LUDLUM MODEL 4901P
PANCAKE G-M
HAND AND SHOE MONITOR

October 2000
Serial No. 154263, 160842,
160843, 169381 and Succeeding
Serial Numbers

LUDLUM MEASUREMENTS, INC.
501 OAK ST., P.O. BOX 810
SWEETWATER, TX 79556
915/235-5494 FAX: 915/235-4672

TABLE OF CONTENTS

LUDLUM MEASUREMENTS, INC.
501 OAK STREET
P.O. BOX 810
SWEETWATER, TEXAS 79556

DESIGNER AND MANUFACTURER
OF
Scientific and Industrial Instruments

800-622-0828 (USA) **915-235-4672 (FAX)** **915-235-5494**

M 4901P Assembly and Disassembly Instructions

The hand detector vertical sections are now shipped detached from the foot detector section. Four (4) screws (8-32X1/2") are used to reattach the vertical sections. A connector is used to distribute power/signals to and from the detectors and main electronics.

✔**Note:** The floor pan is wired such that either upright section may be attached to either side. The floor pan therefore is "non-polarized," and the main electronics will recognize the right and left foot detectors correctly.

Suggested Assembly (Setup) Procedure:

1) Carefully unpack the two upright sections and the floor pan section.

2) Loosen the four screws located on the end of the foot detector section. Leave the upper two screws in place with about ¼" of thread showing. Remove the lower two screws.

3) Lay one of the uprights (detector face down) on the floor or workbench near the opening on either end of the foot section.

4) Look inside the opening for the header that will accept the red plug at the lower end of the upright. Carefully attach the plug to this header.

✔**Note:** The wires should exit the header/plug pointing downward. Make sure the plug is positioned properly (there should be no pins showing on either side of the plug).

5) Carefully raise the upright and hang the assembly on the two screws that were left in step 2 above. The upper holes in the ears of the upright are slotted.

6) Start the two lower screws and tighten all four of these securely.

7) Repeat steps 2 through 6 above for the remaining upright section.

8) Attach the power cord and turn the unit ON.

9) Check that the unit returns to normal service (**READY** LED will light) after the 60-second update interval has expired.

Suggested Disassembly (Teardown) Procedure (over)

LUDLUM MEASUREMENTS, INC.
501 OAK STREET
P.O. BOX 810
SWEETWATER, TEXAS 79556

DESIGNER AND MANUFACTURER
OF
Scientific and Industrial Instruments

800-622-0828 (USA) **915-235-4672 (FAX)** **915-235-5494**

M 4901P Assembly and Disassembly Instructions (continued)

Suggested Disassembly (Teardown) Procedure

1) Turn the power OFF to the Model 4901P and remove the power cord from the receptacle.

2) Place the unit on a workbench or other suitable work area.

3) Loosen the four screws holding one of the upright sections.

4) Leave the upper two screws in place and completely remove the lower screws.

5) Carefully lift the upright off and away from the foot section while disconnecting the harness from the floor header.

6) Reinstall the lower two screws and tighten them to prevent loss.

7) Pack the upright sections and the foot detector section well enough to prevent contact with each other and to provide good cushioning.

✔**Note:** At least two inches of packing should be provided.

1. GENERAL

The Model 4901P Beta/Gamma Hand & Shoe Monitor is intended for use as a medium-level beta and gamma contamination monitor. There are four count channels in the standard configuration, monitoring the palms of each hand and the soles of each shoe.

The Model 4901P employs a total of twenty-two pancake Geiger-Mueller (GM)-type detectors, five in each hand detector (palm side only) and six in each foot detector. LED indicators show status and alarm location. The Model 4901P allows parameter updating by viewing the built-in 16-character LCD display. Detector counts, background, alarm set points and all parameters may be viewed on the LCD display.

Switches at each hand detector initiate an interrogation (both switches must activate). Audible alarm and status change indications are standard.

Features of the Model 4901P include: automatic background accumulate with subtract, password protection of parameters, pushbutton adjustment of the alarm audio volume and simple LED status indicators. All parameters are stored in non-volatile memory, requiring no backup battery.

2. SPECIFICATIONS

- **WEIGHT**: 45 lbs.
- **DIMENSIONS**: 29.5" wide X 15" deep X 40" tall.
- **POWER**: 102-132 VAC, 50/60 Hz, 50 watts maximum.
- **FUSE**: 2 each F-1A, 1 amp, 5 x 20mm, 250 volt.
- **BACKGROUND COUNT RATE:**

  HANDS: 200 to 250 cpm.

  FEET: 250 to 300 cpm.

- **DETECTOR EFFICIENCY (4 pi)**:

  HANDS:
  12% (4pi) Tc-99
  12% (4pi) Cs-137
  3% (4pi) C-14
  Cs-137, 100 sq.cm. yields 7%.

  FEET:
  10%(4pi) Tc-99
  10% (4pi) Cs-137
  3% (4pi) C-14 **(✔ Note: This 1 inch diameter source was placed across feet bars where shielding was minimal.)**
  Cs-137, 100 sq. cm. yields 4%.

✔ **Note**: Data taken with 25 to 47 mm disc sources placed directly over pancake tube, except where noted.

- **COUNTING CAPACITY**: 9999 counts per minute.
- **SENSITIVITY**: 85 millivolts nominal.
- **COUNT TIME**: Adjustable from 1 to 99 seconds
- **ALARM HOLD TIME**: Adjustable from 1 to 99 seconds
- **AUDIO**: Piezo speaker with keypad adjustable alarm volume.

- **BACKGROUND TIME:** Background accumulate time, adjustable from 1 - 99 seconds.

- **BACKGROUND UPDATE INTERVAL:** Adjustable from 1 to 99 minutes. A background count will take place, if the machine is not in use at every interval specified by this timer.

- **FORCE UPDATE:** Background accumulation will be forced within this interval of time if an automatic accumulation has not been made.

3. DESCRIPTION OF CONTROLS AND FUNCTIONS

- **READOUT**: LCD, one line, 16-character alphanumeric display.

- **EXIT Key**: Moves back one menu selection.

☞SPEED TRICK: Press-and-hold the **EXIT** key to quickly return to the **READY** menu.

- **Increment (Up Arrow "↑") Button**: Moves up one line in the current menu.

WITHIN PARAMETER SETUP: A digit increments by one. An on/off parameter toggles to the other state.

- **Decrement (Down Arrow "↓") Button**: Moves down one line in the current menu.

WITHIN PARAMETER SETUP: A digit decrements by one. An on/off parameter toggles to the other state.

- **SELECT Key**: Selects the current menu choice.

☞SPEED TRICK: If the **SELECT** key is held down while a count channel is being displayed, the alarm level for that channel displays. Releasing the **SELECT** key returns to the count for that channel.

- **SAVE Key**: Recessed pushbutton that saves all parameters to non-volatile memory. This button can only be operated by inserting a small screwdriver or pin through the hole. All of the microprocessor RAM is transferred to flash memory when this button is pushed. Any changes made to variables only change the current microprocessor RAM. If the Model 4901P is turned off prior to saving changes, these changes are lost. To save parameter changes, press the **SAVE** button before turning the Model 4901P off. Upon power-up, the flash memory is loaded into the microprocessor.

- **LEDS:** (Refer to drawings at the back of this manual for LED layout)

- **READY** LED: Must be lit prior to any interrogation.

NOTE: It is possible to begin an interrogation from any setup prompt (when all LED's are on). A count may be started by pressing either of the hand switches, causing the **READY** LED to activate, followed by the **COUNTING** LED.

- **COUNTING** LED: Indicates that a hand count is in progress. Deactivating either of the hand switches prior to expiration of the count time will cause this light to go off and the **SHORT COUNT** LED to come on. When the count is complete, the **CHECK OK** or **ALARM** LED activates. **CHECK OK** lights for 2 seconds or until the hand switches are released. The **SHORT COUNT** LED stays on for the alarm hold time or until a hand

switch is reactivated. If no hand switch is sensed during the short count time, then the Model 4901P goes back to the ready state, lighting the **READY** LED.

- **CHECK OK** LED: Indicates that a count has been completed and no alarms were sensed. This LED will stay on until the hand switches are released or for 2 seconds.

- **ALARM**: Indicates that a count has exceeded the alarm set point. The individual **LH, RH, LF or RF** LED lights as soon as alarm is sensed and remain(s) lit for the alarm hold time. The Model 4901P will return to the ready state. The master **ALARM** LED and audible alarm will activate after the end of the count time and the user has removed both hands from the switches. This condition will exist for the duration of the **ALARM HOLD TIME**.

- **SHORT COUNT** LED: Indicates that a count was in progress and the user raised off either hand switch. The **SHORT COUNT** LED stays on for the alarm hold time or until the hand switches are re-activated. A short count resets the count time. If no hand switch is sensed during the short count time, then the Model 4901P goes back to the ready state lighting the **READY** LED.

- **POWER/OK** LED: Indicates that 5Vdc is available on the central processor board.

- **LH, RH, LF, RF** LED's: Indicate which channel in a count has alarmed. These light as soon as an alarm is sensed. When the count is complete, the **CHECK OK** will not light. The **ALARM** LED and audio stay on for the alarm hold time, then the Model 4901P goes back to the ready state lighting the **READY** LED.

- **Power On/Off**: Switch to turn instrument on and off.

4. ASSEMBLY INSTRUCTIONS

The hand detector vertical sections are shipped detached from the foot detector section. Four (4) screws (8-32X1/2") are used to reattach the vertical sections. A connector is used to distribute power/signals to and from the detectors and main electronics.

Note: The floor pan is wired such that either upright section may be attached to either side. The floor pan therefore is "non-polarized," and the main electronics will recognize the right and left foot detectors correctly.

4.1 Assembly (Setup) Procedure

1. Carefully unpack the two upright sections and the floor pan section.

2. Loosen the four screws located on the end of the foot detector section. Leave the upper two screws in place with about ¼" of thread showing. Remove the lower two screws.

3. Lay one of the uprights (detector face down) on the floor or workbench near the opening on either end of the foot section.

4. Look inside the opening for the header that will accept the red plug at the lower end of the upright. Carefully attach the plug to this header. Note: The wires should exit the header/plug pointing downward. Make sure the plug is positioned properly (there should be no pins showing on either side of the plug).

5. Carefully raise the upright and hang the assembly on the two screws that were left in step 2 above. The upper holes in the ears of the upright are slotted.

6. Start the two lower screws and tighten all four of these securely.

7. Repeat steps 2 through 6 above for the remaining upright section.

8. Attach the power cord and turn the unit ON.

9. Check that the unit returns to normal service (**READY** LED will light) after the 60-second update interval has expired.

4.2 Disassembly (Teardown) Procedure

1. Turn the power OFF to the M4901P and remove the power cord from the receptacle.

2. Place the unit on a workbench or other suitable work area.

3. Loosen the four screws holding one of the upright sections.

4. Leave the upper two screws in place and completely remove the lower screws.

5. Carefully lift the upright off and away from the foot section while disconnecting the harness from the floor header.

6. Reinstall the lower two screws and tighten them to prevent loss.

7. Pack the upright sections and foot detector section well enough to prevent contact with each other and to provide good cushioning. Note: at least two inches of packing should be provided.

5. UNIT SETUP

This section gives instructions on how to use the keys to setup the instrument. Examples of keystroke sequences are given for each parameter. For information on using the instrument to make a radiation check, see section 4. For more information on menu layouts, see Figures 1-4 in Section 8.

5.1 Setup Menu

The setup menu has six choices:

1- Setup ALARMS MENU
2- Setup BACKGROUND MENU
3-Setup CAL MENU
4-Setup PASWORD MENU
5- Setup TIME MENU
6- Setup VOLUME MENU

To change a parameter, access the variable of interest through the setup menus using the **SELECT** and **increment/decrement** "↑/↓" keys. Press the **SELECT** key to change the parameter. The cursor becomes visible and blinks on the variable to change. On multiple digit variables, press the **SELECT** key to access the next digit.

☞SPEED TRICK: After changing a parameter, press and hold **SELECT** until a beep is heard. This will quickly exit the setup parameter mode. The setup mode has a blinking cursor.

5.1.1 Set up Alarm Menu

The SETUP ALARM menu allows changes to be made to the individual count alarms. All alarm and background values are in units of Counts per Minute.

- **INDIVIDUAL ALARMS**

The individual channel alarms are lefthand, righthand, leftfoot and rightfoot (LH, RH, LF, and RF).

If the counts are greater than or equal to the count alarm set point for an individual channel during the count time, then the individual alarms LED's (**LH, RH, LF, RF**) activate. When the count time expires and an alarm is present, the alarm audio sounds and the main **ALARM** LED activates. The alarm will sound for the preset ALARM HOLD TIME.

To access the SETUP ALARM menu:

☐ Turn the instrument ON. Wait for **READY** to display on LCD.

☐ Press **SELECT** once, to select the setup menu. SETUP menu appears.

☐ Press **SELECT** once to execute the setup menu. ALARMS menu appears.

☐ Press **SELECT** once to execute the alarms menu. LH ALARM XXXX appears. The XXXX is a number between 0 and 9999. This is the current Left Hand Alarm setting.

☐ To change the current setting press **SELECT** to activate the first digit. Use **increment/decrement** "↑/↓" to change first digit as desired. Press **SELECT** to activate the second digit. Use **increment/decrement** "↑/↓" to change second digit as needed. Press **SELECT** to temporarily save the setting.

☐ From the LH ALARM XXXX selection, the increment/decrement keys may be pressed to access further parameters.

☐ Press the **EXIT** key to exit back to the ALARMS menu.

NOTE: Activate the **SAVE** function in order to store all new parameters in non-volatile memory before power down. A small screwdriver, or other object must be used to activate the save feature.

- **LOW BACKGROUND ALARMS**

Set the parameter for LO BKGND-RH to a value that would allow detection of a bad detector. For backgrounds near 100 counts in one minute this might be 50. Set the LO BKGND-LH, LF, and RF parameter to similar values.

- **HIGH BACKGROUND ALARMS**

Set the high background parameters to preclude nuisance alarms from varying backgrounds. For backgrounds near 100 counts per minute, choose 175. Set both the LH/RH and LF/RF high background set points.

5.1.2 Setup Background Menu

Access the SETUP menu:

☐ With **READY** displayed on LCD.

☐ Press **SELECT** once to select the setup menu. SETUP menu appears.

☐ Press **SELECT** once again to execute the setup menu. ALARMS menu appears.

☐ Press **decrement** "↓" once to advance to the BACKGRND MENU.

☐ Press **SELECT** once to activate menu.

☐ Press **SELECT** and use either **increment** or **decrement** "↑/↓" key to toggle the background subtract feature on or off as desired. This will normally be left in the On position. Activate and exit the on/off prompt by pressing the **SELECT** key one last time.

☐ Press the **decrement** "↓" key to move to the **FORCE UPDATE** interval timer. Press the **SELECT** key to edit this timer as desired. This interval is the maximum time allowed between updates and would normally be set to 15 or 30 minutes. This parameter should be set prior to setting the Update Interval Time or Background Count Time and must always be larger than or equal to either of those (see below). Save and exit this menu item by pressing the **SELECT** key one last time.

☐ Press the **decrement** "↓" key to select the **BKGND UPD INT** timer. This parameter sets the time that will elapse after a hand switch event has ended and a background update takes place. Typical settings are 01 minute. Save and exit this item by pressing the **SELECT** key one time. Note: this parameter must be greater than or equal to the **BKGROUND TIME** parameter below and less than or equal to the **FORCE UPDATE** parameter above.

☐ Press the **decrement** "↓" key to select the **BKGROUND TIME**. This is the actual background count time and may be set from 1 to 99 seconds. Longer count times will tend to smooth the background subtract data. Typical count times might be 60 seconds. Note: This number must be less than or equal to the **FORCE UPDATE** and **BKGND UPD INT** parameters as described above.

5.1.3 Setup Time Menu

This menu sets the count time and alarm hold time. The alarm hold time also applies to the **SHORT COUNT** LED.

To access the SETUP TIME menu:

☐ With **READY** displayed on the LCD.

☐ Press **SELECT** once to select the setup menu. SETUP menu appears.

☐ Press **SELECT** once again to execute the setup menu. ALARMS menu appears.

☐ Press the **increment** "↑" key twice. TIME MENU appears.

☐ Press **SELECT** once to execute the setup time menu. COUNT TIME XX appears. The XX is a number between 0 and 99 (seconds).

☐ Press **SELECT** to activate the first digit. Use **increment/decrement** "↑/↓" to change the first digit. Press **SELECT** to activate the second digit. Use **increment/decrement** "↑/↓" to change the second digit. Press **SELECT** to temporarily save parameter.

☐ Use **increment/decrement** "↑/↓" to change to the next setting.

☐ Press the **EXIT** key to exit back to the TIME menu.

- **COUNT TIME**

The count time is adjustable between 1 and 99 seconds. This time applies to a count activated by the hand switches. Both of the hand switches must be held down for the duration of the count. If they are not, the **SHORT COUNT** LED activates.

- **ALARM HOLD TIME**

The alarm hold time is adjustable from 1 to 99 seconds. This time applies to a hand count that has alarmed. If the **ALARM** LED lights, then this light and alarm audio will be held for the alarm hold time. The **SHORT COUNT** LED will also light for this hold time.

NOTE: Remember to press the **SAVE** key in order to store parameters in non-volatile memory prior to power down.

5.1.4 Setup Volume Menu

The volume menu sets only the ALARM volume. The Model 4901P emits a beeping sound after various events (mode change, parameter change, etc.). This beeping volume is always at the maximum and is not adjustable.

To access the SETUP VOLUME menu:

☐ **READY** is displayed on LCD.

☐ Press **SELECT** once to select the setup menu. SETUP menu appears.

☐ Press **SELECT** once again to execute the setup menu. ALARMS menu appears.

☐ Press the increment key once. VOLUME MENU appears.

☐ Press **SELECT** once to execute the setup volume menu. ALARM VOLUME XXX appears. The XXX is a number between 0 and 255. This variable sets from 255 (lowest level) to 000 (maximum level). Any audio alarm uses this volume set point. The beep audio is not affected by this setting.

☐ Press **SELECT** to activate the first digit. Use **increment/decrement** "↑/↓" to change the first digit. Press **SELECT** to activate the second digit. Use **increment/decrement** "↑/↓" to change the second digit. Repeat for third digit. Press **SELECT** to save.

☐ Press the **EXIT** key to exit back to the VOLUME menu.

NOTE: Remember to press the **SAVE** key in order to store any changed parameters in non-volatile memory prior to power down.

5.2 Read Menu

The read menu has three choices:

1- Read Alarms Menu
2- Read Time Menu
3- Read Volume Menu

The read menu accesses the same menu structure as the Setup Menu. **However, no variables may be changed from the read menu.**

5.2.1 Read Alarms Menu

To access the READ ALARMS menu:

☐ Turn the instrument ON. Wait for **READY** to display on LCD.

☐ Press **SELECT** once to select the setup menu. SETUP menu appears.

☐ Press increment key "↑" once. READ menu appears.

☐ Press **SELECT** once to execute the read menu. ALARM menu appears.

☐ Press **SELECT** once to execute the alarms menu. GLOBAL ALARM XX appears. The XX is a number between 0 and 99.

☐ Use the increment/decrement "↑/↓" keys to change to the next alarm channel.

☐ Press the **EXIT** key to exit back to the ALARMS menu.

5.2.2 Read Time Menu

This menu reads all of the time parameters of the Model 4901P. The user cannot change these values from this menu.

To access the READ TIME menu:

☐ Turn instrument ON. Wait for **READY** to display on LCD.

☐ Press **SELECT** once to select the setup menu. SETUP menu appears.

☐ Press **decrement** key "↓" once. READ menu appears.

☐ Press **SELECT** once to execute the read menu. ALARMS menu appears.

☐ Press decrement key "↓" once. TIME menu appears.

☐ Press **SELECT** once to execute the time menu. COUNT TIME XX appears. The XX is a number between 0 and 99.

☐ Use the increment/decrement "↑/↓" keys to change to other time parameters.

☐ Press the **EXIT** key to exit back to the TIME menu.

5.2.3 Read Volume Menu

This menu reads all of the volume parameters of the Model 4901P. The user cannot change these values from this menu.

To access the READ VOLUME menu:

☐ Turn the instrument ON. Wait for **READY** to display on LCD.

☐ Press **SELECT** once to select the setup menu. SETUP menu appears.

☐ Press decrement key "↓" once. READ menu appears.

☐ Press **SELECT** once to execute the read menu. ALARMS menu appears.

☐ Press decrement "↓" key twice. VOLUME menu appears.

☐ Press **SELECT** once to execute the time menu. ALARM VOLUME XXX appears. The XXX is a number between 0 and 255.

☐ Use the increment/decrement "↑/↓" keys to change to other parameters.

☐ Press the **EXIT** key to exit back to the VOLUME menu.

5.2.4 Password Menu

This menu sets the password and whether the password is On or Off.

To access the PASSWORD menu:

☐ With READY displayed on the LCD.

☐ Press SELECT once to select the setup menu. SETUP menu appears.

☐ Press SELECT once to execute the setup menu. ALARMS menu appears.

☐ Press the increment or decrement "↑/↓" keys until the PASSWORD menu appears.

☐ Press SELECT once to execute the password on/off menu. PASSWORD: XXX appears. The XXX is either ON or OFF.

☐ Press SELECT to change the password status. Use increment/decrement "↑/↓" to change to either ON or OFF. Press SELECT to temporarily save parameter.

☐ Use increment/decrement "↑/↓" to change to the next setting. ENTER PASS: XXXX appears.

☐ To reset the PASSWORD to 0000, hold down the SAVE key while turning on the instrument.

☐ Press SELECT to activate the first digit. Use increment/decrement "↑/↓" to change the first digit. Press SELECT to activate the second digit. Use increment/decrement "↑/↓" to change the second digit. Repeat for third and fourth digit. Press SELECT to save.

☐ Press the **EXIT** key to exit back to the TIME menu.

NOTE: Press the SAVE key in order to store parameters in non-volatile memory prior to power down.

5.3 Cal Menu

The Cal menu has two choices:

5.3.1 Display of Hands Count Data

Selecting this mode provides a one second updating display of the current count from the hand detectors (in counts per second). This mode is used for setting or checking the threshold level and as a general diagnostic using a pulser or source counts from the detectors.

5.3.2 Display of Feet Count Data

Selecting this mode provides fast, one second updating display of the current count from the feet detectors (in counts per second). This mode is used for setting or checking the threshold level and as a general diagnostic using a pulser or source counts from the detectors.

6. USER OPERATION

This section gives instructions on how to use the instrument to make a radiation check. For information on Parameter Setup, see Section 5.

A count starts when both of the hand switches are held down. If the LCD was in a SETUP menu, then the LCD returns to the READY menu and a normal count will take place. If the LCD was in READ COUNTS menu the LCD will remain in this menu and the interrogation will proceed normally. Note: When monitoring counts via the CAL MODE, an interrogation will not be available (the READY LED will be extinguished).

Prior to operation, the monitor must be allowed to update the background count. This mandatory update occurs just after power-up and after expiration of the Force Update interval timer. New background count data is compared to the low and high background set points that have been programmed into the unit. If the set points have been exceeded, an alarm is given (check individual LED's for offending channel) and the unit returns to updating background.

In order to make a radiation check, follow the steps below.

☐ The green **READY** light must be lit in order to use the instrument.

☐ Step up and position both hands over the detectors.

☐ Place palms flat against the bottom screen and push inward until the green **COUNTING** light turns on.

☐ The yellow **SHORT COUNT** light will turn on if the hands are removed before the count is complete.

☐ Once count is complete, the green **CHECK OK** light or the red **ALARM** light will turn on. Smaller red lights will turn on with the **ALARM** light to indicate the location of the alarm.

☐ Remove hands and step off instrument.

7. COMPATIBLE FIRMWARE VERSIONS

FIRMWARE- A computer program loaded into permanent memory of the instrument. This hardware (memory) cannot be changed in its user environment.

This manual works with instrument firmware versions:

M4901P: 420-03-N01

The firmware number displays when the instrument is first turned on or may be viewed through the diagnostic menu.

8. CALIBRATION PROCEDURE

8.1 General

The Model 4901P was set up for 80 mV sensitivity and 900 Vdc operation for G.M. type detectors.

8.2 Equipment

1. Ludlum Model 500 Pulser or equal

2. High Impedance voltmeter for high voltage measurements (10 megohm)

3. 8 to 15 volt DC power supply with modular connection (pin 2 is positive and pin 3 is ground) polarity protected

8.3 Annual Calibration Verification Procedure

Calibration of the Model 4901P is accomplished by checking the threshold level at each preamplifier board (LMI #5436-040) located on each detector.

The design threshold level is 80 mV and operating high voltage is approximately 900 Vdc.

☐ Using a clip lead cable, connect the Model 500 Pulser to the detector ballast board (see figure 1) and apply power to the board.

☐ Sweep pulser amplitude for a negative leading edge 70 to 90 mV pulse and confirm counter turn on at 80 mV +/- 5 mV. If necessary adjust R1 (THS) until pulses just appear.

☐ Check for 900 Vdc +/- 10 V at the detector ballast board. If necessary, adjust R4 (HV ADJ) for 900 Vdc at the ballast board input.

9. TROUBLE SHOOTING

The block diagram of the M4901P can be thought of as four detectors connected to a multi-counter MAIN board. All detectors operate from a single, high voltage power supply (HVPS). This supply is located on the Main Electronics chassis just below the Main board. The count data appears at this Main board as 5-volt digital pulses. These pulses are generated on the preamplifier board at each of the four detectors. Calibration is performed on each detector and consists of setting the lower level threshold or discriminator (LLD) and setting the HV bias to the proper operating point.

The User LED board presents status information to the user via a serial data stream from the Main controller board. This serial data is placed into two drivers that directly drive the LED's.

The Main control board also sends data to the LCD display. The LCD is intended for setup purposes as well as diagnostics. It is not necessary for the user to view the LCD screen under normal conditions. Count data can be reviewed in the display if desired.

The "pancake" G.M. detectors used in this model are simple in application but can cause headaches when "ganged" in parallel as in the M4901P. One bad detector can cause the entire unit to become noisy, due mainly to the use of the single HVPS. Normally, only one detector becomes noisy and the culprit can be found in that particular array. A quick visual check may reveal the bad detector. Inspect the thin membrane cover of each of the pancakes to see if one of them has lost its gas. The membrane will look loose or wrinkled and when touched (carefully) will make a crackling sound. This one will definitely need replacement. If you find no broken membranes and you are in a relatively quite area, you can listen to each tube for the one that is noisy. Each event in the tube is an avalanche of charge (a spark) so they can be heard rather easily, provided you have adequate HV bias. A single bad probe can pull the HV bias down and prevent all others from working.

As a last resort the detector array in question will have to be removed and each detector signal wire unplugged until the offending pancake has been located. The signal wires have a connector on one end to facilitate fast, no-solder removal.

There are no batteries required for parameter storage during power down. All parameters are saved in Flash memory when the Store button is pressed. Press store anytime you change parameters and wish them to be used from then on. If you do not press store, the old values will reappear after the next power down and up cycle.

PARTS LIST

Ref. No.	Description	Part No.
	Model 4901P Hand & Shoe	
UNIT	CompletelyAssembled M4901P Hand & Shoe Monitor	48-3009
	HVPS Board, Drawing 436 x 53	
BOARD	Assembled HVPS	5436-042
•	**CAPACITORS**	
C001	10µF 20V	04-5655
C002	1µF 35V	04-5656
C011-C014	0.0047µF 3KV C	04-5547
C021-C023	0.0047µF 3KV C	04-5547
C024	0.0027µF 3KV C NPO	04-5520
C031	0.0027µF 3KV C NPO	04-5520
C101	1µF 35V	04-5656
C102	10µF 20V	04-5655
C111	0.0047µF 3KV C	04-5547
C112	0.01µF 50V X7R	04-5664
C113	0.1µF 50V X7R	04-5663
C114	0.01µF 50V X7R	04-5664
C121	100pF 3KV 30GAT10	04-5532
C122	0.0047µF 3KV C	04-5547
C123	100pF 100V COG	04-5661
C124	0.1µF 50V X7R	04-5663
C128	0.1 µF 16V	04-5701
C131	68µF 6.3V	04-5654
C211	47µF 10V	04-5666
C212	0.0022µF 50V COG	04-5676
C213	47µF 10V	04-5666
C214	10µF 20V	04-5655
C221	10µF 20V	04-5655
C231	0.1µF 50V X7R	04-5663
C311	1µF 35V	04-5656
•	**DIODES**	
CR021-CR022	1N4007	07-6274
CR031-CR032	1N4007	07-6274
CR101	1N5817	07-6290
DS001	LED-HLMP 3502	07-6280
DS002	LED-HLMP 3000	07-6288
•	**TRANSISTORS**	
Q001	2N7002L	05-5840
Q002	PQ05SZ11 5V	05-5858
Q121	2N7002L	05-5840
Q131	MTD10N05E	05-5839
Q211	PQ20VZ51	05-5863
Q221	MMBT3904T	05-5841
Q222	MMBT4403LT1	05-5842
Q223	TIP120	05-5782
•	**CONNECTORS**	
J130	CONN RAPC712 93F7715	13-8445
P3,P5,P6	CONN-640456-2 MTA100	13-8073
P4	CONN-640456-4 MTA100	13-8088
•	**RESISTORS**	
R001	2.21K 1/8W 1%	12-7835
R002	3.32K 1/8W 1%	12-7870
R003	2.21K 1/8W 1%	12-7835
R011	475K 1/8W 1%	12-7859
R012	1 GIG-OHM FHV-1 2%	12-7686
R013	TRMR-1 MEG	09-6911
R014-R015	100 K 1/4W 5%	10-7023
R021	100 K 1/4W 5%	10-7023
R111	1M 1/8W 1%	12-7844
R112-R113	1 GIG-OHM FHV-1 2%	12-7686
R114	10 MEG 1/4W 5%	12-7955
R115	1M 1/8W 1%	12-7844
R116	TRMR-1 MEG	09-6911
R117	1K 1/8W 1%	12-7832
R121	1M 1/8W 1%	12-7844
R123	432K 1/8W 1%	12-7874
R124	33.2K 1/8W 1%	12-7842
R125	182K 1/8W 1%	12-7860
R126	1K 1/8W 1%	12-7832
R127	4.75K 1/8W 1%	12-7858
R201	7.5K 1/8W 1%	12-7847
R211	100K 1/8W 1%	12-7834
R212	165K 1/8W 1%	12-7877
R213	22.1K 1/8W 1%	12-7843
R214	1.27K 1/8W 1%	12-7902
R215	33.2K 1/8W 1%	12-7842
R221	22.1K 1/8W 1%	12-7843
R222	4.75K 1/8W 1%	12-7858
R223	1K 1/8W 1%	12-7832
R224	TRMR-10K 3269W1-103	09-6931
R225	18.2 K 1./8W 1%	12-7968
R226	10K 1/8W 1%	12-7839
R227	1K 1/8W 1%	12-7832
R228	10K 1/8W 1%	12-7839
R330	TRMR-10K 64W103	09-6787

Ref. No.	Description	Part No.
•	**INTEGRATED CIRCUITS**	
U111	TLC27M7ID	06-6292
U112	TLC372ID	06-6290
U121	ICM7555CBA	06-6300
U211	LT1054CS	06-6315
U221	LM285M-1.2	05-5845
U222	LMC7111BIM5	06-6410
•	**TRANSFORMERS**	
T121	XFMR-M 416-3 HV	4275-145
•	**MISCELLANEOUS**	
10 EA.	CLOVERLEAF RECPT-01106809-000	18-8771

LED Driver Board, Drawing 420 x 4

BOARD	Assembled LED Driver	5420-005
•	**INTEGRATED CIRCUITS**	
U140-U141	SN75512	06-6369
•	**RESISTORS**	
R148	200 OHM	10-7006
R149-R151	10k	10-7016
•	**RESISTOR NETWORKS**	
RN142-RN144	150 OHM	12-7741
•	**CONNECTORS**	
P23	CONN-640456-5 MTA100	13-8057

BALLAST BOARD, Drawing 420 X 155

BOARD	Assembled Ballast	5420-158
•	**CAPACITORS**	
C1	0.0047µF 3KV C04-5547	

Ref. No.	Description	Part No.
•	**RESISTORS**	
R1-R2	100 K 1/4W 5%	10-7023
R3-R8	3.3 MEG 1/4W 5%	10-7044
•	**CONNECTORS**	
P1	CONN-640456-3 MTA100	13-8081

Main Board, Drawing 215 x 60

BOARD	Assembled Main	5215-087
•	**CAPACITORS**	
C101	68µF 6.3V	04-5654
C201	68µF 6.3V	04-5654
C211	0.1µF 50V X7R	04-5663
C231	0.01µF 50V X7R	04-5664
C301	2700µF 35V E	04-5621
C311	27pF 100V COG	04-5658
C312	27pF 100V COG	04-5658
C501	68µF 6.3V	04-5654
C502	0.1µF 50V X7R	04-5663
C503	10µF 20V	04-5655
C504-506	0.1µF 50V X7R	04-5663
C601	10µF 20V	04-5655
C602	4.7µF 20V	04-5653
C603	10µF 20V	04-5655
C611	4.7µF 20V	04-5653
C701	0.1µF 50V X7R	04-5663
C711	0.1µF 50V X7R	04-5663
•	**DIODES**	
CR101-103	CXSH-4 EB33	07-6358
•	**TRANSISTORS**	
Q211	MMBT4403LT1	05-5842
Q401	2N7002L	05-5840
Q402	MMBT4403LT1	05-5842
Q501	MMBT3904T	05-5841
•	**CONNECTORS**	
P14	CONN-640456-2 MTA100	13-8073
P15	CONN-640456-6 MTA100	13-8095
P16	CONN-640456-3 MTA100	13-8081
P17	CONN-640456-5 MTA100	13-8057

Ref. No.	Description	Part No.
P18	CONN-640456-3	
	MTA100	13-8081
P19	CONN-1-640456-1	
	MTA100	13-8059
P20	CONN-1-640456-4	
	MTA100	13-8141
•	**RESISTORS**	
R031	4.75K 1/8W 1%	12-7858
R111	100K 1/8W 1%	12-7834
R131	2.21K 1/8W 1%	12-7835
R1310	100K 1/8W 1%	12-7834
R132-R139	2.21K 1/8W 1%	12-7835
R211-R212	10K 1/8W 1%	12-7839
R231	100K 1/8W 1%	12-7834
R331	22.1K 1/8W 1%	12-7843
R401	10K 1/8W 1%	12-7839
R402	10 OHM 1/8W 1%	12-7836
R403	10K 1/8W 1%	12-7839
R431	10K 1/8W 1%	12-7839
R501	10K 1/8W 1%	12-7839
R502	10 MEG 1/4W 5%	12-7955
R503	73.2K 1/8W 1%	12-7895
R504	10K 1/8W 1%	12-7839
R505	82.5K 1/8W 1%	12-7849
R506	1M 1/8W 1%	12-7844
R507	8.25K 1/8W 1%	12-7838
R508	10K 1/8W 1%	12-7839
R701	TRMR-5K 3269W1-502	09-6918
•	**INTEGRATED CIRCUITS**	
U121	NETWORK-22K	
	DIP 14 PIN	12-7577
U122	LTC1045CN	06-6371
U131	TLC372ID	06-6290
U211	X24C02S8I	06-6299
U231-U233	TLC372ID	06-6290
U311	N87C51FC	06-6303
U331	TLC372ID	06-6290
U421	CD74HC573M	06-6298
U431	N82C54	06-6309
U501	LM358D	06-6312
U502	LM285M-2.5	06-6291
U511	CXK581000AM-70LL	06-6385
U531	N82C54	06-6309
U601	MAX232CSE	06-6382
U611	CD74HC138M	06-6339
U612	CD74HC00M	06-6308
U631	N82C54	06-6309
U711	CD74HC08M	06-6313
•	**SWITCHES**	
S111	92-851.342	08-6726
S121	92-851.342	08-6726
S211	92-851.342	08-6726
S221	92-851.342	08-6726
S321	92-851.342	08-6726
5 EA.	92-960-0 MNT FLANGE	08-6727
•	**VOLTAGE REGULATORS**	
VR201	LT1129CQ-5	06-6372
•	**RESISTOR NETWORKS**	
RN031	NETWORK-4.7 K	12-7918
RN121	NETWORK-4.7K 8P SIP	12-7706
RN331	NETWORK-4.7 K	12-7918
RN421	NETWORK-22 K	12-7917
•	**CRYSTALS**	
Y311	MICRO 6.144 MHZ	01-5262
•	**TRANSFORMERS**	
T401	M 177 AUDIO	4275-083
•	**MISCELLANEOUS**	
*	SOCKET-822276-1 44P	06-6293

LED Display Board, Drawing 420 x 73

BOARD	Assembled LED Display	5420-097
•	**LEDS**	
CR110-CR112	LED-E121 GREEN	07-6310
CR113	LED-E176 RED JUMBO	07-6362
CR114	LED-E120 YELLOW	07-6309
CR115	LED-E121 GREEN	07-6310
CR125-CR130	LED-E112 RED	07-6390
•	**MISCELLANEOUS**	
P12	CONN-CJ50-36B-10	13-8370

Preamplifier Board, Drawing 420 x 47

BOARD	Assembled LED Display	5436-040
•	**Capacitors**	
C001	0.01µF 50V X7R	04-5664
C002	10µF 20V	04-5655
C101	10µF 20V	04-5655
C103	0.001µF 100V COG	04-5659

Ref. No.	Description	Part No.
C104	0.01µF 50V X7R	04-5664
C105	10µF 20V	04-5655
C106	1.0µF 16V C	04-5701
C108	1µF 35V	04-5656
C109	10µF 20V	04-5655
C201	10µF 20V	04-5655
C203	100pF 3KV 30GAT10	04-5532
•	**TRANSISTORS**	
Q101	MMBT3904T	05-5841
•	**RESISTORS**	
R001	4.75K 1/8W 1%	12-7858
R002	100K 1/8W 1%	12-7834
R003	100 OHM 1/8W 1%	12-7840
R004	100K 1/8W 1%	12-7834
R005	1K 1/8W 1%	12-7832
R101-R102	47.5 OHM 1/8W 1%	12-7966
R104	5.62K 1/8W 1%	12-7871
R105	4.75K 1/8W 1%	12-7858
R106	1.27K 1/8W 1%	12-7902
R107-R108	2.37K 1/8W 1%	12-7861
R109	1K 1/8W 1%	12-7832
R201	1K 1/8W 1%	12-7832
R202-R203	47.5K 1/8W 1%	12-7872
R304	TRMR-10K 64W103	09-6787
R1010	22.1K 1/8W 1%	12-7843
R1011	100 OHM 1/8W 1%	12-7840
•	**INTEGRATED CIRCUITS**	
U001	TLC372ID	06-6290
U101	CA3096M	06-6288
•	**CONNECTORS**	
P1	CONN-640456-2 MTA100	13-8073
P2	CONN-640456-4 MTA100	13-8088
•	**INDUCTOR**	
L101	INDUCTOR-TKS1245	21-9699

Ref. No.	Description	Part No.
	Interconnect Board, Drawing 420 x 178	
•	**CONNECTORS**	
P1	CONN-1-640457-0 MTA100-RA	13-8168
P2	CONN-1-640456-0 MTA100	13-8066
	Wiring Diagram, Drawing 420 x 162	
•	**SWITCHES**	
S1	DM62J12S205PQ	08-6715
S2-S3	BZ-2RD-A2-MICRO	08-6538
•	**TRANSFORMER**	
T1	XFMR-CFP302 115/230V	22-9908
•	**CONNECTORS**	
J1	CONN-640456-2 MTA100	13-8073
J2	CONN-640456-4 MTA100	13-8088
J4	CONN-1-640456-4 MTA100	13-8141
J14	CONN-640456-2 MTA100	13-8073
J17	CONN-640456-5 MTA100	13-8057
J18	CONN-640456-3 MTA100	13-8081
J19	CONN-1-640456-1 MTA100	13-8059
J23	CONN-640456-5 MTA100	13-8057
•	**MISCELLANEOUS**	
DSO1	UNIMORPH TEC-3526-PU	21-9251

DRAWINGS AND DIAGRAMS

PANEL AND PLATE ASSEMBLY DRAWINGS

Main Chassis Front Panel, Drawing No. 420 x 171
Front Panel LED, Drawing No. 420 x 170

SCHEMATICS AND COMPONENT LAYOUTS

HVPS Board, Drawing No. 436 x 53
HVPS Board Component Layout, Drawing No. 436 x 54

LED Display Driver Board, Drawing No. 420 x 4
LED Display Driver Board Component Layout, Drawing No. 420 x 89

Detector Ballast Board, Drawing No. 420 x 155
Detector Ballast Board Component Layout, Drawing No. 420 x 156

Main Board, Drawing No. (2 sheets) 215 x 60
Main Board Component Layout, Drawing No. 215 x 103

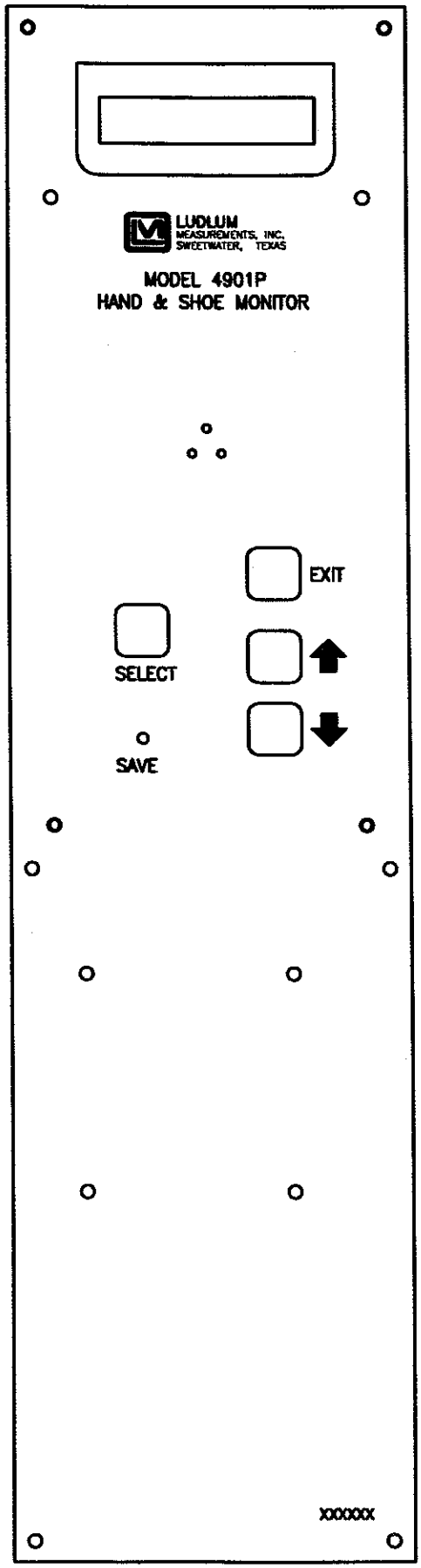
LED Display Board, Drawing No. 420 x 73
LED Display Board Component Layout, Drawing No. 420 x 92

Preamplifier Board, Drawing No. 436 x 47
Preamplifier Board Component Layout, Drawing No. (2 sheets) 436 x 48

Interconnect Board, Drawing No. 420 x 178
Interconnect Board Component Layout, Drawing No. 420 x 179

Wiring Diagram, Drawing 420 x 162

REV #	ALTERATIONS	DATE	BY
	VALID	07-22-98	T.JR



DWN	DATE	CHKD	APPROVED
T.JR	07-22-98	07-22-98	7-22-98

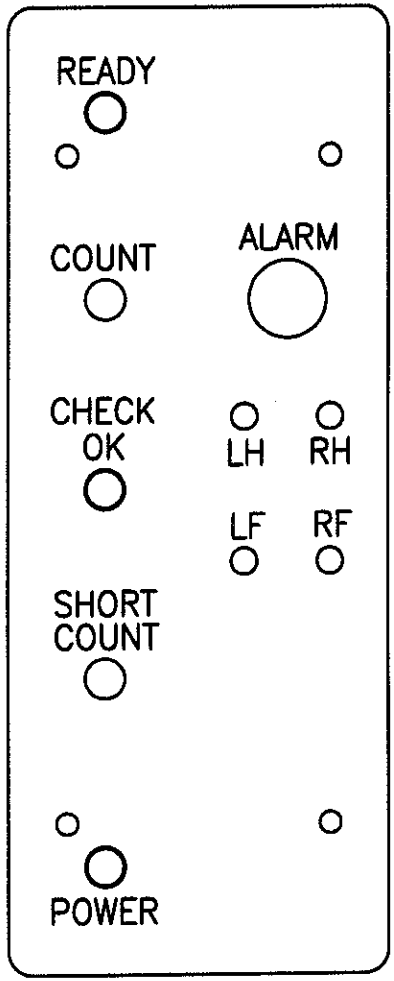
TITLE: M 4901P MAIN ELEC. PANEL

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

SERIES 420

SHEET 171

REV #	ALTERATIONS	DATE	BY
	VALID	07-22-98	TJR



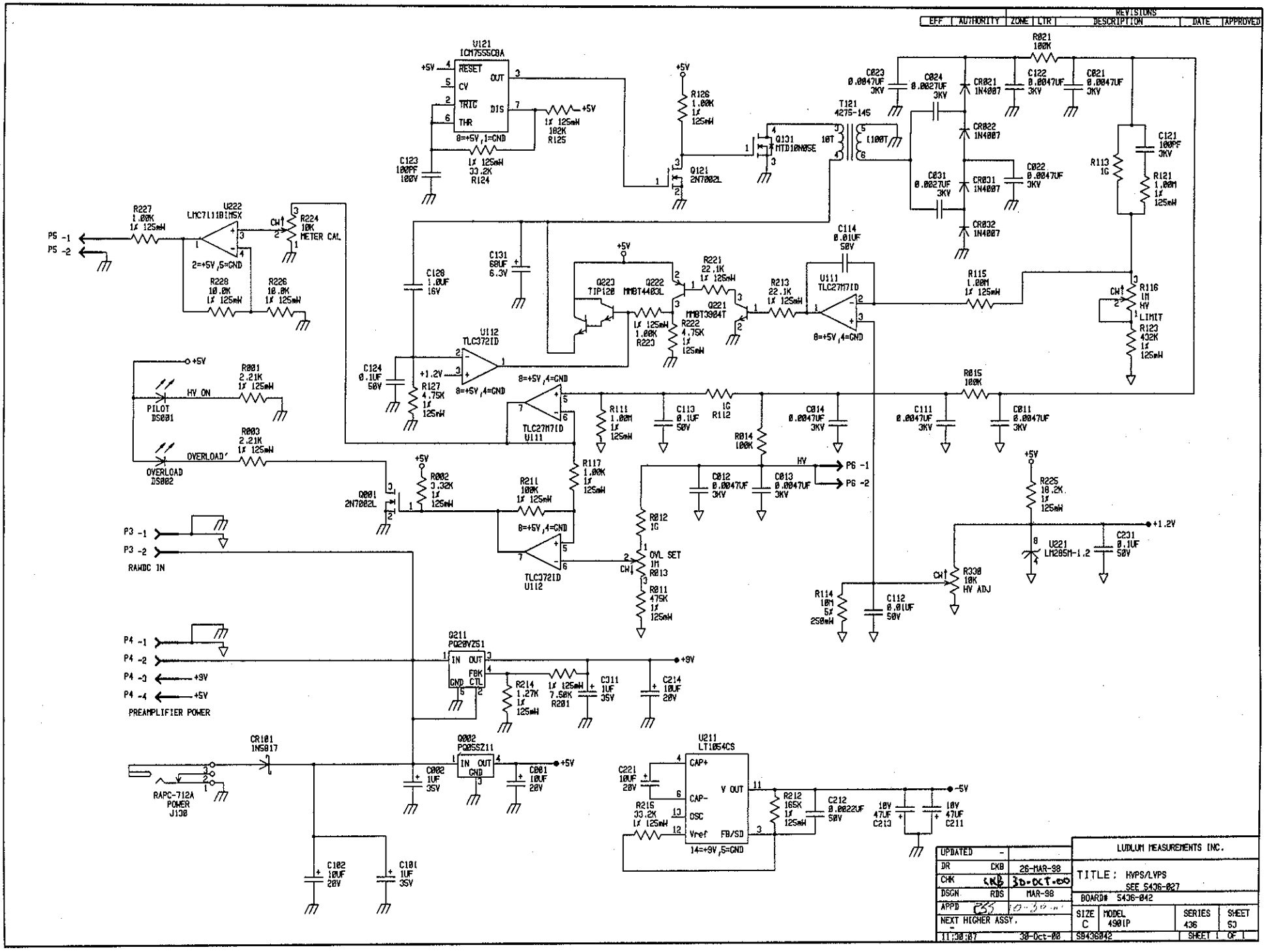
DWN	DATE	CHECKED	APPROVED
TJR	07-22-98	7-22-98	VGW 7-22-98

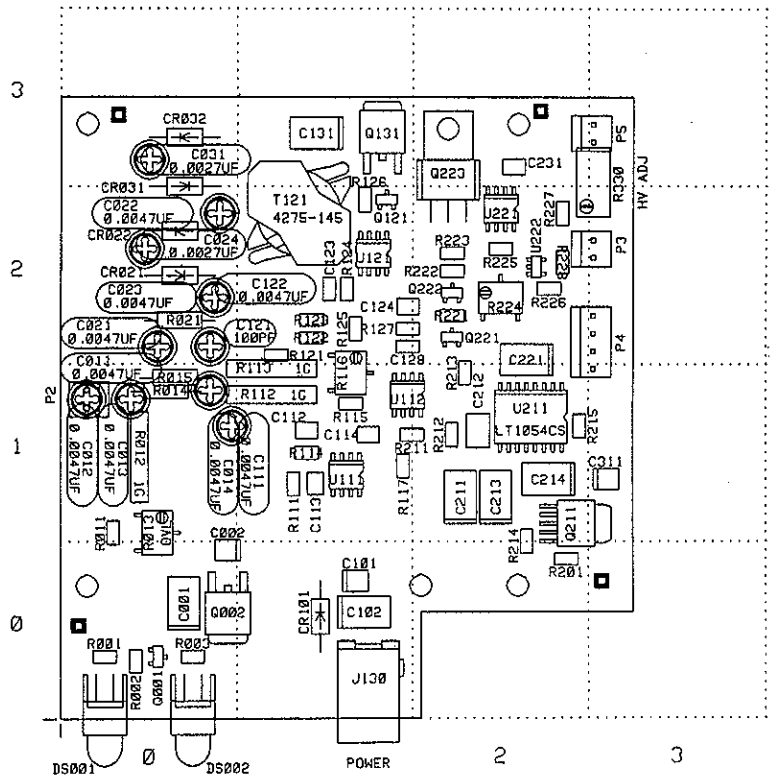
TITLE: M 4901P LED DISPLAY

LUDLUM MEASUREMENTS, INC.
SWEETWATER, TEXAS 79556

SERIES 420

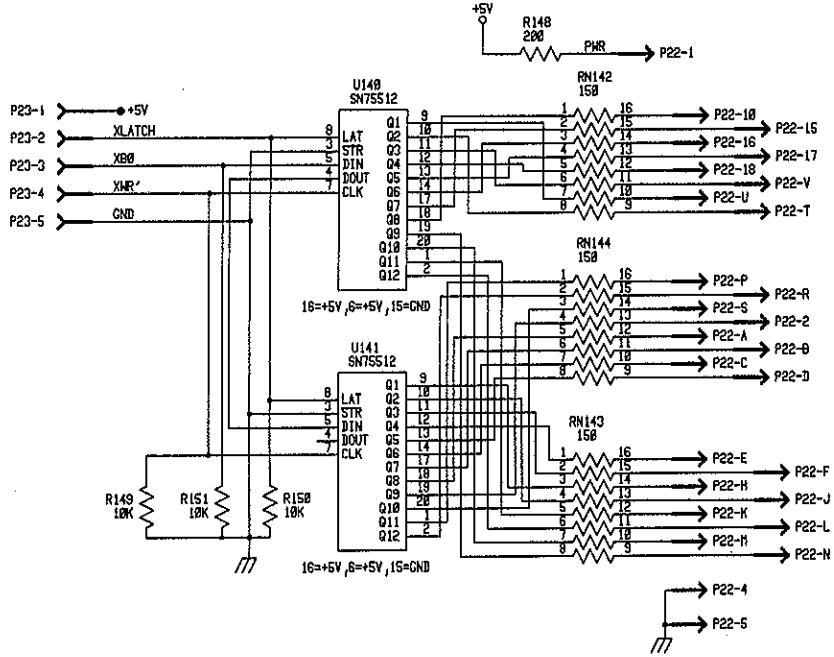
SHEET 170


REVISIONS
EFF. | AUTHORITY | ZONE | LTR | DESCRIPTION | DATE | APPROVED
U121 ICM7555CBA
RESET
CV
TRIG
THR
OUT
DIS
8=+5V,1=GND
+5V
1% 125mW 102K R125
1% 125mW 33.2K R124
C123 100PF 100V
R126 1.00K 1% 125mW
Q121 2N7002L
Q131 MTD10N05E
T121 4275-145
10T
(100T
C023 0.0047UF 3KV
C024 0.0027UF 3KV
CR021 1N4007
C122 0.0047UF 3KV
C021 0.0047UF 3KV
R021 100K
CR022 1N4007
C031 0.0027UF 3KV
CR031 1N4007
C022 0.0047UF 3KV
CR032 1N4007
C121 100PF 3KV
R113 1G
R121 1.00M 1% 125mW
R227 1.00K 1% 125mW
U222 LMC7111BIMSX
2=+5V,5=GND
R224 10K METER CAL
R228 10.0K 1% 125mW
R226 10.0K 1% 125mW
PS -1
PS -2
C128 1.0UF 16V
C131 68UF 6.3V
Q223 TIP128
Q222 MMBT4403L
Q221 MMBT3904T
R221 22.1K 1% 125mW
R222 4.75K 1% 125mW
1% 125mW 1.00K R223
R213 22.1K 1% 125mW
U111 TLC27M7ID
C114 0.01UF 50V
R115 1.00M 1% 125mW
R116 1M HV LIMIT
R123 402K 1% 125mW
U112 TLC372ID
C124 0.1UF 50V
R127 4.75K 1% 125mW
+1.2V
8=+5V,4=GND
TLC27M7ID U111
R001 2.21K 1% 125mW
HV ON
PILOT DS001
R003 2.21K 1% 125mW
OVERLOAD
OVERLOAD DS002
R015 100K
C111 0.0047UF 3KV
C011 0.0047UF 3KV
R111 1.00M 1% 125mW
C113 0.1UF 50V
R112 1G
R014 100K
C014 0.0047UF 3KV
HV
PS -1
PS -2
C012 0.0047UF 3KV
C013 0.0047UF 3KV
R002 3.32K 1% 125mW
Q001 2N7002L
R211 100K 1% 125mW
R117 1.00K 1% 125mW
R012 1G
R013 OVL SET 1M
R011 475K 1% 125mW
TLC372ID U112
R225 10.2K 1% 125mW
U221 LM285M-1.2
C221 0.1UF 50V
+1.2V
R336 10K HV ADJ
R114 10M 5% 250mW
C112 0.01UF 50V
P3 -1
P3 -2
RAWDC IN
P4 -1
P4 -2
P4 -3 +9V
P4 -4 +5V
PREAMPLIFIER POWER
Q211 PQ20VZ51
IN OUT GND FBK CTL
R214 1.27K 1% 125mW
1% 125mW 7.50K R201
C311 1UF 35V
C214 10UF 20V
+9V
CR101 1N5817
RAPC-712A POWER J108
Q002 PQ05SZ11
IN OUT GND
C002 1UF 35V
C001 10UF 20V
+5V
C102 10UF 20V
C101 1UF 35V
U211 LT1054CS
CAP+
CAP-
OSC
Vref
V OUT
FB/SD
14=+9V,5=GND
C221 10UF 20V
R215 33.2K 1% 125mW
R212 165K 1% 125mW
C212 0.0022UF 50V
10V 47UF C213
10V 47UF C211
-5V
UPDATED -
DR CKB 26-MAR-98
CHK CKB 30-OCT-00
DSGN RDS MAR-98
APPD BS 10-30-00
NEXT HIGHER ASSY. -
11:30:07 30-Oct-00
LUDLUM MEASUREMENTS INC.
TITLE: HVPS/LVPS
SEE 5436-027
BOARD# 5436-042
SIZE C | MODEL 4901P | SERIES 436 | SHEET 50
S5436042 | SHEET 1 OF 1

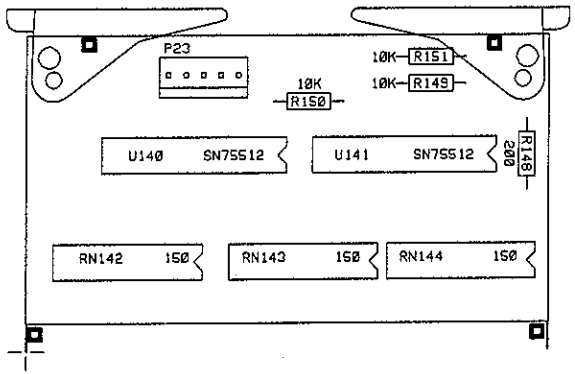


LUDLUM MEASUREMENTS INC. SWEETWATER, TX.			
DR CKB	27-OCT-00	TITLE: HVPS/LVPS BOARD	
CHK CKB	30-OCT-00	BOARD: 5436-042	
DSGN RDS	17-JUL-97	MODEL: 4901P	
APP	10-30-00	FILENAME: BS436042	
		11:30:02	30-Oct-00
COMPONENT	SOLDER	REVISION	SERIES / SHEET
OUTLINE	OUTLINE	1.0	436 / 54

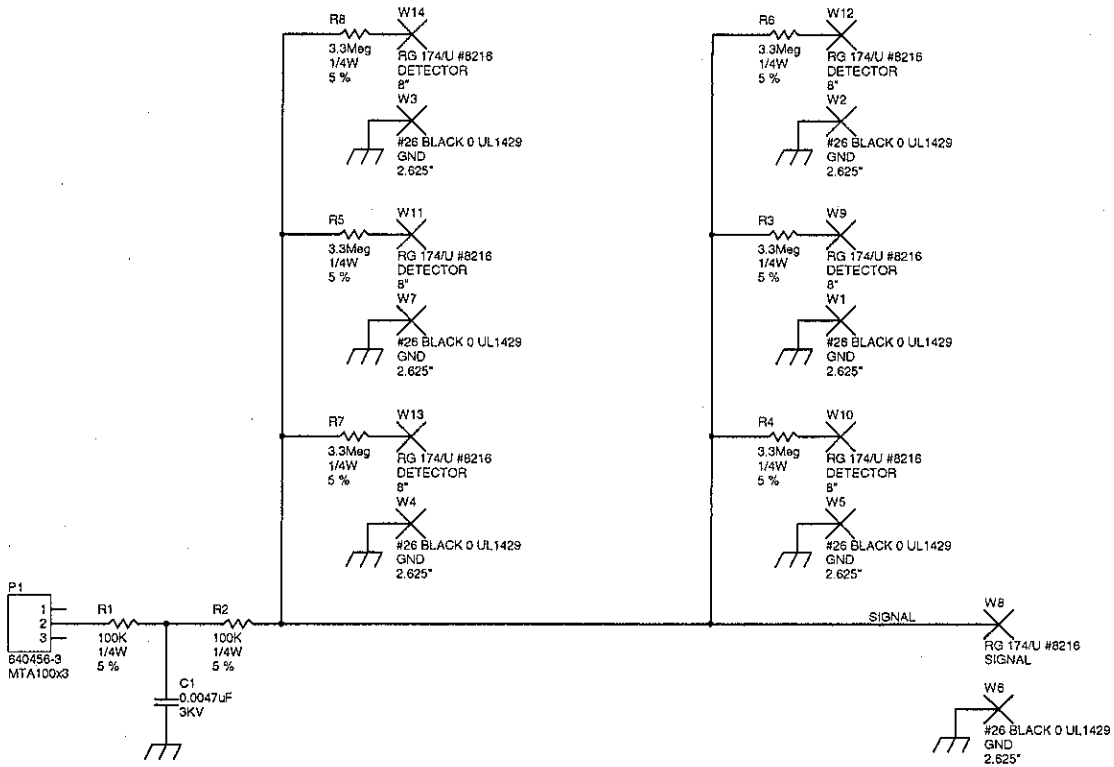
REVISIONS						
EFF	AUTHORITY	ZONE	LTR	DESCRIPTION	DATE	APPROVED



UPDATED	-	LUDLUM MEASUREMENTS INC.	
DR RDS	06APR94	TITLE: LED DISPLAY DRIVER	
CHK CKB	22-Jul-98	BOARD# 5420-005	
DSGN RDS	06APR94		
APPD DJS	7-22-98	SIZE C / MODEL 4901/4901-1/52 / SERIES 420 / SHEET 4	
NEXT HIGHER ASSY. -			
07:42:57	22-Jul-98	S8420005	SHEET 1 OF 1



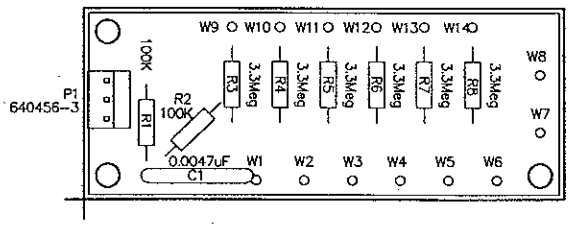
LUDLUM MEASUREMENTS INC. SWEETWATER, TX.					
DR	RDS 07JUN94	TITLE: LED DRIVER			
CHK	CKB 22JUL98				
DSGN	RDS 07JUN94	BOARD# 5420-005			BS420005
APP	BS 2-22-98	MODEL 4901/52	SERIES 420	SHEET 89	
07:44:11	22-Jul-98	COMP SIDE ☐	SLDR SIDE ☐	OUTLINE ☒	
COMP PASTE ☐	COMP MASK ☐	SLDR PASTE ☐	SLDR MASK ☐		



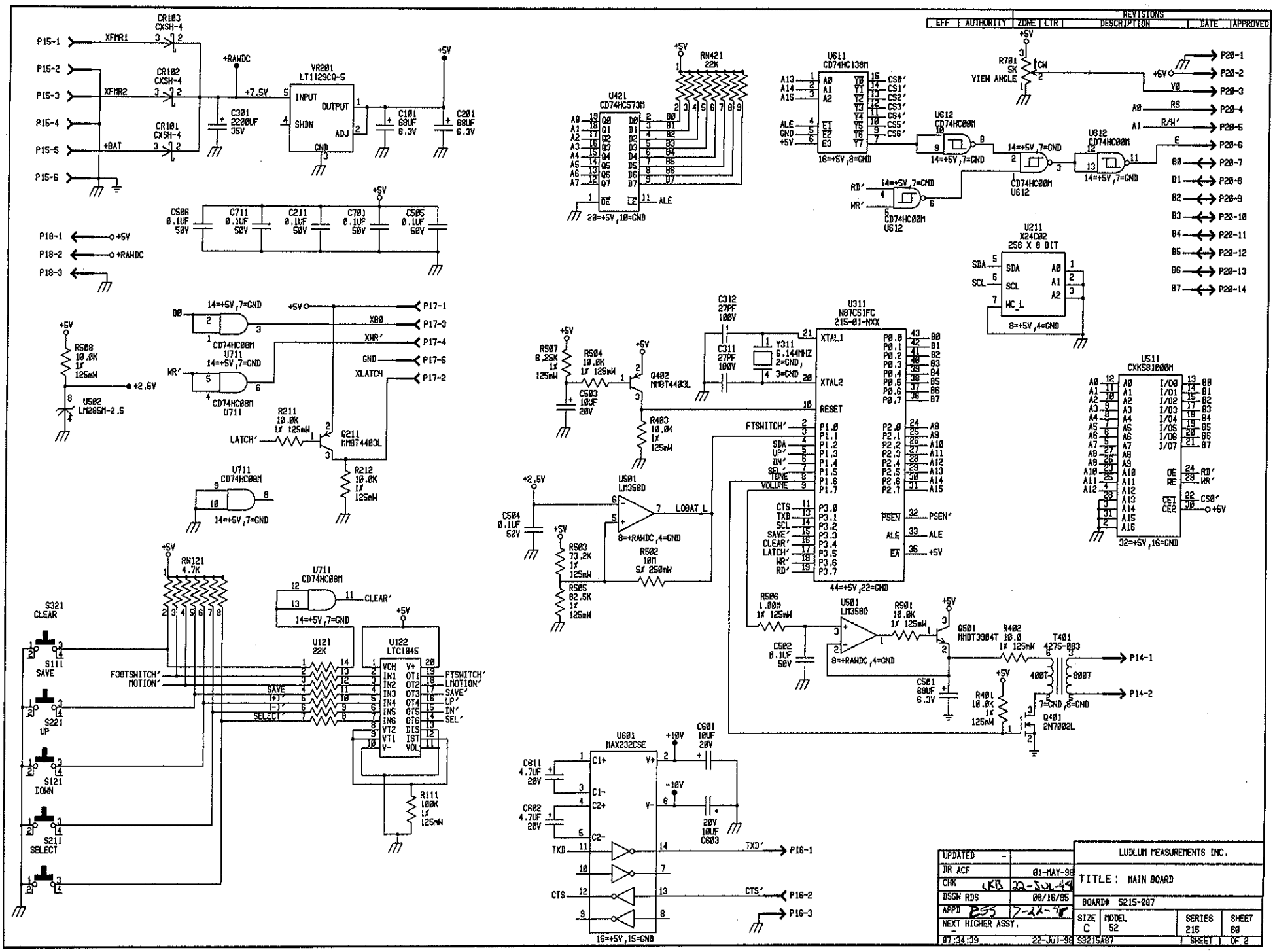
LUDLUM MEASUREMENTS, INC.
PO Box 810
501 Oak Street
Sweetwater, Texas 79556
U.S.A. 1-800-622-0828

Drawn: CKB	17-JUL-00	Title: SIX DETECTOR BALLAST	
Design: RDS	17-JUL-00	Model: 4901P	
Check: RJ	10-27-00	Board#: 5420-158	
Approve: FJS	10-27-00	Sheet: 1 of 1	Series 420 / Sheet 155
08:34:25	27-Oct-2000	Rev: 2.0	

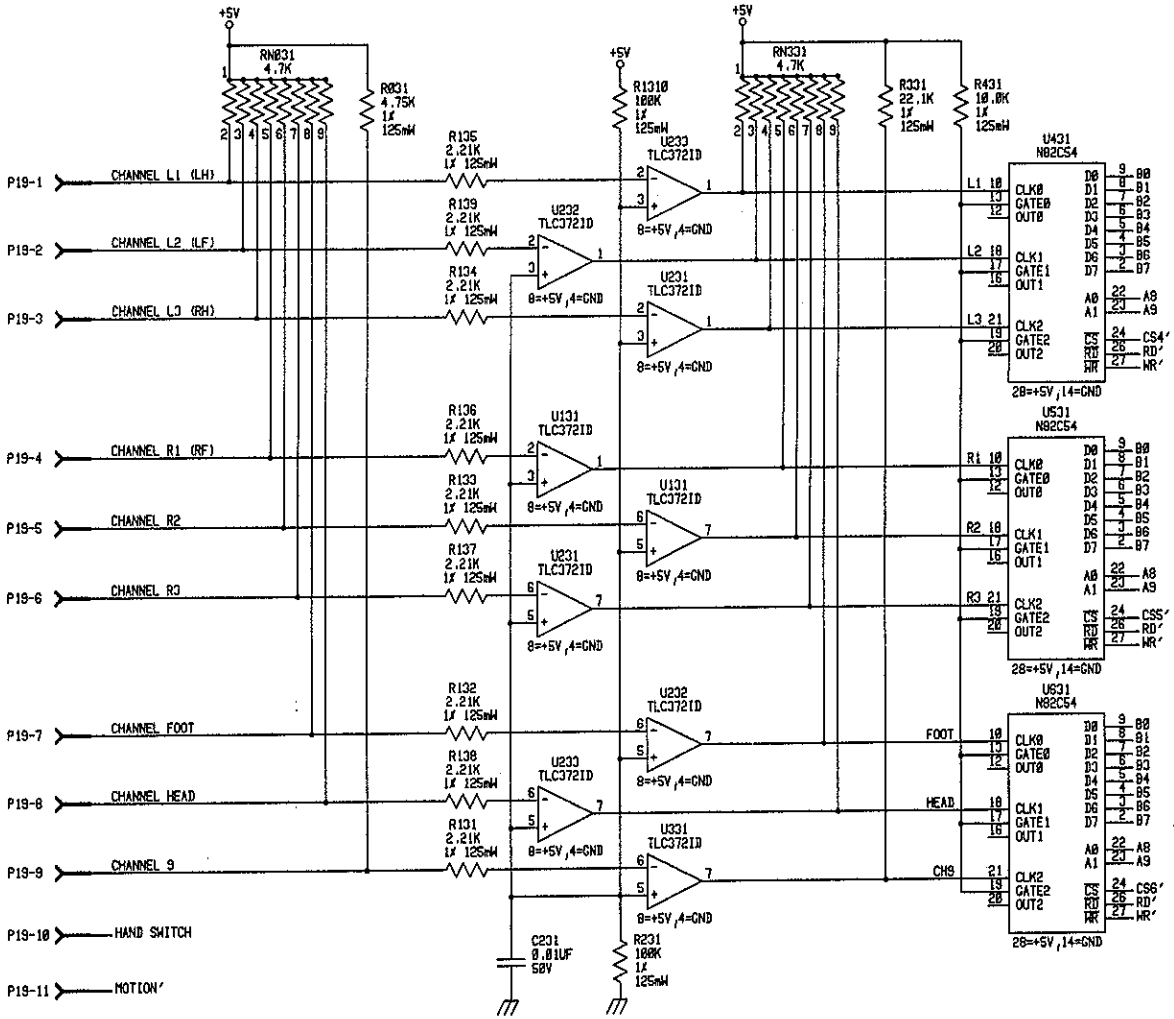
X:\Projects\J&M\M4901P\M4901P.Dcb - Documents\5420-158\rev2.0\420n155.Sch



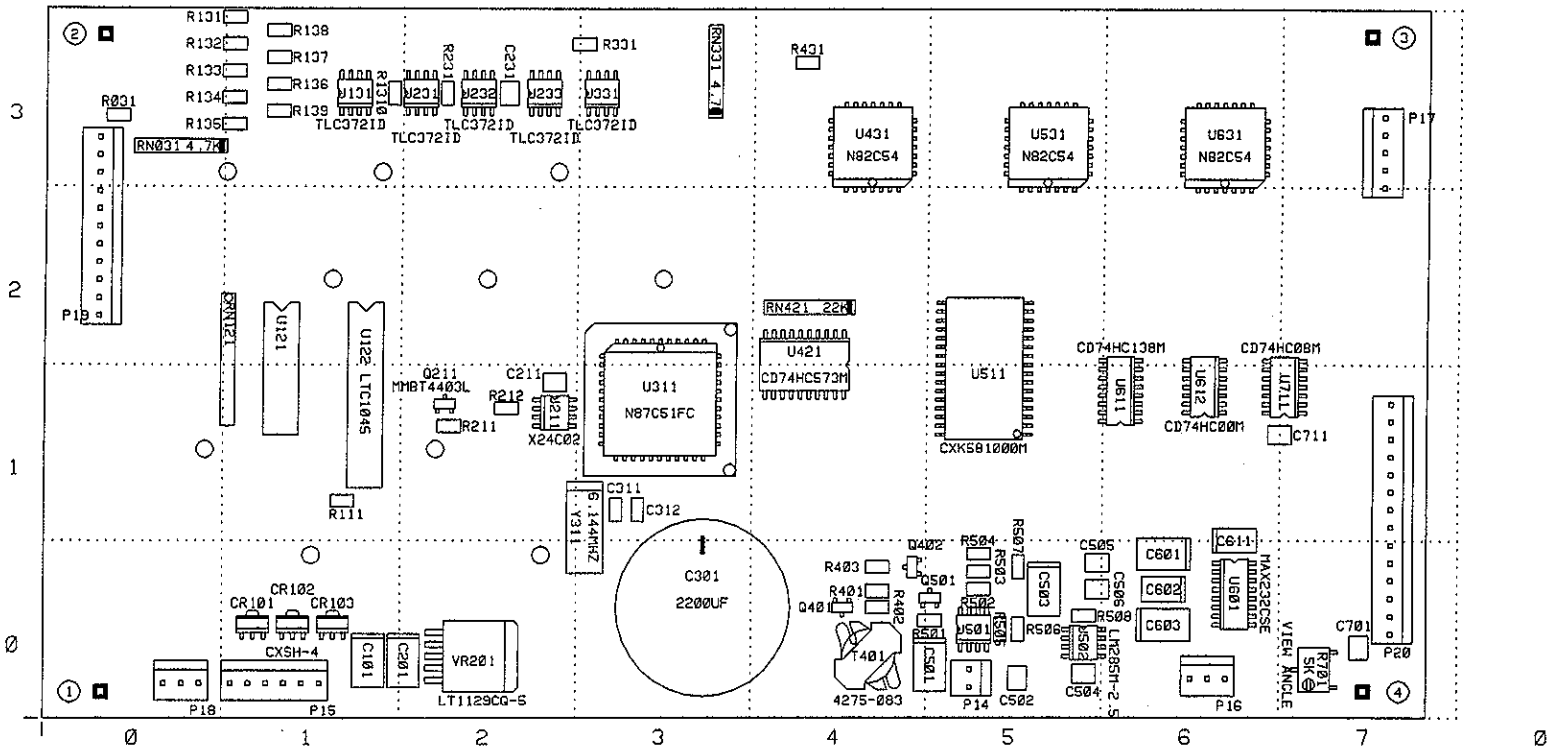
Drawn: CKB	17-JUL-00	Title:	
Design: RDS	17-JUL-00	SIX DETECTOR BALLAST	
Check: P.W.	10-27-00	Model: 4901P	
Approve: RSS	10-27-00	Board#: 5420-158	
Layer: Top Overlay		Rev: 1.0	Series 420 / Sheet 156
Mech.1 Mech.2 Mech.3 Mech.4 MID:		SCALE: 1.00	
08:34:36	27-Oct-2000		


REVISIONS
EFF | AUTHORITY | ZONE | LTR | DESCRIPTION | DATE | APPROVED
P15-1
P15-2
P15-3
P15-4
P15-5
P15-6
XFMR1
XFMR2
+BAT
CR103 CXSH-4
CR102 CXSH-4
CR101 CXSH-4
+RAWDC
+7.5V
VR201 LT1129CQ-5
INPUT
OUTPUT
SHDN
ADJ
GND
C301 2200UF 35V
C101 68UF 6.3V
C201 68UF 6.3V
+5V
P18-1
P18-2
P18-3
C506 0.1UF 50V
C711 0.1UF 50V
C211 0.1UF 50V
C701 0.1UF 50V
C505 0.1UF 50V
RN421 22K
U421 CD74HC573M
OE
LE
ALE
20=+5V,10=GND
U611 CD74HC138M
16=+5V,8=GND
U612 CD74HC00M
14=+5V,7=GND
R701 5K VIEW ANGLE
CW
P20-1
P20-2
P20-3
P20-4
P20-5
P20-6
P20-7
P20-8
P20-9
P20-10
P20-11
P20-12
P20-13
P20-14
RS
R/W'
E
V0
A0
A1
B0
B1
B2
B3
B4
B5
B6
B7
U211 X24C02 256 X 8 BIT
SDA
SCL
WC_L
8=+5V,4=GND
R508 10.0K 1% 125mW
+2.5V
U502 LM285M-2.5
U711 CD74HC08M
XB0
XHR'
GND
XLATCH
P17-1
P17-3
P17-4
P17-5
P17-2
R211 10.0K 1% 125mW
LATCH'
Q211 MMBT4403L
R212 10.0K 1% 125mW
U711 CD74HC09M
C312 27PF 100V
C311 27PF 100V
Y311 6.144MHZ
2=GND, 3=GND
U311 N87C51FC 215-01-NXX
XTAL1
XTAL2
RESET
P1.0
P1.1
P1.2
P1.3
P1.4
P1.5
P1.6
P1.7
P3.0
P3.1
P3.2
P3.3
P3.4
P3.5
P3.6
P3.7
P2.0
P2.1
P2.2
P2.3
P2.4
P2.5
P2.6
P2.7
PSEN
ALE
EA
44=+5V,22=GND
FTSWITCH'
SDA
UP'
DN'
SCL'
TONE
VOLUME
CTS
TXD
SCL
SAVE'
CLEAR'
LATCH'
WR'
RD'
R507 8.25K 1% 125mW
R504 10.0K 1% 125mW
Q402 MMBT4403L
C503 10UF 20V
R403 10.0K 1% 125mW
+2.5V
U501 LM358D
LOBAT_L
8=+RAWDC,4=GND
C504 0.1UF 50V
R503 73.2K 1% 125mW
R505 82.5K 1% 125mW
R502 10M 5% 250mW
US11 CXK581000M
CE1
CE2
OE
WE
32=+5V,16=GND
R506 1.00M 1% 125mW
C502 0.1UF 50V
U501 LM358D
R501 10.0K 1% 125mW
Q501 MMBT3904T
R402 10.0 1% 125mW
T401 4275-003
400T
800T
7=GND,8=GND
P14-1
P14-2
C501 68UF 6.3V
R401 10.0K 1% 125mW
Q401 2N7002L
RN121 4.7K
S321 CLEAR
S111 SAVE
S221 UP
S121 DOWN
S211 SELECT
FOOTSWITCH'
MOTION'
SAVE
(+)'
(-)'
SELECT'
U711 CD74HC08M
CLEAR'
U121 22K
U122 LTC1045
VOH
V+
IN1
IN2
IN3
IN4
IN5
IN6
VT2
VT1
V-
OUT1
OUT2
OUT3
OUT4
OUT5
OUT6
DIS
IST
VOL
FTSWITCH'
LMOTION'
SAVE'
UP'
DN'
SEL'
R111 100K 1% 125mW
U601 MAX232CSE
C611 4.7UF 20V
C602 4.7UF 20V
C601 10UF 20V
C603 10UF 20V
+10V
-10V
C1+
C1-
C2+
C2-
V+
V-
TXD
CTS
TXD'
CTS'
P16-1
P16-2
P16-3
16=+5V,15=GND
UPDATED -
DR ACF 01-MAY-98
CHK LKB 22-JUL-98
DSGN RDS 08/16/95
APPD BSS 7-22-98
NEXT HIGHER ASSY. -
07:34:39 22-JUL-98
LUDLUM MEASUREMENTS INC.
TITLE: MAIN BOARD
BOARD# 5215-007
SIZE C
MODEL 52
SERIES 215
SHEET 00
S8215A87
SHEET 1 OF 2

REVISIONS						
EFF	AUTHORITY	ZONE	LTR	DESCRIPTION	DATE	APPROVED

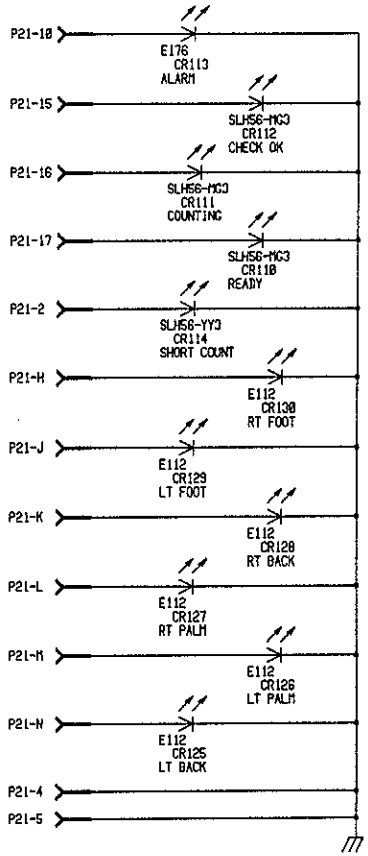


UPDATED	-	LUDLUM MEASUREMENTS INC.	
DR CK'D	08/19/95	TITLE: MAIN BOARD	
CHK'D	7-22-98	BOARD# 5215-087	
DSGN RDS	08/16/95	SIZE C / MODEL S2 / SERIES 215 / SHEET 60	
APPD	7-22-98		
NEXT HIGHER ASSY:			
07:36:32	22-JUL-98	5821S087	1 SHEET 2 OF 2

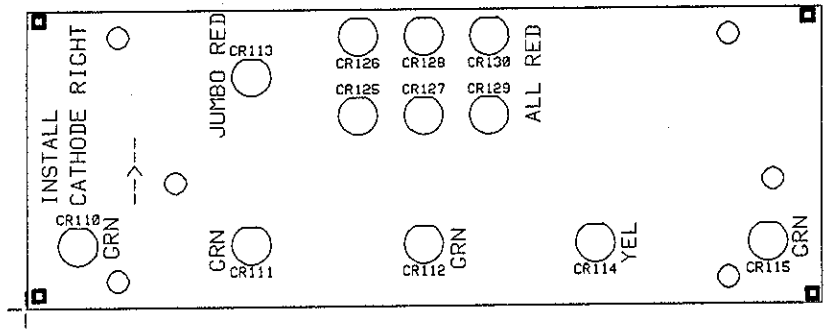


LUDLUM MEASUREMENTS INC. SHEETWATER, TX.					
DR	CKB	08/23/95	TITLE: MAIN BOARDC		
CHK	DW	7-27-95	BOARD# 5215-087		BS215087
DSGN	RSS	08/18/95	MODEL S2	SERIES 215	SHEET 103
APP	RSS	7-28-95	COMP ARTWORK ☐		SLDR ARTWORK ☐
07:38:48		22-Jul-98	COMP OUTLINE ☐		SLDR OUTLINE ☐
COMP PASTE ☐		COMP MASK ☐	SLDR PASTE ☐		SLDR MASK ☐

REVISIONS						
EFF	AUTHORITY	ZONE	LTR	DESCRIPTION	DATE	APPROVED

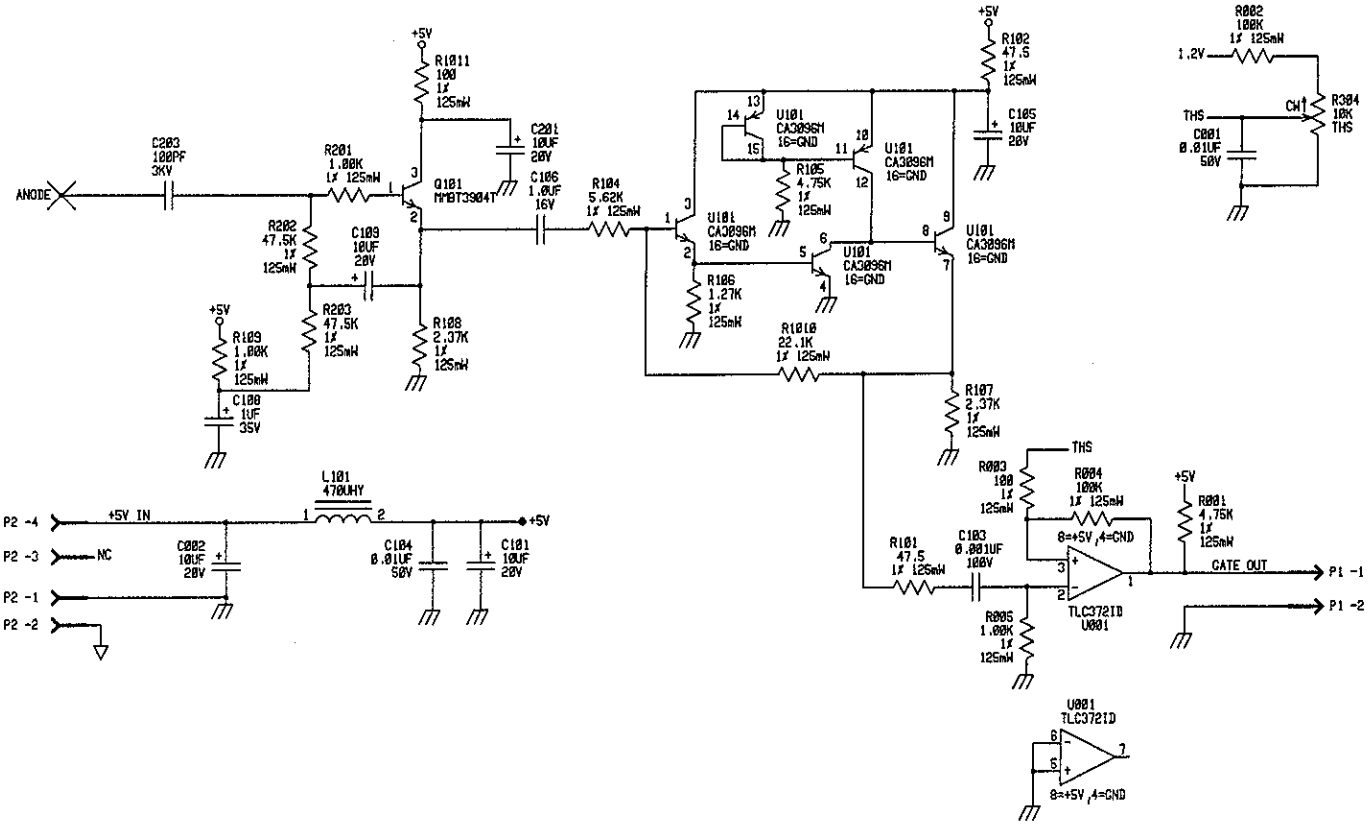


UPDATED	-	LUDLUM MEASUREMENTS INC.	
DR RDS	07OCT94	TITLE: M4901-1 LED DISPLAY	
CHK (KB)	22-JUL-98		
DSGN RDS	SEP94	BOARD# S420-097	
APPD BSS	7-22-98	SIZE C / MODEL 4901-1 / SERIES 420 / SHEET 70	
NEXT HIGHER ASSY. -			
07:47:37	22-JUL-98 S0420097	SHEET 1 OF 1	



LUDLUM MEASUREMENTS INC. SWEETWATER, TX.			
DR RDS	14SEP94	TITLE: LED DISPLAY BOARD	
CHK CRB	23-JUL-98	BOARD# 5420-097	BS420097
DSGN RDS	14SEP97	MODEL 4901-1 / SERIES 420	SHEET 92
APP BS	7-22-98	COMP ARTWORK ☐	SLDR ARTWORK ☐
07:52:49 22-Jul-98		COMP OUTLINE ☐	SLDR OUTLINE ☐
COMP PASTE ☐	COMP MASK ☐	SLDR PASTE ☐	SLDR MASK ☐

REVISIONS					
EFF	AUTHORITY	ZONE	LTR	DESCRIPTION	DATE	APPROVED



UPDATED	-	
DR	CKB	20-AUG-97
CHK	[signature]	7-22-98
DSGN	RDS	17-JUL-97
APPD	[signature]	7-22-98
NEXT HIGHER ASSY.	-	
07:19:54	22-Jul-98	

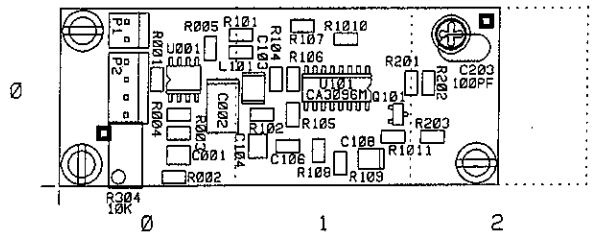
LUDLUM MEASUREMENTS INC.

TITLE: PREAMP

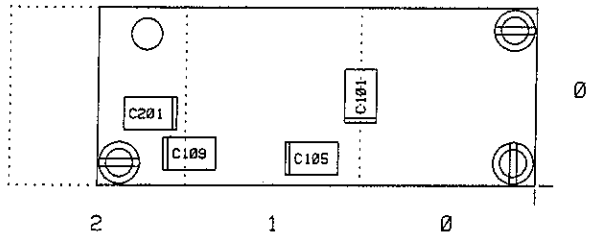
BOARD# 5436-040

SIZE	MODEL	SERIES	SHEET
C	4901P	436	47

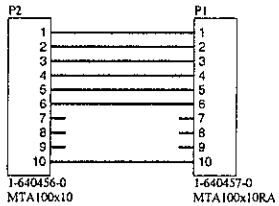
S8436040 SHEET 1 OF 1



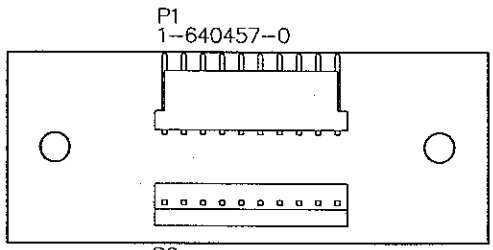
LUDLUM MEASUREMENTS INC. SWEETWATER, TX.			
DR ACF 17-JUL-97	TITLE: PREAMP		
CHK CKB 22-Jul-98	BOARD# 5436-040		BS436040
DSGN RDS 17-JUL-97	MODEL 4901P	SERIES 436	SHEET 48
APP RS 7-22-98	COMP ARTWORK ☐		SLDR ARTWORK ☐
10:48:52 22-Jul-98	COMP OUTLINE ☐		SLDR OUTLINE ☐
COMP PASTE ☐	COMP MASK ☐	SLDR PASTE ☐	SLDR MASK ☐



LUDLUM MEASUREMENTS INC. SWEETWATER, TX.				
DR ACF	17-JUL-97	TITLE: PREAMP		
CHK CKB	22-JUL-97	BOARD# 5436-040		BS436040
DSGN RDS	17-JUL-97	MODEL 4901P	SERIES 436	SHEET 40
APP BSS	7-22-98	COMP ARTWORK ☐		SLDR ARTWORK ☐
01:01:97	17/JUL/97	COMP OUTLINE ☐		SLDR OUTLINE ☒
COMP PASTE ☐	COMP MASK ☐	SLDR PASTE ☐		SLDR MASK ☐

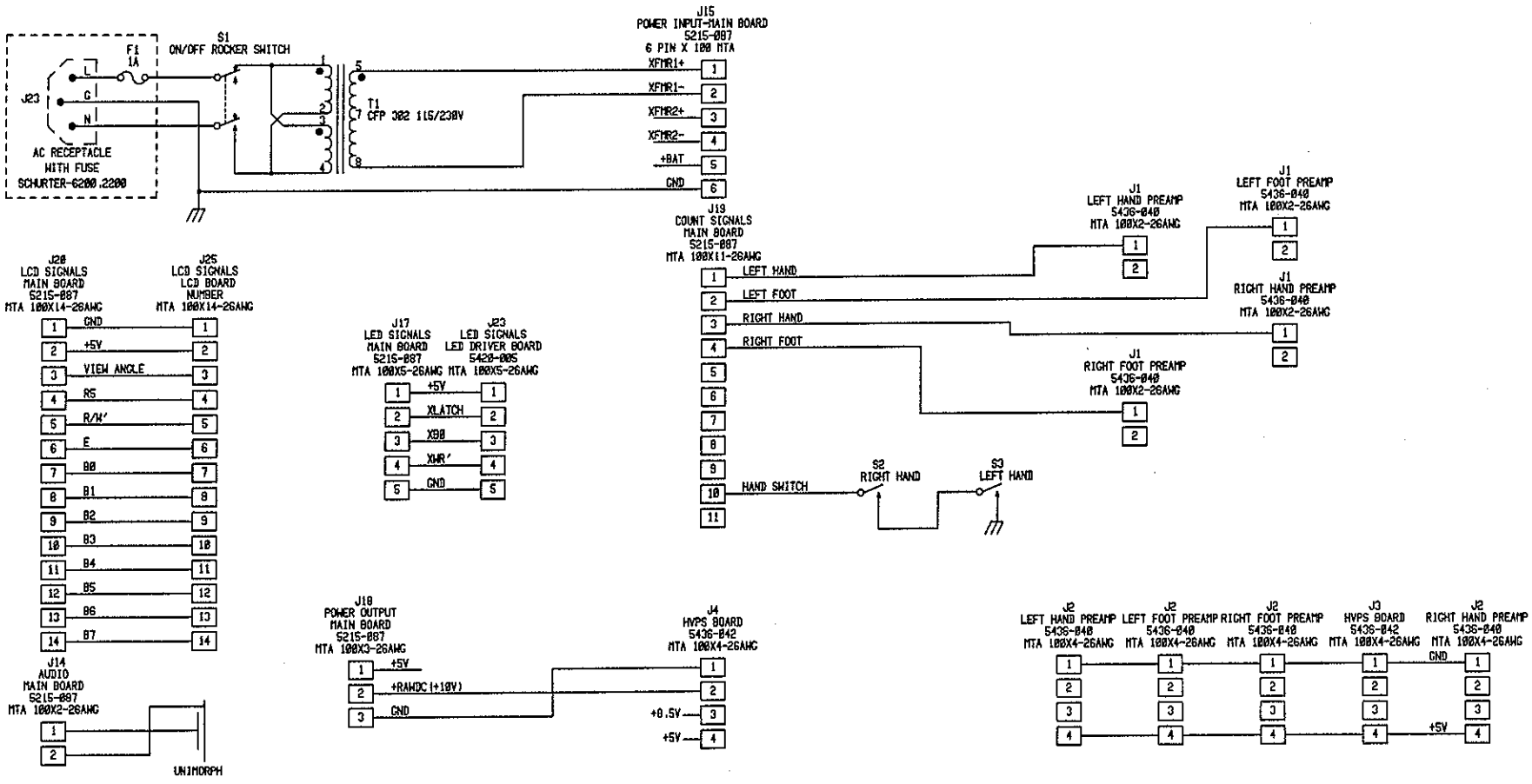


LUDLUM MEASUREMENTS, INC.		PO Box 810 501 Oak Street Sweetwater, Texas 79556 U.S.A. 1-800-622-0828	
Drawn: MG	05-JAN-2000	Title: INTERCONNECT BOARD	
Design: RDS	05-JAN-2000	Model: M4901P	
Check: PW	10-27-00	Board#: 5420-178	
Approve: PSG	10-27-00	Sheet: 1 of 1	Series: 420 / Sheet: 178
08:38:45	27-Oct-2000	Rev: 1.0	
X:\Projects\LMM4901P\M4901P.Dsb - Documents\5420-178\rev1 0\420X178.sch			



Drawn: MG	06-JAN-2000	Title: INTERCONNECT BOARD	
Design: RDS	06-JAN-2000		
Check: P.W.	10-27-00	Model: M4901P	
Approve: RS	10-27-00	Board#: 5420-178	
Layer: Top Overlay Mech.1 Mech.2 Mech.3 Mech.4 MD: 08:42:05 27-Oct-2000		Rev: 1.0 SCALE: 1.00	Series 420 / Sheet 179
bs420178.pcb		bs420178.pcb	

REVISIONS						
EFF	AUTHORITY	ZONE	LTR	DESCRIPTION	DATE	APPROVED



UPDATED	-	LUDLUM MEASUREMENTS INC.
DR ACF	13-JUL-98	TITLE: WIRING DIAGRAM
CHK CRB	23-JUL-98	
DSGN RDS	13-FEB-98	BOARD# 428-162
APPD RDS	23Jul98	SIZE C | MODEL 4901P | SERIES 428 | SHEET 162
NEXT HIGHER ASSY. -		
15:49:02	23-Jul-98	W428162 | SHEET 1 OF 1