

CS140

Background Luminance Sensor



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:

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- Batteries
- Any product which has been subjected to misuse, neglect, acts of God or damage in transit.

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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.



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About this manual

Some useful conversion factors:

Area: 1 in² (square inch) = 645 mm²

Length: 1 in. (inch) = 25.4 mm
1 ft (foot) = 304.8 mm
1 yard = 0.914 m
1 mile = 1.609 km

Mass: 1 oz. (ounce) = 28.35 g
1 lb (pound weight) = 0.454 kg

Pressure: 1 psi (lb/in²) = 68.95 mb

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

Recycling information



At the end of this product's life it should not be put in commercial or domestic refuse but sent for recycling. Any batteries contained within the product or used during the 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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CS140 Background Luminance Sensor

1. General Information

1.1 General Safety

This manual provides important safety considerations for the installation, operation and maintenance of the CS140. 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 CS140 sensor has been checked for safety before leaving the factory and contains no internally replaceable or modifiable parts.

CAUTION

Do not modify the CS140 unit. Such modifications will lead to damage of the unit.

1.3 Recommended Tools

The following tools are recommended for installation:

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

2. Product Overview

2.1 Introduction



Figure 2-1. CS140 Background Luminance sensor

The CS140 Background Luminance Sensor accurately measures background luminance over a wide range from 0 cd/m², to a maximum of 45,000 cd/m².

It uses a photodiode with a spectral response close to the CIE human eye model and removes any unwanted wavelengths via an inbuilt band-pass filter.

The CS140 features a fixed 6° field of view as specified by the FAA. For easy installation the CS140 is simply mounted horizontally with the required 6° inclination being built into the design. (Other angles are possible via the sensors mounting bracket).

A heated hood will prevent ice and snow from building up, dew heaters will prevent condensation on the glass window and a dirty window detection system measures window contamination.

The design is undamaged when pointed directly at the sun allowing complete flexibility in orientation and it has a rugged IP66 rated environmental enclosure that protects it from the harshest conditions and will measure the atmosphere with high stability and repeatability.

2.2 Specifications

2.2.1 Optical Specifications

Accuracy	$\pm 0.2 \text{ cd/m}^2 < 2 \text{ cd/m}^2, \pm 10\% > 2 \text{ cd/m}^2$
Field of view	6°
Spectral response	CIE 1931
Measurement range	0-45,000 cd/m^2
Resolution	0.1 cd/m^2

2.2.2 Electrical Specifications

	Minimum Value	Nominal Value	Maximum value
Main power supply for DSP and dew heater			
Power supply, DC only	9V	12V	30V
Current consumption sampling continuously with dew heater active (at 12V)	5 mA 90 mA	7 mA 95 mA	9 mA 100 mA
Hood heater power supply			
Hood heater voltage (AC or DC)		24V	30V
Hood heater power (at 24V AC or DC)		48W	55W

2.2.3 Communications Specifications

Serial setting 8N1

Supported data rates

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

Supported formats

RS-232 (full duplex, no hardware handshaking)
 RS-485 (half duplex only)

Signal voltage levels

	Minimum Value	Nominal Value	Maximum Value
RS-232 Communications			
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	-7V	-	+7V

2.2.4 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 range			
Operating humidity range	0%	-	100%
Sensor heater thresholds			
Dew heater turn on	-	<35°C	-
Dew heater turn off	-	>40°C	-
Hood heater turn on	-	<5°C	-
Hood heater turn off	-	>15°C	-

(1) Extended temperature ranges are only guaranteed if the sensor has been tested by Campbell Scientific and verified over this temperature range.

Ingress protection	IP66
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2.2.5 CS140CAL Calibrator Specifications

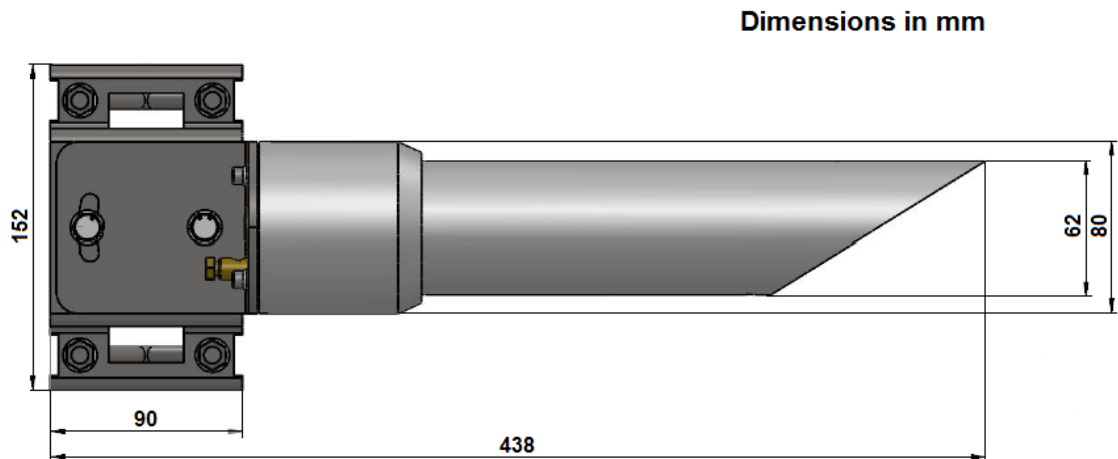
A field calibration device, the CS140CAL, is available. Specifications as below.

Temperature range	0 – 40°C
Calibration value	4,500 cd/m ²
Accuracy	+/- 6%
Ingress protection	IP52
Communication ¹	RS-232, 38400 bd
Dimensions (excluding cables)	72 mm long x 46 mm diameter
Weight	300 g

¹Connecting the CS140CAL to a CS140 forces communications to RS-232, 38400 bd and also forces the sensor ID to '0'.

3. Mechanical Specifications

3.1 Dimensions



3.2 Weights

Sensor weight	2.4 kg
Shipping weight	3.5 kg

4. Installation

4.1 Location and Orientation

The CS140 measures environmental variables and is designed to be located in harsh weather conditions. However there are a few considerations to take into account if accurate and representative data from a site are to be obtained.

In order to reduce the service frequency with the unit, the CS140 should, if possible, be placed away from sources of contamination. More regular maintenance will be required when the instrument is placed in areas where contamination is unavoidable or where measurements may be safety related.

The CS140 can be orientated in any direction required by local practice and it is not damaged by sunlight shining directly into it. It should not be pointed at a source of bright light that may be unrepresentative. Although of course its readings will not be accurate in these circumstances. Note that with the sensor horizontal the centre of the field of view is actually 6 degrees above horizontal. The mounting bracket allows adjustment by $\pm 12^\circ$ if the mast is not vertical or if it is necessary to elevate the field of view at an angle other than 6° .

4.2 Grounding

The CS140 must be properly grounded by taking a ground wire with a minimum cross sectional area of 6 mm² and maximum length of 5 m from the brass grounding lug at the rear of the unit to an adequate grounding point. 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.

4.3 Mounting the CS140

A pole mounting kit is supplied with the CS140. This kit includes a mounting plate, two V-bolts and suitable bolts for clamping the pole between the plate and brackets. To mount the CS140 onto a pole:

1. The mounting plate is supplied ready fixed to the CS140. Offer up the plate to the pole and present the brackets and bolts from the other side of the pole to fit into the matching holes of the plate as shown in Figure 4-1.

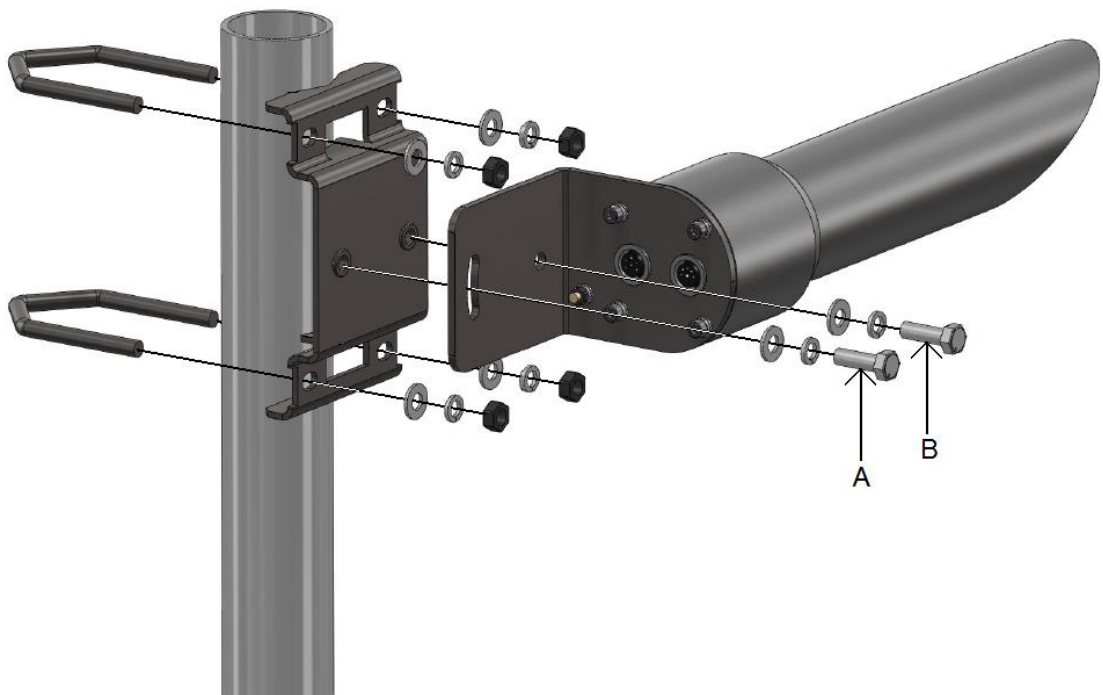


Figure 4-1. Mounting the CS140 onto a pole

2. Clamp the pole between the plate and brackets by tightening using the nuts provided.

The machine screws A and B in Figure 4-1 are used to level the CS140. Screw A is used to lock the CS140 at the right elevation with screw B acting as a pivot. Usually this will be with the hood horizontal which gives a field of view elevated by 6 degrees.

Take care not to overtighten the nuts on the bolts as it may be possible to distort - and/or damage the brackets by doing so, and/or the nuts may seize up. Only tighten the nuts to a degree necessary to hold the CS140 firmly in place.

Where the CS140 is to be mounted onto another type of mast, please refer to the manual for that mast for mounting details.

Do not reposition, once fixings are tightened, by forcing the unit as this can cause damage.

4.4 Connectors

The CS140 has two connectors. One is for communications and the sensor power supply and one provides power to the hood heater.

Figure 4-3 shows the pin-outs of the sockets viewed from outside. Colours shown are the colours of the cores in the supplied cables.

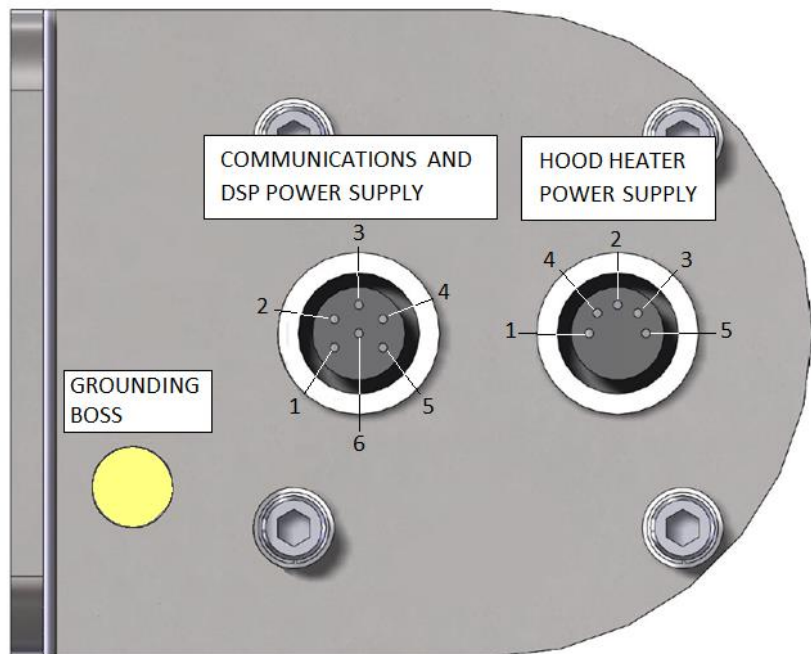


Figure 4-2. Connector layout

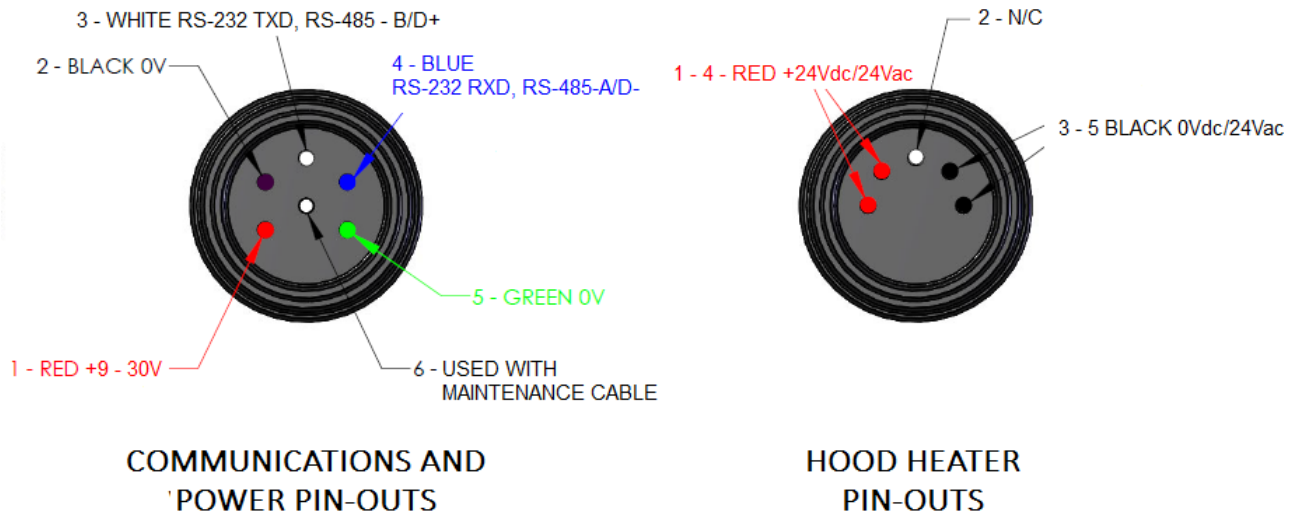


Figure 4-3. Connector pin-outs

4.5 Wiring Using Supplied Campbell Scientific Cables

Two cables are supplied, each 5 m long. One is for communications and the sensor power supply, the other is for the hood heater.

CAUTION

If the power cable is incorrectly wired to the CS140 then irrevocable damage can be done to the unit.

The communications cable is terminated at one end with a 9 pin D-connector (DB9). The D-connector can be connected directly to a PC or data logger 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 can be easily removed.

CAUTION

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

COMMUNICATIONS AND POWER CONNECTOR

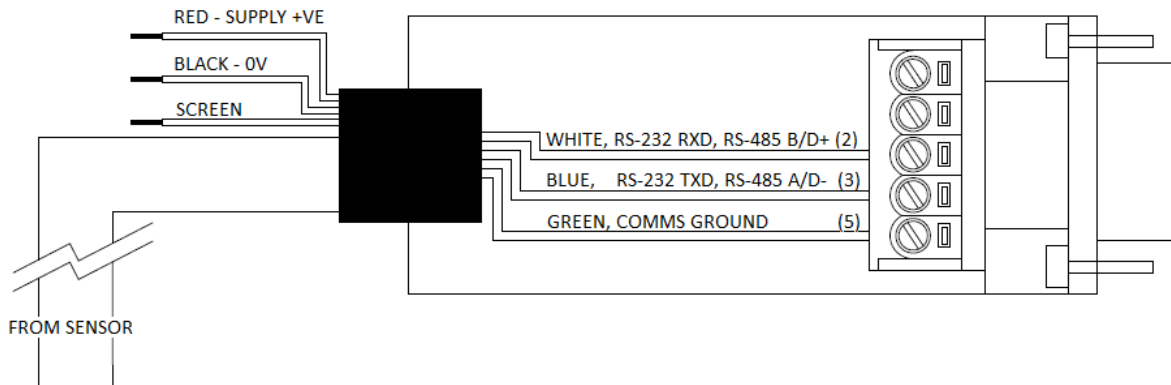


Figure 4-4. Cable Connections

4.6 Maintenance cable

A maintenance cable (pn 006707) is available from Campbell Scientific that will force communications to RS-232 38400 baud, and sensor id “0”.

The cable has connectors allowing it to be put in between the CS140 and the existing connection and a 5 m flying lead with a 9-way D connector for RS-232 communication. The sensor will continue to draw power from the existing source. When installed, the existing communication path is disconnected and communication via the flying lead is forced to RS-232, 38400 bd with a sensor ID of “0”.

When it is removed and replaced with the cable previously used the baud rate and ID will return to those previously set.

CS140 MAINTENANCE CABLE

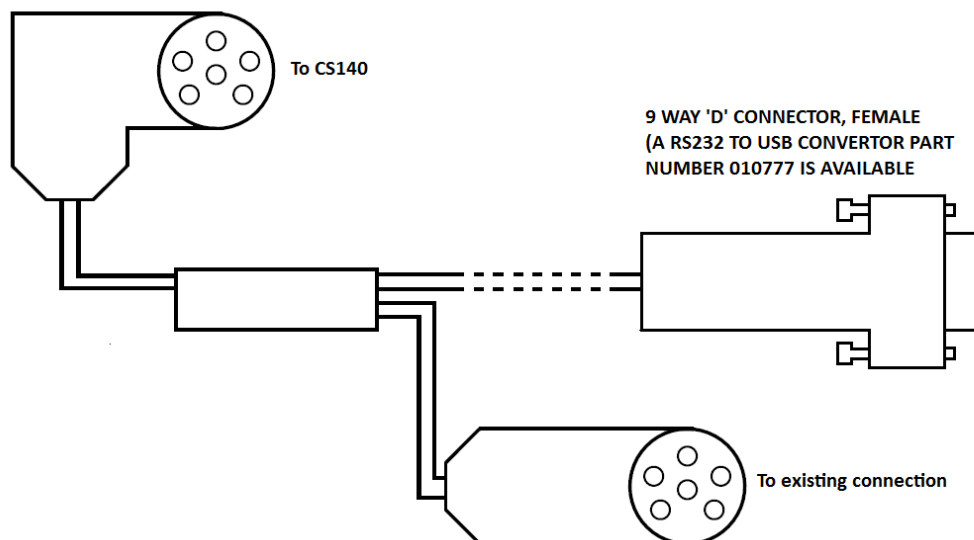


Figure 4-5. CS140 Maintenance Cable

4.7 Storage Information

The CS140 should be stored between -40°C to +85°C in a dry place. The optics should be protected from possible accidental damage.

5. Messages

5.1 Message structure

Basic Format

STX	Message ID	Sensor ID	System status	Luminance	Units	Checksum (CCITT)	ETX	Carriage return	Line feed
0x02	0	0	3	35833.7	1	4E7C	0x03	0x0D	0x0A

Example basic format output

```
0 0 3 35833.7 1 4E7C
```

Partial Format

STX	Message ID	Sensor ID	System status	Message Interval	Luminance	Units	User alarms	Checksum (CCITT)	ETX	Carriage return	Line feed
0x02	1	0	3	10	15732.2	1	0000	1ED9	0x03	0x0D	0x0A

Example partial format output

```
1 0 3 10 15732.0 1 0 0 0 0 1ED9
```

Full Format (default)

STX	Message ID	Sensor ID	System status	Message Interval	Luminance	Units	Averaging Duration	User alarm	System alarms	Checksum (CCITT)	ETX	Carriage return	Line feed
0x02	2	0	3	10	15292.4	1	1	0000	1030000000	F8DA	0x03	0x0D	0x0A

Example full format output

```
2 0 3 10 15292.4 1 1 0 0 0 0 1 0 3 0 0 0 0 0 0 F8DA
```

Message ID break down

ID	Definition
0	Basic format. Contains only luminance and system information
1	Partial format. Contains user alarm outputs
2	Full format. Contains all system alarms codes

Sensor ID break down

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

System status break down^{(1),(2)}

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.
- (2) Refer to the individual alarms (below) for details of the response times of the alarms.

Message interval

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

Luminance break down

ID	Definition
0-50,000	Current luminance being detected by the sensor. The maximum luminance level reported by the sensor can be defined by the user via the menu system.

Visibility units break down

ID	Definition
1	Cd/m ²
2	fL

Averaging duration break down

ID	Definition
1	One minute average
10	Ten minute average

User and system alarms break down

Alarm	Range	System status	Definition
User Alarm	0-1	1	0 = User alarm not active 1 = User alarm active
Spare			Reserved for future use
Spare			Reserved for future use
Spare			Reserved for future use
Window contaminated ⁽¹⁾	0-3	0 1 3	0 = OK. The reported attenuation is below 10%. 1 or 2 = Reported dirt level is over 10% 3 = High level of returned dirty signal. This could be either a blocked sensor or a broken dirty window system.
Photo diode temperature	0-3	0 1 1 3	0 = Temperature is within operating conditions. 1 = Too low. Less than -40°C. 2 = Too high. Over 70°C. 3 = Sensor fault (No sensor detected or below -49°C)
Hood temperature	0-3	0 1 1 2	0 = Temperature is within operating conditions. 1 = Too low. Less than -45°C. 2 = Too high. Over 70°C. 3 = Sensor fault (No sensor detected or below -49°C)
Detector DC saturation level ⁽²⁾	0-1	0 2	The amount of background light as seen by the detector hood. 0 = Within limits 1 = Saturated. The CS140 is experiencing direct light levels that are saturating the photo diode
Signature error	0-1	3	0 = Signature of entire flash was checked and matches the stored version 1 = Signature does not match previous readings
Flash write error	0-1	3	0 = No errors 1 = One or more errors writing user variables to flash occurred
Flash read error	0-1	3	0 = No errors 1 = One or more errors reading user variables from flash occurred
Internal voltages	0-1	3	0 = No errors 1 = One or more errors writing user variables to flash occurred
Spare			Reserved for future use

- (1) With firmware version 9 onwards, this alarm flag will not increase in level until the dirt detector has been above the "dirt" threshold continuously for 15 minutes or more. This is to prevent transient setting of the flag which might be caused by reflections, insects etc.
- (2) With firmware version 9 onwards, this alarm flag will not change to level 1 unless the sensor has been continuously saturated for 60 mins or more. This is to avoid false alarms if the sun shines directly into the sensor.

6. Interface methods

6.1 Command line/menu

The CS140 can be setup and controlled in one of two ways.

The first 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 CS140 if it was connected to a logger for instance. The configuration setting commands can be sent via a logger to the CS140 removing the need for a local PC to set up the unit.

The second method is by using the simple menu interface built into the CS140 communicating via RS-232 or RS-485, using a terminal emulator program. This menu system gives access to the more common settings.

6.2 Configuring a PC for talking to the CS140

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 CS140 should now be ready to accept commands.

6.3 Definition of the variables that can be set by the user on the CS140 with the command line interface

The command line interface can access all the user configurable variables listed below:

ID	Name	Range	Description	Factory default
1	Sensor ID	0-9	Separate ID used as an identifier for a particular CS140 on a network.	0
2	Serial port protocol	0-1	Selects the physical serial interface 0 = RS-232 mode 1 = RS-485 mode	0
3	Serial 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
4	Serial Number (Read only so not used)	0-32000	Internal serial number for the CS140. (<i>Read only</i>)	-
5	Luminance Units	0-1	Units the CS140s luminance value is reported in. 0 = Candela per metres square (cd/m ²) 1 = Foot lamberts (fL)	0
6	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
7	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
8	Message Format	0-2	Level of detail outputted by polled or continuous modes 0 = Basic 1 = Partial 2 = Full	2
9	Sample timing	1-60	Not currently implemented	1
10	Averaging period	1 or 10	The period of time that the luminance value should be averaged over. Either one minute or ten.	1
11	Dew heater override	0-1	0 = Allow the CS140 to automatically control the dew heater 1 = Turn the dew heater off	0
12	Hood heater override ⁽¹⁾	0-1	0 = Allow the CS140 to automatically control the hood heater 1 = Turn the hood heater off	0
13	Dirty window compensation	0-1	0 = No compensation applied 1 = Compensation for dirt on window applied. The CS140 will compensate for up to 10% signal loss due to dirt on the window.	0
14	Use CRC	0-1	0 = Disable command line CRC checking ⁽²⁾ 1 = Enable command line CRC checking Note: this does not affect communications via DevConfig or terminal emulator.	

15	Power Supply Unit (PSU) voltage level shutdown	9-30	PSU Input voltage level below which the CS140 will enter low power mode. This is usually used to protect batteries. (Note: The CS140 will start to shut itself down via hardware at about 8 volts)	9.0
16	Enable alarm	0-1	1 = alarm on	0
17	Alarm high/low	0-1	Sets whether the alarm is triggered by a luminance higher or lower than the alarm level	0
18	Alarm level	0-45,000	In cd/m ²	10,000

(1) Hood heater override needs to be set to `1` (off) when the hood heater has no power connected. 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 CS140 being configured incorrectly by accident.

6.4 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 CS140. 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 CS140 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.

6.4.1 The SET command

The set command is used to configure the CS140 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 an RS-232 or RS-485 port. The SET command accesses identical settings within the CS140. This command is used to change the default power up state of the sensor. The Set command is echoed back.

Example of a SET command and the echoed reply

```
SET:0:0 0 2 0 0 10 1 2 1 1 0 0 0 1 9.5 0 0 10000 :E52F:
0 0 2 1000 0 10 1 2 1 1 0 0 0 1 9.5 0 0 10000 0146
```

SET transmitted/echoed data	
Example	Description
0x02 ⁽¹⁾	STX
:	Delimiting character
SET	SET
:	Delimiting character
0	Address based on Sensor ID
:	Delimiting character
0	Sensor ID
2	Serial port protocol
0	Serial Baud Rate
1000	<i>Sensor serial number (only in echoed reply)</i>
0	Luminance Units
10	Continuous mode output interval
1	Polling Or Continuous modes
2	Message Format (Basic/Partial/Full)
1	Averaging Period
1	Sample timing
0	Dew heater override
0	Hood heater override
0	Dirty window compensation
1	CRC checking on received commands
9.5	Sensor power down voltage
0	Enable alarm
0	Alarm high/low
10 000	Alarm level
:	Delimiting character
0146	Checksum (use the valid CCITT checksum)
:	Delimiting character
0x03 ⁽¹⁾	ETX
0x0D ⁽¹⁾	Carriage return

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

6.4.2 The SETNC Command

The format of the SETNC command is the same as the SET command except it starts with SETNC. 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 CS140 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.

6.4.3 The GET Command

The GET command retrieves settings data from the CS140, including message format data and user alarm settings amongst others. This command does not retrieve visibility or environmental information from the CS140. To retrieve visibility data refer to the POLL command.

The GET command

GET transmitted data	
Example	Description
0x02 ⁽¹⁾	STX
GET	GET
:	Delimiting character
0	Address based on Sensor ID
:	Delimiting character
0	Reserved for future use, zero default
:	Delimiting character
2C67	Checksum
:	Delimiting character
0x03 ⁽¹⁾	ETX
0x0D ⁽¹⁾	Carriage return

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

Example of a GET request

```
GET : 0 : 0 : 2C67 :
```

Example data returned by the GET command

```
GET:0:0:2C67:
0 0 2 1000 0 60 0 2 1 1 0 0 0 1 7.0 0 0 10000 626C
```

GET returned data	
Example	Description
0x02 ⁽¹⁾	STX
0	Sensor ID
0	Serial port protocol
2	Serial Baud Rate
1000	Sensor serial number (read only)
0	Luminance Units
60	Continuous mode output interval
0	Polling Or Continuous modes
2	Message Format (Basic/Partial/Full)
1	Averaging Period
1	Sample timing
0	Dew heater override
0	Hood heater override
0	Dirty window compensation
1	CRC checking on received commands
7.0	Sensor power down voltage
0	Enable alarm
0	Alarm high/low
10000	Alarm level

The following text will now be displayed:

```
WELCOME TO THE CAMPBELL SCIENTIFIC LTD CS140 SETUP MENU
ID 0
S/N 1009
(1) Message output menu
(2) User alarm menu
(3) Communications setup
(4) System information
(5) System configuration
(6) Calibration

(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 `save and exit`. The exception to this is the calibration menu, but you will be informed before any changes are made.

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 CS140's outputs.

Menu 1: The message output menu

```
CS140 MESSAGE - MENU 1
ID 0
S/N 1009
(1) Toggle message format: FULL
(2) Toggle units: cd/m2
(3) Toggle polled or continuous mode: CONTINUOUS
(4) Set continuous mode output interval: 6 second(s)
(5) Toggle output averaging period: 1 minute(s)
(6) Sampling interval: 1 second(s)

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

For example typing `2` will toggle the units through the options cd/m^2 and fL and typing `4` will allow the message interval to be entered.

Option (2) allows the User Alarms to be set, again by toggling through options or changing values.

It also allows the measurement range to be set. Upper and lower limits can be set individually or the CS140 can be set to report between FAA limits (6.85-41115.0 cd/m^2 , 2-12000 fL or UK CAA limits (5-35000.0 cd/m^2).

Menu 2: The user alarm menu

```
CS140 ALARM AND LIMIT - 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 cd/m2
(4) Set upper output limit: 45000 cd/m2
(5) Set lower output limit: 5 cd/m2
(6) Set to FAA limits
(7) Set to CAA limits

(9) Refresh
(0) Return to main menu

->
```

Option (3) gives the communications menu. This 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 3: The communications menu

```
CS140 COMMUNICATIONS - MENU 3
ID 0
S/N 1009
(1) Set sensor ID
(2) Set RS232/RS485 baud rate: 38400
(3) Toggle RS232/RS485 modes: RS232

(9) Refresh
(0) Return to main menu

->
```

Option (4) gives the systems information menu containing useful information such as temperature and system alarms.

Menu 4: The system information menu

```

CS140 INFORMATION - MENU 4
ID 0
S/N 1009
OS version: 7644-07
Alarm      Value
- One Minute Luminance value:  -      3100.0
- Overall system status:       0      No faults
- Detector dirty window alarm: 0       0%
- Sensor internal temperature: 0       28.0
- Hood heater temperature:     0       22.7
- CS140 Rig Constant:         -       100
- CS140 Reference Value:      -       100.00
- Calibration value Fac offset:-      -33.00
- Calibration value Fac scale:-      30.00
- User Reference Value, cd/m2:-     4500.00
- User calibration value offset:-    19.66
- User calibration value scale:-    332.4
- Signature fault:            0       -
- Flash write errors:         0       0
- Flash read errors:          0       0
- Supply voltage:             <9.0V   11.5V
- Aux supply voltages:        +5V=5.0 +3V=3.0

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

->
    
```

If the dirty window alarm is set it is recommended you follow the cleaning section of this manual (Section 8.2).

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

The aux supply voltages are internal 5 volt and 3 volt supplies. They should be between 4.5 and 5.5 and 2.7 and 3.3 volts respectively.

Menu option (5) allows configuration of heaters, window compensation, CRC Checking and the power down voltage.

```

CS140 CONFIGURATION - MENU 5
ID 0
S/N 1009
(1) Toggle dew heater override:      AUTOMATIC
(2) Toggle hood heater override:     AUTOMATIC
(3) Toggle dirty window compensation: NO COMPENSATION
(4) Toggle command line CRC Checking: DO NOT CHECK
(5) Sensor power down voltage:       9.0V

(9) Refresh
(0) Return to main menu

->
    
```

Menu option (6) allows calibration of the CS140 using an optional CS140CAL calibration device.

It also allows the user to reset the CS140 to factory default values.

```
CS140 CONFIGURATION - MENU 6
ID 0
S/N 1004
(1) Perform a user calibration
(2) Reset the user calibration to factory values

(9) Refresh
(0) Return to main menu

->
```

To perform a calibration chose option (1). See section 7.

NOTE

Once a calibration is finished changes are immediate, but factory calibrations can be restored if needed using Option `(2)` in the calibration menu.

```
CS140 CALIBRATION - SUB 1
Are you sure you want to reset to factory defaults?
This will cause the sensor to reset.
Type 1234 followed by return to confirm, or anything
else to exit.
->1234
```

Menu items 9 and 0:

These exit the menu system with or without saving the changes made.

7. Calibrating the CS140

The CS140 can be checked and adjusted using the optional CS140CAL calibrator. The calibration must be run using the onboard menu system. If you have Campbell Scientific's Device Configuration program (DevConfig) a terminal emulation screen is provided in the CS140 screens to let you access this function. To perform the calibration you will need a CS140CAL calibrator and a computer with a compatible USB port.

The CS140CAL is sealed to IP52 and will generate a test light level of 4,500 cd/m² accurate to +/-6% over a temperature range of 0 – 40°C.

It is recommended to clean the window before calibrating the CS140.

The system is self-regulating. However it is recommended that the CS140 is calibrated at least every two years.

The calibration is performed from menu item 6 on the main terminal screen. Once you have selected menu item 6 you will be presented with the following screen.

```

CS140 CONFIGURATION - MENU 6
ID 0
S/N 1004
(1) Perform a user calibration
(2) Reset the user calibration to factory values

(9) Refresh
(0) Return to main menu

->

```

Select option 1 to start the calibration.

At this point the calibration device and cable should be installed as shown in Figures 7-1 and 7-2. Connecting the calibrator switches the CS140 to communication at 38400 bd with a sensor ID of '0'. This will happen whatever the previous setting or whether the CS140 was set to RS-232 or RS-485.

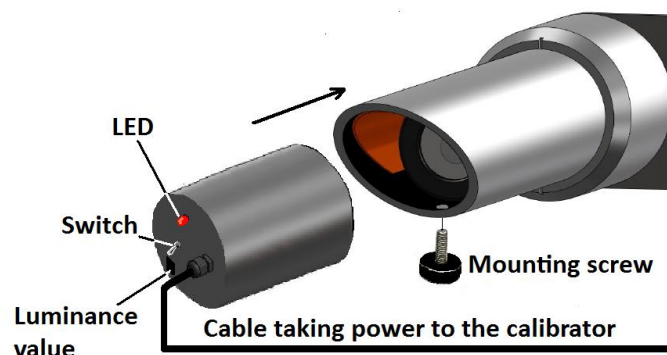


Figure 7-1. CS140 Calibrator

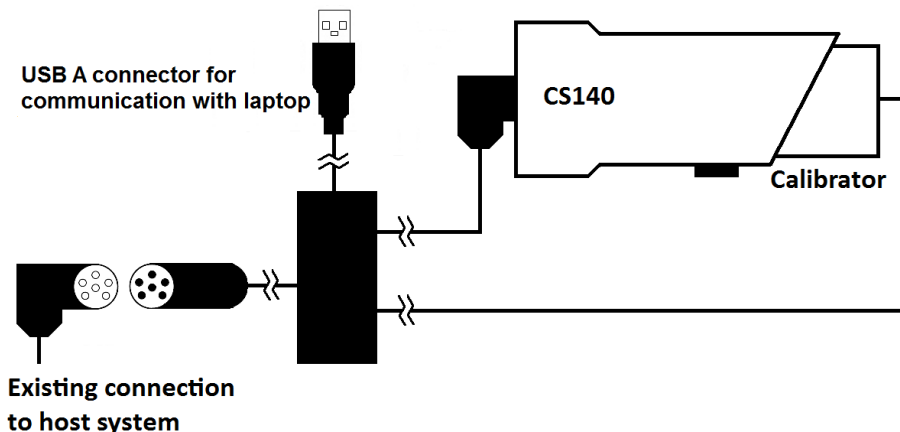


Figure 7-2. CS140 Calibrator Connections

The CS140 menu structure will still be available while the calibrator is connected.

You will then be asked to confirm that you would like to perform a calibration.

Do you want to perform a calibration Y/N?

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.

Once you have started the tests you will be asked for the CS140CAL luminance value with a confirmation at each step giving you the chance to correct typing mistakes. The luminance value will be 4500.0 for CS140CAL calibrators.

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

```

Input the CS140CAL luminance value (cd/m2) -> 4500.0
Is 4500.0 correct? (Y/N)?
Y
Place the CS140CAL into the hood.
Ensure the CS140CAL is turned off, then press any
key.
H
Starting dark level calibration.....
Dark level test complete.
    
```

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.

The CS140 will then ask you to turn on the CS140CAL.

```
Turn the CS140CAL on.

Press any key once this is done.
```

Once confirmed the light level calibration will begin.

```
Starting light level calibration. (This will take
5-6 minutes).....
Saving user calibration settings.

Calibration is now complete. You may remove the
CS140CAL at any time.
CS140CAL Val:4500.0 Offset:20.33 Scale:332.0
Press any key to exit.
```

Once the light level calibration 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.

8. Performing an OS update

Operating system updates for the CS140 background luminance sensor are performed using Campbell Scientific's Device Configuration Utility (DevConfig) software. This is available as a free download from the Campbell Scientific website. Please refer to the help built into the DevConfig software for full instructions on how to update the CS140.

NOTE To use DevConfig to carry out an OS change requires RS-232 communication. However, if a sensor is set to communicate by RS-485 it is not necessary to change this in the sensor.

Connect a PC or laptop with DevConfig running to the sensor with RS-232 communications. Run DevConfig to the stage shown in Figure 8-1. Then turn on the sensors power supply. The update will then take place through RS-232. The sensor will however remain in RS-485 mode afterwards.

Figures 8-1 and 8-2 show the procedure using DevConfig.

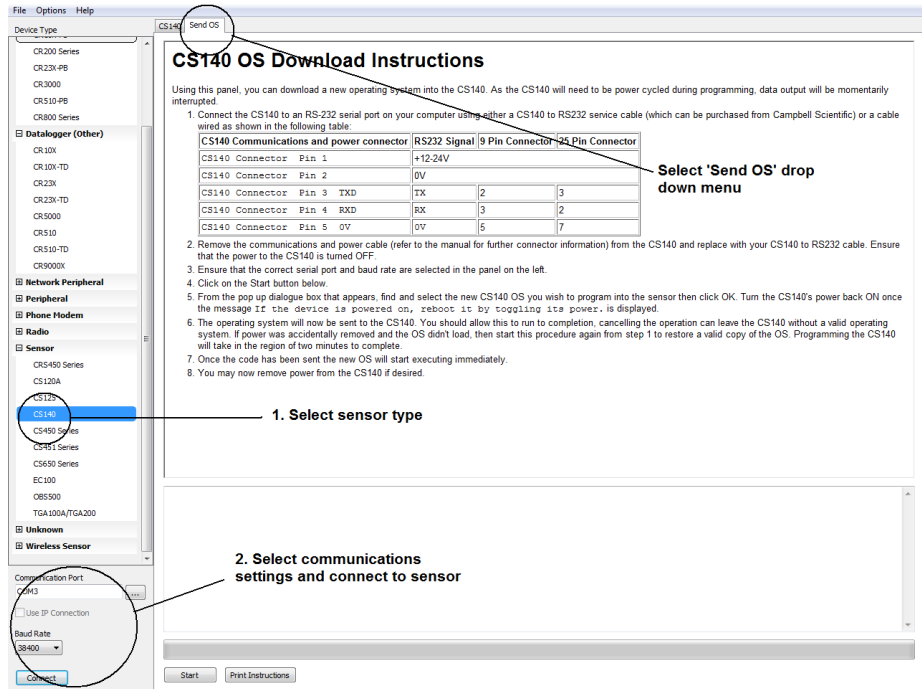


Figure 8-1. CS140 DevConfig OS download instructions

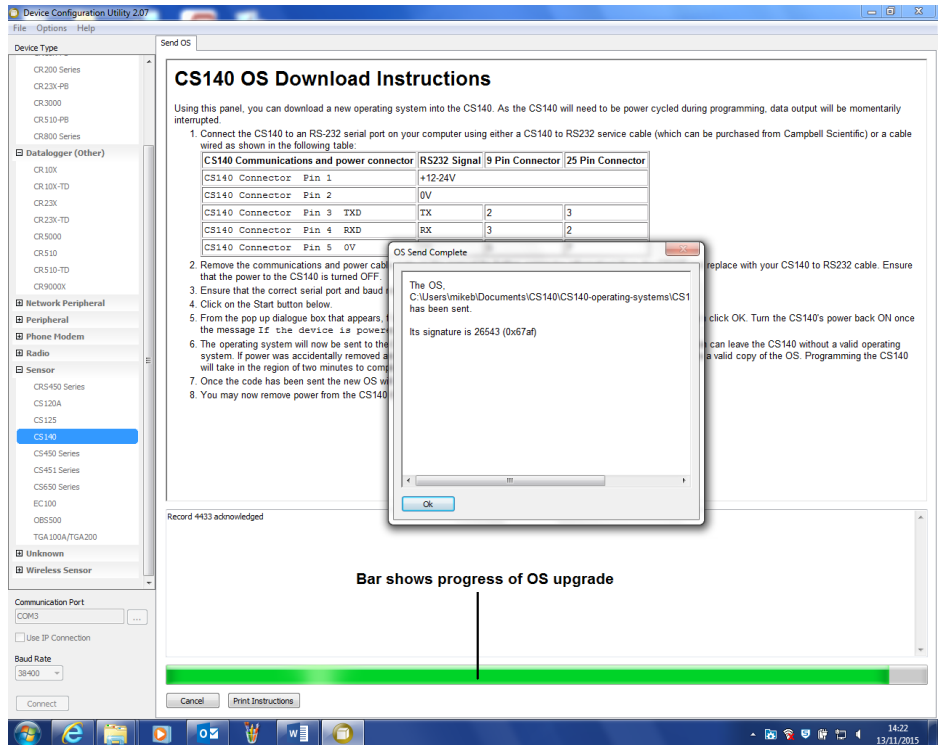


Figure 8-2. CS140 DevConfig screen when OS update is complete

9. Maintenance

9.1 General

The CS140 is a robust weather resistant instrument and there is no need for routine maintenance other than cleaning. The instrument performance is monitored and any potential problems are covered by error messages. Other maintenance is carried out by return to Campbell Scientific.

9.2 Cleaning

The CS140 window will require cleaning from time to time. The frequency of required cleaning depends on the exposure of the instrument to contaminants such as salt and dust. This will vary depending on the site location. The CS140 is capable of self-diagnosing a dirty window and will indicate in its output when the window is contaminated.

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

CAUTION

If the window requires cleaning, it is very important that only a proper lens cloth or lens tissue is used. The use of inappropriate materials to clean the window can permanently damage or reduce the effectiveness of the window 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 window as a first step. Using a lint free lens cloth or lens tissue impregnated with a small amount of isopropyl alcohol solvent clean the surface by dragging the cloth across it being careful not to apply excessive pressure.

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

Appendix A. Example C code of the CCITT CRC

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 CCITT checksum.

Command: Checksum/ChkSumString,1,0).

The checksum includes all characters after the STX and before the space preceding the checksum.

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

```
//-----  
-----  
// Creates a CCITT CRC16 checksum seeded with 0x0000 (XModem  
style) using a  
// fast non table based algorithm.  
// Pass in the data to convert into a CRC in the form of a NULL  
terminated  
// character array (a string).  
// Returns the CRC 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_CCITT(char LineOfData[]){  
    unsigned int crc; // returned CRC 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 B. Example CRBasic programs

B.1 Example CRBasic POLL program

```
'-----  
' CS140 Luminance  
'  
' Program to test the POLL command part of the command line interface on the  
CS140  
' Logger:CR1000  
'  
' Example polling outputs  
' POLL:0:0:3A3B:  
' POLL:1:0:0D0B:  
' POLL:2:0:545B:  
' POLL:3:0:636B:  
' POLL:4:0:E6FB:  
' POLL:5:0:D1CB:  
' POLL:6:0:889B:  
' POLL:7:0:BFAB:  
' POLL:8:0:939A:  
' POLL:9:0:A4AA:  
'-----  
  
Public OutString As String * 40 ' Outgoing sting  
Dim CheckVal As Long ' Checksum value  
Public InString As String * 200 ' Incomming string  
Dim TempString As String * 16  
  
'Main Program  
BeginProg  
  
' open port to the Luminance sensor  
SerialOpen (Com1,38400,3,0,10000)  
  
' Send request for information once every 10 seconds  
Scan (10,Sec,0,0)  
  
' Create the POLL string going out to the CS140  
TempString = "POLL: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 POLL request to the CS140  
  
Delay (1,1,Sec)  
  
SerialIn (InString,Com1,100,0,1000) ' Grab returned data from the POLL  
command  
  
NextScan  
EndProg
```

B.2 Example CRBasic SET program

```

'-----
' CS140 Luminance
'
' Program to test the SET command part of the command line interface on the
CS140
' 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 CS140CArray(21) As String * 6 ' CS140 Command Array

'-----
' This function creates a SET command string for the
' CS140 Luminance sensor. Including all delimiting
' characters and checksums
' then returns the string in "CS140CommandString"
' Array variable order is as follows:
'1. Sensor ID
'2. RS232 or RS485 serial communications enabled
'3. Serial BaudRate
'4. Serial number (Read only so not used)
'5. Lumiance Units
'6. Continuous mode output interval
'7. Polling Or Continuous modes
'8. Message Format (Basic/Partial/Full)
'9. Sample timing
'10. Averaging Period
'11. Dew heater override
'12. Hood Heater override
'13. Dirty window compensation
'14. Use CRC on SET, GET and POLL commands
'15. PSU voltage level shutdown
'16. User Alarm 1
'17. User Alarm 1 Active
'18. User Alarm 1 Activate Level
Function CS140_SETCommand As String *100
  Dim TempStringFunc As String * 100
  Dim CS140CommandString As String * 100
  Dim i As Long
  Dim CheckVal As Long

  ' Create a string containing the values going out to the CS140
  TempStringFunc = "SET:0:"
  For i = 1 To 18
    TempStringFunc = TempStringFunc + CS140CArray(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 CS140 including start characters and end
characters
CS140CommandString = CHR(2) + TempStringFunc + ":" + FormatLong
(CheckVal,"%04X") + ":" + CHR(3) + CHR(13) + CHR(10)
'CS140CommandString = CHR(2) + TempStringFunc + CHR(3) + CHR(13) +
CHR(10) ' Use this line if no checksum is desired
Return(CS140CommandString)
EndFunction
'-----

'Main Program
BeginProg

' open port to the Luminance 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
CS140CArray(1) = 0      ' Set ID to 0
CS140CArray(2) = 0      ' Serial communications to RS232 mode
CS140CArray(3) = 2      ' Baudrate to 38400
CS140CArray(4) = 0      ' The serial number is read only so this is a place holder
CS140CArray(5) = 0      ' Report in cd/m2
CS140CArray(6) = 10     ' Set the output interval to every 10 seconds
CS140CArray(7) = 1      ' Set POLLED output mode
CS140CArray(8) = 2      ' Full output message
CS140CArray(9) = 1      ' Sample once every second
CS140CArray(10) = 1     ' Average output over 1 minute
CS140CArray(11) = 0     ' Dew heater in automatic mode
CS140CArray(12) = 0     ' Hood heater in automatic mode
CS140CArray(13) = 0     ' Output not compensated by window contamination
level
CS140CArray(14) = 1     ' Check the CRC (Applied after this command)
CS140CArray(15) = 9.5   ' Shut down if supply is below 9.5V
CS140CArray(16) = 0     ' User alarm 1 not active
CS140CArray(17) = 0     ' User alarm 1 activates if less than activate level
CS140CArray(18) = 10000 ' User alarm 1 activate level

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

TempString = CS140_SETCommand() ' Create the outgoing string
SerialOut (Com1,TempString,"",0,100) ' Send SET command to the CS140

Delay (1,1,Sec)

SerialIn (InString,Com1,100,0,1000) ' Grab returned data from the CS140
' Returned data is identical to the
' data a GET command would return

NextScan
EndProg

```

B.3 Example CRBasic SETNC program

```

'-----
' CS140 Luminance
'
' Program to test the SETNC command part of the command line interface on the
CS140
' Logger:CR1000
'-----

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

' Variables for the SET command subroutine
Dim CS140CArray(21) As String * 6 ' CS140 Command Array

'-----
' This function creates a SETNC command string for the
' CS140 Luminance sensor. Including all delimiting
' characters and checksums
' then returns the string in "CS140CommandString"
' Array variable order is as follows:
'1. Sensor ID
'2. RS232 or RS485 serial communications enabled
'3. Serial BaudRate
'4. Serial number (Read only so not used)
' 5. Lumiance Units
'6. Continuous mode output interval
'7. Polling Or Continuous modes
'8. Message Format (Basic/Partial/Full)
' 9. Sample timing
'10. Averaging Period
'11. Dew heater override
'12. Hood Heater override
'13. Dirty window compensation
'14. Use CRC on SET, GET and POLL commands
'15. PSU voltage level shutdown
'16. User Alarm 1
'17. User Alarm 1 Active
'18. User Alarm 1 Activate Level
Function CS140_SETCommand As String *100
  Dim TempStringFunc As String * 100
  Dim CS140CommandString As String * 100
  Dim i As Long
  Dim CheckVal As Long

  ' Create a string containing the values going out to the CS140
  TempStringFunc = "SETNC:0:"
  For i = 1 To 18
    TempStringFunc = TempStringFunc + CS140CArray(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 CS140 including start characters and end
characters

```

```

CS140CommandString = CHR(2) + TempStringFunc + ":" + FormatLong
(CheckVal,"%04X") + ":" + CHR(3) + CHR(13) + CHR(10)
'CS140CommandString = CHR(2) + TempStringFunc + CHR(3) + CHR(13) +
CHR(10) ' Use this line if no checksum is desired
Return(CS140CommandString)
EndFunction
'-----

'Main Program
BeginProg

' open port to the Luminance 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
CS140CArray(1) = 0 ' Set ID to 0
CS140CArray(2) = 0 ' Serial communications to RS232 mode
CS140CArray(3) = 2 ' Baudrate to 38400
CS140CArray(4) = 0 ' The serial number is read only so this is a place holder
CS140CArray(5) = 0 ' Report in cd/m2
CS140CArray(6) = 10 ' Set the output interval to every 10 seconds
CS140CArray(7) = 1 ' Set POLLED output mode
CS140CArray(8) = 2 ' Full output message
CS140CArray(9) = 1 ' Sample once every second
CS140CArray(10) = 1 ' Average output over 1 minute
CS140CArray(11) = 1 ' Dew heater OFF
CS140CArray(12) = 1 ' Hood heater OFF
CS140CArray(13) = 0 ' Output not compensated by window contamination
level
CS140CArray(14) = 1 ' Check the CRC (Applied after this command)
CS140CArray(15) = 9.5 ' Shut down if supply is below 9.5V
CS140CArray(16) = 0 ' User alarm 1 not active
CS140CArray(17) = 0 ' User alarm 1 activates if less than activate level
CS140CArray(18) = 10000 ' User alarm 1 activate level

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

TempString = CS140_SETCommand() ' Create the outgoing string
SerialOut (Com1,TempString,"",0,100) ' Send SET command to the CS140

Delay (1,1,Sec)

SerialIn (InString,Com1,100,0,1000) ' Grab returned data from the CS140
' Returned data is identical to the
' data a GET command would return

NextScan
EndProg

```

B.4 Example CRBasic GET program

```

'-----
' CS140 Luminance
'
' Program to test the GET command part of the command line interface on the
CS140
' Connecting to serial port one on a CR1000 logger
' Logger:CR1000
'
' Example outputs including checksums
' 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 sting
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 Luminance sensor

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

' Create the basic GET string for the CS140
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 CS140

Delay (1,1,Sec)

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

NextScan
EndProg

```


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