Product Manual

Sensor

CS120A and CS125

Visibility and
Present Weather Sensors

Issued: 28/11/2018

RELIABLE SINCE 1974 MONITORING

CAMPBELL SCIENTIFIC

Guarantee

This equipment is guaranteed against defects in materials and workmanship. We will repair or replace products which prove to be defective during the guarantee period as detailed on your invoice, provided they are returned to us prepaid. The guarantee will not apply to:

- Equipment which has been modified or altered in any way without the written permission of Campbell Scientific
- Batteries
- Any product which has been subjected to misuse, neglect, acts of God or damage in transit.

Campbell Scientific will return guaranteed equipment by surface carrier prepaid. Campbell Scientific will not reimburse the claimant for costs incurred in removing and/or reinstalling equipment. This guarantee and the Company's obligation thereunder is in lieu of all other guarantees, expressed or implied, including those of suitability and fitness for a particular purpose. Campbell Scientific is not liable for consequential damage.

Please inform us before returning equipment and obtain a Repair Reference Number whether the repair is under guarantee or not. Please state the faults as clearly as possible, and if the product is out of the guarantee period it should be accompanied by a purchase order. Quotations for repairs can be given on request. It is the policy of Campbell Scientific to protect the health of its employees and provide a safe working environment, in support of this policy a "Declaration of Hazardous Material and Decontamination" form will be issued for completion.

When returning equipment, the Repair Reference Number must be clearly marked on the outside of the package. Complete the "Declaration of Hazardous Material and Decontamination" form and ensure a completed copy is returned with your goods. Please note your Repair may not be processed if you do not include a copy of this form and Campbell Scientific Ltd reserves the right to return goods at the customers' expense.

Note that goods sent air freight are subject to Customs clearance fees which Campbell Scientific will charge to customers. In many cases, these charges are greater than the cost of the repair.

CAMPBELL SCIENTIFIC®
WHEN MEASUREMENTS MATTER

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PLEASE READ FIRST

About this manual

Some useful conversion factors:

Area: 1 in^2 (square inch) = 645 mm^2

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^2) = 68.95 mb

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

Recycling information

At the end of this product's life it should not be put in commercial or domestic refuse but sent for recycling. Any batteries contained within the product or used during the 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

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 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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Appendices

Figures

CS120A and CS125 Visibility and Present Weather Sensors

1. Introduction

The CS120A is a visibility sensor. The CS125 additionally detects and reports present weather in the form of SYNOP, METAR or NWS codes. The CS125 has the same specification for visibility measurement as the CS120A. It is possible to upgrade a CS120A to a CS125, please contact Campbell Scientific for more details.

The sensors are infrared forward scatter visibility and present weather sensors for automatic weather stations including road, marine and airport based stations. They both use the well-established forward scatter system for visibility measurement, utilising a 42º scatter angle. The CS125 uses high speed sampling to reduce missed events and improves response to other suddenly changing conditions.

The CS125 has a temperature sensor mounted in the cross arm used as part of the process for identifying precipitation.

When an optional CS215 temperature and RH sensor is connected, the CS125 can distinguish wet and dry obscuration (for example mist and haze) and make more precise discrimination between liquid and frozen precipitation.

Dew heaters are provided to keep the sensor optics clear of condensation and more powerful hood heaters to prevent the build up of snow or ice.

1.1 General Safety

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

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

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

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

1.2 Sensor Unit Safety

The sensor has been checked for safety before leaving the factory and contains no internally replaceable or modifiable parts.

WARNING **Do not modify the sensor unit. Such modifications will lead to damage of the unit and could expose users to dangerous light levels and voltages.**

WARNING **In unusual failure modes and environmental conditions the sensor hood could become hot. In normal operation they will be at ambient temperature or slightly above.**

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

1.3 Principle of operation

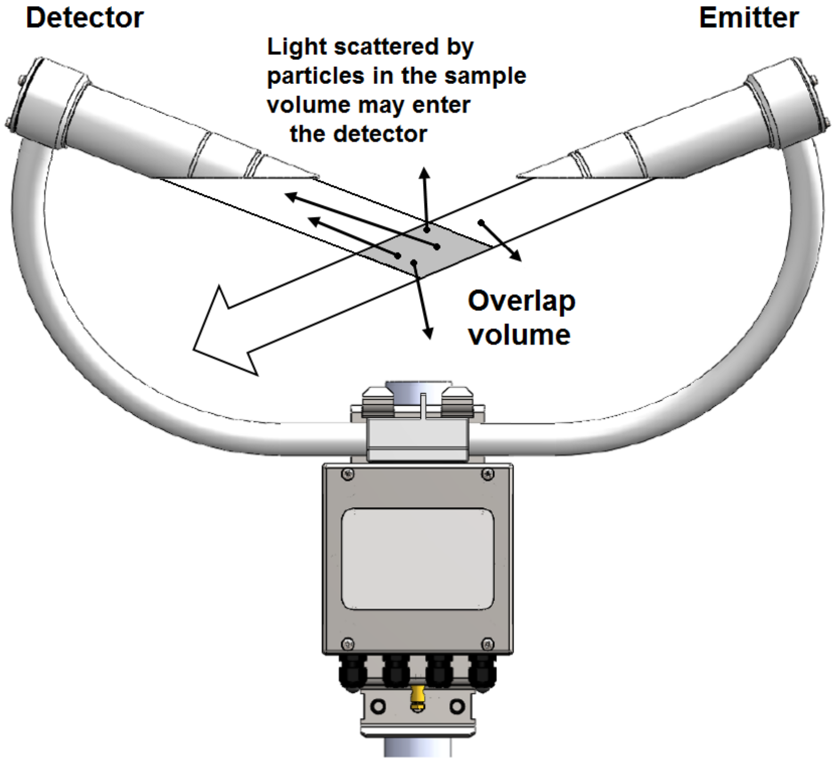


Figure 1-1. Particles in the sample volume scatter light in all directions, including into the detector

The CS120A and CS125 comprise an emitter and detector aligned as in Figure 1-1. The emitter produces a beam of near infra-red light pulsed at 1 kHz. A detector has a field of view which overlaps the beam and is inclined at 42 degrees to it. Light scattered by a particle (for example a fog droplet or particle of precipitation) from the overlap or sample volume towards the detector is detected by a photodiode and recorded as a signal. The size of the signal is therefore proportional to the extinction of the emitted beam caused by scattering. The scattering signal averaged over one second is used to calculate an extinction coefficient or EXCO. Sixty one second averages are then themselves averaged to give a one minute average EXCO. This is then converted to a value of Meteorological Optical Range (MOR) using Koschmieder's law:

MOR = 3/EXCO   where MOR is in km and EXCO in units of km^{-1}.

The CS125 is capable of identifying weather type in addition to measuring visibility. It does this by analysing the amplitude and width of spikes in the APD signal corresponding to particles of precipitation passing through the sample volume. The amplitude of the signal is a guide to the size of the particle and the width, because it represents the time taken for the particle to fall through the sample volume, is proportional to the fall speed, see Figure 1-2.

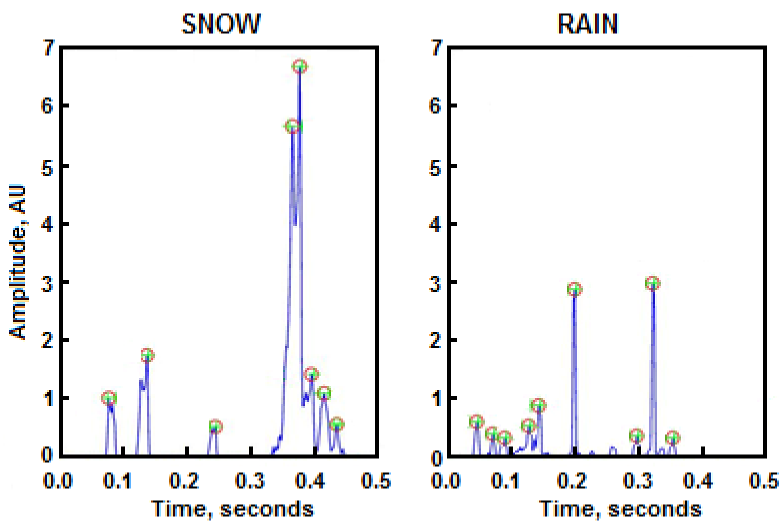


Figure 1-2. Signals from large, slow falling snowflakes and smaller, faster, raindrops

The CS125 also has a temperature sensor. These 3 parameters, fall speed, size and temperature are used to identify the type of particle. If an additional external temperature and relative humidity probe is connected then a wet-bulb temperature can be calculated. This provides useful additional information identifying particles more accurately especially, between liquid and frozen around 0°C.

Figure 1-3 shows how these temperatures are used to define possible precipitation types around 0°C.

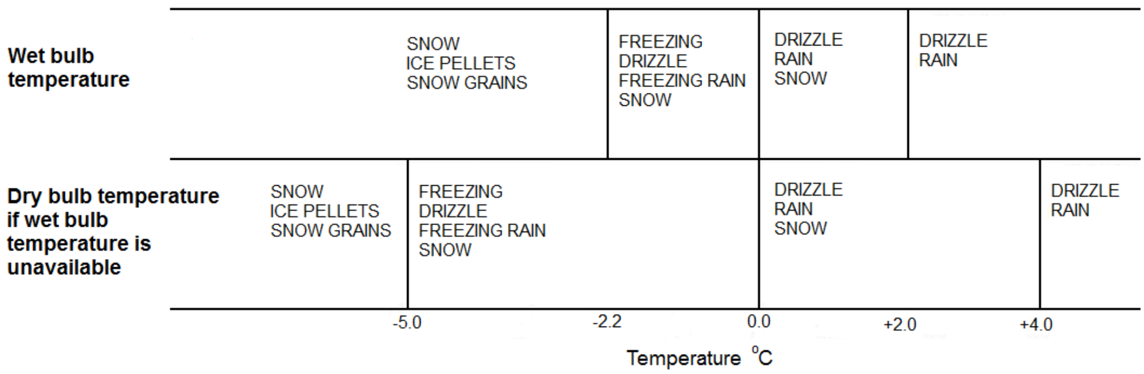


Figure 1-3. Defining possible precipitation types based on wet bulb and dry bulb temperatures

The processing algorithm then works with several ‘maps’ such as Figure 1-4 to identify each particle.

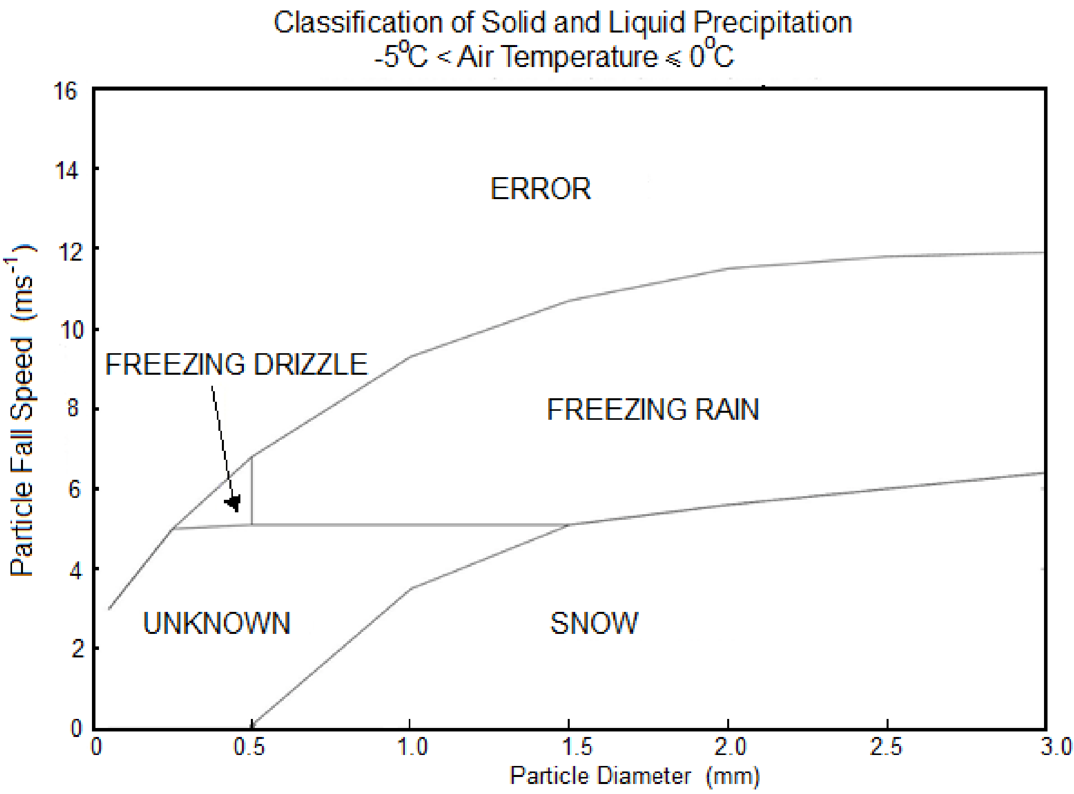


Figure 1-4. A typical size/speed map used by the CS125 present weather algorithm

1.4 Recommended Tools

The following tools are recommended:

10 mm open spanner (for grounding boss, must be open)

13 mm spanner

19 mm open spanner (for cable glands, must be open)

2 mm flat screwdriver

Number 2 cross head screwdriver

1.5 Quickstart

The sensor is shipped set to the following default communication RS-232, 8N1, 38400 baud, a sensor ID = 0 and set to transmit default messages, full format, visibility only for the CS120A, SYNOP present weather full format for the CS125, at 1 minute intevals (see Section 11).

To start using the CS120A or CS125, first connect a DC supply matching the specification in Section 3.1 to the red and black wires on the ‘D-connector’ (see Figure 8-3) and connect to a PC communications port with a terminal emulator set to RS-232, 38400 baud, 8N1. After a couple of minutes, data messages will be received. Typing ‘open 0’ will access the menu structure, see Section 15.

2. Measurement specification

	Minimum Value	Nominal Value	Maximum Value
Visibility characteristics			
Reported visibility (metric)	5 metres	-	75,000 metres
Reported visibility (imperial)	16 feet	-	46 miles
Visibility accuracy calibration against factory calibration disk	-	+/- 2%	-
Visibility accuracy up to 600 m	-	+/-8%	-
Visibility accuracy up to 10,000 m	-	+/-10%	-
Visibility accuracy up to 15,000 m	-	+/-15%	-
Visibility accuracy above 15,000 m	-	+/-20%	-
Precipitation characteristics, water equivalent (CS125 only)			
Reported accumulation range	0 – 999.9 mm		
Accumulation accuracy	20%		
Accumulation resolution	0.1 mm		
Reported intensity range	0-999.9 mm/hr		
Intensity accuracy	20%		
Intensity resolution	0.1 mm		
Detection threshold for present weather	0.02 mm/hr		

3. Technical specification

3.1 Electrical specification

	Minimum Value	Nominal Value	Maximum Value
Main power supply for DSP and dew heaters			
Power supply, (DC only)	7V	12V	30V(1)
Current consumption sampling continuously with dew heaters ON and RS-232 communications active(2, 3) (at 12V DC)	-	200 mA	248 mA
Current consumption sampling continuously with dew heaters disabled (at 12V DC)	-	110 mA	151 mA
Current consumption without any sampling occurring and dew heaters disabled (at 12V DC)	-	21 mA	30 mA

Hood heater power supply			
Hood heater voltage (AC or DC)	-	24V(3)	30V(4)
Hood heater wattage (at 24V AC or DC)	-	60W(5)	-
User alarm outputs			
User output high level (at 85ºC)	3.8V	-	-
User output high level (at 25ºC)	4.13V	-	-
User output low (All temperatures)	0.25V	-	0.55V
User output current	-	-	32 mA

(1) If a CS215 is being used with a CS125 the supply voltage should not exceed 28V.

(2) The RS-232 communications interface will automatically turn itself off when not transmitting.

(3) If hood heaters are not being used ensure 'Hood heater override' (details in Section 13) is set to off.

(4) It is recommended that the hood heaters are run at 24V AC/DC. It's possible to run the heaters at any voltage below 24V but the heaters will generate proportionally less heat reducing their ability to prevent ice build-up.

(5) Each hood takes 30W, 60W is the total for both hoods on the sensor together.

CAUTION If a CS215 is being used the supply voltage should not exceed 28V.

3.2 Optical specification

	Minimum Value	Nominal Value	Maximum Value
Optical characteristics			
LED centre wavelength	-	850 nm	
LED spectral bandwidth	-	+/-35 nm	
Pulse characteristics			
Light pulse rate	-	1KHz	

4. Communications specification

4.1 Communications electrical specifications

	Minimum Value	**Nominal Value**	**Maximum Value**
RS-232 Communications(1)			
RS-232 input threshold Low	0.8V	1.5V	-
RS-232 input threshold High	-	2.0V	2.4V
RS-232 input absolute maximum	-15V	-	+15V
RS-232 input resistance	12KΩ	-	-
RS-232 output voltage low	-	-	0.4V
RS-232 output voltage high (into 3KΩ)	4.4V	-	-
RS-485 Communications			
RS-485 input threshold voltage	-0.2V	-	+0.2V
RS-485 output (Unloaded)	-	-	5V
RS-485 output (Load 50Ω)	2V	-	-
Maximum voltage at any terminal(2)	-7V	-	+7V

(1) The RS-232 communications interface will automatically turn itself off when not transmitting.

(2) The ground of the sensor and the ground of any RS-485 equipment cannot be further apart than this voltage. The sensor ground (pin 1) on connector B, see page 18, can be connected to the ground of the host equipment. This will reduce any parasitic currents.

4.2 Supported data rates and formats

Serial setting 8N1

Supported data rates

- 1200 bps
- 2400 bps
- 9600 bps
- 19200 bps
- 38400 bps - default
- 57600 bps
- 115200 bps

Supported formats

- RS-232 (Full duplex only), default
- RS-485 (Half duplex)
- 8 bit data bytes
- 1 stop bit
- Parity checking is not supported as most communication protocols used by the CS125 have built in checksums as well as checks that communications have been understood.

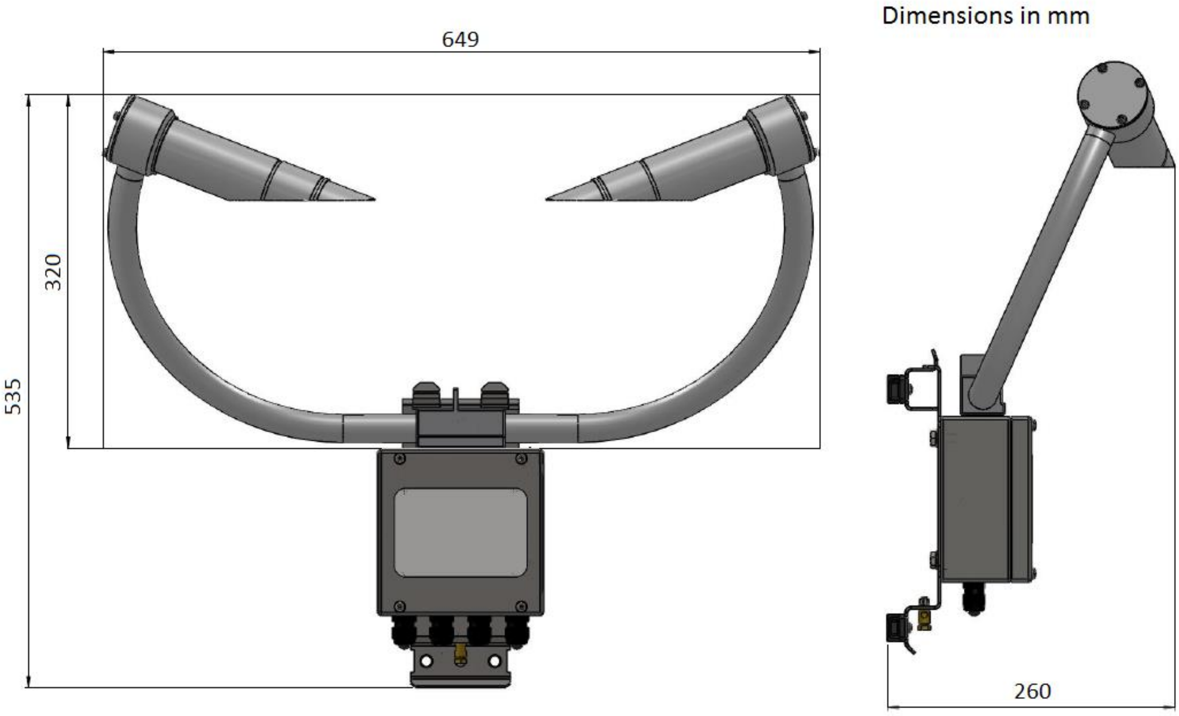
5. Environmental specifications

	Minimum Value	Nominal Value	Maximum Value
Sensor temperature ranges			
Operating temperature	-25°C	-	+60°C
Extended operating temperature	-40°C	-	+70°C (1)
Storage temperature	-40°C	-	+85°C
Sensor humidity ranges			
Operating humidity range	0%	-	100%
Sensor heater thresholds			
Dew heater Turn On	-	<35°C	-
Dew heater Turn Off	-	>40°C	-
Hood heater Turn On	-	<15°C	-
Hood heater Turn Off	-	>25°C	-

(1) Extended temperature ranges are only guaranteed if the sensor has been tested by Campbell Scientific and verified within this temperature range. Some degradation of absolute accuracy can be expected at the extremes of the extended ranges.

6. Mechanical specifications

6.1 Dimensions



6.2 Weights

Sensor weight:	3 Kg
Shipping weight:	6 Kg (including packing box)

6.3 Mounting

Sensor mounting: Bracket mounts on a vertical pole 32-52.5 mm diameter. The mounting bracket has cut-outs for band clamps for larger diameter masts.

7. Installation procedure

The sensor 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.

NOTE The descriptions in this section are not exhaustive. Please refer to meteorological publications for further information on locating weather instruments

The sensor should be sited in a position representative of local weather conditions and not of a specific microclimate (unless the analysis of microclimate weather is being sought).

The sensor has good resistance to background light but it is a good idea to avoid locations where the transmitter is pointing at a light scattering or reflecting surface. Ideally, the receiver should point north in the northern hemisphere or south in the southern hemisphere but this is not critical if the field of view does not include a bright and scattering surface.

To give non-microclimatic measurements the sensor should be sited away from possible physical obstructions that could affect the fall of precipitation. The sensor should also be positioned away from sources of heat, electrical interference and in such a position as to not have direct light on the sensor lenses. Whenever possible, the sensor should be located away from windbreaks.

Several zones have been identified upwind and downwind of a windbreak in which the airflow is unrepresentative of the general speed and direction. Eddies are generated in the lee of the windbreak and air is displaced upwind of it. The height and depth of these affected zones varies with the height and to some extent the density of the obstacle.

Generally, a structure disturbs the airflow in an upwind direction for a distance of about twice the height of the structure, and in a downwind direction for a distance of about six times the height. The airflow is also affected to a vertical distance of about twice the height of the structure. Ideally, therefore, the sensor should be located outside this zone of influence in order to obtain representative values for the region.

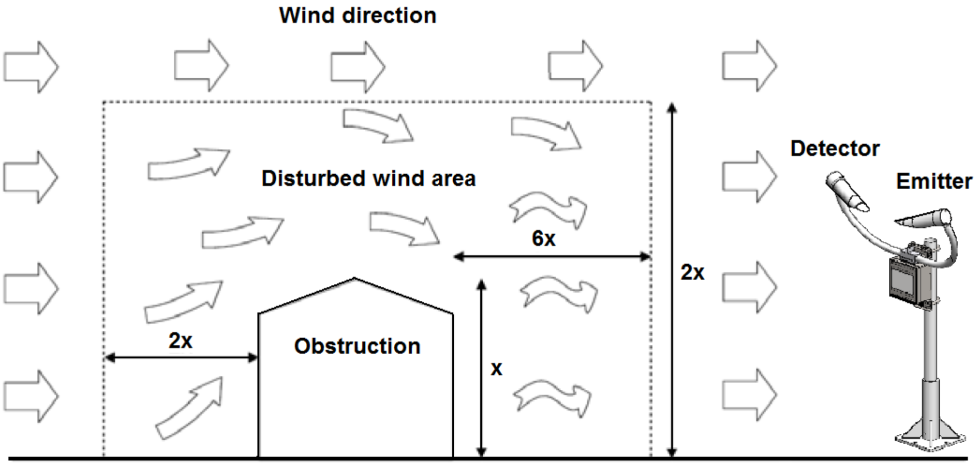


Figure 7-1. Airflow

In order to reduce the service frequency with the unit, the sensor should be placed away from sources of contamination, in the case of roadside monitoring; larger mounting poles can be used. More regular maintenance will be required when the instrument is placed in areas where contamination is unavoidable or where measurements may be safety critical.

The WMO recommend a sample volume height of 1.5 m. However, for applications such as aviation or road visibility other heights may be appropriate.

NOTE If operating a sensor indoors it is likely that there will be sources of light and/or reflections that will create false readings and erratic results.

NOTE If carrying out simple checks, blocking a lens or the sample volume will simulate an INCREASE in visibility not a decrease.

7.1 Equipment grounding

The sensor must be properly grounded. It is sufficient to ground the mounting bracket and if the sensor is connected to a grounded metal mast, and in electrical contact with it, then this will be sufficient. Otherwise, the mounting bracket should be earthed and a grounding boss is supplied to allow this.

A ground wire with a minimum cross section of 6 mm^2 and maximum length of 5 m should be used.

The pole and foundations of a pole mounted installation will provide some basic lightning protection and protection against radio frequency interference and should also be correctly grounded.

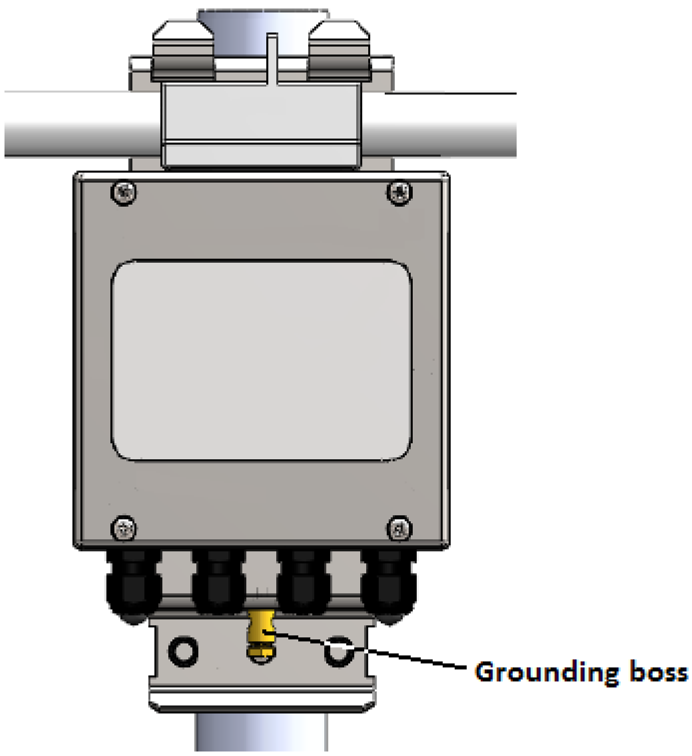


Figure 7-2. Grounding boss

7.2 Mounting the sensor

A quick release pole mounting kit is supplied with the sensor.

If a power supply enclosure has been supplied with the sensor it can be mounted on the pole, near its base using the brackets supplied with the enclosure. Alternatively the power supply can be mounted elsewhere, e.g. on a wall at some distance from the sensor. The power supply enclosure should be mounted away from the sensor head to avoid wind flow disturbance or rain drops bouncing back up into the sensor's sensing volume.

CAUTION Take care not to overtighten the nuts on the bolts, as it may be possible to distort and/or damage the brackets or DSP plate by doing so, and/or the nuts may seize up. Only tighten the nuts to a degree necessary to hold the sensor firmly in place.

Where the sensor is to be mounted onto another type of mast, please refer to the manual for that mast for mounting details.

CAUTION Ensure that the sensor is mounted according to the figure below. Do not reposition, once fixings are tightened, by forcing the arms of the unit as this can cause damage.

CAUTION Do not remove the mounting plate as this will compromise resistance to water ingress.

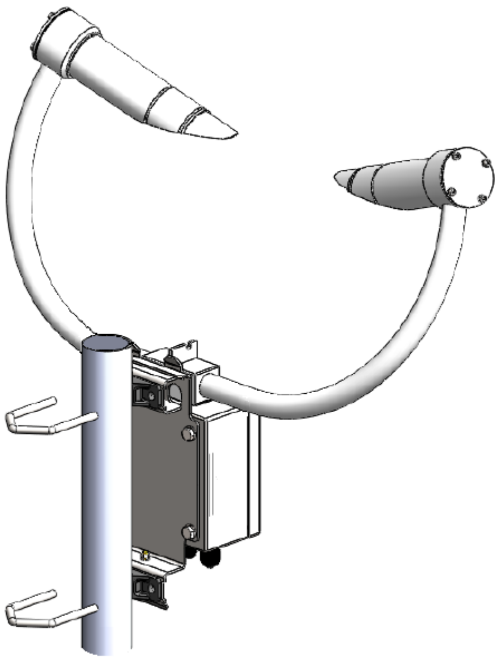


Figure 7-3. Mounting arrangement

If you need to mount the sensor to a flat surface, remove the plastic formers from the mounting brackets and use the holes as shown in Figure 7-4.

NOTE If mounting to a flat surface ensure that there is no obstruction to airflow through the sample volume.

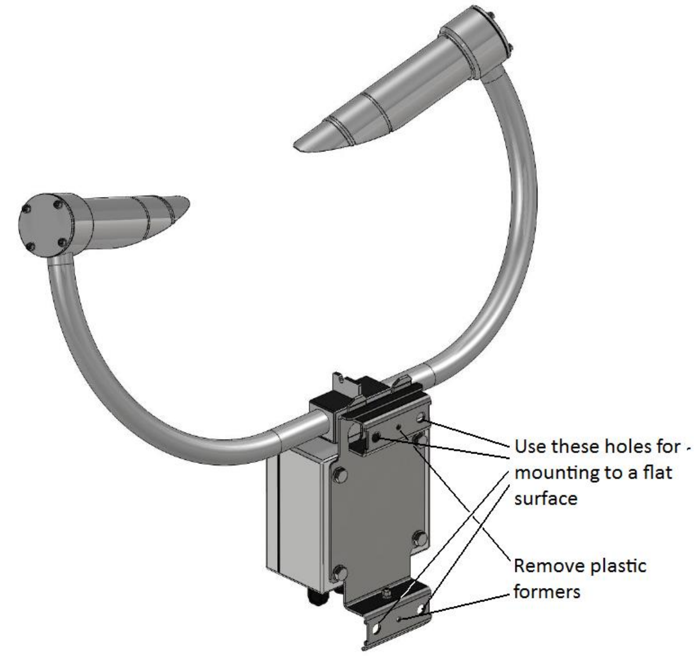


Figure 7-4. Mounting to a flat surface

Slots are provided to allow band clamps to be used with larger diameter masts, see Figure 7-5.

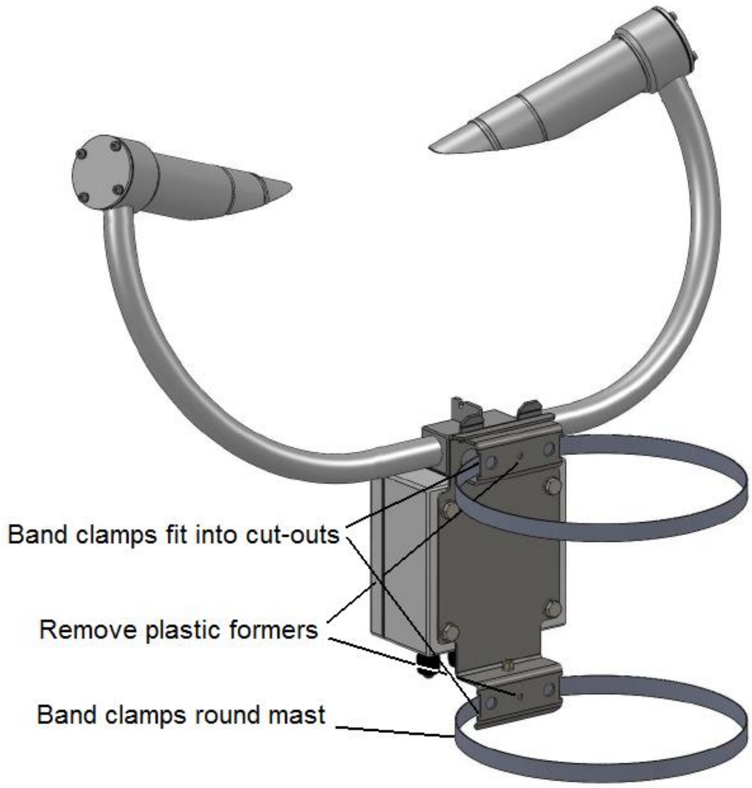


Figure 7-5. Use of band clamps

7.3 Optional Campbell Scientific Mount

A Campbell Scientific ‘optical sensor mount’, part number 009354, is available. This will put the sample volume at about 1.5 m in compliance with the WMO ‘Guide to Meteorological Instruments and Methods of Observation’, 7th Edition, Section 9.3.4.

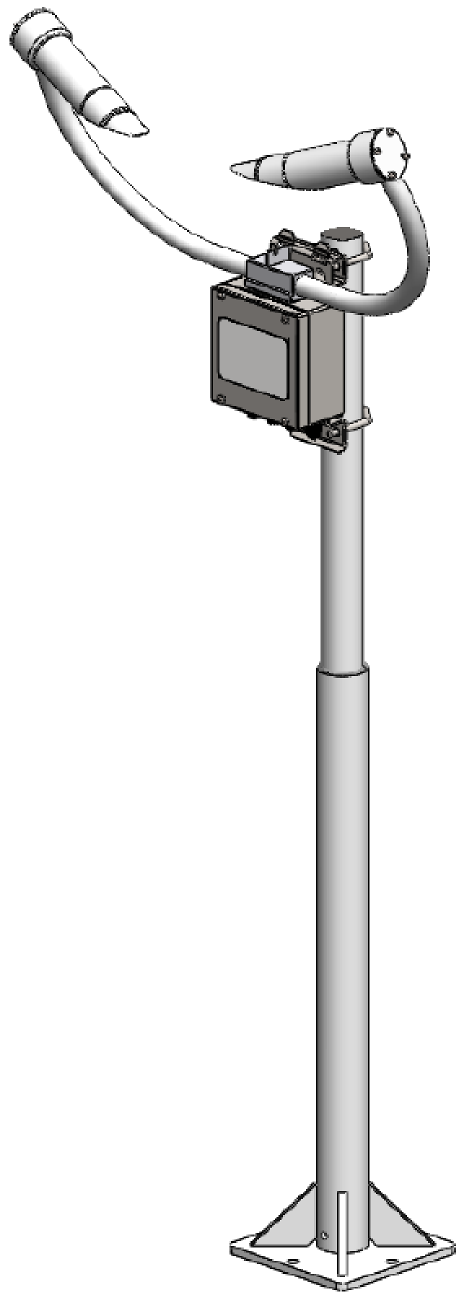


Figure 7-6. Optical sensor mast

If one is to be used, follow the installation instructions below.

The mount should be installed on a concrete foundation. If one does not already exist then a concrete foundation should be constructed at least 600 mm square and 600 mm deep. Ensure the ground consistency is not too loose and will be able to support the mount and concrete foundation.

Drill four 12 mm diameter holes using the mount base as a template or following the drawing below to a depth of 77 mm.

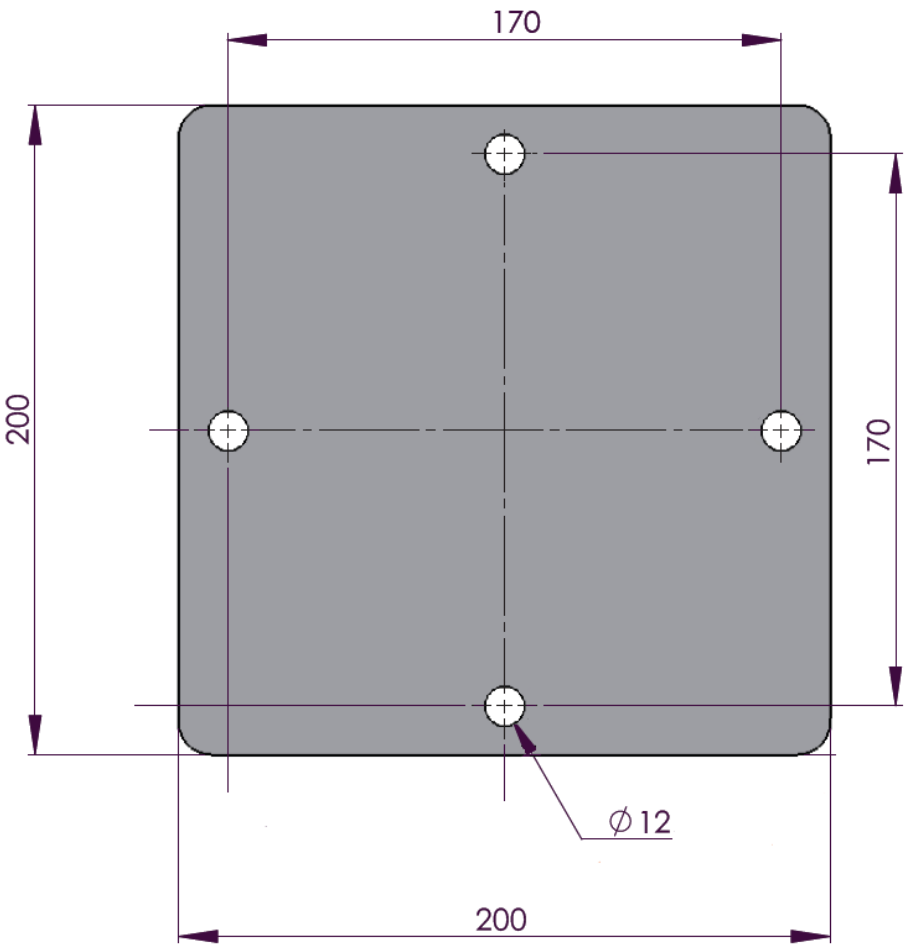


Figure 7-7. Mounting footprint

Clean the holes of all debris.

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

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

Tighten the nuts until about 25 mm of thread protrudes above the surface.

Remove the washers and nuts from the protruding length screw. Then lower the mount into place.

Finally secure the mount with the washers and nuts.

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

8. Sensor internal connectors' description

The sensor has four standard IP66 rated glands. The first gland is by default used by the power/communications line. This comprises the 7-30 V for the main electronics, and the serial communications wires. The sensor is supplied with 5 m cable already connected.

The second gland is used for the 24 V feeds for the hood heaters fitted with a 5 m cable.

Glands 3 and 4 are spare. If user alarms are connected they usually use gland 3 and if a CS215 is fitted this usually uses gland 4.

If you need to run cables through the cable glands follow these guidelines. If a torque wrench is available use a torque of 2.5 Nm (do not over tighten).

Otherwise tighten with fingers as tight as possible and then add a further ¾ turn with a 19 mm spanner (do not over tighten).

The glands are suitable for cables between 5 and 9 mm diameter.

CAUTION If the power cable is incorrectly wired to the sensor then damage can be done to the unit.

CAUTION 10 m is the longest length of the cable type supplied recommended. In particular, additional RS-485 communication should be twisted pair. Please contact Campbell Scientific if you wish to use a longer length of cable.

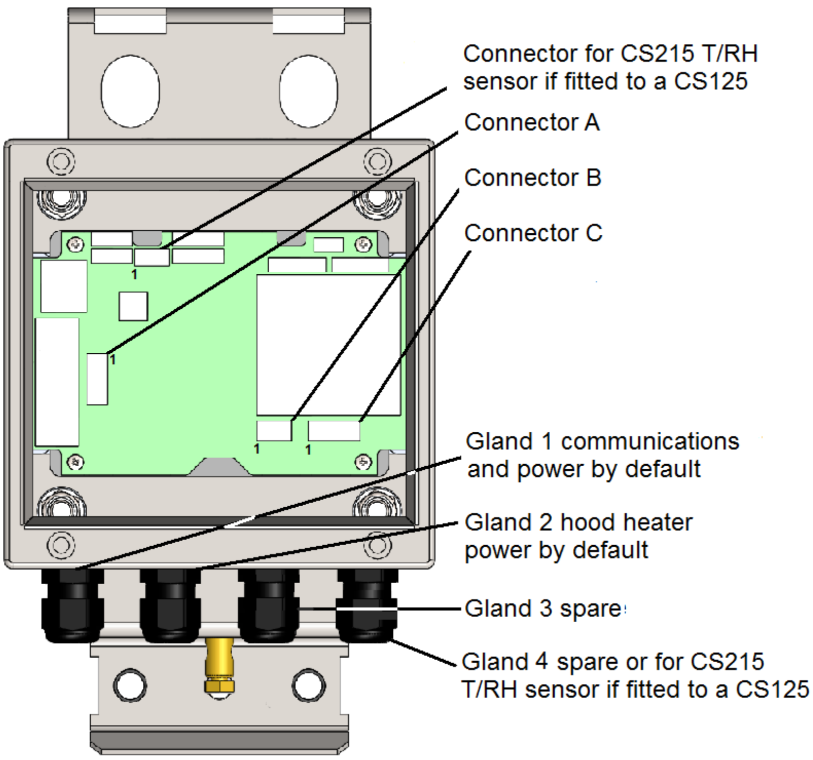


Figure 8-1. Connections

Connector A - Five way connector		
Pin number	**Description**	**Notes**
Pin 1	+ve supply	Main electronics +ve supply input
Pin 2	0V	Auxiliary Electronics 0V. Common with the main electronics 0V.
Pin 3	Hood low	This is for the hood heater power supply. If the hood heater supply is DC it should be the negative connection and if it is AC it should be the 'neutral' or 'ground' connection if there is one.
Pin 4	0V	Auxiliary Electronics 0V. Common with the main electronics 0V.
Pin 5	Hood high	This is for the hood heater power supply. If the hood heater supply is DC it should be the positive connection.

CAUTION To avoid damage to noise filters on the hood heater inputs if the heater voltage is DC the –ve connection should be made to pin 3 and the +ve to pin 5. If the heater voltage is AC with a ground or neutral wire then this should be connected to pin 3. Pin 3 should not be more than 5 volts from the main electronics 0V.

Connector B - Three way connector		
Pin number	**Description**	**Notes**
Pin 1	0V	0V connection for serial communications. This connection is common with the main electronics 0V (Connector A, pin 2).
Pin 2	Receive	RS-232 receive line, RXD, B/D+ for RS-485 half duplex
Pin 3	Transmit	RS-232 transmit line, TXD, A/D– for RS-485 half duplex

It may be necessary to use a 120 ohm termination resistor to reduce signal distortion when using RS-485 for cable runs over about 500 m and baud rates above 38400. It should be connected between pins 2 and 3.

Connector C - Four way connector		
Pin number	**Description**	**Notes**
Pin 1	0V	0V connection for user alarms. This connection is common with the main electronics 0V (Connector A, Pin 2).
Pin 2	User 2	Output for user alarm 2
Pin 3	0V	0V connection for user alarms. This connection is common with the main electronics 0V (Connector A, Pin 2).
Pin 4	User 1	Output for user alarm 1

CS125 only	
Pin number	**Description**
Pin 1	+12V
Pin 2	SDI-12
Pin 3	0V

NOTE To use these connections it is necessary to either use the cable gland taking the hood heater power or, if the hood heater is also required, to use different cables to those supplied. Please contact Campbell Scientific if you need any advice on choice of cable.

8.1 Sensor recommended wiring using Campbell Scientific cables (this cable is supplied already connected as standard)

The sensor is provided pre-wired with a default 5 m power and communications cable which is terminated at one end with a 9 pin D-connector (DB9). The D-connector can be connected directly to a PC or to a datalogger such as the Campbell Scientific CR1000 using a suitable interconnecting cable such as the SC110. If another type of connection is required then the D-connector should be removed.

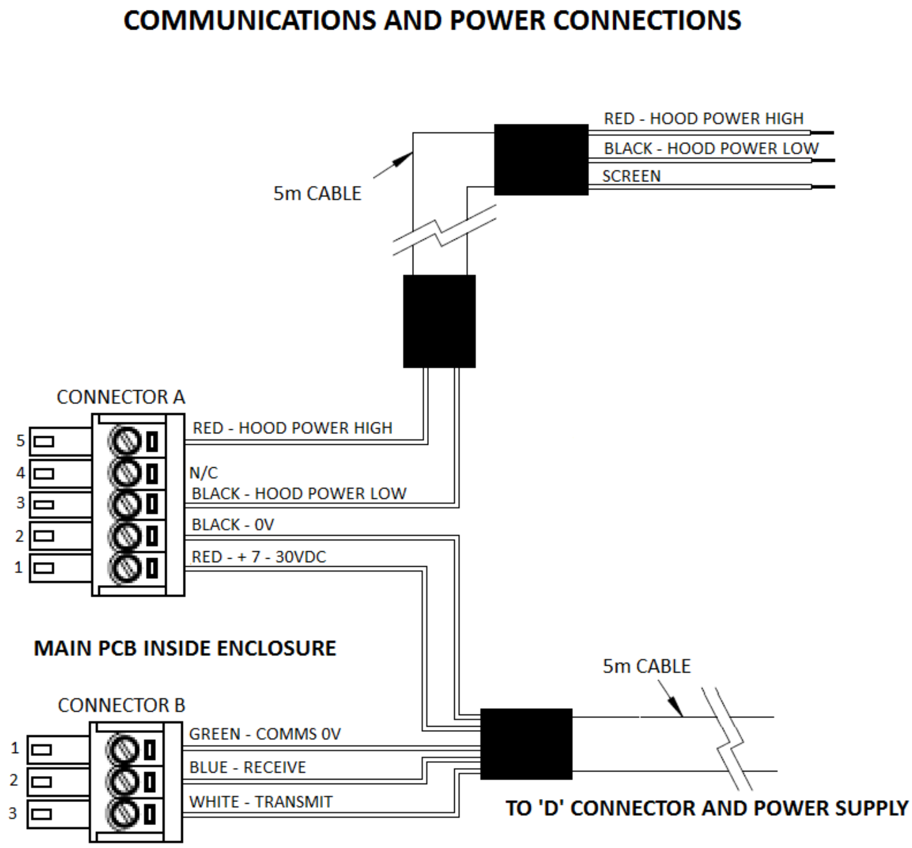


Figure 8-2. Communications and power connections

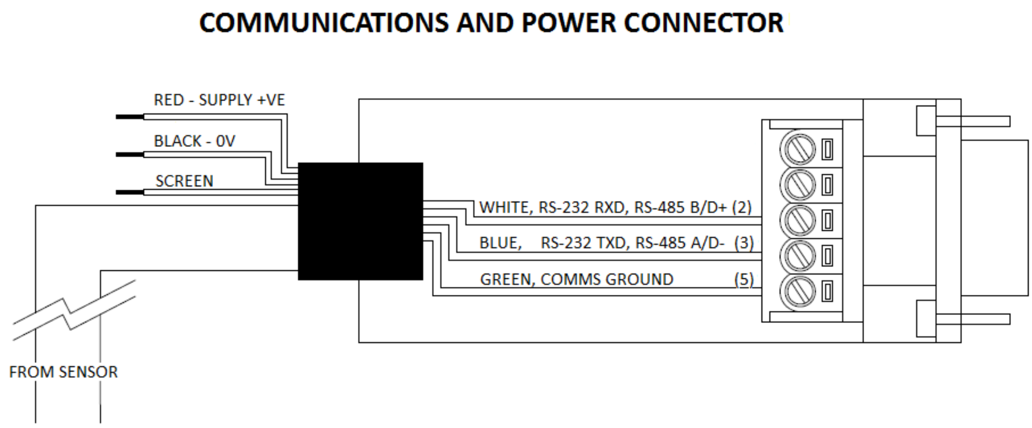


Figure 8-3. Communications and power connector

Two types of configuration cable are available from Campbell Scientific that plug directly into connector B in place of the normal connector and cable. One has a RS-232 or RS-485 output according to how the CS120A/CS125 is configured (Figure 8-4) and one has a USB output (Figure 8-5).

NOTE If the lid is removed, take care not to overtighten the fixing screws. A small gap should remain between the lid and box.

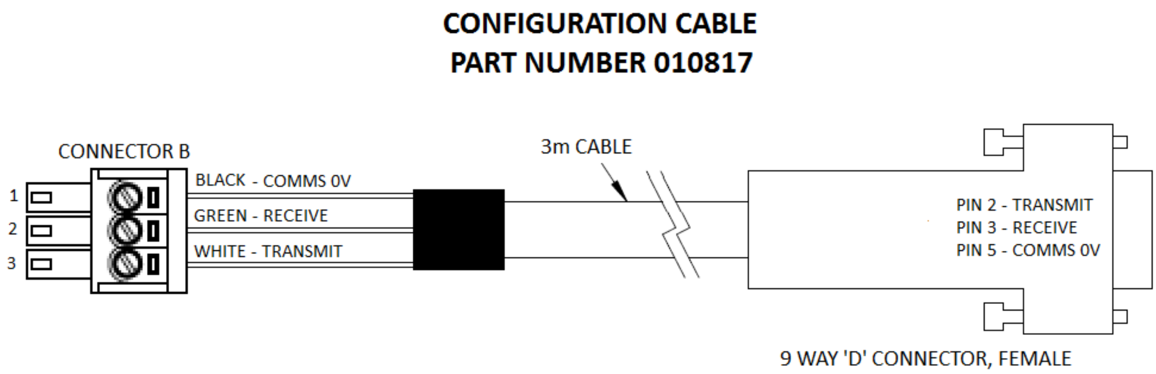


Figure 8-4. Configuration cable

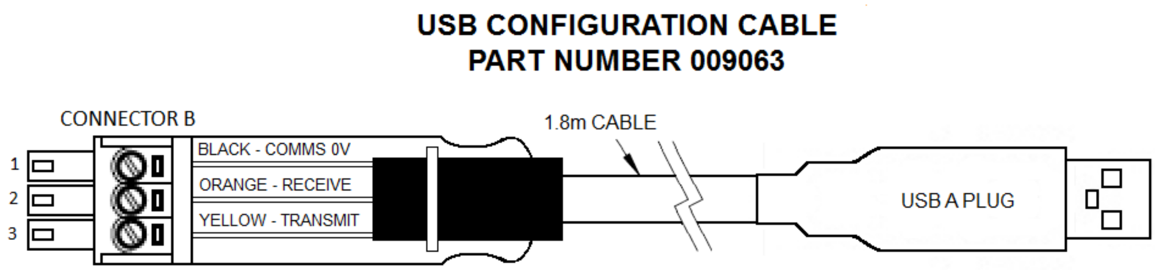


Figure 8-5. USB configuration cable

9. CS215 T/RH Sensor (CS125 only)

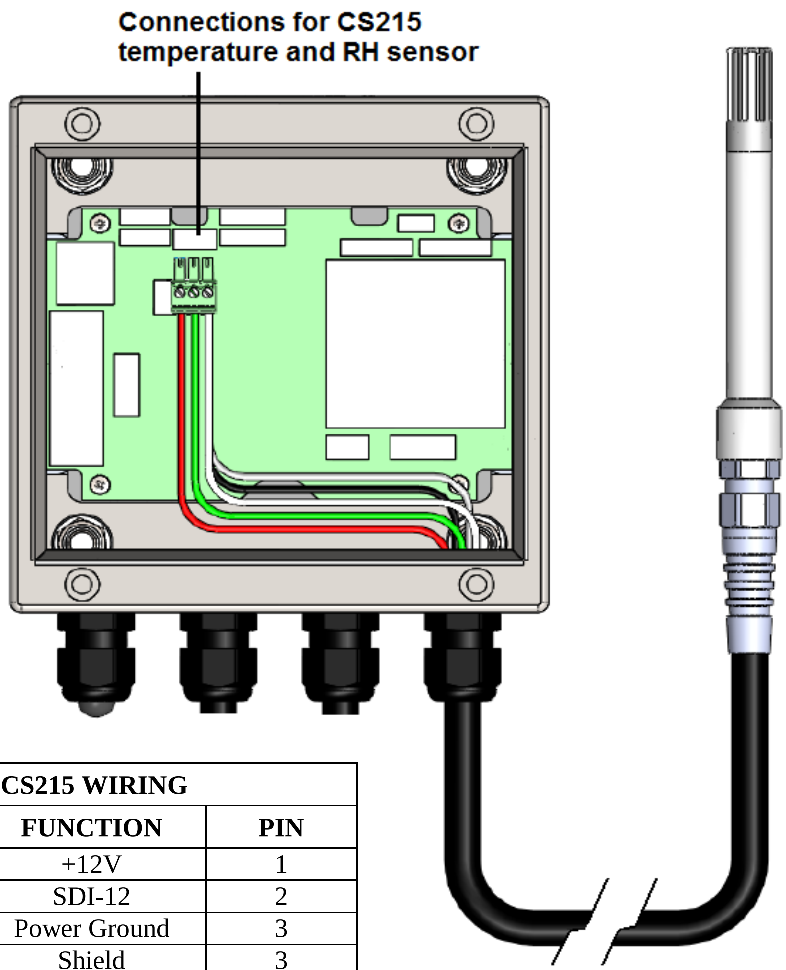
The CS125 has a temperature sensor mounted in the crossarm that is used in determining precipitation type.

A CS215 temperature and RH sensor can be connected to a CS125. This is recommended as it will improve the performance of the CS125 in identifying precipitation and allows it to, for example, distinguish between mist and haze. Precipitation identification at temperatures close to freezing will be much improved by a CS215 and its use is highly recommended in regions where temperatures close to 0°C are common if information on precipitation type is important. It also allows RH information to be included in data messages.

If a CS215 is connected then the temperature used for assessment of precipitation type and included in data messages will come from the CS215 instead of the temperature sensor mounted in the cross arm.

The connections for the CS215 are shown below. The CS215 itself can be mounted in a Met20 screen on the same mast as the CS125. The screen can be mounted on the top section of an OSM1 optical mast below a CS125.

WMO – No. 8, 2.1.4.1 recommends temperature measurement at a height of between 1.2 and 2.0 m above ground. The screen should be below the height of the CS125 electronics box.



CS215 WIRING		
COLOUR	**FUNCTION**	**PIN**
Red	+12V	1
Green	SDI-12	2
Black	Power Ground	3
Clear	Shield	3
White	Power Ground	3 or NC

Figure 9-1. Connection for the optional CS215 T/RH sensors

10. Functions of the internal switches

The sensor is equipped with four switches located within the main enclosure. These switches perform certain functions at power up, their functions are detailed below.

IMPORTANT The switches are only read during the power up sequence of the sensor. This means that if the switches are pressed whilst the sensor is running nothing will happen, the sensor will need to be power cycled leaving at least 10 seconds with the sensor off for any of their functions to be performed.

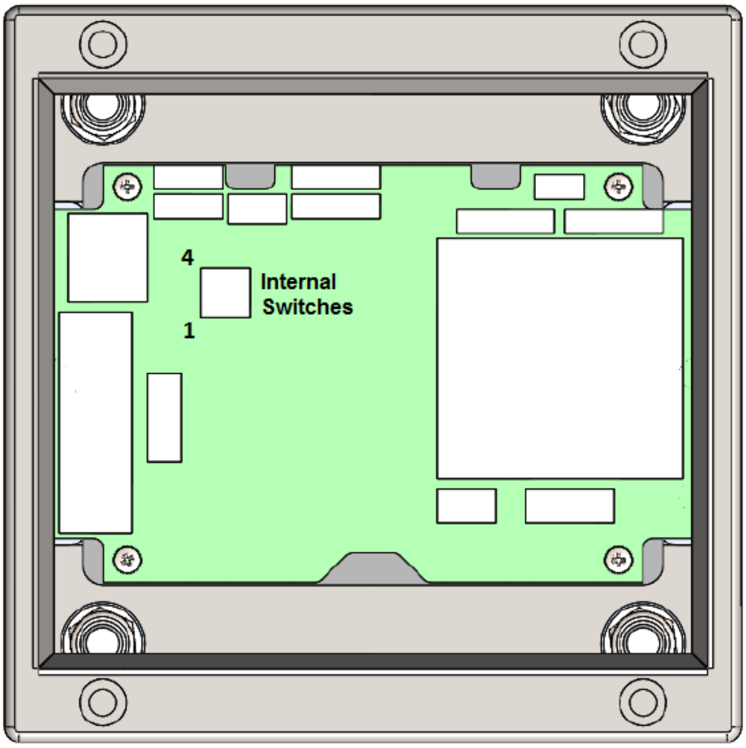


Figure 9-2. Internal switches

Internal switch functions	
Switch number	**Function**
4	*Reserved for future use, set to OFF.*
3	When switched to the ON position and the sensor is power cycled this switch temporarily sets the sensor communications port to a default RS-232 communication state at 38400 baud. This is useful during field tests or maintenance when the sensor has been remotely configured for RS-485 mode or a baud rate your PC does not support. This change is temporary and will not be stored to flash. However, if the menu system is accessed and a 'Save and exit' command is performed these new data rate settings will be committed to flash. Once this switch is returned to its OFF position and the sensor is power cycled the sensor will return to its previous communications settings.
2	*Reserved for future use, set to OFF.*
1	When switched to the ON position this switch will reset the sensor to its factory default values. This reset will affect all communication settings. This will take immediate effect upon power up. NOTE: To use this the power supply must be stable. Do not leave this switch set permanently.

NOTE	If the lid is removed take care not to overtighten the screws when it is replaced. A small gap should remain between the lid and box.

11. Message Formats: A breakdown of the different default outputs of the sensor – Basic/Partial/Full

The sensor has twelve different message formats available to the user. All parameters are space delimited with a unique start and end character allowing easy storage into any logger (see Section 15 on how to set default outputs). The SYNOP Full Format message is the default message for the CS125 and the Full Format Visibility only message is the default for the CS120A.

NOTE	STX and ETX are hexadecimal command characters.

NOTE	Refer to Appendix B for the checksum algorithm.

11.1 Visibility only messages

Basic Format, Visibility Only

STX	Message ID	Sensor ID	System status	Visibility distance	Visibility units	Checksum (CCITT)	EXT	Carriage return	Line feed
0x02	0				M or F	XXXX	0x03	0x0D	0x0A

0 0 0 19837 M FC92 (Example message, visibility units = metres)

NOTE In the example messages below where shown message intervals are 12 seconds and visibility units are in metres unless otherwise indicated.

Partial Format, Visibility Only

STX	Message ID	Sensor ID	System status	Message interval	Visibility distance	Visibility units	User alarms	Checksum (CCITT)	EXT	Carriage return	Line feed
0x02	1					M or F	0 0	XXXX	0x03	0x0D	0x0A

1 0 0 12 20405 M 0 0 EF07 (Example message)

Full Format, Visibility Only (Default message for CS120A)

STX	Message ID	Sensor ID	System status	Message interval	Visibility distance	Visibility units	Averaging duration	User alarms	System alarms 10 characters	Checksum (CCITT)	EXT	Carriage return	Line feed
0x02	2					M or F		0 0	0 0 0 0 0…	XXXX	0x03	0x0D	0x0A

2 0 0 12 68218 F 1 0 0 0 0 0 0 0 0 0 0 0 0 D378 (Example with Visibility Units = Feet)

2 0 0 12 21793 M 1 0 0 0 0 0 0 0 0 0 0 0 0 CB0F (Example with Visibiilty Units = Metres)

11.2 Messages with SYNOP Present Weather Codes (CS125 only)

SYNOP Present Weather Basic Format

STX	Message ID	Sensor ID	System status	Visibility distance	Visibility units	SYNOP Code	Checksum (CCITT)	EXT	Carriage return	Line feed
0x02	3				M or F	0-99	XXXX	0x03	0x0D	0x0A

3 0 0 20428 M 0 20B8 (Example message)

SYNOP Present Weather Partial Format

STX	Message ID	Sensor ID	System status	Message interval	Visibility distance	Visibility units	User alarms	Particle count (minute)	Intensity (mm/h)	SYNOP Code	Temperature (deg C)	Relative humidity*	Checksum (CCITT)	EXT	Carriage return	Line feed
0x02	4					M or F	0 0			0-99			XXXX	0x03	0x0D	0x0A

4 0 0 12 21157 M 0 0 0 0.00 0 24.1 -99 5A55 (Example message)

SYNOP Present Weather Full Format (Default message for CS125)

STX	Message ID	Sensor ID	System status	Message interval	Visibility distance	Visibility units	Averaging duration	User alarms	System alarms 12 characters	Particle count (minute)	Intensity (mm/h)	SYNOP Code	Temperature (deg C)	Relative humidity*	Checksum (CCITT)	EXT	Carriage Return	Line feed
0x02	5					M or F		0 0	0 0 0 0 0…			0-99			XXXX	0x03	0x0D	0x0A

5 0 0 12 20880 M 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.00 0 24.1 -99 CAFA (Example message)

11.3 Messages with METAR Present Weather Codes (CS125 only)

METAR Present Weather Basic Format

STX	Message ID	Sensor ID	System status	Visibility distance	Visibility units	METAR Code	Checksum (CCITT)	EXT	Carriage return	Line feed
0x02	6				M or F		XXXX	0x03	0x0D	0x0A

6 0 0 20573 M NSW 291A (Example message)

METAR Present Weather Partial Format

STX	Message ID	Sensor ID	System status	Message interval	Visibility distance	Visibility units	User alarms	Particle count (minute)	Intensity (mm/h)	SYNOP Code	METAR Code	Temperature (deg C)	Relative humidity*	Checksum (CCITT)	EXT	Carriage return	Line feed
0x02	7					M or F	0 0							XXXX	0x03	0x0D	0x0A

7 0 0 12 20673 M 0 0 0 0.00 0 NSW 24.2 -99 BD78 (Example message)

METAR Present Weather Full format

STX	Message ID	Sensor ID	System status	Message interval	Visibility distance	Visibility units	Averaging duration	User alarms	System alarms 12 characters	Particle count (minute)	Intensity (mm/h)	SYNOP Code	METAR Code	Temperature (deg C)	Relative humidity*	Checksum (CCITT)	EXT	Carriage Return	Line feed
0x02	8					M or F		0 0	0 0 0 0 0…							XXXX	0x03	0x0D	0x0A

8 0 0 12 20504 M 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.00 0 NSW 24.2 -99 40A2 (Example message)

***NOTE** Relative humidity is only available if a CS215 temperature and RH sensor is attached. If not this field is "-99".

11.4 Messages with Generic SYNOP Present Weather Codes (CS125 only)

These messages include simplified, generic present weather codes such as 70 for snow which may be required for some data collection systems.

Generic SYNOP Present Weather Basic format

STX	Message ID	Sensor ID	System status	Visibility distance	Visibility units	Generic SYNOP code	SYNOP code	METAR code	Checksum (CCITT)	EXT	Carriage return	Line feed
0x02	9				M or F				XXXX	0x03	0x0D	0x0A

9 0 0 20481 M 0 0 NSW 73DF (Example message)

Generic SYNOP Present Weather Partial format

STX	Message ID	Sensor ID	System status	Message interval	Visibility distance	Visibility units	User alarms	Particle count (minute)	Intensity (mm/h)	Generic SYNOP code	SYNOP code	METAR code	Temperature (deg C)	Relative humidity (%)	Checksum(CCITT)	EXT	Carriage Return	Line feed
0x02	10					M or F	0 0								XXXX	0x03	0x0D	0x0A

10 0 0 12 20909 M 0 0 0 0.00 0 0 NSW 24.2 -99 AB02 (Example message)

Generic SYNOP Present Weather Full format

STX	Message ID	Sensor ID	System status	Message interval	Visibility distance	Visibility units	Averaging duration	User alarms	System alarms	Particle count (minute)	Intensity (mm/h)	Generic SYNOP code	SYNOP code	METAR code	Temperature (deg C)	Relative humidity (%)	Checksum(CCITT)	EXT	Carriage Return	Line feed
0x02	11					M or F		0 0	0 0 0 0…								XXXX	0x03	0x0D	0x0A

11 0 0 12 21342 M 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0.00 0 0 NSW 24.3 -99 9AD6 (Example message)

Message ID break down	
ID	Definition
0	Basic format. Contains only distance and system information
1	Partial format. Contains user alarm outputs
2	Full format. Contains all system alarms codes
3*	Basic SYNOP present weather format
4*	Partial SYNOP present weather format
5*	Full SYNOP present weather format
6*	Basic METAR present weather format
7*	Partial METAR present weather format
8*	Full METAR present weather format
9*	Generic Basic SYNOP present weather format
10*	Generic Partial SYNOP present weather format
11*	Generic Full SYNOP present weather format
12	Custom output

*CS125 only

Sensor ID break down	
ID	Definition
0-9	Unit number defined by the user to aid identification of data. Zero by default. Useful for RS-485 networks. Operates as an address in RS-485 mode

System status break down(1)	
Status level	Definition
0	No fault
1	Possible degraded performance
2	Degraded performance
3	Maintenance required

(1) System status break down reflects the highest level of severity of any active alarm.

Message interval	
Time	Definition
1-3600	The amount of time, in seconds, between outputs in continuous mode

Visibility distance break down	
ID	Definition
0-75,000 metres	Current visibility distance being detected by the sensor

Visibility units break down	
ID	Definition
M	Metres
F	Feet

Averaging duration break down (see note below)	
ID	Definition
1	One minute average
10	Ten minute average

Note: In accordance with WMO requirements the sensor produces visibility measurement that are either one or ten minute rolling averages that are updated at the chosen output interval or when the sensor is polled. Those averages are not direct averages of MOR measurements but are averages of extinction coefficient and that average is then used to calculate the MOR for that period. As the relationship between extinction coefficient and MOR is not linear it is possible to see quite rapid changes in MOR that might not be expected if the result was a rolling average of MOR. Please consider this, especially when testing the sensor with artificial obscurants or using the calibration disc.

User alarms		
ID	Range	Definition
1	0-1	Visibility either less or greater than a user specified threshold
2	0-1	Visibility either less or greater than a user specified threshold

System alarms break down			
Alarm	Range	Severity (2)	Definition
Emitter failure (emitter hoods main LED output power level)	0-2	0 3 3	0 = Everything is within normal parameters 1 = Light output level too low 2 = Light output level too high
Emitter lens dirty	0-3	0 3 1 2	0 = OK. The reported attenuation is below 10% 1 = Reported window signal value is out of range (>30%) Possible sensor fault or hood could be blocked 2 = Slight dirt build up (10% signal attenuation or higher) 3 = High level of dirt build up (>20%)
Emitter temperature	0-3	0 1 1 3	0 = Temperature is within operating conditions 1 = Too low. Less than -40°C 2 = Too high. Over 80°C 3 = No sensor detected or below -54°C
Detector lens dirty	0-3	0 3 1 2	0 = OK. The reported attenuation is below 10% 1 = Reported window signal value is out of range (>30%) Possible sensor fault or hood could be blocked 2 = Slight dirt build up (10% signal attenuation or higher) 3 = High level of dirt build up (>20%)
Detector temperature	0-3	0 1 1 2	0 = Temperature is within operating conditions 1 = Too low. Less than -40°C 2 = Too high. Over 80°C 3 = No sensor detected or below -54°C
Detector DC saturation level (amount of background light seen by the detector hood)	0-1	0 2	0 = Within limits 1 = Saturated. The sensor may not be able to perform visibility readings in some circumstances. Possibly due to high level of reflections into the detector.
Hood temperature	0-3	0 1 1 2	0 = Temperature is within operating conditions 1 = Too low. Less than -40°C 2 = Too high. Over 80°C 3 = No sensor detected or below -56°C
External temperature (CS125 only)	0-3	0 1 1 2	0 = Temperature is within operating conditions 1 = Too low. Less than -40°C 2 = Too high. Over 80°C 3 = No sensor detected or below -54°C
Signature error	0-4	0 3 2 2 3	0 = No fault 1 = OS signature error at power up 2 = User memory signature did not match when last read 3 = User memory fault at power up. Secondary copy was reinstated to correct error. 4 = User memory fault at power up. No secondary copy was found to reinstate. Factory defaults have been reinstated. System will need re-calibrating
Flash read error	0-1	0 3	0 = No errors 1 = One or more errors reading user variables from flash occurred
Flash write error	0-1	0 3	0 = No errors 1 = One or more errors writing user variables to flash occurred
Particle limit (CS125 only)	0-1	0 1	0 = No errors 1 = More particles detected than can be processed

Errors are checked every 10 seconds and the next message output is updated with the following exceptions:

Signature error is checked and reset at power up.

Flash read and write errors are checked when flash memory is updated, for example when changes are made through the memory structure. They are also reset on power up.

Particle limit is checked every minute and reset when read.

Particle count*	
Range	Definition
0-7200	Value represented by an integer number of the current number of particle per minute. (-99 indicates either an error or that the sensor has been powered less than one minute)

Intensity value*	
Range	Definition
0-100.0	Value represented by a single precision value of the last minutes rainfall intensity in mm/hr (-99 indicates either an error or that the sensor has been powered up less than minute)

SYNOP code*	
Range	Definition
See Appendix D	SYNOP weather code for the last minute as defined by the WMO code table 4680. (-1 indicates either an error or that the sensor has been powered up less than a minute)

Generic SYNOP code*	
Range	Definition
See Appendix D	SYNOP weather code for the last three minutes as defined by the WMO code table 4680 simplified to give generic codes. (-1 indicates either an error or that the sensor has been powered up for less than one minute)

METAR code*	
Range	Definition
See Appendix D	METAR weather code for the last minute as defined by the WMO code table 4678.

External temperature*	
Range	Definition
-40.0 - +80.0°C	External temperature in degrees Celsius

Relative humidity*	
Range	Definition
0 - 100	External relative humidity in %RH (-99 indicates either a fault or no CS215 T/RH sensor is connected)

*CS125 only, see Appendix D.

11.5 Example sensor message outputs

Full format, visibility only (CS120A default)

2 0 0 10 9622 M 1 0 0 0 0 0 0 0 0 0 0 0 0 46AA

SYNOP present weather full format (CS125 deault)

5 0 0 10 112 M 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6 0.14 52 24.0 -99 9190

METAR present weather full format

8 9 0 60 6682 M 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 54 4.5 63 +RA 20.2 91 ABCD

Where:

9 is the sensor id
60 is the message interval (60 seconds)
6682 is the visibility in metres
M is the visibility units (metres)
54 is particle count
4.5 is intensity (4.5 mm/hr)
63 is the SYNOP code (heavy rain)
+RA is the METAR code (heavy rain)
20.2 is the temperature (20.2 deg. C)
91 is the RH (91%)
ABCD is the checksum

11.6 Custom message format

The custom message format allows the CS120A/CS125 message to be modified to meet particular requirements. The custom message contains a fixed basic set of variables and up to 16 additional fields. (Note: the custom message output is only available on OS7 and above). The custom message is as follows:

Custom format

STX	Message ID	Unit ID	System status	Message interval	Visibility distance	Visibility units	Up to 16 custom fields	Checksum	EOT
0x02	12					M or F	X X X …	XXXX	0x04

There are two ways to configure the custom message. The first is through the user menu system. The second is through the use of logger commands. These logger commands are MSGSET and MSGGET.

To configure the message using the user menu you will need to enter the menu, see Section 15.

```
CS125 MESSAGE - SUB 3
 Set the message output format. Current format is: FULL SYNOP
  - Basic                  = 0
  - Partial                = 1
  - Full                   = 2
  - Basic SYNOP            = 3
  - Partial SYNOP          = 4
  - Full SYNOP             = 5
  - Basic METAR            = 6
  - Partial METAR          = 7
  - Full METAR             = 8
  - Generic Basic SYNOP    = 9
  - Generic Partial SYNOP = 10
  - Generic Full SYNOP    = 11
  - Custom output         = 12
  ->
```

Return to the message menu and select option 7. You will now be presented with the list of options shown below:

```
CS125 MESSAGE - SUB 4
 Configure the message output format:
  1 - Averaging duration       = 0
  2 - User alarms              = 0
  3 - System alarms            = 0
  4 - Dirty windows values     = 0
  5 - Sensor serial number     = 0
  6 - Particle count           = 0
  7 - Intensity                = 0
  8 - Accumulation             = 0
  9 - Generic SYNOP            = 0
  10 - SYNOP code              = 0
  11 - METAR code              = 0
  12 - NWS code                = 0
  13 - Temperature (Degrees C) = 0
  14 - Humidity (%)            = 0
  15 - 10 minute ave. vis.     = 0
  16 – TMMOR                   = 0
 Or, type 0 to exit without changes.
```

Enter the number of a custom message field you wish to use and type return. The screen will update with a 1 next to the chosen field. Repeat for each field you want then exit the menu. The changes take effect after selecting “Exit and Save” from the main menu.

Example

In the example below selecting options 1, 3, 4, 10, 15 and 16 puts averaging duration, system alarms, dirty windows values, SYNOP code, 10 minute average MOR, and TMMOR into the custom range.

```
CS125 MESSAGE - SUB 4
 Configure the message output format:
  1 - Averaging duration       = 1
  2 - User alarms              = 0
  3 - System alarms            = 1
  4 - Dirty windows values     = 1
  5 - Sensor serial number     = 0
  6 - Particle count           = 0
  7 - Intensity                = 0
  8 - Accumulation             = 0
  9 - Generic SYNOP            = 0
  10 - SYNOP code              = 1
  11 - METAR code              = 0
  12 - NWS code                = 0
  13 - Temperature (Degrees C) = 0
  14 - Humidity (%)            = 0
  15 - 10 minute ave. vis.     = 1
  16 – TMMOR                   = 1
 Or, type 0 to exit without changes.
```

This would give the following output:

```
12 0 0 1 0 92 M1 000000000000 2 0 3 0 92 135 88EF
```

Above the custom fields are “1 000000000000 2 0 30 92 135”. The averaging duration is 1 minute, no system alarms are set, the emitter is reading 2% contamination, the detector is reading 0% contamination, the SYNOP code is 30, the 10 minute average MOR is 92 m and the TMMOR is 134 m. There are a number of fields that can send out more than one value. These are detailed below.

List of custom output values		
Field	**Description**	**Number of values output**
1	Averaging duration	1
2	User alarms	2
3	System alarms	12
4	Dirty windows values, as percentages, emitter followed by detector	2
5	Sensor serial number	1
6	Particle count (1), particles in the previous minute	1
7	Intensity (1), mm/hr	1
8	Accumulation (1),(2)	1
9	Generic SYNOP (1)	1
10	SYNOP code (1)	1
11	METAR code (1)	1
12	NWS code (1)	1
13	Temperature (degrees C) (1)	1
14	Humidity (%) (1)(3)	1
15	Visibility averaged over the last 10 minutes	1
16	TMMOR(4)	1

(1) These options are only available with a CS125.
(2) This increments to 999.99 mm before resetting to zero. It may be reset to zero at any time with the ACCRES command.
(3) Only outputs a valid value when a CS215 temperature and humidity probe is connected.
(4) Transmissometer MOR equivalent.

12. Interface methods – Device Configuration Utility/Command line/Menu

The sensor can be set up and controlled in one of three ways.

The first method is by using Campbell Scientific’s Device Configuration Utility Software (DevConfig) which is included with each delivery on the manuals/ resource disk. This software allows an easy menu driven interface for configuring the sensor on any Microsoft™ based personal computer. All settings can be accessed using this program.

The program includes online help instructions that describe its general use with the sensor and also how to load an operating system.

The Device Configurator can also be used as a terminal emulator to use the built-in menu system of the sensor and to access its calibration menu.

The second method is by using the command line interface where discrete commands are sent without response from the sensor. This would be the preferred method of setting up a sensor if it was connected to a logger for instance. The configuration setting commands can be sent via a logger to the sensor removing the need for a local PC to set up the unit.

The third method is by using the simple menu interface built into the sensor communicating via RS-232 or RS-485, using a terminal emulator program. This menu system gives access to the more common settings.

All three of these methods use the sensor's serial connector B to communicate with the sensor. This can be via the normal communications cable or a configuration cable as described in Section 8.1.

12.1 Configuring a PC for talking to the sensor

Described below is the procedure for setting up communications using a terminal emulator program. The terminal emulators built into many Campbell Scientific software products can also be used.

The following settings should then be used by default:

Bits per second: 38400
Data bits: 8
Parity: none
Stop bits: 1
Flow control: none

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

It is possible to set the sensor into the default communication state via one of the internal switches on the sensor main board. See Section 9.

13. Definition of the variables that can be set by the user on the sensor

Both DevConfig and the command line interface can access all the user configurable variables within the sensor. The acceptable range and the identification number for these variables are listed below along with a short description.

ID	**Name**	**Range**	**Description**	**Factory default**
1	Sensor ID	0-9	Separate ID used as an extra identifier for a particular sensor on a network.	0
2	User Alarm 1 Enabled	0-1	User alarm one activation state 0 = Alarm one disabled 1 = Alarm one enabled	0
3	User Alarm 1 Active	0-1	0 = Check if distance is *less than* 'User alarm 1 Distance' 1 = Check if distance is *greater than* 'User alarm 1 Distance'	0
4	User Alarm 1 Distance	0-60000	Distance value that alarm one will trigger against. This value will correspond to metres or feet depending upon which is selected in 'Visibility Unit'	10000

5	User Alarm 2 Enabled	0-1	User alarm two activation state 0 = Alarm two disabled 1 = Alarm two enabled	0
6	User Alarm 2 Active	0-1	0 = Check if distance is *less than* 'User alarm 2 Distance' 1 = Check if distance is *greater than* 'User alarm 2 Distance'	0
7	User Alarm 2 Distance	0-60000	Distance value that alarm one will trigger against. This value will correspond to metres or feet depending upon which is selected in 'Visibility Unit'	10000
8	Baud rate	0-6	Baud rate for the main RS-232/RS-485 interface 0 = 115200 bps 1 = 57600 bps 2 = 38400 bps 3 = 19200 bps 4 = 9600 bps 5 = 2400 bps 6 = 1200 bps	2
9	Serial number	-	Internal serial number for the sensor. (*Read only)*	-
10	Visibility Unit	M or F	Unit the visibility value will be presented as M = metres F = feet	M
11	Message Interval	1-3600	Interval in seconds between outputs in continuous mode. This value has no effect if polled mode has been selected in 'Measurement mode'	60
12	Measurement mode	0-1	Selects polled or continuous modes. In continuous mode the sensor will output a string in the format as set by 'Message Format' at regular intervals as defined by 'Continuous Interval'. 0 = Continuous mode 1 = Polled mode	0
13	Message Format	0-12	Output message 0, 1 and 2 = Basic, partial or full visibility messages 3, 4 and 5 = Basic, partial or full SYNOP messages 6, 7 and 8 = Basic, partial or full METAR messages 9, 10 and 11 = Generic basic, partial or full SYNOP messages 12 = Custom message	5
14	Serial port protocol	0-1	Selects the physical serial interface 0 = RS-232 mode 1 = RS-485 mode	0
15	Averaging period	1 or 10	The period of time that the visibility measurement is averaged over. Either one minute or ten.	1
16	Sample timing	1-60	Used to define the time interval between sampling the volume. It is recommended that this value is left at one except when very low power demands are needed. Note that 1s sample timing is needed for present weather measurement. For example: 1 = Sample every second 2 = Sample one second in every two 3 = Sample one second in every three etc.	1

17	Dew heater override	0-1	0 = Allow the sensor to automatically control the dew heaters 1 = Turn the dew heaters off	0
18	Hood heater override(1)	0-1	0 = Allow the sensor to automatically control the hood heaters 1 = Turn the hood heaters off	0
19	Dirty window compensation	0-1	0 = No compensation applied 1 = Compensation for dirt on lenses applied. The sensor will compensate for up to 10% signal loss due to dirt per lens.	0
20	Use CRC-16	0-1	0 = Disable command line CRC-16 checking(2) 1 = Enable command line CRC-16 checking Note: this does not affect communications via DevConfig or terminal emulator.	0
21	Sensor power down voltage	7-30	PSU Input voltage level below which the sensor will enter low power mode. This is usually used to protect batteries.	7.0
22	Relative humidity(3) threshold	1-99	Threshold at which the sensor will define obscuration as liquid or dry if a CS215 is fitted.	80%

(1) Hood heater override needs to be set to '1' (off) when either no hood heaters are installed or the hood heaters have no power connected to them. This will save power as the relay is not enabled at low temperatures in this mode.

(2) If disabled the sensor does not check the validity of received data against the checksum sent. It is, however, recommended that checksum checking is enabled to remove any chance of the sensor being configured incorrectly by accident.

(3) CS125 only.

14. Command line mode

The command line interface is broken down into three major commands. These are GET, SET and POLL. The GET command is used to request all current user settable values from the sensor. The SET commands sets user settable values and the POLL command is used to request the current visibility and/or alarm conditions from the sensor.

The sensor can be configured to expect any commands sent to it to include a valid checksum. For simple commands, e.g. GET and POLL, fixed value checksums can be used (see the example programs). For more complex SET commands the checksum needs to be calculated (see Appendix B). The use of the checksum is disabled by default. It is recommended that the checksum functionality is enabled where possible, especially when long cable runs are used, or in electronically noisy environments.

14.1 The SET Command

The set command is used to configure the sensor via the command line. The SET command is a single space delimited string that can be sent from any data logger or PC equipped with serial communications. The SET command and the 'Device Configuration Utility' software access identical settings within the sensor, please refer to the 'Device Configuration Utility' section of this document for a more detailed breakdown of the setting available here. This command is used to change the default power up state of the sensor. See Section 14.2 if a setting is going to be changed on a regular basis e.g. heater controls.

See Section 12 for more information on the values used by the 'SET' command.

SET transmitted data	
Example	**Description**
0x02(1)	STX ^ B(2)
SET	SET
:	Delimiting character
	Current Sensor ID
:	Delimiting character
	Sensor ID (may be a new ID)
	User Alarm 1 Set
	User Alarm 1 Active
	User Alarm 1 Distance
	User Alarm 2 Set
	User Alarm 2 Active
	User Alarm 2 Distance
	Serial Baud Rate
	Sensor serial number (read only)
	Visibility Units
	Message interval
	Polling or Continuous modes
	Message Format
	RS-232 or RS-485 serial communications enabled
	Averaging Period
	Sample timing
	Dew heater override
	Hood heater override
	Dirty window compensation
	CRC-16 checking on received commands
	Sensor power down voltage
	Relative humidity threshold(3)
:	Delimiting character
XXXX	Checksum (use the valid CRC-16 checksum)
:	Delimiting character
0x03(1)	ETX ^ C(2)
0x0D(1)	Carriage return
0x0A	Line feed

(1) These values are shown in hexadecimal format not ASCII.
(2) As entered on a keypad.
(3) CS125 only.

14.1.1 Example of a SET Command

```
SET:0:0 1 1 1000 1 0 15000 2 0 M 60 1 2 0 1 1 0 0 0 1 7 80 :68A3:
```

14.2 The SETNC Command

The format of the SETNC command is nearly exactly the same as the SET command. The only functional difference is that the SETNC command does not commit the values set into flash memory. This means that the next time the sensor is power cycled it will revert back to its previous settings. This command should be used when a setting in the sensor is changed regularly, e.g. heater functions, as this command avoids the risk of wearing out the flash storage memory. Note: this includes communication data rates as well.

14.2.1 Example of a SETNC Command

```
SETNC:0:0 1 1 1000 1 0 15000 2 0 M 60 1 2 0 1 1 0 0 0 1 7 80 :XXXX:
```

14.3 The MSGSET Command

The user customisable message format can be configured using the MSGSET command.

When a valid MSGSET command is issued a MSGGET response comes back from the sensor.

Example	Bit	Description
0x01 (Hex)	-	SOH
:	-	Delimiting character
MSGSET	-	MSG SET
:	-	Delimiting character
0	-	Sensor ID
:	-	Delimiting character
The following represent 16 bits of a hex value		
	16	*Reserved*
	15	*Reserved*
	14	Humidity (%) (1) (2)
	13	Temperature (Degrees C) (1)
	12	NWS code (1)
	11	METAR code (1)
	10	SYNOP code (1)
	9	Generic SYNOP (1)
	8	Accumulation (1)
	7	Intensity (1)
	6	Particle count (1)
	5	Sensor serial number
	4	Dirty windows values
	3	System alarms
	2	User alarms
	1	Averaging duration
:		Delimiting character
XXXX		Checksum
:		Delimiting character
0x04 (Hex)		EOT

These selections output more than one variable

(1) These options will only be available if you're using a CS125
(2) Only outputs a valid final message value when a CS215 temperature and humidity probe is connected

Description of the custom message bits	
Bit	**Description**
8000	*Reserved*
4000	*Reserved*
2000	Humidity (%)
1000	Temperature (Degrees C)

0800	NWS code
0400	METAR code
0200	SYNOP code
0100	Generic SYNOP
0080	Accumulation
0040	Intensity
0020	Particle count
0010	Sensor serial number
0008	Dirty windows values
0004	System alarms
0002	User alarms
0001	Averaging duration

The HEX value is the sum of all the required fields.

The following example shows the calculation of the HEX value to use a MSGSET message to set a CS125 to output temperature, SYNOP code, sensor serial number, dirty windows values and system alarms.

Description of the custom message bits	
Bit	**Description**
8000	*Reserved*
4000	*Reserved*
2000	Humidity (%)
1000	**Temperature (Degrees C)**
0800	NWS code (3)
0400	METAR code
0200	**SYNOP code (3)**
0100	Generic SYNOP (3)
0080	Accumulation (3)
0040	Intensity (3)
0020	Particle count (3)
0010	**Sensor serial number**
0008	**Dirty windows values**
0004	**System alarms**
0002	User alarms
0001	Averaging duration
121C	**Sum for MSGSET message**

The hex value is the hexadecimal sum of the hex values of the chosen fields (in bold text).

The message sent is:

```
MSGSET:0:161C:9794:
```

The response is:

```
161C 7067
```

In this case “7067” is the checksum

14.4 The GET Command

The GET command retrieves settings data from the sensor, including message format data and user alarm settings amongst others. This command does not retrieve visibility or environmental information from the sensor. To retrieve visibility data refer to the POLL command.

The GET command

GET command transmitted data	
Example	**Description**
0x02(1)	STX ^ B(2)
GET	GET
:	Delimiting character
0	Address based on Sensor ID
:	Delimiting character
0	Reserved for future use, zero default
:	Delimiting character
XXXX	Checksum
:	Delimiting character
0x03(1)	ETX ^ C(2)
0x0D(1)	Carriage return
0x0A	Line feed

(1) These values are shown in hexadecimal format not ASCII.
(2) As entered on a keypad

Example of a GET command

```
GET:0:0:XXXX:
```

Data returned by the GET command

GET returned data	
Example	**Description**
0x02[1]	STX
	Sensor ID
	User Alarm 1 Set
	User Alarm 1 Active (0 = less than)
	User Alarm 1 Distance
	User Alarm 2 Set
	User Alarm 2 Active
	User Alarm 2 Distance
	Serial Baud Rate
	Sensor serial number (read only)
	Visibility Units
	Message interval
	Polling or Continuous modes
	Message Format
	RS-232 or RS-485 serial communications enabled
	Averaging Period
	Sample timing
	Dew heater override
	Hood heater override
	Dirty window compensation
	CRC-16 checking on received commands
	Sensor power down voltage
	Relative humidity threshold
XXXX	Checksum
0x04[1]	EOT
0x0D[1]	Carriage return
0x0A	Line feed

(1) These values are shown in hexadecimal format not ASCII.

Example of a GET returned data

0 0 0 10000 0 0 10000 2 1009 M 30 0 2 1 1 1 0 0 0 1 11.5 80 D4FD

Explanation:

Sensor ID = 0

User Alarm 1 not set

User Alarm 1 not active

User Alarm 1 distance = 10000 metres

User Alarm 2 not set

User Alarm 2 not active

User Alarm 2 distance = 10000 metres

Serial baud rate 2 (=38400Bd)

Serial number = 1009

Visibility Units = M

Continuous mode output interval = 30 seconds

Polling mode = 0 (continuous mode)

Message format = 2 (full message)

RS-232 or RS-485 serial communications = 1 (RS-485)

Averaging period = 1 minute

Sample timing = 1 sample per second

Dew heater override = 0 (sensor will automatically control the dew heaters)

Hood heater override = 0 (sensor will automatically control the hood heaters)

Dirty window compensation = 0 (dirty window compensation off)

CRC-16 checking on received commands = 1 (CRC-16 checking enabled)

Sensor power down voltage = 11.5V

Relative humidity threshold 80 (CS125 only)

Checksum = D4FD

14.5 The MSGGET Command

The Message Get (MSGGET) command retrieves the current settings of the custom message from the sensor.

MSGGET command transmitted data

Example	**Description**
0x01(Hex)	SOH
:	Delimiting character
MSGGET	MSG GET
:	Delimiting character
0	Address based on Sensor ID
:	Delimiting character
0	Payload
:	Delimiting character
XXXX	Checksum
:	Delimiting character
0x04(Hex)	EOT

Example of the MSGGET command as sent to the sensor

The message sent is:

```
MSGGET:0:0:C6ED:
```

The response is:

```
161C 7067
```

14.6 The POLL command – Polling the sensor

The POLL command requests the current visibility and/or alarm conditions from the sensor. The output format of this command depends on how the sensor is configured using the SET command or the menu interfaces.

The POLL command

POLL command transmitted data	
Example	**Description**
0x02(1)	STX, ^B(2)
POLL	POLL
:	Delimiting character
0	Address based on Sensor ID
:	Delimiting character
0	Reserved for future use, zero default
:	Delimiting character
XXXX	Checksum(3)
:	Delimiting character
0x03(1)	ETX, ^C(2)
0x0D(1)	Carriage return
0x0A	Line feed

(1) These values are shown in hexadecimal format not ASCII.
(2) As entered on a keypad.
(3) Not case sensitive.

NOTE The maximum response time to a poll command is 100 ms.

If the setting to check the checksum on received commands is enabled the checksum varies with the Sensor ID value. The table below gives the POLL command for different sensor ID's with the correct checksum.

POLL commands for different sensor IDs

ID	POLL command with checksum
0	POLL:0:0:3A3B:
1	POLL:1:0:0D0B:
2	POLL:2:0:545B:
3	POLL:3:0:636B:
4	POLL:4:0:E6FB:
5	POLL:5:0:D1CB:
6	POLL:6:0:889B:
7	POLL:7:0:BFAB:
8	POLL:8:0:939A:
9	POLL:9:0:A4AA:

14.7 The ACCRES command – Resetting the accumulation value

If accumulation is included in a custom message the ACCRES command resets the accumulation to zero. See Section 11.6.

The ACCRES command

ACCRES command transmitted data	
Example	**Description**
0x02(1)	STX, ^B(2)
ACCRES	ACCRES
:	Delimiting character
0	Address based on Sensor ID
:	Delimiting character
0	Reserved for future use, zero default
:	Delimiting character
XXXX	Checksum(3)
:	Delimiting character
0x03(1)	ETX, ^C(2)
0x0D(1)	Carriage return
0x0A	Line feed

(1) These values are shown in hexadecimal format not ASCII.
(2) As entered on a keypad.
(3) Not case sensitive.

Example of an ACCRES command

```
ACCRES:2:0:3A68:
```

If the setting to check the checksum on received commands is enabled the checksum varies with the Sensor ID value.

15. Entering the sensor menu system

The user can enter the menu system by typing ‘open *id*’ into their terminal program then pressing the return key on their keyboard. The *id* corresponds to the sensor ID number. The Sensor ID number can be in the range of 0 to 9. The factory default is 0.

NOTE The ‘open 0’ command is not normally echoed.
The terminal menu only gives access to more common settings.

The following text should now be displayed:

The setup menu

```
WELCOME TO THE CAMPBELL SCIENTIFIC LTD CS125 SETUP
MENU
 ID 0
 S/N 2003
 (1) Message output menu
 (2) User alarm menu
 (3) Calibrate sensor
 (4) System information
 (5) Communications setup
 (6) System configuration

 (9) Exit and save
 (0) Exit and don't save
```

The displayed options are accessed simply by typing the corresponding number then pressing return. No changes will take effect until you ‘Exit and Save’. The exception to this is the calibration menu, but you will be informed before any changes are made.

Typing ‘1’ opens the message menu containing settings relating to the sensor’s outputs.

Menu 1: The message output menu

```
CS125 MESSAGE - MENU 1
 ID 0
 S/N 1006
 (1) Set message format:FULL SYNOP
 (2) Toggle units:METRES
 (3) Toggle polled or continuous mode:CONTINUOUS
 (4) Set continuous mode message-interval:60 second(s)
 (5) Toggle output averaging period: 1 minute(s)
 (6) Sampling interval:1 second(s)

 (9) Refresh
 (0) Return to main menu
```

While in the message output menu, typing ‘1’ allows the message format to be set. The options are listed as shown below and typing the appropriate number sets the required message format. The messages are described in more detail in Section 11.

Note that the CS120A Visbility Sensor can only output messages 0-2 and a limited custom message.

```
CS125 MESSAGE - SUB 3
 Set the message output format. Current format is: FULL
SYNOP
  - Basic                  = 0
  - Partial                = 1
  - Full                   = 2
  - Basic SYNOP            = 3
  - Partial SYNOP          = 4
  - Full SYNOP             = 5
  - Basic METAR            = 6
  - Partial METAR          = 7
  - Full METAR             = 8
  - Generic Basic SYNOP    = 9
  - Generic Partial SYNOP = 10
  - Generic Full SYNOP    = 11
  - Custom output         = 12
  ->
```

While in the message output menu, typing ‘2’ will toggle the units through the options ‘METRES’ and ‘FEET’ or by typing ‘4’ it will allow the message interval to be entered.

In setup menu, typing ‘2’ allows the User Alarms to be set, again by toggling through options or changing values.

Menu 2: The user alarm menu. Sub menu 2: Alarm two activation level (Option 6)

Option (3) is the calibration menu

```
CS125 ALARM - MENU 2
 ID 0
 S/N 1009
 (1) Toggle user alarm one: DISABLED
 (2) Toggle alarm one threshold: LESS THAN
 (3) Set new user alarm one activation point: 10000 m
 (4) Toggle user alarm two: DISABLED
 (5) Toggle alarm two threshold: LESS THAN
 (6) Set new user alarm two activation point: 10000 m

 (9) Refresh
 (0) Return to main menu

  ->
```

Typing '3' while in the setup menu opens the calibration menu.

Menu 3: The calibration menu

```
CS125 CALIBRATION - MENU 3
 ID 0
 S/N 1003
 (1) Perform calibration
 (2) Restore the factory calibration
 (3) Perform dirty windows zero offset calibration
 (4) Restore dirty windows factory calibration

 (9) Refresh
 (0) Return to main menu

 ->
```

Consult the 'calibration' section of this manual for information on how to calibrate the sensor.

NOTE Once a calibration is finished changes are immediate, but factory calibrations can be restored if needed using Option '(2)' in the calibration menu. The disk constants however remain as the last disk used.

Typing '4' while in the setup menu option opens the systems information menu containing useful information such as temperature and system alarms.

The parameters 'calibration value factory offset' and 'calibration value factors scale' are the factory calibration coefficients from the last factory calibration. The parameters 'calibration value cal offset' and 'calibration value cal scale' are the calibration coefficients from the latest calibration.

Menu 4: The system information menu

```
CS125 INFORMATION - MENU 4
 ID 0
 S/N 1003
 OS version: 007646v1

                                   Alarm       Value
 - Last visibility reading:         -           3258M
 - Overall system status:           0           No faults
 - Emitter dirty window alarm:      0           0%
 - Emitter internal temperature:    0           38.4
 - Detector dirty window alarm:     0           0%
 - Detector internal temperature:   0           31.0
 - Detector DC light saturation:    0            -
 - Hood heater temperature:         0           25.6
 - CS125 Calibrator Serial No:      -           1000
 - CS125 Calibrator Exco:           -           30.5
 - Calibration value factory offset:-           -0.026
 - Calibration value factory scale: -           0.02682
 - Calibration value cal offset:    -           -0.026
 - Calibration value cal scale:     -           0.02682
 - Signature fault:                 0            -
 - Flash write errors:              0           0
 - Flash read errors:               0           0
 - Supply voltage:                  <7.0V       11.3V
 - Aux supply voltages:             +5V=5.0     -5V=-5.1
                                                +6V=5.9
 - External temperature:            0           26.4
 - Present weather mode enabled

 (8) Get debug
 (9) Refresh
 (0) Return to main menu

 ->
```

If either of the dirty window alarms are set it is recommended you follow the cleaning section of this manual (Section 18).

If there is a flash error or signature error it is recommended that you contact Campbell Scientific.

The sensor power down voltage shown before the supply voltage is not available for CS120A sensors with serial numbers less than E1030.

Menu 5: The communication menu

```
CS125 COMMUNICATIONS - MENU 5
 ID 0
 S/N 1009
  (1) Set sensor ID
  (2) Set RS-232/RS-485 baud rate:38400
  (3) Toggle RS-232/RS-485 modes:RS-232

  (9) Refresh
 (0) Return to main menu

   ->
```

The communications menu is used to set baud rates and the mode of operation (RS-232/RS-485).

NOTE No change will take effect until you ‘exit and save’.

Menu 6: Configuration

```
CS125 CONFIGURATION - MENU 6
 ID 0
 S/N 1003
  (1) Dew heater override:           AUTOMATIC
  (2) Hood heater override:          AUTOMATIC
  (3) Dirty window compensation:     NO COMPENSATION
  (4) Command line CRC-16 Checking:  DO NOT CHECK
  (5) Sensor power down voltage:     7.0V
  (6) RH threshold: 80%

  (9) Refresh
 (0) Return to main menu

   ->
```

This menu sets dew and hood heaters to automatic or off, dirty window compensation and CRC-16 checking. In addition it allows the sensor power down voltage to be set. If set this will put the sensor into a low power state (which will not make measurements) before the battery voltage has fallen low enough to damage a back-up battery. The RH threshold for a CS125 can also be set from this menu. This applies if a CS215 sensor is attached and defines the level of RH below which obscuration is deemed to be dry (that is haze, SYNOP 04 or 05, METAR HZ) rather than wet (mist, SYNOP 10, METAR BR or fog, SYNOP 30 etc. METAR FG).

Menu 9 and 0: Exiting the menu system

Options ‘9’ and ‘0’ exit from the menu system. Note that typing ‘0’ will lose all changes made including communications settings.

```
CAMPBELL SCIENTIFIC LTD sensor menu exited.
```

16. Calibrating the sensor

16.1 Visibility calibration

The sensor can be checked and adjusted using the optional sensor high grade calibration kit part number 010805. The calibration must be run using the onboard menu system. If you have Campbell Scientific’s Device configuration program a terminal emulation screen is provided in the sensor screens to let you access this function. To perform the calibration you will need a sensor calibrator disk and a computer with a standard serial port compatible with the sensor. If your sensor is not currently configured for RS-232 communications you can set the internal switch, switch three, to temporarily set the sensor to RS-232 mode 38400 bps. If the sensor is already set in RS-232 mode it should not be necessary to change any internal switches. (See Section 10 for more information on the sensor internal switches.)

The test should ideally be performed in the following conditions:

- Ambient temperature should be between 0ºC and 50ºC
- The local visibility should be approximately 10,000 metres or higher.

The system is self-regulating. However, it is recommended that the sensor is calibrated at least every two years.

The calibration is performed from menu item 3 on the main terminal screen. Please refer to the menu section (Section 13) of this manual for further information on how to access this menu.

Once you have selected menu item 3 you should be presented with the following screen.

```
CS125 CALIBRATION - MENU 3
ID 0
S/N 1006
(1) Perform calibration
(2) Restore the factory calibration
(3) Perform dirty windows zero offset calibration
(4) Restore dirty windows factory calibration

(9) Refresh
(0) Return to main menu
```

Select option 1 to start the calibration. You will then be asked to confirm that you would like to perform a calibration. Please note, once you have entered yes at this point you will not be able to exit until the test is complete. However, power cycling the unit at this point will have no adverse effect on the sensor.

```
Do you want to perform a calibration Y/N?
```

NOTE At this stage it is advisable to clean the lenses. Refer to Section 18 'Cleaning' for more information. A simple visual check may be enough to confirm the lenses are clean.

Once you have started the tests you will be asked for the sensor calibrator serial number and extinction coefficient (EXCO) with a confirmation at each step giving you the chance to correct typing mistakes.

NOTE When asked for confirmation you do not need to press return after you type 'y'.

```
Starting calibration.
Input the sensor calibrator serial number ->E2002
Is E2002 correct? (Y/N)?
Input the sensor calibrator constant ->28.8
Is 28.8 correct? (Y/N)?


Place one calibration bung into each hood, then
press any key.
```

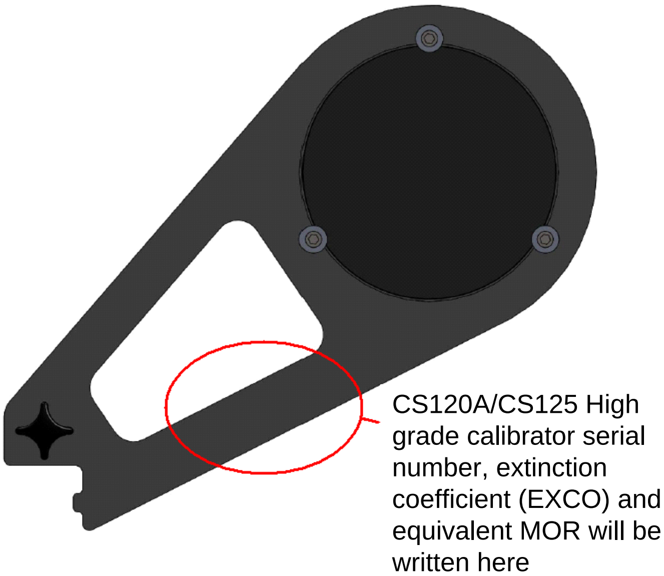


Figure 16-1. Calibration disk

When you have entered the calibrator information the sensor will wait for you to place the foam bungs into the sensor hoods. The bungs are designed to block all light from the outside reaching inside the head. Place one bung into each hood. If either of the bungs are damaged or appear to have any gaps around the edge please contact Campbell Scientific.

```
Starting dark level calibration.
This test will take approximately two minutes
```

This part of the test will take approximately two minutes. Every ten seconds a dot should appear indicating that the test is progressing as normal.

```
Dark level test complete.  Please remove the bungs.
Now place the sensor calibrator into the sampling
volume.
Press any key once this is done.
```

Remove the bungs once the sensor instructs you to. Place the sensor calibrator into the volume by fastening it to the central mounting point.

NOTE At this stage it is advisable to perform a simple visual check of the cleanliness of the calibration plate. If contaminated clean it on both sides. Refer to Section 18, Cleaning.

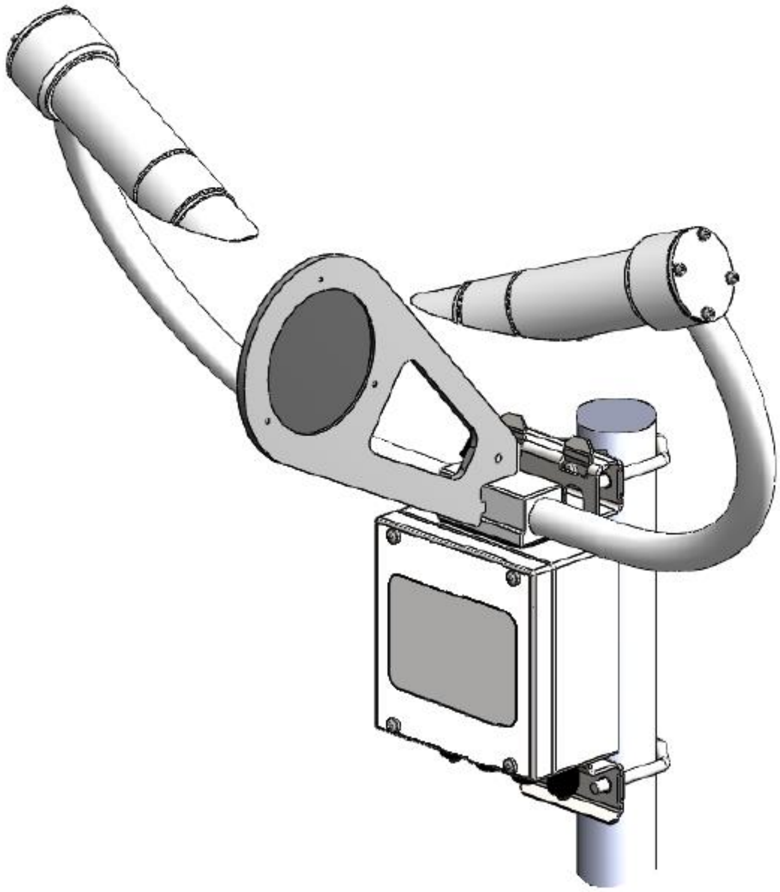


Figure 16-2. Mounting calibration disk

```
Starting light level calibration.
This test will take approximately two minutes.
```

This part of the test will take approximately two minutes. Every ten seconds a dot should appear indicating that the test is progressing as normal.

```
Calibration is now complete.
Saving user settings
Press any key to exit.
```

Once the second stage of the test has been completed the new calibration constants will be saved automatically. All calibration constants including both the user and the factory setting can be viewed from menu item 4 from the main menu once the test is completed.

16.2 Dirty window zero calibration

Option 3 in the calibration menu allows the user to reset the zero contamination level for dirty windows detection (option 4 allows a return to the factory value if something goes wrong with the calibration process.)

This should be carried out every two years to check for any slight drift in the dirty window detection.

To carry out the dirty window zero offset calibration make sure the windows are very clean. Temperature should ideally be in the range 15 – 30°C and the sensor should have been powered up for over 5 minutes.

```
CS125 CALIBRATION - MENU 3
ID 0
S/N 1006
(1) Perform calibration
(2) Restore the factory calibration
(3) Perform dirty windows zero offset calibration
(4) Restore dirty windows factory calibration

(9) Refresh
(0) Return to main menu
```

Typing ‘3’ returns text similar to the following:

```
Current values EO=3200 DO=4649 DD=995
Cal DW offset? Y/N?
```

Then type ‘Y’. The sensor responds in a similar way to the following:

```
Calibrating dirty window system...Please wait

DD=990 DO=4535
DD=1000 DO=4531
DD=1010 DO=4373
DD=1020 DO=4206
DD=1030 DO=3886
DD=1110 DO=2675
DD=1120 DO=2682
DD=1130 DO=2530
DD=1140 DO=2392
EO=3230 ES=371 DO=2251 DS=234 DD=1140
Press any key to exit (Not return)
```

Press any key and the dirty window zero offset calibration is complete.

16.3 Internal temperature check (CS125 only)

The CS125 has an internal temperature sensor in one of the cross arms. This is used as part of the present weather identification if a CS215 temperature and RH sensor is not connected. This does not need recalibration but can be checked if a suitable nearby reference temperature measurement is available. The CS125 external temperature given in some standard messages (see Section 11) or in the system information menu (see Section 15) should be within about 3°C of the reference. The comparison should ideally be made in cloudy and windy conditions and as near to 0°C as possible.

17. Performing an operating system update

Operating system updates for the sensor present weather sensor are performed using Campbell Scientifics Device Configuration Utility (DevConfig) software. Please refer to the help built into the DevConfig software for full instructions on how to update the sensor operating system. The pictures below show the procedure using DevConfig.

NOTE To use DevConfig to carry out an OS change requires RS-232 communication. If a sesor is set to communicate by RS-485 it can be temporarily set to RS-232 with switch 3 (see Section 10).

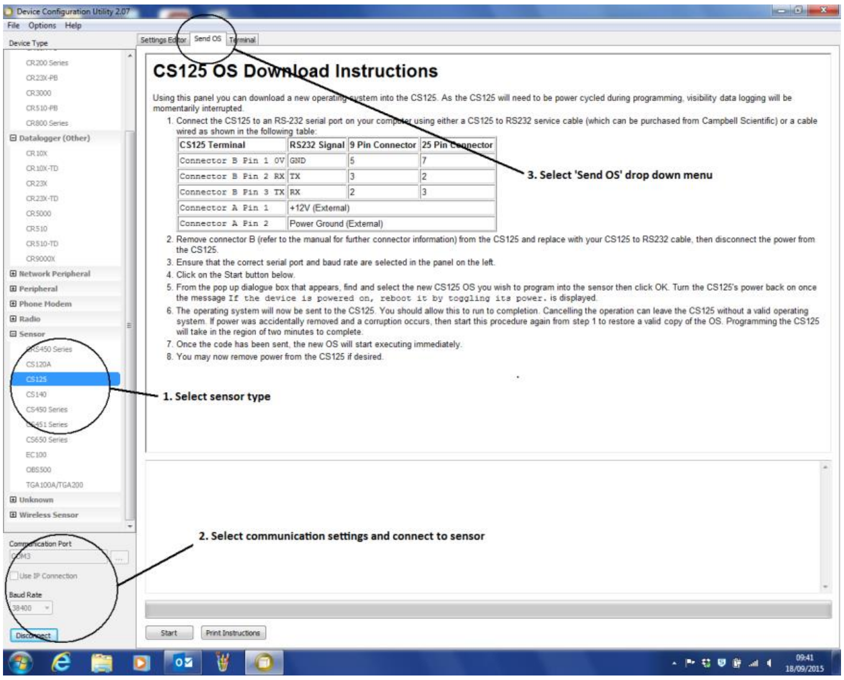


Figure 17-1. Sensor DevConfig download instructions

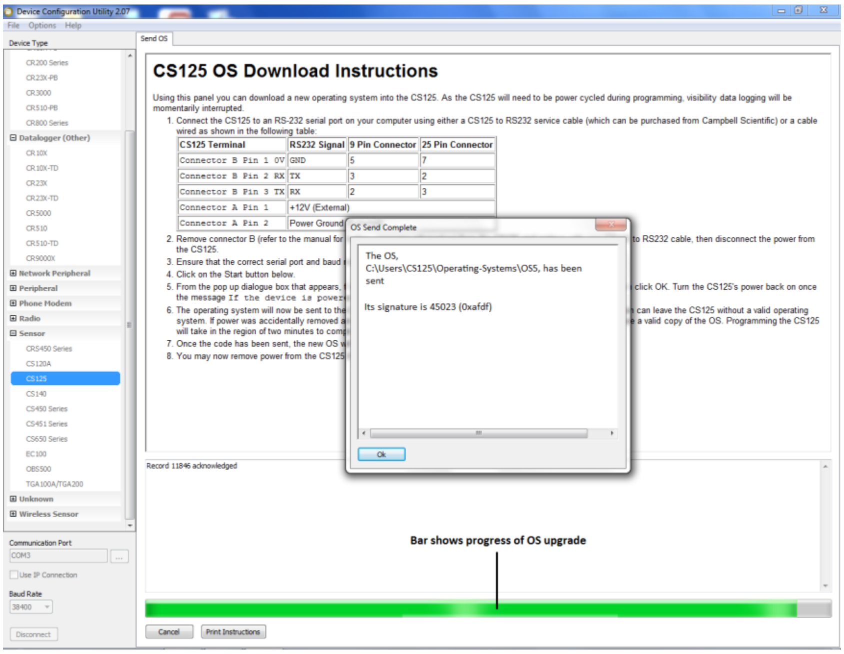


Figure 17-2. Sensor DevConfig screen when OS update is complete

18. Cleaning

The sensor is a robust instrument that will provide years of uninterrupted weather monitoring. Calibration is carried out at the factory and can be redone easily on site with the optional sensor calibrator or carried out by Campbell Scientific if required. Only general cleaning of the lenses is required to keep the sensor working efficiently.

Cleaning of the sensor will be required from time to time to ensure that the lenses are free from contaminants. The frequency of required cleaning depends on the exposure of the instrument to such contaminants. This will vary depending on the site location. The sensor is capable of self diagnosing dirty lenses and will indicate in its output when the lenses are contaminated to such a degree that its visibility measurements may be affected.

NOTE A lower level of contamination than is detected by the dirty window alarms, can affect the visibility measurements. The sensor can be configured to attempt to make a correction for contamination although the accuracy of that correction depends on the ‘type of dirt’.

We suggest 6 monthly intervals for locations not prone to contaminants and monthly intervals for those prone to contamination (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 lenses require cleaning, it is very important that only a proper lens cloth or lens tissue be used. The use of inappropriate materials to clean the lenses can permanently damage or reduce the effectiveness of the lenses leading to errors in measurement of precipitation and visibility.

It is advisable to use an air duster to blow any loose dust and dirt from the lenses as a first step. Using a lint free lens cloth or lens tissue impregnated with a small amount of isopropyl alcohol solvent clean the lens surface by dragging the cloth across the lens surface being careful not to apply excessive pressure.

Excessive pressure may lead to some types of contaminant scratching the lens surface. Over time such scratches can lead to reduced sensor accuracy.

NOTE Spiders webs and certain ‘fluffy’ seeds which get lodged in the optical path can lead to the sensor permanently giving low readings as they can emulate precipitation. Cleaning the contamination away with a duster will return the sensor to normal operation.

If spiders are a persistent problem, using some carefully applied insecticide can deter them.

19. Lubricating the enclosure screws

The sensor enclosure screws should be lubricated with a suitable anti-seize grease (often copper loaded) to protect the threads from corrosion. This should be reapplied when resealing the enclosure at regular intervals, normally after replacing the desiccant. This is of particular importance if using the sensor in corrosive or salt laden atmospheres.

20. Desiccant

Two bags of desiccant are supplied. One is inside the enclosure, the other is separate and sealed in a plastic bag. Desiccant use depends on your application but for use in typical temperature conditions one bag is sufficient for a twelve month period. The desiccant should be placed inside the enclosure taking care that it is not trapped between the lid and the enclosure when the lid is replaced.

The second bag of desiccant should be kept in the plastic shipping bag as a replacement for when the initial bag needs to be dried out. The bags can be rotated in this way many times. Desiccant bags can be dried out by the following method:

1. Arrange the bags on a wire tray in a single layer to allow for adequate air flow around the bags during the drying process. The oven's inside temperature should be room or ambient temperature (25°C - 30°C). A convection, circulating, forced air type oven is recommended for this regeneration process. Seal failures may occur if any other type of heating unit or appliance is used.

2. When placed in a forced air, circulating air, or convection oven, allow a minimum of 4 to 5 cm of air space between the top of the bags and the next metal tray above the bags. If placed in a radiating exposed infrared element type oven, shield the bags from direct exposure to the heating element, giving the closest bags a minimum of 40 cm clearance from the heat shield. Excessive surface film temperature due to infrared radiation will cause the Tyvek material to melt and/or the seals to fail. Seal failure may also occur if the temperature is allowed to increase rapidly. This is due to the fact that the water vapour is not given sufficient time to diffuse through the Tyvek material, thus creating internal pressure within the bag, resulting in a seal rupture. Temperature should not increase faster than 0.1°C to 0.3°C per minute.

3. Set the temperature of the oven to 118°C, and allow the bags of desiccant to reach equilibrium temperature.

CAUTION Tyvek has a melting temperature of 121°C - 127°C.

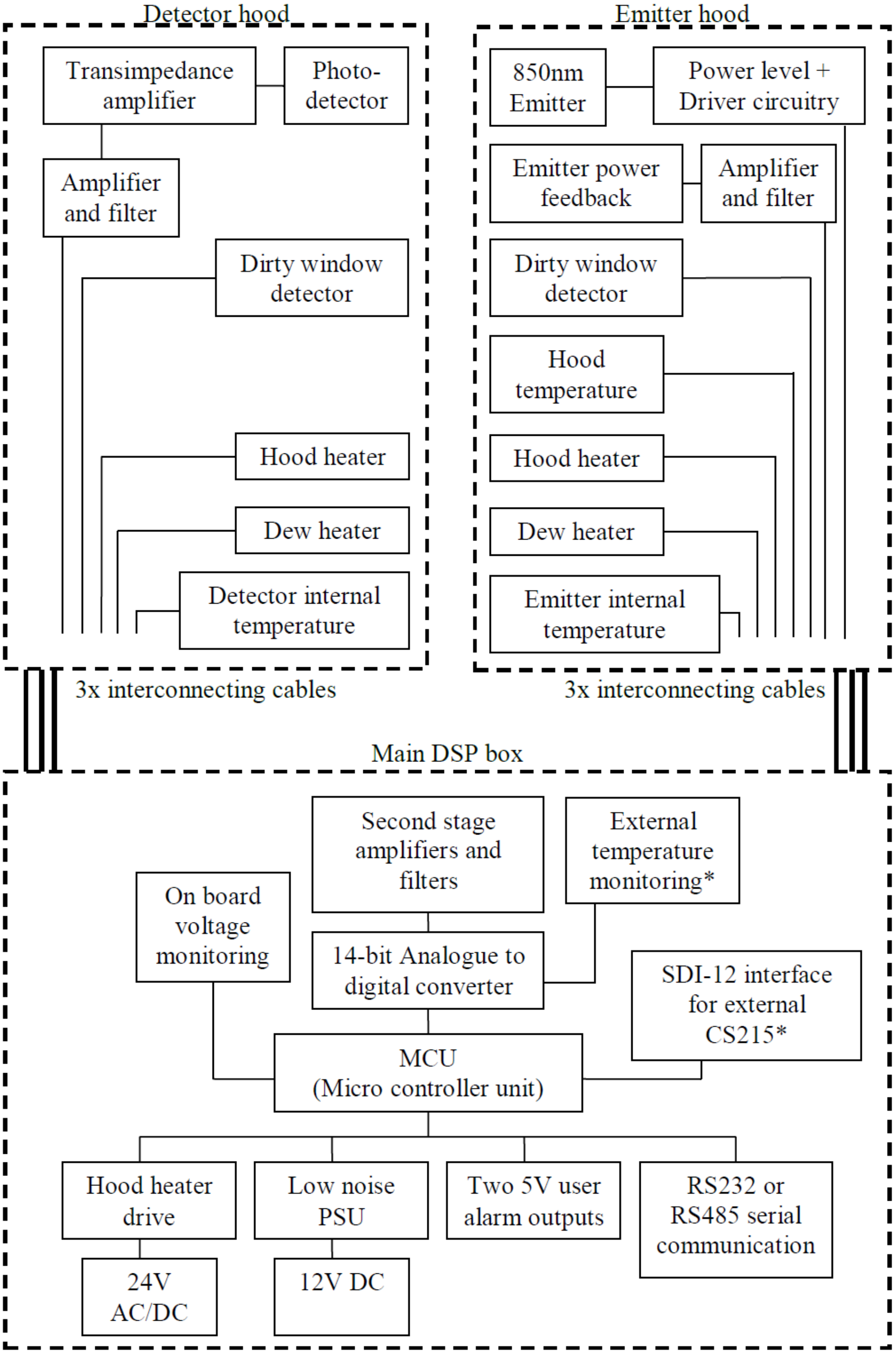
(NON MIL-D-3464E activation or reactivation of both silica gel and Bentonite clay can be achieved at temperatures of 104°C).

4. Desiccant bags should be allowed to remain in the oven at the assigned temperature for 24 hours. At the end of this period, the bags should be immediately removed and placed in a desiccators jar or dry (0% relative humidity) air tight container for cooling. If this procedure is not followed precisely, any water vapour driven off during reactivation may be re-adsorbed during cooling and/or handling.

5. After the bags of desiccant have been allowed to cool in an airtight desiccator, they may be removed and placed in either an appropriate type polyliner tightly sealed to prevent moisture adsorption, or a container that prevents moisture from coming into contact with the regenerated desiccant. Some care should be taken when re-activating desiccant bags. If heated in an oven which is too hot, the bags may burst. If in any doubt, we recommend purchasing new desiccant packs instead of oven drying. Failure to use or exchange the desiccant may lead to condensation inside the enclosure. Not only will this lead to corrupted data but, in the long term, can also cause corrosion which is expensive to repair.

Appendix A. CS120A/CS125 block diagram

Block diagram



*CS125 only

Appendix B. Example C code of the CRC-16 checksum

The code below is provided as an example for programmers implementing their own code to communicate with the sensor. Users using Campbell loggers can use the Checksum command in CRBasic to generate a CRC-16 checksum. Command: Checksum/ChkSumString,1,0).

The checksum includes all characters excluding the SOT, EOT and the checksum itself.

The SET and SETNC commands also exclude the two delimiting `:' characters, one on each side of the checksum itself.

```
//---------------------------------------------------------------------------
// Creates a CCITT CRC-16 checksum seeded with 0x0000 (XModem style) using a
//  fast non table based algorithm.
// Pass in the data to convert into a CRC-16 in the form of a NULL terminated
//  character array (a string).
// Returns the CRC-16 in the form of an unsigned 16 bit integer value
// Note: This algorithm has only been tested on a native 16-bit processor with
//       a hardware barrel shifter
//       All integers are 16-bits long
//---------------------------------------------------------------------------
unsigned int CRC-16_CCITT(char LineOfData[]){

        unsigned int crc; // returned CRC-16 value
        unsigned int i;   // counter

        crc = 0x0000;

        // create a check sum for the incoming data
        for(i=0;i < strlen(LineOfData); i++){
        unsigned crc_new = (unsigned char)(crc >> 8) | (crc << 8);
          crc_new ^= LineOfData[i];
          crc_new ^= (unsigned char)(crc_new & 0xff) >> 4;
          crc_new ^= crc_new << 12;
          crc_new ^= (crc_new & 0xff) << 5;
          crc = crc_new;
        }

        return(crc);
}
```

Appendix C. Example CRBasic programs

C.1 CRBasic read program

```
'CR800
'Demonstration program to read data from a CS125 set to continuous output
'with the full SYNOP (default) message being transmitted
'Note: The CS125 emits this message every minute by default.

Public Visibility
'These variables could be defined as DIM in a final program

Public InString As String * 100 'Incoming string
Public SerialIndest(27) As String, NBytesReturned
Public ChecksumOK As Boolean

Public lngCRCCalc As Long, lngCRCMsg As Long
'Define the aliases for the full message
Alias SerialIndest(1)=Message_ID '0..2
Alias SerialIndest(2)=Sensor_ID '0..9
Alias SerialIndest(3)=System_status '0..3
Alias SerialIndest(4)=Interval_time '1..3600
Alias SerialIndest(5)=Visibilitystr '0..32000 metres
Alias SerialIndest(6)= VisibilityUnits 'M or F for Metres or Feet
Alias SerialIndest(7)=Averaging_duration '1 or 10 minutes
Alias SerialIndest(8)=User_alarm_1 '0..1 - Visibility compared to Threshold One
Alias SerialIndest(9)=User_alarm_2 '0..1 - Visibility compared to Threshold Two
Alias SerialIndest(10)=Emitter_failure '0..2 - Emitter Failure
Alias SerialIndest(11)=Emitter_lens_dirty '0..3 - Emitter Lens Dirty
Alias SerialIndest(12)=Emitter_temp_error '0..3 - Emitter Temperature
Alias SerialIndest(13)=Detector_lens_dirty '0..3 - Detector Lens Dirty
Alias SerialIndest(14)=Detector_temp_error '0..3 - Detector Temperature
Alias SerialIndest(15)=Detector_saturated '0..1 - Detector DC Saturation Level
Alias SerialIndest(16)=Hood_temp_error '0..3 - Hood Temperature
Alias SerialIndest(17)=External_temp_error '0..3 - External Temperature
Alias SerialIndest(18)=Signature_error '0..1 - Signature Error
Alias SerialIndest(19)=Flash_read_error '0..1 - Flash Read Error
Alias SerialIndest(20)=Flash_write_error '0..1 - Flash Write Error
Alias SerialIndest(21)=Particle_Limit_error '0 or 1 - Particle limit reached
Alias SerialIndest(22)=Particle_Count
Alias SerialIndest(23)=Intensity 'mm/h
Alias SerialIndest(24)=SYNOP_code
Alias SerialIndest(25)=Temperature 'deg C
Alias SerialIndest(26)=Relative_Humidity '%, 0..100
Alias SerialIndest(27) = checksumrx 'CCITT Checksum
'Define the serial port to which the CS125 is connected - amend as needed
Const CS125_Comport = COM1
'Main Program
BeginProg
  'Open the logger serial port to which the CS125 is connected
  SerialOpen (CS125_Comport,38400,3,0,1000)

  Scan(10,Sec,1,0)
     'Sensor emits a message every 60 seconds by default so this will fail 5
    'times out of 6 with a 10 second scan
```

```
    SerialInRecord(CS125_Comport,InString,&h02,0,&h03,NBytesReturned,01)
    'Check that a message has been recieved first
    If NBytesReturned > 0 Then
      'Split out the Data into strings
      SplitStr (SerialIndest(),InString," ",27,5)
      'Check the received checksum is valid
      'Calculate the expected checksum
      lngCRCCalc = CheckSum(InString,1,NBytesReturned-5)
      'Extract the checksum from the message & convert it for comparison
      lngCRCMsg = HexToDec(checksumrx)
      ChecksumOK = ( lngCRCMsg = lngCRCCalc)
      'In critical applications the visibility can be set to NaN if the system status
      'is degraded or a critical error flag is set.
      If ChecksumOK Then Visibility = Visibilitystr Else Visibility =NaN
    EndIf
    'Call data storage commands here
  NextScan
EndProg
```

C.2 CRBasic POLL program

```
'CR800
'Demonstration program to read data from a CS125 set to polled output
'with the full SYNOP (default) message being transmitted
'Note: the sensor needs to be configured to behave like this, it is not setup by this
program.

Public Visibility
'These variables could be defined as DIM in a final program

Public InString As String * 100 'Incoming string
Public SerialIndest(27) As String, NBytesReturned
Public ChecksumOK As Boolean

Public lngCRCCalc As Long, lngCRCMsg As Long
'Define the aliases for the full message
Alias SerialIndest(1)=Message_ID '0..2
Alias SerialIndest(2)=Sensor_ID '0..9
Alias SerialIndest(3)=System_status '0..3
Alias SerialIndest(4)=Interval_time '1..3600
Alias SerialIndest(5)=Visibilitystr '0..32000 metres
Alias SerialIndest(6)= VisibilityUnits 'M or F for Metres or Feet
Alias SerialIndest(7)=Averaging_duration '1 or 10 minutes
Alias SerialIndest(8)=User_alarm_1 '0..1 - Visibility compared to Threshold One
Alias SerialIndest(9)=User_alarm_2 '0..1 - Visibility compared to Threshold Two
Alias SerialIndest(10)=Emitter_failure '0..2 - Emitter Failure
Alias SerialIndest(11)=Emitter_lens_dirty '0..3 - Emitter Lens Dirty
Alias SerialIndest(12)=Emitter_temp_error '0..3 - Emitter Temperature
Alias SerialIndest(13)=Detector_lens_dirty '0..3 - Detector Lens Dirty
Alias SerialIndest(14)=Detector_temp_error '0..3 - Detector Temperature
Alias SerialIndest(15)=Detector_saturated '0..1 - Detector DC Saturation Level
Alias SerialIndest(16)=Hood_temp_error '0..3 - Hood Temperature
Alias SerialIndest(17)=External_temp_error '0..3 - External Temperature
Alias SerialIndest(18)=Signature_error '0..1 - Signature Error
Alias SerialIndest(19)=Flash_read_error '0..1 - Flash Read Error
Alias SerialIndest(20)=Flash_write_error '0..1 - Flash Write Error
Alias SerialIndest(21)=Particle_Limit_error '0 or 1 - Particle limit reached
Alias SerialIndest(22)=Particle_Count
Alias SerialIndest(23)=Intensity 'mm/h
Alias SerialIndest(24)=SYNOP_code
Alias SerialIndest(25)=Temperature 'deg C
Alias SerialIndest(26)=Relative_Humidity '%, 0..100
Alias SerialIndest(27) = checksumrx 'CCITT Checksum
'Define the serial port to which the CS125 is connected - amend as needed
Const CS125_Comport = COM1

'Preload the poll command for a sensor for address 0, in this example
'If the sensor has a different address uncomment the relevant line
Const CS125_Poll = CHR(2)&"POLL:0:0:3A3B:"&CHR(3)&CHR(13) 'address 0
'Const CS125_Poll = CHR(2)&"POLL:1:0:0D0B:"&CHR(3)&CHR(13) 'address 1
'Const CS125_Poll = CHR(2)&"POLL:2:0:545B:"&CHR(3)&CHR(13) 'address 2
'Const CS125_Poll = CHR(2)&"POLL:3:0:636B:"&CHR(3)&CHR(13) 'address 3
'Const CS125_Poll = CHR(2)&"POLL:4:0:E6FB:"&CHR(3)&CHR(13) 'address 4
'Const CS125_Poll = CHR(2)&"POLL:5:0:D1CB:"&CHR(3)&CHR(13) 'address 5
'Const CS125_Poll = CHR(2)&"POLL:6:0:889B:"&CHR(3)&CHR(13) 'address 6
'Const CS125_Poll = CHR(2)&"POLL:7:0:BFAB:"&CHR(3)&CHR(13) 'address 7
```

```
'Const CS125_Poll = CHR(2)&"POLL:8:0:939A:"&CHR(3)&CHR(13) 'address 8
'Const CS125_Poll = CHR(2)&"POLL:9:0:A4AA:"&CHR(3)&CHR(13) 'address 9

'Main Program
BeginProg
  'Open the logger serial port to which the CS125 is connected
  SerialOpen (CS125_Comport,38400,3,0,1000)
  Scan(10,Sec,1,0)
    'The sensor is polled every 10 seconds
    SerialOut(CS125_Comport,CS125_Poll,"",0,100)
    SerialInRecord(CS125_Comport,InString,&h02,0,&h03,NBytesReturned,01)
    'Check that a message has been recieved first
    If NBytesReturned > 0 Then
      SplitStr (SerialIndest(),InString," ",27,5)
      'Check the received checksum is valid
      'Calculate the expected checksum
      lngCRCCalc = CheckSum(InString,1,NBytesReturned-5)
      'Extract the checksum from the message & convert it for comparison
      lngCRCMsg = HexToDec(checksumrx)
      ChecksumOK = ( lngCRCMsg = lngCRCCalc)
      'In critical applications the visibility can be set to NaN if the system status
      'is degraded or a critical error flag is set.
      If ChecksumOK Then Visibility = Visibilitystr Else Visibility =NaN
    EndIf
    'Call data storage commands here
  NextScan
EndProg
```

C.3 Example CRBasic SET program

```
'-------------------------------------------------------------------------------
' CS125 Visibility
'
' Program to test the SET command part of the command line interface on the CS125
' Do not run this script for extended periods of time (days!) as it writes
' to flash over and over and will eventually wear the flash out
' Logger:CR1000
'-------------------------------------------------------------------------------

Public InString As String * 200
Public TempString As String *100

' Variables for the SET command subroutine
Dim CS125CArray(21) As String * 6 ' CS125 Command Array

'---------------------------------------------------------
' This function creates a SET command string for the
' CS125 visibility sensor.  Including all delimiting
' characters and checksums
' then returns the string in "CS125CommandString"
' Array variable order is as follows:
' 1. Sensor ID
' 2. User Alarm 1 Set
' 3. User Alarm 1 Active
' 4. User Alarm 1 Distance
' 5. User Alarm 2
' 6. User Alarm 2 Active
' 7. User Alarm 2 Distance
' 8. Serial BaudRate
' 9. Serial number (Read only so not used)
' 10. Visibility Units
' 11. Continuous mode output interval
' 12. Polling Or Continuous modes
' 13. Message Format (Basic/Partial/Full)
' 14. RS232 or RS485 serial communications enabled
' 15. Averaging Period
' 16. Sample timing
' 17. Dew heater override
' 18. Hood Heater override
' 19. Dirty window compensation
' 20. Use CRC checking
' 21. PSU input voltage shutdown level
Function CS125_SETCommand As String *100
  Dim TempStringFunc As String * 100
  Dim CS125CommandString As String * 100
  Dim i As Long
  Dim CheckVal As Long

  ' Create a string containing the values going out to the CS125
  TempStringFunc = "SET:0:"
  For i = 1 To 21
    TempStringFunc = TempStringFunc + CS125CArray(i) + " "
  Next
  ' Create a check sum of the values going out
```

```
  CheckVal = CheckSum (TempStringFunc,1,0)    ' Use the CCITT CRC16 checksum
  ' Create final string going out to CS125 including start characters and end
characters
  CS125CommandString = CHR(2) + TempStringFunc + ":" + FormatLong (CheckVal,"%04X") +
":" + CHR(3) + CHR(13) + CHR(10)
  'CS125CommandString = CHR(2) + TempStringFunc + CHR(3) + CHR(13) + CHR(10) ' Use
this line if no checksum is desired
  Return(CS125CommandString)
EndFunction
'--------------------------------------------------------

'Main Program
BeginProg

  ' open port to the visibility sensor using Com1
  SerialOpen (Com1,38400,3,0,10000)

  ' Note: Change the following array variable to suit your own application
  ' load example/dummy values into the array
  CS125CArray(1) = 0        ' Set ID to 0
  CS125CArray(2) = 1        ' Enable alarm 1
  CS125CArray(3) = 1        ' Set alarm 1 to if greater than
  CS125CArray(4) = 1000     ' Set alarm 1 trigger distance to 1000
  CS125CArray(5) = 1        ' Enable alarm 2
  CS125CArray(6) = 0        ' Set alarm 2 to if less than
  CS125CArray(7) = 15000    ' Set alarm 2 trigger distance to 15000
  CS125CArray(8) = 2        ' Set serial baud rate to 38400bps
  CS125CArray(9) = 0        ' Read only so dummy value added here, but not needed
  CS125CArray(10) = "M"     ' Set unit type to metres (use upper case)
  CS125CArray(11) = 60      ' Set output period to 60 seconds
  CS125CArray(12) = 1       ' Polling mode
  CS125CArray(13) = 2       ' Set FULL output message format
  CS125CArray(14) = 0       ' Set RS232 serial mode
  CS125CArray(15) = 1       ' Set averaging over one minute
  CS125CArray(16) = 1       ' Set sample timing to one second
  CS125CArray(17) = 0       ' Set dew heaters to automatic
  CS125CArray(18) = 0       ' Set hood heaters to automatic
  CS125CArray(19) = 0       ' Don't use dirty window compensation
  CS125CArray(20) = 1       ' Use CRC checking on incoming command line data
  CS125CArray(21) = 7.0     ' Set Low voltage battery shutdown to a very low value so
it doesn't trigger

  ' Send information once every 10 seconds
  Scan (10,Sec,0,0)

  TempString = CS125_SETCommand()       ' Create the outgoing string
  SerialOut (Com1,TempString,"",0,100)  ' Send SET command to the CS125

  Delay (1,1,Sec)

  SerialIn (InString,Com1,100,0,1000)   ' Grab retuned data from the CS125
                                        ' Returned data is identical to the
                                        ' data a GET command would return
  NextScan
EndProg
```

C.4 Example CRBasic SETNC Command

```
'---------------------------------------------------------------------------------
' CS125 Visibility
'
' Program to test the SETNC command part of the command line interface on the CS125
' This command does not commit the settings to flash so settings will be lost if
' the sensor is power cycled
' This example uses a CS215 temperature and humidity probe to determine dew point.
' The CS125s hood heaters are then turned on only when needed, this is to save
power.
' Logger:CR1000
'---------------------------------------------------------------------------------

'Declare Public Variables
Public InStringSETNC As String * 200
Public InStringGET As String * 200
Public TRHData(2)
Public OutString As String * 40, CheckVal

Dim CS125CArray(21) As String * 6 ' CS125 Command Array
Dim TempDewPoint
Dim StatusDewHeater
Dim TempString As String * 100

Alias TRHData(1)=AirTC
Alias TRHData(2)=RH

'--------------------------------------------------------
' This function creates a SETNC command string for the
' CS125 visibility sensor.  Including all delimiting
' characters and checksums then returns the string
' in "CS125CommandString"
' Array variable order is as follows:
' 1. Sensor ID
' 2. User Alarm 1 Set
' 3. User Alarm 1 Active
' 4. User Alarm 1 Distance
' 5. User Alarm 2
' 6. User Alarm 2 Active
' 7. User Alarm 2 Distance
' 8. Serial BaudRate
' 9. Serial number (Read only so not used)
' 10. Visibility Units
' 11. Continuous mode output interval
' 12. Polling Or Continuous modes
' 13. Message Format (Basic/Partial/Full)
' 14. RS232 or RS485 serial communications enabled
' 15. Averaging Period
' 16. Sample timing
' 17. Dew heater override
' 18. Hood Heater override
' 19. Dirty window compensation
' 20. Use CRC checking
' 21. PSU input voltage shutdown level
Function CS125_SETNCCommand As String *100
  Dim TempStringFunc As String * 100
```

```
        Dim CS125CommandString As String * 100
        Dim i As Long
    Dim CheckVal As Long

    ' Create a string containing the values going out to the CS125
    TempStringFunc = "SETNC:0:"
    For i = 1 To 21
      TempStringFunc = TempStringFunc + CS125CArray(i) + " "
    Next
    ' Create a check sum of the values going out
    CheckVal = CheckSum (TempStringFunc,1,0)    ' Use the CCITT CRC16 checksum
    ' Create final string going out to CS125 including start characters and end
  characters
    CS125CommandString = CHR(2) + TempStringFunc + ":" + FormatLong (CheckVal,"%04X") +
  ":" + CHR(3) + CHR(13) + CHR(10)

  'CS125CommandString = CHR(2) + TempStringFunc + CHR(3) + CHR(13) + CHR(10) ' Use this
  line if no checksum is desired
    Return(CS125CommandString)
  EndFunction
  '-------------------------------------------------------

  'Main Program
  BeginProg

    ' Open port to the visibility sensor using Com1
    SerialOpen (Com1,115200,3,0,10000)

    ' Note: Change the following array variable to suit your own application
    ' load example/dummy values into the array
    ' Loading the array is not strictly necessary, but is done as a fail safe in
    ' case the GET command does not return data
    CS125CArray(1) = 0         ' Set ID to 0
    CS125CArray(2) = 0         ' Disable alarm 1
    CS125CArray(3) = 1         ' Set alarm 1 to if greater than
    CS125CArray(4) = 10000     ' Set alarm 1 trigger distance to 10000
    CS125CArray(5) = 0         ' Disable alarm 2
    CS125CArray(6) = 0         ' Set alarm 2 to if less than
    CS125CArray(7) = 10000     ' Set alarm 2 trigger distance to 10000
    CS125CArray(8) = 0         ' Set serial baud rate to 115200bps
    CS125CArray(9) = 0         ' Read only so dummy value added here, but not needed
    CS125CArray(10) = "M"      ' Set unit type to metres (use upper case)
    CS125CArray(11) = 60       ' Set output period to 60 seconds
    CS125CArray(12) = 1        ' Polling mode
    CS125CArray(13) = 2        ' Set FULL output message format
    CS125CArray(14) = 0        ' Set RS232 serial mode
    CS125CArray(15) = 1        ' Set averaging over one minute
    CS125CArray(16) = 1        ' Set sample timing to one second
    CS125CArray(17) = 0        ' Set dew heaters to automatic
    CS125CArray(18) = 0        ' Set hood heaters to automatic
    CS125CArray(19) = 0        ' Don't use dirty window compensation
    CS125CArray(20) = 1        ' Use CRC checking on incoming command line data
    CS125CArray(21) = 7.0      ' Set Low voltage battery shutdown to a very low value so it
   doesn't trigger

StatusDewHeater=False

  Scan (10,Sec,0,0)
```

```
    'CS215 Temperature & Relative Humidity Sensor measurements AirTC and RH
    SDI12Recorder(TRHData(),5,"0","M!",1,0)

    'Calculate DewPoint
    DewPoint(TempDewPoint,AirTC,RH)

    ' Gather the current settings from the CS125
    SerialFlush (Com1)
    TempString = "GET:0:0"
    CheckVal = CheckSum (TempString,1,0)  ' Use the CCITT CRC16 checksum
    OutString = CHR(2) + TempString + ":" + FormatLong (CheckVal,"%04X") + ":" +
CHR(3) + CHR(13) + CHR(10)
    SerialOut (Com1,OutString,"",0,100)   ' Send GET command to the CS125
    Delay (1,1,Sec)
    SerialIn (InStringGET,Com1,100,0,200) ' Save the data returned from the GET
command
    If Len(InStringGET) > 1 Then          ' Check data was returned
      SplitStr (CS125CArray(1),InStringGET, " ",21,5)  ' Strip the settings from the
returned data string
      CS125CArray(1) = Right (CS125CArray(1),1)' Trim the SOT from the first data
point
    EndIf

    'Enable Dew Heaters if AirTC < DewPoint
    If AirTC <= TempDewPoint  AND StatusDewHeater=False Then
      CS125CArray(17)=0
      SerialFlush (Com1)
      TempString = CS125_SETNCCommand()
      SerialOut (Com1,TempString,"",0,100)
      Delay (1,1,Sec)
      SerialIn (InStringSETNC,Com1,100,0,1000)
      StatusDewHeater=True
    EndIf

    'Disable Dew Heaters if AirTC > DewPoint+3
    If AirTC > TempDewPoint+3 AND StatusDewHeater=True Then
      CS125CArray(17)=1
      SerialFlush (Com1)
      TempString = CS125_SETNCCommand()
      SerialOut (Com1,TempString,"",0,100)
      Delay (1,1,Sec)
      SerialIn (InStringSETNC,Com1,100,0,1000)

StatusDewHeater=False
    EndIf

    NextScan
EndProg
```

C.5 Example CRBasic GET program

```
'-------------------------------------------------------------------------------
' CS125 Visibility
'
' Program to test the GET command part of the command line interface on the CS125
' Connecting to serial port one on a CR1000 logger
' Logger:CR1000
'
' Example outputs including checksums (varies with sensor ID)
'  GET:0:0:2C67:
'  GET:1:0:1B57:
'  GET:2:0:4207:
'  GET:3:0:7537:
'  GET:4:0:F0A7:
'  GET:5:0:C797:
'  GET:6:0:9EC7:
'  GET:7:0:A9F7:
'  GET:8:0:85C6:
'  GET:9:0:B2F6:
'-------------------------------------------------------------------------------
Public OutString As String * 40  ' Outgoing string
Dim CheckVal As Long             ' Checksum value
Public InString As String * 200  ' Incomming string
Dim TempString As String * 16

'Main Program
BeginProg

    SerialOpen (Com1,38400,3,0,10000) ' open port to the visibility sensor

    ' Send a request for information once every 10 seconds
    Scan (10,Sec,0,0)

    ' Create the basic GET string for the CS125
    TempString = "GET:0:0"
    CheckVal = CheckSum (TempString,1,0)  ' Use the CCITT CRC16 checksum
    OutString = CHR(2) + TempString + ":" + FormatLong (CheckVal,"%04X") + ":" + CHR(3)
+ CHR(13) + CHR(10)

    SerialOut (Com1,OutString,"",0,100)  ' Send GET command to the CS125

    Delay (1,1,Sec)

    SerialIn (InString,Com1,100,0,200)  ' Save the data returned from the GET command

    NextScan
EndProg
```

C.6 Example CRBasic MSGSET program

```
'-------------------------------------------------------------------------------
' CS125 Present Weather and CS120A Visibility sensor
'
' Program to test the MSGSET command part of the command line interface on the CS120A
' Do not run this program for extended periods of time (days!) as it writes
' to flash over and over and will eventually wear the flash out
'-------------------------------------------------------------------------------

Public MSG_Response As String * 200
Public TempString As String * 100
Public CS120CommandString As String * 100
Public CheckValCCITT

'-------------------------------------------------------------------------------
'Main Program
BeginProg

' open port to the visibility sensor
SerialOpen (Com1,38400,3,0,10000)

  ' Send information once every 30 seconds
    Scan (30,Sec,0,0)
    ' Create a string containing the values going out to the CS125
    ' Output the dirty window values, the sensor serial number, SYNOP codes and the
    '  outside temperature.
    'Bit- Description-             Value-    Nibble value
    ' 16    Reserved                    -
    ' 15    Reserved                    -
    ' 14    Humidity (%)               0      0x1
    ' 13    Temperature (Degrees C)    1
    ' 12    NWS code (3)               0      0x2
    ' 11    METAR code                 0
    ' 10    SYNOP code (3)             1
    ' 9       Generic SYNOP (3)          0
    ' 8       Accumulation (3)           0      0x1
    ' 7       Intensity (3)              0
    ' 6       Particle count (3)         0
    ' 5       Sensor serial number       1
    ' 4       Dirty windows values       1      0x8
    ' 3       System alarms      12        0
    ' 2       User alarms         2          0
    ' 1     Averaging duration           0

    TempString = "MSGSET:0:1218"

    ' Create a check sum of the values going out
    CheckValCCITT = CheckSum (TempString,1,0)
    ' Create final string including start characters and end characters
    CS120CommandString = CHR(2) + TempString + ":" + Hex (CheckValCCITT) + ":" + CHR(3) +
CHR(13) + CHR(10)
    '  Send the string to the sensor
    SerialOut (Com1,CS120CommandString,"",0,100) ' Send SET command to the CS120

    Delay (1,1,Sec)
```

```
    SerialIn (MSG_Response,Com1,100,0,1000)  ' Grab returned data from the sensor
                                              ' Returned data is identical to the
                                              ' data a MSGGET command would return
     NextScan
EndProg
```

C.7 Example CRBasic MSGGET program

```
'--------------------------------------------------------------------------------
' CS125 Present Weather and CS120A Visibility sensor
'
' Program to test the MSGGET command part of the command line interface.
' The sensor should be in POLLED mode for best results.
'
' Examples:
'  MSGGET:0:0:C6ED:
'  MSGGET:1:0:F1DD:
'  MSGGET:2:0:A88D:
'  MSGGET:3:0:9FBD:
'  MSGGET:4:0:1A2D:
'  MSGGET:5:0:2D1D:
'  MSGGET:6:0:744D:
'  MSGGET:7:0:437D:
'  MSGGET:8:0:6F4C:
'  MSGGET:9:0:587C:
'--------------------------------------------------------------------------------

Public CS120CommandString As String * 40, CheckValCCITT
Public MSG_Response As String * 100
Public TempString As String

'Main Program
BeginProg

     ' open port to the visibility sensor
     SerialOpen (Com1,38400,3,0,10000)

     Scan (10,Sec,0,0)

    ' Create the main part of the message
    TempString = "MSGGET:0:0"
    ' Add the checksum and command characters
    CheckValCCITT = CheckSum (TempString,1,0)
    CS120CommandString = CHR(2) + TempString + ":" + FormatLong (CheckValCCITT,"%04X") +
":" + CHR(3) + CHR(13) + CHR(10)
    ' Send the MSGGET command
    SerialOut (Com1,CS120CommandString,"",0,100)
    Delay (1,1,Sec)
    ' Record the returned values
    SerialIn (MSG_Response,Com1,100,0,200)

     NextScan
EndProg
```

Appendix D. Present Weather Codes

D1. SYNOP Codes produced by the CS125

56 codes are available.

Weather Type	4680 Code
No significant weather observed	0
Haze or smoke, or dust in suspension in the air, visibility ≥ 1 km*	4
Haze or smoke, or dust in suspension in the air, visibility < 1 km*	5
Mist	10
Fog (in the preceding hour)	20
Precipitation (in the preceding hour)	21
Drizzle (not freezing) or snow grains (in the preceding hour)	22
Rain (not freezing), (in the preceding hour)	23
Snow (in the preceding hour)	24
Freezing rain or freezing drizzle (in the preceding hour)	25
FOG	30
Fog or ice fog in patches	31
Fog or ice fog, has become thinner during the past hour	32
Fog or ice fog, no appreciable change during the past hour	33
Fog or ice fog has begun or become thicker during the past hour	34
Fog depositing rime	35
PRECIPITATION	40
Precipitation, slight or moderate	41
Precipitation, heavy	42
Solid precipitation, slight or moderate**	45
Freezing precipitation, slight or moderate**	47
Freezing precipitation, heavy**	48
DRIZZLE**	50
Drizzle, not freezing, slight	51
Drizzle, not freezing, moderate	52
Drizzle, not freezing, heavy	53
Drizzle, freezing, slight	54
Drizzle, freezing, moderate	55
Drizzle, freezing, heavy	56
Drizzle and rain, slight	57
Drizzle and rain, moderate or heavy	58
RAIN**	60
Rain, slight	61
Rain, moderate	62
Rain, heavy	63
Rain, freezing, slight	64
Rain, freezing, moderate	65
Rain, freezing, heavy	66
Rain (or drizzle) and snow, slight	67
Rain (or drizzle) and snow, moderate or heavy	68
SNOW**	70
Snow, slight (snow includes graupel)	71
Snow, moderate (snow includes graupel)	72
Snow, heavy (snow includes graupel)	73
Ice pellets, slight	74
Ice pellets, moderate	75
Ice pellets, heavy	76
Snow grains	77
SHOWER(S) OR INTERMITTENT PRECIPITATION	80
Rain shower(s) or intermittent rain, slight	81
Rain shower(s) or intermittent rain, moderate	82

Rain shower(s) or intermittent rain, heavy	83
Rain shower(s) or intermittent rain, violent	84
Snow shower(s) or intermittent snow, slight	85
Snow shower(s) or intermittent snow, moderate	86
Snow shower(s) or intermittent snow, heavy	87
Hail	89

*****Only reported if a CS215 is connected to provide relative humidity, otherwise they will default to mist (10) or fog (20, 30, 31, 32, 33, 34 or 35).

**Only reported in the generic SYNOP messages.

D2. METAR Codes produced by the CS125

The following METAR codes from WMO table 4678 can be output by the sensor.

UP Unidentified precipitation
HZ Haze
BR Mist
FG Fog
DZ Drizzle
RA Rain
SG Snow grains
SN Snow
PL Ice pellets
SMGR Hail*

Notes:

HZ will only be reported if a CS215 is connected to allow relative humidity information to be available.

FZ (freezing) may be added as a descriptor in front of BR, FG, DZ and RA

Intensity qualifiers, '-' for light, '+' for heavy, may be added in front of DZ, RA, SN, and PL

Combinations, for example RASN for rain and snow can be reported.

*Only reported if an optional hail sensor is connected. Contact Campbell Scientific for details.

D3. NWS Codes produced by the CS125

NWS codes produced by the CS125 available in a custom message

Weather type	NWS code
Drizzle	L
Rain	R
Snow	S
Snow grains	SG

Z (freezing) may be added as a descriptor in front of L and R

Intensity qualifiers, '-' for light, '+' for heavy, may be added after the NWS code.

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