

## Turbulence Intensity Measurements

Application Note TSI-141

Turbulence can be thought of as fluctuations in air flow. A steady flow of air would have low turbulence. An unsteady flow of air would have higher turbulence. But what do we mean by “low” and “higher”, when we talk about turbulence? A uniform measurement scale is needed. Turbulence Intensity is that measurement scale.

Turbulence Intensity is a scale characterizing turbulence expressed as a percent. An idealized flow of air with absolutely no fluctuations in air speed or direction would have a Turbulence Intensity value of 0%. This idealized case never occurs on earth. However, due to how Turbulence Intensity is calculated, values greater than 100% are possible. This can happen, for example, when the average air speed is small and there are large fluctuations present.

### Definition of Turbulence Intensity (T.I.)

T.I. is defined in the following equation:

$$\text{T.I.} = u'/U$$

$u'$  = the Root-Mean-Square (RMS), or Standard Deviation, of the turbulent velocity fluctuations at a particular location over a specified period of time

$U$  = the average of the velocity at the same location over same time period

### Why measure T.I.?

The level of turbulence in air has implications in many different fields.

- In the realm of aeronautics, drag on an airfoil (airplane wing) is related to T.I., affecting fuel efficiency and – in extreme cases – aircraft stability.
- In the automobile industry, the measurement of T.I. is used when evaluating the aerodynamics of an auto body design. And it is not always low turbulence intensity that is the goal: some race cars have flaps that deploy to *increase* drag (higher T.I.) when the car goes into a spin, in an effort to more rapidly reduce the car’s speed.



- When working with chemicals, sometimes high T.I. is a good thing (when intentional mixing is desirable), and sometimes high T.I. is not a good thing (at the face of a chemical fume hood, where excessive T.I. may induce unwanted spillage of chemical fumes into a laboratory).
- In the realm of human comfort, heating or air conditioning systems that are perceived to be too “drafty” are not comfortable. It has been discovered that the perceived “draftiness” of air is a function of the T.I. of the moving air.

It is, in fact, in these last two applications (fume hood face velocity measurements, and room comfort measurements) where the AIRFLOW Instruments TA460 can provide useful measurements.

### Measuring TI with the VELOCICALC

The VELOCICALC has a specific applications screen that is setup to measure turbulence intensity. Follow the following steps to measure turbulence intensity:

- Fix the velocity probe on a ring stand in the position for the desired measurement
- Select Turbulence from the Applications Menu
- The unit takes a three minute sample of the velocity readings in that position. Do **not** move the probe during that time. Unit will display the current velocity reading during that time.
- The unit will display the average velocity, the standard deviation and the calculated turbulence intensity.
- The data can be saved as a sample in the memory at that time.

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**TSI Incorporated** - 500 Cardigan Road, Shoreview, MN 55126-3996 USA  
 USA Tel: +1 800 874 2811 E-mail: info@tsi.com Website: www.tsi.com  
 UK Tel: +44 149 4 459200 E-mail: tsuk@tsi.com Website: www.tsiinc.co.uk  
 France Tel: +33 491 95 21 90 E-mail: tsifrance@tsi.com Website: www.tsiinc.fr  
 Germany Tel: +49 241 523030 E-mail: tsigmbh@tsi.com Website: www.tsiinc.de  
 Sweden Tel: +46 8 595 13230 E-mail: tsiab@tsi.com Website: www.tsi.se  
 India Tel: +91 80 41132470 E-mail: tsi-india@tsi.com  
 China Tel: +86 10 8260 1595 E-mail: tsibeijing@tsi.com



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