

**LUDLUM MODEL 177-84-2  
ALPHA/BETA RATEMETER**

**March 2025**

**Serial No. 330935 and Succeeding  
Serial Numbers**

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ALPHA/BETA RATEMETER**

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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**





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### Section

# 1

## Introduction

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The Model 177-84-2 is a microprocessor-based radiation survey instrument used to measure and discriminate low-level alpha/beta radiation when used with an alpha/beta scintillation or proportional detector. The instrument has beta automatic background subtract and beta automatic background update.



The radiation level is displayed on two analog meters. The Alpha meter dial indicates 0-500 cpm with range multipliers of X1, X10, X100, and X1000. The Beta meter dial indicates 0-500 cpm with range multipliers of X1, X10, X100, and X1000. The meter range may be fixed or auto-ranging, depending on PC Interface software settings. Each channel has its own distinguishable click-per-event audible tone. Beta events are a low pitch and alpha events are a high pitch.

Each channel has its own alarm point, which is adjustable from 0 to 500,000 cpm (full scale). Alarms are indicated by an audible tone and LEDs (Light Emitting Diodes) located underneath the meters.

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A regulated high-voltage power supply adjustable from 0 to 1500 volts with detector overload detection is utilized to operate a wide range of scintillation detectors. Other operating features of the instrument include adjustable volume, low-battery LED, high-voltage readout, battery voltage readout, alarm audio acknowledge, and meter reset.

All calibration controls are located internally or require the PC Interface to prevent tampering. The only user-accessible controls include the ACK/RESET and BKG UPDATE push-buttons located on the front and an ON/OFF switch located on the back. The ACK/RESET button functions as a mode button when not alarming to switch between displaying the alarm set point and the battery and high voltage.

The unit operates on line power or an internal rechargeable battery. It is useable in temperatures ranging from -15 to approximately 50 °C (5 to 122 °F).

## Section

# 2

## Specifications

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**HIGH VOLTAGE:** variable from 0 to 1500 volts

**ALPHA THRESHOLD:** Adjustable from -4 to -180 mV, typically -125 mV (measured by pulser)

**ALPHA METER SCALE:** 0-500 cpm, 4-8 Vdc

**ALPHA RANGE:** X1, X10, X100, X1K

**BETA THRESHOLD:** Adjustable from -1 to -4 mV, typically -3.5 mV (measured by pulser)

**BETA WINDOW:** Adjustable from -4 to -70 mV, typically -60 mV (measured by pulser)

**BETA METER SCALE:** 0-500 cpm; 0-1500 V

**BETA RANGE:** X1, X10, X100, X1K

**CROSSTALK:** no more than 1% of gross **Beta** counts in alpha channel and no more than 10% of gross **Alpha** counts in **Beta** channel

**LINEARITY:** within 10% of true value, typically  $\pm 2\%$  of true value when measured with an electronic pulser

**RESPONSE TIME:** The micro-controller calculates the response time based on the number of incoming counts. Both the minimum and maximum values are user adjustable from 1 to 99 seconds in software. The default Beta response times are typically set to 2 seconds minimum and 5 seconds maximum. The Alpha response times are set to 5 seconds minimum and 10 seconds maximum.

**METERS:** 1 mA, 2.5 in., DC movement.

**CONNECTOR:** Series "C" (BNC, MHV, and SHV connectors available)

**REAR PANEL TEST OUTPUTS:** two MHV type connectors for

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attaching directly to a scaler input. These are low-level (5-10 mV) negative-going pulses used for timed counting during test. Set the scaler around 5 mV and preferably adjust the HV on the scaler to 900 V or less, though these outputs can survive up to 1500 Vdc.

**AUDIO:** dual tone click-per-event through a built-in unimorph with an internal volume control.

**ALARM RANGE:** adjustable from 0 through full scale

**FINISH:** powder coat paint

**POWER:** 12 Vdc (9.5-16 Vdc “electronically qualified input”, internal rechargeable 6 V (sealed lead-acid) battery; battery life approximately 50 hours

**BATTERY DEPENDANCE:** instrument calibration change less than 3% until Low Battery LED comes on

**SIZE:** 19.1 x 22.9 x 15.2 cm (7.5 x 9 x 6 in.) (H x W x L), excluding handle

**WEIGHT:** 2.2 kg (4.9 lb)

## Section

# 3

## Description of Controls and Functions

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### Front Panel

**METERS:** The left meter is a 0 to 500 cpm linear scale that shows the number of alpha counts. The right meter is a 0 to 500 cpm linear scale that shows the number of beta counts. LED indicators under each meter show the ranges X1, X10, X100, and X1K for both meters (each meter independently settable).

**STATUS LEDs:** six LEDs that indicate the status of the instrument. When on battery power and in normal mode, the Normal LED blinks at an interval of 0.5 seconds on, 4.5 seconds off to conserve battery.

**RANGE LEDs:** located underneath each meter are four LEDs indicating the respective multiplier. When on battery power and in normal mode, the range LEDs blink at an interval of 0.5 seconds on, 4.5 seconds off to conserve battery.

**ALARM LEDs:** located underneath each meter are red LEDs indicating the alarm status.

**UPDATING BACKGROUND:** When this LED is lit, the instrument is updating only the beta background value it will use when subtracting background. When the instrument is first turned on, it will take a mandatory background count. The count time is set in software and ranges from 0 to 9999 seconds. While it is taking this count, the UPDATING BACKGROUND LED will be flashing. The background can be updated at any time by pressing the BKG UPDATE button.

**OVERLOAD:** This LED will come on to indicate that the detector is saturated either by a puncture in the detector face on a scintillation detector, or an exposure to a radiation field above the counting capability of the instrument. The analog meters will deflect full scale when the OVERLOAD LED is illuminated.

**LOW BATTERY:** This LED will come on when the charge on the battery

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has dropped below the useable range. The voltage level is 5.5 volts measured at the battery terminals.

**ALPHA ALARM:** This LED will latch on when the alpha radiation level has exceeded the alpha alarm point. There is no auto-reset feature in this version of firmware (34702N05).

**BETA ALARM:** This LED will latch on when the beta radiation level has exceeded the beta alarm point. There is no auto-reset feature in this version of firmware (34702N05).

**ACK/RESET:** This pushbutton has three functions. If the instrument is in an alarm condition, the push of the button will turn the audio off and reset the meters to zero. If there is no alarm, the first push will display the alarm set points (ALARMS). The second push will display the battery and high voltage (HV/BAT) using the Vdc and kV scales. The third push will return the mode to display the current ratemeter readings (NORMAL).

**DETECTOR:** This is a coax connector used to connect the instrument to the detector.

### Rear Panel

**POWER:** This switch turns the instrument ON and OFF. The LED power indicator next to the power switch will light (green) if the power adapter being used is the correct voltage (9.5 to 16 Vdc).

**INPUT:** This 5.5 x 2.5 mm socket (center-pin +12 Vdc) accepts the plug providing power to the instrument.

**BATTERY ACCESS DOOR:** The internal rechargeable battery can be accessed by removing this door. The battery should be replaced at least every 4 years. The orange wire plugs onto the positive terminal of the battery.

**ALPHA PULSE:** This is an MHV coax connector used to output the alpha only pulse. This connection provides a very low-level signal out (~5 mV negative pulse) for connection to an accessory scaler/counter. It is recommended that you reduce the scaler HV to 900 V or less when using this connection.

**BETA PULSE:** This is an MHV coax connector used to output the beta only pulse. This connection provides a very low-level signal out (~5 mV negative pulse) for connection to an accessory scaler/counter. It is recommended that you reduce the scaler HV to 900 V or less when using this connection.

**USB:** This is a mini-USB jack used to connect to computer using a USB-A



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to USB-B mini cable.

**FIRMWARE UPDATE:** This pushbutton is used in conjunction with the POWER switch to initiate a firmware update. Press and hold the FIRMWARE UPDATE button and turn the unit OFF, and then back ON. The instrument will remain in firmware update mode until power is cycled again or the “RUN” command in Windows Serial Downloader program is activated.

### Internal Controls

Remove the instrument cover to access the following controls:

**Hread R56:** This trimmer potentiometer is used calibrate the read-back voltage applied to the micro-controller ADC.

**Hcal R55:** This trimmer potentiometer is used to calibrate the actual HV output as measured at the detector connector on the front panel. Use a pulser with high-voltage readout capability or the Ludlum T1016 or something comparable to measure the HV output at the detector connection. The standard calibration is performed with a detector attached at 750 V. Use the Ludlum Software to set up a 750 V output and adjust Hcal until the output level is  $750 \pm 3\%$ .

**Acal R25:** This control calibrates the Alpha meter. Use a pulser or the Ludlum Software program to set up an 80% meter calibration point (400 or 4/5 full-scale reading), and adjust the meter using the Acal potentiometer.

**Note:** This initial calibration applies to all four ranges.

**BCAL R19:** This control calibrates the Beta meter. Use a pulser or the Ludlum Software program to set up an 80% meter calibration point (400 or 4/5 full-scale reading), and adjust the meter using the Bcal potentiometer.

**Note:** This initial calibration applies to all four ranges.

**VOL (Volume):** The volume control is located inside between the meters and on the front-panel mounted LED driver board. Clicks and alarm tones are adjusted by this control.

## **Section**

# **4**

## **Safety Considerations and Maintenance**

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### **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 than 95% (non-condensing)

Mains supply voltage range 95-250 Vac

Maximum transient voltage of 1500 Vac

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

Pollution Degree 2 (as defined by IEC 644) (Normally only nonconductive pollution occurs. Temporary conductivity caused by condensation is to be expected.)

### **Cleaning Instructions and Precautions**

The Model 177-84-2 may be cleaned externally with a damp cloth, using only water as the wetting agent. Do not immerse the instrument in any liquid. In addition, the operator is strongly cautioned to avoid contact with internal hazardous live parts that are accessible using a tool. 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.

### **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.

### **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.

## **Replacement of Fuses**

There are no expendable fuses in this design.

## **Maintenance**

Instrument maintenance consists of keeping the instrument clean, replacing the battery when necessary, and periodically checking the calibration.

An instrument operational check should be performed at least daily by exposing the detector to a known source and confirming the proper reading on the instrument.

Re-calibration should be accomplished after any maintenance or adjustment of any kind has been performed on the instrument.

Ludlum Measurements recommends recalibration at intervals no greater than one year. Check the appropriate regulatory agencies' regulations to determine required recalibration intervals.

## **Instrument Return for Repair/Calibration**

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](http://www.ludlums.com). Find the form by clicking the "Support" tab and selecting "Service Center" from the drop-down menu. Then choose the appropriate Service Center division where you will find a link to the form.

**Note:**

Ludlum Measurements, Inc. recommends recalibration at intervals no greater than one year, assuming that regular operational checks are performed. Check the appropriate local, state, and federal regulations to determine required recalibration intervals.

### Battery Replacement

The battery typically lasts about four years. If allowed to deep discharge many times, the life expectancy will be reduced. To replace the battery, remove the two screws holding the battery access door on the rear of the instrument and remove the door. Slide the battery out and unplug the wires from the terminals. Attach wires to the new battery (orange wire goes to the positive terminal) and slide back into place. Replace the door.

### Electrical Safety Precautions

**Warning!**

Ignoring the following warnings could result in a potentially hazardous situation, which if mishandled, could result in death or serious personal injury.

- 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 of the unit. Using a voltage higher than that which is specified, may result in fire or electric shock.
- Do not cut, kink, or otherwise damage or modify the power supply cord. In addition, avoid using the power cord in proximity to a heater, 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 on an unstable or slanted surface. Doing so may result in the unit falling and causing personal injury or property damage.

## Section

# 5

## Theory of Operation

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Refer to schematic series 347, sheet 563 for the following:

### Detector Input/Amplifier

Negative going detector pulses are coupled from the detector through C31 to Amplifier U9. R33 and CR6 protect the input of U9 from inadvertent shorts. Self-biased amplifier U9 provides gain in proportion to R41 divided by R34. Transistor pins 4, 5, and 6 of U9 provide amplification. Pins 12 and 15 of U9 are coupled as a constant current source to pin 6 of U9. The output self-biases to  $\sim 2 V_{be}$  (approximately 1.4 volts) at pin 7 of U9. This provides just enough bias current through pin 6 of U9 to conduct all of the current for the constant current source. Positive pulses from pin 7 of U9 are coupled to the discriminators through R37 and C33.

### Alpha/Beta Discriminator

Positive-going pulses from amplifier U9 are coupled to comparator U10A, pin 2, for alpha discrimination and pin 2, U13A and pin 5, U10B for beta-region discrimination. The reference voltage, Alld (Alpha lower limit) provides the reference voltage for alpha comparator pin 3, U10A. The reference voltage, Blld (Beta lower limit) and R49 provides the reference voltage for beta threshold comparator pin3 of U13A Beta Window (defined as the upper threshold limit of the beta counting window). The reference voltage, Blud (Beta upper limit) and R42 provides the reference voltage for the beta upper window comparator pin5 of U10B.

### Alpha/Beta Discriminator Logic Circuit

Alpha pulses from U10A, pin 1 are coupled to univibrator U12, pin1. All alpha pulses that are registered pass through a similar fixed gate out at pin 5, U122 and then on to the delay U11, pin1 then out pin 6 of U11 to the alpha gate input at the micro-controller.

Beta pulses from pin 1 of U13A are coupled to univibrator U15. Pulses that meet the timing parameters between U15 univibrator and the delay qualifier

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U14 will be passed out pin 6 of U14 to the micro-controller count input for betas. When a beta window pulse is present, the clear input is pulled low at pin 3 of U15, and the pulse is terminated at pin 5 of U15. No output is produced at pin 6 of U14 in this case.

### Low Voltage Supply

Supply Voltage is supplied by the linear regulator VR2 and associated components to provide +5V to power op-amps and logic circuitry. VR1 and related components provide +3.3 V power to the micro-controller (U6) and peripheral components. U5 supplies a +3.3 V reference to the micro-controller and reference generator, U16. U8 provides multi-state charging for the lead-acid (gel type) 6 V battery.

### High Voltage Supply

High voltage is developed by blocking oscillator Q3, T2, C48, and rectified by voltage multiplier CR7 through CR11, C42, C44, C45, and C47. High voltage increases as current through Q3 increases, with maximum output voltage with Q3 saturated.

High voltage is coupled back through R53 to op-amp pin 6 of U17B. Resistor network R56, R58 completes the HV division circuit to ground. HV limiting is performed in firmware and prevents the reference voltage from going higher than 1500 V. The regulated HV output is controlled by HVCAL trimmer R56. This control provides the reference for opamp U17B pin 6. During stable operation, the voltage at pin 6 of U17B will equal the voltage HSet reference at pin 5 of U17B. Pin 7 of U17B will cause conduction of Q4 to increase or decrease until the HV finds a level of stability.

### Detector Overload

A voltage drop is developed across R48 and R47. OpAmp U17A provides a sense voltage for the micro-controller (Hsense). As detector current increases the difference between Hset and Hsense grows more positive. The micro-controller compares this difference to the software-set Overload Voltage maximum allowed, and if equal or greater, trips an Overload alarm. Adjustment for the overload set point is performed in software. R204, HVR, calibrates the analog meter to the HV output when the METER MODE switch is in the READ HV position.

### Micro-Controller

Micro-controller U6 (Analog Devices ADuC843) processes all of the data, control inputs, and display information. The clock frequency is crystal controlled by Y1 running 32.768 kHz. The  $\mu$ C incorporates internal memory (ROM), storing the program information. At power-on a reset is

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internally generated in the  $\mu\text{C}$ , which initiates the start of the program. During the program loop, the  $\mu\text{P}$  looks at all of the input switches for initiation or status changes and responds accordingly.

The microcontroller uses Mode 3: twin 16-bit pulse width modulators.

### **Audio**

Alpha and/or beta audio pulse frequency is generated by the  $\mu\text{C}$  and coupled to the front-panel board circuitry driving the sounder. Bias voltage is provided by the volume control located between the meters and on the front-panel LED driver board.

## Section

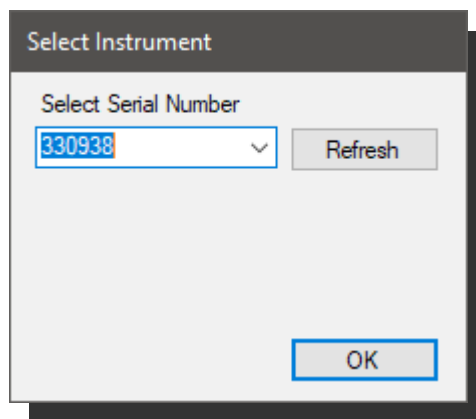
# 6

## PC Interface

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The PC Interface is a Windows application that is used to set the alarm set points, range multiplier for the meters, ratemeter time constants, and voltages.

Connect the Model 177-84-2 to the computer using the supplied USB cable (type A to Mini-B) and install the drivers, which are located on the installation disk under the FTDI folder.

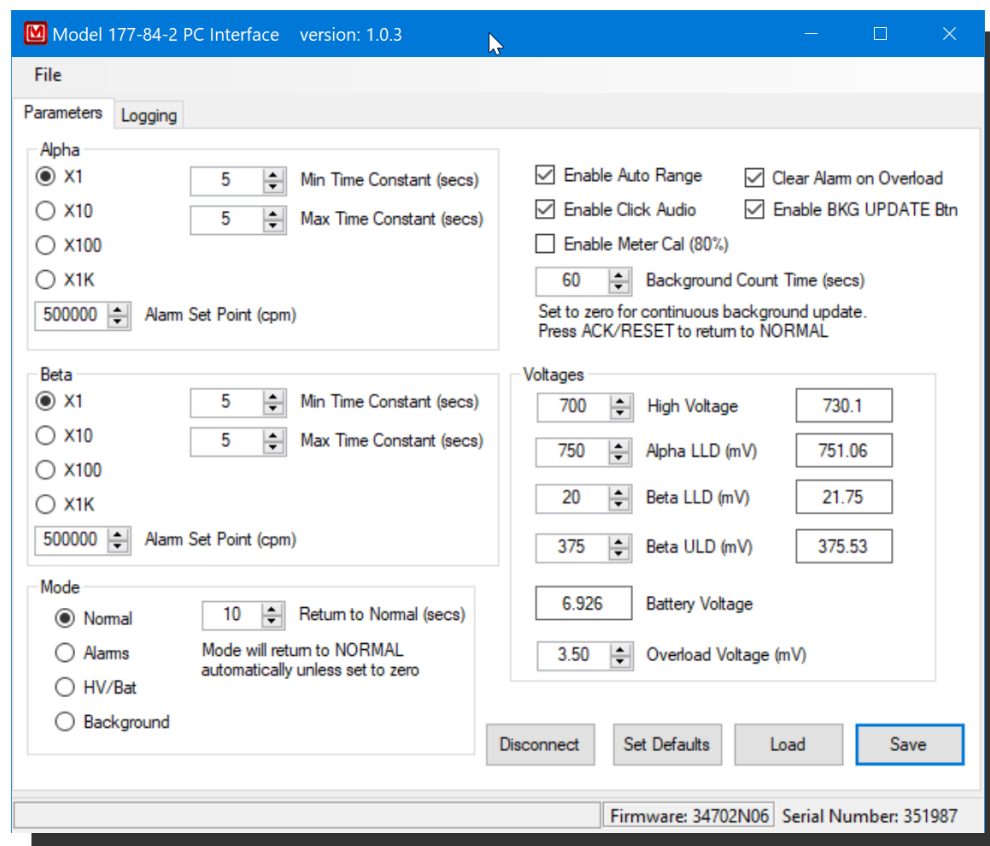


When the application is run, the Select Instrument dialog is displayed. The serial number of the 177-84-2 will be displayed. Select the serial number to change parameters and click OK.

The parameters will be downloaded from the 177-84-2 and displayed on the main screen.



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**Alpha Default Range:** Sets the default starting range for the alpha channel. If the count rate exceeds this range, the next higher range will be selected if auto-range is enabled. The default is the X1 range.

**Alpha Alarm Set Point:** Sets the alpha alarm set point from 0 to 500,000 cpm. The default is 25 cpm.

**Alpha Minimum Time Constant:** Sets the alpha channel minimum time constant. The time constant is adjustable from 1 to 99 seconds. The default is 5.

**Alpha Maximum Time Constant:** Sets the alpha channel maximum time constant. The maximum time constant is adjustable from 1 to 99 seconds. The default is 10.

**Beta Default Range:** Sets the default starting range for the beta channel. If the count rate exceeds this range, the next higher range will be selected if auto-range is enabled. The default is the X10 range.

**Beta Alarm Set Point:** Sets the beta alarm set point from 0 to 500,000 cpm. The default is 1000 cpm.

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**Beta Minimum Response Time:** Sets the beta channel minimum response time. The adjustment is from 1 to 99 seconds.

**Beta Maximum Response Time:** Sets the beta channel maximum time constant. The adjustment is from 1 to 99 seconds.

**Mode:** While connected to the computer, the display mode can be changed between the four different operating modes: Normal, Alarms, HV/Bat, and Background. After selecting a mode, click the Save button to set the new mode.

- Normal – This is the normal operating mode.
- Alarms – The alarm set points are shown on the alpha and beta meters.
- HV/Bat – The current battery voltage is shown on the left (Alpha) meter while the current high voltage is shown on the right (Beta) meter.
- BKG Update – Press to start a new background count.

**Return to Normal (sec):** Sets the number of seconds after changing a mode that it automatically returns to Normal. If this is set to zero, then the model 177-84-2 will not return to normal automatically. Default is 15 seconds.

**Enable Auto Range:** When enabled, meter range will automatically adjust based on the current count rate. Default is OFF.

**Enable Click Audio:** Temporarily disable the audible clicks to indicate counts. This setting only applies until the model 177-84-2 is turned off. After powered on, the click audio is enabled. Default is ON.

**Enable Meter Cal:** When enabled, both alpha and beta meters deflect to 80% to allow the meter movements to be calibrated. This parameter is not saved and will default to OFF during power-up.

**Clear Alarm on Overload:** When enabled, a detector overload will clear any existing alarm and silence the audio. When disabled, any alarm will persist if an overload is detected. Default is ON.

**Enable BKG UPDATE btn:** When enabled the BKG UPDATE button on the front of the instrument will function. When disabled, the button is non-functional and the only way to update the background is to cycle power.

**Background Count Time (secs):** Specify the number of seconds to acquire a background at startup. The default is 20 seconds.

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**High Voltage:** Set the detector high voltage. Voltage is adjustable from 0 to 2000 volts. The default is 750 volts. Check with applicable detector manual for correct high voltage.

**Alpha LLD:** Set the Alpha Lower Level Discriminator in millivolts. Adjustable from 0 to 3300 millivolts. The default is 835 millivolts.

**Beta LLD:** Set the Beta Lower Level Discriminator in millivolts. Adjustable from 0 to 3300 millivolts. The default is 25 millivolts.

**Beta ULD:** Set the Beta Upper Level Discriminator in millivolts. Adjustable from 0 to 3300 millivolts. The default is 225 millivolts.

**Battery Voltage:** Display the current battery voltage. The battery is considered low if the voltage is 5.8 Volts and lower.

**Overload Voltage (mV):** Set the overload battery voltage in millivolts. Adjustable from 0 to 99.99 millivolts. The default is 5.00 millivolts.

**Disconnect:** Clicking the Disconnect button will bring up the Select Instrument window to allow another instrument to be connected.

**Set Defaults:** The Set Defaults button replaces all parameters with the default values. After clicking this button, a dialog window is displayed asking if you are sure you wish to set defaults. It is not necessary to click the save button after setting defaults.

**Load:** The Load button will load the parameters from the instrument and display them on screen. This button can also be used to refresh the parameters to get updates read back voltages.

**Save:** The Save button will save any parameter changes to the instrument.

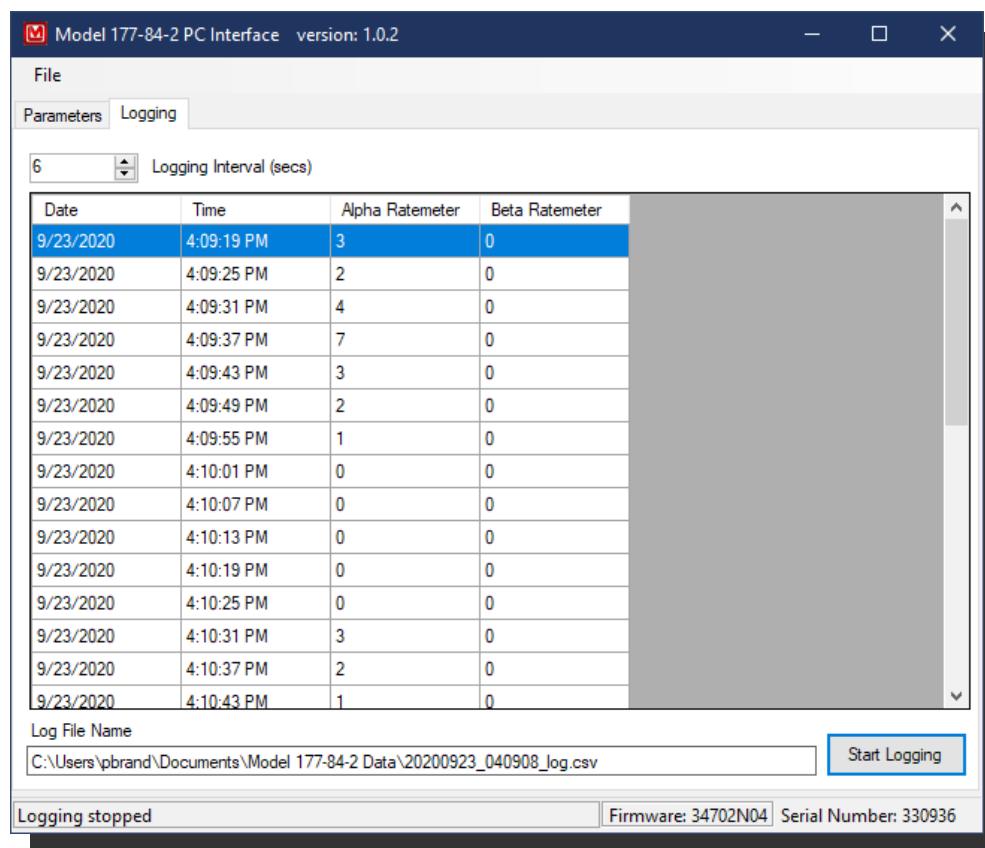
The parameters Enable Click Audio and Enable Meter Cal are not saved to flash memory. On power-up, the click audio will always be enabled.

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The PC Interface can also log the ratemeter reading at user-defined intervals. This data is stored in a comma separated (csv) file that can be loaded into Excel for further processing. The default location is a folder called Model 177-84-2 Data, which is in the user's Documents folder.

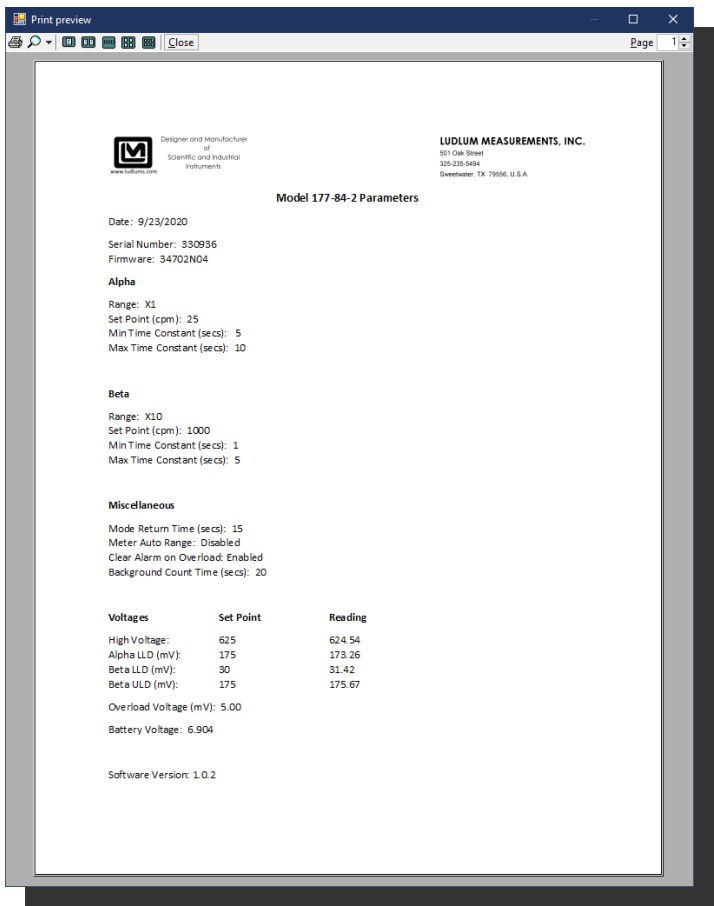
The format of the file is:

```
Date, Time, Alpha Ratemeter (cpm), Beta Ratemeter (cpm), Alpha Alarm, Beta Alarm
9/7/2017, 8:33:49 AM, 341, 3966, False, False
9/7/2017, 8:33:55 AM, 181, 3886, False, False
9/7/2017, 8:34:01 AM, 96, 3845, False, False
9/7/2017, 8:34:07 AM, 51, 3824, False, False
```



# Model 177-84-2 Alpha/Beta Ratemeter

To print the current parameters, select the File/Print menu.



## Section

# 7

## Recycling

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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.



## Section

# 8

## Parts List

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### Model 177-84-2 Alpha/Beta Ratemeter

#### Main Board, Drawing 347 x 563

<u>Reference</u>	<u>Description</u>	<u>Part Number</u>
UNIT	Completely Assembled Model 177-84-2 Alpha/Beta Ratemeter	48-4260
BOARD	Assembled Board	5347-563

#### CAPACITORS

C1	10 $\mu$ F, 100V	04-6011
C2-C3	0.1 $\mu$ F, 25V	04-5744
C6-C7	0.1 $\mu$ F, 25V	04-5744
C8-C12	1 $\mu$ F, 10V	04-5745
C13	10 $\mu$ F, 100V	04-6011
C14	0.1 $\mu$ F, 25V	04-5744
C15-C17	10 $\mu$ F, 100V	04-6011
C18	1 $\mu$ F, 10V	04-5745
C19	0.1 $\mu$ F, 25V	04-5744
C20	10 $\mu$ F, 10V	04-5968
C21	1 $\mu$ F, 10V	04-5745
C22	1 $\mu$ F, 25V	04-5802
C23	68 $\mu$ F, 10V	04-5654
C24	10 $\mu$ F, 100V	04-6011
C25	1 $\mu$ F, 10V	04-5745
C26	0.1 $\mu$ F, 25V	04-5744
C27	1 $\mu$ F, 25V	04-5802
C28-C29	100 pF, 100V	04-5743
C30	10 $\mu$ F, 25V	04-5824
C31	100 pF, 3kV	04-5735
C32-C34	1 $\mu$ F, 10V	04-5745

## Model 177-84-2 Alpha/Beta Ratemeter

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	<u>Reference</u>	<u>Description</u>	<u>Part Number</u>
	C35	100 pF, 100V	04-5743
	C36	4.7pF, 100V	04-5844
	C37	100 pF, 100V	04-5743
	C38-C40	0.01 $\mu$ F, 3kV	04-5525
	C41	1 $\mu$ F, 10V	04-5745
	C42	0.001 $\mu$ F, 3kV	04-5727
	C43	100 pF, 3kV	04-5735
	C44	0.001 $\mu$ F, 3kV	04-5727
	C45	0.01 $\mu$ F, 3kV	04-5525
	C46	68 $\mu$ F, 10V	04-5654
	C47	0.01 $\mu$ F, 3kV	04-5525
	C48	0.1 $\mu$ F, 50V	04-5663
	C49	1 $\mu$ F, 35V	04-5656
	C50	0.01 $\mu$ F, 50V	04-5664
	C51	0.1 $\mu$ F, 25V	04-5744
	C52	1 $\mu$ F, 10V	04-5745
	C53	0.01 $\mu$ F, 50V	04-5664
	C54-C55	1 $\mu$ F, 25V	04-5802
	C56	220 $\mu$ F, 35V	04-5829
	C57	10 $\mu$ F, 100V	04-6011
DIODES	CR1	MBR0520LT1G	07-6422
	CR2-CR4	CXSH-4LF SMT	07-6358
	CR5	MBR0520LT1G	07-6422
	CR6	MMBD7000LT1G	07-6355
	CR7-CR11	GI250-2	07-6266
	CR12	MMBD914LT1G	07-6353
	CR13	SD103AW-13-F	07-6420
TRANSISTORS	Q1	Si2301CDS	07-6486
	Q2-Q3	MJD210T4G	05-5843
	Q4	MMBT3904LT1G	05-5841
RESISTORS	R1	4.75K, 100mW	12-7149
	R2	0 Ohm, 250Mw	12-7104
	R3	523K, 100mW	12-8171
	R4	154K, 100mW	12-7201
	R5	1M, 100mW	12-7081
	R6	4.75K, 100mW	12-7149
	R7-R11	1K, 100mW	12-7084
	R12	523K, 100mW	12-8171
	R13	1K, 100mW	12-7084
	R14	1M, 100mW	12-7081
	R15	154K, 100mW	12-7201



## Model 177-84-2 Alpha/Beta Ratemeter

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<u>Reference</u>	<u>Description</u>	<u>Part Number</u>
R16	1.5K, 100mW	12-7159
R17	22.1K, 100mW	12-7094
R18	100K, 100mW	12-7082
R19	1K, 3269W-1-102G	09-6960
R20	510K, 250mW	12-8187
R21	75K, 100mW	12-8027
R22	249 Ohm, 100mW	12-7191
R23	100K, 100mW	12-7082
R24	16.9K, 100mW	12-7199
R25	1K, 3269W-1-102G	09-6960
R26	475K, 100mW	12-7088
R27	46.4K, 100mW	12-8294
R28	100 Ohm, 100mW	12-7142
R29	49.9K, 100mW	12-7200
R30	2K, 100mW	12-7144
R31	33.2K, 100mW	12-7093
R32	10K, 100mW	12-7083
R33	49.9 Ohm, 250mW	12-8263
R34	4.75K, 100mW	12-7149
R35	2K, 100mW	12-7144
R36	22.1K, 100mW	12-7094
R37	100 Ohm, 100mW	12-7142
R38	169K, 100mW	12-8009
R39	1K, 100mW	12-7084
R40	10K, 100mW	12-7083
R41	124K, 100mW	12-7136
R42	10K, 100mW	12-7083
R43	49.9K, 100mW	12-7200
R44	33.2K, 100mW	12-7093
R45	100K, 250mW	10-7023
R46	2K, 100mW	12-7144
R47	100K, 250mW	10-7023
R48	4.7M, 250mW	10-7030
R49	10K, 100mW	12-7083
R50	2K, 100mW	12-7144
R51	169K, 100mW	12-8009
R52-R53	1G, FHV-12%	12-7686
R54	1M, 250mW	12-7844
R55-R56	100K, 3269W1-104	09-6930
R57	953K, 250mW	12-7950
R58	910K, 250mW	12-7206
R59	200 Ohm, 100mW	12-7155
R60	1M, 100mW	12-8273
R61	2.21K, 100mW	12-7172
R62	1M, 100mW	12-8273

## Model 177-84-2 Alpha/Beta Ratemeter

	<u>Reference</u>	<u>Description</u>	<u>Part Number</u>
	R63	22.1K, 100mW	12-7094
	R64	1M, 100mW	12-8273
	R65	1.69 Ohm, 250mW	12-8304
	R66	22.1K, 100mW	12-7094
	R67-R77	10K, 100mW	12-7083
	R78	5.1M, 250mW	12-7979
	R79	130K, 250mW	12-8302
	R80	169K, 250mW	12-8008
	R81	0 Ohm, 100mW	12-8013
	R82	2K, 100mW	12-7144
	R84	1K, 100mW	12-7084
	R90	0 Ohm, 100mW	12-8013
	R91	1.5K, 100mW	12-7159
SWITCHES	SW2	KSLOV411	08-6798
	SW3	DF62J12S2AHQA ON/OFF	08-6840
TRANSFORMERS	T2	L8050 X50	40-0902
CONNECTORS	P1	DB9RA-PLASTIC FEMALE	22-9149
	P2	1-640456-1 MTA 100X11	13-8059
	P3	6400456-4 MTA 100X4	13-8088
	P4	640456-2 MTA 100X2	13-8073
	P6	6400456-4 MTA 100X4	13-8088
	P7	640456-2 MTA 100X2	13-8073
	J1	CONN-RAPC712	13-8445
INTEGRATED CIRCUITS	U1	LTC6993CS6-3	06-6892
	U2	SN74AHC1G124	06-6935
	U3	SN74AHC1G08DBVT	06-6631
	U4	LTC6993CS6-3	06-6892
	U5	REF3133AIDBZT	06-6973
	U6	ADUC843BSZ62-3	06-6703
	U7	TLV2333	06-6980
	U8	BQ24450	06-7002
	U9	HFA3096BZ96	06-6468
	U10	TLC372IDR	06-6290
	U11	LTC6994-2	06-6951
	U12	SN74LVC1G123DCTR	06-6982
	U13	TLC372IDR	06-6290
	U14	LTC6994-2	06-6951
	U15	SN74LVC1G123DCTR	06-6982
	U16	DAC124S085C1MM12 BIT DAC	06-6734
	U17	TLV2333	06-6980
	U18	LTC4365	06-7005
	U19	IRF7303PBF	05-5971
	U20	SN74AHC1G125	06-6935

## Model 177-84-2 Alpha/Beta Ratemeter

	<u>Reference</u>	<u>Description</u>	<u>Part Number</u>	
VOLTAGE REGULATOR	VR1	TPS76033DBVT	05-5880	
	VR2	REG103UA-5	05-5738	
	VR3	TPS76133DBVR, 3.3V 100mA	06-6804	
CRYSTALS	Y1	32.768KHz	01-6003	
MISCELLANEOUS	DS1	HMMM-A400-U4QM2 Green	07-6522	
	F1-F2	MF-MSMF030-2 300mA, 30V 1812 Fuses	21-8294	
	Mech1	RLP1-200-500 LPR1-LIGHTPIPE	07-6657	
	T2	XFMR-L8050 X50	40-0902	
	W1-W3	73412-0110 Ucoax Jack	13-9376	
	W4	534-1284 Screw Terminal 6/32	18-9797	
	W5	CONTACT #1414	18-9124	
<b>Display Board,</b>				
<b>Drawing 347 x 569</b>				
	BOARD	Assembled Board	5347-564	
		C1	47μF, 10V	04-5947
	CAPACITORS	C2	47μF, 16V	04-5666
LEDS	DS1	LED-E114 YELLOW	07-6392	
	DS2-DS3	LED-E112 RED	07-6390	
	DS4-DS5	LED-E116 GREEN	07-6393	
	DS6	LED-E114 YELLOW	07-6392	
	DS7-DS14	LED-E116 GREEN	07-6393	
	DS15-DS16	LED-E186 BRIGHT RED JUMBO	07-6437	
RESISTORS	R1-R2	10K, 250mW, 1%	12-7839	
	R3-R16	825 Ohm, 250mW, 1%	12-7853	
	R17-R18	150 Ohm, 250mW, 1%	12-7062	
	R19-R20	49.9K, 250mW, 1%	12-7196	
	R21-R22	10K, 250mW, 1%	12-7839	
	R23	10K, 3269X1-103GLF	09-6921	
SWITCHES	S1-S2	92-960.0 MTG FLNGE SW92	08-6727	
TRANSFORMERS	T1	Model 177 AUD (ASY)X50	4275-083	
	Q1-Q2	RK7002AT116	05-5931	
	Q3	2N7002LT1G	05-5840	
INTEGRATED CIRCUITS	U1-U2	SN74AHCT573	06-7003	

## Model 177-84-2 Alpha/Beta Ratemeter

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	<u>Reference</u>	<u>Description</u>	<u>Part Number</u>
CONNECTORS	P1	640456-4 MTA 100X4	13-8088
	P2	640456-2 MTA 100X2	13-8073
	P3	1-640456-1 MTA 100X11	13-8059

### Protection Board,

#### Drawing 347 x 578

	BOARD	Assembled Board	5347-576
CAPACITORS	C1	100pF, 3kV	04-5735
RESISTORS	R1	100K, 250mW	12-8295
	R2	1K, 250mW	12-7832
TRANSFORMERS	Q1-Q2	MMBFJ309LT1G	05-5974
MISCELLANEOUS	W1	73412-0110 uCoax Jack	13-9376

### Wiring Diagram,

#### Drawing 347 x 575

AUDIO	DS1	TEC-3526-PU	21-9251
CONNECTORS	J1	640456-4 MTA 100X2	13-8088
	J2-J3	640456-1MTA 100X11	13-8059
	J6	640456-4 MTA 100X2	13-8088
	J7	640456-2 MTA 100X2	13-8073
MISCELLANEOUS	M1	METER ASSY Model 177	4173-166
	*	MAIN BOARD MODEL 177-84-2	5347-563
	*	DISPLAY BOARD Model 177-84-2	5347-564
	2 EA.	PROTECTION BOARD	5347-576
	*	MAIN HARNESS Model 177-84-2	8347-576
	*	PORTABLE CAN HARNESS	8363-462
	*	UNIMORPH HARNESS Model 215	8110-153
	B1	BATTERY NP1-6 YUASA	21-9385

## Section

# 9

## Revisions

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### Firmware

#### Version 34702N06

Added option to disable the BKG UPDATE button.

#### Version 34702N05

Changed the NORMAL and RANGE LEDs to blink when on battery. The LEDs are on for 500 ms and off for 4.5 seconds.  
Re-enabled idle mode for the processor.

#### Version 34702N04

Added Clear Alarm on Overload.  
Fixed where voltages were not changed immediately when setting default values but would be correct after a power-cycle.  
Updated default values.

#### Version 34702N03

Fixed issue where background subtract was disabled after pressing the ACK/Mode button.

#### Version 34702N02

Fixed issue where ratemeter was not using the user-defined alpha max time constant.

#### Version 34702N01

Initial release.

### Software

#### Version 1.0.3

Added option to disable BKG UPDATE button.

#### Version 1.0.2

Added Clear Alarm on Overload option.

## Model 177-84-2 Alpha/Beta Ratemeter

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### **Version 1.0.1**

Fixed issue where background count time was not updated on main window.

### **Version 1.0.0**

Initial release.

**Section**

**10**

## **Diagrams and Drawings**

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Main Board, Drawing 347 x 563 (4 sheets)

Main Board Component Layout, Drawing 347 x 564 (2 sheets)

Display Board, Drawing 347 x 569

Display Board Component Layout, Drawing 347 x 570 (2 sheets)

Protection Board, Drawing 347 x 578

Protection Board Component Layout, Drawing 347 x 579 (2 sheets)

Wiring Diagram, Drawing 347 x 575

Model 177-84-2 Drain Holes, Drawing 347 x 560G

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B

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C

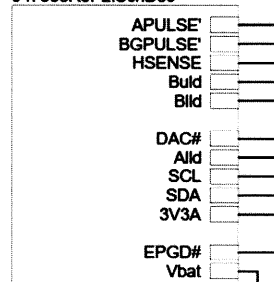
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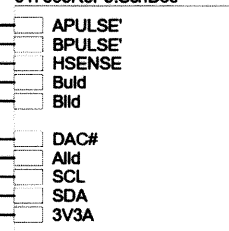
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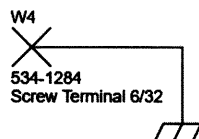
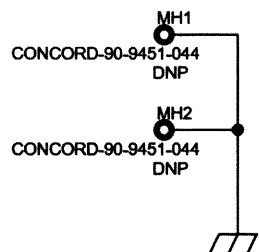
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347563R5P3  
347563R5P3.SchDoc



347563R5P4  
347563R5P4.SchDoc



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Design: RDS	11/17/2022	Model: M 177-84-2	
		Board#: 5347-563	
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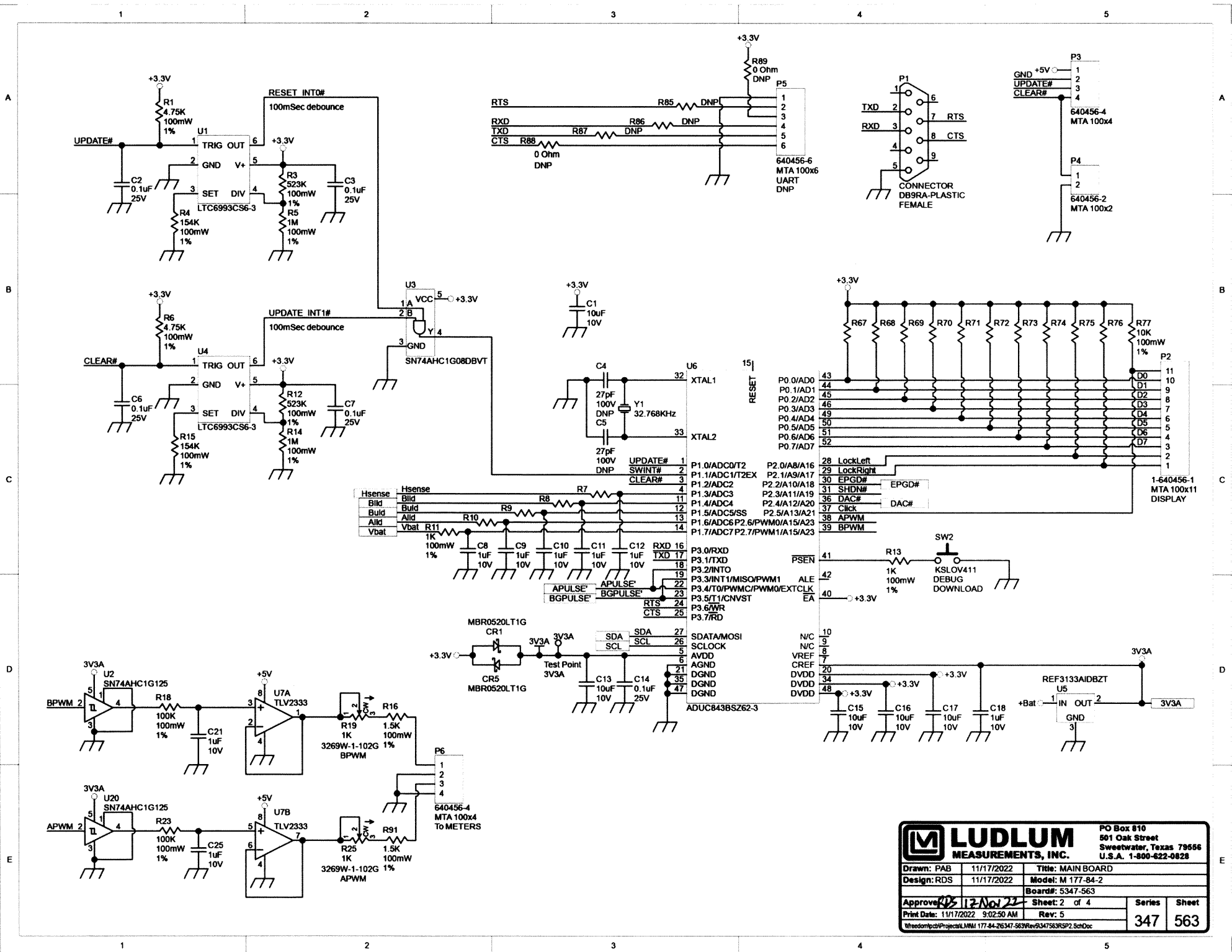
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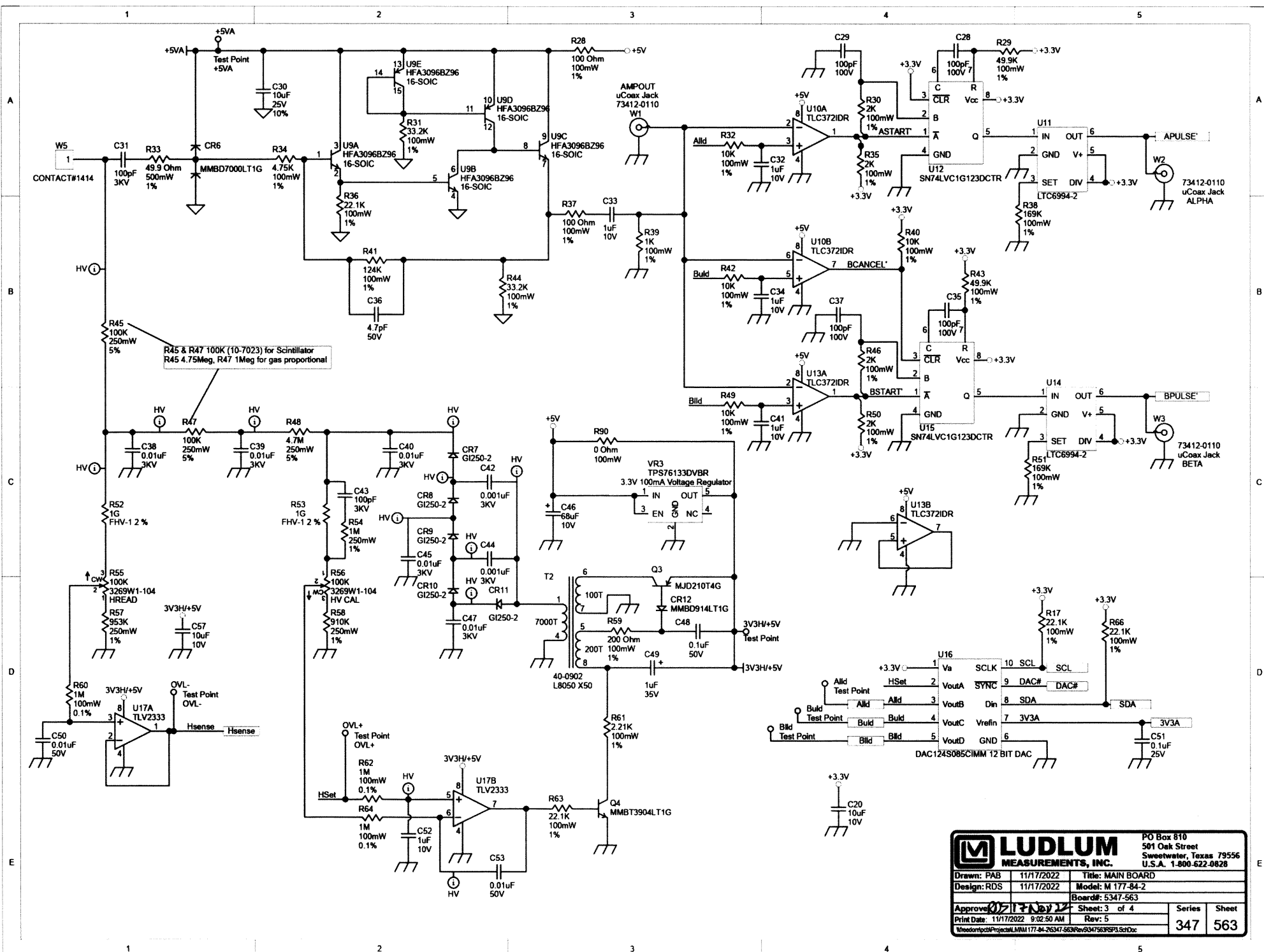
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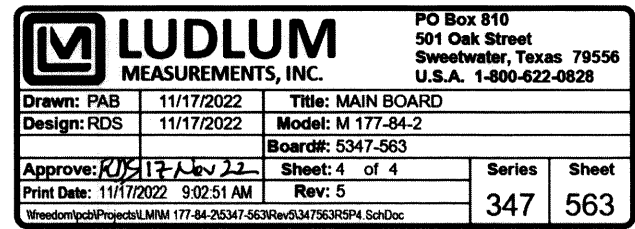




<b>LUDLUM MEASUREMENTS, INC.</b>		PO Box 610 501 Oak Street Sweetwater, Texas 79556 U.S.A. 1-800-622-0828	
Drawn: PAB	11/17/2022	Title: MAIN BOARD	
Design: RDS	11/17/2022	Model: M 177-84-2	
Approved: <i>[Signature]</i> 12-Nov-22		Sheet: 2 of 4	Series
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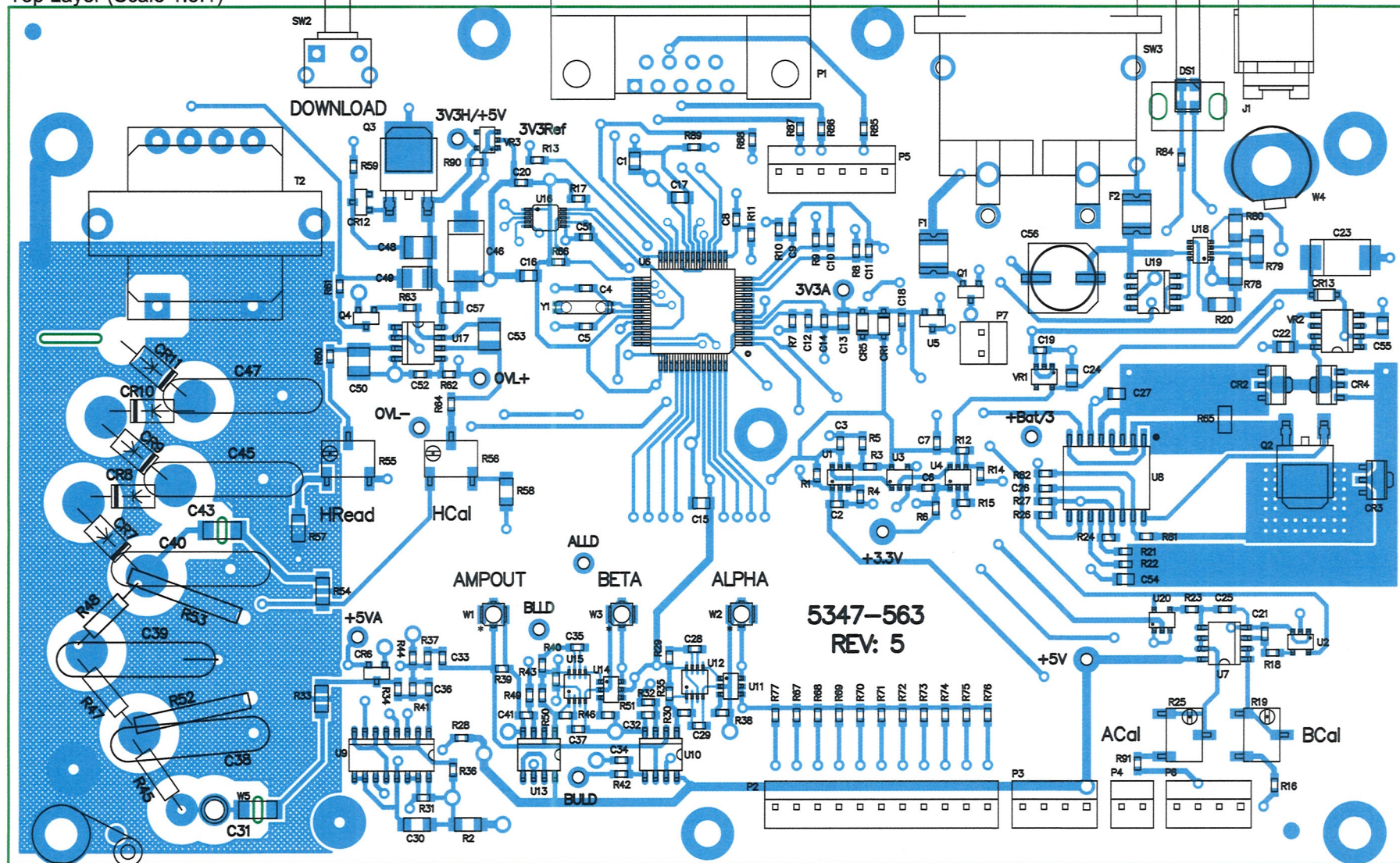
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		Title: MAIN BOARD	
Drawn: PAB	11/17/2022	Model: M 177-84-2	Board#: 5347-563
Design: RDS	11/17/2022	Rev: 5	Sheet: 3 of 4
Approved: <i>[Signature]</i>	11/17/2022 9:02:50 AM	Series	Sheet
Print Date: 11/17/2022 9:02:50 AM		347	563
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DO NOT PLACE C4, C5, R85, R86, R87, R88, R89, P5 and the 2 FASTENER BLOCKS

Top Layer (Scale 1.5:1)



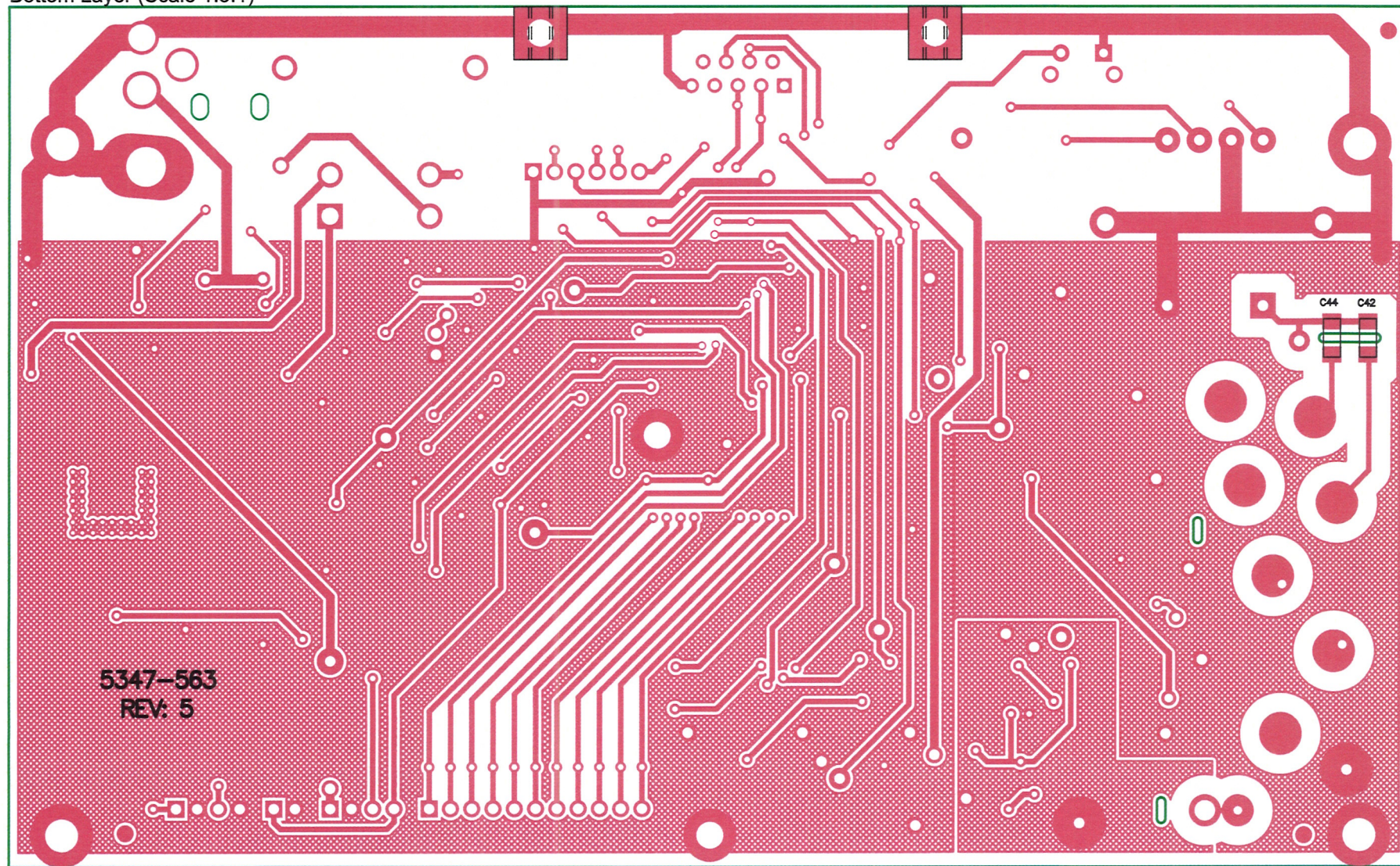
5347-563  
REV: 5

DO NOT BEND RESISTOR OR CAPACITOR  
LEADS GOING INTO ISLAND PAD. LEADS  
GO STRAIGHT INTO ALL ISLAND PADS. BENT LEADS ON R52  
AND R53 SHOULD NOT TOUCH DOWN ON BOARD

LUDLUM MEASUREMENTS			
Part: 5347-563		Model: M 177-84-2	
Desc: MAIN BOARD		Rev: 5	
SHEET: 1 of 5		SERIES	SHEET
DWN: PAB	DATE: 11/17/2022	347	564
APR: RDS	DATE: 17 Nov 22		



Bottom Layer (Scale 1.5:1)



5347-563  
REV: 5

C44 C42



**LUDLUM MEASUREMENTS**

Part: 5347-563

Model: M 177-84-2

Desc: MAIN BOARD

Rev: 5

SHEET: 2 of 5

SERIES SHEET

DWN: PAB

DATE: 11/17/2022

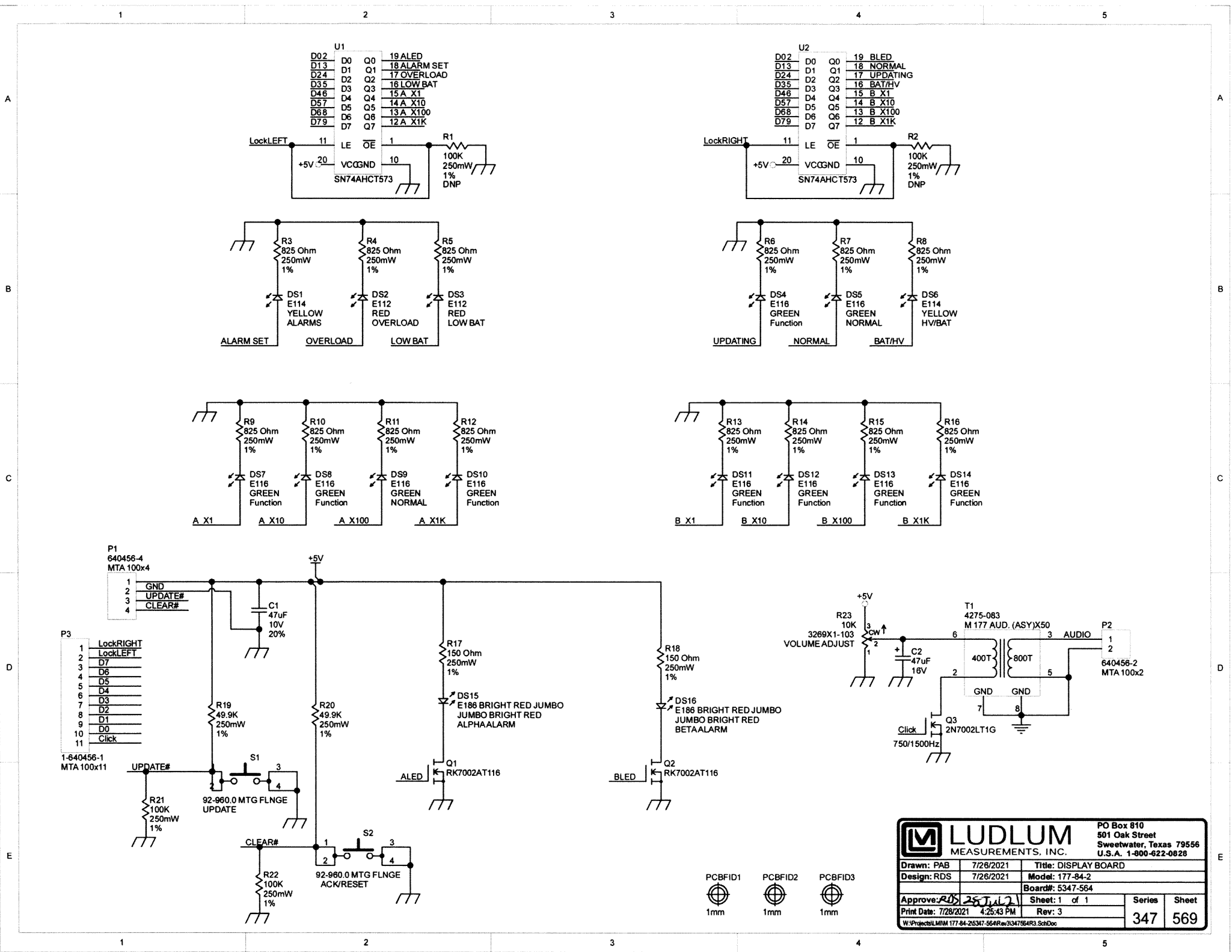
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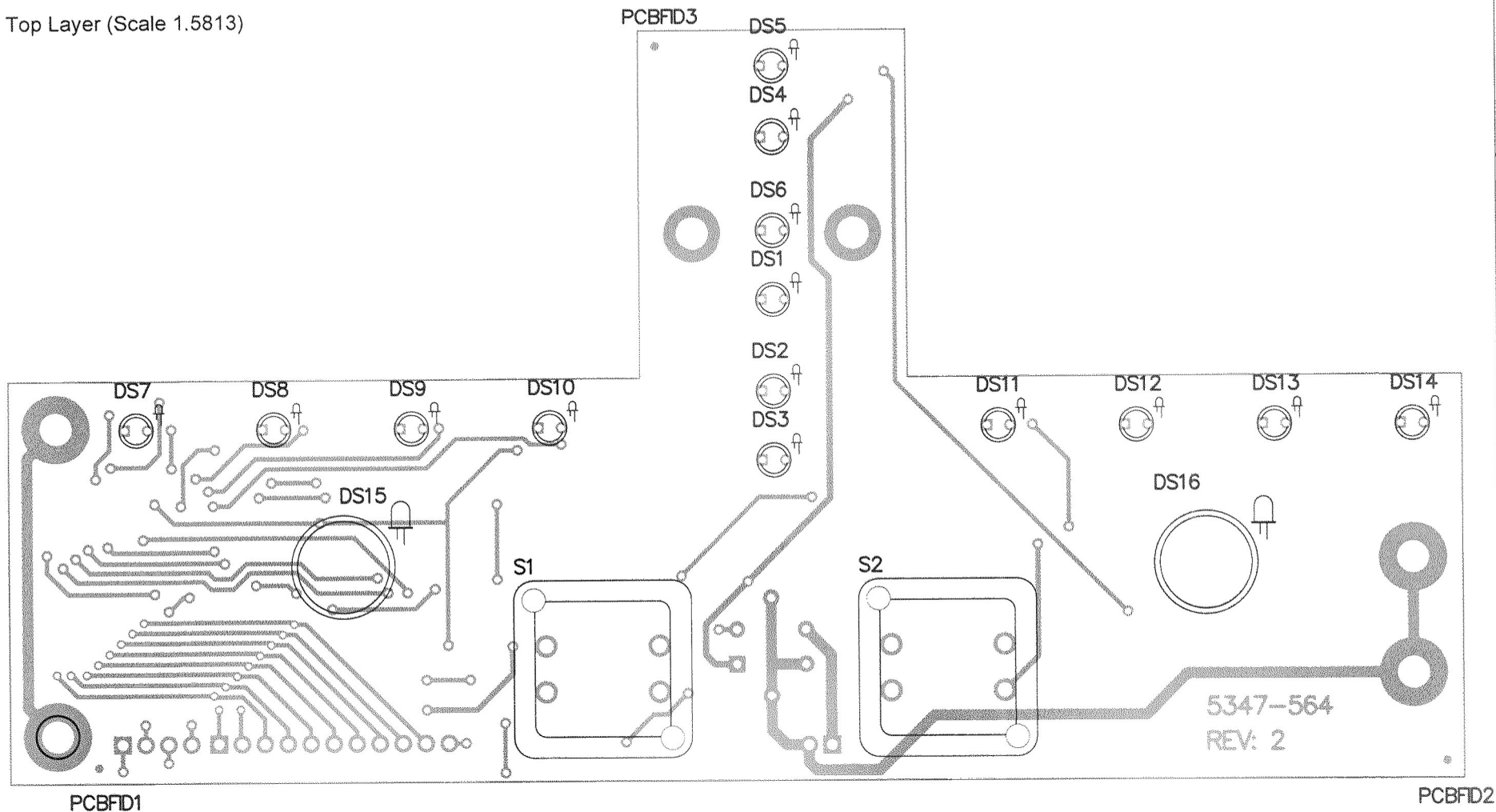
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		PO Box 810 501 Oak Street Sweetwater, Texas 79556 U.S.A. 1-800-622-0828	
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Design: RDS	7/26/2021	Model: 177-84-2	
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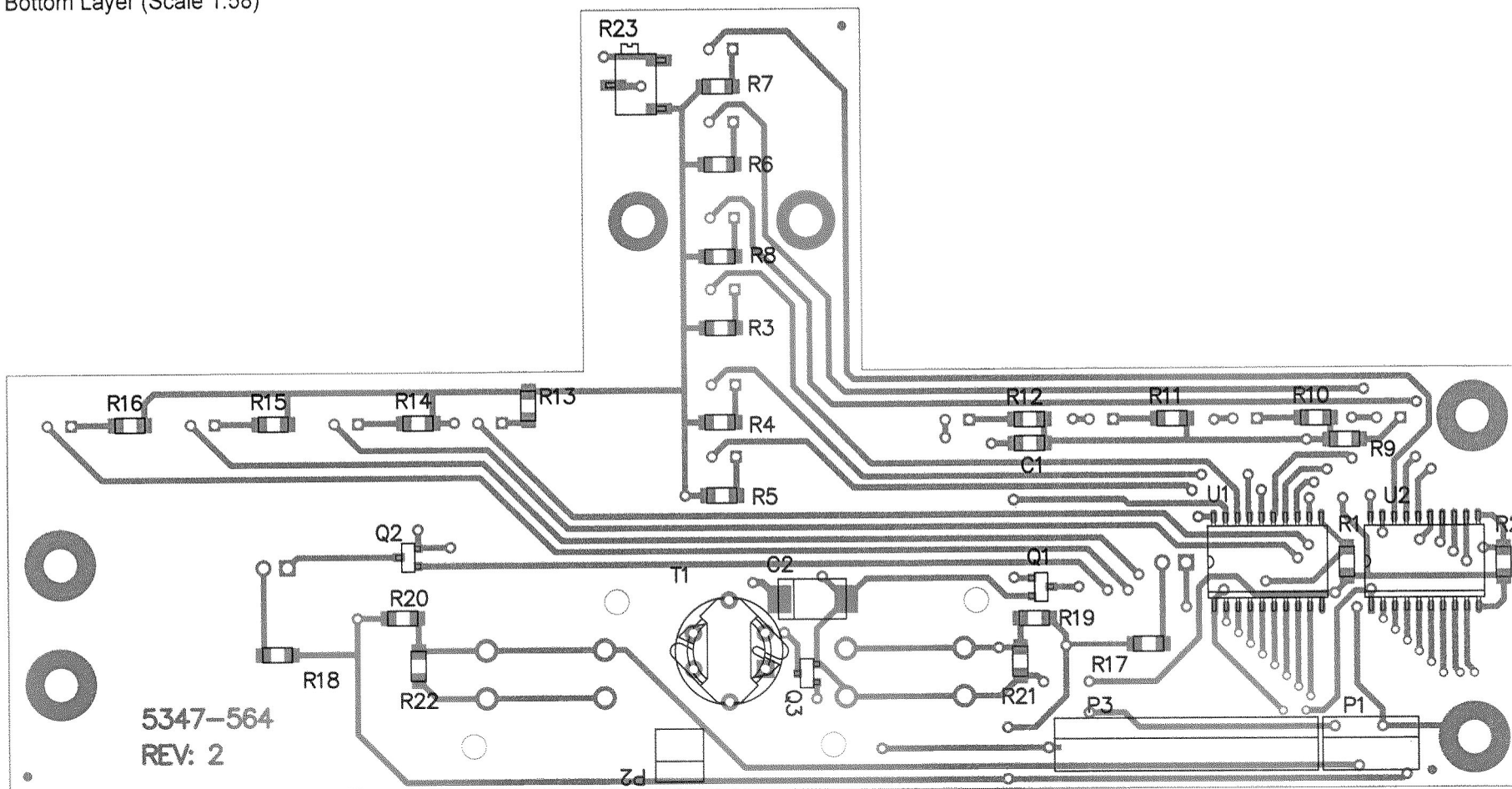
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USE SPACERS(18-9083) ON LEDS ON DS1-DS14

 <b>LUDLUM MEASUREMENTS</b>			
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Desc: DISPLAY BOARD			Rev: 2
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DWN: PAB	DATE: 10/26/2020	347	570
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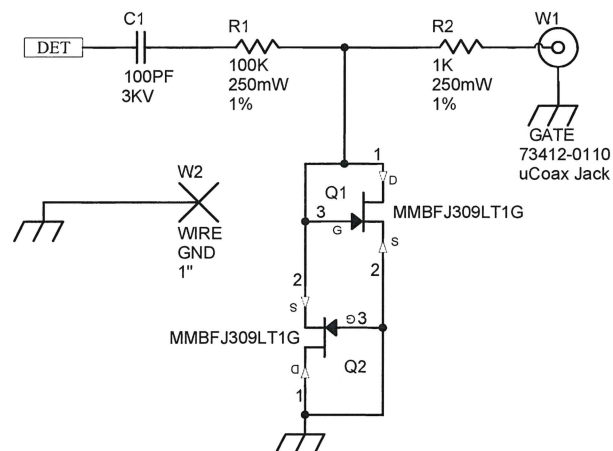
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5347-564  
REV: 2

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Desc: DISPLAY BOARD			Rev: 2
	SHEET: 2 of 3	SERIES	SHEET
DWN: PAB	DATE: 10/26/2020	347 570	
APR: <i>BAT</i>	DATE: <i>11/20/21</i>		





 <b>LUDLUM</b> MEASUREMENTS, INC.		PO Box 810 501 Oak Street Sweetwater, Texas 79556 U.S.A. 1-800-622-0828	
Drawn: PAB	3/6/2025	Title: Protection Board	
Design: RDS	3/6/2025	Model: 177-84-2	
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Top Layer (Scale 6:1)

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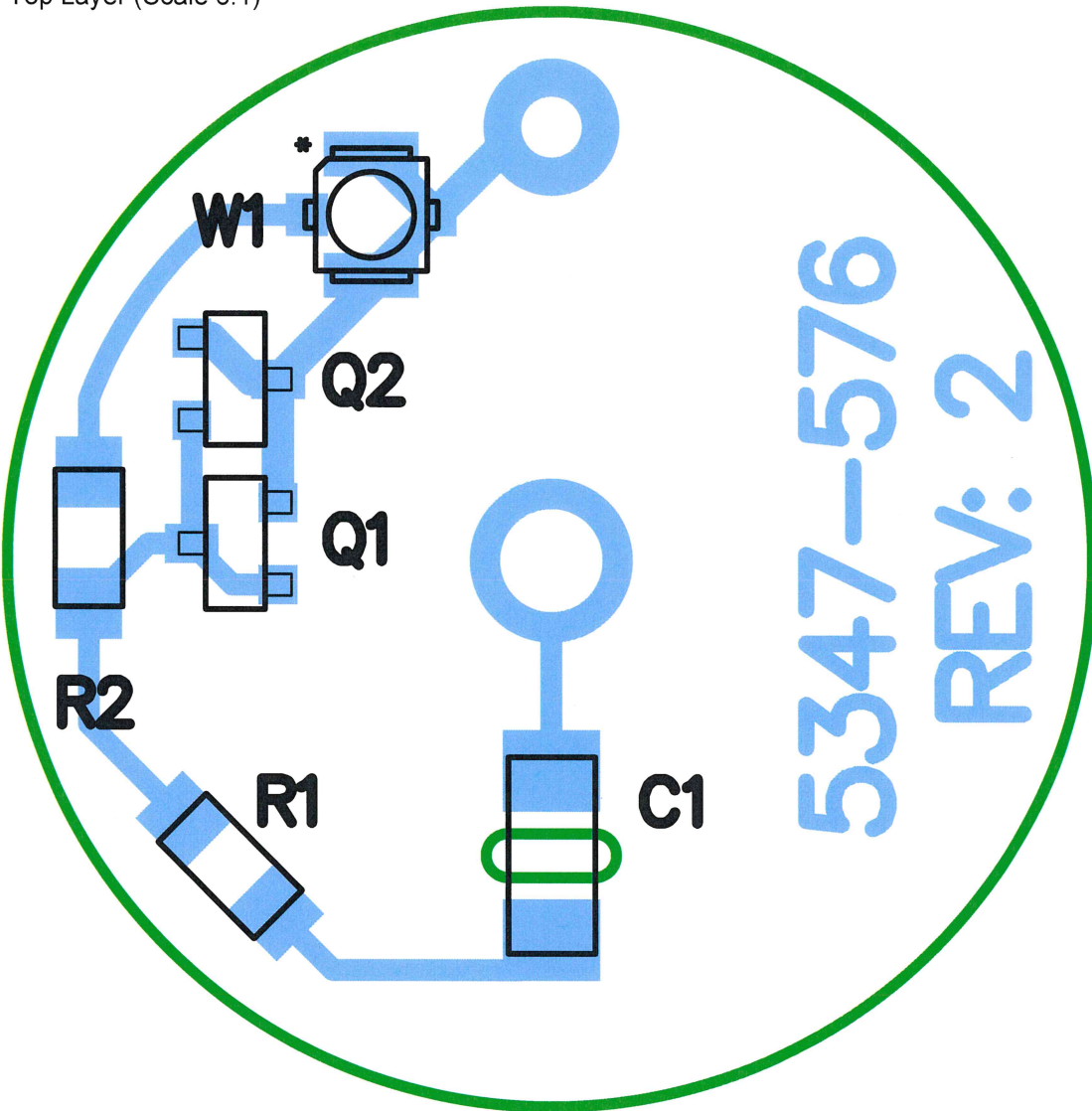
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# LUDLUM MEASUREMENTS

Part: 5347-576

Model: 177-84-2

Desc: Protection Board

Design: RDS Date: 3/6/2025

Rev: 2

Drawn: PAB Date: 3/6/2025

SHEET SERIES SHEET

Apr: RDS Date: 6 Mar 25

1 of 3

347 579

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Bottom Layer (Scale 6:1)

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**LUDLUM MEASUREMENTS**

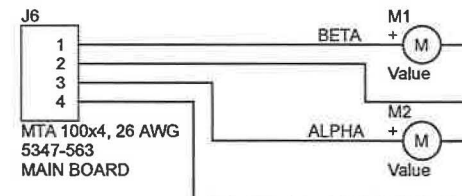
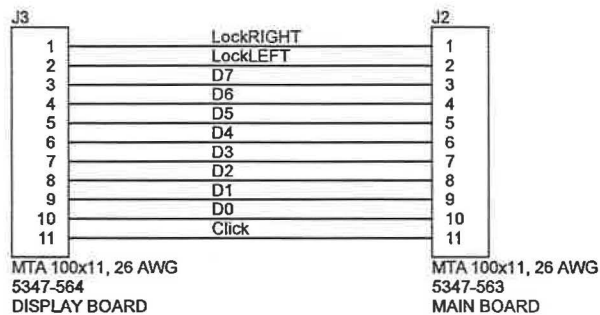
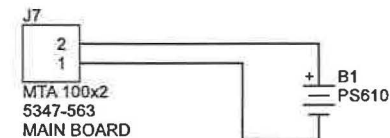
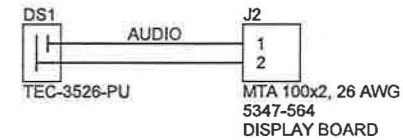
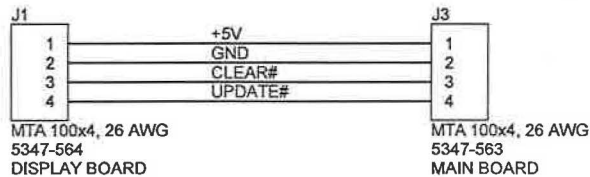
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Desc: Protection Board			
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		2 of 3	
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A

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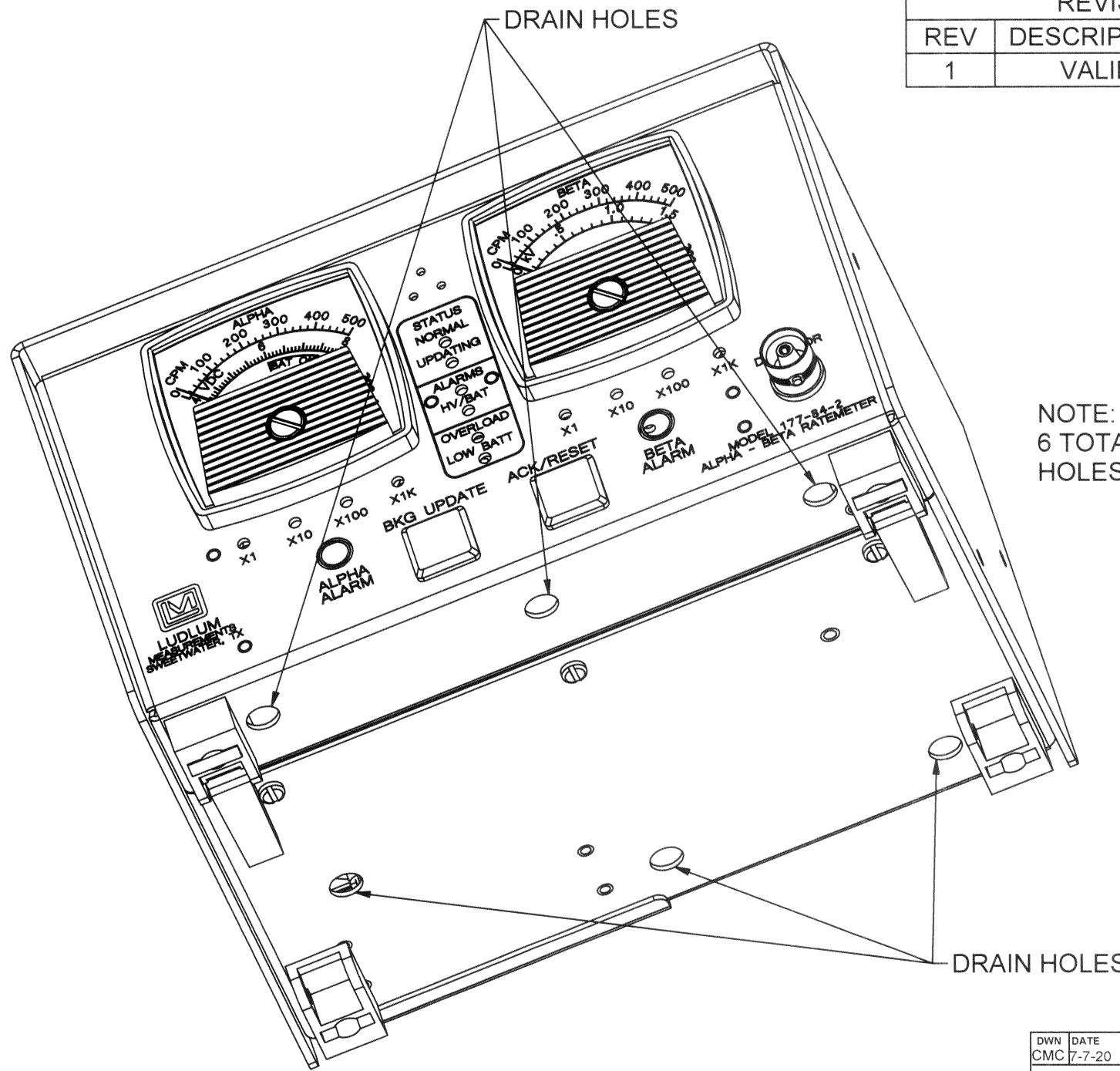
D



 <b>LUDLUM</b> MEASUREMENTS, INC.		PO Box 810 501 Oak Street Sweetwater, Texas 79556 U.S.A. 1-800-622-0828	
Drawn: PAB	4/19/2017	Title: WIRING DIAGRAM	
Design: RDS	4/19/2017	Model: 177-84-2	
		Board#: 5347-575	
Approve: <i>[Signature]</i>	Sheet 1 of 1	Series	Sheet
Print Date: 9/13/2017 1:37:17 PM	Rev: 1	347	575
W:\Projects\LMM 177-84-2\347-575\Rev1\347575R1.SchDoc			

# REVISION HISTORY

REV	DESCRIPTION	DATE	BY
1	VALID	7-7-20	CMC



NOTE:  
6 TOTAL DRAIN  
HOLES AT 0.375" DIAMETER.

DRAIN HOLES

DWN CMC	DATE 7-7-20	CHK	DATE	APP <i>TD Dugard</i>	DATE
DWG NUM: 4347-560				SCALE: 5/8	
TITLE M 177-84-2 DRAIN HOLES					
 LUDLUM MEASUREMENTS, INC. 501 OAK STREET SWEETWATER, TEXAS 79556			SERIES 347		SHEET 560G