LUDLUM MODEL 192

SURVEY METER

May 2000
Serial No. 136329 and Succeeding
Serial Numbers

LUDLUM MEASUREMENTS, INC.
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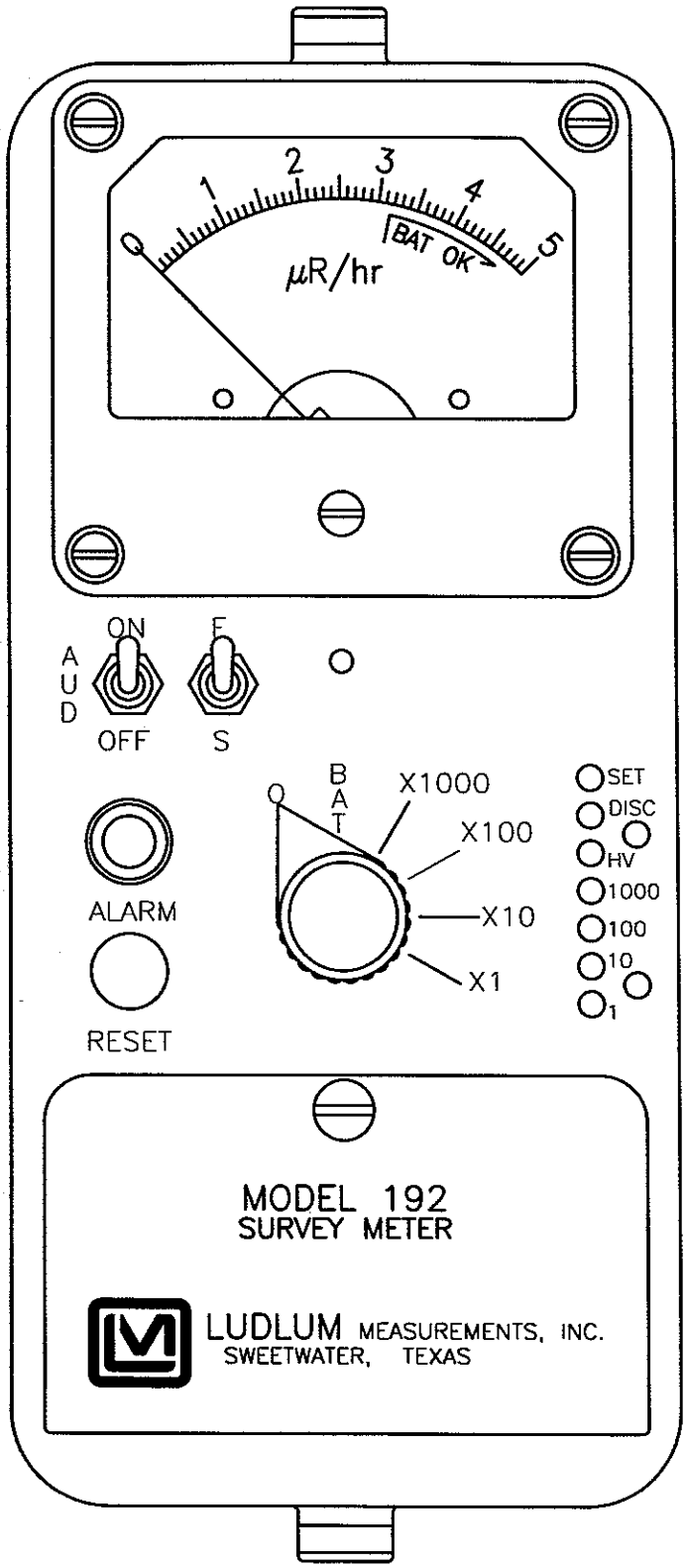
REV #	ALTERATIONS	DATE	BY
	VALID	07-07-97	TJR



DWN	DATE	CHECKED	APPROVED
TJR	07-07-97	BLH 7-7-97	JGW 7-7-97

TITLE: M 192 FRONT PANEL DRAWING

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

SERIES	SHEET
363	770

1. GENERAL

The Model 192 Survey Meter is a portable gamma survey instrument with an adjustable audible and visual alarm. The Model 192 utilizes an internally mounted 2-inch x 1-inch sodium iodide [NaI(Tl)] scintillator which offers optimum performance in counting low level gamma radiation. Range multipliers of X1, X10, X100 and X1000 provide an operating range from 0-5000 microroentgens per hour (μR/hr) (0-50μSv/hr) used in conjunction with the 0-5 μR/hr (0-0.05μSv/hr) meter dial.

The Model 192 offers two types of alarms:

(1) a user-adjustable, meter-driven alarm. For example, an alarm point can be set at 25 μR/hr (0.25μSv/hr), activating a steady tone and alarm light.

(2) A deviation beep alarm which "beeps" and flashes the alarm light when the radiation level rises above background. The background level is determined by an 8-second interval following power-up or following a reset. During these 8 seconds, beeps from the speaker and flashes of the ALARM lamp will occur every ½-second. After the background update period, the instrument is ready to survey.

This instrument is the choice for rapid surveys of very low level radiation. The deviation beep alarm allows inexperienced users to easily use the Model 192. The user does not have to watch the meter closely to find "hot" items. When exposed to predominantly low-energy gamma radiation, the NaI(Tl) scintillator will overrespond. Readings can be corrected by referring to energy-independent instruments such as ion chambers.

CAUTION

The instrument will respond to radiation from X-ray machines and pulsed radiation sources, but non-linearity may occur due to the integration time of the M192.

Other features include a 2-position meter response time selection; adjustable detector operating voltage (HV) from 200-1500 volts; and an alarm audible tone with "AUD ON/OFF" switch.

The instrument is capable of using either standard "D" cell alkaline or the nickel cadmium rechargeable batteries. However, the Model 192 does not include circuitry for recharging batteries; thus, the rechargeable batteries must be removed for recharging. A battery test scale is provided to check the status of the batteries when the range selector switch is moved from "OFF" to "BAT" position.

All controls and adjustments are located on the front panel. The calibration controls are covered to prevent any inadvertent adjustment to the detector operating parameters. The two "D" cell batteries are located in an isolated compartment and are easily accessible from the front panel. The meter is housed in a rugged, aluminum bezel with a gasket seal.

2. SUGGESTED OPERATING PROCEDURES

2.1 Battery Installation

☐ Ensure the Model 192 power switch is in the "OFF" position. Open the battery lid by turning the quarter-turn thumb screw counterclockwise. Install two "D" size batteries in the compartment. Note the (+) and (-) marks inside the battery door. Match the battery polarity to these marks. Close the battery box lid.

✔ NOTE

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

2.2 Power-On and Instrument Check

☐ Check that both toggle switches are up, pointing to AUD "ON," and "F." (See note below.)

✔ NOTE

Operation with toggle switches in AUD "OFF" and Slow ("S") positions is not recommended for surveys. These positions should be used for specific measurements in a radiation field or "hot" spot.

☐ Rotate the Range selector switch to the "BAT" position. The meter pointer should deflect above the vertical mark in the "BAT OK" region.

☐ The M192 will establish the background level during the 8 seconds after power-up. To signify that the instrument is not yet ready to survey, the Model 192 will beep and flash the ALARM lamp every half-second during the 8-second period. When the half-second beeps are finished, the instrument is ready to survey.

✔ NOTE

It is important when turning power on, or when pressing "RESET," to be in an area of normal background radiation. This will ensure the highest sensitivity of the beep deviation alarm toward small increases in background.

☐ Select the X10 range position. If no radiation source is nearby, any meter deflection is due to background radiation. (At the LMI factory, a typical reading is 6 - 12 μR/hr (0.06-0.12μSv/hr.))

☐ Expose the detector end (identified by indentations in sides and end of instrument can) to a check source and confirm meter response. "Beeps" should be audible with increasing frequency as the meter deflects upscale. Position check source where the meter pointer deflects above the alarm threshold and ensure that the ALARM lamp and a constant audible tone are initiated. Remove check source.

✔ NOTE

To produce consistent check source readings between functional checks, be sure to place the source on the can in the same orientation for each test.

2.3 Surveying for Radiation

2.3.1 Background

When surveying for radiation, frequent mention is made of "background radiation," or just "background." Many people do not realize that radiation is everywhere and so is just considered as "background." This background radiation is due to natural materials that emit radiation and to cosmic radiation. The amount of background radiation will vary, depending upon geographical location, environmental factors, and other conditions. The important thing to remember while surveying is that we are looking for **excess** radiation above "background."

2.3.2 Surveying Technique

☐ Follow the procedure under section 2.2 for power-up and instrument check to verify that the instrument is working correctly.

☐ To survey people or items, hold the instrument such that the front end of the instrument (meter end) is within 1-6 inches of the surface of the object/person. Move the instrument slowly over the surface of the object/person, while listening for **multiple** beeps. Occasionally, background will cause the instrument to beep, which indicates that the instrument is OK. But **multiple** beeps indicate an increase in the radiation level and possibly the presence of radioactive material.

☐ Note that with the range switch in the "X1" position, 5 μR/hr (0.05μSv/hr) is the maximum measurable value. In the "X10" position, 50 μR/hr (0.5μSv/hr) is the maximum. For the "X100" and "X1000" positions, the maximum values indicated on the meter are 500 μR/hr (5μSv/hr) and 5000 μR/hr (50μSv/hr), respectively. The value of 5000 μR/hr (50μSv/hr) is equal to 5 mR/hr and represents the largest exposure rate that can be read by the Model 192 Survey Meter. By comparison, current United States Nuclear Regulatory Commission (USNRC) guidelines set a non-occupational limit of 100 mrem/year, with no more than 2 mrem in any one hour. For gamma radiation only, this limit corresponds to about 100 mR/year (1mSv/year), with no more than 2 mR (0.02mSv) in any one hour. Using this dose as an example, if the Model 192 meter reads "5" while in the "X1000" range, a non-radiation worker can spend no more than 24 minutes in that radiation field.

2.3.3 False Alarms

Two situations come up frequently that may cause some concern. The first involves alarms caused by people who have just had some kind of nuclear medicine treatment. These treatments will include a radioactive substance being ingested or injected into the patient. While short-lived, this radiation will be measurable for days after the treatment.

The second situation involves materials which are naturally "hot" or radioactive. These materials, usually minerals dug from the ground, contain trace amounts of radioactive elements, distributed uniformly throughout the load.

Either situation may cause an alarm to be actuated or a reading above background levels; however, if a careful contamination survey reveals no "hot spots," one of these situations could exist.

In any case, take suitable precautions against unnecessary exposure to radiation by utilizing time, distance, and shielding factors.

3. SPECIFICATIONS

- **POWER**: two standard "D" size batteries

- **BATTERY LIFE**: exceeds 600 hours with a fresh set of alkaline "D" cell batteries

- **BATTERY DEPENDENCE**: calibration variance less than 3% to battery endpoint

- **OPERATING TEMPERATURE**: -20 to 140°F (-29 to 60°C)

- **OPERATING RANGE**: 4 linear range multipliers of X1, X10, X100 and X1000; meter scale presentation of 0-5 μR/h (0-0.05μSv/hr) provides an overall range of 0-5000 μR/h (0-50μSv/hr)

- **LINEARITY**: within ±10% of true value

- **RESPONSE**: two selections - Fast ("F") and Slow ("S"), approximately 4 and 22 seconds, respectively, for deflection of 10-90% of full meter scale.

- **INPUT SENSITIVITY**: adjustable from 10-30 mV; typically set at 30 mV

- **HIGH VOLTAGE**: externally adjustable from 200 to 1500 volts

- **ALARM**: adjustable from 10% of full meter scale to greater than full meter scale; audible and visual indication

- **AUDIO**: audible click-per-deviation; beeps for every 1/8 second interval that is 2 sigma above background levels, enabled/disabled by "AUD ON/OFF" toggle switch; corresponds to alarm lamp initiation

- **METER**: 1mA, 2 1/2-inch scale, with pivot-and-jewel suspension

- **SIZE**: 8.5" (21.6cm) H X 3.5in (8.9cm)W X 8.5in (21.6cm)L, including handle

- **WEIGHT**: 5 lbs (2.27kg), including batteries

- **FINISH**: drawn-and-cast aluminum, with computer-beige polyurethane enamel and silk-screened nomenclature

4. PRELIMINARY INSTRUCTIONS

4.1 Unpacking and Repacking

- Remove calibration certificate and place in secure location. Remove instrument and accessories (batteries, etc.) and ensure that all of the items listed on the packing list are in the carton.

- To return the instrument for repair or calibration, provide sufficient packing material to prevent damage during shipment. Provide appropriate warning labels to ensure careful handling. Include brief information as to the reason for return and the return shipping instructions, such as:
  - return shipping address
  - customer name or contact
  - telephone number
  - description of service requested and all other necessary information

5. DESCRIPTION OF CONTROLS AND FUNCTIONS

• **Range Multiplier Selector Switch**: A 6-position rotary switch marked "OFF, "BAT, X1000, X100, X10, and X1." The "BAT" position indicates the battery status. The meter pointer should deflect above the vertical mark on the "BAT OK" scale. The X1, X10, X100, and X1000 range multipliers are used in conjunction with the μR/hr meter dial. Multiply the scale reading by the multiplier for determining the actual reading.

• **AUD ON-OFF Toggle Switch**: In the "ON" position, the switch energizes the unimorph speaker, located on the left side of the instrument.

> **✔NOTE**
> The audible fixed ALARM is independent of the "AUD ON/OFF" switch. The audible alarm can only be silenced by depressing the "RESET" button.

• **F-S Toggle Switch**: To position switch to select meter response. Selecting the fast, "F," position of the toggle switch provides 10-90% of the final meter reading in four seconds. In slow, "S", position, 90% of the final meter reading takes 22 seconds. In "F" position there is fast response and large meter deviation. In "S" position there is a slow response and damped meter deviation.

• **ALARM Light**: A red lamp that illuminates when the meter pointer deflects above the alarm setpoint or flashes when the radiation level rises above background radiation levels. An audible alarm tone will accompany the visual alarm. The alarm is latching and will remain in the alarm condition until the "RESET" button is depressed.

• **RESET Pushbutton**: When depressed, provides a rapid means to drive the meter to zero. The "RESET" also causes an 8-second background update. During these 8 seconds, the unimorph will "beep," and the ALARM light will flash every half-second.

■ Remove the "CAL" cover to access the following controls:

• **Alarm SET**: A multi-turn potentiometer (approximately 20 revolutions) used to adjust the alarm threshold. The threshold is set by exposing the M192 to the desired radiation field and adjusting the "SET" control until the alarm point corresponds to the meter reading. The range is adjustable from 10-100% of full scale on each range multiple.

• **DIS (Discriminator)**: A multi-turn potentiometer (approximately 20 revolutions) used to vary the detector pulse counting threshold (input sensitivity) from 10-30 millivolts. The discriminator is typically set at 30 mV and requires a Model 500 Pulse Generator or equivalent to check/adjust the input sensitivity.

• **H V Adjustment**: A multi-turn potentiometer (approximately 20 revolutions) which provides a means to vary the detector operating voltage (HV) from 200 to 1500 volts. The HV setting may be checked at the detector connection (internal) with an appropriate voltmeter.

• **Range Calibration Adjustments**: Multi-turn potentiometers (approximately 20 turns) for the X1000, X100, X10, and X1 range multipliers. These controls allow individual calibration for each range multiplier.

6. CALIBRATION

■ A Ludlum Model 500 Pulser or equivalent is required. If the Pulser does not have a high voltage readout, use a high voltage meter with at least 1000 megohms input resistance for HV measurements.

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

☐ Rotate the Range selector switch to the "BAT" position. The meter pointer should deflect above the vertical mark on the "BAT OK" indication.

☐ Remove the "CAL" cover. Disable the alarm by adjusting the "SET" control to the maximum counterclockwise position. Rotate the Range switch to the "OFF" position and remove M192 can. Disconnect the detector cable from the circuit board and connect the Pulser in place of the detector. The positive Pulser lead connects to the junction of R27 and C57, while the negative lead connects to chassis ground or the pin where the detector black wire was connected.

☐ Adjust the Pulser pulse amplitude to approximately 30 mV.

☐ Rotate the M192 Range switch to the "X1000" position.

☐ Adjust the Pulser count rate for a cpm output of approximately 260 X 10k (650 cpm/μR/hr) (6.5μSv/hr). The M192 meter should indicate approximately 80% of full scale; however, there will be no needle deflection at all if the M192 DIS potentiometer is set too high (too far counterclockwise). In this case, adjust the potentiometer (clockwise) for maximum needle deflection; that is, until further adjustment produces no additional needle deflection.

☐ Adjust the Pulser MULTIPLIER, COARSE and FINE controls for approximately 80% of full-scale deflection on the M192 meter ("4").

☐ Decrease the Pulser AMPLITUDE LO-HI control until the Pulser meter indicates 30 millivolts (mV).

☐ Adjust the M192 DIS potentiometer (clockwise) until the M192 meter indicates approximately 60% of full scale ("3"). This should be the knee of the input sensitivity plateau or slightly above the area where a small decrease in the AMPLITUDE LO-HI control causes the M192 meter pointer to fall rapidly toward the low end of the dial. The M192 input sensitivity is the voltage indicated at this point on the Pulser meter.

☐ Reconnect detector and can.

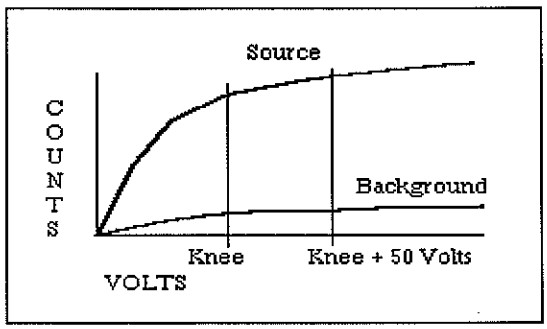
☐ Place ^{241}Am source at the detector end of the M192 can. Switch the Range multiplier switch to the position where the meter responds to the source. Decrease the HV (counterclockwise) until the meter indication starts to drop off. If the meter does not respond, switch to the X1 range position and slowly increase the HV (clockwise) until the meter starts to respond to the source.

☐ Remove the M192 can and measure the detector HV at the junction of R27 and C57.

✓ **NOTE:** The detector is not light-tight outside the M192 can. Having the detector

outside the can may produce extra counts if it is exposed to bright light.

☐ Increment the HV in 50 volts steps and plot exposure rate (source and background) versus HV to produce a graph similar to the one in Figure 1. Repeat without source for measurement of background radiation.



■ The "plateau" is that portion of the curve from the knee to the point where either the source counts or background counts start to rapidly increase with a small change in detector high voltage.

☐ Adjust the HV to approximately 50 volts above the plateau knee. The plateau length should be at least 100 volts.

☐ Replace instrument can.

☐ Switch the Range multiplier to the X1000 position. Expose the instrument to a calibrated gamma field which corresponds to approximately 80% (4000μR/hr (40μSv/hr)) of full meter scale. Adjust the X1000 range calibration control for proper reading. Position instrument in a field which corresponds to approximately 20% of meter scale and confirm meter indicates within ±10% of the field. Repeat calibration for the X100, X10, and X1 ranges.

✓ **NOTE:** If, in the previous step, the calibration range background is too high for the lower scale(s) or if the appropriate radiation fields are not available, the lower scale(s) will have to be electronically (Pulser) calibrated as follows:

☐ Turn instrument off and remove instrument from can.

☐ Disconnect the detector cable from the main circuit board. Connect a Ludlum Model 500 Pulser or equivalent to the C57-R27 junction and switch to the lowest range position calibrated with radiation. Adjust Pulser negative pulse amplitude to 50 mV.

☐ Adjust the Pulser count rate until the meter reads approximately 80% of full meter scale. Note the count rate.

☐ Switch the Model 192 to the next lower position and decade the Pulser to the next lowest range.

☐ Adjust the calibration potentiometer to correspond to approximately 80% of full scale reading. Check the 20% scale indication by dividing the Pulser count rate by 4. Repeat on lower scale if necessary.

☐ Turn the M192 OFF and disconnect the Pulser. Reconnect the detector and reconnect instrument can.

■ The calibrated M192 should display a value representing the background radiation. At the LMI factory, a typical background reading is 6-12 μR/hr (0.06-0.12μSv/hr).

☐ Adjust the alarm set point by exposing the instrument to a source to drive the meter pointer to the desired alarm point. Adjust the alarm "SET" potentiometer until the alarm is initiated. Remove source and depress the "RESET" button to disable alarm. Slowly increase meter reading with check source to confirm desired alarm set point. Readjust "SET" control as necessary.

7. MAINTENANCE

Instrument maintenance consists of keeping the instrument clean and periodically checking the batteries and the calibration.

To assure proper operation of the instrument between calibrations, the instrument should be tested with a check source prior to each use. A reference reading should be obtained when exposed to the check source in a constant and reproducible manner at the time of calibration. If the instrument response differs from the reference reading by more than ±20%, the instrument should be returned to a calibration facility for maintenance, repair or recalibration, as required.

Recalibration should be accomplished after any maintenance or adjustment of any kind has been performed on the instrument. Battery replacements are not considered to be maintenance and do not normally require the instrument to be recalibrated.

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

The batteries should be removed and the battery contacts cleaned of any corrosion at least every 3 months If the instrument has been exposed to a very dusty or corrosive atmosphere, more frequent battery servicing should be used.

Use a spanner wrench to unscrew the battery contact insulators, exposing the internal contacts and battery springs. Removing the handle will facilitate access to these contacts.

✔

NOTE

NEVER STORE THE INSTRUMENT OVER 30 DAYS WITHOUT REMOVING BATTERIES. ALTHOUGH THIS INSTRUMENT WILL OPERATE AT VERY HIGH AMBIENT TEMPERATURES, BATTERY SEAL FAILURE CAN OCCUR AT TEMPERATURES AS LOW AS 100° FAHRENHEIT.

8. THEORY OF OPERATION

8.1 Input

Detector pulses are coupled from the detector through C57 to emitter follower Q96. R83 and R89 provide bias. R137 protects Q96 from input shorts. R27 couples the detector to the high voltage supply.

8.2 Amplifier

Self-biased amplifier U1 provides gain in proportion to R63 divided by R70. Transistor pins 4, 5, and 6 of U1, provide amplification. Pins 10-15 are coupled as a constant current source to pin 6 of U1. The output self-biases to 2Vbe (approx. 1.4 volts) at pin 7 of U1. This provides just enough bias current through pin 6 to conduct all of the current from the constant current source. Positive pulses from pin 7 are coupled to the discriminator (U2) through R64 and C109.

8.3 Discriminator

Comparator U2 provides discrimination. The discriminator is set by the voltage at pin 3 of U2. These pulses are coupled to pin 5 of U3 for meter drive and pin 12 of U3 for audio.

8.4 Scale Ranging

Detector pulses from the discriminator are coupled to univibrator pin 5 of U3. For each scale, the pulse width of pin 6 of U3 is increased by a factor of 10, with the actual pulse width being controlled by the front panel calibration controls and their related capacitors. This arrangement allows the same current to be delivered to C105 by 1 count on the X1 range as by 1000 counts on X1000 range.

8.5 Digital Analog Convertor

Pin 12 and 15 of U4 are coupled as a current mirror. For each pulse of current through R72, an equal current is delivered to C105. This charge is drained off by R74. The voltage across C105 is proportional to the incoming count rate.

8.6 Audio

Discriminator pulses are coupled to univibrator pin 12 of U3. The front panel AUD "ON-OFF" selector controls the reset at pin 13 of U4. When ON, pulses from pin 10 of U3 turns on oscillator U5, which drives the can-mounted unimorph. Speaker tone is set by R84 and C112; with the duration by R86.

8.7 Meter Drive

The meter is driven by the emitter to Q6, coupled as a voltage follower in conjunction with pin 1 of U6. For ratemeter drive, the meter is coupled to C105 at P1-15.

For battery test, the voltage follower is bypassed and the meter movement is directly coupled to the battery through R150.

8.8 Meter Compensation

When the unit is provided with a high torque meter movement, with 1.2 volt drive, a temperature compensation circuit is provided on the main circuit board; components R181,R189 and R190.

8.9 Fast/Slow Time Constant

For slow time constant, C104 is switched from the output of the meter drive to parallel C105.

8.10 Low Voltage Supply

Battery voltage is coupled to U7 and associated components (a switching regulator) to provide 5 volts at pin 5 to power all logic circuits. Unregulated battery voltage is used to power the meter drive (Q6) and the high voltage blocking oscillator (Q145).

8.11 Low Voltage Reference

U101 provides a 1.22-volt precision reference for HV supply. This unit also biases Q96.

8.12 High Voltage Supply

High voltage is developed by blocking oscillator Q145-T165 and rectified by voltage multiplier CR166,167,169 and 175. Output voltage increases as current through Q44 increases, with maximum output voltage with Q44 saturated.

High voltage is coupled back through R47 to opamp pin 6 of U6. R147 completes the high voltage circuit to ground. High voltage output is set by front panel control HV, which sets bias of pin 5 of U6. During stable operation, the voltage at pin 6 of U6 will equal the voltage at pin 5 of U6. Pin 7 of U6 will cause conduction of Q44 to increase or decrease until the high voltage seeks a level of stability.

8.13 Alarm

U2 is configured as a voltage comparator. The alarm "SET" potentiometer "wiper arm" is connected to pin 5 of U2. As the meter drive voltage, coupled to pin 6 of U2, increases above the alarm SET reference, pin 7 of U2 goes low. This causes Q200 to conduct, driving the drain of Q201 low and illuminating the alarm lamp. Audio is generated from Q200 conduction through CR202 to RESET line of U5. R210 and Q213 provide the latching alarm circuitry. Pins 7, 8, and 9 of transistor U4 provide alarm reset by way of the front panel "RESET" switch.

PARTS LIST

Ref. No.	Description	Part No.
	Model 192 Survey Meter	
UNIT	Completely Assembled Model 192 Survey Meter	48-2945
	Circuit Board, Drawing 363 X 756	
BOARD	Assembled Circuit Board	5363-950
	• **CAPACITORS**	
C38	0.0015µF, 3kV, C	04-5518
C40-C41	0.0015µF, 3kV, C	04-5518
C42	0.0027µF, 3kV, C	04-5520
C50	100pF, 3kV, C	04-5532
C56	100µF, 10V, DT	04-5576
C57	100pF, 3kV, C	04-5532
C102	100µF, 10V, DT	04-5576
C103	10µF, 20V, DT	04-5592
C104	47µF, 16V, DT	04-5550
C105	10µF, 20V, DT	04-5592
C106	0.001µF, 100V, C	04-5519
C109	0.01µF, 100V, C	04-5523
C112	470pF, 100V, C	04-5555
C115	100µF, 10V, DT	04-5576
C119	0.001µF, 100V, C	04-5519
C121	330pF, 100V, C	04-5531
C126	10µF, 20V, DT	04-5592
C134	100µF, 10V, DT	04-5576
C163	0.01µF, 100V, C	04-5523
C170	0.1µF, 100V, C	04-5521
C171	1µF, 35V, DT	04-5575
C191	0.0015µF, 3kV, C	04-5518
C199	0.01µF, 100V	04-5523
C2181	22pF, 100V, C	04-5552
C219	0.1µF, 100V, C	04-5521
C230-C231	15pF, 100V, C	04-5626
	• **TRANSISTORS**	
Q6	2N3904	05-5755
Q15	MPSW51	05-5765
Q44	2N3904	05-5755
Q96	2N3904	05-5755
Q145	MPS6534	05-5763
Q200	MPS6534	05-5763
Q201	2N7000	05-5820
Q233	MPS6534	05-5763

Ref. No.	Description	Part No.
	• **INTEGRATED CIRCUITS**	
U1	CA3096	06-6023
U2	TLC372	06-6265
U3	CD4098	06-6066
U4	CA3096	06-6023
U5	ICM7555	06-6136
U6	TLC27M7IP	06-6248
U7	MAX631	06-6249
U101	LM385Z-1.2	05-5808
U224	PIC12C509	06-6420
	• **DIODES**	
CR94	1N4148	07-6272
CR166-CR167	1N4007	07-6274
CR169	1N4007	07-6274
CR175	1N4007	07-6274
CR207	1N4148	07-6272
	• **RESISTORS**	
R18	1k, 1/4W, 5%	10-7009
R27	33k, 1/4 W, 5%	10-7019
R36	10M, 1/4W, 5%	10-7031
R46	10k, 1/4W, 5%	10-7016
R47	1G, FHV-1, 2%	12-7686
R63	82k, 1/4W, 5%	10-7022
R64	1k, 1/4W, 5%	10-7009
R65	10k, 1/4W, 5%	10-7016
R66	1k, 1/4W, 5%	10-7009
R68	8.2k, 1/4W, 5%	10-7015
R70	4.7k, 1/4W, 5%	10-7014
R74	180k, 1/4W, 5%	10-7068
R75	33k, 1/4W, 5%	10-7019
R76	10 OHM, 1/4W, 5%	10-7004
R77	2.2k, 1/4W, 5%	10-7012
R81	10k, 1/4W, 5%	10-7016
R83	100k, 1/4W, 5%	10-7023
R84	470k, 1/4W, 5%	10-7026
R86	2.7M, 1/4W, 5%	10-7029
R87	10k, 1/4W, 5%	10-7016
R89	100k, 1/4W, 5%	10-7023
R91	4.7k, 1/4W, 5%	10-7014
R137	10k, 1/4W, 5%	10-7016
R138	1M, 1/4W, 5%	10-7028
R150	2.37k, 1/8W, 1%	12-7648
R159	10k, 1/4W, 5%	10-7016
R172	47k, 1/4W, 5%	10-7020
R177	200 OHM, 1/4W, 5%	10-7006
R147	SAT TYP. (750k, 1%)	12-7693

Ref. No.	Description	Part No.
R189	301 OHM, 1/3W, 1%	12-7855
R235	100 k, 1/4W, 5%	10-7023
R242	100k, 1/3W, 5%	12-7747
R243-R245	22k, 1/3W, 5%	12-7754
R246-R249	100k, 1/3W, 5%	12-7747
R250	22k, 1/3W, 5%	12-7754
R251	33.2k, 1/3W, 1%	12-7793
R252	10k, 1/3W, 5%	12-7748
R253	47k, 1/3W, 5%	12-7758
R254	33.2k, 1/3W, 1%	12-7793
R255- R256	100k, 1/3W, 5%	12-7747
R257	1k, 1/3W, 5%	12-7750
•	**THERMISTORS**	
R181	R1006-98.4-59-D1	07-6332
R190	R1006-98.4-59-D1	07-6332
•	**CRYSTALS**	
Y229	MICRO XTAL-4.0 MHz	01-5201
•	**INDUCTORS**	
L13	470µHY	21-9600
•	**TRANSFORMERS**	
T165	L8050	40-0902
•	**MISCELLANEOUS**	
7 EA	CLOVERLEAF 011-6809	18-8771
P1	CONNECTOR 1-640456-7 MTA100	13-8121
P2	CONNECTOR 640456-2 MTA100	13-8073
P5	CONNECTOR 640456-2 MTA100	13-8073
1 EA	JACK,-TEST 1128-09-0319	18-8806
1 EA	CONTACT, #1434	18-9124

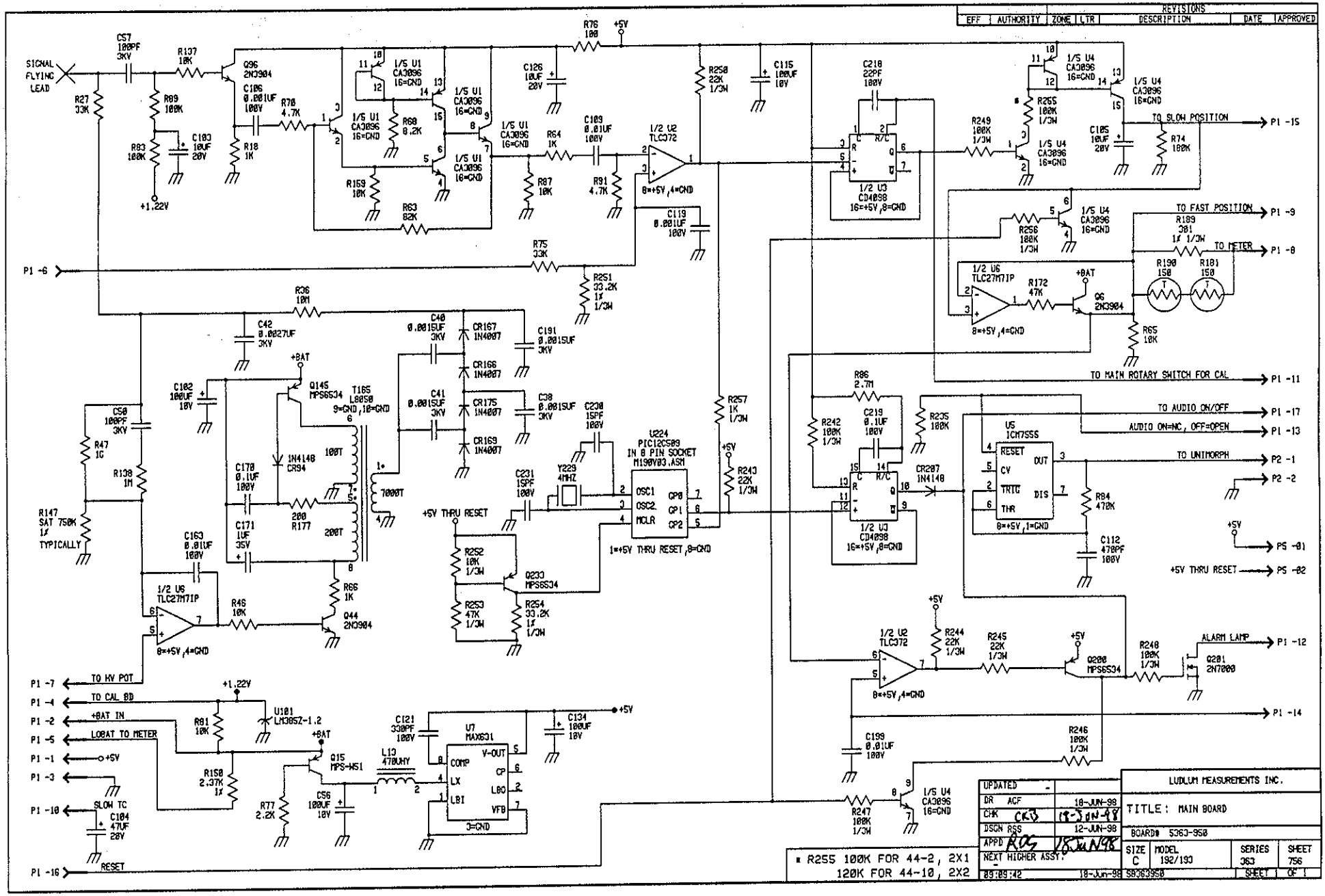
Ref. No.	Description	Part No.
	Calibration Board, Drawing No. 363 X 665	
BOARD	Completely Assembled Calibration Board	5363-821
•	**CAPACITORS**	
C1	0.047µF 100V C X7R	04-5565
C2	0.0047µF 100V C X7R	04-5570
•	**RESISTORS**	
R1-R2	1 Meg Trimmer	09-6814
R3	100k, Trimmer	09-6813
R4	1 Meg Trimmer	09-6814
R5	100k, Trimmer	09-6813
R6	100k, 1/4W, 5%	10-7023
R7	100k, Trimmer	09-6813
R8	47k, 1/4W, 5%	10-7020
R9	100k, Trimmer	09-6813
R10	1k, 1/8W, 1%	12-7637
•	**RESISTOR NETWORKS**	
RN1	NETWORK,-10k, SIP 8PIN	12-7720
•	**MISCELLANEOUS**	
P3-P4	CONN-640456-5 MTA100	13-8057

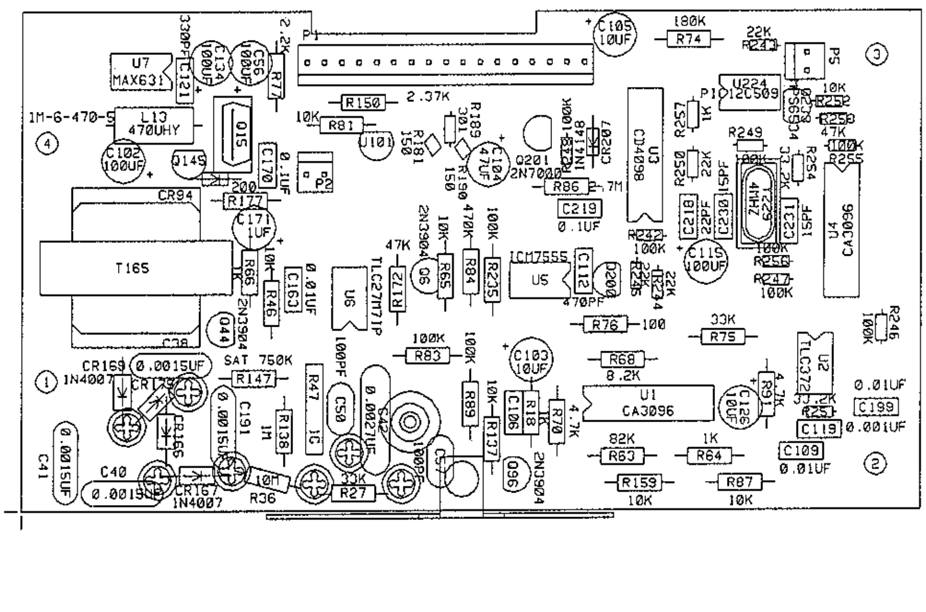
Ref. No.	Description	Part No.
	Chassis Wiring Diagram, Drawing No. 464 X 13	
•	**RESISTORS**	
R12	56 OHM,1/4W, 5%	10-7096
•	**CONNECTOR**	
J1	CONN-1-640442-6	13-8187
J2	CONN-640442-2 MTA100	13-8178
J3-J4	CONN-640442-5 MTA100	13-8140
J5	CONN-640442-2 MTA100	13-8178
•	**SWITCHES**	
S1	Centerlab PA600-210	08-6501
S2-S3	7101-SYZ-QE	08-6511
S4	MPS-203R (PB)	08-6697
•	**BATTERY**	
B1-B2	"D" Duracell Battery	21-9313

Ref. No.	Description	Part No.
•	**MISCELLANEOUS**	
V1	M44-127-1 DETECTOR	47-2951
DS1	UNIMORPH 60690	21-9251
DS2	ALARM LED	07-6409
*	BATTERY CONTACT SET (Portable)	2001-042
*	CASTING Model 12SA	9363-816
*	PORTABLE DEEP CAN ASSY (MTA)	4363-615
*	MAIN HARNESS Model 192	8363-959
	PORTABLE KNOB	08-6613
M1	PORTABLE BEZEL FRONT ASSY	4363-188
*	METER BEZEL W/GLASS, W/O SCREWS	4363-352
*	METER MOVEMENT (1mA)	15-8030
*	PORTABLE METER FACE	7363-136
*	HARNESS-PORT CAN WIRES	8363-462
*	BATTERY LID ASSY	9363-945
*	PORT. LATCH KIT W/O BATT. LID	4363-349
*	PORT. CALIB. COVER W/SCREWS	4363-200
*	PORT. HANDLE (ROLLED) W/SCREWS	4363-139
*	REPLACEMENT CABLE (STD 39")	40-1004

DRAWINGS AND DIAGRAMS

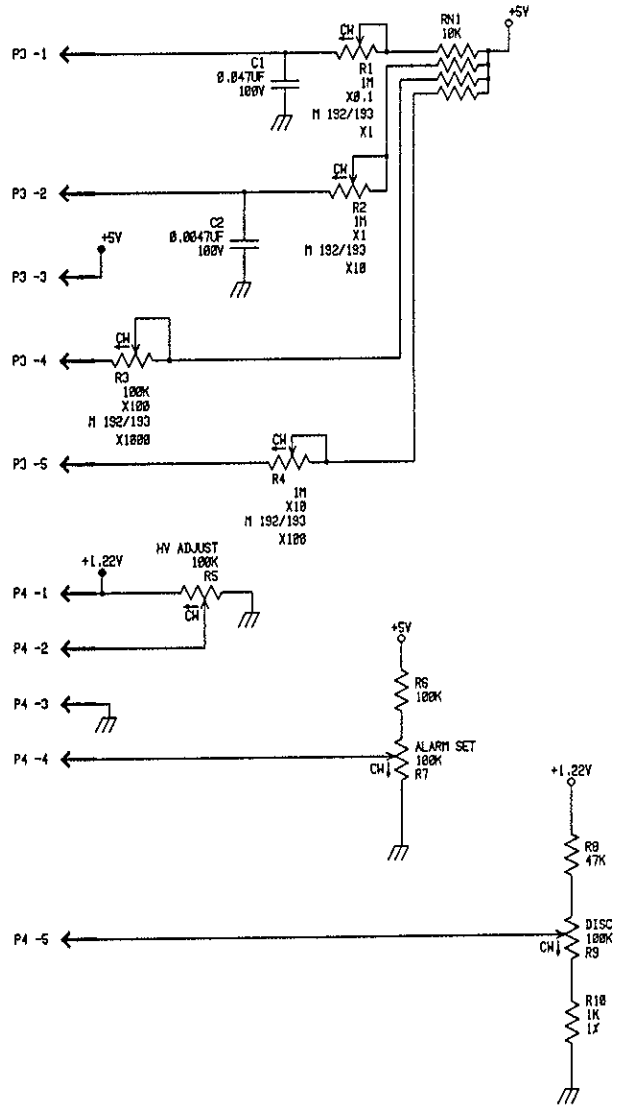
Main Circuit Board, Drawing 363 x 756
Main Circuit Board Component Layout, Drawing 363 x 757
Calibration Board, Drawing 363 x 665
Calibration Board Component Layout, Drawing 363 x 686
Wiring Diagram, Drawing 464 x 13


REVISIONS
EFF | AUTHORITY | ZONE | LTR | DESCRIPTION | DATE | APPROVED
SIGNAL FLYING LEAD
C57 100PF 3KV
R137 10K
Q96 2N3904
C106 0.001UF 100V
R78 4.7K
R27 33K
R89 100K
R83 100K
C103 10UF 20V
R18 1K
+1.22V
1/5 U1 CA3096 16=GND
R69 8.2K
R159 10K
R63 82K
R64 1K
C109 0.01UF 100V
R87 10K
R91 4.7K
1/2 U2 TLC272
8=+5V,4=GND
R76 100
+5V
C126 10UF 20V
R250 22K 1/3W
C115 100UF 10V
C119 0.001UF 100V
P1 -6
R75 33K
R251 33.2K 1% 1/3W
C218 22PF 100V
1/2 U3 CD4098 16=+5V,8=GND
R249 100K 1/3W
1/5 U4 CA3096 16=GND
R255 100K 1/3W
C105 10UF 20V
R74 100K
TO SLOW POSITION
P1 -15
R256 100K 1/3W
TO FAST POSITION
P1 -9
R189 301 1% 1/3W
TO METER
P1 -8
1/2 U6 TLC27M7IP
R172 47K
+BAT
Q6 2N3904
R190 150
R191 150
R65 10K
TO MAIN ROTARY SWITCH FOR CAL
P1 -11
R36 10M
C42 0.0027UF 3KV
C40 0.0015UF 3KV
C41 0.0015UF 3KV
CR167 1N4007
CR166 1N4007
CR175 1N4007
CR169 1N4007
C191 0.0015UF 3KV
C38 0.001SUF 3KV
C102 100UF 10V
Q145 MPS6534
T165 L8050
9=GND,10=GND
7000T
100T
200T
R177 200
C178 0.1UF 100V
1N4148 CR94
C171 1UF 35V
C163 0.01UF 100V
C50 100PF 3KV
R47 1G
R138 1M
R147 SAT 750K 1% TYPICALLY
1/2 U5 TLC27M7IP
R45 10K
R46 1K
Q44 2N3904
C230 15PF 100V
Y229 4MHZ
C231 15PF 100V
U224 PIC12C509 IN 8 PIN SOCKET M190V03.ASM
OSC1 OSC2 MCLR GP0 GP1 GP2
1=+5V THRU RESET,8=GND
+5V THRU RESET
R252 10K 1/3W
Q230 MPS6534
R253 47K 1/3W
R254 33.2K 1% 1/3W
R257 1K 1/3W
R240 22K 1/3W
R86 2.7M
R242 100K 1/3W
C219 0.1UF 100V
R235 100K
CR207 1N4148
1/2 U3 CD4098 16=+5V,8=GND
U5 ICM7555 RESET CV TRIG THR OUT DIS
8=+5V,1=GND
TO AUDIO ON/OFF
P1 -17
AUDIO ON=NC, OFF=OPEN
P1 -13
TO UNIMORPH
P2 -1
P2 -2
R84 470K
C112 470PF 100V
+5V
PS -01
+5V THRU RESET
PS -02
1/2 U2 TLC272
R244 22K 1/3W
R245 22K 1/3W
Q200 MPS6534
R248 100K 1/3W
ALARM LAMP
P1 -12
Q201 2N7000
P1 -14
C199 0.01UF 100V
R246 100K 1/3W
1/5 U4 CA3096 16=GND
R247 100K 1/3W
P1 -7 TO HV POT
P1 -4 TO CAL BD
P1 -2 +BAT IN
P1 -5 LOBAT TO METER
P1 -1 +5V
P1 -3
P1 -10 SLOW TC
C104 47UF 20V
P1 -16 RESET
+1.22V
R81 10K
U101 LM385Z-1.2
R158 2.37K 1%
R77 2.2K
C56 100UF 10V
Q15 MPS-A51
L13 470UHY
C121 330PF 100V
U7 MAX631 COMP LX LBI V-OUT CP LBO VFB 3=GND
C134 100UF 10V
+5V
* R255 100K FOR 44-2, 2X1
120K FOR 44-10, 2X2
UPDATED -
DR ACF 18-JUN-98
CHK CRJ 18-JUN-98
DSGN RSS 12-JUN-98
APPD ROS 18JUN98
NEXT HIGHER ASSY: -
09:09:42 18-Jun-98
LUDLUM MEASUREMENTS INC.
TITLE: MAIN BOARD
BOARD# 5363-950
SIZE C | MODEL 192/193 | SERIES 363 | SHEET 756
SHEET OF 1
S8363950

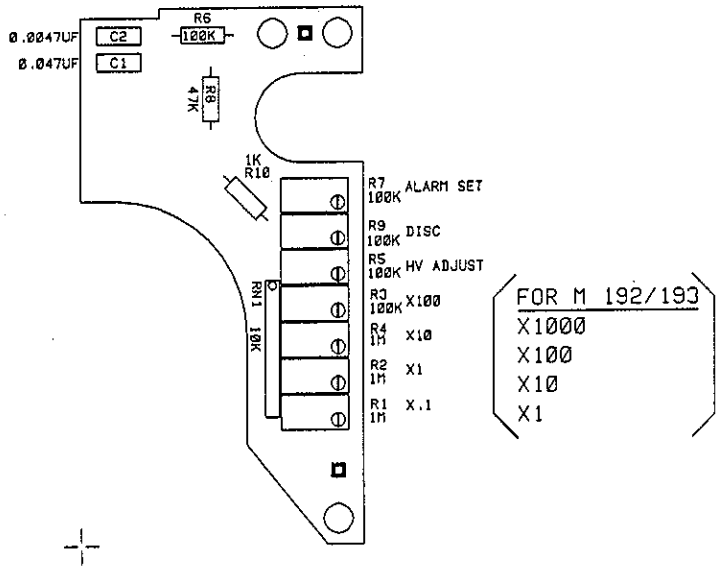


LUDLUM MEASUREMENTS INC. SWEETWATER, TX.				
DR TJR	04-30-97	TITLE : MAIN BOARD		
CHK RSS	5-13-97	BOARD# 5363-950		8S363950
DSGN RRS	04-25-97	MODEL 190	SERIES 363	SHEET 757
APP JGW	5-13-97			
13:45:57	7-May-97	COMP SIDE ☐	SLDR SIDE ☐	OUTLINE ☒
COMP PASTE ☐	COMP MASK ☐	SLDR PASTE ☐	SLDR MASK ☐	

REVISIONS						
EFF	AUTHORITY	ZONE	LTR	DESCRIPTION	DATE	APPROVED

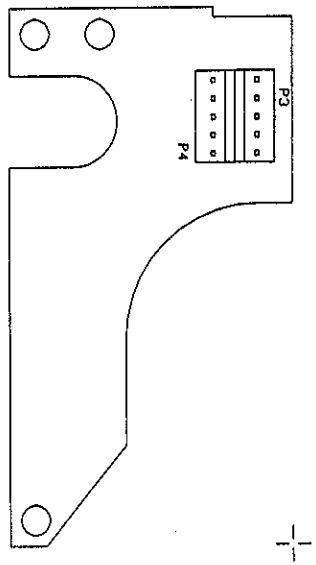


UPDATED	-	LUDLUM MEASUREMENTS INC.	
DR ACF	18-JUN-98	TITLE: CALIBRATION BOARD	
CHK CKB	18-JUN-98	BOARD# 5363-821	
DSGN RSS	12-JUN-98	SIZE C / MODEL 125A \ 192 \ 193 / SERIES 363 / SHEET 665	
APPD RDS	18JUN98		
NEXT HIGHER ASSY. -			
08:41:08	18-Jun-98	SB363821	SHEET 1 OF 1



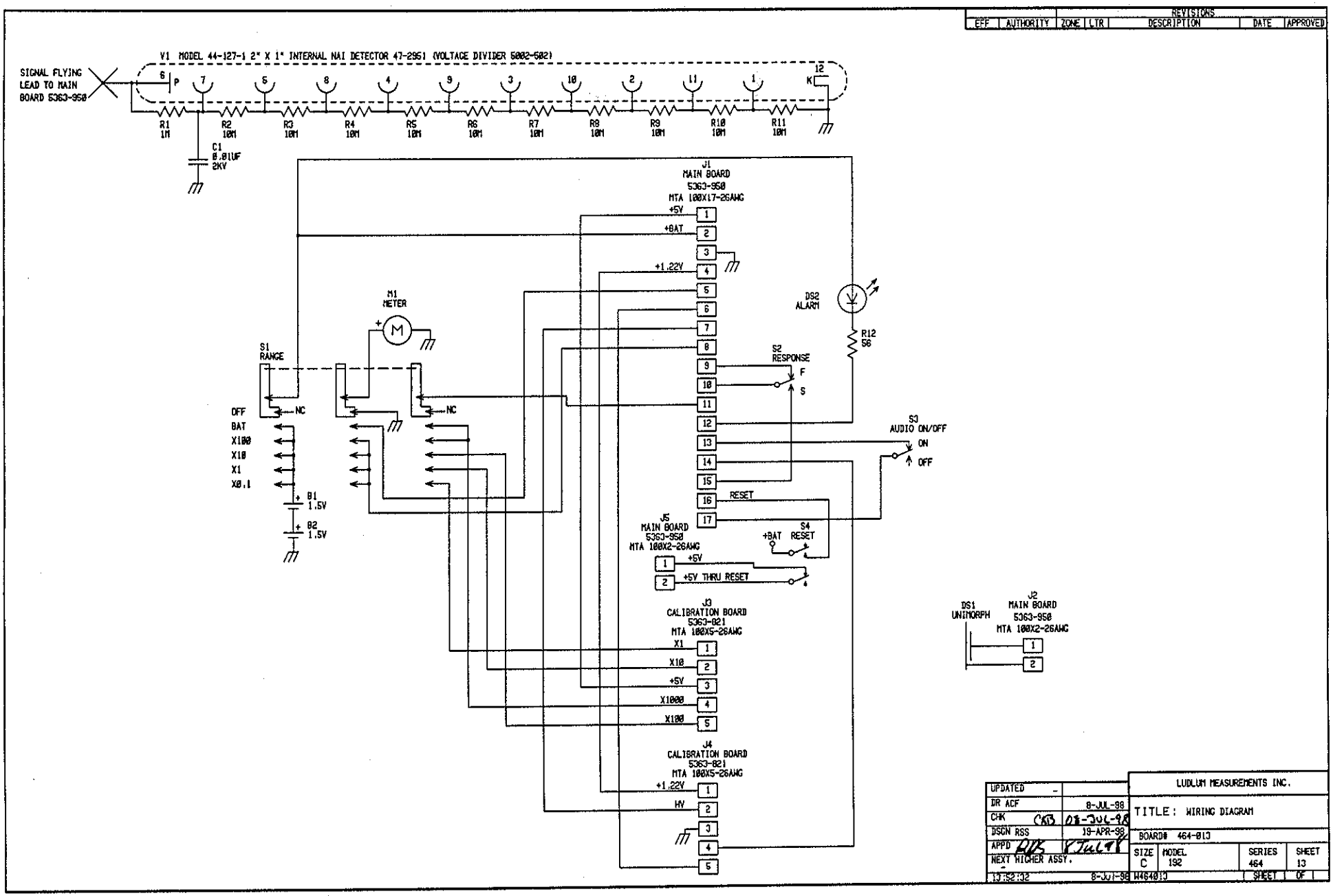
USED ON MODELS: 12SA, 192, 193

LUDLUM MEASUREMENTS INC. SWEETWATER, TX.			
DR ACF	13-JUN-98	TITLE: CALIBRATION BOARD	
CHK CKB	15-JUN-98	BOARD# 5363-821	89363821
DSGN RSS	12-JUN-98	MODEL 12SA SERIES 363	SHEET 606
APP RDS	17 JUN 98	COMP ARTWORK ☐	SLDR ARTWORK ☐
08:20:54	13-Jun-98	COMP OUTLINE ☐	SLDR OUTLINE ☐
COMP PASTE ☐	COMP MASK ☐	SLDR PASTE ☐	SLDR MASK ☐



USED ON MODELS 12SA, 192, 193

LUDLUM MEASUREMENTS INC. SWEETWATER, TX.				
DR ACF	10-JUN-98	TITLE: CALIBRATION BOARD		
CHK CKB	17-JUN-98	BOARD# 5363-821		
DSGN RSS	12-JUN-98	MODEL 12SA	SERIES 363	SHEET 686
APP RDS	17Jun98	COMP ARTWORK ☐	SLDR ARTWORK ☐	
		COMP OUTLINE ☐	SLDR OUTLINE ☒	
COMP PASTE ☐	COMP MASK ☐	SLDR PASTE ☐	SLDR MASK ☐	


REVISIONS
EFF | AUTHORITY | ZONE | LTR | DESCRIPTION | DATE | APPROVED
V1 MODEL 44-127-1 2" X 1" INTERNAL NAI DETECTOR 47-2951 (VOLTAGE DIVIDER 5002-502)
SIGNAL FLYING LEAD TO MAIN BOARD 5363-950
R1 1M
R2 10M
R3 10M
R4 10M
R5 10M
R6 10M
R7 10M
R8 10M
R9 10M
R10 10M
R11 10M
C1 0.01UF 2KV
J1 MAIN BOARD 5363-950 MTA 100X17-26AWG
+5V
+BAT
+1.22V
M1 METER
DS2 ALARM
R12 56
S1 RANGE
OFF
BAT
X100
X10
X1
X0.1
NC
B1 1.5V
B2 1.5V
S2 RESPONSE
F
S
S3 AUDIO ON/OFF
ON
OFF
RESET
S4 RESET
J5 MAIN BOARD 5363-950 MTA 100X2-26AWG
+5V THRU RESET
J3 CALIBRATION BOARD 5363-821 MTA 100X5-26AWG
X1
X10
X1000
X100
J4 CALIBRATION BOARD 5363-821 MTA 100X5-26AWG
HV
DS1 UNIMORPH
J2 MAIN BOARD 5363-950 MTA 100X2-26AWG
UPDATED
DR ACF 8-JUL-98
CHK 08-JUL-98
DSGN RSS 19-APR-98
APPD 8 Jul 98
NEXT HIGHER ASSY.
13:52:32 8-JUL-98
LUDLUM MEASUREMENTS INC.
TITLE: WIRING DIAGRAM
BOARD# 464-813
SIZE C | MODEL 192 | SERIES 464 | SHEET 13
W464813
SHEET 1 OF 1