INSTRUCTION MANUAL

CS445 Liquid Level Sensor

1/04

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Products may not be returned without prior authorization. To obtain an RMA number contact KWK Technologies, Inc., phone (509) 466-5871, www.kwktechnologies.com. NOTE: if the product has been exposed to hazardous media, it must be fully decontaminated and neutralized prior to return to KWK.

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CS445 Liquid Level Sensor

1. Introduction

This manual describes using the CS445, KWK Technologies' SPXD-600 submersible pressure transducer with Campbell Scientific's CR10(X), CR23X, CR510, CR500 and CR200 series dataloggers. Information provided in the manual includes datalogger-to-sensor connection, datalogger programming, and maintenance requirements.

The CS445 Submersible Pressure Transducer is designed to provide reliable, accurate water pressure/level measurements. This device is intended to combine the excellent performance of the KWK analog pressure transmitter with the convenience of the SDI-12 interface and commands. The result is a device with performance exceeding the requirements of many water level measurement applications and the simplicity of the three-wire SDI-12 connection scheme.

Combining the sensor, analog measurement and signal processing within a single housing results in the integration of state-of-the-art sensor and measurement technology. The 24 Bit A/D converter is auto calibrated prior to each pressure measurement. A number of additional advanced measurement techniques are employed to harness the best possible performance available from today's state-of-the-art pressure sensor technology. The Transducer reverts to a low power sleep state between measurements. The auto calibration and measurement cycle takes approximately 1 second. The CS445 responds to the initiate measurement command, issued by a datalogger, indicating that 1 value will be ready in a maximum of 2 seconds.

The CS445 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 utilizes an isolated silicon strain gauge sensor housed in a 316 Stainless Steel package to enhance reliability. The rugged construction makes the CS445 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:	0.36 mA quiescent, ~7 mA peak during wake/measurement cycle
Operating Temperature Range:	0 – 60 °C, Nonfreezing

Communications:

Protocol:	SDI-12 Subset. Supported Commands: aM!, aD!, aAb! (Firmware Version 1.0)
Output Units:	PSI

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:

Diameter:	0.290” Nominal
Shielded, 9 Conductor #24 AWG, Polyethylene Insulators	
Jacket:	Polyurethane
Integral Vent Tube	
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 CS445, 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 CS445 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 CS445 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

Color	Function	CR200 Series	CR23X, CR10(X), CR510, CR500
Red	+ Power. 8 to 24 VDC	Battery +	12V
Black	Ground	G	G
Brown	SDI-12 Data Line	C1/SDI-12	Control Port 1-8
Clear	Shield. Not connected to transducer body	G	G

5. Programming Example

The CS445 uses an SDI-12 compatible hardware interface and supports a subset of the SDI-12 commands. The most commonly used command is the aM! command, issued by the datalogger. Here, ‘a’ represents the sensor address (0 – 9). The communication sequence begins with the datalogger

waking the sensor and issuing the aM! command. The transducer responds to the logger indicating that one measurement will be ready within two (2) seconds. Subsequent communications handle data reporting from the sensor to the datalogger.

Sensor Address

The CS445 is shipped from the factory with a preset SDI-12 address of 0. This can be changed using the SDI-12 command 'aAb!' and the suggested method is to use the SDI-12 Transparent Mode in a logger. See Appendix A for details on Transparent Mode.

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.

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

In the CR200 Series dataloggers, Instruction SDI12Recorder is used to read SDI-12 Sensors. A multiplier of 1.0 and an offset of 0.0 yields water level in units of pounds per square inch (psi). For units of feet use a multiplier of 2.31 and an offset of 0.0.

The SDI12Recorder instruction has the following form:

SDI12Recorder(Destination, Output String, Multiplier, Offset)

Wiring for example program

Red	Battery +
Black	G
Brown	C1/SDI-12
Clear	G

Sample Program for CR200 Series Datalogger

```
'CR200 Series

'Declare the variable for the water level measurement
Public Level

'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 SDI-12 measurements:
            SDI12Recorder(Level,0M!,1,0)
‘           Call the data table:
            CallTable(Hourly)
      NextScan
EndProg
```

5.3 Using Edlog

The following is an example of the P105 SDI-12 Sensor instruction used by array-based dataloggers to interrogate an SDI-12 sensor.

Use Instruction 105 to read the CS445. Your datalogger manual has a detailed explanation of Instruction 105.

Wiring for example program

Red	12V
Black	G
Brown	C1
Clear	G

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

1:  SDI-12 Recorder (P105)
  1:   0          SDI-12 Address
  2:   0          Start Measurement (aM0!)
  3:   1          Port    ;this is where the brown wire is connected
  4:   1          Loc [ Level     ]
  5:   1.0        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 “Pressure” holds the measured pressure, reported in PSI. This result may be further processed within the logger or stored to final storage memory. Note that Port 1 specifies that the SDI-12 data line is to be connected to Port C1. Other ports may be selected. The Multiplier and Offset can be changed to scale the result or perform unit conversions (e.g., Depth = 2.31 * Pressure).

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 will not respond when attempting serial communications.

Suggestion:

Check the power (Red is +V and Black is Ground) and signal (Brown is SDI-12 Data) lines to ensure proper connection to the logger. Check the logger program to ensure that the same port the SDI-12 data line is connected to is specified in the measurement instruction.

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.

Appendix A. SDI-12 Transparent Mode

See Section 9 of the datalogger manual for more details. The datalogger must be powered up, programmed with a P105 instruction, and have the CS445 connected to it.

1. Enter terminal emulator mode in LoggerNet or PC208W software.

2. On the computer keyboard strike the Enter key a few times until the "*" datalogger telecommunications prompt appears.

3. The datalogger telecommunications command to enter SDI-12 transparent mode is "nX<Enter>" where n is the control port being used for SDI-12. In this example the selected control port is C1, so the command would be "1X<Enter>". In response, the datalogger opens the link to control port 1 and responds with a prompt. CR10X and CR500 dataloggers reply with "entering SDI-12". CR10s reply with a "<" sign.

4. Now check for response from the sensor with address zero by typing the SDI-12 Identify command "0I!<Enter>" (that's a zero, not the letter O). The sensor should respond with an identification string similar to "010KWKTechnologiesSPXD-600SDI1.3-1.00." Note that the SDI-12 standard allows for multiple probes to be connected to one datalogger control port. If you have another SDI-12 probe on C1 that has address 7, you could issue the identify command "7I!<Enter>".

5. At this point you may change the CS445's address following this example: To change the address from 0 to 1 type in "0A1!<Enter>" .

To exit SDI-12 transparent mode, type any invalid SDI-12 command string. The simplest would be a blank line such as "<Enter>".

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