How to test bonds » Wire Pull » alignment

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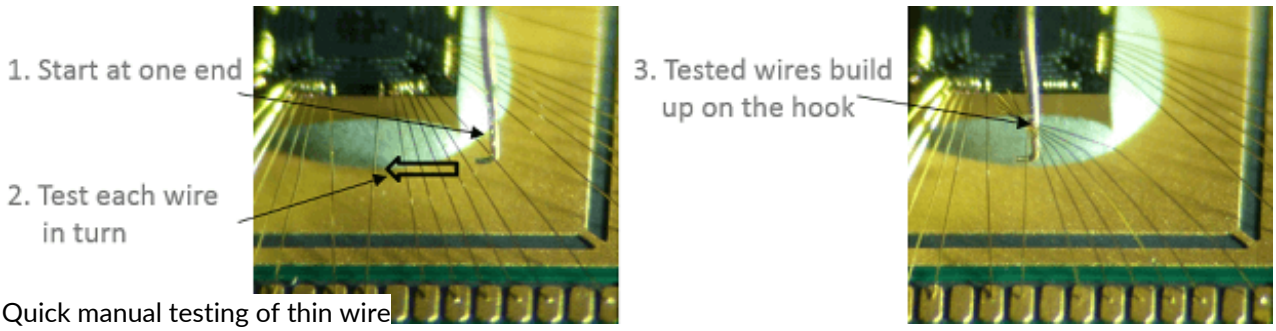
7. Alignment

i. Quick manual testing of thin wire

To test a wire the hook is ideally positioned underneath it without touching any other wire or part of the sample. This enables an accurate sensor null (force zeroing) before the measurement is taken. Manually aligning the hook into this position can be difficult and time consuming. If you want to test all the wires in a fan out it is simple to start at one end and let the tested wires build up on the hook as you proceed. For fine wires their build up on the hook has negligible effect on the test result. This is not true for heavy wires. You can start anywhere and test in any direction. It is a fast way to test both manually and automatically.



Quick manual testing of thin wire

ii. Auto hook

The next step up in terms of automation is using a functionality called auto hook. This makes it possible to rapidly test each wire without disturbing the wires next to it. It is very useful, one could say essential, for non-destruct testing. Auto-hook is one test done automatically. A tester with auto hook enabled does the following when the operator presses the test button:

- Move down between the wires
- Rotate the hook under the wire
- Optionally perform a 'hook shift' movement towards or away from the wire
- Perform the wire pull test
- Reverse these steps and go back to the start position safely

Auto hook can be started from a position where the hook is oriented along the wire, or across the wire. In the case of the latter, extra rotations are performed before and after the test.

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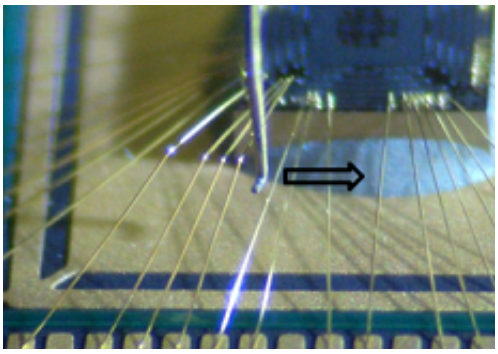
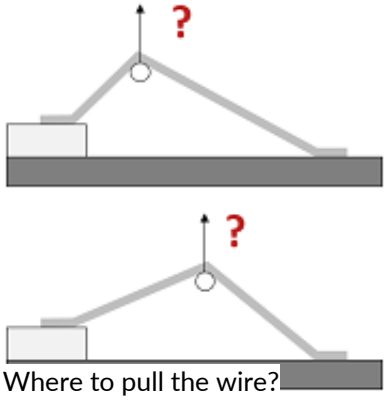


Test away from the previous tests. In this case from left to right.

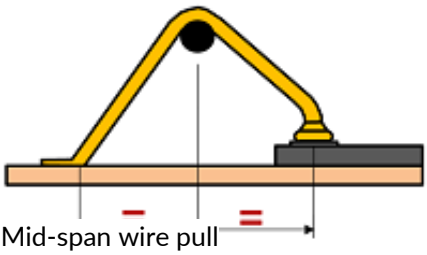
Auto hook along the wire is faster than across the wire because the hook rotates 2 times rather than 4 times. The advantage of starting across the wire is that you can see how the hook will engage with the wire when it will be below it. For both it is important to test away from the previous test so the hook can be aligned low and close to the wire to be tested for easy alignment and to minimize Z movements.

Especially when doing non-destructive wire pull, it is essential to avoid hitting wires other than the one being tested. Hook concentricity is a requirement for auto hook (see chapter 6ii).



Where to pull the wire?

iii. DVS 2811



Mid-span wire pull

We also have to align the hook along the length of the wire; where do we pull? Common practice is to pull at the center of the wire. The MIL standard 2011 specifies pulling between midspan and loop apex in order to avoid adverse wire deformation (previous versions of the same standard specified pulling mid span).

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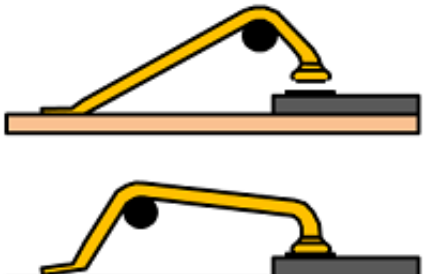
Alternatively if your interest is only in a particular one of the two bonds you can increase the load on it and increase its chance of a bond failure by testing close to it. If your failure mode of interest is the first bond, try aligning your wire hook close to the first bond.



Promote a certain failure mode by changing your alignment

It is important to pull in the same place. Not pulling in the same place will:

- Increase the test force distribution
- Affect the failure modes

Automation ensures tool alignment is always the same. Only highly advanced bond testers with sophisticated automation functionality can achieve the most reliable results to optimize your process.

The alignment along the wire and the wire length affect the angle of the wire pull. The angle in turn changes the load on the bonds. Standard DVS 2811 advises that the pull position should be such that the angle of the wire at the first and second bonds are equal. It then normalizes the results around a “standard” angle of 30° using a correction factor K. The load on the bonds is calculated as the measured pull force multiplied by K. Find K in the table below.

DVS 2811 enables the strenghts of different wire bonds with a variety of pull angles to be compared more meaningfully.

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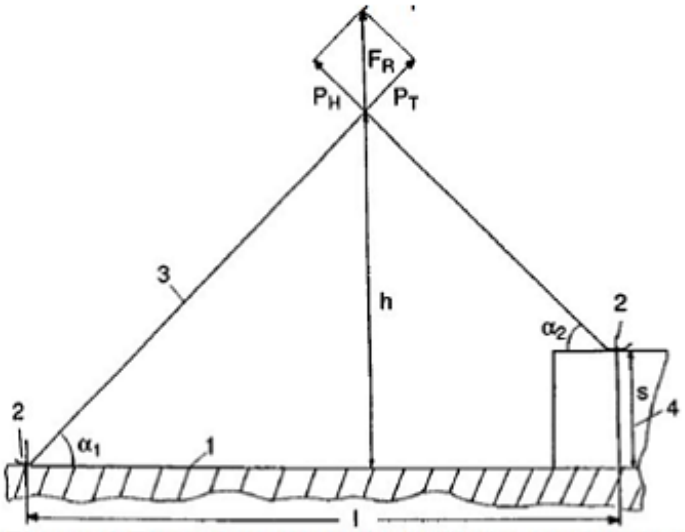
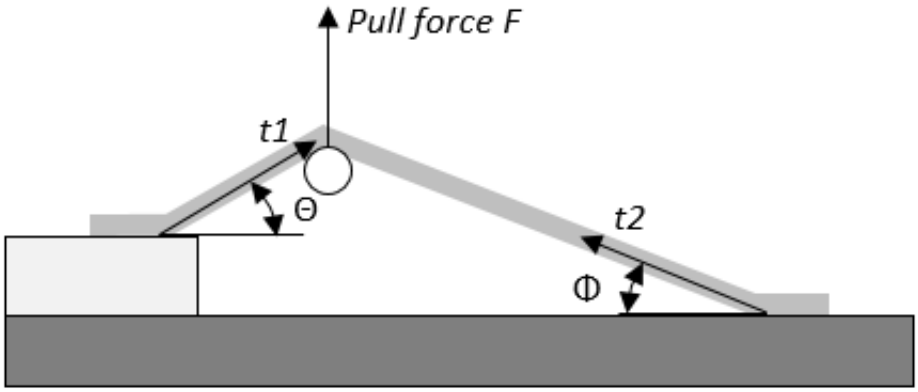


Table 1 Angle a as assigned to correction factor K

Angle a	Factor K
15°	1,9
30°	1,0
45°	0,7
60°	0,6
75°	0,5
90°	0,5

Figure 1: Example arrangement with the two bonds of each wire jumper at different heights (1 Substrate material; 2 Bonds; 3 Bonding wire; 4 Chip; F_R Pull-off force; P_H, P_T Forces in direction of

Extract from DVS 2811. We recommend the interested reader to read the complete standard. Click here to visit the site of DVS.



In DVS 2811 the pull alignment position is made so θ=Φ.

iv. Triangulation

While DVS 2811 sets the angles equal and therefore the forces too, it is possible to pull in many positions and creating different forces on the first and second bonds. This requires some fairly straightforwards mathematics.

In Appendix i of this how-to, the various formulas required to calculate the forces by triangulation are given. It is possible for an advanced bond tester to calculate all of these values for you.

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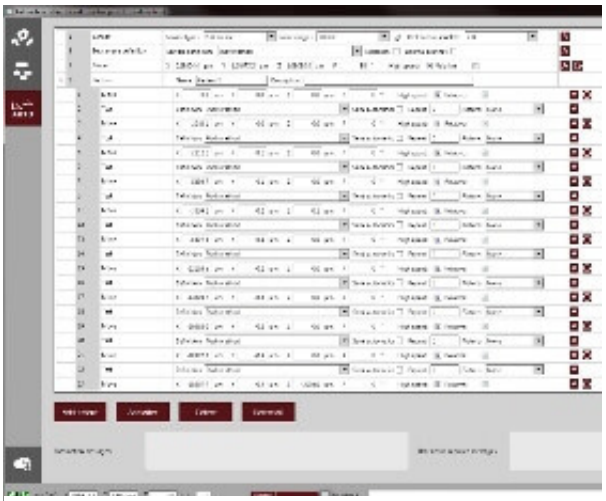

Screenshot of automation programming structure (click to zoom)

v. Automation and wire detect

So far this how-to has focused around manual wire pull testing, whether or not assisted by the auto hook functionality. Experience tells us that the influence of the operator on the measurement results is relatively high. This can be eliminated by automation.

A sufficiently advanced bond tester, like the Condor Sigma, can perform automatic tests by running automation programs that may include fiducial mark recognition. Using automation, all wires are pulled in a very consistent position, so the distribution of results goes down and the quality of measurement data goes up.

The next step up, and one in which the Condor Sigma is truly unique is when the bondtester optically detects the wire and corrects for "wire sweep" before going on to pull the wire automatically. This ensures more repeatable positioning even when the placement of wires is not consistent.

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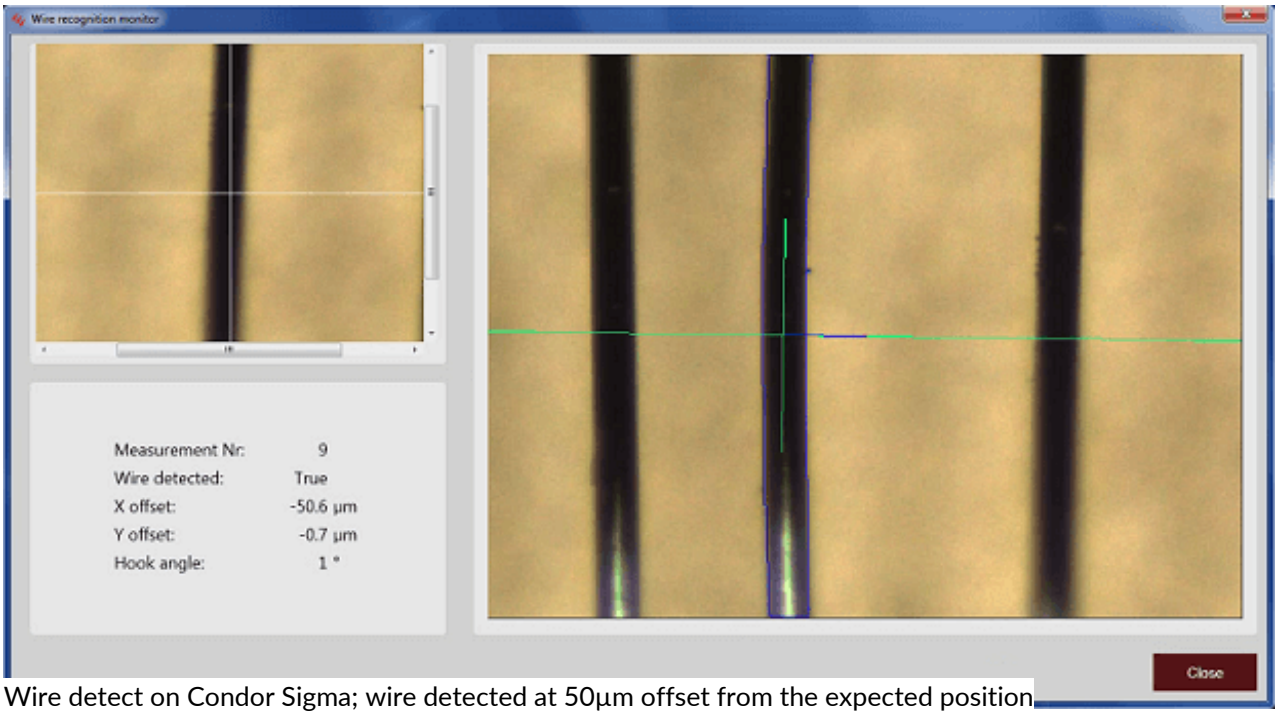
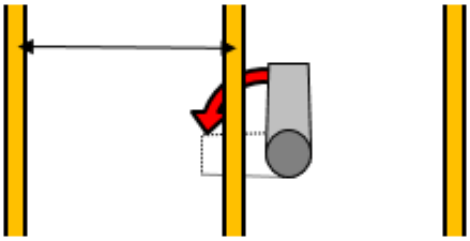
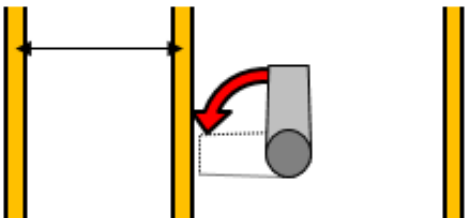


Wire detect on Condor Sigma; wire detected at 50µm offset from the expected position


Programmed pull point


Wire not at programmed position, so the hook misses it

The illustrations show how a traditional bond tester without wire recognition may miss the wire when executing a simple programming macro. Only by measuring changes in the wire position, the tester can correct the test position and ensure consistent results.

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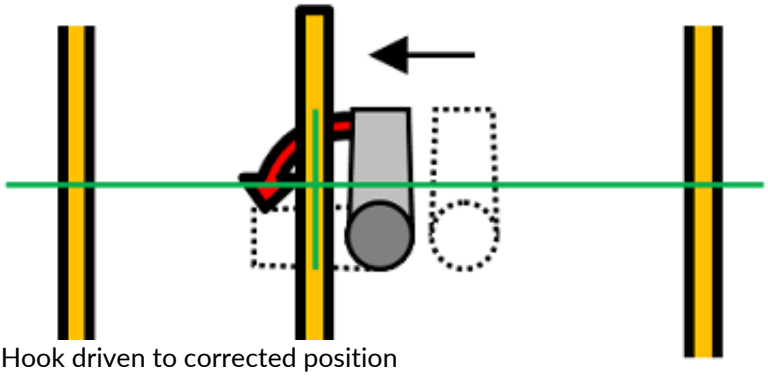
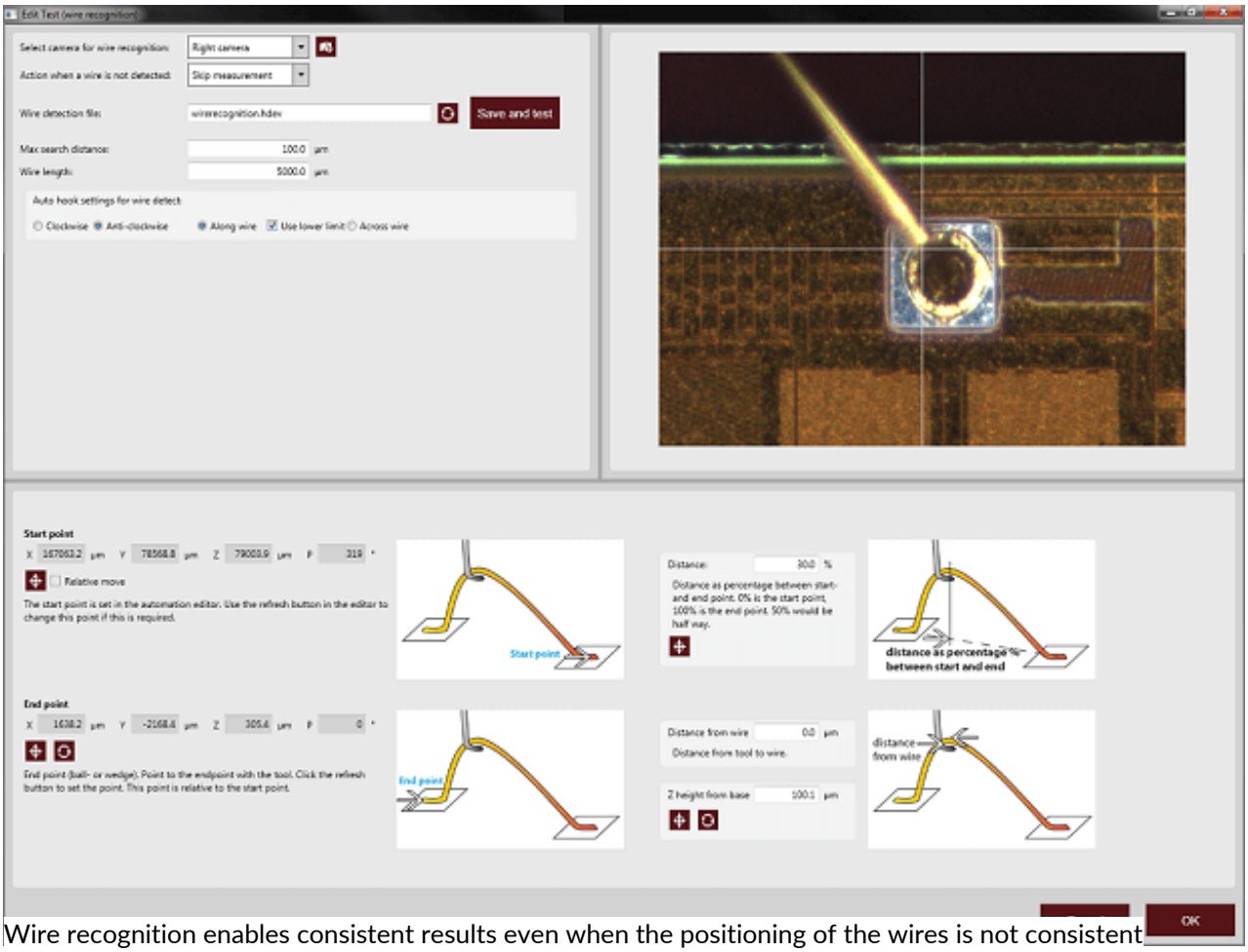


Hook driven to corrected position

The third illustration shows how the hook is driven to a corrected position, after the wire was detected at the position of the green crosshairs.

Now, when the bond tester performs the pull test, it does not miss the wire but pull it in exactly the same position as every other wire. This enables a higher degree of consistency than possible when doing manual tests.



Wire recognition enables consistent results even when the positioning of the wires is not consistent

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