INSTRUCTION MANUAL

MP100H Relative Humidity and Temperature Probe

May 2008

WARRANTY AND ASSISTANCE

This equipment is warranted by CAMPBELL SCIENTIFIC (CANADA) CORP. ("CSC") 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 are not warranted.** ***** CSC's obligation under this warranty is limited to repairing or replacing (at CSC's option) defective products. The customer shall assume all costs of removing, reinstalling, and shipping defective products to CSC. CSC will return such products by surface carrier prepaid. This warranty shall not apply to any CSC 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. CSC is not liable for special, indirect, incidental, or consequential damages.

Products may not be returned without prior authorization. To obtain a Return Merchandise Authorization (RMA), contact CAMPBELL SCIENTIFIC (CANADA) CORP., at (780) 454-2505. An RMA number will be issued in order to facilitate Repair Personnel in identifying an instrument upon arrival. Please write this number clearly on the outside of the shipping container. Include description of symptoms and all pertinent details.

CAMPBELL SCIENTIFIC (CANADA) CORP. does not accept collect calls.

Non-warranty products returned for repair should be accompanied by a purchase order to cover repair costs.

CAMPBELL SCIENTIFIC
CANADA CORP.
11564 - 149 street - edmonton - alberta - T5M 1W7
tel 780.454.2505 fax 780.454.2655
www.campbellsci.ca

MP100H Temperature and Relative Humidity Probe

Warning: HygroClip probes plug in straight - do not twist the connector when inserting. Twisting the connectors will destroy the probe and mating connector and will void the warranty. Refer to Section 7 for maintenance instructions.

1. General

The MP100H measures air temperature with an external fast response Pt100 RTD (1/3 DIN) and relative humidity based on the HygroClip technology. The external Pt100 RTD connection consists of a 3-wire half bridge. Each HygroClip probe is 100% interchangeable and can be swapped in seconds without any loss of accuracy, eliminating the downtime typically required for the recalibration process.

2. Specifications

Operating Temperature: -40°C to +60°C

Probe Dimensions: See Outline Drawing

Probe Weight: 210 g (without cable)

Housing Material: Polycarbonate

Maximum Power Consumption: 10 mA

Supply Voltage: 5 to 30 VDC

Settling Time after power is switched on: 4 seconds

2.1 Temperature Sensor

Sensor: External Pt100 RTD, 1/3 DIN

Temperature Measurement Range: -40°C to +60°C

Temperature Accuracy (at 20-25°C): ± 0.2°C

Temperature Measurement Repeatability: < 0.1°C

2.2 Relative Humidity Sensor

Sensor: HygroClip S3

Relative Humidity (RH) Measurement Range: 0 to 100% non-condensing

RH Output Signal Range: 0 to 1.0 VDC

Relative Humidity Resolution: 0.1% or better

Accuracy (at 20-25°C): ±1.5% RH

Repeatability: ± 0.3%

Typical Long Term Stability: Better than 1% RH per year

Response Time (without filter): 10 seconds (RH and Temperature)

3. Installation

The MP100H must be housed inside a solar radiation shield when used in the field. The 41003-X 10-Plate Radiation Shield (Figure 1) mounts to either of the CM6/CM10 tripods, the CM110/115/120 aluminium tripods, or the UT30 tower. The MP100H is held within the 41003-X Radiation Shield by securing the sensor in the R41046DS-25 adaptor and screwing the adaptor into the base of the Radiation Shield (Figure 1). The sensor must be placed as far in the Radiation Shield without making contact with the inside surface of the Shield.

Figure 1 – MP100H, 41003-X Radiation Shield, and R41046DS-25 adaptor

4. Wiring

Connections to Campbell Scientific dataloggers are given in Table 1. Air Temperature (AT) is measured by the use of a 3-wire Half Bridge instruction and relative humidity is measured using a single-ended voltage instruction.

The AT (Rf) wiring is required for the measurement of the Reference Resistor in the 3-wire Half Bridge circuit. The AT (Rs) wiring is required to measure the PT100 in the 3-wire Half Bridge circuit. The proper operation of the in the 3-wire Half Bridge measurement requires that the signal wiring (Red & Orange) for the 3-wire Half Bridge, must use two consecutive single-ended input channels. The Red wire must be in the first channel and the Orange wire must be in the second channel.

CAUTION Always connect the Black and Grey leads to the datalogger first, and connect the Green (Power) lead last.

TABLE 1. Datalogger Connections

Description	Colour	CR23X/CR1000	CR10(X), CR510
AT (Rf)	Red	Single-Ended Input	Single-Ended Input
AT (Rs)	Orange	Single-Ended Input	Single-Ended Input
PT100 Excitation	Violet	Excitation (Vx)	Excitation (Vx)
AT Reference	Black	⏚	AG
Relative Humidity	White	Single-Ended Input	Single-Ended Input
RH Signal Reference	Yellow	⏚	AG
Power Reference	Grey	G	G
Power	Green	5 V	5 V
Shield	Clear	G	G

5. Program Examples

This section is for users who write their own datalogger programs. A datalogger program to measure this sensor can be created using Campbell Scientific's Short Cut Program Builder Software.

Air Temperature (AT) is measured by the use of a 3-wire Half Bridge instruction and relative humidity is measured using a single-ended voltage instruction.

The probe output scale is 0 to 1000 millivolts for the temperature range of -40°C to +60°C and for the relative humidity range of 0 to 100%. Tables 2 and 3 provide calibration information for temperature and relative humidity. In the CR1000 program the Table 2 multiplier and offset will need to be used in the "PRT" instruction. Whereas for the CR10X program the Table 2 multiplier and offset will need to be used in the "Temperature RTD" instruction.

Table 2. Calibration for Temperature

Units	Multiplier (degrees mV-1)	Offset (degrees)
Fahrenheit	0.18	-40
Kelvin	1.0	-276.14

TABLE 3. Calibration for Relative Humidity

Units	Multiplier (% mV^{-1})	Offset (%)
Percent	0.1	0
Fraction	0.001	0

5.1 Example for CR1000

```
'CR1000


'Declare Public Variables

Public MP100H_TC
Public MP100H_RH

Units MP100H_TC = degrees Celsius
Units MP100H_RH = percent

'Define Data Tables

'Hourly Data for MP100H
DataTable (Hrly_MP100H,True,-1)
  DataInterval (0,60,Min,10)

  Average (1,MP100H_TC,FP2,False)
  Sample (1,MP100H_RH,FP2)

  Maximum (1,MP100H_TC,FP2,False,False)
  Maximum (1,MP100H_RH,FP2,False,False)

  Minimum (1,MP100H_TC,FP2,False,False)
  Minimum (1,MP100H_RH,FP2,False,False)
EndTable

'Main Program

BeginProg
  Scan (5,Sec,0,0)

    'MP100H Measurement
    'Measure Air Temperature in degrees Celcius
    BrHalf3W (MP100H_TC,1,mV2500,1,Vx1,1,1000,True ,0,_60Hz,10,0)
    'Calculate the Air temperature value from the resistance ratio measured in BrHalf3W instruction
    PRT (MP100H_TC,1,MP100H_TC,1.0,0)
    'Measure Relative Humidity as a percent (%)
    VoltSe (MP100H_RH,1,mV2500,3,1,0,_60Hz,0.1,0)

    'Call Output Tables
    CallTable (Hrly_MP100H)

  NextScan
EndProg
```

5.2 Example for CR10X

```
;MP100H Measurement
;Measure Air Temperature in degrees Celcius

1:  3W Half Bridge (P7)
 1: 1        Reps
 2: 25       2500 mV 60 Hz Rejection Range
 3: 1        SE Channel
 4: 1        Excite all reps w/Exchan 1
 5: 1000     mV Excitation
 6: 1        Loc [ MP100H_TC ]
 7: 10       Multiplier
 8: 0        Offset

;Calculate the Air temperature value from the resistance ratio measured in BrHalf3W instruction
2:  Temperature RTD (P16)
 1: 1        Reps
 2: 1        R/R0 Loc [ MP100H_TC ]
 3: 1        Loc [ MP100H_TC ]
 4: 1        Multiplier
 5: 0        Offset


;Measure Relative Humidity as a percent (%)

3:  Volt (SE) (P1)
 1: 1        Reps
 2: 25       2500 mV 60 Hz Rejection Range
 3: 3        SE Channel
 4: 2        Loc [ MP100H_RH ]
 5: 0.1      Multiplier
 6: 0        Offset


;Hourly data outputs

4:  If time is (P92)
 1: 0        Minutes (Seconds --) into a
 2: 60       Interval (same units as above)
 3: 10       Set Output Flag High (Flag 0)


5:  Set Active Storage Area (P80)^28859
 1: 1        Final Storage Area 1
 2: 60       Array ID

6:  Real Time (P77)^13055
 1: 1220     Year,Day,Hour/Minute (midnight = 2400)

7:  Average (P71)^2678
 1: 1        Reps
 2: 1        Loc [ MP100H_TC ]
```

```
8:  Sample (P70)^272
 1: 1        Reps
 2: 2        Loc [ MP100H_RH ]

9:  Maximum (P73)^6145
 1: 1        Reps
 2: 0        Value Only
 3: 1        Loc [ MP100H_TC ]

10:  Maximum (P73)^1539
 1: 1        Reps
 2: 0        Value Only
 3: 2        Loc [ MP100H_RH ]

11:  Minimum (P74)^18658
 1: 1        Reps
 2: 0        Value Only
 3: 1        Loc [ MP100H_TC ]

12:  Minimum (P74)^19651
 1: 1        Reps
 2: 0        Value Only
 3: 2        Loc [ MP100H_RH ]
```

6. Absolute Humidity & Dew Point

The MP100H measures the relative humidity. Relative humidity is defined by Equation (2) below:

$$RH = \frac{e}{e_s} * 100 \qquad (2)$$

where RH is the relative humidity, e is the vapour pressure in kPa , and e_s is the saturation vapour pressure in kPa. The vapour pressure, e, is an absolute measure of the amount of water vapour in the air and is related to the dew point temperature. The saturation vapour pressure is the maximum amount of water vapour that air can hold at a given air temperature. The relationship between dew point and vapour pressure and air temperature and saturation vapour pressure are given by Goff and Gratch (1946), Lowe (1977), and Weiss (1977).

When the air temperature increases, so does the saturation vapour pressure. Conversely, a decrease in air temperature causes a corresponding decrease in saturation vapour pressure. It follows then from Eq. (2) that a change in air temperature will change the relative humidity, without causing a change in absolute humidity.

For example, for an air temperature of 20°C and a vapour pressure of 1.17 kPa, the saturation vapour pressure is 2.34 kPa and the relative humidity is 50%. If the air temperature is increased by 5°C and no moisture is added or removed from the air, the saturation vapour pressure increases to 3.17 kPa and the relative humidity decreases to 36.9%. After the increase in air temperature, the air can hold more water vapour. However, the actual amount of water vapour in the air has not changed. Thus, the amount of water vapour in the air, relative to saturation, has decreased.

Because of the inverse relationship between relative humidity and air temperature, finding the mean relative humidity is meaningless. A more useful quantity is the mean vapour pressure. The mean vapour pressure can be computed by the datalogger.

The example program also shows how Dew Point can be calculated from the Air Temperature and Relative Humidity values. Please refer to Campbell Scientific Technical Note 16 (22.12.00). Example 1 is for use with the CR10(X) datalogger. Example 2 is for use with the CR1000 datalogger.

Example 1. Sample CR10(X) Program that Computes Vapor Pressure (e) and Dew Point.

```
;MP100H Measurement
;Measure Air Temperature in degrees Celcius

1:  3W Half Bridge (P7)
 1: 1        Reps
 2: 25        2500 mV 60 Hz Rejection Range
 3: 1        SE Channel
 4: 1        Excite all reps w/Exchan 1
 5: 1000     mV Excitation
 6: 1        Loc [ MP100H_TC ]
 7: 10        Multiplier
 8: 0        Offset

;Calculate the Air temperature value from the resistance ratio measured in BrHalf3W instruction
2:  Temperature RTD (P16)
 1: 1        Reps
 2: 1        R/R0 Loc [ MP100H_TC ]
 3: 1        Loc [ MP100H_TC ]
 4: 1        Multiplier
 5: 0        Offset

;Measure Relative Humidity expressed as a fraction

3:  Volt (SE) (P1)
 1: 1        Reps
 2: 25        2500 mV 60 Hz Rejection Range
 3: 3        SE Channel
 4: 2        Loc [ RH_Fract  ]
 5: 0.001    Multiplier
 6: 0        Offset
```

```
;Limit maximum value of relative humidity to 1 (expressed as a fraction)

4:  If (X<=>F) (P89)
 1: 2        X Loc [ RH_Fract  ]
 2: 3        >=
 3: 1        F
 4: 30        Then Do

     5:  Z=F x 10^n (P30)
      1: 1        F
      2: 0        n, Exponent of 10
      3: 2        Z Loc [ RH_Fract  ]

6:  End (P95)

;Compute the saturation vapour pressure (e_sat) in kPa.
;Temperature must be in degrees Celsius.

7:  Saturation Vapor Pressure (P56)
 1: 1        Temperature Loc [ MP100H_TC ]
 2: 3        Loc [ e_sat     ]

;Compute the vapour pressure (e) in kPa
;Relative humidity must be a fraction

8:  Z=X*Y (P36)
 1: 3        X Loc [ e_sat     ]
 2: 2        Y Loc [ RH_Fract  ]
 3: 4        Z Loc [ e         ]

; Estimate Dew Point using the equation:
; Dew_Pt = 241.88 * In(e/0.61078) / (17.558 – In(e/0.61078))
; Mulitply e by 1/0.61078 (= 1.6373)

9:  Z=X*F (P37)
 1: 4        X Loc [ e         ]
 2: 1.6373   F
 3: 5        Z Loc [ Work_R    ]

10:  Z=LN(X) (P40)
 1: 5        X Loc [ Work_R    ]
 2: 5        Z Loc [ Work_R    ]

11:  Z=X*F (P37)
 1: 5        X Loc [ Work_R    ]
 2: 241.88   F
 3: 6        Z Loc [ Work_1    ]

12:  Z=F x 10^n (P30)
 1: 17.558   F
 2: 0        n, Exponent of 10
 3: 7        Z Loc [ Work_2    ]

13:  Z=X-Y (P35)
```

```
 1: 7       X Loc [ Work_2    ]
 2: 5       Y Loc [ Work_R    ]
 3: 7       Z Loc [ Work_2    ]

14:  Z=X/Y (P38)
 1: 6       X Loc [ Work_1    ]
 2: 7       Y Loc [ Work_2    ]
 3: 8       Z Loc [ Dew_Pt    ]

;Convert Relative Humidity Fraction to Percentage

15:  Z=X*F (P37)
 1: 2       X Loc [ RH_Fract  ]
 2: 100      F
 3: 9       Z Loc [ RH_pct    ]

;Example of typical hourly output for Dew Point

16:  If time is (P92)
 1: 0       Minutes (Seconds --) into a
 2: 60       Interval (same units as above)
 3: 10       Set Output Flag High (Flag 0)

;Label Output Array

17:  Set Active Storage Area (P80)
 1: 1       Final Storage Area 1
 2: 60       Array ID

18:  Real Time (P77)
 1: 1220     Year,Day,Hour/Minute (midnight = 2400)

19:  Average (P71)
 1: 1       Reps
 2: 1       Loc [ MP100H_TC ]

20:  Sample (P70)
 1: 1       Reps
 2: 9       Loc [ RH_pct    ]

21:  Average (P71)
 1: 1       Reps
 2: 4       Loc [ e         ]

22:  Average (P71)
 1: 1       Reps
 2: 8       Loc [ Dew_Pt    ]
```

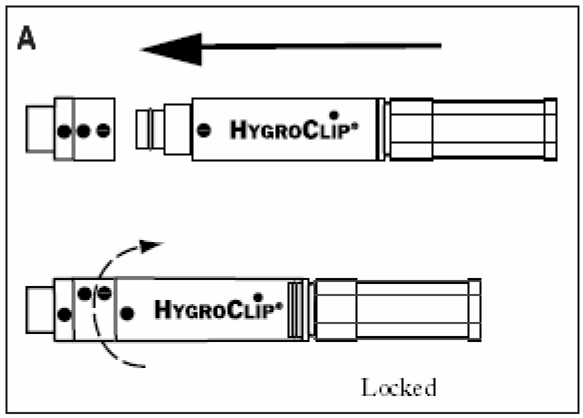
Example 2. Sample CR1000 Program that Computes Dew Point.

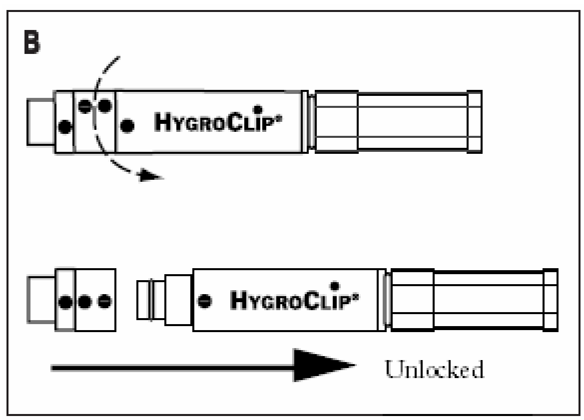
```
'CR1000
'Declare Public Variables

Public MP100H_TC
Public MP100H_RH
Public SVp_6
Public Vp_7
Public Dew_Pt

Units MP100H_TC = degrees Celsius
Units MP100H_RH = percent
Units SVp_6 = kPa
Units Vp_7 = kPa
Units Dew_Pt = Deg C

'Define Data Tables

'Hourly Data for MP100H
DataTable (Hrly_MP100H,True,-1)
  DataInterval (0,5,Min,10)
  Average (1,MP100H_TC,FP2,False)
  Sample (1,MP100H_RH,FP2)
  Average (1,Vp_7,FP2,False)
  Average(1,Dew_Pt,FP2,False)
EndTable

'Main Program
BeginProg
  Scan (5,Sec,0,0)

    'MP100H Measurement
    'Measure Air Temperature in degrees Celsius
    BrHalf3W (MP100H_TC,1,mV2500,5,Vx1,1,1000,True ,0,_60Hz,10,0)
    'Calculate the Air temperature value from the resistance ratio measured in BrHalf3W instruction
    PRT (MP100H_TC,1,MP100H_TC,1.0,0)
    'Measure Relative Humidity as a percent (%)
    VoltSe (MP100H_RH,1,mV2500,3,1,0,_60Hz,0.1,0)

    'Saturation Vapour Pressure calculation
    SatVP (SVp_6,MP100H_TC)

    'Vapour Pressure calculation
    Vp_7=(MP100H_RH/100)*SVp_6

    'Dew Point calculation Dew_Pt:
    DewPoint(Dew_Pt,MP100H_TC,MP100H_RH)
    If Dew_Pt > MP100H_TC OR Dew_Pt = NAN Then Dew_Pt = MP100H_TC

    'Call Output Tables
    CallTable (Hrly_MP100H)

  NextScan
EndProg
```

7. Maintenance

Both the HygroClip S3 and the base of the probe connector are marked with a black dot. The grey locking ring has two of the dots. The HygroClip S3 can be inserted or removed from the connector when all four dots are aligned. Be sure to turn the grey locking ring as in Image A to secure the HygroClip S3 in place.

WARNING: Under no circumstance rotate or twist the HygroClip S3 while insertion or removal, as this will severally damage the probe.





The MP100H Probe requires minimal maintenance. Check monthly to make sure the radiation shield is free from debris. The metallic screen at the tip of the probe should also be checked for contaminants and dust.

When installed in close proximity to the ocean or other bodies of salt water, a coating of salt (mostly NaCl) may build up on the radiation shield, sensor, filter and even the chip. NaCl has an affinity for water. The humidity over a saturated NaCl solution is 75%. A buildup of salt on the filter can delay or destroy the response to atmospheric humidity.

The filter can be rinsed gently in distilled water and wiped, after being unscrewed from the probe. If any stains are not removed, the filter may need replacement.

Please contact Campbell Scientific (Canada) Corp. with any concerns regarding filter replacement, RH chip replacement, or probe recalibration.

7.1 Replacement Parts for Maintenance Concerns

Please note that Part Numbers listed are from Campbell Scientific (Canada) Corp. and are follows:

1. C2084 – Replacement HygroClip probe Relative Humidity (0 to 100%) and Air Temperature (-40°C to +60°C).

2. C2091 – Replacement Filter Cap

Please contact Campbell Scientific (Canada) Corp. regarding pricing and availability.

8. References

Goff, J. A. and S. Gratch, 1946: Low-pressure properties of water from -160° to 212°F, *Trans. Amer. Soc. Heat. Vent. Eng.*, **51**, 125-164.

Lowe, P. R., 1977: An approximating polynomial for the computation of saturation vapor pressure, *J. Appl. Meteor.*, **16**, 100-103.

Weiss, A., 1977: Algorithms for the calculation of moist air properties on a hand calculator, *Amer. Soc. Ag. Eng.*, **20**, 1133-1136.