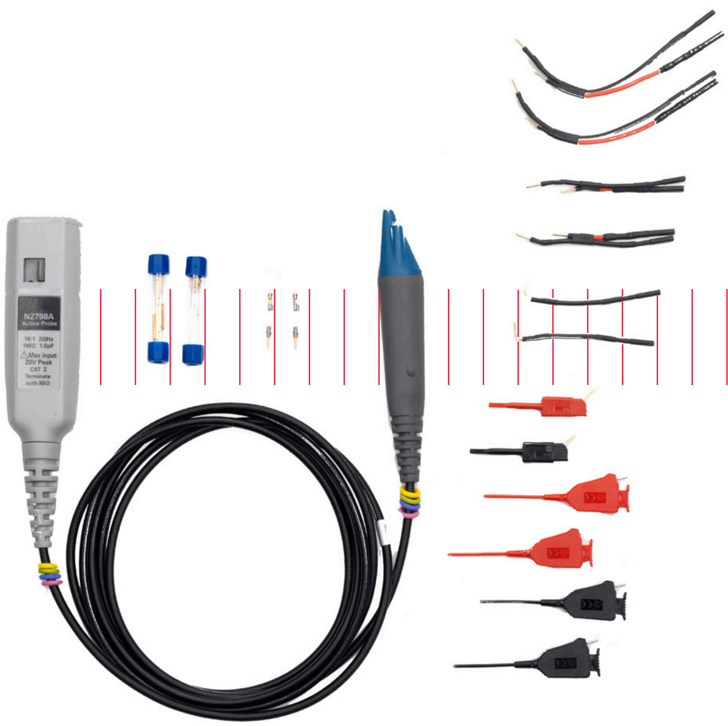
Keysight Technologies
Reliable Temperature Chamber Testing with N2797A Extreme Temperature Active Probe

Application Note



KEYSIGHT
TECHNOLOGIES

Many engineers today need to verify their products' performance over a wide range of operating temperatures. Until now, testing in extreme temperature ranges required engineers to use probes outside their specified operating temperatures, which can damage probes. Whether active or passive, most probes have a specified operating temperature range from 0 to 50 degrees Celsius. The new Keysight Technologies, Inc. N2797A extreme temperature active probe can operate over a much wider range, from -40 to 85 C. Engineers can operate the probe head and the supplied probing accessories inside a temperature chamber, with the probe pod and oscilloscope located outside the temperature chamber.

Reliability temperature testing is very important in the electronics design process. It helps to detect product failure in the early stages; figure out reasonable calibration/warranty time; and understand the product's long term performance under extreme temperature conditions. The electronics industry classifies temperatures into three general ranges. First is a so-called standard range or commercial grade, over which products are fully warranted and typically span from 0 °C to +40 °C. Next is a more severe range, which is typically used when abuse-testing consumer electronics, that covers –45 °C to +80 °C. Last is an extremely harsh range, typically used in the military, automotive and aerospace industries, which is –55 °C to +150 °C.

When conducting environmental tests on electronic products, test engineers often face a dilemma: The probing system has to be able to survive the same severe conditions as the product. For example, the temperature swings can be as wide as -55 °C to +150 °C in accelerated life aging test of an automotive device. Until now, testing in extreme temperature ranges required engineers to use probes outside their specified operating temperatures, which can damage probes. Whether active or passive, most probes have a specified operating temperature range from 0 to +50 °C. Those regular probes could be easily damaged by thermal expansion of the dielectric material in coaxial cables. Plastic housings start to deform above +60 °C. An active probe amplifier's frequency response starts to degrade as the temperature increases to the extreme ranges. Figure 1 shows an outer shield failure on a regular coaxial cable after a high temperature aging test.

Figure 2 shows an X-ray inspection of a probe head connector after multiple thermal cycles in an environmental chamber. The dielectric material in the coaxial cable shrunk backward and pulled the center pin out of the socket. The progressive degradation would eventually lead DC discontinuity.

Figure 1: Regular probe cable damaged after environmental test at 120 °C.

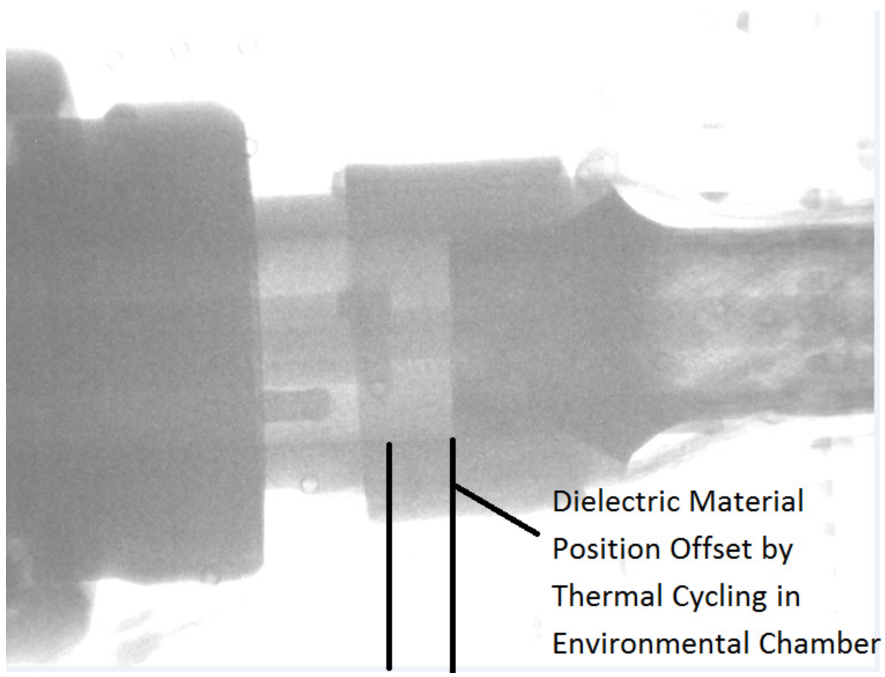


Figure 2: Probe connector failure caused by thermal cycling.

Instead of putting the fragile probe head into the chamber, test engineers often use long extension wires to connect the target to the oscilloscope. However, this method has several serious drawbacks. First, it greatly limits the bandwidth and causes non-flat frequency responses because of the added parasitic inductance and capacitance associated with the extended input leads. The inductance of a typical ground wire is 1nH/mm. A one-meter-long extension wire could introduce about 1uH of inductive impedance on the probing path, which greatly limits the measurable bandwidth down to only ~kHz range. The other issue is the increasing signal distortion from electromagnetic coupling. The longer the extension wires are used, the longer the coupling path will be. As the design complexity level increases, so does the electromagnetic noise source density. The extension wires work like a receiving antenna and could efficiently couple the noises into the measurement path. Finally, the extension wires also add extra loading on the circuit under test. Sometimes, it can be very excessive. For example, a typical FR4 50 Ω coaxial cable has 120pF/meter loading. For high impedance circuits, the heavy loading could heavily distort the signal so that functional failure may occur.

Engineers may choose to use a low-cost, high-impedance passive probe. The input impedance of those passive probes is usually about 10 MΩ with 10 to 15 pF of capacitive loading. It has less of a loading effect than a normal probe with an extension wire. However, the bandwidth is usually limited to 500 MHz when terminated into 1 MΩ input of an oscilloscope. A lot of applications in today's electronic designs require far more bandwidth than this. Also, the operating temperature range of a conventional passive probe is limited to 0 to +50 °C, which doesn't usually meet the measurement temperature requirement in accelerated aging tests.

To address these challenging measurement needs, a specialized active probe with accessories to meet the bandwidth and severe test conditions is required. To meet this need, Keysight offers the industry's first low-cost, high-impedance input active probe solution. The Keysight N2797A extreme temperature single-ended active probe allows the engineer to put the rugged probe head directly into the environmental chamber so that the signal path from the test point to the first amplifier is kept at a minimum. The parasitic inductance (typically less than several nH) and probe loading (typically less than 1pF) is minimized to enable the maximum probing bandwidth to 1.5 GHz. The probe is built with a special high-temperature coaxial cable, high temperature silicon rubber jacket, and a rugged probe amplifier so it can survive wide temperature ranges from -40 °C to +85 °C, which are often required by most commercial- and industrial-grade electronics environmental testing.

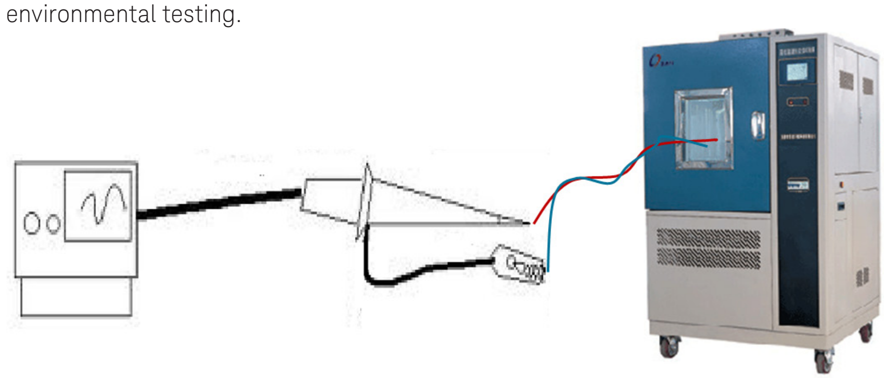


Figure 3: Using long extension wires could lead to severe measurement accuracy problems because the probe's input characteristics may be heavily changed with the extension wires.

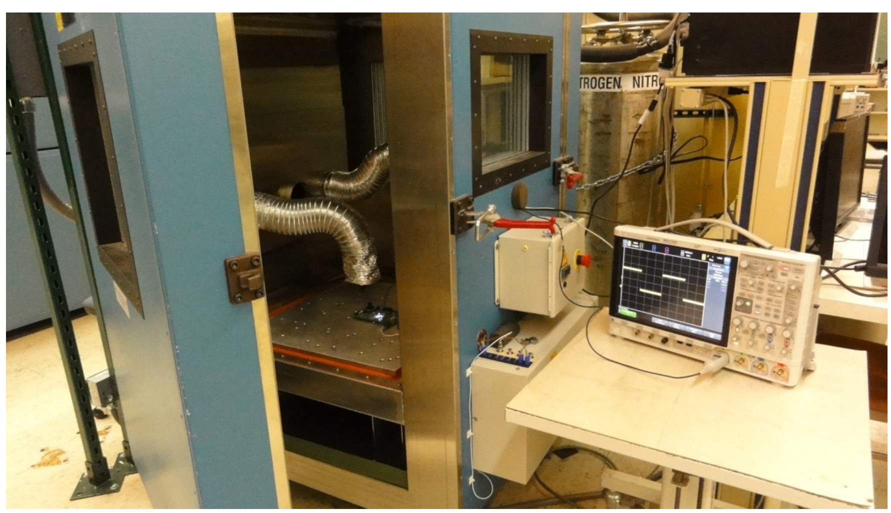


Figure 4: N2797A extreme temperature active probe can be used inside the chamber to make reliable measurements in extreme temperature conditions.

This probe has been proven to provide high temperature stability over long periods of time. Figure 5 shows the frequency response at different temperature ranges. Figure 6 shows the probe stability at +90 °C over a 6 month period.

The N2797A's other outstanding features include a 1 MΩ input impedance to minimize DC loading, 2 meter long cable to extend into chambers, and wide variety of ruggedized probe accessories to support various use models and Keysight's AutoProbe interface to simplify the operation. This type of probe can be very useful in any R&D or test lab where environmental testing is part of the design cycle, especially for engineers working in the semiconductor, computer, wireless, automotive and consumer electronics industries who need to validate and characterize their designs in extreme temperature ranges.

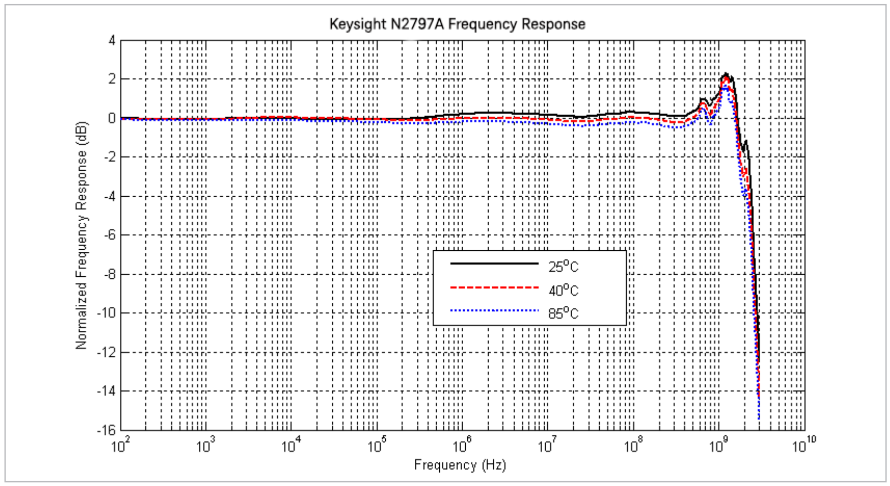


Figure 5: N2797A frequency response at different temperatures.

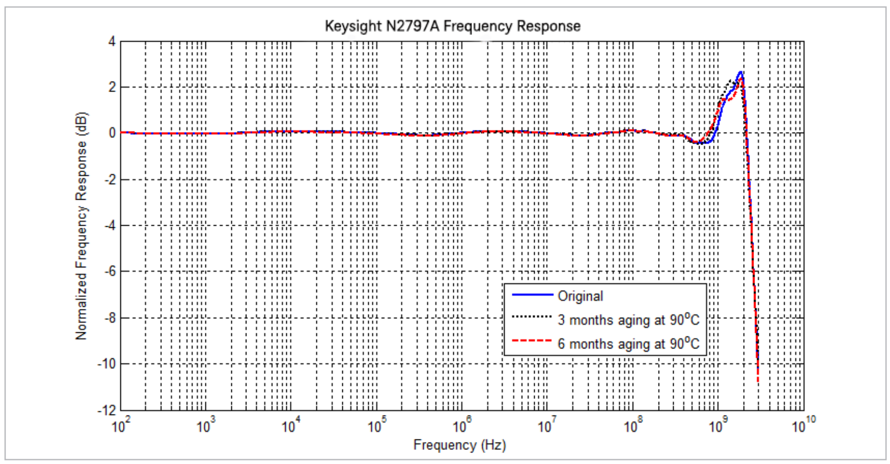


Figure 6: N2797A frequency response at +90 °C over 6 months.

myKeysight

myKeysight

www.keysight.com/find/mykeysight
A personalized view into the information most relevant to you.

DEKRA Certified ISO 9001:2008 Quality Management System

www.keysight.com/go/quality
Keysight Technologies, Inc.
DEKRA Certified ISO 9001:2008
Quality Management System

Keysight Channel Partners
www.keysight.com/find/channelpartners
Get the best of both worlds: Keysight's measurement expertise and product breadth, combined with channel partner convenience.

For more information on Keysight Technologies' products, applications or services, please contact your local Keysight office. The complete list is available at:
www.keysight.com/find/contactus

Americas

Canada	(877) 894 4414
Brazil	55 11 3351 7010
Mexico	001 800 254 2440
United States	(800) 829 4444

Asia Pacific

Australia	1 800 629 485
China	800 810 0189
Hong Kong	800 938 693
India	1 800 112 929
Japan	0120 (421) 345
Korea	080 769 0800
Malaysia	1 800 888 848
Singapore	1 800 375 8100
Taiwan	0800 047 866
Other AP Countries	(65) 6375 8100

Europe & Middle East

Austria	0800 001122
Belgium	0800 58580
Finland	0800 523252
France	0805 980333
Germany	0800 6270999
Ireland	1800 832700
Israel	1 809 343051
Italy	800 599100
Luxembourg	+32 800 58580
Netherlands	0800 0233200
Russia	8800 5009286
Spain	800 000154
Sweden	0200 882255
Switzerland	0800 805353
	Opt. 1 (DE)
	Opt. 2 (FR)
	Opt. 3 (IT)
United Kingdom	0800 0260637

For other unlisted countries:
www.keysight.com/find/contactus
(BP-09-23-14)

KEYSIGHT TECHNOLOGIES

Published in USA, August 3, 2014
5991-3193EN
www.keysight.com