Precision Measurements
Best instrument for flux and other turbulence research projects

Overview
Campbell Scientific’s CSAT3 3D Sonic Anemometer is the 3D sonic anemometer of choice for eddy-covariance measurements. It has an aerodynamic design, a 10 cm vertical measurement path, operates in a pulsed acoustic mode, and withstands exposure to harsh weather conditions. Three orthogonal wind components ($u_x$, $u_y$, $u_z$) and the speed of sound ($c$) are measured and output at a maximum rate of 60 Hz. Analog outputs and two types of digital outputs are provided. Measurements can be triggered from three sources:
- Datalogger’s SDM command
- CSAT3’s internal clock
- PC-generated RS-232 command
The SDM protocol supports a group trigger for synchronizing multiple CSAT3s.

Benefits and Features
- Innovative design provides precision turbulence measurements with minimal flow distortion
- Can be combined with EC150 or EC155 gas analyzers giving near complete colocation for eddy-covariance measurements
- Compatible with most Campbell Scientific dataloggers
- Measurements can be used to calculate momentum flux and friction velocity
- Campbell Scientific’s fine wire thermocouples are an option for fast-response temperature measurements
- Field rugged
- Rain: Innovative signal processing and transducer wicks considerably improves performance of the anemometer during rain events
- Sealed sonic transducers and electronics
Specifications

Measurements

- Outputs: \( u_x, u_y, u_z \) (\( u_x, u_y, u_z \) are wind components referenced to the anemometer axes; \( c \) is speed of sound)
- Speed of Sound: Determined from three acoustic paths; corrected for crosswind effects
- Measurement Rate: programmable from 1 to 60 Hz, instantaneous measurements; two over-sampled modes are block averaged to either 20 Hz or 10 Hz

Measurement Precision RMS

- \( u_x, u_y \): 1 mm s\(^{-1}\) rms
- \( u_z \): 0.5 mm s\(^{-1}\) rms
- \( c \): 15 mm s\(^{-1}\) (0.025°C) rms
- Wind Direction: 0.06° rms

Accuracy

- Offset error: <±8.0 cm s\(^{-1}\) (\( u_x, u_y \)), <±4.0 cm s\(^{-1}\) (\( u_z \))
- Gain Error
  - Wind Vector within ±5° of horizontal: <±2% of reading
  - Wind Vector within ±10° of horizontal: <±3% of reading
  - Wind Vector within ±20° of horizontal: <±6% of reading
- Wind Direction: ±0.7° at 1 m s\(^{-1}\) for horizontal wind

Output Signals

- Digital SDM: CSI 33.3 k bps serial interface for datalogger/sensor communication. Data type is 2 B integer per output plus 2 B diagnostic
- Digital RS-232
  - Baud rate: 9600, 19200 bps
  - Data type: 2 B integer per output plus 2 B diagnostic

Analog

- Number of outputs: 4
- Voltage range: ±5 V
- Number of bits: 12

Reporting Range

- Analog Outputs:

<table>
<thead>
<tr>
<th>Output</th>
<th>Reporting Range</th>
<th>LSB</th>
</tr>
</thead>
<tbody>
<tr>
<td>( u_x ), ( u_y )</td>
<td>±30 m s(^{-1}), ±60 m s(^{-1})</td>
<td>15 mm s(^{-1}), 30 mm s(^{-1})</td>
</tr>
<tr>
<td>( u_z )</td>
<td>±8 m s(^{-1})</td>
<td>4 mm s(^{-1})</td>
</tr>
<tr>
<td>( c )</td>
<td>300 to 366 m s(^{-1})</td>
<td>16 mm s(^{-1}) (0.026°C)</td>
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</tbody>
</table>

SDM and RS-232 Digital Outputs

- Full scale wind: ±65.535 m s\(^{-1}\) autoranging between four ranges; least significant bit is 0.25 to 2 mm s\(^{-1}\)
- Speed of Sound: 300 to 366 m s\(^{-1}\) (-50° to +60°C); least significant bit is 1 mm s\(^{-1}\) (0.002°C)

Physical Description

- Measurement Path Length: 10.0 cm vertical; 5.8 cm horizontal
- Path Angle from Horizontal: 60 degrees
- Transducer: 0.64 cm diameter
- Transducer Mounting Arms: 0.84 cm diameter
- Support Arms: 1.59 cm diameter

Dimensions

- Anemometer head: 47.3 cm (l) x 42.4 cm (h)
- Electronics box: 26 x 16 x 9 cm

Weight

- Anemometer head: 1.7 kg (3.7 lb)
- Electronics box: 3.8 kg (8.4 lb)

Materials

- Anemometer head: stainless steel tubing
- Electronics box: cast aluminum

Environmental

- Operating Temperature: -30° to +50°C

Power Requirements

- Voltage Supply: 10 to 16 Vdc
- Current: 200 mA @ 60 Hz measurement rate; 100 mA @ 20 Hz measurement rate

Resolution values are for instantaneous measurements made on a constant signal; noise is not affected by sample rate.

Accuracy specifications assume -30° to +50°C operating range; wind speeds < 30 m s\(^{-1}\); wind angles between ±170°.