

How to Calibrate Your ASI

Here is a \$3 method of calibrating your airspeed indicator.

BY JIM WEIR

We have relatively inexpensive methods of calibrating most of our aircraft instruments. The VOR/LOC can be calibrated within a degree or so using the FAA-supplied VOT or the airborne or ramp checkpoint from your local VOR. Our altimeters can be checked by noting the difference between the local reported altimeter setting and the field elevation at various points of landing. Turn needles, gyro horizons and directional gyros are all easily tested for calibration with a stopwatch and a short flight. Fuel gauges, oil temperature and even the tachometer are all testable with a little cleverness and a few pennies.

The only gauge on the panel that I've never been able to check really easily and cheaply has been the air-

speed indicator. Oh, sure, I've tried the trick of flying up and down the runway using a stopwatch, but I've never really been able to get an accurate result.

This article will zero in on a method of calibrating your airspeed indicator limited only by your capability of measuring the difference in the height of two water columns. This method will give you a degree of accuracy exceeded only by spending a few kilobucks for a commercially built laboratory standard pressure gauge.

First, a bit of background. The airspeed indicator is really nothing more than a differential pressure gauge. The face of the indicator is marked in miles (or knots, or km) per hour, but the instrument is really only measuring the difference in pressure between the air being rammed into the pitot tube due to the forward motion of the aircraft and the pressure of the ambient atmosphere supplied by the static port on the airplane.

For example, your airplane tied down at Sacratomato Intentional Skypatch at sea level has about 15 psi of pressure applied to both the static and pitot ports. This, as y'all remember from your student pilot days, is the normal pressure of that column of air that stretches from the ground up to the stratosphere. A pressure of 15 psi at both pitot and static ports yields a *differential* pressure of zero, so the airspeed indicator reads zero as well.

As you begin to move the airplane smartly on your takeoff roll, the *pitot* pressure slowly begins to increase while the *static* pressure remains constant. At, say, 50 mph, the *pitot* pressure has risen to about 15.1 psi and the *static* pressure remains constant at 15 psi, yielding a 0.1 psi *difference* between these two ports.

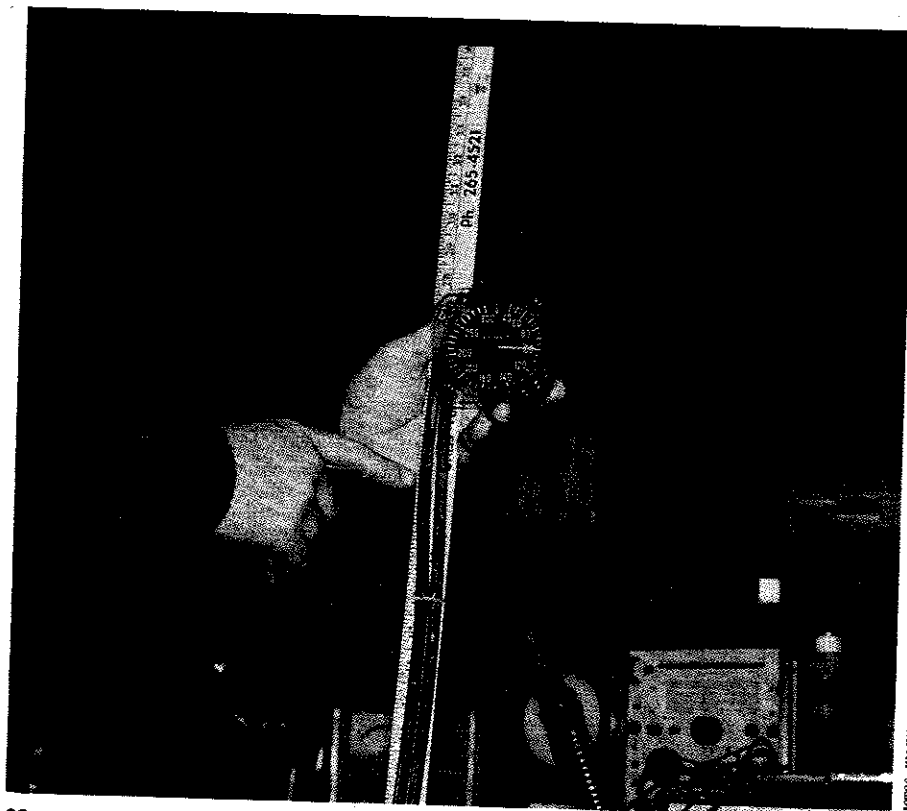
As you continue your takeoff roll and begin your climb, the airspeed indicator (ASI) dutifully presents you with a measure of the differential pressure, and hence the airspeed, of your flying machine. The mere fact that the error between airspeed and differential pressure grows greater with every foot of altitude gain is really of little consequence to the ASI. It continues on with its function of showing you differential pressure that decreases 2% for every thousand feet of elevation above sea level.

The problem of calibrating the ASI really resolves itself to finding a cheap, accurate source of pressure with which to measure the airspeed system. We could use a calibrated air compressor gauge tied onto the pitot port, but that just begs the question as to which mechanical gauge is the more accurate. We could use a calibrated column of mercury, but that stuff is toxic and expensive.

Instead of using mercury, we will use a calibrated column of water. It's cheap, readily available and easy to work with. The whole problem comes down to being able to translate the pressure generated by a column of water to the pressure generated by a pitot tube. Fortunately, the FAA has

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A simple water manometer setup and the accompanying chart will determine ASI calibration.



PHOTOS: JIM WEIR

published a document (AN 05-10-24) that specifies the airspeed that will be generated by a given water column. A little mathematical manipulation and interpolation gives us an amazingly simple formula:

Airspeed in mph = square root of (inches of water times 1980.0).

Thus, for a column of water 5 inches high, the airspeed indicator should read 100 mph. For an indication of water pressure versus airspeed, see Table 1.

The formula, by the way, was optimized for 100 mph and there will be minor errors as you proceed up and down from this value. For example, at 70 mph, the actual value from AN 05-10-24 gives 2.35 inches, or an error of about -1.5 mph. Similarly, at 150 mph, the error is about +2 mph. If you demand split-hair accuracy, I refer you to the table below that gives the value direct from the government publication.

The problem now resolves itself into finding a way of achieving a water column of the desired height. The way I chose to do it was to go down to my local hardware store and buy a few feet

of clear plastic tubing of an inside diameter that made a snug fit onto the airspeed indicator pitot port fitting. That same hardware store gives out wooden rulers that I used to make the inch-meter.

Bend that plastic tubing into a U-shape and lash it securely to the wooden ruler. Fill the U-tube part-way up the ruler to a known starting point, then connect one end of the U-tube to the pitot port fitting. Fill the open end of the tube with water so that the *difference* in the height of the water columns is one of your calibration points. Keep increasing the height differential until you have calibrated the ASI at as many points as you choose.

Write down the indicated airspeed (read on your ASI) versus the calibrated airspeed (determined from the pressure-differential chart) about every 10 mph and you have an accurate calibration chart for use in your aircraft.

That pretty much does it for the project. Normally at this time, I launch into the song and dance that Radio Systems Technology [author Jim Weir's *Grass Valley, California, kit avionics company*—Ed.] will sell you a parts kit for this project for only \$399 and two Cessna parts boxtops. Unfortunately, RST is not in the hardware business, so I suggest you find all these parts locally.

Some fine points— I almost always use red food coloring in the water so that I can clearly see the height difference between the columns. The ultimate California snob will use Gamay Beaujolais instead of water (with the usual -1.345% wine-correction factor). A drop of dishwashing detergent in the water acts as a wetting solution and makes the meniscus (curved surface of the top of the water column) a bit flatter. I use an eyedropper (or a turkey baster for large tubing) for my water filler, but you can use anything you choose.

There is no reason not to use the same setup to test the ASI installed in an airplane; the only thing you have to do is to make the plastic tubing fit over the pitot tube. It is also true that if you fill the tubing to a given airspeed and the airspeed slowly bleeds down, there is a leak in your pitot plumbing or your test setup. The sharp A&P now sees that with a rubber suction cup and a little work, he can make a calibrated static port tester for IFR tests.

Caution: Make certain you never get the level of the water above the pitot fitting, or you might just as well start pricing a new airspeed indicator.

Data from AN 05-10-24

Speed knots	Pressure inches of water
50	1.63
60	2.35
70	3.21
80	4.19
90	5.31
100	6.56
110	7.95
120	9.48
130	11.14
140	12.94
150	14.87
160	16.95
170	19.17
180	21.54
190	24.05
200	26.71
210	29.51
220	32.47
230	35.58
240	38.84
250	42.27

Table 1. Water Pressure vs. Airspeed.

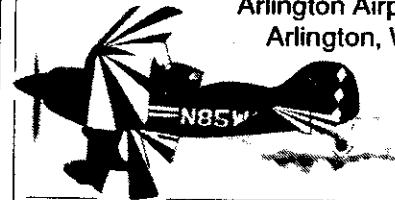
Airspeed mph	Airspeed knots	Inches water	PSI pressure
50	43	1.26	0.042
70	60	2.47	0.084
90	77	4.09	0.139
110	95	6.11	0.207
130	112	8.53	0.290
150	129	11.4	0.388

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