CS420-L AND CS425-L DRUCK'S MODELS PDCR 1830 AND 1230 PRESSURE TRANSDUCERS INSTRUCTION MANUAL

REVISION: 6/03

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Products may not be returned without prior authorization. To obtain an RMA number contact Druck, Inc., phone (203) 746-0400. NOTE: if the product has been exposed to hazardous media, it must be fully decontaminated and neutralized prior to return to Druck.

CS420-L/CS425-L (Druck PDCR Series) Table of Contents

CS420-L and CS425-L Pressure Transducers

This manual describes using the CS420-L and CS425-L pressure transducers with Campbell Scientific's CR10(X), CR23X, CR510, CR500, and 21X dataloggers. Information provided in the manual includes datalogger-to-sensor connection, datalogger programming, use of multiplexers in the system, and maintenance requirements.

1. General Information

The CS420-L is Druck's model PDCR 1830-8388; the CS425-L is model PDCR 1230-8388. Druck PDCR 1230 and 1830 pressure transducers are used for surface and ground water level measurement. The CS425-L sensor can be ordered in pressure ranges between 5 and 900 psi and has an accuracy of ±0.25% of the Full Scale Range (FSR); the CS420-L can be ordered in pressure ranges between 1 and 900 psi and has an accuracy of ±0.1% FSR. Further information on sensor construction can be obtained from Druck's 1230 or 1830 Pressure Transducer brochures.

2. Specifications

Overpressure
- 8x for 1 and 2.5 psig range
- 6x for 5 psig range
- 4x for 10 psig and above ranges

Excitation Voltage
- 10 Volts at 5mA maximum

Output Voltage
- 25mV for 1 psig range
- 50mV for 2.5 and 5 psig ranges
- 100mV for ranges 10 psi and above
- Output is ratiometric to supply

Combined non-linearity, hysteresis and repeatability
- +/- 0.1% of Full Scale, Best Fit Straight Line for CS420-L
- +/- 0.25% of Full Scale, Best Fit Straight Line for CS425-L

Operating Temperature Range
- -20 deg C to +60 deg C

Compensated Temperature Range
- -2 deg C to +30 deg C

Long Term Stability
- Typically +/- 0.1mV/annum

3. Installation

3.1 Vent Tubes

A vent tube incorporated in the cable vents the sensor diaphragm to the atmosphere. This eliminates the need to compensate the water level measurement for changes in barometric pressure.

To prevent water vapor from entering the inner cavity of the sensor, the transducers are typically shipped with the vent tubes sealed. Before operation, visually confirm the vent tube is open. The vent tube opening must terminate inside a desiccated enclosure or a Campbell Scientific DES2 desiccant case.

NOTE The desiccant must be changed regularly.

3.2 Dislodging Bubbles

While submersing the sensor, air bubbles may become trapped between the pressure plate and the water surface, causing small offset errors until the bubbles dissolve. Dislodge these bubbles by gently shaking the pressure transducer while it is under water.

CAUTION Do not hit the sensor against the well casing or other solid surface while dislodging the bubbles, because the diaphragm could be damaged.

3.3 Transient Protection

Campbell Scientific recommends transient surge protection for sensors installed in lightning prone areas. No lightning protection is capable of withstanding a direct hit, but surge protectors afford a degree of protection for near misses. Surge protection can be provided by Campbell Scientific's SVP48 Surge Voltage Protector. When an electrical surge occurs, the surge protectors involved may need to be replaced.

3.4 Temperature Fluctuations

Temperature fluctuations can be minimized by using a minimum cable burial depth of six inches and a sensor submersion depth of one foot. Also, if your site may experience extreme temperature fluctuations, the transducer must be measured using the six-wire configuration.

4. Datalogger - Sensor Connections

The transducers are configured for a six-wire measurement. If using short cable lengths (< 100 feet) and extreme temperature fluctuations are not likely, a four-wire measurement can also be made reliably. The six-wire measurement is more accurate and the only advantage of the four-wire measurement is it requires fewer analog channels. The four-wire configuration does not use the orange and black wires and the ends of each of these wires should be taped to prevent shorting.

4.1 Six-Wire Configuration

Datalogger	CS420-L/CS425-L
Excitation	Red (Supply Positive)
AG (Analog Ground)	White (Supply Negative)
HI (Analog)	Orange (Excitation Monitor +)
LO (Analog)	Black (Excitation Monitor -)
HI (Analog)	Yellow (Signal Output +)
LO (Analog)	Blue (Signal Output -)
G (Ground)	Clear (Shield)

4.2 Four-Wire Configuration

Datalogger	CS420-L/CS425-L
Excitation	Red (Supply Positive)
AG (Analog Ground)	White (Supply Negative)
HI (Analog)	Yellow (Signal Output +)
LO (Analog)	Blue (Signal Output -)
G (Ground)	Clear (Shield)

NOTE The datalogger must be properly grounded. This reduces electromagnetic noise and chances of damage from lightning.

5. Programming

Use Short Cut, Edlog, or the datalogger Keyboard/Display to program the datalogger to read these sensors. All programming methods require the sensitivity value which is listed in the calibration certificate. A calibration certificate should accompany every sensor received from Druck. It is specific to the individual sensor; verify that the certificate and the sensor have the same serial number, and retain the certificate for your records.

5.1 Using Short Cut

Short Cut is the easiest and typically the preferred method for programming the datalogger. Short Cut will ask for the sensitivity which is listed on the calibration certificate. From this value, Short Cut will calculate the multiplier.

Short Cut for Windows has two additional modules for calculating the offset. Choose either the “Manual Offset” or “Automatic Offset” module to adjust the transducer reading to the current water level reading. Short Cut for DOS asks for a current water level reading to automatically calculate the offset. Review Short Cut’s (Windows or DOS) Help for more detail on using the offset.

Older versions of Short Cut for DOS required the transducer’s sensitivity be entered in the units of mV. Visit Campbell Scientific’s web site (www.campbellsci.com) or talk to an applications engineer to receive your free copy of the latest Short Cut release.

Short Cut stores the Druck level data in the high resolution format. Short Cut also generates a wiring diagram that shows how to connect the Druck transducer to your datalogger.

NOTE The sections that immediately follow are for Edlog and Keyboard/Display users. Short Cut users can jump ahead to the Maintenance section (page 14).

5.2 Using Edlog or the Keyboard/Display

Use Instruction 6–Full Bridge Measurement to make a four-wire measurement or Instruction 9–Full Bridge with Measured Excitation to make a six-wire measurement. These instructions require a unique multiplier and offset to be calculated for each sensor. Your datalogger manual has a detailed explanation of Instructions 6 and 9. Also see the programming examples that start on page 7 of this document.

5.2.1 Calculating the Multiplier

The value for the sensitivity is listed on each transducer's calibration certificate. It will be shown in units of either mV/V/psig or mV. Based on the units of sensitivity, choose one of the following equations to calculate the multiplier (M):

$$M = \frac{1}{\text{Sensitivity (mV / V / psig)}} \text{ or } M = \frac{\text{Range (psig)}}{\text{Sensitivity (mV) / Supply Voltage (V)}}$$

After calculating M, use the conversion factor listed in Table 1 to convert the value to the desired engineering units.

TABLE 1. Conversion Factors

To change	To	Multiply by
mb	ft of water	0.0334883
psig	ft of water	2.306725
mb	meters of water	0.010207
psig	meters of water	0.70309

The multiplier is entered in parameter 7 of Instruction 6 or parameter 8 of Instruction 9.

Example:

When Druck calibration certificate lists the following values for a sensor:

sensitivity = 0.98 (mV/V)/psig

The multiplier is:

M = 1/(0.98 (mV/V)/psig)
= 1.02 psig/(mV/V)

If the desired engineering units are feet of water, the multiplier becomes:

(1.02 psig/(mV/V))*(2.306725 ft of water/psig)= 2.3529 ft of water/(mV/V)

5.2.2 Calculating the Offset

The offset is entered in parameter 8 of Instruction 6 or parameter 9 of Instruction 9. Use the following steps to calculate the offset:

1. Program your datalogger with Instruction 6 or 9 using the calculated multiplier and an Offset of 0; set the execution interval to one second.

2. Install the Druck transducer and a staff gauge at the same location or install the Druck transducer at a known depth.

3. If applicable, measure the depth using the staff gauge.

4. Access the datalogger's *6 mode to view the depth reading.

5. Subtract the value displayed in the *6 mode from the known depth or the staff gauge's reading.

NOTE Always make sure your multiplier and offset are in the same units (e.g., feet, inches).

Large offsets may cause truncation of Final Storage values resulting in fewer significant digits. If this is a problem, do the offset correction after the data is collected or use Instruction 78 to store the data in the high resolution format.

Example:

A staff gauge and a Druck transducer are installed at the same location. If the staff gauge reads 10.07 feet and the value displayed in the *6 mode is 10.56 feet, the offset for Instruction 6 or 9 is:

Offset = 10.07 ft - 10.56 ft
= -0.49 ft

Enter -0.49 into parameter 8 of Instruction 6 or parameter 9 of Instruction 9.

5.3 Fine Tuning the Excitation and Input Range

The datalogger input range is designated in parameter 2 for Instruction 6 or parameter 3 for Instruction 9. Choose a datalogger input range that is larger than the output from the sensor. The voltage ranges and codes are listed in Table 9-1 in your datalogger manual or in the Edlog help for Instructions 6 and 9.

The excitation that is applied to the sensor is entered in parameter 5 for Instruction 6 or parameter 6 for Instruction 9. Typically 2500 mV excitation is used with CR10(X), CR510, or CR500 dataloggers; 5000 mV is used with CR23X and 21X microloggers. To calculate the sensor output when a specific excitation is applied, use one of the following equations:

$$\text{output mV} = \frac{(\text{pressure range psig}) * (\text{sensitivity (mV/V)})}{(\text{psig}) * (\text{excitation V})}$$

or

$$\text{output mV} = \frac{(\text{sensitivity mV}) * (\text{excitation V})}{(\text{sup ply voltage V})}$$

The value and units for the sensitivity are listed on Druck's calibration certificate.

NOTE If the pressure range of the sensor is exceeded, the output voltage of the transducer could exceed the input range of the datalogger. A -6999 in the data file represents an overrange. In the monitor mode of PC208(W) an overrange is represented by a -99999. If this occurs, decrease the recommended excitation voltage by ten percent. An open connection, such as a loose wire, can mimic an overrange condition.

5.4 Increasing the Resolution

NOTE The following instructions on increasing resolution are not necessary for most applications. We recommend jumping ahead to the program examples and getting your sensor up and running. If you need a better measurement, refer back to this section.

To increase measurement resolution, adjust the excitation provided to the sensor so that the output is close to, but not exceeding the input range of the datalogger. An adjustment factor for the excitation can be calculated using the following equation:

$$\text{adjustment factor} = \frac{\text{input range mV}}{\text{output mV}}$$

Example:

A 21X datalogger is used to measure a Druck transducer. The Druck calibration certificate lists the following values:

pressure range: 10 psig
sensitivity: 1.1 (mV/V)/psig

If a 5000 mV (5 V) excitation is applied to the sensor, the output of the sensor will be:

$$\text{output mV} = (10 \text{ psig})(1.1 \text{ (mV/V)/psig})(5 \text{ V}) = 55 \text{ mV}$$

The 21X has 5 input ranges: 5, 15, 50, 500, and 5000 mV. The sensor output of 55 mV exceeds the 50 mV range, but using the 500 mV range decreases the resolution. By calculating and applying an adjustment factor, you obtain the best measurement for your sensor.

$$\text{adjustment factor} = \frac{\text{input range}}{\text{output}} = \frac{50 \text{ mV}}{55 \text{ mV}} = .909$$

The excitation adjusted to output 50 mV is:

adjusted excitation
= (original excitation)*(calculated adjustment factor)
= (5000 mV)*(.909)
= 4545 mV

Use 4545 mV to excite the sensor instead of 5000 mV within either Instruction 6 or 9.

6. CR10(X), CR510, and CR500 Wiring and Edlog Examples

6.1 Instruction 6 (4-Wire Full Bridge Measurement)

6.1.1 Wiring

Datalogger		CS420-L/CS425-L
Excitation	E1	Red (Supply +)
Input	H1	Yellow (Output +)
Input	L1	Blue (Output -)
An. Ground	AG	White (Supply -)
	G	Clear (Shield)

The orange and black wires are not used and the ends of these wires should be taped to prevent shorting.

6.1.2 Edlog Program

```
; Measure one 4-wire DRUCK Sensor.

*  Table 1 Program
   01:          5        Execution Interval (seconds)

1:  Full Bridge (P6)
   1:           1        Reps
   2:           3        25 mV slow range
   3:           1        DIFF channel
   4:           1        Excite all reps w/Exchan 1
   5:        2500        mV excitation
   6:           1        Loc [DEPTH_FT]
   7:           2.3529   Mult
   8:          -0.49     Offset

; Every 60 minutes output the array ID, time,
; and average water depth in feet

2:  If Time Is (P92)
   1:           0        Minutes (seconds --) into
   2:          60        Interval (same units as above)
   3:          10        Set output flag high (Flag 0)

3:  Real Time (P77)
   1:         110        Day, Hour/Minute (midnight = 0000)

4:  Average (P71)
   1:           1        Reps
   2:           1        Loc [DEPTH_FT]
```

6.2 Instruction 9 (6-Wire Full Bridge w/Excitation)

6.2.1 Wiring

Datalogger		CS420-L/CS425-L
Excitation	E1	Red (Supply +)
Input	H1	Orange (Monitor +)
Input	L1	Black (Monitor -)
Input	H2	Yellow (Output +)
Input	L2	Blue (Output -)
An. Ground	AG	White (Supply -)
	G	Clear (Shield)

6.2.2 Edlog Program

```
; Measure one 6-wire DRUCK Sensor.

*                1          Table 1 Programs
  01:            5          Sec. Execution Interval

1:  Full Bridge w/mV Excit (P9)
  1:             1          Reps
  2:             5          2500 mV Slow Ex Range
  3:             3          25 mV Slow Br Range
  4:             1          DIFF Channel
  5:             1          Excite all reps w/Exchan 1
  6:          2500          mV Excitation
  7:             1          Loc  [DEPTH_FT]
  8:             2.3529     Mult
  9:            -0.49       Offset

; Every 60 minutes output the array ID, time,
; and average water depth in feet

2:  If time is (P92)
  1:          0000          Minutes (seconds --) into a
  2:            60          Interval (same units as above)
  3:            10          Set output flag high (Flag 0)

3:  Real Time (P77)
  1:           110          Day, Hour/Minute (midnight = 0000)

4:  Average (P71)
  1:             1          Reps
  2:             1          Loc [DEPTH_FT]
```

7. CR23X and 21X Wiring and Edlog Examples

7.1 Instruction 6 (4-Wire Full Bridge Measurement)

7.1.1 Wiring

Datalogger		CS420-L/CS425-L
Excitation	E1	Red (Supply +)
Input	H1	Yellow (Output +)
Input	L1	Blue (Output -)
	G	White (Supply -)
	G	Clear (Shield)

The orange and black wires are not used and the ends of these wires should be taped to prevent shorting.

7.1.2 Edlog Program

```
; Measure one 4-wire DRUCK Sensor.

*  Table 1 Program
   01:           5          Execution Interval (seconds)

1:  Full Bridge (P6)
   1:            1          Reps
   2:            22*        50 mV, 60 Hz Rejection, Slow Range
   3:            1          DIFF Channel
   4:            1          Excite all reps w/Exchan 1
   5:         5000          mV Excitation
   6:            1          Loc [DEPTH_FT]
   7:            2.3529     Mult
   8:           -0.49       Offset
*for 21X use Range Code 3

; Every 60 minutes output the array ID, time,
; and average water depth in feet.

2:  If time is (P92)
   1:         0000          Minutes into a
   2:           60          Minute Interval
   3:           10          Set output flag high

3:  Real Time (P77)
   1:          110          Day, Hour/Minute (midnight = 0000)

4:  Average (P71)
   1:            1          Reps
   2:            1          Loc [DEPTH_FT]
```

7.2 Instruction 9 (6-Wire Full Bridge w/Excitation)

7.2.1 Wiring

Datalogger		CS420-L/CS425-L
Excitation	E1	Red (Supply +)
Input	H1	Orange (Monitor +)
Input	L1	Black (Monitor -)
Input	H2	Yellow (Output +)
Input	L2	Blue (Output -)
	G	White (Supply -)
	G	Clear (Shield)

7.2.2 Edlog Program

```
; Measure one 6-wire DRUCK Sensor.

*  Table 1 Program
   01:            5          Execution Interval (seconds)

1:  Full Bridge w/mV Excit (P9)
   1:             1          Reps
   2             25*         5000 mV, 60Hz Rejection, slow Ex Range
   3:            22**        50 mV, 60 Hz Rejection, Slow Br Range
   4:             1          DIFF Channel
   5:             1          Excite all reps w/Exchan 1
   6:          5000          mV Excitation
   7:             1          Loc [DEPTH_FT]
   8:             2.3529     Mult
   9:            -0.49       Offset
*For 21X use Range Code 5
**For 21X use Range Code 3

; Every 60 minutes output the array ID, time,
; and average water depth in feet

2:  If time is (P92)
   1:          0000          Minutes into a
   2:            60          Minute Interval
   3:            10          Set output flag high

3:  Real Time (P77)
   1:           110          Day, Hour/Minute (midnight = 0000)

4:  Average (P71)
   1:             1          Reps
   2              1          Loc [DEPTH_FT]
```

8. Using Multiplexers

Multiplexers increase the number of transducers a single datalogger can measure. Our CR10(X), CR23X, and 21X dataloggers are compatible with multiplexers.

NOTE The CR500 and CR510 datalogger and Short Cut software do not support the use of multiplexers.

8.1 Example

A CR10(X) datalogger measures four Druck pressure transducers that are connected to an AM416 multiplexer. Excitation is supplied to the sensor from the datalogger wiring panel. In this example, excitation voltage and ground connection to the sensor bypass the multiplexer and are applied directly from the datalogger to the sensor.

This configuration allows up to 16 pressure transducers to be measured using a single CR10(X), CR23X, or 21X datalogger. The CR10(X) and CR23X can measure all 16 sensors in one loop. Because the 5000 mV excitation exceeds the 21X's drive current, the 21X requires two loops that measure eight sensors each.

NOTE This example requires a pressure transducer with a minimum impedance of 2K. Most Druck pressure transducers meet this requirement. However, you can verify the transducer's impedance by reading across the red and white wire with an ohm meter.

8.1.1 Wiring For One Druck/AM416 Multiplexer/CR10(X):

AM416	CS420-L/CS425-L	CR10(X)
SENSOR #1:		
H1 (1)	Orange (Monitor +)	
L1 (1)	Black (Monitor -)	
H2 (1)	Yellow (Output +)	
L2 (1)	Blue (Output -)	
Shield	Clear (Shield)	
	Red (Excitation Voltage)	E1
	White (Supply G.)	AG

Sensors #2, #3, and #4 are wired similarly to the AM416 in sequential input terminals. All red and white sensor wires bypass the multiplexer and connect to the datalogger's E1 and G respectively.

8.1.2 Multiplexer Connection:

AM416	CR10X
COM H1	H1
COM L1	L1
COM H2	H2
COM L2	L2
12V	12V
G	G
RES	C1
CLK	C2
Shield	G

8.1.3 Edlog Program

```
*  Table 1 Program
   01:            60          Execution Interval (seconds)

; Set Reset on AM416 Multiplexer:

1:  Do (P86)
   1:             41          Set Port 1 High

2:  Beginning of Loop (P87)
   1:           0000          Delay
   2:              4          Loop Count

3:  Do (P86)
   1:             72          Pulse Port 2

4:  Excitation with Delay (P22)
   1:              1          Ex Channel
   2:              0          Delay w/Ex (units = 0.01 sec)
   3:              1          Delay after Ex (units = 0.01 sec)
   4:              0          mV Excitation

; Measure Druck Pressure Transducer

5:  Full Bridge w/mV Excit (P9)
   1:              1          Rep
   2:              5          2500 mV Slow Ex Range
   3:              3          25 mV Slow Br Range
   4:              1          DIFF Chan
   5:              1          Excite all reps w/Exchan 1
   6:           2500          mV Excitation
   7:              1--        Loc [DEPTH_FT] (--Index Input Loc.1-4)
   8:              1          Mult
   9:              0          Offset

6:  End (P95)

; Deactivate Multiplexer

7:  Do (P86)
   1:             51          Set Port 1 Low

; Adjust sensor readings for multiplier and
; offset:

8:  Scaling Array (A*Loc + B) (P53)
   1:              1          Start Loc [DEPTH_FT]
   2:              2.2975     A1 ;Multiplier #1
   3:               .36781    B1 ;Offset #1
   4:              1.0560     A2 ;Multiplier #2
   5:               .4011     B2 ;Offset #2
   6:              3.0001     A3 ;Multiplier #3
   7:               .2103     B3 ;Offset #3
   8:              1.9821     A4 ;Multiplier #4
   9:              1.0029     B4 ;Offset #4
```

NOTE Each sensor has an independent multiplier and offset that must be applied. To determine multiplier (M) and offset, see the Multiplier and Offset sections.

```
; Record average depth every hour.

9:  If Time is (P92)
   1:          0000        Minutes (seconds --) into a
   2:            60        Minute Interval (same units as above)
   3:            10        Set output flag high (Flag 0)

10:  Real Time (P77)
   1:           110        Day, Hour/Minute

11:  Average (P71)
   1:             4        Reps
   2:             1        Loc [DEPTH_FT]
```

9. 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

9.1 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.

9.2 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

9.3 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.

10. Troubleshooting

The most common causes of erroneous pressure transducer data include:

- poor sensor connections to the datalogger
- damaged cables
- damaged transducers
- moisture in the vent tube

To troubleshoot, do the following:

- Check your connections to the datalogger. Look for loose or broken wires, and moisture at the points of connection.
- Inspect the pressure transducer cable for wear, stress, or other indications of damage.
- Check the vent tube for plugging and condensation.