2007-2008 High Altitude Student Platform (HASP) Program

Payload Specification and Integration Plan

Distant Aerial Cosmic Radiation Acquisition Package

HASP Payload #8 – Small Payload Class

West Virginia University High Altitude Research Team
(WVU HART)

Team Members – Name / Major, Minor / Class / E-mail
Justin Ellis / Physics / Junior / jellis11@mix.wvu.edu
Mehran Mohebbi / Mechanical and Aerospace Engineering, Physics / Senior / mmohebbi@mix.wvu.edu
Kyle Phillips / Aerospace Engineering / Grad. 2 / kphilli1@mix.wvu.edu

Faculty Advisors – Name / E-mail / Phone
Dr. John Kuhlman / John.Kuhlman@mail.wvu.edu / 304-293-3111 ext. 2328
Dr. Mike Palmer / gmichaelpalmer@comcast.net / 304-293-3111

Point of Contact – Name / E-mail / Phone
Kyle Phillips / kphilli1@mix.wvu.edu / 330-219-7437

Submitted To:
Dr. T. Gregory Guzik
Department of Physics and Astronomy
Louisiana State University
Baton Rouge, Louisiana 70803-4001

Submitted By:
West Virginia University High Altitude Research Team
Department of Mechanical and Aerospace Engineering
West Virginia University
P.O. Box 6106
Morgantown, WV 26505-6106

Submission Date: June 6th, 2008 (i.e. 6-6-2008)

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Brief Introduction

The payload presented by the West Virginia University High Altitude Research Team (WVU HART) will attempt to measure cosmic radiation at varying altitude. Specifically, the WVU HART payload will primarily employ a scintillation detector, constructed by Saint-Gobain Crystals, coupled with a DP4 Digital Pulse Processor, a PC4-2 Power Supply Board, both from AMPTEK, and a control circuit board developed by Dr. Mike Palmer, faculty co-advisor for WVU HART. These components will allow the WVU HART payload to count the number of high-energy particles encountered by the payload, and classify those particles based on an energy spectrum generated by AMPTEK's DP4 circuit board. As the entire High Altitude Student Platform (HASP) payload, including WVU HART's payload, and that of several other universities and institutions, ascends through the Troposphere, the Tropopause, and to a final float altitude at approximately 36 kilometers (22.5 miles or 120,000 feet) in the Stratosphere (also known as the "Ozone Layer"), the WVU HART payload will continuously count and classify the energy levels of the cosmic radiation encountered. In addition, the WVU HART will be able to distinguish between the number of counts and the type of radiation during sunlight and darkness, as the entire HASP payload could be afloat for as long as 20 hours. Thus, the WVU HART payload will contribute to the study of fundamental Physics, high-energy particle Physics, and to the Aerospace industry, as cosmic radiation affects both the human body through genetic mutation, and the performance of various spacecraft hardware components. The five sections to follow will describe some of the technical aspects involved with WVU HART's payload, and how the WVU HART plans to integrate their payload with HASP's main payload.

I. Mechanical Specifications

As previously mentioned, the WVU HART's payload will include several electrical components to enable the detection of and energy level determination of cosmic radiation. These components will be protected by an aluminum frame, which is mounted to the HASP-provided PVC Mounting Plate and encased in Styrofoam®, for protection and thermal insulation. The electrical components will consist of a control and storage circuit board developed by Dr. Mike Palmer, faculty co-advisor to the WVU HART, an AMPTEK DP4 Digital Pulse Processor, and an AMPTEK PC4-2 power supply circuit board for the DP4 board. Furthermore, electrical sensors will consist of the Saint-Gobain scintillation detector, consisting of a 3" diameter, 3"

deep Sodium Iodide Thallium Activated (i.e. Na(Tl)) crystal and photomultiplier tube, as well as three temperature sensors, one mounted on the WVU HART circuit board, another mounted inside the Styrofoam® case near the top of the payload, and a third mounted on the exterior of the Styrofoam® case. Lastly, diagnostic LED indicators, and a GPS unit will be added to the payload, for the purposes of pre-flight diagnostics and post-flight data analysis, respectively. As with any payload that leaves the Earth's surface, weight is a major concern. The HASP program's concerns are no different. Table 1 reports the component-wise weights for each of the aforementioned components, and those that enable the successful operation of the WVU HART's payload. One may note that the weight of WVU HART's payload is within the allotted

Table 1: WVU HART Payload Weight Budget

Payload Item	Weight [g]	Brief Item Description / Notes
Specified Payload Mounting Plate:	552.00	PVC, including wiring / Provided by HASP
Insulation and Protection Case:	148.00	Protective Styrofoam Case
Fully Assembled Frame:	390.00	Aluminum Frame, including Plate Mounting Bolts
Scintillation Detector Protective Core:	60.00	Protective Styrofoam Core, including plastic
Scintillation Detector:	1788.00	Provided by Saint Gobain, including B14 Sockets
Amptek DP4 Circuit Board:	38.00	Provided by Amptek
Amptek PC4-2 Circuit Board:	20.00	Provided by Amptek
Palmer Circuit Board (estimated):	45.00	Designed by Dr. Mike Palmer
GPS (w/ Antenna and Cable):	27.00	Designed and Produced by Dr. Mike Palmer
RS232/TTL Converters (w/ Cables):	35.00	Electronic Components
Measured Total Weight (w/ Plate, w/o Misc.):	3103.00	Measured Weight with HASP PVC Mounting Plate
Measured Total Weight (w/o Plate, w/o Misc.):	2551.00	Measured Weight without HASP PVC Mounting Plate
Misc. Components (conservative estimate):	224.50	Includes weight of wiring, and yet-to-be-added components, like Temp. Sensors
Estimated Measured Weight (w/o Plate):	2775.50	Includes Miscellaneous Components
Maximum Allowable Weight:	3000.00	Maximum Small Payload Class Weight, as Specified by HASP
Weight Limit Check:	Good	Ensures Measured Total Weight Without Mounting Plate is Within HASP Limits

3 kg weight limit for the small payload class, neglecting the HASP-provided PVC mounting plate, as specified by LSU's "HASP – Student Payload Interface Manual."

Furthermore, space is limited on the individual HASP payloads, and those payloads need to accommodate the size allocated to them, based on the class of payload chosen. Since the WVU HART chose the small payload class, their payload must have a maximum footprint no larger than 15 cm x 15 cm (5.875 in x 5.875 in), as specified in the HASP – Student Payload Interface Manual. In addition, the WVU HART was designed for maximum internal frame space for proper operation and installation of components, and to allow for possible maintenance over the lifetime of the payload. The dimensions of the aluminum frame are specified in Figure 1, on the next page, depicting symmetrical side views and an overhead view. Additionally, on page 4, Figure 2 illustrates a cross-sectional view with pertinent dimensions of the WVU HART's payload, shown as if it were cut directly in half longitudinally. One may note that the symmetrical nature of the payload allows for one cross-sectional view. Also, note that the total

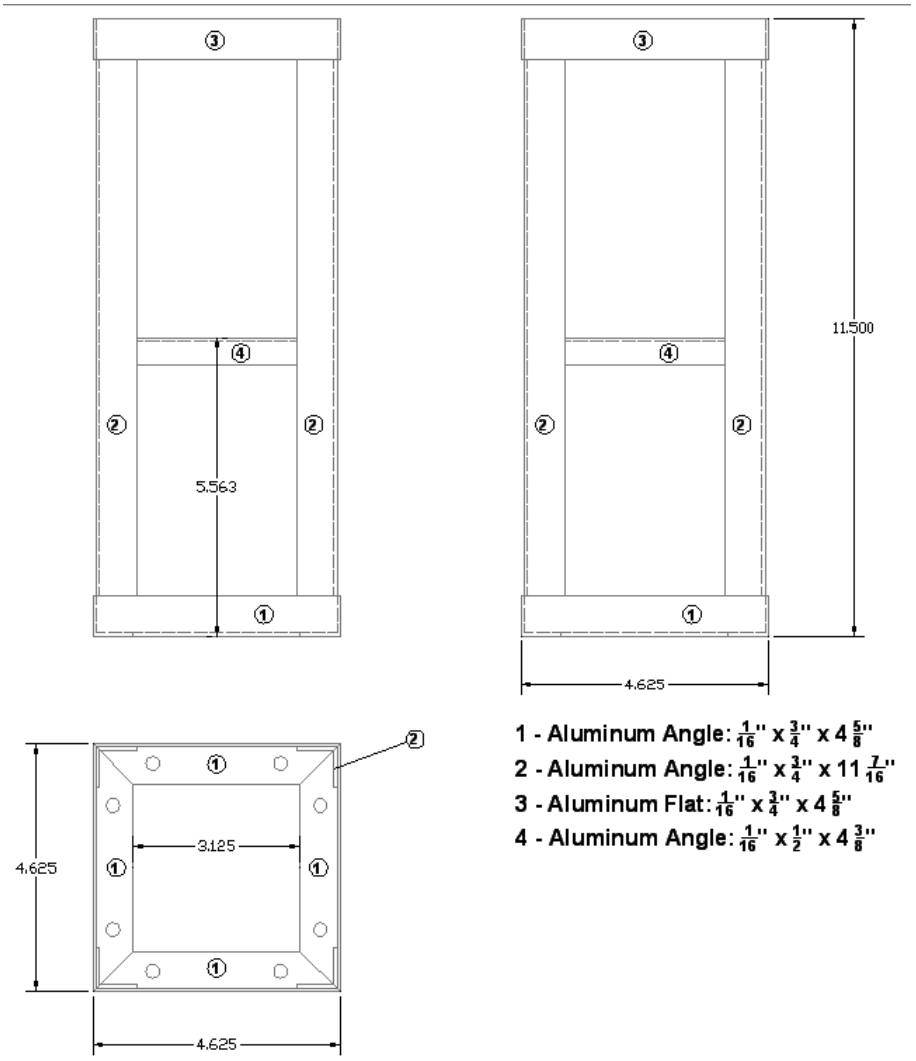

Figure 1: Symmetrical Side and Top-Down Views of WVU HART Payload Frame

base-width of the payload, including the Styrofoam® case, is no more than the allotted 5.875 in by 5.875 in footprint. The mechanical schematics for the WVU HART's payload may also be found in a larger view in Appendix A.

Furthermore, one may note from the mechanical schematics that eight ¼"-20 bolts will be used to secure the WVU HART payload to the HASP primary payload, at the location of payload 08. Assuming that the WVU HART's payload weighs the maximum allotted amount for a small class payload, 3 kg, at a 10 g vertical loading and a 5 g horizontal loading, the WVU HART payload would essentially "weigh" 294 N (i.e. 66.09 lb_f) and 147 N (i.e. 33.05 lb_f) in the vertical and horizontal directions, respectively. The mounting bolts to be used to connect the WVU HART's payload to the HASP-provided PVC mounting plate are ¼"-20 brass flat head bolts, which have head diameters of 0.477 in., yielding head areas of 0.1787 in^2. One may note that

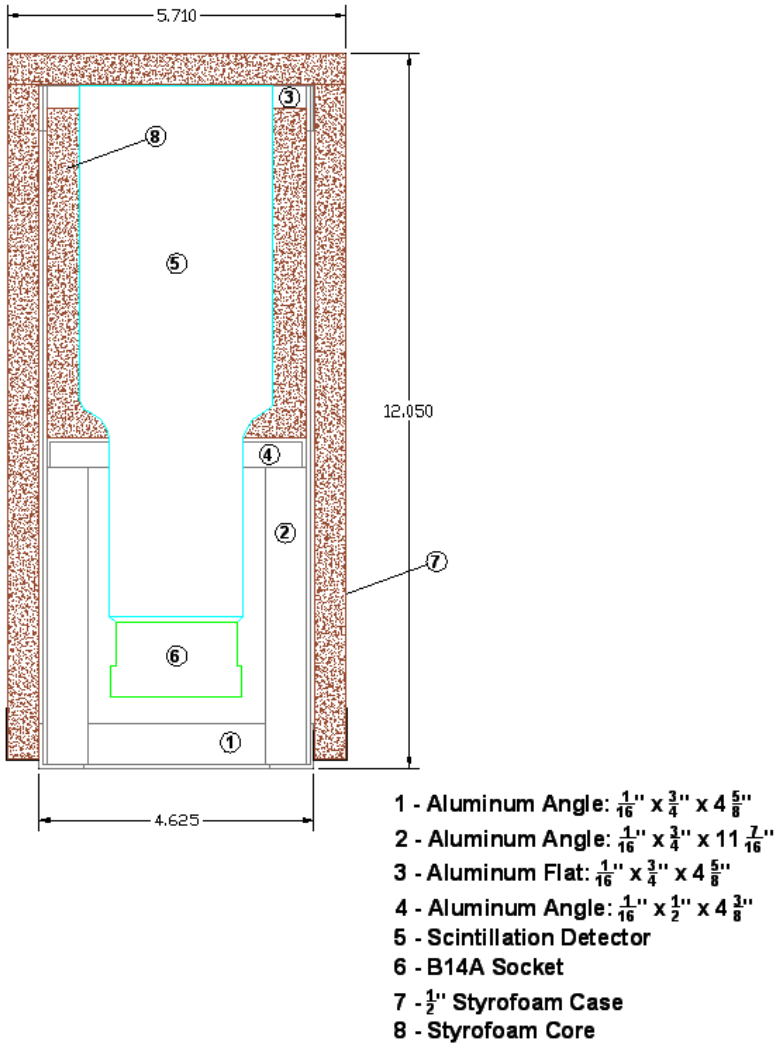

Figure 2: WVU HART Payload Longitudinal Cross-Section View

each bolt will carry pressures of 369.84 psi and 184.95 psi in the vertical and horizontal directions, under the 10 g and 5 g loading conditions, respectively. However, the minimum tensile strength of the mounting bolts is 53,000 psi, each, as provided by McMaster-Carr's website. Hence, factors of safety of 143 and 287 exist in the vertical and horizontal directions, respectively, easily supporting the WVU HART's payload under the HASP-specified loading conditions presented in the "Call for Payloads 2007-2008" document. Figure 3, on the next page, specifies the locations of the bolts that will mount the frame to the HASP-provided mounting plate.

Lastly, the WVU HART's payload will not contain any exotic, potentially hazardous materials. However, hazardous potentials still exist. The WVU HART's payload carries an inherent risk due to its vast abundance of electronics. Any time that electronics are active and

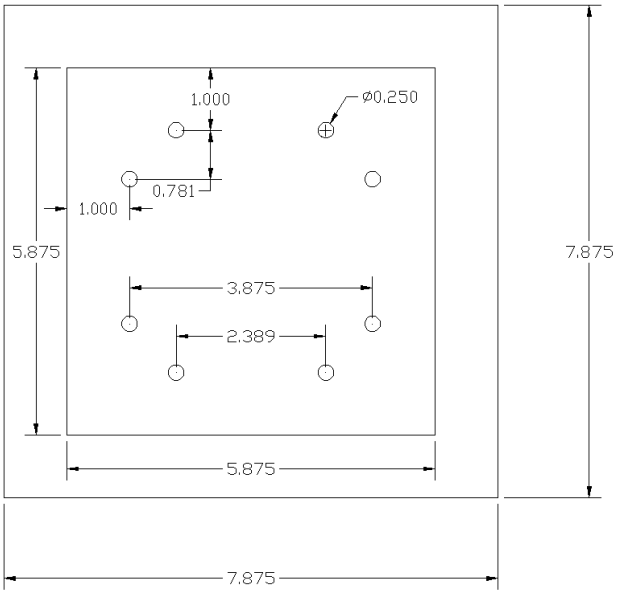

Figure 3: Payload 08 Modified HASP-Provided Mounting Plate

the power is on, there exists the risk of accidental electric shock or accidental electrocution. The highest voltage contained within the current electrical configuration nears 1250 VDC, an amount considered to be high voltage (i.e. voltage above 500 V), which is very hazardous to the human body. Thus, certain procedures must be followed when handling the WVU HART's payload. Whenever the Styrofoam® protective case is removed from the exterior of the payload, the power supplied to the electronics is to be turned off before the removal of the case. Furthermore, if the electronics are to be maintained or measured, precaution and common sense must be used abundantly. One may note that all of the electronics contained within WVU HART's payload will be properly grounded. Additionally, the Styrofoam® pieces, the MSDS of which may be found in Appendix B, were bonded with Loctite® Brand epoxies. Two different types of epoxies were used to construct this payload, specifically 5 Minute Instant Epoxy and 5 Minute Quick Set Epoxy, both MSDS's of which are included in Appendix B. Lastly, an MSDS in Appendix B is provided for the scintillation crystal, even though it will be permanently encased in an aluminum housing, within the Styrofoam® protective core. However, one may note that all of these hazards are relatively low-risk hazards, as long as the proper precautions are taken with the electronics.

II. Power Specifications

Despite the detailed mechanical construction of the WVU HART's payload, the primary operations of the WVU HART's payload, namely cosmic radiation detection, are carried out entirely by electronics, which have also been meticulously designed. As previously mentioned

in the "Brief Introduction," the electronics will be composed of a scintillation detector, three circuit boards, three temperature sensors, and a GPS. The measured current draw at 30 VDC is estimated to be 270 mA. Indeed, the primary HASP payload will be providing 28VDC to the WVU HART payload. A power system wiring diagram is provided in Figure 4. Several observations may be made from this diagram. First, two DC to DC converters convert the

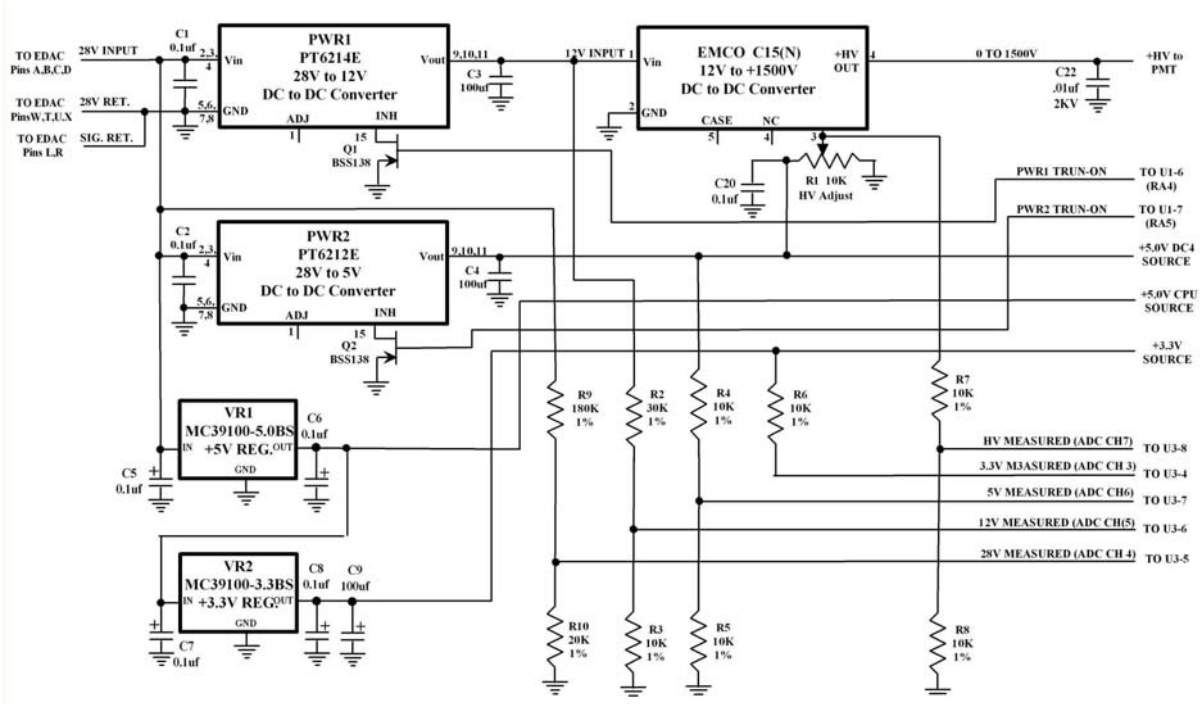

Figure 4: WVU HART Power Supply Diagram

28 VDC supplied by HASP to both 12 VDC and 5 VDC. The 12 VDC is then converted to 1500 VDC high-voltage that supplies the scintillation detector. The 5 VDC powers the AMPTEK DP4 Digital Pulse Processor. Furthermore, one may note the switches that accompany the DC to DC converters. These switches have been installed to limit the current transients encountered during startup of the electronic hardware, enabling a "slow, soft start" of the hardware. In addition, two positive regulators are used to supply a 3.3 V power source and a 5 V power source for the WVU HART circuit board, the wiring diagram of which is shown in Figure 5, on the next page. One may note from Figure 5 that a 12-bit, 8-channel analog to digital converter (ADC) is used to prepare both the measured voltage sources from the power supplies, and the temperature readings from the three temperature sensors, for processing by the CPU; specifically CPU1. The ADC also uses a reference voltage of 4.096 V, yielding 1 mV per ADC code. The CPU then processes this information, in addition to the GPS data. The AMPTEK DP4 processor processes

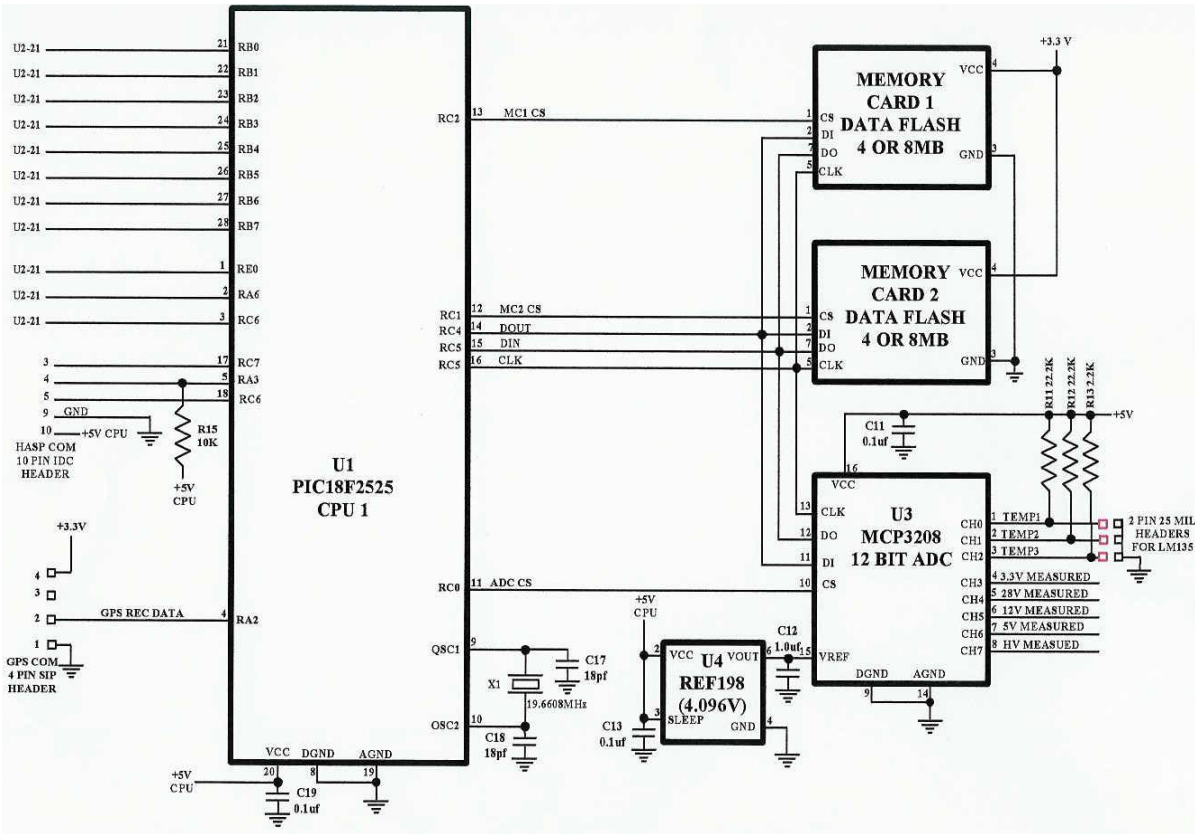

Figure 5: WVU HART Circuit Board CPU 1 Diagram

the data from the scintillation detector directly, and the second CPU, CPU2, on the WVU HART circuit board, the diagram of which is shown in Figure 6, processes the communication between the AMPTEK DP4 processor and CPU1, through a byte-wide parallel interface. The data from

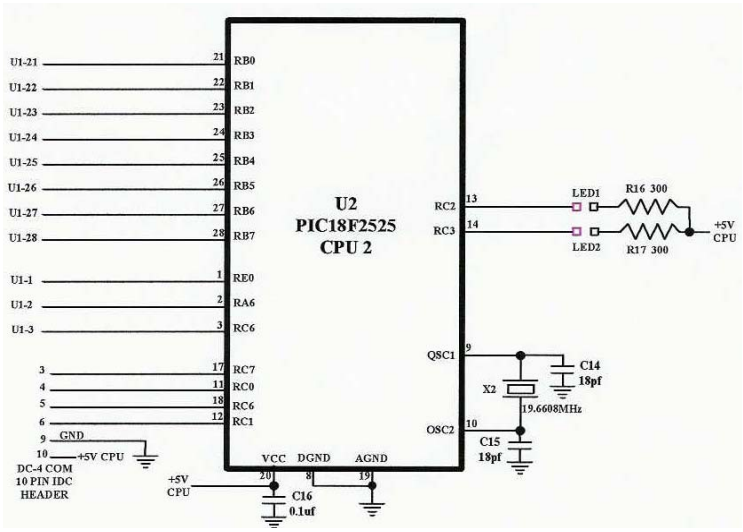

Figure 6: WVU HART Circuit Board CPU 2 Diagram

both of the processors is then stored on two memory cards, on the WVU HART circuit board. Moreover, in Figure 7 on the next page, a general electrical system overview illustrates the

interaction between the various electronic components within WVU HART's payload. The schematics for all of the circuitry may be viewed in larger form in Appendix C.

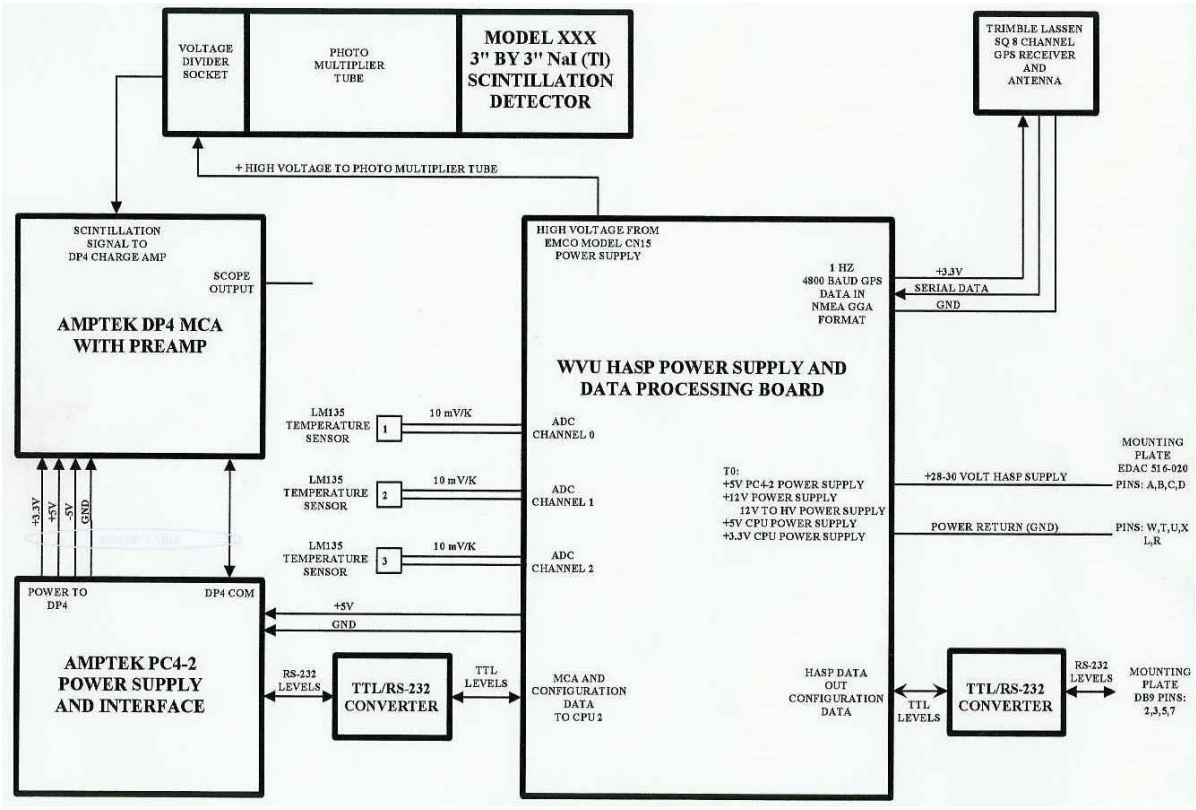

Figure 7: Electronic System Diagram of WVU HART's Payload

III. Downlink Telemetry Specifications

The WVU HART's payload will send a portion of the data stored on the memory cards to the primary HASP payload at regular 60-second intervals. The data will be sent via packetized serial downlink format at approximately 45.00 bits per second, and serve as a source of backup data that can be compared with the data stored on the WVU HART memory cards, during post-flight data analysis. The data being backed up will be comprised of the temperature sensor data, the voltage measurements throughout the circuitry, the GPS data, and the number of counts from the scintillation detector. Specifically, the first 16 bytes will represent the header, specifying the WVU HART payload data. The next 6 bytes will represent the readings from the three temperature sensors, which are allocated 2 bytes each. The next 10 bytes will represent the measured voltages within the circuitry, for 5 measurements in total at 2 bytes each. The next 80 bytes will represent the GPS data. The next 2 bytes will represent the number of counts by the scintillation detector for that time interval. The last 14 bytes will remain as supplementary space for yet-to-be-determined data, or as spare data space. In total, this yields 128 bytes, which will

be collected every 30 seconds and two of these packets will be sent every 60 seconds to the primary HASP payload. One may also note that the WVU HART payload has a GPS receiver operating at the standard civilian L1 band at 1575.42 MHz, but does not contain a transmitter. Instead, the WVU HART will store this data for post-flight data analysis purposes. The WVU HART will not be using any analog channels or discrete lines for downlink purposes.

IV. Uplink Commanding Specifications

The WVU HART will require an uplink command capability to reset its payload in the event of a power loss or malfunction, which requires a reset for the WVU HART's entire payload. However, a payload reset will only occur during unexpected, extraordinary events and during the HASP flight line restart procedure. The WVU HART does not expect to have to uplink any commands to the primary HASP payload. However, in the case of an unexpected event, a restart uplink command will be sent to the primary HASP payload, the specific commands of which are yet to be developed. As noted in the "Power Specifications" section, each restart will be a "soft, slow start," as managed by switches linked to the DC to DC converters. Lastly, as previously mentioned in the "Downlink Telemetry Specifications" section, a GPS receiver operating at the standard civilian L1 band, at 1575.42 MHz, will be used to collect GPS data for post-flight data analysis purposes.

V. Integration and Logistics

For a successful integration of WVU HART's payload with the primary HASP payload, proper logistics and systematic preparation is necessary. Primarily, the WVU HART must package and ship their payload from Morgantown, West Virginia to the National Aeronautics and Space Administration's (NASA's) Columbia Scientific Balloon Facility (CSBF) so that it arrives on or before Friday, August 1st, 2008 (i.e. 8-1-2008), and confirm the delivery of the payload to NASA's CSBF. Then, the WVU HART with its two faculty advisors, Dr. John Kuhlman and Dr. Mike Palmer, plan to arrive in Palestine, Texas the afternoon or evening of Sunday, August 3rd, 2008 (i.e. 8-3-2008), as general HASP integration begins on Monday, August 4th, 2008 (i.e. 8-4-2008).

On Monday, August 4th, the integration team leader, Kyle Phillips (e-mail: kphilli1@mix.wvu.edu), will commence final inspections, mechanically and electronically, on the WVU HART payload, with the help of the integration participants listed in Table 2. The

Table 2: WVU HART Integration Members

WVU HART Team Member	WVU HART Member's E-mail
Justin Ellis	jellis11@mix.wvu.edu
Mehran Mohebbi (Project Lead)	mmohebbi@mix.wvu.edu
Kyle Phillips (Integration Lead)	kphilli1@mix.wvu.edu
Dr. John Kuhlman (Faculty Advisor)	John.Kuhlman@mail.wvu.edu
Dr. Mike Palmer (Faculty Advisor)	gmichaelpalmer@comcast.net

final mechanical inspections will include, but not be limited to, checking bolt tightness, inspection of epoxy adhesives and the seals created by those adhesives, and overall structural support of all electronics. The final electrical inspections will include, but not be limited to performing, both hardware and software diagnostics. Hardware diagnostics may include such steps as the observation of startup current transients and the observation of voltage levels throughout the circuit boards, in addition to ensuring the current draw and power requirements are within limits. Software diagnostics may include such steps as running a typical radiation detection software simulation, without the use of a radiation source. During this simulation, all of the systems will function as if they were in a flight-ready status. The simulation will record test data and run the hardware in a simulated flight-ready status manner. This will allow the WVU HART to observe the operation of both the hardware and the software in a simulated flight mode. Any faults found in either the mechanical or the electrical inspections will be promptly and completely resolved, using any WVU HART materials and tools necessary. Additionally, the WVU HART requests use of NASA's CSBF Thermal and Vacuum Chamber to test for pressure and temperature levels, as well as electrical arching at altitude, a problem believed to have been encountered in last year's failures. Furthermore, the Thermal and Vacuum Chamber test will ensure the proper functioning of the payload at environmental conditions encountered throughout flight, testing the mechanical and electrical systems of the WVU HART's payload.

On Tuesday, August 5th, 2008 (i.e. 8-5-2008) the WVU HART is scheduled for their official integration with the primary HASP payload. The integration process will be very similar to the final inspections that are carried out on August 4th. First, the WVU HART will complete the mechanical integration with the primary HASP payload at its designated position (i.e. Payload 08), ironically on the "*starboard*" side of the HASP payload, as the WVU HART payload will inherently be studying *cosmic* radiation. The mounting of the payload will be inspected thoroughly to ensure a tight and secure mechanical integration. In addition, a quick mechanical inspection of the WVU HART's payload will include inspection of the electronic

mounting within the payload, an inspection of the frame, an inspection of the mounting between the frame and the HASP-supplied PVC mounting plate. After the electronic integration, an inspection of the final and secure position of the Styrofoam® protective and insulating case will be carried out, completing the mechanical integration of WVU HART's payload. Additionally, as previously alluded to, an electrical integration is also very necessary, as a connection must exist between the primary HASP payload and the WVU HART's payload. After a successful physical electrical integration, and after a proper inspection of the electrical connection between HASP and the WVU HART payload, the remainder of the electrical integration will also be similar to the electrical inspection performed on August 4th. However, a foremost electrical diagnostic that must be run is to ensure that there is proper communication between the WVU HART payload and the primary HASP payload. Once a successful connection between the two payloads has been fully established, a software simulation will be run, as was completed on August 4th. Once again, as completed on August 4th, after all hardware and software diagnostics have been run and found to run successfully, the integration of the WVU HART's payload will be considered to have been successfully integrated, at that time. The entire integration of the WVU HART's payload is expected to take no longer than a maximum of 5-7 hours. Again, any faults found in either the mechanical or the electrical inspections will be promptly and completely resolved using any WVU HART materials and tools necessary. The WVU HART does not expect that any LSU personnel, except those overlooking the integration process, or LSU equipment will be needed. However, small hand tools and technical advice may be needed, as unforeseen events could arise. Lastly, one may note that the WVU HART's HASP Flight Operation Plan will accompany the WVU HART to NASA's CSBF, and will be submitted at that time.

Appendix A

Mechanical Schematics

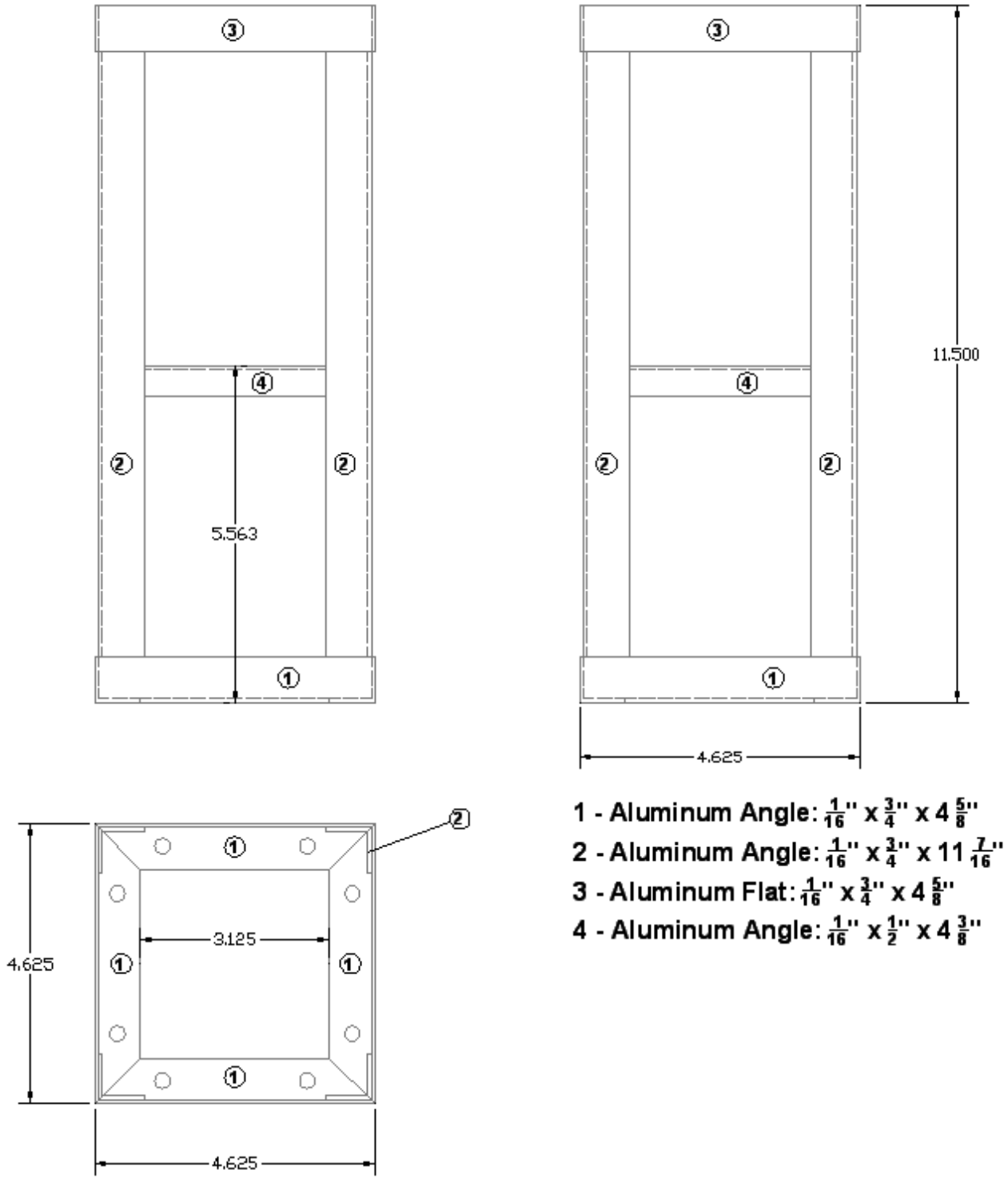

Figure A1: Symmetrical Side and Top-Down Views of WVU HART Payload Frame

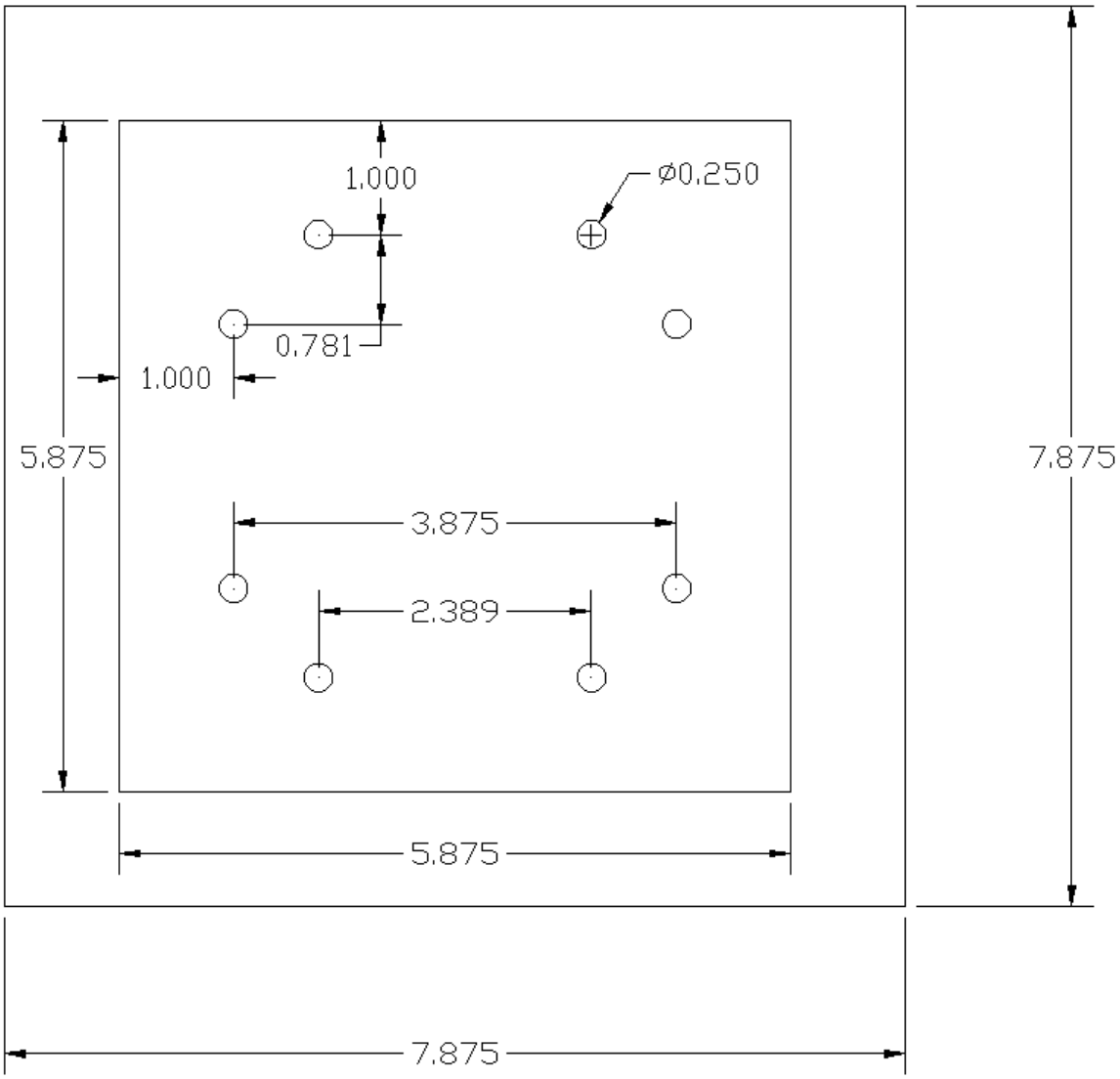

Figure A2: Payload 08 Modified HASP-Provided Mounting Plate

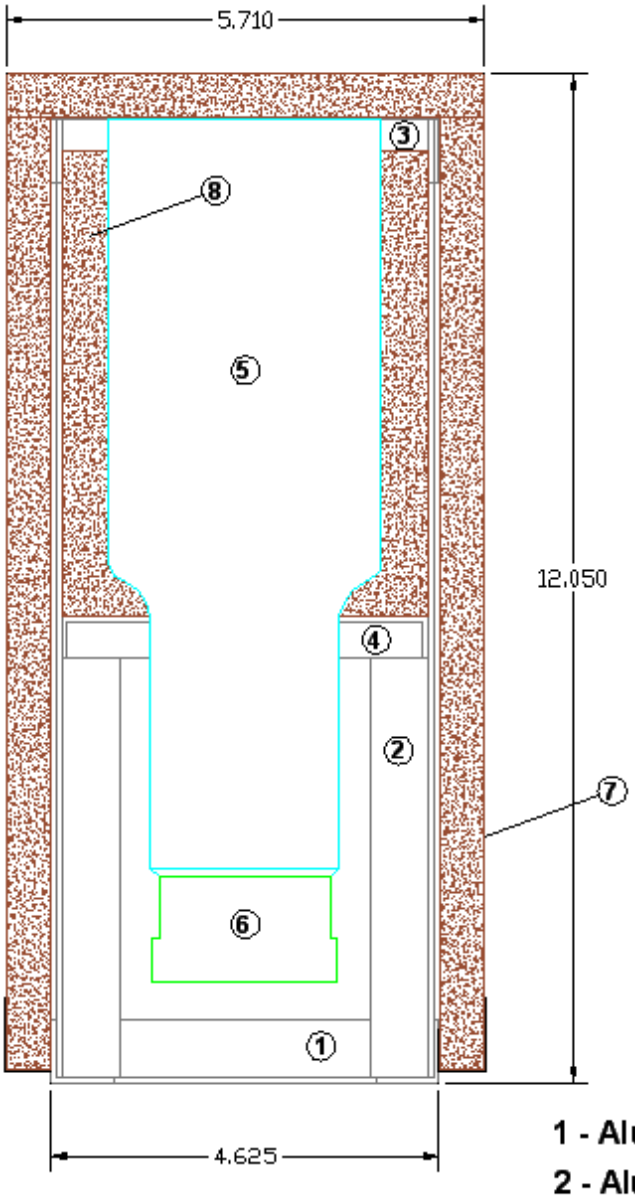

Figure A3: WVU HART Payload Longitudinal Cross-Section View

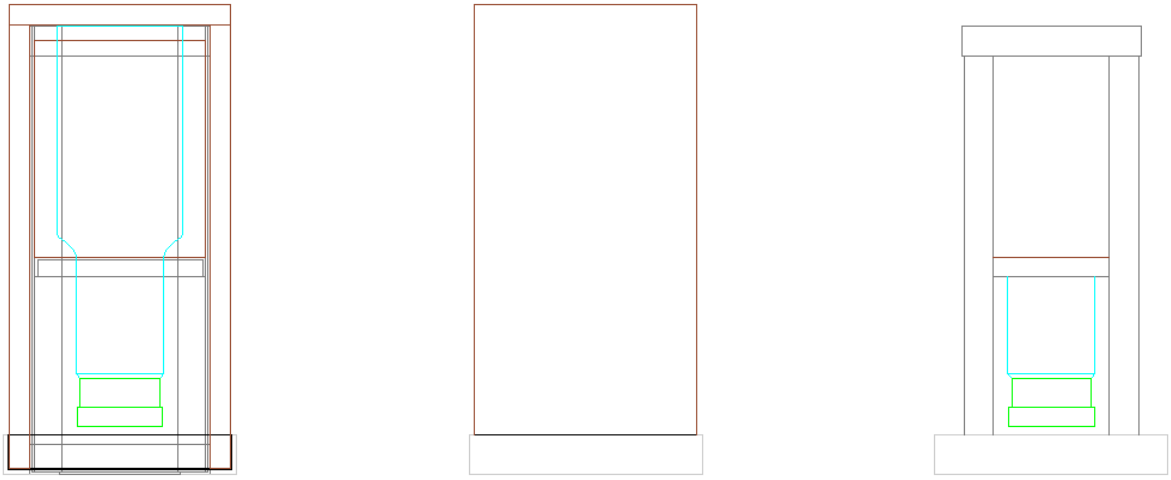

Figure A4: WVU HART Payload Wire Frame View
(L to R: Fully Assembled, Styrofoam Case, Payload Without Case)

Appendix B

MSDS Sheets

Styrofoam® MSDS (Reference: http://building.dow.com/styrofoam/na/res-us/products)

Material Safety Data Sheet
The Dow Chemical Company

Product Name: STYROFOAM* R3 Residential Foam Sheathing Insulation

Issue Date: 02/21/2007

Print Date: 22 Feb 2007

The Dow Chemical Company encourages and expects you to read and understand the entire (M)SDS, as there is important information throughout the document. We expect you to follow the precautions identified in this document unless your use conditions would necessitate other appropriate methods or actions.

1. Product and Company Identification

Product Name
STYROFOAM* R3 Residential Foam Sheathing Insulation

COMPANY IDENTIFICATION
The Dow Chemical Company
2030 Willard H. Dow Center
Midland, MI 48674
USA

Customer Information Number: 800-258-2436

EMERGENCY TELEPHONE NUMBER
24-Hour Emergency Contact: 989-636-4400
Local Emergency Contact: 989-636-4400

2. Hazards Identification

Emergency Overview
Color: Blue
Physical State: Board
Odor: Odorless
Hazards of product:

Toxic fumes may be released in fire situations.

OSHA Hazard Communication Standard
This product is not a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

Potential Health Effects
Eye Contact: Solid or dust may cause irritation or corneal injury due to mechanical action. Fumes/vapor released during thermal operations such as hot-wire cutting may cause eye irritation.
Skin Contact: Essentially nonirritating to skin. Mechanical injury only.
Skin Absorption: Skin absorption is unlikely due to physical properties.

Inhalation: Dust may cause irritation to upper respiratory tract (nose and throat). Fumes/vapors released during thermal operations such as hot wire cutting may cause respiratory irritation. Concentrations of the blowing agents anticipated incidental to proper handling are expected to be well below those which cause acute inhalation effects and below exposure guidelines.
Ingestion: Swallowing is unlikely because of the physical state. Very low toxicity if swallowed. Harmful effects not anticipated from swallowing small amounts. May cause choking or blockage of the digestive tract if swallowed.

3. Composition Information

Component	CAS #	Amount
Styrene, polymers	9003-53-6	> 85.0 %
1-Chloro-1,1-difluoroethane	75-68-3	< 10.0 %
Copolymer mixture	Not applicable	< 15.0 %
Talc	14807-96-6	< 5.0 %

Extruded polystyrene foam containing a halogenated flame retardant system.

4. First-aid measures

Eye Contact: Flush eyes with plenty of water; remove contact lenses after the first 1-2 minutes then continue flushing for several minutes. Only mechanical effects expected. If effects occur, consult a physician, preferably an ophthalmologist.
Skin Contact: Wash skin with plenty of water.
Inhalation: Move person to fresh air; if effects occur, consult a physician.
Ingestion: If swallowed, seek medical attention. May cause gastrointestinal blockage. Do not give laxatives. Do not induce vomiting unless directed to do so by medical personnel.
Notes to Physician: No specific antidote. Treatment of exposure should be directed at the control of symptoms and the clinical condition of the patient.

5. Fire Fighting Measures

Extinguishing Media: Water fog or fine spray. Dry chemical fire extinguishers. Carbon dioxide fire extinguishers. Foam.
Fire Fighting Procedures: Keep people away. Isolate fire and deny unnecessary entry. Soak thoroughly with water to cool and prevent re-ignition. If material is molten, do not apply direct water stream. Use fine water spray or foam. Cool surroundings with water to localize fire zone.
Special Protective Equipment for Firefighters: Wear positive-pressure self-contained breathing apparatus (SCBA) and protective fire fighting clothing (includes fire fighting helmet, coat, trousers, boots, and gloves). If protective equipment is not available or not used, fight fire from a protected location or safe distance.
Unusual Fire and Explosion Hazards: Mechanical cutting, grinding or sawing can cause formation of dusts. To reduce the potential for dust explosion, do not permit dust to accumulate. This product contains a flame retardant to inhibit accidental ignition from small fire sources. This plastic foam product is combustible and should be protected from flames and other high heat sources. For more information, contact Dow. Dense smoke is produced when product burns.
Hazardous Combustion Products: During a fire, smoke may contain the original material in addition to combustion products of varying composition which may be toxic and/or irritating. In smoldering or flaming conditions, carbon monoxide, carbon dioxide and carbon are generated. Combustion products may include and are not limited to: Hydrogen fluoride. Hydrogen chloride. Combustion products may include trace amounts of: Hydrogen bromide. Based on combustion toxicity testing, the effects of combustion from this foam are not more acutely toxic than the effects of combustion from common building materials such as wood.

6. Accidental Release Measures

Steps to be Taken if Material is Released or Spilled: Contain spilled material if possible. Sweep up. Collect in suitable and properly labeled containers. See Section 13, Disposal Considerations, for additional information.
Personal Precautions: There are no special required instructions.
Environmental Precautions: There are no special required instructions.

7. Handling and Storage

Handling

General Handling: This product is combustible and may constitute a fire hazard if improperly used or installed. When installed, this product should be adequately protected as directed by national building regulations or instructions in the specific application brochure. Fabrication methods which involve cutting into this product may release the blowing agent(s) remaining in the cells. Provide adequate ventilation to assure localized concentrations in release areas are maintained below the lower flammable limit. See Section 8, EXPOSURE CONTROLS AND PERSONAL PROTECTION.

Storage

Minimize sources of ignition, such as static build-up, heat, spark or flame. When large quantities of this product are stored or fabricated, blowing agents may be released. Released blowing agents may thermally decompose to form gases which may accelerate corrosion or rust formation of heaters, boilers, gas fired recirculating air furnaces or heaters, or gas water heaters. Flammable vapors may accumulate in some storage situations. In order to prevent buildup of combustible vapors, do not store large quantities of this product in unventilated spaces.

8. Exposure Controls / Personal Protection

Exposure Limits

Component	List	Type	Value
1-Chloro-1,1-difluoroethane	WEEL	TWA	4,100 mg/m3 1,000 ppm

Concentrations of the blowing agents anticipated incidental to proper handling are expected to be well below those which cause acute inhalation effects and below exposure guidelines.

Personal Protection

Eye/Face Protection: Eye protection should not be necessary. For fabrication operations safety glasses are recommended. If there is a potential for exposure to particles which could cause eye discomfort, wear chemical goggles.
Skin Protection: No precautions other than clean body-covering clothing should be needed.
Hand protection: Chemical protective gloves should not be needed when handling this material. Consistent with general hygienic practice for any material, skin contact should be minimized. Use gloves to protect from mechanical injury. Selection of gloves will depend on the task.
Respiratory Protection: Atmospheric levels should be maintained below the exposure guideline. When respiratory protection is required for certain operations, including but not limited to saw, router or hot-wire cutting, use an approved air-purifying respirator. The following should be effective types of air-purifying respirators: Organic vapor cartridge with a particulate pre-filter.
Ingestion: No precautions necessary due to the physical properties of the material.

Engineering Controls

Ventilation: Provide general and/or local exhaust ventilation to control airborne levels below the exposure guidelines.

9. Physical and Chemical Properties

Physical State	Board
Color	Blue
Odor	Odorless
Flash Point - Closed Cup	Not applicable
Flammable Limits In Air	**Lower**: Not applicable **Upper**: Not applicable
Autoignition Temperature	354 °C (669 °F) *ASTM D1929*
Vapor Pressure	Not applicable
Boiling Point (760 mmHg)	Not applicable.
Vapor Density (air = 1)	Not applicable
Specific Gravity (H2O = 1)	0.027 - 0.064 *Estimated*
Liquid Density	Not applicable
Freezing Point	Not applicable
Melting Point	90 - 130 °C (194 - 266 °F) *Estimated*
Solubility in Water (by weight)	insoluble in water
pH	Not applicable
Kinematic Viscosity	Not applicable

10. Stability and Reactivity

Stability/Instability
Thermally stable at typical use temperatures.
Conditions to Avoid: Avoid temperatures above 300°C (572°F) Exposure to elevated temperatures can cause product to decompose. Avoid direct sunlight.

Incompatible Materials: Avoid contact with oxidizing materials. Avoid contact with: Aldehydes. Amines. Esters. Liquid fuels. Organic solvents.

Hazardous Polymerization
Will not occur.

Thermal Decomposition
Does not normally decompose. Evolution of small amounts of hydrogen halides occur when heated over 250°C (482°F). Decomposition products depend upon temperature, air supply and the presence of other materials. Decomposition products can include and are not limited to: Aromatic compounds. Aldehydes. Ethylbenzene. Hydrogen bromide. Hydrogen fluoride. Polymer fragments. Styrene. Under high heat, non-flaming conditions, small amounts of aromatic hydrocarbons such as styrene and ethylbenzene are generated.

11. Toxicological Information

Repeated Dose Toxicity
Based on available data, repeated exposures are not anticipated to cause significant adverse effects. Additives are encapsulated in the product and are not expected to be released under normal processing conditions or foreseeable emergency.

12. Ecological Information

CHEMICAL FATE

Movement & Partitioning

No bioconcentration is expected because of the relatively high molecular weight (MW greater than 1000). In the terrestrial environment, material is expected to remain in the soil. In the aquatic environment, material is expected to float.

Persistence and Degradability

Surface photodegradation is expected with exposure to sunlight. No appreciable biodegradation is expected. Chlorodifluoroethane (HCFC-142b) remains in the foam and diffuses out slowly, most of it degrading in the troposphere to CO2, HCl, and HF. Chlorodifluoroethane (HCFC 142b) has a stratospheric ozone depletion potential (ODP) of 0.065, relative to CFC 12 (ODP=1).

ECOTOXICITY

Not expected to be acutely toxic to aquatic organisms.

13. Disposal Considerations

DO NOT DUMP INTO ANY SEWERS, ON THE GROUND, OR INTO ANY BODY OF WATER. All disposal practices must be in compliance with all Federal, State/Provincial and local laws and regulations. Regulations may vary in different locations. Waste characterizations and compliance with applicable laws are the responsibility solely of the waste generator. DOW HAS NO CONTROL OVER THE MANAGEMENT PRACTICES OR MANUFACTURING PROCESSES OF PARTIES HANDLING OR USING THIS MATERIAL. THE INFORMATION PRESENTED HERE PERTAINS ONLY TO THE PRODUCT AS SHIPPED IN ITS INTENDED CONDITION AS DESCRIBED IN MSDS SECTION: Composition Information. FOR UNUSED & UNCONTAMINATED PRODUCT, the preferred options include sending to a licensed, permitted: Recycler. Reclaimer. Landfill. Incinerator or other thermal destruction device. As a service to its customers, Dow can provide names of information resources to help identify waste management companies and other facilities which recycle, reprocess or manage chemicals or plastics, and that manage used drums. Telephone Dow's Customer Information Group at 1-800-258-2436 or 1-989-832-1556 (U.S.), or 1-800-331-6451 (Canada) for further details.

14. Transport Information

DOT Non-Bulk

NOT REGULATED

DOT Bulk

NOT REGULATED

IMDG

NOT REGULATED

ICAO/IATA

NOT REGULATED

This information is not intended to convey all specific regulatory or operational requirements/information relating to this product. Additional transportation system information can be obtained through an authorized sales or customer service representative. It is the responsibility of the transporting organization to follow all applicable laws, regulations and rules relating to the transportation of the material.

15. Regulatory Information

OSHA Hazard Communication Standard

This product is not a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

Superfund Amendments and Reauthorization Act of 1986 Title III (Emergency Planning and Community Right-to-Know Act of 1986) Sections 311 and 312

Immediate (Acute) Health Hazard	No
Delayed (Chronic) Health Hazard	No
Fire Hazard	No
Reactive Hazard	No
Sudden Release of Pressure Hazard	No

Superfund Amendments and Reauthorization Act of 1986 Title III (Emergency Planning and Community Right-to-Know Act of 1986) Section 313

This product contains the following substances which are subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and which are listed in 40 CFR 372.

Component	CAS #	Amount
1-Chloro-1,1-difluoroethane	75-68-3	<= 10.0 %

Pennsylvania (Worker and Community Right-To-Know Act): Pennsylvania Hazardous Substances List and/or Pennsylvania Environmental Hazardous Substance List:

The following product components are cited in the Pennsylvania Hazardous Substance List and/or the Pennsylvania Environmental Substance List, and are present at levels which require reporting.

Component	CAS #	Amount
1-Chloro-1,1-difluoroethane	75-68-3	<= 10.0 %
Talc	14807-96-6	< 5.0 %

Pennsylvania (Worker and Community Right-To-Know Act): Pennsylvania Special Hazardous Substances List:

To the best of our knowledge, this product does not contain chemicals at levels which require reporting under this statute.

California Proposition 65 (Safe Drinking Water and Toxic Enforcement Act of 1986)

This product contains no listed substances known to the State of California to cause cancer, birth defects or other reproductive harm, at levels which would require a warning under the statute.

Toxic Substances Control Act (TSCA)

All components of this product are on the TSCA Inventory or are exempt from TSCA Inventory requirements under 40 CFR 720.30

CEPA - Domestic Substances List (DSL)

All substances contained in this product are listed on the Canadian Domestic Substances List (DSL) or are not required to be listed.

16. Other Information

Hazard Rating System

NFPA	Health	Fire	Reactivity
	0	1	0

Recommended Uses and Restrictions

Thermal insulation. For industrial use. Dow recommends that you use this product in a manner consistent with the listed use. If your intended use is not consistent with Dow's stated use, please contact Dow's Customer Information Group.

Revision

Identification Number: 81892 / 0000 / Issue Date 02/21/2007 / Version: 2.0
Most recent revision(s) are noted by the bold, double bars in left-hand margin throughout this document.

Legend

N/A	Not available
W/W	Weight/Weight
OEL	Occupational Exposure Limit
STEL	Short Term Exposure Limit
TWA	Time Weighted Average
ACGIH	American Conference of Governmental Industrial Hygienists, Inc.
DOW IHG	Dow Industrial Hygiene Guideline
WEEL	Workplace Environmental Exposure Level
HAZ_DES	Hazard Designation
Action Level	A value set by OSHA that is lower than the PEL which will trigger the need for activities such as exposure monitoring and medical surveillance if exceeded.

Epoxy MSDS (Reference: http://www.henkelcamsds.com/product.asp)

HENKEL CONSUMER ADHESIVES 03/20/07
AVON, OH 44011
TELEPHONE: (440) 937-7000

MATERIAL SAFETY DATA SHEET Page 01 of 04

Loctite Quick Set 5 minute Epoxy Instant Mix
01-06924

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: Loctite Quick Set 5 minute Epoxy Instant Mix
Item No.: 01-06924
Product Type: Epoxy

2. COMPOSITION, INFORMATION ON INGREDIENTS

Ingredients	CAS No.	%
RESIN		
Bisphenol A epoxy resin	25068-38-6	60-100
HARDENER		
Mercaptan termninated polymer	Proprietary*	60-100
*New Jersey trade secret registry number	33611900-5145KP	
Modified Amine	52338-87-1	0-20

3. HAZARDS IDENTIFICATION

Toxicity: Causes eye and skin irritation.
May cause sensitization by skin contact.
May cause respiratory tract irritation.

Primary Routes of Entry: Ingestion, skin, inhalation, eye contact
Signs and Symptoms of Exposure: Eye or skin irritation or injury. Allergic responses such as sensitization or dermatitis.
Existing Conditions Aggravated by Exposure: Skin disorders. Skin allergies. Respiratory disorders. Eye disorders. Asthma

4. FIRST AID MEASURES

Ingestion: Do not induce vomiting. Keep individual calm. Obtain medical attention.
Inhalation: Remove to fresh air. If symptoms persist, obtain medical attention.
Skin Contact: Wash immediately with soap and water. Do not use solvents for cleaning skin. If irritation should develop, consult physician.
Eye Contact: Flush with plenty of water for 20 minutes and get prompt medical attention. Washing within one minute is essential to achieve maximum effectiveness.

Product Name: Loctite Quick Set 5 minute Epoxy Instant Mix
Item No.: 01-06924

5. FIRE FIGHTING MEASURES

Flash Point: > 150°C (302°F) Method: Tag Closed Cup

Recommended Extinguishing Agents: Water spray (fog) Carbon dioxide, foam, dry chemical

Special Firefighting Procedures: Wear self-contained breathing apparatus and full protective clothing, such as turn-out gear. Toxic gases may be released during fire.

Hazardous Products formed by Fire or Thermal Decomp: phenolics, carbon monoxide, carbon dioxide, oxides of sulphur and nitrogen.

Unusual Fire or Explosion Hazards: The smoke may contain polymer fragments of varying compositions.

Explosive Limits:
(% by volume in air) Lower Not available
(% by volume in air) Upper Not available

6. ACCIDENTAL RELEASE MEASURES

Steps to be taken in case of spill or leak: Wear appropriate personal protective equipment. Wipe up or absorb on suitable material and shovel up. Prevent entry into sewers and waterways. Avoid contact with skin, eyes or clothing.

7. HANDLING AND STORAGE

Handling: Ensure good ventilation during processing. Do not breathe mist or vapors. Keep container closed. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling.

Storage: Store between 35 and 120°F. Store in original container until rea to use. Keep in a cool, well-ventilated area away.

8. EXPOSURE CONTROLS, PERSONAL PROTECTION

Eyes: Safety glasses or goggles.

Skin: Rubber gloves. Immediately remove all contaminated clothing.

Ventilation: For the product at ambient temperature, use adequate ventilation. For the heated product, use exhaust ventilation to remove vapor.

Respiratory: No respiratory protection should be needed.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical state:	Viscous liquid
Appearance:	Hardener: clear liquid Resin: colourless to pale yellow
Odor:	Hardener: unpleasant/epoxy Resin: mild
Boiling Point:	> 500°F (resin)
pH:	6-7 (resin); 3-5 (hardener)
Solubility in Water:	Hardener:dispersable in water Resin: negligible(in water)
Specific Gravity	Resin 1.18 , Hardener 1.1
Vapor Pressure:	< 0.13 @ 356°F (kPa), resin
Viscosity (@86°F):	Resin: 6000-8000 cps, Hardener: 10000-15000 cps

10. STABILITY AND REACTIVITY

Stability:	Stable at normal temperature and pressure.
Hazardous Polymerization:	Will not occur
Incompatibility:	Strong oxidizers, acids, Halogonated compounds. Strong mineral acids. Reactive materials. Calcium hypocholrite. Sodium hypochlorite. Nitrous acid and other nitrosating agents.
Conditions to Avoid:	This product is normally stable and is not reactive with water Excessive heat. Storage with incompatible materials.

11. TOXICOLOGICAL INFORMATION

Toxicity (resin): >5,000 mg/kg (LD50 - Rat)
(hardener): >2,000 mg/kg (LD50 - Rat)

Irritating to skin and eyes.

12. ECOLOGICAL INFORMATION

Ecological toxicity:
Large quantities of product should not be allowed to enter drains or water courses or be deposited where it can affect ground or surface water.
Degradability (resin):
Theoretical oxygen demand (ThoD)is calculated to be 2.35p/p. In the atmospheric environment, material is estimated to have a tropospheric half life of 1.92 hr.

13. DISPOSAL CONSIDERATIONS

Recommended methods of disposal:	Dispose of in accordance with federal, state and local regulations.

Product Name: Loctite Quick Set 5 minute Epoxy Instant Mix
Item No.: 01-06924

14. TRANSPORTATION INFORMATION

DOT (49 CFR 172) Domestic Ground Transport
Proper Shipping Name: Not regulated for transport

IATA
Proper Shipping Name: Not regulated for transport

IMO/IMDG
Proper Shipping Name: Not regulated for transport

15. REGULATORY INFORMATION

CA Proposition 65: No Prop65 chemicals are known to be present.

16. OTHER INFORMATION

TSCA 8(b) Inventory Status: All components are listed or are exempt from listing on the Toxic Substances Control Act Inventory.
TSCA 12 (b) Export Notification: None

CERCLA/SARA Section 302 EHS: None above reporting de minimus.
CERCLA/SARA Section 311/312: None.
CERCLA/SARA Section 313: None above reporting de minimus.

Estimated HMIS(R) Code:

Health Hazard:	1
Flammability Hazard:	1
Reactivity Hazards:	0
Personal Protection:	See Section 8.

HMIS is a registered trademark of the National Paint and Coatings Assn.

Prepared by:
Company: Henkel Consumer Adhesive
Regulatory Affairs (440) 937-7000

Quick Set(TM) Epoxy Hardener

HARDENER

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: Quick Set(TM) Epoxy Hardener
Part No.: QM-50
Product Type: Epoxy hardener

2. COMPOSITION, INFORMATION ON INGREDIENTS

Ingredients	CAS No.	%
Polymercaptan	Proprietary	80-85
Substituted aminophenol	90-72-2	5-10
Nonylphenol	25154-52-3	3-5
Heptakis (dipropyleneglycol) triphosphite	116265-68-0	1-3

Ingredients which have exposure limits

Exposure Limits (TWA) Ingredients	ACGIH (TLV)	OSHA (PEL)	OTHER

Exposure Limits (STEL) Ingredients	ACGIH (TLV)	OSHA (PEL)

3. HAZARDS IDENTIFICATION

Toxicity: Skin and eye irritant. Possible respiratory irritant. The aminophenol can cause severe irritation and may be corrosive on prolonged contact. It may be a sensitizer. It can also be corrosive to eye tissue leading to permanent injury including blindness. It may irritate the respiratory tract and may cause delayed lung damage upon overexposure to fumes or vapors. It can also cause fatigue, muscular weakness, labored breathing, or gastrointestinal irritation if swallowed. The relatively low concentration of the aminophenol in the product may minimize some or all of these effects.

Primary Routes of Entry: Skin, ingestion, inhalation.

Signs and Symptoms of Exposure: Eye, skin, respiratory, or gastrointestinal irritation. It is possible that such irritation may be severe and lead to burns. Allergic

3. HAZARDS IDENTIFICATION (continued)

reactions may occur.

Existing Conditions
Aggravated by Exposure: Skin, eye, lung conditions.

Ingredients	Literature Referenced Target Organ and Other Health Effects	Carcinogen NTP	IARC	OSHA
Polymercaptan	No Data	NO	NO	NO
Substituted aminophenol	ALG IRR	NO	NO	NO
Nonylphenol	ALG COR IRR KID	NO	NO	NO
Heptakis (dipropyleneglycol) triphosphite	No Data	NO	NO	NO

Abbreviations

ALG Allergen
IRR Irritant
COR Corrosive
KID Kidney

4. FIRST AID MEASURES

Ingestion: Do not induce vomiting. Keep individual calm. Obtain medical attention.
Inhalation: Remove to fresh air. If symptoms persist, obtain medical attention.
Skin Contact: Wash with soap and water.
Eye Contact: Flush at least 15 minutes with water. Obtain medical attention.

5. FIRE FIGHTING MEASURES

Flash Point: More than 200øF Method: Tag Closed Cup
Recommended Extinguishing Agents: Carbon dioxide, foam, dry chemical
Special Firefighting Procedures: Not available
Hazardous Products formed by Fire or Thermal Decomp: Oxides of carbon, sulfur, nitrogen and phosphorus, phosphite/phosphate esters, hydrocarbon fragments, hydrogen sulfide, phenols, phosphine.
Unusual Fire or Explosion Hazards: None

Explosive Limits:
(% by volume in air)Lower Not available
(% by volume in air)Upper Not available

Product Name: Quick Set(TM) Epoxy Hardener

6. ACCIDENTAL RELEASE MEASURES

Steps to be taken in case of spill or leak:	Take up with an inert absorbent. Store in a closed container until disposal.

7. HANDLING AND STORAGE

Safe Storage:	Store below 110øF.
(Contact Loctite Customer	Service 1-800-243-4874 for shelf life information)
Handling:	Avoid skin contact. Keep away from eyes. Do not breathe vapors.

8. EXPOSURE CONTROLS, PERSONAL PROTECTION

Eyes:	Safety glasses or goggles.
Skin:	Rubber or plastic gloves.
Ventilation:	Local exhaust ventilation should be provided.
Respiratory	NIOSH/MSHA approved organic cartridge respirator if ventilation is inadequate.
	See Section 2 for Exposure Limits.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance:	Colorless, viscous liquid.
Odor:	Unpleasant
Boiling Point:	More than 300øF
pH:	Does not apply
Solubility in Water:	Slight
Specific Gravity	1.08
Volatile Organic Compound (EPA Method 24)	11.08%; 119.7 grams per liter
Vapor Pressure:	Less than 5mm at 80øF
Vapor Density:	Not available
Evaporation Rate (Ether = 1)	Not available

10. STABILITY AND REACTIVITY

Stability:	Stable
Hazardous Polymerization:	Will not occur
Incompatibility:	Strong oxidizing agents, epoxy/amine mixtures. Possibly acids, peroxides, acetaldehyde, caustics.
Conditions to Avoid:	Not available
Hazardous Decomposition Products (non-thermal):	None

Product Name: Quick Set(TM) Epoxy Hardener

11. TOXICOLOGICAL INFORMATION

See Section 3.

12. ECOLOGICAL INFORMATION

No data available

13. DISPOSAL CONSIDERATIONS

Recommended methods of disposal:	Incinerate following EPA and local regulations.
EPA Hazardous Waste Number	NH - Not a RCRA Hazardous Waste Material

14. TRANSPORTATION INFORMATION

DOT (49 CFR 172)
Domestic Ground Transport

Proper Shipping Name:	Unrestricted
Hazard Class or Division:	Unrestricted
Identification Number:	None
Marine Pollutant:	None

IATA

Proper Shipping Name:	Unrestricted
Class or Division:	Unrestricted
UN or ID Number:	None

15. REGULATORY INFORMATION

CA Proposition 65: No Californis Proposition 65 chemicals are known to be present.

16. OTHER INFORMATION

Estimated NFPA(R) Code:

Health Hazard:	2
Fire Hazard:	1
Reactivity Hazard:	0
Specific Hazard:	Does not apply

Estimated HMIS(R) Code:

Health Hazard:	2*
Flammability Hazard:	1
Reactivity Hazards:	0
Personal Protection:	See Section 8.

NFPA is a registered trademark of the National Fire Protection Assn.
HMIS is a registered trademark of the National Paint and Coatings Assn.

16. OTHER INFORMATION (continued)

Prepared by:
Company: Regulatory Affairs - North America,
Henkel Consumer Adhesives Inc. 32150 Just Imagine Dr, Avon OH 44011
(24hr.) Phone: (800) 321-1733

Sodium Iodide Thallium Activated NA(Tl) Crystal MSDS Sheet
(Reference: http://www.detectors.saint-gobain.com/home.asp)

March 2007

MATERIAL SAFETY DATA SHEET

PRODUCT: SODIUM IODIDE (TL) SCINTILLATION CRYSTAL

SECTION I SUPPLIER INFORMATION

Common Name	: Sodium Iodide (Tl) Scintillation Crystal
Chemical Name	: Sodium Iodide Thallium Activated
Formula	: NaI/Tl
Product CAS #	: 7681-82-5/7790-30-9
Supplier	: Saint-Gobain Crystals
Address	: 12345 Kinsman Road
City, State, Zip	: Newbury, OH 44065
Phone	: 440-564-2251

EMERGENCY PHONE #: ChemTrec 1-800-424-9300

SECTION II HAZARDOUS INGREDIENT INFORMATION

INGREDIENT	% Wt.	PEL-OSHA	TLV-ACGIH
Thallium Iodide (as Tl) CAS #: 7790-30-9	< 1	0.1 mg/m^3 SKIN	0.1 mg/m^3 SKIN
Sodium Iodide CAS #: 7681-82-5	99-100	None established	None established

INGREDIENT HAZARD STATEMENT

NOTE: Due to formed nature of this product, no airborne concentrations are expected.
May cause eye and skin irritation.
Harmful if swallowed.

Unless otherwise noted, all values are reported as 8-hour Time-Weighted Averages (TWAs) and total dust (particulates only). All ACGIH TLVs refer to the 2006 Standards.

SECTION III PHYSICAL/CHEMICAL CHARACTERISTICS

Boiling Point	: 1300°C
Specific Gravity (H_2O=1)	: 3.7
Melting Point	: 661°C
Vapor Pressure (mm Hg)	: Not applicable
Vapor Density (Air=1)	: Not applicable
Evaporation Rate (Butyl Acetate=1)	: Not applicable
% Solubility/Water	: Soluble

APPEARANCE AND ODOR

Light yellow solid; odorless.

SECTION IV FIRE AND EXPLOSION HAZARD DATA

Flash Point : Not available
Auto-Ignition : Not available
LEL : Not available
UEL : Not available

NFPA HAZARD CLASSIFICATION

Health: 1 Flammable: 0 Reactivity: 0

HMIS HAZARD CLASSIFICATION

Health: 1 Flammable: 0 Reactivity: 0

EXTINGUISHING MEDIA

Use water, carbon dioxide or foam.

SPECIAL FIRE FIGHTING PROCEDURES

Wear positive-pressure self-contained breathing apparatus.

UNUSUAL FIRE AND EXPLOSION PROCEDURES

Not a fire or explosion hazard. However, toxic emissions are possible in a fire situation.

SECTION V REACTIVITY DATA

Stability : : Generally considered stable.
Avoid : None expected.

INCOMPATIBILITY (Materials to Avoid)

Bromine trifluoride, perchloric acid.

HAZARDOUS DECOMPOSITION OR BY-PRODUCTS

When heated to decomposition, emits toxic fumes of iodine.

Polymerization : Polymerization is not expected to occur.
Avoid : Not applicable.

SECTION VI HEALTH HAZARD DATA

ROUTES OF ENTRY

Eyes? YES Skin? YES Inhalation? YES Ingestion? YES

EFFECTS OF OVEREXPOSURE

EYE CONTACT may cause irritation.

SKIN CONTACT may cause irritation and allergic reaction.

INHALATION may cause delayed toxic effects if exposure is repeated to prolonged.

INGESTION is harmful. May cause irritation and/or systemic toxicity may occur.

NOTE: Although THALLIUM overexposure can result in neurological disturbances, kidney dysfunction, joint pain and alopecia, the small amount in this solid solution is not expected to represent a health hazard unless large amounts of crystals were ingested or large amounts of dust/fume were inhaled.

CARCINOGENICITY

NTP? NO IARC? NO OSHA? NO

CHRONIC HEALTH HAZARDS

None known.

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE

None known.

EMERGENCY AND FIRST AID PROCEDURES

EYES AND SKIN CONTACT : Procedures normally not needed. If exposed to dust, immediately flush eyes with plenty of water and wash skin with soap and water.

INHALATION : Procedures normally not needed. If exposed to excessive levels of dust or fumes, remove to fresh air and seek medical attention.

INGESTION : Procedures normally not needed. If large quantities are ingested, seek medical advice.

SECTION VII PRECAUTIONS FOR SAFE HANDLING AND USE

EPA Waste # : Not regulated
UN # : Not applicable
DOT Classification : Not regulated

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

If broken or not useable, scoop up or vacuum into a container for disposal.

It is recommended that each user establish a spill prevention, control and countermeasure plan (SPCC). Such plan should include procedures applicable to proper storage, control and clean-up of spills, including reuse or disposal as appropriate (see waste disposal method, below).

WASTE DISPOSAL METHOD

Federal, state and local disposal laws and regulations will determine the proper waste disposal procedure. All waste materials should be reviewed to determine the applicable hazards (testing may be necessary). Disposal requirements are dependent on the hazard classification and will vary by location and the type of disposal selected. Some waste materials are amenable to recycle/reuse.

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE

Keep container closed.

PERSONNEL SAMPLING PROCEDURE

For METALLIC COMPONENTS: Refer to NIOSH Manual of Analytical Methods, 3rd Edition, Volume 1, Method 7300.

SECTION VIII CONTROL MEASURES

RESPIRATORY PROTECTION

A NIOSH/MSHA-approved respirator as necessary.

VENTILATION

General; if machined, provide local exhaust ventilation as necessary to control dust.

PROTECTIVE EQUIPMENT

Safety glasses (with side shields).
Rubber or neoprene gloves.
Body protection as necessary to prevent skin contact.
If machined, provide exhaust and dustmask.

WORK/HYGIENE PRACTICES

Wash hands with soap and water after handling.

SECTION IX FEDERAL AND STATE REGULATIONS

SARA HAZARD CATEGORIES

IMMEDIATE (Acute) Health Hazard	: YES
DELAYED (Chronic) Health Hazard	: NO
FIRE Hazard	: NO
REACTIVITY Hazard	: NO
Sudden Release of PRESSURE	: NO

SARA SECTION 313 NOTIFICATION

This product contains a toxic chemical (or chemicals) subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372.

CHEMICAL NAME	CAS#	% Wt.
Thallium Iodide (as Tl)	7790-30-9	< 1

Information presented herein has been compiled from sources considered to be dependable, and is accurate and reliable to the best of our knowledge and belief but is not guaranteed to be so. Since conditions of use are beyond our control, we make no warranties, expressed or implied, except those that may be contained in our written contract of sale or acknowledgement.

Appendix C

Electrical Schematics

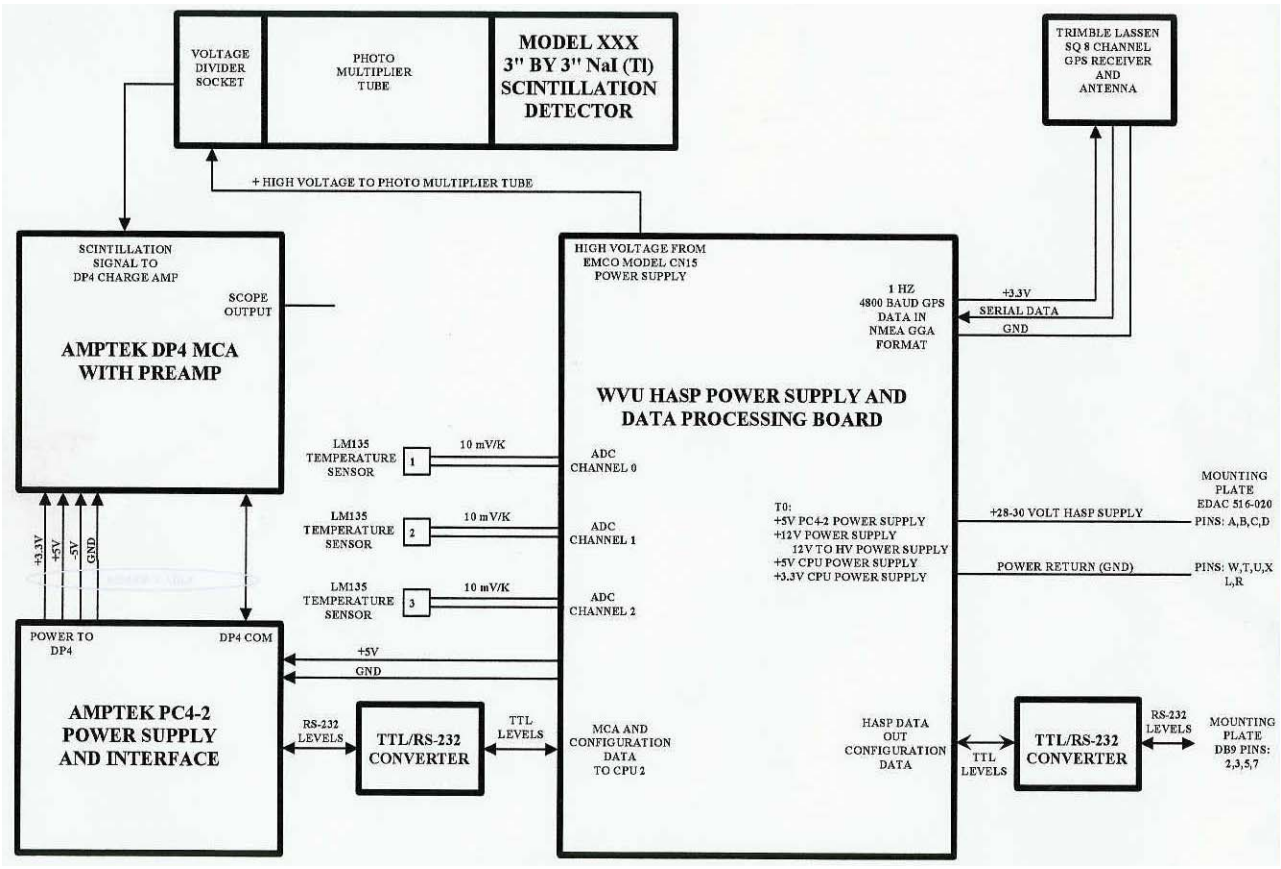

Figure D1: Electronic System Diagram of WVU HART's Payload

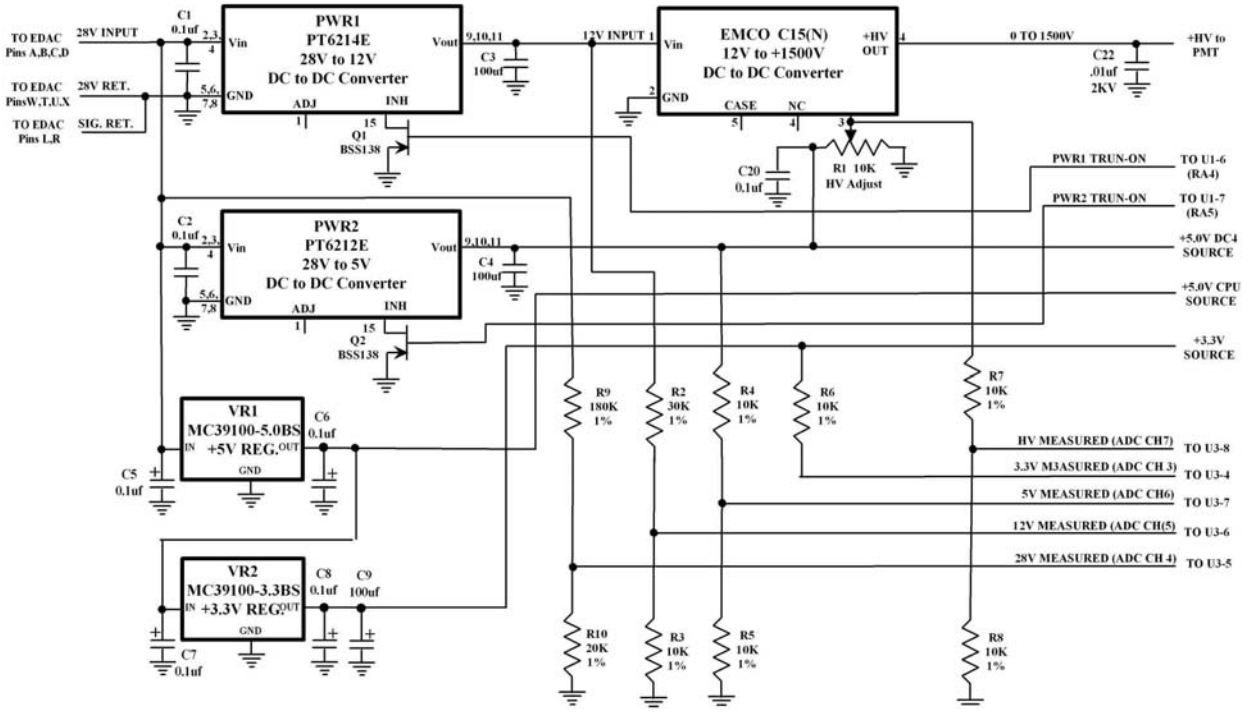

Figure D2: WVU HART Power Supply Diagram

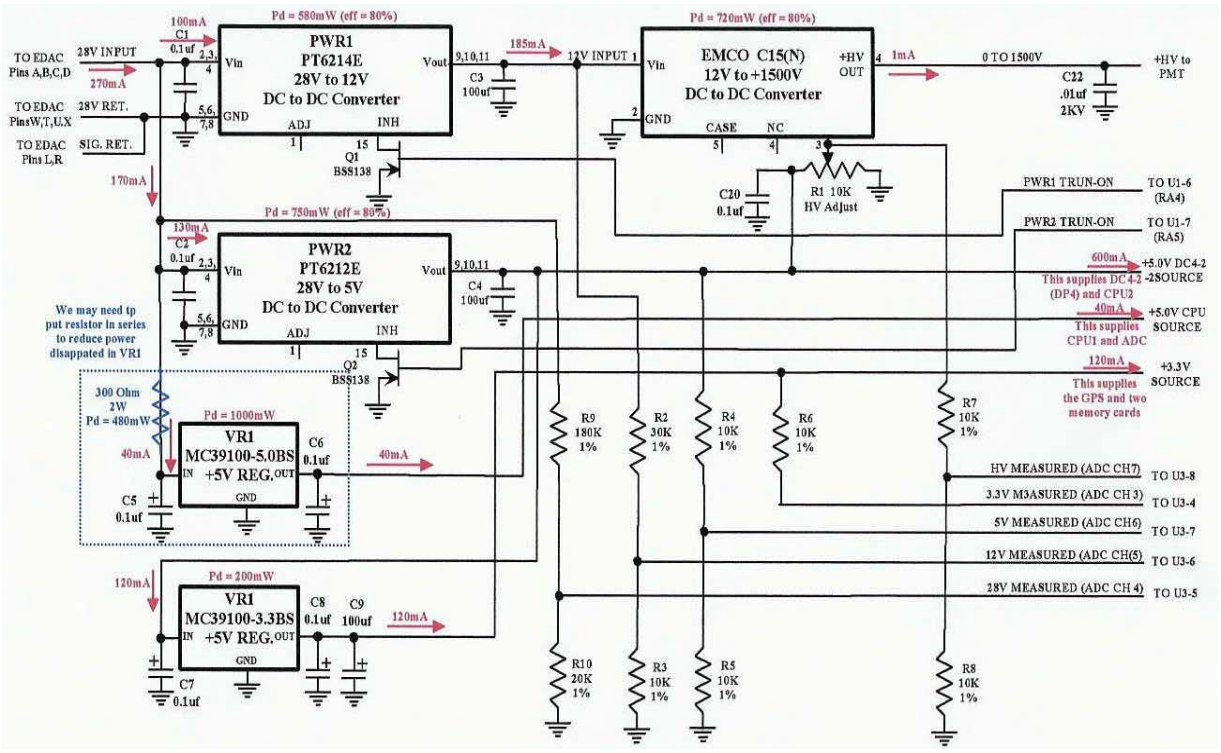

Figure D3: WVU HART Current Draw Estimations Diagram

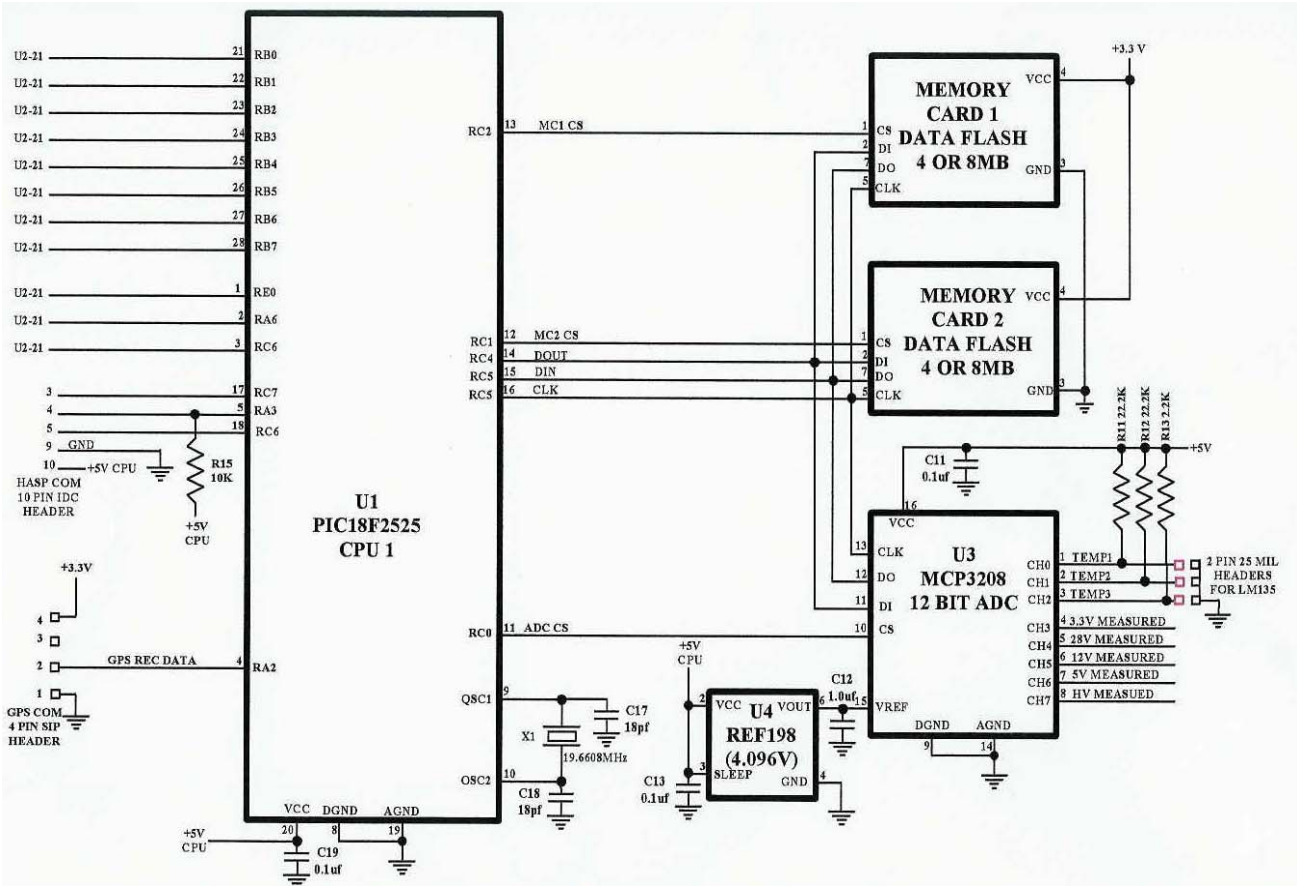

Figure D4: WVU HART Circuit Board CPU 1 Diagram

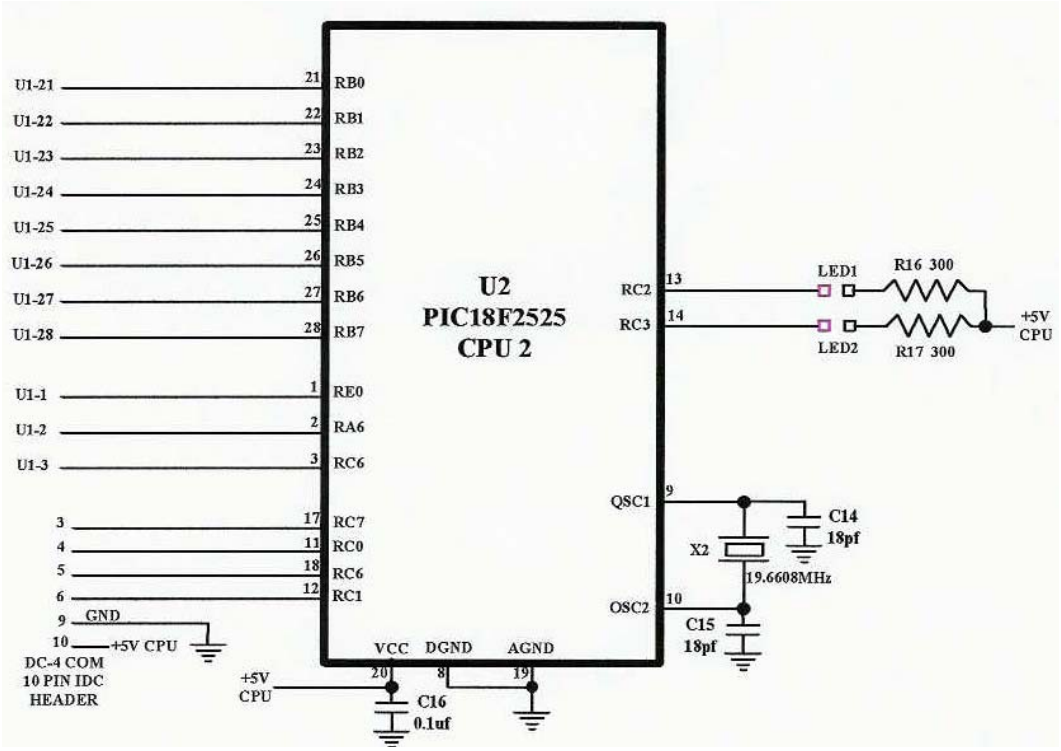

Figure D5: WVU HART Circuit Board CPU 2 Diagram

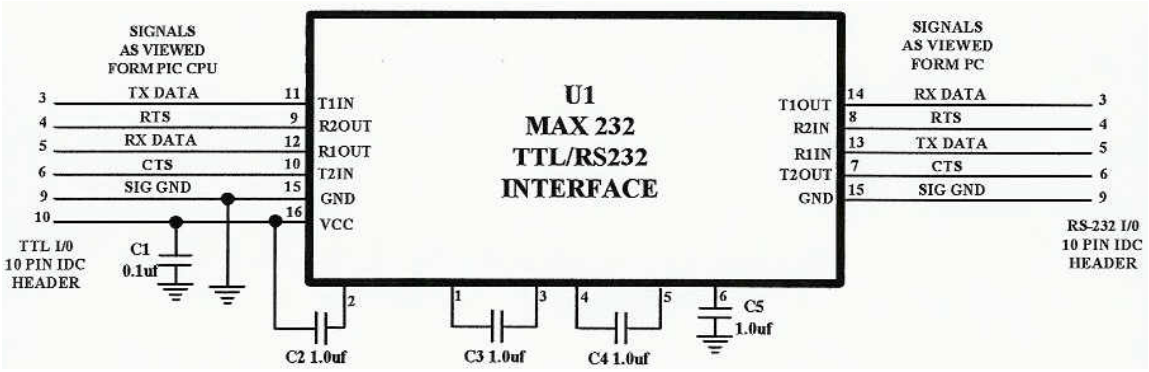

Figure D6: RS-232/TTL Converter

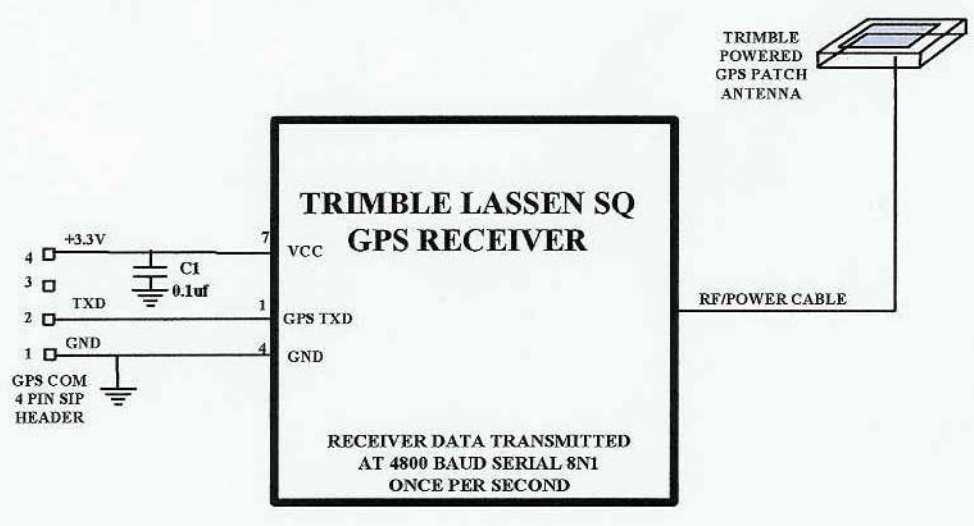

Figure D7: WVU HART GPS Receiver and Antenna

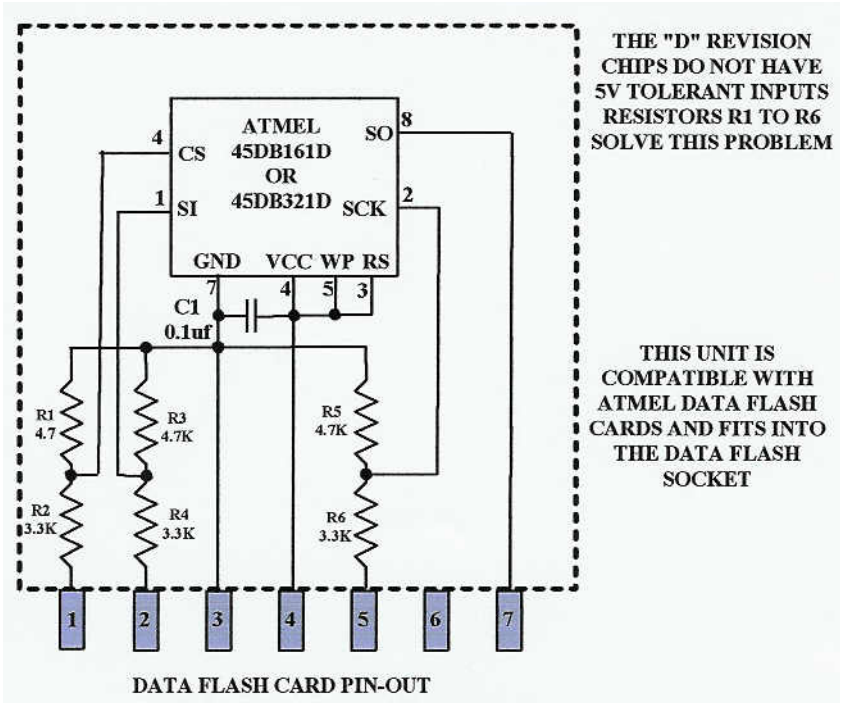

Figure 4: Possible WVU HART Memory Card Replacement