INSTRUCTION MANUAL

MODEL 2030

XRAY MONITOR

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Version 1

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I. INTRODUCTION

The Model 2030 Xray monitor is designed to be used as an area monitor for low energy gamma or x radiation. It has several alarms and trip points that are user set. The front panel display shows the radiation level and the status of the instrument.

The following manual will discuss the various settings and functions of the instrument.

II. OPERATION

The operation of the 2030 is very simple. The first line of the display shows the number of counts per second from the detector. It is updated every second. The second line shows the status of the alarms and is updated every .1 second. The lights on the front panel also show the status of the alarms. There are no controls that are accessible from the front panel.

When the instrument is first turned on there is a wait until the instrument stabilizes. The number of seconds remaining until normal operation begins is shown on the display along with the version number of the software. The detector will take longer than the wait period to completely stabilize to background levels, however this should not effect the alarms because the level is close to background.

The detector is sensitive to mechanical shock. Tapping on the metal part of the detector with a screwdriver will cause the detector to read and alarm if the alarms are set low enough. Large electrical disturbances such as arc welders that are in the vicinity of the detector may also cause it to alarm if the settings are low enough. We recommend that you experiment with the alarm setting to achieve the optimum settings.

III. INSTALLATION

The 2030 is easily installed. It consists of 2 parts, the detector unit and the display unit. There is a single 4 wire connection between the two. Each unit has a terminal strip for connections. The terminal strip unplugs from the circuit board to permit removal of the units without unscrewing the cable. The detector and display can be remoted up to 100 feet. We recommend Belden 8723. This is a 2 pair shielded cable. For short distances any 4 conductor cable will work. For longer distances or if it is used in a noisy environment we recommend a shielded cable.

DETECTOR

The detector is installed by first mounting the mounting bracket. The detector unit may be mounted in any orientation. It is best if the side of the detector faces the radiation source. The detector sets into the mounting bracket and is held in place with the two thumbscrews.

Remove the cover of the detector by removing the four screws on the sides of the box. On one edge of the circuit board is a terminal strip. Push the connector with the four wires of the 4 conductor cable onto the terminal strip according to figure 1. The cable leads out the side of the enclosure near the terminal strip. Replace the cover. This completes the installation of the detector.

DETECTOR CONNECTIONS

PIN #	DESCRIPTION	WIRE COLOR To Display	USE
1	+12 VDC Input		External Power
2	Ground Input		External Power
3	+12 VDC	RED	To Display
4	Ground	BLACK	To Display
5	DATA	WHITE	To Display
6	DATA	GREEN	To Display
7	Not Used		
8	Not Used		

Do not connect the shield for the cable to the display at this end.

The detector is supplied with a 4 place terminal strip mounted in position 3,4,5 and 6. The additional connections to pin # 1 and 2 are made by installing a 2 place terminal strip, PN #EDZ950/2 and #EDSTLZ950/2. The edge of the latter will need to be removed to fit.

DISPLAY

The display is installed by first mounting the mounting bracket. The display unit may be in any orientation. The display sets into the mounting bracket and is held in place with the two thumbscrews. There are 2 cables that connect to the display. The first is the 2 conductor power cable from the wall mounted power supply. The second is the 4 conductor cable from the detector. In addition, wires for RS-232, external alarms, or remote drivers may also be connected to the terminal strip.

Remove the bottom half of the front panel by removing the two screws on the front panel and the single screw on the bottom. The power cable and detector cable are connected according to figure 1. Additional cables may be connected to the display as needed for RS-232, relay contacts, or other needs. The cable leads out through the openings on the bottom of the display. Replace the cover unless you want to change the factory settings. There is no on-off switch since this instrument should be operational 24 hours a day. The only way to turn it on and off is to plug and unplug the wall transformer. After the instrument is installed it may be turned on by plugging in the wall transformer. See section X Maintenance/testing/display for testing alarms.

INTERFERENCE

Interference can cause annoying false alarms. The most likely cause of interference is from noisy AC switches and lamp dimmers. Plugging the 2030 into a line filter, or the offending product into a line filter can help to eliminate the interference.

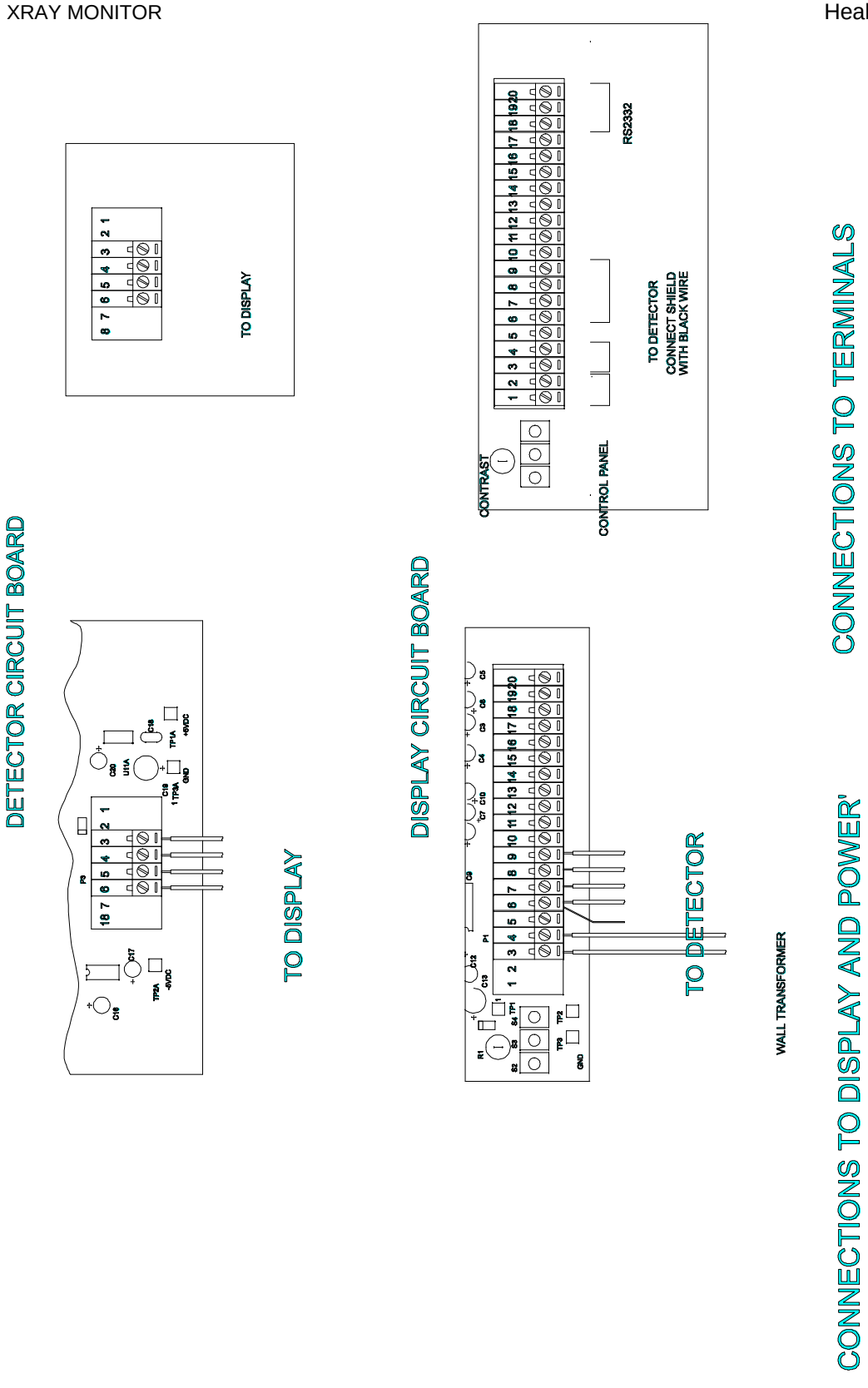


Figure 1 CONNECTION BETWEEN DISPLAY AND DETECTOR

DISPLAY CONNECTIONS

PIN #	DESCRIPTION	WIRE COLOR To Detector	USE
1	+12 VDC Input		External Power
2	Ground		External Power
3	Ground		Wall Transformer
4	+12 VDC Input		Wall Transformer
5	+5 VDC		External Use
6	Ground	Black	To Detector (also shield)
7	+12 VDC Output	RED	To Detector
8	Data *	Green	To Detector
9	Data	White	To Detector
10	Relay NC		External Alarm
11	Relay C		External Alarm
12	Relay NO		External Alarm
13	+12 VDC Output		External Relay
14	Relay Driver		External Relay
15	External Output		
16	External Output		
17	Ground		
18	Ground		RS232
19	TX		RS232
20	RX		RS232

A summary of the pins on the terminal strip.

Pin # 1 is a diode isolated + 12 V input for battery backup.
Pin # 2 is the ground for battery backup.
Pin # 3 is Ground for the wall transformer.
Pin # 4 is the +12 VDC input from the wall transformer.
Pin # 5 is a +5 VDC output available for any need. Max 100 mA from this output.
Pin # 6 is the ground for the cable to the detector.
Pin # 7 is the +12 VDC output for the cable to the detector.
Pin # 8 is the Data* from the detector. It is part of the cable to the detector.
Pin # 9 is the Data from the detector. It is part of the cable to the detector.
Pin # 10 is the NC contact from the Relay.
Pin # 11 is the center pole of the relay contact.
Pin # 12 is the N0 contact from the Relay. The relay is operated in the fail-safe mode.
Pin # 13 is a +12VDC output available for use.
Pin # 14 is a relay driver.
Pin # 15 is an extra relay driver.
Pin # 16 is an extra output.

Pin # 17 is ground.
Pin # 18 is ground and is used for the RS232/485.
Pin # 19 is TX part of RS232/485.
Pin # 20 is RX part of RS232/485.

CONTACT CLOSURE FOR EXTERNAL ALARM

The contact closure from the internal relay is on pins 10,11 and 12. Normally an external alarm would be connected between pin 11 and 12. This alarm operates in the fail-safe mode. If you were to remove power to the display, the relay would open closing contacts on pin 11 and 12. Contacts rated 0.5 A 115 VAC, 1 A 24 VDC resistive.

REMOTE RELAY DRIVER

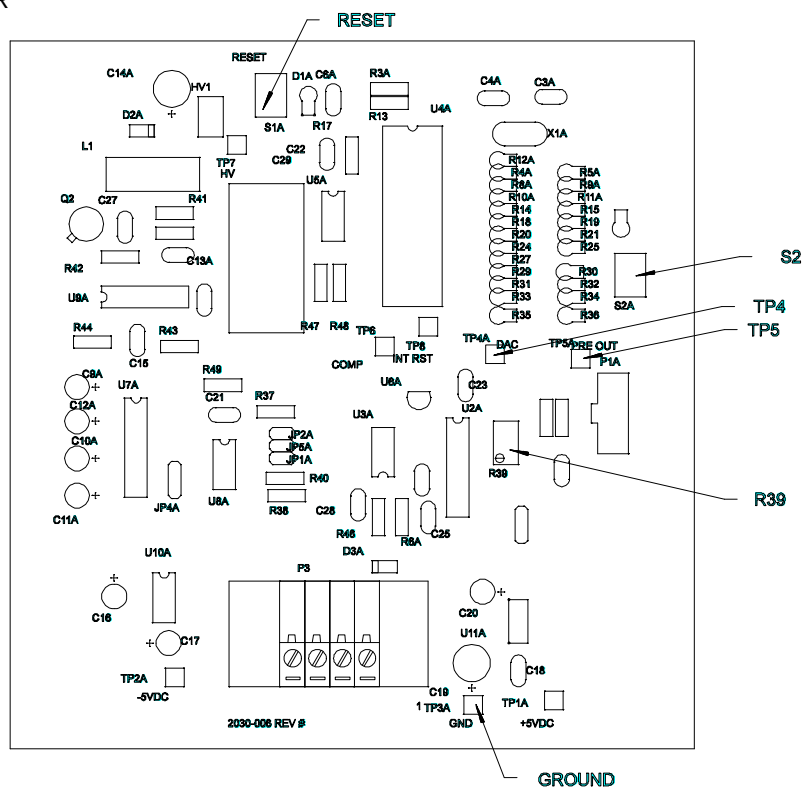
If you do not want to use the internal relay you can install an external 12 volt relay between pin # 13 and 14. Remove the internal relay before connecting an external relay. The relay should not draw more than 300 mR.

EXTRA DRIVERS

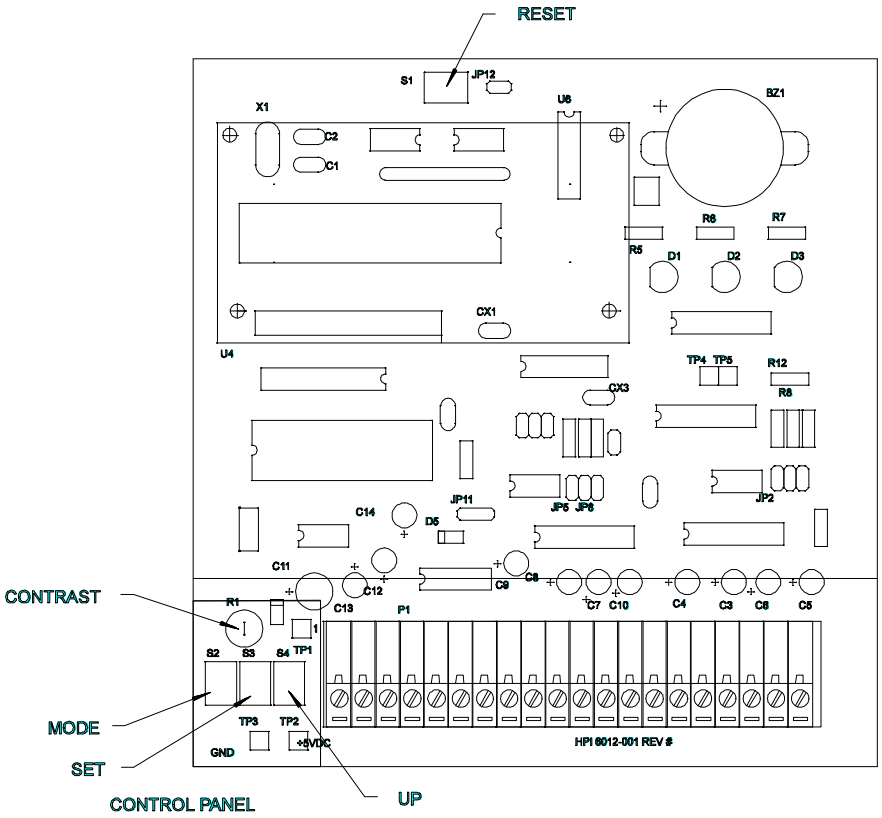
Extra drivers are available on pins 15 and 16. PIN 15 driver duplicates the Remote Relay Driver but is not fail-safe. Pin # 16 is programmable (See section on setup). Both are open collector drivers that need their load between ground and either +5 volts or +12 volts.

RS232/485

An RS232 output is available between pin 18 (ground) and pin 19 (TX). The status is output every second. Pin 20 (RX) is not supported in this version nor is the RS485.



DETECTOR CIRCUIT BOARD



DISPLAY CIRCUIT BOARD

FIGURE 2 CONTROLS, ADJUSTMENT AND CONTROL PANEL

IV. CONTROL PANEL

The control panel is in the display unit under the bottom half of the front panel. Remove the two screws on the front panel and the single screw on the bottom. The control panel is located on the left side of the circuit board and consists of the three push-buttons and the small round trimmer above them (see Figure 2). The three buttons are from left to right, MODE, SET and UP. These names are derived from their use during setup. In this manual they will be referred to as left, center and right push-buttons. The trimmer is to adjust the contrast of the LCD. Turn the trimmer to increase or decrease the contrast of the display. The best setting is where the black squares around the characters just disappear.

PUSH-BUTTON SUMMARY

Name	Location	Primary USE
MODE	LEFT	This is used for changing the settings.
SET	CENTER	Pointing to the digit to set when changing settings
UP	RIGHT	Increment the digit

PUSH-BUTTON ACTION

During Wait period

Left	Enter into setup mode
Center	Test mode for alarms
Right	Start normal operation

Normal operation

Left	Enter into setup mode
Center	Reset Alarms
Right	Display Alarm status

During Setup mode

Left	Enter into setup mode and advance to next item
Center	Move arrow that points to a digit
Right	Increment the digit pointed to by the arrow

Combinations

Right held down and Left pushed	Change serial data to short format

V. ALARMS

There are 5 alarms built into the instrument. All are based on count rate and all are adjustable both for count rate and for their control over the indicators and relays. The only thing that is not adjustable is their priority.

Alarm 1, 2, 3, and 4 all trip if the count level exceeds the alarm setting. The Fail alarm occurs if there are no counts from the detector for a preset time. Each alarm has different settings, and each alarm is designed to look at a different part of the level. Each alarm may be individually turned off if it is not needed. Alarm 1, 2, 3 and 4 all have several settings associated with them. The different parts of the settings are:

1. Trip set This is the alarm level. This setting is a 4 digit number that is compared with the level in counts/interval from the detector.
2. Interval This is the number of .1 seconds that the alarm uses for its time base. It counts the counts from the detector for that time and compares it to the trip set.
3. Delay This is the number of intervals that the alarm must be consecutively activated to actually trip the alarms.
4. Pause This is the number of seconds after the level has decreased below the trip set that the alarm will remain activated. It is used to keep the alarm on longer than one interval. It is usually set around 10 seconds.

ALARM ACTIVATION

Alarms 1, 2, and 3 work in the following manner. When the level rises above the tripset, the delay counts down every interval period from its preprogrammed level. When it reaches zero it turns the alarm on. Until the alarms are activated if the level decreases below the tripset, the delay will reset to its preprogrammed level. This helps to keep noise from tripping the alarm. The pause works like the delay in that it too counts down every second from its preprogrammed level once the level drops below

the tripset. When it reaches zero the alarms will be deactivated for that alarm. If other alarms are still activated they will continue to activate their alarms. If during the pause period the level rises above the tripset again, even for one interval, the pause will be reset to the preprogrammed level. Thus once activated the alarms will stay on for at least the pause period following the last occurrence of a trip. This helps to keep the alarms from cycling on and off in a marginal situation.

ALARM 1

This alarm has the highest priority. It trips if the level rises above the tripset. It is usually setup to trip the front panel Trip High LED and to activate the relay and beeper. When tripped it will show ALARM 1 on the second line of the display. It is usually setup with a long interval and a long delay to catch slowly moving levels.

ALARM 2

This alarm is identical to alarm 1 except it has the third lowest priority. It is usually setup to also trip the front panel Trip High LED and to activate the relay and beeper. It is used with a short interval, short delay and a high tripset to catch fast moving levels. When tripped it will show ALARM 2 on the second line of the display.

ALARM 3

This alarm has the fourth highest priority. It is usually setup with a long interval and a long delay and is used as a warning indicator. It is usually setup to turn on the orange Trip Low LED on the front panel. It usually is not setup to trip the relay or beeper. When tripped it will show WARNING on the second line of the display.

ALARM 4

This is the fastrip or rate or rise alarm. It is used to detect a fast change in the level. This alarm keeps an average with a 60 second time constant and compares it to the trip set. This makes it usable for slowly moving signals. It has the second highest priority. The interval is fixed at 1 second. It is usually setup to trip the front panel Trip High LED and activate the relay and beeper. The delay is usually set low. The average is an ongoing average with an approximation to an RC circuit. The average is updated during the turn on wait period.

FAIL

This alarm is used to indicate that the detector is not functioning. It turns off the alarms and indicators and shows FAILURE in the display. It will not activate the relay. This alarm will activate if there are no counts from the detector for a number of seconds. The number of seconds is the only setting.

PRIORITY

The following table shows the priority of the alarms. Alarm 1 has the highest priority which means its action will supersede the lower priority alarms. Fail has the lowest priority because if the instrument fails, it obviously has no counts and cannot set the other alarms.

Alarm 1 Highest Priority
Alarm 4
Alarm 2
Alarm 3
Fail Lowest Priority

NO ALARM

No alarm is fixed with the OK LED turned on, the relay and beeper turned off and the display showing OK.

FACTORY SETTINGS

The following table lists the factory settings for the alarms.

TRIP

Alarm	Use	Interval	Delay	Trip High LED	Trip Low LED	OK LED	RELAY	BEEPER
1	High Levels	long	long	ON	OFF	OFF	ON	ON
2	Fast Levels	med	short	ON	OFF	OFF	ON	ON
3	Warning	long	long	OFF	ON	OFF	OFF	OFF
4	Fast Rise	fixed @10	short	ON	OFF	OFF	ON	ON
FAIL	Detector Failure	long	n/a	OFF	OFF	OFF	OFF	OFF
Normal	No Trip			OFF	OFF	ON	OFF	OFF

VIEWING ALARMS

The delay and pause and trip status can be viewed on the 2nd line of the LCD during normal operation by pushing the right hand push-button under the front panel cover. When the push-button is down, the status of the four alarms will be displayed on the LCD. The four groups represent the alarms and are in the following order from left to right: alarm 1, alarm 2, alarm 3, alarm 4. If an alarm is off its values will be displayed as blanks.

The first character of each group is an '*' if the alarm is not tripped and a 'T' if the alarm is tripped. The next number is a 2 digit hex number of either the delay or the pause. If the alarm is not tripped then it is the delay. If the alarm is tripped then it is the pause.

This example will use alarm 3. Assume that the delay is preprogrammed to 5 and the delay is set to 8. Normally, with no trip it would read '*05'. The '*' indicates it is not tripped and the '05' is the delay. If the level was brought higher than the tripset then the delay would start to count down every interval period until it reached zero. This shows the delay period. If the level were to decrease below the trip set during the time it was counting down, then the delay would revert back to its preprogrammed level which is 5. When the delay reaches zero, the indicator will change from a '*' to a 'T' to indicate it has been tripped, and the alarms will be set. The display will then show 'T8' and will continue to show 'T8' until the level is brought down below the tripset. When the level is brought below the tripset the pause will start counting down, decreasing by 1 every second. When it reaches zero, the 'T' will change back to a '*' and the alarms will be set to the no alarm condition.

VI. SETUP

The instrument has been setup with its preset values. These values are programmed into the EEPROM (changeable permanent memory). They can be changed by the user. This section shows how to change the presets. APPENDIX I contains blank forms for recording your settings. We recommend that you copy this page and use it to figure out your changes.

The setup mode is different from the normal operation of the instrument. To enter into the setup mode first access the control panel on the display by removing the bottom half of the front panel. At any time push and hold down the left hand button on the control panel. The display will change to the setup mode in about 1 second and show the first adjustment. Release the button as soon as the setup menu appears. The buttons on the control panel will do the following:

MODE (left hand button) will bring up the next item to adjust. Repeatedly pushing the mode button will cycle through all the adjustments.

SET (center button) will move the arrow on the bottom line from one digit to the next. Every time it is pushed the arrow will move to the next digit. When it gets to the last digit it will jump to the first digit.

UP (right hand button) will increment the digit that the arrow points to. Every time the button is pushed the digit will increase.

It only takes a few seconds of playing with the buttons to understand how they function.

Some adjustments have 3 digits and some have 4. All settings are decimal. The adjustments with 3 digits have a maximum setting of 255. If they are set above 255 they will actually be set to 255. The bottom line of the display reminds you that they have a maximum value of 255. The four digit adjustments have no restrictions, they can be adjusted from 0000 to 9999.

Repeatedly pushing the mode button will cycle the display through all of the adjustments. After the last adjustment the program will go to the same display as at turn on. Remember you can cycle right through to the setup, from the turn on display, by again pushing down the MODE button until the setup menu appears. Most of the settings are saved in EEPROM after the last item which is the fail-safe time, consequently if you are part way through changing the settings and decide you don't want the new values hold down the left hand button until the turn-on menu appears, then quickly release the button. You can also turn power off then back on or if the front panel is removed push the reset button.

The following is a list of the parameters in the order that they are seen on the display along with the factory presets. The letters A1, A2 etc. refer to alarm 1, alarm 2 etc. DELAY A2 is the delay value for alarm 2.

Presets @255	
TRIPSET 1	100
TRIPSET A2	20
TRIPSET A3	40
TRIPSET A4	20
DELAY A1	1
DELAY A2	2
DELAY A3	10
DELAY A4	2
INTERVAL A1	10
INTERVAL A2	2
INTERVAL A3	10
PAUSE A1	10
PAUSE A2	10
PAUSE A3	10
PAUSE A4	10
Alm Setup A1	137
Alm Setup A2	137
Alm Setup A3	4
Alm Setup A4	137
No alm Setup	2
Start Time	100
Fail Time	255

Please read the section on the alarms to become familiar with the action of the alarms. All of the parameters are reviewed below. You must cycle through all of the parameters to get back to a normal display.

PRESET

Set this to 255 or above if you want all of the adjustments to be set to their factory preset values. If you do not want the factory preset settings, then push mode again to go to the next item.

TRIPSET

This is the alarm level. This setting is a 4 digit number of counts that are compared with the counts from the detector during the interval.

DELAY

This is the number of intervals that the alarm must be consecutively activated to actually trip the alarms.

INTERVAL

This is the number of .1 seconds that the alarm uses for its time base. It counts the counts from the detector for that time and compares it to the trip set. If this setting is set to 10 it will have a 1 second time base which is the same time base as the display. Note that there is no interval for alarm 4, it is factory set to 1 second because the long term average also has a 1 second interval.

The interval will effect the tripset. If the interval is set to 10 (1 second) then the tripset level will be compared to the counts that arrive in 1 second. If it is set to 1 (.1 second) then the tripset level will be compared to the counts that arrive in .1 second, or 10 times LESS sensitive than the 1 second choice. Thus if the 1 second example had its tripset set to 20, the .1 second example would have to have its tripset set to 2 to be the same sensitivity.

PAUSE

This is the number of seconds after the level has decreased below the trip set that the alarm will remain activated. It is used to keep the alarm on longer than one interval. It is usually set around 10 seconds. It can be set longer but it usually is determined by how long the beeper (or external alarm) needs to be on to arouse someone that there is a problem.

ALM SETUP (ALARM SETUP)

This is a number that is used to set the condition of the alarms, indicators and external outputs. There are 5 setups, one for each of the four alarms and one for no alarms. Below is a description of the alarms, indicators and external outputs. Each can be set to only two values, 0 or 1. Following the descriptions is the method used to calculate the values and to determine the decimal value.

RELAY

This controls the relay. The contacts of the relay are brought out to the terminal strip (TS). When the relay is set to 0, TS10 and TS11 are shorted, and TS11 and TS12 are open. When the relay is 1, pin TS10 and TS11 are open and TS11 and TS12 are shorted. The relay is operated in the fail-safe mode (OFF actually energizes the relay). The signal that drives the relay is also routed to pin 14 on the terminal strip. When the relay is set to 0 the pin is at 12 volts. When the relay is set to 1 the pin is at 0 volts. This setting also controls an extra external output on the terminal strip. When the relay is set to 1 then pin 15 on the terminal strip is low.

TS16

This is pin #16 on the terminal strip. When TS16 is set to 1 then pin #16 on the terminal strip is low. This is only used for external control of additional relays or devices and is not used in normal operation of the monitor.

TP4

This is an internal test pin on the circuit board. When TP4 is set to 1 then the testpoint #4 on the display circuit board is high. This pin has no normal function and is not used in normal operation of the monitor.

TP5

This is an internal test pin on the circuit board. When TP5 is set to 1 then the testpoint #5 on the display circuit board is high. This pin has no normal function and is not used in normal operation of the instrument.

RED LED

This is the front panel red LED. It is marked TRIP HIGH on the front panel. If the RED LED is set to 1 then the LED is on.

YELLOW LED

This is the front panel yellow LED. It is marked TRIP LOW on the front panel. If the YELLOW LED is set to 1 then the LED is on.

GREEN LED

This is the front panel green LED. It is marked OK on the front panel. If the GREEN LED is set to 1 then the LED is on.

BUZZER

This is the front panel buzzer. If BUZZER is set to 1 then the buzzer is turned on and emits a loud continuous beep.

DECIMAL

The following table is a compilation of the settings of all the parts of the alarm setup. The decimal is the value that is calculated from the results of the table. The line of one's and zero's on a row is actually a binary number. This number is converted to decimal and that is the decimal number. For example the first line of the table below shows:

alarm1 1 * * * 1 0 0 1

If you change the * to zeros it becomes the number 10001001. This is a binary number. To find its decimal equivalent, look at the binary to decimal conversion table in the appendix. Look at the third binary column from the left and about 10 numbers down. You should find the number 10001001. Next to it is the number 137. This is the decimal conversion. 10001001 in binary is 137 in decimal. This decimal number is the number you enter into the alarm setup.

The following is a table that shows the normal operation of the instrument as it is setup using the factory presets.

	RELAY	TS16	TP4	TP5	RED LED	YELLOW LED	GREEN LET	BEEPER	DECIMAL VALUE
Alarm 1	1	*	*	*	1	0	0	1	137
Alarm 2	1	*	*	*	1	0	0	1	137
Alarm 3	0	*	*	*	0	1	0	0	4
Alarm 4	1	*	*	*	1	0	0	1	137
No Alarm	0	*	*	*	0	0	1	0	2

-
- *Setting does not matter for normal operation. We suggest each of these be set to 0.

The decimal calculations assume that the items marked * are set to 0.

START TIME

When the instrument is turned on it waits before going into normal operation. This gives time for the instrument to stabilize and to gather an average for alarm 4. The display shows the seconds counting down until normal operation. The start time is the starting number for the countdown. It can also be thought of as the start delay. If it is set to a low number the detector may not stabilize in time for the alarms. If it is set to a high value, it only delays normal operation longer than necessary.

FAIL TIME

If the display does not receive a count from the detector it will show a failure in the display. The fail time is the number of seconds after the last count before the instrument will show FAILURE in the display. If the fail time is set to 60 seconds, it will take 60 seconds after the detector fails before the instrument will display FAILURE. The factory setting is 255 which is the maximum value. The detector should send a count out at least every 2 seconds if it is operating normally.

TURNING THE ALARMS OFF

Each of the alarms can be turned off. To turn off alarm 1, 2 or 3, set the interval to zero. To turn off alarm 4, set the tripset to zero.

VII. CALIBRATION

The instrument has no calibration adjustments. The unit of counts per second is derived from a crystal controlled clock. This instrument is not designed to be calibrated to a known radiation level, however it is a good idea to test it with radiation. If you want to know the sensitivity of you instrument, we suggest you calibrate it with radiation at about 10 mR/h. The counts per second figure that you get (around 250 CPS/mR/h) will give you a good idea of the sensitivity of the instrument and indicate where to set the tripset. The maximum rate is about 6000 CPS. Adjusting the sensitivity of the instrument can be done in several ways. The instrument should be adjusted to as low a setting as possible but with no false alarms. The primary problem with setting it too low is noise from the detector. Temperature, shock and ambient electrical noise can cause the level to fluctuate. Inaccuracies in the DAC and other parts of the circuit can also cause noise.

The noise can be of two types:

1. Transient noise. This type of noise typically comes from the electrometer and from shock. It is short and typically lasts .1 to .2 seconds.
2. Long term noise. This type of noise will cause the output to rise with no radiation. This type of noise is usually caused by fast temperature changes and high ambient temperature.

The alarms should be setup to trip as close to 0 as possible. The factory setting are conservative. They are designed to be the same for all units. You may want to alter some settings or all of them. You can approach this in several ways but we suggest that you make one alarm more sensitive and then run it awhile and see if you get any false trips. This way you can keep track of which alarm may be alarming on noise. Alternatively you could hook up a computer to log the data on the RS-232 and look for the highest noise. This will give you a figure that is averaged for 1 second, but it will still give you an idea of the noise in the instrument.

The different alarms are designed to overcome some of the noise. The fastrip alarm 4 is designed to overcome type 2 noise. Any of the alarms that are setup with a long interval are designed to overcome type 1 noise because they average the readings over several seconds. An alarm that is set for a short interval, but high value tripset will capture high level alarms quickly. We recommend backing up a fastrip alarm 4 setting with a regular alarm. The average that is used for the fastrip will eventually catch up to the fastrip level. This will cause the alarm to cease alarming even though there may be radiation.

VIII. RS232 SERIAL OUTPUT

Every second the display sends out a packet of data via the RS232 serial output. The packet is the data at the time it was sent and should look like:

000001 0100 0020 0040 0020 0A 00 02 00 0A 00 02 00 00 00

the data from left to right is:

1 XXXXXX 6 hex digits Counts per second from detector. The same value as on the display.

2 XXXX 2 hex digits Alarm level for alarm 1

3 XXXX 2 hex digits Alarm level for alarm 2

4 XXXX 2 hex digits Alarm level for alarm 3

5 XXXX 2 hex digits Alarm level for alarm 4

Double space

6 XX XX 2 hex digits separated by a space. The first is the delay. Thesecond is the pause. Both are for alarm 1.

Double space

7 XX XX 2 hex digits separated by a space. The first is the delay. The second is the pause. Both are for alarm 2

Double space

8 XX XX 2 hex digits separated by a space. The first is the delay. The second is the pause. Both are for alarm 3

Double space

9 XX XX 2 hex digits separated by a space. The first is the delay. The second is the pause. Both are for alarm 4

Double space

10 XX 1 hex digit This is the fail. This starts as the fail number and counts down to zero. At zero it shows FAILURE in the display.

12 XX 1 hex digit This is the status byte. See below for a description.

STATUS BYTE

The status byte consists of 8 bits. The bits are represented as follows: Bit 0 is the LSB and bit 7 is the MSB. Only bits 0 thru 4 are used.

BIT FUNCTION

0 0=no trip, 1=trip for alarm 1
1 0=no trip, 1=trip for alarm 2
2 0=no trip, 1=trip for alarm 3
3 0=no trip, 1=trip for alarm 4
4 0=no fail, 1=fail

There is an alternate short serial mode for testing. See the section on maintenance.

IX. CIRCUIT DESCRIPTION

DISPLAY

The display is controlled by the microprocessor, U5. U1 is an address latch that separates the address and data for the EPROM U7. U4 is the LCD display. U2 is the EEPROM that stores the variables. U8 is the address decoder for U4. U11 is a shift register that shifts data in and has a parallel out. It is used, though the buffer U10 to drive the buzzer and the front panel LEDs. The relay is connected directly to the microprocessor through U10:G and U8:D. This is done to make the relay fail-safe. If the microprocessor is reset either by power on or by the watchdog timer U3, then the output pin P1.4 will float high opening the relay. U6 divides the incoming counts by 2 to slow them down. U9 and U12 are RS232 and RS485 outputs respectively. U13 and U14 are used as inputs and outputs to the detector. In this case only U14 is used as an input. U15 is a 5 volt voltage regulator and U16 converts this to -5 volts for the LCD contrast. R1 adjusts the contrast. U3 is a watchdog timer for the MPU and it needs a pulse on the DACCL at least every second to keep the watchdog from timing out.

DETECTOR

The detector V1 is a 4 liter three terminal ion chamber. Ionizing radiation produces ion pairs inside the detector that are collected on the center signal portion of the detector. This current is integrated onto U1, an electrometer amplifier with a 2 pF feedback capacitor (C2). The positive ion chamber current makes the output of the integrator move negative. The output of the electrometer goes from +1 volt to -5 volts. The divider R2 and R7 always keep the voltage on pin 5 of the switch U2:C positive, but reduce the voltage swing by ½. The switch U2:C is set to pass the voltage to the voltage comparator U3 pin 2. This comparator compares the voltage from the integrator with the ladder network that starts with R28 and ends with R30. This ladder network forms a DAC along with U4, a single chip microprocessor. The software keeps the output of the DAC at the same level as the voltage on pin 2 of the comparator U3. It does this by decreasing the level of the DAC as the integrator moves negative. Every time it decreases the DAC by 1 bit it pulses the output through pin 11 on the microprocessor. When the DAC reaches .3 volts the microprocessor initiates a reset. If the output of the electrometer moves positive from bias current leakages, then the watchdog timer inside the microprocessor will time out and this will cause a reset and a pulse out. The integrator is reset with Q1 and U2. A pulse from the microprocessor on pin 7, (TP8) will turn on Q1 and reset the integrator. A Compensation capacitor C5 biases the output of the integrator after reset to 1 volt. This is adjusted through R39.

U4 is a single chip RISC microprocessor. It has a built in EPROM and watchdog timer. U5 is the EEPROM for U4. The output pulses from U4 go to U7 and U8 which are RS232 and RS485 drivers. The high voltage power supply starts with U9. This is an oscillator with a short pulse width and a low duty cycle. The pulses turn on Q2 which makes the inductor L1 ring. The flyback voltage from L1 is rectified by D2 and filtered by C14. U11 is a 3 terminal voltage regulator. U10 is a negative voltage converter for the electrometer. The cable between the detector and the readout carries 12 volts and the counts. The counts are digital using a RS485 driver in the detector and a RS485 receiver in the readout.

MODIFICATIONS

Not all of the parts on the circuit board and schematic are included in this model. They are included for future changes or to allow this circuit board to be used in different ways. The detector circuit board has a place for U6, an LM34 temperature sensor. It can be digitized and used by the microprocessor. The compensation signal can be switched between positive voltage and negative voltage. The data output has jumpers for RS232 as well as RS485. It also includes terminating resistors for the line. An EEPROM is available for data storage.

The display has more options. It includes jumpers for RS232 and RS485 inputs and outputs on both the communications lines and the data lines from the detectors. The lines from the detector are designed to accept pulses or serial data from the detector. The watchdog can be disabled by JP12.

X. MAINTENANCE

This section discusses the circuit of the instrument and any adjustments that may be needed.

SHORTCUTS

Push the right hand button on the control panel during the warm-up period to cancel the warm-up period. Also remember to push the right hand button on the control panel to see the action of the alarms and to tell which

alarm is tripping. Push the center button on the control panel during normal operation to cancel the alarms. This is almost as good as a reset, but it does not clear the average or the current reading.

If you have the complete cover off of the display, the reset button on the top of the board above the display can be used to abort the setup routine. Just push it while in the setup routine. You can also abort the setup routine by turning off the power or by holding down the left hand button until the LCD shows the startup display.

If you are testing the alarms and the noise is too loud, put a piece of tape over the beeper. It will not make it quiet but it will reduce the volume.

ADJUSTMENTS

There are 2 adjustments, one on the display and one on the detector. The contrast is located on the control panel under the bottom cover on the front of the display. Turning it will change the contrast of the display. The best adjustment is to turn the control until the display is too dark, then lighten it up to the point where the black squares around the characters just disappear.

The other adjustment is on the detector. This adjustment sets the compensation capacitor. A digital voltmeter will be needed for the measurements. Connect the negative lead to TP3 (ground) and the positive lead to TP5 (Electrometer output). Make sure that the detector is not exposed to any radiation other than background radiation. Push the reset button (S1). If the voltmeter reads between .9 and 1.1 volts then the setting is OK. You may push the reset button several times to make sure. If the voltage is not between .9 and 1.1 volts then adjust R39, push the reset button and note the reading. Keep repeating this sequence until the voltage is between .9 and 1.1 volts. The target voltage is 1.0 volts. The reading will not change by just adjusting R39. Pushing the reset button is the only way the reading will change.

DESICCANT

The desiccant is inside the electrometer housing in the detector box. It only needs to be replaced if the output is leaking excessively.

TESTING

DISPLAY

The display alarms and annunciators can be tested by pushing down the center button when the display is counting down the startup time. Startup time can be initiated by pushing the reset button on the display if the entire front panel is removed or by interrupting the power. When the center button is held down the instrument will cycle through 9 different annunciators in the following order:

Red LED, Yellow LED, Green LED, Front panel buzzer, Relay (operated fail safe), TS15, TS16, TP4, TP5

The cycle will then repeat as long as the button is held down.

The serial data line can be shortened to only the current CPS from the detector and the status byte. This is handy for data logging to check on the levels. The change is only temporary and the long data line will return after the instrument is reset or the center button is pushed without any of the other buttons. To enter the short serial data line mode, push down the right hand button on the control panel and hold it down. Now momentarily push the center button. The watchdog timer can be checked by holding down the left hand button and holding it down. The display will alternate between the turn-on display and the first preset menu about every 2 seconds and the relay will be de-energized and energized. The pulse is the watchdog timing out and resetting the microprocessor.

DETECTOR

The detector DAC and reset circuitry can be tested by holding down S2 and momentarily pushing the reset button, S1. Then release S2. This puts the microprocessor is a special test mode. Look at pin TP4 with an oscilloscope. The signal should ramp from 5 volts to 0 volts, then repeat. The period of the ramp should repeat every 1.6 seconds. This signal tests the integrity of the ladder network and the output pins of the microprocessor. It also checks the maintenance portion of the software in the microprocessor. While in this test mode, hold down S2. This will causes a reset pulse for the integrator. The pulse can be seen on TP8 and occurs

when the DAC reaches 0 volts. This occurs about every 1.6 seconds. This pulse will only occur if S2 is held down. It can be used to reset the integrator during any circuit tests.

APPENDIX I

USER TABLES

The blank tables below are useful to determine how you want the alarms setup. Copy it and fill it out not only for ease of programming, but also for your records.

DATE_____ SERIAL NUMBER_____ _____

LOCATION _____BY_____

ALARM SETUP

	RELAY	TS16	TP4	TP5	RED LED	YELLOW LED	GREEN LET	BEEPER	DECIMAL VALUE
Alarm 1									
Alarm 2									
Alarm 3									
Alarm 4									
No Alarm									

ENTER THE DECIMAL NUMBERS ABOVE INTO THE SETUP BOXES BELOW

SUMMARY OF SETTINGS

	TRIPSET	DELAY	INTERVAL	PAUSE	SETUP
ALARM 1					
ALARM 2					
ALARM 3					
ALARM 4					
NO ALARM			Preset to 10		

START TIME _____

FAIL TIME _____

.APPENDIX II

DECIMAL/HEX/BINARY
CONVERSION TABLE

DEC	HEX	BINARY
0	00	00000000
1	01	00000001
2	02	00000010
3	03	00000011
4	04	00000100
5	05	00000101
6	06	00000110
7	07	00000111
8	08	00001000
9	09	00001001
10	0A	00001010
11	0B	00001011
12	0C	00001100
13	0D	00001101
14	0E	00001110
15	0F	00001111
16	10	00010000
17	11	00010001
18	12	00010010
19	13	00010011
20	14	00010100
21	15	00010101
22	16	00010110
23	17	00010111
24	18	00011000
25	19	00011001
26	1A	00011010
27	1B	00011011
28	1C	00011100
39	1D	00011101
30	1E	00011110
31	1F	00011111
32	20	00100000
33	21	00100001
34	22	00100010
35	23	00100011
36	24	00100100
37	25	00100101
38	26	00100110
39	27	00100111
40	28	00101000
41	29	00101001
42	2A	00101010
43	2B	00101011
44	2C	00101100
45	2D	00101101
46	2E	00101110
47	2F	00101111
48	30	00110000
49	31	00110001
50	32	00110010
51	33	00110011
52	34	00110100
53	35	00110101
54	36	00110110
55	37	00110111
56	38	00111000
57	39	00111001
58	3A	00111010
59	3B	00111011
60	3C	00111100
61	3D	00111101
62	3E	00111110
63	3F	00111111
64	40	01000000
65	41	01000001
66	42	01000010
67	43	01000011
68	44	01000100
69	45	01000101
70	46	01000110
71	47	01000111
72	48	01001000
73	49	01001001
74	4A	01001010
75	4B	01001011
76	4C	01001100
77	4D	01001101
78	4E	01001110
79	4F	01001111
80	50	01010000
81	51	01010001
82	52	01010010
83	53	01010011
84	54	01010100
85	55	01010101
86	56	01010110
87	57	01010111
88	58	01011000
89	59	01011001
90	5A	01011010
91	5B	01011011
92	5C	01011100
93	5D	01011101
94	5E	01011110
95	5F	01011111
96	60	01100000
97	61	01100001
98	62	01100010
99	63	01100011
100	64	01100100
101	65	01100101
102	66	01100110
103	67	01100111
104	68	01101000
105	69	01101001
106	6A	01101010
107	6B	01101011
108	6C	01101100
109	6D	01101101
110	6E	01101110
111	6F	01101111
112	70	01110000
113	71	01110001
114	72	01110010
115	73	01110011
116	74	01110100
117	75	01110101
118	76	01110110
119	77	01110111
120	78	01111000
121	79	01111001
122	7A	01111010
123	7B	01111011
124	7C	01111100
125	7D	01111101
126	7E	01111110
127	7F	01111111
128	80	10000000
129	81	10000001
130	82	10000010
131	83	10000011
132	84	10000100
133	85	10000101
134	86	10000110
135	87	10000111
136	88	10001000
137	89	10001001
138	8A	10001010
139	8B	10001011
140	8C	10001100
141	8D	10001101
142	8E	10001110
143	8F	10001111
144	90	10010000
145	91	10010001
146	92	10010010
147	93	10010011
148	94	10010100
149	95	10010101
150	96	10010110
151	97	10010111
152	98	10011000
153	99	10011001
154	9A	10011010
155	9B	10011011
156	9C	10011100
157	9D	10011101
158	9E	10011110
159	9F	10011111
160	A0	10100000
161	A1	10100001
162	A2	10100010
163	A3	10100011
164	A4	10100100
165	A5	10100101
166	A6	10100110
167	A7	10100111
168	A8	10101000
169	A9	10101001
170	AA	10101010
171	AB	10101011
172	AC	10101100
173	AD	10101101
174	AE	10101110
175	AF	10101111
176	B0	10110000
177	B1	10110001
178	B2	10110010
179	B3	10110011
180	B4	10110100
181	B5	10110101
182	B6	10110110
183	B7	10110111
184	B8	10111000
185	B9	10111001
186	BA	10111010
187	BB	10111011
188	BC	10111100
189	BD	10111101
190	BE	10111110
191	BF	10111111
192	C0	11000000
193	C1	11000001
194	C2	11000010
195	C3	11000011
196	C4	11000100
197	C5	11000101
198	C6	11000110
199	C7	11000111
200	C8	11001000
201	C9	11001001
202	CA	11001010
203	CB	11001011
204	CC	11001100
205	CD	11001101
206	CE	11001110
207	CF	11001111
208	D0	11010000
209	D1	11010001
210	D2	11010010
211	D3	11010011
212	D4	11010100
213	D5	11010101
214	D6	11010110
215	D7	11010111
216	D8	11011000
217	D9	11011001
218	DA	11011010
219	DB	11011011
220	DC	11011100
221	DD	11011101
222	DE	11011110
223	DF	11011111
224	E0	11100000
225	E1	11100001
226	E2	11100010
227	E3	11100011
228	E4	11100100
229	E5	11100101
230	E6	11100110
231	E7	11100111
232	E8	11101000
233	E9	11101001
234	EA	11101010
235	EB	11101011
236	EC	11101100
237	ED	11101101
238	EE	11101110
239	EF	11101111
240	F0	11110000
241	F1	11110001
242	F2	11110010
243	F3	11110011
244	F4	11110100
245	F5	11110101
246	F6	11110110
247	F7	11110111
248	F8	11111000
249	F9	11111001
250	FA	11111010
251	FB	11111011
252	FC	11111100
253	FD	11111101
254	FE	11111110
255	FF	11111111

DETECTOR PARTS LIST

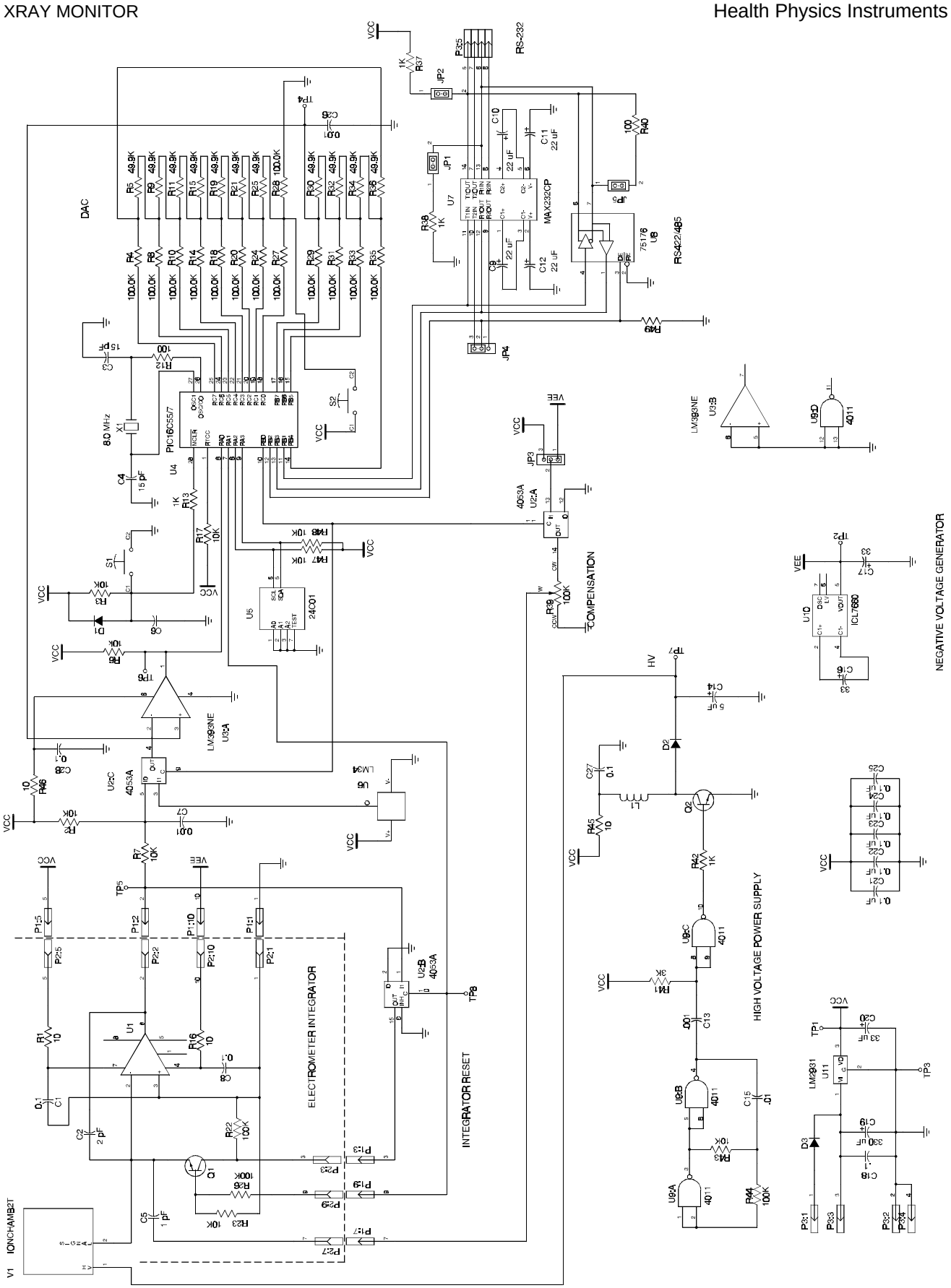
DESIGN	QUAN	PART NO	TYPE	DESCRIPTION	MFG	SUPPLIER	DRAWING #
C01	1		0.1 uF	Capacitor, Mono			2030-001
C02	1		Teflon	Capacitor	HPI		2030-001
C03	1		Teflon	Capacitor	HPI		2030-001
C03	1		15 pF	Capacitor, Mono			2030-001
C04	1		15 pF	Capacitor, Mono			2030-001
C08	1		0.1 uF	Capacitor, Mono			2030-001
C13	1		0.001 uF	Capacitor, Mono			2030-001
C14	1		1 uF 100 VDC	Capacitor, Electro			2030-001
C15	1		0.01 uF	Capacitor, Mono			2030-001
C16	1		33 uF 16 VDC	Capacitor, Tantalum			2030-001
C17	1		33 uF 16 VDC	Capacitor, Tantalum			2030-001
C18	1		0.1 uF	Capacitor, Mono			2030-001
C19	1		470 uF 25 VDC	Capacitor, Electro			2030-001
C20	1		33 uF 16 VDC	Capacitor, Tantalum			2030-001
C21	1		0.1 uF	Capacitor, Mono			2030-001
C23	1		0.1 uF	Capacitor, Mono			2030-001
C24	1		0.1 uF	Capacitor, Mono			2030-001
C25	1		0.1 uF	Capacitor, Mono			2030-001
C27	1		0.1 uF	Capacitor, Mono			2030-001
C28	1		0.1 uF	Capacitor, Mono			2030-001
D2	1	FR107	1000 Volt	Diode, Fast Recovery		Digikey	2030-001
D3	1	1N4004		Diode			2030-001
HV1	1	22-11-2032	3 pin lock	Header	Molex	Digikey	2030-001
HV1A	1	22-11-3037	3 pin lock	Crimp Housing	Molex	Digikey	2030-001
L1	1		330 uH	Inductor		MOUSER	2030-001
M01	1	2030-002		BASE	HPI	Neal Feay	2030-001
M02	1	2030-004		Mounting Bracker	HPI	Neal Feay	2030-001
M02	1	2030-003		Cover	HPI	Neal Feay	2030-001
M03	1	2030-005		Detector Base	HPI	Neal Feay	2030-001
M04	1	2030-007		Detector Shell	HPI	Neal Feay	2030-001
M05	1	Modified Part		Case, Electrometer	HPI	Rose Enclo	2030-001
M06	1	UG-1094/U	Long	BNC Bulkhead W/0 CE	Amphenol	Digikey	2030-001
M07	1			Center Electrode	HPI		2030-001
M08	4		6-32 x 1	Spacer, Hex			2030-001
M09	4		#6 x ¾	Spacer, Round			2030-001
M10	12		#6 Int Star	Lockwashers			2030-001
M11	12		6-32 x ¼	Screws, Pan X			2030-001
M12	4		4-40 x ¼	Screws, Pan X Nylon			2030-001
M13	2		4-40 x ½	Screws, Pan X			2030-001
M14	2		#4 Int Star	Lockwasher			2030-001
M15	2		4-40 small pattern	Nut, machine			2030-001
M16	2		3/8-24 x 3/8	Thumbscrew			2030-001
M17	1		2-46 x ¼	Screw, pan Nylon			2030-001
M18	1		#2 Int star	Lockwasher			2030-001
M19	4		6-32 x 3/8	Screw, Pan X			2030-001
M20	4		#6 Nylon	Washser			2030-001
P1A	1	2510-6002UB	10 Pin Low Profile	Header	3M	Digikey	2030-001
P1B	1		10 Pin	Socket Connector	CW Ind	Digikey	2030-001
P2A	1	2510-6002UB	10 Pin Low Profile	Header	3M	Digikey	2030-001
P2B	1		10 Pin	Socket Connector	CW Ind	Digikey	2030-001
P3A	1	EDSTLZ950/4	4 Pin	Header, Terminal	OST	Digikey	2030-001
P3B	1	EDZ950	4 Pin	Terminal, Plug	OST	Digikey	2030-001
Q1	1	2N4123	NPN	Transistor	National		2030-001
Q2	1	2N2222	NPN	Transistor			2030-001
R01	1		10 5% CF	Resistor			2030-001
R02	1		10K 5% CF	Resistor			2030-001
R03	1		10K 5% CF	Resistor			2030-001
R04	1		100.0K 1% MF	Resistor			2030-001
R05	1		49.9K 1% MF	Resistor			2030-001
R06	1		10K 5% CF	Resistor			2030-001
R07	1		10K 5% CF	Resistor			2030-001
R08	1		100.0K 1% MF	Resistor			2030-001
R09	1		49.9K 1% MF	Resistor			2030-001
R10	1		100.0K 1% MF	Resistor			2030-001
R11	1		49.9K 1% MF	Resistor			2030-001
R12	1		100 5% CF	Resistor			2030-001
R13	1		1K 5% CF	Resistor			2030-001
R14	1		100.0K 1% MF	Resistor			2030-001
R15	1		49.9K 1% MF	Resistor			2030-001
R16	1		10 5% CF	Resistor			2030-001
R18	1		100.0K 1% MF	Resistor			2030-001
R19	1		49.9K 1% MF	Resistor			2030-001
R20	1		100.0K 1% MF	Resistor			2030-001
R21	1		49.9K 1% MF	Resistor			2030-001
R22	1		100K 5% CF	Resistor			2030-001

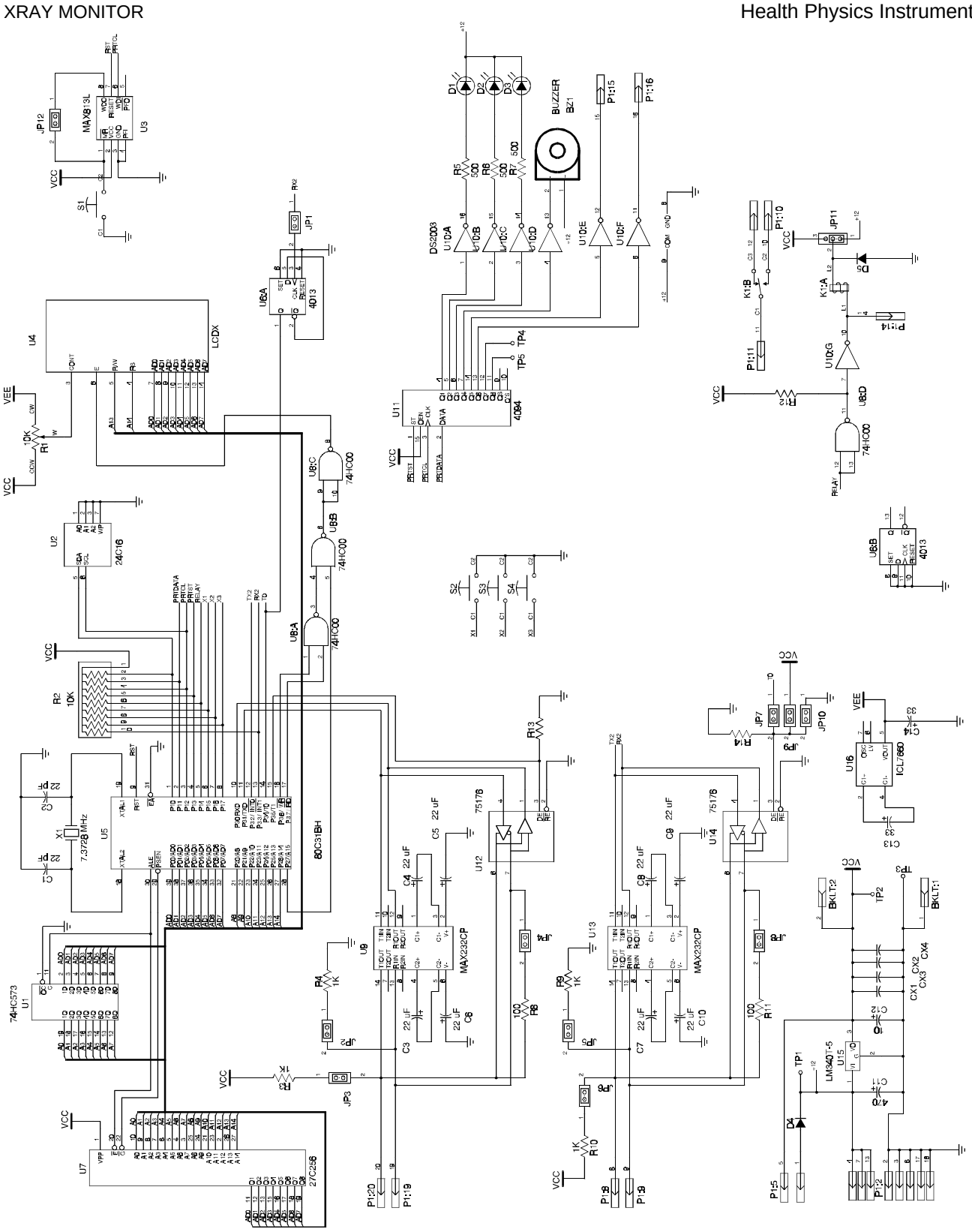
DESIGN	QUAN	PART NO	TYPE	DESCRIPTION	MFG	SUPPLIER	DRAWING #
R23	1		10K 5% CF	Resistor			2030-001
R24	1		100.0K 1% MF	Resistor			2030-001
R25	1		49.9K 1% MF	Resistor			2030-001
R26	1		100K 5% CF	Resistor			2030-001
R27	1		100.0K 1% MF	Resistor			2030-001
R28	1		100.0K 1% MF	Resistor			2030-001
R29	1		100.0K 1% MF	Resistor			2030-001
R30	1		49.9K 1% MF	Resistor			2030-001
R31	1		100.0K 1% MF	Resistor			2030-001
R32	1		49.9K 1% MF	Resistor			2030-001
R33	1		100.0K 1% MF	Resistor			2030-001
R34	1		49.9K 1% MF	Resistor			2030-001
R35	1		100.0K 1% MF	Resistor			2030-001
R36	1		49.9K 1% MF	Resistor			2030-001
R39	1		100K 3/8 top	Trimmer			2030-001
R41	1		3K 5% CF	Resistor			2030-001
R42	1		1K 5% CF	Resistor			2030-001
R43	1		10K 5% CF	Resistor			2030-001
R44	1		100K 5% CF	Resistor			2030-001
R45	1		10K 5% CF	Resistor			2030-001
R46	1		10 5% CF	Resistor			2030-001
R49	1		10K 5% CF	Resistor			2030-001
S1	1	EVQ-QS205K	Min	Switch, Pushbutton	Panasonic	Digikey	2030-001
S2	1	EVQ-QS205K	Min	Switch, Pushbutton	Panasonic	Digikey	2030-001
U01	1	LMC6041AIN	Single	Op Amp	National	Digikey	2030-001
U02	1	4053	3 x SPDT	Switch, Analog			2030-001
U03	1	TLC352CP	3 x SPDT	Switch, Analog			2030-001
U04	1	PIC16C55-HS/P	8 bit RISC OTP	Microprocessor	Microchip		2030-001
U08	1	DS75176BN	RS485	Driver/Rcvr	National		2030-001
U09	1	4011		Quad Nand Gate			2030-001
U10	1	ICL7660SCPA		Voltage Converter	Harris		2030-001
U11	1	7805	5 VDC	Voltage Regulator			2030-001
X1	1	MP080A	8.00 MHZ HC49	Crystal	CTS	DigiKey	2030-001

DISPLAY PARTS LIST

DESIGN	QUAN	PART NO	TYPE	DESCRIPTION	MFG	SUPPLIER	DRAWING #
BZ1	1	EFB-CB37C11		Buzzer	Panasonic	Digikey	6012-001
C01	1		22 pF	Calpacitor, Mono			6012-001
C02	1		22 pF	Calpacitor, Mono			6012-001
C03	1		22 uF 10 VDC	Capacitor, Electro			6012-001
C04	1		22 uF 10 VDC	Capacitor, Electro			6012-001
C05	1		22 uF 10 VDC	Capacitor, Electro			6012-001
C06	1		22 uF 10 VDC	Capacitor, Electro			6012-001
C11	1		100 uF 25 VDC	Capacitor, Electro			6012-001
C12	1		10 uF 10 VDC	Capacitor, Tantalum			6012-001
C13	1		10 uF 10 VDC	Capacitor, Tantalum			6012-001
C14	1		10 uF 10 VDC	Capacitor, Tantalum			6012-001
CX1	1		0.1 uF	Capacitor, Mono			6012-001
CX2	1		0.1 uF	Capacitor, Mono			6012-001
CX3	1		0.1 uF	Capacitor, Mono			6012-001
CX4	1		0.1 uF	Capacitor, Mono			6012-001
D1	1		RED T1 ¾	LED			6012-001
D2	1		YELLOW T1 ¾	LED			6012-001
D3	1		GREEN T1 ¾	LED			6012-001
D4	1	1N4004		DIODE			6012-001
D5	1	1N4004		DIODE			6012-001
K1	1	G2E-184PM-US-DC12	12V SPDT	Relay, Dip	Omron	Digikey	6012-001
P1A	1	EDSTLZ950/20	20 Position	Header, Terminal	OST	Digikey	6012-001
P1B	1	EDZ950/18	18 Position	Plug, Terminal	OST	Digikey	6012-001
P1C	1	EDZ950/2	2 Position	Plug, Terminal	OST	Digikey	6012-001
R1	1		10K 1 Turn	Trimmer			6012-001
R2	1		10K x 9	Resistor Network			6012-001
R5	1		470 5% 1/4W CF	Resistor			6012-001
R6	1		470 5% 1/4W CF	Resistor			6012-001
R7	1		470 5% 1/4W CF	Resistor			6012-001
S1	1		Min EVQ	Switch, Pushbutton	Panasonic	Digikey	6012-001
S2	1		Min EVQ	Switch, Pushbutton	Panasonic	Digikey	6012-001
S3	1		Min EVQ	Switch, Pushbutton	Panasonic	Digikey	6012-001
S4	1		Min EVQ	Switch, Pushbutton	Panasonic	Digikey	6012-001
U01	1	74HC573	8 bit	Latch			6012-001
U02	1	27LC02		EEPROM	Microchip	Digikey	6012-001
DESIGN	QUAN	PART NO	TYPE	DESCRIPTION	MFG	SUPPLIER	DRAWING #
U03	1	MAX813LCPA		Supervisor, Micro	Maxim	Digikey	6012-001
U04	1	MDLS-16265-G-LVLED04	2 x 16 Alphanumeric	LCD Display	VARITRONIX	Digikey	6012-001
U05	1	P80C32GBPN	8 bit	Microprocessor	Signetics		6012-001

U06	1	4013B	Dual D type	Flip Flop			6012-001
U07	1	27C256	32K x 8	EPROM			6012-001
U08	1	74HC00		QUAD NAND			6012-001
U09	1	MAX232CPE		RS232 Driver	Maxim	Digikey	6012-001
U10	1	DS2003N	Darlington	Drivers	National	Digikey	6012-001
U11	1	4094B	8 bit	Shift Register			6012-001
U14	1	DS75176BN	RS485	Driver/Rcvr	National	Digikey	6012-001
U15	1	7805	5 Volt	Voltage Regulator			6012-001
U16	1	ICL7660CSPA	5 Volt	Voltage Inverter	Harris	Digikey	6012-001
X1	1		HC-49 7.3728 MHz	Crystal	CTS	Digikey	6012-001
M01	1	6012-002		BASE	HPI	Neal Feay	6012-005
M02	1	6012-003		COVER	HPI	Neal Feay	6012-005
M03	1	6012-004		COVER SHIELD	HPI	Neal Feay	6012-005
M04	4		#4 x ¾	Nylon Spacer			6012-005
M05	5		6-32 x ¼	Hex Spacer			6012-005
M06	13		6-32 x ¼	Screw, Pan X			6012-005
M07	13		#6, Int Star	Locwasher			6012-005
M08	2		#4 x ½	Spacer, Nylon			6012-005
M09	2		4-40 x ¾	Screw, Pan X			6012-005
M10	2		#4 Int Star	Lockwasher			6012-005
M11	1		6-32 X 1″	Spacer, Hex			6012-005
M12	1		6-32 X ¼	Screw, FH, X			6012-005
M13	2		3/8-24 x 3/8	Thumbscrew			6012-005
M14	1	2030-004		Wall Bracket			6012-005
M15	1		Lexan	Window			6012-005
M16	4		#6 Nylon	Washser			6012-005
M17	4		6-32 x 3/8	Screw, Pan X			6012-005


DAC
RS-232
RS422/485
MAX232CP
75176
PIC16C55/7
8.0 MHz
24C01
4053A
4066A
LM393NE
4011
ICL7660
COMPENSATION
NEGATIVE VOLTAGE GENERATOR
HIGH VOLTAGE POWER SUPPLY
ELECTROMETER INTEGRATOR
INTEGRATOR RESET
IONCHAMB2T
VCC
VEE
HV


MAX813L
LCDX
24C16
80C31BH
MAX232CP
74HC573
27C256
74HC00
4013
4094
DS2003
BUZZER
ICL7660
LM340T-5
VCC
VEE
GND