Product Manual

CS140
Background Luminance Sensor
Limited Warranty

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

Products may not be returned without prior authorization. The following contact information is for US and international customers residing in countries served by Campbell Scientific, Inc. directly. Affiliate companies handle repairs for customers within their territories. Please visit [www.campbellsci.com](http://www.campbellsci.com) to determine which Campbell Scientific company serves your country.

To obtain a Returned Materials Authorization (RMA) number, contact CAMPBELL SCIENTIFIC, INC., phone (435) 227-9000. Please write the issued RMA number clearly on the outside of the shipping container. Campbell Scientific’s shipping address is:

**CAMPBELL SCIENTIFIC, INC.**

RMA#____

815 West 1800 North

Logan, Utah 84321-1784

For all returns, the customer must fill out a “Statement of Product Cleanliness and Decontamination” form and comply with the requirements specified in it. The form is available from our website at [www.campbellsci.com/repair](http://www.campbellsci.com/repair). A completed form must be either emailed to repair@campbellsci.com or faxed to (435) 227-9106. Campbell Scientific is unable to process any returns until we receive this form. If the form is not received within three days of product receipt or is incomplete, the product will be returned to the customer at the customer’s expense. Campbell Scientific reserves the right to refuse service on products that were exposed to contaminants that may cause health or safety concerns for our employees.
DANGER — MANY HAZARDS ARE ASSOCIATED WITH INSTALLING, USING, MAINTAINING, AND WORKING ON OR AROUND TRIPODS, TOWERS, AND ANY ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC. FAILURE TO PROPERLY AND COMPLETELY ASSEMBLE, INSTALL, OPERATE, USE, AND MAINTAIN TRIPODS, TOWERS, AND ATTACHMENTS, AND FAILURE TO HEED WARNINGS, INCREASES THE RISK OF DEATH, ACCIDENT, SERIOUS INJURY, PROPERTY DAMAGE, AND PRODUCT FAILURE. TAKE ALL REASONABLE PRECAUTIONS TO AVOID THESE HAZARDS. CHECK WITH YOUR ORGANIZATION'S SAFETY COORDINATOR (OR POLICY) FOR PROCEDURES AND REQUIRED PROTECTIVE EQUIPMENT PRIOR TO PERFORMING ANY WORK.

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

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

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

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

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

WHILE EVERY ATTEMPT IS MADE TO EMBODY THE HIGHEST DEGREE OF SAFETY IN ALL CAMPBELL SCIENTIFIC PRODUCTS, THE CUSTOMER ASSUMES ALL RISK FROM ANY INJURY RESULTING FROM IMPROPER INSTALLATION, USE, OR MAINTENANCE OF TRIPODS, TOWERS, OR ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC.
Contents

PDF viewers note: These page numbers refer to the printed version of this document. Use the Adobe Acrobat® bookmarks tab for links to specific sections.

Section 1. General Information ................................................. 1
  1.1 General Safety ................................................................................. 1
  1.2 Sensor Unit Safety ........................................................................ 1
  1.3 Recommended Tools ..................................................................... 1

Section 2. Product Overview .................................................. 2
  2.1 Introduction ..................................................................................... 2
  2.2 Specifications ................................................................................ 3
    2.2.1 Optical Specifications ............................................................... 3
    2.2.2 Electrical Specifications .......................................................... 3
    2.2.3 Communications Specifications ............................................. 3
    2.2.4 Environmental Specifications .............................................. 4
    2.2.5 CS140CAL Calibrator Specifications .................................. 4

Section 3. Mechanical Specifications ................................. 5
  3.1 Dimensions .................................................................................. 5
  3.2 Weights ......................................................................................... 5

Section 4. Installation ............................................................... 5
  4.1 Location and Orientation .............................................................. 5
  4.2 Grounding .................................................................................... 6
  4.3 Mounting the CS140 .................................................................... 6
  4.4 Connectors ................................................................................... 7
  4.5 Wiring Using Supplied Campbell Scientific Cables ..................... 8
  4.6 Configuration Cable .................................................................. 9
  4.7 Storage Information ................................................................. 10

Section 5. Messages ................................................................. 10
  5.1 Message structure ....................................................................... 10

Section 6. Interface methods .................................................. 13
  6.1 Command line/menu ................................................................... 13
  6.2 Configuring a PC for talking to the CS140 ................................ 13
  6.3 Definition of the variables that can be set by the user on the CS140 with the command line interface ........................................ 14
  6.4 Command line mode .................................................................. 15
    6.4.1 The SET Command ............................................................... 15
    6.4.2 The SETNC Command ......................................................... 16
    6.4.3 The GET Command ............................................................ 16
    6.4.4 The POLL command – Polling the CS140 ......................... 18
  6.5 The CS140 menu system ........................................................... 18

Section 7. Calibrating the CS140 .............................................. 23
Section 8. Performing an OS update ....................... 25

Section 9. Maintenance ................................. 27
   9.1 General ................................................................. 27
   9.2 Cleaning ................................................................. 27

Appendix
   A. Example C code of the CCITT CRC .............. A-1
   B. Example CRBasic programs ....................... B-1

Figures
   2-1. CS140 Background Luminance sensor .................. 2
   4-1. Mounting the CS140 onto a pole ...................... 6
   4-2. Connector layout .............................................. 7
   4-3. Connector pin-outs .......................................... 8
   4-4. Cable Connections .......................................... 9
   4-5. CS140 Configuration Cable ............................. 9
   7-1. CS140 Calibrator ............................................ 23
   7-2. CS140 Calibrator Connections ....................... 24
   8-1. CS140 DevConfig OS download instructions ....... 23
   8-2. CS140 DevConfig screen when OS update is complete .. 23
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/wrench (for grounding boss, must be open)
- 13 mm spanner/wrench
2. Product Overview

2.1 Introduction

![Figure 2-1. CS140 Background Luminance sensor](image)

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy</td>
<td>±0.2 cd/m² &lt; 2 cd/m², ±10% &gt; 2 cd/m²</td>
</tr>
<tr>
<td>Field of view</td>
<td>6°</td>
</tr>
<tr>
<td>Spectral response</td>
<td>CIE 1931</td>
</tr>
<tr>
<td>Measurement range</td>
<td>0-45,000 cd/m²</td>
</tr>
<tr>
<td>Resolution</td>
<td>0.1 cd/m²</td>
</tr>
</tbody>
</table>

2.2.2 Electrical Specifications

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

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

<table>
<thead>
<tr>
<th></th>
<th>Minimum Value</th>
<th>Nominal Value</th>
<th>Maximum Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RS-232 Communications</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RS-232 input threshold Low</td>
<td>0.8V</td>
<td>1.5V</td>
<td>-</td>
</tr>
<tr>
<td>RS-232 input threshold High</td>
<td>-</td>
<td>2.0V</td>
<td>2.4V</td>
</tr>
<tr>
<td>RS-232 input absolute maximum</td>
<td>-15V</td>
<td>-</td>
<td>+15V</td>
</tr>
<tr>
<td>RS-232 input resistance</td>
<td>12kΩ</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>RS-232 output voltage low</td>
<td>-</td>
<td>-</td>
<td>0.4V</td>
</tr>
<tr>
<td>RS-232 output voltage high (into 3KΩ)</td>
<td>4.4V</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>RS-485 Communications</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RS-485 input threshold voltage</td>
<td>-0.2V</td>
<td>-</td>
<td>+0.2V</td>
</tr>
<tr>
<td>RS-485 output (Unloaded)</td>
<td>-</td>
<td>-</td>
<td>5V</td>
</tr>
<tr>
<td>RS-485 output (Load 50Ω)</td>
<td>2V</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Maximum voltage at any terminal</td>
<td>-7V</td>
<td>-</td>
<td>+7V</td>
</tr>
</tbody>
</table>

### 2.2.4 Environmental Specifications

<table>
<thead>
<tr>
<th></th>
<th>Minimum Value</th>
<th>Nominal Value</th>
<th>Maximum value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sensor temperature ranges</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating temperature</td>
<td>-25°C</td>
<td>-</td>
<td>+60°C</td>
</tr>
<tr>
<td>Extended operating temperature</td>
<td>-40°C</td>
<td>-</td>
<td>+70°C</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-40°C</td>
<td>-</td>
<td>+85°C</td>
</tr>
<tr>
<td><strong>Sensor humidity range</strong></td>
<td>0%</td>
<td>-</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Sensor heater thresholds</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dew heater turn on</td>
<td>-</td>
<td>&lt;35°C</td>
<td>-</td>
</tr>
<tr>
<td>Dew heater turn off</td>
<td>-</td>
<td>&gt;40°C</td>
<td>-</td>
</tr>
<tr>
<td>Hood heater turn on</td>
<td>-</td>
<td>&lt;5°C</td>
<td>-</td>
</tr>
<tr>
<td>Hood heater turn off</td>
<td>-</td>
<td>&gt;15°C</td>
<td>-</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Ingress protection</th>
<th>IP66</th>
</tr>
</thead>
</table>

### 2.2.5 CS140CAL Calibrator Specifications

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

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Temperature range</strong></td>
<td>0 – 40°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Calibration value</strong></td>
<td>4,500 cd/m²</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Accuracy</strong></td>
<td>+/- 6%</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ingress protection</strong></td>
<td>IP52</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Communication</strong></td>
<td>RS-232, 38400 bd</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Dimensions (excluding cables)</strong></td>
<td>72 mm long x 46 mm diameter</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>300 g</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Weight Type</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensor weight</td>
<td>2.4</td>
</tr>
<tr>
<td>Shipping weight</td>
<td>3.5</td>
</tr>
</tbody>
</table>

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 +/- 12° 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.

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](image-url)
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.
4.6 Configuration Cable

A configuration cable 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.
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

<table>
<thead>
<tr>
<th>STX</th>
<th>Message ID</th>
<th>Sensor ID</th>
<th>System status</th>
<th>Message Interval</th>
<th>Luminance</th>
<th>Units</th>
<th>Checksum (CCITT)</th>
<th>ETX</th>
<th>Carriage return</th>
<th>Line feed</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x02</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>35833.7</td>
<td>1</td>
<td>4E7C</td>
<td>0x03</td>
<td>0x0D</td>
<td>0x0A</td>
<td></td>
</tr>
</tbody>
</table>

**Example basic format output**

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

### Partial Format

<table>
<thead>
<tr>
<th>STX</th>
<th>Message ID</th>
<th>Sensor ID</th>
<th>System status</th>
<th>Message Interval</th>
<th>Luminance</th>
<th>Units</th>
<th>User alarms</th>
<th>Checksum (CCITT)</th>
<th>ETX</th>
<th>Carriage return</th>
<th>Line feed</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x02</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>10</td>
<td>15732.2</td>
<td>1</td>
<td>0 0 0 0</td>
<td>1ED9</td>
<td>0x03</td>
<td>0x0D</td>
<td>0x0A</td>
</tr>
</tbody>
</table>

**Example partial format output**

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

### Full Format (default)

<table>
<thead>
<tr>
<th>STX</th>
<th>Message ID</th>
<th>Sensor ID</th>
<th>System status</th>
<th>Message Interval</th>
<th>Luminance</th>
<th>Units</th>
<th>Averaging Duration</th>
<th>User alarm</th>
<th>System alarms</th>
<th>Checksum (CCITT)</th>
<th>ETX</th>
<th>Carriage return</th>
<th>Line feed</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x02</td>
<td>2</td>
<td>0</td>
<td>3</td>
<td>10</td>
<td>15292.4</td>
<td>1</td>
<td>0 0 0 0</td>
<td>1 0 3 0 0 0 0</td>
<td>F8DA</td>
<td>0x03</td>
<td>0x0D</td>
<td>0x0A</td>
<td></td>
</tr>
</tbody>
</table>

**Example full format output**

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

### Message ID break down

<table>
<thead>
<tr>
<th>ID</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Basic format. Contains only luminance and system information</td>
</tr>
<tr>
<td>1</td>
<td>Partial format. Contains user alarm outputs</td>
</tr>
<tr>
<td>2</td>
<td>Full format. Contains all system alarms codes</td>
</tr>
</tbody>
</table>

### Sensor ID break down

<table>
<thead>
<tr>
<th>ID</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-9</td>
<td>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</td>
</tr>
</tbody>
</table>

### System status break down

<table>
<thead>
<tr>
<th>Status level</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No fault</td>
</tr>
<tr>
<td>1</td>
<td>Possible degraded performance</td>
</tr>
<tr>
<td>2</td>
<td>Degraded performance</td>
</tr>
<tr>
<td>3</td>
<td>Maintenance required</td>
</tr>
</tbody>
</table>

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

### Message interval

<table>
<thead>
<tr>
<th>Time</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3600</td>
<td>The amount of time, in seconds, between outputs in continuous mode</td>
</tr>
</tbody>
</table>

### Luminance break down

<table>
<thead>
<tr>
<th>ID</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-50,000</td>
<td>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.</td>
</tr>
</tbody>
</table>

### Visibility units break down

<table>
<thead>
<tr>
<th>ID</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cd/m²</td>
</tr>
<tr>
<td>2</td>
<td>fL</td>
</tr>
</tbody>
</table>

### Averaging duration break down

<table>
<thead>
<tr>
<th>ID</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>One minute average</td>
</tr>
<tr>
<td>10</td>
<td>Ten minute average</td>
</tr>
</tbody>
</table>
## User and system alarms break down

<table>
<thead>
<tr>
<th>Alarm</th>
<th>Range</th>
<th>System status</th>
<th>Definition</th>
</tr>
</thead>
</table>
| 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           | 0-3   | 0             | 0 = OK. The reported attenuation is below 10%.  
1 or 2 = Reported dirt level is over 10%                                                                                                       |
|                              |       | 1             | 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             | 0 = Temperature is within operating conditions.                                                                                                 |
|                              |       | 1             | 1 = Too low. Less than -40°C.                                                                                                                    |
|                              |       | 2             | 2 = Too high. Over 70°C.                                                                                                                         |
|                              |       | 3             | 3 = Sensor fault (No sensor detected or below -49°C)                                                                                             |
| Hood temperature              | 0-3   | 0             | 0 = Temperature is within operating conditions.                                                                                                 |
|                              |       | 1             | 1 = Too low. Less than -45°C.                                                                                                                    |
|                              |       | 2             | 2 = Too high. Over 70°C.                                                                                                                         |
|                              |       | 3             | 3 = Sensor fault (No sensor detected or below -49°C)                                                                                             |
| Detector DC saturation level  | 0-1   | 0             | The amount of background light as seen by the detector hood.                                                                                      |
|                              |       | 1             | 0 = Within limits  
1 = Saturated. The CS140 is experiencing direct light levels that are saturating the photo diode                                             |
| Signature error               | 0-1   | 0             | 0 = Signature of entire flash was checked and matches the stored version                                                                       |
|                              |       | 3             | 1 = Signature does not match previous readings                                                                                                  |
| Flash read error              | 0-1   | 0             | 0 = No errors  
1 = One or more errors reading user variables from flash occurred                                                                               |
|                              |       | 3             | 3 = Sensor fault (No sensor detected or below -49°C)                                                                                             |
| Flash write error             | 0-1   | 0             | 0 = No errors  
1 = One or more errors writing user variables to flash occurred                                                                                 |
|                              |       | 3             | 3 = Sensor fault (No sensor detected or below -49°C)                                                                                             |
| Internal voltages             | 0-1   | 0             | 0 = No errors  
1 = One or more errors writing user variables to flash occurred                                                                                  |
|                              |       | 3             | 3 = Sensor fault (No sensor detected or below -49°C)                                                                                             |
| Spare                         |       |               | Reserved for future use                                                                                                                         |
| Window dirty                  | 0-3   | 0             | 0 = OK. The reported attenuation is below 10%                                                                                                   |
|                              |       | 1             | 3 = High level of dirt build up (>25%) or possible sensor fault or hood could be blocked                                                          |
|                              |       | 2             | 1 or 2 = Slight dirt build up (10% signal attenuation or higher)                                                                                  |
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:

<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
<th>Range</th>
<th>Description</th>
<th>Factory default</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sensor ID</td>
<td>0-9</td>
<td>Separate ID used as an identifier for a particular CS140 on a network.</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>Serial port protocol</td>
<td>0-1</td>
<td>Selects the physical serial interface</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>Serial Baud Rate</td>
<td>0-6</td>
<td>Baud rate for the main RS-232/RS-485 interface</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>Serial Number (Read only so not used)</td>
<td>0-32000</td>
<td>Internal serial number for the CS140. (Read only)</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>Luminance Units</td>
<td>0-1</td>
<td>Units the CS140s luminance value is reported in.</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>Message Interval</td>
<td>1-3600</td>
<td>Interval in seconds between outputs in continuous mode. This value has no effect if polled mode has been selected in ‘Measurement mode’</td>
<td>60</td>
</tr>
<tr>
<td>7</td>
<td>Measurement mode</td>
<td>0-1</td>
<td>Selects polled or continuous modes.</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>Message Format</td>
<td>0-2</td>
<td>Level of detail output by polled or continuous modes.</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>Sample timing</td>
<td>1-60</td>
<td>Not currently implemented</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>Averaging period</td>
<td>1 or 10</td>
<td>The period of time that the luminance value should be averaged over. Either one minute or ten.</td>
<td>1</td>
</tr>
<tr>
<td>11</td>
<td>Dew heater override</td>
<td>0-1</td>
<td>0 = Allow the CS140 to automatically control the dew heater.</td>
<td>0</td>
</tr>
<tr>
<td>12</td>
<td>Hood heater override&lt;sup&gt;(1)&lt;/sup&gt;</td>
<td>0-1</td>
<td>1 = Turn the dew heater off</td>
<td>0</td>
</tr>
<tr>
<td>13</td>
<td>Dirty window compensation</td>
<td>0-1</td>
<td>0 = No compensation applied</td>
<td>0</td>
</tr>
<tr>
<td>14</td>
<td>Use CRC</td>
<td>0-1</td>
<td>1 = Compensation for dirt on window applied.</td>
<td></td>
</tr>
</tbody>
</table>

<sup>(1)</sup> Dirty window compensation

<sup>(2)</sup> Use CRC

Note: this does not affect communications via DevConfig or terminal emulator.
<table>
<thead>
<tr>
<th>15</th>
<th>Power Supply Unit (PSU) voltage level shutdown</th>
<th>9-30</th>
<th>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)</th>
<th>9.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>Enable alarm</td>
<td>0-1</td>
<td>1 = alarm on</td>
<td>0</td>
</tr>
<tr>
<td>17</td>
<td>Alarm high/low</td>
<td>0-1</td>
<td>Sets whether the alarm is triggered by a luminance higher or lower than the alarm level</td>
<td>0</td>
</tr>
<tr>
<td>18</td>
<td>Alarm level</td>
<td>0-45,000</td>
<td>In cd/m²</td>
<td>10,000</td>
</tr>
</tbody>
</table>

(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 0 0 1 0 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

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

(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

<table>
<thead>
<tr>
<th>GET transmitted data</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example</td>
<td>Description</td>
</tr>
<tr>
<td>0x02^{17}</td>
<td>STX</td>
</tr>
<tr>
<td>GET</td>
<td>GET</td>
</tr>
<tr>
<td>:</td>
<td>Delimiting character</td>
</tr>
<tr>
<td>0</td>
<td>Address based on Sensor ID</td>
</tr>
<tr>
<td>:</td>
<td>Delimiting character</td>
</tr>
<tr>
<td>0</td>
<td>Reserved for future use, zero default</td>
</tr>
<tr>
<td>:</td>
<td>Delimiting character</td>
</tr>
<tr>
<td>2C67</td>
<td>Checksum</td>
</tr>
<tr>
<td>:</td>
<td>Delimiting character</td>
</tr>
<tr>
<td>0x03^{17}</td>
<td>ETX</td>
</tr>
<tr>
<td>0x0D^{17}</td>
<td>Carriage return</td>
</tr>
</tbody>
</table>

(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

\[
\text{GET:0:0:2C67:}
\text{0 0 2 1000 0 60 0 2 1 1 0 0 0 1 7.0 0 0 10000 626C}
\]
6.4.4 The POLL command – Polling the CS140

The POLL command requests the current visibility and/or alarm conditions from the CS140. The output format of this command depends on how the CS140 is configured using the SET command or the menu interfaces.

Example of a POLL request with returned message

```
POLL:0:0:3A3B:  
2 0 0 60 22.9 1 1 0 0 0 0 0 0 0 0 0 0 0 5EC7
```

<table>
<thead>
<tr>
<th>POLL transmitted data</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example</td>
<td>Description</td>
</tr>
<tr>
<td>0x02&lt;sup&gt;(1)&lt;/sup&gt;</td>
<td>STX</td>
</tr>
<tr>
<td>POLL</td>
<td>POLL</td>
</tr>
<tr>
<td>:</td>
<td>Delimiting character</td>
</tr>
<tr>
<td>0</td>
<td>Address based on Sensor ID</td>
</tr>
<tr>
<td>:</td>
<td>Delimiting character</td>
</tr>
<tr>
<td>0</td>
<td>Reserved for future use, zero default</td>
</tr>
<tr>
<td>:</td>
<td>Delimiting character</td>
</tr>
<tr>
<td>3A3B</td>
<td>Checksum</td>
</tr>
<tr>
<td>:</td>
<td>Delimiting character</td>
</tr>
<tr>
<td>0x03&lt;sup&gt;(1)&lt;/sup&gt;</td>
<td>ETX</td>
</tr>
<tr>
<td>0x0D&lt;sup&gt;(1)&lt;/sup&gt;</td>
<td>Carriage return</td>
</tr>
</tbody>
</table>

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

6.5 The CS140 menu system

When connected to the CS140 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 will now be displayed:

<table>
<thead>
<tr>
<th>WELCOME TO THE CAMPBELL SCIENTIFIC LTD CS140 SETUP MENU</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID 0</td>
</tr>
<tr>
<td>S/N 1009</td>
</tr>
<tr>
<td>(1) Message output menu</td>
</tr>
<tr>
<td>(2) User alarm menu</td>
</tr>
<tr>
<td>(3) Communications setup</td>
</tr>
<tr>
<td>(4) System information</td>
</tr>
<tr>
<td>(5) System configuration</td>
</tr>
<tr>
<td>(6) Calibration</td>
</tr>
<tr>
<td>(9) Exit and save</td>
</tr>
<tr>
<td>(0) Exit and don't save</td>
</tr>
</tbody>
</table>

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.

Typing ‘1’ opens the message menu containing settings relating to the CS140’s outputs.

Menu 1: The message output menu

<table>
<thead>
<tr>
<th>CS140 MESSAGE - MENU 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID 0</td>
</tr>
<tr>
<td>S/N 1009</td>
</tr>
<tr>
<td>(1) Toggle message format: FULL</td>
</tr>
<tr>
<td>(2) Toggle units: cd/m²</td>
</tr>
<tr>
<td>(3) Toggle polled or continuous mode: CONTINUOUS</td>
</tr>
<tr>
<td>(4) Set continuous mode output interval: 6 second(s)</td>
</tr>
<tr>
<td>(5) Toggle output averaging period: 1 minute(s)</td>
</tr>
<tr>
<td>(6) Sampling interval: 1 second(s)</td>
</tr>
<tr>
<td>(9) Refresh</td>
</tr>
<tr>
<td>(0) Return to main menu</td>
</tr>
</tbody>
</table>

For example typing ‘2’ will toggle the units through the options cd/m² 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/m², 2-12000fL) or UK CAA limits (5-35000.0 cd/m²).
Menu 2: The user alarm menu

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Toggle user alarm one: DISABLED</td>
</tr>
<tr>
<td>2</td>
<td>Toggle alarm one threshold: LESS THAN</td>
</tr>
<tr>
<td>3</td>
<td>Set new user alarm one activation point: 10000 cd/m²</td>
</tr>
<tr>
<td>4</td>
<td>Set upper output limit: 45000 cd/m²</td>
</tr>
<tr>
<td>5</td>
<td>Set lower output limit: 5 cd/m²</td>
</tr>
<tr>
<td>6</td>
<td>Set to FAA limits</td>
</tr>
<tr>
<td>7</td>
<td>Set to CAA limits</td>
</tr>
<tr>
<td>9</td>
<td>Refresh</td>
</tr>
<tr>
<td>0</td>
<td>Return to main menu</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Set sensor ID</td>
</tr>
<tr>
<td>2</td>
<td>Set RS232/RS485 baud rate: 38400</td>
</tr>
<tr>
<td>3</td>
<td>Toggle RS232/RS485 modes: RS232</td>
</tr>
<tr>
<td>9</td>
<td>Refresh</td>
</tr>
<tr>
<td>0</td>
<td>Return to main menu</td>
</tr>
</tbody>
</table>

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

**Menu 4: The system information menu**

<table>
<thead>
<tr>
<th>CS140 INFORMATION – MENU 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID 0</td>
</tr>
<tr>
<td>S/N 1009</td>
</tr>
<tr>
<td>OS version: 7644-07</td>
</tr>
</tbody>
</table>

---

- One Minute Luminance value: 3100.0
- Overall system status: No faults
- Detector dirty window alarm: 0%
- Sensor internal temperature: 28.0
- Hood heater temperature: 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
- Flash read errors: 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.

<table>
<thead>
<tr>
<th>CS140 CONFIGURATION – MENU 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID 0</td>
</tr>
<tr>
<td>S/N 1009</td>
</tr>
</tbody>
</table>

---

(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.

<table>
<thead>
<tr>
<th>CS140 CONFIGURATION - MENU 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID 0</td>
</tr>
<tr>
<td>S/N 1004</td>
</tr>
<tr>
<td>(1) Perform a user calibration</td>
</tr>
<tr>
<td>(2) Reset the user calibration to factory values</td>
</tr>
<tr>
<td>(9) Refresh</td>
</tr>
<tr>
<td>(0) Return to main menu</td>
</tr>
<tr>
<td>-&gt;</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>CS140 CALIBRATION - SUB 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are you sure you want to reset to factory defaults?</td>
</tr>
<tr>
<td>This will cause the sensor to reset.</td>
</tr>
<tr>
<td>Type 1234 followed by return to confirm, or anything else to exit.</td>
</tr>
<tr>
<td>-&gt;1234</td>
</tr>
</tbody>
</table>

**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.

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.
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.

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 Scientifics 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.

```c
//---------------------------------------------------------------
// 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 checksum 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

```crbasic
' CS14 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
BeginPr
'
' 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 return data from the POLL command

NextScan
EndProg
```
B.2 Example CRBasic SET program

```cr
' 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

--------------------------------------------------------

Function CS140_SETCommand As String *100
Dim TempStringFunc As String * 100
Dim CS140CommandString As String * 100
Dim i As Long
Dim CheckVal As Long

' 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

```

B-2
Appendix B. Example CRBasic programs

Example CRBasic programs

---

* Create final string going out to CS140 including start characters and end characters

```vbnet
CS140CommandString = CHR(2) + TempStringFunc + ":" + FormatLong(CheckVal,"%04X") + ":" + 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

```crbasic
' 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. Luminance 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

```

Appendix B. Example CRBasic programs

```plaintext
CS140CommandString = CHR(2) + TempStringFunc + ":" + FormatLong(CheckVal, "%04X") + ":" + 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

```crbasic
' 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
```
Campbell Scientific

Global Sales & Support Network
A worldwide network of companies to help meet your needs

Australia
Location: Garbutt, QLD Australia
Phone: 61.7.4401.7700
Email: info@campbellsci.com.au
Website: www.campbellsci.com.au

Brazil
Location: São Paulo, SP Brazil
Phone: 11.3732.3399
Email: vendas@campbellsci.com.br
Website: www.campbellsci.com.br

Canada
Location: Edmonton, AB Canada
Phone: 780.454.2505
Email: dataloggers@campbellsci.ca
Website: www.campbellsci.ca

China
Location: Beijing, P. R. China
Phone: 86.10.6561.0080
Email: info@campbellsci.com.cn
Website: www.campbellsci.com

Costa Rica
Location: San Pedro, Costa Rica
Phone: 506.2280.1564
Email: info@campbellsci.cc
Website: www.campbellsci.cc

France
Location: Vincennes, France
Phone: 0033.0.1.56.45.15.20
Email: info@campbellsci.fr
Website: www.campbellsci.fr

Germany
Location: Bremen, Germany
Phone: 49.0.421.460974.0
Email: info@campbellsci.de
Website: www.campbellsci.de

South Africa
Location: Stellenbosch, South Africa
Phone: 27.21.8809960
Email: sales@campbellsci.co.za
Website: www.campbellsci.co.za

Southeast Asia
Location: Bangkok, Thailand
Phone: 66.2.719.3399
Email: thitipongc@campbellsci.asia
Website: www.campbellsci.asia

Spain
Location: Barcelona, Spain
Phone: 34.93.2323938
Email: info@campbellsci.es
Website: www.campbellsci.es

UK
Location: Shepshed, Loughborough, UK
Phone: 44.0.1509.601141
Email: sales@campbellsci.co.uk
Website: www.campbellsci.co.uk

USA
Location: Logan, UT USA
Phone: 435.227.9120
Email: info@campbellsci.com
Website: www.campbellsci.com