LUDLUM MODEL 49-12-1
HAND AND SHOE MONITOR

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Serial Number 104242 and Succeeding
Serial Numbers

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1. GENERAL DESCRIPTION

The Ludlum M49-12-1 Hand and Shoe Monitor is designed to check personnel for radiation contamination. The M49-12-1 monitor uses seven gas-proportional probes to check for both alpha and beta radiation, four for the hands, two for the feet and one frisker. A status panel quickly shows whether contamination exists, and if so, shows the location and type of contamination. The status panel also indicates procedural errors, possible background errors, or possible hardware problems. User instructions are simple, and are silkscreened to the front of the instrument. The user has access to only two buttons: the SINGLE HAND request, and the AUDIO ACKNOWLEDGE button.

The cabinet contains additional controls for setup of failure setpoints, diagnostic routines, and readout of the current count or background. An LCD display and a 20-key keypad are provided to view or change any system parameter. In addition to manually setting the alarmpoints, two automatic calculation modes exist. The maximum sensitivity mode continuously sets the alarmpoints to a specified number of sigma factors above ambient background. The minimum count time mode continuously changes the count time to the minimum time required to detect a specified radiation level.

The electronics is microprocessor-based, and housed in a swing-down chassis inside the cabinet. Failure detection features include high voltage, low gas output, low count, and high background. The current high voltage and output gas flow values are also constantly monitored and displayed. Background counting is done automatically when the hand switches are not depressed.

Two P-10 gas inputs provide uninterrupted gas switchover when one bottle depletes. Solid state mass-flow and pressure sensors provide automatic bottle changeover and flow readout to and from the hand, foot and frisker detectors. Gas flow adjustment is accessible inside the instrument cabinet.

2. SPECIFICATIONS

2.1 Markings

The following markings are clearly readable and permanently fixed under normal conditions and service (including decontamination):

- Manufacturer and model number.
- Unique serial number.
- Function designation for controls, switches, and adjustments.

2.2 Readout / Data Output

The monitor has an LCD readout that displays the counts, background counts, and alarmpoints. Each channel reads out on the LCD in counts per minute from 0000-9999. Additional information is accessed through a menu structure.

2.3 Background Update

The monitor continuously takes background counts, going into count mode only when hands are sensed. The keypad allows the user to set a time limit to ensure that a background is taken during the specified time. If a background is not taken during the time limit, the UPDATING BACKGROUND light will come on, and a background update will be taken before operation can resume.

2.4 Count Time

The count time is keypad-adjustable from 1 to 255 seconds. Increasing the count time increases the sensitivity of the monitor, but also decreases throughput.

2.5 Alarm Output

The monitor has visual and audible alarm indicators. The red alarm lamp lights for any type of contamination alarm, and red light emitting diodes (LEDs) show the location and type of contamination. Audible and visual output is held for a keypad-adjustable time, but the audio can be silenced by the AUDIO ACKNOWLEDGE button after four seconds.

2.6 Alarm Setpoints

The counting alarm setpoints are all based on counts per minute from 0000 to 9999 including: beta-gamma alarm, alpha alarm, high alpha background, high beta-gamma background, and low count. The low gas output alert is adjustable from 0-200 cc/min. The high voltage failure alarm will activate whenever the high voltage strays 10% from the high voltage setpoint.

2.7 Ease of Decontamination

The monitor is constructed of painted/anodized aluminum and stainless steel. Polyvinyl chloride (PVC) film covers the status panel and wipes clean with a moist cloth.

2.8 Gas Proportional Detectors

There are seven probes in each monitor. The four hand probes have an active area of 310 cm^2 each and are covered with a 79% open screen. The two foot probes have an active area of 410 cm^2 each and are covered with a 58% open screen. The frisker detector has an active area of 125 cm^2 with a 79% open screen.

2.9 Nuclear Counting Gas Input

P-10 (10% methane, 90% argon) is recommended as the operating gas. The operating gas consumption is approximately 20 cc/min each for the hand feet and frisker detector circuits, giving a total consumption of less than 60 cc/min . This equates to about 0.8 bottles per month in a standard 223 scf (standard cubic foot) bottle.

2.10 Minimum Detector Efficiency

Efficiencies are stated for a 4π geometry. The hand beta efficiency is 23% with strontium-yttrium 90 and an alpha efficiency of 15% with thorium 230. The foot beta efficiency is 11% with strontium-yttrium 90 and an alpha efficiency of 5% with thorium 230.

2.11 Design Threshold Sensitivities

The threshold sensitivity refers to the adjustment of voltage values so that a 5.0 to 50 millivolt pulse from the detector is registered as a beta count. Any pulse from the detector greater than 125 millivolts is registered as an alpha count. In summary:

- 5.0 mV < Beta < 50 mV
- 125 mV < Alpha

2.12 Reliably Detected Activity (RDA)

The RDA is defined as the amount of radioactivity that has a 90% probability of being detected. The RDA is strongly dependant upon the given count time and background. With a six second count time, a background of 10 μR/hr, and a false alarm rate of 1 in 1000, an RDA of 1000 dpm beta can be achieved in the hand detectors. Alpha RDA is less than 500 dpm.

2.13 Calibration

Yearly calibration can be achieved in approximately two hours. Calibration includes: checking the thresholds, calibrating high voltage, verifying levels on the gas board, peaking the detectors, and verification of each channel.

2.14 Power

115 volts AC (alternating current) within 50-60 Hertz at 0.5 amps maximum. 240 VAC at 0.25 amps maximum is also available.

2.15 Size and Weight

32.00" (81.28 cm) long x 28.00" (71.12 cm) wide x 58.00" (147.32 cm) tall.

Weight of the M49-12-1 is 140 pounds (64 kg).

3. THEORY OF OPERATION

The following paragraphs will discuss the different automatic alarm calculation modes. Note that all low count alarmpoints are entered manually, regardless of the calculation mode. Examples of using the automatic calculation modes are in the appendix.

3.1 Manual Set Mode

In this mode, all setpoints are entered from the keypad. The different setpoints can be from 0 to 9999 counts per minute. Alpha and beta-gamma alarms, and also alpha and beta-gamma high background alarms are all entered manually.

3.2 Maximum Sensitivity Mode

This mode uses the current background to calculate alarm levels some specified amount above background. Thus, the alarmpoints will change as the background changes. This mode is used when maximum sensitivity is desired, and widely varying background prevents MANUAL SET mode. The following are the MAXIMUM SENSITIVITY parameters:

- Sigma factor
- Confidence level
- Efficiencies

- Maximum allowable source size

Background may vary from one count to the next. The typical distribution is a bell-shaped curve with most of the background counts close to the background average. 50% of the background counts are above the average, and 50% are below the average. If an alarmpoint were chosen to be the average background, then an alarm would occur 50% of the time. On the other hand, the alarmpoint could be chosen to be many times larger than the background average, eliminating the false alarm rate but also the sensitivity.

The standard deviation is described as the measure of the amount of fluctuation for a given distribution. A small deviation indicates that most counts are near the average; a large deviation indicates that counts are more scattered. The standard deviation is usually defined as the square root of the average and is symbolized with the lower case Greek letter sigma (σ). The problem is to know the sigma factor that yields an alarmpoint with a given false alarm rate. Since background usually follows the normal distribution, statistics provide tables of sigma factors for different false alarm rates. The table below shows some sigma factors and the related false alarm rate.

σ factor	False Alarm Rate
1	15.87% or 15.87 in 100
2	2.28% or 2.28 in 100
3	0.13% or 1.3 in 1,000
4	0.003% or 3 in 100,000
5	0.00003% or 3 in 10,000,000

Once a sigma factor is selected for a specified false alarm rate, the alarmpoint is easily calculated. The formula is (with background subtract on):

$$\beta\text{-}\gamma \ alarmpt = \sigma \ factor \times \sqrt{bkgnd \ av.}$$

β-γ *alarmpt* = beta-gamma alarmpoint
σ *factor* = sigma factor
bkgnd av. = background average

The above formula will not work for alpha radiation since alpha background is usually defined as zero. In order to allow the sensitivity to be adjusted for the alpha alarmpoint, the following formula was adopted:

$$alarmpt = \sigma \ factor \times \sqrt{count \ time} \times \frac{60}{count \ tim}$$

α *alarmpt* = alpha alarmpoint
σ *factor* = sigma factor
count time is in seconds

When the background count becomes large in MAXIMUM SENSITIVITY mode, the ability of the instrument to detect contaminated personnel becomes poor. Therefore, the user can input a maximum allowable source size in dpm. If the background rises to a point where the M49-12-1 can no longer detect this amount of radiation within the desired confidence level, then the HIGH BACKGROUND alarm will activate. The confidence level is described as the probability of alarming on a specified source size. The table below shows confidence levels and the associated factors.

Confidence level	factor
5%	1.645
10%	1.280
15%	1.035
20%	0.840
25%	0.675
30%	0.525
35%	0.385
40%	0.252
45%	0.125
50%	0
55%	-0.125
60%	-0.252
65%	-0.385
70%	-0.525
75%	-0.675
80%	-0.840
85%	-1.035
90%	-1.280
95%	-1.645
99%	-2.325

The condition for the HIGH BACKGROUND lamp to activate in MAXIMUM SENSITIVITY mode follows. Note that the maximum source size is multiplied by detector efficiency so that the resulting number is the count that the detector receives from the source.

$$\text{if } alarmpt \geq \text{max.} + (cfactor \times \sqrt{\text{max.}})$$

alarmpt = calculated alarmpoint
max. = maximum allowable source size multiplied by efficiency
cfactor = confidence level factor

3.3 Minimum Count Time Mode

The MINIMUM COUNT TIME mode allows the user to input a desired level of contamination to be seen, and the monitor will automatically calculate the count time needed to be able to detect this level of contamination. This mode offers the assurance that a certain level of contamination is reliably detected. The following discusses the MINIMUM COUNT TIME parameters:

- Sigma factors
- Confidence level
- Efficiencies
- Desired source sizes
- Maximum count time

The MINIMUM COUNT TIME mode is complicated by the fact that count time is dependent upon the background and the desired source size. The formula uses normalized values (all counts in counts per second):

$$t = \left(\frac{\sigma F \times \sqrt{bkgnd} - CL \times \sqrt{desired + bkgnd}}{desired} \right)^2$$

t = time in seconds
σF = sigma factor
$bkgnd$ = background in cps
CL = confidence level factor
$desired$ = desired source size multiplied by efficiency

The count time is chosen from the longest count time calculated. If the background becomes large, then the count time becomes unacceptably long. Therefore, a maximum count time limit can be entered. If the calculated count time becomes larger than the maximum count time limit, the HIGH BACKGROUND lamp will activate.

4. INITIALIZATION

When the Model 49-12-1 powers up, an initializing routine is entered. All lights on the status box will turn on, the audio will sound, and the LCD will be darkened. The message "BOARDS INITIALIZING... PLEASE WAIT" should appear on the LCD. During power-down the central processor, with its battery backed up memory, stores all system parameters. During initialization all parameters are downloaded from the central processor. If any boards are missing or not working, then the message "_____ BOARD IS MISSING" will be displayed, and operation will stop. When initialization is completed, the status panel lights will clear and the LCD will show the current counts and operating conditions. Under normal conditions, the monitor must take a background before the READY light indicates 'Ready' for normal operation.

5. KEYPAD FUNCTIONS

The keypad is used to view or change the alarmpoints or system parameters. The 20-key keypad has the numerals 0-9, a backspace key, an enter key, and several special function keys. The functions of the special keys are listed in the following sections.
The LCD backlight is turned off during normal operation. Pressing any key on the keypad will activate the backlight for 30 minutes.

5.1 Main Menu Key

The MAIN MENU key displays the main menu in the lower LCD. This menu is the beginning menu from which all other menus can be reached.

5.2 Read Menu Key

The READ MENU key shows the read menu, bypassing the need to go through the main menu. All alarm setpoints and parameters may be read. In addition, all current operating conditions may also be viewed.

5.3 Operating Conditions Key

The OPER COND key displays the current operating conditions, such as high voltage, current sensitivity, current alarm calculation mode, and input and output gas flows. The count time is shown, with a countdown time showing the time left in the current count.

5.4 Alarm Setpoints Key

The ALRM PTS key displays all the current alarm points or parameters. This key is useful for showing, at a glance, all the present count type alarm setpoints or parameters. The information displayed depends upon which alarm calculation (MANUAL SET, MAXIMUM SENSITIVITY, or MINIMUM COUNT TIME) is currently in use.

5.5 Hold Key

The HOLD key "freezes" the counts shown. The HOLD key will also cancel (halt) the parameter setup process.

5.6 Backspace Key

The BKSP key allows changes to be made to a parameter being entered. The backspace key also returns from one menu to the previous menu, if available.

5.7 Enter Key

The ENT key enters in a parameter in the setup mode. The enter key also progresses from one menu to the next menu, if available.

5.8 The CNT Key

The CNT key forces an interrogation without having to depress the hand switches.

5.9 UPDT Key

The UPDT key forces a full 40 second background count and refreshes all background data.

5.10 INVT SCRN Key

The INVT SCRN key changes the LCD display between black characters on white and white characters on a black background.

6. DESCRIPTION OF OPERATOR CONTROLS

6.1 Single Hand Request

The SINGLE HAND button is used to request single-hand count operation. After pressing the SINGLE HAND button, counting will begin when either of the hand switches are pressed. This request is valid for approximately ten seconds.

6.2 Audio Acknowledge

If an alarm or procedural error occurs, the AUDIO ACKNOWLEDGE button can be used to silence the audio after four seconds of audio output.

7. DESCRIPTION OF STATUS LIGHTS

The following section describes the purpose of the lights on the status panel.

7.1 Ready

This green LED indicates that the M49-12-1 is ready to monitor personnel. This light is not lit during a count, when the UPDATING BACKGROUND light is lit, or when the TROUBLE light is lit.

7.2 Counting

This green LED indicates that the M49-12-1 is currently monitoring personnel. Personnel must keep hands pressed down until this light turns off and either the ALARM light or CHECK OK light turns on.

7.3 Check OK

This green LED indicates that the person being monitored is under the radiation contamination limits and is cleared to leave.

7.4 Procedural Error

This orange LED indicates that the user is not properly following procedure. This light will turn on if the user withdraws his hands before the count is finished. Also, insertion of hands while the UPDATING BACKGROUND light is lit will cause the PROCEDURAL ERROR light to light until the hands are removed.

7.5 Updating Background

This orange LED indicates that the system is updating the background. A background update replaces the background averaging stack, and so takes forty seconds to complete. A contamination check cannot take place when this LED is lit.

7.6 Bottle In Use

These green LEDs indicate which (main or aux) gas bottle supply is currently in use. The gas pressure should be maintained ½ psi above the switch point of the bottle present indicators. Normal operating input pressure is from 4 to 6 psi. Do not apply more than 15 psi to this system.

7.7 Bottle Present

These green LEDs indicate the presence of the gas bottle. A gas bottle is considered empty when the gas input pressure drops to the point where this LED goes out.

7.8 Low Gas Output

This yellow LED indicates that the gas output from either the hands or feet detectors is below the minimum gas output parameter. This light is an alert only and does not activate the audio alarm.

7.9 Low Count

This yellow LED indicates that a count has been read in from a beta-gamma channel that is less than the low count parameter for that channel. The audio will be continuous to indicate that a failure condition exists.

7.10 High Bkgnd

This yellow LED indicates that a background has been read in from a channel that is greater than the high alpha or beta-gamma background parameter for that channel. The audio will be continuous to indicate that a failure condition exists. This indication will continue until the condition clears.

7.11 HV Fail

This yellow LED indicates that the measured high voltage on any of the detectors is not within 10% of the high voltage parameter. The audio will be continuous to indicate that a failure condition exists.

7.12 Trouble

This yellow LED signals that an error has occurred that prevents normal operation. Possible errors include: high voltage failure, high background, low count failure, or an internal communication error has occurred. The audio will be continuous to indicate if a failure condition exists. The monitor will update background until the problem is resolved.

8. OPERATING PROCEDURES

The following section describes how to install and operate the monitor.

8.1 Preparing Monitor for Use

A primary requirement for operation is to have the hand and foot detectors purged with P-10 gas. If the system has not run on gas for 24 hours at a minimum of 30 cc/min output flow, then purge the system as described below.

- **Connecting the Gas Supply**

The monitor has dual gas bottle inputs with automatic changeover. Two gas bottles and two regulators are needed. The supplied 1/4" female pipe to 1/8" I.D. (inside diameter) hose nipple (LMI #13-7836) connects to the regulator. The supplied inserts (LMI #22-9639) may be used inside the end of the interconnecting 1/4" O.D. (outside diameter) hose. Adjust the gas pressure from 3 psi to no more than 7.5 psi and watch the Bottle Present LED's. When the LED activates, add ½ psi to the gauge reading. Repeat this for the remaining bottle. After adjusting the supply inlet pressure, adjust the gas flow to the Hands and Feet detectors to 50 cc/min each. This must be read from the LCD display.

The main gas bottle is always selected upon power up. If the bottle select is on automatic and the main bottle is empty or not present, then the auxiliary bottle is selected if it is present. When power is off, the monitor selects the main bottle. Therefore, the monitor should not be turned off without a main bottle or the detectors will not have an adequate supply of gas.

Quick purging of the detectors may be accomplished by turning the needle valve on the gas manager board. This purge is limited to approximately 100

cc/min. After thirty minutes, adjust the input flow to 50 cc/min and maintain an output of at least 46 cc/min. Output flow more than 3 or 4 cc/min less than input indicates a leak which should be corrected.

A puncture of the Mylar probe face or other cause of low gas output is constantly monitored. The low gas flow alert should be established at about 30 cc/min. Low gas flow will light the LOW GAS OUTPUT indicator, but operation of the system is still allowed. However, if the count rate starts to drop off because of a lack of gas in the detectors, the low count alarm will halt operation.

8.2 Parameter Setup Prior to Operation

The setup parameters are discussed in this section. All of the parameters of interest may be viewed in the read menus. The following parameters must be setup or checked prior to monitor operation:

- Low count setpoints
- High background setpoints
- Alarm setpoints
- Upper and lower high voltages
- Count time
- Low gas flow alert and gas bottle mode (automatic or manual switching)
- Background update interval
- Background subtract on/off

- **Low Count Alarm Setup**

The low count alarms monitor the beta-gamma count from the detectors. Ideally, the alpha background is always zero and therefore is not monitored by this alarm. The low count alarm exists to ensure that the probes are connected and getting some minimum of beta-gamma counts. The low count alarm may be set from 0 to 9998 counts per minute, and defeated by entering 9999. An alarm will occur if the last count is less than or equal to the low count alarm. If the beta-gamma background is low enough, and the count time is short enough, then even setting the low count alarm at 0 might cause frequent irritating alarms. If this is the case, then the alarm must be disabled.

- **High Background Alarms Setup**

The high background alarms may be set from 0 to 9998 counts per minute, and defeated by entering 9999. An alarm will occur if the background is greater than or equal to the high background alarm. This alarm should not be disabled except during setup or calibration.

- **Alarm Setpoints or Parameters**

The alarm setpoints may be manually set from 0 to 9999 counts per minute. If the alarm calculation mode is MAXIMUM SENSITIVITY or MINIMUM COUNT TIME, then alarm parameters need to be set. These parameters include alpha and beta efficiency, sigma factor, and the confidence level. In MAXIMUM SENSITIVITY mode, the maximum sensitivity limit (in dpm) is needed. In MINIMUM COUNT TIME mode, the desired sensitivity (in dpm) and the maximum count time are needed. Examples of using the alarm calculation mode are in the appendix.

- **Detector High Voltage Setup**

The high voltage values must be determined by peaking each probe with a beta-gamma source. An automatic peaking routine can be accessed through the menus. If alpha is also being detected, then a plateau with an alpha source should be run to insure the voltage found in the peaking operating is on the alpha plateau. The upper high voltage supplies the four hand probes, and the lower high voltage supplies the two foot probes. The high voltages may be set independently of each other in the voltage range from 250 to 2500 VDC. Typical operation is about 1600 VDC.

- **Count Time**

The count time is adjustable from 1 to 255 seconds. When in MINIMUM COUNT TIME calculation mode, the count time is adjusted automatically to the minimum required to detect a specified contamination level.

- **Gas Parameter Setup**

The low gas flow limit is recommended to be set at 30 cc/min when the operating gas flow is set at 50 cc/min. The low gas flow alert may be set from 0 to 199 cc/min, and disabled by setting to 200 cc/min.

The low gas flow alert should not be disabled, except during setup and calibration.

The gas bottle mode determines which bottle is selected. The gas bottle mode may be automatic, switched to the main gas bottle, or switched to the auxiliary gas bottle. The non-automatic modes are used only when it is desired to disregard the bottle pressures.

In automatic mode the monitor will automatically switch to the auxiliary gas bottle when the main bottle is empty (approximately 4.5 psi). Likewise, when the auxiliary bottle is empty, the monitor will automatically switch to the main gas bottle. If the auxiliary and main bottles are empty, then the main gas bottle is selected. If the auxiliary bottle is selected due to an empty main bottle and a full main bottle is then reconnected, the monitor will switch back to the main bottle. The main bottle is selected upon power-up reset.

- **Background Update Interval Setup**

The maximum background update interval is used to force the monitor to update the background if no background has been taken within the specified update time.

- **Background Subtract Status Setup**

The background subtract status may be active or inactive. The value used to subtract from the current counts being received is an average of the last four background readings. The beta-gamma background average is kept separate from the alpha background average. Under normal operation, the background subtract should be on.

- **Parameter Defeat Values**

The setpoints that may be defeated are listed in the following table. The setpoints should not be overridden for normal operation. These defeat values should only be used to aid in troubleshooting of the monitor.

ALARM OVERRIDES.

PARAMETER	RANGE	DEFEAT VALUE	ACTION ON DEFEAT
HIGH VOLTAGE	250-2500V	250	Disables HV alarm and turns HV off.
LOW GAS OUTPUT ALERT	0-200cc/min	200	Disables low gas alert.
BACKGROUND UPDATE INTERVAL	1-999minutes	999	Interval set to infinity.
COUNT TYPE ALARMS	0-9999cps	9999	No alarm checking for all count channels.
LOW COUNT ALARMS	0-9999cps	9999	No low count checking.

8.3 Optional Parameter Descriptions

This section describes how to set parameters that are optionally needed for operation.

- **Setting the Real Time Clock**

The real time clock is defined in standard military format. The time and the date may be set via SETUP MENU III.

- **Setting the Security Code**

A four key security code may be assigned that allows access to the setup menus. The security code consists of any four of the twenty keys on the 20-key keypad. The security code may be reset (but code is not stored when power is turned off) to "0000" by going to the READ MENU II and pushing the numeral 9 key.

- **Setting the Volume**

The volume can be set from 0 to 255 with 0 being the loudest and 255 be the lowest. The volume does not control any of the alarms or error audio which are always on the loudest setting.

9. CALIBRATION

Yearly calibration should be performed to guarantee accurate operation. Calibration will include the following (in order of procedure): setting the high voltage using a calibrated high voltage voltmeter, checking window levels on the quad amplifier boards, running a beta-gamma peak on each detector, optionally running a plateau (alpha) on each detector, and finding the alpha and beta efficiency of each detector. The gas manager should be checked for proper flow readout and automatic switchover. An operational check should follow calibration of the monitor. A check source (alpha and/or beta-gamma) should be selected and either an alarm point established or alarm parameters defined. Finally, the check source should be passed over every channel to verify the calibration process and alarm setpoints.

9.1 High Voltage Power Supply (HVPS) Board Calibration

A voltmeter with an input impedance of 1000 megohms or greater is necessary for this procedure. The high voltage should be set via the keypad so that each high voltage is set to 1600 VDC. The readout does not need to read 1600 VDC at this time. All detectors should be connected for the following procedure. The background update time interval should be set to 999 minutes. (All underlined words below are the exact letters found on the circuit board.)

The HVPS board #5323-746 is located on the far left of the upper electronics chassis in the slot labeled HVPS1. An extender board is needed so that the potentiometers on the high voltage board are accessible. The potentiometers labeled UH (R183) and LH (R81) set the upper and lower high voltages respectively. Each adjustment should be made to within ± 3 VDC using a high voltage digital voltmeter with an impedance of 1000 megohms or greater measured at pin P6-27 (marked A2 on the connector) for the upper detectors voltage and P6-26 (marked A1 on the connector) for the lower detectors voltage. The voltage on pin 1 of the TLC27M7 amplifier (U155 upper, U77 lower) should be measured while adjusting the potentiometer labeled UR (R178, upper) and LR (R82, lower) to 1.600 VDC ± 0.003 VDC.

The OPER COND key can be used to read the current high voltages. The potentiometer labeled HV CAL (R78) is adjusted until the upper high voltage reads out on the LCD display as 1600 VDC ± 3V. The lower high voltage should be verified to read 1600 VDC ± 3V.

A 4-pin connector P8 is used to configure the beta-gamma threshold (BT), beta-gamma window (BW), and the alpha threshold (AT). Pin 1 labeled GND of connector P8 should be used as a reference for the following measurements. The potentiometer labeled BT (R85) should be adjusted so that the voltage from BT-GND (pins 4 to 1) on connector P8 is 50mV ± 1 mVDC. The potentiometer labeled BW (R84) should be adjusted so that the voltage from BW-GND (pins 3 to 1) on connector P8 is 1.00 VDC ± 0.01 VDC. The potentiometer labeled AT (R83) should be adjusted so that the voltage from AT-GND (pins 2 to 1) on connector P8 is 1.600 VDC ± 0.016 VDC.

- **Sample HVPS Calibration Worksheet**

A sample HVPS Calibration Worksheet is located in the appendix and may be reproduced to meet local needs.

9.2 Quad Amplifier Board Calibration

The detector amplifiers in the main electronics chassis should now be balanced. Note: The reference voltages on the HVPS board must be set as in Section 9.1 above, prior to performing the following adjustments.

The amplifiers are calibrated by applying a "pulser" input to the connector on the rear of the electronics

chassis and adjusting the gain control located on the edge of the Amplifier boards #5323-440. See Appendix D, Drawings and Diagrams for the location of these detector inputs.

Turn the Model 49-12-1 ON and set the Calibrate Mode ON. This will set the count time to 1 second, turn Background Subtract off, and disable the background update interval. Press the OPER COND key to display counts and adjust the pulser to 50 mV and 1000 CPM rate.

Attach cable #8303-339 and "C" to "BNC" adapter to the Model 500 Pulser and connect to the LHB input.

Adjust the gain control until the LHB BETA count rate just sees the 1000 CPM rate.

Now adjust the Model 500 to 5 mV. The count rate should diminish to 0 CPM as you lower the input below 2.5 mV.

Verify Alpha count by sweeping the Model 500 Pulser from 60 mV to 100 mV. Alpha counting should occur at 80 mV $\pm$10%.

Repeat the procedure above for these five channels (LHP<RHP<RHB,LF, and RF.)

Adjust the pulser to 35 mV and 1000 CPM rate.

Attach cable #8303-339 and "C" to "BNC" adapter to the Model 500 Pulser and connect to the FRISKER input.

Adjust the gain control until the FRISKER BETA count rate just sees the 1000 CPM rate.

Now adjust the Model 500 to 5 mV. The count rate should diminish to 0 CPM as you lower the input below 1.2 mV.

Verify Alpha count by sweeping the Model 500 Pulser from 30 mV to 50 mV. Alpha counting should occur at 40 mV $\pm$10%.

- **Sample Quad Amplifier Calibration Worksheet**

A sample Quad Amplifier Calibration Worksheet is located in the appendix and may be reproduced to meet local needs.

9.3 Peaking the Detectors

Peaking the detectors refers to finding the peak operating voltage for each detector. A beta-gamma source is placed on each detector. The high voltage is then incremented from some low voltage to a voltage where the counts begin to drop off. The Model 49-12 typically operates around 1600 VDC. Therefore, a range of 1500 to 1700 VDC is usually sufficient to find the voltage where the most counts are found.

An automatic peaking routine is available at the main menu. For quickest results, six beta-gamma sources should be placed (or taped) over the detectors. If only one source is available, then the peaking routine can be repeated six times, with the source over a different detector each time. The automatic peaking routine will automatically increment the high voltage within the specified range, and report where the peaks are found. The default range is from 1500 to 1700 volts in 25 volt increments.

Once the range parameters are entered, the display will show an estimated completion time, and start the procedure. When finished, the peaks to all six detectors are shown. The average peak value for the four hand probes and the average peak value for the two foot probes are displayed. These two average values are the suggested high voltage setpoints for the upper and lower high voltages.

9.4 Running a Plateau of the Detectors

An alpha plateau may be performed to check that the beta-gamma peak voltage is also on the alpha plateau. The voltage on each detector is incremented throughout the same range as was run in the peaking procedure. The alpha plateau counts should remain approximately constant around the beta-gamma peak operating voltage. The background update time interval should be set to 999 minutes.

9.5 Alpha and Beta Efficiency

When the operating high voltages are set, the alpha and beta efficiencies should be found to ensure correct operation. If the automatic alarm calculation modes are to be used, the efficiencies must be determined.

9.6 Gas Board Verification

The gas board is located at the extreme right of the electronic chassis. Under normal conditions the Gas Manager board P/N 5295-510 will not need re-calibration.

The functional check of this module is recommended at a yearly interval.

Apply a gas supply to the Main input. Decrease the pressure to below 3 psi. The BOTTLE PRESENT LED should be extinguished. Slowly raise the inlet pressure toward 6 psi. Note the gauge reading when the Bottle Present LED activates. This pressure is typically 4.5 psi. Now add 0.5 psi to this reading. Do the same procedure for the AUX. input, noting the action of the AUX BOTTLE PRESENT LED.

With both bottles connected (if you are using the dual gas bottle feature) cycle the power switch for system wide Reset. The "MAIN BOTTLE IN USE"

LED should be lit. Interrupt the Main Supply Line either by closing the valve at the regulator, lowering the incoming pressure to less than 3 psi, or crimping the Main Inlet Supply Line. The unit should select the Auxiliary bottle (if it is present). Check the LCD flow Readouts for acceptable gas flow. Now reactivate the Main Gas Supply. The unit should select the main bottle. Check the LCD flow readout for acceptable gas flow (35-50 cc/min). Turn each needle valve one turn open and check for 90 to 110 cc/min flow rate. Return both needle valves to the range of 40-50 cc/min.

10. MAINTENANCE AND DIAGNOSTIC TROUBLESHOOTING

This section describes daily maintenance and troubleshooting procedures.

10.1 Setting the Contrast On the Displays

The LCD (Liquid Crystal Display) is controlled by the LCD interface board (LMI #5295-512). The board is located second from the right in the upper electronic chassis. The potentiometer on the board is used to adjust the contrast on the display. The control may be rotated in either direction while watching the LCD to obtain the desired contrast.

10.2 Initialization Failure

During initialization, all microprocessor-based boards must communicate with the central processor board. If one of these boards doesn't communicate, then the central processor tells the display to show the message "_____ BOARD IS MISSING" and initialization ceases. The next step is figuring out the problem with that particular board, or cabling to the board. However, if the LCD display board is not working correctly, the message will not be seen. Likewise, if the communication between the central processor and the LCD display board is not working correctly then no message will appear, but the "INITIALIZING ALL BOARDS... PLEASE WAIT" message will be overwritten with periods.

10.3 Troubleshooting the HVPS Board

The high voltage power supply board (LMI# 5323-443), located in the center of the upper electronic chassis, has an LED array on the board. The LED array is composed of 10 lights in a package that measures roughly 1" by 0.4" located on the top of the HVPS board. The LED array may be viewed on the HVPS board without removing the board. The 10 lights have the following meaning:

1) Left light --+ 5V REFERENCE
2) + 5V POWER
3) +15V GENERAL
4) + 5V DIGITAL
5) UPPER HIGH VOLTAGE FAIL
6) No connection
7) LOWER HIGH VOLTAGE FAILS
8) TALKER

9) LOWER HIGH VOLTAGE READ
10) Right light--UPPER HIGH VOLTAGE READ

Lights 1 through 4 should always be on, indicating that the +5V and +15V supplies are good. Upon power up with all external lights and audio on (pre-initialization), the TALKER light should blink, the POWER lights and the UPPER HIGH VOLTAGE READ light should be on. After initialization the TALKER light will turn off and LEDS 9 and 10 will alternate between on and off.

Lights 5 or 7 will light if the high voltage read is more than 10 percent from the high voltage setpoint. However, setting either high voltage to 250 disables high voltage fail detection.

If the LEDs indicate a properly working board, the counts are too low, and the gas flow is good, then the high voltage is not getting to the detector. The following steps should locate the problem.

- The high voltage should be measured at the detector "C" connector.

- The high voltage should be measured at the back of the upper electronic chassis with the D-type connector removed.

- A continuity check should be performed from the HVPS backplane connector to the "C" type connector on the detector.

10.4 Troubleshooting the Counter Boards

The two counter boards (LMI# 5323-440) located on the main electronic chassis has an LED array on the board. The LED array is composed of 10 lights in a package that measures roughly 1" by 0.4" located on the top of each counter board. The LED array may be viewed on the counter board without removing the board. The 10 lights have the following meaning:

1) Left light -- No Connection
2) No Connection
3) No Connection
4) No Connection
5) +5V DIGITAL
6) Ignore
7) Ignore
8) Ignore
9) Ignore
10) Right light--TALKER

Light 5 should always be on. Upon pre-initialization the four LOW COUNT lights will be on and the TALKER LED will blink at a rate faster than once a second. The TALKER light will blink once every count time.

10.5 Troubleshooting the Central Processor Board

The central processor board (LMI #5323-441) has one LED in a T1 3/4 package. The LED is located on the left side and about half way down on the board. This LED indicates communication errors. Every time the LED light occurs, a communication error has occurred with the central processor. The software on each board can overcome an occasional communication error. However, if the LED stays on, then a continuous communication error has occurred and operation becomes unpredictable.

10.6 Diagnostic Screen

The diagnostic screen shows how many errors occured, which board is not repsonding, and the command the CPU board was trying to send. The format of the error code is in the format of AAACCC where AAA is the address of the board and CCC is the command. This display shows a list of up to 18 errors. After 18 error codes are received the list is cleared and started over again.

PARTS LIST

Ref. No.	Description	Part No.
	Model 49-12-1 Hand and Shoe Monitor	
UNIT	Completely Assembled Model 49-12-1 Hand and Shoe Monitor	48-2502
	LED Display Board, Drawing 295 x 364	
BOARD	Assembled LED Display	5295-480
	• **DIODES**	
CR1-CR2	LED-E120 Yellow	07-6309
CR3-CR6	LED-E121 Green	07-6310
CR7-CR8	LED-E120 Yellow	07-6309
CR9-CR15	LED-E118 Red	07-6308
CR16	LED-E120 Yellow	07-6309
CR17-CR21	LED-E118 Red	07-6308
CR22-CR24	LED-E121 Green	07-6310
CR25-CR26	LED-E119 Orange	07-6343
	• **MISCELLANEOUS**	
P1	CONN-102159-3	13-8390
*	RIBBON-102312-2 LATCH	13-7805
	Detector Cable Driver Board, Drawing 295 x 275	
BOARD	Assembled Det Cable Driver	5295-484
	• **CAPACITORS**	
C111	100pF, 3kV, C	04-5532
C114	0.0047μF, 3kV, C	04-5547
C124-C125	10μF, 20V, DT	04-5592
C127	100μF, 10V, DT	04-5576
C129	100pF, 3kV, C	04-5532
C139	100pF, 3kV, C	04-5532
C155	100pF, 3kV, C	04-5532
	• **TRANSISTOR**	
Q135-Q136	2N3904	05-5755
Q142-Q143	2N3904	05-5755
Q146	2N3904	05-5755
Q154	2N3904	05-5755

Ref. No.	Description	Part No.
	• **VOLTAGE REGULATOR**	
VR116	LM317LZ	05-5788
	• **DIODES**	
CR137	1N4001	07-6268
	• **RESISTORS**	
R110	10k, 1%	12-7540
R112-R113	1 MEG	10-7028
R115	243 OHM, 1%	12-7698
R117	100k, 1%	12-7557
R119-R120	10k, 1%	12-7540
R122	1 MEG	10-7028
R123	100 OHM	10-7004
R126	523 OHM, 1%	12-7708
R128	1 MEG	10-7028
R133	100k, 1%	12-7557
R134	10k, 1%	12-7540
R141	10k, 1%	12-7540
R145	10k, 1%	12-7540
R147	100k, 1%	12-7557
R148	1 G	12-7686
R150	10k, 1%	12-7540
R151	100k, 1%	12-7557
R152	10k, 1%	12-7540
R156	1 MEG	10-7028
	• **MISCELLANEOUS**	
P1	CONN-640456-3 MTA100	13-8081
P2-P5	CONN-640456-2 MTA100	13-8073
*	CLOVERLEAF-011-6809-000-599	
*	FUSE-CCL	21-9524
	Gas Control Board, Drawing 295 x 288	
BOARD	Assembled Gas Control	5295-510
	• **CAPACITORS**	
C126	1μF, 35V, DT	04-5575
C145	1μF, 35V, DT	04-5575

C160	27pF, 100V, C	04-5614
C162-163	0.01μF, 100V, C	04-5523
C166	1μF, 35V, DT	04-5575
C177	10μF, 20V, DT	04-5592
C207-C208	10μF, 20V, DT	04-5592
C209	100μF, 10V, DT	04-5576
C210	0.01μF, 100V ,C	04-5523
C212	27pF, 100V, C	04-5614
C215-C216	0.047μF, 100V, C	04-5565
C218	0.001μF,100V, C	04-5519
C221-C222	0.1μF, 100V, C	04-5521
C223-C225	0.01μF, 100V, C	04-5523
C259	10μF, 20V, DT	04-5592

- **CAPACITOR NETWORK**

CN251	0.01μF, 50V	04-5652

- **TRANSISTORS**

Q148	2N7000	05-5820
Q155	2N7000	05-5820

- **INTEGRATED CIRCUITS**

U129	LM331	06-6156
U132	80C51FA	06-6236
U141	ICL7662	06-6261
U143	ICL7667CPA	06-6261
U144	CD74HC14	06-6257
U147	LM329BZ	05-5827
U151	LM358N	06-6024
U153	ICL7667CPA	06-6250
U154	LM358N	06-6024
U157-U158	LM358N	06-6024
U164	CD4097	06-6192
U165	AD625	06-6202
U255	CA3251	06-6182

- **DIODES**

CR159	1N4001	07-6268

- **RESISTORS**

R110	1.82k, 1%	12-7510
R113	24.9k, 1%	12-7639
R115-R120	24.9k, 1%	12-7639
R123	5.6k	10-7042
R125	24.9k, 1%	12-7639
R134	33 OHM, 10%	12-7799
R169	47 OHM,	10-7002
R170	10k OHM, 1%	12-7540
R171-R172	100k, 1%	12-7557
R173	5.6k	10-7042
R174	10k TRIMMER	09-6822
R175	24.9k, 1%	12-7639
R176	10k TRIMMER	09-6822
R178	24.9k, 1%	12-7639
R179	1.82k, 1%	12-7510
R180	24.9k, 1%	12-7639
R181	1.82k, 1%	12-7510
R188	4.7k	10-7014
R189	24.9k, 1%	12-7639
R193	6.81k, 1%	12-7619
R195	4.7k	10-7014
R196-R197	20k, 1%	12-7676
R198	1.27k, 1%	12-7669
R199-R200	1k, 1%	12-7637
R201	22k	10-7070
R202	20k, 15	12-7676
R203	9.09k, 1%	12-7513
R204-R206	1.82k, 1%	12-7510
R261-R266	500 Trimmer	09-6843

- **RESISTOR NETWORK**

RN257	22k DIP, 16P	12-7715
RN258	2.2k SIP 10P	12-7595

- **CRYSTALS**

Y136	12 MHZ HC18	01-5224

- **MISCELLANEOUS**

*	F2815-051B-85	21-9605
*	VALVE-F-2822-41	21-9643
*	FLOW SENSOR AWM2100V	22-9782
*	FTG-MALE TUBE INSERT	22-9840
*	TUBING-1/8 SILICONE 54031	22-9842
*	SOLENOID VALVE CLIPPARD	2310350
*	PRESSURE SENSOR 24PCBBA2G	2310352

LCD Driver Board, Drawing 295 x 292

BOARD	Assembled LCD Driver	5295-512

- **CAPACITORS**

C112	0.1μF, 100V, C	04-5521
C118	10μF, 20V, DT	04-5592
C123	10μF, 20V, DT	04-5592
C125	27pF, 100V, C	04-5614
C131	100μF, 10V, DT	04-5576
C132	0.0047μF, 100V, C	04-5570
C137	1μF, 35V, DT	04-5575
C138	0.0047μF, 100V, C	04-5570

C140	0.0047μF, 100V, C	04-5570
C145	10μF, 20V, DT	04-5592
C146	27pF, 100V, C	04-5614

- **TRANSISTORS**

Q133	2N7000	05-5820
Q149	BUZ 71A	05-5837

- **INTEGRATED CIRCUITS**

U113	MM74C923	06-6072
U114	P80C51FA	06-6236
U115	CD74HC573	06-6093
U117	CD74HC14	06-6257
U120	CD74HC573	06-6093
U121	ICL7662	06-6261
U122	CD74HC14	06-6257
U124	CD74HC245	06-6267
U126	27C512	06-6264
U127	CDM6264	06-6098
U128	CD74HC138	06-6104

- **RESISTORS**

R116	10k TRIMMER	09-6824
R141-R143	4.7k	10-7014
R144	10k	10-7016
R150	0.1 OHM, 3W	12-7647

- **RESISTOR NETWORK**

RN119	22k SIP 10P	12-7566
RN155	22k SIP 10P	12-7566

- **CRYSTALS**

Y148	12 MHZ HC18	01-5224

LED/Switch Board, Drawing 295 x 484

BOARD	Assembled 8x8 LED Driver/ 20 Key switch	5295-685

- **CAPACITORS**

C110	10μF, 20V, DT	04-5592
C116	27pF, 100V, C	04-5614
C122	100μF, 10V, C	04-5576
C143-C145	0.0047μF, 100V, C	04-5570
C148	100μF, 10V, DT	04-5576
C149	27pF, 100V, C	04-5614
C174	.1MF 100 V C X7R	04-5521
C175	100MF 20V DT	04-5583

- **TRANSISTORS**

Q126	2N7000	05-5820
Q130	2N7000	05-5820
Q166	2N7000	05-5820
Q172	2N3904	05-5755

- **INTEGRATED CIRCUITS**

U113	P80C51FA INTEL	06-6236
U115	NMC87C-257Q200 NAT'L	06-6278
U117	CD74HC564E	06-6262
U118	UDN2595A DRIVER	06-6170
U120	UDN2981A	06-6271
U121	CD74HC238E	06-6246
U124	CD74HC14	06-6257
U165	CD74HC573E	06-6093
U167	CD74HC14	06-6257
U173	LM358N	06-6024

- **DIODES**

CR159-CR163	1N4148	07-6272

- **RESISTORS**

R119	4.7 OHM 1/4W 5% CR25	10-7095
R132	5.6 K 1/4W 5% CR25	10-7042
R133-R139	4.7 OHM 1/4W 5% CR25	10-7095
R141-R142	4.7 K 1/4W 5% CR25	10-7014
R146	10 K 1/4W 5% CR25	10-7016
R147	4.7 K 1/4W 5% CR25	10-7014
R151	33 OHM 2W 10%	12-7799
R168	10 K 1/4W 5% CR25	10-7016
R169	10 OHM 1/4W 5% CR25	10-7046
R170-R171	10 K 1/4W 5% CR25	10-7016
R177	1 MEG 1/4W 5% CR25	10-7028
R178	10 K 1/4W 5% CR25	10-7016

- **RESISTOR NETWORK**

RN114	22k SIP, 10P	12-7566
RN157	470OHM SIP, 10P	12-7825
RN158	22k DIP, 16P	12-7715

- **CRYSTAL**

Y123	12 MHZ HC18 MP120	01-5224

- **MISCELLANEOUS**

P62-P63	CONN-1-640456-0 MTA100	13-8066
P66	CONN-640456-6 MTA100	13-8095
P67	CONN-102153-3	13-8339

- **TRANSFORMERS**

T1	M 177 AUDIO $	4275-083

LVPS-100 VAC Input Board, Drawing 295 x 290

BOARD	Assembled LVPS Input	5295-517

- **CAPACITORS**

C173	2200μF, 35V, E	04-5621
C176-C177	0.01μF, 100V, C	04-5523
C178	0.1μF, 100V, C	04-5521
C181	2200μF, 35V, E	04-5621
C184	1μF, 35V, DT	04-5575
C222	0.1μF, 100V, C	04-5521
C224-C25	1μF, 35V, DT	04-5575
C229	0.1μF, 100V, C	04-5521
C280-C281	470μF, 25V	04-5628
C282	100μF, 35V	04-5595
C298	10μF, 20V, DT	04-5592

- **TRANSISTORS**

Q168	MPS6534	05-5763
Q171	MPS6534	05-5763
Q190-Q191	MPSU01	05-5778
Q321-Q322	BUZ71A	05-5837

- **VOLTAGE REGULATORS**

VR277-VR278	LT1076	05-5835
VR283	LT1170	05-5836
VR323	LM340T-15	05-5823

- **INTEGRATED CIRCUITS**

U163	DS1231-20	06-6234
U164	TLC372I	06-6265
U165	LM385Z-1.2	05-5808

- **DIODES**

CR119-CR120	MBR340	07-6347
CR122	MBR340	07-6347
CR127	CBR4-L010	07-6316
CR129	CBR4-L010	07-6316
CR305	1N4001	07-6268

- **DIODE NETWORK**

CRN268	HDSP-4830	07-6336

- **RESISTORS**

R131	15k, 1%	12-7545
R132	3.4k, 1%	12-7600
R133	10k	10-7016
R134	3.4k, 1%	12-7600
R135	15k, 1%	12-7545
R136	2.21k, 1%	12-7509
R137	1k	10-7009
R138	10k	10-7016
R139	1.24k, 1%	12-7703
R140	19.6k, 1%	12-7530
R141	10k	10-7016
R142-R143	1k	10-7009
R145-R147	10k	10-7016
R148-R150	100k	10-7023
R151	5.9k, 1%	12-7616
R152	10k	10-7016
R153	2.7k	10-7055
R155	100k	10-7023
R157	2.87k. 1%	12-7649
R159	2.87k, 1%	12-7649
R160	2.21k, 1%	12-7509
R161	2.7k	10-7055
R262	680 OHM	10-7056
R264-R265	2.7k	10-7055
R269	680 OHM	10-7056
R270	2.7k	10-7055
R341	12.1, 1%	12-7628

- **INDUCTOR**

L193-L194	PE92102K 100UH	21-9672
L195	PE92114K 55UH	21-9673

Central Processor Board, Drawing 295 x 302

BOARD	Assembled Central Processor	5295-526

- **CAPACITORS**

C113	27pF, 100V, C	04-5614
C122	18pF, 100V, C	04-5635
C150	100μF, 10V, DT	04-5576
C155	0.1μF, 100V, C	04-5521
C165	18pF, 100V, C	04-5635
C166	27pF, 100V, C	04-5614

- **INTEGRATED CIRCUITS**

U111	CD74HC14	06-6257
U115	80C51FA	06-6236
U117	DS1211	06-6255
U120	CD74HC573	06-6093
U121	MM58274	06-6254
U127	CDM6264	06-6098
U129	27C512	06-6264
U141	ICL7667	06-6250

- **DIODES**

CR118	SLH56-VR3	07-6308
CR151	1N5817	07-6290

- **RESISTORS**

R110	100k	10-7023
R130	1k	10-7009
2R135	330 OHMS	10-7053
R138	1k	10-7009

- **RESISTOR NETWORK**

RN116	22k SIP 10P	12-7566

- **CRYSTALS**

Y114	12 MHZ HC18	01-5224
Y133	32.768 KHZ	01-5219

Backplane Board, Drawing 295 x 303

BOARD	Assembled Backplane	5295-527

- **CONNECTORS**

J1-J2	CONN-CJ50-50B-10	13-8046
J3	D PLUG	
	CBD21WA4F3	13-8316
J4	CONN-CJ50-50B-10	13-8046
J5	D PLUG	
	CB21WA4F3S6000	13-8316
J6-J8	CONN-CJ50-50B-10	13-8046
J11	D PCB	
	CBD27W2F3S6000	13-8314
P50	CONN-1-640456-0	
	MTA100	13-8066
P51-P52	CONN-640456-5	
	MTA100	13-8057
P94	CONN-640456-4	
	MTA100	13-8088
P95	CONN-640456-9	
	MTA100	13-8094
P96	CONN-102153-4	13-8338
P97	CONN-640445-6	
	MTA156	13-8071
P98	CONN-640456-5	
	MTA100	13-8057

Backlight Power Supply Board, Drawing 295 x 309

BOARD	Assembled Backlight Power Supply	5295-535

- **CAPACITORS**

C110	10μF, 20V, DT	04-5592
C111	0.1μF, 100V, C	04-5521

- **RESISTORS**

R112	0.1 OHM, 3W, 1%	12-7647

- **MISCELLANEOUS**

P90	CONN-640456-3	
	MTA100	13-8081
P91	CONN-640456-5	
	MTA100	13-8057
*	POWER SUPPLY-	
	CXA-L10A	21-9689
*	INSULATING SPACER-	
	939-125	18-8960

Quad Counter Board, Drawing 323 x 261

BOARD	Assembled Quad Counter	5323-440

- **CAPACITORS**

C13	100μF, 10V, DT	04-5576
C14-C15	27pF, 100V, C	04-5614

- **TRANSISTORS**

Q16	2N7000	05-5820

- **INTEGRATED CIRCUITS**

U5	CD74HC14	06-6257
U9	CD74HC00	06-6260
U17-U19	CD74HC573	06-6093
U21	27C512-15N	06-6264
U22	CDM6264	06-6098
U23-U26	LS7062	06-6201
U27	80C51FA	06-6236
U28	CD74HC14	06-6257

- **DIODE NETWORK**

CRN20	HDSP-4830	07-6336

- **RESISTORS**

R29-R30	100k	10-7023

- **RESISTOR NETWORK**

RN31	220k SIP 10P	12-7578
RN32	22k SIP 10P	12-7566
RN33	220k SIP 10P	12-7578
RN34	2.2k SIP 8P	12-7776

- **CRYSTALS**

Y12	12MHZ HC18	01-5224

Quad Preamp Board, Drawing 323 x 263

BOARD	Assembled Quad Preamp	5323-442

- **CAPACITORS**

C134	22μF, 35V, DT	04-5594
C135	100μF, 15V, DT	04-5583
C138	1μF, 35V, DT	04-5575
C140	100μF, 10V, DT	04-5576
C141	330pF, 100V, C	04-5531
C142-C143	10pF, 100V, C	04-5573
C144	100pF, 100V, C	04-5527
C145	10pF, 100V, C	04-5573
C147	0.1μF, 100V, C	04-5521
C148	0.01μF, 100V, C	04-5523
C149	10pF, 100V, C	04-5573
C150	0.1μF, 100V, C	04-5521
C151	47pF, 100V, C	04-5533
C152	10pF, 100V, C	04-5573
C153	0.1μF, 100V, C	04-5521
C154	0.01μF, 100V, C	04-5523
C158	0.1μF, 100V, C	04-5521
C159	10pF, 100V, C	04-5573
C160-C161	100pF, 100V, C	04-5527
C162-C163	47pF, 100V, C	04-5533
C164	100pF, 100V, C	04-5527
C165	47pF, 100V, C	04-5533
C166	0.1μF, 100V, C	04-5521
C169	10pF, 100V, C	04-5573
C170	100pF, 100V, C	04-5527
C171	10pF, 100V, C	04-5573
C172-C173	47pF, 100V, C	04-5533
C174-C175	0.1μF, 100V, C	04-5521
C177	100pF, 100V, C	04-5527
C178	47pF, 100V, C	04-5533
C179	10pF, 100V, C	04-5573
C180-C181	0.1μF, 100V, C	04-5521
C182	10pF, 100V, C	04-5573
C183	0.1μF, 100V, C	04-5521
C186	10pF, 100V, C	04-5573
C187	100pF, 100V, C	04-5527
C188	10pF, 100V, C	04-5573
C189	0.1μF, 100V, C	04-5521
C190	100pF, 100V, C	04-5527
C191	47pF, 100V, C	04-5533
C192	0.1μF, 100V, C	04-5521
C226	0.01μF, 100V, C	04-5523
C233	0.01μF, 100V, C	04-5523
C236	1μF, 35V, DT	04-5575
C237	330pF, 100V, C	04-5531
C256	0.01μF, 100V, C	04-5523
C263	0.01μF, 100V, C	04-5523
C266	1μF, 35V, DT	04-5575
C267	330pF, 100V, C	04-5531
C270	1μF, 35V, DT	04-5575
C277	0.01μF, 100V, C	04-5523
C279	0.01μF, 100V, C	04-5523
C282	330pF, 100V, C	04-5531
C309-C310	0.1μF, 100V, C	04-5521

- **VOLTAGE REGULATORS**

VR1	LM317LZ	05-5788

- **INTEGRATED CIRCUITS**

U97-U102	TLC372I	06-6265
U105	CD4098	06-6066
U109	CD4098	06-6066
U115	CD4098	06-6066
U116	CA3096	06-6023
U119	CD4098	06-6066
U258	CA3096	06-6023
U278	CA3096	06-6023
U283	CA3096	06-6023

- **DIODES**

CR300	1N4001	07-6268

- **RESISTORS**

R3	10k TRIMMER	09-6822
R7	47k	10-7020
R8	470k	10-7026
R9	10k	10-7016
R10	1 MEG	10-7028
R11	100k	10-7023
R12-R14	10k	10-7016
R15-R16	1k	10-7009
R17	10k	10-7016
R18	1k	10-7009
R19	10k	10-7016
R20	1k	10-7009
R21	47k	10-7020
R24	4.7k	10-7014
R25	10k	10-7016
R28-R29	1k	10-7009
R30-R31	47k	10-7020
R32	10k	10-7016
R34	5.6k	10-7042
R37	10k	10-7016
R38	4.7k	10-7014
R39-R41	10k	10-7016
R45-R46	10k	10-7016
R47	1k	10-7009
R48	10k	10-7016
R51-R53	10k	10-7013

R54	1k	10-7009
R55	10k	10-7016
R56	4.7k	10-7014
R57	10k	10-7016
R61	5.6k	10-7042
R62	330 OHMS	10-7053
R63	100 OHMS	10-7004
R64	10k	10-7016
R65	4.7k	10-7014
R66	47k	10-7020
R69	10k	10-7016
R70	1k	10-7009
R71	47k	10-7020
R72	1k	10-7009
R73	47k	10-7020
R76	47k	10-7020
R77	1k	10-7009
R78-R79	10k	10-7016
R80	22k	10-7070
R81	5.6k	10-7042
R82-R84	10k	10-7016
R89	1k	10-7009
R90	10k	10-7016
R94	1 MEG	10-7028
R223-R224	1 MEG	10-7028
R225	22k	10-7070
R227	10k TRIMMER	09-6822
R229	5.6k	10-7042
R230	100k	10-7023
R231	470k	10-7026
R232	100 OHM	10-7004
R234	330 OHM	10-7053
R235	10k	10-7016
R253-R254	1 MEG	10-7028
R255	22k	10-7070
R257	10k TRIMMER	09-6822
R260	10k	10-7023
R261	470k	10-7026
R262	100 OHM	10-7004
R264	330 OHM	10-7053
R265	10k	10-7016
R268-R269	1 MEG	10-7028
R271	330 OHM	10-7053
R272	10k TRIMMER	09-6822
R274	100k	10-7023
R275	470k	10-7026
R276	100 OHM	10-7004
R280	22k	10-7070
R281	10k	10-7016
R294	243 OHM, 1%	12-7698
R295-R297	10k	10-7016
R298	1.69k, 1%	12-7680
R301	10k	10-7016
R308	10k	10-7016

Dual HVPS Board, Drawing 323 x 447

BOARD	Assembled Dual HVPS	5323-746

- **CAPACITORS**

C5	100pF, 3kV, C	04-5532
C8	0.0015μF, 3kV, C	04-5518
C10	0.0015μF, 3kV, C	04-5518
C13	0.0015μF, 3kV, C	04-5518
C14-C15	33pF, 100V, C	04-5616
C16-C17	27pF, 100V, C	04-5614
C18	470pF, 100V, C	04-5555
C19-C20	0.047μF, 100V, C	04-5565
C21	27pF, 100V, C	04-5614
C22-C24	0.1μF, 100V, C	04-5521
C29	0.1μF, 100V, C	04-5521
C30	0.01μF, 100V, C	04-5523
C31	100pF, 100V, C	04-5527
C32	0.1μF, 100V, C	04-5521
C36	0.0056μF, 3kV, C	04-5522
C37-C38	10μF, 20V ,DT	04-5592
C39-C43	1μF, 35V, DT	04-5575
C45-C47	100μF, 10V ,DT	04-5576
C48	10μF, 20V ,DT	04-5592
C49	100μF, 10V, DT	04-5576
C143	0.0056μF, 3kV, C	04-5522
C145	0.0015μF, 3kV, C	04-5518
C148-C149	0.0056μF, 3kV, C	04-5522
C152	0.01μF, 100V, C	04-5523
C156	0.1μ, 100V, C	04-5521
C161	100μF, 10V, DT	04-5576
C162	100pF, 100V, C	04-5527
C166	0.0015μF, 3kV, C	04-5518
C169	0.0015μF, 3kV, C	04-5518
C172	0.0015μF, 3kV, C	04-5518
C173	100pF, 3kV, C	04-5532
C177	0.0015μF, 3kV, C	04-5518
C180	0.15μF, 100V, C	04-5521

- **TRANSISTORS**

Q1	MPSU51	05-5765
Q131	2N7000	05-5820
Q133	2N3904	05-5755
Q154	MPSU51	05-5765
Q171	2N3904	05-5755

- **INTEGRATED CIRCUITS**

U64	CD74HC14	06-6257
U65	CD4052	06-6141
U67	CD74HC573	06-6093
U69	87C257	06-6278
U68	AD7549JN	06-6253
U70	80C51FA	06-6236
U71-U72	LM358	06-6024
U73	LT1078	06-6251
U74	LM331	06-6156

U75	ICL7660	06-6132
U77	TLC27M7	06-6248
U134	LM385Z-2.5	05-5791
U135	LM385Z-1.2	05-5808
U136	LM385Z-2.5	05-5791
U155	TLC27M7	06-6248

- **DIODES**

CR51-CR52	1N4148	07-6272
CR54-CR55	MR250-2	07-6266
CR60-CR61	MR250-2	07-6266
CR63	MR250-2	07-6266
CR160	1N4148	07-6272
CR163	MR250-2	07-6266
CR165	MR250-2	07-6266
CR167-CR168	MR250-2	07-6266
CR176	MR250-2	07-6266
CR181	1N4148	07-6272

- **DIODE NETWORKS**

CRN66	HDSP4830	07-6336

- **RESISTORS**

R78	10k TRIMMER	09-6824
R81-R82	1 MEG TRIMMER	09-6778
R83-R85	100k TRIMMER	09-6829
R86-R87	1 G	12-7686
R90	820 OHM	10-7060
R91	8.2k	10-7015
R92	2.2 MEG	10-7052
R93	8.2k	10-7015
R94	56k	10-7021
R95	100k	10-7023
R96	33k	10-7019
R97	100k, 1%	12-7557
R98	100k	10-7023
R99-R101	4.7k	10-7014
R102	10k	10-7016
R103	6.81k, 1%	12-7619
R104	10k, 1%	12-7540
R105	100k, 1%	12-7557
R106	47 OHM	10-7002
R109	10k	10-7016
R110	22k	10-7070
R111	100k	10-7023
R112	470k	10-7026
R113	470k	10-7026
R114	4.7k	10-7014
R115	1 MEG	10-7028
R121-R122	2.2k	10-7012
R123	5.6k	10-7042
R141	4.7 MEG	10-7030
R142	1 MEG	10-7028
R151	4.7k	10-7014
R157	1 G	12-7686
R158	4.7 MEG	10-7030
R159	10k	10-7016
R164	470k	10-7026
R170	1 MEG	10-7028
R174	1 MEG	10-7028
R175	1 G	12-7686
R178	1 MEG TRIMMER	09-6778
R179	100k	10-7023
R182	470k	10-7026
R183	1 MEG TRIMMER	09-6778
R184	22k	10-7070

- **RESISTOR NETWORK**

RN128	220K SIP 10P	12-7578
RN129	22K SIP 10P	12-7566
RN130	2.2k SIP 8P	12-7776

- **TRANSFORMER**

T138	M2221;2300; 4 HVPS	4275-037
T153	M2221;2300; 4 HVPS	4275-037

- **CRYSTAL**

Y188	12 MHZ HC18	01-5224

- **MISCELLANEOUS**

HD189	CONN-640456-2 MTA100	13-8073
P6	D PCB CBD27W2M5B80000	13-8313
P7	CONN-640456-2 MTA100	13-8073
P8	CONN-640456-4 MTA100	13-8088
*	CLOVERLEAF-011-6809-000-599	18-8771
*	CARD EJECTOR-CE-110-062	22-9725

APPENDIX A

HVPS BOARD CALIBRATION

HVPS BOARD CALIBRATION

1) Rotate chassis door down and turn instrument "ON". Access to the high voltage board is through holes on the left end of the chassis.
2) Push MAIN MENU key to select the setup menu.

   a. Push 1 to select SETUP MENU. Enter the required security code. Push ENT to go to SETUP MENUII.
   b. Push 2 to select BACKGROUND UPDATE INTERVAL. Set interval to 999 and push ENT. Push BKSP to return to SETUP MENU I.
   c. Push 2 to select HIGH VOLTAGE SETUP. Set upper and lower high voltage to 1600 and push ENT.
   d. Select OPER COND key to view the high voltage.

3) The HANDS high voltage may be measured carefully inserting the voltmeter probe in the lower access hole and onto the island where the white teflon wire is attached.

4) Adjust the potentiometer labelled UH (R183) until the actual high voltage output is 1600 VDC ±3 VDC.

   Hands High Voltage:_____V.

5) Now measure the FOOT high voltage through the upper access hole and on the island where the white teflon wire is attached.

6) Adjust the potentiometer labelled LH (R81) until the actual high voltage output is 1600 VDC ±3 VDC.

   Foot High Voltage:_____V.

7) Measure the reference voltage for high voltages supply by carefully inserting test lead through access hole at pins 1 and 2 of the TLC27M7 op amps.

8) For the hands reference measure through the lower access hole and adjust UR (R178) for a voltmeter reading of 1.600 VDC ±3 mV.

   Hands Reference Voltage:_____mV.

9) For the feet reference measure through the upper access hole and adjust LR (R82) for a voltmeter reading of 1.600 VDC ±3 mV.

   Feet Reference Voltage:_____mV.

10) Now view the LCD HV Readouts and adjust the HV CAL control located on the edge of the HVPS board. The Readouts should be 1600 VDC ±5.

11) The Threshold and Window Reference voltages are generated on the HVPS board. Access to these adjustments are again through the left end of the chassis.

12) Place a voltmeter ground lead on pin 1 of connector P8, located on the edge of the HVPS board.

13) Measure the voltage at pin 4 of P8 and adjust the BT potentiometer (R85) until the meter reads 50 mVDC ±1 mVDC.

   Beta Threshold Reference:_____mV.

14) Measure the voltage at pin 3 of connector P8 and adjust the BW potentiometer (R84) until the meter reads 1.000 VDC ±0.01 VDC.

   Beta Window Reference:_____mV.

15) Now measure the voltage at pin 2 of P8 and adjust the AT potentiometer (R83) until the meter reads 1.600 VDC ±0.02 VDC.

   Alpha Threshold Reference:_____mV.

16) Return the Background update time interval high voltage parameters to their original values.

APPENDIX B

QUAD AMPLIFIER BOARD CALIBRATION
AMPLIFIER AMPLITUDE OUTPUT SETTING

QUAD AMPLIFIER BOARD CALIBRATION
AMPLIFIER AMPLITUDE OUTPUT SETTING

a) Turn monitor on. After initialization push the main menu key. Once the main menu is displayed on the lower LCD, push:

#1 key to select SETUP MENU,
Enter security code,
Press ENT to continue to SETUP MENU II.
#5 key to select SET CALIBRATE MODE ON/OFF
#2 key to set ON. Press ENT key twice to accept value. This will set the count time to 1 second, turn background subtract off, and disabled the background update interval.
Select OPER COND key to return to operating conditions screen.

b) Adjust pulser for a 50 mV amplitude pulse height and 1000 CPM.

c) Remove the 8-pin D-type connector located on the back of the upper electronics chassis labelled: **HANDS**

d) Connect pulser to A1 (LHB) of the connector.

e) Rotate potentiometer (R3) labelled SIG1 on board **AMP1** until counts just cease as viewed in the upper LCD.

f) Adjust pulser to the 5 mV scale.

g) Sweep the pulser from 1 to 4 mV. The counts should cease around 2.5 mV. Determine where the counts cease.
Beta-gamma threshold for channel A1 (LHB):_____.

h) Adjust pulser to the 500 mV scale.

i) Sweep the pulser from 60 to 100 Mv. Determine where alpha counts begin. 80 mV is typical for the alpha threshold.
Alpha threshold for channel A1 (LHB):_____.

Repeat for other channels (LHP,RHP, & RHB) and the two feet channels on the other amplifier board (LF and RF).

To calibrate for the frisker channel:

a) Adjust pulser for a 35 mV amplitude pulse height and 1000 CPM.

b) Remove the 8-pin D-type connector located on the back of the upper electronics chassis labelled: **HANDS**

c) Connect pulser to A1 (LHB) of the connector.

d) Rotate potentiometer (R3) labelled SIG1 on board **AMP1** until counts just cease as viewed in the upper LCD.

e) Adjust pulser to the 5 mV scale.

f) Sweep the pulser from 0 to 3 mV. The counts should cease around 1.2 mV. Determine where the counts cease.
Beta-gamma threshold for channel A1 (LHB):_____.

g) Adjust pulser to the 50 mV scale.

h) Sweep the pulser from 30 to 50 Mv. Determine where alpha counts begin. 40 mV is typical for the alpha threshold.
Alpha threshold for channel A1 (LHB):_____.

APPENDIX C

SETUP EXAMPLES

SETUP EXAMPLES

1. Example #1

Scenario: The M49-12-1 is placed at the egress of a laundry. All personnel leaving the laundry must check through the Hand and Shoe Monitor. Background in this area is relatively stable.

Setup: The best alarm calculation mode to use would probably be the MAX SENSITIVITY mode. The sensitivity in this mode is governed by the sigma factors. Too high a sigma factor gives poor sensitivity, and too low a sigma factor gives an unacceptable false alarm rate. The following setup gives some rationale for the numbers entered.

High voltage (hands):	1625 as found in peaking operation
High voltage (feet):	1600 as found in peaking operation
Count time:	10 seconds to give good sensitivity but not excessive delay
Input gas flow:	50 cc/min gives good alpha and beta response
Low gas flow alert:	30 cc/min
Bottle mode:	Automatic switchover
Background Update Limit:	10 minutes
Background Subtract:	On
Alarm Hold Time:	5 seconds
Low Count Alarms:	9999 (disabled, but see below)
Alpha Sigma:	3.10 gives false alarm rate of 1 in 1000
Beta Sigma:	3.10 gives false alarm rate of 1 in 1000
Alpha Hand Efficiency:	18% as found in efficiency operation
Alpha Foot Efficiency:	5% as found in efficiency operation
Beta Hand Efficiency:	26% as found in efficiency operation
Beta Foot Efficiency:	12% as found in efficiency operation
Confidence Level:	90%
Maximum Allowable Source:	1500 dpm
Alarm Calculation Mode:	Maximum Sensitivity

When all the above parameters are set, the M49-12-1 updates the background for the new count time and then the READY light turns on. The beta sensitivity, as shown in the OPERATING CONDITIONS window is approximately 1500 dpm. The alpha alarmpoint is 10 (3.10 times the square root of 10), so the alpha sensitivity at 5% efficiency is better than 600 dpm. The low count alarms can now be set. If the smallest hand beta background seen is about 400 counts per minute, set the hand low count alarms at 200 counts per minute. Similarly, the foot low count alarms should be set to 300 counts per minute. The LOW COUNT alarm will then activate if the beta background drops by half. The polyethylene roll is not used here because its use completely blocks alpha particles. The false alarm rate (1 in 1000) refers to a single detector. Since the M49-12-1 has six detectors, the false alarm rate could be restated as 6 in 1000 employees or 0.6%. For a 1 in 1000 employee false alarm rate, the sigma factor should be 3.54.

SETUP EXAMPLES (cont.)

2. Example #2

Scenario: The M49-12-1 is used during an outage period at a power plant. It is desired to check people through a certain area as quickly as possible, but not allow anyone through with more than 2000 dpm beta contamination or 1000 dpm alpha contamination. Background fluctuates considerably in this area.

Setup: The best alarm calculation mode to use would probably be the MINIMUM COUNT TIME mode. The following setup gives some rationale for the numbers entered.

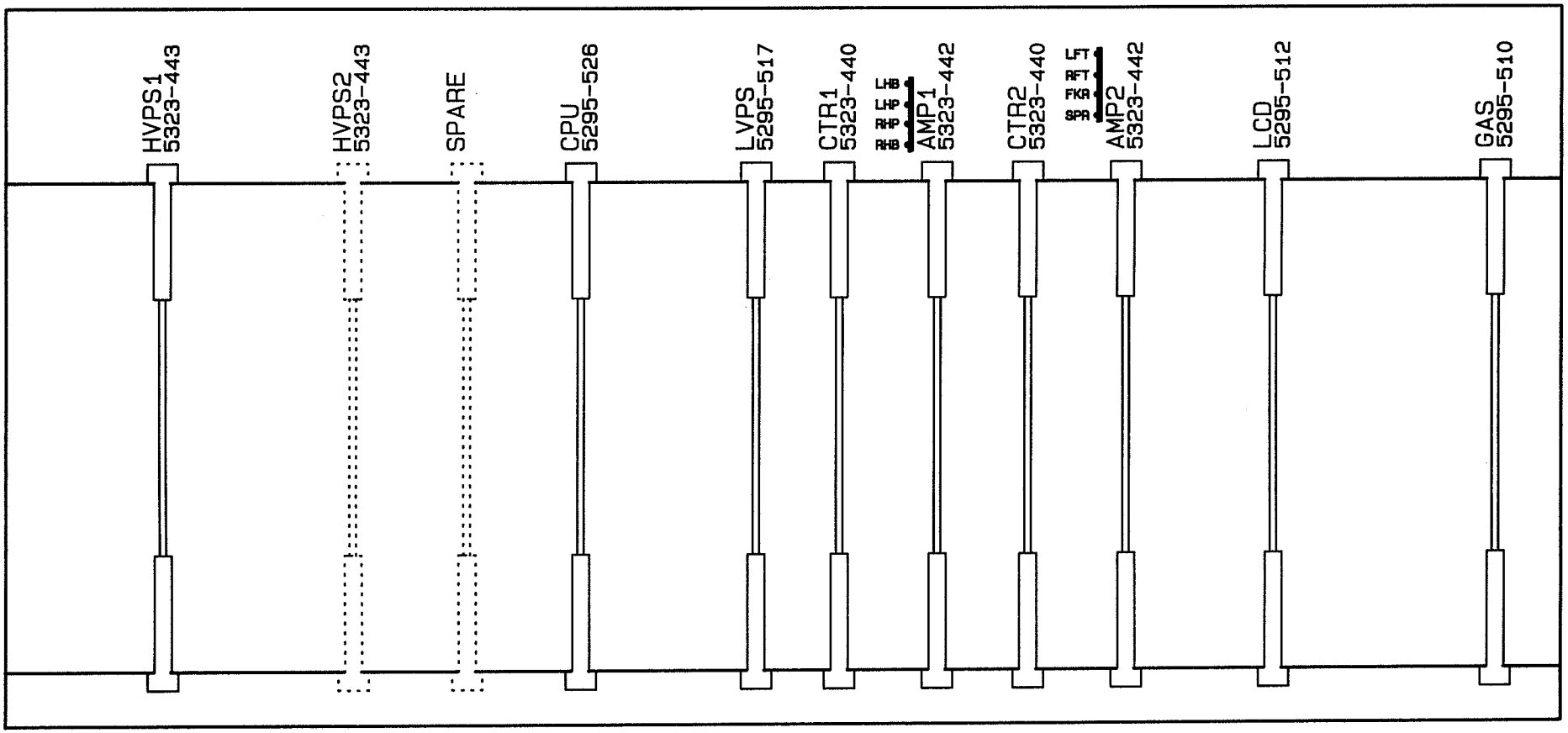
High voltage (hands):	1575 as found in peaking operation
High voltage (feet):	1600 as found in peaking operation
Count time:	10 seconds (see below)
Input gas flow:	50 cc/min gives good alpha and beta response
Low gas flow alert:	30 cc/min
Bottle mode:	Automatic switchover
Background Update Limit:	3 minutes
Background Subtract:	On
Alarm Hold Time:	20 seconds
Low Count Alarms:	9999 (see below)
Alpha Sigma:	3.10 gives false alarm rate of 1 in 1000
Beta Sigma:	3.10 gives false alarm rate of 1 in 1000
Alpha Hand Efficiency:	18% as found in efficiency operation
Alpha Foot Efficiency:	5% as found in efficiency operation
Beta Hand Efficiency:	26% as found in efficiency operation
Beta Foot Efficiency:	12% as found in efficiency operation
Confidence Level:	90%
Desired Beta Source Size:	2000 dpm
Desired Alpha Source Size:	1000 dpm
Maximum Count Time:	25 seconds
Alarm Calculation Mode:	Minimum Count Time

When all the above parameters are set, the M49-12-1 calculates the count time required to achieve the desired sensitivity and updates the background for the new count time and then the READY light turns on. The count time will fluctuate, becoming longer as the background rises, and shorter as the background becomes less. If the background ever rises high enough so that 2000 dpm beta sensitivity cannot be achieved in under 25 seconds, the HIGH BKGND alarm will activate. The background update interval is fairly short, to ensure that the background is re-evaluated frequently. The alarm hold time is relatively long to ensure that a supervisor is aware of the infraction. The low count alarms should be set relatively low since the background and count time can both decrease. Setting the low count alarms to 0000 will cause a low count alarm only when any detector is completely "dead" or disconnected.

APPENDIX D

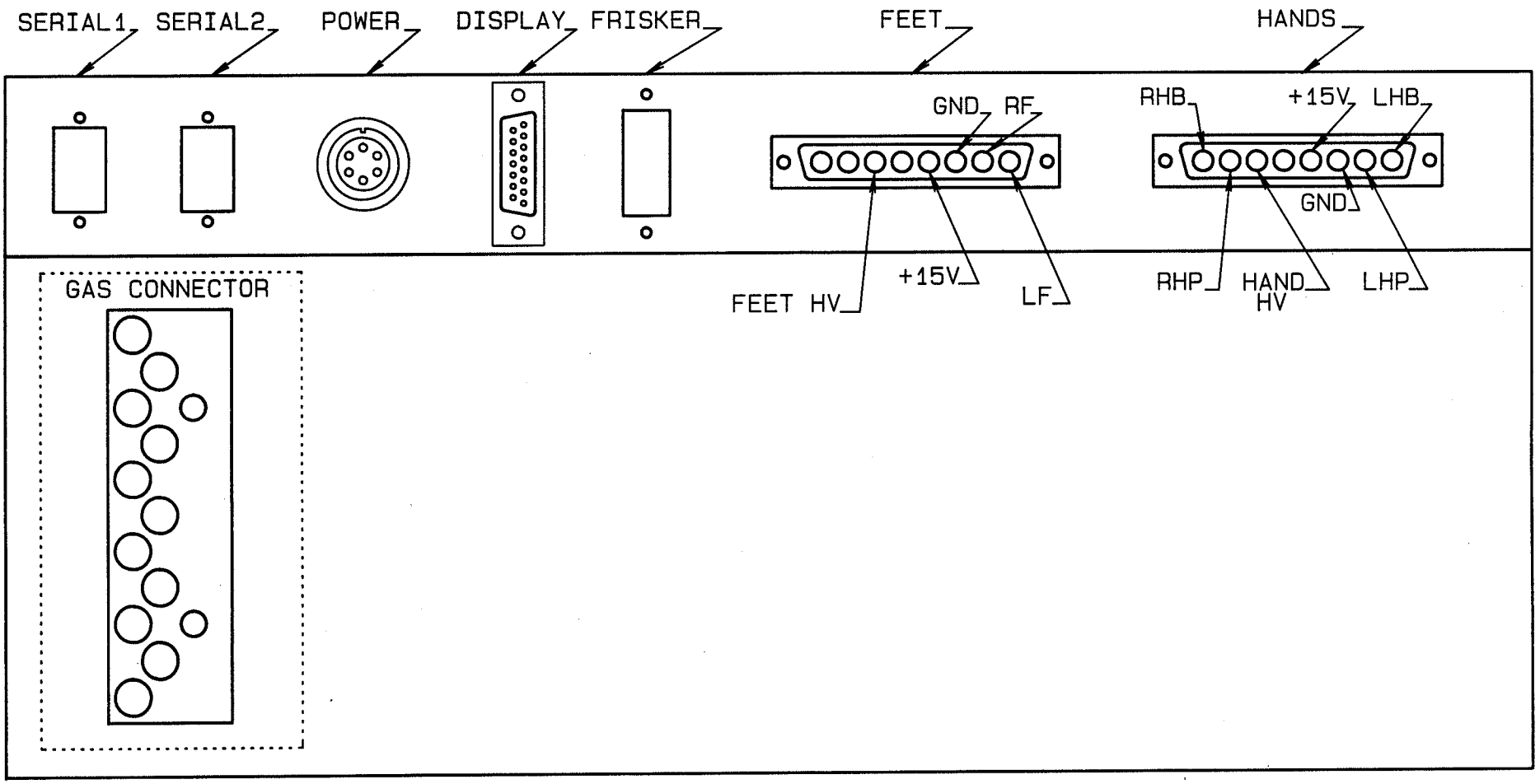
DRAWINGS AND DIAGRAMS

ELECTRONICS CHASSIS FRONT VIEW



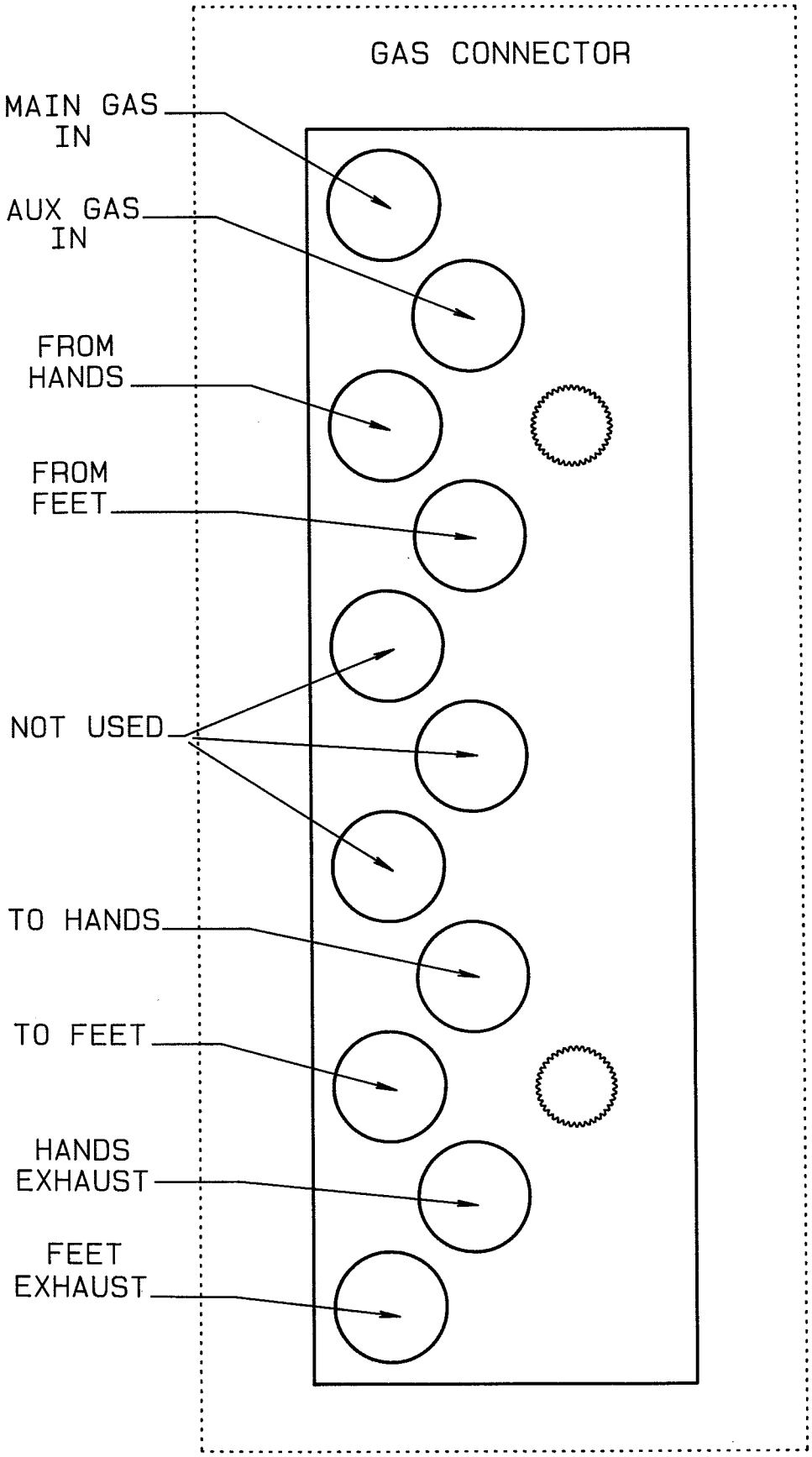
CHG	NO.					DWN	CHK	APP
DWN BK	DATE 3-9-92	CHK	DATE		APP	DATE		
TOL: SHOP STD ☐ OTHER				SCALE: FULL ☐ OTHER				
TITLE M49-12/B HAND/SHOE MONITOR								
LUDLUM MEASUREMENTS, INC. 501 OAK STREET SWEETWATER, TEXAS 79556				SERIES 295		SHEET 340		

ELECTRONICS CHASSIS REAR LAYOUT



VIEW A

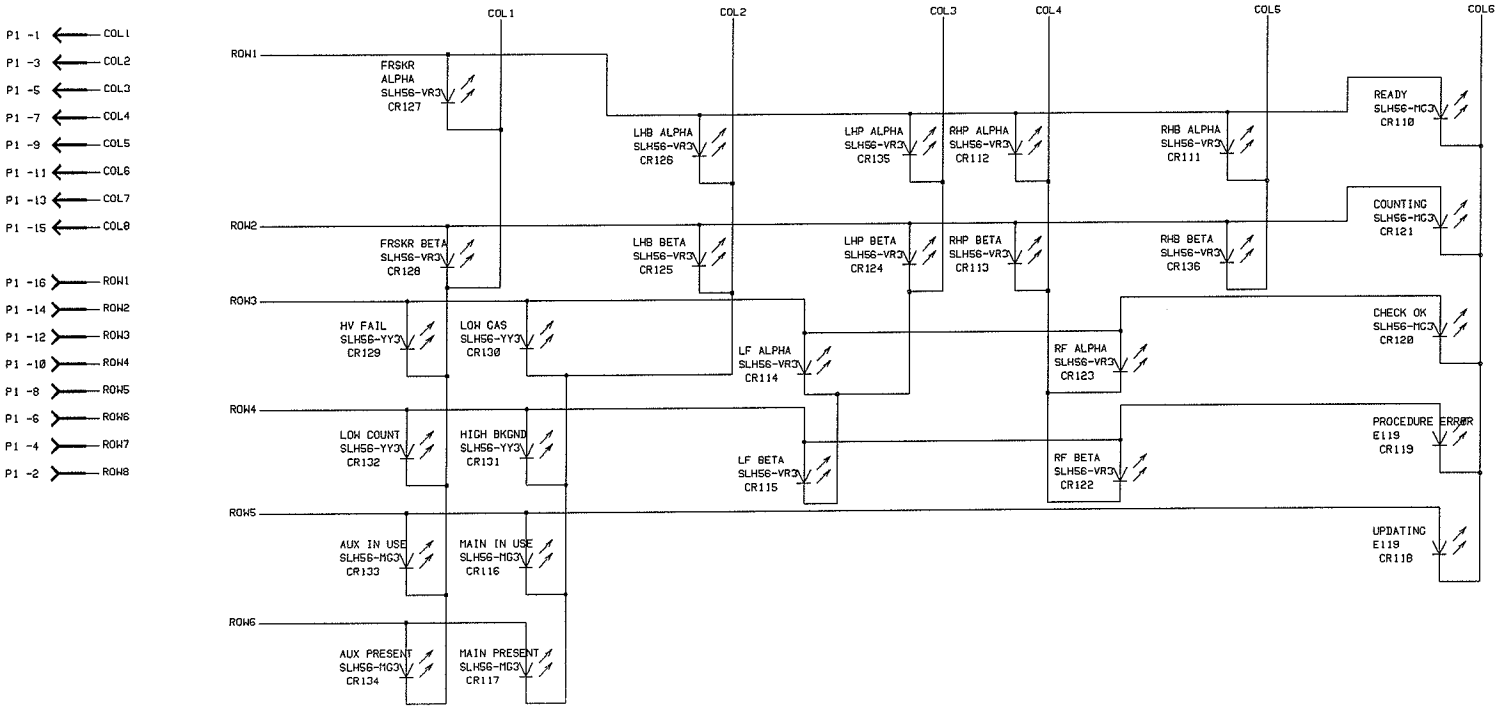
CHG	NO.					DWN	CHK	APP
DWN BK	DATE 3-10-92	CHK	DATE		APP	DATE		
TOL: SHOP STD ☐ OTHER				SCALE: FULL ☐ OTHER				
TITLE M49-12/B HAND/SHOE MONITOR								
LUDLUM MEASUREMENTS, INC. 501 OAK STREET SWEETWATER, TEXAS 79556				SERIES 295		SHEET 341		



VIEW A

CHG	NO.					DWN	CHK	APP
DWN BK	DATE 3-10-92	CHK	DATE		APP	DATE		
TOL: SHOP STD ☐ OTHER				SCALE: FULL ☐ OTHER				
TITLE M49-12/B HAND/SHOE MONITOR								
LUDLUM MEASUREMENTS, INC. 501 OAK STREET SWEETWATER, TEXAS 79556				SERIES 295		SHEET 342		

REVISIONS						
EFF	AUTHORITY	ZONE	LTR	DESCRIPTION	DATE	APPROVED



UPDATED -	/ /
DR RDS	02JUN93
CHK	/ /
DSGN RDS	02JUN93
APPD	/ /
NEXT HIGHER ASSY. -	
12:05:30	17-Feb-98

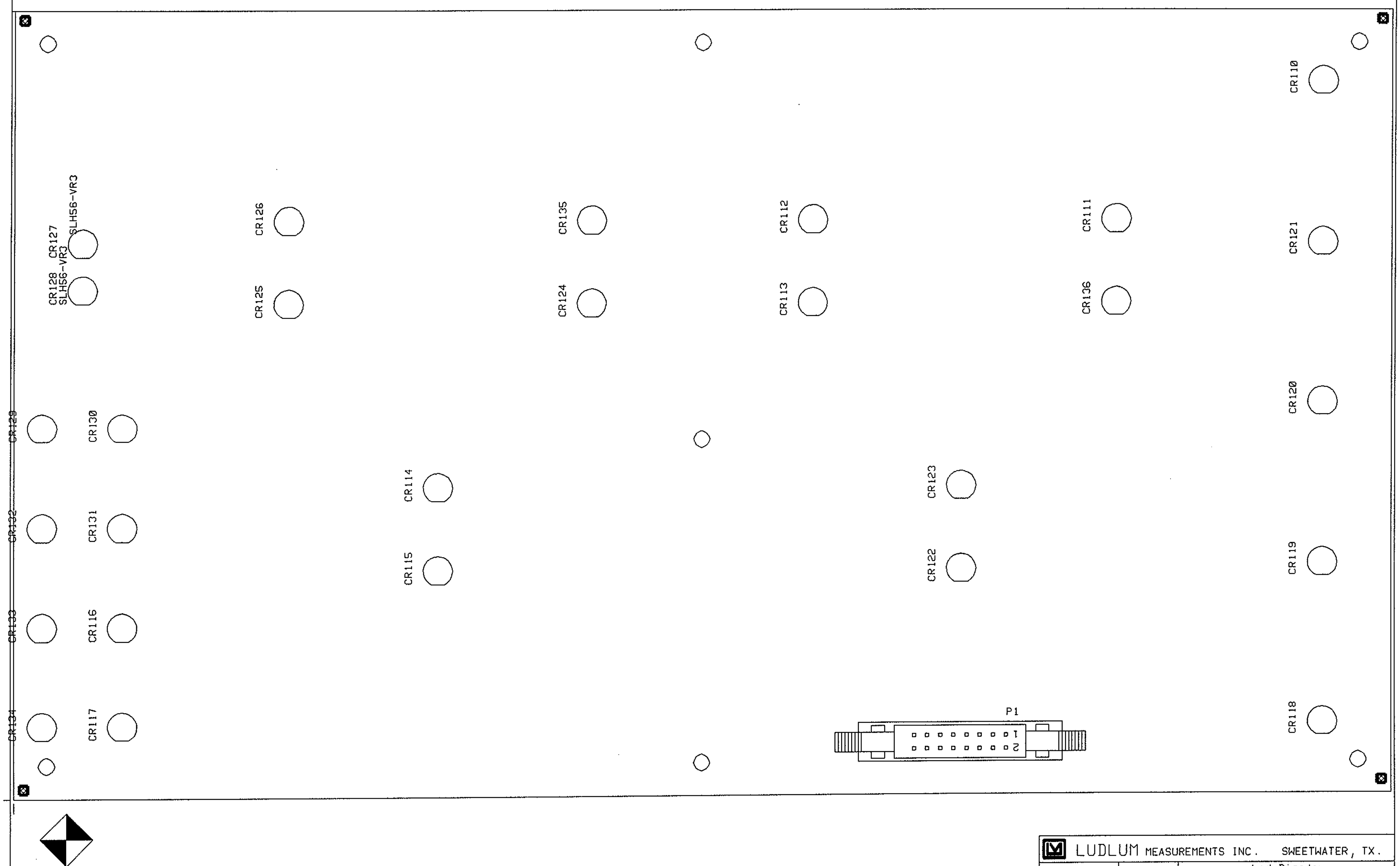
LUDLUM MEASUREMENTS INC.

TITLE: LED DISPLAY

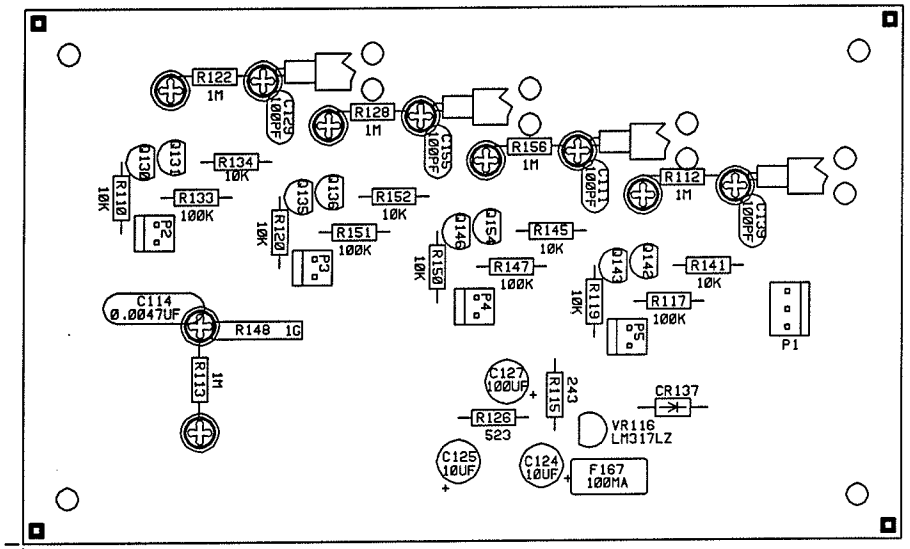
BOARD# S295-613

SIZE	MODEL	SERIES	SHEET
D	49-12-1	295	364

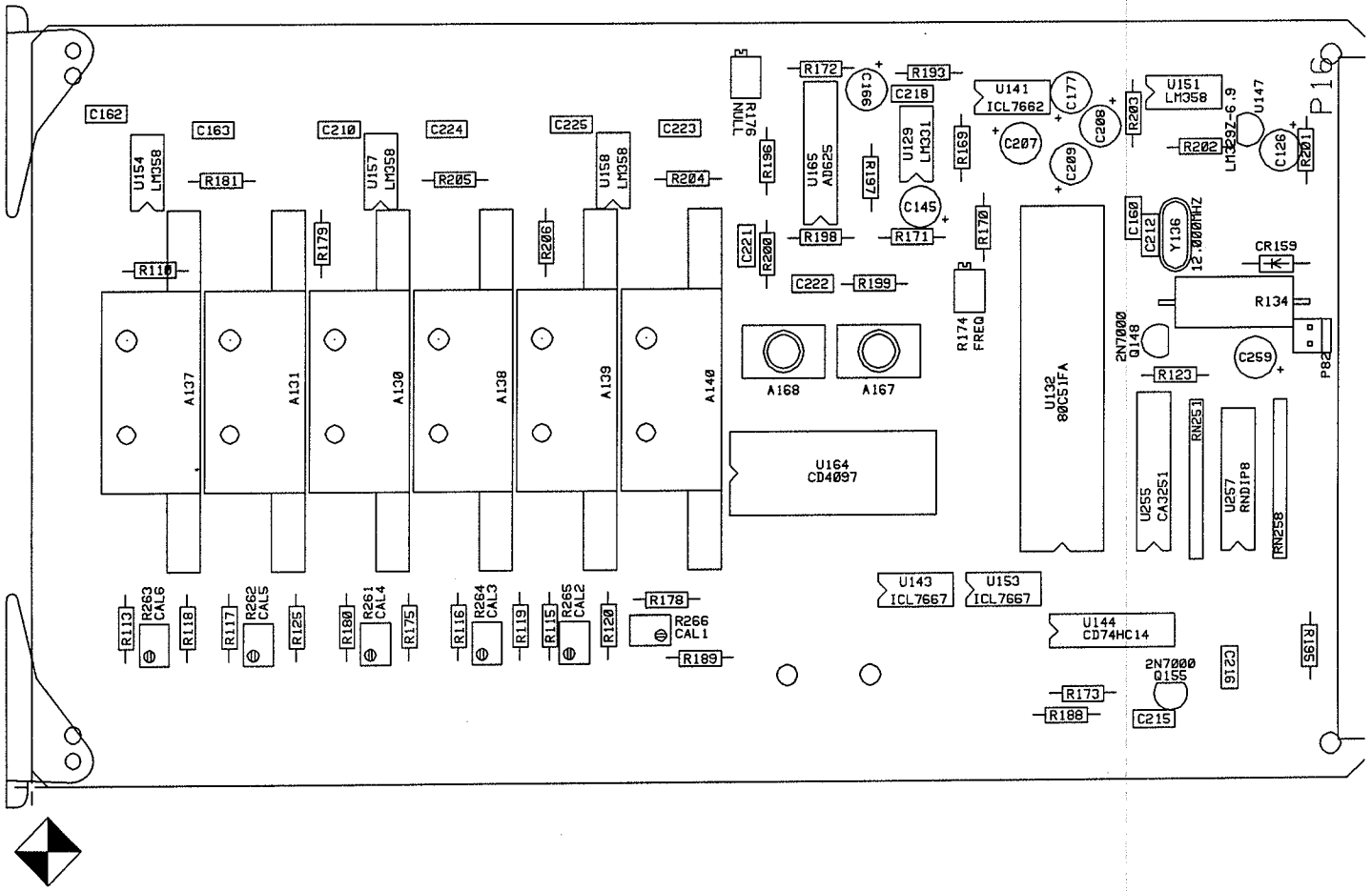
S8295613 SHEET 1 OF 1



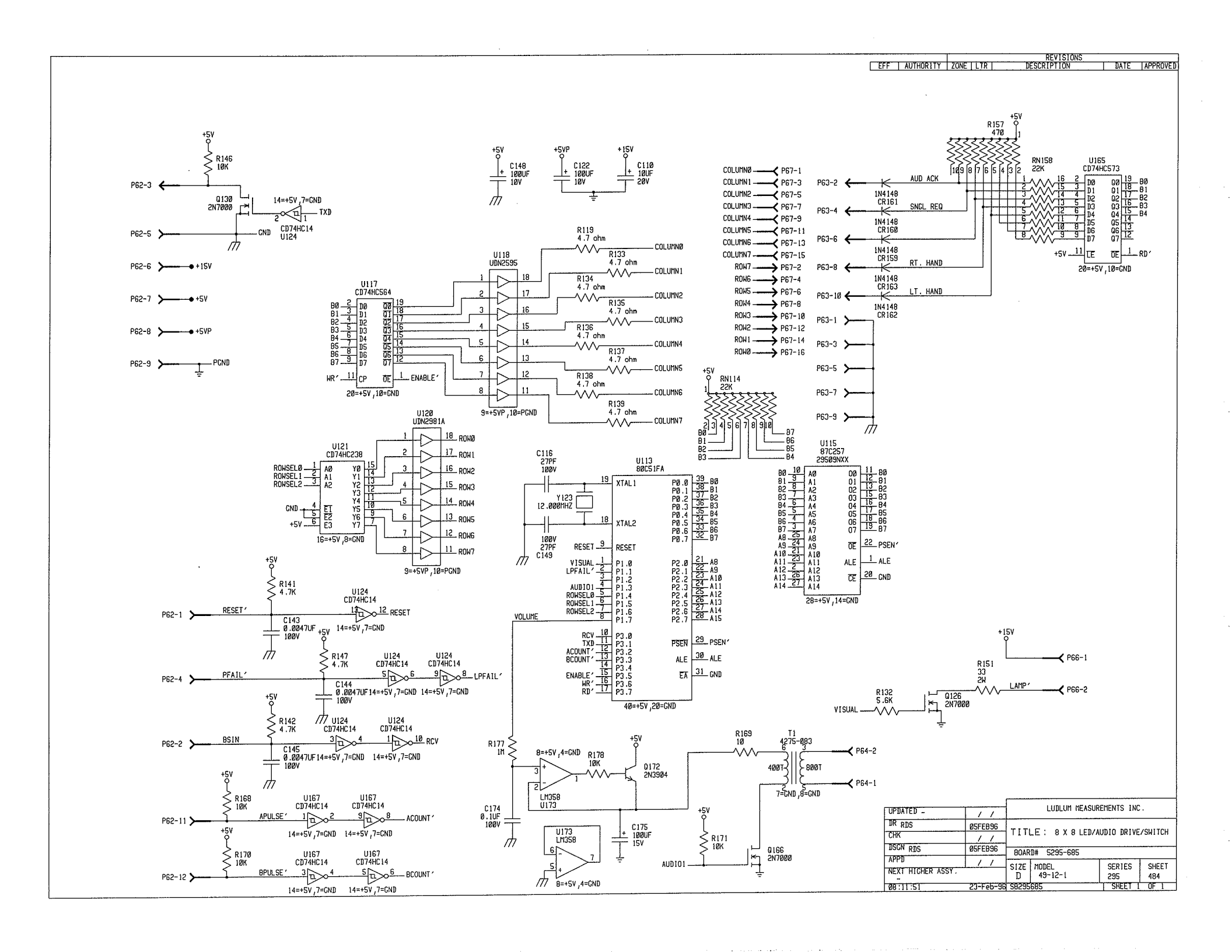
LUDLUM MEASUREMENTS INC. SWEETWATER, TX.					
DR	rds	25Aug93	TITLE : Led Display		
CHK		/ /			
DSGN	rds	25Aug93	BOARD# 5295-613		BS295613
APP			MODEL 49-12-1	SERIES 295	SHEET -
12:52:29		23-Feb-96	COMP SIDE ☐	SLDR SIDE ☐	OUTLINE ☒
COMP PASTE ☐		COMP MASK ☐	SLDR PASTE ☐	SLDR MASK ☐	

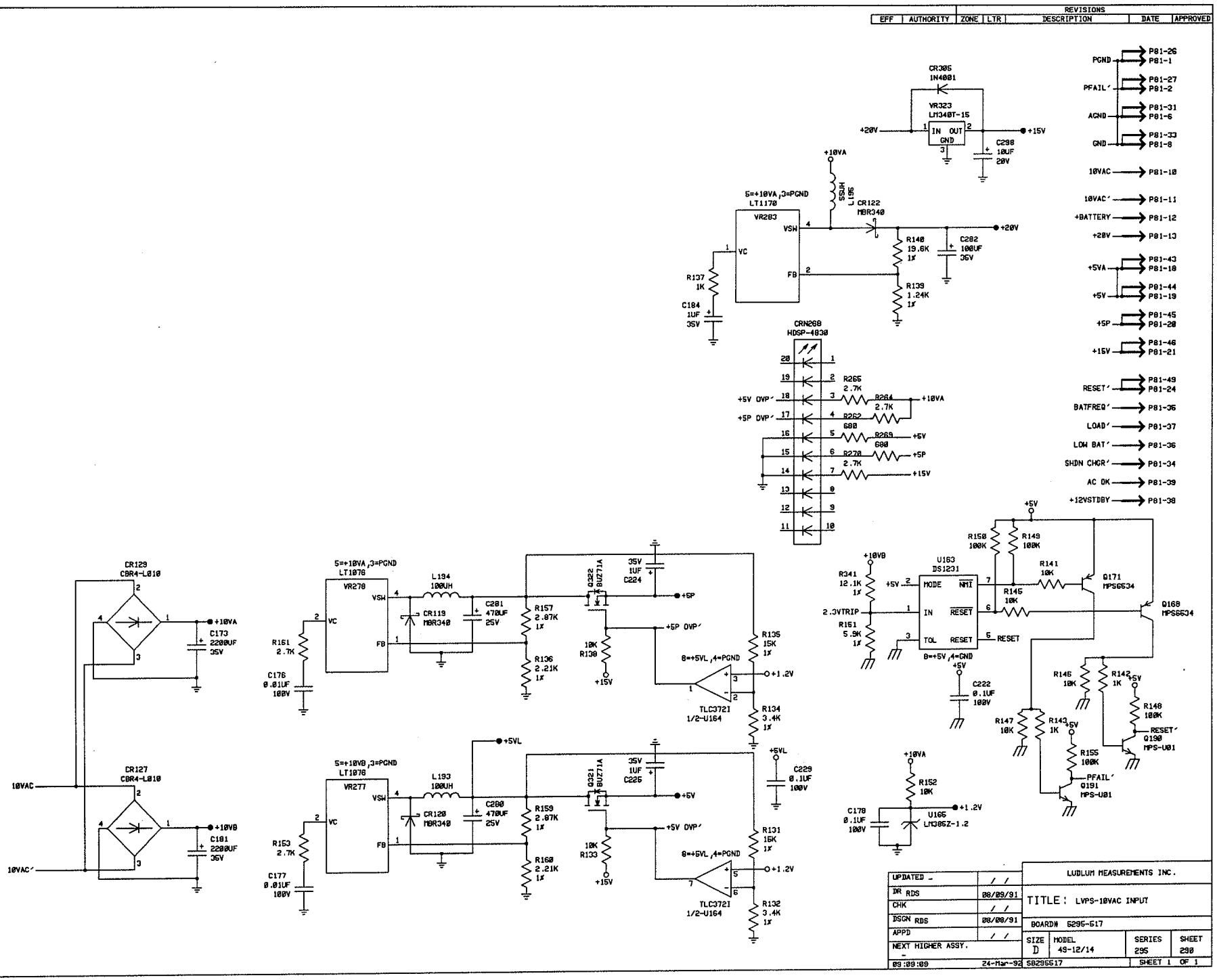


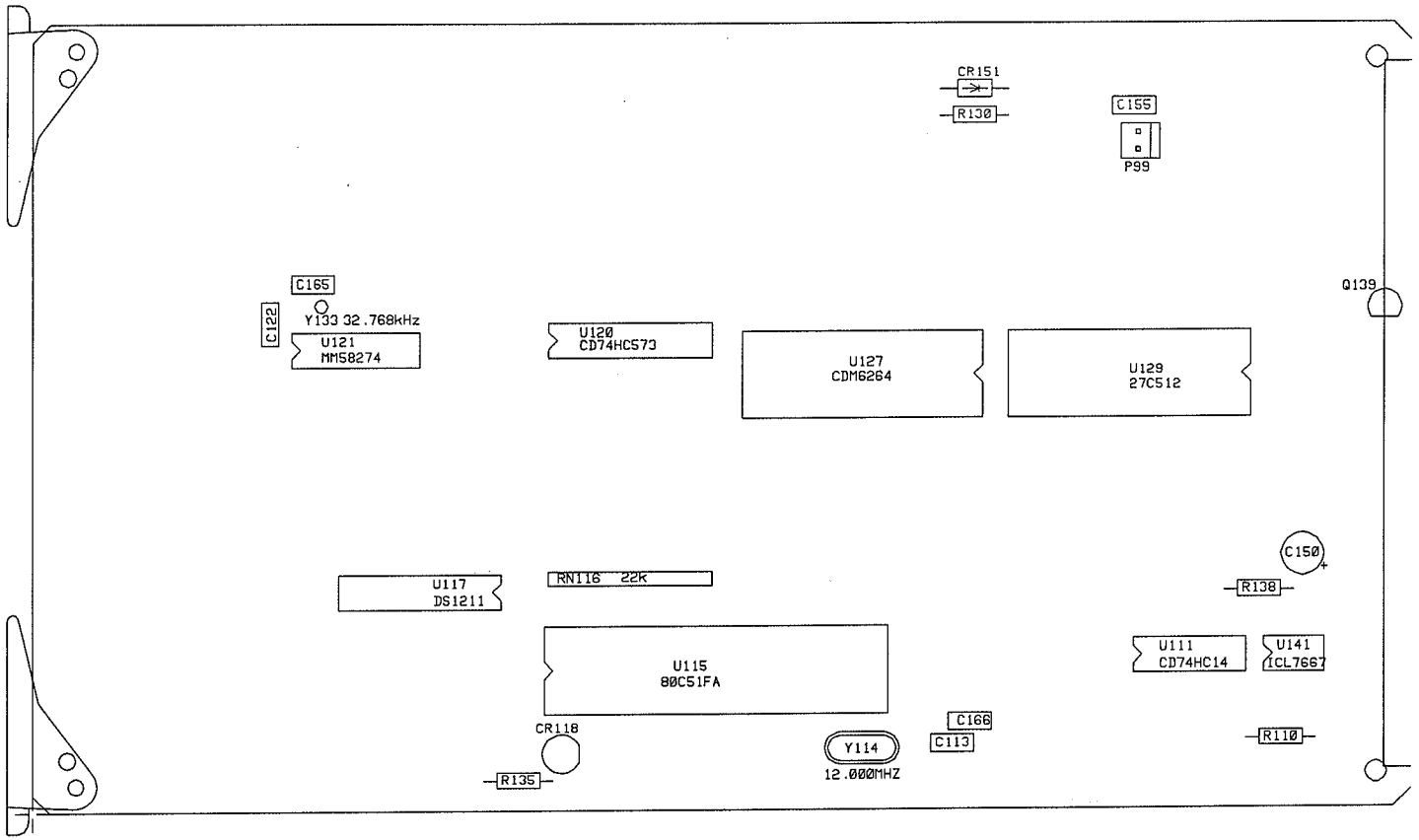
LUDLUM MEASUREMENTS INC. SWEETWATER, TX.			
DR CKB	30-JUL-97	TITLE: DETECTOR CABLE DRIVER	
CHK P.W.	7-31-97	BOARD# 5295-484	BS295484
DSGN DL	31-AUG-90	MODEL 49-12	SERIES 295 SHEET 408
APP JGW	7-31-97	COMP ARTWORK ☐	SLDR ARTWORK ☐
14:21:39	30-Jul-97	COMP OUTLINE ☐	SLDR OUTLINE ☐
COMP PASTE ☐	COMP MASK ☐	SLDR PASTE ☐	SLDR MASK ☐



LUDLUM MEASUREMENTS INC. SWEETWATER, TX.					
DR	RDS	07/29/91	TITLE: GAS MANAGER		
CHK		/ /			
DSGN	RDS	07/01/91	BOARD# 5295-510		BS295510
APP			MODEL 49-12	SERIES 295	SHEET 289
11:37:02	17-Mar-92		COMP SIDE ☐	SLDR SIDE ☐	OUTLINE ☒
COMP PASTE ☐	COMP MASK ☐		SLDR PASTE ☐	SLDR MASK ☐	

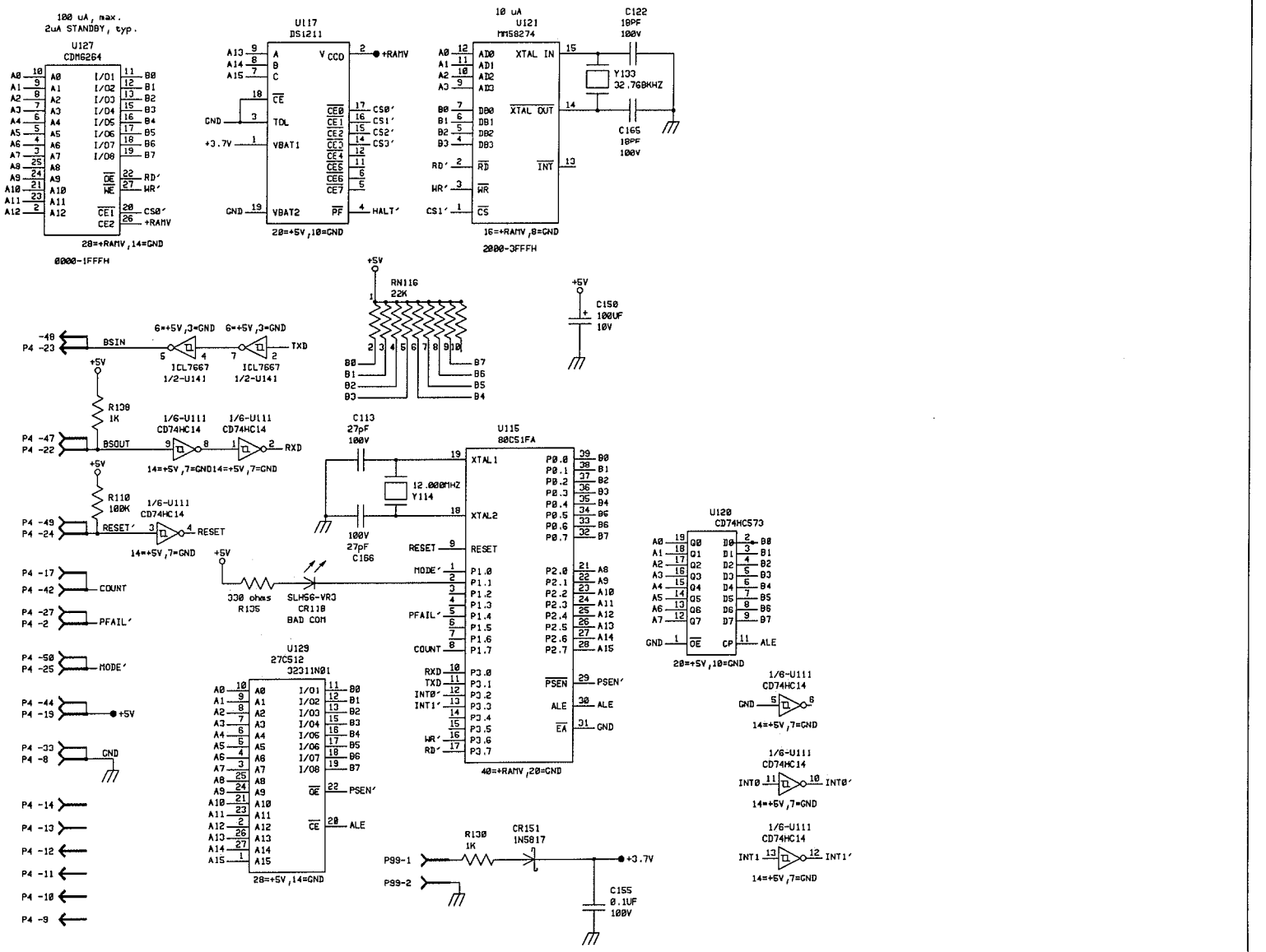

REVISIONS
EFF | AUTHORITY | ZONE | LTR | DESCRIPTION | DATE | APPROVED
P62-3
R146 10K
Q130 2N7000
14=+5V,7=GND
TXD
CD74HC14 U124
P62-5
GND
P62-6
+15V
P62-7
+5V
P62-8
+5VP
P62-9
PGND
C148 100UF 10V
C122 100UF 10V
C110 10UF 20V
U117 CD74HC564
WR'
CP
OE
ENABLE'
20=+5V,10=GND
U118 UDN2595
9=+5VP,10=PGND
R119 4.7 ohm
R133 4.7 ohm
R134 4.7 ohm
R135 4.7 ohm
R136 4.7 ohm
R137 4.7 ohm
R138 4.7 ohm
R139 4.7 ohm
COLUMN0
COLUMN1
COLUMN2
COLUMN3
COLUMN4
COLUMN5
COLUMN6
COLUMN7
U120 UDN2981A
U121 CD74HC238
ROWSEL0
ROWSEL1
ROWSEL2
GND
+5V
16=+5V,8=GND
9=+5VP,10=PGND
ROW0
ROW1
ROW2
ROW3
ROW4
ROW5
ROW6
ROW7
COLUMN0 P67-1
COLUMN1 P67-3
COLUMN2 P67-5
COLUMN3 P67-7
COLUMN4 P67-9
COLUMN5 P67-11
COLUMN6 P67-13
COLUMN7 P67-15
ROW7 P67-2
ROW6 P67-4
ROW5 P67-6
ROW4 P67-8
ROW3 P67-10
ROW2 P67-12
ROW1 P67-14
ROW0 P67-16
R157 470
RN158 22K
U165 CD74HC573
P63-2
AUD ACK
1N4148 CR161
P63-4
SNGL REQ
1N4148 CR160
P63-6
1N4148 CR159
P63-8
RT. HAND
1N4148 CR163
P63-10
LT. HAND
1N4148 CR162
P63-1
P63-3
P63-5
P63-7
P63-9
20=+5V,10=GND
RN114 22K
B0
B1
B2
B3
B4
B5
B6
B7
C116 27PF 100V
C149 27PF 100V
Y123 12.000MHZ
U113 80C51FA
XTAL1
XTAL2
RESET
VISUAL
LPFAIL'
AUDIO1
ROWSEL0
ROWSEL1
ROWSEL2
RCV
TXD
ACOUNT'
BCOUNT'
ENABLE'
WR'
RD'
PSEN'
ALE
EA
40=+5V,20=GND
U115 87C257 29509NXX
A10
A11
A12
A13
A14
28=+5V,14=GND
VOLUME
R141 4.7K
C143 0.0047UF 100V
U124 CD74HC14
P62-1
RESET'
RESET
14=+5V,7=GND
R147 4.7K
C144 0.0047UF 100V
P62-4
PFAIL'
LPFAIL'
R142 4.7K
C145 0.0047UF 100V
P62-2
BSIN
RCV
R168 10K
U167 CD74HC14
P62-11
APULSE'
ACOUNT'
R170 10K
P62-12
BPULSE'
BCOUNT'
R177 1M
R178 10K
Q172 2N3904
LM358 U173
8=+5V,4=GND
C174 0.1UF 100V
C175 100UF 15V
R169 10
T1 4275-083
400T
800T
7=GND,8=GND
P64-2
P64-1
R171 10K
Q166 2N7000
AUDIO1
+15V
P66-1
R151 33 2W
LAMP'
P66-2
R132 5.6K
Q126 2N7000
VISUAL
UPDATED -
DR RDS 05FEB96
CHK
DSGN RDS 05FEB96
APPD
NEXT HIGHER ASSY. -
08:11:51 23-Feb-96
LUDLUM MEASUREMENTS INC.
TITLE: 8 X 8 LED/AUDIO DRIVE/SWITCH
BOARD# 5295-685
SIZE D | MODEL 49-12-1 | SERIES 295 | SHEET 484
S8295685 SHEET 1 OF 1


REVISIONS
EFF | AUTHORITY | ZONE | LTR | DESCRIPTION | DATE | APPROVED
CR305 1N4001
VR323 LM340T-15
+20V
+15V
C298 10UF 20V
+10VA
L195 5USH
5=+10VA,3=PGND
LT1170
VR283
VSW
VC
FB
CR122 MBR340
R140 19.6K 1%
C282 100UF 35V
R137 1K
C184 1UF 35V
R139 1.24K 1%
CRN28B HDSP-4830
R265 2.7K
R264 2.7K
R262 680
R269 680
R270 2.7K
+5V OVP'
+5P OVP'
PGND
PFAIL'
AGND
GND
10VAC
10VAC'
+BATTERY
+5VA
+5V
+5P
RESET'
BATFREQ'
LOAD'
LOW BAT'
SHDN CHGR'
AC OK
+12VSTDBY
P81-26
P81-1
P81-27
P81-2
P81-31
P81-6
P81-33
P81-8
P81-10
P81-11
P81-12
P81-13
P81-43
P81-18
P81-44
P81-19
P81-45
P81-20
P81-46
P81-21
P81-49
P81-24
P81-35
P81-37
P81-36
P81-34
P81-39
P81-38
CR129 CBR4-L010
CR127 CBR4-L010
10VAC
10VAC'
C173 2200UF 35V
C181 2200UF 35V
+10VB
L194 100UH
L193 100UH
VR278
VR277
CR119 MBR340
CR120 MBR340
C281 470UF 25V
C280 470UF 25V
R157 2.87K 1%
R159 2.87K 1%
R136 2.21K 1%
R160 2.21K 1%
R161 2.7K
R153 2.7K
C176 0.01UF 100V
C177 0.01UF 100V
Q322 BUZ71A
Q321 BUZ71A
35V 1UF C224
35V 1UF C225
10K R138
10K R133
TLC3721 1/2-U164
R135 15K 1%
R131 15K 1%
R134 3.4K 1%
R132 3.4K 1%
C229 0.1UF 100V
U163 DS1231
MODE
NMI
IN
RESET
TOL
RESET
R341 12.1K 1%
R161 5.9K 1%
2.93VTRIP
R150 100K
R149 100K
R141 10K
R145 10K
Q171 MPS6534
Q168 MPS6534
C222 0.1UF 100V
R146 10K
R142 1K
R147 10K
R143 1K
R148 100K
R155 100K
RESET'
Q190 MPS-U01
PFAIL'
Q191 MPS-U01
R152 10K
C178 0.1UF 100V
U165 LM385Z-1.2
LUDLUM MEASUREMENTS INC.
UPDATED / /
DR RDS 08/09/91
CHK / /
DSGN RDS 08/08/91
APPD / /
NEXT HIGHER ASSY.
TITLE: LVPS-10VAC INPUT
BOARD# 5295-517
SIZE D
MODEL 49-12/14
SERIES 295
SHEET 290
09:09:09 24-Mar-92 58295517
SHEET 1 OF 1

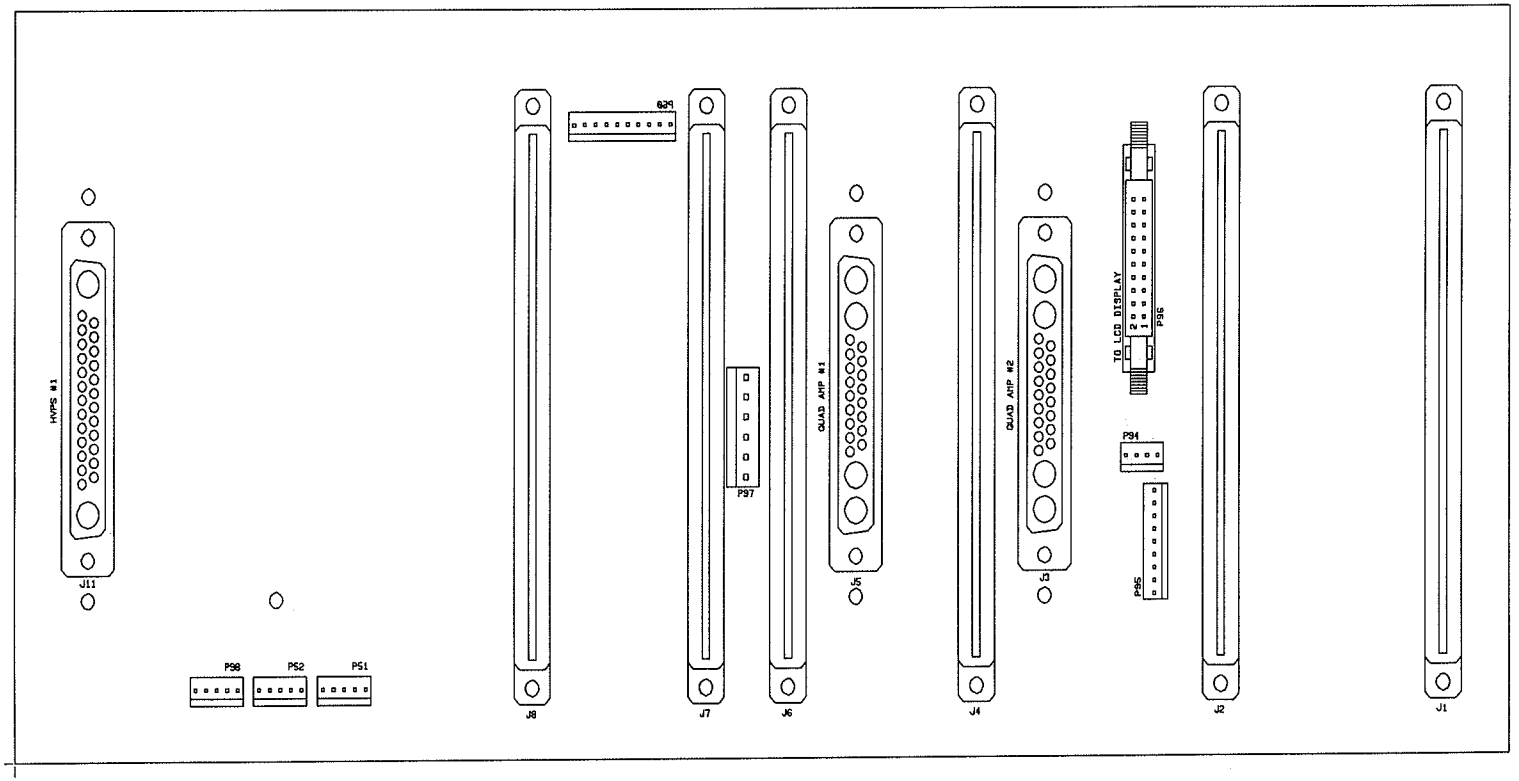


LUDLUM MEASUREMENTS INC. SWEETWATER, TX.					
DR	RDS	12/14/92	TITLE: CENTRAL PROCESSOR W/O BATT		
CHK		/ /			
DSGN	RDS	JAN92	BOARD# 5295-526		BS295526
APP			MODEL 4900	SERIES 295	SHEET 302
07:20:21		14-Jul-92	COMP SIDE ☐	SLDR SIDE ☐	OUTLINE ☒
COMP PASTE ☐		COMP MASK ☐	SLDR PASTE ☐		SLDR MASK ☐

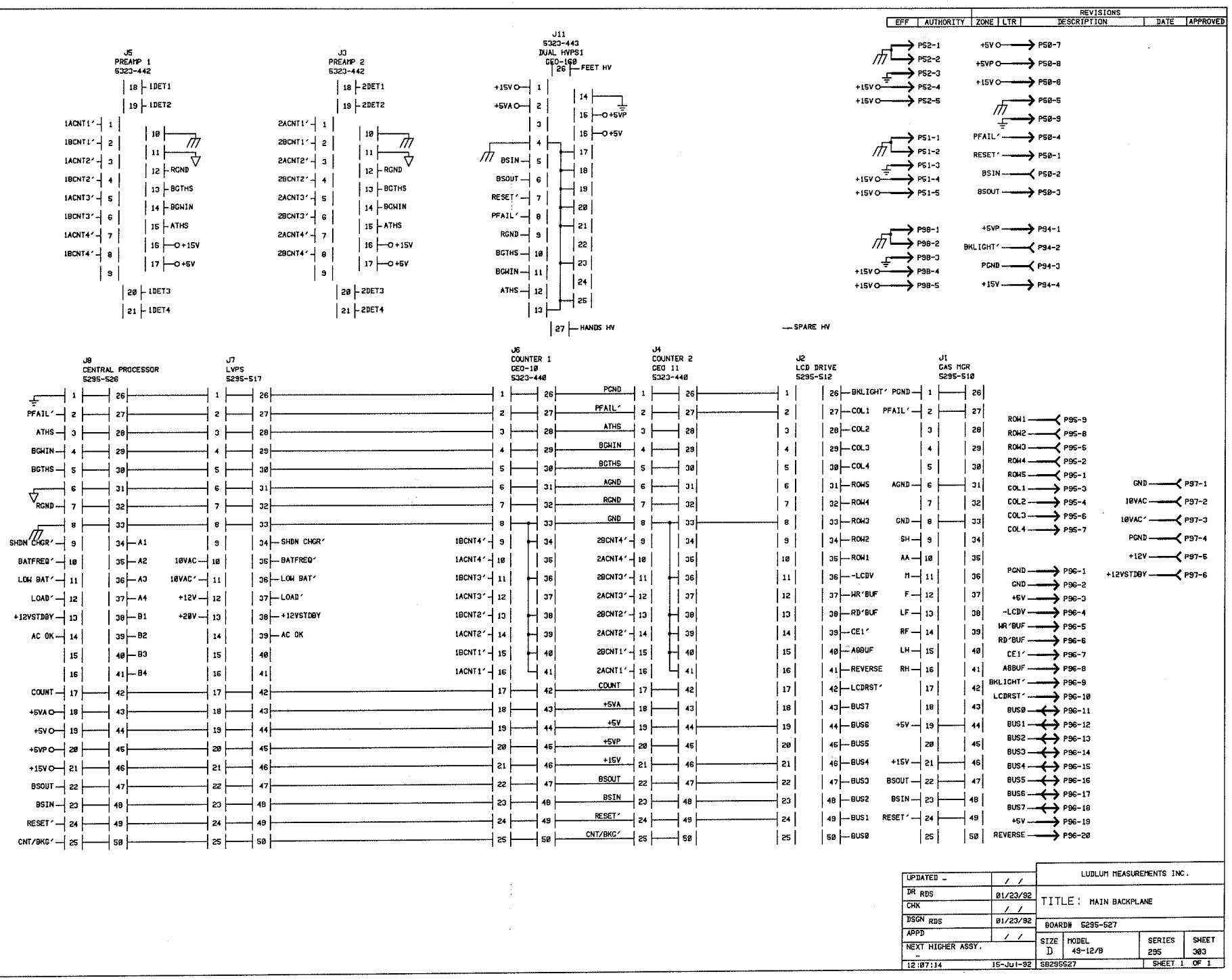
REVISIONS						
EFF	AUTHORITY	ZONE	LTR	DESCRIPTION	DATE	APPROVED

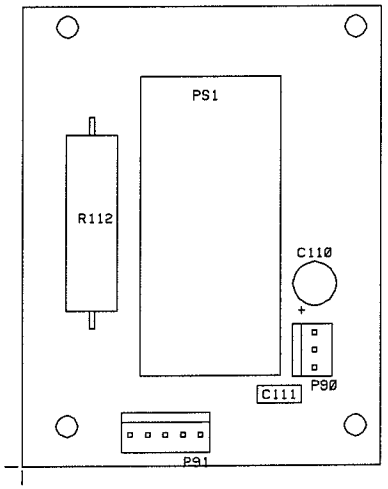


UPDATED -	/ /	LUDLUM MEASUREMENTS INC.	
DR RDS	01/20/92	TITLE: PROCESSOR	
CHK	/ /		
DSGN RDS	01/20/92	BOARD# 5295-526	
APPD	/ /	SIZE D / MODEL M49-12	SERIES 295 / SHEET 302
NEXT HIGHER ASSY. -			
09:52:11	26-Jun-92	S8295526	SHEET 1 OF 1



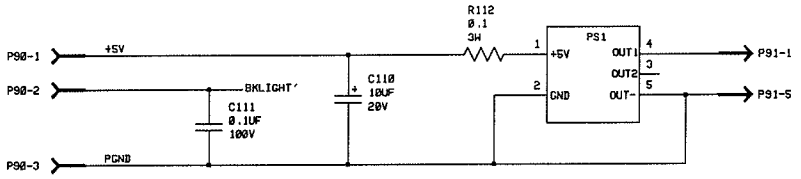
LUDLUM MEASUREMENTS INC. SWEETWATER, TX.					
DR	RDS	28JAN92	TITLE: BACKPLANE		
CHK		/ /			
DSGN	RDS	28JAN92	BOARD# 5295-527		BS295527
APP			MODEL 4900	SERIES 295	SHEET 303
16:14:47	14-Jul-92		COMP SIDE ☐	SLDR SIDE ☐	OUTLINE ☒
COMP PASTE ☐			COMP MASK ☐	SLDR PASTE ☐	SLDR MASK ☐


REVISIONS
EFF | AUTHORITY | ZONE | LTR | DESCRIPTION | DATE | APPROVED
J5 PREAMP 1 5323-442
J3 PREAMP 2 5323-442
J11 5323-443 DUAL HVPS1 CEO-10@ 26 FEET HV
27 HANDS HV
SPARE HV
P52-1 P52-2 P52-3 +15V P52-4 +15V P52-5
P51-1 P51-2 P51-3 +15V P51-4 +15V P51-5
P98-1 P98-2 P98-3 +15V P98-4 +15V P98-5
+5V P50-7 +5VP P50-8 +15V P50-6 P50-5 P50-9 PFAIL' P50-4 RESET' P50-1 BSIN P50-2 BSOUT P50-3
+5VP P94-1 BKLIGHT' P94-2 PGND P94-3 +15V P94-4
J8 CENTRAL PROCESSOR 5295-526
J7 LVPS 5295-517
J6 COUNTER 1 CEO-10 5323-440
J4 COUNTER 2 CEO 11 5323-440
J2 LCD DRIVE 5295-512
J1 CAS MGR 5295-510
PFAIL' ATHS BGWIN BGTHS RGND SHDN CHGR' BATFREQ' LOW BAT' LOAD' +12VSTDBY AC OK COUNT +5VA +5V +5VP +15V BSOUT BSIN RESET' CNT/BKG'
A1 A2 A3 A4 B1 B2 B3 B4
10VAC 10VAC' +12V +20V
1BCNT4' 1ACNT4' 1BCNT3' 1ACNT3' 1BCNT2' 1ACNT2' 1BCNT1' 1ACNT1'
2BCNT4' 2ACNT4' 2BCNT3' 2ACNT3' 2BCNT2' 2ACNT2' 2BCNT1' 2ACNT1'
PGND PFAIL' ATHS BGWIN BGTHS AGND RGND GND COUNT +5VA +5V +5VP +15V BSOUT BSIN RESET' CNT/BKG'
BKLIGHT' COL1 COL2 COL3 COL4 ROW5 ROW4 ROW3 ROW2 ROW1 -LCDV WR'BUF RD'BUF CE1' A0BUF REVERSE LCDRST' BUS7 BUS6 BUS5 BUS4 BUS3 BUS2 BUS1 BUS0
PGND PFAIL' AGND GND SH AA M F LF RF LH RH +5V +15V BSOUT BSIN RESET'
ROW1 ROW2 ROW3 ROW4 ROW5 COL1 COL2 COL3 COL4 → P95-9 P95-8 P95-5 P95-2 P95-1 P95-3 P95-4 P95-6 P95-7
GND 10VAC 10VAC' PGND +12V +12VSTDBY ← P97-1 P97-2 P97-3 P97-4 P97-5 P97-6
PGND GND +5V -LCDV WR'BUF RD'BUF CE1' A0BUF BKLIGHT' LCDRST' BUS0 BUS1 BUS2 BUS3 BUS4 BUS5 BUS6 BUS7 +5V REVERSE → P96-1 P96-2 P96-3 P96-4 P96-5 P96-6 P96-7 P96-8 P96-9 P96-10 P96-11 P96-12 P96-13 P96-14 P96-15 P96-16 P96-17 P96-18 P96-19 P96-20
UPDATED - / /
DR RDS 01/23/92
CHK / /
DSGN RDS 01/23/92
APPD / /
NEXT HIGHER ASSY. -
12:07:14 15-Jul-92
LUDLUM MEASUREMENTS INC.
TITLE: MAIN BACKPLANE
BOARD# 5295-527
SIZE D | MODEL 49-12/B | SERIES 295 | SHEET 303
SB295527 SHEET 1 OF 1



LUDLUM MEASUREMENTS INC. SWEETWATER, TX.					
DR	RDS	30JAN92	TITLE: BACKLIGHT POWER SUPPLY		
CHK		/ /			
DSGN	JGW	29JAN92	BOARD# 5295-535		BS295535
APP			MODEL 4900	SERIES 295	SHEET 339
12:56:34		13-Jul-92	COMP SIDE ☐	SLDR SIDE ☐	OUTLINE ☒
COMP PASTE ☐		COMP MASK ☐	SLDR PASTE ☐		SLDR MASK ☐

REVISIONS						
EFF	AUTHORITY	ZONE	LTR	DESCRIPTION	DATE	APPROVED



UPDATED -	/ /
DR RDS	10JUL92
CHK	/ /
DSGN RDS	JAN92
APPD	/ /
NEXT HIGHER ASSY. -	
10:43:46	10-JUI-92

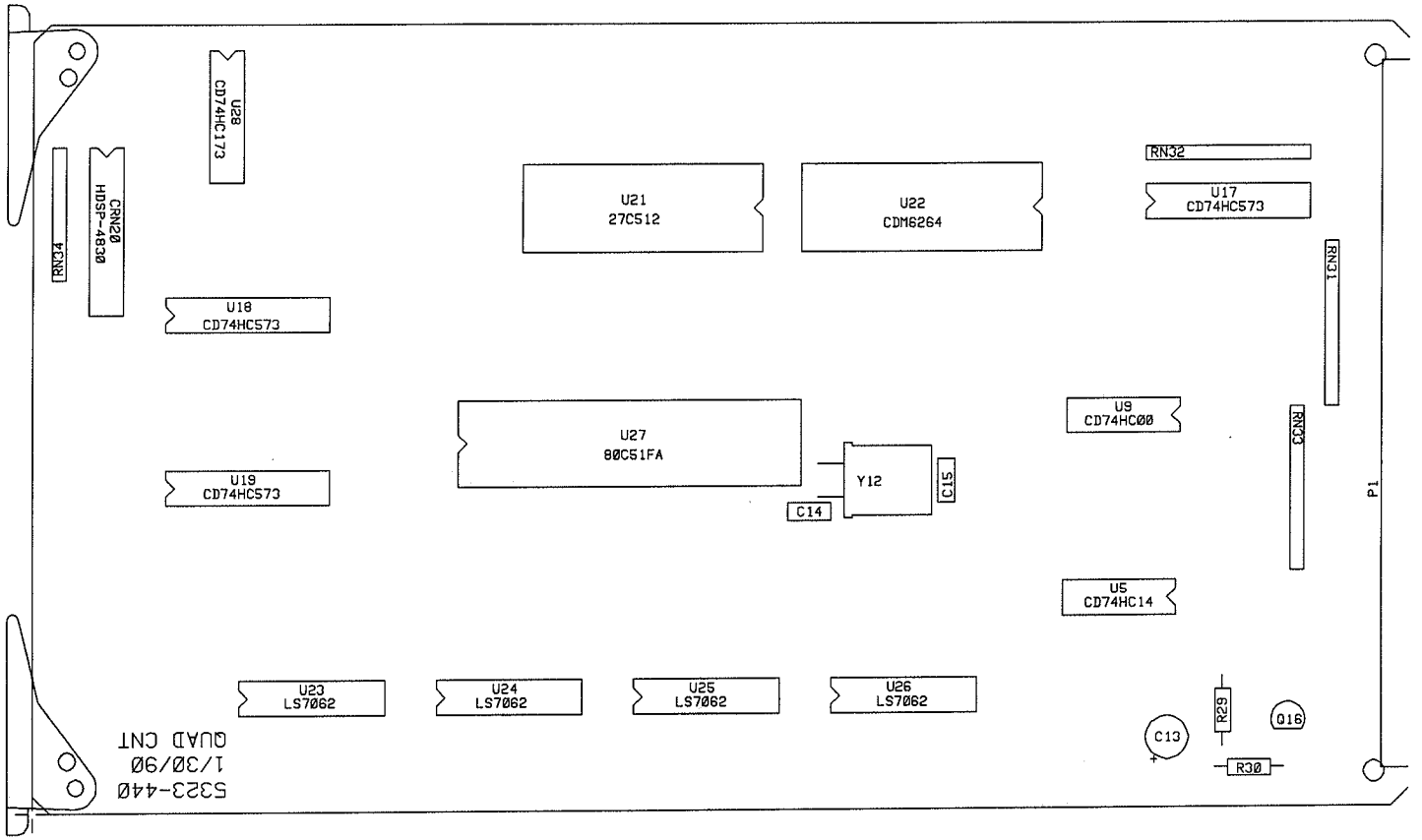
LUDLUM MEASUREMENTS INC.

TITLE: CCFL POWER

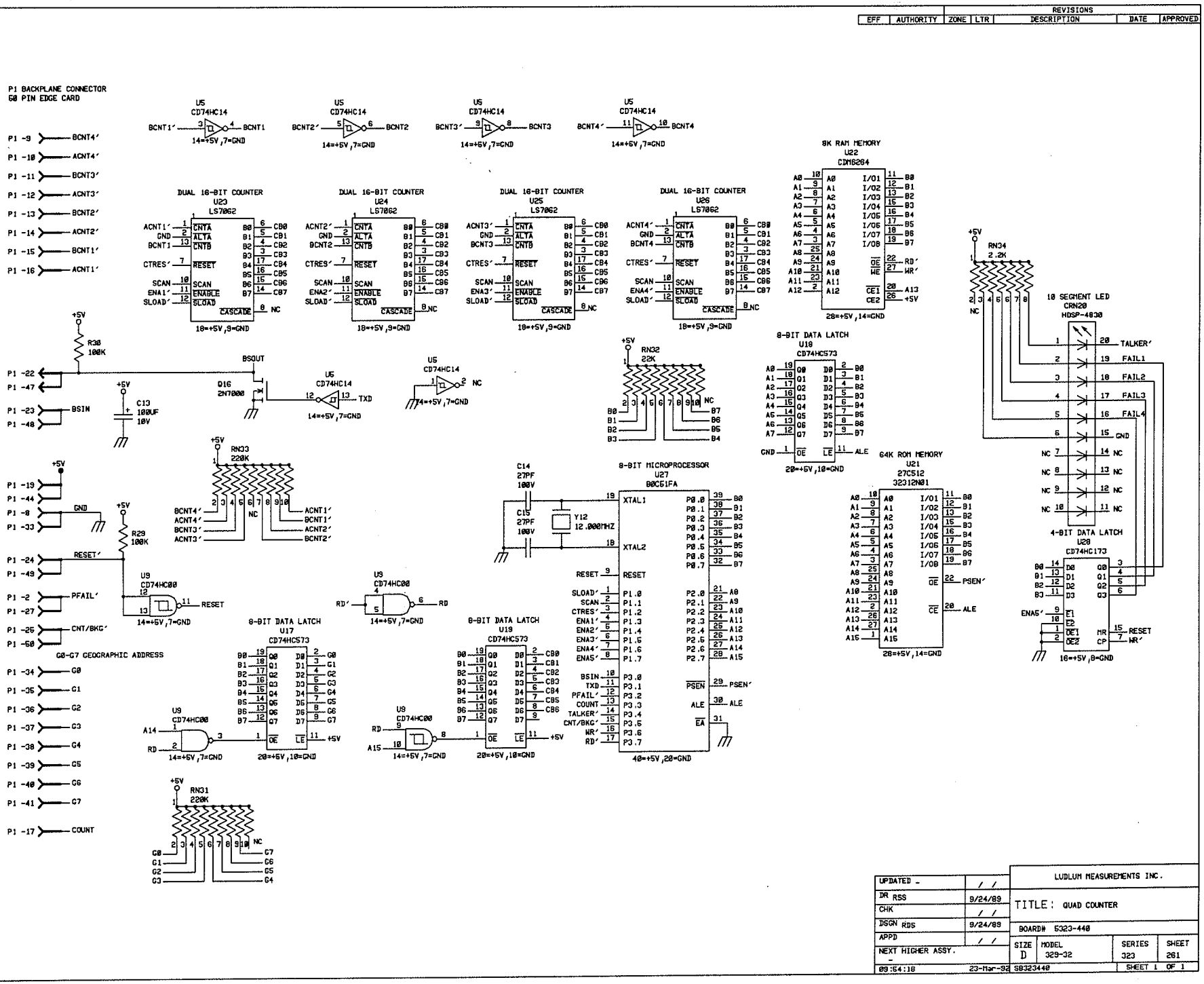
BOARD# 5295-535

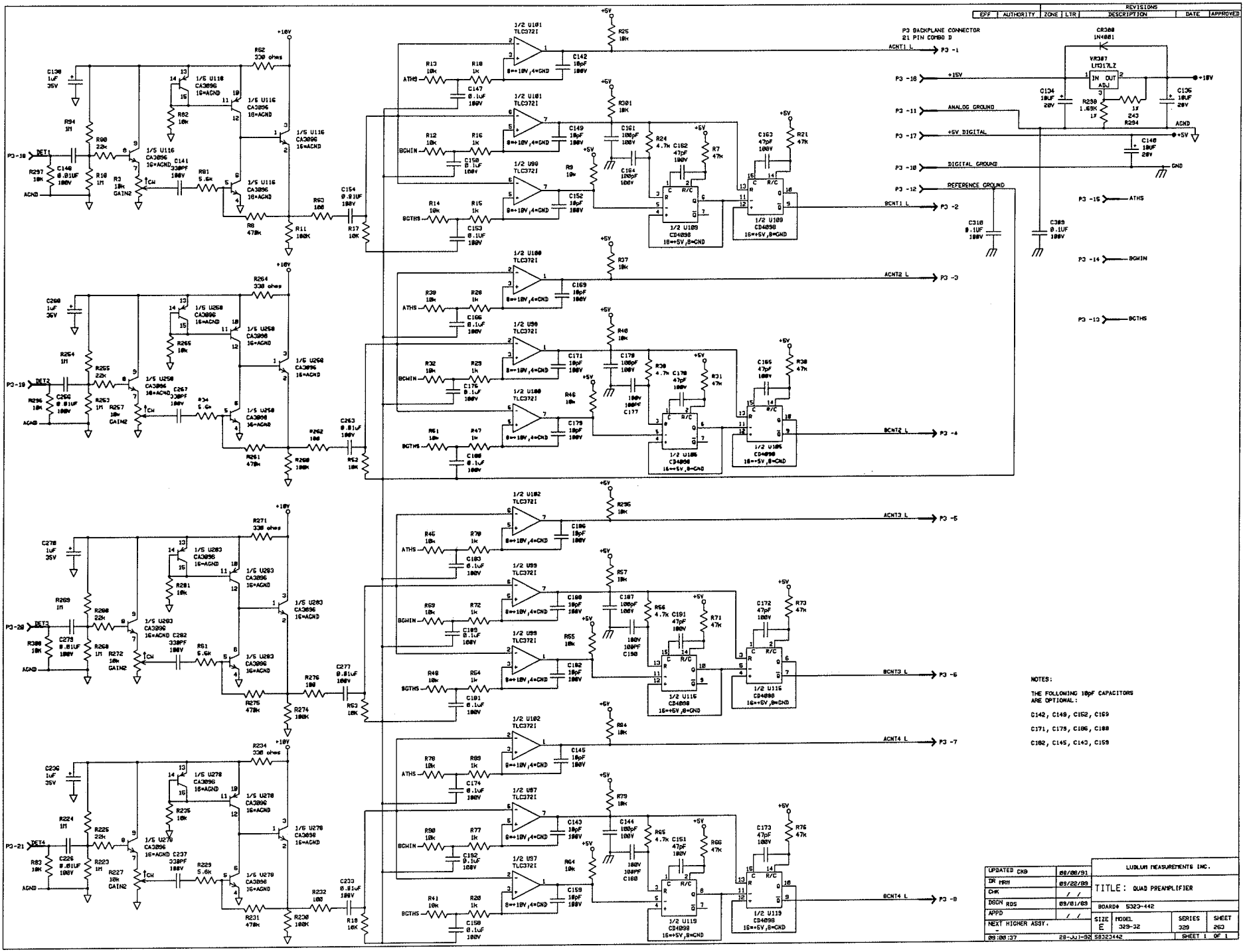
SIZE	MODEL	SERIES	SHEET
D	43-12	295	389

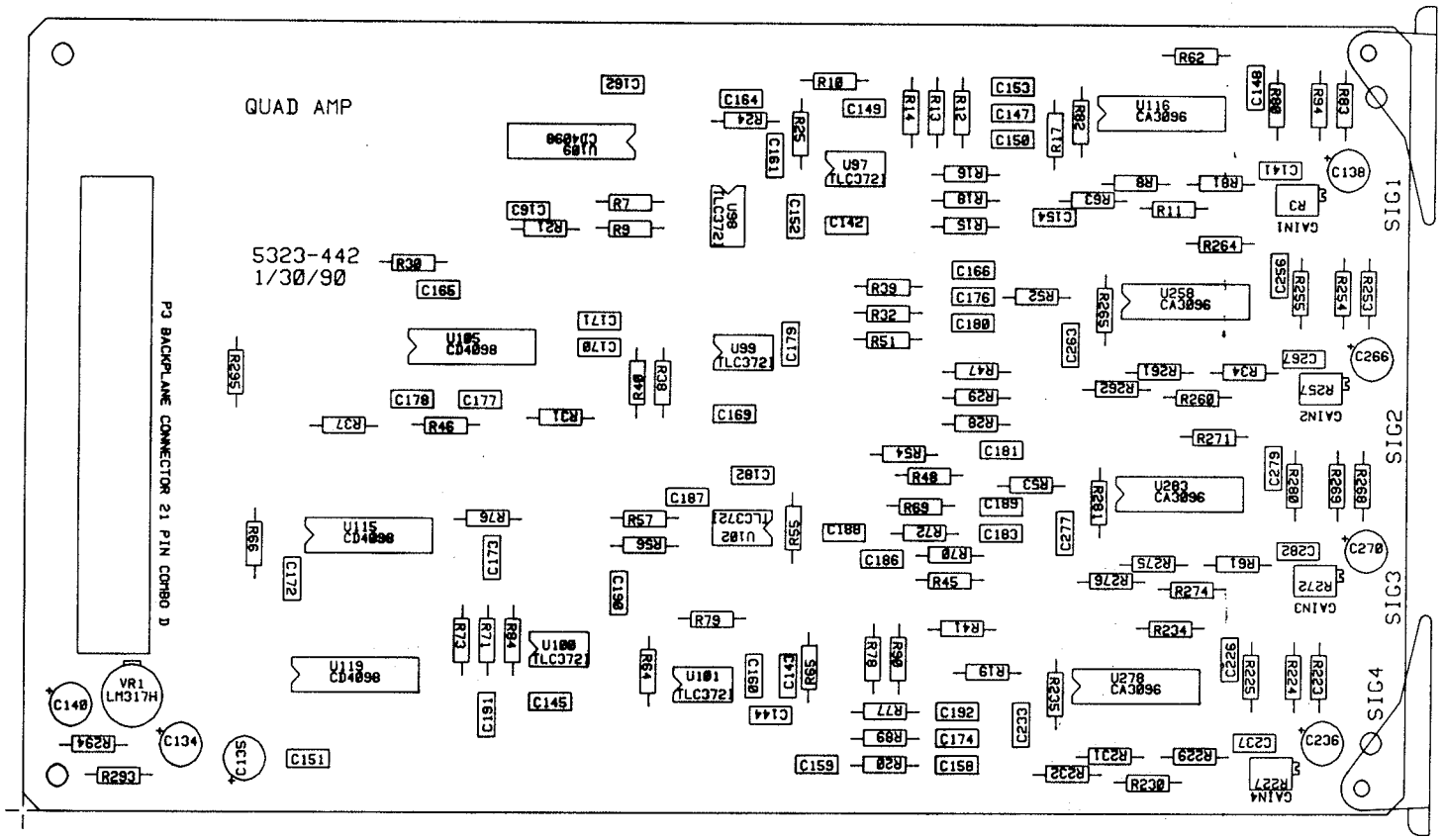
S0295535 SHEET 1 OF 1



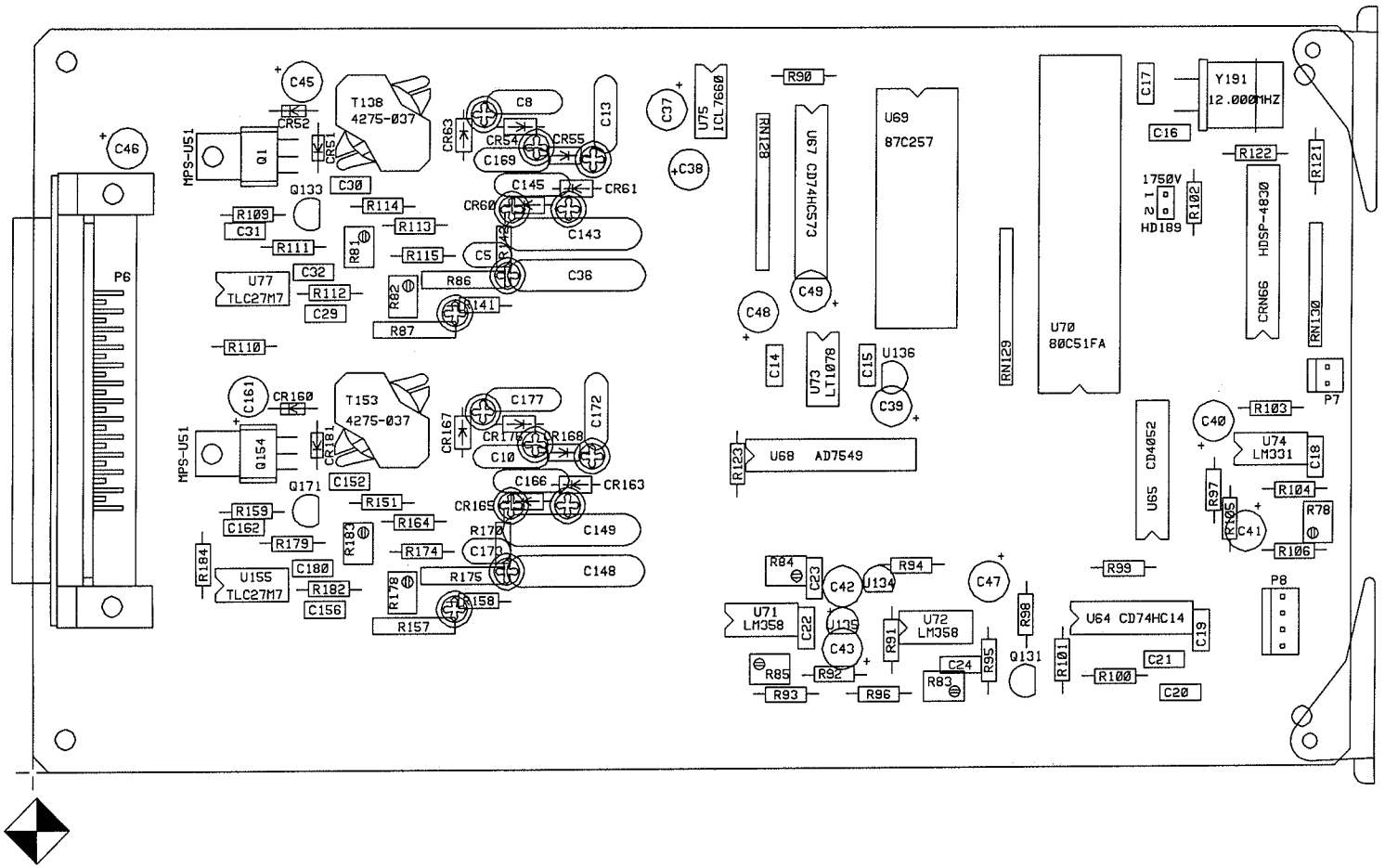
LUDLUM MEASUREMENTS INC. SWEETWATER, TX.			
DR RSS / /	TITLE: QUAD COUNTER		
CHK / /			
DSGN RDS/RSS 30JAN90	BOARD# 5323-440		BS323440
APP	MODEL 329-32	SERIES 323	SHEET -
10:02:43 14-Jul-92	COMP SIDE ☐	SLDR SIDE ☐	OUTLINE ☒
COMP PASTE ☐	COMP MASK ☐	SLDR PASTE ☐	SLDR MASK ☐


REVISIONS
EFF | AUTHORITY | ZONE | LTR | DESCRIPTION | DATE | APPROVED
P1 BACKPLANE CONNECTOR
60 PIN EDGE CARD
P1 -9 BCNT4'
P1 -10 ACNT4'
P1 -11 BCNT3'
P1 -12 ACNT3'
P1 -13 BCNT2'
P1 -14 ACNT2'
P1 -15 BCNT1'
P1 -16 ACNT1'
U5 CD74HC14
BCNT1' BCNT1
BCNT2' BCNT2
BCNT3' BCNT3
BCNT4' BCNT4
14=+5V,7=GND
DUAL 16-BIT COUNTER
U23 LS7062
U24 LS7062
U25 LS7062
U26 LS7062
CNTA CNTB ENABLE RESET SCAN SLOAD CASCADE
18=+5V,9=GND
8K RAM MEMORY
U22
CDM6264
28=+5V,14=GND
10 SEGMENT LED
CRN20
HDSP-4830
TALKER' FAIL1 FAIL2 FAIL3 FAIL4 GND
RN34 2.2K
+5V
R30 100K
BSOUT
P1 -22
P1 -47
P1 -23 BSIN
P1 -48
C13 100UF 10V
Q16 2N7000
U5 CD74HC14 TXD
U5 CD74HC14 NC
RN32 22K
B0 B1 B2 B3 B4 B5 B6 B7
8-BIT DATA LATCH
U18
CD74HCS73
20=+5V,10=GND
64K ROM MEMORY
U21
27C512
32312N01
28=+5V,14=GND
PSEN' ALE
4-BIT DATA LATCH
U28
CD74HC173
RESET' MR'
16=+5V,8=GND
P1 -19
P1 -44
P1 -8 GND
P1 -33
R29 100K
RESET'
P1 -24
P1 -49
P1 -2 PFAIL'
P1 -27
P1 -25 CNT/BKG'
P1 -50
RN33 220K
BCNT4' ACNT4' BCNT3' ACNT3' NC ACNT1' BCNT1' ACNT2' BCNT2'
U9 CD74HC00
RESET'
RD'
RD
14=+5V,7=GND
C14 27PF 100V
C15 27PF 100V
Y12 12.000MHZ
8-BIT MICROPROCESSOR
U27
80C51FA
XTAL1 XTAL2 RESET
SLOAD' SCAN' CTRES' ENA1' ENA2' ENA3' ENA4' ENAS'
BSIN TXD PFAIL' COUNT TALKER' CNT/BKG' WR' RD'
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
P3.0 P3.1 P3.2 P3.3 P3.4 P3.5 P3.6 P3.7
PSEN' ALE EA
40=+5V,20=GND
G0-G7 GEOGRAPHIC ADDRESS
P1 -34 G0
P1 -35 G1
P1 -36 G2
P1 -37 G3
P1 -38 G4
P1 -39 G5
P1 -40 G6
P1 -41 G7
P1 -17 COUNT
8-BIT DATA LATCH
U17
CD74HC573
U19
CD74HC573
A14 A15
RN31 220K
G0 G1 G2 G3 NC G7 G6 G5 G4
UPDATED - / /
DR RSS 9/24/89
CHK / /
DSGN RDS 9/24/89
APPD / /
NEXT HIGHER ASSY. -
09:54:18 23-Mar-92
LUDLUM MEASUREMENTS INC.
TITLE: QUAD COUNTER
BOARD# 5323-440
SIZE D | MODEL 329-32 | SERIES 323 | SHEET 261
S0323440
SHEET 1 OF 1

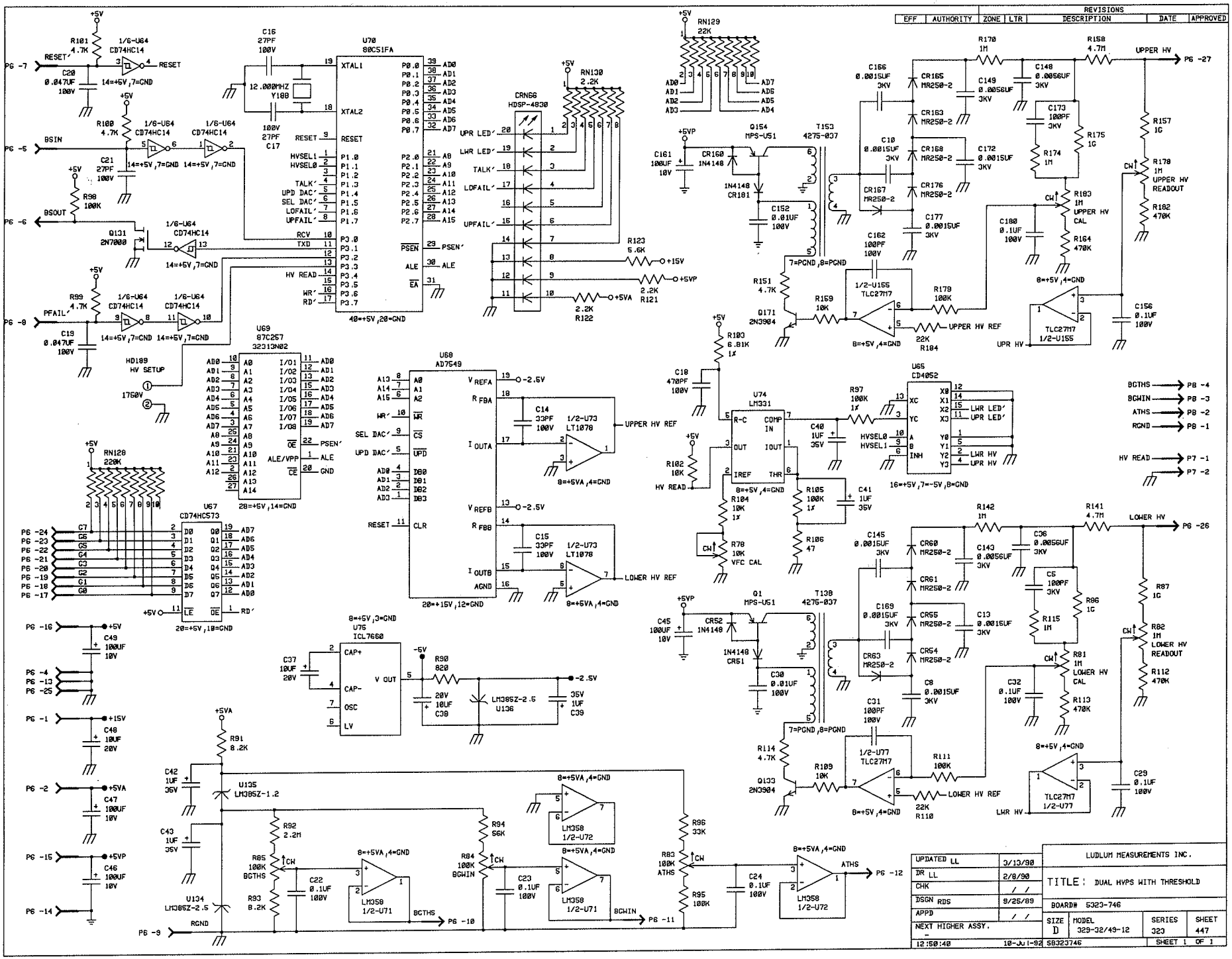

REVISIONS
ECF | AUTHORITY | ZONE | LTR | DESCRIPTION | DATE | APPROVED
P3 BACKPLANE CONNECTOR
21 PIN COMBO D
ACNT1 L
ACNT2 L
ACNT3 L
ACNT4 L
BCNT1 L
BCNT2 L
BCNT3 L
BCNT4 L
ANALOG GROUND
+5V DIGITAL
DIGITAL GROUND
REFERENCE GROUND
ATHS
BGHIN
BGTHS
+15V
-15V
+5V
GND
AGND
NOTES:
THE FOLLOWING 18pF CAPACITORS ARE OPTIONAL:
C142, C149, C152, C159
C171, C179, C186, C188
C182, C145, C143, C159
LUDLUM MEASUREMENTS INC.
TITLE: QUAD PREAMPLIFIER
BOARD# 5323-442
SIZE E
MODEL 329-32
SERIES 329
SHEET 263
SHEET 1 OF 1
UPDATED CKD 08/06/91
DR MRH 09/22/89
CHK
DSGN RDS 09/01/89
APPD
NEXT HIGHER ASSY.
09:00:37 28-JUL-92 S0323442

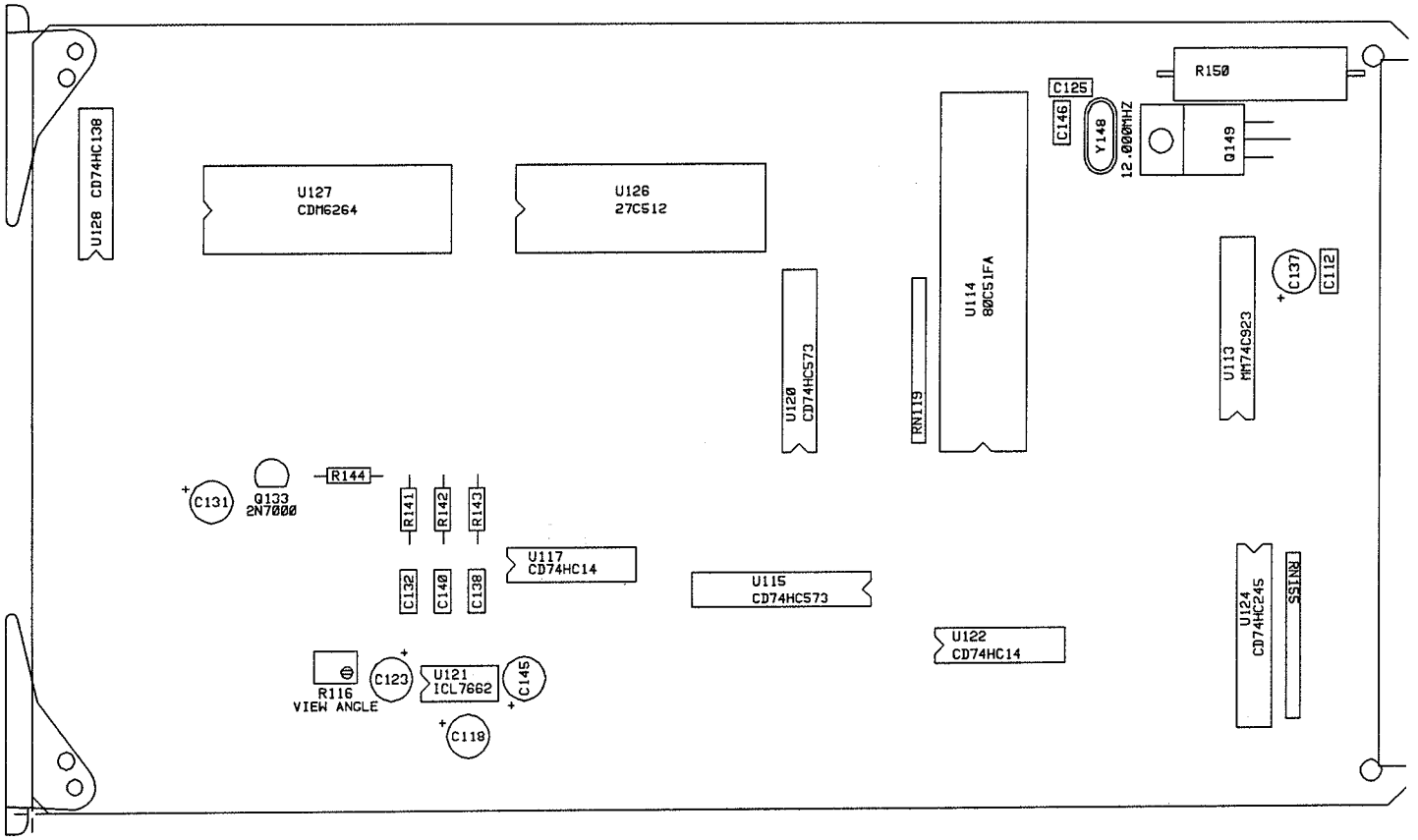


BOARD# 6323-442	
TITLE QUAD AMPLIFIER	
MODEL 329-32	
COMPONENT OUTLINES	
DR RSS	10/11/89
CHK	/ /
DSGN RDS	09/15/89
APPD	/ /
BS323442.DRW	
08-01-90	10:15:22



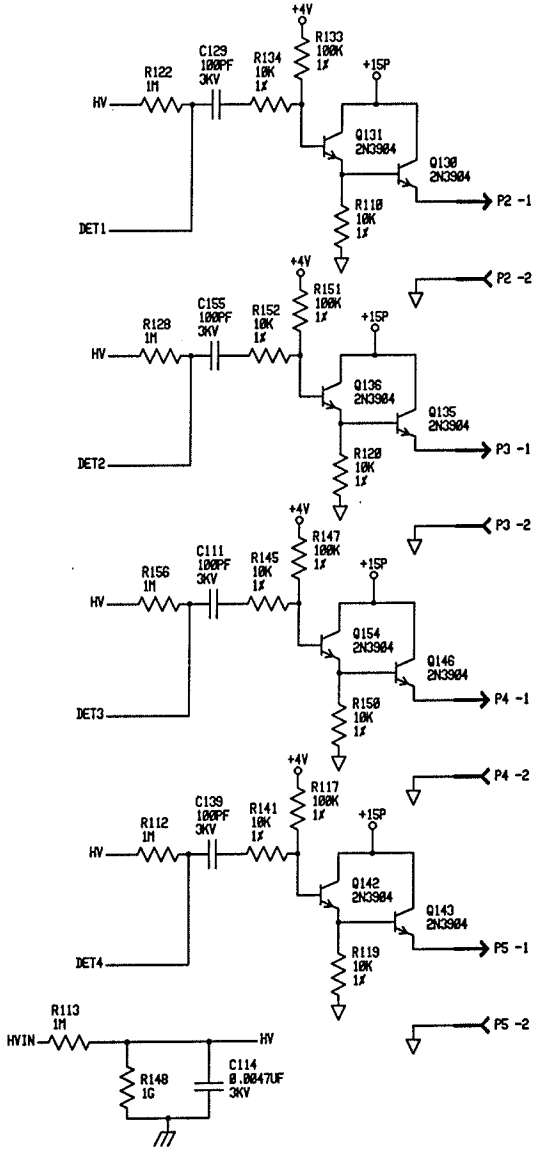
LUDLUM MEASUREMENTS INC. SWEETWATER, TX.			
DR LL	/ /	TITLE: DUAL HVPS	
CHK	/ /	BOARD# 5323-746	BS323746
DSGN LL	/ /	MODEL 329-32 SERIES 323	SHEET 447
APP		COMP ARTWORK ☐	SLDR ARTWORK ☐
15:25:05 10-Jul-92		COMP OUTLINE ☒	SLDR OUTLINE ☒
COMP PASTE ☐	COMP MASK ☐	SLDR PASTE ☐	SLDR MASK ☐

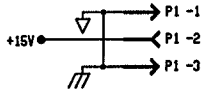

REVISIONS
EFF | AUTHORITY | ZONE | LTR | DESCRIPTION | DATE | APPROVED
U70 80C51FA
XTAL1
XTAL2
RESET
P0.0 AD0
P0.1 AD1
P0.2 AD2
P0.3 AD3
P0.4 AD4
P0.5 AD5
P0.6 AD6
P0.7 AD7
P2.0 A8
P2.1 A9
P2.2 A10
P2.3 A11
P2.4 A12
P2.5 A13
P2.6 A14
P2.7 A15
PSEN
ALE
EA
P3.0 RCV
P3.1 TXD
P3.2
P3.3 HV READ
P3.4
P3.5
P3.6 WR
P3.7 RD
40=+5V,20=GND
U69 87C257 32313N02
28=+5V,14=GND
U68 AD7549
V REFA -2.5V
R FBA
I OUTA
V REFB -2.5V
R FBB
I OUTB
AGND
RESET
20=+15V,12=GND
U74 LM331
U65 CD4052
U67 CD74HCS73
U75 ICL7660
U135 LM385Z-1.2
U136 LM385Z-2.5
U134 LM385Z-2.5
Q154 MPS-U51
Q171 2N3904
Q1 MPS-U51
Q133 2N3904
T153 4275-037
T138 4275-037
Q131 2N7000
HD109 HV SETUP
1750V
UPPER HV
UPPER HV REF
UPPER HV READOUT
UPPER HV CAL
UPR HV
LOWER HV
LOWER HV REF
LOWER HV READOUT
LOWER HV CAL
LWR HV
VFC CAL
HV READ
BGTHS
BGWIN
ATHS
RGND
LUDLUM MEASUREMENTS INC.
TITLE: DUAL HVPS WITH THRESHOLD
UPDATED LL 3/13/90
DR LL 2/8/90
CHK / /
DSGN RDS 9/25/89
APPD / /
NEXT HIGHER ASSY. -
BOARD# 5323-746
SIZE D | MODEL 329-32/49-12 | SERIES 329 | SHEET 447
12:50:40 10-Jul-92 S0323746
SHEET 1 OF 1

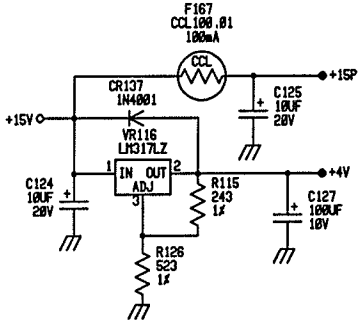


LUDLUM MEASUREMENTS INC. SWEETWATER, TX.			
DR RDS 2JAN92	TITLE: LCD DISPLAY DRIVER		
CHK / /			
DSGN RDS 2JAN92	BOARD# 5295-512		BS295512
APP	MODEL 49-12	SERIES 295	SHEET 338
08:54:07 24-Mar-92	COMP SIDE ☐	SLDR SIDE ☐	OUTLINE ☒
COMP PASTE ☐	COMP MASK ☐	SLDR PASTE ☐	SLDR MASK ☐

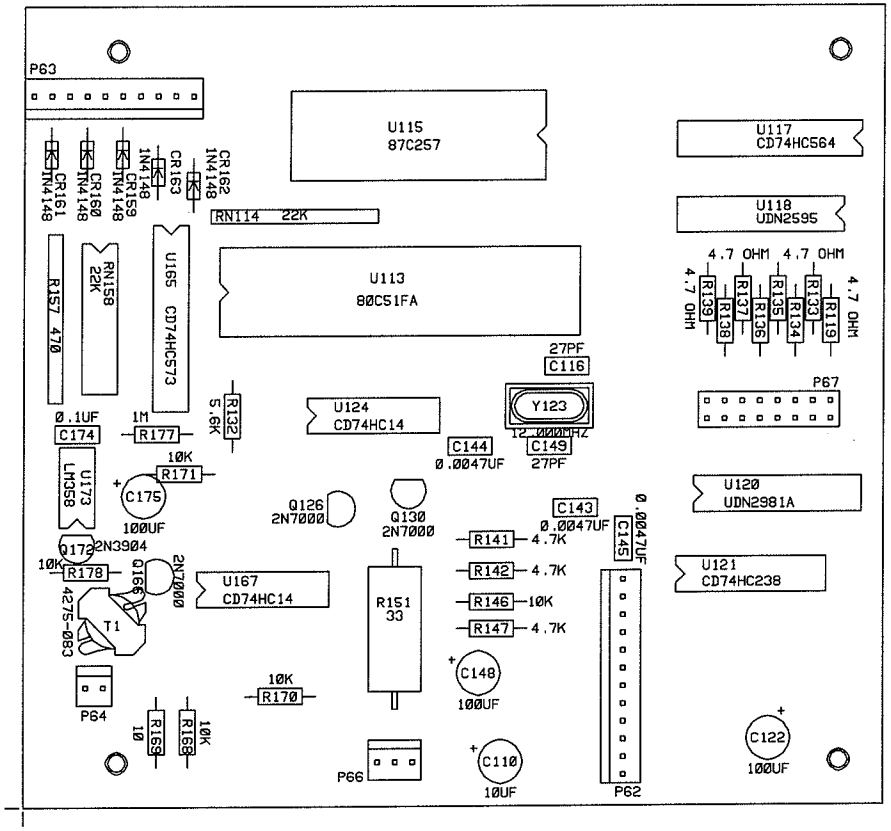
REVISIONS						
EFF	AUTHORITY	ZONE	LTR	DESCRIPTION	DATE	APPROVED



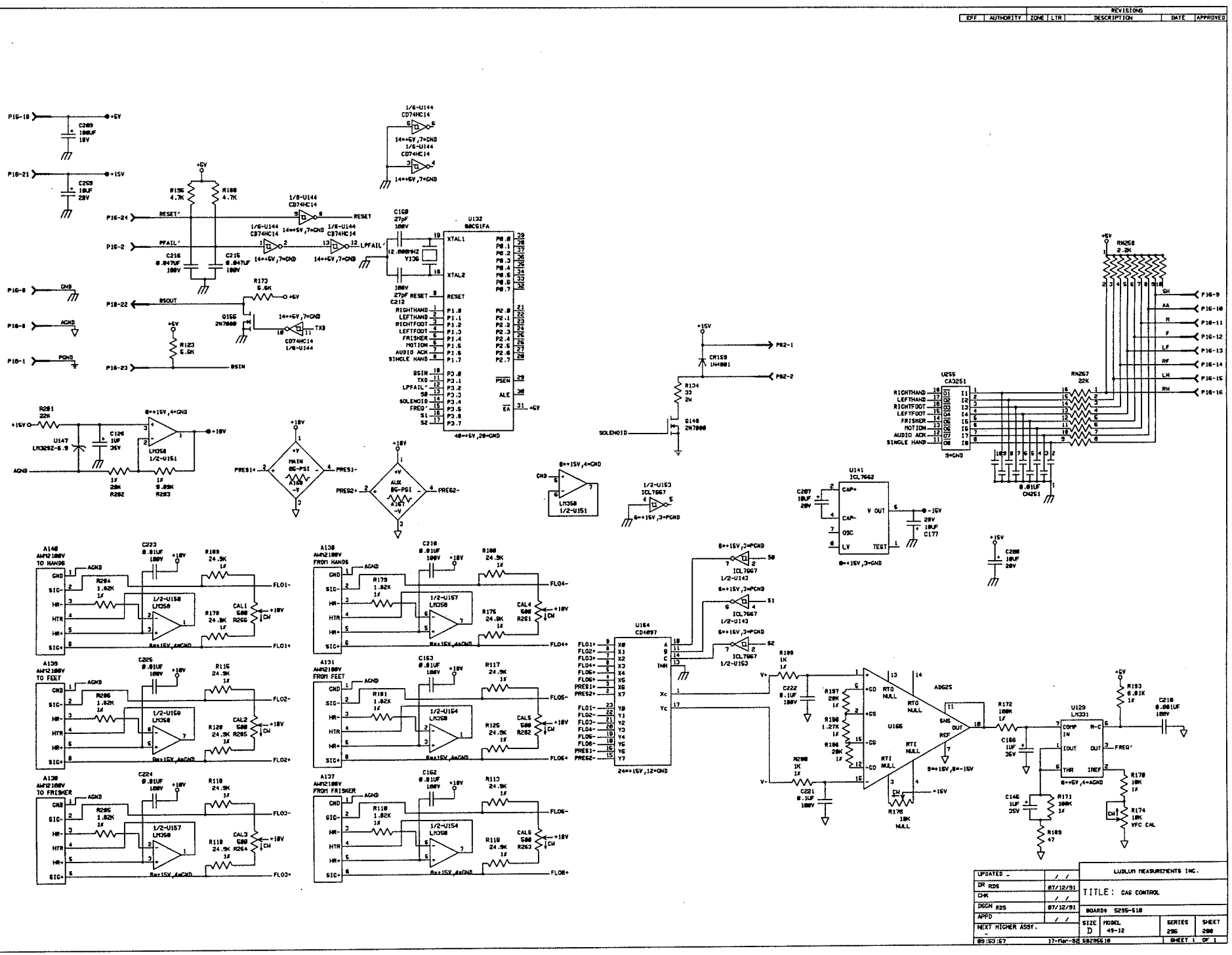


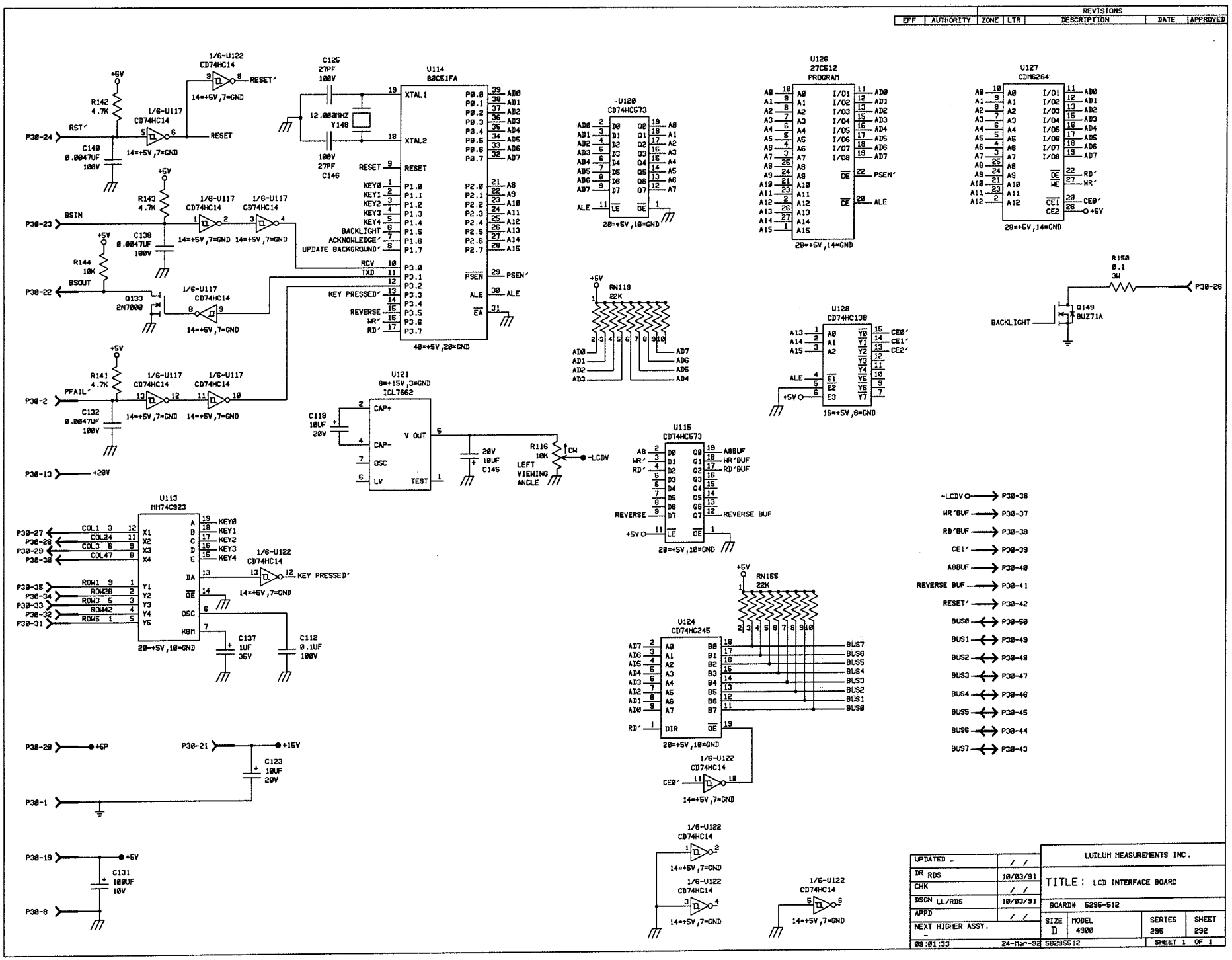


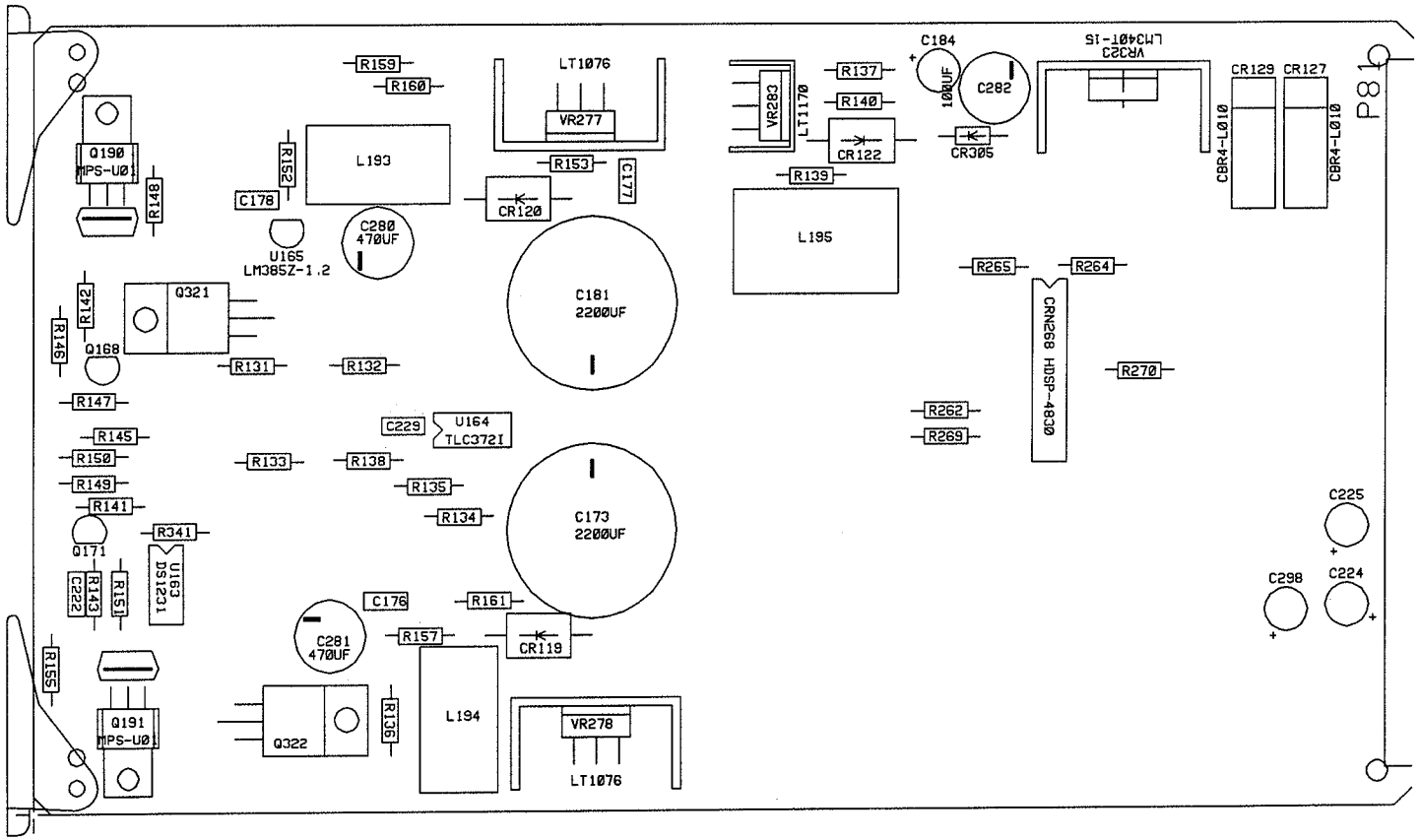
UPDATED	CKB	30-JUL-97	LUDLUM MEASUREMENTS INC.
DR	RDS	31-AUG-90	TITLE: DET CSL DRIVER
CHK Paul		7-31-97	
DSGN	DL	31-AUG-97	BOARD# 5295-484
APPD JCW		7-31-97	SIZE C / MODEL M49-12 / SERIES 295 / SHEET 275
NEXT HIGHER ASSY: -			
14:32:13	30-JUL-97	S8295484	SHEET OF



LUDLUM MEASUREMENTS INC. SWEETWATER, TX.			
DR CKB	02/06/96	TITLE: 8X8 LED/AUDIO/SWITCH	
CHK	/ /	BOARD# 5295-685	BS295685
DSGN RSS	02/05/96	MODEL 49-12- SERIES 295	SHEET 485
APP		COMP ARTWORK ☐	SLDR ARTWORK ☐
10:41:10	10-Feb-96	COMP OUTLINE ☒	SLDR OUTLINE ☐
COMP PASTE ☐	COMP MASK ☐	SLDR PASTE ☐	SLDR MASK ☐


REVISIONS
ECF | AUTHORITY | ZONE | LTR | DESCRIPTION | DATE | APPROVED
P1G-18 +5V C269 100UF 16V
P1G-21 +15V C269 10UF 25V
P1G-24 RESET' R135 4.7K R188 4.7K 1/6-U144 CD74HC14 RESET
P1G-2 PFAIL' C216 0.047UF 100V C215 0.047UF 100V 14=+5V,7=GND LPFAIL'
1/6-U144 CD74HC14 14=+5V,7=GND
P1G-8 GND
P1G-6 AGND
P1G-1 PGND
P1G-22 BSOUT R173 5.6K +5V Q155 2N7000 TXB CD74HC14 1/6-U144
P1G-23 BSIN R123 5.6K +5V
C168 27pF 100V 12.000MHZ Y136 27pF 100V C212
U132 80C51FA
XTAL1 XTAL2 RESET
RIGHTHAND LEFTHAND RIGHTFOOT LEFTFOOT FRISKER MOTION AUDIO ACK SINGLE HAND
BSIN TXD LPFAIL' SB SOLENOID FREQ' S1 S2
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
P0.0 P0.1 P0.2 P0.3 P0.4 P0.5 P0.6 P0.7
P2.0 P2.1 P2.2 P2.3 P2.4 P2.5 P2.6 P2.7
PSEN ALE EA
48=+5V,20=GND
R281 22K +15V U147 LM329Z-6.9 C126 1UF 35V AGND
8=+15V,4=GND LM358 1/2-U151 1F 20K R282 1F 9.09K R283 +18V
MAIN 0G-PSI A186 PRES1+ PRES1-
AUX 0G-PSI A187 PRES2+ PRES2-
+18V
CR159 1N4001 P82-1 P82-2
R134 33 2W Q148 2N7000 SOLENOID
8=+15V,4=GND LM358 1/2-U151
1/2-U153 ICL7667 6=+15V,3=PGND
U141 ICL7662 CAP+ CAP- OSC LV V OUT TEST
C287 10UF 20V C177 28V 10UF -15V
8=+15V,3=GND
RN258 2.2K SH AA R LF RF LH RH P1G-9 P1G-10 P1G-11 P1G-12 P1G-13 P1G-14 P1G-15 P1G-16
U255 CA3251 RIGHTHAND LEFTHAND RIGHTFOOT LEFTFOOT FRISKER MOTION AUDIO ACK SINGLE HAND S=GND
RN257 22K 0.01UF CH251
C208 10UF 20V
A140 AM2108BV TO HANDS C223 0.01UF 100V +18V R189 24.9K 1F
GND SIG- HR- HTR HR+ SIG+ AGND R284 1.82K 1F 1/2-U158 LM358 R178 24.9K 1F CAL1 500 R266 +18V CW FLO1- FLO1+ 8=+15V,4=GND
A139 AM2108BV TO FEET C226 0.01UF 100V +18V R116 24.9K 1F R286 1.82K 1F 1/2-U159 LM358 R120 24.9K 1F CAL2 500 R265 +18V CW FLO2- FLO2+ 8=+15V,4=GND
A138 AM2108BV TO FRISKER C224 0.01UF 100V +18V R110 24.9K 1F R285 1.82K 1F 1/2-U157 LM358 R118 24.9K 1F CAL3 500 R264 +18V CW FLO3- FLO3+ 8=+15V,4=GND
A138 AM2108BV FROM HANDS C218 0.01UF 100V +18V R188 24.9K 1F R179 1.82K 1F 1/2-U157 LM358 R175 24.9K 1F CAL4 500 R261 +18V CW FLO4- FLO4+ 8=+15V,4=GND
A131 AM2108BV FROM FEET C163 0.01UF 100V +18V R117 24.9K 1F R181 1.82K 1F 1/2-U154 LM358 R125 24.9K 1F CAL5 500 R262 +18V CW FLO5- FLO6+ 8=+15V,4=GND
A137 AM2108BV FROM FRISKER C162 0.01UF 100V +18V R113 24.9K 1F R118 1.82K 1F 1/2-U154 LM358 R119 24.9K 1F CAL6 500 R263 +18V CW FLO6- FLO6+ 8=+15V,4=GND
U164 CD4097 X0 X1 X2 X3 X4 X5 X6 X7 Y0 Y1 Y2 Y3 Y4 Y5 Y6 Y7 INH Xc Yc A B C FLO1+ FLO2+ FLO3+ FLO4+ FLO5+ PRES1+ PRES2+ FLO1- FLO2- FLO4- FLO5- FLO6- PRES1- PRES2- 24=+15V,12=GND
8=+15V,3=PGND ICL7667 1/2-U143 50 6=+15V,3=PGND S1 S2
R199 1K 1F C222 0.1UF 100V R197 20K 1F R198 1.27K 1F R196 20K 1F R200 1K 1F C221 0.1UF 100V V+ V- +CD +CS -CS -CD RTO NULL RTO NULL RTI NULL RTI NULL U165 AD625 SNS OUT REF 9=+15V,8=-15V R176 10K NULL +15V
R172 100K 1F C186 1UF 35V U129 LM331 COMP IN IOUT THR OUT IREF R-C FREQ' 8=+5V,4=AGND R193 6.81K 1F C210 0.001UF 100V R178 10K 1F R174 10K VFC CAL C145 1UF 35V R171 100K 1F R189 47
UPDATED / / DR RDS 07/12/91 CHK / / DSGN RDS 07/12/91 APPD / / NEXT HIGHER ASSY.
LUDLUM MEASUREMENTS INC.
TITLE: GAS CONTROL
BOARD# 5295-618
SIZE D MODEL 49-12 SERIES 295 SHEET 200
09:53:57 17-MAY-92 SB2966.10 SHEET 1 OF 1


REVISIONS
EFF | AUTHORITY | ZONE | LTR | DESCRIPTION | DATE | APPROVED
1/6-U122 CD74HC14
1/6-U117 CD74HC14
R142 4.7K
RST'
RESET'
RESET
C140 0.0047UF 100V
14=+5V,7=GND
C125 27PF 100V
12.000MHZ Y148
100V 27PF C146
U114 80C51FA
XTAL1
XTAL2
RESET
KEY0
KEY1
KEY2
KEY3
KEY4
BACKLIGHT
ACKNOWLEDGE'
UPDATE BACKGROUND'
RCV
TXD
KEY PRESSED'
REVERSE
WR'
RD'
P0.0 AD0
P0.1 AD1
P0.2 AD2
P0.3 AD3
P0.4 AD4
P0.5 AD5
P0.6 AD6
P0.7 AD7
P2.0 A8
P2.1 A9
P2.2 A10
P2.3 A11
P2.4 A12
P2.5 A13
P2.6 A14
P2.7 A15
PSEN'
ALE
EA
40=+5V,20=GND
U120 CD74HC573
20=+5V,10=GND
U126 27C512 PROGRAM
28=+5V,14=GND
U127 CDM6264
28=+5V,14=CND
R143 4.7K
P30-23
9SIN
C138 0.0047UF 100V
R144 10K
P30-22
BSOUT
Q133 2N7000
R150 0.1 3W
P30-26
Q149 BUZ71A
BACKLIGHT
RN119 22K
AD0 AD1 AD2 AD3 AD4 AD5 AD6 AD7
U128 CD74HC138
A13 A14 A15
ALE
+5V
CE0' CE1' CE2'
16=+5V,8=GND
R141 4.7K
P30-2
PFAIL'
C132 0.0047UF 100V
P30-13
+20V
U121 ICL7662
8=+15V,3=GND
CAP+
CAP-
OSC
LV
V OUT
TEST
C110 10UF 20V
20V 10UF C145
R116 10K
CW
-LCDV
LEFT VIEWING ANGLE
U115 CD74HC573
A8BUF
WR'BUF
RD'BUF
REVERSE BUF
U113 MM74C923
COL1 COL24 COL3 COL47
ROW1 ROW28 ROW3 ROW42 ROW5
P30-27 P30-28 P30-29 P30-30
P30-35 P30-34 P30-33 P30-32 P30-31
KEY0 KEY1 KEY2 KEY3 KEY4
KEY PRESSED'
C137 1UF 35V
C112 0.1UF 100V
RN155 22K
U124 CD74HC245
BUS0 BUS1 BUS2 BUS3 BUS4 BUS5 BUS6 BUS7
DIR
P30-20 +6P
P30-21 +15V
C123 10UF 20V
P30-1
P30-19 +5V
C131 100UF 10V
P30-8
-LCDV P30-36
WR'BUF P30-37
RD'BUF P30-38
CE1' P30-39
A8BUF P30-40
REVERSE BUF P30-41
RESET' P30-42
BUS0 P30-50
BUS1 P30-49
BUS2 P30-48
BUS3 P30-47
BUS4 P30-46
BUS5 P30-45
BUS6 P30-44
BUS7 P30-43
LUDLUM MEASUREMENTS INC.
TITLE: LCD INTERFACE BOARD
BOARD# 6295-512
UPDATED
DR RDS 10/03/91
CHK
DSGN LL/RDS 10/03/91
APPD
NEXT HIGHER ASSY.
SIZE D
MODEL 4900
SERIES 295
SHEET 292
09:01:33 24-Mar-92 SB295512
SHEET 1 OF 1



LUDLUM MEASUREMENTS INC. SWEETWATER, TX.					
DR	RDS	21AUG91	TITLE: LOW VOLTAGE POWER		
CHK		/ /			
DSGN	RDS	20AUG91	BOARD# S295-517		BS295517
APP			MODEL 49-12/14	SERIES 295	SHEET 300
09:11:41		24-Mar-92	COMP SIDE ☐	SLDR SIDE ☐	OUTLINE ☒
COMP PASTE ☐		COMP MASK ☐	SLDR PASTE ☐		SLDR MASK ☐