

# SkyVUE™ 8M

Tactical LIDAR Ceilometer



Revision: 12/2021

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CSL I.D - 1311



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# About this manual

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Please note that this manual was originally produced by Campbell Scientific Inc. primarily for the North American market. Some spellings, weights and measures may reflect this origin.

Some useful conversion factors:

**Area:** 1 in<sup>2</sup> (square inch) = 645 mm<sup>2</sup>

**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/in<sup>2</sup>) = 68.95 mb

**Volume:** 1 UK pint = 568.3 ml  
1 UK gallon = 4.546 litres  
1 US gallon = 3.785 litres

In addition, while most of the information in the manual is correct for all countries, certain information is specific to the North American market and so may not be applicable to European users.

Differences include the U.S standard external power supply details where some information (for example the AC transformer input voltage) will not be applicable for British/European use. *Please note, however, that when a power supply adapter is ordered it will be suitable for use in your country.*

Reference to some radio transmitters, digital cell phones and aerials may also not be applicable according to your locality.

Some brackets, shields and enclosure options, including wiring, are not sold as standard items in the European market; in some cases alternatives are offered. Details of the alternatives will be covered in separate manuals.

Part numbers prefixed with a “#” symbol are special order parts for use with non-EU variants or for special installations. Please quote the full part number with the # when ordering.

## 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 products 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.



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# Safety

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**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.eu](http://www.campbellsci.eu) or by telephoning +44(0) 1509 828 888 (UK). 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, or 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.

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# 1. General information

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## 1.1 Packing list

The following table lists the products shipped with the SkyVUE 8M.

Table 1-1: Packing list	
Description	Quantity
Ceilometer	1
Cable, USB type A plug to type B plug, 2 m	1
Triangle key	1
Calibration plate	1
Canvas cover, white	1
Canvas cover, olive green	1
T-shaped heavy duty stakes	5
Power and communications cable	1

## 1.2 General safety

This manual provides important safety considerations for the installation, operation and maintenance of the SkyVUE™8M. 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.

## 1.3 Sensor unit safety

The SkyVUE 8M sensor has been checked for safety before leaving the factory and contains no parts that need to be changed during normal use.

**WARNING:**

Do not modify the SkyVUE 8M 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 8M unit without consulting Campbell Scientific.

**CAUTION:**

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

## 1.4 Laser safety

The SkyVUE 8M 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 minimized 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 average power: 15.0 mW (through 50 mm)

Maximum pulse energy: 1500 nJ (through 50 mm)

Pulse duration: 100 ns

Pulse frequency: 10 kHz

Wavelength: 912 nm  $\pm$  5 nm

Tested to: EN 60825-1:2014

Half angle divergence: 0.44 mrad

The sensor is marked with the following warning information:

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 8M 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:**

Annually, check that the laser warning label on the sensor is still visible and can be clearly read.

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

**WARNING:**

Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.



FIGURE 1-1. Location of laser warning label

Before removing the laser module, the sensor must be physically disconnected from its power supply to ensure that the laser is turned off.

## 1.5 Electrical safety

The sensor is powered from a low voltage supply ([Electrical specifications](#) (p. 10)), but potentially hazardous voltages are generated within the internal electronics. Wiring of the power and data cable should only be done by personnel qualified to install electrical equipment. For outside installations, this usually requires a certified electrician who is familiar with local electrical and safety legislation. Some general guidance is given in [Connectors and wiring](#) (p. 17), but the responsibility for the installation lies with the installer.

The unit is tested for electrical safety before dispatch 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.

The SkyVUE 8M 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.

Isolate the sensor before removing internal components, including the cover to the avalanche photodiode (APD) module. Only trained personnel should disassemble the instrument.

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

The SkyVUE 8M must be properly grounded by a licensed and qualified electrician to protect against voltage leakage shock risk ([Grounding](#) (p. 15)).

Campbell Scientific recommends that RCD protection units be used with all sensors. See [Power connections](#) (p. 20) for further information.

Heaters are enclosed to prevent contact.

**CAUTION:**

When powered, the heaters may operate automatically and without warning. They may remain hot when not powered. Follow the isolation precautions, to avoid shock and burn hazards.

## 2. Product overview

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## 2.1 Introduction

The SkyVUE 8M is a light detection and ranging (LIDAR) ceilometer that emits short pulses of near infrared light into the atmosphere from a semiconductor laser. The pulses of infrared light 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 allows identification of cloud bases. If significant scattering is detected without a defined cloud base, then a vertical visibility can be calculated.

The control system of the SkyVUE 8M is divided into three modules, DSP, TOP and PSU as follows:

DSP (Digital Signal Processor) is the main data processing and communications unit of the SkyVUE 8M. It hosts two separate time keeping circuits that are cross checked. An alarm is triggered if the circuits disagree.

TOP (top of the unit) provides safety shutdown features such as over and under laser output level. It also contains the calibration circuitry and dirty windows system.

PSU (Power Supply Unit) controls the power supply including battery charging and deep discharge protection.

The SkyVUE 8M has a rugged environmental enclosure that protects the instrument from the harshest conditions and will measure the atmosphere with high stability and repeatability.

### 2.1.1 Cloud height detection

A scatter profile is measured as described in [Measurement of the attenuated backscatter profile](#) (p. 89).

Cloud height detection is carried out as described in [Cloud height calculation](#) (p. 91). Up to four cloud heights can be detected.

If clouds are not detected, the SkyVUE 8M will give one of these 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 (6560 ft) 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 (160 ft), then vertical visibility is set to 0.

## 2.1.2 Sky condition

Sky condition is an assessment of cloud cover measured in units of eighths known as oktas. The number of oktas is the density of cloud in eighths of that layer. The SkyVUE 8M can report up to five layers of cloud when reporting sky condition. The algorithm used in the SkyVUE 8M follows guidance in the *ICAO 9837, Manual on Automatic Meteorological Observing Systems at Aerodromes*.

Sky condition is not an instantaneous measurement. It is based on cloud data for the previous 30 minutes, with cloud detection in the previous 10 minutes given an extra weighting. Therefore, sky condition is not available until sufficient data has been collected. See [Sky condition algorithm description](#) (p. 92) for more detail.

## 2.1.3 Backscatter profile reporting

Several possible data messages give the two-way attenuated backscatter profile. This consists of 2048 groups of five-character values (10,240 characters in total). Each character is 8 bits long and therefore each 5 figure group is 40 bits. They are given as signed two complement integers and numbers greater than  $2^{39}-1$  represent negative integers.

### NOTE:

After 1600, the remaining groups have values of 00000 to maintain compatibility of the backscatter profile reporting with other sensor models.

Therefore, each group actually represents negative, a value between  $-2^{39}$  to  $+(2^{39}-1)$ , rather than 0 to  $(2^{40}-1)$ , which would be the case for unsigned, positive, 40-bit integers.

Apply the following two-stage process to correct the decimal value:

1. Convert the hexadecimal characters to a decimal number.
2. If the number resulting from this conversion is greater than 1048575, subtract 1,099,511,627,776, which is  $2^{40}$ .

To use this backscatter coefficient in units of  $\text{sr}^{-1} \text{m}^{-1}$ , the sensor multiplies the calculated decimal number by a factor of  $10^{-8}$ . The values are scaled by the **Attenuated\_SCALE** parameter, see [Table 5-1](#) (p. 27).

**NOTE:**

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

## 2.2 Optical measurement

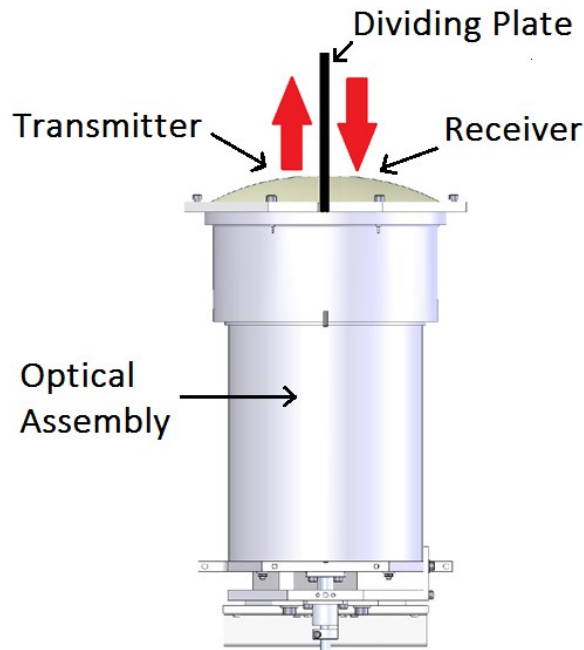


FIGURE 2-1. Principle of operation

### 2.2.1 Optical arrangement

The SkyVUE 8M uses a single lens design that increases optical signal-to-noise ratio, while maintaining Class 1M eye safety by integrating larger optics into a compact package (see [FIGURE 2-1](#) (p. 8)). Half of the lens is used by the transmitter, and the other half is used by the receiver. 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 8M monitors window contamination, key voltages and currents, internal temperature and relative humidity, and other parameters relevant to its performance. Data



messages (see [Operation](#) (p. 24)) include this information allowing remote diagnosis of the SkyVUE 8M condition. In addition, a special status message can be polled.

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### 2.4.1 Measurement specifications

Maximum reporting range:	8 km (26,250 ft)
Minimum reporting resolution:	5 m (15 ft)
Hard target range accuracy:	$\pm 0.25\% \pm 4.6$ m (15 ft)
Reporting cycle:	2 to 600 s
Cloud layers reported:	Up to four layers reported, instantaneously. Up to five layers reported in Sky Condition.

### 2.4.2 Mechanical specifications

Height:	763 mm (30 in) including feet
Width:	253 mm (10 in); 508 mm (20 in) with extended feet
Depth:	360 mm (14.2 in); 435 mm (17 in) with extended feet
Ceilometer weight:	18 kg (40 lb), excluding cables
Shipping weight:	24.6 kg (54 lb)
Hard shell transport case	
Dimensions:	1000 mm x 600 mm x 600 mm (39.5 x 24 x 24 in)

Weight (empty): 28 kg (62 lb)  
Weight with ceilometer and accessories: 49 kg (108 lb)

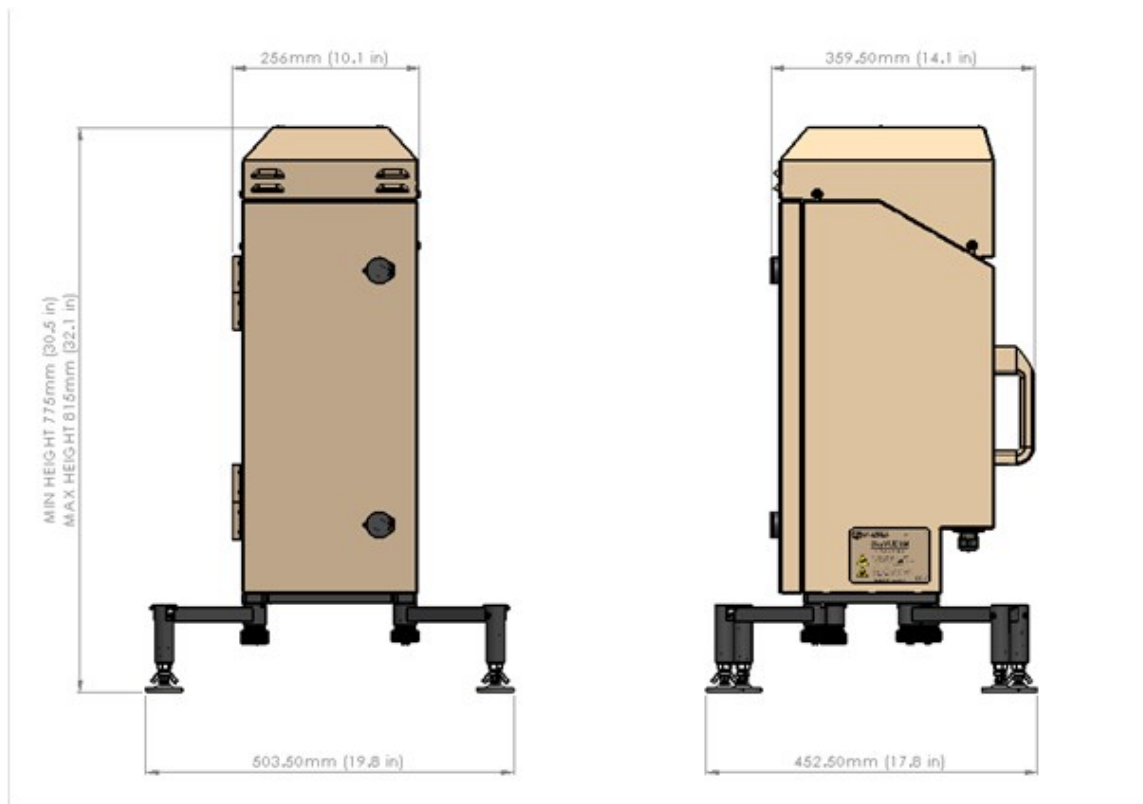


FIGURE 2-2. SkyVUE 8M dimensions

## 2.4.3 Electrical specifications

**Power required:** 10 to 40 VDC (9 A at 12 VDC; 4.5 A at 24 VDC), 102 W total maximum

**DSP and internal heaters:** 10 to 40 VDC input; 3.8 A at 12 VDC; 1.9 A at 24 VDC

**12V OUT:** 1.7 A for optional or external equipment (if the SkyVUE 8M is using a DC supply of less than 14 VDC, the 12V OUT will be less than 12 VDC.)

**Dew heater:** 10 W maximum

**Hood heater input:** 5 A at 12 VDC; 2.5 A at 24 VDC

**Fuses:**

**DSP fuse:** HBC 5A (T)

PSU fuse: HBC 5A (T)

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

The heaters are resistive, which is advantageous when connected to generators or when current consumption is important.

**WARNING:**

Removing the laser module with a battery connected or power applied to the SkyVUE 8M may expose the user to hazardous Class 3B radiation. No attempt should be made to operate the laser module outside of the housing.

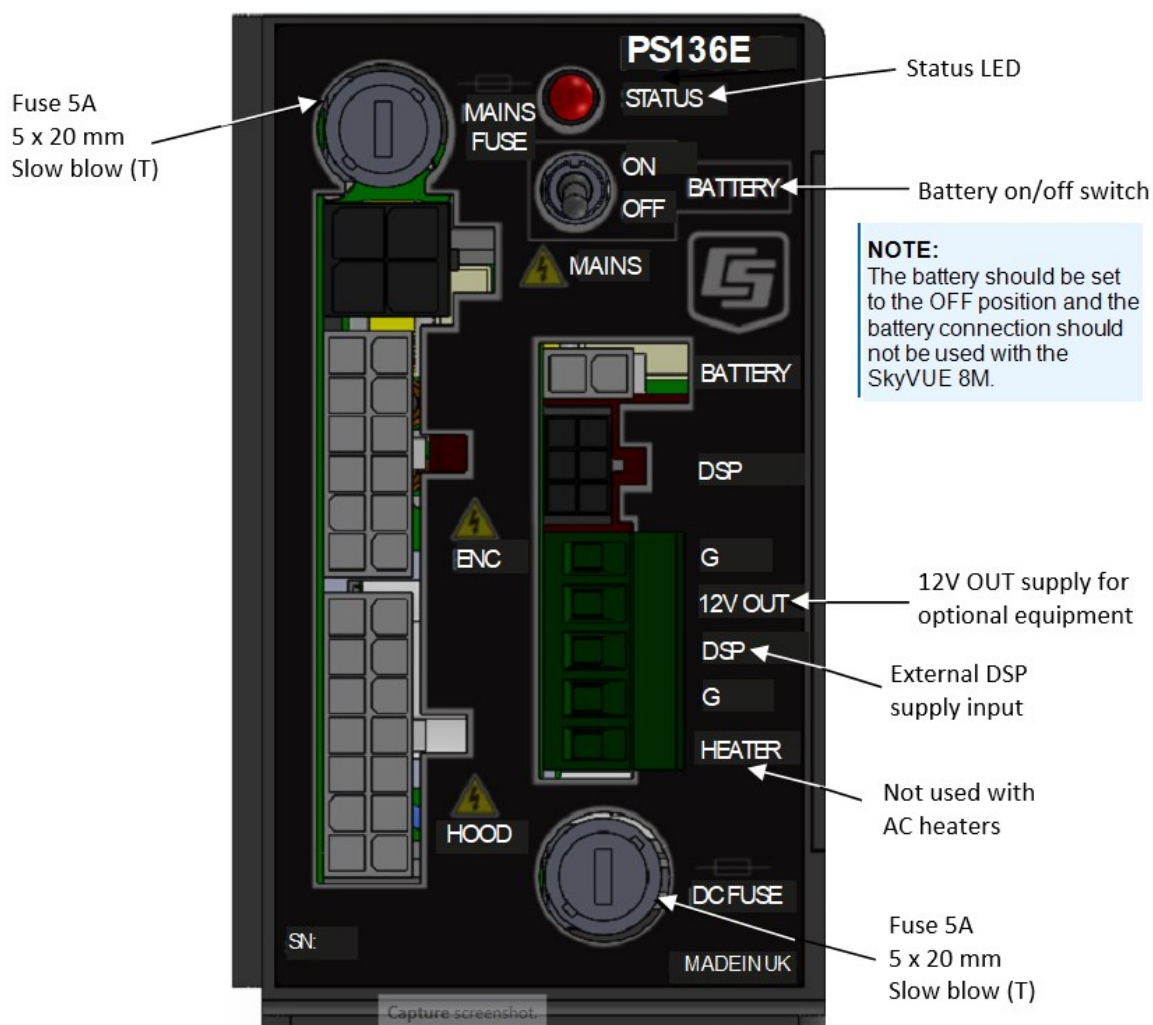


FIGURE 2-3. PSU types

## 2.4.4 Optical specifications

Pulse duration:	100 ns
Pulse frequency:	10 kHz
Wavelength:	912 ± 5 nm
Half-angle laser divergence:	0.44 mrad
Field of view:	2.0 mrad
Laser lifetime:	10 years typical
Eye safety class:	1M

## 2.4.5 Environmental specifications

Standard operating temperature range:	–40 to 60 °C
Relative humidity range:	0 to 100%
IP rating:	IP 66
Maximum tested wind speed:	55 m/s for sensor securely attached to the ground without camouflage covers

## 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	19200 baud
	600 baud	38400 baud
	1200 baud	57600 baud
	2400 baud	76800 baud
	4800 baud	115200 baud (default)
	9600 baud	
Supported standards:	RS-232 (default)	
	If RS-485 half-duplex is required, contact Campbell Scientific.	

## Signal voltage levels:

	Minimum value	Nominal value	Maximum value
<b>RS-232 communications</b>			
RS-232 input threshold low	0.8 V	1.5 V	–
RS-232 input threshold high	–	2.0 V	2.4 V
RS-232 input absolute maximum	–15 V	–	+15 V
RS-232 input resistance	12 K $\Omega$	–	–
RS-232 output voltage low	–	–	0.4 V
RS-232 output voltage high (into 3 K $\Omega$ )	4.4 V	–	–

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

## 2.4.7 Transport, shock, and vibration certification

When contained within the military transport case from Campbell Scientific (see [Military transport case](#) (p. 22)), the SkyVUE 8M complies with the following standards:

MIL-STD-810g

DEF STAN 00-035

Further details are available from Campbell Scientific.

## 2.4.8 Compliance and testing

### NOTE:

Further details regarding compliance and testing are available upon request.

EMC compliance: EN 61326-1:2013

Electrical safety compliance: EN 61010-1:2010

Laser safety compliance: EN 60825-1:2014

Eye safety standard: Class 1M

Vibration: BS EN 60068-2-6:2008 Test Fc: Vibration (Sinusoidal)

Frequency range: 5 to 150 Hz (exceeds Lloyd's Register test levels)

# 3. Initial preparation and checks

---

The following steps will provide basic familiarization with the SkyVUE 8M and perform basic functionality checks. To do these, and connect the sensor to its power supply.

## **WARNING:**

The laser begins operating as soon as the power is connected. Do not point the laser in any direction where it could be viewed with magnifying optics.

The green LED visible from above should flash once every 10 seconds (see [FIGURE 5-2](#) (p. 62)).

Connect the SkyVUE 8M **USB** port (see [FIGURE 4-4](#) (p. 21)) to a computer and use a terminal emulation program to set to 115200 baud, 8N1 bits/parity settings.

The computer should identify the USB connection and allocate a port number. Enter the port setting in the terminal emulator program. Older computer operating systems may need upgrading or additional software.

The SkyVUE 8M will output message type 004 (default) every 30 seconds (see [CS messages](#) (p. 64)).

Use the **open 0** command to open the terminal mode. You should now see the prompt **CS136>**. Type **Status** to see the sensor status information described in [Status command](#) (p. 45). If using date/time information, checked it since the date/time can drift up to  $\pm 14$  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 once power is supplied.

Use the **Close** command to exit the terminal mode. It will close automatically after 10 minutes of inactivity.

# 4. Installation

---

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## 4.1 Location and orientation

The SkyVUE 8M 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.

To reduce the service frequency with the unit, place the SkyVUE 8M away from sources of contamination. More regular maintenance will be required when the instrument is placed in areas where contamination is unavoidable.

### **WARNING:**

If installing at an airport, check and follow local guidance for allowed locations for a non-frangible object 1 m (3.2 ft) tall. Please contact Campbell Scientific if frangible fittings are required.

## 4.2 Grounding

The SkyVUE 8M is grounded through its metal feet and ground spikes where used.

## 4.3 Mounting the SkyVUE 8M

1. Mount the SkyVUE 8M in an upright position in a suitably level and secure location; the adjustable leveling feet should help to achieve this.
2. Secure on soft substrates using the ground spikes provided or on any surface using heavy sand-bags.
3. Weigh down and take care that the cable does not become damaged.
4. Deploy the legs as follows ([FIGURE 4-1](#) (p. 17)):
  - a. Release all four locking mechanisms for the four legs and expand the legs fully, starting with the front legs first.
  - b. Locate the pins on each leg under the main body of the sensor and tighten the nuts fully.
  - c. Level the sensor using the leg adjustments.
  - d. Loosen the nuts above each foot and extend the foot to the required length to achieve a level position.
  - e. Retighten the lock nuts on each leg.
  - f. Secure the SkyVUE 8M to the ground using either four ground spikes (supplied) or with a sand-bag placed across each leg.
  - g. Avoid trapping the power and communication cable.





FIGURE 4-1. Military base

## 4.4 Tilt angle

The SkyVUE 8M is designed for vertical use, but can be angled slightly to keep sunlight from shining directly into the sensor, particularly in tropical locations.

The SkyVUE 8M has tilt sensors in both axes to compensate the cloud height when the base is not level. Set or disable cloud height compensation by using the **UNITS** command ([Terminal mode command examples](#) (p. 26)). This feature is useful for mobile or marine applications. Backscatter profile data is NOT compensated but tilt angles are included in data messages.

### NOTE:

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

By default, tilting beyond 45° will trigger the tilt alarm in the output message.

## 4.5 Connectors and wiring

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## 4.5.1 Base connectors

The SkyVUE 8M has one connector on its base for communications and power to the unit.

**NOTE:**

Tilting the unit provides better access to these connectors.

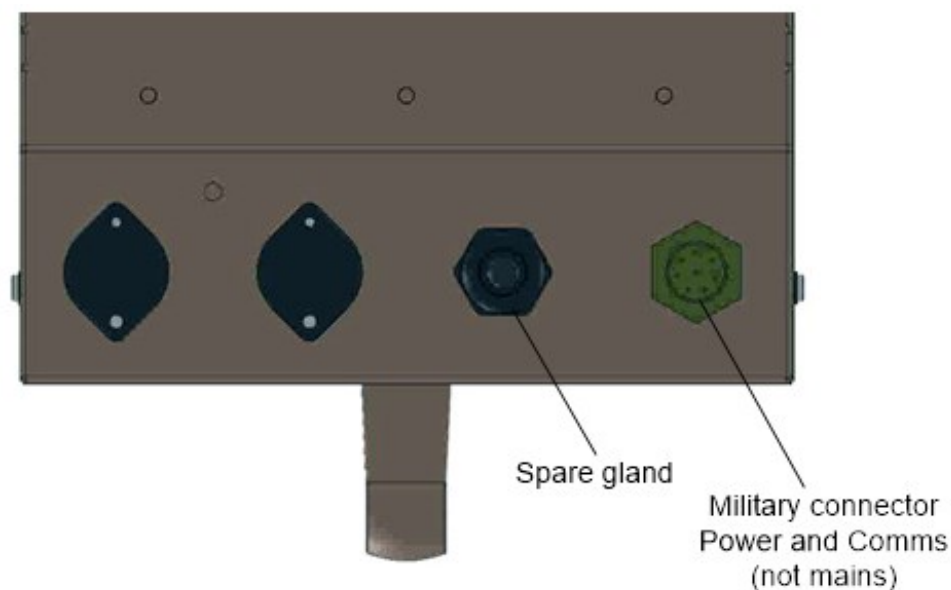


FIGURE 4-2. Connector layout

The function of the connector pins is shown in [Table 4-1](#) (p. 18).

Table 4-1: Power and communications connectors			
Pin on SkyVUE 8M connector	Wire number of supplied cable cores	Description	9-pin D connector (RS-232)
A	1	GND DSP and internal heaters	
B	2	+V DSP and internal heaters 12/24 VDC	
C	3	RS-232 TXD	RS-232,2,RXD
D	4	RS-232 RXD	RS-232,3,TXD
E	5	0 V hood heater	3 (TXD)
F	6	+V hood heater 12/24 VDC	

Table 4-1: Power and communications connectors			
Pin on SkyVUE 8M connector	Wire number of supplied cable cores	Description	9-pin D connector (RS-232)
G	green/yellow	RS-232 resistive GND	RS-232,5,GND
H	cable shield braid terminated with green cable	Cable shield	

The blower/heater connector and cable are located beneath the cowl, which can be removed for access (Table 4-2 (p. 19)). When powered the heater may operate automatically, without warning and may remain hot even when not powered.

Table 4-2: Function of the connector pins for the blower/heater connector		
Pin		
1	Heater 0 V	Black (1)
2	Fan + 12 VDC	Black (2)
3	Thermistor	Black (3)
4	Thermistor / fan (0 V)	Black (4)
5	Switched 24 VDC	Black (5)
6	Switched 12 VDC	Black (6)
E	Earth	Green/yellow

## 4.5.2 Wiring using supplied Campbell Scientific cables

One 5 m (16.4 ft) cable is supplied with the SkyVUE 8M for the power and communications. Please contact Campbell Scientific if longer cables are required.

### **WARNING:**

Incorrectly wiring the power cable can cause irrevocable damage to the unit.

### **WARNING:**

The power cable must not be connected to mains voltage.

### 4.5.2.1 Power connections

The following is a guide for wiring and installing a permanent power supply.

The power source needs to provide the correct voltage and current in excess of the power requirement of the system.

Voltage and current requirements: 10 to 40 VDC input 9 A at 12 VDC, 4.5 A at 24 VDC

DSP and internal heaters input: 3.8A @ 12 VDC, 1.9A at 24 VDC

Hood heater input: 5 A at 12 VDC, 2.5 A at 24 VDC

Total power requirements: 102 W maximum

### 4.5.2.2 Communications connections

The communications cable terminates at one end with a removable 9-pin, D-connector (DB9).

The D-connector connects directly to a computer or data logger such as the Campbell Scientific CR1000X using a suitable interconnecting cable such as the SC110. [FIGURE 4-3](#) (p. 21). The connector can easily be removed for direct connection to screw terminals.

See [www.campbellsci.eu/downloads/skyvue-example-programs](http://www.campbellsci.eu/downloads/skyvue-example-programs) for CRBasic programs that connect the SkyVUE 8M to a Campbell Scientific data logger.

#### **CAUTION:**

The supplied cable is not recommended for lengths greater than 5 m (16 ft). Contact Campbell Scientific if needing longer cable lengths.

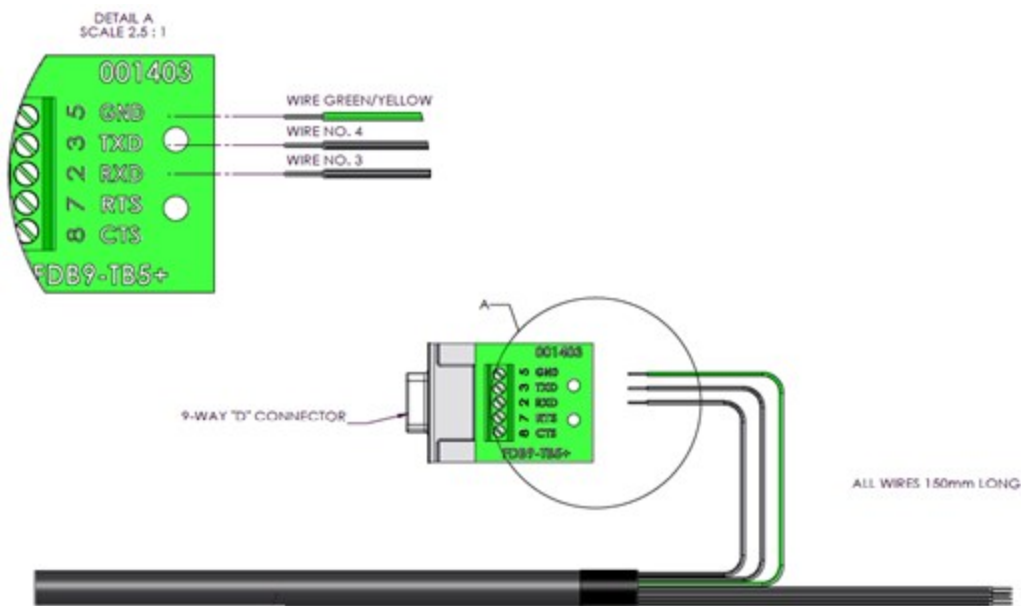


FIGURE 4-3. Cable connections

If fitted with military connectors, see [Table 4-1](#) (p. 18) for wiring descriptions.

### 4.5.3 USB connection

The USB port provided inside the enclosure is for on-site maintenance. It supports communication of commands to the SkyVUE 8M and responses in the same form as the main serial port, except the baud rate is fixed at 115200 (see [FIGURE 4-4](#) (p. 21)).



FIGURE 4-4. USB port

### 4.5.4 I/O connection

The I/O port is only used for factory setting of the instrument.

## 4.6 Military transport case

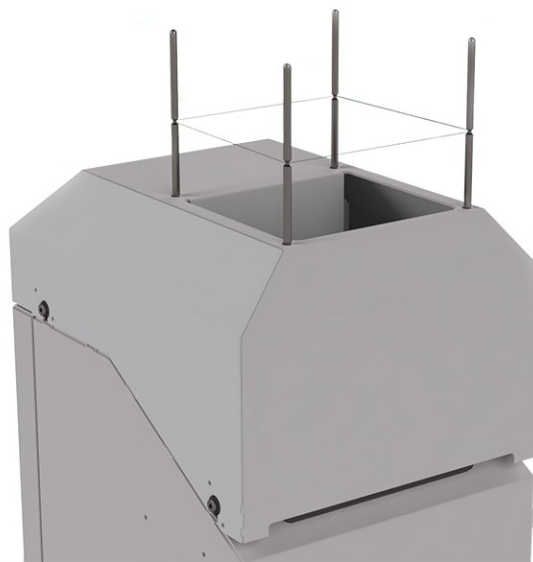
The military transport case can be used for storage and transportation of the SkyVUE 8M and offers protection against the environment, impact and transportation vibration (see [Transport, shock, and vibration certification](#) (p. 13)).

Ensure that the SkyVUE 8M and accessories are appropriately located and that the lid of the case is secured by each of the securing clasps before moving or transporting the case.

While it is ruggedly constructed, do not overload the case or store heavy items upon it.

## 4.7 Bird spike kit

The optional bird spike kit deters birds from sitting on the SkyVUE 8M. It includes four stainless-steel spikes with rounded ends and a small reel of stainless-steel wire. The following figure shows installed bird spikes.



*FIGURE 4-5. Ceilometer bird spike kit installed*

To install the bird spikes, remove the cowl and blanking plugs from the cowl ([FIGURE 4-6](#) (p. 23)). For each hole, place a nut and washer then thread the spike into the hole. Tighten the nuts and washers (see [FIGURE 4-7](#) (p. 23)). Replace the cowl on the SkyVUE 8M.

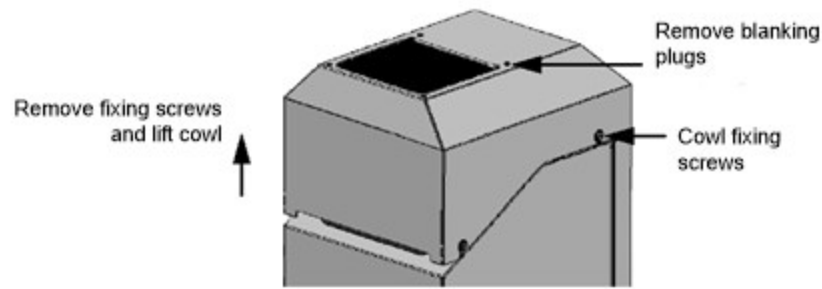


FIGURE 4-6. Preparing the SkyVUE 8M for installing the bird spikes

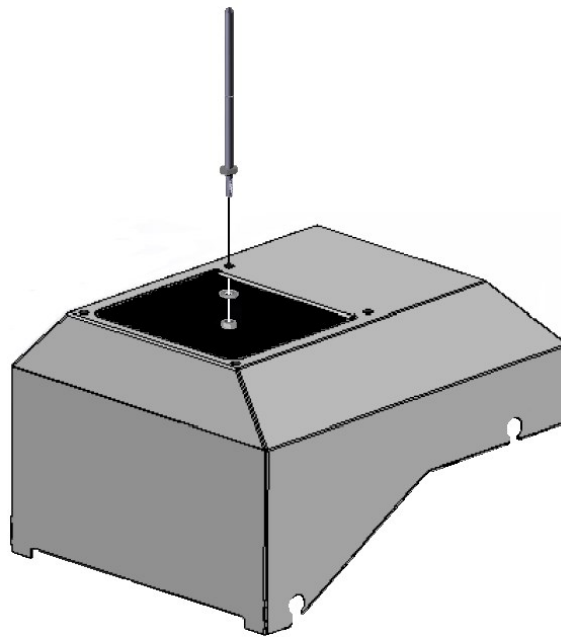


FIGURE 4-7. Attaching bird spikes to the SkyVUE 8M cowl

Wrap the stainless steel wire around each spike using the grooves in the spike then wrap it back on itself.

**CAUTION:**

Do not tighten the wire too much as it may pull the spikes inwards and obscure the field of view of the SkyVUE 8M 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

Store the SkyVUE 8M in a dry place at –40 to 70 °C, preferably with the enclosure securely fastened. Protect the optics from possible accidental damage. .

### NOTE:

Storing the SkyVUE 8M below 0.0 °C will increase the start-up time by up to ten minutes. At –20 °C, the SkyVUE 8M will not achieve full accuracy for an hour.

## 4.9 Fitting the camouflage cover

1. Ensure that the door of the SkyVUE 8M is closed and secure and that the power and communications connector is securely attached.
2. Unfold the cover and place it over the top of the SkyVUE 8M so that the hole in the cover locates over the window aperture.
3. Pull one side down to locate the loop over one hook on the foot.
4. Repeat process with each corner.

# 5. Operation

---

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## 5.1 Terminal mode

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## 5.1.1 Entering/exiting the SkyVUE 8M terminal mode

Use the **OPEN Sensor\_ID Password** command to enter the menu system. The menu will time out and close automatically if not used for ten minutes.

**Sensor\_ID** is the SkyVUE 8M identification, a single character 0-9, a-f, A-F case sensitive. Default is 0. Enter the password if using one. The following text should be displayed:

. **The SkyVUE 8M is now ready for terminal mode commands.**

The SkyVUE 8M commands are not case sensitive, but the parameters and password are case sensitive.

Example of the open command followed by the **0** parameter:

```
OPEN 0
```

Example of the open command with the password **Secret**:

```
OPEN 0 Secret
```

## 5.1.2 Terminal mode commands general

[Table 5-1](#) (p. 27) provides a summary of the terminal mode commands.

To send commands that setup and control the SkyVUE 8M, use the terminal interface, data logger, or terminal emulators built into many Campbell Scientific software products.

### NOTE:

To load an operating system (OS), you need a terminal emulator with XMODEM protocol such as Tera Term.

Use the following settings:

Setting	RS-232/422/485 interface (default)	USB service port
	RS-232	
Baud rate	115200	115200
Data bits	8	8
Parity	none	none
Stop bits	1	1
Flow control	none	none

The baud rate of the SkyVUE 8M must match the port setting baud rate in the terminal emulator. The SkyVUE 8M should now be ready to accept commands.

**NOTE:**

Commands will always output all parameters on a new line after a CR LF (carriage return and line feed) and then the SkyVUE 8M prompt **CS136>**. 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 8M serial port. This example sets the serial port to RS-232 hand shaking at 115200 bps, 8 data bits, no parity.

```
serial 0 10 0
```

To change only the data baud rate, you can replace mode parameter, with a comma (,) 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 a comma (,); you only need to replace the ones up to the parameter you wish to edit.

**NOTE:**

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 four zeros indicate that no other message outputs have been set. The **MCFG** command is described in [Table 5-1](#) (p. 27).

Table 5-1: Summary of the terminal mode commands available		
Command	Parameter/ parameter block	Description
ALARMS	Angle	Angle 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.
APPLICATION	Application_n	<p><b>Application_n</b> selects pre-configured user settings optimized for a specific application. For the following values of n:</p> <ul style="list-style-type: none"> <li>0 = Help</li> <li>10 = Aviation</li> <li>20 = Research</li> <li>40 = Meteorology</li> <li>225 = User defaults</li> </ul> <p>The default application for the SkyVUE 8M is 10, Aviation. Settings adjusted by the <b>APPLICATION</b> command include settings in <b>BS</b>, <b>MCFG</b>, and <b>UNITS</b>.</p>
BS (see <a href="#">Measurement and message intervals</a> (p. 43) for more information on	Attenuated_SCALE, BS_Av_Time, Noise_Gate, Measurement_Period,	<p>Rules for <b>BS</b> command are:</p> <p><b>BS_Av_Time</b> &lt;= <b>Measurement_Period</b>-1s.</p> <p><b>Message_Interval</b> must be a multiple of <b>Measurement_Period</b>.</p> <p><b>Attenuated_SCALE</b> is the scalar for the attenuated backscatter percent. 0.001 to 100% (default 100%)</p>

Table 5-1: Summary of the terminal mode commands available

Command	Parameter/ parameter block	Description
compatibility of different parameters)	<b>Rolling_Average</b> , <b>Message_Interval</b> <b>BS_Temporal_ Filter_Mode</b>	<p><b>BS_Av_Time</b> is the backscatter average time in seconds. 1 to 30 (default 5).</p> <p>Note: Must not be greater than <b>Measurement_Period</b> – 1.0</p> <p><b>Noise_Gate</b> controls the noise threshold applied to back-scatter.</p> <p><b>Noise_Gate</b> = -1000, all backscatter range is corrected.</p> <p><b>Noise_Gate</b> = 0.0 to 1000.0, standard deviation (default 2) for noise threshold. Only backscatter above this is range corrected.</p> <p><b>Measurement_Period</b> = 0 or 2 to 600 seconds (default 10). If set to 0 and the SkyVUE 8M is polled, it will output the last measurement made. If between 2 and 600 seconds, the SkyVUE 8M continually outputs messages. For sky condition output, Campbell Scientific recommends setting the <b>measurement_Period</b> <math>\leq</math> 30 seconds. If a <b>measurement_Period</b> is greater than 30 seconds, the sky condition algorithm will be less able to resolve coverage for higher layers.</p> <p>Note: Must be a sub multiple of <b>Message_Interval</b></p> <p><b>Rolling_Average</b> = 1 to 29 (default ). This is the number of <b>measurement_periods</b> to use in a rolling average of the backscatter.</p> <p><b>Message_Interval</b> is the message interval in seconds. Range is 2 to 600 seconds (default 30 s); 0 gives polled messages.</p> <p>Note: Must be a multiple of <b>Measurement_Period</b></p>

Table 5-1: Summary of the terminal mode commands available

Command	Parameter/ parameter block	Description
		<b>BS_Temporal_Filter_Mode</b> allows the selection of backscatter filtering modes. 0 = Averaging 1 = Median signal processing Default setting is 1, the median mode for aviation.
CLOSE	No parameters	Closes the terminal interface to allow normal message output and saves new settings to flash non-volatile storage.
CLOUDMODE	C1oudMode_A	<b>C1oudMode_A</b> turns on a filter that reports the highest cloud during precipitation to avoid precipitation from being reported as low cloud. 0 = Filter Off 1 = Filter On (default). Reports the highest cloud during precipitation
DEFAULTS	No parameters	Loads factory defaults
GETUSER		Reads all user settings as a string of text. Parameters are read in the following order: <b>user</b> = text user <b>volVer</b> = user volume version <b>OS_VER</b> = DSP OS version <b>PsuOsVer</b> = PSU OS version <b>TopOsVer</b> = TOP OS version <b>Id</b> = SkyVUE 8M ID <b>Pw</b> = SkyVUE 8M password <b>terminalCrc</b> = terminal crc mode <b>terminalTimeout</b> = terminal timeout <b>unitsTiltMode</b> = units and tilt mode <b>hoodHBMode</b> = hood heater / fan heater mode

Table 5-1: Summary of the terminal mode commands available

Command	Parameter/ parameter block	Description
		<p><b>hoodHBTestInt</b> = hood heater / blower test interval in hours</p> <p><b>battBoost_mV</b> = boost voltage used for battery charging mV (not applicable to the SkyVUE 8M)</p> <p><b>battCharge_mA</b> = battery charge current mA (not applicable to the SkyVUE 8M)</p> <p><b>psuPresent</b> = PSU present switch</p> <p><b>hoodHBNormSpeed</b> = fan voltage for normal speed mV</p> <p><b>hoodHBHighSpeed</b> = fan voltage for high speed mV</p> <p><b>hoodHBLowSpeed</b> = fan voltage for low speed mV</p> <p><b>intHMode</b> = internal heater mode</p> <p><b>message[0]</b> = fields for message 0</p> <p><b>message[1]</b> = fields for message 1</p> <p><b>message[2]</b> = fields for message 2</p> <p><b>message[3]</b> = fields for message 3</p> <p><b>message[4]</b> = fields for message 4</p> <p><b>messagePeriod</b> = output message period in seconds</p> <p><b>heightOffset</b> = height offset metres</p> <p><b>bsAvTime</b> = backscatter average time in seconds</p> <p><b>laserMode</b> = laser operation mode</p> <p><b>laserPower</b> = laser power</p> <p><b>laserHeater</b> = laser heater mode</p> <p><b>attenuatedSCALE</b> = attenuated backscatter scaling factor</p> <p><b>logInterval</b> = debug logging interval</p> <p><b>measurementPeriod</b> = measurement interval in</p>

Table 5-1: Summary of the terminal mode commands available

Command	Parameter/ parameter block	Description
		<p>seconds</p> <p><b>rollingAvMeasurements</b> = number used for setting the rolling average</p> <p><b>serialserMode</b> = serial port mode</p> <p><b>serialbaudSel</b> = serial port baud rate mode</p> <p><b>serialdataParityStop</b> = serial port parity mode</p> <p><b>serialrx2txTimeout</b> = serial port RX to TX turnaround time</p> <p><b>snrMarginBoundary</b> = onset of backscatter detection threshold</p> <p><b>snrMarginDetector</b> = cloud detection threshold</p> <p><b>alphaGuessEnd</b> = cloud alpha guess at boundary</p> <p><b>alphaMin</b> = cloud detection alpha minimum</p> <p><b>Vcld_D</b> = cloud detection</p> <p><b>delta_Vcld_D</b> = cloud detection</p> <p><b>vis_Av_T</b> = cloud detection</p> <p><b>alphaGuess</b> = visibility initial alpha guess</p> <p><b>ratioLevel</b> = visibility ratio</p> <p><b>alphaMin</b> = visibility alpha minimum</p> <p><b>viscap</b> = visibility cap in metres</p> <p><b>visFull</b> = vertical visibility full threshold</p> <p><b>visTransparent</b> = vertical visibility transparent threshold</p> <p><b>tiltLimit</b> = tilt limit in degrees used by alarms</p> <p><b>atnoiseGate</b> = attenuated backscatter noise gate mode</p> <p><b>SkvvLimit_percent</b> = sky condition report vertical visibility %</p>

Table 5-1: Summary of the terminal mode commands available

Command	Parameter/ parameter block	Description
		<p><b>alphaGuessStart</b>= cloud detection alpha guess at lowest height bin</p> <p><b>m1hdt</b> = mixing layer height temporal filter (minutes)</p> <p><b>m1hdr</b> = mixing layer height range filter (metres)</p> <p><b>m1hq1threshold</b> = mixing layer height quality factor q1 threshold</p> <p><b>m1hq2threshold</b> = mixing layer height quality factor q2 threshold</p> <p><b>m1hq3threshold</b> = mixing layer height quality factor q3 threshold</p> <p><b>m1hstdWidth</b> = mixing layer height std width (m)</p> <p><b>bsFltMode</b> = back scatter rolling filter mode (28012019c)</p> <p><b>delta_Vcld_det_2</b> = cloud detector type 2 slope threshold in (m/3bins) change in horizontal visibility (14052019a)</p> <p><b>cloudMode</b> = cloud detector mode parameter (03072019a)</p> <p><b>CRC</b> = 4-digit character. CRC calculated from the <b>u</b> up to but not including the CRC using the standard CRC-16.</p> <p>Note: Many parameters are not adjusted. This command allows a reliable technique for copying full settings from one SkyVUE 8M to another with the <b>SETUSER</b> command.</p> <p>A typical response to the <b>GETUSER</b> command is:</p> <pre>&gt;&gt;&gt;&gt; COPY FROM START OF NEXT LINE &gt;&gt;&gt;&gt; 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 4.000E+00</pre>



Table 5-1: Summary of the terminal mode commands available

Command	Parameter/ parameter block	Description
		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 2.00E-03 3.000E+01 1.500E+02 1.800E+00 5.000E+00 1.000E+01 150 98b2 <<<<< TO START OF THIS LINE <<<<<
HEATERS	Hood Internal Laser Test_interval	Sets or reads heater settings as follows: <b>Hood</b> = 0, Hood blower and heater OFF <b>Hood</b> = 1, Hood blower ON and heater OFF <b>Hood</b> = 2, Hood blower ON and heater ON <b>Hood</b> = 3, Hood blower and heater AUTO (default) – (see note (1) below). <b>Internal</b> = 0, Internal heater OFF <b>Internal</b> = 1, Internal heater ON <b>Internal</b> = 2, Internal heater AUTO (default) <b>Laser</b> = 0, laser heater off <b>Laser</b> = 1, laser heater on (default) <b>Test_interval</b> = 1 to 168 hours (default 24 hours). Heater/Blower test interval
HELP	No parameters	Calls up a list of user commands with brief descriptions
HOFFSET	Height_offset	<b>Height_offset</b> is the offset to be added or subtracted in the range of $\pm 10,000$ m ( $\pm 32,808$ 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 character, 0-9, a - z or A - Z, case sensitive. Default ID = 0. Any SkyVUE 8M with firmware OS2 or above will respond to the global ID = 99, regardless of its own ID number.

Table 5-1: Summary of the terminal mode commands available

Command	Parameter/ parameter block	Description
		Note: Lower case letters are not allowed if using a CT25K message.
LASER	Laser Laser_Power	<b>Laser</b> = 0, laser off after power up (user must switch laser on) <b>Laser</b> = 1, laser on after power up (default) <b>Laser_Power</b> = 20% to 100%, default 100%
LASEROFF	No parameters	Instructs the SkyVUE 8M 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 8M to try and turn the laser on
LOADOS	Module	Loads new operating system
MCFG	Message_Interval Message_ID_A Message_ID_B Message_ID_C Message_ID_D Message_ID_E	Set or read message configuration <b>Message_Interval</b> is the message interval in seconds. Range is 2 to 600 s (default 30); 0 gives polled messages.  Note: This command may affect measurement parameters within the <b>BS</b> command. See <a href="#">Measurement and message intervals</a> (p. 43).  <b>Message_ID</b> is the message type to output between 0 and 999 (default 004). If <b>Message_ID</b> = 0, no message type is output. Up to five messages can be set (refer to <a href="#">MCFG command message types</a> (p. 42)).
OPEN	ID Password	Opens the SkyVUE 8M terminal mode <b>ID</b> = Sensor ID as per the terminal <b>ID</b> command. AnySkyVUE 8M with firmware OS2 or newer will respond to global ID = 99, regardless of its own ID number.  <b>Password</b> = The sensors user password as per the terminal <b>PASSWORD</b> command. The default is no password.

Table 5-1: Summary of the terminal mode commands available

Command	Parameter/ parameter block	Description
PASSWORD	Password	Sets or clears a password from 1 to 10 characters in length. Valid characters, 0-9, a - z or A – Z, and letters are case sensitive. Typing the <b>PASSWORD</b> command without any parameters clears the password. The default is no password.
POLL	Sensor_ID Message_ID	Requests <b>Message_ID</b> from <b>Sensor_ID</b> . Refer to <a href="#">Message polling</a> (p. 55) for more information on this command  Note: If <b>Message_ID</b> is omitted, the SkyVUE 8M outputs the message configured by <b>MCFG</b> .
POWEROFF	N/A	Not applicable for SkyVUE 8M.
REBOOT	No parameters	Forces a system reboot. This will restore previously saved user settings. Any unsaved changes will be lost. (Settings are saved in the terminal mode when the <b>CLOSE</b> command is typed, which exits the terminal mode).
SCCAL	No parameters but user interaction required	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 <a href="#">Stratocumulus backscatter calibration</a> (p. 57) for more information.
SERIAL	Mode Baud Bits_Parity Delay	Set or read the serial port. <b>Mode</b> = 0, RS-232, full duplex (default) <b>Mode</b> = 1, RS-232, half duplex <b>Mode</b> = 4, reserved <b>Baud</b> = 0, 300 baud <b>Baud</b> = 1, 600 baud <b>Baud</b> = 2, 1200 baud

Table 5-1: Summary of the terminal mode commands available

Command	Parameter/ parameter block	Description
		<b>Baud</b> = 3, 2400 baud <b>Baud</b> = 4, 4800 baud <b>Baud</b> = 5, 9600 baud <b>Baud</b> = 6, 19200 baud <b>Baud</b> = 7, 38400 baud <b>Baud</b> = 8, 57600 baud <b>Baud</b> = 9, 76800 baud <b>Baud</b> = 10, 115200 baud (default) <b>Bits_Parity</b> = 0, 8 bits, no parity, 1 stop bit (default) <b>Bits_Parity</b> = 1, 7 bits, even parity, 1 stop bit <b>Bits_Parity</b> = 2, 7 bits, odd parity, 1 stop bit
<b>SERVICE</b>	No parameters but user intervention required	Performs a service procedure
<b>SETUSER</b>	String	Load all user settings as a string of text. (not changed) = parameter will not be updated and the previously set value will persist. <b>String</b> = user (not changed) <b>volVer</b> = user volume version (not changed) <b>OS_VER</b> = DSP OS version (not changed) <b>PsuOsVer</b> = PSU OS version (not changed) <b>TopOsVer</b> = TOP OS version (not changed) <b>Id</b> = SkyVUE 8M ID (not changed) <b>Pw</b> = SkyVUE 8M password (not changed) <b>terminalCrc</b> = terminal crc mode <b>terminalTimeout</b> = terminal timeout

Table 5-1: Summary of the terminal mode commands available

Command	Parameter/ parameter block	Description
		<p><b>unitsTiltMode</b> = units and tilt mode</p> <p><b>hoodHBMode</b> = hood heater / fan heater mode</p> <p><b>hoodHBTestInt</b> = hood heater / blower test interval in hours</p> <p><b>battBoost_mV</b> = not applicable to SkyVUE 8M</p> <p><b>battCharge_mA</b> = not applicable to SkyVUE 8M</p> <p><b>psuPresent</b> = PSU present switch</p> <p><b>hoodHBNormSpeed</b> = Fan voltage for normal speed, mV</p> <p><b>hoodHBHighSpeed</b> = Fan voltage for high speed, mV</p> <p><b>hoodHBLowSpeed</b> = Fan voltage for low speed, mV</p> <p><b>intHMode</b> = internal heater mode</p> <p><b>message[0]</b> = fields for message 0</p> <p><b>message[1]</b> = fields for message 1</p> <p><b>message[2]</b> = fields for message 2</p> <p><b>message[3]</b> = fields for message 3</p> <p><b>message[4]</b> = fields for message 4</p> <p><b>messagePeriod</b> = output message period in seconds</p> <p><b>heightOffset</b> = height offset metres</p> <p><b>bsAvTime</b> = backscatter average time in seconds</p> <p><b>laserMode</b> = laser operation mode</p> <p><b>laserPower</b> = laser power</p> <p><b>laserHeater</b> = laser heater mode</p> <p><b>attenuatedSCALE</b> = attenuated backscatter scaling factor</p> <p><b>logInterval</b> = debug logging interval</p>

Table 5-1: Summary of the terminal mode commands available

Command	Parameter/ parameter block	Description
		<p><b>measurementPeriod</b> = measurement interval in seconds</p> <p><b>rollingAvMeasurements</b> = number used for the rolling average</p> <p><b>serialserMode</b> = serial port mode</p> <p><b>serialbaudSel</b> = serial port baud rate mode</p> <p><b>serialdataParityStop</b> = serial port parity mode</p> <p><b>serialrx2txTimeout</b> = serial port RX to TX turnaround time</p> <p><b>snrMarginBoundary</b> = onset of back-scatter detection threshold</p> <p><b>snrMarginDetector</b> = cloud detection threshold</p> <p><b>alphaGuessEnd</b> = cloud alpha guess at boundary</p> <p><b>alphaMin</b> = cloud detection alpha minimum</p> <p><b>Vcld_D</b> = cloud detection</p> <p><b>delta_Vcld_D</b> = cloud detection</p> <p><b>vis_Av_T</b> = cloud detection</p> <p><b>alphaGuess</b> = visibility initial alpha guess</p> <p><b>ratioLevel</b> = visibility ratio</p> <p><b>alphaMin</b> = visibility alpha minimum</p> <p><b>visCap</b> = visibility cap in metres</p> <p><b>visFull</b> = vertical visibility, full threshold</p> <p><b>visTransparent</b> = vertical visibility, transparent threshold</p> <p><b>tiltLimit</b> = tilt limit in degrees used by alarms</p> <p><b>atnoiseGate</b> = attenuated backscatter noise gate mode</p> <p><b>SkyvvLimit_percent</b> = sky condition report</p>

Table 5-1: Summary of the terminal mode commands available

Command	Parameter/ parameter block	Description
		<p>vertical visibility %</p> <p><b>alphaGuessStart</b> = cloud detection alpha guess at lowest height bin</p> <p><b>m1hdt</b></p> <p><b>m1hdr</b></p> <p><b>m1hq1threshold</b> = mixing layer height quality threshold 1</p> <p><b>m1hq2threshold</b> = mixing layer height quality threshold 2</p> <p><b>m1hq3threshold</b> = mixing layer height quality threshold 3</p> <p><b>m1hstdWidth</b> = mixing layer height standard deviation width in metres</p> <p><b>bsFltMode</b> = back scatter rolling filter mode (28012019c)</p> <p><b>delta_Vcld_det_2</b> = cloud detector type 2 slope threshold in m/3bins, change in horizontal visibility (14052019a)</p> <p><b>cloudMode</b> = cloud detector mode parameter (03072019a)</p> <p><b>CRC</b> = 4-digit character. CRC calculated from the <b>u</b> up to but not including the CRC using the standard CRC-16.</p> <p>Note: String is added as text and should be cut and pasted from a stored file.</p>
STATUS	No parameters	<p>Outputs SkyVUE 8M, 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,</p>

Table 5-1: Summary of the terminal mode commands available

Command	Parameter/ parameter block	Description
		temperatures, supply voltages, height offset, visibility cap, laser run days, window parameters, backscatter parameters, features, alarms, warnings, and status.  Note: Refer to <a href="#">Status command</a> (p. 45) for more information on this command
TERMINAL	Terminal Timeout	Sets the user terminal time out.  Timeout is the delay in minutes from 1 to 15 where the terminal will automatically close if no characters are sent to the SkyVUE 8M. The default is 10 minutes.
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  For example: time 2013/05/25 10:00:00, sets the date and time to May 25, 2013 at 10:00:00  Note: The set time could drift by up to $\pm 14$ 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
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:**

If AUTO is set, then the heater / blower will heat to 80 °C if cloud/visibility event detected 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 Application command message types

The **Application\_n** parameter for the APPLICATION command defines settings to optimize the ceilometer for a range of applications, Aviation, Research and Meteorology. The default application setting for the SkyVUE 8M is Aviation, but this can be changed, or returned to, using the **Application\_n** command.

Users can adjust any element of these settings once an application has been applied through the following individual commands: **ALARMS**, **BS**, **CLOUDMODE**, **MCFG** and **UNITS**.

Table 5-2: Summary of applications and applied settings for SkyVUE 8M			
Settings	Application modes for SkyVUE 8M using OS2 and newer		
	Aviation (default)	Research	Meteorology
ALARMS (tilt degs)	30	45	45
APPLICATION: Application n (sets user application settings)	Application 10	Application 20	Application 40
BS: Attenuated scale (%)	100	100	100
BS: Backscatter averaging time (s)	2	7	7
BS: Noise Gate	2 (ON)	-1000 (OFF)	-1000 (OFF)
BS: Measurement Period (s)	10	10	10
BS: Rolling Averages (sets the number of readings for averaging. Alternative description: Backscatter temporal filter rolling samples)	3	6	3
BS: Message Interval (s)	30	30	30
BS: BS_Temporal_Filter_Mode (Sets Averaging or Median Mode.)	1 (Median)	0 (Average)	0 (Average)
CLOUDMODE: CloudMode_A (Reports highest cloud only during precipitation)	ON	OFF	ON

Table 5-2: Summary of applications and applied settings for SkyVUE 8M			
	Application modes for SkyVUE 8M using OS2 and newer		
Settings	Aviation (default)	Research	Meteorology
MCFG: Message ID	4 (CB,SC,BS)	6 (CB,SC,MLH,BS)	4 (CB,SC,BS)
UNITS	2 (Feet, tilt corrected)	0 (Metres, tilt corrected)	0 (Metres, tilt corrected)

## 5.1.5 MCFG command message types

The **Message\_ID\_x** parameter for the **MCFG** commands defines the output types. Refer to [Messages](#) (p. 62) for further information on message output types.

Table 5-3: Summary of message ID and descriptions	
Message_ID_x type	Description
000	No message
001	Campbell Scientific Message 1, no sky condition, no profile data
002	Campbell Scientific Message 2, no sky condition, profile data, 1600 range bins, 5 m resolution. 2048 bins in total are output. However, after bin 1600, the bins only contain zeros.
003	Campbell Scientific Message 3, sky condition, no profile data
004 (default)	Campbell Scientific Message 4, sky condition and profile data, 1600 range bins, 5 m resolution. 2048 bins in total are output. However, after bin 1600, the bins only contain zeros.
101	CL31 Message 1, 770 range bins, 10 m resolution
102	CL31 Message 1, 385 range bins, 20 m resolution
103	CL31 Message 1, 1500 range bins, 5 m resolution
104	CL31 Message 1, 770 range bins, 5 m resolution

Table 5-3: Summary of message ID and descriptions	
Message_ID_x type	Description
105	CL31 Message 1, No profile data
106	CL31 Message 1, Full SkyVUE 8M output, 1600 range bins, 5 m resolution. 2048 bins in total are output. However, after bin 1600, the bins only contain zeros.
107	CL31 Message 2, 770 range bins, 10 m resolution
108	CL31 Message 2, 385 range bins, 20 m resolution
109	CL31 Message 2, 1500 range bins, 5 m resolution
110	CL31 Message 2, 770 range bins, 5 m resolution
111	CL31 Message 2, No profile data
112	CL31 Message 2, Full SkyVUE 8M output, 1600 range bins, 5 m resolution. 2048 bins in total are output. However, after bin 1600, the bins only contain zeros.
113	CT25K Message 1
114	CT25K Message 6

## 5.1.6 Measurement and message intervals

The message interval is the time, in seconds, between the automatic message transmissions. It can be set between 2 to 600 s (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 600 s (default is 10 s). If it is set to 0, then measurements must be polled.

The rolling average (1 to 29, default ) 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:





Line	Example line output
1	Identification CS136 SN1000 ID 0
Description of the line sections	
Section	Description
CS136	Product name
SN1000	Sensor serial number
ID 0	Sensor identification number

Line	Example line output
2	Date Time 2012/01/10 11:39:46
Description of the line sections	
Section	Description
2012/01/10	Date in the format yyyy/mm/dd
11:39:46	Time in the format hh:mm:ss

Line	Example line output
3	DSP_OS A
Description of the line sections	
Section	Description
A	DSP OS revision number

Line	Example line output
4	TOP_OS_HW 8 2
Description of the line sections	
Section	Description
A	TOP board OS revision number

Line	Example line output
5	PSU_OS 1
Description of the line sections	
Section	Description
A	PSU board OS revision number

Line	Example line output
6	Watchdog A
Description of the line sections	
Section	Description
A	Watchdog counter for unscheduled system resets

Line	Example line output
7	Serial A B C D
Description of the line sections	
Section	Description
A	Serial mode (Note: Refer to the SERIAL command)
B	Serial baud rate (Note: Refer to the SERIAL command)
C	Parity and stop bits (Note: Refer to the SERIAL command)

Line	Example line output
8	Heaters A B C D
<b>Description of the line sections</b>	
Section	Description
A	Hood blower mode
B	Internal heater mode
C	Laser heater mode
D	Heater/blower test interval in hours

Line	Example line output
9	MCFG X A B C D E
<b>Description of the line sections</b>	
Section	Description
X	Message interval (Note: Refer to the MCFG command)
A	Message ID A (Note: Refer to the MCFG command)
B	Message ID B (Note: Refer to the MCFG command)
C	Message ID C (Note: Refer to the MCFG command)
D	Message ID D (Note: Refer to the MCFG command)
E	Message ID E (Note: Refer to the MCFG command)

Line	Example line output
10	Angle A B C
<b>Description of the line sections</b>	
Section	Description
A	X axis tilt
B	Y axis tilt
C	Beam angle from vertical



Line	Example line output
11	Units A
Description of the line sections	
Section	Description
A	Measurement units and tilt correction. (Note: Refer to the UNITS command)

Line	Example line output
12	TRH A B C
Description of the line sections	
Section	Description
A	Sensor internal temperature reading in degrees Celsius
B	Sensor internal humidity reading as a percentage
C	Sensors internal dew point value in degrees Celsius

Line	Example line output
13	T A B C D E F
Description of the line sections	
Section	Description
A	External fan blower assembly temperature in degrees Celsius
B	PSU internal temperature in degrees Celsius
C	TOP board laser monitor temperature in degrees Celsius
D	TOP board calibration LED temperature in degrees Celsius
E	Laser module temperature in degrees Celsius
F	Photo diode module temperature in degrees Celsius

Line	Example line output
14	SupplyVoltage A B
<b>Description of the line sections</b>	
Section	Description
A	DSP board supply voltage
B	internal supply voltage
C	Cyclic power cycle counter. Resets after 31 cycles
D	Hood heater voltage
E	Internal heater voltage

Line	Example line output
15	HOffset A
<b>Description of the line sections</b>	
Section	Description
A	Height offset reported in feet or metres dependent upon the UNITS command

Line	Example line output
16	Visibility Cap A
<b>Description of the line sections</b>	
Section	Description
A	Vertical visibility maximum range

Line	Example line output
17	LaserRunDays A
Description of the line sections	
Section	Description
A	Number of days that the laser module has been active for

Line	Example line output
18	WindowTX A
Description of the line sections	
Section	Description
A	Window transmittance %

Line	Example line output
19	BS A B C D E F (Note: refer to the BS command)
Description of the line sections	
Section	Description
A	Attenuated scale
B	Averaging time
C	Noise Gate
D	Measurement period
E	Rolling average
F	Message interval

Line	Example line output
21	Features A
Description of the line sections	
Section	Description
A	List of features enabled

Line	Example line output
22	Flags 0000 0000 0000
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.	
Bit	Description
8000 XXXX XXXX	Units. feet = 0, metres = 8
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 (not applicable to the SkyVUE 8M)
0100 XXXX XXXX	Mains supply has failed (requires a PSU to be present) (not applicable to the SkyVUE 8M)
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

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

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

## 5.1.8 Message polling

The **POLL Sensor\_ID Message\_ID** command requests the **Message\_ID** from the **Sensor\_ID**. Where **Message\_ID** is a SkyVUE 8M message type as defined in [MCFG command message types](#) (p. 42).

The following example uses the SkyVUE 8M **POLL** command to request preconfigured message outputs.

First configure the SkyVUE 8M to use polling mode from the terminal interface via the **MCFG** command as follows:

```
MCFG 0
```

```
010000
```

This configures the SkyVUE 8M 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.

**CLOSE**

**COMMAND CLOSED**

Automatic message outputs should continue. Type the **POLL** command as shown below to verify that the system is working as expected.

**NOTE:**

Once 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 default message output was set. Therefore, the **POLL** command returns text similar to the following.

**NOTE:**

If you have no message configured, the **MCFG** command returns **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.

To poll the SkyVUE 8M for a particular message type, enter the following.

**POLL 0 113**

This command requests CT25K Message 1 and should look similar to the following.

CT00010

10 12345 ///// ///// 00000f80

## 5.1.9 Loading a new operating system (OS)

A new OS can be entered with the **LOADOS** command.



**NOTE:**

The new OS must be sent using xmodem protocol using Tera Term. See [Terminal mode commands general](#) (p. 25).

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: **CS136>**

Type the command: **LOADOS**

The SkyVUE 8M 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 8M will return the message:

**Updating DSP OS, please wait....PASS**

**Updating TOP OS, please wait....PASS**

**Updating PSU OS, please wait....PASS**

**Wait 40 sec for OS to restart**

Afterwards, the SkyVUE 8M will resume operation according to the previously set operating parameters. It will no longer be in terminal mode.

## 5.1.10 Stratocumulus backscatter calibration

The **SCCAL** command 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.

Set the **Measurement\_Period** to 10 (see [Table 5-1](#) (p. 27)).

A detailed description of this technique is given in: Ewan J. O'Connor, Anthony J. Illingworth, and Robin J. Hogan, 2004: A Technique for Autocalibration of Cloud Lidar. *Journal of Atmospheric and Ocean Technology*, **21**, pp 777 – 786.

Enter terminal mode by typing **Open 0** (for a sensor with an ID of 0)

This will return the prompt: **CS136>**

Type **SCCAL**

The SkyVUE 8M 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 then type return.

The SkyVUE 8M will respond: **70 m entered, is this correct? "Y", "N" or "Q"**

Type **Y** to confirm. If you have entered an incorrect number, type **N** and you will be able to replace it. Type **Q** to quit the calibration and return to the terminal command prompt.

The SkyVUE 8M will respond:

**For correct calibration a trained human observer must confirm that the layer is between 250 m (820 ft) to 2500 m (8200 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** and the SkyVUE 8M 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 rough guide, if the calibration factor has changed by less than 20%, there is 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 [Service command](#) (p. 59)).

Type **Y** to confirm and the SkyVUE 8M 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 to 2500 m / 820 ft to 8200 ft)
- Try again when layer is stable
- Error ... Not enough data available try again in 10 minutes.

## 5.1.11 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 character, for example **open 0;233A**. 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.

To find the valid CRC-16 for a command, type the command and then type: ;?????. For example, typing **open 0;????** gives the response [CRLF]CRC>233A<CRC[CRLF] so **233A** is the CRC-16.

The CRC-16 is not case sensitive.

### NOTE:

Make sure the terminal software sends [CR] and not [CRLF] for the command-line termination.

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

Terminal command	CRC-16
open 0	233A
close	D94E
status	7CE5
password	EB85
terminal 0 (this command will remove CRC-16 checking)	B576
defaults	7D8E
serial	7FCE

## 5.1.12 Service command

The service command triggers the SkyVUE 8M 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 8M 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
- Inclinator 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 8M outputs a STATUS message, then goes through various self-test routines 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 side fan at the top)**

**Press Enter to continue**

Cover the detector window and press **Enter** . The computer will respond:

**wait for new measurement.....**

**Place white test surface onto laser window (right side fan at the top)**

**Press Enter to continue**

Cover the laser window and press **Enter** . The computer will respond:

**wait for new measurement.....**

**Remove white test surface from laser window. Press Enter to continue.**

When this is complete, the SkyVUE 8M will output a string of diagnostic data similar. This is useful for a Campbell Scientific engineer investigating problems with the SkyVUE 8M.

## 5.1.13 Locked features

Optional features are protected by a key. They are enabled by typing UNLOCK followed by entering the key. This is specific to the individual SkyVUE 8M and only has to be entered once.

## 5.2 Restoring factory defaults

Restore factory defaults by using the DEFAULTS command in the terminal mode.

### Hard Reset

Alternatively, use the RESET push switch on the DSP to restore factory defaults ([FIGURE 5-1](#) (p. 61)).

#### **WARNING:**

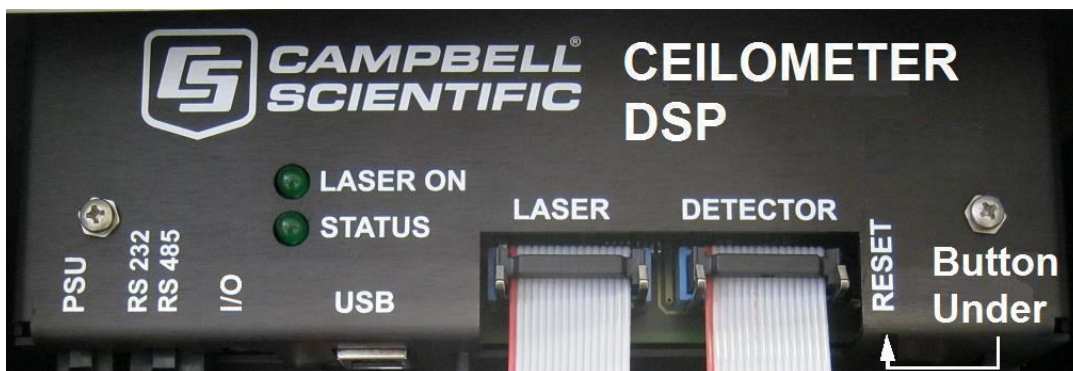
Opening the access lid **MUST** be carried out by a competent person, who has sufficient training, experience and knowledge both in electrical safety and the detail and operation of the sensor.

#### **WARNING:**

Opening the access lid may expose hot surfaces.

Use a narrow tool such as a screw driver to reach the reset switch.

If the reset switch is pushed for four seconds, the SkyVUE 8M will reboot in exactly the same way as the REBOOT terminal command. If it is held closed while the SkyVUE 8M is powered off and on again, it will return to factory defaults. To power cycle the SkyVUE 8M, disconnect the battery and switch the main power off and on.



*FIGURE 5-1. Restoring factory defaults*

## 5.3 LED indicator



*FIGURE 5-2. LED indicator*

A green LED is visible through the window, see [FIGURE 5-2](#) (p. 62). It will give 0.5 second flashes as follows:

Permanently on = top board firmware fault

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

---

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## 6.1 Data messages general

The SkyVUE 8M 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 8M messages

This is based on the CRC-16 with the output XOR'd with Hex 0xFFFF and outputs a two-byte CRC-16 character. The CRC-16 is calculated on all characters after the SOH character up to and including the ETX character.

The following example uses the C code to calculate the SkyVUE 8M 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

### 6.3.1 MESSAGE 001 (no profile, no sky condition)

#### Example message line outputs

CS0001001

10 087 00139 ///// ///// ///// 8000000000000

942f

#### LINE 1

SOH CS ID OS N STX CR LF

where

SOH = Start-of-Heading character

CS = Always "CS"

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

OS (3 characters) = Operating system, 001 to 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

Table 6-1: Most significant alarm word for CS messages	
Bit <sup>1</sup>	Description
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 (not applicable to the SkyVUE 8M)
0100 XXXX XXXX	Mains supply has failed (requires a PSU to be present) (not applicable to the SkyVUE 8M)

Table 6-1: Most significant alarm word for CS messages	
Bit <sup>1</sup>	Description
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
<sup>1</sup> Alarm words are sum of error bits.	

Table 6-2: Middle alarm word for CS messages	
Bit <sup>1</sup>	Description
XXXX 8000 XXXX	The sensors internal humidity is high
XXXX 4000 XXXX	Communications to the DSP board temperature and humidity chip have failed
XXXX 2000 XXXX	DSP input supply voltage is low
XXXX 1000 XXXX	Self-test active
XXXX 0800 XXXX	Watch dog counter updated
XXXX 0400 XXXX	User setting stored in flash failed their signature checks
XXXX 0200 XXXX	DSP factory calibration stored in flash has failed its signature check
XXXX 0100 XXXX	DSP board OS signature test failed
XXXX 0080 XXXX	DSP board RAM test failed
XXXX 0040 XXXX	DSP boards on board PSUs are out of bounds
XXXX 0020 XXXX	TOP board non-volatile storage is corrupt
XXXX 0010 XXXX	TOP board OS signature test has failed

**Table 6-2: Middle alarm word for CS messages**

Bit <sup>1</sup>	Description
XXXX 0008 XXXX	TOP boards ADC and DAC are not within specifications
XXXX 0004 XXXX	TOP boards on board PSUs are out of bounds
XXXX 0002 XXXX	Communications have failed between TOP board and the DSP
XXXX 0001 XXXX	Photo diode background radiance is out of range
<sup>1</sup> Alarm words are sum of error bits.	

**Table 6-3: Least significant alarm word for CS messages**

Bit <sup>1</sup>	Description
XXXX XXXX 8000	Photo diode temperature is out of range
XXXX XXXX 4000	Photo diode is saturated
XXXX XXXX 2000	Photo diode calibrator temperature is out of range
XXXX XXXX 1000	Photo diode calibrator has failed
XXXX XXXX 0800	The sensor could not reach the desired gain levels
XXXX XXXX 0400	Laser run time or maximum laser drive current has been exceeded
XXXX XXXX 0200	Laser temperature out of range
XXXX XXXX 0100	Laser thermistor failure
XXXX XXXX 0080	Laser is obscured. This can only be set if the laser is on
XXXX XXXX 0040	Laser did not achieve significant output power
XXXX XXXX 0020	Laser max power exceeded
XXXX XXXX 0010	Laser max drive current exceeded
XXXX XXXX 0008	Laser power monitor temperature out of range
XXXX XXXX 0004	Laser power monitor test fail
XXXX XXXX 0002	Laser shutdown by top board
XXXX XXXX 0001	Laser is off
<sup>1</sup> Alarm words are sum of error bits.	

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

## 6.3.2 MESSAGE 002 (Profile, no sky condition)

### Example message line outputs

CS0001002

10 085 01123 ///// ///// ///// 8000000000000

00100 05 2048 100 +40 02 0074 0070 30 000

0c5df047.....00000 (Line output cropped for clarity)

9f68

### LINE 1

SOH CS ID OS N STX CR LF

where

SOH = Start-of-Heading character

CS = Always CS

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

OS (3 characters) = Operating system, 001 to 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 and Line Feed

### LINE 3

scale\_res\_n\_energy\_lt\_ti\_bl\_pulse\_rate\_sum CR LF



### 6.3.3 MESSAGE 003 (no profile, sky condition)

#### Example message line outputs

```
CS0001003
10 091 00828 ///// ///// ///// 8000000000000
99 //// 0 //// 0 //// 0 //// 0 ////
f62a
```

#### LINE 1

SOH CS ID OS N STX CR LF

where

SOH = Start-of-Heading character

CS = Always CS

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

OS (3 characters) = Operating system, 001 to 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 10 s of metres or 100 s of feet

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



h2 (4 characters) = Height of the 2nd cloud layer in 10 s of metres or 100 s 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 10 s of metres or 100 s 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 10 s of metres or 100 s 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 10 s of metres or 100 s 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 8M 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

## 6.3.4 MESSAGE 004 (profile, sky condition) — default message

**Example message line outputs**

CS0001004

10 092 00698 /// /// /// 800000000000

99 /// 0 /// 0 /// 0 /// 0 ///

00100 05 2048 100 +40 02 0074 0070 30 000

071fc024d.....000 (Line output cropped for clarity)

6212

## LINE 1

SOH CS ID OS N STX CR LF

where

SOH = Start-of-Heading character

CS = Always CS

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

OS (3 characters) = Operating system, 001 to 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\_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 10 s of metres or 100 s of feet

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

h2 (4 characters) = Height of the 2nd cloud layer in 10 s of metres or 100 s 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 10 s of metres or 100 s 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 10 s of metres or 100 s 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 10 s of metres or 100 s 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 8M has been operating for 30 minutes.

LINE 4

scale\_res\_n\_energy\_lt\_ti\_bl\_pulse\_rate\_sum CR LF

where

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

res (2 characters) = Backscatter profile resolution in metres

n (4 characters) = Profile length

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

It (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 to 2500)

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

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

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

CR LF = Carriage Return + Line Feed

LINE 5

SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS.....(2048 x 5 bytes) CR LF

The two-way attenuated normalized backscatter profile ([Backscatter profile reporting](#) (p. 7)

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

## 6.4 CL31 messages

### 6.4.1 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 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 character, 0 to 9, a to z or A to Z, case sensitive. Default ID = 0

OS = Operating system, 100 to 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

## 6.4.2 MESSAGES 107 - 112, CL31 Message 2

### Example message 107 line outputs

```
CL017021
10 01407 ///// ///// 00000000E080
99 /// 0 /// 0 /// 0 /// 0 ///
00100 10 0770 100 +40 095 02 0031 L0112HN30 000
03301009.....027F      (Line output 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 character, 0 to 9, a to z or A to Z, case sensitive. Default ID = 0

OS = Operating system, 100 to 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 8000 m (samples after 1600 are 00000)

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 to 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 (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 10 s of metres or 100 s of feet

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

h2h2h2 (3 characters) = Height of the 2nd cloud layer in 10 s of metres or 100 s 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 10 s of metres or 100 s 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 10 s of metres or 100 s of feet, if no 4th layer is reported h4h4h4 = ///.

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

h5h5h5 (3 characters) = Height of the 5th cloud layer in 10 s of metres or 100 s of feet, if no 5th layer is reported h5h5h5 = ///.

CR LF = Carriage Return + Line Feed

**NOTE:**

Cloud amount and height cannot be reported until the SkyVUE 8M has been operating for 30 minutes.

**LINE 4**

scale\_res\_n\_energy\_lt\_tr\_ti\_bl\_L0112HN15\_sum CR LF

where

scale (5 characters) = Scale parameter, %, 0 to 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, %





where

SOH = Start-of-Heading character

CT = Always CT

ID (1 character) = Unit number 0 to 9, A to 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

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 = Height of highest signal detected

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

Table 6-4: Most significant alarm word for CT25K messages	
Bit <sup>1</sup>	Description
8000 XXXX	Transmitter shut-off
4000 XXXX	Transmitter failure
2000 XXXX	Receiver failure
1000 XXXX	DSP, voltage or memory failure
0800 XXXX	Reserved for future use
0400 XXXX	Reserved for future use
0200 XXXX	Reserved for future use
0100 XXXX	Reserved for future use
0080 XXXX	Window contaminated
0040 XXXX	Battery low (not applicable to the SkyVUE 8M)
0020 XXXX	Transmitter expire warning
0010 XXXX	Heater or humidity sensor failure
0008 XXXX	High radiance warning, also XXXX 0004
0004 XXXX	DSP, receiver, or laser monitor failure warning
0002 XXXX	Relative humidity > 85 %
0001 XXXX	Light path obstruction, receiver saturation or receiver failure
<sup>1</sup> Alarm words are sum of error bits.	

Table 6-5: Second alarm word for CT25K messages	
Bit <sup>1</sup>	Description
XXXX 8000	Blower failure
XXXX 4000	Reserved for future use
XXXX 2000	Reserved for future use
XXXX 1000	Reserved for future use
XXXX 0800	Blower on

Table 6-5: Second alarm word for CT25K messages	
Bit <sup>1</sup>	Description
XXXX 0400	Blower heater on
XXXX 0200	Internal heater on
XXXX 0100	Units metres if on, feet if off
XXXX 0080	Polling mode on
XXXX 0040	Working from battery (not applicable to the SkyVUE 8M)
XXXX 0020	Always 0
XXXX 0010	Always 0
XXXX 0008	Tilt beyond limit set by user, default 45 degrees
XXXX 0004	High radiance warning, also 0008 XXXX
XXXX 0002	Reserved for future use
XXXX 0001	Reserved for future use
<sup>1</sup> Alarm words are sum of error bits.	

CR LF = Carriage Return + Line Feed

### LINE 3

ETX CR LF

ETX = End-of-Text Character

CR LF = Carriage Return + Line Feed

## 6.5.2 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 to 9, A to 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 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 = Height of highest signal detected

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 (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 10 s of metres or 100 s of feet

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

h2h2h2 (3 characters) = Height of the 2nd cloud layer in 10 s of metres or 100 s 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 10 s of metres or 100 s 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 10 s of metres or 100 s 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 8M has been operating for 30 minutes.

### LINE 4

ETX CR LF

ETX = End-of-Text Character

CR LF = Carriage Return + Line Feed

# 7. Maintenance

---

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## 7.1 General

The SkyVUE 8M 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 8M 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 8M 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.

When the top cover is removed, avoid spraying the fan assembly with liquids. Use damp lens wipes or a clean soft cloth to clean the windows.

Use an air duster to blow any loose dust and dirt from the window as a first step. Use 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.

## 7.3 Diagnostic LED indicators within the enclosure

The **LASER ON** and **STATUS** green LEDs are visible on the DSP (see [FIGURE 7-1](#) (p. 88)). Their function is as follows:

### LASER ON LED:

- Off = laser off
- Flashing = laser fault
- On = laser on

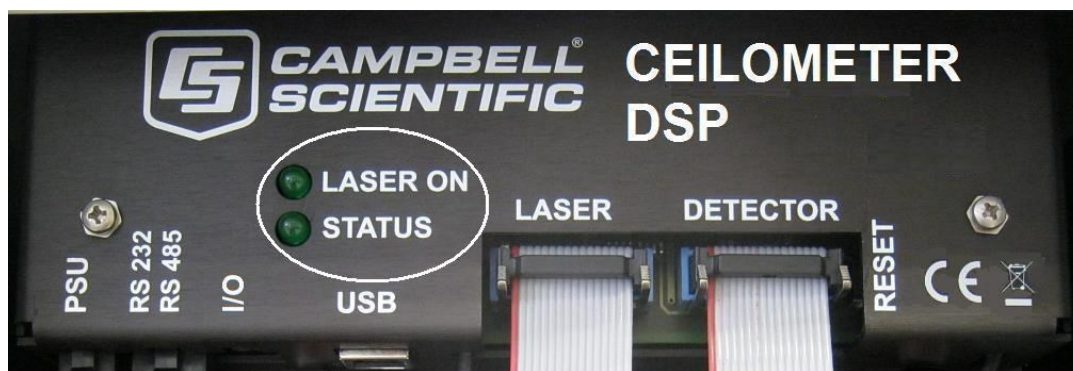
### STATUS LED:

- 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 provides the same function as the LED visible through the top window.

The red LED on the PSU flashes for 0.5 seconds:

- Permanently on = PSU firmware fault
- 1 flash every 10 seconds = PSU OK
- 3 flashes every 10 seconds = no communications to the DSP. This takes 60 seconds to start after a communications failure.



*FIGURE 7-1. Diagnostic LED indicators*

The red LED on the laser module indicates:

- Off = Laser off
- On = Laser on



# Appendix A. Measurement of the attenuated backscatter profile

---

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A.3 Produce attenuated backscatter output message .....	90

## A.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 8M.
- Apply the backscatter calibration constants.
- Remove the laser and electronic artefact signature. This is specific to the individual SkyVUE 8M and determined during calibration.

## A.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.

## A.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 (65.6 ft) detection threshold — this is customer configurable.
- The lower height range bins do not gate noise until the backscatter reaches zero.

# Appendix B. 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 3200 m (10,499 ft) with a slope of 91 m (299 ft) per bin 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  $\pm 30$  m (98 ft) below 1500 m (4921 ft) and 300 m (984 ft) above 1500 m (4921 ft). The lowest cloud height is used. If a thin cloud identified by Criterion 2 above is within  $\pm 150$  m (492 ft) of a cloud identified by criterion 1, then the thin cloud is ignored.

# Appendix C. Sky condition algorithm description

---

The SkyVUE 8M sky condition algorithm follows guidance from ICAO and WMO documents<sup>1</sup> 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:

Height	Bin width
0 – 5000 ft (0 – 1524 m)	100 ft (30.5 m)
5000 – 15,000 ft (1524 – 4572 m)	200 ft (61 m)
15,000 – 26,250 ft (4572 – 8000 m)	500 ft (152 m)

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

$$H_i = \sum(h_i w_i) / \sum(w_i)$$

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:

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

---

<sup>1</sup>ICAO 9837 Manual on Automatic Meteorological Observing Systems at Aerodromes.  
WMO – No. 306 Manual on Codes

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.

Height range	Distance (D)
Height $\leq$ 300 m (1000 ft)	$\leq$ 90 m (300 ft)
300 m $<$ Height $\leq$ 900 m (1000 ft $<$ Height $\leq$ 3000 ft)	$\leq$ 120 m (400 ft)
900 m $<$ Height $\leq$ 1500 m (3000 ft $<$ Height $\leq$ 5000 ft)	$\leq$ 180 m (600 ft)
1500 m $<$ Height $\leq$ 2400 m (5000 ft $<$ Height $\leq$ 8000 ft)	$\leq$ 300 m (1000 ft)
Height $>$ 2400 m (8000 ft)	$\leq$ 480 m (1600 ft)

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

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

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:

$$(W_2/(W_{\max}-W_1)) \times 8$$

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  $\geq$  1/33 oktas

Layer 2  $\geq$  3 oktas

Layer 3  $\geq$  5 oktas

Layer 4  $\geq$  7 oktas

Layer 5  $\geq$  7 oktas

Any layer  $>$   $(8 - 1/33)$  oktas is reported as 8 oktas

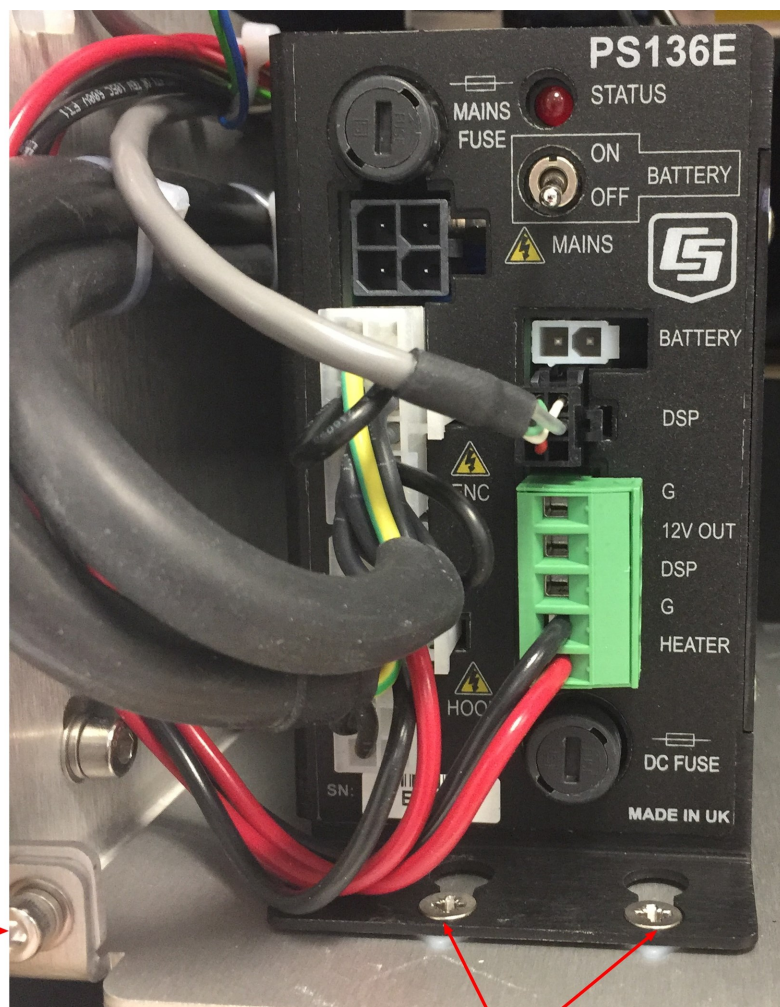
# Appendix D. Replacing the SkyVUE 8M PSU

---

The Power Supply Unit (PSU) can be replaced in the SkyVUE 8M as follows:

1. Disconnect the power to the SkyVUE 8M and open the housing.
2. Disconnect all the plugs from the PSU.
3. Use a 3 mm ball-end hexagonal-key to remove the two M4 x 12 socket head screws on the chassis plate that are on the bent-up tabs on the left and right hand sides.
4. Pull the PSU forward removing the PSU.
5. Loosen the four screws holding the PSU in place and slide off the PSU.
6. Re-insert the new PSU and push back into position.
7. Replace the two screws on the chassis plate.
8. Re-attach the cable plugs into the correct sockets on the new PSU ensuring that each is connected properly.
9. Ensure that the battery ON/OFF switch is set to OFF.

Chassis M4 x12  
plate screw  
(shows one of two)



PSU retaining screws.  
Two further screws are located  
at the rear of the PSU

# Appendix E. SkyVUE 8M

## Laser/APD module replacement

---

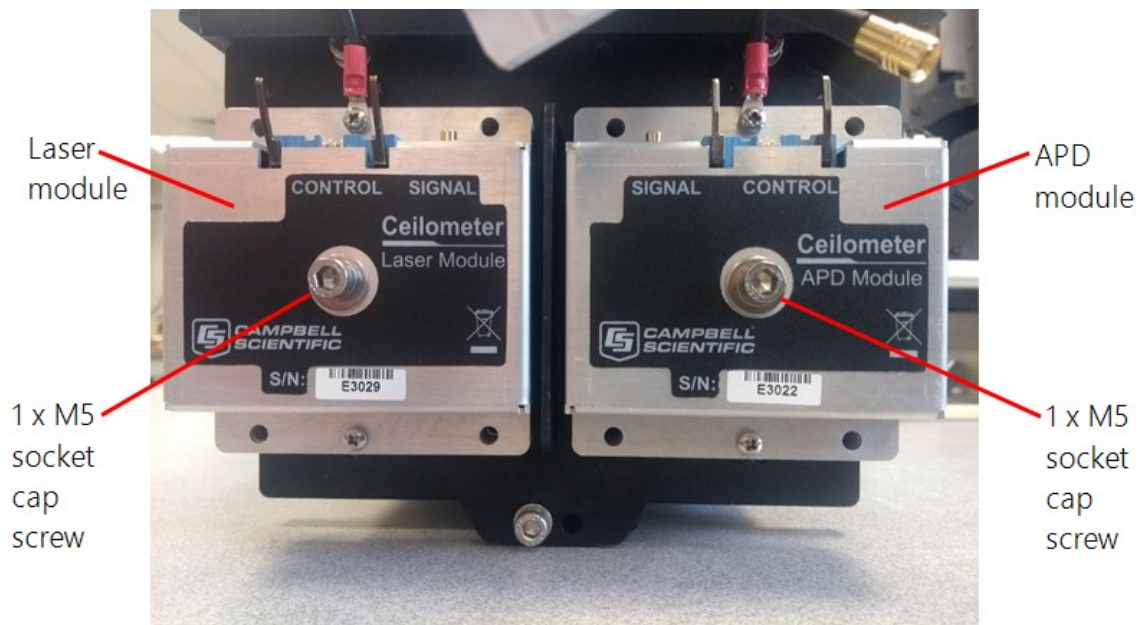
Basic procedure:

1. Isolate the SkyVUE 8M from all sources of power.
2. Remove the access door using the supplied key.
3. Disconnect the cables from the Power Supply Unit (PSU) including the battery.

**NOTE:**

It is very important to disconnect all sources of power from the SkyVUE 8M to ensure that the laser is not powered.

4. Unscrew the two securing screws from the PSU chassis plate so it can be pulled out to gain better access to the Laser and APD module.
5. Now the Laser module and avalanche photo diode (APD) module will be visible.





6. Disconnect the ribbon cable and SMB connector from the module that is being replaced. To avoid damage only pull the gold metal part of the SMB connector.
7. As seen in step 5, the laser module and APD module each have one M5 x 35 mm long socket captive screw with a plain and spring washer securing them. Use a 4 mm ball-end hexagon-key to remove the screws on the module being replaced.

**WARNING:**

Do not loosen any other screws.

**WARNING:**

Do not replace screws with different length screws.

8. Remove any protective film from the filters of the new APD and laser modules before mounting them.
9. Once the screws have been removed pull the module off the locating pins. Fit the new module by pushing it onto the locating pins and then re-assembling, in reverse order, using the original screws, spring washers and plain washers.
10. Reconnect the ribbon cable and SMB connector to the module before closing and securing the access door.

**NOTE:**

Make sure the module sits flat against the plate before tightening the four screws.



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