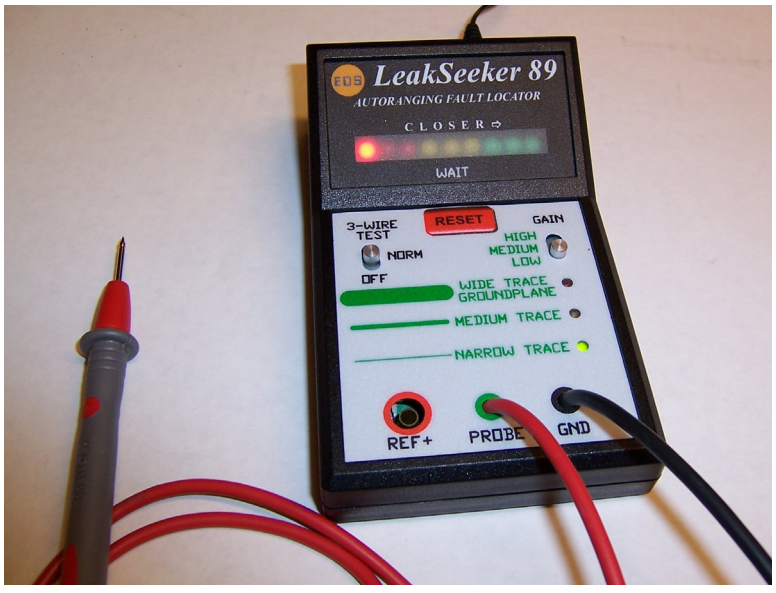


# Meet the LeakSeeker 89 AutoRanging Fault Locator

**Editor's Note:** We ran a press release about this new unit previously in Slot Tech Magazine. Here is how to use it to locate a shorted component on a PCB.

Locating shorted components on PCBs has not been a common issue in the past. However, as we have move to SMD and, especially, the use of high-density, Tantalum capacitors (which have a tendency to short-circuit when they fail at a higher rate than aluminum, electrolytic capacitors, which dry out and open-circuit almost 100% of the time when they fail) it can be important to be able to quickly locate a "mystery short" on something like a power bus.

Engineers hang capacitors all over the power buss in a circuit. Sometimes, these are fairly high-value electrolytic capacitors (100-470 microfarads typically) that are used to present a nice, low-impedance source, physically close to the device that will be using it. A good example of this is the electrolytic capacitors that are placed across the DC input to the A-to-D PCB (the "video" or "scalar" PCB) in an LCD monitor. Because the small "brick" type of power supply may be located a meter away from the monitor at the end of a fairly thin wire (causing voltage fluctuations as the current draw is modulated), the charged electrolytic capacitor acts as a "source" that's only a few millimeters away from the DC-DC Converter. In other words, it's like having another power supply that is very close to the load and no longer subject to voltage drop due to resistance.

Other, smaller capacitors may be placed across the power buss as well. These can range from small, ceramic capacitors that are measured in picofarads (millionths of a millionth of a farad) to .47 or even 1 microfarad. A rating of .1 microfarad is typical for these so-called "bypass" capacitors whose function is to shunt any high-frequency electrical "noise" (typically generated by the switching circuits in the electronics themselves, not from outside sources) to ground, thus eliminating it.

And this is often where our problem lies, especially if SMD, Tantalum capacitors are used as bypass capacitors. If just one of these capacitors fails and develops a short-circuit or low resistance, the entire power buss is taken down. It's easy enough (in general) to determine that the buss is shorted. The power supply voltage will be taken down (often to zero if the power supply's "over-current protection" or OCP has kicked in) with the faulty device connected but will pop back up when it's disconnected OR a "power-off" measurement of the RESISTANCE across the power buss will be very low when compared to "normal."

The challenge here is to locate the shorted compo-

nent, which could be just about anywhere! The power buss goes out to all of the devices on the PCB and these little bypass capacitors are sprinkled like Fairy Dust across the board to keep the EMI in check. If any one of these capacitors short-circuits, the entire buss is dragged down but you can't locate the short with an ordinary ohmmeter because all of the components that take power from the buss or are across the buss will appear to be shorted to an ordinary ohmmeter (the resistance setting of your digital multimeter).

That is where the "LeakSeeker" comes into play. The LeakSeeker is a sophisticated "intelligent" ohmmeter that can read down to thousandths of a ohm ("milliohms"). As anyone who has attended one of my tech classes knows, I work as little as possible with the power on. I don't want to slip with my meter or oscilloscope probe and accidentally cause additional damage to the unit I'm trying to fix! The LeakSeeker is designed to be used, safely on a non-powered circuit. It supplies its own precise test voltages. Be sure power is disconnected from the unit under test, or your LeakSeeker may be damaged!

The LeakSeeker model EDS-89 will locate a shorted or leaky component or any other shorted condition (such as a pinched wire or solder bridge) with a short resistance value from zero to 300 ohms, to the exact spot on a pc board. If the unit has multiple pc boards, LeakSeeker will first identify which board contains the defective component, then will guide the technician directly to the location of the defective component on that board. The EDS-89 version is an updated version of the original LeakSeeker EDS-82 series with three sensitivity modes, all fully automatic. Tests are done simply by touching the solder pads along a "shorted" foil trace and the pad with the highest pitch marks the defect.

**How the Leakseeker Works**

The EDS-89 LeakSeeker pinpoints the exact location of a shorted or leaky component by comparing the resistance at different component solder pads along a shorted pc foil trace, and subtracts the foil's milliohm resistance from the value of the defective component. Therefore, there is a different reading at each pad, although by a very small amount, with the lowest reading at the short. Leakseeker consists of a 16 bit self-calibrating digital comparator with a range of zero to 300 ohms, auto memory, and a variable gain comparison circuit with visual and audible indicators. Initial search for a shorted component automatically starts at the LeakSeeker's maximum range and counts down to the resistance of the defective component, within a "window" that is indicated by nine small distance LEDs. It also uses a variable pitch tone, which will be at its highest when the test probe is touching the pad where the resistance is lowest.

LeakSeeker can use one of two different test methods to locate the defect. The NORMAL test causes a precise voltage/current to appear at the test PROBE, and as the technician touches each pad, the small difference in the voltage/current readings is translated into the change of the beep pitch and distance LEDs. This test method is ideal for finding the location of typical "dead" shorts under a few ohms.

The 3-WIRE test is used when the readings are confusing, for example, if the "short" is actually many ohms, and a large electrolytic capacitor is somewhere along the trace. Instead of a steady tone, the pitch may constantly change as the capacitor tries to charge or the leaky defective component warms up, making stable readings impossible. The 3-WIRE test separates the precise voltage reference +REF from the PROBE port. It is more difficult to use, so the technician should have a thorough understanding of the normal testing methods first.

*First, some important notes that you need to remember:*

LeakSeeker recalibrates itself automatically to a new

range as you get closer to the defect, as ohms get lower. If you get further from the short and resistance goes higher, a lower pitch of the tone, and eventually no tone at all and the lowest red indicator will be the only indication. If you loose your way, or accidentally touch the wrong pad, you can push RESET and LeakSeeker will re-calibrate itself again, as soon as the PROBE is touched to the correct pad. Remember that all tests must start by pushing the RESET button to clear the memory.

During the normal test, you would touch any pad along the "shorted" foil and allow LeakSeeker to recalibrate automatically as you get closer to the defect. However, if all of the solder pads seem to have the same tone because of the low resistance of the ground plane power source of a multi-layer board, using a higher GAIN allows you to increase the resolution many times.

**Normal Testing**

You should be sure that you are looking for a shorted or leaky part by verifying that the pc board trace you are about to test shows a suspiciously low ohms reading. A quick method for checking any type of unit for shorts is to simply measure the resistance across the largest main filters in the power supply with your ohmmeter. In a normal circuit, you will usually see the cap charging up to several thousand ohms. If you own a CapAnalyzer 88, set the LOW DCR warning slider to 50 ohms. Any cap that shows 50 ohms or less is probably the supply line that feeds the shorted component. Be advised that using an ordinary DVM ohmmeter will not find active shorts. Instead, use the CapAnalyzer or LeakSeeker as you would an ohmmeter. Normal circuit conditions would produce no warnings, while passive or active shorts 300 ohms or less will make LeakSeeker calibrate to the short and give you a steady reading.

For example, a normal power supply output usually shows several thousand ohms, after the filter caps finish charging. If you feel that you have a problem with the supply because voltage readings are low while the unit is powered up, or CapAnalyzer warned you with DCR TOO LOW, remove power and use an ohmmeter across the cap to see if the reading is lower than 300 ohms (the maximum range of the LeakSeeker) to ground. Typically, most good supplies show resistances in the thousands of ohms while most with "shorts" will show just a few ohms, or even less than an ohm. The exception to this instance is when you suspect an active short, where a supply is pulled down by a component that does not show shorted with your ohmmeter. This can happen when, for example, a component shorts, but is powered through a diode. Although your ohmmeter cannot measure past the diode, the LeakSeeker (and CapAnalyzer) can. A steady tone after the LeakSeeker calibrates indicates that it found a suspicious reading under 300 ohms and your search can go on. If it simply chirps or gives no reading at all, then no short (active or normal) was found.

**Getting Started**

Look at the GAIN switch. Notice that the lower gain setting is best for thin pc foil traces, and should be your first choice. If you notice very little pitch changes as you hop from pad to pad, you can raise the GAIN, as the foil traces might be thicker.

You would use the highest GAIN setting for very thick traces or multi-layer boards with ground planes.

In the NORMAL test, the BLACK ground wire alligator clip is connected to the best ground available, preferably at the power source. The connection must be of high quality or the results will be misleading. You can ignore the alligator clip and solder the bare wire (behind the alligator clip) to ground to eliminate this source of errors.
Push the RESET button to let LeakSeeker know to start a new search. The test probe is then touched on a solder pad anywhere along the pc board copper trace that you believe a shorted or leaky component is soldered to. If the board is dense, you might use a thin Sharpie marker to outline the trace, to prevent confusion so that you don't accidentally touch the wrong pad.

As you hold the test probe on the first pad, LeakSeeker will beep at its highest pitch and light the WAIT lamp brightly for a few seconds as it ramps quickly down to the short value. Be patient. As it gets closer, the search will slow, the WAIT LED will flash dimly and you will hear the pitch clicking step by step as it gets a few milliohms closer and closer. When it has calibrated, the pitch will be low and steady and one (or a group) of the nine distance LEDs will be lit. Touching the test probe to the next solder pad along the pc trace should make the pitch higher or lower, depending on whether you are moving in the correct direction. The distance lamps will also give rough indications that you are getting closer or further from the defective component. As you touch the probe from pad to pad in the correct direction, the beeps will get higher in pitch and the distance LEDs will go CLOSER > to the green LEDs. As you get out of range of the window, the WAIT LED will come on as LeakSeeker recalibrates the window. If you get further from the short, the LEDs will reverse toward the red LEDs and the pitch will get lower. You should always make it a habit to go back one pad after each new pad test to make sure the pitch is higher on the new pad and lower on the old pad, as LeakSeeker will recalibrate very quickly and you might not notice.

If you accidentally touch the probe to a wrong pad not on the shorted circuit, like maybe ground, and LeakSeeker notices the huge change, it intentionally waits a second before accepting the huge change and recalibrating. The delay is intentional; if you accidentally touched the wrong pad (like a ground), this delay gives you the time to change your mind as long as you lift off of the pad before the WAIT LED comes on and recalibration is complete. You should always double-check your progress by touching the previous pad—the pitch should be lower than the pad closest to the short. If you goof, just press RESET and start off the last valid solder pad.

On older boards with large traces, or on multi-layer boards with groundplanes, you may find that many pads close to each other may have the same pitch. Use the highest GAIN setting and now you will see and hear a slight change between the two pads. The pad with the highest pitch is your objective. When the tone no longer changes and the WAIT LED is off, the window is perfect.

As you touch each pad, remember to always go back one to double-check that the tone is lower (or gone completely as that window is now long gone). At some point, the beep will be highest in pitch at only one pad along the trace. This is the short, and may be the location of the defective component. If you continue past this pad, the pitch will start to go lower and the distance indicator will start to head towards the red indicators. If you backtrack, the pitch will always be highest at the pad with the lowest resistance, and of the possible defective component.

**But what if the highest pitch can't be the bad part?**

If the highest pitch comes from a pad that is a jumper or wire, or coil or transformer, for example, a component that is supposed to

conduct, this means that the defect is probably on the other side of the component, in another area of the board. For example, if you are tracing a short at the collector of the horizontal output transistor and find that the highest pitch is at the flyback transformer primary, this does not necessarily mean that the transformer is shorted; the short may be on the other side of the winding, at the B+ supply. Follow it like a detective, as you may find that you may be jumper-hopping, coil-hopping, possibly even board-hopping, for example from the HV board, to the supply board and so on, to where the bad part actually is. The obvious parts that could be bad are parts that should never show as a low resistance in the first place, such as a capacitor, cathode of a diode, B+ pin of an IC chip and so on.

### Using the Hot/Cool Thermal Test Method

If the defect is several ohms, you can search for the defective component in another, much easier way. To keep your hand free to hold a can of freeze spray or a soldering iron or hot air blower, use the extra plug-in test cable supplied with LeakSeeker that has the solder wire tip, plug it into the REF+ port, and solder the tip to any pad along the shorted trace. The test mode switch remains in the NORMAL position, which joins the REF+ and PROBE ports together. Press the RESET button and wait for a stable reading.

Higher resistance defective components are always thermally responsive. You can use a can of freeze spray to spray each component on the board while the solder tip test cable is soldered on the suspected trace. The spray will make the LeakSeeker change quickly in pitch when the defective component is sprayed.

### 3-Wire Testing

3-Wire testing is used for times when Normal testing becomes difficult. In these cases, a component may not be shorted, but just leaky; perhaps 50 or more ohms, and a capacitor along the trace tries to charge each time the test probe is touched to a pad. Instead of steady tones, the LeakSeeker will chirp from high to low, or the pitch will vary, making testing very difficult in the NORMAL position as you wait forever for the pitch to get stable, but the 3-Wire test will separate the +REF from the PROBE port, and allow the circuit to stabilize under power. Only use the 3-wire test for higher-ohm shorts over about 10 or 15 ohms and when normal testing is too difficult.

Solder the +REF wire solder tip to the normal source of the power in the supply line you are troubleshooting, for example, at the output of the power supply at the big electrolytic that shows a short to ground. This is important, as the 3-Wire test does not allow testing to start anywhere on the board as the NORMAL testing allows. Make sure the mode switch is in the 3-WIRE test mode. You must start probing at the normal source of power, like at one end of the trace by the large power supply capacitors. Allow about 15

seconds for all voltages, currents and temperatures to stabilize, push the RESET button, then touch and hold the test PROBE at the starting point where the +REF is soldered, and allow LeakSeeker to calibrate. Then touch each pad along the bus and proceed as you would in the NORMAL test. Each reading should now be quick and easy since the special signal from LeakSeeker +REF now is no longer changing.

As you proceed, just as in the NORMAL test, the pitch of the tone and distance indicators will guide you towards the defect. As you probe different branches, you will find that some branches do not have any changes from pad to pad. That is because there are no problems in that branch. Go back to the fork and try another branch.

At some point, you will reach the defect and pass it, and the distance indicators and tone pitch will again no longer change, just like the previous branches that had no problems. The first pad on the branch that is highest in pitch is the location of the defect. Going back towards any other branch will cause the tone to get lower, and going forward will no longer cause the highest pitch to change. Therefore, be sure to notice the exact location at which point the readings no longer change as you pass the defect. The exact location of the first pad that has the highest pitch will be the exact location of the defect. All pads beyond this point will have the same pitch as the first pad of the highest pitch. You can verify the defect by using a blast of freeze spray or directed heat on the suspicious component. LeakSeeker will change pitch drastically only when the defective part is cooled or heated.

## Self-Tutorial

To best be familiar with LeakSeeker, try this little experiment. It will give you the direction and understanding in real time of how to use LeakSeeker. You will intentionally create a defect by soldering in a low-value resistor across a capacitor in a power supply trace, and then use your LeakSeeker to find it.

On an old pc board or discarded electronic component, locate a power supply trace on the main board and check the resistance to ground. You will see how a normal circuit should show, probably a few thousand ohms. Now, solder in a low-value resistor across a large capacitor, or maybe somewhere further down the trace to ground, to simulate a leaky capacitor. For example, you could solder a 4.7 ohm resistor to ground at an integrated circuit B+ or small filter cap. (Of course, don't power up the unit, or you might damage its power supply). Use your DVM or ohmmeter to verify that you get the same 4.7 ohm reading to ground, everywhere along the trace.

With the LeakSeeker power switch in the NORMAL test, push RESET once. Start at some distance from the "short" resistor, along the same foil. Use a Sharpie marker if the trace is very thin so you don't get lost. You should follow the instructions for the NORMAL test and follow the LeakSeeker's advice, tracing a path along the PCB foil trace pads, wires, jumpers and connectors, and end up at the resistor that you soldered in. (Don't forget to remove the tutorial resistor from your experiment when done!)

As you progress, you will get the feel and the personality of your LeakSeeker. Try the 3-WIRE test method only after you have mastered the NORMAL test, as this test is more difficult. You'll usually only need this test with shorts higher than 10 ohms anyway, which are rare.

The unit includes a universal AC adapter with a 2.1mm plug. The internal regulator in LeakSeeker allows it to run from any AC or DC adapter from 9 to 25 volts AC or DC, as long as it has a 2.1mm plug.

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