SkyVUE™ PRO (CS135)
LIDAR Ceilometer
About this manual

Please note that this SkyVUE™PRO product manual describes the installation and use of the SkyVUE™PRO and CS135 LIDAR Ceilometers. Please use references made in this manual to either sensor interchangeably.

Some useful conversion factors:

- **Area:** 1 in² (square inch) = 645 mm²
- **Length:** 1 in. (inch) = 25.4 mm
  - 1 ft (foot) = 304.8 mm
  - 1 yard = 0.914 m
  - 1 mile = 1.609 km
- **Mass:**
  - 1 oz. (ounce) = 28.35 g
  - 1 lb (pound weight) = 0.454 kg
- **Pressure:**
  - 1 psi (lb/in²) = 68.95 mb
- **Volume:**
  - 1 UK pint = 568.3 ml
  - 1 UK gallon = 4.546 litres
  - 1 US gallon = 3.785 litres

Recycling information

At the end of this product’s life it should not be put in commercial or domestic refuse but sent for recycling. Any batteries contained within the product or used during the product’s life should be removed from the product and also be sent to an appropriate recycling facility.

Campbell Scientific Ltd can advise on the recycling of the equipment and in some cases arrange collection and the correct disposal of it, although charges may apply for some items or territories.

For further advice or support, please contact Campbell Scientific Ltd, or your local agent.
Limited Warranty

“Products manufactured by CSI are warranted by CSI to be free from defects in materials and workmanship under normal use and service for twelve months from the date of shipment unless otherwise specified in the corresponding product manual. (Product manuals are available for review online at www.campbellsci.com.) Products not manufactured by CSI, but that are resold by CSI, are warranted only to the limits extended by the original manufacturer. Batteries, fine-wire thermocouples, desiccant, and other consumables have no warranty. CSI’s obligation under this warranty is limited to repairing or replacing (at CSI’s option) defective Products, which shall be the sole and exclusive remedy under this warranty. The Customer assumes all costs of removing, reinstalling, and shipping defective Products to CSI. CSI will return such Products by surface carrier prepaid within the continental United States of America. To all other locations, CSI will return such Products best way CIP (port of entry) per Incoterms ® 2010. This warranty shall not apply to any Products which have been subjected to modification, misuse, neglect, improper service, accidents of nature, or shipping damage. This warranty is in lieu of all other warranties, expressed or implied. The warranty for installation services performed by CSI such as programming to customer specifications, electrical connections to Products manufactured by CSI, and Product specific training, is part of CSI's product warranty. **CSI EXPRESSLY DISCLAIMS AND EXCLUDES ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. CSI hereby disclaims, to the fullest extent allowed by applicable law, any and all warranties and conditions with respect to the Products, whether express, implied or statutory, other than those expressly provided herein.**”
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To obtain a Returned Materials Authorization (RMA) number, contact CAMPBELL SCIENTIFIC, INC., phone (435) 227-9000. Please write the issued RMA number clearly on the outside of the shipping container. Campbell Scientific’s shipping address is:

CAMPBELL SCIENTIFIC, INC.
RMA#_____
815 West 1800 North
Logan, Utah 84321-1784

For all returns, the customer must fill out a “Statement of Product Cleanliness and Decontamination” form and comply with the requirements specified in it. The form is available from our website at [www.campbellsci.com/repair](http://www.campbellsci.com/repair). A completed form must be either emailed to repair@campbellsci.com or faxed to (435) 227-9106. Campbell Scientific is unable to process any returns until we receive this form. If the form is not received within three days of product receipt or is incomplete, the product will be returned to the customer at the customer’s expense. Campbell Scientific reserves the right to refuse service on products that were exposed to contaminants that may cause health or safety concerns for our employees.
Safety

DANGER — MANY HAZARDS ARE ASSOCIATED WITH INSTALLING, USING, MAINTAINING, AND WORKING ON OR AROUND TRIPODS, TOWERS, AND ANY ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC. FAILURE TO PROPERLY AND COMPLETELY ASSEMBLE, INSTALL, OPERATE, USE, AND MAINTAIN TRIPODS, TOWERS, AND ATTACHMENTS, AND FAILURE TO HEED WARNINGS, INCREASES THE RISK OF DEATH, ACCIDENT, SERIOUS INJURY, PROPERTY DAMAGE, AND PRODUCT FAILURE. TAKE ALL REASONABLE PRECAUTIONS TO AVOID THESE HAZARDS. CHECK WITH YOUR ORGANIZATION'S SAFETY COORDINATOR (OR POLICY) FOR PROCEDURES AND REQUIRED PROTECTIVE EQUIPMENT PRIOR TO PERFORMING ANY WORK.

Use tripods, towers, and attachments to tripods and towers only for purposes for which they are designed. Do not exceed design limits. Be familiar and comply with all instructions provided in product manuals. Manuals are available at www.campbellsci.com or by telephoning (435) 227-9000 (USA). You are responsible for conformance with governing codes and regulations, including safety regulations, and the integrity and location of structures or land to which towers, tripods, and any attachments are attached. Installation sites should be evaluated and approved by a qualified engineer. If questions or concerns arise regarding installation, use, or maintenance of tripods, towers, attachments, or electrical connections, consult with a licensed and qualified engineer or electrician.

General
- Prior to performing site or installation work, obtain required approvals and permits. Comply with all governing structure-height regulations, such as those of the FAA in the USA.
- Use only qualified personnel for installation, use, and maintenance of tripods and towers, and any attachments to tripods and towers. The use of licensed and qualified contractors is highly recommended.
- Read all applicable instructions carefully and understand procedures thoroughly before beginning work.
- Wear a hardhat and eye protection, and take other appropriate safety precautions while working on or around tripods and towers.
- Do not climb tripods or towers at any time, and prohibit climbing by other persons. Take reasonable precautions to secure tripod and tower sites from trespassers.
- Use only manufacturer recommended parts, materials, and tools.

Utility and Electrical
- You can be killed or sustain serious bodily injury if the tripod, tower, or attachments you are installing, constructing, using, or maintaining, or a tool, stake, or anchor, come in contact with overhead or underground utility lines.
- Maintain a distance of at least one-and-one-half times structure height, 20 feet, or the distance required by applicable law, whichever is greater, between overhead utility lines and the structure (tripod, tower, attachments, or tools).
- Prior to performing site or installation work, inform all utility companies and have all underground utilities marked.
- Comply with all electrical codes. Electrical equipment and related grounding devices should be installed by a licensed and qualified electrician.

Elevated Work and Weather
- Exercise extreme caution when performing elevated work.
- Use appropriate equipment and safety practices.
- During installation and maintenance, keep tower and tripod sites clear of un-trained or non-essential personnel. Take precautions to prevent elevated tools and objects from dropping.
- Do not perform any work in inclement weather, including wind, rain, snow, lightning, etc.

Maintenance
- Periodically (at least yearly) check for wear and damage, including corrosion, stress cracks, frayed cables, loose cable clamps, cable tightness, etc. and take necessary corrective actions.
- Periodically (at least yearly) check electrical ground connections.

WHILE EVERY ATTEMPT IS MADE TO EMBODY THE HIGHEST DEGREE OF SAFETY IN ALL CAMPBELL SCIENTIFIC PRODUCTS, THE CUSTOMER ASSUMES ALL RISK FROM ANY INJURY RESULTING FROM IMPROPER INSTALLATION, USE, OR MAINTENANCE OF TRIPODS, TOWERS, OR ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC.
A SkyVUE™PRO is delivered with the following items:

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceilometer</td>
<td>1</td>
</tr>
<tr>
<td>Power supply cable</td>
<td>1</td>
</tr>
<tr>
<td>Data cable</td>
<td>1</td>
</tr>
<tr>
<td>Bolt, sleeve anchor</td>
<td>4</td>
</tr>
<tr>
<td>Cable USB Type A plug to USB Type B plug 2 m</td>
<td>1</td>
</tr>
<tr>
<td>4 mm Allen key</td>
<td>1</td>
</tr>
</tbody>
</table>
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SkyVUE™ PRO (CS135) LIDAR Ceilometer

Important Safety Instructions – please request a translation or further advice if you cannot understand this document.

Wichtige Sicherheitshinweise - bitte kontaktieren Sie uns bzgl. einer Übersetzung falls Sie Schwierigkeiten haben Inhalte dieses Dokumentes zu verstehen.

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1. General Information

1.1 General Safety

This manual provides important safety considerations for the installation, operation and maintenance of the SkyVUE™ PRO. These safety considerations are classified into three levels:

**WARNING**

Warnings alert the installer or user to serious hazards. Ignoring these warnings could result in injury or death and/or irrevocable damage to the sensor unit.

**CAUTION**

Cautions warn of potential hazards. Ignoring these cautions could result in the sensor being damaged and data being lost.

**NOTE**

Notes highlight useful information in the installation, use and maintenance of this product. These should be followed carefully in order to gain the maximum benefit from the use of this product.

1.2 Sensor Unit Safety

The SkyVUE™ PRO sensor has been checked for safety before leaving the factory and contains no internally replaceable or modifiable parts.
WARNING  Do not modify the SkyVUE™PRO unit. Such modifications will lead to damage of the unit and could expose users to dangerous light levels and voltages.

WARNING  Do not attempt to repair the SkyVUE™PRO unit without consulting Campbell Scientific.

CAUTION  Ensure that the correct voltage supply is provided to the sensor.

1.3 Laser Safety

The SkyVUE™PRO sensor incorporates an InGaAs laser diode which is rated as a class 3B device. This is an embedded laser where the output from the sensor unit, through the optics, is minimised to class 1M. This classification indicates that viewing of the beam with the naked eye is safe but looking directly into the beam with optical instruments, e.g. binoculars can be dangerous.

From the laser head the output has the following characteristics:
- Maximum pulse energy: 4800 nJ
- Pulse duration: 100 ns
- Pulse frequency: 10 kHz
- Wavelength: 912 nm ±5 nm

EN 60825-1:2001

The sensor is marked with the following warning:

INVISIBLE LASER RADIATION
DO NOT VIEW DIRECTLY WITH OPTICAL INSTRUMENTS
CLASS 1M LASER PRODUCT

WARNING  Removing the laser module with the power applied to the SkyVUE™PRO or battery connected may expose the user to hazardous class 3B laser radiation.

No attempt should be made to operate the laser module outside of the housing.

WARNING  Check that the laser warning label on the sensor is still visible and can be clearly read on an annual basis.

When installing the sensor avoid pointing the laser housing towards areas where binoculars are in common use.
1.4 Electrical Safety

As the sensor is powered from potentially hazardous mains volatages the wiring of its power supply should only be carried out by personnel qualified to install electrical equipment. For permanent installations outside, this usually requires a certified electrician who is also familiar with local electrical and safety legislation. Some general guidance is given in Section 4.5, but the responsibility for the installation lies with that installer.

The unit is tested for electrical safety before despatch but may need subsequent testing according to local practice.

---

**NOTE**

The unit should only be serviced by trained personnel.

---

**WARNING**

*Removal of electronic module covers or connectors while the unit is powered will expose the operator to potentially hazardous voltages and risk damage to the sensor.*

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The SkyVUE™PRO has electrical and laser warning labels on the exterior and interior of the unit.

It is recommended that the hood and access panel door are not opened in conditions of rain, hail or snow.

The sensor should be isolated before internal components, including the cover to the avalanche photodiode (APD) module, are removed and the instrument should only be disassembled by trained personnel.

Mains connectors are shrouded to prevent touching of the contacts. The mains supply should be isolated when connecting and disconnecting the cables to the sensor.

Where an isolator switch is fitted, this shall be a two-pole isolator, located as near to the sensor as possible.

The SkyVUE™PRO must be properly grounded by a licensed and qualified electrician to protect against voltage leakage shock risk. See Section 4.2 Grounding.

It is recommended that RCD protection units be employed with all sensors. See 4.5.2.1 Power Connections, for further information.

Mains powered heaters are enclosed to prevent contact. It should be noted that when powered the heaters may operate automatically and without warning and that they may remain hot even when not powered. Follow the isolation precautions, outlined above, to avoid shock and burn hazards.

The sealed battery is fitted with cables and protected connectors, to prevent shorts. Avoid shorting of the battery to protect it from damage and to avoid burns to personnel through contact with hot surfaces.
2. Product Overview

2.1 Introduction

2.1.1 Overview

The SkyVUE™PRO is a LIDAR (Light Detection And Ranging). It emits short pulses of near infra-red light into the atmosphere from a semiconductor laser. These are scattered back by aerosols including cloud droplets. The time between transmission of the pulse and the return signal gives the range, and therefore height, of the scattering aerosols. The variation in the strength of the back-scattered light signal with height gives a profile of scatter coefficients and allow cloud bases to be identified. If significant scattering is detected but there is no defined cloud base then a vertical visibility can be calculated.

The control system of the SkyVUE™PRO is divided into three modules, DSP, TOP and PSU as follows:

DSP is the main data processing and communications unit of the SkyVUE™PRO.

The DSP hosts two separate time keeping circuits. These are cross checked and an alarm produced if they disagree.

TOP provides a number of safety shutdown features such as over and under laser output level. It also contains the calibration circuitry and dirty windows system.
PSU controls the power supply, including battery charging and deep discharge protection.

The SkyVUE™PRO has a rugged environmental enclosure that protects the instrument from the harshest conditions and will measure the atmosphere with high stability and repeatability.

2.1.2 Cloud height detection

A scatter profile is measured as described in Appendix B.

Cloud height detection is carried out as described in Appendix C. Up to four cloud heights can be detected.

If no clouds are detected the SkyVUE™PRO will give one of the following reports:

- No significant backscatter.
- Full obscuration determined but no cloud base detected. This is reported if the criteria for detecting cloud base is not met but the integrated scattering coefficient reaches the limit of vertical visibility below a set height limit. The default value is 2000 m but can be changed by the user. The height at which this occurs is given as vertical visibility.
- Some obscuration detected but determined to be transparent is reported if scattering is detected but no cloud is detected and the calculated vertical visibility exceeds a set height limit.

If no cloud is detected but significant scattering is detected below 50 m (164 ft) then vertical visibility is set to 0.

2.1.3 Sky condition

Sky condition is an assessment of cloud cover measured in units of eighths or “oktas”. The number of oktas is the density of cloud in eighths of that layer. The SkyVUE™PRO can report up to 5 layers of cloud when reporting Sky Condition. The algorithm used in the SkyVUE™PRO follows guidance in ICAO 9837, Manual on Automatic Meteorological Observing Systems at Aerodromes.

Note that sky condition assessment is based on cloud data for the previous 30 minutes, with cloud detection in the previous 10 minutes given an extra weighting and is not an instantaneous measurement. Therefore, it will not be available before sufficient data has been collected. See Appendix D for more detail.

2.1.4 Backscatter profile reporting

Several possible data messages give the two-way attenuated backscatter profile. This consists of 2048 groups of five-character hexadecimal values (10240 characters in total). Each character is 4 bits long and therefore each 5 figure group is 20 bits. They are given as signed two’s complement integers and numbers greater than 2^{19}-1 represent negative integers.

Therefore, each group actually represents negative a value between -2^{19} to +2^{19}-1, rather than 0 to 2^{20}-1, which would be the case for unsigned, positive, 20-bit integers.
In order to translate this to the correct decimal value, a two stage process should be applied. This is as follows:

(1) Convert from a hexadecimal to a decimal number.

(2) If the resulting decimal number lies in the range 0 to 524287 \((2^{19} - 1)\) then nothing further needs to be done. If the number resulting from this conversion is greater than 524287 then subtract 1048576 \((2^{20})\).

In order to use this backscatter coefficient in units of \(\text{sr}^{-1} \text{m}^{-1}\) this calculated decimal number has to be multiplied by a factor of \(10^{-8}\). The values are scaled by the \textit{Attenuated SCALE} parameter, see Table 5.1.

---

**NOTE**

The last two values of the profile will always be zero by design (they are beyond the 10 km (32,800 ft) range of the instrument).

---

**NOTE**

The profile is not corrected for tilt angle even if cloud heights are corrected.

---

### 2.1.5 Mixing layer height

A Mixing Layer Height measurement option is available. This retrieves the height of the mixed aerosol layer by applying the gradient method to the ceilometer’s backscatter signal. This approach, based on the operational algorithm used by KNMI*, searches for the drop in backscatter associated with the transition from boundary layer aerosols to free troposphere. Since the signals measured depend on the type and amount of aerosol present as well as the background light level, the accuracy of the method varies and therefore a quality factor is assigned which indicates the confidence in the reported layer height. The module is also capable of indicating the top of residual layers and aerosol layers aloft. To activate this option please contact Campbell Scientific.

This is a guide to how well the mixing layer is defined on a scale 1 to 3 (3 is best). It is determined by the magnitude of the difference between the average backscatter over a distance below the MLH and the average backscatter over a distance above the MLH.

2.2 Optical Measurement

2.2.1 Optical Arrangement

The SkyVUE™PRO employs a novel single split-lens design to increase optical signal to noise ratio while maintaining Class 1M eye safety by integrating larger optics into a compact package (see Fig 2.2). One half of the lens is used by the transmitter, the other by the receiver. They are therefore very close. This design provides an alternative to traditional two lens or common-optics designs. The optical isolation of traditional biaxial systems is maintained to increase detector sensitivity, while the low overlap onset height of common-optics systems is incorporated to allow measurements at close ranges.

2.3 Internal Monitoring

The SkyVUE™PRO monitors a large number of parameters relevant to its performance. These include window contamination, key voltages and currents and internal temperature and relative humidity. Data messages, see Section 5, include this information allowing remote diagnosis of the SkyVUE™PRO condition. In addition a special status message can be polled.
2.4 Specifications

2.4.1 Measurement Specifications
- Maximum Reporting Range: 10 km (32,800 ft)
- Minimum Reporting Resolution: 5 m (16.4 ft)
- Hard Target Range Accuracy: ±0.25% ±4.6 m (15.1 ft)
- Reporting Cycle: 2 to 600s
- Cloud Layers Reported: Up to four layers reported.

2.4.2 Mechanical Specifications
- Height: 1000 mm (39.3 in)
- Width: 327 mm (12.8 in)
- Depth: 281 mm (11 in)
- Total weight: 33 kg (72 lb) (excluding cables)
- Packed weight: 58 kg (128 lb)

![Fig 2.3 SkyVUE™ PRO Dimensions](image-url)
2.4.3 Electrical Specifications

Power required: Nominal 115 (106-137) or nominal 230 (216-253) V AC, 47-63 Hz, 470 W maximum in total.

The hood heater requires a maximum of 270 W.
The internal heater requires a maximum of 120 W.
The supply voltage required is specified at the time of order.
Fuses: The fuse should be HBC SA(T). Older units contained:

<table>
<thead>
<tr>
<th>Fuse Type</th>
<th>Code</th>
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</thead>
<tbody>
<tr>
<td>AUX fuse</td>
<td>HBC 5 A (T)</td>
</tr>
<tr>
<td>PSU fuse</td>
<td>HBC 500 mA (T)</td>
</tr>
</tbody>
</table>

CAUTION The fuse values used must match the design of power supply unit.

All fuses are 5 x 20 mm slow blow (T) and are the same for both 115V AC and 230V AC.

Battery: Internal 12V 2Ah sealed lead-acid battery provides 2hr measurement without the blower/heater. The power supply is equipped with a system to prevent deep discharge of the battery.

The SkyVUE™PRO uses Positive Temperature Coefficient (PTC) heaters within its design. These heaters are self-regulating, simplifying the internal design of the sensor and improving safety. Due to the nature of these devices the SkyVUE™PRO takes a higher current during start up.

The SkyVUE™PRO will take up to 1 KW for the first few seconds of operation dropping off quickly to its normal operating power over a period of a minute.

In cold environments the power consumption of the SkyVUE™PRO may be as high as 470 W. Also, in warmer environments it may be as low as 200 W.

The heaters within the SkyVUE™PRO are purely resistive which will prove advantageous when connected to generators or when the power factor of your supply is important.
2.4.4 Optical Specifications

- Pulse duration: 100 ns
- Pulse frequency: 10 kHz
- Wavelength: 912 ± 5 nm
- Half-angle laser divergence: 0.35 mrad
- Field of view: 1.5 mrad
- Laser lifetime: 10 years typical
- Eye safety class: 1M
2.4.5 Environmental Specifications

Standard Operating Temperature Range: -40°C to +60°C (Excluding battery)
Battery temperature range: -20°C to +50°C (Alternative battery types available)
Relative Humidity Range: 0 to 100%
IP Rating: IP 66
Maximum wind speed: 55 m/s

2.4.6 Communications Specifications

Supported serial settings
8 bits, no parity, 1 stop bit (default)
7 bits, even parity, 1 stop bit
7 bits, odd parity, 1 stop bit

Supported data rates
300 baud
600 baud
1200 baud
2400 baud
4800 baud
9600 baud
19200 baud
38400 baud
57600 baud
76800 baud
115200 baud (default)

Supported standards
RS-232 (default)
RS-485 full duplex
RS-485 half duplex
### Signal voltage levels

<table>
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<th></th>
<th>Minimum Value</th>
<th>Nominal Value</th>
<th>Maximum Value</th>
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<tr>
<td><strong>RS-232 Communications</strong></td>
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<tr>
<td>RS-232 input threshold Low</td>
<td>0.8V</td>
<td>1.5V</td>
<td>-</td>
</tr>
<tr>
<td>RS-232 input threshold High</td>
<td>-</td>
<td>2.0V</td>
<td>2.4V</td>
</tr>
<tr>
<td>RS-232 input absolute maximum</td>
<td>-15V</td>
<td>-</td>
<td>+15V</td>
</tr>
<tr>
<td>RS-232 input resistance</td>
<td>12KΩ</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>RS-232 output voltage low</td>
<td>-</td>
<td>-</td>
<td>0.4V</td>
</tr>
<tr>
<td>RS-232 output voltage high (into 3KΩ)</td>
<td>4.4V</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

|                          |               |               |               |
| **RS-485/422 Communications** |               |               |               |
| RS-485/422 input threshold voltage | -0.2V         | -             | +0.2V         |
| RS-485/422 output (Unloaded) | -             | -             | 5V            |
| RS-485/422 output (Load 50Ω) | 2V            | -             | -             |
| Maximum voltage at any terminal | -7V            | -             | +7V           |

**USB Service Port** USB1.1 and 2.0 compatible, fixed 115200 baud.

### 3. Initial preparation and checks

The following steps will provide basic familiarisation with the SkyVUE™PRO and perform basic functionality checks. To do these you must first remove the cover and enclosure lid (see Sections 4.6.1 and 4.6.2) and then connect the battery (see Section 4.6). Then connect the hood heater plug. See Fig 4.3 in Section 4.5.1.

#### WARNING

The laser will be operating as soon as the battery is connected. It should not point in any direction where it could be viewed with magnifying optics.

The green LED visible from above should now be flashing once every 10 seconds (see Fig 5.2).

Connect a computer using a terminal emulation program to the USB port (Fig 4.5). The terminal emulator should be set to 115200 baud, 8N1 bits/parity.

Computer operating systems should identify the USB connection and allocate a port number. The terminal emulator program you are using should then be set to this port number. Older computer operating systems may need upgrading or additional software.

The SkyVUE™PRO will be outputting message type 001 every 10 seconds (see Section 6.2).

Open terminal mode with the command “open 0”. You should now see the prompt “CS135>”, Type “Status”. You will now see the sensor status information described in Section 5.1.5. If you plan to use date/time information this should be checked as it can drift up to ±14 seconds per day.
If the unit has been in storage or transit for more than a few months, the clock battery may be discharged. However, it will charge from the back-up battery or mains power.

Close terminal mode with the command “close” (it will close automatically after 10 minutes of inactivity).

If you are not installing the unit and connecting mains power straight away you should disconnect the battery to avoid it being discharged.

4. Installation

4.1 Location and Orientation

The SkyVUE™PRO measures environmental variables and is designed to be located in harsh weather conditions. However, there are a few considerations to take into account if accurate and representative data from a site are to be obtained.

In order to reduce the service frequency with the unit, the SkyVUE™PRO should be placed away from sources of contamination. More regular maintenance will be required when the instrument is placed in areas where contamination is unavoidable or where measurements may be safety related.

Take care that the orientation allows tilting in whatever direction is desired.

**WARNING**

If installing at an airport check and follow local guidance for allowed locations for a non-frangible object 1 m tall. Please contact Campbell Scientific if frangible fittings are required.

4.2 Grounding

The SkyVUE™PRO must be properly grounded by taking a ground wire with a minimum cross sectional area of 16 mm² and maximum length of 10 m (32.8 ft) from the brass grounding boss to an adequate grounding point. Figure 4.3 shows the location of the grounding boss.

4.3 Mounting the SkyVUE™PRO

The SkyVUE™PRO (CS135) should be mounted by bolting to a firm, level foundation. When bolting down take care that the orientation allows tilting in whatever direction is desired.

Figure 4.1 shows the mounting footprint.

If a suitable surface does not already exist then a concrete foundation should be constructed at least 600 mm (23.6 in) square and 600 mm (23.6 in) deep.

Drill four 12 mm (0.47 in) diameter holes using the mount base as a template to a depth of 77 mm (3.03 in).

Clean the holes of all debris.
Place washers and nuts on the ends of the wedge anchors supplied (to protect the threads during installation).

Hammer the wedge anchors into the holes until the start of the threads are below the surface.

Tighten the nuts until about 25 mm (0.62 in) of thread protrudes above the surface.

Remove the washers and nuts from the protruding length screw. Then lower the SkyVUE™PRO into place.

Finally, secure the SkyVUE™PRO with the washers and nuts.

If the surface is not level and flat it may be necessary to add washers under the base on one or more of the foundation screws.

![Fig 4.1 Mounting footprint](image-url)
4.4 Tilt angle

The SkyVUE™PRO is designed to be tilted 6°, 12°, 18° or 24° from vertical. There are several reasons why this might be done. In tropical regions it might be advantageous to tilt the sensor north in the northern hemisphere and south in the southern hemisphere to prevent the sun shining directly into it, it can reduce problems caused by direct specular reflections from ice crystals and reduce problems from rain or snow falling onto the window. To adjust the tilt angle remove the bolts shown in Fig 4.2, move the SkyVUE™PRO to the required tilt angle and replace them.

The SkyVUE™PRO has tilt sensors in both axes so that if it is not possible to provide a level base cloud height can be compensated. Cloud height compensation can be set or disabled using the UNITS command (see Section 5.1.3). This feature can be useful for mobile or marine applications. Note that profile data is NOT compensated but tilt angles are included in data messages.

Note that increasing the tilt angle beyond 24° can cause significant errors in vertical visibility measurements if scatter coefficients vary significantly with height.

Fig 4.2 Setting the tilt angle
4.5 Connectors and wiring

4.5.1 Base connectors

The SkyVue™PRO has three connectors on its base. One is for communications, one provides power input to the unit itself and the other one takes power from the unit to the hood heater and blower.

**NOTE**

Tilting the unit will provide better access to these connectors.

![Diagram of connector layout](image)

*Fig 4.3 Connector layout*

The function of the connector pins is shown in Table 4.1.
### Table 4.1 Function of the connector pins

<table>
<thead>
<tr>
<th>Pin</th>
<th>Function</th>
<th>Colour of supplied cable cores</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Live</td>
<td>Brown</td>
</tr>
<tr>
<td>2</td>
<td>Not connected</td>
<td>NA</td>
</tr>
<tr>
<td>3</td>
<td>Neutral</td>
<td>Blue</td>
</tr>
<tr>
<td>4</td>
<td>Earth</td>
<td>Green/yellow</td>
</tr>
</tbody>
</table>

#### Mains Connector

<table>
<thead>
<tr>
<th>Pin</th>
<th>Function</th>
<th>Colour of supplied cable cores</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Neutral</td>
<td>Black (1)</td>
</tr>
<tr>
<td>2</td>
<td>Fan + 12V</td>
<td>Black (2)</td>
</tr>
<tr>
<td>3</td>
<td>Therm</td>
<td>Black (3)</td>
</tr>
<tr>
<td>4</td>
<td>Therm (0V)</td>
<td>Black (4)</td>
</tr>
<tr>
<td>5</td>
<td>Switched 230/115 AC Live</td>
<td>Black (5)</td>
</tr>
<tr>
<td>6</td>
<td>Fan on</td>
<td>Black (6)</td>
</tr>
<tr>
<td>E</td>
<td>Earth</td>
<td>Green/yellow</td>
</tr>
</tbody>
</table>

#### Blower/Heater Connector

<table>
<thead>
<tr>
<th>Pin on connector on SkyVUE™PRO</th>
<th>Colour of supplied cable cores</th>
<th>9-Pin “D” Connector (Fig 4.4)</th>
<th>RS-232</th>
<th>RS-485 Half duplex</th>
<th>RS-485 Full duplex/ RS-422</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Red</td>
<td>8</td>
<td>B/D+</td>
<td>Y/TXD non-inverting</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Yellow</td>
<td>7</td>
<td>B/RXD non-inverting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Green</td>
<td>5</td>
<td>Gnd</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Black</td>
<td>5</td>
<td>Gnd</td>
<td>Gnd</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>White</td>
<td>2</td>
<td>RXD</td>
<td>A/D-</td>
<td>Z/TXD inverting</td>
</tr>
<tr>
<td>6</td>
<td>Blue</td>
<td>3</td>
<td>TXD</td>
<td>A/RXD inverting</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>Screen</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Communications Connector

### 4.5.2 Wiring using Supplied Campbell Scientific cables

Two cables are supplied, each 10 m (32.8 ft) long. One is for the mains power supply, the other is for communications.

---

**WARNING**

If the power cable is incorrectly wired then irrevocable damage can be done to the unit and there is risk of serious injury or death.
The power cable must not be carrying mains voltage when it is being connected or disconnected.

4.5.2.1 Power Connections

The following guidance is given to help the wiring and installation of a permanent power supply to the sensor.

As the sensor is used outside, the installation of the power cables will normally have to be carried out by a qualified electrician. Please check local safety regulations.

A mains power source needs to be identified and the type of termination, cable type and cable run matched to comply with local regulations and the type of installation.

The power source needs to be able to provide the correct voltage and frequency and current in excess of the power requirement of the system. See below.

Voltage requirements: 106-137V AC or 216-253V AC (check power supply switch and fuses match the nominal 115/230V AC supply)

Current requirements: 5A

Input frequency: 47-63 Hz.

The power source needs to be fused. The fuse rating should be 5A or larger and a “slow blow” design. Any extensions to the cable supplied or alternative replacement should be capable of carrying current in excess of that fuse rating.

The power source should be fitted with a two-pole isolator and should be fitted as near to the sensor as is possible.

The power cable needs to have three conductors, live, neutral and a protective earth, normally with IEC wiring colours to match those used.

This equipment requires a protective earth. THIS MUST BE CONNECTED FOR SAFETY REASONS. Ensure the earth connection at the power source is suitable for this purpose. The connection should be made via the earth wire of the power connector/cable or via the earth stud on the sensor base.

This equipment also requires correct connection of the live and neutral conductors – make sure these are identified and wired correctly at the power source.

Normally, the power source should be fitted with its own or system wide earth leakage breaker (also known as an RCD).

For short term testing of the sensor a suitable plug can be fitted to the end of the power cable and the sensor plugged into a standard mains supply capable of providing 5A at the rated voltage. If this is done the earth wire of the sensor must be connected to a suitable protective earth point.
4.5.2.2 Communications connections

The communications cable is terminated at one end with a removable 9 pin D-connector (DB9). The D-connector can be connected directly to a computer or data logger such as the Campbell Scientific CR1000X using a suitable interconnecting cable such as the SC110. Connections and wire colours are shown in Fig 4.4. The connector can easily be removed for direct connection to screws terminals.

For details of an example of a CRC basic program for connecting the SkyVUE™PRO to a datalogger see Appendix A.

CAUTION

The type of cable supplied is not recommended for lengths greater than 10 m (32.8 ft). In particular, longer length RS-485 cables should incorporate twisted pairs. Please contact Campbell Scientific if you wish to use a longer length of cable.

4.5.3 USB connection

A USB port is provided inside the enclosure to aid on-site maintenance. This allows communication of commands to the SkyVUE™PRO and responses in the same form as the main serial port except that the baud rate is fixed at 115200 (see Fig 4.5).

4.5.4 SDI-12 connection

A SDI-12 port is present but is only used for factory setting of the instrument.
4.6 Connecting the back-up battery

The SkyVUE™PRO will be shipped with the back-up battery disconnected. It should be connected as shown in Fig 4.6 before bringing the unit into use.

To do this the cover and enclosure lid must first be removed. The desiccant included for transport should be removed at the same time.
4.6.1 Removing the cover

The cover is removed by removing the four screws as shown in Fig 4.7.

![Fig 4.7 Removing the cover](image)

The cover can then be lifted away.

**CAUTION**

The cover contains a flying lead used to take power to the hood heater and blower. Be careful not to trap and damage this when lifting the cover clear.

4.6.2 Removing the enclosure lid

Removing the lid covering the electronics unit is accomplished by removing the four screws as shown in Fig 4.8.

![Fig 4.8 Removing the enclosure lid](image)
Opening the access door MUST be carried out by a competent person, who has sufficient training, experience and knowledge both in electrical safety and the detail and operation of the sensor.

Removing the enclosure lid may expose hot surfaces.

## 4.7 Bird Spike Kit

A bird spike kit is available to deter birds from sitting on the SkyVUE™PRO. This comprises 4 stainless “spikes” with rounded ends and a small reel of stainless wire. Fig 4.9 shows installed bird spikes.

![Fig 4.9 Ceilometer Bird Spike Kit installed](image)

To install the bird spikes first remove the cowl and blanking plugs from the cowl as shown in Fig 4.10. If the SkyVUE™PRO is an older unit without pre-existing holes then it will be necessary to drill 4 holes each 4.5 mm diameter, evenly spaced around the aperture and 10 mm in from the edge. Each spike is then inserted into the holes, thread first, and nuts and washers attached and tightened, see Fig 4.11. Then replace the cowl on the SkyVUE™PRO.
Finally wrap stainless steel wire around the spikes using the grooves in the spikes. The wire is easily wrapped around each spike in turn and then back on itself. Do not tighten the wire too much as it may pull the spikes inwards and obscure the field of view of the SkyVUE™PRO optics.

Only use one strand of wire to reduce the possibility of water drops being collected.

Check the wire during maintenance and replace if necessary.

### 4.8 Storage Information

The SkyVUE™PRO should be stored between -40°C to +70°C in a dry place, preferably with the enclosures securely fastened. The optics should be protected from possible accidental damage. For storage the back-up battery should be disconnected.

**NOTE**

Leaving the battery connected during storage will mean that the unit will still be powered until the battery voltage falls below a shut-down threshold.
5. Operation

5.1 Terminal Mode

5.1.1 Entering/Exiting the SkyVUE™PRO Terminal Mode

The menu system is entered with the command OPEN Sensor_ID  Password (The menu will time out and close automatically if not used for 10 minutes).

Sensor_ID is the SkyVUE™PRO identification, a single ASCII character 0-9, a-f,A-F case sensitive. The default is 0. If a password is set then it must be entered here otherwise it can be omitted. The following text should now be displayed: "CS135>". The SkyVUE™PRO is now ready for terminal mode commands.

The SkyVUE™PRO Commands are not case sensitive. The Parameters and/or password following the command are case sensitive.

Example of the “open” command followed by the parameter “0”:

OPEN 0

Example of the open command with the password “Secret”:

OPEN 0 Secret

5.1.2 Terminal Mode Commands General

Table 5.1 gives a summary of the terminal mode commands available.

The SkyVUE™PRO can be setup and controlled by using the terminal interface where discrete commands are sent. The terminal commands can be sent via a data logger to the SkyVUE™PRO removing the need for a local computer to set up the unit.

The terminal emulators built into many Campbell Scientific software products can also be used. Note however that DevConfig and Present Weather Viewer cannot be used to load a new operating system as this requires XMODEM protocol. One common, freely available terminal emulator with this feature is called “Tera Term” which is readily available on the internet.
The following settings are used:

<table>
<thead>
<tr>
<th>Setting</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>RS-232/422/485 interface (default)</td>
<td>USB service port</td>
</tr>
<tr>
<td>RS-232 hand shaking</td>
<td>Baud: rate 115200</td>
</tr>
<tr>
<td>Baud rate:</td>
<td>Data bits: 8</td>
</tr>
<tr>
<td>Data bits:</td>
<td>Parity: none</td>
</tr>
<tr>
<td>Parity:</td>
<td>Stop bits: 1</td>
</tr>
<tr>
<td>Stop bits:</td>
<td>Flow control: none</td>
</tr>
<tr>
<td>Flow control:</td>
<td></td>
</tr>
</tbody>
</table>

 Ensure that if the baud rate of the unit has been adjusted and then the corresponding bits per second value are entered in the port settings of the terminal emulator. The SkyVUE™PRO should now be ready to accept commands.

Note: Commands will always output all parameters on a new line after a CR LF (carriage return, line feed) and then the SkyVUE™PRO prompt “CS135>”. If you only want to see parameter values without changing them then enter the command without parameters. If a particular parameter did not need changing then the parameter can be replaced with a comma (,). Back space will abort the command.

5.1.3 Terminal Mode Command Examples

How to enter a command

Example 1

The following text shows an example of setting up the SkyVUE™PRO serial port. This example would set the serial port to RS-232 hand shaking at 115200 bps, 8 data bits, no parity and if it was in RS-485 mode then a 100 mS turn around delay.

serial 0 10 0 100

You could also type the following to obtain the same results as the RS-485 turn around delay is not needed:

serial 0 10 0

If all you wish to do is change the data baud rate and nothing else you can replace the first number, the mode parameter, with a ‘,’ as shown below.

serial , 10

Alternatively if you just wished to change the parity to 8-bits no parity then type the following:

serial , , 0

You do not need to replace the remaining parameters with ‘,’ you only need to replace the ones up to the parameter you wish to edit.

NOTE

Remember to leave a space character between the command and the parameters as shown in the examples.

Example 2

Entering the MCFG command, as shown below, will set the sensor to send messages at 10 second intervals and to send one message only with the message number 112.

MCFG 10 112 0 0 0 0 (return)

The 4 zeros indicate that no other message outputs have been set. The MCFG command is described in Table 5.1.
Table 5.1 Summary of the terminal mode commands available

<table>
<thead>
<tr>
<th>Command</th>
<th>Parameter/Parameter block</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALARMS</td>
<td>Angle</td>
<td><em>Angle</em> is the threshold tilt angle of the sensor beyond which an alarm will be flagged. The settable range is 0 to 90.0 degrees tilt and the default is 45.0 degrees.</td>
</tr>
<tr>
<td>BS</td>
<td>Attenuated_SCALE, BS_Av_Time, Noise_Gate, Measurement_Period, Rolling_Average, Message_Interval</td>
<td>Rules for BS command are: BS_Av_Time &lt;= Measurement_Period-1. Message_Interval must be a multiple of Measurement_Period.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Attenuated_SCALE is the scalar for the attenuated backscatter %. 0.001 to 1000 (default 100%). BS_Av_Time is the backscatter average time in seconds. 1 to 30 (default 2). Note: Must not be greater than Measurement_Period-1.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Noise_Gate controls the noise threshold applied to back-scatter. Noise_Gate = -1000, all backscatter range is corrected. Noise_Gate = 0.0-1000.0, standard deviation for noise threshold, default 2.0. Only backscatter above this is range corrected.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Measurement_Period 0 or 2 to 600 (default 10). If set to 0 and the SkyVUE\textsuperscript{TM}PRO is polled it will output the last measurement made. If it is between 2 and 600 seconds then the SkyVUE\textsuperscript{TM}PRO will continually output messages. For sky condition output it is recommended that the measurement_Period is set no longer than 30 seconds. If a measurement_Period greater than 30 seconds is used then the sky condition algorithm will be less able to resolve coverage for higher layers. Note: Must be a sub multiple of Message_Interval</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rolling_Average = 1 to 29 default 1. This is the number of measurement_periods to use in a rolling average of the backscatter.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Message_Interval is the message interval in seconds, 2 - 600 seconds. ‘0’ gives polled messages, default 10. Note: Must be a multiple of Measurement_Period</td>
</tr>
<tr>
<td>CLOSE</td>
<td>No parameters</td>
<td>Closes the terminal interface to allow normal message output and saves new settings to flash non-volatile storage.</td>
</tr>
<tr>
<td>DEFAULTS</td>
<td>No parameters</td>
<td>Loads factory defaults</td>
</tr>
<tr>
<td>GETUSER</td>
<td></td>
<td>Reads all user settings as a string of text. Parameters are read in the following order: user = text “user” volVer = user volume version OS_VER = DSP OS version PsuOsVer = PSU OS version TopOsVer = TOP OS version Id = SkyVUE\textsuperscript{TM}PRO ID Pw = SkyVUE\textsuperscript{TM}PRO password terminalCrc = terminal crc mode terminalTimeout = terminal timeout unitsTiltMode = units and tilt mode hoodHBMMode = hood heater / fan heater mode hoodHTestInt = hood heater / blower test interval in hours battBoost_mV = boost voltage used for battery charging mV battCharge_mA = battery charge current mA</td>
</tr>
</tbody>
</table>
psuPresent = PSU present switch
hoodHBNormSpeed = Fan voltage for normal speed mV
hoodHBHighSpeed = Fan voltage for high speed mV
hoodHBLowSpeed = Fan voltage for low speed mV
intHMode = internal heater mode
message[0] = fields for message 0
message[1] = fields for message 1
message[4] = fields for message 4
messagePeriod = output message period in seconds
heightOffset = height offset metres
bsAvTime = backscatter average time in seconds
laserMode = laser operation mode
laserPower = laser power
laserHeater = laser heater mode
attenuatedSCALE = attenuated backscatter scaling factor
logInterval = debug logging interval
measurementPeriod = measurement interval in seconds
serMode = serial port mode
baudSel = serial port baud rate mode
dataParityStop = serial port parity mode
rs2txTimeout = serial port RX to TX turnaround time
snrMarginBoundary = onset of backscatter detection threshold
snrMarginDetector = cloud detection threshold
alphaGuessEnd = cloud alpha guess at boundary
alphaMin = cloud detection alpha minimum
Vcld_D = cloud detection
delta_Vcld_D = cloud detection
tvis_Av_T = cloud detection
alphaGuess = visibility initial alpha guess
tratioLevel = visibility ratio
alphaMin = visibility alpha minimum
cap = visibility cap in metres
tiltLimit = tilt limit in degrees used by alarms
noiseGate = attenuated backscatter noise gate mode
vvLimit_percent = sky condition report vertical visibility %
alphaGuessStart = cloud detection alpha guess at lowest height bin
dt = mixing layer height temporal filter minutes
dr = mixing layer height range filter metres
q1threshold = mixing layer height quality threshold 1
q2threshold = mixing layer height quality threshold 2
q3threshold = mixing layer height quality threshold 3
stdWidth = mixing layer height standard deviation width metres
CRC = 4 digit ASCII hex CRC calculated from the ‘u’ of user up to but not including the CRC using the standard CRC-16.

Note: Many of these parameters may not have been adjusted. This command allows a reliable technique for copying full settings from one SkyVUE™PRO to another with the ‘SETUSER’ command.

A typical response to the GETUSER command is:

>>>>>>>>>> COPY FROM START OF NEXT LINE >>>>>>>>>>

user 7 007638-6da 106 510 0 , 0 10 2 0 1 14520 400 1 1000 1000 2000 0 1 0 0 0 0 10 0.000E+00 2.000E+00 1 1.000E+00 0 1.000E+00 0 10 1 0 10 0 100 2.000E+00 4.000E+00 6.000E+00 2.000E-03 2.500E-04 1.000E+03 2.200E+01 4.800E+03 1.000E-01 9.000E-01 2.500E-04 2.000E+03 4.500E+01 2.000E+00 50 2.000E-03 3.000E+01 1.500E+02 1.800E+00
| HEATERS | **Hood, Internal, Laser, Test_interval,** | Sets or reads heater settings as follows:

- **Hood = 0,** Hood blower and heater OFF
- **Hood = 1,** Hood blower ON and heater OFF
- **Hood = 2,** Hood blower ON and heater ON
- **Hood = 3,** Hood blower and heater AUTO (default) – (See note (1) below).

- **Internal = 0,** Internal heater OFF
- **Internal = 1,** Internal heater ON
- **Internal = 2,** Internal heater AUTO (default)

- **Laser = 0,** Laser heater off
- **Laser = 1,** Laser heater on (default)

**Test_interval** = 1-168 hours (default 24h). Heater/Blower test interval |

| HELP | **No parameters** | Calls up a list of user commands with brief descriptions |

| HOFFSET | **Height_offset** | **Height_offset** is the offset to be added or subtracted in the range -1000 m to +1000 m or -3281 ft to +3281 ft. Positive values are added to measured height and negative values are subtracted from measured height. The default is 0. |

| ID | **Sensor_ID** | Reads or sets the sensor ID, a single ASCII character, 0-9, a-z or A-Z, case sensitive. Default ID = 0. Note that if a CT25K message is to be used lower case letters are not allowed. |

| LASER | **Laser, Laser_Power** | **Laser = 0,** Laser off after power up (user must switch laser on).
- **Laser = 1,** Laser on after power up (default).

- **Laser_Power = 20%-100%**, default 100% |

| LASEROFF | **No parameters** | Instructs the SkyVUE™PRO to turn the laser off until either a power cycle or the sensor is instructed to turn the laser back on. |

| LASERON | **No parameters** | Instructs the SkyVUE™PRO to try and turn the laser on |

| LOADOS | **Module** | Loads new operating system into modules as follows:

- **Module =1,** DSP.

Note: Operating systems earlier than 4 will need the boot loader updating. Refer to Section 5.1.8 for more information.

- **Module =2,** TOP

- **Module =3,** PSU

- **Module =4,** DSP, TOP & PSU as one file. This is only supported from Operating system 8

This command must be sent using XMODEM protocol. Refer to Section 5.1.8 for more information. |
<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
</table>
| **MCFG** | Set or read message configuration. *Message Interval* is the message interval in seconds, 2-600s. 0 gives polled messages, default 10. **Note:** This command may affect measurement parameters within the ‘BS’ command. See [Section 5.1.5](#).  
*Message ID* is the message type to output between 0 and 999 (default 001). If *Message ID* = 0 no message type will be output. Up to 5 messages can be set. Please refer to [Section 5.1.4](#). |
| **MLH** | Sets or reads parameters used in identifying Mixing Layer heights  
*Temporal Filter* = temporal filter half width used to filter data used by mixing layer height algorithm in minutes. 1 to 40 (default 30 minutes)  
*Range Filter* = range filter half width used to smooth data used by mixing layer height algorithm in metres or feet. 15 m to 600 m or 49 ft to 1969 ft (default 150 m or 492 ft)  
*Std Width* = range half width used to calculate standard deviation of the slope in metres or feet. 10 m to 400 m or 33 ft to 1312 ft (default 150 m or 492 ft)  
*Q1 Threshold* = SNR threshold for quality level 1 mixing layer height output. 1.0 to 30.0 (default 1.8)  
*Q2 Threshold* = SNR threshold for quality level 2 mixing layer height output. 1.0 to 30.0 (default 5.0)  
*Q3 Threshold* = SNR threshold for quality level 3 mixing layer height output. 1.0 to 30.0 (default 10.0) |
| **OPEN** | Opens the SkyVUE™PRO terminal mode.  
*ID* = Sensor ID as per the terminal command “ID”  
*Password* = The sensor’s user password as per the terminal command “PASSWORD”. The default is no password. |
| **PASSWORD** | Sets or clears a password from 1 to 10 characters in length. Valid ASCII characters 0-9, a - z or A - Z and letters are case sensitive. Typing the command PASSWORD without any parameters clears the password. The default is no password. |
| **POLL** | Requests the message *Message ID* from the sensor *Sensor ID*. Refer to [Section 5.1.7](#) for more information on this command.  
**Note:** If *Message ID* is omitted the SkyVUE™PRO outputs the message configured by MCFG. |
| **POWEROFF** | This will prepare the PSU to power down the SkyVUE™PRO even if the battery is connected. As soon as the mains supply is disconnected the SkyVUE™PRO will power off and NOT run on battery back-up. The SkyVUE™PRO can be re-activated with battery back-up enabled by re-connecting the mains supply. You will be asked to confirm. |
| **REBOOT** | Forces a system reboot. This will restore previously saved user settings. Any unsaved changes will be lost. (Settings are saved in terminal mode when the command CLOSE is typed, which exits the terminal mode). |
| **SCCAL** | Stratocumulus backscatter calibration. This requires a human observer to confirm a stable Stratocumulus cloud layer between 250 m to 2500 m without holes, precipitation or reduced visibility and has been stable for at least 10 minutes prior to running this command. See [Section 5.1.9](#) for more information. |
| **SERIAL** | Set or read the serial port  
*Mode* = 0, RS-232, full duplex (default). |
| Bits_Parity, Delay | Mode = 1, RS-232, half duplex  
|                   | Mode = 2, RS-485, full duplex  
|                   | Mode = 3, RS-485, half duplex  
|                   | Mode = 4, Reserved  
|                   | Mode = 5, RS-422, full duplex  
|                   | Baud = 0, 300 baud  
|                   | Baud = 1, 600 baud  
|                   | Baud = 2, 1200 baud  
|                   | Baud = 3, 2400 baud  
|                   | Baud = 4, 4800 baud  
|                   | Baud = 5, 9600 baud  
|                   | Baud = 6, 19200 baud  
|                   | Baud = 7, 38400 baud  
|                   | Baud = 8, 57600 baud  
|                   | Baud = 9, 76800 baud  
|                   | Baud = 10, 115200 baud (default)  
| Bits_Parity = 0, 8 bits, no parity, 1 stop bit (default)  
| Bits_Parity = 1, 7 bits, even parity, 1 stop bit  
| Bits_Parity = 2, 7 bits, odd parity, 1 stop bit  
| Delay is the delay time in mS to TX (RS-485 half-duplex mode only). Range 0-100 mS, default 100 mS. |

**SERVICE**  
*No parameters but user intervention required*  
Performs a service procedure

**SETUSER**  
*String*  
Load all user settings as a string of text.  
(not changed) = parameter will not be updated and the previously set value will persist.  
String =  
user (not changed)  
volVer = user volume version (not changed)  
OS_VER = DSP OS version (not changed)  
PsuOsVer = PSU OS version (not changed)  
TopOsVer = TOP OS version (not changed)  
Id = SkyVUE™PRO ID (not changed)  
Pw = SkyVUE™PRO password (not changed)  
terminalCrc = terminal crc mode  
terminalTimeout = terminal timeout  
unitsTiltMode = units and tilt mode  
hoodHBMode = hood heater / fan heater mode  
hoodHBTestInt = hood heater / blower test interval in hours  
battBoost_mV = boost voltage used for battery charging mV  
battCharge_mA = battery charge current mA  
psuPresent = PSU present switch  
hoodHBNormSpeed = Fan voltage for normal speed mV  
hoodHBBHighSpeed = Fan voltage for high speed mV  
hoodHBLowSpeed = Fan voltage for low speed mV  
intHMode = internal heater mode  
message[0] = fields for message 0  
message[1] = fields for message 1  
message[4] = fields for message 4  
messagePeriod = output message period in seconds  
heightOffset = height offset metres  
bsAvTime = backscatter average time in seconds  
laserMode = laser operation mode
laserPower = laser power
laserHeater = laser heater mode
attenuatedSCALE = attenuated backscatter scaling factor
logInterval = debug logging interval
measurementPeriod = measurement interval in seconds
serMode = serial port mode
baudSel = serial port baud rate mode
dataParityStop = serial port parity mode
rx2txTimeout = serial port RX to TX turnaround time
snrMarginBoundary = onset of back-scatter detection threshold
alphaGuessEnd = cloud alpha guess at boundary
alphaMin = cloud detection alpha minimum
Vcld_D = cloud detection
delta_Vcld_D = cloud detection
visAvT = cloud detection
alphaGuess = visibility initial alpha guess
ratioLevel = visibility ratio
cap = visibility cap in metres
tiltLimit = tilt limit in degrees used by alarms
noiseGate = attenuated backscatter noise gate mode
vvLimit_percent = sky condition report vertical visibility %
alphaGuessStart = cloud detection alpha guess at lowest height bin
dt = mixing layer height temporal filter minutes
dr = mixing layer height range filter metres
q1threshold = mixing layer height quality threshold 1
q2threshold = mixing layer height quality threshold 2
q3threshold = mixing layer height quality threshold 3
stdWidth = mixing layer height standard deviation width metres
CRC = 4 digit ASCII hex CRC calculated from the “u” of user up-to but not including the CRC using the standard CRC-16-CCITT.
Note: String is added as text and should be added as a “cut and paste” from a stored file.

STATUS

<table>
<thead>
<tr>
<th>No parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outputs SkyVUE™PRO, serial number, ID, DSP OS version, Time and Date, DSP version, TOP OS version, PSU OS version, watch dog counts, serial parameters, blower heater mode, internal heater mode, message parameters, tilt angle, units, temperature/humidity, temperatures, supply voltages, height offset, visibility cap, laser run days, window parameters, backscatter parameters, MLH parameters, features, alarms, warnings and status.</td>
</tr>
<tr>
<td>Note: Refer to Section 5.1.6 for more information on this command</td>
</tr>
</tbody>
</table>

TERMINAL

<table>
<thead>
<tr>
<th>Terminal, Timeout</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sets CRC-16-CCITT checking and the user terminal time out.</td>
</tr>
<tr>
<td>Terminal = 0, CRC-16-CCITT off (default).</td>
</tr>
<tr>
<td>Terminal = 1, CRC-16-CCITT on (all terminal commands need a CRC. See Section 5.1.10 for details).</td>
</tr>
<tr>
<td>Timeout is the delay in minutes from 1 to 15 where the terminal will automatically close if no characters are sent to the SkyVUE™PRO. The default is 10 minutes.</td>
</tr>
</tbody>
</table>
TIME | Date_Time
---|---
Date is in the format yyyy/mm/dd
Time is in the format hh:mm:ss
yyyy=year, mm=month, dd=day
hh=hours, mm=minutes, ss=seconds
(i.e. time 2013/05/25 10:00:00, would set the date and time to May 25th 2013 at 10:00:00)
Note: The set time could drift by up to ±14 seconds a day.

UNITS | Units
---|---
Sets measurement units and tilt correction.

Units = 0, metres corrected by tilt.
Units = 1, metres not corrected by tilt.
Units = 2, feet corrected by tilt (default).
Units = 3, feet not corrected by tilt.

UNLOCK | Key
---|---
Key = a 12 digit ASCII hex key provided by CSL to unlock pay-for-features

VIS | Cap
---|---
Cap is the vertical visibility maximum range 100 to 10000 in metres or 328 to 32808 in feet (default 2000 m or 6561 ft).

Note (1)
If AUTO is set then the heater / blower will heat to 80 °C if (sky condition > 1 okta coverage) or (cloud height < 3 km (9842 ft) AND sky condition > 1 okta coverage) OR window Tx < 80% OR precipitation detected. When the event has passed, the blower/heater will remain active at 80 °C for a further 15 minutes before going into a fan-off state and the heater temperature drops to an average of approximately 40 °C, ready to be activated again.

5.1.4 MCFG command message types

The MCFG commands “Message_ID_x” parameter defines the following output types. Refer to Section 6 for further information on message output types.

<table>
<thead>
<tr>
<th>Message_ID_x type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>000</td>
<td>No message</td>
</tr>
<tr>
<td>001 (default)</td>
<td>Campbell Scientific Message 1, no sky condition, no profile data</td>
</tr>
<tr>
<td>002</td>
<td>Campbell Scientific Message 2, no sky condition, profile data, 2048 range bins, 5 m resolution</td>
</tr>
<tr>
<td>003</td>
<td>Campbell Scientific Message 3, sky condition, no profile data</td>
</tr>
<tr>
<td>004</td>
<td>Campbell Scientific Message 4, sky condition and profile data, 2048 range bins, 5 m resolution</td>
</tr>
<tr>
<td>005*</td>
<td>Campbell Scientific Message 5, sky condition, no profile data, mixing layer height</td>
</tr>
<tr>
<td>006*</td>
<td>Campbell Scientific Message 6, sky condition, profile data, 2048 range bins, 5 m resolution, mixing layer height</td>
</tr>
<tr>
<td>101</td>
<td>CL31 Message 1, 770 range bins, 10 m resolution</td>
</tr>
<tr>
<td>102</td>
<td>CL31 Message 1, 385 range bins, 20 m resolution</td>
</tr>
<tr>
<td>103</td>
<td>CL31 Message 1, 1500 range bins, 5 m resolution</td>
</tr>
<tr>
<td>104</td>
<td>CL31 Message 1, 770 range bins, 5 m resolution</td>
</tr>
<tr>
<td>105</td>
<td>CL31 Message 1, No profile data</td>
</tr>
<tr>
<td>106</td>
<td>CL31 Message 1, Full SkyVUE™PRO output, 2048 range bins, 5 m resolution</td>
</tr>
<tr>
<td>107</td>
<td>CL31 Message 2, 770 range bins, 10 m resolution</td>
</tr>
<tr>
<td>108</td>
<td>CL31 Message 2, 385 range bins, 20 m resolution</td>
</tr>
<tr>
<td>109</td>
<td>CL31 Message 2, 1500 range bins, 5 m resolution</td>
</tr>
<tr>
<td>110</td>
<td>CL31 Message 2, 770 range bins, 5 m resolution</td>
</tr>
<tr>
<td>111</td>
<td>CL31 Message 2, No profile data</td>
</tr>
<tr>
<td>112</td>
<td>CL31 Message 2, Full SkyVUE™PRO output, 2048 range bins, 5 m resolution</td>
</tr>
<tr>
<td>113</td>
<td>CT25K Message 1</td>
</tr>
<tr>
<td>114</td>
<td>CT25K Message 6</td>
</tr>
</tbody>
</table>

* only available if MLH option is active
5.1.5 Measurement and message intervals

The message interval is the time, in seconds, between the automatic message transmissions. It can be set between 2-600s ("0" gives polled messages). The default is 10, meaning a message will be sent automatically every 10 seconds. The message interval must be a multiple of the measurement period.

The backscatter average time, BS_Av_Time, is the period over which the laser is firing and taking measurements.

The measurement period is the time interval between the start of backscatter average time (BS_Av_Time), during which the laser fires, and the start of the next measurement period. The measurement period must be long enough to include the backscatter average time and some processing time. The minimum measurement period is 2 seconds, which assumes the backscatter average time is 1 second. The measurement period can be set between 2 to 600s (default is 10s). If it is set to 0 then measurements must be polled.

The rolling average (1-29, default 1) is the number of periods used to calculate each scatter value that is either used in a profile message or in a calculation of cloud height.

The message interval chosen may affect measurement parameters allowed within the “BS” command, which can be used to set non-standard measurement parameters) as follows:

- If message interval = measurement period = 2 (the lowest values allowed)
  Then the backscatter average time (BS_Av_Time) must equal 1 and the rolling average must equal 1.

- If the message interval is between 3 and 9s then the measurement period must be the same as the message interval.

In the following examples Yellow means laser firing.

**To comply with the requirements for Sky Condition the total measurement period for rolling averages should not exceed 30 seconds.**

In this case the SkyVUE™PRO sends a message every 2 seconds based on one measurement averaged over 1 second. Therefore, each message is based on a single 1 second period of backscatter average data.

<table>
<thead>
<tr>
<th>Laser firing (yellow)</th>
<th>2s</th>
<th>2s</th>
<th>2s</th>
<th>2s</th>
<th>2s</th>
<th>2s</th>
<th>2s</th>
<th>2s</th>
<th>2s</th>
<th>2s</th>
<th>2s</th>
<th>2s</th>
<th>2s</th>
<th>2s</th>
</tr>
</thead>
<tbody>
<tr>
<td>(BS_AV_Time) = 1s</td>
<td>1s</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measurement Period</td>
<td>2s</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Message Interval</td>
<td>2s</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In this case, with the rolling average set to 1, the SkyVUE™PRO sends a message every 30 seconds. It takes three, 2 second, measurements at 10 second intervals. Only the last measurement is used in the output message but all three are used for calculating sky condition. Therefore, each message is based on a single 2 second period of backscatter average data.

<table>
<thead>
<tr>
<th>Laser firing (yellow)</th>
<th>2s</th>
<th>2s</th>
<th>2s</th>
<th>2s</th>
<th>2s</th>
<th>2s</th>
<th>2s</th>
<th>2s</th>
<th>2s</th>
<th>2s</th>
<th>2s</th>
<th>2s</th>
<th>2s</th>
<th>2s</th>
</tr>
</thead>
<tbody>
<tr>
<td>(BS_AV_Time) = 2s</td>
<td>2s</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measurement Period</td>
<td>10s</td>
<td>10s</td>
<td>10s</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Message Interval</td>
<td>30s</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
In this case, with the rolling average set to 3, the SkyVUE™PRO sends a message every 30 seconds that contains the average of the latest three measurements. Therefore, each message is based on three, 10 second measurement periods, with each containing 2 seconds of backscatter average data.

<table>
<thead>
<tr>
<th>Laser firing (yellow)</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(BS_AV_Time) = 2s</td>
<td>2s</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measurement Period = 10s</td>
<td>10s 10s 10s</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Message Interval = 30s</td>
<td>30s</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In this case, with the rolling average set to 3 (default), the SkyVUE™PRO sends a message every 10 seconds that contains the average of the latest three measurements. Therefore, each message is based on three, 10 second measurement periods, with each containing 2 seconds of backscatter average data.

<table>
<thead>
<tr>
<th>Laser firing (yellow)</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(BS_AV_Time) = 2s</td>
<td>2s</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measurement Period = 10s</td>
<td>10s 10s 10s</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Message Interval = 10s</td>
<td>10s 10s 10s</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In this case, the SkyVUE™PRO sends a message every 14 seconds based on one measurement taking 4 seconds over a 14 second interval. Therefore, each message is based on a single 4 second period of average data.

<table>
<thead>
<tr>
<th>Laser firing (yellow)</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(BS_AV_Time) = 4s</td>
<td>4s</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measurement Period = 14s</td>
<td>14s 14s 14s 14s</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Message Interval = 14s</td>
<td>14s 14s 14s 14s</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This message cannot be set up using the MCFG command alone. The BS command has to be used as follows: BS_Av_Time (averaging period) has to be set to 4, not the default value.
### 5.1.6 STATUS command

The STATUS command returns the following information:

<table>
<thead>
<tr>
<th>Line</th>
<th>Example line output</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Identification CS135 SN1000 ID 0</td>
</tr>
</tbody>
</table>

#### Description of the line sections

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS135</td>
<td>Product name</td>
</tr>
<tr>
<td>SN1000</td>
<td>Sensor serial number</td>
</tr>
<tr>
<td>ID 0</td>
<td>Sensor identification number</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Line</th>
<th>Example line output</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Date Time 2012/01/10 11:39:46</td>
</tr>
</tbody>
</table>

#### Description of the line sections

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012/01/10</td>
<td>Date in the format yyyy/mm/dd</td>
</tr>
<tr>
<td>11:39:46</td>
<td>Time in the format hh:mm:ss</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Line</th>
<th>Example line output</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>DSP_OS A</td>
</tr>
</tbody>
</table>

#### Description of the line sections

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>DSP OS revision number</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Line</th>
<th>Example line output</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>TOP_OS 1</td>
</tr>
</tbody>
</table>

#### Description of the line sections

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>TOP board OS revision number</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Line</th>
<th>Example line output</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>PSU_OS 1</td>
</tr>
</tbody>
</table>

#### Description of the line sections

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>PSU board OS revision number</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Line</th>
<th>Example line output</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Watchdog A</td>
</tr>
</tbody>
</table>

#### Description of the line sections

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Watchdog counter for unscheduled system resets</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Line</th>
<th>Example line output</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Serial A B C D</td>
</tr>
</tbody>
</table>

#### Description of the line sections

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Serial mode <em>(Note: Refer to the SERIAL command)</em></td>
</tr>
<tr>
<td>B</td>
<td>Serial baud rate <em>(Note: Refer to the SERIAL command)</em></td>
</tr>
<tr>
<td>C</td>
<td>Parity and stop bits <em>(Note: Refer to the SERIAL command)</em></td>
</tr>
<tr>
<td>D</td>
<td>Receive to transmit delay time in RS-485 mode <em>(Note: Refer to the SERIAL command)</em></td>
</tr>
</tbody>
</table>
### SkyVUE™ PRO (CS135) LIDAR Ceilometer

#### Line 8
Example line output

| Heaters | A | B | C | D |

**Description of the line sections**

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Hood blower mode</td>
</tr>
<tr>
<td>B</td>
<td>Internal heater mode</td>
</tr>
<tr>
<td>C</td>
<td>Laser heater mode</td>
</tr>
<tr>
<td>D</td>
<td>Heater/blower test interval in hours</td>
</tr>
</tbody>
</table>

#### Line 9
Example line output

| MCFG | X | A | B | C | D | E |

**Description of the line sections**

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>Message interval <em>(Note: Refer to the MCFG command)</em></td>
</tr>
<tr>
<td>A</td>
<td>Message ID A <em>(Note: Refer to the MCFG command)</em></td>
</tr>
<tr>
<td>B</td>
<td>Message ID B <em>(Note: Refer to the MCFG command)</em></td>
</tr>
<tr>
<td>C</td>
<td>Message ID C <em>(Note: Refer to the MCFG command)</em></td>
</tr>
<tr>
<td>D</td>
<td>Message ID D <em>(Note: Refer to the MCFG command)</em></td>
</tr>
<tr>
<td>E</td>
<td>Message ID E <em>(Note: Refer to the MCFG command)</em></td>
</tr>
</tbody>
</table>

#### Line 10
Example line output

| Angle | A | B | C |

**Description of the line sections**

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>X axis tilt</td>
</tr>
<tr>
<td>B</td>
<td>Y axis tilt</td>
</tr>
<tr>
<td>C</td>
<td>Beam angle from vertical</td>
</tr>
</tbody>
</table>

#### Line 11
Example line output

| Units | A |

**Description of the line sections**

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Measurement units and tilt correction. <em>(Note: Refer to the UNITS command)</em></td>
</tr>
</tbody>
</table>

#### Line 12
Example line output

| TRH   | A | B | C |

**Description of the line sections**

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Sensor internal temperature reading in degrees Celsius</td>
</tr>
<tr>
<td>B</td>
<td>Sensor internal humidity reading as a percentage</td>
</tr>
<tr>
<td>C</td>
<td>Sensors internal dew point value in degrees Celsius</td>
</tr>
</tbody>
</table>

#### Line 13
Example line output

| T      | A | B | C | D | E | F |

**Description of the line sections**

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>External fan blower assembly temperature in degrees Celsius</td>
</tr>
<tr>
<td>B</td>
<td>PSU internal temperature in degrees Celsius</td>
</tr>
<tr>
<td>C</td>
<td>TOP board laser monitor temperature in degrees Celsius</td>
</tr>
<tr>
<td>D</td>
<td>TOP board calibration LED temperature in degrees Celsius</td>
</tr>
<tr>
<td>E</td>
<td>Laser module temperature in degrees Celsius</td>
</tr>
<tr>
<td>F</td>
<td>Photo diode module temperature in degrees Celsius</td>
</tr>
</tbody>
</table>
### Description of the line sections

<table>
<thead>
<tr>
<th>Line</th>
<th>Example line output</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>SupplyVoltage A B</td>
</tr>
</tbody>
</table>

#### Section Description

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>DSP board supply voltage</td>
</tr>
<tr>
<td>B</td>
<td>PS135E internal supply voltage</td>
</tr>
<tr>
<td>C</td>
<td>Cyclic power cycle counter. Resets after 31 cycles</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Line</th>
<th>Example line output</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>HOffset A</td>
</tr>
</tbody>
</table>

#### Description of the line sections

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Height offset reported in feet or metres dependent upon the UNITS command</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Line</th>
<th>Example line output</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>Visibility Cap A</td>
</tr>
</tbody>
</table>

#### Description of the line sections

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Vertical visibility maximum range</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Line</th>
<th>Example line output</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>LaserRunDays A</td>
</tr>
</tbody>
</table>

#### Description of the line sections

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Number of days that the laser module has been active for</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Line</th>
<th>Example line output</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>WindowTX A</td>
</tr>
</tbody>
</table>

#### Description of the line sections

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Window transmittance %</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Line</th>
<th>Example line output</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>BS A B C D E F (Note: refer to the BS command)</td>
</tr>
</tbody>
</table>

#### Description of the line sections

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Attenuated scale</td>
</tr>
<tr>
<td>B</td>
<td>Averaging time</td>
</tr>
<tr>
<td>C</td>
<td>Noise Gate</td>
</tr>
<tr>
<td>D</td>
<td>Measurement period</td>
</tr>
<tr>
<td>E</td>
<td>Rolling average</td>
</tr>
<tr>
<td>F</td>
<td>Message interval</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Line</th>
<th>Example line output</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>MLH A B C D E F (Note: refer to the MLH command)</td>
</tr>
</tbody>
</table>

#### Description of the line sections

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Temporal filter</td>
</tr>
<tr>
<td>B</td>
<td>Range filter</td>
</tr>
<tr>
<td>C</td>
<td>STD width</td>
</tr>
<tr>
<td>D</td>
<td>Q1 threshold</td>
</tr>
<tr>
<td>E</td>
<td>Q2 threshold</td>
</tr>
<tr>
<td>F</td>
<td>Q3 threshold</td>
</tr>
</tbody>
</table>
### Description of the line sections

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>List of features enabled</td>
</tr>
</tbody>
</table>

### Description of the most significant alarm word (left side, bits going left to right). Each alarm word is a hexadecimal sum of all the error bits.

<table>
<thead>
<tr>
<th>Bit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>8000 XXXX XXXX</td>
<td>Units. feet = 0, metres = 8</td>
</tr>
<tr>
<td>4000 XXXX XXXX</td>
<td>Reserved for future use</td>
</tr>
<tr>
<td>2000 XXXX XXXX</td>
<td>Reserved for future use</td>
</tr>
<tr>
<td>1000 XXXX XXXX</td>
<td>Reserved for future use</td>
</tr>
<tr>
<td>0800 XXXX XXXX</td>
<td>DSP clock out of specification</td>
</tr>
<tr>
<td>0400 XXXX XXXX</td>
<td>Laser shut down due to operating temperature out of range</td>
</tr>
<tr>
<td>0200 XXXX XXXX</td>
<td>The lead acid battery voltage is reading low</td>
</tr>
<tr>
<td>0100 XXXX XXXX</td>
<td>Mains supply has failed (Required a PSU to be present)</td>
</tr>
<tr>
<td>0080 XXXX XXXX</td>
<td>The external heater blower assembly temperature is out of bounds</td>
</tr>
<tr>
<td>0040 XXXX XXXX</td>
<td>External heater blower failure</td>
</tr>
<tr>
<td>0020 XXXX XXXX</td>
<td>The PSUs internal temperature is high</td>
</tr>
<tr>
<td>0010 XXXX XXXX</td>
<td>PSU OS has failed its signature check</td>
</tr>
<tr>
<td>0008 XXXX XXXX</td>
<td>No communications between DSP and PSU</td>
</tr>
<tr>
<td>0004 XXXX XXXX</td>
<td>Photo diode and Laser windows are dirty. This can only be set if the laser is on</td>
</tr>
<tr>
<td>0002 XXXX XXXX</td>
<td>Tilt beyond limit set by user, default 45 degrees</td>
</tr>
<tr>
<td>0001 XXXX XXXX</td>
<td>No communications between DSP and inclinometer board</td>
</tr>
</tbody>
</table>

### Description of the middle alarm word (middle word, bits going left to right)

<table>
<thead>
<tr>
<th>Bit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>XXXX 8000 XXXX</td>
<td>The sensors internal humidity is high</td>
</tr>
<tr>
<td>XXXX 4000 XXXX</td>
<td>Communications to the DSP boards temperature and humidity chip have failed</td>
</tr>
<tr>
<td>XXXX 2000 XXXX</td>
<td>DSP input supply voltage is low</td>
</tr>
<tr>
<td>XXXX 1000 XXXX</td>
<td>Self-test active</td>
</tr>
<tr>
<td>XXXX 0800 XXXX</td>
<td>Watch dog counter updated</td>
</tr>
<tr>
<td>XXXX 0400 XXXX</td>
<td>User setting stored in flash failed their signature checks</td>
</tr>
<tr>
<td>XXXX 0200 XXXX</td>
<td>DSP factory calibration stored in flash has failed its signature check</td>
</tr>
<tr>
<td>XXXX 0100 XXXX</td>
<td>DSP board OS signature test failed</td>
</tr>
<tr>
<td>XXXX 0080 XXXX</td>
<td>DSP board RAM test failed</td>
</tr>
<tr>
<td>XXXX 0040 XXXX</td>
<td>DSP boards on board PSUs are out of bounds</td>
</tr>
<tr>
<td>XXXX 0020 XXXX</td>
<td>TOP board non-volatile storage is corrupt</td>
</tr>
<tr>
<td>XXXX 0010 XXXX</td>
<td>TOP board OS signature test has failed</td>
</tr>
<tr>
<td>XXXX 0008 XXXX</td>
<td>TOP boards ADC and DAC are not within specifications</td>
</tr>
<tr>
<td>XXXX 0004 XXXX</td>
<td>TOP boards on board PSUs are out of bounds</td>
</tr>
<tr>
<td>XXXX 0002 XXXX</td>
<td>Communications have failed between TOP board and the DSP</td>
</tr>
<tr>
<td>XXXX 0001 XXXX</td>
<td>Photo diode background radiance is out of range</td>
</tr>
</tbody>
</table>

### Description of the least significant alarm word (right side, bits going left to right)

<table>
<thead>
<tr>
<th>Bit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>XXXX XXXX 8000</td>
<td>Photo diode temperature is out of range</td>
</tr>
<tr>
<td>XXXX XXXX 4000</td>
<td>Photo diode is saturated</td>
</tr>
<tr>
<td>XXXX XXXX 2000</td>
<td>Photo diode calibrator temperature is out of range</td>
</tr>
<tr>
<td>XXXX XXXX 1000</td>
<td>Photo diode calibrator has failed</td>
</tr>
<tr>
<td>XXXX XXXX 0800</td>
<td>The sensor could not reach the desired gain levels</td>
</tr>
<tr>
<td>XXXX XXXX 0400</td>
<td>Laser run time has been exceeded</td>
</tr>
<tr>
<td>XXXX XXXX 0200</td>
<td>Laser temperature out of range</td>
</tr>
<tr>
<td>XXXX XXXX 0100</td>
<td>Laser thermistor failure</td>
</tr>
<tr>
<td>XXXX XXXX 0080</td>
<td>Laser is obscured. This can only be set if the laser is on</td>
</tr>
</tbody>
</table>
### 5.1.7 Message polling

The command `POLL Sensor_ID Message_ID` requests the message `Message_ID` from sensor `Sensor_ID`. Where `Message_ID` is a SkyVUE™PRO message type as defined in Section 5.1.4.

The following example shows how to use the SkyVUE™PRO POLL command to request preconfigured message outputs.

First configure the SkyVUE™PRO to use polling mode from the terminal interface via the “MCFG” command as follows:

```
CS135> MCFG 0
0 1 0 0 0 0
```

This configures the SkyVUE™PRO into polling mode leaving your message output configurations unchanged. Exit the terminal by typing the “close” command. This will save the changes you just made.

```
CS135> CLOSE
COMMAND CLOSED
```

Any automatic message outputs should not have stopped. Type the “POLL” command as shown below to verify that the system is working as expected. Note: Once you have exited the terminal characters will not be automatically echoed back to you.

```
POLL 0
```

This should return all messages you have set via the MCFG command. In this example, only one message output was set, the default message. So the POLL command will return text similar to that shown below.

```
abcd
```

**NOTE**

If you have no message configured (i.e. MCFG returned 0 0 0 0 0 0) then nothing will be returned from the command you just typed.

```
CS0100001
10 100 12345 ///// ///// ///// 000000000000
abcd
```

The following example shows how to use the POLL command to request a specific message output type.

First configure the SkyVUE™PRO into polling mode as shown in the example above and exit the terminal interface. To poll the SkyVUE™PRO for a particular message type, type the following.

```
POLL 0 113
```

The example text above will request the “CT25K Message 1” and should look similar to the text below.

```
“CT000010
10 12345 ///// ///// 00000f80”
```
5.1.8 Loading a new Operating System (OS)

A new OS can be entered with the LOADOS module command. Note three different modules each have their own OS. The parameter module loads a new operating system into different modules as follows:

- Module = 1, DSP (file type *.ldr)
- Module = 2, TOP (file type *.hex)
- Module = 3, PSU (file type *.hex)
- Module = 4, DSP, TOP & PSU as one file, type *.ldr. This is the usual method.

The new OS must be sent using xmodem protocol using Tera Term. See Section 5.1.2.

To load a new operating system:

Enter terminal mode by typing “Open 0” (for a sensor with the default ID “0”)

This will return the prompt “CS135>”

Type the command “LOADOS 4”

The SkyVUE™PRO will respond:

“Load OS into DSP
DO NOT REMOVE POWER DURING OS UPDATE!!!
Waiting for xmodem”

At this point use your terminal emulator to send the appropriate file. Loading the OS could take a few minutes.

When the process is complete the SkyVUE™PRO will return the message:

“Wait 40 sec for OS to restart”

after which it will resume operation according to the previously set operating parameters. It will no longer be in terminal mode.

To load a new operating system into a SkyVUE™PRO with an OS between 4 and 7

Enter terminal mode by typing “Open 0” (for a sensor with the default ID “0”)

This will return the prompt “CS135>”

Type the command “LOADOS 1”

The SkyVUE™PRO will respond:

“Load OS into DSP
DO NOT REMOVE POWER DURING OS UPDATE!!!
Waiting for xmodem”

At this point use your terminal emulator to send the *.ldr file using xmodem protocol.

Loading the OS could take a few minutes.

When the process is complete the SkyVUE™PRO will return the message:

“Wait 40 sec for OS to restart” after which it will resume operation according to the previously set operating parameters. It will no longer be in terminal mode.
DO NOT REBOOT THE SkyVUE™ PRO AT THIS POINT

Again enter terminal mode by typing “Open 0” (for a sensor with the default ID “0”)
This will return the prompt “CS135>”
This time type the command “LOADOS 4”
The SkyVUE™ PRO will respond:
“Load OS into DSP
DO NOT REMOVE POWER DURING OS UPDATE!!!
Waiting for xmodem”

At this point again use your terminal emulator to send the *.ldr file using xmodem protocol.

Loading the OS could take a few minutes.
When the process is complete the SkyVUE™ PRO will return the message:
“Wait 40 sec for OS to restart” after which it will resume operation according to the previously set operating parameters. It will no longer be in terminal mode.

To load a new operating system into a SkyVUE™ PRO with an OS between 1 and 3

Operating systems earlier than 4 will need the boot loader updating, use the LOADOS 1 command, not LOADOS 4, before a new DSP OS can be uploaded so the first time the OS is loaded a verify error will be reported (this is normal) as follows:
“Error writing word 32768
Verify OS
Error verifying word 327680 37020 4236”
You will then need to “reboot” and then load the OS using the terminal command “LOADOS 4” to correctly load the OS without errors.

The process is as follows:

Enter terminal mode by typing “Open 0” (for a sensor with the default ID “0”)
This will return the prompt “CS135>”
Type the command “LOADOS 1”
The SkyVUE™ PRO will respond:
“Load OS into DSP
DO NOT REMOVE POWER DURING OS UPDATE!!!
Waiting for xmodem”
At this point use your terminal emulator to send the *.ldr file using xmodem protocol.

Loading the OS could take a few minutes.
When the process is complete the SkyVUE™ PRO will return the message:
“Error writing word 32768
Verify OS
Error verifying word 327680 37020 4236”

NOW REBOOT THE SkyVUE™ PRO USING THE “REBOOT” COMMAND

Wait 40 sec for OS to restart after which it will resume operation according to the previously set operating parameters. It will no longer be in terminal mode.

Again enter terminal mode by typing “Open 0” (for a sensor with the default ID “0”)
This will return the prompt “CS135>”
This time type the command “LOADOS 4”
The SkyVUE™PRO will respond:
“Load OS into DSP
DO NOT REMOVE POWER DURING OS UPDATE!!!
Waiting for xmodem”

At this point again use your terminal emulator to send the *.ldr file again using xmodem protocol.

Loading the OS could take a few minutes.
When the process is complete the SkyVUE™PRO will return the message: “Wait 40 sec for OS to restart” after which it will resume operation according to the previously set operating parameters. It will no longer be in terminal mode.

It is good practice to re-boot the sensor after loading a new OS.

5.1.9 Stratocumulus backscatter calibration

The command “SCCAL” allows a simple Stratocumulus backscatter calibration of the scatter coefficient measurements. This requires a human observer to confirm a stable Stratocumulus cloud layer between 250 m (820 ft) to 2500 m (8202 ft) without holes, precipitation or reduced visibility and has been stable for at least 10 minutes prior to running this command.

Measurement_Period should be set to 10 s. See Table 5.1.


Enter terminal mode by typing “Open 0” (for a sensor with the default ID “0”)

This will return the prompt “CS135:”

Type the command “SCCAL”

The SkyVUE™PRO will respond:

“Stratocumulus calibration.
Enter height above sea level (m)? Press enter to continue:”

Enter the sensor height above sea level, for example 70 m (229 ft) and type return.

The SkyVUE™PRO will respond “70 m entered, is this correct? “Y”, “N” or “Q” ”

Type “Y” to confirm or if you have entered an incorrect number type “N” and you will be able to replace it. Typing “Q” will quit the calibration and return to the terminal command prompt.

The SkyVUE™PRO will now respond:

“For correct calibration a trained human observer must confirm that the layer is between 250 m (820 ft) to 2500 m (8202 ft) and has been stable for at least 10 minutes without drizzle. Has the Stratocumulus been stable for at least 10 minutes? “Y” or “N” ”
To confirm type “Y”

The SkyVUE\textsuperscript{TM} PRO will respond:

“Old Stratocumulus calibration = 0.0282
New Stratocumulus calibration parameters = 0.0258 70 1328
Do you want to apply this calibration? “Y” or “N”

In this example 70 is the height of the sensor above sea level previously entered and 1210 is the cloud base in metres above the sensor.

As a very rough guide if the calibration factor has changed by less than 20% there is probably no need to change. If it has changed by a factor of 2 it is wise to run the service routine on the sensor (See Section 5.1.11).

Type “Y” to confirm and the SkyVUE\textsuperscript{TM} PRO will respond:

“Calibration saved.”

The following error messages may appear during the process.
- Error ... Time out.
- Error ... Cloud not detected or height not within limits (250 m (820 ft) to 2500 m (8202 ft)).
- Try again when layer is stable.
- Error ... Not enough data available try again in 10 minutes.

5.1.10 CRC-16 Codes on terminal commands

If CRC-16 on mode is set using the “Terminal” command, all terminal commands need a CRC-16. A semi-colon is used to indicate start of the CRC-16 in 4 byte ASCII hex, for example “open 0;d2d5”. The CRC-16 is calculated either from the start of a new line or after a [STX] up to but not including the semi-colon. ETX can follow the CRC-16 if required.

The valid CRC-16 can be found for any command by entering the command with the 4 character CRC-16 after the semi-colon replaced with “????”. For example entering “open 0;????” gives the response “[CRLF]CRC>D2D5<CRC[CRLF” so d2d5 is the CRC-16.

The CRC-16 is not case sensitive.

The table below gives some commonly used CRC-16 codes.

<table>
<thead>
<tr>
<th>Terminal Command</th>
<th>CRC-16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open 0</td>
<td>233A</td>
</tr>
<tr>
<td>Close</td>
<td>D94E</td>
</tr>
<tr>
<td>Status</td>
<td>7CE5</td>
</tr>
<tr>
<td>Password</td>
<td>DF20</td>
</tr>
<tr>
<td>Terminal 0 (this command will remove CRC-16 checking)</td>
<td>B576</td>
</tr>
<tr>
<td>Defaults</td>
<td>7D8E</td>
</tr>
<tr>
<td>Serial</td>
<td>7FCE</td>
</tr>
</tbody>
</table>
5.1.11 Service command

The service command triggers the SkyVUE™PRO to go through a series of tests including tests that require the white test surface (ceilometer calibration plate supplied) to be placed on the SkyVUE™PRO windows.

The service command results in the following procedures:

- System noise level including noise spike test
- Detector maximum gain test
- Simulates a clear night sky for calibration offset
- Window contamination functionality test
- Laser function and monitoring alarm check
- Thermistor fault alarm check
- Calibrator LED alarm check
- PSU supply alarm check
- Temperature RH% sensor alarm check
- Inclinometer alarm check
- Heater / blower alarm check
- Internal clocks alarm check
- Top board and PSU communications alarm check.

If any test or check has failed then full instrument status and debug information is output with a fault summary at the end.

The response is similar to the following:

Initially the SkyVUE™PRO will output a “STATUS” message. It will then go through various self-test routines and before requesting a white test surface to be placed over each of the windows in turn. This process is as follows:

self test, please wait
wait for new measurement.............
Place white test surface onto detector window (left hand side fan at the top)
Press enter key to continue

At this point cover the detector window and press the “Enter” key.

wait for new measurement.............
Place white test surface onto laser window (right hand side fan at the top)
Press enter key to continue

At this point cover the laser window and press the Enter key.

wait for new measurement.............
Remove white test surface from laser window. Press enter key to continue.

When this is complete the SkyVUE™PRO will output a string of diagnostic data similar. This can be very useful for a Campbell Scientific engineer investigating problems with the SkyVUE™PRO.
Finally the SkyVUE™PRO will list any faults found as shown below:

******** CS135 FAULT list ********
FAULT - external heater/blower thermistor
FAULT - detector dirty windows with white test surface
FAULT - max APD gain not achieved

Otherwise it will report the following message:
******** CS135 has PASSED all tests ********

5.1.12 Locked features

Optional features such as Mixing Layer Height assessment are protected by a “key”. They are enabled by typing the command “UNLOCK” followed by the key. This is specific to the individual SkyVUE™PRO and only has to be entered once.

5.2 Restoring factory defaults

Factory defaults can be restored using the terminal mode command “DEFAULTS”.

**Hard Reset**

Alternatively, factory defaults can be restored by depressing the RESET push switch on the DSP, as shown in Fig 5.1.

The cover and enclosure lid first have to be removed. Please refer to Sections 4.6.1 and 4.6.2.

The reset switch is recessed and can only be reached using a narrow tool. If the reset switch is pushed for four seconds the SkyVUE™PRO will reboot in exactly the same way as the REBOOT terminal command. If it is held closed while the SkyVUE™PRO is powered off and on again it will return to factory defaults. Note that to power cycle the SkyVUE™PRO the battery has to be disconnected as well as switching the main power off and on.

---

**WARNING**

Opening the access lid MUST be carried out by a competent person who has sufficient training, experience and knowledge both in electrical safety and the detail and operation of the sensor.
5.3 LED indicator

A green LED is visible through the window, see Fig 5.2. It will give 0.5 second flashes as follows:

1 flash every 10 seconds = OK, no fault
2 flashes every 10 seconds = warning (possible degraded performance)
3 flashes every 10 seconds = alarm (measurements not possible)

6. Messages

6.1 Data Messages General

The SkyVUE™PRO can provide a variety of data message types to allow efficient output of data. Not all messages provide the full information available but these messages may be more efficient in terms of data storage and transmission.

CL31 and CT25K messages follow formats used by common existing CL31 and CT25K sensors allowing easier replacement or network expansion.

6.2 Checksums used in SkyVUE™PRO messages

This is based on the CCITT-16 CRC-16 with the output XOR’d with Hex 0xFFFF and outputs a two byte CRC-16 in hex format (four ASCII characters). The CRC-16 is calculated on all characters after the SOH character up to and including the ETX character.

The following example “C” code calculates the SkyVUE™PRO checksum.

NOTE

“Shorts” are 16 bits long and “ints” are 32 bits long.
// Calculate CRC-16
// buf is a pointer to the input string
// len is the length of the input string
unsigned short crc16(char *buffer, int length)
{
    unsigned short crc;
    unsigned short m;
    int i, j;

    crc = 0xFFFF;

    for (i=0; i < length; ++i)
    {
        crc ^= buffer[i] << 8;

        for (j=0; j<8; ++j)
        {
            m = (crc & 0x8000) ? 0x1021 : 0;
            crc <<= 1;
            crc ^= m;
        }
    }

    crc ^= 0xFFFF;
    return crc;
}
6.3 CS Messages

Message 001 (no profile, no sky condition) – Default message

Example message line outputs

<table>
<thead>
<tr>
<th>Example message line outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS0001001</td>
</tr>
<tr>
<td>10 087 00139 ///// ///// ///// 800000000000</td>
</tr>
<tr>
<td>942f</td>
</tr>
</tbody>
</table>

**LINE 1**

```
SOH CS ID OS N STX CR LF
```

where

- **SOH** = Start-of-Heading character
- **CS** = Always "CS"

**ID(1 character)** = A single ASCII character, 0-9, a - z or A - Z, case sensitive. Default ID = 0

**OS (3 characters)** = Operating system, 001 ... 999

**N (3 characters)** = Message number

**STX** = Start-of-Text Character

**CR LF** = Carriage Return + Line Feed

**LINE 2**

```
S WA tr_h1_h2_h3_h4_flags CR LF
```

where

- **S** (1 character) = detection status:
  - 0 = No significant backscatter
  - 1 = One cloud base detected
  - 2 = Two cloud bases detected
  - 3 = Three cloud bases detected
  - 4 = Four cloud bases detected
  - 5 = Full obscuration determined but no cloud base detected
  - 6 = Some obscuration detected but determined to be transparent
  - / = Raw data input to algorithm missing or suspect
WA (1 character) = Warning or alarm status:

0 = No alarm or warning
W = Warning
A = Alarm

\( tr \) (3 characters) = Window transmission, %

\( h1 \) (5 characters) = 1st Height
If detection status is 1, 2, 3 or 4 \( h1 = \) Lowest cloud base reported
If detection status is 5 \( h1 = \) Vertical visibility as calculated
If detection status is 0 or 6 \( h1 = \) \\

\( h2 \) (5 characters) = 2nd Height
If detection status is 2, 3 or 4 \( h2 = \) Second cloud base reported
If detection status is 5 \( h2 = \) Highest signal received
If detection status is 0, 1, or 6 \( h2 = \) \\

\( h3 \) (5 characters) = 3rd Height
If detection status is 3 or 4 \( h3 = \) Third cloud base reported
If detection status is 0, 1, 2, 5 or 6 \( h3 = \) \\

\( h4 \) (5 characters) = 4th Height
If detection status is 4 \( h4 = \) Fourth cloud base reported
If detection status is 0, 1, 2, 3 or 5 \( h4 = \) \\

\( flags \) (12 characters in 3 groups of 4) = Alarm or warning information

<p>| Description of the most significant alarm word (left side, bits going left to right). Each alarm word is a hexadecimal sum of all the error bits. |
|---|---|
| <strong>Bit</strong> | <strong>Description</strong> |
| 8000 XXXX XXXX | Units. Feet = 0, metre = 1 |
| 4000 XXXX XXXX | Reserved for future use |
| 2000 XXXX XXXX | Reserved for future use |
| 1000 XXXX XXXX | Reserved for future use |
| 0800 XXXX XXXX | DSP clock out of specification |
| 0400 XXXX XXXX | Laser shut down due to operating temperature out of range |
| 0200 XXXX XXXX | The lead acid battery voltage is reading low |
| 0100 XXXX XXXX | Mains supply has failed (Required a PSU to be present) |
| 0080 XXXX XXXX | The external heater blower assembly temperature is out of bounds |
| 0040 XXXX XXXX | External heater blower failure |
| 0020 XXXX XXXX | The PSUs internal temperature is high |
| 0010 XXXX XXXX | PSU OS has failed its signature check |
| 0008 XXXX XXXX | No communications between DSP and PSU |
| 0004 XXXX XXXX | Photo diode and Laser windows are dirty. This can only be set if the laser is on |
| 0002 XXXX XXXX | Tilt beyond limit set by user, default 45 degrees |
| 0001 XXXX XXXX | No communications between DSP and inclinometer board |</p>
<table>
<thead>
<tr>
<th>Description of the middle alarm word (middle word, bits going left to right)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit</td>
<td>Description</td>
</tr>
<tr>
<td>XXXX 8000 XXXX</td>
<td>The sensors internal humidity is high</td>
</tr>
<tr>
<td>XXXX 4000 XXXX</td>
<td>Communications to the DSP board temperature and humidity chip have failed</td>
</tr>
<tr>
<td>XXXX 2000 XXXX</td>
<td>DSP input supply voltage is low</td>
</tr>
<tr>
<td>XXXX 1000 XXXX</td>
<td>Self-test active</td>
</tr>
<tr>
<td>XXXX 0800 XXXX</td>
<td>Watch dog counter updated</td>
</tr>
<tr>
<td>XXXX 0400 XXXX</td>
<td>User setting stored in flash failed their signature checks</td>
</tr>
<tr>
<td>XXXX 0200 XXXX</td>
<td>DSP factory calibration stored in flash has failed its signature check</td>
</tr>
<tr>
<td>XXXX 0100 XXXX</td>
<td>DSP board OS signature test failed</td>
</tr>
<tr>
<td>XXXX 0080 XXXX</td>
<td>DSP board RAM test failed</td>
</tr>
<tr>
<td>XXXX 0040 XXXX</td>
<td>DSP boards on board PSUs are out of bounds</td>
</tr>
<tr>
<td>XXXX 0020 XXXX</td>
<td>TOP board non-volatile storage is corrupt</td>
</tr>
<tr>
<td>XXXX 0010 XXXX</td>
<td>TOP board OS signature test has failed</td>
</tr>
<tr>
<td>XXXX 0008 XXXX</td>
<td>TOP boards ADC and DAC are not within specifications</td>
</tr>
<tr>
<td>XXXX 0004 XXXX</td>
<td>Communications have failed between TOP board and the DSP</td>
</tr>
<tr>
<td>XXXX 0001 XXXX</td>
<td>Photo diode background radianc is out of range</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description of the least significant alarm word (right side, bits going left to right)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit</td>
<td>Description</td>
</tr>
<tr>
<td>XXXX XXXX 8000</td>
<td>Photo diode temperature is out of range</td>
</tr>
<tr>
<td>XXXX XXXX 4000</td>
<td>Photo diode is saturated</td>
</tr>
<tr>
<td>XXXX XXXX 2000</td>
<td>Photo diode calibrator temperature is out of range</td>
</tr>
<tr>
<td>XXXX XXXX 1000</td>
<td>Photo diode calibrator has failed</td>
</tr>
<tr>
<td>XXXX XXXX 0800</td>
<td>The sensor could not reach the desired gain levels</td>
</tr>
<tr>
<td>XXXX XXXX 0400</td>
<td>Laser run time or maximum laser drive current has been exceeded</td>
</tr>
<tr>
<td>XXXX XXXX 0200</td>
<td>Laser temperature out of range</td>
</tr>
<tr>
<td>XXXX XXXX 0100</td>
<td>Laser thermistor failure</td>
</tr>
<tr>
<td>XXXX XXXX 0080</td>
<td>Laser is obscured. This can only be set if the laser is on</td>
</tr>
<tr>
<td>XXXX XXXX 0040</td>
<td>Laser did not achieve significant output power</td>
</tr>
<tr>
<td>XXXX XXXX 0020</td>
<td>Laser max power exceeded</td>
</tr>
<tr>
<td>XXXX XXXX 0010</td>
<td>Laser max drive current exceeded</td>
</tr>
<tr>
<td>XXXX XXXX 0008</td>
<td>Laser power monitor temperature out of range</td>
</tr>
<tr>
<td>XXXX XXXX 0004</td>
<td>Laser power monitor test fail</td>
</tr>
<tr>
<td>XXXX XXXX 0002</td>
<td>Laser shutdown by top board</td>
</tr>
<tr>
<td>XXXX XXXX 0001</td>
<td>Laser is off</td>
</tr>
</tbody>
</table>

CR LF = Carriage Return and Line Feed

**LINE 3**

*ETX CRC-16 EOT CR LF*

where

*ETX = End-of-Text character*

*CRC-16 (4 characters) = CRC-16 Checksum*

*EOT = End-of-Transmission character*

*CRLF = Carriage Return + Line Feed*
MESSAGE 002 (Profile, no sky condition)

Example message line outputs

```
CS0001002
10 085 01123 ///// ///// ///// 800000000000
00100 05 2048 100 +40 02 0074 0070 30 000
0c5df047……………………0000
9f68
```

(Line output message cropped for clarity)

**LINE 1**

`SOH CS ID OS N STX CR LF`

where

- `SOH` = Start-of-Heading character
- `CS` = Always "CS"
- `ID` (1 character) = A single ASCII character, 0-9, a-z or A-Z, case sensitive. Default ID = 0
- `OS` (3 characters) = Operating system, 001 ... 999
- `N` (3 characters) = Message number
- `STX` = Start-of-Text Character
- `CR LF` = Carriage Return + Line Feed

**LINE 2**

`S WA_tr_h1_w2_h3_h4_flags CR LF`

where

- `S` (1 character) = detection status:
  - 0 = No significant backscatter
  - 1 = One cloud base detected
  - 2 = Two cloud bases detected
  - 3 = Three cloud bases detected
  - 4 = Four cloud bases detected
  - 5 = Full obscuration determined but no cloud base detected
  - 6 = Some obscuration detected but determined to be transparent
  - `/` = Raw data input to algorithm missing or suspect
WA (1 character) = Warning or alarm status:

0 = No alarm or warning
W = Warning
A = Alarm

\( tr \) (3 characters) = Window transmission, %

\( h1 \) (5 characters) = 1st Height
If detection status is 1, 2, 3 or 4 \( h1 \) = Lowest cloud base reported
If detection status is 5 \( h1 \) = Vertical visibility as calculated
If detection status is 0 or 6 \( h1 \) = "////"

\( h2 \) (5 characters) = 2nd Height
If detection status is 2, 3 or 4 \( h2 \) = Second cloud base reported
If detection status is 5 \( h2 \) = Highest signal received
If detection status is 0, 1, or 6 \( h2 \) = "////"

\( h3 \) (5 characters) = 3rd Height
If detection status is 3 or 4 \( h3 \) = Third cloud base reported
If detection status is 0, 1, 2, 5 or 6 \( h3 \) = "////"

\( h4 \) (5 characters) = 4th Height
If detection status is 4 \( h4 \) = Fourth cloud base reported
If detection status is 0, 1, 2, 3 or 5 \( h4 \) = "////"

flags (12 characters in 3 groups of 4) = Alarm or warning information. Refer to Message 001 for a breakdown of the flags.

\( CR \ LF \) = Carriage Return and Line Feed

\textbf{LINE 3}

scale
res
n
energy
lt
ti
bl
pulse
rate
sum \( CR \ LF \)

where

scale (5 characters) = Attenuated\_SCALE parameter, %, 0 ... 99999. 100% is default

res (2 characters) = Backscatter profile resolution in metres.

n (4 characters) = Profile length

energy (3 characters) = Laser pulse energy, %.

lt (3 characters including leading +/) = Laser temperature, degrees C

ti (2 characters) = Total tilt angle, degrees

bl (4 characters) = Background light, millivolts at internal ADC input (0 ... 2500)
**Product Manual**

\[ \text{pulse (4 characters) = Pulse quantity x 1000 (0000-9999)} \]

\[ \text{rate (2 characters) = Sample rate, MHz, (00-99)} \]

\[ \text{sum (3 characters) = Sum of detected and normalized backscatter, 0 ... 999. Multiplied by scaling factor times 10^4. At scaling factor 100 the SUM range 0 ... 999 corresponds to integrated backscatter 0 ... 0. srad} \]

\[ \text{CR LF = Carriage Return + Line Feed} \]

**LINE 4**

SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS\ldots\ldots (2048 x 5 bytes) \text{CR LF}

The two-way attenuated normalised backscatter profile, see \text{Section 2.1.4}

\[ \text{CR LF = Carriage Return + Line Feed} \]

**LINE 5**

\text{ETX CRC-16 EOT CR LF}

where

\[ \text{ETX = End-of-Text character} \]
\[ \text{CRC-16 (4 characters) = CRC-16 Checksum} \]
\[ \text{EOT = End-of-Transmission character} \]
\[ \text{CR LF = Carriage Return + Line Feed} \]
MESSAGE 003 (no profile, sky condition)

Example message line outputs
CS0001003
10 091 00828 ///// ///// ///// 80000000000
99 ///// 0 ///// 0 ///// 0 ///// 0 /////

LINE 1
SOH CS ID OS N STX CR LF

where

SOH = Start-of-Heading character
CS = Always "CS"
ID(1 character) = A single ASCII character, 0-9, a - z or A - Z, case sensitive. Default ID = 0
OS (3 characters) = Operating system, 001 ... 999
N (3 characters) = Message number
STX = Start-of-Text Character
CR LF = Carriage Return + Line Feed

LINE 2
S WA_tr_h1_h2_h3_h4_flags CR LF

where

S (1 character) = detection status:
0 = No significant backscatter
1 = One cloud base detected
2 = Two cloud bases detected
3 = Three cloud bases detected
4 = Four cloud bases detected
5 = Full obscuration determined but no cloud base detected
6 = Some obscuration detected but determined to be transparent
/ = Raw data input to algorithm missing or suspect
WA (1 character) = Warning or alarm status:

0 = No alarm or warning
W = Warning
A = Alarm

tr (3 characters) = Window transmission, %

h1 (5 characters) = 1st Height
If detection status is 1, 2, 3 or 4 h1 = Lowest cloud base reported
If detection status is 5 h1 = Vertical visibility as calculated
If detection status is 0 or 6 h1 = "/////"

h2 (5 characters) = 2nd Height
If detection status is 2, 3 or 4 h2 = Second cloud base reported
If detection status is 5 h2 = Highest signal received
If detection status is 0, 1, 5 or 6 h2 = "/////"

h3 (5 characters) = 3rd Height
If detection status is 3 or 4 h3 = Third cloud base reported
If detection status is 0, 1, 2, 5 or 6 h3 = "/////"

h4 (5 characters) = 4th Height
If detection status is 4 h4 = Fourth cloud base reported
If detection status is 0, 1, 2, 3 or 5 h4 = "/////"

flags (12 characters in 3 groups of 4) = Alarm or warning information
Refer to Message 001 for a breakdown of the flags

CR LF = Carriage Return and Line Feed

LINE 3
_d_h1__d2_h2__d3_h3__d4_h4__d5_h5 CR LF
(note spaces)

where

d (2 characters) = Data available
_0 to _8 Amount of lowest layer in oktas
 _9 Vertical visibility only available
 -1 No sky condition data available
 99 Insufficient data

h1 (4 characters) = Height of the lowest cloud layer in 10s of metres or 100s of feet

d2 (1 character) = Cloud amount of the 2nd layer in oktas
$h_2$ (4 characters) = Height of the 2nd cloud layer in 10s of metres or 100s of feet, if no 2nd layer is reported $h_2 = '///'$.

$d_3$ (1 character) = Cloud amount of the 3rd layer in oktas

$h_3$ (4 characters) = Height of the 3rd cloud layer in 10s of metres or 100s of feet, if no 3rd layer is reported $h_3 = '///'$.

$d_4$ (1 character) = Cloud amount of the 4th layer in oktas

$h_4$ (4 characters) = Height of the 4th cloud layer in 10s of metres or 100s of feet, if no 4th layer is reported $h_4 = '///'$.

$d_5$ (1 character) = Cloud amount of the 5th layer in oktas

$h_5$ (4 characters) = Height of the 5th cloud layer in 10s of metres or 100s of feet, if no 5th layer is reported $h_5 = '///'$.

$CR \ LF$ = Carriage Return + Line Feed

Note cloud amounts and heights cannot be reported until the SkyVUE™PRO has been in operation for 30 minutes.

**LINE 4**

*ETX CRC-16 EOT CR LF*

where

*ETX* = End-of-Text character

*CRC-16* (4 characters) = CRC-16 Checksum

*EOT* = End-of-Transmission character

*CR LF* = Carriage Return + Line Feed
MESSAGE 004 (profile, sky condition)

Example message line outputs

<table>
<thead>
<tr>
<th>CS0001004</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 092 00698 ///// ///// ///// 800000000000</td>
</tr>
<tr>
<td>99 ///// 0 ///// 0 ///// 0 /////</td>
</tr>
<tr>
<td>00100 05 2048 100 +40 02 0074 0070 30 000</td>
</tr>
<tr>
<td>071fc024d…..00000000</td>
</tr>
</tbody>
</table>

(Line output message cropped for clarity)

LINE 1

SOH CS ID OS N STX CR LF

where

SOH = Start-of-Heading character
CS = Always "CS"

ID (1 character) = A single ASCII character, 0-9, a - z or A - Z, case sensitive. Default ID = 0

OS (3 characters) = Operating system, 001 ... 999

N (3 characters) = Message number

STX = Start-of-Text Character

CR LF = Carriage Return + Line Feed

LINE 2

S WA tr h1 h2 h3 h4 flags CR LF

where

S (1 character) = detection status:

0 = No significant backscatter
1 = One cloud base detected
2 = Two cloud bases detected
3 = Three cloud bases detected
4 = Four cloud bases detected
5 = Full obscuration determined but no cloud base detected
6 = Some obscuration detected but determined to be transparent

/ = Raw data input to algorithm missing or suspect

WA (1 character) = Warning or alarm status:
0 = No alarm or warning  
W = Warning  
A = Alarm

\(Tr\) (3 characters) = Window transmission, \%

\(h1\) (5 characters) = 1st Height  
If detection status is 1, 2, 3 or 4 \(h1\) = Lowest cloud base reported  
If detection status is 5 \(h1\) = Vertical visibility as calculated  
If detection status is 0 or 6 \(h1\) = “/////”

\(h2\) (5 characters) = 2nd Height  
If detection status is 2, 3 or 4 \(h2\) = Second cloud base reported  
If detection status is 5 \(h2\) = Highest signal received  
If detection status is 0, 1, or 6 \(h2\) = “/////”

\(h3\) (5 characters) = 3rd Height  
If detection status is 3 or 4 \(h3\) = Third cloud base reported  
If detection status is 0, 1, 2, 5 or 6 \(h3\) = “/////”

\(h4\) (5 characters) = 4th Height  
If detection status is 4 \(h4\) = Fourth cloud base reported  
If detection status is 0, 1, 2, 3 or 5 \(h4\) = “/////”

flags (12 characters in 3 groups of 4) = Alarm or warning information  
Refer to Message 001 for a breakdown of the flags.

\(CR\ LF\) = Carriage Return + Line Feed.

**LINE 3**

\(d\_d\_h1h1h1\_d2\_h2h2h2\_d3\_h3h3h3\_d4\_h4h4h4\_d5\_h5h5h5\ CR\ LF\)

(note spaces)

where

d (2 characters) = Data available  
_0 to _8  Amount of lowest layer in oktas  
_9  Vertical visibility only available  
-1  No sky condition data available  
99  Insufficient data

\(h1\) (4 characters) = Height of the lowest cloud layer in 10s of metres or 100s of feet

d2 (1 character) = Cloud amount of the 2nd layer in oktas

\(h2\) (4 characters) = Height of the 2nd cloud layer in 10s of metres or 100s of feet, if no 2nd layer is reported \(h2\) = “/////”.

---

**SkyVUE**TM PRO (CS135) LIDAR Ceilometer
\[ d3 \text{ (1 character)} = \text{Cloud amount of the 3rd layer in oktas} \]
\[ h3 \text{ (4 characters)} = \text{Height of the 3rd cloud layer in 10s of metres or 100s of feet, if no 3rd layer is reported } h3 = '///'. \]

\[ d4 \text{ (1 character)} = \text{Cloud amount of the 4th layer in oktas} \]
\[ h4 \text{ (4 characters)} = \text{Height of the 4th cloud layer in 10s of metres or 100s of feet, if no 4th layer is reported } h4 = '///'. \]

\[ d5 \text{ (1 character)} = \text{Cloud amount of the 5th layer in oktas} \]
\[ h5 \text{ (4 characters)} = \text{Height of the 5th cloud layer in 10s of metres or 100s of feet, if no 5th layer is reported } h5 = '///'. \]

\[ CR \ LF = \text{Carriage Return + Line Feed} \]

Note cloud amounts and heights cannot be reported until the SkyVUE™ PRO has been operating for 30 minutes.

**LINE 4**

```
scale_res_n_energy_lt_tr_ti_bl_pulse_rate_sum CR LF
```

where

\[ scale \text{ (5 characters)} = \text{Scale parameter,\%}, 0 \ldots 99999. 100\% \text{ is default} \]

\[ res \text{ (2 characters)} = \text{Backscatter profile resolution in metres}. \]

\[ n \text{ (4 characters)} = \text{Profile length} \]

\[ energy \text{ (3 characters)} = \text{Laser pulse energy, \%}. \]

\[ lt \text{ (3 characters including leading +/-)} = \text{Laser temperature, degrees C} \]

\[ ti \text{ (2 characters)} = \text{Total tilt angle, degrees} \]

\[ bl \text{ (4 characters)} = \text{Background light, millivolts at internal ADC input} (0 \ldots 2500) \]

\[ pulse \text{ (4 characters)} = \text{Pulse quantity x 1000} (0000-9999) \]

\[ rate \text{ (2 characters)} = \text{Sample rate, MHz, (00-99)} \]

\[ sum = (3 \text{ characters}) \text{ Sum of detected and normalized backscatter, } 0 \ldots 999. \text{ Multiplied by scaling factor times } 10^4. \text{ At scaling factor 100 the SUM range } 0 \ldots 999 \text{ corresponds to integrated backscatter } 0 \ldots 0. \text{srad}^{-1}. \]

\[ CR \ LF = \text{Carriage Return + Line Feed} \]
LINE 5
SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS .......(2048 x 5 bytes) CR LF

The two-way attenuated normalised backscatter profile, see Section 2.1.4

CR LF = Carriage Return + Line Feed

LINE 6
ETX CRC-16 EOT CR LF

where

ETX = End-of-Text character
CRC-16 (4 characters) = CRC-16 Checksum
EOT = End-of-Transmission character
CR LF = Carriage Return + Line Feed
MESSAGE 005 (no profile, sky condition, mixing layer heights)
Only available if a key is entered (see Section 5.1.11)

Example message line outputs
CS0001005
10 092 00499 ///// ///// ///// 800000000000
99 ///// 0 ///// 0 ///// 0 ///// 0 /////
///// ///// ///// ///// ///// /////

b4b6

LINE 1
SOH CS ID OS N STX CR LF
where

SOH = Start-of-Heading character
CS = Always "CS"
ID (1 character) = A single ASCII character, 0 - 9, a - z or A - Z, case sensitive. Default ID = 0
OS (3 characters) = Operating system, 001 ... 999
N (3 characters) = Message number
STX = Start-of-Text Character

CR LF = Carriage Return + Line Feed

LINE 2
S WA tr th1 th2 th3 th4 flags CR LF
where

S (1 character) = detection status:
0 = No significant backscatter
1 = One cloud base detected
2 = Two cloud bases detected
3 = Three cloud bases detected
4 = Four cloud bases detected
5 = Full obscuration determined but no cloud base detected
/ = Raw data input to algorithm missing or suspect

WA (1 character) = Warning or alarm status:
0 = No alarm or warning
W = Warning
A = Alarm
\textit{tr (3 characters)} = Window transmission, \%

\textit{h1 (5 characters)} = 1st Height
If detection status is 1, 2, 3 or 4 \( h1 = \) Lowest cloud base reported
If detection status is 5 \( h1 = \) Vertical visibility as calculated
If detection status is 0 or 6 \( h1 = \) "////"

\textit{h2 (5 characters)} = 2nd Height
If detection status is 2, 3 or 4 \( h2 = \) Second cloud base reported
If detection status is 5 \( h2 = \) Highest signal received
If detection status is 0, 1, 5 or 6 \( h2 = \) "////"

\textit{h3 (5 characters)} = 3rd Height
If detection status is 3 or 4 \( h3 = \) Third cloud base reported
If detection status is 0, 1, 2, 5 or 6 \( h3 = \) "////"

\textit{h4 (5 characters)} = 4th Height
If detection status is 4 \( h4 = \) Fourth cloud base reported
If detection status is 0, 1, 2, 3, 5 or 6 \( h4 = \) "////"

\textit{flags (12 characters in 3 groups of 4)} = Alarm or warning information.
Refer to Message 001 for a breakdown of the flags.

\textit{CR LF} = Carriage Return and Line Feed

\textbf{LINE 3}
\_\_\_\_d\_\_h1\_\_d2\_\_h2\_\_d3\_\_d4\_\_h4\_\_d5\_\_h5 CR LF
(note spaces)

where

\textit{d (2 characters)} = Data available
\_0 to \_8 Amount of lowest layer in oktas
\_9 Vertical visibility only available
\_1 No sky condition data available
99 Insufficient data

\textit{h1 (4 characters)} = Height of the lowest cloud layer in 10s of metres or 100s of feet

\textit{d2 (1 character)} = Cloud amount of the 2nd layer in oktas

\textit{h2 (4 characters)} = Height of the 2nd cloud layer in 10s of metres or 100s of feet, if no 2nd layer is reported \( h2 = \) "////".

\textit{d3 (1 character)} = Cloud amount of the 3rd layer in oktas

\textit{h3 (4 characters)} = Height of the 3rd cloud layer in 10s of metres or 100s of feet, if no 3rd layer is reported \( h3 = \) "////".
$d4$ (1 character) = Cloud amount of the 4th layer in oktas

$h4$ (4 characters) = Height of the 4th cloud layer in 10s of metres or 100s of feet, if no 4th layer is reported $h4 = \text{''///''}$.

$d5$ (1 character) = Cloud amount of the 5th layer in oktas

$h5$ (4 characters) = Height of the 5th cloud layer in 10s of metres or 100s of feet, if no 5th layer is reported $h5 = \text{''///''}$.

$CR\ LF = Carriage\ Return\ +\ Line\ Feed$

Note cloud amounts and heights cannot be reported until the SkyVUE™ PRO has been operating for 30 minutes.

**LINE 4**

$mh1_{-}q1_{-}mh2_{-}q2_{-}mh3_{-}q3$

where

$mh1$ (5 characters) = height of the 1st MLH in metres

$q1$ (5 characters) = quality parameter of the 1st MLH

$mh2$ (5 characters) = height of the 2nd MLH in metres

$q2$ (5 characters) = quality parameter of the 2nd MLH

$mh3$ (5 characters) = height of the 3rd MLH in metres

$q3$ (5 characters) = quality parameter of the 3rd MLH

If there are no mixing layers detected, or less than 3, then missing data is shown as “/////”. If the MLH option is not activated then all fields in line 4 are “/////”.

**LINE 5**

$ETX\ CRC-16\ EOT\ CR\ LF$

where

$ETX = End-of-Text\ character$

$CRC-16$ (4 characters) = CRC-16 Checksum

$EOT = End-of-Transmission\ character$

$CR\ LF = Carriage\ Return\ +\ Line\ Feed$
MESSAGE 006 (profile, sky condition, mixing layer heights)  
Only available if a key is entered (see Section 5.1.11)

Example message line outputs

<table>
<thead>
<tr>
<th>Line Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS0001006</td>
</tr>
<tr>
<td>10 095 01732 ///// ///// ///// 800000000000</td>
</tr>
<tr>
<td>99 ///// 0 ///// 0 ///// 0 /////</td>
</tr>
<tr>
<td>00100 05 2048 100 +40 02 0054 0070 30 000</td>
</tr>
<tr>
<td>///// ///// ///// ///// ///// /////</td>
</tr>
<tr>
<td>04ae3015fe………………..0000</td>
</tr>
<tr>
<td>fe91</td>
</tr>
</tbody>
</table>

(Line output message cropped for clarity)

**LINE 1**

SOH CS ID OS N STX CR LF

where

SOH = Start-of-Heading character
CS = Always "CS"
ID (1 character) = A single ASCII character, 0-9, a - z or A - Z, case sensitive. Default ID = 0
OS (3 characters) = Operating system, 001 ... 999
N (3 characters) = Message number
STX = Start-of-Text Character

CR LF = Carriage Return + Line Feed

**LINE 2**

S WA_tr_h1_h2_h3_h4_flags CR LF

where

S (1 character) = detection status:

0 = No significant backscatter
1 = One cloud base detected
2 = Two cloud bases detected
3 = Three cloud bases detected
4 = Four cloud bases detected
5 = Full obscuration determined but no cloud base detected
/ = Raw data input to algorithm missing or suspect

WA (1 character) = Warning or alarm status:

0 = No alarm or warning
W = Warning
A = Alarm

\textit{tr (3 characters)} = Window transmission, \%

\(h1\) (5 characters) = 1st Height
If detection status is 1, 2, 3 or 4 \(h1\) = Lowest cloud base reported
If detection status is 5 \(h1\) = Vertical visibility as calculated
If detection status is 0 or 6 \(h1\) = "////

\(h2\) (5 characters) = 2nd Height
If detection status is 2, 3 or 4 \(h2\) = Second cloud base reported

If detection status is 5 \(h2\) = Highest signal received
If detection status is 0, 1, 5 or 6 \(h2\) = "////

\(h3\) (5 characters) = 3rd Height
If detection status is 3 or 4 \(h3\) = Third cloud base reported
If detection status is 0, 1, 2, 5 or 6 \(h3\) = "////

\(h4\) (5 characters) = 4th Height
If detection status is 4 \(h4\) = Fourth cloud base reported
If detection status is 0, 1, 2, 3, 5 or 6 \(h4\) = "////

\textit{flags} (12 characters in 3 groups of 4) = Alarm or warning information.
Refer to Message 001 for a breakdown of the flags.

\textit{CR LF} = Carriage Return and Line Feed

\textbf{LINE 3}
\_d\_d1\_d2\_d3\_d3\_d4\_d4\_d5\_d5\_h5\_h5\_CR\_LF
(note spaces)

where

\(d\) (2 characters) = Data available
\_0 to \_8 Amount of lowest layer in oktas
\_9 Vertical visibility only available
-1 No sky condition data available
99 Insufficient data

\(h1\) (4 characters) = Height of the lowest cloud layer in 10s of metres or 100s of feet

\(d2\) (1 character) = Cloud amount of the 2nd layer in oktas

\(h2\) (4 characters) = Height of the 2nd cloud layer in 10s of metres or 100s of feet, if no 2nd layer is reported \(h2 = "////".\)
d3 (1 character) = Cloud amount of the 3rd layer in oktas
h3 (4 characters) = Height of the 3rd cloud layer in 10s of metres or 100s of feet, if no 3rd layer is reported h3 = '///'.

d4 (1 character) = Cloud amount of the 4th layer in oktas
h4 (4 characters) = Height of the 4th cloud layer in 10s of metres or 100s of feet, if no 4th layer is reported h4 = '///'.

d5 (1 character) = Cloud amount of the 5th layer in oktas
h5 (4 characters) = Height of the 5th cloud layer in 10s of metres or 100s of feet, if no 5th layer is reported h5 = '///'.

CR LF = Carriage Return + Line Feed

Note cloud amounts and heights cannot be reported until the SkyVUE™PRO has been operating for 30 minutes.

LINE 4
scale_res_energy_lt_tr_ti_bl_pulse_rate_sum CR LF

where

scale (5 characters) = Scale parameter, %, 0 ... 99999. 100% is default

res (2 characters) = Backscatter profile resolution in metres.

n (4 characters) = Profile length

energy (3 characters) = Laser pulse energy, %.

lt (3 characters including leading +/-) = Laser temperature, degrees C

ti (2 characters) = Total tilt angle, degrees

bl (4 characters) = Background light, millivolts at internal ADC input (0 ... 2500)

pulse (4 characters) = Pulse quantity x 1000 (0000-9999)

rate (2 characters) = Sample rate, MHz, (00-99)

sum = (3 characters) Sum of detected and normalized backscatter, 0 ... 999. Multiplied by scaling factor times $10^4$. At scaling factor 100 the SUM range 0 ... 999 corresponds to integrated backscatter 0 ... 0. srad$^{-1}$.

CR LF = Carriage Return + Line Feed
LINE 5
\[ mh1 \_ q1 \_ mh2 \_ q2 \_ mh3 \_ q3 \]

where

\( mh1 \) (5 characters) = height of the 1st MLH in metres
\( q1 \) (5 characters) = quality parameter of the 1st MLH
\( mh2 \) (5 characters) = height of the 2nd MLH in metres
\( q2 \) (5 characters) = quality parameter of the 2nd MLH
\( mh3 \) (5 characters) = height of the 3rd MLH in metres
\( q3 \) (5 characters) = quality parameter of the 3rd MLH

If there are no mixing layers detected, or less than 3, then missing data is shown as “/////”. If the MLH option is not activated then all fields in Line 5 are “/////”.

LINE 6
SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS........(2048 x 5 bytes) \textit{CR LF}

The two-way attenuated normalised backscatter profile, see \textit{Section 2.1.4}.

\textit{CR LF} = Carriage Return + Line Feed

LINE 7
\textit{ETX CRC-16 EOT CR LF}

where

\textit{ETX} = End-of-Text character
\textit{CRC-16} (4 characters) = CRC-16 Checksum
\textit{EOT} = End-of-Transmission character
\textit{CR LF} = Carriage Return + Line Feed
6.4 CL31 Messages

MESSAGES 101 - 106, (CL31 MESSAGE 1)

Example message 101 line outputs
CL017011
10 01128 ///// ///// 00000000E080
00100 10 0770 100 +40 094 02 0032 L0112HN30 000
036B200CC1002....................EEFFB3F (Line output message cropped for clarity)
e515

LINE 1
SOH CL ID OS 1 Samples STX CR LF

where

SOH = Start-of-Heading character

CL = Always CL

ID = A single ASCII character, 0-9, a - z or A - Z, case sensitive. Default ID = 0
OS = Operating system, 100 ... 999

1 = Always 1
Samples = backscatter resolution and number of samples

1 = MESSAGE 101, 10 m x 770 samples, range 7700 m
2 = MESSAGE 102, 20 m x 385 samples, range 7700 m
3 = MESSAGE 103, 5 m x 1500 samples, range 7500 m
4 = MESSAGE 104, 5 m x 770 samples, range 3850 m
5 = MESSAGE 105, no backscatter profile
0 = MESSAGE 106, extended range, 5 m x 2048 samples, range 10,240 m

STX = Start-of-Text Character

CR LF = Carriage Return + Line Feed

LINE 2
S WA_h1_h2_h3_flags CR LF

where
$S$ (1 character) = detection status:

0 = No significant backscatter
1 = One cloud base detected
2 = Two cloud bases detected
3 = Three cloud bases detected
4 = Full obscuration determined but no cloud base detected
5 = Some obscuration detected but determined to be transparent
/ = Raw data input to algorithm missing or suspect

$WA$ (1 character) = Warning or alarm status:

0 = No alarm or warning
W = Warning
A = Alarm

$h1$ (5 characters) = 1st Height
If detection status is 1, 2 or 3 $h1$ = Lowest cloud base reported
If detection status is 4 $h1$ = Vertical visibility as calculated
If detection status is 0 or 5 $h1$ = "////"

$h2$ (5 characters) = 2nd Height
If detection status is 2 or 3 $h2$ = Second cloud base reported
If detection status is 4 $h2$ = Highest signal received
If detection status is 0, 1 or 5 $h2$ = "////"

$h3$ (5 characters) = 3rd Height
If detection status is 3 $h3$ = Third cloud base reported
If detection status is 0, 1, 2, 4 or 5 $h3$ = "////"

$flags$ (12 characters) = Alarm or warning information.

<table>
<thead>
<tr>
<th>Bit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>8000 XXXX XXXX</td>
<td>Transmitter shut-off</td>
</tr>
<tr>
<td>4000 XXXX XXXX</td>
<td>Transmitter failure</td>
</tr>
<tr>
<td>2000 XXXX XXXX</td>
<td>Receiver failure</td>
</tr>
<tr>
<td>1000 XXXX XXXX</td>
<td>Reserved for future use</td>
</tr>
<tr>
<td>0800 XXXX XXXX</td>
<td>Reserved for future use</td>
</tr>
<tr>
<td>0400 XXXX XXXX</td>
<td>Memory error</td>
</tr>
<tr>
<td>0200 XXXX XXXX</td>
<td>Light path obstruction</td>
</tr>
<tr>
<td>0100 XXXX XXXX</td>
<td>Receiver saturation</td>
</tr>
<tr>
<td>0080 XXXX XXXX</td>
<td>Reserved for future use</td>
</tr>
<tr>
<td>0040 XXXX XXXX</td>
<td>Reserved for future use</td>
</tr>
<tr>
<td>0020 XXXX XXXX</td>
<td>Reserved for future use</td>
</tr>
<tr>
<td>0010 XXXX XXXX</td>
<td>Reserved for future use</td>
</tr>
<tr>
<td>0008 XXXX XXXX</td>
<td>Reserved for future use</td>
</tr>
<tr>
<td>0004 XXXX XXXX</td>
<td>Reserved for future use</td>
</tr>
<tr>
<td>0002 XXXX XXXX</td>
<td>Reserved for future use</td>
</tr>
<tr>
<td>0001 XXXX XXXX</td>
<td>Ceilometer engine board failure</td>
</tr>
</tbody>
</table>
### Description of the middle alarm word (middle word, bits going left to right)

<table>
<thead>
<tr>
<th>Bit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>XXXX 8000 XXXX</td>
<td>Window contamination</td>
</tr>
<tr>
<td>XXXX 4000 XXXX</td>
<td>Battery voltage low</td>
</tr>
<tr>
<td>XXXX 2000 XXXX</td>
<td>Transmitter expires</td>
</tr>
<tr>
<td>XXXX 1000 XXXX</td>
<td>High humidity</td>
</tr>
<tr>
<td>XXXX 0800 XXXX</td>
<td>Reserved for future use</td>
</tr>
<tr>
<td>XXXX 0400 XXXX</td>
<td>Blower failure</td>
</tr>
<tr>
<td>XXXX 0200 XXXX</td>
<td>Reserved for future use</td>
</tr>
<tr>
<td>XXXX 0100 XXXX</td>
<td>Humidity sensor failure</td>
</tr>
<tr>
<td>XXXX 0080 XXXX</td>
<td>Heat fault</td>
</tr>
<tr>
<td>XXXX 0040 XXXX</td>
<td>High background radiance</td>
</tr>
<tr>
<td>XXXX 0020 XXXX</td>
<td>Ceilometer engine board failure</td>
</tr>
<tr>
<td>XXXX 0010 XXXX</td>
<td>Reserved for future use</td>
</tr>
<tr>
<td>XXXX 0008 XXXX</td>
<td>Laser monitor failure</td>
</tr>
<tr>
<td>XXXX 0004 XXXX</td>
<td>Receiver warning</td>
</tr>
<tr>
<td>XXXX 0002 XXXX</td>
<td>Tilt beyond limit set by user, default 45 degrees</td>
</tr>
<tr>
<td>XXXX 0001 XXXX</td>
<td>Reserved for future use</td>
</tr>
</tbody>
</table>

### Description of the least significant alarm word (right word, bits going left to right)

<table>
<thead>
<tr>
<th>Bit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>XXXX XXXX 8000</td>
<td>Blower is on</td>
</tr>
<tr>
<td>XXXX XXXX 4000</td>
<td>Blower heater is on</td>
</tr>
<tr>
<td>XXXX XXXX 2000</td>
<td>Internal heater is on</td>
</tr>
<tr>
<td>XXXX XXXX 1000</td>
<td>Working from battery</td>
</tr>
<tr>
<td>XXXX XXXX 0800</td>
<td>Reserved for future use</td>
</tr>
<tr>
<td>XXXX XXXX 0400</td>
<td>Self test in progress</td>
</tr>
<tr>
<td>XXXX XXXX 0200</td>
<td>Reserved for future use</td>
</tr>
<tr>
<td>XXXX XXXX 0100</td>
<td>Reserved for future use</td>
</tr>
<tr>
<td>XXXX XXXX 0080</td>
<td>Units are metres if on, else feet</td>
</tr>
<tr>
<td>XXXX XXXX 0040</td>
<td>Reserved for future use</td>
</tr>
<tr>
<td>XXXX XXXX 0020</td>
<td>Polling mode is on</td>
</tr>
<tr>
<td>XXXX XXXX 0010</td>
<td>Reserved for future use</td>
</tr>
<tr>
<td>XXXX XXXX 0008</td>
<td>Reserved for future use</td>
</tr>
<tr>
<td>XXXX XXXX 0004</td>
<td>Reserved for future use</td>
</tr>
<tr>
<td>XXXX XXXX 0002</td>
<td>Reserved for future use</td>
</tr>
<tr>
<td>XXXX XXXX 0001</td>
<td>Reserved for future use</td>
</tr>
</tbody>
</table>

CR LF = Carriage Return + Line Feed

**LINE 3**

```plaintext
scale_res_n_energy_lt_tr_ti_bl_L0112HN15_sum CR LF
```

where

- **scale** (5 characters) = Scale parameter, %, 0 ... 99999. 100% is typical
- **res** (2 characters) = Backscatter profile resolution in metres.
- **n** (4 characters) = Profile length 385, 770, 1400, or 1500 samples.
- **energy** (3 characters) = Laser pulse energy, %.
$lt$ (3 characters including leading +/-) = Laser temperature, degrees C

$tr$ (3 characters) = Window transmission, %

$ti$ (2 characters) = Total tilt angle, degrees

$bl$ (4 characters) = Background light, millivolts at internal ADC input (0 ... 2500)

"L0112HN15" (9 characters) = Reserved, defaults shown

$sum$ = (3 characters) Sum of detected and normalized backscatter, 0 ... 999.

$CR~LF$ = Carriage Return + Line Feed

---

**NOTE**

This line is omitted from message 105.

---

**LINE 4**

SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS...(5 x 770 bytes) $CR~LF$

The two-way attenuated normalised backscatter profile, see Section 2.1.4.

$CR~LF$ = Carriage Return + Line Feed

---

**NOTE**

This line is omitted from message 105.

---

**LINE 5**

$ETX~CRC-16~EOT~CR~LF$

where

$ETX$ = End-of-Text character

$CRC-16$ (4 characters) = CRC-16 Checksum

$EOT$ = End-of-Transmission character

$CR~LF$ = Carriage Return + Line Feed
MESSAGES 107 - 112, CL31 Message 2

Example message 107 line outputs
CL017021
10 01407 ///// ///// 00000000E080
99 ///// 0 ///// 0 ///// 0 /////
00100 10 0770 100 +40 095 02 0031 L0112HN30 000
03301009…………………….027F  (Line output message cropped for clarity)
e669

LINE 1
SOH CL ID OS 2 Samples STX CR LF

where

SOH = Start-of-Heading character

CL = Always CL

ID = A single ASCII character, 0-9, a - z or A - Z, case sensitive. Default ID = 0

OS = Operating system, 100 ... 999

2 = Always 2

Samples = backscatter resolution and number of samples

1 = MESSAGE 107, 10 m x 770 samples, range 7700 m
2 = MESSAGE 108, 20 m x 385 samples, range 7700 m
3 = MESSAGE 109, 5 m x 1500 samples, range 7500 m
4 = MESSAGE 110, 5 m x 770 samples, range 3850 m
5 = MESSAGE 111, no backscatter profile
0 = MESSAGE 112, extended range, 5 m x 2048 samples, range 10,240 m

STX = Start-of-Text Character

CR LF = Carriage Return + Line Feed
LINE 2
S WA_h1_h2_h3_flags CR LF

where

S (1 character) = detection status:
0 = No significant backscatter
1 = One cloud base detected
2 = Two cloud bases detected
3 = Three cloud bases detected
4 = Full obscuration determined but no cloud base detected
5 = Some obscuration detected but determined to be transparent
/ = Raw data input to algorithm missing or suspect

WA (1 character) = Warning or alarm status:
0 = No alarm or warning
W = Warning
A = Alarm

h1 (5 characters) = 1st Height
If detection status is 1, 2 or 3 h1 = Lowest cloud base reported
If detection status is 4 h1 = Vertical visibility as calculated
If detection status is 0 or 5 h1 = "////"

h2 (5 characters) = 2nd Height
If detection status is 2 or 3 h2 = Second cloud base reported
If detection status is 4 h2 = Highest signal received
If detection status is 0, 1 or 5 h2 = "////"

h3 (5 characters) = 3rd Height
If detection status is 3 h3 = Third cloud base reported
If detection status is 0, 1, 2, 4 or 5 h3 = "////"

flags (12 characters) = Alarm or warning information.
Same as for messages 101 – 106

CR LF = Carriage Return + Line Feed

LINE 3
__d_h1h1h1__d2_h2h2h2__d3_h3h3h3__d4_h4h4h4__d5_h5h5h5 CR LF
(note spaces)
where

\[ d \text{ (1 character)} = \text{Data available} \]

- 0 to 8  \( \text{Amount of lowest layer in oktas} \)
- 9  \( \text{Vertical visibility only available} \)
- -1  \( \text{No sky condition data available} \)
- 99  \( \text{Insufficient data} \)

\[ h1h1h1 \text{ (3 characters)} = \text{Height of the lowest cloud layer in 10s of metres or 100s of feet} \]

\[ d2 \text{ (1 character)} = \text{Cloud amount of the 2nd layer in oktas} \]

\[ h2h2h2 \text{ (3 characters)} = \text{Height of the 2nd cloud layer in 10s of metres or 100s of feet, if no 2nd layer is reported} \]

\[ h2h2h2 = '///' \]

\[ d3 \text{ (1 character)} = \text{Cloud amount of the 3rd layer in oktas} \]

\[ h3h3h3 \text{ (3 characters)} = \text{Height of the 3rd cloud layer in 10s of metres or 100s of feet, if no 3rd layer is reported} \]

\[ h3h3h3 = '///' \]

\[ d4 \text{ (1 character)} = \text{Cloud amount of the 4th layer in oktas} \]

\[ h4h4h4 \text{ (3 characters)} = \text{Height of the 4th cloud layer in 10s of metres or 100s of feet, if no 4th layer is reported} \]

\[ h4h4h4 = '///' \]

\[ d5 \text{ (1 character)} = \text{Cloud amount of the 5th layer in oktas} \]

\[ h5h5h5 \text{ (3 characters)} = \text{Height of the 5th cloud layer in 10s of metres or 100s of feet, if no 5th layer is reported} \]

\[ h5h5h5 = '///' \]

\[ CR LF = \text{Carriage Return + Line Feed} \]

Note cloud amount and height cannot be reported until the SkyVUE™PRO has been operating for 30 minutes.

**LINE 4**

\[ \text{scale}_-_\text{res}_-_n-_\text{energy}_-_lt-_\text{tr}_-_\text{ti}_-_\text{bl}_-_L0112HN15-_\text{sum} \text{ CR LF} \]

where

- **scale** (5 characters) = Scale parameter, %, 0 ... 99999. 100% is typical
- **res** (2 characters) = Backscatter profile resolution in metres.
- **n** (4 characters) = Profile length 385, 770, 1400, or 1500 samples.
- **energy** (3 characters) = Laser pulse energy, %.
- **lt** (3 characters including leading +/-) = Laser temperature, degrees C
tr (3 characters) = Window transmission, %

ti (2 characters) = Total tilt angle, degrees

bl (4 characters) = Background light, millivolts at internal ADC input (0 ... 2500)

"L0112HN15" (9 characters) = Reserved, defaults shown

sum = (3 characters) Sum of detected and normalized backscatter, 0 ... 999. Not used in Operating System 1

CR LF = Carriage Return + Line Feed

NOTE

This line is omitted from message 111.

LINE 5
SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
6.5 CT25K Messages

MESSAGE 113, CT25K Data Message No. 1

Example message line outputs
CT02010
20 01333 01523 ///// 00000F00

LINE 1
SOH CT ID 20 10 STX CR LF

where

SOH = Start-of-Heading character
CT = Always CT
ID (1 character) = Unit number 0 ... 9, A ... Z (capitals only) Default ID = 0
20 = Always “20”
10 = Always “10”
STX = Start-of-Text Character
CR LF = Carriage Return + Line Feed

LINE 2
S WA_h1_h2_h3_flags CR LF

where

S (1 character) = detection status:
0 = No significant backscatter
1 = One cloud base detected
2 = Two cloud bases detected
3 = Three cloud bases detected
4 = Full obscuration determined but no cloud base detected
5 = Some obscuration detected but determined to be transparent
/ = Raw data input to algorithm missing or suspect

WA (1 character) = Warning or alarm status:
0 = No alarm or warning
W = Warning
A = Alarm
If detection status is 1, 2 or 3 $h1 =$ Lowest cloud base reported
If detection status is 4 $h1 =$ Vertical visibility as calculated
If detection status is 0 or 5 $h1 =$ "/////"

$h2 =$ 2nd Height
If detection status is 2 or 3 $h2 =$ Second cloud base reported
If detection status is 4 $h2 =$ Height of highest signal detected
If detection status is 0, 1 or 5 $h2 =$ "/////"

$h3 =$ 3rd Height
If detection status is 3 $h3 =$ Third cloud base reported
If detection status is 0, 1, 2, 4 or 5 $h3 =$ "/////"

$flags =$ Alarm or warning information 4-byte hex coded

<table>
<thead>
<tr>
<th>Bit Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>8000 XXXX Transmitter shut-off</td>
</tr>
<tr>
<td>4000 XXXX Transmitter failure</td>
</tr>
<tr>
<td>2000 XXXX Receiver failure</td>
</tr>
<tr>
<td>1000 XXXX DSP, voltage or memory failure</td>
</tr>
<tr>
<td>0800 XXXX Reserved for future use</td>
</tr>
<tr>
<td>0400 XXXX Reserved for future use</td>
</tr>
<tr>
<td>0200 XXXX Reserved for future use</td>
</tr>
<tr>
<td>0100 XXXX Reserved for future use</td>
</tr>
<tr>
<td>0080 XXXX Window contaminated</td>
</tr>
<tr>
<td>0040 XXXX Battery low</td>
</tr>
<tr>
<td>0020 XXXX Transmitter expire warning</td>
</tr>
<tr>
<td>0010 XXXX Heater or humidity sensor failure</td>
</tr>
<tr>
<td>0008 XXXX High radiance warning, also XXXX 0004</td>
</tr>
<tr>
<td>0004 XXXX DSP, receiver, or laser monitor failure warning</td>
</tr>
<tr>
<td>0002 XXXX Relative humidity &gt; 85 %</td>
</tr>
<tr>
<td>0001 XXXX Light path obstruction, receiver saturation or receiver failure</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bit Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>XXXX 8000 Blower failure</td>
</tr>
<tr>
<td>XXXX 4000 Reserved for future use</td>
</tr>
<tr>
<td>XXXX 2000 Reserved for future use</td>
</tr>
<tr>
<td>XXXX 1000 Reserved for future use</td>
</tr>
<tr>
<td>XXXX 0800 Blower on</td>
</tr>
<tr>
<td>XXXX 0400 Blower heater on</td>
</tr>
<tr>
<td>XXXX 0200 Internal heater on</td>
</tr>
<tr>
<td>XXXX 0100 Units metres if on, feet if off</td>
</tr>
<tr>
<td>XXXX 0080 Polling mode on</td>
</tr>
<tr>
<td>XXXX 0040 Working from battery</td>
</tr>
<tr>
<td>XXXX 0020 Always 0</td>
</tr>
<tr>
<td>XXXX 0010 Always 0</td>
</tr>
<tr>
<td>XXXX 0008 Tilt beyond limit set by user, default 45 degrees</td>
</tr>
<tr>
<td>XXXX 0004 High radiance warning, also 0008 XXXX</td>
</tr>
<tr>
<td>XXXX 0002 Reserved for future use</td>
</tr>
<tr>
<td>XXXX 0001 Reserved for future use</td>
</tr>
</tbody>
</table>

$CR\ LF =$ Carriage Return + Line Feed
LINE 3

ETX CR LF

ETX = End-of-Text Character

CR LF = Carriage Return + Line Feed
MESSAGE 114, CT25K Data Message No. 6

Example message line outputs
CT02060
10 01767 ///// ///// 00000F00
99 /// 0 /// 0 /// 0 ///

LINE 1
SOH CT ID 20 60 STX CR LF

where

SOH = Start-of-Heading character

CT = Always CT

ID (1 character) = Unit number 0 ... 9, A ... Z (capitals only) Default ID = 0

20 = always “20”
60 = always “60”

STX = Start-of-Text Character

CR LF = Carriage Return + Line Feed

LINE 2
S WA_h1_h2_h3_flags CR LF

where

S (1 character) = detection status:

0 = No significant backscatter
1 = One cloud base detected
2 = Two cloud bases detected
3 = Three cloud bases detected
4 = Full obscuration determined but no cloud base detected
5 = Some obscuration detected but determined to be transparent
/ = Raw data input to algorithm missing or suspect

WA (1 character) = Warning or alarm status:

0 = No alarm or warning
W = Warning
A = Alarm

h1 (5 characters) = 1st Height
If detection status is 1, 2 or 3 $h_1 =$ Lowest cloud base reported
If detection status is 4 $h_1 =$ Vertical visibility as calculated
If detection status is 0 or 5 $h_1 =$ "///"

$h_2$ (5 characters) = 2nd Height
If detection status is 2 or 3 $h_2 =$ Second cloud base reported
If detection status is 4 $h_2 =$ Height of highest signal detected
If detection status is 0, 1 or 5 $h_2 =$ "///"

$h_3$ (5 characters) = 3rd Height
If detection status is 3 $h_3 =$ Third cloud base reported
If detection status is 0, 1, 2, 4 or 5 $h_3 =$ "///"

$flags$ (8 characters) = Alarm or warning information 4-byte hex coded

As for CT25K message 1.

$CR \ LF =$ Carriage Return + Line Feed

**LINE 3 (SKY CONDITION)**

```
__d__h1h1h1__d2__h2h2h2__d3__h3h3h3__d4__h4h4h4 CR \ LF
```

(note spaces)

where

$d$ (1 character) = Data available
0 to 8 Amount of lowest layer in oktas
9 Vertical visibility only available
-1 No sky condition data available
99 Insufficient data

$h1h1h1$ (3 characters) = Height of the lowest cloud layer in 10s of metres or 100s of feet

$d2$ (1 character) = Cloud amount of the 2nd layer in oktas

$h2h2h2$ (3 characters) = Height of the 2nd cloud layer in 10s of metres or 100s of feet, if no 2nd layer is reported $h2h2h2 =$ "///".

$d3$ (1 character) = Cloud amount of the 3rd layer in oktas

$h3h3h3$ (3 characters) = Height of the 3rd cloud layer in 10s of metres or 100s of feet, if no 3rd layer is reported $h3h3h3 =$ "///".

$d4$ (1 character) = Cloud amount of the 4th layer in oktas

$h4h4h4$ (3 characters) = Height of the 4th cloud layer in 10s of metres or 100s of feet, if no 4th layer is reported $h4h4h4 =$ "///".

$CR \ LF =$ Carriage Return + Line Feed
Note cloud amount and height cannot be reported until the SkyVUE™PRO has been operating for 30 minutes.

**LINE 4**

*ETX CR LF*

*ETX* = End-of-Text Character

*CR LF* = Carriage Return + Line Feed

## 7. Maintenance

### 7.1 General

The SkyVUE™PRO is a robust weather resistant instrument and there is no need for routine maintenance other than cleaning. The instrument performance is monitored and any potential problems are indicated by error messages.

### 7.2 Cleaning

The SkyVUE™PRO window will require cleaning from time to time. The frequency of required cleaning depends on the exposure of the instrument to contaminants such as salt and dust. This will vary depending on the site location. The SkyVUE™PRO is capable of self diagnosing dirty lenses and will indicate in its output when the lenses are contaminated.

In any case we suggest six monthly intervals for locations not prone to contaminants and monthly intervals for those prone to contamination (coastal, roadside or airport use). In some cases more frequent cleaning may be required where there are high levels of contaminants and high dependency on the instrument output.

---

**CAUTION**

If the window requires cleaning, it is very important that only a proper lens cloth or lens tissue is used. The use of inappropriate materials to clean the windows can permanently damage or reduce their effectiveness leading to reduced performance.

It is advisable to use an air duster to blow any loose dust and dirt from the window as a first step. Using a lint free lens cloth or lens tissue impregnated with a non-aggressive standard window cleaner. Clean the surface by dragging the cloth across it being careful not to apply excessive pressure.

Excessive pressure may lead to some types of contaminants scratching the window surface. Over time such scratches can lead to reduced sensitivity.

When the cowl is removed, avoid spraying the heater/fan assembly with liquids.
7.3 Removing the cover

The cover is removed by removing the four screws as shown in Fig 7.1.

The cover can then be lifted away.

**CAUTION**

The cover contains a flying lead used to take power to the hood heater and blower. Be careful not to trap and damage this when lifting the cover clear.

Removing the cover reveals two carrying handles that allow the SkyVUE™PRO to be moved easily.
7.4 Removing the enclosure lid

In some circumstances it may be necessary to remove the lid covering the electronics unit, for example to replace desiccant or carry out a hardware reset. This is accomplished by removing the four screws as shown in Fig 7.2.

![Removing the enclosure lid](image)

**WARNING**
Opening enclosure lid MUST be carried out by a competent person

**WARNING**
Removing the enclosure lid may expose hot surfaces

**NOTE**
The unit will still be powered by the battery even if the mains is disconnected.

**NOTE**
Do not use any grease or oil on any seals including the enclosure lid gasket. The silicone rubber seals used throughout the SkyVUE™ PRO can be damaged by some mineral oils.
7.5 Diagnostic LED indicators within the enclosure

Two green LEDs labelled "LASER ON" and "STATUS" are visible on the DSP (see Fig 7.3). Their function is as follows:

"LASER ON" LED:
- Off = laser off
- Flashing = laser fault
- On = laser on

"STATUS" LED
- 1 flash every 10 seconds = OK
- 2 flashes every 10 seconds = warning (possible degraded performance)
- 3 flashes every 10 seconds = alarm (measurements not possible)

The DSP "STATUS" LED duplicates the LED visible through the top window.

There is a red LED on the PSU. It will give 0.5 second flashes as follows:

- 1 flash every 10 seconds = PSU OK
- 2 flashes every 10 seconds = running in battery mode
- 3 flashes every 10 seconds = no communications to the DSP. This takes 60 seconds to start after a communications failure.

![Fig 7.3 Diagnostic LED indicators](image)

There is a red LED on the Laser module

- Off = Laser off
- On = Laser on
7.6 Electrical safety testing

**NOTE**

If carrying out insulation tests do not use voltages above 300V RMS because the sensor is designed to clamp any mains input voltages above this level. Voltage clamping can result in a false failure being detected.
Appendix A. Example CRBasic programs

A.1 Basic Logger program without CRC checking

This example is for use with the default message CS message 1. For assistance with other messages including those outputting mixing layer heights, please contact Campbell Scientific, UK.

'CR800 Series Datalogger
'Created by Sue Hill 18 July 2013
'SkyVUEPRO Ceilometer connections
' Blue Tx C1
' White Rx C2
' Green G
'handshake lines shorted

SequentialMode

Const SOH = 1
Const STX = 2
Const ETX = 3
Const EOT = 4

Dim strInSkyVUEPRO As String * 70
Dim Num_Bytes As Long
Dim strSkyVUEPRO_Message_Status As String * 1
Dim strSkyVUEPRO_Alarm_Status As String * 1

Dim SkyVUEPROLines(3) As String * 60
Dim CSLine2_Fields(7) As String * 20

Dim SkyVUEPRO_Unit_of_Measure As String * 3

Public strInformation As String * 100
Public strAlarm As String * 100
Public strError As String * 100

Alias CSLine2_Fields(1)=SkyVUEPRO_MessageAlarm_Status
Alias CSLine2_Fields(2)=SkyVUEPRO_Window_transmission
Alias CSLine2_Fields(3)=SkyVUEPRO_First_Height
Alias CSLine2_Fields(4)=SkyVUEPRO_Second_Height
Alias CSLine2_Fields(5)=SkyVUEPRO_Third_Height
Alias CSLine2_Fields(6)=SkyVUEPRO_Fourth_Height
Alias CSLine2_Fields(7)=SkyVUEPRO_Alarm_Flags

'Define Data Tables

DataTable(Ceilometer,True,-1)
DataInterval(0,15,sec,10)
Sample (1,strSkyVUEPRO_Message_Status,String)
Sample (1,strSkyVUEPRO_Alarm_Status,String)
Sample (1,SkyVUEPRO_First_Height,ieee4)
Sample (1,SkyVUEPRO_Second_Height,ieee4)
Sample (1,SkyVUEPRO_Third_Height,ieee4)
Sample (1,SkyVUEPRO_Fourth_Height,ieee4)
Sample(1,SkyVUEPRO_Alarm_Flags,String)

EndTable
'Main Program
BeginProg
' open the port to the SkyVuePRO Ceilometer
'Assumes default serial settings, if not change baud rate & maybe format (2nd & 3rd parameters)
SerialOpen (Com1,115200,3,0,1000)
SkyVuePRO_Unit_of_Measure="ft"

Scan(15,Sec,1,0)
SerialInRecord (Com1,strInSkyVuePRO,SOH,0,EOT,Num_Bytes,01)
If Num_Bytes > 0 Then
  'Break up message on line feed separator
  SplitStr (SkyVuePROLines,strInSkyVuePRO,CHR(10),3,5)
  'Break up top line using space as separator
  SplitStr (CSLine2_Fields, SkyVuePROLines(2)," ",7,5)
  'First character is msg status
  strSkyVuePRO_Message_Status=Left (SkyVuePRO_MessageAlarm_Status,1)
  'Last character is alarm status
  strSkyVuePRO_Alarm_Status=Right (SkyVuePRO_MessageAlarm_Status,1)
  If strSkyVuePRO_Alarm_Status = "W" Then
    strAlarm = "Warning"
  ElseIf strSkyVuePRO_Alarm_Status = "A" Then
    strAlarm = "Alarm"
  Else
    strAlarm = "OK"
  EndIf
  Select Case strSkyVuePRO_Message_Status
    Case "0"
      strInformation = "No significant backscatter"
    Case "1"
      strInformation = "One cloud base detected"
    Case "2"
      strInformation = "Two cloud bases detected"
    Case "3"
      strInformation = "Three cloud bases detected"
    Case "4"
      strInformation = "Four cloud bases detected"
    Case "5"
      strInformation = "Full obscuration determined but no cloud base detected"
    Case "6"
      strInformation = "Some obscuration detected but determined to be transparent"
    Case "/"
      strInformation = "Raw data input to algorithm missing or suspect"
  Case Else
    strInformation = "Status of message unknown."
  EndSelect
  strError = ""
Else
  strError = "COMMS ERROR - No Message received"
EndIf

'NOTE to be thorough we should really check message is complete & correct by calculating CheckSum and comparing the checksum sent in the message (line 3), discarding the message if 'there is no match.

CallTable(Ceilometer)
NextScan
EndProg
A.2 Basic Logger program with CRC checking

'CR800 Series Datalogger
'Created by Sue Hill 18 July 2013

'SkyVUEPRO Ceilometer connections
' Blue Tx C1
' White Rx C2
' Green G
'handshake lines shorted

SequentialMode

Const SOH = 1
Const STX = 2
Const ETX = 3
Const EOT = 4

Dim strInSkyVUEPRO As String * 70
Dim Num_Bytes As Long
Dim strSkyVUEPRO_Message_Status As String * 1
Dim strSkyVUEPRO_Alarm_Status As String * 1
Dim lngCRCCalc As Long
Dim lngCRCMessage As Long
Dim DataOK As Boolean

Dim SkyVUEPROLines(3) As String * 60
Dim CSLLine2_Fields(7) As String * 20

Dim SkyVUEPRO_Unit_of_Measure As String * 3

Public strInformation As String * 100
Public strAlarm As String * 100
Public strError As String * 100

Alias CSLLine2_Fields(1)=SkyVUEPRO_MessageAlarm_Status
Alias CSLLine2_Fields(2)=SkyVUEPRO_Window_transmission
Alias CSLLine2_Fields(3)=SkyVUEPRO_First_Height
Alias CSLLine2_Fields(4)=SkyVUEPRO_Second_Height
Alias CSLLine2_Fields(5)=SkyVUEPRO_Third_Height
Alias CSLLine2_Fields(6)=SkyVUEPRO_Fourth_Height
Alias CSLLine2_Fields(7)=SkyVUEPRO_Alarm_Flags

'Define Data Tables

DataTable(Ceilometer,True,-1)
  DataInterval(0,15,sec,10)
  Sample (1,strSkyVUEPRO_Message_Status,String)
  Sample (1,strSkyVUEPRO_Alarm_Status,String)
  Sample (1,SkyVUEPRO_First_Height, ieee4)
  Sample (1,SkyVUEPRO_Second_Height, ieee4)
  Sample (1,SkyVUEPRO_Third_Height, ieee4)
  Sample (1,SkyVUEPRO_Fourth_Height, ieee4)
  Sample (1,SkyVUEPRO_Alarm_Flags,String)
EndTable

'Main Program
BeginProg
  ' open the port to the SkyVUEPRO Ceilometer
  'Assumes default serial settings, if not change baud rate & maybe format (2nd & 3rd parameters)
  SerialOpen (Com1,115200,3,0,1000)
SkyVUEPRO_Unit_of_Measure="ft"

Scan(15, Sec, 1, 0)
    SerialInRecord (Com1, strInSkyVUEPRO, SOH, 0, EOT, Num_Bytes, 01)
    If Num_Bytes > 0 Then
        'Break up message on line feed separator
        SplitStr (SkyVUEPROLines, strInSkyVUEPRO, CHR(10), 3, 5)
        'Break up top line using space as separator
        SplitStr (CLine2_Fields, SkyVUEPROLines(2),",",7,5)
        'First character is msg status
        strSkyVUEPRO_Message_Status=Left (SkyVUEPRO_MessageAlarm_Status, 1)
        'Last character is alarm status
        strSkyVUEPRO_Alarm_Status=Right (SkyVUEPRO_MessageAlarm_Status, 1)
        If strSkyVUEPRO_Alarm_Status = "W" Then
            strAlarm = "Warning"
        ElseIf strSkyVUEPRO_Alarm_Status = "A" Then
            strAlarm = "Alarm"
        Else
            strAlarm = "OK"
        EndIf
        Select Case strSkyVUEPRO_Message_Status
            Case "0"
                strInformation = "No significant backscatter"
            Case "1"
                strInformation = "One cloud base detected"
            Case "2"
                strInformation = "Two cloud bases detected"
            Case "3"
                strInformation = "Three cloud bases detected"
            Case "4"
                strInformation = "Four cloud bases detected"
            Case "5"
                strInformation = "Full obscuration determined but no cloud base detected"
            Case else
                strInformation = "Some obscuration detected but determined to be transparent"
            Case "/"
                strInformation = "Raw data input to algorithm missing or suspect"
            Case Else
                strInformation = "Status of message unknown."
        EndSelect
        'Make sure message is complete & correct
        lngCRCCalc = CheckSum (Left(strInSkyVUEPRO, Num_Bytes-4), 18, 0) XOR &HFFFF
        lngCRCMessage = HexToDec (Mid(strInSkyVUEPRO, 59, 4))
        DataOK = (Num_Bytes = 62) AND (lngCRCCalc = lngCRCMessage)
        If NOT DataOK Then
            strError = "Data error, messages may be incomplete!"
        Else
            strError = ""
        EndIf
        Else
            strError = "COMMS ERROR - No Message received"
        EndIf
        CallTable(Ceilometer)
        NextScan
    EndProg
Appendix B. Measurement of the attenuated backscatter profile

B.1 Initial measurement

- Pulse the laser and measure the backscatter at optimal gains.
- Derive the impulse response and impulse correct the backscatter signal using the inverse filter derived.
- Remove the residual offset and slope from the impulse corrected backscatter.
- Apply an overlap correction based on the known generic overlap function of the SkyVUE™PRO.
- Apply the backscatter calibration constants.
- Remove the laser and electronic artefact signature. This is specific to the individual SkyVUE™PRO and determined during calibration.

B.2 Backscatter onset height detection

- Filter the backscatter with 20 m (65.6 ft) and 300 m (984 ft) width filters.
- Look for a 1500 m (4921 ft) block width where the standard deviation is at a minimum for both the 20 m (65.6 ft) and 300 m (984 ft) width filtered backscatters.
- Create a detection threshold by multiplying the 20 m (65.6 ft) and 300 m (984 ft) standard deviations by a constant.
- Find the onset of backscatter height by working from the highest height bin downwards until the backscatter is above one or both of the two detection thresholds.

B.3 Produce attenuated backscatter output message

- Range correct the backscatter to produce the attenuated backscatter.
- Attenuated backscatter (output), calibrated, range corrected but not tilt corrected.
- Smooth with a 20 m (65.6 ft) width running average.
- A noise gate can be applied based on a multiple of the 20 m detection threshold – this is customer configurable.
Note the lower height range bins do not gate noise until the backscatter reaches zero. This allows the full extent of mixing layers to be viewed in gating mode.
Appendix C. Cloud height calculation

The scatter profile is inverted (using the Klett inversion technique) and an extinction profile is calculated.

Cloud base heights are identified using two criteria as follows (cloud is detected if either of them is met):

Criterion 1: likely cloud bases are estimated based on increasing slope of the extinction profile of at least 7 m (22.9 ft) per bin (bin width is 5 m (16.4 ft)) and an extinction threshold. This threshold is based on an extinction coefficient (EXCO) of 3, equivalent to a horizontal visibility (MOR) of 1000 m (3280 ft). This results in a number of possible cloud bases at different heights.

Criterion 2: horizontal visibility falls below an average of 4800 m (15,748 ft) over 300 m (984 ft) starting at an altitude of 1000 m (3280 ft).

To report a cloud layer above a lower one the scatter coefficient first has to fall below the extinction threshold used for cloud definitions (less a small hysteresis offset). The scatter profile must then again meet the criteria above.

If rain is detected the sensitivity of detection is increased by a factor of 3.

To avoid many very narrow close layers being reported when they have little significance a minimum separation based on WMO reporting intervals is applied. The separation is +/- 30 m (98 ft) below 1500 m (4921 ft) and 300 m (984 ft) above 1500 m (4291 ft). The lowest cloud height is used. If a thin cloud identified by Criterion 2 above is within +/- 15 0 m of a cloud identified by criterion 1 then the thin cloud is ignored.
Appendix D. Sky condition algorithm description

The SkyVUE™PRO sky condition algorithm follows guidance from ICAO and WMO documents* and is based on 30 minutes of data. For this reason sky condition is not available for 30 minutes after power cycling the sensor, a reboot or changing measurement parameters. The sky condition algorithm is as follows:

Each measured hit comprising the lowest cloud height, (vertical visibility + onset of backscatter) / 2 and a weighting of 1 or 2 is stored in a running half hour buffer.

The weighting is 2 for hits in the last 10 minutes and 1 for hits in the previous 20 minutes.

If >50% of the hits in the latest 10 minutes are vertical visibility then the vertical visibility averaged over the last 10 minutes is reported. Only hits below the vertical visibility height limit set are used.

The buffer is sorted in height order and hits combined into bins with the following widths.

<table>
<thead>
<tr>
<th>Height</th>
<th>Bin width</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 5,000 ft (0 – 1524 m)</td>
<td>100 ft (30.5 m)</td>
</tr>
<tr>
<td>5,000 – 15,000 ft (1524 – 4572 m)</td>
<td>200 ft (61 m)</td>
</tr>
<tr>
<td>15,000 ft – 33,000 ft (4572 – 10,000 m)</td>
<td>500 ft (152 m)</td>
</tr>
</tbody>
</table>

For each bin a mean height is calculated by the following:

$$H_i = \frac{\sum(h_iw_i)}{\sum(w_i)}$$

Where $$w_i$$ is the weight (1 or 2) of the hit with height $$h_i$$.

Bins are then reduced. A distance (D) between adjacent bins is calculated by the following equation:

$$D = N_iN_j (H_i-H_j)^2/N_i+N_j$$

Where $$N_i$$ and $$N_j$$ are the sum of hits of each bin and $$H_i$$ and $$H_j$$ the respective heights.

Find the pair with the minimum distance D and combine into one bin with the height of the lowest and number of hits of the combined total.
This process is repeated until 5 or less bins remain. These are now taken as cloud layers.

Finally if cloud layers are closer than the distances below then they are merged with the height of the lowest and combined total number of hits.

<table>
<thead>
<tr>
<th>Height range</th>
<th>Distance (D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height ≤ 300 m (1000 ft)</td>
<td>≤ 90 (300 ft)</td>
</tr>
<tr>
<td>300 m &lt; Height ≤ 900 m (1000 ft &lt; Height ≤ 3000 ft)</td>
<td>≤ 120 m (400 ft)</td>
</tr>
<tr>
<td>900 m &lt; Height ≤ 1500 m (3000 ft &lt; Height ≤ 5000 ft)</td>
<td>≤ 180 m (600 ft)</td>
</tr>
<tr>
<td>1500 m &lt; Height ≤ 2400 m (5000 ft &lt; Height ≤ 8000 ft)</td>
<td>≤ 300 m (1000 ft)</td>
</tr>
<tr>
<td>Height &gt; 2400 m (8000 ft)</td>
<td>≤ 480 (1600 ft)</td>
</tr>
</tbody>
</table>

Weights per layer are used to calculate number of oktas per layer.

If the total possible is \( W_{\text{max}} \) then the cover is \( (W_i/W_{\text{max}}) \times 8 \).

Cloud amounts are rounded up to the next highest whole oktas.

For layers above the lowest this is based on the maximum possible weights. If the lower layers have \( W_1 \) hits and the next layer has \( W_2 \) hits then the cover of the higher layer is given by:

\[
(W_2/(W_{\text{max}}-W_1)) \times 8
\]

For example, taking weighting into account, if lower layers of cloud only allow 4/8 of clear sky above and the cover is 2/8 out of those 4/8 then the layer above is taken as 4/8.

Finally only layers meeting the following criteria are reported:

Layer 1 ≥ 1/33 oktas
Layer 2 ≥ 3 oktas
Layer 3 ≥ 5 oktas
Layer 4 ≥ 7 oktas
Layer 5 ≥ 7 oktas
Any layer > \((8 - 1/33)\) oktas is reported as 8 oktas
