Benthic and Resistivity Sensors (BARS)

User's Manual

Designed and Built for:
Marv Lilley (University of Washington)
Canadian Neptune Project

Designed and Built by:
Ocean. Engineering Services
University of Washington
Rex Johnson
Randy Fabro
Tor Bjorklund

Built: July, 2010
Last Update: July 18, 2012

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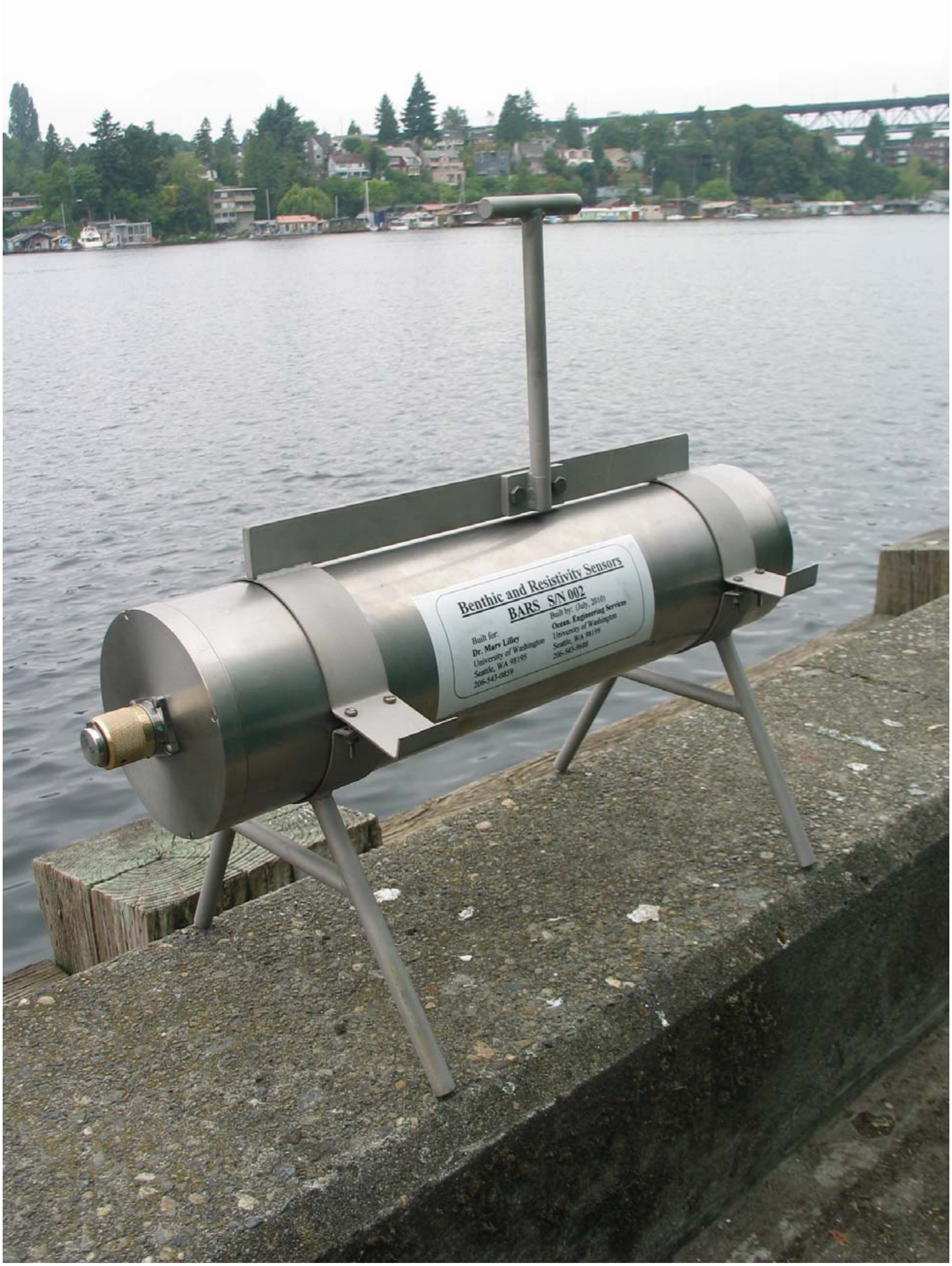
Section 1

Overall System Description


Benthic and Resistivity Sensors
BARS S/N 002
Built for:
Dr. Marv Lilley
University of Washington
Seattle, WA 98195
206-543-0859
Built by: (July, 2010)
Ocean. Engineering Services
University of Washington
Seattle, WA 98195
206-543-9608

BARS System Overview

This instrument was specifically designed to be used on the Canadian underwater cable system commonly referred to as Neptune Canada. The full instrument name is “Benthic And Resistivity Sensors”. For convenience, the acronym is “BARS”. This instrument is a sophisticated underwater scientific sensor interface designed to take measurements from a multitude of sensors in hydrothermal vents and translate the sensor output signals via standard serial communications in useful scientific units. It has sensors to measure resistivity, temperature, eH (oxidizable nature of seawater components) & hydrogen. The heart of the data logger is an Onset Tattletale 8V2 microprocessor. This microprocessor controls power to the sensors, the data collection, formatting of data, data output streaming, and provides user interaction as needed. It is setup as a “plug and play” system in that once power is applied to the system, the Tattletale microprocessor automatically takes data according to preloaded user selected parameters and outputs the data to the cable system via RS422 protocol. The user can send a command to the BARS unit to stop data collection (double Control-S) and enter a Menu Mode where diagnostics can be run, data collection parameters can be changed, power to each sensor can be turned on or off, and data collection restarted. Under the parameter change menu in the software, the user can determine how often to sample the data, which sensors are energized, and whether the system Metadata and Parameters are outputted pm power up and/or restart of data collection. All the user parameters are stored in Eprom memory so they do not need to be reloaded each time the unit is powered back up.

The Tattletale 8V2 Data Logger/Controller Microprocessor lives in a Titanium pressure case, which can be deployed for extended periods of time without concern. The Tattletale 8V2 is programmed in TxBasic (Version 5). TxBasic is very simple, yet powerful. All communications with the Logger/Controller are via standard RS422 protocol at 9600 baud. This system is supplied with a fully operational program (BARS.TXB) for taking the data. This software provides the user with the ability to select parameters, do diagnostics, and collect data based on the operator’s selected parameters, all with user friendly menus. This program also does automatic error checking such as verifying that any user entered parameters are within proper tolerances without conflicts, and even stops the automatic logging if the power to the device drops below the acceptable tolerance, since all data below that point is invalid. This program is preloaded in permanent memory and automatically runs when power is applied to the system.

The system is designed to be operated on the Canadian underwater cable system. It expects the input power to be 15 volts but it can operate properly with an input voltage as low as 13 volts or as high as 30 volts dc. The system outputs serial data to the cable system using RS422 protocol at user defined time intervals from 15 seconds to 60 minutes. An example of the output data is shown on the next page with the formatting of that data shown on the following page.

Sample of Typical BARS Data Stream shown with optional Metadata
(12 words per burst)
(See next page for details)

```
System Name: BARS (Benthic and Resistivity Sensors)
              System Owner: Marv Lilley, University of Washington
              Owner Contact Phone #: 206-543-0859
              System Serial #: 001
              Software Version 1.86, Last Update March 28, 2012
              Made by Ocean Engineering Service, July 2010 (206-543-9688)

   This system is presently setup with the following parameters:
1  = Eprom Status (0 means not setup yet, 1 means ready to use)
20 = Cycle Time (Actual time in seconds or minutes)
0  = Minutes or seconds Cycle Time (0 = seconds mode, 1 = minutes mode)
55 = Power Control Word (Power Control Word = 1 + 2 + 4 + 16 + 32  =  55 if all on)
1  = Res Power Status (0 = Off, 1 + On)
1  = Thermocouple & Hydrogen Amp Power Status (0 = Off, 1 + On)
1  = eH Amp Power Status (0 = Off, 1 + On)
1  = Hydrogen Sensor Power Status (0 = Off, 1 + On)
1  = Reference Temperature Power Status (0 = Off, 1 + On)
0  = Metadata Print Status on Power Up (0 = No print on Power up, 1 = Print)
0  = Metadata Print Status on Restart Data Collection (0 = No print, 1 = Print)

0.065  0.338  1.660  0.123  0.637  3.201  1.994  1.877  3.53  1.284  318.1  9.1
0.066  0.337  1.660  0.122  0.639  3.200  1.993  1.877  3.53  1.283  317.8  9.1
0.067  0.337  1.660  0.123  0.638  3.200  1.993  1.878  3.51  1.283  317.8  9.1
0.067  0.337  1.659  0.122  0.642  3.200  1.993  1.877  3.53  1.283  317.8  9.1
0.067  0.335  1.662  0.120  0.638  3.199  1.995  1.875  3.57  1.284  318.1  9.1
0.067  0.336  1.659  0.123  0.638  3.198  1.993  1.878  3.51  1.283  317.8  9.1
0.068  0.335  1.660  0.121  0.641  3.198  1.994  1.876  3.55  1.283  317.8  9.1
0.067  0.337  1.660  0.122  0.639  3.199  1.993  1.878  3.51  1.283  317.8  9.1
0.068  0.334  1.660  0.121  0.639  3.198  1.994  1.874  3.59  1.284  318.1  9.1
0.067  0.335  1.665  0.120  0.639  3.199  1.995  1.874  3.59  1.282  317.6  9.1
0.065  0.337  1.657  0.123  0.637  3.200  1.994  1.876  3.55  1.283  317.8  9.1
0.067  0.338  1.657  0.122  0.639  3.199  1.993  1.877  3.53  1.283  317.8  9.1
0.066  0.336  1.654  0.125  0.639  3.199  1.993  1.878  3.51  1.283  317.8  9.1
0.068  0.335  1.660  0.121  0.641  3.197  1.994  1.876  3.55  1.283  317.8  9.1
0.067  0.337  1.659  0.123  0.639  3.199  1.994  1.878  3.51  1.284  318.0  9.1
0.066  0.337  1.657  0.123  0.639  3.199  1.994  1.878  3.51  1.284  318.0  9.1
0.068  0.334  1.657  0.121  0.642  3.196  1.994  1.876  3.55  1.283  317.8  9.1
0.065  0.338  1.658  0.123  0.637  3.200  1.994  1.877  3.53  1.283  317.8  9.1
0.065  0.337  1.659  0.123  0.637  3.200  1.995  1.877  3.53  1.283  317.8  9.1
```

BARS Data Format

BARS Outputted Data Format using BARS.TXB Program:

The following is the Data Format for each burst: (12 Words/burst). The time between bursts is user selectable from 15 seconds to 60 minutes.

Word 1	Resistivity/5 (See Note 1)
Word 2	Resistivity X1 (See Note 1)
Word 3	Resistivity X5 (See Note 1)
Word 4	Hydrogen/5 (See Note 1)
Word 5	Hydrogen X1 (See Note 1)
Word 6	Hydrogen X5 (See Note 1)
Word 7	Eh Sensor (See Note 1)
Word 8	Reference Temp Volts (1) (2)
Word 9	Reference Temp Deg C
Word 10	Resistivity Temp Volts (1) (3)
Word 11	Resistivity Temp Deg C
Word 12	Battery Voltage (See Note 1)

Notes:

1. This data is outputted in volts.
2. The Reference Thermistor voltage must be translated into Degrees C based on the tables included in the NOTES and the SCHEMATICS sections of this manual. The Program BARS.TXB uses the equation: Tm(deg C) = 27.50133 – 17.2658*V + 15.83424/V (V = Tm volts)
3. The Thermocouple voltage must be translated into Degrees C based on the tables included in the NOTES and the SCHEMATICS sections of this manual. The Program BARS.TXB uses the equation: Tc(deg C) = (244970*V)/1000 (V = Tc volts). The Final Corrected Temperature = Tm + Tc. The outputted voltage is just that of the sensor. The outputted temperature has been corrected with the reference.

BARS Specifications

Main Control Unit & Data Logger:

Microprocessor	Tattletale 8V2
Operating System	TxBasic Version 5.0
Total Data Storage	512M Bytes
12 Bit A/D Converter	8 Channels of 0-4.096 volts
Clock Stability	+/- 20PPM (+/-1 Min/Mon)

Resistivity Sensor:

Manufacturer	UW-Physics
Electronics Manufacturer	Ocean Eng. Services
Output	0 - 4 volts

Resistivity Temperature Sensor:

Sensor Manufacturer	Omega Engineering (Custom)
Probe Manufacturer	Ocean. Engineering Services
Model Number	CATi-116U-24
Type	K Thermocouple
Range	0-400 C

Reference Temperature Sensor:

Sensor Manufacturer	YSI
Model Number	44031
Characteristics	10K Ohms @ 25C
Usable Range	0 to 30 C

Hydrogen Sensor:

Probe Manufacturer	UW-Physics
Sensor	Entran EPXN-V03*-15P-/Z1
Sensor Output	0 – 69.88 mV FS equals 0-15 PSI
Electronic Gain	10
Usable Range	0-4.096 volts
Pressure Housing	Titanium (1.65”Dia x 3.5”)
Depth Rating	22732 PSI (50604 FT)
Power	4.096V @ 0.25 ma

eH Sensor:

Probe Manufacturer	Ko-ichi Nakamura
Sensor Output	+/-0.5 volts
Electronically shifted and amplified to	0 to 4 volts

BARS Specifications

(Continued)

Logger Pressure Case:

Material	Titanium 6AL4V
Outside dimensions	5.0" Diameter, 19.5" Long
Weight in Air (With Electronics)	31.6 Lbs.
Weight in H2O (With Electronics)	15.6 Lbs.
Collapse Pressure	19656 PSI (43755 FT)

System Power Consumption: (All sensors turned on)

Logger Dropout Voltage	12 volts
System Maximum Voltage	30 volts
Peak current requirement	85 ma
Waiting to take next burst of data	52 ma
Taking A/D Data (5 seconds/cycle)	52 ma
Formatting Data (5 seconds/cycle)	77 ma
Sending Data (1 second/cycle)	85 ma
Menu Mode	50 ma

System Power Control:

Control Line 0	Res Electronics (+9 v)
Control Line 1	Instrumentation Amp (+9 v)
Control Line 2	Iso Amp (+9 v)
Control Line 4	Hydrogen Sensor (+Vref)
Control Line 5	Reference Temperature (+Vref)

System Communications:

Hardware Port	RS422
Baud Rate	9600 Baud

BARS Specifications

(Continued)

Tattletale I/O Assignments:

Digital I/O:

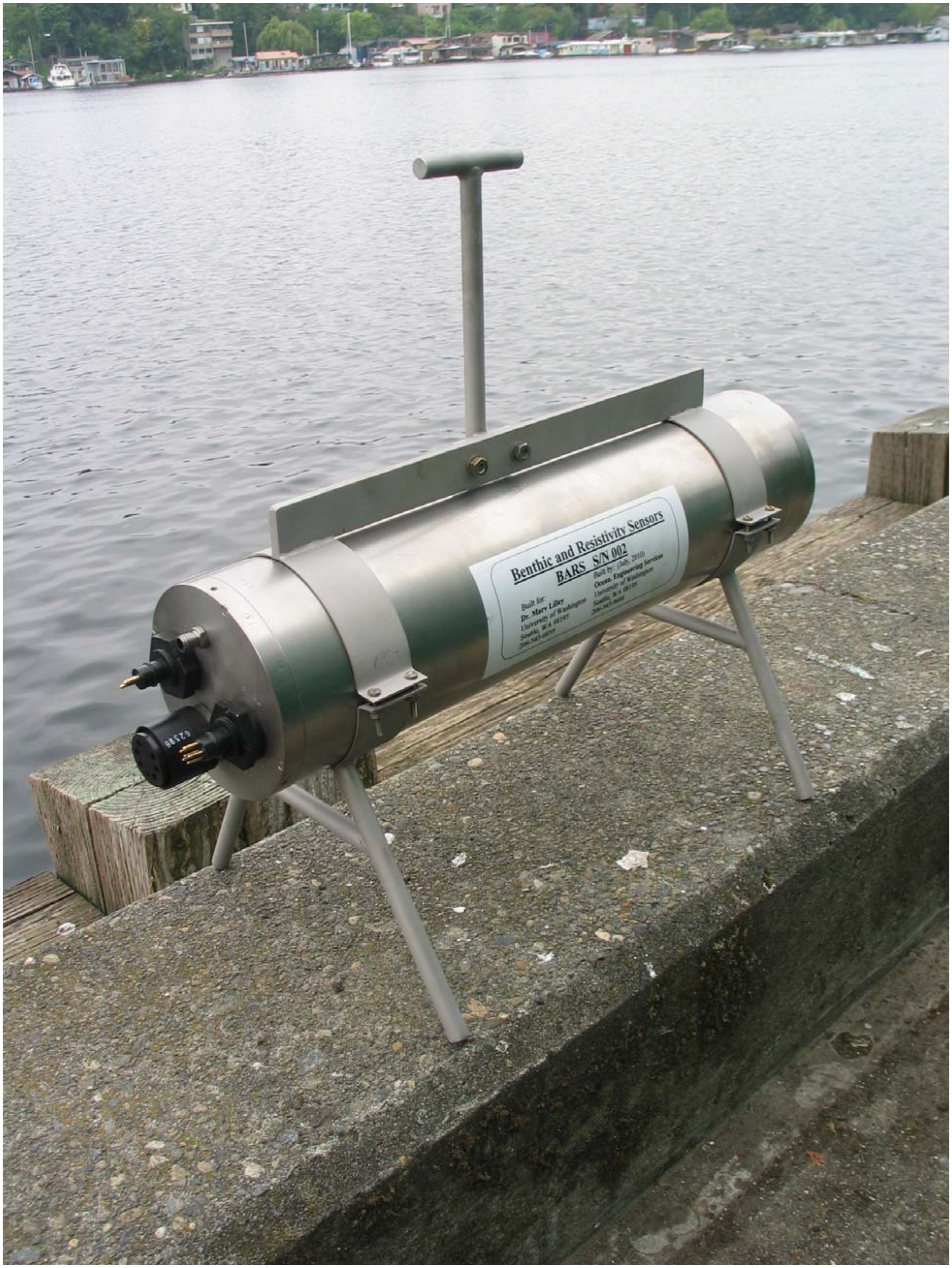
TPU0	Analog Power Control (1 = On)
TPU1	Mux Strobe
TPU2	SDO Latch
TPU3	Not Used
TPU4	Freq. Input (Period/Count)
TPU5	S Clock
TPU6	Not Used
TPU7	Not Used
TPU8	SDO Data
TPU9	D-Out #1 (0 = On)
TPU10	D-Out #2 (0 = On)
TPU11	D-Out #4 (0 = On)
TPU12	Not Used
TPU13	RS232 Out#2 (USEND)
TPU14	RS232 In#2 (UGET)
TPU15	Not Used

Analog I/O (12 Bits):

A0	Resisitivity/5
A1	Resisitivity X1
A2	Resistivity X5
A3	Hydrogen/5
A4	Hydrogen X1
A5	Hydrogen X5
A6	Eh Sensor
A7	Mux Input
Mux0	Reference Temperature
Mux1	Resistivity Temperature
Mux2	Battery Voltage/10
Mux3	Not Used

Section 2

Operating Instructions


Benthic and Resistivity Sensors
BARS S/N 002
Built for:
Dr. Mary Lilley
University of Washington
Seattle, WA 98195
Built by: (July, 2010)
Ocean Engineering Services
University of Washington
Seattle, WA 98195

BARS Operating Instructions

A. Preparations for Deployment:

1. Since this device lives in a titanium pressure case, which is very durable and the microprocessor controller is programmed to be “Plug and Play”, one only needs to plug the sensors into the unit (clean and grease each connector) and attach the interconnecting cable that goes to the underwater cable system. Be sure to use the locking sleeves on each connector. There are no other necessary preparations.

2. If for some reason, you need to open the pressure case, remove the end cap with all the connectors first. To do this remove the 4 small screws that hold the multi-connector end cap to the pressure case. Then use fiberglass wedges to remove the endcap itself **(NEVER USE A SCREWDRIVER!)**. The end cap is connected to the internal electronics through several connectors. Unplug them so the end cap is free. Next remove the opposite end cap that only has one connector using the same method. This end cap is also connected to the internal electronics with a connector. Once it is unplugged, this end cap is free. Then you can slide the electronics out of the case.

3. To talk to this instrument directly with the short interface cable for testing purposes, use a communications program like Onset’s TxTools software. Connect your computer’s RS232 serial port to the interface cable connector (DE9). Start TxTools on your computer. The first time you start TxTools, you will have to set the serial port configuration (9600 Baud). Apply 15 volt power to the interface cable’s banana connectors. After a few seconds, data will stream out of the system in 12 word bursts. The default time between bursts is 20 seconds, but it can be set to anything between 15 seconds and 60 minutes.

4. To access diagnostics and user options, enter the 2 key command “Control-S”. When the unit receives this command, it acknowledges it by sending back a line feed and a carriage return. When you see this, you have about ½ second to send another “Control-S” command, or it will be ignored. This double “Control-S” technique prevents false commands from stopping the data collection. If the unit is in data collection mode which typical lasts for about 6 seconds at the time that the system is setup to take data, it will ignore the “Control-S” command, so it is important to send this command when the unit is not taking data. When the “Control-S” command is properly sent and received, the microprocessor will display a Main Menu of options as follows:

```
Select one of the following functions:
0).  Reprint Time and this Menu
1).  Restart Data Collection
2).  Change Data Collection Parameters
3).  System Diagnostics
4).  Set the system clock
5).  Control Power to Sensors
6).  Provide information on this system
7).  Exit this program
```

BARS Operating Instructions

(continued)

5. When you enter the Main Menu mode, if you have not already set the system clock, you will see a notice to set it. This is done through option #4. After you have set the proper Date and Time, the current system time will be displayed along with the menu options.

6. Option #2 on this menu enables the user to change parameters, including the time between each burst (Cycle Time), whether the unit outputs only the data or goes into a verbose mode to assist debugging any problems remotely, and whether to enable or inhibit the output of the Metadata on power up and/or on restart of data collection. This submenu also has an option to force all the system parameters back to the default settings as shown in the system specifications. Lastly, this menu has an option to output all the system Metadata as a convenience.

7. Option #3 is a System Diagnostics to verify that everything is functioning correctly. See the typical diagnostic output data on the next page.

8. As already mentioned above, Option #4 enables the user to set the system clock.

9. Option #5 allowed the user to remotely turn power on/off to each selected sensors. This can be useful for diagnostics for example it there is a suspected ground loop due to a sensor leak or failure. It can also be used to turn off a damaged sensor that due to the ground loop currents or other problems, it is affecting all the other data.

10. Option #6 provides identification and contact information on this unit. The exact format is as follows:

```
          System Name: BARS (Benthic and Resistivity Sensors)
          System Owner: Marv Lilley, University of Washington
          Owner Contact Phone #: 206-543-0859
          System Serial #: 001
          Software Version 1.86, Last Update March 28, 2012
          Made by Ocean Engineering Service, July 2010 (206-543-9688)

 This system is presently setup with the following parameters:
1   = Eprom Status (0 means not setup yet, 1 means ready to use)
20 = Cycle Time (Actual time in seconds or minutes)
0   = Minutes or seconds Cycle Time (0 = seconds mode, 1 = minutes mode)
55 = Power Control Word (Power Control Word = 1 + 2 + 4 + 16 + 32  =  55 if all on)
1   = Res Power Status (0 = Off, 1 + On)
1   = Thermocouple & Hydrogen Amp Power Status (0 = Off, 1 + On)
1   = eH Amp Power Status (0 = Off, 1 + On)
1   = Hydrogen Sensor Power Status (0 = Off, 1 + On)
1   = Reference Temperature Power Status (0 = Off, 1 + On)
0   = Metadata Print Status on Power Up (0 = No print on Power up, 1 = Print)
```

```
0   = Metadata Print Status on Restart Data Collection (0 = No print, 1 = Print)
```

11. The last option (#7) is necessary, since it is the only way to stop the program. If this option is selected, the following text comes up:

```
        Are you really sure that you want to stop this program?
                Enter 1 for Yes, 0 for No →
```

If the number 1 is entered, the program stops and the TxBasic Prompt will come up. If the number 0 is entered, you are returned to the Main Menu. Do not stop this program unless you really want to and understand the consequences.

12. To restart data collection, select option #1 on the Main Menu.

13. All the submenus that have lists of user's options can accept commands from 0 to 9. If you enter the number "9", while in any of these submenus, the program jumps back to the Main Menu.

14. This system is also setup to ignore random commands whether in the data collection mode or one of the Menu Modes. In addition, if the user enters a value outside the acceptable range of the requested parameter, the program will respond with a warning and the user will have the option of inputting a new value.

BARS Typical Diagnostic Output

```
          This Test Routine Prints out the actual Analog Voltages
                       from all the Analog Inputs.
                  This should be helpful for system testing.


                    How Many Scans do you want? --> 20


-Res/5- -ResX1- -ResX5- -*H2/5- -*H2X1- -*H2X5- -*Eh**- RefTemp ResTemp  VBatt
0.131   0.645   3.167   0.044   0.241   1.448   2.000   1.875   1.227    9.123
0.129   0.646   3.159   0.122   0.621   3.046   2.001   1.876   1.278    9.121
0.130   0.647   3.168   0.126   0.619   3.047   2.000   1.875   1.275    9.122
0.132   0.650   3.168   0.129   0.621   3.046   2.001   1.871   1.280    9.122
0.131   0.646   3.165   0.126   0.621   3.052   2.000   1.876   1.280    9.121
0.130   0.647   3.184   0.132   0.623   3.050   2.001   1.876   1.280    9.123
0.131   0.644   3.170   0.127   0.625   3.051   1.999   1.871   1.276    9.122
0.130   0.646   3.188   0.129   0.622   3.046   2.002   1.875   1.279    9.123
0.131   0.647   3.170   0.129   0.620   3.049   2.000   1.871   1.279    9.122
0.133   0.647   3.164   0.126   0.623   3.046   2.000   1.875   1.279    9.121
0.130   0.647   3.161   0.126   0.622   3.045   2.000   1.876   1.280    9.122
0.132   0.647   3.163   0.128   0.620   3.046   2.000   1.877   1.279    9.122
0.129   0.647   3.166   0.130   0.622   3.048   2.001   1.874   1.282    9.122
0.130   0.646   3.166   0.129   0.620   3.044   2.000   1.876   1.279    9.123
0.129   0.651   3.166   0.127   0.621   3.046   1.999   1.872   1.280    9.122
0.132   0.644   3.188   0.127   0.632   3.050   2.001   1.873   1.279    9.123
0.131   0.646   3.176   0.126   0.624   3.045   2.001   1.874   1.280    9.122
0.132   0.645   3.159   0.129   0.623   3.049   2.002   1.870   1.280    9.121
0.131   0.643   3.173   0.128   0.628   3.047   2.000   1.874   1.279    9.122
0.128   0.646   3.168   0.126   0.621   3.052   1.998   1.874   1.280    9.123
Press Enter to return to Main Menu.
```

BARS Operating Instructions

(Continued)

B. User Operation Notes:

1. The recommended program to operate this logger is called BARS.TXB. It is written in Onset TxBasic.

2. Since this system is designed to be “Plug and Play”, when power is applied, data is automatically be sent out the RS422 port at 9600 Baud. Use a communications program like Onset’s TxTools to talk to the system.

3. To get to the Main Menu of user options, send the 2 key command “Control-S” to the unit from your communication program. The unit should respond with a line feed and a carriage return. You then have about ½ second to enter another “Control-S” command. The unit should bring up the Main Menu.

4. When the Main Menu is displayed, it will list all the user options. If the current Date and Time have not already been set, there will be a notice here to set it.

5. Every time you just press ENTER while in the Main Menu, the Current Date and Time along with the Menu will be reprinted.

6. Option 1 on the Main Menu starts the Data Collection routine. If you are in Data Only mode, only the 12 words of data will be outputted every burst. If you are in Verbose mode, Lots of information will be sent including data labels.

7. Option 2 allows the user to change data collection parameters such as the time between burst, whether to just see the data or go into a verbose mode to help find problems, and whether the Metadata is outputted on power up and at restart of data collection. It also has an option to force all the system parameters back to their default values per the specification page. Lastly it has an option to output all the system Metadata for the user’s convenience.

8. Option 3 on the Main Menu does diagnostics. Here you can look at the analog voltages from all the sensors. This can be very helpful to debug the system.

9. Option 4 allows the user to reset the Tattletale clock. When you press Enter to set the Seconds in the Time, the actual Date and Time are entered into the system. It is recommended that you use WWV or a GPS clock to set the time.

10. Option 5 allow the user to remotely control power to the sensors. This can be useful if a sensor has failed and is now leaking power into the water.

11. Option 6 provide system identification and owner contact information.

12. Option 7 enables the user to stop the program; there is no other to stop the program. But you want to be sure that you really want to do this. If you do stop the program, you will find yourself at

the TxB# prompt. To restart the program, enter a Control-X command followed by “Y” to get to the TOM monitor. Then enter the command “Go 2000” to restart BARS.TXB

BARS Operating Instructions

(Continued)

C. Scientific Event Detection:

Events: There are several scales of events none of which are well defined in terms of their effect on the parameters being measured by our instrument. An Event could be a single earthquake, a swarm of earthquakes, a dike intrusion or a seafloor eruption. These would have progressively larger impacts on the sensors on our instrument.

Temperature Sensor – A sudden change in temperature (up or down) by 2 or 3 degrees likely means an event of some sort has occurred.

Resistivity Sensor- Changes in resistivity can occur as a result of changes in the mixing ratio between vapor, brine and seawater. These will likely be produced during earthquake events and the degree of change is difficult to predict. A change in resistivity of order 10% likely signifies a significant event. Diking or lave flow events could produce changes greater than 50%.

eH Sensor - This sensor responds to changes in the concentration of reduced chemical species in the fluid. Sharp decreases in voltage will accompany a phase separation event due to an increase in hydrogen sulfide.

Hydrogen Sensor – Hydrogen concentrations could increase due to both earthquakes and intrusive lava events but the intrusive events should produce a larger change (of order of tens of millimolar).

D. Troubleshooting Notes:

There are too many possible failures with any sophisticated instruments to list them all, so we will only provide a basic philosophy here. When things are not working properly be sure to try the following:

1. If you can still communicate with the instrument, run the diagnostics and look to see which sensors appear to have reasonable data. The most important value to check first is the voltage to the instrument which is the last column and labeled “Vbatt”. It should be about 9 volts. If it is not 9 volts within +/- 0.5 volts, the system input voltage regulator most likely has a serious problem and the instrument would need to be recovered and repaired. But before doing this serious step, try turning power off to each sensor one at a time to see if a sensor has failed and it bleeding power into the water.

2. Assuming the system voltage is correct, next check each of the data values to see if they are within normal range and reasonable. For each voltage value, the voltage must be between 0 and 4.095 volts. No other values are allowed. If there are values outside this range, that sensor is questionable and the unit will have to be recovered and serviced to get that sensor operational again. In any case, if a sensor has failed, it is recommended that power to that sensor be turned off to prevent deplating of the wires from the sensor back into the pressure case if the sensor has an electrical path to salt water. Note, two of the data channels (RefTemp and ResTemp) are outputted in degrees C, not voltage. The RefTemp should be a value between 1C and 5C if deployed in the ocean or 15 to 30C if in air. The ResTemp should be a value between 50 and 400C if deployed in a hydrothermal vent or 15 to 30C in air.

3. If one channel has voltage values that are locked at 0 or 4.095 volts, this most likely indicates that the sensor for that channel has failed. Depending on the need for that sensor, a decision would have to be made as to whether the instrument needs to be recovered to replace that sensor or can acceptable data still be collected. For example, the instrument can still take useful Resistivity data without Hydrogen and/or eH. However, in any case, if a sensor has failed, it is recommended that power to that sensor be turned off to prevent deplating of the wires from the sensor back into the pressure case if the sensor has an electrical path to salt water.

4. In evaluating Resistivity or Hydrogen, it must be noted that to achieve more resolution, the signal for each of these sensors is logged at 3 different gains. The first channel is the lowest gain and the following channels have an additional gain of 5 from the previous. If the first channel signal is very small, even the highest gain will still be under the 4.095 volt upper limit. If the signal is modest, the highest gain channel will be maxed out at 4.095. If the signal is large, all but the lowest gain channel will be maxed out. This does not mean that there is a problem with the sensor.

BARS Operating Instructions
(Continued)

D. Troubleshooting Notes (continued):

5. Beyond the above diagnostics, any more serious problems will require that the instrument be recovered and checked out/repaired in a lab. The following are suggestions to help find problems:

A. Check all the interconnection wiring between the boards, wiring to the batteries, and to the end cap of the pressure case. Because these wires can be flexed, they can work and break.

B. Check the voltage to the system and coming out of the main regulator which is heat sinked to a piece of aluminum at the bottom of the electronics frame. The input voltage to the system should be at least 12 volts and the output from the regulator should be around 9 volts. If the power to the Tattletale 8 drops below 7 volts, it will not operate any more.

C. Using a lab power supply if available and a digital volt meter, measure the power consumption of the unit. When the program is just sitting in the Main Menu, the current should be 50 ma and when it is logging the current should be around 33 to 85 ma.

D. If you stop the program by mistake, you will find yourself back at the TxB# prompt. To restart the program, enter the command Control-X followed by “Y”. Then enter Go 2000 and the RES8B.txb program should restart.

E. Beyond the above simple tests, you will probably need to get Ocean Engineering Services to repair any serious problems.

BARS Operating Instructions
(Continued)

E. Post Cruise Procedures:

This instrument requires only minimal attention following recovery.

1. Flush the entire unit with fresh water to remove any salt and dirt..

2. There is no need to open the pressure case unless you suspect damage.

3. Clean and regrease all underwater connectors.

4. Note any damage to the underwater units or sensors and have them repaired.

System Program

```
Model 800
extension CFSize, CFAvail, CFSave, CFRead, CFExec, Burst2KSetup, BurstAD,
BurstInfo
extension LPMode, StopWatchStart, StopWatchTime, ADoff, TPUoff, TPUon, HybAt3V
extension TSerResetBaud, TSerPutByte, TSerOpen, TSerInFlush, TSerGetByte
extension TSerClose, TSerByteAvail
'*************************************************************************
'*   Tattletale 8 Canadian Benthic And Resistivity Sensors Program       *
'*                                                                       *
'*                    Written by:  Rex Johnson                           *
'*                                 Ocean Engineering Services            *
'*                                 University of Washington              *
'*                                 Seattle, WA 98195                     *
'*                                                                       *
'*                    Program Name:  BARS1PM2.TXB                        *
'*                                                                       *
'*          This Version was written specially for the Canadian Cable    *
'*          This Version is for BARS Serial Number 1 only                *
'*          It is designed to be Plug and Play                           *
'*          This version adds individual power control on sensors        *
'*          To get to the Main Menu, Use the Control-S Command           *
'*             When you see the Line Feed and Return,                    *
'*             Enter another Control-S                                   *
'*          Only check for Control-S command between Data Outputs        *
'*          Any received Control-C commands are completely ignored       *
'*          This Version adds Eprom storage of user parameters so        *
'*             if there is a power outage, the unit starts running       *
'*             again in the same mode; no user interaction required      *
'*          This version also adds an optional Metadata printout on      *
'*             startup and/or restart of logging                         *
'*          This version checks for bad data on setup of time            *
'*          This version corrects potential LowBatt Error                *
'*************************************************************************
'
'Hardware:
'  I/O lines:
'     D0 = Power Control (1 = On)
'     D1 = Mux Strobe
'     D2 = SDO Latch on Power Control Board
'     D3 = Port 3 Serial In
'     D4 = Period, Count Input
'     D5 = SDI, SDO Clock for Power Control Board
'     D6 = Max 232 Power (Low = On)
'     D7 = Port 3 Serial Out
'     D8 = SDO Data for Power Control Board
'     D9 = Digital Out #1 (ABS Control Line) (Low = On)
'    D10 = Digital Out #2 (ADCP Control Line) (Low = On)
'    D11 = Digital Out #4 or Software UART #2 (Low = On)
'    D12 = Port 4 Serial In
'    D13 = USEND (#2 RS232 Output)
'    D14 = UGET (#2 RS232 Input)
'    D15 = Port 4 Serial Out

'  Analog Inputs (12 Bit A/D)
'    A0 = Resistivity /5
'    A1 = Resistivity X1
'    A2 = Resistivity X5
'    A3 = Hydrogen /5
'    A4 = Hydrogen X1
'    A5 = Hydrogen X5
'    A6 = eH Sensor
'    A7 = Mux Input
'  Mux0 = Reference Temp
'  Mux1 = Thermocouple Temp
'  Mux2 = Battery/10
'  Mux3 = Not Used
'
'  Power Control using  [ SDO PwrWord, 16 ]  Command
'  To control Power to each device, the control word "PwrWord"
'  should be the summation of each number corresponding to each device listed
'  Chan 0 .......................... Res = 1
'  Chan 1 ...........Instrumentation Amp = 2
'  Chan 2 ............. eH Isolation Amp = 4
'  Chan 3 ........................ Spare = 8
'  Chan 4 ..................... Hydrogen = 16
'  Chan 5 ........ Reference Temperature = 32
'  Chan 6 ........................ Spare = 64
'  Chan 7 ........................ Spare = 128
'  Chan 8 ........................ Spare = 256
'  Chan 9 ........................ Spare = 512
'  Chan 10 ....................... Spare = 1024
'  Chan 11 ....................... Spare = 2048
'  Chan 12 ....................... Spare = 4096
'  Chan 13 ....................... Spare = 8192
'  Chan 14 ....................... Spare = 16384
'  Chan 15 ....................... Spare = 32768
'
'  Eprom Storage location assignments (Only Locations 0-31 available)
'     0 .... Status, 0 means not setup yet, 1 means ready to use
'     1 .... CycleTime, Default = 20
'     2 .... MinOrSec, Default = 0 (0 = seconds, 1 = minutes)
'     3 .... PwrWord, Default = 55 (Power Control Word for SDO command =
1+2+4+16+32=55)
'     4 .... ResPwrStatus, Default = 1 (0 = off, 1 = on)
'     5 .... InstrAmpPwrStatus, Default = 1
'     6 .... IsoPwrStatus, Default = 1
'     7 .... H2PwrStatus, Default = 1
'     8 .... RefTempPwrStatus, Default = 1
'     9 .... Print all Metadata on powerup, Default = 0 (0 = no print, 1 =
print)
'    10 .... Print all Metadata on restart of data collection, Default = 0 (0
= no print, 1 = print)
'
'  Serial Ports Assignments
'  Port 3 (Not Used)
'     Input (RX3)  = D3
'     Output (TX3) = D7
'  Port 4 (Not Used)
'     Input (RX4)  = D12
'     Output (TX4) = D15
'
'  Memory allocation
'  0 to 600000 = Datafile
'  600001 to 900000 = Diagnostics
'
'  Set up Month Array, Data Character Array
DIM M(13)
Dim D(14)
```

```
' Be sure all power is turned off
GOSUB TurnOffEverything
' What to do if an error
ONERR ErrorRoutine
' What do if receive a Control-C
' First setup command extension
extension CtrlCHandle
' Execute Command to Completely ignore all Control-C commands
CtrlCHandle(0)

' Set Default Parameters
LF = 10
CR = 13
ClockStatus = 0   // Has the System Clock been set (0 = No, 1 = Yes)
ADRate = 2        // Samples per Second
BOFMarker = -123  // BOF File Marker
Append = 1        // Always append the data file
LowBattMode = 0         // 0 = normal mode, 1 = Low Batt
Verbose = 0       // 0 = print data only, 1 = print all status information
Pointer = 100           // Set an arbitary pointer location so we can find
Control-S input
WriteDataStatus = 0     // 0 = Do not write data to memory, 1 = write data to
memory
' Set up Hybernate mode
' Mode 0 causes TT8 to stay at 5 volt power
' Mode 1 causes TT8 to drop to 3 volt power
Mode = 1
HybAt3V(Mode)
' Set up the number of days in the Month Array
M(1) = 31
M(2) = 28
M(3) = 31
M(4) = 30
M(5) = 31
M(6) = 30
M(7) = 31
M(8) = 31
M(9) = 30
M(10) = 31
M(11) = 30
M(12) = 31

' Check to see if Eprom Memory has been setup with parameters
' Any value other than 1 means current parameters have not been stored
' If parameters have not stored, then store default values and use default
values
' If parameters have been stored, use the stored values
EpromStatus = VGET(0)
IFF EpromStatus <> 1
      VSTORE 0, 1       // Set EpromStatus = 1 (0 = Memory not setup, 1 =
setup)
      VSTORE 1, 20            // Set CycleTime = 20 Minutes or Seconds
depending on MinOrSec
      VSTORE 2, 0       // Set MinOrSec = 1 for Min, or = 0 for Sec
      VSTORE 3, 55            // Set PwrWord = 55, Power Control Word for SDO
command = 1+2+4+16+32=55
      VSTORE 4, 1       // Set ResPwrStatus = 1 for Power On, 0 = Power Off
      VSTORE 5, 1
      VSTORE 6, 1
      VSTORE 7, 1
      VSTORE 8, 1
      VSTORE 9, 0       // Set MetadataStatusPowerUp = 0 for Do not print on
Powerup, 1 = print
      VSTORE 10, 0            // Set MetadataStatusRestartData = 0 for Do not
print on restart of data collection, 1 = print
ENDIF
EpromStatus = VGET(0)
IFF EpromStatus = 1
      CycleTime = VGET(1)
      MinOrSec = VGET(2)
      PwrWord = VGET(3)
      ResPwrStatus = VGET(4)
      InstrAmpPwrStatus = VGET(5)
      IsoPwrStatus = VGET(6)
      H2PwrStatus = VGET(7)
      RefTempPwrStatus = VGET(8)
      MetadataStatusPowerUp = VGET(9)
      MetadataStatusRestartData = VGET(10)
ENDIF

'Print a blank line to show unit is alive
PRINT

'Check to see if print Metadata
IFF VGET(9) = 1
      GOSUB PrtSysInfo
      PRINT
      GOSUB PrintParameters
      PRINT
ENDIF

'For Plug and Play, jump to Data Collection
GOTO TakeData

SetTime:
' Newest Routine to block bad data entries
GOSUB ClearScreen
PRINT "             This routine is to set or adjust the System Clock."
PRINT
RTIME
PRINT "                  The Current System Date = ";
PRINT #02,?(4),"/",?(3),"/",?(5)
PRINT "                  The Current System Time = ";
PRINT #02,?(2),":",?(1),":",?(0)
INPUT "     Do you want to Change the Current Time? (0 = No, 1 = Yes) --> " A
IF A = 0 GOTO MainMenu
IF A <> 1 GOTO SetTime

InputMonth:
INPUT "     Enter the Month (1-12): " Amonth
IFF Amonth > 12 | Amonth < 1
      GOSUB InputErrors
      PRINT
      GOTO InputMonth
ENDIF
CheckFeb:
IFF Amonth = 2
      PRINT
      PRINT " Is this a Leap Year? "
      INPUT " Enter 1 for Yes, 0 for No --> " AA
      IFF AA > 1 | AA < 0
            GOSUB InputErrors
            PRINT
            GOTO CheckFeb
      ENDIF
ENDIF
?(4) = Amonth

InputDay:
IF Amonth = 1 GOTO Days31
IF Amonth = 3 GOTO Days31
IF Amonth = 5 GOTO Days31
IF Amonth = 7 GOTO Days31
IF Amonth = 8 GOTO Days31
IF Amonth = 10 GOTO Days31
IF Amonth = 12 GOTO Days31
IF Amonth = 4 GOTO Days30
IF Amonth = 4 GOTO Days30
IF Amonth = 4 GOTO Days30
IF Amonth = 4 GOTO Days30
IF Amonth = 2 GOTO FebDays
' If you get here, you entered a bad number
GOSUB InputErrors
PRINT
GOTO InputMonth

Days31:
INPUT "     Enter the Day (1-31): " A
IFF A > 31 | A < 1
      GOSUB InputErrors
      PRINT
      GOTO InputDay
ENDIF
?(3) = A
GOTO InputYear

Days30:
INPUT "     Enter the Day (1-30): " A
IFF A > 30 | A < 1
      GOSUB InputErrors
      PRINT
      GOTO InputDay
ENDIF
?(3) = A
GOTO InputYear

FebDays:
IF AA = 1 GOTO Days29
IF AA = 0 GOTO Days28
' If you get here, you entered a bad number
GOSUB InputErrors
PRINT
GOTO InputMonth

Days28:
INPUT "     Enter the Day (1-28): " A
IFF A > 28 | A < 1
```

```
      GOSUB InputErrors
      PRINT
      GOTO InputDay
ENDIF
?(3) = A
GOTO InputYear

Days29:
INPUT "     Enter the Day (1-29): " A
IFF A > 29 | A < 1
      GOSUB InputErrors
      PRINT
      GOTO InputDay
ENDIF
?(3) = A

InputYear:
INPUT "     Enter the Year (Two Digits): " A
IFF A > 99 | A < 12
      GOSUB InputErrors
      PRINT
      GOTO InputYear
ENDIF
?(5) = A

InputHour:
INPUT "     Enter the Hour (0-23): " A
IFF A > 23 | A < 0
      GOSUB InputErrors
      PRINT
      GOTO InputHour
ENDIF
?(2) = A

InputMinute:
INPUT "     Enter the Minute (0-59): " A
IFF A > 59 | A < 0
      GOSUB InputErrors
      PRINT
      GOTO InputMinute
ENDIF
?(1) = A

InputSecond:
INPUT "     Enter the Second (0-59): " A
IFF A > 59 | A < 0
      GOSUB InputErrors
      PRINT
      GOTO InputSecond
ENDIF
?(0) = A

' Change the Clock Status Word
ClockStatus = 1
STIME
RTIME
GOTO SetTime

MainMenu:
```

```
GOSUB TurnOffEverything
GOSUB ClearScreen
PRINT: PRINT
PRINT "      ***************************************************************"
print "      *                                                             *"
PRINT "      *            Welcome to the BARS Program Main Menu            *"
PRINT "      *              (Benthic And Resistivity Sensors)              *"
PRINT "      *                    (Serial Number 001)                      *"
Print "      *                                                             *"
print "      ***************************************************************"
print
PRINT "                 Version 1.86 - Last Revision: Mar. 28, 2012"
PRINT
PRINT "                               Written by:"
PRINT
PRINT "                               Rex Johnson"
PRINT "                               Ocean Engineering Services"
PRINT "                               School of Oceanography"
PRINT "                               University of Washington"
PRINT "                               Seattle, WA 98195"
PRINT: PRINT
IFF ClockStatus = 0
      PRINT "                  The System Clock has not been set."
      PRINT "                    Use option 4 to Set the Clock."
      PRINT
      GOTO PrintOptions
ENDIF
RTIME
PRINT "                  The Current Tattletale Date = ";
PRINT #02,?(4),"/",?(3),"/",?(5)
PRINT "                  The Current Tattletale Time = ";
PRINT #02,?(2),":",?(1),":",?(0)
PRINT
PrintOptions:
PRINT "                  Select one of the following functions:"
PRINT
PRINT "                      0).  Reprint Time & this Menu."
PRINT "                      1).  Restart Data Collection."
PRINT "                      2).  Change Data Collection Parameters."
PRINT "                      3).  System Diagnostics."
PRINT "                      4).  Set the System Clock."
PRINT "                      5).  Control Power to Sensors."
PRINT "                      6).  Provide Information on this System."
PRINT "                      7).  Exit this Program."
PRINT
INPUT "                    Enter 0, 1, 2, 3, 4, 5, 6 or 7 here  --> " A
IF A = 0 GOTO MainMenu
IF A = 1 GOTO SetupToTakeData
IF A = 2 GOTO SetParameters
IF A = 3 GOTO SystemDiag
IF A = 4 GOTO SetTime
IF A = 5 GOTO SetPwrCntrl
IF A = 6 GOTO SysInfo
IF A = 7 GOTO AreYouSure
GOTO MainMenu

SystemDiag:
' This routine can test each device for operation and signal
' Test Routine uses the Chan() command, which is based on putting the
' 12 bit A/D conversion into the upper part of the 16 bit word.
PRINT: PRINT
'  Turn on TPU Processor
TPUon()
'  Turn on analog power
PSET 0
' Turn on Sensor Power
SDO PwrWord, 16
GOSUB ClearScreen
PRINT "             This Test Routine Prints out the actual Analog Voltages"
PRINT "                          from all the Analog Inputs."
PRINT "                   This should be helpful for system testing."
PRINT
PRINT
INPUT "                       How Many Scans do you want? --> " Answer
Print
Hcount = 0
FOR I = 1 TO Answer
'Reset Mux
Pset 1
Sleep 0: Sleep 10
Pclr 1
IFF Hcount = 0
  Print
  Print "-Res/5-  -ResX1-  -ResX5-  -*H2/5-  -*H2X1-  -*H2X5-  -*Eh**- RefTemp
 ResTemp  -VBatt-"
ENDIF
' Get first 6 channels
FOR J = 0 to 6
Volts! = chan(J)*4.096/65520
print #5.3F, Volts;
print "    ";
Next J
' Now get the Reference Temperature on the Mux
Volts = chan(7)*4.096/65520
print #5.3F, Volts;
print "    ";
' Move the Mux to the Next Channel
Pset 1: Pclr 1
' Wait for it to Stabilize
Sleep 0 : Sleep 10
' Now get the Thermocouple Temperature on the Mux
Volts = chan(7)*4.096/65520
print #5.3F, Volts;
print "    ";
' Move the Mux to the Next Channel
Pset 1: Pclr 1
' Wait for it to Stabilize
Sleep 0 : Sleep 10
' Now get the Battery Voltage
Volts = chan(7)*4.096/65520
' Multiply by 10
Volts = 10*Volts
print #5.3F, Volts;
print "    ";
print
Hcount = Hcount + 1
IF Hcount = 20 Hcount = 0
Next I
```

```
INPUT "Press Enter to return to Main Menu." Answer
' Turn power off to sensors
SDO 0, 16
' Turn Power Off Too
Pclr 0
GOTO MainMenu

SetParameters:
GOSUB ClearScreen
PRINT "                               System Parameter Menu"
PRINT
PRINT
"*****************************************************************************
"
PRINT
PRINT "                       The present value for the Cycle Time is"
IFF MinOrSec = 0
PRINT "                                 ",CycleTime," Seconds."
Endif
IFF MinOrSec = 1
PRINT "                                 ",CycleTime," Minutes."
Endif
PRINT
PRINT "                  The present setting for Verbose versus Data only is"
IFF Verbose = 0
PRINT "                                     Data Only."
Endif
IFF Verbose = 1
PRINT "                  Verbose Printing of Status Information with the
Data."
ENDIF
PRINT
IFF VGET(9) = 0
PRINT "                  Printing of the Metadata Printing on Power up is
inhibited."
ENDIF
IFF VGET(9) = 1
PRINT "                  Printing of the Metadata Printing on Power up is
enabled."
ENDIF
PRINT
IFF VGET(10) = 0
PRINT "                  Printing of the Metadata Printing on Restart of Data
is inhibited."
ENDIF
IFF VGET(10) = 1
PRINT "                  Printing of the Metadata Printing on Restart of Data
is enabled."
ENDIF
PRINT
PRINT
"*****************************************************************************
"
PRINT: PRINT
PRINT "                Select one of the following functions:"
PRINT
PRINT "                      0).  Reprint this Menu."
PRINT "                      1).  Change the Cycle Time."
PRINT "                      2).  Change the Verbose Setting."
PRINT "                      3).  Change Print Status of Metadata on Powerup."
PRINT "                      4).  Change Print Status of Metadata on Restart
of Data."
PRINT "                      5).  Reset all Parameters back to Default
Settings."
PRINT "                      6).  Print out all Parameters."
PRINT "                 7 to 9).  Return to the Main Menu."
PRINT
INPUT "                    Enter 0 through 9 here  --> " A
IF A = 0 GOTO SetParameters
IF A = 1 GOSUB SetCycleTime
IF A = 2 GOSUB SetVerbose
IF A = 3 GOSUB SetMetadataStatus1
IF A = 4 GOSUB SetMetadataStatus2
IF A = 5 GOSUB ResetParameters
IFF A = 6
      GOSUB ClearScreen
      GOSUB PrintParameters
      PRINT
      INPUT " Press ENTER to continue. " A
ENDIF
IF A > 6 GOTO MainMenu
GOTO SetParameters

SetCycleTime:
GOSUB ClearScreen
Print "                    Do you want to specify a Cycle Time in"
Print "                           in Seconds or Minutes?"
Input "                    Enter 0 for Seconds, 1 for Minutes --> " A
IF A < 0 | A > 1 GOSUB InputErrors: GOTO SetCycleTime
MinOrSec = A
Print
Print
IFF MinOrSec = 0
INPUT "                    Enter a new value between 15 and 59 here --> " A
IF A < 15 | A > 59 GOSUB InputErrors: GOTO SetCycleTime
Endif
IFF MinOrSec = 1
INPUT "                    Enter a new value between 1 and 60 here --> " A
IF A < 1 | A > 60 GOSUB InputErrors: GOTO SetCycleTime
Endif
CycleTime = A
' Save parameters to Eprom
VSTORE 1, CycleTime
VSTORE 2, MinOrSec
' Reset Variable A so no go back to Main Menu
A = 0
Return

SetVerbose:
GOSUB ClearScreen
Print " Do you want Verbose Status Information during Logging"
Print "               or just the Data?"
Input "    Enter 1 for Verbose, 0 for just Data. --> " Verbose
If Verbose < 0 GOTO SetVerbose
If Verbose > 1 GOTO SetVerbose
Return

SetMetadataStatus1:
```

```
GOSUB ClearScreen
Print " Do you want the Metadata Information printed out at Power up?"
PRINT
Input "    Enter 1 for Yes, 0 for No. --> " A
If A = 0 VSTORE 9, 0
If A = 1 VSTORE 9, 1
Return

SetMetadataStatus2:
GOSUB ClearScreen
Print " Do you want the Metadata Information printed out at restart of data
collection?"
PRINT
Input "    Enter 1 for Yes, 0 for No. --> " A
If A = 0 VSTORE 10, 0
If A = 1 VSTORE 10, 1
Return

SetPwrCntrl:
' Allow user to turn On/Off power to each sensor
GOSUB ClearScreen
IFF PwrWord < 0 | PwrWord > 55
      PRINT "*************** WARNING !!! *******************"
      PRINT
      PRINT "   The Power Control Word = ", PwrWord
      PRINT "   This is not possible!"
      PRINT "   The Power Control Word must be a positive number < 56"
      PRINT
      PRINT "   This program is resetting this Word so that all sensors are
on."
      PwrWord = 55
      INPUT "   Press ENTER to Continue. " A
ENDIF
PRINT "                              Sensor Power Control Menu"
PRINT
PRINT
"******************************************************************************
"
PRINT
PRINT "                 Here is the current status of power to each sensor"
PRINT
PRINT "                      Res Sensor Power is ............ ";
IF ResPwrStatus = 1 PRINT "On"
IF ResPwrStatus = 0 PRINT "Off"
PRINT "                      Instrumentation Amp Power is .... ";
IF InstrAmpPwrStatus = 1 PRINT "On"
IF InstrAmpPwrStatus = 0 PRINT "Off"
PRINT "                      eH Isolation Amp Power is ....... ";
IF IsoPwrStatus = 1 PRINT "On"
IF IsoPwrStatus = 0 PRINT "Off"
PRINT "                      Hydrogen Power ................. ";
IF H2PwrStatus = 1 PRINT "On"
IF H2PwrStatus = 0 PRINT "Off"
PRINT "                      Reference Temperature Power ..... ";
IF RefTempPwrStatus = 1 PRINT "On"
IF RefTempPwrStatus = 0 PRINT "Off"

PRINT
```

```
PRINT
"*****************************************************************************
"
PRINT: PRINT
PRINT "                Select one of the following functions:"
PRINT
PRINT "                      0).  Reprint this Menu."
PRINT "                      1).  Toggle Power to Res Sensor."
PRINT "                      2).  Toggle Power to the Instrumentation Amp."
PRINT "                      3).  Toggle Power to the eH Isolation Amp."
PRINT "                      4).  Toggle Power to the Hydrogen Sensor."
PRINT "                      5).  Toggle Power to the Reference Temperature
Sensor."
PRINT "                 6 to 9).  Return to the Main Menu."
PRINT
INPUT "                    Enter 0 through 9 here  --> " A
IF A = 0 GOTO SetPwrCntrl
IF A = 1 GOSUB ToggleResPwr
IF A = 2 GOSUB ToggleInstrAmpPwr
IF A = 3 GOSUB ToggleIsoAmpPwr
IF A = 4 GOSUB ToggleH2Pwr
IF A = 5 GOSUB ToggleRefTempPwr
IF A > 5 GOTO MainMenu
GOTO SetPwrCntrl

ToggleResPwr:
'Check for errors first
IFF ResPwrStatus < 0 | ResPwrStatus > 1
      GOSUB ClearScreen
      PRINT " There has been a Error in the Power Control Word"
      PRINT " Reset all Parameters back to Default Values using Main Menu
Option 2"
      INPUT "Press ENTER to Continue. " A
      GOTO SetPwrCntrl
ENDIF
' Toggle Res Power
IFF ResPwrStatus = 1
      ResPwrStatus = 0
      PwrWord = PwrWord - 1
      VSTORE 3, PwrWord
      VSTORE 4, ResPwrStatus
      RETURN
ENDIF
IFF ResPwrStatus = 0
      ResPwrStatus = 1
      PwrWord = PwrWord + 1
ENDIF
VSTORE 3, PwrWord
VSTORE 4, ResPwrStatus
RETURN

ToggleInstrAmpPwr:
'Check for errors first
IFF InstrAmpPwrStatus < 0 | InstrAmpPwrStatus > 1
      GOSUB ClearScreen
      PRINT " There has been a Error in the Power Control Word"
      PRINT " Reset all Parameters back to Default Values using Main Menu
Option 2"
      INPUT "Press ENTER to Continue. " A
      GOTO SetPwrCntrl
ENDIF
' Toggle Instrumentation Amp Power
IFF InstrAmpPwrStatus = 1
      InstrAmpPwrStatus = 0
      PwrWord = PwrWord - 2
      VSTORE 3, PwrWord
      VSTORE 5, InstrAmpPwrStatus
      RETURN
ENDIF
IFF InstrAmpPwrStatus = 0
      InstrAmpPwrStatus = 1
      PwrWord = PwrWord + 2
ENDIF
VSTORE 3, PwrWord
VSTORE 5, InstrAmpPwrStatus
RETURN

ToggleIsoAmpPwr:
IFF IsoPwrStatus < 0 | IsoPwrStatus > 1
      GOSUB ClearScreen
      PRINT " There has been a Error in the Power Control Word"
      PRINT " Reset all Parameters back to Default Values using Main Menu
Option 2"
      INPUT "Press ENTER to Continue. " A
      GOTO SetPwrCntrl
ENDIF
' Toggle eH Isolation Amp Power
IFF IsoPwrStatus = 1
      IsoPwrStatus = 0
      PwrWord = PwrWord - 4
      VSTORE 3, PwrWord
      VSTORE 6, IsoPwrStatus
      RETURN
ENDIF
IFF IsoPwrStatus = 0
      IsoPwrStatus = 1
      PwrWord = PwrWord + 4
ENDIF
VSTORE 3, PwrWord
VSTORE 6, IsoPwrStatus
RETURN

ToggleH2Pwr:
IFF H2PwrStatus < 0 | H2PwrStatus > 1
      GOSUB ClearScreen
      PRINT " There has been a Error in the Power Control Word"
      PRINT " Reset all Parameters back to Default Values using Main Menu
Option 2"
      INPUT "Press ENTER to Continue. " A
      GOTO SetPwrCntrl
ENDIF
' Toggle Hydrogen Sensor Power
IFF H2PwrStatus = 1
      H2PwrStatus = 0
      PwrWord = PwrWord - 16
      VSTORE 3, PwrWord
      VSTORE 7, H2PwrStatus
      RETURN
```

```
ENDIF
IFF H2PwrStatus = 0
      H2PwrStatus = 1
      PwrWord = PwrWord + 16
ENDIF
VSTORE 3, PwrWord
VSTORE 7, H2PwrStatus
RETURN

ToggleRefTempPwr:
IFF RefTempPwrStatus < 0 | RefTempPwrStatus > 1
      GOSUB ClearScreen
      PRINT " There has been a Error in the Power Control Word"
      PRINT " Reset all Parameters back to Default Values using Main Menu
Option 2"
      INPUT "Press ENTER to Continue. " A
      GOTO SetPwrCntrl
ENDIF
' Toggle Reference Temperature Sensor Power
IFF RefTempPwrStatus = 1
      RefTempPwrStatus = 0
      PwrWord = PwrWord - 32
      VSTORE 3, PwrWord
      VSTORE 8, RefTempPwrStatus
      RETURN
ENDIF
IFF RefTempPwrStatus = 0
      RefTempPwrStatus = 1
      PwrWord = PwrWord + 32
ENDIF
VSTORE 3, PwrWord
VSTORE 8, RefTempPwrStatus
RETURN

ResetParameters:
VSTORE 0, 1       // Set EpromStatus = 1
VSTORE 1, 20            // Set CycleTime = 20 Minutes or Seconds depending on
MinOrSec
VSTORE 2, 0       // Set MinOrSec = 1 for Min, or = 0 for Sec
VSTORE 3, 55            // Set PwrWord = 55, Power Control Word for SDO
command = 1+2+4+16+32=55
VSTORE 4, 1       // Set ResPwrStatus = 1 for Power On
VSTORE 5, 1
VSTORE 6, 1
VSTORE 7, 1
VSTORE 8, 1
VSTORE 9, 0       // Set MetadataStatusPowerUp = 0 for no print on power up
VSTORE 10, 0            // Set MetadataStatusRestartData = 0 for no print on
restart
EpromStatus = VGET(0)
CycleTime = VGET(1)
MinOrSec = VGET(2)
PwrWord = VGET(3)
ResPwrStatus = VGET(4)
InstrAmpPwrStatus = VGET(5)
IsoPwrStatus = VGET(6)
H2PwrStatus = VGET(7)
RefTempPwrStatus = VGET(8)
MetadataStatusPowerUp = VGET(9)
```

```
MetadataStatusRestartData = VGET(10)
RETURN

PrintParameters:
'  Eprom Storage location assignments (Only Locations 0-31 available)
'     0 .... Status, 0 means not setup yet, 1 means ready to use
'     1 .... CycleTime, Default = 20
'     2 .... MinOrSec, Default = 0
'     3 .... PwrWord, Default = 55
'     4 .... ResPwrStatus, Default = 1
'     5 .... InstrAmpPwrStatus, Default = 1
'     6 .... IsoPwrStatus, Default = 1
'     7 .... H2PwrStatus, Default = 1
'     8 .... RefTempPwrStatus, Default = 1
'     9 .... MetadataStatusPowerUp, Default = 0
'    10 .... MetdataStatusRestartData, Default = 0
PRINT " This System is presently setup with the following Parameters:"
PRINT VGET(0), "  = Eprom Status (0 means not setup yet, 1 means ready to
use)"
PRINT VGET(1), " = Cycle Time (Actual Time in Seconds or Minutes)"
PRINT VGET(2), "  = Minutes or Seconds Cycle Time (0 = Seconds mode, 1 =
Minutes mode)"
PRINT VGET(3), " = Power Control Word (Power Control Word = 1+2+4+16+32 = 55
if all On)"
PRINT VGET(4), "  = Res Power Status (0 = Off, 1 = On)"
PRINT VGET(5), "  = Thermocouple & Hydrogen Amp Power Status (0 = Off, 1 =
On)"
PRINT VGET(6), "  = eh Amp Power Status (0 = Off, 1 = On)"
PRINT VGET(7), "  = Hydrogen Sensor Power Status (0 = Off, 1 = On)"
PRINT VGET(8), "  = Reference Temperature Power Status (0 = Off, 1 = On)"
PRINT VGET(9), "  = Metadata Print Status on Power up (0 = No Print on
Powerup, 1 = Print)"
PRINT VGET(10), "  = Metadata Print Status on Restart Data Collection (0 = No
Print on Restart Data, 1 = Print)"
RETURN

SysInfo:
' Print out System Information to identify this system
GOSUB ClearScreen
GOSUB PrtSysInfo
PRINT
GOSUB PrintParameters
PRINT
INPUT "  Press Enter to return to the Main Menu. --> " A
GOTO MainMenu

PrtSysInfo:
PRINT
PRINT "  System Name: BARS (Benthic And Resistivity Sensors)"
PRINT "  System Owner: Marv Lilley, University of Washington"
PRINT "  Owner Contact Phone #: 206-543-0859"
PRINT "  System Serial #: 001"
PRINT "  Software Version 1.86, Last Update March 28, 2012"
PRINT "  Made by Ocean Engineering Services, July 2010 (206-543-9688)"
RETURN

AreYouSure:
' To verify that user really wants to stop this program
GOSUB ClearScreen
```

```
PRINT "  You have requested to stop this program."
PRINT
PRINT "  Once the Program has been stopped, to restart the program,"
PRINT "  just cycle the system power.  This system is programmed as"
PRINT "  Plug and Play, so it will power up running."
PRINT
PRINT "  Are you really sure that you want to stop this program?"
INPUT "          Enter 1 for Yes, 0 for No --> " A
IFF A = 1
' Stop the program
' Turn Off Everything
    GOSUB TurnOffEverything
    STOP
ENDIF
GOTO MainMenu

SetupToTakeData:
'Check to see if print Metadata
IFF VGET(10) = 1
      GOSUB PrtSysInfo
      PRINT
      GOSUB PrintParameters
      PRINT
ENDIF

TakeData:
HeaderStatus = 0
' Setup the Starting Time & Date Array
' Alway set start time to actual time
RTIME
BrtTimeSec = ?(0)
BrtTimeMin = ?(1)
BrtTimeHr = ?(2)
BrtTimeDay = ?(3)
BrtTimeMon = ?(4)
BrtTimeYr = ?(5)
' If in Minute mode, Seconds always = 0
If MinOrSec = 1 BrtTimeSec = 0
If MinOrSec = 0 BrtTimeSec = ?(0)
' Print "Calculated BrtTimeSec = ", BrtTimeSec
Goto SetupToLog

' No need this section
' Check for overflow
IFF BrtTimeSec > 59
    BrtTimeSec = 0
    BrtTimeMin = BrtTimeMin + 1
Endif
Iff BrtTimeMin > 59
    BrtTimeMin = 0
    BrtTimeHr = BrtTimeHr + 1
EndIF
Iff BrtTimeHr > 23
    BrtTimeHr = 0
    BrtTimeDay = BrtTimeDay + 1
EndIF
IF BrtTimeDay > 28 & BrtTimeMon = 2 GOTO AnotherDay
IF BrtTimeDay > 30 & BrtTimeMon = 4 GOTO AnotherDay
IF BrtTimeDay > 30 & BrtTimeMon = 6 GOTO AnotherDay
IF BrtTimeDay > 30 & BrtTimeMon = 9 GOTO AnotherDay
IF BrtTimeDay > 30 & BrtTimeMon = 11 GOTO AnotherDay
IF BrtTimeDay < 32 GOTO SetupToLog
AnotherDay:
BrtTimeDay = 1
BrtTimeMon = BrtTimeMon + 1
IF BrtTimeMon < 12 GOTO SetupToLog
BrtTimeMon = 1
BrtTimeYr = BrtTimeYr + 1
GOTO SetupToLog

CalNextBurstTime:
RTIME
' Calculate the next Burst Date & Time
' Add CycleTime to get to next burst
' CycleTime can be Seconds or Minutes depending on Value of MinOrSec
IFF MinOrSec = 0
  BrtTimeSec = BrtTimeSec + CycleTime
BurstTimeLoop0:
' Check to see if overflow
  IF BrtTimeSec < 60 GOTO LogLoop
  BrtTimeSec = BrtTimeSec - 60
  BrtTimeMin = BrtTimeMin + 1
  if BrtTimeSec > 59 goto BurstTimeLoop0
Endif
IFF MinOrSec = 1
  BrtTimeMin = BrtTimeMin + CycleTime
Endif
BurstTimeLoop1:
' Check to see if overflow
IF BrtTimeMin < 60 GOTO LogLoop
BrtTimeMin = BrtTimeMin - 60
BrtTimeHr = BrtTimeHr + 1
if BrtTimeMin > 59 goto BurstTimeLoop1
CheckHours:
IF BrtTimeHr < 24 GOTO LogLoop
BrtTimeHr = BrtTimeHr - 24
BrtTimeDay = BrtTimeDay + 1
IF BrtTimeDay > 28 & BrtTimeMon = 2 GOTO NextDay
IF BrtTimeDay > 30 & BrtTimeMon = 4 GOTO NextDay
IF BrtTimeDay > 30 & BrtTimeMon = 6 GOTO NextDay
IF BrtTimeDay > 30 & BrtTimeMon = 9 GOTO NextDay
IF BrtTimeDay > 30 & BrtTimeMon = 11 GOTO NextDay
IF BrtTimeDay < 32 GOTO LogLoop
NextDay:
BrtTimeDay = 1
BrtTimeMon = BrtTimeMon + 1
IF BrtTimeMon < 12 GOTO LogLoop
BrtTimeMon = 1
BrtTimeYr = BrtTimeYr + 1

LogLoop:
RTIME
IFF Verbose = 1
PRINT
PRINT "     The Present Date & Time is -> Date = ",#02,?(4),"/",?(3),"/",?(5);
PRINT "     Time =  ",#02, ?(2),":",?(1),":",?(0)
' Print next cycle date / time
```

```
PRINT "     The Next Cycle will be at --> Date =
",#02,BrtTimeMon,"/",BrtTimeDay,"/",BrtTimeYr;
PRINT "     Time =  ",#02, BrtTimeHr,":",BrtTimeMin,":",BrtTimeSec
Endif
AnotherCycle:
' Is it time to do another cycle?
RTIME
' Check for User command to Stop
GOSUB UserCommand
IFF KeyCommand = 19
' Send out Line Feed and Return to show Control-S has been received
    PRINT
' Check for another Control-S Command
    GOSUB UserCommand
    IFF KeyCommand = 19
      Goto MainMenu
    Endif
Endif
' REMOVE ALL THE FOLLOWING LINES UP TO THE LINE ************************
' BECAUSE THERE IS NO NEED TO HYBERNATE ON THE NEPTUNE CABLE
' ALL LINE WITH COMMENT SYMBOL PLUS * WERE ORGINALLY COMMANDS
' Calculate how much time we have to wait for next Cycle
' If in Minute Mode, wait for next whole minute
' *IF MinOrSec = 1 HybernateTime = 60 - ?(0)
' If in Second Mode, Wait for next Cycle time
' Do not Hybernate if in Second mode & CycleTime < 15 sec
' Print "MinOrSec = ",MinOrSec
' Print "BrtTimeSec = ",BrtTimeSec
' *IFF MinOrSec = 0
'    Print "Inside If Loop"
' *    IF CycleTime < 15 GOTO CheckTime
' *    HybernateTime = BrtTimeSec - ?(0)
' Check for change of Minute
' *    If HybernateTime < 0 HybernateTime = HybernateTime + 60
' Never allow an unreasonable Hybernate Time
' *    If HybernateTime > CycleTime Goto CheckTime
' *Endif
' Print "MinOrSec = ", MinOrSec
' Print "HybernateTime = ", HybernateTime
' The Next make no sense so I am removing it
' IF ?(0) >= 59 GOTO Wait
' Only Hybernate if there is extra time
' *IFF HybernateTime > 8
' Provide 4 second count down time
' *    HybernateTime = HybernateTime - 4
' *    IFF Verbose = 1
' *    Print "   Hybernating for ",HybernateTime," Seconds."
' *    Endif
' Hybernate until we are close to next whole minute
' Hybernate for (HybernateTime) seconds
' *    HYB 0: HYB (HybernateTime)
' *ENDIF
' *************************************************************************
GOTO CheckTime
Wait:
IFF Verbose = 1
  PRINT "  Current Time =  ",#02, ?(2),":",?(1),":",?(0);
  PRINT "  Next Cycle at ",#02, BrtTimeHr,":",BrtTimeMin,":",BrtTimeSec
Endif
```

```
WaitLoop:
'  Print "In WaitLoop, BrtTimeSec = ", BrtTimeSec, "  Actual Seconds = ", ?(0)
  RTIME
  IFF MinOrSec = 1
      IF ?(0) <> 0 GOTO WaitLoop
  Endif
  IFF MinOrSec = 0
      IF ?(0) <> BrtTimeSec GOTO WaitLoop
      GOTO SetupToLog
  Endif
CheckTime:
' Print "Checking Time"
' Print BrtTimeHr," ",?(2)," ", BrtTimeMin," ", ?(1)," ", BrtTimeSec," ", ?(0)
IF BrtTimeHr = ?(2) & BrtTimeMin = ?(1) & BrtTimeSec = ?(0) GOTO SetupToLog
' Check if we have missed the right time
IF BrtTimeHr = ?(2) & BrtTimeMin = ?(1) & ?(0) > BrtTimeSec GOTO SetupToLog
IF BrtTimeHr = ?(2) & BrtTimeMin < ?(1)  GOTO SetupToLog
GOTO AnotherCycle

UserCommand:
' Check for User Command to Stop Logging (Control-S = 19)
' Be sure KeyCommand word = 0
KeyCommand = 0
' Save Memory Pointer
SavePointer = Pointer
' Save Contents of Memory
SaveData = Get(Pointer,#2)
' Decrement Pointer
Pointer = Pointer - 2
' Be sure Memory is Zero
MemValue = 0
Store Pointer, #1, MemValue
' Backup one memory location
Pointer = Pointer - 1
' Look for Keyboard Entry
Iff Verbose = 1
Print "   Enter Control-S ** NOW ** to Stop.    "
Endif
' Print Current Time
RTIME
Iff Verbose = 1
PRINT "  Current Time =  ",#02, ?(2),":",?(1),":",?(0);
Endif
' Print next cycle time if not in Shipping Mode or Low Battery Mode
If LowBattMode = 1 Print "   Vbatt = ", Vbatt!
IFF LowBattMode = 0 & Verbose = 1
    PRINT "  Next Cycle at ",#02, BrtTimeHr,":",BrtTimeMin,":",BrtTimeSec
Endif
' Otherwise Print Date too
IFF Verbose = 1
If LowBattMode = 1 PRINT "   Date = ",#02,?(4),"/",?(3),"/",?(5)
Endif
ITEXT Pointer, 80
' If character stored, adjust memory size
IFF Pointer <> SavePointer
    Pointer = SavePointer
' Get the Keyboard entry
    KeyCommand = GET(Pointer, #1)
' Restore Pointer
```

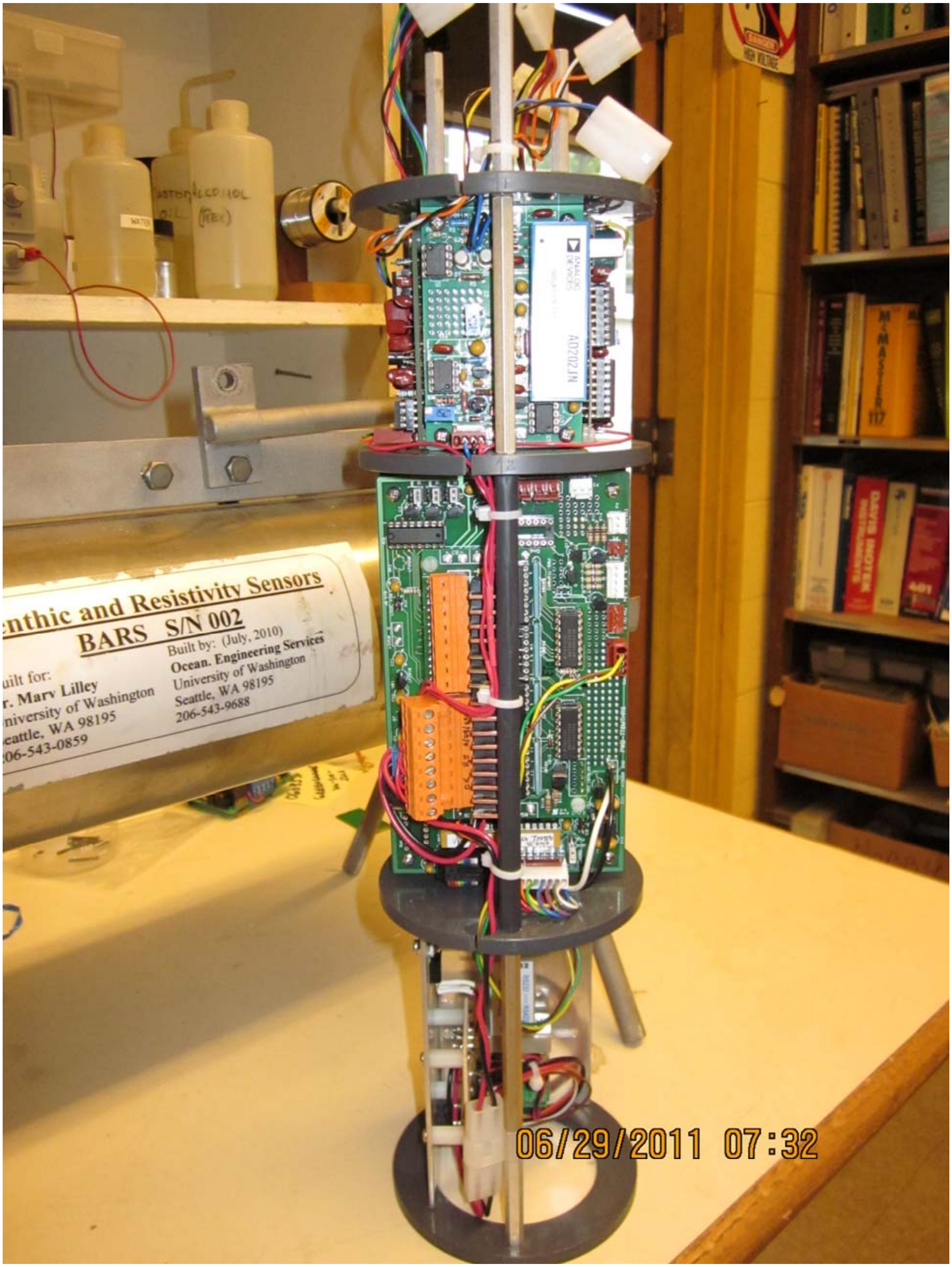
```
    Pointer = SavePointer
ENDIF
' Restore Original Memory
Store Pointer, #2, SaveData
' Decrement Pointer
Pointer = Pointer - 2
return

SetupToLog:
' Check for User command to Stop
GOSUB UserCommand
IFF KeyCommand = 19
    Goto MainMenu
Endif
IFF Verbose = 1
Print
Print "Starting to log a burst of Data to memory."
Endif
' Turn on TPU Processor
TPUon()
' Turn on Analog Power
PSET 0
' Turn on Sensor Power
SDO PwrWord, 16
' Wait a little for power to stabilize
SLEEP 0: SLEEP 400
' Reset Mux
PSET 1
Sleep 0: Sleep 10
Pclr 1
' Move Mux to Battery Channel (Mux2)
For I = 1 to 2
Pset 1: Pclr 1
' Wait for Mux to stabilize
Sleep 0: Sleep 10
Next I
CheckBattery:
' Check the Battery Voltage
' Take 10 values and average
Vave! = 0
BatSum = 0
For I = 1 to 10
Raw = Chan(7)
BatSum = BatSum + Raw
Vbatt! = (40.96*Raw/65536)
Vave = Vbatt + Vave
next I
Vbatt = Vave/10
IFF Verbose = 1
print
print "The Battery voltage is ";
print #5.3F, Vbatt;
print " Volts."
Endif

StartBurst:
IFF Verbose = 1
Print
'************************************************
```

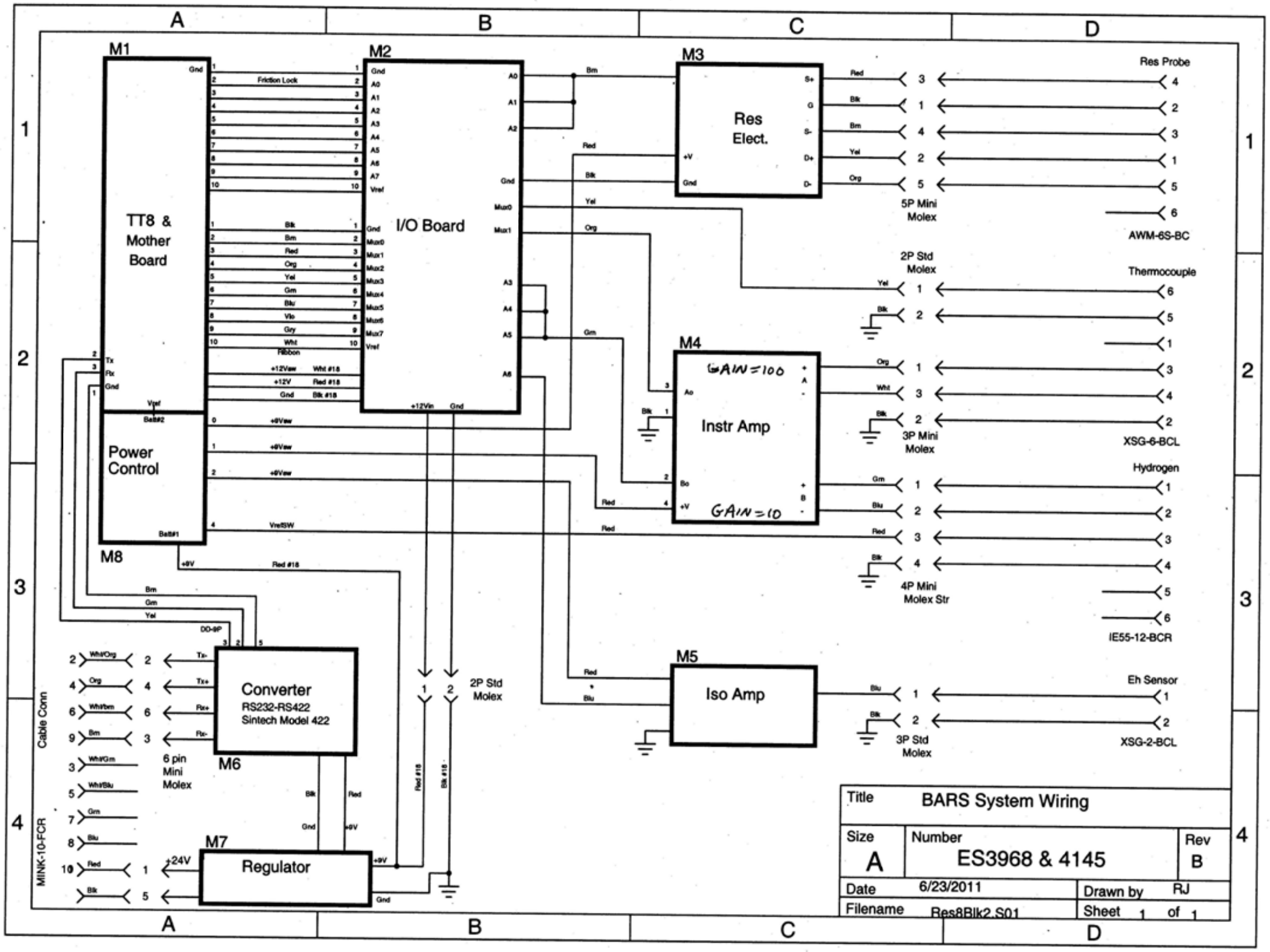
```
' Print Header
IFF HeaderStatus = 0
Print "Res/5  ResX1  ResX5  *H2/5  *H2X1  *H2X5  *eH**  Ref-T  Ref-T  Res-T
Res-T  Vbatt"
Print "Volts  Volts  Volts  Volts  Volts  Volts  Volts  Volts  Deg-C  Volts
Deg-C  Volts"
HeaderStatus = 1
Endif
Endif
'Reset Mux
Pset 1
Sleep 0: Sleep 10
Pclr 1
' Read the starting time
RTIME
' Get Res, Hydrogen, Ref Temp Data and Average (10 values)
Res1Ave = 0
Res2Ave = 0
Res3Ave = 0
H1Ave = 0
H2Ave = 0
H3Ave = 0
EhAve = 0
RefTempAve = 0
Sleep 0
For I = 1 to 10
Res1Ave = Res1Ave + Chan(0)/16
Res2Ave = Res2Ave + Chan(1)/16
Res3Ave = Res3Ave + Chan(2)/16
H1Ave = H1Ave + Chan(3)/16
H2Ave = H2Ave + Chan(4)/16
H3Ave = H3Ave + Chan(5)/16
EhAve = EhAve + Chan(6)/16
RefTempAve = RefTempAve + Chan(7)/16
Next I
Res1Ave = Res1Ave/10
Res2Ave = Res2Ave/10
Res3Ave = Res3Ave/10
H1Ave = H1Ave/10
H2Ave = H2Ave/10
H3Ave = H3Ave/10
EhAve = EhAve/10
RefTempAve = RefTempAve/10
' ***********************************************
' Note all A/D data is divided by 16
' Since it is only 12 but data shifted into 16 bits
' This helps to identify the BOF Markers later!
' ***********************************************
Volts! = Float(Res1Ave)/1000
Print #5.3F,Volts;
Print "  ";
Volts = Float(Res2Ave)/1000
Print #5.3F,Volts;
Print "  ";
Volts = Float(Res3Ave)/1000
Print #5.3F,Volts;
Print "  ";
Volts! = Float(H1Ave)/1000
Print #5.3F,Volts;
Print "  ";
Volts = Float(H2Ave)/1000
Print #5.3F,Volts;
Print "  ";
Volts = Float(H3Ave)/1000
Print #5.3F,Volts;
Print "  ";
Volts = Float(EhAve)/1000
Print #5.3F,Volts;
Print "  ";
Volts = Float(RefTempAve)/1000
Print #5.3F,Volts;
Print "  ";
' Convert Reference Thermistor Value
ThermistorMVolts = RefTempAve
ThermistorVolts! = Float(ThermistorMVolts)/1000
Gosub ConvertThermistorTemp
Print "  ";
' Save Thermistor Temp too
' Need to convert it to mC * 10
' so it is same format as Thermocouple
Tmp = INT(P!*100.)
' Get Thermocouple Temp
' Move Mux to Next Channel
Pset 1: Pclr 1
' Wait for it to stabilize
Sleep 0: Sleep 10
' Take 10 values of Res Temp and average
ResAveTemp = 0
For I = 1 to 10
ResAveTemp = ResAveTemp + Chan(7)/16
Next I
ResAveTemp = ResAveTemp/10
Volts = Float(ResAveTemp)/1000
Print #5.3F,Volts;
Print "  ";
ThermoMVolts = ResAveTemp
ThermoVolts! = Float(ThermoMVolts)/1000
Gosub ConvertThermoTemp
Print "  ";
' Save Thermocouple Temp too
' Need to convert it to mC * 10
' so it is not too big to store
Tmp = INT(T!*100.)
' Already Have Battery Voltage so just print it
Print #4.1F, Vbatt;
Print
' Turn power off to sensors
SDO 0, 16
' Turn off Analog Power
Pclr 0

DoneLogging:
Iff Verbose = 1
Print
Print "                         Memory Pointer = ",Pointer
Print
Endif
```

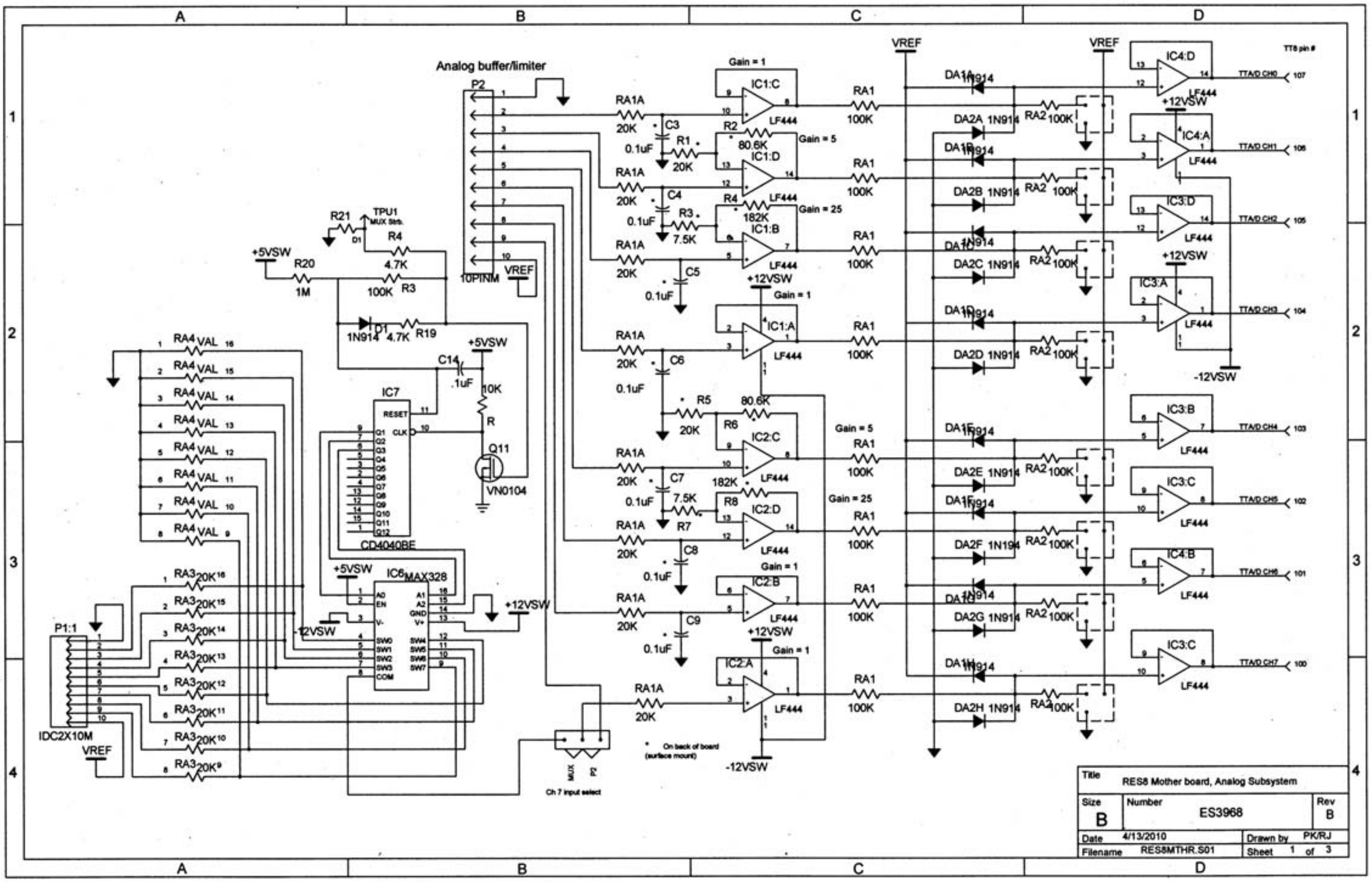
```
ThisCycleIsDone:
'************************************************
TPUoff()
' Update PrevHour Variable
PrevHour = ?(2)
Goto CalNextBurstTime

' Subroutine to convert A/D value ThermistorVolts & print Temp in Degrees C
' Thermistor voltage (Volts) = Y
' Thermistor Temp (C) = P = 27.50133 - (17.2658*Y) + 15.83424/Y
ConvertThermistorTemp:
Y! = ThermistorVolts
' Do not allow Thermistor voltage to be zero or very small
IF Y < 0.5 Y = 0.5
P! = 27.50133 - (17.2658*Y) + 15.83424/Y
Print #4.2F, P;
RETURN

' Subroutine to convert A/D value ThermoMVolts & print Sensor Temp in Degrees
C
' Thermocouple Voltage (Volts) = E = ThermoVolts
' Thermocouple Temp (C) = K = (244970*E)/1000
' Corrected Sensor Temp (C) = T = Th + P
ConvertThermoTemp:
E! = (ThermoVolts)
Th! = (244970*E)/1000
T! = Th + P
Print #5.1F, T;
RETURN

ErrorRoutine:
' Go here in case of a problem with the Software, so can try to recover
' Turn everything off
Gosub TurnOffEverything
Print
Print
Print "       ************************* WARNING !!!
****************************"
Print
Print "                  There has been a problem with the Software!"
Print "                   and this program is attempting to recover."
Print
print "                       Turning all sensor power off."
print
GOTO CalNextBurstTime

TurnOffEverything:
' Note the following are reverse logic
PSET 6, 9, 10, 11, 12, 15
' Turn off all sensor power
SDO 0, 16
' Turn off analog power
Pclr 0
ADoff()
TPUoff()
RETURN

CharCount = 0
DecodeLoop:
  Char = Get(DecodeMem,#1)
'  Print "The character = ", Char
'  Input "Waiting "  A
  If Char = 13 goto Convert
' If the character is not a real number (48 to 57), ignore it
  If Char < 48 goto DecodeLoop
  If Char > 57 goto DecodeLoop
  CharCount = CharCount + 1
  D(CharCount) = Char - 48
  Goto DecodeLoop
Convert:
' Convert the Data
'  For I = 1 to CharCount
'      Print "D(",I,") = ", D(I)
'  Next I
  NumBlocks = 0
  IFF CharCount = 1
      NumBlocks = D(1)
      Return
  Endif
  For I = 1 to (CharCount)
      GOSUB PowerofTen
      NumBlocks = PwrTen * D(I) + NumBlocks
  Next I
Return

PowerofTen:
' Routine to get powers of 10
PwrTen = 1
For J = 1 to (CharCount-I)
    PwrTen = 10 * PwrTen
Next J
Return

InputErrors:
' Input Error Routine
PRINT ""
PRINT "              The value you have entered is not within valid limits!"
PRINT "                               Please Try Again!"
PRINT " "
PRINT "                           Press ENTER to Continue."
INPUT ""A
RETURN

ClearScreen:
' Clear the screen
FOR I = 1 TO 50
PRINT
NEXT I
RETURN

Finish:
'  **This routine is not used on the Canadian Version
' Stop the program
' Turn Off Everything
GOSUB TurnOffEverything
STOP
```

Section 3

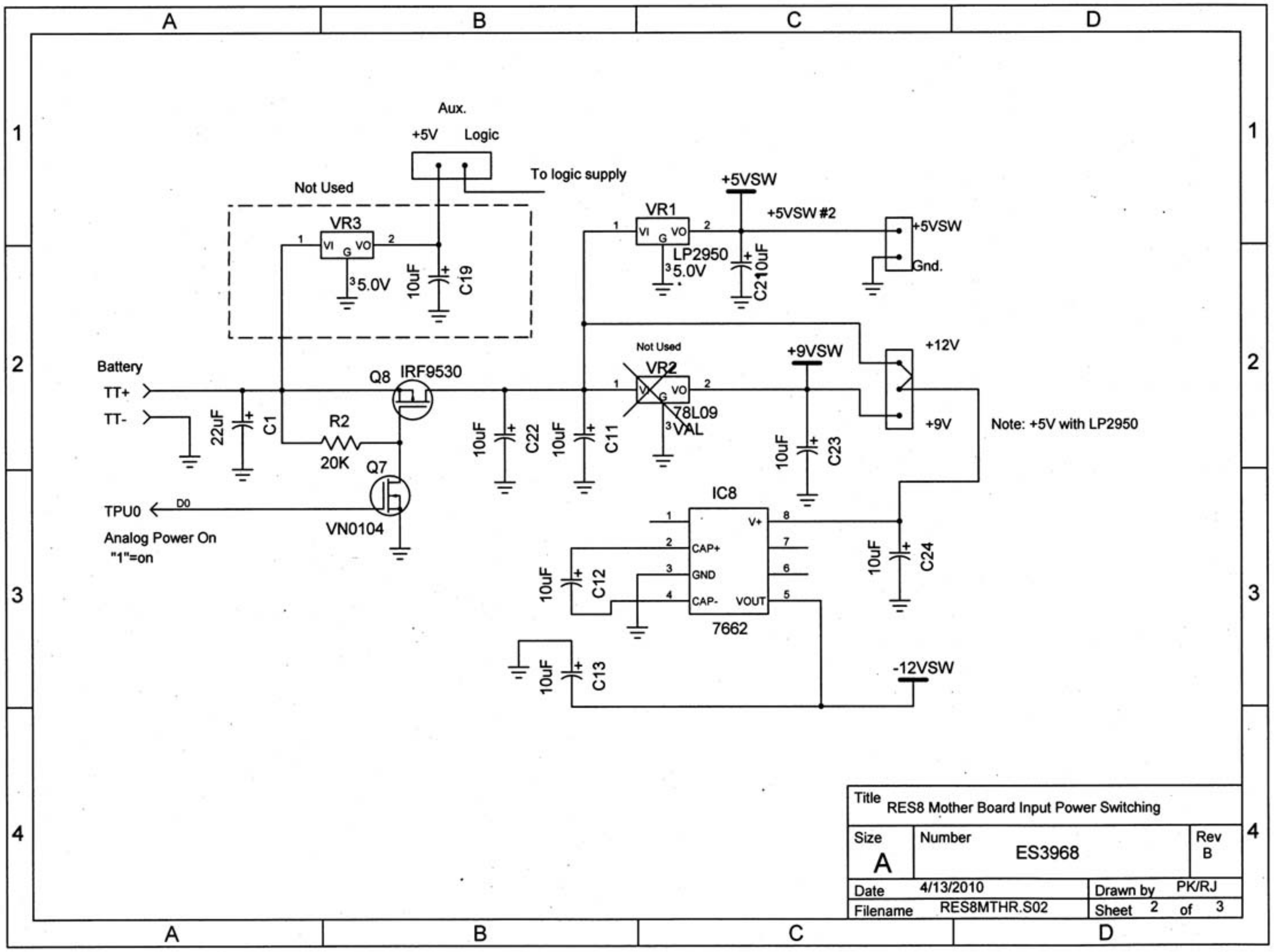
System Schematics


enthic and Resistivity Sensors
BARS S/N 002
Built by: (July, 2010)
Ocean. Engineering Services
University of Washington
Seattle, WA 98195
206-543-9688
uilt for:
r. Marv Lilley
niversity of Washington
eattle, WA 98195
06-543-0859
ANALOG DEVICES
AD202JN
HIGH VOLTAGE
McMASTER
DAVIS INOTEK INSTRUMENTS
06/29/2011 07:32


M1
TT8 & Mother Board
M2
I/O Board
M3
Res Elect.
M4
Instr Amp
GAIN=100
GAIN=10
M5
Iso Amp
M6
Converter
RS232-RS422
Sintech Model 422
M7
Regulator
M8
Power Control
Friction Lock
Ribbon
+12Vaw
+12V
Gnd
Wht #18
Red #18
Blk #18
+9Vaw
VrefSW
Red #18
+9V
+24V
DD-9P
Tx-
Tx+
Rx+
Rx-
6 pin Mini Molex
Cable Conn
MINK-10-FCR
2P Std Molex
5P Mini Molex
AWM-6S-BC
Res Probe
Thermocouple
3P Mini Molex
XSG-6-BCL
Hydrogen
4P Mini Molex Str
IE55-12-BCR
Eh Sensor
3P Std Molex
XSG-2-BCL
Title BARS System Wiring
Size A
Number ES3968 & 4145
Rev B
Date 6/23/2011
Drawn by RJ
Filename Res8Blk2.S01
Sheet 1 of 1
A
B
C
D
1
2
3
4



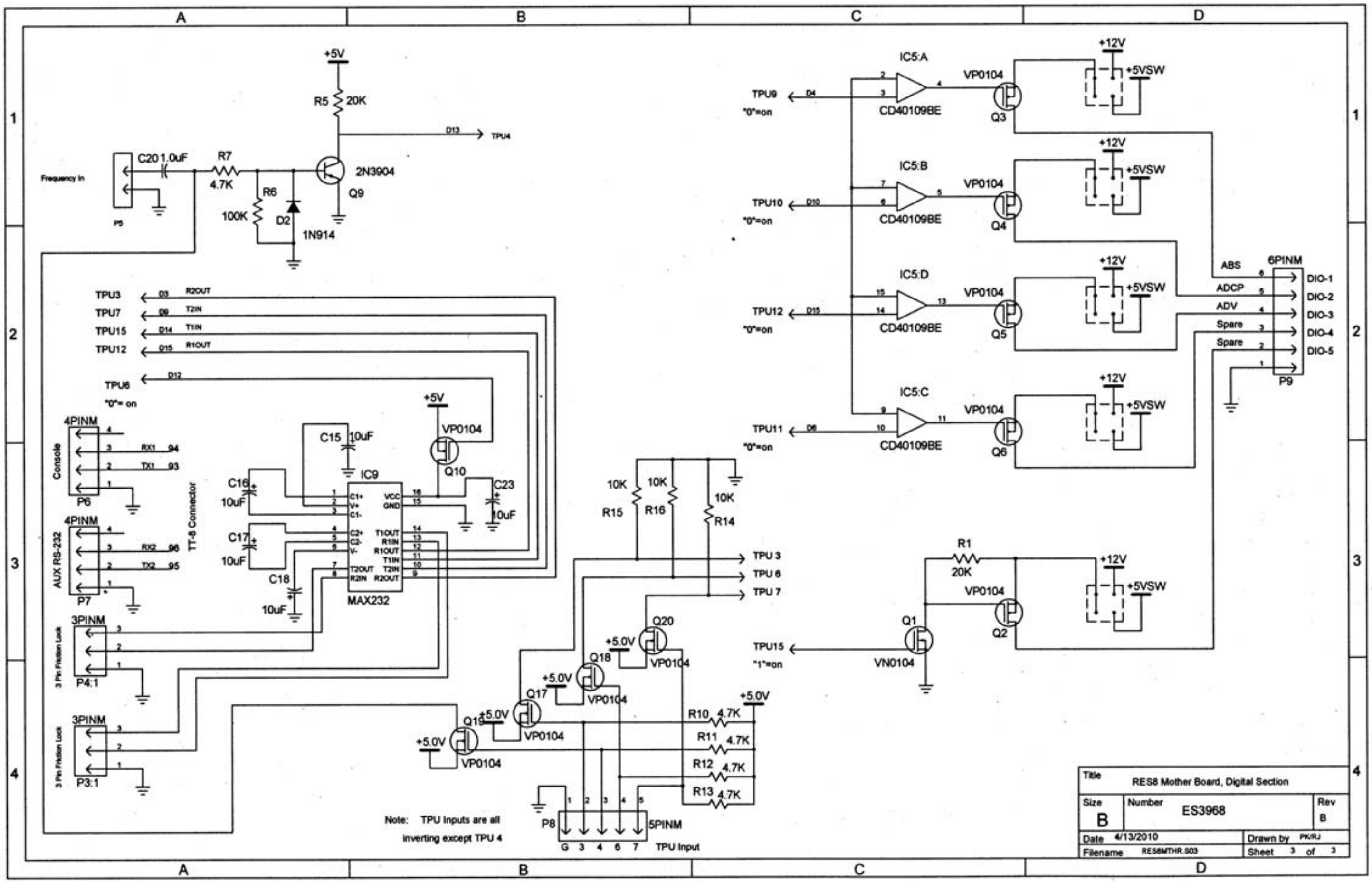
Title	RES8 Mother board, Analog Subsystem		
Size B	Number ES3968		Rev B
Date	4/13/2010	Drawn by	PK/RJ
Filename	RES8MTHR.S01	Sheet	1 of 3

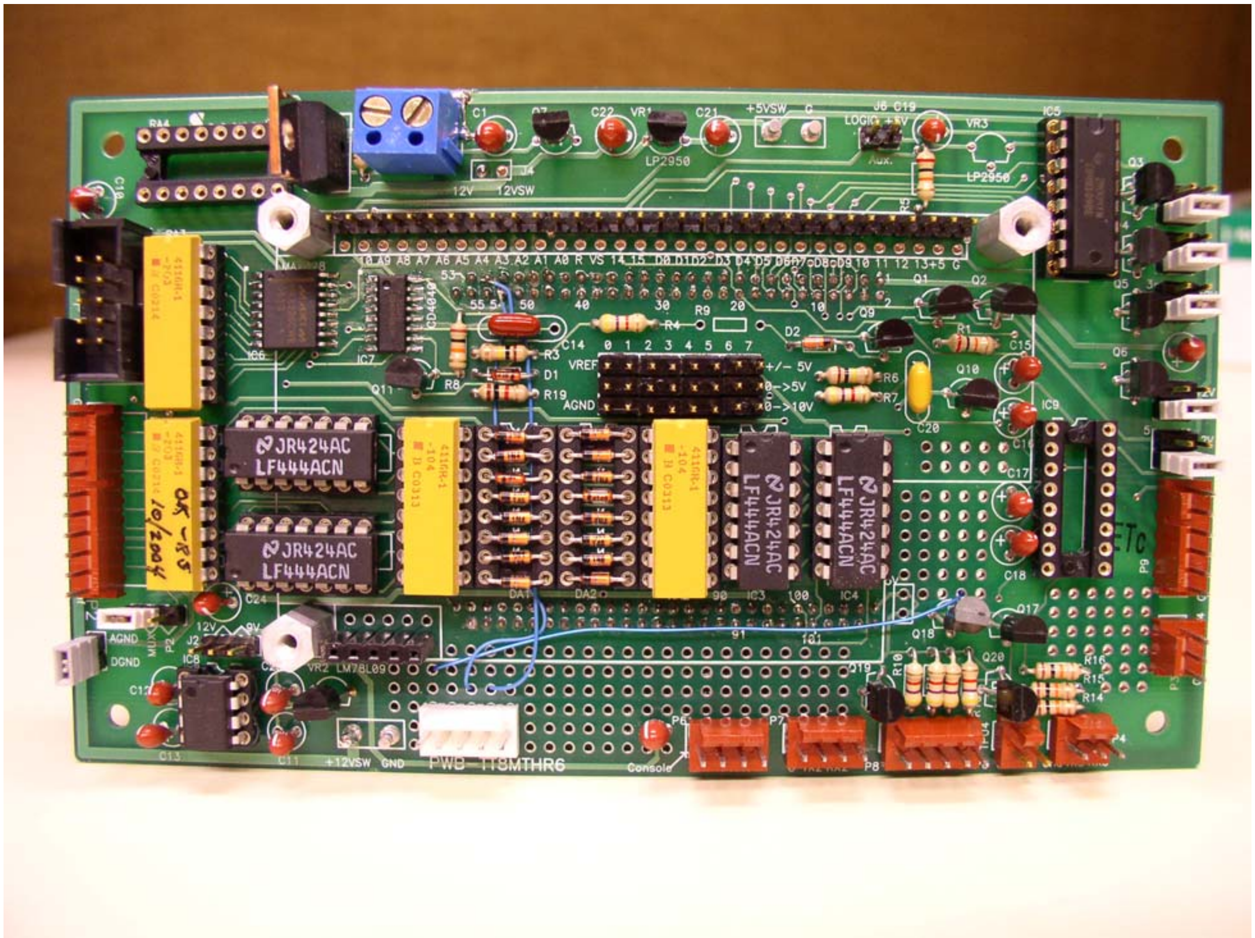


Title RES8 Mother Board Input Power Switching

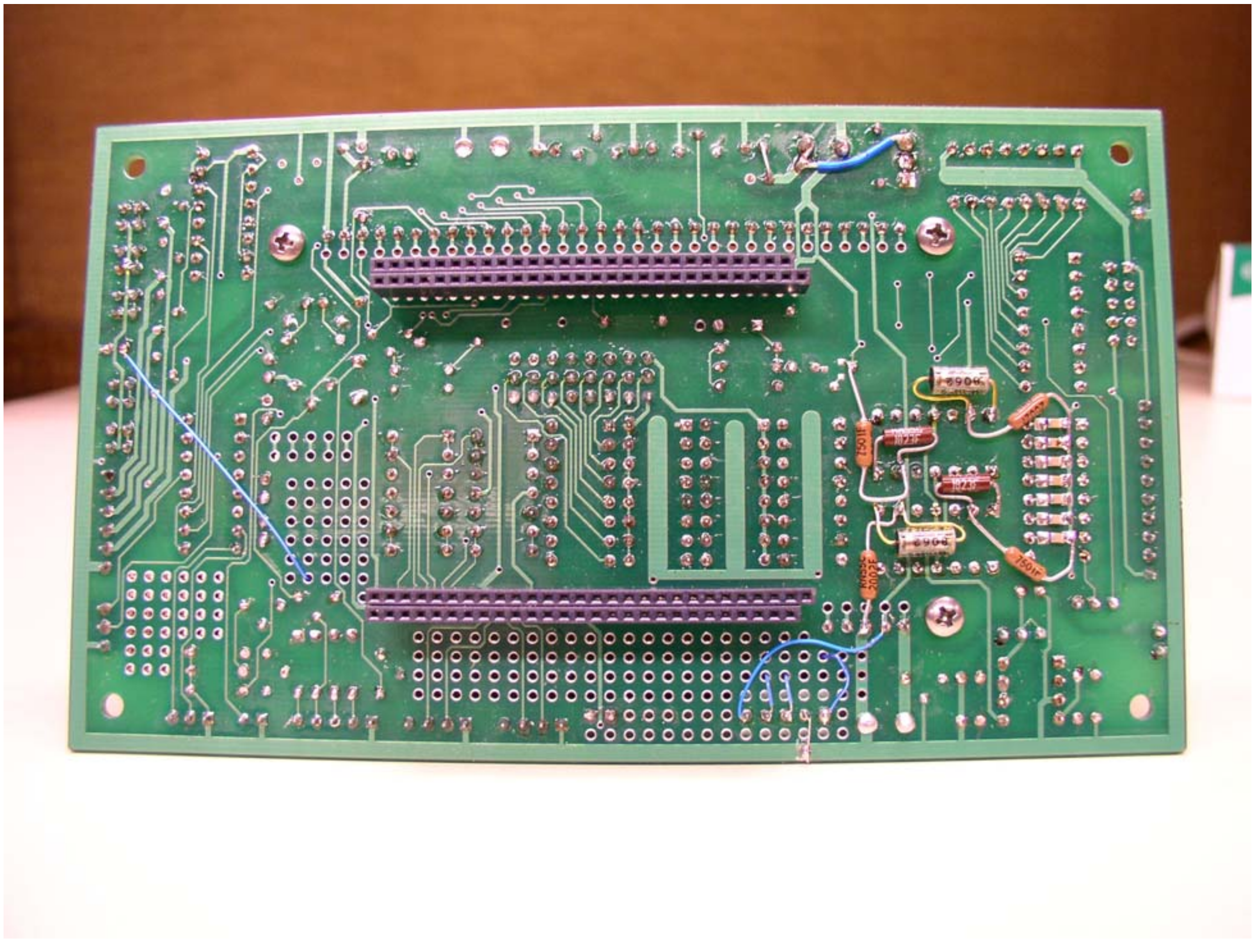
Size	Number	Rev
A	ES3968	B

Date 4/13/2010 Drawn by PK/RJ
Filename RES8MTHR.S02 Sheet 2 of 3

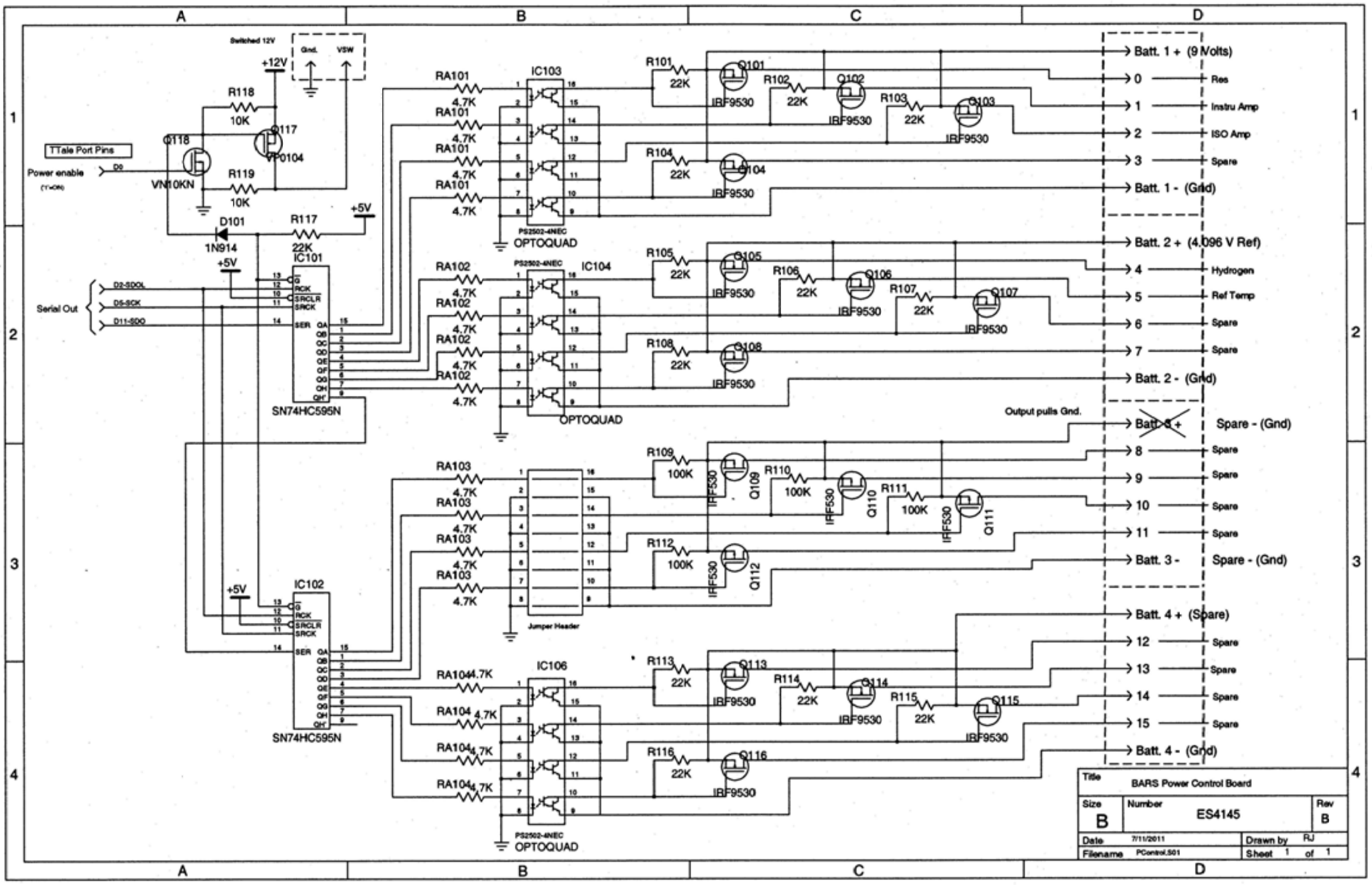

Title RES8 Mother Board, Digital Section
Size B
Number ES3968
Rev B
Date 4/13/2010
Drawn by PK/RJ
Filename RES8MTHR.S03
Sheet 3 of 3
Note: TPU Inputs are all inverting except TPU 4
Frequency In
P5
C20 1.0uF
R7 4.7K
R6 100K
D2 1N914
R5 20K
+5V
2N3904
Q9
D13
TPU4
TPU3 D3 R2OUT
TPU7 D9 T2IN
TPU15 D14 T1IN
TPU12 D15 R1OUT
TPU6 D12
"0"= on
4PINM
Console
P6
RX1 94
TX1 93
AUX RS-232
P7
RX2 96
TX2 95
TT-8 Connector
3PINM
3 Pin Friction Lock
P4:1
P3:1
C15 10uF
C16 10uF
C17 10uF
C18 10uF
C23 10uF
IC9
MAX232
VP0104
Q10
TPU9 D4 "0"=on
TPU10 D10 "0"=on
TPU12 D15 "0"=on
TPU11 D6 "0"=on
IC5:A
IC5:B
IC5:D
IC5:C
CD40109BE
Q3
Q4
Q5
Q6
+12V
+5VSW
ABS
ADCP
ADV
Spare
6PINM
DIO-1
DIO-2
DIO-3
DIO-4
DIO-5
P9
R1 20K
Q1 VN0104
Q2
TPU15 "1"=on
R15 10K
R16 10K
R14 10K
TPU 3
TPU 6
TPU 7
Q17
Q18
Q19
Q20
+5.0V
R10 4.7K
R11 4.7K
R12 4.7K
R13 4.7K
P8
5PINM
TPU Input
G 3 4 6 7
A B C D
1 2 3 4



BARS Motherboard – Component Side



BARS Motherboard – Back side


A
B
C
D
1
2
3
4
Switched 12V
Gnd.
VSW
+12V
R118
10K
Q117
VP0104
Q118
VN10KN
TTale Port Pins
Power enable
D0
('1'=ON)
R119
10K
D101
1N914
R117
22K
+5V
IC101
Serial Out
D2-SDOL
D5-SCK
D11-SDO
G
RCK
SRCLR
SRCK
SER
QA
QB
QC
QD
QE
QF
QG
QH
QH'
SN74HC595N
IC102
SN74HC595N
RA101
RA102
RA103
RA104
4.7K
IC103
IC104
IC106
PS2502-4NEC
OPTOQUAD
Jumper Header
R101
R102
R103
R104
R105
R106
R107
R108
R113
R114
R115
R116
22K
R109
R110
R111
R112
100K
Q101
Q102
Q103
Q104
Q105
Q106
Q107
Q108
Q113
Q114
Q115
Q116
IRF9530
Q109
Q110
Q111
Q112
IRF530
Output pulls Gnd.
Batt. 1 + (9 Volts)
0
Res
1
Instru Amp
2
ISO Amp
3
Spare
Batt. 1 - (Gnd)
Batt. 2 + (4.096 V Ref)
4
Hydrogen
5
Ref Temp
6
Spare
7
Spare
Batt. 2 - (Gnd)
~~Batt. 3 +~~
Spare - (Gnd)
8
Spare
9
Spare
10
Spare
11
Spare
Batt. 3 -
Spare - (Gnd)
Batt. 4 + (Spare)
12
Spare
13
Spare
14
Spare
15
Spare
Batt. 4 - (Gnd)
Title
BARS Power Control Board
Size
B
Number
ES4145
Rev
B
Date
7/11/2011
Drawn by
RJ
Filename
PControl.S01
Sheet 1 of 1

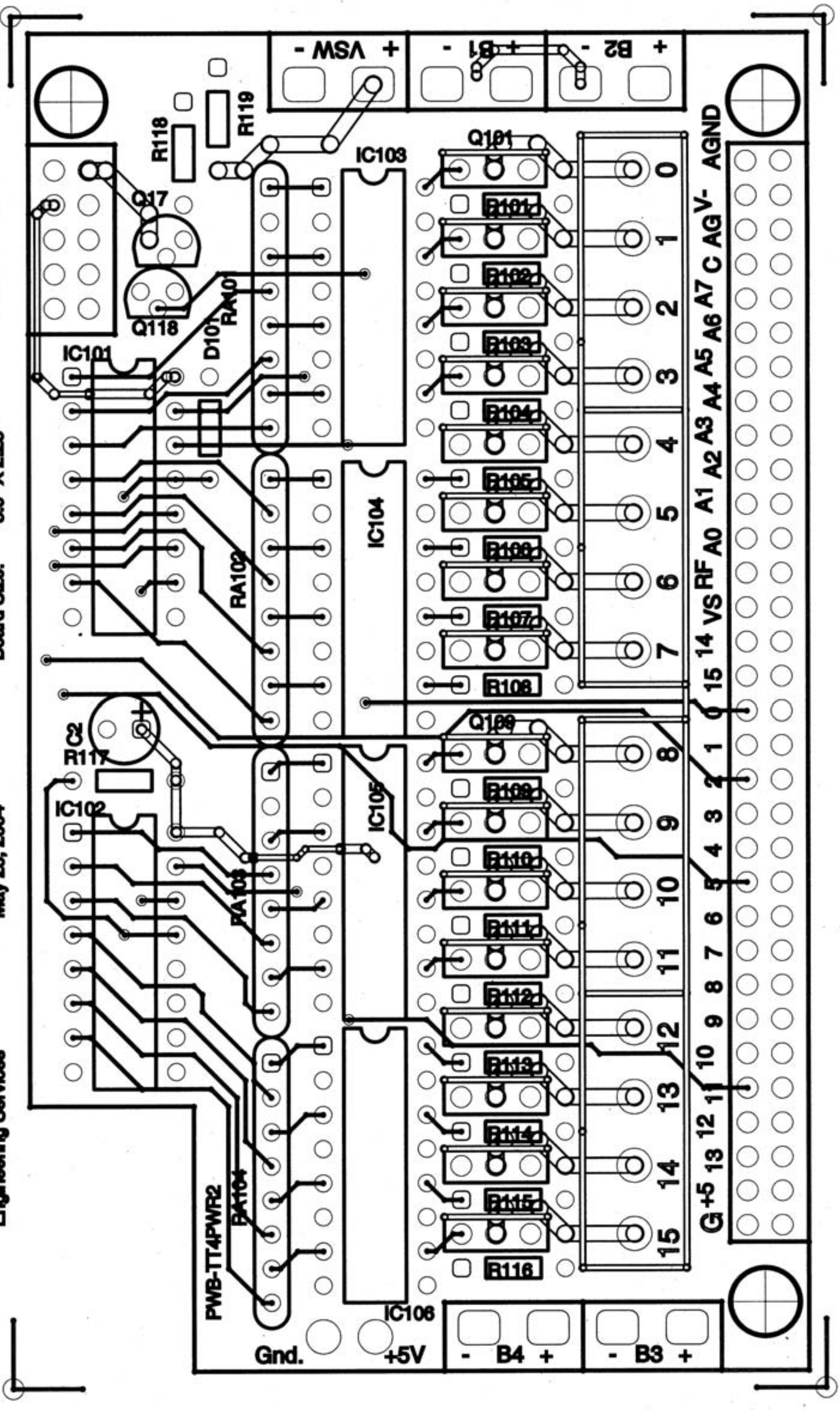
University of Washington
School of Oceanography
Engineering Services

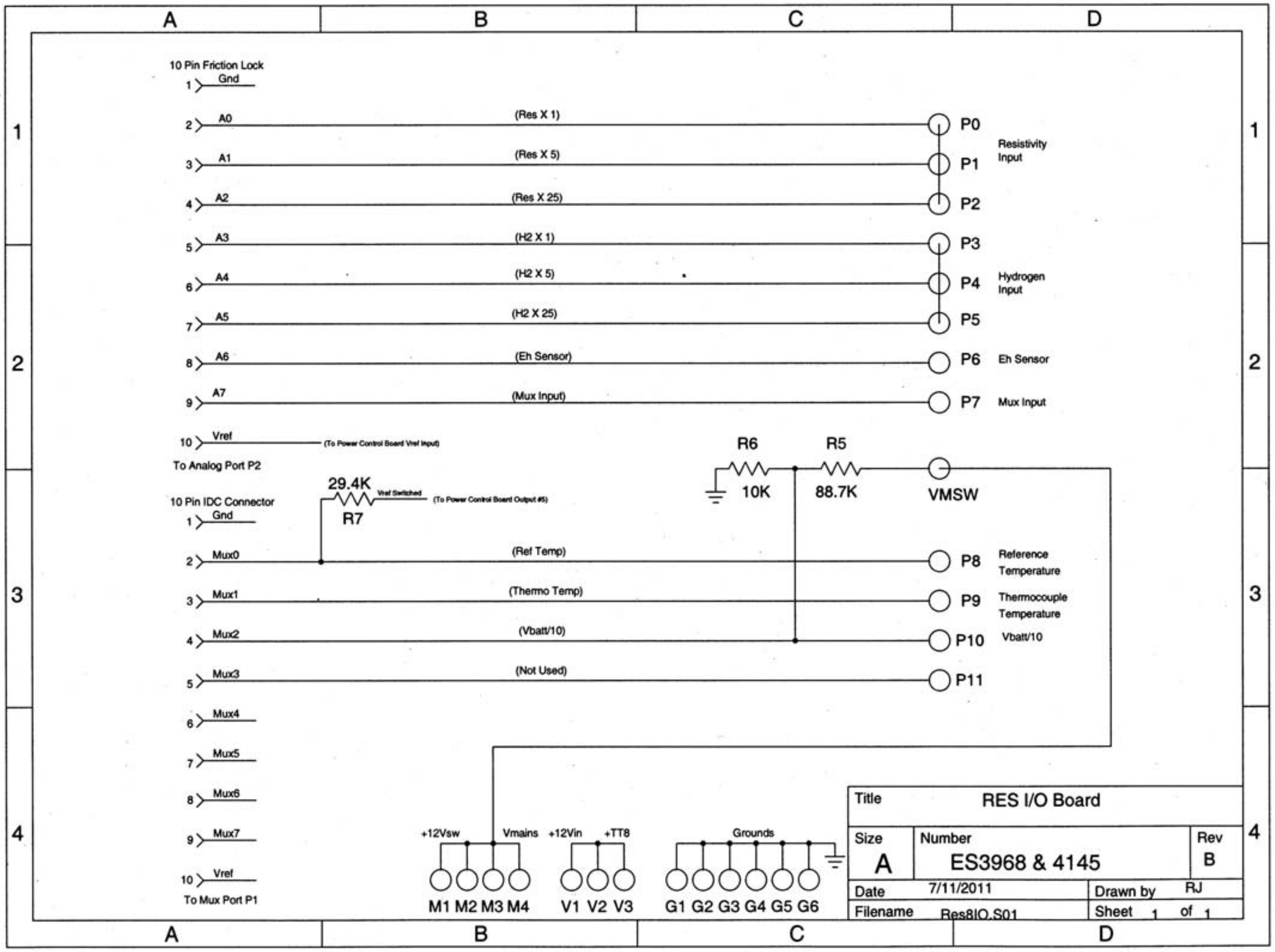
Rex Johnson
206-543-6688
May 28, 2004

Number of Holes = 349
Board Size: 3.9" X 2.25"

Component Side

Silk Side



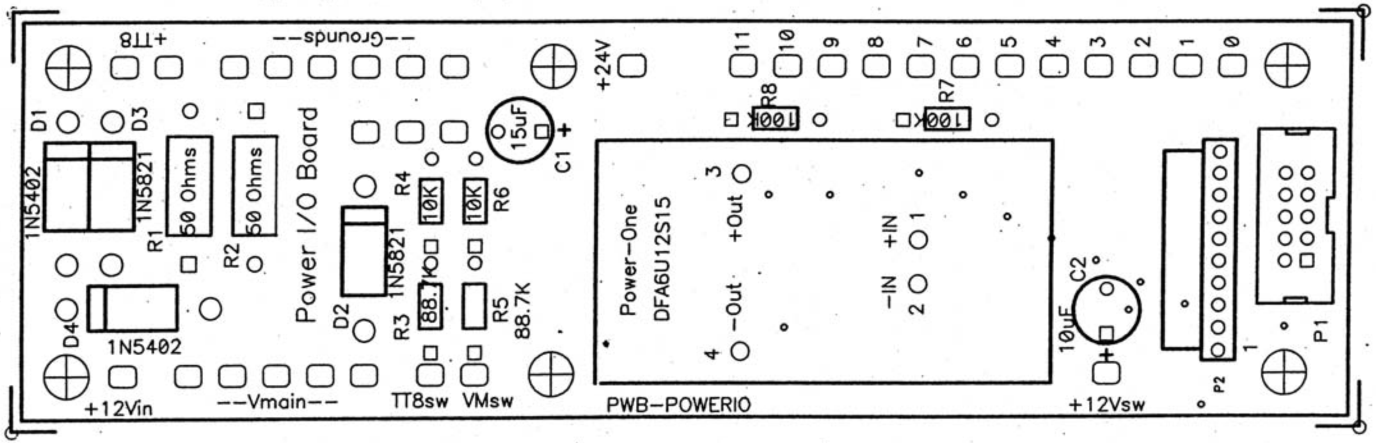

A
B
C
D
1
2
3
4
10 Pin Friction Lock
1 Gnd
2 A0
3 A1
4 A2
5 A3
6 A4
7 A5
8 A6
9 A7
10 Vref
(To Power Control Board Vref Input)
To Analog Port P2
(Res X 1)
(Res X 5)
(Res X 25)
(H2 X 1)
(H2 X 5)
(H2 X 25)
(Eh Sensor)
(Mux Input)
P0
P1
P2
Resistivity Input
P3
P4
P5
Hydrogen Input
P6
Eh Sensor
P7
Mux Input
R6
10K
R5
88.7K
VMSW
10 Pin IDC Connector
1 Gnd
2 Mux0
3 Mux1
4 Mux2
5 Mux3
6 Mux4
7 Mux5
8 Mux6
9 Mux7
10 Vref
To Mux Port P1
29.4K
R7
Vref Switched
(To Power Control Board Output #5)
(Ref Temp)
(Thermo Temp)
(Vbatt/10)
(Not Used)
P8
Reference Temperature
P9
Thermocouple Temperature
P10
Vbatt/10
P11
+12Vsw
Vmains
+12Vin
+TT8
Grounds
M1 M2 M3 M4
V1 V2 V3
G1 G2 G3 G4 G5 G6
Title
RES I/O Board
Size
A
Number
ES3968 & 4145
Rev
B
Date
7/11/2011
Drawn by
RJ
Filename
Res8IO.S01
Sheet 1 of 1

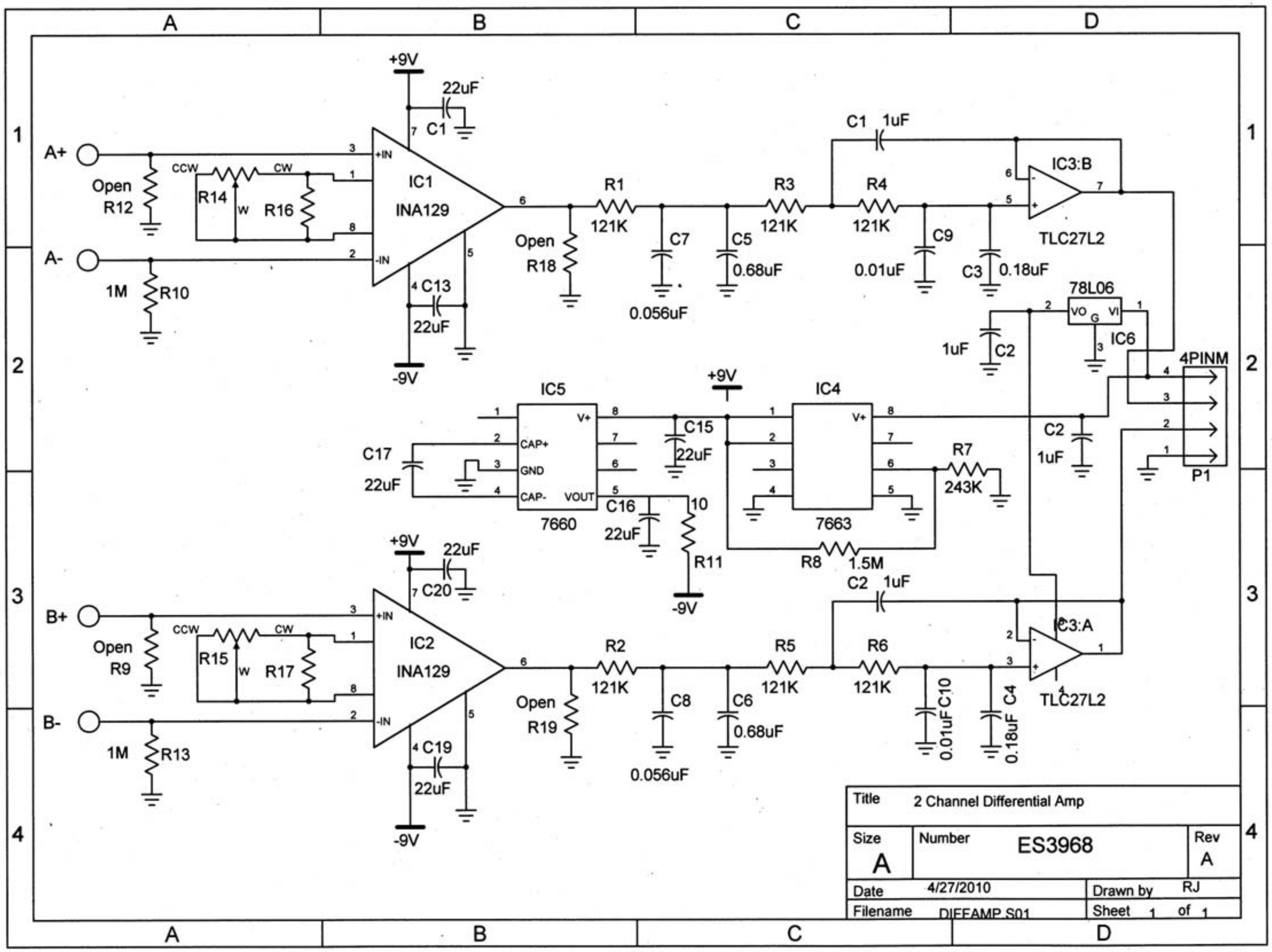
University of Washington
School of Oceanography
Engineering Services

Rex Johnson
206-543-9688
May 28, 2004

Number of Holes = 108
Board Size: 6.0" X 1.8"

Silk Side

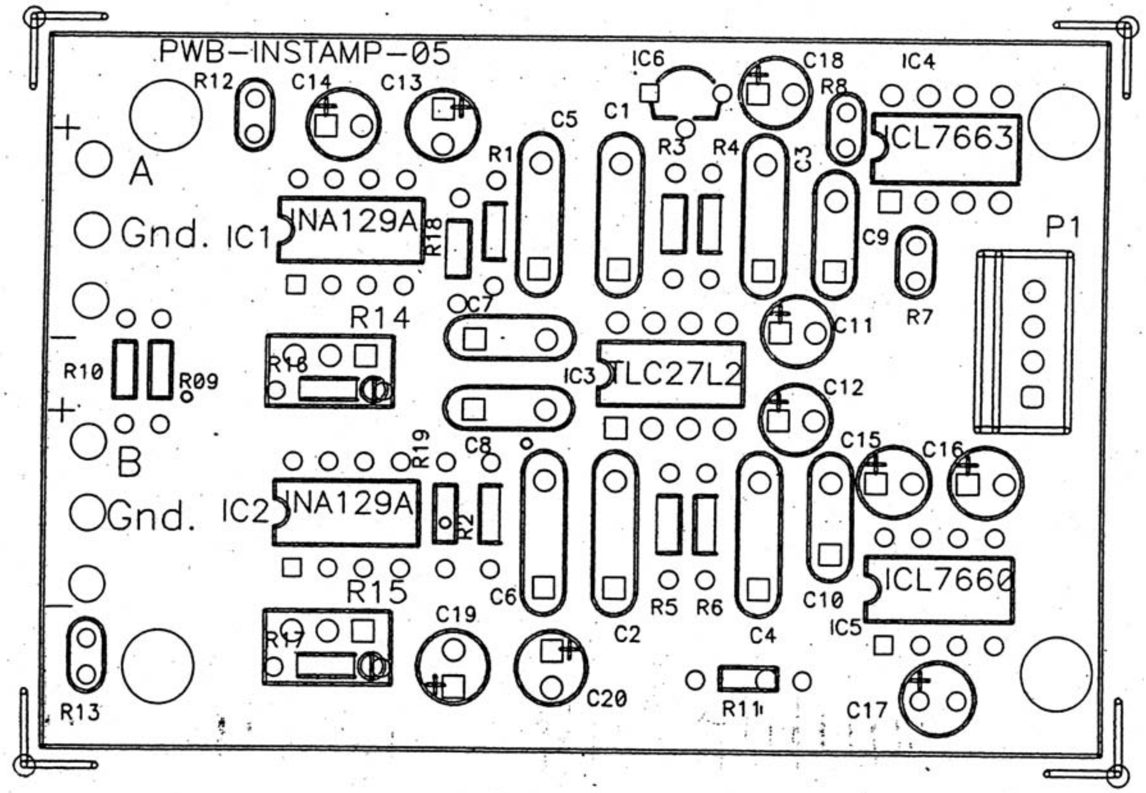



A
B
C
D
1
2
3
4
A+
A-
B+
B-
Open
R12
1M
R10
Open
R9
1M
R13
CCW
CW
W
R14
R16
R15
R17
+9V
-9V
22uF
C1
C13
C20
C19
+IN
-IN
IC1
INA129
IC2
INA129
Open
R18
Open
R19
R1
121K
R2
121K
C7
0.056uF
C8
0.056uF
C5
0.68uF
C6
0.68uF
R3
121K
R5
121K
R4
121K
R6
121K
C9
0.01uF
C10
0.01uF
C3
0.18uF
C4
0.18uF
C1 1uF
C2 1uF
IC3:B
IC3:A
TLC27L2
78L06
VO
G
VI
IC6
1uF
C2
4PINM
P1
IC5
CAP+
GND
CAP-
V+
VOUT
7660
C17
22uF
C15
22uF
C16
22uF
R11
-9V
IC4
7663
R7
243K
R8
1.5M
Title
2 Channel Differential Amp
Size
A
Number
ES3968
Rev
A
Date
4/27/2010
Drawn by
RJ
Filename
DIFFAMP.S01
Sheet 1 of 1

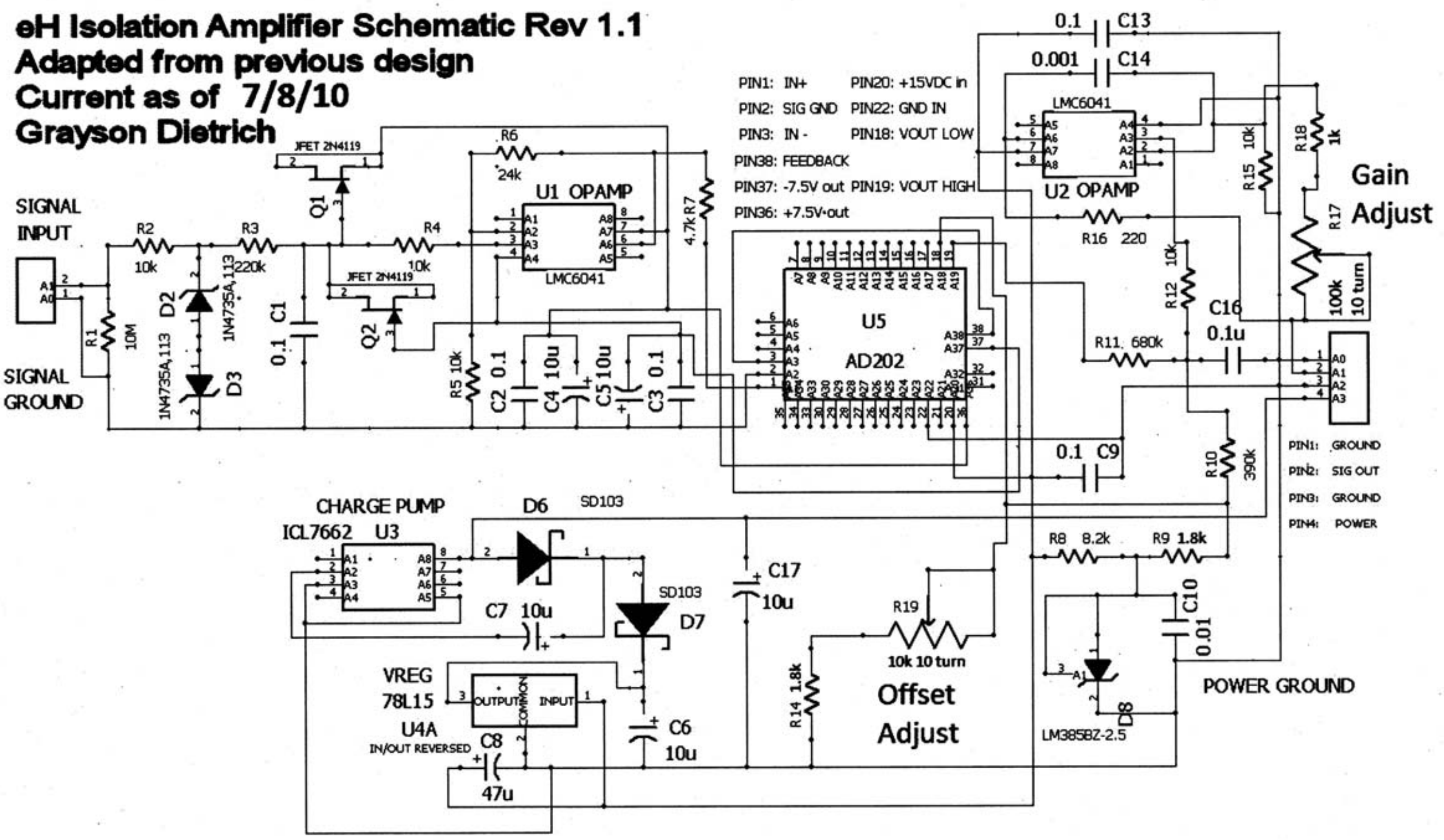
Engineering Services

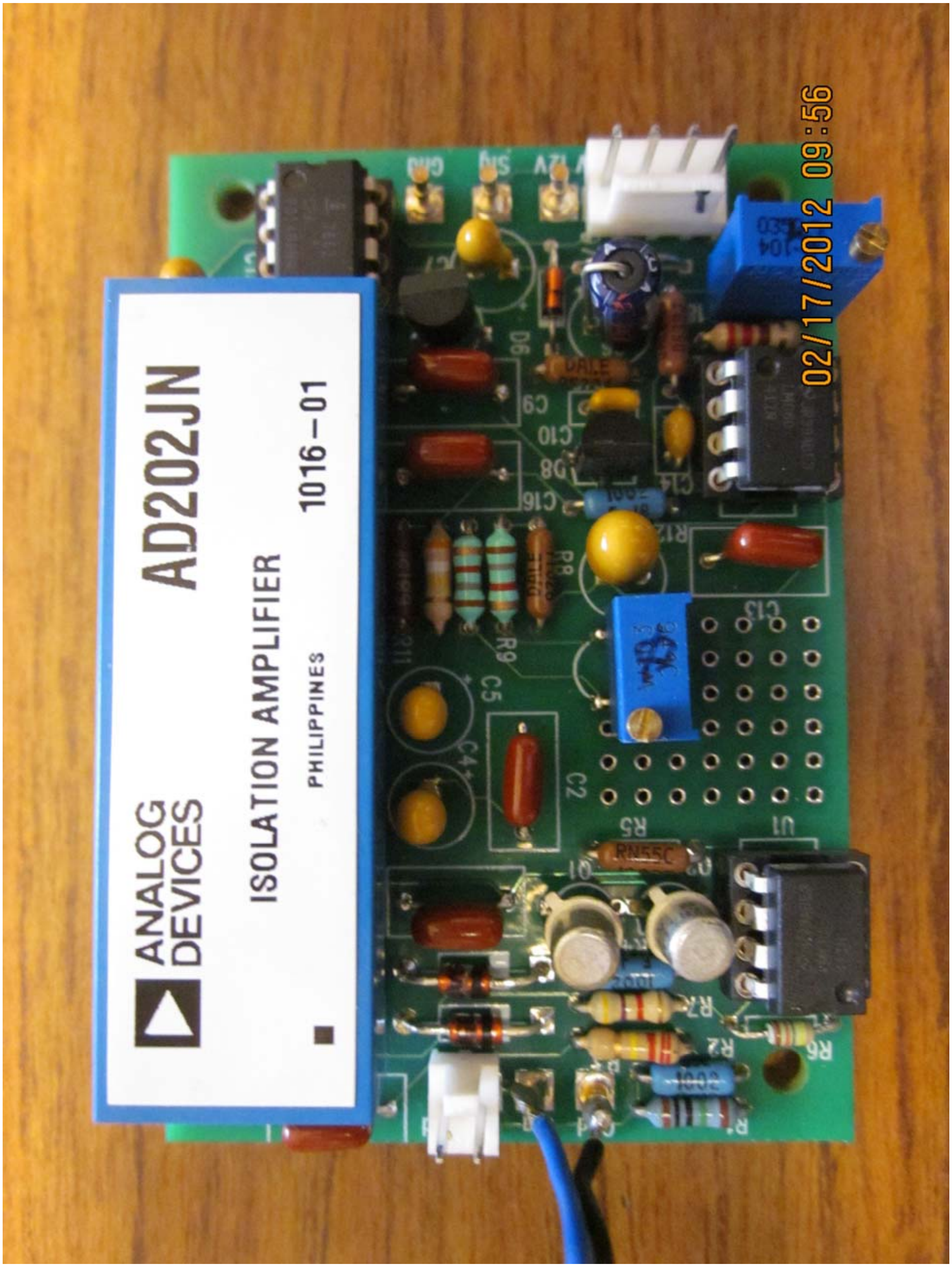
Rex Johnson
206–543–9688
July 6, 2004

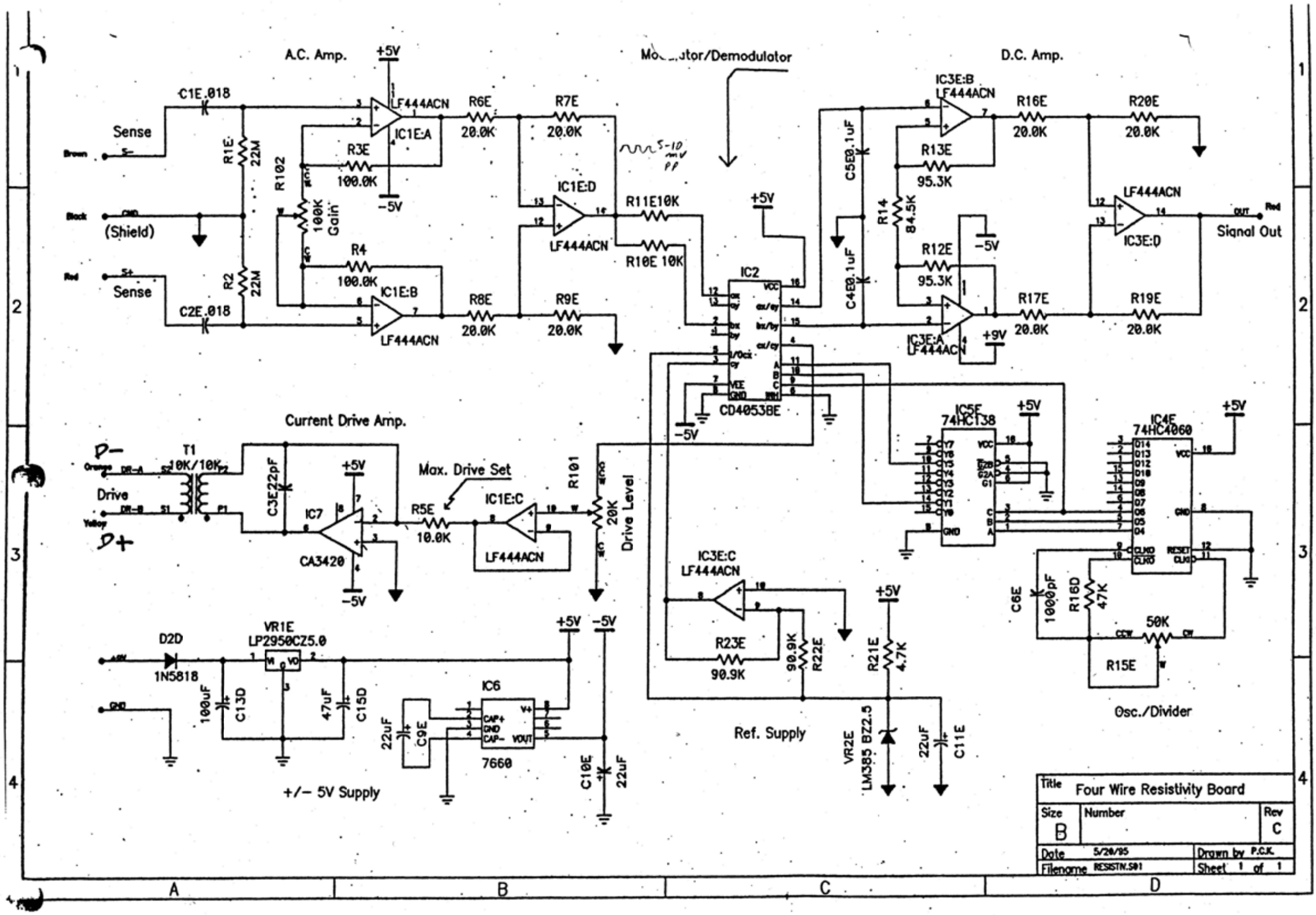
Number of Holes = 145
Board Size: 2" X 2.95"



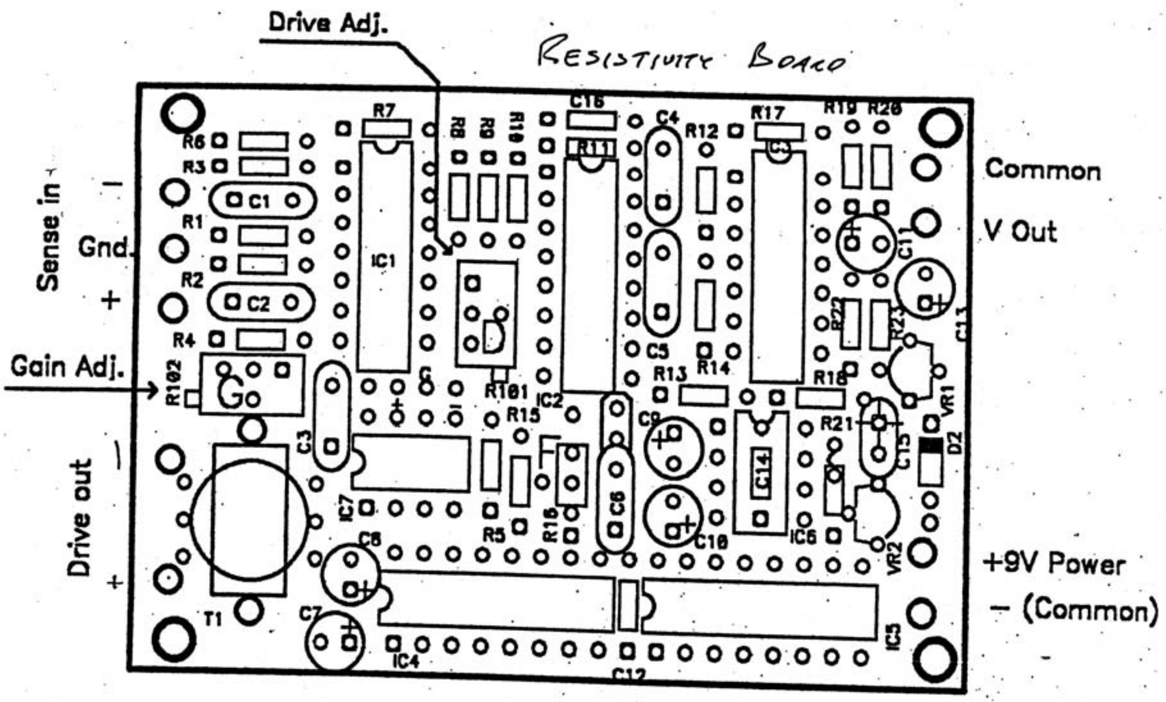
eH Isolation Amplifier Schematic Rev 1.1
Adapted from previous design
Current as of 7/8/10
Grayson Dietrich

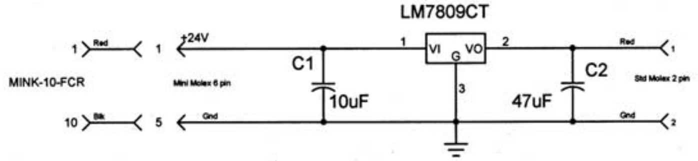



ANALOG DEVICES
AD202JN
ISOLATION AMPLIFIER
1016−01
PHILIPPINES
02/17/2012 09:56

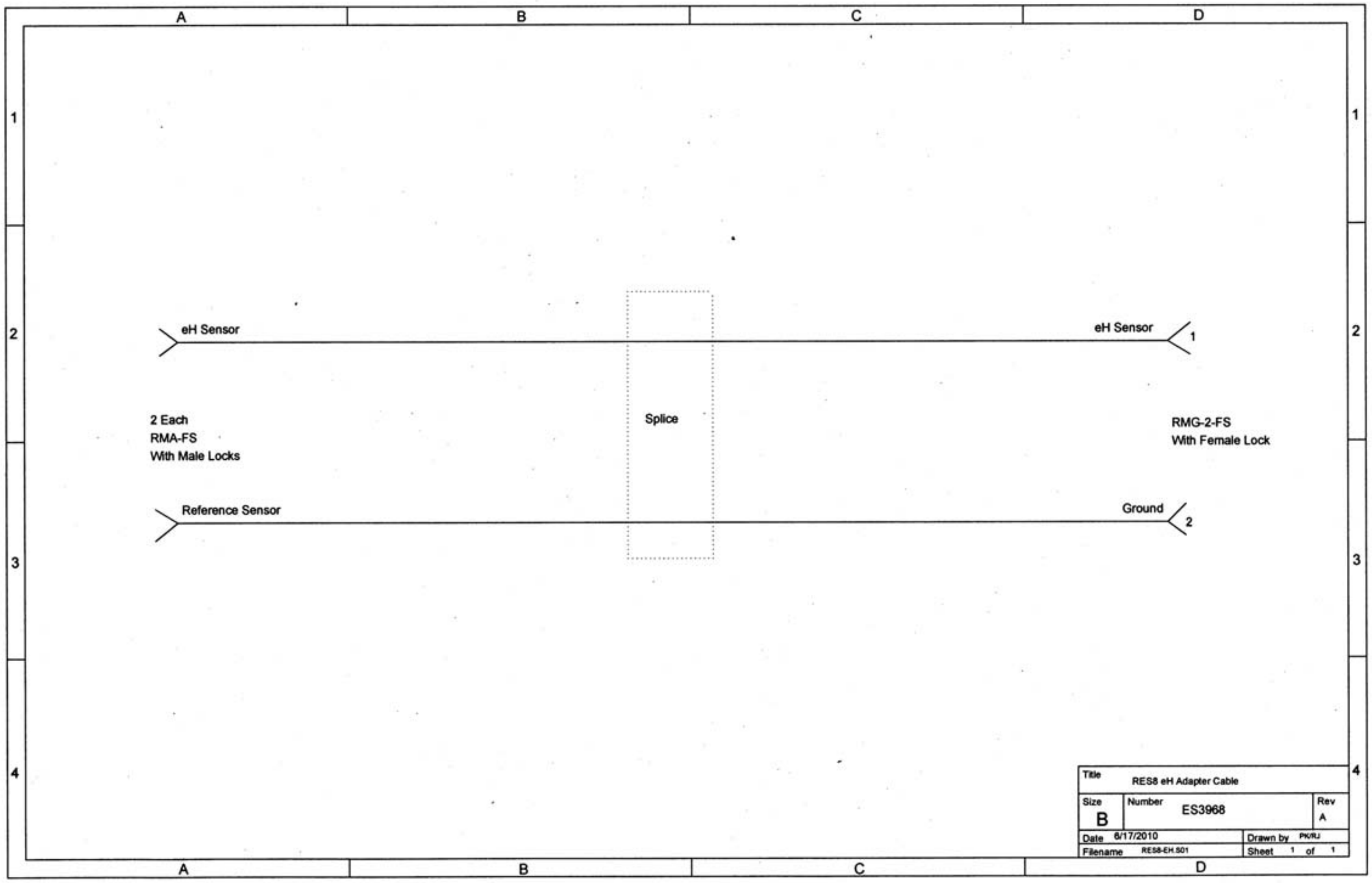

A.C. Amp.
Mo...tor/Demodulator
D.C. Amp.
Current Drive Amp.
Max. Drive Set
Drive Level
Ref. Supply
Osc./Divider
+/- 5V Supply
Sense
S-
Brown
Black
GND
(Shield)
Red
S+
Sense
C1E .018
C2E .018
R1E 22M
R2 22M
R102 100K Gain
R3E 100.0K
R4 100.0K
IC1E:A
IC1E:B
IC1E:C
IC1E:D
LF444ACN
R6E 20.0K
R7E 20.0K
R8E 20.0K
R9E 20.0K
5-10 mv pp
R11E 10K
R10E 10K
IC2
CD4053BE
C5E0.1uF
C4E0.1uF
R14 84.5K
R13E 95.3K
R12E 95.3K
IC3E:A
IC3E:B
IC3E:C
IC3E:D
R16E 20.0K
R20E 20.0K
R17E 20.0K
R19E 20.0K
OUT
Red
Signal Out
+5V
-5V
+9V
D-
Orange
DR-A
Drive
DR-B
Yellow
D+
T1 10K/10K
C3E22pF
IC7
CA3420
R5E 10.0K
R101 20K
IC5F
74HC138
IC4E
74HC4060
C6E 1000pF
R16D 47K
50K
R15E
R23E 90.9K
R22E 90.9K
R21E 4.7K
VR2E LM385 BZ2.5
C11E 22uF
D2D 1N5818
VR1E LP2950CZ5.0
C13D 100uF
C15D 47uF
IC6 7660
C9E 22uF
C10E 22uF
Title Four Wire Resistivity Board
Size B
Number
Rev C
Date 5/20/95
Drawn by P.C.K.
Filename RESISTN.S01
Sheet 1 of 1

Resistivity Board





Title	BARS Power Regulator	
Size A	Number ES3968	Rev A
Date 7/30/2010	Drawn by RJ	
Filename PowerReg.S01	Sheet 1 of 1	



Title RES8 eH Adapter Cable

Size B

Number ES3968

Rev A

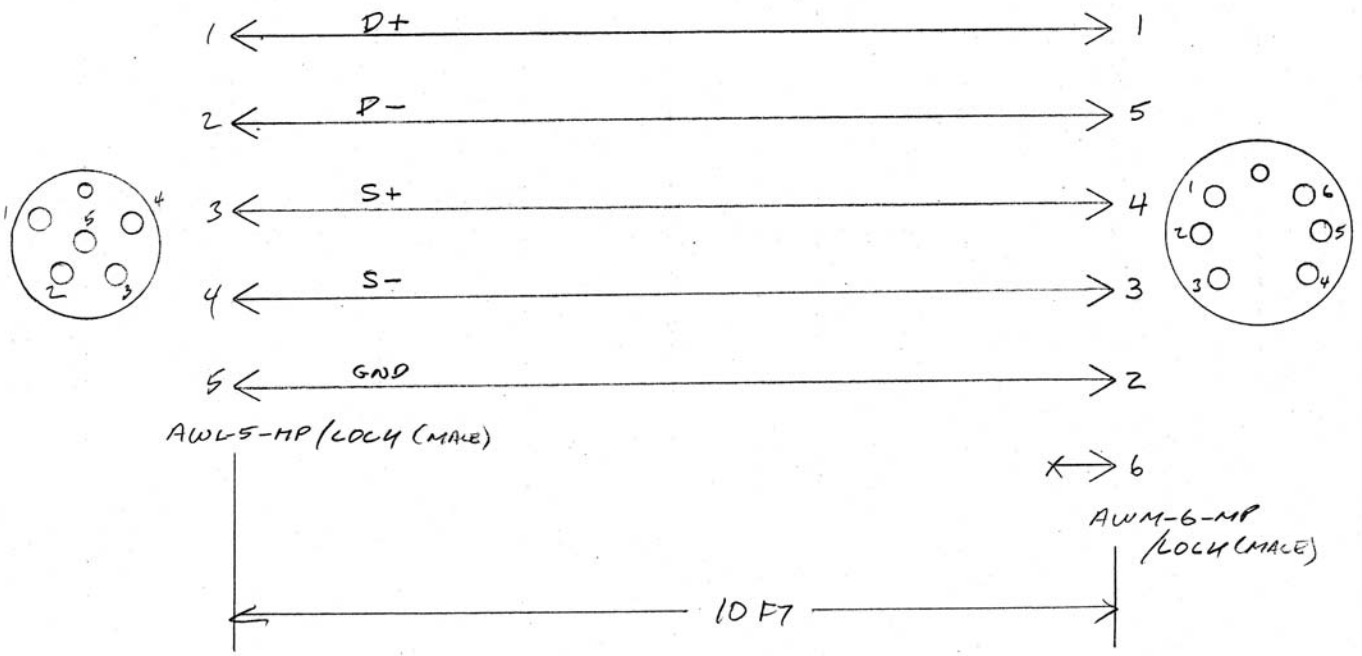
Date 6/17/2010

Drawn by PK/RJ

Filename RES8-EH.S01

Sheet 1 of 1

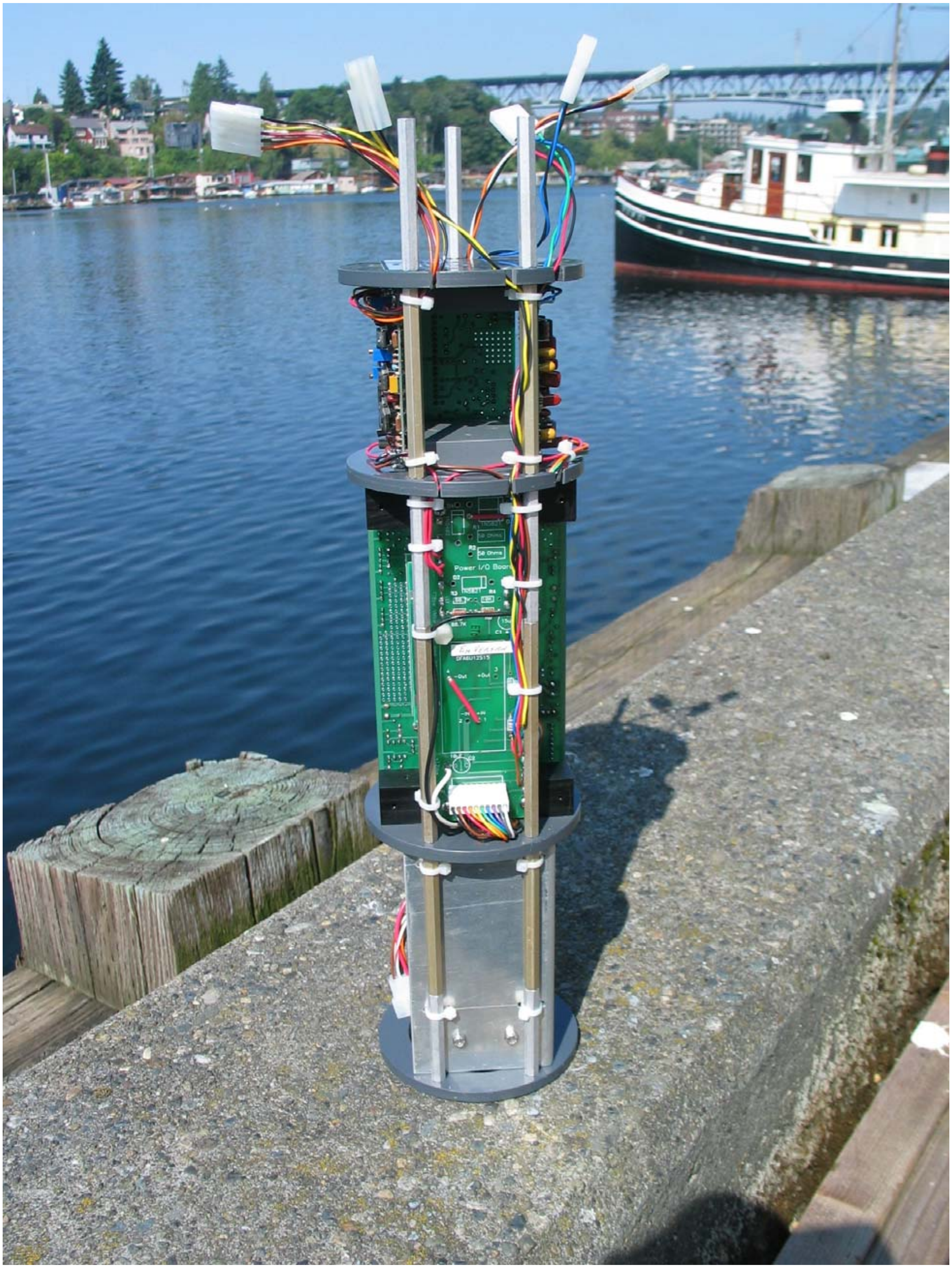
NEW RES PROBE CABLE
JULY 2003



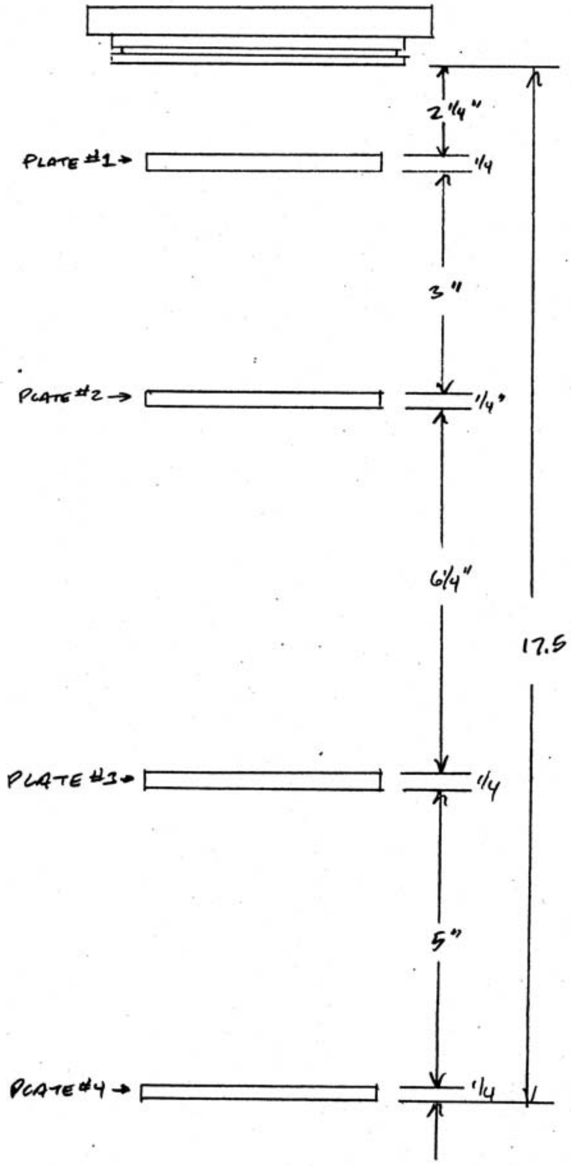
7/9/2003

Section 4

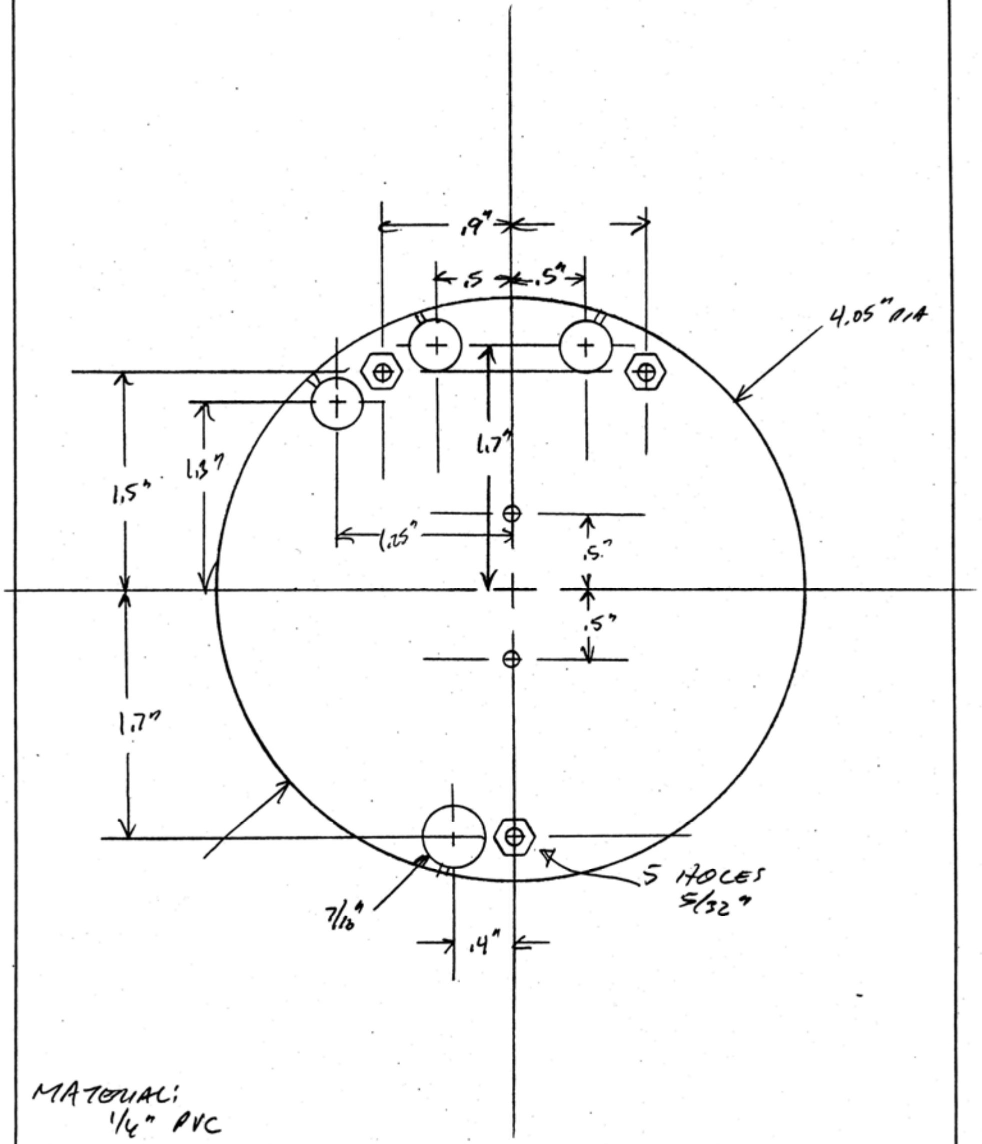
System Mechanical Drawings


R2
50 Ohms
Power I/O Boar
88.7K
DFA6U12S15
-Out
+Out

TT8 RES LOGGER LAYOUT



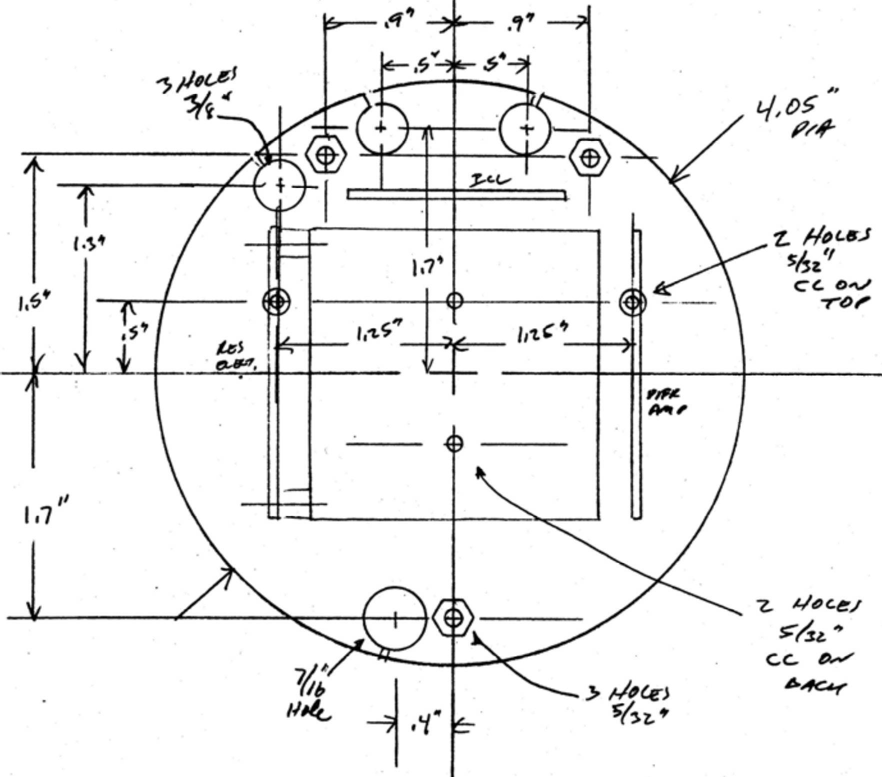
TT8 RES LOGGER
#1 PLATE



MATERIAL:
1/4" PVC
SCALE:
FULL SIZE
QUANTITY:
1 EA

Rex Johnson
6/20/04

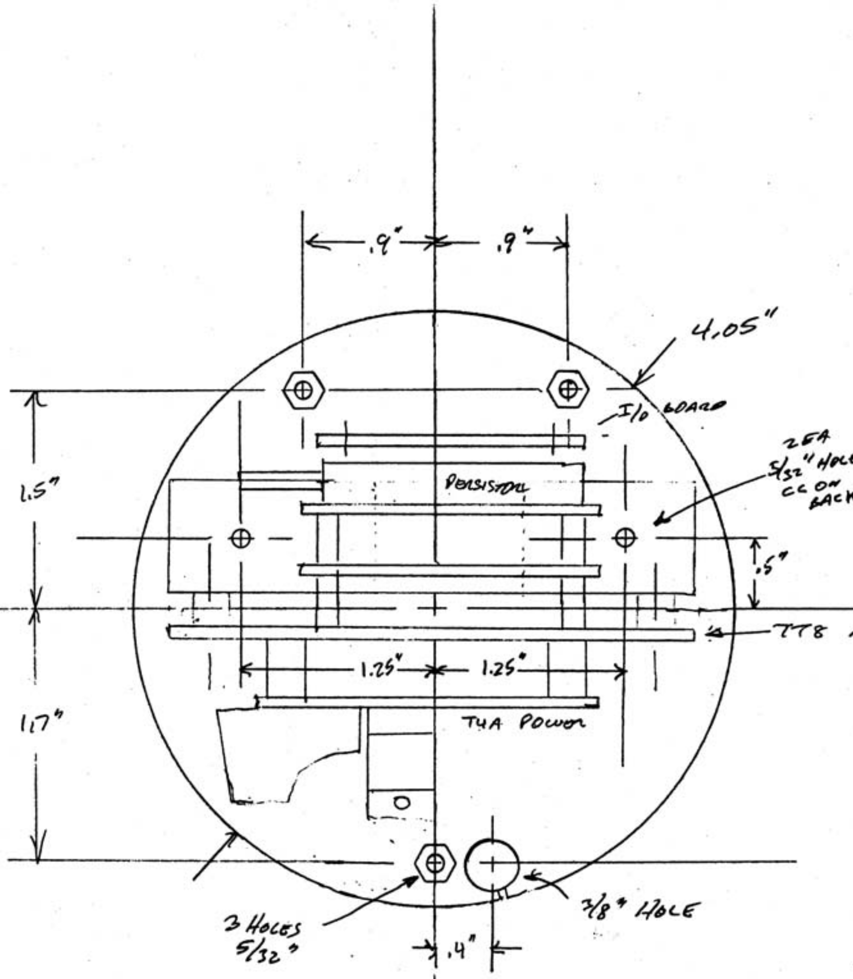
TTB RES LOGGER
#2 PLATE



MATERIAL:
1/4" PVC
SCALE:
FULL SIZE
QUANTITY:
1 EA

6/30/04

TT8 RES LOGGER
#3 PLATE

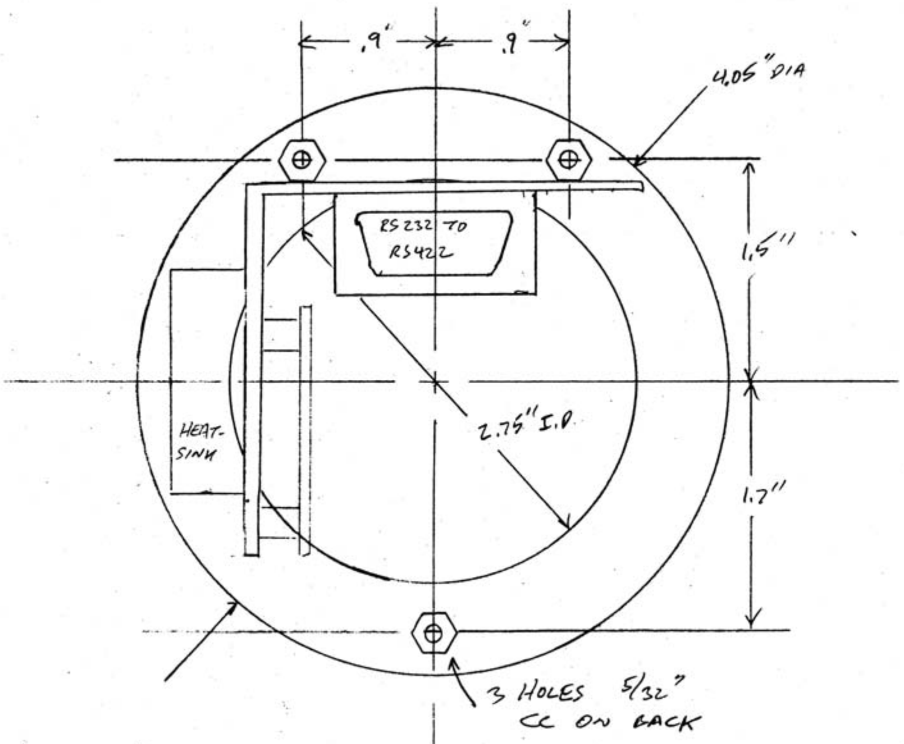


MATERIAL:
1/4" PVC
SCALE:
FULL SIZE
QUANTITY:
1 EA

NOTES:
MOUNT I/O BOARD ON 1/16" NYLON WASHERS.
MOUNT TT8 MOTHER BOARD ON 3/8" STANDOFFS.

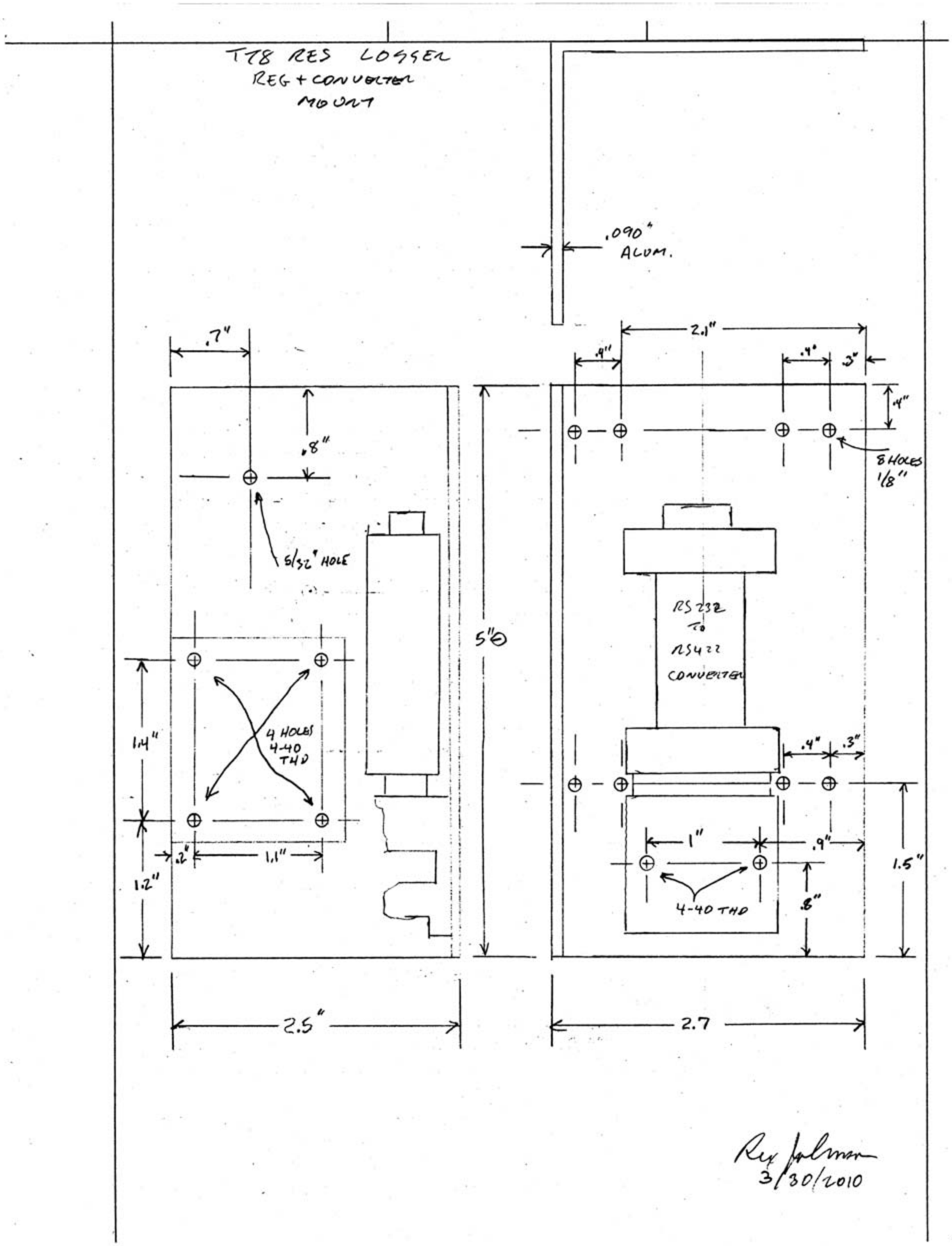
6/30/04

TT8 RES LOGGER
#4 PLATE
CANADIAN VERSION

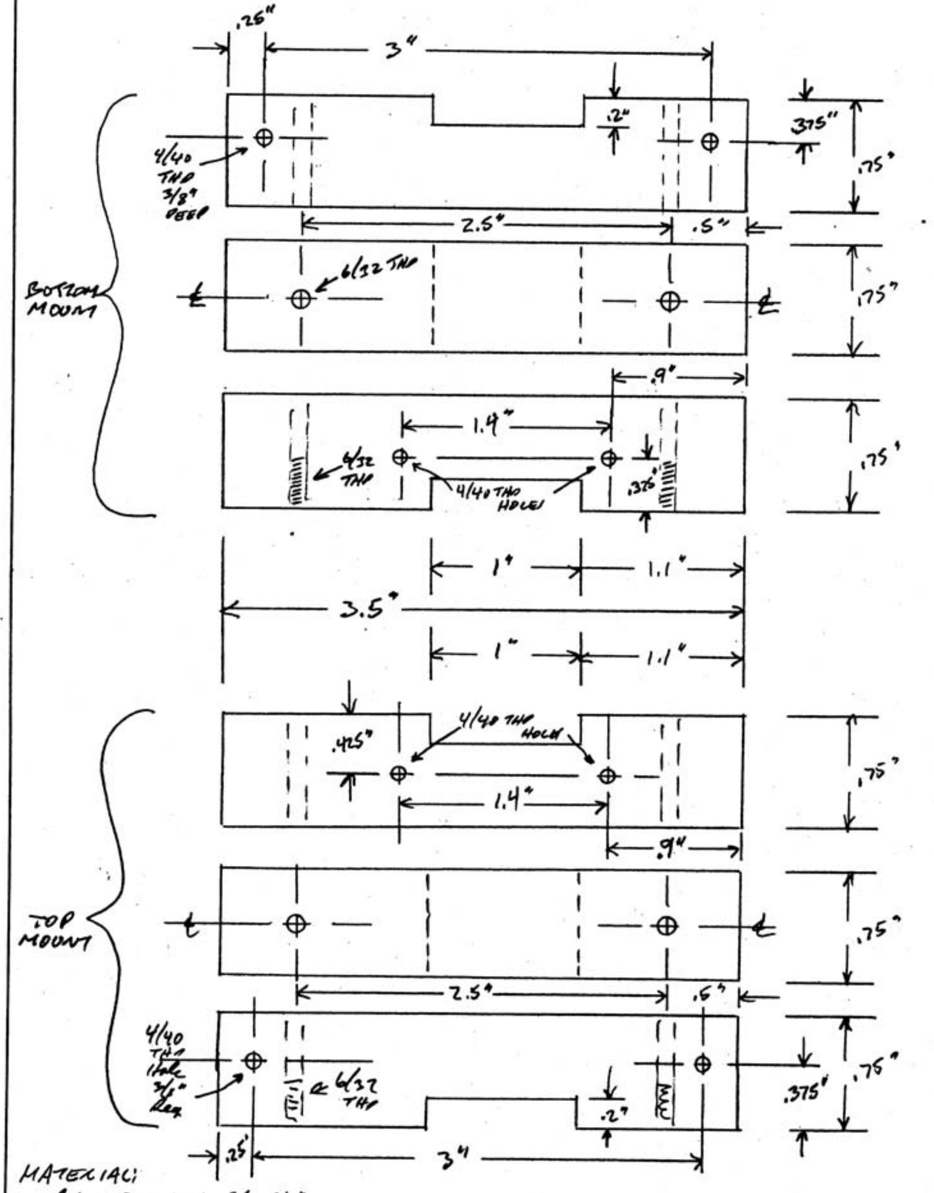


MATERIAL:
1/4" PVC
SCALE:
FULL SIZE
QUANTITY:
1 EACH

3/26/2010


T78 RES LOGGER
REG + CONVERTER
MOUNT
.090"
ALUM.
.7"
.8"
5/32" HOLE
1.4"
4 HOLES
4-40
THD
1.2"
.2"
1.1"
5"
2.5"
2.1"
.9"
.4"
.3"
.4"
8 HOLES
1/8"
RS232
TO
RS422
CONVERTER
.4"
.3"
1"
.9"
1.5"
.8"
4-40 THD
2.7
3/30/2010

TT8 RES LOGGER
TT8 MOUNTS



MATERIAL:
BLK DELRIN 3/4 x 3/4"
McMaster # 8663K21

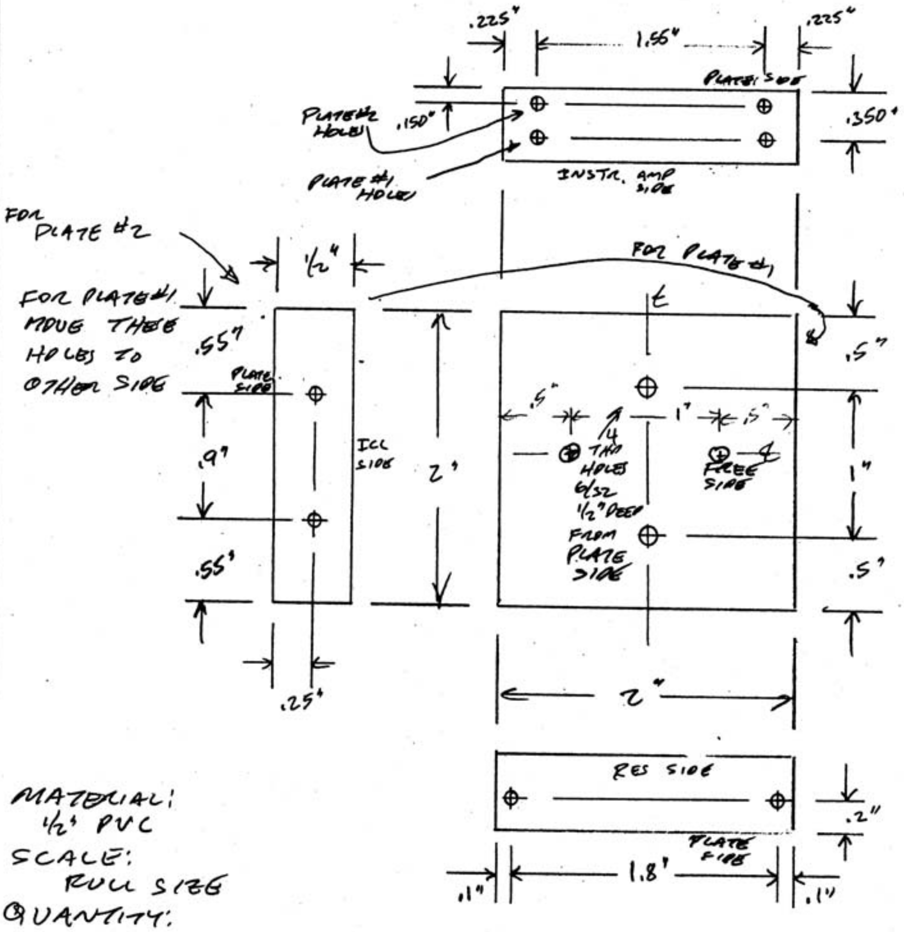
SCALE:
FULL SIZE

QUANTITY:
1 EA

Roy Johnson
6/30/04

TT8 RES LOGGER
ELECTRONICS MOUNT

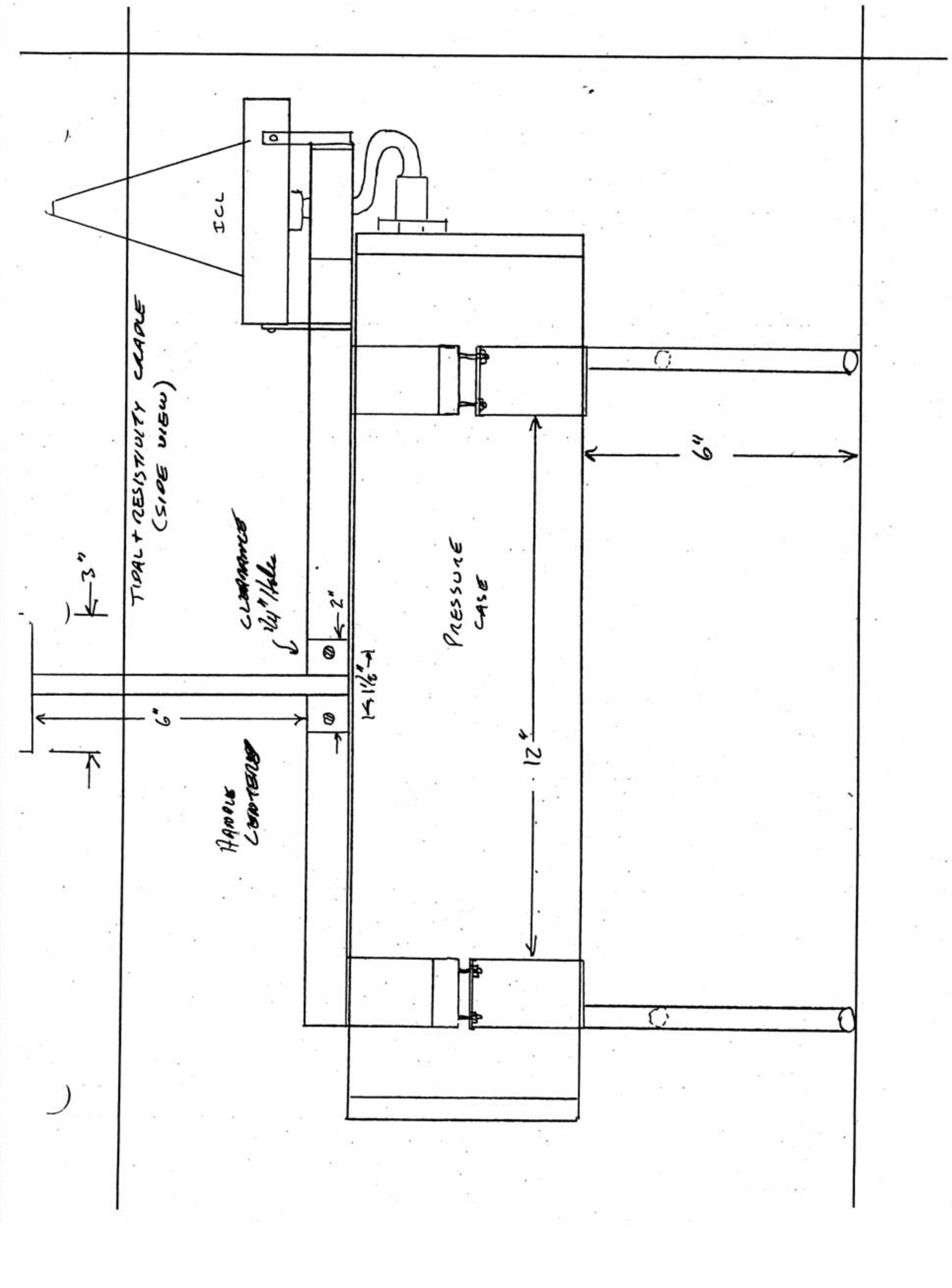
NOTES:
MAKE 2 PIECES
(A) PLATE #2 MOUNT
(B) PLATE #1 MOUNT



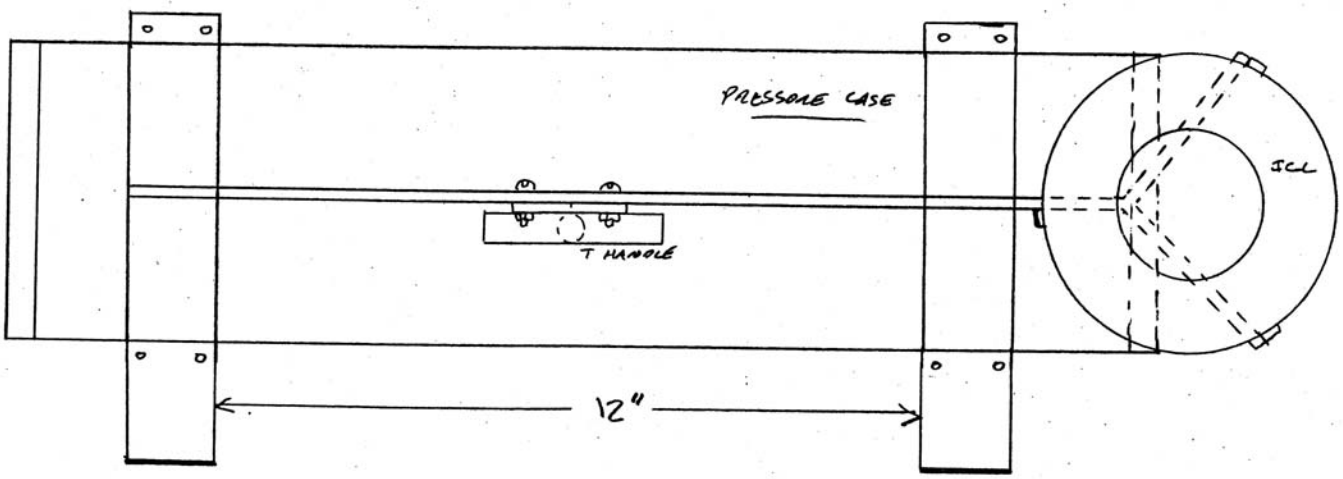
MATERIAL:
1/2" PVC
SCALE:
FULL SIZE
QUANTITY:
2 — TOTAL
1 of EACH

ALL SIDE HOLES:
4-40 × 3/8 DEEP

Rex Johnson

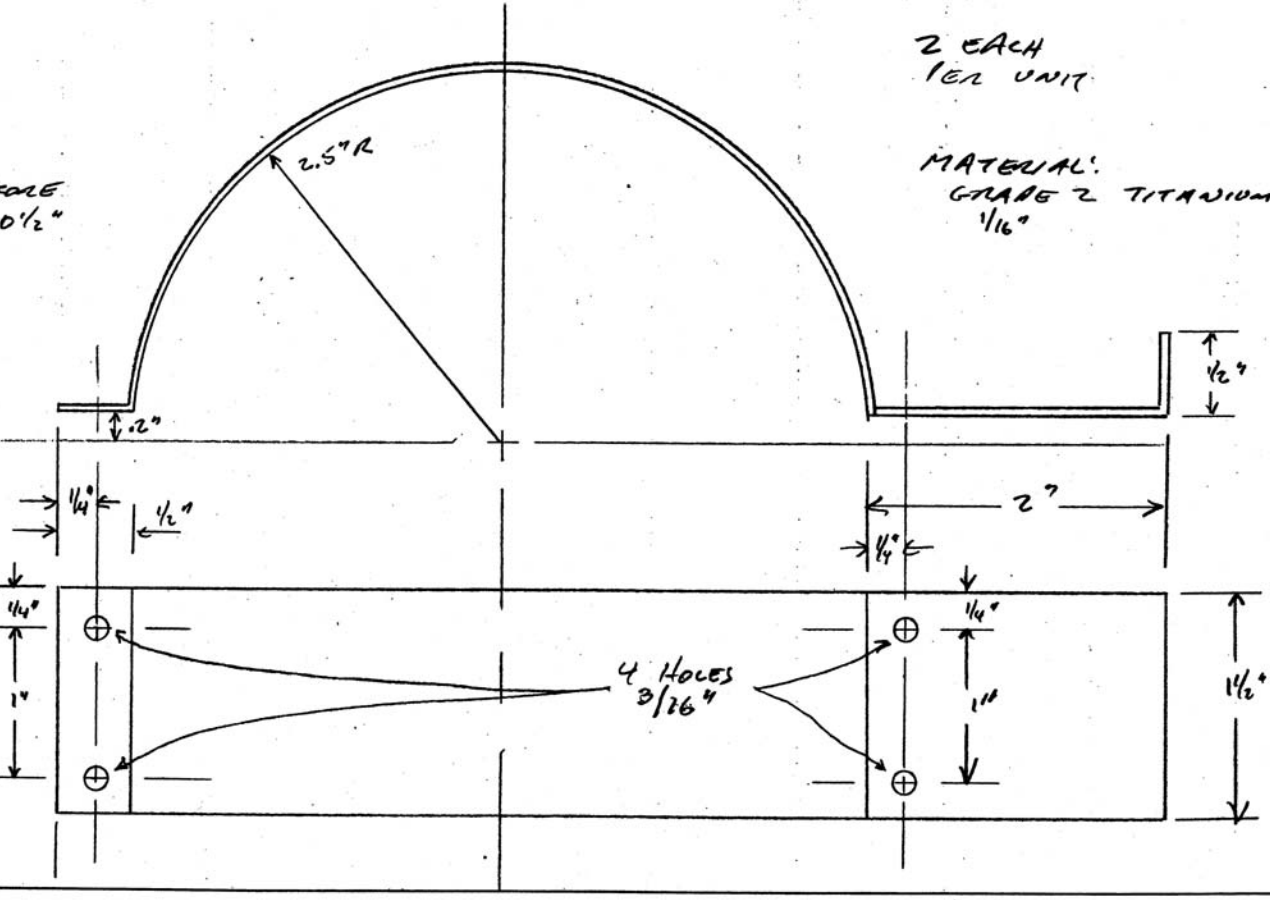

TIDAL + RESISTIVITY CRADLE (SIDE VIEW)

TIDAL + RESISTIVITY CRADLE
(TOP VIEW)



Ray Johnson
5/4/00

RESISTIVITY + TIDAL LOGGER CRADLE
TOP CLAM SHELL



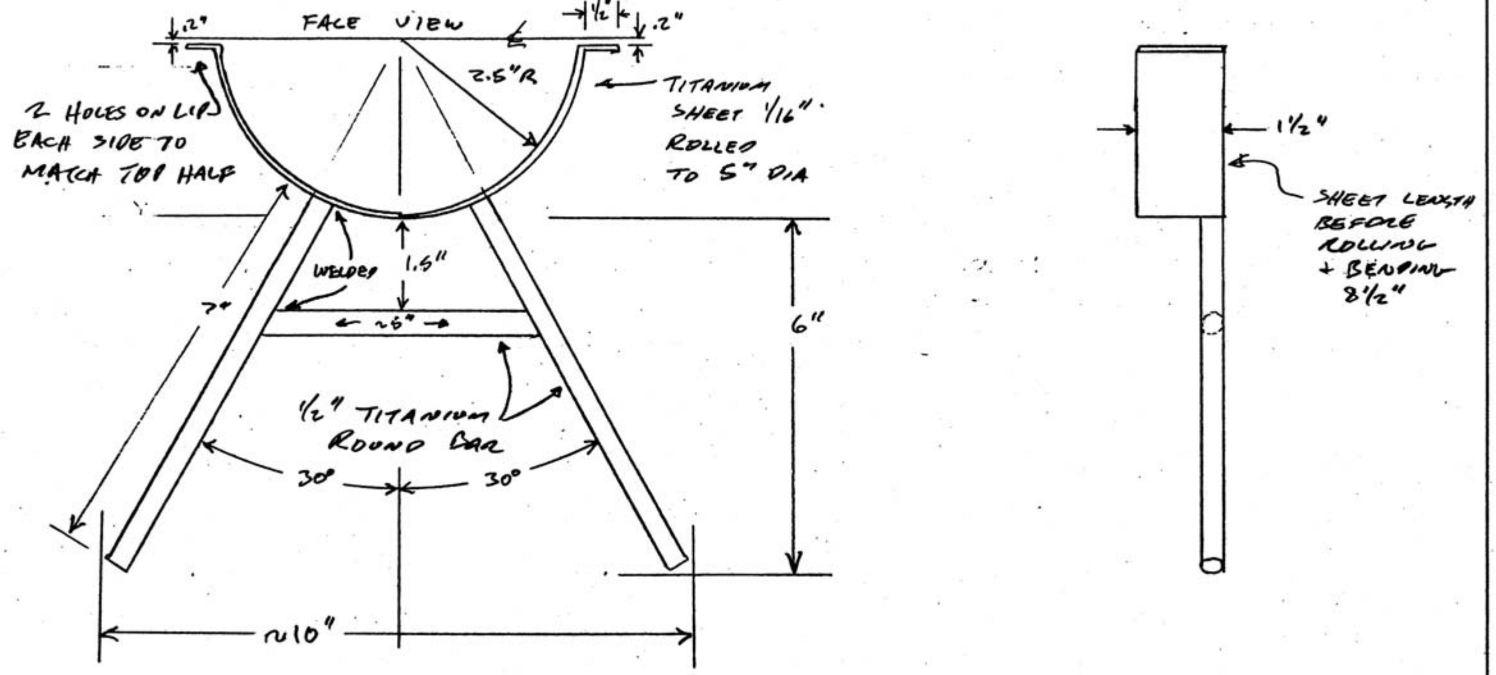
2 EACH
PER UNIT

MATERIAL:
GRADE 2 TITANIUM
1/16"

LENGTH BEFORE
BENDING 10 1/2"

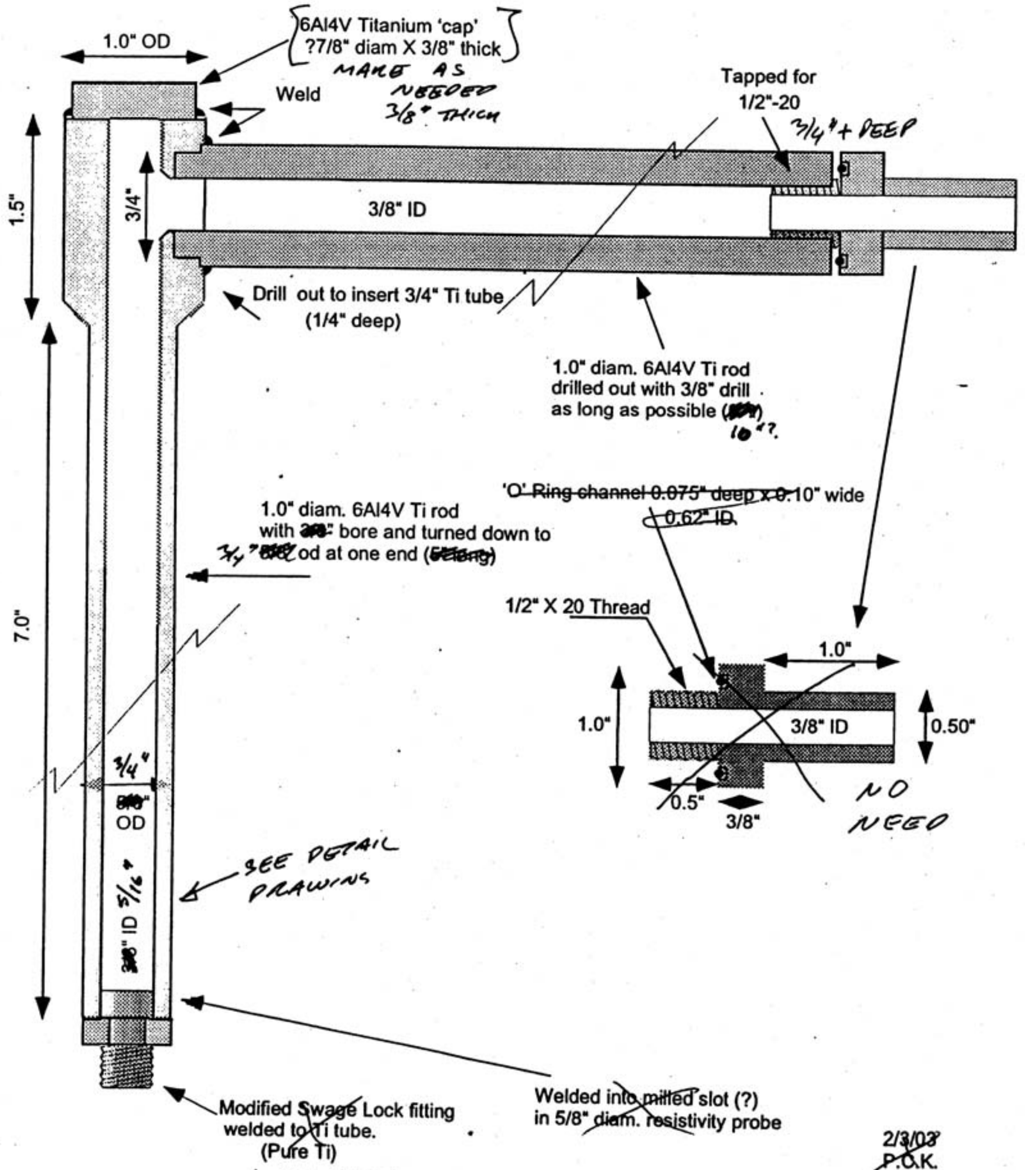
10/5/04

RESISTIVITY + TIDAL LOGGER CRADLE LEGS
(2 PER UNIT)


FACE VIEW
.2"
1/2"
.2"
2.5"R
2 HOLES ON LIP EACH SIDE TO MATCH TOP HALF
TITANIUM SHEET 1/16". ROLLED TO 5" DIA
WELDED
1.5"
~5"
7"
6"
1/2" TITANIUM ROUND BAR
30°
30°
~10"
1 1/2"
SHEET LENGTH BEFORE ROLLING + BENDING 8 1/2"

Rec Johnson
10/28/04

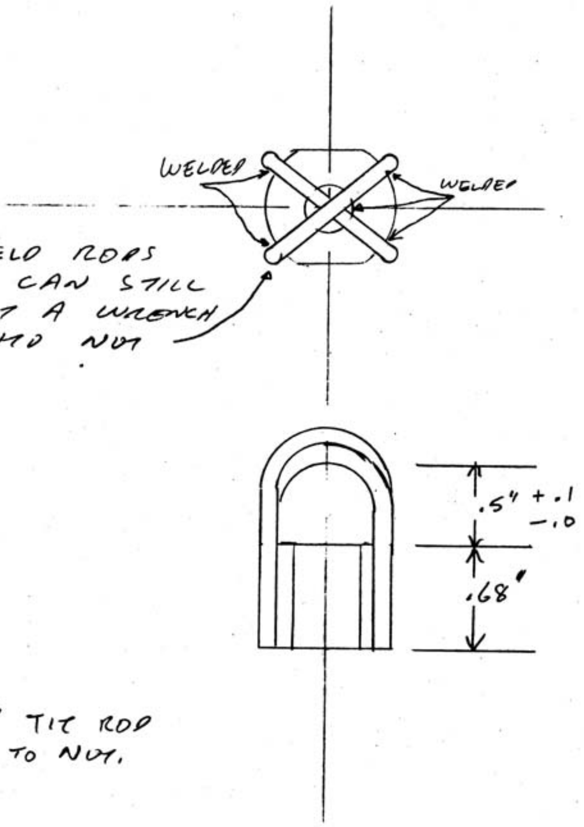
Hydrothermal vent resistivity probe: Machined components


1.0" OD
6Al4V Titanium 'cap'
?7/8" diam X 3/8" thick
MAKE AS NEEDED 3/8" THICK
Weld
Tapped for 1/2"-20
3/4"+ DEEP
1.5"
3/4"
3/8" ID
Drill out to insert 3/4" Ti tube (1/4" deep)
1.0" diam. 6Al4V Ti rod drilled out with 3/8" drill as long as possible ( ) 10"?
~~'O' Ring channel 0.075" deep x 0.~~10" wide
~~0.62" ID~~
1.0" diam. 6Al4V Ti rod with " bore and turned down to 3/4" od at one end ( )
7.0"
1/2" X 20 Thread
1.0"
1.0"
3/8" ID
0.50"
0.5"
3/8"
NO NEED
3/4"
" OD
5/16" " ID
SEE DETAIL DRAWINS
Modified Swage Lock fitting welded to Ti tube. (Pure Ti)
USE DIFF. TIP.
Welded into ~~milled~~ slot (?) in 5/8" ~~diam. resistivity~~ probe

~~2/3/03~~
~~P.O.K.~~

4/26/04
RJ

RES PROBE PROTECTOR



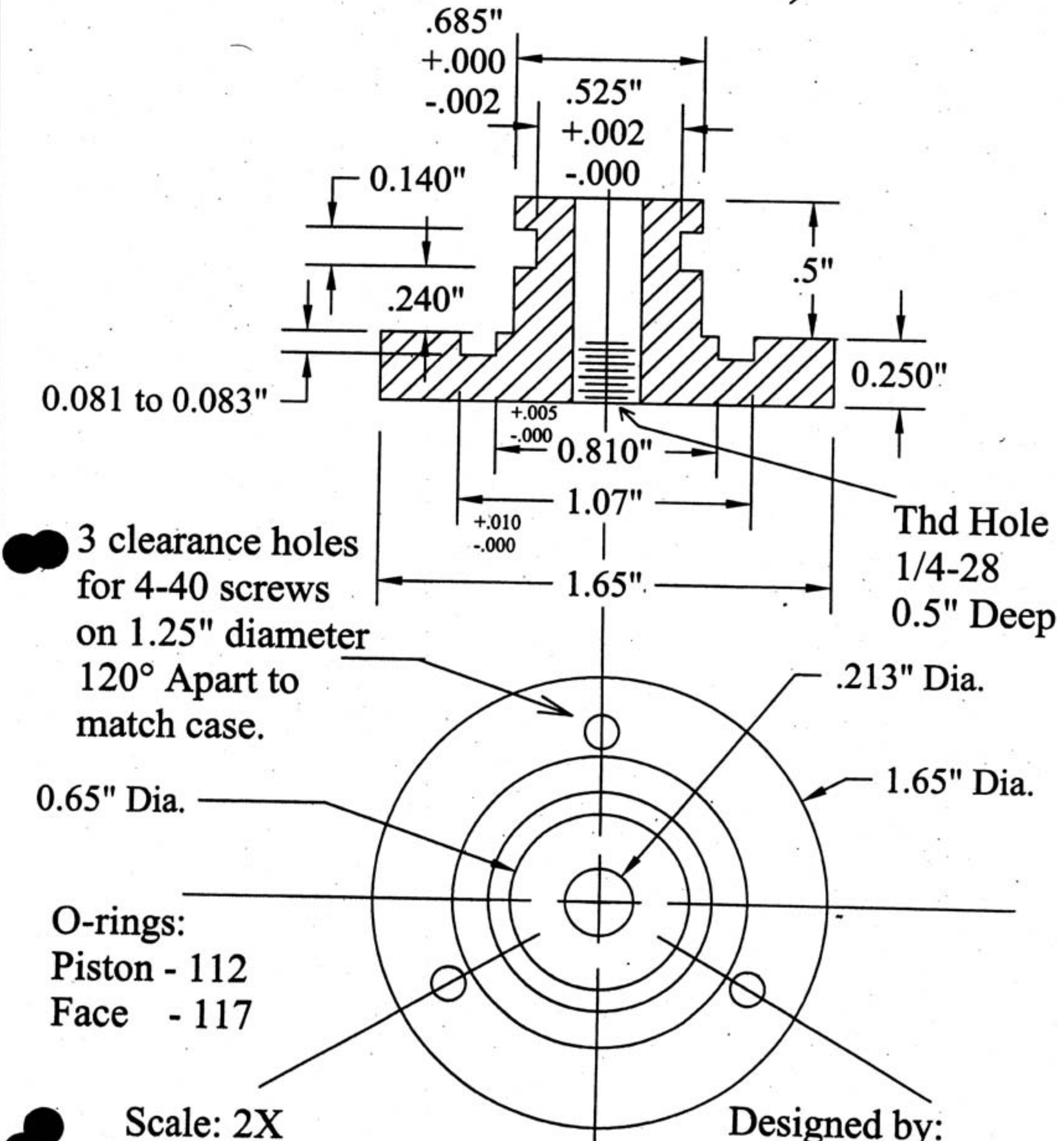
WELD RODS
SO CAN STILL
GET A WRENCH
ONTO NUT

USE 1/8" TIG ROD
& WELD TO NUT.

Rex Johnson
5/11/04

Hydrogen Sensor End Cap

(Connector End)



Thd Hole
1/4-28
0.5" Deep

3 clearance holes for 4-40 screws on 1.25" diameter 120° Apart to match case.

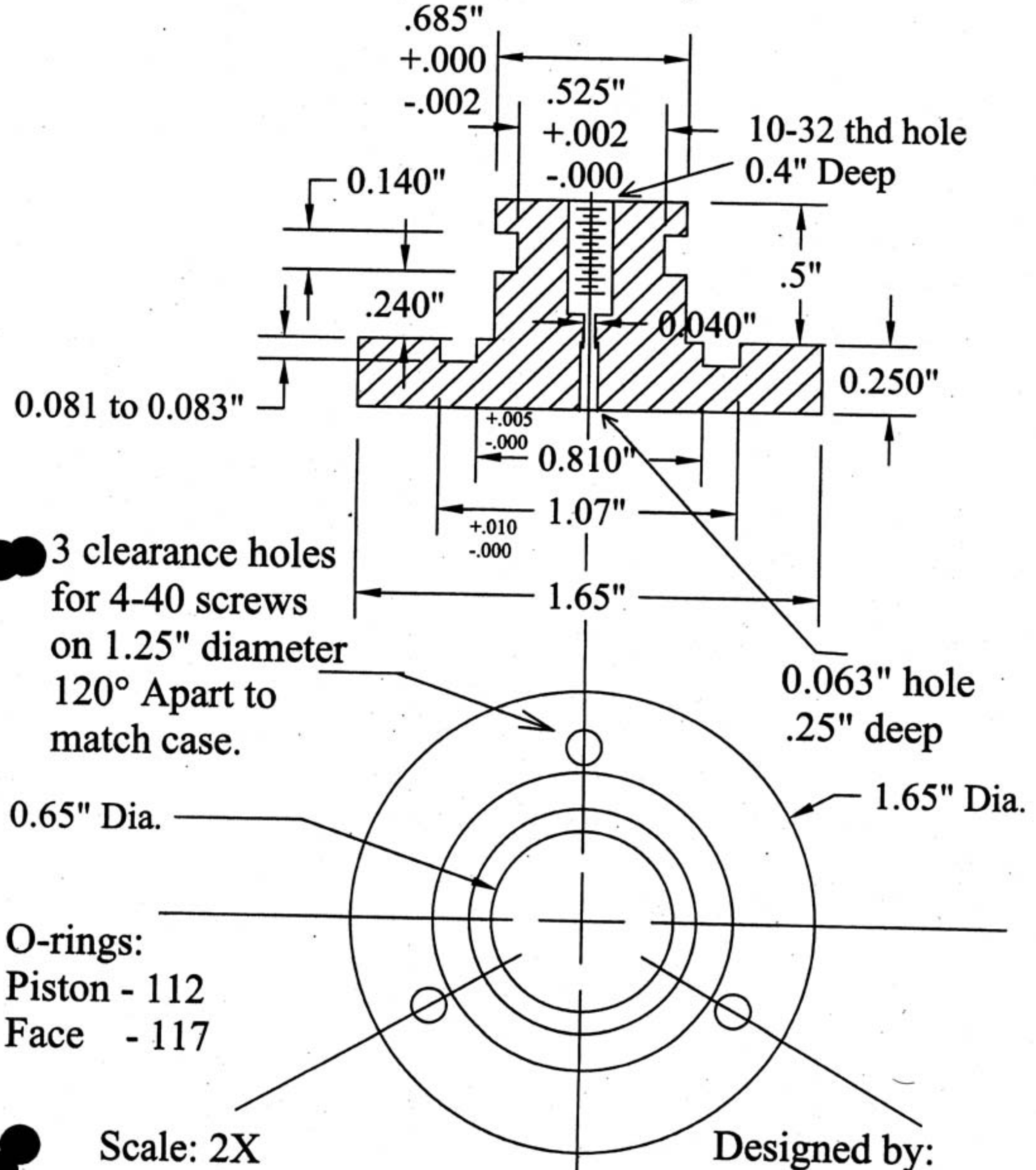
O-rings:
Piston - 112
Face - 117

Scale: 2X
Material: Grade 2 Titanium
All Dimensions - Inches
Both ends of case the same.

Designed by:
Rex Johnson
Engineering Services
July 28, 2004

Hydrogen Sensor End Cap

(Sensor End)

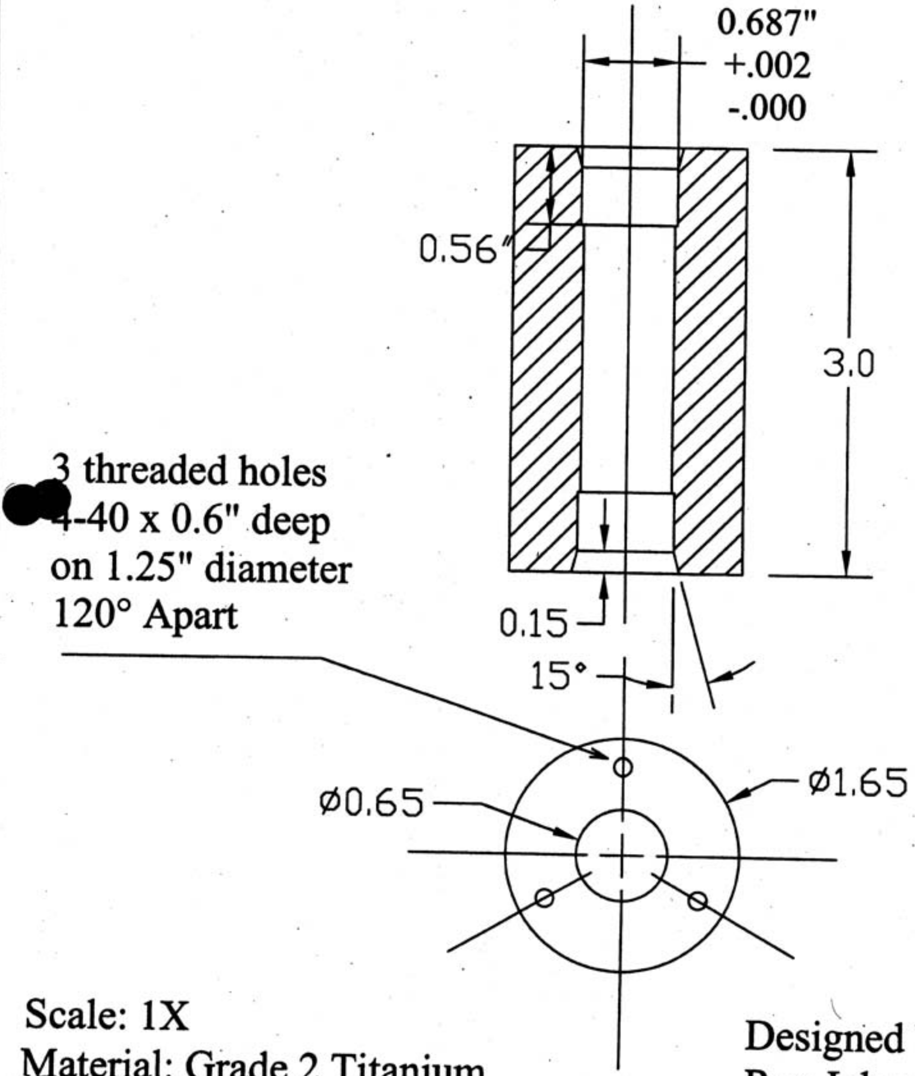


O-rings:
Piston - 112
Face - 117

Scale: 2X
Material: Grade 2 Titanium
All Dimensions - Inches
Both ends of case the same.

Designed by:
Rex Johnson
Engineering Services
July 28, 2004

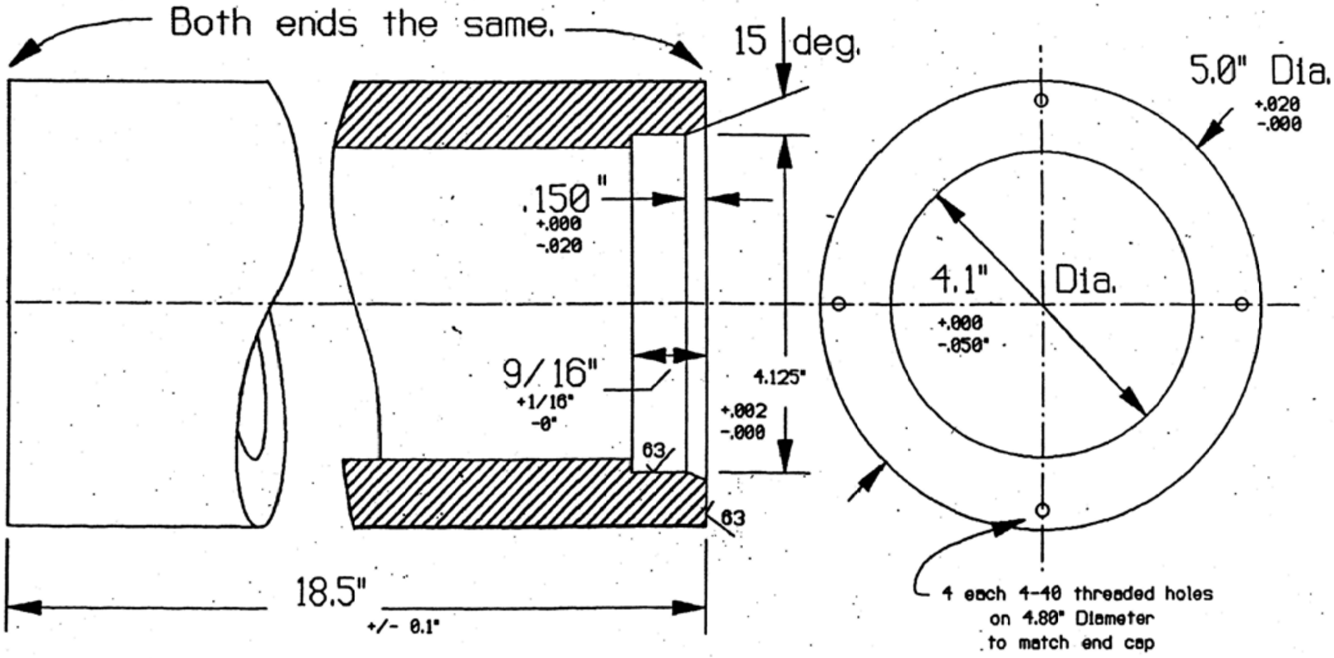
Hydrogen Sensor Case



Scale: 1X
Material: Grade 2 Titanium
All Dimensions - Inches
Both ends of case the same.
COLLAPSE 22732 PSI (50604 FT)

Designed by:
Rex Johnson
Engineering Services
March 19, 2004

Marv Lilley High PT Conductivity Pressure Case



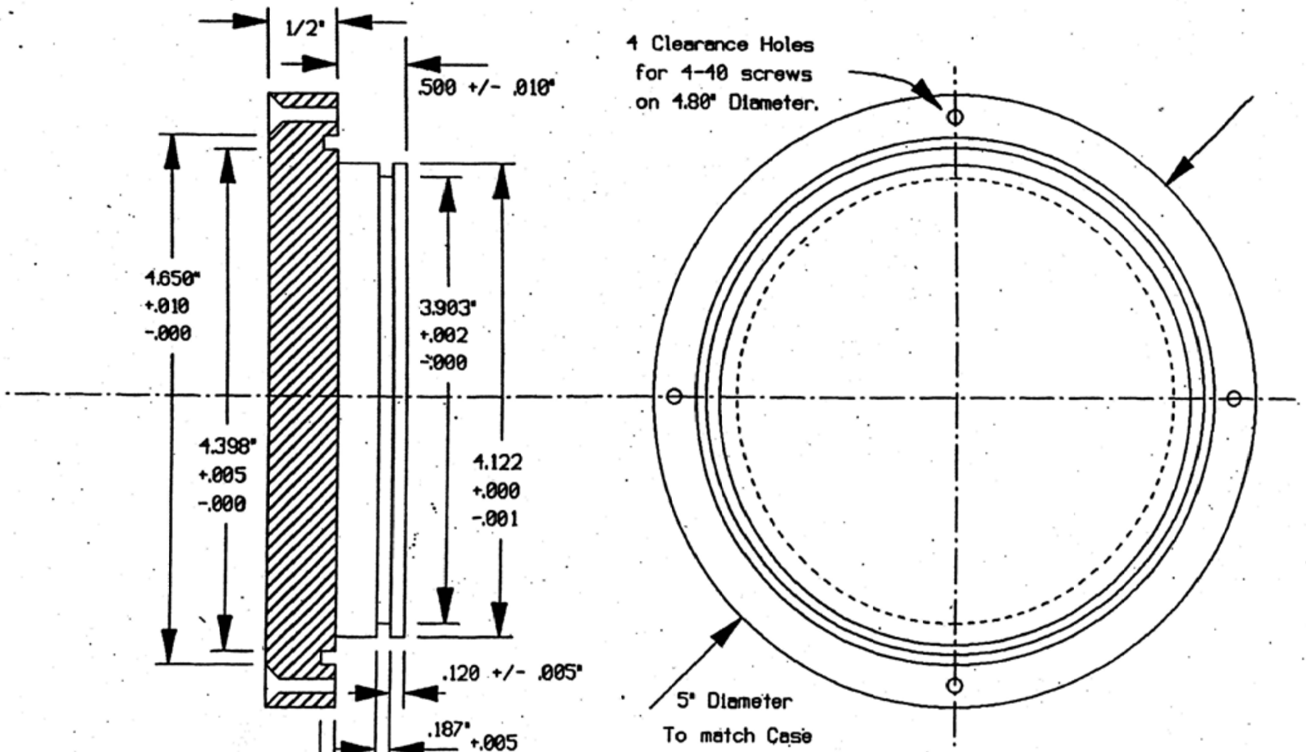
Material: 6AL-4V Titanium
Break all corners .005" Radius
Collapse Rating: 19656 PSI (43755 ft)

Weight in air: 23#
Weight in water: 7#

Drawing Name:
H-PTC-CS.FCD

Rex Johnson
Engineering Services
April 11, 1995

Marv Lilley High PT Conductivity End Cap



Material: 6AL-4V Titanium

Break all corners .005" R

All O-ring surfaces 63 finish

Drawing Name: H-PTC-EC.FCD

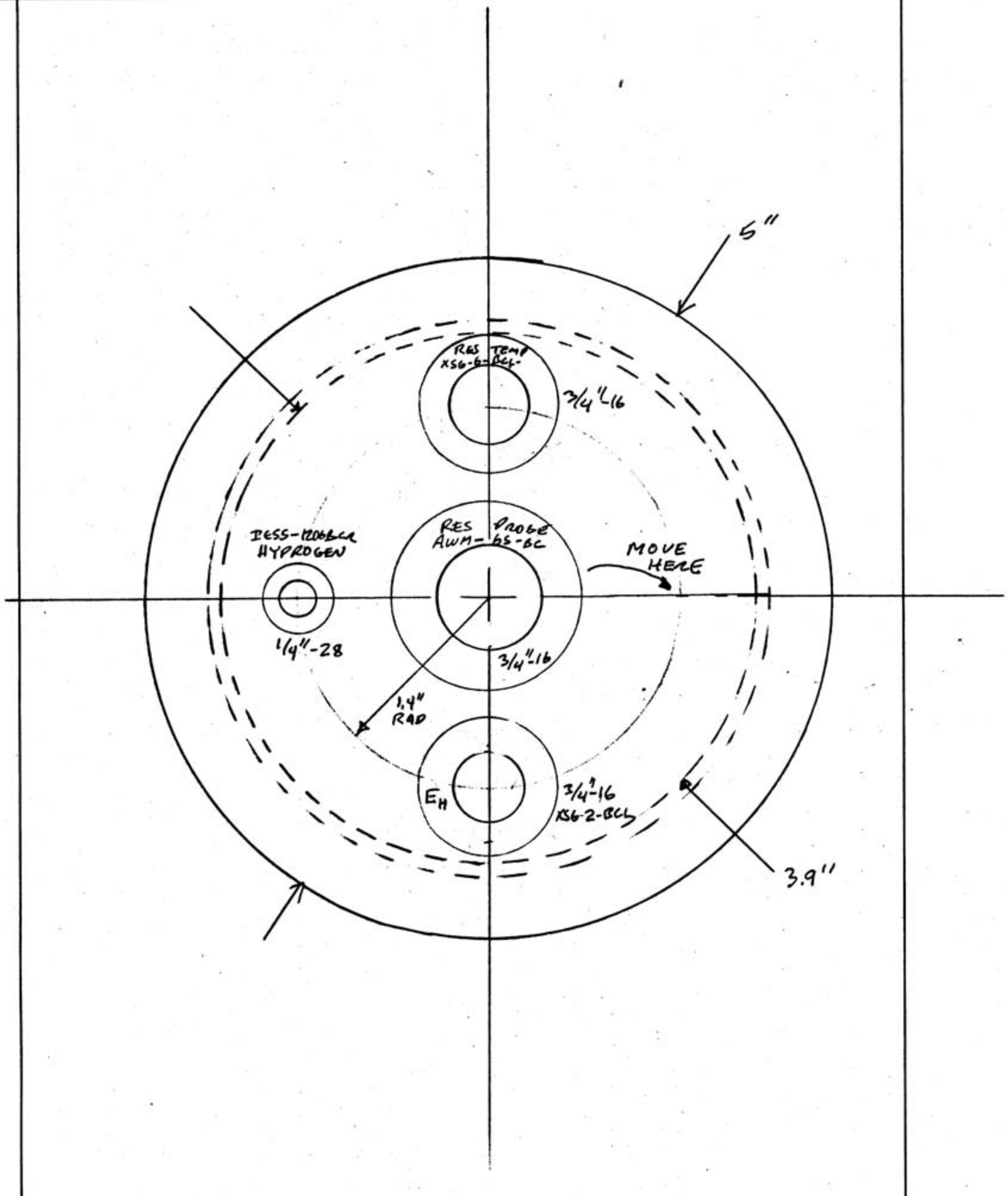
O-Rings:

Piston - 241

Face - 150 (stretched)

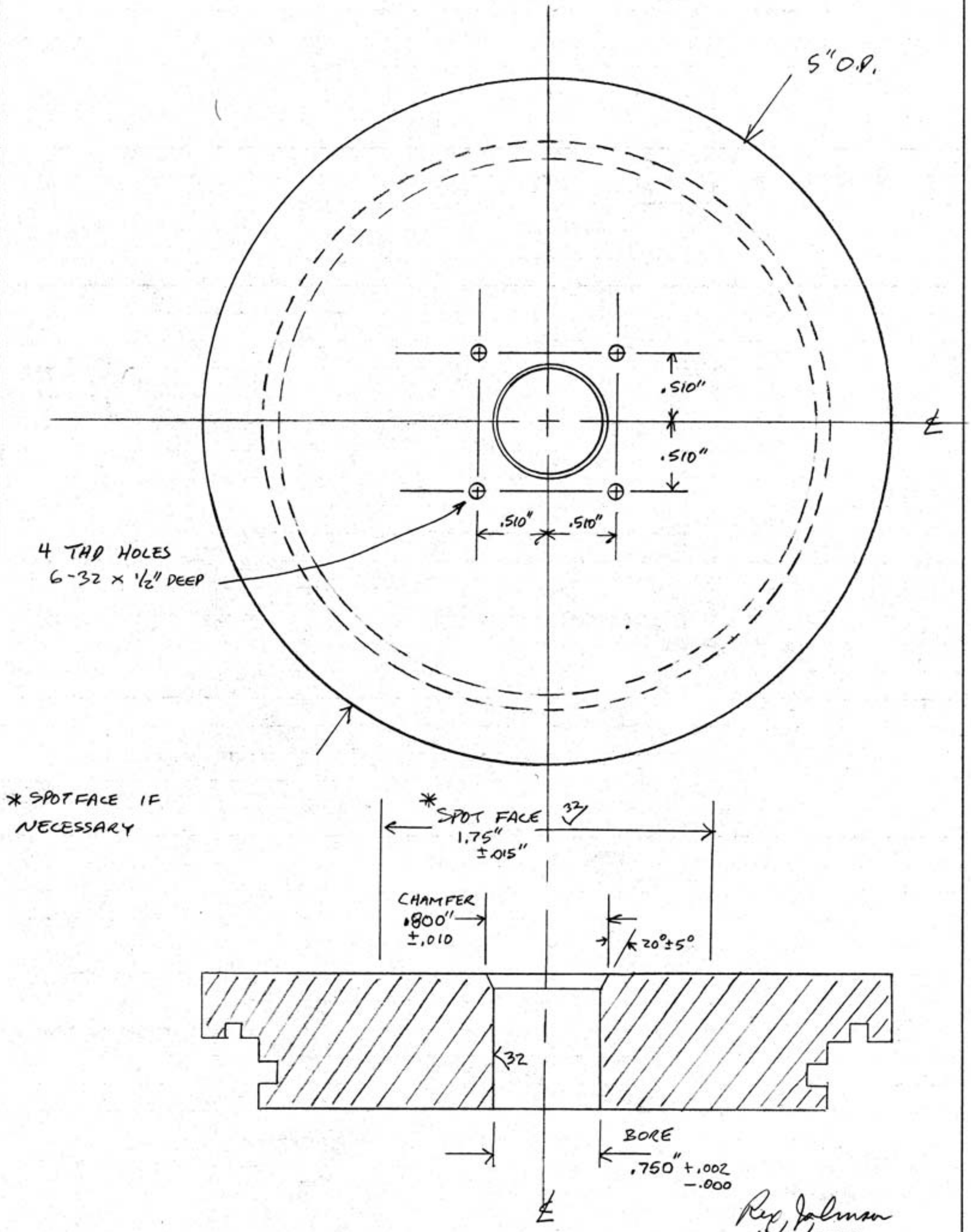
Rex Johnson
Engineering Services
April 11, 1995

RES-8 LOGGER ENDCAP



9/21/04

CANADIAN RES & COMM ENDCAP
DETAILS



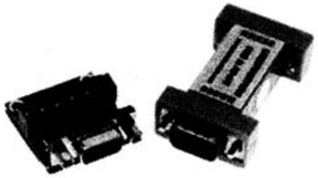
Rex Johnson
4/1/2010

Section 5

System Notes

USCONVERTERS.COM
CALIFORNIA. USA

RS232 to RS422 converter
Model RS422D9



This bi-directional RS232 to RS422 converter is port-powered with an optional external power supply terminal. An internal amplifier supplies power from the RS232 port without initializing the RS232 interface. If the RS232 port is not capable of supplying enough power, an external power supply can easily be connected to the converter. It supports 4-wire RS422 communications, which allows two peer participants to operate in full-duplex. The transmission rate of 300 - 115200bps can be applied to point-to-point and point-to-multipoint networks. A simple and reliable solution for most general and industrial communication needs. Header terminal board is included with each unit.

ISO 9001 RoHS CE FC

Overall features
- Port-powered, no external power supply required
- Plug and play, no drivers needed
- Static and surge protected
- Optional external power supply
- Handshake control not required, no flow control needed
- CE, FCC, RoHS ISO 9001 Certified
- Terminal board included with each unit

SPECIFICATIONS	
Model number	RS422D9
Baud rate	300 - 115200bps
Power	Port-powered from RS232 (RTS, DTR, TXD) Optional external power: 5 - 12VDC
Current consumption	< 10mA
Interface RS232	DB9 female connector
Interface RS422	DB9 male connector and terminal board
Working mode	4-wire RS422 asynchronous, full-duplex differential
Standards	EIA/TIA RS-232C / RS422
Transmission distance RS232	Typical: 15 FT (5m)
Transmission distance RS422	Typical: 4000 FT. (1200m)
Static protection	1500W
Surge protection	600W/ms
Operating Temp.	-40°F to 180°F (-40°C to 85°C)
Operating humidity	5% To 95% - No Condensation
Dimensions	2.47" x 1.33" x 0.70" (62.8 mm x 33.8 mm x 17.8 mm)
Warranty	5-year Limited Warranty