

**LUDLUM MODEL 333-2
BETA AIR MONITOR SYSTEM
WITH UPGRADES**

June 2015

**Serial Number 132876 and Succeeding
Serial Numbers**

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

STATEMENT OF WARRANTY

Ludlum Measurements, Inc. warrants the products covered in this manual to be free of defects due to workmanship, material, and design for a period of twelve months from the date of delivery. The calibration of a product is warranted to be within its specified accuracy limits at the time of shipment. In the event of instrument failure, notify Ludlum Measurements to determine if repair, recalibration, or replacement is required.

This warranty excludes the replacement of photomultiplier tubes, G-M and proportional tubes, and scintillation crystals which are broken due to excessive physical abuse or used for purposes other than intended.

There are no warranties, express or implied, including without limitation any implied warranty of merchantability or fitness, which extend beyond the description of the face there of. If the product does not perform as warranted herein, purchaser's sole remedy shall be repair or replacement, at the option of Ludlum Measurements. In no event will Ludlum Measurements be liable for damages, lost revenue, lost wages, or any other incidental or consequential damages, arising from the purchase, use, or inability to use product.

RETURN OF GOODS TO MANUFACTURER

If equipment needs to be returned to Ludlum Measurements, Inc. for repair or calibration, please send to the address below. All shipments should include documentation containing return shipping address, customer name, telephone number, description of service requested, and all other necessary information. Your cooperation will expedite the return of your equipment.

**LUDLUM MEASUREMENTS, INC.
ATTN: REPAIR DEPARTMENT
501 OAK STREET
SWEETWATER, TX 79556**

**800-622-0828 325-235-5494
FAX 325-235-4672**

Table of Contents

<i>Introduction</i>	<i>1</i>
<i>Specifications</i>	<i>2</i>
<i>Description of Controls & Functions</i>	<i>3</i>
Front Panel	3-1
Back Panel	3-2
Front Chassis	3-3
Rear Chassis	3-4
Internal Controls	3-5
<i>Operating Procedures</i>	<i>4</i>
Filter Replacement	4-1
Control Settings for Normal Operation	4-2
Gear Change-Out Instructions	4-2
Detector Removal	4-3
Chart Loading, Re-Roll Mode	4-3
<i>Calibration Procedures</i>	<i>5</i>
Log/Alarm Board (5229-105)	5-1
HV/ Dual Preamp Board (5229-110)	5-2
Power Supply Board (5229-293)	5-3
<i>Recycling</i>	<i>6</i>
<i>Parts List</i>	<i>7</i>
Model 333-2 Beta Air Monitor	7-1
Alarm/LogRate/Background Subtract Board, Drawing 229 x 63	7-1
Chassis Wiring, Drawing 229 x 174	7-4
HV/Dual Preamp Board, Drawing 229 x 65	7-5
Power Supply Board, Drawing 229 x 173	7-7
Calibration Board, Drawing 229 x 149	7-8
Model 333-2 Spare Parts List	7-9

<i>Manufacturers</i>	<i>8</i>
<i>Drawings and Diagrams</i>	<i>9</i>

Section

1

Introduction

The Ludlum Model 333-2 Beta Air Monitor and the Model 333-1P Regulated Vacuum Pump form a complete air monitoring system. The Model 333-2 is configured for continuous sampling of airborne beta-emitters. The detection system consists of a primary pancake detector facing the upstream side of the filter paper and a second gamma subtract pancake detector located behind and facing the back of the primary detector. The sampling assembly is surrounded by 5.1 cm (2 in.) of lead shielding.

Some standard features of the Model 333-2 follow:

- Dual alarm setpoints provide an independent setting of the ALERT level (strobe) and the ALARM level (bell). Setpoints may be checked via the front panel pushbuttons; however, the adjustments controls are located behind the calibration cover plate.
- Failure detection is provided for loss of count in the primary detector.
- Contact closure is provided for all three of the alarm annunciations listed above.
- Two recorder outputs are provided:
 1. 4-20 mA source
 2. 0-1 Vdc
- A Lo/No air flow indicator flashes when air flow drops below a preset rate.
- Critical air chamber components are constructed of stainless steel.

Section

2

Specifications

Detectors: two standard pancake GM tubes (type 7311); effective diameter is 4.4 cm (1.75 in.)

Detector Arrangement: both detectors contained in a lead shield, with the primary detector facing the filter paper and a second gamma subtraction detector positioned behind the primary detector

Window: 1.5 to 2.0 mg/cm² mica

Window Area: active and open are 15.4 cm² (2.4 in²)

Efficiency 4 π : 5 % for ¹⁴C; 22% for ⁹⁰Sr/⁹⁰Y; 19 % for ⁹⁹Tc; 32% for ³²P

Shield: 5.1 cm (2 in.) lead

Ratemeter: 8.9 cm (3.5 in.) arc 1 mA analog type

Range: 10 to 100,000 counts per minute (cpm)

Sample Chamber: stainless steel construction

Rustrak DC Signal Recorder: a 6 Vdc motor is supplied with this unit

Recorder: striking strip chart (30-day capacity)

Air Pump: Model 333-1P (included)

Maximum Pump Operating Temperature: 82.2 °C (180 °F) (temperature measured at the center of the pump end plate)

Pump Type: world voltage, rotary carbon vane

Motor: continuous duty, 1/3 Hp, 50 Hz, 1425 rpm, 110-115/200-240 Vac, 5.6-5.3/2.8-2.7 amps; or 1/3 Hp, 60 Hz, 1725 rpm, 110-115/200-240 Vac, 5.8-5.1/2.9-2.5 amps

LO/NO Flow Indicator: front-panel flashing red lamp

Flow Regulator: adjustable from 0 to 100 lpm

Filter: type 5211, 47mm diameter paper

Alarm Indication:

1. **ALERT:** flashing red strobe with SPDT (single pole, double throw) contact closure
2. **ALARM:** bell with SPDT contact closure. alarm points are individually adjustable over the full ratemeter range. Set points are displayed on the meter readout by depressing the appropriate button on the front panel. All contacts are rated for 3 A at 120 Vac resistive. The bell is rated at 92 db at 3 m (10 ft).

Alarm Acknowledge: front panel AUDIO ON/OFF forces the flashing strobe on and the bell off.

Alarm Delay: adjustable from 1 to 30 seconds

Lock-In Feature: both ALERT and ALARM circuits with individual switches allowing selection of either lock-in or non-lock-in alarm operation

Fail Indication: front-panel LED and SPDT relay contacts, indicating no counts received in the beta detector

Recorder Output: 4-20 mA current source, capable of driving a maximum 750 ohm external load. 0-1 volt recorder output is also provided.

Power: 95-135 Vac (178-240 Vac available), 50-60 Hz (3A)

Temperature Range: -0 to 50 °C (32 to 122 °F)

Size: 40.4 x 70.6 x 33 cm (15.9 x 27.8 x 13 in.) (H x W x L)

Weight: 72.6 kg (160 lb), excluding pump and flow regulator

Overall Weight: 95.5 kg (210 lb)

Section

3

Description of Controls and Functions

3.1 Front Panel

ALERT: a pushbutton control used to display the ALERT annunciation level on the meter readout

ALARM: a pushbutton control used to display the ALARM annunciation level on the meter readout

AUDIO: a toggle switch used to defeat the bell when placed in the OFF position. The flashing strobe is forced ON when this switch is in the OFF position, alerting the user to an abnormal state.

RESET a pushbutton switch used to zero the meter and reset both the ALERT and ALARM annunciators

RCDR: a toggle switch used to turn the local recorder off without having to shut down the entire instrument

PUMP: a toggle switch used to energize the rear panel motor outlet

MON: a green LED indicating counts are being received in the primary detector. With only background present, this light may momentarily blink off.

PILOT: an orange neon bulb indicating that AC is applied to the electronics of the Model 333-2

ON/OFF: a toggle switch used to energize the electronics of the Model 333-2

METER READOUT: considered to be the primary readout and indicates counts received on a four-decade logarithmic scale from 10 to 100,000 cpm

The following controls are located underneath the Calibration Control Cover:

HV: a recessed control used to adjust the high voltage applied to both detectors. It is variable from approximately 0 to 1250 volts.

BKGND SUB: a recessed control used to adjust the amount of background detector subtraction from 0% to 90%

BKGND PULS: a recessed control used to adjust the pulse width applied to the log/ratemeter subtraction circuit, (refer to Log/Alarm Board calibration procedure)

MTR ZERO: a recessed control used to adjust the mid-scale reading of the primary readout

MTR SPAN: a recessed control used to adjust the primary meter full-scale reading

LCL RCRDR: a recessed control used to calibrate the strip chart recorder on the front instrument panel

RMT RCRDR: a recessed control used to calibrate the external recorder output (available on pin N of the 14-pin MS connector on the rear of the instrument)

ALRM RESP: a recessed control used to vary the ALARM level annunciation time from approximately 1 to 30 seconds

ALRT SET: a recessed control used in conjunction with the ALERT PUSH TO READ button to adjust the ALERT LEVEL (strobe) set point

3.2 Back Panel

DETECTOR OUTPUTS: two BNC connectors that provide preamplifier output from each detector

110 VAC: a socket used to apply power to the electronics chassis and the vacuum pump outlet

REMOTE: a 14-pin MS-style connector used to provide the following external connections:

<u>PIN</u>	<u>CONNECTIONS</u>
A	MONITOR RELAY (Common, COM)
B	MONITOR (Normally Closed, NC)
C	MONITOR (Normally Open, NO)
D	ALARM RELAY (COM)
E	ALARM (NC)
F	ALARM (NO)
G	4-20 mA SOURCE OUTPUT
H	ALERT (COM)
I	ALERT (NC)
J	ALERT (NO)

K	GND
L	+24 VDC @ 100 mA maximum
M	RESET (GND for remote reset)
N	0-1 VDC RCDR OUTPUT

1 AMP: a quickly blowing fuse (type AGC-1) used to protect the counting instrument

7 AMP: a slow-blowing fuse (type MDL-7) used to protect the pump motor circuit

3.3 Front Chassis

LOCAL RECORDER: a striking, strip chart recorder driven from the primary readout indicating in counts per minute (CPM). The standard recorder has a 30-day chart paper capacity.

SAMPLE CHAMBER: a stainless steel assembly with 5.1 cm (2 in.) of lead surrounding the detectors and filter

AIR FLOWMETER: a 5.1 cm (2 in.) scale length meter reading from 10 to 100 liters per minute (lpm)

LO/NO FLOW CAL: a multi-turn control used to set the minimum air flow rate before lighting the LO/NO Flow indicator

3.4 Rear Chassis

PUMP MOTOR OUTLET: a grounded 115 Vac socket providing power to the vacuum pump

VACUUM OUT: a 0.64 cm (0.25 in.) quick-connect nipple for attaching the air line hose to the vacuum pump

3.5 Internal Controls

HVPS/DUAL PREAMPLIFIER BOARD (5229-110)

R4, HV Limit: a board-mounted control used to set the maximum high voltage output from the supply when the front-panel HV control is turned to its maximum clockwise position

LOG/ALARM BOARD: (5229-105)

Note:

See Drawing 229 X 122 in the Drawings and Diagrams Section of this manual for control locations.

S1-1: a switch used to defeat the ALARM “lock-in” feature when in the open position

S1-2: a switch used to read counts from the background detector (DET 2) when in the closed position

S1-3: a switch used to defeat the ALERT “lock-in” feature when in the open position

POWER SUPPLY BOARD (5229-293):

Note:

See Drawing 229 X 173 in the Drawings and Diagrams Section of this manual for control locations.

R36: a control used to adjust the minimum current out of the 4-20 mA recorder driver with no signal applied to the instrument

R37: a control used to adjust the maximum current out of the 4-20 mA recorder driver with a full-scale count rate applied to the instrument

INTERNAL CONNECTIONS

A 7-pin MTA connector is used to connect the strobe and bell to the power supply board and is located at the left side of the board (facing the component side).

Note:

Exercise caution when disconnecting and connecting the plug above. 110 VAC may be present.

LO/NO FLOW SENSOR CONNECTOR: a 5-pin MTA connector located at the upper right side of the Power Supply Board (facing component side)

DET1 & DET2: two BNC -type connectors mounted on the detector assembly and two BNC-type connectors mounted on the HV/dual preamp board (5229-110) used to provide interconnection between the detectors and the counting unit.

Section

4

Operating Procedures

Connect the vacuum pump to the air outlet using the quick-connect hose supplied. The pump motor may be controlled via the front-panel pump switch when using the rear-panel motor outlet. Connect the instrument to AC line using a heavy duty (10 Amp) cordset plugged into the counting unit socket (110 Vac).

4.1 Filter Replacement

To avoid filter paper displacement during filter change, turn the PUMP switch off. Lift the filter holder catch knob and pull the holder out of the sampling chamber. Remove the filter hold-down cap and pull the filter paper off. Replace the filter paper and the hold down cap. Lift the holder catch knob until the filter holder is started in place. Release the knob and push the filter holder in until the catch drops behind the filter holder body. The filter holder and the filter paper are now in position for normal operation.

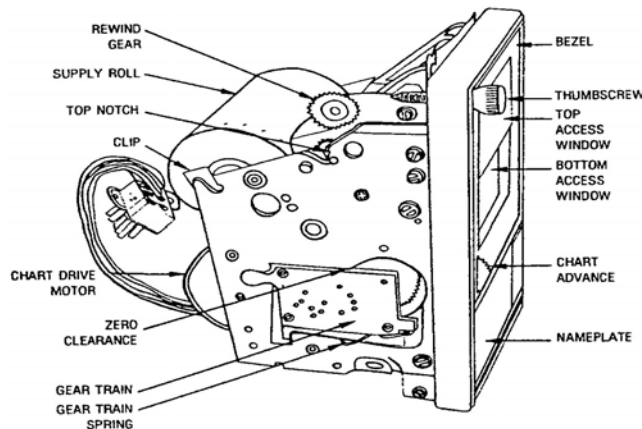
4.2 Control Settings for Normal Operation

- a. Turn the instrument to the ON position.
- b. Set the desired ALERT and ALARM level setpoints by using the PUSH TO READ buttons and the setpoint controls located beneath the CALIBRATION COVER. These points may be chosen anywhere on the primary readout
- c. Rotate the BKGD SUBT control to fully counter-clockwise position for full background subtraction; or turn the control a proportionate amount of the gamma subtraction desired.
- d. The high voltage has been set at the factory to 900 volts and should need no further adjustment.
- e. Rotate the ALARM RESP control counter-clockwise from its fully clockwise position to provide the desired time to annunciation from 1 second to about 30 seconds (fully counter-clockwise).
- f. Confirm that the AUDIO switch is in the ON position
- g. Move the RCDR switch to ON if the recording information is necessary.

- h. Confirm that a new filter is in place.
- i. Turn the PUMP switch ON and adjust the flow rate by loosening the top jam nut and turning the bottom nut inside the cover of the flow regulator, to a value of 5 lpm less than your desired flow rate. The useable flow regulator range is from 0-1100 lpm.
- j. Adjust the LO/NO FLOW CAL control located above the flow meter until a steady flash is seen (LO/NO Flow lamp).
- k. Now adjust the the air flow to your desired rate. The LO/NO Flow lamp indicator should be off.
- l. Confirm that the MON indicator is lit at least 50% of the time (with a new filter in place). Normal backgrounds of 30 cpm should keep the monitor lamp lit at least 90% of the time.
- m. The unit is now ready for use.

4.3 Gear Change-out Instructions

- a. Loosen the bezel thumbscrew and lower the recorder for access to gear assembly on the left side of the unit. See figure below.
- b. Use a pencil or other sharp object to lift the gear train spring off and away from chassis, where the arrow is pointing in the diagram below. Use your finger to prevent loss of the spring should it become loose.
- c. Rock the gear train assembly down toward the chassis until the tang at lower left is free. Remove the gear train from the cassis by pulling sideways.
- d. Install the new gear in reverse sequence of the above instructions.



Standard Model 280 with Case Removed

4.4 Detector Removal

- a. Turn instrument off.
- b. Remove cover by removing the two lower bolts on either end and the machine screws on top of the instrument. Gently lift the cover until the alarm cable is accessible. Unplug alarm cable and lift cover off.
- c. Disconnect the two BNC connectors from the lead shield. Remove the three bolts on the rear of the lead shield and slide the shield end toward the rear of the instrument.
- d. Grasp the rear shield handle and lift the entire assembly out of the instrument, being careful not to hit the detectors against anything.
- e. The OUTER detector can be removed by unplugging the clip on the detector and then loosening the three outer set screws. Remove the INNER detector by unplugging the clip and loosening the remaining set screw.
- f. Reassemble in reverse order of disassembly.

Note:

Be careful not to hit the detector against anything during reassembly.

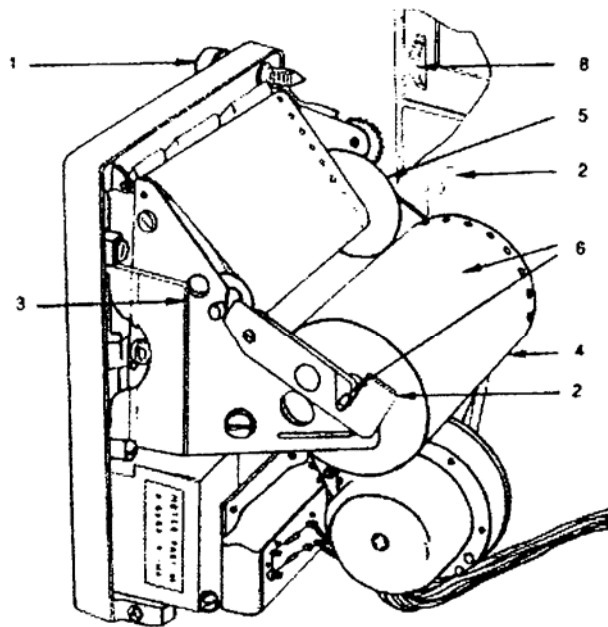
4.5 Chart Loading, Re-Roll Mode

Note:

A warning to RENEW CHART appears on the last 0.9 m (3 ft) of each roll of paper. Refer to diagram on following page.

- a. Turn power off before loading chart paper.
- b. Open recorder by loosening thumbscrew (1)
- c. Unlatch paper retaining clips (2).
- d. Open panel to chassis latch (3) RH side plate.
- e. Remove supply (4) and take up roller (5). If paper is still attached to supply roller, carefully slide the paper from between the front panel and chart drive. Do not pull the paper backward through the recorder because of the danger of snagging the pointer.
- f. Insert the supply roller into the new roll of chart paper. The perforated end of the paper is nearest to the roller shoulder.

- g. Unroll about a foot of paper. Slide the paper between the panel and side plate – sprocket holes first. Keep paper taut and close to the drive drum to prevent snagging the pointer.
- h. Engage the supply roller shaft in both seating notches (6) and check to be sure that the paper sprocket holes engage the time drum sprockets.
- i. Butt paper against the disc and tape the paper to the sleeve, printed side out. Wrap a few turns of the paper to be sure paper is started true.
- j. Continue rolling paper and place roller shaft in notches. (Lower notch LH (1).)
- k. Close clips (2), latch (3), and recorder front panel. Tighten thumbscrew (1).
- l. Advance paper with the chart advance wheel (8) to assure that paper moves through the recorder. Set to time.

**SERIES 200 REROLL**

Section

5

Calibration Procedures

5.1 Log/Alarm Board (5229-105)

- a. The following procedure requires that the HV/Dual Preamp Board (5229-110) and the Power Supply Board (5229-293) be in proper working order and in place before proceeding.
- b. Place the Log/Alarm Board in a 22-pin extender and measure the voltage at pin 3 of U1. See Drawing 229 X 122 in Drawings in Diagrams of this manual for the parts placement. A DC voltage from 40 to 60 mV is normal.
- c. Apply a pulse input of 10 kcpm with an amplitude of 150 mV to the DET1 input.
- d. Attach an oscilloscope lead to pin 10 of U2 and observe +5 V pulse width of 25-40 microseconds.
- e. Apply this same pulse to the DET2 input and move the oscilloscope to lead to pin 6 of U2.
- f. Adjust BKGD PULS on the front panel for an identical +5 V pulse width as observed prior.
- g. Reconnect the pulser to DET1, and turn the pulse amplitude down below 50 mV. The MON LED indicator should remain lit for approximately 10 seconds after receiving the last count pulse.
- h. Disconnect the pulser input cable and depress the RESET button. Release the reset button and wait about 10 seconds then adjust the meter mechanical zero for a meter reading of 10.
- i. Adjust the MTR SPAN control R31 to a fully clockwise position.
- j. Apply a 150 mV pulse of 1 kcpm reading on the primary readout.
- k. Now apply a count rate of 100 kcpm and adjust MTR SPAN for a full scale reading.
- l. Continue the procedure for “8” and “9” until no further adjustment is necessary.

- m. Apply a count rate of 1 kcpm and adjust LCL RCRDR for a strip chart recorder reading of 1 kcpm.

Note:

It is easiest to have the striking bar stopped at its topmost position during this adjustment.

5.2 HV/Dual Preamp Board (5229-110)

- a. Disconnect the detectors during the following procedure.
- b. Turn the front-panel HV control to maximum position (fully clockwise).
- c. Measure the voltage at either detector input connector using a high-impedance voltmeter.
- d. Adjust R4 for a meter reading of 1250 volts ± 50 volts.
- e. Now adjust the front-panel HV control for 900 volts ± 50 volts. (For further information, see the average Model 9 altitude dependence in Drawings and Diagrams.

Note:

The above adjustments may be made without the Board 5229-105 in place.

5.3 Power Supply Board (5229-293)

- a. Disconnect the pulser input cable (or decrease output amplitude to less than 50 mV and push RESET).
- b. Release RESET. Attach an ammeter from pin G of the recorder connector to ground through a 220 ohm resistor (any value from 100 ohm to 750 ohm may be used).
- c. Adjust R36 on board 5229-293 for 4 mA ± 0.1 mA.
- d. Now apply a count rate of 100 kcpm and greater than 120 mV amplitude.
- e. Adjust R37 for a meter reading of 20 mA ± 0.5 mA.

f. Check the following scale readings :

10 cpm (no count)	= 4 mA
100 cpm	= 8 mA
1000 cpm	= 12 mA
10000 cpm	= 16 mA
100000 cpm	= 20 mA

All readings should be within 5%. Accurate calibration of 5229-293 is necessary.

Section

6

Recycling

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

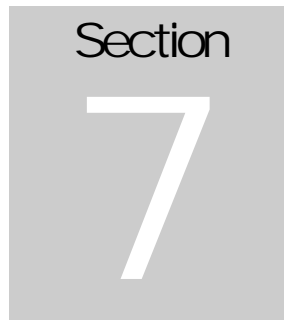
The following types of recyclable materials are present in Ludlum Measurements, Inc. electronics products, and should be recycled separately. The list is not all-inclusive, nor does it suggest that all materials are present in each piece of equipment:

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

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

The symbol appears as such:




 A graphic consisting of a grey square with the word "Section" in a sans-serif font at the top and a large white number "7" in the center.

Parts List

	Reference	Description	Part Number
Model 333-2 Beta Air Monitor	UNIT	Completely Assembled Model 333-2 Beta Air Monitor	48-1430
Alarm/LogRate/ Background Subtract Board, Drawing 229 x 63	BOARD	Completely Assembled ALRM/LG/BK	5229-105
CAPACITORS			
	C1-C2	.001 μ F, 100V, C	04-5519
	C3	.1 μ F, 100V, C	04-5521
	C4-C5	.001 μ F, 100V, C	04-5519
	C6	0.0047 μ F, 100V, C	04-5570
	C7	1 μ F, 35V, DT	04-5575
	C8	.01 μ F, 100V, C	04-5523
	C9	.1 μ F, 100V, C	04-5521
	C10	.01 μ F, 100V, C	04-5523
	C11	22 μ F, 15V, DT	04-5579
	C12	1 μ F, 35V, CT	04-5575
	C13	.01 μ F, 100V, C	04-5523
	C14	1 μ F, 35V, DT	04-5575
	C15	10 μ F, 20V, DT	04-5592
	C16	22 μ F, 15V, DT	04-5579
	C18-C19	10pF, 100V, C	04-5573
TRANSISTORS			
	Q1-Q2	NPN SILICON	05-5778
	Q3-Q4	PNP SILICON	05-5763
	Q5	NPN SILICON	05-5755
	Q6	PNP SILICON	05-5763
	Q7-Q8	NPN SILICON	05-5755
	Q9	PNP SILICON	05-5763
	Q10	NPN SILICON	05-5778

Reference	Description	Part Number
Q11	PNP SILICON	05-5763
Q12	NPN SILICON	05-5755
INTEGRATED CIRCUITS		
U1	GP OP-AMP	06-6890
U2	MULTIVIB	06-6066
U3	TIMMER	06-6017
U4-U5	GP OP-AMP	06-6890
U6	DUAL BIMOS OP-AMP	06-6168
U7	GP OP-AMP	06-6024
U8-U9	X-SISTOR ARRAY	06-6023
DIODES		
CR1-CR1	Si SIGNAL DIODE	07-6272
SWITCHES		
S1	SP/ST 4 RACK DIP SW	08-6554
RESISTORS		
R1-R2	33K, 1/4W, 5%	10-7019
R3-R4	56K, 1/4W, 5%	10-7021
R5-R6	1K, 1/4W, 5%	10-7009
R7	10K, 1/4W, 5%	10-7016
R8	100 OHM, 1/4W, 5%	10-7004
R9-R10	100K, 1/4W, 5%	10-7023
R14	1K, 1/4W, 5%	10-7009
R15-R17	5.6K, 1/4W, 5%	10-7042
R18-R19	5.36K, 1/4W, 1%	12-7507
R20-R21	220 OHM, 1/4W, 5%	10-7041
R22	5.6K, 1/4W, 5%	10-7042
R23	1G, FHV-1, 2%	12-7686
R24	10K, 1/4W, 5%	10-7016
R25	100K, 1/4W, 5%	10-7023
R28-R29	3.3K, 1/4W, 5%	10-7013
R30	27K, 1/4W, 5%	10-7085
R34	2.2K, 1/4W, 5%	10-7012
R35	47K, 1/4W, 5%	10-7020
R38	22K, 1/4W, 5%	10-7070
R39	47K, 1/4W, 5%	10-7020

Reference	Description	Part Number
R40	6.8K, 1/4W, 5%	10-7047
R41	8.2K, 1/4W, 5%	10-7015
R42	2.2K, 1/4W, 5%	10-7012
R43	100K, 1/4W, 5%	10-7023
R44	33K, 1/4W, 5%	10-7019
R45	4.7K, 1/4W, 5%	10-7014
R46-R47	10K, 1/4W, 5%	10-7016
R48	27K, 1/4W, 5%	10-7085
R49-R50	100K, 1/4W, 5%	10-7023
R51	100 OHM, 1/4W, 5%	10-7004
R52	47K, 1/4W, 5%	10-7020
R53	22K, 1/4W, 5%	10-7070
R54-R55	6.8K, 1/4W, 5%	10-7047
R56	2.2M, 1/4W, 5%	10-7052
R57	100K, 1/4W, 5%	10-7023
R58	33K, 1/4W, 5%	10-7019
R59	4.7K, 1/4W, 5%	10-7014
R61	10K, 1/4W, 5%	10-7016
R62	4.7K, 1/4W, 5%	10-7014
R64	10M, 1/4W, 5%	10-7031
R65-R66	4.7K, 1/4W, 5%	10-7014
R68	4.7K, 1/4W, 5%	10-7014
R69	27K, 1/4W, 5%	10-7085
R70	47K, 1/4W, 5%	10-7020
R71	1K, 1/4W, 5%	10-7009
R72	22K, 1/4W, 5%	10-7070
R73	1K, 1/4W, 5%	10-7009
R74	22K, 1/4W, 5%	10-7070
R76	560 OHM, 1/42	10-7054

Reference	Description	Part Number
Chassis Wiring, Drawing 229 x 174		
SWITCHES		
S1	DPDT TOGGLE	08-6525
S2	DPDT TOGGLE	2310048
S3	MST 105D	08-6511
S4	MONETARY P' BUTTON	08-6517
S5-S6	MONETARY P' BUTTON	08-6518
S7	DPDT TOGGLE	08-6545
S8	PRESSURE SNSR	2310237
LAMPS		
DS1	LAMP	21-9296
DS2	FIREBOLT 212352 24V RED	2310180
DS3	LENS-RED	21-9252
	LAMP HLDR	21-9270
	BULB #757	21-9396
METERS		
M1	METER	4229-179
FUSES		
F1	312001	21-9277
F2	7 AMP	2310049
CONNECTORS		
P1	50-24B-10	13-8051
P2	EDGE-22 PIN	13-7866
P3	MTA156 12 PIN	13-8069
P4	MTA100 7 PIN	13-8116
P5	MS RECPT	13-7906
P6	RUSTRAK	21-9641
P7	EDGE-22 PIN	13-7866
P8	EDGE-15 PIN	13-7853
P9	16 COND RIB	22-9667
P10-P11	RECPT SCREW BNC	13-7753
P13	OUTLET HUBBELL	13-7910
P14	RECPT	13-7982

	Reference	Description	Part Number
MISCELLANEOUS			
	B1	BELL	2310141
	T1	XFMR-M333-2, 110V	4275-079
	R1	33 OHM, 1/2W	11-7252
	C1	100 μ F, 50V, E	04-5540
FOR 22V			
	T1	XFMR-M333-2, 220V	4275-080
Note: Specify bell voltage when requesting replacement. Voltage is listed on the bell. (Edwards 340-6N5 or 435-6G1). See Drawing 229 x 172.			
HV/Dual Preamp Board, Drawing 229 x 65	BOARD	Completed Assembled HV/Dual Preamp Board	5229-110
CAPACITORS			
	C1	100 μ F, 10V, DT	04-5576
	C2	.1 μ F, 35V, DT	04-5574
	C3	1 μ F, 35V, DT	04-5575
	C4-C5	.0015 μ F, 3KV, C	04-5518
	C6-C9	.01 μ F, 35V, DT	04-5525
	C10	.0015 μ F, 3KV, DT	04-5592
	C11-C12	1 μ F, 35V, DT	04-5575
	C13	10 μ F, 25V, DT	04-5592
	C14	1 μ F, 35V, DT	04-5575
	C15	.0015 μ F, 3KV, C	04-5518
	C16	.01 μ F, 2KV, C	04-5525
	C17	.01 μ F, 100V, C	04-5523
	C18	10 μ F, 25V, DT	04-5592
	C19	100Pf, 3KV, C	04-5532
TRANSISTORS			
	Q1	PNP SILICON	05-5765
	Q2	NPN SILICON	05-5755
	Q3	5V REGULATOR	05-5815
INTEGRATED CIRCUITS			
	U1	GP OP-AMP	06-6024
	U3-U4	X-SISTOR ARRAY	06-6023
	U5	VOLTAGE REF	05-5808

Reference	Description	Part Number
INTEGRATED CIRCUITS		
CR1	Si SIGNAL DIODE	07-6272
CR2-CR5	Si RECTIFIER	07-6274
CR6	Si SIGNAL DIODE	07-6272
POTENTIOMETERS		
R4	1 M TRIMMER	09-6799
RESISTORS		
R1	270 OHM, 1/4W, 5%	10-7007
R2	1.8K, 1/4W, 5%	10-7010
R3	10K, 1/4W, 5%	10-7016
R5	430K, 1/4W, 5%	10-7081
R6	1G, 1/4W, 5%	12-7686
R7	1M, 1/4W, 5%	10-7028
R8	100K, 1/4W, 5%	10-7023
R9	22K, 1/4W, 5%	10-7070
R10	3.9M, 1/4W, 5%	10-7045
R11	10K, 1/4W, 5%	10-7016
R12	22K, 1/4W, 5%	10-7070
R13	330 OHM, 1/4W, 5%	10-7053
R14	10K, 1/4W, 5%	10-7016
R15	22K, 1/4W, 5%	10-7070
R16	1K, 1/4W, 5%	10-7009
R17	330 OHM, 1/4w, 5%	10-7053
R18	1K, 1/4W, 5%	10-7009
R19	10K, 1/4W, 5%	10-7016
R20	22K, 1/4W, 5%	10-7070
R21	10K, 1/4W, 5%	10-7016
R22-R23	22K, 1/4W, 5%	10-7070
R24	3.9M, 1/4W, 5%	10-7045
R25	100K, 1/4W, 5%	10-7023
R26	330K, 1/4W, 5%	10-7051
R27	1M, 1/4W, 5%	10-7028
R28	100K, 1/4W, 5%	10-7023

	Reference	Description	Part Number
Power Supply Board, Drawing 229 x 173	BOARD	Completely Assembled Power Supply Board	5229-293
CAPACITORS			
	C8-C9	0.1 μ F, 100V, C	04-5521
	C10	0.01 μ F, 100V, C	04-5523
	C11	1 μ F, 35V, DT	04-5575
	C12	0.1 μ F, 100V, C	04-5521
	C13	3300 μ F, 35V, E	04-5543
	C14	3300 μ F, 63V, E	04-5623
	C15	10 μ F, 50V, DT	04-5607
	C16	1 μ F, 35V, DT	04-5575
TRANSISTORS			
	Q17	NPN SILICON	05-5755
	Q18	PNP SILICON	05-5763
	Q22	NPN SILICON	05-5820
	Q69	PNP SILICON	05-5765
	Q73-Q75	PNP SILICON	05-5765
VOLTAGE REGULATORS			
	VR20	3-TERM POSITIVE REG	05-5822
	VR21	3-TERM ADJUSTABLE REG	05-5770
INTEGRATED CIRCUITS			
	U23	TIMER	06-6136
	U24	GP OP-AMP	06-6024
	U25	BiMOS DUAL VOLT COMPTR	06-6143
	U26-U27	GP OP-AMP	06-6024
DIODES			
	CR28-CR33	Si RECTIFIER	07-6268
	CR34-CR35	BRIDGE RECTIFIER	07-6314
POTENTIOMETERS			
	R36-R37	TRIMMER-100K	09-6823
RESISTORS			
	R39	1K, 1/4W, 5%	10-7009
	R41-R42	1K, 1/4W, 5%	10-7009
	R43-R44	4.7K, 1/4W, 5%	10-7014
	R46	33K, 1/4W, 5%	10-7019
	R47	680K, 1/4W, 5%	10-7062

Reference	Description	Part Number
R48	100K, 1/4W, 5%	10-7023
R49	470K, 1/4W, 5%	10-7026
R50	68K, 1/4W, 5%	10-7049
R51-R52	1.5K, 1/4W, 5%	10-7065
R53	330K, 1/4W, 5%	10-7051
R54	270 OHM, 1/4W, 5%	10-7007
R55	1G, 10%	12-7686
R57	20K, 1/4(1/8)W, 1%	12-7676
R58	4.22K, 1/4W, 1%	12-7722
R59	100 OHM, 1/2W, 5%	11-7255
R62	237 OHM, 1/4(1/8)W, 1%	12-7723
R64	1K, 1/4W, 5%	10-7009
R65	10K, 1/4W, 5%	10-7016
R67	68 OHM, 1/4W, 5%	10-7078
R72	1K, 1/4W, 5%	10-7009
R76-R78	4.7K, 1/4W, 5%	10-7014

RELAYS

RLY1-RLY3	RELAY 6VDC	21-9292
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Calibration Board,
Drawing 229 x 149

BOARD	Completely Assembled Calibration Board	5229-236
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POTENTIOMETERS

R1-R2	100K TRIMMER	09-6813
R3-R5	10K TRIMMER	09-6787
R6	330K, 1/4W, 5%	10-7051
R7-R9	100K TRIMMER	09-6813
R10	10K, 1/4W, 5%	10-7016
R11	100K TRIMMER	09-6813
R12	1M TRIMMER	09-6814
R13	7.5K, 1/4W, 5%	10-7083

MISCELLANEOUS

P1	STRIP-102888-8 16 PIN M	13-8112
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Model 333-2 Spare Parts List

Quantity	Description	Part Number
CRYSTALS		
2EA	GM Tube LND 7311 Pancake	01-5008
2EA	Clip Tube 122090	01-5237
SWITCHES		
1EA	Switch Audio and Recorder	08-6511
1EA	Switch Reset	08-6517
2EA	Switch Alarm/Alert Read	08-6518
1EA	Switch Power	08-6525
1EA	Switch Pump	2310048
METER		
1EA	Meter-QAS-35 0-1 MA	15-8028
O RINGS		
1EA	Filter Front O Ring-2-031	16-8278
1EA	Filter Cap Side O Ring 2-132	16-8309
2EA	Filter Holder Side O Ring 2-134	16-8310
1EA	Air Chamber O Ring 2-149	16-8320
1EA	Rear Lead O Ring 2-244	16-8323
MISC		
1EA	Washer-Wave SSR-0237-S17	20-9099
1EA	Bulb #757	21-9396
2EA	Paper-Chart WJ Rustrak	21-9486
1EA	Spring 70108	21-9519
1EA	Power Cord 3.5 M (11.375 in.)	21-9771
10EA	Filter Paper FP 5211-47	22-9696
1EA	Bell-Edwards 435-6G1	2310141
1EA	Light 220100-04 Red 12-72V	2310180
1EA	Flowmeter-RMB-54	22-9813
1EA	Model 333-2 Fltr Hldr Assy	4229-111
1EA	Model 333-1 Rustrak Assy	4229-181
1EA	Model 333-1P Quick Con'c HSE	4229-195
1EA	Model 333-1P Regulator Assy	4229-352
1EA	Model 333-1P Vac Pump	48-1794

1EA	BD(C) Model 333-2 Alarm/Lg/Bk	5229-105
1EA	BD(C) Model 333-2 Ps/2-Pre	5229-110
1EA	BD(C) Model 333-3 Cal	5229-236
1EA	BD(C) Model 333-2 P.S.	5229-293
1EA	Model 333-2 Filter Holder Cap	7229-112
1EA	Model 333-2 Flowmeter Face Scrnd	9202-540

Section
8

Manufacturers

ALC = ALCO

ALL = ALLIED

ALP = ALPHA

AM = AMPHENOL

AMP = AMP

BD = BEEDE

BRS = BOURNES

BS = BUSS

CH = CUTLER HAMMER

CJ = CINCH JONES

CK = C & K

CL = CENTRALAB

CM = CERA-MITE CORP.

CO = CHICAGO MINIATURE

CS = CENTRAL SEMICONDUCTOR

CT = CLAROSTAT

DI = DIALIGHT

DL = DALE ELECTONICS, INC.

DLC = DIALCO

EDW = EDWARDS

GE = GENERAL ELECTRIC

GH = GRAYHILL

GI = GENERAL INSTRUMENT

GU = GULTON INDUSTRIES, INC.

HB = HUBBELL

IN = INTERSIL

IR = INTERNATIONAL RECTIFIER

JMC = JEMCO

KE = KEMET (ELEC. DIV. OF UNION
CARBIDE)

LMI = LUDLUM MEASUREMENTS, INC.

ME = MEPCO/ELECTRA

MI = MOTOROLA INC.

MLY = MALLORY

MLX = MOLEX

MPL = MICRO PNEUMATIC LOGIC INC.

MS = MICRO SWITCH

NAT = NATIONAL SEMICONDUCTOR
CORP.

NI = NICHICON

PB = POTTER-BRUMFIELD

PS = POWER SONIC

RCA = RCA

RST = RUSTRAK

SAM = SAMTEC

SI = SILICONIX

SIM = SIMPSON

SL = SPECTROL

SP = SPRAGUE

SS = SOLID STATE, INC.

ST = STANCOR

SW = SWITCHCRAFT

SWW = SOUTH WEST WHEEL

TN = TINEON

TWR = TWR

WRN = WARN INDUSTRY

Section

9

Drawings and Diagrams

ALARM/LOGRATE METER/BACKGROUND BOARD SCHEMATIC, Drawing 229 X 63

ALARM/LOGRATE METER/BACKGROUND COMPONENT LAYOUT, Drawing 229 X 122 & 122A

CHASSIS WIRING 110V ONLY, Drawing 229 x 174

CHASSIS WIRING 220V ONLY, Drawing 229 x 172

HV/DUAL PREAMP BOARD SCHEMATIC, Drawing 229 x 65

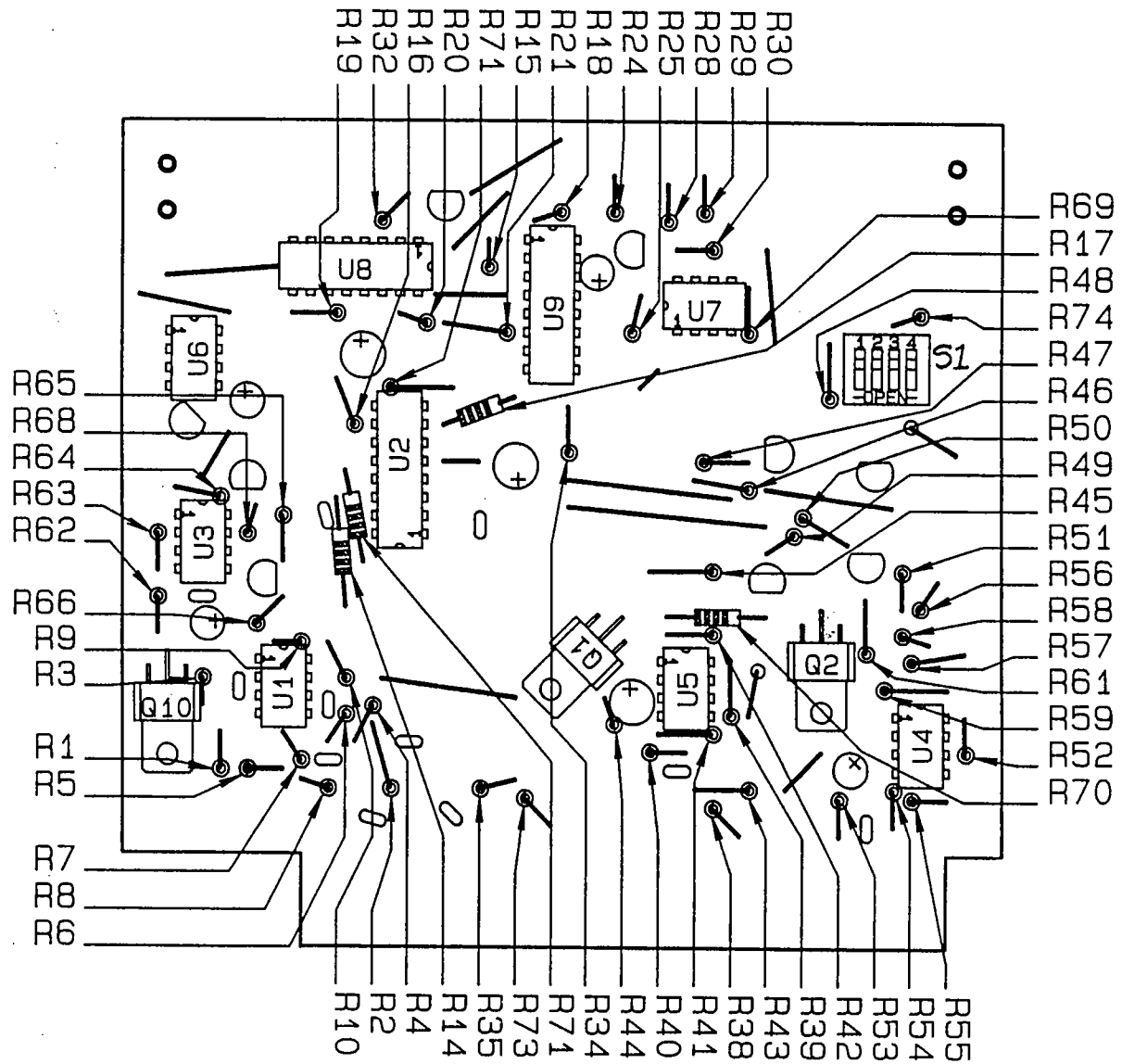
HV/DUAL PREAMP BOARD COMPONENT LAYOUT, Drawing 229 x 119

POWER SUPPLY BOARD SCHEMATIC, Drawing 229 x 173

POWER SUPPLY COMPONENT LAYOUT, Drawing 229 x 539

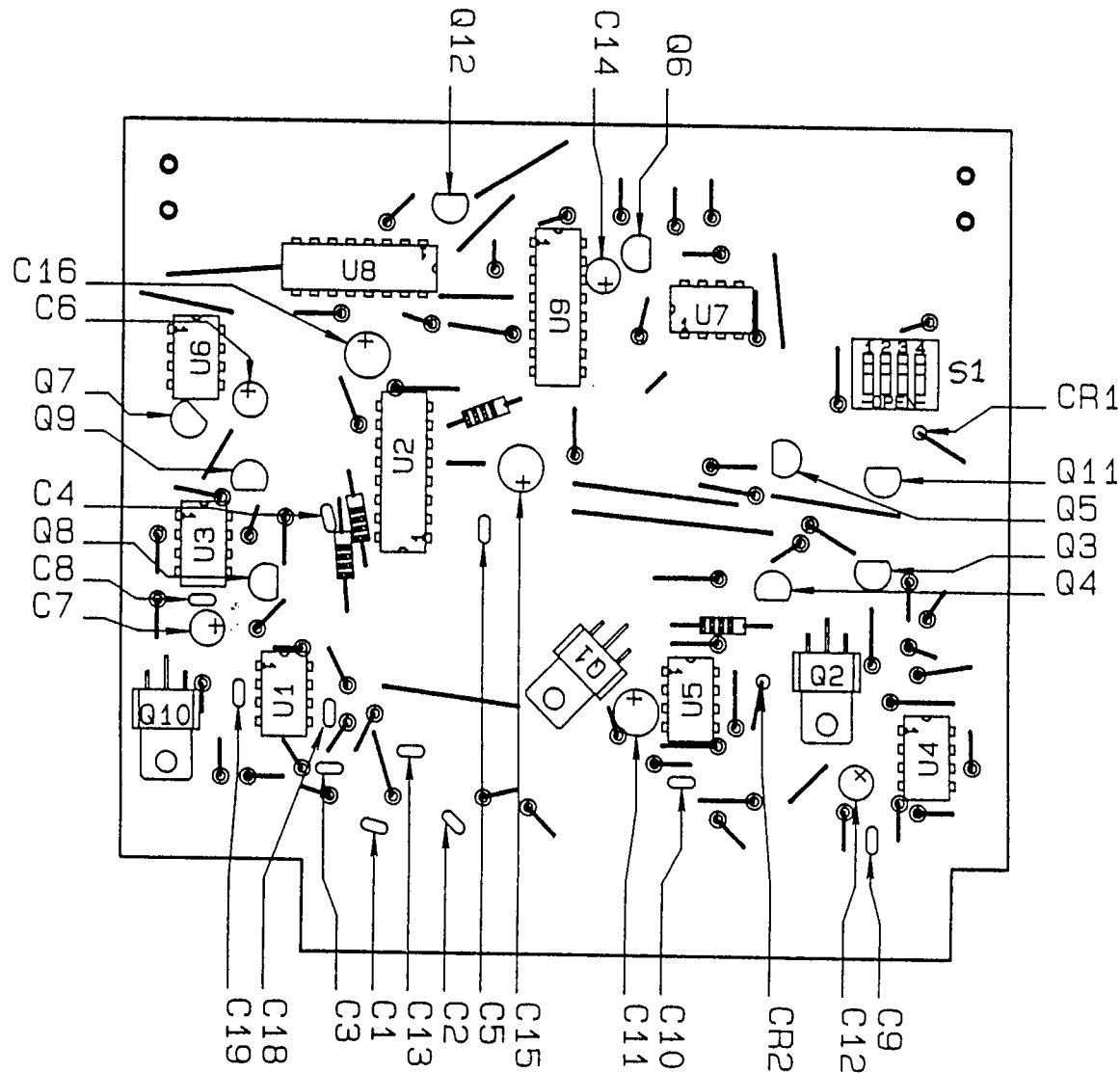
CALIBRATION BOARD SCHEMATIC, Drawing 229 x 149

CALIBRATION COMPONENT LAYOUT, Drawing 229 x 175



DESC: ALARM/LOGRATEMETER/BKGND	
BOARD #: 5229-105	
DWN: BK	DATE: 11-27-91
DSGN:	DATE:

CHG NO.		DWN	CHK	APP
DWN DATE	CHK DATE	APP	DATE	
BK11-27-91				
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TITLE M333-2 BETA AIR MONITOR				
<input checked="" type="checkbox"/> LUOLUM MEASUREMENTS, INC.	SERIES	SHEET		
201 OAK STREET SHEETS WATER, TEXAS 79088	229	122		

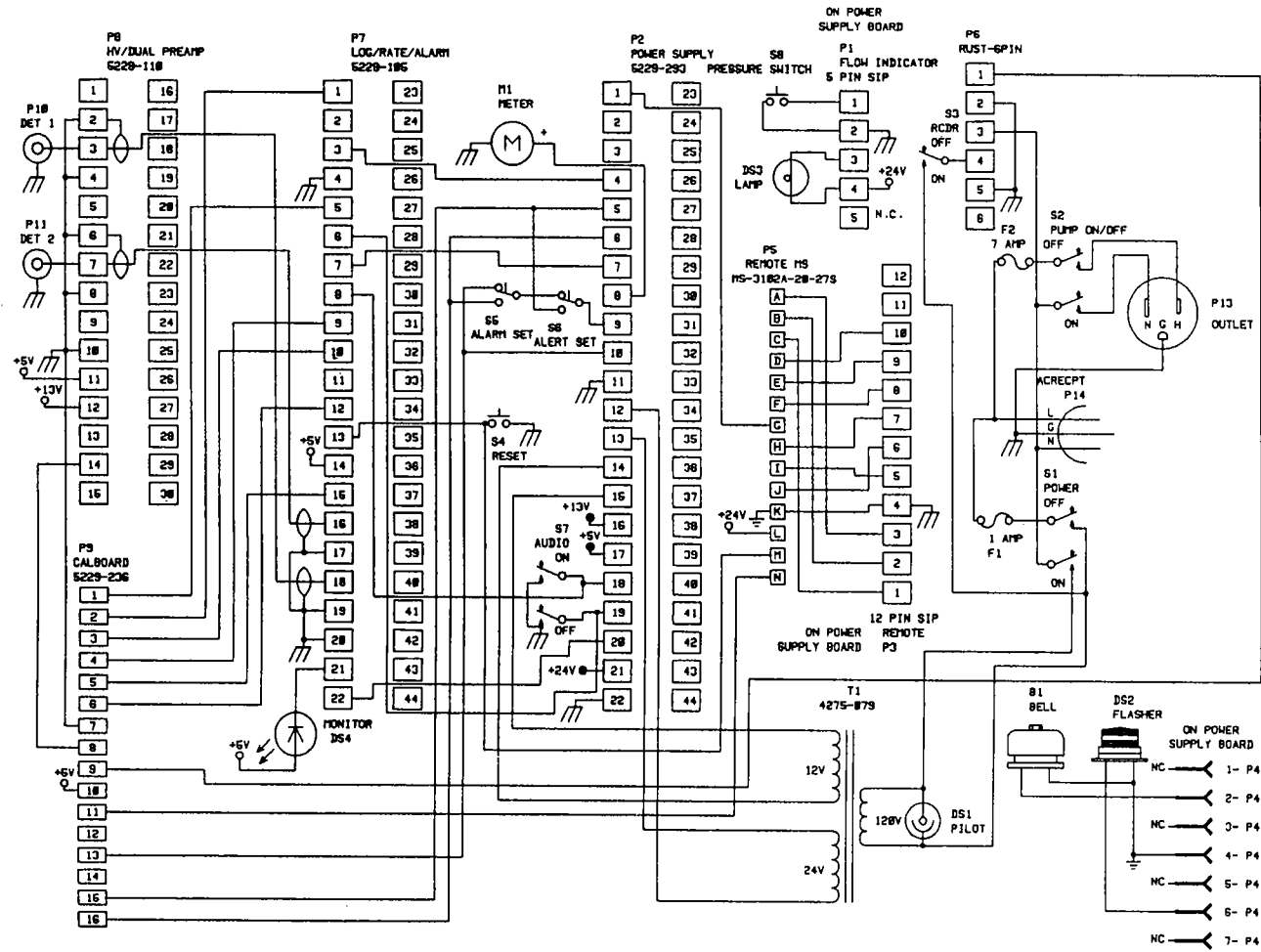


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BOARD #: 5229-105	
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DSGN:	DATE:

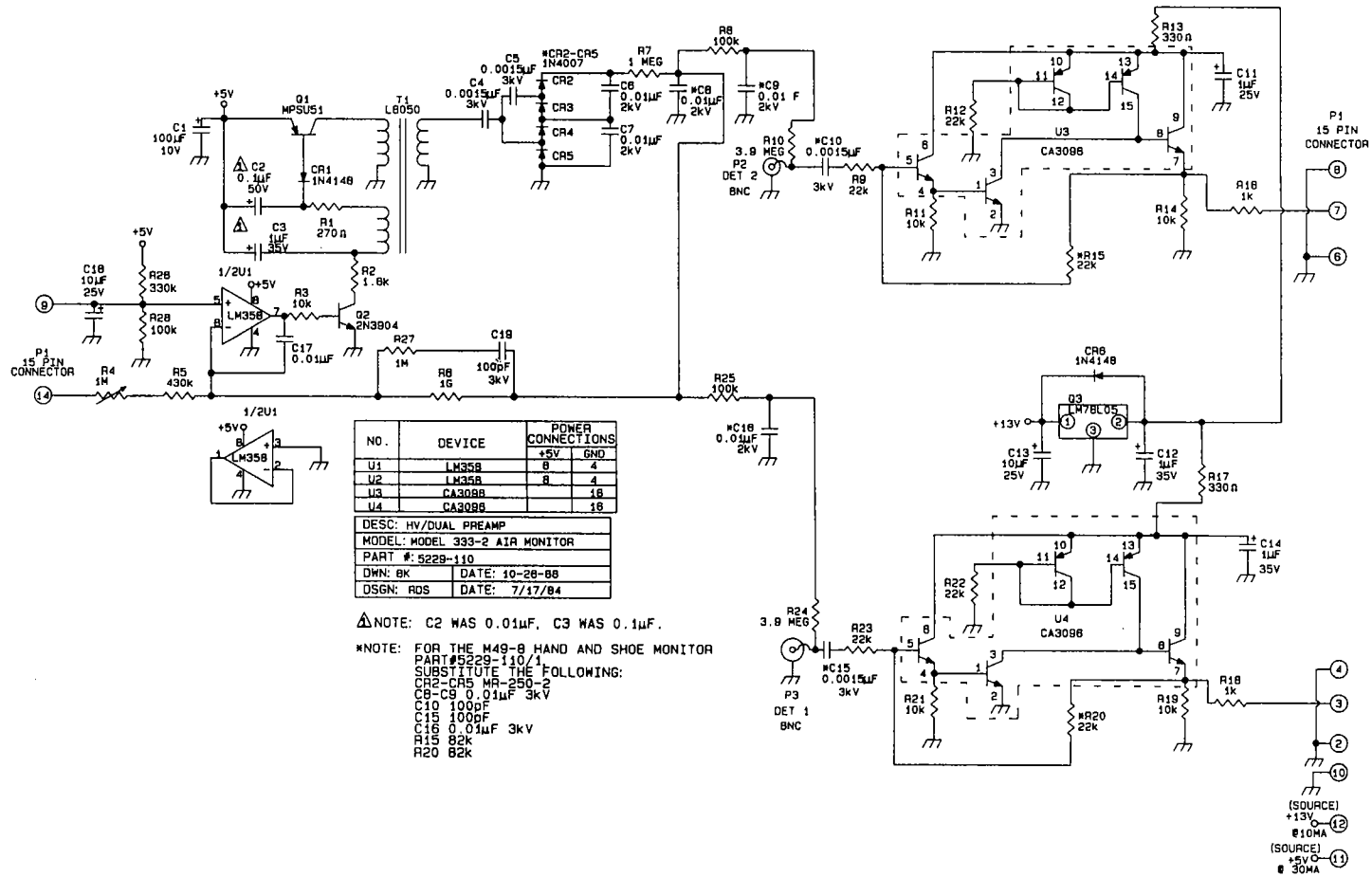
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DWN	DATE	CHK	DATE	APP
BK	11-27-91			
TOL: SHOP STD <input type="checkbox"/>		SCALE: FULL <input checked="" type="checkbox"/>		
OTHER		OTHER		
TITLE M333-2 BETA AIR MONITOR				
LUOLUM MEASUREMENTS, INC. 801 OAK STREET SHEETPORT, TEXAS 75088		SERIES	SHEET	
		229	122A	

110V ONLY

REVISIONS						
EFF	AUTHORITY	ZONE	LTR	DESCRIPTION	DATE	APPROVED

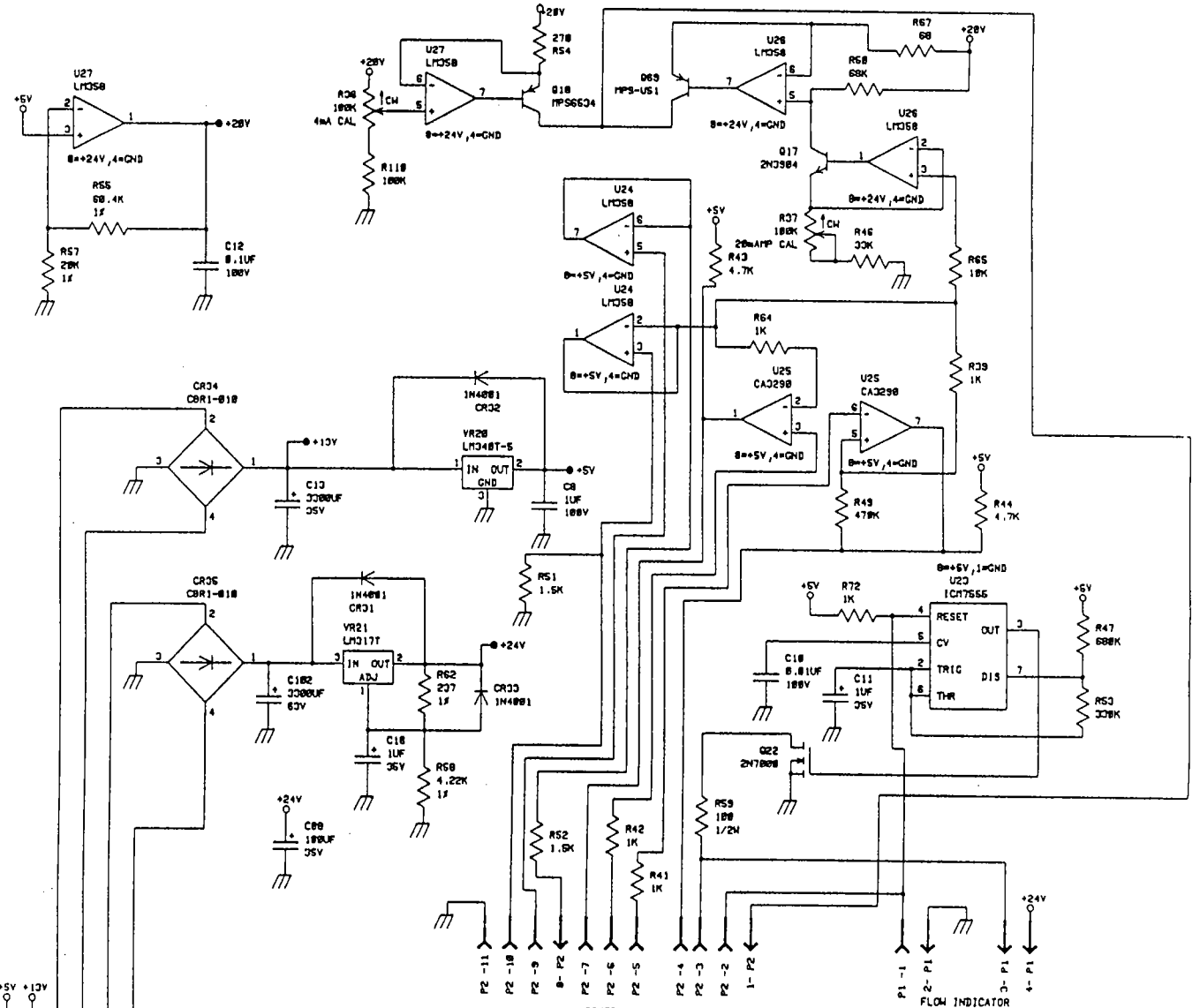
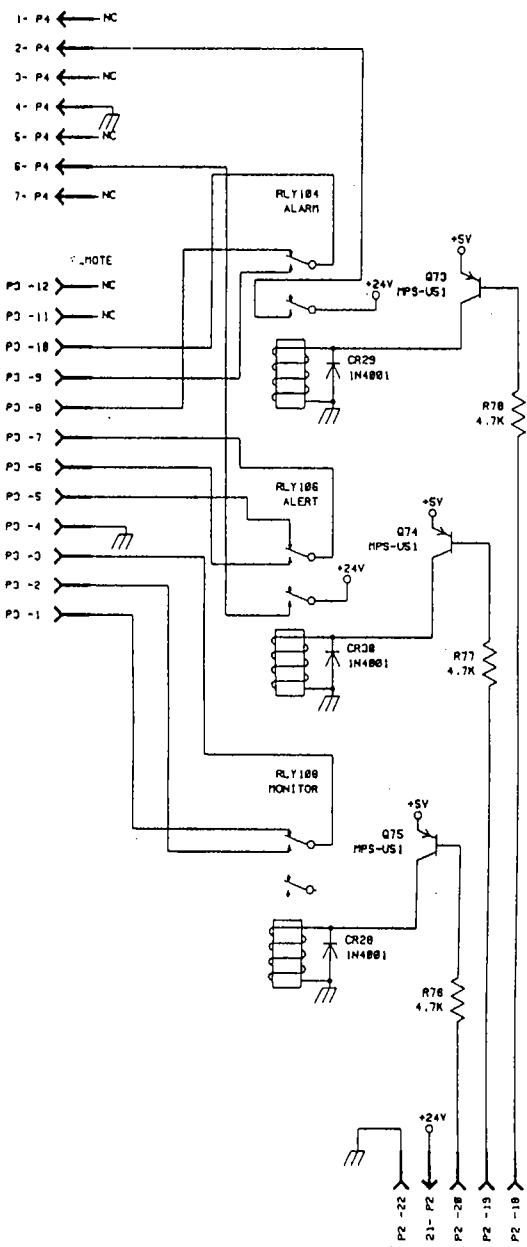


CONTRACT		LUDLUM MEASUREMENTS INC.				
DR HH	11/14/88	TITLE: GENERAL SCHEMATIC				
CHK		BOARD# 229-294				
DSGN		SIZE D	MODEL 333-2	SERIES 229	SHEET 174	
APPD JGW	11/15/88	NEXT HIGHER ASSY.		14:52:44	11-14-88	0:5229294.DRW



CHG	NO.	DWN	CHK	APP
DWN	DATE	CHK	DATE	APP
BK	10-26-88			JG60
TOL: SHOP STD		SCALE: FULL		
OTHER		OTHER		
TITLE MODEL 333-2 AIR MONITOR				
LUDLUM MEASUREMENTS, INC.		SERIES		SHEET
501 OAK STREET		229		65
SWEETWATER, TEXAS 79558				

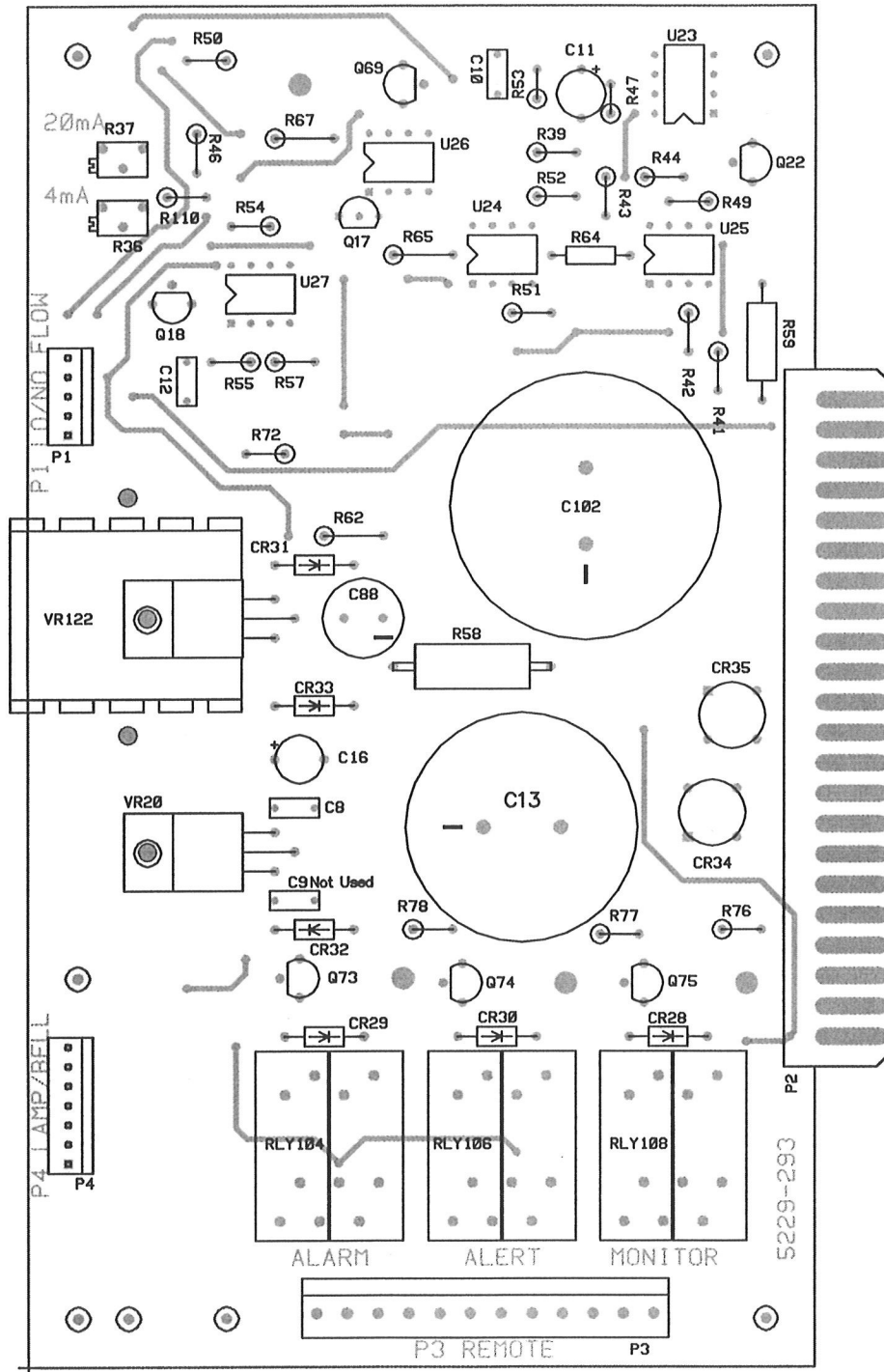
ALARM AND ALERT



POWER



CONTRACT		LUDLUM MEASUREMENTS INC.			
DR -H	B7-26-88	TITLE: POWER SUPPLY BOARD			
CHK	/ /	BOARD: 5229-293			
DSGN DL	B-87	SIZE	MODEL	SERIES	SHEET
APPD	GW	D	303-3	229	173
NEXT HIGHER ASST.	13/18/84				
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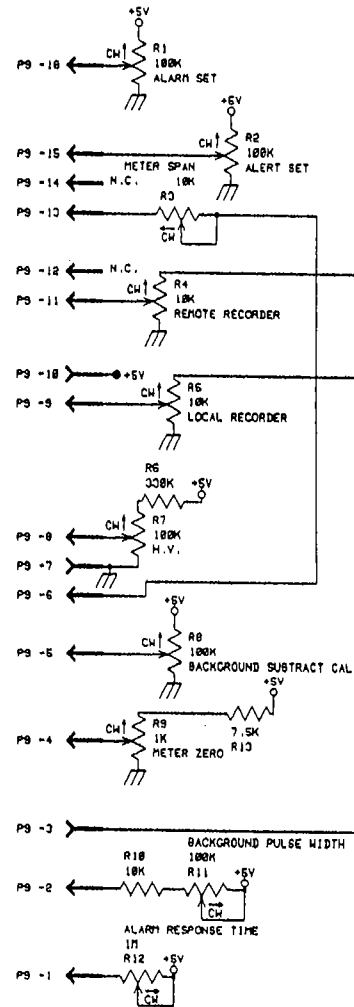


LUDLUM MEASUREMENTS, INC. PO Box 810
501 Oak Street
Sweetwater, TX 79556
U.S.A. 1-800-622-0828

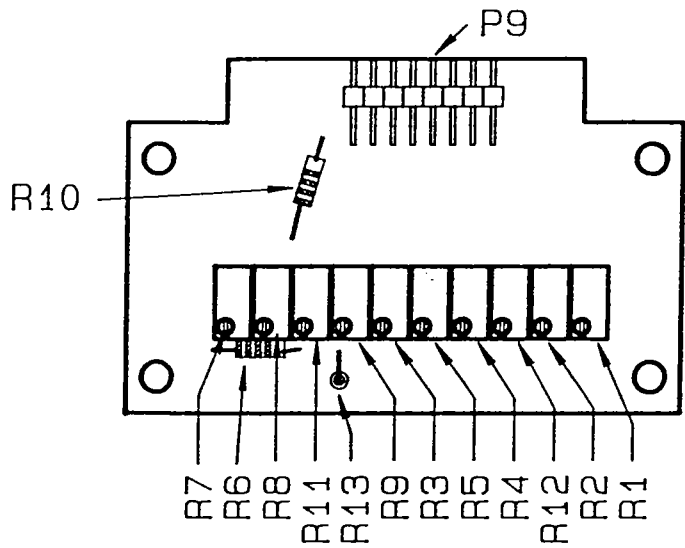
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Drawn: HH	8/87	Model: 333-2
Design: DL	7/29/88	Board#: 5229-293
Approve: <i>DL</i>	<i>20/1/15</i>	Rev: 1
PCBA Drawing		SCALE: 1.05
Print Date: 1/27/2015	4:43:37 PM	Series 229
Top Overlay		Sheet 539

W:\Projects\LM33-25229-293\Rev1\229283R1_Assy.PcbDoc

				REVISIONS		
EFF	AUTHORITY	ZONE	LTR	DESCRIPTION	DATE	APPROVED



CONTRACT		LUDLUM MEASUREMENTS INC.			
DR HH	18/07/87	TITLE: CAL BOARD			
CHK	/ /	BOARD# 6229-236			
DBGN	/ /	SIZE	MODEL	SERIES	SHEET
APPD	/ /	D	333-2	2E9	149
NEXT HIGHER ASSY.					
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DESC: CALIBRATION BRD	
BOARD #: 5229-236	
DWN: JGW	DATE: 7/29/88
DSGN:	DATE:

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DWN	DATE	CHK	DATE	APP
JGW	7/29/88			
TOL: SHOP STD <input type="checkbox"/>		SCALE: FULL <input type="checkbox"/>		
OTHER		OTHER		
TITLE M 333-2 CALIBRATION BRD				
M	LIDUN MEASUREMENTS, INC.	SERIES	SHEET	
	801 DAK STREET	229	175	
	SHEET METAL, TEXAS 75008			