App. Note Code: 2T-M
Revision: 2

APPLICATION NOTE

Wind Chill

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Wind Chill

This application note defines the term wind chill, provides equations for estimating it, includes datalogger programming examples, and discusses the limitations of the wind chill concept.

General Information

The wind chill index estimates the rate a human body loses heat while exposed to cold and wind. The index provides an indication of how warmly to dress to reduce hypothermia, frost bite, or other cold-related ailments.

The original wind chill index was based on research conducted in the Antarctica in the 1940s. This research consisted of measuring the amount of time it took for cans of water to freeze at different temperatures and wind speeds.[1]

In recent years, researchers began questioning the validity of the original wind chill index because several factors were not accounted for in the development of the index.[2] These factors include:

- Differences between heat loss in the sun versus heat loss in the shade
- Human skin freezes at a different rate than water freezes
- Many wind speed measurements are taken at 10 meters where velocities are higher than at ground level

By not accounting for these factors, the original wind chill index may have been overestimated resulting in the adjusted temperature being considerably colder than it should be. In an attempt to derive a more accurate index, the National Weather Service implemented a new wind chill index in August 2001.[3] This index uses:

- Wind speed calculation at 5 feet instead of 10 m
- Human face model
- Modern heat transfer theory
- Lower calm wind threshold of 3 mph
- Solar radiation for the worst case scenario (clear night sky)

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Even with modification, some researchers believe the wind chill concept should be abandoned.

National Weather Service Wind Chill Equations

The following equations assume wind speed is greater than 3 mph (1.3 m s^{-1} or 4.8 km hr^{-1}). Also note that the wind chill index often is not applied to temperatures warmer than 1.7°C (35°F).

Equation 1 estimates wind chill in degrees Fahrenheit and uses a wind speed in mph:

$$Tw = 35.74 + 0.6215T - 35.75\ (v^{0.16}) + 0.4275T\ (v^{0.16}) \qquad \text{Eq. 1}$$

where Tw = wind chill in °F
v = wind speed in mph
T = temperature in °F

Equation 2 estimates wind chill in degrees Celsius and uses wind speed in m s^{-1}:

$$Tw = 13.127 + 0.6215T - 13.947\ v^{0.16} + 0.486\ Tv^{0.16} \qquad \text{Eq. 2}$$

where Tw = wind chill in °C
v = wind velocity in m s^{-1}
T = temperature in °C

Equation 3 estimates wind chill in degrees Celsius and uses a wind speed in km hr^{-1}:

$$Tw = 13.127 + 0.6215T - 11.362\ v^{0.16} + 0.396\ Tv^{0.16} \qquad \text{Eq. 3}$$

where Tw = wind chill in °C
v = wind velocity in km hr^{-1}
T = temperature in °C

Program Examples

The datalogger can be programmed to automatically calculate wind chill. The simplest method to accomplish this is to use an expression in Edlog.

Example 1: Wind Chill in Degrees Fahrenheit

This portion of a CR10X program uses Equation 1 to calculate wind chill. Wind speed is measured with an R.M. Young Wind

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Sentry Anemometer and temperature is measured with a 107 Temperature Probe.

```
;{CR10X}
;
*Table 1 Program
  01:     10          Execution interval (seconds)

;Measure wind speed in mph
1:  Pulse (P3)
  1:        1         Reps
  2:        1         Pulse channel 1
  3:       21         Low level AC, output Hz
  4:        1         Loc [Vmph     ]
  5:        1.677     Mult
  6:        0.4       Offset

;Measure temperature in degrees Fahrenheit
2:  Temp (107) (P11)
  1:        1         Reps
  2:        1         SE channel
  3:        1         Excite all reps w/E1
  4:        2         Loc [Tf  ]
  5:        1.8       Mult
  6:       32         Offset

;Calculate wind chill in degrees Fahrenheit
Twf = 35.74+(0.6215*Tf)-35.75*(Vmph^0.16)+0.4275*Tf*(Vmph^0.16)
```

Example 2: Wind Chill in Degrees Celsius

This portion of a CR10X program uses Equation 2 to calculate wind chill. Wind speed is measured with an R.M. Young Wind Sentry Anemometer and temperature is measured with a 107 Temperature Probe.

```
;{CR10X}
;
*Table 1 Program
  01:     10          Execution Interval (seconds)
```

```
;Measure wind speed in m/s
1:  Pulse (P3)
  1:       1          Reps
  2:       1          Pulse channel 1
  3:      21          Low level AC, output Hz
  4:       1          Loc [Vm_s     ]
  5:       0.75       Mult
  6:       0.2        Offset

;Measure temperature in degrees Celsius
2:  Temp (107) (P11)
  1:       1          Reps
  2:       1          SE channel
  3:       1          Excite all reps w/E1
  4:       2          Loc [Tc     ]
  5:       1.0        Mult
  6:       0.0        Offset

;Calculate wind chill in degrees Celsius
TWc = 13.127+(0.6215*Tc)-13.947*(Vm_s^0.16)+0.486*Tc*(Vm_s^0.16)
```

References and Resources

1. “The Wind Chill Formula, Its Development”; www.usatoday.com/weather/wchilfor.htm (updated 01/06/99)

2. “Accuracy of Wind Chill Factor Questioned”; www.usatoday.com/weather/wchilpro.htm (updated 12/20/00)

3. “Meteorological Tables, August, 2001 Press Release”; http://205.156.54.206/er/iln/tables.htm

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