Pitot-Static System Leak Detector™

Finally an inexpensive and reliable tool to check pitot-static systems for leaks. The AviTool pitot-static system *Leak Detector* kit includes all the components and detailed instructions needed to safely and reliably check most certified and experimental GA aircraft and helicopters.

There is nothing worse than taking your aircraft in for an IFR certification (required every 24 months) to discover that your pitot-static system leaks, delaying and adding cost to the certification. This unnecessary experience can be avoided by testing your aircraft beforehand.

The AviTool *Leak Detector* allows you to individually test your pitot and static systems to the standard required by the FAA (FAR 91.411). In addition to detecting leaks, the *Leak Detector* kit also helps you pin-point the source of leak(s) to repair them.

Warning - Please Read these instructions thoroughly before attempting to work on a pitot-static system. Testing a pitot-static system and the connected "air" instruments is a delicate matter. An error in your testing process can result in damaged instrument(s). Therefore, if you are uncomfortable performing this process as described or you don't understand these instructions, seek someone who is and does.

Disclaimer - AviTool (or its parent, Ohio Avionics) takes no responsibility for any damage to your pitot-static system or instruments that results from use of the *Leak Detector*. Follow these instructions carefully. Check your setup twice before injecting pressure or drawing a vacuum on any test. The *Leak Detector* was designed solely to identify leaks and was not designed for nor is intended to be used to perform pitot-static tests for IFR certification.

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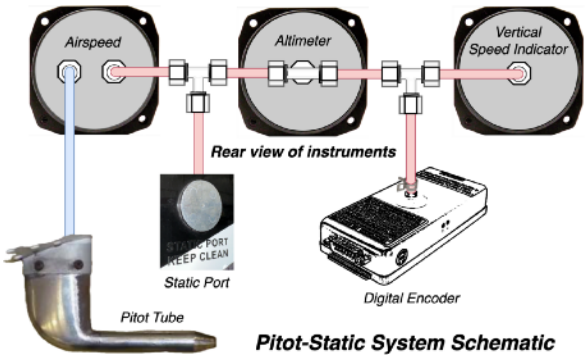

Pitot-Static System Schematic

Pitot-static system basics

Note that when we refer to an airspeed indicator or altimeter, we include their digital counterparts, the ADC (Air-Data Computer) (#20) and EFIS (Electronic Flight Instrument System), used to drive part or all of a "glass" instrument panel.

Pitot-static systems are pressure based. The pitot system is connected to your airspeed indicator and works on forced air pressure entering the pitot tube. The static system is vacuum based

(unless you are flying below sea level) and senses the outside air "pressure" to drive your altitude-related instruments and digital encoder. The airspeed indicator is also fed with static air, used to enable it to compensate for the altitude (air density) affecting airspeed.


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The digital encoder is a small metal box usually found behind the instrument panel that is connected to the static system (#07). The encoder provides altitude data to the transponder. Many ADCs and EFIS' with transponder functionality and newer transponders have this functionality built in. The accuracy of the encoder's altitude data is quite important, as it indicates your (pressure) altitude to ATC so they can route aircraft accordingly. A static leak test includes testing the static "plumbing" connected to the encoder. Don't overlook a possible leak at this connection, as it is not uncommon.

The pitot tube (shown in the diagram on the previous page) is a ram-air device, typically located on the underside of the pilot's wing. Static air port(s) (also shown in the diagram) are small hole(s) found on one or both sides of the fuselage, often between the wing and tail. Cessna static port(s) are usually located in front of the doors. Piper and Diamond aircraft have a combination pitot-static blade-shaped assembly located under the pilot's wing that looks similar to a transponder antenna, see photo below (#10). On some aircraft like RVs, the static ports are often painted and difficult to locate on the sides of the fuselage. There are many variations in both pitot tube and static port designs. These variations make adapting to them for testing, without expense equipment, a challenge.


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What the FAA regs say

The recommended maximum leakage of a closed pitot system should not exceed 10 kts over a minute when the pitot system is "pressurized" to 60-100 kts. Leakage in excess of 10 kts over a minute can adversely affect the airspeed readings. The maximum allowable leakage from a closed static system is 100 ft over a minute when your altimeter is "driven" to 1000 ft over field elevation.

The FAA also stipulates that whenever a static system is opened and closed (i.e., to replace or install an instrument or repair tubing), other than to operate the alternate air source or static drain valve, the static system must be tested for leaks to 1000' over field elevation.

As an aside, prior to taking an aircraft in for an IFR certification, you should confirm that the primary altimeter reads (after tapping it) within 20 ft. of actual field elevation when set to 29.92 Hg. Remember to compensate for the height of aircraft's static port(s) above field elevation, especially if you have a tall aircraft. This 20 ft. tolerance also applies to VFR-only aircraft, but is rarely, if ever, policed.

Connecting to the Pitot-Static ports

This *Leak Detector* comes with a pitot tube adapter consisting of a medical-like latex tube to slip over most cast aluminum/ chrome pitot tubes (#13).


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Small ¼" bent aluminum pitot tubes can be adapted to using the black flexible tubing supplied with the kit, see photo (#15). Pitot tube sizes between these two can be adapted to by wrapping electrical tape around the pitot tube (as a bushing) to increase the diameter to fit inside the latex tube adapter. Then use a zip tie to ensue the seal between the two. If you have difficulty sliding the adapter over the pitot tube, apply a sparing amount of silicone grease on the pitot tube, first, avoiding the pitot orifice.

Connecting the *Leak Detector* to a static port is another story, since static port(s) are typically flush with the side of the fuselage and it is difficult to mount something securely against a vertical, sometimes contoured, surface (#18). We provide a work-around in the instructions, below, though you can purchase an inexpensive suction-cup based adapter from AviTool for this purpose.

As touched on earlier, the Piper/Diamond pitot-static blade assembly also has multiple orifices. Actually, both the pitot and static ports are located on the blade. Some of these blades also have a drain hole in the assembly. Connecting or adapting to this thing is difficult unless you have the special adapter (which AviTool and others sell). In light of this we provide a work-around in the instructions further below.

Newer or upgraded aircraft with a solid-state display have an ADC or EFIS system (defined above) (#20). These devices usually provide altitude data to the transponder in leu of a stand-alone encoder. For this to work, both pitot and static air is provided to them.

Lastly, even the "tightest" pitot-static systems leak a little. A small amount of leakage is tolerable, doesn't adversely affect the values displayed on the instruments and is allowed by the FAA, within reason.

Major Cautions

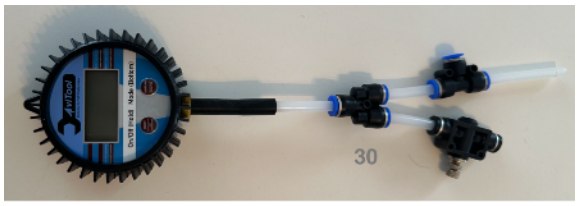
- Never experiment with compressed or canned air in and around pitot-static systems or "air" instruments. Even as little as a couple of psi of pressure incorrectly entering an instrument can be devastating.
- Pitot and static-related instruments are fragile precision devices. Simply blowing sufficiently in a pitot tube or static port can damage an instrument.
- Never apply a suction (vacuum) of any kind to the pitot system. Doing so can deform the diaphragm causing your airspeed indicator to read lower than actual.
- When applying or releasing pressure or vacuum to/from a pitot-static system, limit the rate to no more than your VSI was designed for, e.g., +/- 2000 ft/min. For aircraft with only digital panels (no analog air instruments), +/- 3000 ft/min is acceptable.
  - The *Leak Detector* uses a series of medical syringes as pumps to apply and remove pressure. Great care must be taken to not jerk or rapidly move the plunger.
  - The *Leak Detector* also incorporates a multi-turn needle valve allowing you to control the release of pressure or a vacuum.
- Don't disconnect any component of the *Leak Detector* while under test. Slowly release the pressure or vacuum from the system first.
- Don't yank tubes out of push-to-connect fittings without fully depressing the release ring/flange toward the fitting. Doing so will damage the tubing requiring trimming.
- For aircraft equipped with pitot heat, ensure it's turned off and cool before sliding on the pitot tube adapter.
- To facilitate slipping the pitot tube adapter on the pitot tube, apply silicone lubricant sparingly to the pitot tube while avoiding all orifices.

- Don't fiddle with the *Leak Detector* components or tubing while performing a test, as this will cause slight pressure variations in the tubing that will cause the instrument readings to fluctuate.
- Assemble, configure and use the *Leak Detector* as described and double check your setup to avoid damaging your aircraft instruments.

Working with Push-to-Connect (PTC) Fittings

- If you are unfamiliar with PTC fittings, realize that when you insert a tube it will seem to stop about ¼" in. (#25). Don't let this fool you, continue to push the tube in another ¼", until it truly bottoms out in the fitting.

- To remove tubing from a fitting, hold the blue or black flange (that surrounds the tube to remove) toward the fitting and pull the tube out. Some fittings are more stubborn than others to release the tube - with the ring fully depressed, pull harder.
- Repeated connections and disconnections of tubing with PTCt fittings can ware and mar the tubing causing it to leak at that point. If this occurs or you just wish to be cautious, cut off about ⅜" from the end of the tubing. Use the air tubing cutter tool supplied with your kit.



Initial *Leak Detector* Assembly

Your Leak Detector comes partially assembled - to complete the basic assembly:

1. Remove the gauge from the bubble cushion bag
2. Remove the "Y" assembly from zip lock bag "A"
3. Slide the ¼" nylon tube attached to the gauge into the open (top) fitting of the "Y" assembly as shown above (#30).

Note, each type of leak test requires a different configuring of the Leak Detector. Detailed configuration instructions are provided below for each type of test.

Numerous components come with the *Leak Detector* kit. They are organized in labeled zip lock bags. After assembly and use, it is a good idea to break down the test system and return them to their respective bags to facilitate reassembly.

The kit also comes with a suction cup to hang the gauge on the side of the aircraft during use (#32).

Operation of the digital pressure gauge

Note that the gauge displays a negative sign (-) before vacuum values. No "+" sign is shown for positive pressure values (#35).

• To replace the two AAA batteries in the digital gauge, access the battery door on the upper-back of the gauge. Pull the rubber protective shell out from the top and upper sides of the gauge body enough to pop the door open (see photo). To close the door reverse the process (#37).

- To turn the gauge on, tap the left button. *Note that the gauge automatically powers off (to preserve the batteries) after 20 seconds if it is not sensing a pressure or vacuum above 5 mBar (0.5 kPA).*
- To turn off or reset/zero the gauge, push and hold the left button for a few seconds.
- To toggle between mBar and kPA units, tap the left button when the gauge is on. For our purpose, it doesn't matter which units you use for measurement - we are looking for relative stability of readings (indicating a good system) or decreasing readings (when there is leakage).
- The right button allows you to toggle between display functions like the minimum, maximum, average and current "pressure". You should keep the gauge set to "Current…" (the bottom option on the right side of the display), which is also the default option when you turn on the gauge.
- Note, If the gauge does not display zero after you have released the pressure/vacuum from the test system, turn the gauge off, then back on.
- Last, the Bluetooth function of the gauge is disabled.

Equating gauge with aircraft instrument readings

Aa indicated earlier, the digital gauge reads both pressure and vacuum as either mBar or Kpa. This is okay for detecting a leak, but it doesn't substitute for an actual airspeed indicator, altimeter or vertical speed indicator when trying to determine the extent of the leak. The following table enables you to convert from a gauge reading to the approximate airspeed or altitude reading, or the loss thereof. This is deal when the instruments are excluded from the pitot-static system.

Approximate Leakage Equivalency Table

Gauge Reading		Static System	Pitot System	
Kpa	mBar	Feet/Minute	Kts/Minute	Mph/Min
0.1	1.0	50	35	40
0.2	2.0	100	50	60
0.5	5.0	200	65	75
1.0	10.0	300	90	100
1.5	15.0	450	100	110
2.0	20.0	550	110	125
3.0	30.0	800		

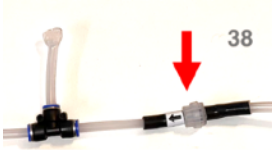
Avitool Leak Equivalency Table

Note, the supplied digital gauge is an ideal tool for determining the rate of leakage, but when dealing with very small leakage values, to be accurate, use the aircraft's airspeed indicator or altimeter (with a time-piece).

***Leak Detector* Self-Test**

It is important that you test the Leak Detector, itself, for leaks each time you configure it for a different test. Should the *Leak Detector*, itself, leak when connected to a pitot-static system, it will appear that your system is leaking. This "self test" configuration is similar to what you will use to test your pitot system.

<u>*Leak Detector* self-test setup</u>



1. Install the one-way valve so the arrow points toward the tee PTC fitting (#38).
2. Select the small 5 mL air injector, labeled "Self Test Air", and confirm that it is disconnected from the *Leak Detector* configuration.
3. Pull the plunger of the pitot air injector out to the 5 mL position.
4. Insert the end of the ¼" tubing connected to the pitot air injector into the open port of the one-way valve.
5. Turn the air injector so that you can see the mL scale printed on the side of the tube when you push the plunger.
6. Insert the longest piece of ¼" tubing into the side of the tee PTC fitting.
7. Install a PTC union fitting on the end of the long piece of ¼" tubing.
8. Insert a tube plug, a black plastic 1/4" OD pin (supplied in bag "C") (shown w/ paperclip, #41) into the open port of the PTC union fitting.

9. Confirm that all the tubes are fully seated in the PTC fittings.
10. Confirm the <u>lock-ring</u> on needle valve is loose (positioned up the shaft) (#43.)

Performing the *Leak Detector* self-test

1. Close the multi-turn needle valve, clockwise without over-tightening.
2. Turn on the digital gauge by tapping the left button. The display should show zero(s).
   Note that the gauge will turn off after 20 seconds unless it is sensing pressure/vacuum in excess of 5 mBar (5.0 kPA).
3. Confirm the small arrow on the right-side of the gauge display is in the bottom ("Current…") selection position (default). If not, tap the right button until it is (there are 4 positions/options).
4. Access a time piece that contains a second-hand.
5. Slowly, push the pitot air injector plunger in about half way until the gauge shows just over 20 mBar (2.0 kPA). The plunger may retract a small amount and the gauge value may show a slightly lower value then stabilize and not continue to decline.
   - If the gauge value continues to decline toward zero, either you have a poor seal on a *Leak Detector* connection or the one-way valve is not sealing. Check that all the tubing connections are fully seated. If in question, pull on the tube connections (without pressing the release ring) to see if any are lose or remove the tubes and re-insert - there should be two noticeable "stops".
   - If you believe that the one-way valve is leaking, refer to the Troubleshooting section, near the end of these instructions.
6. Once the pressure settles, it should not decline over a minute.
7. After completing a successful test, open the needle valve to release the pressure from the system.
8. To repeat this "self" leak test, remove the pump from the configuration, set it to the 5 mL position, reinstall it and repeat the test.

Pitot system leak test

This test determines the integrity of your pitot system and airspeed indicator. Interestingly, the airspeed indicator is connected to both the pitot and static systems in the aircraft. One side will affect the other side, but no air should be exchanged between them directly nor should escape out through the instrument case.

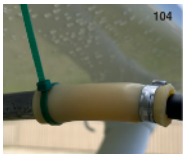
A word of caution - like other "air" instruments, a sudden increase or decrease in test pressure or vacuum can damage the instruments. Similarly, applying too much pressure or vacuum can force an airspeed indicator out of range shifting its calibration - making it inaccurate - or worse, inoperable. As a reference, 1 psi of pitot pressure equals approximately 205 kts or 235 mph on the indicator.

Pitot System Test Setup

1. Assemble the *Leak Detector* the same as for the self test, above, except, without the plug inserted in the tee fitting. Then:
   a. Insert one end of the long ¼" tube (supplied) into the tee as shown (#55).
   b. Open the air release value of the test system.
   c. Ensure the one-way valve is installed so the arrow points toward the gauge.
   d. Locate the medium-size (20 mL) air injector labeled "Pitot/Static Air, 1 Inst.". Before installing it, confirm the plunger is pulled out to the "20 mL" position, then, without disturbing the plunger, insert the injector-snoot into the open end of the rubber tube leading to the one-way value.
2. Wipe off the pitot tube of any debris and scale. A Scotch Brite® cleaning pad works great, then a towel.
3. If the aircraft has a traditional cast aluminum "L" shaped pitot tube:
   a) Locate the pin-size drain hole(s) on the bottom-rear and/or top-rear -back of the casting. (#100 &101)

   b) Thoroughly tape over these holes with poly (electrical) tape. Any leak caused by a poor tape job shows as a leak in your pitot system (#103).

   c) As a safety tip, let the roll of tape or a colored rag dangle below the tube as a flag to remember to remove the tape when you have finished.
   d) Slide the latex pitot tube adapter (provided) onto the pitot tube. As mentioned above, you can apply a small mount of silicone lubricant to the pitot tube to help with this, but avoid all the orifices.
   e) Secure the pitot tube adapter it with a zip tie wrapped around the latex tubing (#104).



   f) Connect the end of the long ¼" tube (supplied) to the pitot tube adapter.
4. If the pitot tube consists of a small aluminum tube, use the flexible black tubing (supplied),

to adapt to the long length of ¼" tubing. (refer to photo #15 on page 2)

a) If the pitot tube is too large for the black tube and too small for the latex tube adapter, cut a short 1-2" section of a scrap tube as a bushing or wrap electrical tape around the pitot tube until it is sufficiently large enough to seal within the latex tube adapter. Be sure to secure the overlap a zip tie.

5. If the pitot tube is an unusual design, like the Piper/ Diamond pitot-static blade assembly, and you don't have the special adapter (it's not supplied):
   Note that this approach requires adding a test port in the form of a tee fitting in your pitot line which you will cap off after testing the system.

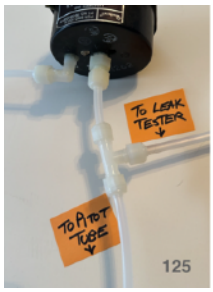
   a) Tightly tape over ALL the small holes in the blade assembly - it may have two or three - with poly (electrical) tape. Wrap extra tape around the blade to help secure the tape. See photo below (#110). Add a flag or allow the tape roll to dangle to serve as a reminder to remove the tape when you are finished.

   b) Note, if you plan on performing a static leak test on the same aircraft, leave the tape on the blade until you have completed the static leak test, below.

   c) Access the rear of the airspeed indicator. It will have two air fittings, one labeled "P" and the other "S". The "P" fitting is usually in the middle of the instrument. You can take a picture of the back-side of the instrument with your cell phone to determine this. See the "P" and "S" in the photo (#115).

   d) As a confirmation, follow the "P" line. It should lead toward the pitot tube on the left wing. Along this path you may find a pitot drain valve. The POH should show if the aircraft has a pitot drain valve.

   e) Find an accessible point along this tube and insert a tee fitting (one is provided for ¼" tubing with the kit). The photo shows the tee added just behind the airspeed indicator, with the line at base of the tee going to the *Leak Detector* (#125).



   f) Insert the long ¼" line provided with the kit in the open port of the tee fitting.

   g) Tighten the threaded fitting just beyond finger tight, but don't force with pliers.

Pitot System Test

1. Confirm you have assembled the *Leak Detector* as described and shown above.
2. Gently close the multi-turn air release valve.
3. Locate a time piece with a second hand (or cell phone with seconds display).
4. Ideally, position yourself so you can see the airspeed indicator. If not, watch the test system "pressure" gauge.
5. Turn on the test system gauge by tapping the left button. *Note that the gauge will turn off after 20 seconds unless it is sensing pressure/ vacuum in excess of 5 mBar (0.5 kPA).*
6. Now slowly inject enough air until the airspeed indicator reads roughly 100 kts (120 mph) or the test system gauge reads roughly 14 mBar (1.4 kPA), then stop injecting.
   a) If you exhaust all the air in the pitot air pump (the plunger bottoms out), it is likely you have a pitot system leak. Let any pressure in the pitot system dissipate naturally or use the multi-turn valve to do so slowly. Exit this test at this point.
   b) When you stop injecting pressure, the air pressure in the system should stabilize to within 5% of the initial airspeed (≈100 kts) or gauge read 0.4 kPA (14 mBar).
7. Watch your time piece for one minute.
8. After one minute, note the airspeed, then subtract it from the stabilized value a minute before. *For example - you inject air until the airspeed indicator reads 100 kts. It settles to 96 kts within a few seconds. Start your clock. After a minute, note the airspeed.*
9. *If the airspeed drops more than 5 kts from the stabilized airspeed a minute before, the pitot system has an unacceptable leak.*
10. Open the air release valve slowly to bring the airspeed indicator back to 0. It is now safe to remove the air injector pump and detach the tubing from the aircraft.
11. If there's a leak, check your connections again and repeat the test.
    a) To reset the plunger (out again), remove the air injector from the system, retract the plunger to "20" mL, reinstall it and rerun the test from step 2 above.
12. If there still appears to be a leak, you will need to investigate the pitot system to determine its location. A list of things to check are included at the end of this document - Refer to the "Locating Leaks" section.
13. Once finished with pitot system testing:

a) Remove any pitot tube adapter and tape you applied to cover any pin holes, unless working on a Piper or Diamond aircraft.
b) If you inserted a tee fitting to gain access to the pitot system, remember to replace the long ¼" tube that leads to the Leak Detector with a plug (supplied), then tighten the tee fittings. ■

Static system NEGATIVE pressure leak test

This test determines the integrity of your static system and altitude-related instruments. Static air is also provided to the other side of the airspeed indicator to compensate for air density at altitude. The static system of your aircraft and the connected instruments work on negative pressure (a vacuum) when you ascend and increasing pressure (less vacuum) when you descend.

Unfortunately, most static systems contain many more components that create more leak "opportunities". These include more tube fittings (especially behind the instrument panel), an alternate air source (valve), possibly a static drain, more instruments cases to leak and more tubing. The aircraft maintenance manual should give you an idea of the static system components and their location.

Just as there are more leak opportunities in a static system, the more components there are, the more air/volume or vacuum is required (by the *Leak Detector)* to cause the altimeter to read the desired result. Consequently, two different size pumps are provided for this purpose. The 20 mL pump is for aircraft with one analog instrument (altimeter, VSI) and the 50 mL pump is for those with more than one analog static instrument. It is assumed in both cases that an analog airspeed indicator is part of the mix.

A word of caution - A sudden increase or decrease in test pressure or vacuum can damage the instruments. Providing positive pressure in excess of 1.1 psi to an analog altimeter (forcing it backwards significantly below 0') can damage the instrument. Remember, also, that the airspeed indicator is attached to the static system as well and reacts similarly. As a reference, 1 psi of positive pressure will force an altimeter down roughly 1000', or amazingly the same distance up (1000') with 1 psi of vacuum.

Static System NEGATIVE Pressure Test Setup

1. Assemble the test system as described and pictured below.
   a) Open the *Leak Detector* air release value.
   b) Ensure the one-way valve is installed so the arrow points toward the pump.
   c) Locate the 20 mL or 50 mL air extractor (based on the number of analog static instruments in the panel - refer to recent paragraph on this topic).
   d) Confirm the plunger is seated at the bottom of the tube, then install the extractor pump snoot into the tube leading to the one-way value as shown, just above (#130).

2. If the aircraft is fitted with an alternate air source, exercise it a few times (to improve its seal) and return it to its normal closed position.
3. Similarly, if the aircraft has a static drain (usually close to the pilot's legs), exercise it as well, then return it to its normally closed position.
4. If you haven't already done so, determine how many static ports the aircraft has and where they are located (refer to the POH). Some static ports are hard to find due to them just being pin-size holes and may have been painted.
5. Wipe off the static port(s) and the surrounding few inches of any dirt and oil.
6. If you are using a AviTool static port adapter (not included in the kit), refer to its instructions for its setup and use.
7. Tape over over the static port(s). Use several inches of wide poly tape (supplied). Ensure there are no folds or bubbles that could allow leakage.
   a) If using an AviTool static port adapter, leave one static port uncovered.
8. If you are working on a Piper or Diamond aircraft with a pitot-static blade assembly and you don't have the special adapter to interface to it, carefully tape over all the ports as described for "Pitot Pressure Setup", above.
9. When not using an AviTool static port adapter:
   a) Confirm that you have taped over all the static ports of the aircraft.
   b) Locate the static tubing in the aircraft that connects the static port(s) to the air influenced instruments.
   c) Install a tee fitting in the static tubing where you have relatively easy access:
      • If done at a tube fitting, loosen the fitting/ "nut" and pull the tube out, then cut a short section of ¼" tubing (supplied) and insert it in the open port.
      • To install a tee fitting in the static tubing, itself, simply split (cut) the static tubing.
      • Insert the tee fitting (supplied) between the open ends of tubing. Later, when

done, you will cap the open port with a plug (supplied).

d) Connect the long length of ¼" tubing leading to the *Leak Detector* to the open port of the tee.

e) Tighten the threaded fittings/"nuts" just beyond finger tight, then snug with pliers ½ turn.

10. Attach the other end of the long ¼" tube from your tee (or AviTool static port adapter) to the open port of the tee fitting of the *Leak Detector*, if not already attached there.

Static System NEGATIVE Pressure Test

1. Confirm that you have assembled the *Leak Detector* as described just above with all the tubing fittings snug and sealed. A leak in the test system will appear as a leak in the aircraft static system.
2. If you can access the aircraft's altimeter, set it to the closest 1000' mark while tapping it. Tapping the altimeter corrects it for any friction or drag holding the pointer back.
3. Gently close the air release valve.
4. Locate a time piece with a second hand or a cell phone with seconds displayed.
5. Turn on the *Leak Detector* gauge by tapping the left button. *Note that the gauge will turn off after 20 seconds unless it is sensing pressure/ vacuum in excess of 5 mBar (5.0 kPA).*
6. Now slowly pull the plunger out of the static air pump until the altimeter reads roughly 1000' this setting (after tapping) or ≈-36 mBar (-3.6 kPA) on the gauge, then stop.
   a) The "air pressure" in the static system should stabilize within a few seconds to within 20-40' of the target altitude or, if using the gauge (supplied), to 2-5 mBar (0.2 -0.5 kPA) of its original "pressure".
   b) Should the plunger reach the outer limit of its travel in the pump and you note a continual decrease in altitude or reduction in gauge pressure, it is likely you have a static system leak. Let the static system naturally "leak" to ground level or use the multi-turn valve to do this slowly.
   c) Before attempting to locate a leak, repeat this test after checking for any user-induced leaks.
   d) To repeat this test, remove the pump from the tester configuration, push the plunger in so it is seated at the bottom (0 mL), reinsert the pump in the open end of the one-way valve, then repeat the process from step 3 above.
7. Tap the altimeter and note the altitude or read the value shown the gauge.
8. Watch your time piece for one minute.
9. If after a minute, read the altimeter (after tapping) or the gauge value.
10. If the altitude (after tapping) dropped by less than 100' or the gauge value dropped by less than 5 mBar (0.5 kPA) from its original stabilized reading, the static system is okay - has acceptable leakage. *For example, you extract air until the altimeter reads 1000' higher or the gauge reads 3.5 mBar (35-36 kPA) lower than 0, then wait a few seconds while the static system settles. Start your timer for one minute. If during this time the altimeter drops more than 100' or the gauge increases more than 5 mBar (0.5 kPA), you have a leaky system that must be fixed.*
11. Before moving the plunger or disconnecting the test system from the aircraft, open the air release valve slowly (to bring the static system back to ground level). Be careful to limit the rate of descent such that it does not exceed the maximum rate displayed on the aircraft's vertical speed indicator.
12. When you have finished this leak test, If you don't plan on performing the positive pressure (Negative Altitude) test, below:
    a) If you inserted a tee fitting to gain access to the static system, replace the long ¼" line that lead to the *Leak Detector* with a plug (supplied), then tighten the tee fittings.
    b) Reset the altimeter to field elevation or the current Hg reported value. ■

Static system POSITIVE pressure test

One of the tests required by the FAA when performing an IFR certification is to test instruments operation below sea level. Yes, there are places in the US 600 feet below sea level. This test tests the static system for leaks with positive pressure causing altimeters/encoders to read negative values and the airspeed indicator to try to show negative speed.

Interestingly, this is actually a good test, as tubing reacts differently to positive pressure than a vacuum. Cracked plastic tubing opens up under pressure revealing a leak that might go undetected under negative pressure which pulls cracks tighter together.

Caution - Applying a positive pressure to your static system will cause any attached analog airspeed indicator to try to turn backwards (CCW) below 0. It is critical that you do not over pressurize the static system during this test. Doing to can result in damage to your airspeed indicator. The maximum positive air pressure applied to the static system should not exceed 10 mBar (1.0 Kpa), equivalent to about -200' on an altimeter.

POSITIVE pressure static system test setup

Follow the instructions above for Static System Negative Pressure Setup, except:

1. Reverse the direction of the one-way valve, so the arrow points away from the pump.
2. Locate the 20 mL pump and "cock" it to no more than the 10 mL position.
3. Insert the pump into the rubber line feeding the one-way valve (#135).

POSITIVE pressure static system test

1. Confirm that you have assembled the *Leak Detector* as described above to perform the positive pressure test, and the one-way valve arrows point away from the pump.
2. Gently close the air release valve.
3. Locate a time piece, if you have not already.
4. If you can view the altimeter while operating the *Leak Detector,* set it to the nearest +1000' mark, otherwise refer to the gauge.
5. Turn on the gauge by tapping the left button.
6. Slowly push the pump plunger in until the altimeter reads roughly 200' below its original reading or 7 mBar (0.7 kPA) on the gauge, then stop.
   a) Depending on your field elevation, the altimeter may read below zero.
   b) The "air pressure" in the static system should stabilize within a few seconds to within 20-30' or a about 1 mBar (0.1-0.2 kPA) less than the original pressure applied.
7. Tap the altimeter and note the altitude or read the value shown the gauge.
8. Watch your time piece for one minute.
9. After a minute, note the altitude (after tapping) or gauge reading.
10. If the value(s) were gradually/steadily decreasing during the minute, then there is a leak, probably in the tubing itself if the tubing tested good in negative pressure test above.
11. If there is little or no decrease in value(s), you have a solid static system.
12. Drain the static system of any remaining pressure by opening the multi-turn valve.
13. To repeat the pressure test:
    a) Remove the pump from the tubing leading to the one-way valve.
    b) Retract the pump plunger to the 10 mL position.
    c) Re-insert the pump into the rubber line feeding the one-way valve.
    d) Repeat the instructions from from step 2 above.
14. Once you have completed the positive pressure leak test and if you don't plan on performing any other tests:
    a) If you inserted a tee fitting to gain access to the static system, remember to replace the long ¼" line that lead to the *Leak Detector* with a plug (supplied), then tighten the tee fittings.
    b) Reset your altimeter to field elevation or the current Hg reported value. ■

Locating leaks

General Considerations

- Before concluding that you have a leak in the aircraft, if you did not first check the *Leak Detector* system by itself, now is the time. Refer to the section titled "*Leak Detector* Self-Test", further above.
- If you have determined that you have a leak and it is not obvious where it resides, it helps if you draw a schematic of your pitot-static system. No two aircraft will have the same tubing configuration and fittings. The drawing will help you understand what you are dealing with and develop a strategy to address the leak(s).
- As was hinted just above, it is not uncommon to have multiple leaks in a system. So, once you have repaired a leak, test the system again.
- If you are using an AviTool pitot or static port adapter, ensure that the long 1/4" line leading to the *Leak Detector* is fully inserted in the PTC fitting at the adapter.
- The first thing I do after confirming that I have a leak, is to ensure that all the fittings that I can reach in the aircraft are tight. Fittings less than finger tight tend to leak. A rule of thumb, though, is to tighten nylon fittings ½ turn more than finger tight.
- An excellent strategy to apply when trying to locate a leak is to divide the system into sections and test each section separately. The kit includes common fittings and caps to aid in this process. If you discover a leak in a section, divide it further and repeat the test until you identify the culprit.
- The plastic tubing used for most pitot and static systems in GA aircraft is good for about 10 years or so, after-which it becomes less flexible and can crack. When it does crack it often is in line with the path of the tube. Interestingly, tubing cracks are not always detected during a vacuum-related test - as the tubing is pulled tighter together - but the tubing leaks like a sieve during the positive pressure test.

- Check the routing of tubes, especially behind the instrument panel, where things tend to get sloppy. Use zip ties to secure the tubing.

• In the rare instance that you find that your pitot or static system is clogged or plugged (e.g., by a mud dauber, insect, small bird-strike, wax or paint), DO NOT use shop air to blow out the system. Be sure to separate your instruments from the rest of the system before you get creative. Don't push or blow blockages into a system, only out, as they ultimately will reside in an instrument.

• Should you need to replace a pitot or static tube, do so with with quality nylon tubing and fittings.
  - Commonly available poly tubing deteriorates when exposed to fuel and fuel fumes and should not be used in aircraft.

• If plastic tubing looks warn, scratched or compressed after you remove it from a fitting, cut off about ½" and reinsert.

• When trimming or replacing a section of the pitot-static system tubing, cut the tubing cleanly and perpendicular to the tubing with a sharp knife or the tubing cutter supplied with the *Leak Detector* kit.

• PTC (push-to-connect) fittings are not 100% reliable. Blue aluminum AN-type and brass fittings are excellent, but more costly. Nylon fittings are excellent, long lasting reliable and cost-effective.

• As a general rule, the threaded components (like found on the back of instruments and inside of static ports) are ⅛" NPT.

• Should you find that your leak detection leads to an instrument, realize instrument cases can leak as they age - the front seals and o-rings around shafts dry out and deteriorate. Instruments are not user-repairable and require calibration and certification after overhaul.
  - You can test an individual "air" instrument by connecting the *Leak Detector* directly to it and performing the appropriate leak test. Realize you will need less air volume (mL) for this test.

<u>Pitot System Leaks</u>

• If the aircraft has a traditional cast-aluminum "L" shaped pitot tube and you are using the supplied pitot tube adapter, confirm that you have securely covered all the small (pin size) drain hole(s) with tape on the bottom and rear of the pitot tube, including any hole near the top-rear where it intersects with the mount.
  - The design of pitot tubes varies, as do the number and placement of the small drain holes. Inspect the pitot tube closely to determine and cover them before performing this test.
  - Obviously, don't cover the opening on the front of the pitot tube.

• When using the AviTool latex pitot tube adapter, ensure it is tight around the pitot tube and shoved on at least an inch or so. As mentioned above, you can wrap a zip tie around the latex tube to ensure a good seal.

• If it appears that your pitot tube is leaking, open the inspection plate under the wing near the pitot-tube and check the connection where the pitot-system tube attaches to the pitot tube itself.
  - If the aircraft has a heated pitot tube, occasionally these pitot tubes will crack internally due to thermal expansion-contraction, causing a leak. If the source of the leak appears to be the pitot tube, confirm it by direct connecting to it and performing the pitot leak test and/or remove the tube from the aircraft and do a submerged water test. A leaky pitot tube is not user repairable and must be replaced.
  - Beware of cast-aluminum pitot tubes with two air line fittings. The second one is for the internal angle-of-attack sensor. Take care to not confuse the two when testing or removing the tube. There should be no leakage between the AOL and pitot "ports".

• If you are working on a Piper or Diamond aircraft with a pitot-static blade assembly, and you are accessing the pitot system via a tee fitting that you added; all the holes of the blade must be taped over, including the pitot orifice.

• Airspeed indicator cases can leak, as well as the diaphragm in the indicator (separating the pitot from the static systems). When either leaks it can affect the accuracy of the airspeed indicated.

<u>Static System Leaks</u>

• If your aircraft has multiple static ports, confirm that any you are not connecting to (via an adapter) are taped over for the test. Later, remember to remove the tape!

• If you are using the AviTool static port adapter (not supplied with the kit), remove it and affix it to another clean flat area on the aircraft away from any paint seams and rivets, then rerun the test. If the leak disappears, then you know the problem is not with the adapter or *Leak Detector* system.

• If your aircraft has an alternate static source valve (refer to your POH), confirm that it is in the normally closed position. An open valve will appear as a major leak.

- It is not uncommon for alternate static air valves to fail - the internal O-rings deteriorate or crack. These O-rings can be replaced but removing the value from the panel can be a challenge on some aircraft like older Cessnas.
- If your aircraft has a static system drain valve (refer to your POH) and you have not exercised it to help it seal, do so. These too can fail to seal.
- All aircraft that have a transponder will have a digital encoder attached to the static system. Newer transponders have these built in. Some encoders (like ACK) use an unusually small nipple fitting on their boxes to connect to small tubing which must be adapted to fit standard ¼" OD tubing. Both are opportunities for leakage. It's a good idea to check the tube connection at the encoder earlier than later.
- Some aircraft, like Cessnas and Cirrus' have a small plastic (fist-size) "sump" bottle (#120) attached to the back-side (just inside the aircraft) of their static port(s) to abate moisture entering the system. A photo of the Cessna version is pictured above on page 6. These small plastic bottles become brittle and crack, and their fittings loosen as the plastic ages, causing leakage. Note, these bottles are "polarized" - have different type fittings on each end.

Troubleshooting *Leak Detector* problems

- If an air pump plunger continues move by itself after injecting or extracting air into the system and the gauge display shows a steady decrease/increase in pressure toward zero, during a leak test, it is likely the one-way valve is not sealing. We have tested numerous valves and these have proven to be the most reliable, but not infallible. Occasionally, these will leak due to a small particle or piece of hair preventing the valve from seating completely. Remove the valve with rubber tubes attached from the configuration, place the tube opposite the arrow-direction in your mouth and blow hard. You will feel the valve open, then reseal when you stop blowing. Reinstall it in the Leak Detector appropriately for the test you are performing. If you find the problem is not resolved by this method, let us know.
- If a pitot or static air pump appears to leak during use, remove the plunger (after draining any pressure/vacuum from the test system) and apply silicone spray (not WD-40) to the rubber piston.
- If the ¼" tubing should pull off the small (5mL) pitot air injector, you may need to heat it slightly to slide it back on. Note that there is a second, smaller section of tube inside this tube to serve as a bushing.

Updates

Owners of the *AviTool Leak Detector Kit* have access to news and the latest documentation on the AviTool website (avi-tool.com). Click on the "Support" menu option and enter the password "avitool docs".

How the Leak Detector came to be

Erik Nebergall, the owner of Ohio Avionics is a FAA-certified avionics repairman, experimental aircraft builder and instrument-rated pilot. Ohio Avionics, an avionics repair station, was the outgrowth of his interest helping aircraft owners to maintain the currency of their transponder and IFR certificates. The *Leak Detector* was the result of finding so many "leaky aircraft" during pitot-static leak tests, delaying IFR certification and incurring additional cost/labor for the aircraft owner. AviTool is the aircraft maintenance tool supplier arm of Ohio Avionics.

***Leak Detector* Warranty**

Should the *Leak Detector* system or any component of the system (other than batteries) fail within 90 days of purchase, AviTool will repair or replace it at no cost for the original owner.

Providing feedback

AviTool welcomes your feedback. This includes corrections to the instructions, problems you're having with the *Leak Detector,* as well as additional components that would enhance the kit. Please take the time to call us at (513) 531-0300 or send us an email at sales@avi-tool.com and let us know about your experience.

What the Leak Detector kit includes

- Detailed setup & use instructions, cautions to avoid damaging your instruments and suggestions on locating leaks, as well as an introduction to pitot-static systems and the applicable FAA regulations.
- A digital pressure/vacuum gauge to accurately determine the leak rate and suction cup to hold it.
- An adapter to fit over most pitot tubes, whether an aluminum casting or ¼" OD aluminum tube (using a bushing), as well as a tee fitting for direct connection to the pitot-static system.
- Numerous aluminum, nylon and brass fittings to adapt to most aircraft pitot-static systems.
- Tubing "plugs" to terminate sections of the pitot-static system to aid in leak diagnosis.
- A roll of ¼" poly tubing, very sharp tubing cutter, and carrying case for all the above.

Note, Avitool offers (as an accessory) a suction-cup based universal static port adapter, as well as a number of tools to facilitate avionics repair and aircraft maintenance.

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