OPERATIONS AND REPAIR MANUAL

MODEL 2080

PULSE NEUTRON SURVEY METER

September 1999 Revision B

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I. INTRODUCTION

The Model 2080 Pulse Neutron Survey Meter is designed to measure either pulsed or steady state neutron fields. The instrument may be operated either as a fixed monitor plugged into the wall, or portable with the internal batteries. The instrument displays the dose rate on a digital alphanumeric LCD display. The microprocessor based instrument incorporates many additional features to make it both easy to use and easy to maintain and calibrate.

II. PRINCIPAL OF OPERATION

The instrument uses the principal of nuclear capture to detect the neutrons. A 25 cm diameter polyethylene pseudosphere moderator thermalizes the neutrons. They are then captured by silver foil. The resulting beta activity is proportional to the previously acquired neutron dose. The betas are detected by a GM tube that is wrapped with the silver foil. Since the GM tube is also sensitive to external radiation not from the silver foil, a second GM tube is used to cancel out any background radiation. The second GM tube is covered with tin. This presents the same gamma attenuation as the silver.

The counts from each detector are scaled in two separate scalers. The response from the two detectors may not be the same to gamma rays due to differences in detector volume, gas pressure or shielding. The two tubes must be matched within 1% mathematically. The software multiplies the counts from each scaler to balance them, then subtracts the gamma counts from the neutron counts to obtain Net Neutron counts. It then divides this number by a calibration factor to obtain a corrected reading. The resulting values because of the low counting rate need to be averaged over a period of time. This is performed by the digital filter. In essence it is a 16 register rotating stack that stores each new value over the oldest one, adds up the stack, then divides by 16 to obtain an averaged signal level. The time taken for a sample is determined by the average time. The alphanumeric display can display several different parameters and functions besides the radiation level. In addition the microprocessor controls the outputs, lamps, and horn.

III. NORMAL OPERATION

The instrument may be operated either from 110 VAC, 60 HZ or from the internal batteries. When first received the batteries may need to be charged. Plug one end of the line cord into the back of the instrument and the other end into an electrical outlet. The LED on the front panel marked AC POWER should light. This indicates that the instrument is plugged into the wall. The batteries take about 30 hours to fully charge. The instrument may be operated on either power source without reservation. If the batteries are too low for proper operation, the instrument will not turn on. If the instrument does turn on and the batteries are low, the display will flash LOW BATT to indicate that the batteries are low.

The whole read-out box tilts up or down for best viewing angle. It is secured in position by the two thumbscrews on the sides.

Turn the instrument on. The horn will beep to indicate that the instrument is functioning properly and the display will show;

XXX mrem/h

The XXX is the radiation level and will indicate the level from 1 to 400 mrem/h. If the radiation was above 400 mrem/h the display will show;

>400 mrem/h.

The value shown on the display represents the average of 16 consecutive readings. This is done to smooth out the fluctuations in the display. The time between readings is determined by the Average Time. The Average Time can be seen by pushing the DISPLAY AVERAGE TIME button. The display will now show X x 15 seconds ; the X representing either 1,2,4,8,16 or 32. There are two ways of thinking of this number. One way is that the total time for a new reading is X x 15 seconds, just like the display says. This means that if the Average Time is set to 8 the time for a complete new reading would be 8 times 15 seconds or 120 seconds or 2 minutes.

The other way of thinking has to do with update time. The update time is the time between readings and is the Average Time times 15/16 seconds. When the Average Time is 1 the display will update every 15/16 seconds. When it is on 8 it will update every 8 time 15/16 second or 7.5 seconds. No matter where the Average Time is set it still takes 16 updates to replace the running average for the display but the display will change every Average Time times 15/16 second. If the PANEL DISABLE switch is not in the locked position, then the Average Time may be changed by pushing the SET switch either up or down.

The DISPLAY switch also shows the Alarm Level. The Alarm Level may be set anywhere from 0 to 400 mrem/h. When the Alarm Level is matched or exceeded the horn turns on. If the instrument is plugged into the wall or the lamps are turned on for battery operation, then the three colored lamps will flash. This alarm is self resetting and will not latch. When the level falls below the Alarm Level the alarms will turn off.

The RESET switch on the front panel resets the instrument to zero. It may be pushed at any time. It is locked out of operation by the PANEL DISABLE switch.

The LAMPS switch turns on the lamps if the instrument is on batteries and the PANEL DISABLE switch is not locked. Push it once to turn on the lamps. Push it again to turn

them off. The battery life is greatly reduced with the lamps on and for this reason they cannot be left on if the PANEL DISABLE switch is locked. If the AC power is removed and the instrument is turned on, the lamps will be turned off.

In addition to the standard Alarm Level which is based on the radiation level displayed, there is another internal alarm level which is based on the rate of radiation received every 15/16 seconds. If this internal level that is set to about 500 mrem/h is exceeded, then the instrument will show FAST TRIP in the display. This is a latching alarm and once tripped can only be turned off by either turning the instrument off then back on or by pushing RESET. The instrument will then resume normal operation.

The instrument checks the status of the detectors and if it detects that one is not working properly, it shows FAIL on the display. FAIL is self-resetting.

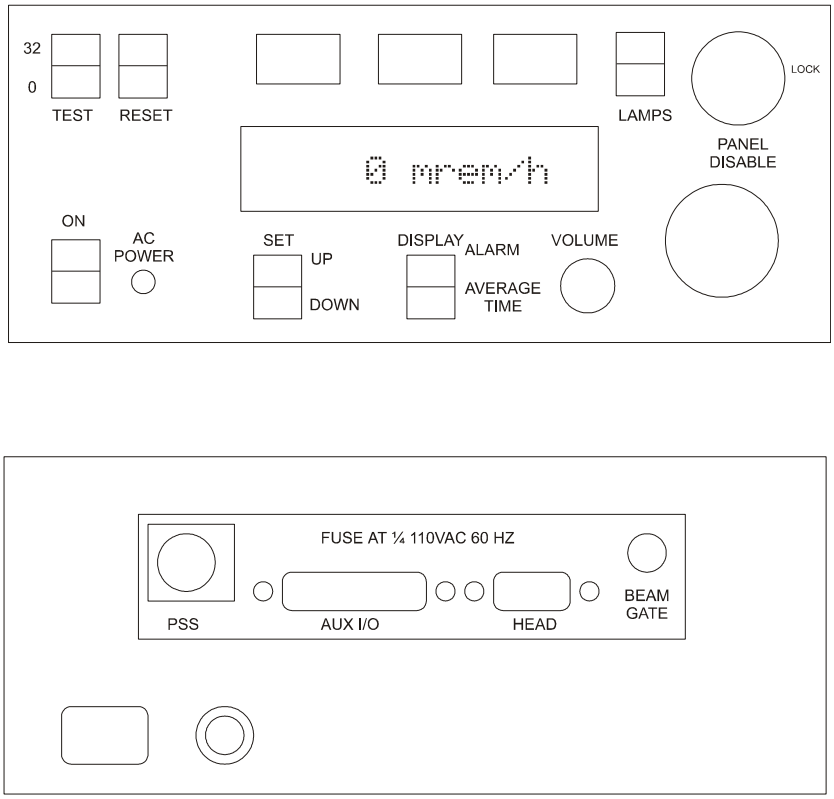


Figure 1 Front and Rear Panels

IV. SWITCH/INDICATOR DESCRIPTIONS

The front panel switches control the operation of the instrument. There are no rear panel switches. They are described in order; the top row from left to right, then the bottom row from left to right.

A. TEST 32

Simulates 32 mrem/h at the GM tubes. The display will increment to 32 mrem/h after the Average Time. This test does not interfere with the routine to check for detector failure. Holding in TEST 32 will not lead to a FAIL indication.

B. TEST 0

Simulates no counts from the GM tubes. FAIL will occur in the number of update cycles programmed in to FAIL COUNT (e.g., after 60 seconds). See SECTION VII MASTER SETTINGS.

C. RESET

Resets the stack, and resets the Average Time. If the Average Time was set to 32, and the RESET was pushed, the time for the next update would be 32 15/16th seconds or 30 seconds. Will not work if the PANEL DISABLE is locked.

D. LAMPS

Turns on or off the front panel indicator lamps if the instrument is on batteries and the PANEL DISABLE is unlocked.

E. PANEL DISABLE

The PANEL DISABLE switch needs a key to operate. When it is in the locked position, the RESET, LAMPS and SET UP and DOWN switches will not function. When it is in the Unlocked position, all front panel switches function.

F. POWER ON

This turns on the power to the instrument.

G. DISPLAY

This switch changes the display from mrem/h to the Alarm Level or to the Average Time setting. The radiation level is the normal display. Pushing the DISPLAY ALARM will change the display to read

XXX mrem/h Alarm

The XXX is the Alarm Level setting. After the switch is pushed, the display will remain for about 5 seconds after which it will revert back to the radiation level. The alarm level may be set at any positive integer from 1 to 400 mrem/h.

Pushing the DISPLAY AVERAGE TIME will cause the display to read:

XX x 15 seconds

The XX is the Average Time and it will only read 1,2,4,8,16 or 32. After the switch is pushed, the display will remain for about 5 seconds after which it will revert back to the radiation level.

H. SET

The SET switch is used in conjunction with the DISPLAY switch. The SET UP or SET DOWN are used to set the Alarm Level and the Average Time. It has no function when the instrument is reading the radiation level.

When the display shows the Average Time (The DISPLAY AVERAGE TIME switch was pushed) the SET UP or SET DOWN switch will cause the displayed Average Time to increase or decrease, but only if the PANEL DISABLE is unlocked. It is necessary to hold the switch down until the desired reading is obtained. The display will not roll over at either end. The display will remain on for 5 seconds after the last switch was pushed.

When the display shows the Alarm Level (The DISPLAY ALARM switch was pushed) the SET UP or SET DOWN switch will cause the displayed Alarm Level to increase of decrease, but only if the PANEL DISABLE switch is unlocked. If either SET switch is held down for 7 seconds, the display, instead of increasing (or decreasing) by units, will increase (or decrease) by 10s. This setting does not roll over at either end.

The Alarm Level and the Average Time are remembered even when the power is turned off and the batteries are removed. The instrument stores these values when the display reverts back to the normal radiation level. Consequently if you change either one then turn the power off before going back to a normal display, the instrument will not store the new value.

I. PANEL INDICATORS

AC POWER indicator indicates that the instrument is plugged into the line and that the batteries are charging.

GREEN, YELLOW, and RED Bar Lights indicate the radiation level. In normal operation, one of these lights flashes according to the following:

GREEN 0 to 2 mrem/h

YELLOW 3 to 19 mrem/h

RED above 20 mrem/h

All three flash when the Alarm Level is exceeded. The LAMPS switch will turn these indicators on and off if the instrument is on batteries and the PANEL DISABLE is unlocked. When the instrument is on and operating from AC power, the lamps will function normally and cannot be turned off using the LAMPS switch. The lamps are off when the instrument is switched to battery operation.

J. HORN

The horn is used to indicate the status of the counts from the neutron GM tube, the Alarm and various beeps from the program. The horn volume control changes only the loudness of the beep from the neutron GM tube. Turn it up and the horn will beep every time a count is detected from the neutron GM tube.

When the instrument is first turned on the horn will beep if all is OK. This is a loud beep. If the volume control is turned up then a soft beep will also be heard as soon as the instrument is turned on followed by the All OK beep. When the Alarm Level is exceeded the horn will also turn on continuously at full volume and is not affected by the setting of the volume control.

K. ALPHANUMERIC DIGITAL LCD DISPLAY

In normal operation there are four possible displays. They are:

DISPLAY	COMMENT
xxx mrem/h	Radiation level
> 400 mrem/h	Over range indicator
FAIL	GM tube failure
FAST TRIP	Fast Trip Level exceeded

The first display is the normal display of the radiation level. The leading zeros are blanked. The second display is the overrange indicator. This will be displayed if the radiation level exceeds 400 mrem/h, but does not exceed the Fast Trip Level. If the radiation level falls below 400 mrem/h the display will revert to the normal radiation level display.

If either GM tube fails to produce a pulse during a predetermined time period, the display panel shows FAIL. This is not latching and resumption of pulses will cause the display to revert to the radiation level.

If the Net Neutron count rate exceeds the Fast Trip Level during any 15/16 second counting period, FAST TRIP will be displayed. See section XIV PSS for a complete description of PS

V. REAR PANEL DESCRIPTION

The rear panel has several plugs and a fuse. All connections to the instrument are made here. A description of each plug from left to right, while looking at the back panel is as follows.

A. POWER CONNECTION

The rectangular line cord connector plugs into an IEC 320 cordset. The instrument is designed for 110 VAC, 60 Hz.

B. FUSE

The fuse holder contains a 1/4 A 3AG Fuse. To remove the fuse, unplug the line cord. Push in on the fuse holder and turn counter-clockwise. The end cap will come loose along with the fuse. Reassembly is just the opposite but replace the fuse with a new one.

C. PSS

The 6 pin circular connector is a connection for the Personal Safety System. This in an interlock connection for use when the instrument is used as an area monitor.

D. AUX I/O

This 25 pin DB connector has several outputs including buffered GM tube counts, an analog LOGOUT signal of the radiation level, an RS-232A output of the radiation level and instrument parameters, and power and reserved function pins. Its use is primarily in system expansion and testing.

E. HEAD

This 9 pin DB connector goes to a cable that in turn plugs into the head. If this cable is not installed the instrument will work but will show a FAIL. The instrument should be turned off when connecting or removing this cable, either from the read-out or the head. No harm will come to any electronics if the instrument is on while the cable is attached or removed but the program may not operate properly. Just turn the instrument on and off if this happens.

F. BEAM GATE

This is an electrically isolated connector that will turn off the counts from the detector when a positive signal is applied to the beam gate. The connector is isolated from ground.

VI. RADIATION CALIBRATION

The instrument has a special routine for radiation calibration that facilitates balancing the two tubes as well as setting the absolute radiation level. The instrument does not have to be opened to calibrate it and the calibration is done using the front panel controls. The calibration is completely digital.

A. CALIBRATE MODE:

To enter the calibrate mode make sure the instrument is unlocked. Hold down the RESET Switch and the LAMPS switch. Now turn the instrument on. The word CAL will appear to tell you that you are in the calibrate mode.

The display will then show three numbers. This is the balance section of the calibrate routine. The idea is to balance the counts from the two GM tubes.

Starting from the left the first number is the counts from the neutron GM tube divided by 256. If the left hand display reads 26 then it means that the internal counter for the neutron GM tube has accumulated 256 times 26 or 6656 counts. The next number is the balance. It is either positive or negative. If there are too many gamma counts then the number goes negative, if there are too many neutron counts then the number goes positive.

The next and last number is the Balance Constant. This number is raised and lowered by the SET UP/DOWN switch on the front panel. Push the SET UP/DOWN switch up and hold it there and every second the number will increase by one. Hold it down and the number will go down by 1 every second. This is the way the Balance Constant is changed.

Internally the instrument has a counter for each GM tube. Each counter has a capacity of 16777215 counts. In a gamma field the GM tubes count about 7 cps per mR/h. Thus in a 10 mR/h field 10 minutes of counting will add about 42000 counts (10 min x 60 sec/min x 7 cps/ mR/h x 10 mR/h). Since this is divided by 256 before it is displayed the display will show about 164 (42000/256). The total number of counts that can be displayed is 61695. At this time the program will accept no more counts. This represents about 62 hours of counting at 10 mR/h. Enough to go have a long coffee break after starting the instrument. Incidentally the RESET button will reset the numbers back to zero. Push it any time you like. It will not however change the Balance Constant.

Every second the counts from the gamma counter (divided by 256) are multiplied by the Balance Constant and subtracted from the counts from the neutron counter (divided by 256) multiplied by 100. The result, positive or negative goes into the center number in the display. Positive means that the Balance Constant is too low. Negative means that the Balance Constant is too high. Mathematically this is expressed by:

$$\text{balance} = 100(\text{n cts}/256) - (\text{Balance Constant})(\text{g cts}/256)$$

In practice the instrument will be put into a gamma field for either a known period of time, or until a certain number appears on the counter. The more counts the better but too many may confuse the issue. The Balance Constant can only be set in unit increments (or about 1% adjustment) When 1000 neutron counts are displayed, the balance will read within + or - 1000 if the Balance Constant is within 1%. With 1000

counts in the display the instrument is easy to balance and the statistical errors of + or - 1 count are insignificant.

Then the SET UP/DOWN switch is manipulated until the balance number is as close to zero as possible. It will probably never be right on zero but as close to it is the goal. A slightly positive number will make the instrument read more neutrons in a high gamma field. The SET UP/DOWN switch is always working and can be moved at any time to change the Balance Constant and thus to change the balance. The display is updated every second.

Once a significant number of counts have been accumulated and the Balance Constant adjusted satisfactorily, the counters may be zeroed using the RESET. A subsequent count may be used to demonstrate reliability and reproducibility, but otherwise unnecessary. That is all there is to balancing the instrument.

The next phase is to set the absolute Calibration Factor.

To do it, push the LAMPS button. The display will look like the normal display except in place of the words "mrem/h" on the right hand side of the display, will be the 3 digit Calibration Factor, followed by the letter C. The letter C is to remind you that you are in the calibration mode. The Calibration Factor may now be set with the SET UP/DOWN switch.

All Switches will work like normal on the front panel except for the PANEL DISABLE switch (More about it in a minute). The Average Time can be changed. The RESET button works like normal.

There are several functions that are defeated. The Alarm horn will not work. The overrange indicators will not work. The FAST TRIP will be displayed but it is not latching. These were defeated to allow testing of the FAST TRIP and to keep the ears of the calibration personnel from ringing after calibration.

The radiation level reading is inversely proportional to the Calibration Factor, i.e., raising the Calibration Factor will lower the mrem/h reading. Once the neutron radiation level has come to equilibrium, it is easy to determine the approximate Calibration Factor by multiplying the current Calibration Factor by the ratio of the current radiation level indication to the "true" radiation level. Although the display updates once per second, the radiation level needs one averaging time to completely fill the register stack with new data. After getting close to the correct value it is a good idea to make small changes, wait one averaging time then make another small change until the instrument reads properly.

B. STORING THE CONSTANTS

Up to this point the Balance Constant and the Calibration Factor have been changed but they are only in volatile memory. If you turn the power off now the new balance and calibration numbers revert back to the old numbers. To make them permanent you only need to turn the PANEL DISABLE back to lock and wait for the beep. The instrument will resume operation just like it was turned on, and beep again to indicate all is well. To change the calibration data again, it is necessary to enter the calibration mode again.

The data can be saved at any time in the course of calibration. The instrument can be balanced one day, then calibrated the next. It is easy to review the settings of the

Balance and Calibration by just entering the calibration mode, looking at the values, then turning the instrument off. Unless the key is turned the values will not be changed. If the key is turned and the values were not changed, the old values will be re-saved in memory, and will therefore not be changed.

C. SAMPLE CALIBRATION

The Model 2080 needs both a gamma calibration and a neutron calibration. The gamma calibration is before the neutron calibration. Set the time constant to 8 x 15 or higher for a more accurate calibration.

1. Gamma Calibration

1. Turn the instrument off. Key should be in PANEL DISABLE position.
2. Hold down the RESET and LAMPS switch and turn the instrument on.
3. Set the instrument in a 20 mR/h gamma field and let the instrument count until the counts in the 1st number are greater than 300. Center the source on the sphere. It should be at least 1 meter away from the sphere.
4. Using the UP/DOWN switch to raise or lower the BALANCE CONSTANT (3rd number) until the BALANCED NUMBER (middle number) is as close to 0 as possible. Positive numbers are better than negative numbers.
5. Turn Key to LOCK to save the values, then return key to original position.

2. Neutron Calibration

1. Turn the instrument off. Key should be in PANEL DISABLE position
2. Hold down the RESET and LAMPS switch and turn the instrument on.
3. Wait for display to stop changing and push LAMPS. The normal display will appear with the letter C to indicate calibration.
4. Set the instrument in a 100 mREM/h neutron field. Wait 5 minutes for the silver foil to reach equilibrium.
5. Using the UP/DOWN switch to raise or lower the CALIBRATION FACTOR until the instrument reading is 100 mREM/h. Raising the CALIBRATION FACTOR will lower the reading.
6. Check it at 50 mREM/h and wait 5 minutes for the silver foil to reach equilibrium. Change the CALIBRATION FACTOR if necessary then recheck at 20 mrem/h.
7. Turn key to LOCK to save the settings and then turn instrument off.
8. If the CALIBRATION FACTOR was changed very much, repeat the gamma and neutron calibrations.

VII. MASTER SETTINGS

The Master Settings routine allows setting of the Fast Trip Level and the Fail Counter. To enter into this routine turn the PANEL DISABLE to unlocked. Push the SET UP/DOWN switch up at the same time hold the DISPLAY ALARM/AVERAGE TIME switch to ALARM. Now turn the instrument on.

The display will show a single number, the Fail Count, in the center of the display. This is the number of 15/16ths of a second that the instrument needs without a count from either GM tube before it will display FAIL. Change the number by pushing on the SET UP/DOWN switch.

Pushing the LAMPS switch will change the display to a 5 digit number which is the Fast Trip Level. It starts out at 25000 and can be raised and lowered in increments of 256 by the SET UP/DOWN switch.

To save the data, Just like the Calibrate routine, turn the PANEL DISABLE switch to locked. The instrument will beep to indicate that all is saved, then it will resume normal operation in which case it will beep again as if it was just turned on. Turning the key saves both the Fail Count and the Fast Trip Level and it can be turned at any time. If it is turned while in the Fast Trip Level change section then it saves both the Fail Counts and the Fast Trip Level.

There is one special function in this routine. When the Fast Trip Level is displayed, pushing the TEST 32 will reset ALL the permanent memory to its default values. The Calibration Factor, Balance Constant, Fast Trip Level, and Fail Count will be reset. It is included to program a new memory chip to the default values or to start everything out fresh if a problem occurs.

A. FAST TRIP CALCULATIONS

The value in the Fast Trip Level is calculated every 15/16 seconds. It is independent of the setting of the Average Time. Every 15/16 seconds it compares the Net Neutron counts for that 15/16 seconds to the Fast Trip Level. If the Net Neutron counts are higher than the Fast Trip Level it goes into FAST TRIP. The Net Neutron counts are related to the mrem/h by the following:

$$\text{Fast Trip Number} = 50\ (\text{mrem/h})\ (\text{Cal Factor} / 100)$$

To trip at 500 mrem/h therefore set Fast Trip Level to:

$$50\ (500)\ (100/100) = 25000$$

This assumes that the Calibration Factor is 100. The default value for the Calibration Constant is 100. The default value for the Fast Trip Level is 25000.

VIII. MAINTENANCE FUNCTION

The maintenance function is built into the instrument to facilitate checking out the instrument. Like the other secondary functions, this is entered by turning the instrument on while a switch is depressed. In this case the switch is the TEST 32 switch. To get into the maintenance function turn the PANEL DISABLE to unlock and hold down the TEST 32 switch. Turn the instrument on. Immediately you will see the display with many numbers and letters. If the instrument displays FAIL then the EEPROM is either defective, not installed, or unprogrammed. See EEPROM section for more details. If the instrument is plugged into AC power the display should look like:

1 2.0 LH 7N 7G

The first digit starting from the left is the switch number that was just pressed, in this case the TEST 32. The next group of figures, the 2.0 is the voltage that should be at the LOGOUT (-2.0 Volts). The third group, LH is an indication of both the AC Power detector, and the Low battery detector. The two last groups, 7N and 7G are the counts from each GM tube.

Most switches do double duty. The action of the switches in order is included in the table below.

NAME	NUMBER	LOGOUT	ACTION
TEST32	1	-2.00	None
TEST 0	2	RMP	Ramps LOGOUT voltage from +1.2 to -5.0 Volts
RESET	3	+1.2	Resets lights, horn, and PSS
LAMPS	4	-3.2	Sets PSS
PANEL	5	----	Turns on Horn RESET to turn off DISABLE
SET UP	6	----	Turns on Green Light
SET DN	7	----	Turns on Yellow Light
ALARM	8	----	Turns on Red Light
AV TIME	9	----	None

You will notice that the switches follow a sequence around the panel starting at the upper left hand corner and proceeding across the top row and then across the lower row.

The LOGOUT Voltage also follows a pattern. RESET sets it for 0 mrem/h or +1.2 Volts. TEST 32 sets it as for 32 mrem/h or -2.0V.

Lamps takes it to -3.2 Volts. These are used in adjusting the offset and gain trimmers inside the instrument. The RMP stands for RAMPING. The voltage slowly ramps between +1.2 and -5 Volts. At -5 Volts it starts over again at +1.2 Volts.

The Lamps and Horn are actuated by the switches shown in the table above. This is to test them. They are turned off by RESET.

The PSS Relay is actuated by the LAMPS switch. Push it and the circuit is closed. After about 5 seconds the contacts will open. This checks the watchdog timer that checks for Microprocessor failure. If the LAMPS switch is pushed then the RESET switch the relay should fall out immediately. This is the normal course of actuation by the computer when it senses that PSS is not allowed.

The two H or L indicators show the status of the AC Power and the Low Battery detector. The table shows their indicators;

AC Power L is AC Connected, H AC not connected

LOW BATT L is low Battery, H is good battery

On battery power they normally read HH on AC Power they would normally read LH.

The Last groups are the GM counters. The two letters next to the digits correspond to N for neutron and G for gamma. The counters count down from 7 to 0 then return to 7. They give an indication of the GM tubes counting. They start at 7 when the maintenance mode is entered.

The maintenance mode also exercises the RS-232. It puts out "HI" continuously at 9600 baud.

IX. INTERNAL ADJUSTMENTS, and CONTROLS

There are only 5 internal adjustments and they are all located on the circuit board in the read-out box; 4 of the 5 are screwdriver adjustments. The 5th is the display contrast. It can be rotated by the finger and is in the right hand corner of the circuit board if the display is facing away from you. To gain access to the adjustments and the inside of the case, remove the two screws located on the sides at the top back of the instrument. The whole front panel and top, which are one piece, rotate up and forward, pivoting on the lower front. There is a small reset push-button on the left hand side of the circuit board. This resets the microprocessor whenever it is pushed (i.e., a warm boot). If it is pushed it does the same thing as when the power is removed then re-applied. Don't hesitate to push it.

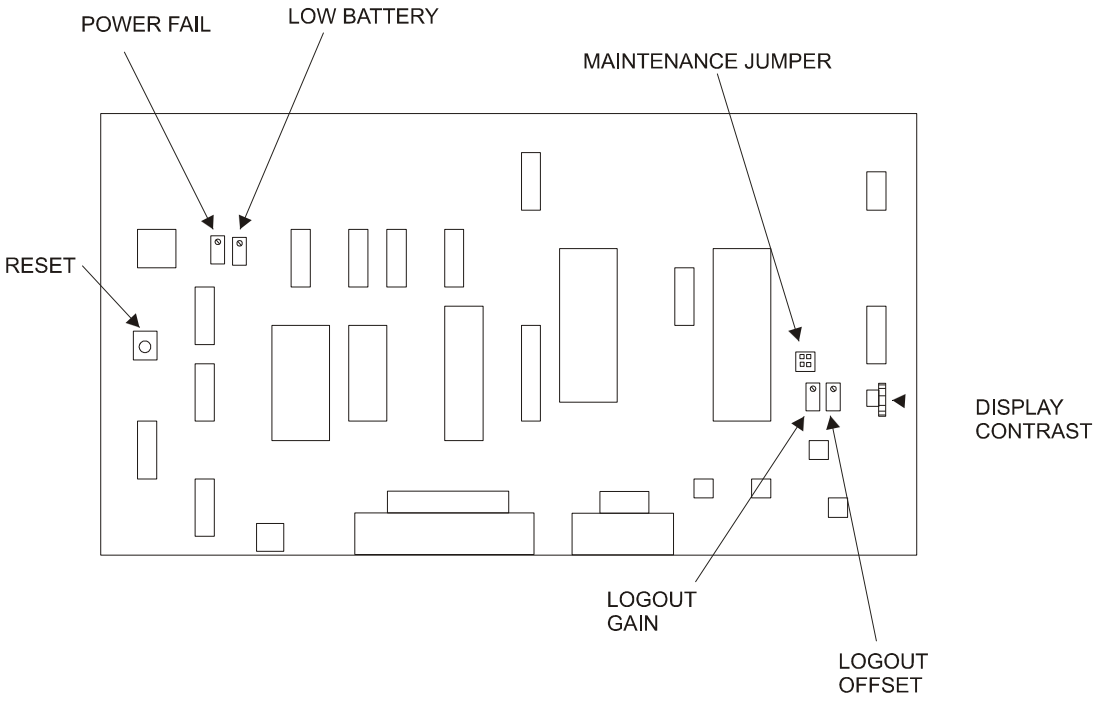


Figure 2 Internal Controls

On the right rear of the circuit board there is also a set of pins with a jumper pushed on one of them. This is the only internal adjustment to the microprocessor. It makes the instrument go into the maintenance mode immediately at turn on. No switches need be pushed to do it and its purpose is for testing when all else fails. To try it, put the jumper on the two rear terminals and turn the instrument on; it should be in maintenance mode. When the jumper is removed the instrument is in its normal mode operation. The jumper can be removed from the instrument or it can be stored by pushing it over only one pin.

The four screwdriver adjustments are factory set, however they may be changed or checked depending on the use of the instrument. The two adjustments next to the contrast control set the voltage gain and offset for the LOGOUT signal on the PSS connector and the AUX I/O connector. To set them put the instrument into the maintenance mode and monitor the LOGOUT voltage. Push RESET on the front panel. Adjust the offset so the LOGOUT reads +1.2 Volts. Depress LAMPS on the front panel

and adjust the gain so the LOGOUT reads -3.2. It will be necessary to repeat the sequence of the two adjustments because they interact somewhat.

To check the intermediate voltage values, see the MAINTENANCE FUNCTION for a complete description of the LOGOUT test voltages.

The other two adjustments are the low battery and power fail detector. The low battery adjustment is made by replacing the batteries with a power supply, and operating the instrument without the line cord. Enter the maintenance mode. Turn the voltage that replaces the batteries to 7.2 Volts. Adjust the low battery adjustment until the low battery indicator in the display changes from L to H or H to L. This is an abrupt change without hysteresis. About 1/4 turn will change the display. CCW turns the display to H and CW turns it to L.

The Power Fail adjustment adjusts the voltage at which the instrument automatically turns off even if the on-off switch is on. This keeps the instrument from reverse biasing the batteries resulting in their catastrophic failure. Use the same connection as for the low battery check except change the external power supply to 6.5 volts. Now turn the Power Fail trimmer until the instrument just turns on. CCW will turn it on and CW will turn it off.

X. SERVICE

Servicing the instrument should be relatively easy since the instrument is designed in a plug together modular fashion. The head and read-out are two separate items and the plug in detector tubes are a third.

To gain access to the instrument the read-out box may be removed from the handle and sphere by removing the thumbscrews. Two washers between the read-out and the handle will fall out. Keep them and put them back when reassembling the instrument. They keep the handles from scratching the case.

The detector box has 4 screws, two on each side. The cover lifts off. Inside is the high voltage power supply and discriminators as well as the detector paddle. The detector paddle unplugs from the board and the paddle removes by just pulling it upward.

The circuit board is held in the instrument by two screws through the board, and the two screws holding the connector to the rear of the case. The stainless tube will have to be removed before the board can be slipped out, it just pulls out.

The read-out box can be opened by removing two top rear screws on each side. The whole top and front panel now pivot up on the two screws on the front bottom of each side. The circuit board is held in place by the two screws on each side cutout on the rear panel. When they are unscrewed and the connectors are removed from the circuit board, the whole board slides out. Underneath the board are the batteries and the power supply. The batteries just slip into the holders.

The front panel may be detached from the read-out box by removing the two screws on the lower front of each side.

XI. CIRCUIT DESCRIPTION

The instrument is divided into two distinct circuits the Head and the Read-out.

A. HEAD

The signal starts at the detector tubes which put out a negative pulse that is discriminated by U1. The negative going signal is then fed to a one shot that has a pulse width of around 30 usec. Q1 and Q2 are power transistors that drive the line between the head and the read-out. At the read-out end, the line goes through the LED in an optocoupler and is returned to the head. This cancels the common mode signals since the instrument was designed to operate with long lines between the head and read-out. If they were to be longer than 100 feet the one shot should be made longer by changing R20/21.

The Low voltage unregulated power is regulated by U4 to 5 volts. The high voltage of +550 volts for the GM tubes is derived from a switching power supply. U2 contains an oscillator, comparator and driver FET. It switches T1 on and off at a rate to keep the supply at 550 volts. It measures the 550 volts through R16 and R17. D5 and D6 act as a voltage doubler.

In measuring the high voltage the probe should have at least a 100 meg input impedance. A normal DVM with a 10 meg input impedance will work but it will make the head draw more power.

The entire head draws about 1 to 1.5 mA of current form the unregulated input when it is not in a high radiation field.

The +5 volts on the external connector may be used but the power drain should remain low since U4 can only supply about 100 mA of current.

B. READ-OUT

The Read-out is an all CMOS microprocessor based unit. U2, a 6805 is the microprocessor. U3 Address latch, U12,U13, address decoders and U4 EPROM form the core of the support circuitry. The Display, U5 is connected just like a peripheral. U6 is a UART that controls the serial output through the voltage translator/ generator of U7. U14 is a peripheral interface adapter that has 24 I/O lines. U11 is a dual counter.

The signal entered the board from the head and is interfaced by the two opto couplers U9 and U10. U8, the beam gate optocoupler, essentially turns off the pulses from the detectors when it is active. Pin 13 and 10 on U22 receive a pulse every 15/16 sec to make sure that the dual counter U11 is set properly.

The timing is done by the crystal Z1 on U2. The frequency is divided to 900 Hz by U1 for the Timer input to the microprocessor. This is the signal used to time the whole instrument.

The EEPROM U25 is attached to the microprocessor. If A new chip is installed it is necessary to program it. See the MAINTENANCE SECTION.

The analog output LOGOUT is generated by RN4 connected to U14 the PIA. It is an R-2R network. Its output is level shifted by U15 to a negative output.

The Lamps and Horn signals are also generated by U14 and buffered for more current by the VFETS Q2,3,4 and 5.

The PSS system contains U16B a retriggerable one shot which acts as a watchdog timer. Every 15/16 seconds the output of U14 PC7 pin #35 pulses. This keeps U16 triggered if its reset pin (U16B p 13) is not activated. If the system quits, and there are no more pulses then U16B will time out in about 5 seconds and turn off the PSS relay RY1. The system can also turn off PSS by activating the reset line on U16B which is its normal way of turning off PSS. The signal from U14 PC7 Pin 35 represents the heartbeat of the system.

One shot, U16A stretches the pulses from the GM tubes enough to be heard on the horn.

The power supply is powered by both batteries and the line. T1 is connected to the line filter and consequently to the line. Z1 is a power conditioner that keeps voltage transients out of the system. The power from T1 is rectified and combined with the signal from the batteries through D4. R13 sets the charging current of the batteries to about 26 mA which is their high end trickle charge rate. Q1 turns the system on and off. U18 detects the voltage that is present and if it is high enough it saturates Q1 and turns on the power. If the battery voltage or the line voltage fall too low then U18 will turn off Q1 and the instrument will appear dead. This prevents reverse discharge of the batteries and also prevents the display from reading an incorrect reading since when Q1 turns off the display will go blank. The other half of U18 is the low battery detector that checks the condition of the input voltage to flag the system to display low battery. U19 detects both the fact that AC power is present by measuring the voltage from the secondary of T1 through D7 and filter C7,R23,D8 and R25 and also generates a reset signal for the system if 5 volts falls too low.

U17 is a 3 terminal voltage regulator which drops the input voltage to 5 volts. U20 is a voltage converter that converts +5 to -5 for the display and the op amp U15.

The reset switch S1 resets the system just like a power on.

The entire system operating off of batteries with the lights off needs about 26 mA at 11 VDC.

XII. SERIAL OUTPUT

The serial output at 9600 baud consists of several groups of digits. On a terminal the output should look like:

000 01 200 0001

The first group of three is the radiation level.

The next group of two is the Average Time

The next group of three is the Alarm Level

The last group is the status.

The radiation level is the same level as on the display. The Average Time is the same level as on the display. The Alarm Level is the same level as on the display. The status consists of two bytes each represented by 2 hex digits. The individual bits of each byte mean something different.

BIT #	DESCRIPTION
1st Byte	
0	Overflow H = overflow
1	Fault H = Fault
2	AC Power H = AC Power
3	Alarm H = Radiation Level above Alarm setting
4	Fast Trip H = Trip
5	Gamma Tube H = Have a count in the tube
6	Neutron Tube H = Have a count in the tube
7	Cycle H = New data
2nd Byte	
0	Flash H = New cycle, used to flash display
1	Debounce H = Debounce Lamps switch
2	Lamps Off Used to indicate lamps off
3	PSS H = PSS Activated
4	Keep H = Program EEPROM
5	Display H = Display Trip Level
6	Display H = Display Average Time
7	Calibrate H = Calibrate mode

H means the bit is High or a 1

A. UNDERSTANDING THE STATUS BYTES

The status bytes are encoded with a normal binary code. To best illustrate the process to encode the data lets assume that the display shows:

000 200 01 00C2

Now lets concentrate on the second status byte: C2. This byte can be broken down into two "nibbles", as they are called, the C and the 2. Nibbles represent any one of 16 possible combinations of binary bits. They are displayed as numbers 0 to 9 and letters A to F. This notation is called "HEXADECIMAL" or "HEX". The table below should clarify this. It shows their equivalents:

DECIMAL	HEX	BINARY
0	0	0000
1	1	0001
2	2	0010
3	3	0011
4	4	0100
5	5	0101
6	6	0110
7	7	0111
8	8	1000
9	9	1001
10	A	1010
11	B	1011
12	C	1100
13	D	1101
14	E	1110
15	F	1111

Above the number 9, letters are used to represent the number.

The Binary equivalent of these numbers is the key to deciphering the status byte. The C and the 2 above in the second status byte now begin to make more sense when their binary equivalents are written down one on top of the other;

STATUS BYTE in HEX	C	2
BINARY EQUIVALENT	1100	0010
Bit number	7654	3210

The bit number below shows the location in the original byte of the individual bits. For example bit 5 is 0, bit 7 is 1 etc. It is now an easy matter to look up the individual bits in the table above and figure out what they mean. Bits number 1,6,and 7 are all high or 1. All the other bits are low or 0. From the table we see that bit 1 is the debounce bit, bit 6 is the display average time bit, and bit 7 is the calibrate bit. Thus the instrument is debouncing the lamps switch while in the Average Time in the Calibrate mode.

XIII. LOGOUT

The LOGOUT signal is an analog voltage that is present on both the PSS connector and the AUX I/O connector. It is the logarithm of the digital radiation level that is displayed. The LOGOUT as it is called has a finer resolution than the display. While the display displays only units, the LOGOUT's resolution is 1/4 mrem. The LOGOUT signal therefore may not appear to follow the digital read-out. A better way to think of this is that the digital display follows the LOGOUT rather than the other way around. The display changes at units with no rounding off.

mRem/h	METER VOLTS	DISPLAY
0	+1.2	0
1/4	+0.8	0
1/2	+0.4	0
1	0.0	1
2	-0.4	2
4	-0.8	4
8	-1.2	8
16	-1.6	16
32	-2.0	32
64	-2.4	64
128	-2.8	128
256	-3.2	256
512	-3.6	512*

** Note FAST TRIP may occur at this point, depending on its setting.*

XIV. Personal Safety System (PSS)

The Personal Safety System is designed to make the instrument useful as an area monitor. The system is self checking and will activate only under the following conditions;

1. Power is on
2. Unit is connected to AC power
3. Unit is not alarming
4. Unit is not in FAST TRIP
5. Unit has not detected a failure
6. PANEL DISABLE is locked

7. Instrument is working properly

Any one condition will cause the instrument to cancel PSS. Item #7 will cause the instrument to release PSS in 5 seconds. All the others will cause it to release in less than 1 second.

XV. REAR PANEL CONNECTORS/CABLES

A. I/O CONNECTOR PINOUT

PIN #	DESCRIPTION
1,7, 19	Ground
2	RS-232 input, Not used
3	RS-232 output, 9600 baud
4,17	RS-232 RTS, Not used
5,18	RS-232 CTS, Not used
6,8	RS-232 -10 V
10	LOGOUT +
11	LOGOUT -
12	+5VDC
13	GAMMA OUT
25	NEUTRON OUT

B. HEAD CONNECTOR

The Head connector is for the cable between the head and the read-out unit. The Cable that is used should be similar to BELDEN 9503. This cable has 3 twisted pairs, each pair in a bedfoil shield. No other cable is recommended. The connections to each end of the DB-9 connector are the same. The connections are;

WIRE PAIR	COLOR	PIN	COLOR	PIN
Red and Black pair:	Red	5	Black	9
White and Black pair	White	2	Black	7
Green and Black pair	Green	1	Black	6

Cables up to 100 feet are allowed. Longer cables can be used but will require a minor component value change. Please consult the factory.

C. PSS CONNECTOR

The PSS Connector is a Burndy 6 Pin Twist Lock connector. There are 2 sets of contacts, Contact set 1 and contact set 2. They are usually wired in series. If one set should stick closed, the other set can still open the circuit.

PIN #	DESCRIPTION
A	PSS Relay Contact 1A
B	PSS Relay Contact 1B
C	PSS Relay Contact 2A
D	PSS Relay Contact 2B
E	Logout Voltage
F	Logout Voltage

XVI. PART LIST

DESIGN	QUAN	PART NO	TYPE	DESCRIPTION	MFG	DRAWING #
C01	1	DD-500	50 pF 1000VDC	CAPACITOR CERAM DISK	CENTRALAB	2080-011
C02	1	DD-500	50 pF 1000VDC	CAPACITOR CERAM DISK	CENTRALAB	2080-011
C03	1	DD-1032	0.01uF 1000VDC	CAPACITOR CERAM DISK	CENTRALAB	2080-011
C04	1	DD-1032	0.01uF 1000VDC	CAPACITOR CERAM DISK	CENTRALAB	2080-011
C05	1	DD-5022	0.005uF 1000VDC	CAPACITOR CERAM DISK	CENTRALAB	2080-011
C06	1	551-10M10	10uF 10VDC	CAPACITOR TANT	PANASONIC	2080-011
C07	1	DD-5022	0.005uF 1000VDC	CAPACITOR CERAM DISK	CENTRLAB	2080-011
C08	1	581-UEZ103K1	0.01uF 50VDC	CAPACITOR MONO NPO	TRW	2080-011
C09	1	581-UEC102J1	0.001uF 50VDC	CAPACITOR MONO NPO	PANASONIC	2080-011
C10	1	581-UNW104M1	0.1uF 50VDC	CAPACITOR MONO CERAM	TRW	2080-011
C11	1	581-UNW104M1	0.1uF 50VDC	CAPACITOR MONO CERAM	TRW	2080-011
C12	1	581-UEZ103K1	0.01uF 50VDC	CAPACITOR MONO NPO	TRW	2080-011
C13	1	581-UEZ103K1	0.01uF 50VDC	CAPACITOR MONO NPO	TRW	2080-011
C14	1	551-10M10	10uF 10VDC	CAPACITOR TANT	PANASONIC	2080-011
C15	1	581-UN104M1	0.1uF 50VDC	CAPACITOR MONO CERAM	TRW	2080-011
C16	1	581-UN104M1	0.1uF 50VDC	CAPACITOR MONO CERAM	TRW	2080-011
C17	1	P1224	470uF 25VDC	CAPACITOR ELECT RADI	PANASONIC	2080-011
D1	1	1N4148		DIODE, HIGH SPEED		2080-011
D2	1	1N4148		DIODE, HIGH SPEED		2080-011
D3	1	1N4148		DIODE, HIGH SPEED		2080-011
D4	1	1N4148		DIODE, HIGH SPEED		2080-011
D5	1	MR818		DIODE, FAST REC 1KV	MOTOROLA	2080-011
D6	1	MR818		DIODE, FAST REC 1KV	MOTOROLA	2080-011
J1F	1	22-01-3067	6 PIN HOUSING	CONNECTOR .1 SIP	MOLEX	2080-011
J1M	1	22-01-2062	HEADER 6 PIN	CONNECTOR .1 SIP	MOLEX	2080-011
J2	1	409F-ND	D TYPE RIGHT ANGLE	CONNECTOR PC MOUNT	TEXTECHS	2080-011
Q1	1	2N4921	NPN POWER	TRANSISTOR		2080-011
Q2	1	2N4921	NPN POWER	TRANSISTOR		2080-011
R01	1	3.3M		RESISTOR 5% 1/4w CF		2080-011
R02	1	330K		RESISTOR 5% 1/4w CF		2080-011
R03	1	2K		RESISTOR 5% 1/4w CF		2080-011
R04	1	51K		RESISTOR 5% 1/4w CF		2080-011
R05	1	3.3M		RESISTOR 5% 1/4w CF		2080-011
R06	1	330K		RESISTOR 5% 1/4w CF		2080-011
R07	1	2K		RESISTOR 5% 1/4w CF		2080-011
R08	1	51K		RESISTOR 5% 1/4w CF		2080-011
R09	1	1M		RESISTOR 5% 1/4w CF		2080-011
R10	1	1M		RESISTOR 5% 1/4w CF		2080-011
R11	1	10K		RESISTOR 5% 1/4w CF		2080-011
R12	1	10K		RESISTOR 5% 1/4w CF		2080-011
R13	1	51K		RESISTOR 5% 1/4w CF		2080-011
R14	1	100		RESISTOR 5% 1/4w CF		2080-011
R15	1	1M		RESISTOR 5% 1/4w CF		2080-011
R16	1	MOX400 1KM		RESISTOR 5%	VICTOREEN	2080-011
R17	1	2.7M		RESISTOR 5% 1/4w CF		2080-011
R18	1	10K		RESISTOR 5% 1/4w CF		2080-011
R19	1	10K	10K	RESISTOR 5% 1/4w CF		2080-011
R20	1	5.1K		RESISTOR 5% 1/4w CF		2080-011
R21	1	5.1K		RESISTOR 5% 1/4w CF		2080-011
R22	1	1K		RESISTOR 5% 1/4w CF		2080-011
R23	1	1K		RESISTOR 5% 1/4w CF		2080-011
R24	1	1K		RESISTOR 5% 1/4w CF		2080-011
R25	1	3K		RESISTOR 5% 1/4w CF		2080-011
R26	1	1K		RESISTOR 5% 1/4w CF		2080-011
R27	1	3K		RESISTOR 5% 1/4w CF		2080-011
T1	1	M8149		TRANSFORMER, HV	MICROTRAN	2080-011
U1	1	LM393N		DUAL COMPARATOR	NATIONAL	2080-011
U2	1	MAX630CPA		VOLT CONV/REG SWITCH	MAXIM	2080-011
U3	1	14528		DUAL MONO		2080-011
U4	1	LP2950CZ-5.0		VOLT REGULATOR	NATIONAL	2080-011
V1	1	713		GM TUBE/DETECTOR	LND	2080-011
V2	1	713		GM TUBE/DETECTOR	LND	2080-011
B1-6	6	P50AA		BATTERY, NICAD AA	PANASONIC	2080-014
C01	1	21RD722	20 Pf 50 vdc	CAPACITOR MONO CERAM	TRW	2080-014
C02	1	21RD722	20 pF 50VDC	CAPACITOR MONO CERAM	TRW	2080-014
C03	1	P1225	1000 uF 25 VDC	CAPACITOR ELECTROLY	PANASONIC	2080-014
C04	1	581-UNW104M1	0.1 uF 50 VDC	CAPACITOR MONO CERAM	TRW	2080-014

DESIGN	QUAN	PART NO	TYPE	DESCRIPTION	MFG	DRAWING #
C05	1	P1221	100 uF 25 VDC	CAPACITOR ELECTRO RA	PANASONIC	2080-014
C06	1	P1221	100 uF 25 VDC	CAPACITOR ELECTRO RA	PANASONIC	2080-014
C07	1	581-UNW104M1	0.1 uF 50 VDC	CAPACITOR MONO CERAM	TRW	2080-014
C08	1	551-2.2M16	2.2 uF 16 VDC	CAPACITOR, TANTALUM	PANASONIC	2080-014
C09	1	P1218 26 VDC	22 uF 26 VDC	CAPACITOR, ELECTRO R	PANASONIC	2080-014
C10	1	P1218	22 uF 26 VDC	CAPACITOR, ELECTRO R	PANASONIC	2080-014

C11	1	P1218	22 uF 26 VDC	CAPACITOR, ELECTRO R	PANASONIC	2080-014
C12	1	P1218	22 uF 26 VDC	CAPACITOR, ELECTRO R	PANASONIC	2080-014
C13	1	581-UNW104M1	0.1 uF 50 VDC	CAPACITOR MONO CERAM	TRW	2080-014
C14	1	581-UNW104M1	0.1 uF 50 VDC	CAPACITOR MONO CERAM	TRW	2080-014
C15	1	581-UNW104M1	0.1 uF 50 VDC	CAPACITOR MONO CERAM	TRW	2080-014
C16	1	581-UNW104M1	0.1 uF 50 VDC	CAPACITOR MONO CERAM	TRW	2080-014
C17	1	581UEZ103K1	0.01 uF 50 VDC	CAPACITOR MONO CERAM	TRW	2080-014
C18	1	551-10M10	10 uF 50 VDC	CAPACITOR ELECTRO RA	PANASONIC	2080-014
C19	1	P1218	22 uF 25 VDC	CAPACITOR ELECTRO RA	PANASONIC	2080-014
C20	1	P1218	22 uF 25 VDC	CAPACITOR ELECTRO RA	PANASONIC	2080-014
D01	1	1N4148		DIODE, HIGH SPEED		2080-014
D02	1	1N4148		DIODE, HIGH SPEED		2080-014
D03	1	1N4148		DIODE, HIGH SPEED		2080-014
D04	1	1N5817		DIODE, SHOTKEY		2080-014
D05	1	1N4002		DIODE		2080-014
D06	1	1N4002		DIODE		2080-014
D07	1	1N4148		DIODE, HIGH SPEED		2080-014
D08	1	1N4148		DIODE, HIGH SPEED		2080-014
D09	1	1N4148		DIODE, HIGH SPEED		2080-014
D10	1	1N4148		DIODE, HIGH SPEED		2080-014
D11	1	1N4148		DIODE, HIGH SPEED		2080-014
D12	1	1N4148		DIODE, HIGH SPEED		2080-014
D13	1	1N4002		DIODE		2080-014
DS1	1	HLMP-2685		LED BAR RED	HP	2080-014
DS2	1	HLMP-2785		LED BAR YEL	HP	2080-014
DS3	1	HLMP-2885		LED BAR GRN	HP	2080-014
FL1	1	1ED1	HIGH PERFORMANCE	LINE FILTER	CORCOM	2080-014
J1	1	31-10	BNC ISOLATED	CONNECTOR, PANEL	AMPHENOL	2080-014
J2F	1	R232-ND	.1x.1 34 PIN	HEADER, RA PC MOUNT	CW	2080-014
J2M	1	R305-ND	.1x.1 34 PIN	CONNECTOR MAS TERM	CW	2080-014
J3F	1	409F-ND	D TYPE RIGHT AGLE	CONNECTOR PC MOUNT	TEXTECHS	2080-014
J3M	2	109M-ND	D TYPE SOLDER CUP	CONNECTOR MACHINED	TEXTECHS	2080-014
J3MB	2	909Z-ND	D TYPE 9 PIN	CONNECTOR METAL HOOD	TEXTECHS	2080-014
J4AF	1	22-01-3067	HOUSING, WIRE	CONNECTOR 6P SIP	MOLEX	2080-014
J4BF	1	22-01-3027	HOUSING, WIRE	CONNECTOR 2P SIP	MOLEX	2080-014
J4M	1	22-12-2084	HEADER, RIGHT ANGLE	CONNECTOR SIP 8P	MOLEX	2080-014
J5	1	725F-ND	D TYPE RIGHT ANGLE	CONNECTOR PC MOUNT	TEXTECHS	2080-014
J6	1	KPT-02-E10-6P	QUICK RELEASE	CONNECTOR CIRCULAR	CANNON	2080-014
J7F	2	IDS-14G	SIP	CONNECTOR, 14P WIRE	PANDUIT	2080-014
J7M	1	TSW 114-076S	SIP	CONNECTOR, 14 P HDR	PANDUIT	2080-014
LS1	1	X70PO6		HORN, LOUD	PROJUNL	2080-014
Q1	1	2N6125	PNP POWER	TRANSISTOR		2080-014
Q2	1	IRF511-ND	FET, POWER N CHANNEL	TRANSISTOR	INT RECT	2080-014
Q3	1	IRF511-ND	FET, POWER N CHANNEL	TRANSISTOR	INT RECT	2080-014
Q4	1	IRF511-ND	FET, POWER N CHANNEL	TRANSISTOR	INT RECT	2080-014
Q5	1	IRF511-ND	FET, POWER N CHANNEL	TRANSISTOR	INT RECT	2080-014
Q6	1	IRF511-ND	FET, POWER N CHANNEL	TRANSISTOR	INT RECT	2080-014
Q7	1	VN10KM	FET, POWER N CHANNEL	TRANSISTOR	SILICONIX	2080-014
R01	1	10M		RESISTOR, 5% 1/4w CF		2080-014
R02	1	180		RESISTOR, 5% 1/4w CF		2080-014
R03	1	1K		RESISTOR, 5% 1/4w CF		2080-014
R04	1	68		RESISTOR, 5% 1/4w CF		2080-014
R05	1	NOT USED		RESISTOR, 5% 1/4w CF		2080-014
R06	1	2k		RESISTOR, 5% 1/4w CF		2080-014
R07	1	1.1K		RESISTOR, 5% 1/4w CF		2080-014
R08	1	51K		RESISTOR, 5% 1/4w CF		2080-014
R09	1	1.1K		RESISTOR, 5% 1/4w CF		2080-014
R10	1	2K		RESISTOR, 5% 1/4w CF		2080-014
R11	1	NOT USED		RESISTOR, 5% 1/4w CF		2080-014
R12	1	51K		RESISTOR, 5% 1/4w CF		2080-014
R13	1	180		RESISTOR, 5% 1/2w CF		2080-014
R14	1	0		RESISTOR, 5% 1/4w CF		2080-014
R15	1	100K		RESISTOR, 5% 1/4w CF		2080-014
R16	1	10K		RESISTOR, 5% 1/4w CF		2080-014

DESIGN	QUAN	PART NO	TYPE	DESCRIPTION	MFG	DRAWING #
R17	1	100K		RESISTOR, 5% 1/4w CF		2080-014
R18	1	1M		TRIMMER 3/8 TOP 20T		2080-014
R19	1	100K		RESISTOR 5% 1/4w CF		2080-014
R20	1	NOT USED		RESISTOR 5% 1/4w CF		2080-014
R21	1	1M		TRIMMER 3/8 TOP 20T		2080-014
R22	1	100K		RESISTOR, 5% 1/4w CF		2080-014
R23	1	4.7M		RESISTOR, 5% 1/4w CF		2080-014
R24	1	249K	1%	RESISTOR, RN55D		2080-014
R25	1	1M		RESISTOR, 5% 1/4w CF		2080-014
R26	1	7.5M		RESISTOR, 5% 1/4w CF		2080-014
R27	1	100K		RESISTOR, 5% 1/4w CF		2080-014
R28	1	10K		RESISTOR, 5% 1/4w CF		2080-014
R29		10K		RESISTOR, 5% 1/4w CF		2080-014
R30	1	20K		TRIMMER, 3/8 SIDE 1T		2080-014
R31	1	3K		RESISTOR, 5% 1/4w CF		2080-014
R32	1	1K		RESISTOR, 5% 1/4w CF		2080-014

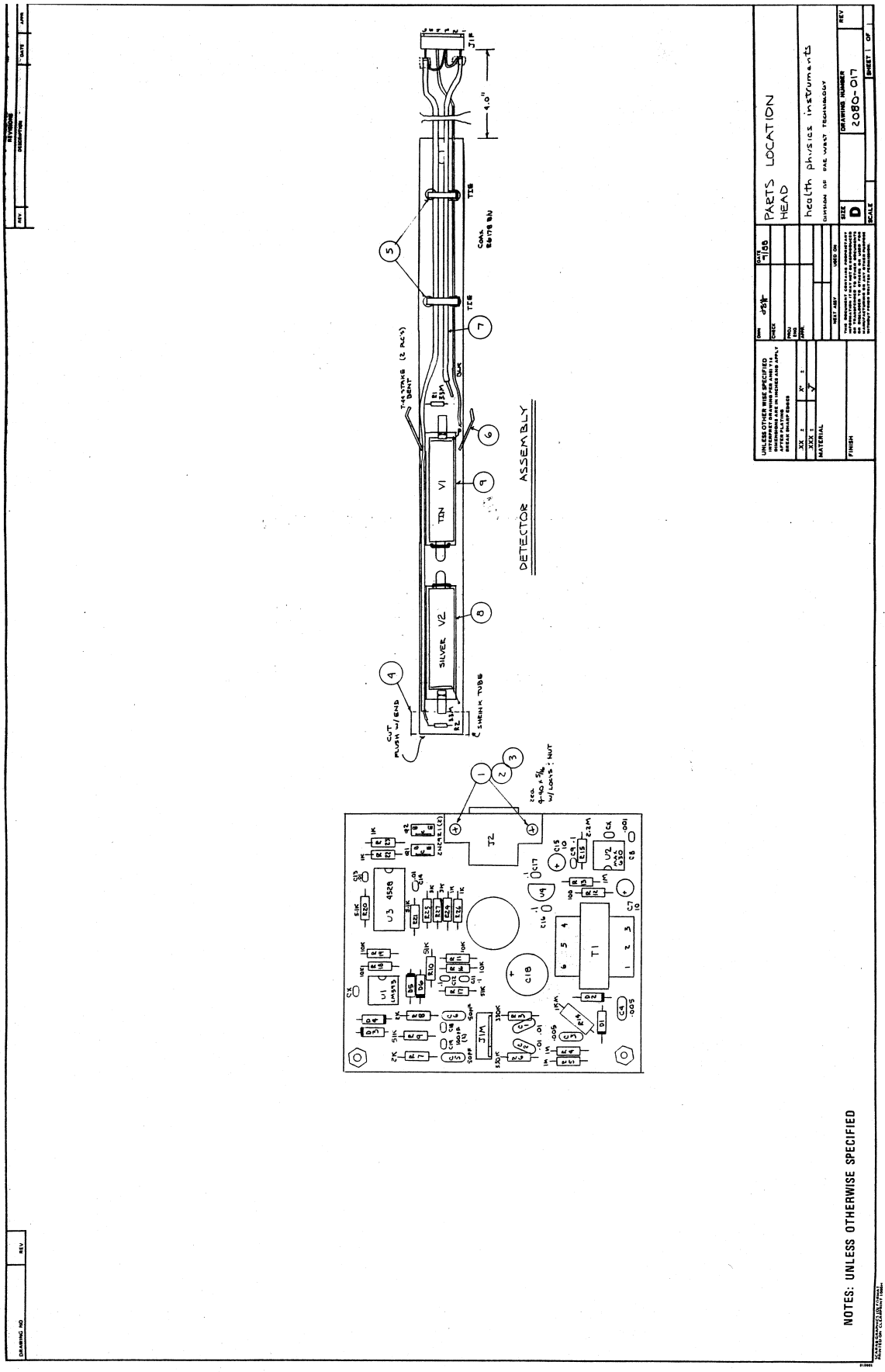
R33	1 100K	3/8 TOP 20TURN	RESISTOR, TRIMMER		2080-014
R34	1 100.0K		RESISTOR, RN55D		2080-014
R35	1 499.0K	1%	RESISTOR, RN55D		2080-014
R36	1 100K	3/8 TOP 20 TURN	RESISTOR, TRIMMER		2080-014
R37	1 499.0K	1%	RESISTOR RN55D		2080-014
R38	1 1K		RESISTOR, 5% 1/4w CF		2080-014
R39	1 1K		RESISTOR, 5% 1/4w CF		2080-014
R40	1 82		RESISTOR, 5% 1w CF		2080-014
R41	1 82		RESISTOR, 5% 1w CF		2080-014
R42	1 82		RESISTOR, 5% 1w CF		2080-014
R43	1 NOT USED		RESISTOR, 5% 1w CF		2080-014
R44	1 NOT USED		RESISTOR, 5% 1w CF		2080-014
R45	1 470K		RESISTOR, 5% 1/4w CF		2080-014
R46	1 470K		RESISTOR, 5% 1/4w CF		2080-014
R47	1 10K		RESISTOR, 5% 1/4w CF		2080-014
R48	1 1K		RESISTOR, 5% 1/4w CF		2080-014
R49	1 200		RESISTOR, 5% 1/4w CF		2080-014
R50	1 10K	1 TURN 2 WATT	RESISTOR, POTENTIOM		2080-014
RN1	1 Q9104	100K X 9 1 COM	RESISTOR NETWORK	MATSUSHITA	2080-014
RN2	1 Q9104	100K X 9 1 COM	RESISTOR NETWORK	MATSUSHITA	2080-014
RN3	1 Q9104	100K X 9 1 COM	RESISTOR NETWORK	MATSUSHITA	2080-014
RN4	1 316L08503	316L08503	RESISTOR NET 2-2R 50	ALLEN BRAD	2080-014
RN5	1 Q6103	10K X 5 SEPARATE	RESISTOR NETWORK	MATSUSHITA	2080-014
RN6	1 Q9104	100K X 9 1 COM	RESISTOR NETWORK	MATSUSHITA	2080-014
RY1	1 W171DIP-21	DIP 2A 5V 200 OHM	RELAY, REED	MAGNACRAFT	2080-014
S1	1 EVQ-QS205K		SWITCH PUSH MIN	PANASONIC	2080-014
S2	1 7105J51ZBE	(ON) OFF (ON)	SWITCH SPDT	C&K	2080-014
S3	1 7105J51ZBE	(ON) OFF (ON)	SWITCH SPDT	C&K	2080-014
S4	1 8125J83ZBE	PUSH BUTTON	SWITCH SPDT	C&K	2080-014
S5	1 8125J83ZBE	PUSH BUTTON	SWITCH SPDT	C&K	2080-014
S6	1 7105J51ZBE	(ON) OFF (ON)	SWITCH SPDT	C&K	2080-014
S7	1 7101J51ZQ	ON NONE ON	SWITCH SPDT	C&K	2080-014
S8	1 Y101-1U	KEY	SWITCH, DPDT	C&K	2080-014
T1	1 241-5-16	110 VAC INPUT	TRANSFORMER	SIGNAL	2080-014
U01	1 74HC4040		BINARY DIVIDER		2080-014
U02	1 MC1456805E2P		MICROPROCESSOR 8BIT	MOTOROLA	2080-014
U03	1 74HC573		OCTAL LATCH		2080-014
U04	1 27C32Q-45		32K EPROM	NATIONAL	2080-014
U05	1 SSM11606SYA	SUPERTWIST 16 X 1	DISPLAY, LCD	SHELLY	2080-014
U06	1 SCC2691AC1N24		UART	SIGNETICS	2080-014
U07	1 MAX232 CPE		RS232 DRIVER/CONV	MAXIM	2080-014
U08	1 HCPL2200		OPTO COUPLER	HP	2080-014
U09	1 6N139		OPTO COUPLER	HP	2080-014
U10	1 6N139		OPTO COUPLER	HP	2080-014
U11	1 CDP1878CE		DUAL COUNTER	RCA	2080-014
U12	1 74HC139		DUAL 2-4 DECODER		2080-014
U13	1 74HC138		3-8 DECODER		2080-014
U14	1 MC146823P		PERPH INTERF ADAPTER	MOTOROLA	2080-014
U15	1 LF356N		OP AMP	NATIONAL	2080-014
U16	1 14538		DUAL PREC. MONOSTAB		2080-014
U17	1 LP2950 CZ 5.0	5 VOLT	VOLT REGULATOR	NATIONAL	2080-014
U18	1 ICL7665CPA		DUAL VOLT DETECTOR	MAXIM	2080-014
U19	1 ICL7665CPA		DUAL VOLT DETECTOR	MAXIM	2080-014
U20	1 ICL7660CPA		VOLT CONVERTER	MAXIM	2080-014

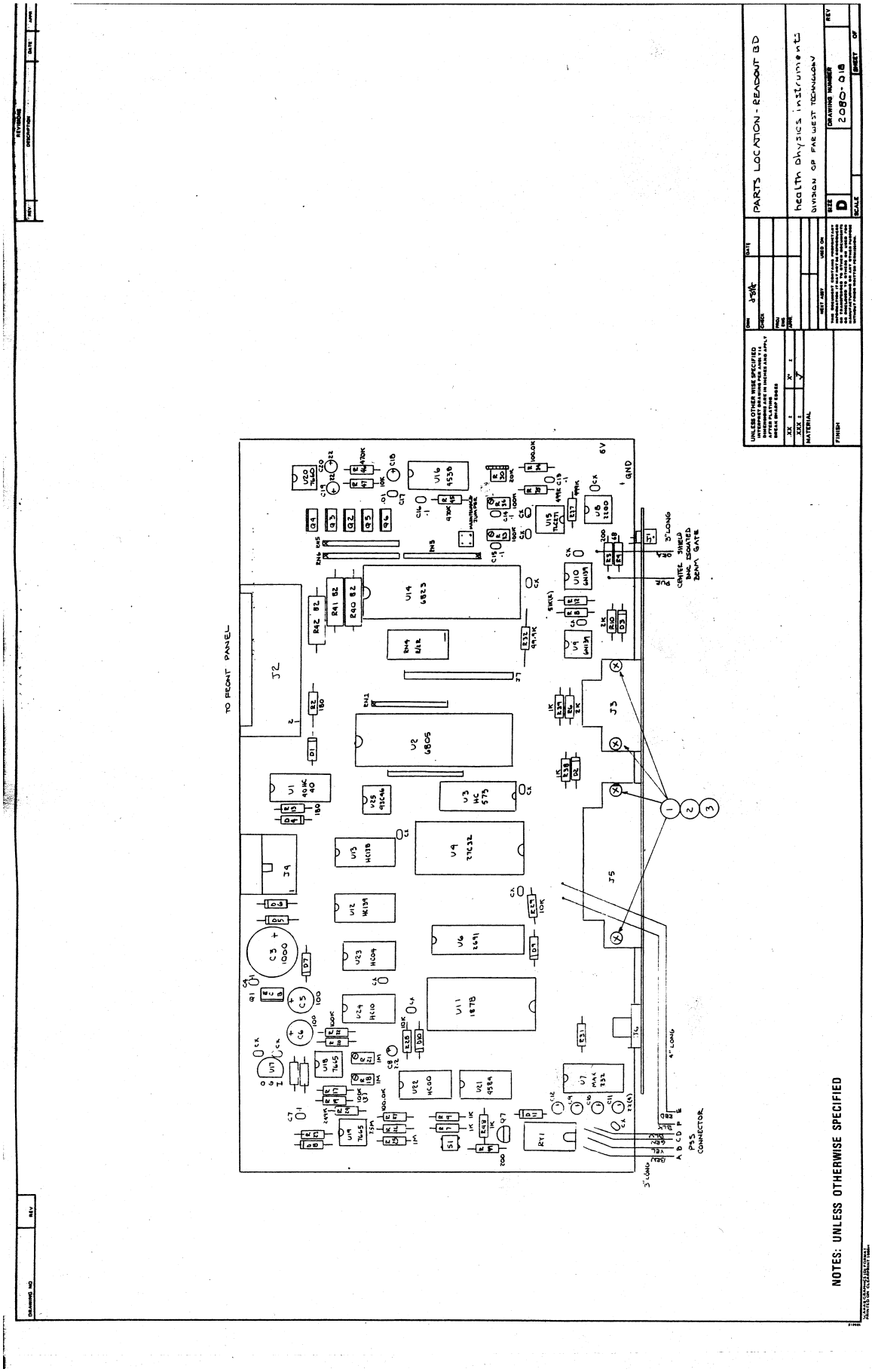
DESIGN	QUAN	PART NO	TYPE	DESCRIPTION	MFG	DRAWING #
U21	1	14584		HEX SCH TRIGGER		2080-014
U22	1	74HC00		QUAD NAND		2080-014
U23	1	74HC04		HEX INVERTER		2080-014
U24	1	74HC10		3 INP NAND		2080-014
U25	1	93C46P	1024 BIT	EEPROM	ICT	2080-014
W1	1	LL14847		CORDSET	BELDEN	2080-014
X1	1	1/4 3AG		FUSE	BUSSMAN	2080-014
Z1	1	P7063		TRANSORB	MITSUBISHI	2080-014
Z1	1	SRX1019	3.6864 MHz	CRYSTAL, MICROP	NYMPH	2080-014
1	2	4-40x5/16		SCREW MACH PAN PH PS		2080-017
2	2	#4		LOCKS, INT STAR		2080-017
3	2	4-40		NUT		2080-017
4	1	1/2 INCH		TUBING, SHRINK		2080-017
5	4			TIE, 3 INCH		2080-017
6	2	T44		STAKE	VECTOR	2080-017
7	2	RG-179B/U		COAX, MIN 10" LONG		2080-017
8	1	SF-2080		FOIL, SILVER 99%		2080-017
9	1	16418		FOIL, TIN .0005	KODAK	2080-017
1	4	4-40x5/16		SCREW MACH PAN PH PL		2080-018
2	4	#4		LOCKS, INT STAR		2080-018
3	4	4-40		LOCKS, INT STAR		2080-018
01	1	2080-001		PSEUDOSPHERE	HPI	2080-019
02	1	2080-002		HANDLE,SIDE RAIL	HPI	2080-019
03	1	2080-003		HANDLE	HPI	2080-019
04	1	2080-005		COVER, HEAD	HPI	2080-019
05	1	2080-004		BASE, HEAD	HPI	2080-019

06	1	2080-007		ENCLOSURE, TOP	HPI	2080-019
07	1	2080-006		ENCLOSURE, BOTTOM	HPI	2080-019
08	4	4-40x1/4		SCREW,MACHINE W/LOK		2080-019
09	2	4-40		NUT		2080-019
10	2	#4		LOCKS, INT STAR		2080-019
11	1	2080-017		PCB ASSY	HPI	2080-019
12	2	341-1321-008		SPACER, NYLON	EFJOHNSON	2080-019
13	2	#4		LOCKWASHER, C		2080-019
15	2	4-40x1/2		SCREW,MACHINE PAN PS		2080-019
16	2	7230		SCREW, JACK	KEKYSTONE	2080-019
17	2			WASHER, FLAT		2080-019
18	2	10-32x1		SCREW MACH PAN PH PS		2080-019
19A	2	3/8-24x3/4		SHCS, BLACK OXIDE		2080-019
19B	2	99-609-0		THUMBSCREW, KNOB		2080-019
20	4	1/4 x 1 1/4		SCREW, LAG		2080-019
21A	4	6-32x3/8		SCREW MACH PAN PH PS		2080-019
21B	4	#6		WASHER, NYLON		2080-019
22	1	2080-022		TUBE, SHIELD	HPI	2080-019
23	1	2080-014/S8		KEYSWITCH		2080-020
24	4	2-56		NUTS		2080-020
25	4	#2		LOCKS, INT STAR		2080-020
26	1	TSW 114-07GS	HEADER 14 PIN	CONNECTOR, PC MOUNT	PANDUIT	2080-020
27	1	2080-016		CABLE, LCD	HPI	2080-020
28	1	2080-014/U5		DISPLAY, LCD		2080-020
29	4	341-321-008		SPACER, NYLON	EFJOHNSON	2080-020
30	1	2080-014/S4		SWITCH		2080-020
31	1	2080-014/S3		SWITCH		2080-020
33	1	2080-014/S5		SWITCH		2080-020
34	1	2080-014/S6		SWITCH		2080-020
35	1	2080-014/S7		SWITCH		2080-020
36	1	2080-014/DS1		LED, BAR RED		2080-020
37	1	2080-014/DS2		LED, BAR YEL		2080-020
38	1	2080-014/DS3		LED, BAR GRN		2080-020
39	3	HLMP-2899		BEZEL, LED BAR	HP	2080-020
40	1	ME352-0002		BEZEL, LED	MOUSER	2080-020
41	1	2080-014/D12		LED, RED T 1 3/4		2080-020
42	1	BK-HTA		HOLDER, FUSE	BUSSMAN	2080-020
43	1	2080-014/FLI		FUSE, 1/4 A	BUSSMAN	2080-020
44	2	BH-3AA		HOLDER, BATTERY	MEM PROT D	2080-020
45	1	2080-014/T1		TRANSFORMER		2080-020
46	1	2080-021L		CARD GUIDE	HPI	2080-020
47	1	2080-021R		CARD GUIDE	HPI	2080-020
48	1	2080-014/J2		CONNECTOR		2080-020
49	1	R6006-ND	MULTICOLOR	CABLE, RIBBON 34 CND	OKI	2080-020

DESIGN	QUAN	PART NO	TYPE	DESCRIPTION	MFG	DRAWING #
50	4	2-56x5/8		SCREW MACH PAN PH PL		2080-020
51	4	2-56x3/16		SCREW MACH PAN PH PL		2080-020
52	2	8-32		NUT		2080-020
53	2	#8		LOCKS, INT STAR		2080-020
54	2	6-32x3/8		SCREW MACH PAN PH PL		2080-020
55	2	6-32x3/8		SCREW MACH PAN PH PL		2080-020
56	4	4x1/4		SCREW TAPPING PAN PH		2080-020
57	2	8-32x1/2		SCREW MACH PAN PH PS		2080-020
58	1	2080-018		CIRCUIT BOARD ASSY	HPI	2080-020
59	1	2080-010D		CIRCUIT BOARD ASSY	HPI	2080-020
60	1	2080-008		CONNECTOR, PANEL	HPI	2080-020
61	4	4-40x5/8		SCREW MACH PAN PH PS		2080-020
62	1	2080-014/J6		CONNECTOR		2080-020
63	4	#4		LOCKS, INT STAR		2080-020
64	4	4-40		NUT		2080-020
65	1	2080-014/J1		CONNECTOR		2080-020
66	1	2080-014/LS1		HORN, LOUD		2080-020
67	2	#6		LOCKS, INT STAR		2080-020
1	1	PCG-3		CARD GUIDE MATERIAL	RICHCO	2080-021
1	1	5/8 DIA X 8"		TUBE, SS WELDED	TUBE SALES	2080-022

XVII. SCHEMATICS


DETECTOR ASSEMBLY
PARTS LOCATION
HEAD
health physics instruments
DRAWING NUMBER
2080-017
NOTES: UNLESS OTHERWISE SPECIFIED


PARTS LOCATION - READOUT BD
health physics instruments
DIVISION OF EAGLE TECHNOLOGY
2080-018
NOTES: UNLESS OTHERWISE SPECIFIED
TO FRONT PANEL
GND
6V
CENTER SHIELD BNC MOUNTED BEAM GATE
3" LONG
4" LONG
PS5 CONNECTOR
A B C D E
J1
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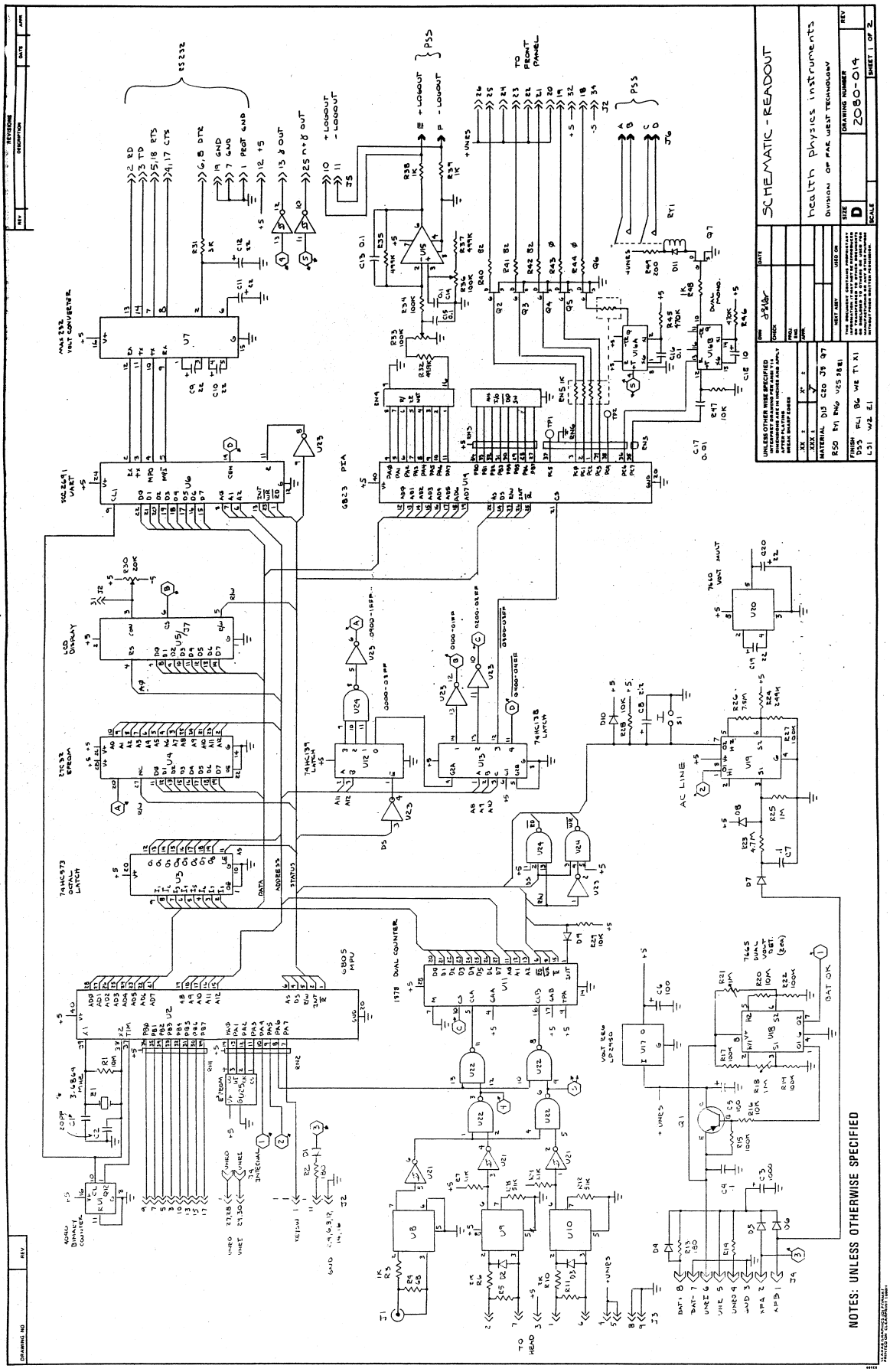
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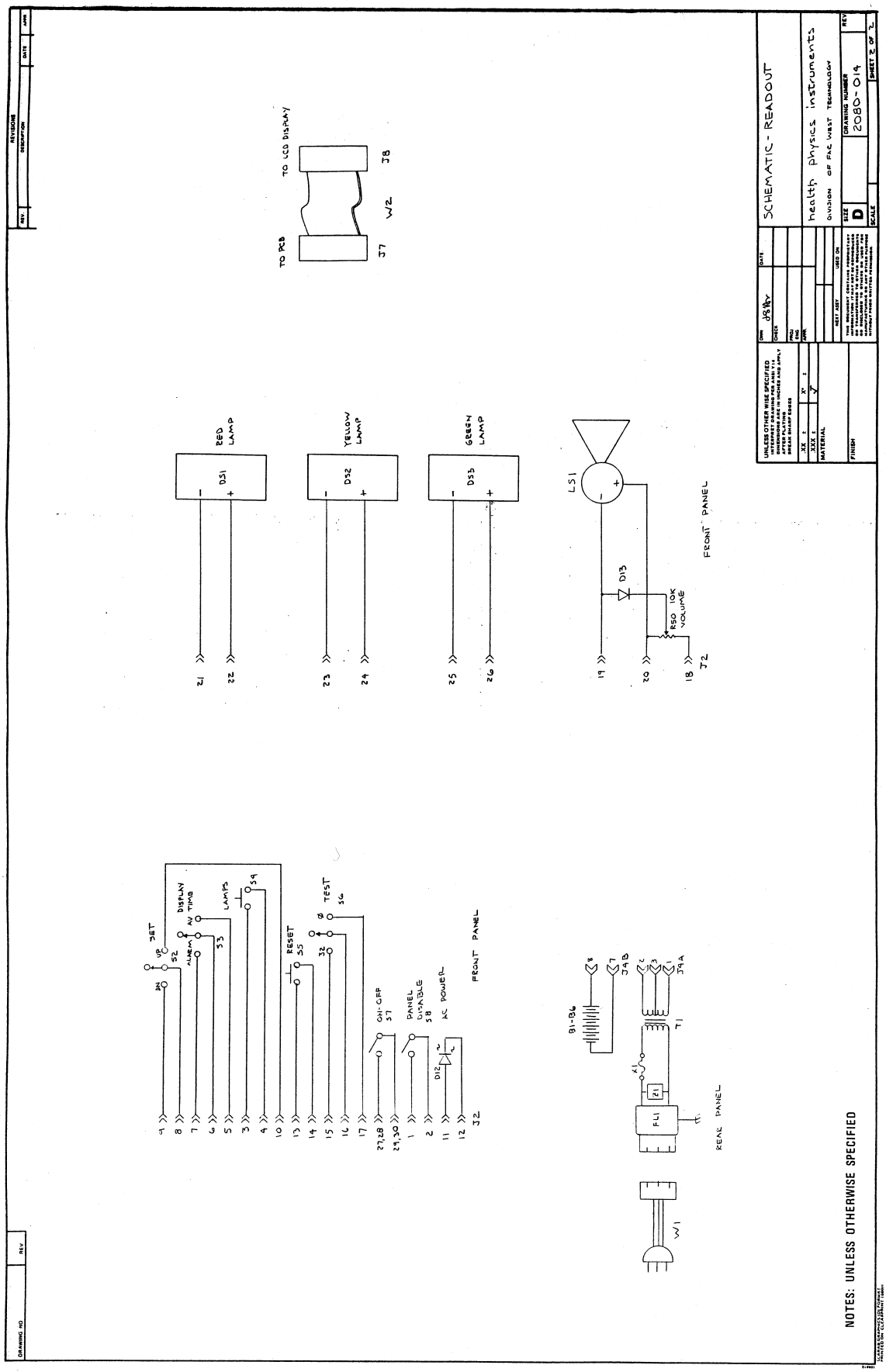
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W2
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RED LAMP
YELLOW LAMP
GREEN LAMP
DS1
DS2
DS3
LS1
D13
R50 10K VOLUME
FRONT PANEL
J2
SET
UP
S2
DISPLAY AV TIME
ALARM
S3
LAMPS
S9
RESET
S5
TEST
S6
ON-OFF
S7
PANEL LIGHTABLE
S8
AC POWER
D12
B1-B6
J4A
J4B
T1
F1
K1
W1
REAR PANEL
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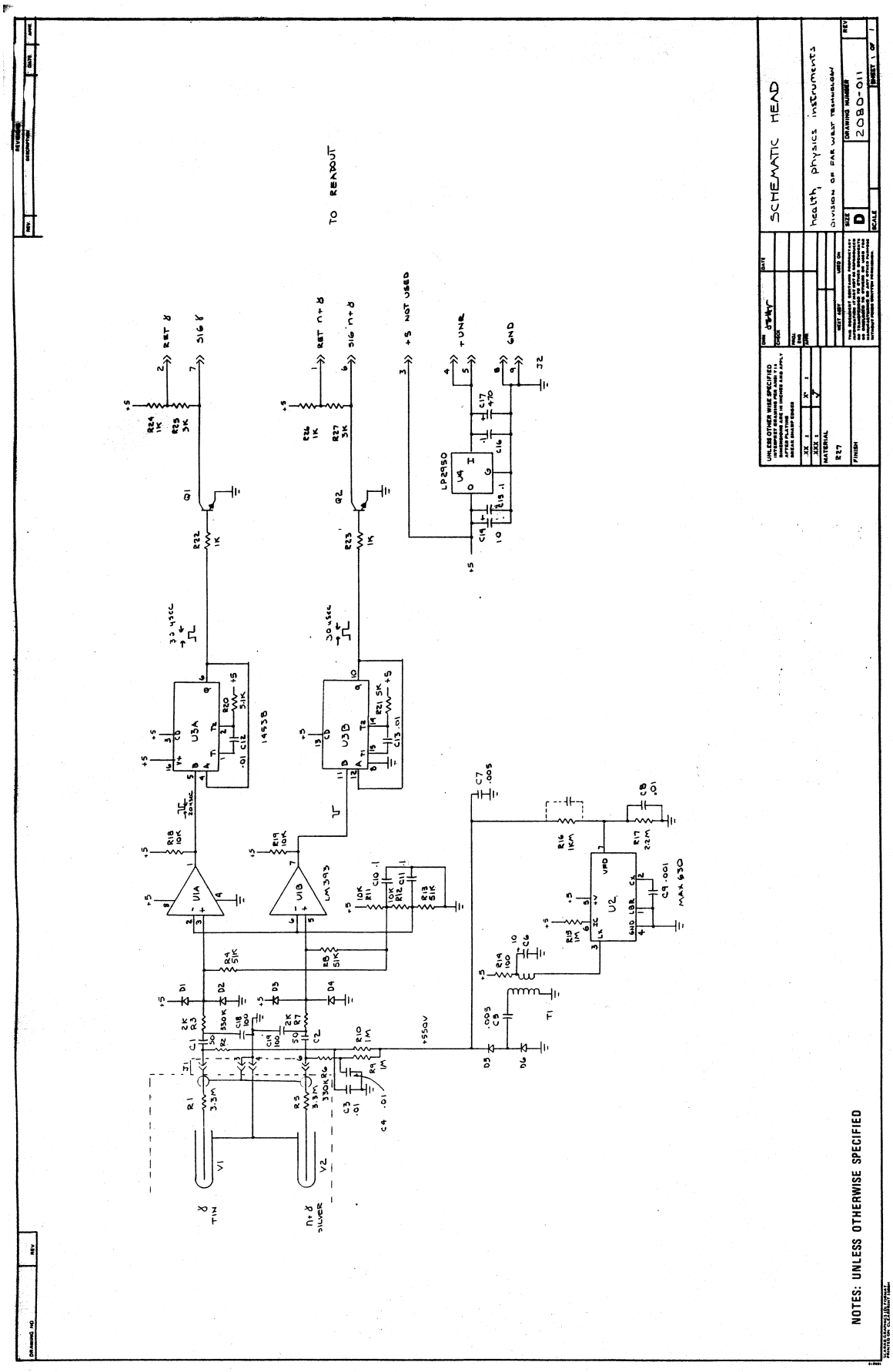
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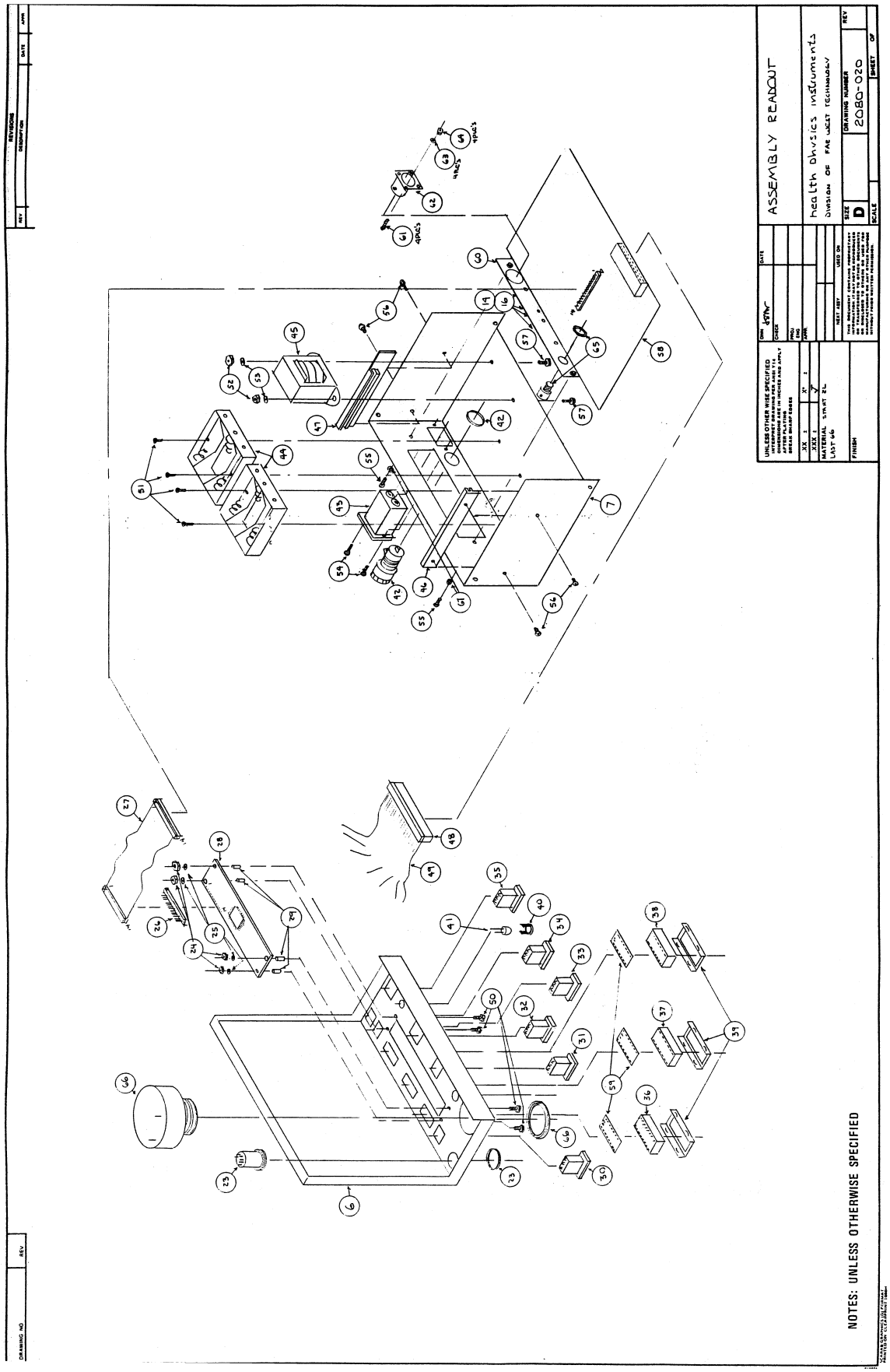
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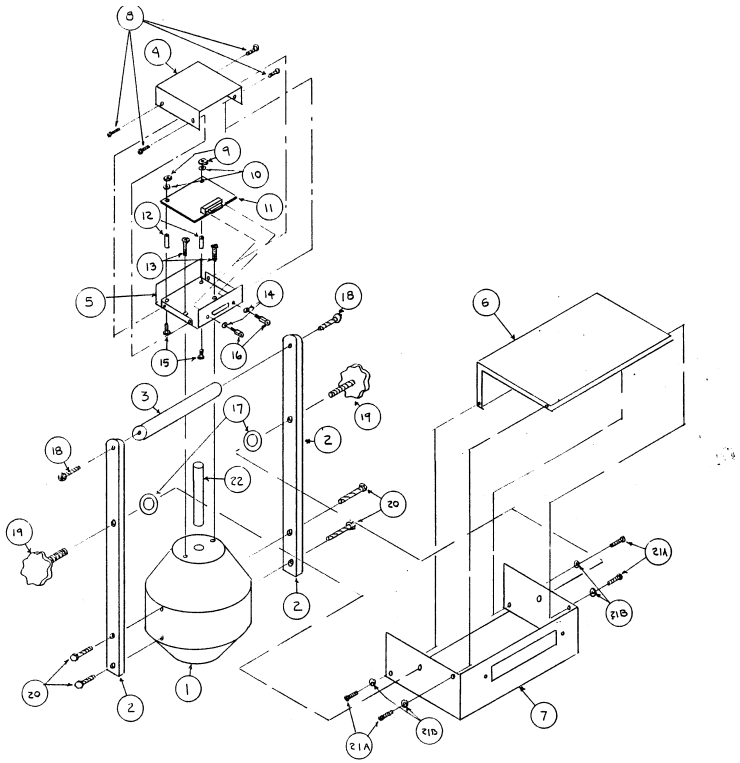

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