OPERATION MANUAL

MODEL 6012
DIGITAL DISPLAY \ CONTROLLER

September 2011

Version 1c

For software V 3.1X
Universal Display

hpi

Health Physics Instruments
330 South Kellogg Ave, Suite D
Goleta, CA 93117
(805) 964-3615
FAX: (805) 964 3162
Email: info@fwt.com
www.fwt.com
Division of Far West Technology

TABLE OF CONTENTS

I. INTRODUCTION

The Model 6012 Digtial Display and Controller is designed to be used as a readout for a number of different detectors. 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 6012 is very simple. The first line of the display shows the radiation level from the detector. It is updated every second. The second line shows the status of the alarms and is updated every second. Overrange is indicated on the first line in place of the radiation level. 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 intervals remaining until normal operation begins is shown on the display along with the version number of the software. The detector may take longer than the wait period to completely stabilize to background levels.

III. INSTALLATION

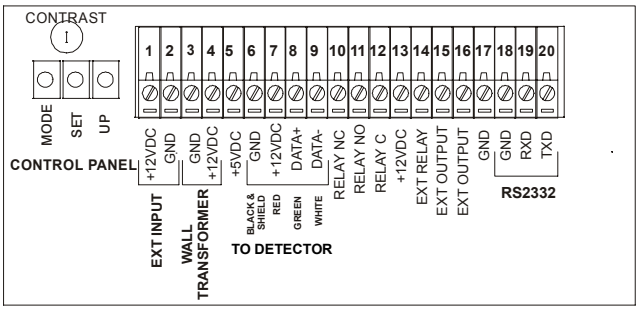
The 6012 is easily installed. It usually consists of 2 parts, the detector unit and the display unit. There is a single 4 wire connection between the detector and the 6012. It has a terminal strip for connections and it unplugs from the circuit board to permit removal of the units without unscrewing the cable. The detector and display can be remoted up to 100 feet. We recommend Belden 8723, 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.

The display is installed by first mounting the mounting bracket. The display unit may be in any orientation. It 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 for testing alarms.

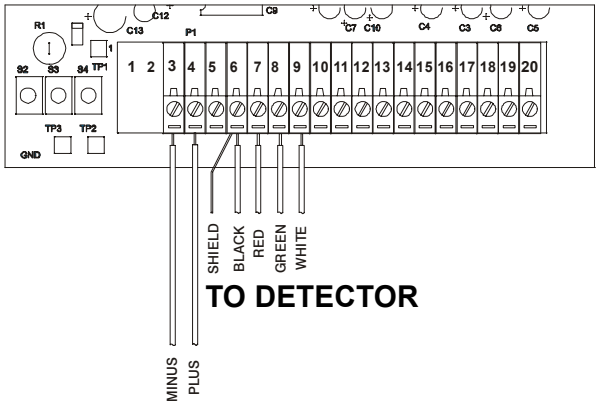
INTERFERENCE

Interference can cause annoying false alarms. The most likely cause of interference is from noisy AC switches and lamp dimmers. Plugging the 6012 into a line filter, or the offending product into a line filter can help to eliminate the interference.



CONNECTIONS TO TERMINALS

DISPLAY CIRCUIT BOARD



WALL TRANSFORMER

CONNECTIONS TO DISPLAY AND POWER

Figure 1 CONNECTIONS TO DISPLAY

DISPLAY CONNECTIONS

PIN #	DESCRIPTION	WIRE COLOR To Detector	USE
1	+12 VDC Input		External Power, Diode isolated
2	Ground		External Power with pin 1 for bat backup
3	Ground		Wall Transformer
4	+12 VDC Input		Wall Transformer
5	+5 VDC		External Use
6	Ground	Black and Shield	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 (normally closed)
11	Relay NO		External Alarm (normally open)
12	Relay C		External Alarm (center pole)
13	+12 VDC Output		External Relay
14	Relay Driver		External Relay
15	External Output		
16	External Output		
17	Ground		
18	Ground		RS232
19	RXD		RS232
20	TXD		RS232

CONTACT CLOSURE FOR EXTERNAL ALARM

The contact closure from the internal relay is on pins 10,11 and 12. Normally an external interlock system would be connected between pin 10 and 12. This alarm operates in the fail-safe mode. If you were to remove power to the display, the relay would open the contacts between pin 10 and 12. Contacts are 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 by unplugging it before connecting an external relay. The external relay should not draw more than 300 mA.

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 the output and either +5 volts or +12 volts.

RS232/485

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

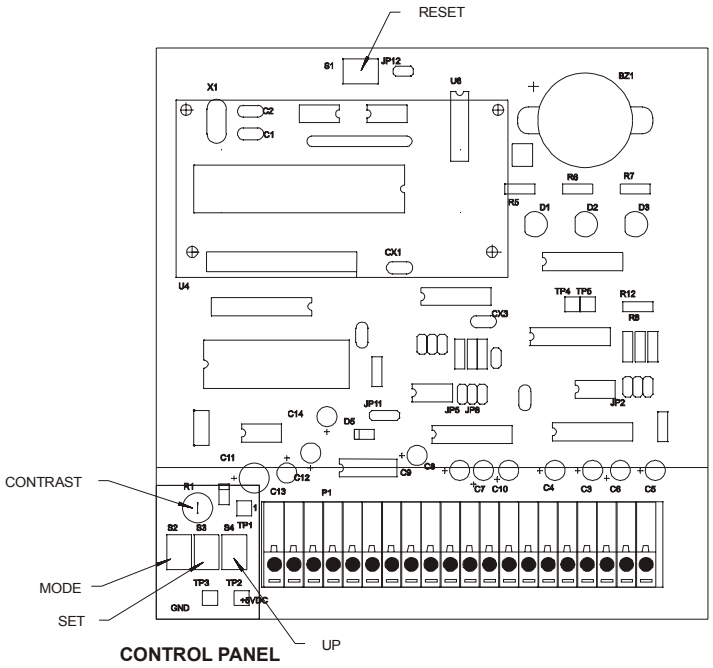


FIGURE 2 CONTROLS, ADJUSTMENT AND CONTROL PANEL

IV. CONTROL PANEL

The control panel is 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 Warm-up Wait period

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

Normal operation

Left	Enter into setup mode
Center	Quiet Buzzer during alarm
Right	Display Alarm status and radiation level without background subtract

During Setup mode

Left	Advance to next item
Center	Move arrow that points to a digit
Right	Increment the digit pointed to by the arrow

V. ALARMS

There are 2 alarms built into the instrument. They are based on radiation level and 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, and 2 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 and 2 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 compared with the radiation level in the display.
2. ***Delay*** This is the number of seconds that the alarm must be consecutively activated to trip the alarms.
3. ***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 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 (HIGH)

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.

ALARM 2 (LOW)

This alarm has the next highest priority. It is usually setup to trip the front panel Trip Low LED and to NOT activate the relay and beeper. When tripped it will show ALARM 2 on the second line of the display.

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. It may be turned off for detectors that have a low count rate.

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 2	
Fail	Lowest Priority

NO ALARM

The No Alarm setting 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	short	short	ON	OFF	OFF	OFF	ON
2	Warning	short	short	OFF	ON	OFF	ON	OFF
FAIL	Detector Failure	N/a	n/a	OFF	OFF	OFF	OFF	OFF
Normal	No Trip			OFF	OFF	ON	ON	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 two alarms will be displayed on the LCD. The two groups represent the alarms and are in the following order from left to right: alarm 1, alarm 2.

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. If the alarm is turned off because the tripset is set to 0, then the alarm will be shown by three dashes (---) in place of the group.

As an example, assume for alarm 2 the delay is set to 5 and the pause 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, CALIBRATION, AND PRESETS

The instrument has been setup with its proper values for the detector. 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.

The first 3 adjustments, presets, calibration, and setup are different than the items that follow. Each has @255 on the center of the display. If you set the display to 255 then you will preset the values, enter the calibration adjustment section, or enter the setup adjustment section depending on which menu you started with.

Some adjustments have 3 digits some have 4, and some have an exponent or units. All settings are decimal. Some of 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 and decimal/exponent adjustments have no restrictions.

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 back into 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, 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, this will reset the 6012 and put you back in the Setup Mode. 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.

Presets @255
Calibr @255
Setup @255
ALARM A1
ALARM A2
DELAY A1
DELAY A2
PAUSE A1
PAUSE A2

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.

Calibration

Set this to 255 or above if you want to enter the calibration menu, which allows you to change the calibration factor and deadtime correction. If you do not want to enter the calibration mode, then push mode again to go to the next item.

Setup

Set this to 255 or above if you want to enter the setup menu, which allows you to change many constants and items. If you do not want to enter the setup mode, then push mode again to go to the next item.

Alarm

This is the alarm level. This setting is compared with the level from the detector during the interval. Each of the alarms can be turned off. To turn off alarm 1 or 2, set the decimal value of the tripset to zero and leave the decimal point location and prefix where it is. You can check if the alarm is turned off reading Viewing Alarms on page 7.

Delay

This is the number of intervals that the alarm must be consecutively activated to actually trip the alarms. It is usually set to 1.

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.

CALIBRATION MENU

If you entered this menu then the following are available:

Calibration Constant

This value will change the level in the display. If the display is reading 10% too low, then raise the calibration constant 10%. The value has 3 digits followed by an exponent. For best results, the 3 digits should be in the range of 1.00 to 9.99. If you need to go up or down beyond these limits, raise or decrease the exponent to account for the change. For example if you had a calibration constant of 9.50 and the exponent is 3 and you needed to increase the reading by 20% then the new value would be 1.14 with an exponent of 4.

Deadtime

This is the number in microseconds that the instrument uses to correct for deadtime losses in the detector. Set it to zero if you do not want any deadtime correction. It is useful to extend the range of pulsed detectors such as GM detectors and proportional detectors. It should be turned off for ion chambers.

SETUP MENU

If you entered this menu then the following are available:

Start Time

When the instrument is turned on it waits before going into normal operation. This gives time for the instrument to stabilize. 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. To turn it off, set it to zero.

Alm Setup (Alarm Setup)

This is a number that is used to set the condition of the alarms, indicators and external outputs. There are 4 setups, one for each of the three 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 1, TS10 and TS11 are shorted, and TS11 and TS12 are open. When the relay is 0, pin TS10 and TS11 are open and TS11 and TS12 are shorted. The relay is operated in the fail-safe mode. 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 and the relay is not energized. When the relay is set to 1 the pin is at 0 volts and the relay is energized. 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 third line of the table below shows:

No Alarm 1 * * * 0 0 1 0

If you change the * to zeros it becomes the number 10000010. 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 10000010. Next to it is the number 130. This is the decimal conversion. 10000010 in binary is 130 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	0	*	*	*	1	0	0	1	9
Alarm 2	0	*	*	*	1	0	0	1	9
No Alarm	1	*	*	*	0	0	1	0	130

*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.

Units

This sets the units that are displayed. It should be preset for your detector. The values are:

UNITS TABLE			
Setting	Units	Setting	Units
0	cnt	6	Gy
1	REM	7	dis
2	rad	8	CPM
3	R	9	CPS
4	Sv		
5	Bq		

Timebase

This has 4 possible settings and sets the characters in the display. It should be preset for your detector. Changing this does not change the calibration.

TIMEBASE TABLE			
Setting	Timebase	Setting	Timebase
0	none	2	/m
1	/h	3	/s

Display Type

There are 4 display types. They change the way the data changes the prefix when it changes ranges. It should be preset for your detector. The 4 types and their settings are:

1. This is engineering format. The units change every 3 decades. This is the recommended setting.

2. This extends the engineering format up 1 so that a prefix change will not occur when the value moves above 999. For example instead of going from 999 mR/h to 1.00 R/h this will go from 999 mR/h to 1000 mR/h with a constant zero in the right hand digit. On the next higher decade change the prefix will change.

3. This extends the engineering format down 1 decade so that a prefix change will not occur when the value goes below 100. For example instead of going from 1.00 mR/h to 999 uR/h the display would go from 1.00 mR/h to .999 mR/h. On the next lower decade the display would change the prefix.

4. This is a combination of 2 and 3 where the span of one prefix will be extended up and down 1 decade.

DISPLAY TYPE			
Setting	Type	Setting	Type
1	Engineering	3	Down 1 decade
2	up 1 decade	4	Up & Dn 1

Prefix

The prefix is the starting point for the display. It should be preset for your detector.

PREFIX TABLE			
Setting	Prefix	Setting	Prefix
0	a atto	7	K kilo
1	f femto	8	M mega
2	p pico	9	G giga
3	n nano	10	T tera
4	u micro	11	P penta
5	m milli	12	E exa
6	none		

Range Hi/Lo Limits

This sets the limits of the display, both upper and lower limits. It has the value from 119 to 136 with 128 in the center. Set this to keep the detector from being too sensitive and to keep it from going into a high scale that may not be usable because of saturation or excessive deadtime losses. Set Range Hi Limit to one value higher than you want to use, Range Lo Limit to the actual range you want to use. It should be preset for your detector.

RANGE HI/LO TABLE Center is the point of calculation for the calibration. Higher means the ranges with more counts. Lower means the ranges with fewer counts. (Table values assuming type 1 Display.)

Setting	Range (decade)	Setting	Range (decade)
128	X.XX Center	127	XXX
129	XX.X	126	XX.X
130	XXX	125	X.XX
131	X.XX	124	XXX
132	XX.X	123	XX.X
133	XXX	122	X.XX
134	X.XX	121	XXX
135	XX.X	120	XX.X
136	XXX Higher	119	X.XX Lower

Time Constant

This sets the rate of change of the display. It should be preset for your detector.

TIME CONSTANT

Setting	Time Constant	Setting	Time Constant
0	Fast	2	Slow
1	Medium		

Zero Offset

The zero offset is for detectors that require it. The 6012 subtracts this value from the raw counts every second before it is used to set the alarms or view on the display. Set it to the value specified in the manual for the detector. The radiation level can be viewed without the zero offset by pushing the up button on the control panel. It is used with ion chambers and set to 0 with GM and proportional detectors.

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 64 1.23 uSv/h

The data from left to right is:

1	XXXXXX	6 hex digits: Counts per second from detector.
6	XX	1 hex digit This is the status byte. See below for a description.
2	XXX	3 digits with units that are the same level as shown on the display

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

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

SERIAL PROTOCOL

9600 baud rate, 1 stop bit, no parity
There is no flow control.

VII. CALIBRATION

The instrument is calibrated digitally. There are two adjustments for each detector that effect the calibration. The instrument is adjusted by changing the calibration factor with exponent, and the deadtime.

ABOUT CALIBRATION, EXPONENT AND DEADTIME FACTORS

The Calibration, Exponent and Deadtime Factors are all used in the Calibration of the instrument. The Calibration and Exponent are in reality one number. This number is used to increase and decrease the value of the calibration. If the calibration is 10% too low then it is necessary to increase the Calibration Factor 10%.

The combination of Calibration Factor and Exponent are, in reality, a number in scientific notation. A Calibration Factor of 6.35 and an exponent of 2 is in scientific notation 6.35×10^2. The Calibration Factor should be set in the range of 1.00 to 9.99. Raise and lower the exponent to compensate if it is necessary to go beyond these limits. For example, if the Calibration Factor is 9.5 and the Exponent is 3 then an increase of 10% would be 9.5 x 1.1 = 10.45. This is not in the range of 1.00 to 9.99 so decrease the Calibration Factor by 10 and add one to the exponent, which would be 1.04 with an exponent of 4. The same is true of the other direction. If the Calibration Factor is 1.24 and the Exponent is 3 and it is necessary to decrease it by 30% then 1.24 would be reduced to .868. This is below 1.00 so decrease the exponent by 1 to 2 and increase the Calibration Factor by 10 to 8.68.

The range of the Exponent is from -40 to +40. In reality it should never be necessary to set it over the range of -8 to +8.

The deadtime is in units of microseconds. It should be close to the value specified by the manufacturer of the detector. Its value is from 0 to 999 μS. It will be adjusted during the calibration.

RADIATION CALIBRATION

1. Expose the detector to a radiation field that is at the lower end of the sensitivity of the detector. Change the Calibration Factor and Exponent until the reading is correct.
2. Expose the detector to a field that is at the upper end of the sensitivity of the detector. Adjust the Deadtime until the reading is correct.
3. Repeat steps 3 and 4 until both settings are correct.
4. Expose each range/decade and note the readings on the calibration report.

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.

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. This 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, it just quiets the buzzer.

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 is 1 adjustment. 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.

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 watchdog timer can be checked by pushing 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. The pulse is the watchdog timing out and resetting the microprocessor.

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									
No Alarm									

ENTER THE DECIMAL NUMBERS ABOVE INTO THE SETUP BOXES BELOW

SUMMARY OF SETTINGS

	TRIPSET	DELAY	PAUSE	SETUP
ALARM 1				
ALARM 2				
NO ALARM				

START TIME _____

FAIL TIME _____

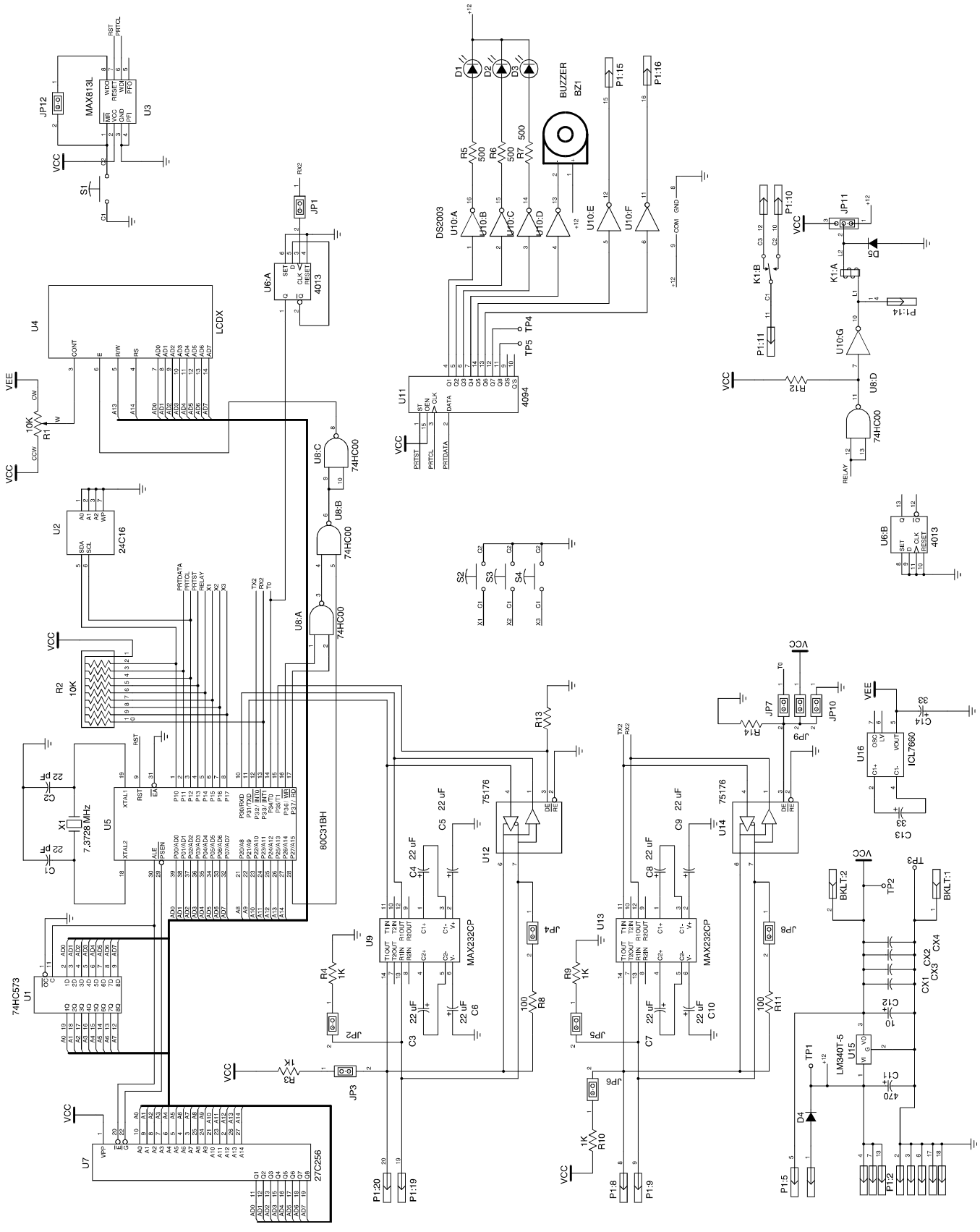
.APPENDIX II

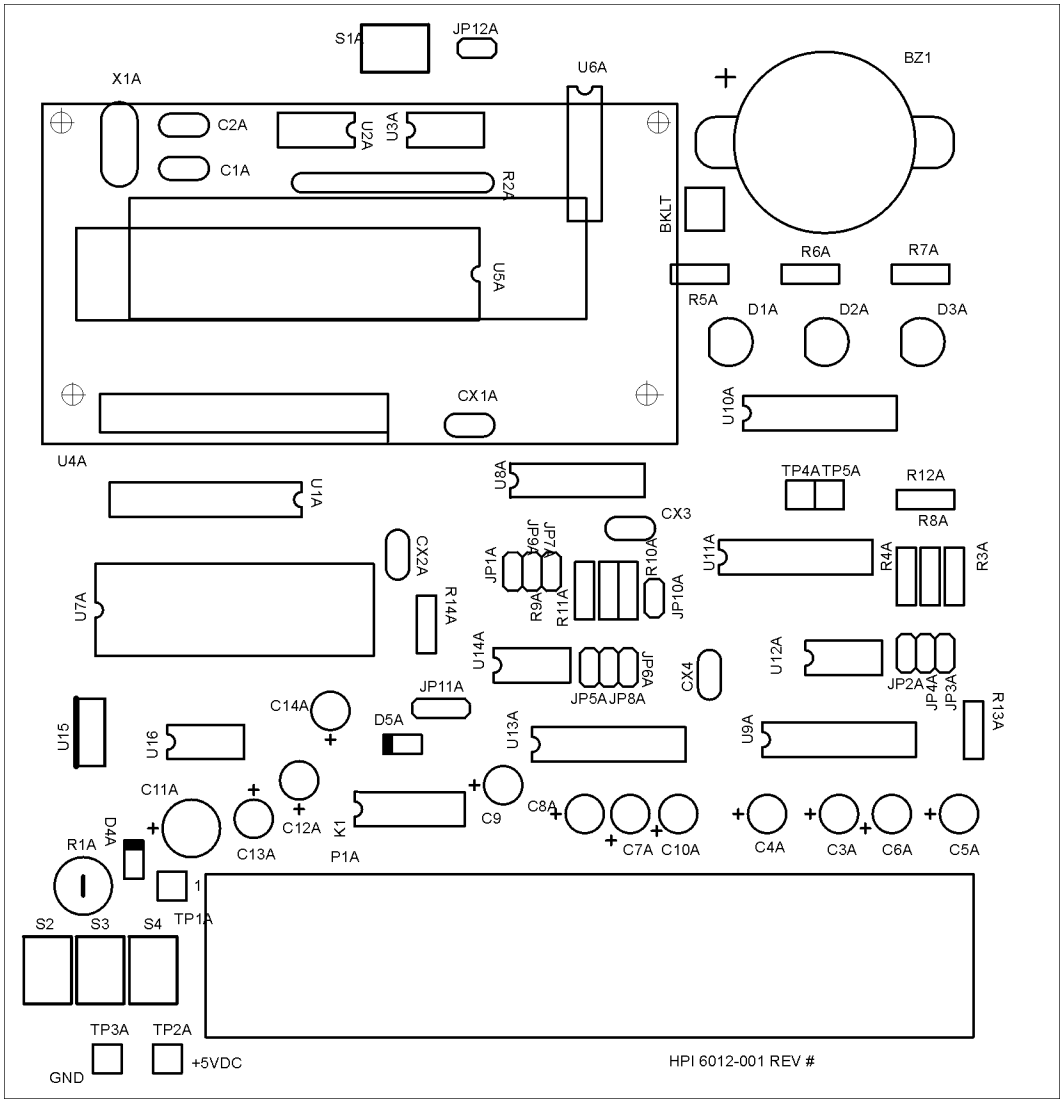
DECIMAL/HEX/BINARY CONVERSION TABLE

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

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
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


80C31BH
74HC573
74HC00
MAX232CP
MAX813L
LCDX
24C16
27C256
4013
4094
DS2003
75176
ICL7660
LM340T-5
BUZZER
7.3728 MHz
VCC
VEE
P1:20
P1:19
P1:8
P1:9
P1:5
P1:12
P1:14
P1:15
P1:16
P1:10
P1:11


S1A
JP12A
U6A
BZ1
X1A
C2A
U2A
U3A
C1A
R2A
BKLT
U5A
R6A
R7A
R5A
D1A
D2A
D3A
CX1A
U10A
U4A
U1A
U8A
TP4A TP5A
R12A
R8A
CX3
CX2A
JP1A
JP9A
JP7A
R10A
U11A
R4A
R3A
U7A
R14A
R9A
R11A
JP10A
U14A
JP6A
CX4
U12A
JP2A
JP4A
JP3A
JP5A JP8A
JP11A
C14A
D5A
R13A
U15
U16
U13A
U9A
C11A
C9
C8A
C12A
C13A
K1
P1A
C7A C10A
C4A
C3A
C6A
C5A
D4A
R1A
1
TP1A
S2
S3
S4
TP3A
TP2A
GND
+5VDC
HPI 6012-001 REV #