

The CSAT3, shown making measurements over a fallow field in Minnesota, provides precision turbulence measurements with minimal flow distortion.

## 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. Analogue 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 co-location 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:  $u_x$ ,  $u_y$ ,  $u_z$ ,  $c$  ( $u_x$ ,  $u_y$ ,  $u_z$  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<sup>a</sup>

- $u_x$ ,  $u_y$ : 1 mm s<sup>-1</sup> rms
- $u_z$ : 0.5 mm s<sup>-1</sup> rms
- $c$ : 15 mm s<sup>-1</sup> (0.025°C) rms
- Wind Direction: 0.06° rms

### Accuracy<sup>b</sup>

- Offset error:  $<\pm 8.0$  cm s<sup>-1</sup> ( $u_x$ ,  $u_y$ ),  $<\pm 4.0$  cm s<sup>-1</sup> ( $u_z$ )
- Gain Error
  - Wind Vector within  $\pm 5^\circ$  of horizontal:  $<\pm 2\%$  of reading
  - Wind Vector within  $\pm 10^\circ$  of horizontal:  $<\pm 3\%$  of reading
  - Wind Vector within  $\pm 20^\circ$  of horizontal:  $<\pm 6\%$  of reading
- Wind Direction:  $\pm 0.7^\circ$  at 1 m s<sup>-1</sup> for horizontal wind

## Output Signals

- Digital SDM: CSI 33.3 k baud 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-byte integer per output plus 2-byte diagnostic

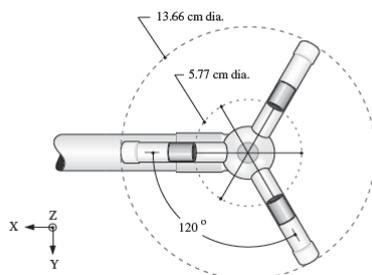
### Analogue

- Number of outputs: 4
- Voltage range:  $\pm 5$  V
- Number of bits: 12

## Reporting Range

- Analogue Outputs:

Output	Reporting Range	LSB
$u_x$ , $u_y$	$\pm 30$ m s <sup>-1</sup> , $\pm 60$ m s <sup>-1</sup>	15 mm s <sup>-1</sup> , 30 mm s <sup>-1</sup>
$u_z$	$\pm 8$ m s <sup>-1</sup>	4 mm s <sup>-1</sup>
$c$	300 to 366 m s <sup>-1</sup> (-50° to +60°C)	16 mm s <sup>-1</sup> (0.026°C)



Low Transducer Assembly Top View

## SDM and RS-232 Digital Outputs

- Full scale wind:  $\pm 65.535$  m s<sup>-1</sup> autoranging between four ranges; least significant bit is 0.25 to 2 mm s<sup>-1</sup>
- Speed of Sound: 300 to 366 m s<sup>-1</sup> (-50° to +60°C); least significant bit is 1 mm s<sup>-1</sup> (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 aluminium

## Environmental

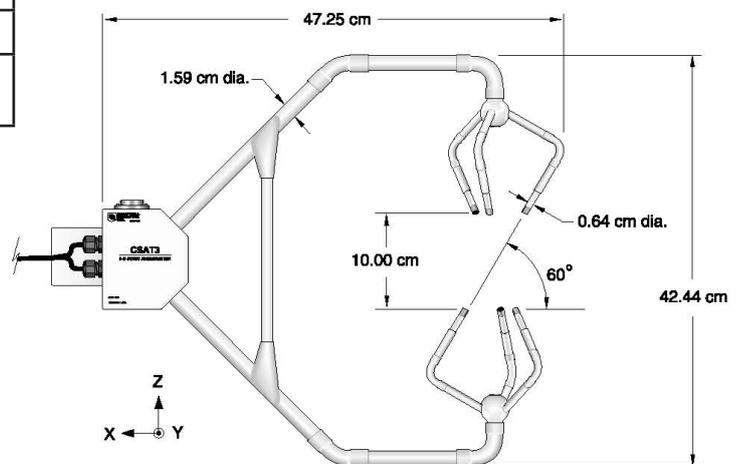
- Operating Temperature: -30° to +50°C

## Power Requirements

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

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

<sup>b</sup>Accuracy specifications assume -30° to +50°C operating range; wind speeds  $< 30$  m s<sup>-1</sup>; wind angles between  $\pm 170^\circ$ .



Anemometer Head