

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 removed 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

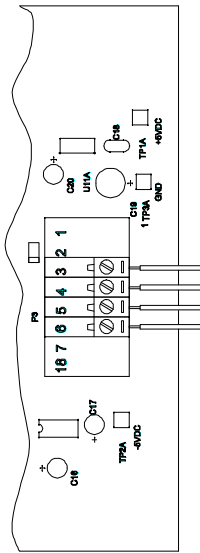
The display is installed by first mounting the mounting bracket. The display unit may be in any orientation. The display sets into the mounting bracket and is held in place with the two thumbscrews. There are 2 cables that connect to the display. The first is the 2 conductor power cable from the wall 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.

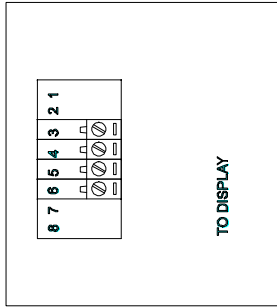
INTERFERENCE

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.

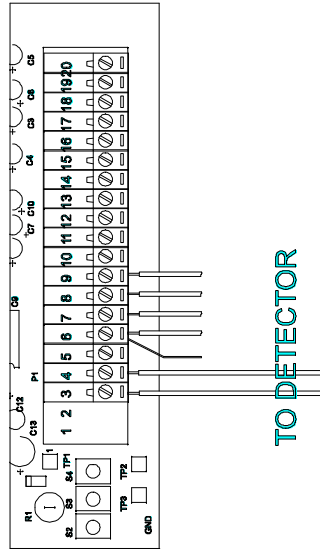
DETECTOR CIRCUIT BOARD



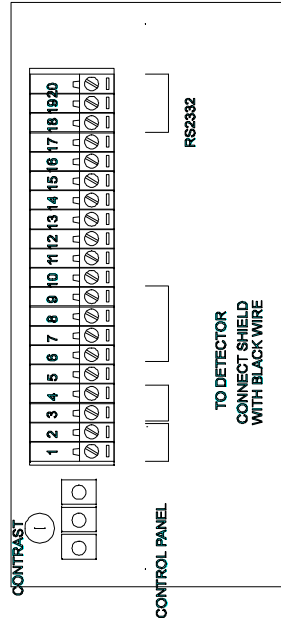
TO DISPLAY



DISPLAY CIRCUIT BOARD



TO DETECTOR



CONNECTIONS TO DISPLAY AND POWER' CONNECTIONS TO TERMINALS

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.

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.

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 your 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 settings 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. The second 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 $\frac{1}{2}$. 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 in 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 cause 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

29 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 Enclou	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 3/4	Spacer, Round			2030-001
M10	12		#6 Int Star	Lockwashers			2030-001
M11	12		6-32 x 1/4	Screws, Pan X			2030-001
M12	4		4-40 x 1/4	Screws, Pan X Nylon			2030-001
M13	2		4-40 x 1/2	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 1/4	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	Washer			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 ¼	LED			6012-001
D2	1		YELLOW T1 ¼	LED			6012-001
D3	1		GREEN T1 ¼	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 3/4	Nylon Spacer			6012-005
M05	5		6-32 x 3/4	Hex Spacer			6012-005
M06	13		6-32 x 3/4	Screw, Pan X			6012-005
M07	13		#6, Int Star	Locwasher			6012-005
M08	2		#4 x 3/4	Spacer, Nylon			6012-005
M09	2		4-40 x 3/4	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 3/4	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	Washer			6012-005
M17	4		6-32 x 3/8	Screw, Pan X			6012-005

