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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 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

![Hygrometer Layout](image)

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 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>
<thead>
<tr>
<th>Mode</th>
<th>T (K)</th>
<th>P (kPa)</th>
<th>Bath</th>
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</thead>
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<tr>
<td>Weak</td>
<td>273.1</td>
<td>78.7</td>
<td>ice/water</td>
</tr>
<tr>
<td>Strong Direct</td>
<td>227.4</td>
<td>52.8</td>
<td>Acetonitrile/N₂(l)</td>
</tr>
<tr>
<td>Strong</td>
<td>209.6</td>
<td>13.5</td>
<td>Chloroform/N₂(l)</td>
</tr>
</tbody>
</table>

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 instrument's 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
\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) xxxxx_ 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) xxxx_ 28-33  Laser Temperature
Set Temp (ohms) xxxx_ 34-39  Laser Temperature Set Point

TEC Current (Counts) xxxx_ 40-45  Thermoelectric cooler current in DAC counts

Spectral line  1c__  46-47  W, D, or S - weak, direct, or strong mode
Δνvoigt (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

\n  2c  82-83 Line termination

25 Hz Data (33 characters)

Field  Format  string index[0…n]
Conc H₂O    sx.xxExxx_  0-9  Moisture Number Density (molecules/cm³)

Std dev H₂O x.xxExxx_ 10-18  Fit Error
Frost/dew Point (°C) sxxx.xx_ 19-26
Number good scans xxxx 28-30
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
0123456789012345678901234567890123456789012345678901234567890123456789012345678901234567
89012345

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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

1 Hz System Info
Each line terminated with \r

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

```c
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(TermOhm, &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(IO, &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]='r';
    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);
}
AC INPUT
1. HOT BLACK
2. COM WHITE
3. GND GREEN

AIRCRAFT_120_VAC

RS-232 OUT from J3
1. TX - BLACK
2. RX - WHITE
3. GND - SHIELD

P3

FROM_J4 TO_GPS_TRIG
EXT TRIG

COAX

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

DB9
MAKE FROM 677DE1018-03 APERTURE PLATE BLANK.

MODIFIED NACA63A025 PROFILE

4X DRILL & TAP FOR .190-32x1D HELICOIL — DO NOT BREAK THROUGH

SECTION A-A

SCALE 2 : 1

PROJECT DWG NO. 67706VCSEL-1

NC

APERTURE PLATE
VCSEL-HYGROMETER

5/8/06
77209

ROUTE: DRC

APPROVALS

APPROVED

REVISIONS

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES.
TOLERANCES ARE:

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

ANGULAR:
FORMED=±2°
MACHINED=±.5°
NOTES:
1) REMOVE BURRS AND BREAK SHARP EDGES.
2) MATERIAL CERTS REQUIRED.
3) ANODIZE PER MIL-A-8625, GOLD.
NOTES:
1) REMOVE BURRS AND BREAK SHARP EDGES.
2) MATERIAL CERTS REQUIRED.
3) ANODIZE PER MIL-A-8625, GOLD.
1) REMOVE BURRS AND BREAK SHARP EDGES.
2) MATERIAL CERTS REQUIRED.
3) ANODIZE PER MIL-A-8625, GOLD.

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

SECTION A-A
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

HIAPER MODIFIED LOWER MIRROR MOUNT

**TABLE**

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<th>JAS</th>
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1. MATERIAL CERTIFICATION REQUIRED

C'BORE AND CLEARANCE FOR
4-40 SHCS
3 PL

2-56 THREAD X .172 DP

---

X

FLAT MIRROR MOUNT

ALUMINUM 6061-T6

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

NEXT ASSEMBLY

—

DO NOT SCALE DRAWING

NEXT ASSEMBLY

—

FLAT MIRROR MOUNT

ALUMINUM 6061-T6

VCSEL HYGROMETER

Hiaper

Design & Fabrication Services
ATMOSPHERIC TECHNOLOGY DIV.

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

1. MATERIAL CERTIFICATION REQUIRED

C'BORE AND CLEARANCE FOR
4-40 SHCS
3 PL

2-56 THREAD X .172 DP

---

X

FLAT MIRROR MOUNT

ALUMINUM 6061-T6

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

NEXT ASSEMBLY

—

DO NOT SCALE DRAWING

NEXT ASSEMBLY

—

FLAT MIRROR MOUNT

ALUMINUM 6061-T6

VCSEL HYGROMETER

Hiaper

Design & Fabrication Services
ATMOSPHERIC TECHNOLOGY DIV.

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

1. MATERIAL CERTIFICATION REQUIRED

C'BORE AND CLEARANCE FOR
4-40 SHCS
3 PL

2-56 THREAD X .172 DP

---

X

FLAT MIRROR MOUNT

ALUMINUM 6061-T6

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

NEXT ASSEMBLY

—

DO NOT SCALE DRAWING

NEXT ASSEMBLY

—

FLAT MIRROR MOUNT

ALUMINUM 6061-T6

VCSEL HYGROMETER

Hiaper

Design & Fabrication Services
ATMOSPHERIC TECHNOLOGY DIV.

NATIONAL CENTER FOR
ATMOSPHERIC RESEARCH
1850 TABLE MESA DRIVE
BOULDER, CO 80305
### Upper Mirror Holder

#### Specifications

**Description:** Upper Mirror Holder

**Material:** Aluminum 6061-T6

**Tolerances:**
- **DIMENSIONS ARE IN INCHES.**
- **UNLESS OTHERWISE SPECIFIED**
- **UNLESS OTHERWISE SPECIFIED: X = ±0.03, XX = ±0.01, XXX = ±0.004.**
- **DECIMALS:**
- **ANGULAR:** FORMED=±12°, MACHINED=±0.5°
- **DO NOT SCALE DRAWING**
- **NEXT ASSEMBLY**

#### Diagram

- **Dimensions:**
  - R.725
  - R.889
  - .390
  - .533
  - .390
  - .170
  - .310
  - .410
  - .150
  - .015
  - .267
  - .350
  - .153
  - .170
  - .390R
  - .150
  - .015
  - .170
  - .310
  - .190
  - .165

#### Approvals

**DR.**

**ENG.**

**CHK.**

**APPD.**

**APPD.**

**Effectivity Date:** 27

#### Additional Information

- **Drill and Tap for 4-40 Helicoil**

#### Table

<table>
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<tr>
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**Note:**

- **Scale:** 2:1
- **Design & Fabrication Services, Atmospheric Technology Div.**
- **Atmospheric Research:**
  - 1850 Table Mesa Drive
  - Boulder, CO 80305
- **Rev.:** NC
- **Cage Code:** 0SEF6
- **Dwg No.:** B
- **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.
**Temp probe tube**

**VCSEL HYGROMETER**

**X**

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</table>

**Approved by**

- **Design & Fabrication Services**, Atmospheric Technology Div.
- **Boulder, CO 80305**

**UNLESS OTHERWISE SPECIFIED**

**DIMENSIONS ARE IN INCHES.**

**TOLERANCES ARE:**

- **.XXX = ±.004**
- **.XX = ±.01**
- **.X = ±.03**

**MACHINED = ±.5°**

**FORMED = ±2°**

**DO NOT SCALE DRAWING**

**NEXT ASSEMBLY**

**DO NOT SCALE DRAWING**

- **SCALE** 2:1
<table>
<thead>
<tr>
<th>ITEM NO.</th>
<th>QTY</th>
<th>PART NO.</th>
<th>DESCRIPTION OR NOMENCLATURE</th>
<th>MATERIAL/SPECIFICATION</th>
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<tbody>
<tr>
<td>6</td>
<td>1</td>
<td>2-008</td>
<td>O-RING</td>
<td>POLYMER</td>
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<td>5</td>
<td>1</td>
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<td>EPOXY</td>
<td>EPOXY</td>
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<td>4</td>
<td>1</td>
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<td>PROBE TIP</td>
<td>STAINLESS STEEL</td>
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<tr>
<td>3</td>
<td>1</td>
<td>BR23KB27 4N-CDEK</td>
<td>THERMISTER</td>
<td>GENERAL ELECTRIC THERMISTER</td>
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<tr>
<td>2</td>
<td>1</td>
<td></td>
<td>TUBE</td>
<td>SS TUBE</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>-1</td>
<td>TIP</td>
<td>STAINLESS STEEL</td>
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</table>

**THERMISTER ASSY**

**VCSEL HYGROMETER**

**DESIGN AND FABRICATION SERVICES, A DIVISION OF NCAR**

**BOULDER, COLORADO  80301     303-497-1000**

**TITLE**

**PARTS LIST**
Static Tip v2
VCSEL HYGROMETER

<table>
<thead>
<tr>
<th>ITEM</th>
<th>PART NO.</th>
<th>DESCRIPTION</th>
<th>MATERIAL</th>
<th>SPECIFICATION</th>
<th>WT.</th>
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<tbody>
<tr>
<td>X</td>
<td>TIP</td>
<td>STAINLESS STEEL</td>
<td></td>
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</tr>
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</table>

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

EFFECTIVITY

REVISIONS

NC
### TUBE

<table>
<thead>
<tr>
<th>ITEM</th>
<th>PART NO.</th>
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<th>MATERIAL</th>
<th>SPECIFICATION</th>
<th>WT.</th>
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<tr>
<td>X</td>
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<td>SS TUBE .066 O.D., .008 WALL</td>
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**UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE:**

- DECIMALS: $X = \pm .03$
- $XX = \pm .01$
- $XXX = \pm .004$

- ANGULAR FORMED $= \pm 12^\circ$
- MACHINED $= \pm .5^\circ$

**DO NOT SCALE DRAWING**

**NEXT ASSEMBLY**

**APPROVALS**

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<thead>
<tr>
<th>DR.</th>
<th>ENG.</th>
<th>CHK.</th>
<th>APPD.</th>
<th>APPD.</th>
<th>EFFECTIVITY</th>
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**SCALE DRAWING**

- 2:1

**DATE**

- 34

**DESIGN & FABRICATION SERVICES, ATMOSPHERIC TECHNOLOGY DIV.**

**ADDRESS**

- 1850 TABLE MESA DRIVE
- BOULDER, CO 80305

**COMPANY**

- NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

**PRODUCT**

- VCSEL HYGROMETER

**DESCRIPTION**

- Pitot tube

**CAGE CODE**

- 0SEF6

**REV.**

- NC
NOTES
1. MATERIAL CERTIFICATION REQUIRED.

DRILL AND TAP FOR 4-40 HELICOIL

<table>
<thead>
<tr>
<th>X</th>
<th>PART NO.</th>
<th>DESCRIPTION</th>
<th>MATERIAL</th>
<th>SPECIFICATION</th>
<th>WT.</th>
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<tr>
<td></td>
<td>BRACKET</td>
<td>ALUMINUM 6061-T8</td>
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XX = ±.01
XXX = ±.004

ANGULAR:
FORMED = ±2°
MACHINED = ±.5°

DO NOT SCALE DRAWING

NEXT ASSEMBLY

EFFECTIVITY

SCALE 2:1

Mirror Y Adjustment Bracket

VCSEL HYGROMETER

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

DESIGN & FABRICATION SERVICES, ATMOSPHERIC TECHNOLOGY DIV.

Sheet 1 of 1
Use any nonmagnetic SS plate 0.020" - 0.050" thick

Ø 1/8" (2) PLCS

R 0.03"

0.33" 0.085"

0.90" 0.25"

1.31" 0.50"

1.50" all centered
APERTURE PLATE

Fuse

DSP CIRCUIT BOARD

TERN MICROPROCESSOR

DC POWER SWITCH

AC POWER SWITCH

BNC TRIGGER

CONTROL BOX

PRESSURE GAUGE

Laser

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

Ø .748±.001
.086-56 UNC-2B

Ø .188 x 0.219 Deep

Ø .110±.002 through

Ø .136+.002-.000 x 0.340" Deep Max
Do Not Break Through

.112-40 UNC-2B
x 0.340" Deep Max
Do Not Break Through

FOR MIRROR FABRICATION
170.0 mm Radius of Curvature
Spherical Surface

TITLE
HIAPER New Front Spherical Mirror

<table>
<thead>
<tr>
<th>AUTHOR</th>
<th>SIZE</th>
<th>DATE</th>
<th>DWG NO</th>
<th>REV</th>
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<tr>
<td>JAS</td>
<td>A</td>
<td>7/11/08</td>
<td>D04-06-02a_SPH</td>
<td>1</td>
</tr>
</tbody>
</table>

MATERIAL
Cu (Provided)

SCALE
2:1

QNTY
Three

SHEET
FOR MIRROR FABRICATION
170.0 mm Radius of Curvature
Spherical Surface

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

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

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 .748 ±

.000 ±0.002
x 0.340" Deep
Do Not Break Through

.156

.094

Southwest Sciences
incorporated

HIAPER New Rear Spherical Mirror

TITLE

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
<table>
<thead>
<tr>
<th>Designation</th>
<th>Part Number</th>
<th>MIL SPEC #</th>
<th>Manufacturer</th>
<th>Supplier</th>
<th>Specs</th>
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<tbody>
<tr>
<td><strong>ELECTRICAL</strong></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>W1</td>
<td>wire ‡</td>
<td>lot # 677-9345-09</td>
<td>M22759/11-22-9</td>
<td>LR458 Specialty All-Cable</td>
<td>22 AWG, red</td>
</tr>
<tr>
<td>W2</td>
<td>wire ‡</td>
<td>lot # 677-9345-08</td>
<td>M22759/11-22-9</td>
<td>LO955 Specialty All-Cable</td>
<td>22 AWG, black</td>
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<tr>
<td>W3</td>
<td>wire ‡</td>
<td>lot # 12944</td>
<td>M22759/11-22-9</td>
<td>KL662 Alcatel All-Cable</td>
<td>22 AWG, green</td>
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<tr>
<td>W4a</td>
<td>wire ‡</td>
<td>22-TE-1902(2)STJ</td>
<td>M16878/4 BFE-9</td>
<td>677F-12 Thermax All-Cable</td>
<td>22 AWG, white</td>
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<tr>
<td>W5</td>
<td>wire ‡</td>
<td>lot # 77886</td>
<td>M22759/11-22-9</td>
<td>KR913 Thermax All-Cable</td>
<td>22 AWG, yellow</td>
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<tr>
<td>CAB1</td>
<td>Shielded twisted pair cable ‡</td>
<td>lot 1050006</td>
<td>MIL-W-16878/4 tel2202STJ</td>
<td>Thermax All-Cable</td>
<td>22 AWG</td>
</tr>
<tr>
<td>CAB2</td>
<td>cox cable ‡</td>
<td>S44193</td>
<td>PIC Wire &amp; Cable</td>
<td>PIC Wire &amp; Cable</td>
<td>50 ohm coax</td>
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<tr>
<td>F2</td>
<td>circuit breaker</td>
<td>7274-11-1</td>
<td>MS 22073-1</td>
<td>Klaxon (TI) Flame Enterprises</td>
<td>1 A</td>
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<tr>
<td>F1</td>
<td>circuit breaker</td>
<td>7274-11-2</td>
<td>MS 22073-2</td>
<td>Klaxon (TI) Flame Enterprises</td>
<td>2 A</td>
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<tr>
<td>SW1,SW2</td>
<td>switch</td>
<td>850069</td>
<td>Eaton</td>
<td>Sun Electric Heater</td>
<td>SPST</td>
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<tr>
<td>LAMP1</td>
<td>lamp housing w/neon clr</td>
<td>Sr6-8396-0937-552</td>
<td>LH74/1, LC13CN2</td>
<td>Dialight PEI-Genesis</td>
<td>125V uses T-2 midget flange base neon lamp</td>
</tr>
<tr>
<td>LED2</td>
<td>LED</td>
<td>162-6430-0937-502</td>
<td>MS2556-8</td>
<td>Dialight Newark 25F1206</td>
<td>Has internal 62 kΩ resistor</td>
</tr>
<tr>
<td>LED1</td>
<td>LED</td>
<td>586-1102-101</td>
<td>MS35256-8</td>
<td>Dialight PEI-Genesis</td>
<td>6 V, for incandescent replacement</td>
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<tr>
<td>LAMP1+A6</td>
<td>Neon lamp</td>
<td>521-9047</td>
<td>C7A</td>
<td>Dialight Newark 05B4378</td>
<td>T-2 midget flange base</td>
</tr>
<tr>
<td>J4</td>
<td>BNC bulkhead isolated</td>
<td>31-4890-1</td>
<td>Amphenol Newark</td>
<td>90F8467</td>
<td>Teflon insulator</td>
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<tr>
<td>J2</td>
<td>Circular connector</td>
<td>MS27473T8B98S</td>
<td>ITT/Canon PEI-Genesis</td>
<td>3 pin (#20 - AC power)</td>
<td></td>
</tr>
<tr>
<td>J3</td>
<td>Circular connector</td>
<td>MS27473T8B35P</td>
<td>ITT/Canon PEI-Genesis</td>
<td>6 pin (#22) - for RS-232 signals</td>
<td></td>
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<tr>
<td>P2</td>
<td>Circular connector</td>
<td>MS27473T8B35S</td>
<td>ITT/Canon PEI-Genesis</td>
<td>6 pin (#22) - for RS-232 signals</td>
<td></td>
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<tr>
<td>J6, J7</td>
<td>9-pin D connector socket</td>
<td>205555-2</td>
<td>M24308/2-1F</td>
<td>Dialight Newark</td>
<td>9S-pin D for RS-232 connector to aircraft</td>
</tr>
<tr>
<td>J1</td>
<td>15-pin D connector socket</td>
<td>M24308/2-2F</td>
<td>Cinch</td>
<td>Newark 45F997</td>
<td>15-pin D socket JTAG</td>
</tr>
<tr>
<td>J9</td>
<td>AC Plug for 120 VAC, 60 Hz</td>
<td>5266-X</td>
<td>Pass &amp; Seymour Summit Electric</td>
<td>to instrument power source on aircraft</td>
<td></td>
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<tr>
<td>DP1</td>
<td>4-pin DSP receptacle</td>
<td>770602-4</td>
<td>AMP</td>
<td>Digikei</td>
<td></td>
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<tr>
<td>DP2</td>
<td>4-pin DSP receptacle</td>
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<td>AMP</td>
<td>Digikei</td>
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<td>AMP</td>
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<tr>
<td>DP5</td>
<td>2-pin DSP receptacle</td>
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<td>AMP</td>
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<td>DP6</td>
<td>2-pin DSP receptacle</td>
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<td>AMP</td>
<td>Digikei</td>
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<tr>
<td>MP1</td>
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<td>AMP</td>
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<td>MP2</td>
<td>20-pin DSP receptacle</td>
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<td>Digikei</td>
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<td>4-pin DSP receptacle</td>
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<td>MP7</td>
<td>2-pin DSP receptacle</td>
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<td>AMP</td>
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<tr>
<td>pins for DSP receptacles</td>
<td>770666-1</td>
<td>AMP</td>
<td>Digikei</td>
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<tr>
<td>pins for 20-pin connector (MDP2)</td>
<td>87523-6</td>
<td>AMP</td>
<td>Digikei</td>
<td></td>
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<tr>
<td>J10</td>
<td>6-pin MTA receptacle</td>
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<td>AMP</td>
<td>Digikei A19494-ND</td>
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<tr>
<td>P10</td>
<td>6-pin MTA header, friction lock</td>
<td>640456-6</td>
<td>AMP</td>
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<tr>
<td>J11</td>
<td>3-pin laser socket</td>
<td>8060</td>
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<td>P12</td>
<td>6-pin ribbon receptacle, 0.1&quot;</td>
<td>320553</td>
<td>MS25036-148</td>
<td>AMP</td>
<td>Digikei A27227-ND</td>
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<tr>
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<td>51863</td>
<td>MS25036-102</td>
<td>AMP</td>
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<td>ring terminal #6 for 18-22 AWG</td>
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<td>MS25036-149</td>
<td>AMP</td>
<td>Digikei A27237-ND</td>
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<tr>
<td>ring terminal #8 for 18-22 AWG</td>
<td>59824-1</td>
<td>AMP</td>
<td>Genuine Aircraft Hardware</td>
<td>10 kohm or 50 kohm</td>
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<tr>
<td>J12</td>
<td>6-pin MTA receptacle</td>
<td>770602-6</td>
<td>AMP</td>
<td>Digikei A19494-ND</td>
<td></td>
</tr>
<tr>
<td>J1</td>
<td>15-pin D connector socket</td>
<td>M24308/2-2F</td>
<td>Cinch</td>
<td>Newark 45F997</td>
<td>15-pin D socket JTAG</td>
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<td>Pass &amp; Seymour Summit Electric</td>
<td>to instrument power source on aircraft</td>
<td></td>
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<tr>
<td>DP1</td>
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<td>AMP</td>
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<td>AMP</td>
<td>Digikei</td>
<td></td>
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<tr>
<td>MP1</td>
<td>10-pin DSP receptacle</td>
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<td>AMP</td>
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<td>MP2</td>
<td>20-pin DSP receptacle</td>
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<td>AMP</td>
<td>Digikei</td>
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<tr>
<td>MP6</td>
<td>4-pin DSP receptacle</td>
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<td>AMP</td>
<td>Digikei</td>
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<tr>
<td>MP7</td>
<td>2-pin DSP receptacle</td>
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<td>AMP</td>
<td>Digikei</td>
<td></td>
</tr>
<tr>
<td>pins for DSP receptacles</td>
<td>770666-1</td>
<td>AMP</td>
<td>Digikei</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pins for 20-pin connector (MDP2)</td>
<td>87523-6</td>
<td>AMP</td>
<td>Digikei</td>
<td></td>
<td></td>
</tr>
<tr>
<td>J10</td>
<td>6-pin MTA receptacle</td>
<td>770602-6</td>
<td>AMP</td>
<td>Digikei A19494-ND</td>
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<tr>
<td>P10</td>
<td>6-pin MTA header, friction lock</td>
<td>640456-6</td>
<td>AMP</td>
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<td>MS25036-148</td>
<td>AMP</td>
<td>Digikei A27227-ND</td>
</tr>
<tr>
<td>ring terminal #4 for 18-22 AWG</td>
<td>51863</td>
<td>MS25036-102</td>
<td>AMP</td>
<td>Digikei A27233-ND</td>
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<td>ring terminal #6 for 18-22 AWG</td>
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<td>MS25036-149</td>
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<td></td>
</tr>
<tr>
<td>ring terminal #8 for 18-22 AWG</td>
<td>59824-1</td>
<td>AMP</td>
<td>Genuine Aircraft Hardware</td>
<td>10 kohm or 50 kohm</td>
<td></td>
</tr>
<tr>
<td>Pitot thermistor</td>
<td>COTS Baratron</td>
<td>T22A17CD3FA</td>
<td>T22A17CD3FA</td>
<td>MKS Instruments</td>
<td>14.7 psi, 0.25% of reading</td>
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<tr>
<td>DSP circuit board - mother</td>
<td>S04-06-01</td>
<td>SO4-06-01</td>
<td>SO4-06-01</td>
<td>Compudraft</td>
<td>6V, 150 mA</td>
</tr>
<tr>
<td>DSP circuit board - daughter</td>
<td>S04-06-02</td>
<td>SO4-06-02</td>
<td>SO4-06-02</td>
<td>Compudraft</td>
<td>6V, 150 mA</td>
</tr>
<tr>
<td>Connector circuit board</td>
<td>Microprocessor</td>
<td>FLASHCORE-B</td>
<td>FLASHCORE-B</td>
<td>Thermometrics</td>
<td>6V, 1A linear supply</td>
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<tr>
<td>Power supply</td>
<td>Power supply</td>
<td>8EB-1000</td>
<td>8EB-1000</td>
<td>Accopain</td>
<td>6V, 1A linear supply</td>
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<tr>
<td>P12</td>
<td>Aperture plate connector, 6 pin</td>
<td>PT07SE10-6P</td>
<td>Amphenol PEI-Genesis</td>
<td>42</td>
<td>McMaster-Carr</td>
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<tr>
<td>R1</td>
<td>Aperture connector, 6 socket</td>
<td>PT06A10-6S(SR)</td>
<td>Amphenol Newark</td>
<td>42</td>
<td>120 VAC, 15W, 1&quot;x3&quot; w/ adhesive</td>
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<tr>
<td>Silicone heater</td>
<td>35750K165</td>
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## MECHANICAL

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<tr>
<th>Designation</th>
<th>Part Number</th>
<th>MIL SPEC #</th>
<th>Manufacturer</th>
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<th>Specs</th>
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<tr>
<td>enclosure</td>
<td>ZT88-154A-42-AL60-GG</td>
<td>ZTPS-51-1-1</td>
<td>Zero Cases</td>
<td>McMaster-Carr</td>
<td>6061-0-AI</td>
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<td>enclosure cover</td>
<td>AT88-154A-COG-1-5-AL60-GG</td>
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<td>McMaster-Carr</td>
<td>6061-0-AI</td>
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<tr>
<td>enclosure gasket (optional)</td>
<td></td>
<td></td>
<td>Custom (NCAR)</td>
<td>Digikei</td>
<td>#8&quot;ID x 3/8&quot;OD x 1/32&quot;, black</td>
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<tr>
<td>Aperture plate &amp; fins</td>
<td></td>
<td></td>
<td>Jack Fox (NCAR)</td>
<td>Parker</td>
<td>#4 for DSP mounting, .25&quot; x 1/32&quot;</td>
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<td>fiber washer</td>
<td>96100A125</td>
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<td>O-rings</td>
<td>92320A691</td>
<td>91075A101</td>
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<td>Digikei</td>
<td>18-8 SS</td>
</tr>
<tr>
<td>spacer 1/2&quot; x 3/8&quot; od, #8-32</td>
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<td>clamp</td>
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<td>MS21919</td>
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<tr>
<td>Pan head screw, #8-32 x 7/8&quot;</td>
<td>91400A198</td>
<td>MS1957-48</td>
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<td>Box mounting</td>
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<td>Pan head screw, #4-40 x 1/4&quot;</td>
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<td>Pan head screw, #4-40 x 3/8&quot;</td>
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<tr>
<td>Pan head screw, #4-40 x 5/8&quot;</td>
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<td>MS1957-18</td>
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<td>MS1957-43</td>
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<td>Set screw, nylon tipped, 18-8 SS</td>
<td>18-8 SS</td>
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<td>McMaster-Carr</td>
<td>438&quot; hole x 1/16&quot; panel</td>
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<tr>
<td>Allen head cap screw, #2-56 x 3/4</td>
<td>1061T17</td>
<td>MS35489-13</td>
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<tr>
<td>grommet silicone</td>
<td>1061T13</td>
<td>MS35489-6</td>
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<td>tygon tubing, P sensor line</td>
<td>5466K11</td>
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<td>pinch clamp</td>
<td>52545K13</td>
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<td>McMaster-Carr</td>
<td>1/16 ID, 3/16 OD, smooth bore, high purity</td>
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<td>cable tie plate, #4</td>
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<td>locknuts #4</td>
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<td>MS21044(C)-04</td>
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<td>MS35333-40</td>
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<td>blind VCR gland, 1/4&quot;</td>
<td>SS-4-VCR-3-BL</td>
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<td>Albuquerque Valve</td>
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<td>VCR short male nut, 1/4&quot;</td>
<td>SS-4-VCR-4-.54NC</td>
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<td>Albuquerque Valve</td>
<td></td>
<td></td>
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<tr>
<td>Ag-plated Cu gasket, 1/4&quot;</td>
<td>CU-4-VCR-2</td>
<td></td>
<td>Albuquerque Valve</td>
<td></td>
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## OPTICAL

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<th>Manufacturer</th>
<th>Supplier</th>
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<td>Mirrors</td>
<td>custom (Spawr)</td>
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<td>Newport</td>
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<td>Mirror mount</td>
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<td>Newport</td>
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<tr>
<td>Mirror mount</td>
<td>MM-050</td>
<td></td>
<td>Newport</td>
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<tr>
<td>Fiberized Diode laser†</td>
<td>VL-1854-1-SP-P5</td>
<td></td>
<td>Newport</td>
<td></td>
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<tr>
<td>Visible tracer laser</td>
<td>V3-780-TO-DA</td>
<td></td>
<td>Vertilas</td>
<td></td>
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<td>Visible tracer laser</td>
<td>HLE312G</td>
<td></td>
<td>ThorLabs</td>
<td></td>
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<td>Fiber collimator</td>
<td>COTS</td>
<td></td>
<td>Oz Optics</td>
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<td>Fiber connector†</td>
<td>SNA-122450</td>
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<td>Metrotek</td>
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<td>Photodiode</td>
<td>J23-181-R01M-1.9</td>
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<td>Judson Technology</td>
<td></td>
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<tr>
<td>Interference filter</td>
<td>BP=1870-105</td>
<td></td>
<td>Spectrogon</td>
<td></td>
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<tr>
<td>GRIN lens for detector</td>
<td></td>
<td></td>
<td>NSG/QTF coating</td>
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</tr>
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### 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 - J23-181-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

FINAL TEST DATA
Serial No. 105834-4
Type VL-1854-1-SP-P5
Diode No. NZTQ-XLOA-XHSU-S
Product State: Engineering Sample

Page 1|4
Date 2007-10-12

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

<table>
<thead>
<tr>
<th>CW Current</th>
<th>Recommended Range</th>
<th>Maximum Ratings</th>
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<tbody>
<tr>
<td>0.5 mA - 7.0 mA</td>
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<td>8.5 mA</td>
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<table>
<thead>
<tr>
<th>Threshold Current</th>
<th>Max. Output Power</th>
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</thead>
<tbody>
<tr>
<td>0.37 mA</td>
<td>ca. 0.48 mW</td>
</tr>
<tr>
<td>0.42 mA</td>
<td>ca. 0.40 mW</td>
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<table>
<thead>
<tr>
<th>Ild (20°C)</th>
<th>1851.63 nm</th>
<th>1852.09 nm</th>
<th>1852.73 nm</th>
<th>1853.63 nm</th>
<th>1854.71 nm</th>
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<tr>
<td>0.55 mA</td>
<td>2.45 mA</td>
<td>4.36 mA</td>
<td>6.25 mA</td>
<td>8.16 mA</td>
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<table>
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<tr>
<th>Wavelength</th>
<th>1852.99 nm</th>
<th>1853.39 nm</th>
<th>1853.95 nm</th>
<th>1854.69 nm</th>
<th>1855.61 nm</th>
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<tbody>
<tr>
<td>Ild (30°C)</td>
<td>0.63 mA</td>
<td>2.31 mA</td>
<td>4.00 mA</td>
<td>5.68 mA</td>
<td>7.36 mA</td>
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CAUTION
INVISIBLE LASER RADIATION
AVOID EXPOSURE TO BEAM
(CLASS 3B LASER PRODUCT)
MAX 0.5 mW
1853 nm

VERTILAS GmbH
Lichtenbergrasse 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

45
VERTILAS VCSEL Diodes

HEADER SCHEMATICS
Serial No. 105834-4
Type VL-1854-1-SP-P5
Diode No. NZTQ-XLOA-XHSU-S
Date: 2007-10-12

dimensions: inch

dimensions: mm

<table>
<thead>
<tr>
<th>Pin assignment</th>
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<tbody>
<tr>
<td>Pin</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
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<tr>
<td>8</td>
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<tr>
<td>9</td>
</tr>
<tr>
<td>10</td>
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<td>1</td>
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Steinhart-Hart-Coefficients

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<th>A</th>
<th>B</th>
<th>C</th>
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<tr>
<td>A</td>
<td>1.129148E-03</td>
<td>2.341250E-04</td>
<td>8.757410E-08</td>
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TEC

<table>
<thead>
<tr>
<th>I&lt;sub&gt;max&lt;/sub&gt;</th>
<th>0.45 A</th>
</tr>
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<tbody>
<tr>
<td>V&lt;sub&gt;max&lt;/sub&gt;</td>
<td>2.1 V</td>
</tr>
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</table>

proper heatsinking is required

T<sub>case</sub> 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 omissions 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.
### Specifications and Ordering Information

**Configuration**

- **Full Scale Ranges**
- **Accuracy (including non-linearity, hysteresis, and non-repeatability)**

**Response Time**

- **Temperature Coefficients**
- **Zero**
- **Span**

**Ambient Operating Temperature**

- **Overpressure Limit**
- **Burst Pressure**
- **Materials Exposed to Gases**
- **Power**
  - **Input**
  - **Output**

**Electromagnetic Compatibility**

**Electrical Connectors**

**Fittings**

**Standard**

**Optional**

---

**Dimensional Drawing**

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

---

**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

Specifications are subject to change without notice.

Baselt® is a registered trademark of MKS Instruments, Inc., Wilmington, MA.
VCRR is a registered trademark of Swagelok® Co., Solon, OH.
Inconel® is a registered trademark of Inco Alloys International, Inc., Huntington, WV.
**Type 722**

**9-pin Type "D"**

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<th>Pin</th>
<th>Description</th>
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<tr>
<td>1</td>
<td>Pressure Output</td>
</tr>
<tr>
<td>2</td>
<td>No Connection</td>
</tr>
<tr>
<td>3</td>
<td>No Connection</td>
</tr>
<tr>
<td>4</td>
<td>+ Power Input</td>
</tr>
<tr>
<td>5 to 7</td>
<td>No Connection</td>
</tr>
<tr>
<td>8</td>
<td>Pressure Return</td>
</tr>
<tr>
<td>9</td>
<td>Power Return</td>
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**5-pin Terminal Block**

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<th>Description</th>
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<tbody>
<tr>
<td>1</td>
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<tr>
<td>2</td>
<td>Pressure Return</td>
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<tr>
<td>3</td>
<td>Pressure Output</td>
</tr>
<tr>
<td>4</td>
<td>No Connection</td>
</tr>
<tr>
<td>5</td>
<td>+ Power Input</td>
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**15-pin Type "D"**

<table>
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<th>Pin</th>
<th>Description</th>
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<tbody>
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<td>2</td>
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<td>3 to 4</td>
<td>No Connection</td>
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<tr>
<td>5</td>
<td>Power Return</td>
</tr>
<tr>
<td>6</td>
<td>No Connection</td>
</tr>
<tr>
<td>7</td>
<td>+ Power Input</td>
</tr>
<tr>
<td>8 to 11</td>
<td>No Connection</td>
</tr>
<tr>
<td>12</td>
<td>Pressure Return</td>
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<tr>
<td>13 to 14</td>
<td>No Connection</td>
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<td>15</td>
<td>Chassis</td>
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</table>

**Note:**

This information is subject to change without notice.
Actual sample values:

- 

Data collection range: 1700 to 2200 nm

Diagram range: 1700 to 2199 nm

- 

CWL = 1870 +/- 20 nm
- HW = 105 +/- 20 nm
- Tmin. = 70 %
- 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

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

Aircraft: GULFSTREAM GV

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

<table>
<thead>
<tr>
<th>Flame Application (seconds)</th>
<th>Flame Time (seconds)</th>
<th>Burn Length (inches)</th>
<th>Drip Flame Time (Seconds)</th>
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</thead>
<tbody>
<tr>
<td>30</td>
<td>0.0</td>
<td>1.3</td>
<td>0 No Drips</td>
</tr>
<tr>
<td>30</td>
<td>0.0</td>
<td>1.2</td>
<td>0 No Drips</td>
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<tr>
<td>30</td>
<td>0.0</td>
<td>0.9</td>
<td>0 No Drips</td>
</tr>
<tr>
<td>Average:</td>
<td>0.0</td>
<td>1.1</td>
<td>0 No Drips</td>
</tr>
</tbody>
</table>

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

Aircraft: GULFSTREAM GV

WO #: 128461-05
Date: 08/04/05
Test Plan #: 
PO #: 10251
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 TEFLO, TEF2202STJ, WHITE, 22AWG, LOT #1050006, REF #RL0427695

<table>
<thead>
<tr>
<th>Flame Application (seconds)</th>
<th>Flame Time (seconds)</th>
<th>Burn Length (inches)</th>
<th>Drip Flame Time (Seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>0.0</td>
<td>1.3</td>
<td>0 No Drips</td>
</tr>
<tr>
<td>30</td>
<td>0.0</td>
<td>1.2</td>
<td>0 No Drips</td>
</tr>
<tr>
<td>30</td>
<td>0.0</td>
<td>1.2</td>
<td>0 No Drips</td>
</tr>
<tr>
<td>Average:</td>
<td>0.0</td>
<td>1.2</td>
<td>0 No Drips</td>
</tr>
</tbody>
</table>

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-453
Client: SOUTHWEST SCIENCES INC  
1570 PACHECO STREET  
SUITE E-11  
SANTA FE NM 87505

Aircraft: GULFSTREAM GV

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

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, TEFLOM COATED, M22759/11/22-0, BLACK 22AWG, LOT #677-9345-08, REF #LQ955

<table>
<thead>
<tr>
<th>Flame Application (seconds)</th>
<th>Flame Time (seconds)</th>
<th>Burn Length (inches)</th>
<th>Drip Flame Time (Seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>0.0</td>
<td>1.0</td>
<td>0 No Drips</td>
</tr>
<tr>
<td>30</td>
<td>0.0</td>
<td>1.5</td>
<td>0 No Drips</td>
</tr>
<tr>
<td>30</td>
<td>0.0</td>
<td>1.3</td>
<td>0 No Drips</td>
</tr>
<tr>
<td>Average:</td>
<td>0.0</td>
<td>1.3</td>
<td>0 No Drips</td>
</tr>
</tbody>
</table>

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

Aircraft: GULFSTREAM GV

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

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, TEFON COATED, M22759/11/22-4, YELLOW, 22AWG, D/L 778846, REF #KR913

<table>
<thead>
<tr>
<th>Flame Application (seconds)</th>
<th>Flame Time (seconds)</th>
<th>Burn Length (inches)</th>
<th>Drip Flame Time (Seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>0.0</td>
<td>1.6</td>
<td>0 No Drips</td>
</tr>
<tr>
<td>30</td>
<td>0.0</td>
<td>1.2</td>
<td>0 No Drips</td>
</tr>
<tr>
<td>30</td>
<td>0.0</td>
<td>1.1</td>
<td>0 No Drips</td>
</tr>
<tr>
<td>Average:</td>
<td>0.0</td>
<td>1.3</td>
<td>0 No Drips</td>
</tr>
</tbody>
</table>

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

Aircraft: GULFSTREAM GV

WO #: 128461-05
Date: 08/04/05
Test Plan #: 
PO #: 10251
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, TEFCHN COATED, M22759/11/22-2, RED, 22AWG, LOT #677-9345-09, REF #LR458

<table>
<thead>
<tr>
<th>Flame Application (seconds)</th>
<th>Flame Time (seconds)</th>
<th>Burn Length (inches)</th>
<th>Drip Flame Time (Seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>0.0</td>
<td>1.3</td>
<td>0 No Drips</td>
</tr>
<tr>
<td>30</td>
<td>0.0</td>
<td>1.4</td>
<td>0 No Drips</td>
</tr>
<tr>
<td>30</td>
<td>0.0</td>
<td>1.2</td>
<td>0 No Drips</td>
</tr>
<tr>
<td>Average:</td>
<td></td>
<td>1.3</td>
<td>0 No Drips</td>
</tr>
</tbody>
</table>

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

Aircraft: GULFSTREAM GV

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

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, TEFLOM CLADDING, YELLOW

<table>
<thead>
<tr>
<th>Flame Application (seconds)</th>
<th>Flame Time (seconds)</th>
<th>Burn Length (inches)</th>
<th>Drip Flame Time (Seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

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

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

<table>
<thead>
<tr>
<th>Flame Application (seconds)</th>
<th>Flame Time (seconds)</th>
<th>Burn Length (inches)</th>
<th>Drip Flame Time (Seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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: [X]

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

Aircraft: GULFSTREAM GV  

WO #: 128461-05  
Date: 08/04/05  
Test Plan #: 10251  
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, TEFOLON COATED, M22759/11/22-9, WHITE, 22AWG, LOT #30424, REF #LN631  

<table>
<thead>
<tr>
<th>Flame Application (seconds)</th>
<th>Flame Time (seconds)</th>
<th>Burn Length (inches)</th>
<th>Drip Flame Time (Seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>0.0</td>
<td>1.5</td>
<td>0 No Drips</td>
</tr>
<tr>
<td>30</td>
<td>0.0</td>
<td>1.2</td>
<td>0 No Drips</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average:</td>
<td>0.0</td>
<td>1.4</td>
<td>0 No Drips</td>
</tr>
</tbody>
</table>

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
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].

PURITY 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)

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.

☐ 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 (11-76) SUPERSEDES PREVIOUS EDITION ELECTRONIC FORMAT (7-00)
# U.S. Department of Transportation
## Federal Aviation Administration
### Statement of Compliance with the Federal Aviation Regulations

**Make:** Gulfstream  
**Model No.:** GV  
**S/N:** 677  
**Type:** Airplane  
**Name of Applicant:** Skandia, Inc.

## Aircraft or Aircraft Component Identification

<table>
<thead>
<tr>
<th>Identification</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work Order # 128461-05</td>
<td>ALCATEL/ALLCABLE: WIRE, TELFON COATED, M22759/11/22-5, GREEN, 22AWG, LOT #12944, REF #KL662, REF TEST ID # 60DEG-452</td>
</tr>
<tr>
<td>Document ID 55815</td>
<td>THERMAX/ALLCABLE: WIRE, TWISTED PAIR SHIELDED TEFLO, TEF2202STJ, WHITE, 22AWG, LOT #1050006, REF #RL0427695, REF TEST ID # 60DEG-453</td>
</tr>
<tr>
<td>Purchase Order # 10251</td>
<td>SPECIALITY/ALLCABLE: WIRE, TELFON COATED, M22759/11/22-0, BLACK 22AWG, LOT #677-9345-08, REF #LQ955, REF TEST ID # 60DEG-456</td>
</tr>
<tr>
<td></td>
<td>TERMAX/ALLCABLE: WIRE, TELFON COATED, M22759/11/22-4, YELLOW, 22AWG, D/L 778846, REF #KR913, REF TEST ID # 60DEG-457</td>
</tr>
<tr>
<td></td>
<td>SPECIALITY/ALLCABLE: WIRE, TELFON COATED, M22759/11/22-2, RED, 22AWG, LOT #677-9345-09, REF #LR458, REF TEST ID # 60DEG-458</td>
</tr>
</tbody>
</table>

## 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:**

<table>
<thead>
<tr>
<th>Designation Number(S)</th>
<th>Classification(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DERY-405143-CE</td>
<td>Structural Special</td>
</tr>
</tbody>
</table>

Carin Demus

---

FAA Form 8110-3 (11-70) supercedes 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.

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

* 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