INSTRUCTION MANUAL

CS710 Snow Depth Sensor

Preliminary: 9/9/15

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* to determine which Campbell Scientific company serves your country.

To obtain a Returned Materials Authorization (RMA), contact CAMPBELL SCIENTIFIC, INC., phone (435) 227-9000. After an application engineer determines the nature of the problem, an RMA number will be issued. Please write this 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 web site at *www.campbellsci.com/repair*. A completed form must be either emailed to *repair@campbellsci.com* or faxed to (435) 227-9106. Campbell Scientific is unable to process any returns until we receive this form. If the form is not received within three days of product receipt or is incomplete, the product will be returned to the customer at the customer's expense. Campbell Scientific reserves the right to refuse service on products that were exposed to contaminants that may cause health or safety concerns for our employees.

Safety

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

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

General

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

Utility and Electrical

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

Elevated Work and Weather

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

Maintenance

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

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

Table of Contents

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

Figures

Tables

CS710 Snow Depth Sensor

1. Introduction

The CS710 uses mono-static ultra wideband radar technology to measure time of flight through the snow. From this measurement, and a snow density input from the user, snow depth is calculated. Typically, the CS710 is used for mobile snow depth applications such as generating snow depth maps for resorts and land management.

2. Precautions

- READ AND UNDERSTAND the *Safety* section at the front of this manual.
- Although the CS710 is rugged, it should be handled as precision scientific instrument.
- Follow local regulations (Appendix A, *GPR Emissions and Regulations (p. A-1)*).

3. Initial Inspection

- Upon receipt of the CS710, inspect the packaging and contents for damage. File damage claims with the shipping company.

4. Overview

The CS710 Snow Depth Sensor measures the distance from the sensor to a target. It is based on mono-static ultra wideband radar technology that determines the distance to a target by sending out radar pulses and listening for the returning echoes that are reflected from the target (FIGURE 4-1). The time from transmission to return of an echo is the basis for obtaining the distance measurement.

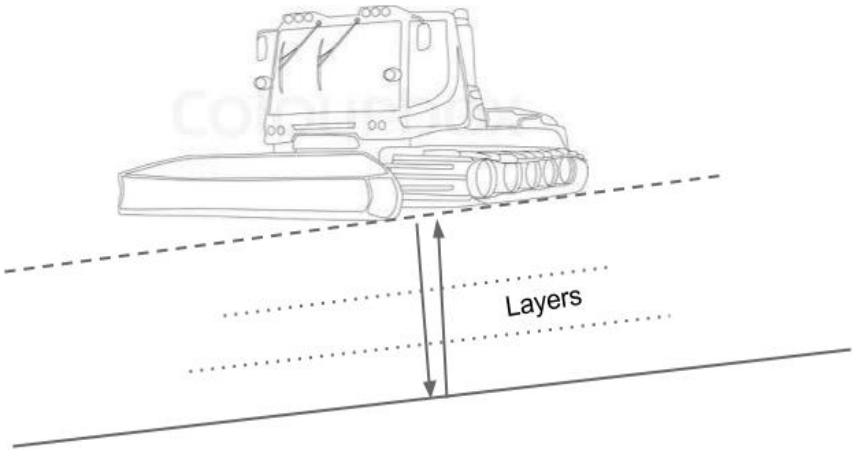


FIGURE 4-1. Radar pulses traveling through layers of snow

When the radar travels through a medium such as snow, the CS710 will calculate the depth of the sampled snow based on the dielectric constant of the snowpack, which must be input. The dielectric constant is directly affected by snow density and free water content.

The CS710 is capable of picking up changes in density such as an ice layer in the snowpack. The strongest echo is generally the ground/snow interface, which is used for snow depth calculations. The following conditions can cause the CS710 to return values based on echoes that are not from the snow/ground interface: free water in snowpack, deep dense snow (<1.2 m), rapid extreme change in density (major ice layers).

The CS710 uses a unique echo/reflection processing algorithm to help ensure measurement reliability. When used in a mobile application, the algorithm amplifies echoes that are changing more than others. Therefore, the sensor must be in motion to apply this algorithm correctly.

5. Specifications

TABLE 5-1. Size Specifications

Power Requirements	10 to 28 Vdc
Typical Active Power Consumption @ 12 Vdc	175 mA
Outputs	RS-232, USB (CAN bus, RS-485, SDI-12 optional)
Measurement Range	15 to 183 cm (6 to 72 in) with sensor mounted 30.5 cm above snow surface
Accuracy	50% measured values ±10 cm (±4 in), 80% measured values ±15 cm (±6 in)
Beam Angle	45°
Operating Temperature	–43 to 54 °C (–45 to 130 °F)
Maximum Cable Length	RS-232: 50 feet using 22 AWG, USB: 15 feet using 22/24 AWG
Dimensions	Length: 21.6 cm (8.5 in) Width: 17.8 cm (7 in) Height: 16.5 cm (6.5 in)
Weight (sensor only)	1.5 kg (3.2 lb)
Environmental	IP67
RS-232 Baud Rate	115200 bps
RS-232 Logic	Binary, no parity, one stop bit, 8 data bits

6. Installation

The CS710 must be used within a frame-like structure under a vehicle such as a snowcat. The entire enclosure must be within the framework and cannot protrude. The CS710 should be mounted such that metal objects are at least one inch away from the plastic enclosure.

FIGURE 6-1 and FIGURE 6-2 show the placement of the sensor on a snowcat.

FIGURE 6-1. CS710 mounted to a snowcat

FIGURE 6-2. CS70 mounted to a snowcat above a pit

6.1 Mounting Height

The CS710 cannot listen for echoes from a desired target within 0.5 m from the bottom of the enclosure (FIGURE 6-3). The CS710 should be mounted as close as possible to the desired target keeping in mind the 0.5 m limitation.

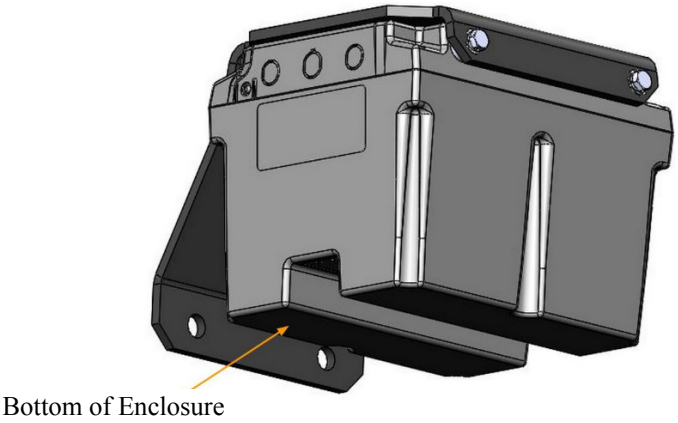


FIGURE 6-3. Bottom of enclosure

6.2 Mounting Holes and Dimensions

The optional mounting bracket has two holes for mounting the CS710 (FIGURE 6-4). Two M12 bolts can be used to mount the CS710 to the auxiliary hydraulics mounting holes on a piston bully, assuming auxiliary hydraulics is not already being used. This same mount also attaches the CS710 directly to a frame rail by drilling and tapping two M12 or 1/2-inch holes.

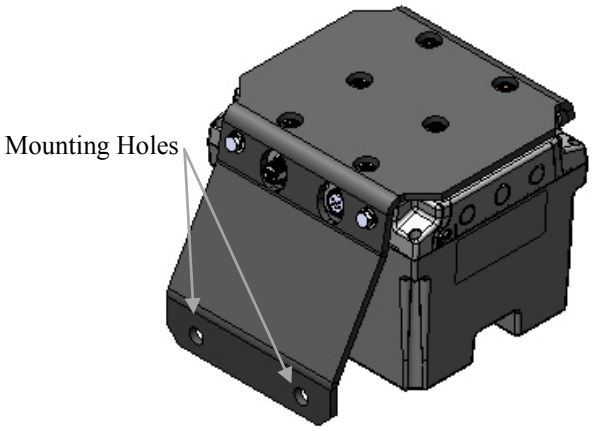


FIGURE 6-4. Optional mounting bracket

6.3 Wiring

Use the provided cable for wiring the CS710. An A200 from Campbell Scientific can be used and wired using the chart found in the RS-232 section. The A200 doesn't provide enough current for the radar. Therefore, external power should be used. The CS710 processor can be powered by the current

supplied from the A200. There are two connectors on the CS710: a 6-pin M16 female connector (FIGURE 6-5) and a sealed mini type B USB connector.

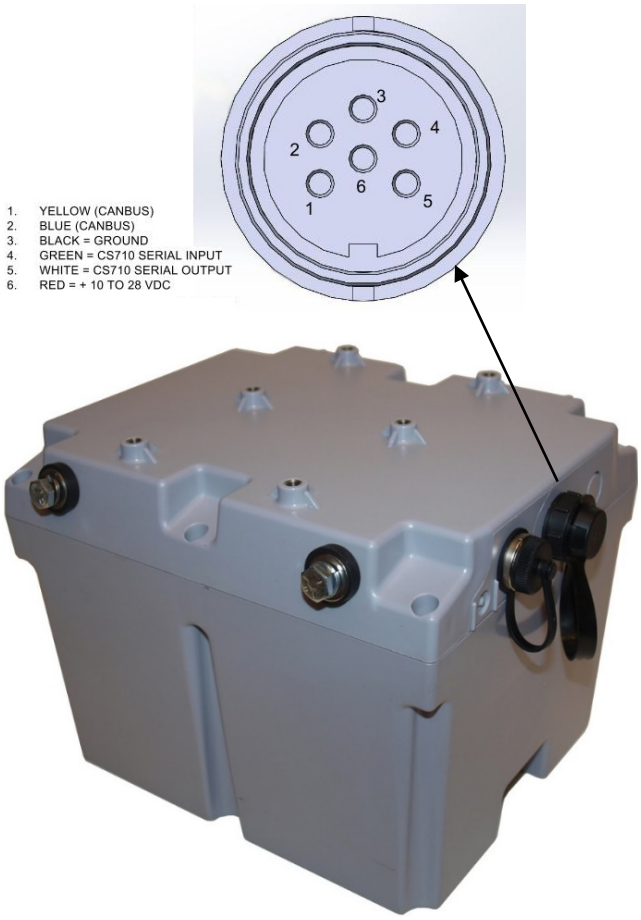


FIGURE 6-5. 6-pin M16 female connector

7. Operation

The CS710 supports RS-232 and USB. RS-232 is preferred for reliability. CAN bus, RS-485, and SDI-12 communications can be made available upon request.

The CS710 algorithm uses two different averaging techniques which will mask rapid changes in depth as well as filter erroneous measurements. Many algorithm settings including the motion amplification discussed in the introduction can be adjusted or turned on/off as desired. The CS710 comes from the factory with the best known settings stored for use in measuring snow depth while mobile.

The distance to the target readings that are obtained from the sensor are referenced from the bottom of the sensor minus an offset called sensor height. The CS710 projects an ultra-wideband radar pulse that can pick up objects in its field of view that is 45° or less. Due to cross-talk between the send and receive antennas, the closest measurable target to the sensor bottom is 0.5 m (1.6 ft).

The CS710 has a resolution of 0.8 cm (0.3 in). The resolution creates a 4 m (13.1 ft) (air distance) or 2.3 m (7.4 ft) (ice distance) window for which the CS710 can listen for the echo. That window can be adjusted depending on the distance from the desired target and CS710. The CS710 will not listen for any echo outside of the window. The start distance can be set using *SDSBuddy* or using RS-232 commands. See Section 7.1, *CS710 Commands and Function (p. 6)*, for more information.

The CS710 does not contain a battery. If operation is interrupted, the CS710 will immediately deactivate because of no power being applied.

7.1 CS710 Commands and Function

7.1.1 Start Distance

There is a limit on how long the receiver can stay turned on to listen for echoes. The start distance is the amount of time (in air distance) the receive antenna will wait before listening for an echo. The maximum window size in air is 4 m (13.1 ft). Therefore, if the desired target is 6 m (20 ft) away, the start distance should be set to 4 m (13.1 ft) such that the desired target is in the middle of the window. For typical use under a snowcat, the start distance is set to be equal to or slightly greater than the sensor height so that the snow surface echo does not appear in the desired target window.

7.1.2 Sensor Height

When being used to measure snow depth on a snowcat, the sensor height is the distance between the snow surface and the bottom of the CS710.

7.1.3 Snow Factor

When being used to measure snow depth on a snowcat, the snow factor is the multiplier used in calculating snow depth from time of flight of the radar.

The snow factor (SF) is:

$$SF = \frac{1}{\sqrt{\mathrm{Kmix}}}$$

Where K_{mix} is the dielectric constant of the mixture—typically air, ice, and liquid water. The dielectric constant of the mixture is:

$$\sqrt{\mathrm{Kmix}} = \mathrm{x1} \cdot \sqrt{\mathrm{Kair}} + x2 \cdot \sqrt{\mathrm{Kice}} + x3 \cdot \sqrt{Kwater}$$

Where x1 is the ratio of air in the mixture, x2 is the ratio of ice in the mixture and x3 is the ratio of water in the mixture. If there is no water in the mixture, then x2 is the density of the snow. An HS2 with CS658 sensor from Campbell Scientific can be used to calculate x3 when x2 is known/measured.

Snow factor and sensor height are used in the sensor to calculate snow depth (SD) as follows:

$$\mathrm{SD} = (\mathrm{DM} - \mathrm{SH}) \cdot \mathrm{SF}$$

Where

DM = Distance Measured by the round trip time of flight of the radar to and from the target,

SF = Snow Factor,

SH = Sensor Height.

The sensor height is subtracted before the snow factor is applied because the sensor height is typically a distance the radar travels through air and not snow.

7.1.4 Search Technique

The raw wave returned to the sensor is analyzed and filtered according to a preconfigured set of algorithms. The processed waveform has several peaks. Those peaks are classified into first, maximum, and last. The search technique specifies which peak to be used as the distance to the target. The first peak might be desirable when looking for a target that is closest to the sensor. In general the tallest peak, or maximum, is the snow/ground interface, and is typically used in mobile snow depth applications.

Another search technique is called fuzzy. Fuzzy logic makes the first peak dominate when the distance is small, and makes the max peak dominate when the distance is large. If the average of the max peak and first peak is less than a fuzzy max but greater than a fuzzy min, a weighted average of the max peak and first peak will be returned as the desired distance to the target.

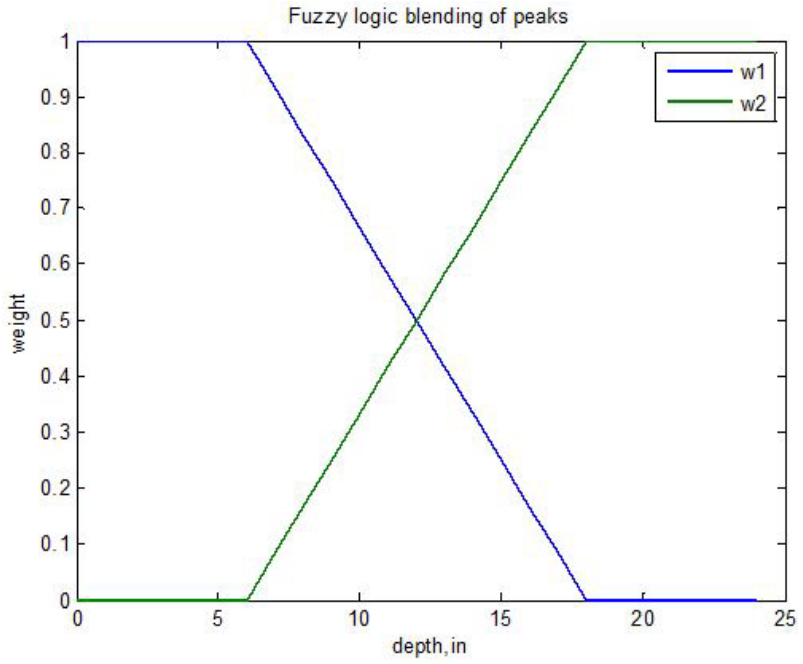


FIGURE 7-1. Weighting scheme example

The weighting scheme shown in FIGURE 7-1 selects the first peak up until a 6-inch depth, blends with the max peak until an 18-inch depth, and then select the max peak for depths greater than 18 inches. At 12 inches, the depth is the

average of the first peak and the max peak. In mobile snow depth applications, the fuzzy max and min should be set depending upon sensor height as follows:

fuzzy min = sensor height + 0.3 m

fuzzy max = fuzzy min + 0.1 m

7.1.5 Depth Alpha

This is a moving average of the returned depth value.

$$Depth = (1 - DA) \cdot NewDepth + DA \cdot OldDepth$$

Where DA represents Depth Alpha. Depth Alpha should be between 0 and 1. A Depth Alpha that is near 1 would average heavily and a Depth Alpha of 0 wouldn't use past measurements at all. This is used to smooth the results to filter bad data, but it also masks rapid changes in snow depth.

7.1.6 Adaptive Beta

Adaptive Beta is similar to Depth Alpha, but applied to the raw signal. What this effectively does is amplifies echoes that are changing. The antenna noise is filtered out because of its consistency and the snow/ground echo is amplified because it is always changing. For the CS710 to be effective for measuring mobile snow depth, the vehicle should be moving. Otherwise the snow/ground echo being returned to the sensor will be averaged out and un-detected by this adaptive beta filter.

7.2 CS710 Calibration

The following refers to mobile snow depth measurements. Sensor height and snow factor are the two values that can be used for calibration. Understanding the following equation is key to CS710 calibration:

$$SD = (DM - SH) \cdot SF$$

Where,

SD = returned snow depth

DM = raw distance measured by the sensor

SH = sensor height

SF is snow factor. Using this equation, manually probed measurements can be compared to snow depth values from the CS710. If the CS710 consistently measures too shallow or too deep in various manually probed depths, then the sensor height should be adjusted to offset the difference. If the CS710 has a greater error at manually probed depths that are deeper than it does with more shallow manually probed depths, then the snow factor should be adjusted accordingly. Generally, if the CS710 is reading too deep, then the snow factor should be reduced and vice versa.

7.3 RS-232 Operation

The CS710 sensor uses unique commands for RS-232 versus USB. RS-232 is the preferred communication method when long-term reliability is needed.

7.3.1 RS-232 Wiring

TABLE 7-1. RS-232 Wiring

Color	Function	Connection
Black	Power Ground	System Ground and/or RS-232 Receiver Ground (pin 5 of a computer (DTE) DB-9 connector)
Red	+10 to 28 Vdc Power	Power Source
Green	RS-232 (CS710 Input)	Reader RS-232 Output or Tx (pin 3 of a computer (DTE) DB-9 connector)
White	RS-232 (CS710 Output)	Reader RS-232 Input or Rx (pin 2 of a computer (DTE) DB-9 connector)
Clear	Shield	Shield/Earth Ground

7.3.2 RS-232 Protocol

All commands begin with the backspace character (0x08) and are terminated with the ">" character (0x3E).

Responses from the sensor are of the format " *,xxxxx,cc0" where xxxxx = return value of the command, cc = 16 bit null signature, 0 is terminating null character

"SET" commands set settings in the device. "SET" commands are of the format "SET_START_DISTANCE_X" where X is the ascii representation of the desired setting value. The response to a "SET" command returns the ascii representation of the value of the setting that was set in the device.

"GET" commands get settings from the device. The response to a "GET" command returns the ascii representation of the value of the setting.

7.3.3 RS-232 Commands

SET_START_DISTANCE_(xx.xx)>
Where xx.xx = string for floating point number. Can be from 0 to 60 m.
Units = Meters.
CS710 response: *,xx.xx, [crc1] [crc0] 0

GET_START_DISTANCE>
CS710 response: *,xx.xx, [crc1] [crc0] 0
Units = Meters

SET_SENSORHEIGHT_(xx.xx)>
Where xx.xx = string for floating point number. Units = Meters
CS710 response: *,xx.xx, [crc1] [crc0] 0

GET_SENSORHEIGHT>
CS710 response: *,xx.xx, [crc1] [crc0] 0
Units = Meters

SET_SNOWFACTOR_(xx.xx)>
Where xx.xx = string for floating point number.
CS710 response: *,xx.xx, [crc1] [crc0] 0

GET_SNOWFACTOR>
CS710 response: *,xx.xx, [crc1] [crc0] 0

SET_SEARCH_TECHNIQUE_(x)>
Where xx.xx = string for floating point number.
x = 0, 1, 2, 3. Corresponds to: Fuzzy, Max, Last, First peak detection
CS710 response: *,xx.xx, [crc1] [crc0] 0

GET_ SEARCH_TECHNIQUE>
CS710 response: *,xx.xx, [crc1] [crc0] 0

SET_FUZZY_MAX_(xx.xx)>
Where xx.xx = string for floating point number. Units = Meters
CS710 response: *,xx.xx, [crc1] [crc0] 0

SET_FUZZY_MIN_(xx.xx)>
Where xx.xx = string for floating point number. Units = Meters
CS710 response: *,xx.xx, [crc1] [crc0] 0

SET_DEPTH_ALPHA_(xx.xx)>
Where xx.xx = string for floating point number.
x = float 0 to 1, (0=no filter, .999=heavy filter)
CS710 response: *,xx.xx, [crc1] [crc0] 0

GET_DEPTH_ALPHA>
CS710 response: *,xx.xx, [crc1] [crc0] 0

SET_ADAPTIVE_BETA_(x)>
Where xx.xx = string for floating point number.
0 to 1, (0= no filter, .990=heavy filter)
CS710 response: *,xx.xx, [crc1] [crc0] 0

GET_ADAPTIVE_BETA>
CS710 response: *,xx.xx, [crc1] [crc0] 0

GET_NUM_PEAKS>
CS710 response: *,xx.xx, [crc1] [crc0] 0

START_RAW_SIGNAL>
This must be performed prior to the GET_SNOWDEPTH command.
CS710 response: *,1, [crc1] [crc0] 0

GET_SNOWDEPTH>
CS710 response: *,xx.xx, [crc1] [crc0] 0

GET_OS_VERSION>
CS710 response: *,version_string,[crc1][crc0]0

SAVE_SETTINGS_(x)>
Where x = 0,1. 1 = true save settings to flash

MASTER_RESET>
CS710 response: *,1,[crc1][crc0]0

7.3.4 Example Pseudo-Code

(For sending the SET_START_DISTANCE command)

```
SerialOpen(COM1,115200)

start_distance = 0

xmit_str = CHR(&H08)                'back space to wake up rs232
SerialOut ( COM1, xmit_str)
SerialOut ( COM1, xmit_str)
SerialOut ( COM1, xmit_str)
SerialOut ( COM1, xmit_str)

xmit_str = "SET_START_DISTANCE_("
SerialOut ( COM1, xmit_str)

SerialOut (COM1, start_dst)

xmit_str = ")>"
SerialOut ( COM1, xmit_str)

SerialIn (rcv_str, COM1, “*”)       //receive up to * character
SerialIn (rsp_str, COM1, 0x00)      //receive up to termination character

check_sum = CheckSum (rsp_string)   //validate checksum
if(check_sum == 0)
{
ParseResponse(value, rsp_str)       //parse through incoming string to find the value
                                    //returned by CS710
VerifyResponse(value, start_dst)    //verify response is within 0.1 of the start_dst sent
}
```

7.4 *SDSBuddy* and Firmware Updates

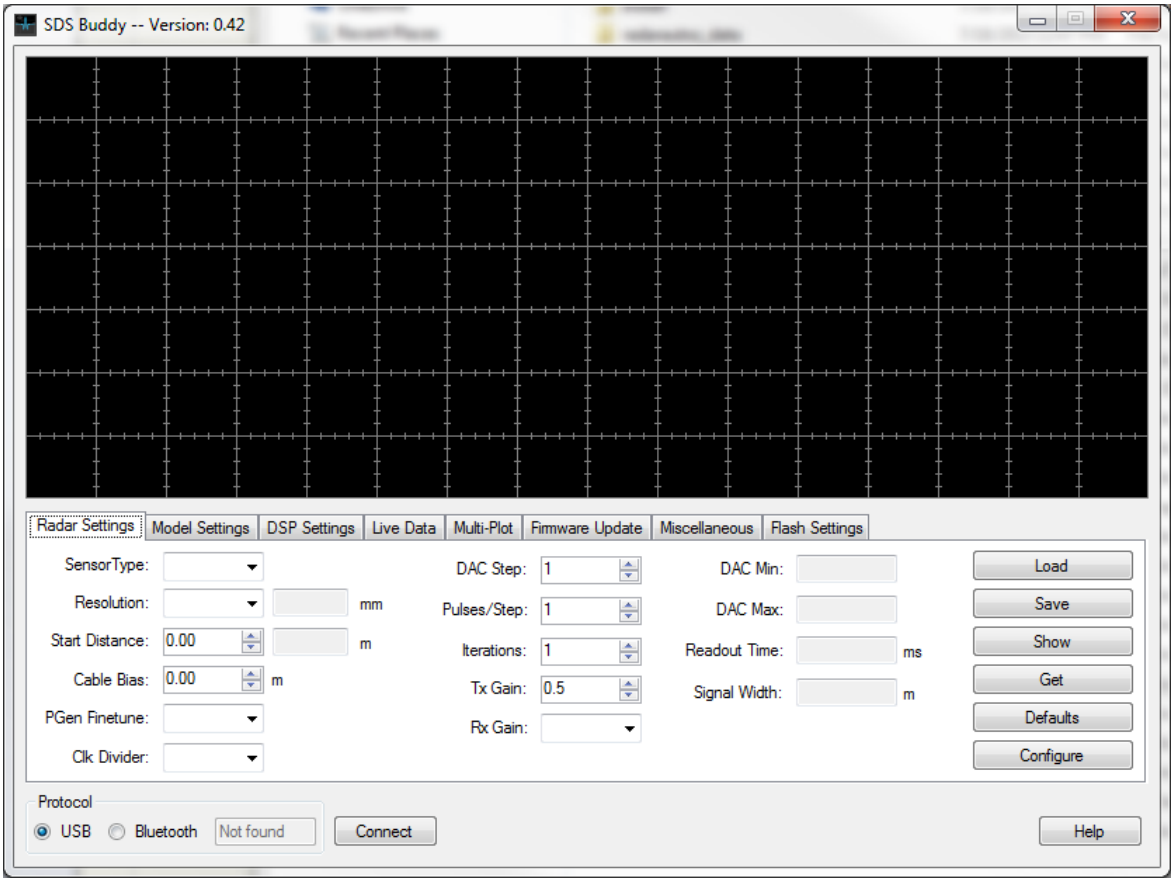
7.4.1 Setting Default Settings

SDSBuddy is a software program that can be used to set default settings as follows.

1. Install the CS710 USB driver CS710DeviceDriver_X.X.exe.

2. Install sdldotnet-6.1.0-runtime-setup.exe.

3. Open SDSBuddyXX.exe.



4. Connect the CS710 using a mini type B USB connector and wait for the driver to initialize.

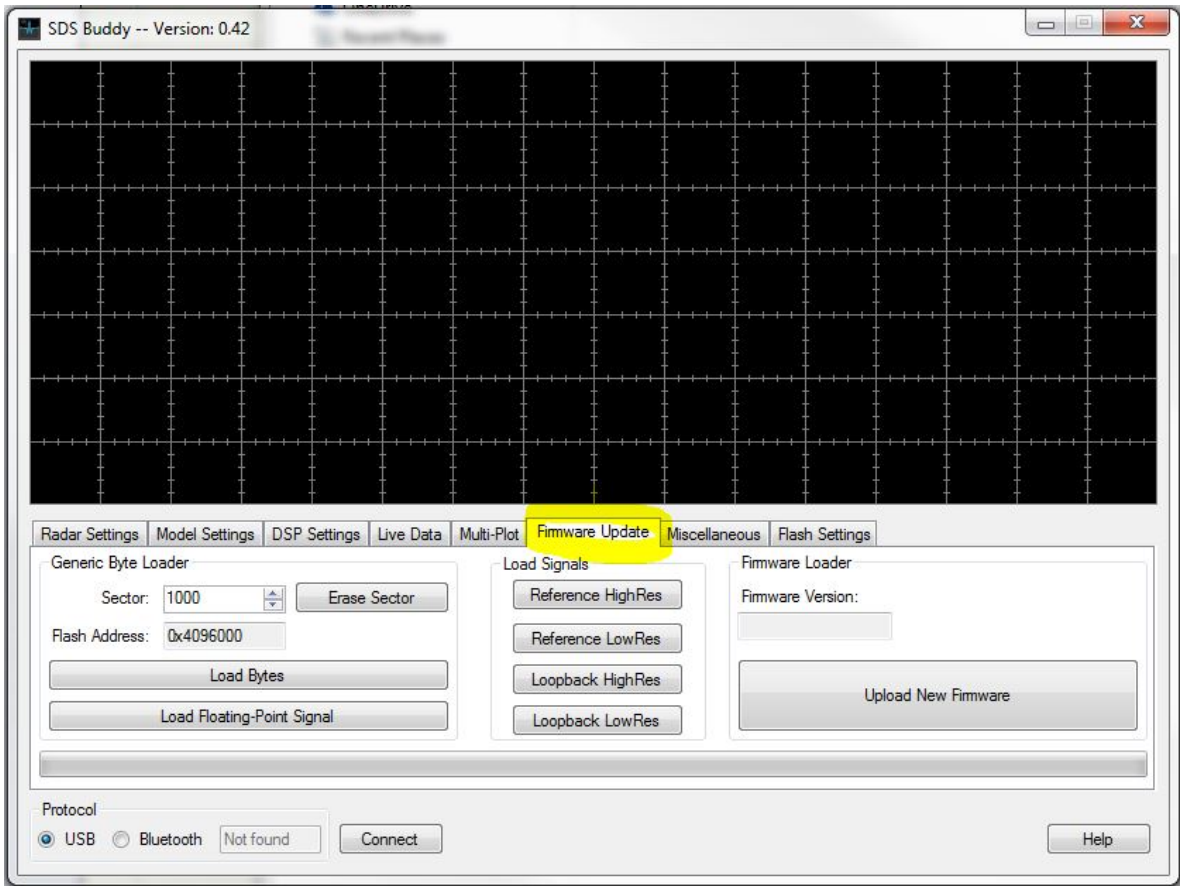
5. Click **Connect** in *SDSBuddy*. The **Connect** button should now say **Disconnect**.

6. Make a note of the following settings: Radar Settings tab: Start Distance, Cable Bias; Model Settings tab: Sensor Height, Snow Factor, Depth Filter; DSP Settings Tab: Adaptive Beta, Analyze Technique, Fuzzy Min Threshold, Fuzzy Max Threshold.

7. Settings can be reset to their default on each of the first three tabs by clicking **Defaults** and then **Configure**. A confirmation pop-up window confirming settings successfully saved will come up.

7.4.2 Firmware Update

1. With *SDSBuddy* open, using steps 1-5 in the Setting Default Settings section, click on the Firmware Update tab.



2. Click the **Upload New Firmware** button and browse to the desired OS file and click **Open**.

3. It can take a few minutes for the new firmware to upload. When complete, there will be a pop-up message saying it was successful.

4. Click **Disconnect** and cycle power on the CS710.

5. Plug the USB cable back in and click **Connect**.

6. Verify Firmware Version by clicking on the Firmware Update tab. It's listed in the Firmware Version box just above the **Upload New Firmware** button.

Appendix A. GPR Emissions and Regulations

Several governments have their own unique regulations. Consult your specific government regulations before use of the CS710. The objective is to ensure safe use and minimize interference with other devices. When properly used, the CS710 has little to no radiated emissions. Due to the unique use case of sending its radiated signal directly into snow, the CS710's radiated signal is typically attenuated in the snow to the point it's unlikely to be harmful to other devices, unless another device were mounted in close proximity to the CS710. If another device is mounted in close proximity to the CS710 and is not functioning properly, discontinue use of the CS710.

The CS710 is considered to be an Ultra Wide Band or UWB device. It has been extensively tested to quantify all radiated emissions.

A.1 FCC Regulations and Compliance

The FCC ID number for the CS710 is B9Q-CS710. This device complies with Part 15 of the USA Federal Communications Commission (FCC) Rules. Operation in the USA is subject to the following two conditions:

1. This device may not cause harmful interference.

2. This device must accept any interference received, including interference that may cause undesired operation.

This equipment complies with the limits for a Class A digital device, under part 15 of FCC rules. These limits provide protection against harmful emission. The device must be installed and used as specified in the user manual. If not used as specified, the device could cause harmful interference. If damage is done, this shall be the sole responsibility of the user, and repaid at their expense.

No change or modification should be made to the CS710. A customer-supplied cable should not be used with the CS710. Changes or modifications not expressly approved by Campbell Scientific, Inc. for compliance will void the user's authority to operate the CS710.

Operation of this device is limited to purposes associated with law enforcement, firefighting, emergency rescue, scientific research, commercial mining, or construction. Parties operating this equipment must be eligible for licensing under the provisions of Part 90 of this chapter.

The use of the CS710 is limited to applications listed in the installation section of this manual. The CS710 is to be used solely for the construction, using snow, of ski runs or similar type construction being performed in remote areas away from the general public. It is implied that this use satisfies the regulations of part 15.509 of the FCC rules with the justification that it is similar to road construction for which asphalt is used, instead of snow, to pave a road, and a GPR device could be used to measure the thickness of the asphalt.

A.1.1 Permit Process for Use

FCC regulation 15.525(c) (updated in February 2007) requires users of GPR equipment to coordinate the use of their GPR equipment as described below:

> TITLE 47--TELECOMMUNICATION
> CHAPTER I--FEDERAL COMMUNICATIONS COMMISSION
> PART 15_RADIO FREQUENCY DEVICES
> Subpart F_Ultra-Wideband Operation Sec.
> 15.525 Coordination requirements.

a) UWB imaging systems require coordination through the FCC before the equipment may be used. The operator shall comply with any constraints on equipment usage resulting from this coordination.

b) The users of UWB imaging devices shall supply operational areas to the FCC Office of Engineering and Technology, which shall coordinate this information with the Federal Government through the National Telecommunications and Information Administration. The information provided by the UWB operator shall include the name, address and other pertinent contact information of the user, the desired geographical area(s) of operation, and the FCC ID number and other nomenclature of the UWB device. If the imaging device is intended to be used for mobile applications, the geographical area(s) of operation may be the state(s) or county(ies) in which the equipment will be operated. The operator of an imaging system used for fixed operation shall supply a specific geographical location or the address at which the equipment will be operated. This material shall be submitted to:

> Frequency Coordination Branch, OET
> Federal Communications Commission
> 445 12th Street, SW, Washington, D.C.
> 20554
> Attn: UWB Coordination

c) The manufacturers, or their authorized sales agents, must inform purchasers and users of their systems of the requirement to undertake detailed coordination of operational areas with the FCC prior to the equipment being operated.

d) Users of authorized, coordinated UWB systems may transfer them to other qualified users and to different locations upon coordination of change of ownership or location to the FCC and coordination with existing authorized operations.

e) The FCC/NTIA coordination report shall identify those geographical areas within which the operation of an imaging system requires additional coordination or within which the operation of an imaging system is prohibited. If additional coordination is required for operation within specific geographical areas, a local coordination contact will be provided. Except for operation within these designated areas, once the information requested on the UWB imaging system is submitted to the FCC no additional coordination with the FCC is required provided the reported areas of operation do not change. If the area of operation changes, updated information shall be submitted to the FCC following the procedure in paragraph (b) of this section.

f) (f) The coordination of routine UWB operations shall not take longer than 15 business days from the receipt of the coordination request by NTIA. Special temporary operations may be handled with an expedited turn-around time when circumstances warrant. The operation of UWB systems in emergency situations involving the safety of life or property may occur without coordination provided a notification procedure, similar to that contained in Sec. 2.405(a) through (e) of this chapter, is followed by the UWB equipment user.[67 FR 34856, May 16, 2002, as amended at 68 FR 19751, Apr. 22, 2003]

Effective Date Note: At 68 FR 19751, Apr. 22, 2003, Sec. 15.525 was amended by revising paragraphs (b) and (e). This amendment contains information collection and recordkeeping requirements and will not become effective until approval has been given by the Office of Management and Budget.

A.2 ETSI Regulations

The CS710 conforms to GPR regulations for the European Community ETSI (European Technical Standards Institute) standard EN 302 066-1 v1.2.1.

A.3 Industry Canada

The CS710 conforms to Industry Canada standard RSS-220 Devices Using Ultra-Wideband (UWB) Technology.

In order to comply the sensor must be mounted within 1 m of the snow surface.

Regarding RSS-220 6.2.1 (b) see Operation section in this manual.

Also, the CS710 shall be operated only by law enforcement agencies, scientific research institutes, commercial mining companies, construction companies, and emergency rescue or firefighting organizations.

This device complies with Industry Canada's license-exempt RSSs. Operation is subject to the following two conditions:

(1) This device may not cause interference; and

(2) This device must accept any interference, including interference that may cause undesired operation of the device.

Cet appareil est conforme aux CNR exempts de licence d'Industrie Canada. Son fonctionnement est soumis aux deux conditions suivantes:

(1) Ce dispositif ne peut causer des interférences; et

(2) Ce dispositif doit accepter toute interférence, y compris les interférences qui peuvent entraîner un mauvais fonctionnement de l'appareil.

Campbell Scientific Companies

Campbell Scientific, Inc.
815 West 1800 North
Logan, Utah 84321
UNITED STATES
www.campbellsci.com • info@campbellsci.com

Campbell Scientific Canada Corp.
14532 – 131 Avenue NW
Edmonton AB T5L 4X4
CANADA
www.campbellsci.ca • dataloggers@campbellsci.ca

Campbell Scientific Africa Pty. Ltd.
PO Box 2450
Somerset West 7129
SOUTH AFRICA
www.campbellsci.co.za • cleroux@csafrica.co.za

Campbell Scientific Centro Caribe S.A.
300 N Cementerio, Edificio Breller
Santo Domingo, Heredia 40305
COSTA RICA
www.campbellsci.cc • info@campbellsci.cc

Campbell Scientific Southeast Asia Co., Ltd.
877/22 Nirvana@Work, Rama 9 Road
Suan Luang Subdistrict, Suan Luang District
Bangkok 10250
THAILAND
www.campbellsci.asia • info@campbellsci.asia

Campbell Scientific Ltd.
Campbell Park
80 Hathern Road
Shepshed, Loughborough LE12 9GX
UNITED KINGDOM
www.campbellsci.co.uk • sales@campbellsci.co.uk

Campbell Scientific Australia Pty. Ltd.
PO Box 8108
Garbutt Post Shop QLD 4814
AUSTRALIA
www.campbellsci.com.au • info@campbellsci.com.au

Campbell Scientific Ltd.
3 Avenue de la Division Leclerc
92160 ANTONY
FRANCE
www.campbellsci.fr • info@campbellsci.fr

Campbell Scientific (Beijing) Co., Ltd.
8B16, Floor 8 Tower B, Hanwei Plaza
7 Guanghua Road
Chaoyang, Beijing 100004
P.R. CHINA
www.campbellsci.com • info@campbellsci.com.cn

Campbell Scientific Ltda.
Fahrenheitstraße 13
28359 Bremen
GERMANY
www.campbellsci.de • info@campbellsci.de

Campbell Scientific do Brasil Ltda.
Rua Apinagés, nbr. 2018 ─ Perdizes
CEP: 01258-00 ─ São Paulo ─ SP
BRASIL
www.campbellsci.com.br • vendas@campbellsci.com.br

Campbell Scientific Spain, S. L.
Avda. Pompeu Fabra 7-9, local 1
08024 Barcelona
SPAIN
www.campbellsci.es • info@campbellsci.es

Please visit www.campbellsci.com to obtain contact information for your local US or international representative.