Student Opportunities in Airborne Research (SOAR) Design Challenge Specs
29 June 2017

NASA Education Office &
Aircraft Operations Division / WB-57 Engineering Group

Student Opportunities in Airborne Research (SOAR) Engineering Challenge – Mechanical Reqmts

- **Payload housing assembly and mounting plate should be constructed from one or more of the following metallic materials:**
  - 6061-T6 aluminum alloy
  - 2024-T3 aluminum alloy
  - 2024-T81 aluminum alloy
  - 7075-T6 aluminum alloy
  - 7050-T7451 aluminum alloy
  - Alternate metallic materials ***may*** be permitted with AOD Engineering approval
  - Use of non-metallic material for housing assembly and mounting plate will not be permitted
  - No welding
  - No flammable materials

- **Payload height (including mounting plate) shall not exceed 8.5 in.**
  - Either small or large mounting plate may be used to meet your size requirements

Student Opportunities in Airborne Research (SOAR) Engineering Challenge – Mechanical Reqmts

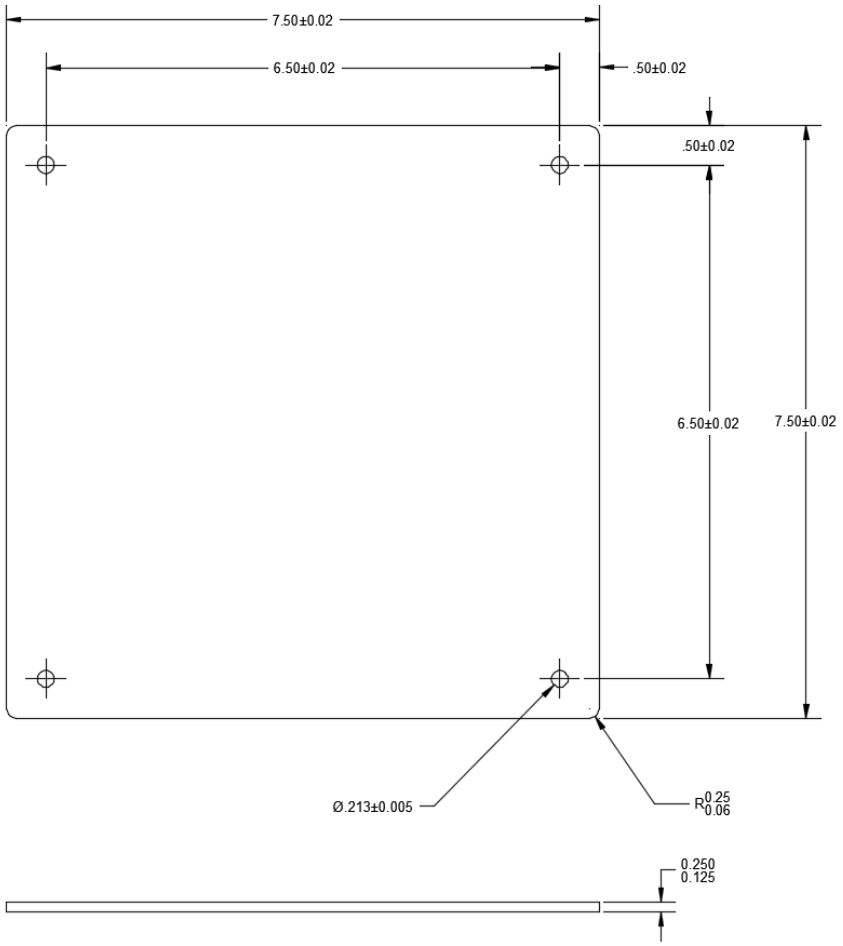
- **Payload weight shall not exceed 40 lbs.**

- **Payload mounting plates require the following:**
  - Plate will be installed to aircraft using No. 10-32 structural fasteners (to be provided by AOD)
  - Ensure adequate clearance around fastener hole to permit use of ratchet/socket and box end wrench
  - Mounting plate mating surface must have no protuberances

- **Structural fasteners**
  - Fasteners used for primary load path shear or combined tensile/shear applications must be sized with proper grip length to ensure no thread bearing loads
  - Minimum fastener diameter shall be 0.164” (No. 8-32)
  - Minimum fastener tensile strength shall be 125 ksi (95 ksi min shear)

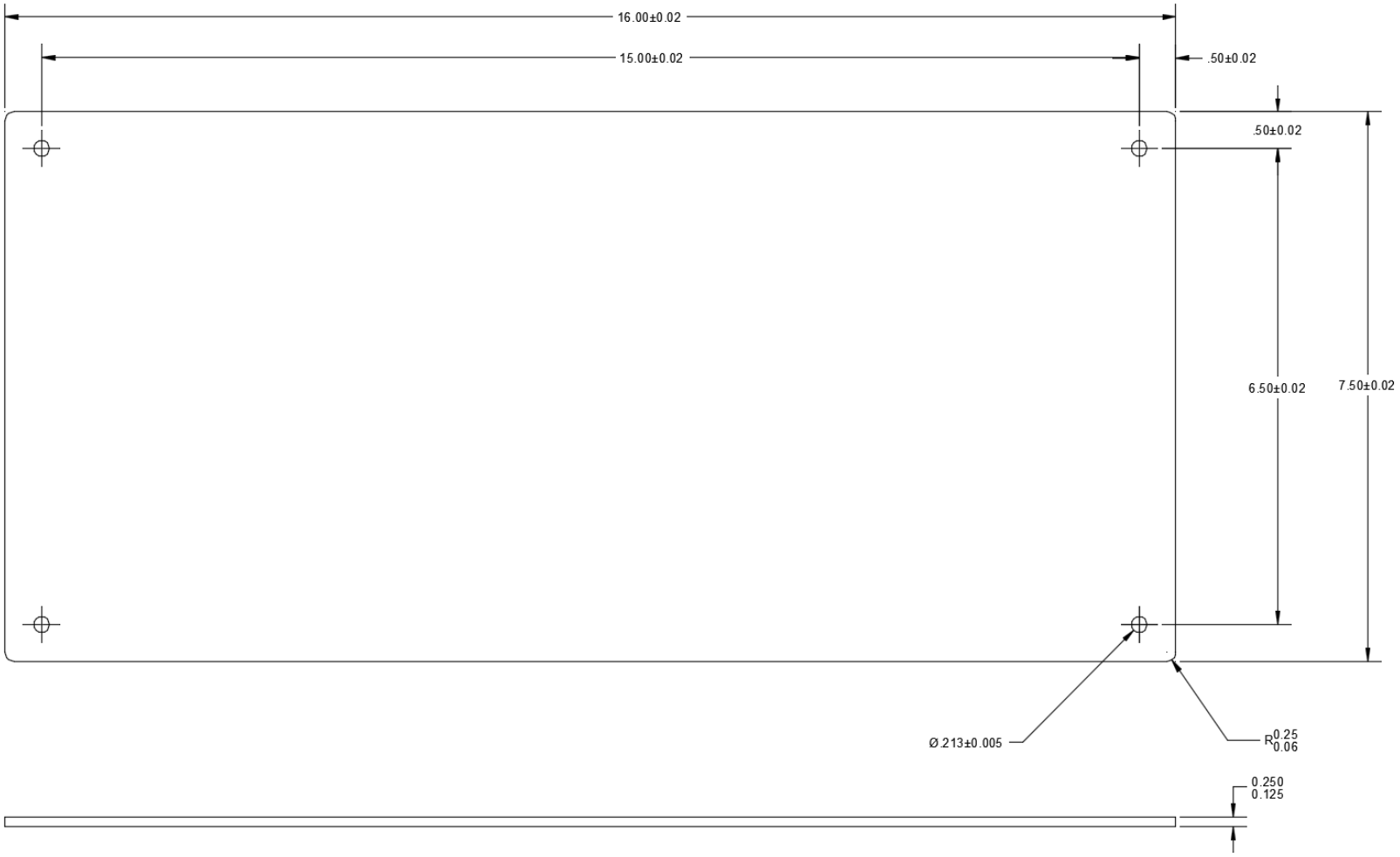
Student Opportunities in Airborne Research (SOAR) Engineering Challenge – Mechanical Reqmts

- **Payload mounting plate shall conform to one of the following designs:**
  - Small plate:



Student Opportunities in Airborne Research (SOAR) Engineering Challenge – Mechanical Reqmts

- Large plate:
  - Note – 7.50” dimension must be in the fore/aft direction



Student Opportunities in Airborne Research (SOAR) Engineering Challenge – Electrical Design Notes

- **Circular connectors are needed to mate to the power and control/data connectors on the aircraft Experimenter Interface Panel (EIP). Either the solder or crimp style version of the connector can be used but the crimp style will require additional tooling to properly crimp the contacts to the wiring. Pin out information can be found in the WB-57 Experimenter's Handbook.**

  - Power Connector

Termination Type	Connector Part Number	Backshell Part Number
Solder	MS3116E20-16P	Included with connector
Crimp	MS3476W20-16P	M85049/52S20W (preferred) M85049/52-1-20W (alternate)

  - Control & Data Connector

Termination Type	Connector Part Number	Backshell Part Number
Solder	MS3116E22-55P	Included with connector
Crimp	MS3476W22-55P	M85049/52S22W (preferred) M85049/52-1-22W (alternate)

Student Opportunities in Airborne Research (SOAR) Engineering Challenge – Electrical Design Notes

- **Aircraft mating wire cable harnesses:**
  - 150˚ C (minimum) aircraft rated wire must be used between the payload and the aircraft EIP.
    - M81044/12-XX-9 : Single conductor wire. Replace XX with the wire gauge, i.e. 22, 20, 16, etc.
    - M27500-XXMLYT08 : Single or multi conductor shielded cable. Replace XX with the wire gauge, i.e. 22, 20, 16, etc. Replace Y with the number of conductors, i.e. 1, 2, 3, etc.
  - Cables should be long enough to accommodate placement at any of the possible payload locations. The longest cable route will be at the spear pod location. Therefore cable harnesses should be 20 feet long.
  - These wire types can typically be purchased in multiples of 1 or 100 foot quantities. Contact the WB-57 team if you need assistance in finding a supplier for a small amounts of a particular type or gauge.

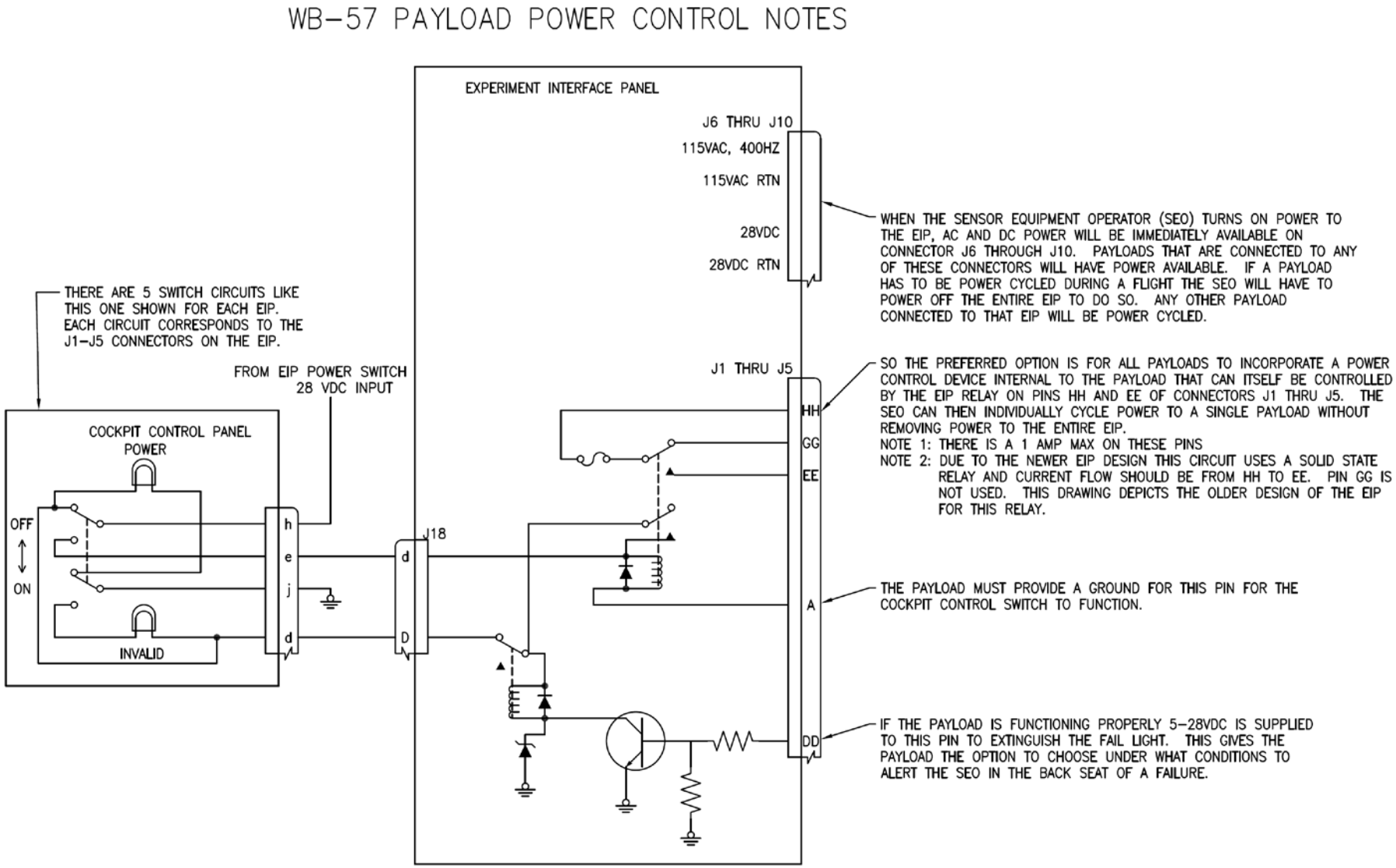
- **Internal payload wiring:**
  - It is required that aircraft rated wiring be used internally to the payload but since these are small payloads and will require small amounts of internal wiring the aircraft rated wiring requirement can be waived particularly for specialty cable types.
  - It is also desirable to use Low Smoke Zero Halogen (LSZH) wiring when possible. Again this requirement can be waived for small payloads.

Student Opportunities in Airborne Research (SOAR) Engineering Challenge – Electrical Design Notes

- **Fuse/Circuit Breaker protection:**
  - Payloads must have properly sized power circuit protection in the payload. EIPs provide up to 15 amps per circuit but these smaller payloads will likely require much less current and to keep them smaller we expect teams to want to use the smallest gauge wiring necessary.
  - MS3320 circuit breakers are preferred because they are rated to the altitudes that the WB-57 achieves. They are easily found for approximately $15.
  - If using fuses instead of circuit breakers keep in mind that their continuous current capacities are typically derated at higher altitudes.

- **Wiring Diagrams should include:**
  - Wiring between the EIPs to the first internal connection to the payload. All other internal wiring can be shown in block diagram form.
  - Wire part numbers and gauge of ALL wiring used, including any wiring shown in the block diagram form.
  - Fuse/circuit breaker protection information for the individual power circuits on the payload side.
  - Aircraft mating connector part numbers
  - Note: Based on power loads from all payloads we may need to move wiring from one contact to another to balance out the overall aircraft loading and to avoid drawing too much current up the line on circuit breakers that are shared between payloads.

Student Opportunities in Airborne Research (SOAR) Engineering Challenge – Electrical Design Notes



Student Opportunities in Airborne Research (SOAR) Engineering Challenge – Electrical Design Notes

- **Miscellaneous Design Requirements:**
  - Payload's onboard record time should be a minimum of 7 hours
  - Environmental – Operate under worst-case environmental conditions in unpressurized payload locations (-60 to +75 deg C and 0 to 70,000 feet MSL)

- **Instrument Measurements (Required and Optional noted):**

Measurement	Units	Accuracy	Requirement
Temperature	degrees C	+/- 1 deg C	Required
Pressure	psia	+/- .5 psi (<70Kft)	Required
Vibration (triaxial)	amplitude (g)	+/- 10%	Required
	frequency (Hz)	+/-5% (Near DC to 4kHz frequency response)	
Humidity	%RH	+/- 5% RH	Optional
Angular Acceleration	deg/sec	+/- 99 deg/s	Optional

  - Provide calibration and test report for sensors with Payload Data Package
  - Provide a sample CSV output data file with the test report to verify compatibility with our current in-house software application

- **Post Flight Data File Format (see csv example data at the end of this document)**
  - Data files should be provided in a Comma Separated Value (csv) format. Teams may want to record a binary file during the flight and then post-flight process that to a CSV file.
  - The csv file should have header data that includes:
    - Recording start date
    - Recording start time
    - Description of each channel (data column)
    - Sample Rate
    - Unit of measure for each sensor
    - Any other header information that may be useful

- **Post Flight Data File Format (continued…)**
  - The csv file should include the following data below the header data:
    - On the first line following the header information there should be a single line entry with these words only: Data Starts Here
    - The line after that should contain data column identifiers (format optional)
    - Then the remaining lines should contain the raw data output of each sensor

      Note: Provide conversion formulas for each sensor reading in the Payload Data Package
    - Each data line entry should be in the following format:
      - Time stamp, Temperature, Pressure, Vibration X, Vibration Y, Vibration Z, Humidity, Angular Acceleration X, Angular Acceleration Y, Angular Acceleration Z
        - » Time Stamp should start at 0 and positively increment with each entry. Increment value will depend on sampling rate. Use the Weight-Off-Wheels relay from the EIP as a trigger to mark the 0 seconds event that will be the first data line in the CSV output file. This is a simple way to synchronize data from all experiments after each flight.
        - » All other entries in the data row should be decimal values (positive or negative as appropriate)
      - Values should be filled in for all rows so that missing entries do not skew the data columns in the output file. If a team is choosing not to measure one of the optional items, it is not necessary to fill in data for those columns.

EXAMPLE CSV DATA FILE (TEXT VIEW)

```
Headers,,,,,,,,,
Test Date,5/7/2014,,,,,,,,
Test Time,14:10:27,,,,,,,,
Test ID,N926-nose,,,,,,,,
Test Description,Pressure Nose Flight,,,,,,,,
Sample Rate (Hz),10000,,,,,,,,
Data Channel Number,0,1,6,7,8,2,3,4,5
Channel Description,Pressure,Temperature,Vibe X,Vibe Y,Vibe Z,Humidity,Angular X,Angular Y,Angular Z
Sensor S/N,7836-2-165,M241478,13374-X,13374-Y,13374-Z,H1,AR00063-X,AR00063-Y,AR00063-Z
Engineering Unit,mV,mV,mV,mV,mV,mV,mV,mV,mV
Number of Pre-Zero Data Pts,0,0,0,0,0,0,0,0,0
Number of Post-Zero Data Pts,100010,100010,100010,100010,100010,100010,100010,100010,100010
Data Zero (CNTS),0,0,0,0,0,0,17,50,67
Scale Factor (EU/CNT),-0.075715974,-0.075922891,0.375066072,0.37122944,0.376294285,-0.076362558,0.075769395,0.075993054,0.075378276
Scale Factor (mV/CNT),0.075715974,0.075922891,0.375066072,0.37122944,0.376294285,0.076362558,0.075769395,0.075993054,0.075378276
Data Starts Here,,,,,,,,,
Time,Chan 0:7836-2-165,Chan 1:M241478,Chan 6:13374-X,Chan 7:13374-Y,Chan 8:13374-Z,Chan 2:H1,Chan 3:AR00063-X,Chan 4:AR00063-Y,Chan 5:AR00063-Z
0,1816.956227,-1432.968654,-2.250396,16.334095,18.43842,339.660657,2.197312,1.975819,1.809079
0.0001,1817.107659,-1433.044577,-1.87533,14.106719,18.43842,341.035183,0,1.671847,0.678404
0.0002,1816.880511,-1433.348269,-2.250396,14.106719,18.43842,338.133406,-1.136541,1.519861,0.603026
0.0003,1816.577648,-1433.196423,-1.87533,15.591636,18.814714,332.253489,-0.606155,2.051812,0.45227
0.0004,1816.199068,-1433.1205,-2.625463,16.334095,17.685831,329.580799,0.833463,2.127806,1.130674
0.0005,1815.669056,-1432.892731,-2.625463,16.334095,18.814714,333.933465,0.985002,0.607944,2.63824
0.0006,1814.83618,-1432.968654,-1.87533,16.334095,17.685831,338.286131,1.28808,-0.151986,2.487483
0.0007,1814.381884,-1433.044577,-1.125198,16.705325,18.814714,336.606154,2.045774,1.899826,0.075378
0.0008,1815.139044,-1433.044577,-2.250396,14.849178,16.556949,330.878963,1.666927,5.015542,-1.507566
0.0009,1815.97192,-1432.968654,-3.750661,16.334095,18.062126,328.206273,-0.454616,6.23143,-0.753783
0.001,1815.517624,-1433.044577,-1.87533,16.334095,18.43842,332.406214,-2.576159,5.243521,-0.075378
0.0011,1814.83618,-1432.968654,-3.000529,15.962866,16.933243,337.67523,-1.742696,2.73575,-1.130674
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0.0013,1816.426216,-1432.892731,-1.500264,17.076554,18.814714,335.918891,1.666927,-0.379965,-2.487483
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0.0016,1815.139044,-1433.044577,-2.250396,17.076554,18.814714,335.231628,-0.075769,-1.063903,-0.753783
0.0017,1814.4576,-1432.740885,-1.87533,16.705325,18.062126,337.293417,0.075769,-0.911917,-0.678404
0.0018,1815.366192,-1433.044577,-1.87533,15.220407,18.062126,340.577007,1.591157,1.215889,0.979918
0.0019,1816.123352,-1433.044577,-1.500264,15.220407,18.43842,340.271557,3.636931,2.431778,2.487483
0.002,1816.274784,-1433.348269,-3.000529,14.477948,18.062126,334.39164,4.091547,2.507771,0.979918
0.0021,1816.123352,-1433.044577,-1.125198,15.220407,18.814714,328.817173,2.651929,2.279792,-0.678404
0.0022,1815.97192,-1432.892731,-2.250396,15.220407,18.43842,330.1917,1.060772,2.583764,-2.035213
0.0023,1815.366192,-1432.816808,-1.500264,15.962866,18.814714,335.613441,0.833463,2.659757,-2.788996
0.0024,1814.83618,-1432.892731,-1.87533,14.849178,19.567303,337.446143,1.21231,2.279792,-1.507566
0.0025,1815.063328,-1432.892731,-1.500264,15.962866,18.062126,336.682517,2.273082,1.139896,1.507566
```

EXAMPLE CSV DATA FILE (TABLE VIEW)

Headers									
Test Date	5/7/2014								
Test Time	14:10:27								
Test ID	N926-nose								
Test Description	Pressure Nose Flight								
Sample Rate (Hz)	10000								
Data Channel Number	0	1	6	7	8	2	3	4	5
Channel Description	Pressure	Temperature	Vibe X	Vibe Y	Vibe Z	Humidity	Angular X	Angular Y	Angular Z
Sensor S/N	7836-2-165	M241478	13374-X	13374-Y	13374-Z	H1	AR00063-X	AR00063-Y	AR00063-Z
Engineering Unit	mV	mV	mV	mV	mV	mV	mV	mV	mV
Number of Pre-Zero Data Pts	0	0	0	0	0	0	0	0	0
Number of Post-Zero Data Pts	100010	100010	100010	100010	100010	100010	100010	100010	100010
Data Zero (CNTS)	0	0	0	0	0	0	17	50	67
Scale Factor (EU/CNT)	-0.075715974	-0.075922891	0.375066072	0.37122944	0.376294285	-0.076362558	0.075769395	0.075993054	0.075378276
Scale Factor (mV/CNT)	0.075715974	0.075922891	0.375066072	0.37122944	0.376294285	0.076362558	0.075769395	0.075993054	0.075378276
Data Starts Here									
Time	Chan 0:7836-2-165	Chan 1:M241478	Chan 6:13374-X	Chan 7:13374-Y	Chan 8:13374-Z	Chan 2:H1	Chan 3:AR00063-X	Chan 4:AR00063-Y	Chan 5:AR00063-Z
0	1816.956227	-1432.968654	-2.250396	16.334095	18.43842	339.660657	2.197312	1.975819	1.809079
0.0001	1817.107659	-1433.044577	-1.87533	14.106719	18.43842	341.035183	0	1.671847	0.678404
0.0002	1816.880511	-1433.348269	-2.250396	14.106719	18.43842	338.133406	-1.136541	1.519861	0.603026
0.0003	1816.577648	-1433.196423	-1.87533	15.591636	18.814714	332.253489	-0.606155	2.051812	0.45227
0.0004	1816.199068	-1433.1205	-2.625463	16.334095	17.685831	329.580799	0.833463	2.127806	1.130674
0.0005	1815.669056	-1432.892731	-2.625463	16.334095	18.814714	333.933465	0.985002	0.607944	2.63824
0.0006	1814.83618	-1432.968654	-1.87533	16.334095	17.685831	338.286131	1.28808	-0.151986	2.487483
0.0007	1814.381884	-1433.044577	-1.125198	16.705325	18.814714	336.606154	2.045774	1.899826	0.075378
0.0008	1815.139044	-1433.044577	-2.250396	14.849178	16.556949	330.878963	1.666927	5.015542	-1.507566
0.0009	1815.97192	-1432.968654	-3.750661	16.334095	18.062126	328.206273	-0.454616	6.23143	-0.753783
0.001	1815.517624	-1433.044577	-1.87533	16.334095	18.43842	332.406214	-2.576159	5.243521	-0.075378
0.0011	1814.83618	-1432.968654	-3.000529	15.962866	16.933243	337.67523	-1.742696	2.73575	-1.130674
0.0012	1815.59334	-1432.968654	-2.625463	16.705325	18.43842	338.057043	0.530386	0.151986	-2.713618
0.0013	1816.426216	-1432.892731	-1.500264	17.076554	18.814714	335.918891	1.666927	-0.379965	-2.487483
0.0014	1816.501932	-1433.1205	-1.500264	16.334095	17.685831	335.689804	1.363849	0.98791	-1.7337
0.0015	1816.047636	-1432.892731	-1.500264	15.962866	18.814714	335.537079	0.303078	0.911917	-0.904539
0.0016	1815.139044	-1433.044577	-2.250396	17.076554	18.814714	335.231628	-0.075769	-1.063903	-0.753783
0.0017	1814.4576	-1432.740885	-1.87533	16.705325	18.062126	337.293417	0.075769	-0.911917	-0.678404
0.0018	1815.366192	-1433.044577	-1.87533	15.220407	18.062126	340.577007	1.591157	1.215889	0.979918
0.0019	1816.123352	-1433.044577	-1.500264	15.220407	18.43842	340.271557	3.636931	2.431778	2.487483
0.002	1816.274784	-1433.348269	-3.000529	14.477948	18.062126	334.39164	4.091547	2.507771	0.979918
0.0021	1816.123352	-1433.044577	-1.125198	15.220407	18.814714	328.817173	2.651929	2.279792	-0.678404
0.0022	1815.97192	-1432.892731	-2.250396	15.220407	18.43842	330.1917	1.060772	2.583764	-2.035213
0.0023	1815.366192	-1432.816808	-1.500264	15.962866	18.814714	335.613441	0.833463	2.659757	-2.788996
0.0024	1814.83618	-1432.892731	-1.87533	14.849178	19.567303	337.446143	1.21231	2.279792	-1.507566
0.0025	1815.063328	-1432.892731	-1.500264	15.962866	18.062126	336.682517	2.273082	1.139896	1.507566