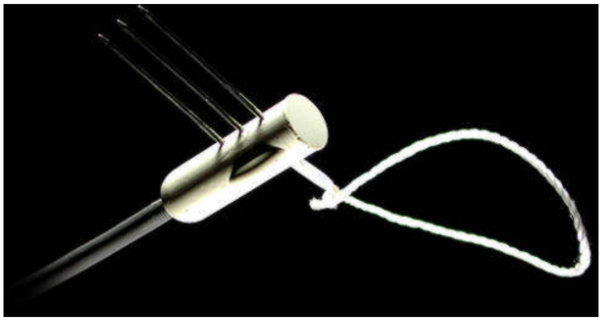
SF3 & SF3C Sap Flow Specification Sheet



Heat Pulse Velocity (Sap Flow) Specifications

- Range: -10 to >200 cm/hr
- Accuracy: 0.2 cm/hr
- Resolution: 0.0001 cm/hr

Sensor Dimensions

- Needle Length: 35 mm
- Needle Diameter: 1.27 mm
- Distance Between Needles: 6 mm
- Temperature Sensor Locations from Needle Tip: 5, 17.5 and 30 mm
- Epoxy Body Height: 40 mm
- Epoxy Body Diameter: 16 mm
- Cable Length: 5m (standard); 20m (maximum)

Temperature Sensor & Heater Specifications

- Type: 10K precision resistor and 10K thermistor
- Temperature Range: -40 to 80°C
- Accuracy: ± 0.2°C
- Resolution: 0.001°C
- Current draw: 1.5 milliamps
- Three wire half bridge
- Data Logger Equation: $T = -0.0837 x^3 + 1.532 x^2 - 22.843 x + 25.019$
- See below for further information on thermistor scripts for data loggers
- Heater Resistance: 44 ohms

Operating Environment

- IP-68 environmental protection
- Temperature: -40° to 80°C

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Reading the Thermistor Sensors with CSI Dataloggers

The thermistor temperature sensor consists of a 10K precision resistor and a 10K thermistor in a waterproof over mold. The resistor and thermistor form a three wire half bridge. See corresponding document for wiring diagram.

The output of the half bridge is

$$\frac{v_{out}}{v_{in}} = \frac{R_o}{R_T + R_o} \qquad (1)$$

where v_{out} / v_{in} is the ratio of output voltage to applied voltage for the half bridge, R_o is the pickoff resistor value (10K, which is also the thermistor resistance at 25 C), and R_T is the thermistor resistance. Rearranging, we obtain

$$\frac{R_T}{R_o} = \frac{v_{in}}{v_{out}} - 1 \qquad (2)$$

The relationship between the logarithm of the ratio of thermistor resistance to resistance at 25C and temperature is well fit by a third order polynomial. Departures of the fit from actual values are less than the thermistor accuracy (0.2C) from –40 to +60 C. If we let $x = ln(R_T/R_o)$ then

$$T = -0.0837\, x^3 + 1.532\, x^2 - 22.843\, x + 25.019 \qquad (3)$$

CR300 and CR1000 Thermistor Script Example

The following code fragment for a Campbell Scientific CR1000 datalogger implements the above equations, giving a temperature output from a thermistor temperature sensor. The sensor is assumed to be connected to excitation 1 and single ended input channel 1.

```
'CR1000

'Program to read thermistor temperature sensor with CRBasic type logger


Public halfbr_out, x, T


DataTable(Table2,True,-1)

      DataInterval(0,30,Min,10)

      Sample(1,T,FP2)

EndTable


BeginProg

      Scan(1,Sec,1,0)

            BrHalf(halfbr_out,1,mV25,1,1,1,30,True,0,_60Hz,1,0)

            x=ln(1/halfbr_out-1)

            T = -0.0837 * x^3 + 1.532 * x^2 - 22.843 * x + 25.019

            CallTable(Table2)

      NextScan

EndProg
```

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CR10X Thermistor Script Example

The following code fragment for a Campbell Scientific CR10X implements these equations, giving a temperature output from a thermistor temperature sensor. The sensor is assumed to be connected to excitation 1 and single ended input channel 1.

```
CR10X Code Fragment for Thermistor Temperature Sensor Measurement


1:  Excite-Delay (SE) (P4)
 1: 1         Reps
 2: 3         25 mV Slow Range
 3: 1         SE Channel
 4: 1         Excite all reps w/Exchan 1
 5: 0000      Delay (units 0.01 sec)
 6: 25        mV Excitation
 7: 1         Loc [ x         ]
 8: .04       Mult
 9: 0.0       Offset



2:  Z=1/X (P42)
 1: 1         X Loc [ x         ]
 2: 1         Z Loc [ x         ]

3:  Z=X+F (P34)
 1: 1         X Loc [ x         ]
 2: -1        F
 3: 1         Z Loc [ x         ]

4:  Z=LN(X) (P40)
 1: 1         X Loc [ x         ]
```

```
 2: 1         Z Loc [ x         ]

5:  Polynomial (P55)
 1: 1         Reps
 2: 1         X Loc [ x         ]
 3: 2         F(X) Loc [ Temp      ]
 4: 25.019    C0
 5: -22.843   C1
 6: 1.532     C2
 7: -.0837    C3
 8: 0.0       C4
 9: 0.0       C5
```