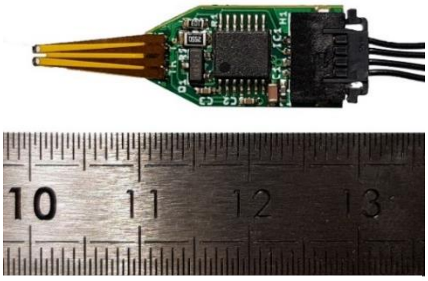
ANALOGUE ‘NANO-CTA’ THERMAL ANEMOMETRY SENSOR

This ultra-miniaturized, analogue thermal anemometer uses proprietary CMOS sensor technology to measure velocities in real-time at speeds down to 10 mm/s.



“nano-CTA” sensing element

- Ultralow velocity range: reliable measurement of speeds in air below 10 mm/s
- Robust, abrasion-resistant permanent sensing element
- Ultra-low calibration drift
- Analogue-balance temperature compensation system
- Surface array mountings available for high-resolution, nonintrusive measurement of wall velocities
- See our ‘nano-CTA array system’ for digital version with data acquisition unit with software and drivers supplied for plug-and-play USB operation

Specification

Velocity range[1]	10 mm/s – 100m/s		
Uncertainty	± 1 % relative		
Compensated temperature range[2]	0° to 70° C ambient for dry air		
Calibration drift	< 2 % over long periods of use or storage		
Storage temperature range	-40° to +85° C		
Maximum relative humidity	95 %		
Supply voltage V_{dd}	Min. 7 VDC	Typ. 15 VDC	Max. 36 VDC
Power	Min. 12mA at V_{dd} = 15 VDC		
Output analogue signal range	0 - V_{dd}		
Connector type	4-way Molex Pico-lock (Molex PN 15131-040x)		
Physical dimensions	Sensor package approx. 10 mm x 20 mm		
Mass (excluding cable)	0.52 g		

1- Custom extended range available
2- Using our analogue-balance temperature compensation system, available via LabVIEW DLL

Additional custom modifications available

- Custom enclosure design service available
- Range of prong diameters and lengths available
- Waterproof – Parylene-coated sensors available, allowing operation in conductive media, seawater and other corrosive or harsh environments
- Extended product support and warranty available

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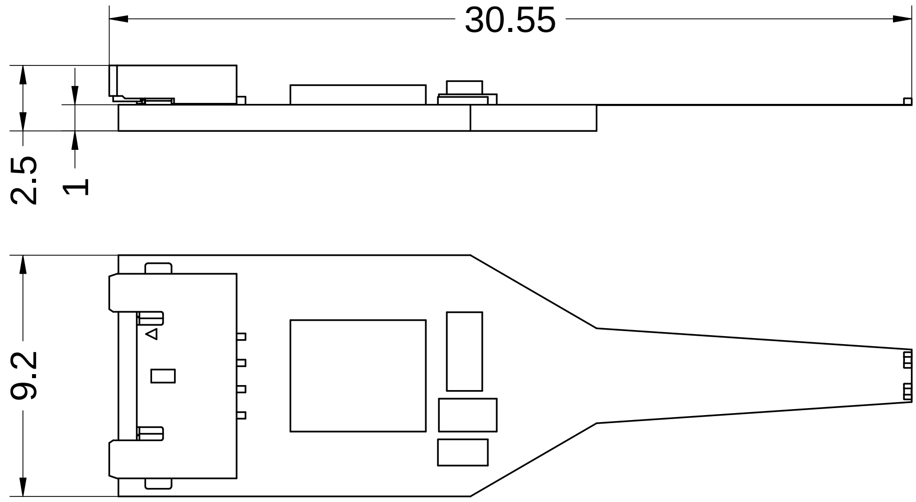
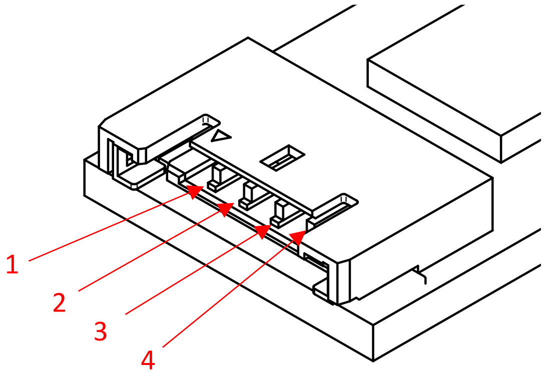
THERMAL ANEMOMETRY SENSOR

Dimensions



Connector Terminal Description

There are four pins: V+ (1), GND (2), Vb (3) and Vc (4), where pin 1 is on the left with the board facing upwards. Note that cable assemblies supplied are not cross-wired.



1	**V+**	Supply Voltage. Recommended 15 VDC for typical application. Absolute maximum 36 VDC.
2	**GND**	Common ground, 0V.
3	**Vb**	Signal voltage (raw). The measurement variable of interest.
4	**Vc**	Compensation voltage (raw). Used for temperature corrections.

The connector terminal labels are written on the reverse side of the board.

Temperature compensation

This sensing system includes an analogue temperature compensation system. A temperature-independent output variable X is obtained as

$$X = \frac{1.634}{k}\left(\frac{V_c(V_b - V_c)}{T_w - T_A}\right)$$

where V_b and V_c are the analogue voltage outputs and k is the thermal conductivity. The constant 1.634 is an arbitrary scaling parameter emerging from nondimensionalization. T_W and T_A are the sensor and ambient temperatures, respectively (in °K), which can be obtained as

$$T_W = 4499.61\left(13.0334 - \ln\left(\frac{V_b}{V_c} - 1\right)\right)^{-1}$$

$$T_A = 3350.33\left(11.2360 - \ln\left(\frac{V_b}{V_c} - 1\right)\right)^{-1}$$

For air at standard conditions, the thermal conductivity may be approximated over the sensor's compensated range as

$$k = 4.988 \times 10^{-3} + 7.140 \times 10^{-5}\left(\frac{T_W + T_A}{2}\right) \ \frac{\mathrm{W}}{\mathrm{mK}}$$

where T is the temperature (in °K).

The variable X can be calibrated against velocity if the variation in fluid properties with temperature remains insignificant over the range of measurement. (which is usually the case in air).

Velocity calibration

For flows in which wide temperature variation is expected, the variation in fluid properties with temperature may become significant. In these cases, X should be calibrated against Reynolds number rather than velocity, so that

$$\frac{Ud}{\nu(T)} = f(X)$$

where U is the fluid velocity, $d = 3 \times 10^{-4}$ m is the characteristic length scale of the sensors, $\nu(T)$ is the temperature-dependent kinematic viscosity of the fluid, and f is the empirical calibration function (to be determined experimentally). In dry air, $\nu(T)$ can be approximated as

$$\nu = 9.6992 \times 10^{-8} \left(\frac{T_W + T_A}{2}\right) - 1.3020 \times 10^{-5} \quad \frac{\mathrm{m}^2}{\mathrm{s}}$$

The calibration response $f(X)$ for the sensors is in most cases well-represented by a fourth-order polynomial, so that the calibration function becomes

$$U = \left(3.2330 \times 10^{-4} \left(\frac{T_W + T_A}{2}\right) - 0.0434\right)(C_0 + C_1 X + C_2 X^2 + C_3 X^3 + C_4 X^4) \quad \frac{\mathrm{m}}{\mathrm{s}}$$

where C_0, C_1, C_2 and C_3 are the constants to be determined by calibration.

Note: The temperature-independent variable X is sensitive to both Reynolds number and Prandtl number; for fluids other than air, any significant change in specific heat (at constant pressure) over the measurement range may also affect performance.