INSTRUCTION MANUAL

CS440 Liquid Level Sensor

Revision: 9/06

Warranty and Assistance

The **CS440 LIQUID LEVEL SENSOR** is warranted by CAMPBELL SCIENTIFIC, INC. to be free from defects in materials and workmanship under normal use and service for twelve (12) months from date of shipment unless specified otherwise. Batteries have no warranty. CAMPBELL SCIENTIFIC, INC.'s obligation under this warranty is limited to repairing or replacing (at CAMPBELL SCIENTIFIC, INC.'s option) defective products. The customer shall assume all costs of removing, reinstalling, and shipping defective products to CAMPBELL SCIENTIFIC, INC. CAMPBELL SCIENTIFIC, INC. will return such products by surface carrier prepaid. This warranty shall not apply to any CAMPBELL SCIENTIFIC, INC. products which have been subjected to modification, misuse, neglect, accidents of nature, or shipping damage. This warranty is in lieu of all other warranties, expressed or implied, including warranties of merchantability or fitness for a particular purpose. CAMPBELL SCIENTIFIC, INC. is not liable for special, indirect, incidental, or consequential damages.

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) 753-2342. After an applications 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

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CS440 Liquid Level Sensor

1. Introduction

This manual describes using the CS440, ACData Solutions' SPXD-500 submersible pressure transducer with Campbell Scientific dataloggers. Information provided in the manual includes datalogger-to-sensor connection, datalogger programming, and maintenance requirements.

The CS440 Submersible Pressure Transducer is designed to provide reliable, accurate water pressure/level measurements. The CS440 is specified for operation over the 0° – 50°C (32° – 122°F) temperature range. Standard pressure ranges include 0 – 5, 15, 30, 50 and 100 PSIG (vented) as well as 30, 50 and 100 PSIA (non-vented).

The design uses an isolated silicon strain gauge sensor housed in a 316 Stainless Steel package to enhance reliability. The rugged construction makes the CS440 suitable for water level measurement in irrigation applications, water wells, lakes, streams and tanks. The cable incorporates a vent tube to compensate for atmospheric pressure fluctuations and the jacket is made of rugged polyurethane, designed to remain flexible and tough, even under harsh environmental conditions.

2. Specifications

Electrical Specifications:

Excitation:	8 – 24 VDC
Operating Current:	4-20 mA
Operating Temperature Range:	0° – 60°C, nonfreezing

Pressure Measurement Specifications:

Static Accuracy:	0.1% span (B.F.S.L.)[1]
Thermal Shift Zero:	±1.0% span[2] (5 PSIG Range)
	± 0.40% span[2] (All Other Standard Ranges)
Thermal Shift Span:	±0.75% span[2] (5 PSIG Range)
	±0.40% span[2] (All Other Standard Ranges)

Mechanical Construction:

Diameter:	1.0"
Length:	13" (includes Flex Seal/Strain Relief)
Sensor Element and Body:	316 Stainless
Top Cap and End Cone Assembly:	Delrin
Other wetted materials:	Viton, Nylon, Buna-N

Cable:

Description:	Shielded, 9 Conductor #24 AWG, Polyethylene Insulators Integral Vent Tube
Diameter:	0.290" Nominal
Jacket:	Polyurethane
Cable Resistance:	0.026 Ohm/Ft Typ., TCR: 0.3%/°C

Notes:

1. Includes Linearity, Repeatability and Pressure Hysteresis at 25 °C.
2. 0 – 50 °C, Referenced to 25°C.

Specifications subject to change without notice.

3. Installation

3.1 Initial Inspection and Handling Guidelines

Upon receipt of the CS440, inspect the packaging for any signs of shipping damage and, if found, report the damage to the carrier in accordance with policy. The contents of the package should also be inspected and a claim filed if any shipping related damage is discovered.

Care should be taken when opening the package not to damage or cut the cable jacket. If there is any question about damage having been caused to the cable jacket, a thorough inspection is prudent.

The model number and pressure range is etched on the housing. Check this information against the shipping documentation to ensure that the expected model number and range were received.

Gauge pressure (vented) devices must always have a desiccant tube attached. New desiccant is blue in color. As the desiccant material absorbs water vapor, it begins to turn pink, and eventually white when fully expired. Desiccant tubes should be inspected regularly (i.e., every two months) and historical information will help to baseline desiccant replacement requirements for a given application/climate.

Absolute pressure (non-vented) units do not require a desiccant chamber. If the cable incorporates a vent tube, the vent tube is heat sealed at both ends prior to shipment and must remain sealed.

Remember that although the CS440 is designed to be a rugged and reliable device for field use, it is also a highly precise scientific instrument and should be handled as such. There are no user serviceable parts and any attempt to disassemble the device will void the warranty.

3.2 Installation Guidelines

The CS440 is designed for water level measurement. Typical applications include agricultural water level/flow, water wells, lakes, streams and tanks. If the device is to be installed in a liquid other then water or in contaminated water, check the compatibility of the wetted materials.

The transducer may be installed in any position but it is calibrated and tested in the vertical orientation, as it would normally be suspended.

Never suspend the transducer from the connections at the top end of the cable. When suspending the device, in a well for example, a proper strain relief should be attached around the cable jacket and properly secured at the well head.

Although the cable jacket is made from a thick, tough polyurethane formation, care should be taken to avoid cable damage. Further, sharp bends or excessive pinching of the cable can cause damage and may pinch off the vent tube causing measurement errors in the case of gauge pressure (vented) devices.

Do not drop the instrument or allow it to “free fall” down a well as this may damage the device.

Never attempt to disassemble the transducer as this will void the warranty.

4. Wiring

The measurement of a 4-20 mA signal requires a precision shunt resistor of either 100 or 125 Ohms. Typical ratings on the resistor are 0.1 percent tolerance, 10 ppm per deg C, and 1/4 watt. The measurement can be single ended or differential. If you are using a CURS100, please refer to the CURS100 manual. If you are using a resister, one side goes to the SE or H input channel with the blue wire. The other end of the resistor goes to the L side for a differential measurement or G for ground on a single ended measurement. The low side of the differential channel is connected to ground via a jumper wire.

Single Ended

Color	**Function**	**CR200 Series**	**CR10(X), CR510, CR1000, CR3000, CR5000**
White	+ Power. 8 to 24 VDC	Battery +	12V
Blue	Signal	SE input	SE input
Resister	Voltage shunt	SE Input	SE Input
Resister		G	G
Clear	Shield. Not connected to transducer body	G	G

Differential

Color	**Function**	**CR10(X), CR510, CR1000, CR3000, CR5000**
White	+ Power. 8 to 24 VDC	12V
Blue	Signal	H Input
Resister	Voltage shunt	H Input
Resister		L Input
Jumper	Tie Low to Ground	L Input
Jumper		G
Clear	Shield. Not connected to transducer body	G

You must also supply power for the 4-20 mA transmitter. For example, if the sensor requires a minimum of 9 VDC and you are using the CURS100, you need to make sure that the supply voltage does not drop below 9 V + (20 mA amps * 100 Ohms) = 11 VDC.

IMPORTANT: Current measurements such as 4-20 mA signals vary widely in how they can be powered and connected to a datalogger. Please refer to the CURS100 manual or the Application Note 2MI-B.

5. Programming Example

5.1 Using ShortCut

ShortCut is the easiest and typically the preferred method for programming the datalogger. ShortCut generates a wiring diagram that shows how to connect the pressure transducer to your datalogger. Select "4-20 mA Input" from the Generic Measurements list. Use desired units when keying in the measurements that correspond to the 4-20 mA end points for measurement equivalents. For example, if the calibrated range was 0-5 psi, the two values should be 0 and 5.

NOTE The sections that immediately follow are for CRBasic, Edlog and Keyboard/Display users. ShortCut users can jump ahead to the Maintenance section (page 6).

5.2 Using CRBasic

For our CR1000, CR3000, and CR5000 dataloggers, the VoltDiff instruction is used. Because our CR200-series dataloggers do not support differential measurements, the VoltSE instruction must be used when you have a CR200-series datalogger.

Sample Program for CR200 Series Datalogger

```
'CR200 Series

'Declare the variable for the water level measurement
Public PSI

'Define a data table for 60 minute maximum and minimums
DataTable(Hourly,True,-1)
    DataInterval(0,60,Min)
    Maximum(1,Level,0,0)
    Minimum(1,Level,0,0)
EndTable
'Read sensor(s) every 60 seconds
BeginProg
    Scan(60,Sec)
        'Code for 4-20 mA measurements:
        VoltSE(PSI,1,1,0.03125,-12.5)
        'Call the data table:
        CallTable(Hourly)
    NextScan
EndProg
```

Multiplier and Offset

The Multiplier and Offset can be changed to scale the result or perform unit conversions. The VoltSE instruction measures mVolts.

V=IR

At 4 mA, V = 4 mA * 100 ohms = 400 mV

At 20 mA, V = 20 mA * 100 = 2000 mV

Pressure = M * mV output + b

Where; M = multiplier, and b = offset

M= Pressure range / (mV2 – mV1)

If the sensor outputs 0 psi at 4 mA (or 400 mV), and 5 psi at 20 mA (or 2000 mV) then the multipliers is calculated as follows for a 50 psi sensor:

M = 50 psi / (2000 mV – 400 mV) = 0.03125 psi/mV

To convert to depth in feet., (Depth = 2.31 * psi).

M = 0.03125 psi/mV * 2.31 ft/psi = 0.7218 ft mV

The offset is typically applied in the field to adjust the reading to whatever datum is used.

5.3 Using Edlog

Typically, Instruction 2 (Volt Diff) is used to read the CS440. Instruction 1 (Volt SE) can also be used to read the CS440. Your datalogger manual provides detailed explanations of Instruction 1 and Instruction 2.

```
;{CR10X}
;
*Table 1 Program
  01:  60             Execution Interval (seconds)

1:  Volt Diff (P2)
  1:    1             Reps
  2:    25            2500 mV 60 HZ rejection
  3:    1             Channel
  4:    1             Loc [ Level     ]
  5:    .7218         Mult
  6:    0.0           Offset

*Table 2 Program
  02:  0.0000         Execution Interval (seconds)

*Table 3 Subroutines

End Program
```

After this command is executed, the input location within the logger called "Level" holds the measured pressure, reported in PSI. This result may be further processed within the logger or stored to final storage memory.

Multiplier and Offset

The Multiplier and Offset can be changed to scale the result or perform unit conversions. The P2 instruction measures mVolts.

V=IR

At 4 mA, V = 4 mA * 100 ohms = 400 mV

At 20 mA, V = 20 mA * 100 = 2000 mV

Pressure = M * mV output + b

Where; M = multiplier, and b = offset

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If the sensor outputs 0 psi at 4 mA (or 400 mV), and 5 psi at 20 mA (or 2000 mV) then the multipliers is calculated as follows for a 50 psi sensor:

M = 50 psi / (2000 mV – 400 mV) = 0.03125 psi/mV

To convert to depth in feet., (Depth = 2.31 * psi).

M = 0.03125 psi/mV * 2.31 ft/psi = 0.7218 ft mV

The offset is typically applied in the field to adjust the reading to whatever datum is used.

6. Maintenance

Periodic evaluation of the desiccant is vital for keeping the vent tube dry. To assess the effectiveness of the desiccant, use one of the following:

- An indicating desiccant that changes color when it's losing its drying power
- An enclosure humidity indicator such as our #6571 humidity indicator card

6.1 Every Visit, At Least Monthly

- Collect data
- Visually inspect wiring and physical conditions
- Check indicating desiccant or enclosure humidity indicator; service desiccant if necessary

- Check battery condition (physical and *6 mode of the datalogger)
- Check all sensor readings (*6 mode of the datalogger); adjust transducer offsets if necessary
- Check recent data (*7 mode of the datalogger)
- Perform routine maintenance suggested by manufacturers

NOTE See datalogger manual for more information on *6 and *7 modes.

6.2 Every Three Months

- Change batteries (as needed--may be less often)
- Replace enclosure desiccants
- Check calibration of all sensors
- Inspect probe cable conditions for deterioration or damage
- Check wire connections ensuring they are still secure

6.3 Every Two to Three Years or on a Rotating Schedule

Send the transducers to the factory or laboratory for inspection and have them serviced and/or replaced as needed.

7. Troubleshooting Hints

Problem:

Unit is not responding to logger or responding erratically.

Suggestion:

Check the electrical connections (White is +V and Blue is Signal Return) to ensure proper connection to the logger. Some loggers require the use of an external termination resistor. In this case, the signal return is generally connected to an input together with one lead from the resistor (make sure both leads are securely connected in the wiring terminal and that the wire itself, not the insulator is secured within the wiring terminal). The other resistor lead is typically connected to a Ground (G) or analog ground (AG) terminal on the wiring panel. This resistor is typically of a value of 100 or 125 Ohms. Consult CSI with further questions on this matter.

Problem:

Transducer appears to be operating properly but data shows a periodic or cyclic fluctuation not attributable to water level changes.

Suggestion:

A kinked or plugged vent tube will not effectively vent a gauge pressure (vented) type of device. Normal changes in barometric pressure will appear as water level fluctuations and these types of errors are typically on the order of 1 foot of water level. If the desiccant chamber has not been properly maintained, water may have condensed in the vent tube and the device should be returned to the factory for service.

Note that errors in uncompensated depth measurement using absolute (non-vented) devices are expected and may or may not be significant, depending on the application. A barometric pressure transducer can be used to provide compensation data, effectively eliminating error due to barometric fluctuations.

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