Technical Manual for Beta Air Monitor

Model AMS-3

eberline

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Figure 1-1. Model AMS-3

SECTION I
GENERAL

A. PURPOSE AND DESCRIPTION

The Model AMS-3 is a versatile instrument designed for the detection and measurement of beta emitting airborne particulate matter. It consists of a lead shielded filter paper and detector, and a four decade count rate meter and recorder. An alarm indication is given by a red rotating beacon and a bell. Relay contacts are provided for remote alarm indication. A second detector provides for subtraction of gamma background.

B. SPECIFICATIONS

1. Detectors: Pancake-type geiger tube, 1-3/4 inch (4.44 cm) diameter, 1.4-2.0 mg/cm^2 thick mica window.
2. Shield: Equivalent to 2 inches (5.1 cm) of lead.
3. Filter Paper: 47mm diameter. A box of 50 Hollingsworth & Vose Type LB5211 is supplied. Other types are equally suitable.
4. Readout: Combination meter and strip-chart recorder. Chart width 60mm.
5. Range: Four decade logarithmic scale; 10-100k CPM.
6. Counting Efficiency: Approximate efficiencies for 47mm diameter standard plated sources listed below.
   ^{99}Tc - 25% of 2π
   ^{90}Sr-^{90}Y - 50% of 2π
7. Ambient Gamma Response: Approximately 200 CPM per mR/hr of ^{60}Co. The subtraction circuit can compensate for ambient gamma under normal conditions.
8. Natural Background Response: The natural background is caused by radon and/or thoron daughters which vary considerably with location and weather conditions. In Santa Fe, New Mexico the equilibrium background does not normally exceed 500 CPM with 60 LPM air flow. With air flow off and a clean filter in place, the background is approximately 30 CPM.
9. Linearity: Within ±10% of reading.
10. Response Time: Varies with count rate to provide constant statistical fluctuation.
11. Alarm Point: Adjustable over full instrument range.
12. Alarm Indication: Red rotating beacon and bell plus SPDT relay contacts for remote indicators. Relay contacts are rated for 3A at 30 VDC or 115 VAC.
13. Air Flow Meter: 10-100 liters per minute.
14. Temperature: The instrument is operational from 20°F to 120°F (-7°C to 49°C). See Figure 1-2.
15. Recorder and Meter: Simpson strip chart with an internal on-off switch for paper drive. 2 cm per hour or 12 cm per hour selectable chart speed.
16. Power: 115/230 VAC ±10%, 60 Hz at approximately 0.3 A.
17. Weight: Approximately 160 pounds (72.6 kg).
18. Dimensions: 11 inches high x 25-1/2 inches wide x 18-1/4 inches deep (28 x 65 x 46.4 cm). Dimensions given are maximum overall, including beacon and handles.

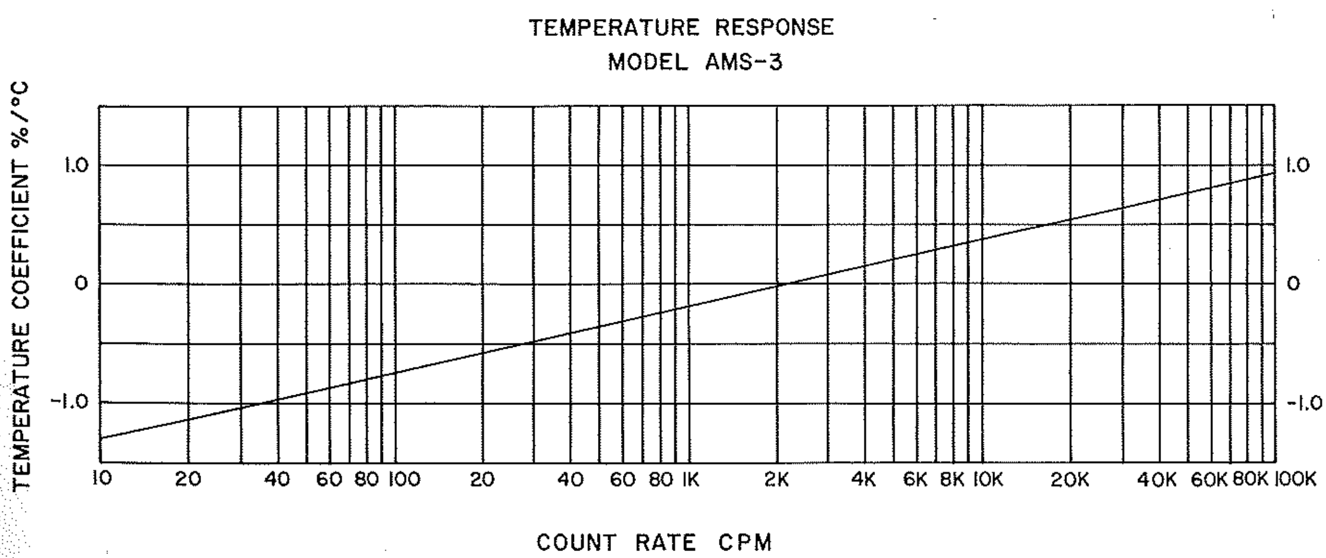


Figure 1-2. Temperature Characteristics, AMS-3

SECTION II
OPERATION

A. DESCRIPTION OF CONTROLS AND CONNECTORS

1. External:

   a. Switch, POWER: Turns AC power either ON or OFF to the instrument.
   b. POWER Lamp: Gives a visual indication of power ON.
   c. COUNTING Lamp: Lights green to indicate normal instrument operation.
   d. FAILURE Lamp: Lights red to indicate that no detector pulses are being counted.
   e. Switch, BACKGROUND SUBTRACTION: Enables or disables the gamma background subtraction circuit.
   f. Switch, PUSH TO SET: When pressed, displays the alarm set point on the recorder. A red lamp in the pushbutton is one of the high alarm indicators.
   g. SET: Adjusts the alarm point to any point in the instrument range.
   h. Switch, ACKNOWLEDGE: Resets the audible alarm (bell) while leaving the visual alarms and relay activated.
   i. Air Flow Meter: Indicates the air flow rate through the filter paper. Typical setting is 60 LPM (2 CFM).
   j. Filter Paper Holder: Located on the front panel. It is constructed so that quick and easy changing of the paper can be accomplished.
   k. AC Power Plug: Used for connection of the AC power cable to the instrument.
   l. Fuse Holder: Integral with cable connector and line filter.
   m. Barrier Strip: Supplied for the connection of external alarms and recorder to the Model AMS-3.
   n. VACUUM, Hose Barb: Supplied for the connection of the vacuum system to the Model AMS-3. For use with 5/16 inch I.D. hose.
   o. Air Intake: For use with 1/2 inch I.D. hose.

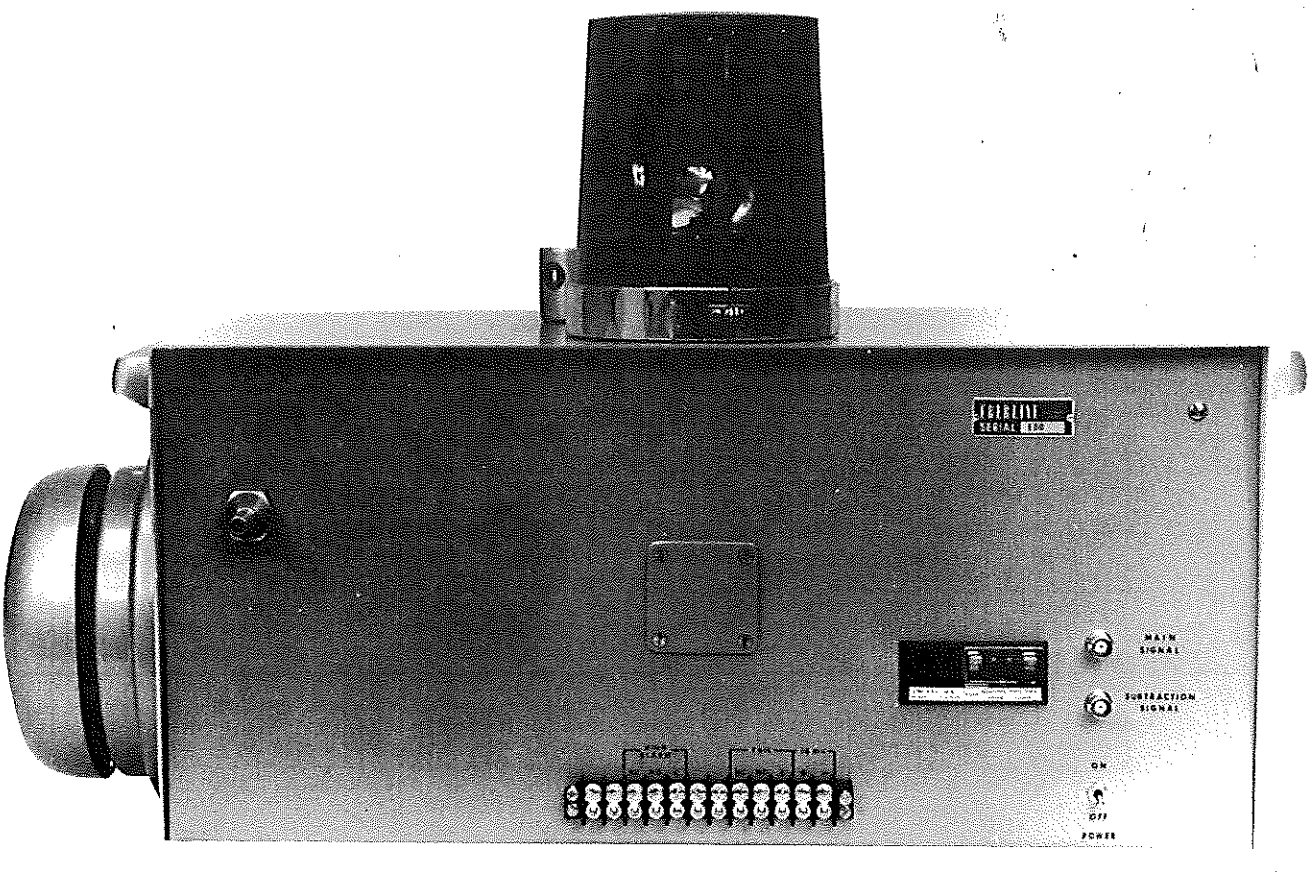


Figure 2-1. Rear View, Model AMS-3

2. Internal:

*Accessible through front panel.

*a. PULSE WIDTH: Controls pulse width of the main channel trigger. This control is used primarily for adjusting the recorder response time.
*b. ZERO: Adjusts the base point for the recorder drive.
*c. SPAN: Adjusts the current change per decade for the recorder drive.
*d. SUBTRACTION ADJUSTMENT: Adjusts the amount of subtraction from the recorder reading produced by each pulse from the background detector. This can be used to compensate for differences in counting efficiency between the two tubes.
e. Alarm Delay: Adjusts the delay between the time the count rate reaches the alarm point and the alarm occurrence. This can be adjusted from approximately one second to thirty seconds.
f. Vacuum Relief Valve: Limits the system pressure drop to reduce the chance that a system blockage will damage the G-M tube window.

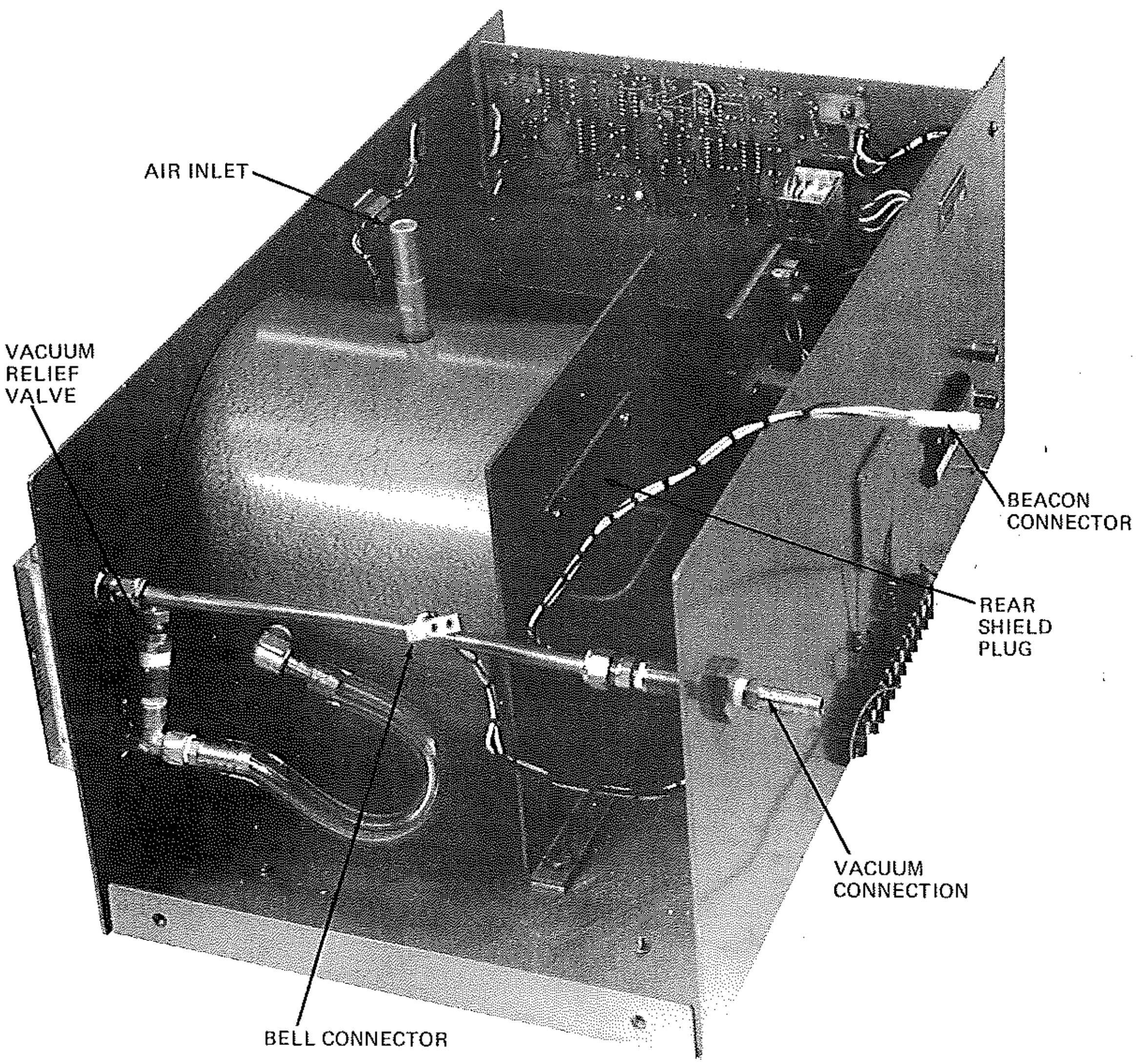


Figure 2-2. Interior, Model AMS-3

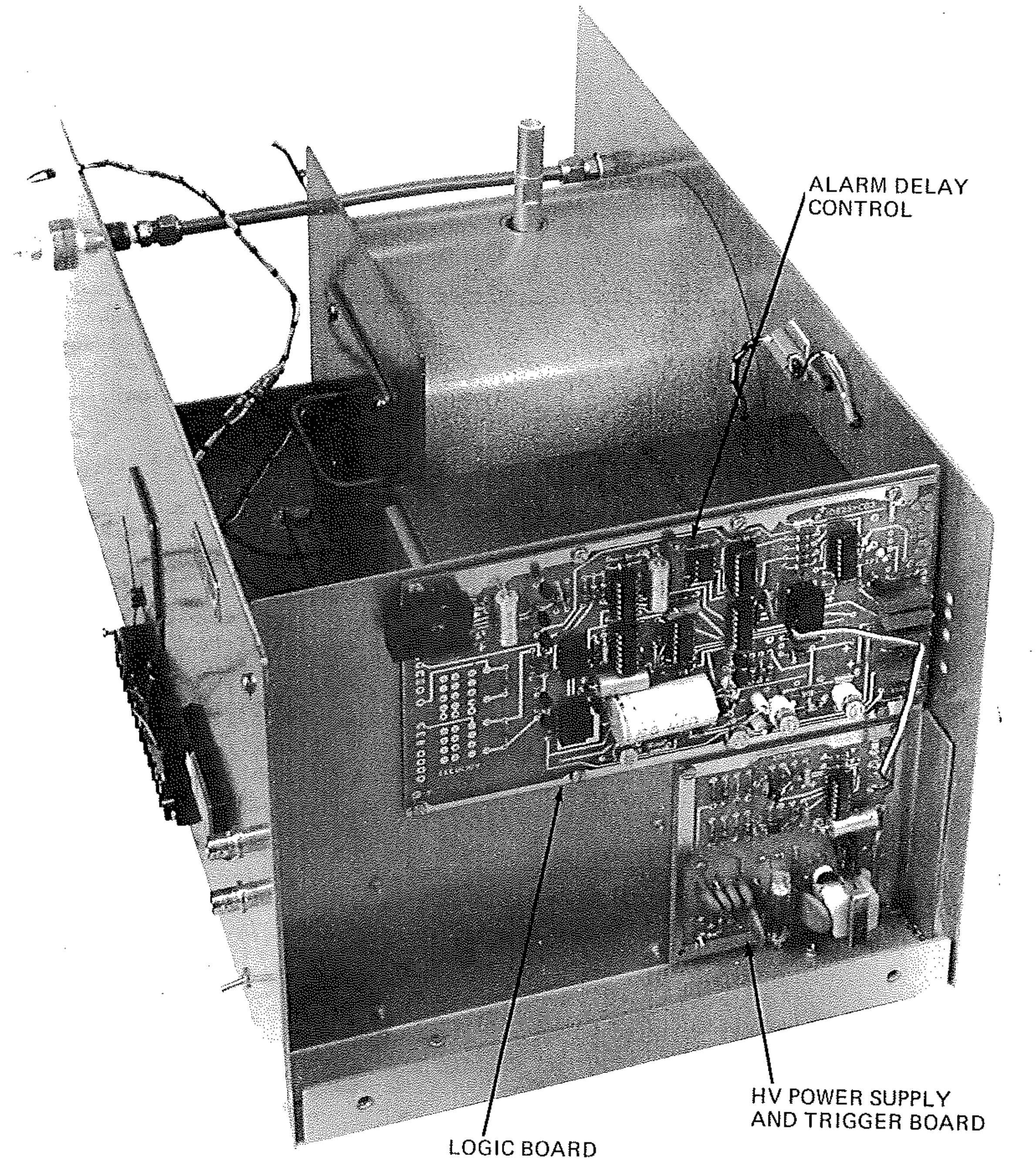


Figure 2-3. Interior, Model AMS-3

B. PREPARATION FOR USE

1. Inspection:
   a. Check the instrument for physical damage caused by shipment.
   b. Check to see that a supply of filter papers and recorder paper is available.

2. Connections:
   a. Operate the AC POWER switch OFF (down). Plug the power cord into a 3-wire 115 VAC, 60 Hz grounded receptacle. The instrument may be changed to 230 VAC, 60 Hz operation by removing and reversing the card in the AC receptacle. (The 100 V and 200 V settings are not functional.) For 50 Hz operation, the recorder must be changed.
   b. Connect the vacuum line to the hose barb on the rear of the instrument.
   c. For remote sampling, lift off intake cap and connect a 1/2 inch (1.3 cm) I.D. hose.

C. OPERATION CHECK

1. Turn the POWER switch ON. The POWER indicator lamp should light. Either the COUNTING or FAILURE lamp should light.
2. Check the meter indication to see that background radiation is a low number. If an appreciable reading exists, it indicates that the detector is contaminated, is in a high gamma radiation field, or an electronic failure has occurred.
3. Place a calibration source into the detector filter holder. The meter should move upscale and stabilize. The actual reading should be the source value multiplied by the detector efficiency.
4. Remove the source from the detector.

D. OPERATION

After proper connections are made and an operation check performed, the unit is ready to operate. Place a clean filter paper in the detector and turn on the vacuum. The ALARM must be set so that an alarm will be indicated as soon as possible if airborne contamination exists, yet not alarm on background radiation. There are two major sources of background radiation to which the detector will respond. These are naturally occurring radon-thoron daughter products in the air and external gamma radiation which penetrates the lead shield to the geiger tube.

Some knowledge of the reading expected from these sources is required before the alarm point can be logically set.

SECTION III
THEORY OF OPERATION

A. GENERAL

The high voltage power supply develops +900 V, which is applied to the anodes of the Geiger-Mueller tubes. When radiation reacts in the G-M tubes, negative voltage pulses are generated.

These pulses are coupled to the trigger circuits where they are converted to standard pulses of power. The pulses are then integrated to produce a current proportional to the input count rate. At this stage, the pulses from the subtraction G-M tubes may be subtracted, if desired, so that the output current is proportional to the net beta activity on the filter paper.

The integrated current is coupled to a logarithmic converter whose output voltage is proportional to the logarithm of the input current. This voltage drives the meter, recorder and alarm sensing circuits.

B. FUNCTIONAL THEORY

1. High Voltage Power Supply (See Figure 6-3)

   The oscillator transistor, Q301, drives the primary (Pins 2 and 3) of the blocking oscillator transformer T301. Feedback for oscillation is generated and derived from a second transformer winding (Pins 4 and 5).

   The output from the secondary of T301 (Pins 1 and 6) is rectified and filtered. The resulting DC voltage is shunt regulated by the 900 V corona tube V301. A resistor in series with the tube, R304, permits checking the VR tube current using a high impedance voltmeter.

   The power level of the oscillator is determined by resistor R302 in the feedback circuit. This is selected for a VR tube current of 5-15 μA (0.5-1.5 V across R304).

2. Trigger Circuit (See Figure 6-3)

   The signals from the two G-M detectors are coupled to identical trigger circuits. The trigger input is an emitter follower for isolation between the high voltage circuit and the logic circuitry. A high speed diode protects the circuit from transients if the high voltage is accidentally shorted.

   The output of the emitter follower is connected to the positive input of one section of a quad voltage comparator, A301. A resistive divider sets the DC difference between the comparator inputs at 200mV. Therefore, when the signal input exceeds -200mV, the comparator output switches from high to low and a negative-going logic pulse is produced.

3. One-shot and Count Rate Circuit (See Figure 6-2)

   a. One-shot: The main counting one-shot circuit consists of two gates of integrated circuit A5 (A5-A and A5-B) and its associated circuitry. The two gates are used to form a monostable multivibrator. The pulse width of the multivibrator is set by R13 and C4.

   b. Count Rate Circuit: The count rate circuit consists of Q1, Q2 and their associated circuitry.

   Driver transistor Q2 is normally off so that no current flows into the integration circuit. When the one-shot is on, Q2 is on and current flows. The amount of current is determined by the voltage on the base of Q2 and R19. The length of time that current flows is determined by the width of the trigger pulse. This (current times time) forms a certain charge which is transferred to C6 for each event counted. C6 discharges through the Log Converter input, yielding a certain average current dependent on the rate of input pulses. Changing the pulse width of the trigger changes the average current for a given input pulse rate.

4. Subtraction One-shot and Count Rate Circuit (See Figure 6-2)

   This circuit subtracts from the recorder reading of the instrument an adjustable current proportional to the counts per minute which are detected by the subtraction detector. The background count on the instrument is due to ambient gamma radiation.

   The circuit consists of a one-shot circuit made up of A5-C and A5-D and a count rate circuit (Q4, Q5). These circuits operate essentially the same way as the main one-shot and count rate circuits described above, except that the trigger is activated every time an output from the subtraction detector occurs. The output of the count rate circuit is applied to the integration capacitor (C6), and since it is working from -5 V it removes, or subtracts, charge. The pulse width of the trigger is adjustable by the SUBTRACTION ADJUSTMENT control (R14). Since the current is fixed by R22, the pulse width determines the quantity of charge removed from C6 for each subtraction pulse.

5. Logarithmic Converter (See Figure 6-2)

   Integrated circuit A6 is an operational amplifier with its gain controlled by the feedback element Q3A. The voltage across Q3A is proportional to the logarithm of the current through it, so the gain of A6 is proportional to the logarithm of its input current. Since the input current for A6 is proportional to the average rate of pulses from the detector, its output voltage is proportional to the logarithm of the rate of input pulses from the detector.

Q3B is the reference element for the op-amp and provides temperature compensation. CR8 speeds up turn-on time by providing a charge on C6 equal to the bias point of A7. CR6 and CR7 produce a dynamic impedance inversely proportional to current to slow the response time of the circuit at low count rates.

The output of A6 changes approximately 60 millivolts per decade of change in input pulse rate.

6. Meter driver (See Figure 6-2)

Integrated circuit A7 is a low output impedance operational amplifier. Its gain is set by the ratio of R27 to R24 + RT1. This yields approximately 0.5 V change on the output (pin 6) per decade of change in pulse rate from the detector.

ZERO control (R26) balances the op-amp for zero volts output at the count rate desired for the lower mark on the readout (M1). SPAN control (R28) sets the amount of current that will flow through M1 for a change in count rate. This allows the meter to be calibrated in count rate from the detector. A 10Ω resistor in series with the recorder provides a 10mV output signal (2.5mV per decade), referred to chassis ground.

7. Alarms

A1-D is used as the alarm comparator. (A1-A, B & C are not used in this instrument.) Pin 4 is connected to the meter circuit so that the voltage applied to the meter is also applied to the comparator. Pin 5 is connected to the emitter of Q6. This voltage is proportional to the position of the ALARM SET control (R201), which allows adjustment of the alarm set point. When the PUSH TO SET alarm switch (S202) is depressed, the alarm voltage is applied to the recorder (M1) and the alarm set point is displayed directly.

When the alarm set point is exceeded and the alarm comparator changes state the output is gated to A9. A9 and its associated circuitry comprise the alarm delay circuit. A9 is connected so that C8 is normally held discharged. When an alarm signal is present C8 is allowed to charge through R33 and R34. R33 is the ALARM DELAY control and is used to adjust the time required for C8 to charge. When the voltage on C8 rises above the trigger voltage of A9, its output goes low.

Gate A8-D inverts this signal, clocks flip-flop A3-B and turns on the alarm relay driver, which consists of Q7 and Q8. Q8 turns on, causing the alarm relay (K101) to pull in, and lights the front panel alarm lamp (DS202) and the beacon (DS206). The contacts of K101 provide a change of state to the ALARM terminals on the rear panel terminal strip.

If preferred, the high alarm lamp relay may be connected to be normally actuated and to drop out on alarm by moving a jumper on the LOGIC BOARD (See Figure 6-5). If this is changed the normally closed and normally open contact markings on the rear panel terminal strip will be reversed.

It will also be necessary to move the Beacon AC connection on the Low Voltage Power Supply Board from the NO terminal to the NC terminal.

The bulb in the front panel PUSH-TO-SET switch should be removed as it will now give a false alarm indication.

When the $\overline{Q}$ output of A3-B goes high, it activates the resettable alarm relay driver, which consists of Q11 and A12. Q12 turns on, applying 28 VDC to relay K2 which activates the bell.

Pressing the ACKNOWLEDGE button on the front panel causes a direct set of A3-B and its $\overline{Q}$ output goes low. This turns off the bell but does not affect the other alarm conditions.

8. Power Supplies

The power supplies consist of transformer T201, bridge rectifiers A101 and A102 and integrated circuit A103. Two of T201's 12 V windings are connected in series and they, along with A101, A103 and C102, form the +24 V power supply. A101 is a full-wave rectifier, C102 is used as a DC filter and A103 is a 24 V voltage regulator. R101 and DS201 (POWER) are used as an indicator circuit to show when the DC voltage is on.

One-half of T201's center-tapped winding, together with A102 and C101, form the negative DC supply. A102 is a full-wave rectifier and C101 is the DC filter.

9. Failure Alarm

The failure alarm consists of A10, Q9, Q10 and their associated circuitry.

The input of the fail alarm circuit is connected to the output of the main trigger so that all pulses from the main detector are applied to the fail alarm. One half of A10 is connected as a monostable multivibrator (one-shot). Its pulse width is set by R41 and C9. The output of the multivibrator is used to discharge capacitor C10 by turning on transistor Q9. As long as C10 is kept discharged, the output of the second half of A10 (pin 9) is high and Q10 is turned on. When Q10 is on, the counting light DS203 is on and the fail alarm relay (K1) is engaged.

If no pulses are received from the trigger, then C10 is allowed to charge. When the voltage on C10 exceeds 2/3 of the supply voltage, the output of the second half of A10 (pin 9) goes low and Q10 is turned off. This causes the counting light (DS203) to go out, the FAIL light (DS204) to turn on, and the fail alarm relay (K1) to disengage. These conditions indicate that the instrument has failed. It takes approximately 30 seconds from the time of the last pulse for the fail alarm to activate. As there are normally a few hundred counts per minute of radon activity occurring, the counting light should always be lit and K1 should always be engaged if the radon deposited on the filter paper is being counted.

If DC power fails DS203 also goes out and indicates a failure condition. Similarly, relay K1 is deactivated and shows a failed condition. Relay contact markings on the rear panel terminal strip indicate the normal condition (relay pulled in).

10. Computer Output (Optional)

Integrated circuits A13 and A14 on the logic board provide for output of detector pulses to a computer or other data acquisition device. A14 is a dual flip-flop connected to change state with each input pulse. This provides a more stable output than would be obtained from the narrow trigger pulses.

A13 is a QUAD NOR gate and 50Ω line driver. The gates are connected as inverters and provide complimentary outputs for both the main and subtraction signals.

No output connectors are provided in the standard instrument. The outputs may be taken to spare contacts on the rear panel barrier strip or a special connector installed.

11. Regulated Air Pump, Model RAP-1

Figure 3-1 shows a cross section of the regulator assembly from the RAP-1. Air flow into the controlled air inlet passes through the variable orifice, causing a pressure drop across that orifice. Each side of the orifice is vented to one side of the diaphragm, so that the diaphragm is positioned by the pressure drop across the orifice, and therefore by the flow.

Attached to the diaphragm is the bypass valve. When the pressure drop across the orifice exceeds the spring pressure on the diaphragm, the bypass valve will start opening. Air now flows into the bypass inlet and out to the pump. Thus the bypass flow is varied by the diaphragm in order to hold the controlled flow constant.

The pump therefore is moving a maximum amount of air at minimum head pressure at all times, so it runs cooler and has a longer lifetime.

Figure 3-2 shows the pump characteristic. At a given vacuum at the intake, the controlled air flow will be that value set and the excess will be through the bypass inlet. For instance, if it were set for 2 CFM and the vacuum was 5 inches of Hg, the total pump flow would be about 3.2 CFM. Of this, the controlled air flow would be 2 CFM and the excess of about 1.2 CFM would be flowing through the bypass.

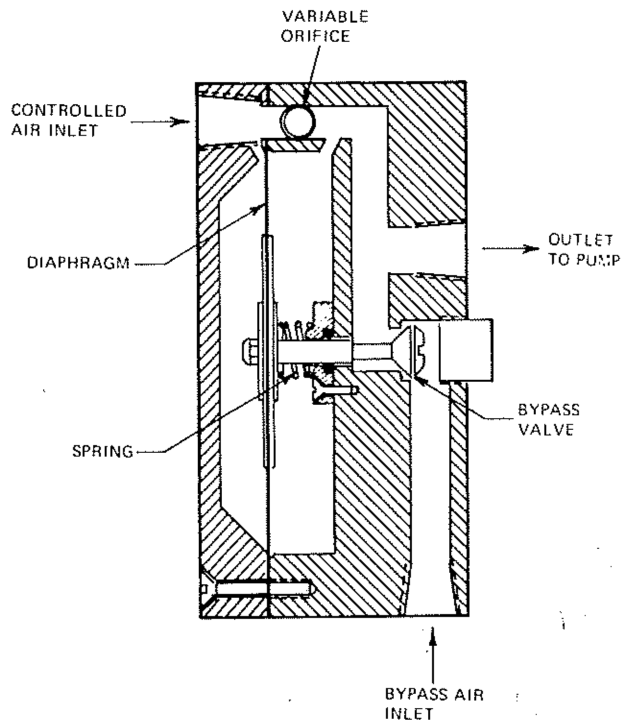


Figure 3-1. Model RAP-1, Regulator Assembly

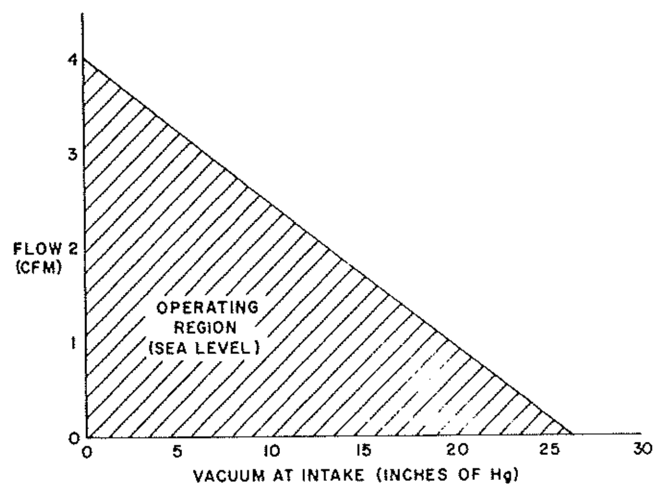


Figure 3-2. Model RAP-1, Pump Characteristics

SECTION IV
MAINTENANCE

A. PREVENTIVE MAINTENANCE

1. Environment

The instrument should not be exposed to rain, snow or extreme temperatures. Always keep the instrument as dry as possible. Should it get wet for any reason, disassemble and dry thoroughly with a hot air dryer, being careful not to get the plastics too warm.

CAUTION
DO NOT use a blower to remove the dust, since this tends to drive the dirt into inaccessible areas and could cause instrument failure.

The mechanical parts may be washed in a mild soap and water, rinsing thoroughly, and drying with clean cloths, Kleenex or hot air dryer. Again, be careful of plastics when using hot air.

2. Mechanical

Inspect the instrument for metal filings and loose or broken wires. Be particularly careful to inspect all electrical connectors. Should any connector show evidence of dirt which does not readily come off, clean the connector with a brush and alcohol. DO NOT use any other type of solvent as it may cause deterioration of the connector insert or the surface surrounding the connector.

Before reassembly, be sure to check the printed circuit assembly for loose connections, burned and/or damaged components. Use a low wattage soldering iron when making repairs to the PC assembly.

B. DISASSEMBLY

1. Power

Remove the AC power by removing the AC power cable from the instrument.

2. Instrument Cover

a. Remove power (see above).
b. Remove four screws from the side panels of the instrument.
c. Remove the protective cap from the air intake on top of the instrument.
d. Slightly spread the cover and lift it from the instrument. Use caution not to break the alarm bell and beacon wires.
e. Disconnect the alarm bell and beacon connectors and set the cover aside.

3. Geiger Tube Access

a. Remove the top cover.
b. Remove the four screws from the rear of the shield assembly.
c. Remove the rear shield plug and the filter holder. (See Figure 2-2)
d. Unscrew and remove the air intake and outlet stacks (top and side of shield).
e. Carefully slide the detector assembly out the rear of the shield.
f. Remove the detector connector.
g. Place the detector assembly face down on the recorder case.
h. Remove the two flat head screws holding the rear plate. The detectors may now be removed.

CAUTION
The G-M tube windows are very thin and can be broken easily.

i. When replacing the detectors, be sure the aluminum disk is between the tubes.
j. When replacing the detector assembly in the shield, make sure the cables and connector are in the shield slot.

C. CALIBRATION

NOTE
There may be a slight difference between the meter scale and the printed trace on the chart paper. The following checkout procedure may be used to calibrate either the meter scale or recorder chart as the primary readout.

1. Readout

a. Connect a short jumper from the base of transistor Q301 on the HV-Trigger Board to +5V. Momentarily short the 900 V VR tube, V301. This disables the high voltage supply so that background counts from the G-M tubes will not affect calibration.
b. Connect a pulse generator to the MAIN SIGNAL connector on the rear panel. The generator must produce a negative pulse of 1 to 50 microseconds pulse width and 600mV or more amplitude. (The Eberline MP-1 Mini-Pulser works well.)
c. Set the pulse generator frequency to 100K counts per minute (CPM).
d. Connect an oscilloscope to the output of A5-B. Adjust the pulse width, using the front panel PULSE WIDTH control, for 10 microseconds.

e. Set the pulse generator for 20 CPM. Adjust the ZERO control so the readout indicates 20 CPM. (The readout will take several minutes to stabilize.)
f. Set the pulse generator for 100K CPM. Adjust the SPAN control so the readout indicates 100K CPM (full scale).
g. Repeat steps e and f until no further adjustment is necessary.

2. Subtraction Calibration
   a. Connect a pulse generator as in step 1.b. above.
   b. Connect a second pulse generator to the SUBTRACTION SIGNAL connector on the rear panel. Adjust the generator output as in step 1.b. above.
   c. Turn the BACKGROUND SUBTRACTION switch OFF.
   d. Set the MAIN pulse generator to 100K CPM. The readout should indicate 100K CPM.
   e. Set the SUBTRACTION pulse generator to 80K CPM. The reading should not change.
   f. Turn the BACKGROUND SUBTRACTION switch ON. Adjust the SUBTRACTION ADJUSTMENT control for a readout indication of 20K CPM.
   g. Remove the jumper from the HV supply.

NOTE

The above procedure adjusts the subtraction circuitry to, nominally, remove all indications due to gamma background. Therefore, with a clean filter in place and no air flow, the readout should peg downscale. However, due to differences in counting efficiency and position of the two G-M tubes, the subtraction may be slightly high or low. The final adjustments should be made on background at the place of use. Adjustments should be made only with a clean filter in place and no air flow to prevent radon daughter background from confusing the final setting.

3. Alarm Delay
   a. With either a pulse generator or beta source produce a meter reading above 100 CPM.
   b. Turn the ALARM SET control fully counterclockwise rapidly and time the delay until the alarm occurs. (See Figure 2-3)
   c. Adjust the delay as desired, using the control at the top center of the LOGIC BOARD, to prevent transient conditions from causing a false alarm.

4. Vacuum Relief Valve

   The vacuum relief valve, located just behind the front panel flowmeter, is installed to help prevent damage to the G-M tube face if the air inlet is accidentally blocked. It is normally adjusted to limit the system pressure drop to 7 inches of mercury measured at the rear panel air outlet (vacuum connection).

   At flow rates above 2 CFM (60 lpm) it may be necessary to close off the relief valve to prevent leakage. If this is done, the detector tube will be quite vulnerable to air inlet blockage but, barring accidents, the system will still work properly.

5. RAP-1 Pump Vane Replacement
   a. Vane Replacement: The four vanes can be replaced simply by removing the end plate shroud and exchanging new for worn or broken vanes.

      Use compressed air to clean out the pump chamber especially if the vane has broken. Do this prior to inserting new vanes.

      Sometimes when a vane breaks, a piece will wedge between the top of the rotor and the body, opening the top clearance. The top clearance should be .002 inches. This can be checked with a feeler gauge. The rotor should be turned while checking this clearance so that all points on the circumference of the rotor will clear. To reduce the top clearance to .002 inches, tap LIGHTLY on the top of the body with a miniature hammer.

      DO NOT at any time remove the rotor. DO NOT loosen bolts on either the body or mounting bracket as this will destroy the preset clearance between the rotor and these parts.
   b. Cleaning: If the pump is permitted to run with a dirty filter or no filter at all, excessive dirt, foreign particles, moisture and possibly even oil (from vapors in surrounding air) could accumulate in the chamber. Any of these could cause the vanes to act sluggish or even break.

      Flushing the pump should take care of these situations, but if not, remove the end plate for further examination.
   c. FLUSHING is accomplished by removing the filter assemblies and adding several teaspoons full of alcohol (away from open flame) at the intake while the pump is running. Repeat the flushing procedure again and after all the solvent has passed through the pump, replace the filters. FLUSH the pump several times a year.

      To clean filter and muffler felts, brush off excess dirt, lint, etc. Wash in cleaning solvent and dry before again installing.

SECTION V
PARTS LIST

REF. DESIG.	PART	DESCRIPTION	MFR. AND PART NO.
1. CHASSIS			
DS201, DS204	Diode	Light Emitting, Red (POWER, FAIL)	HP-5082-4655
DS202	Lamp	#387	
DS203	Diode	Light Emitting, Green (COUNTING)	HP-5082-4955
DS205		Bell	Edward 340
DS206		Beacon, 115 VAC	Federal Model 121-S
F201	Fuse	1/2 ASB, 250 V, 3 AG	Littelfuse 313.500
FL201		RFI Filter and AC Connector	Corcom 6J4
J201, J202	Connector	Chassis Mount, BNC	UG-1094/U
M1	Recorder	0-1 mA, 117 VAC, 60 HZ Motor, 4 decade log scale	Simpson Model 2750 Catalog #22005
R201	Potentiometer	2.5k linear, type RV6 NAYSA 252A (ALARM SET)	CTS Series #300 or equivalent
R202	Resistor	10.0Ω ±1%, 1/4 W or 1/8 W	Type RN55 or equivalent
R203, R204	Resistor	10M, 1/4 W, 10%	
S201, S204	Switch	Toggle, 2-position (POWER), (BACKGROUND SUBTRACTION)	Alco MTA-106D
XD202, S202	Switch	Alarm Light and Switch Combination, Red	Dialco 922-1526-1571-525
S203	Switch	Pushbutton (ACKNOWLEDGE)	Microswitch 1PB5
T201	Transformer		Zenith WE3327
		Power Cord	Belden 17250
	Flowmeter	10-100 LPM	F.W. Dwyer VFA-27B
	Valve	Vacuum Relief Valve	Eberline 10538-A31

REF. DESIG.	PART	DESCRIPTION	MFR. AND PART NO.
1. CHASSIS, continued			
	Detector	G-M Tube	Eberline 10450-B15
		Detector Cable Assembly	Eberline 10846-B67
2. LOGIC BOARD			
A1	Integrated Circuit	Quad Comparator	LM339
A3	Integrated Circuit	Dual JK Flip-Flop	Fairchild 9L24 or 74LS109
A4	Integrated Circuit	Quad, 2-input NOR gate	74LS02
A5	Integrated Circuit	Quad, 2-input NOR gate	Motorola MC717P or MC817P
A6, A7	Integrated Circuit	Operational Amplifier	RCA CA 3140T
A8	Integrated Circuit	Quad, 2-input NAND gate, Open Collector	74LS03
A9	Integrated Circuit	Timer	NE555
A10	Integrated Circuit	Dual Timer	NE556
A11	Integrated Circuit	5 V Regulator, T0-220 package	Motorola MC7805CT or equivalent
A12	Integrated Circuit	-5 V Regulator	Fairchild μA79M05HM or equivalent
C4	Capacitor	0.0047 μF, ±10%, 80 V	Sprague 192P4729R8
C5	Capacitor	0.022 μF, ±10%, 80 V	Sprague 192P2239R8
C6	Capacitor	5.0 μF, ±10%, 100 V	Capco EBL-4
C7	Capacitor	2.2μF, ±10%, 20 V, Tantalum	CS13B, Case A
C8, C10	Capacitor	68μF, ±10%, 20 V, Tantalum	CS13B, Case D
C9, C11, C13 C15	Capacitor	1.0μF, ±10%, 35 V, Tantalum	CS13B, Case A
C12	Capacitor	330μF, ±10%, 6 V, Tantalum	CS13B, Case D
C14	Capacitor	6,8μF, ±10%, 6 V, Tantalum	CS13B, Case A
C16	Capacitor	0.1μF, 12 V	Sprague HY-360
CR4	Diode	Dual Junction	Motorola MZ2361
CR5, CR10, CR11	Diode	Silicon, Switching	1N4148

REF. DESIG.	PART	DESCRIPTION	MFR. AND PART NO.
2. LOGIC BOARD, continued			
CR6, CR7, CR8	Diode	Low Leakage, Silicon	Fairchild FDH 300
CR9	Diode	Germanium	1N34A
K1, K2	Relay	24 VDC Coil	P&B KHU17D11
Q1, Q5, Q6, Q7, Q9, Q11, Q13	Transistor	NPN, Silicon	2N4124
Q2, Q4	Transistor	PNP, Silicon	2N4126
Q3	Transistor	Dual	Precision Monolithics MAT-01
Q8, Q12	Transistor	PNP, Silicon	2N4403
Q10	Transistor	NPN, Silicon	2N4001
RT1	Sensistor	10KΩ, 5 or 10% @ 25°C	TI TM-1/8 or TG-1/8
R4, R5, R6, R17, R31, R32, R37, R50, R51, R54	Resistor	4.7K, ±5%, 1/4 W	Carbon Comp.
R8, R11, R12, R29, R35, R36, R42, R55, R56	Resistor	1K, ±5%, 1/4 W	Carbon Comp.
R13, R14	Potentiometer	20K Ω	Bourns 3005P-1-203 or equivalent
R15, R16, R21 R40, R49, R53, R58	Resistor	10K, ±5%, 1/4 W	Carbon Comp.
R18, R19	Resistor	3.9K, ±5%, 1/4 W	Carbon Comp.
R20	Resistor	5.1K, ±5%, 1/4 W	Carbon Comp.
R22	Resistor	180K, ±5%, 1/4 W	Carbon Comp.
R23	Resistor	68K, ±5%, 1/4 W	Carbon Comp.
R24	Resistor	39K, ±5%, 1/4 W	Carbon Comp.
R25	Resistor	100K, ±5%, 1/4 W	Carbon Comp.
R26	Potentiometer	10K Ω	Bourns 3005P-1-103 or equivalent
R27	Resistor	390K, ±5%, 1/4 W	Carbon Comp.

REF. DESIG.	PART	DESCRIPTION	MFR. AND PART NO.
2. LOGIC BOARD, continued			
R28	Potentiometer	2k Ω	Bourns 3005P-1-202 or equivalent
R30	Resistor	3.3K, ±5%, 1/4 W	Carbon Comp.
R33	Potentiometer	500K Ω	Bourns 3006P-1-504 or equivalent
R34, R39, R52	Resistor	12K, ±5%, 1/4 W	Carbon Comp.
R38, R47, R59	Resistor	20K, ±5%, 1/4 W	Carbon Comp.
R41	Resistor	22K, ±5%, 1/4 W	Carbon Comp.
R43	Resistor	510K, ±5%, 1/4 W	Carbon Comp.
R44	Resistor	2K, ±5%, 1/4 W	Carbon Comp.
R45	Resistor	330, ±5%, 1/4 W	Carbon Comp.
R46	Resistor	220, ±5%, 1/4 W	Carbon Comp.
R48	Resistor	50 or 56 Ω, 5 W wire wound	TRW (IRC) Type PW-5 or equivalent
R57	Resistor	22M, ±5%, 1/4 W	Carbon Comp.
3. HIGH VOLTAGE AND TRIGGER BOARD			
A301	Integrated Circuit	Quad Comparator	LM339
C301	Capacitor	Tantalum, 330μF, ±20%, 6 V	CS13B, Case D
C302	Capacitor	0.047μF, ±20%, 50 V	GE 75F1R5A473
C303	Capacitor	3.3μF, ±20%, 15 V, Tantalum	CS13B, Case A
C304, C305	Capacitor	0.01μF, 3K V, Disc Ceramic	Sprague 30G-S10 or equivalent
C306, C307, C310, C311	Capacitor	0.001μF, 3k V, Disc Ceramic	Sprague DD30-102 or equivalent
C308, C309	Capacitor	1.0μF, ±20%, 35 V, Tantalum	CS13B, Case A
C312, C313	Capacitor	150pF, 1K V, Disc Ceramic	Centralab DD-151 or equivalent
CR301	Diode	2500 PIV	Varo VA-25 or equivalent
CR302, 303	Diode	Switching	1N4148
Q301	Transistor	PNP, Silicon	2N3638 or National PN3638
Q302, Q303	Transistor	PNP, Silicon	2N4126
R301	Resistor	270 ±10%, 1/4 W	

REF. DESIG.	PART	DESCRIPTION	MFR. AND PART NO.
3. HIGH VOLTAGE AND TRIGGER BOARD, continued			
R302	Resistor	7.5K ±5%, 1/4 W	
R303	Resistor	10M ±10%, 1/2 W	
R304	Resistor	100K ±5%, 1/4 W	
R305, R306	Resistor	1M ±10%, 1/4 W	
R307, R314	Resistor	1K ±10%, 1/4 W	
R308, R315	Resistor	20K ±5%, 1/4 W	
R309, R316	Resistor	15K ±5%, 1/4 W	
R310, R317	Resistor	1.5k ±5%, 1/4 W	
R311, R318	Resistor	3K ±5%, 1/4 W	
R312, R319	Resistor	51K ±5%, 1/4 W	
R313, R320	Resistor	4.7K ±5%, 1/4 W	
T301	Transformer	Blocking Oscillator, PC Mount	Microtran M8149
V301		Corona Regulator, 900 V	Victoreen 5841 or equivalent
4. LOW VOLTAGE POWER SUPPLY			
A101, A102	Bridge Rectifier		Varo VS447
A103	Voltage Regulator	24 V	Motorola MC7824CT
C101	Capacitor	250μF, 25 V	Sprague TVA-1208
C102	Capacitor	500μF, 50 V	Sprague TVA-1315
C103	Capacitor	0.01μF, 200 V	Sprague 192P10392
CR101	Diode		1N4148
K101	Relay	24 VDC Coil	P&B KHU17D11
R104	Resistor	4.7K, 1/4 W, 10%	Carbon Comp.

SECTION VI
DIAGRAMS

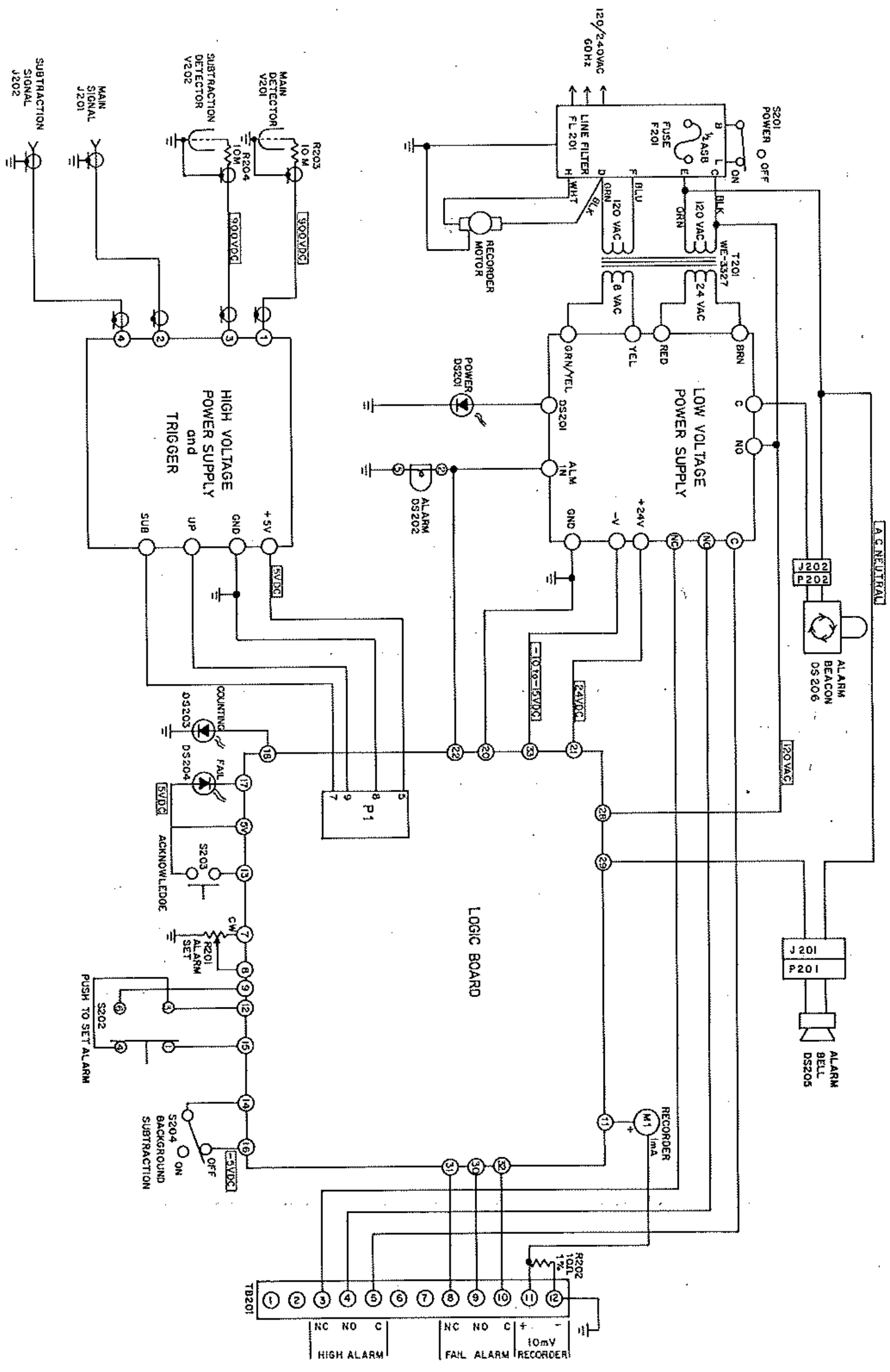


Figure 6-1. Chassis Schematic

NOTES:
1. CAPACITOR VALUES ARE IN MICROFARADS UNLESS NOTED.
2. K1 IS SHOWN IN THE FAIL POSITION.
3. K2 IS SHOWN IN THE NOT ALARMED POSITION.
4. J1 IS A 16 PIN I.C. SOCKET.

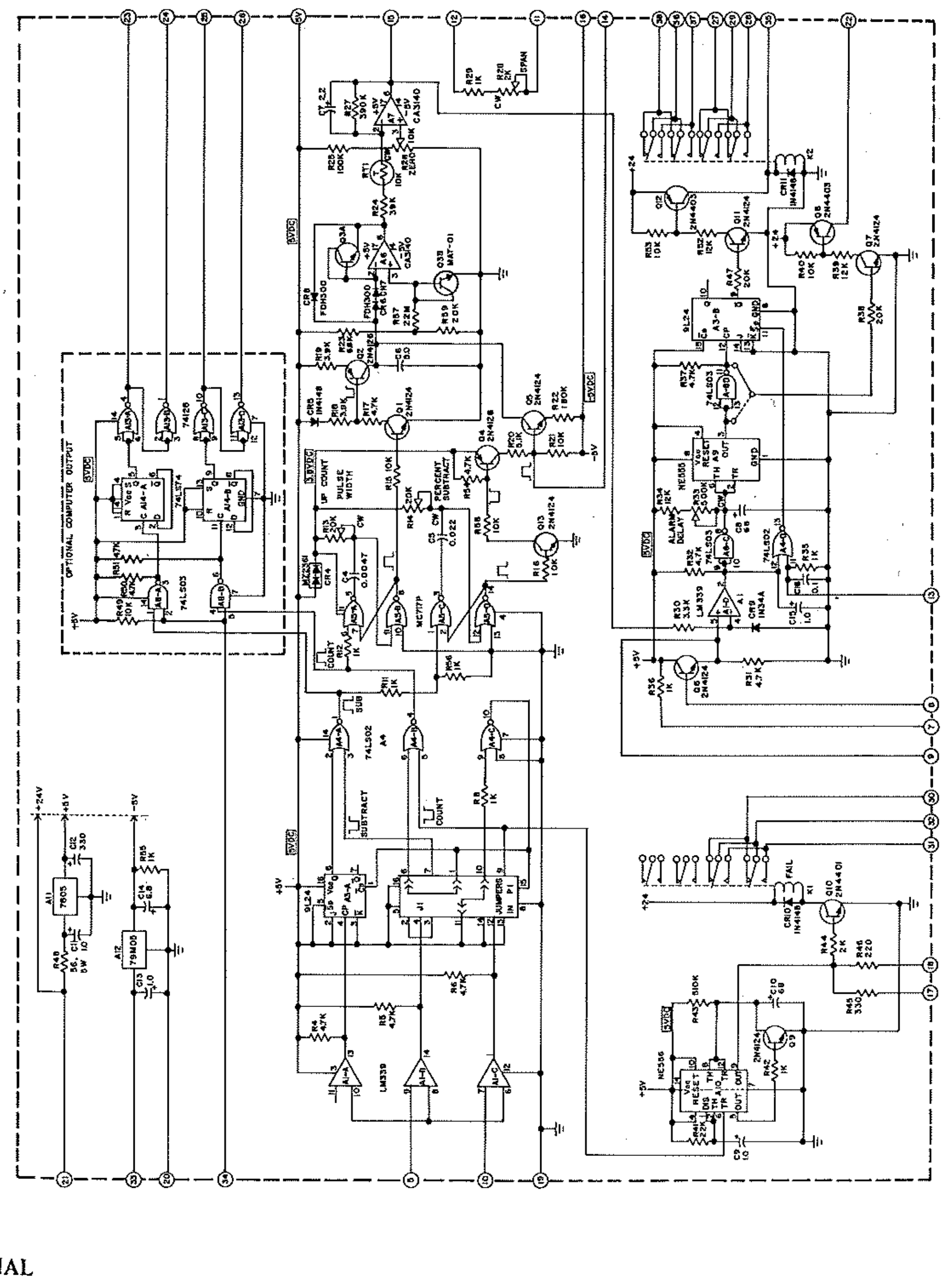
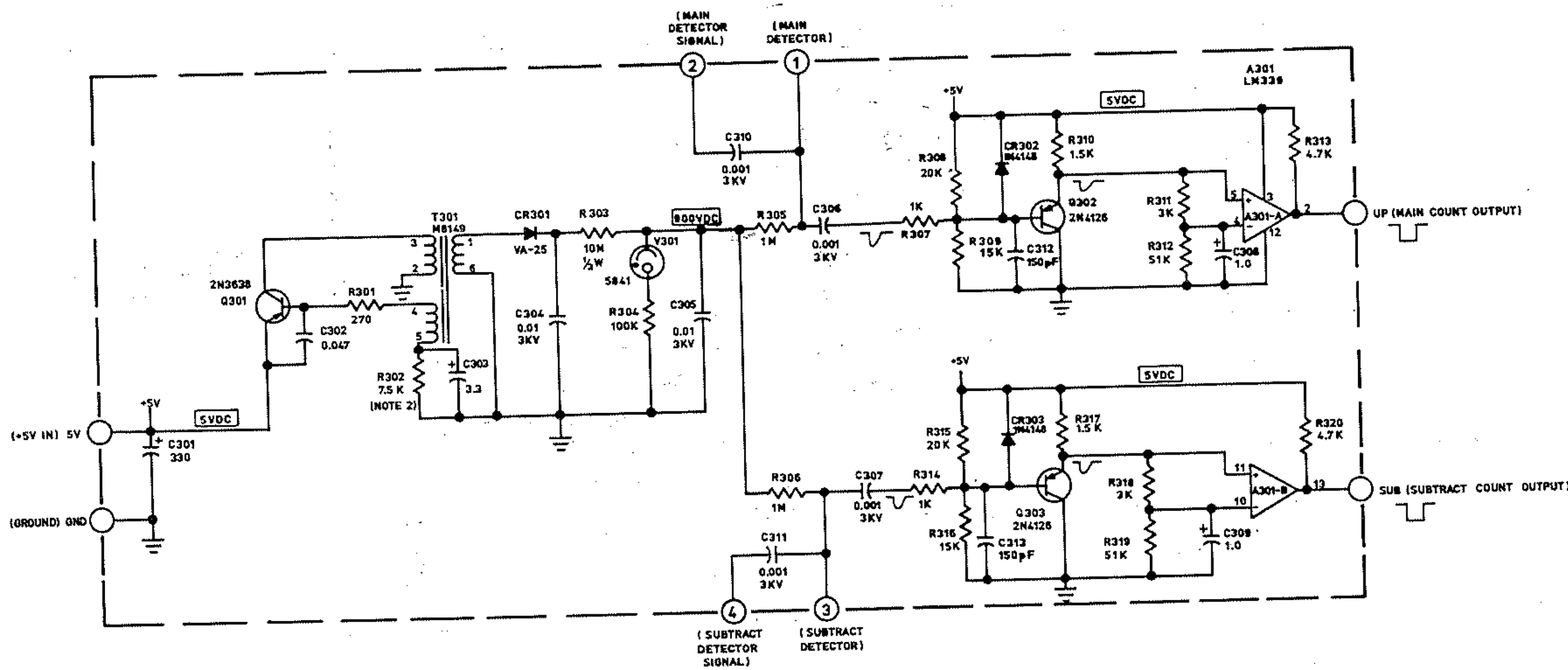


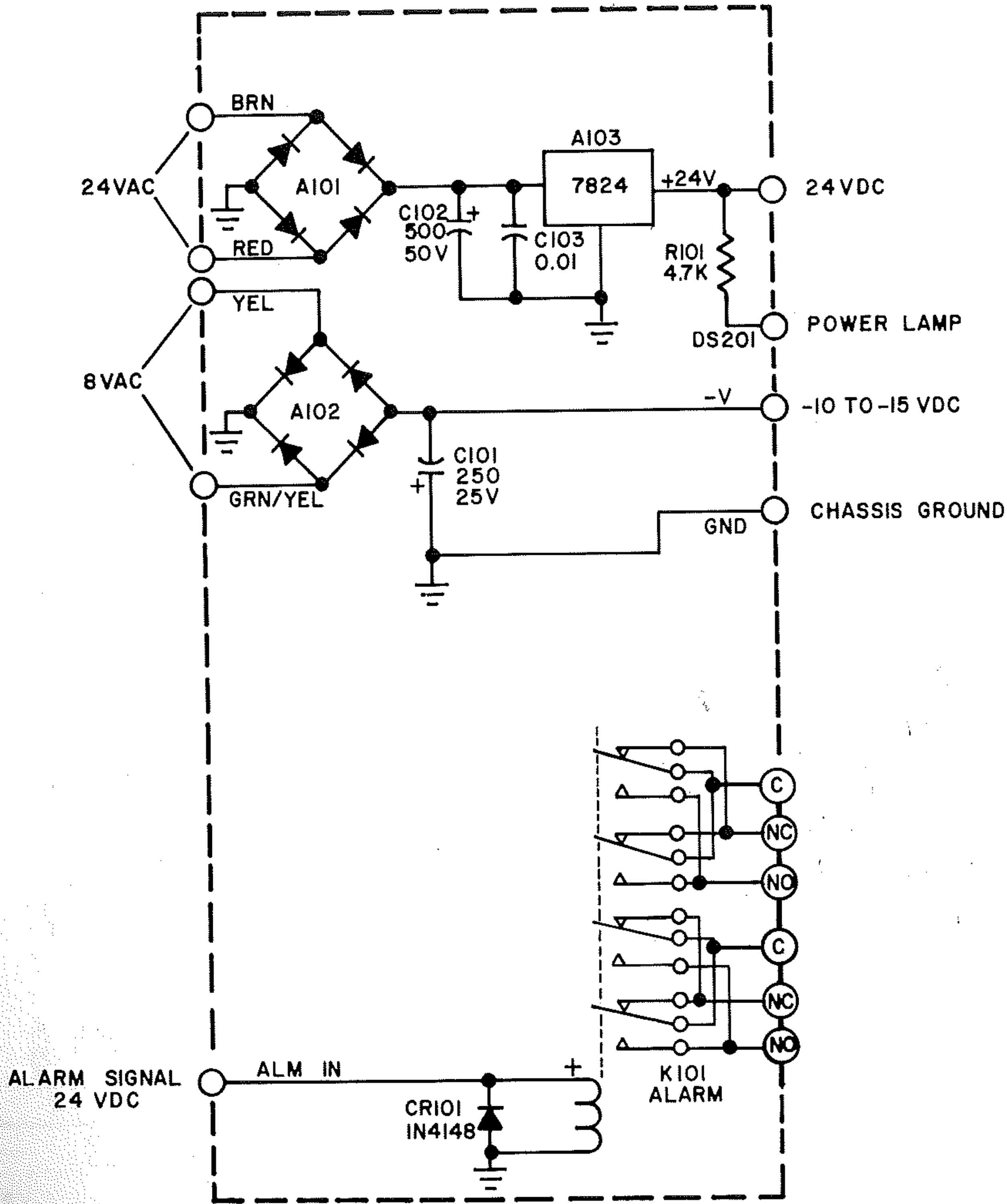
Figure 6-2. Logic Board Schematic



NOTES:

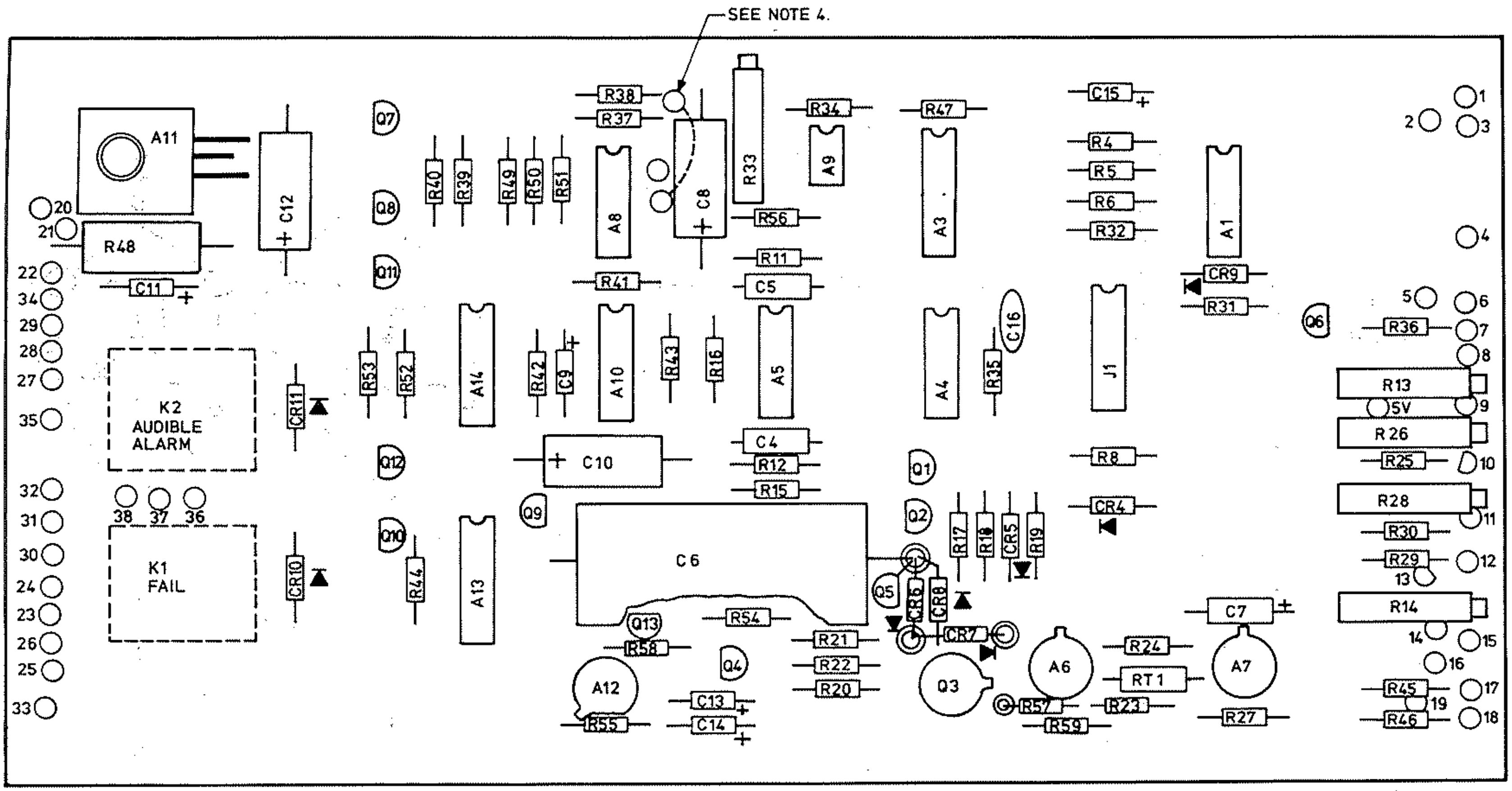
1. ALL RESISTORS ARE ¼ WATT EXCEPT AS NOTED.
2. NOMINAL VALUE. R302 MAY BE SELECTED TO IMPROVE OPERATION.
3. CAPACITANCE VALUES ARE IN MICROFARADS.
4. [XXX] INDICATES A VOLTAGE LEVEL. LOW VOLTAGE ARE MEASURED WITH 10 MEGOHM VOLTMETER. THE 900 VOLT POINT MUST BE MEASURED WITH 1000 MEGOHM OR GREATER INPUT IMPEDANCE METER.

Figure 6-3. HV-Trigger Board Schematic



NOTES:
1. CAPACITOR VALUES ARE IN MICROFARADS.
2. K101 IS SHOWN IN THE UNALARMED CONDITION.

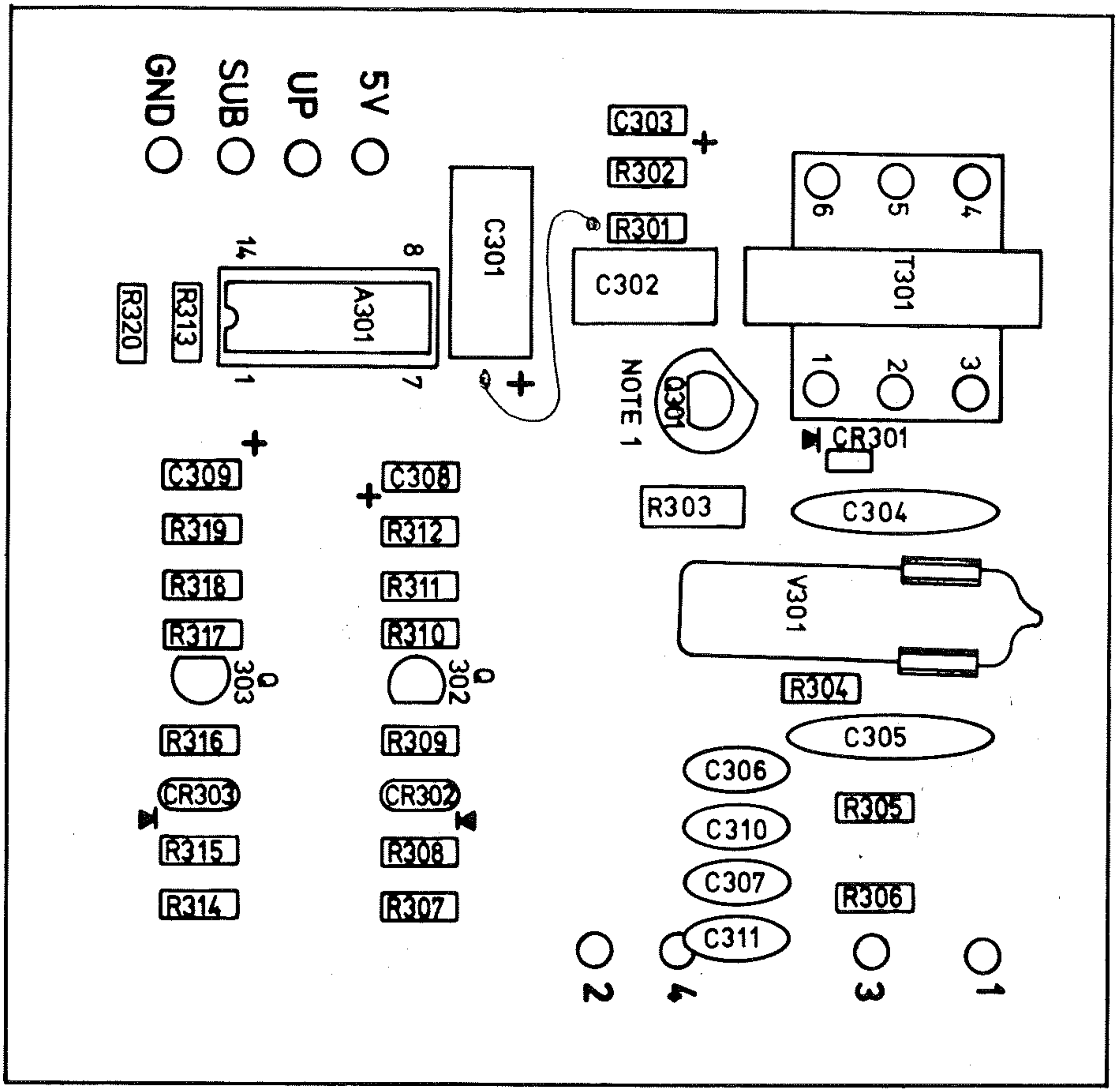
Figure 6-4. LV-Power Supply Board Schematic



NOTES:

1. K1 AND K2 ARE IN SOCKETS ON THE REVERSE SIDE ON THE BOARD.
2. NUMBERED TERMINALS ARE SCHEMATIC REFERENCED WIRE CONNECTIONS.
3. A13 AND A14 ARE USED FOR THE OPTIONAL COMPUTER OUTPUT.
4. THE JUMPER SHOWN (DOTTED LINE) PROVIDES FOR THE ALARM RELAYS TO PULL IN ON ALARM. FOR DROP OUT ON ALARM (FAIL SAFE) JUMPER THE UPPER TWO TERMINALS SHOWN.

Figure 6-5. Component Layout, Logic Board



NOTES:

1. Q301 IS AVAILABLE IN TWO CASE STYLES. BOTH ARE SHOWN.

Figure 6-6. Component Layout, HV-Trigger Board

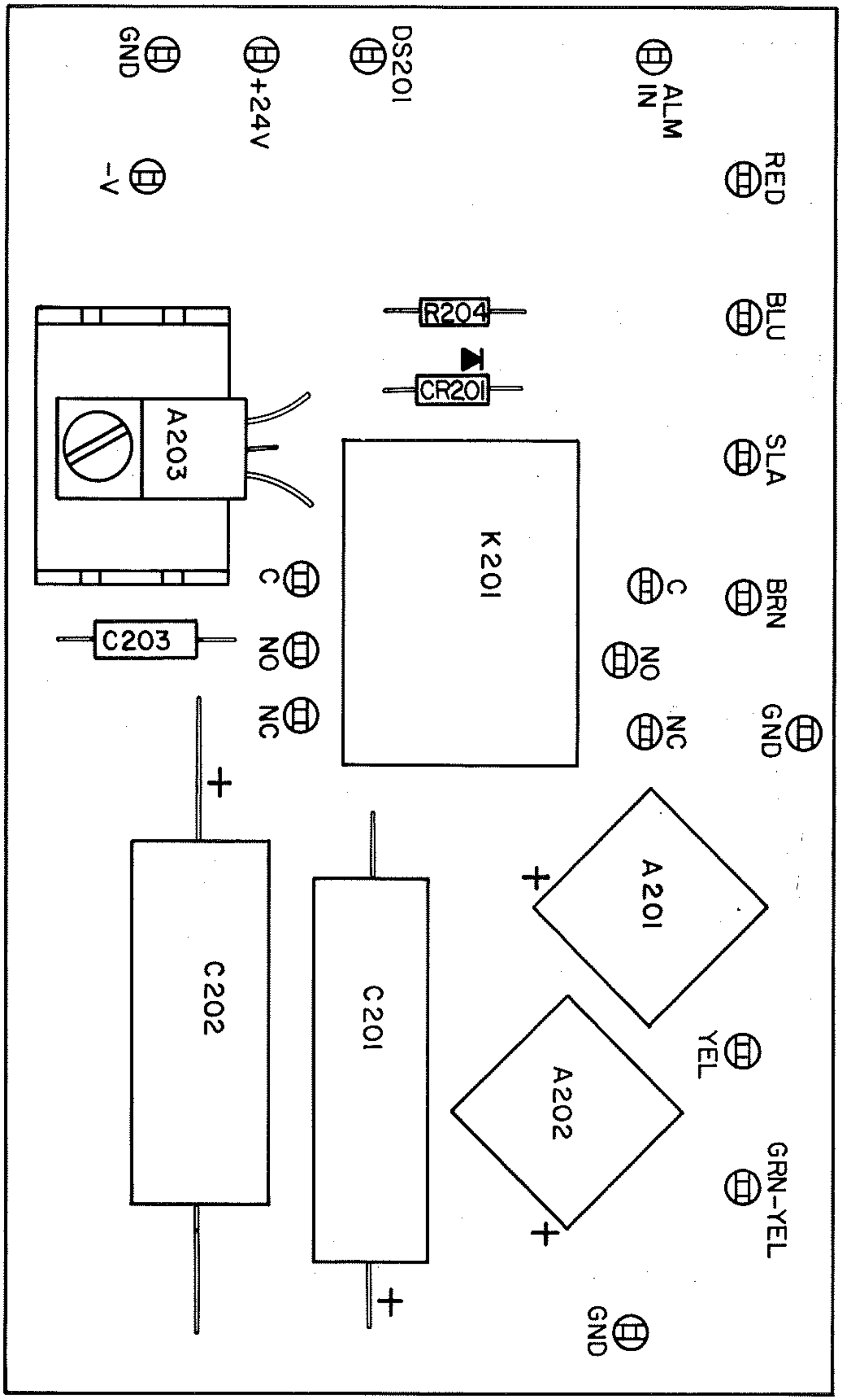


Figure 6-7. Component Layout, LV-Power Supply Board