Application Notes

Application Note 201

Power to Ground shorts
How the Toneohm 950 helps you find them,
and, how FTCam Pro can give you further help with plane short location on complex boards.

Background
Have you ever scrapped a board (loaded or bare) because of an internal power to ground short? Expensive isn't it?
This note explains how the Toneohm 950 works to help you repair many of those boards you may otherwise have considered a write-off.

Secrets of VPS "Vector Plane Stimulus"
To maximise the number of boards you repair it will help if you understand the proprietary Polar "VPS" technique used by the 950 to find power to ground short-circuits. Interested? Then read on...

How does VPS find plane to plane shorts?
VPS is a simple but powerful technique, invented by Polar Instruments.

When ATE or BBT finds a power or ground net shorted, you typically receive a long list of shorted components attached to the net, and the problem is to find exactly where the short is on that net.

Using a 950 you connect 4 plane stimulus leads (VPS) to the 4 corners of the plane. A further lead is connected to the other side of the short (whether another plane or a track).

The magic of VPS happens on the plane driven by the 4 stimulus leads.

First, current is passed from the top left corner to the bottom right corner of the plane. (Call this phase 1). Second, current is passed from the top right corner to the bottom left of the same plane (phase 2)

Current passes diagonally across the board in each of the two phases.

Lets think about what's happening in phase 1. Imagine for a while that the plane is not a plane at all, but a rectangular conductor. Shrink this conductor in your mind until it is very thin, in fact just a piece of wire.

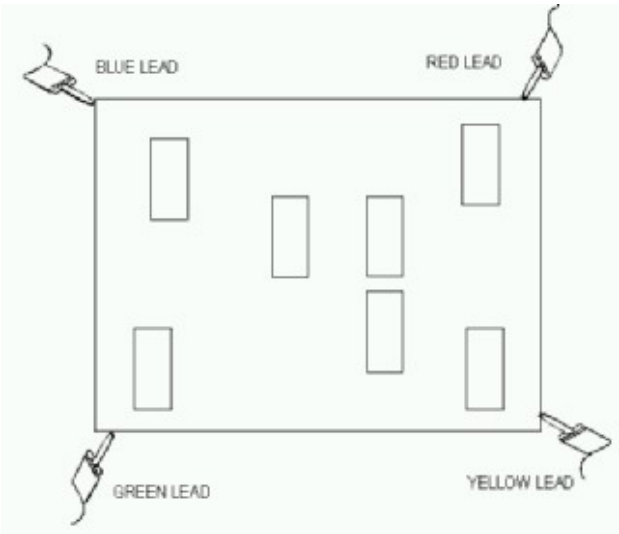
Now in phase 1 the VPS current flows from left to right along the wire.

Again imagine one point on the wire (the imaginary shrunken plane) where it is shorted to an adjacent plane.

Visualise connecting this point to the -Ve lead of a high impedance Voltmeter.

Connect the +Ve lead of your imaginary voltmeter to a range of points on the wire, Move left and the further you go the more positive the voltage reading. Move right and the more negative the reading (-Ve). Call this V1 and at the point where the leads are together you will see V1 = 0v. On a faulty board the 0v reading is on an equipotential line, the location of the short is at one point on this line.

So how do you find where the short is on the first equipotential line? Now think in 2 dimensions, and remember that the first current is injected from the top left of the plane to the bottom right. In phase 2 the current is injected at right angles (top right to bottom left) to form a second set of voltage readings, V2. At some point V2 = 0V. The short lies at the point where V1 = 0V = V2.



VPS connections to a plane

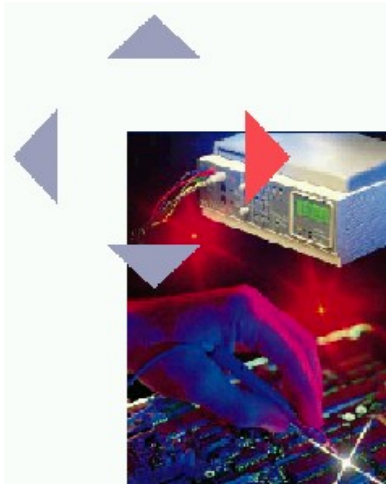
How can FTCam help?

Plane short location is quite simple on a board with a continuous plane on one layer. However if there are multiple planes, for example analog and digital ground planes on the same layer, you need to know the exact layout of the planes so you can connect the stimulus leads correctly.

By reading your cad data into FTCam you can display the copper areas of the ground planes. Treat each plane as if it is a separate PCB.

As described above, VPS drives current across the plane, and any breaks in the plane will result in either the direction arrows giving misleading information, or the plane stimulus not activating.

When you look at the data using FTCam you can clearly see the extents of the copper on inner layers. Use this graphical information to help you connect the Vector Plane Stimulus (VPS) leads correctly.



Toneohm short direction display

Pointing in the right direction

VPS not only looks at the magnitude of V1 and V2, it also monitors the polarity and uses this information to display a directional arrow on the front panel of the Toneohm 950 in conjunction with an audible tone that rises in frequency as you approach the short. The two enables you to localise the fault to a small area. On very dense boards or boards with BGA, you may find that it helps to X-ray in the locality identified by the 950.

You can find a more detailed graphical description of VPS in AP202 which is a PowerPoint presentation. AP202 gives step by step information on the operation and underlying technique of VPS **More information?**

Further information on PCB faultfinding please email: mail@polarinstruments.com
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