LUDLUM MODEL 2360
SCALER/RATEMETER DATA LOGGER

March 2020

Serial Number 342290 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.

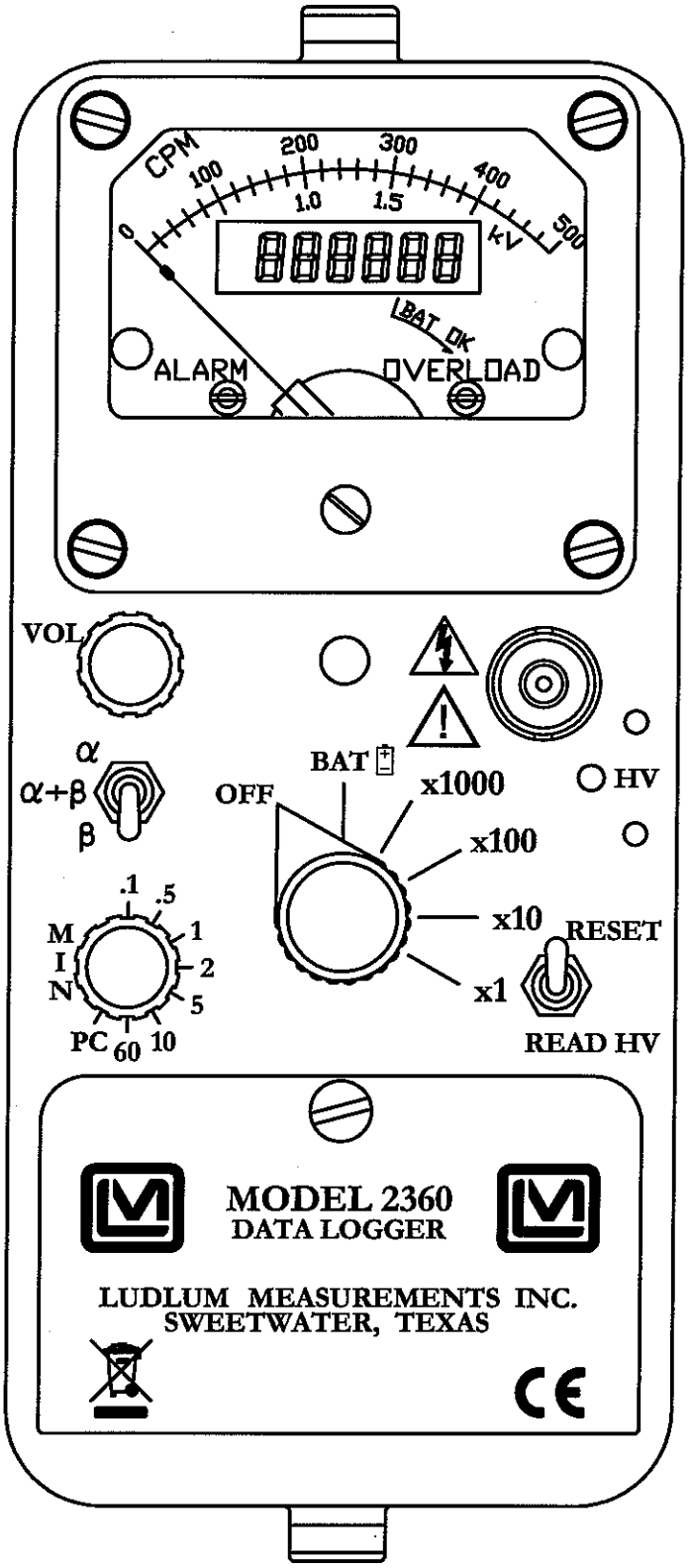
There are no warranties, express or implied, including without limitation any implied warranty of merchantability or fitness, which extend beyond the description of the face there of. If the product does not perform as warranted herein, purchaser's sole remedy shall be repair or replacement, at the option 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

REV #	ALTERATIONS	DATE	BY
1	VALID	8/1/96	RSS
2	UPDATED ARTWORK	5/15/06	CMC



DWN	DATE	CHK	DATE	APP	DATE
CMC	5-15-06			[illegible]	5-15-06
PART NUM: 4390-159			SCALE: FULL ☒ OTHER		
TITLE: M 2360 ALPHA/BETA DATA LOGGER					
LUDLUM MEASUREMENTS, INC. 501 OAK STREET SWEETWATER, TEXAS 79556			SERIES 390	SHEET 157	

Table of Contents

Section 1

Introduction

The Ludlum Model 2360 Scaler/Ratemeter Data Logger is an easy-to-use survey instrument incorporating the best of the analog and digital worlds. Able to measure both alpha and beta radiation levels simultaneously, the Model 2360 presents the data in scaler (digital display) mode or ratemeter (analog meter) mode. The Model 2360 also logs up to 550 data points, consisting of sample number, date/time stamp, sample measurements (both alpha and beta, cpm if ratemeter measurement, or counts per count time if logging scaler count), scaler count time, "S" or "R," identifying whether scaler count or ratemeter was logged, and location identifier (10 characters).

Each alpha-beta data point is logged by simply pressing the button located in the instrument handle. The appropriate scaler or ratemeter measurement is taken, and both alpha and beta readings are logged into non-volatile memory. An internal dipswitch allows for logging of the scaler reading, ratemeter reading, both scaler and ratemeter readings, and NO logging. The location identifier can be input by a PC or other RS-232 device prior to logging a sample.

There are also 6 lines (15 characters each) of header information that can be stored at the beginning of the non-volatile memory. The header lines can contain such information as the user name, survey name, serial numbers, etc. The "CALIBRATION DUE DATE" can also be stored in non-volatile memory, which will disable the instrument when the internal clock date reaches the stored date.

The Model 2360 has a long arc length (6.0 cm {2.4 in.}) meter face that normally reads from 0 to 500 cpm. The main rotary switch allows for multiplication ranges of ×1, ×10, ×100, and ×1000. The Model 2360 has a three-position toggle switch on the front panel to switch between displaying alpha, beta, or alpha + beta levels.

Alpha and beta pulses have different audio tones, so that the user can discriminate between the two. A two-position momentary action switch allows either a meter reset, or displays the detector HV onto the meter. The following six alarms may be set via the RS-232 port:

Alpha Ratemeter (0-999999 cpm)

Beta Ratemeter (0-999999 cpm)

Alpha + Beta Ratemeter (0-999999 cpm)

Alpha Scaler (0-999999)

Beta Scaler (0-999999)

Alpha + Beta Scaler (0-999999)

These alarm points, when exceeded, light the meter face LED, marked ALARM, and activate the audio speaker. The ratemeter alarms are non-latching (will cease when the radiation level drops below the alarm point). The scaler alarm will continue until the RESET is pressed, or the next scaler count is started.

The digital display is a full 6-digit liquid crystal display (LCD) display, which is direct-driven for good viewing and a wide temperature response from -4 to 60 °C (40 to 140 °F). The digital display displays the scaler count, and prior to each sample logging, displays the current sample number. The display also has an arrow symbol for counting overflow and two colons that indicate that a scaler count is in progress.

The Model 2360 communicates through an RS-232 port located on the instrument can. The computer interface software is supplied on CD and includes the following functions:

downloading of header and logged data into an ASCII file

setting and reading of instrument parameters/header information

setting of the ″CALIBRATION DUE DATE″

setting of the internal real-time clock/calendar

setting of the user-definable scaler time

setting of location code and alarm points

clearing of logged memory

Section 2

Getting Started

Unpacking and Repacking

Remove the calibration certificate and place it in a secure location. Remove the instrument and accessories (batteries, cable, etc.) and ensure that all of the items listed on the packing list are in the carton. Check individual item serial numbers and ensure calibration certificates match. The Model 2360 serial number is located on the front panel below the battery compartment. Most Ludlum Measurements, Inc. detectors have a label on the base or body of the detector for model and serial number identification.

Important!

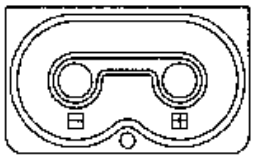
If multiple shipments are received, ensure that the detectors and instruments are not interchanged. Each instrument is calibrated to specific detectors, and is therefore not interchangeable.

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

Every returned instrument must be accompanied by an **Instrument Return Form**, which can be downloaded from the Ludlum website at www.ludlums.com. Find the form by clicking the "Support" tab and selecting "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.

Battery Installation

Ensure the Model 2360 range selector switch is in the "OFF" position. Open the battery lid by pushing down and turning the quarter-turn thumbscrew



counterclockwise a quarter of a turn. Install two ″D″ size batteries in the compartment.

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

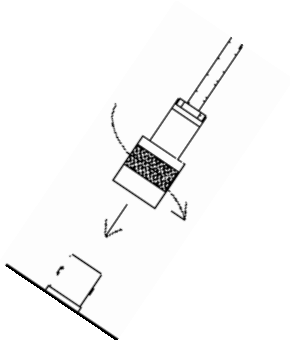
Note:

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

Connecting a Detector to the Instrument

Caution!

The detector operating voltage (HV) is supplied to the detector via the detector input connector. A mild electric shock may occur if you make contact with the center pin of the input connector. Switch the Model 2360 to the ″OFF″ position before connecting or disconnecting the cable or detector.



Connect one end of a detector cable to the detector by firmly pushing the connectors together while twisting clockwise ¼ turn. Repeat the process in the same manner with the other end of the cable and the instrument.

Internal Switches

Release the can latches and remove the cover from the 2360, taking care not to damage the speaker wires. Using a ball-point pen, set the switches for the desired AUDIO division and TONE described on Page 4-3. Replace the cover and fasten the latches.

Battery Test

The batteries should be checked each time the instrument is turned on. Move the range selector switch to the BAT position. Ensure that the meter needle deflects to the battery check portion on the meter scale. If the meter does not respond, check to see if the batteries have been correctly installed. Replace the batteries if necessary.

Turn the range selector switch from the off position to the ×1000 position and verify that the meter needle is driven full-scale for approximately two seconds and then returns to zero. Also ensure both alarm LEDs on the front panel turn on briefly. The LCD should go through an initialization sequence displaying ″88:8.8:8.8,″ then the current sample number, and finally "0."

Operating the Instrument

Connect a detector to the instrument if you have not already done so. Obtain a meter reading from a check source or calibrated source, if available. Verify that the reading falls within the expected range. Remove the source.

If a radiation source is available, increase the meter count to exceed the alarm threshold. Both the appropriate alarm lamp and audio alarm signal should activate.

Depress the RESET toggle switch. The meter needle should drive to zero and the alarm circuit should de-energize, shutting off both visual and audible alarms.

Proceed with use.

Principle of Operation

The Model 2360 is to be used in combination with an alpha/beta scintillation or proportional detector. The pulse height differential between the alpha and beta pulses from the scintillation or proportional detector is discriminated by the Model 2360.

The detected alpha count is displayed by selecting the "α" position on the three-position "α/α+β/β" toggle switch. Likewise, the sum of the alpha and beta counts or the beta counts only are displayed by selecting the appropriate "α + β" or "β" position. Multiply the cpm reading on the analog ratemeter by the range multiplier position. When using the LCD and preset count time interval, the counts are accumulated in each of the three channels during the count cycle. The count cycle is started by depressing the push-button located in the end of the carrying handle. If a scaler or ratemeter alarm is activated, the ALARM LED will light and the audio will sound a steady tone.

The RESET toggle switch position resets the meter pointer to zero and deactivates any current alarm. The detector operating voltage is displayed on

the meter dial by selecting the READ HV position. The high-voltage scale ranges from 0 to 2 kV. The OL (overload) lamp, located in the lower, right corner of the meter dial, indicates that the detector is saturated either by a puncture in the detector face or an exposure to a radiation field above the counting capability of the instrument. The analog meter deflects full scale when the OL lamp is illuminated.

Section 3

Specifications

Compatible Detectors: proportional and dual phosphor scintillation detectors; common Models: 43-1-1, 43-2-2, 43-20, 43-68, 43-89 and 43-93

Data Logger: capable of logging up to 550 individual data points into non-volatile memory with the following identifiers for each point:

alpha and beta sample counts
sample number
date/time stamp
scaler count time
10-character location identifier

Range: four linear range multiples of ×1, ×10, ×100, and ×1000; used in combination with the 0-500 CPM meter dial providing an overall range of 0-500 kcpm

Thresholds: internal control allows for adjustment from -2 to -15 mV for beta and -40 to -700 mV for alpha

Window: internal control allows for adjustment from the beta threshold up to the alpha threshold setting (beta only)

Audio: built-in unimorph speaker with volume control (greater than 60 dB at 0.61 m {2 ft}, full volume); headset jack located on the instrument can

Audio Divide: selectable dual or individual click-per-event for alpha and beta counts with divisions of 1, 10, 100, or 1000 events per click (beta only)

Alarm points: six separate alarm points, set through the RS-232 port, activating the alarm audio tone and lighting the ALARM LED. The six alarm points can be set from 0 to 99999. Ratemeter alarms are non-latching, while scaler alarms are not. (A latched alarm requires the RESET button be pressed in order for the alarm to clear) The six alarms are:

Alpha Ratemeter
Beta Ratemeter
Alpha + Beta Ratemeter
Alpha Scaler
Beta Scaler
Alpha + Beta Scaler

High Voltage: recessed front-panel potentiometer; adjustable from 200 to 2000 Vdc

Linearity: within 10% of true value for the analog CPM meter; within 2% for the LCD

Response Time: ×1 = 7 seconds, ×10 = 2 seconds, ×100 = 2 seconds, x1000 = 2 seconds; all response times measured from 10-90% of full scale

Analog Meter: rugged 1 milliamp (mA), with pivot-and-jewel suspension and 6.0 cm (2.4 in.) arc length

Connector: series ″C″ standard, others available

Temperature Range: -20 to 50 °C (-4 to 122 °F); may be certified for operation from -40 to 65 °C (-40 to 150 °F)

Maximum Relative Humidity: less than 95% (non-condensing)

Power: two standard ″D″ size batteries housed in an externally accessible sealed compartment

Battery Life: typically 250 hours of operation with a fresh set of alkaline ″D″ cell batteries

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

Weight: 1.6 kg (3.5 lb), including batteries

Finish: drawn-and-cast aluminum, with beige powder coating

Section 4

Description of Controls and Functions

Operator Controls

OFF/BAT/X1000/X100/X10/X1 Switch (or Range Selector Switch): a six-position rotary switch to select the analog meter range multipliers and check the battery status. When switched to the ″BAT″ position, the meter pointer should deflect above the left vertical mark on the ″BAT OK″ line. Moving the range selector switch to one of the range multiplier positions (×01, ×10, ×100, ×1000) provides the operator with an overall range of 0-500 kcpm. Multiply the scale reading by the multiplier to determine the actual reading.

During initial instrument turn-on, the meter will be driven full scale for about two seconds and then return to zero. The LCD will show ″88:8.8:8.8,″ display the current sample number, and then "0." If the count button is pressed while the display is showing all 8s then the following numbers are shown: firmware number, date, time, PC defined scaler time, alpha ratemeter alarm, alpha + beta rate meter alarm, alpha scaler alarm, alpha + beta scaler alarm, current sample number, and then "0."

Liquid Crystal Display (LCD): six-digit display that shows the scaler count for the selected channel or the sum of both. It also indicates when a count is in progress by displaying two colons; the colons are turned off when the count is complete. Is the counter exceeds 999999, an arrow in the upper-left corner of the display turns on in order to indicate an overflow; the counter then rolls over to zero and continues counting.

VOL: Turning this control clockwise will increase the speaker volume, and counterclockwise will decrease the volume.

Note:

The volume should be turned down, when not required, to reduce battery drain.

α/α+β/β Switch: A three-position toggle switch used to select the sum of alpha and beta count channels (α+B), alpha count only (α), or beta count only (B), for display. This switch affects both the analog meter and digital display. The rate meter channels are active regardless of the switch position and will continue to function when the channel is not selected for display. This ability allows the operator to view each channel separately or together by simply selecting the appropriate switch position.

Headphone Jack: 0.32 cm (0.13 in. or one-eighth inch) phone jack on instrument can for the connection of external headphones. Inserting a phone plug into the jack disconnects the external unimorph speaker from the audio circuitry. Use 0.32 cm (0.13 in. or one-eighth inch) mating plug-LMI part # 21-9653.

RS-232 Port: located on the instrument can and allows for connection of the instrument to a PC for dumping data and setting up parameters

RESET/HV: a dual-position momentary toggle switch which provides readout of the detector high voltage when the HV position is selected. When the RESET position is selected, this switch provides a rapid means of driving the analog ratemeter to zero and resetting the meter after an alarm condition. Use the 0-2 kV meter scale for high-voltage readings.

MIN 0.1, 0.5, 1, 2, 5, 10, 60, PC Count Time Select Switch: an eight-position rotary switch used to select scaler count times in minutes. When set to PC, the scaler will use the user-defined count time. The count cycle is initiated by depressing the push-button switch in the carrying handle.

Log Push-button (located in the carrying handle): When depressed, the current sample number is displayed, the counter is reset to zero, and the timer is started. If selected, the instrument will also log the current reading. The colons on the display turn on and stay on until the count has expired.

Remove the front panel calibration cover to access the following calibration potentiometer:

HV: a multi-turn potentiometer used to adjust the detector high voltage from 200 to 2000 Vdc

Internal Controls

Remove the instrument cover (can) to access the following dipswitches on SW1.

RECYCLE: A one-pole DIP switch (#1) used to select recycle scaler mode. When placed in the ON position, the instrument will start a count cycle. If the instrument is set to log the sample, it will be saved and a new count will start again. The ratio is selected from the following table:

SWITCH 1	RECYCLE MODE
ON	ON
OFF	OFF

TONE: a one-pole DIP switch (#2) used to select tone discrimination between alpha and beta count channels. When in the DUAL mode, alpha and beta pulse tones will be audible in all selector switch positions (i.e. if in the β-only position and beta radiation is detected, the beta tones will be heard in addition to the alpha tones).

When the SNGL tone position is selected, both alpha and beta pulse tones can be heard in the "α+β" selection, but alpha pulses are the only audible tones in the α-channel selection, and beta pulse tones are the only audible tones in the β-channel selection.

SWITCH 2	TONE MODE
ON	DUAL
OFF	SINGLE

AUDIO Divide: A two-pole DIP switch (#3 & #4) used to select audio divisions of 1, 10, 100, and the beta audio subtract mode.

Note:

The AUDIO divide function only affects the lower-frequency beta tones. The higher-frequency alpha click-per-event will be unaffected by the divide-by selection.

The ratio is selected from the following table:

SWITCH 3	SWITCH 4	DIVIDE BY RATIO
ON	ON	1
ON	OFF	10
OFF	ON	100
OFF	OFF	Beta audio Subtract Mode

LOG SAMPLE: A two-pole DIP switch (#5 & #6) used to select logging mode. When both switches are OFF, the instrument will not log samples but will output the ratemeter readings to the RS-232 port every two seconds in ASCII format. When set to log both scaler and ratemeter, two samples are actually saved. The logging mode is selected from the following table.

SWITCH 5	SWITCH 6	LOGGING MODE
ON	ON	Log ratemeter and scaler
ON	OFF	Log ratemeter
OFF	ON	Log scaler
OFF	OFF	No sample saved. Output ratemeter every 2 seconds.

The following controls are utilized during calibration only and should only be altered by a qualified calibration technician.

MTR: a multi-turn potentiometer used to calibrate the meter to the CPM reading

AT: a multi-turn potentiometer used to vary the alpha pulse discriminator from 40 to 700 millivolts (mV)

BW: a multi-turn potentiometer used to vary the upper beta pulse discriminator from BT setting to AT setting

BT: a multi-turn potentiometer used to vary the lower beta pulse discriminator from 2 to 15 mV

OL: a multi-turn potentiometer thatprovides a means to vary the detector current overload set point

LIM: a multi-turn potentiometer used to set the maximum HV limit to 2000 Vdc

HV: a multi-turn potentiometer used to adjust the high-voltage test reading (0 to 2 kV scale) to correspond with the actual high-voltage output. The HV switch must be depressed during adjustment.

LB: a multi-turn potentiometer used to adjust the minimum battery voltage level (2.2 Vdc), corresponding to the low-battery indication on the meter dial. The BAT switch position must be selected during adjustment.

Section

5

Safety Considerations

Environmental Conditions for Normal Use

Indoor or outdoor use

No maximum altitude

Temperature range of -20 to 50 °C (-4 to 122 °F); may be certified for operation from -40 to 65°C (-40 to 150 °F)

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

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

Cleaning Instructions and Precautions

The Model 2360 Scaler/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 range selector switch to the OFF position.
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.

The Model 2360 Scaler/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 battery lid. See section 10, "Recycling," for further information.

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

Section 6

Calibration and Maintenance

Calibration

Note:

Local procedures may supersede the following.

ESTABLISHING AN OPERATING POINT

The detector operating parameters are established by adjusting the detector operating voltage (HV), alpha threshold, and beta window to find an optimum efficiency for the alpha/beta scintillator or proportional detector.

The threshold and window parameters can be adjusted to optimize alpha/beta count discrimination, count efficiency, and minimize "cross talk" between channels. Refer to the specific detector operation manual or calibration certificate for the suggested threshold and window settings. Once the thresholds and window settings are established, an operating voltage-versus-count rate plot should be performed for both alpha and beta count channels with alpha and beta particle emission sources.

The following procedure is an example of determining the operating voltage for an alpha/beta scintillation or proportional detector:

- Connect a Ludlum Model 500 Pulser or equivalent to the Model 2360.
- Switch the 2360 to the β position. Adjust the beta threshold (BT) for 3.5 mV and the window (BW) for 30 mV. The pulser counts should be detected on the 2360 ratemeter above 3.5 ± 1 mV and should shut off above 30 mV.
- Switch the channel selector switch to the α position. Adjust the pulser for 120 mV pulse output and vary the AT control until counts are detected on the ratemeter.

- Depress the HV switch and adjust the HV potentiometer for 0.4 to 0.5 kV on the 0-2.0 kV scale. Connect the scintillator and switch to the β only position. Place an alpha source on the detector face.

- Slowly increase the HV potentiometer to observe an increase, then decrease, and increase again in count as the HV is increased. Decrease the HV until the ratemeter is in the "dip" of the observed count rate-versus-HV plot just performed. Depress the HV switch and note the HV setting.

- Plot a HV versus count rate plateau in 25 V increments, 50 V each side of the HV reading found in the above step (i.e., HV setting for count "dip" in the above step = 675 V, start the plot at 625 V and increase in 25 V steps until 725 V is reached). Plot alpha source, beta source, and background counts for both α and β channel positions.

- Find the optimum operating voltage from the plot, which gives the greatest alpha and beta source efficiency while maintaining no greater than the maximum acceptable level of cross talk between channels.

- Select the desired count channel display, and proceed to use instrument.

METER CALIBRATION

A Ludlum Model 500 Pulser or equivalent is required. If the pulser does not have high-voltage readout, use a high-impedance voltmeter with at least 1000 megohm input resistance to measure the detector voltage.

Ensure that the meter movement has proper mechanical zero. The adjustment is on the front of the meter bezel. It must be adjusted to ″0″ with the ON/OFF selector switch in the OFF position.

Connect the Model 500 Pulser to the Model 2360 with the appropriate cable. Rotate the Model 2360 range multiplier switch to the ×100 position. Select the α+β channel position.

Adjust the Pulser for 40,000 cpm and adjust the pulse amplitude to at least twice the beta threshold level (i.e.; beta threshold = 3.5 mV, adjust the pulser to 7-10 mV).

Remove the instrument cover and adjust the MTR potentiometer until the meter reads 400 cpm. Adjust the pulser to 10,000 cpm and ensure ratemeter reads 100 ± 10%. Decade the pulser and Model 2360 range multiplier switch

to check meter linearity on the ×1000, ×10, and ×1 positions. Linearity should be within 10% of each reading.

Set the LCD count time for one minute. Adjust the pulser count rate to 40 kcpm. Depress the count button, and when the count cycle is complete, confirm that LCD reads within 2% of the incoming count rate.

Adjust the BT, BW, and AT controls for the appropriate set points as described in the following subsection.

Connect a high-impedance, high-voltage meter (may use the Model 500 Pulser if equipped with an HV meter) to the detector input connector and adjust the HV control for a reading of 1000 Vdc on the voltmeter.

Depress the RES/HV switch to the HV position and adjust the HV potentiometer located on the circuit board for a reading of 1.0 kV on the meter dial. Adjust the HV output from 500 to 1500 Vdc and confirm that the 2360 HV meter corresponds to the external voltmeter within 10% of each reading.

Rotate the range multiplier switch to the OFF position. Remove the batteries from the battery compartment and connect a DC power supply to the two screw terminals located at the rear of the battery compartment. The positive power supply lead should connect to the terminal with the red wire, and the negative lead to the terminal with the black wire.

Adjust the power supply for 2.2 Vdc and switch the 2360 to the BAT position. Adjust the LB potentiometer to align the meter needle with the low-battery mark on the meter dial (vertical line to the left of BAT OK).

Replace the instrument can and proceed with use.

DETECTOR OVERLOAD CALIBRATION

Note:

The detector operating voltage (HV) must be determined and set before the OL (overload) adjustment is performed. If the detector operating voltage is re-adjusted, the overload adjustment must be re-adjusted.

Adjust the OL control to the maximum counterclockwise position.

Note:

Detector saturation is when the meter response no longer increases with increasing radiation field intensity.

For alpha/beta scintillators, expose the detector photomultiplier tube (PMT) to a small light leak by loosening the detector window. Some scintillation detectors incorporate a screw in the detector body, which when removed, will simulate a detector face puncture or light leak. The meter should start to decrease toward zero as light saturates the scintillation material.

Expose just enough light to where the meter starts to decrease. Adjust the OL control until the overload LED just begins to flicker on the meter dial. The ratemeter should deflect above full-meter scale at this point.

Re-seal the detector window and expose the detector to a radiation source that will drive the meter near full scale. Confirm that the LED does not turn on and the meter remains on scale.

Maintenance

Instrument maintenance consists of keeping the instrument clean and periodically checking the batteries and the calibration. The Model 2360 instrument may be cleaned with a damp cloth (using only water as the wetting agent). Do not immerse instrument in any liquid. Observe the following precautions when cleaning:

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

RECALIBRATION

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

Note:

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

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

BATTERIES

The batteries should be removed any time the instrument is placed into storage. Battery leakage may cause corrosion on the battery contacts, which must be scraped off and/or washed using a paste solution made from baking soda and water. Use a spanner wrench to unscrew the battery contact insulators, exposing the internal contacts and battery springs. Removal of the handle will facilitate access to these contacts.

Note:

Never store the instrument over 30 days without removing the batteries. Although this instrument will operate at very high ambient temperatures, battery seal failure may occur at temperatures as low as 37 °C (100 °F).

Section 7

RS-232 Interface

Communicating with the Model 2360

The Model 2360 has an RS-232 serial port that can be connected to a PC or other RS-232 device. The proper communication settings are (2400,8,N,1):

2400 Baud
8 data bits
No parity
1 stop bit

Commands

The following table shows all the commands used to communicate with the Model 2360. All commands must be in uppercase letters. The data can be in either uppercase or lowercase. All set commands should return ″OK″ + a carriage return and line feed.

READ COMMANDS

RA	Read sample number
RC	Read calendar date
RD	Read date
RHx	Read header
RL	Read current location
RP	Read user (PC) time
RR	Read α / β ratemeter
RS	Read samples
R1	Read α ratemeter alarm
R2	Read β ratemeter alarm
R3	Read α+β ratemeter alarm
R4	Read α scaler alarm
R5	Read β scaler alarm
R6	Read α+β scaler alarm

SET COMMANDS

SCmmddyyyy	Set calibration date
SDmmddyyyy	Set current date
SHxyyyyyyyyyyyyyy	Set Header
SLxxxxxxxxxx	Set current location
SMx	Sets ratemeter dumping
SPxxx.x	Set user (PC) time
SR	Send reset samples
SThhmm	Set current time
S1xxxxxx	Set α ratemeter alarm
S2xxxxxx	Set β ratemeter alarm
S3xxxxxx	Set α+β ratemeter alarm
S4xxxxxx	Set α scaler alarm
S5xxxxxx	Set β scaler alarm
S6xxxxxx	Set α+β scaler alarm

COMMAND DESCRIPTIONS

RA

This command reads the current sample number. The output is six characters, including a [CR] and [LF]. The format is:

```
0001[CR][LF]
```

RC

This command reads the calibration date. During power-up, the Model 2360 checks the current date against this date. If the current date is past the calibration date, the message "OUTCAL" is displayed and the Model 2360 is disabled until the calibration date is changed ahead of the current date. The output is 10 characters including a [CR] and [LF]. The format is:

```
MMDDYYYY
12251996[CR][LF]
```

RD

This command reads the current date and time. The output is 21 characters including a [CR] and [LF]. The format is :

```
HH:MM:SS MM/DD/YYYY
16:16:29 11/20/1996[CR][LF]
```

RHx
This command reads the specified header where "x" equals a number 1-6. The output is 17 characters, including a carriage return [CR] & line-feed [LF].

```
[15 characters]
John Smith [5 SPACES][CR][LF]
```

RL
This command reads the current location. The output is 12 characters, including a [CR] and [LF]. The format is:

```
TABLE0001[SPACE][CR][LF]
```

RP
This command reads the user-defined "PC" count time. This is the scaler count time when the Model 2360 count time switch is on the "PC" position. The output is 7 characters, including a [CR] and [LF]. The format is:

```
012.5[CR][LF]
```

RR
This command reads the current alpha and beta ratemeter reading. When dip-switch 5 and 6 are set to **OFF,** the Model 2360 sends this message every 2 seconds. The alpha Ratemeter reading is first, followed by the beta ratemeter reading. The output is 15 characters, including a [CR] and [LF]. The format is:

```
Alpha   Beta
000003 002305[CR][LF]
```

RS
This command will return all logged samples from memory. A "$" signifies the end of samples. The maximum number of samples stored is 550. The format is:

```
0001 11/18/96 14:50:05 000020 000450 R 001.0 CHKSRC
0002 11/18/96 14:50:07 000015 000390 S 001.0 TABLE0001
0003 11/18/96 16:49:49 000040 001400 R 000.1 TABLE0002
$
```

R1, R2, R3, R4, R5, R6
These commands read the alarm set points.

R1 = Alpha Ratemeter.
R2 = Beta Ratemeter.
R3 = Alpha + Beta Ratemeter.
R4 = Alpha Scaler.
R5 = Beta Scaler.
R6 = Alpha + Beta Scaler.

The output is eight characters, including a [CR] and [LF]. The format is:

```
000500[CR][LF]
```

SCmmddyyyy
This command sets the calibration due date. The date is entered in Month-Day-Year (MMDDYYYY) format. During power-up, the Model 2360 checks to see if the current date is past the calibration due date. If it is, then the Model 2360 displays "OUTCAL" and is disabled until this command is issued to set the calibration date ahead of the current date. The length of the command is 12 characters, including a [CR] and [LF]. The format is:

```
SC11201997[CR][LF]
```

Sdmmddyyyyz
This command sets the current date. The date is entered in Month-Day-Year format. The PCF8593 clock/calendar chip uses a counter from 0 to 3 to represent the year. The variable "z" must correspond to the following table. The length of the command is 13 characters, including a [CR] and [LF].

Year ending in	Year Code
04	0
05	1
06	2
07	3
08	0
09	1
10	2
11	3

For example, the command to set the date to March 20, 2006 is:

```
SD032020062[CR][LF]
```

SHxyyyyyyyyyyyyyy
This command sets the specified header. The variable "x" can be any number between 1 and 6. The variable "y" must be 15 characters. If the value is less than 15 characters, it must be padded with spaces. The length of the command is 20 characters, including a [CR] and [LF]. The format is:

```
SH1JOHN SMITH[5 SPACES][CR][LF]
```

SLxxxxxxxxxx
This command sets the current location that will be saved with any subsequent logged samples. The location can be up to 10 characters in length and must be padded with spaces if less than 10 characters. The length of the command is 14 characters, including a [CR] and [LF]. The format is:

```
SLTABLE0007[SPACE][CR][LF]
```

SMx
This command disables or enables the automatic dumping of the ratemeter when the Model 2360 is set not to log samples (dip-switch 5 and 6 both OFF). Specifying SM0 will disable the ratemeter dumping until the unit is turned off or the command SM1 is issued.

SPxxx.x

This command sets the user-defined count time that is selectable by setting the count time switch on the Model 2360 to "PC". The count time can be set from 000.1 minutes (6 seconds) to 546.1 minutes (32766 seconds). The length of the command is nine characters, including a [CR] and [LF]. The format is:

```
SP001.0[CR][LF]
```

SR
This command resets the sample number to one and clears all samples stored in memory. Use this command with caution. The length of the command is four characters, including a [CR] and [LF]. The format is:

WARNING!

This command will erase all logged samples from memory.

```
SR[CR][LF]
```

SThhmm
This command sets the current time in 24-hour format. Twenty-four-hour time is as follows:

12:00 AM	0000	12:00 PM	1200
01:00 AM	0100	01:00 PM	1300
02:00 AM	0200	02:00 PM	1400
03:00 AM	0300	03:00 PM	1500
04:00 AM	0400	04:00 PM	1600
05:00 AM	0500	05:00 PM	1700
06:00 AM	0600	06:00 PM	1800
07:00 AM	0700	07:00 PM	1900
08:00 AM	0800	08:00 PM	2000
09:00 AM	0900	09:00 PM	2100
10:00 AM	1000	10:00 PM	2200
11:00 AM	1100	11:00 PM	2300

The length of the command is eight, characters including a [CR] and [LF]. For example, the command to set the time to 1:00 pm is:

ST1300[CR][LF]

S1, S2, S3, S4, S5, S6
These commands set the alarms for the alpha, beta, and alpha + beta ratemeter and also the alpha, beta, and alpha + beta scaler. If the alarm is set to 0, then the alarm is disabled. S1 = Alpha Ratemeter.

S2 = Beta Ratemeter.
S3 = Alpha + Beta Ratemeter.
S4 = Alpha Scaler.
S5 = Beta Scaler.
S6 = Alpha + Beta Scaler.

The length of the command is 10 characters, including a [CR] and [LF]. For example, to set the alpha ratemeter alarm to 500 the command is:

S1000500[CR][LF]

Model 2360 Interface Software

The Model 2360 Interface (LMI Part #:1370-039) is Windows-based and has a user-friendly interface, which allows the user to communicate with the Model 2360. The Model 2360 interface features automatically loading default values, and a Auto Dump Mode Display. When the program is

started, the user is prompted to either allow the software to find the Model 2360 or to manually specify a serial port. Once connected, the software will download all data from the Model 2360, which includes headers and logged data. The user is able to change any information and update the Model 2360, print hard copies, or save data to an ASCII file for later import into word processors, spreadsheets, or other applications.

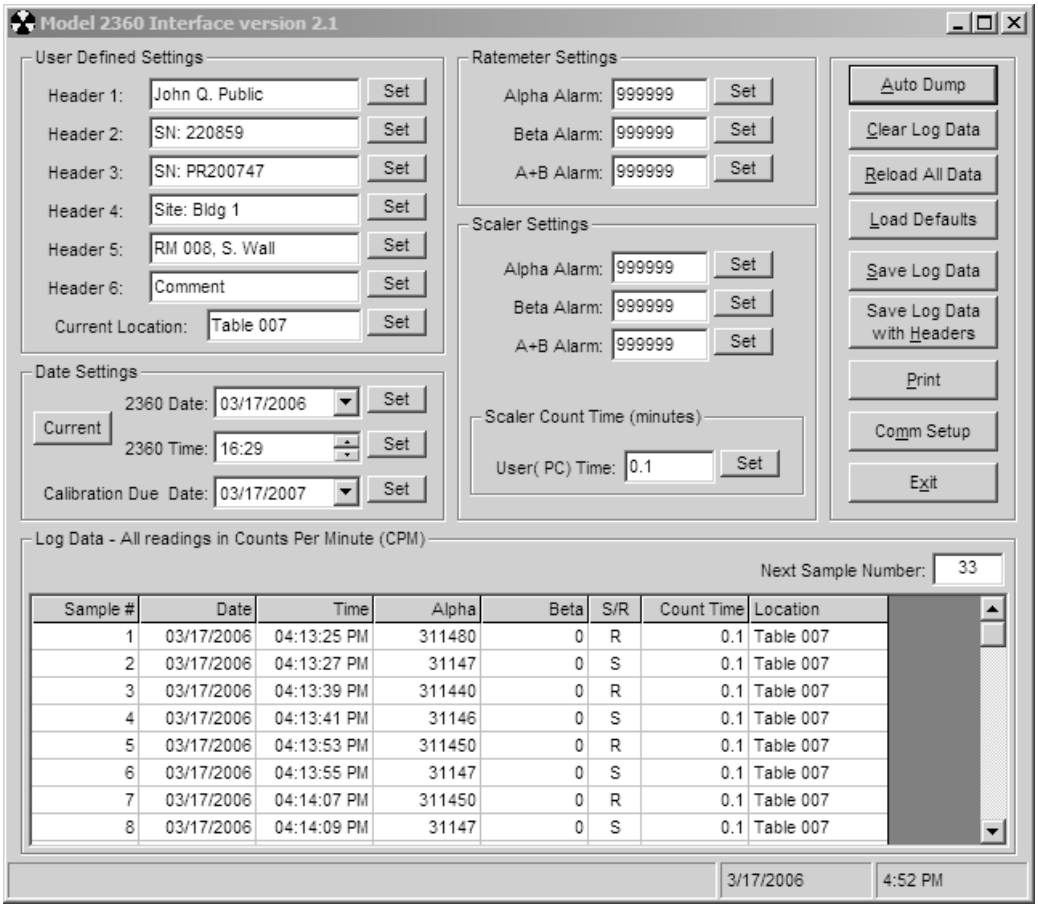
FUNCTIONS

The Model 2360 Interface software has three main functions:

1. Read or update the parameters stored in the Model 2360.

2. Read, save, or delete the logged data stored in the Model 2360.

3. Collect and save real-time data at specified intervals of time.



MAIN SCREEN

[**Set**]—Clicking the **Set** button will save the parameter to the Model 2360. Each parameter has its own **Set** button.

[**Auto Dump**]—Displays the Auto Dump Data screen, which allows for real time logging of data.

[**Clear Log Data**]—Erases the logged sample data in the Model 2360.

Caution:

Data will be lost if this button is pressed and the data has not previously been saved.

[**Reload All Data**]—Downloads all information from the Model 2360.

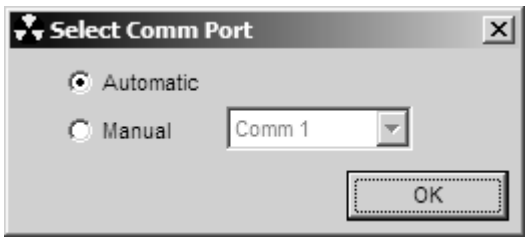
[**Load Defaults**]—Reloads all header data to the original state as shipped from Ludlum Measurements, Inc.

[**Save Log Data**]—Displays the "save file" prompt to allow the user to specify which drive and directory to save the Log File.

[**Save Log Data**]—Displays the "save file" prompt to allow the user to specify which drive and directory to save the Log File. This option also saves the six header fields to the file.

[**Print**]—Prints all parameters as well as logged data to the default printer. If there is no logged data, only the parameters will printed.

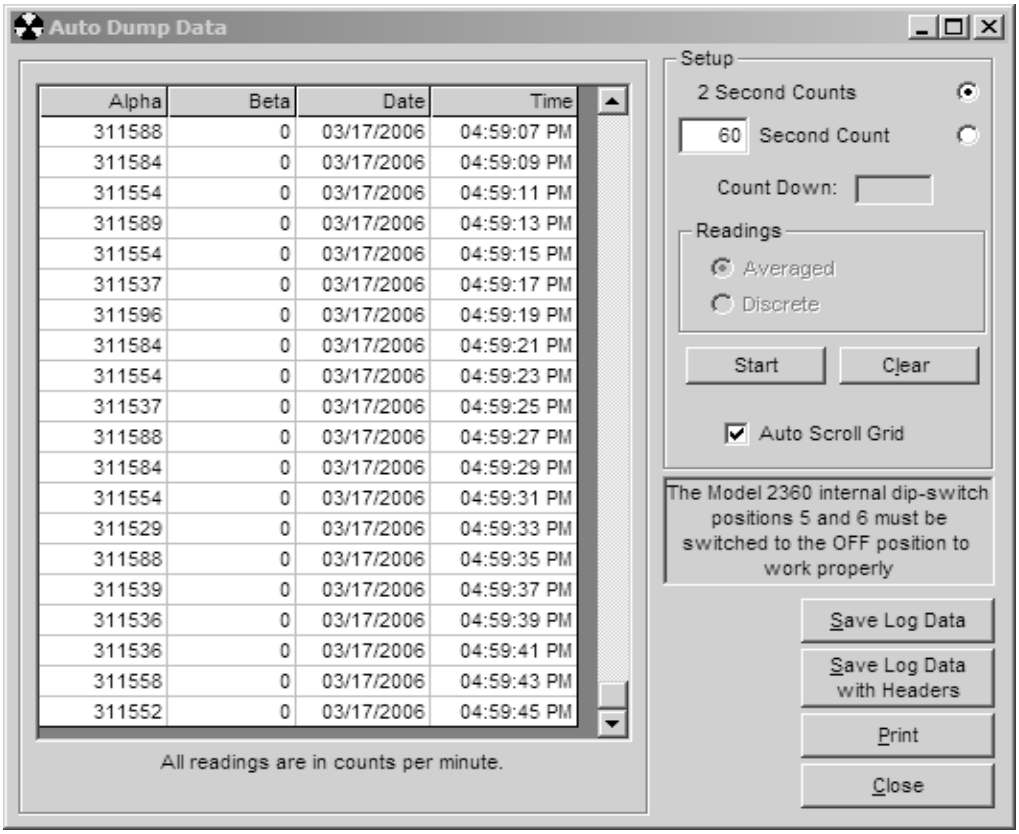
[**Comm Setup**]—Displays the Select Comm Port screen. Select "Automatic" to allow the software to scan all available serial ports to find the Model 2360. Select "Manual" and choose a specific serial port.



AUTO DUMP DATA (SETUP)

Note:

For auto dumping to work properly, the Model 2360 internal dip switches 5 and 6 must be set to the OFF position.



[**Two-Second Counts**]—The Model 2360 outputs the ratemeter reading every two seconds. This option will capture each two-second reading.

[**User Defined Count**]—This option will log the data based on a user-defined count time, which is adjustable from 2 to 9998 seconds. The count time specified here must be evenly divided by 2. The count time may be changed while a count is in progress and will take effect when the current count time is finished. When a user-defined count is in progress, the "Count Down" box will display the remaining count time.

[**Readings**]--When counting with a user-defined count time, the saved readings can be averaged or discrete. When the "Averaged" option is selected, the readings accumulated every two seconds during the count time are averaged. When the "Discrete" option is selected, the last two-second reading at the end of the count time is used. This option is only available when the user-defined count time option is selected.

[**Start**] [**Stop**]—Toggle from Start/Stop to start or stop the dumping of counts.

[**Clear**]—Clears data from the display box. This only clears the grid and does not affect the samples stored in the memory of the Model 2360.

[**Auto Scroll Grid**]—When checked, the grid automatically scrolls to keep the newest record visible.

[**Save Log Data**]—Save the data to a user-specified file and location. The data is saved in standard ASCII and is readable in almost any program.

[**Save Log Data with Headers**]—This button performs the same function as above, but also saves the six header fields.

[**Print**]—Sends data, including the displayed readings, to the default printer. If there is no data displayed, only the header information will be printed.

[**Close**]—Returns to the main menu area.

MODEL 2360 INTERFACE SOFTWARE SAMPLE PRINTOUTS (following pages)

Table 1: Logged data downloaded from the Model 2360 and saved to an ASCII file

Table 2: Auto dump data saved to an ASCII file

Table 3: Printout of logged data

Table 1:

```
Header 1: John Q. Public
Header 2: SN: 220859
Header 3: SN: PR200747
Header 4: Site: Bldg 1
Header 5: RM 008, S. Wall
Header 6: Comment

S=Scaler, R=Ratemeter
```

Sample #	Date	Time	Alpha	Beta	S/R	Count Time	Location
1	03/17/2006	11:48:37 AM	311092	0	R	0.1	Table 007
2	03/17/2006	11:48:39 AM	31112	0	S	0.1	Table 007
3	03/17/2006	11:48:51 AM	311144	0	R	0.1	Table 007
4	03/17/2006	11:48:53 AM	31113	0	S	0.1	Table 007
5	03/17/2006	11:49:05 AM	311127	0	R	0.1	Table 007
6	03/17/2006	11:49:07 AM	31113	0	S	0.1	Table 007
7	03/17/2006	11:49:19 AM	311143	0	R	0.1	Table 007
8	03/17/2006	11:49:21 AM	31113	0	S	0.1	Table 007
9	03/17/2006	11:49:33 AM	311129	0	R	0.1	Table 007
10	03/17/2006	11:49:35 AM	31113	0	S	0.1	Table 007

Table 2:

```
Header 1: John Q. Public
Header 2: SN: 220859
Header 3: SN: PR200747
Header 4: Site: Bldg 1
Header 5: RM 008, S. Wall
Header 6: Comment
```

Alpha	Beta	Date	Time
311348	0	03/17/2006	01:49:44 PM
311344	0	03/17/2006	01:49:46 PM
311299	0	03/17/2006	01:49:48 PM
311348	0	03/17/2006	01:49:50 PM
311314	0	03/17/2006	01:49:52 PM
311312	0	03/17/2006	01:49:54 PM
311297	0	03/17/2006	01:49:56 PM
311296	0	03/17/2006	01:49:58 PM
311348	0	03/17/2006	01:50:00 PM
311314	0	03/17/2006	01:50:02 PM

Table 3:

```
Model 2360 Log Data    Date: 03/17/2006    Time: 01:44:49 PM        Page 1
-----------------------------------------------------------------------
Header 1: John Q. Public
Header 2: SN: 220859
Header 3: SN: PR200747
Header 4: Site: Bldg 1
Header 5: RM 008, S. Wall
Header 6: Comment

Calibration Due Date: 03/15/2007
     Model 2360 Date: 03/17/2006
     Model 2360 Time: 01:37:21 PM

Logged Samples:  10

User PC Scaler Count Time:  0.1 minutes

        Alpha Ratemeter Alarm Setpoint:  999999
        Beta Ratemeter Alarm Setpoint:  999999
Alpha + Beta Ratemeter Alarm Setpoint:  999999

        Alpha Scaler Alarm Setpoint:  999999
        Beta Scaler Alarm Setpoint:  999999
Alpha + Beta Scaler Alarm Setpoint:  999999

S=Scaler, R=Ratemeter
Sample #  Date        Time         Alpha    Beta     S/R  Count Time  Location
--------  ----------  -----------  -------  -------  ---  ----------  ---------
       1  03/17/2006  11:48:37 AM   311092        0    R         0.1  Table 007
       2  03/17/2006  11:48:39 AM    31112        0    S         0.1  Table 007
       3  03/17/2006  11:48:51 AM   311144        0    R         0.1  Table 007
       4  03/17/2006  11:48:53 AM    31113        0    S         0.1  Table 007
       5  03/17/2006  11:49:05 AM   311127        0    R         0.1  Table 007
       6  03/17/2006  11:49:07 AM    31113        0    S         0.1  Table 007
       7  03/17/2006  11:49:19 AM   311143        0    R         0.1  Table 007
       8  03/17/2006  11:49:21 AM    31113        0    S         0.1  Table 007
       9  03/17/2006  11:49:33 AM   311129        0    R         0.1  Table 007
      10  03/17/2006  11:49:35 AM    31113        0    S         0.1  Table 007
```

INSTALLATION OF THE MODEL 2360 INTERFACE SOFTWARE

User must comply with the software license agreement located at the end of this section (pages 7-14 thru 7-16). By installing this software you are consenting to be bound by this agreement. If you do not agree to all the terms of this agreement, do not install the product!

Insert the Model 2360 Interface software CD into the computer. The installation routine should start automatically. If it does not, click on the Start button, select "Run" and type in the following: "d:\setup.exe".

Replace the drive letter with the correct drive letter of the CD-ROM drive. Follow the onscreen prompts to install the software. When complete, the software should be installed in C:\Program Files\2360Win. A shortcut is created in the Start Menu under "Ludlum Measurements, Inc."

REMOVAL OF THE MODEL 2360 INTERFACE SOFTWARE

To remove the program, start from the Windows Desktop. Click on Start Button, Settings, Control Panel, and then Add/Remove Programs. Find LMI 2360 Interface from the list and highlight, then click on the add/remove button to start uninstall.

Setup will prompt to ensure removal of program LMI 2360 Interface is acceptable.

Setup will also present a prompt asking if you wish to keep, remove, remove none, or remove all. Files can be removed since they are installed in C:\Program Files\Model 2360 and should not cause any problems.

Uninstall screen appears and the program removal will be complete.

CONNECTING TO A COMPUTER

Using the supplied cable, connect the end with the female connector to the Model 2360 and the other end to a free COM port on your computer. The pin-outs of the cables are as follows:

9-pin cable

Model 2360	Computer
2	2
3	3
5	5
7	7
8	8

25-pin cable

Model 2360	Computer
2	3
3	2
5	7
7	4
8	5

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

Software License Agreement

Rev. (number) 1.0
Written by (or Revised by): Richard Frola **Date:** 20 Jan 06
Approved by: Ed Ludlum **Date:** 20 JAN 06

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Section 8

Technical Theory of Operation

Refer to Amplifier/Power Supply Board Drawing 390 × 400 for the following:

Detector Input/Amplifier

Negative-going detector pulses are coupled from the detector through C022 to Amplifier U021. R023 and CR021 protect the input of U021 from inadvertent shorts. Self-biased amplifier U021 provides gain in proportion to R021 divided by R022. Transistor pins 4, 5, and 6 of U021, provide amplification. Pins 12 and 15 of U021 are coupled as a constant current source to pin 6 of U021. The output self biases to 2Vbe (approximately 1.4 volts) at pin 7 of U021. This provides just enough bias current through pin 6 of U021 to conduct all of the current for the constant current source. Positive pulses from pin 7 of U021 are coupled to the discriminators through R011 and C011.

Alpha/Beta Discriminator

Positive pulses from amplifier U021 are coupled to comparator U012, pin 6, for alpha discrimination and pins 6 and 2 of U011 for beta discrimination. R201, alpha threshold, provides the reference voltage for alpha comparator U012. R102, beta threshold (defined as the lower threshold limit of the beta counting window), provides the reference voltage for beta threshold comparator pins 1, 2, and 3 of U011. R104, beta window (defined as the upper threshold limit of the beta counting window), provides the reference voltage for the beta window comparator pins 5, 6, and 7 of U011.

Alpha/Beta Discriminator Logic Circuit

Alpha pulses from U012 are coupled to univibrator U111. Pulses at pin 6 of U111 are inverted by Q111 for connection to reset (R) pins 3, 13 of U101. Pin 9 of U111 provides the pulses to be counted by the microprocessor (μP). Pulses from pin 9 of U111 are connected to pin 3 of U111 to provide a time delay for the μP clock cycle to complete before the next alpha pulse can be recognized by the μP.

Beta pulses from pin 1 of U011 are coupled to univibrator U101. Pulses are coupled to the μP from pin 7 of U101 as long as pins 3 and 13 of U011 remain high (+5 V). When an alpha and/or a beta window pulse is present, the reset (pins 3 and 13 of U101) function is enabled, and 7 of U101 remains high. Pin 7 of U101 is connected to pin 13 of U101 to provide a time delay for the μP clock cycle to complete before the next beta pulse can be recognized by the μP.

Low Voltage Supply

Battery voltage is coupled to switching regulator U201 and associated components to provide +5 V to power op-amps and logic circuitry. The charge pump (cp) output C202, CR211, CR212, and C201 form a voltage doubler circuit to provide +9 V for U201 amplifier supply. U001 and related components provide +2.5 V reference for HV SET and alpha/beta discriminator controls. R201 (LO BAT) is adjusted so that the meter pointer is aligned with the left vertical mark on the BAT OK line with 2.2 V battery input.

High Voltage Supply

High voltage is developed by blocking oscillator Q421, T321, C412, and rectified by voltage multiplier CR221-CR224, C221-C223, C211, and C114. High voltage increases as current through Q421 increases, with maximum output voltage with Q421 saturated.

High voltage is coupled back through R123 to op-amp pin 2 of U311. Resistor network R211-214 completes the HV division circuit to ground. R214 provides HV limit at 2.0 kV when the HV SET control on the calibration board is at maximum. The regulated HV output is controlled by HV potentiometer located under the CAL cover on the front panel. This control provides the reference for comparator pin 3, U311. During stable operation, the voltage at pin 2 of U311 will equal the voltage at pin 3 of U311. Pin 1 of U311 will cause conduction of Q312 to increase or decrease until the HV finds a level of stability. R115 (HV TEST) calibrates the analog meter to the HV output when the HV test push-button switch is depressed.

Detector Overload

A voltage drop is developed across R121 and sensed by comparator U012 as detector current increases. When the voltage at pin 3 of U012 goes below pin 2, pin 1 goes low, illuminating the OL LED and driving the meter to full scale. R211, overload, provides adjustment for the overload set point.

Meter Drive

Pulses are coupled from the μP board to the gate of Q302. Q302 inverts the pulses at CR403, and C401 provides integration. Integrated meter drive voltage is coupled from P1-13 via the battery (BAT) and HV test switch to pin 5 of U311. The meter is driven by the emitter of Q111, coupled as a voltage follower in conjunction with pin 6 and 7 of U311. R406, "Meter Cal," is adjusted to calibrate the ratemeter reading corresponding to the incoming count rate. R407 and R408 provide temperature compensation for changes in the meter resistance due to temperature variations.

Refer to Processor Board Drawing 390 × 395 for the following:

Power supply

Battery voltage is coupled to switching regulator U321 and associated components to provide +5 V to power the μP and display drivers U211, 212. R101, C101, Q101, and Q201 form a delay switch, which allows U321 to stabilize before the load current is connected to the +5 V supply.

Microprocessor (μP)

U111, Intel N87C51FC, controls all of the data, control inputs, and display information. The clock frequency is crystal controlled by Y111 and related components at 6.144 MHz. The μP incorporates internal memory (ROM) storing the program information. C211 resets the μP at power-up to initiate the start of the program routine. During the program loop the μP looks at all of the input switches for initiation or status changes and responds accordingly.

The μP uses pulse-width modulation to control the analog ratemeter. The analog output, RATE (P1-3) is divided into 255 increments in a 166 μs period. At full meter deflection the low pulse period – leading edge to leading edge – will be 166 μs, 500 cpm = 163 μs, 400 cpm = 130 μs, 200 cpm = 65 μs, 100 cpm = 33 μs, and 0 = no pulse or +5 V. The pulses are inverted by Q302 on the amp/power supply board and then integrated by R403, C401.

LCD Drive

U101 and U001 make up the liquid crystal display drive circuitry. The display information is sent from the μP to U101 and U001 via DATA 0-1 lines. Each bit is latched into the drivers when the CLOCK line is brought high, then low by the μP. When 32 bits have been clocked to the drivers, the

LOAD line is brought high, and then low. The corresponding digits and segments are illuminated, corresponding to the stored-count information from the μP.

Audio

Alpha and/or beta audio pulse frequency is generated by the μP and coupled to Q211. Q211 then inverts the pulses and drives the low side of the audio transformer T321. Front-panel VOL control provides the bias voltage to the top of T321. Secondary winding of T321 is coupled to unimorph speaker via front-panel audio jack.

Section 9

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 the most common problems encountered with this particular instrument are: (1) detector cables, (2) sticky meters, (3) battery contacts.

Note that the first troubleshooting tip is for determining whether the problem is with the electronics or with the detector. A Ludlum Model 500 Pulser can be 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 Proportional and Scintillator Type Detectors

SYMPTOM	POSSIBLE SOLUTION
No power (or meter does not reach BAT TEST or BAT OK mark)	1. Check batteries and replace if weak. 2. Check polarity (see marks inside battery lid). Are the batteries installed backwards?

SYMPTOM	POSSIBLE SOLUTION
No power (or meter does not reach BAT TEST or BAT OK mark) (continued)	3. Check battery contacts. Clean them with rough sandpaper or use an engraver to clean the tips. 4. Check for loose or broken wires, especially between the main board and the calibration board.
Nonlinear Readings	1. Check the high voltage (HV) by using a Ludlum Model 500 Pulser (or equivalent). If a multimeter is used to check the HV, ensure that one with high impedance is used, as a standard multimeter could be damaged in this process. 2. Check for noise in the detector cable by disconnecting the detector, placing the instrument on the lowest range setting, and wiggling the cable while observing the meter face for significant changes in readings. 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 determine whether or not the cable has failed, causing excessive noise. 2. Check the HV and, if possible, the input threshold for proper setting.

SYMPTOM	POSSIBLE SOLUTION
Meter goes full scale or "pegs out" (continued)	3. Open the instrument can and check for loose wires. 4. Ensure that the instrument's can is properly attached. When attached properly, the speaker will be located on the left side of the instrument. If the can is on backwards, interference between the speaker and the input preamplifier may cause noise.

Section

10

Recycling

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

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

Batteries	Glass	Aluminum and Stainless Steel
Circuit Boards	Plastics	Liquid Crystal Display (LCD)

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

The symbol appears as such: 

Section 11

Parts List

Model 2360 Scaler/Ratemeter

Reference	Description	Part Number
UNIT	Completely Assembled Model 2360 Scaler/Ratemeter	48-2872

Amplifier/Power Supply Board, Drawing 390 × 400

BOARD	Completely Assembled Amplifier/ Power Supply Board	5390-400
CAPACITORS		
C001	100pF, 100V	04-5661
C002	47pF, 100V	04-5660
C011	0.1µF, 50V	04-5663
C012-C013	0.001µF, 100V	04-5659
C016	0.001µF, 100V	04-5659
C017	10µF, 35V	04-5655
C021	10pF, 100V	04-5673
C022	100pF, 3KV	04-5532
C1	1µF, 16V	04-5701
C101-C102	47pF, 100V	04-5660
C111-C113	47pF, 100V	04-5660
C114	0.0047µF, 3KV	04-5547
C121-C122	0.0047µF, 3KV	04-5547
C201-C202	10µF, 35V	04-5655
C203	330pF, 100V	04-5657
C211	0.0047µF, 3KV	04-5547
C212	68µF, 10V	04-5654
C213	1µF, 35V	04-5656
C214	0.01µF, 50V	04-5664
C221-C223	0.0047µF, 3KV	04-5547
C301	68µF, 10V	04-5654
C311	0.01µF, 100V	04-5523

	Reference	Description	Part Number
	C401	0.1µF, 50V	04-5663
	C411	0.1µF, 50V	04-5663
	C412	1µF, 35V	04-5656
	C421	68µF, 10V	04-5654
TRANSISTORS	Q111	2N7002L	05-5840
	Q301	MMBT4403LT1	05-5842
	Q302	2N7002L	05-5840
	Q311-Q312	MMBT3904T	05-5841
	Q421	MJD210	05-5843
INTEGRATED CIRCUITS	U001	LM285MX-2.5	06-6291
	U011-U012	TLC372ID	06-6290
	U021	CMXT3906	05-5890
	U022-U023	CMXT3904	05-5888
	U101	CD74HC4538M	06-6297
	U111	CD74HC4538M	06-6297
	U201	MAX631AESA	06-6285
	U301	CD74HC4066M	06-6323
	U311	TLC27M7ID	06-6292
DIODES	CR021	MMBD7000LT1	07-6355
	CR111-CR112	MMBD914L	07-6353
	CR211-CR212	BAT54	07-6354
	CR221-CR225	GI250-2	07-6266
	CR411	MMBD914L	07-6353
THERMISTOR	R407	250K, 250mW, 1%	07-6366
POTENTIOMETERS	R102	10K, BETA THRESH	09-6921
	R103	1M, BETA WIN	09-6906
	R112	1G, FHV-1, 2%	12-7686
	R115	1M, HV READOUT	09-6909
	R201	1M, ALPHA THRESH	09-6906
	R202	200K, LO BAT (LB)	09-6908
	R211	1M, OVERLOAD	09-6906
	R214	1M, HV LIMIT	09-6906
	R406	5K, METER CAL (MTR)	09-6907

	Reference	Description	Part Number
RESISTORS	R001	22.1K, 250mW, 1%	12-7843
	R002	249K, 250mW, 1%	12-7862
	R003	22.1K, 250mW, 1%	12-7843
	R004	1.5K, 250mW, 1%	12-7878
	R011	100 Ohm, 250mW, 1%	12-7840
	R012	22.1K, 250mW, 1%	12-7843
	R013	33.2K, 250mW, 1%	12-7842
	R014	10.0K, 250mW, 1%	12-7839
	R015	22.1K, 250mW, 1%	12-7843
	R016	10.0K, 250mW, 1%	12-7839
	R021	392K, 250mW, 1%	12-7841
	R022-R023	10.0K, 250mW, 1%	12-7839
	R024	33.2K, 250mW, 1%	12-7842
	R025	22.1K, 250mW, 1%	12-7843
	R026	1.00M, 250mW, 5%	10-7028
	R101	100K, 250mW, 1%	12-7834
	R104	22.1K, 250mW, 1%	12-7843
	R105	100K, 250mW, 1%	12-7834
	R111	100 Ohm, 250mW, 1%	12-7840
	R112	1G, FHV-1, 2%	12-7686
	R113-R114	100K, 250mW, 1%	12-7834
	R116	249K, 250mW, 1%	12-7862
	R121	4.7M, 250mW, 5%	10-7030
	R122	1.00M, 250mW, 5%	10-7028
	R123	1G, FHV-1, 2%	12-7686
	R212-R213	1.00M, 250mW, 1%	12-7844
	R215	1.00M, 250mW, 1%	12-7844
	R301	2.21K, 250mW, 1%	12-7835
	R302-R303	22.1K, 250mW, 1%	12-7843
	R311	10.0K, 250mW, 1%	12-7839
	R312	22.1K, 250mW, 1%	12-7843
	R313	2.21K, 250mW, 1%	12-7835
	R314	10.0K, 250mW, 1%	12-7839
	R401	200 Ohm, 250mW, 1%	12-7846
	R402	221K, 250mW, 1%	12-7845
	R403	7.5K, 250mW, 1%	12-7847
	R404	2.21K, 250mW, 1%	12-7835
	R405	1.00M, 250mW, 1%	12-7844
	R408	301 Ohm, 250mW, 1%	12-7863
	R411	200 Ohm, 250mW, 1%	12-7846
	R412	10.0K, 250mW, 1%	12-7839

	Reference	Description	Part Number
CONNECTORS	P1	1-640456-5 MTA 100x15	13-8355
	P2	640456-3 MTA 100x3	13-8081
INDUCTOR	L301	220µH	21-9678
TRANSFORMER	T321	L8050 x50	40-0902
Processor Board, Drawing 390 × 395	BOARD	Completely Assembled Processor Board	5390-395
CRYSTALS	Y111	MICRO XTAL-6.144 MHZ	01-5262
	Y401	MICRO XTAL-32.768 KHZ	01-5305
CAPACITORS	C111-C112	27PF, 100V	04-5658
	C211	4.7µF, 25V	04-5653
	C221	47µF, 16V	04-5666
	C311-C316	68µF, 10V	04-5654
	C401	10PF, 100V	04-5673
	C411	10µF, 35V	04-5655
	C421	4.7µF, 25V	04-5653
	C422	10µF, 35V	04-5655
	C423	4.7µF, 25V	04-5653
TRANSISTORS	Q101	TRANS-2N7002L	05-5840
	Q102	TRANS-2N7002L	05-5840
	Q211	TRANS-2N7002L	05-5840
INTEGRATED CIRCUITS	U6	LT1304CS8	06-6394
	U101	24C65T-I	06-6401
	U111	AT89C51RC2	06-6893
	U201	24C65T-I	06-6401
	U202	PCF8574TD	06-6402
	U401	PCF8593TD	06-6403
	U421	MAX220ESE	06-6329

	Reference	Description	Part Number
DIODES	CR211-CR212	CXSH-4LF	07-6358
	CR401-CR402	MMBD914L	07-6353
SWITCH	S301	CONFIGURE SWITCH	08-6710
RESISTORS	R101-R102	200 Ohm, 125mW, 1%	12-7846
	R103	22.1K, 250mW, 1%	12-7843
	R104	100K, 250mW, 1%	12-7834
	R201	22.1K, 250mW, 1%	12-7843
	R202	100K, 250mW, 1%	12-7834
	R211	100K, 250mW, 1%	12-7834
	R311	150K, 250mW, 1%	12-7833
	R312	22.1K, 250mW, 1%	12-7843
	R313	68.1K, 250mW, 1%	12-7881
	R314	1M, 250mW, 1%	12-7844
	R321	0 Ohm, 250mW, 1%	12-7104
	R401	1.00K, 250mW, 1%	12-7832
RESISTOR NETWORKS	RN201-RN202	220K, EXB2HV224JV	12-8342
CONNECTORS	P3	1-640456-7 MTA100x17	13-8121
	P4	1-640456-1 MTA100x11	13-8059
	P12	640456-6 MTA100x6	13-8095
	P13	640456-2 MTA100x2	13-8073 \
INDUCTOR	L211	22µH	21-9808
BATTERY	B411	3V LITHIUM	22-9794
TRANSFORMER	T321	XFMR- M 177 AUDIO	4275-083

	Reference	Description	Part Number
LCD Display Board, Drawing 390 × 372	BOARD	Completely Assembled LCD Display Board	5390-372
CAPACITOR	C201	27PF, 100V	04-5658
INTEGRATED CIRCUITS	U001	AY0438-I/L	06-6358
	U101	AY0438-I/L	06-6358
LEDS	DS001	E118, RED	07-6308
	DS201	E118, RED	07-6308
LCD	DSP101	LCD-GD-7427WP 6 DIGIT	07-6624
RESISTORS	R011	10K, 125mW, 1%	12-7839
	R012	10K, 125mW, 1%	12-7839
	R111	10K, 125mW, 1%	12-7839
	R112	10K, 125mW, 1%	12-7839
Calibration Board, Drawing 390 × 176	BOARD	Completely Assembled Calibration Board	5390-172
POTENTIOMETER	R3	250K, HV SET	09-6819
CONNECTOR	P7	640456-5 MTA100	13-8057
BCD Board, Drawing 261 × 107	BOARD	Completely Assembled BCD Board	5261-154
SWITCH	S111	513384	08-6656
CONNECTOR	P5	640456-5 MTA100	13-8057

Chassis Wiring Diagram, Drawing 390 × 179

	Reference	Description	Part Number
SWITCHES	S1	SWITCH-PA-600-210	08-6501
	S3	SWITCH-MPS-103F	08-6699
	S4	PHONE JACK TINI #42A	21-9333
	S5	SWITCH-7103SYZQE TOGGLE	08-6720
	S6	SWITCH-7205SYZQE TOGGLE	08-6750
POTENTIOMETER	R1	10K, VOLUME	09-6753
CONNECTORS	J1	CONN-1-640442-5 MTA100	13-8383
	J2	CONN-640442-3 MTA100	13-8135
	J3	CONN-1-640442-7 MTA100	13-8505
	J4	CONN-640442-3 MTA100	13-8135
	J5	CONN-640442-6 MTA100	13-8171
	J6	D RECPT-RD9F000V3 9 PIN	13-8003
	J7	JACK-09-9011-1-0419	18-9080
	J8	CONN-640442-6 MTA100	13-8171
	J9	CONN-640442-2 MTA100	13-8178
	J12	CONN-640442-6 MTA100	13-8171
	J13	CONN-640442-2 MTA100	13-8178
	J14	Series "C"-UG706/U	13-7751
BATTERIES	B1-B2	"D" DURACELL BATTERY	21-9313
AUDIO	DS1	S100RL-M, UNIMORPH	21-9676
MISCELLANEOUS	M1	METER ASSEMBLY	4390-160
	*	METER-PORT BZL W/GLS	4363-352
	*	M2360 METERFACE	7390-157
	*	METER-MVT #919492 1 MA	15-8030
	*	O RING-BEZEL	16-8334
	*	SPACER-#2 X .187 NYL	18-9143
	*	BATTERY CONTACT SET	40-1707
	*	MAIN HARNESS	8390-162
	*	LCD HARNESS	8390-163
	*	CAN-RS232 HARNESS	8390-166

Section

12

Drawings and Diagrams

AMPLIFER/POWER SUPPLY BOARD, Drawing 390 × 400

AMPLIFER/POWER SUPPLY BOARD COMPONENT LAYOUT, Drawing 390 × 403 (2 sheets)

PROCESSOR BOARD, Drawing 390 × 395

PROCESSOR BOARD COMPONENT LAYOUT, Drawing 390 × 398 (2 sheets)

LCD DISPLAY BOARD, Drawing 390 × 372

LCD DISPLAY BOARD COMPONENT LAYOUT, Drawing 390 × 373A (2 sheets)

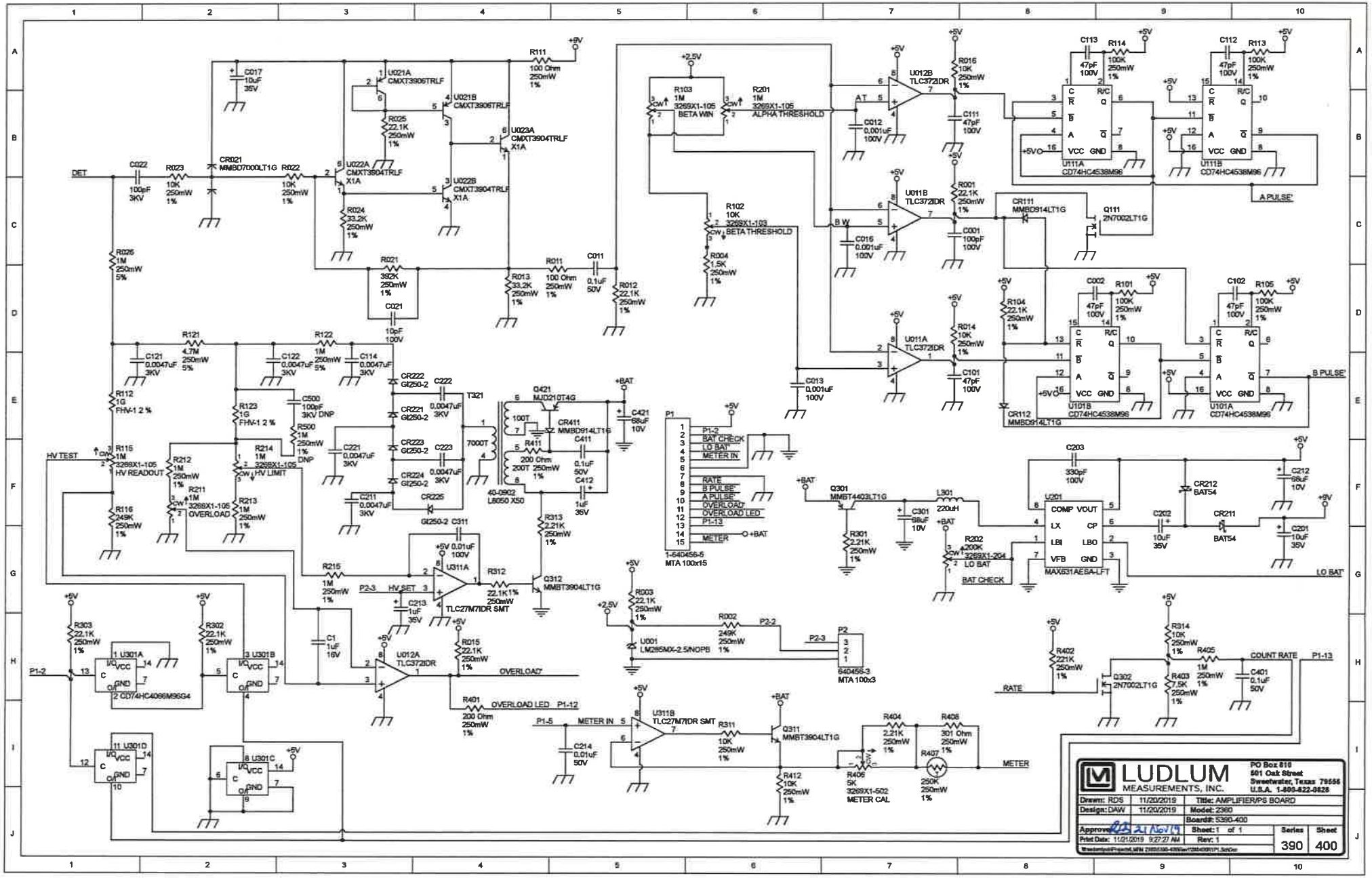
CALIBRATION BOARD, Drawing 390 × 176

CALIBRATION BOARD COMPONENT LAYOUT, Drawing 390 × 177 (2 sheets)

BCD BOARD, Drawing 261 × 107

BCD BOARD COMPONENT LAYOUT, Drawing 261 × 105A (2 sheets)

WIRING DIAGRAM, Drawing 390 × 179


DET
HV TEST
HV READOUT
HV LIMIT
OVERLOAD
HV SET
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OVERLOAD LED
METER IN
METER
BETA WIN
ALPHA THRESHOLD
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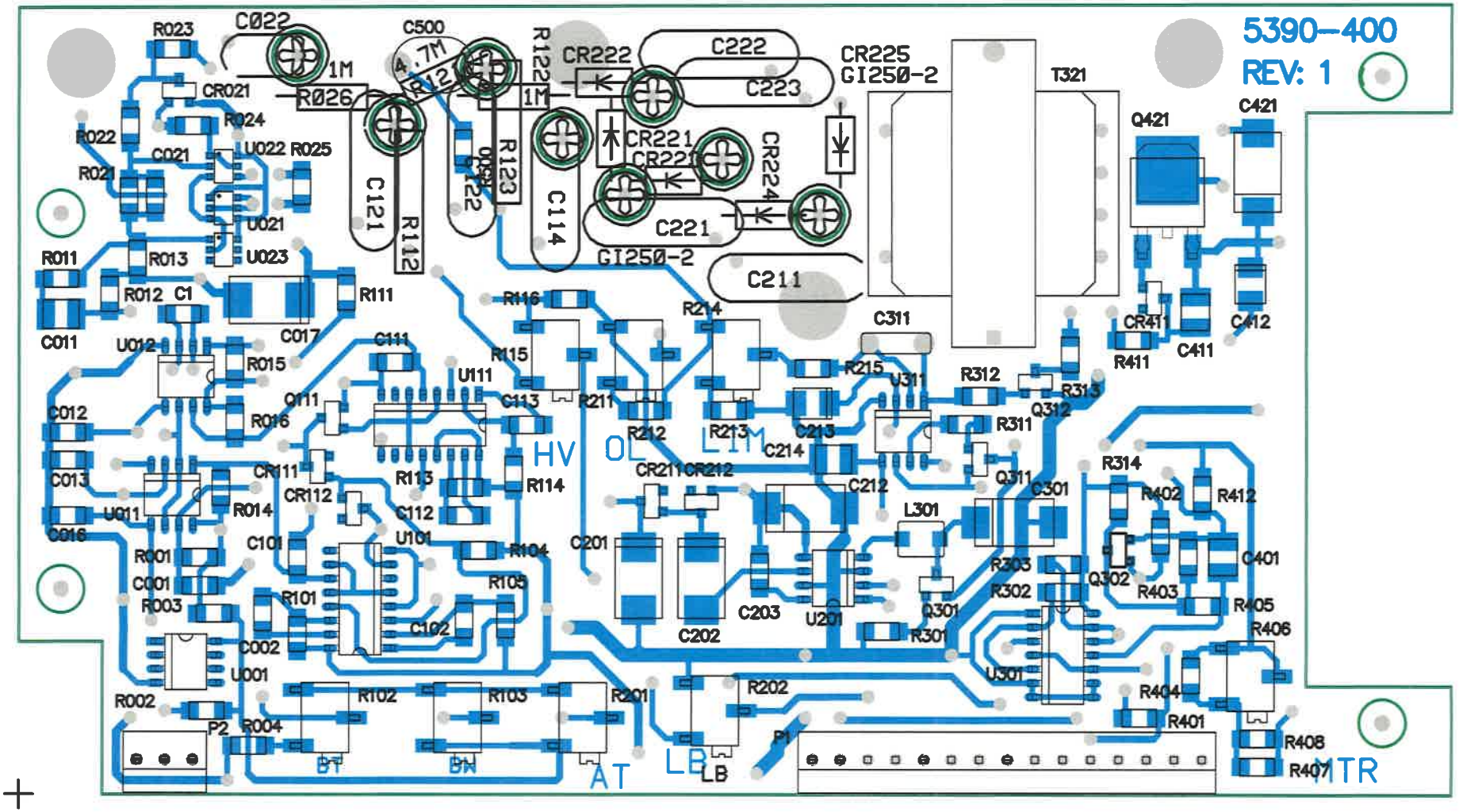
A PULSE'
B PULSE'
BAT CHECK
LO BAT'
RATE
COUNT RATE
P1-13
P1-12
P1-5
P1-2
P2-3
P2-2
TLC27M7IDR SMT
CD74HC4538M96
MAX631AESA-LFT
MTA 100x15
MTA 100x3
METER CAL
LUDLUM MEASUREMENTS, INC.
PO Box 810
501 Oak Street
Sweetwater, Texas 79556
U.S.A. 1-800-622-0828
Drawn: RDS 11/20/2019
Design: DAW 11/20/2019
Title: AMPLIFIER/PS BOARD
Model: 2360
Board#: 5390-400
Approved: 21 Nov19
Sheet: 1 of 1
Rev: 1
Print Date: 11/21/2019 9:27:27 AM
Series 390
Sheet 400

DO NOT PLACE C500 AND R500



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

Title: AMPLIFIER/PS BOARD			
Drawn: PAB	11/20/2019	**Model:** 2360	
Design: RDS	11/20/2019	**Board#:** 5390-400	
Approve: RDS	21 Nov 19	**Rev:** 1	
PCBA Drawing		**SCALE:** 1.08	**Series** 390 / **Sheet** 403
Print Date: 11/21/2019 9:27:34 AM		Top Overlay	

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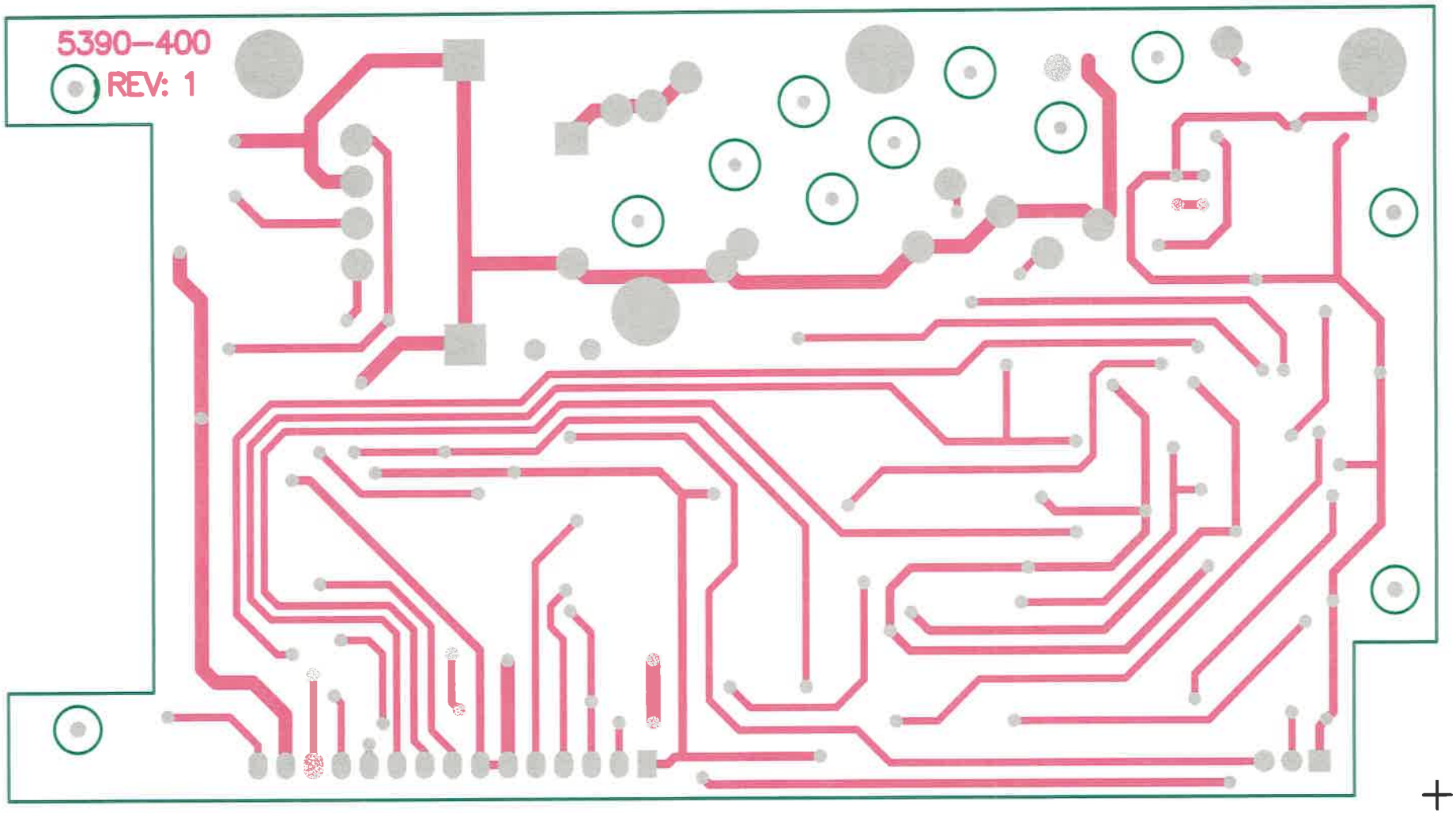

LUDLUM MEASUREMENTS, INC.	PO Box 810 501 Oak Street Sweetwater, TX 79556 U.S.A. 1-800-622-0828		
Title: AMPLIFIER/PS BOARD			
Drawn: PAB	11/20/2019	**Model:** 2360	
Design: RDS	11/20/2019	**Board#:** 5390-400	
Approve: RDS	21NOV19	**Rev:** 1	
PCBA Drawing		**SCALE:** 1.08	**Series** 390 / **Sheet** 403
Print Date: 11/21/2019 9:27:38 AM		Bottom Overlay	
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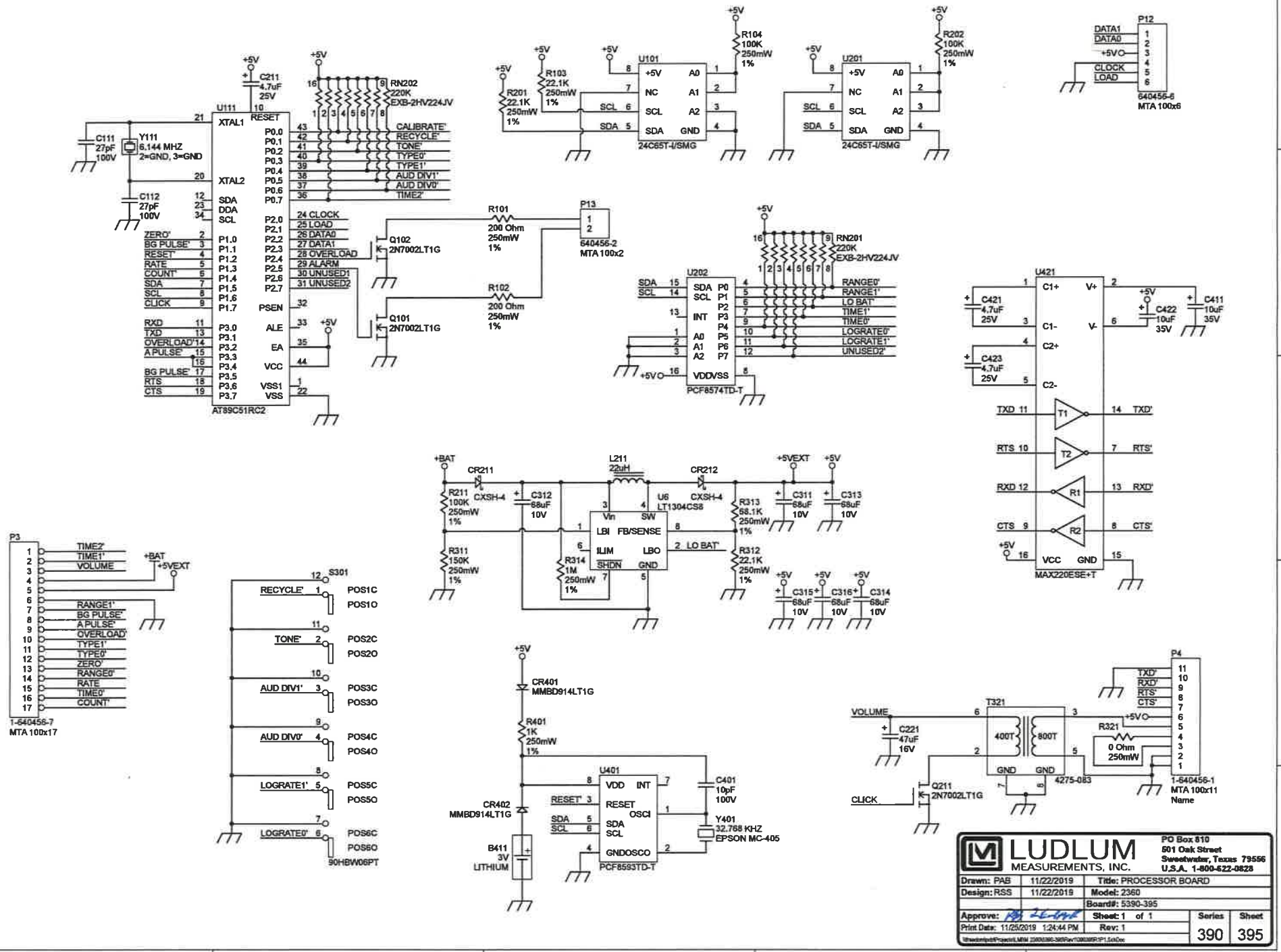
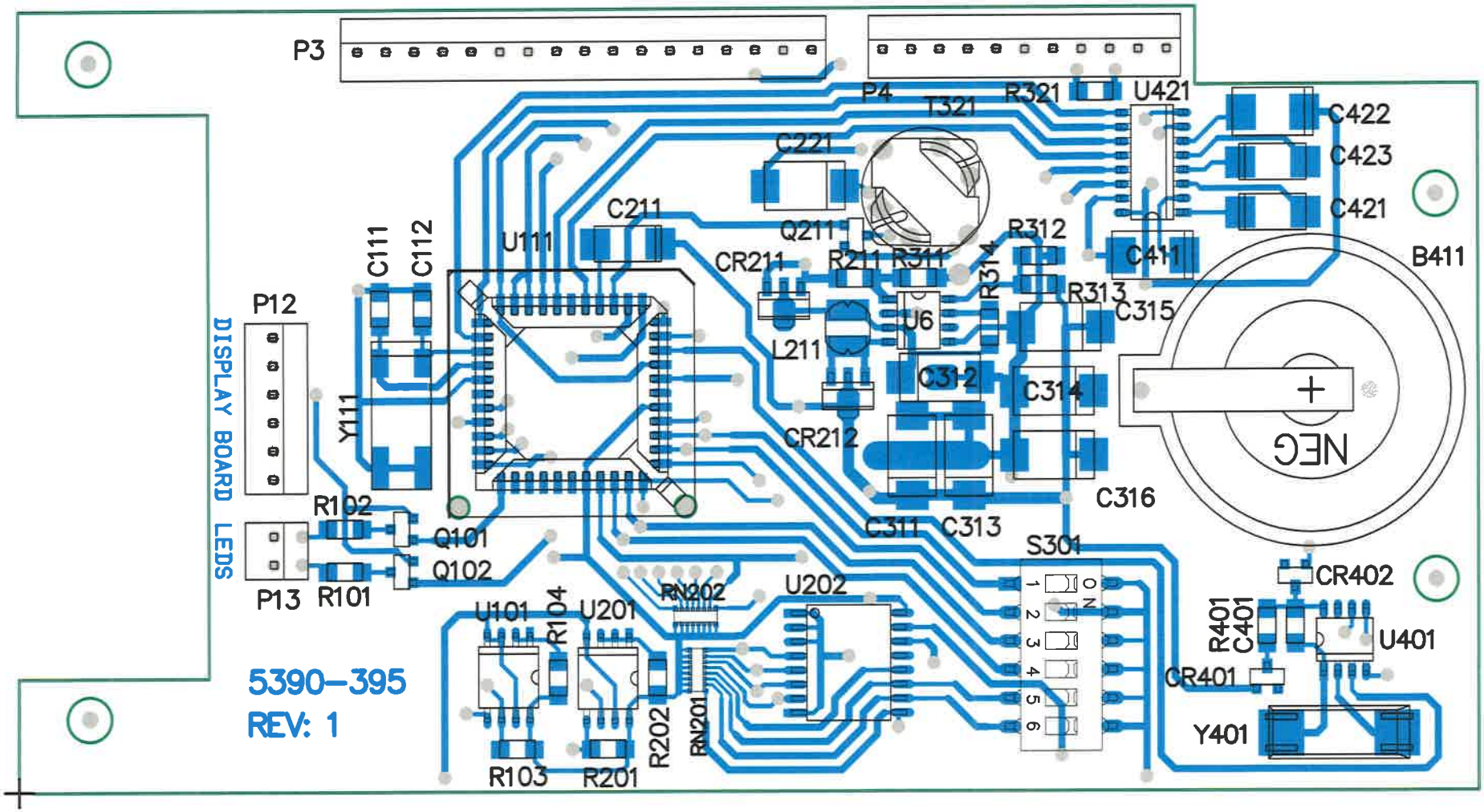

U111
AT89C51RC2
XTAL1
XTAL2
RESET
P0.0
P0.1
P0.2
P0.3
P0.4
P0.5
P0.6
P0.7
P1.0
P1.1
P1.2
P1.3
P1.4
P1.5
P1.6
P1.7
P2.0
P2.1
P2.2
P2.3
P2.4
P2.5
P2.6
P2.7
PSEN
ALE
EA
VCC
VSS1
VSS
P3.0
P3.1
P3.2
P3.3
P3.4
P3.5
P3.6
P3.7
SDA
DDA
SCL
ZERO'
BG PULSE'
RESET'
RATE
COUNT'
SDA
SCL
CLICK
RXD
TXD
OVERLOAD'
A PULSE'
BG PULSE'
RTS
CTS
C211
4.7uF
25V
C111
27pF
100V
C112
27pF
100V
Y111
6.144 MHZ
2=GND, 3=GND
RN202
220K
EXB-2HV224JV
CALIBRATE'
RECYCLE'
TONE'
TYPE0'
TYPE1'
AUD DIV1'
AUD DIV0'
TIME2'
24 CLOCK
25 LOAD
26 DATA0
27 DATA1
28 OVERLOAD
29 ALARM
30 UNUSED1
31 UNUSED2
Q102
2N7002LT1G
Q101
2N7002LT1G
R101
200 Ohm
250mW
1%
R102
200 Ohm
250mW
1%
P13
640456-2
MTA 100x2
R201
22.1K
250mW
1%
R103
22.1K
250mW
1%
U101
24C65T-I/SMG
R104
100K
250mW
1%
U201
24C65T-I/SMG
R202
100K
250mW
1%
P12
DATA1
DATA0
CLOCK
LOAD
640456-6
MTA 100x6
U202
PCF8574TD-T
RN201
Z20K
EXB-2HV224JV
RANGE0'
RANGE1'
LO BAT'
TIME1'
TIME0'
LOGRATE0'
LOGRATE1'
UNUSED2'
U421
MAX220ESE+T
C421
4.7uF
25V
C423
4.7uF
25V
C422
10uF
35V
C411
10uF
35V
T1
T2
R1
R2
TXD
RXD
RTS
CTS
P3
1-640456-7
MTA 100x17
TIME2'
TIME1'
VOLUME
RANGE1'
BG PULSE'
A PULSE'
OVERLOAD'
TYPE1'
TYPE0'
ZERO'
RANGE0'
RATE
TIME0'
COUNT'
+BAT
+5VEXT
S301
90HBW06PT
RECYCLE'
TONE'
AUD DIV1'
AUD DIV0'
LOGRATE1'
LOGRATE0'
POS1C
POS1O
POS2C
POS2O
POS3C
POS3O
POS4C
POS4O
POS5C
POS5O
POS6C
POS6O
CR211
CXSH-4
CR212
CXSH-4
L211
22uH
R211
100K
250mW
1%
R311
150K
250mW
1%
C312
68uF
10V
U6
LT1304CS8
R313
68.1K
250mW
1%
R312
22.1K
250mW
1%
R314
1M
250mW
1%
C311
68uF
10V
C313
68uF
10V
C315
68uF
10V
C316
68uF
10V
C314
68uF
10V
LO BAT'
CR401
MMBD914LT1G
R401
1K
250mW
1%
CR402
MMBD914LT1G
B411
3V
LITHIUM
U401
PCF8593TD-T
C401
10pF
100V
Y401
32.768 KHZ
EPSON MC-405
T321
400T
800T
4275-083
C221
47uF
16V
R321
0 Ohm
250mW
Q211
2N7002LT1G
P4
1-640456-1
MTA 100x11
Name
LUDLUM
MEASUREMENTS, INC.
PO Box 810
501 Oak Street
Sweetwater, Texas 79556
U.S.A. 1-800-622-0828
Drawn: PAB
11/22/2019
Design: RSS
11/22/2019
Approve:
Print Date: 11/25/2019 1:24:44 PM
Title: PROCESSOR BOARD
Model: 2360
Board#: 5390-395
Sheet: 1 of 1
Rev: 1
Series
390
Sheet
395



LUDLUM MEASUREMENTS, INC.	PO Box 810 501 Oak Street Sweetwater, TX 79556 U.S.A. 1-800-622-0828			
Title: PROCESSOR BOARD				
Drawn: PAB	11/22/2019	**Model:** 2360		
Design: RSS	11/22/2019	**Board#:** 5390-395		
Approve:		**Rev:** 1		
PCBA Drawing		**SCALE:** 1.08	**Series** 390	**Sheet** 398
Print Date: 11/25/2019 1:26:31 PM		Top Overlay		
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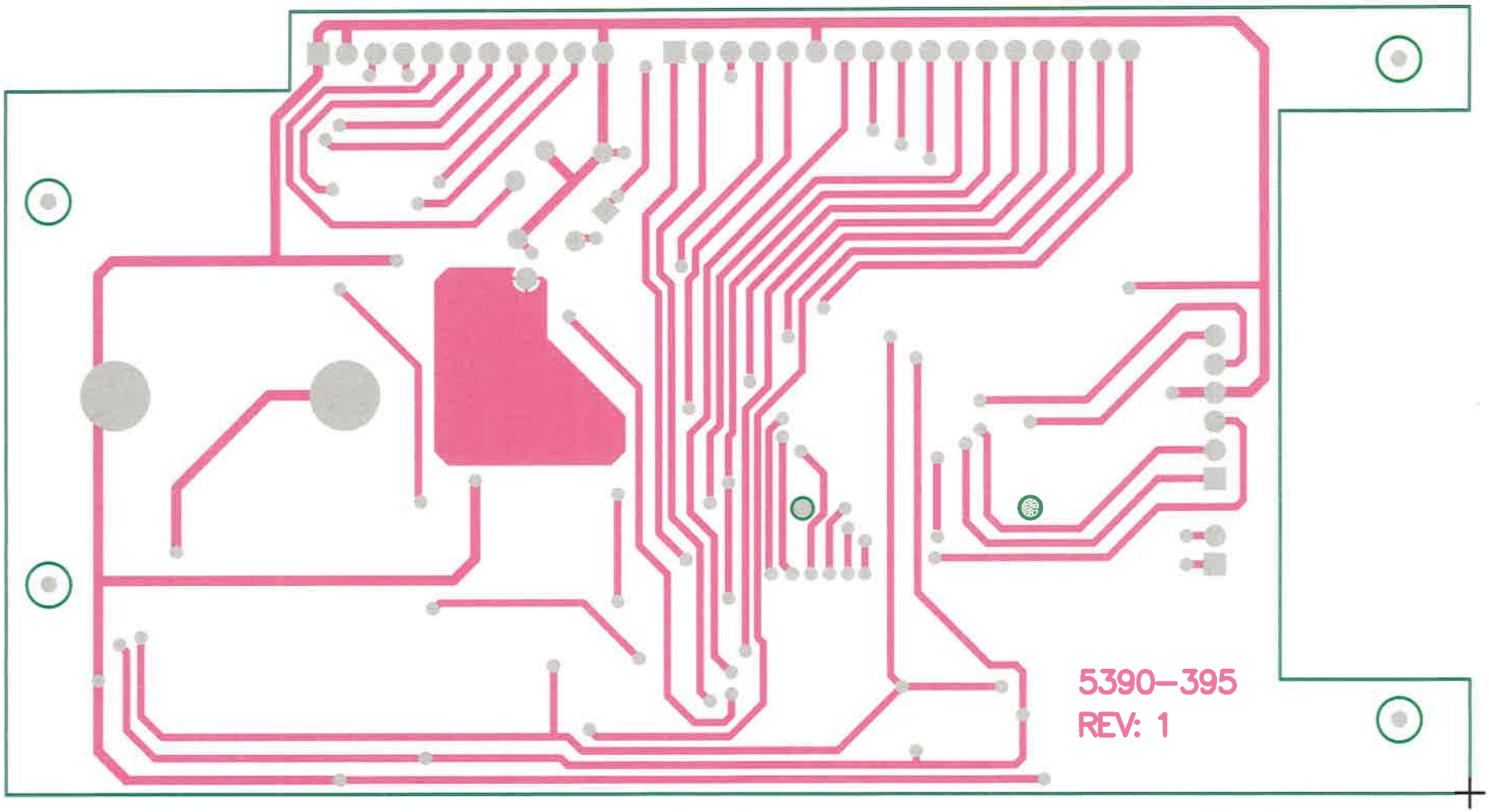

LUDLUM MEASUREMENTS, INC.	PO Box 810 501 Oak Street Sweetwater, TX 79556 U.S.A. 1-800-622-0828		
Title: PROCESSOR BOARD			
Drawn: PAB	11/22/2019	**Model:** 2360	
Design: RSS	11/22/2019	**Board#:** 5390-395	
Approve: [illegible]	26 Nov 19	**Rev:** 1	
PCBA Drawing		**SCALE: 1.08**	**Series** 390 / **Sheet** 398
Print Date: 11/25/2019 1:26:31 PM		Bottom Overlay	
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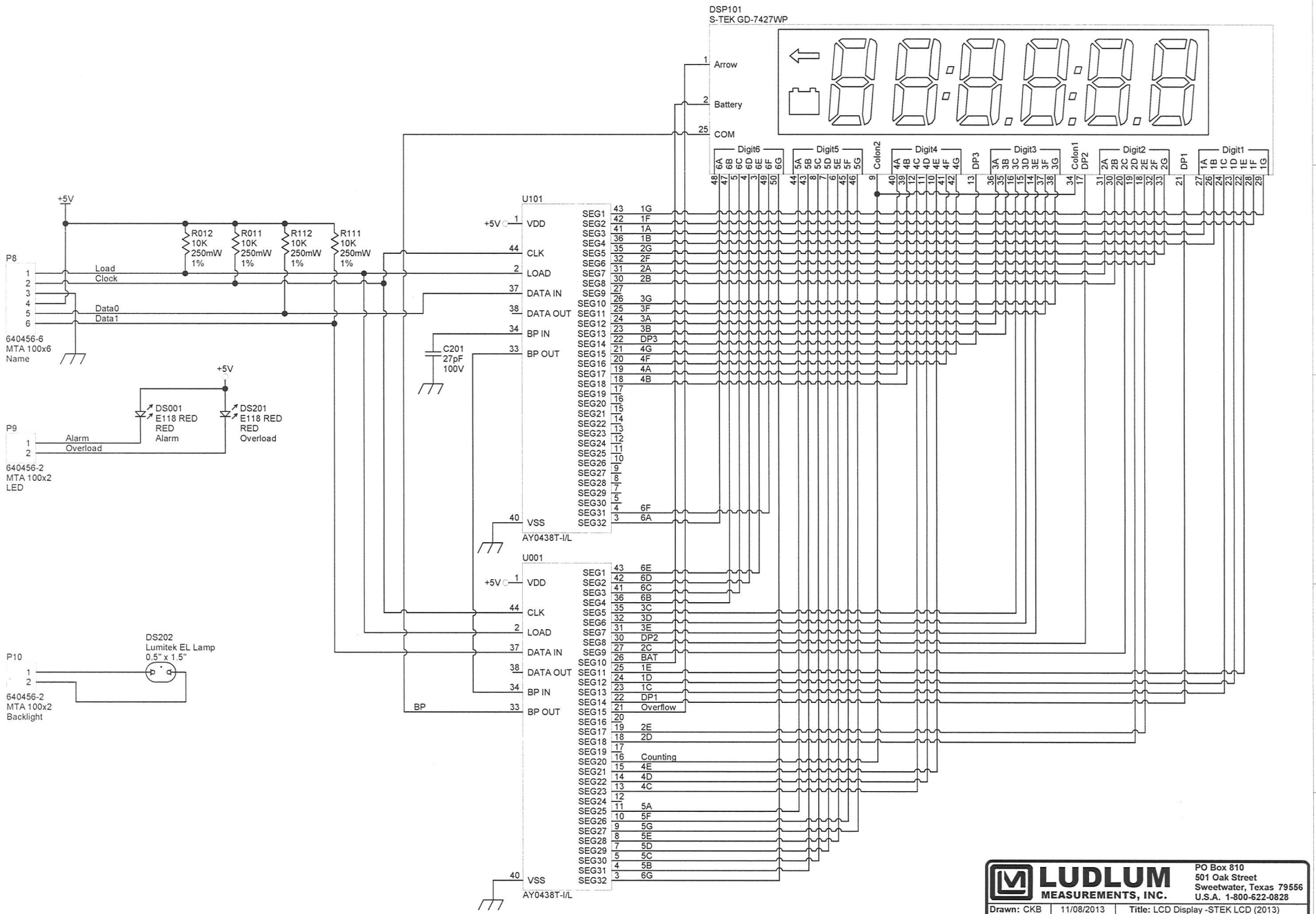

LUDLUM MEASUREMENTS, INC.		PO Box 810 501 Oak Street Sweetwater, Texas 79556 U.S.A. 1-800-622-0828	
Drawn: CKB	11/08/2013	Title: LCD Display -STEK LCD (2013)	
Design: RSS	11/08/2013	Model: 2360	
		Board#: 5390-372	
Approver: RDS	7/11/14	Sheet: 1 of 1	Series: 390 / Sheet: 372
Print Date: 7/1/2014	11:30:52 AM	Rev: 2	
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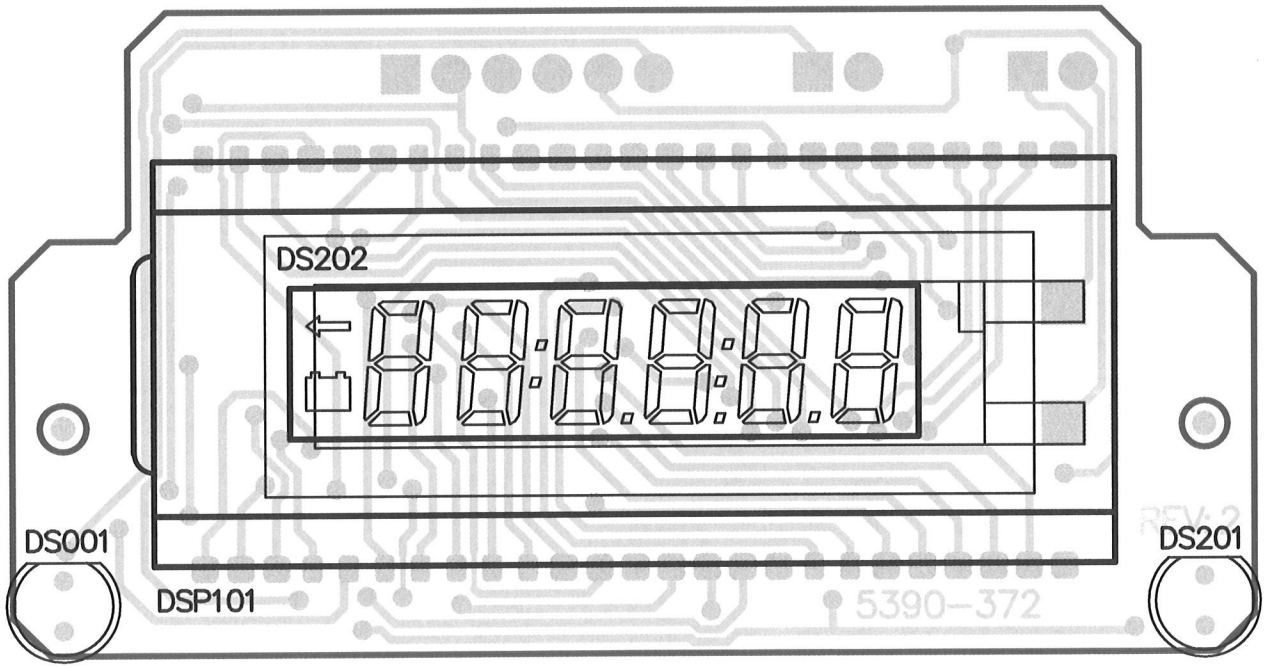

LUDLUM MEASUREMENTS, INC.		PO Box 810 501 Oak Street Sweetwater, TX 79556 U.S.A. 1-800-622-0828	
Title: LCD Display -STEK LCD (2013)			
Drawn: CKB	11/08/2013	**Model:** 2360	
Design: RSS	11/08/2013	**Board#:** 5390-372	
Approve: RDS	1 Jul 14	**Rev:** 2	
PCBA Drawing		**SCALE: 1.05**	**Series** 390 / **Sheet** 373A
Print Date: 7/1/2014 11:31:01 AM		Top Overlay	
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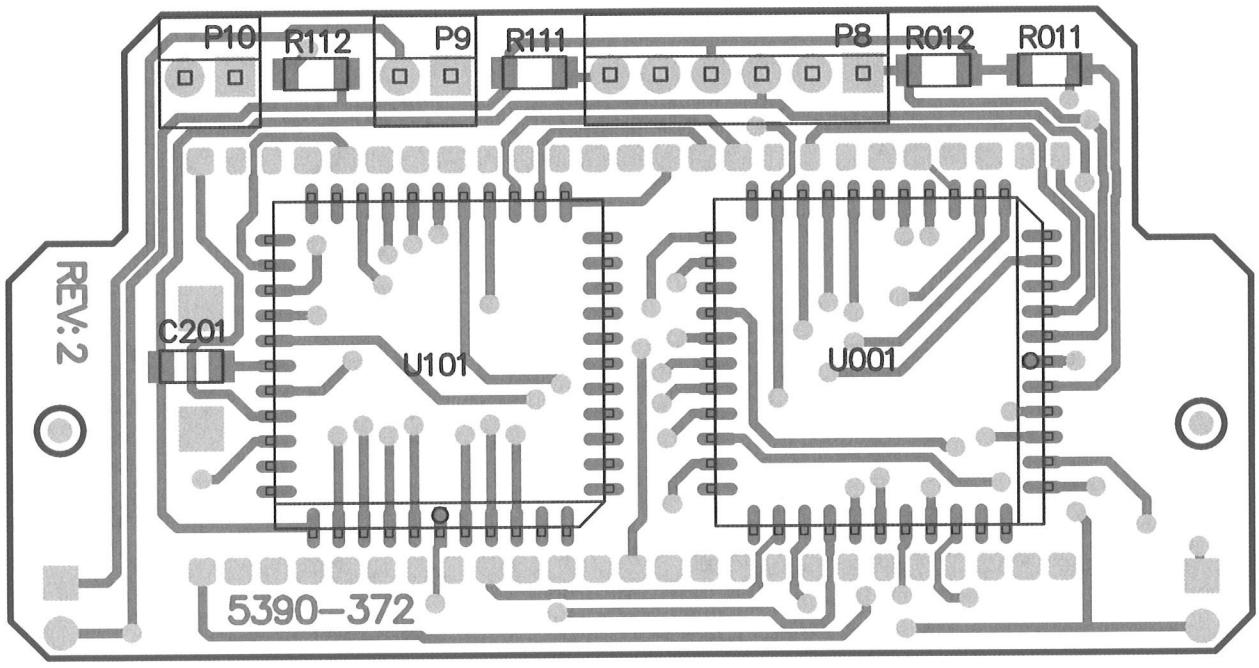

LUDLUM MEASUREMENTS, INC.		PO Box 810 501 Oak Street Sweetwater, TX 79556 U.S.A. 1-800-622-0828	
Title: LCD Display -STEK LCD (2013)			
Drawn: CKB	11/08/2013	**Model:** 2360	
Design: RSS	11/08/2013	**Board#:** 5390-372	
Approve: RDS	1 Jul 14	**Rev:** 2	
PCBA Drawing		**SCALE: 1.05**	**Series** 390 / **Sheet** 373A
Print Date: 7/1/2014 11:31:03 AM		Bottom Overlay	
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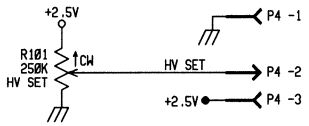
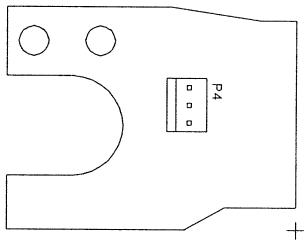
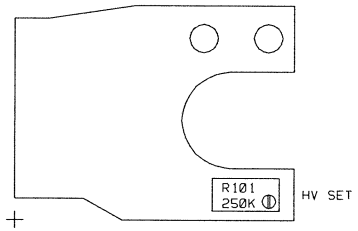
REVISIONS						
EFF	AUTHORITY	ZONE	LTR	DESCRIPTION	DATE	APPROVED



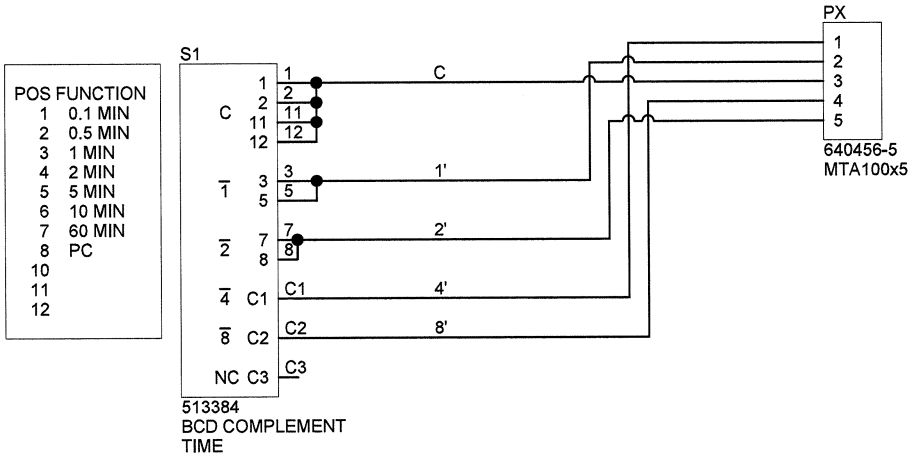
UPDATED -	/ /	LUDLUM MEASUREMENTS INC.
DR CKB	12/14/96	
CHK RSS	3/14/97	TITLE: CALIBRATION BOARD
DSGN RSS	12/14/96	BOARD# 5390-172
APPD JG WJ	3/14/97	SIZE D / MODEL 2360 / SERIES 390 / SHEET 176
NEXT HIGHER ASSY. -		
13:49:27	16-Dec-96	SB390172 / SHEET 1 OF 1



LUDLUM MEASUREMENTS INC. SWEETWATER, TX.					
DR CKB	12/14/96	TITLE: CALIBRATION BOARD			
		BOARD# 5390-172	BS390104		
DSGN RSS	12/14/96	MODEL 2224-1	SERIES 390	SHEET 177	
APP		COMP ARTWORK ☐	SLDR ARTWORK ☐		
09:38:12	20-Nov-96	COMP OUTLINE ☐	SLDR OUTLINE ☒		
COMP PASTE ☐	COMP MASK ☐	SLDR PASTE ☐	SLDR MASK ☐		



LUDLUM MEASUREMENTS INC. SWEETWATER, TX.			
DR CKB 12/14/96	TITLE: CALIBRATION BOARD		
	BOARD: 5390-172		
DSGN RSS 12/14/96	MODEL: 2360		
APP BS 3/5/13	FILENAME: BS390172		
COMPONENT / SOLDER	09:48:56	31-Jul-12	
OUTLINE / OUTLINE	REVISION 1.0	SERIES 390	SHEET 177



LUDLUM MEASUREMENTS, INC.		PO Box 810 501 Oak Street Sweetwater, Texas 79556 U.S.A. 1-800-622-0828	
Drawn: CKB	03/27/01	**Title:** BCD Board	
Design: PW	10/30/96	**Model:** 2360	
		Board#: 5261-154	
Approve: RDS 7Sep12		**Sheet:** 1 of 1	**Series** 261 / **Sheet** 107
Print Date: 9/7/2012 4:39:16 PM		**Rev:** 1	
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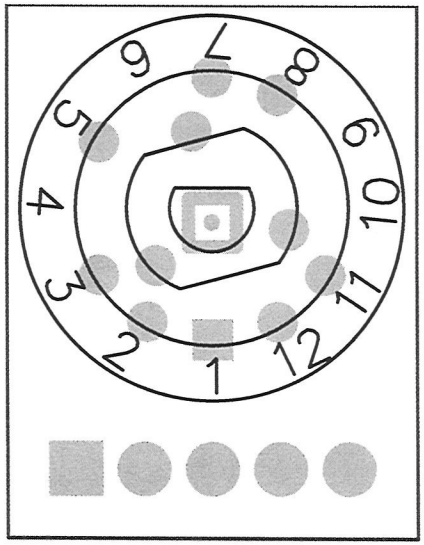

LUDLUM MEASUREMENTS, INC.

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

Title: BCD Board

Drawn: CKB	03/27/01	**Model:** 2360	
Design: PW	10/30/96	**Board#:** 5261-154	
Approve: RDS	18 Nov 15	**Rev:** 2	
Print Date: 1/14/2014 2:08:01 PM		**SCALE: 1.00** Top Overlay	**Series** 261 / **Sheet** 105 A

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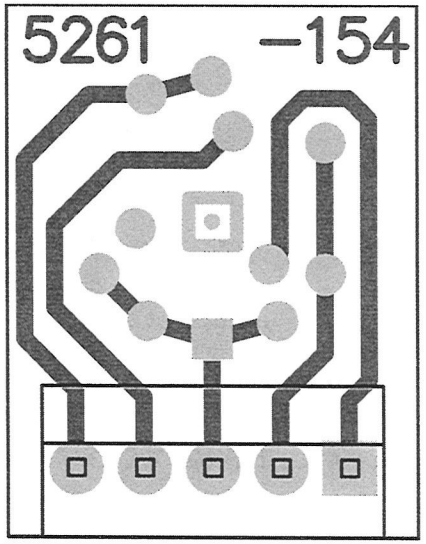

PX
640456-5

LUDLUM MEASUREMENTS, INC.

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

Title: BCD Board

Drawn: CKB	03/27/01	**Model:** 2360	
Design: PW	10/30/96	**Board#:** 5261-154	
Approve: RDS	18 Nov 15	**Rev:** 2	
Print Date: 1/14/2014 2:08:04 PM		**SCALE: 1.00** Bottom Overlay	**Series** 261 / **Sheet** 105 A

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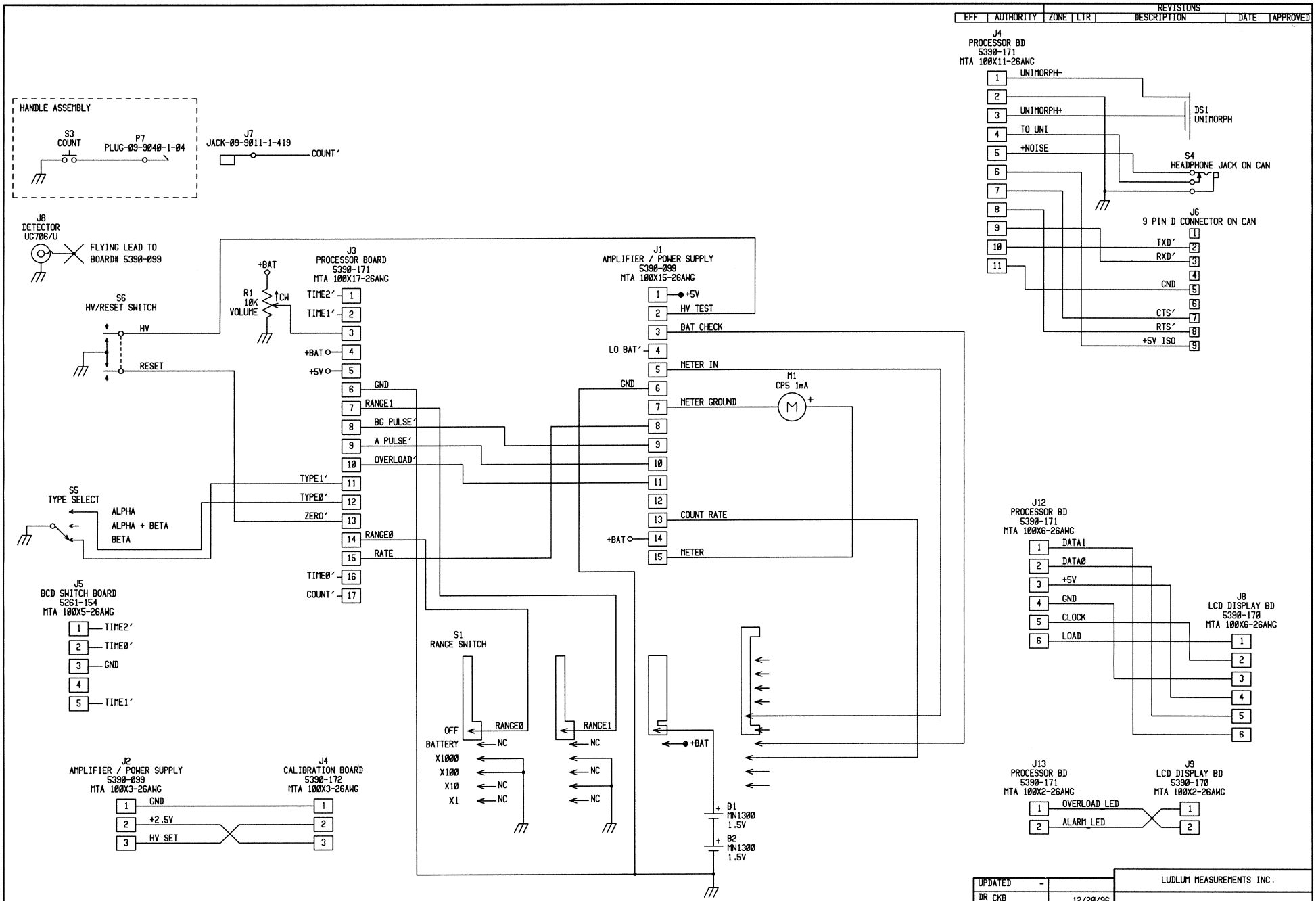
REVISIONS
EFF | AUTHORITY | ZONE | LTR | DESCRIPTION | DATE | APPROVED
HANDLE ASSEMBLY
S3 COUNT
P7 PLUG-09-9040-1-04
J7 JACK-09-9011-1-419
COUNT'
J8 DETECTOR UG706/U
FLYING LEAD TO BOARD# 5390-099
S6 HV/RESET SWITCH
HV
RESET
+BAT
R1 10K VOLUME
CW
J3 PROCESSOR BOARD 5390-171 MTA 100X17-26AWG
TIME2'
TIME1'
+BAT
+5V
GND
RANGE1
BG PULSE'
A PULSE'
OVERLOAD'
TYPE1'
TYPE0'
ZERO'
RANGE0
RATE
TIME0'
COUNT'
J1 AMPLIFIER / POWER SUPPLY 5390-099 MTA 100X15-26AWG
+5V
HV TEST
BAT CHECK
LO BAT'
METER IN
GND
METER GROUND
M1 CP5 1mA
COUNT RATE
+BAT
METER
S5 TYPE SELECT
ALPHA
ALPHA + BETA
BETA
J5 BCD SWITCH BOARD 5261-154 MTA 100X5-26AWG
TIME2'
TIME0'
GND
TIME1'
S1 RANGE SWITCH
OFF
BATTERY
X1000
X100
X10
X1
RANGE0
RANGE1
NC
+BAT
B1 MN1300 1.5V
B2 MN1300 1.5V
J2 AMPLIFIER / POWER SUPPLY 5390-099 MTA 100X3-26AWG
GND
+2.5V
HV SET
J4 CALIBRATION BOARD 5390-172 MTA 100X3-26AWG
J4 PROCESSOR BD 5390-171 MTA 100X11-26AWG
UNIMORPH-
UNIMORPH+
TO UNI
+NOISE
DS1 UNIMORPH
S4 HEADPHONE JACK ON CAN
J6 9 PIN D CONNECTOR ON CAN
TXD'
RXD'
GND
CTS'
RTS'
+5V ISO
J12 PROCESSOR BD 5390-171 MTA 100X6-26AWG
DATA1
DATA0
+5V
GND
CLOCK
LOAD
J8 LCD DISPLAY BD 5390-170 MTA 100X6-26AWG
J13 PROCESSOR BD 5390-171 MTA 100X2-26AWG
OVERLOAD LED
ALARM LED
J9 LCD DISPLAY BD 5390-170 MTA 100X2-26AWG
UPDATED -
DR CKB 12/20/96
CHK 3-14-97
DSGN RSS 10/03/96
APPD JSW 3-14-97
NEXT HIGHER ASSY. -
17:27:27 10-Feb-97
LUDLUM MEASUREMENTS INC.
TITLE: WIRING DIAGRAM
BOARD# 390-173
SIZE C | MODEL 2360 | SERIES 390 | SHEET 179
W390173
SHEET 1 OF 1