Vertical Cavity Laser Hygrometer Manual

July 2008

Southwest Sciences, Inc.

Table of Contents

Contact person: Mark Paige
Southwest Sciences, Inc.
1570 Pacheco St, Suite E-11
Santa Fe NM 87505

Telephone: (505)984-1322 Office
(505)455-7739 Home

Email: mpaige@swsciences.com

Description

The laser hygrometer measures water vapor concentration using optical absorption spectroscopy. The hygrometer is an open path system which mounts in a window sized cutout in the aircraft (see Fig. 1). The exterior portion of the instrument consists of an aerodynamic fin. This fin contains a multipass Herriott cell that provides 375 cm of optical path (25 passes × 15 cm basepath). The electronics system resides inside the aircraft and is attached to the fin baseplate. The physical specifications of the system are noted below:

Fin Dimensions: 30 × 24 × 6 cm Electronics Dimensions: 25 × 14 × 7 cm Weight: 3.2 kg Electrical: 115 VAC, <20 W Output: RS232, 19.6 kBAUD

A fiberized vertical cavity surface emitting laser (VCSEL) located in the electronics box serves as the light source for the hygrometer. The light is fiber coupled to the multipass cell outside the aircraft. To cover the large dynamic range required, a weak (1853.3 nm) and a strong (1854.0 nm) absorption line are used for the measurement. A combination of wavelength modulation and normal direct absorption spectroscopy are employed. There are three measurement modes. At high concentrations (typically above -20 C frostpoints), second harmonic wavelength modulation is performed with the weak line. At intermediate concentrations (typically -20 C to -50 C frostpoints), the strong line is used in direct absorbance mode. At the lowest concentrations, the strong line is measured using wavelength modulation.

Full spectra are measured at a 1.5 kHz rate. Spectra are coaveraged for 40 msec prior to analysis. Thus, the instrument reports independent concentration measurements at a rate of 25 Hz. Reference spectra recorded at typical atmospheric conditions are used to fit the sample spectrum. Fitting is performed using singular value decomposition analysis. Data fitting for the wavelength modulation spectra is limited to the region between the troughs. This region of the spectra shows virtually no change in shape as a function of pressure and temperature. Thus, reference spectra can be readily compared to sample spectra with only minor correction (<2%) for lineshape changes . The scan width and modulation depth is adjusted once per second according to the calculated line width for ambient conditions. These adjustments are

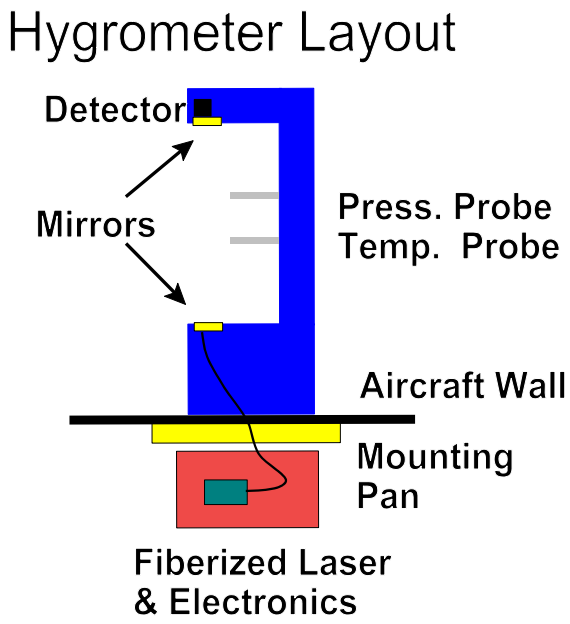


Figure 1 Instrument schematic

made to keep the trough to trough separation a constant fraction of the total scan width. Gain adjustment of the spectrum amplitude is performed once a second to keep the signal plus noise approximately constant.

The system outputs measured concentrations through an RS232 port. As detailed in the communications format section, instrument parameters are reported once per second. The water vapor concentration is reported 25 times a second as the measurements are made. A synchronization trigger from the plane is used to end each second of data collection. The ambient temperature as measured by the plane's Pitot probe (ATX) is sent to the instrument once a second. This temperature is needed because the instrument's temperature probe experiences dynamic heating.

Hazards

The laser is a class 3B device. Eyes should not be directly exposed to the output. The laser output is 0.5 mW and at a wavelength that does not penetrate the cornea. Diffuse scattering is not a hazard.

The electronics box contains 115 V AC voltage. All exposed AC leads are located in the corner of the box by the AC power switch (the fuses and switch). The strip heater on the bottom of the box runs on AC but has not exposed leads.

Operating Instructions

The instrument is clamped into a window sized cutout in the aircraft. The instrument pan seals against a gasket in the cutout. When handling the instrument take care not to touch the mirrors and be careful of the two projecting ambient probes. The instrument has three cables - a circular 3 pin AC power cable, a circular 6 pin communications cable, and a BNC trigger cable. These connect on the front of the electronics box. **The instrument has a ground wire that must be connected to the aircraft frame.** This ground wire prevents static buildup on the exterior fin.

The instrument has AC and DC power switches located on the front of the electronics box (see Fig. 1). The 6 V power supply requires the AC power to be turned on in order to operate. The normal sequence is to turn on the AC and then the DC power. However, the system is not particularly sensitive about this sequence and no damage is done if the sequence is reversed.

The system typically requires about 3 minutes to stabilize and begin making meaningful measurements. Power maybe be turned off at any time without damage to the instrument. However, if the mounting pan is cold (below 0 C), it is recommended that the system be left on to keep the laser from getting cold and to keep moisture from condensing inside the electronics box. The laser fiber coupling can be degraded if the laser is allowed to get below 10 C.

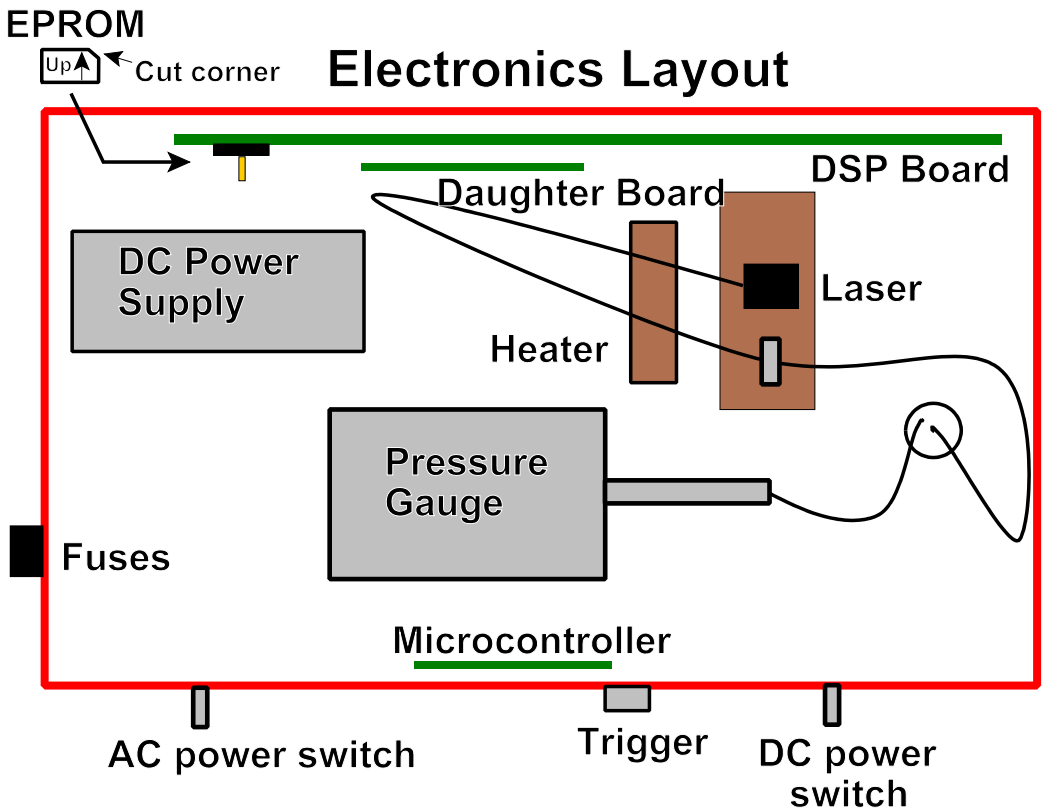


Figure 1 Electronics box layout viewed from top. The EPROM orientation on the DSP board is noted.

Maintenance

Short term maintenance (during measurement campaign)

1) Mirror inspection

A visual inspection of the mirrors will reveal if any foreign material has deposited on the optics. Also, the incident light intensity as reported by the instrument can be checked. This intensity is reported in mV. At the time of instrument delivery, a light intensity of 0.75 to 1 V was typical. The mirrors do have some minor scratches and in time, flying will wear away the coating (from the impact of aerosols, ice particles, etc). If the mirrors need to be cleaned, the use of methanol or hexane is recommended. A soft spray from a wash bottle can be used. Also a drop wipe using lens tissue can be performed. A drop wipe is performed by overlaying the lens tissue on the mirror, placing a drop of solvent on the tissue, and then pulling the tissue across the optic in a single motion. **Do not attempt to scrub the mirrors**! The coating will come off. It is not recommended to perform drop wipes very often for the same reason. The laser fiber optic is located in the mirror closest to the aircraft. The fiber optic is not sealed to the mirror. Spraying at the fiber optic will cause solvent to get inside the fin. Thus, spray this area minimally.

Spraying solvent will leave drops on the mirror that evaporate and leave residue. The drops can be blown off the mirrors but do not use compressed gas cans that contain freon. The freon leaves a residue that will distort the beam significantly. A squeeze bulb is a good way to blow off the mirrors. In general, flying through rain and clouds often cleans the mirrors.

2) Electronics inspection

Taking the cover off the electronics box and visually inspecting the interior will reveal if anything has gotten loose during flights. The power should be turned off during this process. The power supply and pressure gauge are the heaviest objects in the box. A gentle push of these objects with a finger is fine to check their security but make sure to be grounded when sticking a finger inside the box. Static charge can kill the components inside the box. The laser fiber is very delicate so avoid pushing it around when performing a physical inspection.

Long Term Maintenance

As indicated above, the mirror coating will eventually degrade due to atmospheric abrasion. Mirror replacement is a complicated process which will require demonstration by Southwest Sciences personnel. The electronics box is removed, the fin is disassembled, and the fiber optic and detector removed. The multipass cell is realigned using a red diode laser to visualize the multipass pattern.

No other long term maintenance issues are expected to arise.

Software Upgrades

The DSP system software can be upgraded by burning a new program on an EPROM chip and replacing the current chip. The EPROM chip resides in a socket near the processor end of the board. A handle has been glued onto the EPROM chip so that it can be removed from the socket without disassembly of the electronics box. The chip is removed by gently grasping the handle with a pliers and prying it out along the long axis of the chip. The orientation of the chip with respect to the board is shown in Fig. 1. Software upgrades on newly programmed EPROM chips should be obtained from Southwest Sciences.

Calibration

The instrument was calibrated for each mode. A single calibration constant (a span factor) was determined for each mode. The calibrations were performed with the instrument mounted in a vacuum can. Gas was flowed through the vacuum can and then through a commercial chilled mirror system. Readings were taken once the chilled mirror reading was stable for 30 minutes. For the weak line, a 0 C saturated stream was prepared by bubbling dry gas through an ice water bath. For the strong line, room air was drawn through a coil submerged in an acetonitrile slush (-45 C).

Reference spectra used for the fitting process were measured in an identical optical system mounted in a small vacuum can. Reference conditions were created that are typical of the atmospheric region where the specific mode would be employed (see Table 1). The vacuum can was placed in a cooling bath with moisture saturated air.

Table 1 Reference Spectra Conditions

Mode	T (K)	P (kPa)	Bath
Weak	273.1	78.7	ice/water
Strong Direct	227.4	52.8	Acetonitrile/N_2(l)
Strong	209.6	13.5	Chloroform/N_2(l)

The calibration of the instrument should be stable in the long term. The AC part of the signal is normalized by the DC transmission so changes in the transmitted optical intensity do not impact the calibration.

Troubleshooting

Examining the system parameters that are output once per second provides a good diagnostic for the instrument status. See the section on RS232 format to find these output parameters. The status indicator gives a quick indication of whether problems are being experienced. A discussion of how various parameters from the communications stream are relative is presented below:

Laser Transmission - Examining the laser intensity parameter indicates if poor laser transmission is a problem. At time of instrument delivery, 750 to 1000 was typical

Laser Temperature Control - Examining the laser temperature, temperature setpoint, and thermoelectric cooler current will show how well laser temperature is being regulated. The difference between the laser temperature and temperature setpoint should be no more than a couple of ohms (this is the thermistor value) once the system stabilizes. The thermoelectric cooler current range is +/-925. The plus range indicates cooling. If the TEC is approaching 925, it is working very hard to keep the laser temperature regulated. The electronics box temperature which is being regulated to 20 C by a strip heater may not very stable if the TEC is working hard.

Measurement Mode - The measurement mode indicator (W,D,S) and the peak bin location will reveal if the instrument is stable in regard to the measurement. Rapid flipping back and forth between modes may indicate instability (unless the atmosphere is rapidly changing). Mode changes can only occur once per second and after a mode change occurs, there is a waiting period of at least 2 seconds before changing modes again. If the reported concentration is 1.0, the system has determined that the measured concentration is out of range for the current mode (except for the initial warm up).

The spectral scan spans 98 bins. The system adjusts the laser temperature so that the spectral peak is at a specific bin. For W mode, this bin is 50. For S and D modes, this bin is 52. If the peak position is more than 9 bins off, fitting errors from reaching the scan edges may occur.

Ambient Temperature - The instrument receives ambient temperature information from the plane (ATX). The temperature probe on the instrument reads dynamic temperature. Static temperature is required for properly setting the scan width and modulation depth and for calculating the concentration. A bit on the error status indicates if ATX was received. The instrument keeps track of the most recent difference between ATX and the instrument temperature probe. If ATX is not received, this difference is added to the instruments temperature reading. So occasional misses of the ATX information is not critical. The weak peak is particularly temperature sensitive and is most impacted by incorrect temperature readings.

RS232 Output Format

19.2 kBAUD, 8 data bits, 1 stop bit, no parity, no flow control
(all fields filled with spaces, one space between fields)

ASCII CHARACTERS

Firmware ID (1 time transmission at boot up) (42 characters)

Field	Format	string index[0…n]	
SWS5409	7c_	0-7	Hardware ID
SN xxx	6c__	4-15	serial number
GV	7c_	16-23	Aircraft
vx.xx	5c___	24-31	Software version #
xx-xx-xx	8c	32-39	Date
\r\n	2c	40-41	Line Termination - Carriage return, Newline

One Hz System Information Data (84 characters)

Field	Format	string index[0…n]	
SWS	3c_	0-3	Communication check
Elapsed Time (sec)	xxxxxx_	4-10	Counter
Status code	xxxx_	11-15	Error report
Temp (K)	xxx.x_	16-21	Ambient Temperature
Pressure (torr)	xxx.x_	22-27	Ambient Pressure
LaserTemp(ohms)	xxxxx_	28-33	Laser Temperature
Set Temp (ohms)	xxxxx_	34-39	Laser Temperature Set Point
TEC Current (Counts)	sxxxx_	40-45	Thermoelectric cooler current in DAC counts
Spectral line	1c_	46-47	W, D, or S - weak, direct, or strong mode
Δv_{voigt} (cm^{-1})	x.xxxx_	48-54	Voight width for ambient conditions
Center current (Counts)	xxxx_	55-59	Scan center current in DAC counts
Current step size (Counts)	xx_	60-62	Current step size in DAC counts
Modulation Depth (Counts)	xxxx_	63-67	Modulation depth in DAC counts
peak bin	xx_	68-70	Peak position in scan
Pregain setting	x_	71-72	Pregain switch position (0-3)
ac gain	xx.x_	73-77	Post Lock-in Gain
Transmitted Laser I (mV)	xxxx	78-81	Ave Transmitted Laser Intensity
\r\n	2c	82-83	Line termination

25 Hz Data (33 characters)

Field	Format	string index[0…n]	
Conc H_2O	sx.xxEsxx_	0-9	Moisture Number Density (molecules/cm3)
Std dev H_2O	x.xxEsxx_	10-18	Fit Error
Frost/dew Point (°C)	sxxx.xx_	19-26	
Number good scans	xxxx	28-30	

\r\n 2c 31-32 Line termination - Carriage return, newline

11-BIT STATUS CODE

SIG_BLOCKED	0000 0000 0001	1
CALC_ERR_CONC	0000 0000 0010	2
CALC_WARN_NOISE	0000 0000 0100	4
LL_WARN	0000 0000 1000	8
GAIN_AC_SAT	0000 0001 0000	16
GAIN_DC_SAT	0000 0010 0000	32
P_ERR	0000 0100 0000	64
T_ERR	0000 1000 0000	128
T_LIMIT_LASER	0001 0000 0000	256
ATX_ERR	0010 0000 0000	512

Sample Output Lines

```
012345678901234567890123456789012345678901234567890123456789012345678901234567
89012345                    Position
          10        20        30        40        50        60        70
80                          Position
SWS5402 SN 001 GV       V1.00   12-08-05                            Firmware ID
SWS  11455  512 297.4 594.5  8914  8915   402 W 0.0221 2000 16 2255 50 1  8.7
684
 4.00E+16 1.97E+15  -16.83   60
 4.03E+16 1.94E+15  -16.75   60
 4.03E+16 1.85E+15  -16.73   60
 4.00E+16 1.85E+15  -16.83   60
 4.01E+16 1.93E+15  -16.81   60
 4.00E+16 1.91E+15  -16.82   60
 4.00E+16 1.90E+15  -16.83   60
 4.00E+16 1.86E+15  -16.82   60
 4.01E+16 1.92E+15  -16.80   60
 4.00E+16 1.88E+15  -16.84   60
 3.99E+16 1.92E+15  -16.87   60
 4.00E+16 1.91E+15  -16.84   60
 3.98E+16 1.94E+15  -16.88   60
 3.99E+16 1.88E+15  -16.87   60
 3.99E+16 1.90E+15  -16.86   60
 3.98E+16 1.84E+15  -16.88   60
 4.00E+16 1.88E+15  -16.83   60
 4.01E+16 1.79E+15  -16.81   60
 3.99E+16 1.83E+15  -16.86   60
 3.97E+16 1.90E+15  -16.92   60
 3.96E+16 1.83E+15  -16.95   60
 4.01E+16 1.82E+15  -16.82   60
 3.97E+16 1.84E+15  -16.93   60
 3.96E+16 1.89E+15  -16.95   60
 3.98E+16 1.87E+15  -16.89   61
                          1 Hz System Info
Each line terminated with \r\n
```

The plane timestamps each line so the data stream coming from the plane looks like:

```
2008 06 16 15:38:26.0422 0.03713      85 SWS     51    9 277.1 628.9  8849  8848  -622 W 0.0235 2000 21 2137 78 1  1.5  898
2008 06 16 15:38:26.0860 0.04376      34  1.00E+00 0.00E-01   99.99   60
2008 06 16 15:38:26.1079 0.02188      34  1.00E+00 0.00E-01   99.99   60
2008 06 16 15:38:26.1251 0.01719      34  1.00E+00 0.00E-01   99.99   60
2008 06 16 15:38:26.1651    0.04      34  1.00E+00 0.00E-01   99.99   60
```

```
2008 06 16 15:38:26.2051 0.04002      34  1.00E+00 0.00E-01   99.99   60
2008 06 16 15:38:26.2451 0.03997      34  1.00E+00 0.00E-01   99.99   60
2008 06 16 15:38:26.2853 0.04023      34  1.00E+00 0.00E-01   99.99   60
2008 06 16 15:38:26.3251 0.03977      34  1.00E+00 0.00E-01   99.99   60
2008 06 16 15:38:26.3651    0.04      34  1.00E+00 0.00E-01   99.99   60
2008 06 16 15:38:26.4051    0.04      34  1.00E+00 0.00E-01   99.99   60
2008 06 16 15:38:26.4451 0.04002      34  1.00E+00 0.00E-01   99.99   60
2008 06 16 15:38:26.4851 0.03998      34  1.00E+00 0.00E-01   99.99   60
2008 06 16 15:38:26.5251 0.04001      34  1.00E+00 0.00E-01   99.99   60
2008 06 16 15:38:26.5651 0.03999      34  1.00E+00 0.00E-01   99.99   60
2008 06 16 15:38:26.6051 0.04004      34  1.00E+00 0.00E-01   99.99   60
2008 06 16 15:38:26.6476 0.04253      34  1.00E+00 0.00E-01   99.99   60
2008 06 16 15:38:26.6851 0.03744      34  1.00E+00 0.00E-01   99.99   60
2008 06 16 15:38:26.7251    0.04      34  1.00E+00 0.00E-01   99.99   60
2008 06 16 15:38:26.7651 0.03999      34  1.00E+00 0.00E-01   99.99   60
2008 06 16 15:38:26.8051 0.04001      34  1.00E+00 0.00E-01   99.99   60
2008 06 16 15:38:26.8451    0.04      34  1.00E+00 0.00E-01   99.99   60
2008 06 16 15:38:26.8851 0.04003      34  1.00E+00 0.00E-01   99.99   60
2008 06 16 15:38:26.9251 0.03998      34  1.00E+00 0.00E-01   99.99   60
2008 06 16 15:38:26.9651 0.04001      34  1.00E+00 0.00E-01   99.99   60
2008 06 16 15:38:27.0051 0.04002      34  1.00E+00 0.00E-01   99.99   61
```

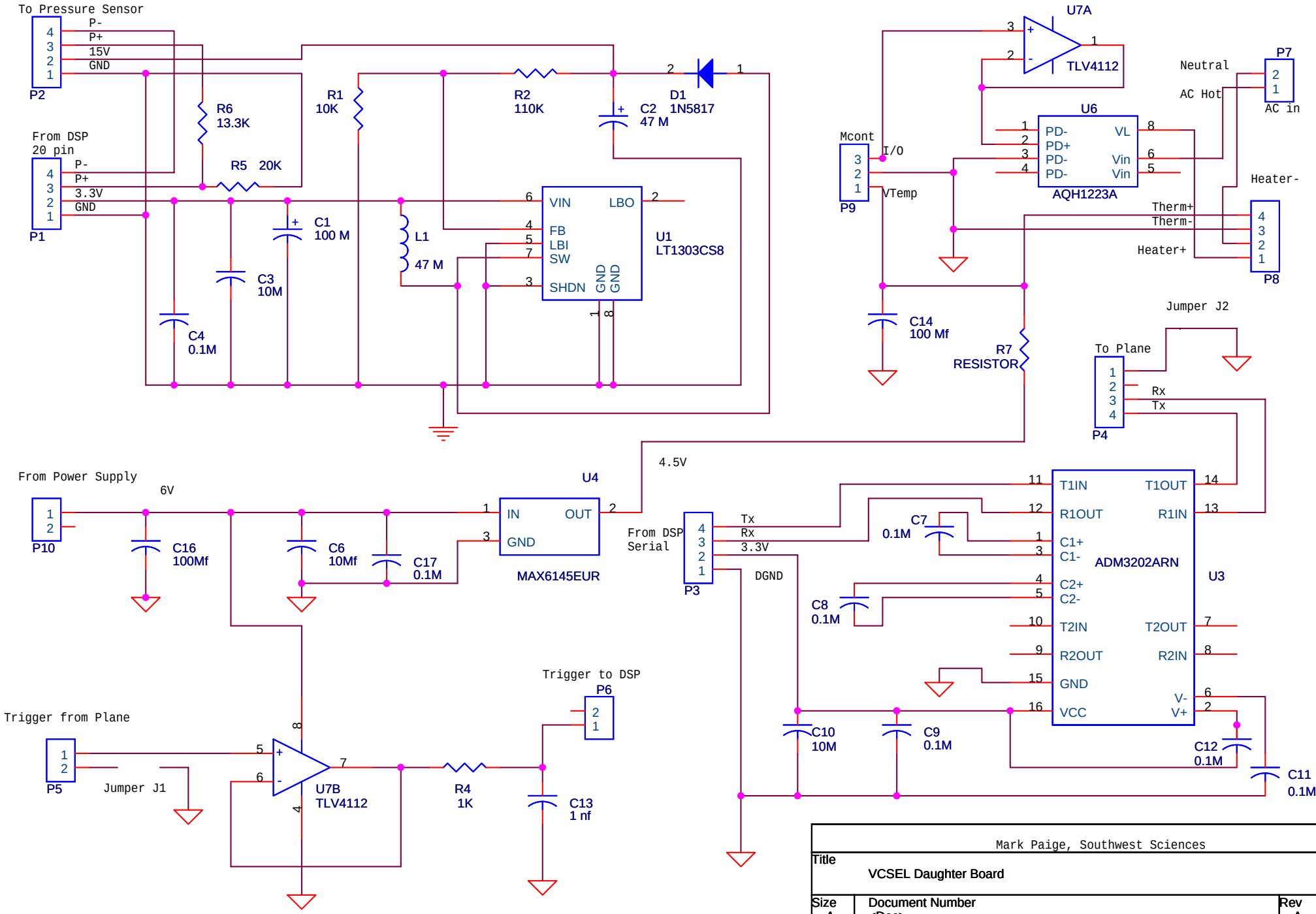
Input

The sole input over the RS232 port is the ambient temperature from the plane's Pitot probe (ATX). This information is sent once a second as an integer in the format T*100 where T is in Celsius.

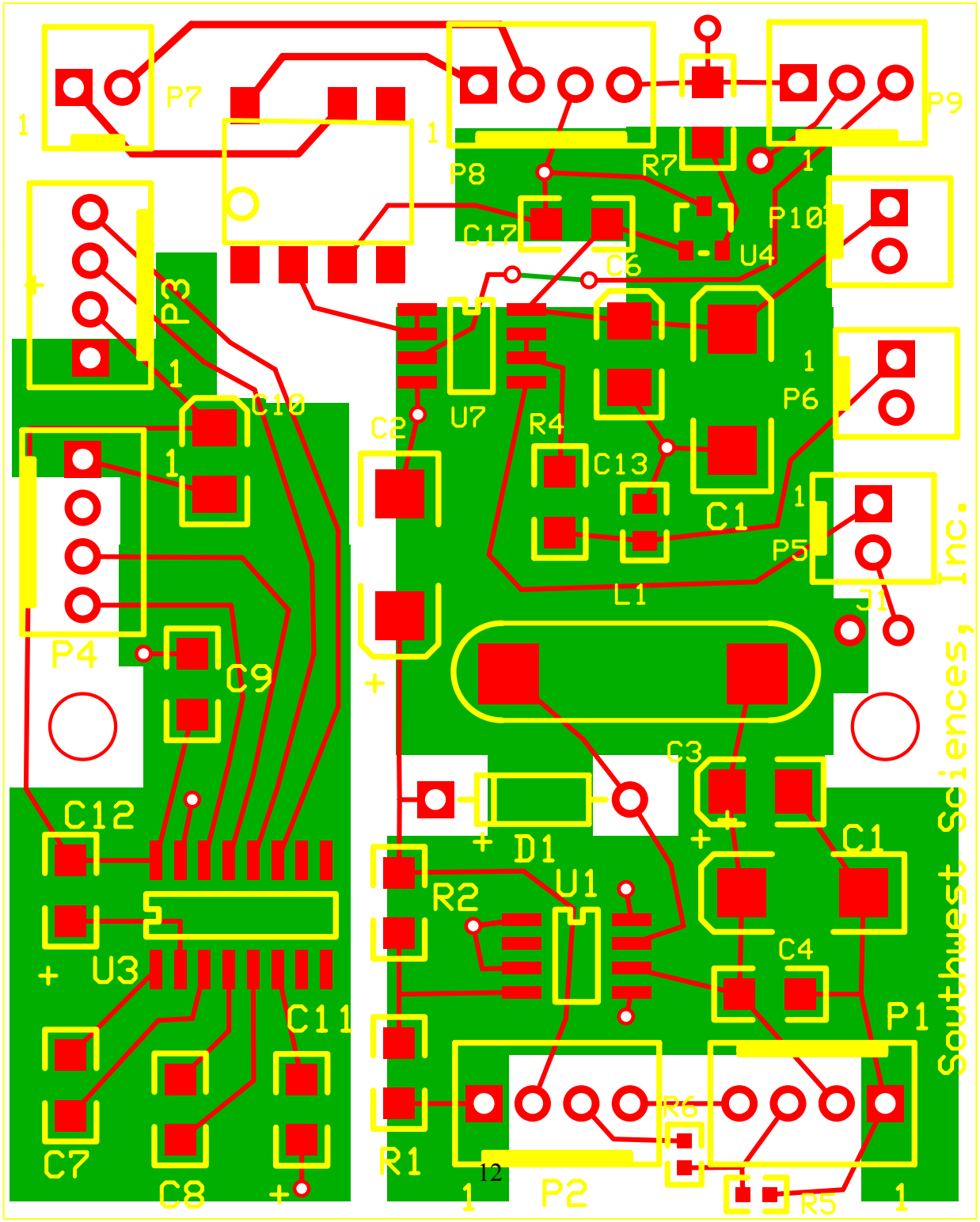
Software code for output

```
if (iLoop==1) // iLoop is data pt number in one second interval
  {
  while (isrTxInProgress==TRUE) {};
  WorkBuf[0]='S';
  WorkBuf[1]='W';
  WorkBuf[2]='S';
  IintoAI(Timestamp, &WorkBuf[3],7,0);
  Timestamp++;
  // Error status word update
  if (abs(ioffcenter)>5) ErrStatus=ErrStatus+8; // Linelocking warning
  if (Saturated==1) ErrStatus=ErrStatus+16;
  if (Saturated==2) ErrStatus=ErrStatus+32;
  if ((Pressure<30)||(Pressure>825)) ErrStatus=ErrStatus+64;
  if ((Temperature<160)||(Temperature>345)) ErrStatus=ErrStatus+128;
  IintoAI(ErrStatus, &WorkBuf[10],5,0);
  ErrStatus=0;
  FintoAF(Temperature, &WorkBuf[15], 5, 1);
  FintoAF(Pressure, &WorkBuf[21], 5, 1);
  IintoAI(ThermOhm, &WorkBuf[27],6,0);
  IintoAI(Tsetpoint, &WorkBuf[33],6,0);
  FintoAF(TECcurrent, &WorkBuf[39],6,0);
  if (PeakType==0) FintoAF(VoightHW5395, &WorkBuf[46],4,4);
  else FintoAF(VoightHW5393, &WorkBuf[46],4,4);
  WorkBuf[45]=' ';
  if (PeakType==2) WorkBuf[46]='S';
  else
   if (PeakType==1) WorkBuf[46]='D';
   else WorkBuf[46]='W';
  IintoAI(CenterCurrent, &WorkBuf[54],5,0);
  IintoAI(RampStepNew, &WorkBuf[59],3,0);
  IintoAI(iModNew, &WorkBuf[62],5,0);
  IintoAI(iPeak, &WorkBuf[67],3,0);
```

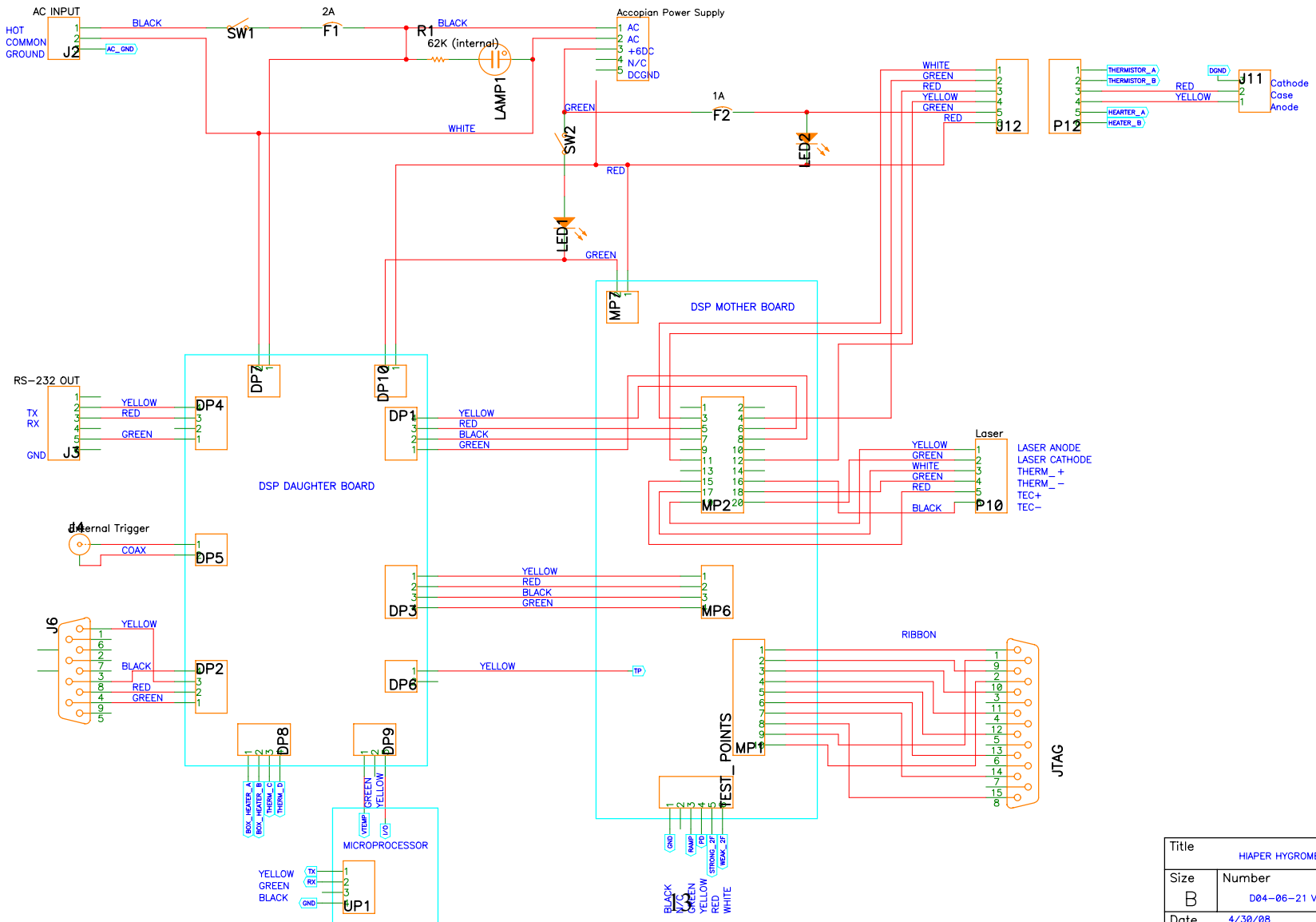
```
  IintoAI(iPreGain2, &WorkBuf[70],2,0);
  FintoAF(ACGain, &WorkBuf[72],4,1);
  IintoAI(I0, &WorkBuf[77],5,0);    // approximately mV

  WorkBuf[82]='\r'; WorkBuf[83]='\n';
  TxString(83);                     // send header info
  FintoAE(Concentration, &TempBuf[0]);
  FintoAE(ChiSq,&TempBuf[9]);
  FintoAF(FrostPoint,&TempBuf[18], 6, 2);
  IintoAI(nGoodScans, &TempBuf[26], 5, 0);
  TempBuf[31]='\r'; TempBuf[32]='\n';
 }

if (iLoop==2)
 {
  while (isrTxInProgress==TRUE) {};
  for (iRow=0;iRow<33;iRow++) WorkBuf[iRow]=TempBuf[iRow];
  FintoAE(Concentration, &WorkBuf[33]);
  WorkBuf[33]=' ';
  FintoAE(ChiSq,&WorkBuf[42]);
  FintoAF(FrostPoint,&WorkBuf[51], 6, 2);
  IintoAI(nGoodScans, &WorkBuf[59], 5, 0);
  WorkBuf[64]='\r'; WorkBuf[65]='\n';
                TxString(65);
 }

if ((iLoop==0)||(iLoop>2))
 {
  while (isrTxInProgress==TRUE) {};
  FintoAE(Concentration, &WorkBuf[0]);
  FintoAE(ChiSq,&WorkBuf[9]);
  FintoAF(FrostPoint,&WorkBuf[18], 6, 2);
  IintoAI(nGoodScans, &WorkBuf[26], 5, 0);
  WorkBuf[31]='\r'; WorkBuf[32]='\n';
  TxString(32);
 }
```

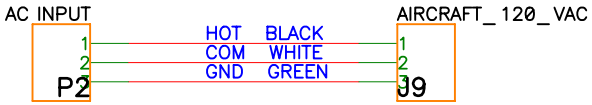


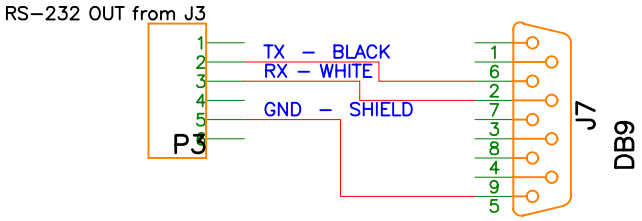
	Mark Paige, Southwest Sciences	
Title	VCSEL Daughter Board	
Size A	Document Number <Doc>	Rev A
Date: Friday, February 29, 2008	Sheet 1 of 1	



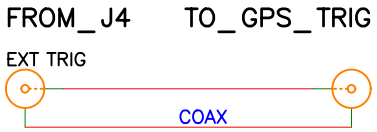
C:\Documents and Settings\Mark\My Documents\Schematics\Hiaper\DaughterBoardE.pcb (Silkscreen, Top layer, Bottom layer)


AC INPUT
HOT
COMMON
GROUND
J2
AC_GND
BLACK
SW1
2A
F1
R1
62K (internal)
LAMP1
Accopian Power Supply
AC
AC
+6DC
N/C
DCGND
1A
F2
SW2
LED2
LED1
WHITE
GREEN
RED
YELLOW
J12
P12
THERMISTOR_A
THERMISTOR_B
HEARTER_A
HEATER_B
DGND
J11
Cathode
Case
Anode
MP7
DSP MOTHER BOARD
DP7
DP10
DP1
DP4
DP5
DP2
DP3
DP6
DP8
DP9
DSP DAUGHTER BOARD
RS-232 OUT
TX
RX
GND
J3
External Trigger
COAX
J4
J6
MP2
MP6
MP1
TEST_POINTS
P10
Laser
LASER ANODE
LASER CATHODE
THERM_+
THERM_−
TEC+
TEC−
RIBBON
JTAG
TP
MICROPROCESSOR
UP1
VTEMP
I/O
BOX_HEATER_A
BOX_HEATER_B
THERM_C
THERM_D
GND
RAMP
PD
STRONG_2F
WEAK_2F
TC
Title
HIAPER HYGROMETER ENCLOSURE WIRING
Size
B
Number
D04-06-21 V3
Rev
Date
4/30/08
Drawn by JAS
Filename
Sheet of
Southwest Sciences, Inc.

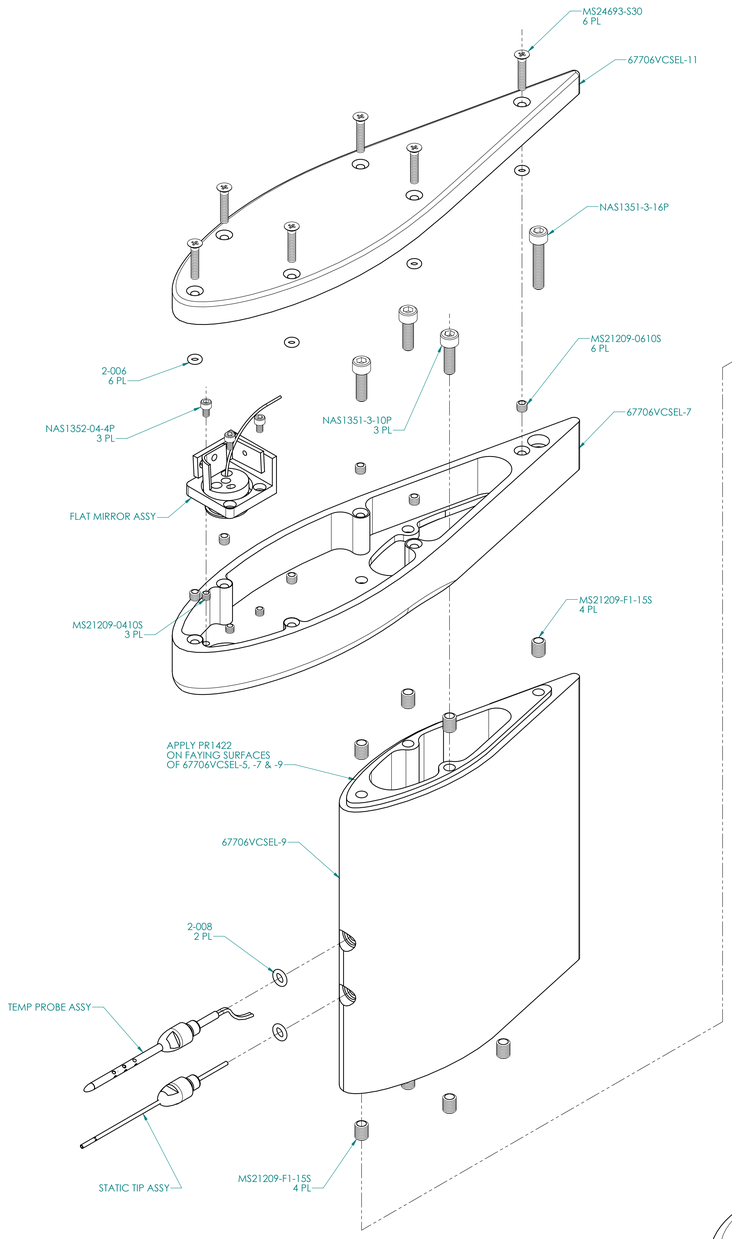


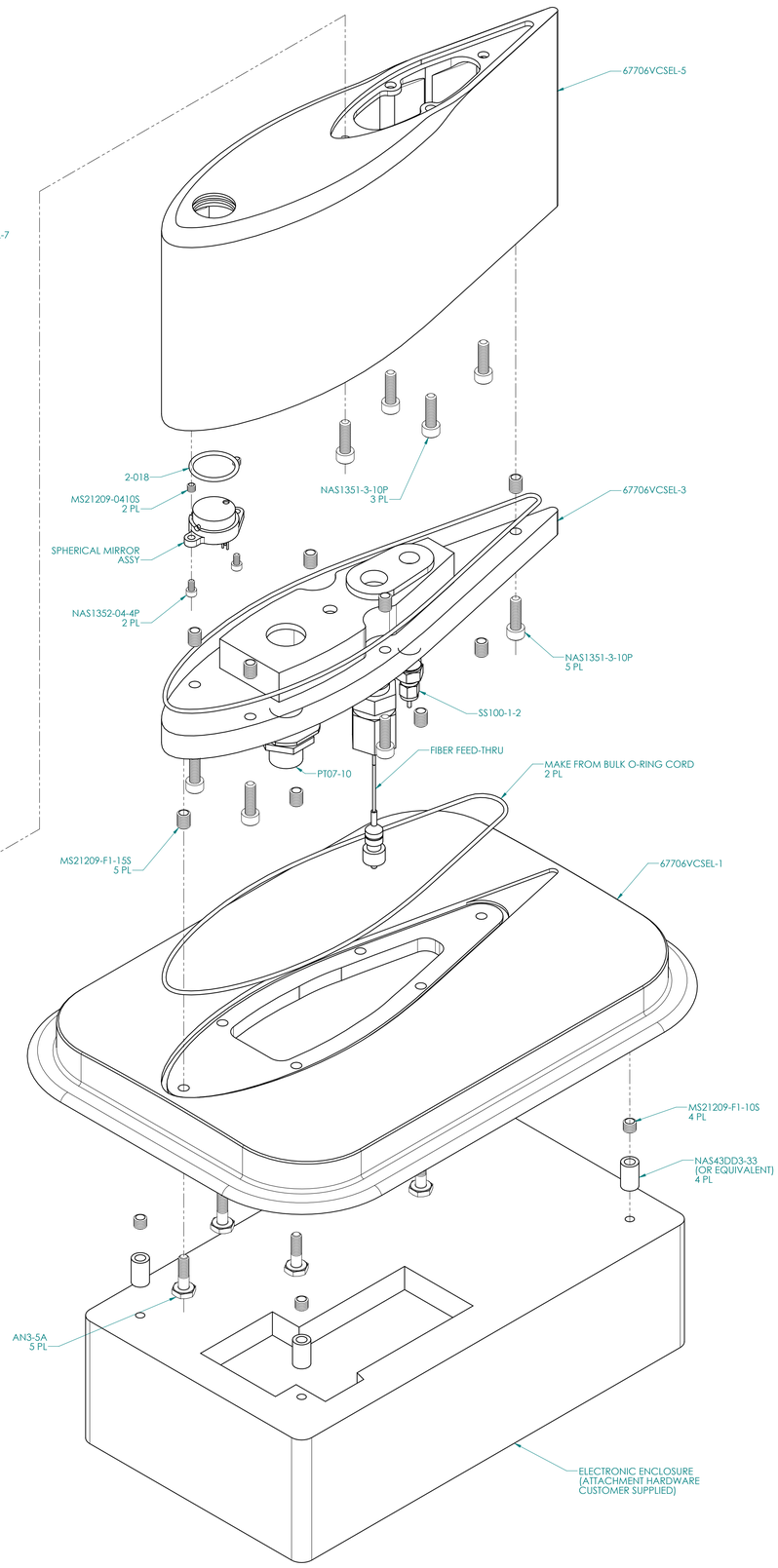


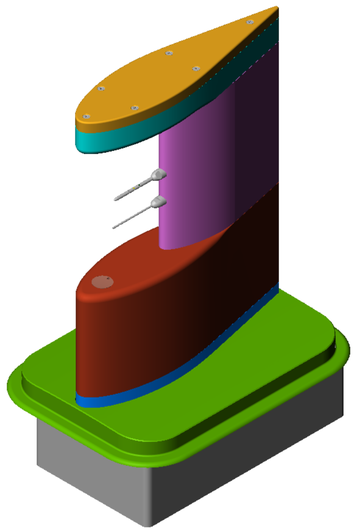
NOTES:
CABLE 2,3 = AWG22 Shileded twisted pairs
CABLE 4 = BNC

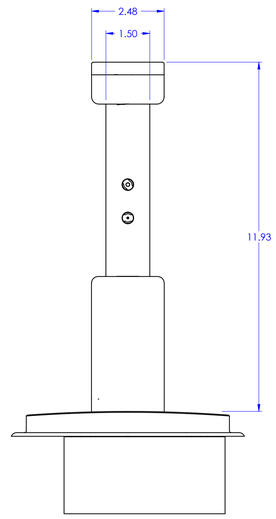


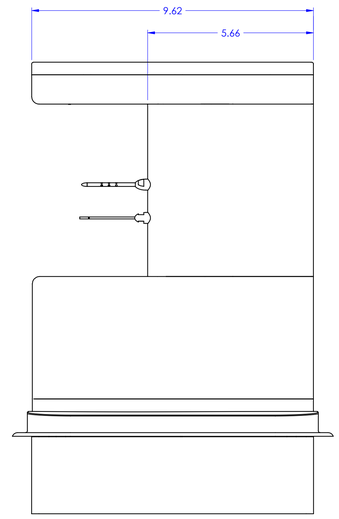
Title	HIAPER HYGROMETER EXTERNAL CABLES	
Size A	Number D04-06-22 v3	Rev
Date 4/30/08		Drawn by JAS
Filename Southwest Sciences, Inc.		Sheet of











AR	36	PR1422	SEALANT		PRC	
	35					
1	34	CUSTOMER SUPPLIED	FEED THRU FITTING			
1	33	CUSTOMER SUPPLIED	TEMPERATURE PROBE ASSY			
1	32	CUSTOMER SUPPLIED	STATIC TIP ASSY			
1	31	CUSTOMER SUPPLIED	FLAT MIRROR ASSY			.10
1	30	CUSTOMER SUPPLIED	SPHERICAL MIRROR ASSY			.06
1	29	CUSTOMER SUPPLIED	ELECTRONIC ENCLOSURE			4.50
	28					
1	27	SS100-1-2	FITTING, 1/16 TUBE TO 1/8 NPT			0.033
1	26	PT07-10	CONNECTOR			.10
1	25	9407K21	LOWER STRUT O-RING	1/16" BUNA-N O-RING CORD	McMASTER-CARR	
	24					
1	23	2-018	O-RING, 0.74 ID x 0.07			
2	22	2-008	O-RING, 0.18 ID x 0.07			
6	21	2-006	O-RING, 0.11 ID x 0.07			
	20					
6	19	NAS1352-04-4P	SCREW, SHC, .112-40x.19			
1	18	NAS1351-3-16P	SCREW, SHC, .190-32x1.00			
12	17	NAS1351-3-10P	SCREW, SHC, .190-32x.62			.08
4	16	NAS43DD3-33	SPACER, 0.19 ID x 0.52			0.012
6	15	MS24693-S30	SCREW, FLUSH HD, .138-32 x .75			
19	14	MS21209-F1-15S	INSERT, HELICOIL, .190-32 x 1.5D			
4	13	MS21209-F1-10S	INSERT, HELICOIL, .190-32 x 1D			
6	12	MS21209-0610S	INSERT, HELICOIL, .138-32 x 1D			
5	11	MS21209-0410S	INSERT, HELICOIL, .112-40 x 1D			
6	10	AN3-5A	BOLT, HEX HD, .190-32 x .66			0.04
	9					
1	8	67706VCSEL-11	STRUT CAP			0.31
1	7	67706VCSEL-9	STRUT, MIDDLE			1.886
1	6	67706VCSEL-7	STRUT, UPPER			0.548
1	5	67706VCSEL-5	STRUT, LOWER			2.301
1	4	67706VCSEL-3	PLATE, INTERFACE			0.625
1	3	67706VCSEL-1	PLATE, APERTURE			2.243
	2					
	1	-A1	CELL STRUT ASSEMBLY			12.85
QTY	ITEM	PARTNUMBER	DESCRIPTION	MATERIAL	SPECIFICATION	WT

-A1 CELL STRUT ASSEMBLY

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:
DECIMALS: X = ±.05, .XX = ±.01, .XXX = ±.004
ANGULAR: FORMED=±2°, MACHINED=±.5°
DO NOT SCALE DRAWING
FINISH N/A
ACCOUNT NO.
APPROVALS
DES. CC 5/9/2006
DR. SJR 120406
CHK.
APPD.
TREATMENT N/A

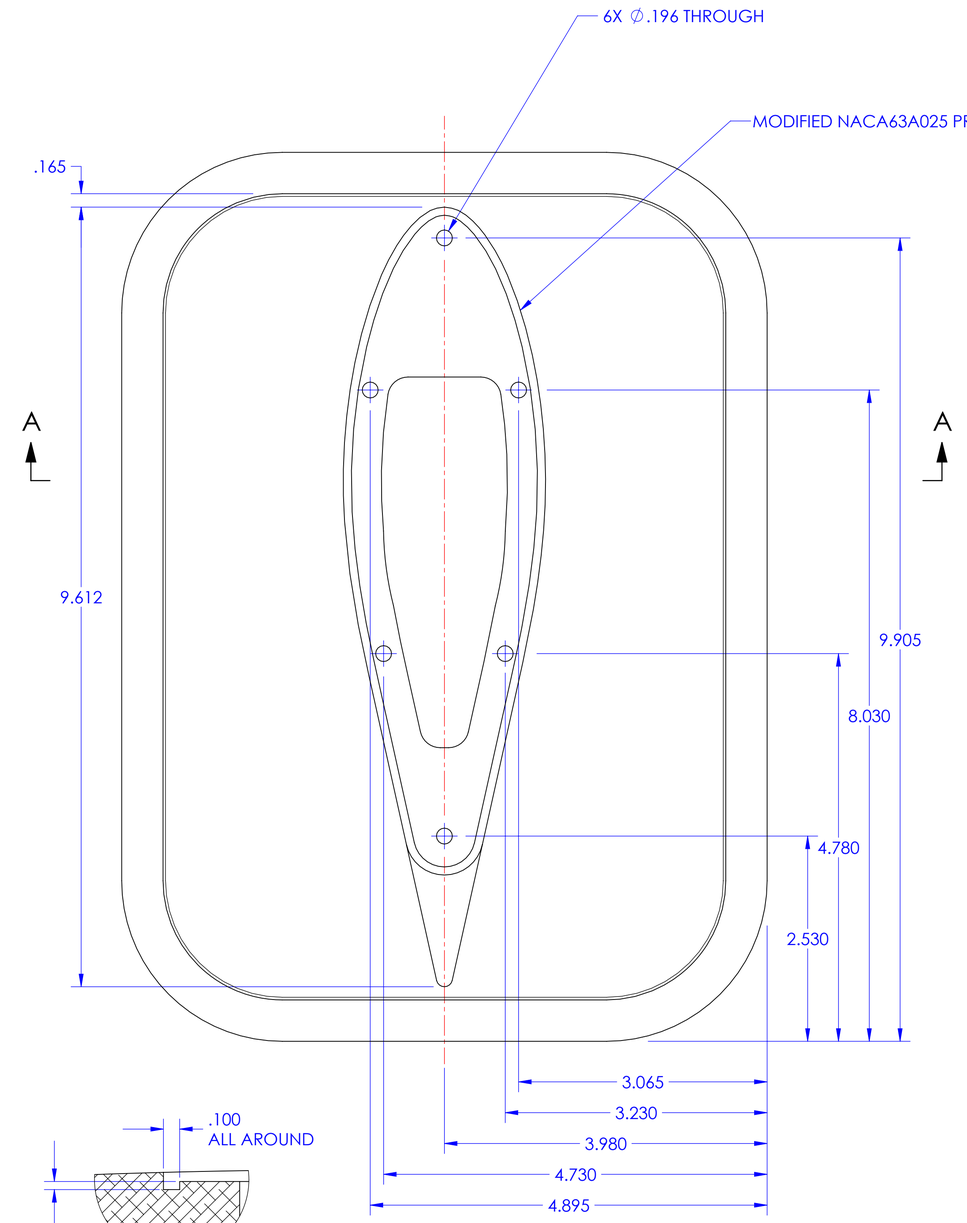
DFS DESIGN & FABRICATION SERVICES
ATMOSPHERIC TECHNOLOGY DIVISION
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

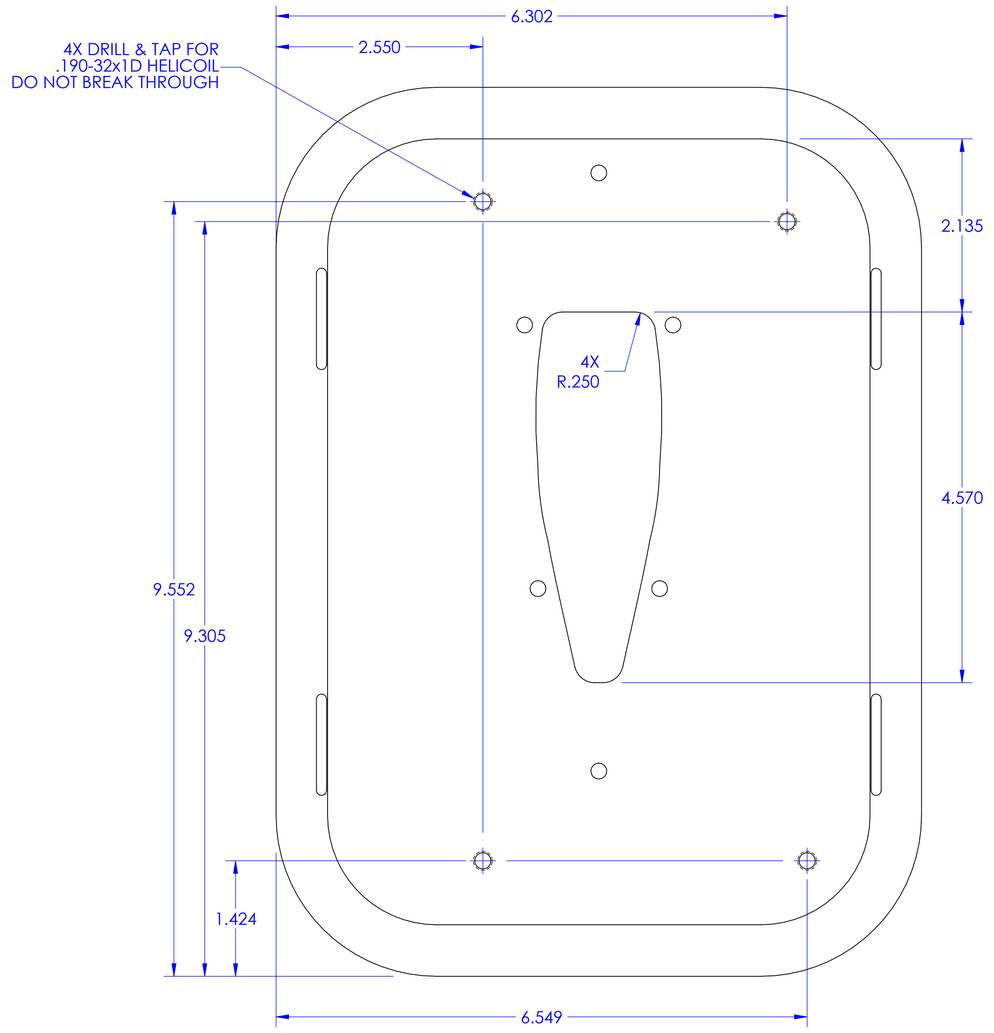
CELL STRUT ASSEMBLY
VCSEL HYGROMETER

SIZE E | PROJECT | DWG NO. 67706VCSEL-A1 | REV. NC
SCALE 1:1 | SHEET 1 of 1

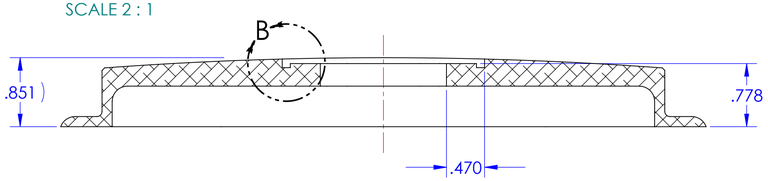
1. MAKE FROM 677DE1098-03 APERTURE PLATE BLANK.

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

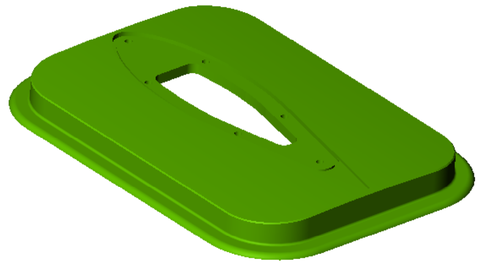




DETAIL B
SCALE 2 : 1



SECTION A-A



QTY REQD	PART NO.	DESCRIPTION	MATERIAL	SPECIFICATION	ZONE
	–1	PLATE, APERTURE	SEE NOTES		

LIST OF MATERIALS OR PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:
DECIMALS: .X = ±.03, .XX = ±.01, .XXX = ±.004
ANGULAR: FORMED = ±2° MACHINED = ±.5°
DO NOT SCALE DRAWING
FINISH: IRRIDITE

ACCOUNT NO.
APPROVALS

DES.	C.C	5/8/2006
DR.	SJR	112206
CHK.		
APPD.		

TREATMENT: NONE

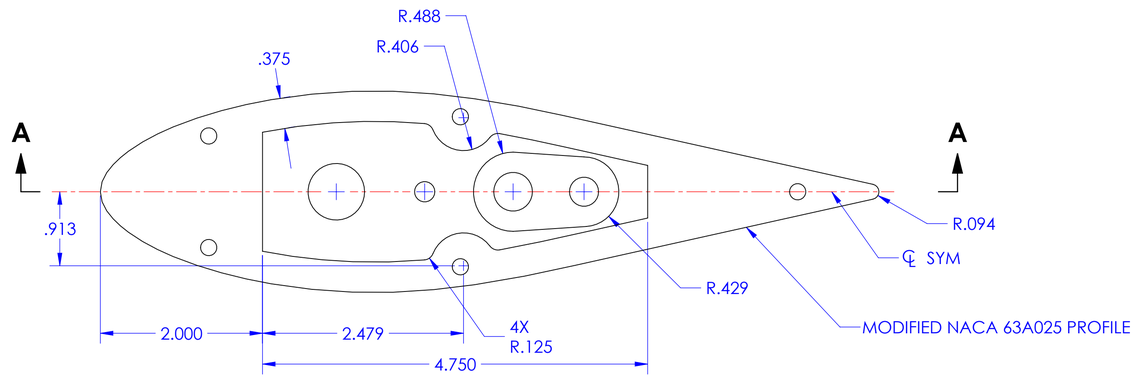
DFS DESIGN & FABRICATION SERVICES
ATMOSPHERIC TECHNOLOGY DIVISION
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

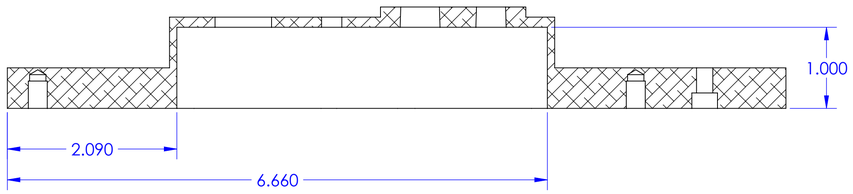
APERTURE PLATE
VCSEL HYGROMETER

SIZE	PROJECT	DWG NO.	REV.
D		67706VCSEL–1	NC

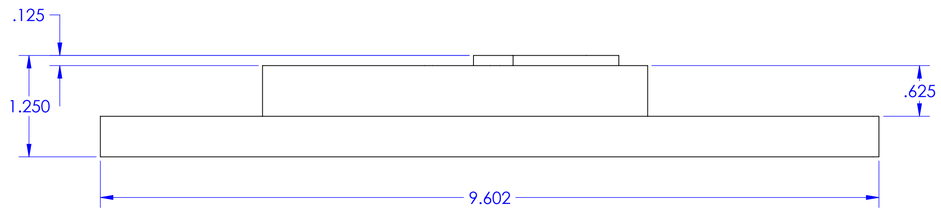
SCALE 1:1 SHEET 1 of 1

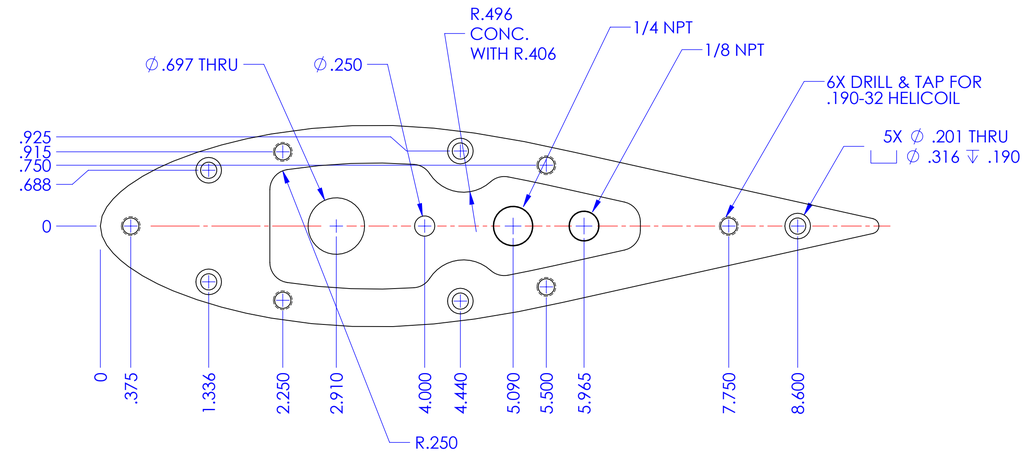
REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

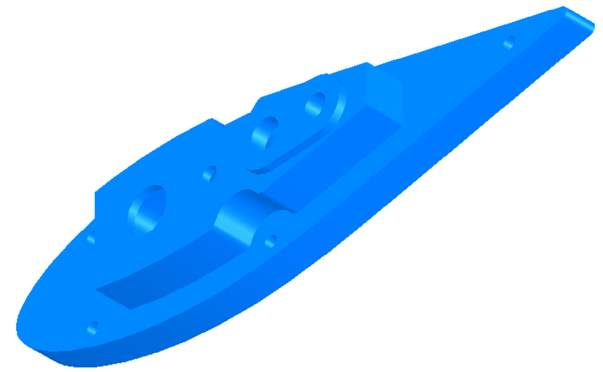




SECTION A-A







NOTES:

1) REMOVE BURRS AND BREAK SHARP EDGES.
2) MATERIAL CERTS REQUIRED.
3) ANODIZE PER MIL-A-8625, GOLD.

QTY REQD	PART NO.	DESCRIPTION	MATERIAL	SPECIFICATION	ZONE
	-3	PLATE, INTERFACE	6061-T6		

LIST OF MATERIALS OR PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:
DECIMALS: .X = ±.03 .XX = ±.01 .XXX = ±.004
ANGULAR: FORMED = ±2° MACHINED = ±.5°
DO NOT SCALE DRAWING
FINISH: SEE NOTES

ACCOUNT NO.
APPROVALS

DES.	C.C.	5/8/2006
DR.	SJR	120406
CHK.		
APPD.		

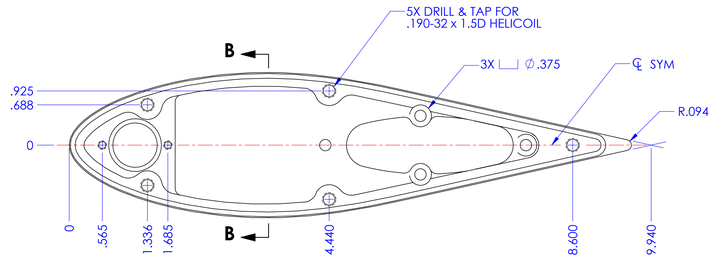
TREATMENT: NONE

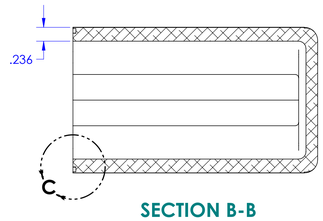
DFS DESIGN & FABRICATION SERVICES
ATMOSPHERIC TECHNOLOGY DIVISION
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

INTERFACE PLATE
VCSEL HYGROMETER

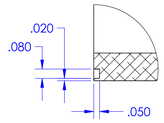
SIZE	PROJECT	DWG NO.	REV.
D		67706VCSEL-3	NC

SCALE 1:1 SHEET 1 of 1

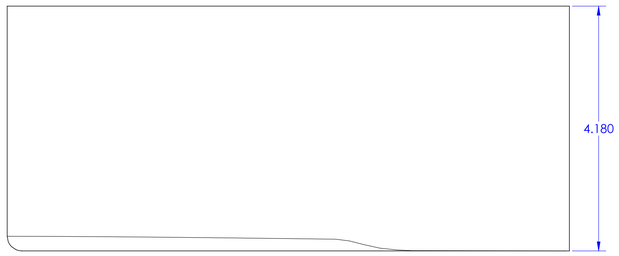


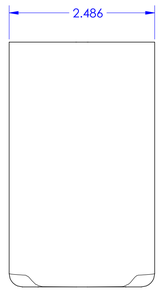


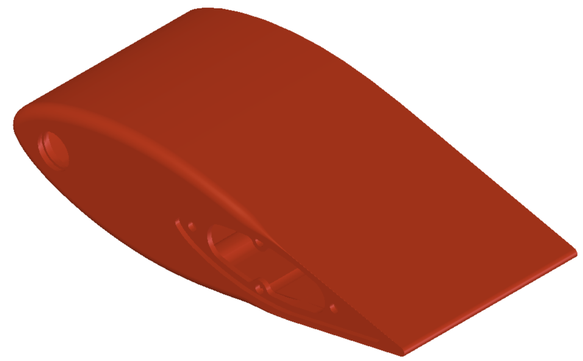
SECTION B-B

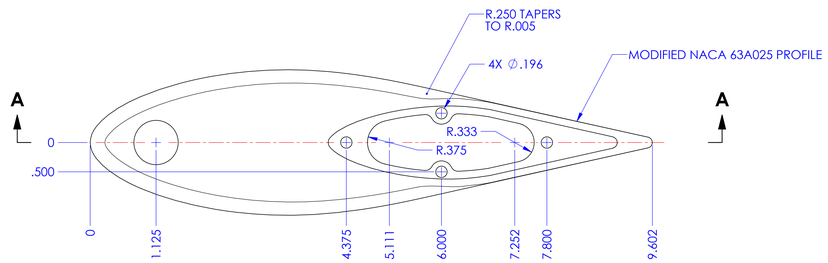


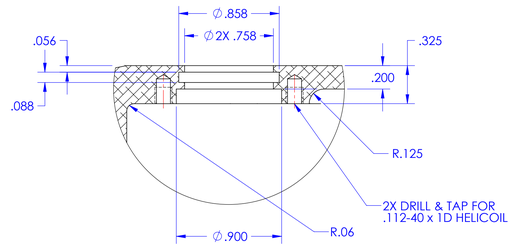
DETAIL C
SCALE 2 : 1



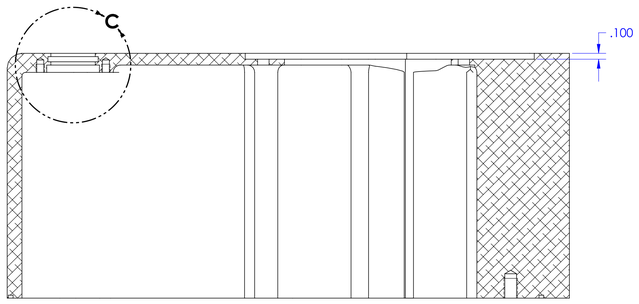








DETAIL C
SCALE 2 : 1



SECTION A-A

NOTES:

1) REMOVE BURRS AND BREAK SHARP EDGES.

2) MATERIAL CERTS REQUIRED.

3) ANODIZE PER MIL-A-8625, GOLD.

QTY. REQD	PART NO.	DESCRIPTION	MATERIAL	SPECIFICATION	ZONE
	-5	STRUT, LOWER	6061-T6		

LIST OF MATERIALS OR PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:
DECIMALS: X = ±.01, XX = ±.01, XXX = ±.004
ANGULAR: FORMED=±2° MACHINED=±.5°
DO NOT SCALE DRAWING
FINISH: SEE NOTES
TREATMENT: NONE

ACCOUNT NO.

APPROVALS

DES.	C.C.	5/9/06
DR.	SJR	112706
CHK.		
APPD.		

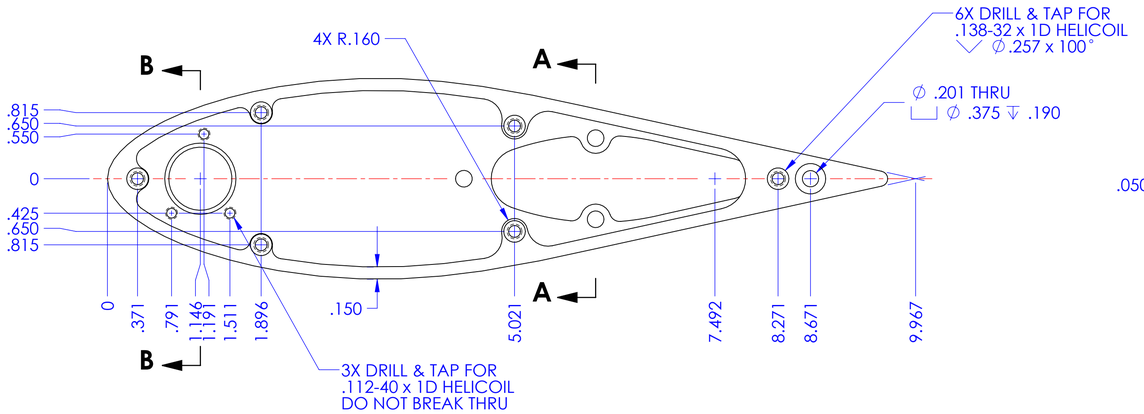
DFS DESIGN & FABRICATION SERVICES
ATMOSPHERIC TECHNOLOGY DIVISION
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

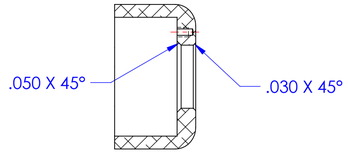
STRUT, LOWER
VCSEL HYGROMETER

SIZE	PROJECT	DWG. NO.	REV.
E		67706VCSEL-5	A

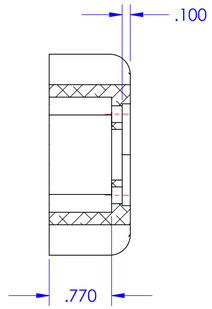
SCALE 1:1 SHEET 1 of 1

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

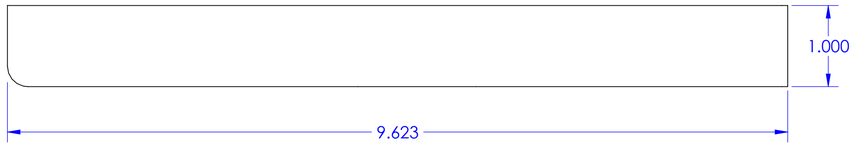


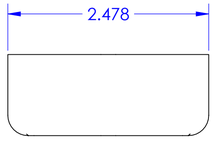


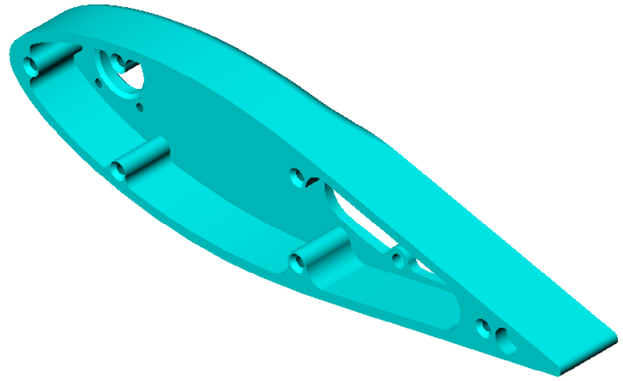
SECTION B-B

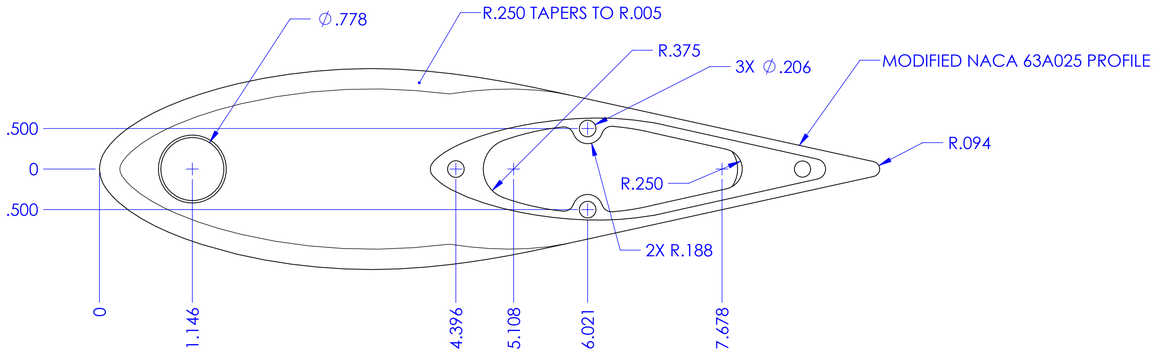


SECTION A-A









NOTES:

1) REMOVE BURRS AND BREAK SHARP EDGES.
2) MATERIAL CERTS REQUIRED.
3) ANODIZE PER MIL-A-8625, GOLD.

QTY REQD	PART NO.	DESCRIPTION	MATERIAL	SPECIFICATION	ZONE
	-7	STRUT, UPPER	6061-T6		

LIST OF MATERIALS OR PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:
DECIMALS: .X = ±.03, .XX = ±.01, .XXX = ±.004
ANGULAR: FORMED = ±2°, MACHINED = ±.5°
DO NOT SCALE DRAWING
FINISH: SEE NOTES

ACCOUNT NO.

APPROVALS

DES.	CC	05/08/06
DR.	SJR	112806
CHK.		
APPD.		

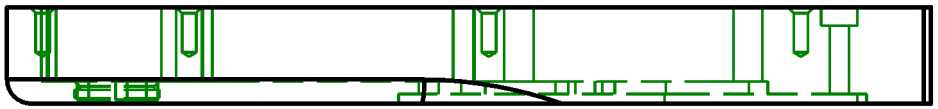
TREATMENT: NONE

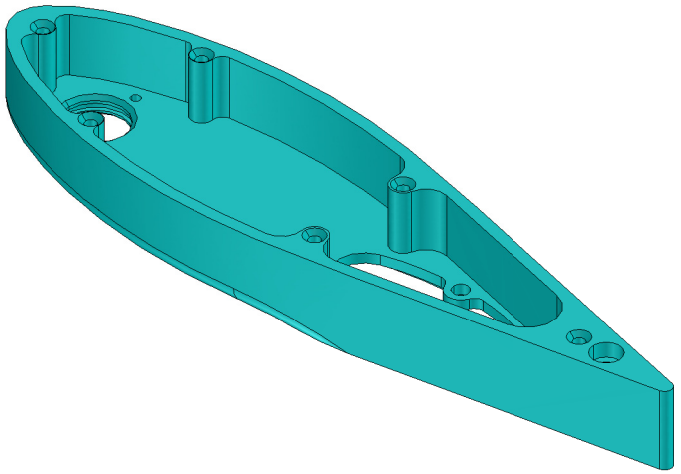
DFS DESIGN & FABRICATION SERVICES
ATMOSPHERIC TECHNOLOGY DIVISION
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

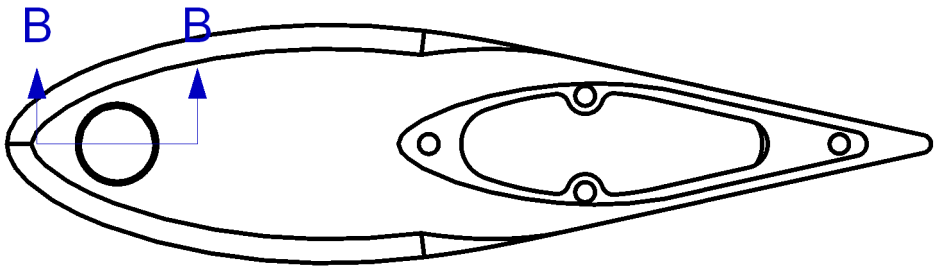
STRUT, UPPER
VC SEL HYGROMETER

SIZE	PROJECT	DWG NO.	REV.
D		67706VCSEL-7	NC

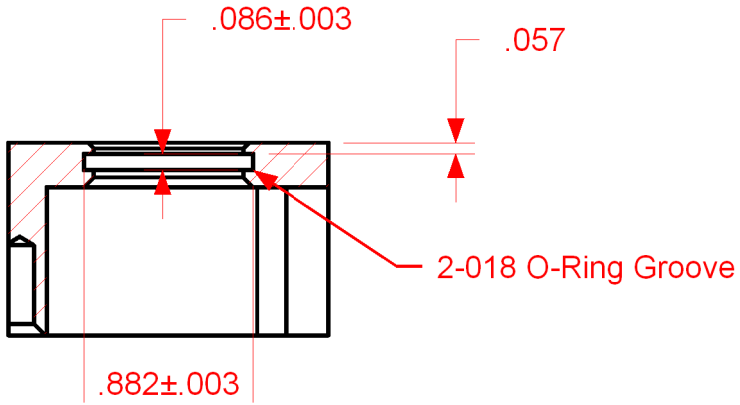
SCALE 1:1 SHEET 1 of 1







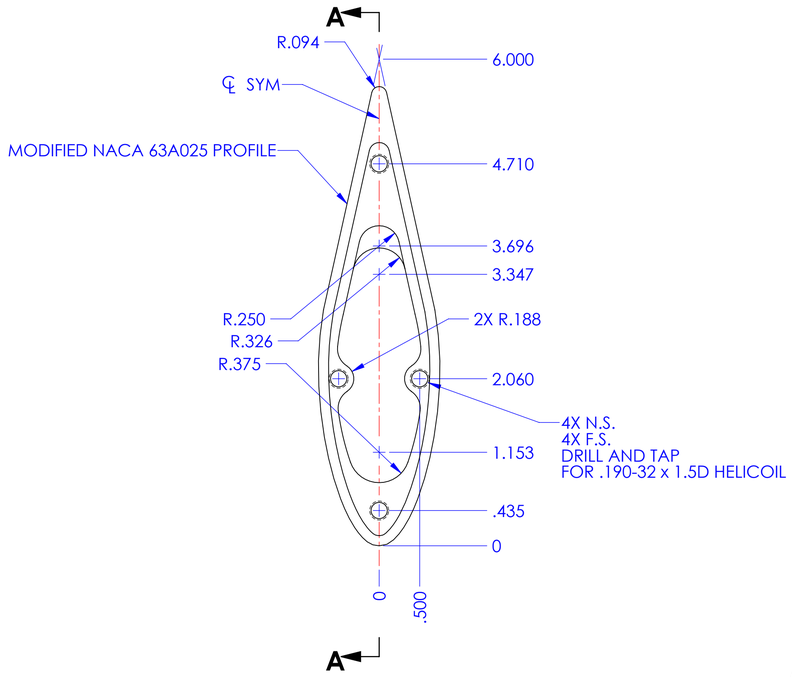
SECTION B-B

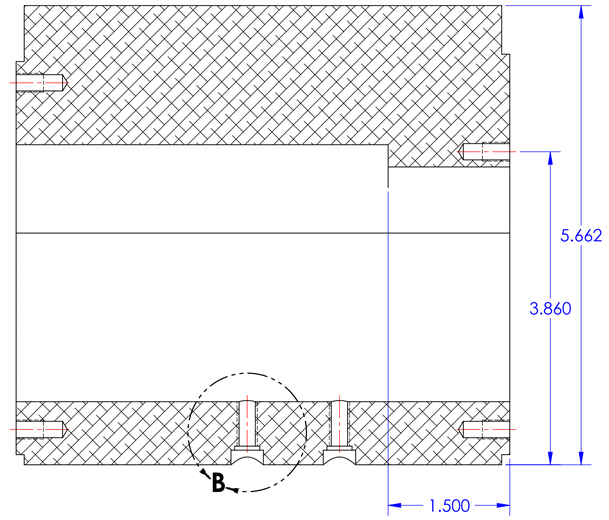


Southwest Sciences incorporated

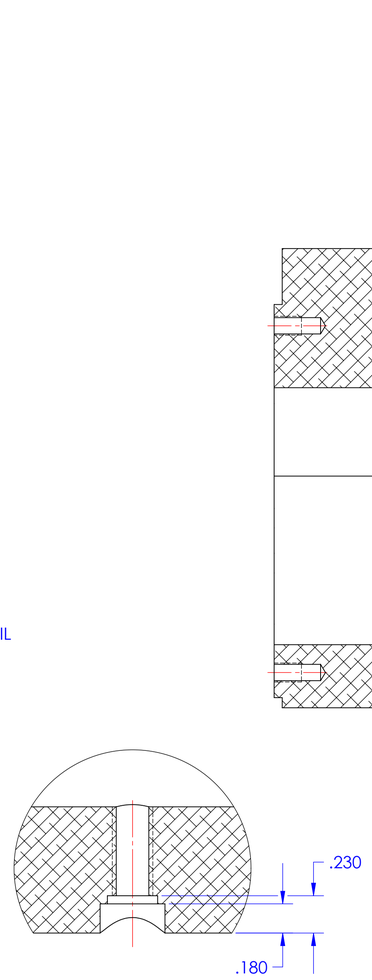
TITLE: HIAPR UPPER STRUT MOD A				
AUTHOR: JAS	SIZE: A	DATE: 2/25/08	DWG NO: D04-06-54	REV:
MATERIAL: 6061 Al	SCALE: 1:2	QNTY: One	SHEET:	

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

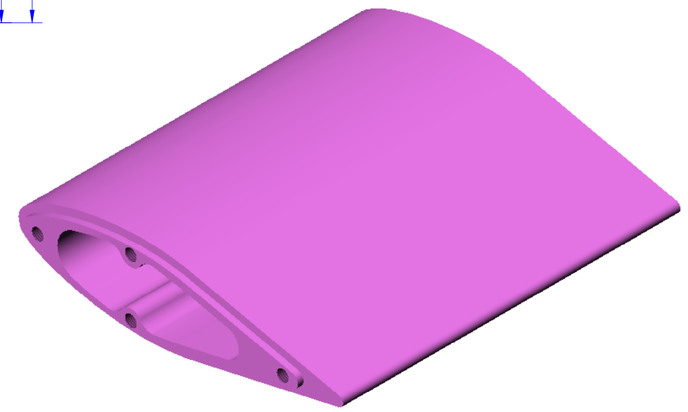


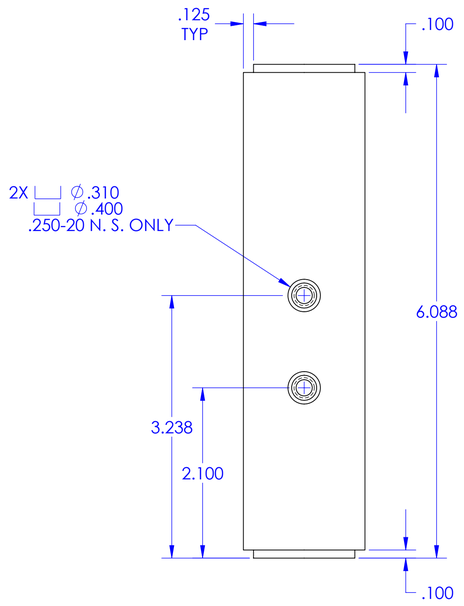


SECTION A-A



DETAIL B
SCALE 2 : 1





NOTES:

1) REMOVE BURRS AND BREAK SHARP EDGES.
2) MATERIAL CERTS REQUIRED.
3) ANODIZE PER MIL-A-8625, GOLD.

QTY REQD	PART NO.	DESCRIPTION	MATERIAL	SPECIFICATION	ZONE
	−9	STRUT, MIDDLE	6061−T6		

LIST OF MATERIALS OR PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:
DECIMALS: .X = ±.03, .XX = ±.01, .XXX = ±.004
ANGULAR: FORMED = ±2° MACHINED = ±.5°
DO NOT SCALE DRAWING
FINISH: SEE NOTES

ACCOUNT NO.
APPROVALS

DES.	C.C	5/9/2006
DR.	SJR	112806
CHK.		
APPD.		

TREATMENT: NONE

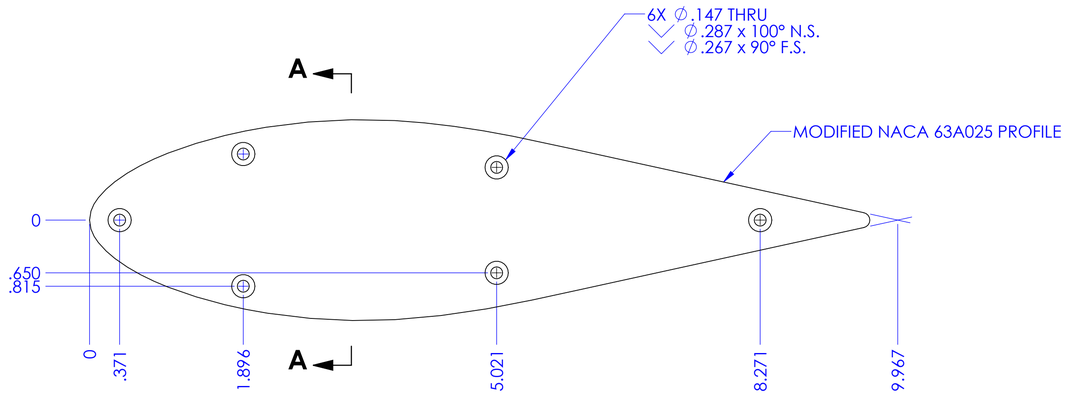
DFS DESIGN & FABRICATION SERVICES
ATMOSPHERIC TECHNOLOGY DIVISION
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

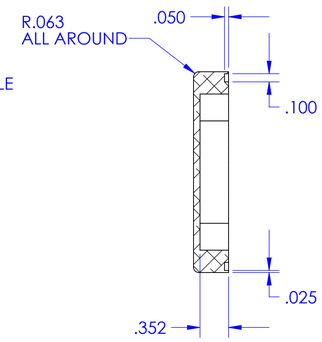
STRUT, MIDDLE
VC SEL HYGROMETER

SIZE	PROJECT	DWG NO.	REV.
D		67706VCSEL−9	NC

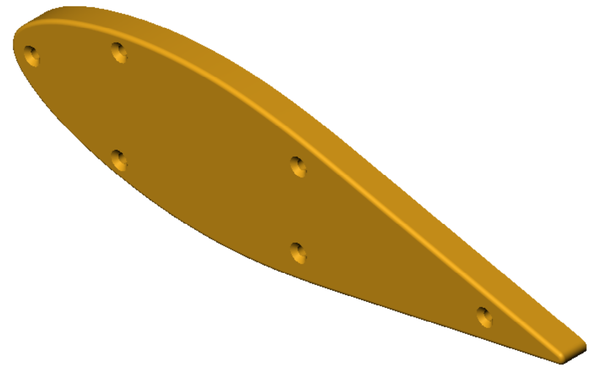
SCALE 1:1 SHEET 1 of 1

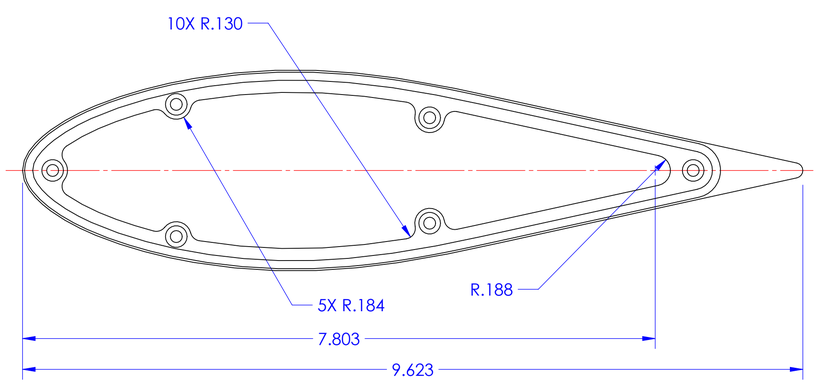
REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED





SECTION A-A





NOTES:

1) REMOVE BURRS AND BREAK SHARP EDGES.
2) MATERIAL CERTS REQUIRED.
3) ANODIZE PER MIL-A-8625, GOLD.

QTY REQD	PART NO.	DESCRIPTION	MATERIAL	SPECIFICATION	ZONE
	-11	STRUT CAP	6061-T6		

LIST OF MATERIALS OR PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:
DECIMALS: .X = ±.03, .XX = ±.01, .XXX = ±.004
ANGULAR: FORMED=±2° MACHINED=±.5°
DO NOT SCALE DRAWING
FINISH: SEE NOTES

ACCOUNT NO.
APPROVALS

DES.	CC	5/8/2006
DR.	SJR	112806
CHK.		
APPD.		

TREATMENT: NONE

DFS DESIGN & FABRICATION SERVICES
ATMOSPHERIC TECHNOLOGY DIVISION
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

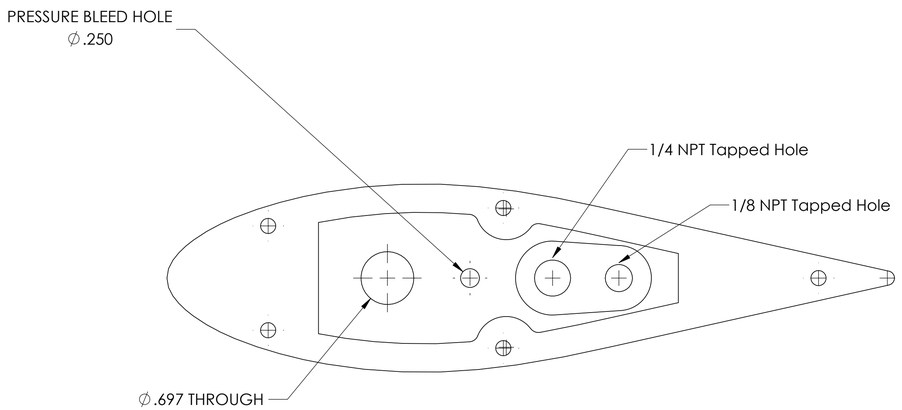
STRUT CAP
VCSEL HYGROMETER

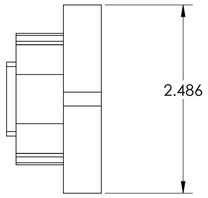
SIZE	PROJECT	DWG NO.	REV.
D		67706VCSEL-11	NC

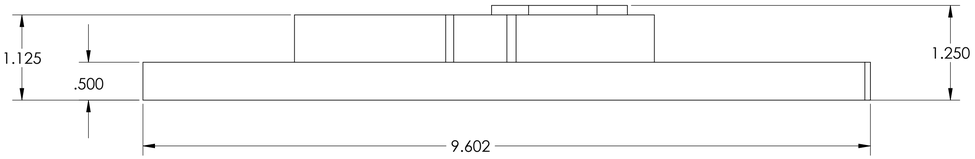
SCALE 1:1 SHEET 1 of 1

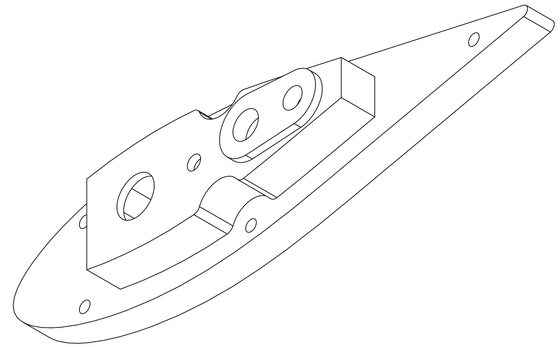
REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED

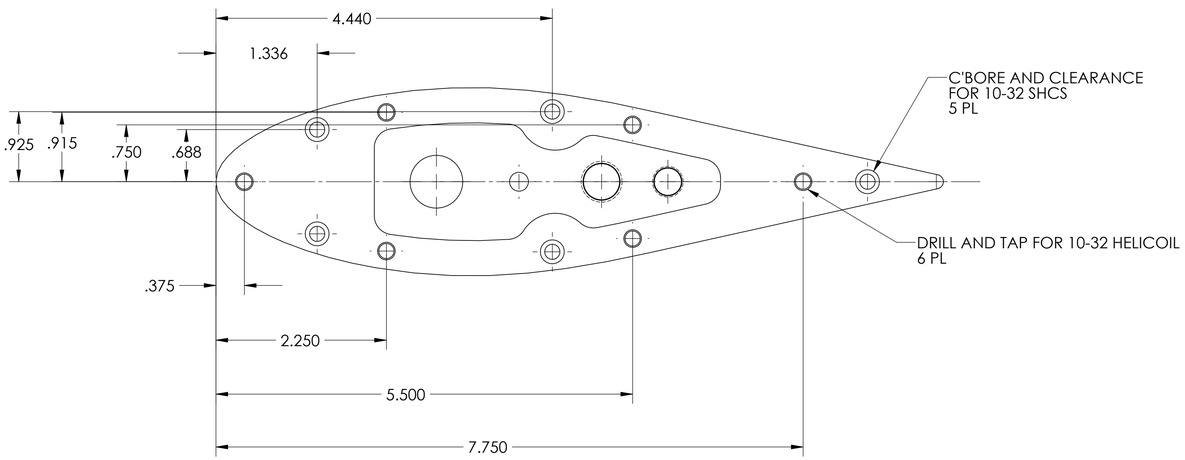
NOTES











ITEM NO.	QTY REQD	PART OR IDENT NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL/SPECIFICATION	ZONE
		-1	PLATE	ALUMINUM 6061-T6	

PARTS LIST

PART DASH NO.	NEXT QTY PER ASSY	FINAL REQD	NEXT ASSY	USED ON
-1	1	1	1-XXXX	PROJECT

APPLICATION

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES
DECIMALS ANGULAR
.XX ± .01 ± 30'
.XXX ± .005
DO NOT SCALE DRAWING

TREATMENT

FINISH

CONTRACT NO.

DESIGN AND FABRICATION SERVICES, A DIVISION OF NCAR
3450 MITCHELL LANE
BOULDER, COLORADO 80301 303-497-1000

DRAWN C. CHAMBELLAN DATE 9/25/2006

CHECK

ENGINEER

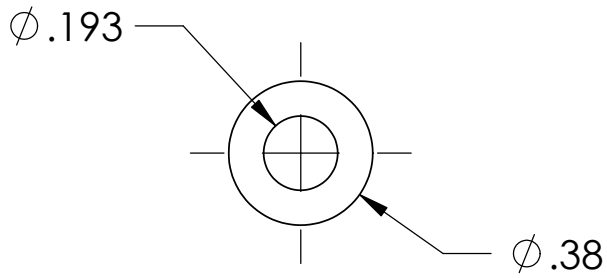
TECHNICIAN

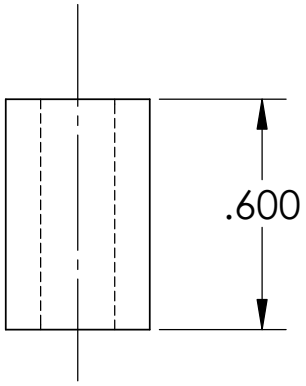
PROJECT SCIENTIST

TITLE
VCSEL HYGROMETER PLATE, INTERFACE

SIZE D | DWG NO. | REV. A

SCALE 1:1 | RELEASE DATE XX/XX/XX | SHEET 1 OF 1





VCSEL HYGROMETER

			NAME	DATE
DRAWN	CHAMBELLAN			
CHECKED				
ENG APPR.				
MFG APPR.				
Q.A.				

COMMENTS:

DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±

MATERIAL
ALUMINUM 6061-T6

FINISH
24

DO NOT SCALE DRAWING

NEXT ASSY	USED ON
APPLICATION	

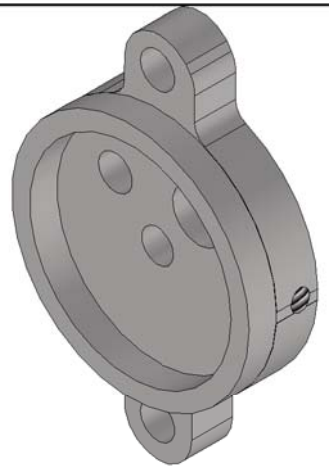
DFS A DIVISION OF NCAR

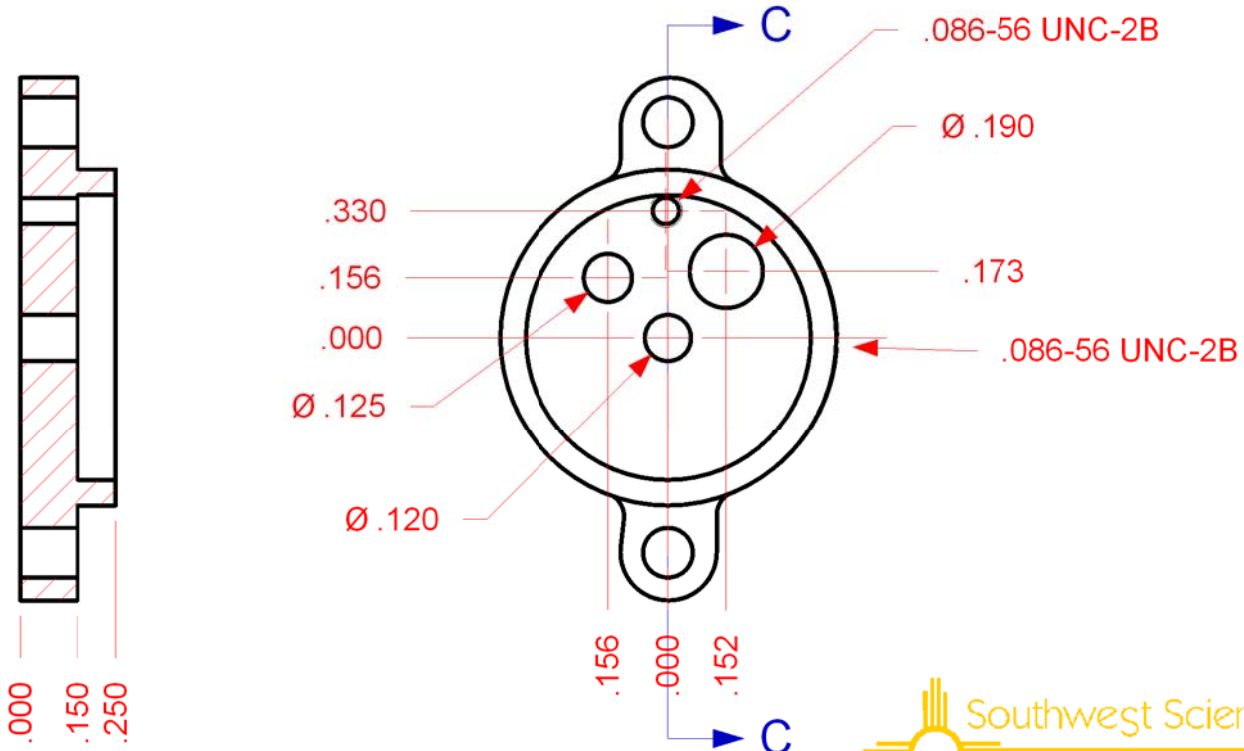
SPACER

SIZE	DWG. NO.	REV.
A	Elec box spacer	
SCALE:2:1	WEIGHT:	SHEET 1 OF 1

NOTE: Modify original design for VCSEL Hygrometer Cell, Lower Mirror as shown in this drawing. we have changed holes and positions in center of piece, added TWO #2-56 THD and changed thicknesses.

SECTION C-C



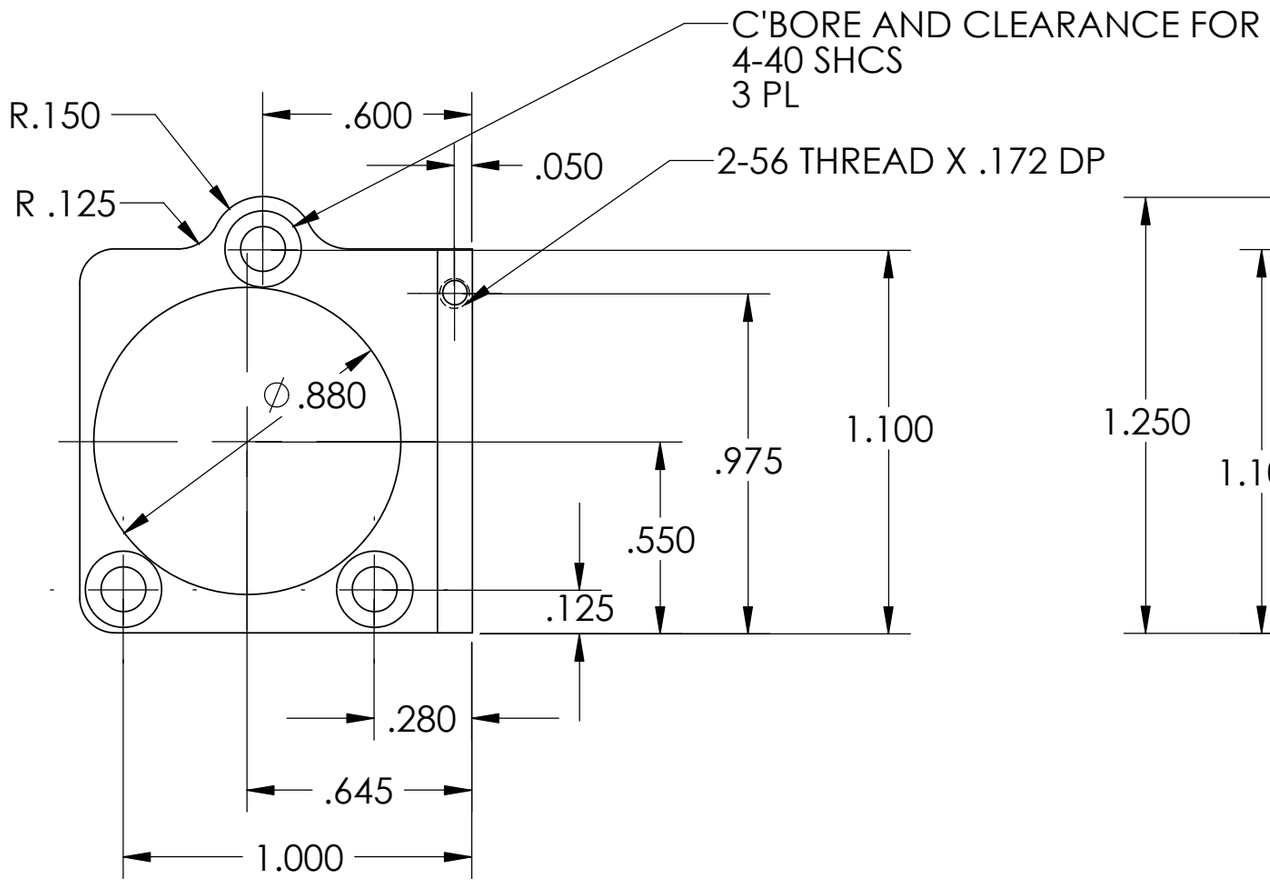


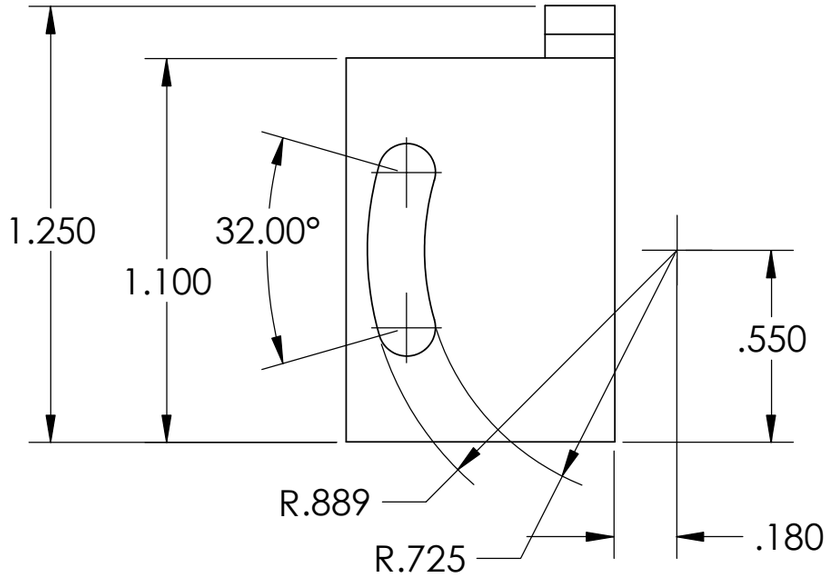
Southwest Sciences incorporated

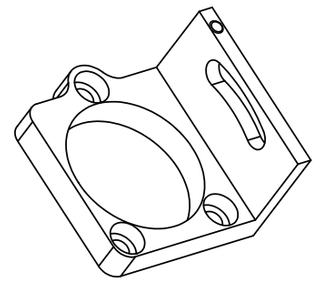
TITLE: HIAPER MODIFIED LOWER MIRROR MOUNT				
AUTHOR: JAS	SIZE: A	DATE: 7/10/08	DWG NO: D04-06-MOUNT02a	REV: 1
MATERIAL: 6061 Al	SCALE:	QNTY: One	SHEET:	

1. MATERIAL CERTIFICATION REQUIRED

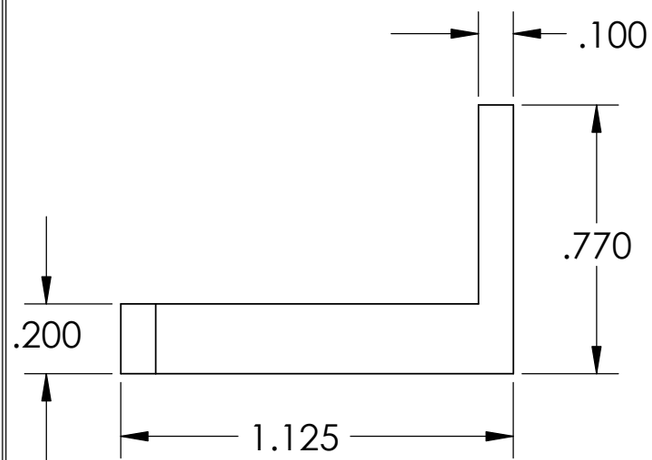
REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED







ISOMETRIC



ITEM	PART NO.	DESCRIPTION	MATERIAL	SPECIFICATION	WT.
X		FLAT MIRROR MOUNT	ALUMINUM 6061-T6		

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.
TOLERANCES ARE:

DECIMALS:
.X = ±.03
.XX = ±.01
.XXX = ±.004

ANGULAR:
FORMED=±2°
MACHINED=±.5°

DO NOT SCALE DRAWING

NEXT ASSEMBLY

APPROVALS		DATE
DR.		
ENG.		
CHK.		
APPD.		
APPD.		

EFFECTIVITY

HIAPER
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH
1850 TABLE MESA DRIVE
BOULDER, CO 80305

Flat Mirror Mount
VCSEL HYGROMETER

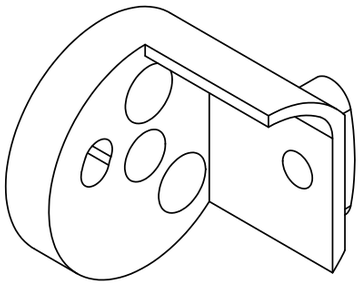
SIZE	CAGE CODE	DWG NO.	REV.
B	0SEF6		NC

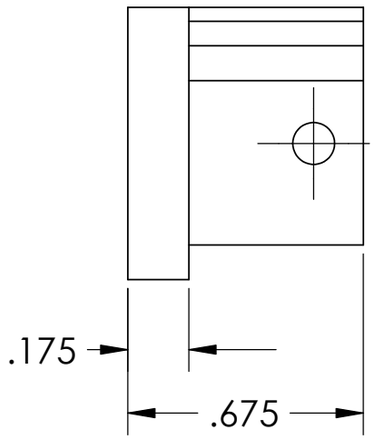
SCALE 2:1

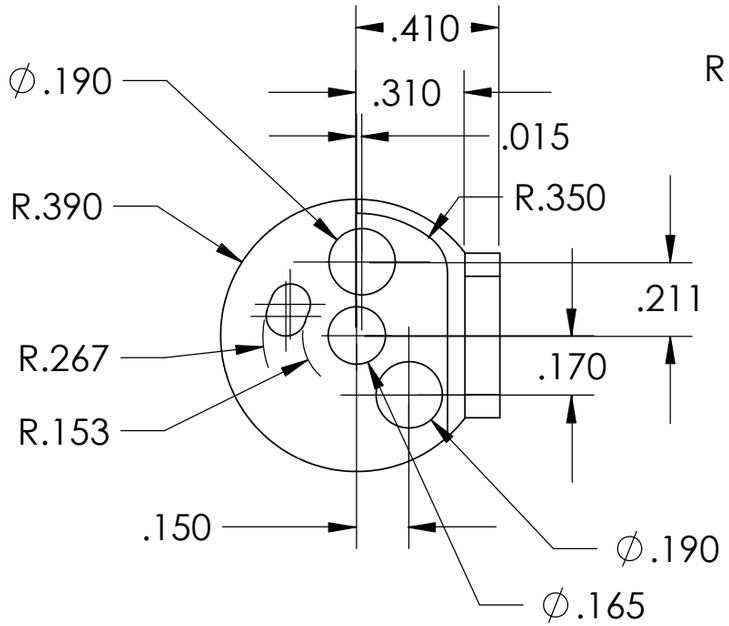
DESIGN & FABRICATION SERVICES, ATMOSPHERIC TECHNOLOGY DIV.

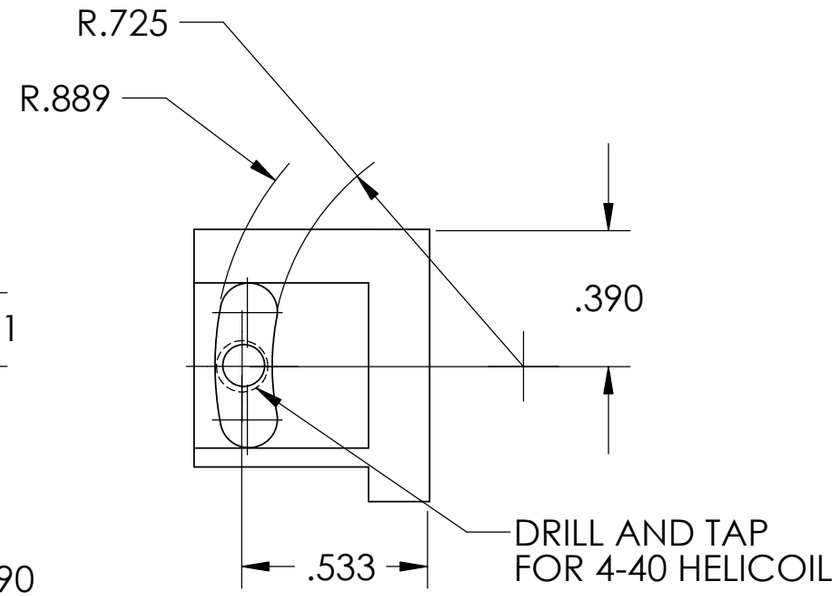
SHEET 1 of 1

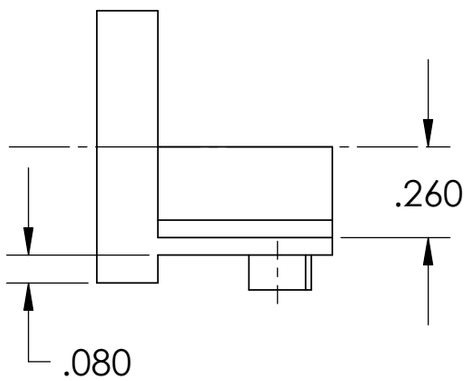
REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED











ITEM	PART NO.	DESCRIPTION	MATERIAL	SPECIFICATION	WT.
X		UPPER MIRROR HOLDER	ALUMINUM 6061-T6		

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:

DECIMALS:
.X = ±.03
.XX = ±.01
.XXX = ±.004

ANGULAR:
FORMED=±2°
MACHINED=±.5°

DO NOT SCALE DRAWING

NEXT ASSEMBLY

APPROVALS		DATE
DR.		
ENG.		
CHK.		
APPD.		
APPD.		

EFFECTIVITY

27

HIAPER

NATIONAL CENTER FOR ATMOSPHERIC RESEARCH
1850 TABLE MESA DRIVE
BOULDER, CO 80305

Flat Mirror Holder
VCSEL HYGROMETER

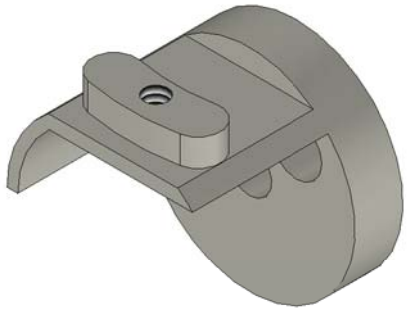
SIZE	CAGE CODE	DWG NO.	REV.
B	0SEF6		NC

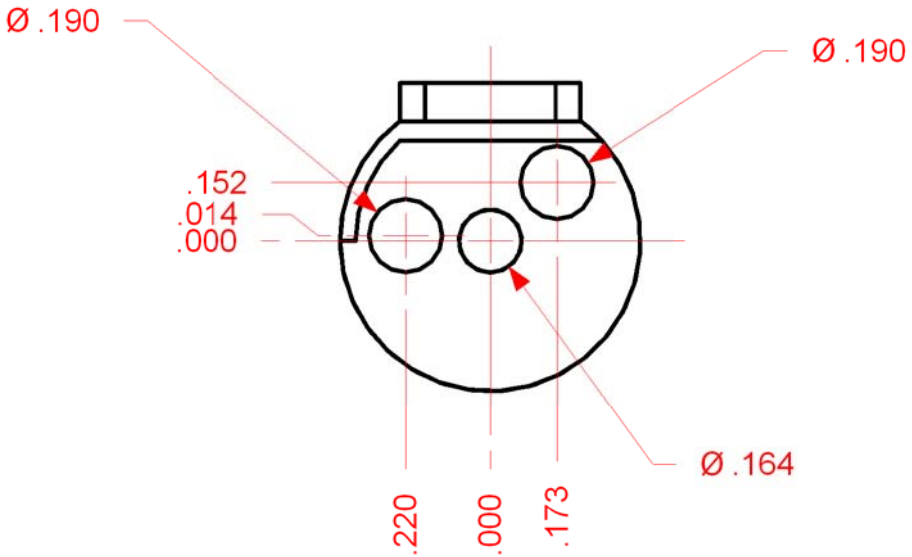
SCALE 2:1

DESIGN & FABRICATION SERVICES, ATMOSPHERIC TECHNOLOGY DIV.

SHEET 1 of 1

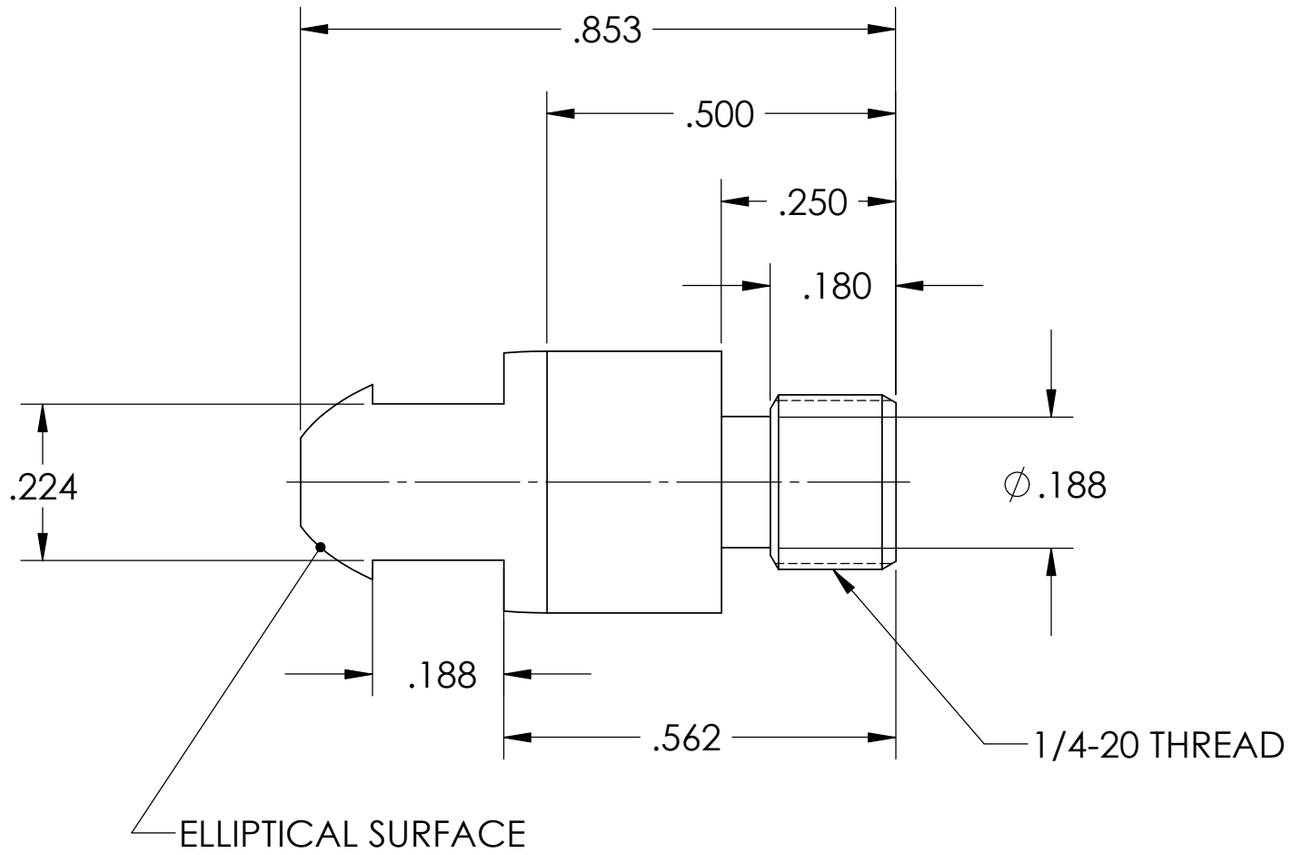
NOTE: Modify original design for VCSEL Hygrometer Flat Mirror Holder as shown in this drawing. We have just changed the holes and pattern in center of piece.

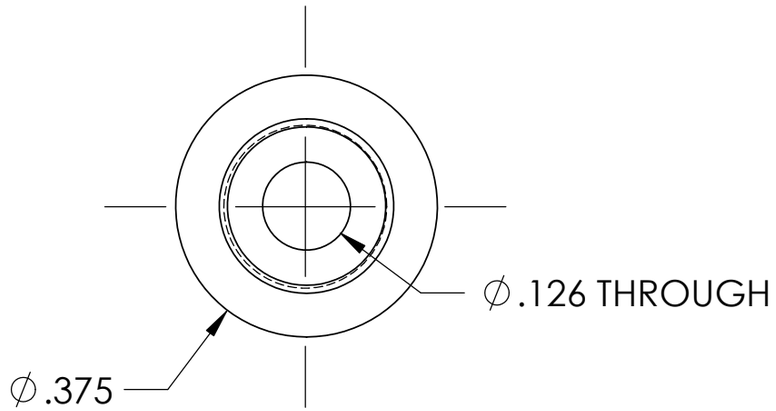




Southwest Sciences incorporated

TITLE: HIAPER Modified Flat Mirror Holder				
AUTHOR: JAS	SIZE: A	DATE: 4/18/07	DWG NO: D04-06-MOUNT01 SPH	REV
MATERIAL: 6061 Al	SCALE:	QNTY: One	SHEET:	





REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

X		TIP	STAINLESS STEEL		
ITEM	PART NO.	DESCRIPTION	MATERIAL	SPECIFICATION	WT.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:

DECIMALS:
.X = ±.03
.XX = ±.01
.XXX = ±.004

ANGULAR:
FORMED=±2°
MACHINED=±.5°

DO NOT SCALE DRAWING

APPROVALS		DATE
DR.		
ENG.		
CHK.		
APPD.		
APPD.		

NEXT ASSEMBLY

EFFECTIVITY

29

HIAPER
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH
1850 TABLE MESA DRIVE
BOULDER, CO 80305

Temp Tip
VCSEL HYGROMETER

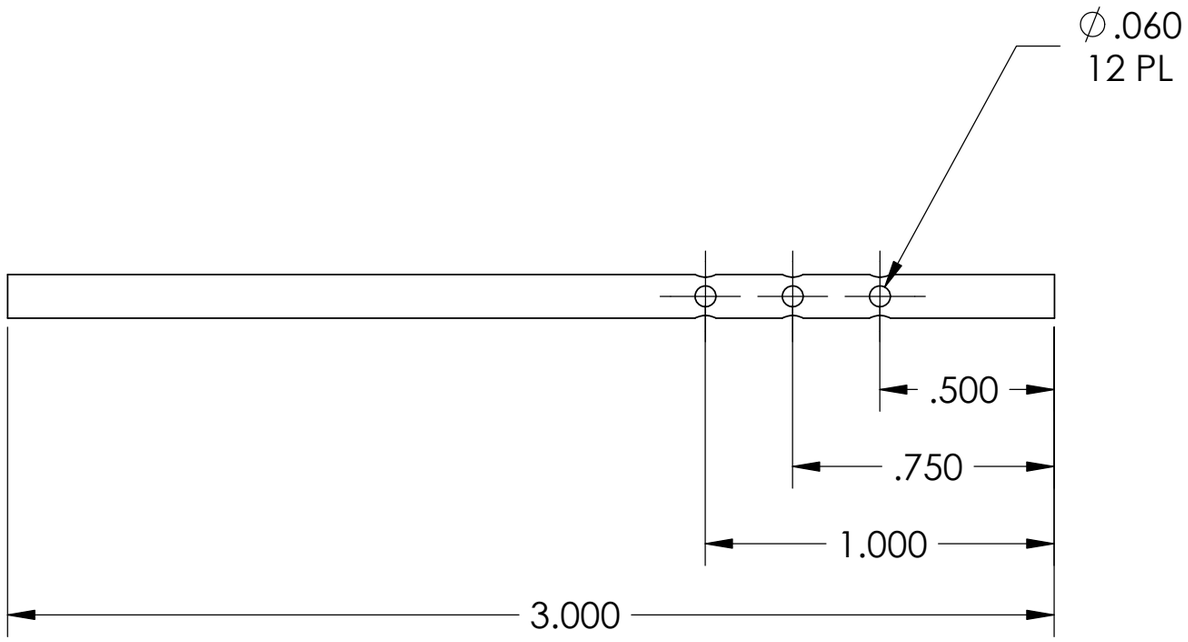
SIZE	CAGE CODE	DWG NO.	REV.
B	0SEF6		NC

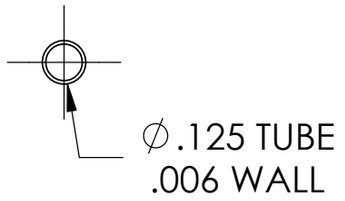
SCALE 4:1

DESIGN & FABRICATION SERVICES, ATMOSPHERIC TECHNOLOGY DIV.

SHEET 1 of 1

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED





ITEM	PART NO.	DESCRIPTION	MATERIAL	SPECIFICATION	WT.
X		TUBE	SS TUBE		

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:

DECIMALS:
.X = ±.03
.XX = ±.01
.XXX = ±.004

ANGULAR:
FORMED=±2°
MACHINED=±.5°

DO NOT SCALE DRAWING

NEXT ASSEMBLY

APPROVALS		DATE
DR.		
ENG.		
CHK.		
APPD.		
APPD.		

EFFECTIVITY

30

HIAPER

NATIONAL CENTER FOR ATMOSPHERIC RESEARCH
1850 TABLE MESA DRIVE
BOULDER, CO 80305

Temp probe tube
VCSEL HYGROMETER

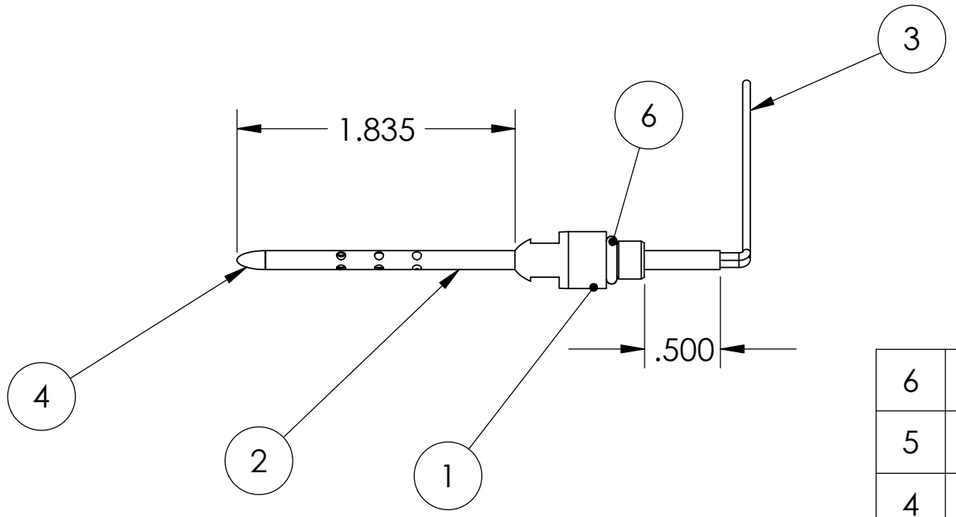
SIZE	CAGE CODE	DWG NO.	REV.
B	0SEF6		NC

SCALE 2:1

DESIGN & FABRICATION SERVICES, ATMOSPHERIC TECHNOLOGY DIV.

SHEET 1 of 1

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED



ITEM NO.	QTY	PART NO.	DESCRIPTION OR NOMENCLATURE	MATERIAL/SPECIFICATION	ZONE
6	1	2-008	O-RING	POLYMER	
5	1		EPOXY	EPOXY	
4	1		PROBE TIP	STAINLESS STEEL	
3	1	BR23KB27 4N-CDEK	THERMISTER	GENERAL ELECTRIC THERMISTER	
2	1		TUBE	SS TUBE	
1	1	-1	TIP	STAINLESS STEEL	

PARTS LIST

PART DASH NO.	NEXT QTY REQD PER ASSY	FINAL QTY REQD PER ASSY	NEXT ASSY APPLICATION	USED ON PROJECT
-1	1	1	ASSY	PROJECT

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES
DECIMALS ANGULAR
.XX ± .01 ± 30'
.XXX ± .005
DO NOT SCALE DRAWING

TREATMENT

FINISH

CONTRACT NO.

DRAWN C. CHAMBELLAN DATE 9/26/2006

CHECK

ENGINEER C.CHAMBELLAN

TECHNICIAN

PROJECT SCIENTIST

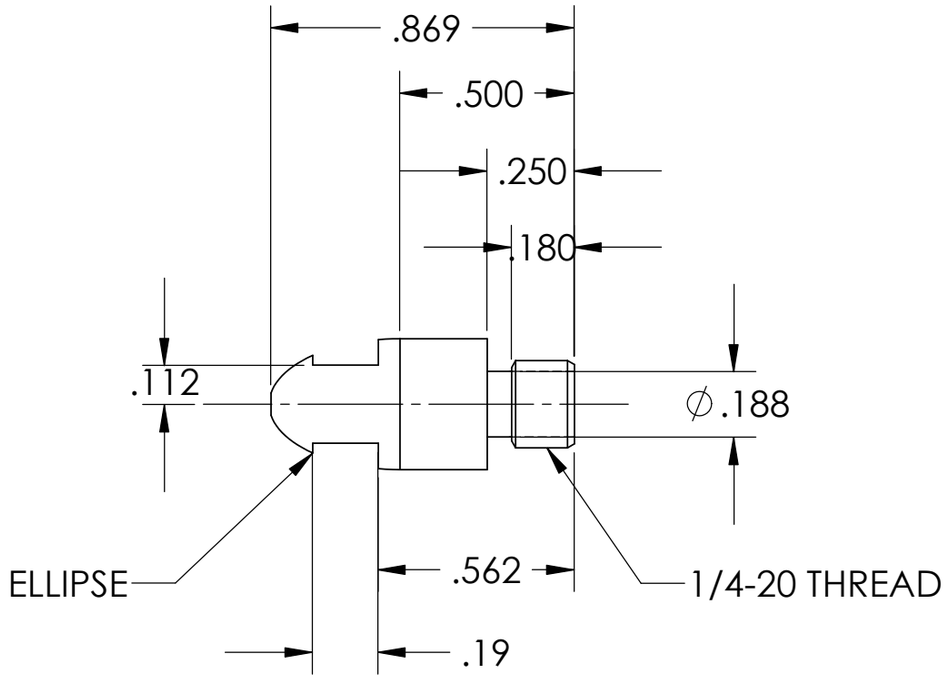
DESIGN AND FABRICATION SERVICES, A DIVISION OF NCAR
3450 MITCHELL LANE
BOULDER, COLORADO 80301 303-497-1000

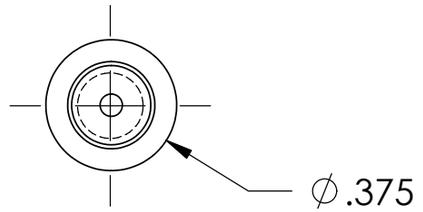
TITLE
VCSEL HYGROMETER
THERMISTER ASSY

SIZE	DWG NO.	REV
B		A

SCALE 1:1 RELEASE DATE XX/XX/XX SHEET 1 OF 1

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED





ITEM	PART NO.	DESCRIPTION	MATERIAL	SPECIFICATION	WT.
X		TIP	STAINLESS STEEL		

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:

DECIMALS:	ANGULAR:
.X = ±.03 .XX = ±.01 .XXX = ±.004	FORMED=±2° MACHINED=±.5°

DO NOT SCALE DRAWING

NEXT ASSEMBLY

APPROVALS		DATE
DR.		
ENG.		
CHK.		
APPD.		
APPD.		

EFFECTIVITY

HIAPER

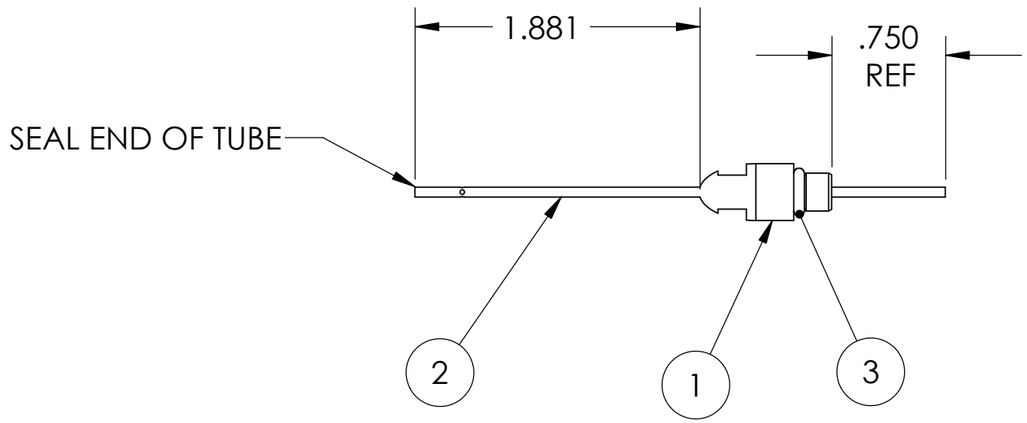
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH
1850 TABLE MESA DRIVE
BOULDER, CO 80305

Static Tip v2
VCSEL HYGROMETER

SIZE	CAGE CODE	DWG NO.	REV.
B	0SEF6		NC

SCALE	DESIGN & FABRICATION SERVICES, ATMOSPHERIC TECHNOLOGY DIV.	SHEET
2:1		1 of 1

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED



ITEM NO.	QTY	PART NO.	DESCRIPTION OR NOMENCLATURE	MATERIAL/SPECIFICATION	ZONE
3	1	2-008	O-RING	POLYMER	
2	1		TUBE	SS TUBE .066 O.D.,0 .008 WALL	
1	1		TIP	STAINLESS STEEL	

PARTS LIST

PART DASH NO.	NEXT QTY REQD PER ASSY	FINAL	NEXT ASSY APPLICATION	USED ON
-1	1	1	ASSY	PROJECT

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES
DECIMALS ANGULAR
.XX ± .01 ± 30'
.XXX ± .005
DO NOT SCALE DRAWING

TREATMENT

FINISH

CONTRACT NO.

DRAWN C. CHAMBELLAN DATE 9/26/2006

CHECK

ENGINEER C.CHAMBELLAN

TECHNICIAN

PROJECT SCIENTIST

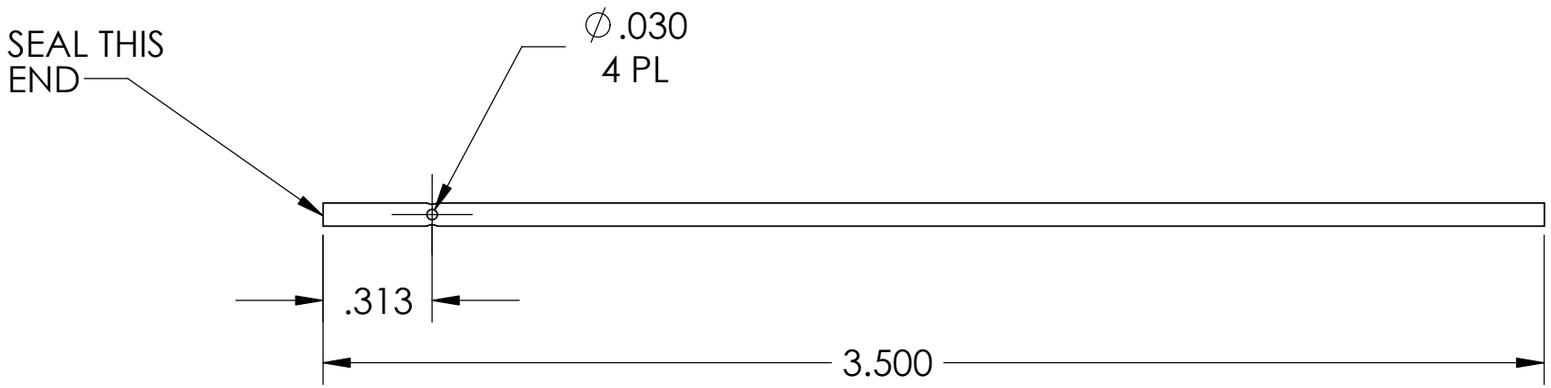
DESIGN AND FABRICATION SERVICES, A DIVISION OF NCAR
3450 MITCHELL LANE
BOULDER, COLORADO 80301 303-497-1000

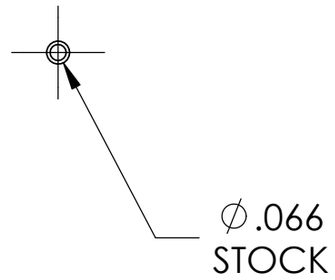
TITLE
VCSEL HYGROMETER
STATIC PROBE ASSY

SIZE	DWG NO.	REV
B		A

SCALE 1:1 RELEASE DATE XX/XX/XX SHEET 1 OF 1

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED





ITEM	PART NO.	DESCRIPTION	MATERIAL	SPECIFICATION	WT.
X		TUBE	SS TUBE .066 O.D.,0 .008 WALL		

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:

DECIMALS:
.X = ±.03
.XX = ±.01
.XXX = ±.004

ANGULAR:
FORMED=±2°
MACHINED=±.5°

DO NOT SCALE DRAWING

NEXT ASSEMBLY

APPROVALS		DATE
DR.		
ENG.		
CHK.		
APPD.		
APPD.		

EFFECTIVITY

HIAPER
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH
1850 TABLE MESA DRIVE
BOULDER, CO 80305

Pitot tube
VCSEL HYGROMETER

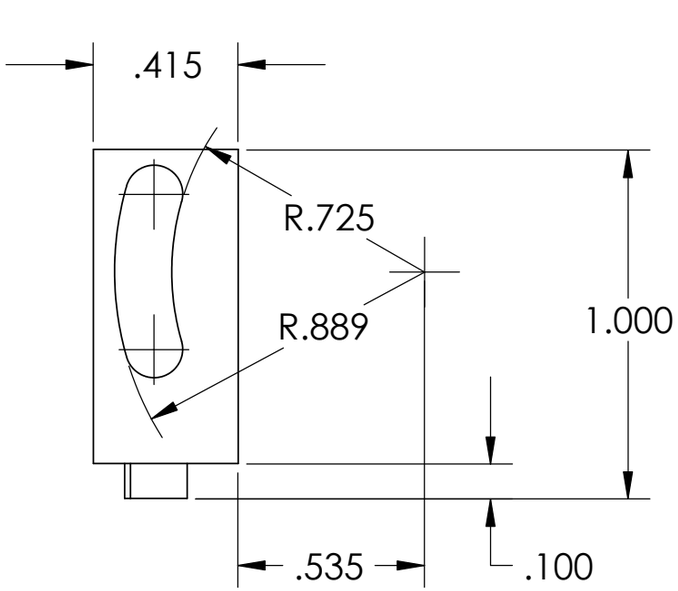
SIZE	CAGE CODE	DWG NO.	REV.
B	0SEF6		NC

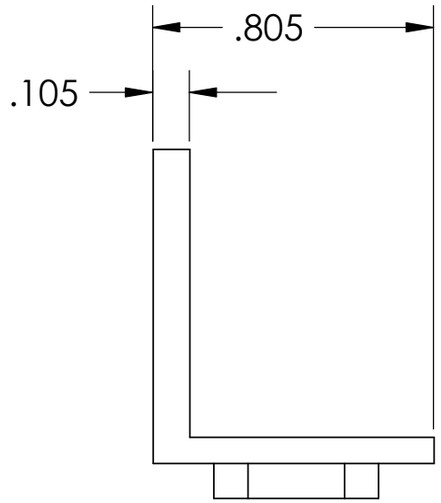
SCALE	DESIGN & FABRICATION SERVICES, ATMOSPHERIC TECHNOLOGY DIV.	SHEET
2:1		1 of 1

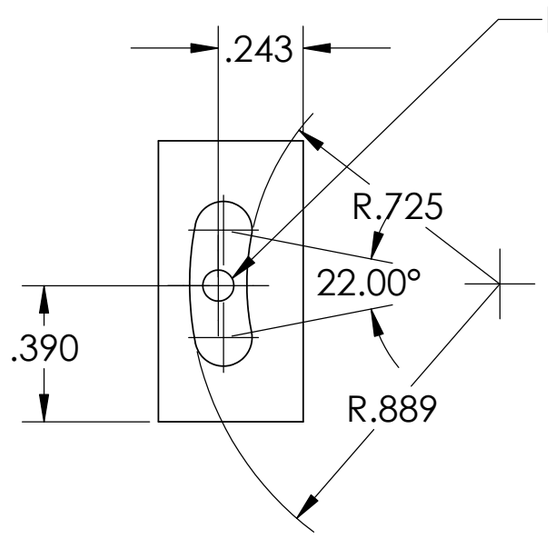
NOTES

1. MATERIAL CERTIFICATION REQUIRED.

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED







ITEM	PART NO.	DESCRIPTION	MATERIAL	SPECIFICATION	WT.
X		BRACKET	ALUMINUM 6061-T8		

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:

DECIMALS:
.X = ±.03
.XX = ±.01
.XXX = ±.004

ANGULAR:
FORMED=±2°
MACHINED=±.5°

DO NOT SCALE DRAWING

NEXT ASSEMBLY

APPROVALS		DATE
DR.		
ENG.		
CHK.		
APPD.		
APPD.		

EFFECTIVITY

35

HIAPER

NATIONAL CENTER FOR ATMOSPHERIC RESEARCH
1850 TABLE MESA DRIVE
BOULDER, CO 80305

Mirror Y Adjustment Bracket
VCSEL HYGROMETER

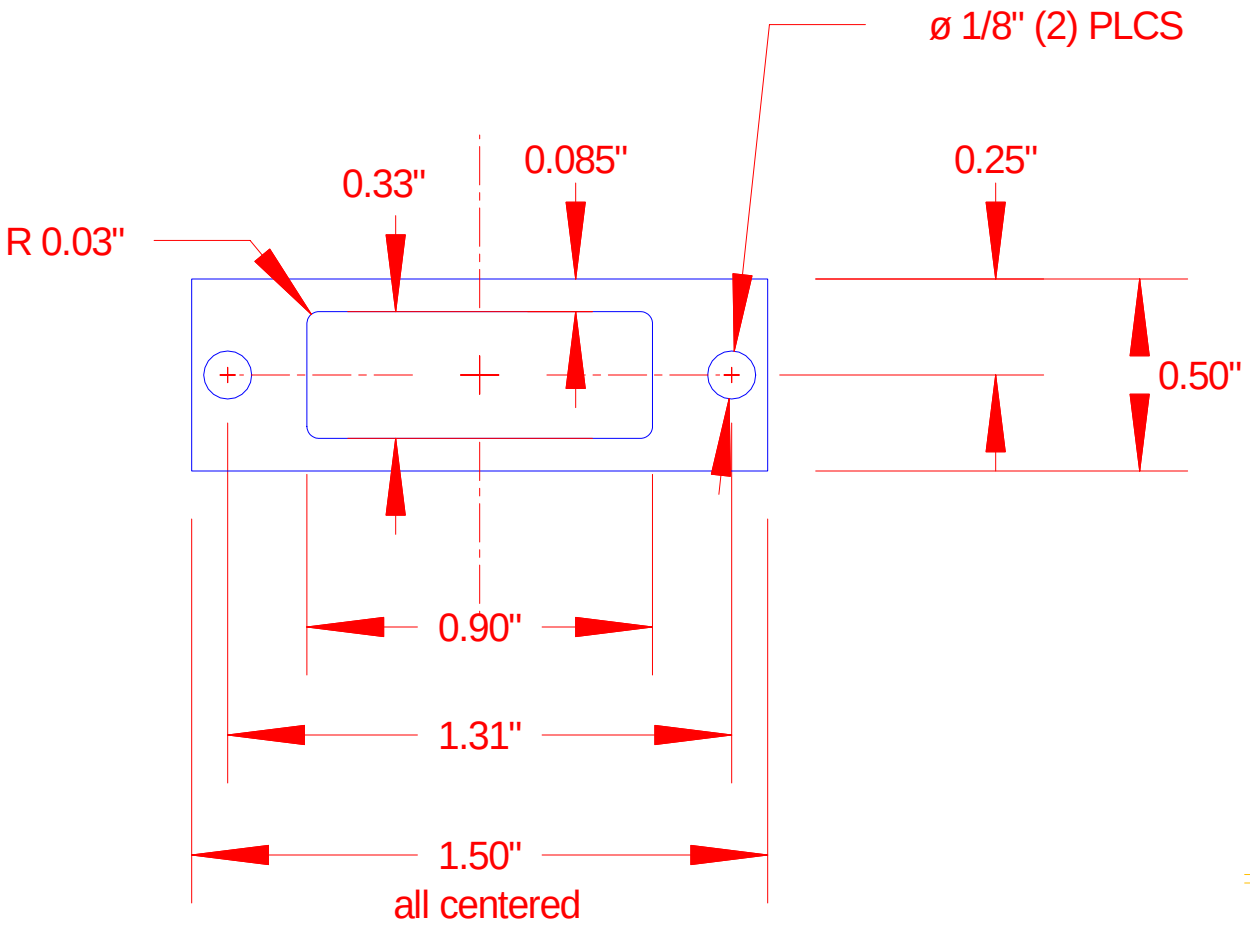
SIZE	CAGE CODE	DWG NO.	REV.
B	0SEF6		NC

SCALE 2:1

DESIGN & FABRICATION SERVICES, ATMOSPHERIC TECHNOLOGY DIV.

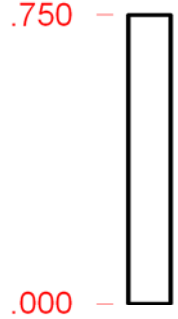
SHEET 1 of 1

Use any nonmagnetic SS plate 0.020" - 0.050" thick



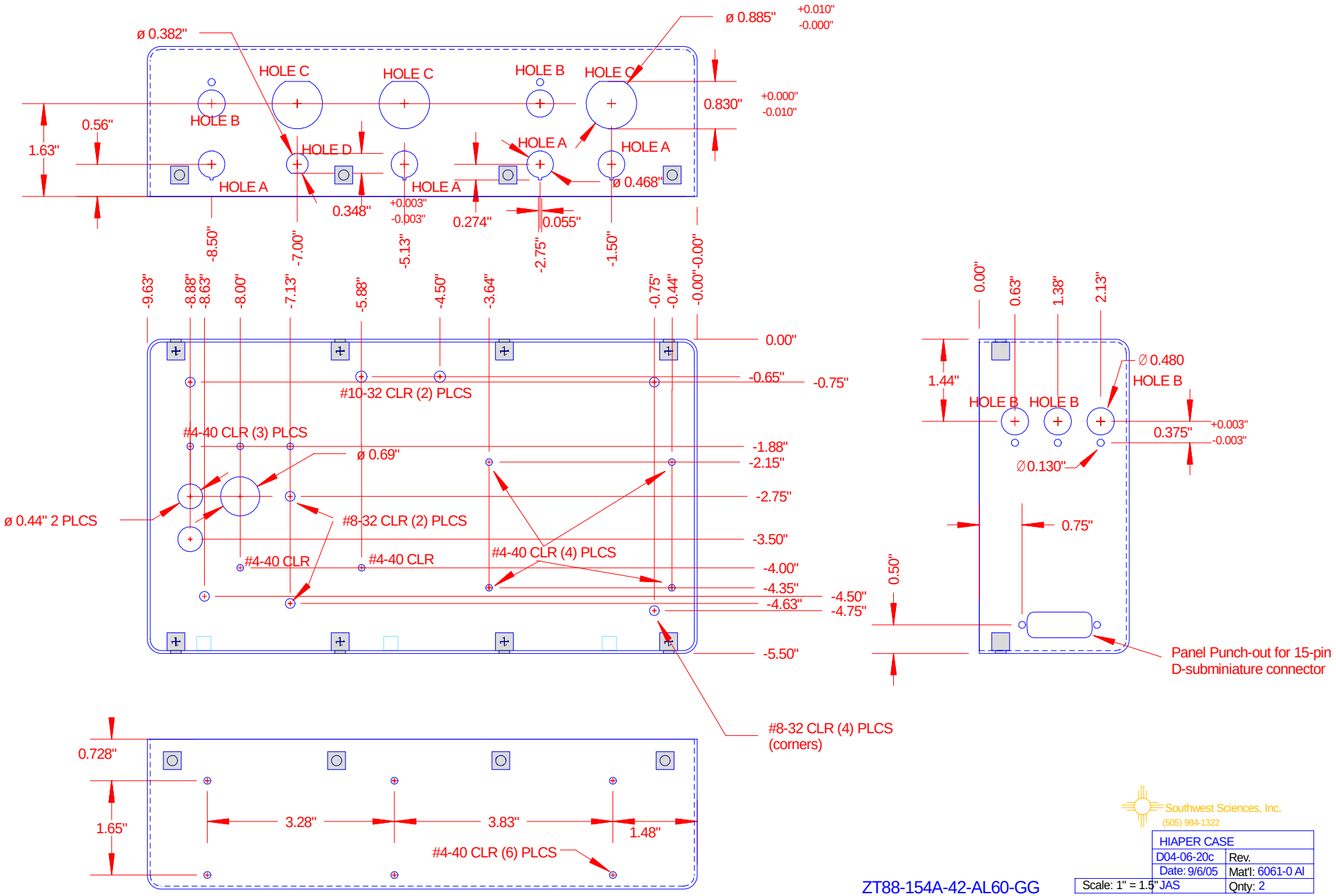
Southwest Sciences, Inc.
(505) 984-1322

	JTAG Adapter Plate	
	D04-06-28	Rev.
	Date12/10/05	Mat'l: see note
Scale: 2" = 1"	JAS	Qnty: Two



Southwest Sciences incorporated

TITLE: Brass Fiber pointer Tube					
AUTHOR: JAS	SIZE: A	DATE: 7/10/08	DWG NO: D05-06-50a		REV
MATERIAL: Brass	SCALE: 1:1	QNTY: One	SHEET		

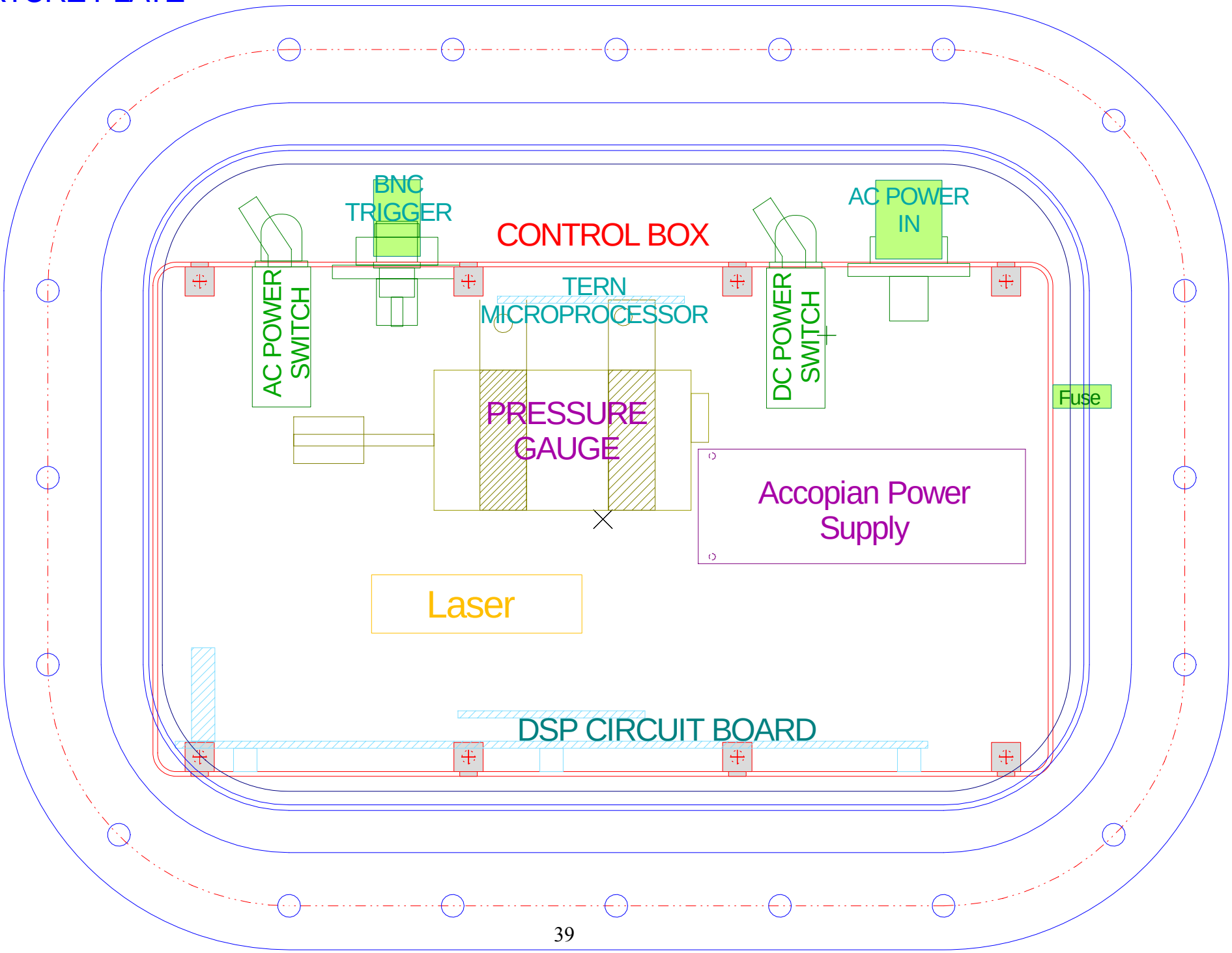


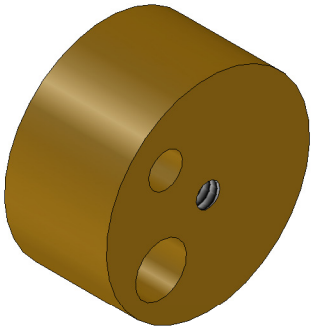
Southwest Sciences, Inc.
(505) 984-1322

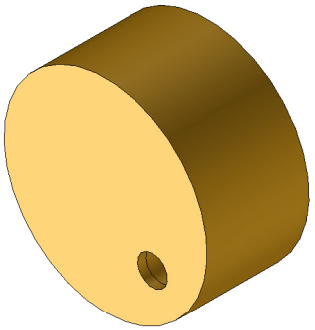
HIAPER CASE	
D04-06-20c	Rev.
Date: 9/6/05	Mat'l: 6061-0 Al
Scale: 1" = 1.5" JAS	Qnty: 2

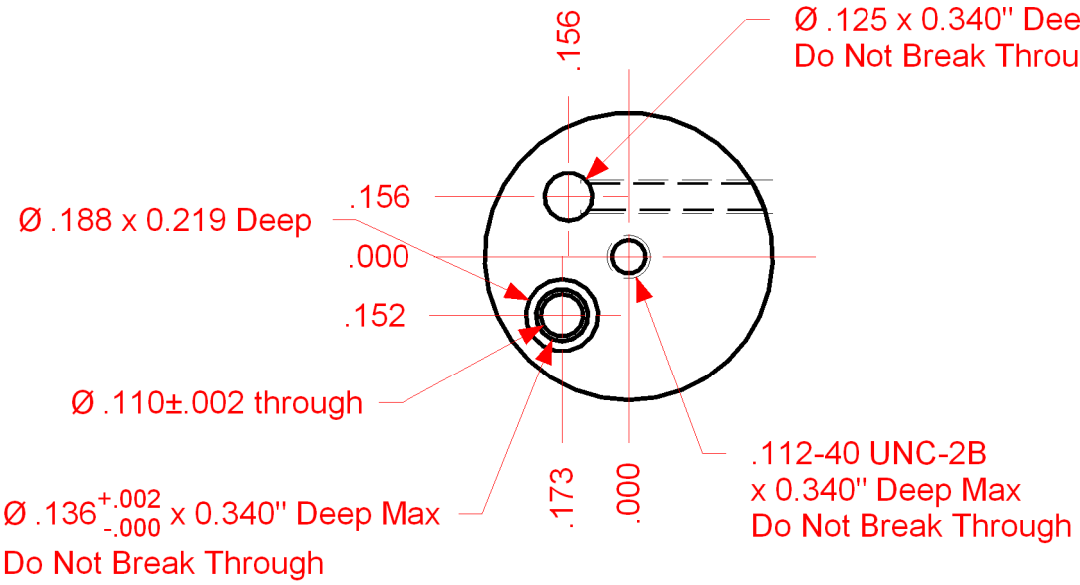
ZT88-154A-42-AL60-GG

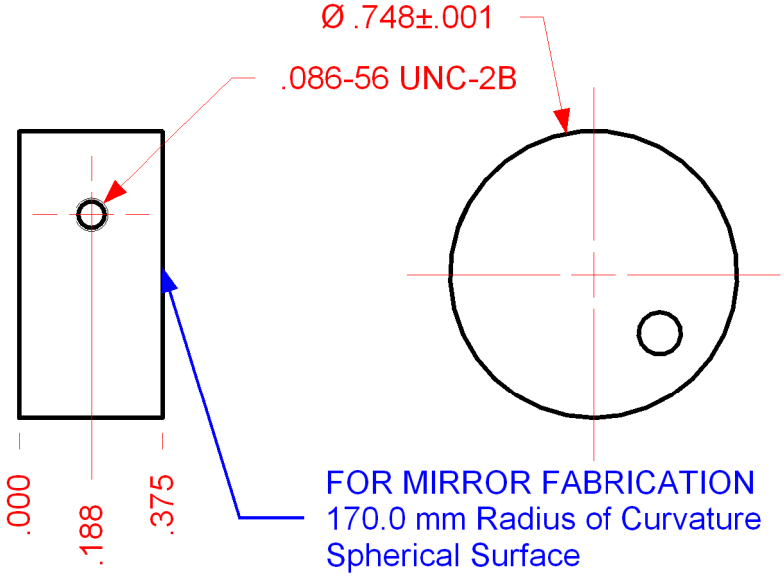
APERTURE PLATE





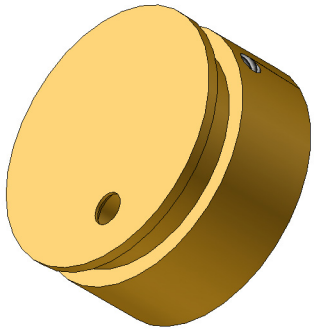




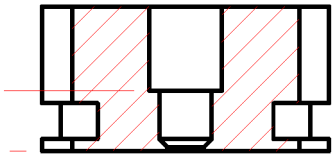


Southwest Sciences incorporated

TITLE: HIAPER New Front Spherical Mirror				
AUTHOR: JAS	SIZE: A	DATE: 7/11/08	DWG NO: D04-06-02a_SPH	REV: 1
MATERIAL: Cu (Provided)	SCALE: 2:1	QNTY: Three	SHEET:	

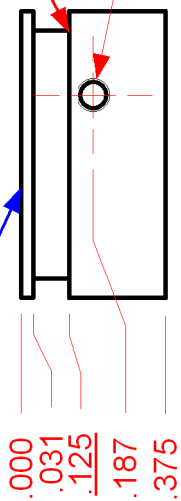


SECTION A-A



#2-016 O-Ring Groove
0.093 +0.005/-0.000" Wide
0.050 ± 0.002" Deep

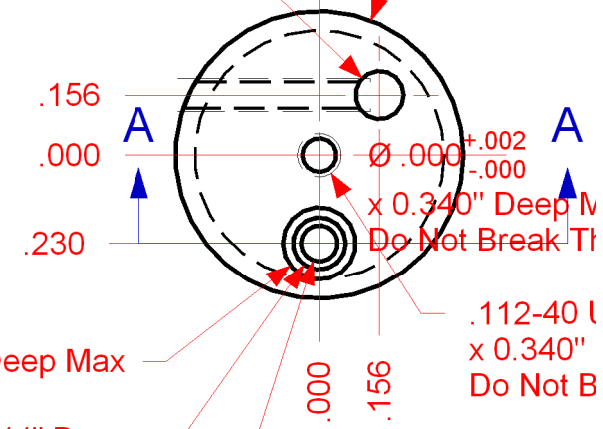
.0



FOR MIRROR FABRICATION
170.0 mm Radius of Curvature
Spherical Surface

Ø .748±.

Ø .125 x 0.340" Deep Max
Do Not Break Through



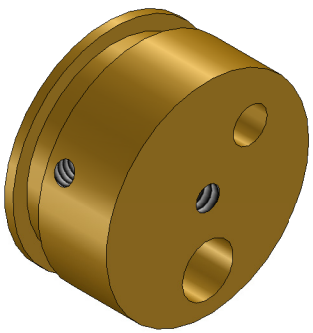
Ø .000 +.002 -.000
x 0.340" Deep M
Do Not Break Th

.112-40 U
x 0.340"
Do Not B

Ø .188 x 0.219" Deep Max

Ø .136 x 0.344" Deep
or use #29 Drill as long
as exit hole is<= 0.094"

Ø .094



Southwest Sciences
incorporated

TITLE: HIAPER New Rear Spherical Mirror				
AUTHOR: JAS	SIZE: A	DATE: 7/11/08	DWG NO: D04-06-01a SPH	REV: 1
MATERIAL: Cu (provided)	SCALE: 2:1	QNTY: Three	SHEET: 41	

Designation	Part	Part Number	MIL SPEC #	Manufacturer	Supplier	Specs
ELECTRICAL						
W1	wire ‡	lot # 677-9345-09 3/05	M22759/11-22-9 LR458	Specialty	All-Cable	22 AWG, red
W2	wire ‡	lot # 677-9345-08 2/05	M22759/11-22-9 LQ955	Specialty	All-Cable	22 AWG, black
W3	wire ‡	lot # 12944 3/99	M22759/11-22-9 KL662	Alcatel	All-Cable	22 AWG, green
W4a	wire ‡	22-TE-1932(2)STJ	M16878/4 BFE-9 677F-12	Thermax	All-Cable [NCAR]	22 AWG, white
W5	wire ‡	lot # 778846 7/03	M22759/11-22-9 KR913	Thermax	All-Cable	22 AWG, yellow
CAB1	Shielded twisted pair cable ‡	lot 1050006 8/04	MIL-W-16878/4 tef2202STJ	Thermax	All-Cable	22 AWG
CAB2	coax cable ‡	S44193	yes	PIC Wire & Cable	PIC Wire & Cable	50 ohm coax
F2	circuit breaker	7274-11-1	MS 22073-1	Klixon (TI)	Flame Enterprises	1 A
F1	circuit breaker	7274-11-2	MS 22073-2	Klixon (TI)	Flame Enterprises	2 A
SW1,SW2	switch	8500K9	MS 24523-22	Eaton	RPA	SPST
	Cartridge heater	SU12505024V15W		Sun Electric Heater	iProcessMart	for mirrors -- metal, ceramic, #24 gauge insulated with Teflon / Fiberglas, rated to 482 F, 12" long
LAMP1	lamp housing w/neon clr	361-8836-0937-552	LH74/1, LC13CN2	Dialight	PEI-Genesis	125V uses T-2 midget flange base neon lamp Has internal 62 kΩ resistor
	lamp housing - LED clear	162-8430-0937-502	MS25256-8	Dialight	Newark 25F1206	
LED2	LED	586-1102-101		Dialight	PEI-Genesis	LED 6 V, green for incandescent replacement
LED1	LED	586-1105-101		Dialight	PEI-Genesis	LED 6 V, blue for incandescent replacement
LAMP1+A6	Neon lamp	521-9047	C7A	Dialight	Newark 05B4378	T-2 midget flange base
J4	BNC bulkhead isolated	31-4890-1		Amphenol	Newark 90F8467	teflon insulator
J2	Circular connector		MS27473T8B98S	ITT/Canon	PEI-Genesis	3 pin (#20 - AC power
P2	Circular connector		MS27474T8B98P	ITT/Canon	PEI-Genesis	3 pin (#20 - AC power
J3	Circular connector		MS27473T8B35P	ITT/Canon	PEI-Genesis	6 pin (#22) - for RS-232 signals
P3	Circular connector		MS27474T8B35S	ITT/Canon	PEI-Genesis	6 pin (#22) - for RS-232 signals
	Right angle strain relief		M85049/47W8	Sunbank	Newark 91C6908	
J6, J7	9-pin D connector socket	205555-2	M24308/2-1F	Amphenol		9S-pin D for RS-232 connector to aircraft
	9-pin d backshells	82H7823	M85049/48-2-1	ITT/Canon	Newark	9S-pin D backshell
	9-D slide lock					
J14	15-pin D connector socket		M24308/2-2F	Cinch	Newark 45F997	15-pin D socket JTAG
J9	AC Plug for 120 VAC, 60 Hz	5266-X		Pass & Seymour	Summit Electric	to instrument power source on aircraft
DP1	4-pin DSP receptacle	770602-4		AMP	Digikey	
DP2	4-pin DSP receptacle	770602-4		AMP	Digikey	
DP3	4-pin DSP receptacle	770602-4		AMP	Digikey	
DP4	4-pin DSP receptacle	770602-4		AMP	Digikey	
DP5	2-pin DSP receptacle	770602-2		AMP	Digikey	
DP6	2-pin DSP receptacle	770602-2		AMP	Digikey	
MP1	10-pin DSP receptacle	770602-0		AMP	Digikey	
MP2	20-pin DSP receptacle	102387-4		AMP	Digikey	
MP6	4-pin DSP receptacle	770602-4		AMP	Digikey	
MP7	2-pin DSP receptacle	770602-2		AMP	Digikey	
	pins for DSP receptacles	770666-1		AMP	Digikey	
	pins for 20-pin connector (MDP2)	87523-6		AMP	Digikey	
J10	6-pin MTA receptacle	770602-6		AMP	Digikey A19494-ND	
P10	6-pin MTA header, friction lock	640456-6		AMP	Digikey A1923-ND	
J11	3-pin laser socket	S8060		Thorlabs		teflon
	10-pin ribbon receptacle, 0.1"				Digikey H3887-ND	
	ring terminal #4 for 18-22 AWG	320553	MS25036-148	AMP	Digikey A27227-ND	
	ring terminal #6 for 18-22 AWG	51863	MS25036-102	AMP	Digikey A27233-ND	
	ring terminal #8 for 18-22 AWG	320551	MS25036-149	AMP	Digikey A27237-ND	
	crimper	59824-1		AMP	Genuine Aircraft Hardware	
	Pitot thermistor	COTS		Vishay Dale or Thermometrics		10 kohm or 50 kohm
	Baratron	722A13TCD3FA		MKS Instruments		14.7 psia, 0.25% of reading
	DSP circuit board - mother	S04-06-01		Compudraft		6V, 150 mA
	DSP circuit board - daughter	S04-06-02		Compudraft		
	Connector circuit board	S04-06-03a				
	Microprocessor	FLASHCORE-B		Tern		low power, A/D options
	Power supply	6EB-1000		Accopian		6V, 1A linear supply
P12	Aperture plate connector, 6 pin	PT07SE10-6P		Amphenol	PEI-Genesis	local substitute for PT02A10-6P on aperture plate
J12	Aperture connector, 6 socket	PT06A10-6S(SR)		Amphenol	Newark	
R1	resistor					100 kΩ, ¼ W
	Silicone heater	35765K165			McMaster-Carr	120 VAC, 15W, 1"x3" w/adhesive

Designation	Part	Part Number	MIL SPEC #	Manufacturer	Supplier	Specs
MECHANICAL						
	enclosure	ZT88-154A-42-AL60-GG		Zero Cases		6061-0 Al
	enclosure cover	AT88-154A-COG-1-5-AL60-GG		Zero Cases		6061-0 Al
	enclosure gasket (optional)	ZFP5-511-1		Zero Cases		neoprene
	Aperture plate & fins	Custom (NCAR)	----------	Jack Fox (NCAR)		Aluminum
	fiber washer	96100A125			McMaster-Carr	#8"ID x 3/8"OD x 1/32" , black
	fiber washer				Digikey 3116K-ND	#4 for DSP mounting, .25" x 1/32"
	O-rings	fluorosilicone, 2-016		Parker	McMaster-Carr	fluorosilicone
	spacer 3/16" x 1/4", #4	92320A691			McMaster-Carr	18-8 SS
	standoff, M-F, #4-40 x 1/4"	91075A101			McMaster-Carr	18-8 SS
	spacer 1/2" x 3/8" od, #8-32	92320A525			McMaster-Carr	18-8 SS
	clamp	MS21919-WDG24	MS21919		Genuine Aircraft Hardware	Aluminum with chloroprene cushion
	Pan head screw, #8-32 x 7/8"	91400A198	MS51957-48		McMaster-Carr	box mounting
	Pan head screw, #4-40 x 1/4"		MS51957-13		Genuine Aircraft Hardware	
	Pan head screw, #4-40 x 3/8"		MS51957-15		Genuine Aircraft Hardware	
	Pan head screw, #4-40 x 5/8"		MS51957-18		Genuine Aircraft Hardware	
	Pan head screw, #8-32 x 3/8"		MS51957-43		Genuine Aircraft Hardware	
	Set screw, nylon tipped, 18-8 SS				McMaster-Carr	misc.
	Allen head cap screw, #2-56 x 3/4", 18-8 SS				McMaster-Carr	
	grommet silicone	1061T17	MS35489-13		McMaster-Carr	.438" hole x 1/16" panel
	grommet silicone	1061T13	MS35489-6		McMaster-Carr	.250" hole x 1/16" panel
	tygon tubing, P sensor line	5466K11			McMaster-Carr	1/16 ID, 3/16 OD, smooth bore, high purity
	pinch clamp	52545K13			McMaster-Carr	7/32" dia.
	cable tie plate, #4	7566K12			McMaster-Carr	
	locknuts #4		MS21044(C)-04		Genuine Aircraft Hardware	
	locknuts #8		MS21044(C)-08		Genuine Aircraft Hardware	
	#2-56 lock washer internal		MS35333-35		Genuine Aircraft Hardware	
	#4-40 lock washer internal		MS35333-36		Genuine Aircraft Hardware	
	#1/4-20 lock washer internal		MS35333-40		Genuine Aircraft Hardware	
	#8-32 lock washer internal		MS35333-38		Genuine Aircraft Hardware	
	blind VCR gland, 1/4"	SS-4-VCR-3-BL			Albuquerque Valve	
	VCR short male nut, 1/4"	SS-4-VCR-4-.54NC			Albuquerque Valve	
	Ag-plated Cu gasket, 1/4"	CU-4-VCR-2			Albuquerque Valve	
OPTICAL						
	Mirrors	custom (Spawr)				Copper, gold
	Mirror mount	MFM-100		Newport		steel
	Mirror mount	MM-050		Newport		Al
	Fiberized Diode laser ‡	VL-1854-1-SP-P5		Vertilas		VCSEL fiberized w/TEC S/N: 105834-4
	Visible tracer laser	V3-780-TO-DA		ThorLabs		780 nm VCSEL, 5.4 mm can
	Visible tracer laser	HL6312G		ThorLabs		Hitachi 635 nm, 5 mW, 9mm can
	Fiber collimator	COTS		Oz Optics		LPC-06-1850-9/125-S-0.5-2.13GR-60-3A-0.25-0.3
	Fiber connector ‡	SNA-122450		Metrotek		SS
	Photodide	J23-18I-R01M-1.9		Judson Technology		extended (1.9 um), 1 mm, TO-18
	Interference filter	BP=1870-105		Spectrogon		1 mm high x 3 mm dia.
	GRIN lens for detector			NSG/QTF coating		

NOTES

‡ All individual wires, fiber optics, and cables fire tested (Form 81100-3) by Skandia and/or use already-approved materials as listed by NCAR.

Limited lifetime parts
Herriot cell mirrors - Spawr Industries

Recommended spare parts list
Fiberized 1854 VCSEL - VL-1854-1-SP-P5, Vertilas AG

2.2 micron photodiode - J23-18I-R01M-2.2, Judson Technology

1870 bandpass filter - BP-1870-105 NM, Spectrogon

grin lens - SLW-3.0-0.25-NC-1.56, 1854 nm AR-V coating, NSG America

Fiberized grin lens with feedthrough -
VAC-01-T-SMJ-1A3A-1850-9/125-1-0.5,0.3+LPC-06-1850-9/125-S-0.5-2.13GR-60-3A-1-0.9-SP,
Oz Optics

O-rings
- 2-006 (0.11 ID x 0.07) for top plate on fin
- 2-008 (0.18 ID x 0.07) for probes
- 052 for top plate on fin
- 3/32" O-ring stock, splice kit, and O-ring grease for large rings

Screws
- 6-32, 3/4" L, 100 deg flat head phillips, 300 series SS, for top plate on fin (MS24693-S30)
- 10-32, 5/8" L, socket head, for feedthrough plate (NAS1351-3-10P, MS16998-28)
- AN3-5A for pan to fin
- 8-32, 7/8" L, socket head for electrical box to pan

Temperature probe - Jack Fox

Pressure probe - Jack Fox

VERTILAS VCSEL Diodes

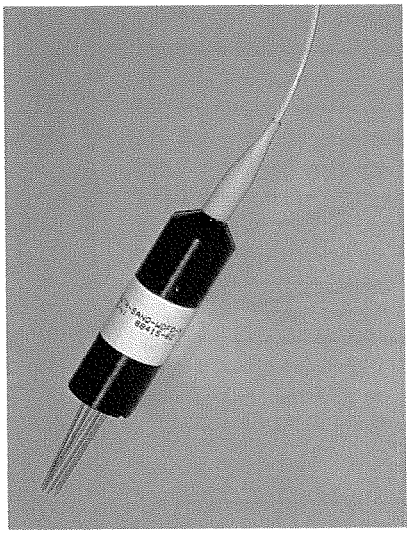
ATTENTION
OBSERVE PRECAUTIONS
ELECTROSTATIC SENSITIVE DEVICES

VERTILAS®

FINAL TEST DATA

Serial No. 105834-4 Diode No. NZTQ-XLOA-XHSU-S Date 2007-10-12

Type VL-1854-1-SP-P5 **Product State: Engineering Sample**



Description

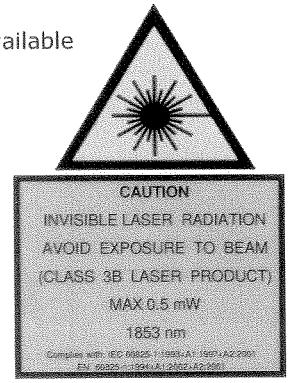
The VL single-mode series diodes are VCSELs for customer specified emission wavelengths. The vertical cavity structure is employed to obtain excellent threshold and operating current and tuning performance.
The range of operation is from -20°C to +70°C (T_{case}) and +15°C to +35°C (T_{laser}).

Applications

- Tunable Diode Laser Absorption Spectroscopy
- Fiberoptical Light Source

Features

- Wide and fast tuning performance for insitu measurements in high pressure environments
- Customer specific packaging options (TO39, TO46 and others)
- Individual laser data sheets available



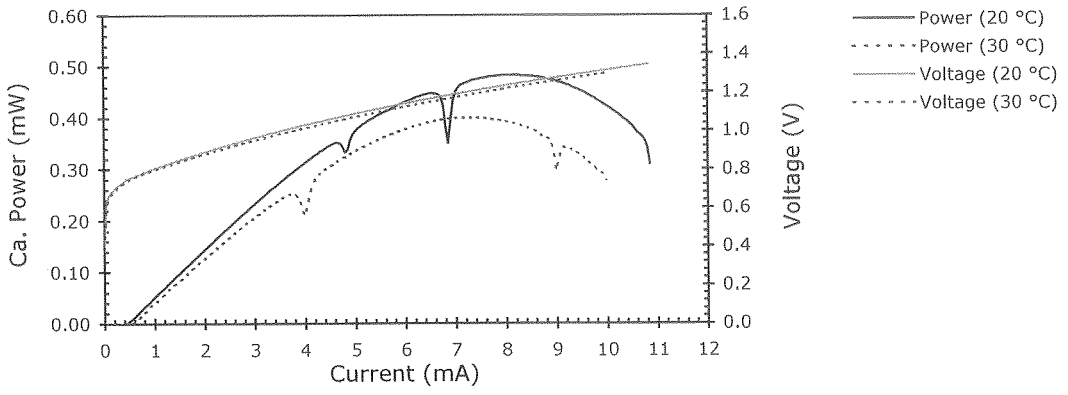
Electrical / Optical Characteristics

Serial No. 105834-4

CW Current	Recommended Range	Maximum Ratings
	0.5 mA - 7.0 mA	8.5 mA

	Threshold Current	Max. Output Power
20 °C	0.37 mA	ca. 0.48 mW
30 °C	0.42 mA	ca. 0.40 mW

Ild (20°C)	0.55 mA	2.45 mA	4.36 mA	6.25 mA	8.16 mA
Wavelength	1851.63 nm	1852.09 nm	1852.73 nm	1853.63 nm	1854.71 nm
Ild (30°C)	0.63 mA	2.31 mA	4.00 mA	5.68 mA	7.36 mA
Wavelength	1852.99 nm	1853.39 nm	1853.95 nm	1854.69 nm	1855.61 nm



VERTILAS GmbH
Lichtenbergstrasse 8
c/o Gate Garching
D-85748 Garching

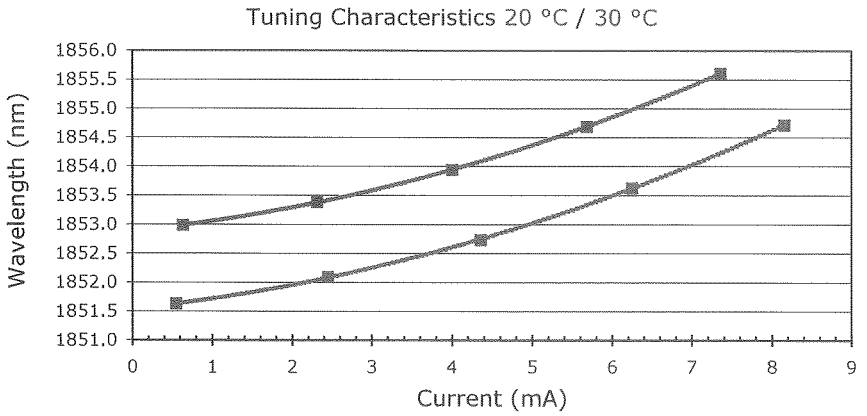
Tel.: +49 (0)89 54 84 20-00
Fax: +49 (0)89 54 84 20-19
www.vertilas.com

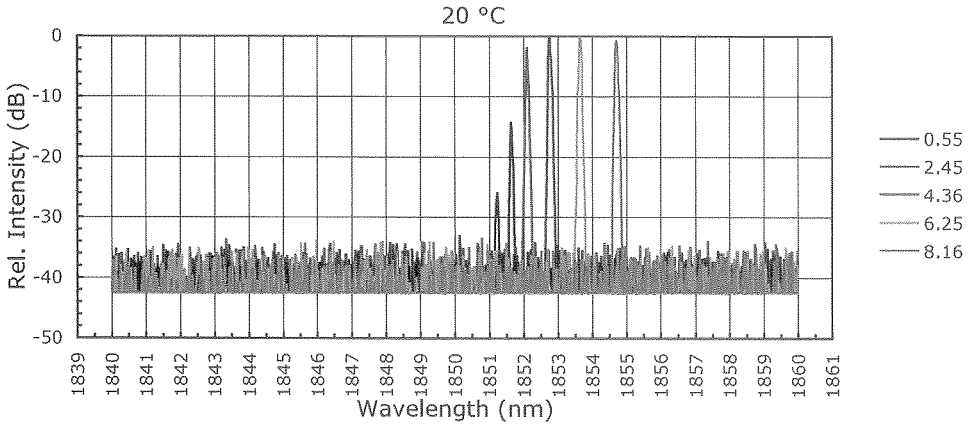
Sales Requirements: sales@vertilas.com
Further information: info@vertilas.com

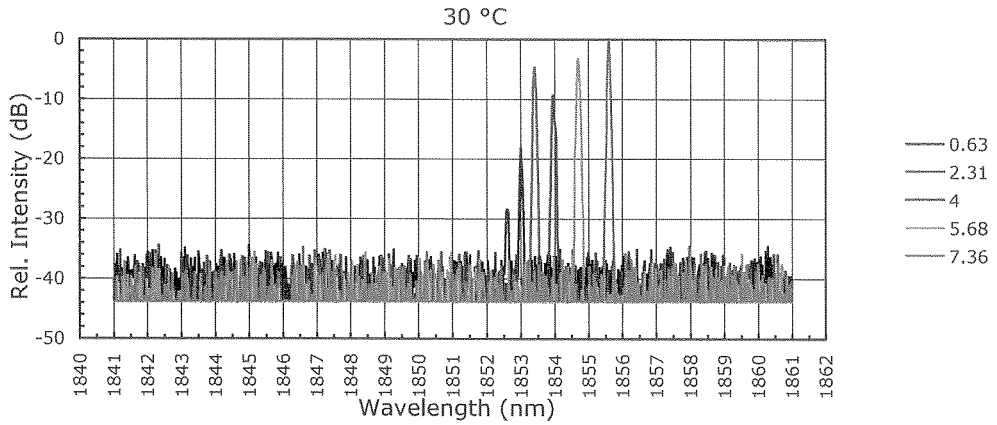
FINAL TEST DATA

Serial No. 105834-4 Diode No. NZTQ-XLOA-XHSU-S Date 2007-10-12

Type VL-1854-1-SP-P5







VERTILAS GmbH
Lichtenbergstrasse 8
c/o Gate Garching
D-85748 Garching

Tel.: +49 (0)89 54 84 20-00
Fax: +49 (0)89 54 84 20-19
www.vertilas.com

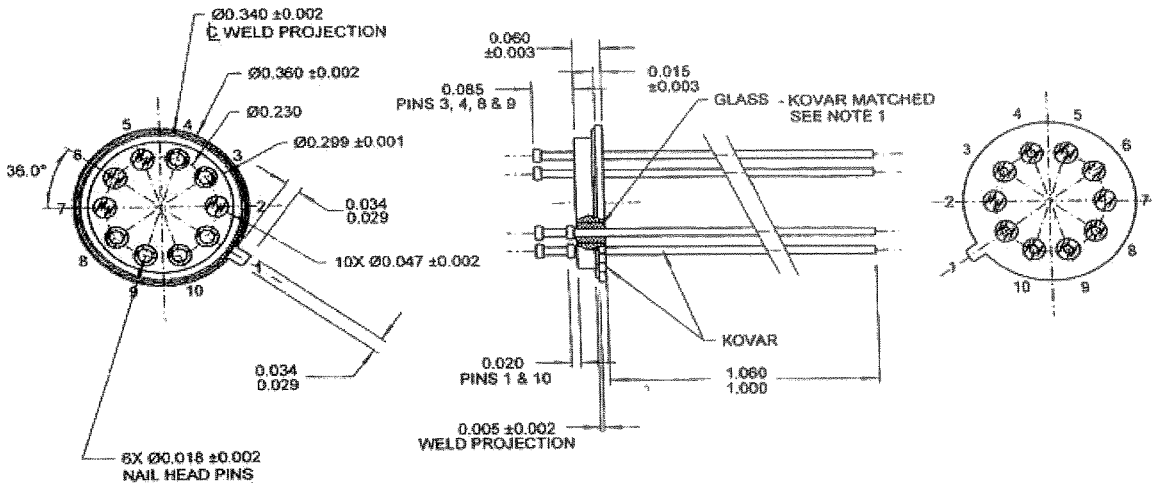
Sales Requirements: sales@vertilas.com
Further information: info@vertilas.com

HEADER SCHEMATICS

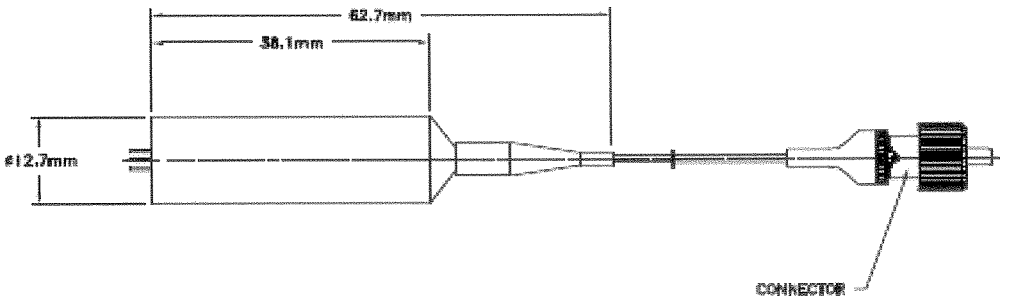
Serial No. 105834-4 Diode No. NZTQ-XLOA-XHSU-S Date: 2007-10-12

Type VL-1854-1-SP-P5

dimensions: inch



dimensions: mm



Pin assignment	
Pin	Function
3	Laser (–)
4	Laser (+)
8	Thermistor
9	Thermistor
10	Cooler (–)
1	Cooler (+)

Steinhart-Hart-Coefficients	
A	1.129148E-03
B	2.341250E-04
C	8.76741E-08

TEC	
I_{max}	0.45 A
V_{max}	2.1 V

proper heatsinking is required

T_{case} max: 70°C

VERTILAS GmbH
Lichtenbergstrasse 8
c/o Gate Garching
D-85748 Garching

Tel.: +49 (0)89 54 84 20-00
Fax: +49 (0)89 54 84 20-19
www.vertilas.com

Sales Requirements: sales@vertilas.com
Further information: info@vertilas.com

General notes and recommendations

➢This product is a class 3B laser product and emits invisible laser radiation. Do not expose eyes to this laser beam, as it may be harmful to the eye.

➢Do not operate or store this product beyond the specified operating or storage conditions. Doing so may damage the product and VERTILAS does not assume any responsibility or warranty in this case.

➢Any product that is supplied in a non-hermetically sealed package is subject to limited warranty. A non-hermetically sealed VCSEL is potentially exposed to hazardous conditions, such as moisture, gases, physical damage, in the customer application, that may damage the product or alter its performance. VERTILAS does not assume responsibility in this case.

➢Handle and operate this product with care. VCSEL products are sensitive, and can be easily damaged, e.g. by electro-static discharge, supply power peaks, signal peaks, overload and other operating or storage conditions. Failing to prevent these conditions may damage the product and VERTILAS does not assume any responsibility or warranty in this case.

➢This specification is subject to change without prior notification. The information is believed to be correct and accurate at the time of printing. However, VERTILAS does not take responsibility for ommissions or inaccuracies.

➢VERTILAS general terms and conditions apply. They can be viewed on the VERTILAS website at www.vertilas.com or we can send them on request.

VERTILAS GmbH
Lichtenbergstrasse 8
c/o Gate Garching
D-85748 Garching

Tel.: +49 (0)89 54 84 20-00
Fax: +49 (0)89 54 84 20-19
www.vertilas.com

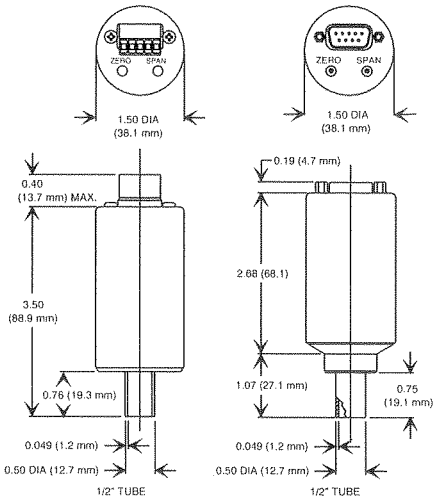
Sales Requirements: sales@vertilas.com
Further information: info@vertilas.com

Specifications and Ordering Information

Configuration	Absolute, single-ended
Full Scale Ranges	1 Torr through 25,000 Torr (mmHg) (0.02 psia through 500 psia)
Accuracy (including non-linearity, hysteresis, and non-repeatability)	0.5% of Reading
Response Time	< 20 msec
Temperature Coefficients	
Zero	0.008% of F.S./°C (10 Torr through 25,000 Torr); 0.020% of F.S. (1 and 2 Torr)
Span	0.04% of Rdg./°C
Ambient Operating Temperature	0° to 50°C (32° to 122°F), 15° to 40°C (59° to 104°F) (1 and 2 Torr only)
Overpressure Limit	45 psia or 2x F.S., whichever is greater
Burst Pressure	10x F.S. or 100 psi, whichever is greater
Materials Exposed to Gases	Inconel® (Optional Fittings: 316SS)
Power	
Input	0 to 10 Volt output, +13 VDC to +32 VDC @ 10 mA max. (For drop-in replacements of 122A and B which have a ±15 VDC input, use Input/Output Ordering Code 2. See below.)
	0 to 5 Volt output, +13 VDC to +32 VDC @ 10 mA max.
Output	0 to 10 VDC into > 10K ohms load
	0 to 5 VDC into > 10K ohms load
Electromagnetic Compatibility	Fully CE Compliant to EMC Directive 89/336/EEC[1]
Electrical Connectors	9-pin Type "D", 15-pin Type "D" on 4.70" (118mm) ±0.5" (12.7mm) cable, 5-pin terminal strip
Fittings	
Standard	1/2" tube
Optional	1/4" VCR® female, 8 VCR female, NW 16 KF[2], mini-CF

[1] For CE Compliance, an overall metal braided shielded cable, properly grounded at both ends, is required.

[2] NW 16 KF fittings cannot be used on units with a pressure range of 10,000 mmHg and higher. For units with a pressure range of 5,000 mmHg, an HPS Overpressure ring must be used.



LOW CAPACITANCE MANOMETER PRESSURE UP TO 1000 TORR

HIGH CAPACITANCE MANOMETER > 1000 TORR THROUGH 25,000 TORR

Dimensional Drawing —

Note: Unless otherwise specified, dimensions are nominal values in inches (mm referenced).

Ordering Code Example: 722A12TCE2FJ

Type 722A	Code	Configuration
Type 722A	722A	722A
Pressure Range Full Scale (mmHg)		
1	01T	
2	02T	
10	11T	
20	21T	
100	12T	12T
500	52T	
1,000	13T	
5,000	53T	
10,000 (must be ordered with a fitting)	14T	
25,000 (must be ordered with a fitting)	RCT	
Fittings		
1/4" VCR VC Female	CD	
1/2" Tube	BA	
8 VCR female	CE	CE
Mini-CF, rotable	HA	
NW 16 KF	GA	
Input/Output		
+13 to +32 VDC/0-10 VDC	2	2
+13 to +32 VDC/0-5 VDC	3	
Accuracy		
0.5% of Reading	F	F
Connectors		
9-pin Type "D"	A	
5-pin terminal strip	J	J
15-pin Type "D" on 6-inch cable	K	

MKS Global Headquarters

90 Industrial Way
Wilmington, MA 01887-4610

Tel: 978.284.4000
Tel: 800.227.8766 (in U.S.A.)
Web: www.mksinst.com

mks
Technology for Productivity

722A - 6/05

Pin-Outs

Application Notes
Technical Papers
Frequently Asked Questions
Data Sheets
Pin-Outs
Manuals
Contact MKS Tech Support

Type 722

9-pin Type "D"

Pin	Description
1	Pressure Output
2	No Connection
3	No Connection
4	+ Power Input
5 to 7	No Connection
8	Pressure Return
9	Power Return

5-pin Terminal Block

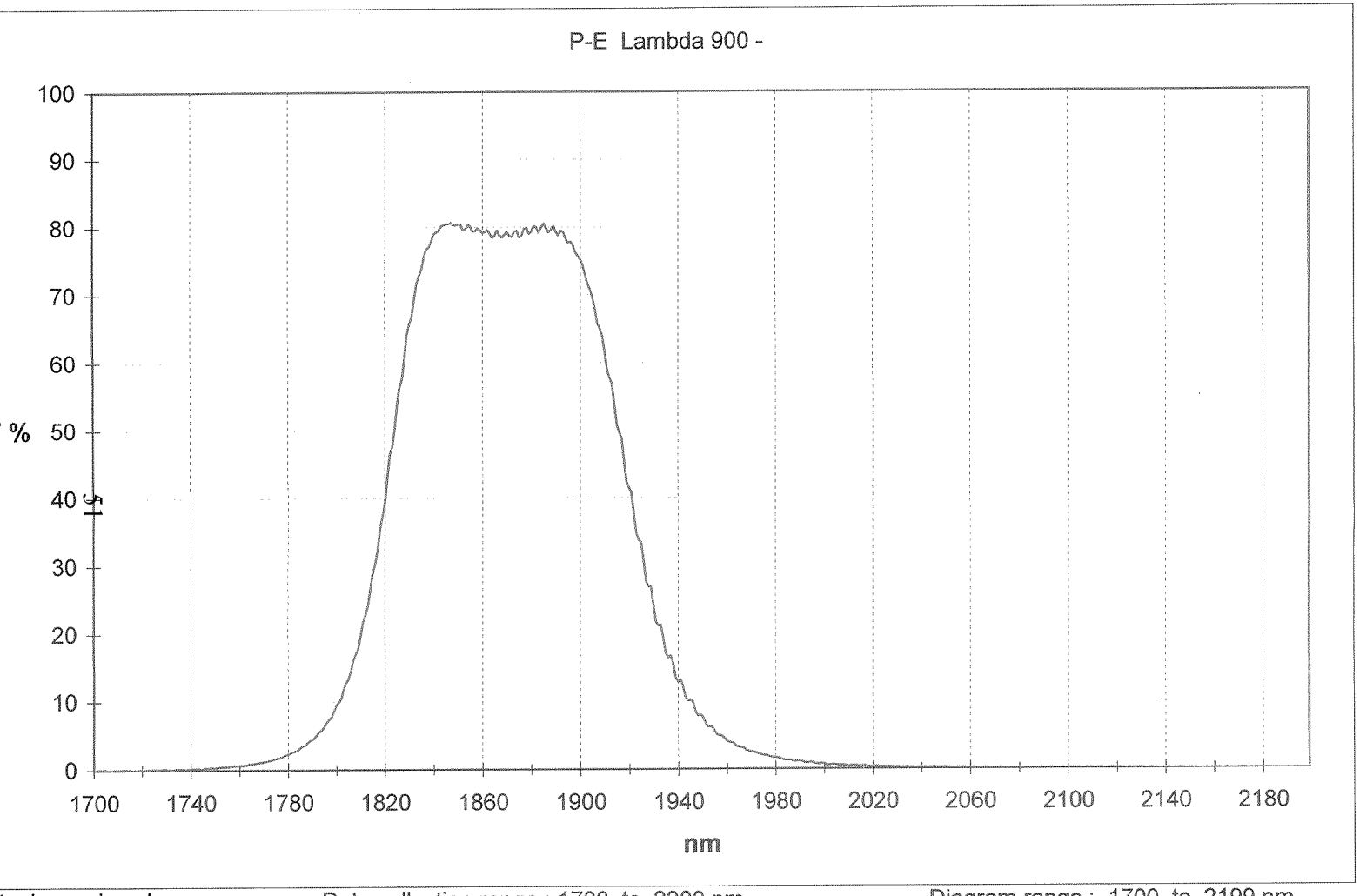
1	Power Return
2	Pressure Return
3	Pressure Output
4	No Connection
5	+ Power Input

15-pin Type "D"

1	No Connection
2	Pressure Output
3 to 4	No Connection
5	Power Return
6	No Connection
7	+ Power Input
8 to 11	No Connection
12	Pressure Return
13 to 14	No Connection
15	Chassis

Note:

This information is subject to change without notice.



SPECTROGON
Optical filters • Coatings • Gratings

Date: 2007-03-14 13:43

Operator :

Filter specification :
Type : BP (Bandpass)

CWL = 1870 +/- 20 nm
HW = 105 +/- 20 nm
Tmin. = 70 %
Left Slope : 5 %
Right Slope : 5 %
Blocking : UV to 3500

Size : 25,4x1,0 mm

Qty : 1 pc

Spectrogon
Art.nr : 713
Batch nr :
Order nr : 07.10527/S-703-219

Customer
Part nr :
P.O. nr : 10907

tual sample values : Data collection range : 1700 to 2200 nm Diagram range : 1700 to 2199 nm

VL = 1870,7 nm OK
V = 101,3 nm 5,42 % OK
ton 5% = 1791,4 nm
toff 5% = 1958,1 nm
nin. = 78,5 % OK
peak = 80,77 %
ave. = 79,59 %

Left Slope : 2,12 % OK
Right Slope : 2,52 % OK

www.spectrogon.com

SKANDIA

5000 N. Highway 251 ▪ Davis Junction, IL 61020
815.393.4600 ▪ 800.945.7135
www.SkandiaInc.com

Client:
SOUTHWEST SCIENCES INC
1570 PACHECO STREET
SUITE E-11
SANTA FE NM 87505

WO #: 128461-05
Date: 08/04/05
Test Plan #:
PO #: 10251

Aircraft:
GULFSTREAM GV

S/N:
677

60 Degree Bunsen Burner Test For Wire

FAR 25.869(a)(4) Appendix F Part I (a)(3) Amendment 25-72

Conditioning Room: Time In: 08/03/05 9:00AM Time Out: 08/04/05 9:00am

Specimen: ALCATEL/ALLCABLE: WIRE, TELFON COATED, M22759/11/22-5, GREEN, 22AWG, LOT #12944, REF #KL662

Flame Application (seconds)	Flame Time (seconds)	Burn Length (inches)	Drip Flame Time (Seconds)
30	0.0	1.3	0 No Drips
30	0.0	1.2	0 No Drips
30	0.0	0.9	0 No Drips
Average:	0.0	1.1	0 No Drips

Comments:

60 Degree Bunsen Burner Test (30 sec.): Average Flame Time may not exceed 30 sec. Average Burn Length may not exceed 3". Average Drip Flame Time may not exceed 3 sec. after falling.

Passed: [X] Failed: [ ]

Signed: Carin Demus

Carin Demus

SKANDIA

5000 N. Highway 251 ▪ Davis Junction, IL 61020
815.393.4600 ▪ 800.945.7135
www.SkandiaInc.com

Client:
SOUTHWEST SCIENCES INC
1570 PACHECO STREET
SUITE E-11
SANTA FE NM 87505

WO #: 128461-05
Date: 08/04/05
Test Plan #:
PO #: 10251

Aircraft:
GULFSTREAM GV

S/N:
677

60 Degree Bunsen Burner Test For Wire

FAR 25.869(a)(4) Appendix F Part I (a)(3) Amendment 25-72

Conditioning Room: Time In: 08/03/05 9:00AM Time Out: 08/04/05 9:02AM

Specimen: THERMAX/ALLCABLE: WIRE, TWISTED PAIR SHIELDED TEFLON, TEF2202STJ, WHITE, 22AWG, LOT #1050006, REF #RL0427695

Flame Application (seconds)	Flame Time (seconds)	Burn Length (inches)	Drip Flame Time (Seconds)
30	0.0	1.3	0 No Drips
30	0.0	1.2	0 No Drips
30	0.0	1.2	0 No Drips
Average:	0.0	1.2	0 No Drips

Comments:

60 Degree Bunsen Burner Test (30 sec.): Average Flame Time may not exceed 30 sec. Average Burn Length may not exceed 3". Average Drip Flame Time may not exceed 3 sec. after falling.

Passed: [X] Failed: [ ]

Signed: Carin Demus
Carin Demus

SKANDIA

5000 N. Highway 251 ■ Davis Junction, IL 61020
815.393.4600 ■ 800.945.7135
www.SkandiaInc.com

Client:
SOUTHWEST SCIENCES INC
1570 PACHECO STREET
SUITE E-11
SANTA FE NM 87505

WO #: 128461-05
Date: 08/04/05
Test Plan #:
PO #: 10251

Aircraft: GULFSTREAM GV
S/N: 677

60 Degree Bunsen Burner Test For Wire

FAR 25.869(a)(4) Appendix F Part I (a)(3) Amendment 25-72

Conditioning Room: Time In: 08/03/05 9:00AM Time Out: 08/04/05 9:10AM

Specimen: SPECIALTY/ALLCABLE: WIRE, TEFLON COATED, M22759/11/22-0, BLACK 22AWG, LOT #677-9345-08, REF #LQ955

Flame Application (seconds)	Flame Time (seconds)	Burn Length (inches)	Drip Flame Time (Seconds)
30	0.0	1.0	0 No Drips
30	0.0	1.5	0 No Drips
30	0.0	1.3	0 No Drips
Average:	0.0	1.3	0 No Drips

Comments:

60 Degree Bunsen Burner Test (30 sec.): Average Flame Time may not exceed 30 sec. Average Burn Length may not exceed 3". Average Drip Flame Time may not exceed 3 sec. after falling.

Passed: [X] Failed: [ ]

Signed: _____

Carin Demus

60DEG-456

SKANDIA

5000 N. Highway 251 ▪ Davis Junction, IL 61020
815.393.4600 ▪ 800.945.7135
www.SkandiaInc.com

Client:
SOUTHWEST SCIENCES INC
1570 PACHECO STREET
SUITE E-11
SANTA FE NM 87505

WO #: 128461-05
Date: 08/04/05
Test Plan #:
PO #: 10251

Aircraft:
GULFSTREAM GV

S/N:
677

60 Degree Bunsen Burner Test For Wire

FAR 25.869(a)(4) Appendix F Part I (a)(3) Amendment 25-72

Conditioning Room: Time In: 08/03/05 9:00AM Time Out: 08/04/05 9:12AM

Specimen: TERMAX/ALLCABLE: WIRE, TEFLON COATED, M22759/11/22-4, YELLOW, 22AWG, D/L 778846, REF #KR913

Flame Application (seconds)	Flame Time (seconds)	Burn Length (inches)	Drip Flame Time (Seconds)
30	0.0	1.6	0 No Drips
30	0.0	1.2	0 No Drips
30	0.0	1.1	0 No Drips
Average:	0.0	1.3	0 No Drips

Comments:

60 Degree Bunsen Burner Test (30 sec.): Average Flame Time may not exceed 30 sec. Average Burn Length may not exceed 3". Average Drip Flame Time may not exceed 3 sec. after falling.

Passed: [X] Failed: [ ]

Signed: _____

Carin Demus

60DEG-457

SKANDIA

5000 N. Highway 251 ▪ Davis Junction, IL 61020
815.393.4600 ▪ 800.945.7135
www.SkandiaInc.com

Client:
SOUTHWEST SCIENCES INC
1570 PACHECO STREET
SUITE E-11
SANTA FE NM 87505

WO #: 128461-05
Date: 08/04/05
Test Plan #:
PO #: 10251

Aircraft:
GULFSTREAM GV

S/N:
677

60 Degree Bunsen Burner Test For Wire

FAR 25.869(a)(4) Appendix F Part I (a)(3) Amendment 25-72

Conditioning Room: Time In: 08/03/05 9:00AM Time Out: 08/04/05 9:15AM

Specimen: SPECIALTY/ALLCABLE: WIRE, TEFLON COATED, M22759/11/22-2, RED, 22AWG, LOT #677-9345-09, REF #LR458

Flame Application (seconds)	Flame Time (seconds)	Burn Length (inches)	Drip Flame Time (Seconds)
30	0.0	1.3	0 No Drips
30	0.0	1.4	0 No Drips
30	0.0	1.2	0 No Drips
Average:	0.0	1.3	0 No Drips

Comments:

60 Degree Bunsen Burner Test (30 sec.): Average Flame Time may not exceed 30 sec. Average Burn Length may not exceed 3". Average Drip Flame Time may not exceed 3 sec. after falling.

Passed: [X] Failed: [ ]

Signed: _____

Carin Demus

60DEG-458

SKANDIA

5000 N. Highway 251 ▪ Davis Junction, IL 61020
815.393.4600 ▪ 800.945.7135
www.SkandiaInc.com

Client:
SOUTHWEST SCIENCES INC
1570 PACHECO STREET
SUITE E-11
SANTA FE NM 87505

WO #: 128461-05
Date: 08/04/05
Test Plan #:
PO #: 10251

Aircraft: GULFSTREAM GV

S/N: 677

60 Degree Bunsen Burner Test For Wire

FAR 25.869(a)(4) Appendix F Part I (a)(3) Amendment 25-72

Conditioning Room: Time In: 08/03/05 9:00AM Time Out: 08/04/05 9:06AM

Specimen: CORNING VERTILAS: WIRE, SINGLE MODE FIBER OPTIC, SMF-28, TEFLON CLADDING, YELLOW

Flame Application (seconds)	Flame Time (seconds)	Burn Length (inches)	Drip Flame Time (Seconds)
30			
30			
30			
Average:			

Comments:

TESTING INCOMPLETE DUE TO WIRE BREAKING

60 Degree Bunsen Burner Test (30 sec.): Average Flame Time may not exceed 30 sec. Average Burn Length may not exceed 3". Average Drip Flame Time may not exceed 3 sec. after falling.

Passed: ☐ Failed: ☐

Signed: Carin Demus

DEG-455

SKANDIA

5000 N. Highway 251 ▪ Davis Junction, IL 61020
815.393.4600 ▪ 800.945.7135
www.SkandiaInc.com

Client:
SOUTHWEST SCIENCES INC
1570 PACHECO STREET
SUITE E-11
SANTA FE NM 87505

WO #: 128461-05
Date: 08/04/05
Test Plan #:
PO #: 10251

Aircraft: GULFSTREAM GV

S/N: 677

60 Degree Bunsen Burner Test For Wire

FAR 25.869(a)(4) Appendix F Part I (a)(3) Amendment 25-72

Conditioning Room: Time In: 08/03/05 9:00AM Time Out: 08/04/05 9:04AM

Specimen: CORNING/VERTILAS: WIRE, SINGLE MODE FIEBER OPTIC, SMF-28, HYTREL CLADDING WHITE

Flame Application (seconds)	Flame Time (seconds)	Burn Length (inches)	Drip Flame Time (Seconds)
30			
30			
30			
Average:			

Comments:

TESTING INCOMPLETE DUE TO WIRE BREAKING

60 Degree Bunsen Burner Test (30 sec.): Average Flame Time may not exceed 30 sec. Average Burn Length may not exceed 3". Average Drip Flame Time may not exceed 3 sec. after falling.

Passed: ☐ Failed: ☐

Signed: Carin Demus

Carin Demus

0DEG-454

SKANDIA

5000 N. Highway 251 ▪ Davis Junction, IL 61020
815.393.4600 ▪ 800.945.7135
www.SkandiaInc.com

Client:
SOUTHWEST SCIENCES INC
1570 PACHECO STREET
SUITE E-11
SANTA FE NM 87505

WO #: 128461-05
Date: 08/04/05
Test Plan #:
PO #: 10251

Aircraft:
GULFSTREAM GV

S/N:
677

60 Degree Bunsen Burner Test For Wire

FAR 25.869(a)(4) Appendix F Part I (a)(3) Amendment 25-72

Conditioning Room: Time In: 08/03/05 9:00AM Time Out: 08/04/05 9:15AM

Specimen: NEXANS/ALLCABLE: WIRE, TEFLON COATED, M22759/11/22-9, WHITE, 22AWG, LOT #30424, REF #LN631

Flame Application (seconds)	Flame Time (seconds)	Burn Length (inches)	Drip Flame Time (Seconds)
30	0.0	1.5	0 No Drips
30	0.0	1.2	0 No Drips
30			
Average:	0.0	1.4	0 No Drips

Comments:

TESTING INCOMPLETE DUE TO WIRE BREAKING

60 Degree Bunsen Burner Test (30 sec.): Average Flame Time may not exceed 30 sec. Average Burn Length may not exceed 3". Average Drip Flame Time may not exceed 3 sec. after falling.

Passed: ☐ Failed: ☐

Signed: Carin Demus

Carin Demus

EG-459

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

STATEMENT OF COMPLIANCE WITH THE FEDERAL AVIATION REGULATIONS

DATE: January 21, 2006

AIRCRAFT OR AIRCRAFT COMPONENT IDENTIFICATION

MAKE	MODEL NO.	TYPE *(Airplane, Radio, Helicopter, etc.)*	NAME OF APPLICANT
Gulfstream	GV	Airplane	National Science Foundation

LIST OF DATA

IDENTIFICATION	TITLE
	VCSEL Hygrometer for Use in the Troposphere and Stratosphere Critical Design Review Report UCAR Subcontract No. S05-39694 V4.0, January 18, 2006 Notes: 1) This approval is for engineering design data only and is not an installation approval. It indicates the data listed above demonstrates compliance only with the regulations specified by paragraph and subparagraph listed below as "APPLICABLE REQUIREMENTS." (Compliance with additional regulations not listed here may be required). This form does not constitute FAA approval of all the engineering design data necessary for substantiation of compliance to necessary requirements for the entire alteration/repair. [Ref. FAA Order 8110.37C paragraph 611g]. 2) This approval is valid only for Gulfstream GV S/N 677. 3) Approval under 14 CFR 25.1351 is valid only for an equipment level electrical load analysis. 4) DER authorization to approve data for alterations for the Gulfstream GV project was granted by the FAA on August 11, 2005. [Ref. FAA Order 8110.37C paragraph 203b].

PURPOSE OF DATA

In support of a major alteration for S/N 677. The approval is design data approval only and is not an installation approval.

APPLICABLE REQUIREMENTS (List specific sections)

14 CFR 25.1301(a)(d), 25.1351.

CERTIFICATION - Under authority vested by direction of the Administrator and in accordance with conditions and limitations of appointment under Part 183 of the Federal Aviation Regulations, data listed above and on attached sheets numbered **N/A** have been examined in accordance with established procedures and found to comply with applicable requirements of the Federal Aviation Regulations.

I (We) Therefore
- ☐ **Recommend approval of these data**
- ☒ **Approve these data**

SIGNATURE(S) OF DESIGNATED ENGINEERING REPRESENTATIVE(S)	DESIGNATION NUMBERS(S)	CLASSIFICATION(S)
Jonathan Lynch	DERT-710166-SW	Systems and Equipment (Electrical)

FAA Form 8110-3 (11-70) SUPERSEDES PREVIOUS EDITION

ELECTRONIC FORMAT (7-00)

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

STATEMENT OF COMPLIANCE WITH THE FEDERAL AVIATION REGULATIONS

DATE: 08/04/05

AIRCRAFT OR AIRCRAFT COMPONENT IDENTIFICATION

MAKE	MODEL NO.	TYPE (Airplane, Radio, Helicopter, etc.)	NAME OF APPLICANT
GULFSTREAM S/N 677	GV	Airplane	Skandia, Inc. SOUTHWEST SCIENCES INC

LIST OF DATA

IDENTIFICATION	TITLE
Work Order # 128461-05 Document ID 55815 Purchase Order # 10251	ALCATEL/ALLCABLE: WIRE, TELFON COATED, M22759/11/22-5, GREEN, 22AWG, LOT #12944, REF #KL662, REF TEST ID # 60DEG-452 THERMAX/ALLCABLE: WIRE, TWISTED PAIR SHIELDED TEFLON, TEF2202STJ, WHITE, 22AWG, LOT #1050006, REF #RL0427695, REF TEST ID # 60DEG-453 SPECIALTY/ALLCABLE: WIRE, TEFLON COATED, M22759/11/22-0, BLACK 22AWG, LOT #677-9345-08, REF #LQ955, REF TEST ID # 60DEG-456 TERMAX/ALLCABLE: WIRE, TEFLON COATED, M22759/11/22-4, YELLOW, 22AWG, D/L 778846, REF #KR913, REF TEST ID # 60DEG-457 SPECIALTY/ALLCABLE: WIRE, TEFLON COATED, M22759/11/22-2, RED, 22AWG, LOT #677-9345-09, REF #LR458, REF TEST ID # 60DEG-458

PURPOSE OF DATA

DEMONSTRATION OF COMPLIANCE WITH MATERIAL FLAMMABILITY REQUIREMENTS

APPLICABLE REQUIREMENTS (List specific sections)

FAR 25.869(a)(4) Appendix F Part I (a)(3) Amendment 25-72

CERTIFICATION -Under authority vested by direction of the Administrator and in accordance with conditions and limitations of appointment under Part 183 of the Federal Aviation Regulations, data listed above and on attached sheets numbered _____ have been examined in accordance with established procedures and found to comply with applicable requirements of the Federal Aviation Regulations.

I (We) Therefore ☐ Recommend approval of these data
☒ Approve these data

SIGNATURE(S) OF DESIGNATED ENGINEERING REPRESENTATIVE	DESIGNATION NUMBER(S)	CLASSIFICATION(S)
Carin Demus	DERY-405143-CE	Structural Special
Carin Demus		

FAA Form 8110-3 (11-70) SUPERSEDES PREVIOUS EDITION

Electrical Load Analysis

The electrical loads for the Southwest Sciences VCSEL Hygrometer are based on the circuit diagram shown in the table below, manufacturers specifications and measured usage of the digital signal processor circuit board. Details of the expected usage is shown in Table A2-I. As can be seen, the total expected power usage for the sensor is about 5 W, occasionally going up to 20 W when the box heater is on. Since the current capacity of all the wiring use is 5 A, there is sufficient margin for safety in this design. The connector current limits are 5 A and the switch limits are 15 A.

Component	Volts	Amps	Watts	Method of Determination	Comment
Circuit boards	6.0	0.15	0.90	Measured	Includes pressure sensor and laser
Mirror Heater	6.0	0.18	1.08	Measured	Protected by 1 A circuit breaker
Neon Lamp Indicator	120	0.0007	0.08	Manufacturer specifications	Prior to AC-DC converter
LEDs	6.0	~ 0.03	0.18	Estimate	
Box Heater*	120	0-0.13	0-15	Measured	On as needed
			2.24-17.24	*Total used power*	
AC-DC Converter			2.24	Manufacturer specifications (6W output capacity)	50 % Efficiency; Protected by 2 A circuit breaker
			4.48-19.48	**Total Sensor Power Drawn from Aircraft**	

* Box Heater is on occasionally during ascent and at highest altitude.

Certificate of Compliance

July 31, 2008

VCSEL Hygrometer for NCAR Gulfstream V

The delivered instrument meets the contract requirements as specified in subcontract S05-39694.

Signed: 

Alan C. Stanton
President
Southwest Sciences, Inc