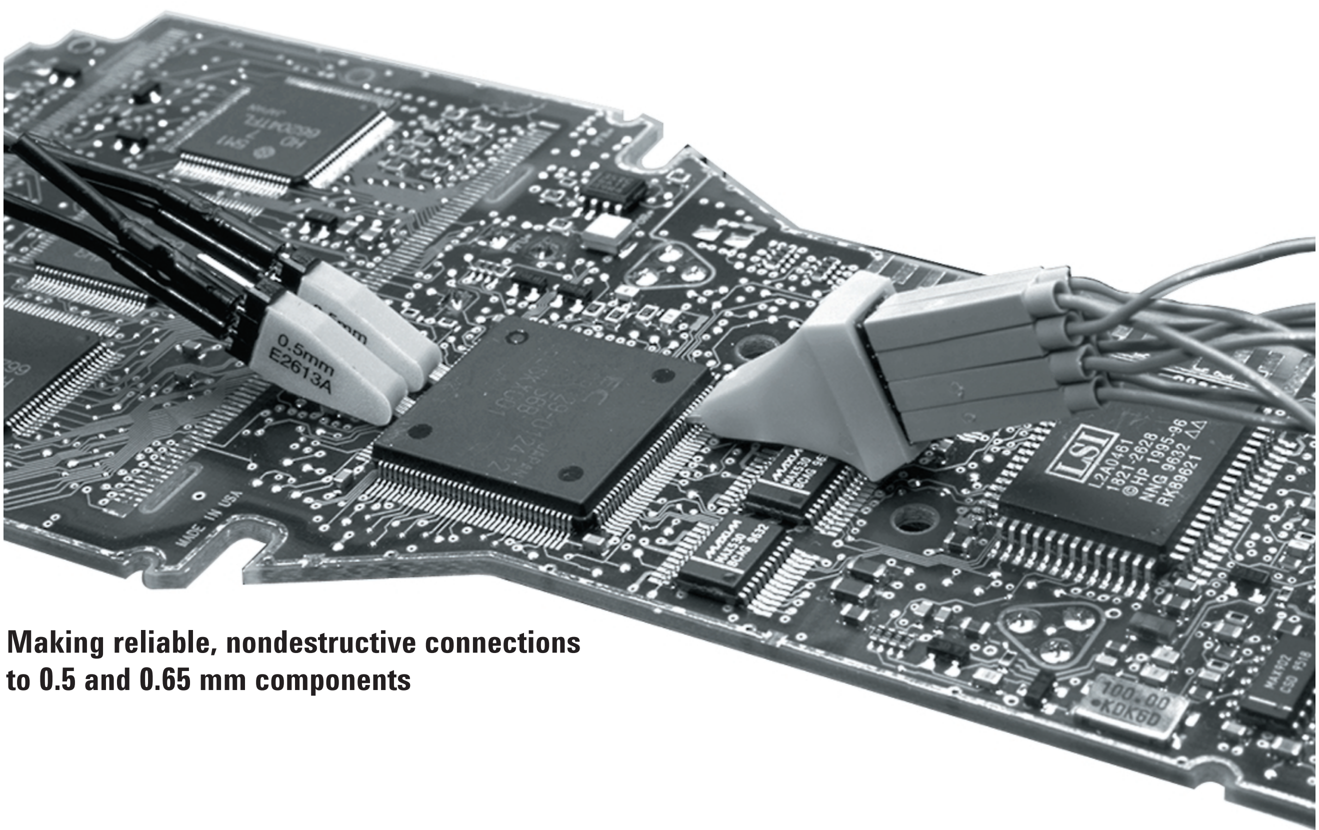
Agilent Wedge for Probing High-Pitch ICs

A Hands-Free Solution for Probing Fine-Pitch ICs

Application Note



Making reliable, nondestructive connections to 0.5 and 0.65 mm components

Agilent Technologies
Innovating the HP Way

Table of Contents

Introduction

As chip designers pack more functions into ICs, pin counts continue to grow and the space between pins keeps shrinking. Pin spacings of 0.5 mm and 0.65 mm are not at all uncommon. The power of these new ICs is wonderful, to be sure, but troubleshooting them can be a chore because connecting scopes and logic analyzers has become much more difficult and less dependable.

This application note explores the problems that arise and some of the usual options employed to probe fine-pitch thin quad flat pack (TQFP) and plastic quad flat pack (PQFP) surface-mount ICs. It then describes how you can use an innovative new solution we have developed—the Agilent Wedge probe adapter—to simplify the process of making reliable, nondestructive connections when probing 0.5 mm and 0.65 mm packages.

The Fine-Pitch Probing Challenge

The usual approaches to connecting to fine-pitch ICs often cause as many headaches as they try to eliminate:

IC clips. Normal clips don't fit fine-pitch IC pins, and special fine-pitch clips can be expensive and fragile. Clips can fall off, short against adjacent pins and degrade signal quality. Plus, you have to remove power to the system under test when you connect a clip, which can complicate matters when you're chasing intermittent glitches.

Scope probes. Instead of actually connecting to the device, an alternative is to poke around with a probe, bouncing from pin to pin, an activity that usually proves risky at best. Using a conventional probe to troubleshoot fine-pitch ICs without damaging the device requires the precision and dexterity of a neurosurgeon (see Figure 1). And if you need to ground the probe to the ground pin of the chip under test, you won't have any hands free to operate your scope or logic analyzer.

Probe support rigs. Another possibility is to build a probe support. However, finding a convenient place to mount the clamp can prove next to impossible. And any vibration between the device being investigated and the clamp could still jostle the probe and result in disaster.

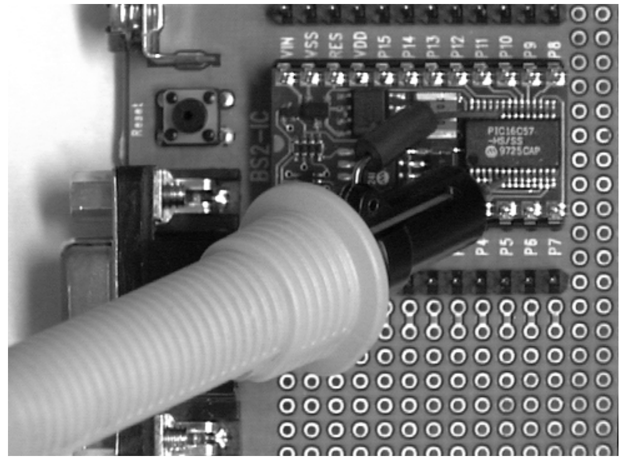


Figure 1. Using a conventional probe to investigate a fine-pitch IC board can create as many problems as it solves.

Soldered kludges. This approach can cause all kinds of problems, from heat damage to the IC to the chore of removing the kludge before you ship the finished product.

Clearly, fine-pitch ICs require a new approach.

Choosing the Correct Agilent Wedge

The Wedge comes in both 3-, 8- and 16-signal versions, as shown in Table 1.

Product	IC pin spacing	Number of signals	Number of Wedges included
E2613A	0.5 mm	3	1
E2613B	0.5 mm	3	2
E2614A	0.5 mm	8	1
E2615A	0.65 mm	3	1
E2615B	0.65 mm	3	2
E2616A	0.65 mm	8	1
E2643A	0.5 mm	16	1
E2644A	0.65 mm	16	1

Table 1. Configurations for the Wedge Probe Adapter. To simplify use and help avoid damage, Wedges are color coded: red for 0.5 mm chips and green for 0.65 mm chips.

How the Agilent Wedge Works

The Wedge provides accurate, mechanically noninvasive contact with the pins of the IC under test by inserting compressible dual conductors in the space between adjacent IC pins (Figure 2). These conductors are connected to pins on the opposite end of the adapter, where you then attach your scope or logic analyzer probes.

The design of the flexible conductors lets them conform to the size and shape of each pin to ensure tight contact. Each Wedge segment consists of two separate conductors separated by a center insulator, as shown in Figure 3. A shortened insulating adhesive between the center insulator and outer conductors creates an air gap at the tip of the Wedge. The air gap lets the conductors conform to the package as the Wedge is inserted between the IC package pins.

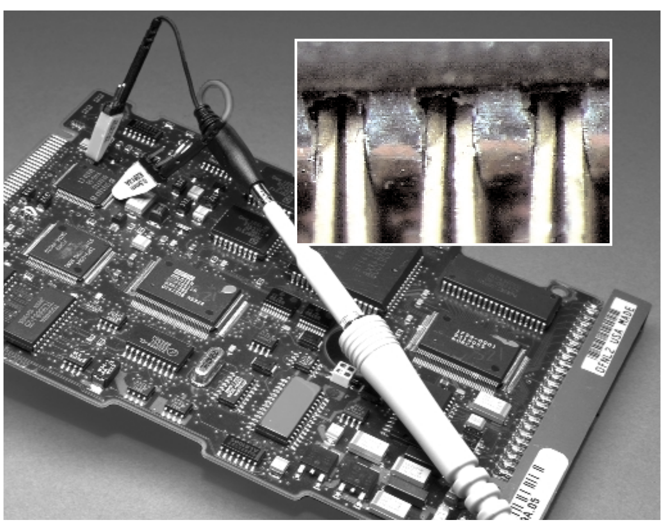


Figure 2. At one end, Wedge conductor segments are inserted into the space between IC pins; at the other end, they connect to scopes and logic analyzers.

The redundant physical connection created by two contact points on each pin of the IC under test (see Figure 4) dramatically increases the reliability of the electrical connection. And because the Wedge doesn’t latch directly onto IC pins and doesn't require expansion beforehand (as a clip does), it can be inserted while the board is active.

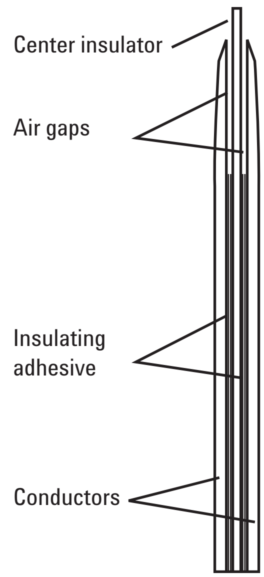


Figure 3. This illustration of the cross-section of a typical Wedge segment shows the flexible conductor design.

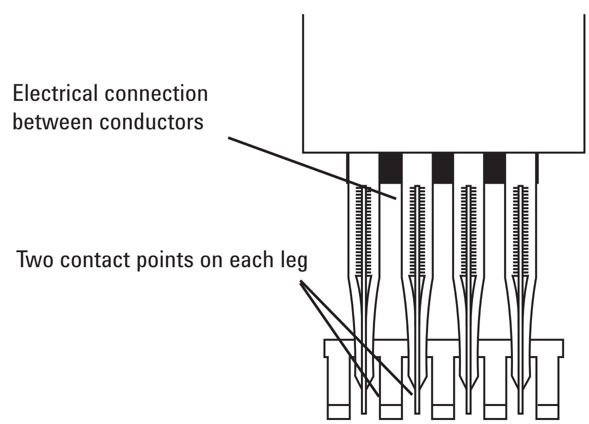


Figure 4. The redundant physical connection between the Wedge segment and IC package pins increases reliability of the electrical connection.

Installing and Connecting the Agilent Wedge

How you install the Wedge depends on the IC package you're investigating. For most PQFP packages, insert the Wedge at a 90 degree angle (perpendicular to the top of the device). For thinner packages, such as the TQFP, insert the Wedge at an angle less than 90 degrees. Once the Wedge is properly located between the IC pins, apply pressure until it is fully seated. To make sure you don't damage the Wedge while you're installing it, use the magnifying glass included for this purpose.

After the Wedge is inserted, you can easily complete the connection to your scope or logic analyzer with the appropriate accessories. Figure 5 shows a dual-lead adapter attached to an Agilent scope probe on one end, with the leads connected to the pins on the Wedge on the other end. Table 2 lists the dual-lead adapters to use with the most-popular Agilent probe families:

The 16 signal Wedge adapters will connect directly to Agilent logic analyzer probes. They also provide an easy method for making a ground connection on the IC for the best possible signal integrity.

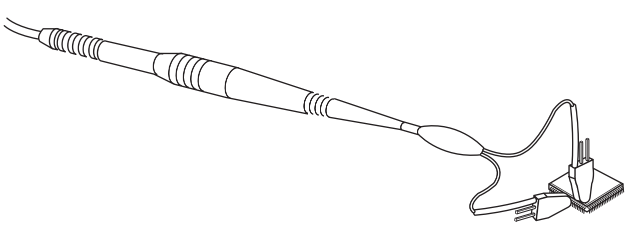


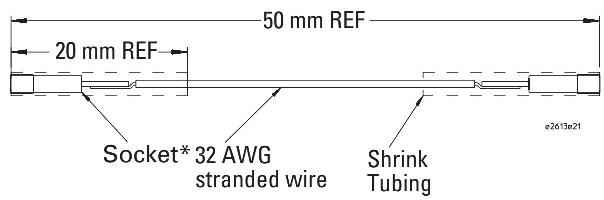
Figure 5. Dual-lead adapters allow easy connection of the oscilloscope probe and Wedge.

Probe Family	Dual-Lead Adapter Part Number
1007x	8710-2063
104xxA	5081-7742
116x/104xxB	5063-2147 (included with probe)

Table 2: Dual-lead adapters for popular Agilent probe families.

To maintain a solid connection to the Wedge, you'll need to use a flexible lead between the probe and the Wedge pins. Without the flexible lead, the weight of the probe on the Wedge will most likely disconnect it from the IC. Obviously, choosing a low-mass probe also makes sense.

If you're using a non-Agilent scope probe, the probe may still include flexible leads similar to the dual lead adapters shown above. Alternatively, one of the dual-lead adapters may fit your instrument's probe. You can also build your own flexible lead (Figure 6). Because the Wedge pins are 0.025 inches square, you'll need a socket designed to fit a 0.015- to 0.025-inch square pin* at the end of the wire that will be connected to the Wedge.



*Mill Max part number 1305-0-15-01-47-14-040 socket

Figure 6. Building your own flexible lead for attaching the Wedge.

The Agilent Wedge's Electrical Response

It's always important to understand the electrical effects of anything you put in the measurement chain between the device under test and the test instrument itself. Table 3 lists the Wedge vital electrical characteristics.

The short connection from the device under test to the Wedge terminals minimizes parasitic effects. Although the effects are not exactly zero, you can ignore them in most practical applications. Of greater concern is the connection from the Wedge to the probe that you connect to your scope or logic analyzer.

To illustrate this, we constructed a fixture, shown in figure 7, designed to optimize the connection between the Wedge and the source. Then we made three measurements on a pulse with a 1 ns rise-time to compare the response of a 10:1 passive probe with the response of the Wedge and passive probe and the response of the Wedge, passive probe and dual-lead adapter.

Operating voltage	<40 V (dc + peak ac)
Operating current	0.5 A maximum
Capacitance between contacts	2 pF (typical) (4.3 pf at 1 MHz E2643/44A)
Self-inductance	15 nH (typical) (37 nH at 1 MHz E2643A/44A)
Contact resistance	<0.1 Ohm

Table 3. Wedge Probe Adapter electrical characteristics

In figure 8, notice the response of the Wedge, then in figure 9, the response of the Wedge and dual lead adapter. When using the dual lead adapter the length of the connection between the probe tip and the Wedge causes significant overshoot. With rise-times approaching 1ns it is essential to keep the electrical path between the Wedge and the probe tip as short as possible.

We then made a real-world measurement using the Wedge and dual-lead adapter and compared it to the best possible probing situation — the probe tip directly on the same pin of the IC and a spring ground to the IC. The 20 MHz microcontroller delivered a pulse with a 10 ns rise time. As figure 10 shows, the response of the actual circuit using the Wedge and dual-lead adapter is nearly identical to that of the spring ground and probe tip on the same IC pin.

In reality, the Wedge is significantly shorter than the IC clips commonly available today. When used with the relatively short dual-lead adapter the combined length is not an issue for signals with 10 ns risetimes. With faster risetimes the length of the connection between the Wedge and the probe tip becomes far more critical as demonstrated in figure 9.

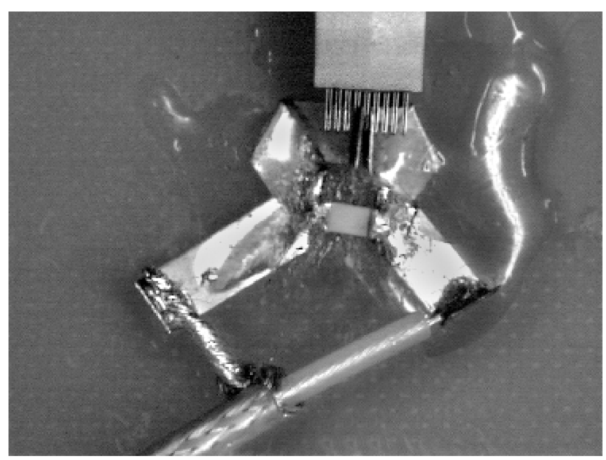


Figure 7. A fixture to measure the electrical response of the Wedge can be constructed from brass shim stock and PC board material.

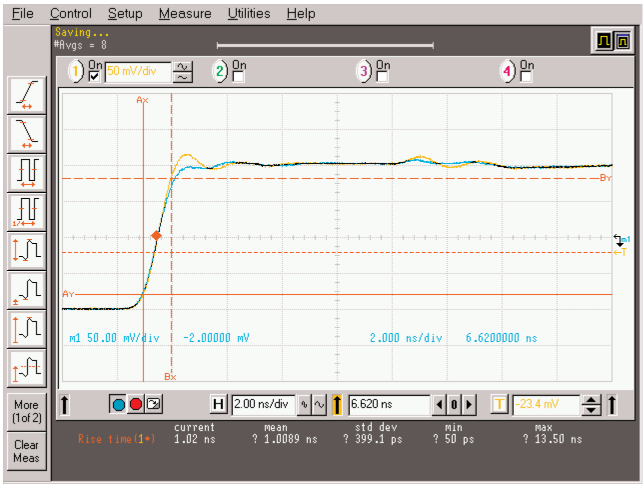


Figure 8. Electrical response of the Wedge. 1ns risetime.

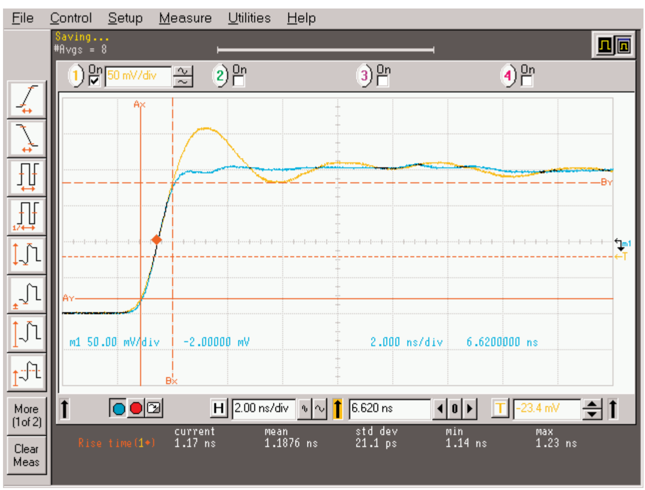


Figure 9. Electrical response when using the dual-lead adapter. 1ns risetime.

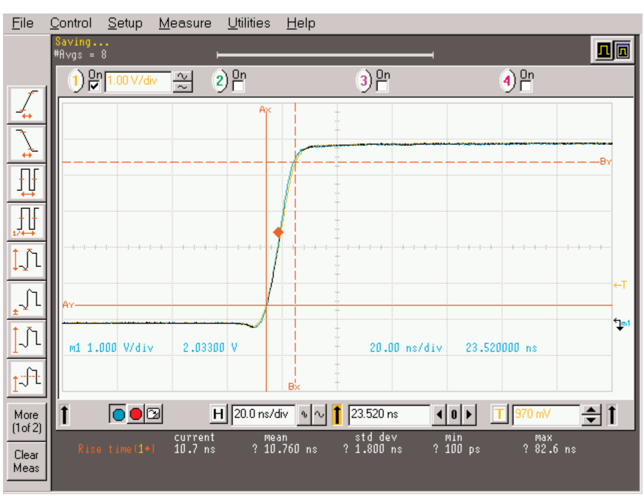


Figure 10. Response of an actual circuit shows that the Wedge trace is nearly identical to that using a spring ground and probe tip on the same active IC pin. 10ns risetime.

Durability and Maintenance

Although it is a precision instrument in itself, the Wedge is quite durable when used correctly. To test its durability, we programmed a robotic arm to repeatedly insert the Wedge into an IC board. After 30,000 insertions, the IC showed wear but the Wedge was still intact.

Correct insertion is important, though. Figure 11 shows a Wedge that was inserted into an IC with mismatched pin spacing.

However, the Wedge can survive the occasional slip-up, and it's rather easy to straighten following the instructions in the User's Guide. Figure 12 shows the Wedge from figure 11, after straightening.

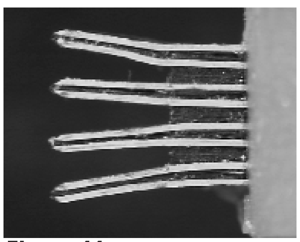


Figure 11.
A 0.5 mm Wedge conductor segment bent by insertion into a 0.65 mm-pitch IC.

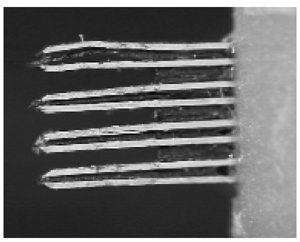


Figure 12.
Following the instructions in the User's Guide, it's usually a simple matter to straighten a bent Wedge.

Summary

The Agilent wedge probe adapter provides accurate, hands-free, mechanically noninvasive contact to fine-pitch IC package pins. Its unique design delivers secure, redundant contact on each pin, with little chance of shorting adjacent pins or damaging the device under test. It connects easily to most oscilloscope or logic analyzers with appropriate accessories. With so many other factors complicating your troubleshooting these days, it makes sense to employ the Wedge to minimize the headaches associated with IC probing while maximizing the quality of the resulting measurements.

By internet, phone, or fax, get assistance with all your test and measurement needs.

Online Assistance
www.agilent.com/find/assist

Phone or Fax
United States:
(tel) 1 800 452 4844

Canada:
(tel) 1 877 894 4414
(fax) (905) 206 4120

Europe:
(tel) (31 20) 547 2323
(fax) (31 20) 547 2390

Japan:
(tel) (81) 426 56 7832
(fax) (81) 426 56 7840

Latin America:
(tel) (305) 267 4245
(fax) (305) 267 4286

Australia:
(tel) 1 800 629 485
(fax) (61 3) 9272 0749

New Zealand:
(tel) 0 800 738 378
(fax) (64 4) 495 8950

Asia Pacific:
(tel) (852) 3197 7777
(fax) (852) 2506 9284

Product specifications and descriptions in this document subject to change without notice.

Printed in U.S.A. 5/00
5968-7142E

Agilent Technologies
Innovating the HP Way