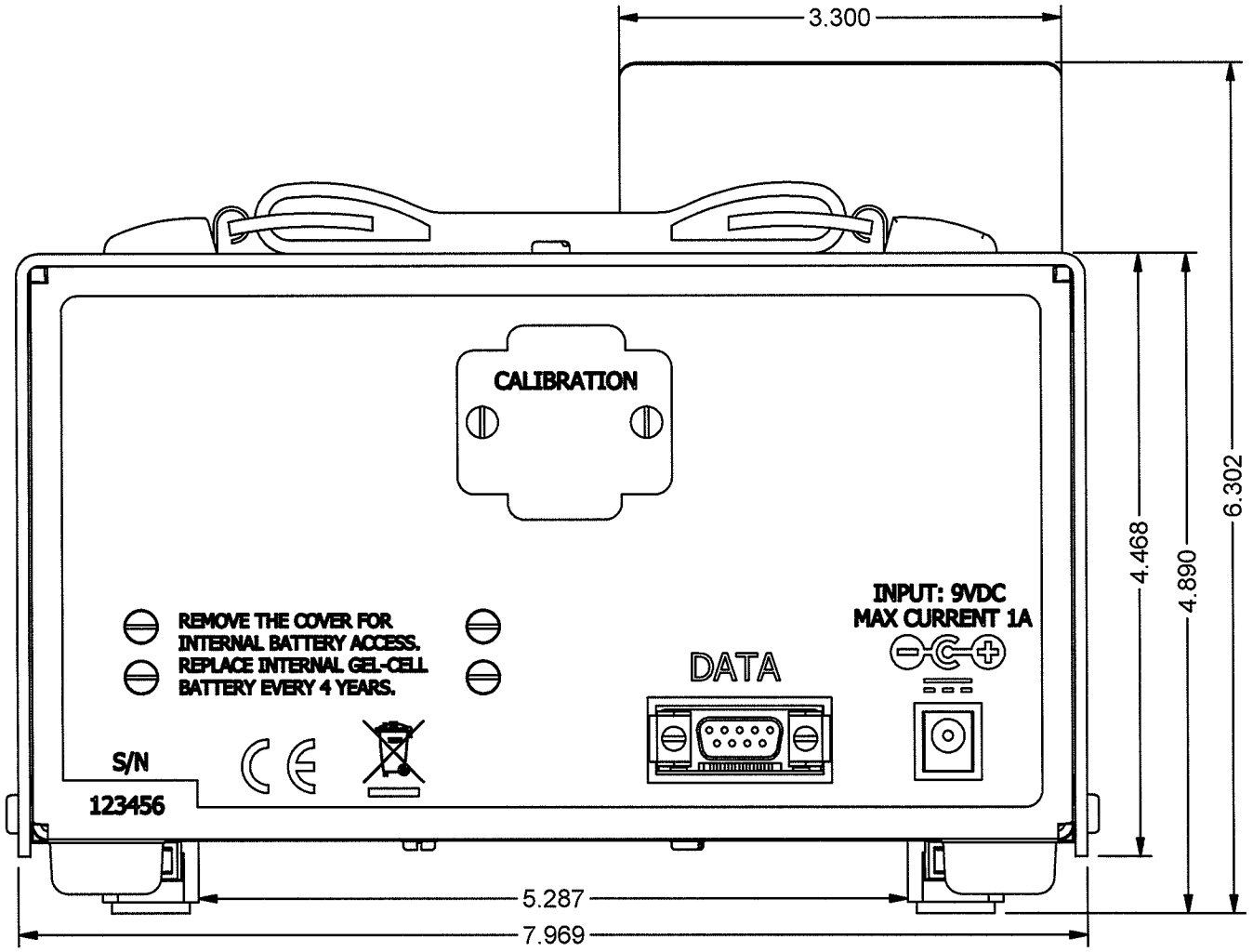

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DWG NUM: 4347-584 SCALE: 3/4

TITLE M 177-56 ASSEMBLY

LUDLUM MEASUREMENTS, INC.
501 OAK STREET
SWEETWATER, TEXAS 79556

SERIES 347

SHEET 584A

Table of Contents

Section 1

Introduction

The Ludlum Model 177-56 is a dual-detector (scintillator/GM) system, allowing selection of either alpha or beta readings, functioning as an alpha/beta frisking station.

Note:

There is no ALARM audio on this system.

It provides both aural and visual indication of the count rate of the detector selected.

The ratemeter has four multiplier scales of 1, 10, 100 and 1K, which result in a range of 0-500,000 counts per minute.

The regulated high-voltage power supply for the primary detector (scintillator/alpha) is externally adjustable and the secondary detector (GM/beta) by an internal trimmer.

The unit features preset calibration for GM or scintillation detectors. Other features include fast or slow time constant, adjustable audio volume, recorder output, and TTL compatible pulse output.

Internal tests include high voltage test (HV).

Section 2

Getting Started

The Ludlum Model 177-56 Ratemeter is designed for use with GM (Geiger Mueller) or scintillation detectors. Typical applications include contamination monitoring, surveying, area monitoring, and frisking station.

Unpacking and Repacking

Remove the calibration certificate and place it in a secure location. Remove the instrument 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 between instruments and detectors (if applicable). The Model 177-56 serial number is located on the back panel of the instrument.

To return an instrument for repair or calibration, provide sufficient packing material to prevent damage during shipment.

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 "Repair and Calibration" from the drop-down menu. Then choose the appropriate Repair and Calibration division where you will find a link to the form.

Preparing the Instrument for Use

For scintillation detectors, the most stable part of the plateau will have to be determined to select the correct operating point. For GM tubes, the voltage is set to 900 volts, unless otherwise indicated.

For scintillator detectors, the high-voltage supply will normally require adjustment each time the detector or source of energy is changed. The gain spectrum of the photomultiplier tubes is very wide (1000 to 1 typically at a

single operating point). Expose the detector to a source and increase the voltage until a stable reading is obtained from the source.

Connect the instrument to line power, and then turn the power switch to ON. Select the operating point and connect a scintillation or GM detector to the instrument. Expose the detector to a source and run a count-versus-HV plateau by adjusting the HV potentiometer located on the back panel.

Finally, select an operating point when a stable reading (small change in count with change in high voltage) is achieved.

Note:

Most GM detectors will operate at 900 volts. However, some smaller GM tubes operate at lower voltages.

Operating the Instrument

The high voltage should be adjusted as determined in the procedure above. Response and volume will be as desired.

The range selector should be set at an appropriate range and the detector connected.

Increase the meter count and listen for audio circuit sound.

Reset button, when depressed, should drive the meter to zero.

Proceed with use.

Section 3

Specifications

Power: 95-250 VAC wall transformer and 6-volt gel-cell (sealed lead-acid) battery; typical battery life of approximately 50 hours with a fully charged battery.

Fuse: 1 amp 3AG fuse

Response Time: toggle switch control selects FAST (2.2 seconds) or SLOW (22 seconds) response, for 90% of full-scale reading

Linearity: within 5% of full scale; typically ±2% of full-scale reading when measured with an electronic pulse generator

Battery Dependence: Meter readings vary less than 3% within battery check limits.

High Voltage 1 (Alpha): variable from 400 to 1500 V (rear-panel adjustment)

High Voltage 2 (Beta): 900 V (internal adjustment on the pancake board)

Input Sensitivity 1 (Alpha): adjustable from -10 through -100 mV

Input Sensitivity 1 (Beta): -10 to -20 mV (fixed)

Connectors: for the beta GM detector, it is a series "C" connector. For the alpha scintillator, it is an MHV connector.

Audio: unimorph speaker with volume control located on the front panel

Meter: 1 mA, size 6.4 x 6.4 cm (2.5 x 2.5 in.), DC movement

Meter Scale: 0-500 cpm; 0-1.5 kV; BAT TEST

Ranges: four ranges of X1 through X1K

Recorder Output: adjustable from 0 to 1.25 V at 1 mA

Unbuffered Output: may be used to externally add to or subtract from the meter reading

Finish: powder coat paint

Size: 16 x 20.3 x 17.5 cm (6.3 x 8 x 6.9 in.) (H x W x D), excluding handle

Weight: 1.9 kg (4.2 lb) with battery

Section 4

Description of Controls and Functions

Front Panel

Power ON-OFF Switch: provides 9 VDC through a wall transformer to the instrument and trickle-charges the standby battery. In case of line power failure, the battery automatically comes online to power the instrument. The battery will provide up to 50 hours of operation.

Note:

To recharge the battery, the ON-OFF switch must be in the ON position.

Power-on Lamp: a red lamp that comes on when power is supplied to the instrument.

VOLUME Control: varies the volume of the audio output through the unimorph speaker.

Audio Speaker: a unimorph speaker, located behind the front panel.

RANGE Selector Switch: a four-position switch providing range multipliers of X1K, X100, X10, and X1. With a scale (meter face) of 0-500 cpm, the full range of the instrument is 0 to 500,000 cpm .

Ratemeter: a four-decade linear meter with ranges of 0-500, 0-5000, 0-50,000, 0-500,000 cpm. Other meter faces are available depending on the application. Readout is on a 6.4 cm (2.5 in.) scale panel meter. A separate scale is provided for battery check and high-voltage readout.

Connectors: The beta/GM detector is a series C connector. The alpha/ scintillator is an MHV connector.

RESET Button: This button, when depressed, provides a rapid means of driving the meter needle to zero.

FAST-SLOW RESPONSE Toggle Switch: When in the FAST position, this switch provides 90% of full-scale meter deflection in 2.2 seconds. With this switch in the SLOW position, 90% of full-scale meter deflection takes 22 seconds. If quick needle response and maximum deviation are desired, the FAST position should be used. For slow response and damped meter movement, the SLOW position should be used.

BAT TEST Button: When this button is depressed, the meter displays the battery status. A sufficiently charged battery is indicated when the meter needle is in the BAT OK marking. If the needle is on or below the lower mark, the battery is dead and should be charged.

HV TEST Button: When this button is depressed, the meter displays the detector high voltage. (scintillator/Alpha HV 1 only)

Back Panel

9 VDC INPUT: Input for external 9 VDC.

Data: a 9-pin type "D" data plug with connections as follows:

> **PIN 1:** Battery terminal. This is a direct connection and does not go through the front-panel ON-OFF switch. Use to parallel the battery.
>
> **PIN 2:** Unregulated supply from approximately 6 volts, battery only at 8.7 volts with wall transformer plugged in. Limit current drain to 50 milliamperes.

PIN 3: instrument common (ground).

PIN 4: N/A was alarm sink in m177.

PIN 5: Pulse out. A negative pulse connected to the discriminator output through a 0.001 μF capacitor, typically -4.0 volts. This output comes from the scintillation (MHV) side only.

PIN 6: Unbuffered output ties directly to the meter drive circuit. (R124/C122). Approximately 1.3 volts at full scale. Using an external constant current sink will allow background subtract. At full scale, draws out approximately 3.3 microamperes to zero the meter.

PIN 7: Recorder output, adjustable from 0 to 1.0 volts at 1 milliamperes.

PIN 8 and PIN 9: Spares.

CAL Control – Alpha

Remove the calibration (cal) cover plate to access the following calibration potentiometers:

DISCR: Discrimination control. Alpha scintillator side, adjust the discriminator to 10 ± 2 millivolts. This control has an adjustable range of 10 to 100 millivolts. A Ludlum Model 500 Pulser may be used to determine the discrimination level.

Calibration Controls: X1000 through X1 calibration controls used to calibrate each of the ranges.

HV ADJ: used to set detector operating voltage (for alpha/scintillators).

RCDR: used to calibrate the recorder output.

Internal Controls (Overhaul Only)

The following controls are located internally, on the main circuit board:

BAT C: used to adjust charge voltage to 6.825 volts.

BAT T: used to adjust meter test voltage reading to 5.97 volts at the BAT OK line (dead battery line).

HV T: used to adjust the high-voltage test reading to correspond with the actual high-voltage output (HV Alpha/scintillator only).

CAL Control – Beta

Pancake DISC: The discrimination level on the pancake board (-595) is fixed at around 10 mV and can be checked with a Ludlum m500 pulser. Apply an -80mV signal to the C connector on the front panel to test.

> **Note:** Approaching -10 mV, the trip point can cause oscillation and will yield count errors. Normal pancake inputs over-drive the -10 mV level and are counted properly.

GM HV: used to adjust the pancake GM detector bias voltage to 900 ±25 VDC. This trimmer is located on the pancake board mounted on the left rear chassis of the unit (looking from the front). Use care when adjusting this trimmer. This trimmer is set at the factory and should not need adjustment.

Section

5

Safety Considerations

Environmental Conditions for Normal Use

Indoor use only

No maximum altitude

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

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

Wall transformer supply voltage range of 95-250 VAC, 50/60 Hz single phase (less than 100 mA)

Maximum transient voltage of 1500 VAC

Installation Category II (Overvoltage Category as defined by IEC 1010-1)

Pollution Degree 2 (as defined by IEC 664) (Normally only nonconductive pollution occurs. Temporary conductivity caused by condensation is to be expected.)

Cleaning Instructions and Precautions

The Model 177-56 Ratemeter 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:

1. Turn the instrument OFF and disconnect the instrument power cord.

2. Allow the instrument to sit for one minute before cleaning.

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.

Electrical Safety Precautions

Warning!

Failure to comply with the following instructions could result in a hazardous situation, which, if mishandled, could result in death or serious personal injury.

When installing the unit:

- Do not expose the unit to rain or an environment where it may be splashed by water or other liquids, as doing so may result in fire or electric shock.
- Use the unit only with the voltage specified on the unit. Using a voltage higher than that which is specified may result in fire or electric shock.

- Do not cut, kink, otherwise damager nor modify the power supply cord. In addition, avoid using the power cord in close proximity to heaters, and never place heavy objects – including the unit itself – on the power cord, as doing so may result in fire or electric shock.

- Avoid installing or mounting the unit or its power supply in unstable locations, such as a rickety table or slanted surface. Doing so may result in the unit falling down and causing personal injury and/or property damage.

The Model 177-56 Ratemeter is marked with the following symbols:

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 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 disconnect the power cord.
2. Allow the instrument to sit for one minute before accessing internal components.

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.

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 back panel. See section 9, "Recycling," for further information.

The "CE" mark is used to identify this instrument as being acceptable for use within the European Union.

Section 6

Calibration and Maintenance

Calibration

Note:

Local procedures may supersede the following.

In order to calibrate both the ratemeter and HV, the user will need a Ludlum Model 500 pulser or equivalent and a high–impedance voltmeter with at least 1000 Megohm meter input resistance to adjust the detector voltage.

Use the MHV (alpha connector) and connect the instrument to a Ludlum Model 500 pulser (pulse generator) or equivalent.

The ratemeter may be calibrated by adjusting the calibration controls labeled 1, 10, 100, and 1K. Starting with the 1000 range, apply 400,000 cpm from the pulser. Adjust the 1K calibration control for a meter reading of 400. Drop the pulse rate to 100,000 cpm and ensure a meter reading of 100 ±10.

Repeat this procedure for the lower scales with scaled pulse rates.

Drive the meter to full scale (500x) and adjust RCDR (recorder output) for 1-volt output.

Alpha scintillators should be set to -35 ±10 mV. To lower the scintillation detector operating voltage, decrease the input sensitivity to 10 ±2 mV. Adjustment is made by setting the pulse generator amplitude to the desired pulse height. Adjust DISCR until the meter reaches 75% of the generated incoming count rate.

Connect the Model 177-56 to an external voltmeter (using the MHV connector). Adjust the rear-panel HV control for a reading of 1000 VDC on the voltmeter. Depress HV TEST. On the main board, adjust HV for a meter reading of 1.0 kV. Using the rear-panel HV control, vary the high-voltage output from 500 to 1200 VDC and ensure that the high-voltage meter reads within 10% of the Model 177-56 meter reading.

Establishing a Detector Operating Point:

The operating point for the instrument and detectors is established by setting the detector voltage and instrument sensitivity (HV and DIS). The proper selection of this point is the key to instrument performance.

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 high voltage affects the output of the detector. The comparator trip point is changed by the DIS (discriminator reference voltage) control.

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:

Alpha Scintillators: Set DIS for 35 millivolts. Carefully increase HV until the instrument plateaus on the background count. This provides the most stable operating point for the detector.

Maintenance

Instrument maintenance consists of keeping the instrument clean and periodically checking the battery and calibration.

An instrument operational check should be performed prior to each use by exposing the detector to a known source and confirming the proper reading on each scale.

Recalibration should be accomplished after any maintenance or adjustment has been performed on the instrument. Ludlum Measurements recommends recalibration at intervals no greater than one year. Local regulations may have precedence over this recommendation.

To maintain the life of the battery, it is recommended that the instrument be constantly connected to external power with the power switch in the ON position, even when the instrument is not in use. This will keep the internal battery fully charged.

When the instrument is used without external power, adequate charge time must be allowed for the internal battery to recharge. If possible, leave the instrument on with line power applied overnight and weekends. At a minimum, allow one hour of charge time for each hour of use. If the battery is inadvertently allowed to fully discharge, and is left in that state, constant charging for 500 hours (3 weeks) may be required for battery recovery.

Note:

The ON-OFF switch must be in the ON position to charge the batteries. If the unit is out of service for extended periods of time, charge the battery every six months.

It is recommended that the internal GEL-CELL battery be replaced every four years.

Section 7

Troubleshooting

Occasionally, you may encounter problems with your LMI instrument or detector that may be repaired or resolved in the field, saving turn-around 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 detector cables and sticky meters.

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 that Utilize a GM or Scintillation Detector

SYMPTOM	POSSIBLE SOLUTION
No power (or meter does not reach BAT TEST or BAT OK mark)	1. Check battery and charge if necessary. 2. Check for loose or broken wires, especially between the main board and the calibration board.

SYMPTOM	POSSIBLE SOLUTION
Non-linear Readings	1. Check the high voltage (HV) by pressing the HV TEST button. 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 and placing the instrument on the lowest range setting. Wiggle the cable and observe the reading for significant changes. 3. Check for "sticky" meter movement. Does the reading change when you tap 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 "0."
Meter goes full-scale or "pegs out"	1. Replace the detector cable to see if it has failed, causing excess noise. 2. Check the HV and, if possible, the input threshold for proper setting. 3. Check for loose wires, especially between the main board and the calibration board.

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. See Page 4-3, "**DISCR**" for further information on sensitivity/discrimination control.

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 aluminized polyester window assembly will usually fix the problem.

Note:

When replacing the window, make sure to use a window made with the same thickness of aluminized polyester 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 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.

Section 8

Technical Theory of Operation

Amplifier

Negative detector pulses are coupled through C124 to emitter follower Pin U121. R127 protects the input from inadvertent high-voltage shorts. R129 couples the detector to the high-voltage supply.

Negative pulses from emitter, Pin 2 of U121, are coupled through C121 to amplifier Pin 5 through Pin 7 of U121. This amplifier is self-biased and provides gain in proportion to R029 divided by R0210. Transistor (pins 4, 5, 6, U121) provides amplification. Pins 12 and 15 of U121 are coupled as a current mirror to provide a load for Pin 6 of U121. The output self-biases to 2 Vbe (approximately 1.4 volts) at Pin 7 of U121. This provides just enough bias current through Pin 6 of U121 to conduct all of the current from the current mirror.

Positive pulses from Pin 7 of U121 are coupled to the discriminator.

Discriminator

Comparator U021 provides discrimination. The discriminator is set by the DIS (Discriminator) control located on the rear panel, coupled to Pin 5 of U021. Negative pulses (approximately 5 volts) at Pin 7 of U021 are coupled to Pin 5 of U011 for meter drive and Pin 11 of U011 for audio.

Digital Analog Conversion

Pin 7 of U021 is connected to the dual univibrator, U011. For each low pulse for Pin 7 of U021, Pin 6 of U011 goes high. The pulse of Pin 6 of U011 is typically 5.0 volts for 6 milliseconds on X1 to 6 microseconds on X1K. This pulse is connected to the constant current drive U012. The pulse width control (R3-C2 on calibration board) is utilized for calibration adjustment. Controls R4 through R6 allow calibration on other scales.

For each positive pulse connected to Pin 8 of U012, a constant current pulse is sourced at Pin 15 of U012. This current pulse charges C122, which is

discharged by R124. The average voltage on C122 is coupled through HV and BAT switch to voltage-follower Pin 5 of U311. Pin 7 of U311 drives the meter and recorder output.

Time Constant

The meter time constant is determined by R124 and C122. For a slower time constant, C122 is paralleled by C101. When C101 is not used, it is connected to Pin 7 of U311 (voltage follower), maintaining the same voltage level as C122. This allows C101 to be switched in or out of the circuit without transients.

Reset

Reset is provided by coupling a voltage to the base of transistors U012 pins 1, 2, 3, and 4, 5, 6. Both transistors saturate. One discharges C122, causing the meter to zero. Pin 3 U012 turns Q102 off.

High Voltage (HV)

The high-voltage power supply is a blocking oscillator utilizing Q401-T411 and quadrupler CR123, CR421, CR422, and through CR423. The HV output is controlled by conduction to ground through Q302. With Q302 saturated, the HV output is maximum.

The op amp, U311 Pins 1, 2, 3, is used as a comparator to compare the voltage reference at Pin 3 to the feedback voltage at Pin 2 through R322 for voltage control and regulation. High voltage is adjusted by HV control R311, changing bias on Pin 2 U311. With the HV control wiper at ground, high-voltage output is maximum.

Low Voltage

Low voltage is supplied by internal battery B1 (wiring diagram, 347 × 613) or external power T1. Unregulated power at C125 is coupled to voltage regulator VR211 and battery charger U201-Q301.

Regulated low voltage is supplied to the balance of the circuit through VR131 at 5.0 volts and U301 at 1.2 volts.

Battery Charge

Battery charge is provided by voltage regulator U201 and power transistor Q301. R402 limits charge current for discharged battery. A negative voltage coefficient of -0.0063 volts per degree F is provided by ratio of R013/R201. R013 sets output voltage to 6.825 volts.

High Voltage Test

High voltage test is supplied by R001 through HV TEST switch, BAT TEST switch, Pin 5 of U311, and then the meter. The HV readout is calibrated by R001.

Battery Test Voltage

Battery test voltage is controlled by R002 through BAT TEST switch, and then voltage follower Pin 5 of U311 to the meter.

Section

9

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 that 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 on the back panel, except for portable equipment where it will be placed on the battery lid.

The symbol appears as such: 

Section

10

Parts List

	Reference	Description	Part Number
Model 177-56 Ratemeter	UNIT	Completely Assembled Model 177 Ratemeter	48-1323
Main Board, Drawing 347 × 603	BOARD	Completely Assembled Circuit Board	5347-603
CAPACITORS			
	C001	10µF, 25V,	04-5655
	C011	47PF, 100V	04-5660
	C012	68µF, 10V	04-5654
	C022	0.001µF, 100V	04-5659
	C023-C024	0.1µF, 50V	04-5663
	C025	10PF, 100V	04-5673
	C101	22µF, 20V	04-5672
	C111	0.022µF, 50V	04-5667
	C112	470PF, 100V	04-5668
	C121	0.001µF, 100V	04-5659
	C122	2.2µF, 20V	04-5671
	C123	1µF, 35V	04-5656
	C124	100PF, 3KV	04-5735
	C125	3300µF, 35V	04-5675
	C211	47µF, 16V	04-5666
	C221	0.0056µF, 3KV	04-5522
	C301-C302	47µF, 16V	04-5666
	C311-C313	0.01µF, 50V	04-5664
	C321	100PF, 3KV	04-5532
	C322	0.0056µF, 3KV	04-5522
	C323	0.0047µF, 3KV	04-5547

	Reference	Description	Part Number
	C401-C402	1µF, 35V	04-5656
	C403	0.1µF, 50V	04-5663
	C411	47µF, 16V	04-5666
	C421	0.0047µF, 3KV	04-5958
	C422	0.0047UF, 3KV	04-5547
	C423	0.0047µF, 3KV	04-5958
TRANSISTORS	Q104	MMBT3904T1G	05-5841
	Q111	MMBT3904T1G	05-5841
	Q301	MJD200	05-5844
	Q302	MMBT3904T1G	05-5841
	Q401	MJD210	05-5843
VOLTAGE REGULATOR	VR211	LM2931AT 5.0	05-5813
INTEGRATED CIRCUITS	U011	CD74HC4538M96	06-6297
	U012	HFA3096BZ96	06-6468
	U021	TLC372IDR	06-6290
	U1	ICL7667CPAZ	06-6250
	U2	MAX4544EUT-T	06-6639
	U111	ICM7555CBA	06-6300
	U121	HFA3096BZ96	06-6468
	U201	ICL7663SCBA	06-6302
	U301	LM285DR-1-2	05-5845
	U311	TLC27M7IDR	06-6292
DIODES	CR1-CR2	MMBD914LT1G	07-6353
	CR111-CR112	MMBD914LT1G	07-6353
	CR201-CR202	CXSH-4LF	07-6358
	CR321	1N4007	07-6274
	CR401	MMBD914LT1G	07-6353
	CR421-CR423	1N4007	07-6274
THERMISTOR	RT314	250K, 250mW	07-6366
POTENTIOMETERS / TRIMMERS	R001	1M, HV TEST	09-6906
	R002	50K, BAT T	09-6920
	R003	475K, 1%, 250mW	12-7859
	R012	82.5K, 1%, 250mW	12-7849
	R013	50K, BAT C	09-6920

	Reference	Description	Part Number
RESISTORS			
	R014-R015	100K, 1%, 250mW	12-7834
	R016	100Ohm, 1%, 250mW	12-7840
	R017	100K, 1%, 250mW	12-7834
	R018	150Ohm, 1%, 250 mW	12-7062
	R019	56.2K, 1%, 250 mW	12-7873
	R020	100K, 1%, 250mW	12 7834
	R021-R022	10.0K, 1%, 250mW	12-7839
	R023	100K, 1%, 250mW	12-7834
	R024	1.00K, 1%, 250mW	12-7832
	R025-R027	10.0K, 1%, 250mW	12-7839
	R027	100K, 1%, 250mW	12-7834
	R028	10.0K, 1%, 250mW	12-7839
	R029	221K, 1%, 250mW	12-7845
	R1-R2	56.2K, 1%, 250 mW	12-7873
	R3-R4	50K, BAT C	09-6920
	R102	10.0K, 1%, 250mW	12-7839
	R103	100 ohm, 1%, 250mW	12-7840
	R112	100K, 1%, 250mW	12-7834
	R113	1.00M, 1%, 250mW	12-7844
	R114	35.7K, 1%, 250mW	12-7911
	R115	100 ohm, 1%, 250mW	12-7840
	R117	1.00M, 1%, 250mW	12-7844
	R118	3.32K, 1%, 250mW	12-7870
	R121	3.92K, 1%, 250mW	12-7875
	R122	10.0K, 1%, 250mW	12-7839
	R123	100, 1%, 250mW	12-7840
	R124	392K, 1%, 250mW	12-7841
	R125	47.5K, 1%, 250mW	12-7872
	R126	100K, 1%, 250mW	12-7834
	R127	10.0K, 1%, 250mW	12-7839
	R128	221K, 1%, 250mW	12-7845
	R129	1M, 5%, 250mW	10-7028
	R201	165K, 1%, 250mW	12-7877
	R202	1.00K, 1%, 250mW	12-7832
	R203	2.2 ohm, 5%, 250mW	12-7932
	R210	5.62K, 1%, 250mW	12-7871
	R221	1M, 5%, 250mW	10-7028
	R301	10.0K, 1%, 250mW	12-7839

	Reference	Description	Part Number
	R302	1.00K, 1%, 250mW	12-7832
	R303	2.21K, 1%, 250mW	12-7835
	R311	750K, 1%, 250mW	12-7882
	R312	301 ohm, 1%, 250mW	12-7863
	R313	475 ohm, 1%, 250mW	12-7851
	R315	22.1K, 1%, 250mW	12-7843
	R316	1.00M, 1%, 250mW	12-7844
	R321-R322	1G	12-7686
	R323	1M, 5%, 250mW	10-7028
	R401	200 ohm, 1%, 250mW	12-7846
	R402	15 ohm, 5%, 1W	12-7738
TRANSFORMERS	T211	M177 Aud (Asy) x50	4275-083
	T411	L8050 X50	40-0902
MISCELLANEOUS	P1	640445-3 MTA 156x3	13-8125
	P2	1-640456-2 MTA 100x12	13-8061
	P3	1-640456-0 MTA 100x10	13-8066
	P4	640456-3 MTA 100x3	13-8081
	W11	7 inch Cable-RG174-Pigtail	8303-1021
	W12-W13	73412-0110 uCoax Jack	13-9376
Calibration Board, Drawing 347 × 132	BOARD	Completely Assembled Calibration Board	5347-189
CAPACITORS			
	C1	0.0047μF, 100V	04-5570
	C2	0.047μF, 100V	04-5565
POTENTIOMETERS			
	R1	10K, RECORDER	09-6787
	R2	100K, HV	09-6813
	R3	1M, X1	09-6814
	R4	1M, X10	09-6814
	R5	2M, X100	09-6834
	R6	250K, X1000	09-6819
	R7	10K, DISCRIMIINATOR	09-6787

	Reference	Description	Part Number
RESISTOR			
	R9	680, 1/3W	12-7885
RESISTOR NETWORK	RN1	10K	12-7720
MISCELLANEOUS			
	P6	CONN 1-640457-1 MTA100	13 8397
Power/Data Board, Drawing 347 × 489	BOARD	Completely Assembled Power/Data Board	5347-489
DIODE	CR1	1N5817	07-6290
RESISTOR	R1	150Ohm, 5%, 250mW	10-7005
CONNECTOR	P1	640445-5 MTA156X5	13-8027
	P2	640445-2 MTA100X5	13-8057
	P3	640445-2 MTA152X2	13-8098
	P4	640456-8 MTA100X8	13-8039
	P5	DB9RA-PLASTIC FEMALE CONNECTOR	13-8577
	W15	RAPC712	13-8445
MISCELLANEOUS	F1-F2	MF-MSMF075/24-2 FUSE	21-9031
Pancake Slave Board, Drawing 347 × 595	BOARD	Completely Assembled	5347-595
CAPACITORS	C1	3000pF, 50V	04-5998
	C2	2kV	04-5971
	C3	0.1µF, 25V	04-5744
	C4	22µF, 16V	04-5903
	C5	10µF, 10V	04-5968
	C6-C11	0.01µF, 200V	04-5765
	C12	0.1µF, 10V	04-5744
	C13	68µF, 10V	04-5654
	C14-C15	0.0039µF, 3kV	04-5458
	C16-C21	0.01µF, 200V	04-5765
	C22	1µF, 10V	04-5745
	C24	1µF, 10V	04-5745
	C25-C26	10µF, 10V	04-5968

	Reference	Description	Part Number
INTEGRATED CIRCUITS	U1	LM1815	06-6937
	U2	LT1304CS8	06-6394
	U3	TLV2333	06-6980
	U4	SN74AHC1G14DBVR	06-6556
	U5	SN74LVC1G07DBVR	06-7033
	U6	TPS76050DBVR	05-5913
DIODES	CR1	MBR0520LT1G	07-6422
	CR2-CR7	CMPD2004S	07-6402
RESISTORS	R1	100K, 1%, 100mW	12-7082
	R2	21.5K, 1%, 250mW	12-7001
	R3-R5	100K, 1%, 100mW	12-7082
	R6	0 Ohm, 100mW	12-8013
	R7	500M, 2%, 3kV	12-7031
	R8	100K, 1%, 250mW	12-7834
	R9	4.75Ohm, 1%, 250mW	12-7980
	R10	249Ohm, 1%, 250mW	12-7891
	R11	1M, 1%, 250mW	12-7844
	R12	499K, 1%, 250mW	12-7037
	R13	1M, 1%, 100mW	12-7081
	R14	1K, 1%, 100mW	12-7084
	R15	10K, 1% 100mW	12-7083
	R16	10K, 3266X1-103	09-6822
	R17	499K, 1%, 100mW	12-7091
	R18-R19	1K, 1%, 100mW	12-7084
	R20	499K, 1%, 100mW	12-8260
	R21	10K, 1%, 100mW	12-7083
	R22	1.5K, 1%, 100mW	12-7159
MISCELLANEOUS	P1	640456-3 MTA 100X3	13-8081
	W1	WIRE	WIRE
	W2	TEFLON WHITE #22 DET	21-8993
	W3-W4	73412-0110 uCoax Jack	13-9376
	W5	SILICONE BLACK #22 GND	21-8552
	T1	TRANSFORMER-4275-156	21-9925
Wiring Diagram, Drawing 347 × 613	S1	46206-LRX SLIDE (POWER)	08-6523
	S2	PA-1002 (RANGE)	08-6543
SWITCHES	S3	M2012SS1W01-RO (RESPONSE)	08-6511
	S4	923 SWITCHCRAFT (HV)	08-6518
	S5	923 SWITCHCRAFT (BATT)	08-6518

	S7	30-1 PB (RESET)	08-6517
	SW1	M2012SS1W01-RO (DETECTOR)	08-6511
POTENTIOMETERS			
	R1	10K, VOLUME	09-6753
CONNECTORS			
	J1	MAIN BOARD 5347-603, (CONN 640428-3 MTA 156X3)	13-8124
	J1	PANCAKE BOARD 5347-595, (CONN 640445-3 MTA 156X3)	13-8125
	J2	MAIN BOARD 5347-603, (CONN 1-640441-2 MTA 100X12)	13-8431
	J3	MAIN BOARD 5347-603, (CONN 1-640441-0 MTA 100x10)	13-8197
	J4	POWER/DATA BOARD 5347-489 (CONN-640456-3 MTA 100x3)	13-8081
	J4	POWER/DATA BOARD 5347-489 (CONN-640445-5 MTA 156X5)	13-8027
	J5	POWER/DATA BOARD 5347-489 CONN-640445-2 MTA-156x2)	13-8098
	J6	CALIBRATION BOARD 5347-189 (CONN 4-640441-1 MTA 100x11)	13-8161
	J7	RECPT-UG706/U "C"	4478-011
	J8	POWER/DATA BOARD 5347-489 FOR MODIFICATION ONLY (CONN-640456-5 MTA 100X5)	13-8057
	J9	POWER/DATA BOARD 5347-489 (CONN-640456-8 MTA100X8)	13-8039
AUDIO	DS1	LAMP-PT502-0UR-002-W6	21-9169
	DS2	UNIMORPH (MZ35290BD0 2.9kHz)	21-9251
BATTERY	B1	6V (PS610 GELL CELL)	21-9385
MISCELLANEOUS	M1	METER HOYT #5025 2.5 INCH	15-8048
	W3-W4	73412-0110 UCOAX JACK	13-9376
	W12-W13	73412-0110 UCOAX JACK	13-9376

Section

11

Drawings

MAIN BOARD, Drawing 347 × 603 (4 sheets)

MAIN BOARD Component Layout, Drawing 347 × 604 (2 sheets)

CALIBRATION BOARD, Drawing 347 × 132

CALIBRATION BOARD Component Layout, Drawing 347 × 133

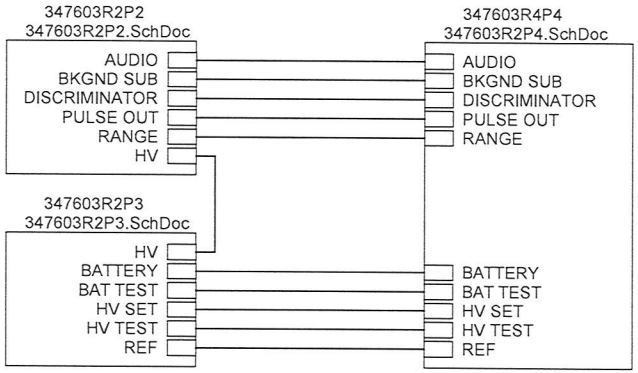
POWER/DATA BOARD, Drawing 347 x 489

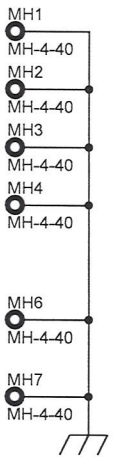
POWER/DATA BOARD Component Layout, Drawing 347 x 490

PANCAKE SALVE BOARD, Drawing 347 x 595

PANCALE SLAVE BOARD Component Layout, Drawing 347 x 596 (2 sheets)

WIRING DIAGRAM, Drawing 347 × 613





LUDLUM MEASUREMENTS, INC.		PO Box 810 501 Oak Street Sweetwater, Texas 79556 U.S.A. 1-800-622-0828	
Drawn: PAB	6/7/2018	Title: MAIN BOARD	
Design: RDS	6/7/2018	Model: 177-56	
		Board#: 5347-603	
Approve: NJS 19JUN18		Sheet: 1 of 4	Series: 347 / Sheet: 603
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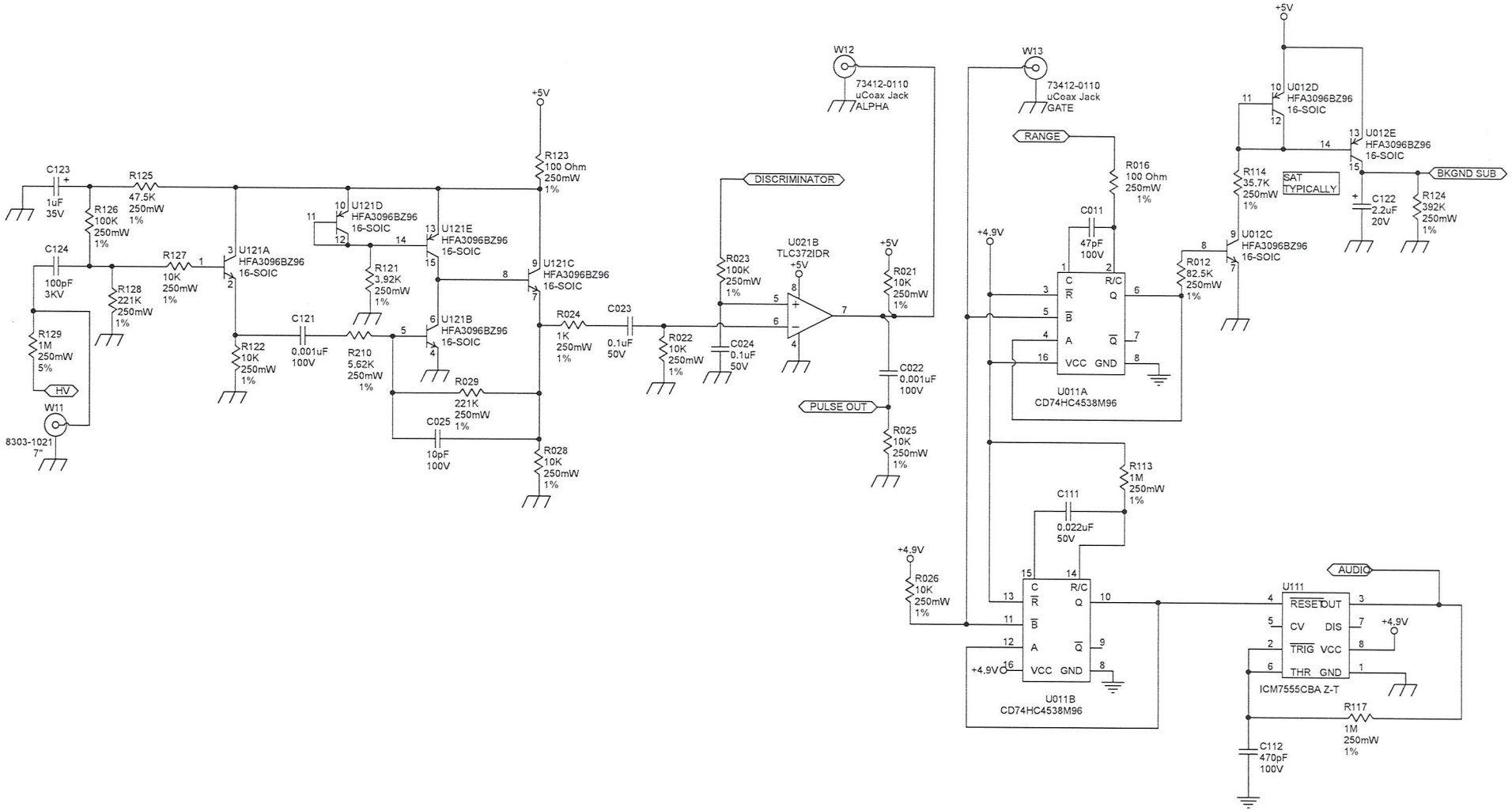

LUDLUM MEASUREMENTS, INC.		PO Box 810 501 Oak Street Sweetwater, Texas 79556 U.S.A. 1-800-622-0828	
Drawn: PAB	6/7/2018	Title: MAIN BOARD	
Design: RDS	6/7/2018	Model: 177-56	
		Board#: 5347-603	
Approved: RDS 15 JUN 18		Sheet: 2 of 4	Series: 347 / Sheet: 603
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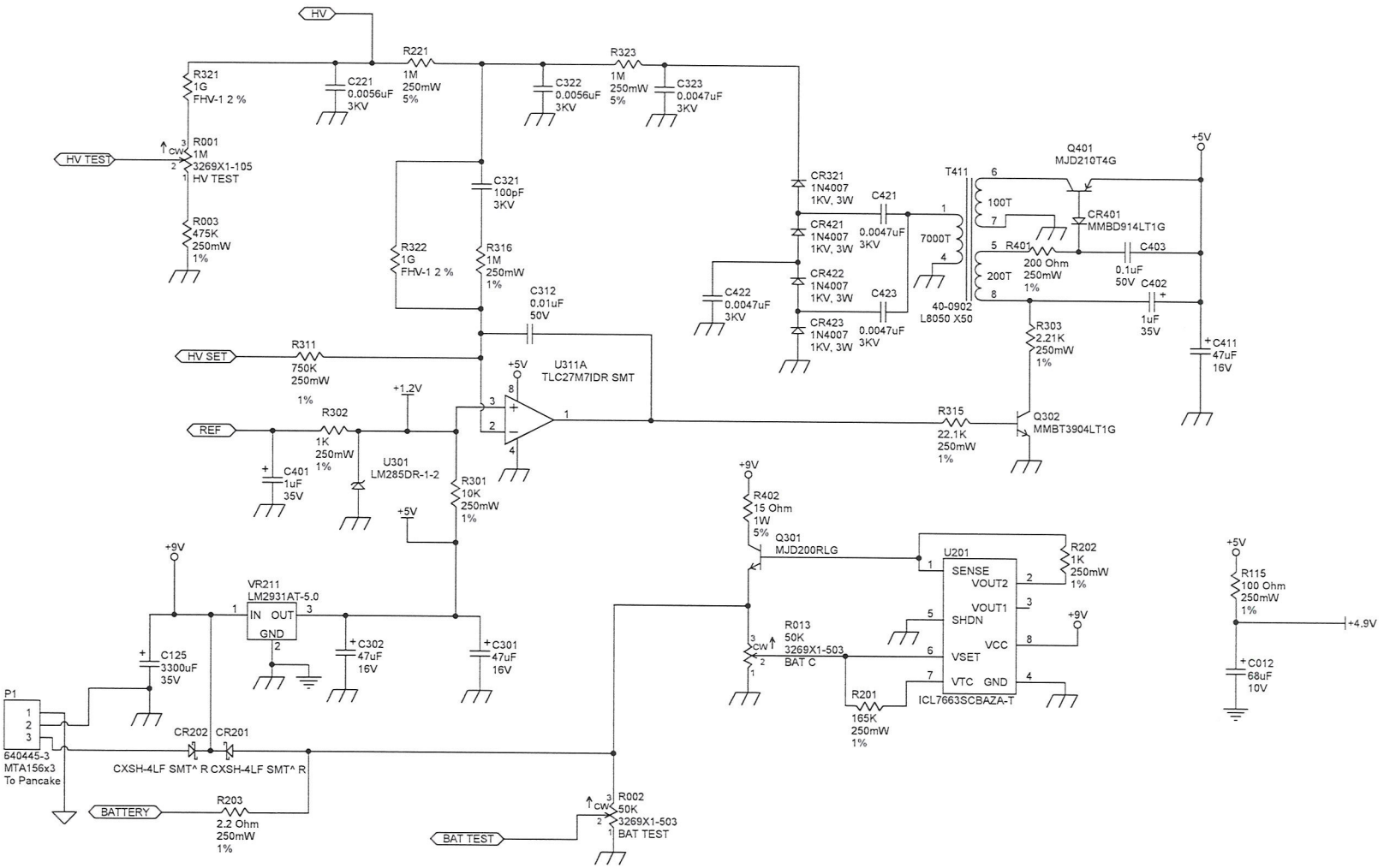

LUDLUM MEASUREMENTS, INC.		PO Box 810 501 Oak Street Sweetwater, Texas 79556 U.S.A. 1-800-622-0828	
Drawn: PAB	6/7/2018	Title: MAIN BOARD	
Design: RDS	6/7/2018	Model: 177-56	
		Board#: 5347-603	
Approved: RVS 6/19 JWJR		Sheet: 3 of 4	Series: 347 / Sheet: 603
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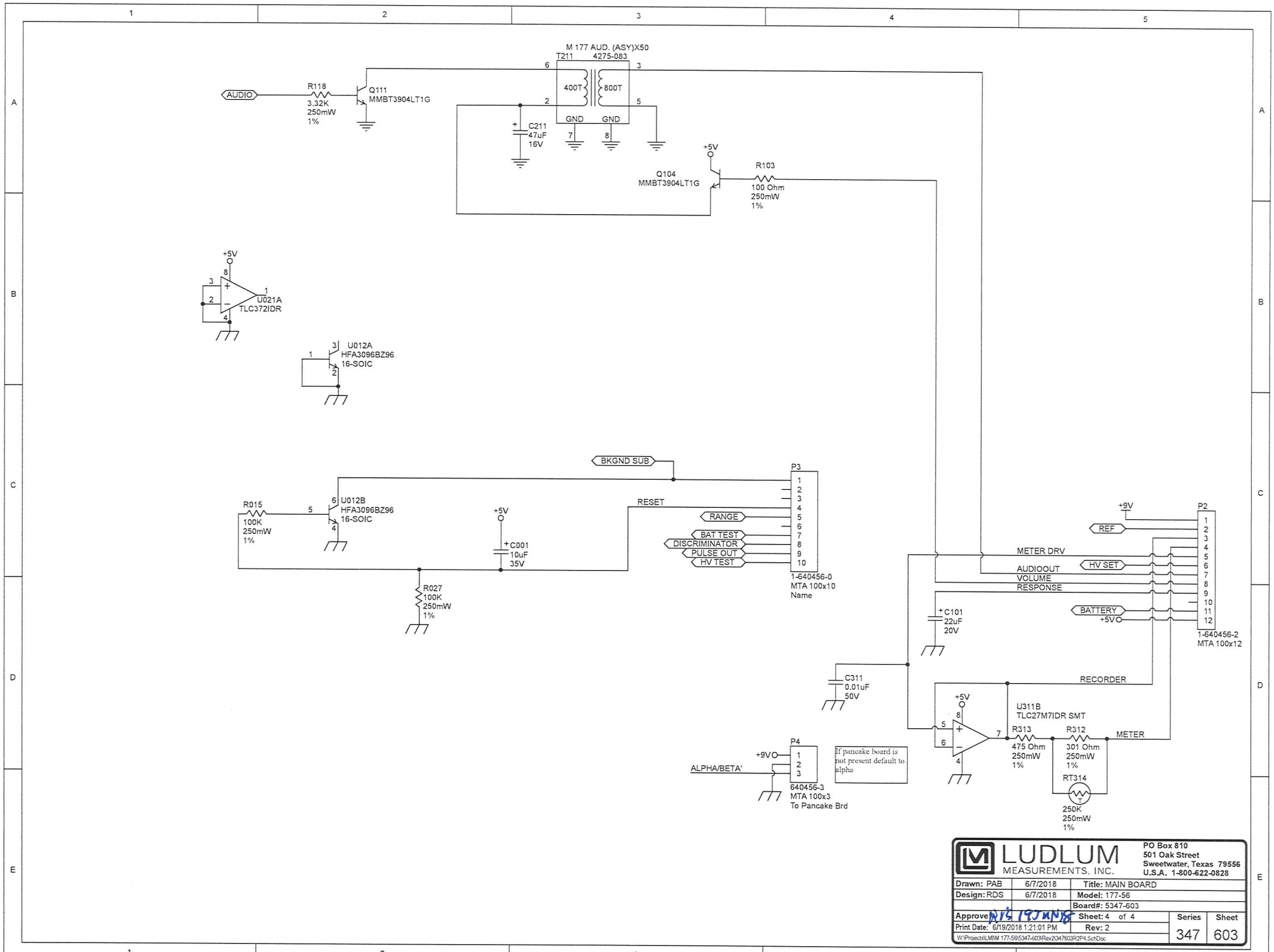

LUDLUM MEASUREMENTS, INC.		PO Box 810 501 Oak Street Sweetwater, Texas 79556 U.S.A. 1-800-622-0828	
Drawn: PAB	6/7/2018	Title: MAIN BOARD	
Design: RDS	6/7/2018	Model: 177-56	
		Board#: 5347-603	
Approved: N/C 19JUN18		Sheet: 4 of 4	Series: 347 / Sheet: 603
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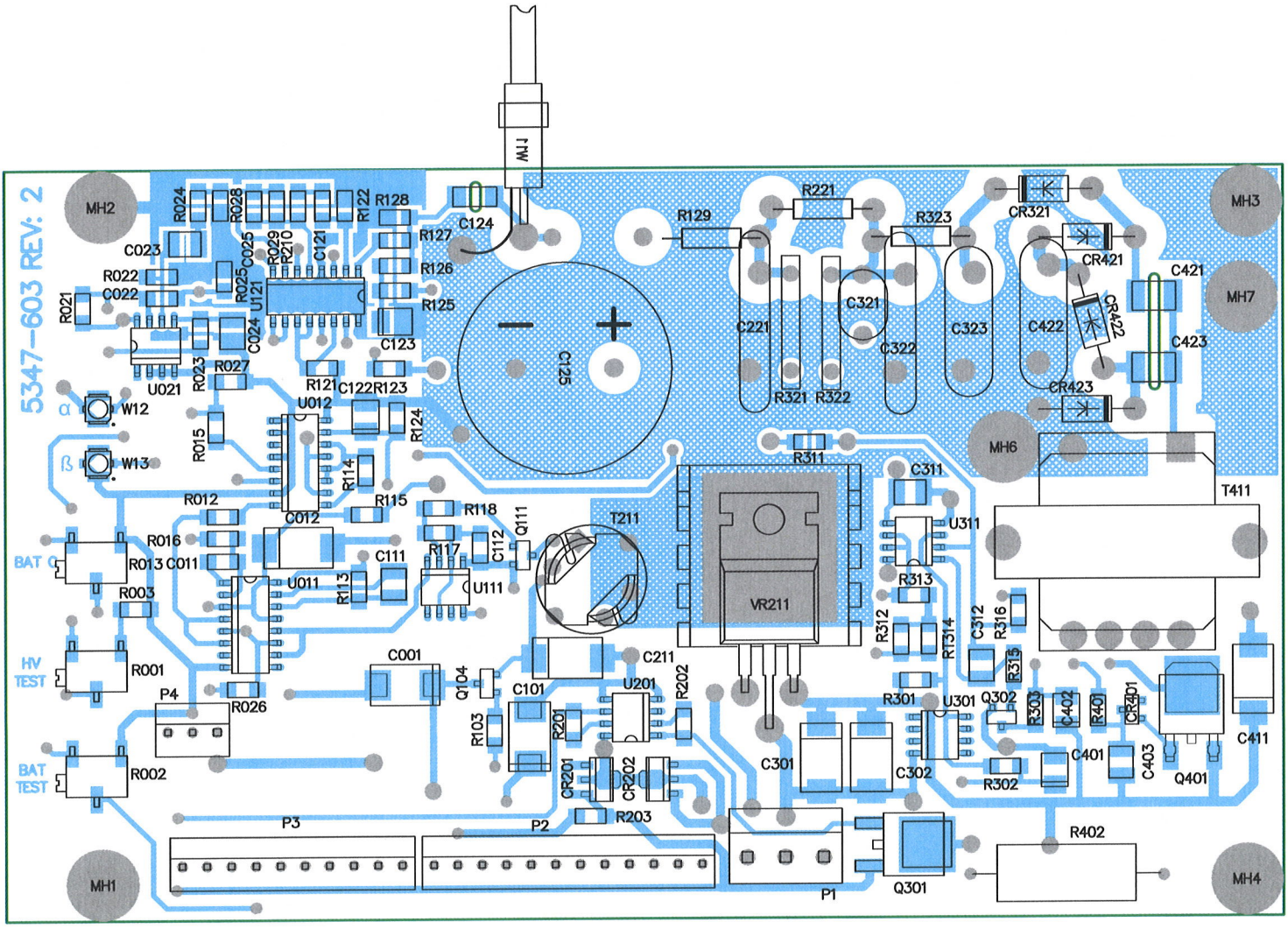

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Title: MAIN BOARD			
Drawn: PAB	6/7/2018	**Model:** 177-56	
Design: RDS	6/7/2018	**Board#:** 5347-603	
Approve: RDS	19JUN18	**Rev:** 2	
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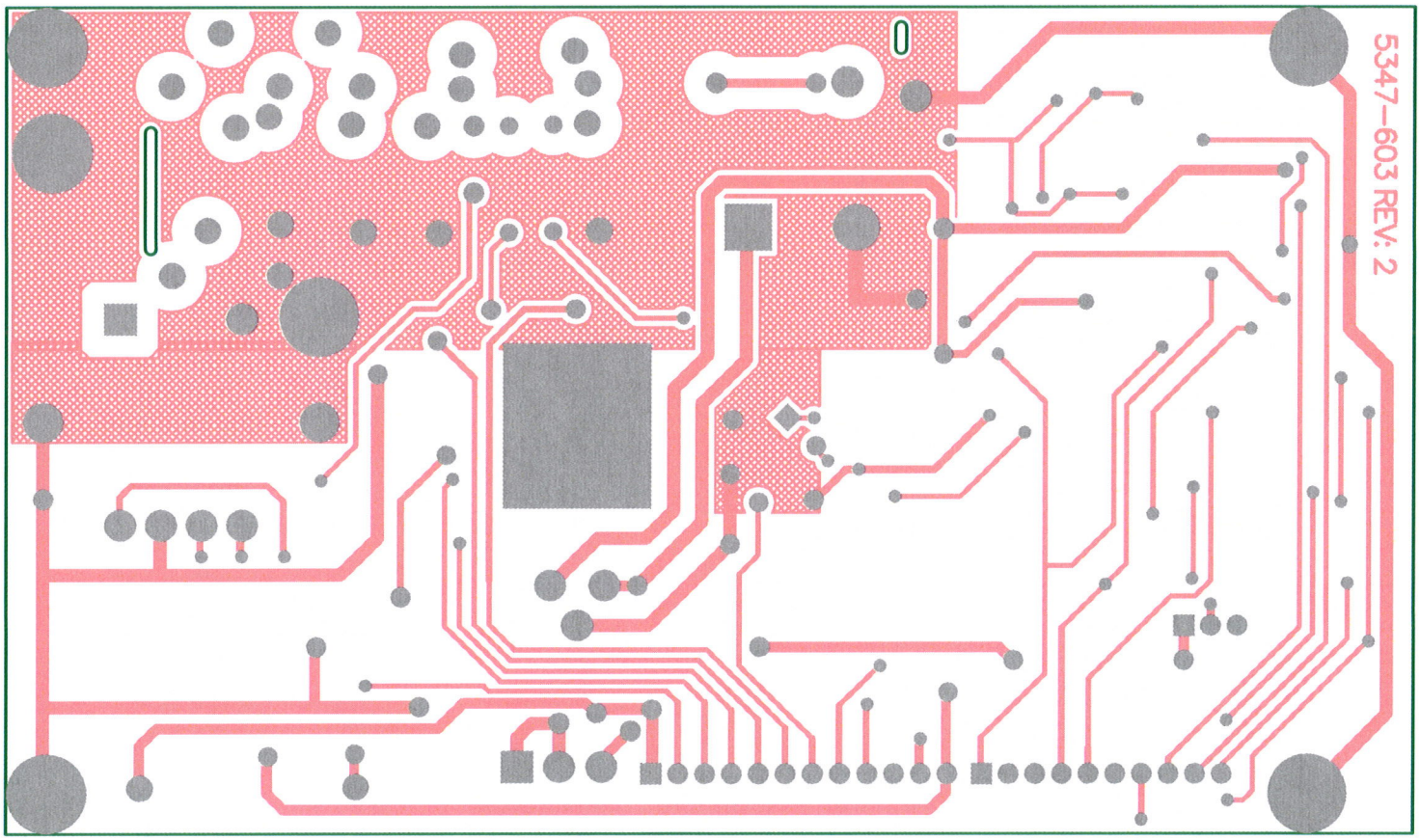

LUDLUM MEASUREMENTS, INC.		PO Box 810 501 Oak Street Sweetwater, TX 79556 U.S.A. 1-800-622-0828	
Title: MAIN BOARD			
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Design: RDS	6/7/2018	**Board#:** 5347-603	
Approve: RDS	19 JUN 18	**Rev:** 2	
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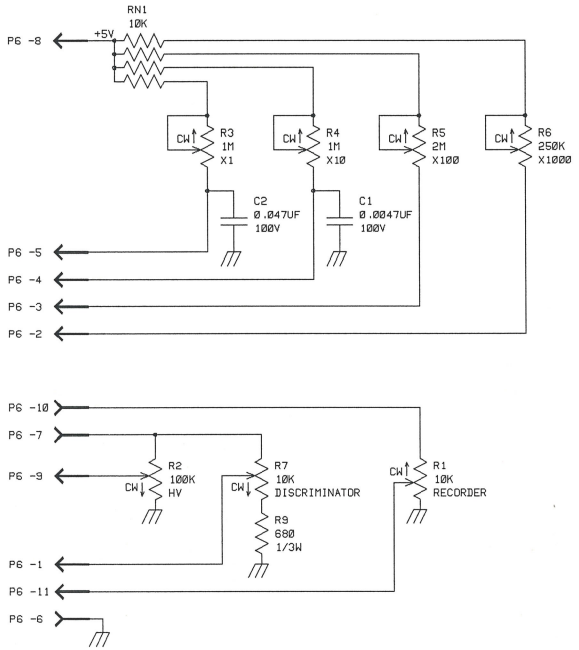
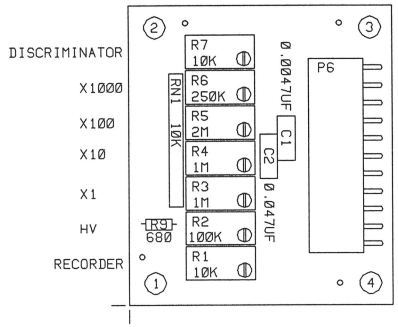
REVISIONS						
EFF	AUTHORITY	ZONE	LTR	DESCRIPTION	DATE	APPROVED



UPDATED -	/ /	LUDLUM MEASUREMENTS INC.
DR CKD	10/20/92	
CHK DW	6/10/93	TITLE: CALIBRATION BOARD
DSGN -	/ /	
APPD JGW	6/10/93	BOARD# 5347-189
NEXT HIGHER ASSY. -		SIZE D / MODEL 177 / SERIES 347 / SHEET 132
14:18:53	10-Jun-93	SB347189 / SHEET 1 OF 1



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LUDLUM MEASUREMENTS INC. SWEETWATER, TX.			
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CHK DW	10/93		
DSGN -	/ /	BOARD# 5347-189	BS347189
APP JGW	6-10-93	MODEL 177 / SERIES 347	SHEET 133
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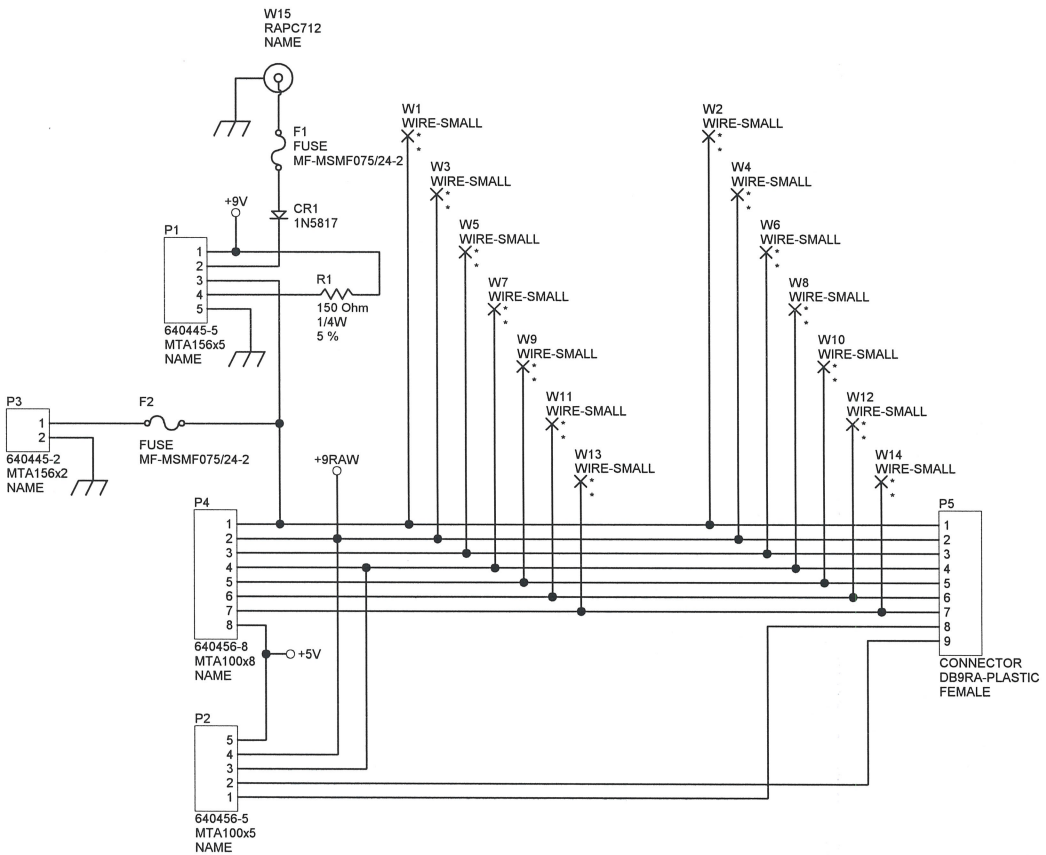
COMP PASTE ☐	COMP MASK ☐	SLDR PASTE ☐	SLDR MASK ☐



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

Drawn: MC	09-DEC-10	Title: POWER/DATA BOARD		
Design: PW	09-DEC-10	Model: M177		
		Board#: 5347-489		
Approve:	12-13-2010	Sheet: 1 of 1	Series	Sheet
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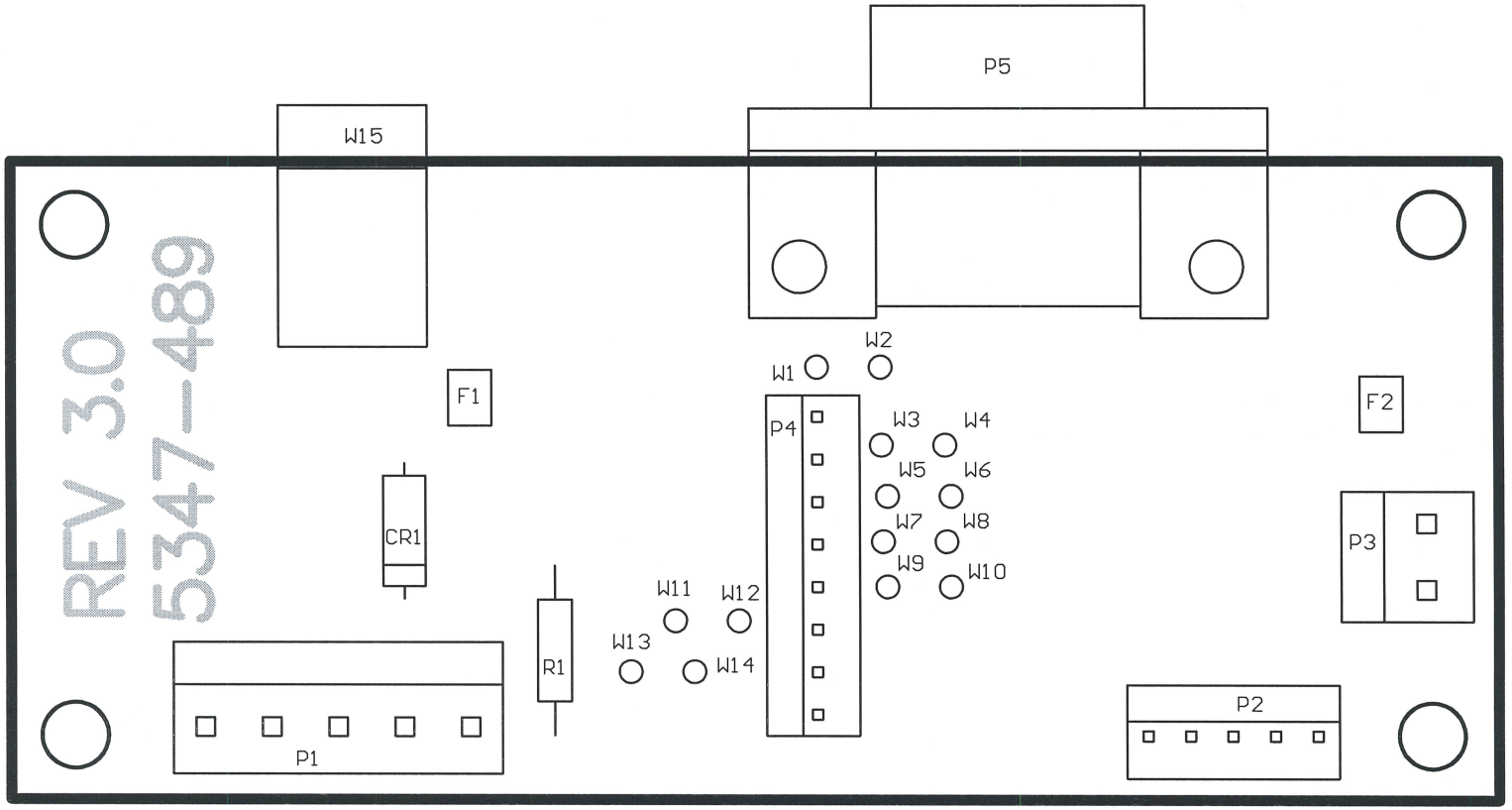

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Design: PW	09-DEC-10				
		Model: M177			
Approve: DW	09-Dec-10	**Board#:** 5347-489			
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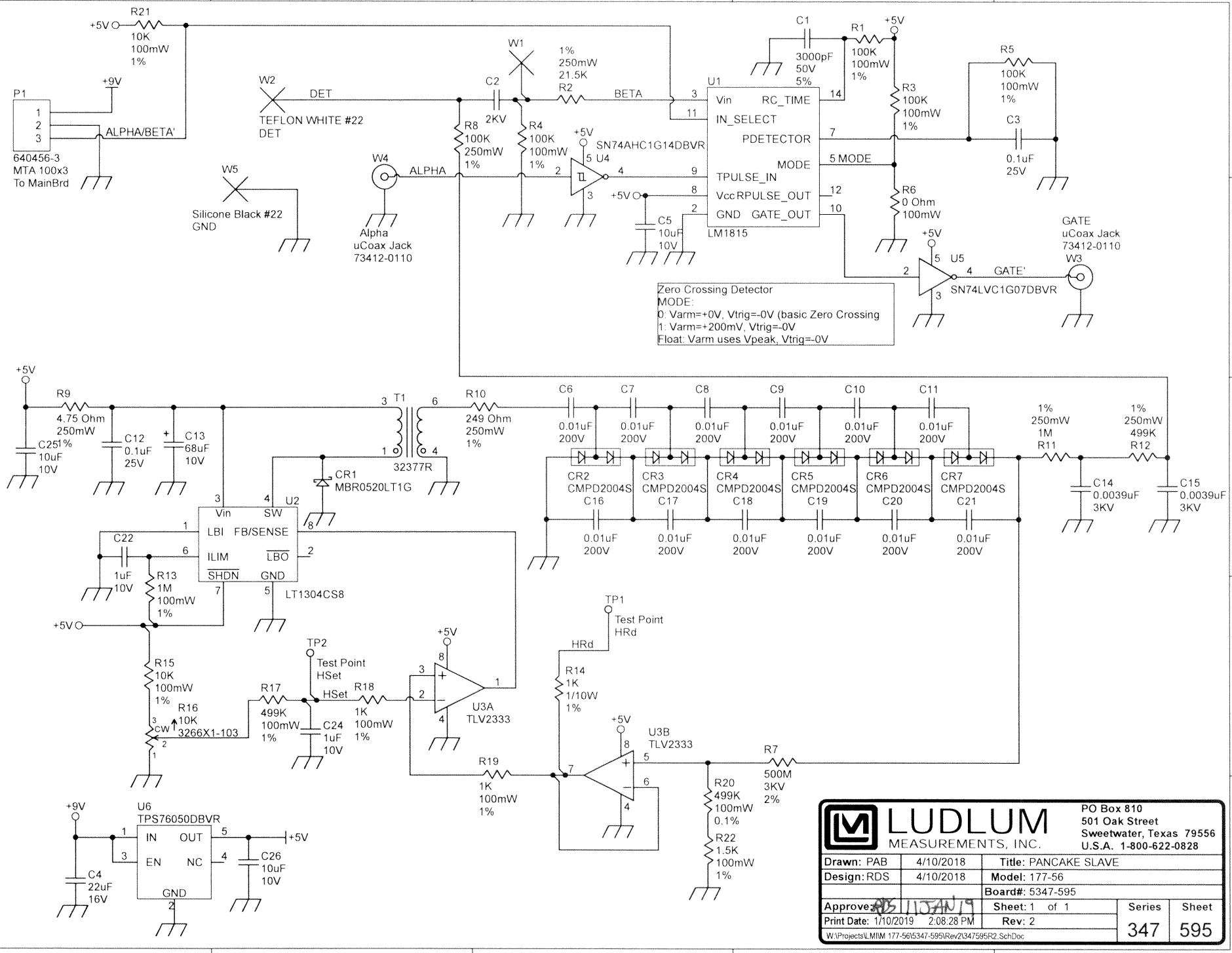

LUDLUM MEASUREMENTS, INC.

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

Drawn: PAB	4/10/2018	Title: PANCAKE SLAVE		
Design: RDS	4/10/2018	Model: 177-56		
		Board#: 5347-595		
Approved: RDS 11JAN19		Sheet: 1 of 1	Series	Sheet
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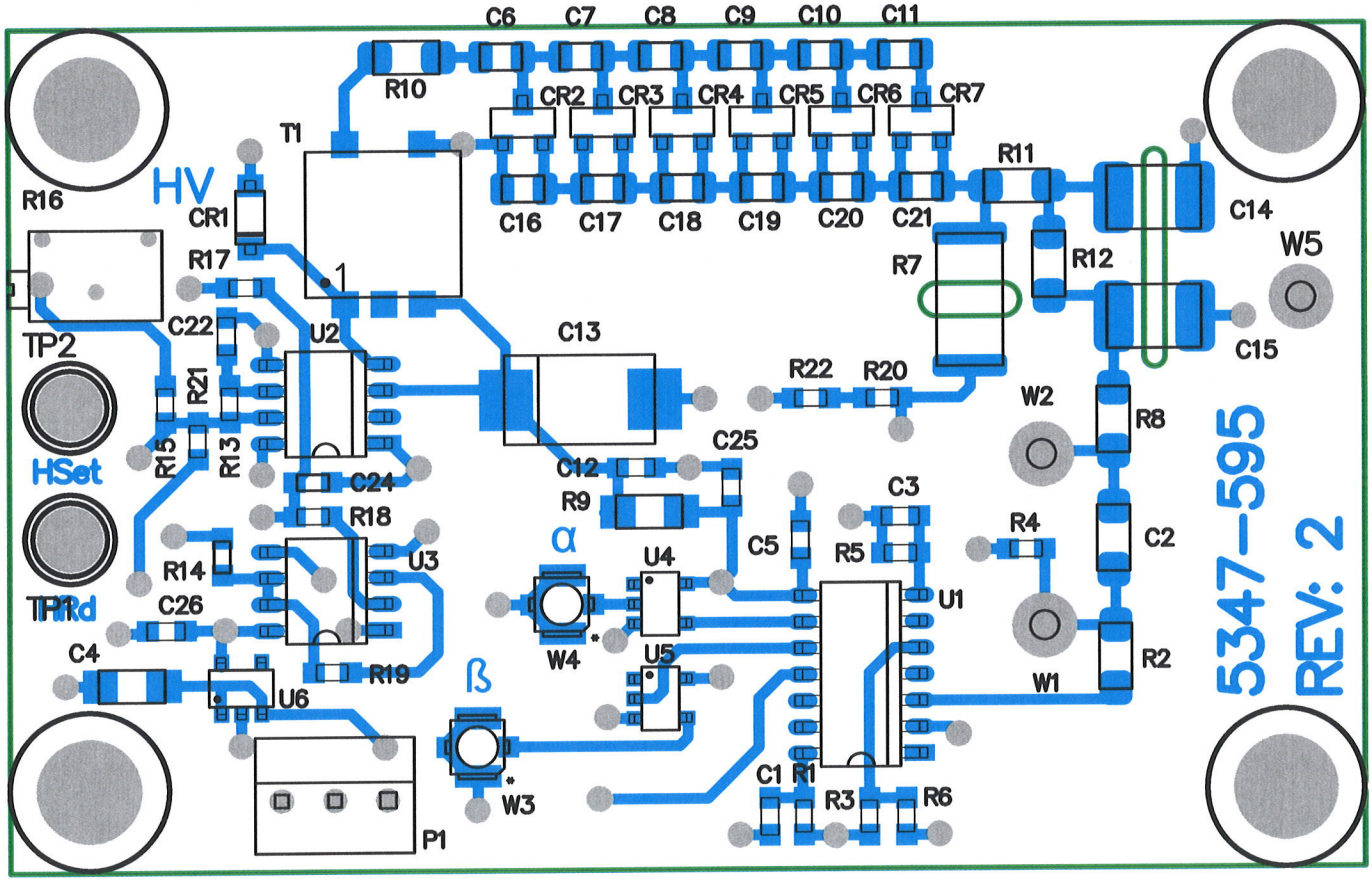

LUDLUM MEASUREMENTS, INC.	PO Box 810 501 Oak Street Sweetwater, TX 79556 U.S.A. 1-800-622-0828			
Title: PANCAKE SLAVE				
Drawn: PAB	4/10/2018	**Model:** 177-56		
Design: RDS	4/10/2018	**Board#:** 5347-595		
Approve: RDS	4 JUN 18	**Rev:** 2		
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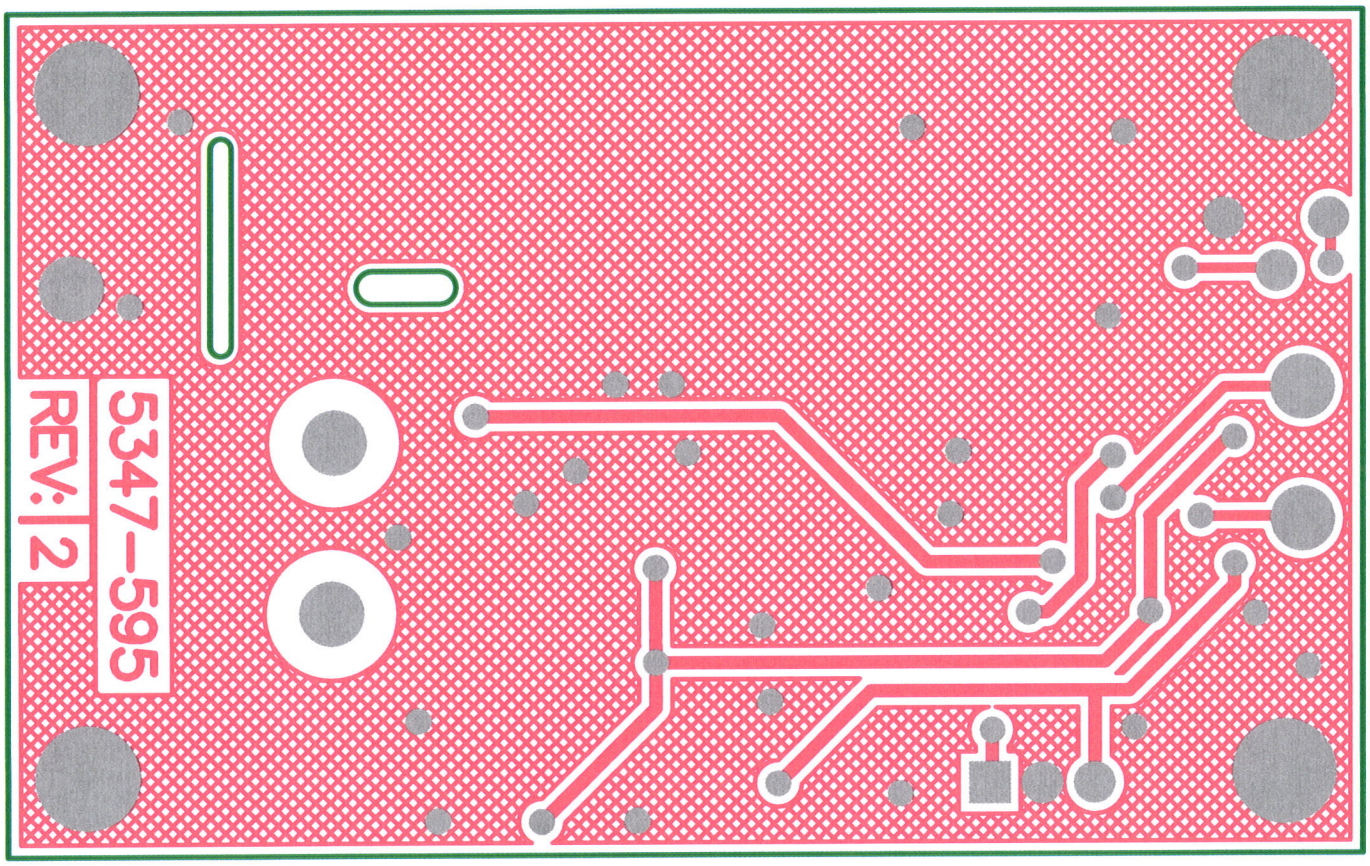

LUDLUM MEASUREMENTS, INC.
PO Box 810
501 Oak Street
Sweetwater, TX 79556
U.S.A. 1-800-622-0828

Title: PANCAKE SLAVE			
Drawn: PAB	4/10/2018	**Model:** 177-56	
Design: RDS	4/10/2018	**Board#:** 5347-595	
Approve: RDS	4 JUN 18	**Rev:** 2	
PCBA Drawing		**SCALE: 1.08**	**Series** 347 / **Sheet** 596
Print Date: 6/4/2018 9:17:57 AM		Bottom Overlay	

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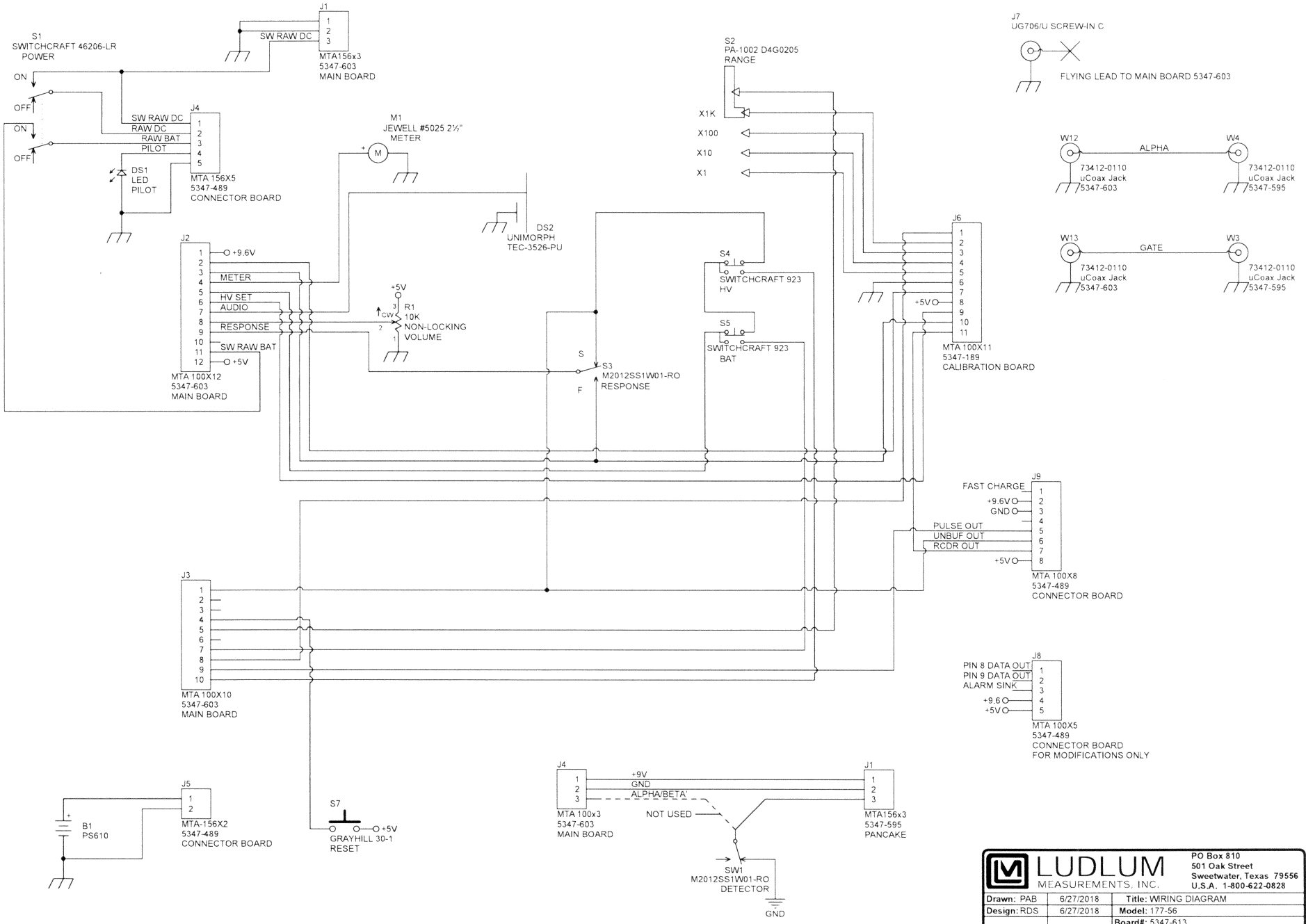

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Drawn: PAB	6/27/2018	Title: WIRING DIAGRAM		
Design: RDS	6/27/2018	Model: 177-56		
		Board#: 5347-613		
Approve: WS 27Jun'18		Sheet: 1 of 1	Series	Sheet
Print Date: 6/27/2018 2:14:32 PM		Rev: 1	347	613

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